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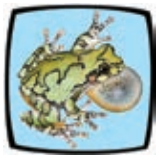
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A Summary and Discussion of Helminth Parasites Reported from Xantusiid Lizards with a New Nematode Record from *Lepidophyma smithii* (Squamata: Xantusiidae)

The xantusiid genus *Lepidophyma* is composed of 19 currently recognized species scattered from Nuevo León, Mexico south to Panama (Bezy and Camarillo 2002; Canseco-Márquez et al. 2008; García-Vázquez et al. 2010). Many of these are known from very few specimens and localities and their helminth parasites remain poorly known. Here we provide a summary of helminths reported from *Lepidophyma* and *Cricosaura* and discuss helminth parasitism in the Xantusiidae. We also report the results of a helminthological examination of Smith's Tropical Night Lizard, *Lepidophyma, smithii* Bocourt, 1876 (Fig. 1) from Chiapas, Mexico. This species is exceptional in the Xantusiidae in having a relatively broad ecological and latitudinal distribution, occurring in caves, rock crevices, and rotting logs along the Pacific versant from Guerrero, Mexico, south through Guatemala to El Salvador (Fig. 2) (Bezy and Camarillo 2002; Mendoza-Hernández and Santos-Barrera 2004). Previously, the only helminths known from *L. smithii* are two species of Nematoda, *Parapharyngodon guerreroensis* Bursey and Goldberg, 2015 and third stage larvae of *Physaloptera* sp. found in specimens from Guerrero and Oaxaca (Bursey and Goldberg 2015).

Methods

Nine *Lepidophyma smithii* (mean snout–vent length [SVL] = 72.7 mm ± 5.5 SD, range = 66–84 mm) from Chiapas, Mexico in the herpetology collection of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California were examined: LACM 100666–100668, 101263, from 48 km NW Huixtla (15.1333°N, 92.4667°W; WGS 84), 30 June 1968; LACM 136359–136361, 136362, 136364 from 8.2 km NE Escuintla (15.3333°N, 92.63333°W; WGS 84), 17 July 1984.

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The body cavity was opened and the esophagus, stomach, small intestine, and large intestine were slit using a razor blade, and the contents examined under a dissecting microscope. Only nematodes were found. Nematodes were assigned to genus based upon the keys of Anderson et al. (2009) and Gibbons (2010) and comparison with nematodes from the original descriptions (Bursey et al. 2006). Each nematode was cleared in a drop of lactophenol on a microscope slide, cover slipped, examined under a compound microscope and identified. Voucher nematodes were deposited in the Harold W. Manter Laboratory (HWML), University of Nebraska, Lincoln, USA as *Aplectana herediaensis* (HWML 92091). Parasite terminology is according to Bush et al. (1997).

Results

All nine *L. smithii* from Chiapas were found to be infected with the nematode *Aplectana herediaensis* (prevalence = number infected [9]/number examined [9] = 100%). A total of 577 nematodes was recovered, with a mean intensity of infection (mean number nematodes per infected host) = 65.2 ± 45.2 SD, range = 5–149. No other nematodes were seen.

Discussion

Summary of helminths known from Lepidophyma.—A total of 15 species of helminths (13 Nematoda, 1 Cestoda, 1 Digenea) are known from the seven species of *Lepidophyma* examined to date (Table 1). Summarized below are their hosts and geographic



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Fig. 1. *Lepidophyma smithii* (Smith's Tropical Night Lizard), LACM 135511, female, SVL 92 mm) from Chiapas, Mexico.

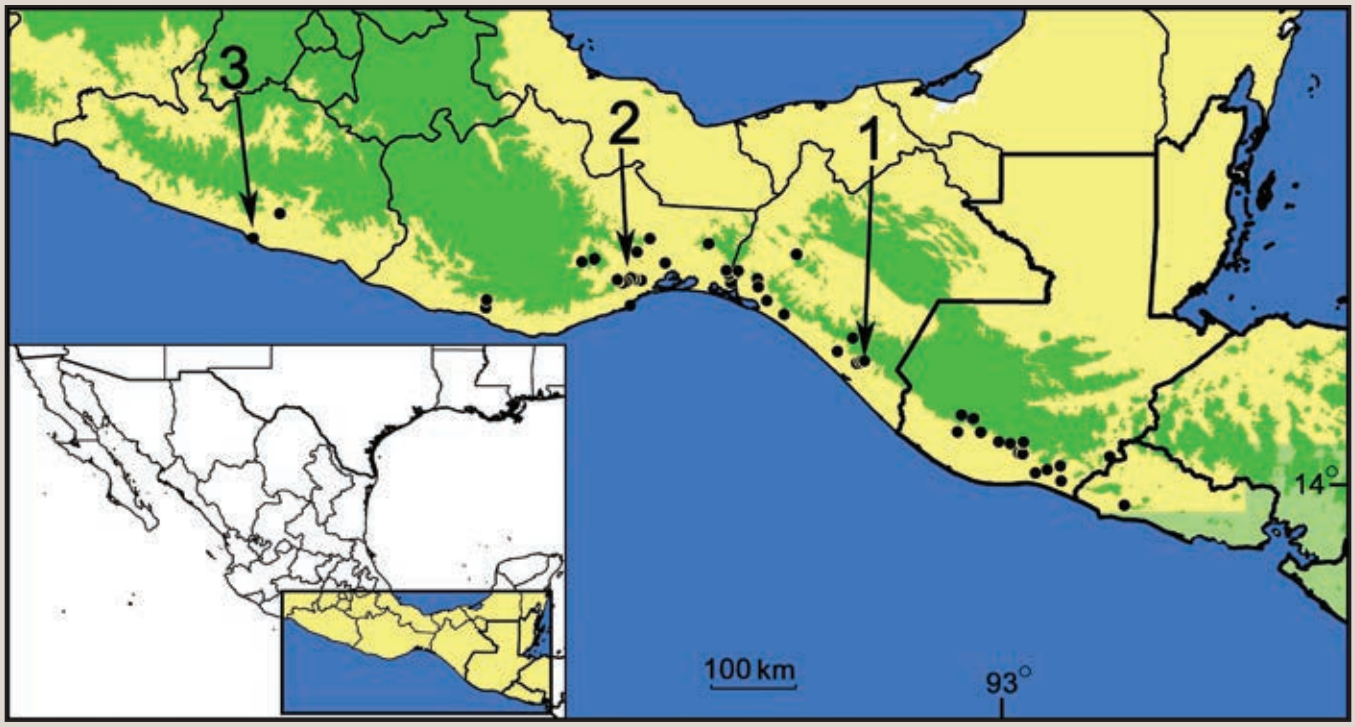


FIG. 2. Geographic distribution of *Lepdophyma smithii* based on museum specimens (listed by Bezy and Camarillo 2002; Mendoza-Hernández and Santos-Barrera 2004). Green indicates elevation greater than 500 m. Arrows indicate areas in Mexico from which helminths have been recovered: 1) NW of Escuintla, Chiapas; 2) W of Tehuantepec, Oaxaca; 3) vicinity of Puerto Marqués, Guerrero.

distributions, life histories, modes of transmission, and known host occurrences in amphibians and reptiles.

The nematode *Aplectana herediaensis* was described from *L. flavimaculatum* from Costa Rica by Bursey et al. (2006). *Aplectana* is a taxon of the Cosmocercidae, which infect directly (monoxenous), either by ingestion or skin penetration (Anderson 2000). It has been reported only from *Lepidophyma* and has been found in all species examined to date, except *L. gaigeae* (Table 1) for which 57 specimens from Hidalgo and Queretaro, Mexico were examined by Goldberg et al. (2002, 2014a). *Lepidophyma gaigeae* occupies a habitat that is unique in the genus, living in limestone crevices in pine-oak woodland of the Sierra Madre Oriental (Bezy and Camarillo 2002; Leavitt and Hibbitts 2012). Infection by *A. herediaensis* was found at high prevalence (9/9) and mean intensity (65.2) in *L. smithii* from Chiapas, where the lizards live in wet decaying logs. That *A. herediaensis* was not recovered from specimens of *L. smithii* from Guerrero (N = 4) and Oaxaca (N = 2) may be an artifact of small number of lizards examined (Bursey and Goldberg 2015) or may reflect habitat in the region (caves, rock-crevices, and road culverts) (Bezy and Camarillo 2002).

The nematode *Africana telfordi* was described from the hoplocercid lizard, *Enyalioides heterolepis* from Panama by Bursey and Goldberg (2002). It also occurs in *Basiliscus plumifrons* (Goldberg and Bursey 2009a) and *L. flavimaculatum* and *L. reticulatum* from Costa Rica (Table 1) (Goldberg and Bursey 2011). *Africana* is a taxon of Heterakidae; infection is direct and occurs when the host ingests an egg (Anderson 2000).

In the genus *Parapharyngodon, P. alvarengai* was reported in *L. sylvaticum* from Hidalgo and Nuevo Leon, Mexico (Goldberg et al. 2014b). It is a generalist nematode occurring in lizards of diverse families Dactyloidae, Gekkonidae, Phrynosomatidae, Scincidae, Teiidae as well as the toad *Rhinella icterica* (Goldberg et al. 2014b). *Parapharyngodon colonensis* was described from *L. flavimaculatum* from Colon Province, Panama by Bursey et al. (2007), which is the only host known for this nematode. *Parapharyngodon guerreroensis* was described from *L. smithii* from Guerrero and Oaxaca, Mexico by Bursey and Goldberg (2015). It is the only host known for this nematode. Life cycles of members of the genus *Parapharyngodon* remain poorly known. *Parapharyngodon* is a taxon of the Pharyngodonidae and members of this order are strictly monoxenous (Anderson 2000).

Raillietnema brachyspiculatum was described from *L. tuxtlae* from Veracruz, Mexico by Bursey et al. (1998) and was also reported from *L. flavimaculatum* from Costa Rica (Goldberg and Bursey 2011). It is a member of the Cosmocercidae; infection is direct and occurs by egg ingestion or skin penetration (Anderson 2000).

Both *Spauligodon giganticus* and *S. oxkutzcabiensis* were found in *L. gaigeae* from Mexico (Goldberg et al. 2002; 2014a). *Spauligodon giganticus* is widely distributed in North America; a host list was provided by Bursey and Goldberg (1992). Additional hosts are in Goldberg et al. (2003). *Spauligodon oxkutzcabiensis* is known from lizards of the families Gekkonidae, Phrynosomatidae and Tropiduridae from Mexico, Costa Rica, Panama and Peru (Goldberg et al. 2003; Bursey et al. 2007; Goldberg and Bursey, 2009b). *Spauligodon* is a taxon of the Pharyngodonidae and members of this family are strictly monoxenous (Anderson 2000).

Strongyluris panamaensis was found in *L. flavimaculatum* from Panama by Bursey et al. (2007) and was described from *Anolis biporcatus* (Dactyloidae) from Panama by Bursey et al. (2003). *Strongyluris* is a taxon of the Heterakidae and members of this family are monoxenous; eggs containing the infective stage are ingested by the host (Anderson 2000).

Three nematode species were found as larvae (Table 1). None of them complete development in lizards, which likely serve as transport (paratenic) hosts. Development to the adult

TABLE 1. Helminth species, localities, and sources reported for species of *Lepidophyma* and *Cricosaura*.

Helminth species	*Lepidophyma, Cricosaura* species	Locality	Source
Digenea			
Mesocoelium sp.	*L. flavimaculatum*	Costa Rica	Bursey et al. 2006; Goldberg and Bursey 2011
		Panama	Bursey et al. 2007
Cestoda			
Bitegmen gerrhonoti	*L. gaigeae*	Mexico: Hidalgo	Goldberg et al. 2002
Nematoda			
Africana telfordi	*L. flavimaculatum*	Costa Rica	Goldberg and Bursey 2011
	L. reticulatum	Costa Rica	Goldberg and Bursey 2011
Aplectana herediaensis	*L. flavimaculatum*	Costa Rica	Bursey et al. 2006
		Panama	Bursey et al. 2007
	L. micropholis	Mexico: San Luis Potosí	Goldberg and Bursey 2012
	L. reticulatum	Costa Rica	Goldberg and Bursey 2011
	L. smithii	Mexico: Chiapas	this paper
	L. sylvaticum	Mexico: Hidalgo, Nuevo León	Goldberg et al. 2014b
	L. tuxtlae	Mexico: Veracruz	Goldberg et al. 2014c
Parapharyngodon alvarengai	*L. sylvaticum*	Mexico: Hidalgo, Nuevo León	Goldberg et al. 2014b
P. colonensis	*L. flavimaculatum*	Panama	Bursey et al. 2007
P. guerreroensis	*L. smithii*	Mexico: Guerrero, Oaxaca	Bursey and Goldberg 2015
Raillietnema brachyspiculatum	*L. flavimaculatum*	Costa Rica	Goldberg and Bursey 2011
	L. tuxtlae	Mexico: Veracruz	Bursey et al. 1998
Spauligodon giganticus	*L. gaigeae*	Mexico: Hidalgo	Goldberg et al. 2002
S. oxkutzcabiensis	*L. gaigeae*	Mexico: Queretaro	Goldberg et al. 2014a
Strongyluris panamaensis	*L. flavimaculatum*	Panama	Bursey et al. 2007
Ascarididae gen. sp. (larvae)	*L. gaigeae*	Mexico: Hidalgo	Goldberg et al. 2002
	L. sylvaticum	Mexico: Hidalgo, Nuevo León	Goldberg et al. 2014b
Contracaecum sp. (larvae)	*L. flavimaculatum*	Costa Rica	Goldberg and Bursey 2011
Physaloptera sp. (3rd stage larvae)	*L. sylvaticum*	Mexico: Hidalgo, Nuevo León	Goldberg et al. 2014b
Skrjabinodon cricosaurae	*C. typica*	Cuba	Barus and Coy Otero 1974; Goldberg et al. 1998b

occurs when the lizard is eaten by a carnivore. Members of the Ascarididae use invertebrates for transmission of second-stage larvae and vertebrates for transmission of third-stage larvae (Anderson 2000). The definitive hosts of *Contracaecum* are piscivorous birds and mammals (Anderson 2000). *Physaloptera* is widespread in amphibians and reptiles (Goldberg et al. 1993b).

The digenean *Mesocoelium* sp. was reported from *L. flavimaculatum* from Costa Rica (Bursey et al. 2006; Goldberg and Bursey 2011) and Panama (Bursey et al. 2007). Formerly any specimens of *Mesocoelium* reported from amphibians or reptiles worldwide were referred to as *M. monas* (Dronen et al. 2012). Recently Calhoun and Dronen (2012) reevaluated specimens previously identified as *M. monas* and proposed keys to some 43 species. Terrestrial mollusks serve as intermediate hosts; however, cercariae emerging from snails encyst readily on any object they happen to settle on and such metacercariae from substrate have been used successfully in infestation experiments of agamid lizards (Thomas 1965).

The cestode *Bitegmen gerrhonoti* (Nematotaeniidae) was originally described as *Baerietta gerrhonoti* by Telford (1965) from the Southern Alligator Lizard, *Elgaria multicarinata* (as *Gerrhonotus multicarinatus*) from California. This cestode was reassigned to *Bitegmen* by Jones (1987). It is also known from the plethodontid salamander *Ensatina eschscholtzii* from southern California (Goldberg et al. 1998a). The life cycle of *B. gerrhonoti* is unknown, but Joyeux (1927) regards the life history of nematotaeniid cestodes to be direct; a new host becomes infected by digestion of eggs.

Overview of helminths in the Xantusiidae.—The helminths reported from *Xantusia* (summary in Goldberg et al. 2015), *Cricosaura* and *Lepidophyma* (Table 1) support that xantusiid lizards are parasitized mainly by nematodes with direct life cycles (monoxenous) (Anderson 2000). For *Lepidophyma* this includes: *Africana telfordi, Aplectana herediaensis, Parapharyngodon alvarengai, P. colonensis, P. guerreroensis, Raillietnema brachyspiculatum, Spauligodon giganticus, S. oxkutzcabiensis,* and *Strongyluris panamaensis* (Table 1). The nematode *Skrjabinodon cricosaurae,* the only parasite known from *Cricosaura typica* (Coy Otero and Barus 1979), and six of seven nematode species known from *Xantusia* (summary in Goldberg et

al. 2015): *Alaeuris clementensis, A. riversianae, Parapharyngodon bicaudatus, P. californiensis, P. pseudothaparius,* and *P. xantusi* have direct life cycles. Xantusiids may be active foragers (Cooper 2000) but the paucity of observations of the lizards active abroad suggests that foraging is primarily restricted to the confines of their microhabitats, which consist of logs, caves, rock-crevices, and rocks on soil (summary in Bezy 1989). It appears this reclusive life style and narrow foraging mode favors infection by Nematoda with direct life cycles in which infection likely occurs during feeding by ingestion of eggs in fecal contaminated soil. Goldberg and Bursey (1992) reported that 74% of *Sceloporus jarrovii* neonates between one day and two weeks of age were infected with eggs or larvae of the nematode *S. giganticus,* which has a direct life cycle.

Moreover, there is a tendency for species of the Xantusiidae to be parasitized by nematodes known only in members of this family: *A. herediaensis* (restricted to *Lepidophyma*), *S. cricosaurae* (restricted to *Cricosaura*), *Alaeuris clementensis, A. riversianae, Parapharyngodon bicaudatus, P. californiensis, P. pseudothaparius, P. xantusi* (restricted to *X. riversiana*). This contrasts with wide-ranging species of Dactyloidae, Phrynosomatidae, and Teiidae, which have greater opportunities for ingestion of insect intermediate hosts containing larvae of nematodes with indirect (heteroxenous) life cycles. They are consequently frequently parasitized by generalist nematodes that infect a variety of lizards (Baker 1987). In some cases the limited number of host species reported for the helminths infecting xantusiid lizards may reflect the small number of helminthological surveys conducted on xantusiids and other tropical lizards. However, in their survey of 1412 lizard specimens from Cuba representing 53 species, Coy Otero and Barus (1979) recovered *S. cricosaurae* only in *C. typica*. The presence of only one species of helminth in this Cuban endemic lizard may reflect its narrow foraging in tunnels under rocks (summary in Fernández de Acrila et al. 2012).

The occurrence of endemic nematodes found only in *X. riversiana* (four of five species) might reflect the geographic isolation of this species on the California Channel Islands (Goldberg et al. 1993a, 2015). The moist maritime climate, overlapping home ranges, and extremely dense populations of *X. riversiana* (Fellers and Drost 1991; Mautz 1993) might promote infection by monoxenous nematodes.

Again, it is conceivable that the sedentary life styles and small home ranges of xantusiids might limit their contact with the intermediate hosts needed to complete heteroxenous life cycles. Considering infections of xantusiids by heteroxenous parasites, *Oochoristica* cestodes have been reported (Goldberg et al. 2015). Conn (1985) reported that tenebrionid beetles served as intermediate hosts for the congener *Oochoristica anolis*. The life cycle of the heteroxenous nematode *Thubunaea iguanae,* found in *X. riversiana* (Goldberg et al. 1993a) and *X. wigginsi* (Goldberg et al. 2015) is unknown; however, Velikanov (1992) reported tenebrionid beetles served as intermediate hosts for the congener *T. baylisi*. Given the encystment on substrate of metacercariae of *Mesocoelium*, after release of cercariae by snails (Thomas 1965), infection may not require ingesting an intermediate host, thus for xantusiids infection by *Mesocoelium* may be more monoxenic-like.

None of the helminth species (monoxenous or heteroxenous) reported to date in xantusiids is shared among *Cricosaura, Lepidophyma*, or *Xantusia*. This is consistent with the ancient divergences (Noonan et al. 2013) and differences in geographic, vegetation, and climatic distributions of the genera, and with the microhabitat restrictions, small home ranges, and philopatry of the lizards (summary in Bezy 1989).

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Natural History Notes on a Northern Population of the Milksnake (*Lampropeltis triangulum*), with Evidence for Ontogenetic Shifts in Cover Use and Diet

Some widely distributed species are generally common throughout their geographic ranges and are consequently well studied (e.g., Common Gartersnake, *Thamnophis sirtalis*). Others are less abundant (or at least less conspicuous) and therefore, despite their wide range, are relatively understudied. One example of such a species is the Milksnake, *Lampropeltis triangulum*, which ranges from southern Canada into South America (Navarrete and Rodríguez-Acosta 2003). This species has been subdivided into numerous subspecies, reflecting the highly variable nature of its color and pattern (Navarrete and Rodríguez-Acosta 2003). In fact, *L. triangulum* is likely a non-monophyletic group of multiple species (Ruane et al. 2014), but I leave that issue aside here. In parts of their range, Milksnakes are especially well known as mimics of venomous coral snakes (Harper and Pfennig 2007). Habitat selection and thermoregulation of Milksnakes have been well studied in the northeastern part of their range (Row and Blouin-Demers 2006a,b), but studies of other aspects of their ecology have been limited (e.g., Fitch and Fleet 1970; Hamilton et al. 2012). The most detailed report of their general ecology is from a very long-term study from Kansas (Fitch 1999).

Species with wide ranges often exhibit significant local and broader-scale geographic variation in life-history traits (Gregory and Larsen 1993, 1996; Tuttle and Gregory 2012), food habits (Gregory and Nelson 1991; Gregory and Isaac 2004), and other aspects of their ecology (e.g., movements: Macartney et al. 1988; Lawson 1994), presumably reflecting phenotypic plasticity and/or adaptation to local conditions. Therefore, it is important to record the natural history of such species at diverse localities throughout their geographic range to facilitate eventual comparisons. Here, I document size distributions, sexual dimorphism, patterns of cover use, and feeding habits of Milksnakes based on a small sample from a population near the northern limit of the species' range in southern Ontario, Canada.

Materials and methods.—I collected data on Milksnakes from 1988–2008 during a long-term study of an assemblage of six species of snakes along Sixteen Mile Creek in Oakville, Ontario (53.3500°N, 112.9167°W). The study site consisted of an approximately 14.5-km stretch of creek valley. I searched for snakes mainly in the valley bottom, especially along the creek, where rocks used as cover by snakes are abundant (Gregory 2004a, 2009), but occasionally also on the valley sides and uplands. I searched during daylight hours, capturing snakes both in the open and under cover objects. I measured the snout–vent length (SVL) and mass of captured snakes, determined their sex, and gently forced snakes with food to regurgitate prey; when possible, I carefully returned prey to the snake before releasing the snake. I also individually marked each snake before release by clipping a unique combination of subcaudal scutes. I used SAS 9.3 to do statistical analyses with an α-level of 0.05.

Results.—I captured a total of 33 Milksnakes during the course of the study; none was ever recaptured. Thirteen of these snakes were male and 20 were female; I scored only one female (477 mm SVL) as possibly gravid, but could not ascertain her reproductive status definitively. Snakes ranged in SVL from 232–810 mm with no significant difference between the sexes (Fig. 1; Kruskal-Wallis test, $\chi^2 = 0.782$, $P = 0.38$). Excluding the possibly gravid female, I obtained measures of mass for 27 snakes, which ranged from 3–160 g. There was no significant difference in relative mass between the sexes (i.e., mass at a given SVL). I tested this by analysis of covariance of mass between the sexes with SVL as a covariate; both mass and SVL were log-transformed for this analysis. The interaction term was non-significant ($F_{1,23} = 2.16$, $P = 0.16$; Type III sum of squares). I therefore redid the analysis including only the main effects; that analysis showed that mass was positively related to SVL ($F_{1,24} = 1006.45$, $P < 0.0001$), but did

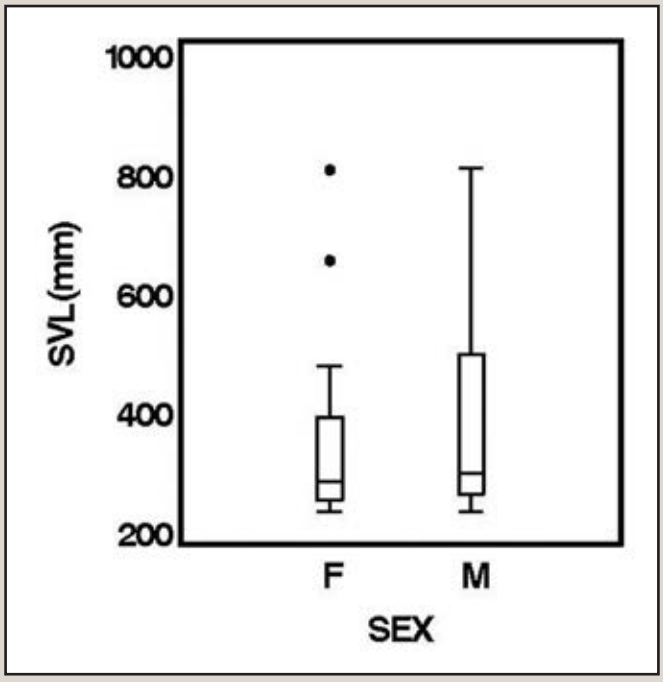


FIG. 1. Boxplots of distribution of snout–vent lengths (SVL) of female (N = 20) and male (N = 13) Milksnakes (*Lampropeltis triangulum*). Upper and lower boundaries of each box represent quartiles (i.e., 25th and 75th percentiles); horizontal line in box is median. Whiskers (vertical lines from box) extend to farthest value not exceeding 1.5 times the distance between the quartiles; more distant values are represented by dots.

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not differ between the sexes ($F_{1,24}$ = 0.83, P = 0.37). I then pooled the two sexes and calculated the slope of the Reduced Major Axis regression; I tested that slope against a null-hypothesis value of 3, representing isometry (Gregory 2004b), and found no significant difference (t_{25} = -1.63, P = 0.12).

The two largest snakes in the sample, one male (810 mm SVL) and the other female (807 mm SVL) were found under adjacent touching rocks. These two large snakes were the only ones showing any sign of injury; both were missing the tips of their tails.

The majority of snakes (29/33) were found under cover rather than in the open, but there was nevertheless a statistically significant trend for larger snakes to be found more often in the open. I determined this via a logistic regression of capture location (in open vs. under cover) against SVL, using the EXACT option for small samples, and found a significant relationship (Score = 5.87, P = 0.016; Fig. 2).

Only six snakes yielded prey, too small a sample for any formal analysis; one additional snake contained unidentified prey (a small lump that I could not coax the snake to regurgitate). Two larger snakes contained rodents (Fig. 3). One of these had three nestling pups in its gut (determined by palpation; only one removed) and the other had the posterior part of a small furred vole in its gut; both prey that I examined had been swallowed headfirst (assuming no change of orientation of the prey in the gut post-swallowing). Four snakes, ranging fairly widely in size (Fig. 3), had each eaten a single DeKay's Brownsnake (*Storeria dekayi*), all of which had been swallowed headfirst. One of the *Storeria* was almost the same length and mass as the Milksnake that ate it (Fig. 4). When first observed, that Milksnake had a misshapen body with numerous lumps where the *Storeria* was kinked inside its gut (see figure 1c in Jackson et al. 2004 for a similar example); the tail of the *Storeria* was folded in the Milksnake's throat. Almost immediately after I captured it, the snake began to regurgitate its prey. In addition to measuring the SVL and mass of this prey item (Fig. 4), I measured its tail length and also was able to measure tail lengths of two of the other *Storeria* that had been swallowed by Milksnakes. Although I could not account for possible sexual dimorphism of tail length of *Storeria*, these data suggest a positive correlation between size of Milksnake (SVL 251, 261, 477 mm) and size of snake prey (tail length 50, 68, 75 mm, respectively).

Discussion.—Despite small sample size, a number of conclusions can be reached and potential trends identified from the data presented here. First, Milksnakes at my study site reach similar maximum body sizes to those reached in Kansas (Fitch and Fleet 1970; Fitch 1999) and Illinois (Dyrkacz 1977), although the latter used total length rather than SVL. Milksnakes in Latin America reach somewhat greater maximum SVL (Rodríguez and Drummond 2000; Navarrete and Rodríguez-Acosta 2003). Row and Blouin-Demers (2006b) did not present SVLs of their radiotracked snakes in Ontario, but their minimum mass of 130 g corresponds to the largest snakes in my sample. The smallest snakes that I found were within the size range for hatchlings reported by Dyrkacz (1977) and Fitch (1999) and the possibly gravid female that I recorded was slightly smaller than the minimum size of gravid female (514 mm SVL) reported by Fitch (1999). Second, I found no evidence of sexual dimorphism in size or relative body mass nor of allometric growth with respect to mass. Other studies of Milksnakes have found that

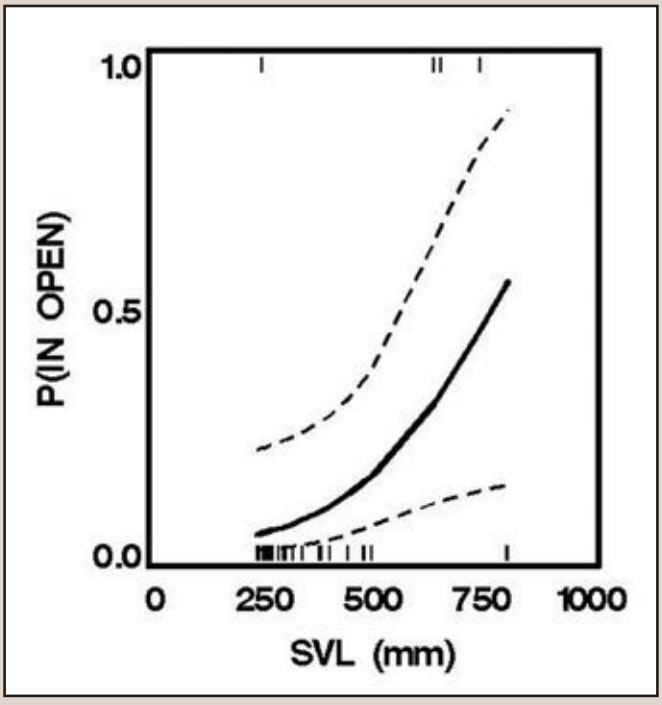


FIG. 2. Plot of logistic regression of probability of being in the open (vs. under cover), P(in open), against snout–vent length (SVL) for 33 Milksnakes (*Lampropeltis triangulum*). Short vertical lines at top and bottom are data (i.e., in open or under cover), solid line is predicted regression, and dashed lines are 95% confidence limits on predicted line.

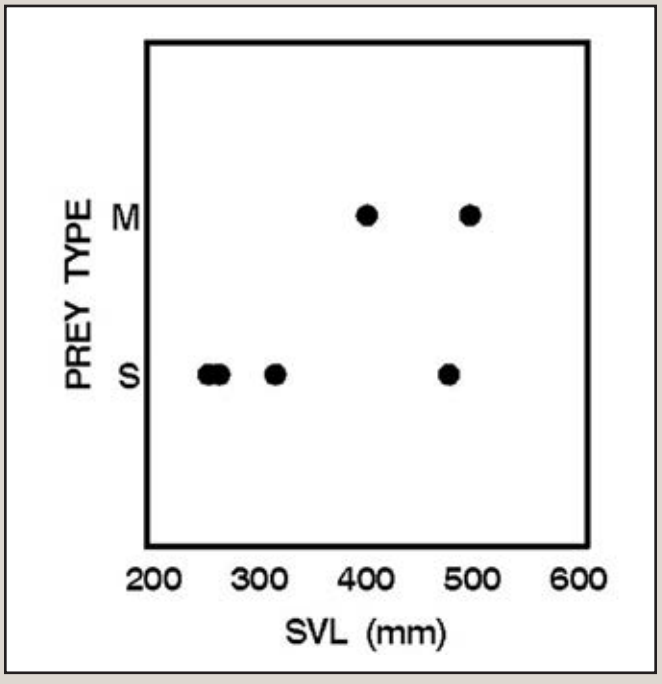


FIG. 3. Plot of prey type (S = snake; M = small mammal) against snout–vent length (SVL) for six Milksnakes (*Lampropeltis triangulum*). All snake prey were *Storeria dekayi* and all mammal prey were nestling or juvenile rodents. One Milksnake (400 mm SVL) shown on this plot had three nestling rodents in its gut, but all others had just one prey item; a seventh Milksnake (249 mm SVL), not shown in this plot, had an unidentified prey in its gut.



FIG. 4. Photograph of a Milksnake (*Lampropeltis triangulum*, bottom) alongside prey (DeKay's Brownsnake, *Storeria dekayi*, top) that it regurgitated upon capture. The Milksnake had a snout–vent length (SVL) of 261 mm and weighed 6 g; the Brownsnake measured approximately 200 mm SVL and weighed 4 g.

males reach slightly greater lengths than females (Fitch and Fleet 1970; Fitch 1999; Hamilton et al. 2012), although, where tested, this difference is statistically non-significant (Rodríguez and Drummond 2000). This pattern differs strongly from that seen in other snakes, in which sexual dimorphism in size and relative mass is strongly evident, and change in mass with respect to SVL is allometric (e.g., Gregory 2004b).

Dyrkacz (1977) noted that most of the Milksnakes that he collected in Illinois were found under cover. According to Fitch and Fleet (1970), Milksnakes do not usually bask in the open, but are thigmothermic, relying on the underside of sun-exposed cover objects, especially flat rocks, as a source of heat. Thus, the high rate of cover use by snakes at my study site is no surprise. Could such cryptic behavior explain why Milksnakes are relatively scarce and understudied? Perhaps, but the other species of snakes at my study site, including three very common ones, also are mostly found under rocks (Gregory 2004a; Gregory and Tuttle, *in press*). Milksnakes are nocturnal in parts of their range (Hamilton et al. 2012), which also would make them inconspicuous, but the extent of nocturnality in northern populations is unknown. Finally, weather also might influence diurnal cover use, but I did not record pertinent data to test this.

The tendency of larger Milksnakes to be in the open is in line with observations of several other species of snakes (Gregory 1984; Mertens 1995), including others at the same study site (Gregory and Tuttle, *in press*). Presumably, this reflects the lower risk of predation that large adults face in the open compared to small snakes. Benefits of being in the open include basking opportunities for thermoregulation (i.e., adults might be partly heliothermic and not just thigmothermic). Thermal quality is an important driver of micro- and macrohabitat selection in northern populations of *L. triangulum* (Row and Blouin-Demers 2006b).

Injuries were rare in my sample of Milksnakes, perhaps reflecting the overall high use of cover, but it is noteworthy that the two injured animals I found were the largest individuals. Larger (presumably older) snakes are more likely to have injuries for at least two reasons: a) small snakes that are attacked by a predator are more likely to be killed outright than to survive with an injury; and b) older snakes simply have had more time to acquire injuries (Gregory and Isaac 2005).

Milksnakes have been reported to eat a diversity of prey, but mainly small mammals (shrews and rodents), squamate reptiles (mainly lizards, but also snakes and their eggs), and nestling birds (Fitch and Fleet 1970; Dyrkacz 1977; Brown 1979; Fitch 1999; Navarrete and Rodríguez-Acosta 2003; Ellison and Ribic 2012; Hamilton et al. 2012). Mammals are generally more important prey than birds, but there are exceptions (Rodríguez and Drummond 2000). Thus, broadly speaking, the diet of Milksnakes at my study site appears to be typical of the species. My data are also consistent with published evidence for an ontogenetic shift in diet from ectotherms (squamates) in small Milksnakes to endotherms (mammals or birds) in larger snakes (Fitch and Fleet 1970; Fitch 1999; Rodríguez and Drummond 2000; Hamilton et al. 2012). Fitch (1999) found that only adult snakes ate mammals, whereas smaller Milksnakes ate only reptiles, suggesting an abrupt ontogenetic change in diet. However, other data suggest a more gradual transition, with mammal prey being added to a diet of squamates before becoming virtually the only prey of the largest snakes (Hamilton et al. 2012). My data, scant as they are, indicate a gradual shift in diet (Fig. 3). Hamilton et al. (2012) found a geographic trend in Milksnake diets, with a higher proportion of mammal prey at higher latitudes; a larger sample, especially of large snakes, would be needed to determine whether this is the case at my study site.

In captivity, hatchling Milksnakes readily eat small neonate mice (pers. obs.), but, given the high growth rate of nestling rodents, such young and small prey may be difficult to find in the wild; they also may be difficult for small snakes to consume if mammal nests are attended by deterrent mothers. Fitch and Fleet (1970) argued that Milksnakes, with their slender bodies and "small and delicate" head and jaws, are not adapted for eating bulky prey. Thus, prey with small cross-sections, such as small snakes, should be more likely to be within the gape limits of small Milksnakes and therefore more easily eaten. However, because they may be long, snakes can nonetheless be bulky prey and consuming them presents its own challenges (Jackson et al. 2004). My observation that the *Storeria* inside the Milksnake shown in Fig. 4 was folded along its vertebral axis is consistent with observations of how Common Kingsnakes (*Lampropeltis getula*) swallow large snake prey (Jackson et al. 2004).

Only one species of lizard occurs in southern Ontario and it is absent from my study area, so available squamate prey for Milksnakes is limited to snakes. *Storeria dekayi* is a commonly encountered species at my study site, is small even when adult, and is mainly found under rocks, so it may be easy and abundant prey for *Lampropeltis*. However, two other species of small snakes occur in much smaller numbers at the study site and both are known prey of Milksnakes: *Storeria occipitomacula* (Brown 1979) and *Diadophis punctatus* (Fitch and Fleet 1970; Fitch 1999). Furthermore, the young of two larger and abundant species, *Thamnophis sirtalis* and *Nerodia sipedon*, presumably would be available to Milksnakes. Thus, there are multiple snake species on which young *Lampropeltis* could feed. Whether my sample is biased because it is small or *Lampropeltis* actively selects *S. dekayi* remains to be determined. Gray (2014a, 2015) also recorded juvenile Milksnakes preying on Brownsnakes in Pennsylvania; he noted that Milksnakes at that site did not eat *T. sirtalis*, but provided no evidence (Gray 2015).

In a laboratory setting, neonate *Thamnophis elegans* avoid shelters bearing the odors of adult conspecifics, which are sometimes ophiophagous and even cannibalistic (Waye and Gregory 1993). Similarly, if small Milksnakes at my study site specialize on Brownsnakes, then we would expect the latter to avoid the former. This is supported by observations that Milksnakes are sometimes found under rocks with other

snake species (*Diadophis*, *Thamnophis*), but not Brownsnakes (Gregory 2004a). However, Gray (2014b) noted that Milksnakes in Pennsylvania are often found under cover with Brownsnakes. Again, my sample is small and this question would benefit from careful experimental work.

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The Identity of a Controversial Neotropical Turtle Hatchling (Reptilia: Testudines: Chelidae)

Due to lack of data and available specimens with confirmed genealogy, the identification of hatchling South American chelid turtles has been difficult and controversial through time. Neonates of few species are unmistakable, either by body profile (*Chelus fimbriata*, *Platemys platycephala*, *Hydromedusa* spp.) or by persistence through life of the ground color or pattern that adults exhibit (e.g., *Phrynops hilarii*). In many other species, however, the hatchlings show coloration and/or patterns that shift across ontogeny, e.g., *Mesoclemmys dahli* (Rueda-Almonacid et al. 2007), *M. gibba* (Métrailler 2001; Rueda-Almonacid et al. 2007; Vogt 2008), *M. tuberculata* (Santana et al. 2015), *M. zuliae* (Pritchard and Trebbau 1984; Rueda-Almonacid et al. 2007), *Phrynops geoffroanus* (Pritchard 1979; Pritchard and Trebbau 1984), and *Phrynops tuberosus* (Böhm 2008; Coelho et al. 2014). Identifying empty shells of juvenile turtles is even harder, due to the occurrence of a yellowish plastron with central expanded black area in several species, e.g., *Mesoclemmys gibba* (Métrailler 2001), *M. heliostemma* (Rueda-Almonacid et al. 2007), *M. nasuta* (Métrailler and Le Gratiet 1996), *M. raniceps* (Böhm 2009), *M. tuberculata* (Reis et al. 2014), and *M. vanderhaegei* (Marques et al. 2014).

The purpose of this paper is to set the identity of a hatchling chelid turtle, purportedly the southernmost record of *Mesoclemmys vanderhaegei* (Bour) (Iverson 1986, 1992), whose identification has been doubted repeatedly (Waller and Chebez 1987; Cabrera 1998; Vinke et al. 2013). This specimen is housed at the Zoologisches Museum Hamburg as ZMH R 1025 (Fig. 1A). Associated data to it are: "*Phrynops nasutus* aus Puerto Malabrigo, Paraná, Provinz Santa Fé, östlicher Rand des südlichen Chaco, Argentinien, von Dr. Med. Schreiber, 5.4.1930."

Puerto Malabrigo is a domestic harbor (not to be confused with the city of Malabrigo, located about 38 km to northwest of it) on the western bank of the Paraná River, at 29°2957S, 59°3701W. The locality is situated about 520 km from the nearest record of *Mesoclemmys vanderhaegei* (Arroyo Zaimán at Misiones Province; Cabrera 1998), assuming dispersal via the Paraná River, or about 380 km from the nearest northern record, if dispersal was via the Paraguay River (Laishí, Formosa Province; Cabrera 1998).

Upon close inspection of ZMH R 1025, we determine that the specimen is a hatchling of the Chaco Side-necked Turtle *Acanthochelys pallidipectoris* (Freiberg). This species has been cited from Santa Fe province (Fernández 1987; Buskirk 1988; Cabrera 1998; Piña and Larriera 2001; Vinke et al. 2011) but it is rarely encountered and vulnerable for being endemic to the Chaco ecoregion. Our determination of the true identity of this hatchling is supported by the following evidence.

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Morphology.— (a) Although considerably smaller than in adults, ZMH R 1025 (Fig. 1A) bears the femoral spurs that only *A. pallidipectoris* exhibits. (b) The noticeable narrowing at the sides of the carapace is due to the freshly-hatched condition of this individual.

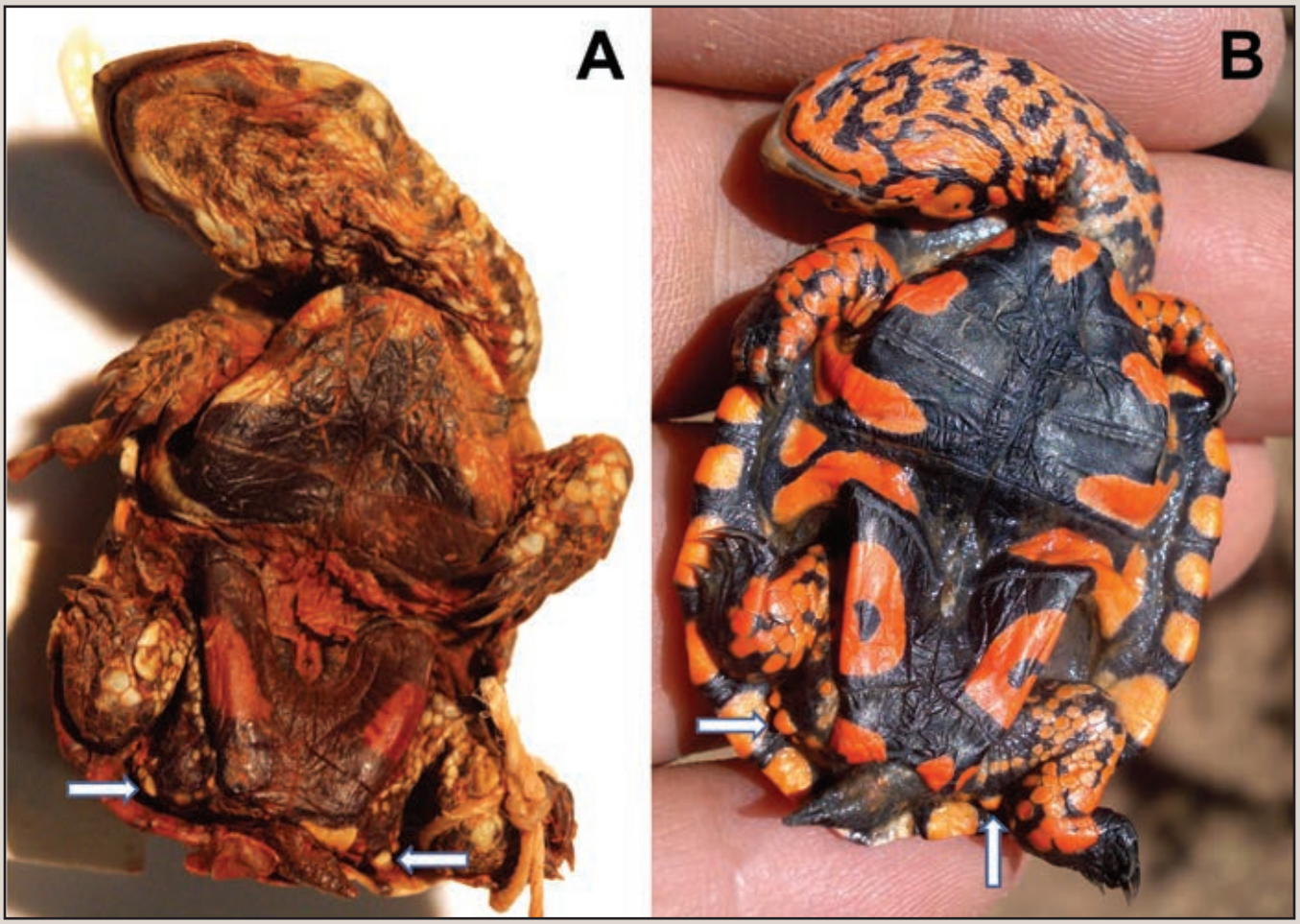
Size.—This specimen's straight-line carapace length (SCL) = 28.4 mm; in three specimens of *A. pallidipectoris* bred in captivity the shell of hatchlings had an average length of 31 mm (Vinke et al. 2011). On the contrary, *Mesoclemmys* hatchlings are at least 35 mm SCL when they hatch, according to our observations on captive-born *M. gibba* and *M. raniceps* (Böhm 2009, and unpublished data). Santana et al. (2015) reported a carapace length of 47.1 mm for *M. tuberculata* , and Souza et al. (2000), in the only published reference to hatchling size of *Mesoclemmys vanderhaegei*, reported SCLs of 39.2 mm and 41.9 mm for two wild-hatched neonates.

Pattern and color.—There is full concordance of the ZMH R 1025 hatchling with living *A. pallidipectoris* juveniles (Fig. 1B). For comparison with *M. vanderhaegei*, see figure 5 in Marques et al. (2014) that shows the largely black plastron and soft body parts of a live *M. vanderhaegei* hatchling.

From an ecological perspective, passive transport of a tiny *M. vanderhaegei* (or any other chelid hatchling) by drifting in a large river through hundreds of kilometers seems unlikely due to hazardous presence of abundant predatory fishes such as *Hoplias malabaricus*, *Salminus brasiliensis,* and others, as well as crocodilians (*Caiman latirostris*, *C. yacare*), in both the Paraná and Paraguay rivers (Vinke et al. 2013). All the species of the genus *Acanthochelys* (*A. macrocephala*, *A. pallidipectoris*, *A. radiolata*, and *A. spixii*) have small hatchlings with vivid red, orange, or yellow colors present on the marginal scutes, the plastron, and soft body parts (Cabrera 1998; Artner 2007; Mocelin et al. 2008; Vinke et al. 2011). Upon growing, these colors fade or disappear altogether, being replaced by brown or black. These bright colors might act as aposematic signals to discourage potential predators of these vulnerable animals in the early stages of their lives. For example, experiments by Britson (1998) and Britson and Gutzke (1993) showed that Largemouth Bass might associate the bright plastral colors and patterns of Red-eared Sliders (*Trachemys scripta*) with the defensive behavior of the turtle. However, in sediment-rich rivers with turbid water such as the Paraná, protection by color cannot act.

The clarification of the true identity of the ZMH R 1025 specimen allows better definition of the actual range of *M. vanderhaegei*, a species assessed as IUCN Data Deficient or Near Threatened (Marques et al. 2014). Except for reference to this hatchling, *Mesoclemmys vanderhaegei* never has been found farther south than 28ºS latitude. This chelid turtle is therefore limited to Brazil, Paraguay, and small portions of southeastern Bolivia and northeastern Argentina.

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PHOTOS BY STEPHAN BÖHM (LEFT) AND SOLEDAD PALOMAS (RIGHT)

FIG. 1. *Acanthochelys pallidipectoris*. (A) The hatchling ZMH R 1025 from Puerto Malabrigo, Santa Fe province, Argentina; (B) A live juvenile (SCL = 43 mm) from Chaco province, Argentina. Note the incipient femoral spurs typical of this species (arrows).

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A Synthesis of Direct Evidence of Predation on Amphibians in New Zealand, in the Context of Global Invasion Biology

There are currently almost as many threatened amphibian species as there are threatened mammalian and avian species combined (Bishop et al. 2012; IUCN 2014). Although the decline of amphibians has been of international concern for more than two decades, the direct causes of these declines are often difficult to identify, or they are difficult to disentangle as they may be acting synergistically (Alford and Richards 1999; Alford et al. 2001; Stuart et al. 2004). Introduced fauna are ranked as the third most important detrimental factor affecting amphibians after habitat modification and pollution (Chanson et al. 2008). Amphibians that have little or no evolutionary history with introduced fauna can exhibit naive responses that are not well suited for survival (Diamond and Case 1986; Gillespie 2001; Kats and Ferrer 2003) and the effect of introduced predators is predicted to be most acute in island ecosystems (Schoener and Spiller 1996; Courchamp et al. 2003; Ahola et al. 2006), particularly on insular endemic species (Diamond and Veitch 1981).

New Zealand's biota evolved in the absence of terrestrial mammals (apart from bats; see Clout and Saunders 1995). The Pacific Rat (*Rattus exulans*) and Polynesian Dog (*Canis familiaris*) arrived in association with the first human settlers in the thirteenth century AD (Anderson and Clark 2001; Wilmshurst and Higham 2004; Wilmshurst et al. 2008) and a range of mammalian species were later introduced by European settlers (from the eighteenth century AD onwards) with 31 introduced mammalian species now present in wild or feral populations (Parkes and Murphy 2003; King 2005).

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The native amphibian fauna of New Zealand consists of four extant endemic frog species: Archey's Frog (*Leiopelma archeyi*), Hochstetter's Frog (*Leiopelma hochstetteri*), Maud Island Frog (*Leiopelma pakeka*), and Hamilton's Frog (*Leiopelma hamiltoni*); as well as three species introduced from Australia: Brown Tree Frog (*Litoria ewingii*), Southern Bell Frog (*Litoria raniformis*), and Green and Golden Bell Frog (*Litoria aurea*) (Bell 1994; Newman 1996; Frost et al. 2006). All four native species are ranked within the top 60 most Evolutionarily Distinct and Globally Endangered amphibians in the world, with Archey's Frog topping that list (EDGE 2008). Additionally, the two introduced bell frog species are declining in their native ranges in Australia and are listed as "Endangered" and "Vulnerable" (IUCN 2014).

The current native frog recovery plan considers the primary threats to be predation by rats and other introduced mammals, habitat loss and modification, disease, toxins, herbicides, and climate change (Bishop et al. 2013). While all these threats undoubtedly had, and continue to have, a devastating impact on native frogs, the problem of introduced mammals appears to be one of the most clear cut to remedy, i.e., through the control of mammal populations. Mammal control demands a large amount of resources and is only a viable option if conservation targets, e.g., an increase in frog abundance, are likely to be met. The evidence to date of introduced fauna negatively impacting *Leiopelma*, although convincing, is largely circumstantial. Therefore, the main objective of our study was to re-examine

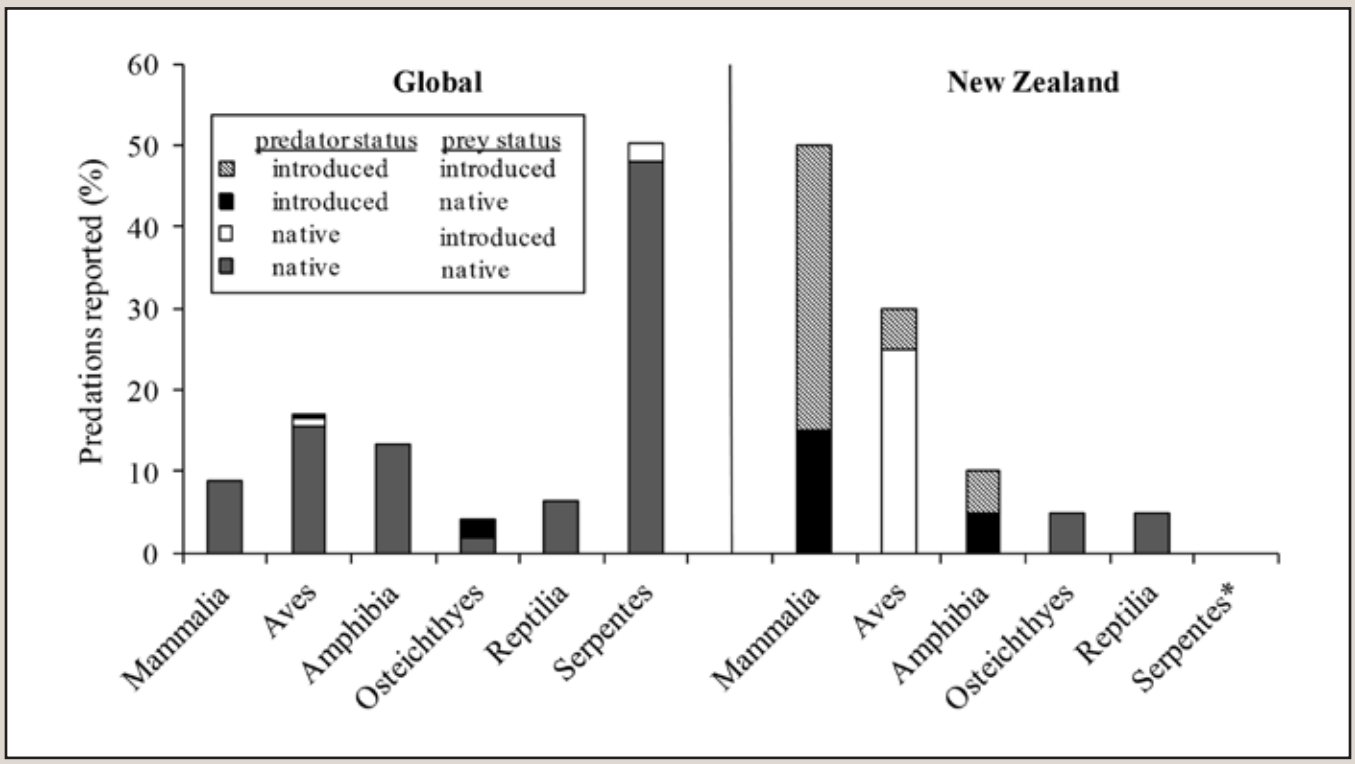


FIG. 1 Reported predator-prey interactions (%) for major vertebrate groups as predators of adult frogs, and their respective status as native or introduced. Global data (N = 217) is from Toledo et al. (2007), New Zealand data is from Table 1 (N = 20). *Note that the group Serpentes is not represented in New Zealand.

the potential for introduced mammals to act as agents of frog declines in New Zealand, using only direct evidence of predation.

The most notable circumstantial evidence for introduced fauna negatively impacting *Leiopelma* comes from the fact that the extinction of three *Leiopelma* species and the range contraction of the currently extant species occurred synchronously with the arrival of introduced mammals, e.g., the Pacific Rat (reviewed by Worthy 1987; Towns and Daugherty 1994). Furthermore, the only known naturally existing populations of the Maud Island Frog and Hamilton's Frog are restricted to mammal-free islands (Bishop et al. 2013).

Although predation by introduced fauna is often referred to in the scientific literature as playing a major role in the current decline of native New Zealand frogs (Worthy 1987; Bell 1994; Bell and Bell 1994; Daugherty et al. 1994; Towns and Daugherty 1994; Holyoake et al. 2001; Bell et al. 2004; Tocher and Pledger 2005; Baber et al. 2006; Haigh et al. 2007; Bell 2010; Bishop et al. 2013), there have so far only been sporadic reports of predation events and there are no published studies quantifying direct evidence of predation (e.g., confirmed predation events). Indirect predation studies have been carried out comparing frog abundance in areas where mammalian predators have been removed against those where no predator control was implemented, but the results to date have been varied.

In a study focused on Archey's Frogs, the Department of Conservation (DOC) ran a large-scale predator removal experiment (from 2005 to 2011). Four frog population monitoring grids were set up, two in an area poisoned for rodents and two in a non-treatment area (Pledger 2011). Over that period frog population sizes remained stable or increased on grids inside the treatment area and decreased in the non-treatment area (Pledger 2011). However, it is not clear whether the data from the relatively small grids (10 x 10 m) can be viewed as representative of the larger 600-ha area.

In a mammal controlled fenced sanctuary (Zealandia, Wellington, New Zealand), a small population of Maud Island Frogs (N = 58) were divided into two groups, with one group placed in a mouse (*Mus musculus*)-proof sub-enclosure and the second released in an area inhabited by mice (Lukis 2009). After one year, only one frog could be found outside the sub-enclosure, while 27 were recaptured inside the sub-enclosure (Lukis 2009). Since then, some more survivors and progeny have been found outside the sub-enclosure, but the population has struggled to survive (B. D. Bell, unpubl. data). However, other potential native avian predators (e.g., Little Spotted Kiwi *Apteryx owenii*, Morepork *Ninox novaeseelandiae*) are also present outside the sub-enclosure, so mice may not have been the only cause of this population struggle.

Nájera-Hillman et al. (2009c) found no difference in the relative abundance of Hochstetter's Frogs between areas that had no rodent control and those that had very low rodent numbers. Conversely, Mussett (2005) and Baber et al. (2008) found that Hochstetter's Frog abundance was far higher in mammal-controlled areas than in non-controlled areas. However, the results of Mussett (2005) were complicated by the fact that at some mammal control sites Ship Rat (*Rattus rattus*) abundance was similar to that of non-control sites. Also, among mammal control sites, the highest Ship Rat abundance coincided with the highest frog abundance (Mussett 2005). It should be noted that only Nájera-Hillman et al. (2009c) considered habitat characteristics in their comparisons, which are known to heavily influence Hochstetter's Frog abundance (Nájera-Hillman et al. 2009b; Nájera-Hillman et al. 2009c). Finally, Nájera-Hillman et al. (2009a) investigated the trophic position of Hochstetter's

TABLE 1. Collation of all reported predation events with frogs as prey in New Zealand. For species names, references, and further details see Appendix 1.

Prey species	Predator species	Predator class	No. of predation events reported
Leiopelma (native to New Zealand)			
Archey's Frog	Ship Rat	Mammalia	19
	Green and Golden Bell Frog	Amphibia	1
Hochstetter's Frog	Ship Rat	Mammalia	2
	Stoat	Mammalia	3
	Banded Kokopu	Osteichthyes	1
Hamilton's Frog	Tuatara	Reptilia	1
Hamilton's Frog or Maud Island Frog†	Laughing Owl, extinct§	Aves	8
Litoria (introduced to New Zealand)			
Green and Golden Bell Frog	Brown Kiwi	Aves	4
	Weka	Aves	4+
	Australasian Harrier	Aves	6+
	Feral Pig	Mammalia	1
Brown Tree Frog	Cat	Mammalia	5
	Ferret	Mammalia	1
	Southern Bell Frog	Amphibia	1+
Southern Bell Frog	European Hedgehog	Mammalia	11+
	Cat	Mammalia	2
Southern Bell Frog or Brown Tree Frog*	Cat	Mammalia	2
frog*	Ferret	Mammalia	35
	White-faced Heron	Aves	2+
	Little Owl	Aves	8
Southern Bell Frog or Green and Golden Bell Frog	Little Shag	Aves	2

† Not distinguished as separate species at the time of the study. * Not identified to species level. § Included here for the sake of completion, but not included in the data set discussed in the text or used to generate Fig. 1. + In cases where the exact number of predation events reported was unclear, only those that could be confirmed were used.

Frog using stable isotope analysis and concluded that Short-finned Eels (*Anguilla australis*) and Banded Kokopu (*Galaxias fasciatus*) might be more significant potential predators than Ship Rats. However, the results for the trophic position of Ship Rats in relation to frogs were inconclusive (Nájera-Hillman et al. 2009a).

Given these varied results, we aimed to clarify the potential for various predator groups to act as agents of frog declines in New Zealand. To do this, we collated all known reports of direct evidence of predation on frogs in New Zealand, providing conservationists with a comprehensive and up-to-date catalogue of known frog predators. We define "direct evidence" as either observations of predation events or prey remains of frogs found in predator stomach and fecal contents. Based on these data, we aimed to identify 1) predator groups that have most been reported as predators of frogs in New Zealand, and 2) predator groups for which predation data is scarce and require further research. Furthermore, we intended to compare the data with global trends, in terms of 1) the percentage of predator-prey interactions attributed to each major predator group, and 2) the percentage of predator-prey interactions attributed to introduced predator species.

We collated all known reports of predation events involving frogs as prey in New Zealand (Table 1; and see Appendix 1). In order to place the data in a global context, we compared it to a similar, but globally inclusive, review carried out by Toledo et al. (2007). Using the information (predator species, prey species, and cited reference) from Toledo et al. (2007), along with the known global distribution of the predator and prey in each case (IUCN 2014), we determined the proportion of reports involving introduced fauna.

It should be noted that we did not include the following predation events listed in Toledo et al. (2007): reports based on frogs being presented to potential predators during laboratory feeding trials (N = 18); reports where locations were not provided (N = 4); reports from New Zealand (N = 3); and reports that appeared to be erroneous (N = 1; the original reference [Caudell et al. 2000] reported a Cane Toad [*Rhinella marina*] consuming a Brown Tree Snake [*Boiga irregularis*], rather than vice versa). Data pertaining to predation events in New Zealand were obtained

using the following search terms in varying combinations: frog, diet, New Zealand, prey, predation, predator, stomach, faecal, contents, *Leiopelma*, and *Litoria*. Databases searched include Google Scholar, the New Zealand Department of Conservation (DOC) publications (http://www.doc.govt.nz/publications/), and the University of Otago library database collection (which includes BioOne, Web of Science Core Collection, Web of Science Zoological Record, Scopus, Science Direct, ProQuest Biological Science Collection and Index New Zealand). Furthermore, we contacted DOC to request any information not publicly accessible. Relevant citations within accessed material were also specifically searched for and included. In total, we collated data from at least 119 predation events in New Zealand, involving 17 predator species, at least 6 frog species and 21 predator-prey interactions (Table 1).

The major difference between predator-prey interactions involving frogs as prey in New Zealand, compared to the global reports reviewed by Toledo et al. (2007), is the proportion attributed to introduced fauna (65% for New Zealand, 2.8% for global data; Fig. 1). A much higher proportion of predator-prey interactions also involved introduced frogs as prey in New Zealand (70%) compared to the rest of the world (3.2%), but this might be expected as there are almost as many introduced frog species in this country as there are native. Given that Serpentes are not represented in New Zealand, the general trend appears to be partially similar to that for the rest of the world, with Aves being a highly reported predator group, followed by Amphibia, Osteichthyes, and Reptilia (Fig. 1). However, the proportion of predator-prey interactions attributed to mammals is far greater in New Zealand (50%) than for the rest of the world (8.8%; Fig. 1). Viewing the data for New Zealand in terms of predation events reported, rather than predator-prey interactions, yielded similar results, the vast majority of events being attributed to mammals (73%; see Table 1).

Based on all known reports, it seems that introduced small mammal species, particularly rodents, may represent the greatest threat to New Zealand's frogs. Furthermore, Ship Rats, Norway Rats (*Rattus norvegicus*), and Pacific Rats have reached about 90% of the world's islands and are likely to pose a major threat to native amphibians in many countries (Innes 2005; Towns et al. 2006).

Our study also shows the apparent paucity of data pertaining to direct evidence of predation on native New Zealand frogs–there have only been five predator species reported, three of which are introduced. Some major predator-prey interactions have **not** been reported in New Zealand, including: Aves as predators of native frogs; introduced Osteichthyes as predators of native frogs; Osteichthyes as predators of introduced frogs and; Reptilia as predators of introduced frogs. Given the global data (Toledo et al. 2007), it would be surprising if these interactions were not taking place and it is likely they have just not yet been observed or reported.

The majority of the predation events collated in the present study were not directly observed, but based on prey remains from predator stomach contents. This is standard practice in ecology (Hyslop 1980; Corse et al. 2010). However, the successful identification of prey depends on an array of factors and can be undertaken using a variety of techniques that can yield very different results. For example, DNA-based diet analysis has been shown, under laboratory conditions, to increase the prey detection rate of frogs in small mammal stomach contents from 2% to 70% (Egeter et al. 2015). It is important to note that the global reports referred to in the present study were limited to those where prey had been identified to species level (Toledo et al. 2007) and this may have caused a bias against the inclusion of mammalian predators. Furthermore, the review was largely limited to reports published in *Herpetological Review* (Toledo et al. 2007), and as such may have included a higher proportion of reports of the prey of herpetofauna than that of other taxa. On the contrary, due to the fact that conservation practices in New Zealand often focus on the effects of introduced mammals, our collated data may have included a bias toward their inclusion. However, as our study aimed only to include information from direct, non-circumstantial, predation events, these caveats are not considered to be major constraints on the data, rather the data help to indicate predator groups for which we have information, as well as predator groups where information is scarce and require further research in order to be properly assessed as potential agents of frog decline.

Based on the results of this synthesis, further research is needed on the impacts of birds, fish, and reptiles on native frogs in New Zealand if we are to build a more complete picture of the predation threats they face. With regard to introduced mammalian predators, only four of the ten species known to consume vertebrates have **not** been reported as predators of frogs: weasels (*Mustela nivalis vulgar*), Norway Rats, House Mice, and possums (*Trichosurus vulpecula*). We therefore suggest that introduced mammals can be considered as having a substantial negative impact on frogs in New Zealand, but that other, perhaps understudied, introduced fauna may also be having an effect.

This study provides the first synthesis of all the known predators of frogs in New Zealand, a valuable resource for frog conservationists, and this information will enable researchers and managers to make better-informed decisions when focussing on predation on frogs in New Zealand. It also draws attention to the paucity of information on the effects of biological invasions on amphibians and has revealed the prevalence of predation on Southern Bell Frogs and Green and Golden Bell Frogs, both of which are threatened and declining in their native ranges in Australia (IUCN 2014), where Feral Cats (*Felis catus*), Ship Rats, Norway Rats, and House Mice have been introduced. Although introduced fish, particularly Mosquito Fish (*Gambusia holbrooki*), are known to have a detrimental effect on bell frog populations in Australia (Pyke and White 1997), very little research has been carried out on the impacts of terrestrial predators.

There have been many studies showing a negative correlation between the introduction of novel predators and native amphibian populations (e.g., Bucciarelli et al. 2014; reviewed by Kats and Ferrer 2003). Fish appear to be the most geographically widespread of the introduced predator groups affecting amphibians (Stebbins and Cohen 1997; Kats and Ferrer 2003). Our re-examination of the data collated by Toledo et al. (2007) concurs with this as 55.6% of the reported Osteichthyes-amphibian interactions could be attributed to introduced Osteichthyes predators.

New Zealand's frogs face a host of threats and a combination of strategies are required to ensure their survival, such as translocations to suitable habitat, habitat enhancement (e.g., through the use of predator control), disease monitoring, and policy implementation to reduce toxins and herbicides in the environment. We are only at the beginning of our journey to counter global amphibian declines, especially in terms of the effects of introduced fauna. The application of novel techniques

to detect predation, as well as the collation of existing knowledge, will help conservationists to discern and combat the detrimental effects of introduced fauna. It is only once more data becomes available on native frogs around the world, as well as on their predators, that the case for effective predator control can be made, resulting in a decrease of the impacts of introduced fauna and the conservation of the world's rich and diverse amphibian biota.

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Appendix 1

Collation of all reported predation events with frogs as prey in New Zealand.

Prey species	Predator Species	Additional Information	References
Archey's Frog (*Leiopelma archeyi*)	Ship Rat (*Rattus rattus*)	12 dead frogs with Ship Rat bite marks evident, plus an additional 5 dead frogs with Ship Rats as suspected cause of death. *L. archeyi* DNA identified from 2 stomachs (out of 17).	Thurley and Bell (1994), Fitzgerald and Campbell (2002), O. Overdyck (pers. comm.), Egeter (2014)
	Green and Golden Bell Frog (*Litorea aurea*)	1 Green and Golden Bell Frog stomach inspected and found to contain an Archey's Frog.	Thurley and Bell (1994)
Hochstetter's Frog (*Leiopelma hochstetteri*)	Ship Rat	1 dead frog with Ship Rat bite marks evident. *L. hochstetteri* DNA identified in 1 stomach (out of 117).	Fitzgerald and Campbell (2002), Egeter (2014)
	Stoat (*Mustela erminea*)	1 Stoat observed carrying live frog, 2 further dead frogs with likely Stoat bite marks evident.	Baber et al. (2008)
	Banded Kokopu (*Galaxias fasciatus*)	1 ingested frog found (out of 369 stomachs).	West et al. (2005)
Hamilton's Frog (*Leiopelma hamiltoni*)	Tuatara (*Sphenodon punctatus*)	1 frog hind limb found in Tuatara feces (out of 14 fecal samples).	Newman (1977)
Hamilton's Frog or Maud Island Frog (*Leiopelma pakeka*)	Laughing Owl (*Sceloglaux albifacies*), extinct	Fossil deposit of prey collected; minimum of 8 individual frogs (out of 79 total prey individuals). Not distinguished as separate species at the time of the study.	Worthy and Holdaway (1994)
Green and Golden Bell Frog	Brown Kiwi (*Apteryx australis*)	Identified in Kiwi feces in an area with a high abundance of frogs, yet the incidence in scats was very low.	Kleinpaste (1990)
	Weka (*Gallirallus australis*)	Frog remains in gizzards (frequency of occurrence 4.7% and 2.9% in respective studies).	Carroll (1963), Coleman et al. (1983)
	Australasian Harrier (*Circus approximans*)	Minimum of 6 frogs out of 243 total prey. Also observed taking frogs by B. D. Bell.	Baker-Gabb (1981), Newman (1982)
	Feral Pig (*Sus scrofa*)	1 frog (out of 50 stomachs).	Krull and Egeter (2016)
Brown Tree Frog (*Litoria ewingii*)	Cat (*Felis catus*)	5 frogs brought to owners' houses (out of 981 prey).	Morgan et al. (2009)
	Ferret (*Mustela putorius furo*)	1 frog out of 12 stomachs.	Clapperton et al. (2011)
	Southern Bell Frog (*Litoria raniformis*)	Both Thurley and Bell (1994) and Mace (2005) cite Bruce W. Thomas, pers. comm., and Littlejohn (1982) mentions unpublished observations, when stating Southern Bell Frogs are known to kill Brown Tree Frogs in the South Island.	Thurley and Bell (1994), Littlejohn (1982), Mace (2005)

Appendix I - Continued

Prey species	Predator Species	Additional Information	References
Southern Bell Frog	European Hedgehog (*Erinaceus europaeus*)	Present in 15% of hedgehog scats collected (and 31% of scats collected in frog breeding areas), 3 hedgehogs observed eating live frogs. One frog found in stomach contents (out of two stomachs).	Brockie (1959), Stewart (2012), Stephen Chadwick (pers. comm.), Egeter (2014)
	Cat	1 frog out of 558 prey items brought to owner's house (all from 1 cat). Cat seen carrying 1 frog.	Flux (2007), Phil Bishop (pers. obs.)
Southern Bell Frog or Brown Tree Frog	Ferret	In ca. 17% of scats, could not be identified to species level.	Roser and Lavers (1976)
	Cat	2 frogs brought to owners' houses (out of 1674 prey), could not be identified to species level.	Gillies and Clout (2003)
	White-faced Heron (*Egretta novaehollandiae*)	Observed herons eating frogs, especially in summer.	Lo (1991), N. M. Grimmond, unpublished data cited by Newman (1982)
	Little Owl (*Athene noctua*)	8 frogs in 2 stomachs (from 242 owls).	Marples (1942)
Southern Bell Frog or Green and Golden Bell Frog	Little Shag (*Microcarbo melanoleucos brevirostris*)	2 out of 56 stomachs. Not distinguished as separate species at the time of the study.	Dickinson (1951)

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Time of Night as a Technique for Conducting American Alligator (*Alligator mississippiensis*) Surveys

Nighttime surveys are a common method for monitoring crocodilian populations because there is an established protocol, they are cost effective, and they provide useful information about abundance, distribution, and size composition (Taylor and Neal 1984; Lentic and Connors 2006; Fujisaki et al. 2011). Woodward and Marion (1978), Lutterschmidt and Wasko (2006), and Eversole et al. (2015) found that several environmental parameters (e.g., water parameters, air temperature, wind speed, cloud cover, moonlight, and precipitation) influence detection rates during alligator surveys. Chabreck (1966) suggested that survey route, time of year, and observer experience contribute large amounts of variability to American Alligator (*Alligator mississippiensis*) survey results (Wood et al. 1985). Understanding how these factors contribute to variation in activity enables managers and scientists to predict optimal times for conducting surveys that will lead to higher detection rates and more accurate estimates of population parameters (Brown and Shine 2002). Wood et al. (1985) indicated that although they did not specifically measure its effects, "timing of surveys probably contributed to variation among these indices." Additionally, Bugbee (2008) recommended conducting alligator surveys after midnight and continuing into the early morning hours to maximize counts of adult alligators. Currently in Texas, the state protocol for conducting annual American Alligator surveys requires that survey start times occur at 30 minutes past sunset and that surveys be conducted during July and August (Thompson et al. 1984). However, scientific research has not determined if this survey start time is optimal for American Alligators in Texas or if it is applicable across all age classes of alligators. Although fluctuating environmental variables may explain why alligator detectability varies from survey to survey, such variables typically do not change substantially during a survey-night. Time of night may encompass all or most variables attributing to alligator detectability during a planned survey. A technique of planning surveys around optimal times conducive to maximum alligator detectability may provide an easily utilized protocol for conducting nighttime alligator surveys. Therefore, the objectives of this study were to 1) determine how time of night affects the estimated relative density of American Alligators from nighttime surveys across all alligator age classes, and 2) use this information to evaluate current survey protocol and potentially guide future survey protocol in order to maximize detectability of American Alligators during nighttime surveys.

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Methods and Materials

Study Area.—Our study was conducted at Brazos Bend State Park (BBSP) located in Fort Bend County, Texas, USA. The alligator population in the park is considered one of the largest, non-hunted, inland populations of alligators in the state (Texas Parks and Wildlife Department [TPWD], unpubl.) and is surveyed annually as part of the TPWD alligator monitoring and management program. Brazos Bend State Park is comprised of 1982 ha, which includes three lakes that were surveyed for alligators during our study. Survey lakes included Elm Lake, Forty-acre Lake, and Pilant Lake, which were 29.1, 34.2, and 16.3 ha, respectively. Aquatic plant species in these three lakes include Common Water Hyacinth (*Eichhornia crassipes*), Alligator Weed (*Alternanthera philoxeroides*), Coontail (*Ceratophyllum demersum*), smartweed (*Polygonum* sp.), American Lotus (*Nelumbo lutea*), Wild Rice (*Zizania aquatica*), Common Duckweed (*Lemna minor*), cattails (*Typha* sp.), and Chinese Tallow (*Triadica sebifera*).



Fig. 1. Survey route for nighttime alligator surveys on Elm lake, Brazos Bend State Park, Needville, Texas.

Alligator Surveys.—We conducted nighttime surveys along designated transects (Figs. 1–3) in each study lake using the methods outlined by Chabreck (1966), Thompson et al. (1984), and Webb et al. (2006). Surveys for each lake were conducted during four successive nights per month during a twelve-month period (16 August 2012 to 10 July 2013). Total transect length for Elm, Forty-acre, and Pilant lakes were 5.9, 3.0, and 1.4 km, respectively (Figs. 1–3). Transect locations were chosen in order to survey as close to 100% of the lake area as possible without the risk of overlapping transects and subsequent double counting of sighted alligators. In instances when the boat operator had to pass down the same transect twice (i.e., for ease of boat navigation), alligators sighted during the second pass were not counted. Sunset times ranged from 1724 h to 2036 h. It took ~ 6 h to complete all surveys in one night. Surveys in each lake were classified as early (1–3 h after sunset) or late (3.01–6 h after sunset). Lake order was randomly selected each night. We conducted each survey at 6–8 km/h from a 5.5-m air ranger airboat (American Airboat Corporation, http://www.americanairboats.com) and using two spotlights, each with 200,000 candle power. Trained observers were positioned in boat seats that were elevated 1.5 m above the water's surface. We determined total length (TL) of each individual alligator observed by estimating the distance between the eyes and tip of the snout (i.e., it has been found that this length in inches correlates strongly to total length in feet) (Chabreck 1966). Each animal was recorded in one of three respective size-class categories based on TL estimates obtained from eye to tip of snout estimates; hatchlings (≤ 30.5 cm TL), sub-adults (30.6–182.9 cm TL), and adults (≥ 183 cm TL). If observers were unable to estimate total length, individuals were recorded as an unknown size. We calculated alligator density for each study lake as the number of alligators observed divided by the survey area (ha). Although seasonal activity might vary by sex, we did not capture individuals to determine sex; therefore, variability due to sex differences was not included in our analysis.

Statistical Analysis.—To determine differences in alligator relative density in relation to survey start time, we used alligator density (number of alligators/ha) as the dependent variable instead of alligator count data in order to satisfy the assumptions of normality underlying this analysis. We used a mixed model procedure (PROC MIXED; Littell 2006) in SAS (SAS Institute, Inc. 1999) to determine differences in density by survey time, month, and alligator size class, as well as interactions between each of these variables. The mixed model procedure fits a variety of mixed linear models to data in order to make statistical inferences (SAS Institute, Inc. 1999). A mixed linear model is a generalization of standard linear models that are robust to correlation and nonconstant variability (SAS Institute, Inc. 1999). If significant interactions were detected, single variables of the interaction were analyzed separately within each grouping of the other main effects. If the comparison of means showed significant differences ($P \leq 0.05$), we used a test of least significant differences (LSD) to make pair-wise comparisons (SAS Institute, Inc. 1999).

Results

Alligator detectability and hence, the estimated relative density of alligators, was affected by time of night. We detected a significant interaction ($F_{2, 127} = 4.11$, $P = 0.019$) between alligator size and time of survey on alligator density (Table 1). Number of hatchlings observed was unaffected ($F_{1, 127} = 0.48$, $P = 0.488$) by survey time; however, subadult and adult alligators were observed more readily observed ($F_{1, 127} = 17.71$, $P < 0.001$) during later survey times (3–6 h after sunset) than during early

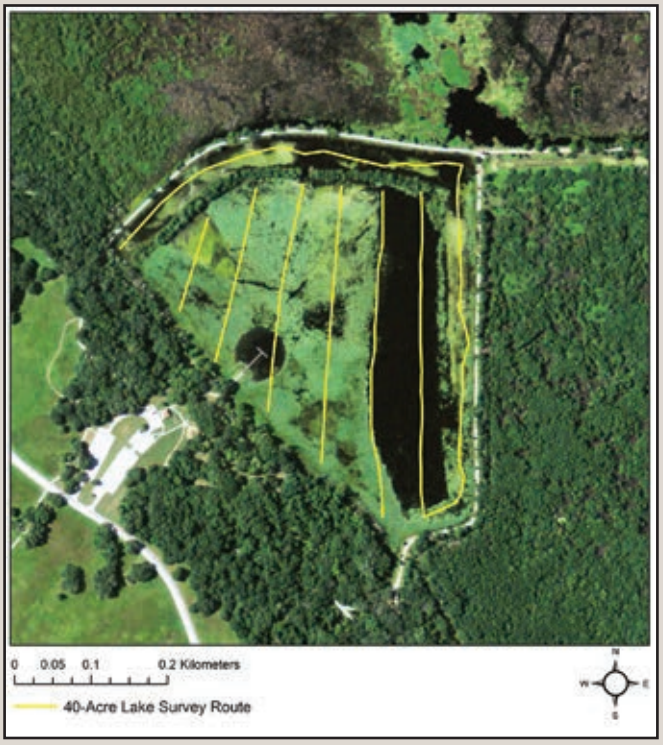


Fig. 2. Survey route for nighttime alligator surveys on Forty-Acre lake, Brazos Bend State Park, Needville, Texas.



Fig. 3. Survey route for nighttime alligator surveys on Pilant lake, Brazos Bend State Park, Needville, Texas.

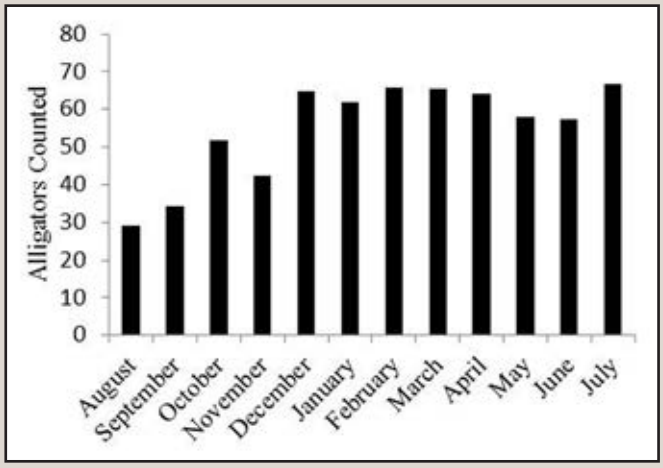


FIG 4. Mean total number of alligators counted during nighttime surveys at Brazos Bend State Park, Needville, Texas, by month.

TABLE 1. Alligator density (alligators/ha ± SE) calculated for three alligator sizes during surveys conducted early (i.e., within 3 h of sunset) and late (3+ h after sunset) from three lakes in Brazos Bend State Park, Texas, 2012–2013. Means with the same upper case letter are not different (P > 0.05) between survey times. Means with the same lower case letter are not different (P > 0.05) between alligator sizes within the same survey time.

Alligator size	Early survey time	Late survey time
Hatchlings	0.051 ± 0.02 Aa	0.056 ± 0.02 Aa
Subadults	0.062 ± 0.02 Aa	0.089 ± 0.02 Ba
Adults	0.062 ± 0.02 Aa	0.089 ± 0.02 Ba

surveys (1 to 3 hours after sunset) (Table 1). We found monthly differences ($F_{11, 124} = 6.85$, $P < 0.001$) in the density of alligators observed across age classes (Fig. 4), but no seasonal pattern emerged. For instance, alligators were more readily observed in January, May, July, August and November, followed by February and March, April, September, and October, then June, and finally December. No other single or interactive effects were found ($F \leq 1.33$, $P \geq 0.360$).

DISCUSSION

Time of night does affect the estimated relative density of American Alligators from nighttime surveys. Our data are directly applicable to providing survey protocol for wildlife agencies in order to increase the accuracy of nighttime American Alligator surveys.

Sub-adult alligators were more abundant, or detectable, during the late survey periods and exhibited similar patterns to those of adult alligators. Bugbee (2008) attributed the increase in adult alligator emergence during later hours of the night to thermoregulatory behavior because adults lose heat at a slower rate throughout the night; therefore, as time progressed, surveys were dominated by adult alligators. This is a logical reason why adult alligators remain active throughout the night. However, this does not explain why adult alligator detectability increased as survey time progressed later into the night. Although this study did not measure the underlying causal factors behind this relationship, other studies indicate that time is correlated to environmental variables as well as thermoregulation, foraging, and activity patterns (Woodward and Marion 1978; Lutterschmidt and Wasko 2006; Bugbee 2008; Eversole et al. 2015).

Similar detection rates of hatchling alligators between survey times are likely because hatchlings were usually found in areas of dense aquatic vegetation and were never observed far from these areas during nighttime surveys (CBE, unpubl. data), presumably as a mechanism of predator avoidance. The detectibility of hatchling alligators was likely not affected by survey time because this behavior never changed throughout the night and was relatively constant across all surveys resulting in similar relative density estimates.

Differences in alligator density by month might reflect differences in behavior during certain times of the year (e.g., breeding season, overwintering; Lutterschmidt and Wasko 2006; Subalusky et al. 2009). Lutterschmidt and Wasko (2006) found that alligators at a Texas site were most abundant during June and September and least abundant during December and January. Our results agree that alligators are least observable during December, but differ in that alligators were most observable during January and July at BBSP. We hypothesize that alligators move in from surrounding wetlands near BBSP and overwinter in the park's lakes (Subalusky et al. 2009). We believe that the large density observed during January is likely the result of this winter immigration. Increased activity during the breeding season in May, and the hatching of young in August, likely increased detection rates, and therefore relative density estimates, at these times (Bugbee 2008).

The monthly results observed in this study are likely the results of changes in detection rates due to changing environmental parameters (Eversole et al. 2015). However, obtaining and utilizing the environmental data as predictors of optimal survey times may not be practical or intuitive. Our study demonstrated that alligator relative densities are correlated with time, thus time should be incorporated into alligator survey methodology in addition to environmental variables. We demonstrated that surveys for adults and subadults should be conducted at later times (e.g., 3–6 h after sunset). By understanding how alligator relative density changes with time we provide a more efficient technique for planning alligator nighttime surveys as an approach to collecting more accurate data on alligator populations. Agency biologists tasked with enumerating alligator populations should incorporate time of night and environmental conditions into the schedule of when to conduct nighttime surveys for alligators.

Importantly, routes should be surveyed with the aid of GPS units and speed should be maintained during surveys to avoid creating potential biases. Approaching alligators to gain "a better look" could potentially be perceived by alligators as threatening, and thus cause their detectability to decrease in subsequent surveys. Although within the scope of this paper, it might be worthwhile to conduct multiple trial surveys prior to enumerating alligators to habituate alligators to the presence of the boat, spotlights, and surveyors.

We suggest that managers and researchers consider our results and conduct alligator surveys at least 3 h after sunset to optimize subadult and adult alligator counts. In addition, we recommend continuing to conduct surveys during July and August under similar weather conditions.

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TECHNIQUES

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Modification of the Radio-Transmitter Harness for Tracking Fossorial Anurans

The small size of many anurans requires that telemetry studies use relatively light transmitters with small batteries, which in turn impart relatively short lifespans for the units. This brief longevity means that to track individual anurans for extended periods, transmitters need to be exchanged periodically (Rathbun and Murphey 1996; McAllister et al. 2004). For externally-attached transmitters, this exchange may be fairly straightforward, although it will require the animals to be repeatedly captured and handled. If using surgically-implanted transmitters, the procedure becomes more complicated and the ethics of multiple surgeries needs to be considered.

The Great Basin Spadefoot (*Spea intermontana*) is an anuran that poses challenges for telemetry: they are relatively small, mainly terrestrial, nocturnal, and fossorial. The latter characteristic is particularly problematic as their tendency to dig backwards (using the hind-foot "spade" tubercle) and the abrasive nature of many soils need to be taken into account. Thus, very little literature exists regarding their terrestrial habits. In 2009 and 2010, we conducted a study on this species that specifically sought data on upland habitat use over the course of entire active seasons (approx. 4 months from May to August). These data were considered critical to crafting and evaluating management plans for this species at its northern limit in British Columbia, Canada. The average weight for animals in this population was 19.6 ± 3.5 g, so transmitters considered suitable for deployment had a maximum lifespan of 21 days (BD-2 external radio-transmitter, Holohil, Carp, Ontario). Surgical implantation of transmitters was not considered an option, as multiple transmitters needed to be affixed to individual animals over the course of each active season to allow extended tracking. Preliminary tests on captive animals with conventional belt-attachment transmitters (Bartelt and Peterson 2000; Griffin and Case 2001; Bull 2006) indicated potential problems with field use. The transmitters would migrate to the ventral surface of the animal, and appeared to prevent normal digging behavior by impeding movement and/or riding up on the body when the animals were digging (*cf.* Bartelt and Peterson 2000), and substrate clinging to the transmitter acted as a source of abrasion on the animals' skin. We therefore created an external transmitter attachment system that used a novel material while deviating from the traditional belt design. We describe this procedure herein, as it proved generally successful and allowed us to collect important data in the field.

Material & Design.—We constructed the harness for the transmitter using Opsite™ FlexiFix™ transparent film. This thin, smooth material is a waterproof, adhesive wrap used to treat humans with burns or other injuries. It can be folded and rolled, thus allowing it to be formed into soft "cords" that we used in the attachment process. Prior to our field work, Opsite™ FlexiFix™ transparent film was compared to polyethlylene

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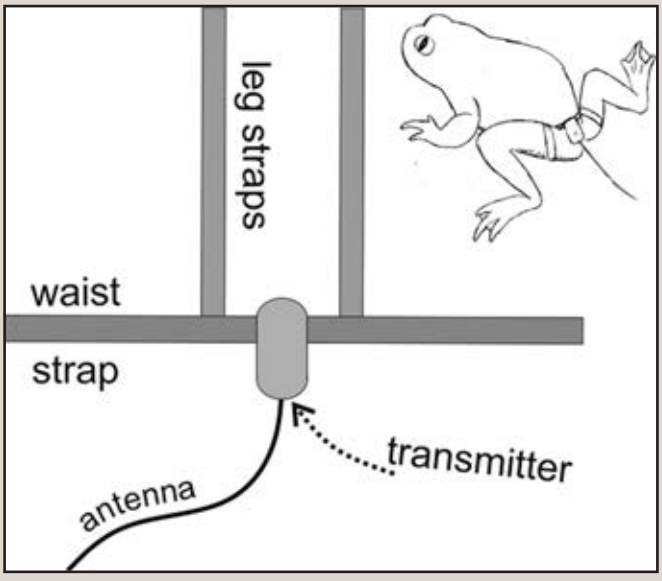


FIG. 1. Schematic of harness package consisting of three pieces of FlexiFix™ folded into straps with a transmitter (not drawn to scale). The waist strap is threaded through an opening built into the housing of the transmitter, and then the leg straps are attached using very small amounts of Krazy Glue®.



FIG. 2. (a) Ventral view of spadefoot in final stages of harness attachment. To protect the animal, a strip of FlexiFixTM (see arrow) is placed under the belt and leg straps at points of gluing. This strip is removed once the glue has dried. (b) Posterior of spadefoot showing leg straps in place to prevent lateral movement of the transmitter.

tubing and silk ribbon using captive spadefoots. FlexiFix™ was selected based on its softness, flexibility, and malleable nature.

Our primary modification to the typical belt design for anuran transmitters was the addition of leg straps that created a harness-type device. These leg straps prevented the transmitter from ventral rotation, and from riding up anteriorly as when the spadefoot was digging into the soil.

We constructed the waist and leg straps from three separate pieces of FlexiFix™: one 1.5 × 8 cm piece for the waist and two 1–1.5 × 5 cm pieces for the legs. Each piece was folded into straps by peeling the white backing off the material and continually folding the adhesive layer back onto itself (≈ 2.0 mm width) until the entire piece had been used. Care was taken to ensure no creases or bubbles formed in the strap, producing a flat, smooth surface (fine-tipped tweezers were useful during this stage). We first attached one of the leg straps to the waist strap using a small amount of Krazy Glue®. Following this, either a 0.66 g (16-day life) or 0.72 g (21-day life) BD-2 external radio-transmitter was threaded onto the waist strap using a small tube (2 mm diam) built into the encasement of the transmitter. The second leg strap was then also attached onto the waist strap producing the harness (Fig. 1). At this point, the harness packages for the two sizes of transmitters weighed 0.87 ± 0.07 g and 0.94 ± 0.09 g, respectively. Note that these weights decreased by ≈ 0.1 g once excess strap material was clipped off the harnesses upon fitting them to animals (see below). We constructed these transmitter-harness packages prior to heading into the field, as assembly time for each harness was 30–45 min. A short video demonstrating the construction of a harness is available at http://vimeo.com/92669521 (password: spadefoot).

Deployment in the field.—Radio-transmitter harnesses were attached to 19 adult spadefoots that were tracked for varying durations (4–90 days) from 10 June–7 Sept 2009, and 17 May–26 Aug 2010. The selection of animals for transmitter attachment was based on individual body mass, as weighed to the nearest 0.1 g with a digital scale. Transmitter and harness packages did not exceed 6% of body weight and most were < 5% (Bartelt and Peterson 2000).

Attachment of the transmitter harness to a spadefoot required two people, one to position the animal (ventral side up) and the other to attach the harness (Rathbun and Murphey 1996). Once the animal was in the proper position, a protective slip was placed on the belly towards the pelvic area to ensure glue did not come in contact with the individual's skin (Fig. 2). We used a piece of FlexiFix™ for this precaution, but any comparable material could be used. The harness waistband was wrapped around the waist and secured with a small drop of glue. The ideal fit of the waistband was such that it would not pull off over the animal's hind legs while not pinching the skin. The leg straps were then wrapped around the legs of the animal and fastened in the same manner (Fig. 2). The leg straps fit looser than the waistband, but were tight enough to prevent the hind foot from becoming lodged in the harness when digging. Once the harness was fully fitted, excess waist and leg strap material was cut and all attachment points were checked to ensure the glue was dry before the protective slip was removed. Study animals were re-hydrated in a container of water prior to compensate for a loss of important stored fluids (see Shoemaker et al. 1969). Note that fluid loss during handling was very common, and this prevented us from calculating the precise weight of the transmitter-harness package once it was fully-fitted and excess strapping had been removed. Still, the average weight gain of the animals from the attachment of the 0.72 g transmitters (used 82% of the time, 45/55 attachments) was 0.63 ± 0.2 g (range = 0.0–1.0). The entire field procedure took approximately 10–15 minutes from capture to release, with a marked drop in timing with experience.

We conducted routine telemetry checks on the animals every one to three days (average = 1.5 days). Given the novelty of the attachment method, we took the precaution of examining closely the telemetered animals every week (in Year 1) or every other week (Year 2) to detect complications. This required locating and handling the spadefoots (normally at night, when they were active). If the harness fit well and no injuries were evident, the animal was released within 1–3 minutes of capture. If abrasions/skin sores were evident the transmitter was removed, the wound was cleaned with distilled water and the animal was released. Using the same procedure, each telemetered animal was briefly re-captured 2–3 days before the projected expiration date of the battery, and refitted with a new transmitter-harness package



FIG. 3. (a) Telemetered spadefoot showing the normal position of the transmitter, with the antenna pointing away posterior from the animal. (b) Spadefoot in daytime retreat showing how the antenna (see arrow) has flipped anteriorly above the animal. The location of completely buried animals often could be determined by the antenna protruding out of the substrate.

provided that no problems were detected. On average each spadefoot received 3 ± 1.6 transmitters (range = 1–5).

Results and Discussion.— Using the method described herein, we tracked 19 spadefoots from 4 to 90 days successfully ($\bar{x}\approx$ 50 ± 28.2 days). All telemetered animals were recorded entering and emerging from burrows, and the antennae often allowed for the precise relocation of individuals (even after transmitter failure), as they would protrude out of the soil above buried animals (Fig. 3). Detection distances using telemetry were substantial (up to 800 m away); considerable movements also were recorded, with animals covering distances up to 1.1 km over an active season (Garner 2012). The spadefoots also appeared able to successfully orientate on the landscape, often returning to previously-used burrows (Garner 2012).

Similar to that reported for the traditional "belt" design, some injuries to the study animals were detected. Rubbing and/or waist abrasions, ranging from a slight chafing of the skin to small cuts on the waist, were detected on five individuals (26%). Goldberg et al. (2002) suggest that terrestrial amphibians might be more prone to abrasions from telemetry belts due to the lack of water to wash away granular material stuck under harnesses. Reported abrasion rates from studies on mainly-terrestrial anurans are wide ranging, including 0% (Miaud et al. 2000), 18% (Bartelt and Peterson 2000), 22% (Griffin and Case 2001), 52% (Constible et al. 2010), and 75% (Goldberg et al. 2002). Several other studies do not mention injuries inflicted by attachment processes (Muths 2003; Bartelt et al. 2004; Forester et al. 2006), or they report abrasions but not the rate of occurrence (e.g., Bull 2006). Admittedly, the assessment of telemetry success was not the focus of these papers, but without these data it becomes difficult to compare abrasion rates over a large number of similar studies. Despite this, our abrasion rate falls within the lower range of observed rates for terrestrial anurans.

Average time to detection of abrasions on five animals was 44 ± 25 days (N = 5; range = 11–71) and was typically after multiple transmitter exchanges and re-fittings. For those animals that never displayed abrasion, average tracking duration was 56 ± 31 days (N = 10; range = 10–90). Despite the attention given by field personnel, it is possible these injuries were caused by an improperly-fitting harness (i.e., too tight or too loose); we likely prevented abrasions on two animals that had their harnesses replaced the day after attachment when it was noticed that the fit was suboptimal. Also of note is the fact that two animals that developed abrasions did so during a period of extended time when we could not locate and inspect them due to failed transmitters (10 and 18 days of wearing harnesses, respectively). Abrasions on these animals were detected when visual searches and knowledge of the past habits of the animals allowed for their recapture (Garner 2012).

We detected three spadefoot mortalities during our study that to some degree may be attributed to the transmitter-harness package. In these cases, abrasions did not appear to be the cause of death, as no superficial injuries were observed on the deceased animals. Rather, on two animals the transmitters appeared to have been embedded in hardened soil, and on the third animal the harness was caught on a root; both situations appeared to have prevented the animal from returning to the surface. Of note here is that our study animals occupied a landscape dominated by heavy clay soils that hardened quickly after rainfall; sandier or more friable soils may have been less problematic. Somewhat analogous results have been observed for aquatic anurans where transmitter and/or belt entanglement on aquatic vegetation caused animals to drown (Rathbun and Murphey 1996; McAllister et al. 2004). Although researchers generally aim to minimize disturbance to their study animals, we agree with Bartelt and Peterson (2000) that in the case of anurans, frequent assessment of each animal's health and condition is necessary to ensure the proper fit of the belt and to prevent and/or detect injuries. Spadefoots are a good example of an anuran that can fluctuate considerably in weight (and waist size) depending on environmental conditions and food intake (Dimmitt and Ruibal 1980): well-fitted harnesses/belts may become ill-fitting in a relatively short period of time. We observed both increases and decreases in weight among individuals carrying transmitters. The average change in weight for telemetered animals in our first study year was -0.8 ± 2.2 g (N = 4), and in the second year it was +0.4 ± 1.7 g (N = 10); placing captive spadefoots in water often produced a quick weight gain, so likely similar fluctuations occur in the wild. In general, researchers need to balance precaution with minimizing the invasiveness of telemetry. We observed

some decrease in abrasion rates between the first and second years of our study (3/7 and 2/12, respectively; $\chi^2 = 1.56$, $df = 1$, $P = 0.21$), suggesting further experience might reduce the rate even more so. We recommend that whenever possible, transmitter attachment should be practiced and tested on captive animals to ensure the investigator is able to attach a well-fitting transmitter in the field.

Overall, our harness-design method of transmitter attachment proved successful in that we were able to follow individuals long enough to firmly establish summer habitat use, and even selection of overwintering sites (Garner 2012). In addition to providing insight into the ecology of these animals, the data were pivotal in establishing specially designated land around known breeding sights. Although not infallible, the judicious use of telemetry, including options for re-attachment of transmitter packages, can provide data critical to the conservation of species such as spadefoots.

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AMPHIBIAN AND REPTILE DISEASES

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Infection Prevalence in Three Lowland Species of Harlequin Toads from the Threatened Genus *Atelopus*

Atelopus, a species-rich Neotropical genus within the family Bufonidae (Lötters 1996), is distributed from Costa Rica south to Bolivia and eastward into the Guyanas (La Marca et al. 2005). Despite declines and disappearances of *Atelopus* species occurring before *Batrachochytrium dendrobatidis* (hereafter, *Bd*) was described (Longcore et al. 1999), *Bd* has been implicated in losses (La Marca et al. 2005; Lampo et al. 2006). The majority of these species occur in the Andes Range above 1500 m, and are considered one of the most threatened genera of amphibians worldwide. At least 71% (69 of 97) of *Atelopus* species are listed as Critically Endangered or Extinct (IUCN 2015). Still, many species have uncertain conservation status because they remain undescribed (Coloma et al. 2010) or because they require systematic revision (Lötters et al. 2011). The most affected species within the genus occur along mid-to-high elevation streams with nearly 75% of those species facing serious declines (La Marca et al. 2005). Colombia harbors the highest number of *Atelopus* species (Lötters 1996) and, similar to other parts of its distribution, nearly all species that occur in the mid-to-high elevations have declined sharply (Rueda-Almonacid et al. 2005). In the Colombian lowlands, however, species still persist at altitudes ranging from 0–600 m and there are no reported declines in this group (Rueda-Almonacid et al. 2005). This difference in survival is usually attributed to *Bd* not being able to survive well at lower elevations, which in the tropics usually means higher and less variable environmental temperatures. In order to evaluate whether *Bd* can be considered as a potential threat for *Atelopus* species, we assessed *Bd* prevalence and infection intensity on three lowland species that occurring between 5–115 m elevation, examining live animals during contemporary field surveys in 2007 to 2012 and archived museum specimens collected between 1968 and 2000.

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We studied three *Atelopus* species occurring in three different localities in the coastal forests of Colombia (Fig. 1). We visited each site 3–5 times between 2007 and 2012 (Table 1). *Atelopus* aff. *elegans*, from Gorgona Island (2.966667°N, 78.166667°W; 6–115 m elev.) was sampled three times (July 2007, July 2010, and June 2012). *Atelopus spurrelli*, in the municipality of Arusí (5.566667°N, 77.5°W; 90 m elev.) on the Pacific coast was sampled five times (May and November 2009, June and September 2011, and June 2012). *Atelopus* aff. *limosus*, an undescribed species occurring near the municipality of Capurganá (8.6°N, 773333°W; 150 m), close to the border between Panama and Colombia, was sampled three times (September 2008, October 2009, and July 2012).

Survey teams composed of 2–5 people conducted field trips to each locality for 2–8 days per trip. To maximize capture success, we surveyed along streams and along forest trails using visual encounter surveys (Heyer et al. 1994). For each animal we collected the following information to look for potential

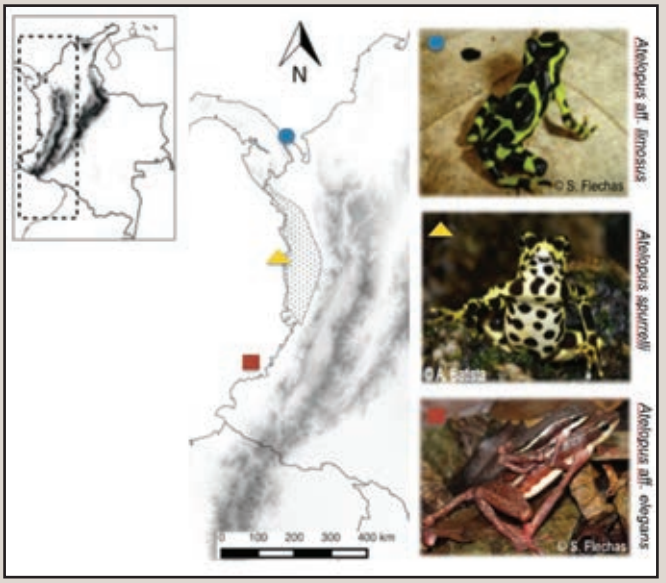


FIG. 1. Colombia locations of the *Atelopus* field sites: (■) *Atelopus* aff. *elegans*; (●) *Atelopus* aff. *limosus;* and (▲) *Atelopus spurrelli*. The distribution of *A.* aff. *elegans* is restricted to Gorgona Island near the Pacific Coast of Colombia, the distribution of *A.* aff. *limosus* is unknown, and the stippled area is the distribution of *A. spurrelli* (IUCN 2015).

TABLE 1. *Batrachochytrium dendrobatidis* prevalence among three lowland *Atelopus* species in Colombia. The number in parenthesis represents the number of *Bd*-positive individuals. p/h = person/hours. Prevalence CI 95% = Prevalence of infection, in parenthesis are the Bayesian Credible Intervals based on 95% confidence. Bold numbers indicate summaries per species.

Species	Date	Sex and Life Stage			Search Efforts (p/h)	Total	Prevalence CI (95%)	Technique
		Female	Male	Juvenile				
Atelopus aff. *elegans*	Jul 2007	15 (4)	57 (10)	6 (1)	144	78 (15)	19 (11.6–29)	PCR
	Jul 2010	12 (2)	25 (5)	46 (2)	150	83 (9)	10.7 (5.4–18.6)	PCR
	Jun 2012	5 (0)	60 (2)	82 (1)	120	147 (3)	2 (0.5–5.3)	qPCR
						308 (27)	**8.7 (5.9–12.2)**	
Atelopus spurrelli	May 2009	1 (0)	67 (1)	6 (0)	96	74 (1)	1 (0.1–6.1)	PCR
	Nov 2009	3 (0)	40 (1)	2 (1)	60	45 (2)	4 (0.9–13.5)	PCR
	Jun 2011	0 (0)	9 (1)	0 (0)	72	9 (1)	11 (1.2–41.4)	PCR
	Sep 2011	1 (0)	4 (1)	7 (0)	96	12 (1)	8 (0.9–32.8)	PCR
	Jun 2012	3 (0)	9 (1)	20 (0)	144	32 (1)	3 (0.3–13.6)	qPCR
						172 (6)	**3.4 (1.4–7.0)**	
Atelopus aff. *limosus*	Sep 2008	1 (0)	8 (0)	2 (0)	48	11 (0)	0 (0–15.6)	PCR
	Oct 2009	0 (0)	61 (0)	11 (0)	48	72 (0)	0 (0–2.6)	PCR
	Jul 2012	8 (0)	87 (0)	0 (0)	72	95 (0)	0 (0–1.9)	qPCR
						178 (0)	**0 (0–1.0)**	

TABLE 2. Museum specimens swabbed. The asterisk (*) indicates the year when *Batrachochytrium dendrobatidis* (*Bd*) was first detected.

Species	Year	No. swabbed	No. *Bd*-positives
Atelopus aff. *elegans*	1968	54	0
	1977	1	0
	1978	12	0
	1985	24	0
	1986	20	0
	1987	1	0
	2000*	25	3
Atelopus spurrelli	1968	6	0
	1969	91	0
	1983	31	0

patterns in *Bd* occurrence: sex and life-stage (male, female; adult, juvenile), snout–vent length (mm), and weight (g). To examine the hypothesis that lowland conditions may be unsuitable for *Bd* occurrence, body temperature was measured using an infrared thermometer (OAKTON ® InfraPro) with a resolution of 0.2°C. From a distance of 50 cm, we pointed the laser to the frog's dorsal surface or the exact place where the individual was perched before handling.

To determine infection status and to avoid cross contamination, animals were collected using clean, decontaminated equipment, individually handled with fresh disposable gloves, and placed in individual bags prior to obtaining the skin swab samples. Each animal was sampled by running a synthetic cotton swab (skin swabs) over the ventral surface, the inner thigh area and the plantar surface of the hind-feet webbing for a total of 50 strokes. Skin swabs were preserved either in 96% ethanol or were air dried and stored at -20°C until processed. To diagnose *Bd* infection we used two techniques: end-point PCR and Real-time TaqMan PCR – qPCR. When we started the surveys our main goal was simply to determine *Bd* presence and thus we ran end-point PCR and qPCR assay to determine presence/absence of the pathogen. Starting in 2012 we performed qPCR assay, to test not only for the presence of *Bd* but also for the infection intensity (pathogen load) and report it as the relative number of zoospores (Zoospore Equivalents, ZE) on each animal.

For end-point PCR, DNA was extracted using GeneReleaser® (Bioventures Inc., Carlsbad, California, USA). We used the primers developed by Annis et al. (2004) to amplify the ITS1-ITS2 region specifically in *B. dendrobatidis*: Bd1a (5'- CAGTGTGCCATATGTCACG-3') and Bd2a (5'-CATGGTTCATATCTGTCCAG-3'). Amplifications were performed in an MJ Research Peltier Thermal Cycler (PTC-200), as follows: an initial 2 min denaturation at 95°C, followed by 35 cycles of DNA amplification (45 sec at 95°C, 45 sec at 55°C, and 1 min at 72°C), and a final extension at 72°C for 10 min completed the amplifications. Each reaction consisted of 0.5 μL of each primer (1 μM), 3.0 μL of doubly distilled DNA-free water, 6 μL of GoTaq® Green Master Mix (1X; Promega) and 2 μL of the DNA extract. The amplified fragments were separated by electrophoresis in 1% agarose gels. The qPCR assay was performed using a BIO-RAD PCR machine (to diagnose) and an Applied BioSystems 7300 Real Time PCR System (to quantify zoospore loads). For the qPCR, DNA was extracted using PrepMan Ultra. Extractions and qPCR's were performed following the methods described by Hyatt et al. (2007) and Boyle et al. (2004). Each reaction consisted of 0.45 μL of each primer (50 μM), 5.975 μl of water, 12.5 μl of TaqMan, 0.625 μL of MGB Probe and 5 μl of the DNA template. To quantify infection intensity we used standards of known concentrations and negative controls.

To determine the historical presence of *Bd*, we swabbed museum specimens of *A. spurrelli* and *A.* aff. *elegans*. Specimens for *A.* aff. *limosus* were not available (Table 2). We used the molecular methods and protocols described by Cheng et al. (2011). In order to decrease the chances of contamination we rinsed each frog with 70% EtOH and we used fresh gloves for each frog handled. We ran a synthetic cotton swab (MWE 113) over the ventral surface, inner thighs, abdomen, and between toes for a total of 30 strokes. DNA was extracted using Prepman Ultra. Each sample was run in triplicate by using qPCR assay following Boyle et al. (2004) using an Applied BioSystems 7300 Real Time PCR System.

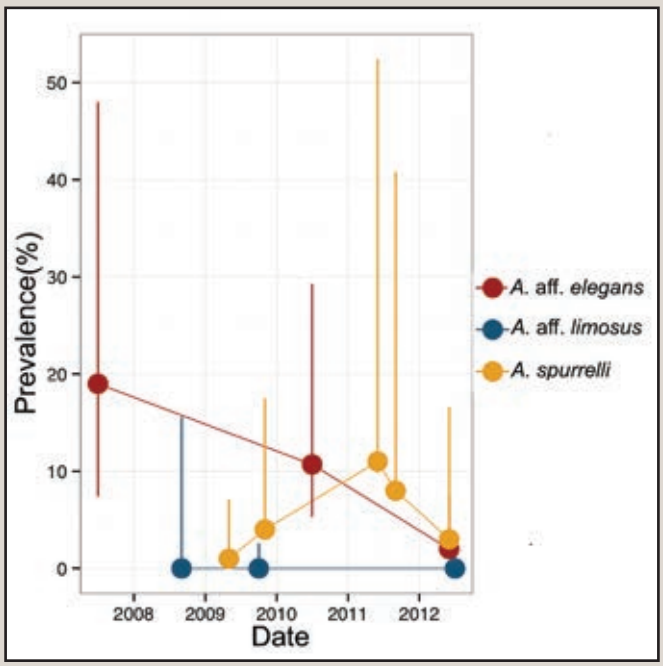


FIG. 2. Prevalence of *Batrachochytrium dendrobatidis* infection over time for the three *Atelopus* species from Colombia. Lines indicate the Bayesian Credible Intervals.

We analyzed skin swabs from a total of 658 individuals collected during the field surveys, including 308 *A.* aff. *elegans*, 178 *A.* aff. *limosus*, and 172 *A. spurrelli* (Table 1). We analyzed for *Bd* presence with 384 samples (end-point PCR and qPCR), and *Bd* zoospore equivalents or infection intensity with 274 swabs (qPCR assay). In total we detected *Bd* in 6 (3.5%) *A. spurrelli* and 27 (8.7%) *A.* aff. *elegans*. We have infection intensity data for four samples taken in 2012: one male *A. spurrelli* (16.9 ZE), two males (63 and 65490 ZE) and one juvenile (726 ZE) *A.* aff. *elegans*. Per sample date, the prevalence of the infection (i.e., the number of infected animals out of the total number of individuals sampled) was very low, ranging from 1–11% in *A. spurrelli* and from 2–19% in *A.* aff. *elegans* (no *Bd*-positive *A.* aff. *limosus*). From 2007 to 2012, the prevalence of *Bd* in *A.* aff. *elegans* dropped steadily (Table 1) (G-test test of independence with Williams' correction, $\chi^2_{df=2}$ = 19.792, $P = 5.037 \times 10^{-5}$); conversely, there was not a discernible pattern in the prevalence of *Bd* in *A. spurrelli* during that same time frame (G-test, $\chi^2_{df=4} = 2.325$, $P = 0.6762$) (Fig. 2). Visual checks of animals that were released after capture did not reveal any signs of chytridiomycosis in any species. We found that *Bd* prevalence was not influenced by body size (N = 658, $Z = 1.067$, $P = 0.286$). However, in *A.* aff. *elegans* the prevalence was higher for males ($\chi^2 = 11.412$, $df = 2$, $P = 0.003$). Frog body temperatures ranged between 23.2–28.2°C ($\bar{x}$ = 25.1°C) in *A.* aff. *elegans*, 22.6–29.3°C ($\bar{x}$ = 25.2°C) in *A.* aff. *limosus*, and 22.5–28.5°C ($\bar{x}$ = 25.4°C) in *A. spurrelli*. We detected differences in body temperature among surveys only for *A.* aff. *limosus* ($F = 136.5$, $P < 0.01$). To provide a retrospective view of *Bd* emergence, we swabbed available museum specimens: 128 formalin-preserved specimens of *A. spurrelli* collected between 1968 and 1983 and 137 *A.* aff. *elegans* collected between 1968 and 2000 (Table 2). We detected *Bd* presence in three (12%) *A.* aff. *elegans* collected in 2000.

Visual encounter surveys showed that from 2009 to 2012, *A. spurrelli* were encountered at a much lower rate. We spent approximately 414 h (person hours) surveying for individuals of *A.* aff. *elegans*, and 168 h and 468 h for individuals of *A.* aff. *limosus* and *A. spurrelli*, respectively. By the end of the study, *A. spurrelli* were difficult to find despite intense effort (Table 1). Our findings suggest a decrease in abundance of *A. spurrelli* during the course of our study. We first detected *Bd* in one of 74 frogs sampled in 2009 in the wild, then in the following surveys (2009–2012), *A. spurrelli* became increasingly harder to find. Although we acknowledge that we did not conduct systematic population abundance monitoring, we did not detect chytridiomycosis and *Bd* prevalence from our samples was low, we hypothesize that *Bd* may have contributed to the apparent decline. We cannot rule out the possibility that this drop in abundance over the time frame sampled might be due to other factors, including natural population variation (Pechmann et al. 1991). The apparent decline of *A. spurrelli* is puzzling due to the presence of cutaneous bacteria with antifungal properties (Flechas et al. 2012), the fact that these frogs occur in an environment with relatively high temperatures (22.6–29.3°C) which may be unsuitable for optimal *Bd* growth (Johnson et al. 2003; Piotrowski et al. 2004), and no observed habitat degradation or other stressors. Based on our retrospective study of museum specimens, we found no evidence of *Bd* presence in this species before the first positive record in 2009. Unfortunately, the lack of systematic population surveys makes it hard to compare abundances between years, which would allow for detecting gradual versus sudden population collapse. Other species of *Atelopus* have declined due to habitat destruction and not *Bd* (Tarvin et al. 2014), but we found no indication of habitat alteration or disturbance in our study area. Therefore we suggest that systematic surveys (population monitoring and disease diagnostics) be conducted to assess the current status of *A. spurrelli* from Arusí in order to more accurately estimate future trajectories for this population.

A recent study conducted on the same three *Atelopus* species that are the focus here revealed that *A.* aff. *elegans*, the species that we found to be most common despite *Bd* infection, harbors the highest proportion of bacterial isolates with anti-*Bd* activity; these bacteria also exhibited the strongest anti-*Bd* effect (Flechas et al. 2012). An alternative explanation for species survival when exposed to lethal strains of *Bd* could be an environmental effect that limits *Bd* growth (Rowley and Alford 2007; Bustamante et al. 2010; Zumbado-Ulate et al. 2014). Various studies have proposed the existence of climatic refugia from chytridiomycosis-driven amphibian declines (Puschendorf et al. 2011; 2013) as a mechanism to allow susceptible species to persist despite infection (Puschendorf et al. 2005). Our three study species occur in tropical coastal forests that exhibit high temperatures, above the optimal physiological range of the pathogen (Johnson et al. 2003; Piotrowski et al. 2004). This temperature regime might limit *Bd* growth causing a decrease in zoospores production, thereby slowing transmission rates and allowing individuals the time to mount an immune response or simply tolerate the pathogen. However, we suggest that when the pathogen first arrives it could cause high mortality in the naïve populations.

Knowing the relative time frame of the emergence of a pathogen in host populations is important for understanding present-day disease dynamics (Briggs et al. 2010; Vredenburg et al. 2010). For example, host pathogen dynamics can move from unstable dynamics soon after pathogens emerge in naïve host populations (e.g., epizootic state) to more stable dynamics long after emergence events (e.g., enzootic state). As part of our study, we provide a retrospective view of *Bd* emergence in two of our

three study species (specimens were not available for the third species). We sampled museum specimens using a molecular technique that has been shown to accurately reflect *Bd* presence or absence in specimens collected up to a century ago (Cheng et al. 2011; Rodriguez et al. 2014). We first detected *Bd* in three of 25 individuals of *A.* aff. *elegans* collected in 2000. Since there is a lack of sampling between 1987 and 2000, we cannot discard the possibility that *Bd* arrived to the island earlier. The elapsed time could fit an enzootic pattern of host/pathogen dynamic, where *A.* aff. *elegans* populations remain stable despite the presence of the pathogen.

Atelopus aff. *limosus,* our third study species, occurs near the border between Colombia and Panamá. This species is believed to have a wider distribution in the Darién region of Panamá (R. Ibáñez, pers. comm.), and this area was considered until recently one of the last *Bd*-free areas in Central America (Rebollar et al. 2014). Our data from 2008 to 2012 did not find any evidence of *Bd*, supporting the idea that the pathogen has not arrived to Capurganá. However, the situation is critical because *Bd* was detected in 2012 in the Darién Province in Panamá (Rebollar et al. 2014) very close (~50 km) to our study site in Colombia. We predict that *Bd* will spread across the Colombian border very soon. The fact that this is a *Bd*-naïve area and the high infection susceptibility reported for the genus, we believe that *Bd* may have a considerable impact on the *Atelopus* aff. *limosus* population. However, we also expect that the suboptimal environmental conditions (i.e., high temperatures) will limit *Bd* growth and colonization rate, which may allow for host tolerance of the infection or evolution of host resistance allowing for coexistence between host and pathogen.

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Ranavirus Detected in *Lithobates clamitans* and *L. catesbeianus* in Indiana

Ranaviruses are an emerging group of pathogens that threaten populations of all three classes of ectothermic vertebrates, especially amphibians (Gray and Miller 2013; Duffus et al. 2015). Infections have now been documented on six continents and in more than 175 species, and are very likely under documented (Duffus et al. 2015). The pathogenicity and broad host range of ranaviruses make them serious threats to both wild and captive populations of ectothermic vertebrate species worldwide. Despite an increased awareness and study of ranaviral infection, much remains unknown about many aspects of their ecology, including geographic distribution.

To date, the distribution of ranavirus in Indiana, USA, is poorly known. Only two studies have tested wild amphibian and reptile populations for the presence of ranavirus (Currylow et al. 2014; Winzeler et al. 2015). In south-central Indiana, Currylow et al. (2014) found PCR evidence of ranavirus in Eastern Box Turtles (*Terrapene carolina carolina*) and larval amphibians (*Ambystoma* sp and unidentified anuran larvae). Overall, ranavirus infections were detected in 2.2% of larval amphibians and 3.0% of Eastern Box Turtles sampled. However, Winzeler et al. (2015) found no SYBR quantitative realtime PCR (qPCR) evidence of ranavirus in Green Frog (*Lithobates clamitans*) tadpoles at five sites distributed across Indiana. In a third study, Kimble et al. (2014) report the presence of ranavirus in a wild-caught, newly captive population of Eastern Box Turtles that was likely initially infected in the wild. Although these studies provide some evidence that ranaviruses are present within Indiana, there is a need for broader surveillance to improve our understanding of ranavirus distribution. Our objective was to test for ranavirus infections in larval Green Frogs and American Bullfrogs (*L. catesbeianus*) from 15 sites distributed across Indiana.

In 2013 and 2014, the Indiana Department of Natural Resources collected live larvae in an ad hoc manner using dipnets or seines from 15 public areas distributed across the state (Table 1, Fig. 1). Field equipment was disinfected between sites with 0.75% Nolvasan (2% chlorhexidine diacetate; Fort Dodge Animal Health, Fort Dodge, Iowa; Bryan et al. 2009). Individuals were euthanized with a 30-minute soak in a 3% solution of neutral-buffered tricaine

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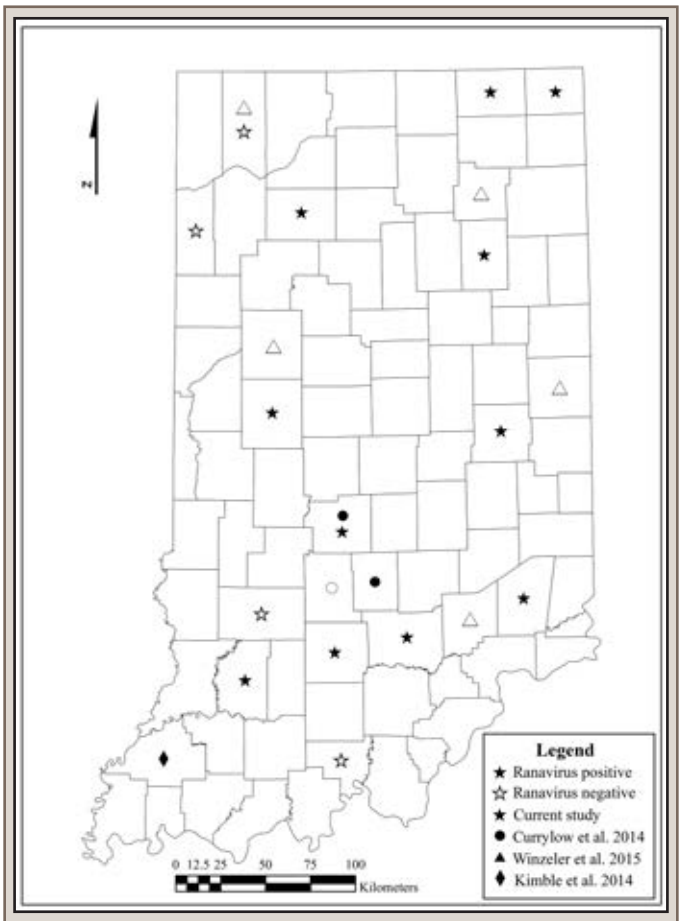


Fig. 1. Map of Indiana showing sample locations for the current study (stars), that of Currylow et al. (2014; circles), Winzeler et al. (2015; triangles), and Kimble et al. (2014; diamonds). Filled symbols indicate sites where ranavirus was detected; empty symbols indicate it was not. These symbols indicate the county, not the exact sampling location.

TABLE 1. Sampling site locations, descriptions, and qPCR results for Green Frog (LICL; *Lithobates clamitans*) and American Bullfrog (LICA; *Lithobates catesbeianus*) tadpoles tested for ranavirus in Indiana. AVO = Avoca Hatchery, BON = Big Oaks National Wildlife Refuge, CIK = Cikana Hatchery, DFT = Drift Wood Hatchery, EFK = East Fork Hatchery, HIL = Hillenbrand Fish and Wildlife Area, HNF = Hoosier National Forest, MNP = Moraine Nature Preserve, PRF = Pigeon River Fish and Wildlife Area, PSP = Pokagon State Park, RSH = Roush Lake, SHD = Shades State Park, WIN = Winamac Fish and Wildlife Area, WWR = Wilbur Wright Fish and Wildlife Area, WSL = Willow Slough Fish and Wildlife Area. Gosner stage data were collected for 2013 individuals only. Prevalence data were estimated per Williams and Moffitt (2001).

Site	Site coordinates (WGS 84)	Site description	Species	Number of indviduals sampled	Number of aggregated samples tested	Number of aggregated samples qPCR positive	Estimated prevalence (95% CI)	Sampling dates(s)	Gosner stage: range (mean)
MNP	41.5426°N, 87.0210°W	Permanent pond	LICL	100	20	0	0 (0, 0)	30 Sept 2014	NA
HNF	38.2527°N, 86.5127°W	Permanent pond	LICL	64	13	0	0 (0, 0)	28 Aug 2014	NA
HIL	39.1244°N, 87.2149°W	Permanent pond	LICL	100	20	0	0 (0, 0)	21 May, 12 June 2014	NA
AVO	38.9116°N, 86.5519 °W	Fish hatchery	LICL	92	19	2	0.0228 (0.0038, 0.0686)	15 Oct 2013	25–38 (34.0)
WIN	41.1286°N, 86.6304°W	Permanent pond	LICL	100	20	5	0.0102 (0.0006, 0.0441)	1 Oct 2014	NA
PRF	41.6809°N, 85.3485°W	Vernal pond	LICL	100	20	5	0.0559 (0.0204, 0.1168)	16 Sept 2014	NA
WWR	39.9632°N, 85.3529°W	Permanent pond	LICL	100	20	9	0.1127 (0.0554, 0.1960)	17 Jul 2014	NA
SHD	39.9351°N, 87.0887°W	Permanent pond	LICL	100	20	9	0.1127 (0.0554, 0.1960)	11 Sept 2014	NA
PSP	41.7069°N, 85.0260°W	Wetland complex of permanent and semipermanent ponds	LICL	100	20	9	0.1127 (0.0554, 0.1960)	15 Sept 2014	NA
BON	38.8359°N, 85.4216°W	Permanent pond	LICL	100	20	20	0.993 (0.993, 1)	25 Apr 2014	NA
WSL	40.9719°N, 87.5180°W	Permanent pond	LICA	100	20	0	0 (0,0)	29 Sept, 29 Dec 2014	NA
HNF	38.2527°N, 86.5127°W	Permanent pond	LICA	52	11	0		28 Aug 2014	NA
AVO	38.9116°N, 86.5519 °W	Fish hatchery	LICA	92	19	2	0.0224 (0.0038, 0.0674)	15 Oct 2013	28–40 (33.0)
CIK	39.4358°N, 86.3826°W	Fish hatchery	LICA	99	20	7	0.0834 (0.0366, 0.1560)	3 Oct 2013	26–40 (36.3)
RSH	40.8140°N, 85.3755°W	Permanent pond	LICA	100	20	9	0.1127 (0.0554, 0.1960)	17 Sept 2014	NA
EFK	38.5298°N, 87.0582°W	Fish hatchery	LICA	100	20	10	0.1127 (0.0554, 0.1960)	29 Oct, 5 Nov 2013	29–41 (37.1
DFT	38.8063°N, 86.0824°W	Fish hatchery	LICA	100	20	13	0.1894 (0.1070, 0.2998)	25 Sept 2013	27–40 (34.8)

methanesulfonate (MS-222; Argent Laboratories, Redmond, Washington) and stored in 70% ethanol. In the laboratory, individuals were identified to species following the methods of Hoverman et al. (2015). Kidney and liver tissue was dissected from up to 100 randomly selected individuals of each species at each sampling location. Dissection equipment was disinfected with 10% bleach between each tadpole. To minimize processing costs while maintaining reasonable sensitivity (Muñoz-Zanzi et al. 2006), we aggregated the kidney and liver tissue samples into groups of up to five individuals of a species from a site (Table 1).

DNA was extracted using a standard phenol-chloroform-isoamyl alcohol extraction method. Purified DNA was resuspended in 50 μL of TLE. A 97 bp portion of the FV3 major capsid protein (MCP) was amplified by qPCR as previously described in Kimble et al. (2014). A synthetic strand of MCP DNA (gBlocks Gene Fragments, Integrated DNA Technologies, Coralville, Iowa) was used to make serial dilutions for a standard curve. Two negative controls (i.e., pure water) were also included. Quantitative PCR was conducted using a CFX Real-Time qPCR thermocycler (Bio-Rad Laboratories, Hercules, California). All standards and unknowns were amplified in technical duplicate. If only one duplicate was positive in a PCR, the sample was considered putatively positive. In this case two more duplicates were amplified and the sample was considered positive if again at least one duplicate was positive. In the case of a disagreement between runs, a third pair of duplicates was amplified and a majority rule among runs was applied to call samples qPCR positive or negative; 17.9% of samples were rerun once and 5.8% required a third run.

We screened 322 aggregate samples representing 1599 individual larvae (956 green frog and 643 bullfrog). There was no evidence of die-offs at any sampling site, yet ranavirus was detected at twelve of the fifteen sampled sites (Table 1). Aggregate samples of green frog larvae were ranavirus-positive at seven of the ten sites where green frogs were sampled. At these sites, we detected ranavirus in 11–100% of the Green Frog aggregate samples tested per site. Aggregate samples of American Bullfrog larvae were ranavirus positive at five of the seven sites where they were sampled. At these sites, we detected ranavirus in 11–65% of the aggregate samples tested.

Our results suggest that ranaviruses may be present across disparate sites (Fig. 1) and site types in Indiana, but that prevalence may vary widely. Infections were detected in wildlife areas, state parks, fish hatcheries, and lakes sampled across the state. This work expands on previous research examining ranavirus in Indiana (Currylow et al. 2014, Winzeler et al. 2015), which demonstrated low to undetectable levels of ranavirus (≤ 3% prevalence) in wild larval amphibians and wild adult Eastern Box Turtles in south-central Indiana. Additionally, Kimble et al. (2014) documented ranavirus infections in a southwestern Indiana population of Eastern Box Turtles that was moved into captivity. Prevalence in this captive population eventually reached 94% (S. Kimble, unpubl. data). Studies in Indiana, therefore, have estimated a large prevalence range (0–94%), typical of surveillance studies conducted in other regions of the United States wherein site-level prevalence of ranavirus ranged from 0.3–84% (Gahl and Calhoun 2008; Todd-Thomas 2010; Hoverman et al. 2012a; Hoverman et al. 2012b; Allender et al. 2013; Sutton et al. 2014). These data suggest that ranavirus may be widespread in Indiana, yet there is a need for more research to document infection prevalence at the population-level for the broad diversity of amphibian and reptile species in the state.

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Batrachochytrium dendrobatidis Dynamics in an Isolated Northern Leopard Frog (*Lithobates pipiens*) Population in Arizona

North American ranid frogs are experiencing population declines in several western species, often resulting in state or federal protection (Clarkson and Rorabaugh 1989; Hale et al. 2005; Rachowicz et al. 2006; Southwest Endangered Species Act Team 2008). The Northern Leopard Frog (*Lithobates pipiens* [*Rana pipiens*]; NLF) has experienced the greatest decline in the western two-thirds of its range (Rorabaugh 2005) and was recently under consideration for listing as federally threatened or endangered in the western part of its range (Smith and Keinath 2007). Several reports implicate chytridiomycosis caused by the pathogenic fungus *Batrachochytrium dendrobatidis* (*Bd*) in the decline of western NLF populations (Carey 1993; Carey et al. 1999; Voordouw et al. 2010), whereas others have found little evidence for *Bd*-related NLF declines (Johnson et al. 2011). Our study goal was to estimate how the abundance of adult NLFs in a single Arizona, USA population changed over a five-year period in relation to *Bd* presence and prevalence.

We conducted this study in a single, isolated pond in Coconino National Forest, Coconino County, Arizona. This pond is a perennial, man-made stock tank, surrounded by Ponderosa Pine (*Pinus ponderosa*) dominated forest and cattle pasture, which is typical habitat for NLFs in Arizona (Rorabaugh 2005). Adult NLFs, Western Chorus Frogs (*Pseudacris triseriata* complex), and Tiger Salamanders (*Ambystoma tigrinum*) breed at this site for several weeks following snowmelt in late February to early March. NLF larvae develop over the summer with tadpoles typically metamorphosing in mid-June to mid-July. Adults and young-of-the-year (metamorphs) forage near pond edges over summer and typically overwinter at pond bottoms (Rorabaugh 2005).

We surveyed the population annually from June 2007 to Aug 2011 (Table 1). We conducted surveys three times annually during the mid-late summer (June, July, August) when frogs are most abundant and readily observed from the pond perimeter (Table 1). We estimated adult NLF abundance using visual encounter surveys of frogs ≥ 6 cm snout–vent length (SVL) encountered while walking the entire perimeter of the pond (Rachowicz et al. 2006). Surveys were conducted between 1000 and 1500 h to control for diel and surveyor bias in estimates. Newly metamorphosed frogs ≤ 4.5 cm SVL were not included in counts, but their presence was noted. We obtained additional evidence for breeding using egg-mass surveys conducted by wading the entire pond during breeding in late February and early March in all years except 2007 (Table 1), when the pond was inaccessible during breeding.

We opportunistically sampled adults, larvae, and metamorphs (Table 1). In each year, we swabbed animals for the presence of *Bd* at two time periods, when breeding was initiated and mid-late summer after metamorphs had emerged. We selected these two time periods to maximize the likelihood of detecting *Bd* by coinciding with the times of highest frog abundance. We captured all animals by hand, wearing disposable vinyl gloves, which were changed after handling each individual to prevent the possible spread of *Bd* and cross contamination of samples. All captured frogs and larvae were placed into individual sterile containers, swabbed (Retallick et al. 2006), and released after all captured individuals were swabbed to prevent resampling. We placed swabs in individual 2-mL screw-cap microcentrifuge tubes (USA Scientific, No.1420-9701) containing 70% ethanol, and stored them at -20°C until DNA extraction (Retallick et al. 2006).

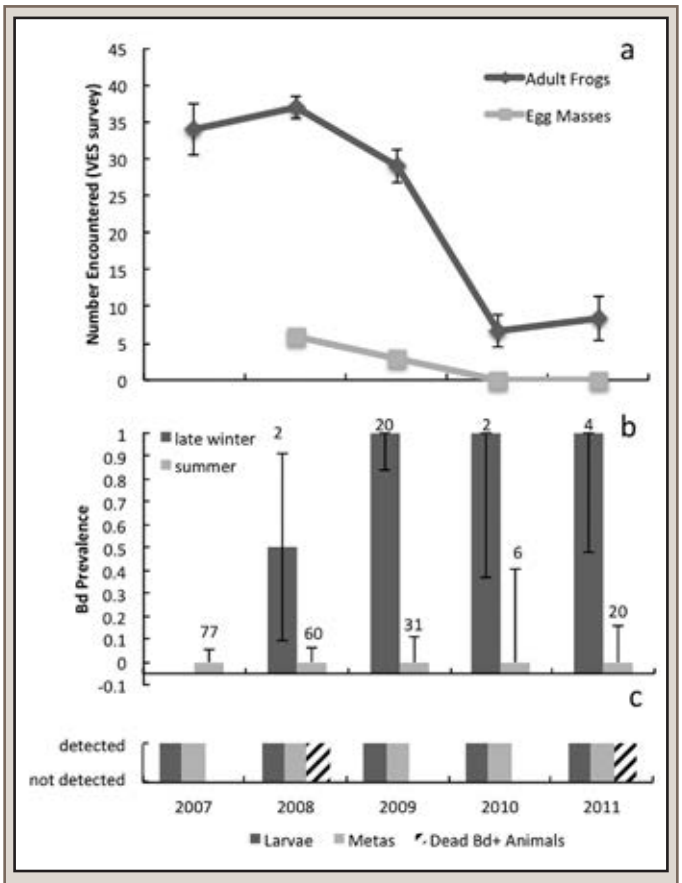


FIG. 1. Northern Leopard Frog (*Lithobates pipiens*) abundance (a; adults: mean ± 1 SE), *Batrachochytrium dendrobatidis* (Bd) prevalence (b; site-specific values during late winter and summer sampling periods), and presence of demographic indicators (c), 2007–2011 in Arizona, USA. Numbers above prevalence bars represent sample sizes; prevalence error bars represent Clopper-Pearson 95% central confidence intervals. Metas = metamorphs.

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TABLE 1. *Batrachochytrium dendrobatidis* (*Bd*) prevalence in Northern Leopard Frogs (*Lithobates pipiens*) collected from 2007–2011 in Arizona, USA. Bold rows indicate sampling periods when *Bd* was detected. meta = metamorph. * Indicates a sampling period in which all animals testing *Bd* positive were found dead.

Date	Total Sampled	Prevalence (95% CI)	Mean Bd Load (SE)	Life Stages Sampled
22-Jun-07	31	0 (0-0.09)	0.0	adult (26), meta (5)
23-Jun-07	30	0 (0-0.09)	0.0	larvae
25-Aug-07	16	0 (0-0.16)	0.0	adult (1), meta (15)
21-Mar-08	**2***	**0.5 (0.09-0.91)**	**2904 (na)**	**adult**
22-Jun-08	29	0 (0-0.1)	0.0	adult (4), meta (25)
09-Jul-08	31	0 (0-0.09)	0.0	adult (1), meta (30)
3-Mar-09	**14**	**1 (0.82-1)**	**4922 (1498)**	**adult**
11-Mar-09	**6**	**1 (0.65-1)**	**22306 (5707)**	**adult**
3-Sep-09	31	0 (0-0.09)	0.0	adult (24),meta (7)
18-Mar-10	**2**	**1 (0.37-1)**	**7105 (6153)**	**adult**
10-Aug-10	6	0 (0-0.35)	0.0	adult
17-Feb-11	**3***	**1 (0.47-1)**	**3428 (2504)**	**adult**
5-May-11	**1**	**1 (0.22-1)**	**10 (na)**	**adult**
12-Jul-11	20	0 (0-0.13)	0.0	adult (6), meta (14)
Total	222	0.12	8424 (2069)	adult (96), meta (96), larvae (30)

We ran samples in duplicate using an Applied Biosystems 7900HT Sequence Detection System (Hyman and Collins 2012). We included standards of 20.0, 2.0, 0.2, and 0.02 *Bd* zoospore genome equivalents (ZGE) μL^{-1} (equivalent to 100, 10, 1, and 0.1 ZGE in the total 5 µL of template added) and negative controls in each 384-well plate. We calculated the ZGE in swab extract as the mean of all Bd-positive wells, multiplied by 400 to account for sample dilutions and unit conversions. We calculated pathogen prevalence by dividing the number of infected animals by the total sample size and included 95% Clopper-Pearson binomial confidence intervals.

Abundance of adult NLFs declined from an average of 34 adults in 2007 to eight adults in 2011 (Fig. 1). Egg mass detection declined from six in 2008 to zero in 2010 and 2011, but metamorphosed frogs were present in 2011, indicating that there was some successful NLF reproduction in that year (Fig. 1).

Bd prevalence during winter breeding increased from 50% (N = 2, 95% CI: 9–91%) in 2008 to 100% in 2009 (N = 20, 95% CI: 84–100%), 2010 (N = 2, 95% CI: 37–100%), and 2011 (N = 4, 95% CI: 48–100%; Fig. 1). However, our small sample size precludes our ability to determine any clear longitudinal trends in *Bd* prevalence during the winter of each year. Overall, 27 of 222 (12%, 95% CI: 8–17%) NLF tested positive for *Bd*. These *Bd*-positive animals were all adult frogs sampled in winter (Fig. 1, Table 1). No *Bd*-positive larvae (N = 31) or metamorphs (N = 96) were detected (Fig.1; Table 1).

There were clear seasonal trends in *Bd* prevalence. Whereas 96% of animals sampled in winter (N = 28) tested *Bd* positive, no animals sampled in summer (N = 194) tested *Bd* positive (Fig. 1; Table 1).

Bd loads on positive animals varied from 10 to almost 42,000 ZGE, with a mean of 8424 (± 2069 SE) ZGE. Four dead animals were detected over the five years of surveys, one in the winter of 2008 and three in the winter of 2011 (Fig. 1). All dead animals tested *Bd* positive, and their pathogen loads (mean 3297 ± 1801 SE) were lower than those of live infected animals (mean 9433 ± 2369 SE). Live infected adults showed no obvious signs of morbidity.

Bd prevalence was high in winter breeding adults, but consistently absent from larvae, metamorphs, and adults in the summer, demonstrating clear seasonality in *Bd* prevalence, and emphasizing the importance of properly timing sampling to detect *Bd* in NLF populations. Similar seasonal reductions in *Bd* prevalence occur in other NLF populations (Voordouw et al. 2010). This seasonal reduction in *Bd* prevalence could alter adult survival (McMahon et al. 2014) and recruitment of metamorphs to adulthood (Muths et al. 2011; Scheele et al. 2015).

It is unclear whether *Bd* was present in this population before our first detection of *Bd* in 2008. Thus, although the abundance of adult NLFs decreased by over 4-fold in the years following our first *Bd* detection, we cannot determine whether the observed decline in adult NLFs was caused by the introduction of *Bd* or was fluctuation in adult abundance caused by other factors. Several adult frogs that were captured alive showed no signs of morbidity despite relatively heavy *Bd* loads (>10,000 ZGE). These loads were above threshold levels that cause death in other ranid species (Vredenburg et al. 2010). If these frogs did indeed survive these infections, it might indicate that they are either tolerant of *Bd* infections, only suffer morbidity/mortality at higher pathogen burdens, or undetected synergisms apply.

Resources for conservation are limited and must be used effectively. If NLF management plans are going to include costly *Bd*-mitigation strategies, such as captive breeding, labor-intensive monitoring, habitat modifications, or species relocations, they should also include examination of the fitness-related costs of *Bd* infection for NLFs (e.g., Voordouw et al. 2010) to refine the effectiveness of management efforts. Still, until we gain a more detailed understanding of the costs of *Bd* infections for NLFs, managers should continue to take a precautionary approach to the protection of threatened NLF populations by using a wide array of the available strategies to bolster populations against *Bd*-related decline.

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A Hatchling Gopher Tortoise (*Gopherus polyphemus*) Care Protocol for Experimental Research and Head-Starting Programs

The Gopher Tortoise (*Gopherus polyphemus*) is federally threatened in its range west of the Mobile River which includes Mississippi and Louisiana, and is under consideration for federal listing throughout its entire range in the southeastern United States. Mississippi populations have been severely reduced or even extirpated from some portions of their range, and recruitment of new reproductive individuals is low (Epperson and Heise 2003). Possible factors contributing to the low recruitment rates in the species' western range are habitat loss from development and fire suppression, lack of genetic diversity (Ennen et al. 2010), low natural hatching success (Epperson and Heise 2003; Noel et al. 2012), and increased risk of predation by domestic dogs (*Canis familiaris*), Coyotes (*Canis latrans*), Nine-banded Armadillos (*Dasypus novemcinctus*), and Red Imported Fire Ants (*Solenopsis invicta*). At the Camp Shelby Joint Forces Training Center (hereafter Camp Shelby), Perry County, Mississippi, the 8–43% hatching success reported for *G. polyphemus* (Epperson and Heise 2003; Noel 2012) is much lower than the 67–97% hatching success reported in the eastern portion of the species' range (Landers et al. 1980; Smith 1995; Butler and Hull 1996). This low hatching success, combined with the range-wide estimated 94% chance of being predated before one year of age (Alford 1980; Landers et al. 1980), can result in continued local population declines and extirpation unless there are strategies devised to increase hatchling survival.

One strategy for increasing hatchling survival is to raise juveniles in captivity (Pedrono and Sarovy 2000). Head-starting can increase juvenile survival prospects by allowing tortoises to obtain larger body sizes and develop harder shells before being released; reducing the number of potential predators that can feed on them. Larger tortoises may also be stronger and more capable of digging deeper burrows, which would be beneficial in soils with higher clay content. This not only decreases the risk of predation, as deeper burrows also offer a wider range of thermoregulatory options and increased protection from fire.

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As part of a larger study investigating factors that may be responsible for such low recruitment and the species' decline, *G. polyphemus* eggs were collected in 2010 from a site with low recruitment rates (Camp Shelby) and from one of Mississippi's few sites with high recruitment rates (Hillsdale). One aim of this study was to collect yolk samples to quantify maternally-deposited corticosterone, a hormone that mitigates the stress response and regulates metabolism and where elevated levels have been shown to decrease hatching success in other species (Eriksen et al. 2003; Love et al. 2005). We also planned to compare hatching success, hatchling growth rates, and behaviors such as burrow construction, basking, and feeding frequencies in hatchlings between the two sites. An important component of this work was the housing and care of captive tortoises prior to and during these investigations. In this account we describe the husbandry protocol that was developed for raising hatchling *G. polyphemus* in captivity. Additionally, we provide comparative data from a previous study at Camp Shelby which looked at survivorship among tortoises released directly after hatching to determine whether these husbandry practices are beneficial and can be adapted for other research and head-starting programs. While head-starting is not a practical solution for maintaining tortoise populations in perpetuity, it can be a useful tool if the protected and faster-growing head-started juveniles have significantly higher survivorship than wild juveniles as well as a reduced age to sexual maturity (Heppell et al. 1996). If successful, head-starting can at the very least slow down population declines and the loss of genetic diversity as effective management strategies are being devised and implemented. Herein we describe a successful husbandry protocol for *G. polyphemus* (and potentially other burrowing tortoise species) that arose from research attempting to understand the decline of this species in Mississippi.

Materials and Methods.—*Gopherus polyphemus* burrows were checked daily from 15 May to 30 June 2010 to ensure that eggs were collected within 24 hours of oviposition. Eggs were collected from Camp Shelby, Mississippi, and Hillsdale,



FIG. 1. Tortoise container with food, water, and PVC burrow. Burrows were placed in the coolest part of the tub, opposite of the basking lamp.



FIG. 2. Lighting and container arrangement in the lab.

Mississippi, USA (geographic coordinates withheld). During excavation and prior to transport, the tops of exposed eggs were marked with a graphite pencil so that they could be kept in the same orientation in which they were found; this guards against damage to the embryo following its attachment to the inside of the egg shell (Limpus et al. 1979). Eggs were placed in individual plastic containers containing vermiculite that was sterilized and dried before being rehydrated with distilled water at a ratio of 0.7 g water per 1.0 g of vermiculite (Packard et al. 1987), and then transported in a foam-lined cooler to reduce vibrations and maintain a constant temperature. Upon arrival at the University of Southern Mississippi, the eggs were weighed and measured, and then incubated at 29.3°C, a recommended temperature for producing a 50:50 sex ratio in this species (Demuth 2001).

Body mass, carapace (CL), and plastron (PL) lengths were recorded within 24 h of hatching, and individual numbers were assigned to each animal using a unique pattern of notches cut from the marginal scutes with a pair of dissecting scissors, similar to those described by Cagle (1939). Each tortoise was housed individually in a plastic tub (Rubbermaid®, Wooster, Ohio, USA) measuring 67.8 × 40.1 × 17.5 cm (L × W × H) to monitor food intake and eliminate stress from resource competition. Each tub was labeled with the occupant's number to assure that tortoises were returned to the proper tubs after measurements and soaking. All tubs contained 8 cm of sandy soil that was collected from the Hillsdale field site (Troup sand), a PVC pipe "burrow" (10 cm wide × 13 cm long) with one end plugged by an ABS test cap (to prevent the tortoises from burrowing through the back and pushing the burrow around the enclosure), and one separated petri dish (FisherScientific®, Waltham, Massachusetts; 60 × 15 mm) (Fig. 1). The petri dish lid and base were recessed into the soil and used for food and water, respectively. After one year, the water dishes were switched to larger and more durable glass culture dishes (63 × 28 mm), but plastic petri dishes continued to be used for food. Basking lamps with 125-watt Sylvania® (Osram Sylvania, Danvers, Massachusetts) brooder bulbs were placed above and in between tubs so that each lamp would heat two tubs simultaneously. This resulted in a basking zone temperature around 34°C, burrow temperatures around 21°C, and a temperature gradient between the basking and burrow areas. Fluorescent light fixtures measuring 1.2 m long with 36-watt ReptiSun® 10.0 UVB fluorescent bulbs (Zoo Med Laboratories, San Luis Obispo, California) were mounted approximately 20 cm above the enclosures so that two bulbs could light five tubs simultaneously (Fig. 2). Fluorescent lamps were maintained on a 12:12 h (light:dark) cycle, while the basking lamps were maintained on a 10:14 h cycle, coming on an hour after and then shutting off an hour before the fluorescent lights.

Between 0800 h and 1100 h each day, feces and uneaten food were removed from the tubs and petri dishes were washed with Dawn® (Proctor & Gamble, Cincinnati, Ohio) dish detergent and rinsed thoroughly before being replaced. Tortoises were provided with tap water daily (aged for one day so chlorine could evaporate), and a commercial tortoise diet (Natural Grassland Tortoise Food; Zoo Med Laboratories) was reconstituted with distilled water and provided *ad libitum*, totaling around 15 g, or one tablespoon of food daily. Initial encouragement was needed to stimulate consumption of the commercial diet, so chopped turnip, mustard, or collard greens were mixed in with the reconstituted food for the first month. After one month, when the tortoises were readily consuming the commercial diet, turnip or collard greens were offered weekly and dusted with calcium (Calcium with Vitamin $D_{3;}$ Rep-Cal, Los Gatos, California) and vitamin supplements (Herptivite™ with Beta Carotene; Rep-Cal). To promote natural foraging behavior and add variety to the diet, rye grass (*Lolium* sp.) was planted in the back of the tub away from the basking lamp (Fig. 3). Old rye grass was removed, and tubs were replanted every two weeks. Tubs were misted weekly



FIG. 3. Rye grass (*Lolium sp.*) planted to supplement the commercial diet and encourage natural foraging behavior.



FIG. 4. Outdoor enclosures used for acclimation and observation of burrowing behavior at the University of Southern Mississippi's Lake Thoreau Environmental center.



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FIG. 5. A hatchling tortoise with transmitter from earlier Nature Conservancy research. The modified transmitters for this project had an antenna protruding from the middle of the transmitter so it would not have to be bent to face posteriorly. Pulse rates were reduced as well in order to extend the lifespan of the transmitter.

to maintain the rye grass, stimulate feeding, and reduce dust. As the tubs were being watered, burrows were refilled with soil to encourage continued burrowing behavior. To ensure hydration, tortoises were soaked weekly in groups of up to six individuals for 10 min in a tub of warm tap water deep enough to cover the lower half of the smallest individual. Body mass, CL and PL were recorded monthly when the tortoises were soaked.

After two years in captivity, hatchlings were transferred to individual 1.8 × 1.8 m outdoor enclosures (Fig. 4) from 7 June to 28 July 2012 to observe natural burrowing behavior and assess their ability to acclimate to outdoor conditions prior to their release into the wild. Each enclosure contained a shallow dish to collect water and a large section of tree bark to provide shelter and shade until the tortoises excavated burrows of their own. An irrigation timer was set to water the enclosures every two days to keep the water dishes filled and to facilitate the growth of grasses and forbs.

To provide adequate time for the tortoises to acclimate and dig suitable burrows, we released them before cold weather arrived on 1 August 2012. Prior to their release, the tortoises were excavated from their burrows, CL, PL, and weights were recorded, and burrow depth and length were measured. Ten tortoises from each site were then randomly selected to receive custom radio transmitters (BD-2; 2g Holohil®, Carp, Ontario, Canada) with the antenna rotated 90 degrees to protrude from the middle of the transmitter. The traditional design required the antenna to be bent to point towards the posterior of the tortoise, which could negatively impact transmitter performance. The pulse rate was also reduced to extend the transmitter lifespan an additional four weeks from the original 10–20 week lifespan. Transmitters were affixed to the fifth vertebral scute with a two part epoxy (Protective Coating Company's PC-7®, Allentown, Pennsylvania) (Fig. 5) and held in place with masking tape overnight while the epoxy cured. The epoxy is strong enough to prevent transmitter loss through burrowing activity, but can easily be removed without any damage to the scutes. Unlike many other epoxies, PC-7® is not exothermic and will not burn the scutes while curing.

Prior to their official release, tortoises were placed in temporary enclosures at their original site of egg collection. This technique, known as a "soft release," is meant to encourage site fidelity and prevent roaming into undesirable areas. The enclosures consisted of a 0.91 m high, 2.4 m diameter circle of hardware cloth held in place with 1.2 m long metal U-posts and secured to the ground with sod staples to prevent tortoises from pushing under the wire. Burlap was draped over the top of the entire enclosure for shading and to prevent bird and snake predation. Camp Shelby and Hillsdale each had two enclosures installed and each received eight tortoises except for one of the enclosures at Camp Shelby, which only received seven. Tortoises were then held in the pens for five days before it was disassembled and they were allowed to roam freely. Tortoises with transmitters (N = 20) were then tracked three times per week for two months using an ICOM® (Kirkland, Washington) IC-R20 receiver and a Wildlife Materials Incorporated® (Murphysboro, Illinois) three element folding antenna. After two months, The Nature Conservancy at Camp Shelby took over telemetry and continued throughout the remaining lifespan of the transmitters.

Results.—A total of 93 eggs were collected in 2010 from Hillsdale (N = 47) and Camp Shelby (N = 46). Average clutch size at Hillsdale was 5.88 ± 1.81 SD (range: 4–9) and 4.6 ± 1.07 SD (range: 3–7) at Camp Shelby. Incubation time for all eggs (N = 36) averaged 81.00 ± 3.36 days (range: 76–89), with a Hillsdale

TABLE 1. Comparison of two-year-old captive and two-year-old wild* Camp Shelby tortoises. CL = carapace length, PL = plastron length.

	Captive-reared			Wild			t-test		
	N	Mean	SD	N	Mean	SD	t-value	df	p
Final Mass (g)	31	203.87	45.8	20	53.32	6.58	14.57	49	< 0.0001
Final CL (mm)	31	97.18	8.37	20	62.25	3.59	17.6	49	< 0.0001
Final PL (mm)	31	95.39	8.31	20	60.19	3.87	17.7	49	< 0.0001
Mass per day (g)	31	0.242	0.06	20	0.021	0.006	15.45	49	< 0.0001

* = Tortoises that hatched in captivity, were outfitted with radio transmitters, released afield shortly after hatching, and tracked via radio telemetry for two years (at which time measurements reported below were taken).

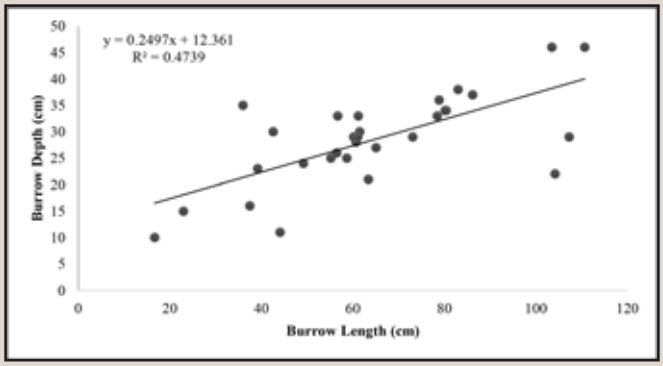


FIG. 6. Burrow depth and length after 51 days in an outdoor enclosure before release.

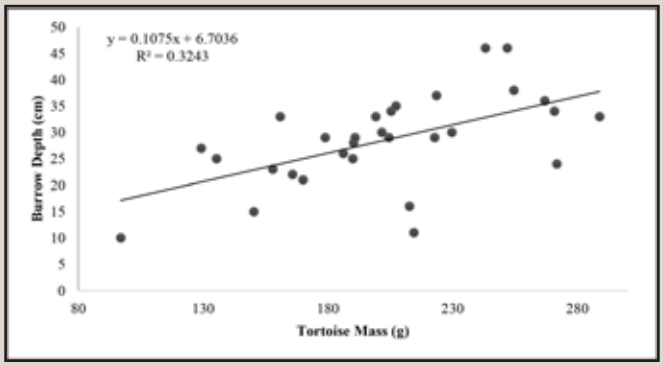


FIG. 7. Tortoise mass and burrow depth after 51 days in an outdoor enclosure before release.

hatching success of 46.8% (22/47) and 30.4% (14/46) for Camp Shelby. While a total of 36 tortoises hatched, three died within a day of hatchling, another perished in April 2011 after flipping over under its basking lamp, and one tortoise never developed full function of its rear legs, leaving 31 individuals that were eventually released. While we found no significant differences in growth rates between captive-reared tortoises from the high and low recruitment sites, captive tortoises (both sites combined) grew at faster rates than wild tortoises of the same age that were released directly after hatching and monitored via telemetry (Table 1). Although *G. polyphemus* are most likely capable of sperm storage, as documented in *G. agassizii* (Palmer et al. 1998; Pearse and Avise 2001), we assumed single paternity for each clutch and accounted for clutch effects using a blocked ANOVA. Even under this level of analysis, all variables of growth in the captive tortoises remained significantly greater than the wild tortoises: final CL ($F_{1,17.3}$ = 176.141, p <.0001), final PL ($F_{1,17.1}$ = 178.271, p <.0001), final mass ($F_{1,18.5}$ = 133.471, p < .0001), and mass gain per day ($F_{1,18.7}$ = 151.054, p <.0001). The wild tortoise data, collected by M. Hinderliter and J. Lee (unpubl. data), also shows that our captive-reared tortoises at two years of age were greater in size than two of the only known wild hatchlings still alive seven years after release (CL = 77.48 and 89.61 mm; PL= 70.96 and 82.59 mm; mass = 129.57 and 160.67g).

From outdoor enclosure observations, the time required for two-year-old *G. polyphemus* (N = 30) to construct burrows deep enough to cover the entire body ranged from 1 to 21 days with an average of 7.1 days (SD = 5.86). One two-year-old Camp Shelby tortoise remained in a pallet burrow (a shallow burrow or depression where the tortoise is still exposed) during the entire 51 day trial. These burrows were dug much quicker than those dug by a group of 2011 hatchlings (N = 26) that were placed directly into the enclosures where burrowing times ranged from 5 to 71 days, with an average of 23.2 days (SD = 17.4). We found a strong correlation between burrow depth and burrow length (Spearman rank correlation: r_s = 0.47, p < 0.0001, N = 30; Fig. 6), burrow depth and mass (r_s = 0.32, p = 0.001, N = 30; Fig. 7) and burrow depth and carapace length (r_s = 0.25, p = 0.005, N = 30; Fig. 8).

At Camp Shelby, one year after release and long after transmitters ceased functioning, The Nature Conservancy staff found that 90% (9/10) of the Camp Shelby captive hatchlings that had transmitters were still alive and all but one individual had stayed within 40 m of the release site. One of the Camp Shelby hatchlings went missing for several weeks and was assumed to have been lost due to predation or transmitter failure. However, after changing out receivers it was rediscovered, having traveled over 250 m from the release site before digging a burrow. At Hillsdale, five tortoises with transmitters were lost within a day of release due to depredation by what appeared to be a domestic dog (based on the size of the canine tracks left near the excavated burrows). After three months at Hillsdale, only two of the remaining five tortoises with transmitters could be accounted for; two were lost to depredation by a small mammal and the third possibly due to transmitter failure.

Discussion.—This husbandry protocol was initially designed to facilitate controlled investigations on the effects of stress on behavior and growth rates in hatchlings. In terms of producing tortoises for captive research and/or release with a very high survival rate, this protocol requires minimal materials for set up and is fairly low effort in terms of husbandry-related tasks. However, there are some caveats that may differ for others using this protocol. We chose a 29.3°C incubation temperature to ensure an equal sex ratio in our captive population so the effects

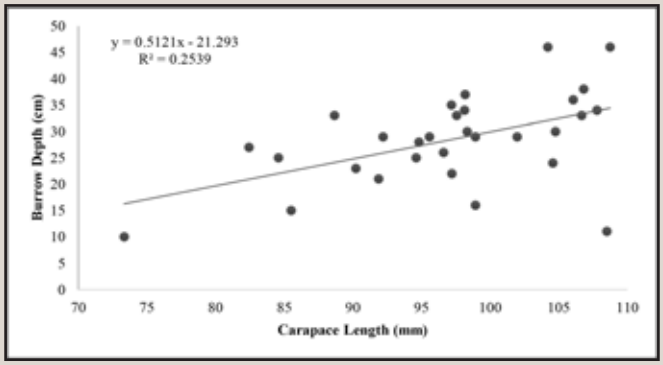


FIG. 8. Tortoise carapace length and burrow depth after 51 days in an outdoor enclosure before release.

of stress could be assessed in both sexes while eliminating the potential effects of temperature on stress response, growth rates, incubation period, and possibly behavior. However, if this protocol is to be used for head-starting programs, temperature optimums for either male (28°C) or female (31°C) *G. polyphemus* should be used since wild clutches of turtles are most often unisex (Vogt and Bull 1984; Limpus et al. 1993; Janzen 1994) and incubation at pivotal temperatures can result in intersexed hatchlings, as demonstrated in European Pond Turtles (*Emys orbicularis*; Pieau et al. 1998). When compared to typical males and females, little is known about the fecundity of intersexed individuals and this could negatively impact head-starting programs. Incubation temperatures in head-starting programs should also be considered when an equal number of males and females are desired or when producing more of one sex would be advantageous for the program. Vogt (1994) suggested that females are the limiting resource in turtle reproductive output considering that males can mate with multiple partners, and recommends a minimum of 6–8 and perhaps as many as 20 females to be released for every male.

This technique for rearing *G. polyphemus* hatchlings in an indoor setting is simple, utilizes affordable and readily available equipment, and requires minimal human contact with tortoises which can reduce stress and possibly encourage natural behavior. Although a single visit per day is all that is required for daily feeding, dishwashing, and wellness checks, one problem encountered was when the tortoises would occasionally flip onto their backs when attempting to climb the side of the tub. In most instances the tortoise would right itself, but sometimes tortoises would have to be righted during morning feedings. The only mortality encountered in two years of captivity occurred when a tortoise flipped over underneath its basking lamp and overheated. To reduce basking lamp mortality, an additional wellness check may be necessary in the afternoon.

How captive-reared hatchlings are released into the wild may need careful consideration with respect to the habitat individuals are released into. When releasing translocated adult tortoises, soft releases where tortoises are penned for up to 12 months can increase site fidelity and survival by discouraging long distance roaming (Tuberville et al. 2005) and decrease the likelihood of predation and road mortality. With head-started tortoises this technique may be unnecessary, as their small size limits them from roaming long distances. Also, in the case of our two year old tortoises, most established burrows within seven days of being transferred to our acclimation pens and less than three days at the release sites. A drawback of soft releases, which was experienced at the Hillsdale site, is that they concentrate individuals in a small area, making them more vulnerable to mass predation. Despite all of the juveniles having dug burrows, half of the juveniles at Hillsdale were predated by a single domestic dog within a day of the enclosures being removed. An alternative to the soft release is a hard release, where juveniles are directly released at the burrows from which they were collected as eggs. This technique would eliminate concentrating tortoises in a few enclosures, instead scattering smaller clutch groups back to their respective burrows of egg origin. This should reduce the likelihood of a mass predation event by a single predator, and there would not be a fenced structure to draw the unwanted attention of potential predators and humans.

Our behavior and growth research required the tortoises to be kept in captivity for two years. With the sizes reached after just one year in captivity, it may not be necessary to keep them any longer than one year. If the objective of the project is to overcome the 90% juvenile/hatchling mortality rate found in first year juveniles and/or head-starting a larger quantity of individuals, then retaining juveniles for one year may be sufficient. One of us (JL) is currently running a head-start program at Camp Shelby and will be releasing one-year old *G. polyphemus* in 2016 that were raised using this protocol. By captive rearing indoors, tortoises can attain a large size in a relatively short period of time, as they gain at least an extra five months (November–March) of foraging and growth over wild *G. polyphemus* and individuals head-started in outdoor enclosures. The increased size reduces the chance of predation by smaller predators and can decrease the time required to reach sexual maturity since sexual maturity depends on size rather than age (Iverson 1980; Landers et al. 1980). At the time of release, the two-year old captive tortoises in the present study were equal in size to 5–7 year old wild juveniles at Camp Shelby (Hinderliter and Lee, unpubl. data), which suggests the time required to reach sexual maturity could be reduced by as much as five years. Additionally, although outdoor enclosures may offer protection from many predators, pesticides have to be applied to control fire ants, and some predators still manage to get into the enclosures (e.g., a juvenile *Crotalus adamanteus* found in an outdoor enclosure at Camp Shelby). The Camp Shelby enclosures also required yearly prescribed burning of the vegetation to maintain suitable groundcover for foraging and for sustaining an open understory. The risks of burning the enclosure vegetation not only increased the potential for wildfires outside the enclosure and enclosure damage, but also increased the risk of tortoise fire mortality. Exposure to excessive heat, cold, and drought can also increase mortality in outdoor head-start enclosures.

In conclusion, our captive rearing protocol was able to produce larger juveniles with the ability to build sufficient burrows and promoted juvenile survival in the wild. Around Camp Shelby, wild hatchlings were often observed seeking shelter under leaves, logs, or in shallow pallet burrows that offered limited protection. All of the released captive-reared two-year-old tortoises were able to dig burrows within two days at the Camp Shelby site. This suggests that larger captive tortoises may be more adept at digging burrows deep enough to protect themselves from extreme temperatures, predators and wildfires, in contrast to recent hatchlings which may be unable to dig quality burrows (especially in soils with a high clay content). Wild hatchling burrows are often found beneath clumps of grass, logs and woody debris, which offer little protection from extreme temperatures, fires and predators. If feral dogs and coyotes are

present, only adult burrows appear to be deep enough to escape predation.

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HERPETOCULTURE NOTES

ANURA — FROGS

***RANA SYLVATICA* (Wood Frog). CLUTCH SIZE MEASUREMENT.** Obtaining total counts of eggs or larvae within ranid egg masses can be challenging due to the three-dimensional structure of egg masses and high numbers of eggs and larvae. Nevertheless, herpetologists are occasionally faced with this daunting task when, for example, determining annual female reproductive output or the proportion of fertilized eggs per mating. Several methods are currently used to count exact numbers of eggs and larvae within ranid egg masses, each suitable for different applications (Browne and Zippel 2007. ILAR J 48:214–234). The Displacement method provides estimates (but not exact counts) of total egg numbers and cannot be used to count larvae. The Image Analysis and Direct Counting methods can provide exact counts of both eggs and larvae but require chemical egg gel dissociation and can be very tedious (e.g., hand-counting larvae dropped from the tip of a pipette). Finally, "flattening" methods have also been used for ambystomatid and ranid egg masses, which involve photographing or counting egg masses that are pressed between gridded glass plates (Harris 1980. Copeia 1980:719–722) or food storage containers (Karraker 2007. Herpetol. Rev. 38:46–48); however, the grid lines themselves can obscure some eggs or embryos. In addition, "flattening" methods cannot be used to count larvae.

Here, I describe an alternative method of counting *Rana sylvatica* eggs and larvae that does not involve egg gel dissociation or a gridded press. *Rana sylvatica* egg masses may contain up to 2000 eggs, and therefore direct quantification can be challenging. I used white miniature ice cube trays (Cubette Ice Trays 180, China) as a tool to count these large egg masses and hatched larvae. To count eggs and embryos within an egg mass, I cut small sections and gently rolled them over the ice cube tray. By pressing a finger lightly over an egg mass section, eggs can be separated into the ice cube tray's cells and viewed as a single layer. Each cell of the tray held up to seven eggs. Eggs were easily visible (Fig. 1), which facilitated rapid counting using a mechanical tally counter. Alternatively, eggs in the ice cube tray can be photographed and digitally counted using ImageJ. The ice cube tray method eliminates the problems associated with grid lines and does not require chemical egg gel dissociation to spread the eggs in a single layer. The contrast between the dark embryos and white tray also permits the approximate staging of embryos, with or without a hand lens.

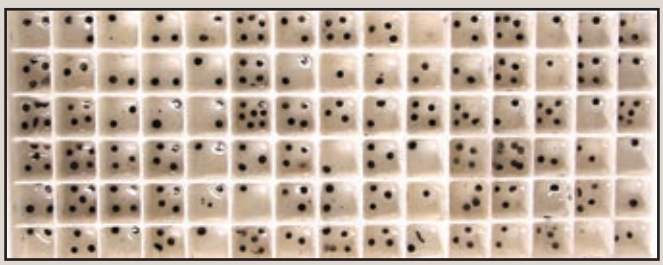


FIG. 1. *Rana sylvatica* eggs prepared for counting using the ice cube tray method.

The ice cube tray method can also be used to rapidly count larvae. *Rana sylvatica* larvae were distributed among the cells of the tray using a plastic disposable pipette with the tip widened or larvae were gently poured from a small specimen cup. Up to six newly hatched larvae can be easily counted per cell. When counting by hand, this method is superior to dropping larvae from a pipette because of the increased accuracy due to the ease of counting, as counts can be performed by counting larvae from left to right in each cell of every row. The ice cube tray method may also be preferred when performing digital larval counts because clumping of larvae can be prevented by adjusting the larval density in individual cells using a pipette, thus providing a more useful photograph for digital analysis. I reared larvae that were counted using this method to metamorphosis in the laboratory; mortality rates for these larvae were low and did not differ from those that were not counted using this method.

All procedures adhered to national and international standards on animal welfare and were compliant with the legal requirements of the United States and the Institutional Guidelines of Penn State University (IACUC permit numbers 42015 and 33346). Animal collection was permitted by the Pennsylvania Game Commission (NC-028-2012) and the Pennsylvania Fish and Boat Commission (Scientific Collector's Permit 483 Type 1).

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TESTUDINES — TURTLES

***PYXIS ARACHNOIDES ARACHNOIDES* (Common Spider Tortoise). EGG SHELL REPAIR.** All turtles are oviparous, producing pliable, hard-expansible or brittle egg shells (Ewert 1985. *In* Gans et al. [eds.], Biology of the Reptilia Volume 14: Development A, pp. 75–241. John Wiley and Sons, Inc, New York). The functions of the egg shell are to protect, allow adequate gas and water exchange, and serve as a mineral reservoir for the developing embryo (Palmer and Guillette 1991. *In* Deeming and Ferguson [eds.], Egg Incubation: its Effects on Embryonic Development in Birds and Reptiles, pp. 29–46. Cambridge University Press, Cambridge). In captivity, brittle or hard-shelled reptile eggs can be cracked or broken during oviposition or shortly thereafter. Damaged eggs can be a result of poor nesting sites (Kohler 2005. Incubation of Reptile Eggs. Krieger Publishing Co., Malabar, Florida) or improper handling when retrieving them (Gurley 2003. Keeping and Breeding Freshwater Turtles. Living Art Publishing, Ada, Oklahoma. 300 pp.). Additionally, changes in humidity during incubation can cause an egg to swell and crack (Packard 1994. *In*

Murphy et al. [eds.], Captive Management and Conservation of Amphibians and Reptiles. SSAR, Ithaca, New York; Gurley 2003, *op. cit*).

Several methods to repair reptile egg shells have been used in both zoological institutions and private collections, and discussed openly on internet forums. These include the use of super glue, freezer tape, vinyl patches, paraffin wax, skin glue, Neosporin® (Johnson and Johnson Consumer Inc., New Brunswick, New Jersey), petroleum jelly, clear plastic sandwich bags, and tea bag fabric. Published accounts include the repair of *Morelia viridis* eggs with melted paraffin or the use of a conspecific's egg shell (Maxwell 2005. The More Complete Chondro. ECO Herpetological Publishing and Distribution, Rodeo, New Mexico. 317 pp.), a *Varanus acanthurus brachyurus* egg repaired with a piece of a *V. tristis* egg shell (Adragna and Madden 2009. Biawak 3:144–145), a *V. beccarii* egg sealed with hot wax (Fischer 2012. Biawak 6:79–87), and a *V. prasinus* egg repaired with tissue adhesive (Davis 2014. Biawak 8:39–42). Three *Dracaena guianensis* eggs that ruptured during incubation at the San Diego Zoo were repaired with Tegaderm™ (3M Inc., St. Paul, Minnesota), a transparent clear dressing (R. Walton, pers. comm.). Chelonian eggs have been repaired with surgical tape, Neosporin® (Gurley 2003, *op. cit.*), and plastic wrap (McKeown 1997. Vivarium 8[5]:6–7); *Geochelone nigra* eggs have been repaired successfully using tissue glue (C. Adams, pers. comm.).



FIG. 1. Distended membrane of a *Pixys a. arachnoides* egg prior to repair on 20 April 2015.



FIG. 2. *Pixys a. arachnoides* egg repaired with a section of *Rhacodactylus leachianus* egg shell.

A *Pixys arachnoides arachnoides* at the Smithsonian National Zoological Park laid a single egg in August 2014, followed by a second in September and a third in November of the same year. These eggs were incubated at 28°C in a 2:1 substrate mixture of vermiculite and water by weight. After four weeks, each egg was gradually cooled over a few weeks to 15.5°C where it remained for six weeks before being gradually warmed back up to 28°C for the remainder of its incubation. A large lateral crack in the shell of the third egg was first noticed on 16 March 2015, one month after warming the egg back up to 28°C. The crack continued to expand as the embryo developed, and eventually resulted in the rupture of the shell membrane on 20 April. Fluid began to leak from the egg and blood vessels were apparent in the distended membrane (Fig. 1).

At this time, the egg was repaired using the egg shell from a hatched *Rhacodactylus leachianus*. This shell was soaked in warm water to regain its pliability and disinfected with a 10% bleach solution. Once disinfected and rinsed repeatedly, the shell was soaked in AmQuel® (Novalek Inc., Hayward, California), an ammonia detoxifier, and then thoroughly rinsed again with water. Once dried, a piece of the *R. leachianus* shell was cut with scissors and rubbed with paper towels to remove any loose shell membrane remaining. New Skin Liquid Bandage® (Medtech, Jackson, Wyoming) was applied with a brush to seal the edges of the crack where the egg membrane was not protruding and to attach the *R. leachianus* egg shell directly over the distended membrane (Fig. 2).

Approximately three hours after the repair, the egg began sweating and a strong odor from the New Skin Liquid Bandage® was apparent. For these reasons, the egg incubation container was vented daily; an increase from once a week. Although the egg stopped sweating within 24 h, the smell of the adhesive persisted throughout the remainder of incubation. On 9 June 2015, after 215 days of incubation, the hatchling pipped the egg shell above the repaired section. By the following day the tortoise had made no progress and was manually assist-hatched in order to assess its condition. Upon examination, the tortoise had an open umbilicus, and was kept in the incubator on unbleached paper towels and treated daily with Nolvasan (Chlorhexidine: Fort Dodge Laboratories, Fort Dodge, Iowa) for four days, at which point the plastron had fully healed. This hatchling weighed 10 g; for comparison, the egg laid in September incubated for 244 days and the hatchling weighted 12 g.

Although the origin of this crack is unknown, it is suspected that the egg was either damaged during oviposition or became cracked as a result of some aspect of the incubation method (humidity and/or temperature). This eggshell repair method proved successful in this instance, allowing the continued development of the embryo. The strong odor of the New Skin Liquid Bandage® was concerning and may be avoided by using other forms of adhesive.

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SQUAMATA — LIZARDS

***CALOTES VERSICOLOR* (Garden Lizard). AGGRESSION.** Aggressive behavior has been studied in a wide range of animal taxa (Maher and Lott 1995. Anim. Behav. 49:1581–1597; Calsbeek and Sinervo 2002. Oecologia 132:468–477). Aggression in lizards has

been associated with territorial defense (Sheldahl and Martins 2000. Herpetologica 56:469–479), and between males especially during the breeding season (Archer 1988. The Behavioral Biology of Aggression. Cambridge University Press, Cambridge. 272 pp.), and it is evident in different forms such as advertisements using visual displays to physical contact (Martins 1994. *In* Vitt and Pianka [eds.], Lizard Ecology: Historical and Experimental Perspectives, pp. 117–144. Princeton University Press, Princeton, New Jersey). However, in some circumstances, agonistic behavior results in combat between opponents; this behavior can be costly for individuals because of resulting physical injury. The intensity of aggression by territory owners against intruders may vary in accordance with available resources in the habitat for retreat sites from predators, food, and mates (Leuck 1995. Herpetol. Monogr. 9:63–74; Bradbury and Vehrencamp 2011. Principles of Animal Communication, 2nd ed. Sinauer Associates, Sunderland, Massachusetts. 697 pp.). Aggressive behavior in anoles and agamids involves a variety of visual displays, such as headbobs, push-ups, dewlap or gular extensions, and lateral body compression which can advance to physical contact (Jenssen 1977. Amer. Zool. 17:203–215; McMann 2000. Anim. Behav. 59:513–522; Paterson 2002. Herpetologica 58:382–393; Perry et al. 2004. Anim. Behav. 67:37–47; Ammanna et al. 2013. Anim. Biol. 63:47–58). Here, I report for the first time a case of aggressive behavior observed in a female agamid lizard *Calotes versicolor* under captive conditions.

This female was hatched in the laboratory within a group of 15 hatchlings (2 males and 13 females). The hatchlings measured 25.11 ± 0.42 mm SVL ± SE and 44.36 ± 1.12 mm in tail length ± SE) and the body mass ± SE was 470.43 ± 12.53 mg. Sex of the hatchlings was recorded on day 4 by protrusion of the hemipenes as per Harlow (1996. Herpetol. Rev. 27:71–72). The hatchlings were placed in a glass terrarium 60 × 30 × 30 cm (L × W × H) with a 2-mm deep sandy substrate layer and a wooden structure for perching. The hatchlings were provided with food consisting of termites and silk moth larvae. Though the food was supplied *ad libitum*, the hatchlings began dying day by day and some of them were found injured and later died. Five females survived for one month. Among these five, the tails of four were observed becoming shorter in length. A single female in the group was observed chasing and eating the tails of other individuals without killing them.

This dominant female was always found at the top of the perch provided in the cage displaying aggressive behaviors such as push-ups and gular extensions. The dominant female attained maturity (83.48 mm SVL, tail length 141 mm) and was shifted to a new terrarium with an adult male of 115 mm SVL. The female did not attack him nor was any aggression observed. The remaining females with broken tails had the following measurements (SVL/TL, in mm): 70.8/35.66, 82.83/68.25, 74.06/60.64mm.

Tails in lizards are involved in diverse functions such as balance, fat storage, and mating (Ali 1949. Proc. Ind. Acad. Sci. 32:87– 95; Robinson et al. 1970. Mariorana 1977; Vitt et al. 1977. Ecology 58:320–337; Schall and Pianka 1978. Am. Nat. 115:551–566). The directed caudal attacks by the dominant female may have been intended to damage the tails of conspecifics in her group in order to suppress her siblings or as a sort of territory guarding behavior to access the food and basking site in the area provided. Further observations are needed from field studies to determine if such behaviors occur in their natural habitat.

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HERPETOLOGICAL HISTORY

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History and Fate of a Troubled Reptile Zoo: The Long Island Reptile Museum

For the herpetological enthusiast, New York City and the surrounding area are home to many zoological and educational facilities where live reptiles and amphibians can be viewed on public display. In addition to a suite of museums and nature centers, the region is home to several AZA accredited zoological parks and aquariums with living herpetological collections. With the exception of some of the larger zoos, particularly the Bronx, Central Park, and Staten Island Zoos, most of these facilities have maintained relatively small reptile and amphibian collections comprised predominately of native or common pet-trade species. The Long Island Reptile Museum, a for-profit herpetological exhibition which closed in 2004, was unique in this regard, as it displayed an extensive collection of live reptiles and amphibians that rivaled that of many North American zoos at the time, and saw tens of thousands of visitors from the greater metropolitan area each year. These attributes, coupled with a troubled history that may be unfamiliar to herpetological enthusiasts outside of New York, make the Long Island Reptile Museum a noteworthy facility for fanciers and historians of zoo herpetology.

In this account, I provide a detailed overview of the history and fate of the Long Island Reptile Museum compiled from interviews conducted with former staff members and volunteers, salvaged museum records, published reviews, travelogues, and newspaper reports, and my own personal experiences and reflections as a former reptile keeper of the facility. Documented herein are many of the challenges, hardships, and problems faced by the facility and its staff during its brief existence.

Early History and Specifications

Privately owned and directed by a commercial real estate developer and exotic bird breeder, the Long Island Reptile Museum (hereafter LIRM) opened its doors in July 1995 to much acclaim (Sutton 1997). Strategically situated in Hicksville, Long Island, New York—centrally located in Nassau County (with more than 1 million residents at the time of its opening) and just 18 km from the New York City border, the museum quickly became a popular destination for residents and tourists of the greater New York City area.

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Retrofitted inside an existing two-story building once occupied by a five and dime store, the LIRM was immense by zoo reptile house standards, with allegedly 27,000 square feet (2,508 m^2) dedicated to exhibit space. A large fiberglass sculpture of a Jackson's Chameleon (*Trioceros jacksonii*) in the parking lot and the fluorescent green exterior of the building (painted this color in the latter half of its existence) made the museum a familiar and near-unavoidable landmark to passing motorists on Route 107 and travelers on the heavily-commuted Long Island Railroad which ran on elevated tracks adjacent to the building. Inside, the museum featured an extensive exhibit area, a gift shop, a pet shop that sold live reptiles, amphibians, invertebrates, and supplies, and a cafeteria and concessions area that seated around 60 visitors.

The museum was open seven days a week, and welcomed visitors from the general public, schools, scout groups, senior citizen and religious groups, and summer camps. Off-site outreach programs, traveling educational presentations, and local television network appearances were also delivered with regularity. General admission to the museum included a self-guided tour through both floors of exhibits, access to a supervised petting area where visitors could handle select tortoises, lizards, and snakes under the supervision of a docent, and hourly films or live animal presentations in the museum's theater. The museum also became a popular destination for children's birthday parties, with sometimes two or three parties being held simultaneously just to meet the demand on weekends.

Staffing.—Estimates suggest that the LIRM employed close to 100 workers over its history. Excluding part-time guides, birthday party hosts, maintenance staff, and gift shop workers, three to seven keepers typically made up the animal husbandry staff at any given time. Beyond providing daily husbandry and maintaining exhibits, keepers were also responsible for delivering educational programming, museum tours, and public outreach. A variety of volunteers ranging from high school students to adult retirees assisted with diet preparation and various other husbandry-related tasks. On weekends, keepers conducted live animal demonstrations in the theater which occasionally featured venomous reptiles including rattlesnakes, cobras, and helodermatids.



FIG. 1. Promotional brochure for the Long Island Reptile Museum (LIRM).

PHOTO BY ROBERT W. MENDYK



FIG. 2. A large *Varanus salvator* measuring close to 3 m in total length arrived at the LIRM in poor physical condition, obese with extensive callouses on its feet and underbelly (most likely from being maintained on bare concrete). It only survived a few months.



PHOTO BY MARK BAYLESS, COURTESY OF BEN ALLER

FIG. 3. The central petting zoo area of the museum housing *Aldabrachelys gigantea, Geochelone sulcata* and *Iguana iguana.*

Exhibits.—The museum's two floors of exhibit space featured approximately 170 exhibits ranging in size from small 100 × 100 × 100-cm (L × W × H) cubicles to spacious 6 × 4 × 4-m walk-in enclosures. The largest of these exhibits featured professionally fabricated naturalistic elements including rock escarpments, boulders, trees, temple ruins, and waterfalls (Fig. 1). Other large walk-in enclosures were constructed of glass panels and relied instead on natural tree limbs, branches, and rocks as furnishings and decoration. Smaller cubicle enclosures made up the majority of the museum's exhibits, and were arranged in double-tiered rows. Glass aquaria of various dimensions were also incorporated into wall units throughout the first floor's exhibit area.

Some of the larger exhibits on the first floor of the museum featured skylights, although it is unlikely that they were constructed from a UVB-transmissive material. Several small prep rooms with sinks, hoses, and storage spaces were located throughout the museum, and were also where pumps and filtration units for some of the larger exhibits were concealed. Despite the expansive area dedicated to exhibits, a proper quarantine room and off-exhibit holding areas were not incorporated into the facility's design. A makeshift quarantine room was eventually established in a back room on the second floor around 2002, but lacked many of the requirements needed to properly accommodate, quarantine, and acclimatize newly acquired or compromised animals such as running water and wastewater drains.

Collection.—The LIRM spared no expense assembling a diverse and impressive collection of reptiles and amphibians, rivaling that of the nearby Bronx Zoo in terms of both the number of species kept and total specimens displayed. Moreover, with very limited off-exhibit space, the museum probably displayed one of the largest captive collections of reptile and amphibian taxa in the country at the time. With the museum's records likely discarded upon its closure, it is impossible to know the exact number of species and individuals maintained; however, it can be confirmed from salvaged personal records, photographs, and recollections from former keepers and volunteers that at least 224 species of reptile (representing 35 families; Table 1) and 38 species of amphibian (representing 14 families; Table 2) were maintained between 1995 and 2004.

Varanid lizards made up an important component of the collection, with a total of 27 species displayed over the museum's history. Noteworthy specimens included a melanistic form of *Varanus salvator*, *V. varius, V. cumingi*, *V. bengalensis, V. prasinus,* and *V. macraei*, as well as a large *V. salvator* that measured close to 3 m in total length (Fig. 2). The LIRM was also one of the first facilities in the United States to display *V. melinus* and *V. yuwonoi* in captivity following their formal descriptions in the late 1990s. Other noteworthy lizard taxa included *Ctenosaura conspicuosa, Sauromalus varius, Dracaena guianensis, Shinisaurus crocodilurus, Tiliqua rugosa, Cyclura cornuta, C. nubila*, and *C. nubila* × *lewisi* and *C. lewisi* × *nubila caymanensis* hybrids.

Typical of most public reptile exhibits, several large constrictors were prominently displayed including a five-meter long *Eunectes murinus* and several large *Python bivittatus* and *Malayopython reticulatus. Python molurus, Malayopython timorensis, Morelia boeleni, M. amethestina*, and several other pythonids (23 species total) and boids (16 species total) were also kept, as well as at least 13 species of colubrids, most notably *Drymarchon couperi.*

Two adult male *Aldabrachelys gigantea* weighing over 90 kg each were housed together with several adult *Geochelone sulcata, Stigmochelys pardalis,* and occasionally *Iguana iguana* in an open pit enclosure in the museum's central petting area (Fig. 3). Several smaller tortoises including *Chelonoidis petersi, C. carbonaria,* and *C. denticulata* were also displayed in various exhibits. As many as 20–30 aquatic turtles representing several native and exotic species were housed together in a large waterfall-fed pond adjacent to the venomous snake collection towards the exit of the exhibit hall.

A fairly large venomous collection included both venomous lizard species (*Heloderma suspectum* and *H. horridum horridum*) as well as several elapids and viperids including, but not limited to *Ophiophagus hannah* (including a 4.5-m individual), *Naja sumatrana, N. haje, N. melanoleuca, N. kaouthia* (including an albino specimen), *Dendroaspis angusticeps, Bitis gabonica, B. arietans, Atheris squamiger, Vipera palaestinae, Bothriechis schlegelii, Agkistrodon piscivorous, A. contortrix*, and at least four species of rattlesnakes: *Crotalus horridus, C. atrox, C. adamanteus,* and *Sistrurus miliarius.*

Four species of crocodilian were displayed, including an adult breeding pair of *Alligator mississippiensis*, as well as *Caiman crocodylus, Paleosuchus palpebrosus,* and *P. trigonautus.*

Dendrobatids (*Dendrobates, Phyllobates, Epipedobates*) were commonly displayed, as were several other terrestrial (e.g., *Mantella* spp., *Discophus guineti, Pyxicephalus adspersus, Ceratoph-*

rys spp.), aquatic (e.g., *Pipa pipa*), and arboreal (e.g., *Hyla* spp., *Agalychnis callidryas*) anurans. Although a few species were kept, caudates were poorly represented in the collection.

The museum regularly purchased rare and unusual specimens from reptile dealers, breeders, and private collectors, whereas more common pet trade species such as *Iguana iguana*, *Trachemys scripta elegans*, *Geochelone sulcata*, *Boa constrictor imperator*, and *V. niloticus* were frequently acquired through donations or the surrendering of unwanted pets to the museum. Occasionally, some less-common species would get donated, particularly Asian box turtles of the genus *Cuora* (*C. amboinensis*, *C. flavormarginata*, and *C. galbinifrons*). While unwanted pet reptiles, particularly iguanas, Red-eared Sliders, and Boa Constrictors were sometimes abandoned in boxes on the doorstep of the museum at night, even in mid-winter, the museum received the majority of these animals by accepting them with an "adoption fee" upwards of US $150 depending on the species. At times, as many as 10 *I. iguana* were surrendered to the museum inside a month; at the behest of the owner, animals were rarely rejected or turned away.

In addition to reptiles and amphibians, the LIRM also maintained a large collection of live exotic insects and arachnids up until around 2001, when they were replaced with static displays of dinosaur and other extinct reptile fossils.

Captive breeding.—Several reptile species were successfully reproduced at the LIRM, although repeat occurrences were uncommon. Lizard taxa bred on-site included *Rhacodactylus leachianus*, *Shinisaurus crocodilurus*, *Physignathus cocincinus*, *Gehyra vorax*, *Chamaeleo calyptratus*, *Trioceros jacksonii*, *Eublepharus macularis*, *Tiliqua gigas*, and *Pogona vitticeps*. The museum may have been the first facility to receive eggs from *V. melinus* in 1999, although no live hatchlings resulted. Viable eggs were also produced by *Hydrosaurus weberi* in 2002, but were discovered by keepers after they had been destroyed by ants. According to exhibit signage, the museum claimed to have been the first facility to breed *R. leachianus* in captivity in 1998; however, the species had been bred more than a decade earlier by the Dallas Zoo in the mid to late 1980s (J. Murphy, pers. comm.). Offspring were produced from several boas and pythons including *B. constrictor imperator*, *P. regius*, and *Epicrates cenchria*. Chelonians bred onsite included *Cuora flavomarginata*, *Chelydra serpentina*, and *G. sulcata*. Although eggs had been received, it is unclear if *Alligator mississippiensis* was successfully hatched at the museum.

Troubled History

To say that the Long Island Reptile Museum experienced its share of problems over its brief history is perhaps a gross understatement. Many issues relating to the LIRM's directorship and financial support, flawed exhibit design, and inability to retain experienced staff affected the health and welfare of its captives, and ultimately contributed to the demise of the facility after just nine years of operation.

High staff turnover.—The museum experienced difficulty maintaining a consistent and qualified keeper staff. Although several qualified and experienced keepers were employed by the LIRM at various times, the bulk of the museum's animal keepers were recent high school graduates or college students with limited experience with captive reptiles or knowledge of their biology; in many cases, keepers were hired out of nepotism by the museum's owner. Low wages, inconsistent paydays and frustrating work conditions (see below) led to high turnover among staff, especially animal keepers. When experienced individuals did come along, they often did not last long. By default, novice keepers were sometimes left in charge of caring for rare or sensitive species, as well as venomous reptiles, large constrictors, monitor lizards, and crocodilians during "in between" periods without experienced keeper staff. High turnover also contributed to generally poor and inconsistent husbandry and accession records.

Exhibit design.—Flawed exhibit design and construction at the LIRM directly impacted keepers' abilities to properly care for specimens and service their enclosures. Little consideration of reptilian and amphibian biology appeared to have been taken into account in their design, leading to various health and welfare issues. For example, basking lights and other heat-emitting fixtures were usually positioned at great distances from any potential basking surface, making it difficult or impossible for some captives to access appropriate temperatures for thermoregulation. Similarly, ultraviolet light fixtures, when offered, were also installed at distances too great for animals to receive any benefit from them. During colder autumn and winter months, substantial heat was lost to the large surface areas of the skylights in some of the larger exhibits, making it difficult to maintain appropriate thermal gradients inside. Open screen tops on most enclosures facilitated strong diffusion gradients and air flow, causing environmental conditions inside exhibits to equalize with the rest of the building. This created difficulties maintaining appropriate temperatures and humidity levels within enclosures, especially during the cold, dry winters of New York; inadequate humidity levels led to chronic dehydration in many species, and eventually gout in some cases (e.g., *V. varius*, *Uromastyx aegyptia*).

Without an appropriate quarantine room or facility, the practice of accepting unwanted pet reptiles without proper veterinary screening and quarantine led to the transmission of parasites and pathogens to the collection. Snake mites (*Ophionyssus natricis*) were a regular scourge, and in 2003, an unidentified ulcerative dermatitis that was suspected of being introduced to the collection via a surrendered pet *Iguana iguana* spread through several herbivorous iguanid and agamid lizards including a *Cyclura nubila* × *lewisi* hybrid, *C. cornuta*, several *I. iguana*, a *Ctenosaura similis*, and a *Uromastyx aegyptia*. Stomatitis and upper respiratory tract infections were commonly encountered in larger constrictor species. In 2002, several keepers simultaneously became ill and were suspected of contracting giardiasis through contact with contaminated aquatic turtle water; *Cyclemys dentata* in the collection later tested positive for *Giardia*.

Many exhibits at the LIRM featured drainage plumbing. While pools in some of the larger enclosures featured their own direct drainage lines, smaller cubicle exhibits shared drainage plumbing, allowing wastewater from adjacent exhibits to occasionally back up into neighboring enclosures. This posed threats of cross-contamination and facilitated the spread of pathogens, particularly among aquatic and semi-aquatic turtles. Additionally, the generally undersized drain lines in both types of exhibits were incapable of handling large waste products or substrate particles, resulting in frequent clogs and breakage. Several drains eventually became unusable due to impenetrable clogs, and waste water had to be flushed out manually with siphons or sump pumps.

The unusual layout of exhibits throughout the museum also presented challenges for maintenance and accessibility. Some of the entranceways to larger walk-in enclosures were too narrow to

allow for garbage cans, ladders and other equipment needed for cleaning and regular maintenance. Several walk-in exhibits were accessible only through other exhibits; in some cases requiring keepers to walk through two other exhibits to access a terminal enclosure. This presented safety issues for keepers when these exhibits housed large varanids or constrictors, as well as risks of cross-contamination between exhibits.

Unlike most zoos that utilize rear-access doors for their reptile and amphibian exhibits which prevent the public from coming into contact with animals and potential zoonotic agents, most of the exhibits at the LIRM were designed to be front-opening, with the public viewing windows doubling as access doors. This space-saving design also included the museum's venomous snake enclosures; their front-opening design and location just before the exit of the museum presented challenges for servicing enclosures during visitor hours and also posed potential safety and security risks for the general public.

Financial support.—Although significant, the effects of staff turnover and poorly designed exhibits paled in comparison to the problems and hardships associated with the museum owner's reluctance or inability to adequately fund the facility. In a telling premonition, monetary issues were apparent before the museum opened to the public, with various contractors, construction crews and exhibit builders walking out on the job due to nonpayment. There were also issues with paying utility companies; on one occasion during the winter before the museum officially opened, the building's heat was shut off due to nonpayment, resulting in the deaths of several animals from hypothermia. As a temporary solution, electric space heaters were placed inside exhibits to keep their inhabitants warm during periods without natural gas service for heat (Fig. 4). Payment issues with electrical and heating utilities continued throughout the museum's history (see below).

Insufficient funding took a direct hit on keepers' abilities to care for animals properly. Although not a problem initially, funding for animal diets became scarce, and keepers were eventually pressured to come up with alternative ways of feeding the collection which included asking local supermarkets for handouts of the previous day's wilted or expired produce and obtaining live rodents for free through local research laboratories. Limited funding also affected the ability to purchase new materials and equipment such as mulch, sand, and other substrates, heating and lighting fixtures, handling equipment and maintenance supplies. Fluorescent UV lamps were often used beyond their intended lifespans, to where they were probably no longer emitting beneficial UV-B wavelengths.

Veterinary practices began refusing to see animals from the LIRM due to nonpayment or simply the museum owner's reputation for nonpayment. In fact, over the course of just nine years, the LIRM went through around a dozen local veterinary practices, including all of the experienced reptile veterinarians on Long Island. The inability to receive veterinary support when needed, especially towards the end of the museum's operation, further limited keepers' options when it came to treating sick or injured animals in the collection. Similarly, given their expense, necropsies were rarely performed to establish a cause for death, making it difficult for keepers to learn from these experiences.

The museum's owner continued to accept unwanted pet reptiles even if there was not sufficient space to accommodate them, in an effort to collect the accompanying "adoption fee." Curiously, when the museum became overwhelmed with surrendered iguanas, the owner would arrange shipments to dealers in Florida, who purportedly paid US $10–15 per iguana. It is difficult to imagine why anyone would pay money for large and particularly intractable iguanas (many of these animals were not tame or tolerant of human interaction) when thousands sit awaiting adoption in rescue groups throughout the country or roam free in southern Florida. Although their true fates were never revealed, some keepers suspected that they were being sold to food markets.



PHOTO BY MARK BAYLESS, COURTESY OF BEN ALLER

FIG. 4. A *Varanus varius* clings to an electric space heater placed in its exhibit during a period when the museum's heat was shut off in mid-winter due to nonpayment.

Investigation by the Turtle Trust.—Alerted to the conditions present at the LIRM, members from the UK-based Tortoise Trust visited the museum in December 2000 and prepared an extensive investigative report detailing the problems and inadequacies observed at the facility as well as recommendations for their remedy (Highfield and Gill 2000). Among their findings, Highfield and Gill (2000) called special attention to the quality of care being provided, the museum's educational value, and the overall conservation message of the facility. In addition to several of the issues hitherto discussed including overcrowding, cross-contagion, mites, and the use of open-topped enclosures which made maintaining appropriate climatic conditions difficult, Highfield and Gill (2000) noted outdated enclosure designs, the unnecessary mixing of unrelated species, inadequate UV exposure, and metabolic bone disease among several tortoises and iguanas in the collection (though these were likely specimens surrendered as adults by pet owners that were already afflicted). The educational focus of the museum was questioned since the conditions on display did not illustrate to the public what they considered to be proper reptile and amphibian husbandry. Also criticized was the conservation message of the facility, since many wild-caught reptiles and amphibians were offered for sale in the museum's pet shop, as well as several species that are poorly suited for private collections including *Geochelone sulcata*, *Python bivitattus*, *Iguana iguana,* and *Varanus salvator*. Similar concerns about the condition of the facility and its husbandry were raised by Harris (2002) following a herpetological society visit to the museum in 2002.

Interestingly, the same conditions and inadequacies highlighted by Highfield and Gill (2000) and Harris (2002) went largely unnoticed or dismissed by the general public, including many reptile hobbyists. Herpetological enthusiasts frequently visited the museum from all over the United States, yet few noticed or raised concerns about its conditions; to the contrary,

TABLE 1. Breakdown of the LIRM's reptile collection by family (1995–2004). Current taxonomic conventions based on Uetz (2014).

Order	Suborder	Family	Number of Species
Crocodilia	Alligatoroidea	Alligatoridae	4
Squamata	Anguimorpha	Anguidae	3
		Helodermatidae	2
		Shinisauridae	1
		Varanidae	27
	Gekkota	Diplodactylidae	4
		Eublepharidae	2
		Gekkonidae	10
		Phyllodactylidae	1
		Sphaerodactylidae	1
	Iguania	Agamidae	16
		Chamaeleonidae	5
		Iguanidae	16
	Lacertoidea	Lacertidae	3
		Teiidae	5
	Scincomorpha	Cordylidae	3
		Gerrhosauridae	2
		Scincidae	6
	Serpentes	Boidae	16
		Colubridae	13
		Elapidae	6
		Natricidae	3
		Pythonidae	23
		Viperidae	13
Testudines	Cryptodira	Carettochelyidae	1
		Chelydridae	2
		Emydidae	8
		Geomydidae/Bataguridae	7
		Kinosternidae	2
		Platysternidae	1
		Testudinidae	8
		Trionychidae	2
	Pleurodira	Chelidae	3
		Pelomedusidae	1

TABLE 2. Breakdown of the LIRM's amphibian collection (1995–2004) by family. Current taxonomic conventions based on Frost (2014).

Order	Suborder	Family	Number of Species
Anura	Archaeobatrachia	Bombinatoridae	1
	Mesobatrachia	Megophryidae	1
		Pipidae	2
	Neobatrachia	Bufonidae	4
		Ceratophryidae	2
		Dendrobatidae	6
		Dicroglossidae	1
		Hylidae	9
		Leptodactylidae	1
		Mantellidae	3
		Microhylidae	2
		Ranidae	2
Caudata	Salamandroidea	Ambystomatidae	2
		Salamandridae	2

many offered their compliments and some even inquired about employment opportunities. An article appearing in *Reptile and Amphibian Hobbyist* magazine around the same time as Highfield and Gill's (2000) investigative report praised the facility and the work that it was doing (Labenda 2000). This would suggest that many reptile and amphibian hobbyists are not familiar with sound husbandry practices or able to recognize signs of impaired animal health and welfare, which raises concerns about the quality of information available to the general pet reptile keeping community and the resulting standards of care they may be providing in their own collections.

Thefts and escapes.—Given the rarity of many specimens in the collection and the poor construction of some of the museum's exhibits, animals were occasionally targeted and stolen from the LIRM by visitors, burglars, and possibly even employees and volunteers. Species stolen from the museum included *Varanus bengalensis, V. prasinus, Rhacodactylus leachianus, Sanzinia madagascariensis, Shinisaurus crocodilurus,* and *Heloderma suspectum*; some, but not all were later recovered by law enforcement officials (Sutton 1996; Lenkowitz 2002; Raferty 2002).

Snake and lizard escapes were not uncommon at the LIRM, with some animals never recovered. Among the most notable escapes were a *Naja kaouthia* that escaped into the floorboards beneath the theater's stage, a five-meter long *Eunectes murinus* that I almost stepped on in a dark hallway one morning after it had escaped from its enclosure the night before when a keeper failed to lock its exhibit door, and a *Varanus melinus* that was regularly spotted throughout the museum, even basking in morning sunlight filtered through the building's skylights, but evaded capture for several weeks. Additionally, like many other zoo reptile buildings, the museum's exhibit area and prep rooms were home to a sizeable breeding population of escaped (or intentionally released?) Tokay Geckos (*Gekko gekko)* which thrived on loose feeder insects and resident cockroaches. Nighttime herping forays for geckos and their eggs became a popular pastime of museum staff and volunteers.

Snakebite.—Emergency responders were called to the museum on 28 December 1997 in response to its first and only venomous snakebite (Crowley 1997; Gearty 1997; McFadden 1997; Miller et al. 1997). A 24-year old keeper was bitten on the hand and envenomated by a 1.2-m long *Bitis gabonica* as he reached into its enclosure to retrieve a water bowl by hand. The victim, who had allegedly been working at the museum for around two years, was airlifted by helicopter to Jacobi Medical Center in the Bronx, where he underwent a fasciotomy and required several vials of antivenom procured by the Bronx Zoo's herpetology department. The keeper eventually recovered from the bite, but never regained full use of his hand. As a result of these injuries, he was later awarded US $1.6 million in damages by a Nassau County Supreme Court referee in 2003 (Anonymous 2003). It is unclear, however, if such a payment was ever received by the victim.

CLOSURE

By 2002, the LIRM had fallen into a state of disrepair, with very little funding available to properly maintain its collection, pay

its employees, and cover basic operational expenses. Faced with even less support from the owner, some keepers began meeting with local authorities from the Nassau County Society for the Prevention of Cruelty to Animals (SPCA) chapter and other rescue organizations, seeking assistance with removing animals in need of veterinary care and getting the museum closed. Despite these talks and knowledge of the museum's conditions by the Nassau County SPCA (Healy 2003), nothing was accomplished and conditions continued to persist for another two years. Keepers were able to convince the owner to voluntarily release some turtles to local rescue groups in 2003; many of these animals required treatment for flagellates (*Giardia* sp. and *Entamoeba* sp.) and nematodes (*Capillaria* sp.). It was also later discovered that during this time a museum volunteer had been working as an undercover operative for an animal rights group and was secretly taking detailed notes and photographs of the museum's conditions, the owner's activities and whereabouts, and the work of its keepers, although this had no apparent effect on the closure of the museum or actions taken against it.

Ironically, the LIRM was forced to close its doors to the public on 29 October 2004 by county officials not because of animal welfare concerns, but because of US $140,000 worth of building and fire code violations (Melago 2004a). After losing heat and electricity to the building several days later due to nonpayment, a small army of volunteers led by the Suffolk County SPCA and representing various agencies, organizations, and rescue groups including Turtlehomes.org and the International Fauna Society (IFS) descended upon the LIRM the evening of 2 November 2004 to remove its living inhabitants as temperatures rapidly dropped to 10°C inside the building (Melago 2004c,d; Winzelberg 2004). Due to a general lack of organization and oversight, several animals mysteriously disappeared from the premises that night without ever being inventoried. The 182 animals that were officially seized were distributed among several rescue groups in the tri-state area for temporary holding, with the majority of animals going to the IFS headquarters in Hauppauge, New York. When it was declared that the owner of the LIRM would not be taking the animals back, some were retained by the IFS for display at its short-lived Serpentarium in Riverhead, New York; others were adopted out or transferred to rescue organizations, and some of the more valuable specimens, including an adult pair of *Varanus cumingi*, were purportedly sold to the public. Many of the animals seized from the museum were in poor physical condition, requiring extensive veterinary treatment or euthanasia.

Coincidentally, the museum's closure occurred just as its owner was in the process of developing a new, floating reptile zoo and aquarium in New York City that was to be permanently docked at South Street Seaport, a popular tourist destination in lower Manhattan. Architectural blueprints had already been drafted and construction of the facility had begun aboard the Cone Johnson, a decommissioned 72-m long ferry purchased from Galveston, Texas (Stewart 2003). Closure of the museum on Long Island and the negative publicity it generated, as well as the owner's citation for misdemeanor animal neglect (Melago 2004b), essentially sealed the fate of this floating facility before it could come to fruition.

The building housing the LIRM was razed the following year and replaced with a retail shopping center.

Discussion

Missed Opportunities for Research.—With such an extensive living collection that included many rare and poorly studied taxa, it is unfortunate that nothing was contributed by the museum's staff to help advance understanding of their biology or husbandry through captivity-based behavioral research or the publication of keeping and breeding reports. For example, captive reproduction occurred in several species at the LIRM that had rarely been bred at the time (e.g., *Rhacodactylus leachianus* and *Shinisaurus crocodilurus*); in these cases, the museum missed out on contributing valuable information to what was then known about their biology, husbandry, and reproduction. Similarly, the museum also missed out on contributing case reports describing novel or unusual health issues and diseases such as the ulcerative dermatitis hitherto discussed as well as an unidentified viral infection that affected the museum's *Aldabrachelys gigantea*.

Financial Sustainability.—Many larger, accredited zoological institutions rely heavily on governmental subsidies, grants, bonds, endowments, corporate beneficiaries, and private donors for covering large parts of their operational expenses; others have branched out to include other revenue streams such as exhibit design to help cover these expenses (e.g., Peeling 2014). As a small for-profit entity, the LIRM relied solely on revenue generated from admission sales, educational programs, and birthday parties to cover its overhead. While the financial mismanagement and business practices of the museum's owner undoubtedly played the greatest contributing role in the facility's demise, it is difficult to imagine how the LIRM could have ever been financially sustainable even if it had been managed effectively. The sheer size of the facility and its associated operational expenses, particularly its monthly electrical usage and heating and cooling costs, should have rendered it cost-prohibitive from its inception. A smaller facility with a smaller collection could have conceivably met the same goals of the LIRM and reached the same number of visitors, while maintaining a much lower operational overhead.

Preventing similar occurrences.—One of the most perplexing questions surrounding the history of the Long Island Reptile Museum is how could it have been allowed to persist for as long as it did given the many problems and animal welfare issues it experienced throughout its history? Where were the authorities? More importantly, what can be learned from the LIRM to prevent similar situations in the future?

First, although volunteer-based animal law enforcement agencies such as the Nassau County SPCA may be highly skilled at pinpointing and addressing welfare concerns among companion animals and domestic livestock, they do not appear as competent or knowledgeable in matters relating to reptiles and amphibians. This may stem from unfamiliarity with reptilian and amphibian biology and husbandry, a general unwillingness to pursue cases involving these taxa, or even a lack of authoritative power regarding the seizure of animals from privately-owned facilities. This latter point may explain why the Suffolk County SPCA (an actual law-enforcement entity) was involved in the LIRM'S seizure rather than the local, volunteer-based Nassau County chapter. Increased training and educational opportunities supported by zoos, federal and state wildlife agencies, and non-profit organizations can help better equip law enforcement officials and related agencies with the knowledge and skills needed for identifying and addressing concerns of poor reptile and amphibian husbandry and welfare.

Second, with the exception of annual license renewals for displaying venomous reptiles and crocodilians through New York State's Department of Environmental Conservation (DEC), the LIRM was exempt from oversight and regulation by



FIG. 5. A young keeper (RWM) experiments with constructing a rock background for a refurbished lizard exhibit.

governmental agencies that monitor or regulate the keeping of certain wildlife groups in captivity such as the United States Fish and Wildlife Service (USFWS) and the United States Department of Agriculture (USDA). Although all facilities publicly displaying live mammals in the U.S. must be licensed as exhibitors through the USDA's Animal and Plant Health Inspection Service (APHIS), which requires adherence to standardized husbandry practices and site inspections, no such regulatory system is in place for facilities displaying live reptiles and amphibians. Additionally, although many zoos and aquariums in North America belong to the AZA, a non-governmental organization that sets rigorous standards for animal husbandry, welfare, and education among its accredited member institutions, membership to the AZA is voluntary, and facilities displaying live animals are not required to join. Thus, problematic herpetological facilities like the LIRM can operate outside the jurisdiction of regulatory governmental agencies and oversight of zoo organizations, where suboptimal husbandry and veterinary care can occur and persist.

While no such system is currently in place for reptiles and amphibians in the USA and no immediate plans to include these taxa have been voiced by the USDA, future inclusion of reptiles and amphibians into APHIS could provide a way in which facilities operating outside the oversight of the AZA like the LIRM can be held accountable and compliant to acceptable standards of herpetological husbandry and welfare. Whether the USDA is logistically capable of launching such a program and effectively regulating herpetological facilities remains to be seen, however, and many zoo curators and registrars would probably argue against such an initiative given the added strain and bureaucracy that it would inevitably create.

Was the Long Island Reptile Museum Valuable to Society?—It might be difficult to look past the many problems and issues experienced by the Long Island Reptile Museum to see any positive aspects, and in reality, an entire book could, and perhaps should be dedicated to the many details of its troubled history and fate. However, in spite of its problems and brief longevity, the LIRM did make three important contributions to society.

First, the Long Island Reptile Museum provided opportunities to many budding herpetologists and naturalists seeking to gain experience working with reptiles and amphibians in captivity. Today, entry-level reptile keeper positions at most AZA accredited zoos in the United States require a bachelor's degree in the biological sciences as well as some level of prior experience working with reptiles and amphibians in a captive setting. First-hand experience gained through private facilities like the LIRM as well as museums and nature centers have prepared individuals for future careers in zoo biology, veterinary medicine or academia, and many prominent zoo biologists have undoubtedly began their careers at smaller, non-accredited facilities. Several former keepers and volunteers of the LIRM including myself have used the experience as a jumping off point to successful careers in zoo biology, veterinary medicine, environmental law, science education, and zoological exhibit design.

Working under such stressful conditions at the LIRM did end up benefiting keepers and volunteers in ways they may not have noticed or appreciated at the time. From my own experience and based on feedback from other former keepers, these suboptimal working conditions contributed to faster learning curves than those we've experienced under more favorable conditions at other zoological facilities. Without in-house maintenance, plumbing, electrical, carpentry, pest control, or exhibit departments to call upon for emergencies and repairs, keepers were forced to learn a myriad of skills and trades on the job through trial and error, teamwork, and collaboration. Solving such problems on a regular basis gave rise to ingenuity and creativity in ways keepers at other zoological institutions might not typically experience or utilize in the day-to-day performance of their jobs. Today, many former keepers of the LIRM are familiar with most areas of general construction and experienced in the fabrication and repair of zoological exhibits (Fig. 5).

Similarly, with very limited husbandry and veterinary support, novice keepers were forced to learn about the biology, health, and medical management of species on their own, by familiarizing themselves with the zoological and veterinary literature and consulting with outside experts. Under unfavorable conditions beyond their control, keepers quickly learned about the individual preferences and tolerances of many reptiles and amphibians as well as their behavioral responses to unnatural social groupings and dominance hierarchies, and suboptimal thermal and hydric conditions. Although far from ideal, these conditions contributed to valuable learning opportunities and unique keeping perspectives that would not have otherwise been possible at other facilities. The experience, knowledge, and know-how gained through working at the LIRM have helped many former keepers succeed and excel at other zoological institutions.

Second, the LIRM played an important role in changing public opinions towards reptiles and amphibians. As some of the most feared and loathed groups of animals on the planet, reptiles and amphibians are frequently misunderstood and misrepresented by the general public, law enforcement officials, politicians, and the media. Zoos and smaller facilities like the LIRM are a necessity for educating people about reptiles and amphibians, while also dispelling fears, myths, and prejudices that can lead to their endangerment in the wild. Given the quantity and breadth of visitors reached through the museum's educational and outreach programs, the LIRM undoubtedly helped further this initiative.

Lastly, and perhaps most importantly, the LIRM was instrumental in inspiring a new generation of herpetologists, naturalists, and wildlife conservationists. For many former keepers, one of the most rewarding aspects of the job was talking with children who returned to the museum with their supportive parents every weekend, who knew the entire collection as well as every minor detail about a species' natural history. It was

gratifying to know that someday these individuals might go on to pursue careers in herpetology or related fields. To further emphasize this final point and conclude this article, I highlight the following experience.

Around 2002, the LIRM was contacted by an 11-year old reptile enthusiast seeking assistance with a proposed project for his elementary school's science fair. As an admirer of snakes and fascinated with snake venoms, the student's ambitious project sought to test and demonstrate, under professional supervision, the effects of rattlesnake venom on human blood. Using just a few droplets of venom collected by keepers from a Pygmy Rattlesnake (*S. miliarius*) in the collection, and petri dishes of fresh blood drawn on-site from the child's father by an accompanying physician, the remarkable platelet-aggregating effect of the venom was demonstrated in real-time and recorded on video by the student. While it is unclear if the student went on to win top prize at his science fair, one can imagine the impact that this experience had on this budding herpetologist's life and career aspirations. Given his age at the time of the experiment, it would not be surprising if this person is now a graduate student on his way to becoming a lead researcher of snake venoms, and perhaps even reading this account.

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GEOGRAPHIC DISTRIBUTION

CAUDATA — SALAMANDERS

***AMBYSTOMA MACULATUM* (Spotted Salamander)**. USA: TENNESSEE: Tipton Co.: Mason Malone Road (35.436139°N, 89.570527°W; WGS 84). 18 March 2014. Robert Colvin and Jake Yoes. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19574 photo voucher). First county record (Scott and Redmond 2008. Atlas of Amphibians in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://www.apsu.edu/amatlas [updated 27 April 2015; accessed 22 July 2015]).

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***AMBYSTOMA TEXANUM* (Small-mouthed Salamander)**. USA: ARKANSAS: Sharp Co.: 5.4 air km W of Ash Flat (36.22245°N, 91.66907°W; WGS 84). 7 March 2014. Charles Foster. Verified by Chris Thigpen. Arkansas State University Museum of Zoology (ASUMZ 32056). New county record (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville, Arkansas. 421 pp.). This record fills a distributional gap between surrounding counties for this species in northern Arkansas. This specimen was collected under a Scientific Collecting Permit (#020520134) issued to SET by the Arkansas Game and Fish Commission.

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***ANEIDES AENEUS* (Green Salamander)**. USA: NORTH CAROLINA: Buncombe Co.: Private property, Rocky Broad River corridor, 3.4 km airline N town of Bat Cave (35.48°N, 82.28°W; WGS 84). 8 May 2015. Lori A. Williams, Alan D. Cameron, Bill and Jerry McAninch. Verified by Jeffrey C. Beane. North Carolina State Museum of Natural Sciences photo voucher (Accession 13183). New county record (NCSM files; Beane et al. 2010. Amphibians and Reptiles of the Carolinas and Virginia, 2nd ed. University of North Carolina Press, Chapel Hill, 274 pp.; North Carolina Natural Heritage Program 2015. Biotics Database. Department of Environment and Natural Resources, Raleigh, North Carolina). Record represents the northernmost known occurrence in the greater Bat Cave area and on the western side of the Hickory Nut Gorge in North Carolina (Beane et al. 2010, *op. cit.* and NCNHP, *op. cit.*). Closest previous historical records in the state are from private property, Henderson Co., 1.6 km airline S (35.47°N, 82.28°W; WGS 84). Juvenile regenerating entire tail (TL = 41.1 mm, SVL = 37.5 mm) found during visual encounter surveys of rock outcrops.

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***EURYCEA GUTTOLINEATA* (Three-lined Salamander)**. USA: ALABAMA: Coosa Co.: 0.16 road km S of Coosa County Road 56 on Coosa County Road 55, in McCutchen Branch just east of road (33.00526°N, 86.36529°W; WGS 84), 186 m elev. 28 April 2015. David Laurencio and Christina M. Holbrook. Verified by Craig Guyer. Auburn University Natural History Museum (AUM 41139). New county record (Mount 1975. Reptiles and Amphibians of Alabama. Auburn University Agricultural Experiment Station, Auburn, Alabama. 347 pp.). Specimen collected under General Scientific Collecting Permit No. 8309, issued by the Alabama Department of Conservation and Natural Resources, Wildlife and Freshwater Fisheries Division.

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***EURYCEA SOSORUM* (Barton Springs Salamander)**. USA: TEXAS: Travis Co.: Zara Monitoring Well (State Well No. 58-50-705; 30.142235°N, 97.842087°W; WGS 84). 30 July 2015. Collected by Peter Sprouse and Barrett Clark. Verified by Andrew Gluesenkamp. Texas Natural History Collections (TNHC 96003 [Zara 8982; AGG 2172]). Sixth known location for the species, the first time that *E. sosorum* has been collected from a well, and the deepest water depth from which it has been documented (Chippindale 2014. Final Report: Status of newly discovered cave and spring salamanders [*Eurycea*] in southern Travis and northern Hays counties. Report prepared for TPWD. 29 pp.). After checking a bottle trap 212 times between 2010 and 2015, a juvenile *Eurycea sosorum* was collected from a 61-m deep monitoring well intersecting the Edwards Aquifer. The bottle trap was located approximately 58 m below the ground surface, at a water depth of 38 m. The external morphology and coloring of this specimen appears very similar to topotypical Barton Springs Salamanders, including a "shovel-nose," reduced eyes, and long, slender limbs. The specimen exhibited a combination of pigment gaps and high iridophore concentration that is typical of specimens from the type locality (Chippindale et al. 1993. Herpetologica 49:248–259).

All other known localities are springs, except the Blowing Sink Cave site, which is a shallow (0.5 m deep) cave stream located in a passage approximately 70 m below the surface. Chippindale (2014, *op. cit.*) suggests that three sites in Travis Co. (Barton Springs, Cold Springs, and Blowing Sink Cave) and two sites in Hays Co. (Spillar Ranch Springs and Taylor Springs) represent the additional known localities of this species. USFWS Recovery Permit: TE85077A-1.

KRISTA McDERMID (e-mail: krista@zaraenvironmental.com), **PETER SPROUSE** (e-mail: peter@zaraenvironmental.com), and **JEAN KREJCA**, Zara Environmental LLC, 1707 West FM 1626, Manchaca, Texas 78652, USA (e-mail: jean@zaraenvironmental.com).

***NOTOPHTHALMUS PERSTRIATUS* (Striped Newt)** USA: FLORIDA: Jefferson Co.: Dixie Plantation (30.635456°N, 83.678316°W, WGS 84). 3 May 2015. E. Pierson Hill and Kimberly J. Sash. Verified by Kenneth L. Krysko. Florida Museum of Natural History (FLMNH 175785). New county record (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final report, Florida Fish and Wildlife Conservation Commission, Tallahassee. 524 pp.). We dipnetted six larvae ranging in size from approximately 2.5–3.0 cm TTL. All were found in 0.5–1 m of water near the edge of a grass-dominated ephemeral pond in fire-maintained upland pine woodlands. To verify the species identity, a single larva was taken into captivity where it was raised to metamorphosis and entered the eft stage during the week of July 27. This specimen partially fills a distributional gap between populations formerly existing in Leon and Wakulla counties and populations along the Suwannee River in northern peninsular Florida. The nearest known population (now extirpated) occurred approximately 45 km to the west in Leon Co. (FLMNH 165018). At present, this record represents one of four known extant populations within the range of the western clade of this rare and declining species.

E. PIERSON HILL, Florida Fish and Wildlife Conservation Commission, 5300 High Bridge Rd., Quincy, Florida 32351, USA (e-mail: Pierson.Hill@MyFWC.com); **KIMBERLY J. SASH**, Tall Timbers Research Station and Land Conservancy, 13093 Henry Beadel Dr., Tallahassee, Florida, 32312, USA (e-mail: ksash@ttrs.org).

***NOTOPHTHALMUS PERSTRIATUS* (Striped Newt)**. USA: FLORIDA: Volusia Co: Merritt Island National Wildlife Refuge (28.8277°N, 80.8288°W; WGS 84). 1 May 2015. Stephanie Weiss. Verified genetically by Eric Hoffman. Florida Museum of Natural History (UF-Herpetology 175884 [color photo]). New county record (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final report, Florida Fish and Wildlife Conservation Commission, Tallahassee. 524 pp.). Nearest record is ca. 37.5 km SW near Chuluota, Seminole Co., from 1935 (CM 9454). Nearest record along the Atlantic Coast is 103 km NNW at Faver-Dykes State Park, St. Johns Co. Collected one larva while dipnetting an interdunal swale in scrub habitat.

KEVIN M. ENGE, Florida Fish and Wildlife Conservation Commission, 1105 S.W. Williston Road, Gainesville, Florida 32601, USA (e-mail: kevin.enge@myfwc.com); **STEPHANIE WEISS** and **M. REBECCA BOLT**, Ino-Medic Health Applications, Inc., Mail Code IHA-200, Kennedy Space Center, Florida 32899, USA; **BESS B. HARRIS** and **TRACI D. CASTELLÓN**, Florida Fish and Wildlife Conservation Commission, 1105 S.W. Williston Road, Gainesville, Florida 32601, USA.

***NOTOPHTHALMUS VIRIDESCENS* (Eastern Newt)**. USA: INDIANA: Jefferson Co.: Big Oaks National Wildlife Refuge (38.840166°N, 85.427178°W; NAD 83). 7 May 2015. Jason Mirtl, Benjamin Walker, and Joseph Robb. Verified by Chris Phillips. Illinois Natural History Survey (INHS 2015av, photo voucher). This capture provides a new county record for Indiana (Minton 2001. Amphibians and Reptiles of Indiana, 2nd ed., revised. Indiana Academy of Science. vii + 404 pp.).

SARABETH KLUEH-MUNDY (e-mail: sklueh-mundy@dnr.IN.gov) and **JASON MIRTL**, Wildlife Science Unit, Indiana Department of Natural Resources, Division of Fish and Wildlife, 5596 East State Road 46, Bloomington, Indiana 47401, USA; **BENJAMIN WALKER** (e-mail: benjamin_walker@fws.gov) and **JOSEPH ROBB**, Big Oaks and Muscatatuck National Wildlife Refuge Complex, 1661 West JPG Niblo Road, Madison, Indiana 47250, USA (e-mail: joe_robb@fws.gov).

***NOTOPHTHALMUS VIRIDESCENS LOUISIANENSIS* (Central Newt)**. USA: ARKANSAS: Cleburne Co.: 0.46 km SE of the intersection of Tylar Road and Center Ridge Road (35.52711°N, 91.84973°W; WGS 84), 180 m elev. 19 June 2015. Thomas J. Belford. Verified by William E. Duellman. The University of Kansas Natural History Museum (KUDA 012449). First county record (Trauth et al. 2004 The Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville. 421 pp.; Roberts and Irwin 2012. Arkansas Herpetological Atlas 2012, Distributions of Amphibians and Reptiles. Available online at: http://www.herpsofarkansas.com/wiki/uploads/Herp/Atlas/arherpatlas2012_appendix_a.pdf). A single specimen in eft stage was found crossing the road after a brief summer storm. This record fills a distribution gap among White, Independence, Stone, Van Buren, and Faulkner counties.

THOMAS J. BELFORD (e-mail: thomasbelfordiniraq@yahoo.com) and **CHLOE A. BELFORD**, 37 White Oak Cir, Searcy, Arkansas 72143, USA.

***PSEUDOBRANCHUS STRIATUS* (Northern Dwarf Siren)**. USA: FLORIDA: Santa Rosa Co.: Blackwater River (30.64837°N, 87.01146°W; WGS 84). 29 April 2015. Jason H. O'Connor. Verified by Paul Moler. Florida Museum of Natural History (UF 175647). New record from the Blackwater River, second confirmed county record (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final report, Florida Fish and Wildlife Conservation Commission, Tallahassee. 524 pp.). Six individuals collected in 2002 from the Escambia River drainages expanded the known range 115 km W from the Choctawhatchee River drainage in Walton Co. (Means and Means 2002. Herpetol. Rev. 33[4]:316). This record is 34 km ESE from the Escambia record and partially fills the large gap between that record and the Choctawhatchee record 90 km to the east. Specimen was collected over mucky substrate, using a boat propelled push net in ~ 1.5 m of water.

JASON H. O'CONNOR, Fish and Wildlife Research Institute, Florida Fish and Wildlife Conservation Commission, 8384 Fish Hatchery Road, Holt, Florida 32564, USA; e-mail: Jason.OConnor@MyFWC.com.

***PSEUDOTRITON MONTANUS* (Mud Salamander)**. USA: GEORGIA: Hancock Co.: St. Pauls Church Rd. (33.24679°N, 82.86308°W; WGS 84). 25 May 2015. S. Graham. Verified by John B. Jensen. Sul Ross State University (SRSU 6745–6746). New county record (Jensen et al. 2008. The Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). Adult and recent metamorph found under leaf litter in first-order branch draining a gum pond.

Funding for this collection trip was provided by a grant from the Georgia Department of Natural Resources.

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ANURA — FROGS

***ACRIS CREPITANS* (Eastern Cricket Frog)**. USA: ALABAMA: Coosa Co.: 0.16 road km S of Coosa County Road 56 on Coosa County Road 55, in a wetland/pond on west side of road (33.00544°N, 86.36530°W; WGS 84), 186 m elev. 28 April 2015. David Laurencio

and Christina M. Holbrook. Verified by Craig Guyer. Auburn University Natural History Museum (AUM 41142). New county record (Mount 1975. Reptiles and Amphibians of Alabama. Auburn University Agricultural Experiment Station, Auburn, Alabama. 347 pp.). Specimen collected under General Scientific Collecting Permit No. 8309, issued by the Alabama Department of Conservation and Natural Resources, Wildlife and Freshwater Fisheries Division.

DAVID LAURENCIO, Auburn University Museum of Natural History, Department of Biological Sciences, 101 Rouse Life Sciences Building, Auburn University, Alabama 36849, USA (e-mail: norops@auburn.edu); **CHRISTINA M. HOLBROOK**, Department of Biological Sciences, 101 Rouse Life Sciences Building, Auburn University, Alabama 36849, USA.

***ANAXYRUS AMERICANUS* (American Toad)**. USA: INDIANA: Noble Co.: Crooked Lake (41.268266°N, 85.480650°W; WGS 84). 23 June 2015. Andrew Hoffman, Sierra Hoffman. Verified by Kenneth Krysko. Florida Museum of Natural History (UF-Herpetology 175751, photo voucher). New county record (www.pwrc.usgs.gov:8080/mapserver/naa/; 27 July 2015; Minton 2001. Amphibians and Reptiles of Indiana. 2nd ed., revised. Indiana Academy of Science. vii + 404 pp.). Numerous recently metamorphosed toads found near lakeshore in grass.

ANDREW HOFFMAN (e-mail: hoffmana10@alumni.hanover.edu) and **SIERRA HOFFMAN**, Terre Haute, Indiana 47803, USA (e-mail: sshepard1@sycamores.indstate.edu).

***ANAXYRUS FOWLERI* (Fowler's Toad)**. USA: ALABAMA: Coosa Co.: Coosa County Road 27 at Mitchell Lake (Hatchet Creek) boat launch, 6.0 road km N of AL 22 (32.85842°N, 86.39697°W; WGS 84), 70 m elev. 28 April 2015. David Laurencio and Christina M. Holbrook. Verified by Craig Guyer. Auburn University Natural History Museum (AUM 41144). New county record (Mount 1975. Reptiles and Amphibians of Alabama. Auburn University Agricultural Experiment Station, Auburn, Alabama. 347 pp.). Specimen collected under General Scientific Collecting Permit No. 8309, issued by the Alabama Department of Conservation and Natural Resources, Wildlife and Freshwater Fisheries Division.

DAVID LAURENCIO, Auburn University Museum of Natural History, Department of Biological Sciences, 101 Rouse Life Sciences Building, Auburn University, Alabama 36849, USA (e-mail: norops@auburn.edu); **CHRISTINA M. HOLBROOK**, Department of Biological Sciences, 101 Rouse Life Sciences Building, Auburn University, Alabama 36849, USA.

***ANAXYRUS FOWLERI* (Fowler's Toad)**. USA: INDIANA: Tippecanoe Co.: Granville Sand Barrens (40.396903°N, 87.057626°W; WGS 84) 23 August 2015. Zachary Truelock. Verified by Kenneth Krysko. Florida Museum of Natural History (UF-Herpetology 176029, photo voucher). New county record (Minton 2001. Amphibians and Reptiles of Indiana. 2nd ed., revised. Indiana Academy of Science. vii + 404 pp.). A single juvenile was found hopping along the ground.

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***ARTHROLEPTIS ADELPHUS* (Foulassi Screeching Frog)**. GABON: Ogooué-Ivindo Province: buffer zone of Lopé National Park, Ramba Village (00.3635°S, 11.7872°E; WGS 84), 220 m elev. 5 June 2013. J. G. Larson. Verified by D. C. Blackburn. Museum of Comparative Zoology (MCZ Cryo 2318). Identification was confirmed by mitochondrial data from the 16S rRNA gene (GenBank Accession KT723025). Divergence from verified *A. adelphus* sequences was <2% (Blackburn 2008 Mol. Phylogenet. Evol. 49:806–826). This is the first record of this species in the vicinity of Lopé National Park of Gabon (Christy et al. 2008. Checklist of the Amphibians, Reptiles, Birds, and Mammals of the National Parks of Gabon. Washington, D.C., Smithsonian Institution). It has previously been recorded from Loango and Moukalaba-Doudou national parks. Adjacency to Lopé National Park suggests that this species is also found within park boundaries. This specimen was collected under permits from Centre National de la Recherche Scientifique et Technologique, (CENAREST; AR0013/13), Agence Nationale des Parcs Nationaux (ANPN; AE130014), and Direction de la Faune et de la Chasse (82/DGFAP).

JOANNA G. LARSON, Department of Ecology and Evolutionary Biology, Museum of Zoology, University of Michigan, 1109 Geddes Avenue, Ann Arbor, Michigan 48109, USA (e-mail: jglarson@umich.edu); **BREDA M. ZIMKUS**, Department of Organismic and Evolutionary Biology, Museum of Comparative Zoology, Harvard University, 26 Oxford Street, Cambridge, Massachusetts 02138, USA (e-mail: bzimkus@oeb.harvard.edu).

***CRAUGASTOR AUGUSTI* (Barking Frog)** USA: TEXAS: Brewster Co.: U.S. Hwy 385, 21.3 km N of Marathon (30.33476°N, 103.08096°W; WGS 84). 21 August 2014. S. Graham and C. Kelehear. Verified by Troy Hibbits. Sul Ross State University (SRSU-D 28, digital photo voucher). New county record (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 447 pp.). There is a previous record for *Craugastor augusti* to the southeast from adjacent Terrell Co., Texas (SRSU-A 119; Joe Chandler Ranch near Dryden; 04-17-1964; SRSU records). However, given that Brewster Co. is larger than the state of Rhode Island, our new record represents a substantial (~ 120 km) range extension to the west for *C. augusti* in this region of Texas.

SEAN P. GRAHAM, Department of Biology, Geology, and Physical Sciences, Sul Ross State University, Alpine, Texas 79832, USA (e-mail: sean.graham@sulross.edu); **SKYLER STEVENS**, Department of Natural Resource Management, Sul Ross State University, Alpine, Texas 79832, USA; **CRYSTAL KELEHEAR,** Smithsonian Tropical Research Institute, Apartado 0843-03092, Balboa, Ancon, Panama (e-mail: crystal.kelehear@hotmail.com).

***DUTTAPHRYNUS STOMATICUS* (Marbled Toad)**. BANGLADESH: RAJSHAHI DIVISION: Naogaon District: Patiamly Village (25.060595°N, 88.440832°E; WGS 84) 25.9 m elev. 1 June 2013. Faysal Ahmad. Verified by Monirul H. Khan. Zoology Museum, Department of Zoology, Jagannath University, Dhaka (P1180109, JnU/Zoo/M/Amp/Pho/2015/0010, photo voucher; adult specimen unnumbered); Zoological Reference Collection, Lee Kong Chian Natural History Museum, National University of Singapore (ZRC [IMG] 1.77, photo voucher). First record for Naogaon District, NW Bangladesh. Previously reported from Chittagong, Syllhet and Khulna Division (Hasan et al. 2014. Amphibians and Reptiles of Bangladesh – A Field Guide. Arannayk Foundation, Dhaka. 191 pp.). From grassland habitat including sandy riverine island and coastal mangroves.

FAYSAL AHMAD (e-mail: faysal.nature@gmail.com) and **SHAYER MAHMOOD IBNEY ALAM**, Department of Zoology, Jagannath University, Dhaka 1100, Bangladesh (e-mail: shayermia@hotmail.com).

***ELEUTHERODACTYLUS CYSTIGNATHOIDES* (Rio Grande Chirping Frog)**. USA: ALABAMA: Mobile Co.: 0.85 road km S of AL 217 (Lott Rd.) on Cayton Rd. (30.79687°N, 88.24260°W; WGS 84). 11 February 2013. Raymond McConnell. Verified by Toby

J. Hibbitts. Auburn University Natural History Museum (AUM 40138–40140). New state record (Mount 1975. Reptiles and Amphibians of Alabama. Auburn University Agricultural Experiment Station, Auburn, Alabama. 347 pp.). To our knowledge, this is the first report of this species in Alabama. This locality extends the species range eastward by 275 km from the nearest location in East Baton Rouge, Louisiana (Boundy and Gregory 2012. Herpetol. Rev. 43:113–114). Specimen collected under General Scientific Collecting Permit No. 8309, issued by the Alabama Department of Conservation and Natural Resources, Wildlife and Freshwater Fisheries Division.

RAYMOND McCONNELL (e-mail: raymondmcconnell@gmail.com) and **TAMARA McCONNELL**, 510 Valley Rd, Chickasaw, Alabama 36611, USA; **CRAIG GUYER** and **DAVID LAURENCIO** (e-mail: norops@auburn.edu), Auburn University Museum of Natural History, Department of Biological Sciences, 101 Rouse Life Sciences Building, Auburn University, Alabama 36849, USA.

***ELEUTHERODACTYLUS CYSTIGNATHOIDES CAMPI* (Rio Grande Chirping Frog)**. USA: TEXAS: Colorado Co.: Zimmerscheidt Road at Brushy Creek (29.806490°N, 96.495880°W; WGS 84), 96 m. elev. 12 April 2015. William L. Farr. Verified by Travis J. LaDuc. Texas Natural History Collections (TNHC 95466). This is the first county record for this introduced species, with previous records for two (Austin to the northeast and Fayette to the northwest) of the five adjacent counties previously documented (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. 3rd ed. Texas A&M University Press, College Station. 477 pp.). Numerous additional calls were heard at this locality and at several other localities in the vicinity, indicating the species is well established in northern Colorado Co. The frog was found out and moving under a bridge at 2309 h. during a light rain.

WILLIAM L. FARR, Houston, Texas 77096, USA (e-mail: williamfarr@sbcglobal.net); **MICHAEL R. J. FORSTNER**, Texas State University, Department of Biology, 601 University Drive, San Marcos, Texas 78666, USA (e-mail: MF@txstate.edu).

***ELEUTHERODACTYLUS CYSTIGNATHOIDES* (=*SYRRHOPHUS CYSTIGNATHOIDES*) (Rio Grande Chirping Frog)**. USA: TEXAS: Bell Co.: Cedar Gap Park in Killeen (31.015196°N, 97.650884°W; WGS 84), 190.8 m elev. 13 May 2015. Ciprenio Magno-naoe, Andrew R. MacLaren, Shawn F. McCracken, and Michael R. J. Forstner. Verified by Toby J. Hibbitts. Texas A&M University, Biodiversity Research and Teaching Collections (TCWC 100343,100344). New county record (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 447 pp.). This discovery occurs within the previously documented *E. cystignathoides* expansion between Dallas and Travis counties. We suspect expansion of this species will continue northward. Unvouchered records of *E. cystignathoides* from Bell Co. exist at the Texas Natural History Collection, but this specimen represents the first confirmed and published record of *E. cystignathoides* record from the county. The nearest (previously unreported) record is 29 km E (TNHC 84601). This species was heard during anuran call surveys at Cedar Gap Park on Stillhouse Lake. Two adult specimens (21.7 mm and 22.8 mm SUL) were collected. Both specimens were captured while calling near one another among dead trees and brush. Anuran calls were only heard on the north side of the park where rotting, flotsam logs had accumulated. Hays Co.: Rio Vista Park and Crook Park in San Marcos (29.880149°N, 97.933757°W; WGS 84), 176.5 m elev. 27 April 2015. Ciprenio Magno-Naoe, Andrew R. MacLaren, Shawn F. McCracken, and Michael R. J. Forstner. Verified by Toby J. Hibbitts. TCWC 100341, 100342. New county record (Dixon 2013, *op. cit.*). The nearest previously documented record is ca. 22.5 km E in Caldwell Co. (TNHC 89683). The record fills the distributional gap among the surrounding counties of Travis, Caldwell, Guadalupe, and Comal. This species was initially observed on 25 April 2015 during anuran call surveys. Two adult specimens (25.5 mm and 21.5 mm SUL) were collected 27 April 2015. The first individual was captured in a concrete crevice near railroad tracks at Rio Vista Park. The second individual was captured on top of a fallen tree limb in Crook Park, 0.38 km S of Rio Vista. Numerous additional individuals were heard calling at both sites.

Specimens collected under Scientific Permit SPR-0102-191 issued to Michael R. J. Forstner by Texas Parks and Wildlife Department.

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***ELEUTHERODACTUS PLANIROSTRIS* (Greenhouse Frog)**. USA: ALABAMA: Mobile Co.: 0.48 road km SW of Foster Rd. on County Road 70, then 0.11 air miles N (30.69760°N, 88.23372°W; WGS 84). 11 February 2013. Raymond McConnell. Verified by Toby J. Hibbitts. Auburn University Natural History Museum (AUM 40142). New county record (Mount 1975. Reptiles and Amphibians of Alabama. Auburn University Agricultural Experiment Station, Auburn, Alabama. 347 pp.). Specimen collected under General Scientific Collecting Permit No. 8309, issued by the Alabama Department of Conservation and Natural Resources, Wildlife and Freshwater Fisheries Division.

RAYMOND McCONNELL (e-mail: raymondmcconnell@gmail.com) and **TAMARA McCONNELL**, 510 Valley Rd, Chickasaw, Alabama 36611, USA; **CRAIG GUYER** and **DAVID LAURENCIO** (e-mail: norops@auburn.edu), Auburn University Museum of Natural History, Department of Biological Sciences, 101 Rouse Life Sciences Building, Auburn University, Alabama 36849, USA.

***FEJERVARYA PIERREI* (Pierre's Cricket Frog)**. BANGLADESH: RAJSHAHI DIVISION: Naogaon District: Nazipur (25.024257°N, 88.450155°E; WGS 84), 23.7 m elev. 4 June 2013. Faysal Ahmad. Verified by Mohammad Abdul Wahed Chowdhury. Zoology Museum, Department of Zoology, Jagannath University, Dhaka (JnU/Zoo/M/Amp/Pho/2015/0011, photo voucher; adult specimen unnumbered); Zoological Reference Collection, Lee Kong Chian Natural History Museum, National University of Singapore (ZRC [IMG] 1.80, photo voucher). First record for Naogaon District, NW Bangladesh. Previously reported from Chittagong (Hathazari), Cox's Bazar (Himchari), Noakhali (Hatia Island), and Barisal (Sundargaon), SE Bangladesh (Rasel et al. 2007. Bannoprani-Bangladesh Wildl. Bull. 4:1–2). Adult male collected alongside water canal inside bamboo garden, with wet grassland, and beside a paddy field.

FAYSAL AHMAD (e-mail: faysal.nature@gmail.com) and **SHAYER MAHMOOD IBNEY ALAM**, Department of Zoology, Jagannath University, Dhaka 1100, Bangladesh (e-mail: shayermia@hotmail.com).

***FEJERVARYA TERAIENSIS* (Terai Cricket Frog)**. BANGLADESH: RAJSHAHI DIVISION: Naogaon District: Nazipur High School Para (25.025489°N, 88.450660°E; WGS 84), 24 m elev. 1 June 2013.

Faysal Ahmad. Verified by Mohammad Abdul Wahed Chowdhury. Zoology Museum, Department of Zoology, Jagannath University, Dhaka (JnU/Zoo/M/Amp/Pho/2015/0012, photo voucher; adult specimen unnumbered); Zoological Reference Collection, Lee Kong Chian Natural History Museum, National University of Singapore (ZRC [IMG] 1.78, photo voucher). First record for Naogaon District, NW Bangladesh. Previously reported from Chittagong (Hathazari), Cox's Bazar (Himchari), Noakhali (Hatia Island), and Barisal (Sundargaon) SE Bangladesh (Rasel et al. 2007. Bannoprani- Bangladesh Wildl. Bull. 4:1–2). Adult male collected alongside water canal, in bamboo garden, with *Cynodon dactylon*.

FAYSAL AHMAD (e-mail: faysal.nature@gmail.com) and **SHAYER MAHMOOD IBNEY ALAM**, Department of Zoology, Jagannath University, Dhaka 1100, Bangladesh (e-mail: shayermia@hotmail.com).

***GASTROPHRYNE CAROLINENSIS* (Eastern Narrow-mouthed Toad)**. USA: TENNESSEE: Hardin Co.: Horse Creek Wildlife Sanctuary (35.120374°N, 88.178330°W; WGS 84). 22 July 2015. Lee J. Barton, Joshua P, Kee, and Joshua M. Hall. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19596, color photo). First record for Hardin Co. (Scott and Redmond 2008 [latest update: 17 August 2015]. Atlas of Amphibians in Tennessee. Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Hard copy and Internet versions [http://www.apsu.edu/amatlas/] accessed 9 September 2015). Adult was found calling from under a rock on a pond levee.

LEE J. BARTON, Freed-Hardeman University, 151 E. Main Street, Henderson, Tennessee 38340, USA (e-mail: lbarton@fhu.edu); **JOSHUA P. KEE**, Austin Peay University, 601 College St., Clarksville, Tennessee 37044, USA; **JOSHUA M. HALL**, Auburn University, Auburn, Alabama 36849, USA.

***GASTROPHRYNE OLIVACEA* (Western Narrow-mouthed Toad)**. USA: TEXAS: Midland Co.: I-20 Pond in Midland (31.963610°N, 102.120764°W; WGS84). 7 November 2009. N. Taylor. Verified by Toby Hibbitts. Sul Ross State University (SRSU-D 19–20, digital photo vouchers). New county record (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 447 pp.).

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***HOPLOBATRACHUS CRASSUS* (Jerdon's Bullfrog)**. BANGLADESH: RAJSHAHI DIVISION: Naogaon District: Nazipur (25.024908°N, 88.445576°E; WGS 84), 21 m elev. 5 June 2013. Faysal Ahmad. Verified by Monirul H. Khan. Zoology Museum, Department of Zoology, Jagannath University, Dhaka (JnU/Zoo/M/Amp/Pho/2015/0013, photo voucher; adult specimen unnumbered); Zoological Reference Collection, Lee Kong Chian Natural History Museum, National University of Singapore (ZRC [IMG] 1.81, photo voucher). First record for Naogaon District, NW Bangladesh. Previously reported from Chittagong (Asmat et al. 2003. Univ. Rajshahi J. Zool. 22:141–143). Adult male collected along riverbank in grassland. Habitat includes wet grassland and beside paddy field, as well as *Bambusa arundinacea* plantation.

FAYSAL AHMAD (e-mail: faysal.nature@gmail.com) and **SHAYER MAHMOOD IBNEY ALAM**, Department of Zoology, Jagannath University, Dhaka 1100, Bangladesh (e-mail: shayermia@hotmail.com).

***HYLA AVIVOCA* (Bird-voiced Treefrog)**. USA: TENNESSEE: Carroll Co.: Milan Army Ammunition Plant (35.86300°N, 88.67092° W; WGS 84), 163 m elev. 10 October 2015. Steven Hromada, Mike Iacchetta, and James Flaherty. Verified by A. Floyd Scott. David H. Snyder Museum of Zoology, Austin Peay State University (APSU 19625, color photo). First vouchered record for Carroll Co. (Scott and Redmond. 2008 [latest update: 25 August 2015]. Atlas of Reptiles in Tennessee. The Center of Excellence for Field Biology, Austin Peay State University, Clarksville, Tennessee. http://www.apsubiology.org/tnreptileatlas/, accessed 3 November 2015). Adult male caught in PVC-pipe refugium attached to side of tree along shore of small fishless pond.

STEVEN J. HROMADA (e-mail: shromada@my.apsu.edu), **MICHEAL IACCHETTA**, and **JAMES P. FLAHERTY**, Center of Excellence for Field Biology/Department of Biology, Austin Peay State University, Clarksville, Tennessee 37040, USA.

***HYLA AVIVOCA* (Bird-voiced Treefrog)** USA: TENNESSEE: Hardin Co.: Horse Creek Wildlife Sanctuary (35.111954°N, 88.159158°W; WGS 84). 20 July 2015. Lee J. Barton, Brian P. Butterfield, Wyatt A. Eason, Josh P. Kee, and Eli M. Todd. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19599 audio recording). First record for Hardin Co. (Scott and Redmond 2008 [latest update: 17 August 2015]. Atlas of Amphibians in Tennessee. Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Hard copy and Internet versions [http://www.apsu.edu/amatlas/]. Accessed 9 September 2015). Call was recorded from calling frog in a tree near a small pond in an open grass field.

LEE J. BARTON (e-mail: lbarton@fhu.edu), **BRIAN P. BUTTERFIELD**, and **WYATT A. EASON**, Freed-Hardeman University, 151 E. Main Street, Henderson, Tennessee 38340, USA; **JOSHUA P. KEE**, Austin Peay University, 601 College St., Clarksville, Tennessee 37044, USA; **ELI M. TODD**, University of Tennessee at Martin, 554 University St., Martin, Tennessee 38237, USA.

***HYLA AVIVOCA* (Bird-voiced Treefrog)**. USA: TENNESSEE: Henry Co.: West Sandy WMA on the Old Union road bed (36.301340°N, 88.170398°W; WGS 84). 11 June 2015. Lee J. Barton and Larissa L. Morningstar. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19584 audio recording). New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Hard copy and Internet versions [http://www.apsu.edu/amatlas/]. Accessed 27 July 2015). Call was recorded from road bed.

LEE J. BARTON, Freed-Hardeman University, 151 E. Main Street, Henderson, Tennessee 38340, USA (e-mail: lbarton@fhu.edu); **LARISSA L. MORNINGSTAR**, 620 North Avenue, Henderson, Tennessee 38340, USA.

***HYLA CINEREA* (Green Treefrog)**. USA: ALABAMA: Coosa Co.: 4.0 road km E of US 231 on Coosa County Road 14 (32.81283°N, 86.18506°W; WGS 84), 213 m elev. 28 April 2015. David Laurencio and Christina M. Holbrook. Verified by Craig Guyer. Auburn University Natural History Museum (AUM 41149). New county record (Mount 1975. Reptiles and Amphibians of Alabama. Auburn University Agricultural Experiment Station, Auburn, Alabama. 347 pp.). Specimen collected under General Scientific Collecting Permit No. 8309, issued by the Alabama Department of Conservation and Natural Resources, Wildlife and Freshwater Fisheries Division.

DAVID LAURENCIO, Auburn University Museum of Natural History, Department of Biological Sciences, 101 Rouse Life Sciences Building, Auburn University, Alabama 36849, USA (e-mail: norops@auburn.

edu); **CHRISTINA M. HOLBROOK**, Department of Biological Sciences, 101 Rouse Life Sciences Building, Auburn University, Alabama 36849, USA.

***HYLA CINEREA* (Green Treefrog)**. USA: TENNESSEE: Chester Co.: Waste Management Pond (35.450717°N, 88.609329°W; WGS 84). 30 June 2015. Lee J. Barton and Larissa L. Morningstar. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19577 audio recording). New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Hard copy and Internet versions [http://www.apsu.edu/amatlas/]. Accessed 27 July 2015). Call was recorded from gravel road adjacent to waste management pond.

LEE J. BARTON, Freed-Hardeman University, 151 E. Main Street, Henderson, Tennessee 38340, USA (e-mail: lbarton@fhu.edu); **LARISSA L. MORNINGSTAR**, 620 North Avenue, Henderson, Tennessee 38340, USA.

***HYLA VERSICOLOR* (Eastern Gray Treefrog)**. USA: INDIANA: Noble Co.: Crooked Lake (41.268903°N, 85.482217°W; WGS 84). 23 June 2015. Andrew Hoffman, Sierra Hoffman. Verified by Kenneth Krysko. Florida Museum of Natural History (UF-Herpetology 175746, audio voucher). New county record (www.pwrc.usgs.gov:8080/mapserver/naa/; 27 July, 2015; Minton 2001. Amphibians and Reptiles of Indiana. 2nd ed., revised. Indiana Academy of Science. vii + 404 pp.). Small chorus heard to the west on the other side of the lake.

ANDREW HOFFMAN (e-mail: hoffmana10@alumni.hanover.edu) and **SIERRA HOFFMAN**, Terre Haute, Indiana 47803, USA (e-mail: sshepard1@sycamores.indstate.edu).

***HYLA VERSICOLOR/CHRYSOSCELIS* COMPLEX (Gray Treefrog)**. USA: TENNESSEE: Tipton Co.: Ballard Slough (35.55169°N, 89.88314°W; WGS84). 5 May 2015. Rob Colvin, Jeremy Dennison, and Jake Yoes. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19578, photo voucher). First county record (Scott and Redmond 2008. Atlas of Amphibians in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://www.apsu.edu/amatlas [updated 27 April 2015; accessed 22 July 2015]).

ROBERT COLVIN (e-mail: Rob.Colvin@tn.gov), **JEREMY DENNISON** (e-mail: Jeremy.Dennison@tn.gov), and **JAKE YOES**, Tennessee Wildlife Resources Agency, Region I, 200 Lowell Thomas Drive, Jackson, Tennessee 38301, USA (e-mail: jyduck1@hotmail.com).

***HYLA WRIGHTORUM* (Arizona Treefrog)**. USA: ARIZONA: Cochise Co.: Brown Canyon Ranch (31.475322°N, 110.297749°W; WGS 84). 7 July 2015. Valerie Buxton. Verified by Christopher A. Phillips. Illinois Natural History Survey (INHS 2015aw, photographic voucher). Updated county record (USFWS Species Assessment Form; http://ecos.fws.gov/docs/candidate/assessments/2014/r2/D03S_V02.pdf; 10 July 2015). Multiple males were observed calling from a breeding pond on 7 July 2015 and subsequent dates. These individuals belong to the Huachuca-Canelo distinct population segment. In Arizona, this species has been observed at eight of 13–16 sites within the last two decades, with the majority of these observations noted more than 10 years ago (USFWS Species Assessment Form; *op. cit.*). The current distribution is poorly understood and the species is a candidate for listing under the Endangered Species Act. This record confirms the current distribution of *H. wrightorum* in the Huachuca Mountains.

VALERIE L. BUXTON, Department of Natural Resources and Environmental Sciences, University of Illinois, Champaign, Illinois 61820, USA (e-mail: vbuxton2@illinois.edu); **JOHN KRAFT**, US Forest Service, Hereford, Arizona 85615, USA; **JINELLE H. SPERRY**, Construction Engineering Research Laboratory, Champaign, Illinois 61820, USA.

***INCILIUS NEBULIFER* (Gulf Coast Toad)**. USA: TEXAS: Jim Hogg Co.: FM 1017 S of Hebronville (27.23623°N, 98.65029°; WGS84) 152 m elev. 6 June 2007. Collected by Carl J. Franklin. Verified by Eric N. Smith. Amphibian and Reptile Diversity Research Center, University of Texas at Arlington (UTA A-58124). First county record (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 447 pp.).

This record completes its expected distribution throughout south Texas as it has previously been documented from all surrounding counties. The location is part of the south Texas brush country, with parts of the sand sheet extending into the northern part of the county, making the vegetation highly diverse and consisting of low to mid-sized woody and mostly thorny shrubs, vines, trees, and grasses, and a mixed composition of succulent and thorn brush vegetation in areas with sandy soils.

MAYRA OYERVIDES, Department of Biology, University of Texas-Pan American, 1201 W. University Drive, Edinburg, Texas 78539, USA (e-mail: mgoyervides@broncs.utpa.edu); **CARL J. FRANKLIN**, Amphibian and Reptile Diversity Research Center at the University of Texas at Arlington, Arlington, Texas 76019 (e-mail: Franklin@uta.edu); **FREDERIC ZAIDAN III**, Department of Biology, University of Texas-Pan American, 1201 W. University Drive, Edinburg, Texas 78539, USA (e-mail: fzaidan@utpa.edu).

***LITHOBATES CATESBEIANUS* (American Bullfrog)**. USA: ALABAMA: Coosa Co.: Coosa County Road 27 at Mitchell Lake (Hatchet Creek) boat launch, 6.0 road km N of AL 22 (32.85842°N, 86.39697°W; WGS 84), 70 m elev. 28 April 2015. David Laurencio and Christina M. Holbrook. Verified by Craig Guyer. Auburn University Natural History Museum (AUM 41143). New county record (Mount 1975. Reptiles and Amphibians of Alabama. Auburn University Agricultural Experiment Station, Auburn, Alabama. 347 pp.). Specimen collected under General Scientific Collecting Permit No. 8309, issued by the Alabama Department of Conservation and Natural Resources, Wildlife and Freshwater Fisheries Division.

DAVID LAURENCIO, Auburn University Museum of Natural History, Department of Biological Sciences, 101 Rouse Life Sciences Building, Auburn University, Alabama 36849, USA (e-mail: norops@auburn.edu); **CHRISTINA M. HOLBROOK**, Department of Biological Sciences, 101 Rouse Life Sciences Building, Auburn University, Alabama 36849, USA.

***LITHOBATES CATESBEIANUS* (American Bullfrog)**. USA: INDIANA: Noble Co.: Crooked Lake (41.268903°N, 85.482217°W; WGS 84). 23 June 2015. Andrew Hoffman, Sierra Hoffman. Verified by Kenneth Krysko. Florida Museum of Natural History (UF-Herpetology 175750, photo voucher). New county record (www.pwrc.usgs.gov:8080/mapserver/naa/, accessed 27 July 2015; Minton 2001. Amphibians and Reptiles of Indiana. 2nd ed., revised. Indiana Academy of Science. vii + 404 pp.). Large, adult female found in shallows of lake. Multiple adults heard calling from the lake that night.

ANDREW HOFFMAN (e-mail: hoffmana10@alumni.hanover.edu) and **SIERRA HOFFMAN**, Terre Haute, Indiana 47803, USA (e-mail: sshepard1@sycamores.indstate.edu).

***LITHOBATES PALUSTRIS* (Pickerel Frog)**. USA: TENNESSEE: Hamilton Co.: Residential property off of Signal Forest Drive (35.191909°N, 85.341366°W; WGS 84). 4 August 2015. Joshua R. Ennen and Noah Ennen. Verified Floyd Scott. Center of Excellence for Field Biology, Austin Peay State University (APSU 19586, digital color photo voucher). New county record (Scott and Redmond 1996. Atlas of Amphibians in Tennessee. Austin Peay State University, Clarksville, Tennessee. Updated online version available at http://apbrwww5.apsu.edu/amatlas/index.html [accessed 7 August 2015]). One sub-adult found under a cedar tree at a residential area dominated by oak and hickory trees.

JOSHUA R. ENNEN, Tennessee Aquarium Conservation Institute, Chattanooga, Tennessee 37402, USA; e-mail: jre@tnaqua.org.

***LITHOBATES SYLVATICUS* (Wood Frog)**. USA: ARKANSAS: Carroll Co.: Ninestone land trust, 1.5 km NW Metalton (36.8445°N, 94.0858333°W; WGS 84). 13 June 2015. J. C. Neal. Verified by S. E. Trauth. Arkansas State University Museum of Zoology Herpetology Collection (ASUMZ 33361, photo voucher). Juvenile observed hopping across a trail at the edge of a glade. First county record (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville. 421 pp.). Fills a distributional hiatus among adjacent Boone, Newton, Madison, and Benton counties.

MATTHEW B. CONNIOR, Life Sciences, Northwest Arkansas Community College, One College Drive, Bentonville, Arkansas 72712 USA (e-mail: mconnior@nwacc.edu); **JOSEPH C. NEAL**, 145 E. Cleburn Street, Fayetteville, Arkansas 72701, USA.

***OSTEOPILUS SEPTENTRIONALIS* (Cuban Treefrog)**. USA: ALABAMA: Lee Co.: 0.10 road km NW of Ingleside Dr. on Kinsley Ct. (32.58252°N, 85.45724°W; WGS 84). 12 November 2012. Charles H. Ray. Verified by Toby J. Hibbitts. Auburn University Natural History Museum (AUM 40229). New county record (Mount 1975. Reptiles and Amphibians of Alabama. Auburn University Agricultural Experiment Station, Auburn, Alabama. 347 pp.). To our knowledge, this is just the second documented record for *Osteopilus septentrionalis* in the state of Alabama, the first being an individual found in Mobile County in 2007 (Florida Museum of Natural History [UF 151411]). Our record is an adult female frog found on the inner vertical face of a fiberglass stepladder at a residence in Auburn, Alabama. The residence had received plantings from a nursery in the previous months. While undoubtedly an isolated occurrence, it adds to growing evidence of this species' ability to survive interstate transport. Specimen collected under General Scientific Collecting Permit No. 8309, issued by the Alabama Department of Conservation and Natural Resources, Wildlife and Freshwater Fisheries Division.

DAVID LAURENCIO (e-mail: norops@auburn.edu), **SCOTT GOETZ**, **CRAIG GUYER**, and **CHARLES H. RAY**, Auburn University Museum of Natural History, Department of Biological Sciences, 101 Rouse Life Sciences Building, Auburn University, Alabama 36849, USA.

***PSEUDACRIS CRUCIFER* (Spring Peeper)**. USA: ALABAMA: Coosa Co.: 0.32 road km N of AL 22 on Coosa County Road 27 (32.81702°N, 86.38043°W; WGS 84), 174 m elev. 28 April 2015. David Laurencio and Christina M. Holbrook. Verified by Craig Guyer. Auburn University Natural History Museum (AUM 41146). New county record (Mount 1975. Reptiles and Amphibians of Alabama. Auburn University Agricultural Experiment Station, Auburn, Alabama. 347 pp.). Specimen collected under General Scientific Collecting Permit No. 8309, issued by the Alabama Department of Conservation and Natural Resources, Wildlife and Freshwater Fisheries Division.

DAVID LAURENCIO, Auburn University Museum of Natural History, Department of Biological Sciences, 101 Rouse Life Sciences Building, Auburn University, Alabama 36849, USA (e-mail: norops@auburn.edu); **CHRISTINA M. HOLBROOK**, Department of Biological Sciences, 101 Rouse Life Sciences Building, Auburn University, Alabama 36849, USA.

***PSEUDACRIS FERIARUM* (Upland Chorus Frog)**. USA: ALABAMA: Coosa Co.: 0.16 road km S of Coosa County Road 56 on Coosa County Road 55, in a tire rut on east side of road (33.00506°N, 86.36552°W; WGS 84), 186 m elev. 28 April 2015. David Laurencio and Christina M. Holbrook. Verified by Craig Guyer. Auburn University Natural History Museum (AUM 41136). New county record (Mount 1975. Reptiles and Amphibians of Alabama. Auburn University Agricultural Experiment Station, Auburn, Alabama. 347 pp.). Specimen collected under General Scientific Collecting Permit No. 8309, issued by the Alabama Department of Conservation and Natural Resources, Wildlife and Freshwater Fisheries Division.

DAVID LAURENCIO, Auburn University Museum of Natural History, Department of Biological Sciences, 101 Rouse Life Sciences Building, Auburn University, Alabama 36849, USA (e-mail: norops@auburn.edu); **CHRISTINA M. HOLBROOK**, Department of Biological Sciences, 101 Rouse Life Sciences Building, Auburn University, Alabama 36849, USA.

***SCAPHIOPUS HOLBROOKII* (Eastern Spadefoot)**. USA: INDIANA: Jackson Co.: east of Medora on Highway 235 (38.818851°N, 86.120517°W; NAD 83). 15 July 2015. Sarabeth Klueh-Mundy and Jason Mirtl. Verified by Alan Resetar. Field Museum of Natural History (FMNH 285200, 285201). New county record (Minton 2001. Amphibians and Reptiles of Indiana. 2nd ed., revised. Indiana Academy of Science. vii + 404 pp.) Two individuals were found dead on the road.

Orange Co.: near Millersburg on Highway 56 (38.557306°N, 86.312802°W; NAD 83). 15 July 2015. Sarabeth Klueh-Mundy and Jason Mirtl. Verified by Chris Phillips. Illinois Natural History Survey (INHS 2015au, photo voucher). New county record (Minton 2001, *op. cit.*). Recently metamorphosed individuals found in the road and along the roadside.

Washington Co.: Livonia Community Park (38.557951°N, 86.279225°W; NAD 83). 15 July 2015. Sarabeth Klueh-Mundy and Jason Mirtl. Verified by Chris Phillips. INHS 2015at, photo voucher. New county record (Minton 2001, *op. cit.*). Recently metamorphosed individuals found in the grass near a temporary pool.

SARABETH KLUEH-MUNDY and **JASON MIRTL**, Wildlife Science Unit, Indiana Department of Natural Resources Division of Fish and Wildlife, 5596 East State Road 46, Bloomington, Indiana 47401, USA (e-mail: sklueh-mundy@dnr.in.gov).

***SPEA BOMBIFRONS* (Plains Spadefoot)**. USA: TEXAS: Hall Co.: Hwy 70, 27.4 km S of Clarendon (34.69332°N, 100.89625°W; WGS 84), 665 m elev. 14 July 2015. Thomas J. Belford. Verified by William E. Duellman. University of Kansas Natural History Museum (KUDA 12450). First county record (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 447 pp.). A single adult was found sitting off the shoulder of the road early morning. Fills a distribution gap among Brisco, Motley, Cottle, Childress, Collingsworth, and Donley counties.

GLENN J. MANNING, School of Mathematical and Natural Sciences, University of Arkansas, Monticello, 397 University Dr., PO Box 3480, Monticello, Arkansas 71656, USA (e-mail: manning@uamont.edu); **THOMAS J. BELFORD**, 37 White Oak Cir, Searcy, Arkansas 72143, USA (e-mail: thomasbelfordiniraq@yahoo.com); **BRAD BIRCHFIELD**, 11050 Cain Road, Mountainburg, Arkansas 72946, USA (e-mail:mulebrother@gmail.com); **JEREMY R. SLOAN**, 330 Deerwood Drive, Greenwood, Arkansas 72936, USA (e-mail: jeremy@jeremysloan.us); **JAMES U. VAN DYKE**, School of Science & Health, University of Western Sydney, Building M15, HWK, Locked Bag 1797 Penrith, NSW, 2751, Australia (e-mail: j.Vandyke@uws.edu.au).

***ZAKERANA ASMATI* (Bangladeshi Cricket Frog)**. BANGLADESH: RAJSHAHI DIVISION: Naogaon District: Nazipur (25.025489°N, 88.450660°E; WGS 84), 24 m elev. 11 August 2013. Faysal Ahmad. Verified by Mohammad Abdul Wahed Chowdhury. Zoology Museum, Department of Zoology, Jagannath University, Dhaka (JnU/Zoo/M/Amp/Pho/2015/0014, photo voucher; adult specimen unnumbered); Zoological Reference Collection, Lee Kong Chian Natural History Museum, National University of Singapore (ZRC [IMG] 1.79, photo voucher). First record for Naogaon District, NW Bangladesh. Described from Chittagong, Bangladesh (Howlader 2011. Zootaxa 2761:41–50). Adult female collected alongside water canal, in bamboo garden, near grasslands and paddy fields.

FAYSAL AHMAD (e-mail: faysal.nature@gmail.com) and **SHAYER MAHMOOD IBNEY ALAM**, Department of Zoology, Jagannath University, Dhaka 1100, Bangladesh (e-mail: shayermia@hotmail.com).

TESTUDINES — TURTLES

***APALONE SPINIFERA* (Spiny Softshell)**. USA: FLORIDA: Escambia Co.: Perdido River (30.655631°N, 87.397761°W; WGS84). 27 March 2002. Dale R. Jackson and Robert N. Walker. Verified by Kenneth L. Krysko. Florida Museum of Natural History (UF 175780, 4 photographic vouchers; specimen alive in captivity, 2015). New drainage record (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn Univ. Agric. Exp. Sta., Auburn, Alabama. 347 pp.; Moler 2006. *In* Meylan [ed.], Biology and Conservation of Florida Turtles. Chelon. Res. Monogr. 3. 376 pp.; Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final report, Florida Fish and Wildlife Conservation Commission, Tallahassee. 524 pp.). The undocumented listing of this species in the Perdido River by Jackson (2005. *In* Meshaka and Babbitt [eds.], Amphibians and Reptiles: Status and Conservation in Florida. Kreiger Publ. Co., Malabar, Florida. 317 pp.) was based on this record. This small blackwater river, which flows 80 straight-line km southward to Perdido Bay on the Gulf of Mexico, is situated between the Escambia River and Mobile Bay drainages (both known to support the species) and forms the southernmost portion of the Alabama-Florida state border for much of its length. One of two small adult males observed basking at river's edge in stretch from 2 miles S of Barrineau Park downstream to County Road 184; most of this stretch on the Florida side was subsequently protected as the Perdido River Water Management Area following the survey in which this population was discovered.

A second, older specimen, in the Auburn University Museum of Natural History, is available from the Alabama side of the river, ca. 19.5 straight-line km downstream of UF 175780's capture site. AUM 25123, an adult male, was collected by G. Baldwin on 17 August 1976, 1.0 mile S of US 90, Baldwin Co. (georeferenced as 30.50752°N, 87.44736°W). We thank David Laurencio for providing data for the Alabama specimen.

DALE R. JACKSON, Florida Natural Areas Inventory, Florida State University, 1018 Thomasville Road, Suite 200-C, Tallahassee, Florida 32303, USA (e-mail: drjackson@admin.fsu.edu); **ROBERT N. WALKER**, 1430 North Randolph Circle, Tallahassee, Florida 32308, USA; **GHISLAINE C. GUYOT**, 2311 Bourgogne Drive, Tallahassee, Florida 32308, USA.

***APALONE SPINIFERA* (Spiny Softshell Turtle)** USA: GEORGIA: Lumpkin Co.: Yahoola Creek below the Lake Zwerner Dam (34.543635°N, 83.970744°W; WGS 84). 9 June 2014. Grover J. Brown. Verified by Kenneth L. Krysko. Florida Museum of Natural History (UF 173910). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens, Georgia. 575 pp.). Adult male observed basking at the base of the dam at Lake Zwerner.

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***APALONE SPINIFERA* (Spiny Softshell)**. USA: INDIANA: Howard Co.: Taylor Township, US-31 crossing east fork of Little Wildcat Creek (40.405319°N, 86.110298°W; WGS 84). 3 June 2015. Michael S. Finkler. Verified by Robert Brodman. Illinois Natural History Survey (INHS 2015as, photo voucher). New county record (Minton 2001. Amphibians & Reptiles of Indiana, 2nd ed. Indiana Academy of Science, Indianapolis. 404 pp.). Fills gap in distribution in north-central Indiana. Known from one of six adjacent counties. Two adult females found on northwest side of highway.

MICHAEL S. FINKLER, School of Sciences, Indiana University Kokomo, PO Box 9003, Kokomo, Indiana 46904-9003, USA; e-mail: mfinkler@iuk.edu.

***APALONE SPINIFERA* (Spiny Softshell)**. USA: TENNESSEE: Tipton Co.: Ballard Slough (35.53963°N, 89.88513°W; WGS 84). 9 June 2015. Robert Colvin, Jeremy Dennison, and Jake Yoes. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19579, photo voucher). New county record (Scott and Redmond 2008. Atlas of Reptiles in Tennessee, Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://www.apsu.edu/reptatlas [updated 25 May 2015; accessed 22 July 2015]).

ROBERT COLVIN (e-mail: Rob.Colvin@tn.gov), **JEREMY DENNISON** (e-mail: Jeremy.Dennison@tn.gov), and **JAKE YOES**, Tennessee Wildlife Resources Agency, Region I, 200 Lowell Thomas Drive, Jackson, Tennessee 38301, USA (e-mail: jyduck1@hotmail.com).

***APALONE SPINIFERA GUADALUPENSIS* (Guadalupe Spiny Softshell)**. USA: TEXAS: Guadalupe Co.: Private property at the end of Old Seguin Road (29.79193611°N, 97.93446111°W; WGS 84), 186 m elev. 6 June 2015. Shashwat Sirsi, Ivana Mali, Andrea Villamizar-Gomez, and Michael R. J. Forstner. Verified by Carl J. Franklin. University of Texas at Arlington, Amphibian and Reptile Diversity Research Center (UTADC-8529–8531, photo vouchers). New county record (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 447 pp.). This record fills a distributional gap within the surrounding counties of Bexar, Hays, Comal, Caldwell, Wilson, and Gonzales counties (Dixon 2013, *op. cit.*) This adult female (SCL: 345 mm; W: 3902 g) was encountered alive about 0.23 km NE off the N end of Old Seguin Road and was captured by hand. Specimen (MF37532) was secured under a Scientific Permit for

Research (SPR-0102-191) issued to Michael R. J. Forstner by the Texas Parks and Wildlife Department.

SHASHWAT SIRSI (e-mail: s_s477@txstate.edu), **IVANA MALI**, **ANDREA VILLAMIZAR-GOMEZ**, and **MICHAEL R. J. FORSTNER**, Department of Biology, Texas State University, 601 University Drive, San Marcos, Texas 78666, USA.

***CHELYDRA SERPENTINA* (Snapping Turtle)**. USA: INDIANA: Tippecanoe Co.: Wabash River (40.382976°N, 87.082825°W; WGS 84). 8 May 2015. Zachary Truelock. Verified by Kenneth Krysko. Florida Museum of Natural History (UF-Herpetology 176028, photo voucher). New county record (Minton 2001. Amphibians and Reptiles of Indiana. 2nd ed., revised. Indiana Academy of Science. vii + 404 pp.). A single juvenile was found submerged in the riverbed.

ZACH TRUELOCK, Purdue University, 580 McCutcheon Hall, West Lafayette, Indiana 47907, USA; e-mail: ztrueloc@purdue.edu.

***CHELYDRA SERPENTINA* (Snapping Turtle)**. USA: TENNESSEE: Dyer Co.: Willow Lake, Moss Island WMA (35.966587°N., 89.593333°W; WGS 84). 12 June 2015. Robert Colvin and Jeremy Dennison. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19580, photo voucher). New county record (Scott and Redmond 2008. Atlas of Reptiles in Tennessee, Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://www.apsu.edu/reptatlas [updated 28 July 2014; accessed 22 July 2015]).

ROBERT COLVIN (e-mail: Rob.Colvin@tn.gov), and **JEREMY DENNISON**, Tennessee Wildlife Resources Agency, Region I, 200 Lowell Thomas Drive, Jackson, Tennessee 38301, USA (e-mail: Jeremy.Dennison@tn.gov).

***CHELYDRA SERPENTINA* (Snapping Turtle)**. USA: TEXAS: Caldwell Co.: Approximately 3 miles E of junction US 183 and FM 20 (29.876393°N, 97.619747°W; WGS 84). 8 Oct 2012. Michael R. J. Forstner. Verified by Toby J. Hibbitts. Biodiversity Research and Teaching Collections, Texas A&M University (TCWC 100347). New county record (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 447 pp.). The species was previously reported in all surrounding counties: Bastrop, Travis, Hays, Comal, Gonzales, Guadalupe, and Fayette (Dixon 2013, *op. cit.*), with the nearest record being ~31.9 km SW in Guadalupe Co. (UTADC 8532–8535). One specimen (Carapace Length: 287 mm) found dead on the road. Specimen (MF37547) was secured under a Scientific Permit for Research (SPR-0102-191) issued to Michael R. J. Forstner by the Texas Parks and Wildlife Department.

ANJANA PARANDHAMAN, Department of Biology, Texas State University, 601 University Drive, San Marcos, Texas 78666, USA (e-mail: a_p233@txstate.edu); **IVANA MALI**, Department of Biology, Eastern New Mexico University, 1500 S Ave K Station 33, Portales, New Mexico 88130, USA; **MICHAEL R. J. FORSTNER**, Department of Biology, Texas State University, 601 University Drive, San Marcos, Texas 78666, USA.

***CHYRSEMYS PICTA* (Painted Turtle)** USA: GEORGIA: Lumpkin Co.: Dahlonega, Cavender Creek Road & Rock House Road, 0.1 mi SW (34.558935°N, 83.928445°W; WGS84). 10 July 2014. Grover J. Brown. Verified by Kenneth L. Krysko. Florida Museum of Natural History (UF 173911). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). Subadult female found foraging in the shallows of a small pond.

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***CHRYSEMYS PICTA* (Painted Turtle)**. USA: INDIANA: Tippecanoe Co.: Celery Bog (40.454519°N, 86.936141°W; WGS 84) 28 April 2015. Zachary Truelock. Verified by Kenneth Krysko. Florida Museum of Natural History (UF-Herpetology 176031, photo voucher). New county record (Minton 2001. Amphibians and Reptiles of Indiana. 2nd ed., revised. Indiana Academy of Science. vii + 404 pp.). A single adult was observed and photographed basking on a log. Numerous others were seen but not photographed.

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***GLYPTEMYS INSCULPTA* (Wood Turtle)**. USA: WISCONSIN: Vernon Co.: Township of Whitestown (43.7°N, 90.6°W; WGS 84). 12 July 2009. Ben Johnston. Verified by Joshua M. Kapfer. Illinois Natural History Survey (INHS 2015a, photo voucher). New county record that completes a gap in the species' documented range (Casper 1996. Geographic Distributions of the Amphibians and Reptiles of Wisconsin. Milwaukee Publ. Mus., Milwaukee, Wisconsin. 87 pp.). An individual Wood Turtle was encountered and photographed by Ben Johnston in the Kickapoo Valley Reserve within a dry-mesic forest and approximately 12 m upland from the Kickapoo River corridor. Adjacent habitat includes non-forested emergent wetlands, floodplain forests, fallow upland fields, and agricultural fields. The only published mention of this species in Vernon Co. (Pope 1930. Trans. Wisconsin Acad. Sci. Arts Lett. 25:273–284) was based on a specimen collected by W. R. Spellum in 1928 along the Bad Axe River (Milwaukee Public Museum, MPM 2291, currently listed as "presumed missing"). Our current report supplements six additional unvouchered observations that have been reported intermittently to the Wisconsin Department of Natural Resources' Natural Heritage Inventory database from 1977 through 2011 for Vernon Co.

BEN JOHNSTON, Kickapoo Valley Reserve, S3661 State Road 131, La Farge, Wisconsin 54639, USA (e-mail: ben.johnston@wisconsin.gov); **ANDREW F. BADJE** and **RICHARD A. STAFFEN**, Wisconsin Department of Natural Resources-Bureau of Natural Heritage Conservation, 101 S. Webster St., PO Box 7921, Madison, Wisconsin 53707-7921, USA.

***GRAPTEMYS GEOGRAPHICA* (Northern Map Turtle)**. USA: TENNESSEE: Lawrence Co.: Little Buffalo River in Laurel Hill Wildlife Management Area (35.380142°N 87.513106°W; NAD 83). 13 July 2015. Brian T. Miller. Verified by A. F. Scott. Austin Peay State University (APSU 19609, color photograph). First record for county (Scott and Redmond 2008, latest update: 25 May 2015. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/(accessed 10 September 2015). An adult found alive in stream.

BRIAN T. MILLER (e-mail: brian.miller@mtsu.edu) and **MARSHALL S. BAUGHMAN**, Department of Biology, Middle Tennessee State University, Murfreesboro, Tennessee 37132, USA.

***GRAPTEMYS OUACHITENSIS* (Ouachita Map Turtle)**. USA: OKLAHOMA: Alfalfa Co.: Salt Fork of the Arkansas River, Great Salt Plains State Park (36.746963°N, 98.1337888°W; WGS 84). 7 October 2013. Gregory A. Geller and Deborah A. Geller. Verified by Peter V. Lindeman. Florida Museum of Natural History (UF

176019, 176020; photo vouchers). New county and tributary record (Lindeman 2013. The Map Turtle and Sawback Atlas: Ecology, Evolution, Distribution, and Conservation. University of Oklahoma Press, Norman. 460 pp.). Several male and female turtles observed basking on rocks downstream of Great Salt Plains Lake spillways. As the salinity of the lake water is reported to be approximately one-quarter that of the ocean (Hedglen 2009. Great Salt Plains State Park and National Wildlife Refuge, Encyclopedia of Oklahoma History and Culture; www.okhistory.org [accessed September 03, 2015]), future dietary and physiological studies of this population may prove of interest.

I thank Peter V. Lindeman for alerting me to the significance of these observations and Kenneth L. Krysko for processing the vouchers.

GREGORY A. GELLER, E7503 County Highway C, North Freedom, Wisconsin 53951, USA; e-mail: ggeller54@gmail.com.

***GRAPTEMYS PSEUDOGEOGRAPHICA KOHNII* (Mississippi Map Turtle)**. USA: TEXAS: Brazoria Co.: Freeport, Brazos River (tidal) approximately 10 river km upstream from mouth. (28.964739°N, 95.374234°W; WGS 84). 11 February 2015. Stephen Curtis and Rachel Byrne. Verified by Carl J. Franklin. Amphibian and Reptile Diversity Research Center, University of Texas at Arlington (UTADC 8570–8574, photo vouchers). New county record (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 447 pp.). Hatchling-sized (SCL = 37 mm) individual captured by hand from piling near a boat ramp. This area of the Brazos River is tidally influenced, and salinities of >10 ppt have been recorded at the site. Capture was following a high water flow event (flow = 24,100 cfs; USGS gauge 08116650) which may have displaced the animal to capture location. Salinity at time of capture was 2 ppt. This specimen increases range approximately 134 km (straight line distance) SE from Mill Creek, a Brazos River tributary, in Austin Co., Texas (VertNet database search, http://www.vertnet.org) and 80 km SW from another recent report in Fort Bend Co., Texas (Alleman et al. 2015. Herpetol. Rev. 46:565). Specimen collected under TPWD Scientific Research Permit SPR-0504-383.

BRYAN J. ALLEMAN (e-mail: balleman@alumni.lsu.edu), **RACHEL E. BYRNE**, **STEPHEN G. CURTIS**, **MANDI L. GORDON**, **GEORGE J. GUILLEN**, Environmental Institute of Houston and University of Houston - Clear Lake, Houston, Texas 77058, USA.

***GRAPTEMYS PSEUDOGEOGRAPHICA KOHNII* (Mississippi Map Turtle)**. USA: TEXAS: Fort Bend Co.: approximately 4 km NW of Rosenberg, Brazos River. (29.591457°N, 95.829300°W; WGS 84). 17–18 May 2015. Michael Lane and Jordan Muegge. Verified by Toby J. Hibbitts. Biodiversity Research and Teaching Collections, Texas A&M University (TCWC 100348). New county record (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 447 pp.). Hatchling-sized specimen captured by hand. Captured during high water event in small creeks directly off main stem of the Brazos River. Multiple individuals observed and captured during event in small creeks on same reach of river. Observations include basking adults. Specimen extends range approximately 55 km SE from Mill Creek in Austin Co., Texas (VertNet database search, http://www.vertnet.org), and approximately 80 km NW of recent Brazoria Co., Texas individual (Alleman et al. 2015. Herpetol. Rev. 46:565). Fills county gap between Austin Co. and Brazoria Co. within Brazos River watershed. Specimen collected under TPWD Scientific Research Permit SPR-0504-383.

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***GRAPTEMYS PSEUDOGEOGRAPHICA* (False Map Turtle)**. USA: TENNESSEE: Dyer Co.: Willow Lake, Moss Island WMA (35.948530°N, 89.580649°W; WGS 84). 12 June 2015. Robert Colvin and Jeremy Dennison. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19581, photo voucher). New county record (Scott and Redmond 2008. Atlas of Reptiles in Tennessee, Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://www.apsu.edu/reptatlas [updated 10 March 2014; accessed 22 July 2015]).

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***GRAPTEMYS PSEUDOGEOGRAPHICA PSEUDOGEOGRAPHICA* (Northern False Map Turtle)**. USA: MISSOURI: Atchison Co.: Slough in Missouri River floodplain (40.404842°N, 95.636146°W; WGS 84), 272 m elev. 10 September 2014. Brian Hubbs. Verified by Neftali Camacho. Natural History Museum of Los Angeles County (LACM PC 1860). New county record (Johnson 2000. The Amphibians and Reptiles of Missouri. Missouri Department of Conservation, Jefferson City, Missouri. 400 pp.; Edmond and Daniel 2015. Missouri Herpetological Atlas Project. <http://atlas.moherp.org/> Accessed 12 November 2015). Turtle observed basking on log.

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***KINOSTERNON SUBRUBRUM* (Mississippi Mud Turtle)**. USA: OKLAHOMA: Oklahoma Co.: NE 50th St. and N Bartell Rd (35.52229°N, 97.43267°W; WGS 84), 368 m elev. 12 May 2015. Cameron D. Siler, Brendan B. Heitz, Alyssa M. Anwar, Elizabeth Gorgone-Barbosa, Michelle L. Penrod, Colin Whitsett, Elyse S. Freitas. Verified by Jessa L. Watters. Sam Noble Oklahoma Museum of Natural History (OMNH 44358–44360). New county record (Sievert and Sievert 2011. A Field Guide to Oklahoma's Amphibians and Reptiles. Oklahoma Department of Wildlife Conservation, Oklahoma City, Oklahoma. 211 pp.). The nearest known vouchered specimens are from ca. 38.0 km to the south in Cleveland Co., Oklahoma (OMNH 38292, 40060–40069). These specimens fill a gap in the known distribution of this species in south-central Oklahoma. One juvenile (78.6 mm carapace length; 73.7 mm plastron length; 98.6 g), and two adult males (107.35 mm and 100.5 mm carapace length; 91.9 mm and 84.0 mm plastron length; 260.2 g and 201.7 g) were collected in a flooded grassy depression just southeast of the intersection between NE 50th St and N Bartell Rd. in Oklahoma City. Specimens collected under an Oklahoma Department of Wildlife Conservation Scientific Collecting Permit (#6147) issued to CDS.

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Museum of Natural History, University of Oklahoma, 2401 Chautauqua Avenue, Norman, Oklahoma, 73072-7029, USA (e-mail: camsiler@ou.edu).

MACROCHELYS APALACHICOLAE **(Apalachicola Alligator Snapping Turtle)**. USA: FLORIDA: Holmes Co.: Choctawhatchee River (30.86580°N, 85.88469°W; WGS 84). 13 May 2014. E. Pierson Hill. Verified by Kenneth L. Krysko. Florida Museum of Natural History (UF 175399, color photo). First record for the county (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final report, Florida Fish and Wildlife Conservation Commission, Tallahassee. 524 pp.). Immature basking on shaded willow trunk.

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MACROCHELYS TEMMINCKII **(Alligator Snapping Turtle)**. USA: TENNESSEE: Decatur Co.: Beech River (35.81743°N, 88.22875°W; WGS 84). 24 June 2015. Andrew Pirtle. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19572, photo voucher). New county record (Scott and Redmond 2008. Atlas of Reptiles in Tennessee, Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://www.apsu.edu/reptatlas [updated 9 January 2015; accessed 22 July 2015]).

ROBERT COLVIN, Tennessee Wildlife Resources Agency, Region I, 200 Lowell Thomas Drive, Jackson, Tennessee 38301, USA: e-mail: Rob.Colvin@tn.gov.

PSEUDEMYS CONCINNA **(River Cooter)** USA: GEORGIA: Lumpkin Co.: Tahoe Run, 0.42 mi NW State Road 400, Dahlonega (34.469541°N, 83.975266°W; WGS 84). 26 May 2014. Grover J. Brown. Florida Museum of Natural History (UF 173864). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). A hatchling was found basking along the riverbank.

White Co.: Sautee Nacoochee, State Road 75, 0.09 mi N State Road 17, Helen (34.686503°N, 83.710564°W; WGS 84). 26 June 2014. Grover J. Brown and Theresa S. M. Stratmann. UF 173912. New county record (Jensen et al. 2008, *op. cit.*). Adult female found nesting in a field along State Road 17. Both specimens verified by Kenneth L. Krysko.

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STERNOTHERUS CARINATUS **(Razor-backed Musk Turtle)**. USA: ARKANSAS: Craighead Co.: Jonesboro, Craighead Lake (35.77894°N, 90.70923°W; WGS84). 10 July 2015. John D. Konvalina. Verified by Michael V. Plummer. Arkansas State University Museum of Zoology (ASUMZ 33368, photo voucher). New county record (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. The University of Arkansas Press, Fayetteville, Arkansas. 421 pp.). An adult female (carapace length: 10.3 cm, plastron length: 7.0 cm, carapace width: 7.8 cm, plastron width: 6.3 cm) was captured using a hoop trap baited with fish. This is the first record for this species in northern Arkansas (above the 35°N parallel). The closest previously cataloged specimen was 165.4 km SW in Prairie Co. This specimen was captured and released during a population survey of Craighead Lake. Scientific Collecting Permit (#012320151) issued to SET by the Arkansas Game and Fish Commission.

JOHN D. KONVALINA (e-mail: john.konvalin@smail.astate.edu), **CHRISTOPHER S. THIGPEN** (e-mail: christopher.thigpen@smail.astate.edu), and **STANLEY E. TRAUTH** Department of Biological Sciences, Arkansas State University, P.O. Box 599, State University, Arkansas 72467, USA (e-mail: strauth@astate.edu).

STERNOTHERUS ODORATUS **(Eastern Musk Turtle)**. USA: GEORGIA: Lumpkin Co.: Tahoe Run, 0.42 mi NW State Road 400, Dahlonega (34.469541°N, 83.975266°W; WGS 84). 21 June 2014. Grover J. Brown. Florida Museum of Natural History (UF 173866). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). Adult female found foraging along a riverbank.

White Co.: Sautee Nacoochee, State Road 75, 0.72 mi S State Road 17, Helen (34.675052°N, 83.713761°W; WGS84). 26 June 2014. Grover J. Brown and Theresa S. M. Stratmann. UF 173913. New county record (Jensen et al. 2008, *op. cit.*). Adult male found struck on State Road 17. The turtle was taken to the Chattahoochee Nature Center for treatment and later released in the same area. Both specimens verified by Kenneth L. Krysko.

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STERNOTHERUS ODORATUS **(Eastern Musk Turtle)**. USA: LOUISIANA: Beauregard Parish: 5 km N, 1.75 km W of the intersection of Highways 171 and 110 (30.650919°N, 93.213395°W; WGS 84). 21 July 2014. Grant J. Gregory. Verified by Jeff Boundy. Louisiana Museum of Natural History (LSUMZ 99076). First parish record (Dundee and Rossman 1989. The Amphibians and Reptiles of Louisiana. Louisiana St. Univ. Press, Baton Rouge. 300 pp.).

BEAU B. GREGORY, Coastal and Nongame Resources Division, Louisiana Department of Wildlife and Fisheries, 1213 North Lakeshore Drive, Lake Charles, Louisiana 70601, USA: e-mail: bgregory@wlf.la.gov.

STERNOTHERUS ODORATUS **(Eastern Musk Turtle)**. USA: PENNSYLVANIA: Montour Co.: Montour Preserve (41.096794°N, 76.663693°W; WGS 84), ca. 170 m elev. 21 June 2015. Sean M. Hartzell. Verified by Kenneth L. Krysko. Florida Museum of Natural History (UF 175782, photo voucher). New county record (Hulse et al. 2001. Amphibians and Reptiles of Pennsylvania and the Northeast. Cornell University Press, Ithaca, New York. 419 pp.; www.paherpsurvey.org, accessed 21 June 2015). This record extends the range of *S. odoratus* within eastern Pennsylvania by ca. 25 km NE from the nearest previous record for this species in Northumberland Co. (CM 113393). Individual encountered basking along the shoreline of a small pond.

SEAN M. HARTZELL (e-mail: smh14844@huskies.bloomu.edu) and **AMBER L. PITT**, Department of Biological and Allied Health Sciences, Bloomsburg University of Pennsylvania, Bloomsburg, Pennsylvania 17815, USA (e-mail: apitt@bloomu.edu).

STERNOTHERUS ODORATUS **(Eastern Musk Turtle)**. USA: TENNESSEE: Lawrence Co.: Highway 240 (35.398939°N 87.382581°W, NAD 83), ca. 05. km NE of Buffalo River crossing. 13 July 2015. Brian T. Miller. Verified by A. F. Scott. Austin Peay State University (APSU 19608, color photograph). First record for county, which decreases the size of the conspicuous hiatus in records reported for central Tennessee by Scott and Redmond (2008, latest update: 25 May 2015. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee.

Available at http://apsu.edu/reptatlas/ [accessed 13 July 2015]). An adult found alive on road.

BRIAN T. MILLER (e-mail: brian.miller@mtsu.edu) and **NICHOLAS A. GONDER**, Department of Biology, Middle Tennessee State University, Murfreesboro, Tennessee 37132, USA.

***TERRAPENE CAROLINA CAROLINA* (Woodland Box Turtle)**. USA: INDIANA: Howard Co.: Kokomo, 3601–3699 Briarwick Dr. (40.443491°N, 86.140760°W; WGS 84). 15 June 2014. Aiden E. Stewart. Verified by Alan Resetar. Illinois Natural History Survey photo voucher (INHS 2015ar). New county record (Minton 2001. Amphibians & Reptiles of Indiana, 2nd ed. Indiana Academy of Science, Indianapolis. 404 pp.). Fills gap in distribution in north-central Indiana. Known from three of six adjacent counties.

AIDEN E. STEWART, **JENNIFER SCHOOLCRAFT**, and **MICHAEL S. FINKLER**, School of Sciences, Indiana University Kokomo, PO Box 9003, Kokomo, Indiana 46904-9003, USA (e-mail: mfinkler@iuk.edu).

***TERRAPENE CAROLINA CAROLINA* (Woodland Box Turtle)**. USA: PENNSYLVANIA: Clarion Co.: Intersection of State Road 478 and Freeman Road (41.168766°N, 79.657650°W; WGS 84). 27 May 2015. Elisabeth T. Regester. Verified by Walter Meshaka. Clarion University Vertebrate Collections and Museum (CUP AP500). Adult male. New county record extending range southeast from Venango Co., northeast from Butler Co., and north from Armstrong Co. (Hulse et al. 2001. Amphibians and Reptiles of Pennsylvania and the Northeast. Cornell University Press, Ithaca, New York. xii + 419 pp.; Pennsylvania Amphibian and Reptile Survey: www.paherpsurvey.org, accessed 27 May 2015).

ELISABETH T. REGESTER and **LAUREL T. REGESTER,** 725 Whitehall Road, Emlenton, Pennsylvania 16373, USA; **KURT J. REGESTER**, Department of Biology, Clarion University, Clarion, Pennsylvania 16214, USA (e-mail: kregester@clarion.edu).

***TRACHEMYS SCRIPTA* (Pond Slider)** USA: GEORGIA: Lumpkin Co.: Lake Zwerner, US 19 & Lake Zwerner, 0.61 mi NE, Dahlonega (34.550928°N, 83.963037°W; WGS 84). 23 June 2014. Grover Brown. Verified by Kenneth L. Krysko. Florida Museum of Natural History (UF 173914). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). Adult female was seen basking on a log in Yahoola Creek. Both *T. s. scripta* and *T. s. elegans* were seen at this location, so it is not known if one species was in fact native to the area, or whether both were introduced.

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***TRACHEMYS SCRIPTA ELEGANS* (Red-Eared Slider)** USA: TENNESSEE: Carrol Co.: Hwy 70 (35.844766°N, 88.573212°W; WGS 84). 30 May 2015. Lee J. Barton. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19557, color photo). First record for Carrol Co. (Scott and Redmond 2008 [latest update: 25 May 2015]. Atlas of Reptiles in Tennessee. Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/, accessed 27 July 2015). Adult was found dead on the highway and photographed.

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SQUAMATA — LIZARDS

***ANOLIS CAROLINENSIS* (Green Anole)**. USA: CALIFORNIA: Los Angeles Co.: Los Angeles (34.07801°N, 118.33476°W; WGS 84). 1 October 2013. Two adult males and two adult females collected in an urban neighborhood along the 300 block of N. June St. Gregory B. Pauly. Verified by Neftali Camacho. Natural History Museum of Los Angeles County (LACM 184412–184415). New county record and second state record. An additional 19 specimens were collected 1 August 2014 (LACM 185160–185178) and included a recent hatchling, adult females, and adult males. Additional juveniles and adults were observed but not captured on both days. All individuals were observed in an area with maximum extent of 315 m along a north-south axis and 300 m along an east-west axis. This area covers ca. 65,600 m^2 centered roughly on the intersection of N. June Street and Oakwood Avenue in the Hancock Park neighborhood of Central Los Angeles. Interviews with area residents indicated the anoles had been there since at least 2001. This is the first report of an established *A. carolinensis* population in the county, although a single escaped pet anole was previously found in the county (LACM 131565). The first state record of anoles is of an established population in San Diego Co. where they are found in Balboa Park, in and around the San Diego Zoo (Jones and Lovich 2009. *In* Jones and Lovich [eds.], Lizards of the American Southwest, pp. 50–52. Rio Nuevo Publishers, Tucson, Arizona).

Specimens were collected under California Department of Fish and Wildlife Scientific Collecting Permit No. SC4307.

GREGORY B. PAULY, Natural History Museum of Los Angeles County, Los Angeles, California 90007, USA (e-mail: gpauly@nhm.org); **DAVID B. BORTHWICK**, 325 Binscarth Road, Los Osos, California 93402, USA.

***ASPIDOSCELIS MOTAGUAE* (Giant Whiptail)**. USA: FLORIDA: Monroe Co.: Summerland Key, 594 West Shore Drive, Summerland Key (24.6528°N, 81.441°W; WGS 84). 7 August 2015. Kenneth L. Krysko, Claudia A. MacKenzie-Krysko, and Harrison W. Butchart. Verified by Matthew T. Fedler. Florida Museum of Natural History (UF-Herpetology 175793). First record from the Florida Keys and a new county record (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final report, Florida Fish and Wildlife Conservation Commission, Tallahassee. 524 pp.). Extends range ca. 132 km SW of the nearest known record and population in Miami-Dade Co. (UF-Herpetology 141595). The population on Summerland Key was first detected in 2014. At least 15 individuals of all size classes were observed.

KEVIN M. ENGE (e-mail: kevin.enge@myfwc.com) and **JONATHAN D. MAYS**, Florida Fish and Wildlife Conservation Commission, 1105 S.W. Willison Road, Gainesville, Florida 32601, USA; **KENNETH L. KRYSKO**, **CLAUDIA A. MacKENZIE-KRYSKO**, and **HARRISON W. BUTCHART**, Florida Museum of Natural History, Division of Herpetology, 1659 Museum Road, Gainesville, Florida 32611, USA; **SCOTT COMPTON**, 596 West Shore Drive, Summerland Key, Florida 33042, USA.

***ASPIDOSCELIS NEOMEXICANA* (New Mexico Whiptail)**. USA: ARIZONA: Navajo Co.: Petrified Forest National Park (PEFO) west of Rainbow Forest Museum (34.815480°N, 109.867766°W; NAD 83). 22 August 2010. David N. Velk. University of Arizona Museum of Natural History (UAZ 57584-PSV, digital photo voucher). Two additional digital photo voucher specimens (UAZ 57581-PSV, 57582-PSV) were found in the park in 2011. One digital photo voucher specimen (UAZ 57583-PSV) in 2011 and one collected specimen (UAZ 57573) in 2013 were found ca. 1 km outside of the

south park entrance near US Highway 180. All verified by George Bradley. New county record (Persons and Wright 1999. Herpetol. Rev. 30:207–209; Brennan and Holycross 2006. A Field Guide to Amphibians and Reptiles in Arizona. Arizona Game and Fish Department, Phoenix, Arizona. 150 pp.).

This species was previously known from only one location in Arizona, ca. 26 km N in PEFO in neighboring Apache Co. Intensive pitfall trapping and visual encounter survey efforts have been conducted throughout PEFO for over 15 years (Drost et al. 2001. *In* Proceedings of the Fifth Biennial Conference of Research on the Colorado Plateau, pp. 83–102. U.S. Geological Survey Report Series USGSFRESC/COPL/2001/24; Persons and Nowak. 2006. Inventory of Amphibians and Reptiles in Southern Colorado Plateau National Parks, 186 pp. U.S. Geological Survey Open File Report 2006-1132), suggesting that the species has only recently become established in the southern portion of the park. All specimens were found in sandy shrubland floodplains within plains grassland habitat. Fieldwork was supported by the National Park Service. Permits were issued by the Arizona Game and Fish Department (SP602226 CLS) and Northern Arizona University (IACUC 09-004).

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***ASPIDOSCELIS TESSELATA* (Common Checkered Whiptail).** USA: COLORADO: Bent Co.: Setchfield State Wildlife Area (37.7557°N, 103.255°W; NAD 83). 14 August 2010. Daniel J. Martin. Verified as *A. tesselata* pattern class D by Harry L. Taylor. University of Colorado Museum (UCM AC-187, photo voucher). First confirmed record for this species in Bent Co. (Hammerson 1999. Amphibians and Reptiles in Colorado. University Press of Colorado, Niwot. 484 pp.; The Global Biodiversity Information Facility: GBIF Backbone Taxonomy 2013-07-01, http://www.gbif.org/species/2472276, accessed 1 Nov. 2014). Nearest known records from adjacent counties include: Otero (15 km), Las Animas (21 km), Baca (69 km); no records are reported for Prowers or Kiowa counties. An adult *A. tesselata* was found actively foraging at 0927 h in the sun near a juniper (*Juniperus* sp.). General habitat was juniper and short-grass prairie on top of a small mesa (approximately 1350 m elev.). There was a previous unconfirmed report of *A. tesselata* from Bent Co., "7.5 mi. NE Higbee" (Smith et al. 1965. Summary of the Distribution of the Herpetofauna of Colorado. Univ. Colorado Studies, Series in Biology 15:1–52).

This observation was made opportunistically during a survey for horned lizards (*Phrynosoma* spp.) funded by a Horned Lizard Conservation Society research grant.

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***CRYPTOBLEPHARUS* CF. *SCHLEGELIANUS* (Timor North Coast Snake-eyed Skink).** TIMOR-LESTE: Lautém District: Jaco Island (8.43°S, 127.32°E; WGS 84). 14 August 2015. Tom Martin and Barnabas Harrison. Verified by Andrew Kathriner and Sven Mecke. National Museum of Natural History, Smithsonian Institution, Herpetological Image Collection (USNM-HI 2846a–d, photo voucher). Easternmost record for Timor-Leste, and first record from Jaco, a 10 km^2, low-lying uninhabited island, 750 m E of mainland Timor-Leste's easternmost point (O'Shea et al. 2012. Asian Herpetol. Res. 3:114–126).

Cryptoblepharus schlegelianus (Mertens 1928) described based on SFM 15604, received in 1854 from the collection in Gießen, Germany (Mertens 1928. Zool. Anz. 78:82–89), listed as collected on Timor. However, our research show that material in Gießen was most likely collected by Salomon Müller on Pulau Semau, a small island off SW coast of Timor, near the port at Kupang (see Kaiser et al. 2011. Zookeys 109:19–86). As the point of origin for specimen shipments from the region, material was often erroneously labeled as having been collected on Timor. The species *C. schlegelianus* has only been reliably reported from coastal habitats on Semau (Brongersma 1942. Zool. Meded. Leiden. 24:125–152). A similar species has been collected at Tasi Tolu and Cristo Rei, both Dili District, and Com, Lautém District (O'Shea et al. 2015. Asian Herpetol. Res. 6:73–131), all Timor-Leste. Although similar to *C. schlegelianus*, these specimens exhibit differences in their pattern, scalation, and ecology (see O'Shea et al. 2015. *op. cit.*; HK unpubl. data), and we refer to them conservatively as *C.* cf. *schlegelianus*. Specimens observed on Jaco belong to this eastern, Timor Island population. Whereas *C. schlegelianus* was observed and collected in sandy beach environments on Semau, *C.* cf. *schlegelianus* has heretofore not been observed on sand, but only along rocky shores and on man-made concrete jetties. They have been observed in the splash-zone on rocks or nearby flotsam (Horner 2007. The Beagle, Suppl. 3:21–198).

On Jaco, TM and BH observed four specimens of *C.* cf. *schlegelianus* foraging along rocky shore (an unnumbered habitat photograph associated with USNM-HL 2846 in USNM database), in keeping with behavior and habitat choice of populations recorded at other locations in Timor-Leste and in contrast to those on Semau. Species appears to occur in populous aggregations unlike two other species on Timor-Leste, *C. leschenault* and *Cryptoblepharus* sp. 'Bakhita,' which have only been sighted singly or in pairs (O'Shea et al. 2015, *op. cit.*).

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***EUTROPIS MACULARIA* (Bronze Grass Skink).** BANGLADESH: KHULNA DIVISION: Meherpur District: Amjhupi (23.450661°N, 88.411260°E; WGS 84), 22 m elev. 12 June 2015. Faysal Ahmad. Verified by Shayer Mahmood Ibney Alam. Zoology Museum,

Department of Zoology, Jagannath University, Dhaka (JnU/Zoo/M/Rep/Pho/2015/0005, photo voucher; adult specimen unnumbered); Zoological Reference Collection, Lee Kong Chian Natural History Museum, National University of Singapore, ZRC (IMG) 2.256. First record for Meherpur District. Previously reported from Rangamati District, Bandarban District under Chittagong Division, Sylhet Division and Dhaka Division (Mahony et al. 2009. Hamadryad 34:80–94). Found in litter of bamboo garden, besides paddy field.

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***GAMBELIA WISLIZENII* (Long-nosed Leopard Lizard)**. USA: ARIZONA: Navajo Co.: Petrified Forest National Park (PEFO), Stagecoach parcel (35.046254°N, 109.889643°W; NAD 83). 5 and 7 September 2012. Iain D. Emmons, Erika M. Nowak, and Robert Bowker. Verified by George Bradley. University of Arizona Museum of Natural History (UAZ 57501-PSV, 57502-PSV, 57503-PSV; digital photo vouchers). First records for the species in PEFO (Brennan and Holycross 2006. A Field Guide to Amphibians and Reptiles in Arizona. Arizona Game and Fish Department, Phoenix, Arizona. 150 pp.).

Although there are records for the species on the southern edge of the Colorado Plateau including a sighting 8 km W of the park boundary, these specimens represent the first records for the species in PEFO. The park has been intensively surveyed for over 15 years (Drost et al. 2001. *In* Proceedings of the Fifth Biennial Conference of Research on the Colorado Plateau, pp. 83–102. U.S. Geological Survey Report Series USGSFRESC/COPL/2001/24; Persons and Nowak 2006. Inventory of Amphibians and Reptiles in Southern Colorado Plateau National Parks, 186 pp. U.S. Geological Survey Open File Report 2006-1132). Two individuals were juveniles and one was a subadult, in open and flat sandy shrubland habitat near a floodplain.

We thank PEFO staff for logistical support. Fieldwork was funded by the National Park Service. Permits were issued by the Arizona Game and Fish Department (SP710162 CLS) and Northern Arizona University (IACUC 09-004).

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***HEMIDACTYLUS FRENATUS* (Common House Gecko)**. MÉXICO: BAJA CALIFORNIA: Municipality of Ensenada: Villa Jesus Maria, Taqueria Kassandra restaurant (28.28782°N, 113.99930°W; WGS 84), 29 m elev. 14 March 2015. L. E. Kabes, C. R. Mahrdt, J. H. Valdez-Villavicencio, and M. A. Stepek. Verified by Bradford D. Hollingsworth. San Diego Natural History Museum (SDSNH_HerpPC_05303, photo voucher). First state and northernmost record for this introduced species, extending its known distribution 198 airline km northwest from Santa Rosalia, Municipality of Mulegé, Baja California Sur (Luja et al. 2011. Herpetol. Rev. 42:240). Adult male found active in the shade at 1050 h on the exterior wall of the restaurant building.

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***HEMIDACTYLUS GARNOTII* (Indo-Pacific House Gecko)**. USA: CALIFORNIA: Los Angeles Co.: Torrance (33.86230°N, 118.31284°W; WGS 84). 18 and 20 April 2013. Gregory B. Pauly and Glen Yoshida. Verified by Aaron Bauer. Natural History Museum of Los Angeles County (LACM 183818, 183819). Additional specimens were collected 11 May 2013 (LACM 183877) and 28 September 2013 (LACM 184388–184389). New county and state record. Searches of this urban neighborhood suggest that the geckos are largely confined to a single house lot with gecko activity observed on the house and the cinder block walls around the lot. Geckos have been observed at this location since 2011, including adults, juveniles, and hatched and unhatched eggs. More than 20 observations of *H. garnotii* from this location have been submitted to the Reptiles and Amphibians of Southern California (RASCals) citizen science project (http://www.inaturalist.org/projects/rascals) by one of us (GSY). Geckos have been observed active at this location during all months of the year, including at air temperatures as low as 12.8°C in January (iNaturalist 533905). Further, recent hatchlings have been observed throughout the year including 14 and 26 December 2013 (iNaturalist 481438 and 487834, respectively) and 6 March 2014 (iNaturalist 555869). These observations demonstrate that eggs can successfully incubate and hatch even during the winter months, at least during the unusually warm 2013–2014 Southern California winter.

Orange Co.: Lake Forest (33.64177°N, 117.70660°W; WGS 84). 13–15 June 2013. Gregory B. Pauly and Robert Worrell. Verified by Aaron Bauer. LACM 184194–184196. New county and second state record. On 15 June 2013, an additional specimen was collected ca. 65 m ENE of the first collection site on an adjacent street (LACM 184197; 33.64183°N, 117.70590°W; WGS 84), and another *H. garnotii* was observed but not captured ca. 104 m NE of the first collection site on a low brick wall adjacent to vegetation (33.64213°N, 117.70557°W; WGS 84). All *H. garnotii* in this urban neighborhood were adults found on houses or on walls in front and backyards, often with overhanging or adjacent vegetation. In total, *H. garnotii* in Lake Forest were observed in an area spanning eight house lots (ca. 125 m) on two adjacent streets. Adult and juvenile geckos have been observed at this locality by one of us (RW) since 2009. A second Orange Co. population was documented 19 July 2014 by Anthony C. Huntley. A juvenile and adult female were collected in a neighborhood in the City of Orange (LACM 185970–185971; 33.79788°N, 117.79728°W; WGS 84). Both of the 2013 new county records resulted from observations first submitted as photo vouchers to the Natural History Museum of Los Angeles County (LACM) Lost Lizards of Los Angeles citizen science project which has been expanded into the RASCals project mentioned above.

Specimens were collected under California Department of Fish and Wildlife Scientific Collecting Permit #SC4307.

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***HEMIDACTYLUS PLATYURUS* (Flat-tailed House Gecko)**. BANGLADESH: RAJSHAHI DIVISION: Naogaon District: Patiamly (25.060595°N, 88.440832°E; WGS 84), 26 m elev. 2 May 2014. Faysal Ahmad. Verified by Reza Khan. Zoology Museum, Department of Zoology, Jagannath University, Dhaka (JnU/Zoo/M/

Rep/Pho/2015/0006, photo voucher; adult specimen unnumbered); Zoological Reference Collection, Lee Kong Chian Natural History Museum, National University of Singapore (ZRC [IMG] 2.255, photo voucher). First record for Naogaon District, NW Bangladesh. Previously reported from Rangamati District, Bandarban District, and Cox's Bazar District under Chittagong Division (Mahony et al. 2009. Hamadryad 34:80–94). Adult collected from garden.

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***HEMIDACTYLUS TURCICUS* (Mediterranean Gecko)**. USA: TEXAS: Kerr Co.: Mo Ranch, Hwy 1340 (30.06116°N, 99.47339°W; WGS 84), 607 m elev. 16 April 2015. Biodiversity Collections (formerly Texas Natural History Collections), The University of Texas at Austin (TNHC 95463). Individual collected on wall of Wynne Lodge at 2201 h (21°C). Menard Co.: Menard, Hwy 83 (E. Ellis St.) and FM 2092 (San Saba Ave.) (30.91719°N, 99.78625°W; WGS 84), 575 m elev. 18 April 2015. TNHC 95465. Individual collected on wall of a store front at 2300 h (16°C). Real Co.: Leakey, on Hwy 83 (Market St.) near intersection with Live Oak Circle (29.73309°N, 99.76110°W; WGS 84), 493 m elev. 16 April 2015. TNHC 95462. Individual collected on wall of a restaurant at 2109 h (22°C). These records partially fill a gap in the known distribution (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 447 pp.). Collections were made by William Farr and Limei Farr under a Texas Parks and Wildlife Hunting License (#792960031568). All specimens were verified by Travis J. LaDuc.

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***HEMIDACTYLUS TURCICUS* (Mediterranean House Gecko)**. USA: TEXAS: Kimble Co.: Junction of Interstate 10 and U.S. Hwy 83 (30.507283°N, 99.776233°W; WGS 84), 520 m elev. 22 July 2012. Matthias Helb and Travis J. LaDuc. Verified by Kelsey Hornung. Biodiversity Collections (formerly Texas Natural History Collections), University of Texas at Austin (TNHC 85381). Junction at Interstate 10 and U.S. Hwy 377 (30.506583°N, 99.775717°W), 519 m elev. 31 August 1988. John Rawlins. Verified by Jose Padial. Carnegie Museum of Natural History (CM 125790). These two specimens are new county records (Dixon 2013. Amphibians and Reptiles of Texas. Texas A&M University Press, College Station, Texas. viii + 447 pp.), and fill in the known distribution of this non-native species as it continues to expand its range in Texas.

We thank Greg Pauly for pointing out the significance of these two specimens. TNHC specimen collected under Texas Parks and Wildlife Department Scientific Collecting Permit SPR-1092-917.

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***HOLBROOKIA MACULATA PERSPICUA* (Prairie Earless Lizard)**. USA: TEXAS: Brisco Co.: Specimen was found 0.26 km NW of the Upper Canyon Trailhead, Caprock Canyons State Park (34.44922°N, 101.08283°W; WGS 84) 760 m elev. 13 July 2015. Thomas J. Belford. Verified by William E. Duellman. University of Kansas Digital Archives (KUDA 021417). First county record (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 447 pp.). A single adult specimen was found sitting beside the trail mid day. Fills a distribution gap among Swisher, Floyd, Hall, Armstrong, and Donley counties.

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***OPHISAURUS ATTENUATUS ATTENUATUS* (Western Slender Glass Lizard)**. USA: KANSAS: Lyon Co.: County Road C (38.504413°N, 96.317920°W; WGS 84). 27 October 2013. Andrew Coleman and Greg Sievert. Verified by Curtis J. Schmidt. Sternberg Museum of Natural History (FHSM 16759). New county record (Collins 2010. Amphibians, Reptiles, and Turtles in Kansas. Sternberg Museum of Natural History, Fort Hays State University, Hays, Kansas. 312 pp.). Fills a gap in the known range of this species in eastern Kansas. A single adult male was found DOR following a night of heavy rain. This species is commonly observed in western Lyon Co. at the nearby Ross Natural History Reservation (a 60-ha plot of mixed prairie/woodland), but no specimens have been collected until now.

Collected under a State of Kansas Wildlife Collecting Permit (SC-078-2013).

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***PHELSUMA GRANDIS* (Madagascar Day Gecko)**. USA: FLORIDA: Monroe Co: Cudjoe Key, 23024 Wahoo Lane (24.6602°N, 81.4746°W; WGS 84). 27 July 2015. Angie Martinez. Verified by Kenneth L. Krysko. Florida Museum of Natural History (UF-Herpetology 175808, color photo). New island record and the tenth known island inhabited in the Florida Keys, where the species has been independently introduced (Krysko et al. 2011. Herpetol. Rev. 42:569). At least four individuals have been observed in the area.

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***PLESTIODON GILBERTI* (Gilbert Skink)**. USA: CALIFORNIA: Yolo Co.: ca. 16 km by air SE Davis (38.468252°N, 121.583287°W; WGS 84), 7 m elev. 23 March 2014. Brian Hubbs and Brian Hinds. Verified by Neftali Camacho. Natural History Museum of Los Angeles County (LACM PC 1725, photo voucher). New county record (Rodgers and Fitch 1947. Univ. California Publ. Zool. 48[4]:169–220; Richmond and Jockusch 2007. Proc. Roy. Soc. Lond. B 274:1701–1708). Notably, this report places *Plestiodon*

gilberti west of the Sacramento River and north of the Sacramento-San Joaquin Delta, two significant hydrological impediments to dispersal in respect to known Sierra Nevada populations to the east and coastal populations to the south. Several lizards were observed under cover boards.

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***PODARCIS SICULUS* (Italian Wall Lizard)**. USA: NEW YORK: Westchester Co.: Hastings-on-Hudson (40.994542°N, 73.878746°W; WGS 84). 29 August 2015. Ben A. Goldfarb, Max R. Lambert, and Colin M. Donihue. Verified by Richard D. Durtsche. Yale Peabody Museum of Natural History (YPM HERR.019476). New state record (Gibbs et al. 2007. The Amphibians and Reptiles of New York State. Oxford University Press, New York. 504 pp.). This represents a northern expansion of the distribution for this exotic species in New York State; the species is known from New York City (Gossweiler 1975. Copeia 1975:584–585; Burke and Ner 2005. Northeast. Nat. 12:349–360). Multiple individuals were seen on the same date on multiple properties within a 3500-m^2 area incorporating three houses, a church, and a small strip mall. Specimen collection was authorized under Yale University IACUC protocol number 2015-10681.

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***VARANUS SALVATOR* (Common Water Monitor)**. BANGLADESH: SYLHET DIVISION: Moulvibazar District: Lawachara National Park (25.8907694°N, 88.8502083°E; WGS 84), 50 m elev. 16 June 2014. A. Ghose, E. Arambul, J. Hakim, E. Trageser, S. Trageser, A. Wiscovitz, S. C. Rahman, L. Gilding, M. Jackson, D. Lambert. Verified by M. Monirul H. Khan. Zoological Reference Collection, Lee Kong Chian Natural History Museum, National University of Singapore (ZRC [IMG] 2.226a–c, photo voucher). New record for Moulvibazar District, Bangladesh. Kabir et al. (2009. Encyclopedia of Flora and Fauna of Bangladesh, Vol. 25. Amphibians and Reptiles. Asiatic Society of Bangladesh, Dhaka. 204 pp.) mentioned its occurrence in northeastern Bangladesh, but without voucher photographs or specimens; other records are from Dhaka, Barisal and Chittagong Division. Specimen collected dead on rail track (SVL: 69 cm, TL: 86 cm).

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SQUAMATA — SNAKES

***AGKISTRODON PISCIVORUS* (Cottonmouth)**. USA: GEORGIA: Glascock Co.: Found in small gum swamp along Sandhill Rd. (33.25511°N, 82.724383°W; WGS 84). 25 May 2015. S. Graham. Verified by John B. Jensen. Sul Ross State University (SRSU-D 5, digital photo voucher). New county record (Jensen et al. 2008. The Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). Funding for this collection trip was provided by a grant from the Georgia Department of Natural Resources.

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***AHAETULLA PULVERULENTA* (Brown Vine Snake)**. BANGLADESH: RAJSHAHI DIVISION: Naogaon District: Nazipur (25.040324°N, 88.442922°E; WGS 84), 23 m elev. 16 August 2013. Faysal Ahmad. Verified by Stephen Mahony. Zoology Museum, Department of Zoology, Jagannath University, Dhaka (JnU/Zoo/M/Rep/Pho/2015/0007, photo voucher; adult specimen unnumbered); Zoological Reference Collection, Lee Kong Chian Natural History Museum, National University of Singapore (ZRC [IMG] 2.257, photo voucher). First record for Naogaon District, NW Bangladesh. Previously reported from Sundarbans of Bangladesh as a first country record (Denzau and Denzau 2010. Herpetol. Notes 3:271–272). Adult collected in lower canopy of *Acacia* forest.

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AMASTRIDIUM SAPPERI. MEXICO: QUERÉTARO: Municipio Arroyo Seco: Valle de Jalpan, Hwy 69 at Puente El Sabino (21.472715°N, 99.641983°W; WGS 84), 640 m elev. 27 July 2005. Robert W. Hansen and Dan Vermilya. Verified by Carl Franklin. Amphibian and Reptile Diversity Research Center, University of Texas at Arlington (UTADC 8561, photo voucher). First municipality record and second for Querétaro, extending the range 70 km WNW of La Cueva, Hidalgo (Lara-Tufiño et al. 2014. Revista Mexicana de Biodiversidad 85:654–657) and 55 km WNW of a specimen in Cornell University Museum of Vertebrates (CUMV 10386), from 2.8 miles (4.5 km) W of El Madroño, Querétaro (Calzada-Arciniega and Toscano Flores 2014. Bull. Maryland Herpetol. Soc. 50:42–43). We take this opportunity to clarify collection data associated with CUMV 10386 (collected 29 July 1973), given that there are two locality references with the specimen. According to the collector (W. J. Mautz, *in litt.*), the locality noted above is accurate and corresponds approximately to 21.275653°N, 99.154326°W, 1635 m elev., which exceeds the published elevational maximum of 1600 m (Lara-Tufiño et al. 2014, *op. cit.*). We follow Lara-Tufiño et al. (2014, *op. cit.*) and Lemos-Espinal and Smith (2015. Check List 11[art. 1642]:1–11) in regarding the northern populations as belonging to *A. sapperi*. The snake reported here was found on the road at 2120 h in thornscrub.

We thank William Mautz for examining his field notes from 1973.

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***BOA CONSTRICTOR* (Boa Constrictor)**. USA: PUERTO RICO: Municipality of Cabo Rojo: Cabo Rojo National Wildlife Refuge (17.978958°N, 67.170910°W; NAD 83). 10 November 2014. O. A. Diaz-Marrero. Verified by S. M. Boback. National Museum of Natural History, Smithsonian Institution (USNM Herp Image 2838a, b; photo vouchers). First municipality record for this exotic species; all previous reports were restricted to the Municipality of Mayaguez, located ca. 25 km north of Cabo Rojo National Wildlife Refuge. Reynolds et al. (2013. Biol. Invasions 15:953–959) concluded that Boa Constrictor introductions into Puerto Rico were likely related to the pet trade and that they genetically matched snakes belonging to the South American clade (*B. constrictor*), instead of *B. imperator,* the Mesoamerican species (Hynková et al. 2009. Zool. Sci. 26:623–631). It also represents the first report of this species from a protected area in Puerto Rico.

An interesting feature relates to why the snake was detected in the first place. It was a direct result of USDA/APHIS/Wildlife Services personnel tracking a radio-collared Mongoose (*Herpestes auropunctatus*) as part of a rabies study. The collar was broadcasting a mortality signal that was tracked to the fairly large gravid female *B. constrictor*, which was captured, sacrificed, and later underwent a necropsy that revealed a fully digested mongoose and its functional intact radio collar.

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***CHRYSOPELEA ORNATA* (Ornate Flying Snake)**. BANGLADESH: RAJSHAHI DIVISION: Naogaon District: Nazipur (25.024012°N, 88.445153°E; WGS 84), 25 m elev. 12 August 2013. Faysal Ahmad. Verified by Stephen Mahony. Zoology Museum, Department of Zoology, Jagannath University, Dhaka (JnU/Zoo/M/Rep/Pho/2015/0008, photo voucher; adult specimen unnumbered); Zoological Reference Collection, Lee Kong Chian Natural History Museum, National University of Singapore (ZRC [IMG] 2.258, photo voucher). First record for Naogaon District, northwestern Bangladesh. Previously reported from Khulna, Chittagong and Syllhet Divisions (Hasan et al. 2014. Amphibians and Reptiles of Bangladesh—A Field Guide. Arannayk Foundation, Dhaka. 191 pp.). Adult collected in mid-canopy of *Mangifera* tree in human modified ecosystem; habitat includes primary forest, bush, and scattered forest close to human settlement.

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***COLUBER CONSTRICTOR* (North American Racer)**. USA: ARKANSAS: Franklin Co.: off St. Hwy. 23 at White Oak (35.552646°N, 93.861238°W; WGS 84). 5 July 2015. C. T. McAllister and H. W. Robison. Verified by S. E. Trauth. Arkansas State University Museum of Zoology, Herpetological Collection (ASUMZ 33367). New county record completely filling a hiatus in northwest Arkansas among previous records for adjacent Crawford, Johnson, Logan, and Sebastian counties (Trauth et al. (2004. Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville. 421 pp.). This female, found DOR, contained 14 oviductal eggs.

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***CONIOPHANES IMPERIALIS* (Regal Black-striped Snake)**. MÉXICO: MÉXICO: Municipio de Tonatico: El Zapote (18.783028°N, 99.626722°W; WGS 84), 1662 m elev. 20 October 2014. Carlos A. Rangel-Patiño, Oswaldo Hernández-Gallegos, María de Lourdes Ruiz-Gómez, and Juan M. Carmen-Cristobal. Verified by Oscar Flores-Villela. Colección Fotográfica de Herpetología, Facultad de Ciencias, Universidad Autónoma del Estado de México, Toluca, México (CFH 9–10, photo vouchers). First record for the state of Mexico (Aguilar-Miguel et al. 2009. Ciencia ergo sum 16:171–180), situated 239 km NE of the nearest reported locality at Cuetzalan del Progreso, Puebla (Canseco-Márquez and M. Gutiérrez-Mayén 2006. *In* Ramirez-Bautista et al. [eds.], Inventarios Herpetofaunisticos de México, Avances en el Conocimiento de su Biodiversidad, pp. 180–196. Sociedad Herpetologica Mexicana, Mexico, D.F.). The snake was found beneath a rock near the edge of an agricultural field, in an area originally covered by tropical deciduous forest.

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***CROTALUS VIRIDIS* (Prairie Rattlesnake)**. USA: TEXAS: Gaines Co.: Found on property 4.8 km W of Co. line, just S of Hwy 180 (32.696902°N, 102.257978°W; WGS 84). 15 May 2007. N. Taylor. Verified by Toby Hibbits. Sul Ross State University (SRSU-D 25, digital photo voucher). New county record (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 447 pp.).

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***ERYX CONICUS* (Common Sand Boa)**. BANGLADESH: RAJSHAHI DIVISION: Naogaon District: Nazipur (25.025479°N, 88.450051°E; WGS 84), 23 m elev. 26 October 2013. Faysal Ahmad. Verified by Stephen Mahony. Zoology Museum, Department of Zoology, Jagannath University, Dhaka (JnU/Zoo/M/ Rep / Pho/2015/0009, photo voucher; adult specimen unnumbered); Zoological Reference Collection, Lee Kong Chian Natural History Museum, National University of Singapore (ZRC [IMG] 2.259a–b, photo voucher). First record for Naogaon District, NW Bangladesh. Previously reported from Dhaka Division (Hasan et al. 2014. Amphibians and Reptiles of Bangladesh—A Field Guide. Arannayk Foundation, Dhaka. 191 pp.). Juvenile collected beside riverbank, within human modified ecosystem.

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***FARANCIA ABACURA* (Red-bellied Mudsnake)**. USA: GEORGIA: Hancock Co.: Found DOR along Sandersville Hwy, State Rt. 15 (33.23709°N, 82.91086°W; WGS 84). 25 May 2015. Sean Graham. Verified by John B. Jensen. Sul Ross State University (SRSU-D 3–4, digital photo vouchers). New county record (Jensen et al. 2008. The Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). Funding for this collection trip was provided by a grant from the Georgia Department of Natural Resources.

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***FORDONIA LEUCOBALIA* (Crab-eating Snake)**. BANGLADESH: KHULNA DIVISION: Bagerhat District: Sundarbans Reserve Forest, Tambulbunia Forest Station (22.21178°N, 89.69746°E; WGS 84). 17 July 2015. Jon Hakim. Verified by S. M. A. Rashid. Zoological Reference Collection, Lee Kong Chian Natural History Museum, National University of Singapore (ZRC [IMG] 2.252a–b, photo voucher). First confirmed record from Sundarbans Reserve Forest, a ca. 6000-km^2 tract of mangrove forest, as well as a UNESCO World Heritage Site, located in southwestern Bangladesh. Nearest recorded population ca. 245 km SE, from Sonadia Island, Cox's Bazaar (Rahman et al. 2014. Herpetol. J. 24:123–128). Its range has been described as throughout coastal Bangladesh (Hasan et al. 2014. Amphibians and Reptiles of Bangladesh—A Field Guide. Arannayk Foundation, Dhaka. 191 pp.), but with no voucher cited. Specimen encountered during night survey on mud bank at ca. 0105 h.

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***HETERODON PLATIRHINOS* (Eastern Hog-nosed Snake)**. USA: GEORGIA: Glascock Co.: Beall Springs Rd. near intersection with School Circle Dr. (33.24530°N, 82.60656°W; WGS 84). 26 May 2015. S. Graham. Verified by John B. Jensen. Sul Ross State University (SRSU-D 6–7, digital photo vouchers). New county record (Jensen et al. 2008. The Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). Found DOR. Funding for this collection trip was provided by a grant from the Georgia Department of Natural Resources.

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***HYPSIGLENA JANI* (Chihuahuan Nightsnake)**. USA: TEXAS: Gaines Co.: Found on property E of CR 141, 0.8 km N of Hwy 180 (32.709153°N, 102.289853°W; WGS 84). 17 May 2015. N. Taylor. Verified by Toby Hibbitts. Sul Ross State University (SRSU-D 26–27, digital photo vouchers). New county record (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 447 pp.).

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***INDOTYPHLOPS BRAMINUS* (Brahminy Blindsnake)**. MÉXICO: CHIHUAHUA: Municipality of Chihuahua: Chihuahua city (28.654772°N, 106.088592°W; WGS 84), 1440 m elev. 7 May 2015. Fidel González-Quiñones. Verified by Bradford Hollingsworth. San Diego Natural History Museum (SDSNH_HerpPC_05274–05276, photo vouchers). New state record, with the closest known locality being ca. 477 airline km W in Hermosillo, Sonora (Quijada-Mascareñas and Enderson 2007. Herpetol. Rev. 38:490). This exotic snake was found in the gardens of the Philosophy and Letters Faculty building, Universidad Autónoma de Chihuahua.

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***LAMPROPELTIS CALLIGASTER CALLIGASTER* (Prairie Kingsnake)**. USA: ARKANSAS: Sevier Co.: 12.8 km NNE of Lockesburg off US 70 at Co. Rd. 333 (34.052344°N, 94.17323°W; WGS 84). 5 September 2015. C. T. McAllister. Verified by S. E. Trauth. Arkansas State University Museum of Zoology, Herpetological Collection (ASUMZ 33378). New county record partially filling a hiatus in far southwestern Arkansas among previous records for the adjacent counties of Howard and Polk (Trauth et al. (2004. Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville. 421 pp.).

Specimen collected DOR under Scientific Collecting Permit (31120151) issued to CTM by Arkansas Game and Fish Commission.

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***LAMPROPELTIS CALLIGASTER* (Prairie Kingsnake)**. USA: TEXAS: Guadalupe Co.: Green Valley Road approximately 2.0 km W of the intersection of Green Valley Road and FM 1044 (29.64334°N, 98.15457°W; WGS 84). 13 June 2015. Romey L. Swanson and Erin Y. Swanson. Verified by Travis LaDuc. Texas Natural History Collection (TNHC 96347). New county record (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps, Texas A&M University Press, College Station. 447 pp.). This individual was collected DOR and measured 528.0 mm SVL and 43.7 g. This record fills a distributional gap in the Post Oak Savannah ecoregion adjacent to Bexar Co. to the west and Comal, Hays, and Caldwell counties to the north and northeast. Habitat adjacent to the road was comprised of active agriculture fields. We previously found another individual alive on 4 May 2015 approximately 2.2 km N within Comal

Co. at the intersection of Morningside Drive and Ron Road in New Braunfels, Texas (29.66345°N, 98.15495°W; WGS 84).

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***LAMPROPELTIS GETULA SPLENDIDA* x *HOLBROOKI* (Desert/Speckled Kingsnake intergrade)**. USA: TEXAS: Hall Co.: 23.4 km S of Clarendon, on Hwy 70 (34.73060°N, 100.89854°W; WGS 84), 694 m elev. 11 July 2015. Brad Birchfield. Verified by William E. Duellman. University of Kansas Digital Archives (KUDA 12452). First county record (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 447 pp.). A single juvenile specimen was found crossing the road after dusk. Fills a distribution gap among Brisco, Motley, Cottle, and Childress counties.

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***LAMPROPELTIS RUTHVENI* (Ruthven's Kingsnake)**. MEXICO: GUANAJUATO: Municipio Coroneo: ca. 6.3 km by air SE of Coroneo (20.1687827418°N, 100.41871356°W; WGS 84), 2222 m elev. August 2007. Ronald Savage. Amphibian and Reptile Diversity Research Center, University of Texas at Arlington (UTADC 8583, photo voucher). Municipio Acámbaro: Sierra de los Agustinos, communidad San Luis de Los Agustinos (20.19255°N, 100.69271°W), 2235 m elev. 16 June 2011. Oscar Alejandro Morales. UTADC 8581, photo voucher. Municipio Yuriria: Cerro de los Amoles, Communidad Cerécuaro (20.07490°N, 101.35326°W), 2224 m elev. 14 May 2015. Raúl Hernández Arciga. UTADC 8582, photo voucher. All the above records reported herein were verified by Carl Franklin and represent first records for Guanajuato and their respective municipalities (Garstka 1982. Breviora 466:1–35; Lohrberg 1991. Sauria, Berlin 13:27–30). *Lampropeltis ruthveni* is endemic to central Mexico and was presumed to occur in southern Guanajuato based on records from the bordering states of Jalisco, Michoacán, and Querétaro. Range maps (www.sierraherps.com/distribution; accessed 14 June 2015) have anticipated its occurrence all across the east–west extent of the Transverse Volcanic Axis, including at the eastern margin of the species' range in Hidalgo, where it was recently confirmed (Roth-Monzón et al. 2011. Southwest. Nat. 56:430–431).

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***LAMPROPELTIS TRIANGULUM SYSPILA* (Red Milksnake)**. USA: TENNESSEE: Tipton Co.: Leigh Chapel Road (35.592064°N, 89.667890°W; WGS 84). 16 April 2015. John David and Robert Colvin. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19582, photo voucher). First county record (Scott and Redmond 2008. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. http://www.apsu.edu/reptatlas [updated 28 July 2014; accessed 22 July 2015]).

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***LYCODON TRAVANCORICUS* (Travancore Wolf Snake)**. INDIA: GUJARAT: Dang District: Vansda National Park (20.7540722°N, 73.4874361°E; WGS 84), 129 m elev. 3 October 2015. Maitry Jani and Milan Sojitra. Verified by S. R. Ganesh. Zoological Reference Collection, Lee Kong Chian Natural History Museum, National University of Singapore (ZRC [IMG] 2.254a–b, photo voucher). New state record and new northernmost limit of snake (Whitaker and Captain 2004. Snakes of India, The Field Guide. Draco Books, Chennai. 479 pp.). Nearest published locality is ca. 195 km SW in Matheran, Maharashtra (Whitaker and Captain 2004, *op. cit.*).

Documentation made during Gujarat Butterfly and Moth Meet, organized by Serenity Library in south Dang division, Vansda National Park. Thanks to K. Patel, S. Singhal, U. Zala, and Y. Dabholkar for participating in documentation and to the Department of Zoology, Maharaja Sayajirao University for support to MJ.

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***MICRURUS TENER* (Texas Coralsnake)**. USA: TEXAS: Starr Co.: 1357 FM 2686 (26.704281°N, 98.651436°W; WGS84). 15 August 2015. Mayra Oyervides and Frederic Zaidan III. Verified by Andrew Gluesenkamp. University of Texas-Pan American vertebrate museum (08151, photo voucher). First vouchered county record (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps, Texas A&M University Press, College Station, Texas. 447 pp.) Dixon (2013, *op. cit.*) notes the presence of the species in Starr Co. but extensive searches using online databases such as GBIF.org, VertNet.org, and literature failed to produce records of any vouchered specimens. One adult individual was found at 2355 h on FM 2686 moving across the road. The specimen was photographed *in situ*. The location is part of the south Texas brush country, characterized by frequent droughts and mostly low to mid-size thorny and woody shrubs, trees, and vines.

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***NINIA ATRATA* (Hallowell's Coffee Snake)**. COLOMBIA: GUAVIARE: San José del Guaviare, vereda La María, embalse La María, Caño Arenales (2.529217°N, 72.692036°W; Bogotá WGS 84), 206 m elev. 5 October 2013. Martha L. Calderón and Guido F. Medina-Rangel. Verified by Martha L. Calderón. Colección de Reptiles, Instituto de Ciencias Naturales, Universidad Nacional de Colombia, Bogotá (ICN 12510–12512). This snake is known from eastern Panama to the Pacific lowlands of Ecuador, reaching northern Venezuela and Trinidad and Tobago, from sea level up to 1600 m elev. (McCranie and Wilson 1995. J. Herpetol. 29:224–232; Köhler 2008. Reptiles of Central America, 2nd ed. Herpeton, Offenbach. 400 pp.; Meza-Joya 2015. Check List 11:1584). In Colombia, is

known from the west (transandean) and the foothills of the Cordillera Oriental, in addition to a record in Leticia, Amazon department (Angarita-Sierra 2009. Pap. Avul. Zool. 49:277–288; Meza-Joya 2015, *op. cit.*). Although the snake is widely distributed to the west of the Eastern Cordillera and in the foothills east of it, until now there were no records in the Guyana Shield of Colombia. This is the first record for the Guyana region in Colombia, and extends species range ca. 140 km SW from the nearest known Colombian locality (Angarita-Sierra 2009, *op. cit.*). Permits were issued by Corporación para el Desarrollo Sostenible del Norte y Oriente Amazónico-CDA (Resolución No. DSGV-112, 25 October 2012).

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***NINIA DIADEMATA* (Ringneck Coffee Snake)**. MÉXICO: HIDALGO: Municipality of Tenango de Doria: El Damo (20.3332844°N, 98.2119598°W; WGS 84), 1537 m elev. 14 March 2015. Cristian Raúl Olvera-Olvera. Verified by Luis Canseco-Márquez. Colección Herpetológica Fotográfica, Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo, Pachuca (CH-CIB 31). First verified locality record within the municipality, extending the known range in the state ca.7.86 km S from the nearest record in the municipality of San Bartolo Tutotepec (Ramírez-Bautista et al. 2014. Los Anfibios y Reptiles del Estado de Hidalgo, México: Diversidad, Biogeografía y Conservación. Sociedad Herpetológica Mexicano, Pachuca, Hidalgo, México. xi + 387 pp.). Ramirez-Bautista et al. (2014, *op. cit.*) did not a specific locality within the municipality of Tenango de Doria, but did depict an individual from that municipality in Foto 214. The snake reported here, along with eight others of the same species, were found in a pasture under a rock on a cattle ranch.

LEONARDO FERNÁNDEZ-BADILLO, Laboratorio de Sistemática Molecular, Centro de Investigaciones Biológicas (CIB), Universidad Autónoma del Estado de Hidalgo, A.P. 1-69 Plaza Juárez, Pachuca, Hidalgo, México and Predio Intensivo de Manejo de Vida Silvestre X-Plora Reptilia, Reyna de la Esperanza # 107. Col. Paseo de las Reinas, 1ª Sección, Mineral de la Reforma, Hidalgo, México (e-mail: cyrtopsis@hotmail.com); **CRISTIÁN RAÚL OLVERA-OLVERA**, **MARIANA BURGOS-TORRES**, **LIZBETH VEGA-CHÁVEZ**, and **JAZMIN MONTER-VARGAS**, Centro de Investigaciones Biológicas (CIB), Universidad Autónoma del Estado de Hidalgo, A.P. 1-69 Plaza Juárez, Pachuca, Hidalgo, México.

***OPHEODRYS AESTIVUS* (Rough Greensnake)**. USA: ARKANSAS: Lee Co.: Lone Point Campground at Bear Creek Lake off County Rd. 223, St. Francis National Forest (34.715334°N, 90.695649°W; WGS 84). 6 July 2008. T. Wilcoxen. Verified by S. E. Trauth. Arkansas State University Museum of Zoology, Herpetological Collection (ASUMZ 33369, photo voucher). New county record (Trauth et al. 2004. Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville. 421 pp.). This record partially fills a hiatus in eastern Arkansas (Crowley's Ridge) among previous records for adjacent Phillips and St. Francis counties.

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***OPHEODRYS AESTIVUS* (Rough Greensnake)**. USA: TENNESSEE: Tipton Co.: Ballard Slough (35.55195°N, 89.88204°W; WGS 84). 5 May 2015. Robert Colvin, Jeremy Dennison, and Jake Yoes. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19583 photo voucher). First county record (Scott and Redmond 2008. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. http://www.apsu.edu/reptatlas [updated 28 July 2014; accessed 22 July 2015]).

ROBERT COLVIN (e-mail: Rob.Colvin@tn.gov), **JEREMY DENNISON** (e-mail: Jeremy.Dennison@tn.gov), and **JAKE YOES**, Tennessee Wildlife Resources Agency, Region I, 200 Lowell Thomas Drive, Jackson, Tennessee 38301, USA (e-mail: jyduck1@hotmail.com).

***PANTHEROPHIS GUTTATUS* (Red Cornsnake)**. USA: TENNESSEE: Loudon Co.: 35.720863°N, 84.2491712°W (WGS 84), 263 m elev. 6 June 2015. Barbara Grove. Verified by John Jensen. Auburn University Natural History Museum (AHAP-D 1072, photo voucher). This observation represents a new county record, although the species is known from surrounding counties (Scott and Redmond 2008 <updated 25 May 2015>. Atlas of Reptiles in Tennessee. The Center of Excellence for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/; accessed 12 June 2015). This adult snake was found dead in garden netting.

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***PANTHEROPHIS OBSOLETUS* (Western Ratsnake)**. USA: IOWA: Winneshiek Co.: Cliffs along Upper Iowa River (43.4317°N, 91.9363°W; WGS 84). 21 June 2015. Mathew Terronez. Verified by Benjamin Lowe. Photographic record deposited in the James Ford Bell Museum (JFBM P503) as well as on HerpMapper.org (HM 59209; www.herpmapper.org/record/59209). Kayaker observed pair of adult ratsnakes along cliff directly below a cliff swallow community. LeClere (2013. A Field Guide to the Amphibians and Reptiles of Iowa. ECO Herpetological Publishing & Distribution, Rodeo, New Mexico. 350 pp.) lists a pre-1950 record for this species in Winneshiek Co. To the best of our knowledge this observation represents an updated county record for *P. obsoletus* in Winneshiek Co., Iowa. We thank Mathew Terronez for reporting his observation to HerpMapper.org.

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***PANTHEROPHIS SPILOIDES* (Gray Ratsnake)**. USA: INDIANA: Tippecanoe Co.: Ross Hills Park (40.40454°N, 87.072579°W; WGS 84) 2 September 2015. Zachary Truelock. Verified by Kenneth Krysko. Florida Museum of Natural History (UF-Herpetology 176030, photo voucher). New county record (Minton 2001. Amphibians and Reptiles of Indiana. 2nd ed., revised. Indiana Academy of Science. vii + 404 pp.). An adult was observed crawling along the forest floor.

ZACH TRUELOCK, Purdue University, 580 McCutcheon Hall, West Lafayette, Indiana 47907, USA; e-mail: ztrueloc@purdue.edu.

***PORTHIDIUM LANSBERGII* (Lansberg's Hognosed Pitviper)**. COLOMBIA: HUILA: Gigante, vereda Matambo, Finca La Ensillada (2.37515833°N, 75.637275°W; Bogotá WGS 84), 985 m elev. 8 November 2014. Y. R. López Perilla. Verified by G. Cárdenas-Arévalo. Colección de Reptiles, Instituto de Ciencias Naturales, Universidad Nacional de Colombia, Bogotá (ICN 12533). Finca La Enea (2.3478278°N, 75.631322°W; Bogotá WGS 84), 889 m

elev. 10 October 2014. Guido F. Medina-Rangel. Verified by G. Cárdenas-Arévalo. ICN 12534. This species is known from central and eastern Panama, northern Colombia, and Venezuela, from sea level to 1000 m elev. (www.reptile-database.org; 8 Sept 2015); it was not recorded in the Biogeographic Chocó region, and records from Ecuador are *Porthidium arcosae* (Campbell and Lamar 2004. The Venomous Reptiles of the Western Hemisphere, Vol. I. Comstock/Cornell University Press, Ithaca, New York. 503 pp.). This snake is found in arid and semiarid plains in Colombia, from northern Choco and Antioquia, coastal Caribean lowlands, and from Rio Magdalena valley, up to Honda, Tolima (Nicéforo-María 1930. Revista de la Sociedad Colombiana de Ciencias Naturales 19:96–104; Campbell and Lamar 2004, *op. cit.*). This record extends the range ca. 325 km S from the nearest known locality around Honda, Tolima department, Colombia (Niceforo-Maria 1930, *op. cit.*; Campbell and Lamar 2004, *op. cit.*). Specimen collected under research permits from Autoridad Nacional de Licencias Ambientales –ANLA (Resolución No. 0899, 15 May 2009).

GUIDO F. MEDINA-RANGEL, Instituto de Ciencias Naturales, Universidad Nacional de Colombia, Apartado Aéreo 7495, Bogotá D.C., Colombia (e-mail: gfmedinar@unal.edu.co); **YENY ROCÍO LÓPEZ-PERILLA**, Universidad Pedagógica y Tecnológica de Colombia UPTC, Tunja, Boyacá, Colombia (e-mail: yrocio.lopez@gmail.com).

***REGINA SEPTEMVITTATA* (Queensnake)**. USA: TENNESSEE: Hardin Co.: Horse Creek Wildlife Sanctuary (35.115051°N, 88.149375°W; WGS 84). 21 July 2015. Lee J. Barton, Larissa L. Morningstar, and Joshua M. Hall. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19598, color photo). First record for Hardin Co. (Scott and Redmond 2008 [latest update: 25 May 2015]. Atlas of Reptiles in Tennessee. Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/, accessed 9 September 2015). Individual was captured in a clear, shallow stream with a loose gravel bottom with some scattered larger rocks. This individual was preparing to shed as determined by opaque eye coloration.

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***RENA DISSECTUS* (New Mexico Threadsnake)**. USA: TEXAS: Gaines Co.: 4.8 km W of Co. line, just S of Hwy 180 (32.696117°N, 102.258704°W; WGS 84). 19 June 2013. N. Taylor. Verified by Toby Hibbitts. Sul Ross State University (SRSU-D 17–18, digital photo vouchers). New county record (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 447 pp.).

NATHAN CALEB TAYLOR (e-mail: ntay8638@sulross.edu) and **SEAN P. GRAHAM**, Department of Biology, Geology, and Physical Sciences, Sul Ross State University, Alpine, Texas 79830, USA (e-mail: sean.graham@sulross.edu).

***RHABDOPHIS SUBMINIATUS* (Red-necked Keelback Snake)**. BANGLADESH: RAJSHAHI DIVISION: Naogaon District: Altadeghee National Park (20.111401°N, 88.515201°E; WGS 84), 32 m elev. 19 April 2014. Faysal Ahmad. Verified by Stephen Mahony. Zoology Museum, Department of Zoology, Jagannath University, Dhaka (JnU/Zoo/M/Rep/Pho/2015/0010, photo voucher; adult specimen unnumbered); Zoological Reference Collection, Lee Kong Chian Natural History Museum, National University of Singapore (ZRC [IMG] 2.260, photo voucher). First record for Naogaon District, NW Bangladesh. Previously reported from Bandarban District, Cox's Bazar District under Chittagong Division and Maulvibazar District under Sylhet Division (Mahony et al. 2009. Hamadryad 34:80–94), and Syllhet and Chittagong Divisions (Hasan et al. 2014. Amphibians and Reptiles of Bangladesh—A Field Guide. Arannayk Foundation, Dhaka. 191 pp.). Adult collected in *Shorea robusta* forest: a habitat including grasslands, marshes, and paddy fields.

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***RHADINAEA FLAVILATA* (Pine Woods Littersnake)**. USA: FLORIDA: Okaloosa Co.: Destin, Bambi Dr and Cobbs Point Rd (30.414877°N, 86.486520°W; WGS 84). 20 August 2015. A. C. Hillman, K. C. Jones, and A. N. Dugan. Verified by Kenneth Krysko. Florida Museum of Natural History (UF 172559). First record for county (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final report, Florida Fish and Wildlife Conservation Commission, Tallahassee. 524 pp.). Extends the range roughly 12.63 km from the closest known specimens (KU 220921, 222307, 222308) from Walton Co. A single juvenile *Rhadinaea flavilata* was found under a stack of floor tiles during a waste cleanup. It may have been injured prior to discovery, as it died shortly after capture.

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***SIBON DIMIDIATUS* (Slender Snail Sucker)**. EL SALVADOR: SANTA ANA: Municipio de Metapán: Cantón El Limo, Área Natural Privada El Limo (14.408242°N, 89.39887°W; WGS 84), 1195 m elev. 20 August 2015. Emanuel S. Morán. Verified by James R. McCranie. University of Kansas Digital Archives (KUDA 012454–012456, photo vouchers). First record for El Salvador (Köhler et al. 2006. The Amphibians and Reptiles of El Salvador. Krieger Publishing Company, Malabar, Florida. 238 pp.), extending the range ca. 75 km SW of the nearest records in western Honduras (McCranie 2011. The Snakes of Honduras: Systematics, Distribution, and Conservation. SSAR Contributions to Herpetology, Volume 26, Ithaca, New York. 714 pp.). The snake was found near Mármol Creek at 2220 h in a tree within a mixed secondary semi-deciduous submontane forest.

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***SISTRURUS TERGEMINUS EDWARDSII* (Desert Massasauga)**. USA: ARIZONA: Graham Co.: San Carlos Apache Reservation,

Ash Flat, Indian Route 8, 2.3 km E jct with Indian Route 19 (33.291772°N, 109.904512°W; WGS 84). AOR. 2 June 2015. James Beauchamp and Ben Calvert. Verified by Andrew T. Holycross. University of Arizona Museum of Natural History (UAZ 57630-PSV). We first observed *Sistrurus tergeminus edwardsii* on Ash Flat in early July 2001, and since that time we have observed 8–9 additional individuals crossing Indian Route 8 between its intersections with Indian Routes 19 and 11 (between 33.301226°N, 109.926970°W and 33.271778°N, 109.852959°W) on Ash Flat. Most of these have been DOR, only two were encountered during daylight, and all were observed during the period May–September.

These observations extend the known distribution of the species 78 km NW of an historical record (CA 12996) obtained by D. B. Carver in 1944 from "21 miles east of Safford" at 1006 m elevation at the northern limit of the San Simon Valley (A. T. Holycross, pers. comm.). Our record is also a new elevational maximum for *S. t. edwardsii* (1548 m is the maximum elevation for the section of road noted above) (A. T. Holycross, pers. comm.). Perhaps most significantly, of the several historical populations of *S. t. edwardsii* recorded in Arizona, only one was demonstrably extant prior to our discovery. The number, duration, and recency of our observations demonstrate that Arizona has a second, and previously undocumented, viable population of *S. t. edwardsii*. The Ash Flat population is ca. 200 km NNW of what was previously presumed to be the last population of the species in Arizona.

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***STORERIA DEKAYI WRIGHTORUM* (Midland Brownsnake)**. USA: TENNESSEE: Hardin Co.: Horse Creek Wildlife Sanctuary (35.123942°N, 88.172383°W; WGS 84). 22 July 2015. Lee J. Barton, Joshua M. Hall, and Joshua P. Kee. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19597, color photo). First record for Hardin Co. (Scott and Redmond 2008 [latest update: 25 May 2015]. Atlas of Reptiles in Tennessee. Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/, accessed 9 September 2015). Juvenile was captured in grass near the water's edge of Horse Creek.

LEE J. BARTON, Freed-Hardeman University, 151 E. Main Street, Henderson, Tennessee 38340, USA (e-mail: lbarton@fhu.edu); **JOSHUA P. KEE**, Austin Peay University, 601 College St., Clarksville, Tennessee 37044, USA; **JOSHUA M. HALL**, Auburn University, Auburn, Alabama 36849, USA.

***SONORA SEMIANNULATA* (Western Groundsnake)**. USA: OKLAHOMA: Pushmataha Co.: Pushmataha Wildlife Management Area (34.50549°N, 95.40022°W; WGS 84), 321 m elev. 26 May 2015. Nicholas A. Huron, Aaron D. Geheber, Elyse D. Ellsworth. Verified by Jessa L. Watters. Sam Noble Oklahoma Museum of Natural History (OMNH 44198). New county record (Sievert and Sievert 2011. A Field Guide to Oklahoma's Amphibians and Reptiles. Oklahoma Department of Wildlife Conservation, Oklahoma City, Oklahoma. 211 pp.). The nearest known vouchered specimens are from ca. 53.3 km to the S in Choctaw Co., Oklahoma (OMNH 26935, 26960, 27057, 27058). This specimen fills a gap in the known distribution of this species in Oklahoma. One adult male (212.0 mm SVL; 47.0 mm tail length; 7.7 g) collected at the Pushmataha Wildlife Management Area underneath a slab-like rock, atypical to the surrounding area, roughly 3 m from a small, well-vegetated pond containing a circle of pine trees and smaller deciduous trees. Specimen collected under an Oklahoma Department of Wildlife Conservation Scientific Collecting Permit (#6105) issued to NAH.

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***STORERIA OCCIPITOMACULATA* (Red-bellied Snake)**. USA: GEORGIA: Johnson Co.: Bartow-Dublin Rd. (32.76693°N, 82.69469°W; WGS 84). 27 May 2015. S. Graham. Verified by John B. Jensen. Sul Ross State University (SRSU-D 8-9, digital photo vouchers). New county record (Jensen et al. 2008. The Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). Found under leaf litter on edge of swamp. Funding for this collection trip was provided by a grant from the Georgia Department of Natural Resources.

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***TANTILLA NIGRICEPS* (Plains Black-headed Snake)**. USA: TEXAS: Gaines Co.: 4.8 km W of Co. line, just S of Hwy 180 (32.694232°N, 102.257752°W; WGS 84). 12 May 2012. N. Taylor. Verified by Toby Hibbitts. Sul Ross State University (SRSU-D 21–24, digital photo vouchers). New county record (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 447 pp.).

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***THAMNOPHIS EQUES MEGALOPS* (Brown Gartersnake)**. USA: ARIZONA: Mohave Co.: Beal Lake Conservation Area, Havasu National Wildlife Refuge (34.776895°N, 114.53217°W; WGS 84). 29 April 2015. Michael B. Lester. Verified by George Bradley. University of Arizona (UAZ 57631-PSV, photo voucher). Considered extirpated from the Colorado River, this is the first sighting of *T. eques* along the main stem of the Colorado River in over a century (USFWS 2014. Endangered and Threatened Wildlife and Plants; Threatened Status for the Northern Mexican Gartersnake and Narrow-Headed Gartersnake; Final Rule. Federal Register 79:38677–38746). Nearest known specimen is from Clark Co., Nevada near Fort Mohave, Mohave County, Arizona recorded in 1911 (de Queiroz and Smith 1996. Herpetol. Rev. 27[3]:155). In 2012, a population was discovered along the Bill Williams River, near Swansea, Arizona (Cotten et al. 2013. Herpetol. Rev. 44[1]:111), approximately 90 km SE of the current sighting.

Snake was found moving slowly between habitat restoration areas (*Prosopis pubescens, Salix exigua, Pluchea sericea, Tamarix* sp.), approximately 75–100 m from water. Most of tail missing due to injury. Also seemed to have recently eaten, as it was found with a swollen abdomen.

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***THAMNOPHIS SAURITUS* (Eastern Ribbonsnake)**. USA: MICHIGAN: Wexford Co.: 3.5 km N of Mesick (44.435373°N, 85.694218°W; WGS 84), 252 m elev. 24 June 2015. John G. Phillips. Verified by Kirsten E. Nicholson. Central Michigan University Museum of Cultural and Natural History (MCNH 2015.010, photo voucher). New county record (Holman 2012. The Amphibians and Reptiles of Michigan: A Quaternary and Recent Faunal Adventure. Wayne State University Press, Detroit, Michigan. 528 pp.; Michigan Herpetological Atlas 2015. Available at: http://miherpatlas.org, accessed 12 November 2015). This specimen fills a gap in the distribution, as *T. sauritus* has been recorded from all surrounding counties. Snake was found swimming across the Manistee River (approx. 30 m wide at that sections).

Special thanks to Angela Reidel at MCNH for accessioning this record. Field support was provided by M. Phillips, G. McPheeters, and M. Phillips.

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***THAMNOPHIS SIRTALIS* (Eastern Gartersnake)**. USA: ALABAMA: Coosa Co.: Coosa Wildlife Management Area, Cahaba & Columbiana Forever Wild Tracts, 5.0 km NNW of AL Hwy 22 and Coosa CR 29 intersection (Kellys Crossroads) (32.87081°N, 86.36947°W; WGS 84). 19 May 2015. E. Soehren, J. Trent, and T. Rush. Verified by David Laurencio. Auburn University Natural History Museum (AUM AHAP-D 1106, digital photo voucher). New county record (Mount 1975. The Reptiles and Amphibians of Alabama. Agricultural Experiment Station, Auburn University, Alabama. 347 pp.). Adult encountered actively moving over ground within mature, montane *Pinus palustris* (Longleaf Pine) forest. This record fills in gap among Chilton, Elmore, and Tallapoosa counties (Mount 1975, *op. cit.*) and was vetted through examination of online museum holdings (VertNet) and literature review (Zoological Record).

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***TRIMORPHODON VILKINSONII* (Texas Lyresnake)**. USA: NEW MEXICO: Hidalgo Co.: Alamo Hueco Mts., 43.24 air mi SE of Animas (31.45969°N, 108.34794°W; WGS 84), 5738 ft (1749 m) elev. 15 September 2011. J. M. Garza and J. T. Fisher. Verified by Travis J. LaDuc. Biodiversity Collections (formerly Texas Natural History Collections), The University of Texas at Austin (TNHC 95461, photo voucher). New county record (Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. University of New Mexico Press, Albuquerque, New Mexico. 431 pp.). Extends edge of known range southwest by approximately 50 air miles.

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***TRIMORPHODON VILKINSONII* (Texas Lyresnake)**. USA: NEW MEXICO: Luna Co.: Carrizalillo Hills, ca. 27.6 km by air W of Columbus (31.809650°N, 107.931483°W; WGS 84), 1481 m elev. 20 June 2015. Kyle Vargas and Justin Garza. Verified by Carl Franklin. Amphibian and Reptile Diversity Research Center, University of Texas at Arlington (UTADC-8558). First record for the Carrizalillo Hills, and the third specimen from Luna Co. (Degenhardt et al. 1996. The Amphibians and Reptiles of New Mexico. University of New Mexico Press, Albuquerque, New Mexico. 431 pp.; VertNet, www.vertnet.org, accessed 2 July 2015). Gravid adult female, observed basking at 1047 h in a rock crevice on a southwest-facing slope. Observations made under New Mexico Department of Game and Fish license 1711508.

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***TROPIDOCLONION LINEATUM LINEATUM* (Northern Lined Snake)**. USA: TEXAS: Armstrong Co.: 21.70 km S of Claude, on Highway 207 (34.91485°N, 101.36138°W; WGS 84), 1030 m elev. 12 July 2015. Thomas J. Belford. Verified by William E. Duellman. University of Kansas Digital Archives (KUDA 012453). First county record (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 447 pp.). Extends range 42 km from nearest known record in Randal Co.

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***XENOCHROPHIS CERASOGASTER* (Painted Keelback Snake)**. BANGLADESH: DHAKA DIVISION: Dhaka District: Arakul, South Keraniganje (23.293512°N, 90.252137°E; WGS 84), 7 m elev. 31 December 2014. Faysal Ahmad. Verified by Stephen Mahony. Zoology Museum, Department of Zoology, Jagannath University, Dhaka (JnU/Zoo/M/Rep/Pho/2015/0011, photo voucher; adult specimen unnumbered); Zoological Reference Collection, Lee Kong Chian Natural History Museum, National University of Singapore (ZRC [IMG] 2.261, photo voucher). First record for Dhaka District. Previously reported from Patuakhali District in Barisal Division (Sourav and Purkayastha 2011. Check List 7:352–353) as first country record. Adult female collected in mud at pond with *Eichhornia crassipes*.

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Distribution Records for Louisiana Amphibians and Reptiles

Over the past few decades there has been an increase in efforts to document the geographical distribution of the Louisiana herpetofauna (Dundee and Rossman 1989; Boundy 2004; Rosenzweig et al. 2007; Boundy and Gregory 2012). Even with the increased effort, there is still a lack of documented records for many widespread species (Conant and Collins 1998), particularly in the northeastern portion of the state (Reid et al. 2014). Here we report a total of 48 records that help to fill distributional gaps primarily in the northeastern region of Louisiana, but other parts of the state as well. Most of these parish records are a result of surveys and class collections conducted by the University of Louisiana at Monroe (ULM) Herpetology Lab. Geographic coordinates are based on the WGS 84 datum. Voucher specimens are deposited in the University of Louisiana at Monroe Museum of Natural History Herpetology collection (NLU). Photo vouchers were deposited in the Florida Museum of Natural History Herpetology collection, with the digital image UF-Herpetology designation shortened to UF in the species accounts below. Specimen identification was verified by Neil Douglas. Standard English names follow Crother (2012).

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CAUDATA — SALAMANDERS

***AMBYSTOMA TALPOIDEUM* (Mole Salamander).** Caldwell Par.: Boeuf Wildlife Management Area (32.12453°N, 91.90636°W). 19 June 2006. Matthew D. Brown. NLU 70709, 70710. New parish record.

***AMPHIUMA TRIDACTYLUM* (Three-toed Amphiuma).** Caldwell Par.: Boeuf Wildlife Management Area, compartment 13 (32.03731°N, 91.97767°W). 26 June 2005. Matthew D. Brown and John E. Quinn 4th. NLU 70711. New parish record. Helps fill gap in north-central Louisiana. Located near an alligator hole. East Carroll Par.: Bayou Macon Wildlife Management Area (32.80190°N, 91.31560°W). 8 August 2006. Ashley N. Hudson. NLU 70712. New parish record. Helps fill gap in northeastern corner of Louisiana.

***SIREN INTERMEDIA NETTINGI* (Western Lesser Siren).** Catahoula Par.: Boeuf Wildlife Management Area, Enterprise Tract (31.92245°N, 91.89134°W). 7 November 2006. Matthew D. Brown. NLU 70713, 70714, 70715; Boeuf Wildlife Management Area (31.95167°N, 91.87255°W). 13 October 2013. Clayton R. Faidley. NLU 70716. New parish record. Fills gap in northeastern Louisiana. Tensas Par.: Buckhorn Wildlife Management Area, Brushy Lake (32.04426°N, 91.36586°W). 24 March 2012. ULM Advanced Herpetology Class. NLU 70717. New parish record. Fills gap in northeastern Louisiana. Caught in an aquatic drift fence in Brushy Lake.

ANURA — FROGS

***ELEUTHERODACTYLUS CYSTIGNATHOIDES* (Rio Grande Chirping Frog).** Rapides Par.: Alexander State Forest Wildlife Management Area, near Indian Creek Reservoir (31.09197°N, 92.46948°W). 22 May 2013. Clayton F. Faidley. NLU 70718. This is a new parish record for this introduced species, found in a rural location rather than the larger cities where it has previously been recorded in Louisiana. Found in a wooded area by a boat launch on Indian Lake, where several males were calling. The locality is within 1.5 km of a large plant nursery.

***HYLA AVIVOCA* (Bird-voiced Treefrog).** Lincoln Par.: Middle Fork of Bayou D'Arbonne (32.71983°N, 92.53183°W). 28 May 2009. Thomas M. Pardue. NLU 70719. New parish record. Near Gill's Ferry boat launch. Union Par.: Middle Fork of Bayou D'Arbonne (32.72153°N, 92.53201°W). 28 May 2009. Thomas M. Pardue. NLU 70720. New parish record. Near Gill's Ferry boat launch.

***HYLA SQUIRELLA* (Squirrel Treefrog).** East Carroll Par.: Bayou Macon Wildlife Management Area (32.82846°N, 91.31704°W). 11 November 2006. Ashley N. Hudson. NLU 70721. New parish record. Madison Par.: Tensas River National Wildlife Refuge (32.31752°N, 91.37711°W). 6 August 2009. Thomas M. Pardue. UF 173946. New parish record. Photographed under the overhang of the refuge headquarters building. Morehouse Par.: Upper Ouachita National Wildlife Refuge, near Mollicy Bayou (32.88710°N, 92.03495°W). 5 June 2012. Charles D. Battaglia. NLU 70722. New parish record. Found in a PVC pipe near a drift fence array by Mollicy Bayou. Tensas Par.: St. Joseph, off Hwy 128 (31.92446°N, 91.24049°W). 24 March 2012. Charles D. Battaglia and Matthew L. Reid. NLU 70723. New parish record. Fills in the northeastern range in Louisiana. On the outside wall of a convenience store.

***LITHOBATES PALUSTRIS* (Pickerel Frog)**. Madison Par.: Tensas River National Wildlife Refuge (32.34979°N, 91.31719°W). 6 August 2009. Thomas M. Pardue. UF 173947. New parish record. Photographed under air conditioning unit adjacent to a refuge maintenance building.

***PSEUDACRIS CRUCIFER* (Spring Peeper)**. East Carroll Par.: Bayou Macon Wildlife Management Area (32.84076°N, 91.32961°W). 20 February 2005. Ashley N. Hudson and Amy N. Wall. NLU 70724. New parish record. Helps fill gap in northeastern Louisiana.

CROCODYLIA — CROCODILIANS

***ALLIGATOR MISSISSIPPIENSIS* (American Alligator)**. Caldwell Par.: Boeuf Wildlife Management Area, (32.02254°N, 91.95168°W). 4 November 2013. Clayton R. Faidley. UF 173948. New parish record. Near bunkhouse in ditch. East Carroll Par.: Bayou Macon Wildlife Management Area (32.83379°N, 91.28793°W). 17 May 2005. Ashley N. Hudson. UF 173949. New parish record. Madison Par.: Tensas River National Wildlife Refuge, Whitney Lake (32.31287°N, 91.36588°W). 21 June 2014. Charles D. Battaglia and John L. Carr. Off of Quebec Rd. along the wildlife drive. UF 173950. New parish record.

TESTUDINES — TURTLES

***APALONE MUTICA* (Smooth Softshell)**. Allen Par.: Ouiska Chitto Creek (30.67899°N, 92.89987°W). 25 May 2011. Field Biology Class. NLU 70725. A new parish record and the first in the Calcasieu River basin. Morehouse Par.: Sandbar on E bank of Ouachita River (32.99560°N, 92.07258°W). 10 July 2001. John L. Carr. NLU 70726, 70727. New parish record. Hatchling vouchers from a nest found in the sandbar.

***CHELYDRA SERPENTINA* (Snapping Turtle)**. East Carroll Par.: Bayou Macon Wildlife Management Area (32.84970°N, 91.28854°N). 11 March 2006. Ashley N. Hudson, Adrian S. Chesh, and J. A. Incalcaterra. NLU 70728. New parish record.

***CHRYSEMYS DORSALIS* (Southern Painted Turtle)**. LaSalle Par.: Dewey W. Wills Wildlife Management Area, DOR on Hwy 28 south of Catahoula Lake (31.46401°N, 92.10667°W). 2 June 2007. John. L. Carr. NLU 70729. New parish record.

***KINOSTERNON SUBRUBRUM HIPPOCREPIS* (Mississippi Mud Turtle)**. Tensas Par.: Buckhorn Wildlife Management Area, margin of Brushy Lake (32.04498°N, 91.36530°W). 5 April 2008. John L. Carr. NLU 70730. Big Lake Wildlife Management Area (32.19829°N, 91.47823°W). 30 March 2008. Kody J. Chase. NLU 70731. New parish record. LaSalle Par.: Dewey W. Wills Wildlife Management Area, AOR on Hwy 28 (31.46643°N, 92.10435°W). 7 June 2014. Charles D. Battaglia, Matthew L. Reid, and Matthew S. Herron. UF 173951. New parish record.

***MACROCHELYS TEMMINCKII* (Alligator Snapping Turtle)**. Allen Par.: Barnes Creek at bridge on Martin Tram Rd. (30.45428°N, 93.04286°W). 17 July 2012. Thomas M. Pardue. UF 173952. New parish record. Photographed basking on fallen tree (see Carr et al. 2011, for other instances of basking in Louisiana). Caldwell Par.: Boeuf Wildlife Management Area, AOR on Big Ridge Rd. (32.04472°N, 91.95348°W). 16 May 2013. Clayton R. Faidley, John L. Carr, and Lisa D. Brown. UF 173953. New parish record. Iberia Par.: Avery Island (29.90624°N, 91.91206°W). 22 April 2014. Cody L. Townsend. UF 173954. New parish record. Found during a ULM class fieldtrip. Madison Par.: Nest found 4.7 km E, 3.6 km S of Waverly (32.41310°N, 91.36097°W). 22 May 2009. Amity A. Bass. NLU 70637. New parish record. Hatchling preserved as a voucher.

***PSEUDEMYS CONCINNA* (River Cooter)**. Caldwell Par.: Boeuf Wildlife Management Area, in woods by Horseshoe Lake (31.94692°N, 91.91745°W). 18 February 2012. Clayton R. Faidley. NLU 70732. New parish record. Shell remains.

***STERNOTHERUS CARINATUS* (Razor-backed Musk Turtle)**. Caldwell Par: Boeuf River (32.17474°N, 91.94520°W). 09 July 2006. Ashley N. Hudson and John L. Carr. NLU 70733. New parish record. Shell remains. East Carroll Par.: Bayou Macon Wildlife Management Area (32.80206°N, 91.31550°W). 8 August 2006. Ashley N. Hudson. NLU 70734. New parish record.

***STERNOTHERUS ODORATUS* (Eastern Musk Turtle)**. East Carroll Par.: Bayou Macon Wildlife Management Area (32.79783°N, 91.31867°W). 3 April 2006. Ashley N. Hudson, Amy N. Wall, and Adrian S. Chesh. NLU 70735. New parish record.

***TERRAPENE CAROLINA TRIUNGUIS* (Three-toed Box Turtle)**. East Carroll Par.: Bayou Macon Wildlife Management Area (32.84940°N, 91.31306°W). 25 August 2005. Ashley N. Hudson. UF 173955. Specimen found along ATV trail leading to compartment 13. This is a documented record from this parish; Dundee and Rossman (1989) referred to an unconfirmed museum record. Based on a recent genetic study, Bradley et al. (2013) suggest that this taxon should be referred to as *T. mexicana triunguis*. West Carroll Par.: AOR on Hwy 17 south of Pioneer (32.68716°N, 91.44994°W). 18 June 2006. Ashley N. Hudson. UF 173956. New parish record.

***TRACHEMYS SCRIPTA ELEGANS* (Red-eared Slider)**. Caldwell Par.: Boeuf Wildlife Management Area, near Cross Bayou (32.12465°N, 91.92355°W). 3 November 2013. Clayton R. Faidley. NLU 70736. New parish record. Shell remains.

SQUAMATA — LIZARDS

***ANOLIS SAGREI* (Brown Anole)**. Ouachita Par.: ULM greenhouse (32.52868°N, 92.07504°W). 26 September 2012. Matthew L. Reid. NLU 70737. A new parish record for this introduced species, the first in northern Louisiana. Found on a small ornamental pine tree in the ULM greenhouse that was acquired from the Home Depot garden center in Monroe earlier that day.

***HEMIDACTYLUS TURCICUS* (Mediterranean House Gecko)**. Grant Par.: Georgetown (31.76263°N, 92.38340°W). 7 June 2014. Charles D. Battaglia, Matthew L. Reid, and Matthew S. Herron. NLU 70738. New parish record. Fills in a distributional gap in northeastern Louisiana (Reid et al. 2014). Found on outside wall of the local post office. LaSalle Par.: 2134 East Oak St., Jena (31.68288°N, 92.12363°W). 7 June 2014. Matthew L. Reid, Charles D. Battaglia, and Matthew S. Herron. NLU 70739. New parish record. Fills a distributional gap in northeastern Louisiana (Reid et al. 2014). Found on outside wall of a gas station on Hwy 84.

***PLESTIODON FASCIATUS* (Common Five-lined Skink).** East Carroll Par.: Bayou Macon Wildlife Management Area (32.86321°N, 91.26924°W). 18 June 2006. Ashley N. Hudson. NLU 70740. New parish record. Fills in the only remaining parish in the state without a record.

SQUAMATA — SNAKES

***CROTALUS HORRIDUS* (Timber Rattlesnake).** Catahoula Par.: Sicily Island Hills Wildlife Management Area, (31.82597°N, 91.75369°W). 29 April 2012. ULM Advanced Herpetology Class. NLU 70741. New parish record. Helps fill gap in northeastern Louisiana. Coiled on the forest floor during a visual encounter survey.

***DIADOPHIS PUNCTATUS STICTOGENYS* (Mississippi Ring-necked Snake).** Tensas Par.: Buckhorn Wildlife Management Area, near Brushy Lake nature trail (32.04530°N, 91.36730°W). 5 April 2008. John L. Carr, Chase Holiday, Kody J. Chase, Thomas M. Pardue, and Samuel R. Holcomb. NLU 70742. New parish record.

***FARANCIA ABACURA* (Red-bellied Mudsnake).** Caldwell Par.: Boeuf Wildlife Management Area, AOR on Hwy 558 (31.97639°N, 91.95929°W). 29 June 2013. Clayton R. Faidley. NLU 70743. New parish record. Fills gap in northeastern Louisiana. East Carroll Par.: Bayou Macon Wildlife Management Area (32.85667°N, 91.27864°W). 31 March 2005. Ashley N. Hudson and Matthew D. Brown. NLU 70744. New parish record. Fills gap in northeastern Louisiana.

***LAMPROPELTIS TRIANGULUM* (Eastern Milksnake).** East Carroll Par.: Bayou Macon Wildlife Management Area (32.82068°N, 91.31544°W). 23 September 2005. Ashley N. Hudson. NLU 70745. New parish record. Recent genetic studies (Ruane et al. 2014) suggest that *L. t. amaura* be subsumed within *L. gentilis*. Based on the morphological characteristics (body ring count) and distribution outlined in Ruane et al. (2014), this specimen would appear to belong to the species *L. triangulum* and not *L. gentilis*.

***NERODIA CYCLOPION* (Mississippi Green Watersnake).** Catahoula Par.: Boeuf Wildlife Management Area, Enterprise Tract (31.93414°N, 91.88318°W). 22 April 2005. Matthew D. Brown and Andrew M. Perry. NLU 70746. New parish record.

***NERODIA FASCIATA CONFLUENS* (Broad-banded Watersnake).** Caldwell Par.: Boeuf Wildlife Management Area, DOR on Hwy 558 (31.97639°N, 91.95929°W). 29 June 2013. Clayton R. Faidley. NLU 70747. New parish record that fills in one of the remaining two Louisiana parishes without records.

***OPHEODRYS AESTIVUS* (Rough Greensnake).** East Carroll Par.: Bayou Macon Wildlife Management Area (32.85577°N, 91.30176°W). 25 May 2005. Ashley N. Hudson. NLU 70748. New parish record.

***PANTHEROPHIS GUTTATUS* (Red Cornsnake).** Catahoula Par.: Sicily Island Hills Wildlife Management Area (31.83222°N, 91.77099°W). 12 April 2008. John L. Carr and ULM herpetology class. NLU 70749 (egg). A new parish record from the flat bottomland of the northern branch of Big Creek. This record extends the range north of the Red River in the Mississippi Alluvial Valley. Female laid eggs in the lab (UF 173957), with one, non-viable egg kept as a voucher. The female and the live hatchlings were returned to the site.

***THAMNOPHIS PROXIMUS* (Western Ribbonsnake).** East Carroll Par.: Bayou Macon Wildlife Management Area (32.79276°N, 91.29892°W). 30 March 2005. Ashley N. Hudson and Matthew D. Brown. NLU 70750. New parish record.

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New County Distribution Records for Amphibians and Reptiles in Wisconsin

These new county records for Wisconsin were collected or verified subsequent to Casper (1996), as part of various projects for the Apostle Island National Lakeshore, Great Lakes Indian Fish and Wildlife Commission, HerpMapper (http://www.herpmapper.org), Lake Superior Binational Program, Milwaukee Public Museum, Ozaukee Washington Land Trust, U. S. Environmental Protection Agency Great Lakes Restoration Initiative, Wisconsin Coastal Management Program, Wisconsin DNR, and Wisconsin Herp Atlas (UWM Field Station Saukville, Wisconsin). The number of decimal places in coordinates reflects estimated precision. Standard English names follow Crother (2012).

CAUDATA — SALAMANDERS

***AMBYSTOMA LATERALE* (Blue-spotted Salamander).** Buffalo Co.: Trevino Bottoms (44.4273°N, 92.0618°W; WGS 84). 8 May 2011. Christopher E. Smith, Ben Lowe, Don Shepard. Verified by Thomas G. Anton. James Ford Bell Museum of Natural History, University of Minnesota, Minneapolis (JFBM Herp Photo 469). New county record within expected range, ca. 51 km SW of nearest published Dunn Co. record (Vogt 1981). Two observed under same piece of wood. Trempealeau Co.: Town 18 North, Range 8 West, Section 33 SW1/4 (quarter-section centroid 43.988°N, 91.346°W; WGS 84). 23 July 1998. Gary S. Casper. Verified by Thomas G. Anton. Milwaukee Public Museum (MPM 30299). New county record within expected range, ca. 3.5 km NNW of nearest published La Crosse Co. record (Casper 1996).

***AMBYSTOMA MACULATUM* (Spotted Salamander).** Douglas Co.: Douglas County Forest along E South Shore Grade (46.5223°N, 91.7716°W; WGS 84). 26 April 2011. Gary S. Casper, Stefanie M. Nadeau. Verified by Gregory Schneider. University of Michigan Museum of Zoology, Ann Arbor (UMMZ 243156). New county record extends range ca. 40 km NW from nearest published Bayfield Co. record (Vogt 1981). In log at roadside pond. Marinette Co.: 2.3 km N of Town Line Rd. on right side of Right-of-Way Rd. (45.270°N, 87.755°W; WGS 84). 27 September 1999. Dawn Dennis-Ruleau. Verified by Thomas G. Anton. Milwaukee Public Museum (MPM Herp Photo 700). New county record within expected range, ca. 44.4 km ENE of nearest published Oconto Co. record (Casper 1996). Under board. Additional specimens collected in 2003 in western Marinette Co. (MPM 33394-5, 33401). Washington Co.: Silverbrook Camp (43.4046°N, 88.2186°W; WGS 84). 17 March 2012. Ron Gritt. Verified by Gregory Schneider. University of Michigan Museum of Zoology, Ann Arbor (UMMZ 243163-4). New county record. Ephemeral wetland in kettle valley with hardwood forest surround. New county record within expected range, ca. 15 km W of nearest published Ozaukee Co. record (Casper 1996).

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***HEMIDACTYLIUM SCUTATUM* (Four-toed Salamander).** Columbia Co.: Wisconsin Dells (43.63°N, 89.77°W; WGS 84). 1967. Roy Fox. Verified by Steve Rogers. Carnegie Museum of Natural History, Pittsburgh, Pennsylvania (CM 62536). First county record, extends range ca. 7 km E from nearest published Sauk Co. record (Vogt 1981). Crawford Co.: N Branch of Copper Creek, Town 10 North, Range 5 West, Section 29 NW1/4 (43.318°N, 90.993°W; WGS 84). 15 September 1973. Sara Kauth. Verified by Thomas G. Anton. University of Wisconsin Zoological Museum, Madison (UWZM 24018). New county record, extends range ca. 25 km SE from nearest published Vernon Co. record (Vogt 1981). Old cow pasture with grasses and goldenrod, mature forest of white birch and poplar found under and in the rotted wood of a fallen trunk, very damp habitat. Douglas Co.: SE of jct of Anderson Rd. and Francis-Willard Rd. (46.473°N, 91.649°W; WGS 84). 17 June 1996. Gary S. Casper, Lacey Klucas, Noah Martinsen. Verified by Thomas G. Anton. Milwaukee Public Museum (MPM 27960). New county record, extends range ca. 24 km NW from nearest published Bayfield Co. record (Vogt 1981). Collected in shoreline clump of *Sphagnum magellanicium* (Brid.). Additional specimens collected ca. 8.5 km further W (46.444°N, 91.759°W; 46.438°N, 91.685°W; 46.4674°N, 91.7580°W; WGS 84), Milwaukee Public Museum (MPM 27961-3 respectively). Lincoln Co.: Ca. 1.31 km southeast of jct of County Rd. A and County Rd. H (45.4928°N, 89.5814°W; WGS 84). 29 April 2011. Gary S. Casper, Stefanie M. Nadeau. Verified by Gregory Schneider. University of Michigan Museum of Zoology, Ann Arbor (UMMZ 243203). New county record within expected range, ca. 23 km S of nearest published record in Oneida Co. (Casper 1996). Under rotted white birch log. Marinette Co.: Town 30 North, Range 23 East, Section 7 (section centroid 45.09°N, 87.75°W; WGS 84). 30 May 1997. Mike Rasmussen. Verified by Thomas G. Anton. Milwaukee Public Museum (MPM Herp Photo 701). New county record within expected range, ca. 37.4 km NE of nearest published Oconto Co. record (Vogt 1981). Additional specimens collected in 2003 from NW Marinette Co. (45.5243°N, 88.3292°W; 45.3192°N, 88.2323°W; WGS 84), Milwaukee Public Museum (MPM 33381, 33413 respectively). Sawyer Co.: Flambeau River area, Town 39 North, Range 3 West, Section 33 SE1/4 of NE1/4 (45.821°N, 90.747°W; WGS 84). 22 June 2000. Kathryn Kirk. Verified by Thomas G. Anton. Milwaukee Public Museum (MPM 32903). New county record within expected range, ca. 49 km SSE from nearest published Ashland Co. record (Vogt 1981). Found in black spruce forest. Second specimen found near residence in Hayward (45.972°N, 91.431°W; WGS 84). 30 September 2001. Mike Heim. Verified by Thomas G. Anton. Milwaukee Public Museum (MPM 33279).

***NECTURUS MACULOSUS* (Mudpuppy).** Trempealeau Co.: Independence (44.36°N, 91.42°W; WGS 84). 1881. A. E. Van Name. Verified by Thomas G. Anton. Yale University, Peabody Museum of Natural History, New Haven, Connecticut (YPM 118). New county record within expected range, ca. 35 km N from nearest published La Crosse Co. record (Casper 1996). Additional specimens from same locality (YPM 31, 395).

***NOTOPHTHALMUS VIRIDESCENS LOUISIANENSIS* (Central Newt)**. La Crosse Co.: Town 17 North, Range 8 West, Section 5 SW1/4, along railroad. (43.974°N, 91.365°W; WGS 84). 27 July 1993. Robert Hay, Dan Nedrelo. Verified by Thomas G. Anton. Milwaukee Public Museum (MPM Herp Photo 460). New county record, fills ca. 126 km gap in range, ca. 75.7 km SE of nearest published Buffalo Co. record (Casper 1996) and ca. 55.5 km NNW of nearest published Vernon Co. record (Vogt 1981). This specimen was previously published as a new Trempealeau Co. record (Casper 1996), but re-examination for georeferencing determined it was actually in La Crosse Co., based on matching the original locality description to aerial photography. The Trempealeau Co. occurrence is therefore suppressed. Marquette Co.: Ca. 2.8 km E of Germania on Eagle Rd. (43.889°N, 89.227°W; WGS 84). 12 May 1999. Matt Wright. Verified by Thomas G. Anton. Milwaukee Public Museum (MPM 30362). New county record, within ca. 85 km gap in expected range, ca. 38 km NW of nearest published Dodge Co. record (Vogt 1981). 30-40 observed in small pond. Oneida Co.: Ca. 619 m north of Oscar-Jenny Lake (45.6305°N, 89.6658°W; WGS 84). 23 March 2012. Robert Hay. Verified by Gregory Schneider. University of Michigan Museum of Zoology, Ann Arbor (UMMZ Herp Photo 1259-60). New county record within expected range, ca. 10 km NNE of nearest published Lincoln Co. record (Casper 1996). Wood Co.: 10 mi SE Stratford (44.67°N, 89.98°W; WGS 84). 29 June 1927. L. C. Stuart. Verified by Gregory Schneider. University of Michigan Museum of Zoology, Ann Arbor (UMMZ 64813-9). New county record within expected range, ca. 61 km N of nearest published Juneau Co. record (Vogt 1981).

ANURA — FROGS

***ACRIS BLANCHARDI* (Blanchard's Cricket Frog)**. Adams Co.: Ca. 8 km W of Briggsville in southeastern Adams Co. (43.65°N, 89.69°W; WGS 84). 22 September 1929. Francis M. Uhler. Verified by Thomas G. Anton. National Museum of Natural History, Smithsonian Institution (USNM 311739). New county record within expected range, ca. 25 km NW of nearest published Columbia Co. record (Vogt 1981). Green Lake Co.: Spaulding's Bridge, Town 16 North, Range 13 East, Section 2 (section centroid 43.89°N, 88.92°W; WGS 84). 14 September 1957. D. G. Dunlap. Verified by Thomas G. Anton. University of Nebraska State Museum, Lincoln (UNSM 22449). New county record within expected range, ca. 23.5 km WSW of nearest published Marquette Co. record (Vogt 1981). Trempealeau Co.: Town 18 North, Range 10 West, Section 2 SW1/4 (quarter section centroid 44.059°N, 91.546°W; WGS 84). 10 September 1965. R. Fassbender. Verified by Thomas G. Anton. University of Wisconsin Zoological Museum, Madison (UWZM 19038). New county record within expected range, ca. 33 km W of nearest published La Crosse Co. record (Vogt 1981).

***HYLA CHRYSOSCELIS* (Cope's Gray Treefrog)**. Jefferson Co.: Lost Lake, just W of Rock Lake (43.0824°N, 88.9462°W; WGS 84). 30 April 1997. Karen Etter Hale, Mary Nelesen. Verified by Thomas G. Anton. Milwaukee Public Museum (MPM Herp Photo 658 with associated audio recording). New county record within expected range, ca. 21 km SE of nearest published Dane Co. record (Vogt 1981).

***HYLA VERSICOLOR* (Gray Treefrog)**. Door Co.: Bay Shore Bluff-lands State Natural Area (44.9489°N, 87.3758°W; WGS 84). 31 May 2014. Nancy Aten, Dan Collins. Verified by Gregory Schneider. University of Michigan Museum of Zoology, Ann Arbor (UMMZ Herp Photo 1261 with sonogram and digital audio recording). New county record within expected range, ca. 69 km NNE of nearest published Kewaunee Co. record (Vogt 1981). Full chorus calling from ephemeral pond in mixed northern hardwood forest, 0246 hr CST, ambient temperature 15.5°C.

***LITHOBATES CATESBEIANUS* (American Bullfrog)**. Grant Co.: N of Dubuque, Iowa, on Wisconsin side of Mississippi River (42.5733°N, 90.6597°W; WGS 84). 27 June 2008. Kyle Salzmann. Verified by Christopher E. Smith. James Ford Bell Museum of Natural History, University of Minnesota, Minneapolis (JFBM Herp Photo 470). New county record within expected range, ca. 88 km SSE of nearest published Crawford Co. record (Vogt 1981), 47 km NW of nearest published Jo Daviess Co., Illinois, record (Smith et al. 1999, AMNH 137397), and confirms prior published observational record from same area (Vogt 1981). Trempealeau Co.: Perrot State Park (44.02°N, 91.47°W; WGS 84). 11 September 1947. Strand and Edgren Stahlecker. Verified by Thomas G. Anton. Chicago Academy of Sciences, Chicago, Illinois (CHAS 19340, now housed at FMNH). New county record within expected range, ca. 34.7 km NW of nearest published La Crosse Co. record (Casper 1996).

***LITHOBATES PALUSTRIS* (Pickerel Frog)**. Fond du Lac Co.: Adjacent to campground at NE side of Mauthe Lake, Town 13 North, Range 19 East, Section 12 NE1/4 of SW1/4 of SW1/4 (43.6043°N, 88.1765°W; WGS 84). 5 May 2000. Deb Coblentz. Verified by Thomas G. Anton. Milwaukee Public Museum (MPM 32883). New county record, within ca. 100 km gap in expected range, ca. 31 km SSW of nearest published Sheboygan Co. record (Vogt 1981). From cold seeps. Jackson Co.: Black River Falls (44.30°N, 90.85°W; WGS 84). 4 June 1920. A. J. Poole. Verified by Thomas G. Anton. University of Wisconsin Zoological Museum, Madison (UWZM 3501). New county record within expected range, ca. 21 km SSW of nearest published Clark Co. record (Vogt 1981).

***LITHOBATES SYLVATICUS* (Wood Frog)**. Walworth Co.: Mallard Ridge Landfill ca. 5 km west of Delavan N side Hwy 11 (42.6468, 88.7191°W; WGS 84). 22 April 1996. Gary S. Casper. Verified by Thomas G. Anton. Milwaukee Public Museum (MPM Herp Photo 538). New county record within expected range, ca. 37 km ENE of nearest published Rock Co. record (Vogt 1981). 18 egg masses photographed in ephemeral wetland.

***PSEUDACRIS CRUCIFER* (Spring Peeper)**. Green Lake Co.: White River Marsh, Town 17 North, Range 12 East, Section 21 (section centroid 43.93°N, 89.08°W; WGS 84). 17 April 1959. D. G. Dunlap. Verified by Thomas G. Anton. University of Nebraska State Museum, Lincoln (UNSM 22864). New county record within expected range, ca. 22 km SE of nearest published Waushara Co. record (Vogt 1981).

TESTUDINES — TURTLES

***APALONE MUTICA MUTICA* (Midland Smooth Softshell)**. La Crosse Co.: Mississippi River backwater approx. 0.4 km S of I-90 bridge (43.8564°N, 91.2713°W; WGS 84). 8 July 1999. Eric Kramer. Verified by Thomas G. Anton. Milwaukee Public Museum (MPM 33150). New county record within expected range, ca. 23 km SE of nearest published Trempealeau Co. record (Vogt 1981). One of two drowned in fish survey net. Supports additional unverified specimens collected in 1973 by M. A. Ewert from an

unspecified locality in the Mississippi River in La Crosse Co., Carnegie Museum of Natural History, Pittsburgh, Pennsylvania (CM 88440-74).

***APALONE SPINIFERA SPINIFERA* (Eastern Spiny Softshell).** Kenosha Co.: Powers Lake (42.55°N, 88.30°W; WGS 84). 17 May 2001. Rick Dauffenbach. Verified by Thomas G. Anton. Milwaukee Public Museum (MPM Herp Photo 699). New county record within expected range, ca. 17 km S of nearest published Racine Co. record (Vogt 1981). One of two caught in fyke nets during fish surveys. Supports prior observational record in slough on S end of Paddock Lake (42.570°N, 88.102°W; WGS 84), 1987, Barbara Wolf; and from Elizabeth Lake (42.51°N, 88.27°W; WGS 84), 1989, Ken Mierzwa (GSC, unpubl. data). Ozaukee Co.: Lac du Cours Creek, tributary of Milwaukee River (43.1967°N, 87.9565°W; WGS 84). 31 May 2011. Luke Roffler. Verified by Christopher A. Phillips. Illinois Natural History Survey, University of Illinois, Champaign (INHS Herp Photo 2012h). New county record within expected range, ca. 31 km NNE of nearest published Milwaukee Co. record (Casper 1996). Photographed basking in small pond. Second photo from same site on 23 April 2012. Supports unverified specimen from Donges Bay (43.20 °N, 87.89°W; WGS 84), 1933, L. R. Taylor, Milwaukee Public Museum (MPM 2459), which is missing. Additional observation from River Island Park in Milwaukee River in Grafton ca. 14 km N of Lac du Cours Creek (43.3252°N, 87.9461°W; WGS 84) on 21 July 2012 by Phyllis McKenzie (GSC, unpubl. data). Price Co.: Jump River, Ogema Township (45.41°N, 90.66°W; WGS 84). Approx. 1995. Mike Lord. Verified by Thomas G. Anton. Milwaukee Public Museum (MPM Herp Photo 704). New county record within expected range, ca. 53 km SE of nearest published Sawyer Co. record (Casper 1996). Sheboygan Co.: Sheboygan (43.75°N, 87.71°W; WGS 84). 23 September 1956. C. Benninghaus. Verified by Charles M. Dardia. Cornell University Museum of Vertebrates, Ithaca, New York (CU 11332). New county record adjacent to documented counties to south and west, ca. 58 km NE of nearest published Washington Co. record (Casper 1996). Skull only. Washington Co.: Big Cedar Lake, directly opposite Gonring Dr. boat launch (43.4022°N, 88.2523°W; WGS 84). 16 August 2010. Carcass from anonymous boaters photographed by Gary S. Casper. Verified by Christopher A. Phillips. Illinois Natural History Survey, University of Illinois, Champaign (INHS Herp Photo 2010q). New county record within expected range, ca. 40.3 km NNE of nearest published Waukesha Co. record (Casper 1996). Found washed up on shore with propeller wounds.

***CHRYSEMYS PICTA* (Painted Turtle).** Green Co.: near Sugar River, Town 3 North, Range 8 East, Section 14 (42.73°N, 89.52°W; WGS 84). 9 May 1998. Andrew H. Williams. Verified by Alan Resetar. Field Museum of Natural History, Chicago, Illinois (FMNH 270549). New county record within expected range, ca. 23 km S of nearest published Dane Co. record (Vogt 1981). Dead on road.

***GRAPTEMYS GEOGRAPHICA* (Northern Map Turtle).** Milwaukee Co.: Milwaukee, Milwaukee River on south side of old North Ave. dam (43.0579°N, 87.8947°W; WGS 84). 11 July 2007. Gary S. Casper. Verified by Christopher A. Phillips. Illinois Natural History Survey, University of Illinois, Champaign (INHS Herp Photo 2012m). First county record and first verified record for Milwaukee River system, ca. 127 km E of nearest published Dane Co. record (Vogt 1981). Three individuals basking. Possibly introduced in this urban area, with nearest known natural populations in the Wisconsin River (Vogt 1981) and Des Plains River, Illinois (Phillips et al. 1999). Additionally reported from the Milwaukee River at two Ozaukee Co. locations in 2013, suggesting the species is established in this river beyond Milwaukee Co. (Kristina M. Kroening, personal communication July 2014). The earliest known reports for Milwaukee Co. are from the Wildlife ARC, which received two injured specimens on 20 June 1987 for rehabilitation (*fide* Dawn Reshel) from Town 8 North, Range 21 East, Sections 23 and 35, ca. 3.5 km from the Milwaukee River (GSC, unpubl. data). Pierce Co.: Diamond Bluff (44.65°N, 92.62°W; WGS 84). 5 August 1899. Collector unknown. Verified by Christopher E. Smith. James Ford Bell Museum of Natural History, University of Minnesota, Minneapolis (JFBM R490). First county record, ca. 38 km SSE of nearest published St. Croix Co. record (Vogt 1981). Supports observational records reported by Vogt (1981).

***GRAPTEMYS PSEUDOGEOGRAPHICA PSEUDOGEOGRAPHICA* (Northern False Map Turtle).** Buffalo Co.: On main channel of Mississippi River across from W Newton Chute (44.287°N, 91.918°W; WGS 84). 12 July 2011. Christopher E. Smith. Verified by Thomas G. Anton. James Ford Bell Museum of Natural History, University of Minnesota, Minneapolis (JFBM Herp Photo 472). First county record within expected range, ca. 30.5 km SE of nearest published Pepin Co. record (Vogt 1981). Captured in turtle trap. Chippewa Co.: Chippewa River, 3.2 km S of Jim Falls (45.021°N, 91.295°W; WGS 84). 12 July 1973. Richard C. Vogt. Verified by Thomas G. Anton. Milwaukee Public Museum (MPM 6836). First county record, extends range ca. 33 km NE of nearest published Eau Claire Co. record (Casper 1996).

SQUAMATA — LIZARDS

***PLESTIODON SEPTENTRIONALIS SEPTENTRIONALIS* (Northern Prairie Skink).** Buffalo Co.: Trevino Bottoms (44.4274°N, 92.0607°W; WGS 84). 14 September 2014. Erica Hoaglund, Ben Lowe, Chris Smith, Jon Murray. Verified by Thomas G. Anton. James Ford Bell Museum of Natural History, University of Minnesota, Minneapolis (JFBM Herp Photo 473). First county and southern-most Wisconsin record, extends range ca. 51 km SW of nearest published Dunn Co. record (Vogt 1981). Under railroad tie along railroad right of way. Second specimen photographed ca. 402 m to W (44.4279°N, 92.0657°W; WGS 84) on same date, James Ford Bell Museum of Natural History, University of Minnesota, Minneapolis (JFBM Photo 474).

SQUAMATA — SNAKES

***COLUBER CONSTRICTOR* (North American Racer).** Lafayette Co.: Town 4 North, Range 5 East, Section 26 NW1/4 (quarter section centroid 42.795°N, 89.873°W; WGS 84). 22 October 1963. Collector unknown. Verified by Thomas G. Anton. University of Wisconsin Zoological Museum, Madison (UWZM 17362). First county record, extends range ca. 35 km SSE from nearest published Iowa Co. record (Vogt 1981), and ca. 62 km NE from nearest published Jo Daviess Co., Illinois, record (Phillips et al. 1999).

***DIADOPHIS PUNCTATUS EDWARDSII* (Northern Ring-necked Snake).** Manitowoc Co.: Two Rivers (44.15°N, 87.57°W; WGS 84). Date unknown. Collector unknown. Verified by Chris R. Feldman. University of Nevada, Museum of Biology, Reno (UNR 6343). First county record, fills ca. 104 km gap in range along Lake Michigan, ca. 53 km from nearest published Sheboygan Co. record to south (Vogt 1981) and ca. 55 km from nearest published

Brown Co. record to north (Casper 1996). Oconto Co.: Bear Paw Scout Camp (estimated location 45.19°N, 88.40°W; WGS 84). 17 July 1956. P. Litchfield. Verified by Steve Rogers. Carnegie Museum of Natural History, Pittsburgh, Pennsylvania (CM 36867). First county record, extends range ca. 32 km ESE from nearest published Langlade Co. record (Casper 1996).

***LAMPROPELTIS TRIANGULUM* (Eastern Milksnake)**. Green Lake Co.: Snake Creek (43.87°N, 89.00°W; WGS 84). 19 June 1959. D. G. Dunlap. Verified by Thomas G. Anton. University of Nebraska State Museum, Lincoln (UNSM 16472). New county record within expected range, ca. 19 km SE of nearest published Marquette Co. record (Vogt 1981). Supports prior observational record from Boy Scout camp on S shore of Green Lake (43.80°N, 89.00°W; WGS 84) by William Hilsenhoff in the 1940s, ca. 7.4 km to S (GSC, unpubl. data).

***NERODIA SIPEDON SIPEDON* (Northern Watersnake)**. Chippewa Co.: 9.7 km from Eau Claire (44.89°N, 91.47°W; WGS 84). 17 July 1927. L. C. Stuart. Verified by Gregory Schneider. University of Michigan Museum of Zoology, Ann Arbor (UMMZ 64740). First county record within expected range, ca. 30 km WNW from nearest published Eau Claire Co. record (Vogt 1981). Second specimen found on Hwy M W of 160th St. (45.2326°N, 91.3575°W; WGS 84). 20 May 2003. Richard A. Sajdak. Verified by Thomas G. Anton. Milwaukee Public Museum (MPM 33346). Polk Co.: 19.3 km E of Luck at Big Round Lake (45.52°N, 92.30°W; WGS 84). 4 August 1946. M. J. Toews. Verified by Christopher E. Smith. James Ford Bell Museum of Natural History, University of Minnesota, Minneapolis (JFBM R1294). First county record within expected range, ca. 28 km S from nearest published Burnett Co. record (Vogt 1981). Confirms earlier Vogt (1981) observation from Polk Co. Second specimen collected from same lake on 6 July 1940 is unverified, American Museum of Natural History, New York (AMNH 64101). St. Croix Co.: specific locality unknown (county centroid 45.03°N, 92.45°W; WGS 84). 30 May 1939. R. Anderson. Verified by Christopher E. Smith. James Ford Bell Museum of Natural History, University of Minnesota, Minneapolis (JFBM R1024). First county record within expected range, county centroid is ca. 42 km NE from nearest published Pierce Co. record (Casper 1996), and county line ca. 14 km N of same.

***OPHEODRYS VERNALIS* (Smooth Greensnake)**. Ashland Co.: Long Island, Apostle Islands National Lakeshore, between lighthouse and pier (46.7289°N, 90.7848°W; WGS 84). 27 May 2001. Brian J. Halstead. Verified by Thomas G. Anton. Milwaukee Public Museum (MPM 33088). First county record within expected range, ca. 42 km NE from nearest published Bayfield Co. record (Vogt 1981). Under board near pile of boards/driftwood in bluegrass. La Crosse Co.: On County Hwy DE, Section 7 SE1/4 of NE1/4 (43.9634°N, 91.0154°W; WGS 84). 21 July 1990. J. Kerkman. Verified by Thomas G. Anton. Milwaukee Public Museum (MPM 23519). First county record within expected range, ca. 22 km W from nearest published Monroe Co. record (Casper 1996). Road kill, upland oak and aspen forest with cultivated farmland nearby. Vernon Co.: Wildcat Mountain State Park, just off Hwy 33 on road to lower picnic area (43.695°N, 90.577°W; WGS 84). 28 July 1990. Karen Teed. Verified by Thomas G. Anton. Milwaukee Public Museum (MPM 23475). First county record within expected range, ca. 25.3 km NW from nearest published Richland Co. record (Casper 1996). Road kill.

***PANTHEROPHIS VULPINUS* (Eastern Foxsnake)**. Ashland Co.: Residence along Luttinen Rd., Marengo (46.395°N, 90.847°W; WGS 84). 10 October 2007. Gus Smith. Verified by Christopher A. Phillips. Illinois Natural History Survey, University of Illinois, Champaign (INHS Herp Photo 2011j). New county record, ca. 50 km ENE from nearest published record in SW Bayfield Co. (Casper 1996). Photographed in yard. Second specimen found at jct of Bass Lake and North York roads (46.3666°N, 90.7800°W; WGS 84). 2 June 2011. Thomas G. Anton, David Mauger. Verified by Alan Resetar. Field Museum of Natural History, Chicago, Illinois (FMNH 282467). Male with 39 dorsal blotches. Also observed gravid female with 38 dorsal body blotches, under board on top of wood chip pile in old gravel quarry. Surrounding habitat grassy fields and second growth northern hardwood forest. Price Co.: 1.6 km S of Fiefield on Hwy 13 (45.868°N, 90.428°W; WGS 84). 23 May 1978. M. R. Niblick. Verified by D. S. McLeod. University of Nebraska State Museum, Lincoln (UNSM 16104). New county record within expected range, ca. 69 km NE from nearest published record in Rusk Co. (Casper 1996). Second specimen from Co. Rd. C, 0.2 km south of RR tracks just within limits of Village of Prentice (45.537°N, 90.289°W; WGS 84). June 1999. Mike Spagnolo. Verified by Thomas G. Anton. Milwaukee Public Museum (MPM 30385).

***REGINA SEPTEMVITTATA* (Queensnake)**. Green Co.: Tributary of Sugar River (42.6°N, 89.4°W; WGS 84). May 2005. Aaron Garland. Verified by Christopher E. Smith. James Ford Bell Museum of Natural History, University of Minnesota, Minneapolis (JFBM Herp Photo 471). New county record, extends range ca. 49.5 km W from nearest published Wisconsin record in Rock Co. (Kapfer et al. 2009), and 51.5 km NNW from nearest published Illinois record in Winnebago Co. (Phillips et al. 1999). Location generalized due to Endangered Species status. Sunning in rock fill of dam spillway. Supports ca. 1960 observation by George Bachay on Sugar River ca. 9 km NNW of this record (GSC, unpubl. data).

***SISTRURUS CATENATUS* (Eastern Massasauga)**. Portage Co.: specific locality unknown (county centroid 44.47°N, 89.50°W; WGS 84). 1 October 1967. J. Small. Verified by Steve Rogers. Carnegie Museum of Natural History, Pittsburgh, Pennsylvania (CM 70492). New county record, extends range at least 25 km NE from nearest published record in Juneau Co. (Vogt 1981). Dried skin with rattle.

***STORERIA DEKAYI* (Dekay's Brownsnake)**. Green Lake Co.: White River Wash Area, Town 17 North, Range 12 East, Section 32 (section centroid 43.90°N, 89.10°W; WGS 84). 30 May 1974. Richard C. Vogt. Verified by Thomas G. Anton. Milwaukee Public Museum (MPM 7934). New county record within expected range, ca. 38 km NNW from nearest published record in Dodge Co. (Vogt 1981). St. Croix Co.: specific locality unknown (county centroid 45.03°N, 92.45°W; WGS 84). 2 July 1939. R. Anderson. Verified by Christopher E. Smith. James Ford Bell Museum of Natural History, University of Minnesota, Minneapolis (JFBM R1019). New county record within expected range, county centroid is ca. 26 km NW from nearest published record in Pierce Co. (Casper 1996), and county border is ca. 0.8 km N from same. Washburn Co.: Hwy M, 14.5 km E and 4.0 km S of Spooner (45.800°N, 91.725°W; WGS 84). 18 August 1971. W. G. Reeder. Verified by Thomas G. Anton. University of Wisconsin Zoological Museum, Madison (UWZM 24065). New county record within expected range, ca. 50 km SE from nearest published record in Burnett Co. (Vogt 1981).

***STORERIA OCCIPITOMACULATA OCCIPITOMACULATA* (Northern Red-bellied Snake)**. Menominee Co.: Big Eddy Falls (44.965°N, 88.635°W; WGS 84). 19 June 1925. T. E. B. Pope. Verified by Thomas G. Anton. Milwaukee Public Museum (MPM 1903). New county record within expected range, ca. 16 km NNE from nearest published record in Shawano Co. (Vogt 1981).

***THAMNOPHIS PROXIMUS PROXIMUS* (Orange-striped Ribbonsnake)**. Jefferson Co.: 6.4 km W of Eagle (42.88°N, 88.55°W; WGS 84). 23 July 1963. R. G. Pladies. Verified by Thomas G. Anton. Brigham Young University, Monte L. Bean Life Science Museum, Provo, Utah (BYU 40420). New county record. Extends range ca. 110 km SE from nearest Sauk Co. records (Vogt 1981).

***THAMNOPHIS RADIX* (Plains Gartersnake)**. Lafayette Co.: specific locality unknown (county centroid 42.66°N, 90.13°W; WGS 84). 22 October 1963. Unknown. Verified by Thomas G. Anton. University of Wisconsin Zoological Museum, Madison (UWZM 17284). New county record. Second specimen from Lafayette / Iowa Co. line ca. 100 m E of bridge crossing Pecatonica River (42.8119°N, 90.2574°W; WGS 84). July 1995. Brick M. Fevold. Verified by Thomas G. Anton. University of Wisconsin Zoological Museum, Madison (UWZM 23900). Road kill. These records extend range ca. 35 km S and 48 km W from nearest published records in Vogt (1981). Sauk Co.: 4 mi SE of Reedsburg. (43.49°N, 89.95°W; WGS 84). 15 September 1963. D. Bray. Verified by Thomas G. Anton. University of Wisconsin Zoological Museum, Madison (UWZM 17277). New county record, extends range ca. 32 km W from nearest published Columbia Co. record (Vogt 1981).

***THAMNOPHIS SAURITUS SEPTENTRIONALIS* (Northern Ribbonsnake)**. Columbia Co.: Gibraltar Rock, Lodi (43.34°N, 89.60°W; WGS 84). 12 October 2014. Lester Doyle. Verified by Jace W. Robinson. University of Michigan Museum of Zoology, Ann Arbor (UMMZ Photo 1262-4). New county record, ca. 35 km S of nearest published Adams Co. record (Casper 1997). Locality generalized due to Wisconsin Endangered Species status. Door Co.: Peninsula State Park, found on road. (45.14°N, 87.21°W; WGS 84). 5 June 2008. Nicholas J. Meiers. Verified by Gregory Schneider. University of Michigan Museum of Zoology, Ann Arbor (UMMZ Photo 1257-8). New county record, extending range ca. 71 km E from nearest published record in Marinette Co. across Green Bay (Vogt 1981). Confirms observation reported from same location in 1963 by George J. Knudsen (GSC, unpubl. data). Locality generalized due to Wisconsin Endangered Species status.

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Distributional Records for Amphibians and Reptiles from Wisconsin, USA

The following 32 county records either fill distribution gaps, or expand the known range of amphibian and reptile species native to Wisconsin beyond Vogt (1981), Casper (1996), and the many records that have been published since (e.g., Casper 1997, 1999). These records were obtained through field observations vouchered with photographs, through cross-referencing specimen collection databases, and through physical searches of specimen collections. Further documentation of the locality records described herein that are supported only by photographic vouchers or by very old specimens is desired, ideally by appropriate voucher specimens.

Several of these county records are based on old specimens that did not always include the specific location (other than county), date of collection (other than year), or additional contextual information. Although these records might be questionable, we have included them because they are supported by voucher specimens. Furthermore, they provide historical information relevant to upper Midwestern herpetology and could have important implications for future research and conservation endeavors. We also provide additional context for several of the more questionable old specimens. We do not further comment on old specimens that simply fill gaps for the known range of a species and instead focus on those that result in more substantial extensions to currently documented distributions. We also generally do not further comment on old specimens that represent range extensions into counties immediately adjacent to those with records supported by vouchers. Additional investigation into the locations associated with these questionable or old records is warranted and welcomed.

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CAUDATA — SALAMANDERS

***AMBYSTOMA LATERALE* (Blue-spotted Salamander).** Green Co.: Town of Avon (T1N R9E, Section 13). 31 May 2008. Jeffrey Lorch. Verified by Robert Hay. Illinois Natural History Survey (INHS 2015l photo voucher). Found in floodplain forest habitat. Iowa Co.: Village of Arena (T8N R5E, Section 9 NE1/4). 24 April 2010. Jeffrey Lorch. Verified by Robert Hay. Illinois Natural History Survey (INHS 2015m, photo voucher). Found under log in floodplain forest near ephemeral pond. This voucher is corroborated by numerous additional observations of *A. laterale* at this location by Joshua Kapfer, and voucher photographs taken at a different location by Jeffrey Lorch (INHS 2015n, T8N, R4E, Section 20) on 16 October 2010 (verified by Robert Hay). Jefferson Co.: Village of Cambridge (T6N R13E, Section 17). 2 May 2008. Jeffrey Lorch. Verified by Robert Hay. Illinois Natural History Survey (INHS 2015v, photo voucher). Eight individuals found under logs in woodlot adjacent to a shallow pond and lake. This record is supported by additional observations at another location (INHS 2015w; T5N R16E, Section 25) on 2 May 2008 by Jeffrey Lorch (verified by Robert Hay). Rock Co.: Town of Avon (T1N R10E, Section 28). 21 April 2007. Jeffrey Lorch. Verified by Robert Hay. Illinois Natural History Survey (INHS 2015ad, photo voucher). Seven individuals found under bark or logs in floodplain forest. This observation is corroborated by a voucher photograph taken at another location (INHS 2015ae, T1N R10E, Section 18) by Jeffrey Lorch on 21 April 2007 (verified by Robert Hay).

***AMBYSTOMA MACULATUM* (Spotted Salamander).** Calumet Co.: Town of Stockbridge (T18N R18E, Section 12). 26 September 2010. Jeffrey Lorch. Verified by Robert Hay. Illinois Natural History Survey (INHS 2015d, photo voucher). One juvenile found under a rock. Dodge Co.: Town of Mayville (T11N R16E, Section 1). 9 April 2011. Jeffrey Lorch and Corey Raimond. Verified by Robert Hay. Illinois Natural History Survey (INHS 2015g, photo voucher). Racine Co.: "Racine, Wisc" is the only location information accompanying these specimens. Exact collection date unknown, but according to museum ledger information, this specimen was collected by S.F. Baird and entered into the collection on 2 August 1858. Verified by Kenneth Tighe. Specimen found in the National Museum of Natural History collection (USNM 3938). Five additional specimens accompanied by a similar lack of contextual data are housed in the National Museum of Natural History (USNM 270087–270091). S. F. Baird, or Spencer Fullerton Baird, was a former curator at the National Museum of Natural History. Baird traveled to Racine in 1853 where he, Jared P. Kirtland, and Philo R. Hoy collected numerous specimens (Deiss 1985). The group did not restrict their collecting to Racine County (Schorger 1944) and it is unclear why at least some of

the specimens collected at this time were not accessioned until 1858. Many herpetological specimens collected by Hoy that currently reside in various collections lack detailed contextual information. Furthermore, others have suggested that some of Hoy's specimens were wrongfully attributed to Racine (where he lived) instead of where the specimens were actually collected (Vogt 1981). For example, Hoy included several eastern salamander species in his "Catalogue of the cold-blooded vertebrates of Wisconsin" (Hoy 1883) that might have actually been collected in Ohio (Vogt 1981). It is plausible that Hoy retained Wisconsin specimens collected during Baird's 1853 visit, which were accidentally inter-mixed with his Ohio specimens, and later sent to USNM incorrectly labeled as originating in Racine County. Despite these potential issues, suitable habitat for *A. maculatum* would have existed in Racine County in the 1850s (Curtis 1959). Hoy specifically mentions that this species was found in Racine (Hoy 1883), although he did not report specimen numbers. A reliable record, supported by a voucher specimen in the Milwaukee Public Museum (MPM 2470) exists for Milwaukee County (Casper 1996), which is immediately north of Racine County. It is also vouchered just across the Wisconsin-Illinois border in nearby Lake, Cook, and Will counties (Anton 1999; Phillips et al. 1999). For these reasons it is probable that the specimen is labeled accurately, and this species existed historically in Racine County. The current status of *A. maculatum* in Racine County, however, is unknown.

***HEMIDACTYLIUM SCUTATUM* (Four-toed Salamander).** Iowa Co.: Village of Ridgeway (T6N R4E, Section 10). 18 May 2008. Jeffrey Lorch. Verified by Robert Hay. Illinois Natural History Survey (INHS 2015o, photo voucher). An adult on a nest under a clump of moss in a wooded area near the base of a spring seepage. This is further corroborated by other observations of this species in Iowa County by Jeffrey Lorch on 16 May 2009 (INHS 2015q) at a different location (T7N R1E, Section 18; verified by Robert Hay). Price Co.: Chequamegon National Forest (T39N R3E, Section 26). 20 May 2011. Jeffrey Lorch and Corey Raimond. Verified by Robert Hay. Illinois Natural History Survey (INHS 2015ab, photo voucher). An adult female with eggs under sphagnum moss on a log overhanging a pool in a cedar-hemlock-white pine swamp.

***NOTOPHTHALMUS VIRIDESCENS* (Eastern Newt).** Columbia Co.: Village of Rio (T11N R10E, Section 14). 24 March 2007. Jeffrey Lorch. Verified by Robert Hay. Illinois Natural History Survey (INHS 2015e, photo voucher). Two terrestrial phase adults: one crossing road at 1 pm, the other captured while dipnetting within a small cattail/sedge pond within oak opening. Richland Co.: Village of Lone Rock (T8N R2E, Section 11). 31 August 2007. Jeffrey Lorch and Corey Raimond. Verified by Robert Hay. Illinois Natural History Survey (INHS 2015ac, photo voucher). One terrestrial phase adult under a railroad tie near a trestle running through a slough of the Wisconsin River.

***PLETHODON CINEREUS* (Eastern Red-backed Salamander).** Calumet Co.: Town of Stockbridge (T18N R19E, Section 7). 26 September 2010. Jeffrey Lorch. Verified by Robert Hay. Illinois Natural History Survey (INHS 2015c, photo voucher). Ten individuals captured under rocks and logs in dry mesic woods. Dane Co.: museum database lists "Madison" as the location and includes the following coordinates: 43.0731°N, 89.4012°W; WGS 84 (which is roughly in the middle of the University of Wisconsin-Madison campus). No collection date or collector provided. Verified by Kenneth Tighe. National Museum of Natural History collection (USNM 10903). An additional specimen apparently collected at this location (USNM 10902) is now lost. It is uncertain if coordinates accompanying this record represent the location of collection or the location of Madison, Wisconsin where the specimen may have resided prior to being transferred to USNM. Although there is a report of *P. cinereus* approximately 45 km to the northwest of Madison (Lange 2014), the nearest confirmed records are at least 150 km away. Furthermore, central Dane County was historically oak savanna—a dry habitat type that is not typically associated with this species. Thus, it seems unlikely that the specimen was collected in Dane County, but future surveys might shed additional light on the subject. Menominee Co.: Census Designated Place of Keshana, Menominee Native American Reservation (no additional specific locality data provided). 18 May 1951. R. Nero. Verified by Chris Phillips. University of Wisconsin-Madison Zoology Museum (UWZM 17592). Six individuals were in the jar associated with this number. Racine Co.: original museum ledger entry lists "Racine Wis". According to museum ledger, this specimen was collected by "Bailey" and accessioned on 2 August 1858. Verified by Kenneth Tighe. National Museum of Natural History (USNM 3788). According to associated notes, multiple specimens were housed under this catalogue number and "7 of 8" remained at the National Museum of Natural History and re-catalogued as USNM 276576–276582 in January 1987. It is unclear who "Bailey" was, but that this specimen was accessioned on the same date as USNM 3938 could suggest that it was part of Hoy's collection or was obtained during the 1853 collection event involving Baird (see *Ambystoma maculatu*m account for Racine County). Hoy does not mention that this species occurred near Racine (Hoy 1883), but it is possible that he confused *P. cinereus* for another species that he erroneously considered present (e.g., *Eurycea bislineata*). Suitable habitat for *P. cinereus* would have occurred near Racine in the mid 1800s (Curtis 1959). This coupled with the new record for this species from Washington County (see below) and the fact that it is vouchered in nearby Cook County, Illinois (Anton 1999; Phillips et al. 1999), indicates that at one time *P. cinereus* distribution followed the corridor of mesic forest along the western shore of Lake Michigan, as suggested by Casper (1996). For these reasons, we believe this record may be historically accurate, but the current status of *P. cinereus* in Racine County is unknown. Washington Co.: Kettle Moraine State Forest-Northern Unit (T12N, R19E, Section 14). 4 May 2008. Jeffrey Lorch. Verified by Robert Hay. Illinois Natural History Survey (INHS 2015ak, photo voucher). Seven more individuals found in general vicinity on 13 July 2008 by Jeffrey Lorch (INHS 2015al, verified by Robert Hay).

ANURA — FROGS

***LITHOBATES PALUSTRIS* (Pickerel Frog).** Adams Co.: Township of Douglas (specific location information accompanying specimen is "ca. 5 mi W of" the community of Briggsville). 22 September 1929. Collector not recorded. Verified by Kenneth Tighe. National Museum of Natural History collection (USNM 312213). Additional specimens reportedly collected on the same date from the same location are USNM 312214–312216. The location associated with this record is somewhat suspect, given the fact that "ca. 5 mi W" of Briggsville is very close to the border with Marquette County (Briggsville is actually located just over the border in Marquette County). Yet this species is documented in most of the immediately adjacent counties, which supports its

presence in Adams County. Further survey work to confirm the presence of *L. palustris* in this county is warranted.

***LITHOBATES SEPTENTRIONALIS* (Mink Frog)**. Marathon Co.: City of Marathon (T28N R05E Section 1). 10 June 1949. Sr. M. Joyce. Verified by Robert Hay. Milwaukee Public Museum (MPM 3474).

***LITHOBATES SYLVATICUS* (Wood Frog)**. Racine Co.: original museum ledger entry lists "Racine Wis" and museum database includes the following specific location: 42.7264°N, 87.8056°W; WGS 84. 31 July 1858. P. Hoy. Verified by Kenneth Tighe. National Museum of Natural History collection (USNM 3385). It is uncertain if coordinates accompanying this record represent the location of collection or the location of Racine, Wisconsin. According to associated notes, 12 specimens were housed under this number and 1–3 of them were sent to the University of Michigan Museum of Zoology (UMMZ 3865). The reliability of specimens donated to USNM by Hoy is described in greater detail in the *Ambystoma maculatum* account for Racine County. The habitat preferences of *L. sylvaticus* are similar to those of *A. maculatum* and such habitat existed near Racine in 1858 (Curtis 1959). Furthermore, many voucher specimens of *L. sylvaticus* exist in the Milwaukee Public Museum that came from Milwaukee County, which is immediately north of Racine County (e.g., MPM 1263, 1287–1363, etc.), although these were collected in the early 1900s. It has also been documented across the Wisconsin-Illinois border in Lake, Cook, and Will Counties (Anton 1999; Phillips et al. 1999). Thus, it is likely that this record is historically accurate, but the current status of *L. sylvaticus* in Racine County is unknown.

TESTUDINES — TURTLES

***APALONE SPINIFERA* (Spiny Softshell)**. Waupaca Co.: 44.633054°N, 88.634074°W. 6 June 2000. Erik Wild and Joel Ernst. Verified by Peter Zani. University of Wisconsin-Stevens Point Museum of Natural History (UWSP 3803). Backwater-bay of Wolf River at public boat landing off Hwy 156, laying on surface of floating vegetation in about 1-m deep water.

***GRAPTEMYS OUACHITENSIS* (Southern Map Turtle)**. Portage Co.: specific locality unknown. Date of collection unknown. Richard Vogt, Alan Jaslow, Bruce Hellmich. Verified by Robert Hay. Carnegie Museum of Natural History collection (CM 95113). This represents a substantial northward extension in the documented range of this species. It bypasses Juneau, Adams, and likely Wood counties (where *G. ouachitensis* has not yet been documented) and creates a new gap in its known range in Wisconsin. However, the same distributional pattern is documented for a related riverine species (*G. pseudogeographica*), which has also been vouchered in Portage County (Carnegie Museum of Natural History, CM 95112; Vogt 1981). The Wisconsin River runs through Juneau, Adams, and Wood counties, creating an obvious connection between Portage County and documented populations in Sauk and Columbia counties to the south. Therefore, it is reasonable that this species' range historically extended into Portage County, although modern anthropogenic modifications to the river along its course (e.g., dams) may have restricted movement. For example, substantial dams along the Wisconsin River exist near the city of Wisconsin Rapids (Wood County), which could have fragmented populations to the north and south. It is possible that a lack of recent *G. ouachitensis* documentation in more northern counties (such as Portage) reflects the slow decline or extirpation of previously isolated populations.

***GRAPTEMYS PSEUDOGEOGRAPHICA* (False Map Turtle)**. Pierce Co.: Bay City (specific locality given as "Lake Pepin"). 10 June 1973. Michael Ewert. Verified by Tony Gamble. Carnegie Museum of Natural History (CM 87555).

***TERRAPENE ORNATA* (Ornate Box Turtle)**. Jackson Co.: Only specific location information accompanying specimen is "near Hatfield," Wisconsin. According to museum records, the specimen was collected "before the 1950's". Charles F. Sindelar. Verified by Thomas Erdman. University of Wisconsin-Green Bay, Richter Museum of Natural History (R451). The validity of the location associated with this specimen is difficult to assess. The area from which this specimen was purportedly collected is approximately 100 km north of the currently recognized range limit for the species in Wisconsin (Casper 1996; Vogt 1981). The vague information regarding the location of its collection could potentially associate it with several habitat types. The unincorporated census-designated place of Hatfield is within the vicinity of three major plant community-types in Wisconsin: oak savanna, pine barrens/savanna, and conifer-hardwood forest (Curtis 1959). The other known populations of *T. ornata* in Wisconsin are almost exclusively associated with oak savanna and prairie (Vogt 1981). While they are not found in the conifer-hardwood forest community or documented in the pine savanna community, the latter is dry, open, and sandy like oak savanna. Thus, oak savanna and perhaps pine savanna could have potentially provided suitable habitat for *T. ornata* at this location. However, it seems unusual that the species would exist in an isolated pocket so far north of its known range, particularly when suitable habitat was historically common between the location of this record and the known southern populations (Curtis 1959). Yet, the area along the Black River in Jackson County is known to contain other species with more southern affinities (Wisconsin Department of Natural Resources 2005), which may have contributed to the presence of an isolated *T. ornata* population in Jackson County. This record may support that the historic range of *T. ornata* in Wisconsin was once larger, and this species perhaps occupied the suitable habitat up to Jackson County, but has undergone a more recent range contraction. Given that box turtles are easily collected and transported by humans, perhaps the Jackson County specimen is the result of a translocation. Regardless, given the sensitive nature of this species in Wisconsin (i.e., currently considered endangered), this record may be important for future conservation endeavors.

SQUAMATA — LIZARDS

***PLESTIODON FASCIATUS* (Common Five-lined Skink)**. Marquette Co.: Village of Coloma (T17N R9E, Section 3). 3 July 2010. Jeffrey Lorch. Verified by Robert Hay. Illinois Natural History Survey (INH 2015aa, photo voucher). One juvenile found under woody debris in pine-oak barrens. Waupaca Co.: No specific location given, aside from county. 10 July 1955. F. Iwen and Stanley Wellso. Verified by Chris Phillips. University of Wisconsin-Madison Zoology Museum (UWZM 14718).

SQUAMATA — SNAKES

***DIADOPHIS PUNCTATUS* (Ring-necked Snake)**. Vernon Co.: 43.536042°N, 91.151527°W; WGS 84. 11 June 2006. Joshua Kapfer. Verified by Chris Phillips. Illinois Natural History Survey (INHS 2014z, photo voucher). Several individuals (one gravid female and two mature males) found on a partially wooded slope under a rock. Adjacent habitat was pasture and a small creek.

***HETERODON PLATIRHINOS* (Eastern Hog-nosed Snake)**. Green Co.: No specific location given aside from Albany, Wisconsin. Specimen collected in "fall" 1960. Lloyd France. Verified by Chris Phillips. University of Wisconsin-Madison Zoology Museum (UWZM 22788). Jefferson Co.: Kettle Moraine State Forest-Southern Unit (T5N R16E, Section 33). 7 June 2006. Jeffrey Lorch. Verified by Robert Hay. Illinois Natural History Survey (INHS 2015x, photo voucher). Two juveniles found under rotting logs in open sandy area in transmission line right-of-way. La Crosse Co.: Community of Mindoro (T18N R5W, Section 19). 23 June 2010. Kate Olson. Verified by Robert Hay. Illinois Natural History Survey (INHS 2015h, photo voucher). One adult found crossing a residential lawn.

***LAMPROPELTIS TRIANGULUM* (Eastern Milksnake)**. Trempealeau Co.: City of Galesville (44.099791°N, 91.352259°W; WGS 84). 13 July 2014. Patrick Stoner. Verified by Chris Phillips. Illinois Natural History Survey (INHS 2014w, photo voucher). Numerous individuals found on the same day at this location.

***STORERIA DEKAYI* (Dekay's Brownsnake)**. Adams Co.: T16N R5E, Section 23. 4 July 2008. Jeffrey Lorch. Verified by Robert Hay. Illinois Natural History Survey (INHS 2015b, photo voucher). Eight individuals found under logs in a small opening in oak barrens.

***STORERIA OCCIPITOMACULATA* (Red-bellied Snake)**. Lafayette Co.: Town of Fayette (T4N R4E, Section 34). 6 October 2007. Jeffrey Lorch. Verified by Robert Hay. Illinois Natural History Survey (INHS 2015z, photo voucher). Approximately 30 individuals seen both alive and as roadkill on a gravel road separating a mesic and wet-mesic field from upland woodlots.

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One Hundred Two New County Records for Amphibians and Reptiles in Alabama, USA

The diversity and distribution of Alabama's amphibians and reptiles was first examined comprehensively in Mount's (1975) regional field guide. In subsequent years, however, less effort was invested into general inventory of the state's herpetofauna. Interest in generating a thorough documentation of Alabama's herpetofauna has re-emerged in the last decade. In particular, an impressive effort by Graham et al. (2009) documented 101 new county records for the state, and their inspiring efforts appear to have spurred other significant projects, such as inventories in Tuskegee National Forest (Graham et al. 2012), Pike County (Burchill and Diamond 2014), and northern Alabama (Sutton et al. 2014). Despite the renewed interst, few counties within Alabama have been sampled extensively, and large distributional gaps still remain for the majority of species in the state.

In anticipation of a forthcoming revision to Mount (1975), we sought to further the spirit of our Auburn colleagues by compiling a series of new county records of amphibians and reptiles throughout Alabama. We accrued novel observations and specimens during research activities, nocturnal road-cruising surveys, class field trips, and targeted collecting trips to under-sampled areas. Here we report 102 new county records for Alabama, which includes at least one new county record for 52 species. Records were vouchered as specimens or digital photographs and were deposited into the Herpetological Collections of the Auburn University Museum of Natural History (AUM, AUMO, AHAP-D, AHAP-C, AHAP-P). All records were verified by Craig Guyer. The datum for all GPS coordinates is WGS 84. Standard English names follow Crother (2012).

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CAUDATA — SALAMANDERS

***AMBYSTOMA MACULATUM* (Spotted Salamander)**. USA: ALABAMA: Madison Co.: Monte Sano State Park Bankhead parkway (34.74690°N, 86.50720°W). 23 April 2010. J. Stiles, S. Stiles. AUM 38876.

***AMBYSTOMA TIGRINUM* (Eastern Tiger Salamander)**. USA: ALABAMA: DeKalb Co.: Farm pond, 200 m S of CR 624 (34.50206°N, 85.60568°W). 12 May 2012. J. Stiles, S. Stiles. AUM 39673.

***AMPHIUMA MEANS* (Two-toed Amphiuma)**. USA: ALABAMA: Elmore Co.: Tumkeehatchee Creek (32.51725°N, 86.01073°W). 2 September 2001. J. C. Godwin, J. G. Godwin. AUM 36383. Escambia Co.: Solon Dixon Center, Rope Swing, Cypress Oxbow Pond (31.18907°N, 86.70925°W). 4 October 2013. J. Stiles, S. Stiles. AUM 40455. Geneva Co.: Spring Creek at Spring Creek Rd. (31.03273°N, 85.70049°W). 4 October 2013. D. Werneke. AUM 40447. Mount (1975) reports a literature record for the county; this animal represents the first vouchered individual.

***EURYCEA GUTTOLINEATA* (Three-lined Salamander)**. USA: ALABAMA: Chambers Co.: Off of Highway 50 at intersection with Little Chatahospee Creek (32.84134 °N, 85.4918°W). 16 March 2015. R. Birkhead. AUM 41035. Collected from a leaf pack in the creek's floodplain.

***GYRINOPHILUS PORPHYRITICUS* (Spring Salamander)**. USA: ALABAMA: Franklin Co.: Rock Bridge Canyon Park, spring run (34.36270°N, 87.93321°W). 23 August 2014. J. Stiles, S. Stiles. AUM 40821.

***PSEUDOTRITON RUBER RUBER* (Northern Red Salamander)**. USA: ALABAMA: Tallapoosa Co.: Tributary to Timbergut Creek, east of Patterson Rd, 0.48 km N of intersection with Cowpens Rd (33.05020°N, 85.78149°W). 10 May 2011. D. Werneke, J. Armbruster, T. Mosely, C. Ray, T. Hess, C. Ames. AUM 39760.

***PSEUDOTRITON RUBER VIOSCAI* (Southern Red Salamander)**. USA: ALABAMA: Covington Co.: Conecuh National Forest, Pond Creek at CR 24 (31.10167°N, 86.53900°W). 22 May 2013. B. Folt, J. Goessling. AUM 40223–40224, 40230.

***PLETHODON GLUTINOSUS* (Northern Slimy Salamander)**. USA: ALABAMA: Randolph Co.: Off of Highway 77, 0.56 road km SE from intersection with CR 15 (33.14067°N, 85.61987°W). Found under logs on hardwood slope. 16 March 2015. R. Birkhead. AUM 41036–41037.

***PLETHODON GROBMANI* (Southeastern Slimy Salamander)**. USA: ALABAMA: Bullock Co.: The Wehle Tract (32.02917°N, 85.47493°W). 26 April 2014. B. Folt, M. Miller, C. Guyer. AUM 40582.

***PLETHODON WEBSTERI* (Webster's Salamander)**. USA: ALABAMA: Randolph Co.: In ravine 0.07 air km SW of intersection of CR 15, CR 889, and railroad tracks (33.19665°N, 85.57873°W). Found by raking leaf litter on hardwood slope. 16 March 2015. R. Birkhead. AUM 41044.

***SIREN INTERMEDIA* (Lesser Siren)**. USA: ALABAMA: Autauga Co.: CR 29, 3.22 road km S of CR 14, wetland next to New Jericho Missionary Baptist Church (32.40363°N, 86.51600°W). 13 May 2014. D. Laurencio, S. Belford. AUM 40645. Houston Co.: Irwin Mill Creek, immediately west of AL 95 (31.00504°N, 85.04117°W). 4 March 2014. D. Laurencio, S. Belford. AUM 40489.

ANURA — FROGS

***ACRIS CREPITANS* (Eastern Cricket Frog)**. USA: ALABAMA: Autauga Co.: 3.22 road km S of CR 14 on CR 29, wetland next to New Jericho Missionary Baptist Church (32.40363°N, 86.51600°W). 31 April 2014. D. Laurencio, A. T. Harris, R. Burgenden. AUM 40597. Cherokee Co.: Captured along small tributary of Terrapin Creek along CR 33 between Sanford Springs and Frog Mountain (34.01887°N, 85.57391°W). 26 August 2014. R. Birkhead. AUM 40755. Lowndes Co.: 0.32 road km S of CR 40 on Lake Berry Rd (32.32101°N, 86.53706°W). 14 May 2014. D. Laurencio, S. Belford. AUM 40654–56. Randolph Co.: Captured along Cornhouse Creek at Highway 431 bridge (33.23896°N, 85.44194°W). 27 August 2014. R. Birkhead. AUM 40756. Tallapoosa Co.: The Coon Creek Forever Wild Tract (32.59779°N, 85.87508°W). 5 November 2011. J. Goessling, B. Folt, I. E. P. Turner. AUM 39724–39727, 39730.

***ACRIS GRYLLUS* (Southern Cricket Frog)**. USA: ALABAMA: Autauga Co.: south of CR 14 on CR 29, wetland next to New Jericho Missionary Baptist Church (32.40363°N, 86.51600°W). 13 May 2014. D. Laurencio, S. Belford. AUM 40639–40640. Franklin Co.: Spring outflow at Rock Bridge Canyon (34.36269°N, 87.93300°W). 23 August 2014. J. Stiles, S. Stiles. AUM 40767. Lamar Co.: Collected from swamp 1.1 km S of Fernbank Rd. (CR 12) on AL 17 (33.58066°N, 88.08423°W). 5 May 2014. R. Birkhead. AUM 40621.

***ANAXYRUS AMERICANUS* (American Toad)**. USA: ALABAMA: Lauderdale Co.: CR 9, 0.4 km W of intersection with CR 41 (34.88779°N, 87.74103°W). 12 March 2015. J. Stiles. AUM 41021. Tallapoosa Co.: Ca. 5 km S of Highway 280 on CR 89 (32.74032°N, 85.65764°W). 10 January 2012. B. Folt, J. Goessling. AUM 39778.

***ANAXYRUS TERRESTRIS* (Southern Toad)**. USA: ALABAMA: Elmore Co.: 3.54 road km E of CR 8 on CR 4 (32.45090°N, 86.15934°W). 30 April 2014. D. Laurencio, A. T. Harris, R. Burgenden. AUM 40591. Mount (1975) lists only hybrids between *A. fowleri* x *A. terrestris* for Elmore Co.

***GASTROPHRYNE CAROLINENSIS* (Eastern Narrow-mouthed Toad)**. USA: ALABAMA: Lowndes Co.: 3.1 road km W of CR 37 on CR 54 (32.32413°N, 86.539027°W). 14 May 2014. D. Laurencio, S. Belford. AUM 40666.

***HYLA AVIVOCA* (Bird-voiced Treefrog)**. USA: ALABAMA: Autauga Co.: 3.22 road km S of CR 14 on CR 29, wetland next to New Jericho Missionary Baptist Church (32.40363°N, 86.51600°W). 13 May 2014. D. Laurencio, S. Belford. AUM 40635–36. Elmore Co.: Poundstone Lake (32.43751°N, 86.11422°W). 30 April 2014. D. Laurencio, A. T. Harris, R. Burgenden. AUM 40594–95. Geneva Co.: CR 4 (31.03893°N, 85.922275°W). 21 May 2012. B. Folt. AHAP-C 0014. Numerous males calling in a roadside beaver pond.

***HYLA CHRYSOSCELIS* (Cope's Gray Treefrog)**. USA: ALABAMA: Autauga Co.: 3.21 road km S of CR 14 on CR 29, in a wetland immediately north of New Jericho Missionary Baptist Church (32.40363°N, 86.51600°W). 13 May 2014. D. Laurencio, S. Belford. AUM 40637-38. Coffee Co.: 10 m N of CR 484 on CR 473 (31.20898°N, 86.14799°W). 14 April 2014. J. Goessling. AUM 40536. Elmore Co.: 3.54 road km E of CR 8 on CR 4 (32.45090°N, 86.15934°W). 30 April 2014. D. Laurencio, A. T. Harris, R. Burgenden. AUM 40592.

***HYLA CINEREA* (Green Treefrog)**. USA: ALABAMA: Autauga Co.: 3.22 road km S of CR 14 on CR 29, wetland next to New Jericho Missionary Baptist Church (32.40363°N, 86.51600°W). 13 May 2014. D. Laurencio, S. Belford. AUM 40633–34. Geneva Co.: CR 4 (31.047017°N, 85.899119°W). 21 May 2012. B. Folt. AHAP-C 13. Numerous males were recorded calling from a roadside pond at night.

***LITHOBATES CATESBEIANUS* (American Bullfrog)**. Cherokee Co.: Captured in drying beaver pond on Sandy creek where it crosses CR18 at Sandy Springs (34.072956°N, 85.499496°W). 26 August 2014. R. Birkhead. AUM 40757. Lamar Co.: State Highway 17 at intersection with Fernbank Rd. (33.58182°N, 88.08466°W). 3 March 2015. B. Folt, J. Goessling, C. Guyer. AUM 40965.

***LITHOBATES CLAMITANS* (Green Frog)**. USA: ALABAMA: Barbour Co.: Tributary to Leak Creek, immediately north of where creek crosses Old Batesville Rd (31.93325°N, 85.32658°W). 7 February 2015. C. Kemp, B. Folt. AUM 40937. Cherokee Co.: Captured in drying beaver pond on Sandy creek where it crosses CR 18 at Sandy Springs (34.072956°N, 85.499496°W). 26 August 2014. R. Birkhead. AUM 40758. Covington Co.: Conecuh National Forest (31.10860°N, 86.57620°W). 10 July 2014. J. Stiles, S. Stiles. AUM 40711. Franklin Co.: Hulsey Branch near Bear Creek and Highway 187 (34.35879°N, 87.90043°N). 23 August 2014. J. Stiles, S. Stiles. AUM 40771. Geneva Co.: 1.5 km W of AL 52 on AL 54 (31.11450°N, 86.13235°N). 14 April 2014. J. Goessling, J. Stiles, S. Stiles. AUM 40534. Dead on road (DOR). Randolph Co.: Wolfpen Creek, 0.37 air km SE of intersection of where Wolfpen Creek intersects CR 843. (33.13972°N, 85.62504°W). 16 March 2015. R. Birkhead. AUM 41038. Tallapoosa Co.: The Coon Creek Tract (32.60301°N, 85.8631°W). 5 November 2011. B. Folt, J. Goessling, I. E. P. Turner. AUM 39729.

***LITHOBATES PALUSTRIS* (Pickerel Frog)**. USA: ALABAMA: Franklin Co.: Piney Point Recreation Area (34.39191°N, 87.98483°W). 11 March 2015. J. Stiles. AUM 41014.

***LITHOBATES SPHENOCEPHALUS* (Southern Leopard Frog)**. USA: ALABAMA: Autauga Co.: Spring feeding into Bear Creek, south of bridge at Highway 14 (32.43086°N, 86.57449°W). 1 June 2013. B. Folt, C. Montross. AUM 40236. Adult collected in swampy

floodplain. Covington Co.: Conecuh National Forest (31.12014°N, 86.59860°W). 31 January 2013. J. Stiles, S. Stiles. AUM 40713. Elmore Co.: 0.32 road km E of Laprade Rd (32.45321°N, 86.06511°W). 30 April 2014. D. Laurencio, A. T. Harris, R. Burgenden. AUM 40594–95. Geneva Co.: CR 4 (31.03779°N, 85.95413°W). 21 May 2012. B. Folt. AHAP-D 568. Found DOR while night driving. Mount (1975) reports a literature record for the county; this animal represents the first vouchered individual. Marion Co.: Collected from small borrow pit Alabama Rd. 19 between Hamilton and Vina (34.28519°N, 88.06445°W). 5 May 2014. R. Birkhead. AUM 40625. Pickens Co.: Liberty Rd./CR 75, 0.64 km S of intersection with McDill Rd. (33.49297°N, 88.17159°W). 3 March 2015. B. Folt, J. Goessling, C. Guyer. AUM 40964.

***PSEUDACRIS BRACHYPHONA* (Mountain Chorus Frog)**. USA: ALABAMA: Chambers Co.: 1.3 road km E of Chambers CR 11 on Chambers CR 22 (32.780611°N, 85.54050°W). 20 January 2012. J. Goessling, D. Laurencio. AUM 39781-82. Franklin Co.: Piney Point Recreation Area (34.39232°N, 87.98689°W). 11 March 2015. J. Stiles. AUM 40990. Lamar Co.: Ditch north of Fernbank Rd., 0.80 km west of intersection with Pleasant Ridge Rd. (33.57900°N, 88.10063°W). 3 March 2015. J. Goessling, B. Folt, C. Guyer. AUM 40966.

***PSEUDACRIS CRUCIFER* (Spring Peeper)**. USA: ALABAMA: Autauga Co.: 3.2 road km S of CR 14 on CR 29, wetland next to New Jericho Missionary Baptist Church (32.40363°N, 86.51600°W). 31 April 2014. D. Laurencio, A. T. Harris, R. Burgenden. AUM 40605, 40667. Elmore Co.: Forever Wild property near Kent (32.63076°N, 85.94417°W). 17 January 2012. B. Folt, J. Goessling. AHAP-D 534. Found AOR. Lauderdale Co.: CR 16, just west of Cypress Creek (34.85831°N, 87.73693°W). 12 March 2015. J. Stiles. AUM 41006.

***PSEUDACRIS FERIARUM* (Upland Chorus Frog)**. USA: ALABAMA: Houston Co.: 0.16 road km W of Springhill Church Rd. (CR 101) on Turnpike Rd. (31.11909°N, 85.11150°W). 4 March 2014. D. Laurencio, S. Belford. AUM 40495. Calling male. Lowndes Co.: cattle field immediately south of intersection of CR 40 and Robinson Switch Rd. (32.32259°N, 86.616407°W). 10 January 2013. B. Folt. AUM 40120. Calling male.

***SCAPHIOPUS HOLBROOKII* (Eastern Spadefoot)**. USA: ALABAMA: Geneva Co.: CR 4 (31.03742°N, 8595763°W). 21 May 2012. B. Folt. AUM 39866.

CROCODYLIA — CRODODILIANS

***ALLIGATOR MISSISSIPIENSIS* (American Alligator)**. USA: ALABAMA: Geneva Co.: Pea River (30.99758°N, 86.01225°W). 24 May 2012. B. Folt, J. Godwin, J. Lovich, J. Ennen. AHAP-D 572.

TESTUDINES — TURTLES

***APALONE SPINIFERA* (Spiny Softshell)**. USA: ALABAMA: Lauderdale Co.: McFarland Park (34.78483°N, 87.68995°W). 31 July 2014. J. Stiles, S. Stiles. AHAP-D 939.

***CHELYDRA SERPENTINA* (Snapping Turtle)**. USA: ALABAMA: Colbert Co.: 0.8 road km S of Flatwoods Rd on Frankfort Rd (34.62778°N, 87.77964°W). 3 May 2014. J. Stiles, S. Stiles. AUMO 4818. Gravid adult female found DOR. Eggs preserved as AUM 40610. Geneva Co.: Pea River (31.21252°N, 86.12341°W). 23 May 2012. B. Folt, J. Godwin, J. Lovich, J. Ennen, B. Kreiser. AHAP-D 570. Found swimming in shallow water near a sandy shoreline. Lamar Co.: Found DOR 1.1 km S of Fernbank Rd (CR 12) on AL 17 (33.58066°N, 88.08423°W). 5 May 2014. R. Birkhead. AUMO 4852.

***GRAPTEMYS PULCHRA* (Alabama Map Turtle)**. USA: ALABAMA: Coosa Co.: Coosa Wildlife Management Area (32.84785°N, 86.39541°W). 15 July 2012. B. Folt, I. E. P. Turner. AHAP-D 594; AUMO 4622. Skull and shell found in a creek.

***KINOSTERNON SUBRUBRUM* (Eastern Mud Turtle)**. USA: ALABAMA: Geneva Co.: 150 m W of Maloy Rd. where AL 54 crosses Panther Creek (31.10956°N, 86.14525°W). 27 April 2014. J. Goessling. AUM 40571. DOR.

***STERNOTHERUS ODORATUS* (Eastern Musk Turtle)**. USA: ALABAMA: Autauga Co.: 3.2 road km S of CR 14 on CR 29, ditch next to New Jericho Missionary Baptist Church (32.40390°N, 86.51631°W). 31 April 2014. D. Laurencio, A. T. Harris, R. Burgenden. AUM 40600.

***TERRAPENE CAROLINA* (Eastern Box Turtle)**. USA: ALABAMA: Cherokee Co.: 0.47 road km N of CR 308 on CR 33 just south of McFrey Crossroads (33.98892°N, 85.57805°W). 26 August 2014. R. Birkhead. AUM–O 4819. DOR.

***TRACHEMYS SCRIPTA* (Pond Slider)**. USA: ALABAMA: Autauga Co.: 0.23 road km W of Buena Vista Blvd on CR 4 (32.42391°N, 86.45240°W). 13 May 2014. D. Laurencio, S. Belford. AUM 40662. Conecuh Co.: SR 55, 0.5 road km past County Highway 107 (31.51186°N, 86.70181°W). 17 June 2012. B. Folt. AHAP-D 575. Intact shell found on road. Franklin Co.: Sloss Lake (34.48587°N, 87.70807°W). 23 August 2014. J. Stiles, S. Stiles. AHAP-D 944.

SQUAMATA — LIZARDS

***ANOLIS CAROLINENSIS* (Green Anole)**. USA: ALABAMA: Coosa Co.: CR 29 (32.95209°N, 86.33030°W). 15 July 2012. B. Folt, I. E. P. Turner. AUM 39945. Mount (1975) reports a literature record, but this specimen is the first voucher. Sumter Co.: Sumter County Recreation Association Park (32.5538°N, 88.19995°W). 3 March 2014. J. Goessling, B. Folt, C. Guyer. AUM 40957. Mount (1975) reports a literature record, but this specimen is the first voucher.

***SCINCELLA LATERALIS* (Little Brown Skink)**. USA: ALABAMA: Bullock Co.: Wehle Tract, on dirt road north of pond next to Wehle Office (32.03563°N, 85.47168°W). 26 April 2014. C. Guyer, M. Miller, B. Folt. AUM 40573.

***PLESTIODON FASCIATUS* (Common Five-lined Skink)**. USA: ALABAMA: Bullock Co.: Wehle Tract (32.03504°N, 85.47283°W). 26 April 2014. C. Guyer, M. Miller, B. Folt. AUM 40574. Randolph Co.: 0.92 road km E of CR 32 on Wedowee Creek View Dr. (33.34292°N, 85.51219°W). 19 October 2013. S. Abate. AUM 40454. Sumter Co.: floodplain east of CR 17, 0.64 km N of bridge over Interstate Highway 59 (32.52749°N, 88.29874°W). 3 March 2015. C. Guyer, J. Goessling, B. Folt. AUM 40958.

SQUAMATA — SNAKES

***AGKISTRODON CONTORTRIX* (Copperhead)**. USA: ALABAMA: Chambers Co.: State Route 77 (33.05693°N, 85.43458°W). 9 September 2012. B. Folt. AHAP-D 622. DOR adult. Geneva Co.: Eulon Mills

Rd., 200 m W of Old County Rd. (31.11520°N, 86.18915°W). 23 April 2014. J. Goessling. AUM 40565. Monroe Co.: CR 47, ca. 25 km W of Greeneville (31.820972°N, 86.951778°W). 23 March 2012. J. Goessling, M. Wines. AHAP-D 544.

***AGKISTRODON PISCIVORUS* (Cottonmouth)**. USA: ALABAMA: Franklin Co.: Small creek by Prices Bridge (34.31207°N, 87.82220°W). 23 August 2014. J. Stiles, S. Stiles. AUM 40876. Lowndes Co.: Between 3.2–4.0 km NE of Braggs pine/swamp (32.06945°N, 86.77163°W). 2 May 1996. M. Bailey. AUM 33789.

***CARPHOPHIS AMOENUS* (Common Wormsnake)**. USA: ALABAMA: Chambers Co.: Off of Highway 50, at its intersection with Little Chatahospee Creek (32.84074°N, 85.49256°W). 16 March 2015. R. Birkhead. AUM 41033. Found by raking leaf litter on a hardwood-covered slope above the creek's floodplain.

***COLUBER CONSTRICTOR* (North American Racer)**. USA: ALABAMA: Dallas Co.: 0.64 road km W of CR 25 on Highway 80 (mile marker 70) (32.43997°N, 87.25317°W). 21 April 2012. D. Laurencio. AUM 39904.

***CROTALUS HORRIDUS* (Timber Rattlesnake)**. USA: ALABAMA: Clay Co.: Rock Pile Creek, off Fuller Rd., 1.13 road km N of White Plains Rd. (33.147303°N, 85.78384°W). 10 July 2012. I.E.P. Turner. AHAP-D 607. Sub-adult found crossing a dried-up stream bed. Coosa Co.: State Highway 22 (32.88303°N, 86.05581°W). 15 July 2012. B. Folt, I. E. P. Turner. AHAP-D 593. Henry Co.: State Highway 95, 0.48 road km S of CR 204 (31.65066°N, 85.21984°W). 19 August 2013. C. Guyer. AUM 40408.

***HETERODON PLATIRHINOS* (Eastern Hog-nosed Snake)**. USA: ALABAMA: Butler Co.: State Route 10 (Pineapple Highway) ca. 18 km W of Greeneville (31.828056°N, 86.78425°W). 23 March 2012. J. Goessling, M. Wines. AHAP-D 543. Melanistic individual found DOR. Cleburne Co.: CR 522, ca. 0.32 km NW of intersection with CR 523 (33.70555°N, 85.62835°W). 16 September 2014. J. Stiles, S. Stiles. AHAP-D 958. Coffee Co.: AL 52, 0.58 km SE of CR 490 (31.19320°N, 86.15690°W). 23 April 2014. J. Goessling. AHAP-D 798. Geneva Co.: Geneva State Forest, Forest Area Rd., ca. 0.5 km W of Harrison Rd (31.11974°N, 86.16515°W). 14 April 2014. J. Goessling. AUM 40540.

***LAMPROPELTIS ELAPSOIDES* (Scarlet Kingsnake)**. USA: ALABAMA: Colbert Co.: Dirt road west of Coon Dog Cemetery Rd. (34.62390°N, 87.97257°W). 7 May 2010. S. Stiles. AUM 40183.

***NERODIA SIPEDON* (Common Watersnake)**. USA: ALABAMA: Randolph Co.: Cornhouse creek at Highway 431 bridge (33.23896°N, 85.44194°W). 27 August 2014. R. Birkhead. AUM 40753-54. Found beneath flat rocks right at edge of water.

***REGINA SEPTEMVITTATA* (Queensnake)**. USA: ALABAMA: Escambia Co.: Wing Rd. bridge over Blackwater Creek (31.02881°N, 86.704706°W). 1 September 2013. J. Goessling, B. Folt, C. Murray, M. Cook, S. Johnson, J. Zeyl, C. Guyer. AHAP-D 914. DOR; ravaged by ants, but identified by ventral scale color pattern.

***OPHEODRYS AESTIVUS* (Rough Greensnake)**. USA: ALABAMA: Geneva Co.: Geneva State Forest, Mud Hole Rd., ca. 100 m W of Harrison Rd. (31.16129°N, 86.18737°W). 27 April 2014. J. Goessling. AHAP-D 799. Monroe Co.: Along train track on west side of tunnel (31.665359° N, 87.229261° W). 23 April 1999. R. Birkhead. AHAP-D 858.

***PANTHEROPHIS SPILOIDES* (Gray Ratsnake)**. USA: ALABAMA: Elmore Co.: Forever Wild Property (32.63430°N, 85.93947°W). 22 March 2012. B. Folt, J. Goessling. AHAP-D 537. Found within the door of an abandoned refrigerator. Franklin Co.: 0.9 km S of Jackson Rd. on AL 247 (34.5079.0°N, 88.01897°W). 8 May 2014. R. Birkhead. AUM 40626.

***TANTILLA CORONATA* (Southeastern Crowned Snake)**. USA: ALABAMA: Elmore Co.: Forever Wild Property, north of Kent (32.633083°N, 85.941306°W). 10 March 2012. J. Goessling, S. Goetz, M. Miller. AUM 39812.

***THAMNOPHIS SAURITUS* (Eastern Ribbonsnake)**. USA: ALABAMA: Tallapoosa Co.: 1.7 road km NW of CR 98 on Piedmont Drive/Mayton Street (32.82212°N, 85.65006°W). 13 April 2012. D. Laurencio. AUM 39833.

***THAMNOPHIS SIRTALIS* (Common Gartersnake)**. USA: ALABAMA: Geneva Co.: Geneva State Forest, Harrison Rd., ca. 100 m W of Mud Hole Rd (31.15813°N, 86.18046°W). 27 April 2014. J. Goessling. AHAP-D 800.

***SISTRURUS MILIARIUS* (Pygmy Rattlesnake)**. USA: ALABAMA: Escambia Co.: CR 11, south of intersection with Highway 15/29 (31.11183°N, 86.76351°W). 31 August 2013. B. Folt, C. Guyer, C. Murray, J. Zeyl, J. Stiles, M. Cook, S. Johnson. AUM 40387.

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New Geographic Distributional Records of Amphibians and Reptiles in Georgia, USA

The publication *Amphibians and Reptiles of Georgia* (Jensen et al. 2008) represents the most recent collection of distributional records for the state. Despite this robust data set, numerous gaps remain for common and rare species at both the county and projected statewide range levels. Reported herein are 20 novel county distributional records including valuable range extension data on several cryptic species, 19 of which represent the upper Piedmont, Ridge and Valley, and Blue Ridge physiographic provinces. Unless otherwise noted, all records consist of vouchered digital photographs located in the Georgia Museum of Natural History (GMNH). Species identifications were verified by Nikole Castleberry unless indicated otherwise. All coordinates are based on datum WGS 84. Standard English names follow Crother (2012).

CAUDATA — SALAMANDERS

***AMBYSTOMA MACULATUM* (Spotted Salamander).** White Co.: 3.00 km NW of Sautee Nacoochee, just NW of the intersection of Bean Creek Road and Gold Valley Road (34.708709°N, 83.685396°W). 28 February 2011. B. Hudson, Z. Seymour, and N. Dean. GMNH 50908. Numerous adults (>15) observed in several ephemeral pools during a rain event at night. Depressions were formed from previous gold mining activities. Five adults were captured using a dip net for photo vouchers.

***AMBYSTOMA TALPOIDEUM* (Mole Salamander).** Banks Co.: 4.20 km SE of Gillsville, 1.50 km SW of the intersection of Carson Segars Road and Mize Cemetary Road (34.299602°N, 83.588992°W). 9 March 2014. B. Hudson and K. McEntire. GMNH 50897. A single adult flipped under a rock on the edge of a beaver controlled wetland, just N of county reservoir 21. Polk Co.: 8.00 km NW of Cedartown, 1.00 km NW of the intersection of Cave Springs Road and Kings Bridge Road (34.063883°N, 85.316451°W). 4 January 2015. B. Hudson and J. Oguni. GMNH 50906. Two terrestrial adults found with spotlights at night and captured using a dip net in an ephemeral pool created in the early 1900's for iron ore production. Two additional paedomorphic adults were captured by using a dip net at another ephemeral pool just W of the first pool.

***AMBYSTOMA TIGRINUM* (Eastern Tiger Salamander).** Bartow Co.: 8.60 km N of Taylorsville, 0.15 km NW of the intersection of Taylorsville Macedonia Road and Ore Mine Road (34.163990°N, 84.986994°W). 20 May 2013. E. Rush, B. Wilson, J. Oguni, and B. Hudson. GMNH 50903. A single adult found after pushing out the stump of a pecan tree in the yard of a private residence.

***EURYCEA GUTTOLINEATA* (Three-lined Salamander).** Fannin Co.: 12.6 km NW of Blue Ridge, 1.85 km SW of the intersection of Lebanon Road and Madola Road (34.927550°N, 84.438567°W). 23 June 2010. B. D. Hudson and T. Stratmann. Verified by Elizabeth McGhee. GMNH 50131. A single adult found surface active on the bank of a small creek.

***HEMIDACTYLIUM SCUTATUM* (Four-toed Salamander).** Banks Co.: 5.30 km S of Alto, 0.40 km W of the intersection of Beaver Swamp Road and Lost Corner Road on Wilson Shoals Wildlife Management Area (34.419847°N, 83.564944°W). 25 March 2014. B. Hudson and D. Duff. GMNH 50898. Two adults flipped under logs on the edge of a small ephemeral pool located just inside a unit burned a few weeks prior to the observations.

TESTUDINES — TURTLES

***CHELYDRA SERPENTINA* (Snapping Turtle).** Pickens Co.: Camp Dobbs Road, 0.2 km E of intersection with Pleasant Union Road (34.384633°N, 84.500327°W). 8 June 2014. Z. Felix. GMNH 50916. A single adult found alive on road.

SQUAMATA — LIZARDS

***PLESTIODON LATICEPS* (Broad-headed Skink).** Stephens Co.: 4.80 km N of Toccoa, 0.85 km NW of the intersection of Anderson Road and Highview Road (34.620621°N, 83.331799°W). 22 May 2014. B. Hudson and D. Duff. GMNH 50907. A single adult flipped under a rock on a rocky, south-facing, forested hillside.

***SCINCELLA LATERALIS* (Little Brown Skink).** White Co.: 6.60 km NE of Helen, N of the parking lot for Anna Ruby Falls, at the end of Anna Ruby Falls Road (34.758468°N, 83.710207°W). 9 April 2011. B. Hudson. GMNH 50909. A single adult found basking on top of leaf litter near Anna Ruby Falls Trail.

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SQUAMATA — SNAKES

***COLUBER FLAGELLUM* (Coachwhip)**. Clay Co.: 7.95 km NE of Fort Gaines, just W of the intersection of Coleman Road and Bethel Church Road (31.641718°N, 84.972493°W). 16 April 2005. B. Hudson. GMNH 50902. A single juvenile flipped under a sign on the forest edge.

***CROTALUS HORRIDUS* (Timber Rattlesnake)**. Dawson Co.: 16.40 km NW of Dawsonville, 2.75 km NW of the intersection of HWY 342 and HWY 52, on HWY 52 (34.542944°N, 84.220707°W). 16 August 2014. B. Hudson. GMNH 50923. A single adult found dead on road (DOR).

***FARANCIA ABACURA* (Red-bellied Mudsnake)**. Cobb Co.: Intersection of Wynford Colony SW and Wynford Drive SW, Marietta (34.922229°N, 84.637641°W). 25 May 2014. S. Cornett. GMNH 50918. A single adult found dead on road (DOR).

***HETERODON PLATIRHINOS* (Eastern Hog-nosed Snake)**. Polk Co.: 8.20 km NW of Cedartown, 0.50 km NW of the intersection of Cave Springs Road and Santa Claus Road (34.061560°N, 85.321308°W). 15 May 2005. B. Hudson. GMNH 50905. A single gravid adult female found beneath a piece of roofing tin at a private residence. Walker Co.: Ridgetop approximately 1.2 km ENE of the intersection of GA SR1 and SR136 in the city of Lafeyette (34.704136°N, 85.261835°W). 1 October 2014. A. Parnell. GMNH 50917. A single juvenile found in a pool skimmer at a private residence.

***LAMPROPELTIS GETULA* (Eastern Kingsnake)**. Hall Co.: 9.70 km NE of Gainesville, 0.75 km SE of the intersection of Reservoir Drive and Old Cornelia HWY, on Reservoir Drive (34.337463°N, 83.730129°W). 30 April 2011. B. Hudson. GMNH 50890. A single sub-adult found dead on road (DOR) next to a mesic forest.

***LAMPROPELTIS TRIANGULUM* (Eastern Milksnake)**. Habersham Co.: 12.30 km NE of Helen, 0.75 km E of Tray Mountain, (≈1265 m elev.) on SE slope (34.803276°N, 83.676911°W). 20 May 2012. B. Hudson. GMNH 50900. A single juvenile flipped under a rock on a steep forested and rocky hillside.

***NERODIA ERYTHROGASTER* (Plain-bellied Watersnake)**. Murray Co.: 1.2 km ESE of the intersection of GA SR225 and Oak Hill Street, Chatsworth (34.662992°N, 84.813758°W). 20 September 2014. T. Lewis. GMNH 50919. A single adult found in a house foundation in a wooded area.

***PITUOPHIS M. MELANOLEUCUS* (Northern Pinesnake)**. Floyd Co.: 8.45 km ESE of Rome, 0.4 km W of the intersection of Sproull Road SE and Reynolds Bend Road SE, on Shoals Ferry Road (34.238928°N, 85.075805°W). 20 May 2010. H. Brooks. GMNH 50920. A single adult found near a private residence.

***SISTRURUS MILIARIUS* (Pygmy Rattlesnake)**. Banks Co.: 6.45 km S of Alto, 1.00 km W of the intersection of Wynn Lake Road and Louden Ridge Road, just S of Louden Ridge Road (34.409320°N, 83.571247°W). 30 August 2012. B. Hudson and Z. Seymour. GMNH 50899. A single adult female found coiled and basking on top of leaves in a mixed pine-hardwood forest.

***STORERIA OCCIPITOMACULATA* (Red-bellied Snake)**. Fannin Co.: 13.20 km NW of Suches, 0.45 km SW of the intersection of Rock Creek Road and Rivers End Trail (34.741573°N, 84.151659°W). 14 June 2010. B. Hudson and T. Stratmann. Verified by Kenneth L. Krysko. FMNH 165472. A single adult found crossing a small gravel road on Blue Ridge Wildlife Management Area.

Acknowledgments.—We thank J. Jensen and the Georgia Department of Natural Resources for quickly verifying that our records remained undocumented. N. Castleberry helped tremendously by verifying and accessioning our records, as did K. Krysko and E. McGhee. We thank those in charge of Blue Ridge and Wilson Shoals Wildlife Management Areas for their continued support in our herpetological endeavors. Special thanks are given to the numerous private landowners who gave permission for us to document these records, including the Williams, White, Finlayson, Ferrier, Goodson, Chambless, Cash, Crunkleton, Rush, and Hudson families.

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Significant New Records of Amphibians and Reptiles from Georgia, USA

Distributional maps found in *Amphibians and Reptiles of Georgia* (Jensen et al. 2008), along with subsequent geographical distribution notes published in *Herpetological Review*, serve as essential references for county-level occurrence data for herpetofauna in Georgia. Collectively, these resources aid biologists by helping to identify distributional gaps for which to target survey efforts. Herein we report newly documented county records for a variety of amphibian and reptile species in Georgia. All records below were verified by David Bechler (VSU), Nikole Castleberry (GMNH), David Laurencio (AUM), Lance McBrayer (GSU), and David Steen (SRSU), and datum used was WGS84. Standard English names follow Crother (2012).

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CAUDATA — SALAMANDERS

***AMBYSTOMA OPACUM* (Marbled Salamander)**. Calhoun Co.: 7.8 km W Leary (31.488749°N, 84.595917°W). 18 October 2014. D. Stevenson. GMNH 50875. Lowndes Co.: Langdale Park, Valdosta (30.878524°N, 83.317114°W). 3 April 1998. J. Evans. VSU C0015. First Georgia record for the Suwannee River drainage. Murray Co.: Conasauga Natural Area (34.845116°N, 84.848180°W). 12 November 2013. N. Klaus and C. Muise. GMNH 50548.

***AMBYSTOMA TALPOIDEUM* (Mole Salamander)**. Berrien Co.: St. Hwy. 168, 3.9 km W of jct. with St. Hwy. 135 (31.177228°N, 83.125489°W). 28 February 1995. R. Moulis and G. Williamson. GSU 22356.

***DESMOGNATHUS CONANTI* (Spotted Dusky Salamander)**. Glascock Co.: Unnamed tributary of Joes Creek at St. Hwy. 102, 1.8 km of Mitchell (33.22882°N, 82.68713°W). 14 May 2014. S. Graham, C. Kelehear, J. Jensen, and B. Edelbrock. SRSU 6638.

***EURYCEA CIRRIGERA* (Southern Two-lined Salamander)**. Glascock Co.: Sphagnum seepage along Deep Creek downstream from Blankenship Pond on S side of Blankenship Mill Road (33.25627°N, 82.54572°W). 14 May 2014. S. Graham, C. Kelehear, J. Jensen, and B. Edelbrock. SRSU 6637.

***EURYCEA GUTTOLINEATA* (Three-lined Salamander)**. Clay Co.: Ravine along Ledbetter Branch, 1.6 km ESE of Ft. Gaines (31.59541°N, 85.04153°W). 14 May 2014. S. Graham and C. Kelehear. AUM AHAP-D 00839.

***HEMIDACTYLIUM SCUTATUM* (Four-toed Salamander)**. Lumpkin Co.: 8 km W Dahlonega (34.536929°N, 84.031054°W). 17 September 2009. G. Gilbert. GMNH 50512. Stephens Co.: St. Hwy. 184 at Tugaloo River (34.64407°N, 83.28468°W). 11 March 2014. A. Hall, C. Camp, M. Douglas, J. Hoffman, K. Norman, E. Rossignol, S. Thomas, and J. Whitmire. GMNH 50695.

***NOTOPHTHALMUS VIRIDESCENS* (Eastern Newt)**. Bartow Co.: 1.0 km SW jct. of Pine Valley and Pleasant Valley roads (34.329335°N, 84.875640°W). 11 March 2014. J. Jensen, T. Patrick, and M. Medley. GMNH 50758.

***PLETHODON GLUTINOSUS* (Northern Slimy Salamander)**. Cherokee Co.: S. Cherokee Lane (34.075512°N, 84.468509°W). 14 April 2014. P. Higgins. GMNH 50877.

***PLETHODON GROBMANI* (Southeastern Slimy Salamander)**. Lanier Co.: 2.1 km SW Stockton (30.932697°N, 83.021096°W). 22 October 2013. D. Stevenson. GMNH 50545.

***PSEUDOTRITON RUBER* (Red Salamander)**. Clay Co.: Ravine along Ledbetter Branch, 1.6 km ESE of Ft. Gaines (31.59541°N, 85.04153°W). 14 May 2014. S. Graham and C. Kelehear. AUM AHAP-D 00840.

***SIREN INTERMEDIA* (Lesser Siren)**. Candler Co.: Canoochee River at Stillmore Highway, 5.4 km SE Stillmore (32.426030°N, 82.161521°W). W. Vaigneur. 29 August 2014. GSU 25388.

***STEREOCHILUS MARGINATUS* (Many-lined Salamander)**. Screven Co.: Horse Creek at St. Hwy. 21, 12.5 km ESE Millen (32.793188°N, 81.815821°W). 7 April 1999. T. Foard. GSU 23869. Three large larvae found in pools of drying swamp.

ANURA — FROGS

***GASTROPHRYNE CAROLINENSIS* (Eastern Narrow-mouthed Toad)**. Clay Co.: Chorus recorded along Bluffton-Ft. Gaines Road (31.52889°N, 84.94924°W). 14 May 2014. S. Graham and C. Kelehear. AUM AHAP-C 0048.

***HYLA AVIVOCA* (Bird-voiced Treefrog)**. Clay Co.: Chorus recorded along Bagby Parkway at George T. Bagby State Park (31.66371°N, 85.05223°W). 13 May 2014. S. Graham and C. Kelehear. AUM AHAP-C 0045.

***HYLA CHRYSOSCELIS* (Cope's Gray Treefrog)**. Clay Co.: Chorus recorded along St. Hwy. 266, 2.2 km NNE of Ft. Gaines (31.62725°N, 85.03888°W). 13 May 2014. S. Graham and C. Kelehear. AUM AHAP-C 0046.

***HYLA CINEREA* (Green Treefrog)**. Chattooga Co.: Swamp off Everett Springs Road (34.528110°N, 85.116789°W). 31 May 2014. P. Higgins. GMNH 50794. Whitfield Co.: Lakeshore Park (34.750814°N, 84.975696°W). 24 June 2014. K. Esters. GMNH 50781.

***HYLA SQUIRELLA* (Squirrel Treefrog)**. Clay Co.: Chorus recorded along Bluffton-Ft. Gaines Road (31.52889°N, 84.94924°W). 14 May 2014. S. Graham and C. Kelehear. AUM AHAP-C 0047.

***LITHOBATES CAPITO* (Gopher Frog)**. Irwin Co.: 12.0 km SW Ocilla (31.52479°N, 83.347385°W). 31 May 2014. B. Schlimm and M. Moore. GMNH 50765.

***LITHOBATES CATESBEIANUS* (American Bullfrog)**. Brantley Co.: St. Hwy. 82, 0.1 km N CR 68, E 0.2 km (31.20126°N, 82.00816°W). 9 March 2012. R. Horan III. GMNH 50279, 50280.

***LITHOBATES HECKSCHERI* (River Frog)**: Cook Co.: Reed Bingham State Park (31.176612°N, 83.538607°W). 7 December 2013. K. Stohlgren. GMNH 50670.

***OSTEOPILUS SEPTENTRIONALIS* (Cuban Treefrog)**. Camden Co.: 112 Azalea Court, Kingsland (30.791284°N, 81.651727°W). 13 September 2013. E. Dealto. GMNH 50511. Multiple individuals of this invasive exotic were discovered at this site suggesting a likely established local population, the first for the state.

***PSEUDACRIS CRUCIFER* (Spring Peeper)**. Brantley Co.: Jct. St. Hwy. 121 and Bay Road (31.16794°N, 82.13242°W). 9 March 2012. R. Horan III. GMNH 50295, 50296.

***SCAPHIOPUS HOLBROOKII* (Eastern Spadefoot)**. Clay CO.: AOR Bluffton-Ft Gaines Road, 200 m NW of Huckleberry Creek (31.55408°N, 84.97495°W). 14 May 2014. S. Graham and C. Kelehear. AUM AHAP-D 00838.

TESTUDINES — TURTLES

***APALONE FEROX* (Florida Softshell)**. Laurens Co.: Private residence on NeSmith Road, Dexter (32.396984°N, 83.082839°W). 6 May 2014. T. Thomas. GMNH 50757.

***APALONE SPINIFERA* (Spiny Softshell)**. Calhoun Co.: 1.9 km NNW Arlington (31.455767°N, 84.732517°W). 2 July 2004. C. Craig. VSU TE0022. Screven Co.: 15.8 km NE Sylvania (32.810300°N, 81.484418°W). 22 September 2013. J. Oguni and B. Boone. GMNH 50515. Treutlen Co.: 13.3 km SW Soperton. Oconee River at St. Hwy 46 (32.295950°N, 82.697551°W). D. Stevenson. 24 August 2014. GMNH 50788.

***CHELYDRA SERPENTINA* (Snapping Turtle)**. Brantley Co.: St. Hwy. 82, 0.1 km N CR 68, E 0.2 km (31.20126°N, 82.00816°W). 27 August 2011. R. Horan III. GMNH 50221. Clay Co.: U.S. Hwy. 27 at Little Pachitla Creek (31.61711°N, 84.82995°W). 12 July 2014. S. Graham. AUM AHAP-D 00845. Echols Co.: Statenville (30.701985°N, 83.027950°W). 6 July 2013. D. Stevenson. GMNH 50533.

***DEIROCHELYS RETICULARIA* (Chicken Turtle)**. Candler Co.: St. Hwy. 46 at the Canoochee River floodplain, 6.4 km WSW Metter (32.384371°N, 82.126027°W). 5 July 2014. W. Vaigneur. GMNH 50789.

***GRAPTEMYS GEOGRAPHICA* (Northern Map Turtle)**. Walker Co.: Hog Jowl Creek adjacent to Hog Jowl Road 2.8 km S of jct. with Captain Wood Road (34.683891°N, 85.408315°W). 10 April 2014. J. Jensen and C. Camp. GMNH 50697.

***KINOSTERNON BAURII* (Striped Mud Turtle)**: Wheeler Co.: Little Ocmulgee Lake, Little Ocmulgee State Park (32.088084°N, 82.893400°W). June 2013. Photo of captive maintained by State Park staff. GMNH 50666.

***KINOSTERNON SUBRUBRUM* (Eastern Mud Turtle)**. Atkinson Co.: 11.1 km S Willacoochee (31.240493°N, 83.039860°W). 19 March 2014. K. Stohlgren. GMNH 50754.

***PSEUDEMYS CONCINNA* (River Cooter)**. Rabun Co.: Lake Burton, Timpson Cove; 10.5 km WSW Clayton (34.878203°N, 83.400953°W). 14 July 2014. C. Jenkins. GMNH50786. Toombs Co.: Old River Road 5.0 km W of U.S. Hwy 1 (31.976058°N, 82.406225°W). 6 June 2014. M. Moore. GMNH 50783.

***PSEUDEMYS FLORIDANA* (Coastal Plain Cooter)**. Brooks Co.: 16.6 km SE Quitman (30.676041°N, 83.441144°W). 26 June 2014. D. Stevenson. GMNH 50772.

***STERNOTHERUS MINOR* (Loggerhead Musk Turtle)**. Candler Co.: Canoochee River at Stillmore Hwy., 5.4 km SE Stillmore

(32.426030°N, 82.161521°W). W. Vaigneur. 25 May 2014. GMNH 50792. Echols Co.: Statenville (30.704383°N, 83.032489°W). 1998. Valdosta State University Ichthyology Class. VSU TE0057. Wheeler Co.: Little Ocmulgee State Park, Little Ocmulgee Lake (32.088084°N, 82.893400°W). June 2013. Photo of captive maintained by State Park staff. GMNH 50667.

***STERNOTHERUS ODORATUS* (Eastern Musk Turtle)**. Atkinson Co.: 16.4 km SW Pearson (31.192514°N, 82.973532°W). 10 August 2014. D. Stevenson and F. Snow. GSU 25355. Wayne Co.: Penholloway Creek at State Hwy 301, 12.1 km SSW Jesup (31.500825°N, 81.913615°W). 11 September 2014. D. Stevenson. GSU 25367.

***TERRAPENE CAROLINA* (Eastern Box Turtle)**. Candler Co.: Hwy. 46 on the W side of Metter (32.396490°N, 82.077344°W). 12 May 2014. W. Vaigneur. GMNH 50791.

***TRACHEMYS SCRIPTA* (Pond Slider)**. Brantley Co.: St. Hwy. 82, 0.2 km E of Brantley County High School (31.19640°N, 82.03311°W). 10 March 2012. R. Horan III. GMNH 50294. Randolph Co.: CR 3 (31.82813°N, 84.64143°W). 03 May 2014. S. Graham, C. Kelehear, C. Guyer, B. Batistella, and S. Hermann. AUM AHAP-D 00846.

SQUAMATA — LIZARDS

***ANOLIS CAROLINENSIS* (Green Anole)**. Irwin Co.: 13.6 km SW Ocilla (31.521994°N, 83.367475°W). 31 May 2014. B. Schlimm and M. Moore. GMNH 50764.

***ANOLIS SAGREI* (Brown Anole)**. Thomas Co.: In front of The Plaza Restaurant on South Broad Street, Thomasville (30.835751°N, 83.978407°W). 20 October 2014. J. Turner. GMNH 50881. Non-native species.

***ASPIDOSCELIS SEXLINEATA* (Six-Lined Racerunner)**. Colquitt Co.: 4.5 km SE Doerun (31.2964356°N, 83.8779249°W). 14 April 2014. K. Stohlgren. GMNH 50753. Tift Co.: Private tract south of Chula-Brookfield Road (31.5389294°N, 83.4648996°W). 27 June 2013. B. Thesing. GMNH 50768.

***HEMIDACTYLUS TURCICUS* (Mediterranean House Gecko)**. Calhoun Co: Chickasawatchee Wildlife Management Area campground, 6.5 km ENE Leary (31.498384°N, 84.447135°W). Found in firewood pile. 19 November 2013. K. Stohlgren. GMNH 50671. Terrell Co.: 341 Stonewall St. SE, Dawson (31.770951°N, 84.445517°W). 28 September 2013. N. McGhee. GMNH 50546.

***OPHISAURUS ATTENUATUS* (Slender Glass Lizard)**. Telfair Co.: Orianne Society Indigo Snake Preserve (31.857214°N, 82.830899°W). 16 June 2014. B. Schlimm. GMNH 50780.

***PLESTIODON ANTHRACINUS* (Coal Skink)**. Taylor Co.: Fall Line Sandhills Wildlife Management Area, West Tract (32.560230°N, 84.399777°W). 21 April 2014. B. Morrison. GMNH 50759.

***PLESTIODON FASCIATUS* (Common Five-lined Skink)**. Jasper Co.: Private residence on State Hwy. 16 E, Monticello (33.298980°N, 83.662902°W). 22 August 2014. J. Jensen. GMNH50886.

***PLESTIODON INEXPECTATUS* (Southeastern Five-lined Skink)**. Talbot Co.: Camping area at Big Lazer Creek WMA at jct. of Bunkham Road and River Road (32.78691°N, 84.42266°W). 05 June 2014. S. Graham, C. Kelehear, B. Batistella. AUM AHAP-D 00841.

***SCELOPORUS UNDULATUS* (Eastern Fence Lizard)**. Echols Co.: Woodpecker Route at Perch Creek (30.635230°N, 82.660863°W). 29 March 2014. J. Oguni, M. King, A. King. GMNH 50892.

***SCINCELLA LATERALIS* (Little Brown Skink)**. Irwin Co.: 13.6 km SW Ocilla (31.521994°N, 83.367475°W). 31 May 2014. B. Schlimm and M. Moore. GMNH 50766.

SQUAMATA — SNAKES

***AGKISTRODON CONTORTRIX* (Copperhead)**. Chattooga Co.: Everett Springs Road (34.579204°N, 85.09064°W). 12 July 2014. P. Higgins. GMNH 50895. Taylor Co.: Wesley Church Road 0.9 km from jct. with Jinks Road (32.604767°N, 84.357383°W). 7 May 2014. R. Herrington. GMNH 50782.

***AGKISTRODON PISCIVORUS* (Cottonmouth)**. Johnson Co.: 11.4 km NW Wrightsville (32.729084°N, 82.719835°W). 15 July 2014. J. Sumner. GMNH 50790.

***CARPHOPHIS AMOENUS* (Common Wormsnake)**. Lamar Co.: St. Hwy. 18 W, Barnesville (33.051689°N, 84.186047°W). 13 April 2014. C. Muise and D. Love. GMNH 50756.

***CEMOPHORA COCCINEA* (Scarletsnake)**. Berrien Co.: 12.5 km SSW Willacoochee (31.232022°N, 83.076511°W). 16 June 2013. Kelsie Kincaid. GMNH 50755. Brantley Co.: St. Hwy. 82, 0.1 km N CR 68, E 0.2 km (31.20126°N, 82.00816°W). 20 August 2011. R. Horan III. GMNH 50167. Jenkins Co.: Doyle Road (CR 6) 0.16 km SW of Beaverdam Creek (32.951425°N, 81.858218°W). 25 May 1997. D. Holland and R. Legere. GSU 24028. Laurens Co.: Riverbend Wildlife Management Area (32.465540°N, 82.815255°W). 9 June 2014. D. Larson. GMNH 50784. Lowndes Co.: 14.6 km NW Valdosta (30.875093°N, 83.422990°W). 5 July 1998. D. Bechler. VSU SE0125. Tattnall Co.: 5.7 km SSW Glennville (31.890900°N, 81.956200°W). 27 May 2014. D. Stevenson. GSU 25352. Wheeler Co.: 13.6 km SE Alamo (32.043645°N, 82.700007°W). 12 May 2014. B. Schlimm. GMNH 50767.

***COLUBER FLAGELLUM* (Coachwhip)**. Lowndes Co.: 898 Long Pond Road, Lake Park (30.692959°N, 83.184372°W). 26 March 2001. P. Futch. VSU SE0054. Wayne Co.: 1.0 km NNE Mount Pleasant (31.442290°N, 81.676451°W). 7 November 2013. D. Stevenson. GMNH 50649.

***CROTALUS HORRIDUS* (Timber Rattlesnake)**. Chattooga Co.: Everett Springs Road (34.528490°N, 85.116822°W). 25 June 2012. P. Higgins. GMNH 50795.

***DIADOPHIS PUNCTATUS* (Ring-necked Snake)**. Clay Co.: CR 9 at Kolomoki Creek (31.49881°N 84.97361°W). 14 May 2014. S. Graham and C. Kelehear. AUM AHAP-D 00842.

***FARANCIA ABACURA* (Red-bellied Mudsnake)**. Candler Co.: St. Hwy. 46 on the W side of Metter (32.396490°N, 82.077344°W). 12 May 2014. W. Vaigneur. GMNH 50861. Dodge Co.: Old Bethel Road bridge near Gresston (32.306145°N, 83.261773°W). 5 March 2014. W. Huff. GMNH 50674.

***FARANCIA ERYTROGRAMMA* (Rainbow Snake)**. SCREVEN CO.: 24.3 km NNE Sylvania (32.938175°N, 81.504220°W). 19 July 2013. I. Deery. GMNH 50534.

***HETERODON PLATIRHINOS* (Eastern Hog-nosed Snake)**. HEARD CO.: Private residence on South River Road, Franklin (33.265894°N, 85.097306°W). 11 October 2014. S. Hinely. GMNH 50874.

***LAMPROPELTIS GETULA* (Eastern Kingsnake)**. LOWNDES CO.: Burma Road near airstrip, Moody Air Force Base (30.9535°N, 83.1970°W). 15 June 1993. D. Stevenson. GMNH 49867. First record for county supported by a vouchered specimen.

***LAMPROPELTIS ELAPSOIDES* (Scarlet Kingsnake)**. BARTOW CO.: Holly Springs Road, 3.8 km SW of White (34.257633°N, 84.717433°W). 7 September 2013. P. Higgins. GMNH 50770. Extends the known range of the species in Georgia ca. 56 km N of the previous northernmost occurrence.

***MICRURUS FULVIUS* (Harlequin Coralsnake)**. BULLOCH CO.: 3.7 km NNE Groveland (32.16454°N, 81.714289°W). 3 November 1985. R. Redmond and R. Sokal. GSU 2941. CLINCH CO.: 3.2 km W Homerville (31.029778°N, 82.779001°W). 2 October 1982. W. Cribbs. VSU SE0178. LOWNDES CO.: 18.4 km S Valdosta (30.666625°N, 83.264197°W). 7 March 1997. M. Selph. VSU SE0176.

***NERODIA ERYTHROGASTER* (Plain-bellied Watersnake)**. CHARLTON CO.: Stephen C. Foster State Park, 25.3 km NE Fargo (30.827100°N, 82.362592°W). 29 March 2014. J. Oguni, M. King, A. King. GMNH 50751. First Georgia record for the Okefenokee Swamp region. LAMAR CO.: Brent Road ca. 0.4 km W of Ramah Church Road (33.008106°N, 84.084414°W). 18 November 2013. C. Muise. GMNH 50559. TREUTLEN CO.: Tributary to Ohoopee River at St. Hwy. 297, 0.32 km S of Ohoopee River (32.437786°N, 82.383364°W). 7 September 1997. J. Blue, R. Moulis. GSU 24038.

***NERODIA FLORIDANA* (Florida Green Watersnake)**. CHARLTON CO.: Stephen C. Foster State Park, 24.8 km NE Fargo (30.82262°N, 82.364930°W). 14 August 1970. J. Tanguay. GSU 7236.

***NERODIA TAXISPILOTA* (Brown Watersnake)**. PIERCE CO.: US Highway 84 at Satilla River (31.238820°N, 82.322850°W). 1 May 1998. A. Safer. GSU 24075.

***OPHEODRYS AESTIVUS* (Rough Greensnake)**. BRANTLEY CO.: St. Hwy. 82, 10 m N County Road 68, (31.20045ºN, 82.0097ºW). 15 March 2012. R. Horan III. GMNH 50285. LOWNDES CO.: 14.8 km E Valdosta (30.830291°N, 83.124313°W). 21 May 1998. Valdosta State University Herpetology Class. VSU SE0059. MACON CO.: Bank of Flint River (32.369324°N, 84.030230°W). 12 April 2014. J. Jensen and R. King. GMNH 50769.

***PANTHEROPHIS ALLEGHANIENSIS* (Eastern Ratsnake)**. QUITMAN CO.: DOR on St. Hwy. 39 (31.79694°N, 85.09251°W). 13 May 2014. S. Graham and C. Kelehear. AUM AHAP-D 00843.

***PANTHEROPHIS GUTTATUS* (Cornsnake)**. JONES CO.: Jct. Jarrell Plantation Road and St. Hwy. 16 (33.016583°N, 83.705229°W). 29 April 2014. J. Jensen. GMNH 50771.

***PITUOPHIS MELANOLEUCUS* (Eastern Pinesnake)**. BARTOW CO.: Etowah River near Kingston (34.196396°N, 84.975512°W). 11 May 2014. C. Bell and R. Bell. GMNH 50760.

***SISTRURUS MILIARIUS* (Pigmy Rattlesnake)**. BURKE CO.: 7.1 km NW Girard (33.08427°N, 81.767961°W). 12 September 2012. I. Deery. GMNH 50517. LOWNDES CO.: 6248 Upper New Bethel Road, Ray City (31.004081°N, 83.197465°W). 8 September 2002. T. Le. VSU SE0202. MURRAY CO.: Near Coosawattee WMA (34.651928°N, 84.761169°W). 30 October 2013. J. Spence. GMNH 50547.

***STORERIA DEKAYI* (DeKay's Brownsnake)**. BLECKLEY CO.: 10.6 km NW Cochran (32.428104°N, 83.455961°W). 22 April 2014. M. Moore. GMNH 50752. CALHOUN CO: 6.4 km SE Leary (31.465393°N, 84.451135°W). 20 November 2013. K. Stohlgren. GMNH 50672. STEPHENS CO.: Lake Russell WMA (34.535803°N, 83.383595°W). 1 October 2013. D. Duff. GMNH 50513.

***STORERIA OCCIPITOMACULATA* (Red-bellied Snake)**. BROOKS CO.: 7.4 km E Quitman (30.790209°N, 83.484034°W). 4 December 1982. R. Howell. VSU SE0010. CHEROKEE CO.: S. Cherokee Lane (34.075783°N, 84.468463°W). 15 September 2014. P. Higgins. GMNH 50973. MACON CO.: DOR on Butler Mill Road (32.47476°N, 84.10190°W). 02 May 2014. S. Graham and C. Kelehear. AUM AHAP-D 00844.

***THAMNOPHIS SAURITUS* (Eastern Ribbonsnake)**: COFFEE CO.: 22.2 km SW Douglas (31.420912°N, 83.059196°W). 21 October 2013. D. Kelly. GMNH 50668. DECATUR CO.: 15.3 km SW Bainbridge (30.8253773°N, 84.705981°W). 26 September 2013. D. Kelly. GMNH 50665.

***THAMNOPHIS SIRTALIS* (Common Gartersnake)**. BROOKS CO.: 10.9 km SSE Quitman (30.69737°N, 83.507472°W). 23 October 2013. D. Stevenson. GMNH 50544. ECHOLS CO.: Woodpecker Route 4.2 km SW of jct. with St. Hwy. 94 (30.650106°N, 82.642513°W). 29 March 2014. J. Oguni, M. King, A. King. GMNH 50893. LANIER CO.: 6.0 km NE Lakeland (31.063231°N, 83.021917°W). 10 August 2014. D. Stevenson. GSU 25356. SEMINOLE CO.: 29.8 km WSW Bainbridge (30.869664°N, 84.884431°W). 24 October 2013. D. Kelly. GMNH 50669. WHEELER CO.: 4.5 km NE Lumber City (31.954435°N, 82.643383°W). 28 October 2013. D. Stevenson. GMNH 50543.

***HALDEA STRIATULA* (Rough Earthsnake)**. CAMDEN CO.: 2.2 km N Waverly (31.114140°N, 81.727893°W). 25 February 1998. R. Moulis and G. Williamson. GSU 24416. LOWNDES CO.: Langdale Park, Valdosta (30.878524°N, 83.317114°W). 13 March 2006. D. Bechler. VSU SE0227.

***VIRGINIA VALERIAE* (Smooth Earthsnake)**. ATKINSON CO.: 10.8 km SSE Willacoochee; Live Oak Church Road (CR 36) (31.184550°N, 83.024675°W). 21 July 2014. K. Kincaid. GMNH 50787. BANKS CO.: Wilson Shoals Wildlife Management Area (34.41318°N, 83.58697°W). 17 May 2014. D. Duff. GMNH 50785. FRANKLIN CO.: Near Tugaloo State Park Road, 3.0 km E Greenleaf Drive jct. (34.49873°N, 83.06137°W). 12 September 2013. D. Booher. GMNH 50523. LOWNDES CO.: Valdosta State University campus (30.848393°N, 83.288933°W). 28 October 2003. T. Peters. VSU SE0222. PAULDING CO.: Fuller Road ca. 11 km SW Dallas (33.830061°N, 84.884642°W). 3 September 1994. M. Wallace and K. Fuller. GSU 24425.

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New Distribution Records of Amphibians and Reptiles in West-Central Georgia, USA

The geographic region of Georgia known as the Piedmont Plateau has a diverse herpetofauna. Specimens of the following species were collected to increase the knowledge and accuracy of information with regard to their ranges and habitats. Coordinates are based on datum WGS 84. Specimens were collected under Georgia Department of Natural Resources Scientific Collections Permits (29-WJH-13-126) CN:25018 and (29-WJH-14-159) CN: 25018, and Gordon State College Institutional Animal Care and Use Committee Protocols IACUC-002-2014 and IACUC-008-2014. All of the specimens described herein are fluid-preserved vouchers housed in the Gordon State College Collection of Vertebrates (GSC). Standard English names follow Crother (2012).

CAUDATA — SALAMANDERS

***AMBYSTOMA OPACUM* (Marbled Salamander).** Butts Co.: Halls Bridge Road in Stark (33.346579°N, 83.905007°W). 11 April 2013. J. Strickland. Verified by Michael J. Bender. GSC 050. This species has been documented in five (Henry, Jasper, Monroe, Newton, and Spalding) of the six adjoining counties (Jensen et al. 2008). Salamander was found alive beneath a rock in a flower bed.

***DESMOGNATHUS CONANTI* (Spotted Dusky Salamander).** Butts Co.: Halls Bridge Road in Stark (33.346324°N, 83.904854°W). 17 April 2013. J. Strickland. Verified by John B. Jensen. GSC 052. This species has been documented in four (Jasper, Lamar, Monroe, and Newton) of the six adjoining counties (Jensen et al. 2008). Salamander was found alive underneath a rock in Caney Creek in the afternoon. Henry Co.: Leguin Mill Road in Ola (33.379741°N, 84.040813°W). 30 April 2014. J. Strickland. Verified by John B. Jensen. GSC 069. This species has been documented in five (Butts, Clayton, DeKalb, Newton, and Rockdale) of the six adjoining counties (Jensen et al. 2008; this paper). Salamander was found alive underneath leaf litter on a sandbar.

***EURYCEA CHAMBERLAINI* (Chamberlain's Dwarf Salamander).** Pike Co.: 1096 Day Road in Meansville (32.979112°N, 84.365559°W). 26 March 2014. J. Strickland. Verified by John B. Jensen. GSC 062. This species has been documented in two (Lamar and Meriwether) of the four adjoining counties (Jensen et al. 2008, West and Hartman 2014). Salamander was found underneath a rotting log that was partially submerged in a marsh.

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***HEMIDACTYLIUM SCUTATUM* (Four-toed Salamander).** Butts Co.: Halls Bridge Road in Stark (33.346667°N, 83.904451°W). 8 March 2014. J. Strickland. Verified by Michael J. Bender. GSC 061. This species has been documented in two (Jasper and Newton) of the six adjoining counties (Jensen et al. 2008). Salamander was found alive inside of a rotting log that was partially submerged in a marsh.

***PLETHODON GLUTINOSUS* (Northern Slimy Salamander).** Butts Co.: Halls Bridge Road in Stark (33.346516°N, 83.904718°W). 18 April 2013. J. Strickland. Verified by Michael J. Bender. GSC 054. This species has been documented in four (Henry, Jasper, Lamar, and Monroe) of the six adjoining counties (Jensen et al. 2008; Jensen et al. 2011). Salamander was found alive underneath a rotting log.

***PSEUDOTRITON RUBER* (Red Salamander).** Butts Co.: Halls Bridge Road in Stark (33.346662°N, 83.904455°W). 3 June 2013. J. Strickland. Verified by John B. Jensen. GSC 060. This species has been documented in 4 (Jasper, Lamar, Monroe, and Newton) of the six adjoining counties (Jensen et al. 2008). Salamander was found alive underneath a rotting log that was partially submerged in Caney Creek.

ANURA — FROGS

***GASTROPHRYNE CAROLINENSIS* (Eastern Narrow-mouthed Toad).** Butts Co.: Halls Bridge Road in Stark (33.347060°N, 83.904916°W). 5 August 2014. J. Strickland. Verified by Michael J. Bender. GSC 071. This species has been documented in four (Bibb, Henry, Jasper, and Newton) of the six adjoining counties (Jensen et al. 2008). Frog was found alive underneath a foam mat.

***HYLA CINEREA* (Green Treefrog).** Butts Co.: Halls Bridge Road in Stark (33.346783°N, 83.904555°W). 25 April 2014. J. Strickland. Verified by Michael J. Bender. GSC 068. This species has been documented in six (Henry, Jasper, Lamar, Monroe, Newton, and Spalding) of the six adjoining counties (Jensen et al. 2008). Frog was found alive on a tree limb overhanging Caney Creek.

***HYLA GRATIOSA* (Barking Treefrog).** Butts Co.: Halls Bridge Road in Stark (33.346780°N, 83.904551°W). 2 June 2015. J. Strickland. Verified by John B. Jensen. GSC 072. This species has been

documented in three (Jasper, Lamar, and Monroe) of the six adjoining counties (Jensen et al. 2008). Frog was found alive crossing a private drive during a thunderstorm.

***LITHOBATES SPHENOCEPHALUS* (Southern Leopard Frog)**. Pike Co.: 1096 Day Road in Meansville (32.979112°N, 84.365559°W). 26 March 2014. J. Strickland. Verified by Michael J. Bender. GSC 067. This species has been documented in three (Lamar, Meriwether, and Spalding) of the four adjoining counties (Jensen et al. 2008; Jensen et al. 2011). Frog was found alive by a rock in a small stream.

***PSEUDACRIS FERIARUM* (Upland Chorus Frog)**. Butts Co.: Halls Bridge Road in Stark (33.346788°N, 83.904557°W). 21 May 2013. J. Strickland. Verified by John B. Jensen. GSC 056. This species has been documented in three (Jasper, Monroe, and Newton) of the six adjoining counties (Jensen et al. 2008). Frog was found alive atop a rotting log.

SQUAMATA — LIZARDS

***PLESTIODON FASCIATUS* (Common Five-lined Skink)**. Butts Co.: Halls Bridge Road in Stark (33.346519°N, 83.905592°W). 1 June 2013. J. Strickland. Verified by Michael J. Bender. GSC 058. This species has been documented in three (Henry, Monroe, and Newton) of the six adjoining counties (Jensen et al. 2008). Skink was found alive atop a rock.

***SCINCELLA LATERALIS* (Little Brown Skink)**. Butts Co.: Halls Bridge Road in Stark (33.346698°N, 83.905399°W). 1 June 2013. J. Strickland. Verified by Michael J. Bender. GSC 059. This species has been documented in five (Newton, Jasper, Henry, Lamar, and Monroe) of the six adjoining counties (Jensen et al. 2008; Jensen et al. 2011). Skink was found alive amongst leaf litter.

SQUAMATA — SNAKES

***AGKISTRODON CONTORTRIX* (Copperhead)**. Butts Co.: Halls Bridge Road in Stark (33.343200°N, 83.902655°W). 28 April 2013. J. Strickland. Verified by Michael J. Bender. GSC 051. This species has been documented in four (Jasper, Newton, Monroe, and Spalding) of the six adjoining counties (Jensen et al. 2008). Snake was found alive underneath a piece of tin roofing material.

***CEMOPHORA COCCINEA* (Scarletsnake)**. Butts Co.: Halls Bridge Road in Stark (33.346994°N, 83.905436°W). 26 June 2013. J. Strickland. Verified by Michael J. Bender. GSC 057. This species has been documented in two (Lamar and Monroe) of the six adjoining counties (Jensen et al. 2008; Jensen et al. 2011). Snake was found alive underneath a rotting log.

***DIADOPHIS PUNCTATUS* (Ring-necked Snake)**. Butts Co.: Halls Bridge Road in Stark (33.346516°N, 83.904718°W). 16 May 2013. J. Strickland. Verified by Michael J. Bender. GSC 055. This species has been documented in four (Henry, Jasper, Monroe, and Newton) of the six adjoining counties (Jensen et al. 2008). Snake was found alive amongst leaf litter.

***VIRGINIA VALERIAE* (Smooth Earthsnake)**. Butts Co.: Halls Bridge Road in Stark (33.346660°N, 83.904450°W). 8 April 2014. J. Strickland. Verified by Michael J. Bender. GSC 063. This species has been documented in three (Jasper, Henry, and Monroe) of the six adjoining counties (Jensen et al. 2008). Snake was found alive underneath a piece of plywood.

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New County Records of Reptiles and Amphibians from State-Managed Properties in Illinois

The publication of *The Amphibians and Reptiles of Illinois* (Phillips et al. 1999) provided a widely available record of the known county-level distributions of herpetofauna in Illinois. Since its publication, multiple articles documenting new county records from the state have been published in *Herpetological Review* (e.g., Petzing et al. 2000, 2002, and 2007; Foster and Mullin 2007).

As part of a study examining the ecological integrity of seasonal wetlands on state-managed properties in Illinois, we repeatedly sampled 240 wetlands over three years for the presence of amphibians and reptiles. The study resulted in 17 new Illinois county records collected from 2010–2012 (Kessler et al 2013). Herein we report 19 specimens collected in 2013 and 2014 that represent new county records in the state of Illinois as well as two vouchered specimens that were previously known only from photographs. All vouchered specimens listed are housed in the Illinois Natural History Survey (INHS) amphibian and reptile collection.

County records were confirmed using the Illinois Herpetological Database at INHS, which contains records of Illinois amphibians and reptiles from 30 museum collections as well as a collection of photographs of unvouchered specimens and observations from herpetologists and state biologists, and by examining volumes of *Herpetological Review* published since Phillips et al. (1999). Coordinates are presented in decimal degrees using map datum WGS 84. Scientific and common names follow Crother (2012).

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CAUDATA — SALAMANDERS

***AMBYSTOMA TEXANUM* (Small-mouthed Salamander).** Adams Co.: Siloam Springs State Park, 16 km E of Liberty (39.88455°N, 90.92078°W). 23 October 2013. A. R. Kuhns and C. A. Phillips. Verified by D. B. Wylie. INHS 23643. One of four young-of-year found under log in dry vernal wetland. Brown Co.: Siloam Springs State Park- Buckhorn Unit; 11.8 km SW of Mount Sterling (39.90165°N, 90.84560°W). 19 March 2014. E. J. Kessler and C. E. Cook. Verified by C. A. Phillips. INHS 23897. Captured in a minnow trap in an ephemeral wetland.

***AMBYSTOMA TIGRINUM* (Eastern Tiger Salamander).** Massac Co.: Sielbeck Forest State Natural Area; 8.1 km ENE of Joppa (37.22499°N, 88.75672°W). 7 February 2013. A. R. Kuhns, C. M. Rhoden, E. J. Kessler, and E. M. Wright. Verified by D. B. Wylie. INHS 22991. Captured in minnow trap in semi-permanent wetland.

***NOTOPTHALMUS VIRIDESCENS* (Eastern Newt).** Massac Co.: Fort Massac State Park; 3.0 km E of Metropolis (37.16076°N, 88.69995°W). 22 May 2013. A. R. Kuhns, J. D. Folkerts, and A. K. Keigher. Verified by C. A. Phillips. INHS 23338. Captured in minnow trap in wetland. Randolph Co.: Randolph County State Recreation Area; 7.0 km N of Chester (37.97963°N, 89.80649°W). 12 March 2014. A. R. Kuhns, A. K. Keigher, and S. J. Gerstman. Verified by C. A. Phillips. INHS 23872. Captured in minnow trap placed in pond with submergent vegetation.

***SIREN INTERMEDIA* (Lesser Siren).** Jefferson Co.: Wayne Fitzgerrell State Recreation Area; 7.1 km SE of Waltonville (38.16762°N, 88.97731°W). 25 February 2014. A. R. Kuhns, E. J. Kessler, J. A. Crawford, and C. E. Cook. Verified by C. A. Phillips. INHS 23841. Adult found dead under ice in permanent pond. Saline Co.: Saline County Conservation Area; 5.1 km SW of Equality (37.69828°N, 88.37889°W). 19 February 2014. A. R. Kuhns, J. P. Ross, A. K. Keigher, and C. A. Phillips. Verified by D. B. Wylie. INHS 23844. Adult caught in minnow trap in floodplain wetland.

ANURA — FROGS

***ANAXYRUS AMERICANUS* (American Toad).** Jefferson Co.: Rend Lake State Fish and Wildlife Area; 2.3 km S of Bonnie (38.18642°N, 88.91930°W). 11 April 2014. E. J. Kessler and C. E. Cook. Verified by C. A. Phillips. INHS 23953.Captured in ephemeral wetland in woodlot near wildlife food plot. Massac Co.: Mermet Lake State Fish and Wildlife Area; 9.9 km E of Karnak (37.27881°N, 88.86499°W). 18 April 2013. E. J. Kessler, C. M. Rhoden, and C. A. Phillips. Verified by D. B. Wylie. INHS 23267. Adult caught in a pitfall trap near an ephemeral wetland.

***PSEUDACRIS CRUCIFER* (Spring Peeper).** Adams Co.: Siloam Springs State Park; 16 km E of Liberty (39.89251°N, 90.92080°W). 20 March 2014. E. J. Kessler and C. E. Cook. Verified by C. A. Phillips. INHS 23915. Chorusing in shallow wooded wetland.

***LITHOBATES CLAMITANS* (Green Frog)**. Brown Co.: Siloam Springs State Park; 16.5 km E of Liberty (39.88979°N, 90.91503°W). 24 October 2013. A. R. Kuhns and C. A. Phillips. Verified by D. B. Wylie. INHS 23639. Juvenile captured from small intermittent stream.

***LITHOBATES PIPIENS* (Northern Leopard Frog)**. Peoria Co.: Jubilee College State Park; 7.3 km ESE of Brimfield (40.81179°N, 89.80737°W). 10 April 2013. E. J. Kessler, C. M. Rhoden, and J. D. Folkerts. Verified by C. A. Phillips. INHS 23254. Large chorus from created wetland.

TESTUDINES — TURTLES

***CHELYDRA SERPENTINA* (Snapping Turtle)**. Franklin Co.: Wayne Fitzgerrell State Recreation Area; 4.4 km WNW of Whittington (38.10999°N, 88.94483°W). 7 June 2013. E. J. Kessler, C. M. Rhoden, and A. R. Kuhns. Verified by D. B. Wylie. INHS 23329. Juvenile caught in minnow trap in ephemeral wetland. Previously only known in the county from photo voucher.

***STERNOTHERUS ODORATUS* (Eastern Musk Turtle)**. Johnson Co.: Heron Pond-Wildcat Bluff Nature Preserve; 5.3 km SSW of Vienna (38.37358°N, 88.92725°W). 17 April 2013. C. A. Phillips, E. J. Kessler, and C. M. Rhoden. Verified by D. B. Wylie. INHS 23302. Carapace and plastron found at edge of cypress swamp. Juvenile (INHS 23380) captured following day at Ferne Clyffe State Park (Johnson Co.). Previously only known in the county from photo voucher.

***TRACHEMYS SCRIPTA* (Pond Slider)**. Franklin Co.: Wayne Fitzgerrell State Recreation Area; 4.4 km WNW of Whittington (38.10999°N, 88.94483°W). 7 June 2013. E. J. Kessler, C. M. Rhoden, and A. R. Kuhns. Verified by D. B. Wylie. INHS 23330. Juvenile caught in minnow trap in ephemeral wetland.

SQUAMATA — LIZARDS

***EUMECES FASCIATUS* (Five-lined Skink)**. Franklin Co.: Wayne Fitzgerrell State Recreation Area; 3.6 km WNW of Whittington (38.09579°N, 88.94275°W). 4 June 2013. E. J. Kessler and C. M. Rhoden. Verified by D. B. Wylie. INHS 23381. Adult found under log near ephemeral wetland.

***EUMECES LATICEPS* (Broad-headed Skink)**. Massac Co.: Mermet Lake State Fish and Wildlife Area; 2.8 km S of Goreville (37.52967°N, 88.97050°W). 21 May 2013. E. J. Kessler and C. M. Rhoden. Verified by D. B. Wylie. INHS 23336. One of three individuals captured at the site in the same week.

***SCINCELLA LATERALIS* (Little Brown Skink)**. Cass Co.: Jim Edgar Panther Creek State Fish and Wildlife Area; 4.2 km SE of Chandlerville (40.01703°N, 90.12729°W). 3 April 2013. E. J. Kessler and C. M. Rhoden. Verified by D. B. Wylie. INHS 23383. Adult captured in pitfall trap along drift fence array.

SQUAMATA — SNAKES

***STORERIA DEKAYI* (Dekay's Brownsnake)**. Jefferson Co.: Rend Lake State Fish and Wildlife Area; 6.4 km WNW of Ina (38.16559°N, 88.97446°W). 20 June 2014. C. E. Cook, C. E. Butkus, and S. Hernandez. Verified by D. B. Wylie. INHS 24008. Adult captured near ephemeral wetland. Massac Co.: Fort Massac State Park; 2.4 km NW of Brookport (37.13604°N, 88.65221°W). 17 April 2013. A. K. Keigher and J. D. Folkerts. Verified by D. B. Wylie. INHS 23399. Adult captured in funnel trap along drift fence array.

***STORERIA OCCIPITOMACULATA* (Red-bellied Snake)**. Saline Co.: Saline County State Fish and Wildlife Area; 5.5 km SW of Equality (37.69284°N, 88.37859°W). 2 April 2014. A. K. Keigher, S. J. Gerstman, and A. R. Kuhns. Verified by D. B. Wylie. INHS 23928. Adult captured in funnel trap along fence array.

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New Distributional Records for the Herpetofauna of Texas

From a historical perspective, the state of Texas has been one of the most herpetologically diverse and traditionally sampled areas of the country. However, primarily due to collecting bias, several areas of Texas remain overlooked, particularly areas that lie outside of the Trans-Pecos region, and several species of herpetofauna tend to be largely unnoticed as well. Here we report on new county records that serve as either range extensions or that function as the "filling in" of distributional gaps for numerous species of amphibians and reptiles in several counties of Texas.

Although the majority of these records have been recorded within the past several years, many of these observations are of specimens that were discovered, journaled, and photographed without recognition of their significance. Therefore, many of the observations reported herein go back to the latter part of last century.

From 1986 to present, fieldwork has been conducted in the following 18 counties: Borden, Crane, Crockett, Ector, Gaines, Garza, Glasscock, Hale, Hockley, Irion, Midland, Runnels, Schleicher, Scurry, Sterling, Sutton, Taylor, and Upton. Voucher specimens or photographs were deposited into the Biodiversity Collections (formerly the Texas Natural History Collections) at The University of Texas at Austin (TNHC) and all vouchers were verified by Travis J. LaDuc. Coordinates and elevations of observation sites were taken with a GPS device using map datum WGS 84.

A total of 66 records comprised of 47 species of amphibians and reptiles are reported for the first time in the counties listed above. The new county records are listed below. Standard English names follow Crother (2012).

CAUDATA — SALAMANDERS

***AMBYSTOMA MAVORTIUM* (Western Tiger Salamander).** Borden Co.: Gail, 0.48 air mi N on RM 669 (32.77738°N, 101.44652°W), 2529 ft elev. 20 June 2009. T. M. Dimler. TNHC 89529. Fills distributional gap.

ANURA— FROGS

***ANAXYRUS COGNATUS* (Great Plains Toad).** Scurry Co.: Snyder, 7.56 air mi WSW on private ranch (32.69028°N, 101.04617°W), 2292 ft elev. May 1991. M. S. Price. TNHC 92932, photo voucher. Extends distributional record.

***ANAXYRUS DEBILIS DEBILIS* (Eastern Chihuahuan Green Toad).** Scurry Co.: Snyder, 7.56 air mi WSW on private ranch (32.69028°N, 101.04617°W), 2292 ft elev. May 1991. M. S. Price. TNHC 92933, photo voucher. Fills distributional gap.

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***ANAXYRUS PUNCTATUS* (Red-spotted Toad).** Scurry Co.: Snyder, 7.56 air mi WSW on private ranch (32.69028°N, 101.04617°W), 2292 ft elev. May 1991. M. S. Price. TNHC 92934, photo voucher. Fills distributional gap.

***ANAXYRUS SPECIOSUS* (Texas Toad).** Borden Co.: Gail, 9.79 air mi NNE on private ranch (32.91113°N, 101.42322°W), 2534 ft elev. 9 May 2009. T. M. Dimler. TNHC 84916. Fills distributional gap.

***ELEUTHERODACTYLUS MARNOCKII* (Cliff Chirping Frog).** Crockett Co.: Ozona, 32.37 air mi SW on RM 2083 (30.32592°N, 101.52662°W). 1915 ft elev. 14 June 2015. M. S. Price, N. M. Price, and S. G. Price. TNHC 95430, photo voucher. Fills distributional gap.

***GASTROPHRYNE OLIVACEA* (Western Narrow-mouthed Toad).** Borden Co.: Gail, 5.28 air mi W on private ranch (32.75718°N, 101.53513°W), 2603 ft elev. 12 October 2012. T. M. Dimler. TNHC 89542. Fills distributional gap. Midland Co.: Midland, 3.41 air mi SW on the premises of the I-20 Wildlife Preserve (31.96345°N, 102.12018°W), 2803 ft elev. 1 June 2015. M. S. Price N. R. Price, and K. Conder. TNHC 95431, photo voucher. Fills distributional gap. Scurry Co.: Snyder, 2.50 air mi SE on private residence (32.69872°N, 100.88120°W), 2355 ft elev. June 1994. M. S. Price. TNHC 92925, photo voucher. Fills distributional gap. Sterling Co.: Sterling City, 16.91 air mi SSE on RM 2034 (31.59654°N, 100.92406°W), 2397 ft elev. 20 April 2012. M. S. Price and N. M. Price. TNHC 89541. Fills distributional gap.

***LITHOBATES CATESBEIANUS* (American Bullfrog).** Midland Co.: Midland, 3.43 air mi SW on the premises of the I-20 Wildlife Preserve (31.96413°N, 102.12131°W), 2812 ft elev. 24 June 2014. M. S. Price and T. M. Dimler. TNHC 95432, photo voucher. Fills distributional gap.

***PSEUDACRIS CLARKII* (Spotted Chorus Frog).** Scurry Co.: Snyder, 13.62 air mi ENE on RM 1614 (32.73937°N, 100.68519°W), 2181 ft elev. August 1992. M. S. Price. TNHC 92922, photo voucher. Fills distributional gap.

***SCAPHIOPUS COUCHII* (Couch's Spadefoot).** Borden Co.: Gail, 13.2 air mi S on Willow Valley Road (32.56336°N, 101.39130°W), 2357 ft elev. 12 October 2009. T. M. Dimler. TNHC 89753. Fills distributional gap. Scurry Co.: Snyder, 7.56 air mi WSW on private ranch (32.69028°N, 101.04617°W), 2292 ft elev. May 1991. M. S. Price. TNHC 92935, photo voucher. Fills distributional gap.

TESTUDINES — TURTLES

***APALONE SPINIFERA GUADALUPENSIS* (Guadalupe Spiny Soft-shelled Turtle).** Scurry Co.: Snyder, 0.20 air mi SW along Deep Creek (32.71593°N, 100.92005°W), 2294 ft elev. May 1991. M. S. Price. TNHC 92919, photo voucher. Fills distributional gap.

***APALONE SPINIFERA GUADALUPENSIS* (Guadalupe Spiny Soft-shelled Turtle).** Sterling Co.: Sterling City, 3.33 air mi SE in North Concho River (31.80288°N, 100.94389°W), 2198 ft elev. 18 June 2015. M. S. Price. TNHC 95424. Fills distributional gap.

***GRAPTEMYS VERSA* (Texas Map Turtle)**. Sterling Co.: Sterling City, 3.33 air mi SE in North Concho River (31.80288°N, 100.94389°W), 2198 ft elev. 5 May 2010. M. S. Price. TNHC 92937, photo voucher. Extends distributional record.

***KINOSTERNON FLAVESCENS* (Yellow Mud Turtle)**. Crockett Co.: Ozona, 24.01 air mi N on SH 163 (31.04931°N, 101.16528°W), 2661 ft elev. 13 May 2009. M. S. Price. TNHC 92910, photo voucher. Fills distributional gap.

***PSEUDEMYS TEXANA* (Texas River Cooter)**. Sterling Co.: Sterling City, 3.33 air mi SE in North Concho River (31.80288°N, 100.94389°W), 2198 ft elev. 20 April 2013. M. S. Price. TNHC 95429, photo voucher. Fills distributional gap.

***STERNOTHERUS ODORATUS* (Eastern Musk Turtle)**. Sterling Co.: Sterling City, 3.33 air mi SE in North Concho River (31.80288°N, 100.94389°W), 2198 ft elev. 5 May 2010. M. S. Price. TNHC 92946, photo voucher. Extends distributional record.

***TERREPENE ORNATA ORNATA* (Ornate Box Turtle)**. Upton Co.: McCamey, 19.30 air mi NNW on SH 329 (31.40741°N, 102.28381°W), 2610 ft elev. June 1997. M. S. Price and D. B. Wuerch. TNHC 92942, photo voucher. Fills distributional gap.

***TRACHEMYS SCRIPTA ELEGANS* (Red-eared Slider)**. Sterling Co.: Sterling City, 3.33 air mi SE in North Concho River (31.80288°N, 100.94389°W), 2198 ft elev. 5 May 2010. M. S. Price. TNHC 92938, photo voucher. Fills distributional gap.

SQUAMATA — LIZARDS

***ASPIDOSCELIS SEXLINEATA VIRIDIS* (Prairie Racerunner)**. Scurry Co.: Snyder, 0.53 air mi SW at private residence (32.71478°N, 100.92600°W), 2320 ft elev. April 1993. M. S. Price. TNHC 92920, photo voucher. Fills distributional gap.

***ASPIDOSCELIS TESSELATA* (Common Checkered Whiptail)**. Midland Co.: Midland, 3.62 air mi SW on the premises of the I-20 Wildlife Preserve (31.96178°N, 102.12337°W), 2826 ft elev. 25 April 2014. M. S. Price and B. Williams. TNHC 95422. Extends distributional record.

***HOLBROOKIA MACULATA MACULATA* (Great Plains Earless Lizard)**. Scurry Co.: Hermleigh, 4.82 SW on CR 4146 (32.57274°N, 100.79597°W), 2332 ft elev. April 1993. M. S. Price. TNHC 92930, photo voucher. Fills distributional gap.

***HEMIDACTYLUS TURCICUS* (Mediterranean House Gecko)**. Midland Co.: Midland, 3.18 air mi SW on the premises of the I-20 Wildlife Preserve (31.96607°N, 102.11764°W), 2815 ft elev. 18 April 2015. M. S. Price, N. M. Price, T. M. Dimler, and H. McMillan. TNHC 95423. Extends distributional record. Sterling Co.: Sterling City, on Dairy Queen building (31.83588°N, 100.98355°W), 2284 ft elev. 16 October 2012. M. S. Price. TNHC 89546. Extends distributional record. Sutton Co.: Sonora, Jct. of IH-10 & U.S. Hwy. 277 (30.58036°N, 100.64621°W), 2138 ft elev. 19 May 2011. M. S. Price and N. M. Price. TNHC 89547. Fills distributional gap.

***PLESTIODON OBSOLETUS* (Great Plains Skink)**. Midland Co.: Midland, 3.43 air mi SW on the premises of the I-20 Wildlife Preserve (31.96482°N, 102.12223°W), 2810 ft elev. 9 September 2010. M. S. Price and N. Knowles. TNHC 95428, photo voucher. Fills distributional gap.

SQUAMATA — SNAKES

***AGKISTRODON CONTORTRIX LATICINCTUS* (Broad-banded Copperhead)**. Runnels Co.: Paint Rock, 12.68 air mi E (31.49230°N, 99.70584°W), 1566 ft elev. May 2002. M. S. Price and R.L. Dearth. TNHC 89748. Extends distributional range.

***ARIZONA ELEGANS ELEGANS* (Kansas Glossy Snake)**. Scurry Co.: Snyder, 7.10 air mi S on Round Top Road (32.61551°N, 100.91970°W), 2267 ft elev. May 2004. M. S. Price. TNHC 92929, photo voucher. Fills distributional gap.

***COLUBER CONSTRICTOR FLAVIVENTRIS* (Eastern Yellow-bellied Racer)**. Borden Co.: Gail, 4.49 air mi WSW on private ranch (32.76017°N, 101.52193°W), 2559 ft elev. 18 July 2012. T. M. Dimler. TNHC 92906, photo voucher. Extends distributional range.

***CROTALUS LEPIDUS LEPIDUS* (Mottled Rock Rattlesnake)**. Schleicher Co.: Eldorado, 15.37 air mi SW on RM 2129 (30.74197°N, 100.81969°W), 2382 ft elev. 8 April 2009. M. S. Price and N. M. Price. TNHC 84918. Extends distributional range.

***CROTALUS VIRIDIS* (Prairie Rattlesnake)**. Scurry Co.: Hermleigh, 5.41 air mi SSW on CR 4136 (32.55796°N, 100.77467°W), 2352 ft elev. 14 October 2011. M. S. Price. TNHC 89750. Fills distributional gap.

***DIADOPHIS PUNCTATUS REGALIS* (Regal Ring-necked Snake)**. Borden Co.: Gail, 4.68 air mi WNW on private ranch (32.78703°N, 101.52444°W), 2639 ft elev. 19 October 2012. T. M. Dimler. TNHC 89745. Fills distributional gap. Scurry Co.: Hermleigh, 5.67 air mi WNW on private ranch (32.55937°N, 100.79331°W), 2356 ft elev. May 1991. M. S. Price. TNHC 92931, photo voucher. Fills distributional gap.

***DRYMARCHON MELANURUS* (Central American Indigo Snake)**. Sutton Co.: 0.70 air mi SE of IH-10 & U.S. Hwy. 277 (corner of Water & Pecan St. in Sonora) (30.56933°N, 100.64261°W), 2118 ft elev. 19 September 2009. M. S. Price and M. H. Humphrey. TNHC 84899. Extends distributional range.

***GYALOPION CANUM* (Chihuahuan Hook-nosed Snake)**. Midland Co.: Midland, 11.94 air mi SE on SCR 1160 (31.84537°N, 101.98024°W), 2691 ft elev. 24 June 2014. M. S. Price and A. Barentse. TNHC 95421 Fills distributional gap. Upton Co.: McCamey, 9.7 air mi NNE on private ranch (31.26706°N, 102.17448°W), 2819 ft elev. October 1996. M. S. Price and D. B. Wuerch. TNHC 92943, photo voucher. Extends distributional range.

***HETERODON PLATIRHINOS* (Eastern Hog-nosed Snake)**. Borden Co.: Gail, 11.89 air mi NE on private ranch (32.91631°N, 101.3366°W), 2654 ft elev. 22 September 2004. T. M. Dimler. TNHC 92907, photo voucher. Extends distributional record. Schleicher Co.: Eldorado, 9.49 air mi E on US 190 (30.87105°N, 100.44167°W), 2303 ft elev. 30 June 2010. M. S. Price and B. Vanecek. TNHC 92918, photo voucher. Extends distributional record.

***HYPSIGLENA JANI* (Chihuahuan Nightsnake)**. Midland Co.: Midland, 6.96 air mi SSW on SCR 1210 (31.89644°N, 102.08528°W),

2743 ft elev. 24 June 2014. M. S. Price and A. Barentse. Fills distributional gap. Scurry Co.: Snyder, 2.46 air mi SE on Brick Plant Road (32.69548°N, 100.88486°W), 2292 ft elev. June 1992. M. S. Price. TNHC 92924, photo voucher. Fills distributional gap. Upton Co.: Rankin, 13.54 air mi NW on SH 329 (31.33071°N, 102.12911°W), 2785 ft elev. June 1997. M. S. Price and D. B. Wuerch. TNHC 92940, photo voucher. Fills distributional gap.

***LAMPROPELTIS ALTERNA* (Gray-banded Kingsnake)**. Upton Co.: McCamey, 11.08 air mi NE on private ranch (31.28823°N, 102.17560°W), 3030 ft elev. May 1995. M. S. Price and D. B. Wuerch. TNHC 95426, photo voucher. Extends distributional range.

***LAMPROPELTIS GETULA SPLENDIDA* (Desert Kingsnake)**. Upton Co.: McCamey, 19.31 air mi NNW on SH 329 (31.40625°N, 102.29046°W), 2607 ft elev. June 1997. M. S. Price and D. B. Wuerch. TNHC 92941, photo voucher. Fills distributional gap.

***LAMPROPELTIS TRIANGULUM* (Milksnake)**. Ector Co.: Penwell, 2.78 air mi SSE on RM 1601 (31.70203°N, 102.57582°W), 2879 ft elev. May 1997. M. S. Price and M. Adcox. TNHC 92911, photo voucher. Fills distributional gap. Gaines Co.: Seminole, 19.76 air mi SW on CR 324 (32.55763°N, 102.92518°W), 3418 ft elev. August 2004. M. S. Price and M. Webb. TNHC 92912, photo voucher. Fills distributional gap. Garza Co.: Post, 12.91 air mi SW on CR 308 (33.06578°N, 101.54392°W), 2844 ft elev. May 1998. M. S. Price and T. Reagan. TNHC 92913, photo voucher. Fills distributional gap. Hockley Co.: Sundown, 4.62 air mi SE on SH 41 (33.40673°N, 102.43520°W), 3491 ft elev. April 1998. M. S. Price and K. Howard. TNHC 92915, photo voucher. Fills distributional gap. Taylor Co.: Hamby, just west on private residence (32.51846°N, 99.63183°W), 1735 ft elev. May 1991. B. Baldwin. TNHC 92939, photo voucher. Fills distributional gap.

***MASTICOPHIS TAENIATUS GIRARDI* (Central Texas Whipsnake)**. Upton Co.: McCamey, 9.7 air mi NNE on private ranch (31.26706°N, 102.17448°W), 2819 ft elev. October 1996. M. S. Price and D. B. Wuerch. TNHC 92944, photo voucher. Extends distributional range.

***NERODIA RHOMBIFER* (Diamond-backed Watersnake)**. Sterling Co.: Sterling City, 3.33 air mi SE in North Concho River (31.80288°N, 100.94389°W), 2198 ft elev. 5 May 2010. M. S. Price and N. M. Price. TNHC 89752. Extends distributional record.

***PANTHEROPHIS EMORYI* (Great Plains Ratsnake)**. Scurry Co.: Dunn, 1.33 air mi NW on RM 1606 (32.57362°N, 100.90688°W), 2184 ft elev. April 1993. M. S. Price. TNHC 92926, photo voucher. Fills distributional gap.

***PITUOPHIS CATENIFER SAYI* (Bullsnake)**. Upton Co.: McCamey, 9.7 air mi NNE on private ranch (31.26706°N, 102.17448°W), 2819 ft elev. October 1996. M. S. Price and D. B. Wuerch. TNHC 92945, photo voucher. Extends distributional range.

***REGINA GRAHAMII* (Graham's Crayfish Snake)**. Scurry Co.: Snyder, 2.47 air mi S on the premises of Western Texas College Golf Course (32.68208°N, 100.91808°W), 2304 ft elev. October 1986. M. S. Price. TNHC 92936, photo voucher. Fills distributional gap.

***SISTRURUS CATENATUS* (Massasauga)**. Borden Co.: Gail, 18.26 air mi SE on RM 1785 (32.55636°N, 101.26105°W), 2317 ft elev. 5 September 2010. T. M. Dimler. TNHC 89754. Fills distributional gap. Crane Co.: Crane, 14.70 air mi NW on RM 1233 (31.50763°N, 102.56322°W), 2679 ft elev. 7 October 2008. M. S. Price and M. Webb. TNHC 92909, photo voucher. Fills distributional gap. Glasscock Co.: Garden City, 3.45 air mi SSE on County Road 270 (31.81828°N, 101.45742 °W), 2587 ft elev. 2 July 2009. M. S. Price. TNHC 84934. Fills distributional gap. Scurry Co.: Snyder, 10.7 air mi W on CR 370 (32.72388°N, 101.10137°W), 2423 ft elev. April 1991. M. S. Price. TNHC 92928, photo voucher. Fills distributional gap.

***SONORA SEMIANNULATA* (Variable Groundsnake)**. Sterling Co.: Sterling City, 16.91 air mi SSE on RM 2034 (31.57941°N, 100.92093°W), 2460 ft elev. 10 April 2009. M. S. Price. TNHC 84901. Fills distributional gap.

***TANTILLA CUCULLATA* (Trans-Pecos Black-headed Snake)**. Crockett Co.: Ozona, 29.32 air mi SW on RM 2083 (30.35988°N, 101.49351°W), 1914 ft elev. 20 May 2009. M. S. Price and S. Gelsomino. TNHC 95427, photo voucher. Extends distributional record.

***TANTILLA GRACILIS* (Flat-headed Snake)**. Sterling Co.: Sterling City, 19.02 air mi SSE on RM 2034 (31.56498°N, 100.92743°W), 2402 ft elev. 9 April 2009. M. S. Price. TNHC 84902. Extends distributional record.

***TANTILLA HOBARTSMITHI* (Smith's Black-headed Snake)**. Sterling Co.: Sterling City, 18.30 air mi SSE on RM 2034 (31.57941°N, 100.92093°W), 2460 ft elev. 9 April 2009. M. S. Price. TNHC 84917. Extends distributional record.

***TANTILLA NIGRICEPS* (Plains Black-headed Snake)**. Sterling Co.: Sterling City, 3.4 air mi SE on RM 2034 (31.81718°N, 100.93689°W), 2292 ft elev. 9 April 2009. M. S. Price. TNHC 84903. Fills distributional gap.

***THAMNOPHIS PROXIMUS* (Western Ribbonsnake)**. Scurry Co.: Snyder, 13.62 air mi ENE on RM 1614 (32.73937°N, 100.68519°W), 2181 ft elev. July 1994. M. S. Price. TNHC 92923, photo voucher. Fills distributional gap.

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New County Records of Reptiles from the Suwannee River, Florida, USA

These records were collected during a turtle study from July 2011 through December 2013 in the Suwannee River, Florida. The Suwannee River serves as the boundary between counties, and we considered a capture as a new county record (Krysko et al. 2011) only if it came from the correct side of the river. Many counties along the Suwannee River are rural, potentially explaining why many of these new records represent common species. *Trachemys scripta elegans*, which is not native to Florida, appears to be distributed throughout the entire Suwannee River in Florida and is apparently reproducing. A large female captured in Gilchrist County (UF 174471) laid an egg soon after capture. This is of concern because this non-native subspecies can intergrade with native *T. s. scripta*. We removed all captured *T. s. elegans* from the wild. Records were verified by Kenneth L. Krysko, and digital photographic vouchers were deposited in the Florida Museum of Natural History (UF). Geocoordinates are based on datum WGS 84. Standard English names follow Crother (2012).

TESTUDINES — TURTLES

***APALONE FEROX* (Florida Softshell).** Hamilton Co.: Suwannee River, near White Springs 150 m upstream from CR 136 bridge (30.326677°N, 82.760333°W). 23 March 2012. T. Thomas, K. Enge, and E. Suarez. UF 174417. Captured in a hoop net.

***CHELYDRA SERPENTINA* (Snapping Turtle).** Gilchrist Co.: Suwannee River, 50 m from Sun Spring's head (29.704621°N, 82.933554°W). 2 May 2012. T. Thomas and E. Suarez. UF 174418. Captured by hand.

***KINOSTERNON BAURII* (Striped Mud Turtle).** Madison Co.: Suwannee River, ~ 5.5 km downstream from I-10 bridge (30.327343°N, 83.211448°W). 17 October 2012. T. Thomas and E. Suarez. UF 174464. Captured by hand along bank. Suwannee Co.: boat ramp at the Spirit of the Suwannee Music Park (30.405882°N, 82.949105°W). 15 June 2012. T. Thomas and E. Suarez. UF 174465. Hand captured in a flooded ditch along dirt road.

***MACROCHELYS SUWANNIENSIS* (Suwannee Alligator Snapping Turtle).** Madison Co.: Suwannee River, ~ 8.5 km downstream from I-10 bridge (30.305378°N, 83.218073°W). 17 October 2012. T. Thomas and E. Suarez. UF 174466. Captured in a hoop net. Gilchrist Co.: Suwannee River, ~ 3.1 km upstream from CR 340 (29.81564°N, 82.931430°W). 7 April 2012. T. Thomas and E. Suarez. UF 169563. Captured in a hoop net.

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***PSEUDEMYS SUWANNIENSIS* (Suwannee Cooter).** Hamilton Co.: Suwannee River, ~ 3.8 km upstream from CR 6 bridge (30.529023°N, 82.727748°W). 11 June 2013. Basking along the bank. T. Thomas and K. Enge. UF 174468. Madison Co.: Suwannee River, ~ 8.5 km downstream from I-10 bridge (30.305378°N, 83.218073°W). 16 March 2012. Captured in a hoop net. T. Thomas and E. Suarez. UF 174470.

***TRACHEMYS SCRIPTA ELEGANS* (Red-eared Slider).** Dixie Co.: Suwannee River, near the town of Suwannee, 700 m upstream from the mouth of Demory Creek (29.322880°N, 83.131272°W). 12 July 2012. T. Thomas and E. Suarez. UF 174471. Captured in a hoop net. Hamilton Co.: Suwannee River, near White Springs downstream from canoe launch at Stephen Foster Folk Culture Center State Park (30.329784°N, 82.761116°W). 13 November 2012. T. Thomas, Natalie Lamneck, and Michael Ruccolo. UF 174473. Captured in a hoop net. Lafayette Co.: Suwannee River, ~ 600 m downstream from Dowling Park boat ramp at CR 250 (30.239757°N, 83.253223°W). 10 May 2012. T. Thomas and E. Suarez. UF 174474. Captured in a hoop net.

SQUAMATA — SNAKES

***NERODIA TAXISPILOTA* (Brown Watersnake).** Madison Co.: Suwannee River, near flooded spring 6.5 km upstream from boat ramp at CR 250 (30.276452°N, 83.235968°W). 15 September 2012. T. Thomas and E. Suarez. UF 174477.

***THAMNOPHIS SIRTALIS* (Common Gartersnake).** Suwannee Co.: Suwannee River, near Branford in a floodplain spring (29.934272°N, 82.920730°W). 28 August 2013. E. Suarez. UF 174478.

CROCODYLIA — CROCODILIANS

***ALLIGATOR MISSISSIPPIENSIS* (American Alligator).** Madison Co.: Suwannee River, ~ 6 km downstream from I-10 bridge (30.303183°N, 83.223343°W). 26 September 2012. T. Thomas, K. Enge, and E. Suarez. UF 174479. Captured in a hoop net.

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NATURAL HISTORY NOTES

CAUDATA — SALAMANDERS

EURYCEA LUCIFUGA **(Cave Salamander). PREDATION.** Specific predator species have apparently not been reported for *Eurycea lucifuga* (Juterbock 2005. *In* M. J. Lannoo [ed.], Amphibian Declines: The Conservation Status of United States Species, pp. 750–753. University of California Press, Berkeley, California). Hutchison (1958. Ecol. Monogr. 28:1–20) speculated that *Diadophis punctatus* (Ring-necked Snake) may be an important predator of *E. lucifuga* because he observed these snakes at the openings of salamander-rich caves. *Diadophis punctatus* is known to prey upon salamanders (e.g., Blanchard et al. 1979. J. Herpetol. 13:377–402). On 09 July 2015 we observed a Cave Salamander hanging by its head that appeared stuck in a rock crevice within the twilight zone of Screech Owl Cave on Pigeon Mountain, Walker Co., Georgia, USA (ca. 34.6650°N, 85.3635°W; WGS 84). Upon lifting the salamander we observed a *D. punctatus* grasping the head of the salamander. As part of an on-going effort to monitor salamanders using caves in northwestern Georgia (Camp and Jensen 2007. Copeia 2007:594–604; Camp et al. 2014. Can. J. Zool. 92:119–127) we have seen *D. punctatus* on several occasions within twilight zones of caves. However, it is unclear whether this species of snake actively forages for salamanders within this habitat or if the observed incident represents a rare, coincidental event.

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NOTOPHTHALMUS VIRIDESCENS **(Eastern Newt). DIET.** We studied the diets of adult *Notophthalmus viridescens* from three lakes to evaluate whether adult newt diets differ across ponds locally or if they exhibit prey preferences. We conducted macroinvertebrate surveys and collected a total of 67 *N. viridescens* adults using dipnet surveys from three ponds in Sewanee, Franklin Co., Tennessee, USA (Pond 1: 35.2139°N, 85.9130°W; Pond 2: 35.2128°N, 85.9190°W; Pond 3: 35.2212°N, 85.9354°W; WGS 84), from October to December 2014. Prey surveys were standardized to four dips at ten locations around each lake. All prey organisms were identified to class or family using a dissecting microscope. Salamander diets were assessed by conducting a non-lethal lavage on each individual using protocols identified in Cecala et al. (2007. J. Herpetol. 41:741–745). 89.3% of adults had stomach contents. We conducted chi-square tests to determine if diets differed among ponds or were distinct from macroinvertebrate availability. We extracted 204 food items including organisms from the following groups ranked by abundance: Gastropoda (42.6%), Diplostraca (22.5%), Odonata (15.2%), Tricoptera (5.9%), Oligochaeta (5.9%), Diptera (2.5%), Coleoptera (1%), Plecoptera (0.5%), Ephemeroptera (0.5%), and Arachnida (0.5%). Adult newts consumed prey items in proportion to their availability (Pond 1, $\chi^2 = 1.64$, $p = 0.98$; Pond 2, $\chi^2 = 0.30$, $p = 0.99$; Pond 3, $\chi^2 = 0.93$, $p = 0.97$) despite availability of prey varying among ponds. Pond 2 and Pond 3 all had more human disturbance within their catchments than Pond 1 and had much higher densities of gastropods (Pond 1 = 0% Gastropoda, Pond 2 = 48% Gastropoda, and Pond 3 = 35% Gastropoda in prey item sampling). Because of variation in prey availability among ponds, newts also demonstrated diet variability between Pond 1 and Pond 3 ($\chi^2 = 20.30$, $p = 0.005$) but not between any other pond pairing (Pond 1 and 2, $\chi^2 = 13.03$, $p = 0.16$; Pond 2 and 3, $\chi^2 = 0.16$, $p = 0.99$). In conclusion, *N. viridescens* appears to consume prey in proportion to their availability despite pond heterogeneity in prey availability.

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NOTOPHTHALMUS VIRIDESCENS **(Eastern Newt). SIZE AT METAMORPHOSIS.** Body size at metamorphosis is an important determinant of future success in amphibians (e.g., Semlitsch et al. 1988. Ecology 69:184–192). Due to climate, resource availability, and regional variation, size at metamorphosis and growth can vary widely throughout the range of *Notophthalmus viridescens* (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, D.C. 587 pp.). We observed growth rates and size at metamorphosis of *N. viridescens* from a large constructed, permanent pond in an understudied region on the southern Cumberland Plateau near Sewanee, Franklin Co., Tennessee, USA (35.2095°N, 85.9317°W; WGS 84). This pond has served as a source population for previous studies on *N. viridescens* physiology (e.g., Berner et al. 2013. J. Herpetol. 47:466–470). Surveys were conducted approximately every 10 days beginning 28 May 2014 and included dipnetting and visual observations of the pond shoreline. We observed recent hatchlings on 9 June 2014 as small as 9 mm SVL. We collected 28 individuals on 09–12 June 2014 with SVL ranging from 9 to 19 mm suggesting wide variation in timing of hatching. We did a second collection on 19–21 June 2014 of 334 individuals with SVL ranging from 9 to 21 mm. Our first observations of a metamorphic *N. viridescens* individual occurred on 03 July 2014, and we captured 14 metamorphic individuals from 3 July 2014 – 1 September 2014. The SVL at metamorphosis of these individuals ranged from 15 to 20 mm with a mean of 17.6 ± 0.50 mm SVL. Nine individuals marked with visible implant elastomer on 19 June 2014 (334 marked in total) and recaptured from 15 July–01 September 2015 exhibited mean growth rates of 0.15 ± 0.072 mm/day. These values represent the smallest metamorphic *N. viridescens* described in the

literature. In conclusion, *N. viridescens* in Sewanee, Tennessee, USA exhibit a distinct eft life stage, slow growth rates, and small sizes at metamorphosis.

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***PLETHODON CINEREUS* (Eastern Red-backed Salamander). COLORATION.** The salamander *Plethodon cinereus* is an abundant species that exhibits two primary color variations (Redback and Leadback), which occur throughout eastern North America (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington D.C. 587 pp.). Erythrism, leucism, albinism, iridism, amelanism, and melanism are also known for this species, as are varying degrees of intermediacy for each morph (Moore and Oulett 2014. Can. Field Nat. 128:250–259). Herein, I report an observation of a poorly known color morph of *P. cinereus* that has only been mentioned in passing in the peer-reviewed literature, and for which a published image does not exist (Moore and Oulett 2014, *op. cit.*).

On 11 April 2015, at Buttermilk Falls State Park, Tompkins Co., New York, USA (42.4129°N, 76.5262°W; WGS 84), I found an adult *P. cinereus* of unknown sex that exhibited unusual coloration; the salamander was found under a stone on a steep WNW-facing hillside. The dorsal stripe of this specimen was white with occasional melanophores, uniform in shape, and clearly defined (Fig. 1.), while the sides and venter were normally colored. No red pigment could be found on the dorsal stripe upon close examination. This specimen can be distinguished from a partially leucistic individual by a lack of blotching of the white coloration, by the normally colored venter, and the presence of flecking on the sides. Thus, it seems to represent a variation of the abundant Redback morph. Subsequent surveys at this site failed to locate further specimens of *P. cinereus* with similar coloration, but typically patterned individuals of both the striped (Redback) and unstriped (Leadback) morphs were found in abundance.



FIG. 1. Dorsal view of the white-striped color variant of *Plethodon cinereus*.

I thank Kraig Adler for helpful comments on drafts of this note.

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***SIREN INTERMEDIA* (Lesser Siren). LIMB REGENERATION.** Current hypotheses regarding the evolution of epimorphic regeneration capacity in vertebrates include a variety of explanations as to why some taxa are capable of limb regeneration while others lack such restorative survival mechanisms. General phylogenetic trends in the distribution of regeneration capacity include a negative correlation between regeneration capacity and animal maturity/size as well as a positive correlation between regeneration capacity and theorized selective pressure (Goss 1969. Principles of Regeneration. Academic Press Inc., New York. 278 pp.; Reichman 1984. Am. Nat. 123:752–763). In a previous review of amphibian regeneration capacity, it was reported that one family of salamanders, Sirenidae, lacked this restorative mechanism. Moreover, this same review noted specifically that *Siren intermedia* exhibits "no apparent regenerative ability to the capacity to produce a heteromorphic regenerate" (Scadding 1977. J. Exp. Zool. 202:57–68). This conclusion fit nicely into the observed trends mentioned above; an aquatic species propelled by undulation would have little selective pressure to regenerate forelimbs and *S. intermedia* is well above the size boundary previously correlated to lack of regeneration.

Contrary to the initial study and general trends noted above, we provide the first report of epimorphic limb regeneration in *S.*

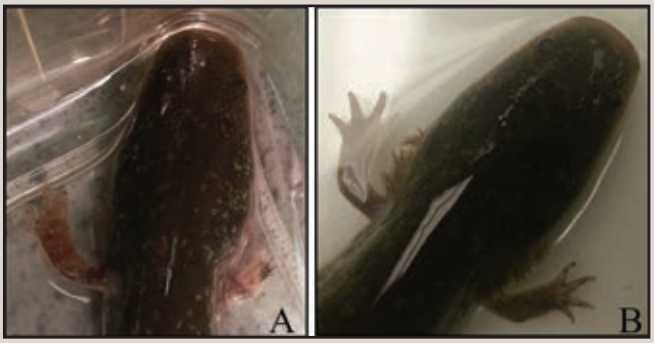


FIG. 1. Photographs of a Lesser Siren (*Siren intermedia*) right forearm regeneration progress at (A) 3 weeks and (B) 25 weeks after initial recorded observation

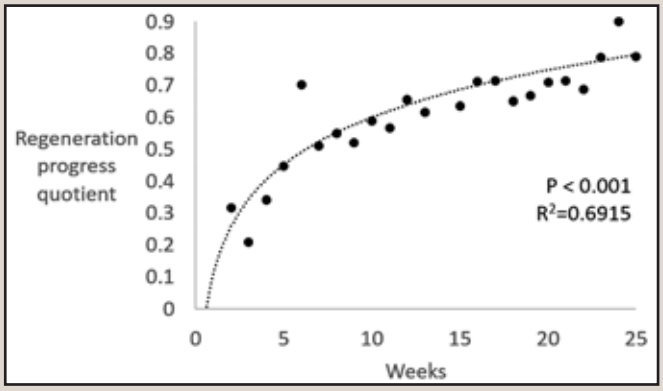


FIG. 2. Regeneration progress of an amputated forearm in a *Siren intermedia* over 25 weeks. Regeneration progress has been estimated by the quotient of the regenerating forearm area divided by the normal forearm area.

intermedia. In late summer 2014, two individual *S. intermedia* were collected from their native habitat in northern Florida (exact time and location unknown). The individuals were shipped to Nebraska Wesleyan University to be used as display specimens in early September 2014. Both individuals measured ca. 25 cm in length. After arrival, it was noted that the right forearm was amputated distal to the elbow (the time and cause of amputation is unknown) in one of the individuals. After observing unexpected digit formation with stump remodeling several weeks later, observations were recorded. Along with observations, quantitative regeneration progress and growth rate were estimated over 6 months. At one-week intervals, digital photographs were taken directly above the individual with the two limbs spread out flat within a tray of shallow water (Fig. 1). Areas of each forearm were estimated using ImageJ software and the relative area of the regenerating forelimb was plotted with respect to time in weeks (Fig. 2). The regenerating forearm grew (i.e., increased in area) at an average of +2.0% per week compared to growth of the non-amputated, normal limb. This observation calls for further regeneration studies of *S. intermedia*, re-evaluation of the regeneration capacity of the entire family Sirenidae, and suggests potential revision of observed general trends.

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ANURA — FROGS

***ADENOMUS KELAARTII* (Kelaart's Dwarf Toad). PREDATION.** Amphibians have been recorded being predated by other vertebrates, including other amphibians (Toledo et al. 2007. J. Zool. 271:170–177), as well as invertebrates (Toledo 2005. Herpetol. Rev. 36:395–400) and carnivorous plants (Duellman and Trueb 1994. Biology of Amphibians. John Hopkins University Press, Baltimore, Maryland. 670 pp.). Among the invertebrates recorded preying on amphibians, attacks by Araneae spiders are quite well documented (Menin et al. 2005. Phyllomedusa 4:39–47). Although Menin et al. (2005. *op cit.*) reviewed such phenomena in amphibians in the Neotropics, with a special attention on the Central Amazonia and the Order Araneae, such records from the Paleotropics remain scarce. The only published accounts of invertebrates predating adult amphibians in Sri Lanka involve the huntsman spider (Bambaradeniya 2001. Lyriocephalus 4:140) and coleopteran larvae (De Silva et al. 2009. Froglog 91:5–7). Contributing to above knowledge, herein, we report the first ever observation from Sri Lanka of an *Adenomus kelaartii* (Kelaart's Dwarf Toad) being predated and fed upon by a huntsman spider of the genus *Heteropoda* (Fig. 1). The observation was made at 2224 h on 14 March 2015 during dry weather, on a rock outcrop of a fast flowing stream bank in Hunuwela Rubber Estate, Ratnapura District, Sri Lanka (6.6366°N, 80.6005°E, WGS 84; 266 m elev.). The site is surrounded by well grown evergreen forests including rubber and tea plantations and is close to the southern slope of the central hills.

The spider was observed to grip the sub-adult toad from the posterior end with its chelicerae together with the aid of the palpus. Although the toad made several escape attempts, the spider was able to held its prey steadily using sticky webs. The immobilization effect of the spider venom was fast, resulting in the frog showing no more reaction within the course of a few minutes. The Bufonid genus *Adenomus* is endemic to Sri Lanka (Manamendra-Arachchi and Pethiyagoda 1998. J. S. Asian Nat. Hist. 3:213–248) and includes only three species: *A. kelaartii* (listed as Endangered on the IUCN Red List), *Adenomus kandianus* (Kandy Dwarf Toad), and *Adenomus dasi* (Das' Dwarf Toad), both of which are Critically Endangered (Manamendra-Arachchi and Meegaskumbura 2012. *In* Weerakoon and Wijesundara [eds.], The National Red List 2012 of Sri Lanka, pp. 92. Ministry of Environment, Colombo, Sri Lanka). Seventeen more individuals of *A. kelaartii* were recorded from the same location along a 50 m transect of the stream over a 30 min period using flash lights. Other amphibians recorded from the location included two endemic species: *Lankanectes corrugate* (Corrugated water frog) and *Pseudophilautus cavirostris* (Hollow snouted shrub frog).



FIG. 1. *Adenomus kelaarti* being preyed upon by a spider (*Heteropoda sp.*).

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***AGALYCHNIS CALLIDRYAS* (Red-eyed Treefrog). PARASITISM.** Ticks belonging to the genus *Amblyomma* have been documented parasitizing toads and reptiles. For example, *Rhinella marina* (Cane Toad) is a well-known host of *Amblyomma* (Lampo and Bayliss 1996. Parasitology 113:199–206). Guglielmone and Nava (2010. Zootaxa 2541:27–49) have recorded *Amblyomma rotundatum* on several additional species of the Bufonidae family: *Rhinella arenarum* (Argentine Common Toad), *Rhinella crucifer* (Crucifer Toad), *Rhinella granulosus* (Granular Toad), *Rhinella icterica* (Yellow Cururu Toad), *Peltophryne peltocephala* (Cuban Giant Toad), *Rhinella schneideri* (Cururu Toad) and *Anaxyrus terrestris* (Southern Toad). This same genus was found parasitizing *Atelopus varius* (Harlequin Frog) and *Atelopus zeteki* (Panamanian Golden Frog; Richards et al. 2006. Herpetol. Rev. 37:332–333). Besides bufonids, *Discoglossus pictus* (Painted Frog), *Spea*



FIG. 1. *Amblyomma* sp. parasitizing an adult female *Agalychnis callidryas* in Sarapiquí, Heredia, Costa Rica.

bombifrons (Plains Spadefoot), *Pipa pipa* (Suriname Toad), *Pelophylax esculentus* (Edible Frog), and *Eupemphix nattereri* (Cuyaba Dwarf Frog) are also known hosts of *Amblyomma* (Guglielmone and Nava 2010, *op. cit.*, Gambale et al. 2014. Herpetol. Bull. 130:22–23).

At 1700 h on 5 October 2012, during a field trip to Isla Verde Reserve, Sarapiquí, Heredia, Costa Rica (10.4357°N, 84.0446°W; WG S84), an *Agalychnis* adult female (SVL = 54.87 mm) was found on a plant from the Heliconiaceae family and was being parasitized by a tick of the genus *Amblyomma* (Fig. 1). I did not collect the frog or the tick but the external characters (especially the shape of the scutum) are similar to the nymphs of *Amblyomma*. This genus is the most widely distributed in lowland forests of Central America. In Costa Rica there are 24 species of *Amblyomma* recorded, of which *A. dissimile* is considered a parasite of amphibians and reptiles (Jiménez et al. 2015. Syst. Appl. Acarol. 20:471–477).

Although *A. callidryas* is relatively common and has been widely studied, little is known about their parasites, especially ectoparasites. This observation is the first record of a tick parasitizing a frog from the Hylidae family, and a new host record for the genus *Amblyomma*.

I thank S. Bermudez (The Gorgas Memorial Institute for Health Studies, Panamá City, Panamá) for confirming the tick identification.

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***ATELOPUS HOOGMOEDI* (Harlequin Toad). PREDATION.** *Atelopus hoogmoedi* is a small diurnal anuran from Guyana, Suriname, French Guiana and Brazil (Frost 2015. http://research.amnh.org/herpetology/amphibia/index.html; 25 April 2015). Adults are colorful and their conspicuousness might serve as a warning to potential predators not to eat them, as harlequin frogs contain potent skin toxins (Rueda-Almonacid et al. 2005. Ranas Arlequines: Bogotá, Colombia, Serie Libretas de Campo, Conservación Internacional. 158 pp.). *Atelopus* juveniles are less aposematic but might be toxic. *Leptodactylus mystaceus* (Common Toad-Frog, Sapo-rana Comun) is a large species of the *Leptodactylus fuscus* group, distributed throughout Brazil, occurring from the southern Amazon basin to Paraná (Affonso et al. 2011. Check List 7:198–199).



FIG. 1. A) *Leptodactylus mystaceus* preying upon a juvenile *Atelopus hoogmoedi*; B) dead regurgitated *Atelopus* juvenile.

Herein we report an opportune observation of an adult *L. mystaceus* preying upon a juvenile *A. hoogmoedi*. The predation occurred at 1025 h on 19 May 2014 in upland forest at Reserva de Desenvolvimento Sustentável Iratapuru, municipality of Laranjal do Jari, Amapá State, Brazil (0.3599°S, 52.0935°W, WGS 84; 108 m elev.). The ingestion of *A. hoogmoedi* must have started headfirst as by the time of our observation only the hind legs were visible (Fig. 1a). A few minutes later, the *L. mystaceus* regurgitated the juvenile *A. hoogmoedi* (Fig. 1b). After predation, the *L. mystaceus* was observed for one hour to check for any ill effects, and we noted none. This is the first report of *L. mystaceus*, a primarily nocturnal species, feeding on a diurnal anuran. The presence of numerous post-metamorphic and juvenile *A. hoogmoedi* on the day of observation suggests that *L. mystaceus* may have a generalist diet (Camera et al. 2014. Herpetol. Notes 7:31–36), consuming prey that is commonly available. Our observation may also suggest presence and effectiveness of toxicity in *A. hoogmoedi*, although the juvenile was dead after the predation attempt.

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***HYLA CINEREA* (Green Treefrog). PREDATION.** Arachnid species have frequently been documented to feed on anurans (Neil



FIG. 1. *Dolomedes triton* subduing *Hyla cinerea.*

1948. Herpetologica 4:158; Raven 1990. Mem. Queensland Mus. 29:448; Steehouder 1992. Litteratura Serpentium 12:71). According to a cursory literature review of invertebrates and their anuran prey (Toledo 2005. Herpetol. Rev. 36:395–400), *Hyla cinerea* has been preyed upon by the spider species *Dolomedes okefinokensis* (Okefenokee Fishing Spider; Jeffery et al. Herpetol. Rev. 35:158) and *Acanthepeira stellata* (Starbellied Orbweaver). At 2150 h on 17 August 2015 a *Dolomedes triton* (Six-spotted Fishing Spider) was observed grasping a juvenile *H. cinerea* and trying to subdue it (Fig. 1). The spider was perched on a reed in a water-filled ditch alongside County Road 414, 0.2 km S of Jonesboro, Craighead Co., Arkansas, USA (35.7559°N, 90.7048°W; WGS 84). *Dolomedes triton* has been observed feeding on adult *Acris gryllus* (Southern Cricket Frog; Graham and Sorrel 2009. Herpetol. Rev. 40:198) and larval *Lithobates catesbeianus* (American Bullfrog; Rogers 1996. Herpetol. Rev. 27:75) in Alabama.

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***LEPTODACTYLUS KNUDSENI* (Pepper Frog). DIET.** Leptodactylids are frogs known as sit-and-wait predators that consume several different types of arthropods (Toft 1980. Oecologia 47:34–38; Solé et al. 2009. Herpetol. Notes 2:9–15; Sugai et al. 2012. Biota Neotro. 12:99–104; Camera et al. 2014. Herpetol. Notes 7:31–36). The prey is often swallowed whole since anurans do not chew food, limiting the size of the prey they can eat (Lima and Moreira 1993. Oecologia 95:93–102).

Leptodactylus knudseni is a large (SVL = 113–135 mm), nocturnal frog generally found on the forest floor in riparian habitat (Lima et al. 2008. Guide to the Frogs of Reserva Adolpho

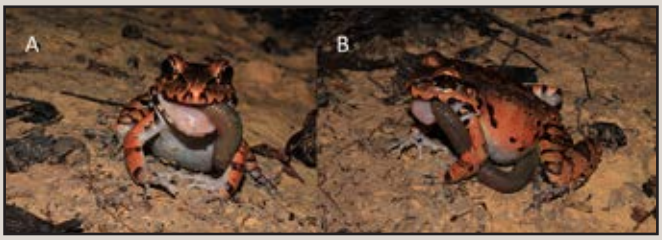


FIG. 1. A) *Leptodactylus knudseni* swallowing the giant worm, *Rhinodrilus priolli.* B) During our presence the frog stopped swallowing the worm and it began crawling out of the frog's mouth.

Ducke, Central Amazonia. Attema Design Editorial, Manaus. 168 pp.). *Rhinodrilus priolli* (Giant Earthworm) is one of the largest terrestrial invertebrates known in the world reaching over 2 m in length (Lang et al. 2012. Am. Midl. Nat. 167:384–395). At 0130 h on 30 April 2012 at Fazenda Experimental da UFAM (2.6589°S, 60.0660°W; WGS 84), 38 km from Manaus, Amazonas, Brazil on Hwy BR174, we observed a male *L. knudseni* (SVL = 97.8 mm), swallowing a *R. priolli* which had a total length of 210 mm (Fig. 1). While we observed the frog feeding, it became inactive and started to regurgitate the worm. At the same time, the worm was crawling out of the frog's mouth. The worm was ingested headfirst but suffered little apparent damage despite having been nearly totally swallowed by the frog. The size of the worm may have prevented the frog from swallowing it.

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***PHYSALAEMUS NATTERERI* (Cuyaba Dwarf Frog). TADPOLE DIET.** The functional roles and trophic status of generalized tadpoles are poorly understood (Altig et al. 2007. Freshwater Biol. 52:386–395). At 2030 h on 27 November 2014 at the Reserva Natural de Laguna Blanca, Departamento San Pedro, Paraguay (23.8127°S, 56.2949°W; WGS 84), I encountered a small ephemeral pond (ca. 3 m × 3 m) where I observed dozens of *Physalaemus nattereri* tadpoles consuming the flesh of the seeds of a Coco Palm (Family Arecaceae). In the same pond, I also observed several of the same seeds that had already been cleared of their flesh. To my knowledge, this is the first time that *P. nattereri* tadpoles have been observed consuming the flesh of the seeds of Coco Palms. In a study of their diet in southeastern Brazil, tadpoles of *P. nattereri* that occurred in both temporary and permanent ponds had large proportions of plant fragments, euglenids, algae, and diatoms in their diet (Do Prado et al. 2009. S. Am. J. Herpetol. 4:275–285). While it was not specified as to the type of plant fragments found in the diet of *P. nattereri* in Brazil, my observation is consistent with the previous report that plant material is a component in the diet of *P. nattereri* tadpoles.

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***PRISTIMANTIS REICHLEI*. EYE COLORATION.** Among anurans, eye color is used as a reliable taxonomic character (Lynch and Duellman 1997. Univ. Kansas Nat. Hist. Mus. Spec. Publ. 23:1–236). This is a useful tool for the frogs in the genus *Pristimantis* where external morphology is highly variable across species groups and conservative in assemblages, and few reports show eye color variation (Duellman and Lehr 2009. Terrestrial-breeding frogs (Strabomantidae) in Peru. NTV Science, Münster, Germany. 382 pp.). *Pristimantis reichlei* was first described as having a metallic yellow-to-orange iris with a transverse bold black stripe (Padial and De la Riva 2009. Zool. J. Linn. Soc. 155:97–122) and this pattern is commonly found throughout its range (Melo-Sampaio and Souza 2009. Check List 6:385–386).

On 11 September 2009 at Fazenda Experimental Catuaba, municipality of Senador Guiomard, Acre, Brazil (10.0822°S, 67.0626°W, WGS 84; 180 m elev.), I observed, photographed, and collected an individual of *P. reichlei* (UFAC-RB 4594) with an unusual pattern of eye coloration. The eye was metallic silver in upper half of the iris, the center was tan, with less silver coloration in the lower part (Fig. 1). Other individuals from this site displayed typical diurnal and nocturnal eye coloration as described in Padial and De la Riva (2009, *op. cit.*) and Melo-Sampaio and Souza (2009, *op. cit.*). Although eye coloration is a useful diagnostic character in the genus *Pristimantis* and this variation appears to be rare, this fact should be evaluated within species accounts and/or descriptions.



FIG. 1. *Pristimantis reichlei* showing unusual eye coloration.

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***RHINELLA ARENARUM* (Argentine Toad). EGG PREDATION BY LEECHES.** Leech predation on amphibians has been previously reported (Moore 1953. Not. Nat. Acad. Nat. Sci. Philadelphia 250:1–13; Cargo 1960. Chesapeake Sci. 1:119–120; Loebmann et al. 2008. Amphibia 7:31–34; Alvarez 2010. Bol. Asoc. Herpetol. Esp. 21:25–26; Tiberti and Gentilli 2010. Acta Herpetol. 5:255–258). Amphibian egg predation by leeches has been reported in North and South America, Southeast Asia, Australia, and Europe (Burgin and Schell 2005. Acta Zool. Sinica 51:349–353; Gunzburger and Travis 2005. J. Herpetol. 39:547–571; Romano and Di Cerbo 2007. Acta Zool. Sinica 53:750–754; Soler et al. 2014. Cuad. Herpetol. 28:39–41). Previous reports of anuran eggs being predated by leeches in Argentina include an unidentified *Oxyptychus* feeding on eggs of *Rhinella dorbignyi* (Dorbigny's Toad) and *Hypsiboas pulchellus* (Montevideo Treefrog; Soler et al. 2014. *op. cit.*).



FIG. 1. Specimens of *Oxyptychus striatus* collected in the observation area.

Herein we report a case of egg predation on at least two clutches of *Rhinella arenarum* by the leech *Oxyptychus striatus* (Ringuelet 1945. Fauna de agua dulce de la Republica Argentina. Volumen XVII Annulata, Fasciculo 1 Hirudinea. pp. 225–232; Fig. 1). The observations were made in a very slow flowing stream in San Luis, Departamento Conlara, Ruta Provincial 5, 15 KM NW Santa Rosa del Conlara, Argentina (32.2567°S, 65.3214°W, WGS 84, 717 m elev.), at ~2300 h on 19 January 2013. Several leeches (reference voucher specimens MACN-In 40169) were attached with their sucker to the gelatinous egg strings, surrounding and penetrating them with their mouths at the point where each egg was found (Fig. 2). After the eggs were consumed, the string was left completely empty (Fig. 3). Once each egg was consumed, the leech left a characteristic cylindrical projection perpendicular to the longitudinal axis of the string, as if the jelly was everted by the leech's mouth once it finished feeding on the egg (Fig. 3).

Oxyptychus is a hirudiniform genus of leeches with seven species distributed in Puerto Rico, Panama, Ecuador, and east of the Andes to the north of the extra-Andean Patagonia. Though they feed mainly on the blood of their hosts (Ringuelet 1945. *op. cit.*), recent observations suggest that they also prey on their eggs (Soler et al. 2014. *op. cit.*; present observation). Several similar cases have been observed among hirudiniforms: *Macrobdella ditetra* consumes blood and eggs of frogs (Moore 1953. *op. cit.*), and *M. diplotertia* has been observed attacking tadpoles and simultaneously consuming the eggs of *Lithobates clamitans* (Green Frog) and *L. sphenocephalus* (Southern Leopard Frog) (Turbeville and Briggler 2003. J. Fresh. Ecol. 18:155–159). Hirudiniform leeches lack a proboscis, and to feed they employ their jaws to tear the skin of the host. In the case of egg predation, they manage to bypass the gelatinous capsules surrounding the eggs, perforating them with their jaws. There are different known ways to achieve this: (a) the leech *Bassianobdella fusca* specializes on this type of food, for which it enters the foam nest, then surrounds the egg using its ventral surface and swallows it



FIG. 2. An individual of *Oxyptychus striatus* surrounding egg strings of *Rhinella arenarum*.



FIG. 3. Arrangement of egg strings of *Rhinella arenarum* with perpendicular eversions of the egg jelly (the arrow indicates one of these eversions).

wholly (Burgin and Schell 2005. *op. cit.*), and (b) *M. diplotertia* begins investigating the eggs with its head, and once it chooses an egg, it extends its body and secures its sucker to the gelatinous capsule of another egg to enter the selected one, and once inside, surrounds the egg and consumes it (Trauth and Neal 2004. J. Ark. Acad. Sci. 58:139–141).

Most bufonids have toxins (bufadienolides) from the egg stage to adulthood. The diversity and concentration of these molecules varies during ontogeny: the eggs contain the most toxin, with toxicity decreasing during larval development and increasing again after metamorphosis. The surrounding jelly coat that protects the eggs from predators lacks these toxins (Hayes et al. 2009. J. Chem. Ecol. 35:391–399). In Australia, deaths of native species of turtles and fish were reported after consuming eggs of *Rhinella marina* (Cane Toad) and, to a lesser extent, its tadpoles (Greenlees and Shine 2011. Austral Ecol. 36:53–58). Insects can also find the early stages of toads unpalatable: cases where Odonata larvae preferred not to consume tadpoles of *Rhinella spinulosa papillosa* (Sapo Espinosus) have been recorded (Jara and Perotti 2006. Cuad. Herpetol. 19:37–42). In contrast, Dytiscidae beetles prefer *R. marina* tadpoles to native Australian tadpoles or fish (Cabrera-Guzmán et al. 2012. Biol. Cons. 153:1–9). However, there are reports of leeches that apparently are not affected by these toxins and consume eggs and tadpoles of bufonids (see revisions of Gunzburger and Travis 2005. *op. cit.*; Romano and di Cerbo 2007. *op. cit.*). Nevertheless, there are also cases where other species of leeches have been affected by these toxins, such as *Goddardobdella elegans* where the survival rate was significantly reduced after feeding on tadpoles of *R. marina* (Crossland and Alford 1998. Aust. J. Ecol. 23:129–137). In that same study, other invertebrates did not suffer lethal effects after consuming eggs or tadpoles. Litch (1969. Am. Midl. Nat. 82:296–298) also reported unpalability of eggs of *Anaxyrus boreas* (Western Toad) by *Haemopsis* sp., showing a high aversion to egg compounds.

Leeches of the genus *Oxyptychus* are likely natural predators of *Rhinella*. The specific mechanism that allows these leeches to tolerate the toxicity of egg compounds so that they may be consumed safely is unknown.

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***RHINELLA SCHNEIDERI* (Cururu Toad). EPIBIOSIS.** Epibiosis is a facultative relationship between an epibiont and a basibiont (Wahl 1989. Mar. Ecol. Prog. Ser. 58:175–189). The term epibiont is used to designate individuals that colonize a free-living substrate and the term basibiont is used to describe individuals that host the epibiont (Taylor 2002. Palaios 17:522–525). Reports of tadpoles as basibionts in Brazil are very scarce, with only two published accounts, both for the toad *Rhinella crucifer* (Striped Toad) in Juiz de Fora municipality, Minas Gerais state, in the Atlantic Forest biome (Dias et al. 2009. Parasitol. Int. 58:471–474; Fernandes et al. 2011. Zoologia 28:777–783). Both studies identified the tadpoles involved as *Rhinella pombali* (Pombal's Toad), however Thomé et al. (2012. BMC Evol. Biol. 12:242) considered *R. pombali* a hybrid of *R. crucifer* and *R. ornata*, rather than a valid species. Accordingly, toads previously assigned to *R. pombali* are now considered to be either *R. crucifer* or *R. ornata*, depending on the locality. According to Frost (2015. http://research.amnh.org/vz/herpetology/amphibia; 23 Aug 2015), populations from Minas Gerais state should be considered *R. crucifer*. Ciliates of the genus *Trichodina* are reported as epibionts of many amphibian and fish species (Kreier and Baker 1991. *In* Sleigh [ed.], The Nature of Protozoa, pp. 1–53. Academic Press, San Diego; Xu et al. 1999. Syst. Parasitol. 42:229–237). Trichodinids mostly feed on bacteria present on tadpole skin mucous, but not from the host skin itself (Collymore et al. 2013. Comp. Med. 63:310–312). Possible pathogenic disturbance in amphibians might occur due to the spinning movements of attached ciliates in high intensity infestations, possibly causing tegument damage of the epithelial cells (Poynton and Whitaker 2001. *In* Wright and Whitaker [eds.], Amphibian Medicine and Captive Husbandry, pp. 193–221. Krieger Publishing Company, Malabar, Florida; Zanolo and

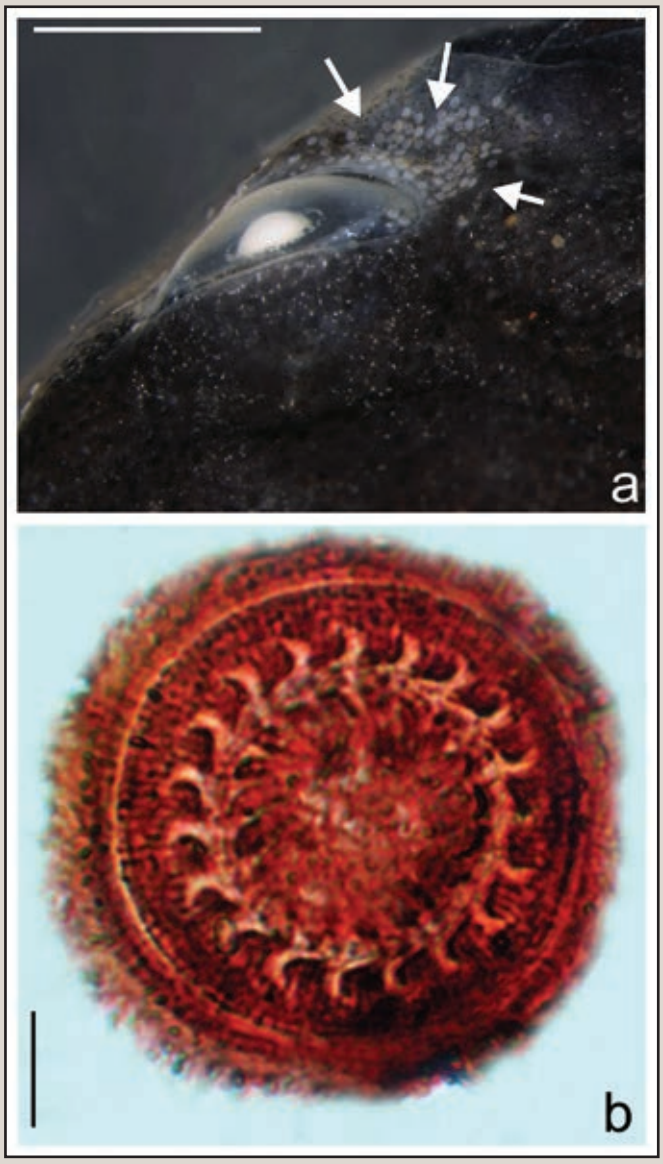


FIG. 1. A) View of the eye of the tadpole *Rhinella schnederi*. Arrows indicate an area with great abundance of ciliates. Scale bar = 1 mm. Photo credit to Fausto Nomura. B) *Trichodina* sp. revealed by dry silver impregnation technique. Scale bar = 10 µm.

Yamamura 2006. Semin. Ci. Agr. 27:281–288). Ciliates that belong to the subclass Peritrichia, such as those in the genus *Trichodina*, are mostly tolerant to pollution, being abundant in organically enriched freshwater ecosystems with high bacterial densities (Kuskoa and Watabe 1987. Oecologia 73:16–20). The presence of a high infestation of these protozoa on the surface of an organism may reflect poor water quality (Collymore et al. 2013. Comp. Med. 63:310–312). According to Palma and Dobberstein (1999. Parasitol. Res 85:726–732) the abundance of *Trichodina* sp. can indicate not only the health status of the host but also the eutrophication level of the environment.

Rhinella schneideri is a common toad species in the Cerrado biome in central Brazil and is widely distributed throughout Brazil, Paraguay, Bolivia, Argentina and Uruguay, occurring in forested and urban areas (Pramuk 2006. Zool. J. Linn. Soc. 146:407–452; Frost 2015. http://research.amnh.org/vz/herpetology/amphibia; 22 June 2015). The larval period is relatively short, lasting ca. two months (Barreto and Moreira 1996. J. Herpetol. 30:87–92). Here, we report an epibiotic relationship of *Trichodina* sp. infesting tadpoles of the species *R. schneideri*.

On 28 October 2014 and 21 November 2014, 50 tadpoles of *R. schneideri* were collected from ponds in two urban parks: Liberdade (16.6498°S, 49.2346W; WGS 84) and Beija-Flor (16.6526°S, 49.2315°W, WGS 84), both located in Goiânia municipality, state of Goiás, Central Brazil. In the laboratory, we detected ciliates on some of the tadpoles, especially around the eyes (Fig. 1A) and on the tail base. The ciliates were screened and submitted to a dry silver impregnation technique (Klein 1958. J. Protozool. 5:99–103) for analysis of essential structures that allowed the identification of the ciliate as belonging to the genus *Trichodina* (Fig. 1B). The prevalence of infestation was 38%. Tadpole vouchers were housed at the Coleção Zoológica da Universidade Federal de Goiás (ZUFG), Goiânia, Goiás, Brazil (ZUFG 2671). There are few studies on epibiotic relationships between tadpoles and ciliates; more research is required for a better understanding of the relationship dynamics. This note represents the first documentation of the epibiotic association between *Trichodina* sp. and *R. schneideri* as well the first report of this relationship for the Cerrado biome.

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TESTUDINES — TURTLES

***CARETTA CARETTA* (Loggerhead Sea Turtle). DIET.** Loggerhead Sea Turtles have the most diverse diet among marine turtles with 178 items registered from 14 phyla, with strong spatial and ontogenetic variations (Dodd 1988. US Fish Wildlife Service Biological Report 88, 110 pp.). There are also temporal changes in diet (Plotkin et al. 1993. Marine Biol. 115:1–15). Diet analysis of 52 Loggerhead Sea Turtles collected as bycatch from 1990 to 1992 demonstrated that these turtles fed predominantly at the surface (Parker et al. 2005 Fish. Bull. 103[1]:142–152). Shifts in diet between 1983 to 2002 have been documented, suggesting that declines in horseshoe crab and blue crab populations have caused Loggerheads to forage in nets or on discarded fishery bycatch (Seney and Musick 2007. Copeia 2007:478–489).

During two field trips in 2014 we collected food samples from the esophagi of 25 *Caretta caretta* (body mass 10–25 kg, and straight carapace length [SCL ± 0.1 cm] 47–71 cm; mean SCL = 59 ± 5 cm) captured at Golfo the Ulloa (25.98777°N, 112.976666°W and 25.98944444°N, 112.71666666°W; WGS 84) located in Bahía Magdalena, Baja California Sur, Mexico.

In all the samples a combination of squat lobster (*Plereucodes planipes*), octopus (*Octopus hubbsorum*), squid (*Loligo* sp.), and fish bones (most likely sardines) were present and comprised 80% of the total volume. To our knowledge, this is the first report of targeted squat lobster, octopus, squid, and fish consumption by *Caretta caretta*. The fact that squat lobster, octopus, squid, and fish occurred in such high proportion among a substantial number (80%) of turtles suggests that this new diet

combination is a major food resource for these turtles at Golfo de Ulloa. It also supports an earlier suggestion that benthic prey were common in small turtles (< 26 cm SCL) and more oceanic prey were used by larger animals (Casale et al. 2008. Mar. Ecol. Prog. Ser. 372:265–276). We thank CONANP and PROFEPA for their assistance in the logistics of field work.

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***CHELONIA MYDAS AGASSIZII* (East Pacific Green Sea Turtle). DIET.** The East Pacific Green Sea Turtle is considered the most carnivorous of all Green Sea Turtle subpopulations worldwide (Bjorndal 1997. *In* Lutz and Musick [eds.], The Biology of Sea Turtles, pp. 199–231. CRC Press, Boca Raton, Florida). Novel Green Sea Turtle diet items have been reported, including the Sea Pen, *Ptilosarcus undulatus* (Seminoff et al. 2002. Copeia 2002:266–268), pelagic red crabs, *Pleuroncodes planipes* (Lopez-Mendilaharsu et al. 2005. Aquat. Conserv. Mar. Freshwater Ecosyst. 15:259–269), tunicates and crustaceans (Amorocho and Reina 2007. Endang. Species Res. 3:43–51), hydrozoans, scyphozoans, nematodes, annelids, mollusks (Carrion-Cortez et al. 2010. J. Mar. Biol. Assoc. U.K. 90[5]:1005–1013), sponges, *Craniella* sp. and *Suberites aurantica* (Rodriguez-Baron 2010. MS thesis. Centro Interdisciplinario de Ciencias Marinas [CICIMAR-IPN]. 98 pp.), and the anemone *Palythoa ignota* (Rodriguez-Baron et al. 2011. Herpetol. Rev. 42:416).

It has been suggested that such dietary diversity is a response to the energy requirements of these animals in the early life stages, facilitating nutritional (e.g., protein) gains for development and maturation (Bjorndal 1985. Copeia 1985[3]:736–751) and optimizing digestion time (Amorocho and Reina 2008. J. Exp Mar. Biol. Ecol. 360:117–124). It has also been noted that *C. mydas* diet is influenced by resource availability (Balazs 1980. NOAA Tech. Memo. NOAA-TM-NMFS-SWFS-7; Garnett et al. 1985. Wildl. Res. 12:103–112) and that diet selection is linked to the composition and capacity of the hind-gut microflora, which may change as turtles grow and/or occupy different habitats (Bjorndal 1980. Mar. Biol. 56:147–154).

During two field trips in 2014 we collected food samples from the esophagi of 17 Green Sea Turtles (body mass 8–20 kg, and straight carapace length [SCL ± 0.1 cm] 43–45 cm; mean SCL = 85 ± 4 cm) captured at Golfo the Ulloa (25.59166°N, 112.58361°W and 25.59222°N, 112.43°W) located in the Bahía Magdalena, Baja California Sur, Mexico. A combination of octopus (*Octopus hubbsorum*), squid (*Loligo* spp.), and fish bones (most likely sardines) were present in all the samples and comprised 70% of the total volume. Turtle mean body condition index (BCI) was 1.45 (range = 1.30–2.10), similar to the values reported in previous studies (Koch et al. 2007. Mar. Biol. 153[1]:35–46; Seminoff et al. 2003. J. Mar. Biol. Assoc. U.K. 83:1355–1362). To our knowledge, this is the first report of targeted octopus, squid, and fish consumption by *Chelonia mydas agassizii*. The fact that octopus, squid, and fish occurred in such high proportion among a substantial number (70%) of turtles suggests that this diet combination is a major food resource for these turtles at Golfo de Ulloa, and that Green Sea Turtles have the capacity to assimilate nutrients from these invertebrate and fish species (Bjorndal 1990. Bull. Mar. Sci. 47[2]:567–570). We thanks CONANP and PROFEPA for their assistance in the logistics field work.

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***CHRYSEMYS PICTA BELLII* (Western Painted Turtle). RECORD CARAPACE LENGTH.** *Chrysemys picta bellii* is the largest and one of the most geographically widespread subspecies of *C. picta*, reaching the northern extent of the species' range in western Canada (Ernst and Lovich 2009. Turtles of the United States and Canada, 2nd ed. John Hopkins University Press, Baltimore, Maryland. 187 pp.). *C. picta bellii* exhibits sexual size dimorphism such that females attain larger carapace lengths than males.

On 2 June 2015 we captured a female *C. picta bellii* in Wascana Marsh in Regina, Saskatchewan, Canada, as part of a radio-telemetry project. The female weighed 2590 g and had a straight-line carapace length of 266 mm. To our knowledge, this is the largest documented carapace length for *C. picta bellii*. The previous record straight-line carapace length was 254 mm as documented by Ernst and Lovich (*op. cit.*), location unknown. Our observation was made in a population near the northern extent of the subspecies' range, where females have been found to mature later and attain larger body sizes than those in southern populations of the species' range (Moll 1973. Herpetologica. 20[4]:307–318; St. Claire et al. 1994. Can. J. Zool. 72:1436–1443).

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***ERETMOCHELYS IMBRICATA* (Hawksbill Turtle). DIET.** *Eretmochelys imbricata* is distributed throughout the tropics where it fills an important ecological role consuming sponges that grow on coral reefs. Here we document *E. imbricata* consuming *Hermodice carunculata* (Bearded Fireworm), a prey item that to our knowledge has not been previously documented for this species. At 1400 on 19 September 2013, while scuba diving under the Frederiksted Pier in Frederiksted, St. Croix, US Virgin Islands, we witnessed a juvenile *E. imbricata* consume *H. carunculata*, which was located on the surface of the seafloor at a depth of approximately 9 m. The turtle consumed the worm in a single bite and did not show an aversion to having consumed it, even though *H. carunculata* possesses bristles that secrete neurotoxins. Before swimming out of view, the turtle continued to forage for 15 minutes on crustaceans that were growing on pier pylons.

Eretmochelys imbricata primarily consumes sponges that possess both physical and chemical defenses composed of toxic compounds and siliceous spicules (Meylan 1988. Science 239: 393–395). The species possesses a specialized digestive system that enables it to eat such prey, which is hazardous to many other animals. This ability to consume toxic items evidently also enables *E. imbricata* to consume polychaetes such as *H. carunculata* that possess chemical defenses. As one of the few species that can consume sponges, *E. imbricata* plays an essential role in preventing sponges from overpopulating reefs, thus helping to maintain reef biodiversity (Leon and Bjorndal 2002. Mar. Ecol. Prog. Ser. 245:249–258). Our observation suggests that *E. imbricata* might also aid in regulating numbers of other toxic invertebrates that have few natural predators.

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***GLYPTEMYS INSCULPTA* (Wood Turtle). NEST PREDATION.** *Glyptemys insculpta* is a riverine turtle species that inhabits the Great Lakes and New England regions of North America, ranging from eastern Minnesota to Nova Scotia (Ernst and Lovich 2009. Turtles of the United States and Canada, 2nd ed. Johns Hopkins Univ. Press, Baltimore, Maryland. 827 pp.). Despite many known mammalian, avian, and reptilian predators (see Ernst and Lovich 2009, *op cit.*), to our knowledge predation by *Taxidea taxus* (American Badger) has not been documented. *T. taxus* is primarily found in the western and central portions of the United States (Long 1999. The Smithsonian Book of North American Mammals, Smithsonian Inst. Press, Washington, D.C., 750 pp.) The ranges of *G. insculpta* and *T. taxus* overlap in portions of Minnesota, Wisconsin, Michigan, Pennsylvania, and southern Ontario.

On 15 June 2015, we documented *G. insculpta* nest predation by two *T. taxus* in Minnesota (specific locations withheld in compliance with state of Minnesota data practices law). The nest predation events were captured by a camera trap (Browning Strike Force HD, BTC-5) from 1820 h until 1923 h, and from 2026 h to 2257 h. The two *T. taxus* dug in the sand where *G. insculpta* had recently laid eggs and consumed eggs that were found. Over 600 pictures captured the entire sequence of events, including an image taken at 1828 h showing *T. taxus* eating one of the excavated eggs (Fig. 1).

Nest predation by *T. taxus* was also documented at a separate site in Minnesota where *G. insculpta* stage and nest. At this site, *T. taxus* was observed digging in the sandy substrate and consuming turtle eggs on 4 June 2015 from 1151 h to 1201 h. Both nest predation sites have been known *G. insculpta* nesting locations since 1990 (Buech et al. 1997. *In* Proceedings: Conservation, Restoration, and Management of Tortoises and Turtles—An International Conference, pp. 389–391. New York Turtle and Tortoise Society, New York). Additional nest predators captured in pictures excavating nests at these nesting sites between May and July 2015 include *Procyon lotor* (Raccoon), *Mephitis mephitis* (Striped Skunk), *Corvus corax* (Common Raven), and *Corvus brachyrhynchos* (American Crow). Other potential nest predators whose presence was captured at nesting sites include *Urocyon cinereoargenteus* (Gray Fox) and *Lontra canadensis* (North American River Otter). *Chelydra serpentina* (Snapping Turtle) and *Chrysemys picta* (Painted Turtle) were also present and nesting in the vicinity. Between the two sites, at least 12 nests were predated within a week of being laid.



FIG. 1. *Taxidea taxus* predating recently laid *Glyptemys insculpta* eggs.

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***GOPHERUS POLYPHEMUS* (Gopher Tortoise). COYOTES DENNING IN GOPHER TORTOISE BURROW.** Gopher tortoises are ecosystem engineers and their burrows are used by a number of taxa including both invertebrate and vertebrate species (Speake 1981. *In* Lohoefener et al. [eds.], The Future of Gopher Tortoise Habitats, pp. 44–47. Proceedings 2nd Annual Meeting Gopher Tortoise Council. Florida State Museum, Gainesville). Over 360 species are known to use *G. polyphemus* burrows and consequently, it is considered to be a keystone species within its ecosystems (Eisenberg 1983. Proceedings of the 4th Annual Meeting of the Gopher Tortoise Council, pp. 1–4). *G. polyphemus* is a state threatened species in Georgia, is a candidate for federal listing in the eastern portion of its range, and is currently a federally listed threatened species in the western portion of its range (USFWS 2009. Federal Register 74:46401–46406).

In a Longleaf Pine (*Pinus palustris*)-dominated forest community at the Joseph W. Jones Ecological Research Center in Newton, Georgia, USA, we documented the use of *G. polyphemus* burrows by *Canis latrans* (Coyote). On 16 July 2012, we received a report of multiple *C. latrans* entering a *G. polyphemus* burrow. Upon investigation, we observed *C. latrans* tracks around the entrance and leading into the burrow. Trail camera photos confirmed the eyewitness account and field sign that a breeding pair of *C. latrans* were denning in the burrow with ≥ 2 pups. There was no evidence that *G. polyphemus* were still using the burrow. Given that coyotes are likely to feed upon many of the vertebrate and invertebrate species that inhabit burrows, including *G. polyphemus* (Moore et al. 2006. Herpetol. Rev. 37:78–79), we assumed the majority of the burrow's inhabitants had been displaced.

Canis latrans is considered a nonnative species in Georgia, having only recently entered the state presumably facilitated by anthropogenic factors; their impacts on native fauna is of great concern to wildlife managers. Although Coyote use of *G. polyphemus* burrows has been documented in the western portion of *G. polyphemus* range, these interactions are novel in Georgia where these species did not co-occur historically (Cox et al. 1987. Ecology and Habitat Protection Needs of Gopher Tortoise [*Gopherus polyphemus*] Populations Found on Lands Slated for Large-scale Development in Florida. Florida Game and Fresh Water Fish Commission Nongame Wildlife Program Technical Report No. 4, Tallahassee). *Canis latrans* might negatively influence *G. polyphemus* and associated burrow communities through direct predation and kleptoparasitism.

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***MACROCHELYS APALACHICOLAE* (Apalachicola Alligator Snapping Turtle). AERIAL BASKING.** The Alligator Snapping

Turtle was recently split into three species (Thomas et al. 2014. Zootaxa 3786:141–165). Observations of basking *Macrochelys* are rare. Carr et al. (2011. IRCF Reptiles & Amphibians. 18:2–5) reviewed nine previously documented basking events and Elsey and Bourgeois (2014. Herpetol. Rev. 45:688–689) recently reported two additional observations. With the exception of Thomas (2009. Herpetol. Rev. 40:336), who reported on *M. suwanniensis* in the Suwannee River, Florida (*M. temminckii* at time of observation), all previously reported aerial basking observations were of *M. temminckii*. Here we report the first two aerial basking observations for the newly recognized *M. apalachicolae*.

On 13 May 2014 at 1603 h EPH and JDM observed an immature *M. apalachicolae* (estimated mass less than 4.5 kg) basking on the Choctawhatchee River, Holmes Co., Florida, USA. The turtle was perched on a willow trunk (*Salix* sp.) that was horizontal to the river surface. The turtle was located about 2 m out from the bank and approximately 0.5 m above the water. The turtle escaped into the water after a photo was taken. Air temperature was approximately 32°C under partly sunny skies.

A second immature *M. apalachicolae* (similar in size to the above) was observed basking by JDM at 1547 h on 21 May 2014 on the Apalachicola River, Liberty Co., Florida, USA. This turtle was perched more than 1 m above the water's surface at the top of a nearly vertical snag located 5 m out from the bank. The turtle was clinging to the snag with the head up, but upon detection it dropped into the river. Air temperature was approximately 32°C under mostly sunny skies.

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***PHRYNOPS TUBEROSUS* (Cotinga River Toad-headed Turtle). PREDATION.** Turtles and their eggs are predated by a wide variety of animals, including many species of mammals. Here we report predation on eggs and hatchlings of *Phrynops tuberosus* by reintroduced monkeys, *Sapajus libidinosus*, in Brazil.

Data was collected on an island (area approximately 8 ha) near the Mae D'Agua dam, municipality of Coremas, state of Paraíba, northeastern Brazil, within the caatinga biome (7.0694°S, 37.9525°W). This study was associated with "Project *Cebus*: Welfare and monitored reintroduction of capuchin monkeys," coordinated by UFRN and the Brazilian Wildlife Rescue Center from the Institute of Environment and Natural and Renewable Resources (CETAS-IBAMA). This project prepares rescued individual Brown Capuchin Monkeys (*Sapajus libidinosus*) for reintroduction, and monitors monkey groups released on islands in areas of known historical occurrence.

In August 2009, a group *S. libidinosus* consisting of 13 individuals (8 males and 5 females) was released and monitored for three consecutive months, for 24 days (eight days per month), totaling 144 h of sampling effort, and over 5 h of effective group observations and data collection. The follow-up protocol includes direct animal focal-scan sampling, recording the animals' foraging and use of space at one-minute intervals. During these observations, predation on eggs and hatchlings of turtles by capuchin monkeys was recorded. Turtle remains were collected and subsequently identified by experts at the Laboratory of Animal Ecophysiology, Department of Systematics and Ecology of the Universidade Federal da Paraíba.

Three events of predation on eggs and young of *Phrynops tuberosus* were observed on 20 September 2009 (approximately 1300 h local time) and two events were noted on 23 October 2009 (at 1211 h and another about 1243 h). This results in a frequency of one predation event / observation hour. In addition, predation traces such as eggshells and damaged turtle shells near the sites of oviposition (Fig. 1) were noted. Although not quantified, qualitative analyses indicate that such events have increased in number over the course of several months. It is noteworthy that no other predator on the island was observed predating turtle eggs or turtles, which reinforces the suggestion that the reintroduced capuchins predated the turtles and their eggs.



FIG. 1. A–B) Brown Capuchin Monkeys (*Sapajus libidinosus*) foraging on the ground. C–D) Eggshells and a broken shell of a young turtle (*Phrynops tuberosus*) found nearby.

Predation on nests and hatchlings of *Phrynops hilarii* and *P. geoffroanus* has been reported (Schneider et al. 2011. Chelon. Conserv. Biol. 10:206–212). However, to date there are no records of predation on turtles in the semiarid caatinga habitat, and this is apparently the first report on predation of *P. tuberosus* nests by the capuchin monkey, *Sapajus libidinosus*.

This report suggests the need for additional studies to measure the impact of reintroduced capuchin monkeys on the population of *P. tuberosus*, as well as on populations of other turtle species that inhabit the release areas. We are grateful to Brazilian Wildlife Rescue Center (CETAS) at Paraíba, Brazil, for logistical support.

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***RHINOCLEMMYS RUBIDA PERIXANTHA* (Colima Wood Turtle). COURTSHIP AND MATING BEHAVIOR.** *Rhinoclemmys rubida perixantha* is a small terrestrial turtle endemic to the tropical deciduous forests of western Mexico, ranging from the states of Jalisco to Michoacán (van Dijk et al. 2007. *In* IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1). No information is available on courtship and mating behavior of *R. rubida* in the wild, however courtship in captive animals has been described for its southern relative *R. r. rubida*, housed at the Behler Chelonian Center, where males are aggressive during courtship, following females in circles while biting the forelimbs, displaying rapid head bobbing (both sexes), and rubbing the head and nostrils of the female (Liu 2012. The Tortoise Magazine 1[1]:59). Here I present the first observations of courtship and mating behavior in wild *R. r. perixantha* in its tropical deciduous forest habitat.

On 10 August 2015 at 1255 h, during the wet season in the lowland tropical deciduous forest of the Chamela-Cuixmala Biosphere Reserve (19.49868°N, 105.04449°W; WGS 84) in Jalisco, Mexico, while monitoring six adult male and six adult female *R. r. perixantha* using radiotelemetry, I observed a male (radio tagged) and female *R. r. perixantha* displaying mating behavior on a flat hilltop in upland deciduous forest. As I approached, both male and female were vigorously bobbing heads while rubbing heads and nostrils; shortly after, the male mounted the female twice, but mating was unsuccessful. After the second mount, both turtles retreated to a nearby tree shelter with the male following the female. Partial video of this behavior was captured and is available for review (http://dx.doi.org/10.6084/m9.figshare.1510910). Prior to this observation, from 29 June to 6 August 2015, turtle pairs (male and female together) were seen on hillsides in upland deciduous forest a total of 21 times with males observed behind females, inactive or following. For six of these observations the same male and female were seen together for a second or third time, however, mating behavior was not observed.

Three phases of courtship and mating behavior have been described in *Rhinoclemmys pulcherimma incisa* (Hidalgo 1982. Trans. Kansas Acad. Sci. 85:82–95). In phase one, the male approaches the female, while vibrating his head and neck; in phase two the female engages the male with nose-to-nose contact and biting, presumably signaling to the male to mount; in phase three, the male mounts the female, grasps her carapace, inserts his penis, and performs pumping motions during coition (Hidalgo 1982, *op. cit.*). If courtship and mating behavior rituals are similar in *R. r. perixantha*, the turtle pair observations most likely correspond to phase one; however, six observations of the same pair of turtles several days apart suggests that this phase may last several days. Furthermore, the observation of mating behavior most likely corresponds to phase two, with the female responding, and the beginning of phase three with the male attempting to mount the female. However, phase three may have been disrupted by my presence, as the pair retreated to a shelter shortly after my arrival.

These observations suggest that courtship may take place over several days, and courtship and mating behavior may be similar for other species of *Rhinoclemmys*. Because this species is considered near threatened (van Dijk 2007, *op. cit.*), future research should focus on habitat requirements for turtle reproduction, which may provide insight on critical habitats that should be protected.

I acknowledge Caleb L. Loughran for revision of this note and continued fruitful and informative conversations on herpetofauna. I also thank Daniel Beck for his moral and logistical support on my excursions to the tropical dry forest of western Mexico.

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***STERNOTHERUS ODORATUS* (Eastern Musk Turtle). PREDATION.** Birds and fish can be important predators of small aquatic turtles, but direct observations may be sparse for some species. This note documents both as predators of the Eastern Musk Turtle.

The remains of an immature *Sternotherus odoratus* (CL 53 mm, PL 39 mm; NPS-SEAC-243.1.1) were recovered from a Channel Catfish (*Ictalurus punctatus*; 2.48 kg, standard length 54 cm, total length 60 cm; NPS-SEAC-190.2.1) collected 16 January 2001 in the St. Johns River, between lakes Harney and Jessup, Seminole County, Florida (28.8263°N, 81.1165°W; WGS 84).

During May 1999 and April–May 2000, staff of a local environmental education center in southern Tallahassee, Leon County, Florida, retrieved shells of a series of *S. odoratus* that were dropped from a Red-shouldered Hawk (*Buteo lineatus*) nest (30.4102°N, 84.3442°W) located 100 m and 125 m from two drying depressions at the edge of Lake Bradford (75 m further, also receding). Ten shells (UF 175575–175584) measured 33.9–83.5 mm CL and 23.6–55.4 mm PL and included small juveniles to relatively large adults; the shell of one female still contained the eggshell of an unlaid egg. At least two additional shells were not retrieved. Similarly depredated shells were observed but not collected in 1997 and 1998. These years were marked by substantial drought, which may have stranded turtles in small, shallow pools, leaving them more susceptible to predation than normal.

Feeding upon post-hatchling non-marine turtles has now been documented for several species of North American predatory birds, often in association with feeding nestlings. Such data exist chiefly for Bald Eagles (*Haliaeetus leucocephalus*), which are known to prey upon *Chrysemys picta* (Wood and Smith 2012. Tenth Ann. Symp. Cons. Biol. Tortoises and Freshwater Turtles: 64), *Clemmys guttata* (Clark 1982. J. Field Ornithol. 53:49–51), *Graptemys barbouri* (Means and Harvey 1999. Florida Field Nat. 27:1), *Malaclemys terrapin* (Clark, *op. cit.*; Wood and Smith, *op. cit.*), *Pseudemys nelsoni* (McEwan 1977. M.S. thesis, Univ. Florida), *Terrapene carolina* (Clark, *op. cit.*), *Kinosternon subrubrum* (Clark, *op. cit.*), *Sternotherus carinatus* (Shively et al. 2011. Herpetol. Rev. 42:423), *S. odoratus* (Clark, *op. cit.*; Wood and Smith, *op. cit.*), *Chelydra serpentina* (Clark, *op. cit.*; Wood and Smith, *op. cit.*), *Apalone ferox* (Pike 2005. Herpetol. Rev. 36:440), and *A. mutica* and *A. spinifera* (Watermolen 2004. Bull. Chicago Herpetol. Soc. 39:69–70; Shively et al., *op. cit.*). Additional reports exist for Red-tailed Hawks, *Buteo jamaicensis* (*Gopherus polyphemus*: Fitzpatrick and Woolfenden 1978. Florida Field Nat. 6:49); Red-shouldered Hawks, *B. lineatus* (*C. picta*: Welch 1987. Passenger Pigeon 49:81–92; *S. odoratus*: Kimmel and Fredrickson 1981. Trans. Missouri Acad. Sci. 15:21–27; *Ch. serpentina*: Stewart 1949. Wilson Bull. 61:26–35); Northern Harriers, *Circus cyaneus* (*K. picta*: Bowne 2002. Herpetol. Rev. 33:132); Snail Kites, *Rostrhamus sociabilis* (*S. odoratus*, *K. baurii*, *A. ferox*, *Pseudemys floridana*, *P. nelsoni*: Beissinger 1990. The Auk 107:327–333); Ospreys, *Pandion haliaetus* (*C. picta*: Postupalski and Kleiman 1965. Wilson Bull. 77:401–402; *P. nelsoni*: Wiley and Lohrer 1973. Wilson Bull. 85:468–470); Gulls, *Larus* sp. (*M. terrapin*: Watkins-Colwell 1997. Herpetol. Rev. 28:87–88); American Crows, *Corvus*

brachyrhynchos (*C. picta*: Baxter-Gilbert et al. 2013. Herpetol. Rev. 44:302–303); and Common Ravens, *Corvus corax* (*C. picta*: Baxter-Gilbert et al., op. cit.; *Gopherus agassizii*: Boarman 2002. U.S. Geol. Surv., West. Ecol. Res. Center, Tech. Rpt). In at least one instance, a *K. subrubrum* was able to avoid predation by a raptor (Bald Eagle) by closing its shell tightly (Mitchell et al. 2006. Herpetol. Rev. 37:216–217). However, this option is unavailable to *Sternotherus* and leaves it vulnerable to predatory birds, as shown above.

Coupled with observations from another recent study (Walsh and Heinrich 2015. Florida Field Nat. 43:79–85), these combined observations confirm that, rather than being isolated incidents, avian predation is a regular source of mortality for non-hatchling aquatic turtles. Although fewer data are available, the same may be true for terrestrial turtles.

I thank staff of the Tallahassee Museum of History and Natural Science for monitoring the hawk nest and retrieving turtle remains, and Mike Russo of the National Park Service for lending the specimen from the catfish.

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***STERNOTHERUS ODORATUS* (Eastern Musk Turtle) and *CHRYSEMYS PICTA* (Painted Turtle). INTERSPECIFIC BASKING.** Aerial basking is generally uncommon in *Sternotherus odoratus* (Ernst and Lovich 2009. Turtles of the United States and Canada, 2nd ed. Johns Hopkins University Press, Baltimore, Maryland. 827 pp.; but see Nickerson 2000. Herpetol. Rev. 31:238–239). Conversely, *Chrysemys picta* are frequent aerial baskers and are often observed basking with conspecifics and occasionally other turtle species (Ernst and Lovich 2009, *op. cit.*). On 30 May 2015 at 1130 h, we observed an adult *S. odoratus* and adult *C. picta* basking in close proximity (ca. 15–20 cm apart) on a log protruding from a canal remnant in the Blue Marsh National Recreation Area, Berks County, Pennsylvania, USA (40.380000°N, 76.031389°W; WGS 84). Both turtles remained on the log and in the same positions during approximately 20 minutes of observation. Although *C. picta* have been noted to display aggressive behaviors (e.g., open-mouthed gestures, biting, and pushing) towards basking conspecifics and other turtle species (Lovich 1988. Herpetologica 44:197–202), we observed no interaction occur between either individual. To our knowledge, interspecific basking has not previously been reported with *S. odoratus* and *C. picta*. Additionally, our observation suggest these species are tolerant toward one another in shared basking locations.

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***TERRAPENE CAROLINA* (Eastern Box Turtle). COLOR AND PATTERN.** Coloration and pattern of *Terrapene carolina* is highly variable, both in shell and skin (Ernst et al. 1994. Turtles of the United States and Canada. Smithsonian Institution Press, Washington DC. 578 pp.; Dodd 2001. North American Box Turtles. A Natural History. University of Oklahoma Press, Norman. 231 pp.). The carapace is typically brownish in ground color with yellow or orange radiating lines, spots, bars, or blotches, and the limbs are usually dark with yellow, orange, or red spots and streaks. Only the plastron is often without pattern, but that too is highly variable (Ernst et al. 1994, *op. cit.*; Dodd 2001, *op. cit.*). On 18 June 2015, a most unusual *T. carolina* (Fig. 1) was observed attempting to excavate a nest in the gravel roadside of McCollum Road, Cherokee Co., Georgia, USA (34.203468°N, 84.492845°W; WGS 84). The individual, an adult female (ca. 130 mm CL), was nearly solid dark brown-black in shell and skin coloration, completely lacking pattern on the carapace, plastron, limbs, and neck. The only noticeable pigmented pattern was a single, small orange spot immediately posterior to each tympanum. Several small, light spots on the carapace represented chips in the epidermal scutes, revealing the lighter bone below rather than actual pigment. I am unaware of any previously published observations of *T. carolina* almost entirely lacking pattern, and in a thorough review of melanism in North American emydids, Lovich et al. (1990. *In* Gibbons [ed.], Life History and Ecology of the Slider Turtle, pp. 233–254. Smithsonian Institution Press, Washington, DC) included no records of this development in *T. carolina*. It seems likely, however, that this individual has displayed this color and lack of pattern its entire life, rather than having become melanistic through ontogeny.



PHOTOS BY JIM BUSCHUR

FIG. 1. Eastern Box Turtle *(Terrapene carolina)* lacking pigmented pattern, with the exception of a single, small orange spot behind the tympanum. Light spots visible on carapace are chips from the epidermal scutes exposing underlying bone.

I thank Brian Folt for reviewing and improving this note.

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***TERRAPENE CAROLINA CAROLINA* (Eastern Box Turtle). HIBERNATION SITE FIDELITY.** Hibernation site fidelity has been reported for *Terrapene c. carolina* on several occasions and in several geographic locations but has not been reported for the state of Tennessee. Ernst and Lovich (2009. Turtles of the United States and Canada. Johns Hopkins University Press, Baltimore, Maryland. 827 pp.) reviewed research suggesting that Eastern Box Turtles return to the same overwintering area across subsequent years. Stickel (1989. J. Herpetol. 23:40–44) found that four *T. c. carolina* in Maryland returned to the general area (within several meters) where they had hibernated during previous winters, but the years in which they returned were not always consecutive. Another study done in Maryland found that two individual *T. c. carolina* showed hibernation site fidelity, returning to the same general area across two consecutive winters (Savva et al. 2010. Can. J. Zool. 88:1086–1094). Similarly, Seibert and Belzer (2015. IRCF Reptiles and Amphibians 22:56–67) reported hibernation site fidelity in *T. c. carolina* introduced into a nature sanctuary in Pennsylvania with at least one individual returning to the exact same hibernation site across two winters. In Ohio, one of three monitored *T. c. carolina* hibernated in the exact same location during two winters (1986–1987 and 1988–1989) with one winter in between (1987–1988) in which it overwintered only 8 m away from the original hibernaculum (Claussen et al. 1991. J. Herpetol. 25:334–341).

Three Eastern Box Turtles were fitted with radio transmitters during the active season of 2013 at Nickajack Wetlands and Black Fox Trace (Nickajack) in Murfreesboro, Tennessee, USA. These turtles were tracked throughout the active season and hibernation period. All hibernacula were marked and monitored throughout the winter until emergence in early April 2014. In the winter of 2014, the hibernacula were reexamined for the presence of turtles. One of the three turtles returned to her exact same hibernaculum (35.800017°N, 86.351117°W; WGS 84) and overwintered there until April 2015.

Selection of the hibernation site is very important for box turtles, leading them to return to successful overwintering sites over multiple years (Dodd 2001. North American Box Turtles: A Natural History. University of Oklahoma Press, Norman, Oklahoma. 231 pp.). However, use of the exact same hibernaculum has been reported only a few times, and hibernation site fidelity has never been reported for Eastern Box Turtles in the state of Tennessee. Currylow (2013. J. Wildl. Manage. 77:326–335) suggests that habitat alteration, such as clear cutting, may impact selection of hibernation sites. Further monitoring is important to see how often this phenomenon occurs and to encourage preservation of ideal hibernation sites that are reused year after year.

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CROCODYLIA — CROCODILIANS

***ALLIGATOR MISSISSIPPIENSIS* (American Alligator). NESTING BY A REINTRODUCED FEMALE.** The state of Louisiana has an alligator management program that includes a commercial alligator farming program (Elsey and Kinler 2004. *In* Crocodiles. Proceedings of the 17th Working Meeting Crocodile Specialist Group, pp. 92–101. IUCN–The World Conservation Union, Gland, Switzerland and Cambridge UK; Elsey 2013. Herpetol. Rev. 44:309–310). The alligator farming program allows for the collection of eggs from the wild, with mandatory release of a portion of juvenile alligators hatched from collected eggs as a "head-start" program to ensure future recruitment (Elsey and Kinler 2011. *In* Global Re-introduction Perspectives: 2011. More Case Studies from around the Globe, pp. 125–129. Gland, Switzerland: IUCN/SSC Re-introduction Specialist Group and Abu Dhabi, UAE: Environment Agency-Abu Dhabi; Elsey 2013, *op. cit.*). The juvenile alligators released from farms are measured, the sex is determined and recorded, and they are marked with monel tags placed between the toes of the hind legs and by tail notching (Elsey and Kinler 2011, *op. cit.*). The juvenile alligators (allowable size range of 91.4–152.4 cm total length [TL] at release) are then released back to the wetlands from which the eggs were collected one or two years earlier (Elsey 2013, *op. cit.*).

An important measure of the success of this program would be documentation of successful reproduction by the reintroduced alligators after release to the wild. We have observed that many of the released juveniles grow to adult size and are subsequently caught in the annual regulated harvest. We documented presumptive morphological evidence that numerous harvested females had reproductive tracts suggesting they had attained sexual maturity and had ovulated (Elsey et al. 2001. *In* Grigg et al. [eds.], Crocodilian Biology and Evolution, pp. 244–255. Surrey Beatty & Sons Pty Ltd, Chipping Norton, NSW). We have also had numerous reports by commercial egg ranchers of sightings of tail-notched alligators defending nests, yet still lack certain confirmation of fertile eggs being deposited by reintroduced alligators. We have previously reported that in the farm-released alligators, nesting can occur earlier and at a younger age and smaller size than native wild specimens (Elsey et al. 2001, *op. cit.*; Elsey 2007. Herpetol. Bull. 102:11–14). We herein present evidence that a farm-released female alligator nested in the wild, and produced fertile eggs, some of which hatched successfully after collection and incubation.

On 28 June 2014 at approximately 0740 h, CW and an associate were collecting alligator eggs on private wetlands in St. Mary Parish, Louisiana via airboat. As a nest was approached, the female alligator was seen on top of the nest. The airboat operator (CW) attempted to abort the approach to the nest so as to not disturb what appeared to be the female possibly in the process of egg deposition; however airboats are not equipped with brakes, and the boat slid toward the nest due to high water conditions. With the boat now adjacent to the nest, the female was closely observed depositing eggs into the nest cavity. Immediately the female alligator was noted to have tail notches, a method of permanently marking the alligator and indicating it had been released to the wild from a farm as described above. During some twenty minutes of observation, approximately 6–8 eggs were deposited. A series of photographs (Fig. 1) and a video clip were taken; providing clear evidence the farm-released female successfully nested. Tail notches present indicated the female had been released from a farm as part of the "head start" reintroduction program, and the year-specific notches appeared to be those used in 1994. All 32 eggs present (the entire clutch) were collected for incubation at a commercial alligator farm.

Although that specific clutch of eggs was not "flagged" for later identification after incubation, we were later able to review



FIG. 1. Female American Alligator depositing eggs into nest on 28 June 2014 in St. Mary Parish, Louisiana, USA. Year-specific permanent tail notches indicated the female was released to the wild in 1994. Video clip of female depositing eggs also available.

egg hatch records from the alligator farm when egg hatching was completed. Only five clutches were collected that day having a clutch size of 32 eggs, and between 24 and 27 eggs hatched in clutches collected that day wherein 32 eggs were incubated. Thus, we were able to document successful hatching (75.0–84.4%) from eggs laid by a farm-raised alligator after release to the wild.

The tail notch indicated the female alligator was released in 1994; thus she was probably 21–22 years old during the 2014 nesting season (alligators released for the "head-start" program must be released within two years of egg collections; Elsey et al. 2001, *op. cit.*). Some alligators occasionally nest in sequential years, and we have some data available on inter-nest interval (Elsey et al. 2008. Southeast. Nat. 7:737–743). Almost certainly the female alligator observed would have nested several times in the twenty years between release in 1994 and the 2014 observation. This lends further support to the conservation benefits of the egg ranching program in Louisiana as this female likely contributed numerous clutches of hatchlings for population recruitment over the years since initial release to the wild.

As previously reported (Elsey et al. 2001, *op. cit.*) it would be advantageous to have additional data as to nest success and egg viability (clutch size, fertility rates, hatch rates, and hatchling survival) of eggs produced by alligators released from farms. Documentation of a farm-released alligator having survived some twenty years and nesting successfully (and presumably having contributed numerous clutches of eggs over that time interval, adding to population sustainability) lends support to the philosophy of sustained use management of this valuable resource. Other species of crocodilians (including *Crocodylus porosus, C. palustris, C. intermedius*, and *Caiman latirostris*) have been studied for evidence of nesting after release to the wild (see references in Elsey et al. 2001, *op. cit.*). Further information may help refine management programs with reintroductions of crocodilians of other species as well.

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***CROCODYLUS ACUTUS* (American Crocodile). LONG DISTANCE JUVENILE MOVEMENT.** *Crocodylus acutus* is the most widely distributed New World crocodilian species with its range extending from Peru in the south to the southern tip of peninsular Florida in the north. *Crocodylus acutus* occupies primarily coastal brackish water habitat, however, it also occurs in freshwater to hypersaline habitats (Thorbjarnarson 2010. *In* S. C. Manolis and C. Stevenson [eds.], Crocodiles. Status Survey and Conservation Action Plan [3rd ed.], pp. 46–53. Crocodile Specialist Group, Darwin). There is limited literature on long-distance movements of juvenile crocodilians worldwide and no literature on juvenile crocodiles in Florida. However, adult *C. acutus* in Florida have been documented to make seasonal movements of 5–15 km from preferred foraging habitat to nesting beaches (Mazzotti 1983. The Ecology of *Crocodylus acutus* in Florida. PhD Dissertation. The Pennsylvania State University, University Park, Pennsylvania. 161 pp.), and one adult was documented making a 35-km trip from her nest site to preferred foraging habitat (Cherkiss et. al. 2006. Herpetol. Rev. 38:72–73). Rodda (1984. Herpetologica 40:444–451) reported on juvenile *C. acutus* movement in Gatun Lake, Panama, and found that juveniles stayed within 1 km of their nest site for the first month. Movements of juvenile *Crocodylus porosus* (Saltwater Crocodile) in a river system in Northern Australia showed a maximum movement of 38.9 km from a known nest site, with the majority of the crocodiles staying within 15.6 km downstream to 6.8 km upstream (Webb and Messel 1978. Aust. Wildl. Res. 5:263–283). Juvenile movement of *Crocodylus niloticus* (Nile Crocodile) in Lake Ngezi, Zimbabwe showed crocodiles restricted their movements from 1.0 km up to

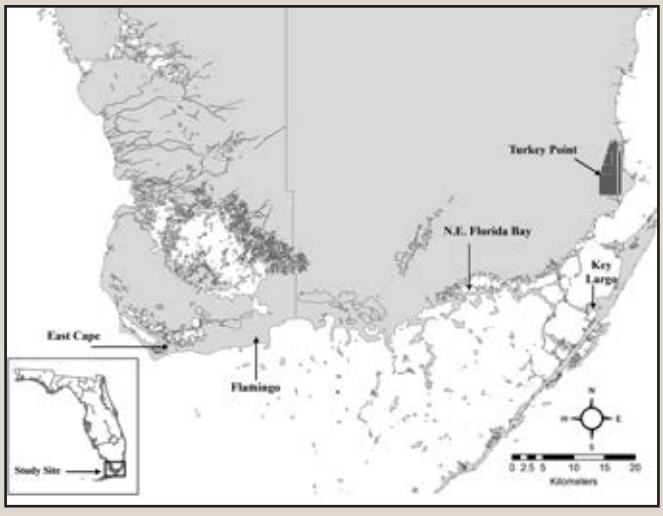


FIG.1 Capture locations for juvenile *Crocodylus acutus* in Florida.

TABLE 1. Initial capture and recapture total length (TL), days, and distance traveled for *Crocodylus acutus* in Florida.

Clip#	Initial / Recapture TL (cm)	Initial Capture Location	Final Capture Location	Days Between Captures	Total distance traveled (km)	Distance traveled (m/day)
809	34.2 /102.0	Chapman Field	N.E. Florida Bay	1646	54.3	30
1361	25.8 / 82.6	Flamingo	Turkey Point	900	59.0	70
2499	23.9 / 96.1	Flamingo	N.E. Florida Bay	1327	34.4	30
3910	26.6 / 40.4	N.E. Florida Bay	Turkey Point	295	34.2	120
4838	25.6 / 101.7	East Cape	Turkey Point	1001	76.3	80
6421	26.9 / 65.2	Flamingo	N.E. Florida Bay	569	36.2	60
6662	26.1 / 93.0	East Cape	Key Largo	584	69.6	120

4.5 km through the wet and dry seasons (Hutton 1989. Am. Zool. 29:1033–1049). Long distance movements of alligators were recorded for sizes ranging from 28 cm to 361 cm in a coastal refuge in Louisiana, where the distance traveled ranged from 0.3 km to 90.2 km. The data showed that the smaller alligators moved greater distance than larger ones (Lance et al. 2011. Southeast. Nat. 10:389–398).

An ongoing 30-year mark and recapture study for *Crocodylus acutus* in Florida allowed us to look at long distance movement (> 30 km) of juveniles (< 1.25 m). Of the 446 individual juvenile crocodiles recaptured, only seven animals demonstrated an exceptional movement (> 30 km). Initial and most recent captures as a juvenile were used to analyze distances moved (Fig. 1). These distances were measured linearly between capture locations. Maximum linear distances of 76.3 km and 69.6 km were recorded for animals 4838 and 6662. All crocodiles moved from nesting habitat through potentially optimal nursery habitat prior to reaching their recapture locations. These juvenile long distance movements could be due to larger crocodiles facilitating their dispersal from the nest location (Lance et al. 2011, *op. cit.*). These data (Table 1) support that there is exchange of individuals among the nesting colonies and our ongoing efforts to monitor this threatened species allow us to make observations of how juvenile crocodiles are moving throughout the landscape in an ecosystem currently undergoing restoration.

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SQUAMATA — LIZARDS

BASILISCUS BASILISCUS **(Common Basilisk). PREDATION.** *Basiliscus basiliscus* are very common in streams, rivers, or lakes of Neotropical lowlands and are important in trophic interactions, as prey or predators. They are subject to predation by a wide array of vertebrates such as birds, large fishes, some mammals, and other reptiles. Rarely, invertebrates such as large crustaceans also predate basilisks (Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna between Two Continents, between Two Seas. University of Chicago Press, Chicago, Illinois. 934 pp.; Flaherty and Friers 2014. Southeast. Nat. 13:N57–N58). Here we describe a predation event on a young *Basiliscus basiliscus* (SVL ca. 7 cm) by an invertebrate, a sub-adult female scorpion, *Opisthacantus elatus* (Scorpiones: Hemiscorpiidae). The event was at 1025 h on 26 August 2014, on the shore of Perresénico River, Estación Rancho Frío in Parque Nacional Darién, Darién, Panamá (8.0198907°N, 77.730486°W, WGS 84; 111 m elev.). The scorpion was 200 cm above the ground and positioned horizontally inside an interstice of a fallen branch, but with the anterior carapace region and the right pedipalp outside and holding with the chela the posterior left leg of the lizard. The lizard made occasional movements forward to escape but the scorpion held strong. We pulled the lizard with herpetological tongs and the scorpion held stronger. *Opisthacantus elatus* has a considerable mechanical strength to trap and manipulate large prey and is found more frequently under rocks or fallen trunks (Álvarez et al. 2013. Rev. Col. Entomol. 39:301–304). We think that the scorpion climbed up the fallen branch to hide and hunt. However, we did not see the scorpion eat the lizard. We captured both animals; the scorpion was deposited in Museo de Invertebrados de la Universidad de Panamá (MIUP) with collection data, but the lizard escaped after capture. Other lizards in the genera *Homonota*, *Podarcis*, *Liolaemus*, and some geckos have been preyed upon by scorpions (Fulvio and Minoli 2014. Cuad. Herpetol. 28:1–2). This is the first observation of a large scorpion trapping young *B. basiliscus*, presumably for predation, and gives insights to consider *O. elatus* as ecological pressure for young basilisks.

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BRASILISCINCUS HEATHI **(Brazilian Mabuya). TAIL BIFURCATION.** Tail bifurcation has been commonly reported for several lizard families worldwide such as Agamidae (Ananjeva and Danov 1991. Amphibia-Reptilia 12:343–356), Diploglossidae (Cozendey et al. 2013. Herpetol. Rev. 44:145–146), Scincidae (e.g., McKelvy and Stark 2012. Herpetol. Rev. 43:138; Mitchell et al. 2012. Herpetol. Rev. 43:650), Teidae (Gogliath et al. 2012. Herpetol. Rev. 43:129), and Tropiduridae (Martins et al. 2013. Herpetol. Notes. 41: 369:371), including bizarre cases of species exhibiting from three to six regenerated tails (Koleska and Jablonski 2015. Ecol. Mont. 3: 26–28; Pelegrin and Leão 2015. Cuad. Herpetol. 30:1–3). Most tail bifurcation observations were reported for a single individual and usually found at low rates within populations (Vrcibradic and Niemeyer 2013. Herpetol. Rev. 44:510–511).

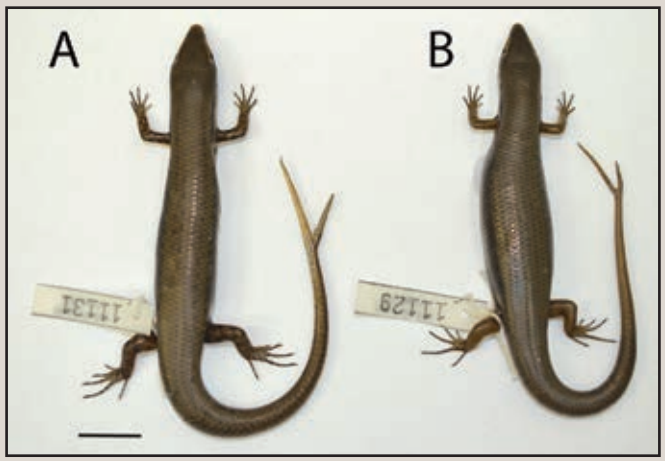


FIG. 1. A) Adult male (AAGARDA 11131), and B) pregnant female (AAGARDA 11129) *Brasiliscincus heathi* exhibiting tail bifurcation. Scale = 10 mm.

Herein, we report the first case of tail bifurcation in multiple individuals within a population of the Neotropical skink *Brasiliscincus heathi*.

During a field survey at Serra das Confusões, Piauí State, Brazil (9.1410°S, 43.5619°W, WSG84; 510 m elev.) in October 2014 we collected two adult *Brasiliscincus heathi* with tail bifurcation from an area of rock outcrops. The first individual, a male (AAGARDA 11131; SVL = 69.8 mm, Fig. 1A) had 22.5 mm of original tail followed by a regenerated portion extending to 47.8 mm before bifurcating into a smaller (8.6 mm) lateral and a larger (15.9 mm) axial branch. The second individual, a pregnant female (AAGARDA 11129; SVL = 64.7 mm, Fig. 1B) had an original (non-regenerated) portion of tail 41 mm long, followed by a regenerated portion extending 29 mm before bifurcating into a smaller lateral (6 mm) and a larger (12 mm) axial branch. Along with these two individuals, we collected 12 more specimens from which 8 exhibited a regenerated tail (not including the specimens with bifid tails). In this case, the frequency of bifurcated tail as a consequence of tail regeneration can be estimated as 20% (2/10).

Vrcibradic and Niemeyer (2013, *op. cit.*) provided an estimation of tail bifurcation for populations of *Notomabuya frenata* and *Psychosaura macrorhyncha* (1.7% and 1.2%, respectively). Such estimations were made through the examination of several individuals (more than 100 specimens) from each species. Although we examined fewer individuals, the elevated frequency found by us (20%) might indicate that this abnormality occurs at a high rate within our studied population or such estimation may be biased due to an insufficient sampling. Nevertheless, this abnormality does not seem to affect the fitness or survival rate of the individuals as a pregnant female was found exhibiting a bifid tail.

We are grateful to Adrian Antonio Garda for suggestions. Collections were made under permit (SISBIO # 46129-1).

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***CALOTES VERSICOLOR* (Oriental Garden Lizard). DIET.** *Calotes versicolor* is among the most geographically widespread members of the genus (Uetz and Hošek 2014. The Reptile Database. http://reptile-database.reptarium.cz, accessed 29 Apr 2014) naturally occurring in Afghanistan, Bangladesh, Bhutan, Cambodia, India, Indonesia (Sumatra), Myanmar, Nepal, Pakistan, Peninsular Malaysia, South East Iran, Singapore, South China, Sri Lanka, Thailand, and Vietnam, and additional introduced populations in Sulawesi, Malaysian Borneo, Maldives, Mauritius, Oman, Seychelles, and USA (Florida) (Enge and Krysko 2004. Florida Sci. 67:226–230; Matyot 2004. Phelsuma 12:35–47; Radder 2006. Curr. Sci. 91:1354–1363). It is a very adaptable, prolific species and is commonly found in human-altered environments including highly urbanized areas (Erdelen 1988. J. Herpetol. 22:42–52). Although it is generally considered an insectivore, field records suggest that it is more an opportunistic omnivore with a wide range of prey. However, such records are often scattered in gray literature and in this review we collate published records and observations of our own and those of our colleagues, and subsequently discuss the possible reasons for dietary breadth.

Our review revealed records of *Calotes versicolor* feeding on members of nine broad faunal groups (annelids, mollusks, insects, myriapods, arachnids, crustaceans, amphibians, reptiles, birds, and mammals) as well as plant matter (Table 1). Insects comprise most of the diet of *C. versicolor*. One of us (HS) observed an adult lizard feeding on a swarm of ants on the ground at a rate of one ant in every five to six seconds for ca. 30 seconds. Sit-and-wait foraging patterns have also been used to catch wasps visiting a puddle of water (Supun Wellappuliarachchi, pers. comm.). *Calotes versicolor* even preys upon large species like the Atlas Moth (*Attacus taprobanis*) (HS, pers. obs.). Additionally, orthopterans, mantodeans, dipterans, odonates, blattodeans, hemipterans, and dermapterans constitute a lesser content in the diet (Rao 1975. Brit. J. Herpetol. 5:467–470; Indurkar and Sabnis 1976. Comp. Physiol. Ecol. 1: 9–12; Sharma and Vazirani 1977. Rec. Zool. Surv. India 73:77–93; Chandra 1983. Plant Protection Bulletin 35:35; Qiu et al. 2001. Zool. Res. 22:367–374). Annelids are a constituent of the diet of *C. versicolor*, but are represented in a low volume in gut contents (Rao 1975, *op. cit.*) which could be due to high digestion rate of soft-bodied prey (Verheyen 1991. Funct. Ecol. 5:507–517; Qu et al. 2011. Curr. Zool. 57: 684–700). RS observed an adult male feeding on a small annelid, *Megascolex coeruleus*, that emerged on the surface soon after a rain. This lizard generally forages on the surface (tree trunks or on ground), but can opportunistically unearth fossorial prey like annelids (Sharma 2002. Cobra 48:14–15). RS observed a sub-adult lizard preying on an asparassid *Heteropoda venatoria* and a failed attempt of an adult female to catch a sub-adult theraphosid *Poecilotheria pedersoni* (before it escaped to a tree hollow) in Sri Lanka.

Several groups of herpetofauna, including amphibians, agamids, geckos, skinks, and snakes are known prey items of *C. versicolor*. Records of feeding on juveniles of other agamids are common. S. Wellappuliarachchi (pers. comm.) observed an adult *C. versicolor* preying upon an injured *C. calotes* (SVL ca. 80–100 mm) after the latter was attacked by a cat. Holding its prey by the belly, the lizard hit the *C. calotes* on a brick wall vigorously several times and then carried it onto the top of a coconut tree. Senanayake (1980. Tiger Paper 7:26–28) reported

TABLE 1. Records of prey items of *Calotes versicolor* (AH: Anthropogenic Habitat; DO: Direct Observation; N/A: Not Available; SC: Stomach Contents).

Prey taxon	Location	Habitat	Evidence	Citations	Notes
ANNELIDS Earthworm	[1]Orissa, India; [2]Rajasthan, India	[1]AH; [2]Forest nursery	[1]SC; [2]DO	[1]Rao 1975; [2]Sharma 2002	[1] size of prey: 65 mm; SVL of lizard: 106 mm
Megascolex coeruleus	Kithulgala, Sri Lanka	Lowland rainforest	DO	Somaweera, pers. obs.	size of prey: ~250 mm; SVL of lizard: > 400 mm
MOLLUSCANS Gastropods	[1]Orissa, India; [2]Tongshi, China	[1]AH; [2]N/A	[1]SC; [2]SC	[1]Rao 1975; [2]Qiu et al. 2001	
INSECTS *Attacus taprobanis* (Sri Lankan Atlas Moth)	Peradeniya, Sri Lanka	AH	DO	Sudasinghe, pers. obs.	size of prey: 220 mm wingspan
Caterpillar of a moth	India	AH	SC	Sharma and Vazirani 1977	
Butterflies	[1]Amarvati, India; [2]India; [3]Tongshi, China	[1]N/A; [2]AH; [3]N/A	[1]SC; [2]SC; [3]SC	[1]Indurkar and Sabnis 1976; [2]Sharma and Vazirani 1977; [3]Qiu, et al. 2001	
Lepidoptera larvae	Orissa, India	AH	SC	Rao 1975	
Beetle (Coleopterans)	[1]Yagirala, Sri lanka; [2]Amarvati, India; [3]India; [4]Orissa, India; [5]Tongshi, China	[1]AH; [2]N/A; [3]AH; [4]AH; [5]N/A	[1]DO; [2]SC; [3]SC; [4]SC; [5]SC	[1]Sudasinghe, pers. obs.; [2]Indurkar and Sabnis 1976; [3]Sharma and Vazirani 1977; [4]Rao 1975; [5]Qiu et al. 2001	
Hemipterans	Tongshi, China	N/A	SC	Qiu, et al. 2001	
Cicadas	Tongshi, China	N/A	SC	Qiu, et al. 2001	
Ants	[1]Weerapokuna, Sri Lanka; [2]Amarvati, India; [3]India; [4]India; [5]Orissa, India; [6]Tongshi, China	[1]AH; [2]N/A; [3]AH; [4]N/A; [5]AH; [6]N/A	[1]DO; [2]SC; [3]SC; [4]N/A; [5]SC; [6]SC	[1]Sudasinghe, pers. obs.; [2]Indurkar and Sabnis 1976; [3]Sharma and Vazirani 1977; [4]Daniel 1983; [5]Rao 1975; [6]Qiu et al. 2001	
Bees	Tongshi, China	N/A	SC	Qiu et al. 2001	
Wasps	[1]Mihintale, Sri Lanka; [2]India; [3]Tongshi, China	[1]Wild; [2]N/A; [3]N/A	[1]DO; SC; [3]SC	[1]S.Wellappuliarachchi, pers. comm.; [2]Bhatti 1988; [3]Qiu et al. 2001	[1]SVL of lizard: ca. 100–120 mm
Termites	[1]Tamilnadu, India; [2]India	[1]Wild; [2]N/A	[1]DO; [2]DO	[1]Manakadan 1993; [2]Parihar 1978	
Grasshoppers	[1]Amarvati, India; [2]Orissa, India; [3]Tongshi, China	[1]N/A; [2]AH; [3]N/A	[1]SC; [2]SC; [3]SC	[1]Indurkar and Sabnis 1976; [2]Rao 1975; [3]Qiu et al. 2001	
Chrotogonus sp. (Grasshopper sp.)	India	N/A	DO	Chandra 1983	
Cockroaches	[1]Amarvati, India; [2]Arugambay, Sri Lanka	[1]N/A; [2]Wild	[1]SC; [2]DO	[1]Indurkar and Sabnis 1976; [2]Naalin Perera, pers. comm.	
Dragonflies	[1]Orissa, India; [2]India; [3]India; [4]Tongshi, China	[1]AH; [2]AH; [3]N/A; 4N/A	[1]SC; [2]SC ; DO; SC	[1]Rao 1975; [2]Sharma and Vazirani 1977; [3]Mitra 1996; [4]Qiu et al. 2001	
Earwigs	[1]Orissa, India;[2]Amarvati, India	[1]AH; [2]N/A	[1]SC; [2]SC	[1]Rao 1975; [2]Indurkar and Sabnis 1976	
Mantises	Tongshi, China	N/A	SC	Qiu et al. 2001	
Dipterans	Tongshi, China	N/A	SC	Qiu et al. 2001	

Table 1. Continued.

Prey taxon	Location	Habitat	Evidence	Citations	Notes
MYRIAPODS Millipedes and centipedes	[1]Amarvati, India; [2]Orissa, India	[1]N/A; [2]AH	[1]SC; [2]SC	[1]Indurkar and Sabnis 1976; [2]Rao 1975	
Scolopendra sp. (centipede)	Assam, India	AH	DO	Kalita 2000	
Rhysida sp. (centipede)	West Bengal, India	N/A	SC	Ahmed 1984	
Proterosperphormage sp. (millipede)	West Bengal, India	N/A	SC	Ahmed 1984	
Siphonophorids	Tongshi, China	N/A	SC	Qiu, et al. 2001	
ARACHNIDS Spiders	[1]India; [2]Orissa, India; [3]Tongshi, China	[1]AH; [2]AH; [3]N/A	[1]SC; [2]SC; [3]SC	[1]Sharma and Vazirani 1977; [2]Rao 1975; [3]Qiu et al. 2001	
Heteropoda venatoria	Kandy, Sri Lanka	Home garden	DO	Somaweera, pers. obs.	size of prey: ca. 30 mm; SVL of lizard: ca. 70 mm
Poecilotheria pedersoni	Bundala, Sri Lanka	Dry scrubland	DO	Somaweera, pers. obs.	size of prey: ca. 70 mm; SVL of lizard: > 300 mm
CRUSTACEANS Isopods	Tongshi, China	N/A	SC	Qiu et al. 2001	
AMPHIBIANS Frogs	India	N/A	N/A	Daniel 1983	
REPTILES Sub-adult *Calotes versicolor*	Jaipur, India	Forestry arboretum	DO	Sharma 1992	TotL of lizard: ca. 330 mm
Juvenile *Calotes versicolor*	Singapore	Urban park	SC	Diong 1994	size of prey: 35 & 45 mm; SVL of lizard: 104 & 110 mm
Calotes calotes (Green Garden Lizard)	Matara, Sri Lanka	AH	DO	S. Wellappuliarachchi, pers. comm.	size of prey: ca. 80–100 mm; SVL of lizard: > 150 mm
Juvenile *Ceratophora stoddarti* (Rhino Horned Lizard)	Sri Lanka	N/A	DO	Senanayake 1980	
Sitana ponticeriana (Fan-throated Lizard)	Sri Lanka	N/A	DO	de Silva 2006	
Hatchlings of *Draco volans* (Flying dragons)	Singapore	N/A	SC	Diong et al. 1994	
Lizard (unidentified)	Orissa, India	AH	SC	Rao 1975	size of prey: 21 mm; SVL of lizard: 92 mm
Hemidactylus brooki (Brook's House Gecko)	Jaipur, India	Forestry arboretum	DO	Sharma 1992	
Hemidactylus sp.(possibly *H. frenatus*)	Mihintale, Sri Lanka	AH	DO	S.Wellappuliarachchi, pers. comm.	size of prey: 100 mm (TotL); SVL of lizard: 150 mm
Hemidactylus leschenaultii (Bark Gecko)	Naula, Sri Lanka	Home garden (on a shed wall)	DO	Somaweera, pers. obs.	size of prey: 120 mm (TotL); TotL of lizard: ca. 350 mm

Table 1. Continued.

Prey taxon	Location	Habitat	Evidence	Citations	Notes
Lankascincus fallax (Common Lanka Skink)	Mihintale, Sri Lanka	AH	DO	S.Wellappuliarachchi, pers. comm.	size of prey: 80–100 mm TotL); SVL of lizard: ca. 140 mm
Xenochropis piscator (Checkered Keelback)	Pune, India	Abandoned quarry	DO	Thite and Nerlekar 2012	size of prey: ca. 80–200 mm (TotL); SVL of lizard: 120 mm
Amphiesma stolatum	Chennai Snake Park, India	wild	DO	Kalaiarasan and Rajarathinam 2005	size of prey: 130–170 mm (TotL)
Lycodon aulicus (Common Wolf Snake)	Rajasthan, India	Forest nursery	DO	Sharma 1998	size of prey: 250 mm (TotL)
BIRDS Eggs of *Ploceus phillipinus* (Baya Weaver) *P. benghalensis* (Black Throated Weaver) *P. manyar* (Streaked Weaver)	Punjab, India	AH	DO	Dhindsa and Toor 1983	
Passer domesticus (House sparrow)	Bombay, India	N/A	DO	Paralkar 1995	
Small birds, nestlings	India	N/A	N/A	Daniel 1983	
MAMMALS *Mus* sp. (Field Mouse)	Sigiriya, Sri lanka	AH	DO	S.Wellappuliarachchi, pers. comm.	size of prey: 40–50 mm (head and body)
ANIMAL EXCRETA Excreta of *Iguana iguana* (Green Iguana)	India	AH	Captivity	Rajarathinam and Kalaiarasan 1999	
PLANT MATTER buds of *Tabarnaemontana* sp.	Bombay, India	National Park	DO	Sekar 1987	
Plant matter of *Dalbergia sissoo, Rosa indica, Gossypium* sp., *Saccharum onunjo, Sorghum, Morus alba, Cyanadon* sp., *Kochia* sp., *Acacia* sp., *Sestrum nocturnion, Sestrum alba,* and flower parts of *Calotrophis procera, Solanum nigrum, Solanum melanogena, Rosa indica, Althea rosea, Malvestrum* sp.	Hansi and Bulandshar, India	N/A	SC	Bhatti et.al. 1988	
fallen dry leaf of *Magnifera indica*	Deola forest range, India	Forest nursery	DO	Sharma 1998	
fallen flowers of *Morinda tinctoria* and flowers of *Cassia marginata*	Chennai snake park, India	AH	DO	Aengals 2000	
Germinating seeds of *Feronia limonia*	Rajasthan, India	Forest nursery	DO	Sharma 1993	
Shoots of *Vigna sinensis* (Cowpea)	Calicut,India	AH	DO	Devasahayam and Devasahayam 1989	
Grass, leaves, twigs	Amarvati,India	N/A	SC	Indurkarand Sabnis 1976	
Grasses, leaves, seeds, twigs	Orissa,India	AH	SC	Rao 1975	
Stones	[1]Amarvati, India; [2]Orissa, India	[1]N/A; AH	[1]SC; SC	[1]Indurkar and Sabnis 1976; [2]Rao 1975	

the Sri Lankan montane agamid *Ceratophora stoddarti* as a prey item of *C. versicolor*. However, currently *Ceratophora stoddarti* and *C. versicolor* are largely allopatric and thus this report seems questionable. Several species of geckos including *Hemidactylus frenatus* (S. Wellappuliarachchi, pers. comm.) and *H. leschenaultii* (RS, pers. obs.) are also taken. Several incidents of these lizards taking small snakes as prey are known from India (Sharma 1998. J. Bombay Nat. Hist. Soc. 96:146–147; Kalaiarasan and Rajarathinam 2005. Cobra 61:16–20; Thite and Nerlekar 2012. Herpetol. Notes 5:518–518). Endotherms are arguably rare in the diet of *C. versicolor*, but they do feed on bird eggs, nestlings, and adult birds (Daniel 1983. The Book of Indian Reptiles. Bombay Natural History Society, Bombay, India; Dhindsa and Toor 1983. J. Bombay Nat. Hist. Soc. 80:221–222; Paralkar 1995. J. Bombay Nat. Hist. Soc. 92:426). S. Wellappuliarachchi (pers. comm.) observed an adult lizard (total length ca. 180–200 mm) feeding on a *Mus* sp. (Field Mouse) in Sri Lanka, taking more than 20 minutes to completely swallow it, during which the lizard frequently squashed the mouse by hitting it on a rock. However, it is uncertain whether the lizard actively caught the live mouse or if the mouse was scavenged.

Plant material is also a known component of the diet. The reason for feeding on plant matter is not clear, but could be for obtaining moisture (Devasahayam and Devasahayam 1989. J. Bombay Nat. Hist. Soc. 86:253) as well as nutrients (Indukar and Sabnis 1976, *op. cit.*), or could reflect secondary or accidental ingestion (Rao 1975, *op. cit.*; Bhatti et al. 1988. J. Bombay Nat. Hist. Soc. 84:692–693). However, active feeding on plant matter has been observed (Sekar 1987. J. Bombay Nat. Hist. Soc. 85:199; Devasahayam and Devasahayam 1989, *op. cit.*; Sharma 1994. J. Bombay Nat. Hist. Soc. 91:150; Sharma 1998. Cobra 34:21–22; Aengals 2000. Cobra 40:18).

Several factors may influence the wide spectrum of food habits known for this species. 1) *Calotes versicolor* is among the most widespread non-gekkonid lizards in the world (Enge and Krysko 2004, *op. cit.*; Matyot 2004, *op. cit.*; Radder 2006, *op. cit.*), thus would encounter and hence could potentially prey on a large range of prey items within its range. 2) It is a relatively large lizard where males may attain 140 mm (SVL) and a total length over 450 mm (Radder et al. 2001. J. Herpetol. 35:156–160). Adults also have large heads with a relatively wide gape. Body size is known to greatly influence many aspects of the morphology, physiology, and ecology of organisms (Meiri 2008. Global Ecol. Biogeog. 17:724–734.), thus prey size as well prey spectrum could vary linearly with the size of the predator allowing them to consume a larger range of prey items. Arguably, this could help them displace populations of smaller competitors (e.g., *Bronchocela cristatella* in Singapore: Diong et al. 1994. Nature Malaysiana 19:46–54). 3) *Calotes versicolor* is commonly observed in anthropogenic habitats including home gardens, parks, plantations, and cities (Somaweera and Somaweera 2009. Lizards of Sri Lanka: A Colour Guide with Field Keys. Chimaira Buchhandelsgesellschaft mbH, Frankfurt am Main. 304 pp.). Individuals often forage on ground, foliage, and on man-made structures, and males often display from fences and other conspicuous perches. Hence the species is more commonly seen, increasing the likelihood of observing foraging behavior. This explains why most feeding observations are anecdotal and opportunistic in man-made environments.

Diet breadth and foraging success are of great importance in understanding the distribution of a predator and to understand its population dynamics and inter-specific interactions (Pitt and Ritchie 2002. Oikos 96:157–163). Coupled with its wide thermal tolerance limits (Qiu et al. 2009. Acta Ecol. Sinica 29:1738–1744) and habitat generalism (Radder 2006, *op. cit.*), a broad diet may have assisted the colonizing success of this species.

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***CHAMAELEO ZEYLANICUS* (Indian Chameleon). CLUTCH SIZE.** Reported clutch size of *Chamaeleo zeylanicus* ranges from 10–33 (Daniel 2002. The Book of Indian Reptiles and Amphibians. Bombay Natural History Society and Oxford University Press, Mumbai. viii + 238 pp.; Das 2002. A Photographic Guide to Snakes and other Reptiles of India. New Holland Publishers [UK] Ltd, London. 144 pp.). One female *Chamaeleo zeylanicus* (357 mm total length) was confiscated at Kolkata, West Bengal, India by authorities on 1 November 2014 and was housed in the Wildlife Rescue Centre, Kolkata. On 3 November 2014 at ca. 1030 h we found a clutch containing 65 eggs in the enclosure. The eggs were laid in a water bowl and a few eggs were drowned and rotten at the time of collection. Egg diameter ranged from 20–21.2 mm in length (mean: 20.54 mm) and 14.9–15.6 mm in width (mean: 15.32 mm). The top of the eggs were marked with a non-toxic marker during collection to avoid turning of eggs and 60 healthy looking eggs were kept in a plastic container (25 cm × 30 cm × 15 cm) with vermiculite as an artificial substrate for incubation. Small holes were made in the lid for circulation of air. The container was kept inside a wooden cupboard. To maintain temperature, external heat source of a 100-watt bulb was used. The bulb was kept on during the night to keep the ambient temperature between 27–30°C. The eggs were sprayed lightly with water when they looked dry.

By February 2015, 31 eggs were rotten. The rotten eggs were removed when found. On 29 May 2015 at ca. 1130 h, after 207 days of incubation, the first hatchling was observed to put its head out from one of the eggs. When it failed to get out by itself after another two hours, it was manually pushed out of the eggshell.



FIG. 1. Clockwise from upper left: Eggs, emergence, healthy hatchlings, and care of weak hatchling of *Chamaeleo zeylanicus*.

The hatchling started moving within a minute and then opened its eyes. It was shifted to a bigger container (25 cm × 36 cm × 27 cm) and was given twigs to climb on. In the next seven days, 18 more eggs hatched at varying times of the day. On 12 June 2015 ca. 2150 h, after 222 days from the date of laying the final hatchling emerged. Smith (1935. The Fauna of British India, Ceylon and Burma. Reptiles and Amphibia, Vol. II.Sauria. Taylor and Francis, London. 440 pp.) noted the clutch size to be 31 and the egg size to be 13 mm × 7 mm. He also mentioned another clutch containing 13 eggs that measured 19 mm × 12 mm. Another study noted the species has an incubation period of eight months and a clutch size of 32–40 with the range of size and weight of the eggs to be 15–22.5 mm × 9–12 mm and 1–2 g (Singh et al. 1984. J. Bombay Nat. Hist. Soc. 81[1]:86–92). Our present report documents the largest clutch size recorded for the species.

The snout–vent length of the hatchlings ranged from 23–32 mm (mean = 27.6 mm) and the tail length ranged from 31–38mm (mean = 34 mm). Singh et al. (1984, *op. cit.*) reported the size of four hatchlings: total length 70–72.5 mm, SVL 30–34.5. The weight of the hatchlings ranged from 0.93–1.8 g (mean = 1.3 g). The weak embryos which still had good amount of yolk inside their umbellica were carefully transferred to disinfected banana leaves to cushion them and were kept in a separate plastic container at room temperature (ca. 31ºC). They recovered within 24–36 h. Some eggs showed pipping but they failed to emerge. These eggs were carefully slit with a scalpel to assist emergence. The remaining nine eggs were kept under observation for another seven days. Then they were cut open. Five of those eggs had fully formed dead embryos. The remaining eggs did not form any embryos and yolk was in liquid state. Twenty eggs were thus successfully hatched.

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***COLEODACTYLUS MERIDIONALIS* (Meridian Gecko). PREDATION.** The lizards of the genus *Coleodactylus* (Sphaerodactylidae) are widely distributed in northeastern South America (Kluge 1995. Amer. Mus. Novit. 3139:1–23). This genus is composed of a complex of small diurnal species that inhabit leaf litter (Ávila-Pires 1995. Zoologische Verhandelingen 299:1–706; Vanzolini 1968. Arq. Zool. 17:1–84). *Coleodactylus meridionalis* is a litter-dweller distributed in the Caatinga and Atlantic Rainforest of northeastern Brazil (Ribeiro et al. 2013. Herpetol. Notes 6:23–27). Here we report a predation event on an individual of *C. meridionalis* (SVL = 26.18 mm; tail length = 20.84 mm; 0.3 g) by *Brasiliscincus heathi* (SVL = 65.96 mm; tail length = 77.8 mm; 6.1 g). On 18 November 2014 at 1611 h, in Serra Grande (6.503499ºS, 35.933579ºW; WGS 84) municipality of Cuité, Paraíba State, northeastern Brazil, during an active search in leaf litter for reptiles, we observed a *C. meridionalis* being preyed upon by a *B. heathi* (Fig. 1). The observation lasted at least five minutes, after which the lizards were collected and subsequently euthanized, fixed with 10% formalin, and deposited at the Coleção Herpetológica da Universidade Regional do Cariri (URCA-H 10.176 and 10.164, respectively). Although *C. meridionalis* has been reported in the diet of *Tropidurus hygomii* (Vargens et al. 2005. Herpetol. Rev. 36:173–174), to our knowledge this is the first record of predation of *C. meridionalis* by *B. heathi*.



FIG. 1. Predation of *Coleodactylus meridionalis* by a *Brasiliscincus heathi*, Paraíba, Brazil.

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***CTENOSAURA OAXACANA* (Oaxacan Spiny-Tailed Iguana). PREDATION.** *Ctenosaura oaxacana* is a critically endangered species distributed in tropical dry forest along the Pacific coast of the Mexican state of Oaxaca (Köhler 2004. IUCN 2013; Köhler and Hasbún 2001. Senckenberg Biol. 81:257–267). As part of an ongoing project to examine *C. oaxacana* habitat use, we radiotracked *C. oaxacana* outfitted with Holohil Ltd. PD-2 transmitters affixed externally at the dorsal base of the tail with the antenna extending anteriorly. On 25 May 2014 and 30 May 2014 in San Pedro Huamelula Municipality, we found one adult female and one adult male radio tagged iguanas (13.5 cm SVL, 20.5 cm tail length, 84 g, and 15.4 cm SVL, 17.5 cm tail length, 107 g, respectively) each ingested by adult female Western Lyre Snakes (*Trimorphodon biscutatus*) (99.8 cm SVL; 18.4 cm tail length; 215 g, and 104.5 cm SVL, 20.5 cm tail length, 292 g, respectively). The *T. biscutatus* were maintained at ambient temperature for 5 and 10 days, respectively, until the transmitter and string attached to iguana scales were defecated (snake mass post-defecation = 175 g and 225 g, respectively). The iguanas represented 48.0% and 47.6% of the snake body mass, and 28.8% and 26.3%, of the total length of the snakes respectively, considering 4 g mass of receiver and glue.

Trimorphodon biscutatus is a mostly terrestrial, nocturnal, active forager known to predate snakes, mammals, and diurnal lizards including *Ctenosaura* (Scott and Norman 1984. Cat. Amer. Amph. Rept. 353.1–353.3). In Costa Rica, *T. biscutatus* is one of the main predators of *C. similis* (Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna between Two Continents, between Two Seas. University of Chicago Press, Chicago, Illinois. 934 pp.). A juvenile *C. pectinata* (30 cm SVL; 46 cm tail length; 405 g) predated by a *T. biscutatus* (150 cm SVL; 25 cm tail length; 1183 g, representing 34.2% of body mass of the snake) proved fatal within 20 minutes of ingestion (Ramírez-Bautista 1992. Herpetol. Rev. 23[3]:82) despite the *C. pectinata* being relatively smaller in size than the *C. oaxacana* predation instances we present here. These observations represent the first reports of *C. oaxacana* being predated by *T. biscutatus* and establish that adults are susceptible to predation by relatively small snakes while in refugia. Our observations also add to the understanding of relative meal size in *T. biscutatus*.

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***LIOLAEMUS TENUIS TENUIS* (Slender Jewel Lizard). NOCTURNAL ACTIVITY.** The highly speciose genus *Liolaemus* is widespread in southern South America but only a few species have been described as human commensals in the way that they survive, proliferate, and colonize urban or suburban areas (Vidal and Labra 2008 [eds.], Herpetología de Chile. Science Verlag Ed., Santiago, Chile. 600 pp.). Despite a remarkable diversity of ecological and biological traits, all species are diurnal. This note documents a case of nocturnal activity in *Liolaemus tenuis tenuis*, a small lizard with a wide distribution in central Chile, but in Argentina is only found in a small area covered with Andean-Patagonian forest, in Neuquén Province (Christie and Sage 2002. Cuad. Herpetol. 16:80–82). The present observation occurred after 2200 h on a wall facing northeast on the main building hallway of Hosteria Piedra Pintada (39.1177°S, 71.0967°W, WGS 84; 1046 m elev.) at Provincial Road 11 (km marker 50), on the southern coast of Pulmari Lake, Alumine Department, Neuquén Province. On 24 January 2013, several lizards (4–5) were observed around an illuminated electric wall lantern, situated ~ 2.50 m above ground and surrounded by branches of an ornamental rose vine. Apparently, they were feeding on insects but when we approached to less than 5 m all but one adult female ran away in different directions. This individual was photographed with a digital camera (Fig. 1) and remained in the same position for ~ 2 minutes until she started moving around the lantern and between vegetation to finally disappear from our view after two or three minutes. Three other smaller individuals were later observed moving near the lamp over the next 15–20 minutes but vine foliage density obscured clear spotting and accurate identification. Our observation occurred on an unusually warm night (> 20°C) and after a hot day that probably warmed the building walls allowing lizards to maintain nocturnal activity. This observation is apparently the first report of nocturnal activity in *L. tenuis tenuis* and probably for the entire genus. Other species of *Liolaemus* may remain active for a brief period after nightfall via thigmothermy on warm substrates but this has only observed in desert species (e.g., *L. darwinii*, *L. olongasta*, *L. koslowskyi*) in the Monte biogeographic region but never in colder regions such as the Andean Patagonian forest.



FIG. 1. A) Adult female of *Liolaemus tenuis tenuis*. B) Lantern and wall where nocturnal activity was observed, white arrow marks exact place were female was photographed.

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***MENETIA GREYII* (Grey's Skink). DIET.** Despite widespread insectivory there are remarkably few records of the species identity of insect dietary items of any Australian lizard species, and little is known of the biology of the minute terrestrial lygosomine skinks of the genus *Menetia*. On 29 October 1990, 1400 h, MP detected a mature adult (SVL 32 mm) *Menetia greyii* Gray, 1845, with complete original tail eating an adult (total length ca. 25 mm) damselfly, *Austrolestes io* (Selys, 1862) (Odonata: Zygoptera: Lestidae), on brick pavers in the brick wall-enclosed backyard (ca. 7 × 3 m) of Unit 1/12 Hannibal Street, Palmyra, metropolitan Perth, Western Australia, Australia (32.038056°S, 115.780278°E, WGS 84; 20 m elev.). When first observed, the *M. greyii* had already swallowed most of the *A. io*, head-first and including all four wings, and it was only detected by ca. 3 mm of the abdomen protruding from the mouth. The *M. greyii* eventually regurgitated the *A. io* after 5–6 minutes, perhaps because of perceived threat due to close proximity and movements of the photographer and disturbance from the camera flash, but more likely due to the *A. io* being too long for the *M. greyii* to swallow completely, as it spent 2–3 minutes attempting to swallow the rest of the abdomen even after we had stopped taking photos. Neither subject was retained. Observations were made on a sunny mid-spring day with no cloud cover or perceptible wind; temperature was not recorded. The *M. greyii* was one of 4–5 adults resident in the yard, which was void of vegetation except for two exotic succulents 20–30 cm high situated at the base of a wall; small populations of two arboreal species, the larger skink *Cryptoblepharus buchanani* and the gecko *Christinus marmoratus*, were present on brick walls of the building by day and night, respectively.

Austrolestes io would therefore appear to be just beyond the upper size-limit of single prey items for adult *Menetia greyii*, although whether there were other prey items in the gut that may

have impeded full swallowing was undetermined; lizards may occasionally attempt to swallow single prey items beyond their gustatory capacity, and then regurgitate the swallowed portion (e.g., the eublepharid gecko *Coleonyx variegatus* with a large road-killed centipede, Gardner and Mendelson 1999. Herpetol. Rev. 30[4]:227), as likely the case in the above observations. Other lizard species have been occasionally reported to deal with relatively large arthropod prey items by disarticulation and then consumption of the portions (e.g., the polychrotid *Anolis uniformis* with large Alate Diptera, Eifler 1995. Herpetol. Rev. 26[4]:204; the teiid *Ameiva ameiva* with large cerambycid beetles, Morato 2012. Herpetol. Rev. 43[3]:328), however this did not occur in the above case. How this strictly terrestrial species was able to secure the *A. io* in the above interaction is unknown (not observed); this may have been by active predation, or opportunistic salvage of an individual killed or injured by another predator such as a bird or spider.

There is a report of *Menetia greyii* hunting insects in a lump of dry branches in Fromes Creek, 2 km W of Banncannia waterhole, Sturt NP, New South Wales (NSW), arid east Australia, but identities of the potential prey were not provided (Henle 1996. Herpetofauna 26[1]:12–25). Gut content analysis of vouchers from two semi-arid localities in southern Australia (N = 85; most from "Erskine Park," Salter Springs, 85 km N of Adelaide; 13 km from coastal Port Gawler, 30 km N of Adelaide) revealed 128 identifiable remains of various small Arthropoda (most Insecta) as dietary items of 44 *M. greyii*, 45% termites (Isoptera), 13% bugs (Hemiptera), 10% ants (Hymenoptera: Apocrita: Formicidae), 9% beetles (Coleoptera), 8% spiders (Arachnida: Aranea), 7% moths (Lepidoptera), and a few flies (Diptera), cockroaches (Blattodea), nymphal grasshoppers (Orthoptera), and pseudoscorpions (Arachnida: Pseudoscorpiones) (Smyth and Smith 1974. J. Herpetol. 8[4]:329–35). More recently, gut content analysis of a larger sample (N = 448) of *Menetia* "*greyi*" [*sic*] from sites in the Great Victoria Desert in arid west Australia (some collected by the present first author) found 468 dietary items in 146 vouchers, comprising (by conversion of proportions of numbers to percentages) 33.1% spiders (Aranea), 22.2% silverfish (Thysanura), 17.7% bugs (Hemiptera), 3.4% beetles (Coleoptera), 3.4% termites (Isoptera), 2.6% ants (Formicidae), 3.0% mites (Arachnida: Acarina), 2.4% grasshoppers (Orthoptera), 1.5% flies (Diptera), 0.9% (proportion given as .004, in error) wasps (Hymenoptera: Apocrita), 0.9% pseudoscorpions (Pseudoscorpiones), 0.6% cockroaches (Blattodea), 0.2% moths (Lepidoptera), 0.2% centipedes (Myriopoda: Chilopoda), 2.1% other Insecta, 4.7% eggs and 1.3% larvae (presumably Insecta), 0.2% unidentified plant remains, and 0.1% unidentified (Pianka 2011. West. Austral. Nat. 28[1]:12–17). Other than ants (resolvable to family), no identities of prey items to species, genus, or family were given in these papers. Both studies found diets comprised of small arthropods, but the range of arthropod orders taken and proportions in diets differed markedly. Most striking, Isoptera were the dominant item in diets in the southern Australia sample, but comprised a low proportion of items in the west Australia sample which instead was dominated by Aranea and Thysanura with the latter dominant by volume (35.3%) but absent in the southern Australia sample; discrepancy in the results of gut content analyses illustrates how diets in the same species may vary between different regions and habitats, and perhaps with year and season. A notable feature in both studies was the apparent absence of prey items in a large proportion of vouchers (ca. 67.41% and 48.24%, respectively). All prey items in both studies were of small size, relative to their predators, however our above record indicates that the range of prey-size taken by *M. greyii* is much greater than previously reported, and may include items of roughly equivalent body length to themselves in diets; although protagonists were not weighed, the mass of the single item would have constituted a major proportion of unfed total body mass of the predator in this interaction. Our record is also notable as the first report of predation by *M. greyii* on Odonata.

Menetia greyii is distributed over most of the Australian mainland except much of Victoria, the southeast coast, the eastern slopes of the Great Dividing Range, and Cape York (Cogger 2014. Reptiles and Amphibians of Australia [7th ed.]. CSIRO Publishing, Collingwood, Victoria, Australia. xxx + 1033 pp.), with apparently isolated populations in the northern Australian Capital Territory (ACT) (Jenkins and Bartell 1980. A Field Guide to Reptiles of the Australian High Country. Inkata Press Proprietary Limited, Melbourne. 2 pp. [unpaginated] + 278 pp.) and the Northern Tablelands of NSW (DCM, unpubl. data); as currently conceived *M. greyii* includes both sexual and parthenogenetic populations. *Austrolestes io* is a disjunctly distributed southern Australian species, present in Tasmania, Victoria, southern ACT, and in the southwest of Western Australia where it is relatively common, but is infrequently encountered and therefore likely sparsely distributed in southeastern Australia (MP, unpubl. data). The current known distributions of the predator and prey species in the above interaction only overlap in southwest Australia with the isolated population of the latter, although known localities of the two species approach in the highlands of the ACT.

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***MICROLOPHUS BIVITTATUS* (Lava Lizard). PREDATION.** On 13 January 2015 at 1138 h we observed an *Ardea alba* (Great Egret) stalk, capture, and consume an adult female *Microlophus bivittatus* in Puerto Baquerizo Moreno, San Cristóbal, Galápagos, Ecuador (0.90336°S, 89.6105°W). The setting was an urban vacant lot with scattered building material and low plants. *M. bivittatus* were conspicuously common in the town, and appeared to be the only available food there for *A. alba*; the close flight distance of *A. alba* in the Galápagos probably contributed to its ability to forage in a busy urban area. *Ardea alba* normally forage in nearshore habitats and are native to San Cristóbal (Fitter et al 2000. Wildlife of the Galápagos, Princeton University Press, Princeton, New Jersey. 254 pp.). The capture and consumption took approximately 20 seconds.

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***OPLURUS CUVIERI CUVIERI* (Madagascan Spiny-tailed Iguana). DIET.** Several studies have shown that *Oplurus cuvieri cuvieri* mainly prey on invertebrates, with a high proportion of those being ants, and also occasionally feeds on plant materials (Delheusy and Bels 1992. J. Exp. Biol. 170:155–186; Randriamahazo and Mori 2012. Curr. Herpetol. 31:8–13). In addition, two reports suggest active predation on nestling birds by *O. c. cuvieri*. Eguchi (2005. *In* Yamagishi [ed.], Social Organization of the Rufous Vanga, pp. 83–104. Kyoto Univ. Press, Kyoto, Japan) observed that



FIG. 1. *Oplurus cuvieri cuvieri* climbed the tree while holding adult *Cinnyris sovimanga*.

an adult *Schetba rufa* (Rufous Vanga) intensively attacked an individual of *O. c. cuvieri* that came close to a nest of the *S. rufa*, and he inferred that *O. c. cuvieri* feeds on nestlings of *S. rufa*. Ito (2013. Herpetol. Rev. 44:678) reported a predation event of *O. c. cuvieri* on a fledgling of *Hypsipetes madagascariensis* (Madagascar Bulbul) that had fallen from its nest. Here, we report a case of active predation on an adult bird by *O. c. cuvieri*.

In Ampijoroa forest of Ankarafantsika National Park, Madagascar, at approximately 1150 h on 2 December 2012, we found a pair of *Cinnyris sovimanga* (Souimanga Sunbird) perching on a branch of a tree approximately 4 m high. An adult male *Oplurus cuvieri cuvieri* (SVL ca. 170 mm) approached the base of the tree and started to climb the trunk. The lizard intermittently climbed up to an approximately 3-m high branch in several minutes. At the branch, the lizard turned toward the birds and slowly came close to them. Then the lizard stepped on another branch and remained motionless for approximately 10 seconds at this position 20 cm behind the birds. At 1205 h, the lizard sprang at the male *C. sovimanga* from the branch and held the bird with its mouth. Although they fell down to the ground together from the branch, the lizard was still holding the bird with its mouth. Immediately after the landing, the lizard ran away to another tree approximately 5 m away and quickly climbed the tree while holding the bird (Fig. 1). Finally, the lizard began to eat the bird on a branch 4 m high. This is the first report on active hunting of adult birds by *O. c. cuvieri*.

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***PHRYNOSOMA CORNUTUM* (Texas Horned Lizard). HABITAT USE.** The combination of high temperatures and low humidity from lack of precipitation, as has happened frequently over the last few years in Oklahoma, USA, can create desiccation cracks in dry, bare clay soil (Morris et al. 1992. Can. Geotech. J. 29:263–277; Peron et al. 2009. Can. Geotech. J. 46:1177–1201; Burmeier et al. 2010. Plant and Soil 333:351–364). This phenomenon occurred on Core Reserve Area 3 (CRA3), a preserved area of tallgrass prairie and woodland on Tinker Air Force Base on the outskirts of Oklahoma City. One of the few remnant populations of *Phrynosoma cornutum* in central Oklahoma occurs on CRA3 (35.415780°N, 97.410975°W; WGS 84), and this population has been studied intensively with visual surveys and radio telemetry (Endriss et al. 2007. Herpetologica 63:320–331; Bogosian et al. 2012. Ecol. Model. 237/238:63–73; Wolf et al. 2013. Herpetologica 69:265–281). We directly observed 10 telemetered *P. cornutum* taking refuge in these drought-induced cracks on multiple occasions during the summer and autumn between 2010 and 2014 (Fig. 1). Several additional *P. cornutum* were suspected of being in cracks based on telemetry signals, but could not be visually confirmed. Various ages of *P. cornutum* were observed using these cracks, including hatchlings (SVL 23–26 mm) and adults of both sexes (SVL 52–72 mm). Cracks were generally only a few centimeters wide at ground level, and the width of the cracks decreased with increasing depth. *P. cornutum* were observed up to 150 mm below ground level. Individuals of all ages were also observed partially



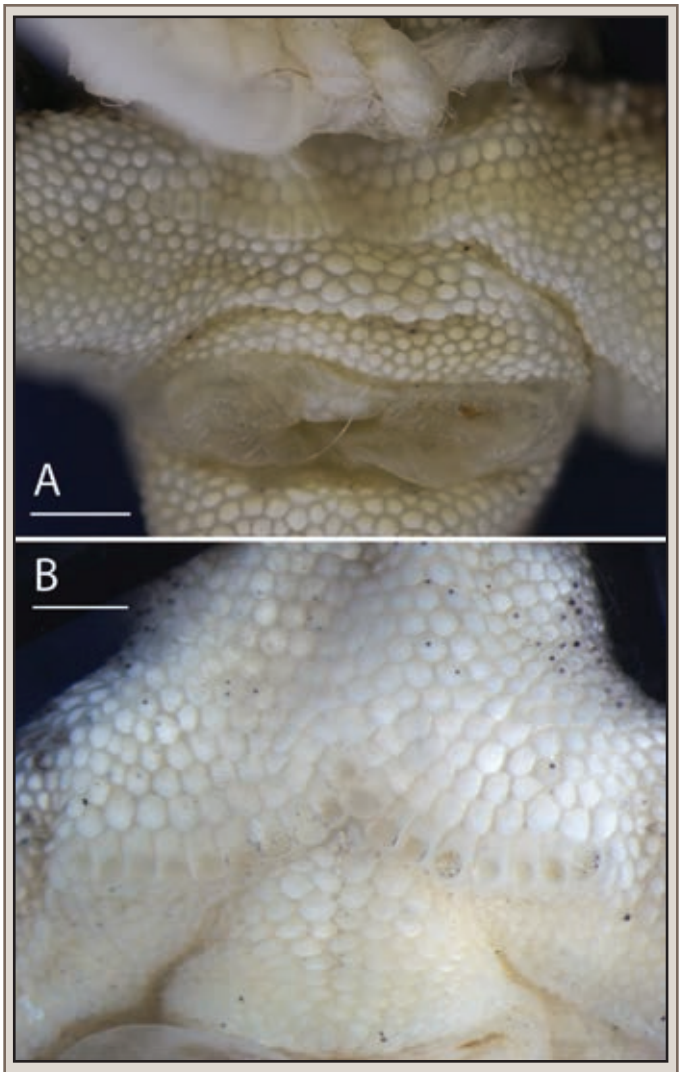
FIG. 1. *Phrynosoma cornutum* utilizing an ephemeral desiccation crack as a refuge.

in or adjacent to cracks, and would seek refuge deeper in cracks upon approach by researchers. Pianka and Parker (1975. Copeia 1975:141–162) suggested that *Phrynosoma* engage in bimodal daily activity patterns during June, July, and August to avoid the heat of the day, which can often exceed 32°C at CRA3. Crack use may represent an escape from heat during summer. However, *P. cornutum* have also been observed using cracks in the autumn during temperatures of 16–21°C suggesting that cracks may also provide refuge from predators, as is indicated by *P. cornutum* seeking shelter in cracks when approached by researchers. To our knowledge, use of desiccation cracks in substrate has not been documented in the literature for *Phrynosoma*, but these refugia seem to represent a valuable, though ephemeral, microhabitat. Such cracks may be especially valuable, given that refugia provided by vegetative cover may be reduced during and soon after times of extreme high heat and low humidity.

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***PSEUDOGEKKO DITOY* (Leyte Diminutive False Gecko). MORPHOLOGY.** *Pseudogekko ditoy* is a recently described, secretive species of gecko known only from the islands of Leyte and Samar in east-central Philippines. Few specimens of this species have been encountered or collected, and as such, researchers have had limited ability to detect morphological variation among individuals. The examination of secondary sexual characteristics has been an important tool used to determine the sex of individuals in this genus. Many secondary sexual characteristics exist among lizards, but a widespread diagnostic character used to differentiate sexes is the presence of enlarged, precloacal or femoral pores. Typically, these pores are used to identify males of a species; however, the presence of precloacal pores in females has been documented in several families, including Lacertidae (Khanoon et al. 2013. Zool. Sci. 30:110–117), Liolaemidae (Valdecantos et al. 2014. Acta Herpetol. 9:147–158), and Gekkonidae. Within the family Gekkonidae, females with precloacal pores have been reported for multiple genera, including *Cyrtodactylus* (Bauer et al. 2010. Zootaxa 2570:41–50; Pauwels et al., 2014. Zootaxa 3755:584–594), *Hemiphyllodactylus* (Zug 2010. Smithson. Contr. Zool. 631:1–70), *Hoplodactylus* (Jewell 2006. Identifying Geckos in Otago. Science & Technical Publishing, Department of Conservation. Wellington, New Zealand. 60 pp.), and *Naultinus* (Jewell 2006, *op cit.*). Herein, we report on the first record of precloacal pores in female *Pseudogekko*.

During a recent biodiversity survey from 1 June to 9 July 2014 on Samar Island in the eastern Philippines, we collected two adult *P. ditoy* on leaf litter near stream systems: a single, gravid, adult female (KU 338507) in Municipality of San Jose de Buan, Western Samar Province, Samar Island, Philippines (12.05262°N, 125.03429°E, WGS 84; 209 m elev.), and a single adult male (KU 338508) in Barangay San Rafael, Municipality of Taft, Eastern Samar Province, Samar Island, Philippines (11.80255°N, 125.29276°E, WGS 84; 140 m elev.). The specimens have 18 (female) and 17 (male) small pores in continuous, precloacal series, which are moderately arched anteromedially. The posterior half of the body on the male specimen is damaged; however, comparisons with the pore series of a previously collected adult male (KU 326438, paratype) shows female pores to be smaller in size than male pores (Fig. 1). Recognizing that this character has been used to determine sex in systematic studies of this genus, with the presence of pores recognized to occur in males only (Siler et al. 2014. Herpetol. Monogr. 28:110–139), caution must be taken in future studies concerning the use of this character to determine sex, and gonadal inspection may be necessary for proper validation. Fieldwork was supported by NSF DEB 0743491 and EF-0334952 to RMB, and NSF DEB 0804115 and IOS 1353683 to CDS.



PHOTOS BY JESSA L. WATTERS

FIG. 1. Photographs of precloacal pore series in preserved specimens of *Pseudogekko ditoy* from the Philippines. A) Adult female (KU 338507; SVL = 49.7 mm) from northern Samar Island. B) Adult male (KU 326438; SVL = 49.4 mm) from southern Leyte Island. Scale bars = 2 mm.

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***SPHAERODACTYLUS BROMELIARUM*. SIZE RECORD.** On 30 January 2005, Ariel Rodríguez and Roberto Alonso collected an adult female and two juveniles of *Sphaerodactylus bromeliarum* inside a bromeliad from Yunque de Baracoa, Baracoa Municipality, Guantánamo Province. The adult female (CZACC 4.5657, Herpetological Collection of the Instituto de Ecología y Sistemática, Havana Province, Cuba) measures 28.1 mm snout–vent length (SVL), and has 41 dorsal and 36 ventral scales between axilla and groin, respectively; 54 scales around midbody and 12 fourth toe lamellae. The previously reported maximum length for this species is 24.0 mm SVL, also in another adult female (Peters and Schwartz 1977. Mitt. Zool. Mus. Berlin 48:393–399).

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***SPHENOMORPHUS SABANUS* (Sabah Slender Skink). REPRODUCTION.** *Sphenomorphus sabanus* is endemic to Borneo, Southeast Asia, where it is found from lowlands to submontane forests (Das 2010. A Field Guide to the Reptiles of South-East Asia, Myanmar, Thailand, Laos, Cambodia, Vietnam, Peninsular Malaysia, Singapore, Sumatra, Borneo, Java, Bali. New Holland Publishers, UK. 376 pp). It is oviparous and produces clutches of 2–3 eggs (Das 2010, *op. cit.*). In this note I add information on the reproductive biology of *S. sabanus* from a histological examination of gonadal material from the herpetology collection of the Field Museum of Natural History (FMNH), Chicago, Illinois.

A sample of 53 *Sphenomorphus sabanus* from Sabah, (5.2500°N, 117.0000°E) Borneo, Malaysia collected 1986 to 1991, consisting of 31 males (mean SVL = 51.1 mm ± 2.7 SD, range = 44–55 mm), 21 females (mean SVL = 51.3 mm ± 2.3 SD, range = 47–55 mm) and one subadult female (SVL = 44 mm) was examined from the following localities: Lahad Datu District FMNH 230137, 230139, 230141, 230143, 230144, 230150, 230153, 235176, 235180, 235183, 246352; Kota Marudu District FMNH 239790, 239791–239794, 239796, 239798, 239799, 239801, 239803, 239804; Tenom District FMNH 239805, 239806, 239808, 239810, 239811, 239813, 239815–239817, 239819, 239821, 239829, 243830, 243832; Lahad Datu District FMNH 240575, 240577, 240578, 240581, 240584, 240586, 240587, 240589; FMNH 243829, 246338, 246343, 246346, 246348, 246351, 246355; Tawu District FMNH 248517, 248519.

A cut was made in the lower abdominal cavity and the left testis or ovary was removed, embedded in paraffin, cut into 5 µm sections and stained with Harris hematoxylin followed by eosin counterstain. Enlarged follicles (> 3 mm) or oviductal eggs were counted. Histology slides were deposited in FMNH.

The only stage present in the testicular cycle was spermiogenesis in which the lumina of the seminiferous tubules were lined by sperm or clusters of metamorphosing spermatids. The following monthly samples of males were examined: June (N = 4); July (N = 4); August (N = 1); September (N = 2); October (N = 2); November (N = 10); December (N = 8). The smallest reproductively active male (spermiogenesis) measured 44 mm SVL (FMNH 230153) and was collected in December.

TABLE 1. Monthly stages in the ovarian cycle of 21 adult *Sphenomorphus sabanus* from Sabah, Malaysia; * indicates one oviductal female each from July, October, and December were also undergoing concurrent yolk deposition for a subsequent egg clutch.

Month	N	Quiescent	Enlarged follicles	Oviductal eggs > 3 mm
June	1	0	1	0
July	3	0	1	2*
August	1	1	0	0
October	5	0	2	3*
November	5	0	1	4
December	6	1	1	4*

Three stages were present in the ovarian cycle (Table 1): (1) quiescent, no yolk deposition; (2) enlarged follicles > 3 mm; (3) oviductal eggs. Three females with oviductal eggs, one each from July (FMNH 239821), October (FMNH 239794) and December (FMNH 240586) contained concurrent vitellogenic follicles indicating *Sphenomorphus sabanus* can produce multiple clutches in the same year. Mean clutch size (N = 19) was 1.9 ± 0.32 SD, range = 1–2. The smallest reproductively active female (one enlarged follicle > 3 mm) measured 47 mm SVL and was collected in June. One smaller female with quiescent ovaries (FMNH 239794) measured 44 mm SVL and was considered to be a subadult.

Because both males and females (Table 1) were reproductively active at opposite ends of the year (June versus December), it is apparent *Sphenomorphus sabanus* exhibits an extended reproductive cycle. Whether *S. sabanus* reproduces throughout the year will require examination of additional specimens.

I thank Alan Resetar (FMNH) for permission to examine *S. sabanus* and L Lee Grismer (LaSierra University, Riverside, California) for taxonomic verification.

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***TARENTOLA MAURITANICA* (Moorish Gecko). EYE DISEASE.** Of approximately 150 specimens of *Tarentola mauritanica* that we examined in Cádiz Province, Spain, between 1969 and 1971, only one was found to exhibit an eye disease. It was collected 15 August 1970, 13.3 km ESE (bearing 95°; 36.137876°N, 5.555630°W, WGS 84; ~305 m elev.) from Facinas in an area currently within the Parque Natural de Los Alcornocales.

Lymphoreticular cells, derived from bone marrow by stem cell multiplication, circulate through the body as monocytes, and differentiate into histiocytes (tissue macrophages) to become part of the body's mononuclear phagocytic system. Scleritis, an inflammatory disease affecting the sclera, and keratitis, a condition in which the cornea becomes inflamed, often results in perforation of the cornea and complete loss of the eye. Hystiocytic and lymphoplasmacytic scleritis and keratitis, coupled with possible secondary glaucoma, were determined to be responsible for the malady evident in the specimen illustrated (Fig. 1; Histology Report 87059/A, 30 July 2014; Department of Pathology, Necropsy and Forensic Medicine, University of Agricultural Sciences and Veterinary Medicine, Cluj-Napoca, Romania).

Anomalies and eye diseases of captive reptiles have been reviewed in the literature of veterinary medicine (Millichamp et al.

PHOTOS A & B BY S. D. BUSACK; PHOTOS C & D BY G. M. BORZA

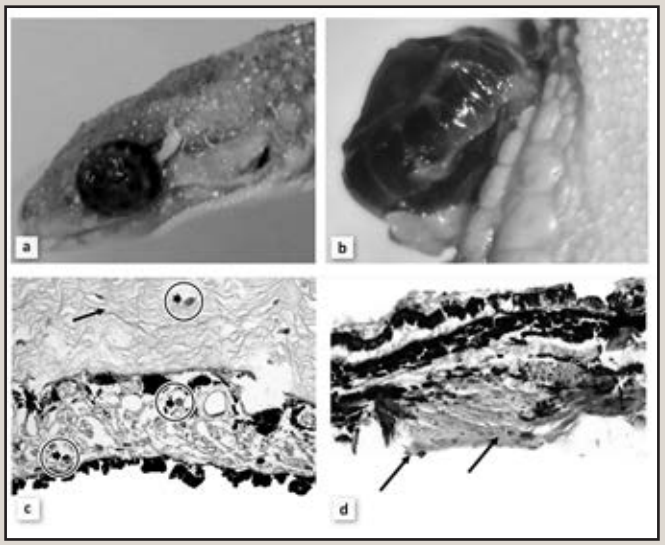


FIG. 1. a) Hystiocytic and lymphoplasmacytic scleritis and keratitis in left eye of a *Tarentola mauritanica* (UCM 44970); b) enlarged ventral view; c) thickened corneal tissue (elongated arrow) with inflammatory cells (encircled arrows) present in the sclera and choroid; d) keratitis with presence of inflammatory cells (arrows).

1983. J. Amer. Vet. Med. Assoc. 183:1205–1212; Sabater and Pérez 2013. Vet. Ophthalmol. 16:47–55) but no information regarding occurrences in natural environments is readily available. This condition was not addressed within either review and, to our knowledge, has not been recorded previously.

We are indebted to Christy McCain and Emily Braker at the Museum of Natural History, University of Colorado, for the loan of the specimen, permission to excise and examine the eye, and for placing several photographs showing different views of this condition in the museum's collections. Liz Bradford (OX•HIP Studio, Raleigh) prepared Fig. 1.

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SQUAMATA — SNAKES

***AGKISTRODON CONTORTRIX* (Copperhead). DIET.** *Agkistrodon contortrix* is a medium-sized pit-viper found in the eastern United States (Ernst and Ernst 2002. Snakes of the United States and Canada. Smithsonian Institution Press, Washington D.C. 661 pp.) that feeds on a variety of prey, including mammals, birds, reptiles, amphibians, and a variety of invertebrates (Fitch 1960. Univ. Kansas Publ. Mus. Nat. Hist. 13:85–288; Gloyd and Conant 1990. Snakes of the *Agkistrodon* Complex: A Monographic Review. Society for the Study of Amphibians and Reptiles, Oxford, Ohio. 614 pp.). The only species of whiptail (genus *Aspidoscelis*) explicitly reported in the diet of *A. contortrix* is *A. sexlineatus* (Six-lined Racerunner). Here we report an unusual predation event and a novel prey item (*Aspidoscelis gularis*; Common Spotted Whiptail) in the diet.



FIG. 1. *Agkistrodon contortrix* holding both leaves and the autotomized tail of an *Aspidoscelis gularis* in its mouth.

At 1600 h on 27 May 2015, we were walking on a nature trail behind the westbound I-10 Guadalupe County Rest Area in Guadalupe Co., Texas, USA (29.616486°N, 97.805625°W; WGS 84). As we walked, we startled several *Aspidoscelis gularis*, which ran off the trail. One small whiptail ran directly towards a coiled *A. contortrix*, which struck at it. This happened very quickly and we had not noticed the snake beforehand, so we did not have an opportunity to observe the interaction in detail, but the snake must have made contact with the lizard's tail, which autotomized. The lizard immediately ran off at a ~90° angle to the snake, away from the path, and we lost track of it. The snake's mouth had closed over both the lizard's tail, which thrashed vigorously, and the nearby leaves of a small herbaceous plant. Momentarily, the snake was able to partially open its mouth and withdraw its jaws from the plant leaves without dropping the still-moving tail, which it then jaw-walked and, eventually, swallowed.

Consumption of autotomized lizard tails has been documented in snakes, particularly from the stomachs of preserved museum specimens (Greene 1983. Am. Zool. 23:431–441). Medel et al. (1988. Oikos 53:321–324) suggested that tail autotomy represented inefficient predation by snakes and other predators, but when autotomized tails are consumed (as in this case) predators do obtain some nutrition from even a botched predation event. Unpublished data being collected by G. Salmon and H. W. Greene also document *A. gularis* in the diet of *A. contortrix* in central Texas.

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***AGKISTRODON PISCIVORUS CONANTI* (Florida Cottonmouth). DIET.** *Agkistrodon piscivorus* is a dietary generalist,

having been documented eating a diverse array of taxa (Ernst and Ernst 2011. Venomous Reptiles of the United States, Canada, and Northern Mexico, Vol. 1. Johns Hopkins University Press, Baltimore, Maryland. 352 pp.). In peninsular Florida, *A. p. conanti* lives in sympatry with many nonnative species, some of which have the potential to be included in its wide diet.

On 11 May 2014, at approximately 1100 h, an *A. p. conanti* (total length ca. 38 cm) was observed actively foraging in a shallow pool at the base of a culvert in the Everglades National Park, Miami-Dade Co., Florida, USA (25.519900°N, 80.567023°W; WGS 84). The snake proceeded to capture and swallow headfirst a small (ca. 15 cm) *Clarias batrachus* (Walking Catfish). After swallowing the fish, the snake remained immobile for approximately 15 min. and then left the pool.

This is the first documented instance of *A. p. conanti* feeding upon the nonnative *C. batrachus*. With up to 60 species of nonnative fish species documented in the greater Everglades drainage (Nico and Fuller 1999. Fisheries 24:16–27), it is likely that resident *A. p. conanti* frequently utilize nonnative fish as a food resource. *Clarias batrachus* can potentially be a difficult prey species to subdue, having stinging dorsal and pectoral spines (Ng and Kottelat 2008. Zool. J. Linn. Soc., 153:725-732). Krysko et al. (2010. Herpetol. Rev. 41:348–349) captured an unusually lethargic *Caiman crocodilus*, and attributed the atypical behavior to the *C. batrachus* later found to be lodged in its throat. Being that *A. p. conanti* is a well-known predator of native ictalurid catfishes with similar dorsal and pectoral spines (Ernst and Ernst, *op. cit.*), it is possible that *A. p. conanti* is not susceptible to these anti-predatory morphological traits.

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***BOTHROPS LEUCURUS* (Whitetail Lancehead). DIET.** *Bothrops leucurus* is a medium-sized, terrestrial, viperid snake of the *B. atrox* group that is found in the Atlantic Forest of northeastern and eastern Brazil (Campbell and Lamar 2004. The Venomous Reptiles of the Western Hemisphere. Cornell Univ. Press, Ithaca, New York. 870 pp.). The diet of this species consists of small vertebrates with an ontogenetic shift from frog and lizard prey as juveniles to rodents as adults (Lira-da-Silva 2009. Gaz. Med. Bahia 79:56–65).

On 14 June 2012, an adult female *B. leucurus* was collected in Trilha Ecológica do Clube Granjeiro (7.165166°S, 39.261562°W, WGS 84; 708 m elev.), located in the foothills of the Chapada do Araripe, municipality of Crato, Ceará, northeastern Brazil. The snake (SVL = 844 mm; tail length = 126 mm; 325 g) was euthanized and during the fixing process expelled an adult male *Atractus ronnie* (Fig. 1; SVL = 212 mm; Tail length = 28 mm; 6.2 g). Both the *B. leucurus* and the *A. ronnie* were deposited in the Coleção Herpetológica da Universidade Regional do Cariri (URCA-H 3478, 6204, respectively).

Atractus ronnie is a small snake distributed in areas of Atlantic forest in the semiarid Caatinga in Serra de Baturité, Planalto da Ibiapaba and Chapada do Araripe, state of Ceará, Brazil (Passos et al. 2007. Copeia 2007:788–797; Loebmann et al. 2009. Biotemas 22:169–173), and is listed as Endangered by the IUCN – the World Conservation Union (IUCN 2015. IUCN Red List of Threatened Species. Version 2015.1. <www.iucnredlist.org> 09 June 2015). Ophiophagy is rare in *B. leucurus*, with only one snake, *Micrurus corallinus*, recorded as prey (Fagundes et al. 2009. Bol. Mus. Biol. Mello Leitão 25:67–71).



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FIG. 1. *Atractus ronnie* preyed upon by a *Bothrops leucurus* collected at Trilha do Granjeiro municipality of Crato, Ceará, Brazil.

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***BOTHROPS JARARACA* (Jararaca). PREDATION.** The genus *Bothrops* comprises ca. 40 species that use cryptic coloration and potent venom as defenses against predators (Sasa et al. 2009. Toxicon 54:904–922). Therefore, we know little about natural predators of free-living *Bothrops*. Occasional records of predators include birds, snakes, and mammals (Sazima 1992. *In* Campbell and Brodie [eds.], Biology of Pitvipers, pp. 199–216. Selva, Tyler, Texas; Sasa et al., *op. cit.*).

Here we report a case of predation on *Bothrops jararaca* in Parque Estadual da Ilha Grande (23.1781°S, 44.1860°W, WGS 84; 23 m elev.), an island of Atlantic forest southeast of Rio de Janeiro, Brazil. On 29 September 2014, at 0900 h, LMV observed a *Buteogallus lacernulatus* (White-necked Hawk) hunting in the litter of secondary forest. The hawk then flew up with a snake in its talons and perched on a branch ca. 3 m high above the ground (Fig. 1). The hawk held the snake by its neck and after ca. 5 min. flew away with the snake in its talons. The snake was identified as *B. jararaca* by the spot coloration pattern typical of the species (Sazima 1988. Mem. Inst. Butantan 50:83–89). Considering that the tarsus of *B. lacernulatus* is ca. 80 mm in length (M.A.S. Alves, unpubl. data), we estimate that the snake was an adult of at least 60 cm in total length.

There are records of predation on *B. jararaca* by *Clelia plumbea* (Mussurana; Pinto and Lema 2002. Iheringia, Zool. 92:9–19) and *Didelphis albiventris* (White-eared Opossum; Oliveira

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FIG. 1. An adult *Bothrops jararaca* held in the talons of *Buteogallus lacernulatus* (White-necked Hawk).

and Santori 1999. Stud Neotrop. Fauna E 34:72–75), but the only known avian predators are *Rupornis magnirostris* (Roadside Hawk; Sazima 1992, *op. cit.*), *Buteogallus urubitinga* (Great Black Hawk; Carvalho 2006. Rev. Bras. Ornitol. 14:445–448), and *Geranoaetus albicaudatus* (White-tailed Hawk; Motta et al. 2010. Biota Neotrop. 10:355–159). The diet of *B. lacernulatus* is not well known, but is thought to be variable. Although arthropods may predominate, there are reports of consumption of snakes and other vertebrates by this hawk (Thiollay 1994. *In* del Hoyo et al. [eds.], Handbook of the Birds of the World, vol. 2, pp. 52–205. Lynx Editions, Barcelona). However, our record is the first to identify a snake preyed upon by *B. lacernulatus* to species level.

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***CLELIA SCYTALINA* (Mexican Snake-eater) DIET.** *Clelia scytalina* is known to consume snakes, frogs, and lizards (García and Ceballos 1994. Guía de Campo de los Reptiles y Anfibios de la Costa de Jalisco, México. Fundación Ecológica de Cuixmala AC, Instituto de Biología, UNAM, México. 184 pp.; Pérez-Higareda et al. 2007. Serpientes de la Región de los Tuxtlas, Veracruz, México.



FIG. 1. Juvenile *Clelia scytalina* with four partially digested *Peromyscus maniculatus* (North American Deer Mice).

Guía de Identificación Ilustrada. UNAM, México. 189 pp.). Herein we report the first account of a *C. scytalina* consuming *Peromyscus maniculatus* (North American Deermouse) from the municipality of Cuauhtemoc, Colima, Mexico.

On 07 August 2014, a juvenile *C. scytalina* was found dead on the Cuauhtemoc–Buenavista freeway in the municipality of Cuauhtemoc, Colima, Mexico (19.292922°N, 103.595868°W, WGS 84; elev. 790 m). While the snake was being preserved, four partly-digested young *P. maniculatus* (identified by the shape of the skull and the feet in the most intact individual) were found in the stomach (Fig. 1). The freeway where the snake was found is surrounded by patches of tropical deciduous forest and sugar cane and rice fields.

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***COLUBER CONSTRICTOR* (North American Racer). FORAGING BEHAVIOR.** Observations of non-marine snakes foraging in intertidal areas are rare. On 10 May 2015, at 1330 h, a *Coluber constrictor* was observed actively foraging within the intertidal zone (Fig. 1) at the north end of Christy Beach on the west end of Santa Cruz Island, California, USA. This is the only documented record of *C. constrictor* foraging within the intertidal zone. *Coluber constrictor* is found throughout much of California, but is recorded from only one California Island—Santa Cruz (Schoenherr et al. 1999. Natural History of the Islands of California. Univ. California Press, Berkeley. 491 pp.). Observations of *C. constrictor* are relatively rare even in upland regions of the island, and conferring

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FIG. 1. *Coluber constrictor* hunting within the intertidal zone on West Santa Cruz Island, California, USA.

with island biologists who have worked on the island for over 30 years, *C. constrictor* has never been observed in the intertidal region. Four years of record drought and increased competition with other wildlife such as the recovering population (N = 1200) of the Federally Endangered *Urocyon littoralis santacruzae* (Santa Cruz Island Fox) are suspected of driving *C. constrictor* to forage within the more productive intertidal habitats along the coast of the island due to the lack of prey in terrestrial habitats. This individual was observed tracking *Tegula* sp. (turban snails) and *Pachygrapsus crassipes* (Rock Shore Crab) as they moved across pools within the intertidal; however, no feeding was observed.

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COLUBER FLAGELLUM **[=** ***MASTICOPHIS FLAGELLUM*****] (Coachwhip). ULTRAVIOLET (UVB) EXPOSURE.** *Coluber flagellum* is an active diurnal snake that thermoregulates to maintain a relatively stable body temperature (≈ 32°C) when active (Hammerson 1989. J. Therm. Biol. 14:219–224; Secor and Nagy 1994. Ecology 75:1600–1614). In spring and autumn *C. flagellum* basks in the sun upon emergence in the morning to raise its body temperature and then maintains its body temperature at a steady level throughout the day by moving among thermal microenvironments. During the summer months in more open desert habitats *C. flagellum* retreats underground during the middle of the day (Jones and Whitford 1989. Southwest. Nat. 34:460–467). Although the thermal environment and thermoregulation has been investigated for this species, its exposure to solar ultraviolet-B (UVB) to our knowledge remains unreported in the literature. While basking in the sun is an important source of heat for many diurnal lizards and snakes during thermoregulation, it also exposes them to UVB radiation. The effects of UVB exposure can be both detrimental, causing tissue damage (Chang and Zheng 2003. J. Photochem. Photobiol. B 72:79–85), and beneficial, facilitating vitamin D production (Ferguson et al. 2005. Physiol. Biochem. Zool. 78:193–200; Acierno et al. 2008. Am. J. Vet. Res. 69:294–297). Knowledge of the natural UVB environment is important from the point of view of conservation and captive management of amphibians and reptiles (Antwis and Browne 2009. Comp. Biochem. Physiol. A 154:184–190; Ferguson et al. 2010. Zoo Biol. 29:317–334).

During field studies in West Texas and New Mexico from 2008 through 2012, we recorded the UVB exposure and environmental temperatures of ten *C. flagellum* during the day (Table 1). UVB irradiance was measured using two hand-held broad-band UVB meters, the Solarmeter 6.2 (displays µW / cm^2), and Solarmeter 6.5 (displays ultraviolet index [UVI]) (Solartech, Inc. Harrison Township, Michigan). These meters are sensitive to irradiance within the UV range (280–400 nm) and respond most strongly to wave lengths in the UVB range below 320 nm. We took readings by placing the base of the unit on the substrate and orienting the flat sensor disk on the top of the unit (≈ 10.8 cm from the base) toward the sun or to the adjacent open sky. We obtained substrate temperature (T_s) holding a digital infrared thermometer (Raytek PM-30' Santa Cruz, California) within 5-cm of the substrate and air temperatures (T_a), holding a cloacal thermometer (Miller and Weber, Inc., Ridgewood, New York), with bulb shaded, 5-cm above the substrate. The cloacal thermometer was also used to record cloacal body temperature (T_b; for one snake only).

The average UV index of exposure during the day was 4.69 with a median of 3.15 (Table 1). This is the highest voluntary

TABLE 1. Temperature and ultraviolet light exposure of ten *Coluber flagellum* encountered in Texas and New Mexico. T_s = substrate temperature (°C); T_a = air temperature (°C); T_b = body temperature (°C). All data were recorded at the exact site of discovery of each snake. All snakes were immobile when first sighted except the last one.

Date	Time	Location	T_s	T_a	UVB (µW cm^{-2})	UVI	Notes
14 Aug 2008	0930 h	Brisco Co. TX	32.8		120.00	1.90	hatchling on tarmac
14 Aug 2008	0940 h	Brisco Co. TX	31.2		148.00	2.30	hatchling on tarmac
18 June 2009	1151 h	Cottle Co., TX	43.0	34.0	310.00	7.70	adult on gravel clay road
26 May 2010	1644 h	Cottle Co., TX	33.4	26.7	110.00	2.00	small adult on dirt road; cloud covering sun
26 May 2010	1700 h	Cottle Co., TX	32.2	23.9	122.00	1.90	juvenile on dirt road; cloud covering sun
17 June 2010	1830 h	Cottle Co., TX	41.8	35.7	82.00	1.20	adult on dirt road
29 April 2012	1143 h	Chavez Co., NM	34.4	27.2	321.00	7.10	juvenile on dirt road
29 April 2012	1208 h	Chavez Co., NM	34.6	27.8	354.00	8.20	adult on dirt road
30 April 2012	1315 h	Chavez Co., NM		31.0	414.00	10.60	juvenile on plant; T_b = 36.2°C
5 May 2012	1025 h	Cottle Co., TX	38.0	32.5	225.00	4.00	adult slowly crossing dirt road
Mean			35.7	29.9	220.60	4.69	
SD			4.3	4.1	120.11	3.39	

exposure yet recorded for a diurnally active snake and the median value qualifies it as a UVB zone-4 species (see Ferguson et al. 2010, *op. cit.* for definition of the four UVB zones, zone-4 being the highest).

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COLUBER TAENIATUS **[=** ***MASTICOPHIS TAENIATUS*****] (Striped Whipsnake). RAIN-HARVESTING.** Rain-harvesting behavior—the collection and consumption of water (rain or condensation from fog) on the body or from environmental surfaces—has been reported in lizards (e.g., Schwenk and Greene 1987. J. Herpetol. 21:134–139; Sherbrooke 1990. J. Herpetol. 24:302–308; Sherbrooke 1993. J. Herpetol. 27:270–275; Peterson 1998. Southwest. Nat. 43:391–394; Veselý and Modrý 2002. J. Herpetol. 36:311–314; Sherbrooke 2004. Amphibia-Reptilia 25:29–39), several species of viperid snakes (Robinson and Hughes 1978. Ann. Transvaal Mus. 31:189–193; Aird and Aird 1990. Bull. Chicago Herpetol. Soc. 25:217; Ashton and Johnson 1998. Herpetol. Rev. 29:170; Andrade and Abe 2000. Amphibia-Reptilia 21:485–492; Cardwell 2006. Herpetol. Rev. 37:142–144; Rorabaugh 2007. Sonoran Herpetol. 20[12]:128–129; Repp and Schuett 2008. Southwest. Nat. 53[1]:108–114; Glaudas 2009. Southwest. Nat. 54[4]:518–521; Mata-Silva et al. 2014. Southwest. Nat. 59[2]:303–304; Murray and Irish 2015. Herpetol. Rev. 46[2]:266), and one natricid snake (Miller 1985. Herpetol. Rev. 16:71). Nearly all of these reports were for species occurring in xeric environments.

On 10 September 2011, at 2130 h during a thunderstorm, RP encountered an adult (Total length ≤ 1 m) *Masticophis taeniatus* on a paved road ca. 21 km ENE of Big Pine on the xeric western slopes of the White Mountains, Inyo Co., California, USA. The snake had not been on the road 30 min earlier when RP passed this location. The snake was observed with its head directed upward and mouth agape. It appeared to be capturing large raindrops, which were then swallowed. *Masticophis taeniatus* is a diurnal species, whose nocturnal activity was presumably triggered by this rare late-summer rainfall event. To our knowledge, previous reports of rain-harvesting in snakes have mostly involved viperids that drank water that had accumulated in the depressions formed by a tightly coiled body.

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CROTALUS DURISSUS **(South American Rattlesnake). SWIMMING BEHAVIOR TO CROSS GEOGRAPHICAL BARRIER.** *Crotalus durissus* is the only rattlesnake found in South America (Wüster et al. 2005. Mol. Ecol. 14:1095–1108). Divided into five subspecies in Brazil (SBH 2015. Sociedade Brasileira de Herpetologia), this savannah-associated species is invading disturbed areas of other biomes, including the Atlantic Forest (Bastos et al. 2005. Rev. Bras. Zool. 22:812–815). Rivers are strong geographical barriers for many species (Ribas et al. 2011. Proc. R. Soc. B. 1729:681–689). However, phylogenetic inferences showed that this species has low genetic divergence between populations across its wide distribution (Wüster et al. 2005. Mol. Ecol. 14:1095–1108). On 4 April 2015 at 1207 h we observed a *C. durrisus* crossing the Rio Grande (49.258578°W, 20.256825°S; WGS 84), municipality of Fronteira, state of Minas Gerais, southeastern Brazil, which is 310 m wide at that point. Although rattlesnakes are known to be adept swimmers, this snake's willingness to cross such a large expanse of open water provides direct evidence for these features not being a strong geographical barrier for this species.



MAP BY LUCAS FERRANTE; PHOTO BY RAFAEL MENEGUCCI

FIG. 1. Observation point of *Crotalus durissus* in Rio Grande River, state of Minas Gerais, Brazil.

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CROTALUS HORRIDUS **(Timber Rattlesnake). DIET.** The diet of the predominantly terrestrial *Crotalus horridus* is composed mostly of small mammals; birds make up only a small percentage of known prey items (Clark 2002. J. Herpetol. 36:494–499, Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Books, Washington D.C. 668 pp.). Herein, we report the first documented instances of *C. horridus* predation on two bird species, *Molothrus ater* (Brown-headed Cowbird) and *Cardinalis cardinalis* (Northern Cardinal). Both observations occurred 8.3 km NNW of Pembroke, Bulloch Co., Georgia, USA (32.210084°N,



FIG. 1. Adult *Crotalus horridus* from Bulloch Co., Georgia, consuming a *Molothrus ater* (Brown-headed Cowbird).

81.633875°W; WGS 84). At 1755 h on 17 May 2012, GH observed an adult *C. horridus* (SVL = ca. 95 cm) kill and consume an adult *M. ater* (Fig. 1). The bird was initially ambushed and struck by the snake inside a small children's plastic pool where the snake sat coiled in ca. 1.5 cm of water. The *M. ater* died approximately 1 m from where it was struck by the snake. Approximately 2 min after the strike, the snake left the pool and crawled to the now dead bird and ingested it.

At the same locality at 0850 h on 30 August 2014, GH observed an adult male *C. horridus* (SVL = ca. 120 cm) kill and consume a *C. cardinalis*. In this instance, the rattlesnake ambushed the bird on the ground beneath a hanging bird feeder. The bird died nearly instantly ca. 1 m from the snake. Approximately 10 min after the bite, the snake crawled to the bird and ate it. After striking mammalian prey, *C. horridus* will typically release the animal and later begin a chemical search to locate and consume it. Presumably it is more difficult to conduct a chemical search to locate potentially airborne avian prey. Thus, it is interesting that both birds in the current observation were released, but injected with enough venom to prohibit them from traveling far from where they were struck.

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***CROTALUS HORRIDUS* (Timber Rattlesnake), *AGKISTRODON CONTORTRIX* (Copperhead), *THAMNOPHIS SIRTALIS* (Common Gartersnake), *NERODIA SIPEDON* (Northern Watersnake), *DIADOPHIS PUNCTATUS* (Ring-necked snake), *STORERIA DEKAYI* (Dekay's Brownsnake). AGGREGATION.** On 12 days between 28 July and 2 October 2009, I watched up to six snake species simultaneously occupy a single hollow log (Figs. 1, 2), 0.8 km from the start of the Little River Trail within the Great Smoky Mountains National Park, Tennessee, USA. Eleven total snakes was the greatest daily emergence (Fig. 2) and although no snakes were captured, all appeared to be mature adult size. On 25 August 2009, I saw what I believed to be the resident rattlesnake (same color and size), dead along the stream's edge. Some large single-species aggregations of snakes are well-known and are usually related to mating or hibernation (Gregory et al. 1987. *In* Seigel et al. [eds], Snakes: Ecology and Evolutionary Biology, pp. 366–395. Macmillan, New York; Ford and Burghardt 1993. *In* Seigel and Collins [eds], Snakes: Ecology and Behavior, pp. 117–164. McGraw-Hill, New York), but intraspecific aggregations and social behavior of snakes are poorly understood. Given that this aggregation occurred during the summer and included multiple species that feed on a wide array of different prey, thermoregulation or protective cover are potential drivers of this aggregation.

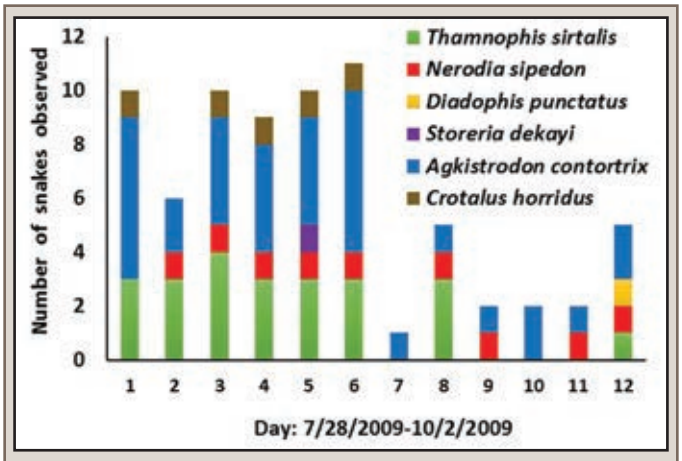


FIG. 2. Daily observations of snakes at the "Snake Log," Great Smoky Mountains National Park, Tennessee, USA, in 2009.

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***CROTALUS OREGANUS HELLERI* (Southern Pacific Rattlesnake). DIET / SCAVENGING.** *Crotalus oreganus helleri* is a large pitviper found in southwestern California, USA, and adjacent Mexico (Ernst and Ernst 2002. Snakes of the United States and Canada. Smithsonian Institution Press, Washington D.C. 661 pp.), and feeds mostly on endotherms, especially mammals. Here we report evidence that, like other pitvipers, including *C. o. oreganus* (Dornburg and Weaver 2009. Northwest. Nat. 90:55–57) and *C. o. lutosus* (Diller 1990. J. Herpetol. 24:95–97), *C. o. helleri* sometimes scavenges dead prey in the wild.



FIG 1. *Crotalus horridus*, *Thamnophis sirtalis*, and *Agkistrodon contortrix* emerging from the "Snake Log," Great Smoky Mountains National Park, Tennessee, USA in 2009



FIG. 1. *Crotalus oreganus helleri* scavenging posterior portion of a *Sylvilagus bachmani* (Western Brush Rabbit) carcass.

At 1500 h one day in late March 2009, one of us (JMG) found and photographed an adult *C. o. helleri* feeding on the posterior portion of a *Sylvilagus bachmani* (Western Brush Rabbit) carcass at Simi Valley, Ventura Co., California, USA (34.223611°N, 118.777778°W; WGS 84). The snake was at the edge of a fire road underneath a probable hawk perch. The rabbit had clearly been killed and partially eaten by another predator, likely a hawk, because its intestines, forelimbs, and head were missing, and the exposed flesh of the rabbit was visibly dry. The snake continued ingesting the carcass despite becoming agitated, and was left alone.

Carrion feeding by wild snakes has been documented numerous times, particularly in pit vipers (DeVault and Krochmal 2002. Herpetologica 4:429–436). Most of these observations involve scavenging of road-killed carcasses (e.g., Durso et al. 2010. Herpetol. Rev. 41:94), whereas this appears to be an instance of scavenging a natural carcass. Most scavenging events are probably overlooked because scavenged carcasses are difficult to differentiate from live prey. Snakes' exceptionally low metabolic demands make it possible for them to capitalize on irregular, low-risk meals in a way that may be unrealistic for many endothermic predators.

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***CRYPTOPHIS NIGRESCENS* (Eastern Small-eyed Snake). DIET.** Small Australian elapids such as *Cryptophis nigrescens* are rarely encountered consuming novel prey items. Most of these smaller species feed on a variety of skinks; however individuals have occasionally been detected preying on larger serpentiforms such as the legless lizard *Pygopus lepidopodus* (Michael et al. 2014. Vic. Nat. 131:186–187). Even rarer is opportunistic ophiophagy. To our knowledge only one study documents this. Shine (1984. J. Herpetol. 18:33–39) analyzed gut contents of *C. nigrescens* museum specimens from across the species range. Of 560 specimens, only one Queensland specimen contained an unidentified species of blindsnake.

On 17 January 2015 at 0125 h (20°C, several hours after light rain), we observed a *C. nigrescens* (total length ca. 60 cm) along a stretch of unsealed road in the Myall River State Forest (32.380°S, 152.137°E, WGS 84; 62 m elev.) near Bulahdelah, New South Wales, Australia. On closer inspection, the *C. nigrescens* was biting an *Anilios nigrescens* (= *Ramphotyphlops nigrescens*) (total length ca. 25 cm) mid-body. The blindsnake was already dead, suggesting successful envenomation. When we approached, the *C. nigrescens* fled a short distance with the blindsnake in its mouth. Once undisturbed, it proceeded to swallow the blindsnake head first over the course of ca. 3 min (Fig. 1). This observation highlights the broad diet of *C. nigrescens*, and allowed us to verify the species of blindsnake predated. This is the second recorded observation of blindsnakes as a diet item and the first time it has been recorded in New South Wales, Australia.



FIG. 1. *Cryptophis nigrescens* consuming an *Anilios nigrescens* in Myall River State Forest, New South Wales, Australia.

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***DENDRELAPHIS SCHOKARI* (Schokar's Bronzeback). PREDATION.** Colubrid snakes of the genus *Dendrelaphis* range from Pakistan in the west, to the northern and eastern coast of Australia in the east and south, and to southern China in the north. They are slender, diurnal, and arboreal snakes that mainly feed on lizards and amphibians (Van Rooijen and Vogel 2008. Contrib. Zool. 77:33–43). *Ceylonthelphusa sentosa* is an endemic, Least Concern (LC), species of freshwater crab found in southern part (Galle) of Sri Lanka (Bahir et al. 2005. Raffles Bull. Zool. 12:47–75). On 14 December 2014, around 1355 h, in a stream in the Ritigala Strict Nature Reserve (SNR), Sri Lanka (8.1050°N, 80.6591°E, WGS 84; elev. 576 m), we observed an adult *C. sentosa* (6 cm carapace width) holding on to the tail of an adult *D. schokari* (total length ca. 55 cm; Fig. 1). The snake was trying to escape from the crab by vigorous body movements. We observed this struggle for nearly 5 min and in the end the crab tried to drag the snake to its hole (Fig. 1). However, due to our presence, the crab was disturbed and released the snake's tail. According to our literature survey, this seems to be the second record (Greene 1997. Snakes: the Evolution of Mystery in Nature. University of California Press,



FIG. 1. A) Adult *Ceylonthelphusa sentosa* trying to drag *Dendrelaphis schokari* in to its burrow. B). *Dendrelaphis schokari* trying to escape from the crab.

Berkeley, California. 99 pp.) of an attempted predation of a snake by a freshwater crab.

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***DIPSAS CATESBYI* (Catesby's Snail-eater). DEFENSIVE BEHAVIOR.** Snakes can exhibit a suite of defensive behaviors to protect themselves against a wide variety of predators (Greene 1979. Experientia 35:747–748). *Dipsas catesbyi* is a nocturnal arboreal dipsadid snake found in humid tropical forest from lowlands to mountainous areas, including forest edges (Kornacker et al. 2010. *In* The IUCN Red List of Threatened Species 2010. <www.iucnredlist.org> Accessed 28 March 2015). This species is widely distributed in the Amazon region, and has an isolated population in the Atlantic Forest of southeastern Bahia, Brazil (Argôlo 2004. As Serpentes dos Cacauais do Sudeste da Bahia. Editus, Ilhéus, Bahia. 260 pp.). On 26 March 2015, at 0015 h, we encountered an adult *D. catesbyi* on the forest floor of an area of Atlantic Forest at Michelin Ecological Reserve (13.816667°S, 39.133333°W; SAD 69), Igrapiúna municipality, Bahia, Brazil. The *D. castebyi* first displayed immobility, followed by dorsoventral flattening of the body. When touched, the snake raised the anterior portion of the body (ca. 200 mm), keeping the body flattened and expanding its head to simulate a triangular shape (Fig. 1). The snake held this position for several minutes while moving, always trying to escape. Head elevation and triangulation tend to be more common defensive behaviors in arboreal snake species, whereas dorsoventral body depression is more common in terrestrial species (Martins et al. 2008. South Am. J. Herpetol. 3:58–67). Dorsoventral flattening has been recorded in other arboreal *Dipsas* species: *D. indica* and *D. pavonina* (Martins and Oliveira 1998. Herpetol. Nat. Hist. 6:78–150). The only previously reported defensive behavior of *D. catesbyi* was head triangulation (Cadle and Myers 2003. Am. Mus. Novit. 3409:1–47).



FIG. 1. Defensive behavior of *Dipsas catesbyi*: A) dorsoventral flattening followed by raising of the anterior portion of the body; B) detail of the head triangulation.

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***ERYTHROLAMPRUS MILIARIS* (Watersnake). PREDATION.** Fishes are uncommonly cited as predators of snakes (Greene 1997. Snakes: the Evolution of Mystery in Nature. University of California Press, Berkeley. 351 pp.). On 28 April 2015 at 1600 h, an adult of the predatory fish *Hoplias malabaricus* (Trahira; Characiformes: Erythrinidae; Total length = 405 mm; mass = 1000 g) was caught in an artificial pond surrounded by Atlantic Forest at municipality of Registro, São Paulo State, Brazil (24.2836°S, 47.5510°W, WGS 84; 46 m elev.). During dissection we found a juvenile *Erythrolamprus miliaris* (SVL = 225 mm; Tail length = 40 mm; 6.6 g) in the stomach (Fig. 1). Considering the broad distribution of this predator in South America (Oyakawa 2003. *In* Reis et al. [eds.], Check List of the Freshwater Fishes of South and Central America, pp. 238–240. Edipucrs, Porto Alegre) as well as the distribution and habitat preferences of *E. miliaris* (Gans 1964. Am. Mus. Novit. 2178:1–58; Michaud and Dixon 1989. Herpetol. Rev. 20:39–41), this may not be a rare event. Both predator and prey were deposited in the Ichthyology collection of the UNESP, Campus Registro (CIR 002 and CIR 003, respectively), State of São Paulo, Brazil.

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FIG. 1. *Hoplias malabaricus* (Characiformes: Erythrinidae) with *Erythrolamprus miliaris* that it had consumed.

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***FURINA TRISTIS* (Brown-headed snake). DIET.** *Furina tristis* is a small (<1 m), poorly known elapid found in northeastern Australia and southern Papua New Guinea. A single study has examined the life-history attributes and gut content of 37 specimens held in the collections of Australian museums (Shine 1981. J. Herpetol. 15:219–224). Of these specimens, only four prey items were recovered, all of which were scincid lizards.

At 2012 h on 05 March 2015 (air temperature 25°C), we observed a male *F. tristis* (total length = 82 cm; 131 g) crossing a road within semi-deciduous mesophyll vine forest in the Lockerbie scrub (10.768°S, 142.503°E, WGS 84; 94 m elev.) Cape York Peninsula, Queensland, Australia. The *F. tristis* was holding a dead *Anilios* (*Ramphotyphlops*) *polygrammicus* (gravid female; total length = 49 cm; 46 g) in its mouth at mid-body. The *F. tristis* attempted to escape with the blindsnake when approached, but dropped it after moving several meters. Upon closer inspection, we observed that the blindsnake had several wounds along its body, including on the head and tail. The wounds were very deep and wide, and were unlikely to have been inflicted by the snake (which would be expected to make a series of small punctures; Fig 1). Because of these wound characteristics we are confident that the blindsnake was dead when the *F. tristis* found it. Given the size and shape of the wounds inflicted on the blind snake we hypothesize that it was attacked by a rodent.

A review of literature for wild snakes exhibiting scavenging behavior recorded 26 species representing five families, only one of which was an elapid (*Pseudechis australis*; DeVault and Krochmal. 2002. Herpetologica. 58:429–436). Known blindsnake predators are *Vermicella annulata* (Bandy-bandy Snakes; Shine 1980. J. Herpetol. 14:71–77), owls (Gehlbach and Baldridge 1987. Oecol. 71:560–563), toads (Pizzatto et. al. 2012. Herpetol. Rev. 43:469–470), and potentially rodents (based on our observation). This note is important because it identifies a novel prey item for *F. tristis* and reveals scavenging behavior in this species, although it is unknown with what regularity this behavior occurs.



FIG. 1. Wounds inflicted on *Anilios polygrammicus* left: anterior body, middle: tail/vent, right: head.

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***GEOPHIS RHODOGASTER* (Rosebelly Earth Snake). REPRODUCTION.** *Geophis rhodogaster* occurs at intermediate elevations from southern Chiapas, Mexico to southwestern Honduras and northwestern El Salvador (McCranie 2011. The Snakes of Honduras, Systematics, Distribution, and Conservation. Society for the Study of Amphibians and Reptiles, Ithaca, New York. 714 pp.). I know of no reports on the reproduction of *G. rhodogaster* other than that it is oviparous (McCranie, *op. cit.*). In this note I report results of a histological examination of gonadal material from *G. rhodogaster* museum specimens.

A sample of 36 adult *G. rhodogaster* consisting of 19 males (mean SVL = 213.4 mm ± 14.9 SD, range = 181–240 mm) and 17 females (mean SVL = 239.1 mm ± 15.9 SD, range = 216–267 mm) collected between 6 July and 4 August 1965 in Guatemala, Departamento Chimaltenango, Acatenango Volcano, Quisache (14.5008°N, 90.8758°W, WGS 84, elev. ca. 1750 m) and deposited in the University of Colorado Museum of Natural History (UCM), Boulder, Colorado, USA was examined: UCM 30673, 30680, 30682, 30684, 30687–30689, 30693, 30696, 30701, 30705– 30707, 30710, 30711, 30713, 30717, 30719, 30720, 30725, 30726, 30729–30735, 30739, 30743, 30745–30748, 30755, 30773. The lower part of the body cavity was opened and the left testis or ovary was removed, embedded in paraffin, histological sections were cut at 5 µm and stained by Harris hematoxylin followed by eosin counterstain. Histology slides are deposited at UCM.

All 19 *G. rhodogaster* males were undergoing spermiogenesis in which the seminiferous tubules were lined by sperm or groups of metamorphosing spermatids. Three males exhibited late spermiogenesis in which the germinal epithelium was reduced to a few layers of spermatogenic cells. These males (UCM 30696, 30720, 30730) were likely near the close of sperm formation. Goldberg (2006. Herpetol. Rev. 37:351) similarly reported all seven *G. semidoliatus* males collected in July from Veracruz, Mexico exhibited spermiogenesis. The smallest reproductively active *G. rhodogaster* male measured 181 mm SVL (UCM 30734).

The mean SVL of the female sample was significantly larger than that of the male sample (unpaired t-test, $t = 5.1$, $df = 34$, $p = < 0.0001$). Two stages were present in the ovarian cycle: 1) quiescent, no yolk deposition; 2) early yolk deposition (basophilic vitellogenic granules in ooplasm). Seventy-six percent (13/17) of females exhibited early yolk deposition. This large number of females in the same stage of the ovarian cycle (early vitellogenesis), from a limited time period (6 July to 4 August), suggests a high level of synchrony in the ovarian cycle of *G.* rhodogaster. The smallest reproductively active female (early yolk deposition) measured 220 mm SVL (UCM 30706).

I thank Christy McCain (UCM) for permission to examine *G. rhodogaster* and Emily M. Braker (UCM) for facilitating the loan.

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***HETERODON KENNERLYI* (Mexican Hog-nosed Snake). MAXIMUM SIZE.** The maximum size reported for *Heterodon kennerlyi* for the state of New Mexico is 760 mm total length (Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. University of New Mexico Press, Albuquerque. 431 pp.). On 10 June 2015 at 1005 h, a large female *H. kennerlyi* was encountered moving along an access road along the eastern periphery of the main dune field outside of White Sands National Monument proper, Otero Co., New Mexico, USA. The snake measured 705 mm SVL, 795 mm total length and weighed 301 g. This record exceeds the maximum recorded total length for the species in New Mexico

by 35 mm (5%). The snake was released at point of capture the following day.

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***HETERODON NASICUS* (Plains Hog-nosed Snake). DIET.** *Heterodon nasicus* uses both olfactory and visual cues to find its prey: toads, reptiles, smaller snakes, and small turtles and their eggs (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Books, Washington, D.C. 668 pp.). On 6 June 2000, a *H. nasicus* was observed on a roadside in the Pawnee National Grassland (Weld Co, Colorado, USA; 40.6824°N, 104.4859°W, WGS 84; elev. 1557 m). The snake had seized a *Phrynosoma hernandesi* (Greater Short-Horned Lizard) by the lizard's head (Fig. 1). In response to the attack, the lizard inflated its lungs. *H. nasicus* have large and flexible mouths with rear fangs and are mildly venomous, adaptations that facilitate eating inflated toads. However, the lizard managed to briefly free itself from its head-first position in the snake's mouth. The snake quickly repositioned itself and seized the torso directly behind the prey's right foreleg. The lizard remained inflated. With the lizard secured in this position, the snake moved (2.5 m) from the roadside into vegetation where it eventually repositioned the unresponsive lizard before ingesting it. Elapsed time was approximately 3.25 h. Ernst and Ernst (*op. cit.*) report "*Phrynosoma* sp." as a prey item of *H. nasicus*. To our knowledge, this is the first photograph-verified record of a *P. hernandesi* as confirmed prey in the diet of *H. nasicus*.



FIG. 1. *Heterodon nasicus* predation of *Phrynosoma hernandesi* in Colorado, USA.

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***LAMPROPELTIS HOLBROOKI* (Speckled Kingsnake). DIET / OPHIOPHAGY.** Previous diet studies on *Lampropeltis holbrooki* have found that they prey on a multitude of animals including venomous and non-venomous snakes, lizards, turtles, reptile eggs, nestling and fledgling birds, mice and rats (Ernst and Barbour 1989. Snakes of Eastern North America. George Mason University Press, Fairfax, Virginia. 282 pp.). Herein, we report on the first incidence of *L. holbrooki* feeding on *Virginia striatula* (Rough Earthsnake).



FIG. 1. Posterior half of *Virginia striatula* extending from the body of *Lampropeltis holbrooki*.

On 17 April 2015 we collected a road-killed female *Lampropeltis holbrooki* (SVL = 696 mm; tail length = 96 mm) 4.0 km N of Ravenden Springs on Upper Jane's Creek Road, Randolph Co., Arkansas, USA (36.33362°N, 91.23387°W, NAD 83; elev. 169 m). The stomach had been split open, revealing the tail of a partially digested *V. striatula* (Fig. 1; SVL = 250 mm; tail length = 42 mm). This record is not surprising, given that *L. holbrooki* are known to feed on *Virginia valeriae* (Smooth Earthsnake; Viosca 1918. *In* Dundee and Rossman 1989. The Amphibians and Reptiles of Louisiana. Louisiana University Press, Baton Rouge, Louisiana. 300 pp.) and that both *Lampropeltis calligaster rhombomaculata* (Mole Kingsnake) and *L. elapsoides* (Scarlet Kingsnake) have been known to prey on *V. striatula* (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens, Georgia. 600 pp.). Both snakes were deposited in the Arkansas State University Museum of Zoology Herpetological Collection (ASUMZ 33346, 33347, respectively), Arkansas State University, Arkansas, USA.

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***LAMPROPELTIS ZONATA* (California Mountain Kingsnake). PREDATION.** Predation of *Lampropeltis zonata* in the wild has rarely been observed, with other species of snakes (*L. californiae, Diadophis punctatus*) as the only documented predators (Staub et al. 2006. Herpetol. Rev. 37:231–232). On 26 April 2015, at 1150 h, RC and AC observed a *Urocyon littoralis* (Island Fox) that had made visual contact with an adult *L. zonata* (Total Length ca. 75 cm; LACM PC 1869) on a trail on Santa Catalina Island, Los Angeles Co., California, USA (33.32193611°N, 118.343344°W, WGS 84; 227 m elev.). As the fox approached the slow-moving snake, the snake stopped (Fig. 1A). The fox made two quick moves toward the snake's head, and then bit down on the snake's body (Fig. 1B), shook it violently, and ran off into nearby brush. The fox proceeded to consume the snake, rested for an hour, and then moved out of view.

Studies of Island Fox diet suggest that snakes are rarely taken (Collins 1980. *In* Proceedings of the Second Conference on Scientific Research in the National Parks, pp. 152–164. USDI National Park Service, Washington, DC; J. King, pers. comm.). For example, an analysis of > 2900 fox scats collected from all six of the California Channel Islands revealed no snake remains (Cypher et al. 2011. Resource Exploitation by Island Foxes: Implications for Conservation. California Department of Fish and Game, Nongame

PHOTOS BY RICHARD CAZARES



FIG. 1. A) Island Fox at first encounter with an adult *Lampropeltis zonata* on Santa Catalina Island, Los Angeles Co., California. B) After an initial approach, the fox bit the snake at midbody and carried it off into nearby brush, where it was consumed.

Wildlife Program Report No. 2011-01, San Diego, California. 25 pp.). We are aware of only one other report of snake predation by Island Foxes. Coonan et al. (2010. Decline and Recovery of the Island Fox: a Case Study for Population Recovery. Cambridge University Press, New York. 232 pp.) published a photo of a fox that had captured an adult *Coluber constrictor* near Scorpion Ranch, Santa Cruz Island (Santa Barbara Co., California) in July 2006 (C. Schwemm, pers. comm.; www1.islandfox.org/2006/08/what-do-island-foxes-eat.html).

This observation also represents an important locality record for *L. zonata*, which is rare or absent from islands off California. Holder (1910. The Channel Islands of California: A Book for the Angler, Sportsman, and Tourist. Hodder and Stoughton, London. 397 pp.) observed a "coral snake" on Santa Catalina Island, clearly a first reference to the occurrence of *L. zonata* on any of the California Channel Islands. Backlin et al. (2005. Baseline Biodiversity Survey for Santa Catalina Island: Herpetofauna and Ants with Remarks on Small Mammals and Others. USGS Western Ecological Research Center Final Report, San Diego, California. 45 pp.) published a photo of a *L. zonata* found in 1999 at Black Jack Campground, ca. 9 km by air NW of the new locality. Because Backlin et al. (2005, *op. cit.*) did not record *L. zonata* during their extensive trapping surveys over a 34-month period, they questioned whether that species naturally occurs on the island. However, given the antiquity of Holder's (1910) report, together with our new record from a wilderness area, we regard *L. zonata* as a natural inhabitant of Santa Catalina Island. The island localities are roughly 60 km SE overwater from the nearest vouchered locality of *L. zonata* on the mainland (SDNHM 24269; 2 miles S of Irvine, Orange Co., California), although Hubbs (2004. Mountain Kings: A Collective Natural History of California, Sonoran, Durango and Queretaro Mountain Kingsnakes. Tricolor Books, Tempe, Arizona. 319 pp.) noted an unconfirmed sight record for the Palos Verdes Hills, Los Angeles Co., roughly 40 km N of the Santa Catalina Island localities. This report confirms the presence of *L. zonata* on Santa Catalina Island. This species remains unknown from any other California islands.

In addition to digital images of the snake-fox interaction, a video file is available as LACM PC 1871. We thank Paul Collins, Julie King, and Cathy Schwemm for helpful discussion, information, and references.

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***LEPTODEIRA ANNULATA* (Banded Cat-eyed Snake). REPRODUCTION / MATING AGGREGATION.** Aggregative behavior constitutes one of the unambiguous cases of social behavior in snakes, and research increasingly supports the complexity of snake social systems (Greene et al. 2002. *In* Schuett et al. [eds.], Biology of the Pitvipers, pp. 179–205. Eagle Mountain Publishing, Eagle Mountain, Utah; Clark et al. 2012. Biol. Lett. 8:523–525). In fact, records of snake aggregations are widespread (e.g., Gregory et al. 1987. *In* Seigel et al. [eds], Snakes—Ecology and Evolutionary Biology, pp. 366–395. Macmillan, New York; Ford and Burghardt 1993. *In* Seigel and Collins [eds], Snakes—Ecology and Behavior, pp. 117–164. McGraw-Hill, New York), and many tend to be related to reproductive activities (Graves and Duvall 1995. Herpetol. Monogr. 9:102–119; Rivas and Burghardt 2005. J. Comp. Psychol. 119:447–454).

Leptodeira annulata is a nocturnal and semi-arboreal snake widely distributed in the Neotropics that feeds mainly on anurans. Although its ecology has been relatively well studied in South America (Vitt 1996. Herpetol. Nat. Hist. 4:69–76; Ávila and Morais 2007. Herpetol. Rev. 38:278–280; Mesquita et al. 2013. Pap. Avul. Zool. 53:99–113), little is known about its mating behavior (Carvalho-Neto et al. 2007. Herpetol. Rev. 38:89). Herein, we expand the understanding on the reproductive behavior of *L. annulata* through the record of breeding aggregation for this species.

On 1 May 2011 at 1030 h, five *L. annulata* were collected at Mocozal (3.9815°S, 38.7284°W, WGS 84; elev. 138 m), Maranguape municipality, Ceará state, northeastern Brazil, and deposited in the scientific collection Coleção Herpetológica da Universidade Federal do Ceará (CHUFC 3606–3610). The snakes, a female (SVL = 61.5 cm) and four males (SVLs = 56.1, 52.5, 51.5, and 47.8 cm), were found tangled together at ground level. The close arrangement among the individuals and the male-biased sex ratio suggest that this was a mating aggregation. Our observation provides evidence that *L. annulata* forms breeding balls, and despite its primarily arboreal and nocturnal habits, may copulate on the ground during daylight.

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***LYTORHYNCHUS DIADEMA* (Awl-headed Snake). DEFENSIVE BEHAVIOR.** At 2330 h, SDB collected a female *Lytorhynchus diadema* (total length = 333 mm) crossing the road ~21.7 km N on N-1 from the intersection of P-1600 and N-1 just outside of Tan-Tan, Morocco (28.562037°N, 10.907357°W, WGS 84; elev. ~318 m, T_a = 17.8°C). The snake was photographed in life the following morning, and preserved (CM 55251). During the initial encounter, this individual presented a cobra-like display, flattening its neck and raising its head and body about 5 cm off the ground. The entire display lasted 15–20 sec. This behavior has not been reported in this species from northwestern Africa (PG, JMP, L. García-Cardenete, and R. León, pers. comm.; Šmíd 2010. Herpetol. Notes 3:329–332), but it is apparently not rare in Israel where it can be elicited by touching the snake on the base of the tail (Fig. 1).

Juvenile and adult sand snakes (*Ragerhis moilensis)* and cobras (*Naja haje*), which are sympatric and syntopic with *Lytorhynchus* throughout much of its range, commonly exhibit neck-spreading defensive behavior (Geniez et al. 2004. The Amphibians and Reptiles of the Western Sahara. Chimaira Buchhandelsgesellschaft mbH, Frankfurt am Main, Germany. 229 pp.; Sindaco et al. 2013. The Reptiles of the Western Palearctic. 2. Monografie della Societas Herpetologica Italica – II. Edizioni Belvedere, Latina, Italy. 543 pp.) and the display of *Lytorhynchus* might be an example of mimicry. The blotched pattern typical of *L. diadema* and *R. moilensis* is also seen in sympatric vipers: *Bitis, Cerastes, Daboia, Echis, Macrovipera,* and *Pseudocerastes.* If potential predators generalize blotched patterns of venomous snakes broadly, *L. diadema* may be incorporating features of both cobra neck-spreading and viper pattern similarity as an anti-predator defense. Alternatively, both the pattern and the behavior of *L. diadema* may be pleisiomorphic, developmentally-canalized characters (Pough 1988. *In* Gans and Huey [eds], Biology of the Reptilia, Vol. 16, Ecology B, Defense and Life History, pp.153–234. Alan R. Liss, New York; Pough 1988. Am. Nat. 131:S67–S102).

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PHOTO BY J. SIVAN



FIG. 1. Cobra-like display of *Lytorhynchus diadema* in the Negev Desert.

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***MICRURUS DUMERILII* (Dumeril's Coralsnake). MAXIMUM SIZE.** The maximum total length reported for *Micrurus dumerilii* is 948 mm (Campbell and Lamar 2004. The Venomous Reptiles of the Western Hemisphere. Cornell University Press, Comstock Publishing Associates, Ithaca, New York. 870 pp.). At 1015 h on 26 Febraury 2014, during a diurnal visual encounter transect for herpetofauna, we captured a female *M. dumerilii* (SVL = 858 mm, tail length = 96 mm) in Predio La Vega, vereda Mirabel, municipality Betulia, Santander, Colombia (7.030917°N, 73.378778°W, WGS 84; 198 m elev.). At 954 mm total length, this specimen is the longest known *M. dumerilii*. The snake was collected and deposited in the Colección Herpetológica at the Universidad Industrial de Santander, Colombia (UIS-R-2711).

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***NERODIA ERYTHROGASTER* (Plain-bellied Watersnake). PREDATION.** *Nerodia erythrogaster* is found throughout much of the eastern and central United States. Surprisingly few species have been recorded as predators of this widespread snake (Gibbons and Dorcas 2004. North American Watersnakes. University of Oklahoma Press, Norman. 438 pp.). For example, although *N. erythrogaster* is highly aquatic, to our knowledge there is only one documented observation of a fish as a predator. In 1984, a small *N. erythrogaster* in Tarrant Co., Texas was reported within a *Micropterus salmoides* (Largemouth Bass; Parmley and Mulford 1985. Texas J. Sci. 37:389). However, no museum records are associated with the observation.

On 3 April 2015, several *M. salmoides* were captured in a private fishing pond in Edgefield Co., South Carolina (33.635976°N,



FIG. 1. Juvenile *Nerodia erythrogaster* found within a *Micropterus salmoides* (Largemouth Bass) captured in South Carolina. The snake was discovered and cut in pieces in the course of filleting the fish.

81.889167°W; WGS 84). Upon cleaning one of the fish, RA noticed a dead but largely intact juvenile *N. erythrogaster* inside (Fig. 1), suggesting that the snake had been consumed in a recent predation event. The current observation is separated from the only other known fish predation record by over 30 years and 1000 km. Photographic vouchers were deposited in the Auburn University Museum of Natural History (AHAP-D 1092a, b).

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***NERODIA SIPEDON PLEURALIS* (Midland Watersnake). ACANTHOCEPHALAN PARASITE.** Although much is known about the helminth parasites of *Nerodia sipedon*, little is known of those of *N. s. pleuralis* (Ernst and Ernst 2006. SSAR Herpetol. Circ. 34:1–86). In addition, we are not aware of any acanthocephalan (spiny-headed worm) parasite reported from *N. s. pleuralis*. Here, we report a new host and distributional record for an acanthocephalan from a *N. s. pleuralis* in Arkansas.

Nine juvenile and adult *N. s. pleuralis* (SVLs = 162–775 mm) were collected between April 2010 and July 2014 from Fulton (N = 1), Franklin (N = 1), Independence (N = 5), Marion (N = 1) and Montgomery (N = 1) counties, Arkansas, USA. They were euthanized with an intraperitoneal injection of sodium pentobarbital (Nembutal®) and a mid-ventral incision was made to expose the visceral contents. A single male acanthocephalan was recovered from the small intestine, placed overnight in tap water, fixed in 70% ethanol, stained with acetocarmine and mounted in Damar balsam, and identified by MAB. A voucher specimen (HWML 75378) was deposited in the Harold W. Manter Laboratory (HWML) of Parasitology, University of Nebraska-Lincoln. A host voucher specimen was deposited in the Arkansas State University Museum (ASUMZ) Herpetological Collection, State University, Arkansas.

One of 9 (11%) *N. s. pleuralis* collected on 5 March 2014 from Mill Creek at Spring Mill, Independence Co. (35.825°N, 91.725°W; WGS 84) was found to be infected with a single male acanthocephalan that fit the description of *Pomphorhynchus bulbocolli* Linkins in Van Cleave, 1919. This acanthocephalan has been previously reported widely from North America in over 80 freshwater fishes (Amin 1987. J. Parasitol. 73:278–289; Hoffman 1999. Parasites of North American Freshwater Fishes. 2nd ed. Comstock Publishing Associates, Ithaca, New York. 539 pp.). Intermediate hosts of *P. bulbocolli* are the amphipods, *Gammarus pseudolimnaeus* and *Hyalella azteca* (Muzzall 1982. J. Helminthol. Soc. Washington 49:289–294; Barger and Nickol 1998. J. Parasitol. 84:534–537). The presence of *P. bulbocolli* in this snake is considered to be an artifact of a piscivorous diet and the host should be considered accidental. However, this is the first time this acanthocephalan has been reported in *N. sipedon*.

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***OXYBELIS AENEUS* (Brown Vinesnake). DIET.** *Oxybelis aeneus* is a long, slender, arboreal snake that is widely distributed from Arizona, USA, to southeastern Brazil (Stebbins 1954. Amphibians and Reptiles of Western North America. McGraw-Hill, New York, USA. 536 pp.). Its diet includes a wide range of vertebrates, including amphibians, arboreal mammals, small rodents, small birds, fish, and primarily lizards (Henderson 1982. Amphibia-Reptilia 3:71–80; Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna between Two Continents, between Two Seas. University of Chicago Press, Illinois. 934 pp.; Hetherington 2006. Herpetol. Rev. 37:94–95).

At 1119 h on 19 May 2015, at Pontal da Santa Cruz (7.21051111°S, 39.7335444°W, WGS 84; 730 m elev.), located at Chapada do Araripe municipality of Santana do Cariri, Ceará state, Brazil, an adult male *O. aeneus* (SVL = 917 mm; Tail length = 549 mm; 91 g) was sighted in a tree ingesting an adult male *Tropidurus hispidus* (Fig. 1A; SVL = 79 mm; Tail length = 130 mm; 25.4 g) headfirst. During collection the snake regurgitated the freshly killed lizard. Both the snake and the lizard were collected and deposited at the Coleção Herpetológica da Universidade Regional do Cariri (Fig. 1B; URCA-H 11017, 11018, respectively). Despite the variety of prey types reported for diet of *O. aeneus*, to the best of our knowledge this is the first record of predation by *O. aeneus* on *T. hispidus*.

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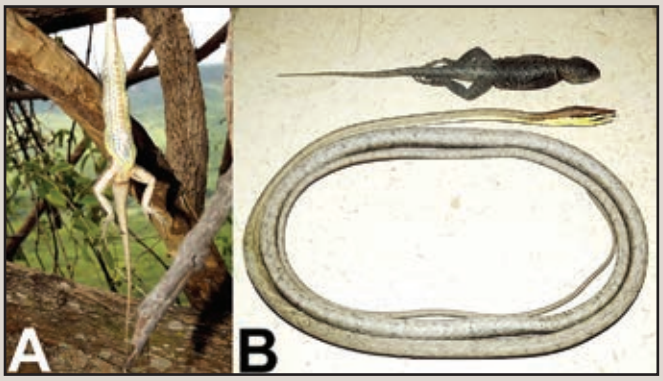


PHOTO BY H. F. OLIVEIRA

FIG. 1. Predation by *Oxybelis aeneus* on *Tropidurus hispidus*.

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***PSAMMOPHIS SCHOKARI* (Schokari Sand Racer). ENDOPARASITE.** *Psammophis schokari* occurs throughout Israel and is widely distributed in the Middle East and northern Africa (Bar and Haimovitch 2011. A Field Guide to Reptiles and Amphibians of Israel. Pazbar Ltd., Herzilya. 245 pp.). Tomé et al. (2013. J. Parasitol. 99:883–887) reported apicomplexan parasites in *P. schokari*. In this note we add to the *P. schokari* parasite list.

The body cavity of one female *P. schokari* (SVL = 545 mm) from the Zoological Museum of Tel Aviv University (TAUM), Tel Aviv, Israel (TAUM 12177) collected May 1980 at Holon (32.0167°N, 34.7667°E; WGS 84) in the Southern Coastal Plain Region, was examined for endohelminths. One nematode was found. It was cleared in lactophenol, placed on a microscope slide, coverslipped, and studied using a compound microscope. A mature female nematode was found. The presence of unlobed pseudolabia supporting medial and externolateral teeth allowed it to be identified as *Abbreviata* sp. (Physalopteridae). Species assignment depends on male characters; although it should be noted that *A. adoisi* has been reported from lizards collected in Lebanon (Sulahian and Schacher 1968. J. Helminthol. 42:373–382). The specimen was deposited in the Harold B. Manter Helminthological Collection (HWML), University of Nebraska, Lincoln, USA as (HWML 64807).

Species of *Abbreviata* are common parasites of lizards and snakes (Baker 1987. Mem. Univ. Newfoundland, Occas. Pap. Biol. 11:1–325). The infection site typically is the stomach (Anderson 2000. Nematode Parasites of Vertebrates Their Development and Transmission, 2nd ed., CABI Publishing, Oxfordshire, UK. 650 pp.). It may have entered the body cavity through a perforation in the stomach wall during preservation of the snake. *Psammophis schokari* represents a new host record for species of *Abbreviata.*

We thank Shai Meiri (TAUM) for permission to examine *P. schokari,* Erez Maza (TAUM) for facilitating the loan, and the National Collections of Natural History at Tel Aviv University for providing the *P. schokari* to examine.

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***PSEUSTES SHROPSHIREI* (Shropshire's Puffing Snake). DIET.** The genus *Pseustes* includes diurnal, nocturnal, terrestrial, and semi-arboreal snakes (Martins and Oliveira 1998. Herpetol. Nat. Hist. 6:78–150). The diet of *P. shropshirei* is poorly known, consisting only of the seeds from an undetermined plant, and two white brittle-shelled eggs with partially developed avian embryos (Cisneros-Heredia 2005. Herpetol. Rev. 36:327) recovered from a specimen from Ecuador. Here, we present the first record of predation of *P. shropshirei* upon nestling birds (Columbidae: *Zenaida*).

On 30 July 2014 at 1430 h, a juvenile male *P. shropshirei* (SVL = 900 mm; TL = 360 mm; 246 g) was found at the edge of a dirt road in Vereda Cadenales, municipality of Norcasia, department of Caldas, Colombia (5.60759°N, 74.90998°W, WGS 84; elev. 874 m). The snake, which had been killed by a local farmer, was collected and deposited in the herpetological collection of the Museo de Historia Natural de la Universidad de Caldas (MHN-UCa 252). The specimen appeared to contain a large food item, and dissection revealed two nestling *Zenaida* sp. (Fig. 1). The first prey item (Length = 6.5 cm; 27.1 g) was consumed headfirst, and the second prey (Length = 7.2 cm; 24 g) was consumed legs-first. The birds appeared to have been recently consumed and were probably captured alive.

This record provides new knowledge about the feeding habits of *P. shropshirei*, suggesting that like other species in the genus, it preys upon eggs and nestlings of various bird species (Tweit 1996. The Birds of North America. Cornell Lab of Ornithology, Ithaca, New York. 20 pp.; Stake et al. 2005. J. Herpetol. 39:215–222).



FIG. 1. Dead male *Pseustes shropshirei* from the department of Caldas, Colombia that had consumed two nestlings of *Zenaida* sp.

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***SIBON LONGIFRENIS* (Drab Snail-eater). AGGREGATION.** Aggregation is a behavior known in many species of snakes throughout the world. Aggregation has been observed mainly in species from temperate and subtropical zones and has been attributed to mating and overwintering behavior. However, few cases have been observed in tropical species. Here, we report the first aggregation of *S. longifrenis* in tropical rain forest habitat in Costa Rica.

On 27 July, during a field trip in Quebrada González sector of Braulio Carrillo National Park (10.16280°N, 83.94030°W, WGS 84; 535 m elev.), at ca. 0032 h, we observed an aggregation of six *S. longifrenis* actively moving in an understory palm tree, ca. 2–3 m above the ground (Fig. 1). The aggregation consisted of five males (SVLs = 36–58.5 cm) and one non-gravid female (SVL = 56 cm). Since the observation took place at night in tropical rain forest habitat and the individuals were actively moving in a palm tree,



FIG. 1. Aggregation of *Sibon longifrenis* on a palm tree in Braulio Carrillo National Park, Costa Rica. Four of six individuals can be seen.

it is likely that the aggregation was related to mating, rather than thermoregulation. This conclusion is further supported by the highly skewed sex ratio of the group.

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***SONORA SEMIANNULATA* (Western Groundsnake). PREDATION.** *Sonora semiannulata* is a common snake found in the central and southwestern U.S. and northern Mexico (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Institution Press, Washington, D.C. 668 pp.). They have a range of documented predators, including lizards, snakes, birds, and mammals (Ernst and Ernst, *op. cit.*). On 01 November 2014, 11.5 km SE of Valentine, Jeff Davis Co., Texas, USA (30.52166°N, 104.40198°W, WGS 84), we collected at least two identifiable *S. semiannulata* impaled on barbed wire (Fig. 1) at a larder of *Larius ludovicianus* (Loggerhead Shrike). To our knowledge this is the first documented instance of this bird predating *S. semiannulata*

PHOTO BY CRYSTAL KELEHEAR



FIG. 1. *Sonora semiannulata* (SRSU 6658) found impaled on barbed wire by *Larius ludovicianus* in Jeff Davis Co., Texas, USA.

(Clark 2011. Son. Herpetol. 24:20–22). A representative specimen one of the impaled *S. semiannulata* was preserved in the James F. Scudday Vertebrate Collections at Sul Ross State University (SRSU 6658).

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***STORERIA DEKAYI* (Dekay's Brownsnake). POPULATION SIZE, DENSITY, AND BIOMASS.** *Storeria dekayi* is a small North American natricine snake that is relatively common in a wide variety of habitats, including those associated with human habitation (Christman 1982. Cat. Amer. Amphib. Rept. [461]:1–2). Despite the ubiquity of *S. dekayi*, population size and density estimates for the species are few. In suitable habitat, with a plentiful supply of shelter and prey (e.g., slugs and earthworms), population of *S. dekayi* can be quite large (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Press. Washington, DC. xi + 668 pp). The purpose of this note is to report multi-year estimates of population size (N), density (N/area of sampled habitat), and biomass (N × average mass of all marked snakes) at a 0.5-ha urban site in Erie, Pennsylvania, USA.

During the active seasons (March–October) of 2012–2014, I used artificial cover objects along a vegetated slope to study a population of *S. dekayi* (Gray 2014. J. North Amer. Herpetol. 2014:28–39). The Schumacher-Eschmeyer mark-recapture method was used to estimate population size (Ricker 1975. Computation and Interpretation of Biological Statistics of Fish Populations. Bull. Fish. Res. Board Canada 191:1–382). For the population size estimates, each sample consisted of a weekly sampling period up until the first neonate(s) were observed. The population size and density at the site during 2012 were estimated as 130 ± 35 individuals and 260 *S. dekayi* / ha, respectively (Gray 2014, *op. cit.*). Total biomass of *S. dekayi* during 2012 was estimated to be 855 g.

During 2013, thirty-seven adult male (mean ± 95% C.I., SVL = 214.2 ± 6.7 mm), 24 adult female (SVL = 267.5 ± 12.7 mm), 37 juvenile male (SVL = 149.4 ± 5.7 mm), and 52 juvenile female (SVL = 163.8 ± 8.5 mm) *S. dekayi* were marked. During 2013 the first neonates were observed 6 August. Population size was estimated as 195 ± 53 individuals, resulting in a population density of 390 *S. dekayi*/ha. Total biomass during 2013 was estimated to be 975 g. During 2014, fifteen adult male (SVL = 218.1 ± 11.4 mm), 16 adult female (SVL = 277.9 ± 11.2 mm), 13 juvenile male (SVL = 150.0 ± 9.6 mm), and 11 juvenile female (SVL = 170.2 ± 18.0 mm) *S. dekayi* were marked. During 2014 the first neonates were observed 18 August. Population size during 2014 was estimated as 77 ± 16 individuals, resulting in a population density of 154 *S. dekayi*/ha. Total biomass of *S. dekayi* during 2014 was estimated to be 485 g.

Populations of *S. dekayi* vary considerably in size depending on numerous factors, including the amount of suitable habitat, abundance of prey, intensity of predation, and female fecundity. For instance, estimated population sizes and densities from select studies range from 152–4200 individuals and 14–300/ha, respectively (Freedman and Catling 1978. Can. Field Nat. 92:167–173; Mitchell 1995. Catesbeiana 15:15–22; Ernst 2003. Herpetol. Bull. 86:10–18). Populations of *S. dekayi* at sites noted by Ernst have since been extirpated (Ernst 2003, *op. cit.*). The apparent decline of *S. dekayi* at my Erie County site may have been due

to the harsh winter of 2013–2014. Average air temperature in Erie, Pennsylvania during 1 November 2013 through 31 March 2014 was 5.2°F below average, with March 2014 being the 7th coldest (mean temp 28.1°F) on record (National Oceanic and Atmospheric Administration, http://www.weather.gov/climate/. Accessed 11 January 2015). Furthermore, during 2014 the first *S. dekayi* were observed 19 April, compared to 21 March and 30 March during 2012 and 2013, respectively. Such an extended winter may have caused substantial mortality during hibernation.

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***TACHYMENIS PERUVIANA*. DIET.** Snakes in the genus *Tachymenis* are known to feed mainly on amphibians and lizards (Walker 1945. Publ. Mus. Comp. Zool. 55:1–55; Greene and Jaksi 1992. Rev. Chil. Hist. Nat. 65:485–493). On 2 January 2014 we encountered a dead and dried-out juvenile *T. peruviana* (SVL = 144 mm, Tail Length = 44 mm) that had fed on a male *Liolaemus aparicioi* (SVL = 44 mm; swallowed headfirst), an endemic lizard species of La Paz valley, Bolivia (Ocampo et al. 2012. Herpetologica 68:410–417). The specimen was found at Taypichulo (16.64°S, 68.05°W, WGS 84; elev. 3002 m), a locality on the eastern bank of the Rio La Paz. The snake's midbody was distended, and its ventral region was slightly decomposed and opened with forelimbs and abdomen of the lizard exposed (Fig. 1). Although it is common to find positive correlations between prey and snake size, juvenile snakes sometimes eat relatively large prey (Sazima and Martins 1990. Memórias do Instituto Butantan 52:73–79), as in this case. Sazima and Martins suggest that eating large prey entails increased handling time as well as time and energy invested in digestion, while it may increase the risk of predation, or death by internal injuries or asphyxia, as may have been the case here. This is the first report of a diet item for juvenile *T. peruviana* in the field. The specimen (CBF 3913) was deposited as a voucher in Herpetology Field of Colección Boliviana de Fauna.

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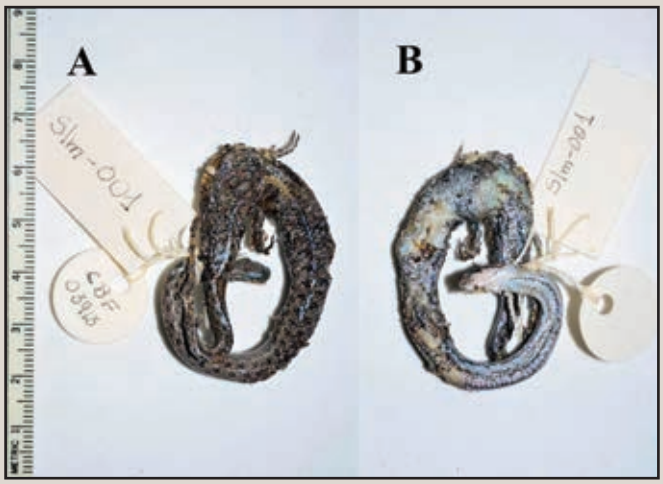


FIG. 1. Dorsal (A) and ventral (B) view of juvenile *Tachymenis peruviana* (CBF 3913) and partially ingested *Liolaemus aparicioi* (forelegs seen next to the head of the snake) from Bolivia.

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***TANTILLA CORONATA* (Southeastern Crowned Snake). COLORATION.** On 5 July 2008, in Okaloosa Co., Florida, USA, an adult (total length = 20 cm) amelanistic *Tantilla coronata* was found under a piece of plywood near the edge of a mixed pine/hardwood forested area with no recent history of fire. The snake was photographed (Fig. 1) and immediately released where it was found. This is apparently the first documented amelanistic *T. coronata*. Although it might be difficult to get a good sense of how frequently this coloration occurs in this generally seldom seen species, a study involving 1640 captures of *T. coronata* over 56 years (Todd et al. 2008. Copeia 2008:388–394.) included no amelanistic individuals (B. Todd, pers. comm.).



PHOTO BY K. JONES

FIG. 1. Amelanistic *Tantilla coronata* (Southeastern Crowned Snake) on ground near where it was found.

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***THAMNODYNASTES STRIGATUS* (Corredeira). DIET.** *Thamanodynastes strigatus* is a semi-arboreal opportunistic predator (Bernarde et al. 2000. Bol. Mus. Nac. Zool. 428:1–8; Franco and Ferreira 2002. Phyllomedusa 1:57–74) with a wide geographic distribution in Paraguay, Uruguay, Argentina, and southern and southeastern Brazil (Bernarde et al. 2000, *op. cit.*; Condez et al. 2009. Biot. Neotrop. 9:157–185). Its diet is composed mainly of anurans, but it has also been recorded preying on fish, rodents, and small reptiles (Bernarde et al. 2000. Rev. Bras. Biol. 60:695–699; Marques et al. 2001. Serpentes da Mata Atlântica. Guia Ilustrado. Holos Editora, Ribeirão Preto. 184 pp.). Among the fish comprising part of its diet, only small and inoffensive fish as some poeciliid species have been recorded (Bernarde et al. 2000, *op. cit.*; Ruffato et al. 2003. Phyllomedusa 2:27–34). In 09 April 2015 we received a dead adult female *T. strigatus* (SVL = 40.0 cm; Tail length = 12.0 cm) from Condomínio Estância Zaúna (23.396083°S, 51.835916°W, WGS 84; 468 m elev.), a settlement in the municipality of Maringá, Paraná state, Brazil. We dissected the specimen and recorded one *Hoplias* aff. *malabaricus* (Trahira; SVL ca. 16.0 cm) in the stomach of snake (Fig. 1). *H. malabaricus* is a carnivorous and aggressive fish and is considered an important aquatic predator (Luz et al. 2000. Act. Sci.



FIG. 1. *Hoplias* aff. *malabaricus* (Trahira) consumed by a *Thamnodynastes strigatus* in Brazil.

22:465–469). The present record expands the known diet of *T. strigatus* and further demonstrates the dietary plasticity of this species.

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***THAMNOPHIS BRACHYSTOMA* (Short-headed Gartersnake). POPULATION SIZE, DENSITY, AND BIOMASS.** *Thamnophis brachystoma* is endemic to the Allegheny High Plateau of northwestern Pennsylvania and southwestern New York. *Thamnophis brachystoma* is reportedly extremely abundant within its limited geographic range (Conant 1950. Bull. Chicago Acad. Sci. 9[4]:71–77; Hulse et al. 2001. Amphibians and Reptiles of Pennsylvania and the Northeast. Cornell University Press, Ithaca, New York. i–xi + 419 pp.), especially in localized habitat (Rossman et al. 1996. The Garter Snakes: Evolution and Ecology. University of Oklahoma Press, Norman. i–xx + 332 pp). Despite these reports of abundance, quantitative estimates such as population size and density of *T. brachystoma* are sparse (Asplund 1963. Herpetologica 19:128–132; Engelder 1988. A study of the short-headed garter snake, *Thamnophis brachystoma* in New York State. Unpubl. Master of Science Dissertation, St. Bonaventure University, New York. 72 pp.). Herein we provide estimates of population size, density, and biomass for two urban *T. brachystoma* populations in Erie, Pennsylvania, USA.

During April–August 2011, we studied two urban *T. brachystoma* populations. At both sites we used artificial cover objects and existing natural cover (e.g., rocks) to sample for snakes. At site 1, Shannon Road (42.12440°N, 80.00000°W; WGS 84) we sampled ca. 3.6 ha of old field habitat. At site 2, McClelland Park (42.12960°N 80.01820°W; WGS 84) we sampled ca. 4.8 ha of old field habitat. Both sites are insular and are surrounded primarily by residential neighborhoods. We used the Schumacher-Eschmeyer mark-recapture method (Ricker 1975. Computation and Interpretation of Biological Statistics of Fish Populations. Bull. Fish. Res. Board Canada 191:1–382) to estimate population size (N). For the population estimates, each sample consisted of a weekly sampling period up until the observation of the first neonate(s) or post-partum female. Density (N/area of sampled habitat) and total biomass (N x average mass of all marked snakes) was also calculated.

At the Shannon Road site, 5 juvenile male (mean ± 95% C.I. SVL = 214.2 ± 4.8 mm; mass 6.1 ± 0.4 g), 8 juvenile female (SVL = 228.6 ± 22.5 mm; mass 6.7 ± 1.2 g), 18 adult male (SVL = 273.6 ± 16.9 mm; mass 12.5 ± 2.3 g), and 25 adult female (SVL 310.8 ± 14.9 mm; mass 21.7 ± 4.0 g) *T. brachystoma* were marked. Population size was estimated to be 93 (95% C.I. = 54–132) *T. brachystoma*; population density was estimated to be 26 snakes/ha. Total biomass of *T. brachystoma* at the Shannon Road site was estimated to be 1.42 kg. At the McClelland Park site, 28 juvenile male (SVL = 190.9 ± 6.4 mm; mass 4.9 ± 0.4 g), 35 juvenile female (SVL = 205.3 ± 8.2 mm; mass 6.1 ± 0.6 g), 12 adult male (SVL = 273.4 ± 18.6 mm; mass 12.9 ± 2.6 g), and 19 adult female (SVL 322.0 ± 23.1 mm; mass 26.4 ± 6.7 g) *T. brachystoma* were marked. Population size was estimated to be 161 (95% C.I. = 125–197) *T. brachystoma*; population density was estimated to be 34 snakes/ha. Total biomass of *T. brachystoma* at the McClelland Park site was estimated to be 1.72 kg.

Both of the Erie County sites studied by us were female-biased in both the juvenile and adult age classes. Engelder (*op. cit.*) reported that four populations in New York were female-biased, with females comprising 54.8–71.4% of marked snakes. Asplund (*op. cit.*) estimated two Pennsylvania *T. brachystoma* populations to be between 555–1290 and 218–418 snakes, respectively. By contrast, Engelder (*op. cit.*) estimated a population at Horseheads, New York to average 33 (95% C.I. 17–49) *T. brachystoma*; estimated density for this same population was 20 snakes/ha. To our knowledge, site-specific biomass estimates of *T. brachystoma* have not been reported previously.

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***THAMNOPHIS EQUES* (Mexican Gartersnake). MAXIMUM SIZE.** Data on size of *Thamnophis eques* from the southern portion of their range are sparse. Two Mexican populations have been studied; one at Tecocomulco, Hidalgo, where the maximum reported SVL is 68 cm (Macias 1984. Universidad Nacional Autónoma de México. 67 pp.) and one in the Valley of Toluca (Manjarrez 1998. J. Herpetol. 32:464–468) where maximum reported SVL is 63.5 cm. Here we report a female *T. eques* captured by Victor Sustaita in the Canal Japón of the Lago de Xochimilco (south of Mexico City) on a morning in June 2008 that measured 91 cm SVL and 110 cm total length. To our knowledge, this is the largest *T. eques* reported from Mexican populations and is similar in size to the largest individuals reported in Arizona, USA (Total Length = 120 cm; Schwalbe and Rosen 1988. *In* Szaro et al. [tech. coords.], Management of Amphibians, Reptiles, and Small Mammals in North America, pp. 166–173. USDA Forest Service Gen. Tech. Rept. RM-166, Fort Collins, Colorado).

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***THAMNOPHIS PROXIMUS* (Western Ribbon snake). ARBOREAL BEHAVIOR.** Many species that are considered terrestrial will intermittently exploit habitats outside of their typical habitat. Even though terrestrial, *Thamnophis* spp. have been found to use arboreal basking locations, either commonly as in *T. sauritus* (Eastern Ribbonsnake) (Langford et al. 2011. Herpetol. Conserv. Biol. 6:400–409) or occasionally for thermoregulation, as in *T. sirtalis parietalis* (Red-sided Garter snake) (Shine et al. 2005. J. Therm. Biol. 30:179–185). However, there are no records to document this behavior in *T. proximus*.

On 13 March 2015 (0900 h) at Evariste Nunez Woods and Bird Sanctuary (Cameron Parish, Louisiana; 29.73857°N, 92.8373139°W, WGS 84) we observed a *T. proximus* basking ca. 1.5 m up in a young *Quercus virginiana* (Live Oak; Fig. 1) located along an edge between maintained grassland (mowed) and coastal Chenier forest; presumably, this location was ideal to thermoregulate during the spring. The surrounding Chenier had some standing water from recent precipitation events, but there was no precipitation immediately prior to the observation, which has been found to elicit arboreal basking in *T. s. parietalis* (Shine et al., *op. cit.*). Tinkle (1957. Ecology 38:69–77) found that most *T. proximus* basked in *Rubus* (blackberry) and *Typha* (cattail) mats; when shade increased with leaf out during the course of the year, individuals moved to different areas instead of moving up trees within the same habitat. However, the use of small trees for basking or foraging might be more common than represented in the literature.



FIG. 1. *Thamnophis proximus* basking in young tree in Louisiana, USA.

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***THAMNOPHIS SIRTALIS* (Common Gartersnake). DIET / SCAVENGING.** Occasional consumption of carrion in the wild is known in *Thamnophis sirtalis*, but interspecific competition over carrion has not been previously reported. Markezich (2010. Herpetol. Rev. 41:99–100) recently reviewed six records for scavenging in *T. sirtalis* and added two more. We provide additional reports of *T. sirtalis* scavenging, and suggest that scavenging may be a deliberate foraging strategy in this species (DeVault and Krochmal 2002. Herpetologica 58:429–436). The widespread availability of road kills is a relatively recent phenomenon from an evolutionary perspective. There are advantages to highly plastic foraging behaviors that can exploit new food resources (Krause and Burghardt 2001. Herpetol, Monogr. 15:100–123). Scavenging on roadways may be especially successful during periods of concentrated amphibian migrations that result in many road kills. Whether or not this is an advantageous survival strategy is questionable, however, as snakes are also likely to experience higher mortality when foraging along roadways.

On 3 September 1994, JBL observed a *T. sirtalis* attempting to consume a deceased *Lithobates pipiens* (Northern Leopard Frog) in the middle of a paved road in Scott Co., Minnesota, USA (ca. 5 km SW of Shakopee; 44.752951°N, 93.595761°W, WGS 84). The road-killed frog was planate, desiccated, and firmly adhered to the road surface. The snake was preoccupied due to the difficulty of removing the frog from the road, and appeared to be unaware of its immediate surroundings. No attempt to flee was made upon approach and the snake was relocated to a roadside ditch, but quickly returned and resumed its effort to dislodge the frog. JBL observed another *T. sirtalis* attempting to consume a deceased adult *Cardinalis cardinalis* (Northern Cardinal) in Muscatine Co., Iowa, USA, on 14 April 2001 (Swamp White Oak Preserve ca. 5 km NE of Conesville; 41.405973°N, 91.304328°W, WGS 84). The bird was decomposed to the point of desiccation, light in weight, and much larger than the snake (457 mm total length). The snake unsuccessfully attempted to dislodge the carcass from vegetation by pulling on it while the snake's posterior region was anchored in a small burrow for leverage. After ca. 5 min, the snake released its hold on the bird, fully emerged from the burrow and rested in the sun ca. 76 cm away from the carcass. On 19 July 1995, JCG observed a large female *T. sirtalis* (SVL = 840 mm SVL; tail length = 147 mm; 305 g without prey) with a large bolus at midbody in the northwest corner of Miller's Marsh not far from West Side Drive on Beaver Island, Charlevoix Co., in northern Lake Michigan, Michigan, USA (45.613397°N, 85.593722°W, WGS 84). The snake was captured and with gentle palpation a young (113 g) *Lepus americanus* (Snowshoe Hare) was regurgitated and preserved (deposited at Central Michigan University Museum of Cultural and Natural History). Examination of the hare revealed it to have a crushed skull, indicating that it had probably been killed by an automobile and then scavenged postmortem. Finally, at 2200 h (CST) on 14 June 1994, GSC observed an adult *T. sirtalis* in a tug-of-war with a *Carabus nemoralis* (European Ground Beetle) over a piece of carrion (a ca. 6 cm long frog limb, likely *Lithobates clamitans* or *L. pipiens*) on a rural gravel road in Forest Co., Wisconsin, USA (Berry Lane ca. 45 m E of Hemlock Creek; 45.479739°N, 88.876267°W, WGS 84). The beetle had one end of the carrion clamped in its mandibles while being dragged by the snake, its feet leaving furrows in the sandy road surface. The tug-of-war was observed for 1–2 min.; upon closer approach, the snake disengaged and fled, leaving the beetle with the carrion. The beetle was deposited at FMNH (determined by Robin Delapena). These observations lend support to the importance

of scavenging as a feeding strategy for *T. sirtalis* and report a novel prey item (*L. americanus*) for this species.

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BOOK REVIEWS

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The Anoles of Honduras

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Although anoles might be better known as a remarkable example of adaptive radiation in the Caribbean, the dirty secret is this: the mainland has greater diversity. Our knowledge of mainland anole biology lags behind that of island species (Losos 2009), though various workers, Gunther Köhler and Randy McCranie included, have worked tirelessly to make up some of that ground. While basic ecological studies are still sorely needed for most species, large strides have been made in our alpha taxonomic knowledge in the mainland.

Which brings us to Honduras and this book. That *The Anoles of Honduras* can exist in its current form is a testament to McCranie, Köhler, Larry David Wilson, and colleagues. Thanks to these researchers, herpetologists now have access to several books detailing the herpetological diversity in this Central American country (McCranie and Wilson 2005; McCranie et al. 2006; Köhler 2008; Townsend and Wilson 2008; Köhler 2011; McCranie 2011). Much of what makes Honduras special is its location. Although the majority of Honduras lies within what is commonly known as Nuclear Central America, it differs from the other countries in the extent of biogeographic overlap with lower Central America. The book is therefore generally useful for the Nuclear Central American region as well as Nicaragua, and, to some extent, Costa Rica. Most major Central American anole species groups are represented in the Honduran anoline fauna, and this book is a solid place to become familiar with the morphology and basic natural history of Central American anoles. And, as far as anole expertise goes, the authors had a hand in describing 16 (out of 40, or 40%) of the species known from the country, which likely explains why the species accounts contain such detailed information. Clearly, McCranie and Köhler have spent countless hours in the field and looking at specimens, and this book would not have been possible without such dedication.

The book begins with an Introduction, a Materials and Methods section, and a brief overview of the history of anole work in Honduras. These sections are short and informative. After explaining their decision to use the Nicholson et al. (2012) taxonomic classification for anoles (discussed below), they briefly address the "ecomorph" vs "ecomode" topic that was also raised in the Nicholson et al. work (2012). I agree with the authors on this topic that the term "ecomode" was not well defined and that most of Nicholson et al.'s (2012) assignments were both subjective and based on very little information. McCranie and Köhler's decision to describe their direct ecological and morphological observations for the anoles of Honduras is much more useful than "ecomode" assignments would have been, and ecomorph assignments would have been equally inappropriate given the evidence that the well-defined island ecomorph classes are by and large unsuitable for describing the ecomorphological diversity of mainland anoles (Schaad and Poe 2010).

The authors made their case for the use of Nicholson et al.'s (2012) taxonomy for anoles as part of their Materials and Methods. I find their arguments to be misleading—the focus is mostly on Poe's (2013) statements on taxon sampling, data limitations, and monophyly among the proposed genera. Yet the most important arguments put forth by Poe (2013) for maintaining *Anolis* as a single, large genus lie in the fact that there are no scientific reasons to split up the genus that everyone acknowledges is monophyletic. There are numerous interpretations of the same phylogeny (i.e., generic divisions) that would be equally viable, and there is no objective reason to accept any particular arrangement over another. Alternative arrangements are presented in Poe (2013: fig. 1), along with a discussion for each. Nicholson et al. (2014) have made clear their purpose for dividing *Anolis* into eight genera: they want recognition of the genus *Norops* (Nicholson et al. 2012: p. 117), demonstrating the subjectivity highlighted by Poe (2013). Some will use the Nicholson (2012) classification for anoles but the majority of anole researchers have stuck to the one-genus arrangement for the time being. It should be noted that a rankless taxonomic system (PhyloCode: de Queiroz, 2006) would allow use of clade names without the problems that go along with the Nicholson et al. (2012) treatment.

The species accounts make up the majority of the book, and are more than worth the price of admission. This section is where the book shines and will prove valuable to researchers in Central America for the foreseeable future. There is a wealth of information on scale traits and coloration, useful for anyone in need of a data set for analyses involving morphology. There are figures, distributional information, and photographs for all 39 species from Honduras known to the authors (a 40th species, *Anolis wermuthi*, was reported from near the Nicaragua border shortly before proofs were finalized; Sunyer et al. 2013). Before this book, identifying anoles in Honduras required a fair amount

of knowledge and experience. Now a researcher or enthusiast can travel to Honduras and with a little investigative work, identify male anoles without too much trouble. The photos of the male dewlaps provided for each species are a key inclusion. Although some of the images are less than stellar, it's impressive enough that the authors were able to compile photos of all 39 species. This fact alone makes the book quite valuable.

I came across occasional mistakes in the species accounts but none were especially problematic. For example, in the *Anolis beckeri* account, the authors describe the distribution as occurring from the Mexican state of Tabasco to Nicaragua. The actual distribution of this species begins considerably farther to the north and west, into the states of Veracruz and Oaxaca, at the very least. The species account even references a population from Veracruz in the natural history section. Most mistakes were similarly small and of little importance.

The later sections of the book include a dichotomous key, assorted information on the distribution and biogeography, and conservation status. I found these sections to be generally informative, with some caveats. For one, anyone who has used (or attempted to use) Köhler's dichotomous key for anoles in *Reptiles of Central America* (Köhler 2008) is aware that this type of key is likely to test the patience of even the most level-headed herpetologist. There are too many species and many of the traits used are not easily scored, so that someone without much anole experience has no chance of effectively navigating through the key. The key in this book deals with fewer taxa and has more figures to help with scoring traits, but I must offer a word of warning for anyone attempting to use it alone as a way of identifying individuals: prepare for frustration. This is not the fault of the authors, of course—the species diversity and limited number of useful traits for identification are the true culprits. The best advice I can give for an inexperienced researcher/traveler is to find an adult male. Juveniles and even adult females are often remarkably similar between species. It's all about the dewlaps and the quicker you learn that, the better.

Unlike in much of Nuclear Central America, the mountain ranges in Honduras tend to be lower and less connected to each other, with the geographic separation perhaps producing a stronger pattern of isolation in the various reptiles and amphibians inhabiting the region. A number of endemic species have been described from Honduras in the past 20 years, and the rate at which they are being described has not slowed. This book offers considerable information on these endemics, allowing interested researchers an opportunity to pursue a multitude of questions relating to diversification in the region. For instance, why are there endemic species related to *Anolis laeviventris* in Honduras? *Anolis laeviventris* is currently considered to be a widespread species (from Panama to Mexico) and the presence of diagnosable microendemic species of this form only within Honduras seems odd. Phylogeography of the *A. laeviventris* group would be quite illuminating, as would further work on any of the anole groups generally considered to be composed of mid- to high-elevation isolates such as *Anolis pijolense* and *A. purpurgularis*.

One thing readers of this book may notice is the high number of subtly-diagnosed Honduran species that have small distributions and are presumed to be isolates of more widely distributed species (e.g., *Anolis bicaorum, A. morazani, A. roatanensis, A. rubribarbaris, A. utilensis, A. wampuensis, A. zeus*). I am hoping that this book will trigger further taxonomic work on these groups so that we can get a better handle on whether these purportedly isolated lineages are indeed legitimate species. For instance, the account for *A. wampuensis* states that the only major difference between this form and *A. tropidonotus* is an "extreme" difference in habitat—the latter has never been found in Honduras in "undisturbed broadleaf rainforest." The explanation seems strange, considering *A. tropidonotus* is found in a wide variety of lowland habitats (based on personal experience in both Mexico and Honduras) and there is likely to be very little undisturbed broadleaf rainforest left in the country. According to the book, *A. tropidonotus* is found in more departments than any other species in the country, has a wider elevational distribution than any other species, and occurs in the most "physiographic" areas as defined by the authors. And looking at the distribution maps, it appears *A. wampuensis* simply fills a small gap in the range of the more widespread, nearly continuously distributed *A. tropidonotus*. Minor dewlap differences have been reported, but that would be more consistent with some form of clinal variation in dewlap coloration, adaptation to local conditions, individual variation, or between-population variation. Complicating matters even further was the designation of *A. wampuensis* as one of the two most vulnerable anole species in the country, a bold assessment considering how likely this population is to simply be a representative of one of the least vulnerable anole species in Honduras (by any estimation), *A. tropidonotus*. While going through the species accounts, I was surprised by the number of species described with similarly limited evidence.

Some of these questionable species are diagnosed primarily based on limited observations of hemipenes, an increasingly common practice in anole systematics that I believe needs to be carefully evaluated and perhaps reconsidered. My concerns stem from a few observations made from published works, conference talks, and my own experiences working on the *Anolis sericeus* group. To begin with, it has been noted that hemipenes evolve much faster than other measured morphological traits in anoles (Klaczko et al. 2015). This fact alone can mean that differentiation in hemipenial traits can occur prior to speciation, and many species will be polymorphic for these traits. Furthermore, there is no evidence that reproductive isolation results from closely related populations with differentiated hemipenes. For example, Köhler and colleagues presented evidence against such reproductive isolation in follow-up work on *A. osa* (Köhler et al. 2012), which was described entirely on differences in hemipenial morphology (Köhler et al. 2010). Given the evidence from Köhler et al. (2012), the obvious conclusion is that *A. osa* should not be recognized as a distinct species. Results from a recent systematic study of the *A. humilis* group using molecular data (Phillips et al. 2015) were not consistent with Köhler et al.'s (2006) findings that relied heavily on hemipenial morphology. Finally, my own work on silky anoles (*A. sericeus* group) is in agreement with the *A. humilis* findings—evolutionary lineages, as deduced from multigene evidence (Gray, unpubl. data), are not at all concordant with the distributions of forms associated with hemipenes (Köhler and Vesely 2010). I worry that these traits have little to do with species differentiation and many species are being described under false assumptions. Even if hemipenial traits are found to be fixed within populations in anoles (a doubtful proposition given the rapidity of evolution in hemipenial morphology), intraspecific variation and interpopulation differentiation exist for many traits. The observation that a particular population can be diagnosed morphologically is not sufficient grounds for describing a population as a distinct species under any widely used species concept currently in practice.

To be clear, the issues I raised concerning species limits and taxonomy are largely the result of reading this volume, which contains a wealth of information. The authors present an account of the Honduran anole fauna that is more thorough than any previous summary of anole diversity for any country. *The Anoles of Honduras* is a must-have for any anole researcher in Central America and would be a good pickup for anyone with a general research interest on anoles. And I haven't even gotten to the best part—the price! Although one can order a hard copy for a very reasonable price, an electronic copy is free. The bar has now been set—it would be fantastic if someone could take on an even more challenging country such as Panama!

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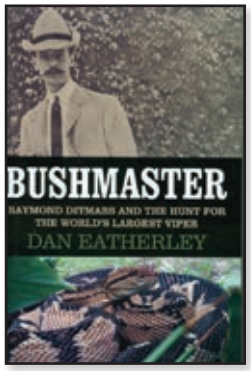
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Bushmaster: Raymond Ditmars and the Hunt for the World's Largest Viper

Dan Eatherley. 2015. Arcade Publishing, New York (www.arcadepub.com). xxiv + 303 pp., 16 pp. pls. Hardcover. US $24.99. ISBN 978-1-62872-511-7.

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JUST LIKE A COFFIN. So begins this part biography and part personal quest, sprinkled with just a bit of danger and death. Dan Eatherley immediately grabs the reader with his retelling of a scene from Raymond L. Ditmars' "Episode of the Bushmaster" from *Thrills of a Naturalist's Quest*, a 1932 classic I first read nearly 40 years later. In the prologue, "His Unwavering Grip," readers learn that the author is a British zoologist and filmmaker who discovered Ditmars while working on a project with Rom Whittaker in Costa Rica. He first wanted to make a film, but after 9/11 the industry changed drastically, eliminating that possibility. In his book, the bushmaster serves as a sort of "MacGuffin," the device filmmakers use to drive a story.

The author's approach, in fifteen chapters, each of which begins with a pithy Ditmars quote, is to alternate between his odyssey and a paraphrasing of stories Ditmars shared in his many books, or that appeared in *The New York Times* and other newspapers.

In "Working up Snakes" (the chapter titles are also Ditmars quotes found within the chapter. You'll have fun trying to find them!) a teenage Raymond L. Ditmars (RLD) meets "Professor George O'Reilly" at the Central Park Zoo. Is this perhaps his first introduction to the bushmaster? Eatherley accompanies Regina Alvarez of the Central Park Conservancy to Central Park and its Zoo, the first of many visits to Ditmars' haunts.

In "Pleased with a Rattler, Tickled with its Fang," in the library at the American Museum of Natural History (AMNH), Eatherley delves into how RLD's first association with science and scientists began. With several local herp enthusiasts, Peter Warny, Steve Ricker, and Erik Zeidler, he seeks snakes "within 50 miles of New York City" (also the title of RLD's first publication).

"Silent Death of the Black Night" begins with what is likely RLD's first long trip, by ship to Florida with John Bernhardt Smith, an entomological associate of his AMNH supervisor William Beutenmüller. RLD's family allows snakes in their new home, and he strives to fill up the attic. R. R Mole of Trinidad, who would supply the original bushmaster, appears.

In "The Master of Snakes," after much difficulty, Eatherley succeeds in finding Edwin McGown of the Palisades Interstate Park Commission to escort him to Timber Rattlesnake (*Crotalus horridus*) dens RLD might have visited. The famous "Episode" is touched upon. RLD's fame begins as does his reporter position with *The New York Times*.

"A Snapping Turtle in a Tin Bathtub" opens with the American Inter-Continental Exhibition of Reptiles, a large event RLD assisted in organizing, that might have been another reason William Hornaday offered him a position at the New York Zoological Park. The origin of what came to be called the Bronx Zoo encompasses the bulk of this chapter. Eatherley peruses the scant Ditmars material in the zoo library, disappointed about not finding a single reference to bushmasters.

"A Decided Awakening of Unbiased Interest" revisits opening day of the Bronx Zoo, 8 November 1899, and delves into the early years. Eatherley visits the Reptile House, now rebranded "World of Reptiles" with collections manager Chris Hutson.

In "Reptilian Deviltry of the World," RLD and head keeper Charley Snyder recapture two immense King Cobras accidentally released by animal dealer William Bartels. They later force feed a python. At the "best Italian restaurant in the Bronx" Eatherley visits Bronx Zoo retiree Peter Brazaitis, who regales him with stories, probably also published in his memoir, *You Belong in a Zoo!* The next day Peter takes him to the New York/Connecticut border where RLD likely searched for *Crotalus horridus*. Eatherley discusses RLD's attempts at veterinary work.

"A Sort of Freemasonry" opens with RLD and his family, keeper Snyder, and several others in South Carolina. The Pinelands Club there served as the base for collecting southeastern species for the zoo collection. His two teen daughters stayed back at a cabin during the hunt and with their grandfather, end up catching the biggest diamondback! With Ed McGowan, Eatherley returns to timber country and almost steps on one. We learn about the bite that Ed's colleague, William H. "Marty" Martin, survives.

RLD, with Snyder's assistance, milks a Fer-de-lance (*Bothrops asper*), which introduces "A Messy Business," a chapter about snakebite and its treatment both now and years ago. In the zoo archives again, Eatherley now reads over bushmaster records in bulletins and reports. None survives long. Curator Don Boyer explains the success of keeping them now.

In "A Sympathetic Knowledge," after depicting a performance of the Bronx Zoo Reptile Circus at the Waldorf-Astoria, Eatherley sits in the New York Public Library and pores over articles featuring Ditmars, leading to a discussion of RLD's own writing, declaring it "precise, readable, and entertaining." He mentions something I've always cherished: President Theodore Roosevelt's praise for *The Reptile Book,* including an open invitation to the White House. Can you imagine that happening today? There's an overview of RLD's attempts at research in primate intelligence and his public speaking. His lectures, of course, always included live animals and photographic slides. Soon he would incorporate another medium.

"The Stage of Nature" begins with RLD, his wife Clara, and assistant "Andy," filming a Fer-de-lance at the Ditmars' residence. The scene, of course, goes awry with the serpent unexpectedly slithering off stage down to the floor. "Don't worry," laughs Clara struggling to her feet. "It missed!" Eatherley visits the Westchester County Archives where he studies a copy of the Ditmars' will: Approximately 270 cans of film, perhaps 300,000 feet and 150 hours of viewing, appraised at $5000. Although few now survive, these enhanced his lectures and were even shown in movie theaters. "Andy" convinced RLD to add the emotion and humor the theaters demanded, resulting in "The Jungle Circus" eventually the ending of his six-reel masterpiece "The Book of Nature." Our author/filmmaker provides pages of details of RLD's work with film. He savors the existing films he views at the Library of Congress.

Finally to the tropics in "A Naturalist's Paradise"! The Ditmars family spends *muchas semanas en Honduras* battling mosquitos while searching for snakes. The author visits the Smithsonian's Museum Support Center and examines preserved specimens associated with RLD. He sees his first bushmaster, albeit pickled. After retelling the story of the Zoo's first-ever snakebite in 1916, which almost killed keeper John Toomey, he introduces the Antivenin Institute of America.

In "The Main Thing Is the Bushmaster," RLD searches successfully for vampire bats in Panama, accompanied by Arthur Greenhall, perhaps somewhat the son he never had, but yet again strikes out with *Lachesis*. Eatherley fares better during his visit with Dean Ripa at his Cape Fear Serpentarium in North Carolina, where he finally sees living bushmasters.

"Six Feet Long and Vicious" focuses on Trinidad. R. R. Mole had sent the bushmaster featured in the "Episode," and almost every other specimen exhibited at the Zoo, from there. Both RLD and Eatherley visit the island nation. Thanks to his colleague Friedrick Willlliam "Jangoon" Urich, RLD brings back the Zoo's first specimen in decades. Eatherley begins networking for advice about bushmasters. At the Emperor Valley Zoo, he talks with keeper Delbert Charleau, Jr. With his cousin's husband Ian, a native Trinidadian, they seek out Delbert's former supervisor, Hans Boos, author of *Snakes of Trinidad and Tobago,* and "Snake Man" Allan Rodriguez. No one offers a technique guaranteed to find a bushmaster.

Still on the island in "We Can Get All We Want Now," Eatherley rendezvous with long-time SSAR member John C. Murphy, a Chicago-based specialist of Trinidad and Tobago herps, his friends Gabriel Hast and Tom Anton, guides Mukesh Ramdass and Molly Calderon, and Abraham Diaz, a photographer for the *Trinidad Guardian*. They examine a recently killed bushmaster at the Asa Wright Nature Center and search for a live one. Were they successful?

In "Epilogue: My Happiest Hours" Eatherley overviews both the dubious future of the world's largest viper throughout its range and the remarkable career of its seeker.

To conclude, in "Author's Note: Meeting Gloria" Eatherley introduces us to RLD's only grandchild, describing her as inheriting her grandfather's physical features. She reminisces about her "Pop," ("…just *delicious*…A character, a dignified character.") playing at the zoo, and travelling to the West Indies.

I'm honored to be among the many listed people in the three pages of "Acknowledgements."

Toward the middle are eleven pages of contemporary color photographs of snakes and people, the final one is Gloria holding a large portrait of her beloved grandfather. Five more pages of black & white from RLD's era follow. I counted 17 similar images scattered throughout the text.

At the American Museum of Natural History, Eatherley discovers two letters written by RLD's father to curator William Beutenmüller about a position for his son. He rightly declares these documents as a defining moment in RLD's career. While I appreciate the word-for-word transcriptions (pp. 22 and 24), photographs of John V. H. Ditmars' "elegant flowing hand" would have been even better.

I learned several new words, including "gormless" (page 23) for "stupid" and the possible origin of the name bushmaster, from *bosmeester* coined by Dutch explorers (p. 50).

I found few misspellings or factual errors, although I've never heard of "green chicken snakes" (p. 9). The statement about the lack of hearing in snakes (p. 178) might have been updated.

Common names are not consistent: On p. xix, rat snakes, yet coralsnakes; on p. 27, watersnakes, yet garter snakes. Perhaps consulting Crother (2012) would have been wise.

Eatherley corrects the error of the only prior Ditmars biographer (Wood 1944), C. *Stover* Allen to C. *Slover* Allen, a physician interested in snakebites. While on the subject of errors, I would like to discuss the dilemma of the birthdate of Raymond L. Ditmars; I hope not too trivial a point.

His obituaries stated his birthdate as 20 June 1876, as did Albert H. Wright (1949). The death record instead lists 22 June (I have my suspicions about the disparity). His biographer, Laura Newbold Wood Roper (1994), Kraig Adler (1989), and Eatherly all repeated the 22nd. As recently noted by Adler (2014), I obtained a document from the New Jersey Archives that substantiates the correct birthdate as June 20. So we'll wish a happy 140th birthday to RLD on the Summer Solstice 2016!

When I was fervently "following the Ditmars trail" (p. 275) especially at the turn of the century/millennium, it took a couple of years and couple of hundred dollars to locate his only grandchild, Gloria. "Pop" dedicated *Confessions of a Scientist* to her when she was about six and half years old, and she may be the only person still alive who knew him. I put Eatherley in touch with Gloria and I'm so happy he devoted four pages to her. To my inquiry whether her grandfather had a New York accent, she had said no, so Eatherley's observation after viewing/hearing a "talkie" titled *Killing the Killer,* "the New York inflection obvious" (p. 200) was quite a revelation.

Eatherley and I were in touch off and on during his project, but now I lament we did not collaborate more. Although he quotes me correctly about the family throwing everything away, at a later point I learned some specifics of a book sale in the late 1960s. What a tragedy for posterity that so few of RLD's "papers" survive.

Eatherley suggested visiting me, but I discouraged him from devoting the precious time and money because I wondered how much insight I had to offer. Upon reflection, and after reading about the others he met, I too could have shown him some snakes, taken him out to eat, to bond as kindred souls, and filled him in about how I've tried to lead a Ditmarseque life in a so much more modest way in my Rust Belt city [look how my byline copies the "cadence" of Raymond L.(ee) Ditmars], and shared my cherished complete book collection. That might have merited one of his color photos?

A list of illustrations is often standard companion to a table of contents, but is lacking here. I liked how Eatherley often included RLD's age at the time of a given narrative and would have much appreciated a timeline about his life. If provided, I would have referred to maps of significant places such as "within 50 Miles of New York" and Honduras, Panama, and Trinidad, etc. But of course, I have atlases and Internet access.

Eatherley uses a storyteller style and paraphrases Ditmars' writing, and that of others, throughout. And that of others. For example, I immediately recognized familiar passages such as Adler (1989, 2014) on p. 173 and Kate Swan's 1897 newspaper article (pp. 63–64) that I annotated a century later (Novotny 1999). I wish that all the others were cited with notes and a bibliography. I began to search, with some success, for those in my Ditmars collection and *The New York Times* online archives, but this painstaking process would have held up this piece until the next issue of *Herp Review*.

In 1989, Kraig Adler wrote, correctly, that Ditmars had influenced many herpetologists still active. A decade later I expressed concern that Ditmars was being forgotten. Dr. Adler assured me that, because of the continuing availability of his books, that was not the case at all.

I'm not sure if he fully convinced me, but with Dan Eatherly's labor of love now published, Raymond L. Ditmars is back in the news, and I hope it leads to a resurgence of appreciation. I enjoyed this book immensely and recommend it to everyone interested in him, herpetology, or a good story. Buy one for yourself and for those on your gift list. Every library in the English-speaking world should own it. And despite the judgment that RLD's writing is "peppered with behind-the-scenes anecdotes too topical to stand the test of time" (Goddard and Swope 1995), admirers of *Bushmaster* may want to delve into RLD's original works, too.

Recall that this project originated with Dan Eatherly's idea for a film featuring Raymond L. Ditmars. I'm sure he could make a movie just as good as his book. But who should be cast as the bushmaster hunter? Chris Pratt starred in last summer's blockbuster *Jurassic World* and is the rumored successor to Harrison Ford in the next installment of the *Indiana Jones* franchise. In the meantime, would he be willing to grow a mustache and don some leather puttees?

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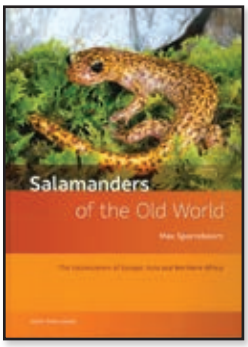
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Salamanders of the Old World

Max Sparreboom. 2014. KNNV Publishing, Zeist, The Netherlands (www.knnvpublishing.nl). 431 pp. Hardcover. € 125.00 (approximately US $134.00). ISBN 978 90 5011 4851.



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If you are like me, you have a well-used copy of Petranka's (1998) *Salamanders of the United States and Canada* sitting bruised and loyal within arm's reach of your work desk. That book has been with me on field trips to the Appalachians, the Northwest rainforests, and the swamps of south Georgia, but unfortunately it doesn't get used much anymore since I now live in the desert. But it is nice to know those thorough species accounts are there, and as a natural history editor for *Herpetological Review* I do get to flip it open every now and then to check up on somebody's facts. So, when I heard about the new book *Salamanders of the Old World* by Max Sparreboom (2014), I thought I should get it right away, even though I have never been to Europe or Asia. Maybe just having such a book would in some way transport me to misty Mediterranean cliff faces populated by *Speleomantes*, or tumbling splash zones of Colchian streams teaming with *Mertensiella*. And it would possibly be a necessary reference for those occasional natural history observations sent from Eurasia. I bring up Petranka because the inevitable comparison between Sparreboom's book—especially for North American readers—will be to *Salamanders of the United States and Canada* (although, covering 160 versus 127 species, Sparreboom had a bigger task and certainly a much bigger geographic scope).

This hardcover book is wonderfully designed, with 431 glossy pages each laid out slickly, and richly illustrated with full-color photographs of adult and larval salamanders as well as egg sacs (only three species are not illustrated with photographs—one of which has not been seen since it was described in 1910), photographs of habitats and landscapes, illustrations from classic texts, line drawings, range maps, and a frontispiece showing salamander morphology. The book begins with an excellent introduction covering basic salamander biology, reproduction, evolution, and conservation. The book is then organized alphabetically by family, genus, and species names. Each family section has a detailed familial summary, and each genus is similarly (if a bit too technically) summarized. There are individual accounts for all the species covered with sections on their general description, diagnosis, eggs and larvae, distribution, habitat, behavior, threats and conservation, observations in captivity, and taxonomic comments. A reference section follows each account. Many of the species accounts are spare and repetitious, since only one or two of the species within any of the genera are well known. There is a glossary and thorough reference list.

I thought it was a good attempt by Sparreboom to include the "observations in captivity" section to simultaneously appeal to the herpetoculture crowd and also demonstrate that much of our knowledge of the interesting courtship rituals of many salamanders comes from captive observations. The taxonomy is up-to-date and follows recent work by Pyron and Wiens (2011); a phylogram is provided showing familial relationships and the generic relationships within the largest Eurasian family Salamandridae. The book is ambitious in scope both in terms of geography, topics, and the number of species involved. Sparreboom admits the book is an attempt to update Robert Thorn's treatise on Old World Salamanders (1969), and pays appropriate homage to this author and work. So how does Sparreboom's book measure up?

I have to point out that I am no expert on Old World salamanders so I can't be trusted to determine the overall accuracy of the book. And while I cannot say how well the book replaces Thorn (that book is in French), I should mention that my comparison to Petranka (1998) is not entirely fair. Sparreboom does not set out to write a book as comprehensive and detailed as Petranka's. For me this was frustrating, but then again I am an inveterate salamander nerd. Although not written at a juvenile level, the book for the most part could be understood by a student, which is probably for the best. It could easily be argued that Sparreboom's approach—a richly and beautifully illustrated book spare on details but filled with references guiding true nerds to the published literature—is actually superior to the more thorough approach of Petranka. But I personally would have rather had a more complete summary of the literature. And in some cases Sparreboom mentions interesting details and does not expand upon them, instead referring us to citations. This was his worst offense, and the best example of this is found on p. 161 when Sparreboom mentions tantalizingly that *Speleomantes sarrabusensis*, a plethodontid, might be viviparous. He mentions this bombshell only in passing and refers the reader to a reference that is not in English, leaving the poor English reader (for the record, the book is in English) to wonder about this incredible fact and why it is suspected to be true. Something like this needs to be covered in a book like this, not simply mentioned and cited.

In other cases, Sparreboom appears to simply be reiterating every detail from another account (e.g., the descriptions for many *Hynobius* rely heavily on Thorn), or worse yet, from an online source (e.g., amphibiaweb.org; salamandersofchina.org). Sparreboom mentions that this book grew out of an attempt to archive natural history information on Old World salamanders on a website, thus the web citations and thin species accounts; for the book, primary literature should have been used.

In terms of illustrations, Sparreboom's book is certainly far superior to Petranka's. All but a handful of the salamanders covered are illustrated with large, full cover photographs of living individuals, most of them taken *in situ*. These include gorgeous photographs of gorgeous salamanders taken from some rather unreachable locations, such as Syria, northern Iraq, and Iran. Many of the photographs were taken by Sparreboom himself, who must have racked up some serious frequent flyer miles and must have some great stories to tell about his travels.

This brings me to another disappointing aspect of the book. Sparreboom presumably has extensive first-hand experience with many of the salamanders he covers (in the field and in captivity), but this is not conveyed in the writing. It is certainly evident from his photographs, which include pictures of living salamanders and also their habitats (a very nice touch). Sparreboom has presumably seen more of these species firsthand than anybody else alive, or at least anybody else alive who has tried to write a book about them. But this firsthand knowledge does not bleed into the

species accounts. Many are instead spare and based on sketchy sources, and are inordinately preoccupied with mating behavior. It made me wonder if a much better book could have been written by Sparreboom had he kept detailed field notes of his encounters during his travels. Or, if a better book could have been written by a team of European, Chinese, and Japanese authors, since many of the Asian species have an extensive, un-translated literature that Sparreboom tells us about but does not attempt to summarize. A bias toward the European species is definitely evident, although this was both inevitable and forgivable. The species accounts for European species are much more thorough and well researched, and this is where Sparreboom's book becomes more comparable to Petranka's.

Another area where the book is definitely weak is the range maps. The maps are topographic but not at a scale where this was warranted. At the scale of the entirety of China, showing topography just muddles the picture. The distributions of most species are plotted with hashed lines that are too similar in color to the topographic lines, so most of the maps are difficult to interpret. Although there are maps in the back of the book that allow the unfamiliar reader to refer to various regions of southeast Asia and Europe, I doubt if even a resident of Turkey would be able to locate themselves relative to the range maps of *Lyciasalamandra* found on p. 241. An inset showing the relationship of the distribution to a larger, more recognizable region (all of Asia, or Europe) was needed for nearly all the maps, and a fully grey-shaded distribution blob (as in Petranka) would have been much better.

I don't get much satisfaction from reading lists of slight errors in book reviews, but I will mention that there were some (as one might expect from a book with 431 pages), but not many. After going through the whole thing I only found around twenty. These ranged from obvious formatting errors (such as p. 144 where the illustration overlaps the figure legend text) to redundancies (p. 311, column 2, line 11, the color description of *Salamandra salamandra* is stated twice within the same section), and simple mistakes (pp. 126 and 130, Sparreboom mentions that *Paradactylodon* are active at night outside caves "where the difference between day and night is not apparent").

On the other hand, for every slight error like this, I probably learned one or more remarkable facts that I was not aware of before reading this book. The line drawings of hynobiid egg sacs are weird and terrific. The description of hynobiid males pulling eggs out of the female while simultaneously kicking her away, so that he may fertilize them in privacy, is hilarious and a strange curiosity of natural selection. The book has nuggets of intrigue and mystery: the lost *Hynobius* of Turkestan, and the presumably extinct *Cynops wolterstorffi*—a salamandrid endemic to a single lake in China that was once common but has not been seen in decades. Strange reproductive features I was unaware of are described and illustrated: the hypertrophied thighs of *Onchodactylus* used in amplexus, and the spectacular dorsal tail knobs of *Lyciasalamandra* and *Mertensiella*, which are used during courtship to stimulate the female cloaca while males hold them on their backs in ventral amplexus. *Echinotriton* males secrete a wispy spiderweb of mucous from their cloaca as they court females, possibly tying them down for positioning the spermatophore. For me, these wonderful natural history stories and their accompanying illustrations make the book worth the exorbitant US $134 price. As I told one interested but reluctant colleague: relax, you are simply paying less than a dollar for each species account.

That price will probably cost this book most of its potential readership. But libraries across Eurasia and North America should have this book, as well as some die-hard collectors like me. The information on captive husbandry undoubtedly will be useful to the thriving salamander herpetoculturalist crowd in Europe. But I'm not sure if this book will become a dog-eared and battered field companion for anyone in Eurasia, much less for curious readers in North America looking to plan their next vacation. So maybe there is room for improvement and there might still be a book waiting to be written that could aim to be a well-illustrated "Petranka for the Old World." But for now Max Sparreboom's nice book will do just fine if you can afford it.

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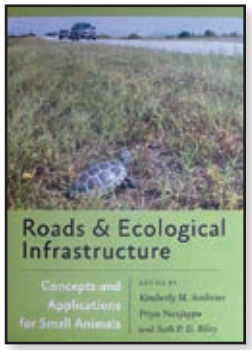
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Roads and Ecological Infrastructure. Concepts and Applications for Small Animals

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"*America is proud of her magnificent record in road building, but nothing has been so destructive of wild life as our good roads.*"
—Thomas Barbour, 1944

This book is for people seeking ways to lessen the impact of roads and vehicular traffic on amphibians, reptiles, and mid- to small-sized mammals (i.e., "small animals" in the editors' parlance) and their habitats and populations. The text on the back cover states that this is the first book to focus on "improving outcomes where transportation needs and small animal habitats overlap." Well, not exactly. Langton (1989) published the first book of which I am aware on resolving and mitigating conflicts between amphibians and roads, and made it available to participants of the First World Congress of Herpetology in England that year.

The editors seem to imply in the Introduction that the term "ecological infrastructure" is novel; they provide no evidence to the contrary. The term was first used in a 1984 report by the Man and Biosphere Program to the United Nations Educational,

Scientific and Cultural Organization (UNESCO) (Wang et al. 2008). It was used initially to represent the habitat network and emphasized the biodiversity conservation functions of many landscape components, such as corridors. There are several other definitions usually associated with urban ecology (Banzhaf and Netzband 2011). The editors of this book define ecological infrastructure as "*the basic habitat components and their connections necessary for species survival, and for natural populations, communities, and ecosystems to function properly.*" A primary goal of the editors is to broaden the reader's view of road impacts on small animals by providing the ecological context within which the public infrastructure (roads, bridges, etc.) functions. Information presented in the book demonstrates the many ways they are intertwined. The book is a call to action for researchers, engineers, landscape planners, and others involved with road ecology to collaborate better than they usually do to reach common goals.

Road construction and the resulting mortality of small vertebrates has been abundantly described from early in the 20th century onward. Efforts to do something about it began with the use of signs in the early 1960s in Europe. Underground passages appeared in the late 1960s. Underpasses in the United States were first constructed in the late 1960s along I-75 which cuts across the Everglades between Ft. Lauderdale and Naples. Nearly all of the examples of road and wildlife conflicts in the book are from Europe and the United States. Projects in other regions such as South Africa are rarely mentioned.

Following a review of the history of road ecology, three chapters address the natural history of small vertebrates, direct effects like roadkill, and how habitat modification, in turn, affects their survival and persistence. Information and examples focus mostly on amphibians and reptiles. There are substantially fewer examples and discussions on mammals. Chapter 2 includes a long list of topics on animal behavior, movements, physiology, and other aspects of species biology. Chapter 3 on direct effects includes the important topics of road mortality, roads as barriers, road density, habitat fragmentation, and landscape genetics. How roads affect habitat quality, covered in Chapter 4, focuses on effects of chemicals such as heavy metals, road salt, and other forms of pollution, environmental stressors such as moving and stationary lights, habitat modification, human access, and animal behavior.

Chapters 5–12 cover numerous practical topics ranging from public education to road construction specifications. The authors in these chapters include a breadth of subjects within their topics: planning and design, funding, mitigating road effects with structural modifications, modifying structures on existing roads, construction and maintenance, and monitoring and adaptive management. Numerous case studies and photographs illustrate specific points. This is not a technical manual, although design specifications for culverts, underground passageways, and barriers appear in Chapter 9. The authors provide realistic descriptions of processes and challenges, background where needed, and evaluations of problems and solutions pertinent to their topic. One comes away realizing there are many complexities involved with solving any road and wildlife problem. In the last chapter, Andrews lays out a general, multifaceted overview of where future efforts should be made, but offers few specific targets.

Each of these chapters ends with a section of bulleted Key Points that reviews the highlights and messages the authors consider important. Fortunately, literature citations are provided at the end of each chapter making it easier to connect a point of discussion with its corresponding literature. There are two lengthy practical examples on road problems and solutions by guest authors. One focuses on turtle mortality on a causeway to a barrier island and the other on the effectiveness of New York State's first amphibian tunnel. Embedded within each chapter are one or more short case studies by other authors. The index covers topics but not species.

This is a handsome, well-constructed book, although I was annoyed with the low quality of the black-and-white photographs. The layout includes three layers of section subtitles that break up the text into manageable units to enhance readability. I would not buy the eBook version because it costs as much as the hardcover version.

Everything humans do with and on roads causes a long list of problems for small vertebrates. This book provides information on and solutions for many of them. Some of the same topics are explored in Forman et al. (2003), as well as others not discussed in Roads and Ecological Infrastructure. The latter does not establish the background on road densities and mortality statistics needed by newcomers to understand why this is such an important subject critically in need of resolution. People interested in road-vs-wildlife issues should read both of these books to get a thorough overview of the seemingly intractable problems roads create for small animals.

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HERPETOLOGICAL NOMENCLATURE

The years 2013–2014 have been especially controversial ones insofar as herpetological nomenclature is concerned. It began with an article in this journal by Kaiser et al. (2013) recommending a standard of best practices for systematic herpetology. The article in particular reviewed the practices of R. T. Hoser and his notorious *Journal of Australasian Herpetology*. In that "journal" he has created hundreds of taxonomic names proposed in ways that most herpetologists think do not meet the conditions for publication required by the International Code of Zoological Nomenclature (International Commission of Zoological Nomenclature 1999). In what is clearly a ploy to legitimatize his journal, Hoser has applied to the Commission in Case 3601 (see below) to endorse his claims that his "journal" meets the requirements of the Code thereby making his multitude of new names available.

Kaiser et al. (2014) countered Hoser's contentions and there is widespread support in the herpetological community for placement of all issues of the *Journal of Australasian Herpetology* on the Index of Rejected and Invalid Works in Zoological Nomenclature. This action is certainly within the purview of the Commission under Arts. 78 and 81 relating to the Plenary Power, which may be invoked to suppress a particular name or works that would "disturb stability or universality or cause confusion."

The problems raised by the Hoser case clearly test the long held notion that the Commission not make judgments on the taxonomic quality of an author's work by applying the Code in as neutral manner as possible. Nevertheless, in ruling on individual cases presented to the Commission, the attempt at neutrality is not uniformly successful. In almost all cases, there are differences of opinion among the Commissioners, hence the requirement that approval of most applications be a simple majority, but where the Plenary Power is involved a two-thirds majority is required for approval. Because of these concerns, Commissioners Harvey and Yanega (2013) prepared a brief, very thoughtful, document requesting advice from the taxonomic community as a whole on possibly changing the guidelines for Commission actions to deal with such extreme cases as Hoser's. They asked that responses address the issues they raise not the specific case that has led to the controversy. The results of their survey have not yet been published and there is still time to comment anonymously on their questions via the Commission website.

While all this activity was going on, major changes took place in the location and operations of the Commission. A major financial crisis led to the dissolution of the International Trust for Zoological Nomenclature that had long been the financial entity supporting Commission activity. In another move, the University of Singapore agreed to provide space and staff for the coordinating activities of the Commission, for three years. A small staff, including the editor of the Bulletin of Zoological Nomenclature (BZN), will remain at the Natural History Museum in London. Visit the ICZN website (http://iczn.org/) for more details. The University of Singapore's rescue is temporary and it remains to be seen if the Zoological community will rise to the occasion and develop a funding plan that insures the continuance of the vital functions of the Commission.

Recent Rulings on Herpetological Names
(BZN = *Bulletin of Zoological Nomenclature*)

Opinion 2328 (Case 3571). *Crotalinus catenatus* Rafinesque, 1818 (currently *Sistrurus catenatus*) and *Crotalinus tergeminus* Say in James, 1822 (currently *Sistrurus tergeminus*; Reptilia, Serpentes): usage conserved by designation of neotypes for both species. BZN 70(4):282–283.

Opinion 2331 (Case 2331) *Cetiosaurus* Owen, 1841 (Dinosauria, Sauropoda): usage conserved by designation of *Cetiosaurus oxoniensis* Philipps, 1871 as the type species. BZN 71 (1):48–50.

Opinion 2350 (Case 3566) *Tropidolaemus* Wagler, 1830 and *Cophias wagleri* F. Boie, 1827 (currently *Tropidolaemus wagleri*) (Reptilia, Squamata, VIPERIDAE): usage conserved. BZN 71 (4):271–273.

Pending Cases of Herpetological Interest

Case 3625. *Kinosternon chimalhuaca* Berry, Seidel, & Iverson in Rogner, 1996 (Reptilia, Testudines): proposed confirmation of the publication date. BZN 70(3):190–102.

Case 3628. *Terrapene putnami* Hay, 1906 (Testudines, EMYDIDAE): replacement of the holotype by designation of a neotype. BZN 70(3):193–198.

Case 3601. *Spracklandus* Hoser, 2009 (Reptilia, Serpentes, Elapidae): Request for the confirmation of the availability of the generic name and for the nomenclatural validation of the journal in which it was published. BZN 70(4): 234–237.

Case 2641. *Ascalabotes sthenodactylus* Lichtenstein, 1823 (currently *Stenodactylus sthenodactylus*; Reptilia, Gekkota, GEKKONIDAE): proposed conservation of current usage of the specific name by designation of a neotype. BZN 71(1):17–21.

Case 2629. *Vipera latastei* Boscá, 1878 (Reptilia, Serpentes, VIPERIDAE): request for conservation of the original spelling. BZN 71 (1):22–25.

Case 3666. Dicroglossidae Dubois, 1987 (Amphibia, Anura): proposed conservation. BZN 71 (4):244–249.

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—Jay M. Savage, Section Editor

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What are the Correct Family Names for the Taxa that include the Snake Genera *Xenodermus*, *Pareas*, and *Calamaria*?

We all know that the scientific names of organisms are mostly derived from Classical Greek and Latin. Once the Linnean binominal system of nomenclature became firmly established by the early 19th century, individual species names consisted of a genus name and a specific epithet (e.g., *Heloderma horridum*). Genus-group names traditionally, and according to Art. 11.8 of the International Code of Zoological Nomenclature (International Commission on Zoological Nomenclature, 1999), must be singular and in the nominative case (the equivalent of the subject of a sentence in English). All zoological names must be in the Latin alphabet and genus-group names may be a Greek noun transliterated into Latin, a Latin noun, or a latinized version of a Greek noun with a change of ending and treated like a Latin noun. Unlike English, Greek and Latin nouns have gender, they are feminine, masculine, or neuter (*f. m. n.*). Gender may be determined by reference to Greek or Latin dictionaries. Many generic names are compound words, for example *Heloderma* (*helo* = wart; *derma* = skin). The gender of the genus name is determined by the terminal noun's portion. In the case of *Heloderma*, as *derma* is a Greek neuter noun transliterated into Latin, *Heloderma* is neuter too. In this example, the specific epithet for the Mexican Beaded Lizard, is *horridum*, an adjective that must agree in gender with the generic name. Genus names derived from other languages or formed as arbitrary combinations of letters have their gender determined by special rules.

Family names must be derived from the nominative plural form of a genus name by adding the suffix –idae to the noun's stem. In the example of *Heloderma,* the plural is Helodermata, the stem Helodermat–, and the family name derived from it is Helodermatidae. Other suffixes are used for other family-group names: superfamilies –oidea, subfamilies –inae, tribes –ini, and subtribes –ina.

We now examine the situation of the family name based on the snake name *Xenodermus* (*xeno* = strange; *dermus* = skin). Reinhardt (1837) named this genus for the new species *Xenodermus javanicus*. The family-group name Xenoderminae was proposed by Cope (1900:731). For most of the 20th century, the names Xenoderminae, Xenodermidae, or Xenodermini were used universally as family-group names for *Xenodermus* and several subsequently described genera (e.g., *Achalinus*, *Fimbrios*, *Stoliczkaia*, and *Xylophis*) whenever the clade was accorded family-group status (e.g., Smith 1943; Bogert 1964; David and Vogel 1996). More recently, some authors (e.g., Zaher 1999; Vidal et al. 2007; Grazziotin et al. 2012; Pyron et al. 2013) cite the family-group name as Xenodermatidae or Xenodermatinae.

The authors of these papers apparently think that *Xenodermus* is a neuter Greek compound noun like *Heloderma*. This is not the case. The latinized version of the Greek noun *derma* (*f.*) is *dermus* and compound nouns based on the latter must take the gender (*m.*) indicated by its Latin suffix (–us). It was clearly Reinhardt's (1837) intent to coin a Latin generic name of the masculine gender as indicated by his coupling of *Xenodermus* with the specific epithet *javanicus*, a masculine adjective agreeing in gender with the generic name, not the neuter *javanicum*. Consequently, the correct family name is Xenodermidae Cope, 1900, not Xenodermatidae.

A slightly different situation involves the family name for the snake genus *Pareas* Wagler, 1830. *Pareas* is a latinized Greek masculine noun *parieas* with the "*i*" ellipsed that means a kind of snake. Authors in the 20th century (e.g., Smith 1943:117–121; Romer 1956:583; David and Vogel 1996:138) have treated *Pareas* as masculine.

The first use of a family-group name for this genus is by Romer (1956:583), who proposed the subfamily name Pareinae. Dowling and Duellman (1978:112b.3) introduced the tribal spelling Paretini [sic] without comment. Recently, some authors (e.g., Zaher 1999; Vidal et al. 2007; Grazziotin et al. 2012; Pyron et al. 2013) use the family-group name Pareatidae or Pareatinae for this group of snakes. The latter authors, perhaps influenced by Dowling and Duellman (1978), seem to have thought that *Pareas* is of neuter gender and its combining form is *pare*–, the nominative plural *pareta*, and the stem *paret*–. If that were the case, as in the example of Helodermatidae, the family name would be Paretidae. That interpretation is not tenable as *Pareas* is masculine, its nominative plural is *pareae*, and the stem is *pare*–. Consequently, the correct formation of the family name derived from *Pareas* is Pareidae Romer, 1956.

The genus name *Calamaria* was proposed by H. Boie in F. Boie (1827:519). It is a Latin masculine adjective used as a noun (*calamaria* = having the nature of a reed; a writing reed; a reed for holding a pen). The type species of *Calamaria* is *Calamaria linnaei* H. Boie in F. Boie, 1827 by action of the International Commission on Zoological Nomenclature in Opinion 2196 (2008). The family-group name Calamarina was proposed by Bonaparte (1838:125). Under the current rules of nomenclature the proper spelling is Calamariina. Bonaparte appears to have ellipsed the –ii into a single –i. Consequently, the correct spelling for the family name is Calamariidae.

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CONSERVATION

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SSAR and PARC: A Synergy of Science and Conservation Action

The July 2015 meeting of the Society for the Study of Amphibians and Reptiles (SSAR) in Lawrence, Kansas, served as a unique opportunity to formalize and enhance the relationship between Partners in Amphibian and Reptile Conservation (PARC) and SSAR. Throughout PARC's now 16-year history, SSAR members have engaged in PARC meetings and vice versa. However, this was the first time we collaborated directly on conference content. As part of this strengthened relationship, PARC was asked to put together an article for *Herpetological Review* about our past accomplishments and current activities. In particular, we were asked to consider where SSAR members fit into PARC's past, present, and future. The answer: Everywhere!

PARC's mission: *To conserve amphibians, reptiles and their habitats as integral parts of our ecosystem and culture through proactive and coordinated public/private partnerships.*

As we all know, effective management and conservation is dependent on sound science. Researchers are compiling an immense amount of data via an ever-increasing toolbox of techniques, which has the potential to fundamentally change conservation actions. However, all too often individuals charged with making policy or on-the-ground conservation decisions are unable stay abreast of the most current findings to improve and enhance management and policy decisions. To further compound this problem, researchers often struggle to get their findings into an application setting for natural resource managers. Enter PARC, whose mission is accomplished through partnerships—we engage experts in both the science and management realms to achieve conservation guidance and on-the-ground action. We provide recommendations and guidelines based on sound science and common sense; we also facilitate real conservation action.

PARC's Vision: *To provide leadership in the implementation of effective amphibian and reptile conservation on a local, state, regional, national and international scale in order to foster improved conditions for amphibians, reptiles and their habitats; one where common species remain common, and the future persistence of endangered and rare species is more certain.*

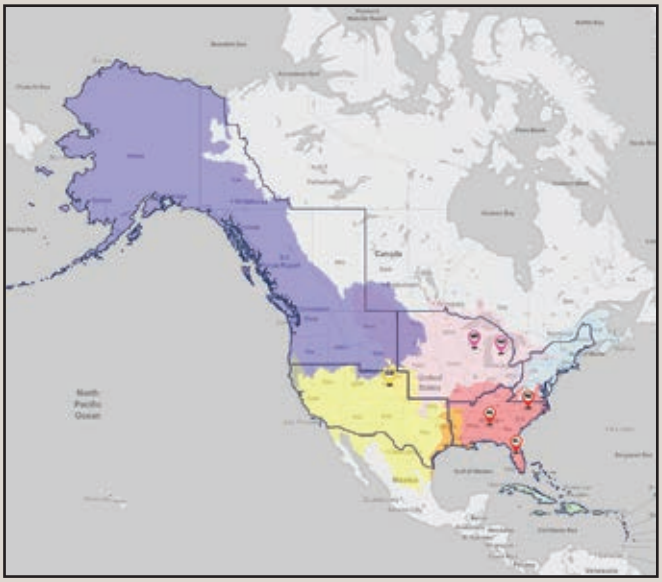


FIG. 1. Map of PARC regions, with regional working groups outlined in black, based on political boundaries. However, colored shading based on ecoregional boundaries is also included to depict how people may engage in PARC based on the location of their species of interest, research sites, or habitats with which they are most familiar; there are no constraints for participation solely based on physical address.

The partnership that comprises PARC is diverse, and includes representatives of government, industry, nongovernmental organizations, private consultants, interested individuals, and academia. Our membership now extends from western Canada throughout the continental US and into the Caribbean (Fig. 1). PARC is unique in that anyone and everyone can get involved,

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FIG. 2. Timeline of major PARC activities and accomplishments, 1999–present.

regardless of their level of experience or expertise with amphibians or reptiles. To be a PARC member, the only requirement is a passion for the conservation of herpetofauna.

Another distinctive trait of PARC is that it is truly a bottom-up organization, where those in the field conducting scientific research, or those struggling with management challenges, come together to help provide expert-based guidance and conservation action at state, regional, or even national scales. We accomplish this primarily through our five Regional Working Groups and associated state chapters, which collectively form the foundation of PARC. These groups meet annually and identify amphibian and reptile conservation needs and goals. Goals identified then become projects or initiatives of Task Teams at the state or regional level, and some are carried forward via regional leadership to the Joint National Steering Committee. When multiple regions share the same priorities, their efforts are coordinated through National Task Teams.

Facts and Figures:
In its short history, PARC can attribute:

- Over **$4.1 Million** in grants and contributions that were directly related to PARC conservation activities and products.
  - Many of these grants also supported post-doctoral, doctoral, or master's degree student research.
  - Sources were primarily federal grant programs and direct contributions, including Landscape Conservation Cooperatives, Competitive State Wildlife Grants, Regional Conservation Needs (Northeastern US), National Park Service, US Fish & Wildlife Service, Bureau of Land Management, Department of Defense Legacy Resource Management Program, US Forest Service (USFS), and others.
  - Sources of cash and in-kind matching funds for these grants included numerous state fish and wildlife agencies and academic institutions, and other private and nongovernmental partners, such as The Orianne Society and the Amphibian and Reptile Conservancy (ARC).
- Over **184,000** hits to our jobs page since we relaunched our website in November 2010.
- Over **3600** "likes" on our national Facebook page, and many more on each regional page.
- Over **2000** subscribers to our listserv, which has evolved over the years into an announcement-only, informational list.
- Nearly **500** followers on our national Twitter handle, @PARCorg.

PARC's History, in Brief

PARC was established in 1999 to address widespread declines, extirpations, and range reductions of amphibians and reptiles primarily in the United States. Over 200 people attended the inaugural PARC meeting, including 40 representatives of academic and research institutions. PARC was created as the first and only network to focus on all native amphibians and reptiles, regardless of conservation status. We work proactively to benefit herpetofaunal populations before regulatory actions are required. Our intent is to "keep common species common." Because of PARC's inclusive nature, with respect to people as well as herpetofauna, we believe it to be the most comprehensive conservation effort ever undertaken for amphibians and reptiles.

As shown in Fig. 2, we have maintained steady growth overall since our inception. An increase in activity occurred starting in 2006, facilitated by an extended period with both of PARC's paid national coordinators in place (see below). The two coordinators were able to work together to initiate issue-driven conferences and training workshops, begin identifying strategic directions for PARC, and support the regional working groups that were seeking to achieve structure and stabilization. Although there has been occasional turnover among the two coordinator positions, both are filled currently, and we are again experiencing another burst of activity as an organization.

Our 2007 international conference, "Amphibian Declines and Chytridiomycosis: Translating Science into Urgent Action" convened over 200 participants representing nine countries across four continents, including 68 attendees from academic research institutions. We held our 2010 and 2013 roads and energy symposia, respectively, at the Joint Meetings of Ichthyologists and Herpetologists. In 2014, our "15 and Forward" symposium at The Wildlife Society annual conference celebrated PARC's 15 years of growth and accomplishments; interactive sessions helped identify potential areas of improvement and future directions.

The PARC Organization

Joint National Steering Committee.—The 21-member governing body of PARC with representatives from each of five regional working groups, external advisory committees, the national chairs and coordinators, and three at-large members representing industry, zoos, and nongovernmental organizations (Fig. 3) (Table 1).

External Advisory Committees.—The chairs of two external advisory committees serve on PARC's Joint National Steering Committee.

Federal.—Eleven (11) federal natural resource and land management agencies are represented on PARC's Federal Agencies



Fig. 3. The PARC organizational structure. Arrows depict the general flow of communication. Regional working groups form the foundation of PARC, driving up priorities and issues via their regional co-chairs to the Joint National Steering Committee (JNSC), the governing body of PARC. These co-chairs as well as the co-chairs of the external advisory groups, and at-large members, sit on the JNSC. Staffing is provided by two National Coordinators.

TABLE 1. Membership of the Joint National Steering Committee, the governing body of PARC, as of December 2015. Regional leadership elections occur at regional working group meetings, and national leadership elections occur each Spring.

Name	Affiliation	PARC Role
JJ Apodaca	Warren Wilson College, North Carolina	National Co-chair
Kristin Stanford	Ohio Sea Grant and Ohio State University Stone Lab	National Co-chair
Jen Williams	PARC, Colorado	National Coordinator, federal agencies
Priya Nanjappa	Association of Fish & Wildlife Agencies/PARC, DC	National Coordinator, state agencies
Alex Novarro	University of Maryland	Communication Specialist
Rob Lovich	US Naval Facilities Command, Southwest, California	Federal Agencies Steering Committee Co-chair
Casey Burns	Bureau of Land Management, Alaska	Federal Agencies Steering Committee Co-chair
Patty Riexinger	New York Department of Environmental Conservation	AFWA Amphibian & Reptile Subcommittee Chair
Eric Gardner	Washington Department of Fish and Wildlife	AFWA Amphibian & Reptile Subcommittee Vice-chair
Erica Hoaglund	Minnesota Department of Natural Resources	MW PARC Co-chair
Mark Jordan	Indiana-Purdue University, Fort Wayne	MW PARC Co-chair
Kathy Gipe	Pennsylvania Fish and Boat Commission	NE PARC Co-chair
Brian Zarate	New Jersey Department of Environmental Protection	NE PARC Co-chair
Kris Kendell	Alberta Conservation Association	NW PARC Co-chair
Betsy Howell	US Forest Service, Washington	NW PARC Co-chair
Andrea Drayer	Eastern Kentucky University	SE PARC Co-chair
Tom Gorman	Virginia Tech	SE PARC Co-chair
Michelle Christman	US Fish and Wildlife Service, New Mexico	SW PARC Co-chair
Clint Henke	ERO Resources, Colorado	SW PARC Co-chair
Jessica Homyack	Weyerhaeuser, North Carolina	At-large Member, Industry
James Lewis	Amphibian Survival Alliance, Virginia	At-large Member, NGO
Steve Olson	Association of Zoos and Aquariums, DC	At-large Member, Zoos
Jeff Holmes	Amphibian and Reptile Conservancy, Tennessee	ARC representative, Ex-officio
Ed Christoffers	Amphibian and Reptile Conservancy, Pennsylvania	ARC representative, Ex-officio
Linda Weir	US Geological Survey, Maryland	Past National Co-chair, Ex-officio
Polly Conrad	Utah State University	Past National Co-chair, Ex-officio

Steering Committee (FASC). These agencies are signatories to a PARC Memorandum of Understanding, established in 2001 and renewed every ten years, which formalizes their support and participation in the organization.

State.—States are represented in PARC via the Amphibian & Reptile Subcommittee of the Association of Fish and Wildlife Agencies (AFWA), which is a coordinating entity for all state and territorial fish and wildlife agencies in the United States and Canada. The subcommittee was established in 2008.

Regional Working Groups.—These groups are the foundation of PARC, where most of our members began their involvement. The Northeast (www.northeastparc.org) and Southeast (www.separc.org) are the oldest of the five regional working groups (regions), having initiated annual meetings in 1999 and 2000, respectively, shortly following PARC's first organizational meeting. The Midwest (www.mwparc.org) and Southwest (www.swparc.org) regions were initiated in 2002, and began regular annual meetings in 2006 and 2007, respectively. The Northwest region began meeting in 2008, and in the following year, expanded into western Canada. In 2013, the Southeast region expanded into the Caribbean.

Multiple examples exist in each region of people who became connected with PARC as undergraduate or graduate students, often due to involvement and encouragement by their professors to attend regional PARC meetings. In turn, many students have risen into leadership roles within PARC. One such example is our current Joint National Steering Committee chair, Dr. JJ Apodaca (Professor of Conservation Biology, Warren Wilson College). JJ began attending Southeast PARC regional meetings as a first-year graduate student. He went on to become co-chair of that region, and now leads the PARC organization.

Among those who have chaired the regions or the national steering committee over the years, representatives have included:
- 20 from academic research institutions
- 10 from federal agencies
- 20 from state/provincial agencies
- 1 from industry
- 4 from zoos
- 3 from non-governmental organizations
- 6 from private consultancies

National Coordination.—There are two paid, national coordinators for PARC. The Federal Agencies Coordinator, Dr. Jen Williams, is the only full-time, paid national employee for PARC. The position is supported by the contributions of several federal agencies, and is term-limited to four years. However, efforts are underway to make this role a permanent, federal position, given the longevity of support and need for such coordination capacity among the federal agencies.

The State Agencies Coordinator, Priya Nanjappa, is the only other paid national employee for PARC. This position was initially devoted to PARC and herpetofaunal conservation, and was supported by state and nongovernmental sources and grants. However, due to various funding challenges, and to increase the stability of the position, the position portfolio was shifted. As such, 1/3 of Priya's time is spent in her PARC role while another 1/3 of her time is spent coordinating state agency amphibian and reptile conservation activities. The remaining 1/3 of her time is spent addressing invasive species policy (all taxa) for AFWA. The position is now funded by a variety of state, federal, and private sources.

Both Jen and Priya address general national PARC coordination, including conference and symposia development, implementation of national priorities, and serving as national points of contact for PARC. These duties are in addition to specific projects and tasks for federal and state agencies, respectively. The federal position is currently hosted by the National Park Service in Fort Collins, Colorado, while the state position is hosted by the Association of Fish and Wildlife Agencies in Washington, DC.

The Amphibian and Reptile Conservancy

The Amphibian and Reptile Conservancy (ARC) is a 501(c)(3) non-profit organization that supports amphibian and reptile conservation, and PARC activities. Originally named Friends of PARC, Inc., it was founded by former PARC leaders in November 2007 and received its non-profit, charitable organization tax status in 2009. Because PARC is not an incorporated entity, ARC serves as the fiscal sponsor for PARC, handling and distributing funds, fundraising, and managing grants. Staffed by two volunteer officers and managed by a board of eight directors, ARC's operations are supported by product sales and a modest amount from overhead from grant management, as well as from donations from partners and the general public. To learn more about ARC or to read their prior annual reports, visit www.amphibianandreptileconservancy.org.

Current and Future Conservation Programs and Projects

Priority Amphibian and Reptile Conservation Areas (PARCAs).—The concept of identifying geographic areas that are important for the survival of herpetofauna arose about the same time within the southeast, northeast and southwest regions. Given this broad interest, a national task team was formed in 2008 to develop criteria and an implementation plan, completed in 2012. In 2015, the PARC Joint National Steering Committee agreed to make the implementation of PARCAs a national priority for the next three to five years. Modeled in part on the successful Important Bird Areas concept, this effort aims to promote voluntary conservation actions through the identification of the most significant geographic areas important for herpetofauna. Determination of PARCAs is intended to be coordinated nationally, but implemented locally at the state or regional scale. PARCAs carry no regulatory authority; however, the goal is to encourage and incentivize habitat management, restoration, or acquisition actions to benefit amphibian and reptile populations. Shapefiles for PARCAs will be made available for download via the PARC website starting in 2016. Our hope is that these areas will help scientific and conservation communities leverage research and management activities within them.

Roads Task Force.—In 2015, Johns Hopkins University Press published the book, *Roads and Ecological Infrastructure*, part of their new book series with The Wildlife Society. This book was a direct result of the PARC National Roads Task Force, which was created to develop solutions and conservation strategies for passage, connectivity, collision, and other road-related issues for amphibians and reptiles, in partnership with transportation entities. The book offers the most current research and knowledge in maintaining ecosystem connectivity and natural ecological functions while minimizing road effects on animals, including herpetofauna, small mammals, and other small vertebrates. Support for this effort has been generously provided by the USFS, ACO Wildlife, and ARC.

Disease Task Team.—Several recent amphibian and reptile pathogens, such as *Batrachochytrium salamandrivorans* (*Bsal*), ranavirus, and snake fungal disease, have received significant attention for their threat to herpetofaunal biodiversity. To address these threats, PARC formed a disease task team in January 2015 composed of biologists, veterinarians, and wildlife managers from the United States, Canada, and Mexico, with the goal of facilitating and guiding communication, collaboration, and response to outbreaks of herpetofaunal diseases. The team has developed a website, created a handout on *Bsal*, started a regional list of professional contacts when new disease outbreaks occur, and supplied input on the North American response to *Bsal*.

Federal Agency Conservation Activities.—PARC's federal agency partners have voiced their need for, and interest in, receiving conservation and management guidance for amphibians and reptiles. Very few agencies have full-time, permanent herpetologist positions. Given this lack of herpetofaunal management and conservation capacity, they have been strong supporters, both financially and in an advisory role, for PARC to help meet federal agency information and capacity needs. In 2009, the Department of Defense (DoD) took a particular interest in elevating the profile of herpetofaunal conservation on their lands and initiated an agency-based subgroup, DoD PARC. In 2015, a DoD PARC Strategic Plan was officially approved and implementation is underway.

State Agency Conservation Activities.—Only about 1/2 of state fish and wildlife agencies have full-time herpetologists on staff, yet all states are charged with managing herpetofauna. In particular, states are charged with overseeing personal and commercial uses of herpetofauna. In 2000, Congress mandated states to develop State Wildlife Action Plans that identified species of greatest conservation need, and priority conservation goals and actions. With PARC starting around the same time, partnering to provide the latest scientific information that could aid the development of these plans was a natural fit. Over the years, PARC representatives have advised in the development and revision, and have developed products that would guide the implementation, of these State Wildlife Action Plans. One state that has been particularly innovative in developing their herpetofaunal conservation capacity is North Carolina. There, the coordinator of the state PARC chapter is a full-time, paid employee of the North Carolina Wildlife Resources Commission. The state coordinator and other chapter members work together on matters of herpetofaunal conservation and management.

Through the financial support and in-kind contributions of both state and federal agencies, PARC has developed several conservation projects for them geared toward their employees or toward conservation and management on their lands. We implement these projects using our network of scientific and topical

experts as authors, information resource providers, instructors, or project leads. The following are a subset of these existing and future resources:

- Habitat Management Guidelines regional book series
- Inventory and Monitoring recommended techniques manual
- Training workshops in
  - habitat management, and inventory and monitoring guidance
  - law enforcement, including basic species identification and handling
  - wetland restoration and creation, resulting in the restoration or creation of more than 40 wetlands since 2013
- Guidance for sustainable use of herpetofauna through regulatory measures
- Webinars on scientific research findings, and in basic herpetology
- Identification of PARCAs, and incentivizing conservation actions within them
- Climate vulnerability assessments of priority herpetofauna
- Coordinated sampling and surveillance for the *Bsal* fungal pathogen

Internships

Starting in 2014, PARC initiated internships geared toward students or others interested in assisting us in our communications, social media, and photo curation. Such opportunities for engagement become available periodically, and are excellent ways to network within our broad partnership, demonstrate leadership and initiative on a resumé, and, if desired, gain college credit.

Summary

Science is in everything that PARC does; the involvement of scientists and experts on species and conservation issues is what keeps our efforts current and useful. At the national scale, we tackle large, overarching issues, while at regional and state scales, we tackle more specific and focused issues. At all levels, there are opportunities for anyone, whether an undergraduate or graduate student or a tenured professor, to become involved or even lead in our conservation initiatives and focused projects.

The PARC connection to the 2015 SSAR meeting provided an opportunity for our colleagues who are not typically able to attend scientific meetings to hear talks on cutting edge research and to network with the SSAR community. The social events were especially enjoyable, with the chance to meet and talk with our herpetological heroes and rising stars alike. PARC members were greatly appreciative to SSAR for the opportunity to partner in the planning of the conference, particularly the time granted to PARC to present information about our activities during the plenary session, and also the space provided to create nontraditional, applied symposia. Many students approached PARC members throughout the meeting to say that they were previously unfamiliar with our organization and indicated an interest in becoming more involved.

The chance to reach so many budding and established herpetologists in one place was immensely valuable to PARC. We hope, following the meeting, SSAR members think of PARC more readily, and perhaps this article will further facilitate engagement from the SSAR community in the future. To participate in PARC meetings or activities, please visit our website (www.parcplace.org) for additional information, or contact our national coordinators, Priya Nanjappa (pnanjappa@fishwildlife.org) or Jen Williams (jen_williams@nps.gov). We look forward to further strengthening this important partnership with SSAR and hope you will join us at our upcoming regional and state chapter meetings. Likewise, we hope to see you all again as part of further PARC involvement in future SSAR meetings.

Acknowledgments.—We are deeply indebted to Joe Mendelson for the invitation to PARC to collaborate with SSAR on the 2015 meeting, and for his additional efforts to better connect our two organizations in the past few years. We also acknowledge Kraig Adler, Bob Aldridge, Aaron Bauer, Rafe Brown, Rich Glor, and Robert Hansen for their interest and assistance in including PARC as a co-sponsor of the 2015 SSAR meeting, leading to the development of this manuscript. We thank Kraig Adler, in particular, for the idea to create such an article, and suggestions for content as well as improvements to early drafts. We are appreciative to Linda Weir and Kristin Stanford for their ideas and insights in the development of this manuscript, and in planning content for the meeting. Our gratitude extends to Phillip deMaynadier, Bill Sutton, David Bender, and Danny Martin for their direct assistance in planning and coordinating some of the PARC symposia and events held at the 2015 SSAR meeting, and to Kimberly Andrews, Bob Brodman, Jason Daniels, Allison Sacerdote-Velat, John Moriarty, and George Pisani for their time and suggestions as part of the PARC-SSAR planning team. Valorie Titus was instrumental in coordinating items for, and overseeing, the PARC booth, and student volunteers Alex Novarro, Sarah Bailey, and Kiley Briggs provided excellent assistance during the PARC symposia with loading talks and timing speakers. Scott Hove provided us with excellent graphic design of the figures in this paper. Finally, we are grateful for the financial support provided by the Amphibian and Reptile Conservancy, and Jeff Holmes and Ed Christoffers in particular, toward the PARC events and speakers at the 2015 SSAR meeting.

ZOO VIEW

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Studies on Lizards and Tuataras in Zoos and Aquariums. Part II—Families Teiidae, Lacertidae, Bipedidae, Amphisbaenidae, Scincidae, Cordylidae, Xantusiidae, Anguidae, Helodermatidae, Varanidae, Lanthanotidae, Shinisauridae, Xenosauridae, and Sphenodontidae

> The human imagination has never run as wild with lizards as it has with snakes; the familiar English expression "snake story" does not have its counterpart for lizards. Perhaps the one worldwide false belief about lizards is that they are venomous, and this belief is much harder to explain than the corresponding one about snakes. How could the presence of two poisonous lizards in sparsely inhabited parts of North America give rise to an interhemisperical belief that all lizards are dangerous? As a boy living in Georgia, I was taught to fear the little skinks (*Eumeces*) with their brilliant azure tails. The ominous name "scorpion" is applied to them there, to the confusion of many who know the scorpion as an invertebrate with a jointed, stinging tail. In tropical America, Africa, and Asia a general fear of lizards is often prevalent, and is based on the conviction that all are deadly.
>
> —Clifford H. Pope, *The Reptile World*, 1955

In Part I in the last issue of *Herpetological Review*, I included an introduction to the studies of captive lizards mostly in zoos and aquariums, history of lizards in these institutions, and lizard families Iguanidae, Agamidae, Chamaeleonidae, and Infraorder Gekkota**.** In this article (Part II), I continue with the rest of the lizard families and Tuatara.

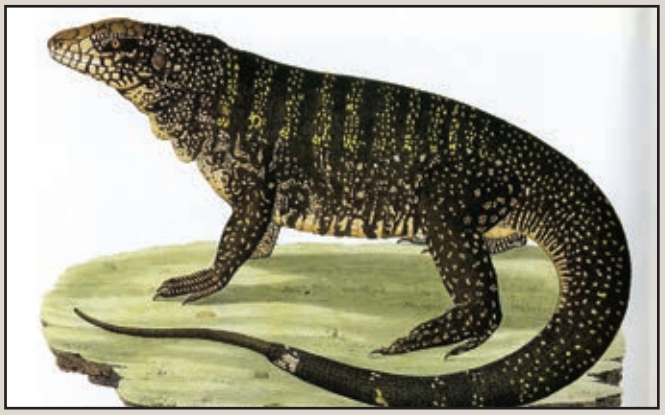
Family Teiidae—At National Zoo, Hall (1978) documented husbandry, behavior, and breeding of Tegu lizards (*Tupinambis tequixin*) (Fig. 1.). McCrystal and Behler (1982) described husbandry and reproduction of captive Giant Ameiva (*Ameiva ameiva*) at New York Zoological Park. At Prague Zoo, Rehák (1999) bred the Guyana Caiman Lizard (*Dracaena guianensis*; Fig. 2.) and Denver Zoo has been successful in breeding this taxon. Three neonates hatched at the Shedd Aquarium in Chicago in 2005.

At the American Museum of Natural History in New York, Townsend (1979), Porter et al. (1994) and Townsend and Cole (1985) established colonies of parthogenetic whiptail lizards *Cnemidophorus* spp; a colony of parthenogenetic *C. exsanguis* reached seven generations. Tocidlowski et al. (1997) from North Carolina Zoological Park diagnosed teratoma in the Desert Grassland Whiptail (*Cnemidophorus uniparens*).

How could we have ever imagined that we would know precisely when a new species came into existence? Cole et al. (2014) described a new species called Neaves' Whiptail Lizard (*Aspidoscelis neavesi*). Their abstract: "The first known tetraploid amniote that reproduces through parthenogenetic cloning by individual females is named and described. The species originated through hybridization between *Aspidoscelis exsanguis* (triploid parthenogen) x *Aspidoscelis inornata* (diploid bisexual or gonochoristic species) in the laboratory." Future zoo record keeping for population managers or scientists who bank biomaterials is likely to be challenging—"Normally, new species are named not because they are newly formed but because they became recently known to science. In this case, *A. neavesi* really is a new species; its date of origin was August 12, 2008, when the first F_2 individual hatched."

Family Lacertidae—Herrmann (1998) from Cologne Zoo described reproduction in the East African Fringe-tailed Forest

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Fig. 1. Illustration of Common or Black Tegu (*Tupinambis tequixin*) by H. R. Schinz in 1833, *Naturgeschichte und Abbildungen der Reptilien*. Tegus remain popular zoo lizards, hardy, large, and showy.



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Fig. 2. Illustration of Caiman Lizard (*Dracaena guianensis*) in Baron Georges Cuvier's *Le règne animal…*, published in 1836–9. This lizard easily crushes large snail shells, which compose a significant part of the diet.

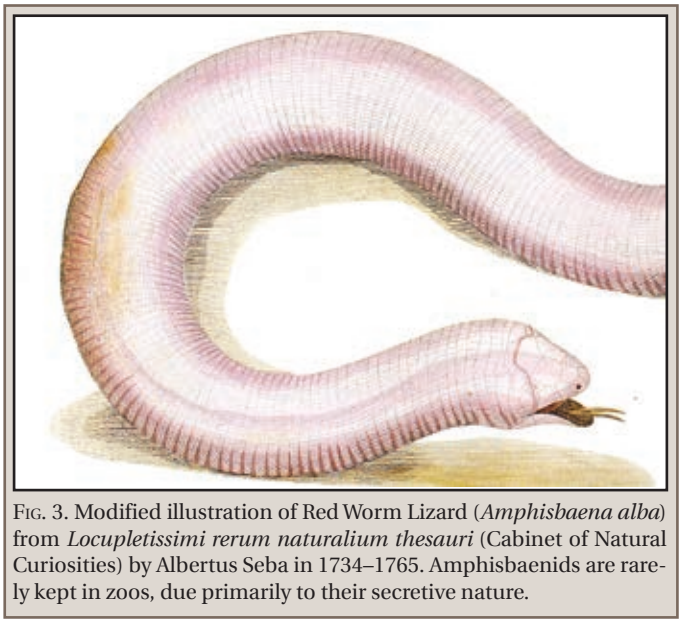
Lizard (*Holaspis guentheri laevis*). Avery (1994) discussed "shuttling thermoregulatory behavior" in two European lacertid lizards: *Lacerta vivipara* and *Podarcis muralis*. Cooper (1958) published observations on the eggs and young of the Wall Lizard (*Lacerta muralis*). Mendyk and Agragna (2014) described two introduced populations of the Italian Wall Lizard (*Podarcis siculus*) on Staten Island, New York. Rehák (2015) from Prague Zoo, Czech Republic, described the program for protecting and managing the European Green Lizard (*Lacerta viridis*).

Family Bipedidae—Jonathan Campbell brought a number of Four-toed Worm Lizards (*Bipes caniculata*) from Mexico to Dallas Zoo and they were hardy captives but insisted on burrowing so they were kept in jars with substrate in the rear section where they were off-exhibit. They fed avidly on small insects such as crickets, sarcophagid fly larvae, and mealworms (*Tenebrio*). Shaw (1962) wrote an article on the genus in the San Diego Zoo publication named ZOONOOZ, which can be turned upside-down but remains the same.

Family Amphisbaenidae—The only amphisbaenian I have seen on exhibit were several adult Red Worm Lizards (*Amphisbaena alba*) in the late 1960s at Fort Worth Zoo (Mehrtens 1962; Fig. 3.). John Mehrtens (pers. comm.) said they were hardy captives and showed no inclination to burrow out of sight. They were always visible every time I visited. The diet was a variety of insects and spiders.

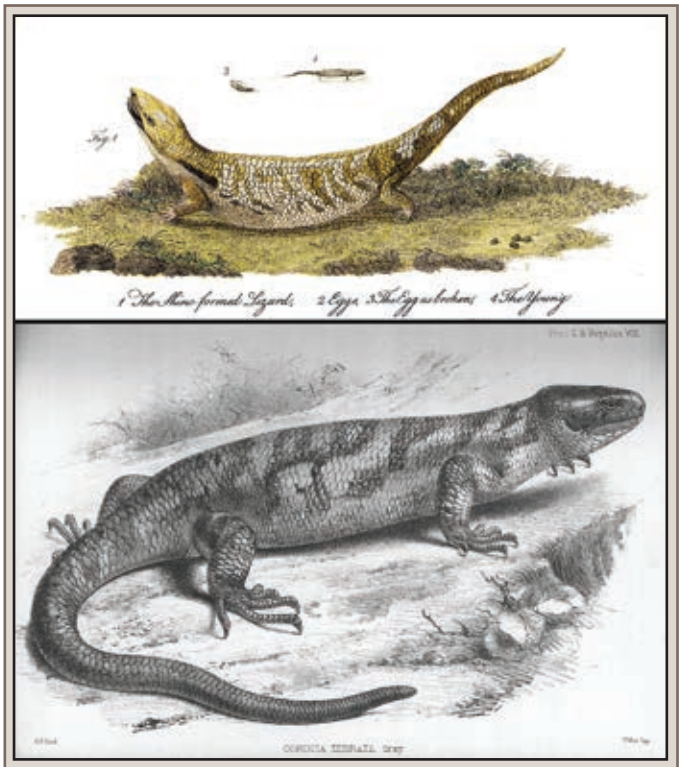
Family Scincidae—At London Zoo, the first New Guinea Blue-tongued Skinks (*Tiliqua gigas*) were purchased on 17 June 1852 and gave birth to 27 neonates between 1866 and 1893 (Coote, 2001). Carpenter and Murphy (1978) saw tongue displays directed toward conspecifics by the Common or Australian Blue-tongue Skink (*Tiliqua scincoides*) at Dallas Zoo (Fig. 4, top). Tschambers (1949) from Brookfield Zoo documented birth of this lizard. Schildger and Wicker (1987) used endoscopic gender determination in the Shingleback Skink (*Tiliqua rugosa*) at Frankfurt Zoo (Fig. 5.). Schneider (1941) described fat storage in the tails of helodermatids and *T. rugosa*. The Melbourne Zoo sent a group of Shingleback Skinks to Dallas Zoo. We were interested in the intriguing reports on mate fidelity (over ten consecutive years) being published by C. Michael Bull and associates (1987, 1988, 2000). Our group was comprised of both sexes but we never saw male-male combat, courtship or copulatory behavior, much less evidence of monogamy. Our lizards thrived although one problem was the difficulty of shedding skin on digits, even when maintained on a rough substrate. The skinks had to be soaked in water and stuck skin manually removed with tweezers. If humidity was increased to try to prevent this problem, dermal lesions mostly on the dorsum began to develop.

Honegger (1975, 1985) from Zürich Zoo detailed the management and biology of the Prehensile-tailed Skink (*Corucia zebrata*). Groves (1994) described husbandry and reproduction of the colony of skinks at Philadelphia Zoo. Wright (1992, 1993) and Wright and Skeba (1992) explored husbandry and medical management of this skink at the Zoo. At Dallas Zoo, the skinks climbed the smooth metal shafts of snake hooks held in a vertical plane—a truly remarkable show of strength (Fig. 4, bottom). These hooks were slightly over four feet in length and constructed with aluminum golf club-shafts. When lifted on the hook, all lizards would start climbing the shaft until the handle was reached. If the hook was reversed, the lizards began moving again toward the top. The tails were very loosely coiled around the shaft; movement was accomplished by gripping the shaft tightly with three feet and extending one foreleg to move ahead.



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FIG. 3. Modified illustration of Red Worm Lizard (*Amphisbaena alba*) from *Locupletissimi rerum naturalium thesauri* (Cabinet of Natural Curiosities) by Albertus Seba in 1734–1765. Amphisbaenids are rarely kept in zoos, due primarily to their secretive nature.



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FIG. 4. Two of the largest skinks on the planet are pictured here. Top: Illustration of Eastern Blue-tongued Skink (*Tiliqua scincoides*) from *Journal of a Voyage to New South Wales with Sixty-five Plates of Non Descript Animals…* by John White (1790). This lizard displays its dramatic blue tongue toward conspecifics. Bottom: Prehensile-tailed Skinks (*Corucia zebrata*) from Solomon Islands and Papua New Guinea are incredibly strong. These skinks can climb the smooth metal shafts of snake hooks with aluminum golf club-shafts held in a vertical plane. Illustration from J. E. Gray's *New genus of fish-scaled lizards* (*Scissosaurae*) *from New Guinea* (1855).

Preserved lizards were scanned by a technician at University of Texas at Arlington with SEM to see if there were morphological adaptations to palmar or plantar surfaces—none could be located.

COURTESY OF JOHN EDWARDS



FIG. 5. London Zoo keeper with Shingle-back Skinks (*Tiliqua rugosa*) between 1872–1890. These lizards develop permanent pair-bonds (social monogamy) for up to 10 years.



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FIG. 6. Modified image of Zonure (*Cordylus giganteus*) from Andrew Smith's *Illustrations of the Zoology of South Africa* (1838–1849). He was one of the first to include backgrounds in his illustrations.

Bloxam (1976) discussed maintenance and breeding of the Round Island Skink (*Leiolopisma telfairii*) at Jersey Wildlife Preservation Trust. Russell (1996) explored the natural history, captive husbandry, and reproduction of Crocodile Skinks (*Tribolonotus gracilis)* at Dallas Zoo. Morley (1992) reproduced the Narrow-banded Sand Swimmer (*Eremiascincus richardsoni*) and Post (2000) outlined captive husbandry and reproduction of the Hosmer's Skink (*Egernia hosmeri*) at Adelaide Zoo. Dathe and Dedekind (2002) reproduced Fire Skinks (*Riopa fernandi*) in Berlin Tierpark. At Dallas Zoo, a group of adult Schneider's Skinks (*Eumeces schneideri*) was on display for many years; the lizards were large, dramatic, attractive, and not secretive. Curator E. G. Boulenger (1920) from London Zoo discussed the Cylindrical Skinks (genus *Chalcides*). His father George A. Boulenger from British Museum described Armitage's Cylindrical Skink (C. *armitagei*) living in the Society's Gardens (1922).

At Dallas Zoo, three species of skinks were kept outdoors throughout the year in a massive exhibit with a hibernaculum and numerous rock crevices. The enclosure was heavily planted with cacti and succulents, mostly collected in southwest Texas. There were many other species in this exhibit such as chuckwallas, whiptails, side-blotched lizards, and fence, spiny, and sagebrush lizards. The three skinks were Five-lined Skink (*Plestiodon fasciatus*), Great Plains Skink (*P. obsoletus*) and Broadhead Skink (*P. laticeps*). All three skink neonates have vivid blue tails and each year, the exhibit would be filled with them darting through the rocks, constantly lifting and waving these tails. We assumed that this was an anti-predator behavior used to distract threatening enemies or demonstrate fitness. As the lizards matured to adulthood, the body and tail colors became muted and the skinks discontinued the tail-waving behavior.

Family Cordylidae.—Knowsley Park (1834–1851), the home of the Earls of Derby, housed the giant or Lord Derby's girdled lizard (described as *Zonurus derbianus*, now known as *Cordylus giganteus*; Figs. 6, 7.) (Keeling, 1984). At Dallas Zoo, we kept this lizard successfully. Another large African mixed exhibit there included many active and hardy lizards, exceedingly popular with visitors: Lesser Flat Lizard (*Platysaurus guttatus*), Drakensberg Craig Lizard (*Pseudocordylus subviridis*), Armadillo Girdled Lizard (*Cordylus cataphractus*); some Large-scaled Snake Lizards (*Chamaesaura macrolepis)* spent most of the time resting in tufts of grass. The enclosure had many rocky crevices and multiple basking spots.

Clay Garrett, one of my employees at Dallas Zoo, surprised me by naming a new species of *Eimeria* (Apicomplexa) from our *Cordylus cataphractus* from Namaqualand, South Africa after me (Upton et al. 1993).

Family Xantusiidae.—Holmback (1984) discovered parthenogenesis in the Central American Night Lizard (*Lepidophyma flavimaculatum*) at San Antonio Zoo. At Dallas Zoo we received a group of Desert Night Lizards (*Xantusia vigilis*) and Granite Night Lizards (*X. henshawi*) as food lizards from a California supplier but the keepers wanted to keep them as pets instead—they said that these creatures were too adorable to feed to other lizards. Receiving a stay of execution, they lived for years.

Family Anguidae.—Lawler and Norris (1980) bred the Haitian Giant Galliwasp (*Diploglossus warreni*) at Knoxville Zoo and over 300 offspring have been produced at the Nashville Zoo since 2000. One Central American Giant Galliwasp (*Diploglossus monotropis*) hatched at Nashville Zoo in 2005. Claffey and Johnson (1983) reproduced the Sheltopusik (*Ophisaurus apodus* now *Pseudopus apodus*) at Metro Toronto Zoo (Fig. 8.).

At Dallas Zoo, we successfully kept two species of *Abronia*: Mixtecan Arboreal Alligator Lizard (*A. mixteca*) and Martin del Campo's Alligator Lizard (*A. martindelcampoi*); and Imbricate Alligator Lizard (*Barisia imbricata*). They were kept at ca. 72°F (22°C) ambient temperature with a basking spot. Ardell Mitchell at Dallas Zoo collected the holotype of a new *Abronia* from Mexico, later named Mitchell's Arboreal Alligator Lizard (*A. mitchelli*) in his honor by Jonathan Campbell. Campbell collected an original series of a new *Abronia* in Jalapa, Guatemala, described by Edmund Brodie and Ron Savage as *A. campbelli* in 1993. This taxon is seriously endangered, likely close to extinction. The late John Werler, director of Houston Zoo, published several papers on *Abronia* and other lizards: Werler (1951, 1970) and Werler and Shannon 1961 (description of *Abronia reidi* and

PHOTO BY E. HARDY, NATIONAL ZOOLOGICAL PARK PHOTO ARCHIVES



FIG. 7. Girdled-tailed Lizards (*Cordylus giganteus*) on exhibit at Smithsonian National Zoological Park in Spring 1934. Charles R. Knight (1874–1953) was a famous artist, known for his paintings of prehistoric creatures such as dinosaurs and extant wildlife in museums, colleges, books, stained-glass windows, calendars, and other venues. He painted murals, backgrounds in animal enclosures, and animals at several zoos—Brookfield, Lincoln Park, National, and Bronx Zoos. This habitat painting in the Zonure display was one of many commissioned for the Reptile Building at National Zoo in the early 1930s. Unfortunately, these paintings deteriorated over time and were replaced three decades later. The bison on the 1901 US ten-dollar bill was drawn by Knight.

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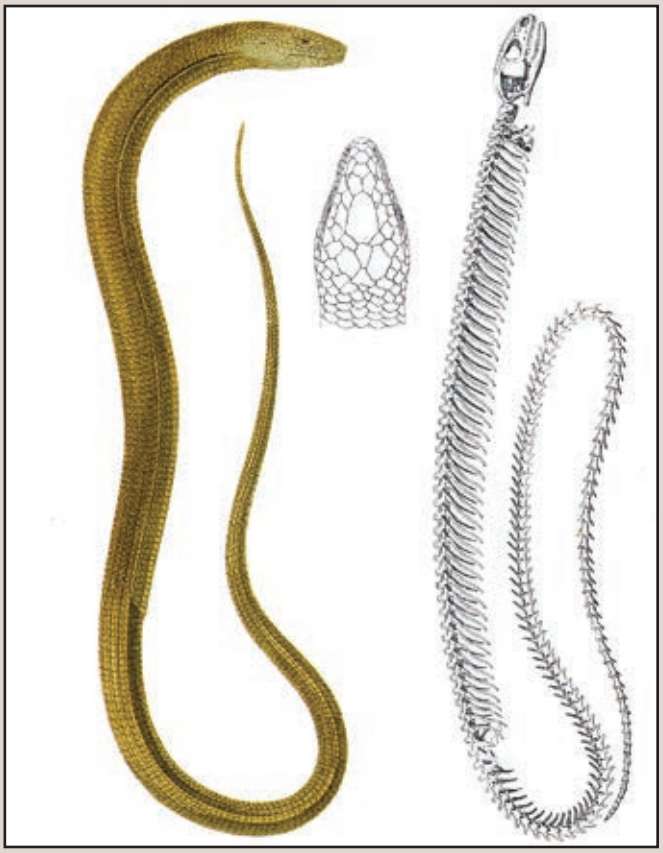


FIG. 8. Illustration of European Glass Lizard or Sheltopusik (*Ophisaurus apodus*) in Baron Georges Cuvier's *Le règne animal…*, published in 1836–1839. These hardy lizards are excellent zoo exhibit reptiles. Visitors often believe that these reptiles are snakes.

Xenosaurus sanmartinensis). He also published a paper with Jonathan Campbell in 2004 naming Ingrid's Galliwasp (*Diploglossus ingridae*) in honor of his late wife, Ingrid. One of the most interesting lizards displayed at Dallas Zoo was a small group of Madagascar Girdled Lizards (*Zonosaurus madagascariensis*). These lizards were attractive, active, and hardy in captivity. They regularly basked at high temperatures under a "hotspot" (100°F, 38°C) in a thermal gradient and fed mostly on insects rather than fruits and other vegetation.

At Dallas Zoo, we kept two species of the genus *Elgaria*: Arizona Alligator Lizard (*E. kingii nobilis*) and California Alligator Lizard (*E. m. multicarina*). Both were hardy captives and reproduced at the zoo but were likely impregnated in the wild when collected in autumn. These lizards can store sperm until eggs are fertilized. A live adult Texas Alligator Lizard (*Gerrhonotus liocephalus*) was found by a visitor in a wooded park next to a railroad track situated across the road to the front entrance of Dallas Zoo which was unusual as this is not within the range for this species. Jon Campbell said that there are no other records from Dallas and suggested that it surely escaped from our insecure collection.

Observations on the rare gerrhonotine *Coloptychon rhombifera* were made on captives at Parque Reptilandia, near San Jose, Costa Rica (Lamar et al. 2015). Neonates are spectacularly colored with bold black and white bands that become muted and the dorsum nearly patternless as the lizard ages. As this species is likely arboreal with a long prehensile tail, the eyes are oriented downward. Insects comprise the bulk of the diet, especially katydids which are a favorite food item. It moves in a snake-like, undulating fashion with limbs adpressed to the body.

Family Helodermatidae.—Murphy (2014) has covered these lizards recently in a review article.

Family Varanidae.—Horn and Visser (1989) reviewed reproduction of 20 spp. of monitor lizards in captivity and data on the biology of monitors (1991). The same authors (1997) provided an updated account which covered behavior, diet, egg incubation, light, reproduction, sexing, and taxonomy. Winston Card from Dallas Zoo and Arnold Kluge discussed hemipeneal skeleton and varanid lizard systematics (1995) and Card (1994) reported on the reproductive history of monitors at Dallas Zoo. Robert Mendyk and associates have discussed reproduction, mortality and longevity. Several reference books cover monitor lizards: Bennett 1998, Hutchins et al. 2003, Pianka et al. 2004. A survey on thermal requirements was published by Mendyk et al. (2014). An impressive and informative contribution for varanid biologists is

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FIG. 9. Illustration of Le Varan à deux bandes (*Varanus bivittatus*, now *V. salvator*) in Alfred E. Brehm's *Les Merveilles de la Nature. Les Reptiliens et les Batraciens* in 1885. Robert Mertens considered the Philippine taxon (*nuchalis*) to be a subspecies of *salvator* in his varanid monograph in 1942. Now elevated to specific status, it is rare in captivity—I have only seen one specimen at the Berlin Zoologischer Garten's Aquarium Unter den Linden in 1969.

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FIG. 10. Dumeril's Monitor *(Varanus dumerili)* from *Verhandelingen over de natuurlijke geschiedenis der Nederlandsche overzeesche bezittingen…"* by Salomon Müller (1839–1844). The newly hatched neonates are dramatically colored with a bright red head and black body with yellow-white bands.

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FIG. 11. Desert Monitor (*Varanus griseus)* from *Symbolae Physicae-Zoologica,* by Christian Gottfried Ehrenberg (1828). This varanid is at risk, due primarily to habitat alteration and is listed in CITES Appendix I.

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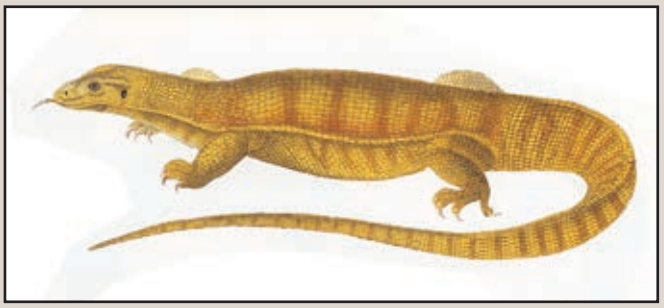


FIG. 12. Illustration of Yellow Monitor (*Varanus flavescens*) from *Illustrations of Indian Zoology Chiefly Selected from the Collection of Maj.-Gen. Hardwicke* by John Edward Gray (1830–1835). The species is listed in CITES Appendix I.

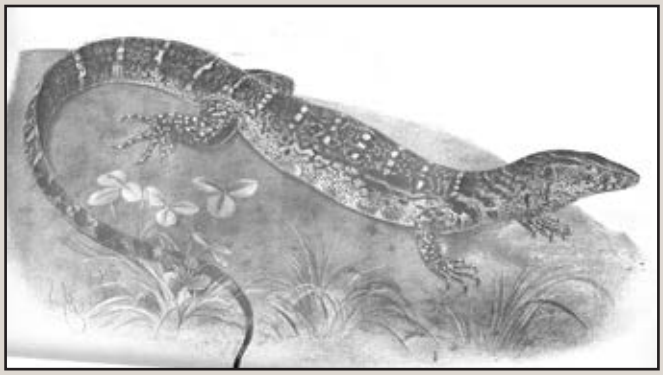


FIG. 13. Illustration of Nile Monitor (*Varanus niloticus*) from John Anderson's *Zoology of Egypt Volume First. Reptilia and Batrachia* (1898). A tame one was used for demonstrations at Dallas Zoo.

Biawak—Journal of Varanid Biology and Husbandry, an on-line journal edited by Robert Mendyk.

There are a number of accounts of Indo-Australian monitor lizards. Murphy (1971, 1972) provided data on Indo-Australian varanids at Dallas Zoo. Stirnberg (1997) described care and breeding of the Australian Lace Monitor (*Varanus varius*) in Bochum Zoo which led to 2nd generation offspring. Christie (1982) successfully introduced three incompatible male lace monitors at Indianapolis Zoo. Male Pygmy Mulga Monitors (*V. gilleni*) embraced conspecifics in an arching posture during combat rituals at Dallas Zoo (Murphy and Mitchell, 1974; Carpenter et al., 1976) and later Boyer and Lamoreaux (1983) bred this species there. Seemingly irrelevant behaviors can sometimes occur.

Dominant Pygmy Mulga Monitors treated subdominants as females after male-male combat. The loser became immobile and allowed the winner to mount and initiate pre-copulatory behaviors (Radcliffe and Murphy 1983). Irwin (1994) reported on the behavior and diet of the Queensland Tree Monitor (*V. teriae*) at Queensland Reptile and Fauna Park (now Australia Zoo). Gaikhorst et al. (2009) bred Mitchell's Water Monitor (*V. mitchelli*) at Perth Zoo. Brotzler (1965) outlined Mertens' Water Monitor (*V. mertensi*) breeding in Wilhelma Zoo (Stuttgart). In 2005, this taxon reproduced at Wildlife Conservation Society. Murphy and Lamoreaux (1978) saw dramatic bipedal threatening behavior in Mertens' water monitor directed toward other large iguanid lizards at Dallas Zoo. The varanid compressed its body laterally with gular extension. At National Zoo, this semi-aquatic species used its body and tail to herd live fishes in order to trap them in shallow water. Its body was moved parallel to the side of the pool which was rocky around the perimeter and the monitor used its tail in small radius bends to block openings between the rocks. When the fishes were trapped with no avenue for escape, the monitor turned its head posteriorly but kept body and tail in place, and grabbed some of them in mid-air as they tried to jump over the lizard (pers. observ.). Mitchell (1990) reported on reproduction of Gould's Monitors (*V. gouldii*), Garrett et al. (1996) compared chemosensory behavior and prey trail-following in the varanoid lizards *V. gouldii* and *Heloderma suspectum,* Doles and Card (1995) discussed delayed fertilization, and Card (1994) reported double clutching in Gould's Monitors and Gray's Monitors (*V. olivaceus*) at Dallas Zoo. Walter Auffenberg deposited an adult male Gray's Monitor at this Zoo. He invited one of the zoo staffers to join him in the Philippines to help gather data for his intended book on this taxon. Another male and two females were collected and transferred to Dallas where the lizards easily adapted to captivity. We tried palm nuts, various fruits, terrestrial snails and other food items based on Auffenberg's analysis but all were mostly ignored except laboratory rats which were immediately consumed. Yuyek (2012) reported on husbandry and reproduction of *V. olivaceus* at Avilon Montalban Zoological Park in the Philippines. Stunkard and Gandal (1961) identified nematodes and cestodes from the Gould's Monitor. Irwin (1996) described courtship, mating and egg-deposition by the Perentie (*V. giganteus*) at Queensland Reptile and Fauna Park (now Australia Zoo). The Melbourne Zoo kindly sent two young pair of Perentie Monitors to Dallas and one hatched later. Eidenmüller and Wicker (1991) covered captive breeding, artificial egg incubation, development and surgical removal of impacted eggs in *V. timorensis similis* at Frankfurt Zoo.

We had several Crocodile Monitors (*V. salvadorii*) ranging in size from subadults to large adults at Dallas Zoo. I learned the hard way that the long tail is a potentially lethal weapon. When I was moving the largest one from the cage to the floor, it used its tail and accurately struck me in the face with the tip, just missing my eyes. Each time it aimed for my eyes and I took to using a welder's mask to protect myself. I noticed that all of these monitors had a frothy mixture of blood and saliva around the dental arcade. At first we thought that this was due to an infectious disease but found that many captives at other zoos had this same exudate and it was also present in published photographs. It would be interesting to compare this taxon with Komodo Dragons, which often are seen with long strands of saliva hanging from the mouth. Camina et al. (2013) described husbandry and breeding of the Crocodile Monitor in two zoos in Madrid, Spain.

Hartdegen et al. (1999) observed feeding behavior of the Black Tree Monitor (*V. beccarii*) at Dallas Zoo. One interesting feature was the use of permanent prey killing sites on horizontal branches, much like raptors. Mendyk and Horn (2011) described forelimb movements and extractive foraging in this lizard. Kuppert (2013) described this unique feeding strategy in the closely related arboreal Green Tree Monitor (*V. prasinus*) at National Zoo—"… drill holes in a thick branch. The openings should be small and long enough so that the monitors cannot stick their snouts into an opening. But they must be large enough for them to reach inside with their forelimbs to extract food. It is important that the holes are drilled neatly, so that the lizards cannot injure themselves. The lizards will be able to smell the food, but not necessarily see it… Once the prey item was detected by smell or by sight, both lizards tongue-flicked around the opening to investigate its content, then stuck their snouts in the opening, only to discover that the food was out of reach. After the unsuccessful attempt with their snouts, they reached into the hole with a forelimb while maintaining eye contact with the food. The prey was hooked with the claws, extracted, and consumed. Extraction of food items out of a small opening requires highly coordinated movements of the wrist and the digits." At Dallas Zoo, this lizard would wrap the tip of its prehensile tail and drop the body from the perch and snatch prey off the substrate (see Greene 1986). Shuter (2014) described a novel underwater foraging behavior observed in *Varanus prasinus* at the Wildlife Conservation Society's Bronx Zoo; the lizard kept its eyes closed and tongue-flicking was not observed while submerged as it probed crevices for prey.

Müller (1970) bred the Water Monitor (*V. salvator*) at Leipzig Zoo (Fig. 9), David (1970) at the Ahmedabad Zoo, and Hairston and Burchfield (1992) at Gladys Porter Zoo in Brownsville, Texas. Herrmann (1999) documented husbandry and captive breeding of the water monitor in Cologne Aquarium at the Zoo. Honegger and Heusser (1969) contributed an analysis of the behavior inventory of the Water Monitor. Davis et al. (1986) recorded ritualized combat in captive Dumeril's Monitors (*V. dumerili*; Fig. 10). I saw a film of an adult Dumeril's Monitor attacking a large crab and it was grisly. The lizard began by pulling off both pinching claws, then removing each leg until only the carapace remained. Each part was quickly ingested. The crab was still alive but finally died when the monitor crushed it in its jaws and swallowed it piecemeal. Judd et al. (1977), Morris and Alberts (1996) and Morris et al. (1996) explored sex determination in the Komodo Dragon (*V. komodoensis*) and White-throated Monitor (*V. albigularis*) at San Diego Zoo.

When I was in college, I spent much time with the late George McDuffie who was a rather portly eccentric high school biology teacher in Cincinnati, Ohio. He was known throughout the region for his encyclopedic memory, evidenced by his ability to recite hundreds of limericks—mostly unacceptable in polite society—and his total lack of fashion sense, proven by the abundance of food stains and his collection's fecal matter on his clothing. Most of his garish mismatched garments appeared to be purchased for a paltry sum at a garage sale. One early evening, parents were invited to meet with him in his classroom to discuss academic progress or lack thereof related to their teenagers. Being a misanthrope, George found the whole exercise unpleasant and unproductive but his superiors insisted that this bonding be done with a positive attitude. This room was filled with tame crocodilians, tegus, rhino iguanas, water monitors, tortoises, an adult alligator snapping turtle with three legs and a cropped tail, and so on which were allowed complete freedom to traipse around

the room and rest under the desks of the students. During class, it was strange to see students resting limbs on the tops of large African spurred tortoise shells barely listening to his lectures or petting a two-meter alligator while taking a test likely to be failed. One large water monitor spent most of the time lying on the grate on top of the heater next to the window basking in the sun. I watched one elegantly-dressed mother move cautiously toward this immobile varanid until she was next to the head—clearly she thought it was dead and stuffed and wanted a closer look. The saurian flicked its tongue and the tines touched her face, causing her to jump backwards, scream loudly, and experience unanticipated micturition—she was mortified, quickly left the school without cleaning up her metabolic waste, and never returned for a future conference, according to George who found the episode most amusing. He told me that he had to figure a way to have this happen with all of the parents so he could be left in peace until retirement.

Perry et al. (1993) described the first captive reproduction of the Desert Monitor (*V. g. griseus*) at the Research Zoo of Tel Aviv University (Fig. 11). Visser (1981, 1985) provided notes on the breeding of the White-throated Monitor (*V. albigularis*) and Yellow Monitor (*V. flavescens*) in Rotterdam Zoo (Fig. 12). Monitors are known to be voracious feeders but, in a particularly strange instance, one *V. albigularis* ingested a metal fork used to feed it dog food (Hubbard 1996). Ferguson et al. (2009) used juvenile Black-throated Monitors to test the efficacy of dietary and UVB sources. Manrod et al. (2008) described rapid solving of a problem apparatus by juvenile Black-throated Monitors (*V. a. albigularis*). Barker (1984) reproduced Green Tree Monitors (*V. prasinus*) at Dallas Zoo and H. Bosch at Löbbecke-Museum + Aquazoo (1999). Davis (2014) successfully repaired a ruptured egg by using tissue adhesive at Bristol Zoo. Bosch also published on parasites in monitors (1999). Pauly (2007) diagnosed chronic stomatitis caused by an ectopic tooth in a Blue-tailed Monitor (*V. doreanus*) in Tierpark Berlin. One Black Tree Monitor (*Varanus beccari*) hatched at Buffalo Zoo in 2005. Radford and Paine (1989) hatched five Dumeril's monitors (*V. dumerili*) at Buffalo Zoo. Rehák (1996) followed the reproductive biology of the Mangrove Monitor (*V. indicus*) in Prague Zoo. Ziegler et al. (2010) reported upon the first F_2 breeding of the Quince Monitor Lizard (*V. melinus*) with conjoined dead twins at Cologne Zoo Aquarium. Ziegler et al. (2009) described the first captive breeding of the Blue Tree Monitor (*V. macraei*) at Plzen and Cologne Zoos. At Antwerp Zoo, van Dyjk (2007) trained the Nile Monitor (*V. niloticus*) and at Dallas Zoo, we used a completely tame adult for demonstrations for the visitors. This lizard allowed touching and petting, and thus was a perfect ambassador for varanid lizards (Fig. 13).

In 1942, Gustav Lederer, who redesigned the Aquarium and renamed it "Exotarium" after it was destroyed by Allied bombing at Frankfurt Zoo, published obervations on captive Komodo Dragons (*V. komodoensis*), including a photograph of a woman with a large dragon. Lederer discovered that dragons can recognize different humans and are able to distinguish one from another person. At this Zoo, the dragon knew the veterinarian after the second treatment and could no longer be persuaded to leave its hiding place as soon as the vet appeared. The lizard even recognized the operating table and fled from it (Lederer 1931). Murphy and Walsh (2006) recorded the surprising interactions between dragons and humans over time, many in zoo settings, "At the Dallas Zoo, Curator Ruston Hartdegen and associates have discovered that a dragon could discriminate between its permanent keeper, another reptile keeper who had less contact with the dragon, and a keeper from another animal department. The dragon was calm with the familiar caretaker, nervous around the less-familiar reptile keeper, and displayed defensive behavior to the keeper from another animal department (R. Hartdegen, pers. comm.). Kraken at National Zoological Park exhibited the same responses toward familiar and unfamiliar persons." Dragons have now been bred for three generations at Rotterdam Zoo but Visser et al. (2009) covered the issue of inbreeding. In this case, reproduction was not planned but four neonates suddenly appeared in a heavily-planted enclosure. Sunter (2008) described management and reproduction at London Zoo.

Murphy et al. (2002) investigated factors necessary for the captive management and conservation of these lizards and confirmed some of the Lederer observations. Komodo Dragons reproduced at National Zoo beginning in 1992 for the first time in any zoo in the Western Hemisphere, providing an opportunity to look at individual variation with a larger sample size. Four clutches were laid at the Zoo, resulting in 55 hatchlings. All but two hatchlings were tractable but those two individuals were aggressive toward humans for their entire lives. At the Zoo, an adult female named Kraken recognized the permanent keeper and researcher Trooper Walsh during trials to study play behavior; in only one instance did the lizard react in a threatening manner toward Trooper and that was when he was scratching its dorsum with his fingernails. The varanid immediately assumed an aggressive stance, extending the hyoid and compressing the body laterally. We interpreted this unusual response to a misreading of its dorsum being scratched as pre-copulatory behavior by a courting male, resulting in a rejection response. Kraken always reacted aggressively to another keeper in the department. A series of studies at National Zoo confirmed that Komodo Dragons indeed play with inanimate objects and interact with caretakers (Burghardt et al. 2002). Kuppert (2013) investigated olfaction and trail following behavior. Murphy (2014) discussed the recent research on dragon venoms and parthenogenetic reproduction. Hellmuth et al. (2012) used operant conditioning and desensitization to facilitate veterinary care with captive reptiles, including dragons at National Zoo. Since 1996, this species is listed in CITES Appendix I as vulnerable.

Chris Wemmer told me that many years ago, National Zoo herp keepers routinely fed dead animals from the collection after necropsy to reptiles. Head keeper Lee Schmeltz acquired a carcass of a muntjac that recently died in the collection and fed it to the Komodo dragon during visiting hours. The dragon seized the muntjac by the belly and tossed its head in a violent slashing motion which eviscerated the deer, splashing the glass front of the enclosure with blood, metabolic by-products, and entrails. Predictably, the incident was reported in record time to higher authorities and Schmeltz was warned never to let it happen again.

When the late Walter Auffenberg gave a talk at the Dallas Zoo's Zoological Society dinner, the topic was Komodo dragons. His book on them had been recently published and there was much interest. As we sat down for dinner, Walt showed a series of slides of dragons attacking live tethered goats and the bloody images were riveting. I figured that the vast majority of the attendees would be unable to finish their dinners but they munched away without pause as they sat staring at the graphic images. One fact was absolutely stunning: an adult female weighing 42 kg ate a wild boar carcass of 30 kg in 17 minutes; Walt's wry sense of humor was in evidence as he warned the diners not to overeat. Some years later, I went to Komodo Island and asked

the rangers if I could duplicate Auffenberg's earlier predation studies by finding several live goats to present to the dragons (see Auffenberg 1978). The Indonesian government had set aside a protected raised area for the tourists to watch dead goats being flung into a group of 20 lizards below several times a week. Ranging in size from large males to subadults, the dragons were habituated to this place in order to make an easy living. I was surprised that Timor deer and boar slowly moved and grazed quite near the lizards and these mammals were ignored. The rangers were willing to help with my observations but we could not figure out how to stake out live goats without risk to our well-being. Finally, we euthanized the goats as it simply was not safe to do otherwise. When the first young goat hit the ground to the point where not a single speck of goat other than a few tufts of hair and spilled stomach and intestinal contents were visible, I timed the episode—seven minutes! This was much faster than the timeframe I expected after reading the Auffenberg book and paper but I had counted the lizards beforehand so there were a lot of mouths operating simultaneously. Surprisingly, I never saw one dragon bite another even though they were side-by-side and vigorously tugging and tearing the carcass. The younger dragons were cautious, darting in to snatch a piece while the large ones were preoccupied with the goat. Young dragons are arboreal to avoid predation by adults. Later, one of the rangers tied a hind limb of a goat to a long rope and ran around to show how fast dragons could run. He was not running at sprinter's speed but fast enough, followed by a bunch of lizards. It reminded me of a pied piper leading a group of children. The rangers tied the goat hindquarters to a tree branch to demonstrate how the lizards could stand on their hind feet, using the tails to stabilize their bodies in three places when attempting to reach the meat. The lizards never tried to jump. Later I watched two large males of equal size stand bipedally, wrap the forelimbs around each other, and engage in ritualized combat until one was the clear winner—the struggle lasted ca. 15 minutes with no biting. The other quickly dashed away. Males courted and mounted females constantly but I never observed copulation. Females remained immobile beneath males.

The next day, I traveled to Rinja Island and watched a subadult dragon ca. one meter total length forage for two hours. The lizard thoroughly examined every branch, rock or other object, circling each possible site and directing rapid tongue-flicks under each if there was a gap beneath the object and ground. The foraging was unsuccessful. See Chiszar et al. (2009) on response of hatchling Komodo dragons at Denver Zoo to visual and chemical cues arising from prey. Later, I was walking on a dirt trail and heard an alarm call from a Timor deer. Fifteen minutes later an adult dragon ca. 2 meters slowly crossed the trail, ignoring me. The call was very loud and penetrating so I believe that the lizard made contact with the mammal but was unable to bring it down. This story does not have a happy ending. When the government decided to discontinue the feeding on Komodo so the lizards would act normally, many refused to leave the site and starved to death. Quentin Bloxam sent photographs to me documenting this saddening event (see Walpole 2001).

Pianka (1995) presented information on size differences in varanids. Body mass varied nearly five full orders of magnitude. In Australia, two major lineages have evolved extensive radiation: one evolved dwarfism (subgenus *Odatria*) and the other remained large (subgenus *Varanus*). Several evolved gigantism. When Arnold Kluge kindly placed an adult Short-tailed Pygmy Monitor (*Varanus brevicauda)* on loan to Dallas Zoo, we were

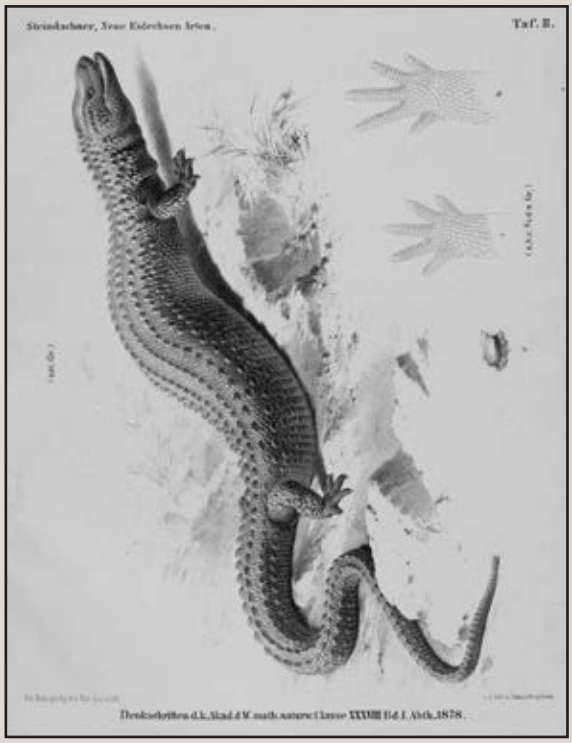


FIG. 14. Illustration of Borneo Earless Monitor (*Lanthanotus borneensis*) from Franz Steindachner's (1878) new species description in *Über zwei Eidechsen-Arten aus Süd-Amerika und Borneo. Denkschr. Kais. Akad. Wiss.* (*Wien*). Due to its rarity, only a few specimens have been kept in zoos.

able to show living examples of the World's smallest monitor and the largest (*V. komodoensis*).

Pianka and King (2004) wrote: "Recent experiments on captive *V. albigularis* by John Phillips at the San Diego Zoo suggest that some varanids can actually count. Lizards were conditioned by feeding them in groups of four snails in separate compartments with movable partitions, which were opened one at a time to allow monitors to eat each batch of four snails. Upon finishing the fourth snail, lizards were allowed into another chamber containing four more snails. After such conditioning, one snail was removed from some snail groups. Lizards searched extensively for the missing fourth snail, even when they had access to the next group. Similar experiments with varying numbers of snails showed that these varanids can count up to six, but with groups of snails larger than six, the monitors seemed to stop counting and merely classified them as "lots", eating them all before moving on to the next chamber (King and Green, 1999, p. 43)." King and Green (1999) concluded: "So it would seem goannas can count better than a lot of small children."

Family Lathanotidae.—The Borneo Earless Monitor (*Lanthanotus borneensis*) has been rarely kept in zoos, being seldom collected (Fig. 14). I have seen them at New York Zoological Society and Cincinnati Zoo. In both places, I was told that they were so secretive, they could not be exhibited. They fed on living fishes and earthworms, which the lizards located in the water with tongue-flicking. Most of the time, they remained soaking in the water dish. Three were also kept at San Diego Zoo off-exhibit, at least when I visited Chuck Shaw (see Shaw 1963). Robert Sprackland has created a recent Facebook page (https://www.facebook.com/lanthanotus) showing a neonate hatching in a Japanese zoo from an egg. The iZoo in Japan specializes in amphibians

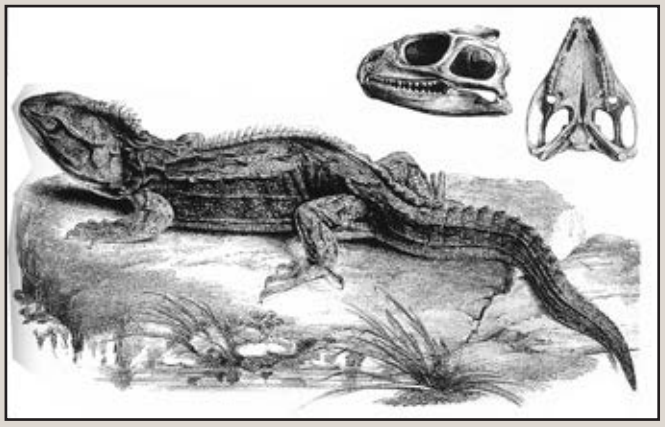


FIG. 15. Illustration of Tuatara (*Sphenodon punctatus*) in *The Lizards of Australia and New Zealand* by John Edward Gray (1867). He believed that this reptile belonged in the Family Agamidae.

and reptiles. Reproducing this species is a major accomplishment. There is a photo of the female surrounded by six eggs on the Zoo's website. Shirawa and Bacchini (2015) described captive maintenance and first reproduction.

Family Shinisauridae.—Visser (1989) and Kudryavtsev and Vassiliev (1998) reproduced the Chinese Crocodile Lizard (*Shinisaurus crocodilurus*) at the Rotterdam and Moscow Zoos, respectively. At Tiergarten Nürnberg, Germany, Mágdefrau (1997) described biology, sex determination using head morphology, care and breeding of this species. Whiteside and Garner (2001) found a thyroid adenocarcinoma in this lizard. During the past decade, zoos have been successful at reproducing this taxon. In early 2015, seven were born at Staten Island Zoo.

Family Xenosauridae.—In 2005, the San Antonio Zoo reproduced the Flathead Knob-scaled Lizard (*Xenosaurus platyceps*). We kept a group of *X. grandis* at Dallas Zoo but they did not reproduce.

TUATARA

> EVEN THE SPIRITS OF CHILDREN ARE SAID FREQUENTLY TO RETURN AS GODS, AND HEAL THE SICK WHO COME TO THEM. SOME YEARS AGO, A CHILD NAMED MATI WAS SAID TO HAVE THUS REAPPEARED ; NUMBERS WENT AND CARRIED THEIR SICK TO HIM ; HE ALWAYS TOLD THEM HE KNEW WHAT WAS THE MATTER WITH THEM—THEY HAD A LIZARD IN THEM , WHICH WAS THE CAUSE OF THE DISEASE ; OR, IF THE PERSON WAS VERY BAD, HE WOULD SAY HE HAD TWO OR MORE OF THESE REPTILES IN HIM ; AND IF EXTREMELY ILL, THAT HE HAD A GREAT RUATARA, OR GUANA [TUATARA], IN HIM ; THIS, OF COURSE, WAS VERY ALARMING TO THE FRIENDS OF THE SICK, WHO WOULD IMMEDIATELY ENTREAT THE GOD TO CAST IT OUT, WHICH HE READILY ENGAGED TO DO, ALTHOUGH SOMETIMES IT WAS STIPULATED BEFOREHAND WHAT REMUNERATION HE WAS TO RECEIVE ; HE THEN IMITATED THE SQUEAKING OF THIS LIZARD , AND TOLD THE PARTIES HE HAD EXPELLED THE REPTILE, AND THE PATIENT WOULD NOW SPEEDILY RECOVER.
>
> *TE IKA A MAUI, OR, NEW ZEALAND AND ITS INHABITANTS : ILLUSTRATING THE ORIGIN, MANNERS, CUSTOMS, MYTHOLOGY, RELIGION, RITES, SONGS, PROVERBS, FABLES, AND LANGUAGE…* BY RICHARD TAYLOR, 1870, P. 153.

When I was at Dallas Zoo, we began arrangements with the New Zealand government to receive a group of eight captive-hatched Tuatara (*Sphenodon punctatus*) from Stephens Island being held at the Wellington Zoo (Fig. 15). We worked with David Towns, a biologist who was a conservation researcher in country. One night he explained over a few beers how difficult it was to remove feral cats from these rocky islands—trapping, poisoning, shooting, and so on was ineffective. As there were no sandy beaches, one creative biologist suggested putting traps around sandboxes—amazingly, it worked beautifully and cats were removed. This was during a period when there were disagreements about who was responsible for overseeing New Zealand fauna and flora—the government or the Maori people (see Cree 2014:466–469 for an historical overview). This was a protracted exercise as there were many legal issues that had to be resolved. In the meantime, I asked Carl Gans (who had studied tuatara extensively), to share tips for keeping them successfully as he had one, which eventually was sent to the Saint Louis Zoo for breeding. I visited with curator Ron Goellner and director Charles Hoessle at the Zoo, asking advice for successful management. They kindly showed me the elaborate setup in the basement with sophisticated temperature devices since these reptiles would quickly deteriorate if kept too warm (see Goellner 1984).

After many months, the government agreed to send the animals to Dallas but an elder Maori husband and wife team would need to bless the enclosure beforehand. This was necessary as our zoo was one of the first to be granted permission to display tuataras by the New Zealand government; in the past, these reptiles had to be kept off-exhibit as stipulated by the government. When the couple arrived from New Zealand they were dressed in western clothing; they changed into traditional clothing for the blessing. This was a big event so the New Zealand government invited press and many dignitaries. It was a really nice ceremony and all guests were taken with the Maori prayers, chanting, songs, and best wishes for the well-being of the tuataras and caretakers. When finished, they changed back into their original garments in order to fly to Los Angeles to see their daughter at UCLA.

Later, Barbara Blanchard, a keeper from Wellington Zoo, accompanied the animals from New Zealand to Dallas and all went well. As we unpacked them at the Zoo, I remembered a story from Reverend Gregory Bateman (1897), "Some time ago, I was looking at the various animals in a very large dealer's establishment, when I made a remark about a fine pair of Tuateras which I saw in a big cage. The assistant who was with me immediately opened the door of the den and seized one of the reptiles by the tail, and I shall not readily forget the ominous sound made by the animal's closing jaws as he just missed the man's fingers, at which he had just snapped. I at once mentally resolved never to catch a Tuatera [sic] by the tail. As I congratulated the man upon his escape, he said, 'I am a bit lucky this time, for I have just come out of the 'orspital, where I have been laid up with blood-poisoning through the bite of one of them pythons.' " Later, we sent two specimens to Toledo Zoo but I cannot attest to their tractability.

Hick (1965) solicited comments by specialists of captive Tuatara held at the Auckland, Basel, Chester, Detroit, Dublin, Jersey, and San Diego Zoos. Austin (1962) described captive Tuatara at Detroit Zoo. Hoessle (1969) described the Tuatara display at St. Louis Zoo. Cree et al. (1994) highlighted the importance of captive management to the conservation of Tuatara in New Zealand. Goetz and Thomas (1994) used annual growth and activity patterns to assess management practices for captive Tuatara. Hartley (1963) described observations on Tuatara at Jersey Wildlife Preservation Trust. Lange (1997) outlined the husbandry and captive maintenance of 10 young Tuatara in Berlin Aquarium. Gillingham and Miller (1991) studied reproductive ethology and Gillingham et al. (1995) described social behavior. Keall et al.

(2010) described the use of artificial incubation with threatened populations.

Wood (1967) and Tintinger (1987) bred the Tuatara at Auckland Zoo. This Zoo has been involved in an important conservation program. Six of the last remaining Tuatara were removed from Cuvier Island (Repanga Island) between 1989 and 1991 for captive breeding. Thirty offspring have been produced which were returned to the island after rats were removed (Cree 2014). Newman (1982) offered suggestions for breeding Tuatara in captivity. The rare North Brother Island Tuatara (*Sphenodon guntheri*) are being produced in numbers from eggs incubated in captivity in New Zealand (Cree et al. 1994). Eight specimens were at San Diego Zoo in 2002 (Blanchard et al. 2002). Tuataras are now regarded as a single species (*S. punctatus*; Hay et al. 2010) but each island population should be maintained separately.

Liu and King (1971) described microsporidiosis in Tuatara at New York Zoological Park. Blanchard (1992) focused on management in the wild and in captivity. Boardman and Sibley (1991) covered captive management, diseases, and veterinary care of Tuatara, based on experiences at Auckland Zoo. Newman et al. (1979) used field observations to underscore their recommendations for captive maintenance. Two articles appeared in "Animal Kingdom," the publication of New York Zoological Society (Oliver 1953; Waddick 1973). See also Goetz and Thomas (1994), Terezow et al. (2008), and Wörner (2009).

An important book has just been published by Alison Cree, called *Tuatara*: *Biology and Conservation of a Venerable Survivor* (2014). Contents include biological, historical, cultural, and conservation topics. Major Stanley Smyth Flower (1925) had his final word, "That *Sphenodon* lives to fourteen years, and probably longer, is a fact of interest." Flower's record of over 28 years refers to a captive Tuatara at University of Upsala, Sweden, whereas Dawbin (1946) lists longevity at 77 years for one kept by Europeans in New Zealand. This sentence from Dawbin caught my attention, "Dr. Falla (1935) records a specimen which lived in a shell pit at Motiti Island and was said to have been known to the Maoris for 300 years." My final word is that unlike Richard Taylor's report, I have never heard a Tuatara make a croak, much less a squeaking sound. And as far as I know, no guana has ever lived in me, even when I was really sick.

Acknowledgments.—This paper is dedicated to my son James B. Murphy III who is an environmental lawyer for Texas Parks & Wildlife Department in Austin. He has always had an intense interest in protecting biodiversity. He decided to attend law school at Lewis and Clark University in Portland, Oregon rather than becoming a biologist because a number of my herpetological friends and colleagues assured him that greater strides in conservation could be made by adopting this plan, salaries were higher, and lawyers dressed more fashionably, using his father as an example. When he was a student, his law professor invited him to be an observer at the CITES meeting in Thailand. He returned home most disillusioned, complaining about the focus on economic considerations as well as professional and personal agendas, rather than conservation priorities.

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GLIMPSES OF THE PAST

Herpetology as a discipline is comparatively modern, but it still boasts its iconic figures and its famous (or infamous) expeditions from the early days. Moreover, reptiles and amphibians often figured in the chronicles of other explorers or adventurers. Today's digital wizardry allows us to enjoy an unprecedented feast of color images featuring rare species from all corners of the globe; but what of the images of yesteryear? Sepia, black & white, and early color-toned photographs are largely unnoticed as they languish in institutional and personal archives. Often, they convey the hardships faced by early explorers and scientists. Some may be humorous; still others show legendary figures at work or at rest. From remote field camps to exotic locales, images from the past stir our imaginations, or they bring back memories of a time when life was different, there was less development, more nature, and more mystery in the world.

In this spirit, *HR* welcomes contributions to this new section. Historical materials should be copyright-free and provided as high-resolution digitized files (consult Section Editor for specifications). Accompanying text should provide relevant context and can include in-text literature citations as needed. Contributions should be submitted to William W. Lamar, Section Editor (e-mail: wlamar@uttyler.edu).

GLIMPSES OF THE PAST

Fred Medem – Crocodile Hunter

Friedrich Johann Graf von Medem, affectionately known to all as "Fred," was a Renaissance man in every sense of the term, descended from nobility, distinguished in wartime, an inveterate traveler, and possessing broad and varied interests and a ravenous curiosity about the world. He had two overriding passions: crocodilians and turtles, and these landed him, at the age of 38, in Colombia in 1950. He plied wild rivers and camped in rainforests in remote sectors of the Magdalena, Orinoco, and Amazon basins as he studied systematics and life histories of Colombia's rich chelonian and crocodilian fauna. Throughout his career he was the leading authority on these reptiles in the neotropics, but he collected everything from mammals to invertebrates and helped countless scientists, always with a smile.

Logistics were formidable and supplies scarce, so it was necessary to spend months at a time in the field. Although it was difficult, Fred was content, as he could quench his thirst for knowledge about all things natural. He never lost his sense of wonder, and on his deathbed was asking questions and expressing excitement about field observations.

—Contributed by William W. Lamar,
University of Texas at Tyler, USA
e-mail: wlamar@uttyler.edu



ALL PHOTOS FROM MEDEM ARCHIVES, COURTESY OF W. W. LAMAR

"FRED" Friedrich Johann Graf von Medem
29 August 1912 – 01 May 1984.



A juvenile Mottled-face Tamarin, *Saguinus inustus*, perches on Fred Medem's head. Tamarins are often kept as pets by locals and juveniles habitually cling to one's hair for security. El Refugio, Río Guayabero, La Macarena, Meta, Colombia, 1959.



Fred Medem collecting tabanid flies from a male *Caiman crocodilus apaporiensis* which measured 2 meters in length. On his first expedition to the Río Apaporis, Fred was struck by the remoteness and inaccessibility of the upper reaches. What he discovered there was a remarkable narrow-snouted population of caimans which he subsequently described as *Caiman crocodilus apaporiensis*. La Isla, Río Apaporis, Vaupés, Colombia, 21 February 1969.



Fred with a freshly collected female Orinoco Crocodile, *Crocodylus intermedius*, which measured 3.25 m in length. Upper Río Guayabero at El Refugio, La Macarena, Meta, Colombia, 08 March 1959.



The Medem family, cerca 1932. From left to right: Fred's mother Ellen, his father Karl, his sister Else, and a young Fred, ready for adventure.



Fred with a recently captured female Green Anaconda, *Eunectes murinus*, which measured 4.83 m in length and contained 35 embryos. Río Guayabero, La Macarena, Meta, Colombia, 03 February 1959.



Fred and an assistant pose with a Smooth-fronted Caiman, *Paleosuchus trigonatus*. Caño Itílla, Vaupés, Colombia, 13 March 1958.



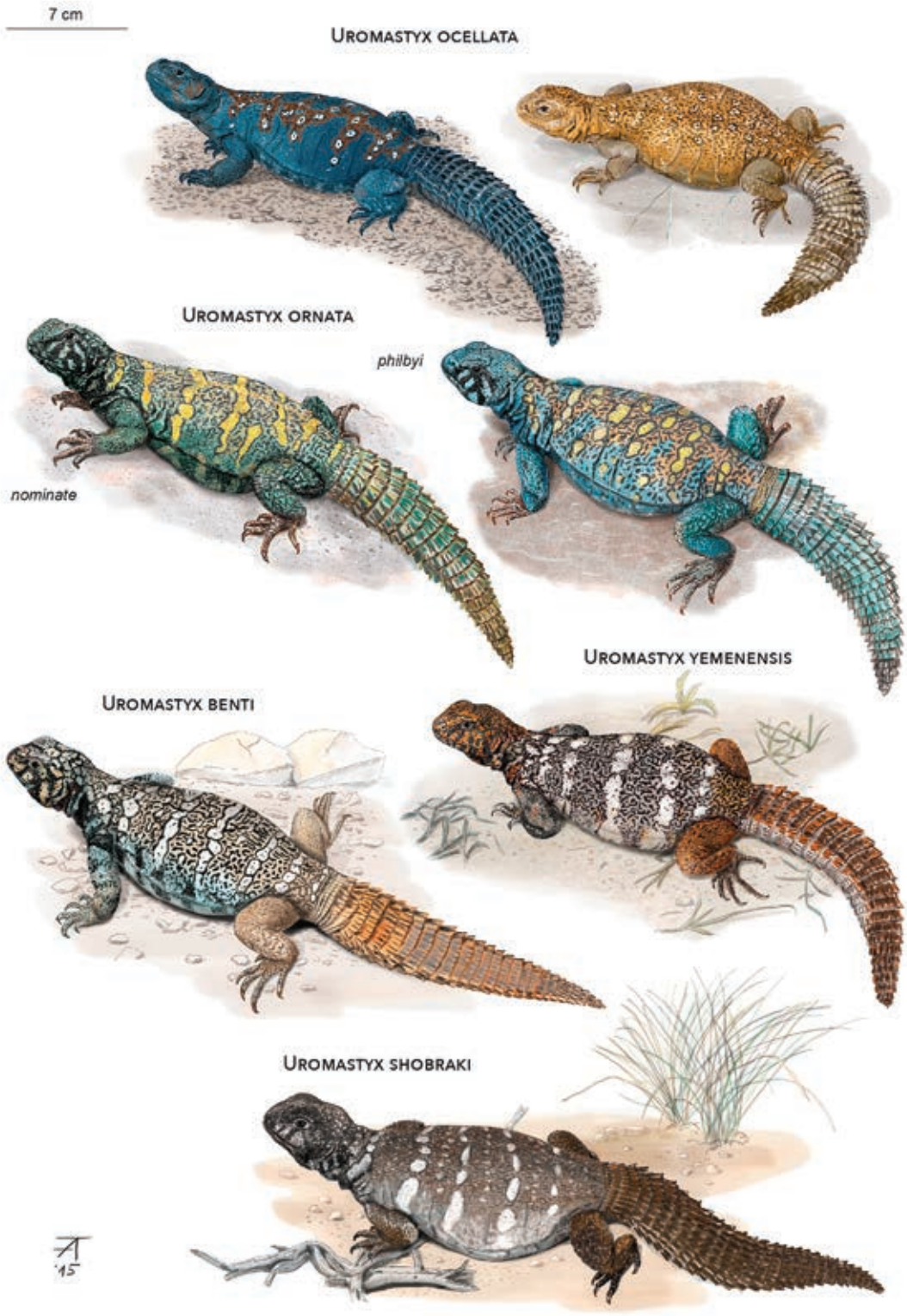
Carlos Velásquez, longtime aide to Fred Medem, uses a cast net in the early morning. Lack of provisions was a constant problem during lengthy field excursions. Accordingly, fishing and hunting and bartering with locals were of paramount importance. Caño Danta, tributary of the Río Uré, Córdoba, Colombia, 07 February 1963.



Medem with a 3.3-m female *Boa constrictor*. Angostura II, Río Guayabero, La Macarena, Meta, Colombia, 03 January 1957.



Medem feeds a baby Woolly Monkey, *Lagothrix lagotricha*. Fred had an affinity for all animals, and in his later years he kept quite a menagerie at the Instituto Roberto Franco where he was Director. La Isla, Río Apaporis, Vaupés, Colombia, February, 1969.


7 cm
UROMASTYX OCELLATA
UROMASTYX ORNATA
philbyi
nominate
UROMASTYX YEMENENSIS
UROMASTYX BENTI
UROMASTYX SHOBRAKI
'15

Western Spiny-tailed Lizards (II): *Uromastyx ocellata* group of species

Arthur Tiutenko – digital painting, 12″ x 16″

Due to the advancement of digital photography in the past two decades, more authors of nature science books, field guides, and articles have opted to use photographs as illustrations they have taken themselves or received from their colleagues. In herpetological books, photographs have become noticebly prominent because amphibians and reptiles can be captured from close distances and with relatively affordable equipment. Very few herpetological publications nowadays are accompanied by drawn or painted illustrations relative to works on other taxonomic groups, such as birds for example. In particular, books covering large systematic groups illustrated with paintings appear rarely in herpetology.

The important role of photography in zoological research is indisputable. In terms of the value of accurate documentation, a photograph may be decidedly superior to a drawing. Nonetheless, even if such factors as aesthetics and classic spirit are left aside, graphical illustrations have practical advantages in science. Painted or drawn organisms, biological events, or other such phenomena can be presented that have not yet been photographed or are potentially impossible to photograph. While a photograph always captures a moment of time and shows a concrete individual subject, more general traits that are common to many or all individuals can be better depicted with a painted or drawn image. Graphical illustrations allow standardized, uniform presentation of subjects throughout the entire publication, whether they are extinct or extant taxa, but whose live photographs do not exist in adequate quality. Further, uniformly high quality illustrated images can be more easily and consistently achieved with paintings and drawings than with photographs obtained from various sources whose quality may vary significantly.

Arthur Tiutenko has taken up the challenge of using the advantages of graphical illustration with one of the most diverse and species-rich lizard families, the Agamidae. Over 90 color plates are estimated to cover all of around 500 currently recognized species. Each plate presents three to eight taxa, depending on maximum physical size of typical individuals. Within a single plate, the animals are depicted with a single scale, in similar postures, and turned into one direction—either left or right. If relevant, polymorphism and sexual dimorphism are also shown. If members of the same genus are spread over several plates, the same scale is used; this should facilitate visual comparison of systematically close taxa. The grouping of taxa on a single plate and the order of plates are based on current phylogenetic relationships. Some distinctive subspecies are shown as well, along with nominate taxa. For instance, a whole plate is dedicated to *Stellagama stellio,* a polytypic species.

Because the taxonomy of this family is frequently reviewed and new taxa are being described, the illustrations will be periodically corrected and updated. One of 12 plates that were completed in 2015 is shown above. This project has a working title called "The Book of Dragons" and is currently projected to continue until 2020, ending with a publication.

All images are drawn and painted freehand and are not based on a single specimen or a single photograph. Several sources always serve as reference for each subject including photographs, preserved specimens, and species descriptions. Arthur uses digital tools to produce his work: a computer, a pen display, and software that simulates traditional art materials and techniques, such as watercolor, gouache, pencils, and ink. Each illustration is first painted as a high resolution image, with maximum detail; subsequently, several such images are merged to create a plate. All illustrations are optimized for book publication: Although each color plate is very large in original (25" × 35", or 63 × 89 cm) and can be printed on a very large paper sheet, optimum look and fine details for close viewing are provided on pages of up to around 12" × 16" (around 30 × 40 cm). Digital images are saved with a resolution of 400 ppi. This makes them suitable for offset printing with 200 lpi, i.e., with highest print quality currently available for books. Printed with a giclée printer on heavy fine art paper, such illustrations look just like paintings on a traditional medium with real brushes and pens. In addition to color plates, Arthur creates maps, diagrams, and drawings that are intended for use as figures in a text for this project.

Arthur Tiutenko is a nature science illustrator and photographer based in Bavaria, Germany. He studied biology and computer science, and is an assistant professor at Friedrich-Alexander University of Erlangen/Nuremberg. Since the 1980s Arthur has participated in a number of herpetological expeditions to Caucasus and Central Asia. He frequently travels on his own in Africa and Asia for zoological collecting and photography, and also leads photography tours and workshops.

Fine art prints of selected art work and photographs by Arthur Tiutenko, including many illustrations from this agamid project, are available in an online shop at Arthur's website: www.nature-images.eu. News and updates on his ongoing illustration projects are published on his Facebook page /*ArthurTiutenkoIllustration.*

ABOUT OUR COVER: *Heosemys depressa*



The Arakan Forest Turtle (*Heosemys depressa*) has had an interesting history since its discovery in the Arakan Hills of Western Myanmar in 1875 (Anderson 1875. Annals and Magazine of Natural History [4]16:282–285; Platt et al. 2003. Hamadryad 27:273–276). Only 33 years after its discovery, the species "went missing," presumed extinct for the next 86 years until in 1994 scientists rediscovered it in a Chinese food market (Platt et al. 2003. Chelonian Conservation and Biology 4:678–682). It was not formally discovered again in the wild until a few individuals were found by researchers in a remote Elephant Sanctuary in 2009 in western Myanmar (Platt et al. 2010. Chelonian Conservation and Biology 9:114–119).

The low density of the known populations, small historical range, and local hunting pressure for Chinese food markets have led to it being recognized as critically endangered (Turtle Conservation Coalition [Rhodin, A. G. J., A. D. Walde, B. D. Horne, P. P. van Dijk, T. Blanck, and R. Hudson (eds.)]. 2011. Turtles in Trouble: The World's 25+ Most Endangered Tortoises and Freshwater Turtles—2011. IUCN/SSC Tortoise and Freshwater Turtle Specialist Group, Turtle Conservation Fund, Turtle Survival Alliance, Turtle Conservancy, Chelonian Research Foundation, Conservation International, Wildlife Conservation Society, and San Diego Zoo Global. Lunenburg, Massachusetts. 54 pp.).

Another major and fortunate discovery came in 2014 when a team led by Caesar Rahman (lead researcher for the Creative Conservation Alliance) discovered a population in the Chittagong Hill Tracts in southeastern Bangladesh, across the border from Myanmar and the Arakan Hills (Rahman et al., *in press.* Chelonan Conservation and Biology). *Heosemys depressa* is considered Critically Endangered on the IUCN Red List and considerable efforts are being made to protect its remaining bamboo habitat in both Bangladesh and Myanmar (Asian Turtle Trade Working Group 2000. *In* The IUCN Red List of Threatened Species 2000 <iucnredlist.org>, accessed 07 October 2015). Several populations also exist in European and American zoos as well as various private collections, of which some have been successful in captive breeding.

Four species are currently placed in the genus *Heosemys* (Turtle Taxonomy Working Group (IUCN/SSC Tortoise and Freshwater Turtle Specialist Group [van Dijk, P. P., J. B. Iverson, A. G. J. Rhodin, H. B. Shaffer,and R. Bour]. 2014. Turtles of the World, 7th Edition: Annotated Checklist of Taxonomy, Synonymy, Distribution with Maps, and Conservation Status. Chelonian Research Monographs No. 5, Chelonian Research Foundation. doi:10.3854/crm.5.000.checklist.v7.2014). Collectively, these species occur in Southeast Asia, including the Philippines.

Our cover image was recorded by **Scott Trageser** in Bandarban, Bangladesh. Scott's equipment consisted of a Nikon D810 with a Nikkor 16mm f/2.8 Fisheye lens (f/6.3, 1/250 sec, ISO 400). Lighting was accomplished by two SB700 strobes with softboxes positioned off camera. Scott is a self-described "nature junkie" and photographer (NatureStills Photography / www.naturestills.com). An avid traveler and conservation biologist, Scott travels the world working with various NGOs and research groups to document and conserve dwindling biodiversity.



SSAR BUSINESS

2015 Annual Meeting at University of Kansas, Lawrence, Kansas

The 58th Annual Meeting of SSAR took place from July 30th to August 2nd, 2015 on the beautiful University of Kansas campus in Lawrence, Kansas (Figs. 1, 2). This meeting was the first in ten years since SSAR last met on a university campus (excluding the World Congress in Vancouver). Plans for this meeting began around five years ago, followed shortly thereafter by an informal offer from Rafe Brown to host the meeting at the University of Kansas (KU). KU is a particularly appropriate venue, as an institution with a distinguished history of herpetological research and education, to which many of today's herpetologists can trace their roots, and having hosted previous SSAR meetings in 1977 and 1996 (Fig. 3). The 2015 meeting sprung from a desire, shared by many members of SSAR, to occasionally hold a meeting reminiscent of the smaller, more intimate gatherings that older members recall. The primary aims were to hold an especially student-friendly meeting, honor some of our distinguished senior herpetologists, and bring back some of the special features of SSAR meetings that had been lost over the years. The Board regards it as important for student members, at least once during their student years, to experience a style of meeting different from the successful JMIH events that we have become used to in recent years.

The 2015 meeting was a resounding success, certainly on a par with the great SSAR meetings of the past, due largely to years of planning and hard work as well as a commitment to the future of the Society. SSAR met in association with Partners in Amphibian and Reptile Conservation (PARC), Center for North American Herpetology, Kansas Herpetological Society, Missouri Herpetological Society, Arkansas Herpetological Society, and the International Society for the History and Bibliography of Herpetology. The local hosts were Rafe Brown (co-Chair), Bill Duellman, Rich Glor (co-Chair), George Pisani, and Linda Trueb. Kraig Adler was SSAR's official liaison for the meeting. Student co-liaisons were Karen Olson, Tashitso Anamza, and Jesse Grismer. Stacey Walters, Kevin Curry, Justine Hamilton, Sharon Leatherman, Jeremy Whetstone, and Jennifer Schmitendorf also worked hard to keep

PHOTO BY R. W. HANSEN



FIG. 1. View of meeting venue from atop the Oread Hotel. Kansas Union and Museum of Natural History on the right beyond parking lot; Spooner Hall across street from museum.



FIG. 2. Welcome poster, drawn by David Dennis. Image of a male Eastern Collared Lizard (*Crotaphytus collaris*), a typical reptile of the Great Plains.



PHOTO BY BRIAN GOODMAN

FIG. 3. KU herpetologists: From the left, Philip Taylor (representing his grandfather, Edward H. Taylor), Alice Fitch Echelle (representing her father, Henry S. Fitch), William Duellman, Linda Trueb, Rafe Brown, and Rich Glor.

things running smoothly. Kudos to the whole team for some last-minute adjustments, and especially to Rafe and Rich, who somehow managed to turn a problem with mold into free drinks at multiple events!

Approximately 452 herpetologists attended the meeting. This included 161 regular students, 18 student recipients of the Carl Gans Registration Awards, 13 graduate student volunteers, six Distinguished Seniors, five exhibitors, 165 regular registered members, 23 non-members, and 22 other miscellaneous registrants.

SSAR was pleased to have in attendance three pre-baccalaureate students—Ali Metler, Justin Lee, and Eli Haines-Eitzen. The first two have previously attended our annual meetings and Justin and Eli were sponsored by SSAR this year. Justin was the first recipient of the SSAR pre-baccalaureate award, at the 2010 JMIH meeting in Rhode Island. Justin and Eli participated in the mentor program (along with seven other mentees), ably organized by Kris Kaiser, Andrew Durso, and Joe Mendelson, III.

One of the many enjoyable aspects of the meeting was its "manageable" size, in terms of numbers of attendees, number of concurrent sessions, and proximity of events. It was easy to interact with everybody! Over the three days of presentations, there were four plenary sessions, 27 oral sessions (with 155 presentations), 70 poster presentations (Figs. 4–5), and five symposia. SSAR sponsored two symposia: "Frontiers in Integrative Organismal Biology" and "Bones, Frogs, and Evolution" (Figs. 6–7) Thanks to Rafe Brown and Rich Glor for organizing the former. Dave Blackburn, Rafe Brown, Dave Cannatella, and Anne Maglia organized the latter, held in honor of Linda Trueb. PARC sponsored three symposia: "Identifying Priority Areas for Herpetofauna Conservation," "PARC's Partners Focusing on Habitat," and "Communicating Herpetofaunal Conservation to the Public."

Social and Professional Events

The meeting kicked off on July 30th with a full-day Board meeting and several tours. These included the KU Natural History Museum, where Rich Glor provided a behind-the-scenes look at the research collections (Fig. 8). George Pisani led many tours

PHOTO BY R. W. HANSEN

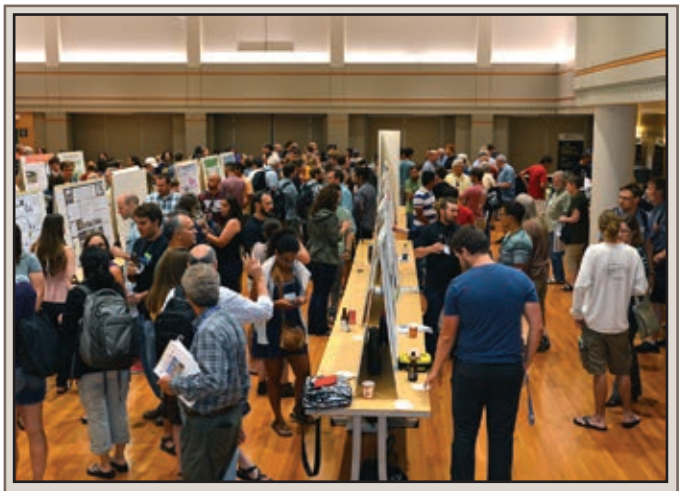


Fig. 4. Poster presentations were divided into two afternoon sessions in the main ballroom to maximize exposure, with plenty of food and drink to facilitate discussions.

PHOTO BY R. W. HANSEN

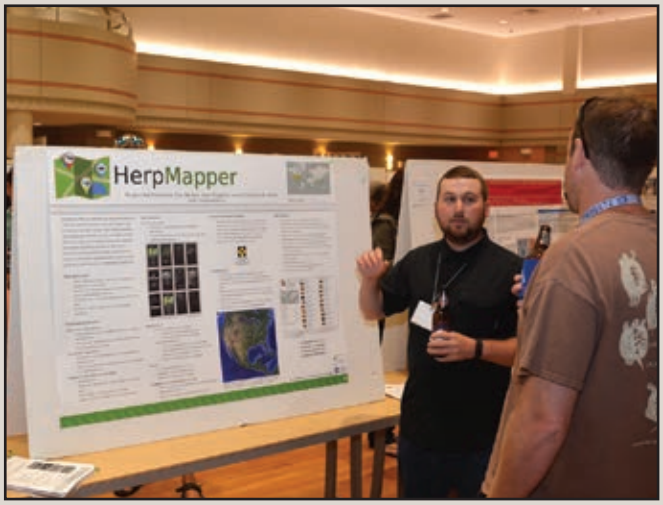


Fig. 5. Chris Smith explaining the HerpMapper Project of Don Becker, Mike Pingleton, and Chris Smith.

PHOTO BY BRIAN GOODMAN



Fig. 6. Speakers in the symposium, "Frontiers in Integrative Organismal Biology" organized by Rafe Brown and Rich Glor.

PHOTO BY R. W. HANSEN



Fig. 7. Poster for symposium honoring Linda Trueb "Bones, Frogs, and Evolution" organized by Dave Blackburn, Rafe Brown, Dave Cannatella, and Anne Maglia. Marvalee Wake and Ana Baez signing poster for Linda.

PHOTO BY RAFE BROWN



Fig. 8. Rich Glor (on left) conducting tour of the collections in the Division of Herpetology, Museum of Natural History.

to the Henry Fitch Natural History Reservation (Fig. 9). This was such a popular event that additional tours were added. A Live Animal Exhibit of 100 Kansas herp species, complete with photographic stages, was assembled by the Kansas Herpetological Society. For bibliophiles, a popular destination was the Classical and Illustrated Herp Books Exhibit at KU's Spencer Library. This was followed in the evening by the always-anticipated Presidential Travelogue. President Bauer introduced this year's speaker, Miguel Vences (Technical University of Braunschweig), noting that one of the pleasures of being President was being able to select the Travelogue speaker. The title of Miguel's presentation was "Inventory of an Imperiled Paradise: Two Decades of Herpetology in Madagascar." Miguel has been active in herpetological conservation on a global scale and is sometimes referred to as "Mr. Madagascar." He referred to Madagascar as a "micro-continent" with habitats ranging from rainforest in the East to dry regions in the Southwest. Madagascar, a highly modified, biodiversity conservation hotspot, is home to around 300 described species of frogs, around 400 described species of reptiles, and many species yet to be described. Within a single location one can find up to 110 species of frogs and many species are "micro-endemic" with very small ranges. The early days of Miguel's research in Madagascar (early- to mid-1990s) were made challenging by poor infrastructure and a lack of funding. Later expeditions were larger and better equipped, such that travel to more

remote sites was possible. As most Malagasy frog species cannot be identified reliably based solely on morphology, the advent of DNA barcoding in the mid-2000s led to an "explosion" of species numbers. A 2014 estimate placed the number of species at 500–600. Miguel referred to taxonomic species descriptions as the "new bottleneck." He cited deforestation, habitat destruction, and climate change as threats to species on Madagascar.

For many, the highlights of the meeting were the multiple plenary sessions, three sponsored by SSAR, and one by PARC. On the morning of July 31st, the first plenary session began with a welcome and introductory comments by local co-Chairs Rafe Brown and Rich Glor. Rafe referenced the 100-year history of herpetology research at KU and indicated that much of that history was represented "in the flesh" at this meeting. He particularly welcomed relatives of Edward H. Taylor and Henry Fitch in the audience. Leonard Krishtalka, Director of the Biodiversity Institute at KU, echoed Rafe's welcome. Following a slight wait for an appearance by the Mayor of Lawrence, during which Rich Glor began to recount a story of meeting with the Mayor and an uncomfortable allusion to snakes in city hall, the Mayor, Jeremy Farmer, arrived (Fig. 10). The Mayor then proceeded to finish Rich's story. Despite being bitten by a copperhead at age seven, the Mayor had declared this "International Amphibian and Reptile Week" in Lawrence and presented the society with a proclamation that acknowledged reptiles and amphibians as an essential part of the ecology of Kansas and the importance of the University of Kansas Biodiversity Institute as home to the fifth largest collection of reptiles and amphibians in the USA with more than 340,000 specimens representing more than 5000 species from 156 countries.

Rich then acknowledged the many local student volunteers who dedicated many hours to make the 2015 meeting a reality (Fig. 11). Jesse Grismer and Karen Olson drew attention to the many student-centered activities offered over the next few days, including the Herp Quiz, the PARC lunch, the SSAR Student Social, the Picnic, and even a (non-SSAR related) Tractor Pull Competition in town!

Rafe Brown spoke for a few minutes more about KU taking its herpetological history seriously and being aware of its importance. He mentioned that the program traces its history back to the early publications of Edward H. Taylor based on his work in the Philippines in the 1910s. He then acknowledged Ed's grandson, Dr. Philip Taylor, and his family, as well as Alice Fitch Echelle, Henry Fitch's daughter, and her family, in the audience.

A number of individuals representing participating societies then spoke. Dan Fogell introduced officers of the Kansas Herpetological Society, followed by J. J. Apodaca who introduced PARC officers. Suzanne Collins and Kelly Erwin represented the Center for North American Herpetology and presented the Slowinski Award *in absentia* to Paola Carrasco. SSAR Past-President Bob Aldridge introduced officers of the Missouri Herpetological Society and Glen Manning represented the Arkansas Herpetological Society. Richard Wahlgren represented the International Society for the History and Bibliography of Herpetology and noted that this society was founded in 1996 at KU's Spencer Library.

Dora Pinou, representing the Herpetological Education Committee, presented the Meritorious Teaching Award in Herpetology to Brad Shaffer (University of California at Los Angeles) commenting on the fact that, over his career, Brad has mentored 19 graduate students and 16 post-docs.

Kraig Adler was asked by Rafe Brown to recount some of the history of SSAR, including its origination as The Ohio



PHOTO BY ALISON CREE

FIG. 9. Numerous tours of the Henry Fitch Natural History Reservation were led by George Pisani. Pictured, from left, Rick Shine and Robin Andrews.



PHOTO BY MARION PREEST

FIG. 10. Mayor of Lawrence, Jeremy Farmer, and Rich Glor at the Plenary Session on July 31st.



PHOTO BY R.W. HANSEN

FIG. 11. KU Herp Division presents Kraig Adler with a memento for his help with the meeting.

PHOTO BY R. W. HANSEN



FIG. 12. Members, from the 1950s, of The Ohio Herpetological Society, forerunner of SSAR. From left, David Dennis, Steve Tilley, and Kraig Adler.

PHOTO BY R. W. HANSEN



FIG. 13. Presentation of framed original artwork and SSAR poster to the KU Division of Herpetology. From left, Rich Glor, SSAR President Aaron Bauer, artist David Dennis, and Rafe Brown.

Herpetological Society (OHS) founded by a handful of teenagers (including Kraig) in 1958. Kraig pointed out Steve Tilley and David Dennis in the audience as other founding members of OHS (Fig. 12). From humble beginnings, SSAR has grown to become the largest professional herpetological society in the world.

Jen Williams and Priya Nanjappa spoke of the mission of PARC to "conserve amphibians, reptiles and their habitats as integral parts of our ecosystem and culture through proactive and coordinated public-private partnership" and mentioned some relevant guidelines and handbooks that are available from PARC. Priya then presented the Alison Haskell Award for Excellence in Herpetofaunal Conservation to John Jensen (Georgia Department of Natural Resources). Kurt Buhlmann (Savannah River Ecology Laboratory, University of Georgia), the PARC Visionary Leader Award recipient for 2015, spoke about where we might focus our efforts to secure viable populations and prevent loss of herp species in the next decade.

Following a break, President Bauer briefly introduced SSAR officers and then gave the SSAR Presidential Address, including a special message for students. Aaron began with a question—"Why is this meeting different?" For most people under age 40 at the KU meeting, their only experience with a herp meeting is that of JMIH. Aaron acknowledged that those meetings work well, but they are a very different type of meeting than we are aiming for in 2015. Because of the large number of attendees, including ichthyologists, at the combined meetings, these are held in convention centers and large hotels and are organized by meeting professionals rather than local herpetologists. Because of this, some of the "special touches" of previous SSAR meetings have been lost, e.g., live animal exhibits, the herp quiz, the AV shows, etc. Those signature events are being brought back to this meeting and SSAR is proud of its long tradition of being student-centered and of being able to offer students more than just our journals. Aaron introduced the Distinguished Senior Herpetologists attending the KU meeting (Vic Hutchison, Bayard Brattstrom, Alan Leviton, William Duellman, Itzchak Gilboa, and David Wake) and encouraged students to attend the reception in honor of these individuals. He referred to them as "pillars in our field," and pointed out that the reception was a rare opportunity for students to mingle with individuals who, sadly to many, are just renowned names in books or on papers. Aaron then moved to the other end of the age-spectrum and welcomed Justin Lee and Eli Haines-Eitzen, the two pre-baccalaureate students sponsored by SSAR. Aaron acknowledged the very generous gift from the Carl Gans Charitable Trust to SSAR that will support student attendance indefinitely at our meetings. In return for this support and the many other things that SSAR is pleased to provide to student members, Aaron encouraged them to get involved in the society. He referred to SSAR as "a very special society for students."

Aaron then presented the handsomely framed original artwork, featuring an Eastern Collared Lizard by David Dennis, that was featured so prominently on the giveaway meeting poster (Fig. 13) to the Herpetology Division at KU as SSAR's tribute to everyone in the Division who helped with meeting organization. He returned to his special message to students and noted that one of the things we (and all other organismal-based societies) worry about is decreased membership. He acknowledged that there are a variety of reasons why this is happening. When we lose members, we lose the most important part of our revenue stream. No revenue means no journals, no books, no meetings, no travel awards, no research awards, etc. We are a non-profit organization and none of our officers (President, Secretary, Treasurer, Members of the Board), Editors, or Committee chairs receive any compensation—we are all volunteers. As a society we value this culture of service. Aaron recalled his days as a graduate student when his Ph.D. advisor Marvalee Wake made it very clear to him that he was expected to go to professional meetings and eventually assume duties within societies. (To all who know Aaron, it is obvious that he is continuing that tradition with his own students.) Aaron said that this is the 26th SSAR meeting that he has attended (he admitted to missing a few when he was in the field as a student, but even then felt guilty about not being present!) and he encouraged students to invest in this society and become active members. He said he hopes they have such a good time at this meeting that, if they don't already have the mindset that "to be a herpetologist is to participate," it will develop. Aaron encouraged students and all SSAR members to attend the Business Meeting to find out what is happening in the society. He said they might find it tedious (actually, it was not!), but at least they didn't have to attend the day-long Board Meeting!!

Aaron ended on a somber note and reminded us that the work of herpetologists today is built on the foundations established by those who have come before. He then gave a moving tribute to, what he acknowledged, was only a partial list of herpetologists who had passed away since our 2014 meeting: Ray Semlitsch, Doug Rossman, Dick Peterson, Charlie Painter,

PHOTO BY R. W. HANSEN



FIG. 14. David Hillis presents SSAR Keynote Lecture about the value of herps as model organisms.

PHOTO BY R. W. HANSEN



FIG. 15. Harry Greene presents SSAR Plenary Lecture about Henry Fitch's life.

Eduardo Bustos-Obregon, James Dixon, Herndon Dowling, Jack Fouquette, James Organ, Victor Quesnel, Graham Turbott, and Margarita Metallinou.

In anticipation of the 8th World Congress of Herpetology (WCH) in Hangzhou, China, Dr. Xiang Ji (WCH Secretary General-Elect and Local Host) gave a promotional presentation. He mentioned the long history of herpetological research in China dating back 2000 years and the increasingly rapid growth of research in this area. Tours will be organized before and after the meeting (which will run August 15–21, 2016) and the deadline to submit abstracts is June 15, 2016. Website: www.worldcongressofherpetology.org/ and local contact: wch2016@vip.163.com

David Hillis (University of Texas at Austin) then gave the first plenary lecture of the meeting: "Progress in Reconstructing the Phylogeny of Amphibians and Reptiles: Where We've Been and Where We Need to Go" (Fig. 14). Dave noted that towards the end of the 1970s, when there was much discussion about the principles of cladistics, we were limited by the abilities of our computers. By the late 1970s there were so few papers that included phylogenies that you could easily read them all. He recalled setting up a molecular biology lab from scratch at KU as he was working towards his dissertation entitled "Phylogeny and Biogeography of New World *Rana*." In 1985 at the SSAR meeting in Tampa he began talking with Craig Moritz about a book on molecular systematics. That book (*Molecular Systematics*, Hillis and Moritz) appeared in 1990 just as molecular biology was about to "take off." In the 1970s and 1980s it was a matter of needing more data, in the 1990s and 2000s we needed better sampling on taxa, by 2010 we were finally getting good data sets, but questions were being asked about whether the models we were using were up to the task of analyzing the data. Dave posed the question—"Are we overconfident in the conclusions we draw from the models we use?" Errors in these models fall into two categories: easy to fix sampling errors, and more difficult to fix, and often ignored, errors in assumptions.

The Plenary speaker on Day 2 was Harry Greene (Cornell University) who spoke on "Life and Times of a KU Herpetological Icon: Henry Fitch and 70 Years of Snake Ecology" (Fig. 15). By almost any measure Henry Fitch (1909–2009) was a remarkable herpetologist—he collected thousands of specimens for museums and he published over 4000 pages in 200 papers. But what interests Harry is "Why did he do it?" In trying to answer this question for us, Harry recounted some of the details of Henry's life. He entered the University of Oregon in 1926 at around 16

PHOTO BY R. W. HANSEN



FIG. 16. Tyrone Hayes presents the PARC Plenary Lecture about the impact of pesticides on natural ecosystems.

years of age, he arrived at the Museum of Vertebrate Zoology at University of California at Berkeley in 1931, completing a Masters thesis on the natural history of *Elgaria* in 1933 and a Ph.D. thesis on the systematics of *Thamnophis* in 1939. In 1948 he was hired by KU as an ecology instructor and superintendent of the new Natural History Reservation. Over time he gained the nickname "the father of snake ecology." At one point a KU graduate student asked "How many copperheads does he need to mark?" In 1980 at the age of 71, he "retired." However, as Harry noted, Henry just kept going. In an attempt to figure out what made Henry "tick" and how he knew what to measure, Harry got nowhere with direct questions to Henry, so his questions became more oblique. Harry concluded that Henry was driven by innate curiosity, not theory (although he was not naive to theory). As Henry said "I've always spent time on whatever interested me most—with or without grants—and have greatly enjoyed all my projects, especially the fieldwork . . . I wouldn't change a thing. People who work with animals in the field, whether snakes or birds or rodents or monkeys, find it deeply satisfying and wouldn't trade it for any other career—even though it may not be financially rewarding."

Tyrone Hayes (University of California at Berkeley) was the PARC Plenary speaker on the third day of the meeting (Fig. 16). His talk was titled "From Silent Spring to Silent Night: A Tale of Toads and Men." As Tyrone often does, he began his talk with acknowledgments, thanking those who have influenced his life and career. He recalled advice from his grandmother—"Don't preach, don't teach, just tell a story!"—and that's what he proceeded to do. He spoke of being contacted early in his academic career by Novartis to study the effects of the herbicide atrazine on *Xenopus* frogs. In the late 1950s, despite being banned (or in "Novartis-speak" "denied regulatory approval") in Europe, atrazine was still in use in the USA. Tyrone's research showed, among other effects, that atrazine inhibited the growth of the larynx in male frogs and that the male gonads were "not normal." Further work revealed hermaphroditism caused by exposure to atrazine, and Tyrone became interested in the questions of whether these individuals are females with testes or males with ovaries, and what happens when they become adults. He carried out behavioral trials comparing control and atrazine-treated males and found that the controls had higher levels of testosterone, greater mating success, and higher fertilization rates than seen in the experimental group. He referred to these effects in a paper in PNAS as "chemical castration" (a term he said, not surprisingly, Novartis hates). He then turned his attention to the effects of atrazine in the wild, given that he found sufficient atrazine in water, even drinking water, to cause the above effects. Tyrone said that many people don't care about frogs the way we do; however, in many respects they are the new "canary in the coal mine," in the same way as the birds that Rachel Carson referred to in her book, *Silent Spring*. He reported that effects of atrazine, similar to those he saw in *Xenopus*, have now been seen in fish, reptiles, birds, and mammals. Those mammals include humans. Tyrone cited a recent study showing increased atrazine levels in men with fertility problems and indicated that some effects are also seen in women. His interest in aquatic frogs has taught him about another aquatic organism—embryonic humans. Both are exposed to environmental chemicals. He mentioned the existence of second-generation effects, i.e., evidence of exposure showing up in the grand-offspring of those exposed. Tyrone finished by referring to chemical exposure more broadly as an issue of environmental justice. He referenced his home state of California with the 5th largest economy in the world and one in nine jobs in agriculture. California uses more pesticides than any other state in the USA and 90% of field workers (exposed to these chemicals) are Hispanic, thus the "consequences of atrazine exposure are more likely to be felt by people of color."

In terms of special events throughout the meeting, we welcomed back some old SSAR favorites. For example, the live animal exhibit, run by members of the Kansas Herpetological Society, was held throughout the meeting and featured all 100 species of amphibians and reptiles found in Kansas (except for the venomous ones, which had to be excluded due to local statute). And, for those confident enough to put their herp know-how to the test, the Herp Quiz was offered on two days.

A special reception was held on Saturday, August 1st, for several authors to sign copies of their books. Bill Duellman signed copies of his new books just issued this summer: *Herpetology at Kansas: A Centennial History*, and *Marsupial Frogs:* Gastrotheca *and Allied Genera* (Fig. 17). Copies of the first title were presented to every meeting registrant. As a special addition, Philip Taylor and Alice Fitch Echelle, grandson and daughter of the two KU herpetology icons featured in Bill's book, were also on hand to sign the chapters about Ed Taylor and Henry Fitch, respectively (Figs. 18–19). Sally Haines, author of the book, *Slithy Toves: Illustrated Classic Herpetological Books at the University of Kansas* (SSAR 2000), signed complimentary copies of her book.

Throughout the meeting, a special display of herpetological books was exhibited at the Kenneth Spencer Research Library.

KU possesses one of the world's greatest collections of books on amphibians and reptiles. We are grateful to several persons for arranging an exhibit illustrating the history of herpetological book illustration over the past five centuries (Karen Cook, Elspeth Healey, Whitney Baker, Roberta Woodrick, Caitlin Donnelly, Beth Whitaker, and Sally Haines, plus three student trainees, Ryan Ridder, Megan Sims, and Sydney Goldstein). This exhibit was also tied into the satellite meeting of the International Society for the History and Bibliography of Herpetology, which met at Spencer Library on Monday, August 3rd.

In 2013, in anticipation of the KU meeting, the SSAR Board allocated funding to update and digitize the audio-visual shows that David Dennis, Eric Juterbock, and Kraig Adler produced in the early 1980s for use at SSAR, SSAR/HL, World Congress, and other meetings in the USA, Canada, and the UK. The shows celebrated the field of herpetology, the people, the animals, and the places they live. These old shows not been shown in at least a decade because the technology was out of date (six slide projectors coordinated by an ancient computer) and they were not of high quality.

Kraig Adler introduced the updated versions of two of the original four shows ("Amphibians of the Appalachians" and "Herpetologists Past and Present" (plus an alternate version of "Amphibians of the Appalachians" with species and localities identified) when they premiered in the evening of July 31st (they were shown again on August 2nd). Getting to this point was truly remarkable. Over a five-year period, to update "Amphibians of the Appalachians" David and Eric made around 20 trips covering all seasons to the original locations. All of the digital photographs taken were natural (i.e., no nature faking!). "Herpetologists Past and Present" was also updated and provided a quick chronology of the field. It also would have benefitted from having another version with the photographs from the younger days of some of the present-day herpetologists identified!

On the evening of July 31st, just prior to the AV shows noted above, there was a special reception honoring the Distinguished Senior Herpetologists to which all meeting attendees were invited (Figs. 20–23). On the same evening, a special banquet was held in the Panorama room of the Museum of Natural History for all KU herpetology graduates, sponsored by Bill Duellman and Linda Trueb (Fig. 24).

Two afternoon workshops followed the PARC symposium on "Communicating Herpetofaunal Conservation to the Public" on August 2nd. "Distilling your Message" was run by Christine O'Connell from the Alan Alda Center for Communicating Science at Stony Brook University in New York. Participants worked on "perfecting" their three-minute elevator talks about their science (Fig. 25).

The annual SSAR student reception was, as usual, well attended. Invited professionals, including many of the senior herpetologists, mingled with graduate and pre-baccalaureate students (Figs. 26–27). It was quite an age range! The live auction was adjacent to the reception and followed immediately. Food and drinks were readily available throughout the evening. Auctioneers Greg Watkins-Colwell, John Moriarty, Frank Burbrink, Rich Glor, David Hillis, and Joe Mendelson, III did a masterful job of keeping the evening fun and profitable for SSAR, raising over $8,000 for student activities. Students assisting the live auction were Krista Mougey (Texas Tech University), Megan Smith (University of Mississippi), Catriona Hendry (George Washington University), John Phillips (University of Oklahoma), Elyse Freitas (University of Oklahoma), Kai Wang (University



PHOTO BY R. W. HANSEN

FIG. 17. Book-signing event. Bill Duellman signing copies of his new books, *Herpetology at Kansas* and *Marsupial Frogs*, for KU grad, Rafael de Sá.



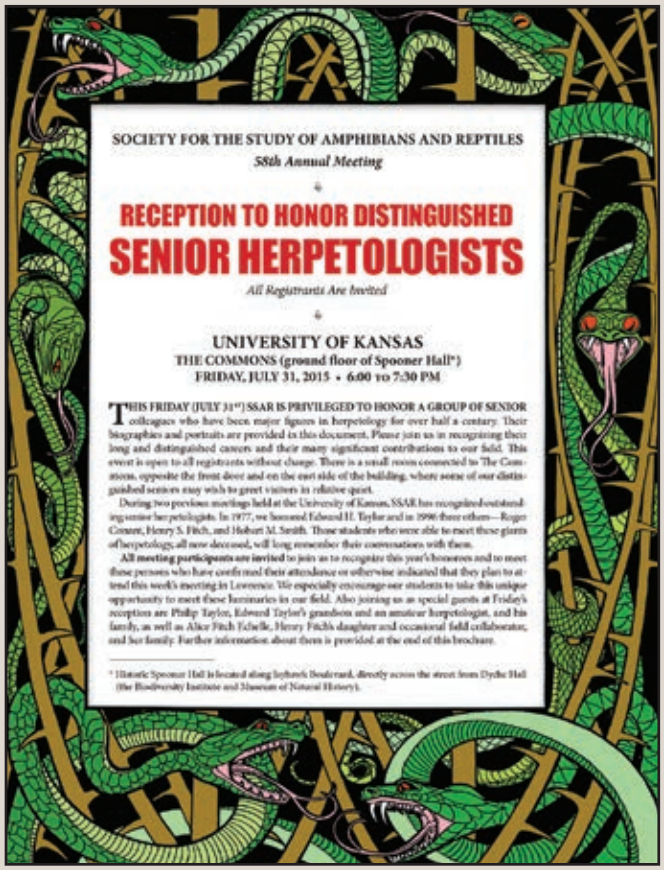
PHOTO BY R. W. HANSEN

FIG. 18. Philip Taylor sits before posters honoring two KU herp icons, Henry Fitch and Phil's grandfather, Edward Taylor.



PHOTO BY R. W. HANSEN

FIG. 19. Alice Fitch Echelle signs the chapter about her father, Henry Fitch, in Duellman's new book, *Herpetology at Kansas*, for Dale Hoyt.


SOCIETY FOR THE STUDY OF AMPHIBIANS AND REPTILES
58th Annual Meeting

RECEPTION TO HONOR DISTINGUISHED
SENIOR HERPETOLOGISTS

All Registrants Are Invited

UNIVERSITY OF KANSAS
THE COMMONS (ground floor of Spooner Hall*)
FRIDAY, JULY 31, 2015 • 6:00 TO 7:30 PM

THIS FRIDAY (JULY 31st) SSAR IS PRIVILEGED TO HONOR A GROUP OF SENIOR colleagues who have been major figures in herpetology for over half a century. Their biographies and portraits are provided in this document. Please join us in recognizing their long and distinguished careers and their many significant contributions to our field. This event is open to all registrants without charge. There is a small room connected to The Commons, opposite the front door and on the east side of the building, where some of our distinguished seniors may wish to greet visitors in relative quiet.

During two previous meetings held at the University of Kansas, SSAR has recognized outstanding senior herpetologists. In 1977, we honored Edward H. Taylor and in 1998 three others—Roger Conant, Henry S. Fitch, and Hobart M. Smith. Those students who were able to meet these giants of herpetology, all now deceased, will long remember their conversations with them.

All meeting participants are invited to join us to recognize this year's honorees and to meet those persons who have confirmed their attendance or otherwise indicated that they plan to attend this week's meeting in Lawrence. We especially encourage our students to take this unique opportunity to meet these luminaries in our field. Also joining us as special guests at Friday's reception are Philip Taylor, Edward Taylor's grandson and an amateur herpetologist, and his family, as well as Alice Fitch Echelle, Henry Fitch's daughter and occasional field collaborator, and her family. Further information about them is provided at the end of this brochure.

* Historic Spooner Hall is located along Jayhawk Boulevard, directly across the street from Dyche Hall (the Biodiversity Institute and Museum of Natural History).

FIG. 20. Brochure for the SSAR reception honoring several distinguished senior herpetologists: Bayard Brattstrom, Bill Duellman, Itzchak Gilboa, Vic Hutchison, Al Leviton, and David Wake. The brochure had bios and portraits of the honorees.



PHOTO BY R. W. HANSEN

FIG. 21. Bayard Brattstrom talking with Sophie Liu, Sean McHugh, Brian Worthington, and Joey Chase, all members of the Cornell Herpetological Society which had its reunion at the KU meeting.

of Oklahoma), and Stuart Neilsen (University of Mississippi). They worked hard before, during, and after the auction! Bill Duellman's machete was the highest priced item of the evening and a large audience was maintained late into the evening (Figs. 28–31).



PHOTO BY R. W. HANSEN

FIG. 22. Al Leviton, another honored senior herpetologist, is accompanied by his frequent co-author, Michele Aldrich. They are flanked by Rafe Brown, at left, and his and Leviton's Filipino collaborator, Arvin Diesmos.



PHOTO BY R. W. HANSEN

FIG. 23. Vic Hutchison talking with students at the seniors reception. The first Victor Hutchison Best Student Poster Awards were presented at the KU meeting.

Vinny Farallo (co-Chair Student Travel Awards Committee) oversaw the silent auction again. Recipients of the $500 SSAR Student Travel Awards took turns to work the silent auction table for 2–3 hrs throughout the course of the meetings. The Silent Auction raised just over $1,000 for student activities.

The winners of the Herp Quiz were announced by Jesse Grismer during the live auction. They were Joseph Chase, Mike Gründler, Eli Haines-Eitzen, Justin Lee, and Erik Wild. They each received a cash prize, and, later, a beautiful glass etching produced by the multi-talented Ronn Altig (Fig. 32). Many will recall the wine glasses that Ronn fashioned for the banquet at our 50th anniversary meeting in 2007. The meeting wrapped up on the evening of August 2nd, with a picnic held on the roof of the seven-story-tall Oread Hotel on the KU campus, the highest point in the entire county (Figs. 33–36).

Board and Business Meeting Summaries

SSAR Board Meeting

Society President Aaron Bauer called the Board Meeting to order at 0902 h on July 30th, 2015 in the Kansas Union, University of Kansas, Lawrence, Kansas. In attendance were the following members of the Board of Directors, Editors, and Committee

PHOTO BY BRIAN GOODMAN



FIG. 24. KU herp alumni and faculty on the steps of the museum. A special banquet for this group was held in the Panorama Room of the museum on July 31st.

PHOTO BY MARION PREEST



FIG. 25. Christine O'Connell (on right, Alan Alda Center for Communicating Science) speaking with Emily Grabowski and Linda Weir at the conclusion of PARC's "Distilling your Message" workshop.

PHOTO BY R. W. HANSEN



FIG. 26. The student social featured plentiful food and drink.

PHOTO BY R. W. HANSEN



FIG. 27. Student Social. From left, Justin Lee and Eli Haines-Eitzen, 2015 SSAR pre-baccalaureate students and winners of the team prize in the Herp Quiz.

Chairs: Kraig Adler (Editor, *Contributions to Herpetology*, and chair, Long-Range Planning Committee), Bob Aldridge (Past-President), Robin Andrews (Board Member, Reg. 2018), Paul Bartelt (co-Editor *Journal of Herpetology*), Breck Bartholomew (Publications Secretary), Aaron Bauer (President; Editor, *Facsimile Reprints in Herpetology*), Rafe Brown (Chair, Seibert Award Committee; Local Meeting co-Chair, 2015), Alison Cree (Board Member, non-US 2016), Raul Diaz (Member, Website Subcommittee), Tiffany Doan (co-Editor *Journal of Herpetology*), Richard Durtsche (Coordinator, Symposium Committee), Vincent Farallo (co-chair, Student Travel Award Committee; Member, Website Subcommittee), Rich Glor (Local Meeting co-Chair, 2015), Robert Hansen (Editor, *Herpetological Review*), Lisa Hazard (Board Member, Reg. 2016), Michelle Koo (Member, Website Subcommittee), Kim Lovich (Board Member, Conserv. 2018), John Moriarty (Editor, *Herpetological Circulars*), Joe Mitchell (Editor, *Herpetological Conservation*), Ann Paterson (Treasurer), George Pisani (Trustee), Marion Preest (Secretary), Al Savitzky (SSAR Representative to AIBS and BioOne), Rick Shine (President-Elect), Lynnette Sievert (Chair, Kennedy Student Award Committee), Carol Spencer (Chair, Website Subcommittee), and Greg Watkins-Colwell (Board Member, Reg, 2016; Organizer, SSAR/HL Live Auction). Additional society members present included David Auth, Vic Hutchison, Roy McDiarmid, Dave McLeod, and Joe Mendelson III.

Introductions were made and minutes of the 2014 Board of Directors Meeting (Chattanooga, Tennessee) were approved. President Aaron Bauer then called for a round of applause for Local Meeting Committee co-Chairs, Rafe Brown and Rich Glor, in appreciation of their hard work and finally reaching the opening day of the 2015 KU meeting.

Officers' Reports

President Bauer reported that the Board approved funding of half (~ $2,000) of the Alan Alda Workshop for the KU meeting. PARC will cover the remaining half. Sixteen slots will be available at the workshop, half of which will be for SSAR members. In November 2014, President Bauer signed a joint letter to Director Ashe (US Fish and Wildlife Service) requesting urgent action to prevent introduction of *Batrachochytrium salamandrivorans*, which poses a severe threat to native amphibians in the USA and neighboring countries.

In July 2015, President Bauer welcomed the arrival of the new SSAR website and thanked the committee (Raul Diaz, Vincent Farallo, Michelle Koo, and Carol Spencer) for their outstanding work. He made the following appointments:

PHOTO BY R. W. HANSEN



FIG. 28. Stuart Nielsen (apparently!) with carved mask he won at the live auction.

PHOTO BY R. W. HANSEN



FIG. 29. Dave Hillis at the Live Auction demonstrating the fine points for use of Bill Duellman's machete, the top prize at the auction.

PHOTO BY R. W. HANSEN



FIG. 30. Eric Hileman placing his bid at the Live Auction.

PHOTO BY R. W. HANSEN



FIG. 31. John Moriarty, one of several auctioneers, in action at the Live Auction.



FIG. 32. Stoppered glass museum jars were etched by Ronald Altig and presented to all Herp Quiz winners.

PHOTO BY R. W. HANSEN



FIG. 33. Picnic atop the on-campus Oread Hotel. Bryan Stuart in foreground (with sun glasses).

PHOTO BY R. W. HANSEN



FIG. 35. Picnic, from right to left, Steven Salinas and Lisa McBride (both from New Mexico Highlands University) and Vinnie Farallo speaking with Jillian Kay.

PHOTO BY R. W. HANSEN



FIG. 34. End of meeting picnic. Justine Hamilton, Stacey Walters, and Jennifer Schmitendorf (from left to right), members of the KU conference-organizing team.

PHOTO BY R. W. HANSEN



FIG. 36. Picnic. From left, Al Savitzky, Marty Crump, and Robin Andrews.

- Greg Watkins-Colwell, to chair the SSAR Membership Committee;
- Jeremy Feinberg, to chair the Student Participation Committee.

In December, Aaron wrote to Vic Hutchison to announce that the Board unanimously and enthusiastically voted to change the name of the "SSAR Student Poster Awards" to the "Victor Hutchison Student Poster Awards." (Vic served as SSAR President in 1999.)

Treasurer Ann Paterson reported that SSAR had a mixed financial year in 2014. Most expenses were close to predictions and our investments did well. However, membership income is a bit lower this year and publication income has decreased again. She reported that we have made some substantial changes to our accounting procedures and investment management this year. While this means that some numbers are estimates, she hopes that these changes will simplify reporting in the future. We underspent our budget this year by $53,946. This was largely a result of lower expenses because income was also down.

Ann noted that we have transitioned to a new accountant, Beverly Powell. We have moved our investments from Fidelity Investments to the Truman Heartland Community Foundation (TCFH). This means that our investments are now being managed by experienced investment managers. Additionally, it now requires a more complex process to withdraw funds (increasing security). This change allowed us to set up investment accounts that match our specific Restricted and Non-Restricted funds, meaning that we can invest each one using the most appropriate strategy. It also affects the way that money will be moved out of the funds when awards or other withdrawals are made. This transfer brought our book and market value to be the same at the point of transfer. Most nonprofits currently record and report their investments at market value and this is the protocol used by THCF. Currently, these values are very close for our funds.

Ann also reported that our relationship with the Truman Heartland Community Foundation allows contributions to be made on the foundation website, www.thcf.org, for any funds housed there. Individuals can make a one-time donation or set up a recurring donation on a monthly, quarterly, or annual basis. SSAR now has an Amazon "Smile" account and it is possible to make small donations to the Society when shopping on Amazon.

The Treasurer now receives membership reports, deposit reports, and profit-and-loss statements monthly from the Publications Secretary's office. Ann hopes this will improve the accounting system. Although SSAR adopted a new credit card processing

system in 2015, Ann suggested we need to consider whether to stop accepting credit cards at auctions or adopting a newer, more expensive system. She also suggested that we need to consider ways to increase oversight of SSAR finances.

Ann plans to overhaul the way that SSAR finances are reported next year. She says that this will allow her to more rapidly generate information as needed, as well as more accurately reflecting SSAR's current expenses and income categories.

Secretary Marion Preest provided Officers, Editors, and Committee Chairs with minutes of the 2014 Board Meeting, summarized the 2014 Annual Meeting for publication in *Herpetological Review*, and regularly updated the SSAR letterhead to reflect changes in personnel. She informed the Editors of *Journal of Herpetology* and *Herpetological Review* of these changes and provided various updates for Vinny Farallo (webmaster). Marion also wrote letters to student winners of various awards and prepared announcements for publication in *Herpetological Review*. She compiled the 2015 Annual Report, prepared agendas for the Board and Business meetings for the 2015 Annual Meeting, and was again involved in organizing a reception for student members of SSAR to be held at the Annual Meeting. Marion called for votes from the Board on various issues, e.g., SSAR Presidential Awards, symposium proposals, etc. She circulated documents that needed to be signed by members of the Board, e.g., Conflict of Interest, and dealt with many emails and phone calls from SSAR members and the general public.

Breck Bartholomew (Publications Secretary) reported that he submitted his resignation as Publications Secretary earlier in 2015. He has given SSAR through 2016 to find a replacement or to decide what to do with the publications. He will also be closing ZenScientist.com by September 30, 2016. This gives the society plenty of time to fill the multiple duties he has been performing. Breck informed the Board that, in his view, our publications series have become a liability and in their present form are no longer viable for the society. With the amount of information available on the internet, most people feel printed literature is burdensome and difficult to work with. Few people are buying books, and in many cases they simply do not want books, even if they are given to them. People do seem to have an increased desire for pdfs of books. For people who are not at institutions, there are many websites, forums, groups, etc., where people can obtain most books and journal articles for free. Unless donations, authors, or advertisements are paying for books to be published, there seems little possibility for hard-copy publishing to remain a viable option for the society. Breck recommends that we consider discontinuing some series and limiting the print runs of books that are published. Perhaps a print-on-demand type printing should be considered. The quality of print-on-demand tends to be poor, but perhaps there are higher quality options available.

According to Breck, another option might be for the society to start publishing books of general interest with the goal of distributing these through large distributors. This type of series might also help recruit members. Large publishers regularly publish books on amphibians and reptiles for the general public.

Breck's goal over the remainder of his term as Publications Secretary is to liquidate as many books as possible. After the KU meeting he will contact remainder dealers to try to sell off several titles. SSAR does have several books that remainder dealers are not interested in.

In addition to books, Breck has the overruns of *Journal of Herpetology* and *Herpetological Review*. He has been reducing the numbers held to ten copies once the journal issue is two years old. Most of the overrun copies are mailed to late subscribers or to replace lost or damaged copies.

Breck suggests SSAR consider having Allen Press handle back issues of the journals, as they used to do. There are fees associated with this service. Allen Press will charge a storage fee, a fee for each journal sent, and even to destroy older journals. Allen Press will need very specific instructions in terms of what to dispose of. This will help reduce storage costs.

Page charges are currently the responsibility of the Publications Secretary's office. The Publications Office has been assisting *Herpetological Review* by billing for advertisements and mailing out pdf copies of articles to member authors. The office has also been maintaining the *Herpetological Review* index in Endnote and uploading pdfs of *Herpetological Review* to ZenScientist.com for SSAR member access. Breck suggests these duties (with the exception of maintenance of the EndNote Index) may be able to be moved to the Treasurer's office.

Breck indicates that, with ZenScientist.com closing, he does not know if online access to *Herpetological Review* can continue. It could be added to the SSAR website, but then someone would have to be in charge of membership. If it is online, it might be something the Treasurer could oversee, but Breck recommends they receive a budget for a part-time employee. Both the *Journal of Herpetology* page charges and the *Herpetological Review* duties currently have a budget for an employee.

The donated libraries that SSAR has received take up almost as much space as the publications inventory. Donations are much more difficult to process and sell, since each item is unique. Selling these donated libraries is time consuming. It might be possible to sell parts of them through an auction house. Breck thinks it is too time consuming to expect them to be sold on a volunteer basis, although it may be possible to offer them on eBay, if the person listing them is paid. That leaves the problem of what to do with items that do not sell.

George Pisani reported that he again filed SSAR's annual corporate report with the Office of the Kansas Secretary of State.

Editors' Reports

Co-Editors of *Catalogue of American Amphibians and Reptiles*, Chris Bell and Travis LaDuc, reported that two new *CAAR* accounts will have been published (open access at www.SSAR-CAAR.com) by the time the Lawrence meeting begins. Five additional accounts are in various stages of review. Chris and Travis continue to field inquiries for new accounts: one generic account and 16 species accounts have been claimed. They encourage potential authors to not only look at those species for which no accounts exist, but also at many of the published accounts: over half of all existing accounts are 25+ years old.

The co-editors assumed all of the editorial responsibilities in an effort to maintain the high standards of the series. They conservatively estimate that 80% of the citations they review require editorial changes. Many of these problem citations are for papers that were published in Latin American titles and journals. Chris and Travis continue to invest a large amount of time in acquiring and/or indexing significant holdings of published, but unindexed herpetological material. As a result, for some accounts under review they have found an additional 30 citations, helping to ensure that these accounts will be the authoritative reference for a given taxon. Chris and Travis thank the authors of the submitted accounts for their patience as they continue to refine their editorial process and incrementally add to their list of citations.

Kraig Adler (Editor, *Contributions to Herpetology*) reported that the revised and expanded version of *Contributions to the History of Herpetology*, vol. 1 was published in 2014. The original volume was distributed at the First World Congress of Herpetology in 1989 but has been out of print since 2000. The reprint is heavily annotated and includes six portraits that were missing in volumes 1–3, as well as corrections to all three volumes. There are also 96 new plates (mostly in color), with substantial captions.

Herpetology at Kansas: A Centennial History, by William E. Duellman, a detailed history of one of the most distinguished herpetological research and graduate education programs, was published in July 2015 and will be available at the KU meeting.

A grant from the Seidell Program at the Smithsonian was obtained to cover the translation of *Salamanders of Japan*, by Ikio Sato. SSAR will cover the formatting, printing, and binding costs and publication is expected in 2016. In various stages of preparation in this series are *A Guide to the Snakes of the Philippines* by Rafe Brown, Alan Leviton, Maren Gaulke, and Arvin Diesmos; *Field Guide to Amphibians and Reptiles of the West Indies* by S. Blair Hedges; and *Lizards of Southern Africa*, edited by William R. Branch and Aaron Bauer.

Aaron Bauer (Editor, *Facsimile Reprints in Herpetology*) notes that activity in 2015 continues to be associated with progress on the production of *The Collected Herpetological Works of Giorgio Jan*, with an introduction, annotated bibliography, and extensive systematic comments by Roy McDiarmid and Jay Savage. Material was received, edited, and initial layout was completed by late 2014. Authors' revisions, however, continued until early 2015 and editing of the completed new text is being finished now. The *Iconographie* was scanned by a commercial firm in San Francisco identified by the California Academy of Sciences, which has kindly provided partial funding for the scanning costs. However, extensive post-scanning modifications are still required. Original estimates of publication in 2014 have been revised to the last quarter of 2015.

Cantor's *Zoology of Chusan* (1842) and his *General Features of Chusan* (1842), together comprising 70 text pages and 11 leaves of color plates, represent an early treatment of the herpetofauna and other natural history of Zhoushan, Zeijiang Province, China, will be prepared as a facsimile give-away for the next World Congress of Herpetology, to be held in nearby Hangzhou, China in 2016. It is planned to print the book in China to avoid shipping costs and customs issues.

Aaron reports that work on *The Collected Herpetological Works of J. V. Barboza du Bocage (1823–1907)* and *The Herpetological Contributions of John Edward Gray* is still underway.

John Moriarty (Editor, *Herpetological Circulars*) reported that *Herpetological Circulars* 42 (*Herpetological Collecting and Collections Management, 3rd Edition* by John Simmons) was published in June 2015. There are no new circulars planned for later in 2015; however, John would like to convert several recent circulars to e-books.

Joe Mitchell, Editor of *Herpetological Conservation*, reported that, despite placing an ad in *Herpetological Review* requesting proposals for the *Herpetological Conservation* series, there have been no viable proposals since *Urban Herpetology* was published in 2008. Joe suggests that the Board should decide whether or not to cancel this series. The Board indicated a strong desire that the series not disappear, as it sends an important message about the Society's commitment to conservation. The Board indicated that publication does not need to be an annual event, and urged Joe to continue to think of possibilities for this series, including contacting colleagues at PARC.

Robert Hansen, editor of *Herpetological Review*, reported that Volume 45 consisted of 752 pages (a nearly 19% increase since the new format was adopted in 2011, and a far cry from when he took over as Editor in 1991). Personnel changes include the resignations of David Steen and Kyle Miller Hesed and the addition of Robert Mendyk, Chava Weitzman, and Travis Taggart. President Bauer indicated his intent to step down as book review editor for *Herpetological Review* and is looking for a replacement for this position.

Tiffany Doan and Paul Bartelt remain as co-Editors of *Journal of Herpetology*. Erin Muths and Gad Perry, as outgoing co-editors, continue to handle papers submitted in 2013 and before. The Associate Editor (AE) roster at the end of 2014 contained 22 continuing AEs: Neil Bernstein (US), Phil Bishop (New Zealand), Xavier Bonnet (France), Rafe Brown (US), Russell Burke (US), David Chapple (Australia), Steve Corn (US), Jennifer Gillette (New Zealand), Evan Grant (US), Brian Greene (US), James Harris (Portugal), Hinrich Kaiser (US), Nancy Karraker (US), Edgar Lehr (US), Marc Mazerolle (Canada), Frank Mazzotti (US), Rocky Parker (US), John Rowe (US), Christopher Salice (US), Stephen Tilley (US), James Watling (US), and Eric Wild (Brazil); all four Editors also function as AEs. R. Graham Reynolds (US) and Reid Tingley (Australia) came on as new AEs during 2014 and the first half of 2015. During the first half of 2015, Glenn Shea (Australia) resigned. Andrew Durso (US) served as a guest AE for a special section on detectability. Paul Andreadis remains the Index Editor for the journal. The Editorial Board gained one new member during the first half of 2015, Brian Sullivan. Brian Crother, David Cundall, William Dunson, David Green, Diana Hews, Joe Mendelson, III, James Petranka, Rick Shine, Gregory Watkins-Colwell, John Wiens, and Dawn Wilson remain from the past Board.

The addition of two new AEs has replenished the AE pool from the losses encountered during 2013. Tiffany and Paul are still looking to add one or two more AEs, especially those versed in squamate ecology, for which they receive a large number of manuscripts. They are especially interested in expanding representation from Brazil, a country that contributes many manuscripts each year, and from Asia or Africa, which are not represented.

A source of concern to Tiffany and Paul is the fact that overall submissions to *Journal of Herpetology* declined again in 2014. Submissions for 2015 (110 as of the end of May), however, are higher than the number submitted during the same period in 2014. The amount of time needed to reach initial decisions decreased in 2014, but the days from receipt to final decision remained high. Part of this can be attributed to reviewers not responding in a timely fashion. The wait between acceptance of a paper and publication averages 9-13 months. However, thanks to "Online First," readers have access to a near-final version almost as soon as a paper is accepted.

During 2014, the journal received submissions from 23 countries, which is lower than all of the years from 2009–2013, which had 33–48 countries represented. Tiffany and Paul believe this primarily reflects the decrease in the number of manuscripts. The leading countries from which manuscripts originate remain the USA (77) and Brazil (20), ranks both countries have held since data became available in 2006. During 2014, 67 amphibian and 114 reptile manuscripts were submitted (this was the first full year for which amphibian versus reptile submissions were tracked).

Over the past few years Tiffany and Paul have implemented a number of new features:

1. A new Aims & Scope for the Journal, in consultation with several Society members. It now appears on the journalofherpetology.org and the ssarherps.org websites.
2. A twitter account for the Journal, @JofHerp, which has over 300 followers at this writing.
3. Optional second-language abstracts (started for all languages in 2011), which are becoming more common.
4. Invited Long-term Perspectives (started in 2011)
5. Inclusion on the back cover of each issue (starting in 2012) of a world map indicating countries from which published papers are included.
6. Full-color, no-cost for graphics (option added 2013).
7. No page charges for SSAR members (starting in 2013).
8. Online-early appearance of accepted articles (starting in 2013) at journal website, Online First.
9. Associate Editor Lunch at SSAR annual meetings.

Standing Committee Chair Reports

The following SSAR members continued their service on the Conservation Committee in 2014–2015: Ross Alford, Nicole Angeli, April Barreca, John Jensen, Nancy Karraker, Karen Lips, Joe Mendelson, III, Gad Perry, Stephen Richter, Betsie Rothermel (Chair), and Susan Walls. During the past year, the Conservation Committee advocated for emergency measures to prevent introduction of a newly discovered chytrid fungus (*Batrachochytrium salamandrivorans*, or *Bsal*) responsible for die-offs of salamanders in Europe. Following publication in Fall 2014 of studies demonstrating the virulence of *Bsal* to North American salamanders, the Committee coordinated submission of a joint letter from four major herpetological societies (SSAR, ASIH, HL, and Canadian Herpetological Society) to U.S. Fish & Wildlife Service urging them to use their authority under the Lacey Act to suspend imports of salamanders and also to develop pathogen screening and certification programs to provide more comprehensive protection against introduction of amphibian pathogens. Unfortunately, the U.S. Fish & Wildlife Service has not taken any action to date. The other main focus was on a renewed effort to end the few remaining rattlesnake roundups in Alabama, Georgia, Oklahoma, and Texas. Joe Mendelson, III remarked that he had contacted some prominent companies listed as sponsors of some of these events. Their "sponsorship" apparently was (unwelcome) news to them. Joe suggested that SSAR consider writing letters to companies when their names are attached to such events. In the year ahead, the Committee is planning to engage with the zoo community and other herpetological societies in a broader push to convince the promoters and organizers to change the focus of remaining roundup events to be wildlife-friendly. Betsie Rothermel announced her decision to step down as chair and Joe offered to assume this position. President Bauer immediately accepted Joe's offer!

Joe Beatty, Chair of the Dean Metter Award Committee, received eight proposals for the Dean E. Metter Memorial Award. This year's winner is Carmen Harjoe, a Ph.D. student in the Department of Integrative Biology at Oregon State University. Her dissertation research deals with the status of populations of Western Toads (*Anaxyrus boreas*) in southeastern Alaska. Carmen is interested in determining if southeastern Alaskan populations of the toads are stable or declining. She will do this by determining toad site occupancy and abundance at localities where the toads are found and also whether the toads are infected with disease(s).

The 23rd annual Seibert Awards Competition (Rafe Brown, Chair) was run at the 57th Annual Meeting of SSAR in Chattanooga. There were 29 eligible presentations. The Seibert Award winners for 2014 were: Systematics/Evolution: **Elyse Freitas** (Villanova University), "Molecular phylogenetics and patterns of limb loss in the genus *Scelotes*." Ecology: **Chris Thawley** (PennState University), "The cost and benefits of adaptation: a case study using native fence lizards and invasive fire ants." Conservation: **Drew Davis** (University of South Dakota), "Effects of agricultural tile drainage on amphibians in eastern South Dakota." Physiology/Morphology: **Patrick Moldowan** (Laurentian University), "Turtles with teeth: tomiodont morphology and functional significance in the painted turtle (*Chrysemys picta*). All winners received a check for US $200 and a book from CRC Press.

Honorable mentions were: Systematics/Evolution: **Rachel Skinner** (Villanova University), "Phylogenetic relationships of South African geckos in *Pachydactylus geitje* species complex (Squamata: Gekkonidae)." Ecology: (A) **Meagan Thomas** (Eastern Illinois University), "Quantifying dietary overlap in a community of invertebrate feeding snakes;" and a *special undergraduate honorable mention* (B) **Mark Herr** (James Cook University), "Stressed snakes strike first: hormone levels and defensive behavior in free-ranging cottonmouths." Conservation: **Brian Crawford** (University of Georgia), "Does pride work? Evaluating an NGO's integrative model for promoting community conservation behavior." Physiology/Morphology: **Matthew Dickson** (California State University, Northridge), "Rapidly adapting to the neighborhood: physiological responses of Mediterranean house geckos to their introduced climates."

The members of the Herpetological Education Committee (HEC) this year were Craig Guyer (Chair), Scott Boback, Dora Pinou, Lynne Haugen, and Al Richmond. The biggest HEC project continued to be the Meritorious Teaching Award in Herpetology (MTAH), sponsored by SSAR, HL, and ASIH.

At the request of President Bauer, the committee also reviewed criteria for presentation of the pre-baccalaureate travel awards. The HEC revised the rules to restrict awards to students in grades 9–12 with an interest in herpetology. Applications will consist of a letter of interest written by the student indicating why they want to attend a herpetology conference and what their herpetological interests are, a letter of support from a teacher, and a letter from a parent or guardian indicating willingness to provide transportation and serve as chaperone for the student during the conference. The HEC then will review these materials and provide awards based upon overall strength of the application. Only applications received by April 30 of the year of the meeting will be evaluated. Applicants will be judged on financial need and academic maturity. There was some discussion of building an endowment to support this program once we have appropriate guidelines and an application process in place.

The HEC has instituted a system in which committee members have defined terms, during which each member eventually becomes chair and then cycles off the committee. This procedure is being implemented to provide greater institutional memory. Under this system, Scott Boback will become chair for 2016 and Craig Guyer will cycle off the committee.

The winning paper for the 2014 Kennedy Award (Lynnette Sievert, Committee Chair) is "The Relationships between Parasite Intensity, Locomotor Performance, and Body Condition in Adult Toads (*Rhinella ictericа*) from the Wild" by **Eduardo H. Moretti** et al., *Journal of Herpetology* 48:277–283. Eduardo will receive a check for $200 or $400 in SSAR publications.

Kraig Adler, Chair of the Long-Range Planning Committee (LRPC), reported that neither Past-President Aldridge nor current President Bauer has referred any items to the LRPC for discussion this past year, and the LRPC did not meet in 2014. However, an open meeting of the LRPC has been scheduled for the KU meeting.

The current LRPC has been active since September 2010. The Committee has accomplished a great deal over these last four years, but Kraig thinks it is time for a new committee to take a fresh look at SSAR: evaluate the changes that have been put in place since 2010 and consider new ideas to better secure our future as a vibrant, member-led and -oriented scientific organization that continues to be a pace-setter among the world's herpetological societies.

Kraig remarked that it was the LRPC (in 2011) that recommended SSAR to consider returning to holding occasional meetings on university campuses. The Board approved this recommendation and the LRPC followed through by endorsing a plan to hold the 2015 meeting at KU. We invited PARC to be our major partner this year. This is the first time that PARC has held a nation-wide meeting of its otherwise regional organizations. SSAR is very pleased that they have joined with us and we look forward to much cross-fertilization of interests and ideas by bringing SSAR and PARC together at KU.

The JMIH meetings remain SSAR's default arrangement for annual meetings and this is our main mode of operation for annual meetings. However, every 3–5 years (i.e., once during the career of most students) SSAR may choose to hold a different kind of meeting where students can interact more intimately with herpetologists, including our seniors, and do so at low cost. The KU meeting is a test of this new approach and the LRPC asked for feedback about the KU meeting at its open meeting in Lawrence. President Bauer commented that he has invited the Presidents of ASIH and HL to visit him later this year to talk about issues facing all three societies, including membership and meetings.

In his report, Rafe Brown (co-Chair of the Local Committee for the 2015 meeting) presented a draft of the meeting schedule. The Membership Committee was inactive in 2014. Former co-Chairs, Ann Paterson and Marina Gerson, suggest that the Committee needs clear objectives provided by society leadership and that the implementation of any recommendations be taken on by elected leaders. Ann has been in contact with the new Chair of this committee, Greg Watkins-Colwell. She will continue to communicate with him and include the members of the LRPC in the discussion.

In 2014, memberships in SSAR totaled 1,862, which is 145 fewer than in 2013. Regular memberships and student memberships continue as the two most important categories, numerically. Seventy-three percent of the 2014 members were continuing their memberships from previous years; of the 27% new memberships, some of these may have been members in prior years. In all categories of membership combined, 1,643 were print memberships and 219 were for online access only. Student members showed greater demand for online memberships, than did Regular members. The 2014 memberships represented herpetologists from 67 countries (up from 63 in 2013), but addresses from the United States made up 80% of all memberships. The next eight most-represented countries, ordered from the greatest number of members were Canada, Australia, Brazil, United Kingdom, Germany, Japan, Mexico, and the Netherlands. There were fewer than ten members from each of the other 58 countries.



PHOTO BY MARION PREEST

FIG. 37. Participants in the SSAR Mentor program.

The Mentorship Committee consists of Kris Kaiser (Chair), Andrew Durso, Joe Mendelson III, and Marion Preest. At the Tennessee meeting, the Mentorship Program paired 17 students from across the societies with mentors. Mentees in the program ranged from three pre-baccalaureate students to beginning Ph.D. students, and came from all societies. Mentees were all previous attendees of the meetings. Follow-up surveys showed a general satisfaction with the program. Joe Mendelson, III indicated that the program this year (2015) was smaller than usual, but very successful (Fig. 37). The Committee is debating whether to increase the size and scope of the program in the future.

Robert Espinoza, Nominations Committee Chair, reported that no election was held in 2015 and thus the Nominations committee was inactive. Members are asked to pass on suggestions of nominees for the 2016 election to the Chair.

Resolutions were presented at the SSAR Business Meeting in Chattanooga in 2014, and these have been published in *Herpetological Review*.

Josh Kapfer (Chair, Roger Conant Grants-in-Herpetology Committee) received 64 proposals. Most applications were in the "Laboratory Research" category.

The winners each received $500 and they are:

Conservation.—**Pamela Clarkson**, Southeastern Louisiana University, "Rehabilitation stress dynamics of incidentally caught Kemp's Ridley Sea Turtles (*Lepidochelys kempii*)." **Madeline Cooper**, Humboldt State University, "Examining invasive Bullfrog (*Rana* [*Lithobates*] *catesbeiana*) movement patterns on the Trinity River."

Education.—**Valentine Kheng**, Surya University (Indonesia), "HEAR: Hello Amphibians and Reptiles!!!"

The Andrew H. Price Field Research Grant-in-Herpetology.—**Samantha Rumschlag**, Miami University, "Toads in Peril? Assessing the risk of American Toad populations to an emerging infectious disease, chytridiomycosis." **Hannes Schraft**, San Diego State University, "Infrared prey sensing in rattlesnakes (*Crotalus* spp.)."

Laboratory Research.—**Sean Harrington**, San Diego State University, "Constructing the pitviper tree of life." **Alexander Novarro**, University of Maryland, "Will intraspecific variation buffer the effects of climate change in lungless salamanders? Measuring the effects of adult body size on the thermal physiology of *Plethodon cinereus* across an elevation gradient."

Travel.—**Kyle Hovey**, John Carroll University, "Alkaloid-based chemical defenses of the Strawberry Poison Frog *Oophaga pumilio*: do variable defenses provide equal protection from microbial pathogens? **John Phillips**, University of Tulsa, "Comparative genomics of eyes in spelerpine salamanders."

International.—**Ivan Camilo Beltran Arevalo**, University of Los Andes (Colombia), "Autoresistance to batrachotoxin (BTX) in *Phyllobates bicolor*: a molecular and physiological approach." **Saeed Hosseinian**, Ferdowsi University of Mashhad (Iran), "Biogeography and phylogenetics of the *Paralaudakia caucasia* species complex." (Because of current restrictions on sending funds from the U.S. to Iran, and despite prolonged efforts, we regret that SSAR has been unable to provide Saeed Hosseinian with his award. He has been informed that SSAR will retain the funds and, if policies change, the Society will be pleased to send him his award).

Undergraduate Research.—**Mark Herr**, Penn State University, "Thermoregulation and predation trade-offs by gravid Timber Rattlesnakes, *Crotalus horridus*, at gestation sites."

Since Spring 2013, the Website Subcommittee has been comprised of Carol Spencer (Chair), Michelle Koo, Raul Diaz, Vincent Farallo, Joe Mendelson III, and Todd Pierson. Carol reports that in the first year, the committee accomplished the ambitious goal of publishing a completely new website and content management system (http://ssarherps.org/). This went live 28 July 2014, in time for the SSAR/JMIH 2014 meeting. This completely revamped site benefits users as well as committee/ board members and editors, who needed an easily editable site that can be updated often.

Since the website went live, 32 blogs, news, events, and updates have been provided to the Latest News and Homepage Slideshow. The Subcommittee has edited many pages since the launch, and allowed specific individuals (editors, committee chairs, all website committee members) access to edit parts of the WordPress site themselves, so they can change and update their specific pages of interest. They are still working on streamlining these processes and have created some tutorials and guidelines specific to these tasks (e.g., Blog Guidelines).

Google Analytics is compiling some interesting statistics now that we have our first year tracked. For example, from 28 July 2014 to 14 Jun 2015, we have had ~41,000 sessions from new visitors to the site, viewing 2 pages per session, and ~16,000 visits from returning visitors, viewing 2.4 pages per session. Visitors reached us via various searches on Google, including "SSAR," "herpetology," "herpetologist," and "grants-in-herpetology" as the search terms that accounted for the most new sessions after unexplained search terms. The United States accounted for most users of the site, with Brazil, Canada, and United Kingdom the next three countries of origin for sessions. Peaks in usage occurred in July 2014 (when the site launched), and May 2015 (probably because of the SSAR conference abstract deadline).

The Subcommittee implemented backup services for the website and its content. Much of this and the Google Analytics required a gmail account and so we needed to 're-initiate' the previously dormant/lightly used ssarherps@gmail.com account. We are now regularly using this and checking it.

In 2015, the focus has been on implementing a completely new Common Names Database, which will have all the current updates from the taxonomic subcommittees from Brian Crother as of December 2014.

Some features of the site include: simple searches, loose (partial string searches) and fuzzy (close match) searches, searches by taxonomic group (e.g., snakes, turtles, etc.), and other advanced searches, such as clade, subtype, family, genus authority or species authority searches, searches on alien species and many other features. The resulting data displayed include genus, species, subspecies (when applicable), English name, images (links to CalPhotos when available), major common type (e.g., snake, salamander), English subtype, Linnean order, genus authority, species authority, and authority year. When you click on a row in the resulting database, you can view more information, such as taxon notes, authors and dates of the current taxon information, and links to other sites for more information about each species, such as iNaturalist, CalPhotos, the Reptile Database or AmphibiaWeb. Users will be able to download the entire database as a csv file.

As the Website Subcommittee finishes the Common Names Database pages, they plan to move into the next phase of responsibilities, hopefully reducing the editing and work load on most members. Website updates are easy to do with the new WordPress site, but they still require regular amounts of time and energy by various committee members. George Pisani suggested that the Board and other members of the society should be the ones generating content for the website, not necessarily the already-hardworking members of the Subcommittee.

Brian Crother (Chair) Standard English and Scientific Names Committee reported that Steven Tilley and David Wake stepped down last year and they have been replaced by Ron Bonnet and Elizabeth Jockusch. The professionals on the committee are thanked for their terrific work: Jeff Boundy, Frank T. Burbrink, Jonathan A. Campbell, Kevin de Quieroz, Darrel Frost, David Green, Richard Highton, John B. Iverson, Fred Kraus, Roy W. McDiarmid, Joseph R. Mendelson III, Peter A. Meylan, Alex Pyron, Tod W. Reeder, and Michael E. Seidel.

No report was received from the Student Participation Committee this year. President Bauer will be in touch with the new Chair, Jeremy Feinberg, about reactivating this Committee. The Board expressed a desire to increase student involvement (including pre-baccalaureate students) in the Committee. The names of several students were suggested and Aaron will pursue this.

The fourth annual SSAR Student Poster Awards (recently named the Victor Hutchison Student Poster Awards) were presented during the 57th Annual Meeting of SSAR in Chattanooga, Tennessee. We had 40 eligible posters. All awardees received a check for US $200 and a book from CRC Press. This was the first year the award was $200, double that in previous years. The winners are:

Physiology & Morphology.—**Krista Mougey**, Texas Tech University, "Thermal ecology and locomotor performance of the critically endangered stout iguana *Cyclura pinguis.*"

Conservation & Management.—**Grant Connette**, University of Missouri, "Historic timber harvest predicts abundance but not genetic diversity of a terrestrial salamander, *Plethodon shermani.*"

Ecology, Natural History, Distribution, & Behavior.—**E. Alexander Rohtla**, Villanova University, "Advertisement calls of the thick-toed geckos (Reptilia: Gekkonidae: *Pachydactylus*)."

This year's judges were Tiffany Doan (Chair, State College of Florida, Manatee-Sarasota), Marina Gerson (California State University, Stanislaus), Jon Davenport (University of Montana), Bruce Kingsbury (Indiana-Purdue University at Fort Wayne), Kristen Cecala (Sewanee-University of the South), Thomas Lozito (University of Pittsburgh), and Frances Irish (Moravian College).

In 2014, Mike Jorgensen and Vincent Farallo continued as co-chairs of the Student Travel Awards Committee. In 2014 the value of travel awards was increased from US $400 per award to $500. Fourteen applications were received for the 10 available awards of $500 to help fund student travel to the 2014 JMIH in Chattanooga. The main role of the Student Travel Awards Committee is to accept applications for the award and coordinate with the awardees to supervise the silent auction table at the annual meeting; Vincent Farallo was able to attend the meeting to direct awardees and oversee the silent auction table. Students receiving awards helped supervise the silent auction table as has been done in previous years. There will be 12 awards of $500 available for the 2015 SSAR meeting in Lawrence, Kansas to help cover the increasing cost of travel. Details of the travel award are presented on the new SSAR website and are regularly updated to ensure students have current information. Finally, Mike Jorgensen is stepping down from the Student Travel Awards committee. Vincent Farallo will continue as the chair of this committee.

Coordinators' Reports

Dan Noble, Election Officer, reported that 11 mail and 123 electronic ballots were received for the 2014 election. The following people were elected to their respective roles for 2015:

President-elect: **Rick Shine**

Treasurer: **Ann Paterson**

Secretary: **Marion Preest**

Board of Directors I (two people with highest votes): **Robin Andrews** and **Emily Taylor**

Board of Directors II: **Kim Lovich**

Board of Directors III: **Tony Gamble**

The Live Auction in 2014 was organized by Samantha Kahl, Greg Watkins-Colwell, Kirsten Nicholson, and Meredith Mahoney. This year Kirsten and Meredith stepped down from the committee at the completion of the live auction, having served for many years.

Greg reported that in 2014 the SSAR and HL Live Auction returned to the "normal" operation of generating funds to be split between SSAR and HL. Efforts were made to include as many different auctioneers (with different auctioning styles) as possible. Humor and "unique" items were also part of the night's festivities adding to the levity. The auction maintained a large audience late into the evening. Auctioneers for 2014 were Sara Ruane, Travis Hagey, and Sean Graham. Students assisting the live auction were Krista Mougey, Catriona Hendry, Elyse Freitas, Arianna Kuhn, and Rachel Skinner. Additional help was provided by Nathali Aall and Ross Maynard.

The Live Auction made $6,808. Expenses associated with the Live Auction continue to take a sizeable cut from the funds raised. The total profit following expenses was $4,855, which was split evenly with HL resulting in $2,428 to help fund SSAR student travel awards. The Board talked about the importance of members understanding "the point of the auction," i.e., to support students.

Greg confirms that he will step down from the Chair of the Auction Committee following the Live Auction at the 2015 SSAR meeting in Lawrence, Kansas. Samantha Kahl and Sean Graham will assume that role.

Al Savitzky, Representative to AIBS and BioOne, reported that as of this year, BioOne has published 1.1 million pages and has returned $32 million to its member publishers. The funds are returned in the form of both royalties and profit-sharing, and are based on an algorithm that reflects relative use of the journal within the collection. BioOne has merged its two collections (formerly known as BioOne.1 and BioOne.2) into a single collection for the purpose of sales (now known as BioOne Complete), and future sales will be only for the full collection. However, the two collections remain internally distinct, to protect the financial returns to the individual publishers.

Al described three presentations at this year's Publishers & Partners Meeting that may be of particular interest to our society members. First, an update was provided on BioOne's new journal *Elementa: Science of the Anthropocene*. This open-access journal continues to seek new manuscripts, and society members are encouraged to visit their website (https://www.elementascience.org/) to consider whether *Elementa* would be an appropriate outlet for their publications on human impacts on fauna or habitats.

Second, Amy Brand of Digital Science gave a presentation entitled "Beyond Authorship: An Introduction to the Credit Taxonomy." The presentation dealt with the increasing complexities of authorship and credit for scientific publications, including the issues of "coercion authorship" and "honorary authorship." She noted that a Committee on Publication Ethics (COPE) has been established in the UK, and other organizations are considering the implications of modern trends in authorship and credit.

Finally, Kathleen Erickson discussed the new joint editorial office for the American Ornithological Union and the Cooper Ornithological Society. Having failed to fully merge the several ornithological societies headquartered in North America, the AOU and COS did succeed in merging their editorial offices. Kathleen, who serves as Managing Editor for both societies' journals, discussed their joint publication office in detail. The goals, among other things, were to effect savings in publication costs and also to protect print publication for as long as possible. The two societies maintain separate Editors-in-Chief and Associate Editors, but they share a Managing Editor and her office, with both societies contributing equally to the costs of that office. Great care went into establishing the joint editorial office, which is overseen by a Joint Advisory Committee (for editorial policy) and a Joint Management Committee (for financial oversight). Many benefits have emerged from this relationship, including the online publication of a joint newsletter which is read by >10,000 people. This may be an appropriate model for collaboration among several of the herpetological and ichthyological societies. These and other presentations from the 2015 Publishers & Partners Meeting can be viewed at http://www.bioone.org/page/about/presentations.

Al reported that this year, AIBS has been re-examining its structure and reconsidering its core mission. Key to that mission will be a continuing commitment to the AIBS Public Policy Office, which provides direct communication between our societies and legislators and other lawmakers. AIBS continues to provide direct access to legislators on behalf of its professional society constituents. Society members are encouraged to consider signing up with the AIBS Legislative Action Center (LAC; http://policy.aibs.org/), which provides immediate alerts regarding relevant legislation and simplifies contacting individual legislators to express an opinion on those issues, many of which are related to conservation or the federal funding of science. This year the Public Policy Office was heavily involved in efforts to ensure re-authorization of the America COMPETES Act, which included funding for NSF.

This year two symposium proposals were submitted to Symposium Coordinator, Dick Durtsche, for SSAR sponsorship at the 2016 JMIH meeting in New Orleans. The first proposal

entitled "*Eco-Evolutionary Dynamics Across Taxa: Fishes, Amphibians and Reptiles*" was submitted by David M. Green and Andrew Hendry. This symposium will focus on evolutionary changes that can occur through varied ecological processes influencing phenotypic changes in natural populations. The second proposal entitled "*Digital Herp Information and Communication*" was submitted by Peter Uetz as the symposium organizer. This proposal was submitted as either a symposium or a workshop depending on how much hands-on activities the speakers wanted to offer. It identifies the importance of digital information as a currency in science from data collection to publication, and communications not only among scientists but also to the general public through social media or on-line publications. Both proposals were sent out for external review and the proposals and reviews were given to the Board for their consideration. The Board voted to support the first proposal above, but not the second in its current form. The Board recognized the potential importance of the second proposal and recommended that the organizer reach out to HL and ASIH for "buy in" and encouraged him to think about developing the ideas as a workshop for 2017.

New Business

The Board reviewed the JMIH 10-year, renewable memorandum of understanding (MOU). The version of the MOU submitted to the Board was ambiguous with respect to the "opt-out" clause (allowing SSAR to occasionally hold independent meetings with sufficient advanced notice) found in the previous version signed by SSAR. Once this ambiguity is rectified, the Board authorized President Bauer to sign it on behalf of the society. Future JMIH meetings are to be held in New Orleans (2016) and Austin (2017). A location for 2018 is yet to be determined. Cleveland (Ohio), Providence (Rhode Island), and Duluth (Minnesota) are being discussed. The Board was reminded of the World Congress of Herpetology (WCH) to be held in China in 2016. SSAR will have a presence at the meeting, but because it is not in North America, it will not substitute for JMIH.

The Board discussed restrictions on eligibility for Roger Conant Grants-in-Herpetology in light of difficulties encountered this year sending funds to an awardee in Iran. The Board decided that the wording of the announcement for these awards should be changed to indicate that we cannot send funds to international applicants hailing from countries to which monetary transfers are prohibited by the US government. The Board regrets having to make such a decision. The Andrew H. Price Field Research Grant-in-Herpetology will be renamed the Roger Conant Field Research Grant-in-Herpetology.

SSAR received a request from WCH to join in developing a Global Communication Network for Herpetologists. After some discussion it was determined that this was not necessary as many SSAR members are active in the WCH organization; however, it would be useful to provide WCH with the name of someone active on the SSAR website. Carol Spencer (Chair, Website Subcommittee) will recommend someone to President Bauer.

Discussion then turned to the issue of open access requirements increasingly faced by authors. For example, researchers in Canada who obtain funding from the Natural Sciences and Engineering Research Council are required to publish their work only in peer-reviewed journals that are freely accessible (i.e., open access) within 12 months of publication. In the USA, the National Institutes of Health, but not (yet) the National Science Foundation have a similar requirement. This has implications for researchers wanting to publish in SSAR journals. The Board talked about the potential financial costs of going open access and what a reasonable open access fee might be. Al Savitzky suggested that we seek advice from BioOne. The consensus was that we need a uniform policy, i.e., not something that is applied to a subset of our authors, but to all authors. The same policy, but not necessarily the same fee, would apply to individuals publishing in *Journal of Herpetology* and *Herpetological Review*. After discussion of waiving or reducing the fee for non-members, it was decided that we would not do this in light of the fact that we already waive page charges for members. President Bauer appointed the following individuals to an *Ad Hoc* committee to investigate this matter further—Breck Bartholomew, Al Savitzky, Bob Hansen, Tiffany Doan, and Paul Bartelt. They were charged with developing a policy to be considered by the Board. It was recognized that this policy would likely need to be evaluated regularly.

Breck Bartholomew received a request from EBSCO that databases be full-text searchable with non-EBSCO discovery services. To meet this library expectation, EBSCO requests permission to share the full text in their databases with third-party discovery vendors for searching but not display. Breck indicated that we receive very minor annual payment from EBSCO and recommended that we decline this request. The Board agreed.

The Board then turned their attention to several issues raised by the co-Editors of *Journal of Herpetology*. The Board approved a request for continued funding of lunches for Associate Editors who attend the annual meeting. Following discussion of a request to provide free pdf files to authors publishing in *Journal of Herpetology*, including the financial implications, it was decided that the editors will work out the details and then return to the Board with a proposal.

The *Journal* currently has a policy that authors are required to use standard common names for all USA, Canadian, and Mexican species. Tiffany and Paul report that they have not had pushback against the USA and Canadian names, but some authors oppose the Mexican names, which they claim are not the common names used on the ground and that the names lead to confusion. The Board indicated that such a requirement was waived a number of years ago. Finally, Tiffany and Paul reminded the Board that, in 2016, they will publish the 50th volume of *Journal of Herpetology* and they are soliciting ideas for how to commemorate this milestone.

There was some discussion of the very generous support that SSAR has received from the Carl Gans Charitable Trust. Kraig Adler indicated that the Trust's Advisory Board is likely interested in continuing their support of SSAR, particularly for programs that would not happen without their support.

President Bauer thanked Breck Bartholomew for his many years of selfless service to SSAR in his role as Publications Secretary. The Board then focused its attention on the implications for SSAR of Breck's upcoming resignation. There are multiple issues to consider and Aaron urged the Board to not necessarily think of them as all being linked. He indicated that things will need to change, as he does not believe that we can find one individual to take over all of the roles that Breck has served. For example, we will need to reduce our storage costs by decreasing the size of print runs of SSAR publications (and accepting that some items will go out of print), considering print-on-demand in some cases, and decreasing the volume of material stored. Breck currently has approximately 1,000 ft^2 of books. He aims to reduce this to 500 ft^2.

Allen Press could store back issues of our journals and ship them when replacements are requested or in the case of late membership renewal. Allen Press would charge us for this. Rather than SSAR referring to this as a penalty for late renewal, we could refer to it as a discount for early renewal. Breck's office currently handles page charges, indexing of *Herpetological Review*, and mailing of pdf files to authors. The Board felt we could find some individual(s) willing to take over these jobs. Breck said it would likely need to be a society member and he hoped this could be handled soon.

Dealing with membership duties is a major task and we will need a plan in place by Fall 2016. There tends to be a period of peak activity, typically December–February. Allen Press was discussed as possibly taking over this responsibility (they have handled our membership in the past), however they are expensive. Al Savitzky encouraged the Board to consider the model recently adopted by the ornithological societies as well as thinking about including non-US herpetological societies in a common membership office. Joe Mendelson, III mentioned a large "volunteer army" at, for example, ZooAtlanta and suggested that such groups may be willing to take on some of these tasks for the Society. Vinny Farallo indicated a need to integrate membership activities with the website.

Even if we are able to farm out many of these tasks, we will still need someone to handle the publications side of Breck's responsibilities. Pre-publicity of SSAR publications is done by the series' editors, but we still need someone to continue with the advertising, particularly if we hope to move inventory rapidly to save on storage costs.

Despite the issues that Breck raised in terms of dealing with donated libraries, Aaron encouraged the Society to be open to the idea of continuing to accept these. In wrapping up this discussion, Aaron reminded the Board that we will need to generate solutions to the issues of membership duties and back issues of publications between now and the 2016 JMIH. He indicated the importance of involving the LRPC, and tasked Breck with disposing (preferably selling) of donated items and reducing the square footage of books.

The Board then turned to the 2016 budget. A balanced budget of $299,250 for 2016 was approved by the Board.
The meeting was adjourned at 1547 hrs.

LRPC Open Meeting

An open meeting led by the Long-Range Planning Committee (LRPC) for all SSAR members was held on the afternoon of August 2nd. Discussed were: (1) evaluation of having occasional annual meetings on a university campus, and (2) future development of the newly redesigned SSAR web page.

SSAR Business Meeting

The Annual SSAR Business Meeting was called to order by President Bauer (1635 hrs, Aug 2nd). Over 150 members of SSAR were present. Officers, Editors, and Committee Chairs who were at the Business Meeting introduced themselves to the other attendees and gave brief summaries of their annual reports and relevant information from the Board Meeting.

Stu Nielsen read the following resolutions: "SSAR wishes to thank a large number of individuals for service and other contributions to the Society. First and foremost, we thank the members of the local committee who have put on such a fun and successful meeting. It's truly been a monumental amount of work. We wish to particularly acknowledge Rafe Brown, Rich Glor, and Kraig Adler, also George Pisani, Bill Duellman, and Linda Trueb. Thanks to the hordes of local students who have been involved for months in planning for this meeting as well as associated organizations—Partners in Amphibian and Reptile Conservation, Center for North American Herpetology, Kansas Herpetological Society, Missouri Herpetological Association, Arkansas Herpetological Society, and International Society for the History and Bibliography of Herpetology. We are grateful to Stacey Walters, Kevin Curry, Justine Hamilton, Sharon Leatherman, Jeremy Whetstone, and Jennifer Schmitendorf. SSAR is very pleased to have the following Senior Herpetologists in attendance at the 2015 Annual Meeting: Victor Hutchison, Bayard Brattstrom, Alan Leviton, Bill Duellman, Itzchak Gilboa, and David Wake. We greatly appreciate their presence. Thanks to Dave Dennis and Eric Juterbock for the updating and resurrection of their AV shows which had been missing from SSAR meetings for far too long. Thanks to this year's President's Travelogue speaker, Miguel Vences for his talk "Inventory of an Imperiled Paradise: Two Decades of Herpetology in Madagascar." The fact that it was essentially standing-room only attested to the popularity of this event. SSAR is immensely grateful to the Carl Gans Charitable Trust for their generous contributions to SSAR student members. The Trust covered the meeting registration fees for 20 students and provided $500–$1000 contributions towards travel costs of attending the meeting for an additional 11 students. SSAR, and especially Treasurer Ann Paterson, wishes to thank John Psaltos for many years of service as SSAR's accountant. We welcome Beverly Powell as our new accountant. Editors of *CAAR*, Travis LaDuc and Chris Bell particularly thank Bob Powell and Breck Bartholomew for their persistent help navigating through the logistics of editing this series. Kraig Adler wishes to acknowledge a grant from the Seidell Program at Smithsonian Institution to cover the translation by Richard Goris of *Salamanders of Japan* that is in Kraig's *Contributions to Herpetology* series. Robert Hansen, Editor of *Herpetological Review*, thanks David Steen (Section Editor, Natural History Notes) and Kyle Miller Hesed (Copy Editor) for their excellent service. Betsie Rothermel is stepping down as chair of the Conservation Committee after many years in this role. Thanks to Betsie and also to Joe Mendelson, III who has offered to assume this role. We thank Craig Guyer who has been chair of the Herp Education Committee for the past two years and will now be replaced by Scott Boback. A huge thanks to Vic Hutchison for the generous donation of his library to SSAR. This has allowed us to fund the Student Poster Awards program, which we have gratefully named after Vic. SSAR acknowledges John Sulzycki of CRC Press for his continued support of the Seibert Student Awards and the Victor Hutchison Student Poster Awards. Mike Jorgenson, co-chair of the Student Travel Awards Committee has resigned after several years of service. Thankfully, Vinny Farallo is willing to continue chairing this important committee. The society joins Greg Watkins-Colwell in thanking Kirsten Nicholson and Meredith Mahoney for their efforts on the Live Auction Committee for many years. Greg will continue to chair this committee through the end of 2015. Congratulations to the sixth winner of the SSAR/HL/ASIH Meritorious Teaching Award in Herpetology, Dr. Brad Shaffer. Thanks again to those who were part of the Mentorship Program and served as mentors for students attending this meeting. Finally, thanks to Carol

PHOTO BY R. W. HANSEN



FIG. 38. Some of the 12 winners of the SSAR Travel Awards. From left to right, Zachary Martin, Jordan Meyer, Rachel Flanagan, Megan Smith, Stu Nielsen, and Molly Womack.

PHOTO BY R. W. HANSEN



FIG. 39. Winners and recipients of Honorable Mentions in the Henri Seibert Student Paper Award competition, with Rafe Brown, committee chair. From left to right, Robin Abraham, Carl Hutter, Matt Buehler, Jesse Grismer, Rafe Brown, David Penning, Melissa Van Kleeck, Alexa Warwick, and Alex Rohtla.

PHOTO BY R. W. HANSEN



FIG. 40. President Aaron Bauer with Alex Rohtla and Aaron Griffing, both Villanova University students (honorable mention in the Ecology Section of the Henri Seibert Student Paper Award and winner of a Victor Hutchison Student Poster Award, Evolution, Genetics and Systematics Section, respectively).

PHOTO BY MARION PREEST



FIG. 41. Aaron Bauer presents SSAR Presidential Award for Lifetime Achievement in Herpetology to Bob Hansen on the 25th anniversary of his editorship of *Herp Review*.

PHOTO BY MARION PREEST



FIG. 42. Aaron Bauer presents SSAR Presidential Award for Lifetime Achievement in Herpetology to Kraig Adler for outstanding service to herpetology.

Spencer, Michelle Koo, Raul Diaz, Vincent Farallo, Joe Mendelson III, and Todd Pierson on the Website Subcommittee, as well as members of the Standard English and Scientific Names Committee for their efforts in getting the names database on the beautifully redesigned SSAR website.

Henri Seibert Best Paper, Victor Hutchison Student Poster, and Student Travel Awards were presented by Rafe Brown, Tiffany Doan, and Vinny Farallo, respectively (Figs. 38–40).

President Bauer then presented "SSAR Presidential Awards for Lifetime Achievements in Herpetology" to Tom Beauvais, Bob Hansen, and Kraig Adler. The award to Tom mentioned "his comprehensive research on the Eastern Massasauga," and "leading important innovations in SSAR's quarterly journals." Bob

was acknowledged for his "25 years as editor of *Herpetological Review* and his commitment to the conservation of amphibians and reptiles of California." The award to Kraig acknowledged his "outstanding service to herpetology as founder and dedicated officer, editor, advisor, and member of the Society for the Study of Amphibians and Reptiles." These awards barely scratched the surface of what the Society owes to these hard-working and dedicated individuals (Figs. 41, 42).

Al Breisch, co-Chair of PARC, thanked SSAR for the invitation to participate in such a successful annual meeting. President Bauer adjourned the business meeting at 1740 hrs.

For more photos of the KU meeting, visit https://www.flickr.com/groups/2485879@N22/ and select "photos."

List of Abbreviations Used

AIBS - American Institute of Biological Sciences
ASIH - American Society of Ichthyologists and Herpetologists
HL - The Herpetologists' League
JMIH - Joint Meeting of Ichthyologists and Herpetologists
KU - University of Kansas
LRPC - Long-Range Planning Committee
MTAH - Meritorious Teaching Award in Herpetology
PARC - Partners in Amphibian and Reptile Conservation
WCH - World Congress of Herpetology

—Respectfully submitted by **MARION PREEST**, *SSAR Secretary*

Support SSAR through Amazon Smile

If you use Amazon.com you can give back to the society with every purchase. Through the Amazon Smile program, you are able to designate an organization to receive a small contribution with each purchase. For instructions, visit the SSAR website <https://ssarherps.org/2015/10/help-support-ssar-for-free/> or go directly to <smile.amazon.com> and type "Society for the Study of Amphibians and Reptiles" in the search bar at the top of the screen. Once SSAR is selected, that will remain your default organization for future purchases.

MEETINGS

Meeting announcement information should be sent directly to the Editor (herpreview@gmail.com) well in advance of the event. We also welcome brief reports of meetings; please consult the Editor for details.

7–8 January 2016—California/Nevada Amphibian Populations Task Force, University of California, Davis, USA. Information: http://www.canvamphibs.com/APTF2016/APTF_2016_Announcement.pdf

19–21 February 2016—Desert Tortoise Council Symposium, Las Vegas, Nevada, USA. Information: www.deserttortoise.org.

14–17 April 2016—63rd Annual Meeting of the Southwestern Association of Naturalists, Mexico City, Mexico. Information: http://www.biosurvey.ou.edu/swan/annualm.html

23–27 May 2016—1st National Congress of Mexican Pitvipers and Ophidism, Monterrey, Nuevo León, Mexico. Information: http://www.fcb.uanl.com http://www.facebook.com/animalesvenenososmexicanos or congresoviperidos@gmail.com

22–25 June 2016—39th Annual International Herpetological Symposium (HIS), Saint Louis Zoo, St. Louis, Missouri, USA. Information: http://www.internationalherpetologicalsymposium.com/39th-annual-symposium/

6–10 July 2016—Joint Meeting of Ichthyologists and Herpetologists, New Orleans, Louisiana, USA.

15–21 August 2016—8th World Congress of Herpetology, Hangzhou, China. Information: http://www.wch2016hangzhou.com/

CURRENT RESEARCH

The purpose of Current Research is to present brief summaries and citations for selected papers from journals other than those published by the American Society of Ichthyologists and Herpetologists, The Herpetologists' League, and the Society for the Study of Amphibians and Reptiles. Limited space prohibits comprehensive coverage of the literature, but an effort will be made to cover a variety of taxa and topics. To ensure that the coverage is as broad and current as possible, authors are invited to send reprints to the Current Research section editors, Ben Lowe or Chava Weitzman; e-mail addresses may be found on the inside front cover.

When it Comes to Size, Does Climate Matter?

Bergmann's Rule, where bodies tend to be bigger in colder environments, is well documented for mammals and birds. However, results from studies of ectotherms have been conflicting and controversial. The authors of this paper address whether there are relationships between body size and various climatic variables in amphibians of Europe and North America north of Mexico. To accomplish this, they gathered distributional and body size data for nearly all relevant species. They also amassed temperature, seasonality, net primary productivity, and

precipitation data for the regions. The authors employed three methods of analysis (orders analyzed separately). First, they conducted a grid cell analysis by dividing the region into cells, determining median body size and species richness for each cell, and assessing correlation with the environmental data using simultaneous autoregressive models (a regression method for spatial data). To investigate the importance of species richness, they simulated random-draw species assemblies (same dimensions as the empirical data; selection probability proportional to range size) and calculated a 95% confidence interval of median body size per richness value; this was compared with the empirical data. Finally, they performed a phylogenetic generalized least square (PGLS) regression using published phylogenetic relationships to determine whether they could detect correlations between distributional climate variables and body size. The grid-cell analysis found that for both orders, richness, mean temperature, and temperature seasonality were all correlated with body size. Median body size of both orders decreased with increasing richness. However, as temperature and temperature seasonality increased, anuran body size decreased, while caudate body size increased. Importantly, when all variables except richness are excluded from median body size models, the pseudo-R^2 values decrease little, suggesting that median body size is not strongly predicted by climatic variables. Further, median size fell mostly within the 95% confidence intervals based on random assignment. The PGLS analyses resulted in opposite, though weak, trends from those of the grid-cell analyses. These results overall support the importance of species richness in body-size clines found among Anura and Caudata. The opposite trends between these orders also indicate that a general rule cannot be assumed for climatic impacts on evolution of ectothermic body size. The authors acknowledge weaknesses in both of the methods in this study. Neither method incorporates variation in size across a species distribution, though a grid-cell analysis could be altered to discern population-level changes. Also, incorporating a larger geographical area could help detect other mechanisms relevant to patterns of body size in vertebrate ectotherms.

Slavenko, A., and S. Meiri. 2015. Mean body sizes of amphibian species are poorly predicted by climate. Journal of Biogeography 42:1246–1254.

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Extreme Resistance to Toxins by an Unknown Mechanism

Tetrodotoxin (TTX) is a chemical weapon found in many animal taxa and is known to block the movement of sodium across cell membranes. Few species are able to feed on animals with TTX and able to tolerate its effect. Snakes include some of the only species that regularly consume such toxic prey, and here, the authors present findings on the Eastern Hog-Nosed Snake (*Heterodon platirhinos*) and its occasional toxic prey, the Eastern Newt (*Notophthalmus viridescens*). In most systems, TTX resistance in a predator results from changes in the structure of the outer pore of the sodium channel. Through mutations in the genes coding for the outer pore protein, many species have converged upon TTX resistance. In the present article, the authors were interested in levels of TTX in newts and TTX-resistance in hog-nosed snakes where they live in sympatry and allopatry. They assayed both newt and snake phenotypes, as well as the functional genotype of the gene encoding the skeletal muscle sodium channel (*SCN4A*). Prey assays included measurements of TTX in newt skin and extrapolating measurements to the whole animal. For predator assays, snakes were injected with 1 and 10 mass-adjusted mouse units (MAMUs) for species allopatric and sympatric with newts, respectively, with serially increasing doses. Snakes were subjected to performance trials of sprint speed to calculate the required dose for a decrease in sprint speed by 50%. While newts from the two sampled sites did not possess significantly different levels of TTX, the snake populations tested (sympatric: 8 *H. platirhinos* localities; allopatric: one *H. platirhinos* locality and one *Heterodon nasicus* locality) had extremely different levels of resistance. The allopatric snakes had similar TTX resistance to other snakes lacking resistance. Alternatively, sympatric snakes were able to resist high doses of TTX, some to an extent that would kill most other terrestrial vertebrates. Surprisingly, the *SCN4A* allele of all the *Heterodon* was the same as the wild type found in non-resistant snakes, lacking any of the predictable mutations present in other resistant species. Thus, these snakes are able to consume some of the most toxic prey and are protected by mechanisms not yet known. It may be that these snakes co-opt mechanisms already present that protect them from their own venom to capture TTX. Whatever the mechanism, the convergence of phenotype on TTX-resistance has resulted from multiple paths.

Feldman, C. R., A. M. Durso, C. T. Hanifin, M .E. Pfrender, P. K. Ducey, A. N. Stokes, K. E. Barnett, E. D. Brodie III, and E. D. Brodie Jr. 2015. Is there more than one way to skin a newt? Convergent toxin resistance in snakes is not due to a common genetic mechanism. Heredity (*in press*) doi:10.1038/hdy.2015.73

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Sleep with One Eye Open

Unihemispheric sleep is when an organism sleeps with half of its brain at a time, and this type of sleep could allow individuals to maintain vigilance or group structure while also getting those much-needed hours of rest. Some species able to use unihemispheric sleep include birds and aquatic mammals. One hint toward use of unihemispheric sleep is unilateral eye closure (UEC) of the eye associated with the hemisphere of the brain that is awake. The open eye could be used to detect potential threats or conspecifics; species that thrive in groups could use UEC to maintain group cohesion. Many reptile species exhibit UEC, including many turtles and lizards and some crocodilians. To explore the evolutionary history of UEC between birds and reptiles, the authors of this paper investigated the use of UEC in juvenile Saltwater Crocodiles (*Crocodylus porosus*). They conducted experimental trials for eye closure before, during, and after exposing the crocodiles to conspecifics and humans. While UEC was not common in baseline measurements and did not increase in the presence of a conspecific, the open eye did tend to be directed toward the visible crocodile, when present. In the presence of a human and immediately following presentation, crocodiles exhibited UEC a greater proportion of the time. Again, the open

eye was directed toward the human or where the human had stood. Periods of UEC more frequently involved an open right eye than left eye; in birds, the visual system is lateralized, with the right eye/left side of the brain better able to detect changes in the environment, and further studies are required to determine whether this is the case in crocodilians as well. These results agree with past studies of *Sceloporus* fence lizards. The authors discuss the possible evolutionary origins of UEC in reptiles, potentially arising as early as stem amniotes. Although these data suggest unihemispheric sleep, electrophysiological recordings should be conducted to determine whether unihemispheric sleep coincides with UEC in the case of the saltwater crocodile, and understanding the brains in more detail would also help to elucidate the evolutionary history of unihemispheric sleep in these organisms.

Kelly, M. L., R. A. Peters, R. K. Tisdale, and J. A. Lesku. 2015. Unihemispheric sleep in crocodilians? Journal of Experimental Biology 218:3175–3178.

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Continental Islands and Marine-Tolerant Frogs: A New Spin on Island Biogeography

One prediction of island biogeography is that islands that are closer to the mainland or are larger should contain more genetic diversity. Specifically, islands that are larger can maintain larger populations, and therefore more genetic diversity, and both larger and closer islands will receive more migrants, boosting genetic diversity. The frog species *Thoropa taophora* (Cycloramphidae) is endemic to Brazil's Atlantic Coast and adjacent continental islands, and has a high tolerance to salt. Here, the authors wanted to see if they could detect the signal of vicariance in these populations, and see if genetic diversity in these frogs matches the expectations from island biogeography. The authors collected frog samples from 7 coastal and 10 island sites, representing 9–49 frogs per site and used nine microsatellite loci to answer these questions. Results indicate that some expectations from island biogeography theory may not be applicable to recently isolated continental islands. Although the island populations had less genetic diversity, as one would expect from isolation and drift, the predicted effects of land area and distance to the mainland were not found in this study. STRUCTURE analysis separated the 17 sites into eight genetic demes, with nearby populations grouping into the demes and low admixture among the demes. Island area and distance to the mainland did not correlate with maximum likelihood estimates of island population sizes. Maximum likelihood estimates of migration rates detected migration in both directions between island and mainland populations, and migration rates near zero among most neighboring coastal populations. Analyses also estimated similar times since divergence among coastal and island populations. The authors discuss two processes that could lead to such results of genetic diversity: continued migration and the possibility of different genetic signatures for vicariance and founder events. With a small, salt-tolerant frog species, it is possible that islands more so represent a habitat fragment, where total area available may be less important than suitable habitat. A similar study with larger-bodied organisms may result in expected interactions of island size and genetic diversity. Additionally, in species such as *T. taophora* with high tolerance to salinity, or in species where the islands are within possible dispersal ranges, distance between island and mainland may have to be larger in order to detect expected effects of distance on evolutionary patterns. For conservation, this study detected low effective population sizes and low gene flow in the northern populations, indicating that those populations and populations of other species that share that habitat may be of considerable concern for conservation.

Duryea, M. C., K. R. Zamudio, and C. A. Brasileiro. 2015. Vicariance and marine migration in continental island populations of a frog endemic to the Atlantic Coastal forest. Heredity 115:225–234.

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Skinks and Salt Secretions in Extreme Habitats

In extreme habitats such as desert or marine areas, species require adaptations that allow them to maintain homeostasis or tolerate fluctuations into an homeostasis in the face of fluctuating water and ion availability. Some species secrete concentrated stores of ions at once to minimize water loss, while others have salt glands that allow them to regulate ion concentrations. The paper described here is the first to investigate salt secretions in skinks that inhabit intertidal zones to determine how they cope with the high ion levels from their diet. The authors use a variety of techniques to study two populations of Suter's Skink (*Oligosoma suteri*) northeast of Auckland, New Zealand, with differing available habitat in terrestrial and intertidal zones. Measurements detected diet composition (stable isotope analyses) and nasal and cloacal salt secretions, as well as fecal water loss. Fecal samples included those from wild-caught diets and after laboratory feeding experiments. Skinks and invertebrate prey items were caught in four habitat zones, ranging from closer to farther from the ocean. The authors estimated proportional contribution of prey items to diets by fitting a Markov chain Monte Carlo model to the stable isotope data. At the site with less available vegetation, stable isotope analysis detected the main food source for the skink to be a type of amphipod, while skinks at the second site seemed to have a more balanced diet among prey items along the gradient from the ocean. This supports the authors' hypothesis that when a wide variety of food sources are available, the skinks will use both intertidal and vegetation zones for feeding. This pattern seems to have changed in recent years at one site studied, possibly due to the eradication of invasive predators in the area that may have limited the skinks' usage of the more terrestrial zones. Interestingly, the stable isotope analysis detected a separation between larger and smaller skinks and how they use the intertidal and terrestrial habitats; smaller skinks seem to forage more in the intertidal zone, while larger skinks consume more prey in the terrestrial areas. Generally speaking, these skinks excreted sodium predominantly through nasal secretions and urine, and potassium via feces. Amounts of ions in nasal secretions varied widely, but were comparable to those in other intertidal lizards. In the intertidal habitat, excess sodium is the limiting factor in a diet. This skink's ability to secrete sodium via multiple methods and in varying amounts may allow it to exploit multiple habitats and have a flexible diet. As this is the first

report on intertidal skink ion secretions, the authors end with a note that follow-up studies should include additional laboratory experiments with different salt-loads, as well as further experiments on the ontogenetic differences in diet composition and habitat use.

Janssen, J., D. R. Towns, M. Duxbury, and I. M. A. Heitkönig. 2015. Surviving in a semi-marine habitat: dietary salt exposure and salt secretion of a New Zealand intertidal skink. Comparative Biochemistry and Physiology, Part A 189:21–29.

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Olive Ridley Sea Turtle Reported in the Mediterranean

This paper documents the stranding of an Olive Ridley Sea Turtle (*Lepidochelys olivacea*) in one of the northern-most occurrences of Olive Ridleys, and the first occurrence in the Mediterranean Sea. In May 2014, a sea turtle was stranded ashore on the Mediterranean coast of Spain, just north of 40° latitude. The authors used morphological characteristics to determine this turtle to be in the genus *Lepidochelys*, and DNA sequencing of a control region of mitochondrial DNA to identify the species. The individual's haplotype matched the Atlantic populations of Guinea-Bissau, Surname, and Brazil, as opposed to the other Atlantic and Pacific populations. The authors discuss two possible migration routes leading to the Mediterranean. The first is travel from South America northeastward across the Atlantic. The second route could be northward from the west coast of Africa. The paper discusses the likelihood of increased research and rescue efforts to help detect more individuals outside their circumtropical distribution, particularly in the eastern Atlantic, where data are sparse.

Revuelta, O., C. Carreras, F. Domènech, P. Gozalbes, and J. Tomás. 2015. First report of an olive ridley (*Lepidochelys olivacea*) in the Mediterranean Sea. Mediterranean Marine Science 16:346–351.

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Though They Can Be Quick, Caecilians May Evolve Slowly

Though the genomes of anurans and caudates have been evaluated extensively, the genomic architecture of caecilians is relatively unknown. Studies of caecilian genomes, therefore, can provide insights into genome evolution in amphibians and tetrapods. As full genome sequences are not available for caecilians, the authors of this paper studied Hox genes, as they include pivotal information regarding organismal form and development, and gene function is known to rely on both coding and non-coding sequences. Thus, changes in Hox gene sequences are thought to have important impacts on major structural evolution of organisms. In addition to the sequences themselves, identifying patterns in Hox gene clusters can hint toward patterns in the rest of the genome of the organism. The authors used a combination of previous PCR surveys, long-range PCR, and genome walking to compile sequences for the majority of the four Hox clusters in the Banna Caecilian (*Ichthyophis bannanicus*). The caecilian Hox gene clusters were compared with those of other vertebrates to investigate phylogenetic patterns of conserved non-coding elements and repetitive elements. Rate of evolution was estimated using Tajima's relative rate test (RRT) to determine how that of caecilian compares with those of other vertebrates. The RRT detected that over 62% of caecilian's Hox coding sequences had slower evolutionary rates than the Western Clawed Frog, and over 80% evolved slower than humans, while the reverse of these was never true. General rates of evolution in the caecilian were similar to those observed in the Indonesian Coelacanth, which is considered to be a slowly-evolving species, and seven caecilian Hox genes evolved faster than their equivalents in the coelacanth. In the RRT analyses for proteins, one protein in frogs evolved slower than its analog in caecilians. Phylogenetic studies detected similar patterns. The *HoxC1* gene was present in the caecilian sequence, but absent in the rest of tetrapods, indicating that this gene was lost in the remaining tetrapod lineages. The *HoxD12* gene is also lost or has become a pseudogene in the caecilians and frogs analyzed. Snakes and lungfish also lack this gene, and it's thought the gene is connected to the reduction of digits in amphibians. This is either not the only path, or not the main component of digit reduction, however, as *HoxD12* is present in many limbless lizards. The authors leave us with many directions to head toward for future studies. What is the role of *HoxD12* in digit reduction? Who will sequence the intergenic gaps of this study to further understand the compact, minimalistic nature of caecilian's Hox clusters? And will further genome sequencing for caecilians corroborate the story of their slow evolution?

Wu, R., Q. Liu, S. Meng, P. Zhang, and D. Liang. 2015. Hox cluster characterization of Banna caecilian (*Ichthyophis bannanicus*) provides hints for slow evolution of its genome. BMC Genomics 16:468.

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Hard Egg Shells: Rare but Beneficial in Gekkotans

The parchment-shelled eggs of most squamates are highly permeable to water vapor from the environment, and thus, these eggs are laid underground where conditions allow for water uptake. However, species in the gecko clade made up of the families Gekkonidae, Sphaerodactylidae, and Phyllodactylidae lay rigid-shelled eggs, which are less permeable to water vapor. These eggs are generally laid above ground, in drier environments. There are multiple fitness costs to laying rigid-shelled eggs for these gekkotans, including small hatchling size and the need for provisioning the egg with all the water necessary for embryo development. This clade accounts for 85% of gecko diversity, suggesting rigid eggs might be a key innovation that has allowed these geckos to be remarkably successful despite the apparent costs. Here, the authors examine the role of nest

moisture and temperature conditions on egg survival and hatchling phenotype. The study organisms, *Chondrodactylus turneri* (Gekkonidae) and *Eublepharis macularius* (Eublepharidae), lay rigid-shelled and parchment-shelled eggs, in dry and moist environments, respectively. Eggs were incubated at 25°C, 28°C, and 31°C, with low (*C. turneri* only) or high (both species) moisture. When exposed to low moisture conditions, *C. turneri* eggs had survival rates of over 90% at all temperatures, higher than the two lower incubation temperatures for both species incubated with high moisture. Egg survival was temperature-dependent in high moisture conditions, and death of eggs was linked to fungal infection. *C. turneri* eggs had varied amounts net water exchange depending on incubation moisture, not temperature. Values ranged from -15% to +0.4% initial egg mass, while *E. macularius* eggs increased up to 28% egg mass in high moisture conditions. The uptake of water in rigid-shelled eggs can cause shell cracks, increasing likelihood of fungal infection. In *C. turneri*, embryos incubated with high moisture did not utilize all of the yolk, and hatchlings were relatively smaller. They also selected relatively lower body temperatures if incubated at with high moisture or 31°C as opposed to 28°C. However, incubation temperature and moisture did not correlate with growth rates in the first 60 days. Egg survival in both species was highest in conditions most similar to natural nest conditions. When incubated in high moisture environments, *C. turneri* egg survival decreased and embryo development was slower, likely due to embryos competing for space in the egg with water, and fungi infecting cracked shells. As conditions ideal for these rigid-shelled eggs are poor for parchment-shelled eggs, and previous studies have found the opposite to be true as well, the authors discuss the likelihood that harder eggs enabled development in dryer environments, and brought an escape from infection. They may also provide more physical protection of the embryo. Higher survival of also allows for smaller clutches, possibly also offsetting the costs of calcium and water for each egg.

Andrews, R. M. 2015. Rigid shells enhance survival of gekkotan eggs. Journal of Experimental Zoology 323A:607–615.

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Everybody Poops… Nematodes, If You're a Galápagos Giant Tortoise

The Galápagos Islands have unique flora and fauna that have been impacted over the years by the introduction of non-native species, overexploitation, and habitat loss. The Galápagos Giant Tortoise (*Chelonoidis nigra*) species complex included 10 species with a total population size of approximately 250,000 before the arrival of humans to the region. Seven species remain, with a total of 6,000–20,000 individuals. Though much of these species' ecology has been studied, their internal parasite communities have been largely ignored. Parasites can be important drivers of population fluctuations and diversity of their hosts and communities. In this paper, the authors report on the nematode community of tortoises from four wild populations and three captive breeding centers, to identify important nematode taxa, a measure of abundance, and patterns across the islands. Parasites were collected from fecal samples; egg density was measured using a modified McMaster method, and when available, expelled nematodes were identified using morphology and sequence data. The authors collected one fecal sample from 362 individual tortoises, representing six tortoise species. Nematodes were present in all populations except the captive tortoises on San Cristobal. Over 80% of the wild tortoises were infected. Nematode community composition differed by tortoise species, co-varying with island. Egg analyses detected five nematode types, representing four superfamilies. Two types of strongyle eggs were detected by visibly different egg sizes; the large type was found in all of the populations with nematodes, while the small type was only found in the two populations from Isabela Island. Trichurid eggs were found in all infected populations except the one on Pinzón Island. Infected samples had 1–404 eggs per gram, and over 90% of the eggs counted were strongyle eggs. Two nematode genera were identified from adults expelled in the feces of Santa Cruz tortoises, representing types not represented in egg counts, as these species hatch in utero. Neither sex nor relative tortoise age classes (old vs. young) had differing prevalence or mean abundance of nematodes. For wild tortoises, though prevalence was high, egg counts were relatively low. The authors provide data for present background levels of nematode parasitism in some Galápagos Giant Tortoises, and urge that more precise measures would give further insight into the evolutionary history of these host-pathogen interactions. The field would benefit from more detailed information on parasite species present, better measures of species abundance over time within individuals and populations, and a better understanding of how fecal parasites correlate with internal parasite load. The authors also urge conservation measures to be more mindful of parasites when housing and releasing tortoises in and from captive breeding sites, to avoid possibly detrimental introductions of new parasites into populations.

Fournié, G., S. J. Goodman, M. Cruz, V. Cedeño, A. Vélez, L. Patiño, C. Millins, L. M. Gibbons, M. T. Fox, and A. A. Cunningham. 2015. Biogeography of parasitic nematode communities in the Galápagos giant tortoise: implications for conservation management. PLoS ONE 10: e0135684.

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OBITUARIES

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Douglas Athon Rossman 1936–2015: The Gentle Renaissance Man of Herpetology

Douglas Athon Rossman passed away on 23 July 2015 in Decorah, Iowa, of complications from a long battle with muscular dystrophy. Doug was born on Independence Day in 1936 in Waukesha, Wisconsin, the elder son of Vernon and Josephine Rossman. He is survived by his first wife Nita, his younger brother Will Rossman, his two children, Chuck Rossman, of Greenwell Springs, Louisiana, and Kathleen Rossman, of Baton Rouge, Louisiana, and nine grandchildren, and his second wife Sharon (married on 5 May 1990), her three sons Eric, David, and Doug Bates, and their four children.

As a young boy, Doug lived in Peoria, Illinois, and later in Kankakee, Illinois, before moving with his family to Coatsville, Pennsylvania, in the later 1940s. The family then moved to Hopewell, New Jersey, and Doug attended Princeton High School, in nearby Princeton, New Jersey. During these early years, Doug was a counselor at summer camps run by the Young Men's Christian Association, for which organization his father was an administrator. This was a formative period for Doug, offering an opportunity to both study nature and to educate young people. He was fond of accompanying his father to the camp during the off-season, where he was released into the woodlands to catch box turtles and water snakes. Perhaps as importantly, the time he spent alone in the woods allowed him to contemplate nature in a spiritual manner that molded his quiet demeanor and guided his creative writing in later years. Living in New Jersey also placed Doug in the proximity of the Philadelphia Zoo, where he met its Reptile Curator Roger Conant. Conant had a research interest in natricine snakes, which also became Doug's lifelong focus of academic research. When time came for college, Doug enrolled at Southern Illinois University in Carbondale, Illinois, where he was graduated in 1958 with a B.A. degree in zoology. At SIU, he held a position as an undergraduate research assistant from 1956–1957, and while there he married his first wife, Nita. Soon thereafter, he moved to the "Land of Sunshine" and enrolled in the graduate program at the University of Florida in Gainesville. Doug bypassed the M.S. degree, going straight for the Ph.D., co-advised by Archie Carr and William Riemer, which he was awarded in 1961. At UF, he functioned as a graduate teaching assistant from 1958–1959.

Doug's first academic position was as an interim instructor at the University of North Carolina in Chapel Hill from 1961–1963. In 1963, Doug accepted a position as an assistant professor at Louisiana State University at Baton Rouge, where he remained for the remainder of his academic career until his retirement in 1998. He moved up through the ranks steadily, becoming a full professor in 1976. Doug was also responsible for the curation of the herpetological collections at LSU, starting as an assistant curator in 1963 and becoming curator in 1976, coincidental with his move through the professorial ranks. During his curatorial tenure, the herpetology collection increased from roughly 8,000 to a little over 80,000 specimens, and due to his interest in snake anatomy, he built into it the world's largest collection of snake skeletons.

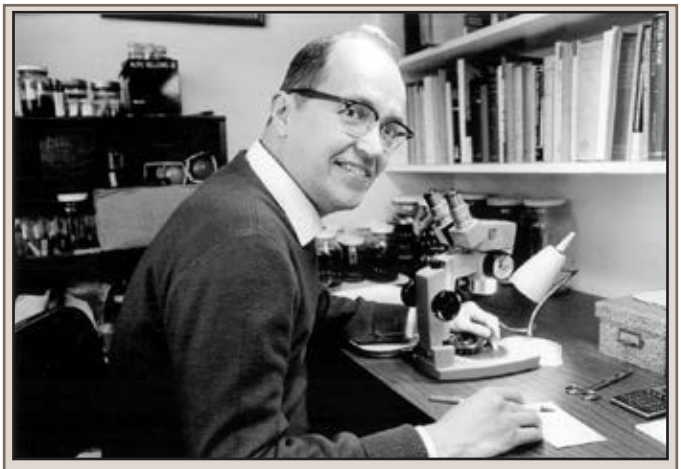


PHOTO BCOURTESY OF LSU MUSEUM OF NATURAL HISTORY

FIG. 1. Douglas A. Rossman, ca. 1980, in his office at the Louisiana State University Museum of Natural Science, Baton Rouge, Louisiana.

Doug built a strong research presence in herpetology from an early stage of his academic career. His first paper, a two-pager on food habits of a captive *Seminatrix* [now *Liodytes*] *pygaea*, appeared in 1956, when he was 20 years of age. Thereafter, Doug produced a steady output of publications, with at least one paper appearing each year, with the exception of very few years. Over the course of his publishing career, he produced 98 scientific publications, including two books.

Doug's central research interest involved the systematic study of snakes, most notably those belonging to the natricid genus *Thamnophis*, but also other related genera in the United States and Mexico (*Adelophis*, *Clonophis*, *Liodytes*, *Nerodia*, *Regina*, *Storeria*, *Tropidoclonion*, and *Virginia*). His work on *Thamnophis* culminated in a book—*The Garter Snakes: Evolution and Ecology*—coauthored with Neil B. Ford and Richard A. Seigel and published in 1996. These authors recognized 30 species in the genus; currently, 34 are recognized at the Reptile Database website. Interestingly, the four species described subsequent to the appearance of the *Thamnophis* book either were described by Doug, in collaboration with Frank Burbrink, or were named for Doug, by Roger Conant. Doug and Frank named *T. bogerti*, *T. conanti*, and *T. lineri*. Roger Conant named *T. rossmani*, which was truly an appropriate patronym, given Doug's longtime devotion to this genus. Doug also considered Roger Conant as his mentor, as evidenced by his dedication in the *Thamnophis* opus,

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which reads "To Roger Conant, my mentor and friend, who introduced me to the wonderful world of thamnophiine systematics and thereby changed the path of my professional life forever…" That Doug would have dedicated much of his publishing career to this genus is testament to the degree of meticulousness and perspicacity he brought to his work on a group of snakes whose initial revisor, A. G. Ruthven, described in his 1908 monograph as one that "has long stood in the minds of herpetologists as a synonym for chaos" (Rossman et al. 1996: 9). Though happy to tackle the problems within garter snake systematics, Doug first dabbled in studies in another vexing group, the Dusky Salamanders of the genus *Desmognathus*, naming his first new taxon *D. conanti*. Doug later averred that he was happy to have left systematics of that group to the molecular biologists. Aside from the salamander, Doug named three new subspecies, ten species, two genera, and one family of snakes.

Doug began his research into *Thamnophis* systematics while he was a doctoral student at UF. He chose to work on ribbon snakes (*T. proximus* and *T. sauritus*) for his dissertation, his monograph on which appeared in 1963. He continued to work on this subject until his masterwork appeared in 1996 and another piece of work on the Mexican snakes *T. scalaris* and *T. scaliger* in 1997, coauthored with G. Lara-Gongora. During those 34 years, Doug wrote some 20 papers on the members of the genus *Thamnophis*.

Although his name will be linked forever to the garter snakes, Doug was not a one-note snake systematist. We mentioned above that he also worked on other natricids in the New World, and he began to develop a long-standing interest in the dipsadid genus *Helicops*, a sort of ecological counterpart of the semiaquatic natricids found in South America. He wrote his first paper on a member of this genus in 1968 coauthored with Norman Scott; at the end of his life, he was working on a paper also dealing with this genus, which he was coauthoring with William Lamar.

Although a large amount of Doug's herpetological work dealt with snake systematics, he was also interested in other subjects in the field. The major evidence of such interest was his other book-length work, *The Amphibians and Reptiles of Louisiana*, coauthored with Harold Dundee, then of Tulane University. At the time, Doug and Harold were the two preeminent herpetologists in the state, so it was natural that they should band together to "work up" the herpetofauna of the state where they both lived and worked. This book won the 1990 Louisiana Literary Award for its two authors, a feat not often accomplished by authors of scientific works. Doug also worked and published on several groups of southeastern arachnids, and assisted other researchers by collecting invertebrates for them. A new species of crane fly that he collected on the screen door of his Baton Rouge home was named *Tipula rossmani* by George Byers, entomologist at the University of Kansas.

When Doug transitioned to LSU from Chapel Hill in 1963, one of his responsibilities was to attract students to the graduate program in zoology. It was in the spring of that year that he visited the campus of UF and enthused the senior author of this piece to become his first graduate student. Thus, in the fall of 1963, Wilson moved to Baton Rouge to begin what would become a five-year stint that led to his M.S. degree in 1965 and his Ph.D. in 1968. The work that Wilson undertook for his doctorate became exemplary of the sort of topics that Doug's subsequent doctoral students pursued, i.e., a taxonomic survey of a broadly-distributed species of snake occurring somewhere in the Western Hemisphere. During the period from 1967–1999, Doug oversaw the work of eight doctoral students, including Edmund D. Keiser (1967, *Oxybelis aeneus*), Larry David Wilson (1968, *Masticophis flagellum*), Kenneth L. Williams (1970, *Lampropeltis triangulum*), Richard M. Blaney (1971, *Lampropeltis getula*), Alexander Varkey (1973, North American natricine snake cranial myology), J. P. Richard Thomas (1976, Antillean *Typhlops*), Robin



PHOTO BY L. J. VITT

FIG. 2. Douglas A. Rossman and five of his former graduate students on the occasion of a reunion in 2011 in Baton Rouge, Louisiana. Pictured from left to right are Kenneth. L. Williams, Janalee P. Caldwell, Doug, Donald E. Hahn, Larry David Wilson, and Jeff Boundy.

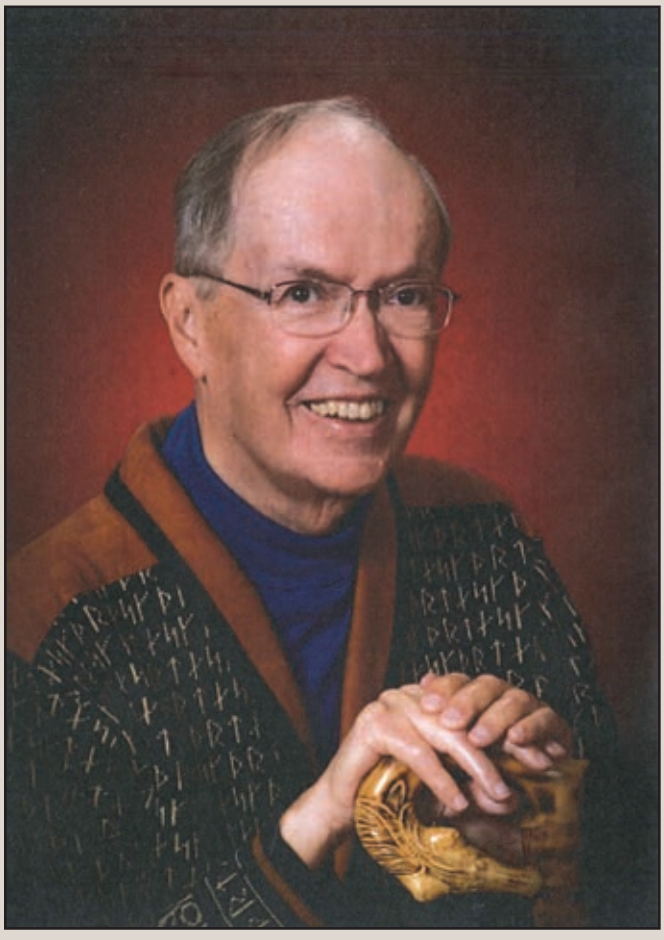


PHOTO COURTESY OF SHARON ROSSMAN

FIG. 3. Douglas A. "Dag" Rossman, 2013, Decorah, Iowa.

Lawson (1985, thamnophine snake molecular systematics), and Jeff Boundy (1999, *Thamnophis sirtalis*). He also served as major professor for 17 M.S. students, including Janalee Caldwell, Donald Hahn, Darrel Frost, and Van Wallach.

Doug's initial pace in academia was busy. Within his first eight years at LSU, he graduated five Masters and three PhD students, applied for and received at least two grants, travelled internationally to collect specimens for his research, hosted an international symposium on snake systematics, and published 21 papers. His philosophies and techniques regarding science changed little during his career: usually a student selected a taxon or taxonomic group, and evaluated it for geographic variation and/or morphological adaptation. There were occasional projects involving anatomy and faunistic surveys, and even some genetics work. Typically, a graduate study could be completed with a dissection kit, stereomicroscope, and a typewriter. His first "molecular" study was a master's project by Gary Eberle that evaluated chromosomes in the cosmopolitan water snake genus *Natrix*. One result of that study was the recognition of North American water snakes as a distinct genus, *Nerodia*. That split offended Roger Conant so much that he turned his back on Doug for years, and it was only through the efforts of Jim Dixon's wife, Mary, that Conant reconciled himself with Doug. Robin Lawson's dissertation on New World natricine relationships evaluated allozymes, but that was the limit of Doug's involvement with molecular systematics. As the techniques for DNA extraction and sequencing advanced, and new phylogenies were constructed that were solely based on sequences, Doug became increasingly discouraged by the results. A typical complaint from 2011 reads "As I have said before, the molecular folks are self-admittedly trying to base their phylograms on 'selectively neutral mutations' and, in so doing, are deliberately assessing the effects of [genetic] drift and ignoring selection, which I would contend is the chief driving force of evolution since it is where the 'survival rubber hits the road' for individual species." Thus, up to his retirement, Doug's research continued to ponder adaptation through morphology, and in the antiquated fashion, he recorded raw data on specimen cards, wrote his manuscripts longhand with extraordinary penmanship, and sent these to the museum secretary to be typed for publication.

Doug Rossman retired from LSU in 1998 after 35 years of service. His retirement was the occasion for a gathering of many of his students and colleagues in Baton Rouge that brought people from as far away as Oklahoma, Florida, and New York. Although his longtime mentor was unable to travel from New Mexico, Roger Conant sent a letter of congratulations to Doug. The senior author of this piece served as a master of ceremonies for a meeting in the halls of the Louisiana State University Museum of Natural Science. He arranged with Rick Blaney to share the reading of this letter to Doug and the assembled body…but with a twist. When the time came, Larry called Rick to the podium and in front of Doug folded Conant's letter lengthwise and tore it in half. There was an audible gasp in the crowd, as Rick and Larry read the letter switching between left and right sides of the torn document. At the conclusion, Larry took both pieces and presented them to Doug with Conant's compliments. Doug was noticeably flabbergasted until later when he discovered that Rick and Larry had photocopied Conant's letter and used the photocopy during the reading. Thus, continued the longtime tradition of pulling jokes at the museum, often arranged by the two bad-boy students, Ed Keiser and Larry Wilson. For his part, Doug managed to suffer through these shenanigans with his characteristic good grace and aplomb.

At this point, Doug had been married to Sharon for eight years. Together, they decided on the direction of their lives, occasioning a move in 1999 almost directly north from Baton Rouge to Decorah, Iowa. Sharon and Doug decided to retire in Decorah for three reasons: one, because of the Scandinavian background; two, because of Luther College; and three, because of the beauty of the Decorah area (Tollenaar 2015). Decorah became Doug's home until his death 16 years later. Whereas this move might seem to be in jarring contrast to the life Doug spent as a university professor and researcher, he actually developed a range of interests in anthropology and the literary arts that marked him as a renaissance man among herpetologists. In fact, he acknowledged that in his college years, he was tempted to study anthropology rather than systematic biology.

The transition to avocational anthropology began with travels to southern Appalachia in the early 1970s, where Doug interacted with the Cherokee community. As a spiritual individual, he was particularly interested in their myths and legends, and eventually published a book on Cherokee mythic places and their spiritual significance. In the 1980s, he began a routine of spending summers in the upper Midwest, attending Nordic festivals, and story-telling and role-playing events. It was at one of these events that he met Sharon. Nearly full-time involvement in Norse culture enabled Doug to release his creativity in writing, and in his later years he published seven books on Norse Culture and of his own mythic Norse tales. These works were preceded in the early 1990s by four cassette tapes of Doug's alter ego, Dag, ormseeker and itinerant storyteller, explaining the origin of the Seven Worlds and his adventures therein. With characteristic subtle humor, Doug explained that *The Walker in Shadows* was the fourth and final book of the Dag trilogy. The previous book, *Way of the Elves*, contains a section that will convey, to anyone who knew Doug, his philosophy of one's earthly life—a window into his own soul. Doug was also a collector (and reader) of adventure and children's serials: Tarzan, Sherlock Holmes, Fu Manchu, the works of Frank Baum, and many others. He was co-founder of the Sax Rohmer Society, and at the time of his death was co-authoring an exhaustive biography of that writer.

Doug's gentle demeanor and sober assessment of science made him an exceptional instructor, advisor, and colleague. Whether at home or office, his door was always open, and he welcomed discussion of many topics, from fronto-nasal articulation of water snake skulls to the influence of animate spirits in the beliefs of early civilization. In his youth he learned to throw an atlatl, and in his last years learned to walk with two canes. Last year he and the junior author took a last walk together along a road across which some of his beloved natricines were travelling to their summertime haunts. Doug managed over a mile on the rutted track, his two canes keeping him upright long enough to see three snakes. Several months earlier, he wrote to Jeff that "I have reached a point where I can no longer dissect skulls out of pickled specimens….As you can imagine, this physical impediment—combined with my inability to walk on other than unimpeded level ground—has been hard to deal with emotionally. My career as a herpetologist did not end with my retirement in 1998 . . . but it is now a reality."

In the year that followed, Doug's mind was as keen as ever, but his ability to keep himself upright waned to a point that he needed Sharon's physical support to travel within the house. That tenuous situation came to an end when Doug collapsed, and Sharon was unable to raise him back to his feet. It was at that point that Doug consented to housing in a nursing home, but

his stay was short. After a few days there, his spirit unexpectedly departed.

Acknowledgments.—Our writing of this obituary for our friend and colleague would not have been possible without the assistance of a number of others, most especially Doug's widow Sharon, who graciously spoke at length with us during the first difficult days past her husband's death. We also were ably assisted by Janalee C. Caldwell, Kenneth L. Williams, Edmund D. Keiser, Richard M. Blaney, and Donald E. Hahn, who shared their reminiscences unstintingly about the influence Doug had on their lives.

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Memories and Reflections: Phillip Andrew Cochran A Beloved Minnesota Biologist and Herpetologist (1956–2015)

There are few that have touched the lives of so many as Phillip Andrew Cochran. He was a selfless individual, whose academic prowess, candor, sincerity, and witty humor were coupled with extreme modesty that made him a true unsung hero.

Phil Cochran, Professor and Chairman, Department of Biology, Saint Mary's University, Winona, Minnesota, suffered a tragic event on 23 February 2015 that required his being airlifted from Winona Hospital to Gundersen Hospital, La Crosse, Wisconsin. To ease the minds of those concerned, and to insure that his students would not be deprived of a scheduled exam, he humorously sent a text message to his departmental administrative assistant while in transport reading, "I am on the way to my arraignment, hope to post bond tomorrow." She responded that she could proctor his exam, but would not post bond. Unfortunately, that was Phil's last text. After suffering an aortic aneurysm, Phil survived a complex surgery, but shortly thereafter a severe stroke proved unrelenting. Friends and family were ever-present at his side. It was hopeful Phil would recover. Unfortunately, it was not to be, and he passed away amidst the comfort of his family's love in the afternoon of 4 March 2015. A most touching memorial service was held in a packed Saint Mary's basketball gym on 14 March, where Phil regularly played noon round-ball games with his colleagues and friends. His oldest son, Joe (now a neurosurgeon), shared many moving memories on behalf of the family. There was not a dry eye in the field-house. Phil is survived by wife, Michelle; sons Joe, Andy, and Gus, and daughters Jesse and Jenny, and siblings Cathy, Chris, Randy, and Cindy.

Phil was born 13 September 1955. His dad, Andrew Gibbs Cochran, had been a pilot in the Air Force, an airline pilot, and then worked as an electrician when he and Phil's Mom, Mary Lou Bauer Cochran settled in Chicago around 1953. However, they soon moved to Bensenville, Illinois to raise their family. Phil's father passed away during his high school years after a ten-year battle with heart disease. Phil's character developed profoundly after the death of his father when the family (five siblings total) had a hard time making ends meet.

Early in life it was apparent that Phil would someday become a biologist as his brother, Chris, so clearly remembers those earlier years. "As a child, he loved to explore the swamps, ponds, wooded areas, and natural fields near our suburban home. He favored books about nature (the "How & Why" series were well-thumbed and dog-eared). As he learned about the world around us, he began to identify the various animals in our environment. I recall his triumphant return from an exploration of an area pond with jelly jars of water containing microscopic animals. He told me the Latin names, but to ease my understanding, gave them nicknames like Sams and Mergatroids. He knew which logs to turn to find salamanders, which pond would hold tadpoles, where the Starling would nest, what the names were of the various tree frogs and creeping critters. Many of these would be guests occupying jars in our bedroom."



Fig. 1. Phil Cochran with tubed Minnesota *Crotalus horridus*, his favored rattlesnake species, and a "nuisance" snake that he relocated to a protected area, August 2014.

"He learned to be a conservationist as a naturally felt responsibility to the nature that he loved. He led me, and our youngest

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FIG. 2. Phil at graduation time (2010) with student Courtney Keyler, whom he mentored for her senior thesis, "Genetic Variation of Neonate and Juvenile Rattlesnakes (*Crotalus horridus*) as Determined by Analysis of DNA from Shed Skins."



FIG. 3. A button symbolizing the memory of Phil designed by his beloved students.

brother, Randy, in keeping the environment clean. He led us (not exactly willingly), to scour the woods and remove trash. This became a great burden when, during the late 60s, large groups of 'hippies' invaded our wooded areas and clearings on most weekends and left enormous scatterings of cans, bottles, and debris. Phil would make us go in and drag it all out. I believe that this illustrates more than just his concern for the environment. He had a highly developed sense of conscience. He always did the right thing."

A trail of academic achievements began early in Phil's life. When it came time for Phil to consider what college he might attend, his wife Michelle fondly reflected about his first visit to Saint Mary's University in Winona, Minnesota in 1973 for an interview. He related how he had called from the Winona train station to the campus switchboard to tell them that he had arrived. He said the operator simply told him where to go stand, and stick out his thumb to hitch a ride to the campus. At the end of his visit, the admissions staff took him to lunch at Shorty's, and they drank a beer, before putting him on the train back to Chicago.

Without much hesitation, Phil decided to attend Saint Mary's, and he found himself enveloped in all of the things he loved, spending his college summers in Winona working on the Mississippi River. During his senior year in 1977 he met Michelle, a sophomore, and they married in January 1978. They lived in Roseville, Minnesota, while he was in graduate school at the University of Minnesota. To make financial ends meet, he worked as a night security guard, loaded bread trucks, and was a research / teaching assistant at the University. Michelle worked as a waitress, and their first child Joe was born during this time. Michelle recalls that "we were poor but very happy."

Phil completed a B.A. in Biology from Saint Mary's University, Winona, Minnesota in 1977. His undergraduate thesis concerned feeding ecology and growth in Spiny Softshell Turtles of the Upper Mississippi River Valley, and this was his initial academic effort in herpetology. He continued the pursuit of higher academics by completing an M.S. in Biology at the University of Minnesota in 1980. During this period he became involved with helping Dr. Jim Kitchell at the University of Wisconsin, Madison solve a complicated math problem concerning one of Jim's research publications. Not long thereafter, Phil was awarded a fellowship at the University of Wisconsin where Jim became his PhD advisor and a respected friend. For the next four years the Cochrans lived in a mobile home parked in Don's Mobile Manor (4 miles outside of Middleton, Wisconsin). His second son (Andy) and twin daughters (Jenny and Jesse) were born while living the trailer park life. Phil completed his PhD in Zoology in 1984, where he trained as an ichthyologist.

Phil accepted his first academic position with St. Norbert College, DePere, Wisconsin, as an Assistant Professor (1984–1991), and Associate Professor (1991–2000) with the Division of Natural Sciences. Aside from his teaching responsibilities he was always involved in research, setting and checking traps (fish, turtle, and any other creature that swam in) on the Fox River and the East and West Twin Rivers. Family outings were a favorite with picnic lunches along the river in Mishicot and fishing trips all around the area. Phil always had either his family or students in tow. When not accompanied by the whole family he often took along one of his older sons who enjoyed tagging along, especially with college students. During the family time in DePere his wife said, "he kicked me back into college, encouraged and gently pushed me to continue with art studies. Under his loving care I earned degrees in Art, Art Education, and Adaptive Education. This all formed a basis for my having a job that would sustain me, as he had always told me that I needed to be able to earn a living in case he was not around. He encouraged all the family to do what they love."

Although Phil had a wonderful career at St. Norbert, in 2000 a job opened at Saint Mary's University in the Biology Department that seemed like it was designed with him in mind. It was not long after Phil's return to Saint Mary's that he became headlong involved with Minnesota's keystone snake species, the Timber Rattlesnake, *Crotalus horridus*. His interest in the conservation and natural history of this species in the Upper Mississippi River Valley was of the most genuine and sincere in every aspect. He

responded to calls when rattlesnakes were found in yards and school areas, and would relocate the snakes to a secure site. He inspired many students in the study of the biology, natural history, genetics, and ecology and conservation of the Timber Rattlesnake in the region. Along with his newfound interest in Timber Rattlesnakes he continued his studies of the fishes and turtles of the Upper Mississippi, working with sturgeon (*Scaphirhynchus albus* and *S. platorynchus*), paddlefish (*Polyodon spathula*), and his beloved lampreys (*Ichthyomyzon unicuspis,* and multiple other lamprey genera and species). Phil worked in concert with academics from other institutions, the state Department of Natural Resources, and conservation groups to improve the conservation and scientific study of all things natural. His academic, motivational, and inspirational talents with students soon led to his becoming Chairman of the Department of Biology in 2004. Additionally, he served as Acting Associate Dean of Mathematics and Sciences, 2011–2012.

Phil's herpetological and ichthyological studies ranged across international borders, extending into Mexico, and Central and South America. However, during the past decade his keen interest in all aspects of Timber Rattlesnake biology was reflected in a series of publications (Cochran 2008; 2010; 2014a, b, c; Cochran and Riebel 2014; McLaughlin et al. 2015). Phil hosted the first Timber Rattlesnake Symposium in Minnesota at Saint Mary's University, in Winona, 24 September 2005, and published the proceedings (Keyler and Cochran 2005). Collectively, his publications in journals, newsletters, books, briefs, and bulletins number in the hundreds, and he was an internationally recognized biologist. Despite these and many more contributions he made to us all, Phil never boasted of his achievements, and would always generously share the credit of his efforts.

Significantly, in addition to his academic and scholarly penmanship, Professor Cochran enriched the lives of his students. He has undoubtedly motivated hundreds of biology students to further their scientific knowledge, and use it to conserve our natural world and expand horizons in multiple scientific fields. He touched the minds and hearts of more students than he ever realized.

We have lost a Champion to herpetological education, a Champion mentor to future biologists and herpetologists, a Champion to conservation of our natural world, a Champion for the Timber Rattlesnake, and a Champion to humanity and his family. The fish and turtles of Ole' Man River, the Father of Rivers, and the snakes and other creatures of the Blufflands of the Mighty Mississippi River Valley will all remember his spirit. And, when the winds whisper through the Valley and up over the Blufflands it will carry Phil's spirit. The people of the Upper Mississippi River Valley whose lives he touched will carry on in his footsteps. The path this humble human being started will be forever ongoing through the lives of all that knew him. I will miss having a Rush River or Snake Hollow barley pop (as he referred to a good beer) with my colleague and friend after a day of climbing the Mississippi River bluffs in search of *Crotalus horridus*, but know that he is in the field with us always.

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Gans Fund Announces Student Grants to Three Conferences for 2016

The Carl Gans Collections and Charitable Fund is pleased to announce that it will support attendance awards to students—both graduate and undergraduate, but not postdoctoral—who are attending any of the following three conferences in 2016:

International Society of Vertebrate Morphology (ICVM) June 29 – July 3 in Washington, DC

Joint Annual meeting of ASIH, HL, and SSAR (JMIH) July 6 – 10 in New Orleans, Louisiana

8th World Congress of Herpetology (WCH) August 15 – 21 Hangzhou, China

The awards are open to all students regardless of nationality who are eligible to register at the specific conference. **The deadline for receipt of applications is March 15, 2016.**

To be eligible, applicants (1) must certify their student status with a separate message from their professor; (2) must list the herpetological society or societies to which they belong; (3) must be intending to present a paper (oral or poster) at the meeting; and (4) the paper's subject area must be within the broad spectrum of research conducted by Professor Gans on the biology of amphibians and reptiles (especially morphology, systematics, faunistics, behavior, physiology, and evolution). Applicants must provide a paragraph or abstract (no more than 300 words) describing the work to be presented at the meeting, to enable the selection process. Award announcements will be made around April 15, 2016, allowing all applicants to know their status before meeting registrations begin.

Selections will be made by the Gans Fund, on the recommendation of its Scientific Advisory Board. The Board consists of: Kraig Adler, Cornell University (USA), Aaron Bauer, Villanova University (USA), Amos Bouskila, Ben Gurion University (Israel), Herbert Rosenberg, University of Calgary (Canada), Linda Trueb, University of Kansas (USA).



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Tragically, Margarita's life was cut short in a wildlife accident while conducting fieldwork in Zambia, southern Africa, in July of 2015. She had been scheduled to present her latest results at the SSAR meeting later that month at the University of Kansas. The suddenness of her loss has shaken the entire scientific community who not only lost a promising and gifted researcher, but also a brilliant and vibrant role-model for aspiring female scientists. **To commemorate her legacy, SSAR wishes to establish a Postdoctoral Travel Award endowment for one or more persons to attend the Society's annual meetings**. These annual awards will honor in perpetuity Margarita's dedication and passion for science, her tenacity, her boundless energy, her ability to help everyone around her, and her determination to enjoy life and follow her dreams. Donations to support this endowment can be made to SSAR (see below).

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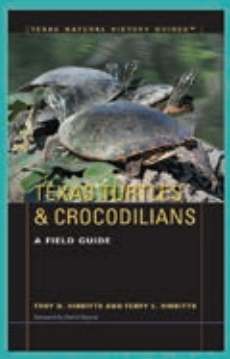
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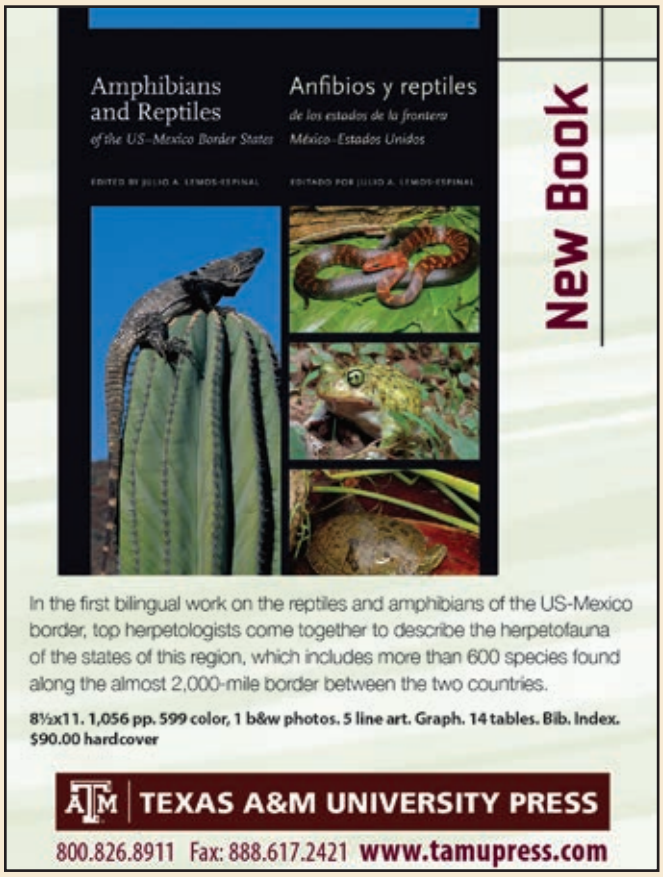
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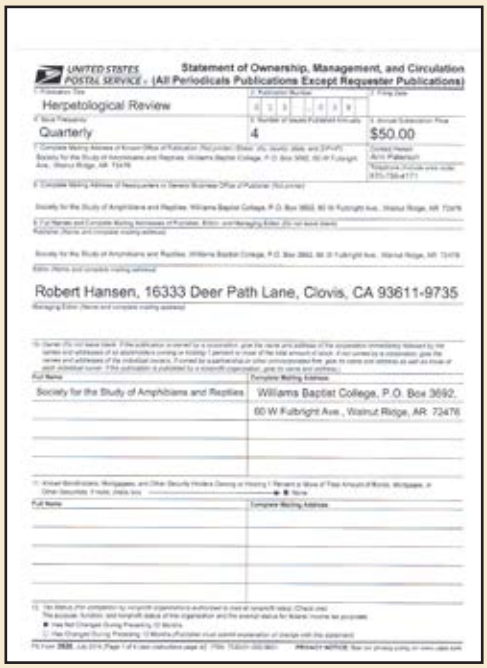
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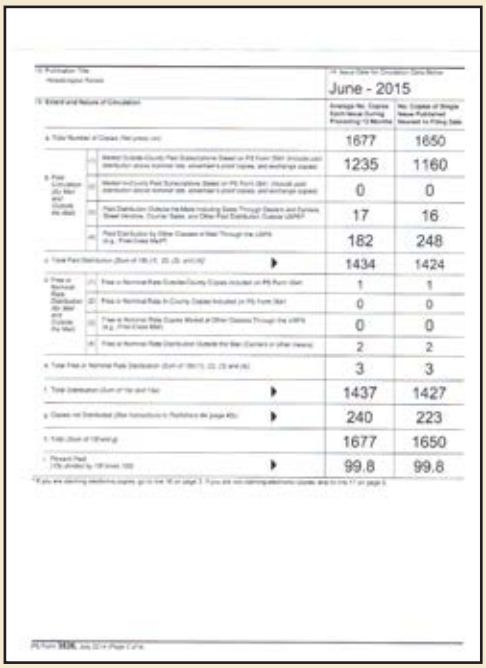
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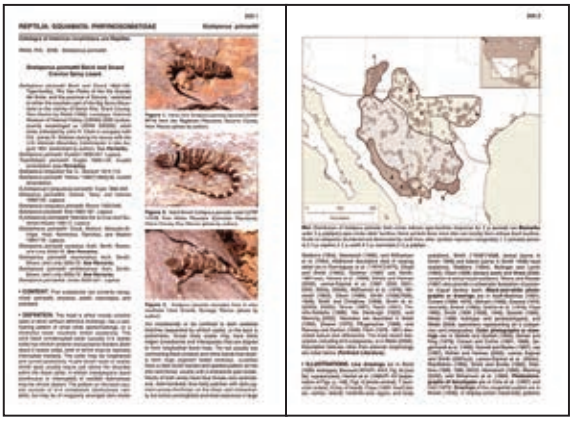
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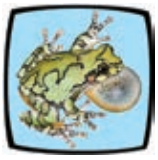
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Helminths of Night Lizards in the Genus *Xantusia* (Squamata: Xantusiidae) and the Effects of Host Ecology

The 34 living species of the Xantusiidae are arrayed in three genera distributed from the southwestern United States to Panama with a single species in Cuba (Noonan et al. 2013). The northernmost genus, *Xantusia* (Night Lizards), contains 14 named species with populations scattered from southern Utah to Durango and Zacatecas, Mexico (Bezy and Flores Villela 1999; Sinclair et al. 2004; Bezy et al. 2008); plus two genetically isolated lineages that remain to be formally described (Leavitt et al. 2007).

Night Lizards (*Xantusia*) are secretive, philopatric lizards that may be found under the same cover throughout life (Zweifel and Lowe 1966; Mautz 1993; Davis et al. 2011) but occasionally have been observed active abroad (Lee 1975; Fellers and Drost 1991). The species are habitat specialists, living primarily in rock crevices, under rocks, or in decaying yuccas, agaves, and other plants (Bezy 1989). As a result of these microhabitat restrictions they may be exposed to fewer sources of parasites than most other lizards.

Gastrointestinal parasites have been reported previously in four species of *Xantusia*: Bolsón Night Lizard, *X. bolsonae*; Granite Night Lizard, *X. henshawi*; Island Night Lizard, *X. riversiana*; and Desert Night Lizard, *X. vigilis* (Lucker 1951; Brattstrom 1952; Read and Amrein 1952; Telford 1970; Goldberg 1985; Goldberg et al. 1993). In general, helminth species appear to have a high level of endemism in xantusiids (Goldberg et al. 1993). We here report the helminths of five additional species with small geographic ranges and discuss the relationship of the lizards' habitat and ecology to their parasite communities.

Two species live primarily in yuccas and agaves: *Xantusia wigginsi* (Wiggins' Night Lizard) in the Sonoran Desert of Baja California, Mexico, and extreme southern California, and *X. extorris* (Durango Night Lizard) in the southern Chihuahuan Desert of Durango and Zacatecas, Mexico; three occur primarily in rock crevices: *X. sierrae* (Sierra Night Lizard) in the western foothills of the Greenhorn Mts. of California, *X. arizonae* (Arizona Night Lizard) and *X. bezyi* (Bezy's Night Lizard) in the mountains of central Arizona (Webb 1965; Bezy et al. 2008; Sinclair et al. 2004; Noonan et al. 2013).

Materials and methods.—A sample of 86 xantusiid lizards consisting of nine *Xantusia arizonae* (mean snout–vent length, SVL = 51.4 mm ± 4.7 SD, range = 42–56 mm), 12 *X. bezyi* (mean SVL = 52.1 ± 3.3 SD, range = 47–60 mm), 24 *X. extorris* (mean SVL = 35.5 mm ± 3.0 SD, range = 30–42 mm), 21 *X. sierrae,* (mean SVL 43.8 mm ± 4.4 SD, range = 36–51 mm), 20 *X. wigginsi* (mean SVL = 36.1 mm ± 3.1 SD, range = 31–43 mm) were borrowed from the herpetology collections of the Natural History Museum of Los Angeles County (LACM), Los Angeles, USA and the University of Arizona Museum of Natural History (UAZ), Tucson, Arizona, USA, and examined for helminths (Appendix 1).

The digestive tract was removed and the contents of the esophagus, stomach, small and large intestines were examined under a dissecting microscope. Cestodes were regressively stained in hematoxylin, dehydrated in an ascending series of alcohols, cleared in xylol, mounted in Canada balsam, cover slipped and studied under a compound microscope. Nematodes were placed on a microscope slide, cleared in lactophenol, cover slipped and studied under a compound microscope. Parasite terminology is according to Bush et al. (1997).

Results.—Found were one species of Cestoda, *Oochoristica bezyi* Bursey and Goldberg, 1992 and three species of Nematoda,



PHOTO BY R. L. BEZY

FIG. 1. Space beneath a rock inhabited by *Xantusia riversiana* on San Clemente Island, California with an accumulation of feces "defecatorium" (arrow), 13 July 1972.

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TABLE 1. Number of helminths (N), prevalence (%), mean intensity + 1 SD, and range for four species of *Xantusia*.

Xantusia	Helminth	N	Prevalence	Mean Intensity	Range
X. arizonae					
	Oochoristica bezyi	1	11% (1/9)	1	—
	Parapharyngodon californiensis	11	67% (6/9)	1.8 ± 1.2	1–4
	Physaloptera sp. (larva)	1	11% (1/9)	1	—
X. bezyi					
	Oochoristica bezyi	15	45% (5/12)	3.0 ± 2.6	1–7
	Parapharyngodon californiensis	10	58% (7/12)	1.4 ± 1.1	1–4
X. sierrae					
	Oochoristica bezyi	15	27% (5/21)	3.8 ± 1.7	2-6
	Parapharyngodon californiensis	21	57% (12/21)	1.8 ± 1.0	1–4
X. wigginsi					
	Thubunaea iguanae	11	15% (3/20)	2.3 ± 2.3	1–5

TABLE 2. Helminth records for the nine species of *Xantusia* examined so far: Arizona (*X. arizonae, X. bezyi*); California (*X. henshawi, X. riversiana, X. sierrae, X. vigilis*); Baja California, Mexico (*X. wigginsi*); Durango, Mexico (*X. bolsonae; X. extorris*). SCI = San Clemente Island. Lizard species names are abbreviated with first two letters of genus and species.

Microhabitat	Rock crevice						Yucca, Agave		Under rocks
Location	Mainland								SCI
Xantusia spp.	XAAR	XABE	XABO	XAHE	XASI	XAEX	XAVI	XAWI	XARI
Helminth									
Mesocestoides sp. (tetrathyridia)	—	—	—	—	—	—	—	—	1*
Oochoristica bezyi	2	2	—	3	2	—	3	—	—
Oochoristica islandensis	—	—	—	—	—	—	—	—	3
Alaeuris clementensis	—	—	—	—	—	—	—	—	3
Alaeuris riversianae	—	—	—	—	—	—	—	—	3
Parapharyngodon bicaudatus	—	—	—	—	—	—	—	—	4
Parapharyngodon californiensis	2	2	3	3,4,5	2	—	3,4,5	—	—
Parapharyngodon pseudothaparius	—	—	—	—	—	—	—	—	3,6
Parapharyngdon xantusi	—	—	—	—	—	—	—	—	3,6
Physaloptera sp. (larva)	2	—	—	—	—	—	—	—	—
Thubunaea iguanae	—	—	—	—	—	—	—	2	3

*References: 1. Goldberg 1985; 2. This study; 3. Goldberg et al. 1993; 4. Read and Amrein, 1952; 5. Telford 1970; 6. Lucker 1951.

Thubunaea iguanae Telford, 1965, *Parapharyngodon californiensis* (Read and Amrein, 1952), and *Physaloptera* sp. (Tables 1–2). *Parapharyngodon californiensis* had the highest prevalence (infected individuals/number examined × 100) and *Oochoristica bezyi* had the highest mean intensity (mean number of helminths per infected lizard) (Table 1).

Voucher helminths were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland, USA as: *Xantusia arizonae*: *Oochoristica bezyi* (USNPC 108200); *Parapharyngodon californiensis* (USNPC 108201); *Physaloptera* sp. (larva) (USNPC 108202); *Xantusia bezyi*: *Oochoristica bezyi* (USNPC 108203); *Parapharyngodon californiensis* (USNPC 108204); *Xantusia sierrae*: *Oochoristica bezyi* (USNPC 108205), *Parapharyngodon californiensis* (USNPC 108206); *Xantusia wigginsi*: *Thubunaea iguanae* (USNPC 108207). All helminths are new host records for *X. arizonae, X. bezyi, X. sierrae,* and *X. wigginsi*, respectively.

Discussion.—*Oochoristica bezyi* was described from *Xantusia vigilis* from the southern Mojave Desert in Los Angeles and San Bernardino counties, California, by Bursey and Goldberg (1992). It also has been reported from *X. henshawi* (Goldberg et al. 1993). Although the life cycle of *O. bezyi* has not been studied, Conn (1985) found that tenebrionid beetles served as intermediate hosts for the congener *O. anolis*. *Parapharyngodon californiensis* is, to date, restricted to xantusiid lizards (Baker 1987; Goldberg et al. 1993). Like other oxyurids (Anderson 2000), *P. californiensis* has a direct life cycle with no intermediate host. Infection presumably occurs by lizards ingesting eggs from infected substrate during feeding. The physalopterid, *Thubunaea iguanae* presumably utilizes an intermediate host (Anderson 2000).

Considering the ecological distribution of the xantusiid hosts, the high prevalences of *P. californiensis* in rock crevice species *X. arizonae, X. bezyi, X. bolsonae, X. henshawi,* and *X. sierrae* (67%, 58%, 50%, 28% 57%, respectively) is noteworthy and contrasts sharply with that in *Xantusia* species living in yuccas and agaves, i.e., *X. vigilis, X. wigginsi,* and *X. extorris* (1%, 0%, 0%, respectively). The reasons for high prevalences of *P. californiensis* in rock crevice *Xantusia* are speculative, but the

rock crevices may allow accumulations of moist feces promoting excellent opportunities for repeated infections. The dryer, more complex microhabitats of yucca-dwelling species may promote a sporadic infection rate. In *Sceloporus jarrovii* (Yarrow's Spiny Lizard), a phrynosomatid species that utilizes rock crevices, Goldberg and Bursey (1992) found that 74% of neonates between one day and two weeks of age were infected with eggs or larvae of the oxyurid nematode *Spauligodon giganticus* which has a direct life cycle. Infection of *Sceloporus jarrovii* by *Spauligodon giganticus* likely is facilitated by the substrate licking behavior of *S. jarrovii* (DeFazio et al. 1977), which promotes ingestion of parasite eggs from the soil.

Oochoristica bezyi was present in all rock crevice species (Table 2) except *X. bolsonae*. In yucca dwellers it was present in *X. vigilis,* but absent in *X. wigginsi* and *X. extorris.* This might reflect sample size or conceivably that the range of *O. bezyi* and its intermediate tenebrionid host do not extend south to either Baja California or Durango, Mexico. The rock crevice species *X. arizonae, X. henshawi* (Brattstrom 1952), and presumably *X. bezyi* and *X. sierrae* include coleopterans (supposed intermediate hosts for *Oochoristica*) in their diets, which would facilitate cestode infection.

Turning to an island endemic that lives under rocks, in a moist maritime climate, *X. riversiana,* besides harboring a unique species of cestode, *O. islandensis* Bursey and Goldberg, 1992, it is host to four unique species of nematodes, with direct life cycles, *Alaeuris clementensis* (Telford, 1965), *A. riversianae* (Telford, 1965), *Parapharyngodon pseudothaparius* (Telford, 1965) and *P. xantusi* (Lucker, 1951) (Lucker 1951; Telford 1970; Goldberg et al. 1993). Fellers and Drost (1991) found that on Santa Barbara Island, California 29% of the fecal samples of *X. riversiana* harbored oxyurid nematodes. We have observed the accumulation of fecal piles in one corner of the space under rocks inhabited by *X. riversiana* (Fig. 1) and this likely facilitates infection by the four oxyurid (direct life cycle) nematodes unique to *X. riversiana*. This may help explain why *P. californiensis*, which is common in rock crevice xantusiids from Arizona and California, was absent from *X. riversiana* under rocks on San Clemente Island, suggesting the use of defecatoria and the moist maritime climate may favor survival of oxyurid species other than *P. californiensis*.

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Appendix 1

Specimens of *Xantusia* examined for helminths from the herpetology collections of the University of Arizona Museum of Natural History (UAZ) and the Natural History Museum of Los Angeles County (LACM). All GPS coordinates are WGS84.

Xantusia arizonae (N = 9): Arizona, Yavapai County, Yarnell (34.2225°N, 112.7497°W), May 1982, LACM 134510–134516, 134524,

134526. *Xantusia bezyi* (N = 12): Arizona, Pinal County, Superior (33.2889°N, 111.1039°W), May 1982, LACM 134479–134481, 134484, 134486–134488, 134491, 134493; Arizona, Maricopa County, Sunflower (33.8642°N, 111.4676°W), May 1982, LACM 134500, 134503, 134504. *Xantusia extorris* (N = 24): Mexico, Durango, Pedriceña (25.1000°N, 103.7833°W), September 1971, 1972, LACM 72329, 72330, 76152, 116266; April 1965, UAZ 17401, 17404, 17405, 17408, 17474, 17559, 17563–17565, 17568–17570, 17572–17574, 17576, 17578–17582. *Xantusia sierrae* (N = 21): California, Kern County, Granite Station (35.6139°N, 118.8589°W), April 1971, LACM 76128, 76130–76134, 76137–76141, 76144, 134549, 134551, 134552, 134554, 134557, 134561–134564. *Xantusia wigginsi* (N = 20): Baja California, Mexico, El Rosario (30.0603°N, 115.7269°W), April 1954, LACM 10211; Valle de San Felipe (31.0275°N, 114.8353°W), May 1967, LACM 36569; Punta Prieta (28.9500°N, 113.5500°W), June 1959, LACM 62240; Los Angeles Bay (28.9500°N, 113.5500°W), August 1961, LACM 62245; SE of Ensenada (31.8578°N, 116.6058°W), June 1963, LACM 101213; Valle de la Trinidad (31.1368°N, 116.1554°W), April 1963, LACM 101214, 101215, 101217–101225; San Ignacio (27.2822°N, 126139°W), June 1977, LACM 126139, 126140, 126142.

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New Northern Distribution Records for Pattern Classes A, B, and D of *Aspidoscelis neotesselata* (Colorado Checkered Whiptail) in Colorado, and Biogeographic Sources of Northern Colonists

Aspidoscelis neotesselata (Colorado Checkered Whiptail) originated from a hybridization event between individuals of *A. tesselata* (Common Checkered Whiptail) and *A. sexlineata viridis* (Prairie Racerunner) (Parker and Selander 1976; Dessauer and Cole 1989; Walker et al. 1995; Taylor et al. 2015). *Aspidoscelis neotesselata* inherited its parthenogenetic mode of reproduction from *A. tesselata*, and embryogenesis in both species is initiated and completed independently of spermatozoa. Therefore, a local group of *A. neotesselata* females lacks the genetic cohesion of a local population of a sexually reproducing species, and clonal divergence—a consequence of random mutation—is the principal mode of evolution. Based on the mother-daughter pattern of descent in obligate parthenogens, with evolution expressing itself as clonal divergence, local groups of related parthenogenetic females are more appropriately referred to as "arrays" ("tokogenetic arrays" of Frost and Hillis 1990) rather than "populations."

Color pattern differences among arrays of *A. neotesselata* illustrate that clonal inheritance has not prevented postorigin evolution (Taylor et al. 2015). Although ontogenetic and individual variation add to the challenge of discerning discrete

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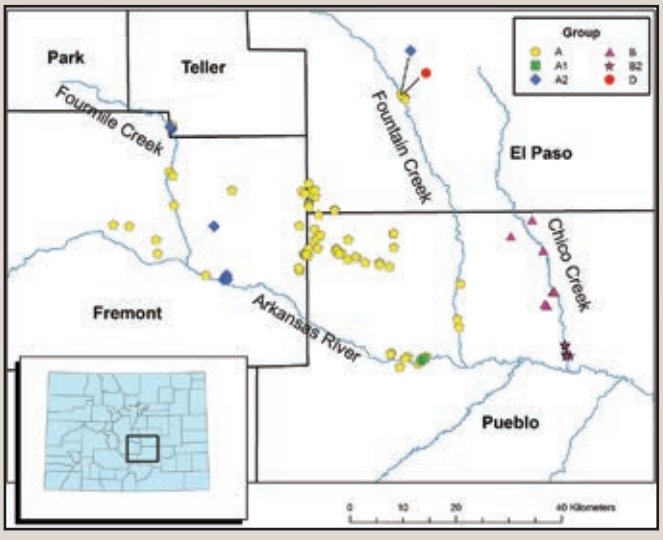


FIG. 1. Selected localities showing the geographic distributions of pattern classes A, B, and D of *Aspidoscelis neotesselata*, primarily north of the Arkansas River in El Paso, Fremont, Pueblo, and Teller counties, Colorado. Symbols identify localities detailed in Appendices 2 and 3. Yellow pentagons = pattern class A lacking statistical confirmation of A1 or A2 group; green squares = group A1 of pattern class A; blue diamonds = group A2 of pattern class A; magenta triangles = pattern class B lacking statistical confirmation of B1 or B2 group; magenta stars = group B2 of pattern class B; red circle = pattern class D.



FIG. 2. Photograph of an individual of *Aspidoscelis neotesselata* of pattern class B (with a partially regenerated tail) taken on 27 June 2014 at Chico Basin Ranch by William Maynard—the northernmost record of *A. neotesselata* B for Pueblo County, Colorado. This individual can be identified as pattern class B by the prominent longitudinal mid-vertebral line and transverse white bars crossing the lower lateral dark field.



FIG. 3. Individuals of *Aspidoscelis neotesselata* at Fountain Creek Nature Center and Fountain Creek Regional Park (Appendix 3). This area supports the northernmost self-sustaining array of *A. neotesselata* that has been discovered in Colorado. A) An individual of pattern class A, photographed by Don Erickson on 13 July 2012 at FCNC, El Paso Co., Colorado. B) A juvenile individual of *A. neotesselata* hatched in 2014, photographed by William Maynard on 27 October 2014 at the north end of Rice's Pond, FCNC. Photographs are not at same scale.

groups within this variation, specific color pattern attributes have been used to identify four color-pattern classes. These are designated by capital letters: A and B (Zweifel 1965), C (Walker et. al. 1997), and D (Walker et al. 2012).

Histocompatibility among color pattern classes (Walker et al. 2012; J. E. Cordes and J. M. Walker, unpubl.) indicates that *A. neotesselata* originated from a single parthenogenetic hybrid, thereby nullifying a hypothesis that color pattern classes A and B were derived from different hybridization events (Densmore et al. 1989). Additional morphological groups, designated as A1, A2, B1, and B2 within pattern classes A and B, were revealed by multivariate statistical analyses of meristic characters (Taylor et al. 2015). Because pattern classes A, B, C, and D are typically allopatric, as are groups A1, A2, B1, and B2, pattern classes are useful for depicting fine-scale geographic distributions, and pattern class groups have value in identifying genealogical sources of disjunct arrays.

This project was a collaborative effort to clarify the distribution of *A. neotesselata* north of the Arkansas River in southeastern Colorado. New localities include those that add El Paso and Teller counties to the four-county distribution (Fremont, Las Animas, Otero, and Pueblo) previously known to define the general range of *A. neotesselata* in Colorado. We also report an elevation record for *A. neotesselata* in Teller County that substantiates one reported from Fremont County (Banta and Kimmel 1965). Finally, we identify the likely biogeographical sources of the northern arrays of pattern classes A and D that now define the northern boundary of the species' range in Colorado.

Methods and materials.—Only two whiptail lizards, *A. neotesselata* and *A. sexlineata viridis*, are present in the study area, and these species have distinctive color patterns and coloration, making species misidentification unlikely (Hammerson 1999, plates 8.55 and 8.56). We documented new distribution records of *A. neotesselata* by voucher specimens, photographs, and reliable observations. We obtained direct GPS coordinates for most localities (UTM coordinates based on GPS datum WGS84). In a few instances, the location was estimated by comparing the observation location with satellite images available on Google Earth©. For published localities, we used associated information to map estimated localities. We determined elevation for each set of coordinates by mapping them in National Geographic TOPO! © (Version 4.5.0) software and obtaining the elevation from the Quad level map (USGS 1 arc-second National Elevation Dataset, 1 meter vertical precision).

We used seven meristic characters in the multivariate analyses (Appendix 1; Table 2). The L-breaks character is subject to ontogenetic development. Therefore, we used linear regression to check reference samples for a relationship between L-breaks and snout–vent length (SVL). This relationship was

TABLE 1. Descriptive statistics for samples of *Aspidoscelis neotesselata* from southeastern Colorado. PNC A1 = pattern class A from Pueblo Nature Center; Fremont A2 = pattern class A from Fremont County; LJ D = pattern class D from La Junta (Appendix 2). Means ± SE and range limits are shown. Means sharing the same letter (a, b, c) are not significantly different at $\alpha = 0.05$. Group assignments of voucher specimens by CVA are shown below specimen numbers. FCNC = Fountain Creek Nature Center, El Paso County.

Characters	Reference samples			FCNC vouchers			Teller Co. vouchers		
	PNC A1 N = 27	Fremont A2 N = 30	LJ D N = 18	396 A2	397 A2	398 D	399 A2	400 A2	401 A2
CV1	0.3 ± 0.19 a -1.3 to 2.0	1.1 ± 0.21 b -1.6 to 3.5	-2.4 ± 0.18 c -4.5 to -1.2	0.5	0.3	-1.7	2.3	1.8	2.7
CV2	-1.5 ± 0.22 a -3.8 to 0.5	1.0 ± 0.20 b -2.2 to 2.6	0.5 ± 0.12 b -0.4 to 1.5	1.4	2.6	0.7	1.1	0.7	0.2
LSG	23.0 ± 0.57 a 17–28	23.4 ± 0.45 a 18–28	17.7 ± 0.43 b 15–21	26	26	23	26	23	27
SDL	33.2 ± 0.25 a 30–35	35.2 ± 0.19 b 33–38	33.4 ± 0.26 a 32–36	34	35	33	37	37	36
GAB	81.9 ± 0.70 a 74–90	80.9 ± 0.51 a 76–87	76.4 ± 0.61 b 72–81	74	73	72	82	84	81
SPV	6.3 ± 0.19 a 4–8	7.3 ± 0.14 b 6–9	6.3 ± 0.16 a 5–7	7	7	6	6	6	6
FP	38.4 ± 0.27 a 36–41	39.9 ± 0.31 b 36–43	39.9 ± 0.29 b 38–42	40	42	39	39	39	38
L-breaks	3.0 ± 0.70 a 0–11	1.8 ± 0.40 a 0–10	1.2 ± 0.23 a 0–3	0	0	0	0	1	0
COS	11.9 ± 0.28 a 10–16	12.5 ± 0.20 a 9–15	12.3 ± 0.14 a 11–13	12	12	14	12	10	9
SVL	82.4 ± 1.42 a 70–96	85.1 ± 1.21 a 75–100	80.9 ± 2.49 a 59–94	83	88	88	101	96	78

found in sample A2 and removed by using only specimens > 65 mm SVL in the analyses. We used the seven univariate characters in a principal components analysis (PCA) of a pooled sample of voucher and reference specimens to produce a set of uncorrelated principal components; these were used as characters in a canonical variate analysis (CVA) for definitive comparisons (Jombart et al. 2010). Because all characters were measured on the same scale (discrete counts of scales and femoral pores), we used a variance/covariance matrix to obtain coefficients used to compute principal component scores. A variance/covariance matrix retains the relative variances of original characters, so that characters with larger variances are given greater weight in developing the principal components (Neff and Marcus, 1980). We used reference samples of A1, A2 and D as a priori (preidentified) groups (Appendix 2), and stepwise selection of principal components to include in the CVA (*F*-to-enter probabilities < 0.05 that did not exceed 0.06 when other components were added to the model). The six voucher specimens from Fountain Creek Nature Center (FCNC), El Paso County, and Shelf Road, Teller County, were included in the CVA as unassigned individuals for classification to the reference sample each most closely resembled. We used Mahalanobis D^2 distance as a resemblance index (smaller D^2 values = greater resemblance and higher probability of correct classification of vouchers). Mahalanobis D^2 distances are sensitive to multivariate outliers (Tabachnick and Fidell, 2013). Therefore, we checked each reference sample for multivariate outliers by evaluating D^2 distances from each specimen to the centroid of the remaining cases. Specimens would be identified as outliers from a standard table of critical values for Chi Square; i.e., those with D^2 values exceeding a critical Chi-square value at $P = 0.001$, and degrees of freedom defined by the number of characters (principal components) included in the CVA model (Tabachnick and Fidell, 2013). We used SPSS© and NCSS© software for statistical routines, tests, and scatterplot construction.

Results.—Three key pieces of evidence formed the foundation of this study. First, Dick Roth discovered *A. neotesselata* in Teller County on 16 July 2004 (Fig. 1; Appendix 3) and documented a new elevation record of 2138 m for this species (UTM 13S 480729E, 4279916N). We augmented this Teller County record with voucher specimens collected on 21 August 2014, approximately 0.3 km S of Dick Roth's 2004 observation location (Appendix 3). All were representatives of pattern class A (Fig. 4A: a–c).

Second, a photograph taken by William Maynard on 27 June 2014 at Chico Basin Ranch (CBR), Pueblo County (Fig. 2; Appendix 3), documented a new northern record for pattern class B of *A. neotesselata*. Latitudinally, the photographic location (UTM 13S 548568E, 4261673N) is approximately 24 km N of the previous northernmost record for pattern class B (UTM 13S 554644E,

TABLE 2. Loadings: correlations between seven meristic characters and principal components 1, 2, and 4 and between five principal components (selected for inclusion in the CVA model) and canonical variates 1 and 2: multivariate statistical analyses of *Aspidoscelis neotesselata* pattern classes A and D from southeastern Colorado.

Characters	Loadings				
	PC1	PC2	PC4	CV1	CV2
LSG	0.321	0.927	-0.014		
SDL	0.286	0.168	0.664		
GAB	0.966	-0.090	-0.014		
SPV	0.281	-0.085	0.571		
FP	-0.336	0.170	0.752		
L-breaks	0.599	-0.506	0.073		
COS	0.093	-0.220	0.323		
PC1				0.559	-0.310
PC2				0.429	0.019
PC4				0.126	0.705
PC5				-0.037	-0.241
PC7				0.128	0.181
Eigenvalues	18.489	12.375	3.013	2.066	1.349
Percentage of variance	44.6	29.9	7.3	60.5	39.5

4238113N) at Pueblo Chemical Depot (PCD), Pueblo County (Taylor et al. 2006a). We made two unsuccessful attempts in August 2014 to collect a voucher specimen from the CBR location.

Third, a photograph taken at FCNC by Don Erickson on 13 July 2012 (Fig. 3A) and posted on http://www.donerickson.com/reptiles/reptiles.html provided the first evidence of *A. neotesselata* in El Paso County. Significantly, this photograph and voucher specimens collected from the photographic location (UTM 13S 524574E, 4284921N) document a new northernmost record for *A. neotesselata* in its natural range. A young individual, photographed on 27 October 2014 by William Maynard (Fig. 3B), indicates that *A. neotesselata* had reproduced successfully at FCNC in 2014. We collected three voucher specimens of *A. neotesselata* from FCNC (Appendix 3), two of pattern class A (Fig. 4B: d, e), and one of pattern class D (Fig. 4B: f). The latter was unexpected because the distribution of pattern class D is centered on a small area associated with railroad yards in northeast La Junta, Otero County, approximately 125 straight-line km SE of FCNC (Walker et al. 2012; Taylor et al., *in press*). We determined the morphological affiliations of voucher specimens from FCNC and Teller County by a CVA in which reference samples of A1, A2, and D were used as a priori groups (Appendix 2), and the six voucher specimens were included as unassigned for classification to group. Two outliers in the PNC sample and four specimens with SVL < 65 mm in the Fremont County sample were excluded from the definitive multivariate analyses. Reference samples differed significantly for different combinations of univariate characters (Appendix 1). Reference samples A1 and A2 differed in SDL, SPV, and FP, whereas the reference sample of pattern class D differed from A1 in LSG, GAB, and FP, and from A2 in LSG, SDL, GAB, and SPV (Table 1). The CVA model (Table 2) classified 68 of the 75 reference specimens (90.7%) to correct samples of origin. Reference sample PNC A1 had 4 of 27 specimens misclassified as Fremont County A2, and reference sample Fremont A2 had 3 of 30 specimens misclassified: 2 to PNC A1 and 1 to LJD D. None of the individuals in the LJD D reference sample was misclassified. This overall high level of classification success was reflected by the significant differences in CV1 among the three reference samples (Table 1).

Each of the three voucher specimens from Teller County was assigned to reference sample A2 by the CVA (probabilities of 0.990 for HLT 399; 0.957 for HLT 400; and 0.937 for HLT 401). The two voucher specimens of pattern class A from FCNC were also assigned to reference sample A2 (probabilities of 0.969 for HLT 396 and 0.987 for HLT 397). Our identification of specimen HLT 398 as pattern class D was supported by its classification to the reference sample of pattern class D from La Junta (P = 0.963). The probability that HLT 398 actually represented A2, the group to which the other two FCNC vouchers were classified, was only 0.021. These robust classifications of voucher specimens are shown graphically by their positions in A2 and D clusters of canonical variate scores (Fig. 5). Although CVA classified FCNC and Teller County voucher specimens of pattern class A to group A2, vouchers from these two localities are distinctly different in GAB scores. All FCNC vouchers (pattern class A as well as pattern class D) most closely resembled the reference sample of pattern class D in GAB (Table 1).

Discussion.—Our locality records (Fig. 1; Appendices 2 and 3) extend the known distribution of *A. neotesselata* into Teller and El Paso counties, verify a previously reported elevation record, and establish a new northern range limit for *A. neotesselata* in Colorado. These new county records are of particular significance because they provide information regarding the ecological amplitude and the potential for range expansion in *A. neotesselata*.

The range of *A. neotesselata* extends approximately 173 km WNW beyond the range of *A. tesselata* in Colorado (Taylor et al. 2006b). Therefore, because triploid *A. neotesselata* inherited a diploid genome from *A. tesselata* and a haploid genome from *A. sexlineata viridis* (Neaves 1969; Parker and Selander 1976; Taylor et al. 2015), the greater ecological breadth of *A. neotesselata* may be related to the genome inherited from *A. sexlineata* (Taylor et al. 2006b). A natural experiment based on elevation records for the three species supports this hypothesis. We have not encountered *A. tesselata* above 1507 m in Colorado. Specimens of both *A. tesselata* and *A. neotesselata* were collected at this elevation by HLT on 11 June 2005 from a juniper (*Sabina monosperma*) woodland north of Lockwood Canyon and west of the Sharp Ranch road, U.S. Army Pinyon Canyon Maneuver Site, Las Animas County (UTM 13S 601962E, 4151131N). Other prominent plants at this site were skunkbush sumac (*Rhus* sp.), snakeweed (*Gutierrezia* sp.), and a cactus (*Opuntia imbricata*). Therefore, 1500 m might represent an approximate upper ecological limit for *A. tesselata* in Colorado. In contrast, the new elevation record of 2138 m for *A. neotesselata* in Teller County is similar to the maximum elevation (2103 m) reported for *A. neotesselata* in Fremont County (using the name *Cnemidophorus tessellatus*) by Banta and Kimmel (1965). This is slightly lower than the upper elevation of 2286 m reported for *A. sexlineata* in Colorado by Banta (1968b). Therefore, based on these data, the upper elevation boundary for *A. neotesselata* is approximately 600 m higher than that of *A. tesselata*. In addition, the northern distribution record of *A. neotesselata* from FCNC, El Paso County,

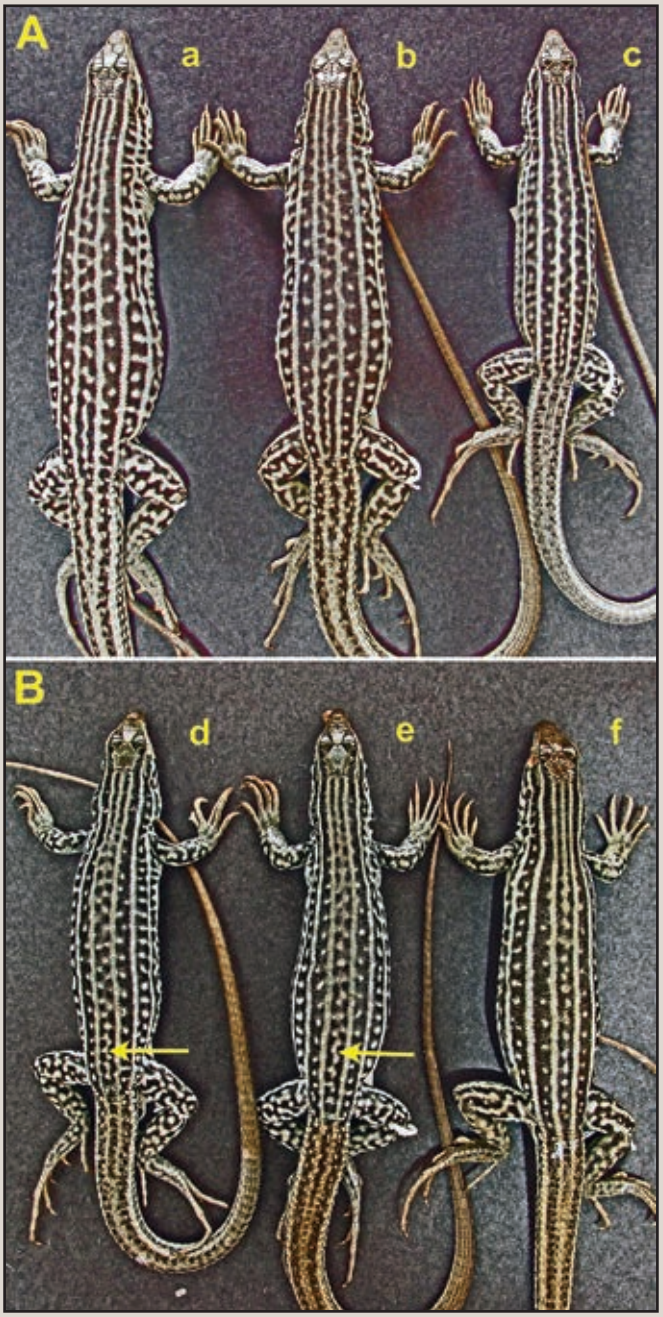


FIG. 4. Voucher specimens of *Aspidoscelis neotesselata* of pattern class A (a–e), and pattern class D (f). A. Shelf Road, Teller County, Colorado: a. HLT 399: 101 mm SVL; b. HLT 400: 96 mm SVL; c. HLT 401: 78 mm SVL (all collected 21 August 2014). B. Fountain Creek Nature Center, El Paso County, Colorado; d. HLT 396: 83 mm SVL (collected 18 July 2014); e. HLT 397: 88 mm SVL; f. HLT 398: 88 mm SVL (both collected on 15 August 2014). See Appendix 3 for details. Photographs are not at same scale. We identified specimen f (HLT 398) as pattern class D based on relatively uncluttered dark fields and a linear series of spots, rather than a short irregular-line (arrows), as found posteriorly in the vertebral field of pattern class A (also seen in specimens a–c). HLT 398 also had pale-tan spots and stripes, rather than gray (as shown for specimens a–e). Multivariate analysis of meristic characters confirmed this visual identification of specimen f as pattern class D.

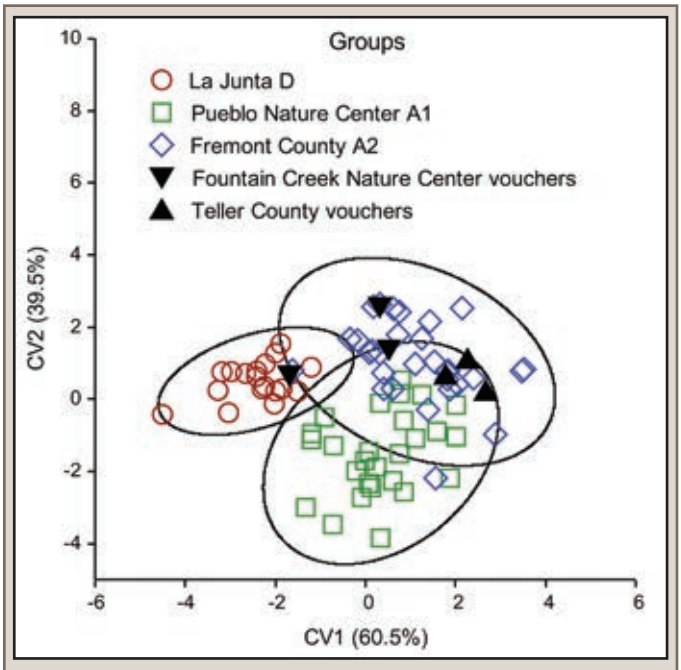


FIG. 5. Scatterplot of canonical variate scores CV1 and CV2 based on functions derived from CVA of three reference samples (a priori groups) of *Aspidoscelis neotesselata* from southeastern Colorado: group A1: 27 specimens from Pueblo Nature Center, Pueblo County; group A2: 30 specimens from north of Florence, Fremont County; group D: 18 specimens from La Junta, Otero County. Scores for six voucher specimens from Fountain Creek Nature Center, El Paso County, and Shelf Road, Teller County, were from classifications of vouchers, treated as "unknowns," by the CVA. Axis percentages are proportions of variation accounted for by canonical variates CV1 and CV2, and ellipses enclose the 95% confidence limits of the score distributions.

is only ca. 6 km farther north than the northern record from Teller County, suggesting that a northern latitudinal limit may have been identified for *A. neotesselata* in its natural range.

A number of alternative scenarios could account for the presence of pattern class A at FCNC. First, habitats associated with Fountain Creek might have served as a dispersal corridor from Pueblo to FCNC, a distance of approximately 51 straight-line km (Fig. 1). Pattern class A occurred along Fountain Creek within the city limits of Pueblo in the 1960s (Walker et al. 1996), and also north of Pueblo (Fig. 1) as documented by a specimen collected in 1965 near Fountain Creek, via Overton Road, 12.4 km N of Hwy U.S. 50 (G. Hammerson, pers. comm.). There is a distributional gap between this record and FCNC. On 9 August 1994, Hobart Smith, David Chiszar, and Lauren Livo searched the vicinity of Fountain Creek in El Paso County, approximately 15 km N of the Hammerson record. Representatives of *A. sexlineata*, but not *A. neotesselata*, were encountered. However, our multivariate evidence identified the two voucher specimens of pattern class A from FCNC as representatives of group A2 from Fremont County, not A1 from Pueblo County, thereby contributing no support for arrival by northward dispersal along Fountain Creek. It is unlikely that pattern class A arrived at FCNC by dispersal from the east. Banta (1968a) used a pitfall trapline (July through October, 1963) to assess the herpetological community 22.5 km E of FCNC. Fifty-seven individuals of *A. sexlineata* were among the 586 reptiles and amphibians captured, but *A. neotesselata* was not represented.

Although human introduction of pattern class A into FCNC cannot be excluded, there are potential source arrays of pattern class A located on the U.S. Army Fort Carson Installation southwest of FCNC (Fig. 1; Appendix 3). Fort Carson arrays have

not been sampled and statistically confirmed as representing group A2, but they are geographically proximate to the A2 reference sample from Fremont County (Fig. 1; Appendix 3). The Teller County array of pattern class A is also linked to the A2 reference by the strong, multivariate classification of voucher specimens to that group and by a chain of observations north of Cañon City (Fig. 1, Appendix 3).

Similarly, the new northern record for pattern class B in Pueblo County is connected to the source array of group B2 at PCD by a well-defined path of observations along Chico Creek, (Fig. 1).

The discovery of a new pattern class of *A. neotesselata* (pattern class D) was an accidental surprise based on the capture, by nine-year old Michelle Keefer, of an individual of pattern class D that had wandered a short distance from its highly localized range within the city limits of La Junta (Walker et al. 2012). Therefore, the discovery of an individual of pattern class D at FCNC was unexpected. Although dispersal from the small local array of pattern class D at La Junta across 128 km of questionable habitats seems unlikely, there are other possible explanations for its presence at FCNC.

First, pattern class D might have been introduced into the FCNC area. The inherent capacity of *A. neotesselata* to establish an array following introduction is illustrated by a self-sustaining array of *A. neotesselata* in Grant County, Washington, approximately 1600 km NW of its natural range in Colorado (Weaver et al. 2011). That human introduction might have been involved in the geographic distribution of some of the arrays of *A. neotesselata* in Colorado is illustrated by the following example. On 29 May 2004, Joey Kellner, Paul Differding, and Melissa Van Dreese photographed an adult *A. neotesselata* (pattern class A) located approximately 1.61 km from the nearest road in Chatfield State Park, Douglas County, Colorado. It is unknown whether this individual represented an intended release or inadvertent transport to the area. Although J. Kellner checked the observation area several times in subsequent years, *A. neotesselata* was not reencountered. The Chatfield State Park locality is approximately 94 straight-line km N of FCNC and has an elevation of approximately 1724 m. According to our evidence, the latitude of Chatfield State Park exceeds the tolerance boundary for the perpetuation of arrays of *A. neotesselata* in Colorado.

A second possibility is that pattern class D appeared at FCNC by expression of an alternative developmental pathway in one or more eggs of an individual of pattern class A at that locality. Pattern classes A and D are members of the same basic morphological subgroup (subgroup A: groups A1, A2, and D versus subgroup B: groups B1, B2, and C: Taylor et al. 2015). They have similar color pattern features (Fig. 4), but statistical differences can be revealed by quantification of color pattern characters (Walker et al. 2012). Similarities between pattern classes A and D extend to ranges of variation for the univariate meristic characters used in the present study. Of the seven characters analyzed, GAB was the only character in HLT 398 (FCNC D) with a value (72) outside the range limits (74–90) of reference samples A1 and A2 (Table 1). However, if pattern class D originated at FCNC from an individual of pattern class A, the morphological link to that event is tenuous. Our CVA provided a probability of only 2% that HLT 398 represented group A2 rather than pattern class D. Specimen HLT 398 was 88 mm in SVL when collected, which exceeds the average size of 102 gravid females of *A. neotesselata*: SVL = 84.8 ± 0.72 SE, 68–101 (Taylor et al. 2006b). If HLT 398 had originated at FCNC, it would have been a potential contributor to several reproductive seasons of recruitment. If pattern class D is established and sympatric with pattern class A at FCNC, this can be ascertained by photographic evidence, and this investigation will begin in 2015.

Aspidoscelis neotesselata is endemic to southeastern Colorado (Walker et al. 1997). It is regarded as a species of special concern by Colorado Parks and Wildlife, is ranked as Near Threatened in the 2014 IUCN (International Union for the Conservation of Nature) Red List, and is currently under consideration for listing under the Endangered Species Act (http://www.fws.gov/southeast/candidateconservation/pdf/Petition_53AmphibiansReptiles.pdf, submitted 11 July 2012). Contemporary distribution information on *A. neotesselata*, such as presented herein, and continuing efforts to develop standardized monitoring protocols; e.g., Great Plains Reptile Monitoring Project (www.reptilemonitor.org), should contribute to understanding its status in nature and facilitating decisions on appropriate management protocols.

Acknowledgments.—Don Erickson discovered *A. neotesselata* at Fountain Creek Nature Center, and we extend our thanks for permission to use his photographic documentation. Thanks to Nancy Stone Bernard, Supervisor of FCNC and Tim Wolken, Community Services Director, for information on sighting locations and permission to collect voucher specimens. Voucher specimens and reference samples were collected under the provisions of Scientific Collecting License HP772 issued to HLT by Colorado Parks and Wildlife, Department of Natural Resources. We thank Libby Henits, Special Licensing Coordinator, CPW, for facilitating license addenda as arrays of *A. neotesselata* in El Paso and Teller counties were brought to our attention. We thank U.S. Army, Pueblo Chemical Depot (access coordinated by K. M. Canestorp, U.S. Fish and Wildlife Service and operations security approval facilitated by Clark Jones, U.S. Fish and Wildlife Service) for permission to collect a sample of *A. neotesselata* at PCD. We thank Roger Peyton, Forestry and Natural Resources Section, Directorate of Public Works, Environmental Division, Fort Carson, for facilitating operations security approval for records of *A. neotesselata* on Fort Carson Military Installation. Collection of samples on the Pinyon Canyon Maneuver Site was approved by U.S. Army (access coordinated by R. Bunn, DECAM, Ft. Carson Army Installation); on-site assistance was provided by M. Klavetter and D. Sharps. We thank Tim Warfel for alerting us to photographic documentation of *A. neotesselata* at Chico Basin Ranch, and Duke Phillips and Michael Moon for permission to conduct research on that property. The Colorado State University survey efforts conducted by Celina Bycenski, Devin Jacobs, Jake Milford, Molly Parren, Ed Schmal, Melissa Thompson, and Beth Wittmann were enhanced by valuable advice provided by Cameron Aldridge and Larissa Bailey. Funding for that effort was provided under a competitive State Wildlife Grant in cooperation with the U.S. Fish and Wildlife Service's Wildlife and Sport Fish Restoration Program, Colorado Parks and Wildlife, Texas Parks and Wildlife, Colorado State University, Colorado State Land Board, and the U.S. Geological Survey. We thank Robert Day for facilitating access to Fort Carson for the Colorado State University survey crews. We are grateful to Steve Wilcox for assistance in the field and technical assistance in preparing Fig. 3. We appreciate the careful reviews of the manuscript provided by William B. Neaves, Charles J. Cole, and K. M. Canestorp.

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APPENDIX 1

Morphological meristic characters: **L-breaks**: bilateral count of number of dark disruptions (breaks) in the pale lateral stripe. Pale scales in the stripe may accumulate melanin during ontogeny to form localized transverse bridges between dark fields (Taylor et al. 2003). **COS**: bilateral total of circumorbital scales. **FP**: sum of femoral pores on both thighs. **GAB**: number of granular dorsal scales in a single row around midbody. The third ventral row of enlarged ventral scales, lateral to the mid-sagittal line, terminates anteriorly in the axillary region. The 15th ventral scale posterior to this terminus established the point for beginning the GAB count. **SPV**: number of scales separating clear medial margins of paravertebral stripes as close as possible to the counting position for GAB. **LSG**: bilateral total of number of lateral supraocular granules. These granular scales are located between the supraoculars and superciliary scales, and the count includes all scales anterior to a line extended from the suture line between the third and fourth supraoculars. **SDL**: number of subdigital lamellae on the fourth toe of one foot (right was chosen unless damaged).

APPENDIX 2

Reference samples of *Aspidoscelis neotesselata* assembled in 1998, and 2002–2006. HLT numbers = Regis University numbers. UTM coordinates are based on GPS datum WGS84. (1) *A. neotesselata* A1: Colorado, Pueblo County, Pueblo Nature Center (UTM 13S 528035E, 4235693N): HLT 53–74, 102, 104, 180–184; N = 29. (2) *A. neotesselata* A2: Colorado, Fremont County, several sites north of Florence including (13 S 490238E, 4250759N: southernmost site) and (13 S 490785E, 4251693N: northernmost site): HLT 85–93, 96, 98–101, 105, 106, 108–115, 190–192; Sixmile Park, Indian Springs Ranch (UTM 13S 488250E, 4261108N) : HLT 94, 95, 193–197; N = 34 (pooled). (3) *A. neotesselata* D: Colorado, Otero County: La Junta (UTM 13S 628661E, 4206010N): RU 02090, 98083, 98084, HLT 333, 335–348; N = 18. (4) *A. neotesselata* pattern class B2: Colorado, Pueblo County: U.S. Army Pueblo Chemical Depot. Found at several localities adjacent to Chico Creek, including: (13S 554931E, 4235951N: southernmost site) and (13S 554644E, 4238113N: northernmost site): HLT 1–6, 11–14, 18–22, 33–38, 107, 133–136, 178, 179; N = 28.

APPENDIX 3

New distribution records of *Aspidoscelis neotesselata*. HLT numbers = Regis University numbers. UTM coordinates are based on GPS datum WGS84.

Locations documented by voucher specimens: **Teller County:** Shelf Road north of Cañon City: HLT 399 (UTM 13S 480638E, 4279276N); HLT 400 (480320E, 4279645N); HLT 401 (480483E, 4279391N), Pattern class A, collected by Lauren Livo, Steve Wilcox, and Harry Taylor on 21 August 2014. **El Paso County**: Fountain Creek Nature Center (13S 524574E, 4284921N): HLT 396, Pattern class A, collected by HLT on 18 July 2014; HLT 397, Pattern class A and HLT 398, Pattern class D, collected by Lauren Livo, Steve Wilcox, and Harry Taylor on 15 August 2014.

Other locations (order of information for each set of coordinates: UTM Zone, Easting, Northing, Elevation, Evidence, Observer): **El Paso County:** Pattern class A: Fountain Creek Nature Center (13S 524584E, 4284914N, 1708m, Photo, D.E.); Fountain Creek Regional Park (13S 523913E, 4285600N, 1711m, Photo, W.R.M.; 13S 524649E, 4284668N, 1706m, Photo, W.R.M.); Ft. Carson Army Base (13S 505111E, 4267384N, 1887m, Sight, *; 13S 505700E, 4266964N, 1876m, Sight, *; 13S 506399E, 4268921N, 1926m, Sight, *; 13S 506413E, 4264709N, 1819m, Sight, *; 13S 506431E, 4265124N, 1836m, Photo, *; 13S 506446E, 4264425N, 1820m, Sight, *; 13S 506450E, 4265039N, 1837m, Sight, *; 13S 506488E, 4265110N, 1829m, Sight, *; 13S 506820E, 4267141N, 1880m, Sight, *; 13S 507022E, 4267605N, 1888m, Photo, *; 13S 507597E, 4267596N, 1881m, Sight, *; 13S 507647E, 4266417N, 1871m, Sight, *; 13S 511247E, 4263852N, 1823m, Photo, *; 13S 511254E, 4263754N, 1839m, Sight, *). **Fremont County:** Pattern class A: Ft. Carson Army Base (13S 504459E,

4252913N, 1614m, Sight, *; 13S 504555E, 4252482N, 1600m, Sight, *; 13S 504590E, 4260876N, 1793m, Photo, *; 13S 504591E, 4252452N, 1603m, Sight, *); Pathfinder Regional Park (13S 486880E, 4251652N, 1579m, Photo, W.R.M.); Shelf Road (13S 480107E, 4271286N, 1872m, Photo, L.J.L.; 13S 480736E, 4270478N, 1897m, Photo, D.R.; 13S 480938E, 4264888N, 1761m, Photo, H.T., L.J.L.). **Pueblo County:** Pattern class A: Ft. Carson Army Base (13S 505458E, 4255581N, 1773m, Sight, *; 13S 505497E, 4255618N, 1754m, Sight, *; 13S 505659E, 4255386N, 1723m, Sight, *; 13S 505659E, 4255424N, 1720m, Sight, *; 13S 505874E, 4255492N, 1758m, Sight, *; 13S 505882E, 4255482N, 1757m, Sight, *; 13S 505948E, 4255340N, 1750m, Sight, *; 13S 506203E, 4255160N, 1704m, Sight, *; 13S 506283E, 4256486N, 1770m, Sight, *; 13S 507326E, 4258077N, 1772m, Sight, *; 13S 507420E, 4260184N, 1776m, Sight, *; 13S 507954E, 4258496N, 1767m, Sight, *; 13S 508009E, 4256528N, 1718m, Sight, *; 13S 508265E, 4262876N, 1792m, Sight, *; 13S 508536E, 4259117N, 1769m, Sight, *; 13S 511466E, 4255929N, 1697m, Sight, *; 13S 511480E, 4256480N, 1733m, Sight, *; 13S 511779E, 4256234N, 1721m, Photo, *; 13S 512113E, 4255492N, 1686m, Photo, *; 13S 512582E, 4255657N, 1718m, Photo, *; 13S 513715E, 4254481N, 1664m, Sight, *; 13S 513819E, 4258191N, 1792m, Sight, *; 13S 515233E, 4254918N, 1679m, Sight, *; 13S 515314E, 4254834N, 1677m, Sight, *; 13S 516997E, 4253838N, 1738m, Sight, *; 13S 519674E, 4253475N, 1664m, Sight, *; 13S 519713E, 4253874N, 1664m, Sight, *; 13S 521564E, 4253076N, 1671m, Sight, *; 13S 522358E, 4259302N, 1750m, Sight, *; 13S 522370E, 4259328N, 1749m, Sight, *; 13S 522408E, 4256672N, 1717m, Sight, *); Lake Pueblo State Park (13S 523427E, 4234087N, 1502m, Photo, L.J.L.; 13S 524414E, 4235801N, 1449m, Photo, L.J.L.; 13S 524937E, 4236027N, 1446m, Photo, L.J.L.; 13S 526848E, 4234657N, 1438m, Photo, W.R.M.); Pattern class B: Chico Basin Ranch (13S 544539E, 4258617N, 1556m, Sight, T.P., A.E.; 13S 548568E, 4261673N, 1539m, Photo, W.R.M.; 13S 550641E, 4255880N, 1489m, Photo, W.R.M.; 13S 550877E, 4245784N, 1453m, Photo, C.B.; 13S 551158E, 4245521N, 1449m, Photo, D.M.; 13S 551176E, 4245559N, 1449m, Photo, B.W.; 13S 552293E, 4248083N, 1472m, Photo, C.B.; 13S 552552E, 4248139N, 1460m, Photo, E.S.; 13S 552646E, 4248172N, 1449m, Photo, C.B.). **Teller County:** Pattern class A: Shelf Road (13S 480394E, 4279433N, 2090m, Sight, L.J.L.; 13S 480534E, 4279383N, 2093m, Sight, L.J.L.; 13S 480729E, 4279916N, 2143m, Sight, D.R.).

* Individuals reporting observations of *A. neotesselata* on Ft. Carson Army Base include: Richard Bunn, Chris Caris, Rick Clawges, Bobby Day, April Estep, Michael Christine Farrell, Danny Follett, Raquel Levya-Lander, Daniel Martin, Jake Milford, Nina Nedrow, Erin Parks, Tracy Perfors, and Beth Wittmann. Observers at other localities: Celina Bycenski (C.B.), Don Erickson (D.E.), April Estep (A.E.), Lauren J. Livo (L.J.L.), William R. Maynard (W.R.M.), Daniel Martin (D.M.), Tracy Perfors (T.P.), Dick Roth (D.R.), Ed Schmal (E.S.), Harry Taylor (H.T.), and Beth Wittmann (B.W.).

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Marine Turtles and Estuarine Crocodiles in Lampi Marine National Park, Myanmar: A Conservation and Threat Assessment with Recommendations

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National parks, wildlife sanctuaries, and other protected areas often figure prominently in successful species conservation strategies (Stohlgren et al. 1994; Bruner et al. 2001). Protected areas can safeguard habitats for the long-term maintenance of biodiversity while at the same time serving as baselines against which biological and ecosystem change can be measured (Stohlgren et al. 1994). To realize these objectives, protected area managers require species inventories, accurate assessments of conservation status, and an understanding of existing and potential anthropogenic threats (Stohlgren et al. 1994; Castellano et al. 2003; Tuberville et al. 2005). Such information is essential for effectively targeting conservation efforts, formulating management policies, prioritizing research, and designing appropriate monitoring protocols, especially where cryptic, rare, and threatened species are concerned (Oliver and Beattie 1993; Stohlgren et al. 1994; Castellano et al. 2003; Tuberville et al. 2005).

The protected area system in Myanmar plays a pivotal role in the national and regional conservation of marine turtles (Olive Ridley [*Lepidochelys olivacea*], Loggerhead [*Caretta caretta*], Green Turtle [*Chelonia mydas*], Hawksbill [*Eretmochelys imbricata*]), and Estuarine Crocodiles (*Crocodylus porosus*). For example, Thamihla (also spelled "Thameehla") Kyun Wildlife Sanctuary hosts nesting populations of *C. mydas*, *L. olivacea*, *C. caretta*, and *E. imbricata*, Moscos Island Wildlife Sanctuary is an important nesting area for *E. imbricata* and Meinmahla Kyun Wildlife Sanctuary harbors the only viable population of *C. porosus* remaining in Myanmar and one of the few known in the region (Thorbjarnarson et al. 2000a, 2000b; Rao et al. 2002; Thorbjarnarson et al. 2006; Onishi 2009; Beffasti and Galanti 2011; Holmes et al. 2014).

Lampi Marine National Park (LMNP; 10°50'N; 98°12'E) encompasses parts of the Myeik (formerly "Mergui") Archipelago in Tanintharyi Region (formerly "Division") of southernmost Myanmar (Beffasti and Galanti 2011). Reconnaissance surveys conducted in the 1980s (Blower 1983) and 1990s (Rabinowitz 1995) documented the occurrence of marine turtles and estuarine crocodiles within the park and concluded these reptiles

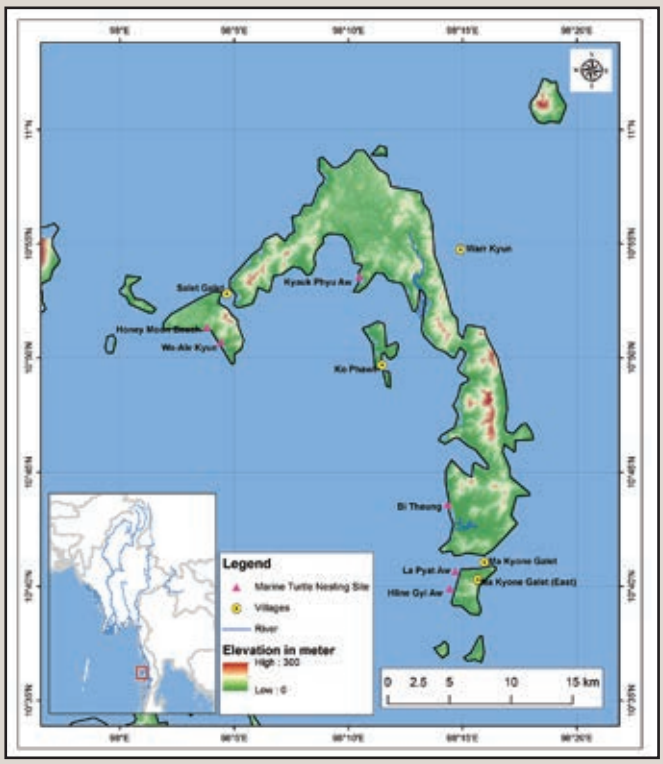


FIG. 1. Map of Lampi Marine National Park showing location of villages and marine turtle nesting sites. Inset shows location of the Park within Myanmar.

were imperiled by various anthropogenic threats. More recently, Beffasti and Galanti (2011) included three species of marine turtles on a faunal checklist of LMNP, but noted few data were available to assess their conservation status. Recent information regarding *C. porosus* in LMNP is likewise scant, although attacks on humans elsewhere in the Myeik Archipelago (Platt et al. 2012a, 2014a; www.crocodile-attack.info) suggest crocodiles could be present in the park.

This situation is not unique to LMNP as most protected areas in Myanmar lack data on the occurrence and conservation status of even common species, in large part due to the paucity of financial and technical resources available to park managers (Rao et al. 2002). More generally, there is an overall paucity of information on Myanmar's herpetofauna (Leviton et al. 2008), and in particular, few studies of marine turtles and crocodiles are yet available in the peer-reviewed scientific literature (but see Thorbjarnarson et al. 2000a, 2000b, 2006). As a first step towards addressing this need, we conducted a conservation assessment of marine turtles and estuarine crocodiles in LMNP with the objectives of 1) determining if populations of marine turtles and estuarine crocodiles occur within the park, 2) locating critical nesting habitat for marine turtles and estuarine crocodiles, 3) identifying and evaluating potential anthropogenic threats to these populations, and 4) developing a set of conservation recommendations based on our findings.

LAMPI MARINE NATIONAL PARK

Lampi Marine National Park (205 km^2; Fig. 1) was established in 1996 to protect coastal fauna and flora, particularly coral reefs (Beffasti and Galanti 2011). The park consists of Lampi Island and adjacent satellite islands, surrounded by a no-fishing exclusion zone extending offshore approximately 3.2 km from the high tide mark. The park is located approximately 25 km from mainland Tanintharyi and the intervening sea is shallow (mean depth = 12 m) with a maximum depth of 24 m. The islands within the park are characterized by steep terrain (to 455 m) supporting relatively undisturbed tropical evergreen forest (Beffasti and Galanti 2011; Blower 1983; Rabinowitz 1995). The park is well-watered with two spring-fed perennial rivers (Me Gyaung Chaung and Labi Chaung) and numerous smaller streams flowing from the uplands into the Andaman Sea. Extensive seagrass beds occur in shallow offshore waters, and mangrove forests are present along the two perennial rivers. Most of the coastline is rocky, although limited areas of sand beach are scattered around the island (Beffasti and Galanti 2011).

Although permanent settlements are prohibited on Lampi Island, four large villages (Ma Kyone Galet, Warr Kyun, Ko Phawt, and Salet Galet) containing a total of 3,000 residents are located on satellite islands encompassed by the boundaries of LMNP (Beffasti and Galanti 2011). These communities consist of ethnic Burmese, Karen, and Moken (also known as "Salone" within Myanmar). The latter are one of several semi-nomadic peoples, collectively known as "Sea Gypsies," who inhabit coastlines and islands of the Andaman Sea (Andrews 1962; Diran 2001). Harvesting marine resources (primarily fish, squid, and sea cucumbers) provides the principal source of income for island communities (Beffasti and Galanti 2011; Platt et al. 2014b). Wildlife and forest resources within LMNP are completely protected under Myanmar law; however, commercial poaching of wildlife, often by organized gangs from mainland urban centers, has been reported, and illegal timber-felling is widespread, but largely confined to the vicinity of permanent settlements (Rabinowitz 1995; Beffasti and Galanti 2011; Platt et al. 2014b). In addition to national protected area status, LMNP is recognized as an ASEAN Heritage Site and an Important Bird Conservation Area (Beffasti and Galanti 2011). The natural and cultural resources of LMNP are described in greater detail by Beffasti and Galanti (2011) and Platt et al. (2014b).

METHODS

We conducted fieldwork in LMNP from 10–21 December 2013. During this period we traveled throughout the park, stopping at villages and fishing encampments where we conducted semi-directed, opened-ended interviews (Martin 1995; Gilchrist et al. 2005) of fishermen and other knowledgeable individuals regarding the past and present occurrence of marine turtles and crocodiles, local ecological knowledge (*sensu* Anadón et al. 2009) about these species, folk taxonomy (*sensu* Berlin et al. 1966), the whereabouts of marine turtle and crocodile nesting sites, exploitation of turtles and crocodiles, fishing practices, and potential threats to turtles and crocodiles. While recognizing the limits of local ecological knowledge (Huntington 2000), our experience (Platt et al. 2004, 2005; Thorbjarnarson et al. 2006) and that of others (Thirakhupt and van Dijk 1995; Zhou et al. 2008; Anadón et al. 2009; Kanagavel and Raghavan 2012) indicates such individuals can be reliable sources of information concerning the occurrence, abundance, natural history, and local exploitation of turtles and crocodilians.

In accordance with the format of a semi-directed interview, we asked informants a series of questions that included standard questions prepared in advance and others that arose during the course of conversation. We guided the discussion, but the direction and scope of each interview was allowed to follow the

TABLE 1. Vernacular names of marine turtles found in Myanmar.

Species	Vernacular name and comments
Marine turtles (generic name)	*Pinle Leik* = Sea Turtle
Dermochelys coriacea	*Leik Zaung Lyar* = Star Fruit Turtle; name based on resemblance of carapacial ridges to longitudinal ridges on fruit of *Averrhoa carambola*.
Caretta caretta	*Leik Khway* = Dog Turtle; facial appearance, particularly prominent eyes, is said to be suggestive of a domestic dog.
Chelonia mydas	*Pyin Thar Leik* = non-descriptive name of uncertain meaning.
Eretmochelys imbricata	*Leik Kyat Tu Yway* = Parrot Turtle; name derived from the distinctive beak which resembles that of a parrot.
Lepidochelys olivacea	*Leik Laung* = Immature Turtle; so named because adults of this species are smaller than other marine turtles.

TABLE 2. Marine turtles found during a survey of Lampi Island Marine National Park, Myanmar in December 2013.

Species	Comments
Dermochelys coriacea	Fisherman stated that a small turtle (CL ca. 40 cm) fitting the description of a leatherback was found dead on a baited hook set in offshore waters in 2012.
Chelonia mydas	Carapace (CL = 415 mm) in possession of a fisherman in Ma Kyone Galet; reportedly removed from a turtle found dead on a nearby beach.
Eretmochelys imbricata	A disintegrating carapace (CL = 273 mm) obtained from a villager in Ma Kyone Galet who recovered it from a nearby beach; carapacial and plastral scutes along with bony elements found during a search of Honey Moon Beach.

participants' train of thought (Huntington 1998). Semi-directed interviews are more of a conversation than a typical question and answer session, and rather than rigidly adhering to a set of prepared questions, the interview provides an opportunity for collecting and discussing unanticipated information (Huntington 2000; Gilchrist et al. 2005). We conducted interviews of individuals as well as groups ranging in size from 3 to 36 people. Interviews were conducted by native Burmese speakers and later translated into English and transcribed. During interviews we also asked to examine any turtle shells that might be available in villages. We then measured straight-line carapace length (CL) with tree calipers (± 1 mm) and photographed each specimen. We later visited beaches where marine turtles were reported to nest as well as other sites that appeared likely nesting habitat. At each site, we searched for crawls (trackways made by nesting female turtles), nests, and other signs of activity. Crawls were identified on the basis of characteristics outlined in Pritchard and Mortimer (1999). Interview transcripts, voucher photographs of specimens, and field notes are archived in the Campbell Museum, Clemson University, Clemson, South Carolina, USA. Place names are in accordance with a national gazetteer currently being compiled by the Myanmar government. We determined geographic coordinates (India-Bangladesh Datum) with a Garmin® GPSmap76.

RESULTS

Marine turtles.—We interviewed about 110 villagers (ca. 83 men and 27 women) at various locations in LMNP during this survey. Obtaining a precise count proved difficult because interviews were often conducted in a group setting and individuals tended to wander in and out of the meeting venue. The information on marine turtles that we obtained often proved difficult to categorize to species as most people refer to marine turtles (except *D. coriacea*) generically (*Pinle Leik*) without distinguishing among species. Although vernacular names are available for each species (Table 1), these are apparently used by only the most knowledgeable individuals. We nonetheless were able to document the occurrence of *D. coriacea*, *C. mydas*, and *E. imbricata* within LMNP. Our records of *C. mydas* and *E. imbricata* are based on physical remains obtained from villagers or found while searching beaches, whereas our inclusion of *D. coriacea* is based on information provided by two fishermen (Fig. 2; Table 2). The physical remains we examined originated from dead turtles that washed ashore. We found no evidence for the occurrence of *C. caretta* or *L. olivacea* during our survey. A group of divers (N = 8) who harvest sea cucumbers (Echinodermata: Holothuroidea) from October–April reported encountering at least one marine turtle during about 50% of their nocturnal dives.

According to our informants, *C. mydas* figures prominently in Moken *Nat* worshiping practices. In Moken culture, *Nats* are spiritual guardians of the land- and seascape that must be properly propitiated; those who fail to do so risk divine retribution in the form of misfortune, sickness, or even death (Spiro 1967). Each of the two Moken communities in LMNP annually sacrifices a single large subadult or adult *C. mydas* to sea-dwelling *Nats*. The source of the turtles used in this ceremony is unclear, but most are probably captured from waters within or adjacent to the park. Importantly, we found nothing to suggest nesting female turtles are harvested for this ceremony. As part of this *Nat* worshiping ceremony, the turtle is killed and beheaded;



FIG. 2. Carapace of Green Turtle (*Chelonia mydas*) (above) and Hawksbill (*Eretmochelys imbricata*) (below) obtained from fishermen in Ma Kyone Galet. Both turtles were found dead on beaches in Lampi Marine National Park.

TABLE 3. Geographic coordinates of beaches used by nesting marine turtles in Lampi Marine National Park, Myanmar.

Beach	Latitude (°N)	Longitude (°E)
Bi Thaung	10.7265	98.2390
Hline Gyi Aw	10.6652	98.2350
Honey Moon Beach	10.8556	98.0633
Kyauk Phyu Aw	10.8930	98.1746
La Pyat Aw	10.6778	98.2445
Wah Ale Kyun	10.8453	98.0735

the head is proffered to the *Nats*, while the meat is consumed in a raucous village feast. Consumption of turtle meat outside of this ceremony is believed offensive to the *Nats* and could invite misfortune upon the community. We found no evidence that other ethnic groups dwelling within the park consume marine turtles. However, we cannot rule out this possibility owing to the reticence of informants to discuss illegal practices.

We identified six beaches in LMNP used as nesting sites by marine turtles: Bi Thaung, Kyauk Phyu Aw, Wah Ale Kyun, Honey Moon Beach, Hline Gyi Aw, and La Pyat Aw (Table 3; Fig. 1). In general, these beaches are characterized by a wide expanse of deep sand fronted by low dunes with a deep-water approach. Evidence of recent nesting activity was noted on Wah Ale Kyun and La Pyat Aw. We found two fresh (< 48 h) crawls made by nesting females at Wah Ale Kyun on 15 December 2013; large holes excavated at the apex of each trackway and numerous human footprints indicated fishermen had harvested both clutches. Based on crawl width (>100 cm), parallel lines of symmetrical flipper marks, and straight, well-defined tail-drag marks, we attributed these crawls to nesting female *C. mydas*. We also found an indistinct crawl and large excavation on La Pyat Aw where fishermen reportedly collected a clutch of turtle eggs on 6 December 2013. No sign of recent (<1 month) nesting activity was found at the other beaches.

Based on information provided by fishermen, we estimate that about 20 clutches of marine turtle eggs are annually collected from various beaches in LMNP. We were unable to determine which species of turtles nest on these beaches because informants invariably used the generic *Pinle Leik* when describing nesting activity. Most nesting is said to occur from early November through late March. Fishermen opportunistically monitor nesting beaches during this period, follow any tracks they find, and harvest the eggs, which are sold in local markets or retained for domestic consumption. Fishermen receive 100 Myanmar Kyats per egg (about US $0.10) and a large clutch represents a significant income if sold. According to observations made by our informants, semi-feral dogs (*Canis familiaris*) and monitors (*Varanus* sp.) also excavate nests and consume turtle eggs in LMNP. Although we observed numerous macaques (*Macaca* sp.) on beaches in LMNP, these primates were surprisingly not among the nest predators described by informants.

In addition to anthropogenic nest predation, our informants identified several other potential threats to marine turtles in LMNP. Foremost among these are commercial trawlers that regularly, albeit illegally, operate within the exclusion zone surrounding LMNP. Interviewees were unanimous in their condemnation of commercial trawlers (often foreign-owned boats) which frequently damage or sweep away artisanal fishing gear. We likewise observed fishing trawls legally operating in shallow waters just beyond the exclusion zone on several occasions during our survey. Other potential threats to marine turtles identified by interviewees include long-line fisheries (lines of baited hooks, sometimes extending >1 km) and dynamite fishing. Fishermen also reported occasionally finding marine turtles entangled in discarded monofilament fishing nets; if alive, the turtle is cut free and any wounds are treated with turmeric powder, which is believed to promote healing. About 50% of our informants had found dead marine turtles or their remains on area beaches within the past five years.

In contrast to commercial fisheries, the artisanal fishers we interviewed claimed to capture few marine turtles either intentionally or as by-catch. Artisanal fishermen maintain that they respect marine turtles as long-lived organisms and believe that to kill such an animal will bring misfortune to an individual. Our examination of floating wire cage traps (N = 30), one of the most common methods used by artisanal fishers to catch fish and squid in LMNP, suggests these pose little threat to marine turtles because the diameter of the funnel-shaped opening is too small to permit entry except by the smallest of turtles.

Estuarine Crocodiles.—Our interview data suggest *C. porosus* is no longer extant within LMNP. Indeed, <25% of our informants had knowledge of crocodiles, but because one of the two pe-

rennial rivers on Lampi Island is known as Me Gyaung Chaung (= Crocodile Creek), most people assumed crocodiles once occurred locally. Several older individuals stated that in the past, crocodile eggs were harvested for domestic consumption and juveniles and adults were captured and sold to buyers in neighboring Thailand. A subadult *C. porosus* (TL ca. 150 cm) we examined at a monastery in Ma Kyone Galet was reportedly captured on the coast of Rakhine State near the Myanmar-Bangladesh frontier and transported to Lampi Island for exhibition as a curiosity. In contrast to Lampi Island, our informants stated crocodiles persist in other parts of the Myeik Archipelago. Two *C. porosus* (TL ca. 180 and 300 cm) believed responsible for a spate of attacks on humans were killed in 2013 near Mine Twin Village (Kyun Su Township, Ye Ngan Aw Group), approximately 90–120 km N-NW of LNMP.

Discussion

Marine turtles.—Our survey documented the occurrence of three species of marine turtle within LMNP, which are classified as Endangered (*C. mydas*) and Critically Endangered (*D. coriacea* and *E. imbricata*; IUCN 2014; Wallace et al. 2011). Our results complement an earlier survey that reported *C. mydas, L. olivacea*, and *C. caretta* in the park (Beffasti and Galanti 2011). In contrast to our findings, neither *E. imbricata* nor *D. coriacea* had previously been reported in LMNP (Beffasti and Galanti 2011). The occurrence of *E. imbricata* and *C. mydas* in LMNP is especially encouraging because both species are endangered and the former is approaching extinction in Myanmar (Thorbjarnarson et al. 2000b; Limpus 2012; Holmes et al. 2014). Our record of *D. coriacea* is likewise important as this species is considered the rarest marine turtle in Myanmar (Maxwell 1911; Thorbjarnarson et al. 2000b).

Based on characteristics of turtle crawls, the species known to inhabit area waters, and reports from nearby Moscos Island (Beffasti and Galanti 2011; Limpus 2012), it is probable that most clutches deposited on beaches in LMNP are those of *C. mydas* and *E. imbricata*. Nesting populations of both species in Myanmar have declined from "thousands" in the early 1900s (Maxwell 1911) to a "few tens" today (Limpus 2012; Holmes et al. 2014). Thus, even though a relatively small number of clutches are apparently deposited in LMNP, these are nonetheless extremely important from a local conservation standpoint. Protecting these nests will undoubtedly prove challenging as egg harvesting has a long history in the Mergui Archipelago (Andrews 1962) and appears to be culturally entrenched in island communities (Rabinowitz 1995). Nevertheless, nest protection should be accorded high priority by park authorities as chronic over-harvesting of eggs has been implicated in the long-term decline and near-extirpation of several species of marine turtles in Southeast Asia, most notably for *D. coriacea* in Malaysia (Chan and Liew 1996; Thorbjarnarson et al. 2000b; Chan 2006).

The construction of commercial eco-tourist resorts at two of the seven known nesting beaches in LMNP (Bi Thaung and Honey Moon Beaches) is also cause for concern. Although the presence of resorts and their security staff are likely to deter egg poachers, these establishments nonetheless pose two distinct threats to marine turtles. First, resort construction could result in the direct loss of critical nesting beach habitat. Such habitat is limited in LMNP, where most of the coastline is rocky and few suitable beaches are available for nesting turtles. Second, because neonates emerging from nests are attracted to light, any unmanaged artificial lighting generated by the resorts could disorient hatchlings, thereby increasing the time spent on beaches with the concomitant risks of predation and desiccation (Lorne and Salmon 2007).

Our study is the first to describe some of the cultural beliefs of indigenous maritime communities in southern Myanmar regarding marine turtles. The veneration of marine turtles as long-lived organisms seems to reflect a wider belief among rural Burmese that misfortune will befall anyone who intentionally harms an organism that has endured years of hardship to attain advanced age (e.g., Platt et al. 2008). Among some communities, to accidentally capture and then liberate such an animal is viewed as a means of gaining karmic merit and the release is often accompanied by an elaborate ceremony (Platt et al. 2008). The *Nat*-worshiping practices we documented among the Moken are not unusual. *Nat*-worship is widespread in Myanmar (Spiro 1967) and *Nats* are perceived as guardians of tortoises (Platt et al. 2003), some species of freshwater turtles (Platt et al. 2013a), and King Cobras (*Ophiophagus hannah*; Platt et al. 2012b). Although generally quite localized and occasionally even restricted to a single community (Platt et al. 2013a), these beliefs are nonetheless consistent with conservation objectives and can be harnessed to this end (Platt et al. 2003). For example, a conservation program for the critically endangered Burmese Star Tortoise (*Geochelone platynota*) premised on reinforcing local *Nat* worshiping practices has to date proven highly successful (Platt et al. 2014c). The cultural taboos of the Moken therefore warrant further investigation as a potential tool for marine turtle conservation in LMNP, perhaps as part of a community-based conservation initiative (see below).

The potential anthropogenic threats faced by marine turtles in LMNP are representative of those confronting marine turtles throughout the region (Chan 2006; Diamond et al. 2012; Settle 1995; TRAFFIC 2004). We consider fishing trawlers to pose the most serious potential threat to turtles in LMNP despite the existence of an exclusion zone where commercial fishing is prohibited. Although trawls deployed anywhere in the territorial waters of Myanmar are legally required to be outfitted with turtle excluder devices (TEDs), compliance is difficult to monitor and appears minimal in most areas (Aung Hlaing Win and Maung Maung Win 2012; Holmes et al. 2014). This is unfortunate because the installation of TEDs has repeatedly been demonstrated to significantly reduce drownings of marine turtles by trawls (Jenkins 2012; National Research Council 1990). When not equipped with TEDs, fishing trawls are the primary source of mortality of subadults and adults in many marine turtle populations (National Research Council 1990). Longline and dynamite fishing are also likely to pose a risk to turtles (Chan et al. 1988; Chan 2006), and although strictly prohibited by park regulations, legal enforcement to date has been weak or non-existent. However, we stress that our assessment of these threats must be considered tentative pending the completion of more detailed investigations to quantify mortality among marine turtles in LNMP.

Given the lack of historic baseline data, conclusions regarding long-term population trends of marine turtles in LMNP are at best speculative. Although encounter rates reported by fishermen suggest marine turtles are still fairly common within the protected waters of the park, illegal fishing practices appear commonplace and could be killing turtles at unsustainable levels. That said, corroborative evidence in the form of stranding and carcass surveys (Shaver and Teas 1999) is lacking and must be obtained

before this conclusion can be uncritically accepted. Moreover, the annual loss of turtle nests to predation and anthropogenic harvest must be quantified before its impact on turtle populations can be accurately assessed. What little data are available from elsewhere in Myanmar suggests a similar suite of threats has resulted in population declines among all species, including the near-extirpation of *E. imbricata* (Thorbjarnarson et al. 2000b; Limpus 2012; Holmes et al. 2014). Indeed, Limpus (2012) concluded that without dramatic improvements in the effectiveness of conservation measures, all species of marine turtles will be approaching extinction in Myanmar by 2030.

Estuarine Crocodiles.—That *C. porosus* occurred on Lampi Island within the recent past is unequivocal. Estuarine Crocodiles are known to occur elsewhere in the Mergui Archipelago (Andrews 1962), and both Blower (1983) and Rabinowitz (1995) reported fishermen collecting crocodile eggs for domestic consumption on Lampi Island. Additionally, a freshwater river (Me Gyaung Chaung) on Lampi Island is almost certainly named for the crocodiles that once inhabited it. Place names often attest to the past occurrence of fauna, flora, and habitats which are no longer extant (Platt and Brantley 1997; Sousa and García-Murillo 2001). The fact that most (but not all) informants had no knowledge of crocodiles is not unexpected given the relatively brief duration of "community memory" regarding locally extinct species (Turvey et al. 2010). Indeed, Turvey et al. (2010) demonstrated that even charismatic megafaunal species are rapidly forgotten by communities once they cease to be encountered on a regular basis.

The extirpation of *C. porosus* from LMNP probably resulted from egg collection for domestic consumption (Andrews 1962; Rabinowitz 1995) and harvesting of the demographically important adults for illegal sale to wildlife traffickers in Thailand. During the 1970s and 1980s, there was a heightened demand among Thai crocodile farmers for *C. porosus* to hybridize with the more readily obtainable Siamese Crocodiles (*Crocodylus siamensis*). Hybrid progeny are commercially desirable because they exhibit rapid growth rates, attain large body sizes, and yield high-quality skins (Suvanakorn and Youngprapakorn 1987). As far as we could determine, the last crocodiles collected from LMNP were three adults captured and sold in 1986, although eggs were still being harvested as late as the early 1990s when Rabinowitz (1995) visited the islands. Given this timeframe, *C. porosus* was probably extirpated from LMNP by 2000 or shortly thereafter.

Recommendations.—We consider the absence of effective law enforcement to be the single greatest obstacle to preserving the biological integrity of LMNP. Although existing regulations appear adequate to protect marine turtles, crocodiles, and other wildlife resources, without rigorous enforcement of these legal statutes, the continued erosion of biodiversity from the park is inevitable. This state of affairs stems not from any lack of will on the part of Myanmar conservation authorities, but is instead due to the paucity of resources available to park staff, particularly boats and communications equipment. Therefore, it is imperative that government authorities and non-governmental organizations (NGOs) tasked with managing LMNP make every effort to address this situation and adequately equip those responsible for enforcing park regulations. Without vastly improved enforcement capabilities, preventing the illegal incursions of commercial trawlers, enforcing compliance with fishing regulations, and safeguarding marine turtle nesting sites are unrealistic expectations. Eco-tourist lodges now being established within the park could play a significant part in enhancing law enforcement capacity, particularly if this role is mandated by the Myanmar government in exchange for being granted a development concession within a national park. Eco-tour operators could collaborate with Forest Department rangers and local NGOs to conduct joint patrols, report violators, provide boat transportation, and facilitate radio communication. Importantly, incentives would be aligned because eco-tour operators have a vested financial interest in maintaining and protecting the biodiversity their clients are paying to view (Zander et al. 2014).

A community-based conservation initiative (Campbell and Vainio-Mattila 2003) offers further options for strengthening the protection of marine turtles in LNMP. We recommend that such a program be developed as a partnership between park authorities, NGOs, eco-tour operators, and local communities with the goal of protecting nesting beaches, bolstering hatchling recruitment, and reducing the incidental take of larger turtles in fisheries operations. The latter is critically important, given the demographic importance of the larger size classes (Congdon et al. 1993; Heppell et al. 2003), and best addressed through a community education campaign emphasizing turtle-friendly fishing practices, proper disposal of used fishing gear (especially monofilament nets), and protection of nesting beaches. Importantly, local *Nat* worshiping beliefs consistent with conservation goals should be integrated into all levels of any community education program. Furthermore, fishing regulations mutually developed by local communities and government authorities would go far toward protecting marine turtles in the park. Such regulations are perhaps the best approach for limiting potentially harmful fishing practices and gear and designating areas closed to fishing (Johannes 2002).

As an immediate first step in implementing a community-based conservation program, we recommend that a beach-monitoring and egg collection program be initiated whereby local fishermen are recruited as "beach wardens" to monitor known nesting sites in the park. Wardens will notify Forest Department staff when a turtle has nested so the clutch can be collected and transferred to a secure incubation area for hatching. A similar program along the upper Chindwin River has been instrumental in reversing the decline of the only remaining wild population of Burmese roofed turtles (*Batagur trivittata*) in Myanmar (K. Platt et al. 2013).

Again, ecotourist resorts being constructed in LMNP could be important partners in this aspect of marine turtle conservation, especially if tasked by the Myanmar government to do so. The resorts could host and manage the hatchery and assist with transporting park staff to nesting sites, hiring beach wardens, and releasing neonates. Additionally, donations or even a small fee levied on tourists could partly offset costs incurred by the tour operators participating in the project (Meletis and Harrison 2010; Zander et al. 2014). Furthermore, the marine turtle conservation program could serve as an attraction for tourists desiring to participate in an actual conservation project. Such "experiential" tourists could be involved in monitoring beaches, collecting and transporting eggs, and releasing neonates. Similar participatory conservation programs for marine turtles have enjoyed success in the United States and elsewhere (Tisdell and Wilson 2002; Wilson and Tisdell 2003; Ballantyne et al. 2009). That said, given the brief temporal distribution of nesting activity by a what appears to be a relatively small number of females (ca. 20 nests/year), an ecotourist venture based solely on marine turtles is unlikely to prove economically viable (Troëng and Drews 2004). However, marine turtles are just one of the many natural attractions of LNMP likely to appeal to ecotourists; others include scuba diving and snorkeling, hiking, bird-watching, and viewing marine

mammals, all of which can serve as the foundation for successful ecotourism ventures.

Despite being locally extirpated, the recovery of *C. porosus* in LMNP can probably be accomplished if adequate levels of protection are afforded to crocodiles. Crocodilian populations are resilient to over-exploitation and often respond dramatically to timely and well-planned conservation measures (Bayliss 1987). For example, a 10- to 20-fold increase occurred among *C. porosus* populations in northern Australia following the enactment of legal protection (Webb et al. 2010). This dramatic response is largely due to a suite of life-history traits that crocodilians possess (e.g., high fecundity, rapid growth of offspring, high adult survival, and extended parental care of offspring) which are unique among large predators (Bayliss 1987). Given the proximity of potential source populations on other islands in the Myeik Archipelago as well as the Tanintharyi mainland (Platt et al. 2012a, 2014a) and the fact that long distance movements between widely separated island populations are commonplace among *C. porosus* (Campbell et al. 2010), natural re-colonization of Lampi Island will almost certainly occur without direct human interventions. Given the small number of likely founders, however, the time to recovery could prove lengthy.

Alternatively, translocating wild-caught individuals or reintroducing captive-bred crocodiles to LMNP could facilitate the recovery of *C. porosus* in a comparatively brief period, although we urge caution if this option is pursued by management authorities. First, capturing wild subadult or adult crocodiles from elsewhere in Myanmar (e.g., Meinmahla Wildlife Sanctuary) and releasing them on Lampi Island is unlikely to prove successful due to the tendency of translocated crocodiles to return to their original home range (Lang 1987); e.g., unidirectional movements >100 km are commonplace among translocated *C. porosus* (Read et al. 2007). Second, the demographic consequences of removing even a small number of crocodiles from Meinmahla Kyun Wildlife Sanctuary (the likely source of crocodiles for any reintroduction) are unclear and could threaten the continued viability of this small population (Thorbjarnarson et al. 2000a). That said, captive-bred *C. porosus* are available from the government-operated Thaketa Crocodile Farm near Yangon. However, the genetic integrity of this population has likely been compromised by hybridization with Siamese Crocodiles obtained from Cambodia during the 1960s (Platt et al. 2013b). Therefore, it must first be determined that any crocodiles selected for reintroduction from the farm are indeed genetically pure *C. porosus*. Moreover, because the farm has experienced repeated disease outbreaks, it is imperative that crocodiles be thoroughly screened for infectious diseases before being released into the wild (Platt et al. 2013b).

In our opinion, a more desirable option would be to obtain crocodiles for reintroduction to LNMP from a head-starting program using eggs and hatchlings collected from Meinmahla Wildlife Sanctuary. Removal of eggs and hatchlings from the wild has minimal demographic impacts on crocodilian populations and survival of head-started juveniles released into the wild is typically high (Elsey et al. 1998, 2000). Importantly, any future reintroduction of crocodiles to LMNP should be closely monitored to determine the fate of released animals (Dodd and Seigel 1991).

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Contribution to the Reproductive Biology of *Bothrops erythromelas* (Squamata: Viperidae) in the Semiarid Region of Brazil

Although oviparity is the prevalent reproductive mode among reptiles, squamates exhibit significant reproductive plasticity, with oviparous and viviparous species in numerous clades (viperids in particular, see Fenwick et al. 2012) and with different structural adaptations in both reproductive modes. In viviparous species, embryonic development occurs entirely in the oviduct, and the embryos can be fed entirely by the vitellus (lecithotrophic viviparity) or by nutrient transfer from the mother via the placenta (placentotrophic viviparity) (Yaron 1985; Stewart and Thompson 2000).

Reproductive seasonality is a widely discussed phenomenon in squamate reptiles from temperate zones, where there are marked variations in temperature and photoperiod (Marion 1982). On the other hand, a more frequent occurrence in tropical regions is an adjustment between the reproductive period and rainfall seasonality. This tendency seems to be related to food availability, which can significantly decrease during the dry season (Janzen and Schoener 1968; Ribeiro and Freire 2011). In this sense, most data on snake reproduction refer to temperate and subtropical regions. Neotropical snakes were until recently relatively little studied with regard to reproduction (Amaral 1977; Vanzolini et al. 1980; Seigel and Ford 1987). However, this scenario has changed considerably and several studies have produced a substantial amount of information, thereby significantly increasing our knowledge about the reproduction of neotropical snakes (David and Lewis 2011; Mesquita et al. 2011; Gomes and Marques 2012; Bellini et al. 2013; Figueroa et al. 2013; Marques et al. 2013; Panzera and Maneyro 2013; Siqueira et al. 2013; Sousa et al. 2014).

The genus *Bothrops* has a biennial, seasonal reproductive cycle, exhibiting an active phase of follicular growth, mating, and gestation in one year, and a parturition phase followed by follicular quiescence in the next year (Almeida-Santos and Orsi 2002; Barros et al. 2014). The reproductive apparatus contains two ovaries and two oviducts (Gomes and Puorto 1993). Copulation occurs during the fall with a gestation between four and five months and offspring are born in the summer (Almeida-Santos and Orsi 2002). It is a widely diversified clade with origin and recent radiation in the neotropical region,

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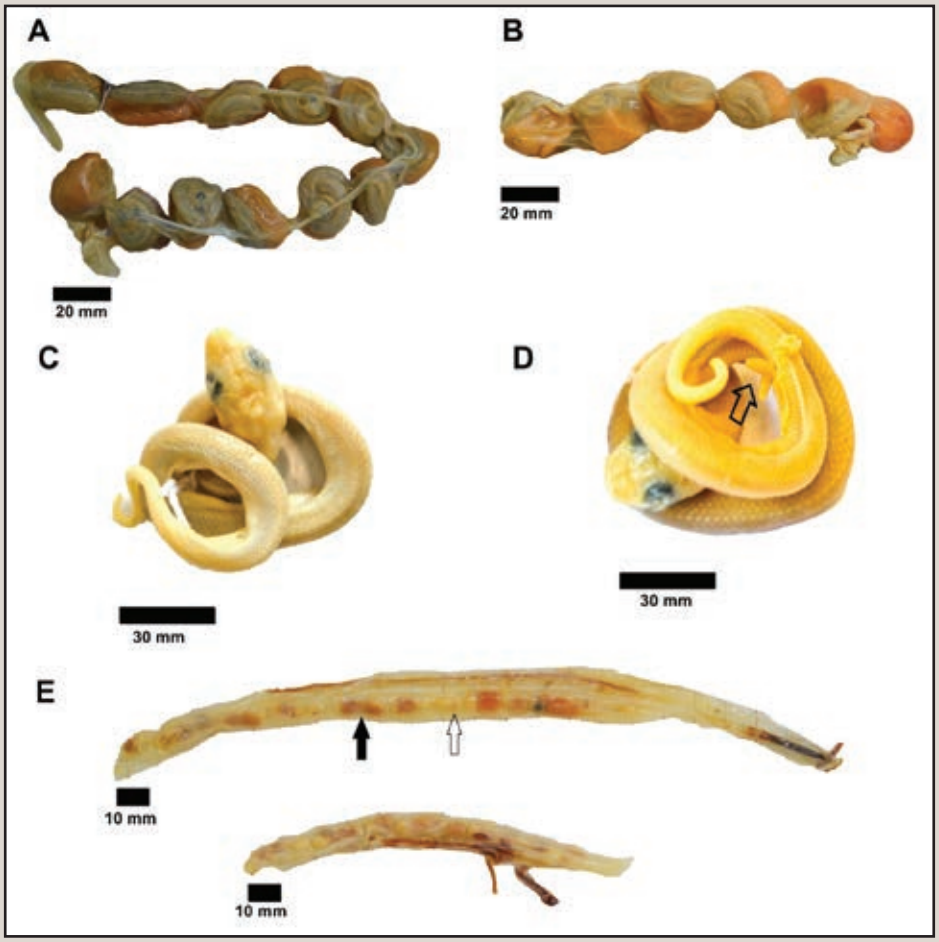


FIG. 1. Reproduction in *Bothrops erythromelas*. Right oviduct (A) with 12 embryos and left oviduct (B) with six remaining. Embryos at stage 31 of embryonic development, according to Zehr (1962): embryo with scales visible only on the body and not on the head (C), and male with hemipenes everted (arrow) visible on trunk coil (D). Right ovary (top) and left ovary (bottom) with transparent follicles without vitellus deposition (quiescent phase) (white arrow) and yellow follicles with vitellus deposition (active phase) (black arrow) (E).

and currently comprises 58 species, distributed primarily in South America (Wüster et al. 2002; Campbell and Lamar 2004; Uetz and Hošek 2014). The species *B. erythromelas*, popularly known as "jararaca-da-seca" or "jararaca-avermelhada," is widely distributed in the Caatinga (Tropical Thorny Deciduous Savanna), in addition to "Brejos de Altitude" (humid forest remnants). These forest fragments are remnants of the cycles of expansion and retraction of the humid forests that were initiated during the Pleistocene and are represented by some "islands" of humid forest that cover some isolated plateaus and mountain ranges varying from 600 to 1200 m of altitude within the Caatinga lowlands (Soares 2001). Previous studies describe the litter size (Lira-da-Silva et al. 1994), courtship and copulation behavior, and fecundity of *B. erythromelas* carried out in captivity (Silva et al. 2013). The present study aims to contribute knowledge on the reproductive aspects of *B. erythromelas* derived from nature. Here we describe the number of days in captivity until parturition, offspring morphology, and the relationship between litter size and female length.

Six *B. erythromelas* females were collected during fauna rescue efforts associated with the São Francisco River Integration Project (PISF) at different locations in the semiarid region of northeastern Brazil, two in Brejo Santo township (7.492778°S, 38,985°W), one in Jati, in Ceara state, and one each in Sertânia, Salgueiro and Petrolina (9.392778°S, 40.507778°W), in Pernambuco state.These areas are semiarid (Ab'Sáber 1974), with a short irregular rainy season concentrated in 2–3 months of each year, between January and March, and rainfall ranging between 500 and 700 mm/year. Mean annual temperatures vary from 28 to 30°C, and maximum temperatures exceed 40°C, whereas the minimum temperatures range between 17 and 20°C. Relative humidity oscillates around 30–50% in the dry season, reaching 80–90% in the rainy season (Nimer 1972).

One of the snakes collected in Brejo Santo, in December 2009, was seriously wounded and was euthanized in the field and deposited in the Herpetology Collection of the Caatinga Fauna Museum – CEMAFAUNA (voucher number MFCH 3000). The dissection was performed in December 2012 and it was found that the specimen was in the gestational phase with the presence of embryos and extra-embryonic structures. The embryonic development stage was estimated according to Zehr (1962). Biometric and body mass data were collected from these embryos. A t-test was used to determine differences in the total length of female and male embryos.

The other specimens, collected at Petrolina in August 2012, Brejo Santo in May 2013, Salgueiro in May 2013, Jati in July 2013 and Sertânia in January 2014, were held in captivity at the serpentarium of the Center for Conservation and Management of Caatinga Fauna – CEMAFAUNA, housed in 100 × 70 × 60 cm plastic boxes under a controlled temperature of 27°C until parturition. During the screening of these snakes in order to record biometric data and sex, dilation was observed in the ventral and paraventral region, suggesting pregnancy. After the offspring were born, biometric data (snout–vent length, tail length, and body mass) were measured. Spearman's correlation was used to correlate litter size with female length. Data were analyzed using SPSS version 13.0. The signicance level adopted for obtaining critical values on the tests was 0.05 (Zar 1999), and descriptive statistics are given as mean ± 1 SD.

A total of 22 offspring from five litters of *B. erythromelas* were analyzed, an average of four per litter. Offspring were born on average 157 days after the females arrived at the serpentarium, with mean length of 200.5 ± 12.61 mm (166.1–224.0 mm) and weight of 4.5 ± 1.01 g (4–6 g) (Table 1).

Twenty-one embryos were found in the dissected female, 12 in the right oviduct and nine in the left. According to Koba et al. (1970), number of eggs in the right oviduct is always greater than the left side in snakes due to its forward positioning in relation to

TABLE 1. Reproductive and morphological data of *Bothrops erythromelas* from the semiarid northeast of Brazil. Sex was determined only for those embryos from snake VI based on everted hemipenes, as described by Zehr (1962).

Snout–vent length of mother or dam (I–VI) (mm)	Parturition month	Number of neonates / embryos	Sex F: female, M: male	Neonate / embryo data Total length (mm)	/Body mass (g)
I. 650	December 2013	3	—	193.0	6
				195.0	6
				195.0	6
				Mean 194.3	Mean 6
II. 526	January 2014	4	—	207.1	6
				207.9	4
				211.4	6
				190.1	4
				Mean 204.1	Mean 5
III. 619	January 2014	4	—	216.0	6
				217.5	6
				209.0	6
				224.0	6
				Mean 216.6	Mean 6
IV. 524	January 2014	5	—	199.5	4
				208.3	4
				206.0	4
				208.0	4
				199.5	4
				Mean 204.2	Mean 4
V. 558	January 2014	6	—	166.1	4
				199.3	4
				187.3	4
				190.7	4
				194.5	4
				190.3	4
				Mean 188.0	Mean 4
VI. 563	____	21	F	120.0	0.45
			F	122.0	0.30
			M	112.0	0.33
			F	118.0	0.43
			M	107.0	0.31
			M	107.0	0.44
			F	115.0	0.44
			M	106.0	0.39
			F	116.0	0.40
			M	107.0	0.55
			F	120.0	0.70
			F	118.0	0.73
			M	111.0	0.59
			F	122.0	0.60
			F	112.0	0.60
			F	124.0	0.61
			M	114.0	0.57
			M	125.0	0.60
			M	110.0	0.62
			F	111.0	0.56
			F	112.0	0.50
				Mean 114.7	Mean 0.51

the left. In *B. jararaca* a larger number of eggs in the right oviduct (69.92%) was observed when compared to the left (30.08%) (Janeiro-Cinquini 2004).

All embryos were enveloped by amniotic sacs separated by tissue constriction isolating each one (Fig. 1A–B). These embryos, in an advanced stage of development, were characterized as stage 31 as described by Zehr (1962). In this phase the scales are visible only on the body and not on the head (Fig. 1C). In males, the hemipenes still everted are also visible on trunk coil (Fig. 1D). The snout–vent length of females (101.2 ± 5.5 mm, 94–110 mm, N = 12) was significantly greater than that of males (92.2 ± 5.2 mm, 87–105 mm, N = 9) (t-test = 3.831, df = 17.89, P = 0.001).

The uterine wall was distended around the embryos and below it was a thin chorioallantoic membrane. It was also observed that the ovaries were asymmetrically disposed, the right more anterior and much larger than the left. Two types of follicles were found in the ovaries: transparent or whitish, without vitellus deposition, in the quiescent phase, and yellow with vitellus deposition in the active phase (Fig. 1E).

Analysis of snout–vent length in females and litter size showed no significant correlation (r_s = –0.406, N = 6, P = 0.425), even when disregarding the female with the maximum litter size (21 embryos) (r_s = –0.616, N = 5, P = 0.269). Solórzano and Cerdas (1987, 1989), studying the reproductive biology of *Crotalus durissus durissus* and *B. asper* of Costa Rica, found a significant correlation between the total length of females and the number of neonates ($r = 0.579$, $p < 0.05$ and $r = 0.779$, $p < 0.01$, respectively). Significant correlation was also observed by Janeiro-Cinquini et al. (1990) and Janeiro-Cinquini (2004) between the length of the mother and litter size in *B. jararaca* populations.

The birth and litter records of *B. erythromelas* in December and January, notably in January (four litters), indicate that summer is the preferential reproduction period for this snake, reinforcing the observations made by Almeida-Santos and Orsi (2002) and Silva et al. (2013). The birth of newborns in the wet season is a characteristic of *B. erythromelas* shared with every species of the genus *Bothrops* studied to date (Almeida-Santos and Salomão 2002). According Barros et al. (2014) this similarity in reproductive timing in *Bothrops* species may be attributed to the influence of phylogenetic inertia in the determination of reproductive events for females. The number of days held in captivity prior to parturition for the five *B. erythromelas* at the serpentarium varied from 19 to 236 days. Although these data do not represent the total gestation period, Klauber (1972) and Aldridge and Duvall (2002) argue that variation in gestational period in pitvipers may result from sperm storage, or be influenced by temperature and/or seasonal fluctuations in food availability, making it difficult to determine the standard gestation period of the species.

There was a large difference between the number of offspring in *B. erythromelas* females who laid their litters and the dissected individual (21 offspring), even though the mothers exhibited nearly the same snout–vent length, with a mean of 573 mm. This difference in litter size may be explained by climatic fluctuations at the sites of specimen occurrence, influenced by the availability of food and the nutritional status of females (Fitch 1985; Aldridge and Duvall 2002). The number of embryos here described is much larger than that mentioned in the literature. Lira-da-Silva et al. (1994) reported 11 neonates for one *B. erythromelas* female, and Barros et al. (2014) found two to 13 embryos (average = 8) in the oviducts of five females. Lira-da-Silva et al. (1994) corroborate with the opinion of Klauber (1972) who affirm that intrinsic factors (e.g., physiological) can also interfere in the fertility rate. In this respect, marked reproductive effects that sometimes result in geographic variations can occur.

Silva-Filho (2000) followed the birth of 20 offspring of *B. erythromelas* kept in captivity, observing, based on the biometric data of newborns, that this species can be included among the smaller species of the genus *Bothrops*. However, biennial cycles are common in viperids and, considering the different factors that interfere in determining reproductive frequency in snakes and the size of their litter, it is premature to confirm, based on this sample, the proportion of the population that reproduces each year. Only a more detailed study will be able to determine the proportion of *B. erythromelas* females in the reproductive state per year and the possible fluctuations in reproductive frequency, identifying the existence of years with a larger or smaller number of reproductive females (Vitt and Seigel 1985; Ernst 1993).

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Comparing Common Five-lined Skink (*Plestiodon fasciatus*) Diet Among Populations and Time

Having knowledge of an animal's diet helps to provide an understanding of its biology, ecology, natural history and can help in its conservation. Although predators are often considered dietary generalists or specialists, virtually all species show some specificity. Food items taken may also vary depending on availability in space and time. Most lizards are carnivorous and many, if not most, small to medium body-sized species are considered to be gape-limited generalized arthropod predators. Having a generalized diet or being opportunistic would allow a species greater success when food resources change through time or differ among locations.

Although the details of the Common Five-lined Skink (*Plestiodon* [formerly *Eumeces*] *fasciatus*) diet have not been thoroughly documented, the species is widely considered to be a generalized arthropod predator with a preference for arachnids, orthopterans, and blattids (Fitch 1954 and references therein). We studied diet of the Common Five-lined Skink near the northern edge of its range at Point Pelee National Park, Ontario, Canada, in 2000 (Hecnar et al. 2002), which supported this general description of the diet. In 2013 we reexamined skink diet at the same location and in the neighboring but isolated Rondeau Provincial Park, Ontario population with the goals of determining if diet changed through time or differed among

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PHOTOGRAPH: D.R. HECNAR



FIG. 1. The distinctive scat of a Common Five-lined Skink on the bark of a prone log. Fragments of exoskeletons from prey items give the scat a coarse texture. The scat is tipped by a cap of uric acid (white).

locations. Both locations lie within the "Carolinian Population" of the species' range in Canada where *P. fasciatus* is designated as an endangered species (COSEWIC 2015).

Methods.—We determined skink diet by examining scats following the methods we previously described (Hecnar et al. 2002). This sampling method is advantageous because it is non-invasive and non-lethal. We collected fresh scats in glass vials during population surveys in 2013 in the same area as we collected in 2000 at Point Pelee National Park, Ontario, Canada (PPNP; 41.9629°N, 82.5163°W; WGS84), and from 70 km E at Rondeau Provincial Park, Ontario, Canada (RPP; 42.2808°N, 81.8550°W). Skinks have distinctive cylindrical, straight, brown to black scats ca. 1.0–2.5 cm long (2–5 mm diam.) capped by a plug of white uric acid (Fitch 1954; Judd 1955; pers. obs.). Fragments of arthropod body parts that make up the main body of the scat give it a coarse texture and exoskeleton parts are usually obvious without magnification (Fig. 1). Compared with similar bird scats, skink scats are generally more uniform in shape, rougher and drier in texture, and the uric acid cap is less compact making them distinctive (Fitch 1954; pers. obs.). At RPP we collected some scats when individuals that we captured defecated during handling. We used these scats to determine if diet differed among sexes or age classes (male or female adult, juvenile). Sampling occurred near the peak of nesting season when size, color, and patterns allow sex and age classification. Vials were topped with 40% ethanol and transported to the lab for study. Contents of each scat were separated with probes in water and examined under a dissecting microscope to identify items to the lowest taxonomic category possible (all to Order, some to Family or species). Chitinous exoskeleton fragments were sorted to facilitate identification. Remains also tend to occur sequentially in a scat allowing counting of the number of food items (Hecnar et al. 2002).

We determined if diet changed in two different ways. First we counted the number of food items in each scat and then compared number of items between years and location using a separate variance *t*-test on square root transformed data followed by a Mann-Whitney *U* test for a non-parametric equivalent. Second, after identifying food items, we ranked items by decreasing abundance and conducted a Kendall's rank test to determine if the type of diet items changed over time or between location. This non-parametric test considers the ranked order of items by abundance between groups to determine if the groups are associated (i.e., correlated; Sokal and Rohlf 2012). If items among groups are not significantly associated, it means that diets differ. If items are significantly associated among groups (same ranked order) diets are similar among groups. Considering only abundance can inflate the perceived importance of particular dietary items (e.g., multiples of small items in individual scats) so we also conducted Kendall's rank test for the frequency of item occurrence in scats (number of scats containing each item). We used Systat 12 for all statistical analyses. Measures of central tendency are indicated with means ± 1 standard error (SE).

Results.—We collected 41 individual scats (17 PPNP, 24 RPP) containing 110 individual food items (40 PPNP, 70 RPP) among 15 arthropod groups representing eight orders (Table 1). In some cases we were able to identify items to taxa lower than order. Our most detailed identifications and incidence (% of scats) included: Family Forculidae, *Forficula auricularia*, European Earwig (49%); Family Salticidae, jumping spiders (10%); Family Rhinotermatidae, termites (7%); Family Aphidae, aphids (7%); Sub-order Zygoptera, damselflies (5%); Family Carabidae, carabid beetles (2%); and Family Ixodidae, ticks (2%). An average of 2.4 ± 0.23 items (1–5) occurred in PPNP scats and 2.9 ± 0.96 items (1–24) occurred in RPP scats. The number of items per scat did not differ between PPNP and RPP in 2013 (separate variance $t = 0.06$; 30.29 df; $P = 0.95$; $U = 229.5$; 1 df; $P = 0.12$). Similarly, number of items did not differ between PPNP in 2000 (3.2 ± 0.36 items, range 1–6, data from Hecnar et al. 2002) and 2013 (separate variance $t = 1.77$; 33.45 df; $P = 0.09$; $U = 254.5$; 1 df; $P = 0.16$). Combining data for both years at PPNP and RPP for 65 individual skinks indicates an average of 2.9 ± 0.39 SE items (1–24) occurred per scat among 15 taxonomic groups.

A high proportion of dietary items in 2013 were arachnids (Orders Arachnida, Opiliones, Acarina) at both PPNP (35%) and RPP (20%) and this was similar to PPNP in 2000 (43%). However, substantial differences in the proportion of other insect groups in lizard scats occurred at both locations in 2013 (Table 1, Figs. 2–5). Most notable was the high proportion of Dermaptera (Earwigs) at both PPNP (35%) and RPP (23%) and Isoptera (Termites) that dominated the number of diet items at RPP (41%). Kendall's rank tests indicated no association between the abundance of each type of dietary items compared between years at PPNP ($\tau = 0.07$; $N = 14$; $P > 0.1$) or between PPNP and RPP ($\tau = 0.36$; $N = 10$; $P > 0.5$)(Fig. 2). Tests using frequency of items among scats had similar results; no association between years at PPNP ($\tau = 0.01$; $N = 14$; $P > 0.1$) or between PPNP and RPP ($\tau = 0.46$; $N = 10$; $P > 0.1$) (Fig. 3).

We were able to collect 16 scats from skinks at Rondeau (4 ♀♀, 5 ♂♂, 7 juveniles) while they were being processed for another study (Table 1). Number of food items per scat did not differ among sex or age class (males 2.2 ± 1.64; females 2.5 ± 1.73; juveniles 1.7 ± 1.25; Kruskal-Wallis $H = 1.45$; 2 df; $P = 0.484$; Fig. 4). Kendall's rank test indicated no association between the abundance of each type of food items consumed among males, females, and juveniles (Taus ranged $\tau = 0.27$–0.58; $N = 6$–8; and $P > 0.05$ for all comparisons). Tests using frequency of items among scats had similar results; no association among males, females, and juveniles (Taus ranged $\tau = 0.14$–0.59; $N = 6$–8; $P > 0.1$ for all comparisons; Fig. 5).

Discussion.—In general our recent sampling confirms findings of earlier studies that Five-lined Skinks largely consume ground-active rather than flying forms of arthropods (Fitch 1954 and references within; Hecnar et al. 2002). Our results also add

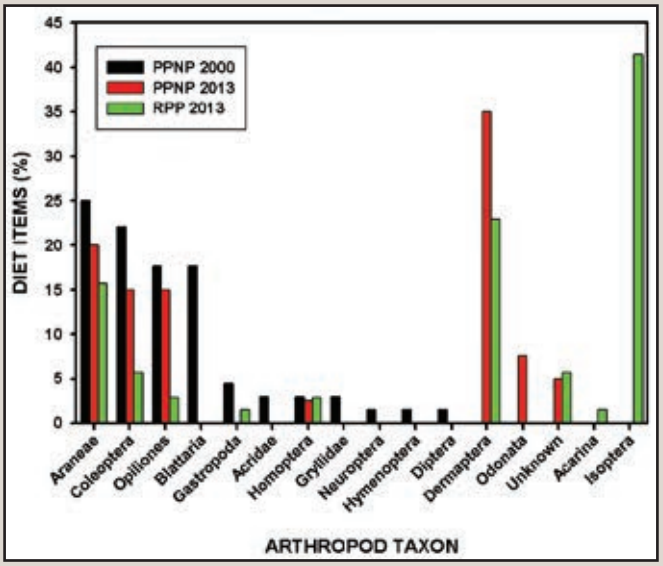


FIG. 2. Abundance of diet items by arthropod taxon found in skink scats at Point Pelee National Park, and Rondeau Provincial Park, Ontario, Canada. Data for PPNP in 2000 from Hecnar et al. 2002.

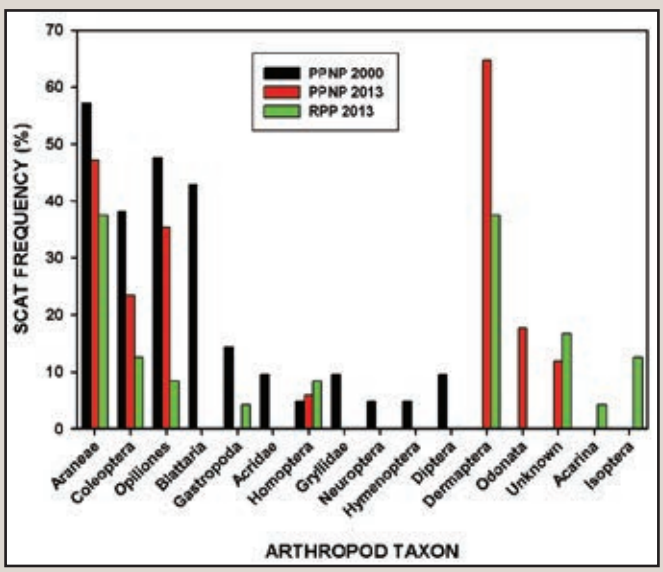


FIG. 3. Frequency of occurrence of diet items in skink scats by arthropod taxon at Point Pelee National Park, and Rondeau Provincial Park, Ontario, Canada. Data for PPNP in 2000 from Hecnar et al. 2002.

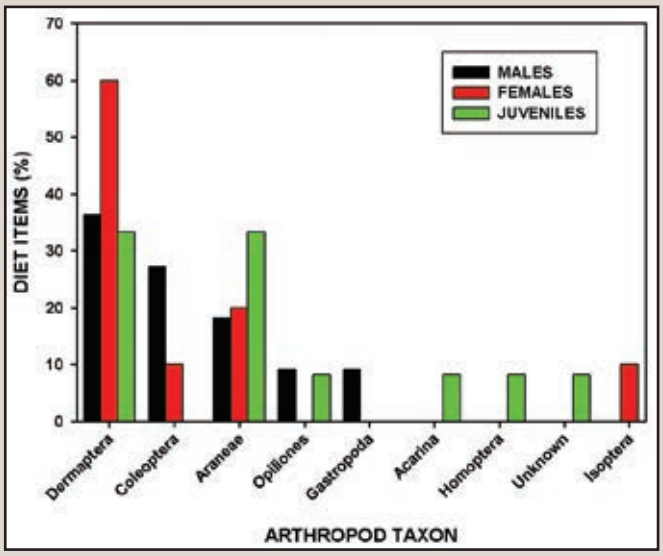


FIG. 4. Abundance of diet items by arthropod taxon found in male, female, and juvenile skink scats at Rondeau Provincial Park, Ontario, Canada in 2013.

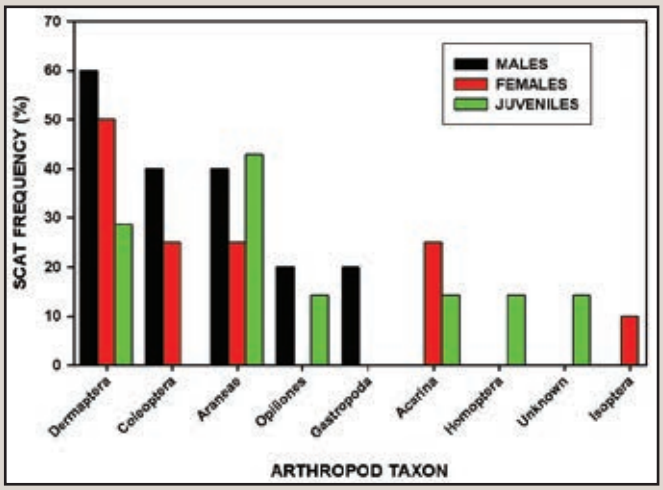


FIG. 5. Frequency of occurrence of diet items in male, female, and juvenile skink scats by arthropod taxon at Rondeau Provincial Park, Ontario, Canada in 2013.

evidence of dietary differences between locations or changes over time potentially or presumably reflecting prey availability and opportunistic feeding.

Exoskeletons of individual items were sometimes missing pieces, but in most cases a sufficient number allowed some level of identification. Although considered a gape-limited predator, Fitch (1954) suggested that missing parts of exoskeletons in scats indicated that Five-lined Skinks battered larger prey items prior to swallowing. On several occasions, we observed skinks capturing and battering larger grasshoppers and harvestmen to subdue them and accommodate swallowing. Judd (1955) noted that sometimes two skinks would grasp a single food item and tear it apart.

Numbers of items per scat did not change significantly over time at PPNP or between PPNP and RPP, suggesting that skinks had the same abundance of food. Interestingly, the average number of items in scats from our samples in both years (2.9–3.2 items/scat) was nearly double the number reported from Kansas (1.67 items/scat; Fitch 1954). Skinks took a wide variety of food items at both PPNP and RPP in 2013, as they did at PPNP in 2000, with arachnids (spiders and harvestmen) forming a sizeable portion of the diet. This adds additional evidence that skinks might exhibit some preference for arachnids. We cannot demonstrate selectivity as we did not measure the array of available foods. However, the proportion of arachnids in scats appears much greater than their availability. Similarly, coleopterans (beetles) were well represented in diets. We found the remains of a carabid beetle (genus *Agonum*) in one 2013 PPNP scat, and beetles, most of which were carabids, were the second most common food item found in the 2000 analysis. This contrasts surprisingly with a study of the closely related Southeastern Five-lined Skink (*Plestiodon inexpectatus*), which indicated that they avoid eating and are repelled by secretions of the carabid beetle *Pasimachus*

TABLE 1. Number of arthropods and other taxa identified in skink scats. Sex and age for RPP scats are noted as M = male, F = female, and J = juvenile.

Scat	Araneida (spiders)	Coleoptera (beetles)	Opiliones (harvestmen)	Gastropoda (snails)	Homoptera (aphids)	Dermaptera (earwigs)	Odonata (damselflies)	Unknown	Acarina (ticks)	Isoptera (termites)	Total
PPNP											
1	1		1			1					3
2	1		1								2
3						2					2
4	1							1			2
5			1			1					2
6						1					1
7								1			1
8	1	2				1	1				5
9		2									2
10		1					1				2
11	1					1					2
12	1					2					3
13		1	1			1					3
14	1		1			1					3
15	1		1		1						3
16						2					2
17						1	1				2
Subtotal Items	**8**	**6**	**6**	**0**	**1**	**14**	**3**	**2**	**0**	**0**	**40**
Subtotal Scats	**8**	**4**	**6**	**0**	**1**	**11**	**3**	**2**	**0**	**0**	**17**
RPP											
1 M		1				1					2
2 M	1			1							2
3 F						5					5
4						1		1			2
5 F	2										2
6	1										1
7 J	2					1					3
8	1				1			1			3
9 M		2	1			2					5
10 J			1								1
11								1			1
12 F		1				1					2
13 J						3		1			4
14	1										1
15 F										1	1
16 J	1										1
17 J	1										1
18 J									1		1
19 M	1										1
20 J					1						1
21						1					1
22										24	24
23 M						1					1
24										4	4
Subtotal Items	**11**	**4**	**2**	**1**	**2**	**16**	**0**	**4**	**1**	**29**	**70**
Subtotal Scats	**9**	**3**	**2**	**1**	**2**	**9**	**0**	**4**	**1**	**3**	**24**
Total Items	**19**	**10**	**8**	**1**	**3**	**30**	**3**	**6**	**1**	**29**	**110**

TABLE 1. Continued.

Scat	Araneida (spiders)	Coleoptera (beetles)	Opiliones (harvestmen)	Gastropoda (snails)	Homoptera (aphids)	Dermaptera (earwigs)	Odonata (damselflies)	Unknown	Acarina (ticks)	Isoptera (termites)	Total
Total											
Scats	**17**	**7**	**8**	**1**	**3**	**20**	**3**	**6**	**1**	**3**	**41**
Male											
Items	**2**	**3**	**1**	**1**	**0**	**4**	**0**	**0**	**0**	**0**	**11**
Female											
Items	**2**	**1**	**0**	**0**	**0**	**6**	**0**	**0**	**0**	**1**	**10**
Juvenile											
Items	**4**	**0**	**1**	**0**	**1**	**4**	**0**	**1**	**1**	**0**	**12**
Male											
Scats	**2**	**2**	**1**	**1**	**0**	**3**	**0**	**0**	**0**	**0**	**5**
Female											
Scats	**1**	**1**	**0**	**0**	**0**	**2**	**0**	**0**	**1**	**0**	**4**
Juvenile											
Scats	**3**	**0**	**1**	**0**	**1**	**2**	**0**	**1**	**1**	**0**	**7**

subsulcatus (Witz and Mushinsky 1989). Fitch (1954) and earlier sources he cited also suggested a preference for orthopterans (grasshoppers) and blattids (cockroaches), with which our study at PPNP in 2000 concurred. However, neither group was represented in 2013 at either location (Table 1: Blattaria and Gryllidae). Ants (Family Formicidae) were also absent at both locations in 2013, and we found only one ant in a scat at PPNP in 2000. Considering that ants commonly co-occur with skinks at both sites but are essentially absent in scats suggests that they are avoided as food items as Taylor (1935) noted for the *Eumeces* group of skinks. Formic acid and other associated defensive chemicals present in ants likely deters consumption (Blum 2012).

Judd (1962) examined stomach and intestinal contents of seven male skinks captured at RPP and found remnants of 11 crickets, 2 snails, 2 spiders, 1 cockroach, 1 sow bug, and 1 caterpillar. Although his sample size was small, the nature of dietary items clearly differs from our observations at the same location 54 years later—adding further evidence to an assumption of dietary change or opportunistic feeding over time. Each of the food items found in skinks in the 1959 study (Judd 1962) also occurred in sympatric Jefferson Salamanders (*Ambystoma jeffersonianum*, [now considered Jefferson Complex at RPP] (Judd 1957). We also noted high seasonally syntopic local distribution of ambystomatid salamanders with skinks in 2013.

Despite similarities in the number of dietary items and some evidence of preferences for arachnids, other types of dietary items differed widely in both time and location. The most striking differences were the appearance of Dermaptera at both locations in 2013. Although earwigs were not recorded as dietary items at PPNP in 2000, they dominated diets in 2013. Similarly, they were the second most common diet item at RPP in 2013, following only termites. In most cases we were able to identify dermapteran fragments as belonging to *Forficula auricularia*, the European Earwig. The termite fragments were likely *Reticulitermes flavipes* (Isoptera: Rhinotermitidae), the only termite known from wild populations in the region (Raffoul et al. 2011). Two of us documented the first occurrence of a wild population *R. flavipes* for the region at Point Pelee (Raffoul et al. 2011). This species is becoming an important pest in southern Ontario cities. In recent years, the abundance and distribution of termites has expanded at PPNP and now they apparently also occur at RPP.

Our sample of food items among sex and age classes was small but indicated that number of food items per scat was not significantly different between males, females, and juveniles. Similar to our time (2000 vs. 2013) and location (PPNP vs. RPP in 2013) analyses, the types of dietary items consumed were not associated when either abundance of items or their frequency among scats were considered. This suggests sex and age classes may have dietary differences. That female and juvenile diets were not associated was somewhat surprising as they often co-occurred at nest sites when we collected our samples (Hecnar 1994). Results for sex and age class comparisons should be interpreted cautiously as sample sizes were small.

Our studies show how a simple non-invasive sampling technique can be useful for reconstructing diets of arthropod or insectivorous lizards. Scats are easily recognizable, are easy to collect, do not degrade quickly, and the identity of prey items is relatively easy to determine. Our studies now suggest that the Five-lined Skink in the Carolinian portion of its northern range is a generalist arthropod predator that appears to show some preference for arachnids, but it also demonstrates that skinks are opportunistic feeders. Dietary breadth is likely a characteristic that promotes skink survival in these highly dynamic coastal dune communities. Considering the broad overlap of geographic ranges for Five-lined Skinks with earwigs and termites, they may be important predators on these pest species. This evidence for skink predation on invasive pests and other evidence that skinks may serve as "dilution hosts" (reduce prevalence) for Lyme disease (Giery and Ostfield 2007) highlight often overlooked services reptilian species provide for humans.

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The First Report of *Aplectana hylambatis* (Nematoda; Cosmocercidae) Associated with *Dermatonotus muelleri* (Anura; Microhylidae) from Brazil

Dermatonotus muelleri (Boettger 1885) is the only species for this genus from the family Microhylidae. This anuran is hard to find due to its fossorial habits, and it is an explosive breeder during the wet season (Nomura 2009). Concerning its helminth fauna, only specimens from Paraguay have been recorded, including the nematode *Aplectana hylambatis* (Baylis 1927) and the cestode *Ophiotaenia cohospes* Coredo, 1946 (Campião et al. 2014). In Brazil, there are records of *Aplectana* sp., a species of Cosmocercidae, and plerocercoid larvae of *Spargana* parasitizing *D. muelleri* (Bezerra et al. 2012; Campião et al. 2014). In light of this, we present the first record of *A. hylambatis* parasitizing a Brazilian anuran species, *D. muelleri*, as well as the ecological descriptors of parasitism. In addition, we also describe the morphological characterization of this nematode species.

During the rainy season in February 2013, we collected 19 specimens of *D. muelleri* from a biological reserve in the State of São Paulo (Reserva Particular do Patrimônio Natural Foz do Rio Aguapeí). The anurans were necropsied and upon discovery, nematodes were fixed with hot alcohol (70%) and then mounted on temporary slides with Lactofenol. The identification was based on Travassos (1931), Baker (1980), Vicente et al. (1991), and recent articles about the species description of *Aplectana* spp. The ecological descriptors of parasitism—prevalence (%), mean abundance (MA), and mean intensity of infection (MII)—were calculated according to Bush et al. (1997). MII and MA are presented as mean values with their standard errors.

Aplectana hylambatis was the only helminth species found in these anurans. Only 3 of 19 (15.8%) anurans examined had this parasite in the large intestine, with a total of 678 helminths detected (range: 16–553). Parasitized individuals were infected with an average of 226.0 ± 165.7 helminth individuals per host, and MA was 35.7 ± 29.3.

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Family Cosmocercidae Travassos, 1925
***Aplectana hylambatis* (Baylis, 1927) Travassos, 1931**

These nematodes present marked sexual dimorphism, wherein females are slightly longer than males. Both sexes have a transversal cuticle, mouth with three lips, and a very visible excretory pore that is anterior from bulb of oesophagus (Fig. 1A). There are no plectanes at the end of males' tails, but there are some papillae distributed with number and pattern variable. The spicules are very marked and present a hook at the extremity (Fig. 1B). Females have an equatorial vulva with a salient border which is easily notable (Fig. 1C), and the majority of them present numerous thin shell eggs. Unfortunately, females of several species of Cosmocercidae have very similar morphology, thus it is necessary, often, to have the presence of males in

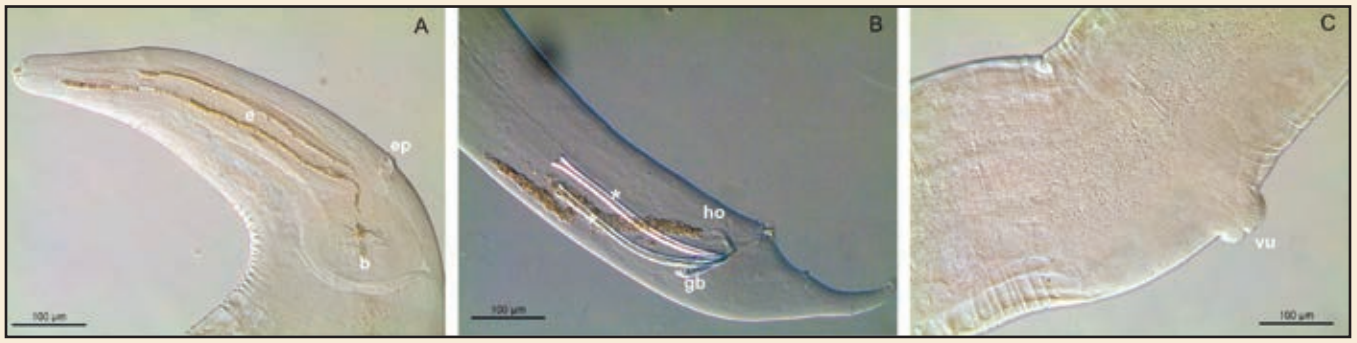


FIG. 1. Photomicrograph of *Aplectana hylambatis* associated with *Dermatonotus muelleri* from Brazil. A: anterior end of a female, showing esophagus (e), bulb (b), and excretory pore (ep). B: posterior end of a male, showing spicules (*), gubernaculum (gb) and hooks (ho) at extremity. C: vulva (vu) of female, showing the salient borders.

TABLE 1. Body measurements of male and female *Aplectana hylambatis* parasitizing the anuran *Dermatonotus muelleri*, in Brazil.

Measurements (µm)	Males (N = 10)			Females (N = 4)		
	Mean	SD	Range	Mean	SD	Range
Total length	2868.4	539.1	2231.0–4005.0	3127.25	640.2	2353.0–3860.0
Width	193.4	45.4	137.0–282.0	242.0	55.6	188.0–299.0
Muscular esophagus	560.0	35.5	503.0–610.0	634.0	20.2	612.0–661.0
Bulb length	105.1	12.3	91.0–131.0	123.0	7.5	115.0–132.0
Bulb width	125.5	13.1	106.0–145.0	153.0	13.6	136.0–169.0
Excretory pore from anterior end	425.1	33.4	382.0–496.0	481.5	46.6	412.0–509.0
Vulva from anterior end	–	–	–	2047.5	387.7	1604.0–2549.0
Tail	208.6	38.6	160.0–279.0	198.0	15.4	182.0–219.0
Gubernaculum	68.2	11.0	53.0–85.0	–	–	–
Spicules	276.8	36.8	228.0–340.0	–	–	–

TABLE 2. Size of spicules, gubernaculum, and distribution of caudal papillae in males of *Aplectana hylambatis* in different hosts from South America.

Host	*Physalaemus santafecinus*	*Rhinella arenarum*	*Dermatonotus muelleri*	*Dermatonotus muelleri*
Reference	González and Hamann 2010	González et al. 2013	Baker and Vaucher 1986*	Present study
Locality	Argentina	Argentina	Paraguay	Brazil
Spicules (µm)	255 – 298	240 – 348	319 – 350	228 – 340
Gubernaculum	67 – 89	48 – 78	109 – 116	53 – 85
Papilaes Preanals	6 pairs	4 pairs	5 pairs	3 – 4 pairs
Papilaes Adanals	1 large unpaired + 3 pairs + 1 sublateral pair	1 unpaired + 3 pairs + 1 lateral pair + 1 posterior pair + 2 ventrolateral pairs	1 sublateral pair + 3 pairs + 1 unpaired	1 large unpaired + 2 pairs + 1 pair sublateral
Papilaes Postanals	1 large subventral pair + 3 lateral subventral pairs + 3 lateral subdorsal pairs + 2 unpaired ventral	2 ventral pairs + 2 ventrolateral pairs + 1 lateral pair	2 subventral pairs + 1 subdorsal pair + 2 lateral pairs + 1 subventral pair	3 ventrolateral pairs + 2 unpaired ventral

*In *Dermatonotus muelleri* from Paraguay, Baker and Vaucher (1986) report that descriptions of *Aplectana hylambatis* were attributed to Baker (1980), where this nematode was redescribed parasitizing *Rhinella achalensis* from Argentina.

the sample to distinguish taxa. Due to this, most descriptions address characteristics of males. The measurements of males and females are showed on the Table 1.

Aplectana hylambatis was described by Baylis (1927) in *Leptopelis aubryi* (Duméril, 1856) (Arthroleptidae) from Guinea, Africa, and it is redescribed by Baker (1980), recording this nematode in *Rhinella achalensis* (Cei, 1972) from Argentina. After this, other studies showed the morphological variation of this nematode species associated with other hosts (e.g., González and Hamann 2010; González et al. 2013). The number of caudal papillae on the posterior end of males is variable, and the two articulation parts of spicules can be seen clearly through the scanning electron microscope (González and Hamann 2010).

The papillae pattern of *A. hylambatis* can vary in some specimens associated with different species of host, but this variation is not so marked (Table 2). The spicules of specimens associated with anurans from South America (Argentine, Paraguay, and the present study in Brazil) vary from 228 µm to 350 µm in length, while the gubernaculum can measure 48–116 µm (Table 2). This cosmocercid has a wide distribution, occurring in six countries from South America (Argentina, Ecuador, Guyana, Paraguay, Peru, and Uruguay), and 22 anuran species are associated with it (Campião et al. 2014). However, in Brazilian anurans, this is the first record; *Aplectana hylambatis* has never been recorded in Brazil. This study increases the geographic distribution of this nematode.

Aplectana hylambatis, as well as other cosmocercids, is a generalist nematode parasite, but the association with *D. muelleri* from Brazil may suggest host specificity because this nematode of trophic infection has also been reported in *D. muelleri* from Paraguay (Baker and Vaucher 1986). In the present study, the exclusive parasitism by *A. hylambatis* with this population of *D. muelleri*, without cosmocercids of skin penetration, indicates that the fossorial habitat and skin secretions of this anuran may hinder infections by parasites with skin penetration (Tempone et al. 2007).

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TECHNIQUES

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Field Venom Extractions: Saving Fingers with Tubes, Forceps, and Nerf Bullets

Historically, reptile venom research has only been correlated with medical significance to humans (Weiner 1960; Shafqat et al. 1990; Earl et al. 2012; Savanur et al. 2014). Thanks to technological and analytical advancements, venomics has extended into other fields of biology such as ecology and phylogeny (Li et al. 2005; Mackessy et al. 2006; Richards et al. 2012; Heyborne and Mackessy 2013; Benard-valle et al. 2014). Proteomic techniques (e.g., electrophoretic profiling, spectrometry, transcriptomics) have been effective for exploring interspecific and intraspecific protein variability geographically and ontogenetically (Mackessy et al. 2006; Alape-Giron et al. 2008; Barlow et al. 2009; Casewall et al. 2009; Madrigal et al. 2012; Lourenco et al. 2013; He et al. 2014; Lanari et al. 2014), thus presenting new evidence for untangling the complex trajectories of venom evolution (Calvete et al. 2009; Fry et al. 2009; Casewall et al. 2009; Margres et al. 2014; Brahma et al. 2015).

In contrast to methodological advancements in venom analysis, the general procedure for extracting crude venom from live specimens remains essentially unchanged (Willemse et al. 1979; Savanur et al. 2014). The only apparent documented exceptions rely on techniques such as electrical pulsations and anesthesia (McCleary and Heard 2010; Margres et al. 2014), which present obvious limitations in the field. The traditional method for venom extraction from high-pressure delivery species (e.g., viperids and elapids) relies on manual subcranial restraint followed by venom delivery into a collection vessel, often through a membrane. Accidental envenomations during traditional extractions are accredited to human error in combination with the impressive cranial dexterity of specimens (Hayes 2008; J. Harrison, pers. comm.). Acknowledgment of this inherent danger generates logistical complications (e.g., collection permits and IACUC protocols) that might compromise or limit venom research efforts (pers. obs.).

To increase the relative safety while extracting venom, the separating tube extraction method was established and evaluated for effectiveness on terrestrial pit vipers (Crotalinae). The proposed method was designed to operate within the limitations of a field setting while minimizing stress for the specimen. It combines previously established handling techniques (Johnson 2011) with a novel concept in an attempt to eliminate direct physical contact with the snake's head.

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Materials

Separating Snake Tubes.—A custom set of snake tubes were fabricated from 1-m lengths of rigid vinyl tubing (Lowes® item numbers: 652376, 652385, 652455, 432506, 432501, 443439, 443438, 35778, 35768). Finished tubes separate into two pieces when grasped at opposite ends flexed side to side. Separation points were positioned 20 cm off-center (resulting in 30 cm and 70 cm segments when separated) and the friction-dependent joints were meticulously constructed to ensure a reliable connection. Tapering directionality for the joints is depicted in Fig. 1. This layout preserves interior diameters of the shorter segments where the snake's head is exposed during extractions.

Padded Forceps for Gland Manipulation.—Curved hemostat forceps (HTS 161S3, 12") were modified to replace the extractor's hands during head positioning and venom gland manipulation (Fig. 2). The unnecessary locking mechanism was removed to prevent accidental locking. Tool-grip rubber was applied over the teeth to coat any sharp edges. Cylindrical foam was positioned over the coated teeth (13 mm diameter) to disperse pressure during gland manipulation. The foam was derived from Nerf® darts based on their availability and contrasting coloration (Nerf® product number: 62567).

Venom Collection Vessels.—Plastic beakers (50 mL) with plastic membranes were chosen for venom collection vessels. Rubber bands were utilized for securing membranes over beakers and also for fastening beakers to sturdy rocks or logs in field extraction settings. Beakers were prepped each day before entering the field to minimize set-up time. Venom was pipetted out of the membrane-covered beakers into 2-ml sample tubes and stored on ice while in the field.

Methods

The step-by-step procedure below was tested and refined via mock scenarios using various non-venomous snakes from the Herpetology Collection at the University of Massachusetts (e.g., *Pantherophis, Elaphe, Aspidites*). The technique was then tested periodically between April and July of 2014 in the field on 11 wild adult *Crotalus oreganus* (Western Rattlesnake, one extraction

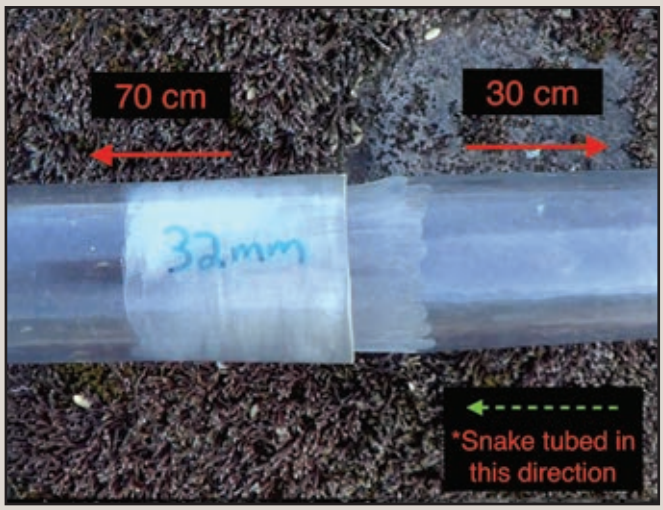


FIG. 1. Close up of the connection point on the 32-mm interior diameter tube. The vinyl was tapered for 5 cm to the edge on the outside of the 30-cm segment and 5 cm on the interior of the 70-cm segment.



FIG. 2. Modified forceps. The rubber band was used to prevent the tool from inverting accidentally during extractions when only one hand was available.

session per snake) in the Columbia River Plateau Ecoregion of Oregon and Washington, USA. These efforts were supplementary to a population genetics project. The extractor was proficient in using standard venomous snake handling equipment (regular acrylic snake tubes, tongs, hooks, and bags) and safety measures (snake proof "gators" and/or boots, multiple individuals present on site, reliable research vehicle, localities and contact information for closest antivenom-stocked medical centers). For our purposes, a venom extraction was considered successful after collecting at least 0.1 ml uncontaminated crude venom (Mackessy 2002) (Fig. 3E) while avoiding direct physical contact with snake's head. All snakes were released at respective capture locations the same day as capture. Extractions were videotaped using a Sony HD Handycam and later reviewed for potential improvements.

The following is the proposed venom extraction procedure. Extraneous details were excluded in this outline for clarity (e.g. capture and release strategies, additional specimen processing, proper use of bags and other handling equipment, preparing and sterilizing extraction equipment). It is presented as a second-person instructional narrative to concisely highlight timing details for the reader and minimize misinterpretation. I believe the best treatment for snakebite is prevention.

PROPOSED PROCEDURE

1. *Set up Extraction Station.*—Designate a sturdy surface to serve as the extraction station (e.g., tailgate, picnic table, flat boulder, log). Using one or two rubber bands, secure the prepped collection vessel to a flattened stone or similar object (approximately the size and weight of a brick). Minimal mobility of the collection beaker is preferable. Stage the padded forceps next to the collection vessel for ease of access. Assemble the separating tubes and make sure all the joints are intact and functional. Assess the surroundings for potential obstacles and confirm the location's suitability for venom extraction.

2. *Tubing the Snake.*—Select the smallest diameter tube which accommodates the snake's midsection. If uncertain, always undershoot and adjust accordingly. The goal is not to prevent the snake from "turning around" but rather to minimize body contortions for maximum control. Correct tube size is crucial for optimizing safety and yield. While holding the tube at the very end of the larger segment, guide the snake into the opposite opening using snake tongs and gently coax it inside until the head is within a couple centimeters of the joint. This may be performed in a bucket to help contain the snake. When ready, drop the tongs and with that hand quickly grasp both the snake body and tube at the opening. The grip should be relaxed yet firm. With the tubed snake in hand, slowly relocate to the extraction station. Support the snake's un-tubed posterior to avoid damaging the vertebrae.

3. *Venom Extraction.*—Position the tube on a flat surface with the snake's head facing away. Carefully feed more of the body into the tube until the head passes over the joint seam (Fig. 3A). Grab the far end of the tube and wiggle using moderate effort until the joint gradually releases. Take your time with this step. The separation of the two halves exposes the snake's head from the smaller segment (Fig. 3B). Use the padded forceps to gently restrain the snake directly behind the head. Lift the snake over to the venom collection beaker and offer it the membrane surface (Fig. 3D). If the snake is unwilling to bite, a gentle nudge against the beaker is sufficient to elicit a bite. After fang penetration, reposition the forceps over the venom glands and apply pulsating pressure. The effort is comparable to squeezing a tube of toothpaste. Cease gland manipulation after approx. 30 seconds (or when enough venom is delivered) and allow the snake to release itself. If a fang becomes stuck gently maneuver it out using the forceps. Promptly re-attach the tube segments following the extraction as a safety precaution.

RESULTS

All extractions attempted were successful with 0.10 ml or higher yields and no direct contact was made with the exposed heads. Snout vent length of the 11 snakes ranged from 62 cm to 99.8 cm, and extraction stations included the hood and trunk space of our research vehicle (Jeep Grand Cherokee), pickup truck tailgates, and boulders at capture locations.

DISCUSSION

On two occasions a fang penetrated through the rubber band securing the collection vessel and on one occasion a fang missed the vessel completely. However this had no effect on the extractor's safety and sufficient yield was still attained. If a snake was extracted at the place of capture, the elapsed time between capture and release was less than 20 min (making it our preferred method). This would not be possible if the procedure relied on anesthetics

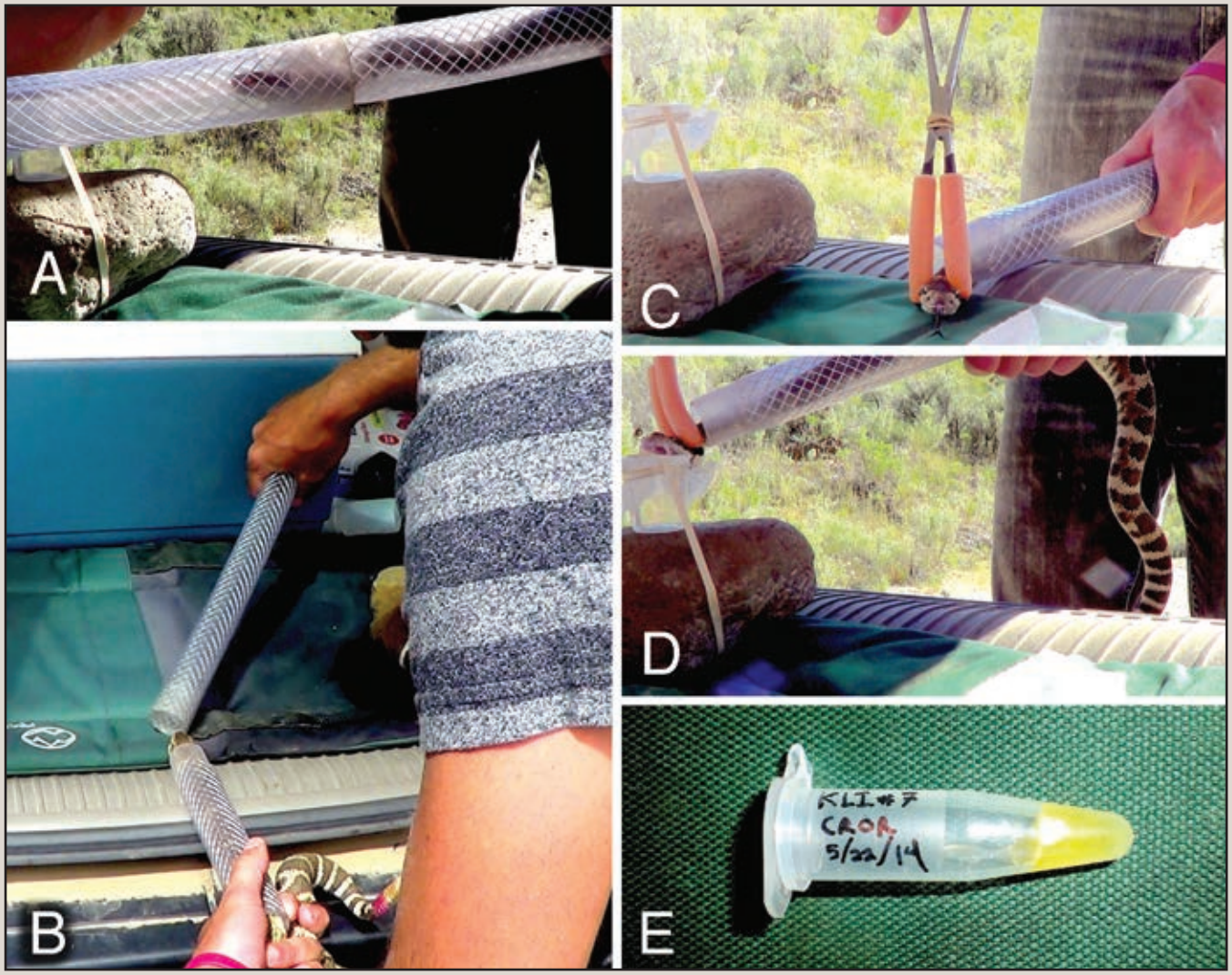


FIG. 3. The back of a research vehicle is one example of a field extraction station. A) Positioning an adult *Crotalus oreganus* in relation to the separation joint. B) Exposing head of an adult *Crotalus oreganus*. Proper hand placement is demonstrated during tube separation, i.e., grasping the break away section from the very end. Rattle painted pink to prevent re-capture. C, D) Application of the padded forceps. Establishing initial control of the head was particularly challenging at first. Patience and practice increased proficiency. E) Yield of approx. 0.2 ml from adult *Crotalus oreganus*.

(McCleary and Heard 2010). On multiple occasions, snakes were spotted on days following their venom extractions mirroring the behaviors observed during their capture (e.g., basking outside burrow, coiled in ambush).

The separating tubes revealed a few unexpected advantages during the field tests. First they were far more practical to carry around than standard snake tubes. Their ruggedness also provided an additional sense of security by eliminating the possibility of brittle tubes breaking with a snake in hand. Since they were made from vinyl and slightly malleable, the mistake of overshooting tube size for a given snake and having it turn around while tubed can be counteracted by simply squeezing the tube. In regard to applying for permits, this method merits the same or similar risk of envenomation as does general snake tubing. Since the process was designed to be implementation by a single individual, the risk of envenomation due to miscommunication is small. Most notably from a safety standpoint, there is no reason to rush during this method and the best results come from working slow and methodically. The extractor does not have to race or outwit the snake in pursuit of pinning or releasing it. This in turn reflects on the overall well being of the snake throughout this process; anyone familiar with snake handling can attest to the advantages of moving slow and methodical.

Areas of improvement also became apparent both in the field and during post-project discussions. The forceps used for gland manipulation might be further modified with the addition of elevated foam areas to provide more direct pressure to the glands. Alternatively, the gland manipulation step may be excluded altogether as the morphological consequences of this step are not yet completely understood (Giannotti et al. 2013). Inflammation of gland tissues may affect mRNA expression patterns and compromise transcriptomic analyses (D. Rokyta, pers. comm.). The snake tubes may be redesigned to increase control by positioning the separation point based on projected snake lengths for a given size tube (as opposed to making segments 30 mm and 70 mm, exclusively). Thus, smaller snakes may be held in relatively shorter tube segments than longer snakes during extractions. Another possibility is customizing the extraction opening with

a slightly smaller interior diameter at the separation point. This could further limit head contortions and increase overall control, although it may create issues when removing the snake afterwards. Material choice for the tubes might also be reconsidered for increased safety, control, and overall functionality of the joint.

I predict that given enough practice and (potential) equipment improvements, this technique will produce comparable yields to the traditional method at a greatly reduced risk of envenomation. Furthermore, the reduced risk supports general implementation of field extractions, which completely removes the step of bringing snakes into the lab. Collaborative efforts for improving and establishing a universally accepted technique will streamline safe venom research. Veterinary applications such as oral care for venomous snakes in husbandry settings might also benefit. Suggestions for improvements are encouraged. Video footage demonstrating the separating tube extraction technique may be viewed here:

Complete Procedure: https://www.youtube.com/watch?v=QnwWFXr_Nwg
Additional Footage: https://www.youtube.com/watch?v=vij-5X_Fd4U

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Characterization of Microsatellite Loci for the Spotted Dusky Salamander (*Desmognathus conanti*) Using Paired-end Illumina Shotgun Sequencing and Cross-Amplification in Another Species of *Desmognathus*

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Amphibians are underrepresented in the field of population genetics (Jehle and Arntzen 2002; Allendorf and Luikart 2007), and some groups, like those that breed in streams, are infrequently the focus of these studies (Emel and Storfer 2012). This is particularly true of dusky salamanders (genus *Desmognathus*), for which few, highly variable markers, such as microsatellites, have been published (e.g., Croshaw and Glenn 2003; Adams et al. 2005) or tested across multiple species within the genus (but see Munshi-South et al. 2013). Microsatellites loci are useful in characterizing patterns of gene flow and genetic diversity among populations (Avise 2004; Selkoe and Toonen 2006). There are multiple applications for such data within *Desmognathus*, a genus comprised of species that exhibit a wide range of ecologies (e.g., aquatic [*D. marmoratus*] to terrestrial [*D. aeneus*]) (Petranka 1998), that face a variety of threats, and among which hybridization is known to occur, or have occurred, in the recent past (Tilley 1988; Beamer and Lamb 2008).

The two species of *Desmognathus* of interest in this study are the Spotted Dusky Salamander (*D. conanti*) and the Southern Dusky Salamander (*D.* cf. *auriculatus*). *Desmognathus conanti* is a moderately sized, semi-aquatic species that was first described by Rossman (1958) from populations in western Kentucky and Tennessee. The expansive range of *D. conanti* stretches from western Kentucky south into the Gulf Coastal Plain and east across parts of the lower Atlantic Coastal Plain (Means and Bonett 2005). There are multiple genetically differentiated groups within *D. conanti* (i.e., Karlin and Guttman 1986; Bonett 2002; Kozak et al. 2005; Beamer and Lamb 2008), but whether these groups reflect strong phylogeographic structure or distinct species has yet to be determined. Populations appear stable throughout most of the aforementioned range, but this salamander is classified as "critically imperiled" (state rank S1) in Arkansas, "imperiled" in Illinois (S2), and "vulnerable" in Kentucky (S3) (NatureServe 2015). These salamanders can be found in seeps, springs, and lower order streams in areas with moderate relief, as well as along the edges of swamps and floodplain pools or sloughs (Valentine 1963; Means 2005a; Jensen et al. 2008; Graham et al. 2010).

Molecular work completed by Beamer and Lamb (2008) indicates that what is currently referred to as the Southern Dusky Salamander (*Desmognathus auriculatus*) is likely a conglomeration of several species. The original range of *D. auriculatus* stretched along the Coastal Plain from eastern Texas in to Virginia and included a large portion of both Louisiana and Mississippi (Means 2005b). Populations from Louisiana and Mississippi attributed to *D. auriculatus* were not included in Beamer and Lamb's (2008) work, and, pending taxonomic revisions, we will refer to these populations as *D.* cf. *auriculatus*. *Desmognathus* cf. *auriculatus* is infrequently encountered in Louisiana and Mississippi. It is classified as "critically imperiled" (state rank S1) in Louisiana (Louisiana Natural Heritage Program 2015; and see Boundy [2005]) and as "rare or uncommon" to "imperiled" (S2S3) in Mississippi (Mississippi Natural Heritage Program 2015). In Louisiana and Mississippi, *D.* cf. *auriculatus* is associated with swamps and bottomland seeps and streams that contain black-organic or silt/clay-based muddy substrates.

Methods and Results

Tissue samples from *Desmognathus* species were collected from various locales in Mississippi. We used sharp scissors sterilized with ethanol, by flame, or both to collect 2–5 millimeters of tissue from the tip of the tail. Tail tips were placed in individually labeled vials containing 95% ethanol and stored at –20°C in the laboratory. Total genomic DNA was extracted with the DNeasy Tissue Kit (QIAGEN Inc.). We sent genomic DNA for a specimen of *D. conanti* from south Mississippi to the Savannah River Ecology Laboratory Molecular Ecology Laboratory (SREL MEL), where an Illumina paired-end shotgun library was prepared (Nunziata et al. 2013) and PAL_FINDER_v0.02.03 (Castoe et al. 2012) was used to extract reads containing di-, tri-, tetra-, penta-, and hexanucleotide microsatellite sequences. SREL MEL used Primer3 (Rozen and Skaletsky 2000) to design primers for these reads. We screened 40 of the 4777 loci identified by SREL MEL. These included tetra- and pentanucleotide loci for which sequences occurred only one or two times among reads.

We collected tissue from two, widely separated populations of *D. conanti* from Mississippi. The northernmost population occurs on private-property in a seep-fed, 1st order (Strahler 1964) stream feeding into the Yazoo River in Union Co. (N = 23; population A), and was accessed with permission from the property owners. All individuals from this population were collected on 5 August 2014. The southernmost population of *D. conanti* is ca. 300 miles south at the Ward Bayou Wildlife Management Area in Jackson Co., Mississippi (N = 30; population B). Salamanders were caught in and along small seeps draining into a 1st order stream. Tissue samples were collected from this population from January to April 2013. We collected tissue from a single population of *D.* cf. *auriculatus* from the floodplain of a 2nd order stream in Camp Shelby, Forrest Co., Mississippi (N = 23) on two separate occasions, 27 October 2014 and 27 February

TABLE 1. Characterization of 20 polymorphic microsatellite loci developed for *Desmognathus conanti* and tested with *D.* cf. *auriculatus*. Forward primers are reported without the tailed M13 sequence. The information for each locus is reported such that the first row contains information for a population of *D. conanti* from Union Co., Mississippi (A), the second for a population of *D. conanti* from Jackson Co., Missouri (B), and the third row for a population of *D.* cf. *auriculatus* from Forrest Co., Missouri (cf. auric.). All loci were tested on 23 individuals for A, 30 individuals for B, and 23 individuals for cf. auric. Size describes the range of observed alleles in base pairs not including the 19 base pairs from the M13 tail. N indicates the number of individuals successfully genotyped, and NA the number of alleles. HO and HE are observed and expected heterozygosities, respectively. T°C represents the annealing temperature used for that population and locus.

Locus	Primer sequence 5'–3'	Motif	Population	Size (bp)	N	N_A	H_O	H_E	T°C
Dcon01	F: TTTCATAGGGTGAACTTGTGTGC	ATTGG	A	286 & 291	14	2	0.071	0.191	56
	R: CAATAGTGGCACTCTCTACCAACC		B	301–331	26	7	0.923	0.793	56
			D. cf. auric.	–	–	–	–	–	–
Dcon04	F: TCGATGCGTATCACTCTGTGC	ATCT	A	411–475	20	11	0.900	0.880	56
	R: AAAGCTTATGGCAGTTCAGTTCG		B	381–409	28	7	0.679	0.798	56
			D. cf. auric.	–	–	–	–	–	–
Dcon05	F: GGATTCGGGTTCATGTCAGC	ATCT	A	239–267	19	6	0.579	0.598	56
	R: TGCACTATTATAGCAGACAGATTAGGTAGG		B	231–371	25	14	0.880	0.836	56
			D. cf. auric.	268–356	21	9	0.667	0.834	56
Dcon11	F: TTCTCTTTCTGCACACAAACACC	AAAG	A	289–373	22	9	0.636	0.829	56
	R: TGTGTATTGATTAGGGCAATGG		B	217–265	21	11	0.762	0.865	56
			D. cf. auric.	235 & 243	15	2	0.267	0.320	56
Dcon12	F: ATAAGTGTGCATCCTCCTTGC	ATCT	A	280–360	18	17	0.889	0.918	54
	R: ACAAGCCTGCTATCACAGCG		B	221–253	29	9	0.793	0.867	56
			D. cf. auric.	–	–	–	–	–	–
Dcon13	F: GGAGGGAGCAGAAGGAAGG	AAAG	A	258–282	23	7	0.522	0.812	56
	R: ACGGGTCGATTTGAATCTGG		B	273–337	28	12	0.607 ‡	0.878	56
			D. cf. auric.	308–424	14	5	0.143 ‡	0.615	56 †
Dcon14	F: TTCGTACAGAAACCATTCATTCC	ATCT	A	286–378	20	16	0.850	0.901	56
	R: CAGTGCAGAATGATCCCAGC		B	265–289	30	7	0.833	0.823	56
			D. cf. auric.	311–319	22	3	0.636	0.594	56
Dcon16	F: CCATTGGCTTCAAACCG	ATCT	A	414–510	23	9	0.739	0.687	56
	R: TGCTGATTTCAAATGGTATGTTATCC		B	–	–	–	–	–	–
			D. cf. auric.	428–460	20	7	0.750	0.826	56 †
Dcon17	F: CTAGAAGTCTTGACGATAGAGCG	ATCT	A	–	–	–	–	–	–
	R: TCACAGCAGTCACTATTGCCC		B	225–257	22	9	0.364 ‡	0.848	56
			D. cf. auric.	–	–	–	–	–	–
Dcon18	F: TCATGTAATGTAGCTGAAGGCG	ATCT	A	469–561	22	12	0.864	0.837	56
	R: ATATGCAACAGTGCCCAAGC		B	447–483	26	9	0.808	0.863	56
			D. cf. auric.	–	–	–	–	–	–
Dcon21	F: TCTACGTGAGTGGTATCCGGC	AATAC	A	197–217	21	5	0.714	0.709	56
	R: TTATACTCTCGACATTCTGCAGGG		B	218–243	29	5	0.483	0.683	56
			D. cf. auric.	180 & 195	21	2	0.286	0.472	56 †
Dcon22	F: GGTACTTGGGATGTGGAGGG	ATCT	A	–	–	–	–	–	–
	R: CCAATGCCTTTCAATTCTTAATGC		B	263–299	27	9	0.667	0.834	56
			D. cf. auric.	–	–	–	–	–	–
Dcon23	F: TTCTTTCCTTTGTGTCCACTGC	AAAG	A	377–429	20	9	0.850	0.831	56
	R: GGTTGGCACTGGTTTGTGC		B	368–444	26	16	0.731	0.904	56
			D. cf. auric.	261 & 349	19	2	0.105	0.100	56
Dcon26	F: AACCACAATTTGTCAGCCTGC	ATCT	A	303–351	21	9	0.857	0.851	56
	R: TAGCATACAGATGCCGTTGGC		B	245–305	26	13	0.885	0.875	56
			D. cf. auric.	275–303	19	8	0.737 ‡	0.837	52
Dcon28	F: TCCCTTCACCTCGAAGCC	ATCT	A	482	20	1	0.000	0.000	56
	R: CTTTCAAGCCCACAGAGCC		B	240–280	26	11	0.885	0.879	56
			D. cf. auric.	258	20	1	0.000	0.000	56

Table 1. Continued.

Locus	Primer sequence 5'–3'	Motif	Population	Size (bp)	N	N_A	H_O	H_E	T°C
Dcon31	F: CAATTCATTGTGAATAGTAACGAGGG	AAAG	A	–	–	–	–	–	–
	R: TCACAGACTCTAAGCTGAGCACG		B	334–382	28	8	0.750	0.833	56
			D. cf. auric.	–	–	–	–	–	–
Dcon34	F: TTTGGTGCACTTAGAAGTCGG	ATCT	A	254–342	23	8	0.739	0.805	56
	R: AGTCGTAATGGTGCTCAGCG		B	238–362	29	19	0.655 ‡	0.900	56
			D. cf. auric.	299–351	22	5	0.318 ‡	0.635	56 †
Dcon36	F: GTCTCTCCTCCCTCAGCACC	ATCT	A	250–318	23	14	0.826	0.903	56
	R: GAAATGTGTCCAGGCTCGC		B	210–274	27	16	0.741	0.886	56
			D. cf. auric.	195–215	22	3	0.500	0.549	56
Dcon38	F: GAAGTAAAGAGGAAATTAGAGAAGGG	AAAG	A	254	23	1	0.000	0.000	56
	R: GATTGACCAATCTGGAAGGG		B	294–366	30	14	0.433 ‡	0.896	56
			D. cf. auric.	–	–	–	–	–	–
Dcon40	F: CAGCTTAAGACCCTGTTGTTCG	ATCT	A	–	–	–	–	–	–
	R: GGTTGTCGGTGTGAATACATCC		B	234–290	28	13	0.821	0.875	56
			D. cf. auric.	–	–	–	–	–	–

‡Locus deviates significantly from HWE after Bonferroni correction across loci for that population. †Locus was optimized with 3 mM concentration of MgCl2 for the population in question. All loci for population A were amplified using 1 µL of genomic DNA. Loci that were not successfully or reliably amplified for one population are indicated with a –.

2015, to test for cross-species amplification of these primers. All individuals were captured by hand from beneath natural cover items (e.g., litter packs, logs), and we released any individuals that we did not use as site vouchers immediately following tissue collection. Species identifications were verified by amplifying and sequencing a ~550 base pair region of the mitochondrial gene cytochorome oxidase subunit c (*cox1*) using primers from Beamer and Lamb (2008) and the Eurofins sequencing service (unpublished data).

We used five individuals of *D. conanti* from population B and five individuals of *D.* cf. *auriculatus* from the Camp Shelby population to complete our initial screening of the 40 loci meeting our selection criteria. Amplifications were conducted in a total volume of 12.5 µl using 1X standard Taq (Mg-free) buffer (BioLabs), 2 mM dNTPs, 2 mM $MgCl_2$, 0.1875 units of *Taq* polymerase (New England Biolabs), 0.3 µM of the M13 tailed forward primer (Boutin-Ganache et al. 2001), 0.3 µM of the reverse primer, 0.004 µM of the labeled M13 primer (LICOR Co.), 20–150 ng of template DNA, and water to the final volume. PCR cycling conditions consisted of an initial denaturing step of 94°C for 2 min followed by 35 cycles of 30 sec at 94°C, 30 sec at 56°C, and 1 min at 72°C. A final elongation step of 10 min at 72°C ended the cycle. We visualized microsatellite alleles on acrylamide gels using a LICOR 4300 DNA analyzer, and sized alleles using GeneProfiler ver. 4.05 (LICOR Co.). Any loci that amplified well under these initial conditions were then screened for polymorphism across all individuals in each of the three populations. We attempted to optimize conditions for loci that did not initially amplify, or for which bands were too faint to score, by using one or more of the following variations: decreasing the annealing temperature to 54 or 52°C, increasing the concentration of $MgCl_2$ to 3 mM, or increasing the amount of DNA template used. Annealing temperatures and conditions for 20 polymorphic loci are reported in Table 1. We calculated summary statistics for these loci for each population using GENALEX 6.5 (Peakall and Smouse 2012), and tested for deviations from Hardy-Weinberg equilibrium and for linkage disequilibrium using the probability tests in GENEPOP v 4.2 (Raymond and Rousset 1995; Rousset 2008). We adjusted our threshold for statistical significance for all multiple tests within a population using sequential Bonferroni procedures (Rice 1989).

A total of 20 loci were optimized across the species and populations tested. Sixteen loci amplified reliably for population A, 19 for population B, and 11 for the single population of *D.* cf. *auriculatus* (Table 1). For population A, the number of alleles per locus ranged from 1 to 17 (mean = 8.50), and observed heterozygosity levels from 0.000 to 0.900 (mean = 0.627). Individuals screened from this population had only 2 alleles for *Dcon01,* and only one allele for both *Dcon28* and *Dcon38.* No loci deviated significantly from Hardy-Weinberg Equilibrium (Table 1). For population B, the number of alleles per locus ranged from 5 to 19 (mean = 11), and observed heterozygosity levels from 0.364 to 0.923 (mean = 0.721). Four loci, *Dcon13, Dcon17, Dcon34,* and *Dcon38,* deviated significantly from Hardy-Weinberg Equilibrium (Table 1). For the population of *D.* cf. *auriculatus,* the number of alleles per locus ranged from 1 to 9 (mean = 4.27), and observed heterozygosity levels from 0.000 to 0.750 (mean = 0.401). Individuals screened from this population had only 2 alleles for *Dcon11, Dcon21,* and *Dcon23,* and only one allele for *Dcon28.* Three loci, *Dcon13, Dcon26,* and *Dcon34* deviated significantly from Hardy-Weinberg Equilibrium (Table 1). No loci exhibited linkage disequilibrium in any of the species or populations tested.

Discussion

The long-term survival of amphibian species and the preservation of regional biodiversity will depend on our ability to identify current and historic patterns of population connectivity (i.e., gene flow) and genetic diversity using molecular tools, such as these 20 microsatellite loci (Semlitsch 2002; Beebee 2005; Allentoft and O'Brien 2010). Genetic diversity is positively correlated with fitness in many amphibians (Allentoft and O'Brien 2010) and it can buffer populations against stressors such as UV-B radiation (Weyrauch and Grubb 2006) and

emergent pathogens (Pearman and Garner 2005). Population connectivity, which counteracts inbreeding depression and genetic drift, is one facet responsible for maintaining high levels of genetic diversity (Allendorf and Luikart 2007). Consequently, it is important to understand how gene flow is affected by prior and ongoing management practices and the natural history of the species of interest. We successfully amplified many of these microsatellite loci in both of our study species (*D. conanti* and *D.* cf. *auriculatus*), as well as in widely separated populations within one of these species (e.g., population A and B of *D. conanti*). This is, hopefully, indicative of the utility of these loci in addressing the aforementioned areas of conservation interest not only across populations of *D. conanti* and *D.* cf. *auriculatus*, but also across other species within the genus *Desmognathus*. Our laboratory is currently using these microsatellites in tandem with mitochondrial gene sequencing to characterize geographic patterns of genetic structure in *D. conanti* across the Gulf Coastal Plain, as well as to examine fine-scale patterns of gene flow within the Pascagoula and Pearl River Drainages. Future endeavors include using these loci to examine current levels of genetic diversity and isolation in Mississippi populations of *D.* cf. *auriculatus*, as well as to investigate the paternity of clutches of eggs that have resulted from captive courtship trials for this species (unpublished data).

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Lateral Vessel Puncture: A New Method for Drawing Blood from Small Snakes

Genetic analyses have revolutionized our understanding of phylogenetic relationships (Pyron et al. 2013), interactions between and within populations (Castoe et al. 2007), relationships between species, geology, and climate (Ornelas et al. 2013), and other important aspects of biology (Vonk et al. 2013). Increasingly, they are the preferred method for answering questions not only regarding the evolution of organisms, but also their conservation (Holycross and Douglas 2007). However, obtaining reliable genetic material from some organisms in the field without injuring or sacrificing the animal can be challenging.

Researchers requiring a non-lethal method of collecting genetic material from small snakes often use ventral scale clips (e.g., Bryson et al. 2011). The keratin cells that comprise the posterior portion of each scale are non-nucleated, so scale clips must include connective tissue at the base of the scales (Burbrink and Castoe 2009). Biologists have long used ventral scale clips to mark snakes in population studies (Woodbury 1956). Negative effects have not been reported, but infection is a potential risk, especially given that the resulting open wound remains in direct contact with the ground.

Although scale clips can provide useable amounts of DNA, blood is a more reliable source of non-degraded genetic material. The primary method used by herpetologists to draw blood from snakes is venipuncture of the caudal vein (Gorzula et al. 1976). The methodology involves using a syringe to puncture the tail from the ventral side through to the vertebral column, whereupon the needle punctures the caudal vein and blood can be drawn. While some biologists have had success using this technique with relatively small snakes (e.g., Holycross and Douglas 2007), I found that the technique rarely worked in a study of *Crotalus pricei* (Twin-spotted Rattlesnakes), one of the smallest rattlesnakes. Not only did I typically fail to obtain blood, but the method involved an apparent risk of damage to the snake's hemipenes, hemipene retractor muscles, musk glands, and spinal cord. I did not observe any injuries caused by this method, but it is likely that harm to the animal would be subtle and go unnoticed.

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PHOTO BY B. WEISE

Fig. 1. With the snake tubed and in a vertical orientation with the head up, use a pair of cuticle clippers to make an incision on the side of the tail, revealing a blood vessel.

PHOTO BY D. PRIVAL



FIG. 2. This photo was taken one year after the lateral vessel puncture method was used. The incision site is indicated by the red oval.

PHOTO BY B. WEISE



FIG. 3. Puncture the blood vessel with a syringe and draw the drops of blood that form on the surface.

In order to obtain genetic material while mitigating the risks these techniques may present to the snake, I developed a new blood draw method that combines clipping scales and puncturing a blood vessel. First, orient the snake in a vertical or near-vertical position so that its head is elevated, causing blood to pool in the tail. This is easiest to achieve if the snake is tubed (Murphy 1971). The snake should remain in this position throughout the blood-drawing process. A pair of cuticle clippers and a small area on one side of the snake's tail should be cleaned with 70% isopropyl alcohol or another disinfectant. Then, create a skin flap on the cleaned side of the tail with the cuticle clippers (Fig. 1). A skin flap can be made by slightly angling the cuticle clippers to ensure that there is no skin between the lowest ends of the blades while there is skin between the upper ends. The incision should be about 2 mm wide and should extend from about 1 mm below the dorsal-ventral scale boundary up through the second dorsal scale row (Fig. 2). The incision should be made at the point where you can cover this entire area in a single clip. This point will be closer to the vent in smaller snakes and closer to the tail tip in larger snakes. Leave the skin flap attached on the dorsal side. Care must be taken to cut only the skin and not any underlying tissue.

Fold the skin flap up with a sterile syringe needle. This exposes a small blood vessel which is generally located near the dorsal-ventral interface line, but is embedded in muscle and can change position to be as much as two dorsal scales above that line or a bit below. This thin red blood vessel is clearly visible against the gray exposed tissue. Puncture the vessel with the syringe needle and then remove the needle. I use 25-gauge needles but other sizes may work equally well. If successful, drops of blood will form at the puncture site within 30 seconds. Draw each blood drop into the syringe and deposit it in a vial containing preservative (Fig. 3).

I have found that even a single drop of blood is sufficient for obtaining enough genetic material for analysis, but typically draw three to five drops of blood to ensure that there is plenty of material. When enough blood has been obtained, reorient the snake so that the tail is elevated, causing blood to flow toward the head. This often stops the bleeding if it has not stopped already. Fold the skin flap back over the wound with the syringe needle and use a paper towel or sterile pad to apply direct pressure to the wound until you are certain that bleeding has completely stopped. Direct pressure will usually stop any bleeding within 30 seconds, though occasionally several minutes of direct pressure may be needed. Finally, apply a skin sealant to the wound to help keep the skin flap in place and reduce the risk of infection. I use Skin Shield® Liquid Bandage (Del Pharmaceuticals, Inc., Uniondale, New York), but other skin sealants such as Vetbond™ Tissue Adhesive (3M, Saint Paul, Minnesota) should work as well.

Although DNA lysis buffer is typically recommended as the preferred field preservative for genetic samples (Burbrink and Castoe 2009), I recommend using 70–95% ethanol with this blood draw method. The blood drops from the punctured vessel usually form slowly and single drops of blood dry quickly in the syringe needle, so in most cases it is necessary to flush the blood out of the syringe with the preservative during the blood collection process. This leaves trace amounts of preservative on the syringe needle which could enter the snake's bloodstream. While many of us have found through personal experience that small amounts of ethanol do not have lasting negative effects, the chemicals in DNA lysis buffer may or may not be harmful.

I have attempted to use this lateral vessel puncture method to draw blood from 100 *Crotalus pricei*. Although there have been a few occasions when I was unable to get snakes to bleed, my success rate is 92%. I have successfully drawn blood from snakes ranging in size from 161 mm SVL, 3.5 g to 551 mm SVL, 126 g. This method is a bit easier to employ if one person holds the snake while the other draws the blood, but it is not difficult to conduct the entire operation alone in the field as long as all materials are ready and at hand.

The main advantage to the lateral vessel puncture method over the traditional caudal vein venipuncture method is that it can be used with small snakes in which the caudal vein is too narrow for success to be likely. An additional advantage is that all injuries can be observed clearly and mitigated with basic first aid techniques (elevation and direct pressure). The disadvantage is that in most cases only a few drops of blood can be collected before the snake stops bleeding. However, a few drops of blood should be sufficient for any genetic analysis.

The lateral vessel puncture method has proved to be successful with a small, terrestrial rattlesnake species and should work equally well for other terrestrial snake species. The method was especially successful with the smallest snakes, as blood was obtained during all attempts with snakes measuring 161–320 mm SVL (N = 22). Researchers studying snakes that are significantly

smaller than *Crotalus pricei* (e.g., *Tantilla*) may find this method useful. However, the method may prove to be less effective with arboreal species. Arboreal snakes can regulate the blood flow to their tails very effectively while in a vertical orientation, which may mean that less blood would be produced by a lateral vessel puncture (Lillywhite 1987).

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A Novel Protocol for Washing Environmental Microbes from Amphibian Skin

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A key derived feature of amphibians is their unique skin morphology, which includes a perpetually moist surface associated with mucous and granular (e.g., poison) glands (Duellman and Trueb 1986). The skin morphology of different amphibian species varies considerably (Heatwole and Barthalmus 1994), ranging from the highly toxic alkaloids sequestered onto the surface of dendrobatid frogs (Saporito et al. 2004) to the highly vascularized surface of the lungless plethodontid salamanders (Czopek 1962). Associated with this diversity of skin morphologies is an array of microorganisms, which when mutually beneficial, represent an important line of defense against pathogens (Belden and Harris 2007; Ramsey et al. 2010). The moist, thin, bare surface of amphibian skin allows gas exchange and is permeable to water (Heatwole and Barthalmus 1994), and therefore could be less effective at preventing pathogen transmission than the more impervious skin surfaces of other tetrapods. In addition, the skin of amphibians has been documented in the past to have a poor or non-existent cell-mediated and humoral immune response (Berger et al. 1998; Pessier et al. 1999; Woodhams et al. 2006). Recent evidence indicates that amphibians can acquire behavioral and immunological resistance to emerging fungal pathogens like *Batrachochytrium dendrobatidis* (McMahon et al. 2014). Amphibians have also developed an armory of potent antimicrobial peptides (Nicolas and Mor 1995; Simmaco et al. 1998; Rollins-Smith et al. 2002) that may somewhat compensate for their lack of scales, feathers, and hair. Evidence suggests

Table 1. Standardized washing protocol developed and tested in this study.

Protocol Step	Researcher #1 Description	Researcher #2 Description
Squirt bottle	Begin the protocol with clean nitrile or latex gloves. Hold the salamander while researcher #2 washes it.	Wash the salamander for 15 seconds (25 mL sterile ddH_2O) using a squirt bottle.
Wash bath #1	Change into fresh gloves at this time to prepare for transfer of the salamander into the second wash bath after the first wash is complete.	Place the salamander into a sterile 90 mm petri dish containing 25 mL sterile ddH_2O and swirl the plate in a circular motion for 30 seconds.
Wash bath #2	Wearing fresh gloves, place the salamander into a sterile 90 mm petri dish containing 25 mL sterile ddH_2O and swirl the plate in a circular motion for 30 seconds.	Change into fresh gloves at this time to prepare for transfer of the salamander into the third wash bath after the second wash is complete.
Wash bath #3	Change into fresh gloves at this time to prepare for swabbing of the salamander.	Wearing fresh gloves, place the salamander into a sterile 90 mm petri dish containing 25 mL sterile ddH_2O and swirl the plate in a circular motion for 30 seconds.
Swabbing	Hold the salamander while researcher #2 performs the swabbing technique.	Swab the salamander on the left, right, dorsal, and ventral sides for a total of 15 strokes from the head to the tip of the tail.
Storage	Store swabs at -20°C within one hour of being collected for lab specimens or in 99.9% acetone for field collections.	

that the cutaneous antimicrobial peptides and microbiota associated with amphibians may play a key role in maintaining amphibian health and mediating the effects of emerging infectious diseases, which have been implicated as a major cause of amphibian declines worldwide. For example, species-specific differences in both antimicrobial peptides (Rollins-Smith et al. 2002; Rollins-Smith 2009) and microbiota (Harris et al. 2009) are associated with susceptibility to *B. dendrobatidis*, the fungal pathogen responsible for amphibian population crashes in Australia, western North America, and the American tropics. Specifically, cutaneous microbiota and secreted antimicrobial peptides of amphibians can kill or inhibit the growth of *B. dendrobatidis* (Rollins-Smith and Conlon 2005; Harris et al. 2006; Brucker et al. 2008a; Brucker et al. 2008b; Becker et al. 2009; Harris et al. 2009). Therefore, a better understanding of amphibian microbial communities may increase our understanding of this devastating wildlife disease.

To date, studies on the skin microbiota of amphibians have been variable, with protocols differing substantially among studies. For example, the two most cited papers (Culp et al. 2007; Lauer et al. 2007) describing the methodology for removing environmental microbes prior to skin sampling and characterization of the resident microbial communities differ in methodology (e.g., the number of times each animal was washed and the volume of water used for each wash). However, these two protocols are often cited in a single study, and citing studies do not precisely follow the same protocols (McKenzie et al. 2012; Fitzpatrick and Allison 2014; Kueneman et al. 2014). A standardized washing protocol is necessary to allow for comparison of independent studies on the skin microbiota of amphibians.

Any conclusions regarding resident symbionts depend on the ability of the researcher to separate environmental microbiota from strict host/symbiont associations. To contribute to the study of amphibian skin microbiota, we set out to develop a standardized sampling protocol for biologists studying this topic. We conducted identical protocols using plethodontid salamanders in both the laboratory and the field, to ensure that this protocol can be used in both settings. Moreover, we used an experimental approach to determine if our washing protocol worked. We used a plate-based assay to count colony-forming units to show a sequential reduction of cultureable bacteria in our four-step protocol and molecular confirmation using PCR to show resident microbial community presence after the decontamination protocol. Here, we present evidence for our ability to retrieve microbial communities from amphibian skin after washing off transient environmental microbes.

Materials and Methods

Study species.—Red-backed Salamanders (*Plethodon cinereus*; N = 23) were collected at Jolliffe Nursery in Wetzel Co., West Virginia, USA (39.657°N, 80.555°W), on 20 December 2013. Red-backed Salamanders were kept individually in microcosms (40 × 25 × 18 cm) on natural soil substrate (depth = 10 cm), misted daily with water, and maintained at 21.5°C on a 12 h dark: 12 h light cycle in the laboratory (as a component of another research project). After 12 weeks salamanders were subjected to the washing protocol described below. The washing protocol was also field tested on Northern Gray-cheeked Salamanders (*Plethodon montanus*; N = 6) in Nantahala National Forest (35.700°N, 082.399°W), North Carolina, USA. Northern Gray-cheeked Salamanders were collected by hand from beneath logs on 12 May 2014, stored with moist substrate in plastic ziplock bags, and subjected to the washing protocol within 8 h of collection.

Washing protocol.—This procedure required two researchers beginning the protocol with clean nitrile or latex gloves and is outlined in Table 1. Researcher #1 held the amphibian while

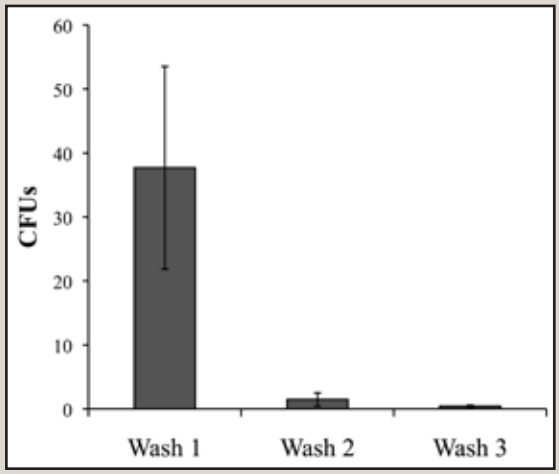


FIG. 1. Colony forming units (CFUs) for three sequential washes of Red-backed Salamanders (*Plethodon cinereus*). Mean (± 1 S.E.) CFUs.



FIG. 2. Gel electrophoresis of laboratory-tested Red-backed Salamander (*Plethodon cinereus*) skin swabs (lanes 1–10) and negative controls (–a, –b).



FIG. 3. Gel electrophoresis of field-tested Northern Gray-cheeked Salamanders (*Plethodon montanus*) skin swabs (lanes 1–6) and negative control (lane –a).

researcher #2 washed the animal for 15 sec (25 ml sterile ddH_2O) with a squirt bottle. The animal was then placed into a sterile 90 mm Petri dish with 25 ml sterile ddH_2O and gently swirled in a circular motion for 30 sec. With a new set of gloves researcher #1 picked up the animal and carried out two additional (sequential) Petri dish washes repeating the aforementioned steps. The squirt bottle was only used once at the beginning of the protocol. With a fresh set of gloves, researcher #1 then picked up the animal while researcher #2 swabbed it 15 times on the right, left, dorsal, and ventral sides of the salamander. A total 15 strokes with the swab was performed from the head to tail tip of each salamander. Swabs were stored at -20°C within one hour of being collected (Red-backed Salamanders) or stored in 99.9% acetone (Fukatsu 1999) for field collections (Northern Gray-cheeked Salamanders); differences in storage conditions allowed assessment of the feasibility of field *vs* lab-based applications of this protocol.

Plate-based assay.—An aliquot of the Petri dish water from the three sequential salamander washes was sampled using a plate-based method by quantifying bacterial colony forming units (CFUs). Specifically, 150 µl of wash water was transferred to a 90 mm Tryptic Soy Agar (Fisher Scientific) plate and spread across the surface of the medium using a glass L-shaped rod. Plates were then inverted and incubated for 48 h at 32°C. CFUs were counted and recorded for each of the three sequential washes. To evaluate whether our washing protocol reduced the quantity of bacteria on the salamander's skin we performed a repeated measures ANOVA on ln-transformed CFUs using JMP Pro 9.0.0.

Molecular methods.—To confirm the presence of resident microbial communities a subset of the salamanders (N = 10, *P. cinereus*; N = 6, *P. montanus*) subjected to the washing protocol were swabbed with a sterile cotton swab autoclaved for two hours (Gefrides et al. 2010) and DNA extracted with the Qiagen DNA Micro Kit according to the manufacturers protocol for isolating genomic DNA from small volumes of blood. The following alterations were made to the DNA extraction protocol: extraction was performed directly from the swab after an incubation period of 7 h (with proteinase K - step 5 of protocol). PCR conditions were as follows for a 25 µl reaction: 12.5 µl New England Biolabs Taq 2X Master Mix, 1 µl (10 µM) forward primer 515F, 1 µl (10 µM) reverse primer 806R (Caporaso et al. 2011), 5 µl DNA, 5.5 µl sterile ddH_2O. Electrophoresis was performed in a 1% agarose gel at 140 volts for 40 min. Five µl of each PCR reaction was added to each well. PCR amplicon fluorescence was interpreted as the presence of resident microbial communities from the salamander skin.

RESULTS

There was a significant reduction in the amount of environmental bacteria (CFUs) with washing ($F_{1,45} = 34.89$; $P < 0.0001$; Fig. 1). DNA extraction, PCR, and gel electrophoresis of both field and lab tested skin swabs indicated the presence of PCR amplicons targeting resident bacterial communities on the skin of these salamanders (Figs. 2– 3). For *P. cinereus*, 9 of 10 skin swabs showed PCR amplicons (Fig. 2), whereas for *P. montanus* 4 of 6 skin swabs had dull PCR amplicons (Fig. 3).

DISCUSSION

This study successfully demonstrates and tests a new standardized protocol for removing environmental microbes for studies on resident microbes composing the amphibian microbiome. We show that successive washes with sterile ddH_2O significantly reduce the amount of CFUs and also that PCR amplifiable microbial DNA is present upon concluding the protocol from salamanders in both the field and the laboratory. Field and laboratory experiments revealed similar results, confirming that our methods can be made portable for biodiversity inventories. Presumably, since no significant change was detected after the third wash in either laboratory maintained or field-collected salamanders, only the endemic microbiota associated with the salamander is sampled after our protocol. This technique is similar to previous studies that showed similar results (Lauer et al. 2007). This protocol will help standardize wash time, water volume, and researcher technique, all of which are critical in the removal of environmental microbes from amphibian skin. Adopting a standardized protocol amongst labs will be imperative for direct comparison of future studies on the amphibian microbiome.

TABLE 2. Comparison of washing protocols.

	Study species	Number of washes	Total wash time (sec)	Total wash water volume (ml)	Type of wash	Swabbing protocol
This study	*Plethodon cinereus* *Plethodon montanus* *Notophthalamus viridescens* *Lithobates catesbeianus*	4	105	100	sterile ddH_2O	15 swab strokes from head to tail on the right, left, dorsal, and ventral sides
Culp et al. 2007	*Plethodon cinereus*	3	90	60	sterile ddH_2O	Dorsal and ventral sides swabbed; number of strokes unreported
Lauer et al. 2007	*Plethodon cinereus*	2	Not reported	50	sterile dechlorinated H_2O	10 swab strokes on lateral and ventral sides
McKenzie et al. 2012	*Lithobates pipiens* *Pseudacris triseriata* *Ambystoma tigrinum*	3	Not reported	300	sterile H_2O	Swab brushed over entire amphibian for 30 sec
Fitzpatrick & Allison 2014	*Plethodon jordani*	1	Not reported	50	sterile dechlorinated H_2O	10 swab strokes on lateral and ventral sides
Kueneman et al. 2014	*Anaxyrus boreas* *Pseudacris regilla* *Taricha torosa* *Lithobates catesbeianus* *Rana cascadae*	2	Not reported	100	sterile H_2O	Swab brushed over ventral surface and limbs for 30 sec
Walke et al. 2014	*Lithobates catesbeianus* *Notophthalmus viridescens*	2	Not reported	Not reported	sterile dechlorinated H_2O	10 swab strokes along the ventral and 5 strokes along each dorsal/lateral sides

We acknowledge that a plate-based assay is a limitation of this study since it only quantifies microbes capable of growing on synthetic medium at 32°C. In addition, gel electrophoresis of PCR amplicons from salamander skin swabs was used to confirm the presence of skin symbionts. It could be argued that these microbes are environmental in origin. However, based on past research by Culp et al. (2007), Lauer et al. (2007), and the plate-based assay results in this study, we conclude that environmental microbes were successfully removed and the PCR amplicons are representative of skin symbionts of *P. cinereus* and *P. montanus*. We also acknowledge the limitations placed on this washing protocol by the size of the amphibian; studies on larger amphibians will be restricted by Petri dish size. This protocol was designed for small to medium amphibians (< 150 mm length × < 15 mm height) and should prove useful for studies of many similar-sized amphibian species worldwide.

Previous studies have reduced cutaneous microbiota using broad-spectrum antibiotics and/or hydrogen peroxide in salamanders and fish (Lumsden et al. 1998; Russo et al. 2007; Becker and Harris 2010). Our study suggested that these extreme measures might not be necessary to remove environmental microbes. We hypothesize that a volume of 50 ml of sterile water is sufficient to remove the vast majority of environmental microbes, similar to that used in previous studies (60 ml ddH_2O in Culp et al. 2007; 50 ml ddH_2O in Lauer et al. 2007). If this is the case, then results based on next-generation sequencing studies using variations on these washing protocols are likely accurate in the characterization of the amphibian skin microbiome (McKenzie et al. 2012; Fitzpatrick and Allison 2014; Kueneman et al. 2014; Walke et al. 2014).

The need for standardization of such protocols has arisen due to the precarious health of world amphibian populations. This is due in part to emerging infectious pathogens such as *B. dendrobatidis* and the newly discovered *B. salamandrivorans*, which has caused population crashes of salamanders in Europe and has the potential to cause worldwide declines if it spreads to North America and Asia (Martel et al. 2013). Since the associated microbiota of amphibians can be considered an important component of the amphibian immune response, studies focusing on intra- and interspecific differences in microbiota components and diversity are needed to better understand interactions between the skin of amphibians and pathogens. In the future such studies are capable of becoming exceedingly sophisticated with the advent of next-generation sequencing and bioinformatics approaches. However, a necessary first step is a clean sample. We recommend standardization of protocols as studies proceed. This protocol provides researchers with a viable and experimentally tested washing protocol to remove environmental bacteria from the skin of small to medium sized amphibians.

Acknowledgments.—Salamanders were collected under permit numbers: CHE901200, 14-SC00873. DMW would like to thank Nancy Jolliffe and Bob Schlegel at Jolliffe Nursery at Knob Creek for allowing this research project to take place on their property, and Benjamin Bennett for coordinating the research efforts. DMW would also like to thank the students from his Introduction to Research classes (2013–2015) at The University of Findlay for their contribution to this project and Adam E. Rakestraw, Natalie E. Rakestraw, and Madelyn R. Rakestraw for aiding in the collection of numerous specimens. The University of Findlay's institutional research policies and guidelines for the ethical treatment of animals were followed during this study.

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AMPHIBIAN AND REPTILE DISEASES

This section offers a timely outlet for streamlined presentation of research exploring the geographic distribution, host range, and impact of emerging amphibian and reptile pathogens, especially fungal infections and ranaviruses. Amphibian chytrid fungi, *Batrachochytrium dendrobatidis* and *B. salamandrivorans* are both linked to amphibian mass mortality episodes, yet both have also been detected in amphibians without disease. Snake fungal infections in snakes and turtles are not well known, but are being detected more frequently in the last few years and may be primary or secondary infections leading to local losses. Ranaviruses also cause mass mortality, infecting both amphibians and reptiles, but have not yet been linked to large-scale declines. For each of these pathogens, we know relatively little about the global distribution, host range, or impacts on host populations. To improve our understanding of the scope of this issue, we encourage submission of studies that illuminate the geographic distribution, host ranges, and impact of these pathogens on amphibian and reptile populations, including research on individual species or groups of species, wild or captive animals, native or non-native species, live animals or museum specimens, environmental samples, and, provided there is sufficient sampling[1], reports of non-detections.

We ask authors to: 1) restrict the Introduction of their paper to a maximum of one paragraph to highlight the context of their study; 2) briefly include both field and laboratory Methods; 3) present Results in a Table, although a map might also be useful, and limited text; and 4) have a short discussion of a maximum of three paragraphs to touch upon key findings. Please include the following information in submissions as appropriate: coordinates and description of sampling areas (or please note if locations are extremely sensitive to reveal, and provide general area instead); species name(s) and life history stages examined, as well as other species present; whether samples were collected randomly or just from dead or moribund animals; date of specimen collection; evidence of unusual mortality; numbers of positive and negative samples; disposition of voucher specimens; name of collaborative laboratory or researcher conducting histological sections or PCR analyses; and names of cooperative land owners or land management agencies. We encourage researchers to conduct post-mortem examinations when possible to identify the cause of death when reporting mortalities. We aim to expedite the review and publication process! Please e-mail submissions directly to Associate Editor, Dr. Dede Olson.

Upon publication, we encourage authors to import their data to online disease reporting portals for rapid communication with researchers and natural resource managers. The Global Bd Mapping Project is available at: Bd-maps.net. The Global Ranavirus Reporting System is available at: https://mantle.io/grrs. The Bsal online portal is under construction at AmphibiaWeb.org.

[1]If a sample of 30 individuals of a particular life history stage of a particular species yields no positive results, and the diagnostic test is highly sensitive, one can conclude that the prevalence of infection is less than 10% with 95% confidence. With a sample of 10 an infection in one of four individuals could go undetected. We encourage researchers to collect sufficient samples so that negative results are meaningful.

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First Report of *Batrachochytrium dendrobatidis* in *Atelognathus reverberii*, a Threatened Species in Argentina

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Patagonia and other Andean regions of Argentina have many species of conservation concern because of local endemism or restricted regional distribution, and several threat factors including habitat alteration, chemical contamination, invasive species, and emerging diseases (Vaira et al. 2012). Since the first report of *Batrachochytrium dendrobatidis* (*Bd*) in Argentina in 2002, the pathogenic fungus has been reported in 14 of 23 provinces of the country, infecting numerous amphibian species in diverse environments (Herrera et al. 2005; Barrionuevo and Mangione 2006; Fox et al. 2006; Arellano et al. 2009; Ghirardi et al. 2009, 2012, 2014; Gutierrez et al. 2010; Delgado et al. 2012; Lescano et al. 2013). Many of these reports have addressed infection of endangered species inhabiting Andean regions, such as *Telmatobius atacamensis* and *T. pisanoi* in the northern Andes (Barrionuevo and Magione 2006) or *Alsodes pehuenche* and



FIG. 1. Study site on the Somuncurá Plateau (A) and the Laguna Azul (blue circle), Argentina. Collection site of *Atelognathus reverberii* individuals (star) on the banks of the Laguna Azul (B).

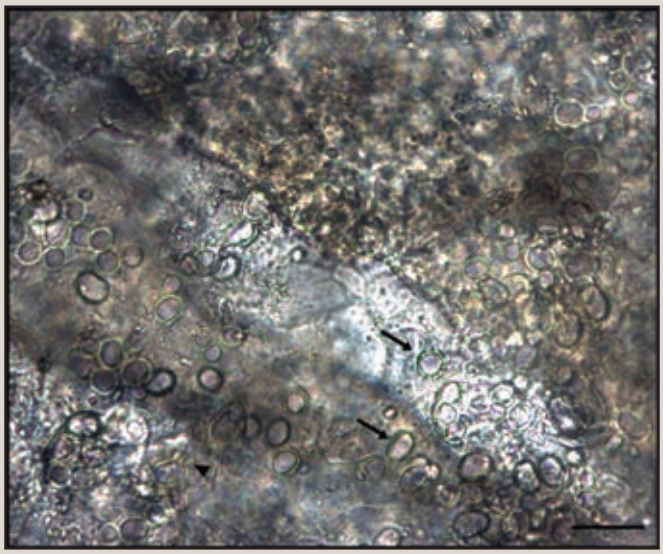


FIG. 2. Fresh skin surface (without stain) from the hind limbs of *Atelognathus reverberii* infected with *Batrachochytrium dendrobatidis* (400×) in Argentina. Arrows indicate zoosporangia and arrowhead a discharge tube. Scale bar = 20 µm.

Atelognathus patagonicus in the southern Andes (Fox et al. 2006; Ghirardi et al. 2014), with mortality recorded in the last species.

The Laguna Raimunda Frog, *Atelognathus reverberii* (Cei 1969), is an endemic species of conservation concern associated with permanent and temporary lagoons between 920 and 1200 m elevation in the Provinces of Chubut and Rio Negro (Cei 1969; Martinazzo et al. 2011). This frog, which has a fragmented distribution within its 500 km^2 range (Úbeda et al. 2004), is classified as Vulnerable in Argentina (Vaira et al. 2012) and is listed as Endangered by the IUCN Red List (Úbeda et al. 2004). The reproductive biology of the species is unknown, yet a relatively low reproductive potential is supported (Vaira et al. 2012). These attributes suggest that *A. reverberii* may be highly vulnerable to *Bd*-related population declines (see Bielby et al. 2008). Herein we provide the first report of the presence of *Bd* in *A. reverberii*, and associated mortality supporting a disease threat for this rare species.

In January 2015, during a field survey of this species in the Somuncurá Plateau, a Natural Protected Area of Río Negro Province, Argentina (41.288738°S, 66.831912°W; 1182 m elev.; Fig. 1), we found 11 dead *A. reverberii* individuals within a 0.6-m diameter and 1.5-m deep pit, holding 30-cm water in the bottom. These water pits, locally named "jagüeles," are dug by local residents near water bodies to obtain water for human and cattle consumption. The dead frogs were collected using latex rubber gloves (which were changed between specimens), and fixed in a solution of 10% formaldehyde. We analyzed shed skin from the hind limbs of all fixed individuals through direct examination without stain, under a compound optical microscope at 400× magnification. Specimens were deposited at the Colección Herpetológica del Museo de La Plata, Argentina (MLP A 5758–A 5768).

All dead individuals had excessive shed skin, which is one of the clinical signs of chytridiomycosis. We detected *Bd* zoosporangia in 100% (N = 11) of the shed skin samples analyzed (Fig. 2). Samples were compared with previous *Bd*-infected shed skin (Arellano, unpubl. data), some of which belonged to frogs in controlled *Bd* experimental infections with very high zoospore treatment doses (6×10^4 zoospore/ml). Due to the comparability of zoospore densities between these new and experimental skin samples, the natural infection of *A. reverberii* appeared to be very high. Based on previous studies of *Bd* in Argentina (Fox et al. 2006; Ghirardi et al. 2014; Bd-maps.net, accessed 2 June 2015), our detection of infection in *A. reverberii* is the southernmost record of *Bd* in this area of the central Patagonian steppe, and is near to the known southernmost extent of *Bd* in South America (in Chile, 43.78°S; Bourke et al. 2011).

In March 2015, we revisited the study area and found a high density of *A. reverberii* individuals (>100) hiding under rocks at the edge of Laguna Azul (the highest wetland of the area). A great number of individuals (~50%) were observed in a very weakened state and another ~10% were dead under the rocks, although these samples were not analyzed (Fig. 3).

The fact that we found dead and very weak individuals during the survey, added to the excessive shed skin seen in all the individuals, is very worrying, since this frog is potentially vulnerable to losses (Bielby et al. 2008) and is currently affected by several human-related activities. Other amphibian species on the Plateau, including *Pleurodema somuncuriensis*, an aquatic frog recently reported with *Bd* infection (Kacoliris, pers. comm.), are also listed as critically endangered (IUCN) (Úbeda and Lavilla 2004). Because many Argentinian regions remain unsurveyed for *Bd* and there are many endemic species or species with restricted distributions that are of significant concern (Vaira et al. 2012), much more extensive *Bd* sampling focused on these species is warranted to set priorities for future conservation actions.



FIG. 3. *Atelognathus reverberii* in Argentina. Appearance of a normal (left) and weakened (right) individual.

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First Report of Ranavirus and *Batrachochytrium dendrobatidis* in Green Salamanders (*Aneides aeneus*) from Virginia, USA

The Green Salamander (*Aneides aeneus*) is distributed from extreme southwest Pennsylvania, USA to northern Alabama and Mississippi with a disjunct population in southern North Carolina, northeastern Georgia, and northern South Carolina (Petranka 1998). Because of unique habitat requirements, Green Salamanders are thought to be at risk of range-wide declines and extirpations (Corser 2001). Green Salamanders primarily dwell in rock crevices within rock outcrops (Gordon 1952; Rossell et al. 2009). Like its western congeners, Green Salamanders also inhabit arboreal habitats (Petranka 1998; Waldron and Humphries 2005) as well as decaying logs and stumps on the forest floor (Fowler 1947).

Green Salamander populations, especially those in the disjunct Carolina populations, have experienced declines and extirpations (Snyder 1991; Corser 2001). From the 1970s to 1980s local extirpations occurred in once-abundant North Carolina populations (Snyder 1991), and since the 1980s reductions of up to 98% have occurred in remaining populations (Corser 2001). One of the most-studied Blue Ridge escarpment populations was located at Biscuit Rock (Highlands, North Carolina; Gordon 1952; Snyder 1991; Corser 2001), and in the past five years this population became extirpated without a definitive cause (Lori Williams, unpubl. data). Various hypotheses have been proposed for Green Salamander declines such as disease and loss of surrounding timber (Snyder 1991; Petranka 1998; Corser 2001). Diseases are one of the leading causes of worldwide amphibian declines (Stuart et al. 2004; Young et al. 2004; Sodhi et al. 2008). Currently the Green Salamander is listed as threatened or endangered in Indiana, Maryland, Mississippi, North Carolina, Ohio, and Pennsylvania (MDNR 2005; MMNS 2005; PGCPBFC 2005; IDNR 2006; NCWRC 2014; ODNR 2014) and as a species of greatest conservation need in all other inhabited states (GDNR 2005; SCDNR 2005; TWRA 2005; VDGIF 2005; WFFDADCNR 2005; WVDNR 2005; KDFWR 2013). However, the potential impact of diseases on Green Salamanders is unknown, especially in Virginia.

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Diseases caused by ranaviruses are responsible for amphibian die-offs throughout Europe and North America, including the southeastern United States (Green et al. 2002; Miller et al. 2011; Hoverman et al. 2012), and may contribute to population declines (Gray et al. 2009a). In the southern Appalachian Mountains, ranavirus infections have been reported in 18 species of plethodontid salamanders, but Green Salamanders have not been sampled (Miller et al. 2011; Hamed et al. 2013). Overall ranavirus prevalence in plethodontid salamanders has varied from 3–81% throughout the southern Appalachian Mountains (Gray et al. 2009b; Hamed et al. 2013) with salamanders from the genus *Desmognathus* having highest individual prevalence (Sutton et al. 2014). Only a single past study has sampled plethodontid salamanders for ranavirus within the Virginia portion of the Green Salamander's range (Wise Co.; Davidson and Chambers 2011a); overall ranavirus prevalence in this study was 33%, although Green Salamanders were not sampled.

Chytridiomycosis, the disease caused by *Batrachochytrium dendrobatidis* (*Bd*), has also been responsible for numerous amphibian declines and extirpations worldwide, especially in Central American anurans (Lips et al. 2006; Lötters et al. 2009). Infection rates of *Bd* vary throughout the southeastern U.S., with 17 species of plethodontid salamanders testing positive for *Bd* in past studies, and an additional 23 species not infected (Hughey et al. 2014). However, *Bd* is thought to have played a role in the declines of plethodontid salamanders in Central America and has been shown to be lethal to plethodontid salamanders in the western United States (Lips et al. 2006; Weinstein 2009; Cheng et al. 2011). Only a single prior study with a limited sampled size (N = 3) has surveyed Green Salamanders for *Bd*, with no positive results (Hill et al. 2011). Our goal was to determine ranavirus and *Bd* prevalence in Green Salamander populations from southwest Virginia.

To determine the potential impact of ranaviruses and *Bd*, we sampled Green Salamanders from known historic locations as well as new locations with ideal habitat in southwestern Virginia (Dickenson, Scott, Washington, and Wise counties; Fig. 1; VDGIF 2014) and tested them for infection by these pathogens. Multiple observers searched rock crevices and surrounding trees and mid-story vegetation for Green Salamanders from May–August 2013. We also used burlap bands at three sites to intercept Green Salamanders climbing trees (Thigpen et al. 2010), but burlap proved to be ineffective due to repetitive damage from mammals, presumed to be Black Bears (*Ursus americanus*). Once located, we captured Green Salamanders by hand, while wearing nitrile gloves (Fisher Scientific, Pittsburg, Pennsylvania USA), and placed salamanders in individual 1.2-liter plastic bags, where they remained throughout processing and until released. We measured both snout–vent length (SVL) and total length (TL) using dial calipers to assess life stage (adult, subadult, juvenile; Waldron and Humphries 2005). To sample for ranavirus (N = 38), we followed procedures of Hamed et al. (2013) and used sterilized stainless steel forceps to collect a small tail section

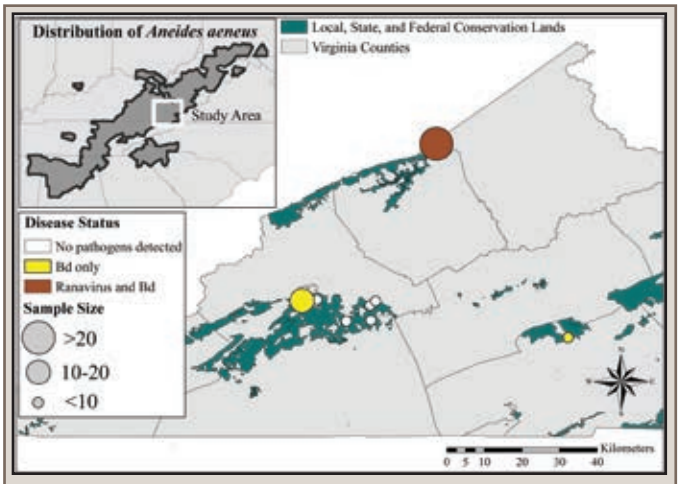


FIG. 1. Distribution of sampling sites and presence of ranavirus and *Batrachochytrium dendrobatidis* (Bd) for *Aneides aeneus* across four counties in southwest Virginia, USA. The diameter of the symbol for each sampling locality is proportional to the sample size at each site. Inset map indicates U.S. states and location of study area (white box) relative to the distribution of *A. aeneus* (dark gray).

from a natural break point. Each sample was placed in a sterile, 2-ml microcentrifuge tube with 99% reagent grade isopropyl alcohol. We did not sample for ranavirus if a salamander had tail damage, and we also excluded female salamanders guarding eggs. To sample for *Bd* infection (N = 41), we swabbed each Green Salamander with a Dryswab™ with wire shaft and rayon bud swab (MW&E, England). First, we swabbed each flank 5 times, then the ventral surface 10 times, and finally the bottom of each foot 5 times (Chatfield et al. 2012). Swab tips were placed in separate microcentrifuge tubes with 99% reagent grade isopropyl alcohol. We released all salamanders at their original location of capture. Bags and gloves were changed and forceps autoclaved after each use.

Genomic DNA was extracted from tail samples and swabs using Qiagen DNeasy Blood and Tissue Kits (Qiagen Inc., Valencia, California, USA) and then quantified utilizing a Qubit™ fluorometer (Life Technologies Corp., Carlsbad, California, USA). We used quantitative real-time PCR (qPCR) utilizing an ABI 7900HT PCR system (Life Technologies Corp.). For ranavirus testing, we used identical primers and protocol of Gray et al. (2012) and ran samples in duplicate. We utilized two positive (cultured virus and DNA from a confirmed positive animal) and two negative (water and DNA from a known negative animal) controls. We deemed samples to be positive if C_T value ≤ 30, based on a 95% confidence interval that we derived from a standard curve originating from runs with known concentrations of virus (Caraguel et al. 2011). For *Bd* testing, we also used qPCR following the procedure and primers of Boyle et al. (2004) and ran samples in duplicate. We repeated analysis if C_T values differed by more than 1 C_T value. We used two positive (DNA from a *Bd* culture and DNA from a confirmed positive animal) and two negative (water and DNA from a known negative animal) controls. We considered samples to be positive for *Bd* infection if C_T value ≤ 35, which was similarly based on a 95% confidence interval derived from a standard curve (Caraguel et al. 2011). All DNA extraction and PCR testing was conducted in the Center for Wildlife Health at the University of Tennessee. We established 95% confidence intervals (CIs) for prevalence using Lowry (2014) 2-sided CIs from a single proportion.

Our survey is the first known to document ranavirus and *Bd* infections in Green Salamanders (Miller et al. 2011; Hughey et al. 2014). We did not observe co-occurrence of pathogens in a single individual, but we did within the same site (Breaks Interstate Park; Fig. 1). We sampled a total of 42 Green Salamanders (21 adults, 15 subadults, and 6 juveniles), but due to tail damage, escape, or females guarding eggs we did not collect a tail sample or swab from every individual. We sampled 38 Green Salamanders for ranavirus, and salamanders averaged 41.22 ± 1.90 (mean ± SE) mm in SVL. Ranavirus prevalence was 8% (3/38), and no salamanders testing positive for ranavirus displayed external signs of infections (Table 1; Miller et al. 2011). Only one Green Salamander testing positive for ranavirus was an adult (50 mm SVL) while the remaining two salamanders were both subadults (40 mm SVL each). Green Salamanders infected with ranavirus were collected only from the Breaks Interstate Park (Dickenson Co.; Fig. 1), which had the greatest number of Green Salamanders encountered during the survey.

We swabbed 41 Green Salamanders for *Bd*, and salamanders averaged 42.70 ± 1.89 mm SVL. We detected *Bd* in 6 of 41 (15%) sampled Green Salamanders (Table 1). Two Green Salamanders infected with *Bd* were adults (52 and 57 mm SVL), whereas the other four were subadults (32–42 mm SVL). Only one salamander that tested positive for *Bd* displayed external signs of illness (e.g., emaciation). However, another Green Salamander was thin but not emaciated and did not test positive for either pathogen. Plethodontid salamanders from Mexico that were *Bd*-positive also lacked clinical external signs, thus suggesting positive salamanders do not always exhibit external signs of disease (Rooij et al. 2011). Green Salamanders infected with *Bd* were collected from Breaks Interstate Park (N = 4), Flag Rock (N = 1; Wise Co.), and Brumley Cove Camp (N = 1; Washington Co; Table 1; Fig. 1).

Due to the cryptic behavior of Green Salamanders and the presence of nesting females, we were only able to sample a single individual at six locations and are therefore cautious about inferring the potential disease status of these populations. However, two locations (Breaks Interstate Park, N = 22; Flag Rock, N = 13) provided a sufficient sample size to evaluate disease status. Only the Breaks Interstate Park had ranavirus-positive individuals, and this location was much lower in elevation (553 m) than Flag Rock (983 m), where no Green Salamanders tested positive for ranavirus. A similar trend was observed in the Great Smoky Mountains National Park where ranavirus prevalence was greater in salamander communities at lower elevation sites (Gray et al. 2009b; Sutton et al. 2014). However, our two sites were separated by almost 50 km and could have been influenced by other factors, including variation in temperature and moisture that have also been linked with ranavirus prevalence (Sutton et al. 2014). The Breaks Interstate Park also had the highest prevalence for *Bd*. A seep and subsequent stream were adjacent to three rock crevices at the Breaks Interstate Park. Both ranavirus and *Bd* are associated with streams and aquatic environments (Lips et al. 2006; Sutton et al. 2014).

Green Salamanders are not typically associated with aquatic habitats, but other hosts (i.e., those associated with aquatic habitats) may be transmitting one or both of these pathogens. For example, ranavirus has been demonstrated to be transmitted by an infected individual to an uninfected individual following a short contact time (Brunner et al. 2007). Also, *Bd* can be passed via water containing zoospores (Carey et al. 2006) and can survive for up to three months in river sands, thus suggesting moist rock ledges could harbor *Bd* (Johnson and Speare 2005). Brumley

TABLE 1. Ranavirus and *Batrachochytrium dendrobatidis* (*Bd*) prevalence in Green Salamanders (*Aneides aeneus*) from Southwest Virginia, USA, May–August 2013. I = total number of infected individuals; N = total number sampled.

Location	*Bd* I / N	Prevalence (95% CI)	Ranavirus I / N	Prevalence (95% CI)
Breaks Interstate Park (37.2947°N; 82.4505°W)	4 / 22	0.18 (0.07–0.39)	3 / 22	0.14 (0.05–0.33)
Flag Rock (36.9194°N; 82.6268°W)	1 / 13	0.08 (0.01–0.33)	0 / 14	0 (0–0.22)
Brumley Cove Camp (36.8315°N; 81.9901°W)	1 / 1	1.00 (0.21–1.00)	—	—
Clear Creek Gorge (36.9217°N; 82.5908°W)	0 / 1	0 (0–0.79)	0 / 1	0 (0–0.79)
Guest River Gorge (36.9183°N; 82.4505°W)	0 / 1	0 (0–0.79)	—	—
Jaybird Branch (36.9081°N; 82.4638°W)	0 / 1	0 (0–0.79)	0 / 1	0 (0–0.79)
Kitchen Rock (36.8703°N; 82.5208°W)	0 / 1	0 (0–0.79)	—	—
Little Stony Gorge (36.8726°N; 82.4623°W)	0 / 1	0 (0–0.79)	—	—
Total	6 / 41	0.15 (0.07–0.28)	3 / 38	0.08 (0.03–0.27)

Cove Camp had a *Bd*-positive individual and a large stream (Brumley Creek) that drains a reservoir (Hidden Valley Lake) is within a few meters of the rock face. We observed *Desmognathus ochrophaeus* (Alleghany Mountain Dusky Salamander) on the Brumley Cove Camp rock faces. In southwest Virginia, two sister species, *D. ochrophaeus* and *D. orestes* (Blue Ridge Dusky Salamander), have tested positive for ranavirus (Davidson and Chambers 2011a; Hamed et al. 2013) and the former also has tested positive for *Bd* (Davidson and Chambers 2011b). Thus, it is possible that salamanders of the genus *Desmognathus* could be moving both ranavirus and *Bd* out of aquatic systems to rock crevices. Flag Rock had no flowing or standing water, and only a single salamander tested positive for *Bd*, with no ranavirus infections.

The only observation of negative pathogen impacts was the emaciated Green Salamander that tested positive for *Bd* infection. We did not collect tissue samples for histological examination, but the animal was also lethargic. Anurans with *Bd* infections are often emaciated, with symptoms persisting for 2–3 months after clearing *Bd* infections (Parker et al. 2002). However, emaciation does not always imply a *Bd* infection, as anurans with parasite infections often appear emaciated (Young et al. 2012). We are cautious in assigning the condition of this salamander to *Bd* without histological evidence, but our results warrant further sampling, including histological examination and surveys for visibly infected or dead Green Salamanders.

Our finding of both ranavirus and *Bd* in Green Salamanders for the first time suggests that both pathogens could impact Green Salamander populations. Due to the conservation status of Green Salamanders throughout their range, our findings support implementation of range-wide monitoring. These results also confirm that Green Salamanders can be infected by either or both pathogens, suggesting that past declines could have been influenced by pathogens. Ranavirus prevalence has been shown to increase in drought years (Gray et al. 2009b; Sutton et al. 2014), and thus future long-term monitoring is warranted at yearly intervals to detect possible infection trends, especially on dry rock outcrops. Lastly, on rock faces where other amphibians are utilizing the same rock ledges or those in close proximity to known Green Salamander crevices, a broader sampling effort would determine if other amphibians are potentially spreading ranavirus and/or *Bd* from aquatic environments to rock faces inhabited by Green Salamanders.

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A Report of Ranavirus Infecting Midland Painted Turtles with Novel Localities for Frog Infection in Northwest Ohio

Amphibian die-offs attributed to ranaviruses (genus *Ranavirus*, Family Iridoviridae) continue to be reported from around the world (Gray et al. 2009; Duffus et al. 2015), and constitute one of the single most important factors in mass mortalities in the United States in recent years (Green et al. 2002). Continued reporting is important as it affords an opportunity to monitor the spread and distribution of the pathogen (Muths et al. 2006), identify affected species (Duffus et al. 2015), potentially compare viral genomes (e.g., Tan et al. 2004), and study the long-term effects of viral infections on host survival in local populations (Gray et al. 2009).

In September 2011, during the third year of a routine, biweekly sampling of frogs at a five-year old, 1-ha, mitigated wetland named Spurgat's Wetland in Hancock County in northwest Ohio, USA (40.9905°N, 83.7596°W), dozens of tadpoles and recently metamorphosed American Bullfrogs (*Lithobates catesbeianus*) were found dead or moribund at the water's edge. Most exhibited edema, diffuse petechial lesions, and bloating, which are signs of ranavirus documented in Wood Frogs (*Lithobates sylvaticus*) by Brunner et al. (2011). Over the next four weeks (September through November 2011), we surveyed for dead or moribund frogs on six different occasions, during which we collected three dead Bluegill fishes (*Lepomis macrochirus*), two Midland Painted Turtles (*Chrysemys picta marginata*), and 139 dead or moribund tadpoles, recently transformed larvae, or adult frogs, all ≤ 55 mm snout–vent length that were either *Lithobates catesbeianus* or *L. clamitans* (Table 1).

Whole dead or moribund frogs were collected and transported in sterile, plastic bags to the laboratory for both gross examination and genetic testing for the presence of ranavirus (Table 1). Liver samples (~ 5 mm in diameter) were taken from 13 whole frog specimens and immediately frozen at -20°C for use in molecular analysis before the whole specimen was fixed in formalin. All tools used for liver sample collection were rinsed between each specimen in 50% bleach solution for 20 minutes and thoroughly rinsed in sterile distilled water. The life stage of whole frog specimens was determined as described by (Gosner 1960) and physical signs of disease were noted. Skin swab samples were collected using sterile, single use, cotton-tipped transport swabs with a plastic shaft. Skin swab samples were transported on wet ice to the laboratory where DNA extraction was performed.

DNA was extracted from both liver and skin swab samples for molecular analysis using DNeasy Blood and Tissue Kit (Qiagen, Valencia, California) following the manufacturer's protocol. Extracted DNA was used to perform conventional PCR of two targets in the major capsid protein (MCP) gene using previously published gene specific primers, including: MCP1, MCP6R, M153, and M154 (Hyatt el al. 2000, Marsh et al. 2002). Each PCR reaction was carried out using established methodology (Hyatt el al. 2000, Marsh et al. 2002). Samples showing an approximate amplicon size of 1300 bp (MCP1 / 6R primer set) or 600 bp (M153 / 154 primer set) after gel electrophoresis were sent to the University of Chicago Comprehensive Cancer Center DNA Sequencing and Genotyping Facility for Sanger sequencing.

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TABLE 1. Species, stage, and quanitity of individuals collected from six surveys conducted between 26 September 2011 until 09 November 2011. A molecular assay using conventional PCR was used to test these samples for ranavirus.

Date	Species	Common Name	Stage	Number Tested	Number Positive for Ranavirus
26-Sep-11	*Lithobates catesbeianus*	American Bullfrog	tadpole	1	1
			metamorph	2	0
			adult	2	1
	Lithobates clamitans	Green Frog	metamorph	1	0
			adult	3	1
			Total	9	3
11-Oct-11	*Lithobates catesbeianus*	American Bullfrog	adult	3	2
	Lithobates clamitans	Green Frog	adult	3	2
			Total	6	4
12-Oct-11	*Lithobates catesbeianus*	American Bullfrog	tadpole	8	4
			metamorph	2	1
			adult	74	52
	Lithobates clamitans	Green Frog	adult	12	1
	Chrysemys picta marginata	Midland Painted Turtle	adult	2	1
	Lepomis macrochirus	Bluegill Fish	adult	3	0
			Total	101	59
4-Nov-11	*Lithobates catesbeianus*	American Bullfrog	tadpole	8	2
			adult	14	5
			Total	22	7
6-Nov-11	*Lithobates catesbeianus*	American Bullfrog	adult	4	1
			Total	4	2
9-Nov-11	*Lithobates catesbeianus*	American Bullfrog	adult	2	1
			Total	2	2
			Overall Total	144	77

All forward and reverse sequences were assembled into contigs using the assembly function in Geneious™ version 6.0 (Biomatters, New Zealand; www.geneious.com), and any ambiguous nucleotides were corrected using the electropherogram as reference. The average nucleotide length (bp) of PCR products for reactions using MCP1 / 6R primer set was 1365 bp (± 15 bp, standard deviation). For the M153 / 154 primer set, average nucleotide length was 593 bp (± 29 bp, standard deviation). Reference ranavirus sequences were downloaded from GenBank (Accession Numbers: GU391284, DQ897669, FJ459783, FVU36913, AB474588, FJ515796, AY03363, HM133594, GU391285, DQ335253). Sequences were aligned in BioEdit version 7.2.5 (http://www.mbio.ncsu.edu/bioedit/bioedit.html) and a nucleotide query was performed using Blast (http://blast.ncbi.nlm.nih.gov/Blast.cgi). There was 100% identity between sequences collected in this study and the type ranavirus frog virus sequence (FV3; GenBank Accession Number AY548484). The experimental sequences from this study covered nucleotide regions 41–1393 of the type FV3 protein coding reference sequences, representing 97% of the full MCP coding sequence. Based on the number of successful PCR amplicons in all of the samples, ranavirus was confirmed in approximately 53.5% of the samples (Table 1).

Ranavirus was previously identified in central Ohio (Homan et al. 2013) in *Ambystoma maculatum, L. catesbeianus, L. clamitans, L. sylvaticus,* and *Anaxyrus americanus*, and our study expands the known distribution of ranavirus into new localities in northwestern Ohio. Ranavirus in frogs has also been detected in surrounding states including Illinois, New York (Brunner et al. 2011), Pennsylvania (Glenney et al. 2010), and Tennessee (Green et al. 2002; Gray et al. 2009). Genetic sequences produced in this study confirm that ranavirus may also be found in Midland Painted Turtles (*Chrysemys picta marginata*) in Ohio. Ranavirus has been isolated from other naturally-occurring populations of North American turtle species, including: the Eastern Painted Turtle (*C. picta picta;* Goodman et al. 2013), Eastern Box Turtle (*Terrapene carolina carolina*; DeVoe et al. 2004, Johnson 2008, Ruder et al. 2010, Allender et al. 2011, Allender et al. 2013), Florida Box Turtle (*Terrapene carolina bauri*; Johnson 2008), and the Common Musk Turtle (*Sternotherus odoratus;* Goodman et al. 2013). Ranavirus was not detected in any of the three Bluegill fish (*L. macrochirus*), even though FV3-like ranaviruses are known to infect fishes (e.g., Mao et al. 1999; Brenes et al. 2014), but the advanced state of decomposition of the fishes may have prevented successful detection of ranavirus using the molecular techniques in this study.

Continued biological sampling and ecological monitoring of amphibians in Spurgat's Wetland in northwestern Ohio will allow appropriate documentation of the ecology of ranavirus. Dedicated sampling and monitoring is necessary to determine the long-term impact that ranavirus may have on the organismal community in Spurgat's Wetland. The current study adds to the growing body of literature concerning the impact of ranavirus on various populations, and continued monitoring and sampling will further contribute to our understanding of its distribution, virulence, and impact on herpetological and non-herpetological (e.g., fishes) populations.

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Relationship between the Water Temperature Experienced by Captive Loggerhead Turtles (*Caretta caretta*) and Eggshell Formation

Loggerhead Turtles, *Caretta caretta*, have a worldwide distribution, encompassing temperate and tropical oceans (Pritchard 1997). Adult female Loggerhead Turtles tend to migrate long distances from foraging areas to breeding areas (Miller 1997). Subsequently, they mate with males and then lay several clutches of eggs on sandy beaches, which are separated by approximately two-week internesting intervals (the period between nesting and next nesting) during a single nesting season (Miller 1997). Although vitellogenesis (i.e., ovarian growth) of sea turtles may continue into the early nesting season (Wibbels et al. 1990), it is almost complete prior to nesting season (i.e., migrating and mating season) (Rostal et al. 1996; 1998; 2001; Hamman et al. 2003; Rostal 2005, 2007). First ovulation may be induced by the mating stimulus (Manire et al. 2008), and all subsequent ovulations occur immediately after each nesting event (Licht et al. 1979, 1980, 1982; Licht 1982; Wibbels et al. 1992). Mature follicles which are ovulated are subsequently fertilized, covered with albumen, and are finally surrounded by an eggshell in preparation for the laying (Owens 1980; Rostal 2005, 2007).

The internesting intervals for Loggerhead Turtles vary between 9 and 28 days (Dodd 1988), with this variation being influenced by water temperature. Mrosovsky (1980) reported a negative correlation between internesting intervals and the ambient water temperature experienced by wild Loggerhead Turtles, followed by similar findings by Sato et al. (1998) and Hays et al. (2002). Although the thermal mechanism of this phenomenon is still unclear, Sato et al. (1998) hypothesized that the pre-ovipositional development of eggs during the internesting periods seems to be expedited by high water temperature, because the body temperature of Loggerhead Turtles is dependent on the ambient water temperature (Sato et al. 1994, 1995, 1998). Their results led to the assumption that egg formation is regulated by both water and body temperature. Yet, this hypothesis has not been confirmed to date. To test this hypothesis, the relationship between ambient water temperature and egg formation process in captive Loggerhead was explored. A study performed in captivity using ultrasonography, within which it is possible to follow the reproductive events (e.g., nesting and internesting) of identifiable individual turtles and nests, would provide information about egg development during the internesting intervals over the course of a season (Rostal et al. 1990, 1996, 1997; Rostal 2005, 2007; Kawazu et al. 2014b); such a study would not be possible to undertake in the wild.

In the current study, the egg development of two captive Loggerhead Turtles was recorded during the internesting periods, along with the daily water temperatures of the tanks over a 6-yr period. Ultrasonography was used to observe the oviducts of both turtles at regular intervals to determine the relationship between the water temperature experienced by the turtles and egg formation.

In 1994, two adult female Loggerhead Turtles (referred to as Turtle 1 and 2) were incidentally captured in the set-nets of fishing boats operating around Okinawa Island, and were subsequently

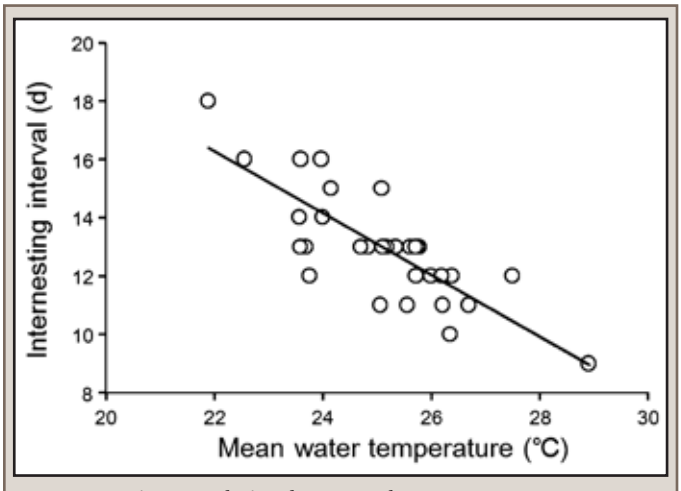


FIG. 1. Negative correlation between the mean water temperature and internesting intervals for two captive Loggerhead Turtles *Caretta caretta*. Mean water temperatures were averaged for each internesting interval. The regression line is shown by Y = -1.06X + 39.58 (Spearman's rank correlation coefficient = -0.8, N = 32, P < 0.001).

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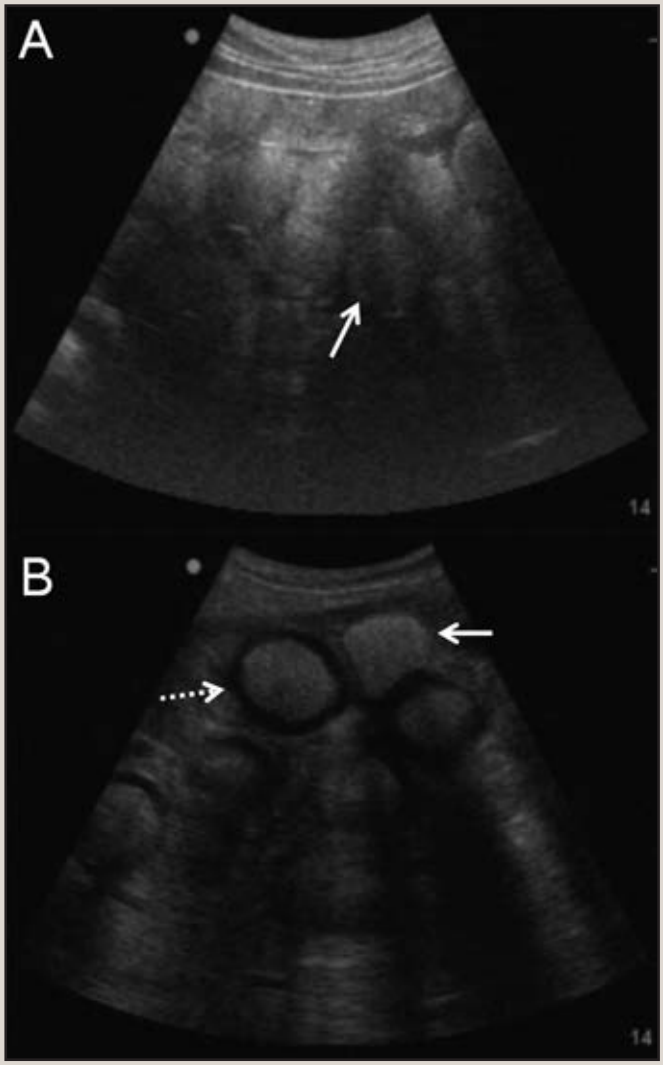


FIG. 2. Representative ultrasonograms at 1 day (A) and 3 days (B) after nesting by a loggerhead turtle *Caretta caretta* (Turtle no. 1). The solid arrows indicate examples of vitellogenic follicles in the ovary (slide A) and oviduct (slide B), while the dotted arrow indic

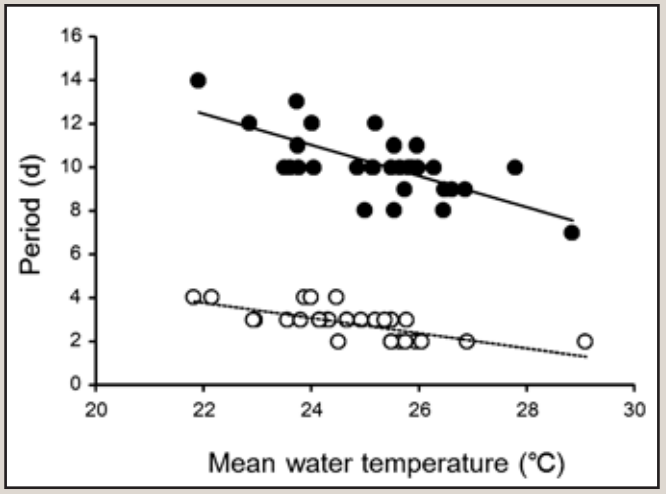


FIG. 3. Relationship between the mean water temperature and the days from egg laying to the onset of eggshell formation (early egg formation period) and from the onset of eggshells formation to the subsequent egg-laying event (late egg formation period) for two captive Loggerhead Turtles *Caretta caretta*. Open and solid circles indicate the periods for early and late egg formation, respectively. The mean water temperatures were averaged for each period. The regression line of the early and late egg formation period is shown by Y = -0.33X + 11.03 (Spearman's rank correlation coefficient = -0.71, N = 32, P < 0.01) and Y = -0.73X + 28.6 (Spearman's rank correlation coefficient = -0.71, N = 32, P < 0.001), respectively.

kept in captivity at the Ocean Expo Park, Motobu-tyo, Okinawa Prefecture, Japan. The two turtles were kept for the development of a captive breeding program (Teruya et al. 1997), and were maintained under conditions based on the ethical guidelines for animal exhibition and research of JAZA (Japanese Association of Zoos and Aquariums). The holding tank (16.8 × 10.5 × 2 m, outdoors) had an open-water system and a sandy nesting area (115 m^2) (Teruya et al. 1997). The water temperature of the tank was measured daily, ranging between 20°C and 30°C across a 12-month period. This water temperature range was similar to that experienced by Loggerheads under natural conditions (sea surface temperature), at least around Okinawa Island. The turtles were fed at 24-h intervals, with a diet that included fish and squid in quantities equivalent to 2% of their body weight. A male Loggerhead Turtle was also present in the holding tank since 1994, with which the two turtles mated at 1- to 2-year intervals, and subsequently nested on the sandy area (Teruya et al. 1997). The straight carapace length and body weight of the two females turtles between 2007 and 2013 were 940 ± 0.5 mm (mean ± SD) and 126.6 ± 4.9 kg for Turtle no. 1 and 829 ± 0.2 mm and 103.8 ± 4.8 kg for Turtle no. 2, respectively. The number of clutches (nesting) per season of both turtles combined was 4.2 ± 1.0 (Turtle no. 1: 4.2 ± 1.3 days, Turtle no. 2: 4.2 ± 0.8 days; Table 1). For both turtles, lengths of all internesting intervals and clutch sizes were recorded according to the method described by Miller (1999). Specifically, clutch size was measured as the number of eggs with albumen and yolk (normal eggs).

Beginning one day after each nesting event to the onset of eggshell formation, we observed the left and right ovaries and oviducts of both turtles daily by using ultrasonography with a 5-MHz probe (Mini-dock P04341-04, Sonosite Inc., USA). The turtles were placed in dorsal recumbency, and the probes were positioned in the inguinal region of both the right and left rear flippers at a water depth of 200 mm, as described previously (Kawazu et al. 2014b). We used the results of this procedure to document the number days from egg laying to the onset of eggshell formation (early egg formation period). In addition, we also documented the number days from the onset of eggshell formation to the subsequent egg-laying event (late egg formation period) by subtracting the early egg formation period from the internesting interval. Spearman's rank correlation coefficient was calculated for mean water temperature versus the internesting intervals, the early egg formation period, and the late egg formation period for both turtles combined.

The mean clutch size of both turtles combined was 113 ± 17.6 eggs (Turtle no. 1: 121.8 ± 14.2 eggs, Turtle no. 2: 104.1 ± 16.5 eggs). The mean internesting intervals of both turtles combined were 13 ± 1.9 days (Turtle no. 1: 13.3 ± 1.9 days, Turtle no. 2: 12.6 ± 1.8 days). During these nesting periods, the water temperature in the holding tank was between 20.5°C and 29.2°C. There was a significant negative correlation between mean water temperature and internesting interval for both turtles (Fig. 1; Spearman's rank correlation coefficient = -0.80, N = 32, P < 0.001).

TABLE 1. Number of nesting events and date of two captive Loggerhead Turtles, *Caretta caretta*.

Year	Turtle no. 1 Number of nesting	Nesting date	Year	Turtle no. 2 Number of nesting	Nesting date
2007	4	6 May	2007	4	8 May
		22 May			22 May
		4 Jun			4 Jun
		16 Jun			17 Jun
2009	6	17 Apr	2009	5	4 May
		5 May			20 May
		19 May			2 Jun
		31 May			15 Jun
		13 Jun			26 Jun
		23 Jun			
			2011	4	22 May
2010	5	20 Apr			4 Jun
		5 May			16 Jun
		20 May			25 Jun
		1 Jun			
		13 Jun	2012	3	17 May
					28 May
2011	3	17 May			10 Jun
		30 May			
		11 Jun	2013	5	4 May
					20 May
2012	3	16 May			2 Jun
		29 May			13 Jun
		11 Jun			24 Jun

Ultrasonography clearly showed the presence of vitellogenic follicles (Fig. 2A) and calcified eggs (Fig. 2B). Therefore, we were able to confirm the day that eggshell formation started. However, we could not distinguish oviductal eggs without shells after ovulation from ovarian follicles. The mean early egg formation period was 2.8 ± 0.7 days in both turtles combined (range: 2–4 days). There was a significant negative correlation between mean water temperature and the early egg formation period for both turtles (Fig. 3; Spearman's rank correlation coefficient = -0.71, N = 32, $P < 0.01$). In contrast, the mean late egg formation period was 10.6 ± 1.5 days (range: 7–14 days). There was a significant negative correlation between mean water temperature and the late egg formation period for both turtles (Fig. 3; Spearman's rank correlation coefficient = -0.71, N = 32, $P < 0.001$).

This study confirmed the negative correlation between mean water temperature and internesting interval for two captive Loggerhead Turtles, supporting the thermal trends documented for wild loggerheads by Mrosovsky (1980), Sato et al. (1998), and Hays et al. (2002) (Fig. 1). Miller (1997) reported a mean of 3.49 clutches per season for loggerheads, with an internesting interval of 14 days and clutch size of 112.4 eggs. These parameters appeared to be similar to those recorded in the current study (mean of 4.2 clutches, internesting intervals of 13 days, and 113 eggs per clutch). Although the remigration intervals of wild nesting loggerheads are averaged approximately 2- to 3-year (Miller 1997; Schroeder et al. 2003), the fewer intervals, such as captive loggerheads (1- to 2-year), are also observed in wild (Dodd 1988; Schroeder et al. 2003; Kawazu et al. 2014a). Therefore, we assumed that reproductive parameters in the captive animals reflected those of wild animals. In addition, we observed a negative correlation between each mean water temperature and early and late egg formation periods during the interesting intervals (Fig. 3). This result indicates that the egg formation process is influenced by temperature, supporting the hypothesis of the relationship between water temperature and the egg formation. We suggest that the egg formation process is expedited by the ambient water temperature experienced by turtles, which results in the documented shorter internesting intervals at higher temperatures and with nesting progression.

In sea turtles, ovulation, fertilization, and covering of the fertile yolk with albumen are completed before eggshell formation (Owens 1980). Unfortunately, ultrasonography could not determine the period of ovulation after nesting in the captive loggerheads. However, some previous studies have demonstrated the periovulatory period of some sea turtles species on the basis of changes in the levels of follicle follicle-stimulating hormone (FSH), luteinizing hormone, and progesterone. For instance, wild green and Loggerhead Turtles ovulate from 20 to 50 h after nesting (Wibbels et al. 1992). Other physiological studies have shown that Green Turtles ovulate 6 to 48 h after nesting, while Olive Ridley Turtles, *Lepidochelys olivacea*, ovulate from 1 to 3 days after nesting (Licht et al. 1979, 1982). In addition, Kawazu et al. (2014b) reported that egg formation occurred one day after ovulation based on the administration of FSH to Hawksbill Turtles, *Eretmochelys imbricata*. These previous studies indicate that eggshell formation tends to start within four days of nesting. In the current study, these similar results demonstrated that the early egg formation period (before eggshell formation) occurred within 2–4 days of egg laying in the two captive loggerheads. Fertilization and covering of fertile yolk with albumen also occur during this period, because the egg formation process follows this ordering after ovulation, ending with eggshell formation

(Owens 1980). Even though we could not use ultrasonography to document the day on which egg formation was completed, Miller (1985) described the eggshell as not being fully formed until at least 7 days after ovulation. This previous study indicates that yolk fertilization and/or albumen secretion in the oviducts simultaneously progress with eggshell formation. A review by Hamann et al. (2003) stated that eggshell formation is complete at 9–10 days after ovulation, which is similar to the mean late egg formation period (eggshell formation period) documented in the current study (mean: 10.6 ± 1.5 days). Thus, egg formation may be completed just before the subsequent nesting event, at least a few days beforehand.

Mature follicles are likely to be covered with albumen in the anterior glandular region of the oviduct, after which they are surrounded by eggshells in the shell-forming region, which has the function of protein carbohydrate shell membrane formation and calcium deposition (Solomon and Baird 1976, 1979; Owens 1980; Rostal et al. 1997; Rostal 2005, 2007). During the internesting intervals, sea turtles must rapidly provide albumen (i.e., protein) and eggshell (i.e., calcium) for egg development (Wallace et al. 2006). The plasma total protein and calcium levels of Loggerheads during nesting are significantly higher than those during foraging (Deem et al. 2009). These blood parameters significantly drop with the progression of each nesting event in Hawksbill Turtles (Goldberg et al. 2013) and the calcium level remain in Kemp's Ridley Turtles (Rostal et al. 1998) and Leatherback Turtles *Dermochelys coriacea* (Rostal et al. 2001) during nesting. These reduction and maintenance of two blood parameters with nesting progression may indicate the utilization for egg formation (i.e. albumen and eggshell) throughout the metabolic process of protein and calcium. Loggerheads use metabolic heat production to maintain their body temperatures slightly higher than the ambient water temperature; thus, water temperature influences the internesting interval (Sato et al. 1994, 1995, 1998). Hence, faster egg formation at higher water temperature indicates that the elevated temperature may accelerate the metabolism of compounds for egg formation in turtles. Consequently, the internesting interval may be shorter at higher temperatures and with the progression of nesting, as inferred by previous field studies (Sato et al. 1998). Further studies on the thermal mechanism of captive sea turtles during nesting need to be performed by controlling the water temperature.

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Feeding Frequency Influences Weight Gain Independently of Dietary Intake in Juvenile *Boa constrictor* (Squamata, Boidae)

The somatic growth rate of snakes may be defined by feeding frequency and the amount of food intake (Barnard et al. 1979; Taylor and Denardo 2005; Penning and Cairns 2012). In studies where snakes were separated into different feeding groups, treatment groups that ate more frequently (Myer and Kowell 1973; Taylor and Denardo 2005) or consumed larger amounts of food in the same time interval (Forsman and Lindell 1996; Penning and Cairns 2012) grew more rapidly and were larger than snakes in groups fed with a lower frequency or at a lower prey mass to snake body mass ratio. However, studies on growth rates in snakes have generally focused on feeding frequency (Taylor and Denardo 2005) or the amount of food ingested (Barnard et al. 1979; Forsman and Lindell 1996; Penning and Cairns 2012), with few relating these two variables (Myer and Kowell 1973). Furthermore, in these studies, the amount of food and frequency of the feedings were not controlled in relation to each other or to body size (but see Penning and Cairns 2012). Thus, it is difficult to accurately infer the effects of feeding frequency and food intake based on these results because animals eating weekly ingest a greater amount of food (twice as much) than individuals eating biweekly if individual meal size remains constant.

The aim of this study was to evaluate the combined influence of feeding frequency and food mass on the growth rates of snakes in captivity, using juvenile *Boa constrictor* as a model. As far as we can tell, this is the first study that seeks to evaluate growth in snakes using these standardizations. *Boa constrictor* has a wide distribution, occurring from northern Mexico to central Argentina (Pope 1961; Vanzolini et al. 1980), feeds on mammals, birds, and lizards (Vanzolini et al. 1980; Pizzatto et al. 2009; Gondim et al. 2012; Rodrigues et al. 2014), and belongs to the family Boidae, a taxonomic group that has low metabolic rates when compared to other squamates (Chappell and Ellis 1987). To our knowledge, all studies evaluating growth rates in snakes have focused on species belonging to the families Colubridae or Viperidae (e.g., Dmi'el 1967; Barnard et al. 1979; Taylor and

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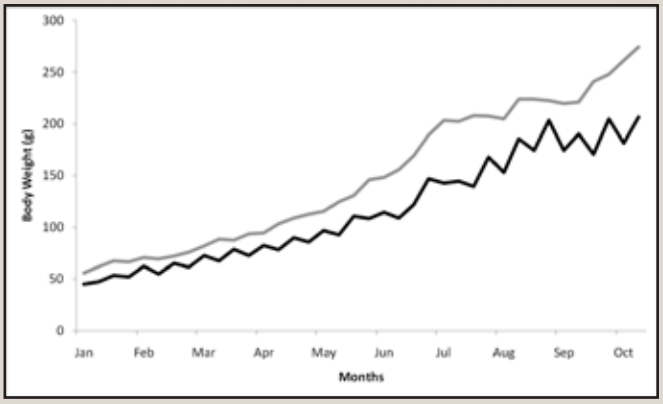


FIG. 1. Growth rate curves of mean body mass (g) for juvenile *Boa constrictor*. Snakes in the weekly group (grey; N = 4) were fed once a week with mice weighing 10% of their body mass; those in the biweekly group (black; N = 5) were fed every other week with mice weighing 20% of their body mass.

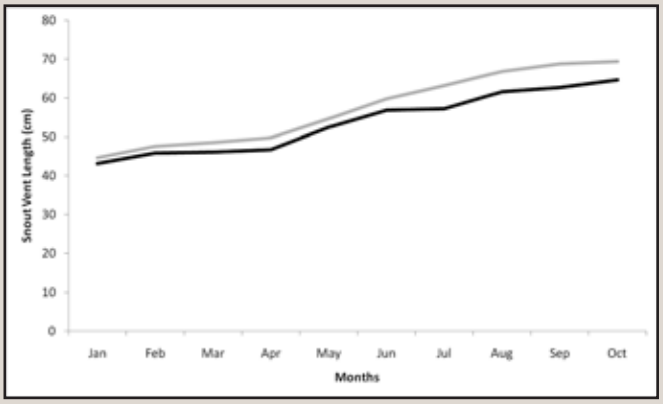


FIG. 2. Growth rate curves of mean snout–vent length (cm) for juvenile *Boa constrictor*. Snakes in the weekly group (grey; N = 4) were fed once a week with mice weighing 10% of their body mass; those in the biweekly group (black; N = 5) were fed every other week with mice weighing 20% of their body mass.

Denardo 2005; Penning and Cairns 2012); therefore, *B. constrictor* represents a suitable model for studying the influence of prey size and feeding frequency on the growth rate of snakes. Additionally, this work seeks to aid in improving the husbandry and breeding of *B. constrictor* in captivity, since this species is commercially bred for the pet trade and is commonly raised as pets throughout the world.

Materials and methods.—The juvenile *Boa constrictor* used in this study originated from a litter born at the Núcleo Regional de Ofiologia da Universidade Federal do Ceará (NUROF-UFC) on 28 November 2012. The litter was randomly divided into two groups, which were not statistically different in body mass or body length (body mass: Mann-Whitney U = 17, $P = 0.11$; body length: Mann-Whitney U = 4, $P = 0.17$; see Table 1): Group 1 (weekly) with four individuals and Group 2 (biweekly) with five individuals. The study period extended from January to October 2013, totaling 10 months.

The animals were housed individually in cylindrical plastic tubs (26.5 cm in diameter and 36.5 cm in height) with small perforations to allow the passage of air. Sheets of newspaper were used as substrate. After nine months of the experiment, the snakes were relocated to wooden boxes (31 × 47 × 31 cm [L × W × H]) with small perforations in the sidewalls for the passage of air. Newspaper continued to serve as substrate. Enclosures were cleaned weekly for both groups, and water was offered *ad libitum*. Snakes did not have access to artificial heat sources because the ambient temperature of the room where the animals were kept remained around 30°C.

Initially, from December 2012 to early January 2013, all snakes were fed biweekly with mice equivalent to 10% of their body mass. From January 2013 onward, snakes from Group 1 were fed weekly on mice with a mass equivalent to 10% of their body mass, while snakes from Group 2 were fed biweekly (every other week) on mice with a mass equivalent to 20% of their body weight. Although subject to different feeding frequencies, all animals consumed the same amount of food within a two-week interval, which was 20% of their body mass.

All snakes (including the biweekly group) were weighed on a digital scale every week prior to feedings. The snout to vent length (SVL) of each individual was measured monthly using a thin cord that was aligned along the spine of the animal; this cord was then measured with a ruler.

The net gains in body mass and SVL at the end of the experiment (the difference between the final measurements and those taken at the beginning of the study) were evaluated using Mann-Whitney U tests. This test was also used to verify the differences between the initial weights and SVLs among the groups. In order to ensure that our results were not limited or biased by the small sample size in each group, a null model was performed in which 1000 numbers were obtained from a normal distribution, with mean and standard deviation equal to the values obtained when all of the snakes were considered as a single group. Next, we randomly sampled four and five numbers and evaluated if there was a difference between these groups using the Mann-Whitney test. Since both groups were collected from the same population (the 1000 numbers generated), no difference was expected between them. Finally, we report how many times we found this lack of difference, divided by the number of samplings performed (this ratio is hereafter referred to as "efficiency"), representing how well our sampling design is able to represent the real population. This null model was performed in our study using 1000 comparisons between groups randomly generated from sampling. Statistical analyses were performed in R ver. 2.15.3 (R Development Core Team 2012), and descriptive statistics are reported as mean ± standard deviation.

Results.—Mean body masses and SVLs of snakes in the two groups are shown in Table 1. After ten months, the general pattern of weight gain differed for weekly and biweekly groups (Fig. 1). For the group of snakes fed weekly, weight gain was constant and ever-increasing from the start of the experiment until July 2013, when there was a change in the pattern of weight gain in this group, becoming irregular and even showing decreases between samples. Body mass was also increasing for the biweekly group, but this group showed large increases in mass the week after a feeding. Decreases in mass were observed the following week (just before feeding again), but these reductions were slightly smaller than the gains in the postprandial week.

At the end of the experiment, snakes in the weekly group had an average net gain of 207.51 ± 27.54 g, whereas the biweekly group had an average net gain of 136.75 ± 47.81 g. There were significant differences in net weight gain (U = 19, $P = 0.03$, efficiency = 0.968) and final mass (U = 19, $P = 0.03$, efficiency = 0.965) between the groups at the end of the experiment. These high values of efficiency suggest that these significant differences

Table 1. Average snout–vent lengths and body masses of *Boa constrictor* in this study. Statistics are presented as mean ± standard deviation.

Group	N	Snout–vent length (cm)		Mass (g)	
		Initial	Final	Initial	Final
Group 1 (weekly)	4	36.62 ± 1.70	69.40 ± 4.77	53.98 ± 2.77	261.49 ± 29.17
Group 2 (biweekly)	5	38.70 ± 1.64	64.60 ± 7.09	44.87 ± 7.29	181.62 ± 53.34
Groups 1 & 2 (combined)	9	37.77 ± 1.90	66.73 ± 6.33	48.92 ± 7.24	217.12 ± 59.28

are real, because if the groups belonged to the same population there is a probability of 96% that this pattern would be recovered. These values of efficiency were very similar to simulated values havin a high number of replicates, such as 100 in each group, been used in our study (efficiencies = 0.967 and 0.973 for net gain and final mass, respectively). There were no significant differences in net gain in SVL at the end of the experiment (U = 16, $P = 0.19$) or in the final SVL (U = 16, $P = 0.17$) between groups (Fig. 2). Together, snakes from both groups had an average net gain of 28.95 ± 6.44 cm in SVL (Table 1).

Discussion.—Net gain in body mass differed between the feeding groups over the course of this study, where snakes fed weekly gained more weight than those fed biweekly. Similar results were found by Myer and Kowell (1973) and Taylor and Denardo (2005) for groups eating more frequently. However, in these studies, the amount of food offered in feeding events was similar for both groups or was not properly quantified. Unlike these works, both dietary groups in the present study ate the same amount of food relative to body mass within a standard two-week interval, and the feeding frequency was still a determining factor in the differential weight gain. Our results also reinforce the assertion that body mass is not a good estimate of age in snakes (also observed in Penning and Cairns 2012), considering that despite having the same age, snakes differed in body mass according to their feeding frequency.

There was no difference in SVL between feeding groups in our study, demonstrating the stability of growth in length, which is more invariant with respect to changes in food consumption patterns (see Fig. 2). However, in other studies, differences in total length (Myer and Kowell 1973) and SVL growth rates (Taylor and Denardo 2005) were observed between groups fed with different frequencies, but the amount of food ingested per feeding event was similar in both experimental groups or sometimes not quantified.

Seven months into the experiment, an adverse effect was observed in the weekly feeding group, with at least one snake regurgitating its prey after each feeding trial. Additionally, snakes in the weekly group sometimes refused food during feeding trials and there was an increase in the amount of feces produced by these animals in the final months of the study (visual evaluation only; feces were not weighed). These results may indicate an overfeeding of this group in terms of feeding frequency and, consequently, a need for changes in feeding schedule and prey size. Although the metabolism of neonatal snakes is high, demanding a high energy input, older snakes do not require a constant food supply due to the accumulation of body reserves (Dmi'el 1967). It may be inferred that in the first seven months of the experiment, individuals in the weekly group accumulated sufficient amounts of corporal reserves where weekly feedings were no longer necessary. In the studies of Dmi'el (1967) and Myer and Kowell (1973), food was offered *ad libitum*, and these authors also observed changes in patterns of prey ingestion. Dmi'el (1967) reported that the snakes increased food intake throughout life, but there was a decrease in the mass ratio of prey items to the body mass of the snakes. Myer and Kowell (1973) noted that snakes changed from eating small amounts of food every day to eating larger prey items less frequently. These results may explain the regurgitations and decreased interest in feeding observed in snakes fed weekly in the present study. Furthermore, weekly feedings may represent the best feeding schedule for juvenile *B. constrictor* during the initial seven to nine months, followed by a change to biweekly feedings with larger prey. Some *B. constrictor* fed biweekly also experienced occasional regurgitations, but not at the frequency seen in the weekly group.

In summary, weight gain in snakes appears to be influenced by feeding frequency. An initial dietary pattern with high feeding frequency and small prey items resulted in rapid growth of juvenile snakes in captivity. Future studies should evaluate the effectiveness of changing this feeding routine after some months to a lower frequency, with larger prey items relative to body mass. Moreover, future studies could also determine the ideal body weights (standardized by body length) of *B. constrictor*, which can then be used as a guideline to determine the best feeding routine for the species in captivity.

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An Incidence of Twinning in Taylor's Cantil (*Agkistrodon taylori*) at the Wildlife Conservation Society's Bronx Zoo

Animals in managed care, such as in zoos and aquaria, can provide insights into occurrences rarely observed in the wild. Thus, these institutions have a great potential for contributing biological information to the scientific community. Reproductive behaviors in reptiles, particularly egg-laying and the bearing of live young are infrequently observed in the wild; therefore, observations in captivity can provide insight as to what can be expected within wild populations. Instances of twinning in reptiles have been reported by Derickson (1927), Curtis (1950), List and Smith (1954), Carpenter and Yoshida (1957), Crooks and Smith (1958), Yntema (1971), Singh and Thapliyal (1973), Marion (1980), Eckert (1990), Tucker and Janzen (1997), and Mendyk (2007), but to our knowledge, observations of true twinning in live-bearing snakes are lacking. Here, we report a case of twinning in Taylor's Cantil (*Agkistrodon taylori*).

The Wildlife Conservation Society's Bronx Zoo received a female *A. taylori* from the Abilene Zoo on 20 April 2011. This individual was captive-born at the San Antonio Zoo on 23 June 2005. Upon her arrival at the Bronx Zoo, she was housed off-exhibit in a custom-built wooden enclosure measuring ca. 100 × 75 × 75 cm (L × W × H). During her routine quarantine examination, a radiograph revealed numerous developing embryos, and on 8 June 2011, this snake was observed bearing her young. It was noted at the time of birth that one of the egg sac membranes contained two individuals (Fig. 1). All eight young were individually weighed and measured upon emerging from their egg sac membranes (Table 1), as were three infertile eggs (not reported here). Mean mass of young at the time of birth was 11.65 ± 1.144 g, mean snout–vent length (SVL) was 17.98 ± 0.638 cm, and mean total length was 21.99 ± 0.769 cm. The twins were significantly smaller than the rest of their siblings in both mass and SVL (Mann-Whitney U-test, $P = 0.0455$ and $P = 0.0455$,

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Fig. 1. Two neonatal Taylor's Cantils (*Agkistrodon taylori*) in one egg sac at the time of birth. There are two heads within the circled area; one oriented vertically and the other horizontally with the ventral side of the lower jaw facing upward.

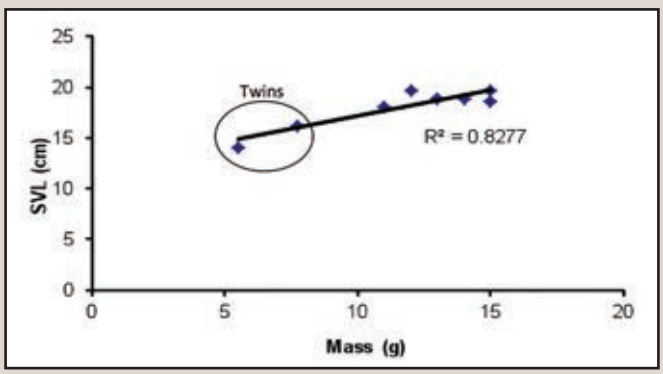


Fig. 2. The mass (g) to SVL (cm) ratios of eight Taylor's Cantils (*Agkistrodon taylori*) at the time of birth; the twins are encircled.

Table 1. Mass (g), snout–vent length (cm), and total length (cm) of Taylor's Cantils (*Agkistrodon taylori*) at time of birth on 8 June 2011. ID#'s H11052 and H11053 represent the two twins.

ID	Mass (g)	Snout–vent length (cm)	Total length (cm)
H11052	7.7	16.2	19.8
H11053	5.5	14.1	17.4
H11054	11.0	18.0	21.9
H11055	12.0	19.7	24.0
H11056	15.0	19.7	24.2
H11057	15.0	18.6	23.0
H11058	14.0	18.8	23.0
H11059	13.0	18.8	22.7

respectively). To determine if the twins were proportionate in size compared to the rest of the clutch, we performed a linear regression. The ratio of mass to SVL does appear to be similar to the remainder of the clutch (Fig. 2; $R^2 = 0.8279$, $P = 0.0017$).

It is unclear whether this occurrence implies identical or fraternal twinning, as we did not identify the presence of a single or double yolk. One twin did not survive long after birth; necropsy detected fluid in the lungs, but there were no apparent developmental deformities. Lack of space in the egg sac and the potential for sharing a yolk appears to impede the growth of embryos during this developmental stage (Marion 1980). Marion (1980) cited several accounts of twins having a combined weight similar to those of single siblings. Since the twins were significantly smaller than their siblings, this could indicate that twins born in the wild may be less fit than non-twin siblings.

Acknowledgments.—We thank the Wildlife Conservation Society's Bronx Zoo Department of Herpetology for their assistance in obtaining the neonate morphometrics. Pat Thomas and Don Boyer reviewed an earlier draft of this manuscript.

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HERPETOCULTURE NOTES

SQUAMATA — LIZARDS

***CTENOPHORUS MIRRITYANA* (Barrier Range Dragon). LONGEVITY.** *Ctenophorus mirrityana* is an endangered species of rock-dwelling agamid, currently known only from four locations in western New South Wales, Australia. It was only described in 2013, when it was split from the closely related *C. decresii* (McLean et al. 2013. Rec. Aust. Mus. 65:51–63). Although the longevity of wild *C. mirrityana* is not known, this genus is typically short-lived with the wild lifespan of three studied species recorded at 1–2 years (Cogger 1978. Aust. J. Zool. 26:653–672; Dickman et al. 1999. Oecologia 119:357–366). Despite their short lifespans in the wild, captive individuals may live much longer, with a captive specimen of this species (reported therein as *C. decresii*) previously recorded to live to over 9 years old (McFadden and Harlow 2007. Herpetofauna 37:22–26). Herein we report a captive male *C. mirrityana* that lived for 11 years, 6 months, and 5 days.

The dragon was bred at Taronga Zoo, Sydney, from specimens collected at Mutawintji National Park in 1998 and 1999. It hatched on 22 November 2003. This specimen was housed individually, excluding a period with a post-reproductive female from March 2006 to April 2008, so did not reproduce during its lifetime. It was euthanized on 27 May 2015 due to a decline in mass and body condition, despite remaining active and feeding. Post-mortem examination revealed the dragon had a liver tumor, or biliary adenoma undergoing malignant transformation.

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SQUAMATA — SNAKES

***HETERODON SIMUS* (Southern Hog-nosed Snake). LONGEVITY.** Longevity is an important factor in any organism's biology. Even though captivity may potentially prolong an animal's "natural" lifespan, information on maximum potential longevity, particularly for species of conservation concern, can be an important consideration when conducting field studies and making management decisions.

A captive longevity record of 12 years and 42 days for *Heterodon simus* was reported by Beane and Thorp (2007. Bull. Chicago Herpetol. Soc. 42[12]:193), who further reported four additional specimens that had exceeded 11 years in captivity, as of that writing. All of those snakes are now deceased. The individual surviving the longest was a male, wild-collected as a recent hatchling in Moore County, North Carolina, USA (7.6 km WSW Pinebluff, 35.0894°N, 79.5514°W; WGS 84) on 17 October 1996 by Jeffrey C. Beane and Laura H. Terry. The snake was maintained in captivity until his death on 10 April 2015. During that period, he was fed mostly laboratory House Mice (*Mus musculus*) and neonatal laboratory Norway Rats (*Rattus norvegicus*). Initially, these were "scented" with Squirrel Treefrogs (*Hyla squirella*),

Green Treefrogs (*H. cinerea*), Pine Woods Treefrogs (*H. femoralis*), or Spring Peepers (*Pseudacris crucifer*). Other food items eaten between 17 October 1996 and 1 February 1998 were *H. femoralis*, *H. squirella*, and cut pieces of chicken (*Gallus gallus*) flesh. The snake first accepted an "unscented" neonatal laboratory mouse on 18 September 1997. From 1 February 1998 until his death, he was fed exclusively laboratory mice and rats. The snake molted 33 times during his captivity (and almost certainly had undergone only one postnatal molt when first collected). During the last few years of his life, he experienced difficulty with ecdysis, developed cataracts in both eyes, and occasionally regurgitated food. During his final months, he had difficulty swallowing even small food items, and occasionally was gently "assisted" with swallowing. On 9 April 2015, the day before his death, he attempted to feed, but was unable to swallow unassisted.

To my knowledge, this period of 18 years, 5 months and 24 days far surpasses all previously reported records for the species. Upon death, the snake measured 379 mm SVL and 485 mm total length. The specimen was maintained under permits issued by the North Carolina Wildlife Resources Commission, and is deposited in the herpetological collection of the North Carolina State Museum of Natural Sciences (NCSM 84567).

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GEOGRAPHIC DISTRIBUTION

GYMNOPHIONA — CAECILIANS

***SIPHONOPS PAULENSIS* (Boettger's Caecilian)**. BRAZIL: CEARÁ: Municipality of Crato: ca. 3.5 km SW of Crato (7.279722°S, 39.438250°W; WGS 84). 11 February 2014. Milene G. Gaiotti. Verified by I. J. Roberto. Coleção Herpetológica da Universidade Regional do Cariri, Crato, Ceará, Brazil (URCA-H 7095). *Siphonops paulensis* has a large distribution, from tropical Brazilian rainforest in the southern Amazon basin, to northern Argentina, Paraguay, and eastern Bolivia (Taylor 1968. The Caecilians of the World. A Taxonomic Review. University of Kansas Press, Lawrence, Kansas. 848 pp.). In Brazil, it occurs in the states of Rio de Janeiro, São Paulo, Goiás, Mato Grosso do Sul, Rio Grande do Norte, Rio Grande do Sul, Minas Gerais, Distrito Federal, Ceará, Mato Grosso, Tocantins, Maranhão and Sergipe (Sawaya 1937. Bol. Facul. Fil. Ciên. Letras Univers. SP. 1:225–263; Dunn 1942. Bull. Mus. Comp. Zool. 91:437–540; Dunn 1942. Bull. Mus. Comp. Zool. 91:437–540; Schmidt and Inger 1951. Fieldiana Zool. 31:439–465; Braun and Braun 1980. Iheringia. Sér. Zool. 56:121–146; Kokubum and Menin 2001. Herpetol. Rev. 32:53; Souza et al. 2002. Herpetol. Rev. 33:146–147; Loebmann and Haddad 2010. Biota Neotrop. 10:227–256; Faria and Mott 2011. Herpetol. Notes 4:53–56; Lema and Martins 2011. Anfíbios do Rio Grande do Sul. Catálogo, Diagnose, Distribuição e Iconografia. Ed. Univ. PUCRS. Press, Porto Alegre, Brazil. 196 pp.; Valdujo et al. 2011. Biota. Neotrop. 11:251–262; Maciel et al. 2012. J. Herpetol. 46:47–50; Miranda et al. 2013. Herpetol. Notes 6:327–329; Santana et al. 2015. Check List 11:1531–1533). This new record fills the gap in the distribution between Ibiapaba Municipality (Ceará State), and Simão Dias Municipality (Sergipe State; Loebmann and Haddad 2010, *op. cit.*; Santana et al. 2015, *op. cit.*) and is the first record from Chapada do Araripe in northeastern Brazil. The new record extends the distribution ca. 300 km SE from the Planalto da Ibiapaba, Ceará and ca. 400 km NW from Simão Dias, Sergipe.

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CAUDATA — SALAMANDERS

***AMBYSTOMA JEFFERSONIANUM* (Jefferson Salamander)**. USA: INDIANA: Scott Co.: Clark State Forest (38.642740°N, 85.885825°W; NAD 83). 1 April 2015. Sarabeth Klueh-Mundy and Jason Mirtl. Verified by Chris Phillips. Illinois Natural History Survey (INHS 2015ao, photo voucher). This capture provides a new county record for Indiana (Minton 2001. Amphibians and Reptiles of Indiana. Indiana Academy of Science, Indianapolis, Indiana. 404 pp.).

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***AMBYSTOMA MACULATUM* (Spotted Salamander)**. USA: ALABAMA: Sumter Co.: CR 85, ~3.83 road km N of AL 116 (32.84188°N, 88.19707°W; WGS 84). 21 March 2015. Brian D. Holt and Evan Lawrence. Verified by David Laurencio. Auburn University Natural History Museum (AUM AHAP-D 961, digital photographic voucher). New county record (Mount 1975. Reptiles and Amphibians of Alabama. Agricultural Experiment Station, Auburn University, Alabama. 347 pp.). One adult observed crossing road during light rain. The nearest previously documented locations in the state occur in Pickens Co. to the north (Mount 1975, *op. cit.*) and Greene Co. to the east. This record fills a gap in the Southeastern Floodplains and Low Terraces section of the Southeastern Plains ecoregion in western Alabama.

Thanks to Eric Soehren for reviewing this note and David Laurencio for verifying the identification and confirming the county record. Additional online museum records were examined for county occurrences via VertNet.

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***AMBYSTOMA MACULATUM* (Spotted Salamander)**. USA: TENNESSEE: Grainger Co.: 7.5 km W of New Market (36.1072°N, 83.6365°W; WGS 84). 19 February 2011. Lynn F. Faust. Verified by Floyd A. Scott. David H. Snyder Museum of Zoology, Austin Peay State University (APSU 19480, color photo). New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Hard copy and Internet versions, the latter [http://www.apsu.edu/amatlas/, accessed 9 March 2015] including links to data on amphibians in Tennessee that have appeared since 1996). A single individual was found under a small log near a vernal pool on McBee Island along the Holston River.

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***AMBYSTOMA OPACUM* (Marbled Salamander)**. USA: TENNESSEE: Grainger Co.: 7.5 km W of New Market (36.1072°N, 83.6365°W; WGS 84). 13 November 2010. Lynn F. Faust. Verified by A. Floyd Scott. David H. Snyder Museum of Zoology, Austin Peay State University (APSU 19479, color photo). New county

record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Hard copy and Internet versions, the latter [http://www.apsu.edu/amatlas/, accessed 9 March 2015] including links to data on amphibians in Tennessee that have appeared since 1996). A single individual was found under a piece of bark near a vernal pool on McBee Island. The individual was surrounded by eggs.

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***AMPHIUMA TRIDACTYLUM* (Three-toed Amphiuma)**. USA: ALABAMA: Dallas Co.: 0.34 mi WSW of AL 14 along train tracks (32.42926°N, 86.95938°W; WGS 84). 30 June 2013. C. Davis. Auburn University Museum of Natural History (AUM 40446). Verified by David Laurencio. New county record (Mount 1996. The Reptiles and Amphibians of Alabama. University of Alabama Press. xi+347 pp.). *Amphiuma tridactylum* is assumed to occur throughout the western half of the state; however, verified records are lacking for many Alabama counties. Specimen collected with a baited funnel trap. Specimen collected under an Alabama Department of Conservation and Natural Resources permit (#2014044694668680) issued to CKW and CWD.

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***ANEIDES AENEUS* (Green Salamander)**. USA: NORTH CAROLINA: Buncombe Co.: Rocky Broad River corridor, 3.4 km airline N town of Bat Cave (location details withheld and on file with the North Carolina Wildlife Resources Commission). 8 May 2015. Lori A. Williams, Alan D. Cameron, Bill McAninch, and Jerry McAninch. Verified by Jeffrey C. Beane. North Carolina Museum of Natural Sciences (NCSM 13183, photo voucher). New county record (NCSM files; Beane et al. 2010. Amphibians & Reptiles of the Carolinas and Virginia, 2nd ed. University of North Carolina Press, Chapel Hill, 274 pp.; North Carolina Natural Heritage Program [NCNHP]. 2015. Biotics Database. Department of Environment and Natural Resources, Raleigh, North Carolina.). Record represents the northernmost known occurrence to date in the greater Bat Cave area and on the western side of the Hickory Nut Gorge in North Carolina (Beane et al. 2010, *op. cit.*; NCNHP, *op. cit.*). Closest previous historical records in the state are from private property, Henderson County, 1.6 km airline S (location details withheld and on file with the North Carolina Wildlife Resources Commission). Juvenile regenerating entire tail (TL = 41.1 mm, SVL = 37.5 mm) temporarily collected during visual encounter surveys of rock outcrops.

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***NOTOPHTHALMUS VIRIDESCENS* (Eastern Newt)**. USA: ALABAMA: Pickens Co.: Coal Fire Creek at AL 17, approximately 7.15 road km S of intersection with AL 96 (33.51627°N, 87.98272°W; WGS 84). 3 March 2015. Ashley Peters and Brian D. Holt. Verified by David Laurencio. Auburn University Natural History Museum (AUM AHAP-D 917, digital photographic voucher). New county record (Mount 1975. Reptiles and Amphibians of Alabama. Agricultural Experiment Station, Auburn University, Alabama. 347 pp.). Three adults, two of which were in amplexus, were observed in a ditch filled with overflow from Coal Fire Creek. Previously documented locations in the state occur in Lamar County to the north (Graham et al. 2009. Herpetol. Rev. 40:367–371), Tuscaloosa County to the east, and Greene County to the south (Mount 1975, *op. cit.*). This record fills a gap in the Fall Line Hills of the Southeastern Plains ecoregion in western Alabama.

We thank Eric Soehren for reviewing this note and David Laurencio for verifying the identification and confirming the county record. Additional online museum records were examined for county occurrences via VertNet.

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***NOTOPHTHALMUS VIRIDESCENS* (Eastern Newt)**. USA: INDIANA: Lawrence Co.: Hoosier National Forest (38.737985°N, 86.581768°W; NAD 83). 9 May 2015. Amy Kearns, Noah Kearns, and Sarabeth Klueh-Mundy. Verified by Chris Phillips. Illinois Natural History Survey (INHS 2015an, photo voucher). New county record (Minton 2001. Amphibians and Reptiles of Indiana. Indiana Academy of Science, Indianapolis, Indiana. 404 pp.).

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ANURA — FROGS

***ACRIS BLANCHARDI* (Blanchard's Cricket Frog)**. USA: WISCONSIN: Adams Co.: ca. 5 miles W of Briggsville (43.655°N, 89.688°W; WGS 84). 22 September 1929. Collector unknown. Verified by K. Tighe. National Museum of Natural History (USNM 311739). New county record that completes a gap in the species' documented range (Casper 1996. Geographic Distributions of the Amphibians and Reptiles of Wisconsin. Milwaukee Publ. Mus., Milwaukee, Wisconsin. 87 pp.). Supplied coordinates have been approximated and are based on the museum specimen's locality description. Given the age of this specimen, it is unknown if this species still resides in the general vicinity; however, this specimen provides important historical context for the distribution of this species in Wisconsin. *Acris blanchardi* has experienced a range contraction in the state from the 1960s to the 1980s, and is listed as endangered in Wisconsin. Currently, the nearest known Wisconsin population is ca. 20 km to the south. Because the circumstances surrounding the collection of this specimen are unknown, additional effort to re-confirm the presence of this species in Adams Co. is warranted.

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***ACRIS CREPITANS* (Eastern Cricket Frog)**. USA: ALABAMA: Sumter Co.: Approximately 3.83 road km N of AL 116 on CR 85 (32.84188°N, 88.19707°W; WGS 84). 21 March 2015. Brian D. Holt and Evan Lawrence. Verified by David Laurencio. Auburn University Natural History Museum (AUM 41116, 41117). New county record (Mount 1975. Reptiles and Amphibians of Alabama. Agricultural Experiment Station, Auburn University, Alabama. 347 pp.). Several individuals observed with *Acris gryllus* (Southern Cricket Frog; AUM 41114, 41115) on road during light rain. The nearest previously documented locations in the state occur in each adjacent county: Greene County to the east (VertNet), Pickens to the north, Marengo to the southeast, and Choctaw to the south (Mount 1975, *op. cit.*). This record fills a gap in the Southeastern Floodplains and Low Terraces section of the Southeastern Plains ecoregion in western Alabama.

Thanks to Eric Soehren for reviewing this note and David Laurencio for verifying the identification and confirming the county record. Additional online museum records were examined for county occurrences via VertNet.

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***ANAXYRUS AMERICANUS* (American Toad)**. USA: INDIANA: Noble Co.: Crooked Lake (41.268266°N, 85.480650°W; WGS 84). 23 June 2015. Andrew Hoffman and Sierra Hoffman. Verified by Kenneth Krysko. Florida Museum of Natural History (UF 175751, photo voucher). New county record (Minton 2001. Amphibians and Reptiles of Indiana. Indiana Academy of Science, Indianapolis, Indiana. 404 pp.). Numerous recently metamorphosed toads found near lake shore in grass.

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***ANAXYRUS AMERICANUS* (American Toad)**. USA: TENNESSEE: Hardin Co.: Horse Creek Wildlife Sanctuary and Animal Refuge (35.123433°N, 88.167761°W; WGS 84). 30 April 2015. Lee J. Barton, Brian P. Butterfield, Paige Whittaker, and Joshua P. Kee. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19549, color photo). First record for Hardin County (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Hard copy and Internet versions [http://www.apsu.edu/amatlas/]. Accessed 2 May 2015). Calling male was captured by hand. Voucher collected under Tennessee Wildlife Resources Agency Permit 1494.

LEE J. BARTON, **BRIAN P. BUTTERFIELD** (e-mail: bbutterfield@fhu.edu), and **PAIGE WHITTAKER**, Freed-Hardeman University, 151 E. Main Street, Henderson, Tennessee 38340, USA; **JOSHUA P. KEE**, Department of Biology, Austin Peay State University, Clarksville, Tennessee 37044, USA.

***CALLUELLA FLAVA* (Yellow Burrowing Frog)**. BRUNEI DARUSSALAM: TEMBURONG: Amo District: Ulu Temburong National Park, low ridge between Sungei Temburong and Sungei Apan (4.55762°N, 115.15099°E; WGS 84), 120 m elev. 25 November 2012. Hanyrol H. Ahmad Sah. Verified by Samuel Shonleben. Universiti Brunei Darussalam Natural History Museum (UBDM 2.00199). Female, on ridge (presumably drier, sandy soil) of lowland mixed-dipterocarp forest in plastic bucket pitfall trap (SVL 37.2 mm; with eight large ova). Bucket filled with 5 cm of water as result of heavy rain. Extends previous single record from Kerangas Forest between Camp 5 and Sungei Berrar, Gunung Mulu National Park, Sarawak, Malaysia (Kiew 1984. Malayan Nat. J. 37:163–166) by 54 km to the northeast. First record for Brunei Darussalam and second record for species. Permit No. UBD/KBFSC/R/2.

HANYROL H. AHMAD SAH (e-mail: spanish_novia@yahoo.co.uk) and **T. ULMAR GRAFE**, Faculty of Science, Universiti Brunei Darussalam, Gadong, BE1410, Brunei Darussalam (e-mail: ulmar.grafe@ubd.edu.bn).

***CRAUGASTOR BRANSFORDII* (Bransford's Robber Frog)**. REPUBLIC OF PANAMA: VERAGUAS: Santa Fe District: Guayabito River (8.54719°N, 81.02581°W; WGS 84), 633 m elev. 25 July 2014. E. E. Flores. Verified by Andreas Hertz. Museo de Vertebrados, Universidad de Panamá, Panama City, Panama (MVUP 2483). This report vouchers for the first time the presence of this species in Veraguas Province and in the Santa Fe National Park and extends the known range of the species in Panama 48 km to the east of Fortuna Forest Reserve in Chiriqui Province (NMNH 572226.6567807), and 50 km to the west of El Cope National Park in Cocle Province (NMNH 572221.6567800). The frog was captured at 1835 h on rain forest leaf litter near the river's bank. This work was conducted under the scientific permit (SE/A-114-13) provided by the Panamanian National Authority for the Environment (ANAM).

ERIC ENRIQUE FLORES, Friends of Santa Fe National Park & Panama Wildlife Conservation, Apartado 0923-00126, Veraguas, Panama (e-mail: sailax1@gmail.com); **JOELBIN DE LA CRUZ,** Herbios-Group Panama, Santiago de Veraguas, Panama (e-mail: joelbin-18@hotmail.com); **BERNARDO PEÑA** (e-mail: bernadp1990@gmail.com), **VAYRON DE GRACIA** (e-mail: vayrondv_13grx@hotmail.com), **ILIANA CISNEROS** (e-mail: ilianacisnero08@yahoo.es), and **JOSUE ORTEGA**, University of Panama, School of Biology, Canto Del Llano, Santiago de Veraguas, Panama (e-mail: josueortega26@yahoo.es).

CRAUGASTOR LAURASTER. NICARAGUA: RIVAS: Ometepe Island: Reserva de la Biósfera Isla Ometepe, Reserva Natural Volcán Maderas, 1.6 airline km S of Finca Magdalena on trail to summit of Volcán Maderas (11.46869°N, 85.50687°W; WGS 84), 466 m elev. 23 August 2009. Javier Sunyer, Lenin A. Obando, Sean M. Rovito, and Theodore J. Papenfuss. Verified by Vance Vredenburg (based on the sequence of the 16S mitochondrial gene compared to a known population from Finca Monimbó, Matagalpa [MVZ 264231]). Museum of Vertebrate Zoology (MVZ 263735). First record for Rivas and southernmost record for the species, and about a 175 km range extension from its closest known locality at Selva Negra, Matagalpa (Köhler 2001. Anfibios y Reptiles de Nicaragua. Herpeton, Verlag Elke Köhler, Offenbach, Germany. 208 pp.). The frog was found on leaf litter along a path surrounded by undisturbed premontane moist forest (Holdridge 1967. Life Zone Ecology. Tropical Science Center, San José, Costa Rica. 206 pp.). The frog was caught under permit No. 006–062009 issued by Ministerio del Ambiente y los Recursos Naturales, Managua, Nicaragua.

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***DENDROPSOPHUS MICROCEPHALUS* (Small-headed Treefrog)**. NICARAGUA: CHINANDEGA: Comarca Las Grietas, Finca San José de las Marías (12.73027°N, 86.86583°W; WGS 84), 25 m elev. 1 September 2012. Javier Sunyer and Pedrarias Dávila. Verified by Lenin A. Obando. Museo Herpetológico de la Universidad Nacional Autónoma de Nicaragua-León, León, Nicaragua (MHUL 163). First record for Chinandega, with the closest known locality ca. 65 km northeast at Estelí (Köhler 2001. Anfibios y Reptiles de Nicaragua. Herpeton, Verlag Elke Köhler, Offenbach, Germany. 208 pp.). The frog was calling at night on grass that emerged from a seasonal pond in a pasture carved from lowland dry forest (Holdridge 1967. Life Zone Ecology. Tropical Science Center, San José, Costa Rica. 206 pp.). The frog was caught under permit No. 002–012012 issued by Ministerio del Ambiente y los Recursos Naturales, Managua, Nicaragua.

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***ELEUTHERODACTYLUS PLANIROSTRIS* (Greenhouse Frog)**. USA: MISSISSIPPI: Hinds Co.: Jackson (32.31342°N, 90.16976°W; WGS 84). 11 June 2014. Wenhua Lu, Tom Mann, and Debora L. Mann. Verified by Robert L. Jones. Mississippi Museum of Natural Science (MMNS 10386). New county record. Introduced species previously recorded in Mississippi from a greenhouse in Oktibbeha Co., Starkville (about 180 km to the NE), from Harrison Co., Gulfport (about 238 km to the SE; Dinsmore 2004. Herpetol. Rev. 35:403), and Jackson Co., Ocean Springs (Jennifer Y. Lamb, pers. comm.). Five or six individuals were calling from a wooded ravine in the Belhaven residential neighborhood of Jackson. One was calling from leaf of a shrub at a height of approximately 1 m.

A survey for calling frogs was undertaken on the night of 14 June 2014. The species was heard at the collection site and 7 other locations within 1 km. An additional specimen (MMNS 10475) was collected on 29 August 2014, approximately 3 km from the Belhaven collection site; others were heard calling nearby.

The presence of the frogs in multiple locations over a distance of at least 3 km suggests that the species is established in Jackson. This represents the most northerly inland population established outdoors of which we are aware. The population survived a cold winter: the US National Weather Service recorded 62 days between October 2013 and April 2014 when the temperature reached 0°C or lower in Jackson (National Weather Service, Jackson, MS Weather Forecast Office. http://www.srh.noaa.gov/jan/?n=climate_zone_jan_90_100_degs, updated 12 September 2014, accessed 12 September 2014). The means of introduction is not known; the Gulfport population is suspected to have arrived on nursery stock (Dinsmore 2004, *op. cit.*).

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DENDROPSOPHUS HADDADI. BRAZIL: SERGIPE: Municipality of Areia Branca: Parque Nacional Serra de Itabaiana (PARNASI) (10.74775°S, 37.34010°W; WGS 84), 212 m elev. 2 July 2015. Jefferson O. Lima and Rony P. S. Almeida. Verified by Mirco Solé and Caio V. M. Mendes. Herpetological Collection of Laboratório de Biologia e Ecologia de Vertebrados, Universidade Federal de Sergipe, Itabaiana, Sergipe, Brazil (LABEVA 1168 [SVL = 17.10 mm], 1169 [SVL = 18.42 mm], 1170 [SVL = 19.34 mm], 1171 [SVL = 17.29 mm]). Species previously known from the Atlantic Rain Forest and restingas habitat of Pernambuco, Alagoas, Bahia, and Espírito Santo states (Araújo-Neto et al. 2012. Check List 8:248–250). First state record, extends the species distribution ca. 907 km N from the type locality, in Conceição da Barra in State of Espírito Santo (Bastos and Pombal 1996. Amphibia-Reptilia 17:326) and ca. 213 km S from closest locality in Maceió in State of Alagoas (Araújo-Neto et al., *op. cit.*). Specimen collected under an approved SISBIO/ICMBio (#38769-2).

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***GASTROPHRYNE CAROLINENSIS* (Eastern Narrow-mouthed Toad)**. USA: ALABAMA: Tallapoosa Co.: Coon Creek Forever Wild Tract, Coon Creek Landing Road approximately 1.05 road km N of intersection with Gravel Pit Drive (32.59706°N, 85.88016°W; WGS 84). 22 May 2014. Brian D. Holt, Betsy Battistella, and Kevin Carr. Verified by David Laurencio. Auburn University Natural History Museum (AUM AHAP-D 967, digital photographic voucher). New county record (Mount 1975. Reptiles and Amphibians of Alabama. Agricultural Experiment Station, Auburn University, Alabama. 347 pp.). One adult observed under hardwood log upslope from floodplain at mouth of Coon Creek. The nearest previously documented locations in the state occur in Chambers Co. to the northeast, Lee Co. to the east, and Macon Co. to the south (Mount 1975, *op. cit.*). This record fills a gap in the Southern Outer Piedmont section of the Piedmont ecoregion in east-central Alabama.

Thanks to Eric Soehren for reviewing this note and David Laurencio for verifying the identification and confirming the county record. Additional online museum records were examined for county occurrences via VertNet.

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HYALINOBATRACHIUM MONDOLFII. BRAZIL: PARÁ. Municipality of Vitória do Xingu: 24 km NNW of Altamira (2.971°S, 52.277°W; WGS 84). 22 January 2014. E. A. Oliveira and J. Carvalho. Verified by J. C. Señaris. Laboratório de Zoologia de Altamira, Altamira, Pará, Brazil (LZA 841, 844). Previously known from Amazonian areas of Venezuela, Bolivia, and Colombia (Castroviejo-Fisher et al. 2011. Zootaxa 3132:1–55). From Brazil it is known from Para State, Óbidos, north of the Amazon River (Avila-Pires et al. 2010. Bol. Mus. Para. Emílio Goeldi. 5:13–112 [reported as *Cochranella* sp.]) and Acre State, Municipality of Feijó, on the left bank of the Jurupari River (8°9'S, 70°21'W) (Venâncio et al. 2014. Check List 10:1184–1186). Southeasternmost record for the species, extends known distribution 490 km from Óbidos (Avila-Pires et al., *op. cit.*) the nearest locality previously known.

We thank SISBIO/Brazil for the permit for collection of biological material (#32401).

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***HYLA CHRYSOSCELIS* (Cope's Gray Treefrog)**. USA: ALABAMA: Sumter Co.: CR 85, 2.61 road km N of intersection with CR 34 (32.95910°N, 88.19701°W; WGS 84). 22 March 2015. Brian D. Holt and Evan Lawrence. Verified by David Laurencio. Auburn University Natural History Museum (AUM AHAP-D 963, digital photographic voucher). New county record (Mount 1975. Reptiles and Amphibians of Alabama. Agricultural Experiment Station, Auburn University, Alabama. 347 pp.). One adult observed crossing road during light rain. The nearest previously documented locations in the state occur in Lamar Co. to the north (Graham et al. 2009. Herpetol. Rev. 40:367–371) and Greene Co. to the east (Mount 1975, *op. cit.*). This record fills a gap in the Southeastern Floodplains and Low Terraces section of the Southeastern Plains ecoregion in western Alabama.

Thanks to Eric Soehren for reviewing this note and David Laurencio for verifying the identification and confirming the county record. Additional online museum records were examined for county occurrences via VertNet.

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***HYLA CINEREA* (Green Treefrog)**. USA: ARKANSAS: Van Buren Co.: Highway 92, 13.4 km NE of Bee Branch (35.50183°N 092.27854°W; WGS 84), 190 m elev. 25 May 2015. Thomas J. Belford. Verified by William E. Duellman. University of Kansas Digital Archives (KUDA 21417, photographic voucher). First county record (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas, University of Arkansas Press, Fayetteville. 421 pp.). A single adult specimen was found sitting in the middle of the road during a light rain storm. This specimen extends the range 25.81 km W of the nearest known record in Cleburne Co., Arkansas.

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***HYLA CINEREA* (Green Treefrog)**. USA: MISSOURI: Cape Girardeau Co.: Cape Girardeau, Old Route V (37.340641°N, 89.496753°W; WGS 84). 19 June 2015. Jon Davenport and Dustin Siegel. Verified by Richard Daniel. University of Missouri–Columbia (UMC 2804P, digital image voucher). New county record (Daniel and Edmond 2014. Missouri Herpetological Atlas, available at http://atlas.moherp.org, last updated 3 March 2015, accessed 23 June 2015). Single specimen captured and photographed after heard calling in ditch on Old Route V, opposite (north) to Juden Creek Conservation Area.

JON M. DAVENPORT (e-mail: jdavenport@semo.edu) and **DUSTIN S. SIEGEL**, Department of Biology, Southeast Missouri State University, One University Plaza MS6200, Cape Girardeau, Missouri 63701, USA (e-mail: dsiegel@semo.edu).

***HYLA VERSICOLOR* (Eastern Gray Treefrog)**. USA: INDIANA: Noble Co.: Crooked Lake (41.268903°N, 85.482217°W; WGS 84). 23 June 2015. Andrew Hoffman and Sierra Hoffman. Verified by Kenneth Krysko. Florida Museum of Natural History (UF 175746, audio voucher); New county record (Minton 2001. Amphibians and Reptiles of Indiana. Indiana Academy of Science, Indianapolis, Indiana. 404 pp.). Small chorus heard to the west on opposite side of the lake.

ANDREW HOFFMAN (e-mail: hoffmana10@alumni.hanover.edu) and **SIERRA HOFFMAN** Terre Haute, Indiana 47803, USA (e-mail: sshepard1@sycamores.indstate.edu).

***HYPOPACHUS VARIOLOSUS* (Sheep Frog)**. MÉXICO: GUERRERO: Municipality of Pilcaya: El Transformador (18.665°N, 99.4808°W; WGS 84), 1117 m elev. 7 November 2014. Oswaldo Hernández-Gallegos and Ana Esthela López-Moreno. Verified by Luis Canseco Marquez. Colección Fotográfica de Herpetología, Facultad de Ciencias, Universidad Autónoma del Estado de México (CFH 11–12, photo voucher). New municipality record that fills a distributional gap of about 190.5 airline km between Soyatepec, El Ocotito, Guerrero and San Andrés de la Cal, Tepoztlán, Morelos (Greenbaum et al. 2011. Mol. Phylog. Evol. 61:265–277). The frog was found under a rock in tropical deciduous forest interspersed with agricultural crops and grassland.

OSWALDO HERNÁNDEZ-GALLEGOS (e-mail: ohg@uaemex.mx), **ANA ESTHELA LÓPEZ-MORENO**, **AILED PÉREZ-PÉREZ**, **ORLANDO SUÁREZ-RODRÍGUEZ**, and **GABRIEL SUÁREZ-VARÓN,** Facultad de Ciencias, Universidad Autónoma del Estado de México, Instituto Literario 100, Toluca Centro, Estado de México, México, C.P. 50000.

***LEPTOPELIS MACKAYI* (Mackay's Forest Treefrog)**. DEMOCRATIC REPUBLIC OF CONGO: ORIENTALE PROVINCE: Toyokana (2.02734°N, 30.06653°E, WGS84, elev. 1294 m). 31 December 2014. Lodjo (2.20135°N, 30.06653°E; WGS84), elev. 1220 m. 4 January 2015. Chifundera Kusamba, Mwenebatu M. Aristote, Wandege M. Moninga, and Franck M. Masudi. Verified by S. Lötters. University of Texas at El Paso Biodiversity Collections (UTEP 21170–71). Collected on vegetation in secondary, transitional forest during opportunistic visual searches in the evening. New country record (Köhler et al. 2006. Herpetol. J. 16:183–189), extending the distribution ca. 550 km WNW from the type locality at Kakamega Forest, western Kenya, the only known locality for the species.

ELI GREENBAUM (e-mail: egreenbaum2@utep.edu) and **DANIEL F. HUGHES**, Department of Biological Sciences, University of Texas at El Paso, 500 W. University Ave., El Paso, Texas 79912, USA; **CHIFUNDERA KUSAMBA**, Laboratoire d'Herpétologie, Département de Biologie, Centre de Recherche en Sciences Naturelles, Lwiro, République Démocratique du Congo; **FRANCK M. MASUDI**, Université de Kisangani, Centre de Surveillance de la Biodiversité (DEBRT), B.P. 2012 Kisangani, République Démocratique du Congo.

***LITHOBATES AREOLATUS* (Crawfish Frog)**. USA: ALABAMA: Sumter Co.: in the vicinity of Gainesville (location information withheld and on file with the Alabama Department of Conservation and Natural Resrouces). 10 March 2015. Brian D. Holt. Verified by David Laurencio. Auburn University Natural History Museum (AUM AHAP-C 52, audio recording). New state record (Mount 1975. Reptiles and Amphibians of Alabama. Agricultural

Experiment Station, Auburn University, Alabama. 347 pp.). Several individuals heard calling for a stretch of approximately 3.21 km along the south side of roadway. A second location was discovered on 11 March 2015 (AUM AHAP-C 53, audio recording) approximately 18.62 air km S of the first location. Individuals were calling east and west of this site for a stretch of approximately 1.21 km. The nearest previously documented location occurs in Winston Co., Mississippi. These records extend the previously accepted range of *L. areolatus* to the southeast into the Blackland Prairie section of the Southeastern Plains ecoregion in western Alabama.

This species appears to be in decline throughout much of its range (Dodd 2013. Frogs of the United States and Canada. Johns Hopkins University Press, Baltimore, Maryland. 982 pp.) and is expected to receive Priority 1 status for the state (Mark Bailey, *in litt.*). Priority 1 status is defined as taxa critically imperiled and at risk of extinction/extirpation because of extreme rarity, restricted distribution, decreasing population trend/population viability problems, and specialized habitat needs/habitat vulnerability due to natural/human-caused factors (Mirarchi 2004. Alabama Wildlife. Volume 1. A Checklist of Vertebrates and Selected Invertebrates: Aquatic Mollusks, Fishes, Amphibians, Reptiles, Birds, and Mammals. University of Alabama Press, Tuscaloosa. 209 pp.).

Thanks to Eric Soehren for reviewing this note and David Laurencio and Mark Bailey for verifying the identification. Additional online museum records were examined for county occurrences via VertNet.

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***LITHOBATES AREOLATUS* (Crawfish Frog)**. USA: ILLINOIS: Gallatin Co.: pond in pasture, 25 m E of Shain Cemetery Road, 0.3 km N of U.S. Route 45 (37.901839°N, 88.369745°W; WGS 84). 13 March 2015. John G. Palis and Erin L. Palmer. Verified by Christopher A. Phillips. Illinois Natural History Survey (INHS 43259, photo voucher). First record for county, filling gap between Saline and White Counties (Phillips et al. 1999. Field Guide to Amphibians and Reptiles of Illinois. Illinois Natural History Survey. Manual 8, Champaign, Illinois. 282 pp.). Gravid adult female observed with vocalizing males at 2145 h.

JOHN G. PALIS, P.O. Box 387, Jonesboro, Illinois 62952, USA, e-mail: jpalis@yahoo.com.

***LITHOBATES CATESBEIANUS* (American Bullfrog)**. USA: ALABAMA: Sumter Co.: AL 116, approximately 4.84 road km E of AL 17 (32.81076°N, 88.26282°W; WGS 84). 10 March 2015. Brian D. Holt. Verified by David Laurencio. Auburn University Natural History Museum (AUM AHAP-D 959, digital photographic voucher). New county record (Mount 1975. Reptiles and Amphibians of Alabama. Agricultural Experiment Station, Auburn University, Alabama. 347 pp.). One adult observed at the edge of a roadside ditch. The nearest previously documented locations in the state occur in Greene Co. to the east and Choctaw Co. to the south (Mount 1975, *op. cit.*). This record fills a gap in the Blackland Prairie of the Southeastern Plains ecoregion in western Alabama.

Thanks to Eric Soehren for reviewing this note and David Laurencio for verifying the identification and confirming the county record. Additional online museum records were examined for county occurrences via VertNet.

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***LITHOBATES CATESBEIANUS* (American Bullfrog)**. USA: INDIANA: Noble Co.: Crooked Lake (41.268903°N, 85.482217°W; WGS 84). 23 June 2015. Andrew Hoffman and Sierra Hoffman. Verified by Kenneth Krysko. Florida Museum of Natural History (UF 175750, photo voucher). New county record (Minton 2001. Amphibians and Reptiles of Indiana. Indiana Academy of Science, Indianapolis, Indiana. 404 pp.). Large, adult female found in shallows of lake. Multiple adults heard calling from the lake that night.

ANDREW HOFFMAN (e-mail: hoffmana10@alumni.hanover.edu) and **SIERRA HOFFMAN**, Terre Haute, Indiana 47803, USA (e-mail: sshepard1@sycamores.indstate.edu).

***LITHOBATES CATESBEIANUS* (American Bullfrog)**. USA: TENNESSEE: Hardin Co.: Horse Creek Wildlife Sanctuary and Animal Refuge (35.12005°N, 88.178636°W; WGS 84). 30 April 2015. Brian P. Butterfield, Lee J. Barton, Eli Todd, and Kyle Robertson. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19550, color photo). First record for Hardin County (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Hard copy and Internet versions [http://www.apsu.edu/amatlas/]. Accessed 2 May 2015). Calling male was captured by hand. Voucher collected under Tennessee Wildlife Resources Agency Permit 1494.

BRIAN P. BUTTERFIELD (e-mail: bbutterfield@fhu.edu), **LEE J. BARTON**, **ELI TODD**, and **KYLE ROBERTSON**, Freed-Hardeman University, 151 E. Main Street, Henderson, Tennessee 38340, USA.

***LITHOBATES FORRERI* (Forrer's Leopard Frog)**. MÉXICO: SONORA: Municipality of Hermosillo: 21 km NE of Hermosillo (29.20267°N, 110.78407°W; WGS 84), 258 m elev. 27 August 2014. J. H. Valdez-Villavicencio and A. Peralta-García. Verified by James C. Rorabaugh. San Diego Natural History Museum (SDSNH HerpPC 5284, 5285, photo vouchers). First municipality record and the northernmost record for the species in Sonora, extending the range ca. 126 airline km N from the closest known locality, 16 km NE of Guaymas (UIMNH 32067, 32068). The frog was found active between 1930 h and 2100 h near a cattle pond along with five other individuals.

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***LITHOBATES MAGNAOCULARIS* (Northwest Mexico Leopard Frog)**. MÉXICO: JALISCO: Municipality of Huejuquilla El Alto: 6 airline km W of Huejuquilla El Alto (22.609698°N, 103.954398°W; WGS 84), 1700 m elev. 18 July 2014. Rubén A. Carbajal-Márquez, Jorge A. Bañuelos-Alamillo, Eric A. Rivas-Mercado, and Marco A. Domínguez-De la Riva. Verified by Edmundo Pérez-Ramos. San Diego Natural History Museum (SDSNH HerpPC 5263, photo voucher). First municipality record, with the closest known locality being ca. 63 airline km SW from La Vuelta, Nayarit (McDiarmid 1963. Los Angeles Co. Mus. Contr. Sci. 68:1–15). The frog was found at night in an artificial pond.

RUBÉN A. CARBAJAL-MÁRQUEZ, Centro de Investigaciones Biológicas del Noroeste, Instituto Politécnico Nacional No. 195, Col. Playa Palo de Santa Rita Sur, C.P. 23096, La Paz, Baja California Sur, México (e-mail: redman031@hotmail.com); **JORGE A. BAÑUELOS-ALAMILLO**, Unidad Académica de Ciencias Biológicas, Universidad Autónoma de Zacatecas, Edificio de Biología Campus II Ave. Preparatoria S/N Col. Agronómica, C.P. 98066, Zacatecas, Zacatecas, México (e-mail: j.alberto.ba@gmail.com); **ERIC A. RIVAS-MERCADO**, **GUSTAVO E. QUINTERO-DÍAZ,** and **MARCO A. DOMÍNGUEZ-DE LA RIVA**, Universidad Autónoma de Aguascalientes, Centro de Ciencias Básicas, Departamento de Biología, Avenida Universidad No. 940, Aguascalientes, Aguascalientes 20131, México.

***PELOPHRYNE LIGHTI* (Mindanao Flat-headed Toad)**. PHILIPPINES: SAMAR ISLAND: Eastern Samar Province: Municipality of Taft, Barangay San Rafael (11.953°N, 125.84893°E; WGS 84), 140 m elev. 12 October 2007. Cameron D. Siler and Jason B. Fernandez. Verified by Rafe M. Brown. University of Kansas Biodiversity Institute (KU 310635). Western Samar Province: Municipality of San Jose de Buan, Mt. Huraw (12.05262°N, 125.03429°E; WGS 84), 209 m elev. 6 July 2014. Cameron D. Siler, Kerry A. Cobb, Dyanne Realubit, Joseph Brown, Nicholas A. Huron, Vicente Yngente, and Marvic Yngente. Verified by Cameron D. Siler. KU 338130. First vouchered specimens from Samar, former record (Frost 2014. Amphibian Species of the World: an Online Reference. Version 6.0. http://research.amnh.org/vz/herpetology/amphibia/index.html), lacking specimen vouchers, as indicated by a comprehensive literature review (Taylor 1920. Philipp. J. Sci. 16:338; Inger 1954. Fieldiana: Zool. 33:233–239; Inger 1960. Fieldiana: Zool. 39:415–418). Subadult frogs collected in leaf litter near streams. First described from Bunawan, Agusan del Sur, Mindanao (Taylor 1920. Philipp. J. Sci. 16:338), and endemic to Bohol, Mindanao, and Samar islands in southeastern Philippines.

Fieldwork supported by NSF DEB 0743491 and NSF EF-0334952 to Rafe M. Brown, and NSF DEB 0804115 and NSF IOS 1353683 to Cameron D. Siler. Fieldwork was conducted under the Memorandum of Agreement with the Protected Areas and Wildlife Bureau of the Philippines (2009–2014), Gratuitous Permit to Collect No. 221, and KU and OU IACUC Approval Nos. 158-01 and R13-011, respectively.

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***PSEUDACRIS BRACHYPHONA* (Mountain Chorus Frog)**. USA: TENNESSEE: Morgan Co.: Hangover Ridge, 10.3 km N of Wartburg (36.1978°N, 84.5953°W; WGS 84). 28 May 2013. Ted M. Faust. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19478, color photo). New county record (Redmond and Scott. 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Hard copy and Internet versions, the latter [http://www.apsu.edu/amatlas/ accessed 9 March 2015] including links to data on amphibians in Tennessee that have appeared since 1996). A single individual was found on top of Hangover Ridge in a puddle along a dirt road. The individual was found at 1340 h on a clear cool day. We also heard a second individual calling nearby but were unable to locate it for visual identification.

TED M. FAUST (e-mail: tmfaust21@gmail.com) and **MARTIN K. WOOD**, Clinch River Environmental Studies Organization (CRESO), Clinton, Tennessee 37716, USA (e-mail: woodvflwfs@gmail.com).

***RHINELLA MARINA* (Cane Toad)**. MÉXICO: JALISCO: Municipality of Mezquitic: Mezquitic (22.387784°N, 103.728252°W; WGS 84), 1355 m elev. 19 July 2014. Rubén A. Carbajal-Márquez, Jorge A. Bañuelos-Alamillo, Eric A. Rivas-Mercado, and Marco A. Domínguez-De la Riva. Verified by Bradford Hollingsworth. San Diego Natural History Museum (SDSNH HerpPC 5266, photo voucher). First municipality record, with the closest known locality being ca. 75 airline km E at La Vuelta, Nayarit (McDiarmid 1963. Los Angeles Co. Mus. Contr. Sci. 68:1–15). The toad was found at night in downtown Mezquitic.

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***SCAPHIOPUS HOLBROOKI* (Eastern Spadefoot Toad)**. USA: FLORIDA: Hamilton Co.: Suwanee Ridge Mitigation Park Wildlife and Environmental Area (30.44366°N, 83.04613°W; WGS 84). 3 June 2014. Cody D. Godwin. Verified by Kenneth L. Krysko. Florida Museum of Natural History (UF 173690, digital photographic voucher). First verified record for Hamilton Co. (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida, Final report, Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida. 524 pp.). Juvenile trapped in funnel trap along drift fence in sandhill habitat.

CODY D GODWIN (e-mail: codydg1dwin@gmail.com), **JONATHN D. MAYS**, and **KEVIN M. ENGE**, Florida Fish and Wildlife Conservation Commission, 1105 S.W. Williston Road, Gainesville, Florida 32601, USA.

***SCINAX NASICUS* (Lesser-snouted Treefrog)**. BRAZIL: RIO DE JANEIRO: Municipality of Porto Real: Porto Real (22.42°S, 44.28°W; SAD 69). 17 November 2013. J. Pederassi. Verified by U. Caramaschi. Museu Nacional, Rio de Janeiro, Brazil (MNRJ 87535–87537). This species is known to occur in Bolivia, Paraguay, Uruguay, Argentina, and in Brazil it occurs in the states of Mato Grosso, Mato Grosso do Sul, southern Goiás, western Minas Gerais, São Paulo, Paraná, Santa Catarina, and Rio Grande do Sul. This species has never been recorded east of Serra da Mantiqueira or closer than 230 km from the Atlantic Ocean (Natale and Herrera 2006. Herpetol. Rev. 37:360; Carezzano and Cabrera 2010. Check List 6:390–391; IUCN 2013. Red List of Threatened species. Version

2013.2. http://www.iucnredlist.org/details/55980/0; Frost 2014. Amphibian Species of the World: an Online Reference. Version 6.0. http://research.amnh.org/vz/herpetology/amphibia/). First state record, extending its occurrence beyond the Mantiqueira Ridge by at least 160 km SE from the nearest locality in Minas Gerais (Municipality of Alfenas), representing the nearest occurrence to the Atlantic Ocean in an area formerly considered part of the Floresta Atlântica domain, but that is now climatically more similar to Cerrado domains because of deforestation. Specimens were collected under a permit (#45308-2) from Sistema de Autorização e Informação em Biodiversidade - SISBIO.

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TESTUDINES — TURTLES

***CHELONIA MYDAS* (Green Sea Turtle)**. USA: LOUSIANA: Vermilion Parish: salt marsh bayou approximately 8.5 km S of Louisiana State Hwy 82, near the eastern end of Rockefeller Wildlife Refuge (29.591119°N, 93.559816°W; WGS 84). 5 May 2015. Will Selman, William Strong, Jordan Donini, and Willis Sylvest. Verified by Jeff Boundy. Florida Museum of Natural History (UF 175627, photo voucher). New parish record (Dundee and Rossman 1989. The Amphibians and Reptiles of Louisiana. Louisiana State University Press, Baton Rouge, Louisiana. 300 pp.; Selman et al. 2014. Herpetol. Rev. 45:89). This is the second inland record for *C. mydas* in southwestern Louisiana. The individual was located approximately 130 km E of the Cameron Parish record from 2013 (UF 170048). Similar to the Cameron Parish record and others recently reported (St. Bernard Parish: UF 171444; Terrebonne Parish: UF171449; Selman et al. 2014, *op. cit.*), this juvenile individual (~30 cm midline carapace length [MCL]) was live-captured in a fyke net while sampling for *Malaclemys terrapin* (Diamondback Terrapin) under similar environmental conditions (water depth = 1.82 m, bayou width = 22.6 m, salinity = 22.5 ppt, water temperature = 23.7°C). All recent inland records have been juveniles (≤ 30 cm MCL) and have been captured in brackish-salt marshes between late April and mid-May.

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***CHELYDRA SERPENTINA* (Snapping Turtle)**. USA: MINNESOTA: Saint Louis Co.: Hwy 44 (47.24513°N, 91.86366°W; NAD 83). 29 May 2015. Madaline M. Cochrane, Lucas J. O'Neil, Katelin M. Goebel, Stephen D. Nelson. Verified by Chris Phillips. Illinois Natural History Survey (INHS 2015aq, photo voucher). New county record, replaces unvouchered sighting record (Moriarty and Hall 2014. Amphibians and Reptiles in Minnesota. University of Minnesota Press, Minneapolis, Minnesota. 370 pp.). Adult DOR (260 mm straight line carapace length, 97 mm body depth). No vehicle-induced shell damage; flesh consumed prior to collection.

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***CHELYDRA SERPENTINA* (Snapping Turtle)**. USA: TEXAS: Guadalupe Co.: ca. 0.13 km E of Old Seguin Road (29.791199°N, 97.935246°W; WGS 84). 10 June 2015. Ivana Mali, Andrea Villamizar-Gomez, and Shashwat Sirsi. Verified by Carl J. Franklin. University of Texas Arlington Amphibian and Reptile Diversity Research Center (UTADC 8532–8535, photo voucher). New county record (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 447 pp.). This record fills in the distributional gap within the surrounding counties of Bexar, Comal, Hays, and Gonzales, with the exception of Wilson and Caldwell counties (Dixon 2013, *op. cit.*). One juvenile specimen (carapace length: 143 mm; 798 g) captured using a hoopnet trap in a private pond. Specimen (MF37533) was secured under a Scientific Permit for Research (SPR-0102-191) issued to Michael R. J. Forstner by the Texas Parks and Wildlife Department.

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***MESOCLEMMYS HELIOSTEMMA* (Amazon Toad-headed Turtle)**. BRAZIL: AMAZONAS: Municipality of Jutaí: right margin of Jutaí River, at the Jutaí River Extractive Reserve (3.270745°S, 67.324521°W; WGS 84). 20 May 2014. T. Q. Morcatty. Verified by J. Valsecchi. Coleção Herpetológica do Instituto de Desenvolvimento Sustentável Mamirauá (HERPETO 0717). Specimen collected in tropical upland forest by hand. Municipality of Maraã: Juá Grande stream, at the Amanã Sustainable Development Reserve (2.463195°S, 64.846692°W; WGS 84). 16 February 2014. I. V. Debien and T. Q. Morcatty. Verified by J. Valsecchi. HERPETO 0718. Specimen collected in tropical upland forest with a pitfall trap. Originally, the distribution of *M. heliostemma* was restricted to a small area between the north of Ecuador and Peru and the southern end of Venezuela (McCord et al. 2001. Rev. Biol. Trop. 49:715–764). In 2012, based on a revision of few museum specimens, the species occurrence was confirmed in some parts of Brazil, on the edge of the Amazon rainforest, in the states of Roraima, Amazonas, Pará, Mato Grosso, Rondônia, and Acre (Molina et al. 2012. Zootaxa 3575:63–77). For both new records, the previously known closest record is in Rio Baría, Venezuela (McCord et al. 2001, *op. cit.*), which is 391 kilometers NW from the specimen collected in Maraã and 475 kilometers NE from the specimen collected in Jutaí. Based on these two new records, the distribution of *M. heliostemma* is extended to the central Amazon region, filling a gap of around 1,800,000 km^2 with no previous records. *Mesoclemmys heliostemma* is an inhabitant of temporary pools of upland forest situated near the headwaters of Amazon streams, and the nocturnal habits of the species hampers its collection. These specimens were collected under licences (SISBIO 43620-1 and SISBIO 40358-4) approved by the Instituto Chico Mendes de Conservação da Biodiversidade.

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***MESOCLEMMYS RANICEPS* (Black-lined Toad-headed Turtle).** BRAZIL: AMAZONAS: Municipality of Jutaí: left margin of Jutaí River (3.988056°S, 67.826666°W; WGS 84). 14 June 2014. T. Q. Morcatty. Verified by J. Valsecchi. Coleção Herpetológica do Instituto de Desenvolvimento Sustentável Mamirauá, Tefé, Amazonas, Brazil (HERPETO 0716). Specimen collected with a trammel net. *Mesoclemmys raniceps* is expected to occur in the Amazon basin (Bour and Zaher 2005. Pap. Avul. Zool. 45:295–311), including in Peru, Colombia, Venezuela, Bolivia, and Brazil. However, most of the records for the Brazilian Amazon are sparse and old, and some identification problems with the records make it difficult to determine the exact distribution of this species (Iverson 1992. A Revised Checklist with Distribution Maps of the Turtles of the World. Privately printed, Richmond, Indiana. 363 pp.). In Brazil, the species occurs in the states of Amazonas, Roraima, Acre, Pará, and Mato Grosso (Iverson 1992, *op. cit.*). This new record confirms the presence of this species in poorly known areas of central Amazon, covering a gap of 500 km between the two previously documented records. The previous records nearest to the new record are located 253 km NE, in the region of the mouth of the Juruá River, and 257 km SW, in the city of Tabatinga (Iverson 1992, *op. cit.*). Specimen collected under permits (SISBIO 43620-1) granted by Instituto Chico Mendes de Conservação da Biodiversidade.

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***PSEUDEMYS CONCINNA* (River Cooter).** USA: TENNESSEE: Hardin Co.: Horse Creek Wildlife Sanctuary and Animal Refuge (35.124275°N, 88.170613°W; WGS 84). 1 May 2015. Brian P. Butterfield, Lee J. Barton, and T. J. Bivins. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19551, color photo). First record for Hardin Co. (Scott and Redmond 2008 [latest update: 27 October 2014]. Atlas of Reptiles in Tennessee. Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/, accessed 2 May 2015. Juvenile individual was captured by hand. Voucher collected under an approved Tennessee Wildlife Resources Agency Permit (#1494).

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***PSEUDEMYS CONCINNA FLORIDANA* (Coastal Plain Cooter).** USA: ALABAMA: Bullock Co.: near intersection of Reeder Branch and Highway 51 west of Hurtsboro, AL (32.23175°N, 85.45277°W; WGS 84). 17 May 2015. Roger Birkhead, Chelsea Ward, Michael Birkhead, Sawyer Birkhead and Adelaide Birkhead. Verified by Craig Guyer and David Laurencio. Auburn University Natural History Museum (AUM-O 4875). New county record (Mount 1996. The Reptiles and Amphibians of Alabama. University of Alabama Press. 347 pp.). In addition to Mount (1996), VertNet and AUM holdings were searched 3 June 2015. Adult female with a straight line carapace length of 28.0 cm collected DOR. Skeletal specimen and DNA sample taken.

Pseudemys c. floridana is assumed to occur primarily in the southern tier of counties of the state encompassing the Southern Pine Hills and Dougherty Plain physiographic regions (Mount 1996, *op cit.*). This specimen extends the range of *P. c. floridana* northward into the Black Prairie physiographic region across the Chunnenuggee Hills and Southern Red Hills ca. 105 km from the nearest verified specimen (AUM 8963) collected in Coffee Co., Alabama. Because nearby Cowikee Creek is part of the Chattahoochee drainage it might serve as a natural corridor connecting populations to the south.

It should be noted that there were problematic specimens found in the AUM collection. Several specimens (AUM 9443, 9450, 10102) are identified as *P. c. floridana* from Calhoun Co., Alabama, and were examined by RDB on 3 June 2015. They appear to be *P. c. floridana* (lacking distinctive "C" marking on 2nd costal); however, this county is far outside of the known range for the species. This would be approximately 260 km N of the known range and located in the Coosa Valley or Weisner Ridges physiographic provinces. Additional specimens (AUM 9462, AUM 10103) collected by the same collector in the same year and county clearly align with *P. c. concinna* (clearly have the distinctive "C" markings on the 2nd costal). Additionally, specific locality information and the exact collection date are not recorded, making the validity of these specimens suspect. Specimen collected under and Alabama State Department of Conservation and Natural Resources permit (#2014063841468680) issued to RDB.

Thanks to S. Graham for reviewing this note and D. Laurencio and M. Bailey for verifying known localities.

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***PSEUDEMYS SUWANNIENSIS* (Suwannee Cooter).** USA: FLORIDA: Pasco Co.: Pithlachascotee River (28.23648°N, 82.69871°W; WGS 84). 4 June 2015. Timothy J. Walsh and George L. Heinrich. Verified by Kenneth L. Krysko. Florida Museum of Natural History (UF 175737, photographic voucher). New county record and new river record (Heinrich et al. 2015. J. N. Am. Herpetol. 1:53–59). This record is within an ~79 km distributional gap between the Weeki Wachee and Alafia rivers. The juvenile turtle was basking on a tree branch protruding from the water. Two other *P. suwanniensis* (subadult and adult) were also observed basking on logs within the upper 2.4 km of the Pithlachascotee River, but we were unable to photograph them.

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***STERNOTHERUS MINOR* (Loggerhead Musk Turtle).** USA: GEORGIA: Putnam Co: Little River/Lake Sinclair near Burtom Rd (33.224444°N, 83.408333°W; WGS 84). 24 June 2014. James F. Mead. Verified by John Jensen. Georgia Museum of Natural History (GMNH 50979, photo voucher). Within expected range, but first county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens, Georgia. 575 pp.). Single adult collected within riprap at the base of seawall along shoreline (elevation 103 m) near the confluence of Little River with Lake Sinclair.

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***TERRAPENE CAROLINA* (Eastern Box Turtle)**. USA: GEORGIA: Pickens Co.: Talking Rock, Highway 515 ca. 1.5 km N of junction with Carnes Mill Road. (34.541780°N, 84.517121°W; WGS 84). 29 May 2015. James T. Greenway. Verified by James F. Koukl. Department of Biology, University of Texas at Tyler photo voucher (15-GA-0001). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia, University of Georgia Press, Athens, Georgia. 575 pp.). *Terrapene carolina* is assumed to have a statewide distribution; however, there are no verified records for Pickens Co. Empty shell with evidence of traffic damage found on highway.

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***TRACHEMYS SCRIPTA ELEGANS* (Red-eared Slider)**. USA: ARIZONA: Cochise Co.: pond next to San Pedro River (31.541872°N, 110.133448°W; WGS 84), 1238 m elev. 26 February 2012. Brian Hubbs. Natural History Museum of Los Angeles County (LACM PC 1795, photo voucher). Turtles observed basking and floating in pond at 1229 h. Gila Co.: pond in Payson (34.232132°N, 111.346465°W; WGS 84), 1475 m elev. 31 May 2014. 1306 h. Brian Hubbs. LACM PC 1796, photo voucher. All verified by Neftali Camacho. New county records (Brennan and Holycross 2006. A Field Guide to the Amphibians and Reptiles in Arizona. Arizona Game and Fish Department, Phoenix. 150 pp.). These records fill gaps in the range (Stebbins 2003. Western Reptiles and Amphibians. Houghton Mifflin Co., Boston, Massachusetts. 560 pp.)

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SQUAMATA — LIZARDS

***COLEODACTYLUS MERIDIONALIS* (Meridian Gecko)**. BRAZIL: PIAUÍ: Municipality of Altos: Ouro Verde farm (4.965287°S, 42.413062°W; WGS 84). 30 December 2013. Franciéle P. Maragno. Verified by E. M. X. Freire. Coleção de Herpetologia do Museu de Fauna da Caatinga, Centro de Conservação e Manejo de Fauna da Caatinga – Universidade Federal do Vale do São Francisco (UNIVASF), Petrolina, Pernambuco, Brazil (MFCH 3551). Species previously known for seven northeastern Brazilian states: Bahia, Sergipe, Alagoas, Pernambuco, Paraíba, Rio Grande do Norte and Ceará (Ribeiro et al. 2013. Herpetol. Notes 6:23–27). First state record extending the distribution ca. 215 km SW from the nearest population at Ubajara municipality (Ceará State), 410 km NW from Exu municipality (Pernambuco State), and 515 km N from Casa Nova municipality (Bahia State). Adult individual was found in leaf litter in a forest fragment of the Brazilian Savanna (Cerrado). Collecting permit was issued by Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (IBAMA) (#366/2013, process nº 02001.002793/2013-40).

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***HELODERMA HORRIDUM* (Mexican Beaded Lizard)**. MÉXICO: JALISCO: Municipality of Huejuquilla El Alto: 8 airline km W of Huejuquilla El Alto (22.605762°N, 103.955995°W; WGS 84), 1740 m elev. 10 October 2014. Jorge A. Bañuelos-Alamillo and Gabriela Moreno-Ochoa. Verified by Bradford Hollingsworth. San Diego Natural History Museum (SDSNH HerpPC 5258, photo voucher). First municipality record, with the closest known locality being ca. 23 airline km NW from the dirt road between San Juan Capistrano and San Rafael de las Tablas, Zacatecas (Ávila-Villegas 2007. Herpetol. Rev. 38:218). The lizard was found foraging during the day in tropical deciduous forest.

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***HELODERMA SUSPECTUM* (Gila Monster)**. ARIZONA: Santa Cruz Co.: Atascosa Mountains, ~9.0 km SE Ruby town site (31.413547°N, 111.160586°W; NAD 83), 1373 m elev. Thomas R. Jones and Ross J. Timmons. 18 August 2007. Verified by G. Bradley. University of Arizona (UAZ 57567-PSV, voucher photograph). This is the first Gila Monster documented from the Atascosa and Pajarito mountains complex (Beck 2005. Biology of Gila Monsters and Beaded Lizards. University of California Press, Berkeley, California. 211 pp.). Crossing a road on the south slope of the Atascosas at 1842 h; photographed, collected blood sample, and released.

The nearest vouchered records are in Pima Co. ~52 km NNE in the vicinity of Green Valley and adjacent slopes of the Santa Rita Mountains (many records) and ~51 km NW in the Altar Valley (UAZ 46221). We are aware of no nearby records in Sonora, México (J. C. Rorabaugh, pers. comm.). *Heloderma suspectum* is a species ordinarily found in arid habitats of southeastern Arizona, including semidesert grassland or Sonoran desertscrub, but this site is in more mesic Madrean evergreen woodland (Brown 1994. Biotic Communities: Southwestern United States and Northwestern Mexico. University of Utah Press, Salt Lake City, Utah. 346 pp). That *H. suspectum* has never been found in this area is somewhat surprising given the popularity of these mountains among both amateur and professional herpetologists. However, *Gopherus morafkai* (Sonoran Desert Tortoise) has also recently been documented from the Pajarito Mountains (Babb et al. 2013. Herpetol. Rev. 44:623) suggesting the possibility of relatively recent elevational shifts among some Sonoran Desert species.

G. Bradley provided UAZ data for southeastern Arizona *Heloderma*; additional locality data for Arizona and Sonora were accessed 31 December 2014 through HerpNET2 (http://www.herpnet.org).

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***HELODERMA SUSPECTUM CINCTUM* (Banded Gila Monster).** USA: CALIFORNIA: San Bernardino Co.: Mesquite Mountains (35.43060°N, 115.41260°W; WGS 84). 7 May 2015. Barrett Scurlock. Verified by D. Goodward. Natural History Museum of Los Angeles County (LACM PC1872, photographic voucher). New locality and first record from the Mesquite Mountains, ca. 21 km from nearest known localities in the Kingston Mountains and ca. 24 km at Clark Mountain (Lovich and Beaman 2007. Bull. South. California Acad. Sci. 106:39–58). This record fills a gap in the distribution of *H. s. cinctum* in California. Specimen observed at 1330 h.

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***MARISORA ALLIACEA* (Costa Rican Four-lined Skink).** NICARAGUA: RÍO SAN JUAN: Dos Bocas de Río Indio (11.0482°N, 83.8800°W; WGS 84), 8 m elev. 6 April 2012. Theodore J. Papenfuss, Javier Sunyer, Todd W. Pierson, and Milton F. Ubeda-Olivas. Verified by Lenin A. Obando. Museum of Vertebrate Zoology (MVZ 269259). Northernmost record for the species and about a 60 km range extension east-northeast from Bartola, Dept. Río San Juan (as *Mabuya unimarginata*; Köhler 2001. Anfibios y Reptiles de Nicaragua. Herpeton, Verlag Elke Köhler, Offenbach, Germany. 208 pp.). The skink was found active at midday around an abandoned ranger guard station in a lowland wet forest (Holdridge 1967. Life Zone Ecology. Tropical Science Center, San José, Costa Rica. 206 pp.). The skink was captured under permit No. 002–012012, issued by Ministerio del Ambiente y los Recursos Naturales, Managua, Nicaragua.

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***OPHISAURUS ATTENUATUS ATTENUATUS* (Western Slender Glass Lizard).** USA: TEXAS: Jim Hogg Co.: Balluarte Ranch Road (27.18972088°N, 98.58506918°W; WGS 84). 16 May 2015. Mayra Oyervides and (Trey) James D. Petty, III. Verified by Frederic Zaidan, III. University of Texas-Pan American Vertebrate Museum (UTPA 051501, photo voucher). New county record (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 447 pp.). Extends the currently known distribution 12.45 km E of the Brooks Co. line. On 16 May 2015 at 2019 h one individual was found basking on the north side of Balluarte Ranch Road (a dirt road). This specimen was a subadult and had a partially regenerated tail. Heading east on the same road, we found a second adult specimen at 2033 h and 3.32 km from the first adult. The location is part of the south Texas sand sheet, a unique habitat consisting of mostly sandy soils, with grasslands containing low shrubs, including a number of endemic species of the families Fabaceae, Asteraceae, Hydrophyllaceae, and Malvaceae. This population of *O. a. attenuatus* is presumed to be abundant, but seldom encountered. It is currently listed on the Texas Parks and Wildlife Department's species of greatest conservation need.

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***PLESTIODON CALLICEPHALUS* (Mountain Skink).** MÉXICO: JALISCO: Municipality of Huejuquilla el Alto : 6 airline km W of Huejuquilla El Alto (22.610586°N, 103.957425°W; WGS 84), 1718 m elev. 19 July 2014. Jorge A. Bañuelos-Alamillo, Rubén A. Carbajal-Márquez, Eric A. Rivas-Mercado, and Marco A. Domínguez-De la Riva. San Diego Natural History Museum (SDSNH HerpPC 5264, photo voucher). First municipality record, with the closest known locality being ca. 159 airline km to the northwest from 3 mi. W of Tepic, Nayarit (Taylor 1935. Univ. Kansas Sci. Bull. 23:19–643). The female lizard and five eggs were found under a rock in a patch of pine-oak forest surrounded by tropical deciduous forest. Municipality of Mezquitic: 15 airline km NNW of Mezquitic (22.518749°N, 103.763393°W; WGS 84), 1919 m elev. 20 July 2014. Rubén A. Carbajal-Márquez, Jorge A. Bañuelos-Alamillo, Eric A. Rivas-Mercado, and Marco A. Domínguez-De la Riva. SDSNH HerpPC 05265, photo voucher. First municipality record, with the closest known locality being ca. 150 airline km NW from Mezquital del Oro, Zacatecas (Taylor 1935, *op. cit.*) The skink was found basking on oak forest ground litter. Both specimens verified by Bradford Hollingsworth.

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SQUAMATA — SNAKES

***CEMOPHORA COCCINEA* (Scarletsnake).** USA: ALABAMA: Baldwin Co.: Bon Secour National Wildlife Refuge, AL 180 approximately 14.66 road km W of AL 59 (30.24612°N, 87.83372°W; WGS 84). 24 October 2013. Brian D. Holt. Verified by David Laurencio. Auburn Unviersity Natural History Museum (AUM AHAP-D 968, digital photographic voucher). New county record (Mount 1975. Reptiles and Amphibians of Alabama. Agricultural Experiment Station, Auburn University, Alabama. 347 pp.). A single individual observed under pile of scrap lumber in power line right-of-way. The nearest previously published locations in the state occur in Washington Co. to the northwest and Mobile Co. to the west (Mount 1975, *op. cit.*). A query of museum holdings on VertNet (VertNet.org) produced two unpublished records (UF 113794, 113795). Both were collected by Paul E. Moler on 5 June 1979 with no other collection information provided. This record fills a gap in the Gulf Barrier Islands and Coastal Marshes

section of the Southern Coastal Plain ecoregion in southwestern Alabama.

Thanks to Eric Soehren for reviewing this note and David Laurencio for verifying the identification and confirming the county record. Additional online museum records were examined for county occurrences via VertNet.

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***CEMOPHORA COCCINEA COPEI* (Northern Scarletsnake)**. USA: FLORIDA: Hamilton Co: Suwannee Ridge Mitigation Park Wildlife and Environmental Area (30.44366°N, 83.04613°W; WGS 84). 3 June 2014. Jonathan D. Mays. Verified by Kenneth L. Krysko. Florida Museum of Natural History (UF 173271, digital photographic voucher). First county record (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final report, Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida. 524 pp.). Adult male trapped by a drift fence installed in sandhill habitat.

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***COLUBER CONSTRICTOR* (North American Racer)**. USA: TENNESSEE: Morgan Co.: 8.1 km N of Wartburg (36.1777°N, 84.5904°W; WGS 84). 9 August 2008. Ted M. Faust. Verified by Floyd A. Scott. David H. Snyder Museum of Zoology, Austin Peay State University (APSU 19481, color photo). New county record (Scott and Redmond 2008 (latest update: 12 January 2015). Atlas of Reptiles in Tennessee. The Center of Excellence for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at [http://apsu.edu/reptatlas/, accessed 9 March 2015]). A single individual was found crossing Greasy Creek Road at 1410 h on a cloudy day. We have observed, but not photographed, at least two other individuals in this area of Morgan Co. on other occasions.

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***CROTALUS BASILISCUS* (Mexican West Coast Rattlesnake)**. MÉXICO: ZACATECAS: Municipality of Valparaiso: 11 airline km SW of Valparaiso (22.691875°N, 103.634363°W; WGS 84), 1870 m elev. 20 July 2014. Rubén A. Carbajal-Márquez, Jorge A. Bañuelos-Alamillo, Eric A. Rivas-Mercado, and Marco A. Domínguez-De la Riva. Verified by Bradford Hollingsworth. San Diego Natural History Museum (SDSNH HerpPC 5260–5262, photo vouchers). First record for the municipality and only the second for Zacatecas, with the closest known locality being ca. 85 airline km SW from the border between Jalisco and Nayarit (McCranie 1981. Cat. Amer. Amphib. Rept. 283:1–2). The previously known single locality in Zacatecas is ca. 170 airline km SSE from 2.25 km N of Santa Rosa, Moyahua de Estrada, Zacatecas (Ahumada-Carrillo et al. 2011. Herpetol. Rev. 42:397–398). This record also confirms the presence of this species in the Municipality of Valparaiso. Previously, McCranie (1981, *op. cit.*) noted that a badly-damaged DOR specimen found nearby from 18 km NE of Huejuquilla el Alto, Jalisco, could not be assigned with confidence to this species. Our specimen was found DOR in tropical deciduous forest.

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***DIPSAS TEMPORALIS* (Temporal Snail-eater)**. REPUBLIC OF PANAMA: VERAGUAS: Santa Fe District: Guayabito River (8.54719°N, 81.02581°W; WGS 84), 633 m elev. 25 July 2014. E. E. Flores. Verified by Andreas Hertz. Museo de Vertebrados, Universidad de Panamá, Panama City, Panama (MVUP 2144). This record is located 125 km W of Campana Hill (KU 110293) and 11 km E of Mariposa Hill, located within Santa Fe National Park (Lotzkat et al. 2010. Herpetol. Rev. 41:520–523) that helps bridge a distributional gap in Panama's Central Cordillera. The snake was captured at 1915 h near the ground on branches of a shrub (*Heliconia* sp.) in rainforest. This work was conducted under the scientific permit (SE/A-114-13) provided by the Panamanian National Authority for the Environment (ANAM).

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***FARANCIA ABACURA REINWARDTII* (Western Mudsnake)**. USA: ARKANSAS: Prairie Co. Specimen was found 5.85 km N of Bayou Des Arc Wildlife Management Area off Highway 11 (35.06188°N, 91.53749°W; WGS 84), 65 m elev. 12 May 2015. Thomas J. Belford. Verified by William E. Duellman. University of Kansas Digital Archives (KUDA 12339, 12340, photographic vouchers). First county record (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville, Arkansas. 421 pp.). A single adult specimen was found sitting on the bottom of a recently dredged irrigation ditch. This specimen fills a distribution gap among White, Lonoke, Arkansas, Monroe, and Woodruff counties.

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***HETERODON PLATIRHINOS* (Eastern Hog-nosed Snake)**. USA: TENNESSEE: Grainger Co.: Sulpher Springs Hollow, Cherokee Lake (36.31198°N, 83.40425°W; WGS 84). 11 April 2015. Sydney N. McCubbins. Verified by A. Floyd Scott. David H. Snyder Museum of Zoology, Austin Peay State University (APSU 19548, color photo). Adult observed swimming across lake. First record for the county (Redmond and Scott 2008 [latest update: 12 January 2015]. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/; accessed 30 April 2015.

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***IMANTODES LENTIFERUS* (Blunt-headed Tree Snake)**. BRAZIL: PARÁ: Municipality of Paragominas: mining company Norsk Hydro (3.22944°S, 47.83577°W; WGS 84), 85 m elev. 28 February 2015. Alexandre C. Ascenso and Anderson V. Furtado. Verified by João C. L. Costa. Museu Paraense "Emilio Goeldi," Zoologia, Belém, Pará, Brazil (MPEG 26154). Adult male (SVL 540 mm; TL 217 mm) found in a disturbed lowland area, in a dense ombrophilous forest formation in the area of influence of the mining company Norsk Hydro, near to the ecotonal region between Amazon and Cerrado. This species occurs in the Amazon Basin and Guyana Region of Colombia, Ecuador, Peru, Surinam, French Guiana, Guyana, Bolivia, Venezuela, and Brazil (Myers 1982. Am. Mus. Nov. 2738:1–50; Pérez-Santos and Moreno 1988. Ofidios de Colombia. Museo Regionale di Scienze Naturali, Torino. 520 pp; Donnelly and Myers 1991. Am. Mus. Nov. 3017:1–54; Sampaio and Maciel 2012. Herpetol. Rev. 43:307; Cole et al. 2013. Proc. Biol. Soc. Washington 125:317–578), whereas in Brazilian Amazon, it occurs in the states of Amapá, Amazonas, Rondônia, Pará, and Mato Grosso. First county record, extends known range ca. 170 km SE from the nearest record in Acará municipality, Pará State (Cunha and Nascimento 1993. Mus. Par. Emílio Goeldi Publ. Avuls. 9:1–191), on the right margin of the Amazon River, besides being the southeastern most record from Pará. Specimens were collected under permit number IBAMA 2607/2014 (Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis), and this is the publication BRC 0001 of Biodiversity Research Consortium Brazil-Norway (http://brc.museu-goeldi.br/).

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***NERODIA ERYTHROGASTER* (Plain-bellied Watersnake)**. USA: ARKANSAS: Cleburne Co.: 1.41 km W of Big Creek Natural Area off of Heritage Road (35.50611°N, 91.84705°W; WGS 84), 161 m elev. 2 June 2015. Thomas J. Belford. Verified by William E. Duellman. University of Kansas Digital Archives (KUDA 12448, photographic voucher). First county record (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville, Arkansas. 421 pp.). A single adult specimen was found foraging at noon in a small Ozark stream. This specimen fills a distribution gap among White, Independence, Stone, Van Buren, and Faulkner counties.

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***PANTHEROPHIS VULPINUS* (Eastern Foxsnake)**. USA: INDIANA: Montgomery Co.: Crawfordsville (40.067614°N, 86.979865°W; WGS 84). June 2013. Kayla Leach. Verified by Kenneth Krysko. Florida Museum of Natural History (UF 175717, photo voucher). New county record (Minton 2001. Amphibians and Reptiles of Indiana. Indiana Academy of Science, Indianapolis, Indiana. 404 pp.). Adult snake found on two different occasions in open areas where grass is mown regularly.

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***RHINOCHEILUS LECONTEI* (Long-nosed Snake)**. MÉXICO: ZACATECAS: Municipality of Jalpa: Jalpa (21.645985°N, 102.977801°W; WGS 84), 1401 m elev. 18 October 2014. Iván Sánchez, Rubén A. Carbajal-Márquez, and Eduardo Alfonso Ochoa-Medina. Verified by Bradford Hollingsworth. San Diego Natural History Museum (SDSNH HerpPC 5271, photographic voucher). New municipality record, extending the known range in Zacatecas ca. 19 km SW from the closest known locality 2.7 km SW of the Aguascalientes state line on Mexican Highway 70, in the Municipality of Huanusco (Frost and Aird 1978. Herpetol. Rev. 9:62). The record also represents the southernmost known population for the species on southern limit of the Central Plateau. The snake was found foraging at night at the periphery of Jalpa.

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***STORERIA DEKAYI* (Dekay's Brownsnake)**. USA: ALABAMA: Sumter Co.: ca. 2.44 road km E of AL 17 on AL 116 (32.80996°N, 88.28738°W; WGS 84). 10 March 2015. Brian D. Holt. Verified by David Laurencio. Auburn University Natural History Museum (AUM AHAP-D 960, digital photographic voucher). New county record (Mount 1975. Reptiles and Amphibians of Alabama. Agricultural Experiment Station, Auburn University, Alabama. 347 pp.). One individual observed crossing road after recent rain. The nearest previously documented locations in the state occur in Tuscaloosa Co. to the northeast, Perry Co. to the east, and Washington Co. to the south (Mount 1975, *op. cit.*; VertNet). This record fills a gap in the Blackland Prairie of the Southeastern Plains ecoregion in western Alabama.

Thanks to Eric Soehren for reviewing this note and David Laurencio for verifying the identification and confirming the county record. Additional online museum records were examined for county occurrences via VertNet.

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***STORERIA DEKAYI* (Dekay's Brownsnake)**. USA: TENNESSEE: McNairy Co.: Finger, 294 Sherry Lynn Drive (35.357800°N, 88.635583°W; WGS 84). 31 March 2015. Brian P. Butterfield, Valerie K. Butterfield, and Joseph B. Butterfield. Verified by A. F. Scott. David H. Snyder Museum of Zoology, Austin Peay State University (APSU 19545, color photo). New county record (Scott and Redmond 2008 [latest update: 19 May 2014]. Atlas of Reptiles in Tennessee. Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/, accessed 31 March 2015). Individual was found being attacked by domestic dogs.

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***TRILEPIDA KOPPESI* (Amaral's Blind Snake)**. BRAZIL: MINAS GERAIS: Municipality of Governador Valadares: São Manoel Island (19.01°S, 42.11°W; SAD 69), 181 m elev. 19–23 December 2008. R. Filogonio and M. A. S. Canelas. Verified by V. Germano. Museu de Ciências Naturais, Pontifícia Universidade Católica de

Minas Gerais, Belo Horizonte, Minas Gerais (MCNR 3294–3296). *Trilepida koppesi* is known from Mato Grosso do Sul (Parnaíba and Terenos), Goiás (Mineiros), São Paulo (Mogi-Guaçú, Brotas, Itirapina, and Pirassununga) and Tocantins (Palmas) states (Passos et al. 2006. Amphibia-Reptilia 27:347–357; Pinto and Fernandes 2012. Copeia 2012:37–48). First state record, increases the species known distribution ca. 624 km airline NE of Mogi-Guaçú, and ca. 1100 km E of Mineiros, and is the closest record to the littoral zone. Permissions were conceded by Instituto Brasileiro do Meio Ambiente e Recursos Naturais Renováveis (IBAMA) under licenses nº141/2008 NUFAS/MG Process IBAMA nº02015.011675/2007-25, and nº516/2009 NUFAS/MG Process IBAMA nº02015.011675/2007-26.

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***TRIMORPHODON PAUCIMACULATUS* (Sinaloan Lyresnake).** MÉXICO: ZACATECAS: Municipality of Valparaiso: El Zapote (22.534313°N, 104.025634°W; WGS 84), 1100 m elev. 7 September 2014. Jorge A. Bañuelos-Alamillo and Gabriela Moreno-Ochoa. Verified by Bradford Hollingsworth. San Diego Natural History Museum (SDSNH HerpPC 5259, photo voucher). First record for Zacatecas, with the closest known locality being ca. 162.8 airline km SW from 10.2 miles E of San Blas, Nayarit (Hensley and Lannom 1966. Herpetologica 22:231–235). The specimen was found foraging at night in tropical deciduous forest.

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***TROPIDOPHIS FUSCUS*.** CUBA: GUANTÁNAMO: Municipality of El Salvador: Limonar (20.3500°N, 75.3167°W; WGS 84). June 2013. Marco A. Olcha Cordero, Jans Morffe, and Nayla García. Verified by Michel Domínguez. Herpetological Collection of the Instituto de Ecología y Sistemática, Havana, Cuba (CZACC 4.5624). First municipality record and westernmost locality for this species on Cuba, located 28 km SW from the nearest record at Cupeyal del Norte, Moa, Holguín Province, Municipality of Moa (Rodríguez-Schettino et al. 2013. Smithson. Herpetol. Info. Serv. 144:1–92). The snake was found under a rock next to a road in a coffee plantation.

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***TYPHLOPS LEPTOLEPIS*.** CUBA: GRANMA: Municipality of Niquero: Cabo Cruz (19.8408°N, 77.7267°W; WGS 84). No date available. Collector unknown. Verified by Michel Domínguez. Herpetological Collection of the Instituto de Ecología y Sistemática, Havana, Cuba (CZACC 4.5625). First record for Granma Province and southwestern most record on Cuba, with the nearest known record being 254 km NE at La Vigía, Sierra del Crista, Holguín Province (Rodríguez-Schettino et al. 2013. Smithson. Herpetol. Info. Serv. 144:1–92). The blindsnake was found under a limestone rock in a dry semideciduous hardwood coastal forest, which is a new record for that habitat type on Cuba (Domínguez et al. 2013. Zootaxa 3681:136–146).

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***VIRGINIA VALERIAE ELEGANS* (Western Smooth Earthsnake).** USA: TENNESSEE: McNairy Co.: Finger, 294 Sherry Lynn Drive (35.357800°N, 88.635583°W; WGS 84). 5 April 2015. Brian P. Butterfield and Joseph B. Butterfield. Verified by A. F. Scott. David H. Snyder Museum of Zoology, Austin Peay State University (APSU 19546, color photo). New county record (Scott and Redmond 2008 [latest update: 28 July 2014]. Atlas of Reptiles in Tennessee. Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/, accessed 5 April 2015). Individual was found under pine needles.

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New Data on the Distribution of Snakes in Georgia (Caucasus)

The territory of Georgia remains one of the most interesting in the Caucasus for studying the biology of many species of snakes. Despite the publication of a detailed monograph on snakes of the Caucasus (Tuniyev et al. 2009) and subsequent publications (Tarkhnishvili et al. 2002; Frotzler et al. 2011; Tuniyev et al. 2014), a number of aspects of snake biology in the region remain poorly studied. During work in Georgia during 1992, 2009–2014, we obtained new data on the distribution of snake species. We recorded coordinates and elevation of localities using a Garmin GPS navigator; localities are shown in Fig. 1. We highlight several important records here. Specimens are identified by temporary field numbers pending permanent accession to the Institute of Zoology, Georgia collection.

1. We recorded a completely melanistic specimen of *Coronella a. austriaca* Laurenti, 1768 (Figs. 2, 3) on 19 June 2012 in the vicinity of the Roshka village, Dusheti Municipality, Mtskheta-Mtianeti Region (42.5439°N, 44.9139°E; ~1880 m elev.). This is the first significant discovery of melanistic *C. austriaca* in the Caucasus (Doronin 2012), which is extremely rare for this species (Pernetta and Reading 2009).

2. Two melanistic individuals of *Macrovipera lebetina obtusa* (Dwigubsky, 1832) were found on 12 May 1992 at Samshvilde Hill fort, Tetritskaro Municipality, Kvemo Kartli Region (41.5081°N, 44.5022°E; ~760 m elev.). In the Caucasus, a melanistic *M. lebetina* was previously found only in the Eastern Caucasus in Dagestan, Russia (Doronin 2012).

3. We recorded the first population of *Hierophis caspius* (Gmelin, 1789) (Figs. 4, 5) in the east suburb of Rustavi, Kvemo Kartli Region (41.5167°N, 45.0667°E; ~330–410 m elev.) in the valley of the Kura River. At this locality, specimens of different ages were observed in spring and summer during 2009–2014. This locality is significantly isolated from the main range of this species in the Caucasus; previously known localities along the Black Sea coast are approx. 370 km away, while those on the Caspian coast are approx. 290 km distant. We observed this newly recorded population of *H. caspius* to be sympatric with the closely related species *H. schmidti* (Nikolsky, 1909) though at a much lower density than *H. schmidti*; we recorded eight individuals of *H. schimidti* but only two *H. caspius*. This record of *H. caspius* in southeastern Georgia significantly alters knowledge of its distribution in the region (Tuniyev et al. 2009).

4. We recorded several new localities for *Pelias dinniki* (Nikolsky, 1913) (Figs. 6, 7). This includes records from Mtskheta-Mtianeti Region: one adult specimen found on 17 July 2010 at the Sno riverhead, Kazbegi Municipality (42.5983°N, 44.8081°E; ~3000 m elev.) (Fig. 8); one adult specimen found on 07 June 2013 in gorge of Kistinka (= Khde, Brolistskali) Kazbegi Municipality (42.7397°N, 44.6408°E; ~1810 m elev.) (Fig. 9); one adult specimen found on 07 August 2011 in the vicinity of Gudani village (= Gadani), Dusheti Municipality (42.5508°N, 44.9811°E; ~2390 m elev.). These localities are in the territory of Kazbegi National Park and complement the fragmentary data on species range in Georgia. This species is rare in this region. All recorded specimens exhibited bright coloration, with the pattern and color of the body being similar to the *Pelias renardi* complex.

5. Four adult specimens of *Pelias lotievi* (Nilson, Tuniyev, Orlov, Hoggren et Andren, 1995) (Figs. 10, 11) were found on 11 August 2012 in the gorge of Tsovatitskali River in the vicinity of Indurta village, Akhmeta municipality, Kakheti Region (42.4556°N, 45.4381°E; ~2390 m elev.) (Fig. 12). We also found one dead specimen 2 km upriver from that locality (42.4597°N, 45.4281°E;

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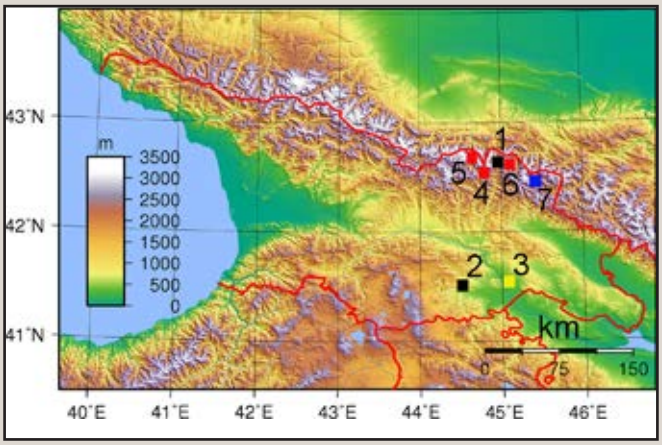


FIG. 1. Location of snakes in the Georgia, Caucasus. 1) Completely melanistic individual *Coronella a. austriaca* (black square), vicinity of the Roshka village. 2) Completely melanistic individual of *Macrovipera lebetina obtusa* (black square), Samshvilde Hill fort. 3) *Hierophis caspius* (yellow square), east suburb of the city of Rustavi. 4) *Pelias dinniki* (red squares), Sno riverhead. 5) *P. dinniki*, Gorge of Kistinka. 6) *P. dinniki*, vicinity of the Gudani village; 7) *Pelias lotievi* (blue square), gorge of Tsovatitskali River, vicinity of the Indurta village.



FIG. 2. Completely melanistic individual of *Coronella a. austriaca* Laurenti, 1768 from the vicinity of Roshka village.



FIG. 3. Head of melanistic *Coronella a. austriaca* Laurenti, 1768, vicinity of the Roshka village.



FIG. 4. *Hierophis caspius* (Gmelin, 1789), east suburb of the Rustavi city (IZG v.53). Dorsal view.



FIG. 5. *Hierophis caspius* (Gmelin, 1789), east suburb of the Rustavi city (IZG v.53). Ventral view.



FIG. 6. *Pelias dinniki* (Nikolsky, 1913), gorge of Kistinka [= Xde] (IZG v.54). Dorsal view of head.

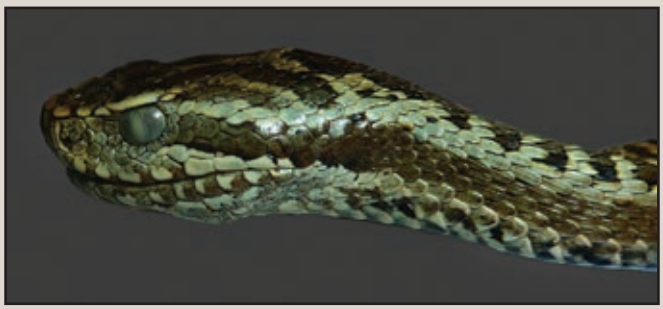


FIG. 7. *Pelias dinniki* (Nikolsky, 1913), gorge of Kistinka [= Xde] (IZG v.54). Left lateral view of the head.



FIG. 8. Sno riverheads, Kazbegi Municipality, Mtskheta-Mtianeti Region.



FIG. 9. Gorge of Kistinka [= Khde, Brolistskali], Kazbegi Municipality, Mtskheta-Mtianeti Region.

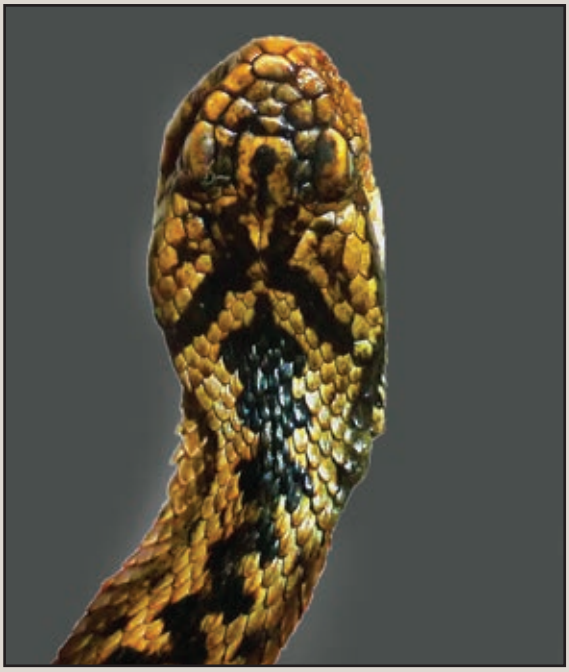


FIG. 10. *Pelias lotievi* (Nilson, Tuniyev, Orlov, Hoggren et Andren, 1995), the gorge of Tsovatitskali River in the vicinity of Indurta village (IZG v.55). Dorsal view of head.



FIG. 11. *Pelias lotievi* (Nilson, Tuniyev, Orlov, Hoggren et Andren, 1995), the gorge of Tsovatitskali River in the vicinity of Indurta village (IZG v.55). Right lateral view of head.



FIG. 12. The gorge of Tsovatitskali River in the vicinity of Indurta village.

~2230 m elev.). Both localities are in the territory of Tusheti National Park. Previously, the species was known in Georgia based only on a photograph taken in the vicinity of the small town of Kazbegi (= Stepantsminda) (Frotzler et al. 2007; Tuniyev et al. 2011).

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Baseline Distribution Records for Amphibians and Reptiles in the Upper Peninsula of Michigan

Species distribution maps are useful for a variety of purposes. With the widespread adoption of GIS-based analysis, biogeographic studies utilize distribution data at many scales, including for conservation status assessments. These studies rely upon accurately published distribution data, and standards for publishing new county records are enforced by the Society for the Study of Amphibians and Reptiles (SSAR; Anonymous 2014). These standards require independent verification of voucher specimens. When distribution data are published or otherwise made available (e.g., on a website) without meeting these standards, problems can arise which confuse the record on what is actually known. Here we address distribution data confounded by just such problems for all species of amphibians and reptiles in the fifteen counties comprising the Upper Peninsula of Michigan (U.P.), and reset the record of valid county level distribution status. This is a result of over a decade of field work and a comprehensive review of all distribution data for the U.P., which cannot be added to the scientific record without first establishing a valid baseline.

Holman (2012) provides the most recent published maps for amphibian and reptile distribution in Michigan. For the past fifteen years we have performed herpetofaunal inventories and monitoring in the U.P. for a variety of initiatives, systematically collecting all known occurrence records, examining voucher material, and constructing an occurrence database with vetting ranks. Recently we noted many discrepancies between Holman's published maps and our collected data. We suspected that many of these resulted from an aborted review of records, given that the author passed away before completing the manuscript. Here we present corrections and updates to the distributions of U.P. herpetofauna. Since many of the corrections suppress previously published county records, we hope that future confusion resulting from repeated citation of erroneous or undocumented records might be avoided by treating this review as a new baseline to which future updates can be added. We hope this reassessment adds value to the substantial contributions of the many past and present Michigan herpetologists whose work we reviewed, and provides a newly vetted opportunity to build upon this valuable knowledge base.

Knowledge of Michigan herpetofaunal distribution has advanced through several stages from Ruthven et al. (1928) through Johnson (1965), Tinkle et al. (1979), Harding (1997), Harding and Holman (1990, 1999), Holman (2004), Holman and Harding (2006), and Holman (2012). Most of these publications have used "blob" maps—polygons drawn to approximate the suspected ranges of species. Blob maps represent a hypothesis on the extent of a species' range, based on the author's review of known records and assumptions about undocumented range limits. Blob maps usually do not provide fine precision on distributions, but are meant as coarse representations of the area within which a species might be found if suitable habitat is present, and authors may warn against using them as a basis for new county distribution records (see Harding 1997).

Blob maps contrast with dot maps which plot a point at each known species occurrence, sometimes generalizing these dots to township or county centers. Traditionally, dot maps have been based on empirical data (e.g., specimen vouchers), and behind each dot on a published map would be a list of specimens examined, or at least a list of the institutions wherein these vouchers reside (see Pfingsten et al. 2013). In some instances, non-vouchered records (i.e., observations) are used in dot maps, typically differentiated from voucher-based dots by using open circles, rather than solid dots (see Ruthven et al. 1928; Vogt 1981).

Converting blobs to dots for range maps is not recommended. Dots derived from blobs can easily be misconstrued as being confirmed records, or as having a finer precision than they actually do. This generates confusion and can result in compounded errors when cited. To minimize such misinterpretation, dot symbols should differentiate between vouchered and unvouchered records (as only vouchered records can be independently verified) and sources should be cited in text or appendices. We also recommend differentiating between verified and unverified voucher material, as errors do persist in museum specimen data, and these can only be discovered by examining material. In short, citing sources and specimens examined enables future workers to avoid having to repeat the work.

Distribution record standards are set by the SSAR (Anonymous 2014). To be accepted by the scientific community, records generally must meet two criteria—physical evidence (e.g., a voucher specimen or photograph), and independent verification. Specimen vouchers should be deposited in a university or museum collection with complete locality and other data, and catalog numbers provided. This is necessary so that specimens are properly curated in an accredited permanent collection. Photo vouchers have substantially less longevity than specimen vouchers, even when properly curated (Rothenberg 1995), and provide substantially less scientific information as well (Graeter et al. 2013). Moreover, care must be taken to ensure that the photos are of sufficient quality and that they show enough diagnostic characters to confirm a species' identification (Graeter et al. 2013). Hence, photos should only be used when voucher specimens cannot be collected. Private collections and web-based photo services are not considered an acceptable permanent record (Anonymous 2014). Often these exist at the discretion of a single individual, and can easily be lost or discarded during major life events, such as a relocation, upon death, or computer failure (for digital collections). When such programs collect significant records, these vouchers should be deposited at an accredited museum for acceptance into the scientific record,

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enabling them to be queried through search engines and direct correspondence with institutions.

The second requirement for county record acceptance, independent verification, is a basic tenant of science. The scientific method rejects non-evidence based claims, requiring evidence that can be independently corroborated. For species distributions to be so verified physical evidence must exist, typically properly preserved voucher specimens, photos, audio recordings, or tissue samples. Observational records cannot be corroborated in this manner, but do have value in filling distribution gaps in the verified record, in natural history studies, and in biogeographical analyses. They should not be used as evidence for range extensions.

We were at first perplexed at how many county records for the U.P. in Harding (1997) and in Holman (2012) did not match with our review of historical occurrence data. Moreover, our extensive field surveys failed to discover many species in the indicated counties. Holman's (2012) maps indicate whether or not he had evidence for species occurrence in a county, with dots generalized to one per county (approximately the center), although some major islands were treated separately. These dots are not ranked with differing symbols to indicate date of most recent occurrence, or for voucher status, as in Phillips et al. (1999). However, Holman does provide more detail on sources in some species accounts. In early 2014 James Harding discovered and shared with us a set of working maps that were the basis for Holman's published maps, and were among Holman's notes preserved in the Michigan State University Museum. These working maps included notes indicating the source used for each county record. We compared these working maps to our comprehensive database and unpublished field notes, and quickly discovered a major discrepancy. In sum, Holman had used blob maps as evidence of occurrence, along with personal observations and those of colleagues, and observations from state agency programs, converting all of these sources to undifferentiated county dots. In particular, Casper (2002) was cited often. However, Michigan maps in Casper (2002) were county-level shading derived from digitized maps from the web site of the Herpetology Collection at the University of Michigan Museum of Zoology (representing UMMZ specimens) and Harding's (1997) blob maps. Harding had a policy of making conservative blob maps, extending somewhat beyond confirmed records, given his experience that more records are usually acquired when these areas are surveyed (J. Harding, pers. comm.). While these caveats on Michigan data sources are discoverable through the appendices included with Casper (2002), and Harding's (1997) introduction, they may not be otherwise apparent. Many of the discrepancies between Holman's 2012 maps and our data can be traced to an incorrect assumption that Casper's 2002 maps, derived in turn from Harding (1997), were voucher based. We correct these assumptions here.

The literature that has cited voucher material for Michigan amphibian and reptile distribution is limited (e.g., Ruthven et al. 1928). We examine this history and newly apply the aforementioned standards for documentation to these and all other distribution data sources. We provide a new vetted baseline upon which new county records can be added, with assurance that scientific standards are applied. We discuss county records without proper documentation in the species accounts, and encourage the collection of voucher specimens for deposit at accredited institutions. Where collecting a voucher specimen is a conservation concern, photo vouchers can serve this purpose if they clearly show enough diagnostic characters for a firm identification to be made (for Michigan species see Graeter et al. 2013), and are properly deposited as detailed above.

We have undoubtedly missed some voucher material despite our best efforts to be comprehensive, and we welcome additions. We do note some instances where vouchers are known to exist (mostly photos) but have not been submitted to acceptable repositories. Properly documenting these findings is encouraged. The collection and deposit of voucher material into acceptable repositories should be standard practice for important records gained through research, or collected through public programs such as the Michigan Frog and Toad Survey (MFTS) and the Michigan Herp Atlas (MHA). We caution against citing works that are non-voucher based when publishing new county records. For example, Wogahn and Ray (2014) published a new county record for Wisconsin citing a non-voucher based blob map (Christoffel et al. 2002) as support for the record being new, rather than using available voucher-based references for Wisconsin (e.g., Vogt 1981, Casper 1996, and subsequent geographic distribution accounts in *Herpetological Review*). The practice of citing non-vouchered sources to support new records may result in errors. We therefore make an appeal to return to voucher-based standards in order to advance science in a reputable manner. Programs and websites that gather occurrence data can partner with an institution who will accept voucher material for documenting noteworthy records.

Methods

Using our vetted database, Holman's unpublished notes, the published literature, and all other available data sources, we reviewed the empirical evidence for the occurrence of each species in each U.P. county for adherence to SSAR standards (Anonymous 2014). We reviewed records from museum collections, the MFTS, MHA, Michigan Natural Features Inventory (MNFI), Herpetological Education and Research Project (H.E.R.P. 2014), and HerpMapper (2014). We used Holman (2012) and Ruthven et al. (1928) as a basis for assigning the newly vetted records to one of three ranks. Voucher material supporting observational records in Ruthven et al. (1928) was treated as re-confirming these records, rather than as new county records, as these have been generally accepted as valid records for many decades, and we did not view them as new. Instead, we now support these with empirical evidence meeting modern standards.

We do not assume evidence is available to support published blob maps that are derived works and/or do not cite source data (e.g., Harding 1997; Harding and Holman 1990, 1999; Casper 2002, Holman 2012, Tekiela 2014). As Harding (1997) notes, typically these are not intended to be used as a basis for new distribution records.

All non-vouchered records were considered observational. Photo "vouchers" posted only to a website are problematic (e.g., some MHA, H.E.R.P., and HerpMapper records). These do not meet SSAR standards for a county record as they are not deposited in a curated collection where all associated data can be examined. Moreover, since some of the photos are copyrighted (MHA), only the copyright holder can deposit them as required. All such records with photo documentation are therefore treated as observational here, pending deposition into museum collections meeting SSAR standards. Properly depositing photos with full data into museum collections is fairly easy, and HerpMapper will currently accommodate this data transfer on request.

The three ranks we applied to records are as follows:

1) Accepted: County records for which we could find properly deposited specimen or photo vouchers corroborating a prior published record. We cited the earliest voucher we could find, along with the earliest voucher we verified, if any (Tables 1–4).

2) Suppressed: These are published records for which we could find no supporting vouchers meeting the SSAR standard. These were mostly from published blob maps, but we corrected some errors as well. These counties may have observational records for the suppressed species (e.g., author notes, MHA or MFTS records), which are discussed, as observational records suggest that the species does in fact occur and vouchers can be collected with relative ease to properly document occurrence.

3) New: These are vouchers we collected for counties that previously had no supporting voucher material meeting SSAR standards, and had not been previously published by Ruthven et al. (1928). Records from Holman's 2012 maps that are supported only (to our current knowledge) by our collections were considered new, as neither his notes nor our correspondence with him prior to his passing indicated that he utilized any of our voucher material.

Below we review each species for specimen vouchers supporting occurrence in each county (Tables 1–4). We discuss the empirical evidence for changing county statuses, and list accepted, suppressed, and new county records. Specimen vouchers examined are cited, and photo vouchers are only mentioned if specimen vouchers were not found. Sources and acronyms for voucher material follow Sabaj Pérez (2014). For space considerations, we have not supplied new maps, but rather present tabular data for easy reference. We include notes on Isle Royale because of its size and distance from the mainland, but do not address species occurrence on other islands. The number of decimal places in coordinates reflects precision estimates. Common and scientific names follow Crother et al. (2012). All GPS locations are WGS 84.

CAUDATA — SALAMANDERS

***AMBYSTOMA LATERALE* AND POLYPLOIDS (Blue-spotted Salamander complex).** Dickinson Co.: Benton Lake Road south of Benton Lake (45.8735°N, 87.9029°W). 1 October 2014. Ryne D. Rutherford. UMMZ 243460. Verified by Gregory Schneider. New county record. Under log along edge of ephemeral pond. Menominee Co.: along Vega Road 01 ca. 2.08 km S of Sand Road (45.8174°N, 87.61454°W). 1 October 2014. Ryne D. Rutherford. UMMZ 243459. Verified by Gregory Schneider. New county record. Under log along road.

The most common salamander in the U.P., verified from all counties (with Dickinson and Menominee first county records provided here) and Isle Royale (Casper 2008). A Dickinson Co. photo from 2011 is also posted on the MHA website without full data. Holman (2012) included an account for polyploid hybrids of *A. laterale* and *A. jeffersonianum*, but we do not attempt to segregate out polyploid records here, as a taxonomy for these combinations has yet to be settled (Bi and Bogart 2010). It is possible that there are instances of polyploid populations in some U.P. counties, and this should be investigated.

Accepted: All counties.

Suppressed: None.

***AMBYSTOMA MACULATUM* (Spotted Salamander).** Baraga Co.: Ottawa National Forest, along FR 2200 ca. 0.6 km N of Hwy 227 (46.546412°N, 88.666084°W). 4 June 2013. Ryne D. and Jenny L. Rutherford. UMMZ 1250 (photo). Verified by Gregory Schneider. New county record. Photo of egg mass in ephemeral pond. Chippewa Co.: South end of beaver pond ca. 0.8 km S of Cranberry Lake (45.968800°N, 84.016529°W). 15 September 2014. Ryne D. Rutherford. UMMZ 243462. Verified by Gregory Schneider. New county record. Under old log in open grassy area along open lake shoreline. Delta Co.: Gravel pit off Limpert Road ca. 2.4 km NW of Hwy 35 (45.572621°N, 87.286464°W). 27 August 2014. Jenny L., Cypress, and Ryne D. Rutherford. UMMZ 243461. Verified by Gregory Schneider. New county record. Under wet board in sandy gravel pit. Houghton Co. Ottawa National Forest, forest road ca. 0.68 km NE of Dunn Lake (46.422558°N, 88.835821°W). 21 July 2010. Gary S. Casper, Thomas G. Anton, Dave Mauger. FMNH 281085. Verified by Alan Resetar. New county record. Under log in old quarry next to spruce bog. Keweenaw Co.: Along Mandan Rd. ca. 1.6 km N of Maniton Lookout Rd. (47.4457°N, 87.7692°W; WGS 84). 20 May 2011. Ryne D. and Jenny L. Rutherford. Verified by Gregory Schneider. New county record. UMMZ 1232 (photo). Photo of ca. 87 egg masses. Luce Co.: Along Camp 9 Rd. near Lost Lake, wetland on E side of road (46.4583°N, 85.7986°W; WGS 84). 10 May 2011. Ryne D. and Jenny L. Rutherford. Verified by Gregory Schneider. New county record. UMMZ 1231 (photo). Photo of ca. 22 egg masses. Menominee Co.: Small gravel pit on N side of Hayward Lake Rd. (45.3473°N, 87.5132°W; WGS 84). 4 August 2008. Ryne D. Rutherford. Verified by Gregory Schneider. New county record. UMMZ 1248 (photo). Photo of adult under log.

A common but cryptic salamander throughout the U.P., now confirmed from all counties except Dickinson (we have an observational record but lack a voucher). Spotted Salamanders have been confirmed in Thunder Bay, Ontario (ROM 1011–13, 1016, 11981), but are not known from Isle Royale (Casper 2008).

Accepted: All counties except Dickinson.

Suppressed: Dickinson (observation only).

***AMBYSTOMA TIGRINUM* (Eastern Tiger Salamander):** Three larval specimens were collected in 1962 and 1963 from Merwin Lake in Alger Co. (Hensley 1964). These were reportedly deposited at the Department of Zoology, Michigan State University, but only one specimen could be located (MSUM 10935). Hensley (1964) dissected one larval specimen and found well-developed eggs in both ovaries, indicating neoteny. MSUM 10935 is a recently transformed adult, which presumably metamorphosed in Hensley's lab. No other records are available and aquatic funnel trap surveys conducted at the site in 2008 (RDR, unpubl. data) yielded negative results. We suspect the population was introduced with bait minnows and is now extirpated, as the species is otherwise unknown from the U.P. Holman (2012) suggested they may be a glacial relict population, but there is no other evidence of the species' range ever having extended this far north post-Pleistocene. We consider this occurrence an anomaly, which should be treated as accidental or introduced on range maps, typically symbolized by an X or question mark.

Accepted: None.

Suppressed: Alger (possibly introduced).

New: None.

***HEMIDACTYLIUM SCUTATUM* (Four-toed Salamander).** Baraga Co.: Ottawa National Forest, McCormick Wilderness, Evergreen Lake (46.7115°N, 88.0381°W). 20 April 2012. Ryne D. and Jenny L. Rutherford. UMMZ 243173. Verified by Gregory Schneider. On nest with eggs in sphagnum moss. Delta Co.: Ca. 0.34 km SW of junction of CR511 and K10 Road (45.7871°N, 86.8674°W).

12 May 2014. Ryne D. Rutherford. UMMZ 243464. Verified by Gregory Schneider. New county record. Adult on nest with eggs, ephemeral pond in red oak/mixed hardwood forest with scattered mossy logs. Houghton Co. Ottawa National Forest, wetland along Forest Road 1360 (46.6384°N, 88.8091°W). 11 June 2003. Gary S. Casper. MPM 33290. Verified by Gregory Schneider. New county record. Roadside wetland of alder in mixed northern hardwood. Mackinac Co. ca. 1.2 km N of Big Knob Campground on Big Knob Road (46.0479°N, 85.5861°W). 21 September 2014. Jenny L., Cypress and Ryne D. Rutherford. UMMZ 243463. Verified by Gregory Schneider. New county record. Under birch log. Menominee Co. Along River Road ca. 2.4 km N of jct. with Santosa Lane (45.4489°N, 87.8342°W). 10 May 2014. Ryne D. Rutherford. UMMZ 1241 (photo). Verified by Gregory Schneider. New county record. In mossy clump in ephemeral pond along road. Ontonagon Co. Ottawa National Forest, west side of Choate Road just south of Steusser Lake (46.4432°N, 89.2507°W). 10 June 2003. Gary S. Casper. MPM 33291. Verified by Jeffrey A. Soltesz. New county record. On nest with Speckled Alder, sedges, and sphagnum moss.

Currently verified from most U.P. counties, but surveys are incomplete and require special knowledge for success. Probably occurs in all counties, but vouchered records are still lacking for four, with Holman's notes indicating these dots were inferred from Casper (2002). Holman's Schoolcraft Co. dot is attributed to a note from J. Harding. They appear to be absent from Isle Royale (Casper 2008).

Accepted: Alger, Baraga, Chippewa, Delta, Gogebic, Houghton, Iron, Mackinac, Marquette, Menominee, Ontonagon counties.

Suppressed: Schoolcraft (observational record). Dickinson, Keweenaw, Luce (no records) counties.

***NECTURUS MACULOSUS MACULOSUS* (Common Mudpuppy).** Probably found throughout the U.P., but vouchers lacking for Iron, Marquette, and Ontonagon counties. Known to occupy harbors and shoals of lakes Superior and Michigan, and inland streams and lakes, especially where streams are (or were) connected to the Great Lakes. Holman's notes indicate Iron and Ontonagon county dots were inferred from Casper (2002), and the source for Marquette Co. is unattributed. Ruthven et al. (1928) included an open circle for Iron Co., indicating a non-vouchered record, but we have been unable to discover any other records for this county. Mudpuppies are verified from Isle Royale (Casper 2008), but may have declined or become extirpated there and elsewhere, especially where lampricide treatment is practiced (Matson 1990, 2005).

Accepted: All counties except Iron, Marquette and Ontonagon counties.

Suppressed: Iron, Marquette, Ontonagon (no records) counties.

New: None.

***NOTOPHTHALMUS VIRIDESCENS* (Eastern Newt).** Gogebic Co.: ca. 1.3 km E of South Boundary Road along dirt road (46.697872°N, 89.950110°W). 17 July 2014. Ryne D. Rutherford. UMMZ 243465. Verified by Gregory Schneider. New county record. Eft found under log.

Found throughout the U.P., but vouchers are currently lacking for Dickinson Co. and there appear to be gaps in the range (unpubl. data). Holman's notes indicate the Dickinson Co. dot was inferred from Casper (2002). This species is verified from Isle Royale (Casper 2008).

Accepted: All counties except Dickinson.

Suppressed: Dickinson (no records) Co.

***PLETHODON CINEREUS* (Eastern Red-backed Salamander).** This common salamander is verified from every county in the U.P. They appear to be absent from Isle Royale (Casper 2008).

Voucher Specimens: All counties.

Suppressed: None.

New: None.

ANURA — FROGS

***ANAXYRUS AMERICANUS AMERICANUS* (Eastern American Toad).** One of the most widespread and abundant species in the U.P., it is accepted from all counties and Isle Royale (Casper 2008).

Accepted: All counties.

Suppressed: None.

New: None.

***HYLA CHRYSOSCELIS* (Cope's Gray Treefrog).** A rare frog in the U.P. often misreported based on calls being confused with *Hyla versicolor*. Reported from Baraga Co. by the Keweenaw Bay Indian Community Frog and Toad Survey, and from Mackinac Co. by the MFTS, these records are considered observational pending supporting voucher specimens with karyotype or sonogram evidence. Also reported from Schoolcraft Co. by the Seney National Wildlife Refuge (Anderson 1982), but vouchers (MSUM 8271–72, UMMZ 166599) lack supporting evidence to distinguish them from *H. versicolor* (although J. Harding states recordings are available). However, we (RDR) have confirmed presence at Seney NWR and have a video of a calling frog there, so we accept this county record. Holman's notes indicate that dots for all counties except Houghton were inferred from Casper (2002). The Houghton Co. record is based on MFTS data (Sargent 2012), with a supporting note stating calls were confirmed by tape recording or local expert (Sargent 2000). We treat this as an observational record. At this time we consider this species occurrence in the U.P. limited to the Seney NWR, and encourage the deposition of additional voucher material with digital audio recordings of the specimen calling with temperature data. The habitat where this species is found at Seney NWR is unusual for the U.P. (large sedge meadows).

Accepted: Schoolcraft Co.

Suppressed: Alger, Baraga, Chippewa, Delta, Dickinson, Gogebic, Houghton, Iron, Keweenaw, Luce, Mackinac, Marquette, Menominee, and Ontonagon counties.

New: None.

***HYLA VERSICOLOR* (Gray Treefrog)** Baraga Co.: T49N, R34W, Section 16 (section centroid 46.6441°N, 88.5646°W). 28 June 1967. Richard E. Fitzner. MSUM 10096. Verified by James Harding. New county record. Delta Co.: near 6463 East Stonington AA.5 Road (45.7793°N, 86.8260°W). 30 June 2012. Ryne D. Rutherford. UMMZ 243457. Verified by Gregory Schneider. New county record. Calling on Ironwood (*Ostyra virginiana*) branch in forest. Houghton Co.: (reconfirmed), on FR-16 (46.5229°N, 88.8875°W). 2 June 2014. Gary S. Casper, Julia L. Robson. UMMZ 243451. Verified by Gregory Schneider. New county record. Iron Co. (reconfirmed): Mint Pond, N side of W Brule Lake Rd., Ottawa National Forest (46.0712°N, 88.7984°W; WGS 84). 21 July 2014. Ryne D. Rutherford. Verified by Gregory Schneider. UMMZ 243473. New

county record. Ontonagon Co.: Ottawa National Forest, Jack Pine Lake (46.5617°N, 89.0246°W). 19 July 2010. Ryne D. and Jenny L. Rutherford. FMNH 281081. Verified by Alan Resetar. New county record.

One of the most widespread and abundant species in the U.P., found in all counties. For this study, we assumed all *Hyla* voucher specimens were *H. versicolor* unless otherwise indicated by collecting notes, karyotype, or sonogram evidence. The Schoolcraft Co. specimens collected at Seney National Wildlife Refuge (MSUM 8271–72, UMMZ 166599) however, could be *H. chrysoscelis* (see above). Luce Co. lacks voucher specimens. For Chippewa Co., tadpole specimens (UMMZ 228023) were too desiccated to confirm, and MSUM 8273 cataloged as *Hyla* sp. was determined to be *Pseudacris crucifer*. Both Chippewa and Luce counties have observational records (GSC, unpubl. Data; MFTS), and we are confident this species can be confirmed with proper vouchers (e.g., Luce Co. MHA photo record 3192 could be submitted as documentation). Holman's notes do not attribute sources for Chippewa or Luce counties, and cite the MFTS for the Baraga Co. record. We provide the first published Baraga Co. voucher here (specimen re-determined from an original identification of *Pseudacris nigrita*). Houghton and Iron county observational records were provided by Ruthven et al. (1928), and we here reconfirm these counties with first published vouchers, along with new Delta and Ontonagon county records. Rare on Isle Royale, but a recent 2012 sighting (P. Brown, pers. comm.; MHA record 2613).

Accepted: All counties except Chippewa and Luce.

Suppressed: Chippewa (observations), Luce (observations and MHA photo) counties.

***PSEUDACRIS CRUCIFER* (Spring Peeper).** Verified from every U.P. county except Luce. Luce Co. has observational records from the MFTS and our surveys, but vouchers are lacking. For Holman's Luce Co. dot, MFTS data (Sargent 2012) is cited as the source. Johnson (1965) states this species is recorded from all U.P. counties, but there is no indication he examined any material from Luce Co. Verified from Isle Royale (Casper 2008).

Accepted: All counties except Luce.

Suppressed: Luce Co.

New: None.

***PSEUDACRIS MACULATA* AND *P. TRISERIATA* (Chorus Frogs).** Gogebic Co.: Ottawa National Forest along FR 8100 (46.3716°N, 89.7845°W). 4 May 2012. Gary S. Casper, David Mauger, Ryne D. and Jenny L. Rutherford. UMMZ 242996. Verified by Gregory Schneider. New county record. In forested ephemeral pond, many observed and calling from pond over several days.

The recent reorganization of chorus frogs based on mtDNA analysis (Moriarty Lemmon et al. 2007) suggests that all U.P. occurrences are *P. maculata*. However, no samples from the U.P. were evaluated. There is no solid evidence (yet) for chorus frogs in the eastern and central U.P., but if eastern specimens are later obtained they are more likely to be *P. triseriata*. We suspect that *P. maculata* is colonizing from Wisconsin in the west. We treat these as a species complex here, pending further molecular studies to resolve this issue. The U.P. is at a range limit, where these species may cycle through range expansions and retractions over time, resulting in ephemeral populations and rarity.

Published chorus frog distribution is currently more confused than any other U.P. amphibian. Ruthven et al. (1928) listed only unvouchered records from Iron and Dickinson counties. Since then, unverified records have been published for nearly all other counties (Holman 2012; Tekeila 2014), but only three counties have actual voucher material, and one of those (Gogebic) is newly published here. Interestingly, the Tekiela (2014) range map is almost the exact opposite of the actual U.P. distribution, whereas Harding's (1997) blob map closely reflects actual data. In our experience, the trill calls of the Spring Peeper are often mistaken for Chorus Frog calls (as are *A. americanus* calls on occasion), and this probably results in many erroneous reports to volunteer frog call survey programs. Calls should be confirmed by collecting voucher specimens or photos.

Chorus frog records from frog call survey programs are available for Baraga, Houghton, Mackinac, and Marquette counties, but are suspect without supporting documentation. We have not heard chorus frogs in these counties in any of our surveys. In Holman's notes, Alger, Chippewa, Delta, Dickinson, Houghton, mainland Keweenaw, Luce, Mackinaw, Marquette, Menominee, and Schoolcraft county records are attributed to MFTS data (Sargent 2012), and are here suppressed. Holman's notes do not attribute the Baraga Co. dot to any specific source, but we redetermined a 1967 specimen labeled as "*Pseudacris nigrita*" as *Hyla versicolor* (MSUM 10096). *P. maculata* is verified from Isle Royale (Casper 2008).

Accepted: Gogebic, Iron, Keweenaw (Isle Royale only) counties.

Suppressed: Alger, Baraga, Chippewa, Delta, Dickinson, Houghton, Luce, Mackinac, Marquette, Menominee, and Schoolcraft (observational only) counties.

***LITHOBATES CATESBEIANUS* (American Bullfrog).** Dickinson Co.: Little Fumee Lake (45.8206°N, 87.9537°W). 20 May 2011. Ryne D. and Jenny L. Rutherford. UMMZ 1242 (photo). Verified by Gregory Schneider. New county record. In cattails along a lake edge.

American Bullfrogs have a patchy distribution in the U.P., possibly as a result of one or more anthropogenic introductions (e.g., tadpoles mixed with bait minnows). Johnson (1965) quotes David Johnson, a Michigan Conservation Officer, regarding introductions in Marquette Co. by individuals attempting to raise them commercially. Populations could also be naturally invading from Wisconsin and some may be post-glacial relics (Holman 2004). Holman's notes indicate that dots for Alger, Chippewa, Delta, Houghton, Iron, Keweenaw, and Ontonagon counties were inferred from Casper (2002); while dots for Dickinson and Menominee counties are attributed to MFTS data (Sargent 2012). American Bullfrogs are absent from Isle Royale (Casper 2008).

Accepted: Baraga, Dickinson, Gogebic, Luce, Mackinac, Marquette, and Schoolcraft counties.

Suppressed: Alger, Houghton (observations only). Chippewa, Delta, Iron, Keweenaw, Menominee, and Ontonagon counties (no records).

***LITHOBATES CLAMITANS* (Green Frog).** A very widespread and abundant species in the U.P., verified from all counties and from Isle Royale (Casper 2008).

Accepted: All counties.

Suppressed: None.

New: None.

***LITHOBATES PALUSTRIS* (Pickerel Frog).** Rare and local in the U.P., absent from Isle Royale (Casper 2008). Easily confused with *L. pipiens*, Baraga Co. observations from the Keweenaw Bay

Indian Community Frog and Toad Survey, and Luce County observations from the MFTS, are suppressed without supporting documentation, as are Houghton Co. observations provided in 2010 by the MHA. Holman's notes indicate that dots for Alger, Chippewa, Delta, Dickinson, Gogebic, Houghton, Keweenaw, Luce, Mackinac, and Schoolcraft counties were inferred from Casper (2002), and Iron Co. is attributed to MFTS data (Sargent 2012), now suppressed without supporting documentation. Johnson (1965) states this species is recorded from Chippewa Co., but we are unable to find any evidence for this. We have never encountered this species in the U.P. despite extensive fieldwork. It is very rare with the last confirmed record in 1947. Any additional encounters should be documented and published.

Accepted: Marquette, Menominee.

Suppressed: Baraga, Luce (observations only). Alger, Chippewa, Delta, Dickinson, Gogebic, Houghton, Iron, Keweenaw, Mackinac, Ontonagon, Schoolcraft (no records) counties.

New: None.

***LITHOBATES PIPIENS* (Northern Leopard Frog)**: A common species verified in every county, but absent from Isle Royale (Casper 2008). Anecdotal evidence suggests that the species has declined dramatically in the U.P. and large range gaps exist (our unpublished data), although it is still extant in every county.

Accepted: All counties.

Suppressed: None.

New: None.

***LITHOBATES SEPTENTRIONALIS* (Mink Frog)**: Found throughout the U.P. with verified specimens from all counties except Luce. Four Luce Co. observations reported by the MHA are undocumented. Holman's notes for his Luce Co. dot are not attributed to any specific sources. Johnson (1965) states this species is recorded from all U.P. counties, but there is no indication he examined any material from Luce Co. This species is verified from Isle Royale (Casper 2008).

Voucher Specimens: All counties except Luce.

Suppressed: Luce Co.

New: None.

***LITHOBATES SYLVATICUS* (Wood Frog)**: An abundant frog verified in every U.P. county and from Isle Royale (Casper 2008).

Voucher Specimens: All counties.

Suppressed: None.

New: None.

TESTUDINES — TURTLES

***CHELYDRA SERPENTINA* (Snapping Turtle)**. Alger Co.: (reconfirmation) Pictured Rocks National Lakeshore, Sand Point (46.4494°N, 86.6034°W). 5 June 2004. Gary S. Casper, Thomas G. Anton, David Mauger. UMMZ 1236–7 (photo). Verified by Gregory Schneider. New county record. Two caught in turtle trap. Houghton Co.: (reconfirmation) Ottawa National Forest, stream crossing (unnamed tributary of Beaver Creek) at FR 1250 (46.5498°N, 88.9164°W). 6 June 2012. Ryne D. and Jenny L. Rutherford . UMMZ 1239 (photo). Verified by Gregory Schneider. New county record. Digging on roadside. Iron Co.: (reconfirmation) Ottawa National Forest, Jumbo River at FR 4080 (46.4147°N, 88.9708°W). 18 June 2013. Ryne D. and Jenny L. Rutherford. UMMZ 1255 (photo). Verified by Gregory Schneider. New county record. Photo of depredated nest. Keweenaw Co.: Across from Bette Gris Preserve parking lot along Gay Lac La Belle Road (47.3586°N, 87.9611°W). 19 May 2011. Stefanie M. Nadeau, Gary S. Casper. UMMZ 1233 (photo). Verified by Gregory Schneider. New county record. In swale wetland. Luce Co.: Along Camp 9 Road near Lost Lake (46.45831°N, 85.7986°W). 10 May 2011. Ryne D. and Jenny L. Rutherford . UMMZ 1234 (photo). Verified by Gregory Schneider. New county record. Ontonagon Co.: Ottawa National Forest, Steusser Lake (46.4512°N, 89.2485°W). 7 June 2010. Gary S. Casper. FMNH 281365. Verified by Alan Resetar. New county record. Juvenile found along shoreline.

Found throughout the U.P. but vouchers lacking for Baraga Co. The only Alger Co. specimen voucher was lost in the CMU collections fire, but we here provide a new reconfirming photo voucher. Holman's notes indicate that the Baraga Co. dot was inferred from Casper (2002), but Robinson and Werner (1975) also published an observational record and a 2014 photo on the MHA site could be submitted as a voucher. Snapping Turtles were noted as present in Houghton and Iron counties by Ruthven et al. (1928) and Johnson (1965) but without vouchers, and we reconfirm these by providing new photo vouchers (Table 3). Iron and Keweenaw county photos from 2011 are also posted on HerpMapper (HM 9038, 9058) and duplicated on H.E.R.P. and MHA websites. Snapping Turtles are not known from Isle Royale (Casper 2008).

Accepted: Alger, Chippewa, Delta, Dickinson, Gogebic, Houghton, Iron, Keweenaw, Luce, Mackinac, Marquette, Menominee, Ontonagon, and Schoolcraft counties.

Suppressed: Baraga Co. (literature and MHA photo records)

***CHRYSEMYS PICTA* (Painted Turtle)**. Alger Co: (reconfirmed). Pictured Rocks National Lakeshore, wetland along Hwy 58 (46.4911°N, 86.3846°W,). 3 June 2004. Gary S. Casper. MPM 33483. Verified by Alan Resetar. New county record. Juvenile in turtle trap. Baraga Co: Little Lake (46.6471°N, 88.5599°W,). 16 May 2014. Gary S. Casper, Ryne D. Rutherford. UMMZ 243471. Verified by Gregory Schneider. New county record. Small lake in Jack Pine managed forest, turtle found dead along shore, probably winter kill. Iron Co.: (reconfirmed) Ottawa National Forest, jct W Brule Lake Rd and Hagerman Lake Rd (46.0714°N, 88.7941°W). 10 June 2010. Gary S. Casper. FMNH 275484. Verified by Alan Resetar. New county record. Hand-captured juvenile crossing road. Mackinac Co.: Along unnamed road ca. 0.4 km S of Hwy 134. (46.0110°N, 84.5185°W). 18 September 2014. Ryne D. Rutherford. UMMZ 1245–6 (photos). Verified by Gregory Schneider. New county record. Swimming near edge of large quarry pond.

Found throughout the U.P. with vouchers confirmed for every county, with Baraga and Mackinac vouchers newly presented here. Ruthven et al. (1928) included a solid dot representing a specimen for Alger Co., which we could not locate, but it may have been UMMZ 51953, a specimen without any data other than county. We reconfirm this record here with a new voucher collected in 2004. Likewise, Ruthven et al. (1928) provided a hollow dot for Iron Co. which we reconfirm with a new voucher collected in 2010 (Table 3). Baraga and Mackinac county photos from 2010 are also posted on HerpMapper (HM 8736, 8785) and duplicated on H.E.R.P. Several Baraga and one Mackinac Co. photo are also posted on the MHA site but lack full data. This species is verified from Isle Royale (Casper 2008).

Accepted: All counties.

Suppressed: None.

***EMYDOIDEA BLANDINGII* (Blanding's Turtle).** Dickinson Co.: On Swanson Rd, 1 mile in from M95 (45.9372°N, 88.0490°W). 18 July 2011. Bill Baily. UMMZ 1240 (photo). Verified by Gregory Schneider. New county record. Menominee Co.: On north side of Snakey Lake Rd (45.3567°N, 87.7989°W). 2 May 2007. Ryne D. and Jenny L. Rutherford. UMMZ 1247 (photo). Verified by Gregory Schneider. New county record. Basking on log in ephemeral pond.

This species is rare and at its range limit in the U.P., with an isolated population in Marquette Co., and new Dickinson and Menominee county records provided here. Our Dickinson Co. photo voucher confirms a skeleton collected by Johnson (1965), which specimen we could not locate. Chippewa (MNFI 2002), Iron (MNFI 2003), Schoolcraft (MNFI 1989), and Mackinac (MHA in 2005) county observations lack documentation. A second Iron Co. record from 2011 with a photo of a road-killed specimen was submitted to the MHA (record 3183). We encourage submission of the photo to a museum collection. Holman's notes indicate that his Alger, Dickinson, and Menominee county records were inferred from Casper (2002), and the Delta Co. record is observational. This species is absent from Isle Royale (Casper 2008).

Accepted: Dickinson, Marquette, Menominee counties.

Suppressed: Iron (MHA photo record requires museum deposition), Delta, Schoolcraft (observations only), Alger (no records) counties.

***GLYPTEMYS INSCULPTA* (Wood Turtle).** Baraga Co.: Ottawa National Forest, Sturgeon River (46.5°N, 88.6°W,). 25 May 2012. Gary S. Casper, Kristina M. Kroening. UMMZ 243381. Verified by Gregory Schneider. New county record. Dried shell found on bluff. Iron Co.: Ottawa National Forest, Tamarack River (46.2°N, 88.9°W). 9 June 2010. Gary S. Casper. UMMZ 1235 (photo). Verified by Gregory Schneider. New county record.

A fairly common species in the western U.P., but sensitive to road mortality, collecting, and riparian habitat degradation. An Alger Co. specimen is available (MPM 33960), but the circumstances raise questions. The dried shell was found on high ground in Pictured Rocks National Lakeshore in 1990 by Jeffrey S. Davis. It is stained brown as is common in turtles from the tannin rich streams of the Lake Michigan drainage to the south (in Schoolcraft and a portion of Alger counties). No other Wood Turtles have been found despite extensive surveys in Alger Co. by us and Jeffrey S. Davis. Bald Eagles are known to prey on turtles and bring them to their nests, discarding the shells (Mabie et al. 1995), and it is possible this individual was transported this way. Until additional records are obtained for Alger Co., we treat their presence there as hypothetical.

A 1997 Chippewa Co. record lacks documentation (MNFI 1997). We provide the first voucher specimens (salvaged shell and photo) here for Baraga and Iron counties, with the Iron Co. voucher supporting 1995 (MNFI 1995) and 1998 observations (MNFI 1998b). Two recent Marquette Co. photo records (MHA from 2008 and 2011) require action for meeting SSAR standards. Interestingly, earlier Marquette Co. observations from 1998 and 2005 (MNFI 1998a, 2005) are recognized as a new county record but not thus documented by depositing photo vouchers. Accordingly, we reluctantly treat Marquette Co. as having only observational data although photo vouchers are clearly available and need only be properly deposited and published. Holman's notes indicate that his Luce and Mackinac county dots were inferred from Casper (2002), and Chippewa and Marquette counties are observational. This species is absent from Isle Royale (Casper 2008).

Accepted: Baraga, Delta, Dickinson, Gogebic, Houghton, Iron, Menominee, Ontonagon, and Schoolcraft counties.

Suppressed: Alger (questionable). Chippewa, Marquette (MHA photos require deposition). Luce, and Mackinac (no records) counties.

***GRAPTEMYS GEOGRAPHICA* (Northern Map Turtle).** Holman's notes attribute his Dickinson Co. dot to J. H. Harding. Harding (pers. comm.) recalled an observation from Dickinson Co. by a credible naturalist in the late 1980s or early 1990s. There are no records for this species from adjacent Florence and Marinette counties in Wisconsin (Vogt 1981; Casper 1996). Harding (*op. cit.*) also personally saw one in the Manistique River in Schoolcraft Co. "years ago," but does not consider them native there. However, a small male was taken in a fyke net in Swan Lake, Schoolcraft Co., in 1975 (UMMZ 142771). This is an isolated lake near the Indian River, which drains into the Manistique River. We accept Schoolcraft Co. based on this voucher but recognize that questions remain over whether or not a population is native and/or established. This species is absent from Isle Royale (Casper 2008).

Accepted: Schoolcraft.

Suppressed: Dickinson (observational only).

New: None.

***TRACHEMYS SCRIPTA ELEGANS* (Red-eared Slider).** Iron Co.: (introduced) Ottawa National Forest, in outflow creek north end of Lake Ottawa (46.0949°N, 88.7524°N). 22 June 2010. Ryne D. and Jenny L. Rutherford. FMNH 281240. Verified by Alan Resetar. New county record. Old adult male.

We provide a new Iron Co. voucher collected in 2010, interpreted as a translocation, as it is far outside the normal range and this species is not considered native to the U.P. (Holman 1994). It is absent from Isle Royale (Casper 2008).

SQUAMATA — LIZARDS

***PLESTIODON FASCIATUS* (Common Five-lined Skink).** This lizard is common in and around granite bedrock glades northwest of Marquette to the Huron Mountains and in a variety of open and edge habitats in Menominee and southwestern Delta counties, including sandy beach ridges, forest edges, and gravel pits (RDR, pers. obs.). We also have a report for Mackinac Co. (Tinkle et al. 1979) but without verification. Holman's notes indicate that dots for Alger and Dickinson counties were inferred from Casper (2002). This species is absent from Isle Royale (Casper 2008).

Accepted: Delta, Marquette, and Menominee counties.

Suppressed: Alger and Dickinson (no records) counties.

New: None.

SQUAMATA — SNAKES

***COLUBER CONSTRICTOR* (North American Racer).** Holman (2004) indicates a "relict" population in Menominee Co., but we are uncertain about the information this is based upon, and the narrative in Holman (2012) simply states it occurs in the county. J. Harding has no data for Menominee Co. (pers. comm.), and there are no records for adjacent Wisconsin counties (Casper 1996). Absent documentation, we treat this record as hypothetical.

Accepted: None.

Suppressed: Menominee (no records).

New: None.

TABLE 1. Salamander matrix. AMLA = *Ambystoma laterale*, AMMA = *Ambystoma maculatum*, HESC = *Hemidactylium scutatum*, NEMA = *Necturus maculosus*, NOVI = *Notophthalmus viridescens*, PLCI = *Plethodon cinereus*. (P) = photo.

County	AMLA	AMMA	HESC	NEMA	NOVI	PLCI
Alger						
earliest year	1949 - UMMZ 100203-4	1957 - UMMZ 117092	1916 - UMMZ 48589-91	1916 - UMMZ 48539-41	1916 - UMMZ 48582-8	1916 - UMMZ 48592-4
earliest verified	1949 - UMMZ 100203-4	1957 - UMMZ 117092	1916 - UMMZ 48589-91	1916 - UMMZ 48539-41	1916 - UMMZ 48582-8	1947 - UMMZ 157144
Baraga						
earliest year	1928 - UMMZ 83865	2013 - UMMZP 1250 (P)	2012 - UMMZ 243173	1958 - UMMZ 118844	1955 - UMMZ 113417	1903 - UMMZ 30773-4
earliest verified	1928 - UMMZ 83865	2013 - UMMZP 1250 (P)	2012 - UMMZ 243173	1958 - UMMZ 118844	1955 - UMMZ 113417	1951 - UMMZ 103706
Chippewa						
earliest year	1913 - UMMZ 46057	2014 - UMMZ 243462	1912 - UMMZ 42786	1938 - UMMZ 83272	1914 - UMMZ 45691	1912 - UMMZ 42787-94
earliest verified	1913 - UMMZ 46057	2014 - UMMZ 243462	1912 - UMMZ 42786	1938 - UMMZ 83272	1914 - UMMZ 45691	1964 - MSUM 8030-58
Delta						
earliest year	1970 - MSUM 14192	2014 - UMMZ 243461	2014 - UMMZ 243464	1955 - UMMZ 113420	1937 - UMMZ 81945-6, 83817	1937 - UMMZ 81947
earliest verified	1970 - MSUM 14192	2014 - UMMZ 243461	2014 - UMMZ 243464	1955 - UMMZ 113420	1937 - UMMZ 81946, 83817	1938 - UMMZ 83756
Dickinson						
earliest year	2014 - UMMZ 243460			1909 - UMMZ 40321		1909 - UMMZ 40342-3, 40346-7
earliest verified	2014 - UMMZ 243460			1909 - UMMZ 40321		1909 - UMMZ 40342-3, 40346-7
Gogebic						
earliest year	1913 - USNM 51937-42	1919 - UMMZ 54058	1964 - UMMZ 125020, 125180	1963 - UMMZ 126601	2014 - UMMZ 243465	1913 - MPM 1690; UMMZ 51943-54
earliest verified	1919 - UMMZ 54056	1919 - UMMZ 54058	1964 - UMMZ 125020, 125180	1963 - UMMZ 126601	2014 - UMMZ 243465	1913 - MPM 1690
Houghton						
earliest year	1976 - MPM 13602	2010 - FMNH 281085	2003 - MPM 33290	1925 - UMMZ 63134	1910 - UMMZ 40703	1925 - UMMZ 83864
earliest verified	1976 - MPM 13602	2010 - FMNH 281085	2003 - MPM 33290	1925 - UMMZ 63134	1910 - UMMZ 40703	1925 - UMMZ 83864
Iron						
earliest year	1938 - UMMZ 83888	1957 - UMMZ 117271	1960 - MSUM 12559		1937 - UMMZ 83782, 151063	1935 - UMMZ 77829
earliest verified	1979 - UWGB 93	1957 - UMMZ 117271	2003 - MPM 33666-7, 33670		1937 - UMMZ 83782, 151063	1960 - UMMZ 121009
Keweenaw						
earliest year	1926 - UMMZ 83889			1905 - UMMZ 33512	1926 - UMMZ 83866-7, 83886	1926 - UMMZ 83870
earliest verified	1931 - UMMZ 70197			1905 - UMMZ 33512	1926 - UMMZ 83866-7, 83886	1926 - UMMZ 83870
Luce						
earliest year	1927 - UMMZ 68387			1925 - UMMZ 61705, 61772-3	1925 - UMMZ 61706, 61761, 61777, 63076	1925 - UMMZ 61758
earliest verified	1927 - UMMZ 68387			1925 - UMMZ 61705, 61772-3	1925 - UMMZ 61706, 61761, 61777, 63076	1946 - UMMZ 165358
Mackinac						
earliest year	1924 - UMMZ 59184	1947 - UMMZ 164685	2014 - UMMZ 243463	1926 - UMMZ 240706	1947 - UMMZ 164686-7	1931 - FMNH 15934-5
earliest verified	1924 - UMMZ 59184	1947 - UMMZ 164685	2014 - UMMZ 243463	1929 - UMMZ 83877	1947 - UMMZ 164686-7	1948 - UMMZ 163250
Marquette						
earliest year	1904 - UMMZ 42468	1905 - UMMZ 83879	1963 - MSUM 11383		1904 - UMMZ 42470	1919 - UMMZ 54060
earliest verified	1904 - UMMZ 42468	1905 - UMMZ 83879	2012 - UMMZ 243195		1904 - UMMZ 42470	1947 - UMMZ 164922
Menominee						
earliest year	2014 - UMMZ 243459		2014 - UMMZ 1241 (P)	1954 - UMMZ 111531-2	1927 - UMMZ 83869, 83885	1938 - UMMZ 83757
earliest verified	2014 - UMMZ 243459		2014 - UMMZ 1241 (P)	1954 - UMMZ 111531-2	1927 - UMMZ 83885	1938 - UMMZ 83757
Ontonagon						
earliest year	1938 - UMMZ 83755	1949 - MSUM 13608	2003 - MPM 33291		1966 - MSUM 12536	1903 - UMMZ 30778-9
earliest verified	1938 - UMMZ 83755	2011 - UMMZ 243154	2003 - MPM 33291		2010 - FMNH 281093, 243245	1946 - UMMZ 165263
Schoolcraft						
earliest year	1976 - USNM 209389	1979 - UMMZ 166607-8		1915 - UMMZ 47362	1942 - UMMZ 92002	1915 - UMMZ 47400-2
earliest verified	1976 - USNM 209389	1979 - UMMZ 166607-8		1915 - UMMZ 47362	1942 - UMMZ 92002	1915 - UMMZ 47401

Notes:
Blank cells have no supporting vouchers.
Ambystoma tigrinum is suppressed from Alger Co.

TABLE 2. Anuran matrix. ANAM = *Anaxyrus americanus*, HYVE = *Hyla versicolor*, PSCR = *Pseudacris crucifer*, PSMA = *Pseudacris maculata* / *triseriata*, LICA = *Lithobates catesbeianus*.

County	ANAM	HYVE	PSCR	PSMA	LICA
Alger					
earliest year	1901 - UMMZ 48542-3, 48581	1949 - UMMZ 100195	1916 - UMMZ 48580		
earliest verified	2004 - MPM 33514-3	2004 - MPM 33415-6, 33428-9, 33525-6	1916 - UMMZ 48580		
Baraga					
earliest year	1964 - MSUM 8234, 8239, 8240	1967 - MSUM 10096	1903 - UMMZ 30775		1937 - UMMZ 89641
earliest verified	1999 - UMMZ 227595	1967 - MSUM 10096	1903 - UMMZ 30775		1937 - UMMZ 89641
Chippewa					
earliest year	1912 - UMMZ 42775-8, 42785		1913 - UMMZ 47807		
earliest verified	1912 - UMMZ 42785		1914 - UMMZ 45678		
Delta					
earliest year	1935 - UMMZ 77824	2012 - UMMZ 243457	1937 - UMMZ 81944		
earliest verified	1935 - UMMZ 77824	2012 - UMMZ 243457	2014 - UMMZ 243458		
Dickinson					
earliest year	1909 - UMMZ 40304-13, 40348	1962 - MSUM 13794	1909 - UMMZ 40344-5		2011 - UMMZP 1242
earliest verified	1909 - UMMZ 40304-13, 40348	1962 - MSUM 13794	1909 - UMMZ 40344-5		2011 - UMMZP 1242
Gogebic					
earliest year	1909 - CAS 39706, 39723-36	1967 - MSUM 12072	1913 - USNM 51923	2012 - UMMZ 242996	1913 - USNM 51931-2
earliest verified	2000 - UMMZ 227594	2011 - UMMZ 242953	2010 - FMNH 281088	2012 - UMMZ 242996	2010 - FMNH 281067-9, 281388
Houghton					
earliest year	1901 - UWZ 9458	2014 - UMMZ 243451	1905 - UMMZ 32820, 32923		
earliest verified	1951 - UMMZ 103697	2014 - UMMZ 243451	1955 - UMMZ 113527		
Iron					
earliest year	1935 - UMMZ 77823	Ruthven et al. (1928)	1935 - UMMZ 77827	1996 - UMMZ 218524-8	
earliest verified	1955 - UMMZ 113517	2014 - UMMZ 243473	1955 - UMMZ 113519	1996 - UMMZ 218524-8	
Keweenaw					
earliest year	1904 - UMMZ 32318-9, 32876-8, 33515	1938 - UMMZ 83777	1905 - UMMZ 33442, 33456-7, 33459	1964 - UMMZ 126073	
earliest verified	1955 - UMMZ 113508	1938 - UMMZ 83777	1905 - UMMZ 33442, 33456-7, 33459	1964 - UMMZ 126073	
Luce					
earliest year	1925 - UMMZ 61709, 61775, 63074, 139255-6				1925 - UMMZ 63075, 139252
earliest verified	1951 - UMMZ 106489				1925 - UMMZ 63075
Mackinac					
earliest year	1927 - UMMZ 64384	1956 - UMMZ 114182	1945 - UMMZ 95053		1946 - UMMZ 95377
earliest verified	1956 - UMMZ 114179	1956 - UMMZ 114182	1948 - UMMZ 101355		1946 - UMMZ 95377
Marquette					
earliest year	1927 - UMMZ 64277, 64296, 65191, 71447, 149627	1930 - UMMZ 83890	1919 - UMMZ 54062		1937 - UMMZ 83805
earliest verified	1951 - MPM 23797-9, UMMZ 106464	1930 - UMMZ 83890	1940 - UMMZ 88439		1937 - UMMZ 83805
Menominee					
earliest year	1927 - UMMZ 83853-54	1927 - UMMZ 139278	1927 - UMMZ 83862		
earliest verified	1964 - MPM 9943-75	2014 - UMMZ 243454-6	1927 - UMMZ 83862		
Ontonagon					
earliest year	1903 - UMMZ 30768-9	2010 - FMNH 281081	1904 - UMMZ 32320, 33516		
earliest verified	1949 - UMMZ 100474	2010 - FMNH 281081	1949 - UMMZ 100475		
Schoolcraft					
earliest year	1915 - UMMZ 47365-73	1964 - MSUM 8271-2	1915 - UMMZ 47363-4		1951 - UMMZ 103713
earliest verified	1960 - MPM 9682-7	1979 - UMMZ 166599	1915 - UMMZ 47364		1951 - UMMZ 103713

Notes:
Blank cells have no supporting vouchers.
Hyla chrysoscelis - Schoolcraft Co. earliest year (1964 - MSUM 8271-2), earliest verified (1979 - UMMZ 166599).

Table 2. Continued. LICL = *Lithobates clamitans*, LIPA = *Lithobates palustris*, LIPI = *Lithobates pipiens*, LISE = *Lithobates septentrionalis*, LISY = *Lithobates sylvaticus*.

County	LICL	LIPA	LIPI	LISE	LISY
Alger					
earliest year	1916 - UMMZ 48547-8, 48569-70, 48573, 48609-11		1916 - UMMZ 48544-6, 48571-2	1916 - CAS 42061-63; UMMZ 48549-68	1916 - UMMZ 48574-9
earliest verified	1916 - UMMZ 48548, 48573, 48609-11		1949 - UMMZ 100201	1916 - UMMZ 48549-68	1949 - UMMZ 100202
Baraga					
earliest year	1903 - UMMZ 30771-2		1925 - UMMZ 62576	1964 - CMU 1444; MSUM 8574-9	1903 - UMMZ 30770, 30785
earliest verified	1957 - UMMZ 117061		1925 - UMMZ 62576	1964 - MSUM 8574-9	1951 - UMMZ 103707
Chippewa					
earliest year	1912 - UMMZ 42772-4, 42779, 42795-96		1912 - UMMZ 42757-62, 42780-2	1912 - UMMZ 42783-4	1912 - UMMZ 42763-71
earliest verified	1912 - UMMZ 42772-4, 42779		1951 - UMMZ 103724	1913 - UMMZ 44704, 44707	1912 - UMMZ 42763
Delta					
earliest year	1935 - UMMZ 77825		1937 - UMMZ 81943, 83810	1958 - UMMZ 118854	1937 - UMMZ 82084, 83811
earliest verified	1935 - UMMZ 77825		1970 - MSUM 14186	1958 - UMMZ 118854	1937 - UMMZ 82084, 83811
Dickinson					
earliest year	1908 - UMMZ 40327		1908 - UMMZ 40325	1908 - UMMZ 40326	1909 - UMMZ 40289-300
earliest verified	1998 - UMMZ 224800		1962 - MSUM 11780	1962 - MSUM 12531	1964 - MSUM 8611-4
Gogebic					
earliest year	1913 - USNM 51933-6		1909 - CAS 39707-22	1909 - CAS 39698	1909 - CAS 39697, 39699-705
earliest verified	1919 - UMMZ 54054		1955 - UMMZ 113521	1938 - UMMZ 84723-4	1999 - UMMZ 227588
Houghton					
earliest year	1905 - UMMZ 32922		1905 - UMMZ 32816-9, 32917-19, 145710	1905 - UMMZ 32920	1925 - UMMZ 62588
earliest verified	1905 - UMMZ 32922		1951 - UMMZ 103703	1925 - UMMZ 62585	1925 - UMMZ 62588
Iron					
earliest year	1926 - UMMZ 63450		1955 - UMMZ 113522-3	1926 - UMMZ 63451	1937 - UMMZ 83784
earliest verified	1926 - UMMZ 63450		1998 - UMMZ 224820	1926 - UMMZ 63451	1955 - UMMZ 113529
Keweenaw					
earliest year	1905 - UMMZ 33423-5, 33429-41, 33443-51, 33460; USNM 57929, 57933		1926 - UMMZ 88474, 139317, 139320, 142909, 172707	1905 - UMMZ 33426	1904 - UMMZ 32313
earliest verified	1905 - UMMZ 33441, 33446-7		1926 - UMMZ 142909	1905 - UMMZ 33426	1955 - UMMZ 113513
Luce					
earliest year	1925 - UMMZ 61708, 61759-60, 61776, 139253-4, 139257		1925 - UMMZ 61707, 61774		1957 - UMMZ 117091
earliest verified	1925 - UMMZ 61708, 61759-60, 61776		1925 - UMMZ 61707		1957 - UMMZ 117091
Mackinac					
earliest year	1926 - UMMZ 63449, 139267		1918 - UMMZ 52272-4	1993 - UMMZ 206366-9	1905 - UMMZ 33455
earliest verified	1932 - UMMZ 72432		1918 - UMMZ 52272-4	1993 - UMMZ 206366-9	1918 - UMMZ 52275
Marquette					
earliest year	1927 - UMMZ 65069, 145735	1927 - UMMZ 64298, 139273	1923 - UMMZ 139269	1923 - UMMZ 92310	1927 - UMMZ 64282, 64299
earliest verified	1927 - UMMZ 65069, 145735	1927 - UMMZ 64298, 139273	1927 - UMMZ 64278	1923 - UMMZ 92310	1940 - UMMZ 88429
Menominee					
earliest year	1926 - UMMZ 63448	1926 - UMMZ 83859	1926 - UMMZ 63443	1927 - UMMZ 83856-58, 83893-4	1927 - UMMZ 83851, 83860-1, 96014
earliest verified	1940 - UMMZ 88466	1926 - UMMZ 83859	1927 - UMMZ 83989	1927 - UMMZ 83856, 83858, 83893-4	1927 - UMMZ 83851
Ontonagon					
earliest year	1903 - UMMZ 30756-7, 30759		1903 - UMMZ 30755, 30758, 30760-2	1904 - UMMZ 32309, 32317	1903 - UMMZ 30763-6, 30776-7, 35600
earliest verified	1903 - UMMZ 30757, 30759		1903 - UMMZ 30755	1904 - UMMZ 32309, 32317	1903 - UMMZ 30764
Schoolcraft					
earliest year	1915 - UMMZ 47384-92		1915 - UMMZ 47374-8	1915 - UMMZ 47394-7	1915 - UMMZ 47379-83, 47393, 47398-9
earliest verified	1915 - UMMZ 47384-92		1998 - UMMZ 224819	1915 - UMMZ 47394-7	1915 - UMMZ 47379

Notes:
Blank cells have no supporting vouchers.
Hyla chrysoscelis - Schoolcraft Co. earliest year (1964 - MSUM 8271-2), earliest verified (1979 - UMMZ 166599).

TABLE 3. Turtle and lizard matrix. CHSE = *Chelydra serpentina*, CHPI = *Chrysemys picta*, EMBL = *Emydoidea blandingii*, GLIN = *Glyptemys insculpta*, PLFA = *Plestiodon fasciatus*. (P) = photo, (S) = skeleton.

County	CHSE	CHPI	EMBL	GLIN	PLFA
Alger					
earliest year	1965 - CMU 751	unknown year - UMMZ 51953			
earliest verified	2004 - UMMZP 1236-7	2004 - MPM 33483			
Baraga					
earliest year		2014 - UMMZ 243471		2012 - UMMZ 243381	
earliest verified		2014 - UMMZ 243471		2012 - UMMZ 243381	
Chippewa					
earliest year	1913 - UMMZ 44571	1912 - UMMZ 42806-7			
earliest verified	1913 - UMMZ 44571	1912 - UMMZ 42806-7			
Delta					
earliest year	1939 - UMMZ 85589	1976 - UWGB 369		1971 - CM 87454-5	1951 - MPM 3032
earliest verified	1939 - UMMZ 85589	1976 - UWGB 369		1971 - CM 87454-5	1951 - MPM 3032
Dickinson					
earliest year	1909 - UMMZ 40382	1908 - UMMZ 40331	2011 - UMMZ 1240 (P)	1961 - UMMZ 123183	
earliest verified	1909 - UMMZ 40382	1908 - UMMZ 40331	2011 - UMMZ 1240 (P)	1961 - UMMZ 123183	
Gogebic					
earliest year	1938 - UMMZ 83779	1920 - UMMZ 55308, 55618		1963 - UMMZ 124487, 124613, 125561-4	
earliest verified	1938 - UMMZ 83779	1920 - UMMZ 55308, 55618		1963 - UMMZ 124487, 124613, 125561-4	
Houghton					
earliest year	2012 - UMMZ 1239 (P)	1964 - MSUM 8687		2007 - UMMZ 243383-4	
earliest verified	2012 - UMMZ 1239 (P)	1964 - MSUM 8687		2007 - UMMZ 243383-4	
Iron					
earliest year	2013 - UMMZ 1255 (P)	2010 - FMNH 275484, 281382		2010 - UMMZ 1235 (P)	
earliest verified	2013 - UMMZ 1255 (P)	2010 - FMNH 275484, 281382		2010 - UMMZ 1235 (P)	
Keweenaw					
earliest year	2011 - UMMZ 1233 (P)	1929 - UMMZ 68757			
earliest verified	2011 - UMMZ 1233 (P)	1948 - UMMZ 98435			
Luce					
earliest year	2011 - UMMZ 1234 (P)	1925 - UMMZ 61762, 61783			
earliest verified	2011 - UMMZ 1234 (P)	1932 - UMMZ 72403			
Mackinac					
earliest year	1918 - UMMZ 65213	2014 - UMMZ 1245-6 (P)			
earliest verified	1918 - UMMZ 65213	2014 - UMMZ 1245-6 (P)			
Marquette					
earliest year	1941 - UMMZ 89937	1927 - UMMZ 64381-3	1927 - UMMZ 64284		1924 - UMMZ 60882
earliest verified	1941 - UMMZ 89937	1927 - UMMZ 64381-3	1927 - UMMZ 64284		1924 - UMMZ 60882
Menominee					
earliest year	1940 - UMMZ 89516	1927 - UMMZ 83850	2007 - UMMZ 1247 (P)	1940 - UMMZ 88457	1940 - UMMZ 88463, 89525
earliest verified	1964 - MSUM 8684	1927 - UMMZ 83850	2007 - UMMZ 1247 (P)	1940 - UMMZ 88457	1940 - UMMZ 88463, 89525
Ontonagon					
earliest year	2010 - FMNH 281365	1903 - UMMZ 30787		1967 - MSUM 4321 (S)	
earliest verified	2010 - FMNH 281365	1903 - UMMZ 30787		2013 - UMMZ 243385	
Schoolcraft					
earliest year	1915 - UMMZ 47348, 47361	1915 - UMMZ 47360		1915 - UMMZ 47349-59	
earliest verified	1915 - UMMZ 47348	1915 - UMMZ 47360		1915 - UMMZ 47349-59	

Notes:
Blank cells have no supporting vouchers.
Graptemys geographica - Schoolcraft Co. earliest year (1975 - UMMZ 142771), earliest verified (1975 - UMMZ 142771).

TABLE 4. Snake matrix. DIPU = *Diadophis punctatus edwardsii*, LATR = *Lampropeltis t. triangulum*, NESI = *Nerodia s. sipedon*, OPVE = *Opheodrys vernalis*.

County	DIPU	LATR	NESI	OPVE
Alger				
earliest year			1937 - UMMZ 89575	1949 - UMMZ 100207
earliest verified			1937 - UMMZ 89575	1949 - UMMZ 100207
Baraga				
earliest year	2010 - FMNH 281235			1951 - UMMZ 103704
earliest verified	2010 - FMNH 281235			1951 - UMMZ 103704
Chippewa				
earliest year	2014 - UMMZ 243467		1912 - UMMZ 42741	1912 - UMMZ 42730-36, 42742-50
earliest verified	2014 - UMMZ 243467		1912 - UMMZ 42741	1912 - UMMZ 42730-36, 42742-50
Delta				
earliest year	1978 - CMU 1073		1933 - UMMZ 74514	1938 - UMMZ 83761
earliest verified	1978 - CMU 1073		1970 - MSUM 11026	1938 - UMMZ 83761
Dickinson				
earliest year	2014 - UMMZ 243466			1908 - UMMZ 40329
earliest verified	2014 - UMMZ 243466			1962 - MSUM 14175
Gogebic				
earliest year	1974 - UMMZ 133327			1932 - UMMZ 75859
earliest verified	1974 - UMMZ 133327			1932 - UMMZ 75859
Houghton				
earliest year	2013 - UMMZ 243258			2010 - FMNH 281096
earliest verified	2013 - UMMZ 243258			2010 - FMNH 281096
Iron				
earliest year	1953 - UMMZ 117068			1957 - UMMZ 117270, 118738
earliest verified	1953 - UMMZ 117068			1957 - UMMZ 117270, 118738
Keweenaw				
earliest year	2011 - UMMZ 243259			
earliest verified	2011 - UMMZ 243259			
Luce				
earliest year				1927 - UMMZ 68420
earliest verified				1927 - UMMZ 68420
Mackinac				
earliest year	1927 - UMMZ 64388	1950 - UMMZ 101449	1927 - UMMZ 64386, 89163-4	1918 - UMMZ 52271
earliest verified	1927 - UMMZ 64388	1950 - UMMZ 101449	1927 - UMMZ 64386	1918 - UMMZ 52271
Marquette				
earliest year	1905 - UMMZ 83873	1941 - UMMZ 90496-8		1927 - UMMZ 83848
earliest verified	1905 - UMMZ 83873	1941 - UMMZ 90496-8		1927 - UMMZ 83848
Menominee				
earliest year	2014 - UMMZ 243468			1939 - UMMZ 100887
earliest verified	2014 - UMMZ 243468			1940 - UMMZ 88459
Ontonagon				
earliest year	1966 - MSUM 12529			2010 - FMNH 281098
earliest verified	1966 - MSUM 12529			2010 - FMNH 281098
Schoolcraft				
earliest year	1922 - UMMZ 56749		1957 - UMMZ 117186	1915 - UMMZ 47341-7
earliest verified	1922 - UMMZ 56749		1957 - UMMZ 117186	1915 - UMMZ 47341-7

***DIADOPHIS PUNCTATUS EDWARDSII* (Northern Ring-necked Snake)**. BARAGA CO.: Ottawa National Forest, Evergreen Lake (46.7111°N, 88.0619°W). 10 July 2010. Ryne D. and Jenny L. Rutherford. FMNH 281235. Verified by Alan Resetar.. New county record. CHIPPEWA CO.: Northeast side of Caribou Lake (46.0038°N, 83.9872°W,). 15 September 2014. Jenny L., Cypress, and Ryne D. Rutherford. UMMZ 243467. Verified by Gregory Schneider. New county record. Under cobble along forest edge. DICKINSON CO.: Sturgeon hydrodam (45.7424°N, 87.8635°W). 9 September 2014. Jenny L., Cypress, and Ryne D. Rutherford. UMMZ 243466. Verified by Gregory Schneider. New county record. Under rubber refuse along forest edge on a steep slope. HOUGHTON CO.: Ottawa National Forest, near FR1334 and railroad crossing (46.5660°N, 88.8230°W). 4 June 2013. Kristina M. Kroening, Gary S. Casper. UMMZ 243258. Verified by Gregory Schneider. New county record. In downed woody debris. KEWEENAW CO.: Along Hwy 26 near Lower Silver River Road (47.4665°N 88.0669°W). 19 May 2011. Ryne D. and Jenny L. Rutherford. UMMZ 243259. Verified by Gregory Schneider. New county record. Found dead alongside rock. MENOMINEE CO.: Along Hwy 366 ca. 0.31 km E of Hwy 360 (45.5228°N, 87.4313°W). 12 August 2014. Ryne D. Rutherford. UMMZ 243468. Verified by Gregory Schneider. New county record. Found crawling over rocks in a gravel pit.

A locally abundant snake, especially in areas with exfoliating rock (granitic, volcanic, and sedimentary bedrock outcrops, exposures of coarse glacial till). Probably distributed throughout the U.P. where suitable habitat is available, but vouchers are lacking for two counties. Holman's notes indicate dots for Alger and Luce counties were inferred from Casper (2002). Jeffrey S. Davis reported Alger Co. observations from Grand Island and the Kingston Plains area (pers. comm.; Casper 2005). A 2011 photo of a road-killed specimen from Dickinson Co., posted anonymously on the MHA website, lacks sufficient data. This species is absent from Isle Royale (Casper 2008).

Accepted: Baraga, Chippewa, Delta, Dickinson, Gogebic, Houghton, Iron, Keweenaw, Mackinac, Marquette, Menominee, Ontonagon, and Schoolcraft counties.

TABLE 4. Continued. PAVU = *Pantherophis vulpinus*, STDE = *Storeria dekayi*, STOC = *Storeria o. occipitomaculata*, THSI = *Thamnophis sirtalis*. (P) = photo.

County	PAVU	STDE	STOC	THSI
Alger				
earliest year	1957 - UMMZ 117184		1927 - UMMZ 65066	1916 - UMMZ 48595-601
earliest verified	1957 - UMMZ 117184		1927 - UMMZ 65066	1916 - UMMZ 48595-601
Baraga				
earliest year			1896 - ANSP 19858	1903 - UMMZ 30784
earliest verified			1896 - ANSP 19858	1903 - UMMZ 30784
Chippewa:				
earliest year			1912 - UMMZ 42737	1912 - UMMZ 42751-6, 42805
earliest verified			1912 - UMMZ 42737	1912 - UMMZ 42751-6
Delta				
earliest year	1964 - MSUM 8788	2014 - UMMZ 243470	1929 - UMMZ 83847	1957 - UMMZ 121672
earliest verified	1964 - MSUM 8788	2014 - UMMZ 243470	1929 - UMMZ 83847	1957 - UMMZ 121672
Dickinson				
earliest year	1909 - UMMZ 40340		1908 - UMMZ 40330	1908 - UMMZ 40328
earliest verified	1961 - MSUM 5080		1908 - UMMZ 40330	1908 - UMMZ 40328
Gogebic				
earliest year			1909 - CAS 39691	1905 - UMMZ 32821
earliest verified			1926 - UMMZ 63427	1905 - UMMZ 32821
Houghton				
earliest year			1891 - USNM 55787	1905 - UMMZ 32916, 34121
earliest verified			1909 - UMMZ 40484	1905 - UMMZ 32916, 34121
Iron				
earliest year	1934 - UMMZ 77707		1905 - UMMZ 32814-5, 32845	1935 - UMMZ 77822
earliest verified	1934 - UMMZ 77707		1905 - UMMZ 32814-5, 32845	1935 - UMMZ 77822
Keweenaw				
earliest year			1904 - UMMZ 33408-17, 172049	1904 - UMMZ 33418-21
earliest verified			1904 - UMMZ 33408-17, 172049	1904 - UMMZ 33418-21
Luce				
earliest year			1925 - UMMZ 61771	1925 - UMMZ 61711, 61719, 61778-9
earliest verified			1925 - UMMZ 61771	1925 - UMMZ 61711, 61719, 61778-9
Mackinac				
earliest year			1921 - UMMZ 56324-5, 56333	1917 - UMMZ 54065
earliest verified			1921 - UMMZ 56324-5, 56333	1917 - UMMZ 54065
Marquette				
earliest year	1926 - UMMZ 63418		1919 - UMMZ 54061	1895 - USNM 44366
earliest verified	1926 - UMMZ 63418		1919 - UMMZ 54061	1904 - UMMZ 46482
Menominee				
earliest year	1924 - UMMZ 63423	2009 - UMMZP 1243-4 (P)	1939 - UMMZ 85536	1926 - UMMZ 63434
earliest verified	1963 - MSUM 8793	2009 - UMMZP 1243-4 (P)	1939 - UMMZ 85536	1926 - UMMZ 63434
Ontonagon				
earliest year			1903 - UMMZ 31379	1903 - UMMZ 30780-3
earliest verified			1903 - UMMZ 31379	1903 - UMMZ 30780-3
Schoolcraft				
earliest year	1943 - UMMZ 92364	1979 - UMMZ 166598	1915 - UMMZ 47335-40	1915 - UMMZ 47323-34
earliest verified	1943 - UMMZ 92364	1979 - UMMZ 166598	1915 - UMMZ 47335-40	1915 - UMMZ 47323-34

Notes:
Blank cells have no supporting vouchers.
Coluber constrictor is suppressed from Menominee Co.
Heterodon platirhinos - Menominee Co. earliest year (1924 - FMNH 5998), earliest verified (1940 - UMMZ 89502-3).
Regina septemvittata - Mackinac Co. earliest year (1942 - UMMZ 91994, 92232), earliest verified (1942 - UMMZ 91994, 92232).
Sistrurus catenatus - Mackinac Co. earliest year (1926 - UMMZ 67714), earliest verified (1926 - UMMZ 67714).
Thamnophis sauritus septentrionalis - Mackinac Co. earliest year (1956 - UMMZ 114175), earliest verified (1956 - UMMZ 114175).

Suppressed: Alger (observational only) and Luce (no records) counties.

***HETERODON PLATIRHINOS* (Eastern Hog-nosed Snake).** Known only from extreme southern Menominee Co. in the U.P., where it is at its range limit. The last verified museum records are from 1940, but we (RDR) reconfirmed presence in 2014 with a road-killed specimen (UMMZ 243469). This species is absent from Isle Royale (Casper 2008).

Accepted: Menominee.
Suppressed: None.
New: None.

***LAMPROPELTIS TRIANGULUM TRIANGULUM* (Eastern Milksnake).** Verified in only two U.P. counties. MHA reports an observation from Dickinson Co. This species is absent from Isle Royale (Casper 2008).

Accepted: Mackinac, Marquette.
Suppressed: None.
New: None.

***NERODIA SIPEDON SIPEDON* (Northern Watersnake).** Confirmed in five counties. A specimen originally listed as from Gogebic Co. (UMMZ 75850) was determined to have actually been collected in Preston Co., West Virginia, in 1932. Holman's notes indicate dots for Gogebic and Luce counties were inferred from Casper (2002), while attribution for Menominee and Ontonagon

county dots is unspecified. This species is absent from Isle Royale (Casper 2008).

Accepted: Alger, Chippewa, Delta, Mackinac, Schoolcraft.

Suppressed: Gogebic, Luce, Menominee, Ontonagon (no records).

New: None.

***OPHEODRYS VERNALIS* (Smooth Greensnake).** Houghton Co.: Ottawa National Forest, along FR 2276 (46.6808°N, 88.7335°W). 30 June 2010. Gary S Casper, Jason M. Dare. FMNH 281096. Verified by Alan Resetar. New county record. Under plywood board. Ontonagon Co. Ottawa National Forest, Bond Falls Flowage at Little Falls (46.3794°N, 89.1006°W). 18 July 2010. Gary S. Casper, Thomas G. Anton, David Mauger. FMNH 281098. Verified by Alan Resetar. New county record. In fractured basalt and woody debris in large grassed meadow of drained flowage bed.

Verified in all U.P. counties except for Keweenaw. The distribution appears to have some gaps in the western U.P. (unpubl. data), which are not readily apparent from county level maps. We provide two new county records here. Holman's notes indicate his Keweenaw Co. dot was inferred from Casper (2002). This species is absent from Isle Royale (Casper 2008).

Accepted: All counties except Keweenaw.

Suppressed: Keweenaw Co. (no records).

***PANTHEROPHIS VULPINUS* (Western Foxsnake).** Alger Co.: (reconfirmed) T46N R17W Sec. 30, Cusino Station (46.445°N, 86.35861°W). 20 July 1957. O. Hammerberg. UMMZ 117184. Verified by Gregory Schneider. New county record.

This species is verified in several central U.P. counties, but purported records from the western counties have not been confirmed. Extensive sampling throughout the Ottawa National Forest has yielded negative results, with the Iron River area being the furthest west occurrence known (GSC and RDR, unpubl. data, 2010–2014). Ruthven et al. (1928) included solid dots for Ontonagon and Alger counties, but we have been unable to locate the specimens, suggesting that they were later re-determined, or are lost. We leave Ontonagon as suppressed, but the earliest (1957) specimen we could find for Alger Co. reconfirms that record (first published here). Holman's notes indicate dots for Baraga, Gogebic, Houghton, Keweenaw, and Ontonagon counties were inferred from Casper (2002). This species is absent from Isle Royale (Casper 2008).

Accepted: Alger, Delta, Dickinson, Iron, Marquette, Menominee, and Schoolcraft counties.

Suppressed: Baraga, Gogebic, Houghton, Keweenaw, and Ontonagon (no records) counties.

***REGINA SEPTEMVITTATA* (Queen Snake).** This species is known only from a 1948 record on Bois Blanc Island in Lake Huron, which, while politically in Mackinac Co., has more biological affinity with the Lower Peninsula than the U.P. Surveys are needed to determine if this species is still extant there.

Accepted: Mackinac.

Suppressed: None.

New: None.

***SISTRURUS CATENATUS* (Eastern Massasauga).** This species is known only from Bois Blanc Island in Lake Huron, which, although in Mackinac Co., has more biological affinity with the Lower Peninsula than the U.P.

Accepted: Mackinac.

Suppressed: None.

New: None.

***STORERIA DEKAYI* (Dekay's Brownsnake).** Delta Co.: West side of Point Detour (45.6045°N, 86.6161°W). 31 August 2014. Jenny L., Cypress and Ryne D. Rutherford. UMMZ 243470. Verified by Gregory Schneider. New county record. Under limestone slab in shoreline alvar adjacent to upland cedar forest. Menominee Co. The Oxbow, Menominee River (45.3692°N, 87.8754°W). 26 June 2009. Ryne D. and Jenny L. Rutherford. UMMZ 1243–4 (photo). Verified by Gregory Schneider. New county record. On moist soil along river.

This species is verified only from Delta, Menominee, and Schoolcraft counties, two of which are newly presented here. Holman's notes indicate his Keweenaw County dot was inferred from Casper (2002), and Marquette Co. is without any specific source. This species is absent from Isle Royale (Casper 2008).

Accepted: Delta, Menominee, and and Schoolcraft counties.

Suppressed: Keweenaw and Marquette counties (no records).

***STORERIA OCCIPITOMACULATA OCCIPITOMACULATA* (Northern Red-bellied Snake).** Menominee Co.: (reconfirmed) ca. 1.6 km S of Harris (45.69°N, 87.35°W). 20 August 1939. Collector unknown. UMMZ 85536. Verified by Gregory Schneider.

This is the most common snake in the U.P., verified from every county and Isle Royale (Casper 2008). Holman (2012) omitted a dot from Menominee Co., but the dot is plotted in his notes, and mentioned by Johnson (1965), so we suspect this omission was a transcription error, given the ready availability of specimens from this county (MSUM, UMMZ). We provide voucher confirmation here.

Accepted: All counties.

Suppressed: None.

***THAMNOPHIS SAURITUS SEPTENTRIONALIS* (Northern Ribbonsnake).** Verified only from Bois Blanc Island in Lake Huron, which, while politically in Mackinac Co., has more biological affinity with the Lower Peninsula than with the U.P. Holman (2012) also reports them from Drummond Island, Chippewa Co., without providing a source (a dot was placed only on the island). The Keweenaw Co. record from Isle Royale is based upon a specimen collected by Dr. A. E. Foote in the early 1900s and has been lost, and is considered an error (Johnson 1965; Casper 2008). A MHA observational record from Marquette Co. lacks documentation.

Accepted: Mackinac.

Suppressed: Chippewa and Keweenaw counties (see above).

New: None.

***THAMNOPHIS SIRTALIS* (Common Gartersnake).** Menominee Co.: (reconfirmed) 16.1 km NE of Menominee (45.3°N, 87.5°W). 1939. H. Vander Schalie. UMMZ 85583. Verified by Gregory Schneider. New county record.

The second most common snake in the U.P. (after *S. occipitomaculata*), confirmed in every county. Holman (2012) omitted a dot from Menominee Co., but the dot is plotted in his notes, and mentioned by Johnson (1965), so we suspect this omission was a transcription error, given the ready availability of specimens from this county (MSUM, UMMZ). We provide voucher confirmation here. This species is verified from Isle Royale (Casper 2008, Mooi et al. 2011).

Accepted: All counties.
Suppressed: None.

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NATURAL HISTORY NOTES

CAUDATA — SALAMANDERS

***AMBYSTOMA VELASCI* (Plateau Tiger Salamander). MORTALITY.** *Ambystoma velasci* is a salamander endemic to Mexico, and has been reported to feed on any vertebrates and invertebrates that can possibly be swallowed (Lemos-Espinal and Dixon 2013. Amphibians and Reptiles of San Luis Potosí. Eagle Mountain Publishing, LC, Eagle Mountain, Utah. 300 pp.), including conspecifics (Vite-Silva et al. 2009. Bull. Maryland Herpetol. Soc. 45:1). However, herein we report a case of a fatality of *A. velasci* due to the failed consumption of a dragonfly naiad.

At 1455 h on 20 September 2012, a male *A. velasci* (SVL = 66 mm) was found freshly dead on the edge of a pond (Fig. 1A) located in the vicinity of El Ocotoreo, municipality of Xichú, Guanajuato, Mexico (21.3143°N, 100.1088°W, WGS84, 2252 m elev.). After a closer examination, we found a live dragonfly naiad (Odonata) lodged deeply within its mouth (Fig. 1B). We speculate that the salamander died by the failure to subdue, kill, and pass the lodged dragonfly naiad deeper into the digestive tract. Although dragonfly naiads are very common in ponds and similar areas where *A. velasci* is present, it still remains to be studied what proportions of them occur in the diet of *A. velasci*.

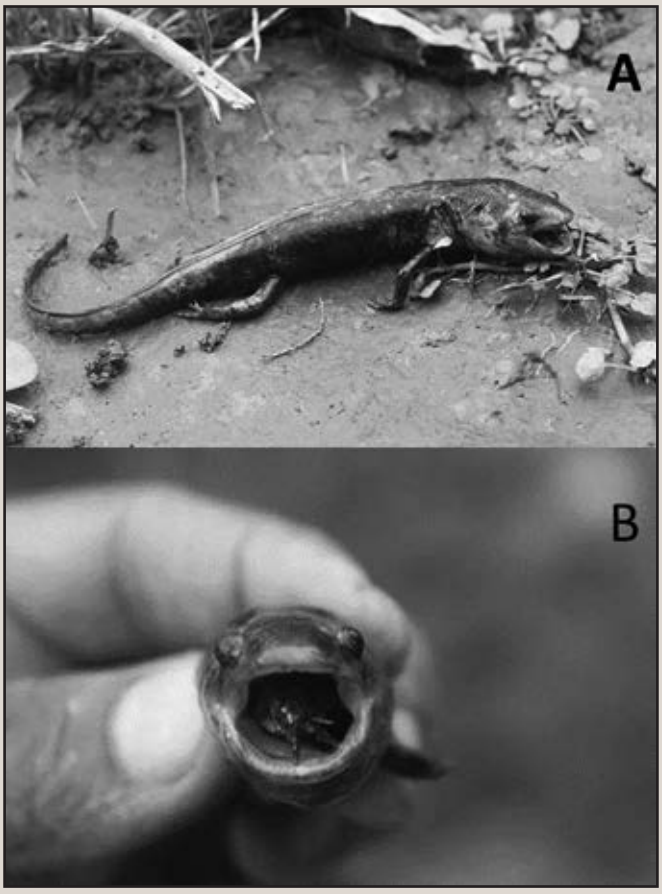


PHOTO BY ADRIAN LEYTE-MANRIQUE

FIG. 1. A freshly dead *Ambystoma velasci* with a live dragonfly naiad lodged in its mouth.

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***BOLITOGLOSSA CELAQUE* (Celaque Climbing Salamander). DIET.** The plethodontid salamander *Bolitoglossa celaque* inhabits the highlands of southwestern Honduras in the departments of Íntibuca, La Paz, and Lempira (McCranie and Castañeda 2007. Guia de Campo de los Anfibios de Honduras. Bibliomania!, Salt Lake City, Utah. 304 pp.), and is considered Endangered by the IUCN (Townsend and Wilson 2010. *In* Wilson et al. [eds.], Conservation of Mesoamerican Amphibians and Reptiles, pp. 461–486. Eagle Mountain Publishing, Eagle Mountain, Utah). No information has previously been reported regarding the diet of this species (McCranie and Wilson 1993. Herpetologica 49:1–15; McCranie and Wilson 2002. Amphibians of Honduras. Society for the Study of Amphibians and Reptiles, New York. 625 pp.; McCranie and Castañeda 2007, *op. cit.*).

We examined dietary items from ten preserved specimens of *B. celaque*: eight individuals (five juveniles [UF 156457, 156459, 156461, 156467–156468] and two females [UF 156463, 156465]) from Parque Nacional Celaque, Dept. Lempira (14.558°N, 88.674°W, WGS84, 2575 m elev.); one juvenile (UF 156484) from El Rodeo, Dept. Íntibuca (14.461°N, 88.156°W, WGS84, 2170 m elev.); and one juvenile (UF 156473) from Reserva Biologíca Guajiquiro, Dept. La Paz (14.145°N, 87.837°W, WGS84, 2160 m elev.). Dietary items were flushed from the mouth, throat, and stomachs of preserved specimens without dissection, stored in 70% EtOH, and examined using light stereomicroscopy. Identification was done to the lowest taxonomic order possible based on sample condition using the descriptors and keys provided by Borror and White (1970. A Field Guide to Insects: America North of Mexico. Houghton Mifflin Co., Boston, Massachusetts. 404 pp.).

Twenty-two individual diet items were identified, representing the insect orders Coleoptera (36.4%) and Hymenoptera (13.6%), arachnid orders Acari (18.2%) and Araneae (9.1%), and other arthropods represented by the class Diplopoda (9.1%), and order Isopoda (4.5%). Eight coleopteran specimens represented

the majority of identified dietary samples; two specimens were larvae. Two adult coleopteran were identified to family representing Circulionidae and Staphylinidae. Hymenoptera were primarily identified based on wing and head morphology. Arachnida was represented by six specimens (27.3%), primarily from the subclass Acari. Within the order Araneae, one specimen could be identified to family Salticidae based on morphology. Diplopoda were identified based on the presence of two leg attachment points per segment and Isopoda (4.5%) based on morphology, color and patterning.

Five individuals contained multiple prey items. The highest prey diversity was observed in a juvenile (UF 156457, SVL = 23.2 mm) containing five unique prey items representing Coleoptera (Circulionidae), Diplopoda, Acari, Hymenoptera, and an unidentified larva. A single juvenile from Intibuca (UF 156484, SVL = 27.8 mm) contained four unique prey items, including Acari, Araneae, Hymenoptera, and Diplopoda. Another juvenile from Lempira (UF 156459, SVL = 31.9 mm) had three unique prey items from the Order Coleoptera including a larva and two adults (one Family Staphylinidae). One juvenile (UF 156473, SVL = 33.6 mm) from La Paz, one coleopteran and one hymenopteran (Family Sphecidae). A juvenile (UF 156468, SVL = 21.2 mm) from Lempira contained two Acari.

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***BOLITOGLOSSA DIAPHORA* (El Cusuco Salamander). DIET.** The plethodontid salamander *Bolitoglossa diaphora* is endemic to Parque Nacional Cusuco in the Sierra de Omoa in northwestern Honduras, and is considered Critically Endangered due to its limited distribution and the infrequency with which it is encountered (Townsend and Wilson 2008. Guide to the Amphibians and Reptiles of Cusuco National Park, Honduras. Bibliomania!, Salt Lake City, Utah. 322 pp.). Nothing has previously been reported regarding the diet of this species (McCranie and Wilson 1995. J. Herpetol. 29: 447–452; McCranie and Wilson. 2002. The Amphibians of Honduras. Society for the Study of Amphibians and Reptiles, New York. 625 pp.; Townsend and Wilson 2008, *op. cit.*).

We examined dietary items of nine preserved specimens of *B. diaphora* from Parque Nacional Cusuco, Dept. Cortés (15.495°N, 88.211°W, WGS84, 1520–1990 m elev.): three males (UF 144082, UF 156491, USNM 335046), five females (UF 144085, UF 156492–93, USNM 335047–8), and a single juvenile (UF 142739). Dietary samples were flushed from the mouth, throat, and stomachs of preserved specimens without dissection, stored in 70% EtOH, and examined using light stereomicroscopy. The identification of prey items was done to the lowest taxonomic level based on body parts and using descriptors and keys (Borror and White 1970. A Field Guide to Insects: America North of Mexico. Houghton Mifflin Co., Boston, Massachusetts. 404 pp.).

We found 14 individual prey items comprised of insect orders Hymenoptera (64.3%) and Coleoptera (7.13%), and two classes of arthropods: Arachnida (14.3%) and Diplopoda (14.3%). Seven of the Hymenoptera diet specimens were identified to the Family Formicidae and a single sample into the Family Sphecidae. The two arachnid samples represented the orders Pseudoscorpionidae and Salticidae. Among *B. diaphora*, we found the maximum number of prey items within a single individual to be five. The female (UF 156492, SVL = 30.2 mm) with the largest sample had a single pseudoscorpionid and four Hymenoptera (Formicidae). One female (UF 144085, SVL = 41.9 mm) contained a single Hymenoptera (Formicidae) and a Coleopteran; another female (UF 335047, SVL = 35.7 mm) had consumed a Hymenoptera (Formicidae) and a Diplopoda.

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***DESMOGNATHUS ABDITUS* (Cumberland Dusky Salamander). PREDATION.** On 12 July 2015, we moved a small streamside rock along a tributary of Tennessee's Obed River, Morgan Co., Tennessee, USA (36.0820°N, 84.7610°W, WGS84) to discover a small adult *Desmognathus abditus* being consumed by an adult *Diadophis punctatus* (Ring-necked Snake). After being disturbed, the snake regurgitated the still-living salamander. *Diadophis punctatus* is a frequent predator of plethodontid salamanders, including *Desmognathus* (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Books, Washington, DC. 668 pp.), but this is the first documented occurrence of predation of *Desmognathus abditus*, or any other species in the *Desmognathus ochrophaeus* complex, by *Diadophis punctatus*. Forester (1978. J. Herpetol. 12:537–541) conducted experimental encounters between *Diadophis punctatus* and *Desmognathus ochrophaeus* (now *Desmognathus ocoee*, Ocoee Dusky Salamander) and demonstrated attempted predation by the former and a strong flight response in the latter. Cupp (1994. Anim. Behav. 48:232–235) showed that *Desmognathus ochrophaeus* avoid substrates marked with the scent of *Diadophis punctatus*. However, we are not aware of any prior field observations of predation of members of the *Desmognathus ochrophaeus* complex by *Diadophis punctatus*.



FIG. 1. Small adult *Desmognathus abditus* being consumed by an adult *Diadophis punctatus*.

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***DESMOGNATHUS QUADRAMACULATUS* (Black-bellied Salamander). MAXIMUM CLUTCH SIZE.** *Desmognathus quadramaculatus* is a semi-aquatic plethodontid of the southern Appalachians in the southeastern USA. The reproductive ecology of this species has been studied in sites throughout its range (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, DC. 587 pp.; Camp et al. 2000. Can. J. Zool. 78:1712–1722; Camp et al. 2002. Herpetologica 58:471–484). Average clutch size is typically 31–54, depending on locality (Petranka 1998, *op. cit.*). A previous note reported a maximum clutch size of 82 from northeastern Georgia, USA (Camp et al. 2010. Herpetol. Rev. 41:330). In the late morning of 01 June 2013 we discovered two *D. quadramaculatus* clutches attended by females (both escaped and were not captured) under small rocks (~15 × 8 × 5 cm) in a tributary of the Toccoa River in Union Co., Georgia, USA (34.7589°N, 84.0310°W; WGS84). We counted 71 eggs in the smaller clutch and 105 eggs in the larger clutch, which now represents the maximum clutch size for this species. We returned the rocks carefully to their position in the stream and returned to check the rocks five hours later to determine if the females returned to their clutch. The female attending the larger clutch had returned, but the other had not.

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***EURYCEA NAUFRAGIA* (Georgetown Salamander). BEHAVIOR.** *Eurycea naufragia* is a neotenic spring and cave dwelling plethodontid salamander. This species is known from approximately 15 sites from the San Gabriel River watershed in Texas, an area that is undergoing rapid urbanization. The limited range of the species and its restricted habitats led to its recent listing as a threatened species. From 22 March to 03 May 2012, salamanders were trapped at a permanent spring in Williamson Co., Texas, USA (precise locality withheld due to conservation concerns). Each trap consisted of a fine mesh net 76.2 cm long with a 16.5 cm opening supported by wire at one end and the other end attached to a capped 5.08 × 29.2 cm PVC pipe, with a mesh covered opening on the side to allow water flow. Each week we conducted one diurnal and one nocturnal sampling event separated by 24 to 48 h. We randomized whether diurnal or nocturnal trapping was conducted first within each week. Three traps were placed at the same locations within the spring run (at the spring outflow, 1 m and 7 m downstream) for each sample. Diurnal sampling was conducted from 0700 h to 1900 h and nocturnal sampling from 1900 h to 0700 h. Based on a visual estimate of total length (following Bowles et al. 2006. Hydrobiologia 553:111–120; Pierce et al. 2010. Southwest. Nat. 55:296–301; Bendik et al. 2014. Herpetol. Conserv. Biol. 9:206–222), each salamander was assigned to one of two size classes: juvenile (<5.1 cm total length) or adult (>5.1 cm total length). After processing, all salamanders were released back into the spring run at point of capture. For comparison of nocturnal and diurnal samples, we combined all salamanders captured in the three traps during a sampling event.

We captured more salamanders during the nocturnal sampling events (5.71 ± 2.56 salamanders, mean ± SD) than during diurnal sampling events (1.14 ± 1.07). These differences, however, were not consistent across the two size classes. We captured more juvenile salamanders in nocturnal sampling events (4.57 ± 2.30) than in diurnal sampling events (0.14 ± 0.38). There was no significant difference in number of adult salamanders captured during nocturnal (1.14 ± 1.46) and diurnal sampling events (1.00 ± 1.15). The total number of salamanders that we captured in this study (N = 48) was relatively low, but the results were nevertheless straightforward and suggest that juvenile *E. naufragia* salamanders are more active at night.

A number of other studies have concluded that terrestrial salamanders are more active at night (e.g., Hairston 1949. Ecol. Monogr. 19:47–73; Connette et al. 2011. Southeast. Nat. 10:109–120). However, only a few studies have examined daily activity in aquatic life stages and none have examined permanently aquatic species. A study on activity patterns of aquatic stream salamander larvae (*Desmognathus fuscus* [Northern Dusky Salamander], *Eurycea cirrigera* [Southern Two-lined Salamander], *E. guttolineata* [Three-lined Salamander], *Pseudotriton montanus* [Mud Salamander], and *P. ruber* [Red Salamander]) found higher nighttime activity (Connette et al. 2011, *op. cit.*). In a study of *E. bislineata*, aquatic larvae were more active at night (Petranka 1984. J. Herpetol. 18:48–55). Contrary to the current study, densities of *D. fuscus* aquatic larvae were similar during day and night (Orser and Shure 1975. Am. Midl. Nat. 93: 403–410).

Our observations suggest that juvenile *E. naufragia* are more active at night and that nocturnal surveys will result in higher abundance observations for this life stage. These conclusions are limited by only sampling during a single season and using a single survey method (traps). Nevertheless our observations suggest that investigators surveying larval or aquatic salamanders should be aware of potential differences in diurnal and nocturnal activity patterns that may affect survey results.

We thank the property owners for permission to survey salamanders on their land. The Texas Parks and Wildlife provided a scientific research permit for study of the salamanders. This study complied with all applicable institutional animal care guidelines.

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***PLETHODON CINEREUS* (Eastern Red-backed Salamander). MORPHOLOGY.** Two color morphs are common in *Plethodon cinereus*, striped and unstriped (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, D.C. 587 pp.). Both morphs are present in Ohio, with the northwestern portion of the state containing a high frequency of the unstriped morph, which is typically far less common than the striped morph. South Bass Island, part of the Lake Erie archipelago, contains a well-documented monomorphic unstriped population (Pfingsten and Walker 1978. J. Herpetol. 12:163–167;



FIG. 1. Striped *Plethodon cinereus* found within a monomorphic unstriped population on South Bass Island, Ohio. This individual represents the only striped individual collected from the island.

Hantak, pers. obs.). To date, a single striped individual has been discovered on South Bass Island (Reichenbach 1981. Herpetol. Rev. 12:53) among hundreds of unstriped *P. cinereus* collected over decades (Pfingsten and Walker 1978, *op. cit.*; Reichenbach 1981, *op. cit.*; Hantak, pers. obs.). Thirty-six years after the sighting of the first striped individual on South Bass Island (Reichenbach 1979, pers. obs.), a second individual has been found (Fig. 1). It was discovered on 29 April 2015 on the Heineman property, South Bass Island, Ottawa Co., Ohio, USA (41.6465°N, 82.8234°W, WGS84). The individual was a juvenile (SVL = 22.75 mm; 0.26 g), and was found with three unstriped juveniles under a decaying log. This specimen was collected and preserved at Ohio University (MMH459), unlike the previous individual, which was only photographed. The genetics underlying the striped/unstriped color polymorphism of *P. cinereus* are currently not well understood; however, discordant results by Highton (1959. Copeia 1959:33–37; Highton 1975. Genetics 80:363–374) suggest that the genetics of the polymorphism may be geographically variable. Whether the striped morphs occur on South Bass Island as a consequence of a recent, novel mutation, or whether these individuals reflect the retention of an ancestral polymorphism, is not known.

We thank the Heineman family for allowing us to work on their property.

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ANURA — FROGS

HYLA CHRYSOSCELIS **(Cope's Gray Treefrog) ×** ***HYLA CINEREA*** **(Green Treefrog). PUTATIVE NATURAL HYBRID.** Naturally occurring hybrid treefrogs have been occasionally found in the eastern United States. However, these hybrids are almost always between members of the same species group (e.g., Gerhardt 1974. Behaviour 49:130–151; Gerhardt et al. 1980. Copeia 1980:577–584; but see Anderson and Moler 1986. Copeia 1986:70–76). When *Hyla cinerea* group individuals were artificially crossed with *H. versicolor* group individuals, little reproductive success was achieved, and those tadpoles that survived to metamorphosis showed severe phenotypic abnormalities, and abnormal or incomplete sexual development (Mecham 1965. Am. Midl. Nat. 74:269–308).

At 2145 h on 10 June 2014 we heard an unusual anuran advertisement call along Bayou Manual Road in Sherburne Wildlife Management Area in the Atchafalaya Basin of south-central Louisiana, USA (30.4026°N, 91.6748°W, WGS84). The call resembled that from a *Hyla*, but did not sound like any of the *Hyla* species known from the area (*H. cinerea*, *H. chrysoscelis*, and *H. squirella* [Squirrel Treefrog]). The dominant calls at that time in the immediate vicinity were from *H. chrysoscelis*, with *H. cinerea*, *H. squirella*, *Incilius nebulifer* (Gulf Coast Toad), and *Gastrophryne carolinensis* (Eastern Narrow-mouthed Toad) each vocalizing to lesser degrees.

We collected the individual and brought it to the laboratory for further study. The treefrog measured 45 mm (SVL), with an elongated body shape, appearing more like *H. cinerea* than *H. chrysoscelis* in that regard. The subocular spot typical of *H. chrysoscelis* and the lateral stripe typical of *H. cinerea* were both absent. The overall pattern was mottled, and his coloring changed dramatically from predominantly green to predominantly brown. Even while green, however, his lower legs remained gray. The inner thighs did not exhibit bright flash colors typical of *H. chrysoscelis* (Fig. 1). Mecham (1965, *op. cit.*) described similar physical characteristics to our hybrid in his laboratory–crossed female *H. cinerea* and male *H. chrysoscelis* hybrid treefrogs. Reciprocal crosses between male *H. cinerea* and female *H. chrysoscelis* produced different patterns and resulted in a lack of one or both eyes (Mecham 1965, *op. cit.*).

The frog did not respond to calls of recordings of *H. cinerea* but did vocalize in response to the recorded call of *H. chrysoscelis*. We made a recording of the call of the putative hybrid in the laboratory at an air temperature of 24.6°C. We analyzed only four calls for measurements of the pulse duration, pulse interval, and pulse period by using the measurement tool in Sound Ruler ver. 0.9.6 (Gridi-Papp [ed.]. 2007. SoundRuler: Acoustic Analysis for Research and Teaching. http://soundruler.sourceforge.net). The dominant frequency was found using the dfreq function in the R package seewave (Sueur et al. 2008. Bioacoustics 18:213–226). The analyses produced the following means: pulse duration 0.0703 s, pulse period 0.1171 s, pulse interval 0.0473 s, and pulse rate 8.782 pulses/s. The mean dominant frequency of the calls was 2169 Hz (Fig. 2) which is higher than the 1906 Hz mean dominant frequency (at 25.0°C air temperature) of a laboratory-reared 38.2 mm hybrid resulting from a cross between a female *H. cinerea* and a male *H. chrysoscelis* (Fortman and Altig 1974. Herpetologica 30:221–234). The call had a frequency spectrum within the range of frequencies by the putative parent species (Fig. 2). The pulse rate, however, lay intermediate between the putative parent species (much faster than *H. cinerea*, and much slower than *H. chrysoscelis*). The full audio recording has been accessioned into the Macaulay Library with catalog number ML 148096 (http://macaulaylibrary.org/audio/148096).

Flow cytometry was used (Jenkins et al. 2011. Reproduction 141:55–65) to determine whether this individual had produced viable spermatozoa. The putative hybrid showed 3.4% (SE = 0.009) viable testicular cells in a suspension of the macerated testis compared to a normal male *H. chrysoscelis*, which had 44.3% (SE = 0.014) viable testicular cells. The testes of the putative hybrid were smaller (3.67 mm length, 1.44 mm width) compared to the normal *H. chrysoscelis* (4.5 mm length, 2.37 mm width). No



FIG. 1. Photos of the putative hybrid treefrog (*Hyla chrysoscelis* × *H. cinerea*) captured in the Atchafalaya Basin.

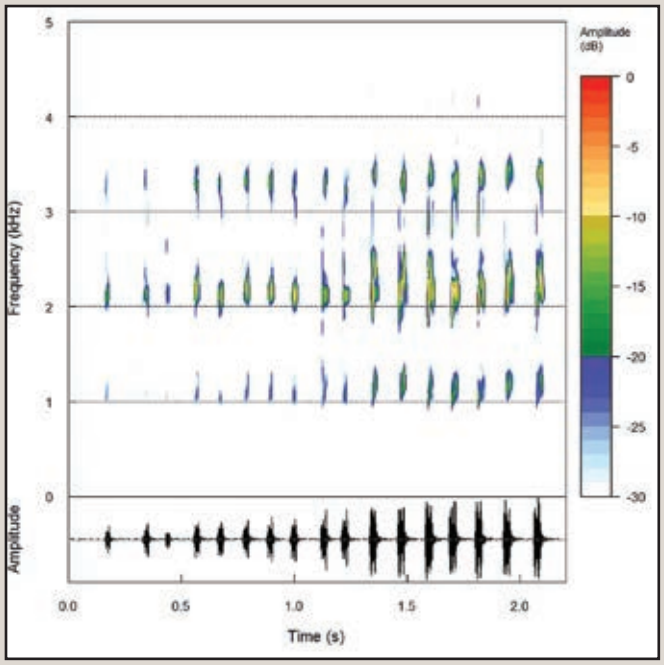


FIG. 2. Spectrogram of a call from the putative hybrid treefrog (*Hyla chrysoscelis* × *H. cinerea*) recorded at a distance of ca. 0.5 m from the calling frog at 24.6°C air temperature.

morphologically normal spermatozoa from the putative hybrid could be found by light microscopy, as cells appeared round and not like the cylindrical cells observed from the normal male *H. chrysoscelis*. Of the six adults Mecham (1965, *op. cit.*) sacrificed, all had either very small, rudimentary testes or lacked oviducts, and no sperm could be located in suspension. Mecham (1965,*op. cit.*) also stated that none of his grossly normal hybrids from female *H. cinerea* and male *H. chrysoscelis* that matured to adult size ever developed male throat pigment or definite vocal sacs, whereas this putative hybrid displayed both throat pigment and a vocal sac.

Flow cytometry was also used for high resolution nuclear DNA analysis to estimate the total genome size from nuclei of whole blood cells of the putative hybrid and the putative parental species, as species delineation can be discovered through the genetic complement. According to laboratory-generated genome size data from *H. chrysoscelis* and *H. cinerea* collected in the same area (J. Jenkins, unpubl. data), and data from the Animal Genome Size database (www.genomesize.com), the hybrid's diploid genomic complement was 9.8 pg, which was intermediate between the putative parental species.

Based on the phenotype, unusual call, small testes, lack of viable sperm, and intermediate genome size of this frog, we conclude that this treefrog is a hybrid of *H. chrysoscelis* and *H. cinerea*. Because the treefrog's characteristics are largely consistent with those described from laboratory crosses of male *H. chrysoscelis* and female *H. cinerea* (Meacham 1965, *op. cit.*), and because the reciprocal crosses typically resulted in high rates of abnormal early embryonic cleavage, very few tadpoles, and only one short-lived transformed individual (Pyburn and Kennedy 1960, *op. cit.*; Littlejohn 1961, *op. cit.*), we conclude that this individual is likely the result of a mating event between a male *H. chrysoscelis* and female *H. cinerea*. To our knowledge, natural hybrids between *H. chrysoscelis* and *H. cinerea* have not been previously reported (Dodd 2013. Frogs of the United States and Canada. Johns Hopkins University Press, Baltimore, Maryland. 982 pp.).

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***HYPSIBOAS PULCHELLUS* (Montevideo Tree Frog, Ranita de Zarzal). PREDATION.** Predation is one of the main causes of mortality in natural amphibian populations and may occur in any stage of the life cycle (Zug et al. 2001. Herpetology. An Introductory Biology of Amphibians and Reptiles. 2nd ed. Academic Press, San Diego. 630 pp.). Many authors have pointed out that arachnids (mainly Aranae) are one of the most important predators of tadpoles in the Neotropics. Most of these records belong to Pisauridae, Ctenidae, Lycosidae, Sparassidae, and Theraphosidae families (Menin et al. 2005. Phyllomedusa 4:39–47). However, predation on adult and juvenile amphibians has been poorly documented, mainly due to the difficulty of obtaining direct records in the field (Pombal 2007. Rev. Bras. Zool. 24:841–843).

At 2125 h on 9 November 2013, we recorded two predation events of *Hypsiboas pulchellus* juveniles by wolf spiders (Lycosidae). Both observations were made in flooded grasslands of Punta Lara Nature Reserve (34.8043°S, 58.0319°W; WGS84), Buenos Aires, Argentina. In the first case, the predator was an adult male *Lycosa erythrognatha*. It was collected and deposited in the collection of Invertebrate Zoology, La Plata Museum (MLP-Ar 19385). The second predator corresponded to a species belonging to an undescribed genus of the Lycosidae (Fig. 1). This specimen was not collected. During the period we observed both predation events the larval cycle of *H. pulchellus* was concluding (having started in spring) and we noted high densities of juveniles.

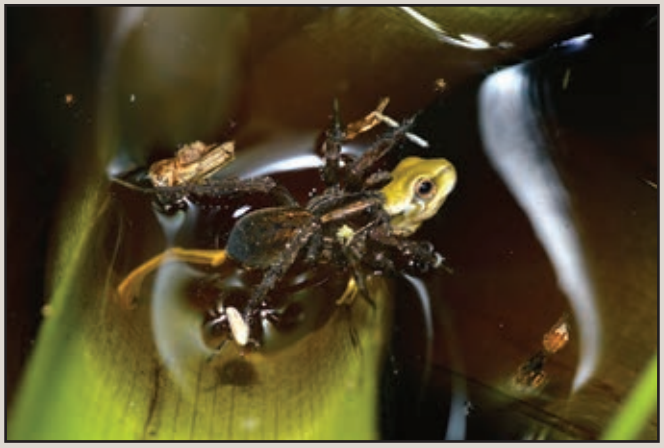


FIG. 1. Undescribed spider of the family Lycosidae (wolf spider) preying on a juvenile *Hypsiboas pulchellus* from Punta Lara Nature Reserve, Argentina.

Spiders are potential predators of both juvenile and adult anurans. Significant linear correlations between the body lengths of prey and predator have been demonstrated, with the size of the spider being similar or slightly smaller than the anuran prey (Menin et al. 2005. Phyllomedusa 4:39–47). The body lengths of *H. pulchellus* span 1.95–5 cm (Maneyro and Carreira 2012. Guía de Anfibios del Uruguay. Ediciones de la Fuga, Montevideo, Uruguay. 207 pp.), whereas the largest wolf spiders can reach more than 30 mm body length (Jocqué and Dippenaar-Schoeman 2015. Spider Families of the World. Royal Museum for Central Africa, Tervuren, Belgium. 336 pp.); therefore, we can infer that these spiders can prey on both juvenile and adult stages of *H. pulchellus*.

Here we present the first records of two species of lycosid spiders preying on *H. pulchellus*. Given that spiders of the Lycosidae are abundant in the Argentine Pampas grasslands (Platnick 2014. www.wsc.nmbe.ch; 15 Jun 2015), they could have an important role in regulating *H. pulchellus* populations.

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***ISCHNOCNEMA GUENTHERI* (Steindachner´s Robber Frog). PREDATION.** *Ischnocnema guentheri* is a litter frog of medium size with crepuscular/nocturnal activity and occasional diurnal activity (Pombal 1997. Rev. Brasil. Biol. 57:583–594; Dixo and Verdade 2006. Biota Neotrop. 6:1–20), especially in rain showers (Giaretta and Facure 2008. Contemp. Herpetol. 3:1–4). It is widespread in the Atlantic forest from southern Brazil to northeastern Argentina (Van Sluys et al. 2010. www.iucnredlist.org; 17 Mar 2015). We report predation upon *I. guentheri* by *Baryphthengus ruficapillus* (Rufous-capped Motmot). Our observation occurred during regular mist-netting (permits: CEMAVE/ICMBio no. 1237, INEA no. 051/2011, SISBIO 14210-7) at Parque Estadual da Ilha Grande (23.1638°S, 44.1888°W, WGS84; 690 m elev.), an oceanic island at Angra dos Reis municipality, Rio de Janeiro State, Brazil. At 0820 h on 16 December 2014 we captured an adult *B. ruficapillus* with a *I. guentheri* (SVL = 31.5 mm; 2.4 g) in its bill. We deposited the frog in Museu Nacional do Rio de Janeiro, Amphibians Collection (MNRJ 88864). During focal observations in October and November 1997 of an active nest of *B. ruficapillus* in the same study area, frogs (unidentified) and reptiles, along with fruits, arthropods, and mollusks, were noted as part of the diet delivered to nestlings (Alves et al. 1999. Ararajuba 7:31–34). Prior published records of predation on frogs by *B. ruficapillus* (Alves et al. 1999, *op. cit.*) and *B. martii* (Rufous Motmot; Master 1999. Wilson Bull. 111:439–440; Alvarado et al. 2013. Herpetol. Rev. 44:298) were all observed during the breeding period. Motmots may prey on frogs over the whole year; however, these events may be easier to detect during the bird's breeding period as adults can be observed carrying prey items to be delivered to the chicks. As *I. guentheri* follows a cryptic strategy (Gomiero et al. 2006. Biota Neotrop. 6:1–5) and is present at low density at Ilha Grande (Rocha et al. 2001. Austral Ecol. 26:14–21) it is possible that *B. ruficapillus* is able to detect this frog moving in the litter during the day. Before our unique predation record of *I. guentheri* by a bird this frog was recorded as an unusual prey of the fish *Brycon opalinus* (Pirapitinga-do-sul), a characid species that regularly consumes fruits and insects (Gomiero et al. 2006, *op. cit.*).

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***KALOULA PULCHRA* (Banded Bullfrog). DEFENSIVE BEHAVIOR.** At ~1100 h on 12 August 2014 I observed a novel defensive behavior of *Kaloula pulchra* in Bawngkawn, Aizwal, Mizoram, India (23.7554°N, 92.7287°E, WGS84; 1022 m elev.). While I was holding each of the frogs (1 female and 3 males), they puffed up their bodies and released sticky secretions, which are among the recorded defensive behaviors of this species (Sazima 1974. J. Herpetol. 8:376–377). As I continued holding each frog I felt a tingling sensation in my palm and noticed the fourth and largest toe was vibrated by the frog in a very similar way a mouth organ player vibrates his playing hand. This vibration of the toe was followed by a forward body jerk. This continued for as long as I held the frog. Different defensive strategies are used in different phases of predation, and I assume that holding the frog tightly in my hand simulated ingestion. The behavior exhibited by *K. pulchra* is most similar to the "phalanx aggression" reported by Toledo et al. (2011. Ethol. Ecol. Evol. 23:1–25), which is exhibited by some frogs during ingestion. However, as defined by Toledo et al. (2011, *op cit.*), this behavior includes morphological specializations in which the distal phalanges pierce the skin and abrade

the potential predator. Perhaps the vibration of the toe of *K. pulchra* simply produces a tingling sensation in the oral cavity of the predator, and may cause it to loosen the grip on the frog and the subsequent body jerk may set the frog free.

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***KALOULA WALTERI* (Walter's Narrow-mouthed Frog). PREDATION.** *Kaloula walteri* is a small (SVL = 24.5–35.5 mm) endemic microhylid occurring at sea level to mid-montane rainforest (0–900 m elev.) on Luzon and Polillo Island, Philippines (Diesmos et al. 2002. Copeia 2002[4]:1037–1051). Among invertebrates, crabs are considered important frog predators and several predation incidents of frogs at various life stages by marine and freshwater crabs have been previously documented (Toledo 2005. Herpetol. Rev. 36:395–400; Wells 2007. The Ecology and Behavior of Amphibians. University of Chicago Press, Chicago, Illinois. 1148 pp.; Andrade et al. 2012. Herpetol. Notes 5:173–175; Pyke et al. 2013. Herpetol. Notes 6:195–199; Motta-Tavares et al. 2015. Herpetol. Rev. 46:73–74). Herein, we report an endemic *Sundathelphusa longipes* (Philippine Long-legged Freshwater Crab) eating an adult *K. walteri*.

At 0020 h on 26 March 2015, while conducting fieldwork at Mount Banahao in Barangay Bukal, Municipality of Majayjay, Laguna Province, Luzon Island, Philippines (14.0978°N, 121.482°E, WGS84; 851 m elev.), a freshwater crab (carapace = 23.6 × 19.8 mm) in a small pool with a rocky bottom (ca. 50 × 100 cm; water depth = 8 cm), beside a temporary stream, was observed grasping a deceased and mutilated *K. walteri* (SVL = 34.25 mm) in its claws. The crab immediately released the frog carcass when we approached closer. Upon further inspection, the frog's skin on the body, digits, and internal organs were completely consumed. The frog was identified based on head characteristics, size, and microhabitat. Another adult *K. walteri*, several tadpoles, and three adult crabs were also in the same pool. Although this may be the first reported Philippine frog predation by an invertebrate, it is also possible that the crab only scavenged an already dead frog. The frog (field number EYS 440) and crab (EYS 441) were preserved in 70% ethanol and deposited in the Herpetology Section of the National Museum of the Philippines.

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FIG. 1. *Sundathelphusa longipes* with predated *Kaloula walteri*.

***LEPTODACTYLUS FUSCUS* (Whistling Frog). MYIASIS.** Several fly species, from the families Sarcophagidae, Calliphoridae, and Chloropidae, are agents of myiasis and their larvae can develop in living amphibians, often killing their hosts (Crump and Pounds 1985. J. Parasitol. 71:588–591). Myiases have been recorded in anurans including the families Bufonidae, Centrolenidae, Craugastoridae, Dendrobatidae, Hylidae, Leptodactylidae, Odontophrynidae, and Ranidae (Bokermann 1965. Acad. Bras. Cienc. 37:525–537; Gómez-Hoyos et al. 2012. Herpetol. Notes 5:27–29). For leptodactylids, which are conspicuous elements of Neotropical assemblages, there are few available records that report only egg predation by fly larvae on *Leptodactylus bufonius* (Vizcachera White Lipped Frog), *L. fuscus*, and *L. pentadactylus* (South American Bullfrog) (Downie et al. 1995. J. Nat. Hist. 29:993–1003). In this study, we report observations of myiases by two fly species in adult *L. fuscus*, representing the first evidence of myiasis on this species.

Anurans were surveyed at the Pantanal wetlands, in the Nhecolândia region, Brazil (19.6558°S, 57.0417°W, WGS84; 90 m elev.) from 11–19 February 2006. Individuals were caught in pitfall-traps with drift fences. All frogs were inspected for the presence of maggots; infected individuals were placed in plastic jars containing vermiculite, and maggots were allowed to pupate to identify them to species level. The following species of frogs were collected: *Rhinella schneideri* (Cururu Toad; N = 29), *Elachistocleis bicolor* (Two-colored Oval Frog; N = 13), *Pseudis paradoxa* (Paradox Frog; N = 15), *Physalaemus albonotatus* (Menwig Frog; N = 43), *L. chaquensis* (Creole Frog; N = 57), *L. podicipinus* (Pointed-belly Frog; N = 68), and *L. fuscus* (N = 122). *Leptodactylus fuscus* was the only species infected, with five individuals (4.1%) infected (mean intensity = 2.8 maggots per frog). Two fly species, belonging to two families were recovered from *L. fuscus*: *Megaselia scalaris* (Phoridae) and *Oxysarcodexia carvalhoi* (Sarcophagidae). Three (prevalence of 2.5%) of the frogs were infected with *Oxysarcodexia carvalhoi* with 3, 4, 2 maggots/frog, whereas two (prevalence of 1.6%) frogs were infected with *Megaselia scalaris* with 2 and 3 maggots per frog.

Megaselia scalaris is cosmopolitan and synanthropic and larvae are considered extremely opportunistic, with several cases of facultative myiasis reported on a wide variety of hosts, like arthropods (Arredondo-Bernal and Trujillo-Arriaga 1994. Vedalia 1:27), snakes (Silva et al. 1999. J. Med. Entomol. 36:630), and humans (Singh and Rana 1989. J. Med. Entomol. 26:228–229). Considered generalists, *Oxysarcodexia* are known for preferring uninhabited areas (Dias et al. 1984. Mem. Inst. Oswaldo Cruz. 79:83–91) with some cases of facultative myiasis reported in fish, mammals, and carcasses of humans (Mello-Patiu et al. 2014. Rev. Bras. Entomol. 58:142–146). Ecological interaction between flesh eating flies and frogs is an important area of research as previous studies have shown that these relationships are generally lethal (Crump and Pounds 1985, *op. cit.*).

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***LITHOBATES SPHENOCEPHALUS* (Southern Leopard Frog). FALL BREEDING.** For two of the past three years, *Lithobates sphenocephalus* has bred during the fall in Greene Co., Indiana, USA (39.1107°N, 87.2222°W; WGS84). On 16 March 2013, we began capturing overwintered (Gosner stage 25) *L. sphenocephalus* tadpoles in funnel traps set for breeding *L. areolatus* (Crawfish Frog) at three seasonal/semipermanent wetlands. On 13 March 2015, we began capturing overwintered tadpoles at these three wetlands plus three additional wetlands. At four of these wetlands, *L. sphenocephalus* were the only ranid tadpoles present, at the fifth they co-occurred with overwintered *L. catesbeianus* (American Bullfrog) tadpoles, at the sixth they co-occurred with overwintered *L. clamitans* (Green Frog) tadpoles.

McCallum et al. (2004. Southeast. Nat. 3:401–408) offer a detailed account of fall breeding in *L. sphenocephalus* from Arkansas. Minton (2001. Amphibians and Reptiles of Indiana. Indiana Academy of Science, Indianapolis, Indiana. 404 pp.) reports spring breeding and occasional fall calling from Indiana. Our data are the first report confirming fall breeding from Indiana—at a latitude approaching the northern end of this species' range (Lannoo 2005. Amphibian Declines: The Conservation Status of United States Species. University of California Press, Berkeley, California. 1094 pp.)—and based on Minton's experience may represent a new phenomenon at this latitude. Given the documented effects of climate change on accelerating amphibian breeding phenology (Beebee 2002. Conserv. Biol. 16:1454; Blaustein et al. 2002. Conserv. Biol. 16:1454–1455), our observations suggest that in temperate climates, spring breeding phenology may be accelerated through the winter, into the previous fall, under suitable weather conditions (such as heavy rains; McCallum et al. 2004, *op. cit.*).

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***LITHOBATES SYLVATICUS* (Wood Frog). CANNIBALISM.** It is known that larval *Lithobates sylvaticus* will cannibalize recently oviposited egg masses, newly hatched larvae, and smaller conspecifics (Petranka and Thomas 1995. Anim. Behav. 50:731–739). Although instances of cannibalism of older and more developed conspecifics by younger larvae is known to occur in other anurans (*Scaphiopus hurterii* [Hurter's Spadefoot], *S. bombifrons* [Plains Spadefoot; Bragg 1957. Wassman J. Biol. 15:61–68; Bragg 1964. Herpetologica 20:17–24], *S. multiplicata* [Mexican Spadefoot], *S. couchii* [Couch's Spadefoot; Pomerory 1981. Unpubl. PhD. Dissert. Univ. of California] and *Osteopilus septentrionalis* [Cuban Treefrog; Crump 1986. Copeia 1986:1007–1009]), we were unable to find prior accounts of this phenomenon occurring in *L. sylvaticus*. Here we describe an instance of active cannibalism in *L. sylvaticus* where less developed and presumably younger larvae attacked and devoured an injured and nearly transformed conspecific.

At 2315 h on 16 June 2014 we observed a larval *Ambystoma maculatum* (Spotted Salamander) attacking a larval Wood Frog in an ephemeral wetland (ca. 3.5 m × 2 m and 45 cm deep) at the Smithsonian Environmental Research Center, Anne Arundel Co., Maryland, USA (38.9015°N, 76.5515°W, WGS84; 24 m elev.). The *A. maculatum* larva seized the *L. sylvaticus* larva by its hindquarters and limb and shook it with sideways sweeps of the head. The *L. sylvaticus* larva had fully formed fore and hind limbs, but its tail was not yet resorbed (ca. Gosner stage 42). Shortly after we approached the wetland the *A. maculatum* larva released the *L. sylvaticus* larva, presumably because it was disturbed by our flashlights. Once released, the *L. sylvaticus* larva appeared to be severely injured, and lethargically attempted to swim with irregular and weak lateral undulations. Within ca. 30 sec of its release by the *A. maculatum* larva, the injured *L. sylvaticus* larva was swarmed and consumed by ca. 10 conspecific larvae, only one of which had limbs (hind only; ca. stage 39, the rest appeared to < stage 30). What triggered the swarming behavior and sequence of predatory behaviors of the *L. sylvaticus* cannibals is unclear. It may have been initiated by biochemical cues released by the injured *L. sylvaticus* larvae during the *A. maculatum* attack (Crump 1986. Copeia 1986:1007–1009) and/or by its irregular swimming. Regardless of the specific trigger, it appears as if cannibalism by less developed larvae occurs in *L. sylvaticus* and may be an important component of its reproductive strategy.

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***LITORIA HAVINA*. PREDATION.** *Litora havina* is a poorly known treefrog recorded from the upper Fly and Kikori Rivers in the southern high rainfall zone of Papua New Guinea, and the Wondiwoi and Fakfak regions of Papua Province, Indonesia (Menzies 2006. The Frogs of New Guinea and the Solomon Islands. Pensoft Publishers, Sofia, Bulgaria. 345 pp.). It occurs in swamps from 300–1300 m above sea level in tropical rainforest, and lays clutches of 10–20 large (ca. 4 mm diam) eggs on vegetation over water (Richards and Günther 2004. The IUCN Red List of Threatened Species. www.iucnredlist.org; accessed 1 Feb 2015). This note presents the first published observation of predation on *L. havina* in the field.

Between 29 June and 27 July 1993 we observed *L. havina* in several swamps around the township of Tabubil, Western Province, Papua New Guinea (5.26°S, 141.22°E, WGS84; 558 m elev.). While looking for frogs at night, we also observed one or more *Tropidonophis* sp. (Keelback Snake) in vegetation around most swamps we visited. On 9 July 1993 we observed a *Tropidonophis* moving among low vegetation in a swamp 13 km S of Tabubil along the Tabubil-Kiunga Road. On that night this swamp hosted a frog chorus containing adult *L. havina* and many tens of their egg masses were found at heights between 0.4 and 2.5 m above water level on the vegetation around the swamp. We saw the snake moving around the swamp over 2–3 h, and collected it just before we left the swamp late in the evening. Upon dissection of the snake we found an adult female *L. havina* and several eggs masses in its stomach (Fig. 1). Although we did not directly observe predation, this confirmed not only our suspicions that *Tropidonophis* were predating adult *L. havina*, but also demonstrated that the snakes were eating the frogs' arboreal egg masses. We are unsure of the specific identity of the snake; four species of *Tropidonophis* (*T. doriae*, *T. mairii*, *T. multiscutellatus*, and *T.*



FIG. 1. An adult female *Litoria havina* (SVL ca. 37 mm) and *L. havina* eggs in the stomach of a *Tropidonophis* sp. (Keelback Snake) from near Tabubil in the Western Province of Papua New Guinea.

statisticus) occur in the general area where our observations were made (O'Shea 1996. A Guide to the Snakes of Papua New Guinea. Independent Publishing, Port Moresby, Papua New Guinea. 239 pp.).

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***PHYSALAEMUS PUSTULOSUS* (Túngara Frog). SEXUAL COMMUNICATION.** At ca 1930 h on 14 June 2015 we made an interesting observation of sexual communication of a *Physalaemus pustulosus* in the Darien National Park in Darien (7.747°N, 77.536°W; WGS84), Panama.

Túngara Frogs produce mating calls (ca. 350 ms duration) that consist of a downward frequency sweep which can be produced alone or can be followed by 1–7 short, ca. 45 ms, bursts of sound called "chucks." The call is accompanied by inflation and deflation of a relatively large vocal sac (Ryan 1985. The Túngara Frog, A Study in Sexual Selection and Communication. University of Chicago Press, Chicago, Illinois. 236 pp.). On this night we observed a small group of male Túngara Frogs, ca. 3–6, calling from a puddle on a trail. As chucks are typically always produced immediately after a whine, we were struck by what we thought was a chuck produced in isolation. We then located the male producing the call in question. During ca. 5–10 min of observation, the male did indeed produce calls with only chucks. These chucks sounded similar to chucks typical of this species; although the amplitude seemed a bit lower than typical it was clearly audible. The male also produced whines in isolation and whines followed by chucks as is typical for this species, as well as what is best described as a "half-whine," but he then returned to producing chucks in isolation. During this time we also observed the male inflating and deflating his vocal sac as if he were calling but without any audible call; this occurred several times. In all instances, whether or not accompanied by sound, the inflation-deflation of the vocal sac produced vibrations on the water's surface, which is merely an epiphenomenon of vibrating a structure on the water's surface. During all of these behaviors, chuck-only and half-whine calls, typical whine and whine-chuck calls, and muted vocal sac inflation-deflation, the male was alternating his display with neighboring calling males, as is typical for this species. Thus he was participating in the chorus in a typical manner even when producing an atypical signal.

One of us, MJR, has been studying this species for several decades (Ryan 1980. Science 209:523–525; Ryan 2011. *In* Losos [ed.], In Light of Evolution, Essays from the Laboratory and Field, pp. 185–203. Roberts and Company, Greenwood Village, Colorado) and only once previously did he observe a male producing a chuck-only. Examination of that male's larynx showed it was normal (MJR, unpubl. data; our current permits in the Darien did not allow collecting). Never, to our knowledge, has anyone observed a Túngara Frog inflating and deflating its vocal sac independent of sound production. The diurnal African frog *Phrynobatrachus krefftii* (Krefft's Puddle Frog) also shows this behavior which clearly is a communication signal (Hirschmann and Hödl 2006. Herpetologica 62:18–27). There are similar reports of muted vocal sac inflations for Bornean frogs in the genus *Staurois*, but their role in communication has not been investigated (Boeckle et al. 2009. Herpetologica 65:154–165). This observation is germane to the study of sexual communication in this species for several reasons. Female Túngara Frogs strongly prefer whines with chucks to whines-only (Gridi-Papp et al. 2006. Nature 441:38). Normally, males do not produce chucks without the preceding whine and females do not show phonotaxis to chucks-only. In addition, females do not accurately group whines and chucks to the same source (Ryan 1985, *op. cit.*). A chuck spatially displaced by 135° from a whine is perceptually bound to that whine by the female, (i.e., she perceives the two sounds as a single whine-chuck call), and she then approaches the chuck rather than the whine (Farris et al. 2002. Brain Behav. Evol. 60:181–188). Thus a male producing a chuck-only in a chorus could attract a female if his chuck follows the whine of another male calling within a 135° arc. We knew that; now we know that at least one male in the Darien can produce a chuck without a whine.

Vocal sacs recycle air between the lungs and the vocal sac, saving the male the effort of buccal pumping to fill the lungs between each call (Pauley et al. 2006. Comp. Physiol. Biochem. 79:708–719). In a number of frogs the inflation-deflation cycle of the vocal sac also serves as a visual cue (Starnberger et al. 2014. Anim. Behav. 97:281–288), and as mentioned above in *P. krefftii*, this is true even in the absence of accompanying sound. Our observations show that muted vocal sac inflation-deflation occurs in at least one Túngara Frog in the Darien. In Túngara Frogs the vocal sac inflation synchronous with a call enhances the attraction of the call (Taylor et al. 2008. Anim. Behav. 76:1089–1097), and typically

the vocal sac must be synchronous with the call to produce a salient bimodal display (Taylor et al. 2011. J. Exp. Biol. 214:815–820).

Finally, the movement of the vocal sac also produces water-surface ripples that enhance the saliency of a typical call (Halfwerk et al. 2014. Science 343:413–416). When the deviant male we observed inflated and deflated his vocal sac, not only was he producing a visual cue but vibrational cues as well. Although we have shown that the water-surface vibrations by themselves are not salient as a mating display, they do enhance the acoustic-only component of the male Túngara Frog's display (Halfwerk et al. 2014, *op. cit.)*.

The female Túngara Frog is permissive in responding to and sometimes preferring sexual signals that typically do not exist in nature (Ryan et al. 2010. Curr. Zool. 56:343–357), thus acting on signal variation as it arises. Our observations of this one male Túngara Frog in the Darien rainforest show that there is more standing phenotypic, and perhaps genetic, variation for sexual signaling in this frog than previously appreciated. Thus, we now have evidence of variation arising in both signal production and perception, providing the raw materials necessary for complex anuran signals to evolve.

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***PLECTROHYLA POKOMCHI* (Rio Sananja Spikethumb Frog). ALTITUDINAL DISTRIBUTION.** *Plectrohyla pokomchi* is a critically endangered species of stream-breeding frog endemic to Guatemala. An adult female specimen (SVL = ca. 4 cm) was found climbing on the leaves of a tree fern *Cyathea* sp. (Fig. 1) about 2 m above the ground at 2032 h on 15 March 2014 at Apaj River source within Biotopo Protegido Mario Dary Rivera para la Conservación del Quetzal, Purulha, Guatemala (15.2070°N, 90.2326°W, WGS84; 2120 m elev.). This record extends the upper known vertical distribution from the highest elevation reported of 1900 m by 220 m (Duellman and Campbell 1992. Misc. Publ. Mus. Zool. Univ. Michigan 181:1–32). This species is considered to be declining severely, especially in the location where we found it (Mendelson et al. 2004. Rev. Biol. Trop. 52:991–1000). This record also indicates that, as of 2014, the species is still extant within the confines of the protected area mentioned above. A photographic voucher of the specimen was deposited at Colecciones Biológicas de la Universidad del Valle de Guatemala, Guatemala (UVG-F-0004).



FIG. 1. *Plectrohyla pokomchi* found at 2120 m elev. in Purulha, Guatemala.

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***PRISTIMANTIS CERASINUS* (Clay-colored Rain Frog). MORTALITY.** *Pristimantis cerasinus* is a craugastorid frog found in humid lowland and premontane forests from Nicaragua to Panama (Savage 2002. The Amphibians and Reptiles of Costa Rica. University of Chicago Press, Chicago, Illinois. 934 pp.; Padial et al. 2014. Zootaxa 3825:1–132). At ca. 1100 h on 13 April 2013, an adult *P. cerasinus* was found in the web of a Golden Silk Orbweaver (*Nephila clavipes*, Araneidae) on the Lindero Sur trail at La Selva Biological Station, Costa Rica (10.4300°N, 84.0200°W; WGS 84). We identified the frog as *P. cerasinus* by the presence of heel tubercles, the absence of enlarged supraocular tubercles, the relative width and shape of finger toe pads, the dark brown coloration of the posterior thigh, paired suprascapular ridges shaped as inverted parentheses, and failure of the tip of toe V to reach the ultimate subarticular tubercle on toe IV (Savage 2002, *op. cit.*; Guyer and Donnelly 2005. Amphibians and Reptiles of La Selva, Costa Rica, and the Caribbean Slope: A Comprehensive Guide. University of California Press, Berkeley, California. 299 pp.). Although we did not verify that the frog was depredated by the spider, the frog was dead, its body was desiccated, and strands of spider web were wrapped tightly around the frog's left hind leg at three places.

To our knowledge, this is the first published record of death of a craugastorid frog due to *N. clavipes*. *Pristimantis cerasinus* is known to occupy arboreal perch sites in vegetation at night, and the individual may have jumped from a perch site to be ensnared in the web. *Nephila clavipes* webs are known to entrap hummingbirds (Graham 1997. J. Field Ornithol. 68:98–101), small songbirds (Cox and NeSmith 2007. Florida Field Nat. 35:46–48), and bats (Nyfeller and Knörnschild 2013. PLOS ONE 8:e58120). We are unaware of any records of *N. clavipes* consuming trapped vertebrates, although there are two records of *Nephila plumipes* feeding on unidentified anurans (McCormick and Polis 1982. Biol. Rev. 57:29–58).

We thank Kelsey Reider for verifying the identification of the frog and an anonymous reviewer for suggestions that improved this note. A digital photograph of the frog was vouchered at the Georgia Museum of Natural History (GMNH 50832).

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***PSEUDACRIS MACULATA* (Boreal Chorus Frog). CALLING PHENOLOGY.** *Pseudacris maculata* is a widespread hylid found

throughout central North America (Dodd 2013. Frogs of the United States and Canada. Johns Hopkins University Press, Baltimore, Maryland. 982 pp.). Chorus frogs are known to be among the earliest calling species of the season throughout their range. For example, a study analyzing *Pseudacris* breeding call characteristics spanning from Oklahoma to South Dakota began as early as March (Platz 1989. Copeia 1989:704–712). However, occasional calls have been heard in northern Alberta, Canada, extending into late August and mid-September after breeding cessation (Dodd 2013, *op. cit.*), and *P. maculata* call in South Dakota on occasional cool and wet days through the summer (Smith, unpubl. data).

On the early afternoon of 11 October 2014, we heard breeding calls of *P. maculata* in an area about 4.25 km E of Provo, Fall River Co., South Dakota, USA (43.1882°N, 103.7820°W, WGS84; 1100 m elev.). The habitat was a roadside ditch overflow from a semi-permanent wetland. It was 18°C, clear with winds at 5.4 m/sec, and 37% humidity. We classified calling intensity as level II on the Amphibian Calling Index (ACI; Heyer et al. 1994. Measuring and Monitoring Biological Diversity: Standard Methods for Amphibians. Smithsonian Institution Press, Washington D.C. 384 pp.). Later that night, we heard a full chorus (ACI level III) calling from pre-sunset and into the evening on the periphery of a permanent wetland in the ghost town of Ardmore, Fall River Co., South Dakota (43.0214°N, 103.6531°W; 1080 m elev.). The temperature was 16°C, wind at 8.2 m/sec, 54% humidity. Shortly before sunset on 18 October 2014, we located a third site, a cattle pond, where individual *P. maculata* were heard calling (ACI level I). This spot is located approximately 1.3 km E of Smithwick, Fall River Co., South Dakota (43.3038°N, 103.2022°W; 1005 m elev.). It was a clear day at 19°C with 4.9 m/sec winds and 42% humidity. Peak calling season for *P. maculata* within South Dakota is May–July (Dodd 2013, *op. cit.*) and they have been known to call as late as August (Ballinger et al. 2000. Trans. Nebraska Acad. Sci. 26:29–46). *Pseudacris maculata* has not been previously recorded calling later than September (Dodd 2013, *op. cit.*) anywhere in its range.

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***PSEUDOPALUDICOLA POCOTO*. PREDATION.** *Pseudopaludicola pocoto* is a newly described small frog species that can be found in open areas within the Caatinga in the states of Paraíba, Rio Grande do Norte, Ceará and Pernambuco in northeast Brazil (Magalhães et al. 2014. Herpetologica 70:77–88). We record a predation event on *P. pocoto* (SVL = 13.83 mm; 3 g) by the spider *Ancylometes rufus* (Fishing Spider; Fig. 1). Our observation took place at the Ecological Station Aiuaba (6.36065°S, 40.07285°W, WGS84; 425 m elev.), municipality of Aiuaba, state of Ceará, Brazil, during the course of an active search of the vicinity of a lake for frogs at 2030 h on 22 January 2015. The individuals were collected, euthanized, fixed in 10% formalin, and preserved in 70% alcohol. Voucher specimens are housed in the Laboratório Especial de Coleções Zoológicas do Instituto Butantan, São Paulo (*A. rufus*, IBSP 166751) and in the Coleção Herpetológica da Universidade Regional do Cariri (*P. pocoto*, URCA-H 10403). Only a few anuran species have been observed being preyed upon by *A. rufus*: *Ischnocnema ramagii* (Paraiba Robber Frog; De-Carvalho et al. 2010. Herpetol. Rev. 41:336–337), *Dendrophryniscus minutus* (Amazonian Tiny Tree Toad), *Dendropsophus minutus* (Lesser Tree Frog), *Hypsiboas geographicus* (Map Tree Frog), *Adenomera*



FIG. 1. Predation of *Pseudopaludicola pocoto* by *Ancylometes rufus*.

andreae (Lowland Tropical Bullfrog; Menin et al. 2005. Phyllomedusa 4:39–47), *Dendropsophus melanargyreus* (Interior Tree Frog; Azevedo 2011. Biota Neotrop. 11:349–351), *Dendropsophus sarayacuensis* (Shreve's Sarayacu Tree Frog; Rodrigues and Arruda 2007. Herpetol. Rev. 38:437), and *Scinax alter* (Crubixa Snouted Tree Frog; Prado and Borgo 2003. Herpetol. Rev. 34:238–239). The record presented here increases our knowledge of the relationship between spiders and anurans, highlighting the existence of important trophic connections between these groups. This is the first predation event registered for *P. pocoto*.

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***RANA TEMPORARIA* (Common Frog). MAXIMUM SIZE.** Maximum body size reported for *Rana temporaria* in the literature is 100 mm (Bannikov et al. 1977. A Guide to Amphibians and Reptiles of the USSR. Moscow, Prosveshchenie. 415 pp.; Gollmann et al. 2014. *In* Böhme [ed.], Handbuch der Reptilien und Amphibien Europas. Bd 5/III A: Froschlurche (Anura) III A (Ranidae I), pp. 305–437. AULA-Verlag, Wiebelsheim). On 28 September 2012, we found an adult female *R. temporaria* on the forest road near Sekowiec, Bieszczadzki National Park, Poland, in the San River valley (49.2360°N, 22.5637°E; WGS84). The frog was 110.1 mm SVL, representing a new maximum size for the species. This exceeds the maximum recorded SVL for the species by 10.1%. According to Gollman et al. (2014, *op. cit.*), *R. temporaria* reaches maximum body size in northern Europe along the transect of



FIG. 1. Maximum size *Rana temporaria* from Sekowiec, Bieszczadzki National Park, Poland. Coin size = 18.5 mm.

65°N. Our observation demonstrates that maximum sized frogs can be found not only in the north.

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***RHACOPHORUS PARDALIS* (Harlequin Tree Frog). DEFENSIVE BEHAVIOR.** Defensive behavior of anuran amphibians was thoroughly reviewed in Toledo et al. (2011. Ethol. Ecol. Evol. 23:1–25), who recognized about 30 types of such behavior. Eye-protection has been described in a number of species (Toledo et al. 2011, *op. cit.*) and here we report this defensive behavior for *Rhacophorus pardalis*. Observations were made in the lowland mixed-dipterocarp rainforest near the Kuala Belalong Field Studies Centre in Ulu Temburong National Park (Brunei Darussalam; 4.546°N, 115.157°E, WGS84; 119 m elev.) at 2230 h on 5 February 2015. An adult male individual (SVL = 52.4 mm) was captured on understory vegetation (ca. 1.8 m above the forest floor) during a night survey. When attempting to capture the individual, the frog pressed its body to the ground, slightly arched its back and raised its forelimbs to its head. In this position the webbed front limbs completely covered its eyes and it displayed its red and yellow coloration almost completely (Fig. 1). The eyes were open and the individual remained in this position for at least 2 min. During subsequent handling the back remained arched and it stayed motionless. No defensive call or smell was emitted. This behavior was observed in one of the five individuals handled during this field survey. This type of defensive behavior has also been reported from two other treefrogs in the genus, *Rhacophorus feae* (Thao Whipping Frog; Duong and Rowley 2010. Herpetol. Rev. 41:342; Vinh et al. 2013. Herpetol. Rev. 44:129) and *Rhacophorus margaritifer* (Java Flying Frog; Streicher et al. 2011. Herpetol. Rev. 42:590).



FIG. 1. *Rhacophorus pardalis* displaying defensive behavior.

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***RHINELLA* GR. *MARGARITIFERA* (Mitred Toad). PREDATION.** *Rhinella* gr. *margaritifera* are a species complex of medium-sized toads that inhabit forest litter, occurring throughout Amazonian South America to eastern Panama (Frost 2015. http://research.amnh.org/vz/herpetology/amphibia; 9 Apr 2015). *Rhinella marina* is native from south Texas in the United States to southern Brazil (Lever 2001. The Cane Toad. The History and Ecology of a Successful Colonist. Westbury Publishing, Otley, West Yorkshire. 230 pp.). During a field expedition to the Serra Azul in western Pará state, city Monte Alegre, Brazil (1.1787°S, 54.1868°W; WGS84)



FIG. 1. Adult male *Rhinella marina* preying upon *Rhinella* gr. *margaritifera*.



FIG. 2. *Rhinella* gr. *margaritifera* released from the mouth of the adult male of *Rhinella marina*.

we observed an adult male *R. marina* swallowing a live adult *R.* gr. *margaritifera* near a weir at 2000 h on 13 January 2015 (Fig. 1). The *R. marina* started ingesting the toad headfirst leaving only the legs of *R.* gr. *margaritifera* out of the mouth (Fig. 1). We captured the *R. marina* and removed *R.* gr. *margaritifera* for the purpose of photographing it and identifying it (Fig. 2). We then released both individuals. *Rhinella marina* is considered a generalist and opportunistic predator that includes both invertebrates and vertebrates in its diet (Lever 2001, *op. cit.*).

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***RHINELLA MARINA* (Cane Toad). REPRODUCTIVE ACTIVITY.** Amplexus in most anuran species lasts for a relatively short duration of a few hours to days (Wells 1977. Anim. Behav. 25:666–693, but see Dole and Durant 1974. Copeia 1974:230–235). The potential costs of amplexus include metabolic costs (McLister 2003. Can. J. Zool. 81:388–395), increased predation risk (Howard 1981. Ecology 62:303–310), decreased locomotor (sprint and swim) performance, and a reduction or loss of feeding opportunities (Bowcock et al. 2009. Copeia 2009:29–36). In laboratory experiments, feeding rates of amplexed female *Rhinella marina* were reduced and males did not feed at all (Bowcock et al. 2009, *op. cit.*). These laboratory results suggest that there may be significant costs involved in prolonged amplexus for both males and females. Toads may remain in amplexus overnight since egg deposition often doesn't begin until the following morning (Floyd 1983. Unpubl. PhD thesis. Griffith University, Australia. 315 pp.). However, amplexus over a period of days has not been reported under natural conditions (Bowcock et al. 2009, *op. cit.*).

Here we report prolonged amplexus of at least 14 days in a pair of *R. marina* in Paramaribo, Republic of Suriname (5.8288°N, 55.1436°W; WGS84). The amplexed pair (Fig. 1) was first observed at approximately 0830 h on 11 June 2014 and observed in amplexus on 10 different days between 0730–0900 h through 24 June 2014. They were still amplexed when observers left Suriname on 24 June 2014. All observations took place from an outdoor dining area approximately 2.5 m from a bird feeder stocked with bread and fruit which spilled to the ground where the amplexed pair and one other toad were periodically observed (Fig. 1). Although *R. marina* are considered to be primarily nocturnal, a lone female was photographed eating bread at 0845 h on 6 June 2014. Diurnal feeding and consumption of stationary anthropogenic food items (e.g., carrot peelings, corn kernels, black-eyed peas, and canned dog food) has been previously observed in *R. marina* (Alexander 1964. Herpetologica 20:255–259). Identification of the pair was achieved by comparing images taken of the pair over the duration and matching unique markings on the female between days (e.g., small white spot on the first tubercle posterior to male foreleg on the right lateral side; Fig. 1). In addition to the pair, no more than one other toad was observed at the same time. These observations demonstrate that prolonged amplexus in *R. marina* occurs under natural conditions. Although no measurements of male mass were taken, the male's concave sides, visible in the image taken on 17 June 2014 (Fig. 1), suggest that the male was not feeding. While not definitive, these observations lend credence to the laboratory results of Bowcock et al. (2009, *op. cit.*), that males do not feed while amplexed with females and males may be more negatively energetically impacted by prolonged amplexus than females, when the female has access to food.



FIG. 1. Amplexed pair of *Rhinella marina* surrounded by pieces of bread in Paramaribo, Suriname.

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***SCAPHIOPUS HURTERII* (Hurter's Spadefoot). ENDOPARASITES.** We report, for the first time, on endoparasites from *Scaphiopus hurterii* from Louisiana. On 3 April 2012, we collected six adult *S. hurterii* (5 males, mean SVL = 66.8 mm, range 62.0–70.0 mm and 1 female, SVL = 68.0 mm) by hand from northern Louisiana (3.75 km NE Spearsville, Union Parish, Louisiana, USA; 32.9562°N, 92.5718°W, WGS84) and examined them for helminth parasites. *Scaphiopus hurterii* were euthanized with a concentrated chloretone solution and their gastrointestinal tract, from the esophagus to rectum, was removed and split entirely, placed in a Petri dish containing amphibian saline (0.6% NaCl) and examined under a dissection microscope; we removed their lungs, gonads, and other visceral organs as well. Cestodes were stained with acetocarmine and mounted in Canada Balsam, and nematodes and acanthocephalans were studied as temporary mounts in glycerol. Voucher specimens of *S. hurterii* are deposited in the Arkansas State University Museum of Zoology (ASUMZ) Herpetological Collection, State University, Arkansas, and helminths are deposited in the Harold W. Manter Laboratory of Parasitology (HWML), University of Nebraska-Lincoln.

Five of six *S. hurterii* were infected with at least one helminth. Two of six had the cestode *Mesocestoides* sp. encapsulated within gastrointestinal tissues. Five of six were infected with the nematode *Oswaldocruzia pipiens*. One of six was infected with numerous nematodes, *Cosmocercoides variabilis*, in the rectum. One of six was infected with an unidentified oligacanthorhynchid acanthocephalan cystacanth; in this case, *S. hurterii* is likely a paratenic (transport) host. Amphibians are known as paratenic hosts of species of the acanthocephalan family

Oligacanthorhyncidae (Schmidt 1985. *In* Crompton and Nickol [eds.], Biology of the Acanthocephala, pp. 273–305. Cambridge University Press, Cambridge, UK). Development to the adult worm occurs when the amphibian is eaten by a suitable definitive host.

One female was infected with both *Mesocestoides* sp. and *O. pipiens* and one male (SVL = 70.0 mm) was infected with all four parasite species. Both *Mesocestoides* and *O. pipiens* have been reported in *Anolis carolinensis* (Green Anole) from Louisiana (Conn and Etges 1984. Proc. Helminthol. Soc. Washington 51:367–369) and in *S. hurterii* from Oklahoma previously (McAllister et al. 2005. Texas J. Sci. 57:383–389). *Cosmocercoides variabilis* has been reported from *Gastrophyrne carolinensis* (Eastern Narrowmouth Toad) from Louisiana (McAllister and Bursey 2005. Comp. Parasitol. 72:124–128) and from *S. hurterii* in Oklahoma (McAllister et al. 2005, *op. cit.*).

In summary, the acanthocephalan cystacanth represents a new paratenic host record for *S. hurterii* (HWML 64768), although not a new geographic record for the parasite in Louisiana (Elkins and Nickol 1983. J. Parasitol. 69:951–956). We suggest that additional *S. hurterii* from other parts of Louisiana be examined as new host and distributional records may be added to the growing list of helminths of this amphibian.

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***SCAPHIOPUS HURTERII* (Hurter's Spadefoot). REPRODUCTION.** *Scaphiopus hurterii* is considered an explosive breeder associated with torrential rainfall. Because of these requirements, they are seldom observed breeding. Between 11 March and 3 April 2012, we observed this species breeding three times during torrential rainfall events at a site in extreme northern Louisiana (3.8 km NE Spearsville, Union Parish, Louisiana, USA; 32.9562°N; 92.5718°W, WGS 84). On 11 March (ambient temperature 16.1°C), we discovered a breeding site (Fig. 1A), consisting of a temporary pool in a cattle pasture and were able to capture a total of eight toads (five males, three females). On 21 March (ambient temperature 12.2°C), we were able to document another breeding event at the same site and were able to capture 11 individuals (nine males, two females). Finally, on 03 April (ambient temperature 15.5°C), we observed another breeding event and were able to capture six individuals (five males, one female). The mean snout-vent length (SVL) for a small sample of adult individuals was 63.2 mm (range 57–68 mm) for six females and 67.4 mm (range 62–71 mm) for nine males. Our male-biased captures are likely the result of our sampling time (ca. 2200–2400 h), since males migrate to breeding site first and start calling to attract females. Both calling males and amplectant pairs were observed during all three of these events. Previously, the lowest air temperature for calling males in Louisiana was 16°C (Dundee and Rossman 1989. The Amphibians and Reptiles of Louisiana. Louisiana State University Press, Baton Rouge, Louisiana. 300 pp.); however, rainfall more so than ambient temperature is likely a predictor of breeding. We also collected six egg clusters that were laid on vegetation (Fig. 1B) and mean egg counts were 100.8 (range 49–131). This is comparable to mean egg cluster counts of 111.8 in Arkansas (Trauth and Holt 1993. Bull. Chicago Herpetol. Soc. 28:236–239). Voucher specimens were deposited within the Arkansas State University Museum of Zoology (ASUMZ) Herpetology Collection, State University, Arkansas as ASUMZ 32017–32025.



FIG. 1. A) *Scaphiopus hurterii* breeding site in Union Parish, Louisiana. B) *S. hurterii* egg clusters attached to vegetation in the temporary breeding pool in top photo.

This research was conducted under a Louisiana Department of Wildlife and Fisheries scientific collecting permit.

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***TELMATOBIUS ATACAMENSIS* (Atacama Water Frog). CANNIBALISM.** Among anurans, cannibalism has been documented both in tadpoles preying on conspecific eggs or tadpoles and in adults preying on those stages and/or on other postmetamorphic individuals (Polis and Myers 1985. J. Herpetol. 19:99–107). *Telmatobius atacamensis* is a medium-sized aquatic frog living in high altitude streams of a restricted area of the Puna Plateau of Salta Province, in northern Argentina (Lavilla and Barrionuevo 2005. Monogr. Herpetol. 7:115–165). As in most of the 62 species of *Telmatobius*, the diet of *T. atacamensis* is unknown, although some data exist for nine species (e.g., Lavilla 1984. Acta Zool. Lilloana 38:51–57; Wiens 1993. Occ. Pap. Mus. Nat. Hist. Univ. Kansas 162:1–76; Formas et al. 2005. Monogr. Herpetol. 7:103–114).

On 24 February 2005 a female *T. atacamensis* (SVL = 60.4 mm) was found in a small lateral pool (ca. 200 × 300 cm, 50 cm deep) that had lost contact temporarily with the stream Los Patos (24.3108°S, 66.2162°W, WGS84; 3945 m elev.), close to San Antonio de Los Cobres. The female was fixed 12 h after collection (FML SB0157). Upon examination of the female's stomach contents, a juvenile of the same species (SVL ca. 28 mm) was found. It was only partially digested at the anterior part of the head and therefore was perfectly recognizable. In the same pool, four adult *T. atacamensis* were found and many tadpoles and juveniles were observed.

This is the first case of cannibalism in *T. atacamensis*. Cannibalism has been recorded among species of *Telmatobius* so far only in *T. culeus* (Pérez Bejar 1998. Unpubl. dissertation Universidad de San Andres, Bolivia). Among the species of Ceratophryidae, a phylogenetically related group, cannibalism is common both in adults and larvae (Schalk et al. 2014. South. Am. J. Herpetol. 9:90–105). Cannibalism in aquatic environments has been associated with high concentrations of several cohorts in small bodies of water, a condition observed in our study site.

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***THELODERMA ASPERUM* (Hill Garden Bug-eyed Frog). DEFENSIVE BEHAVIOR.** Amphibians exhibit a wide range of defensive behaviors that differ between taxonomic groups (Toledo et al. 2011. Ethol. Ecol. Evol. 23:1–25). Herein, we report the antipredator behavior of a southeast Asian rhacophorid frog, *Theloderma asperum*. This genus currently includes 23 recognized species (Frost 2014. http://research.amnh.org/vz/herpetology/amphibia/; 31 Mar 2015). *Theloderma asperum* inhabits lowland to mountain forests from northeast India through Myanmar and adjacent China, upland Thailand, Laos, central and northern Vietnam to southwest Guangxi and south Indonesia (Sumatra).

At 2308 h on 27 June 2012, we captured an adult female *T. asperum* (SVL = 30 mm) on vegetation (ca. 2 m above the forest floor) near Sa Pa town in mountainous subtropical forest of Hoang Lien Mountains, northern Vietnam (22.328°N, 103.826°E, WGS84; 1266 m elev.). After its capture, the individual was put on the ground where it immediately curled up into an arched and rigid posture. The head was ventrally flexed, all limbs were bent and kept close to the body (Fig. 1). Eyes were closed the whole time and the individual remained in this position for at least 15 min (Fig. 1A) and remained arched and motionless during subsequent handling (Fig. 1B). No defensive call or smell was emitted.

We consider the defensive behavior shown in this case as "shrinking or contracting behavior" (sensu Toledo et al. 2010. J. Nat. Hist. 44:1979–1988; Toledo et al. 2011, *op. cit.*), a type of death feigning (or thanatosis) behavior. There is a published technical report that gives a similar description of this behavior in *T. asperum* (see Pawar and Birand 2001. A Survey of Amphibians, Reptiles, and Birds in Northeast India. Centre for Ecological Research and Conservation, Mysore, India. 120 pp.). The genus *Theloderma* is well known for cryptic coloration and body shape (e.g., Vitt and Caldwell 2014. Herpetology: An Introductory Biology of Amphibians and Reptiles. 4th ed., Elsevier, San Diego, California; Rauhaus et al. 2012. Asian J. Conserv. Biol. 1:51–66), which are types of passive defense employed by anurans (Toledo et al. 2011, *op. cit.*). For example, *T. asperum* is a tree bark and potentially a bird-dropping mimic and *T. corticale* (Mossy Frog) is mottled green and brown and resembles moss growing on rock



FIG. 1. Defensive behavior displayed by *Theloderma asperum* in northern Vietnam. A) Dorsal view, B) ventral view.

(Vitt and Caldwell 2014, *op. cit.*). Therefore, they may use contracting behavior in addition to cryptic coloration to evade predation. A similar case of defensive behavior has been reported for another member of the family Rhacophoridae, *Rhacophorus feae* (Fea's Treefrog; Vinh et al. 2013. Herpetol. Rev. 44:129).

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***ZACHAENUS CARVALHOI* (Carvalho's Bug-eyed Frog). DIET.** Frogs in the genus *Zachaenus* (Cycloramphidae) are associated with leaf litter in forested areas and are endemic to the Atlantic Forest of Brazil (Izecksohn 1982. Arq. Univ. Fed. Rural. R. de Janeiro 5:7–11). The information on diet for this genus is exclusive to *Z. parvulus* (Van Sluys et al. 2001. J. Herpetol. 35:322–325). Herein we present data on the diet of specimens of *Z. carvalhoi* present in the collections of the Universidade Federal de Juiz de Fora (UFJF 663, 674–678, 692, 708, 753, 760, 773, 781, 792–800, 819–830, 863–865) collected at three forest fragments in the municipality of Juiz de Fora, state of Minas Gerais, Brazil: Fazenda Floresta (21.7425°S, 43.2922°W; WGS84), Reserva Biológica Municipal Poço D'Anta (21.7541°S, 43.3108°W), and Parque Municipal da Lajinha (21.7922°S, 23.3808°W). We found identifiable items in 17 out of the 36 guts examined. The items were identified to the lowest possible taxonomic level. The primary items found were Coleoptera (76%) and Hymenoptera (ants; 58%), and occasional items were Myriapoda (11%), Arachnida

(Pseudoscorpionida; 11%), Hemiptera (Cercopidae 5%), Isoptera (5%), and Mollusca (Gastropoda, 5%). We also found plant matter in two individuals (11%).

The variety of prey items found in *Z. carvalhoi* indicates a generalist diet. These suggestions are consistent with data on the diet of other members in the family, with Hymenoptera and Coleoptera being the most common food items (e.g., Van Sluys et al. 2001, *op. cit*; Siqueira et al. 2006. J. Herpetol. 40:520–525; Maia-Carneiro et al. 2012. Zoologia 29:277–279). The presence of Hymenoptera and Myriapoda in the diet of *Z. carvalhoi* is noteworthy, as individuals in these groups produce toxins that potentially could be biosequestrated or transformed into skin chemicals (Hantak et al. 2013. J. Chem. Ecol. 39:1400–1406). The species in Cycloramphidae are not known to possess skin toxins, but do have macroglands (lateral glands in *Thoropa*, inguinal macroglands in *Cycloramphus*, and inguinal gland conglomerates in *Zachaenus*; Verdade 2005. Unpublished thesis, Universidade de São Paulo, Brazil), whose function and secretions have not been studied.

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TESTUDINES — TURTLES

***CHELYDRA SERPENTINA* (Snapping Turtle). DIET AND FORAGING BEHAVIOR.** *Chelydra serpentina* are omnivorous, consuming an extensive variety of foods including worms, mollusks, arthropods, and other invertebrates, fish, birds, amphibians, small mammals, small turtles, snakes, and other vertebrates, algae, aquatic macrophytes, and the fruits, stems, and leaves of higher plants (Ernst and Lovich 2009. Turtles of the United States and Canada, 2nd ed. Johns Hopkins University Press, Baltimore, Maryland. 827 pp.). On 14 May 2015 at 1310 h, I observed a large (carapace length ca. 40.0 cm) *C. serpentina* browsing on Skunk Cabbage (*Symplocarpus foetidus*) on land at a distance of ~2 m from the shoreline of a large pond in Espy, Columbia Co., Pennsylvania, USA (41.010206°N, 76.416294°W, WGS84; elev. ~150 m). The *C. serpentina* was observed for approximately 5 minutes at a distance of ~8 m. During observation, the *C. serpentina* removed Skunk Cabbage leaves by shearing the stalk near the base of each plant and subsequently consumed each leaf. When approached for closer observation, the *C. serpentina* became aware of my presence, ceased feeding, and assumed a defensive posture before retreating into the water. Closer inspection of the area in which this observation occurred revealed that approximately 40–50% of stems among ~20 clusters of Skunk Cabbage plants were sheared in a similar manner to those consumed by the observed *C. serpentina* (Fig. 1). Several partial fragments of Skunk Cabbage leaves were also noted on the surrounding substrate.



FIG. 1. Skunk Cabbage (*Symplocarpus foetidus*) stalks browsed by *Chelydra serpentina*.

Multiple markings in the substrate surrounding Skunk Cabbage clusters consistent with *C. serpentina* claw marks and a "slide" depression on the shoreline on which the individual *C. sperpentina* traveled upon during retreat may suggest that either the same or multiple individuals frequent this area to feed upon Skunk Cabbage. I noted an additional area that displayed similar characteristics (browsed Skunk Cabbage and multiple *C. serpentina* claw markings) along the pond shoreline approximately 20 m from the first.

Chelydra serpentina occasionally browse vegetation on land. Ernst and Lovich (2009, *op. cit.*) report an observation of two large individuals on land browsing upon sedge grass. However, Skunk Cabbage appears to be an uncommon component of *C. serpentina* diet. Upon examination of the stomach contents of 470 *C. serpentina*, Alexander (1943. J. Wildl. Manage. 7:278–282) reported Skunk Cabbage in less than 1% of individuals studied. Observations reported herein suggest that terrestrial browsing of Skunk Cabbage by *C. serpentina* may be more typical in this species than previously documented. The pond shore and surrounding area in which these observations occurred is a portion of a once larger wetlands area that has been reduced and fragmented by development. Alternatively, *C. serpentina* may more commonly utilize Skunk Cabbage as a food source when other resources are limited.

I thank Amber L. Pitt for advice during the preparation of this note. Observations reported herein were conducted during turtle transect survey research approved by Bloomsburg University of Pennsylvania IACUC (Protocol #131, Summer 2015). Additional photographs of Skunk Cabbage browsed by *C. serpentina* and other aspects of the area described in this note are available from the author.

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***GOPHERUS AGASSIZII* (Agassiz's Desert Tortoise). ATTEMPTED PREDATION.** Desert Tortoises have many predators (Rostal et al. 2014. Biology and Conservation of North American Tortoises. Johns Hopkins University Press, Baltimore, Maryland. 190 pp.). Several ophidian species have been identified as potential predators (Ernst and Lovich 2009. Turtles of the United States and Canada. Johns Hopkins University Press, Baltimore,



FIG. 1. *Arizona elegans* attempting to prey on *Gopherus agassizii* at Edwards Air Force Base, Kern Co., California, USA.

Maryland. 827 pp.), but no published reports have mentioned *Arizona elegans* (Glossy Snake).

At 0827 h on 3 October 2013, we observed an *Arizona elegans* ca. 80 cm total length attempting to prey on an 8.6-yr old juvenile *Gopherus agassizii* (midline carapace length = 90.5 mm, width = 72.4 mm, height = 42.1 mm, weight = 137.3 g) that had been fitted with a radio-transmitter and released the previous day from a head-start facility at Edwards Air Force Base in the Mojave Desert, Kern Co., California, USA. When first observed, the tortoise was 2 cm outside the entrance of a rodent burrow, the snake was between the tortoise and burrow entrance, and the snake had the head of the tortoise firmly in its jaws. The tortoise initially was immobile and probably cold (air temperature at 1 cm 18.0°C, soil temperature 16.2°C). The snake coiled around the tortoise shell three times and pulled the tortoise head first, closer to, and partially within the burrow entrance. The snake appeared to use the radio transmitter attached to the 5th vertebral scute of the tortoise as purchase for its coils. The tortoise with the snake coiled around it was too large to be pulled further into the burrow, and the head and anterior half of the tortoise were not visible (Fig. 1). The right hind foot of the tortoise was pinned backwards by the snake's coils and was immobile. The snake appeared to squeeze the tortoise shell with its coils; at the same time, the snake's head was still out of view within the burrow and possibly still gripping the tortoise's head. At 0912 h, the tortoise and snake moved slightly, and the snake's head, with partially opened mouthed and disarticulated jaws, came into view, exiting the burrow along the bridge of the tortoise shell. One of the coils loosened. Both animals remained still for another 10 min. Observations ceased and were re-initiated at 1110 h, but neither the tortoise nor the snake was evident at the burrow. The tortoise had moved 20 m away and was basking at the entrance of a small mammal burrow. No injuries were apparent on head or limbs. After a few minutes, the tortoise walked into the burrow and turned sideways, almost entirely within the burrow. By 1345 h, the tortoise was 15 cm into the burrow tunnel and no longer visible. The tortoise dug the burrow deeper and did not emerge again until 10–11 October, when it moved to and enlarged another rodent burrow for fall-winter brumation. The juvenile tortoise had apparently been too large for the snake to eat and was still alive the following spring. Our observation is the first record of an *A. elegans* attempting to prey on a juvenile *G. agassizii*. The diet of *A. elegans*, based on evaluation of 205 museum specimens, is composed of lizards, birds, mammals, and insects (Rodríguez-Robles et al. 1999. J. Herpetol. 33:87–92). The diet differed significantly by snout–vent length, with larger snakes consuming birds, followed in descending order by mammals, and lizards. If *A. elegans* had attempted to prey on a recently hatched, soft-shelled juvenile tortoise, the predation likely would have been successful.

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***GOPHERUS AGASSIZII* (Agassiz's Desert Tortoise). MECHANICAL INJURY.** On 3 June 2015 at 1024 h, a team of U.S. Geological Survey scientists located an immature *Gopherus agassizii* at Joshua Tree National Park, near the southern Cottonwood Canyon entrance, that had been injured by a large *Ferocactus cylindraceus* (California Barrel Cactus) spine. The *G. agassizii* was estimated to be four years old by counting growth rings on the plastron, and was 89.4 mm in carapace length and weighed 160 g. It was found basking on a flat spot on a north-facing, steep, rocky slope with the *F. cylindraceus* spine impaling it under the right leg. The area is typical of the Sonoran Desert in California, with several species of cacti, some of which are locally abundant.

The tip of the spine had entered the body at the right anterior axillary area and penetrated the lower body to the posterior portion of the neck, at a right angle to the long axis of the *G. agassizii*, along a plane parallel with the ground, and close to the inside of the plastron. The spine was removed; significant tissue debris had formed around the diameter of the spine for approximately a centimeter from the insertion spot. It is unknown how long the spine had been in the *G. agassizii* but the dark color of the spine



FIG. 1. Immature *Gopherus agassizii* with *Ferocactus cylindraceus* spine that was removed from its body. Built-up tissue can be seen on the removed spine from the left end to where it overlaps the seam between the second and third vertebral scutes of the *G. agassizii*.

suggests that either it had been present for a relatively long time or that the spine was from an already dead cactus. The length of the inserted portion of the spine was about 27 mm, and the total length was about 63 mm (Fig. 1). The average diameter of the spine was about 1.5 mm. The protruding portion of the spine had likely inhibited movement of the immature tortoise.

Lanius excubitor (Northern Shrike) has been known to impale hatchling *Testudo gracea gracea* (Moorish Tortoise) on spiny plants in Morocco (Barje et al. 2005. Amphibia-Reptilia 26[1]:113–115). We do not believe local shrikes (*Lanius ludovicianus*) are the cause of this event. The mean carapace length of *T. gracea gracea* reported in the study above was 28 mm, which is smaller than the mean carapace length of a *G. agassizii* hatchling at 40–50 mm (Ernst and Lovich 2009. Turtles of the United States and Canada, 2nd ed. Johns Hopkins University Press, Baltimore, Maryland. 827 pp.). *Lanius ludovicianus* in the southwestern United States weigh an average of 40 g and select prey weighing an average of 8 g (Bartholomew et al. 1953. Physiol Zool. 162–166; Slack 1975. Auk 812–814). Even if the event occurred in the *G. agassizii*'s first year, *G. agassizii* hatchlings are much bigger than *T. gracea gracea*, rendering *L. ludovicianus* an unlikely predator due to their small size (Barje et al 2005, *op. cit.*).

We do not know how this injury occurred but present three possibilities. First, it is possible the *G. agassizii* was feeding near a cactus or on a cactus flower and became impaled. However, *F. cylindraceus* is not listed specifically in *G. agassizii* diets (Grover and DeFalco 1995. Desert Tortoise (*Gopherus agassizii*): Status-of-Knowledge Outline with References. USDA For. Serv. Gen. Tech. Rep. Int-GTR-316). Given the rocky and steep terrain, a second possibility is that the *G. agassizii* may have fallen into a living or dead cactus. Third, it is also possible that an avian predator like a *Corvus corax* (Common Raven) may have picked up the tortoise and dropped it by chance on a *F. cylindraceus* (Boarman 2003. Environ Manage. 32:205–217). Mechanical injuries from other plant parts have been reported in *G. agassizii* (Medica 2007. Herpetol Rev. 38: 446–448). As cacti are prominent in the Sonoran Desert, this may happen to *G. agassizii* with some regularity. However, we are unaware of any previous reports of *G. agassizii* being impaled by large cactus spines.

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***KINOSTERNON HIRTIPES* (Rough-footed Mud Turtle). AERIAL BASKING, WINTER ACTIVITY, HABITAT, AND NEW LOCALITY.** *Kinosternon hirtipes* occurs from extreme western Texas, south into northern and central Mexico (Ernst and Lovich 2009. Turtles of the United States and Canada. 2nd ed. Johns Hopkins University Press, Baltimore, Maryland. 827 pp.). In Texas, *K. hirtipes* is restricted to the Alamito Creek drainage in Presidio Co. (Scudday and Miller 1986. The Status of the Chihuahuan Mud Turtle, *Kinosternon hirtipes murrayi*. Report to United States Fish and Wildlife Service, Washington, D.C. 40 pp.), and classified as a threatened species owing to its limited distribution and continuing habitat degradation (Texas Parks and Wildlife Department. 2013. Species of Conservation Concern. Available from: www.tpwd.state.tx.us). *Kinosternon hirtipes* is one of the least-studied turtles in North America and very little is known concerning its natural history (Ernst and Lovich, *op. cit.*; Lovich and Ennen 2013. Amphibia-Reptila 34:11–23). We here present observations of aerial basking by *K. hirtipes* made during late winter at a locality in Presidio Co., Texas, USA, describe the habitat at this site, and comment on the significance of our findings.

On 14 February 2009 (1400–1555 h), one of us (LM) observed two adult (straight-line carapace length ca. 140–160 mm) *K. hirtipes* basking in direct sunlight on exposed rocks in springfed pools about 50 m apart on the floor of Robbers Roost Canyon (30.0451°N, 103.9425°W; 1294–1304 m elev.). Both turtles were basking within 30 cm of the water; one on a horizontal surface and the other on a steep incline (ca. 40°). The carapace of one turtle was covered with a thick growth of algae. The carapace of the second turtle lacked algae and appeared dry, suggesting this individual had been basking > 30 minutes. We estimated the air and water temperature in Robbers Roost Canyon at the time the turtles were basking to be 18°C and 15°C, respectively. The minimum and maximum air temperature recorded at the nearest weather station (Marfa, Texas) on 14 February 2009 was -3.3°C and 18.8°C, respectively. Air temperature on the preceding day had likewise been relatively mild (range = 3.8–20°C) (Available from: www.wunderground.com). Small cyprinids (possibly Red Shiner [*Cyprinella lutrensis*]), sunfish (*Lepomis* spp.), and largemouth bass (*Micropterus* spp.) were also present in the pools, the latter being potential predators of neonate *K. hirtipes* (Smith et al. 2015. Herpetol. Rev. 46:82–83).

The pools in Robbers Roost Canyon are up to 8 m wide in places, 3–4 m deep, relatively clear, and contain dense mats of muskgrass (*Chara* sp.) and filamentous algae. Narrow channels link the pools, which extend along the canyon floor for about 2 km before debouching into an arroyo leading southwest to Alamito Creek, a distance of approximately 6.0 km. Neither the arroyo nor Alamito Creek contain water except after heavy rainfall (Wilde and Platt 2011. J. Big Bend Studies 23:85–106). Robbers Roost Canyon appeared relatively undisturbed at the time of this observation; evidence of cattle grazing was minimal and woody riparian vegetation remained largely intact. There are no obvious habitat linkages between Robbers Roost Canyon and other wetlands in the Alamito Creek watershed known to harbor *K. hirtipes*, the nearest of which is 20 km SW (straight-line distance) at Plata (Scudday and Miller, *op. cit.*). The intervening xeric landscape may function to isolate the *K. hirtipes* population at Robbers Roost Canyon.

Our observation of basking *K. hirtipes* in Robbers Roost Canyon is noteworthy for several reasons. First, to our knowledge this is the first report of aerial basking by *K. hirtipes*. A juvenile *K. hirtipes* that appears to be basking on a horizontal tree branch is pictured in Ernst and Lovich (*op. cit.*), although no details are provided in the accompanying figure caption or text. Aerial basking by *K. hirtipes* is not unexpected as this behavior is reportedly commonplace among North American Kinosternidae

(*Kinosternon arizonense*, *K. flavescens*, *K. sonoriense*, *K. subrubrum*, *Sternotherus carinatus*, *S. depressus*, *S. minor*, *S. odoratus*; reviewed by Ernst and Lovich, *op. cit.*). Our observation seems clearly related to thermoregulation given the turtles were basking in direct sunlight in early to mid- afternoon on a warm late winter day. Second, our observation constitutes the first report of winter activity in a natural population of *K. hirtipes*. Beltz (1954. Herpetologica 10:124) described an adult female that escaped from captivity and overwintered beneath a pile of leafy debris in southern California, but otherwise winter activity of *K. hirtipes* has gone unreported. Our observation lends support to an earlier suggestion by Iverson et al. (1991. J. Herpetol. 25:64–72) that *K. hirtipes* is probably sporadically active throughout the winter on warm days.

Robbers Roost Canyon also represents a new locality record for *K. hirtipes* in Texas where it was previously known from only six small wetlands in the Alamito Creek drainage (Scudday and Miller, *op. cit.*). At one time connectivity between these populations was probably maintained by Alamito Creek, a permanent free-flowing stream corridor linked by tributary creeks to riparian wetlands and springs throughout its drainage (Wilde and Platt, *op. cit.*). These wetlands later became isolated after Alamito Creek ceased flowing (except following heavy rainfall) due to hydrological changes wrought by over-grazing and water diversion in the late 1800s (Wilde and Platt, *op. cit.*). Without stream corridors to provide connectivity between occupied sites, the continued exchange of individuals among the remaining populations can seemingly be accomplished only by lengthy (> 5 km) overland movements across an arid landscape. Successful overland dispersal seems doubtful given the high rate of evaporative water loss reported for *K. hirtipes* and its inability to tolerate prolonged dehydration (Seidel and Reynolds 1980. Comp. Biochem. Physiol. 67A:593–598; Ligon and Peterson 2002. Physiol. Biochem. Zool. 75:283–293); however, further study is required to resolve this question of obvious conservation significance.

Finally, our observation compliments the few previously published descriptions of *K. hirtipes* habitat. Iverson et al. (*op. cit.*) reported a large population of *K. hirtipes* inhabiting a springfed stream flowing through arid grassland in Chihuahua, Mexico. The stream was described as clear and fast-flowing, 100–200 cm wide (average width = 100 cm) and 10–100 cm deep (average depth = 50 cm) with a sand-gravel substrate and deeply undercut banks where turtles sought refuge. Dense stands of *Typha* were established along the bank in backwater areas where the current was reduced. In another area of Chihuahua, Van Devender and Lowe (1977. J. Herpetol. 11:41–50) stated *K. hirtipes* is "very common in streams." Ernst and Lovich (*op. cit.*) described a population of *K. hirtipes* inhabiting a livestock pond in Texas (480 m^2 and 4.0 m deep) "choked" with muskgrass (*Chara* sp.). Smith et al. (*op. cit.*) captured a record-sized *K. hirtipes* in a springfed wetland that had been dammed to form a livestock watering pond. The pond was clear, averaged 5.0 m deep with a relatively stable water level even during drought conditions, and supported abundant emergent aquatic vegetation (*Scirpus*, *Typha*, and Poaceae), mats of *Chara* sp., and filamentous algae. Taken together, our observation and reports of others suggest that permanent streams and springfed wetlands with an abundance of submerged and emergent aquatic vegetation provide habitat for *K. hirtipes*. Such habitats are probably crucial for the survival of *K. hirtipes* in west Texas (Ernst and Lovich, *op. cit.*; Smith et al., *op. cit.*).

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***MACROCHELYS APALACHICOLAE* (Apalachicola Alligator Snapping Turtle). AERIAL BASKING.** The Alligator Snapping Turtle was recently split into three species (Thomas et al. 2014. Zootaxa 3786:141–165). Observations of basking *Macrochelys* are rare. Carr et al. (2011. IRCF Reptiles & Amphibians 18:2–5) reviewed nine previously documented basking events and Elsey and Bourgeois (2014. Herpetol. Rev. 45:688–689) recently reported two additional observations. With the exception of Thomas (2009. Herpetol. Rev. 40:336), who reported on *M. suwanniensis* in the Suwannee River, Florida (*M. temminckii* at time of observation), all previously reported aerial basking observations were of *M. temminckii*. Here we report the first two aerial basking observations for the newly recognized *M. apalachicolae*.

On 13 May 2014 at 1603 h, EPH and JDM observed an immature *M. apalachicolae* (estimated mass less than 4.5 kg) basking on the Choctawhatchee River, Holmes Co., Florida, USA. The turtle was perched on a willow trunk (*Salix* sp.) that was horizontal to the river surface (Fig. 1). The turtle was located 2 m out from the bank and approximately 0.5 m above the water. The turtle escaped into the water after a photo was taken. Air temperature was approximately 32°C under partly sunny skies.

A second immature *M. apalachicolae* (similar in size to the above) was observed basking by JDM at 1547 h on 21 May 2014 on the Apalachicola River, Liberty Co., Florida, USA. This turtle was perched more than 1 m above the water's surface at the top of a nearly vertical snag located 5m out from the bank. The turtle was clinging to the snag with the head up, but upon detection it dropped into the river. Air temperature was approximately 32°C under mostly sunny skies.



FIG. 1. An immature *Macrochelys apalachicolae* basking along the Choctawhatchee River, Holmes Co., Florida, USA.

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***MALACLEMYS TERRAPIN RHIZOPHORARUM* (Mangrove Diamond-backed Terrapin). DIET.** *Malaclemys terrapin rhizophorarum,* one of seven subspecies of *M. terrapin,* inhabits subtropical mangrove habitats in South Florida, USA. In temperate climates *M. terrapin* is largely carnivorous, feeding primarily on gastropods, bivalves, and decapod crustaceans (Tucker et. al. 1995. Herpetologica 51:167–181; Butler et. al. 2012. Chelon. Conserv. Biol. 11:124–128). In addition to its preferred prey, *M. t. rhizophorarum* has also been reported to consume barnacles, fish, and vegetation (Tucker et. al. 1995, *op. cit.*; Butler et. al. 2012, *op. cit.*; Tulipani 2013. Ph.D. Dissertation. The College of William and Mary, Williamsburg, Virginia. 224 pp.). Herein, we report observations regarding the diet of *M. t. rhizophorarum* from the southernmost extent of their range in the Florida Keys, USA.

On 9 April 2013, we collected opportunistic fecal samples from 29 adult female *M. t. rhizophorarum* with straight plastron lengths (SPL) ranging from 145–175 mm (mean 158 mm ± 7) and one yearling *M.t. rhizophorarum* (SPL 30 mm), from Barracouta Key (24.54799°N, 81.92127°W; WGS84) 12 miles W of Key West, Florida, USA. We identified 14 different categories of fecal remains, ten of which were classified as food (Table 1), with an additional four classified as non-food (e.g., Ostracoda [ostracods], parasites, sand/sediment, and other). The "other" category consisted of small bits of glass and an unidentifiable substance. *Cerithidea scalariformis* (Ladder Horn Snail) was the primary food item occurring in 100% of samples and accounted for approximately 97% of total dry mass for each mature terrapin as well as across all samples. Vegetation, unidentifiable gastropod and bivalve remains, *Melampus coffeus* (Coffee Bean Snail), crabs, and small fish constituted the remaining 3% of samples by weight. Gastropod opercula were documented in 93% of the samples, and although not identified to species, were frequently associated with the shell fragments of *C. scalariformis*. Crab remains were too fragmented for species identification but likely were *Uca* sp. (Fiddler Crab) based their small size and their common occurrence along the edge of the island. Insects were identified in 77% of the samples, but this food item may be over-represented because of difficulty distinguishing between prey and incidental drowning after terrapins were placed in collection buckets. Parasites were found in 48% of the samples examined, including the one yearling terrapin.

The one yearling terrapin's fecal sample contained the remains of four food (insect, crab, *C. scalariformis*, vegetation) and three non-food items (parasites, sand, Ostracoda). Diets were similar between the two age groups with all items (food and non-food) documented in the yearling's fecal sample also documented in mature terrapins, but in different proportions. Unlike the mature adults, insects dominated the yearling's sample in both abundance and mass, with few crab or Ladder Horn Snail remains. Intriguingly, unlike adult female diet samples, the one yearling sample was dominated by beetle and other insect remains that were clearly ingested as prey and may be an important food item for smaller size classes. This could be due to their using habitats around dead wood, or their smaller head size may preclude them from producing the crushing jaw forces necessary to process harder-shelled prey.

All sampled mature *M. t. rhizophorarum* were females, captured on the interior of the island during the end of the dry season. During the time of this study, *C. scalariformis* dominated the habitat while crabs and bivalves were found less frequently and concentrated along the edge of the island. This pattern of prey availability could explain the appearance of selective feeding on *C. scalariformis*, since these were more abundant and less mobile than crabs. Further investigation into the diet of *M. t. rhizophorarum* is desirable, including samples from males and females in different seasons, to provide valuable information on the foraging ecology of terrapins living in the southernmost extreme of their range.

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TABLE 1. Frequency of occurrence (FO) and total dry weight (DW) of food items identified from *Malaclemys terrapin rhizophorarum* fecal samples from Barracouta Key, Florida, USA in April 2013.

	Mature (N = 29)		Immature (N = 1)
Food item	DW (g)	FO (%)	DW (g)
Ladder Horn Snail (*Cerithidea scalariformis*)	116.589	100	0.0001
Vegetation fragments	1.176	97	0.0002
Gastropod operculum	0.215	97	–
Unidentifiable (combination of gastropods and bivalves)	1.007	93	–
Insects	0.064	76	0.0208
Coffee Bean Snail (*Melampus coffeus*)	0.085	21	–
Fiddler crab (*Uca* sp.)	0.101	10	0.0003
Fish bones (unknown sp.)	0.057	7	–
Pointed Venus Clam (*Anomalocardia auberiana*)	0.764	3	–
Atlantic Pearl Oyster (*Pinctata imbricata*)	0.001	3	–

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***PELOMEDUSA GALEATA* (South African Helmeted Turtle). MUTUALISTIC BEHAVIOR.** There are few published instances of turtles showing mutualistic behavior by removing ectoparasites from other organisms. In Ontario, Canada, *Chrysemys picta* (Painted Turtle) were observed removing leeches from *Chelydra serpentina* (Snapping Turtle), and this was judged to be the first documentation of active participation in any mutualism by any species of turtle (Krawchuk et al. 1997. Can. Field Nat. 111:315–317). This type of interaction was recorded between *C. picta* and *C. serpentina* ten times, and the *C. serpentina* remained passive during these interactions. In South Africa, *Pelomedusa subrufa* were observed to remove ticks from *Diceros bicornis* (Black Rhinoceros) on several occasions, and the *D. bicornis* did not interfere with the turtles' activities (Deane 1969. Lammergeyer 2:69, Rochat 1969. Lammergeyer 2:69). These observations did not report a specific locality in South Africa, and may refer to either *P. subrufa* sensu stricto or *P. galeata*, following a recent taxonomic revision (Petzold et al. 2014. Zootaxa 3795:523–548).



FIG. 1. *Pelomedusa galeata* inspecting the head of an adult male *Phacochoerus africanus* (Warthog).



FIG. 2. *Pelomedusa galeata* removing and eating a *Tabanus biguttatus* from the warthog.



FIG. 3. *Pelomedusa galeata* climbing onto the back of the *Phacochoerus africanus* to remove a tick. The *P. africanus* remained motionless throughout this encounter.

We observed a lone adult male Warthog (*Phacochoerus africanus*) southeast of Hilltop Camp in the Hluhluwe section of the Hluhluwe-iMfolozi Park, KwaZulu-Natal, South Africa on 4 February 2015 at 1255 h. The *P. africanus* approached and then walked into a small roadside wallow; we observed it from 10 m away, while remaining inside our vehicle. As soon as the *P. africanus* entered the water, it was approached by two adult *Pelomedusa galeata*, and as it lowered itself into the water, the turtles began swimming around the warthog's body. The warthog stopped moving once the water level had reached its neck, with only the shoulders and the top of the back and rump above water. The turtles inspected the skin of the warthog and occasionally lunged forward at unseen items. The turtles' claws were frequently seen touching the warthog's skin as they swam around it, and they closely inspected the face and snout of the warthog with no adverse response (Fig. 1). The warthog's back had a Hippo Fly (Tabanidae: *Tabanus biguttatus*) attached to it, and after 5 min of observation, the warthog lowered itself further into the water. As soon as the fly was in reach of one of the turtles, it reached up onto the warthog's back and ate the fly (Fig. 2). The turtle then climbed onto the back and bit something on the warthog (Fig. 3). Upon review of our photographs, we were able to see at least ten ticks embedded in the left side of the warthog's body, and one tick was clearly the object that the turtle is biting in Fig. 3. Other than adjusting its body depth in the water, the warthog remained motionless throughout the observation time (approximately 10 min).

This is the first documentation of a mutualism between *Phacochoerus africanus* and *Pelomedusa galeata*. Taken together with published information on *P. subrufa/galeata* and *D. bicornis* in mud wallows, we expect that additional field observation will show that ectoparasite removal is an opportunistic mutualism by *Pelomedusa* spp. This behavior should be looked for in mud wallows during the dry season throughout the range of this genus, and the mammalian partners in this mutualism could include other common species that use these wallows (e.g., *Syncerus caffer* [African Buffalo], *Connochaetes taurinus* [Blue Wildebeest], and *Loxodonta africana* [African Elephant]).

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***STERNOTHERUS ODORATUS* (Eastern Musk Turtle). DEFENSIVE BEHAVIOR.** *Sternotherus odoratus* is a small, freshwater turtle in which aerial basking is generally uncommon; however, this species will occasionally bask on logs, within tree limbs, and along shorelines (Nickerson 2000. Herpetol. Rev. 31:238–239; Ernst and Lovich 2009. Turtles of the United States and Canada, 2nd ed. Johns Hopkins Univ. Press, Baltimore, Maryland. 827 pp.). When disturbed, basking adult *S. odoratus* commonly escape by retreat into the water, while juveniles latch onto logs or tree limbs, presumably to impede removal (Ernst and Lovich 2009, *op. cit.*). On 21 June 2015 at 1220 h, I observed an adult *S. odoratus* basking



FIG. 1. Defensive posture of an adult *Sternotherus odoratus*.

along the shoreline of a small, unnamed pond within the Montour Preserve, Montour Co., Pennsylvania, USA (41.096794°N, 76.663693°W; WGS84). Instead of retreating into the water, when approached the *S. odoratus* retracted its head, tucked its limbs slightly underneath its plastron and tightly grasped the grassy substrate along the shoreline (Fig. 1). The behavior observed by the adult *S. odoratus* appears to be analogous to the grasping behavior described in juveniles by Ernst and Lovich (2009, *op. cit.*). This observation suggests that the defensive behavior employed by *S. odoratus* juveniles may be retained by adults in some populations. Furthermore, this note may represent the first account of this behavior occurring upon non-woody (i.e., logs, tree limbs) substrate.

Many thanks to Amber L. Pitt for identifying the *S. odoratus*, and to Michael B. Hartzell and Sarah C. Hartzell for transportation to the Montour Preserve.

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CROCODYLIA — CROCODILIANS

***ALLIGATOR MISSISSIPPIENSIS* (American Alligator). TELEMETRY UNIT RETENTION.** Numerous radio-telemetry studies have been conducted on American Alligators in Louisiana (Joanen and McNease 1970. Proc. SE Assoc. Game Fish Comm. 24:175–193; Joanen and McNease 1972. Proc. SE Assoc. Game Fish Comm. 26:252–275) and Florida (Rosenblatt et al. 2013. Estuarine, Coastal, and Gulf Sci. 135:182–190). Many telemetry studies are only able to collect data from animals for less than one year (see review in Rosenblatt, *op. cit.*). We herein report on the recovery of a surgically implanted telemetry unit in an American Alligator after over 13 years.

As part of a study on thermoregulation in alligators (Seebacher et al. 2003. Physiol. Biochem. Zool. 76:348–359) conducted in June–July 2001 (summer) and February 2002 (winter), 20 free-ranging alligators were implanted with temperature loggers, and seven of the alligators were also implanted with a temperature-sensitive radio transmitter in each season (Seebacher et al., *op. cit.*). The study was conducted on Rockefeller Wildlife Refuge in Grand Chenier, Louisiana, USA (29.7167°N, 92.8167°W), a coastal marsh habitat. The transmitters and data loggers were surgically implanted into the peritoneal cavity via a small incision in the right flank of each alligator, as previously described (Seebacher et al., *op. cit.*). After the alligators were released to the wild, we recovered seven alligators in both the summer phase and the winter phase; obtaining continuous body temperature data for up to 17 days in summer and up to 13 days in winter for the short-term study (Seebacher et al., *op. cit.*).

On 3 September 2014, during the annual nuisance alligator harvest conducted on Rockefeller Refuge, one of the study animals from the summer 2001 phase was recaptured. During the lengthy time period since the initial capture and study, the identifying foot/web tag was lost. However, when the alligator was butchered at a processing shed, the radio transmitter spontaneously fell out of the peritoneal cavity and was recovered. Employees of the facility brought this to the attention of SFD, who inquired with RME and PLT as to the origin of the unit. The identifying number on the transmitter was from an alligator that was captured on 22 June 2001 and was released on 24 June 2001 after surgical implantation of the data logger and radio transmitter. The female alligator was initially 1.78 m total length and had a mass of 16.8 kg at capture in 2001. The exact length at recapture in 2014 was unknown, as the skin (with identifying CITES tag) had been separated from the carcass from which meat was being deboned when the transmitter was noted. However, six female alligators caught that day on Rockefeller Refuge with the same identifying tail notch as the marked study alligators ranged in length from 2.03–2.39 m total length. The number of days elapsed between release and recapture was 4821 days (13 years, 2 months, and 12 days).

It is noteworthy that this recovery was made after such a long time interval after implantation. The transmitter fell out of the abdominal cavity during processing; there was apparently no evidence of adhesions or complications from the earlier procedure; the alligator appeared healthy and robust. The transmitter appeared nearly pristine and the identifying numbers were clearly visible and no wear or erosions were seen on the protective coating on the unit. Of the seven alligators recovered with data loggers in the initial summer phase in July 2001, four also had telemetry transmitters; thus the unit recovered in 2014 was one of only three possibly remaining from the summer experimental phase conducted over 13 years earlier. It is also significant that the alligator had such long term survival, particularly after the region was adversely impacted by two major hurricanes (Hurricane Rita in 2005 [Lance et al. 2010. J. Exp. Zool. 313A:106–113], and Hurricane Ike in 2008). In some cases flooding from hurricanes pushed alligators north off the refuge, and alligators can disperse long distances (Lance et al. 2011. SENA 10:389–398), although we documented several cases of nest-site fidelity by nesting females on Rockefeller Refuge, even after Hurricane Rita and a subsequent catastrophic drought (Elsey et al. 2008. SENA 7:737–743).

We thank the staff at D & D in Gueydan, Louisiana for assistance in recovery of the telemetry transmitter.

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***CROCODYLUS ACUTUS* (American Crocodile). ECTOPARASITISM.** Crocodilians host a diversity of parasites (Tellez 2013. A Checklist of Host-Parasite Interactions of the Order Crocodylia. University of California Press, Berkeley, California. 388 pp.). Although parasitism of crocodilians by endoparasites and aquatic ectoparasites is fairly well-documented (Cott 1961. Trans. Zool. Soc. Lond. 29:211–359; Webb and Manolis, 1983. Aust. Wildl. Res. 10:407–420; Riley and Huchzermeyer 2000. Copeia 2000:582–586), comparatively little is known regarding parasitism of crocodilians by terrestrial ectoparasites. Scattered reports exist describing crocodilian parasitism by ticks (Terenius et al. 2000. J. Med. Entomol. 37:973–976; Rainwater et al. 2001. J. Wildl. Dis. 37:836–839; Sejas, 2007. Interciencia 32:56–60), and even fewer reports exist regarding parasitism of crocodilians by hematophagous (blood-feeding) flies, although due to their affinity for aquatic habitats crocodilians are generally more vulnerable to the latter.

Hematophagous fly parasitism has been reported for *Crocodylus niloticus* (Nile Crocodile) (Hoare 1931. Parasitology 23:449–484; Cott, *op. cit.*) as well as multiple caiman species including *Caiman crocodilus* (Spectacled Caiman), *Melanosuchus niger* (Black Caiman), *Paleosuchus trigonatus* (Smooth-fronted Caiman), and *P. palpebrosus* (Dwarf Caiman) (Medem 1981. Cespedesia 10:123–191; Henriques et al. 2000. Rev. Brasil. Zool. 17:609–613; Ferreira et al. 2002. Mem. Inst. Oswaldo Cruz, Rio de Janeiro. 97:133–136). However, to our knowledge no published accounts exist regarding hematophagous fly parasitism in New World crocodiles. Here, we report an observation of parasitism by a hematophagous fly on *C. acutus* in Costa Rica.

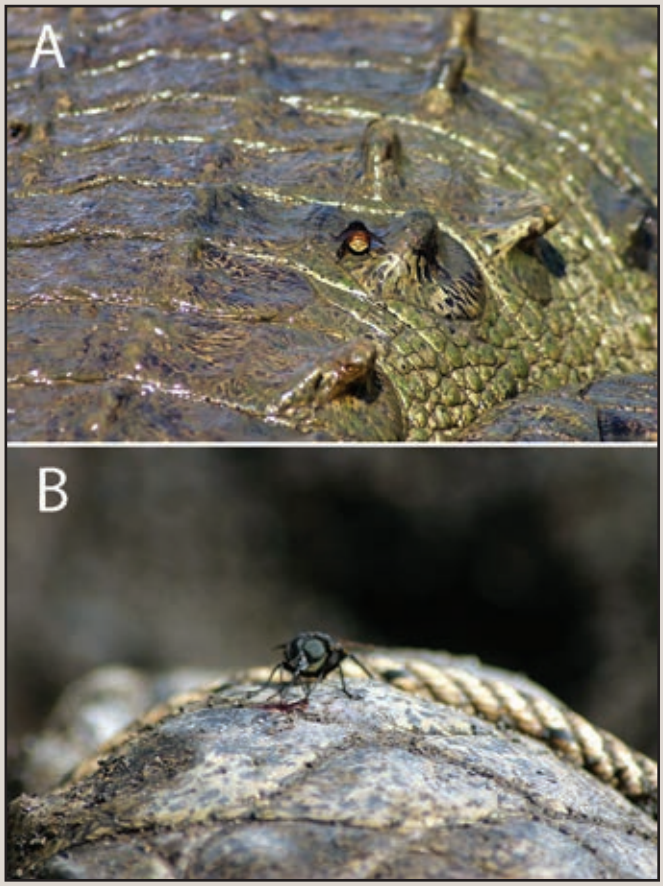


FIG. 1. A) *Fidena bicolor* (rear view) on the back of *Crocodylus acutus* in the Tarcoles River, Costa Rica. B) *Fidena bicolor* (front view) on the rear leg of *Crocodylus acutus* in the Tarcoles River, Costa Rica. Note the tip of the fly's proboscis inserted into the skin between scales.

On 12 September 2007 at approximately 1530 h, we captured an adult (total length = 376 cm) male *Crocodylus acutus* in the lower Tarcoles River, Costa Rica (9.785892°N, 84.617481°W; WGS84) during a study of ocular disease in this crocodile population (Rainwater et al. 2011 J. Wildl. Dis. 47:415–426). The crocodile was captured by actively attracting it to bait on the river bank and then placing a breakaway snare around its upper jaw. Prior to capture, as the crocodile slowly crawled onto the bank toward the bait, we observed a *Fidena bicolor* (horse fly; Diptera: Tabanidae) hovering around the crocodile and eventually landing on its back (Fig. 1A). Following capture and during our examination of the animal, we observed a *F. bicolor* (possibly the same one) on the crocodile's right leg. The fly appeared to be feeding, as the tip of its proboscis was inserted between two scales on the leg (Fig. 2B) (Medem, *op. cit.*). The fly remained in the same position for approximately 10 sec and then flew away, possibly disturbed by our constant movement around the crocodile.

Although the horse fly *Fidena flavipennis* is known to feed on caiman in Costa Rica (John Burger, pers. comm.), to our knowledge this is the first report of ectoparasitism by a hematophagus fly on a New World crocodile and by *F. bicolor* on any crocodilian.

Voucher photographs of *Fidena bicolor* were deposited in the Campbell Museum, Clemson University (CUSC 2912). We thank John Burger for identifying the horse flies and Stanlee Miller for archiving the voucher photographs.

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***CROCODYLUS ACUTUS* (American Crocodile). ECTOPARASITE.** Crocodilians are host to a diverse assemblage of parasite species, particularly endoparasites (Tellez 2013. A Checklist of Host-Parasite Interactions of the Order Crocodylia. University of Press, Berkeley, California. 388 pp.; Tellez and Nifong 2014. Intl. J. Parasitol: Parasitol. Wild. 3:227–235). Ectoparasitism, however, is not a common phenomenon. The thick epidermal layer, in addition to osteoderms, likely decreases the success rate of penetration or attachment of ectoparasites onto the crocodile. Thus, unlike the majority of other vertebrates, the crocodilian epidermis is perhaps the primary defense mechanism against ectoparasitism. Previous records of ectoparasitism, or micropredation, have documented penetration or attachment of ectoparasites between scale sutures and softer locations of the skin, such as on the legs, and around the border of the eyes and nose (Tellez 2013, *op. cit.*). Parasitic arthropods represent the largest group of ectoparasites to infect crocodiles, which include members from the order Diptera, Hemiptera, Ixodida, Porocephalida, and Sessilia (Tellez 2013, *op. cit.*). Here, we report the collection of an isopod (Phylum Arthropoda: Order Isopoda) from a wild crocodile in Belize, in concomitance to recording the first documentation of isopod parasitism among crocodilians.



FIG. 1. *Crocodylus acutus* (American Crocodile) with parasitic isopod *Rocinela signata* on the eye.

On 26 August 2013, during a routine evening tagging survey, a female, sub-adult (total length = 115.40 cm) *Crocodylus acutus* was captured by hand for the first time and microchipped (#0A02153718) at 2015 h. The crocodile was located via spotlight under a home on stilts in the cove at the lagoon-side entrance to San Mateo, Ambergris Caye (17.933283°N, 87.9566694°W) in which the salinity of the water was measured at 31 ppt via a portable refractometer. The crocodile was only in fair condition in conjunction with a slightly sunken supertemporal fossae and relatively underweight. Approximately five isopods were randomly attached to the crocodile's nictating membrane of the left eye, as well as attached to the ear flaps. While the isopods were being removed from the eye, the importance of documenting the infection became apparent, as this was the second observation of isopods infecting *C. acutus* since July 2013. As such, photos were taken of the remaining isopod (Fig. 1). Upon returning from the crocodile survey, the isopod was placed in a small vial and preserved in alcohol until further taxonomic identification. Since this event, several additional *C. acutus* have been recorded with isopod infections of the eyes and ear flaps.

The isopod was identified as *Rocinela signata* from the family Aegidae, a common micro-predator and/or parasite of marine fish (Cavalcanti et al. 2012. Mar. Biol. Rec. 5:66–70). To our knowledge, this is the first record of *R. signata* infecting a marine-inhabiting reptile. It is likely that our findings are an example of accidental parasitism, or an anomaly of micro-predation on crocodiles. However, the decline of fish hosts around Ambergris Caye due to overfishing, pollution, and habitat destruction of fish nurseries for the construction of resorts (Young 2008. Trop. Conserv. Sci 1:18–33; Chenot-Rose, pers. obs.) is perhaps forcing isopods to exploit a new dietary niche or host, i.e., the crocodiles. Interestingly, the current rise of isopod eye infections parallels the recent emergence of ocular abnormalities among crocodiles inhabiting Ambergris Caye (Chenot-Rose, pers. obs.). Further exploration into the isopod-crocodile interaction should be pursued to determine if human transformation of the islands' mangrove ecosystem is indeed forming a new host-parasite dynamic.

We thank Vince Rose and Chris Summers from the American Crocodile Education Sanctuary (ACES) for their assistance in the capture of crocodiles and collection of isopods, and Rick Brusca for the positive identification of *R. signata*. We also acknowledge Alvaro Font for providing the picture of the isopod infection of *C. acutus*.

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***MELANOSUCHUS NIGER* (Black Caiman). DIET.** Many crocodilian species are known to consume fruits and seeds but diet information for some species is still lacking (Platt et al. 2013. J. Zool. 291:87–99). We captured an adult female *Melanosuchus niger* (SVL = 139 cm; total length = 255 cm; 57 kg) on 7 February 2014 near Yupukari, Guyana (3.6967°N, 59.3275°W; WGS84) and collected its stomach contents using the hose-Heimlich technique (Fitzgerald 1989. J. Herpetol. 23:170–172). While examining its stomach contents we found a partially digested seed measuring 2.7 × 2.9 cm and weighing 1.6 g. We identified the seed as coming from a tree in the Mimosoideae, a subfamily of Fabaceae. This observation constitutes the first record of seed consumption by *M. niger*, but we do not know if the seed was consumed intentionally or incidentally during other feeding activities.

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SQUAMATA — LIZARDS

***AMEIVULA ABAETENSIS*. SAUROCHORY.** Two essential stages in the life cycle of plants, pollination and seed dispersal, could be directly affected by animals (Godínez-Álvarez 2004. Rev. Chil. Hist. Nat. 77:569–577). Some species of lizards feed on seeds, nectar, pollen, and fruit, being considered important disperser agents (e.g., Olesen and Valido 2003. Trends Ecol. Evol. 18:177–181; Casado and Soriano 2010. Ecotrópicos 23:18–36; Gomes et al. 2014. Plant Biol. 16:315–322). Some lizards are seed dispersers of Cactaceae in Brazil. *Tropidurus cocorobensis* is considered a disperser of *Melocactus paucispinus* (Fonseca et al. 2012. Acta Bot. Bras. 26:481–492); *T. torquatus* a disperser of *M. violaceus* (Figueira et al. 1994. Biotropica 26:295–301); *T. semitaeniatus* a disperser of *M. ernestii* (Gomes et al. 2014, *op. cit.*); and *Ameivula ocellifera* a disperser of *M. glaucescens* (Fonseca et al. 2012, *op. cit.*). *Ameivula abaetensis* is a lizard endemic to the sand dune habitat ("restinga") of northern Bahia State from Salvador Municipality to Pirambu Municipality, with a disjunct population in Areia Branca Municipality, all located in Sergipe State, Brazil. The diet of this lizard species consists of small arthropods and murici fruits (*Byrsonima microphylla*) (Dias and Rocha 2007. Braz. J. Biol. 67:41–46).

On 13 and 14 April 2014 we collected two adult females of *Ameivula abaetensis* (SVL = 67.87 mm, 61.79 mm) in a fragment of "restinga" habitat (36.84364°W, 10.69363°S, WGS84; 89 m elev.), Pirambu Municipality, Sergipe State, Brazil. The lizards were captured (collection permit: 42941-1 SISBIO/ICMBio), euthanized (protocol license: 16/2014 CEUA), and deposited in the collection of the Laboratório de Biologia e Ecologia de Vertebrados / Universidade Federal de Sergipe (LABEVL578; LABEVL579). The specimens were dissected, and food items identified and counted. Among them we recorded presence of fruits of *Melocactus violaceus* Pfeiff. subsp. *margaritaceus* N. P. Taylor. Each lizard had one

fruit and a variable number of intact seeds. This is the first record of cactus fruits consumed by *Ameivula abaetensis*. Fleshy fruits of cactus are an energy source and have high water content (Figueira et al. 1994, *op. cit.*). Fruits of *Byrsonima microphylla* were recorded in the diet of *A. abaetensis*, but seeds were not found in the gut (Dias and Rocha 2007, *op. cit.*; Santa-Rosa et al. 2012. Bol. Mus. Biol. Mello Leitão 29:53–63). The presence of seeds of *Melocactus violaceus* in the gut of *A. abaetensis* is an important indicator of the role of this lizard as a disperser. Passing through the digestive tract of reptiles may increase the germination rate of seeds (Figueira et al. 1994, *op. cit.*) or may not influence seed germination (Valido and Nogales 1994. Oikos 70:403–411; Fonseca et al. 2012, *op. cit.*).

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***ANOLIS AURATUS* (Grass Anole). AVIAN PREDATION.** On 15 November 2013, at 0902 h, KMOA observed and photographed an adult Spotted Puffbird (*Bucco tamatia*) grasping an adult *Anolis auratus* in its beak (Fig. 1). The bird was observed in municipality of Ferreira Gomes (0.903°N, 51.259861°W; WGS84), state of Amapá, North Brazil. The entire consumption of the lizard was completed in ca. three minutes, during which time the bird appeared to have no trouble swallowing. Neither the bird nor the lizard were collected. The Spotted Puffbird is an insectivorous and frugivorous bird (Sigrist 2013. Avifauna Brasileira. Avis brasilis. 594 pp.). This is the first record of predator-prey relationship in *B. tamatia* and *A. auratus*, as well as the first prey items (vertebrates; lizards) reported for the diet of *B. tamatia*.

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FIG. 1. A Spotted Puffbird (*Bucco tamatia*) with an adult Grass Anole (*Anolis auratus*) in municipality of Ferreira Gomes, Amapa, North Brazil.

***ANOLIS CRISTATELLUS* (Crested Anole). DIET.** At approx. 1300 h on 23 October 2012 we observed an *Anolis cristatellus* with a lizard tail protruding from its mouth. The anole was in leaf litter next to a trail at the Guana Island Resort on Guana Island, British Virgin Islands (18.47786°N, 64.57806°W; WGS84). We captured the anole and it regurgitated its prey, an adult *Sphaerodactylus macrolepis* (Caribbean Dwarf Gecko; Fig. 1).

Anolis cristatellus are known to feed on small lizards, though species-level identification of the prey is rarely reported. Lizard species predated upon include conspecifics (Henderson and Powell 2009. Natural History of West Indian Reptiles and Amphibians. University Press of Florida, Gainesville, Florida. 496 pp.), *Anolis krugi* (Henderson and Powell 2009, *op. cit.*), *Hemidactylus mabouia* (Owen and Perry 2005. Herpetol. Rev. 36:444), and *Sphaerodactylus nicholsi* (Thomas and Gaa Kesler 1996. *In* Reagan and Waide [eds.], The Food Web of a Tropical Rain Forest, pp. 354–355. University of Chicago Press, Chicago, Illinois; López-Ortiz and Lewis 2004. Herpetologica 60:438–444). To our knowledge, this is the first report of *A. cristatellus* preying on *S. macrolepis*. Other known predators of *S. macrolepis* on Guana Island include *Borikenophis portoricenis* (Puerto Rican Racer; Henderson and Powell 2009, *op. cit.*), *Geotrygon mystacea* (Bridled Quail-Dove; Boal 2008. J. Carib. Ornithol. 21:50), and *Coccyzus minor* (Mangrove Cuckoo; Henderson and Powell 2009, *op. cit.*). Other known lizard predators of *S. macrolepis* include *Ameiva exsul* and *Anolis pulchellus* (Henderson and Powell 2009, *op. cit.*).

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FIG. 1. *Anolis cristatellus* (Crested Anole) with the *Sphaerodactylus macrolepis* (Caribbean Dwarf Gecko) that it regurgitated.

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***BRONCHOCELA CRISTATELLA* (Green Crested Lizard). ENDOPARASITES.** *Bronchocela cristatella* (previously *Calotes cristatellus*) ranges from the Nicobar Islands of India, eastward through Myanmar and Thailand and south through Peninsula Malaysia

and Singapore, eastward through the Philippines, Indonesia and Papua New Guinea (Diong and Lim 1998. Raffles Bull. Zool. 46:345–359; Hallermann 2005. Russ. J. Herpetol. 12:168–183). To our knowledge, there are four reports of endoparasites in *B. cristatella*: Blasingam (1964. Bull. Singapore Nat. Mus. 32:103–127) reported the digenean *Paradistomum orientalis* and the nematode *Strongyluris calotis*; Fischthal and Kuntz (1965. Proc. Helminthol. Soc. Washington 32:124–136) reported the digenean *Mesocoelium sociale* and nematodes *Parapharyngodon maplestoni* and *Strongyluris calotis*; McQuistion et al. (2001. Acta Protozool. 40:71–74) described a coccidian, *Isospora bronchocelae*; and Kuzmin et al. (2012. J. Parasitol. 98:608–611 described a nematode *Rhabdias odilebaini*. The purpose of this note is to add to the parasite list of *B. cristatella*.

A sample of eight *B. cristatella* (mean SVL = 103.3 mm ± 5.3 SD, range = 97–113 mm) collected in West Malaysia during 2003–2006 by LLG and deposited in the herpetology collection of La Sierra University (LSUHC), Riverside, California, USA were examined for helminths. Lizards examined were from the following states Johor (N = 7: LSUHC 5526, 5568, 5777, 6394, 7678, 8022, 8121), and Penang (N = 1: LSUHC 6742).

The digestive tract was removed and the esophagus, stomach, small and large intestine were opened and their contents were examined for parasites utilizing a dissecting microscope. Nematodes were the only helminths found. Each was placed in a drop of lactophenol on a glass microscope slide, cover slipped and studied under a compound microscope. Four species of Nematoda were identified as: *Abbreviata deschiensi, Meteterakis singaporensis, Orneoascaris sandoshami* and *Strongyuris calotis*.

Voucher helminths were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland, USA as *Abbreviata deschiensi* (USNPC 108143), *Meteterakis singaporensis* (USNPC 108144), *Orneoascaris sandoshami* (USNPC 108145), *Strongyuris calotis* (USNPC 108146).

Three *Abbreviata deschiensi* were found in the stomach; prevalence = number infected lizards/number lizards examined × 100 = 25%, mean intensity = mean number helminths per infected lizard = 1.5 ± 0.70 SD, range = 1, 2. One *Meteterakis singaporensis* was found in the large intestine; prevalence = 13%; two *Orneoascaris sandoshami* were found, one each in the small and large intestine (note: these appeared to be spent females); prevalence = 13%; 43 *Strongyuris calotis* were found in the small and large intestine (prevalence = 100%; mean intensity = 5.4 ± 3.7 SD, range = 1–11).

Abbreviata deschiensi was described from *Calotes versicolor* from Vietnam by Van-Hoa et al. (1966. Bull. Soc. Pathol. Exot. Filal. 59:991–996). To our knowledge, *Bronchocela cristatella* is the second species to harbor it. *Meteterakis singaporensis* was described from *Duttaphrynus melanostictus* (as *Bufo melanostictus*) from Malaysia by Sandosham (1954. Stud. Inst. Med. Res. Malaya 26:210–226), and is also known from *Eutropis multifasciata* also of Malaysia (Singh 1967. Bull. Nat. Mus. Singapore 33:95–100). *Orneoascaris sandoshami* was described from *Megophrys aceras* from Kuala Lumpur, Malaysia (Yuen 1963. Parasitology 53:89–94) and is known from *Gonocephalus abbotti* (Goldberg et al. 2005. Herpetol. Rev. 36:450). *Strongyluris calotis* is a widespread nematode in lizards from Southeast Asia (Baker 1987. Mem. Univ. Newfoundland, Occas. Pap. Biol. 11:1–325). See Yildirimhan et al. 2006. (Comp. Parasitol. 73:257–262) for an updated host list. *Bronchocela cristatella* represents a new host record for *Abbreviata deschiensi, Meteterakis singaporensis* and *Orneoascaris sandoshami*.

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***COLEODACTYLUS MERIDIONALIS*. PREDATION.** Spiders have been reported preying upon a wide variety of vertebrate taxa, particularly small lizards (Ervin et al. 2007. Herpetol. Rev. 38:468; Carbajal-Márquez et al. 2013. Herpetol. Rev. 44:505). Such predatory behavior can occur via active foraging, ambush, or by use of webs (Hamilton 2012. Herpetol. Rev. 42:603; Lanschi and Barbosa 2012. Herpetol. Rev. 43:l34: Lazcano et al. 2012. Herpetol. Rev. 43:l38).

Coleodactylus meridionalis is a litter-dwelling gekkonid lizard distributed in the tropical dry forest Caatinga and Atlantic Rainforest of northeastern Brazil (Vanzolini et al. 1980. Répteis das Caatingas. Acad. Bras Cienc., São Paulo. 161 pp.), and its small size facilitates their predation by other larger litter dwelling animals (Vargens et al. 2005. Herpetol. Rev. 36:l73–174).

On 20 December 2011 during the sampling of leaf-litter herpetofauna at 2253 h in Reserva Caju (11.19038°S, 37.31750°W; 13 m elev.), Itaporanga D'Ajuda municipality, Sergipe State, Brazil one of us (RPSA) observed a specimen of the spider *Parabatinga brevipes* preying on *Coleodactylus meridionalis* (Fig. 1). *Parabatinga brevipes* is a generalists Ctenidae species and has been recorded preying on small amphibians in the Amazon Rainforest (Caldwell and Myers 1990. Am. Mus. Novit. 2988:1–23). This is the first record of predation of *C. meridionalis* by spiders in Atlantic Rainforest and contributes to the knowledge of food webs involving small litter vertebrates.

We thank Marcelo Cesar Lima Peres for identification of the spider described in this report and Elves de Lima Alves, Tassiana Alves Maciel, and Rúbia Kelly Côrtes Rocha for assistance in collecting the specimen.



PHOTO BY RONY PETERSON SANTOS ALMEIDA

FIG. 1. Predation of the lizard *Coleodactylus meridionalis* by the spider *Parabatinga brevipes*, in Itaporanga D'Ajuda, Sergipe, Brazil.

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***CTENOPHORUS RETICULATUS* (Western Netted Dragon), *CTENOPHORUS CAUDICINCTUS* (Ring-tailed Dragon), and *EGERNIA EOS* (Central Pygmy Spiny-tailed Skink). PREDATION.** Clarifying the suite of predators can contribute to understanding how populations are regulated, and how predators influence the behavior of prey. Yet, the suite of predators is often poorly known for a given small vertebrate, especially in the tropics. Herein we report nine observations of predation on lizards (*Ctenophorus, Egernia*) by at least five individual Australian Kestrels (*Falco cenchroides*) in northern and western Australia.

On 15 August 2012, two of us (SC and JT) located an Australian Kestrel nest site on a rock ledge approximately 4 m high in breakaway country in the eastern Gascoyne region of Western Australia (26.135443°S, 121.341007°E). The nest was inactive but contained signs of prior use (eggshell, scats, pellets, and a few prey remains), and an adult kestrel was flushed from a roost site adjacent to the nest at the time of discovery (1040 h). Included in the prey remains were the tails of two lizards, which were identified as *Egernia eos* (Doughty et al. 2011. Rec. West. Austral. Mus. 26:115–137). The tails, which were undoubtedly not consumed due to their spines, measured approximately 50 mm, indicative of adult lizards.

At 1140 h on 11 October 2011, one of us (SC) discovered a freshly caught, dead *Ctenophorus caudicinctus* in an active Australian Kestrel nest on an ironstone ridge in the Murchison Region of Western Australia (25.814023°S, 117.337149°E). The nest was on a horizontal ledge 5 m high and 1 m deep, and contained five nestling kestrels. Lizard scales, which appeared to belong to other agamids, were observed in pellets both in and below the nest cavity. Similarly and also in the Murchison Region (27.055624°S, 118.143344°E), on 10 August 2010 one of us (JT) discovered the remains of three *Ctenophorus reticulatus* in a recently active Kestrel nest, after flushing an adult from the nest. Also in the Murchison (26.905426°S, 117.688449°E), on 28 March 2009 one of us (JT) found a live but mortally wounded *C. reticulatus* on the slopes of a breakaway at Weld Range. Just a few meters above the lizard was a second *C. reticulatus* (dead) on a ledge next to an active Australian Kestrel nest.

On 18 October 2013, one of us (SC) located an Australian Kestrel nest site in a hollow cavity 2 m above the ground in a *Eucalyptus* tree in the Gascoyne Region (26.135443°S, 121.341007°E). An adult kestrel was observed delivering a fresh prey item to the three chicks inside the nest at approximately 0715 h. Closer inspection revealed the prey animal to be a lizard, *Ctenophorus sp.* (Fig. 1). The kestrel, along with its mate, was later observed foraging over nearby chenopod habitat where *Ctenophorus salinarum* is a common species. However, we could not be certain of species identification; also present in the general area are *C. isolepis, C. nuchalis, C. reticulatus,* and *C. scutulatus.*

PHOTO BY S. CHERRIMAN



FIG. 1. A dead lizard (*Ctenophorus* sp.) lays (belly-up) next to three nestling Australian Kestrels (*Falco cenchroides*). The lizard was provided by one of the parent birds.

Although we did not observe prey capture during these observations, kestrels are generally hunters rather than scavengers, suggesting that the raptors had recently caught and killed the lizards (indeed one lizard was still alive). Lizards can comprise the bulk of the biomass in the diet of Australian Kestrels in some arid populations (Dickman et al. 1991. Emu 91:69–72; Aumann 2001. Wildl. Res. 28:379–393), but may be less important in other populations (e.g., Olsen et al. 1978. Emu 79:133–138). Congeners have been reported in kestrel pellets from arid Australia (*Ctenophorus nuchalis, C. caudicinctus, Egernia* spp., Doody and Schembri 2014. Herpetol. Rev. 45:494–495; Dickman et al., *op. cit.*; Aumann 2001, *op. cit.*). Because these small- to medium-sized lizards are an important prey group to kestrels, kestrels are likely a chief predator of the lizards. We might expect that these lizards have thus evolved antipredator behaviors to reduce predation by Australian Kestrels; observations of vigilance behavior of these lizards are needed to address this hypothesis.

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***INTELLAGAMA LESUERII LESUERII* (Eastern Water Dragon). TRIFID TAIL.** On 15 November 2014, a wild adult male *Intellagama lesuerii lesuerii* was captured and removed from a Southern Hairy-nosed Wombat (*Lasiorhinus latifrons*) enclosure at the Taronga Zoo, Sydney, Australia (33.85°S, 151.25°E). This individual had a trifurcated tail (Fig. 1).

Tail bi-, tri-, and poly-furcation often occurs during the regeneration process that follows autotomy (Sluys et al. 2002. Stud. Neotrop. Fauna E. 37:227–231; Galdino et al. 2006. Phyllomedusa 5:25–30), and autotomy is typically used as an anti-predator defense during a predation event (Bateman and Fleming 2009 J. Zool. 277:1–14). Within the zoo grounds, roaming wild *Intellagama lesuerii lesuerii* regularly enter enclosures and come in contact with a variety of novel domestic and exotic predators, resulting in frequent successful and unsuccessful predation events taking place. For this reason we believe that the trifid tail of this individual may have been caused by regeneration of the tail after a single, or multiple predation attempt(s). However, there is also a high degree of urbanization around the zoo grounds; as such, pollution may have caused the trifurcation of this tail through developmental deformity, similar to pollution-triggered developmental deformities seen in snakes (Gray et al. 2001. Bull. Chicago Herpetol. Soc. 36:144–148; Gray et al. 2003. Bull. Chicago Herpetol. Soc. 38:4–6; Wallach 2007. Bull. Maryland Herpetol. Soc. 43:57–95). Bifurcated tails have been reported for many lizard groups, such as Agamidae (Brindley 1898. J. Bombay Nat. Hist. Soc. 11:680–689; Ananjeva and Danov 1991. Amphibia-Reptilia. 12:343–356), Scincidae, Lacertidae, Iguanidae (Brindley 1898,



FIG. 1 An adult male Eastern Water Dragon (*Intellagama lesuerii lesuerii*) captured at the Taronga Zoo, Sydney, Australia, after climbing into a wombat enclosure (A). The individual was found to have grown a trifurcated tail (B) likely due to repeated predation attempts from wildlife living either on zoo grounds or in the surrounding suburbs.

op. cit.), and Gekkonidae (Woodland 1920. Q. J. Microscop. Sci. 65:63–100). However, to the best of our knowledge, this is the first recorded case of tail trifurcation in *Intellagama lesuerii lesuerii.*

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***PLESTIODON FASCIATUS* (Five-lined Skink). DIET.** Five-lined Skinks (*Plestiodon fasciatus*) are reported to primarily ingest a variety of insects and other arthropods (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville. 421 pp.), but earthworms, crustaceans, snails, baby mice, and small lizards have also been reported as prey (Sievert and Sievert 2011. A Field Guide to Oklahoma's Amphibians and Reptiles. Oklahoma Department of Wildlife Conservation, Oklahoma City. 211 pp.). I am not aware of previous reports of *P. fasciatus* eating any other skink species. Here I report an instance of *P. fasciatus* ingesting a Ground Skink, *Scincella lateralis.*

A sub-adult *Plestiodon fasciatus* (SVL = 50 mm) was collected by hand on 21 September 2014 from Hochatown, McCurtain Co., Oklahoma, USA (34.123155°N, 91.690684°W; WGS84). It was euthanized with an intraperitoneal injection of sodium pentobarbital (Nembutal®) and a mid-ventral incision was made to expose the viscera. On examination of stomach contents, a hatchling (SVL = 23 mm) *S. lateralis* was found (Fig. 1).



FIG. 1. Hatchling *Scincella lateralis* from stomach contents of *Plestiodon fasciatus.* Scale bar = 5 mm.

In addition, a portion of a cricket was in the stomach contents. Voucher specimens of skinks are deposited in the Arkansas State University Museum of Zoology (ASUMZ) Herpetology Collection as ASUMZ 33322, 33323.

Fourteen additional *P. fasciatus* were examined from McCurtain Co. and no *S. lateralis* were found in stomach contents. Bowie (1973. J. Herpetol. 7:318) reported an instance of a Florida Scrub Lizard (*Sceloporus woodi*) feeding on *S. lateralis. Plestiodon fasciatus* should be listed as a potential predator of *Scincella lateralis.*

I thank the Oklahoma Department of Wildlife Conservation for a Scientific Collecting Permit and S. E. Trauth (ASUMZ) for expert curatorial assistance.

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***PLESTIODON FASCIATUS* (Five-lined Skink). PREDATION BY FISH.** *Plestiodon fasciatus* is a common lizard found throughout much of the eastern half of the United States and inhabits woodland and mesic habitats including near-stream environments (Gibbons et al. 2009. Lizards and Crocodiles of the Southeast. University of Georgia Press, Athens. 235 pp.). *Plestiodon fasciatus* has historically been rumored to possess a chemical defense (Fitch 1954. Univ. Kansas Publ., Mus. Nat. Hist. 8:1–156) associated with the bright blue tail (considered to be a warning color). But this potential defense has never been definitively demonstrated. Despite this putative defense, the documented list of potential predators of *P. fasciatus* includes snakes, hawks, crows, moles, shrews, and opossums (Fitch 1954, *op. cit.*). We present here the first documented occurrence of a fish consuming a *P. fasciatus.*

An individual Alabama Bass, *Micropterus henshalli,* measuring 33 cm standard length (SL) was caught by hook and line in the Cahaba River on 20 June 2014 approximately 5 km downriver (33.3755°N, 86.6761°W) from the intersection of Grants Mill Road and the Cahaba River, Birmingham, Alabama. The bass was hooked along the bank of the river in an area characterized by the presence of tree branches extending low over the water and downed trees and tree roots partially submerged in the river. The fish was consuming an adult female *P. fasciatus* that measured



FIG. 1. *Plestiodon fasciatus* in mouth and gullet of an Alabama Bass (*Micropterus henshalli*).

approximately 14 cm from snout to tail tip (Fig. 1). The skink, while completely intact, was dead, most likely from drowning. The head of the skink protruded from the mouth of the bass (Fig. 1), but the mid and lower body and tail of the skink were in the fish's gullet (JBM, pers. obs.).

Freshwater bass in the genus *Micropterus* are considered opportunistic predators that feed primarily on fish, crayfish, and a wide variety of aquatic insects. Observations of the consumption of lizards by bass have never been published in the scientific literature to our knowledge. A number of studies have examined the natural dietary habits of the Spotted Bass, *Micropterus punctulatus* (Applegate et al. 1967. Proc. Ann. Conf. SE Assoc. Game Fish Comm. 20:469–482; Smith and Page 1969. Trans. Amer. Fish. Soc. 98:647–651; Scott and Angermeiere 1998. N. Amer. J. Fish. Manag.18:221–235), the species most closely related to *M. henshalli*. These studies indicate that the primary prey types of adult fish include various species of fish, crayfish, and aquatic insects. Juvenile Spotted Bass (<7.5 cm total length) consume smaller prey comprised primarily of aquatic insects and zooplankton (Smith and Page 1969, *op. cit.*). Adult Smallmouth Bass, *M. dolomieu*, consume fish and aquatic insects and to a lesser degree crayfish (Robertson and Winemiller 2001. Southwest. Nat. 46:216–221). Adult Largemouth Bass primarily consume fish and crayfish with aquatic insects less common in the diet (Wheeler and Allen 2003. Trans. Amer. Fish. Soc. 132:438–449; Rayborn et al. 2004. Ecol. Freshwater Fish 13:276–284). Long and Fisher (2000. J. Freshwater Ecol. 15:465–474) examined diets of all three of these bass species in an Oklahoma Reservoir and found that adult Largemouth Bass fed primarily on fish, while adult Smallmouth and Spotted Bass consumed mostly crayfish and insects. None of the dietary studies cited above report the inclusion of any lizards among prey items.

There are some interesting natural history considerations pertinent to our observation. One question is: how was the skink captured by the bass? One possibility is that the skink fell off a branch or log into the river and was consumed by the bass. The other possibility is that the bass observed the movements of the skink on a branch or log near the air-water interface and leapt out of the water to capture the skink. This latter possibility is supported by the pattern of habitat utilization of this species of bass. *Micropterus henshalli* is similar to *M. punctulatus* in that it occurs in primarily riverine habitats and prefers river banks where it exploits woody debris and bank vegetation as cover (Scott and Angermeier 1998, *op. cit.*). This would place it in close proximity to invertebrates and vertebrates that perch on branches, sticks, roots, and tree trunks.

The present study adds further evidence that the putative chemical defense of *P. fasciatus* failed to protect the skink from predation from another group of vertebrates. Clearly the tail did not inhibit consumption by *Micropterus henshalli*, nor did the capacity of the skink to autotomize its tail as a predator diversion tactic. In all likelihood, the skink was ambushed by the bass and loss of the tail would have come too late to serve as an effective diversion as it might have against more visual predators such as birds and small mammals.

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***PODARCIS MURALIS* (Common Wall Lizard). COMMUNAL NESTING.** Ovoposition strategies vary among species and even within the same species. One of these strategies is communal nesting. The "constraint" (nests with optimal conditions for laying eggs are scarce) and the "adaptation" (a fitness benefit due to egg aggregation) are two reasons why female lizards lay their eggs in communal nests (Rader and Shine 2007. J. Anim. Ecol. 76:881–887). In the Iberian Peninsula, communal nesting has occasionally been reported in the species *Psammodrommus algirus, Podarcis bocagei*, *Iberolacerta aranica*, and *Zootoca vivipara* (Braña 1996. Oikos. 75:511–523; Galán 2009. Bol. Asoc. Herpetol. Españ. 20:2–34; Pleguezuelos et al. 2004. Amphibia-Reptilia 25:333–336).

In July 2013 we observed a communal nesting of *Podarcis muralis* with five clutches in a pathway close to Torla, Huesca, Aragón, Spain (42.64207°N, 0.074998° W; WGS84). The total number of eggs were 10. Nine of the eggs were intact and one was empty, suggesting that this had already hatched. They were under a stone of approximately 30 cm length, 25 cm width, and 25 cm depth. The stone was surrounded by grass and piled pieces of limestone, but nearby we could see plant species like *Pinus uncinata* and *Echinospartum horridum*. Eggs laid under large stones may benefit from stable environmental conditions for incubation. Climatic conditions in 2013 were particularly cold in the north of Spain. Normally, mating and egg-laying in *P. muralis* occurs from April to July, but in 2013 some high altitude regions remained with snow until late July. In addition, people frequently traverse the area where the communal nesting was observed. The unfavorable environmental conditions and the settlement of a nest site beside such a well traversed path may suggest that the choice of location was due to the lack of optimal oviposition sites, rather than the benefits of aggregation. Thus, the nest place was probably chosen because it offered protection against inclement weather and predators due to the stone size.

Mountain species are more vulnerable to processes associated to climate change (Sinervo et al. 2010. Science 328: 894–899). Monasterio et al. 2013 (Zoology 291:136–145) hypothesized that climate change may affect oviposition in some lizard species, as it may be in this case, inducing communal nesting. However, sorting out among constraint hypotheses requires experimental approaches. On the other hand, Gosá and Bergerandi 1994 (Munibe 46:109–189) mentioned communal nesting of *P. muralis* in Navarra, Spain. To our knowledge, this is the first description of the number of eggs and location of a communal nest in *P. muralis*. Communal nesting seems to be a common behavior in

lacertids, observational data on communal egg-laying are scarce in general and, in particular, for this species.

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***PTENOPUS KOCHI* (Koch's Barking Gecko). DIURNAL ACTIVITY.** Geckos in the genus *Ptenopus* are considered to be crepuscular and nocturnal lizards that normally ambush prey from their burrow entrances, although in some regions of southern Africa *Ptenopus garrulus* (Common Barking Gecko) has been reported to become diurnally active on rainy or overcast summer afternoons when their termite prey are swarming (Huey and Pianka 1981. Ecology 62:991–999). Little information is available on the Namib Desert endemic *P. kochi*. Here we document the first reported cases of diurnal activity in this species. On 26 June 2014 between 1030–1312 h we encountered five juvenile *P. kochi* active on gravelly-sand substrates in an interdune region south of the Kuiseb River at Gobabeb Research and Training Centre, Namibia (23.57903°S, 15.03838°E; WGS84), 411 m elev. In the same area we documented an additional juvenile *P. kochi* active on the surface at 1144 h on 5 July 2014. This individual was 24 mm SVL, weighed 0.50 g, and had an 18 mm-long original tail. Although we did not weigh or measure the first five geckos, they all appeared similar in size to the measured gecko. Both mornings had started out cloudy and cool, but five out of the six geckos noted here were active in the full sun. The clouds had cleared by 1112 h on 26 June and by 0806 h on 5 July. Mean cloacal temperature within seconds of capture was 28.7 ± 1.1°C (range 25.4–30.0°C; N = 4), the air temperature 10 mm above the surface where geckos were observed active averaged 25.6 ± 0.8°C (range 24.0–28.0°C; N = 5), and the surface temperature where geckos were located averaged 30.7 ± 1.0°C (range 27.0–32.9°C; N = 5). In three of the cases, no burrows were visible near the active geckos. In one case the gecko was active ca. 20 cm away from the closest burrow. Two of the observed geckos were located ca.1 m from the closest burrow, and when startled one of these individuals immediately fled straight to this burrow. It is possible that these geckos were actively foraging during daylight, outside of their burrows, but we did not observe any swarming termites active near any of the geckos, and we did not observe any larger juvenile or adult *P. kochi* diurnally active. Instead, we hypothesize that these were all post-hatchling geckos that may have been dispersing away from the burrows that they hatched in. Hatchlings of the closely related and slightly smaller *P. garrulus* are ca. 22 mm SVL (Hibbitts et al. 2005. J. Herpetol. 39:509–515), which is a close approximation to the sizes we observed, supporting the notion that the *P. kochi* seen here had recently hatched. These observations contribute to the dearth of information available on the ecology of *P. kochi*, and prompt further questions about the dispersal of juvenile geckos away from their natal burrows, and whether or not they construct their own burrows or use pre-existing burrows.

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***SALVATOR MERIANAE* (Tegu). DIET.** *Salvator merianae* is a teiid lizard widely distributed in Argentina, Uruguay, Bolivia, and Brazil. The diet of this lizard is mainly composed of fruits, flowers, invertebrates (such as spiders, crustaceans, and insects), small vertebrates, eggs, and decomposing animals (Kiefer and Sazima 2002. Amphibia Reptilia 23:105–108). Records of predation on vertebrates consist of other lizards, such as *Tropidurus hispidus* (Silva et al. 2013. Herpetol. Notes 6:51–53), *T. torquatus* (Arruda et al. 2007. VIII Congr. Ecol. Brasil. 1–2), and the bird *Turdus leucomelas* (Santos and Vaz-Silva 2012. Herpetol. Brasil. 1[1]:35–36).

We observed two cases of predation by *S. merianae* in different domains. The first observation was made during the collection of lizards in an area of Caatinga, in Sítios Novos (9.80500°S, 37.68444°W), Municipality of Poço Redondo, Sergipe State, Brazil. On 10 January 2012, an individual was seen preying on an anuran, *Rhinella granulosa* (SVL = 58.83 mm). The second record is from the Atlantic Forest, in the Refúgio de Vida Silvestre Mata do Junco (10.53972°S, 37.06194°W), Municipality of Capela, Sergipe, State. On 25 January 2013, a young individual (SVL = 22.27 cm; 320 g) was collected and regurgitated a frog, *Leptodactylus natalensis* (SVL = 15.32 mm), and two orthopterans with volumes of 0.0014 and 0.0004 mm^3, respectively (ellipsoid formula). The voucher specimens of *R. granulosa* and *L. natalensis* and the second individual of *S. merianae* were preserved in alcohol and deposited in the collection of Laboratório de Biologia e Ecologia de Vertebrados of the Universidade Federal de Sergipe (LABEVA 862; LABEVA 1129 and LABEVL 408, respectively). This is the first record of *Rhinella granulosa* and *Leptodactylus natalensis* being included in the diet of *Salvator merianae*, and it can help in understanding the trophic food webs of these groups.

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***SCELOPORUS CYANOSTICTUS* (Yarrow's Blue-spotted Spiny Lizard). FIELD AND PREFERRED BODY TEMPERATURE.** Monitoring thermal requirements and thermoregulatory behavior of reptiles is crucial for understanding effects of global warming on species (Sinervo et al. 2010. Science 328:894–899). *Sceloporus cyanostictus* is an endangered species endemic to Mexico (www.iucnredlist.org; 9 Oct 2014), with a geographically restricted distribution and little variation in habitats occupied (Gadsden et al. 2006. Bull. Chicago Herpetol. Soc. 41:2–9; Lemos-Espinal and Smith 2007. Amphibians and Reptiles of the State of Coahuila, Mexico. UNAM-CONABIO. 550 pp.). There have been reports detailing the field body temperature of *Sceloporus* lizards (e.g., Andrews et al. 1997. Copeia 1997:108–115), although data on T_p (preferred temperature) within this genus are not usually reported (Mathies

and Andrews 1997. Funct. Ecol. 11:498–507; Lara-Reséndiz et al. 2014. Rev. Mex. Biol. 85:875–884). Field body temperature and preferred body temperature has not been documented in *S. cyanostictus*. Here, we describe field body temperature and thermal preference under laboratory conditions for this species.

During September 2009, we conducted fieldwork in Sierra San Lorenzo (25.651103°N, 103.172353°W, WGS84; 1146 m elev.), 15 km NE Matamoros, Coahuila, Mexico. Vegetation was dominated by *Yuca filifera, Agave lechuguilla, Fouqueria splendens, Opuntia rufida*, and *O. rastrera*. Throughout the study site, rock faces with crevices were numerous. The data presented are based on 33 adults (> 60.0 mm SVL; 18 females and 15 males) of *Sceloporus cyanostictus* captured by noose. The field body temperature (T_b) of each lizard captured was measured using a digital thermometer (Fluke™ model 51-II) with a thermocouple inserted into the cloaca.

In the laboratory, the lizards were separated by gender and maintained at 25°C in plastic containers with 2 cm of rocky ground and hydrated with sprinkler. Laboratory experiments were conducted two days after capture using a thermal gradient. The thermal gradient consisted of a wooden shuttle box of 150 × 100 × 80 cm (length, width and height) divided into ten tracks with insulation barriers to prevent behavioral influence of adjacent lizards, and filled with 2–3 cm of rocky ground. The shuttle box was housed in a room with air conditioning at a constant temperature of 20°C. At one end, and at the center of the box, lamps were placed at different heights to generate a thermal gradient from 20 to 50°C. The T_p of lizards was measured every hour from 0900 until 1800 h (foraging activity period) using a digital thermometer. The 25% and 75% quartiles of T_b in field (T_{b25} and T_{b75}) and T_p in laboratory (T_{p25} and T_{p75}) ranges were calculated to obtain the lower and upper limit (Van Damme et al. 1990. Oikos 57:61–67; Herts et al. 1993. Am. Nat. 142:796–818). After laboratory experiments, all lizards were released at their capture sites. We applied a nonparametric Kruskal-Wallis one-way test (denoted H) to analyze differences between all measurements of T_b and the same test to analyze differences between all measurements of T_p, also we used a Mann-Whitney Rank test to analyze the differences between gender.

There were no statistically significant difference between measurements of T_b (the observed value $H_1 = 0.52$, P = 0.46 was less than the critical value) or T_p (the observed value $H_{16} = 20.47$, P = 0.20 was less than the critical value). Also there were no statistically significant difference between gender in T_b (U = 286.0, P = 0.48). Mean T_b for males was 32.58°C (SE = 0.67, range = 29–38.1°C; N = 15); interquartile of 25% and 75% was 29.8 and 34.6, respectively. Mean T_b for females was 31.52°C (SE = 0.66, range = 22–35.2°C; N = 18); interquartile of 25% and 75% was 30.5°C and 33.4°C, respectively. However there were statistically significant difference between gender in laboratory (U = 9524.5, P = 0.03). Mean T_p for males was 32.37°C (SE = 0.27, range = 24.4–36.8°C; N = 110); interquartile of 25% and 75% was 30.2 and 34.6, respectively. Mean T_p for females was 33.2°C (SE = 0.31, range = 26–38.4°C; N = 76); interquartile of 25% and 75% was 32.0°C and 35.2°C, respectively. The field body temperature and preferred body temperature of *Sceloporus cyanostictus* were very similar to those previously recorded for other closely related species of *Sceloporus torquatus* species-group (Andrews 1998. J. Therm. Biol. 23:329-334; Martínez-Méndez and Méndez de la Cruz 2007. Zootaxa 1609:53–68).

These results suggest that *Sceloporus cyanostictus* can be considered a eurythermic species due to its wide range of T_b and T_p. Therefore, we propose to evaluate the thermal efficiency by monitoring mean thermal requirements and microhabitat temperatures across its distribution for understanding effects of global warming on this geographically restricted lizard.

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***SCELOPORUS GRAMMICUS* (Mesquite Lizard). PURSUIT-DETERRENT SIGNALING.** Tail waves and tail barring patterns in *Cophosaurus* and *Callisaurus* lizards are hypothesized forms of pursuit-deterrent signals (Dial 1986. Am. Nat. 127:103–111; Hasson et al. 1989. Can. J. Zool. 67:1203–1209). *Anolis* lizards perform push-ups and dewlap extensions as pursuit-deterrent signals directed toward snakes and snake models (Leal and Rodríguez-Robles 1997a. Anim. Behav. 54:1147–1154; 1997b. Biotropica 29:372–375), and the displays may serve as honest signals of a lizard's ability to escape predation (Leal 1999. Anim. Behav. 58:521–526). Here, we report two observations of male *Sceloporus grammicus* displaying to snakes that prey on lizards (Ramírez-Bautista et al. 2009. Herpetofauna del Valle de México: Diversidad y Conservación. Universidad Autónoma del Estado de Hidalgo UAEH – Comisión Nacional para el Conocimiento y Uso de la Biodiversidad CONABIO, México. 213 pp.). Both observations were made under natural conditions in the breeding season of a *S. grammicus* population located ca. 1.5 km NW of Nopala, Hidalgo, México (20.26152°N, 99.63414°W, WGS84; 2482 m elev.).

On 9 October 2014, two of us (JAP and JJZV) were observing a male *S. grammicus* basking on a rock wall. We were ca. 8 m away from the lizard and had observed it for approximately 3 min before the lizard moved ca. 1.5 m in a direct line toward a large (ca. 1 m SVL) *Pituophis deppei* that was crawling along the base of the rock wall. The lizard approached the snake to within ca. 3 m and performed several displays. The displays included full-shows (dewlap extension, arched back, and dorsolateral flattening that exposes colorful abdominal patches) with four-leg push-ups (repeated elevation of the body on all four limbs) and two-leg push-ups (repeated elevation of the body on the front two limbs) without full-shows. The snake was disturbed by the observers and retreated into the rock wall. The lizard moved to the top of the rock wall and remained exposed but ceased performing displays.

On 18 October 2014, four of us (JAP, AOK, CVG, and DKH) observed a *Crotalus triseriatus* crawling down the limb of a large *Yucca filifera*. The snake was about 2 m above the ground and was followed by an adult male *Sceloporus grammicus*. The lizard was ca. 1.5 m from the snake when initially seen by us and moved to within 1 m from the snake during the observation. The lizard approached the snake in a series of short lunging-like movements separated with short bouts of displays (full-shows with four-leg push-ups and two-leg push-ups without full-shows). The snake continued moving away from the lizard and entered a hollow crevice within the tree while the lizard remained exposed on the limb of the *Y. filifera*. The snake was subsequently captured and confirmed to be large enough (>30 cm total length) to consume an adult *S. grammicus*. Given our estimates of the lizard's approach distance and the length of the snake, the lizard decreased the distance between itself and the snake by approximately 33% but never entered the snake's strike range.

The display behaviors we observed are commonly used in social interactions in *Sceloporus* lizards (e.g., Carpenter 1978. Contrib. Biol. Geol. Milwaukee Public Mus. 18:1–71), but no other lizards were observed in the immediate areas of either interaction reported here. The focal lizard in the first observation was oriented laterally toward the snake while displaying, and both lizards approached the snakes prior to or while displaying. Thus, the lizards decreased the distance between themselves and the snakes while increasing conspicuousness through orientation and displays. The behaviors we observed are similar to those exhibited by *Anolis* lizards during predator-prey interactions with snakes, and the displays described above may serve as pursuit-deterrent signals in *S. grammicus*.

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***SCELEPORUS OBERON* (Royal Lesser Minor Lizard). DIET.** This lizard is distributed in the Sierra Madre Oriental in the southeastern mountains of Coahuila and the central southern mountains in Nuevo Leon, Mexico (Köhler and Heimes 2002. Stachelleguane, Offenbach Herpeton. 174 pp.; Lemos-Espinal and Smith 2007. Amphibians and Reptiles of the State of Coahuila, Mexico. CONABIO-UNAM. 550 pp.). To the best of our knowledge there is very little known on the diet of this species. Herein, we report on an individual *Sceloporus oberon* feeding on a centipede, *Orphnaeus brevilabiatus* (Oryidae), an introduced species in Mexico.

On 22 June 2014, at 1125 h, we observed a male *Sceloporus oberon* (SVL = 101 mm; total length = 238 mm; mass = 25.5 g; body temperature = 28.5°C, substrate temperature = 24.5°C; UANL 7406) capturing, subduing, and consuming a centipede, *O. brevilabiatus* (total length = 144.6 mm, mass = 0.4 g). The observation took place in San Isidro Canyon, located in Santiago, Nuevo Leon, Mexico (25.375307°N, 100.311236°W, WGS84; 1600 m elev.). Among lizards of the genus *Sceloporus*, centipedes have been reported to be common prey in the diet of *S. consobrinus* (Lahti and Leach 2009. *In* Jones and Lovich [eds.], Lizards of the American Southwest, pp. 210–212. Rio Nuevo Publishing, Tucson, Arizona), *S. poinsetti* (Webb 2009. *In* Jones and Lovich, *op. cit.*, pp. 246–249); less frequent in *S. torquatus* (Ferria-Ortiz et al. 2011. J. Herpetol. 35:104–112), *S. magister* and *S. undulatus* (Johnson 1966. Am. Midl. Nat. 76:504–509), and *S. siniferus* (Sánchez de la Vega et al. 2014. Herpetol. Rev.45[1]:133–134.). It is important to mention that other species of centipedes occur in this area: *Labrobius major*, *Mexicobius vistanus*, *Nuevobius cavicolens*, *Chomatophilus leonensis*, and *Polycricus nuevus* are potential prey items for lizards. *Orphnaeus brevilabiatus* has recently been collected in the urban area of Puerto Vallarta, Jalisco, Mexico (Capul-Magaña 2009. BIOCYT 2[6]:48–54; Capul-Magaña 2011. Interciencia 36[11]:853–859). Also, our record represents the second occurrence of this centipede in Mexico. Mexico is not included in the known distribution of *O. brevilabiatus* (Minelli [ed.] 2013. Chilobase: A Web Resource for Chilopoda Taxonomy; http://chilobase.bio.unipd.it, accessed 27 June 2014).

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***SCINCELLA SILVICOLA* (Taylor's Ground Skink). ARBOREALITY.** The nine described species of New World *Scincella* (García-Vázquez et al. 2010. Copeia 2010[3]:373–381; Linkem et al. 2011. Zool. J. Linn. Soc. 163:1217–1243) are typically characterized as terrestrial with an affinity for leaf litter (e.g., Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens, Georgia. 575 pp.; Canseco-Márquez and Gutiérrez-Mayen 2010. Anfibios y Reptiles del Valle de Tehuacán-Cuicatlán. CONABIO/Fundación para la Reserva de la Biosfera Cuicatlán A. C./Benemérita Unversidad Autónoma de Puebla, México. 302 pp.). The common name for the genus (ground skinks) exemplifies this. However, some published evidence shows that one species, *S. lateralis*, can be scansorial. This species has been reported as "frequently" occupying the overlapping dead fronds of *Sabal palmetto* in Florida at heights of ≤ 45 cm (Lee 1969. Herpetologica 25[1]:70–71), and was observed at night climbing up to 122 cm above ground on a *Nyssa sylvatica* trunk in Virginia (Townsend et al. 2005. Herpetol. Rev. 36[2]:184). Here, we report scansorial behavior and canopy occupancy in another species, *S. silvicola* from México. This observational evidence suggests a much broader ecological niche for this genus.

While conducting a rope-aided herpetofaunal survey of an emergent tree (species unknown) on 12 April 2014 at 1115 h among intact, old-growth rainforest in the Ejido Adolfo Ruiz Cortínez, Municipality of San Andrés Tuxtla, Veracruz (18.53273°N, 95.14403°W, WGS84; 1100 m elev.), we encountered an adult male *S. silvicola* (MZFC 28760). The lizard was discovered inside a 10-cm thick mat of moss and orchids on a horizontal, 20-cm diameter branch ~25 m above ground, in the middle canopy. It was quite active, and initially escaped capture within the complex epiphytic growth.

Additionally, in July 2004 we observed two individuals of *S. silvicola* in the Cuicatlan Valley, Municipality of Santa Maria Texcatitlan, Oaxaca, México, exhibiting scansorial behavior. These animals were observed active at night in a mesquite tree (*Prosopis* sp.) at a height of approximately 2 m above ground.

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***SPHENOMORPHUS MULTISQUAMATUS*. REPRODUCTION.** *Sphenomorphus multisquamatus* is endemic to Borneo where it inhabits lowland rain forests and peat swamps (Das 2010. A

Field Guide to the Reptiles of South-East Asia, New Holland Publishers, UK. 376 pp.). There is, to my knowledge, no information on reproduction of *S. multisquamatus*. In this note, I provide information on reproduction of *S. multisquamatus* as part of an ongoing series of studies on reproduction of South-East Asian reptiles.

A sample of 28 *S. multisquamatus* consisting of 9 adult males (mean SVL = 60.4 mm ± 7.3 SD, range = 49–73 mm), 11 adult females (mean SVL = 59.5 mm ± 5.9 SD, range = 8–68 mm) and 8 unsexed subadults (mean SVL = 34.6 mm ± 5.3 SD, range = 25–43 mm) from Sabah and Sarawak were borrowed from the herpetology collection of the Field Museum of Natural History (FMNH), Chicago, Illinois, USA: Sabah (N = 11): Kota Marudu District, FMNH 239896; Ranau District, FMNH 248993, 248995; Sipitang District, FMNH 235168, 235172, 235173, 239899, 239900; Tawu District, FMNH 248994; Tenom District, FMNH 239897, 239898; Sarawak (N = 17): Bintulu District, FMNH 148573, 148577, 148578, 148581, 148585, 148587, 161496, 161499, 161502; Kapit District, FMNH 138536, 145660, 188585; Kota Marudu District, FMNH 239896; Miri District, FMNH 120240, 120242, 120243, 129548. *Sphenomorphus multisquamatus* were collected during the years 1959–1991.

A cut was made in the lower abdominal cavity and the left testis or ovary was removed, embedded in paraffin, cut into 5µm sections and stained with Harris hematoxylin followed by eosin counterstain. Enlarged yolking follicles (> 4 mm) or oviductal eggs were counted. Histology slides were deposited in FMNH.

The only stage noted in the testicular cycle was spermiogenesis in which seminiferous tubules are lined by sperm or clusters of metamorphosing spermatids. Males undergoing spermiogenesis were collected in February (N = 2), June (N = 2), July (N = 2), September (N = 1), November (N = 2). The smallest reproductively active male measured 49 mm SVL (FMNH 239846) and was collected in November.

Four stages were observed in the ovarian cycle (Table 1): 1) quiescent, no yolk deposition; 2) early yolk deposition, basophilic vitellogenic granules in the ooplasm; 3) enlarged follicles > 4 mm; 4) oviductal eggs. There was no evidence that *S. multisquamatus* produces multiple clutches (oviductal eggs and concurrent yolk deposition), although this may reflect my small female sample size. Clutch size (N = 6) was an invariant 3.0. The smallest reproductively active female (FMNH 161499) measured 56 mm, contained three oviductal eggs and was collected in July.

TABLE 1. Monthly stages in the ovarian cycle of 11 adult female *Sphenomorphus multisquamatus* from Sabah and Sarawak; *enlarged follicles (> 4 mm) in one August and one December female were broken and could not be counted.

Month	N	Quiescent	Early yolk deposition	Enlarged follicles > 4 mm	Oviductal eggs
January	2	0	1	0	1
March	1	0	0	1	0
April	1	1	0	0	0
June	1	1	0	0	0
July	2	0	0	0	2
August	2	0	0	2*	0
November	1	0	0	0	1
December	1	0	0	1*	0

Sphenomorphus multisquamatus sub-adults were collected through much of the year: January (N = 1), July (N = 1), August (N = 2), September (N = 1), December (N = 2).

While it is clear *S. multisquamatus* exhibits an extended reproductive cycle, examination of additional monthly samples will be needed to ascertain if reproduction occurs throughout the year as has been reported for other lizards from a Bornean rain forest (Inger and Greenberg 1966. Ecology 47:1007–1021).

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***VARANUS PILBARENSIS* (Pilbara Rock Monitor) and *VARANUS GLAUERTI* (Kimberley Rock Monitor). TAIL DISPLAY BEHAVIOR.** Among reptiles, lizards are best known for signaling to conspecifics and to would-be predators (Cooper 2003 *In* Fox et al. [eds.], Lizard Social Behavior, pp. 107–141. Johns Hopkins University Press, Baltimore, Maryland. 438 pp.). Stereotypical displays include head bobbing, pushups, arm waving, foot shaking and tail wagging (Font et al. 2012. J. Comp. Psychol. 126:87–96 and references therein). Some families of lizards are well known for displays (e.g., Agamidae, Dactyloidae), while others are not. Monitor lizards (Varanidae) apparently exhibit limited overt displays (Pianka and King 2004. Varanoid Lizards of the World. Indiana University Press, Bloomington, Indiana. 602 pp.; Sweet 2007. *In* Horn et al. [eds.], Advances in Monitor Research III: Mertensiella 16, pp. 378–402, Reinbach). Herein, we report on observations of apparent tail signaling in *Varanus pilbarensis* and *V. glauerti*.

At 1630 h on 23 February 2014, two of us (SD, BS) noticed a *V. pilbarensis* on a rock ledge on a mesa in the Pilbara region of Western Australia (22.035584°S, 119.413951°E). The adult lizard was about 5 m above us, moving slowly along, tongue flicking, and often stopping to observe us. On four separate occasions, the lizard draped its tail over the rock ledge in a vertically hanging position, and began to wag the tail. The tail wagged in a sinusoidal fashion several cm to each side and slowly at first. After about 3–5 seconds the tail movements would accelerate for a few seconds, culminating in the last few cm of the tail vibrating rapidly. Each tail wag lasted about 10 seconds. During these bouts the lizard was otherwise mainly motionless, although the bouts at times started or ended with "nervous" (but not overly so) movements of the body. After about five minutes the lizard disappeared over the ledge, and despite our climbing and searching we could not relocate it. We were not able to determine the sex of the lizard, but its relatively large size suggested that it was a male. The weather was hot (~35°C) and mostly clear and calm.

One of us (SSS) occasionally observed similar tail wagging displays in *Varanus glauerti* while conducting radio-tracking work with that species (Sweet 1999. Mertensiella 11:317–366; Sweet 2007, *op. cit.*). The behavior occurred mostly in situations where the animal under observation was intent on another subject, but also aware of the observer's presence nearby. During mating season two or even three male *V. glauerti* attended a single female, and the additional male(s) waited 1–3 m away from a mating pair (always in a hollow branch with tails protruding). Twice when these males were closely approached (within about 4 m) they did not leave their sites, but instead engaged in intense tail wagging as described for *V. pilbarensis*. Similar behavior was noted on 4–5 occasions when a *V. glauerti* pursued one or more skinks (*Cryptoblepharus* sp.) through *Dryandra* ferns on narrow rock ledges and came within 2–3 m of an observer. The monitor stopped and

performed 1–3 bouts of strong tail undulations before turning away.

The tail wagging and vibrating we observed appeared to be deliberate signaling. Although lizards often wag their tails when nervous (for example, upon capture varanids will undulate their tail slowly), the *V. pilbarensis* we observed invariably draped its tail over the rock ledge just prior to wagging, but did not drape the tail over the ledge when it was not wagging. During the entire observation we scanned the remaining cliffs for any conspecifics, prey or predators that might have been targets of the signaling, but could find no receiver. In each case of tail wagging in *V. glauerti*, it seemed clear that the observer was the cause and target of the behavior because the behavior occurred upon the observer's approach. The deliberate nature of the displays, and the fact that the lizards could clearly see us, brings us to the tentative conclusion that the tail wagging behaviors we observed were pursuit-deterrent signals (PDS) aimed at us. PDS are used by animals to make predators aware that they have been identified, in order to reduce the probability that the predator will pursue the signaler (Woodland et al. 1980. Am. Nat. 115:748–753; Hasson 1991. Trends Ecol. Evol. 6:325–329).

Sweet (2007, *op. cit.*) reported a different context for tail undulation in *V. tristis*, in which foraging monitors sought out shallow depressions in the forest floor caused by uprooted trees, which were now filled with 10–30 cm of dry leaves. The monitors entered the leaf pack rapidly 2–5 cm below the surface and surged forward 0.5–1 m before emerging and standing high on their forelimbs. Any movement in the leaves elsewhere was pounced on, and skinks (several genera) were actively pursued under the leaves. The standing high posture was usually followed by a bout of rapid tail undulation under the leaves. This was sufficiently energetic to flip some leaves into the air, and often caused concealed skinks to change their positions. There was no indication that this was directed at an observer; rather, it was done to flush prey. Further observations of tail wagging behavior in nature, and perhaps experiments, are needed to determine the frequency of the behavior and its function(s) in *V. pilbarensis*, *V. glauerti*, and in other monitor lizards. Interestingly, the monitor perhaps best equipped to use tail signaling behavior, *V. glebopalma* (distal third of tail bright yellow), never did so in over 1400 field encounters (Sweet 1999, *op. cit.*).

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***XANTUSIA EXTORRIS* (Durango Night Lizard). FIELD AND PREFERRED BODY TEMPERATURE.** In lizards, body temperature affects virtually all behavioral and physiological traits (Bellure et al. 1996. Ecology 77:1163–1173; Herczeg et al. 2006. Behav. Ecol. Sociobiol. 60:405–414). However, data on preferred body temperature (T_p) is actually quite rare (Sinervo et al. 2010. Science 328:894–899) because measurement in a laboratory thermal gradient under standard conditions is required (Huey 1982. *In* Gans and Pough [eds.], Biology of the Reptilia, Vol. 12, Physiology C, pp. 25–91. Academic Press, New York). The T_p that a lizard voluntarily selects in a laboratory thermal gradient provides a reasonable estimate of what a lizard would attain in the wild with a minimum of associated costs in absence of constraints (biotic and abiotic factors) for thermoregulation (Huey and Slatkin 1976. Q. Rev. Biol. 51:363–384; Pough and Gans 1982. *In* Gans and Pough [eds.], Biology of Reptiles, Vol. 12, Physiology C, pp. 17–23. Academic Press, New York). *Xantusia extorris* is an endemic species of Mexico and has a restricted distribution in northeastern and southwestern Durango and Coahuila, respectively, within the Sierra Madre Oriental physiographic province in the central Chihuahuan Desert (Webb 1965. Am. Mus. Novit. 223:1–16; Bezy et al. 2008. J. Herpetol. 42:680–688; Castañeda-Gaytán et al. 2013. Acta Zool. Mex. [n.s.] 29:240–244). This crepuscular and nocturnal species inhabits desert and arid lands with a ground cover of rocks, fallen yucca plants, fallen branches of Ahuehuete Trees (*Taxodium mucronatum*), and agaves (Webb 1965, *op. cit.*; Gadsden et al. 2006. Bull. Chicago Herpetol. Soc. 41:2–9). There have been several reports detailing thermal ecology in *X. riversiana* and *X. vigilis* (Mautz et al. 1992. Herpetologica 48:271–279; Rabosky et al. 2012. PLoS ONE 7(7):e40866. doi:10.1371/journal.pone.0040866); nevertheless, data on T_p of xantusiids are incomplete (Kaufmann and Bennett 1989. Physiol. Zool. 62:1047–1058; Mautz et al. 1992, *op. cit.*). Both the preferred body temperature in laboratory and body temperature in natural populations have not yet been documented in *X. extorris*. Here, we describe field body temperature and thermal preference under laboratory conditions for this species.

During September and October 2013, we conducted fieldwork in Municipal Ecological Reserve Sierra and Canyon of Jimulco (25.1279°N, 103.2869°W, WGS84; 1640 m elev.), 50 km SE of Torreón, Coahuila, Mexico. Vegetation was dominated by *Yucca* sp. and *Agave lechuguilla*. The data presented are based on 20 adults (> 34 mm SVL) of *X. extorris* captured by hand. Active body temperature (T_b) of each lizard captured was measured using a digital thermometer (Fluke™ model 51-II) with a thermocouple inserted into the cloaca. All lizards were transferred to a laboratory thermal gradient to obtain T_p range. The thermal gradient consisted of a wooden shuttle box of 150 × 100 × 80 cm (length, width, and height) divided into ten tracks with insulation barriers to prevent behavioral influence of adjacent lizards, and filled with 2 cm of sandy soil. The shuttle box was housed in a room with air conditioning at a constant temperature of 20°C. One end of the thermal gradient was heated from below by Nu-Klear (Nu-Klear©, Auckland, New Zealand) thermostatically controlled electric heat pads while the opposite end was cooled using a chamber cooling (by the external side of the shuttle box) apparatus to generate a thermal gradient from 16 to 42°C (Hertz et al. 1993. Am. Nat. 142:796–818). The T_p of lizards were measured every hour from 1740 h and until 1130 h (activity period) using the same digital thermometer used in field. The 25% and 75% quartiles of T_b (T_{b25} and T_{b75}) and T_p (T_{p25} and T_{p75}) ranges were calculated to obtain the lower and upper limit (Van Damme et al. 1990. Oikos 57:61–67; Hertz et al. 1993, *op. cit.*). After laboratory experiments, all lizards were released at their capture sites. We applied a nonparametric Mann-Whitney Rank Sum Test to analyze the differences between T_b and T_p.

There were statistically significant difference between T_b and T_p (U = 959.5, P = 0.01). Mean T_b was 30.2°C (SE = 0.49, range = 24.3–33.2°C; N = 20). Interquartile of 25% and 75% was 29.4°C and 32.0°C, respectively. On the other hand mean of T_p was 28.3°C (SE = 0.27, range = 18.6–35.4°C; N = 149). Interquartile of 25% and 75% was 26.3°C and 30.7°C, respectively.

These results are within the previously reported range of field body temperature for Xantusiidae (Sinervo et al. 2010, *op. cit.*), and suggest that *X. extorris* can be considered a eurythermic

species due to its wide range of T_b and T_p. Future research should evaluate the thermal efficiency by monitoring mean thermal requirements and microhabitat temperatures across its distribution for understanding effects of global warming on this geographically restricted lizard.

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SQUAMATA — SNAKES

***ACROCHORDUS ARAFURAE* (Arafura File Snake). FORAGING / PREY CORALLING BEHAVIOR.** Aquatic feeding, including piscivory, occurs in several snake families, and these snakes have predictably evolved adaptations to facilitate feeding on fish. Perhaps the most interesting of these is the "feint" behavior in Tentacled Snakes (*Erpeton tentaculatus*), whereby the snake lies in a "J-shape" and uses its body to startle a fish towards the snake's rapidly approaching mouth (Catania 2009. Proc. Nat. Acad. Sci. USA 106:11183–11187). Below we describe how *Acrochordus arafurae* attempted to prey upon fish in northern Australia.

At ~2230 h on 12 April 2014 two of us (GV and PM) discovered two individual *A. arafurae* in Coomallie Creek, a small perennial system ~70 km south of Darwin, Northern Territory, Australia (13.009798°S, 131.114325°E; WGS 84). The two snakes, which were both approximately 1 m long, were swimming slowly in the creek, which was about 0.3 m deep and clear. One of the snakes became stationary on the bottom (also at 0.3 m depth) and, its head held motionless, began to loop its body counterclockwise around two small (~8 cm) Rainbowfish (*Melanotaenia* sp.) that were also near the bottom. The snake closed the loop by bringing its tail to the left side of its head, and then slowly "tightened" the loop, moving the fish closer to its head. The movement of the body towards the fish was sufficient to move them; they were not touched by the snake. When the fish were within ~5 cm of the snake's head, the snake flicked its tongue, turned its head towards the fish and struck at them. However, the fish eluded capture by swimming rapidly over the snake's body and out of sight. The observation lasted no more than 20 sec.

Because this species feeds almost exclusively on fish (Houston and Shine 1993. J. Anim. Ecol. 62:737–749), our observation likely reflects a novel behavior specifically evolved for capturing fish. It is possible that the snake we observed, like the Tentacled Snake, also used feint behavior in its attempt to capture the fish (the feinting motion is subtle and can only be detected with high-speed film in the laboratory; Catania, *op. cit.*). Although specific behaviors for capturing fish have been observed in other snakes (e.g., Gillingham and Rush 1974. J. Herpetol. 8:384–385; Drummond 1983. Behaviour 86:1–30; Balent and Andreadis 1998. J. Herpetol. 32:575–579; Bilcke et al 2006. Biol. J. Linn. Soc. 88:73–83), we can find no description of corralling behavior in other aquatic snake species. Corralling behavior may have evolved within the acrochordids or within *A. arafurae;* however, it may occur in other aquatic snakes, considering the basal evolutionary position of acrochordids to most other aquatic snakes (Colubroidea) (Lawson et al. 2005. Mol. Phylog. Evol. 37:581–601; Pyron et al. 2013. BMC Evol. Biol. 13:93).

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***AGKISTRODON PISCIVORUS* (Cottonmouth). COLD TOLERANCE.** At 1250 h on 18 December 2014, I saw an *Agkistrodon piscivorus* (total length ca. 50 cm) stretched out lengthwise on a levee, a suspected hibernaculum, at the Beech Ridge Unit of the Obion River Wildlife Management Area, Weakley Co., Tennessee, USA. Air temperature was 3.9°C with heavy cloud cover and an approximately 5–10 mph breeze. There had been sleet and rain earlier in the day. Since I did not handle the snake, I could not determine sex or make body measurements. I did not notice any abnormalities or injuries; the snake did not appear emaciated. According to Ernst and Ernst (2003. Snakes of the United States and Canada. Smithsonian Books, Washington D.C. 668 pp.), *A. piscivorus* displays cold tolerance and is active late in the year. I am not aware of any reports of *A. piscivorus* active on the surface at this temperature or colder.

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***ALSOPHIS PORTORICENSIS ANEGADAE* (Puerto Rican Racer). DIET / CANNIBALISM.** Snake cannibalism is a rare but well-documented occurrence (e.g., Engeman et al. 1996. The Snake 27:149–152; Göçmen et al. 2008. Curr. Herpetol. 27:1–7; Mociño-Deloya et al. 2009. Anim. Behav. 77:145–150), and for some species, the opportunistic capture and consumption of conspecifics may represent an important and understudied component of the diet (Polis and Meyers 1985. J. Herpetol. 19:99–107). *Alsophis portoricensis* is thought to be a dietary generalist (Henderson and Crother. 1989. *In* C. A. Woods (ed.), Biogeography of



FIG. 1. Adult female *Alsophis portoricensis* juxtaposed against the regurgitated juvenile to show size differentiation.

the West Indies: Past, Present, and Future, pp. 479–517. Sandhill Crane Press, Gainesville, Florida), but the breadth of its diet has received limited attention in the literature. A case of intraspecific predation was described by Perry and Powell (2008. Herpetol. Rev. 39:465) on Guana Island, British Virgin Islands, but as both *A. portoricensis* involved in that report were dead when discovered, it is a possible case of carrion consumption. Here, we report on a second case of cannibalism, also from Guana Island, in which the prey was definitely alive.

On 23 October 2014, at 1230 h, we captured an adult female *A. portoricensis* (SVL = 612 mm; Tail length = 256 mm; 61 g) within the Guana Island hotel complex (18.4793°N, 64.5781°W; WGS84). The snake had a small portion of still-moving tail sticking out of its mouth. Upon capture, the *A. portoricensis* regurgitated a juvenile of the same species (SVL = 181 mm; Tail length = 89 mm; 2 g), appearing by size to be a just-hatched individual (Fig. 1). The ingested juvenile had some perforations from the adult's teeth and initially did not move, but it was not bleeding and slowly recovered. Both snakes were released at the site of capture on the following day, with the juvenile still doing well. Observations of scavenging and cannibalism in *A. portoricensis* (Perry et al. 2007. Herpetol. Rev. 38:203; Perry and Powell 2008. Herpetol. Rev. 39:465) emphasize that these snakes have more diverse diets than sometimes assumed.

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***AMPHIESMA STOLATA* (Buff Striped Keelback). DIET / SCAVENGING.** *Amphiesma stolata* is known to feed on a variety of prey including frogs, insects, scorpions, fish and lizards (Das 2002. A Photographic Guide to Snakes and Other Reptiles of India. New Holland Publishers Ltd., UK. 144 pp.). Here we report a case of *Amphiesma stolata* preying upon a dead fish (Cyprinidae), at Amlamethi Ghaat, Sundarbans, (22.104056°N, 88.7071°E; datum: Indian Regional Navigation Satellite System [IRNSS]), West Bengal, India. On 5 December 2014, at ca. 1100 h, we observed an *A. stolata* approaching a dead fish and thereafter starting to feed on it. The snake took approximately 10 min to completely swallow the fish headfirst. After this, the snake retreated into adjacent mangrove forest.



FIG. 1 *Amphiesma stolata* scavenging on a dead fish belonging to the family Cyprinidae.

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***ANILIOS KIMBERLEYENSIS* (Kimberly Blindsnake). DEFENSIVE BEHAVIOR.** Defenses used by snakes against potential predators include foul-tasting secretions, venoms, hardened scales or shells, large teeth, claws, and tails which may be used as a whip, in addition to camouflage and retreat or "run and hide" behaviors (Greene 1988. *In* Gans and Huey [eds.], Biology of the Reptilia, Vol. 16, Ecology B, pp. 1–152. Alan R. Liss Inc. New York). Although defense strategies are more prominent or visible in some species, other species appear to have little in the way of defense when at risk of capture or predation. The terminal tail spine in some snakes has previously been identified as a morphological feature that may have an antipredator function, although the use and effectiveness of this defense strategy is unknown (Davis 1948. Copeia 1948:208–211; Greene, *op. cit.*). For example, Davis (*op. cit.*) in reference to the use of the tail spine as a defense mechanism by *Farancia abacura* (Red-bellied Mudsnake) stated "when handled would … stab ineffectively with the diminutive spine." Greene (*op. cit.*) noted that this behavior was only known in a few species and suggested it was more widespread in scolecophidians. Greene (*op. cit.*) noted "*Typhlops* thrash, discharge the cloaca, and press a captor with the tail spine." Other than odiferous cloacal excretions no other defensive strategies have been identified in Australian blindsnakes of the genus *Anilios* (Greer 1997. The Biology and Evolution of Australian Snakes. Surrey Beatty & Sons, Chipping Norton, NSW. 358 pp.). This note presents an observation of the use of the terminal tail spine as an apparent defense mechanism by the blindsnake *Anilios kimberleyensis*. *Anilios kimberleyensis* is a small, slender, species found in the Kimberley region of Western Australia and northwest Northern Territory. Similar to most other *Anilios* species, *A. kimberleyensis* possesses a small (1–1.5 mm) conical terminal tail spine.

In April 2012 an adult *A. kimberleyensis* was collected from underneath a sheet of tin at El Questro Wilderness Park in the Kimberley, Western Australia (16.008587°S, 127.977409°E; WGS84). During handling the snake struggled and both its anterior and posterior thirds moved erratically. The tail was slightly coiled and moved continuously back and forth with the terminal tip of the tail and regularly coming into contact with the upper surface of the collector's hand. When the tail spine came into contact with the collector's hand it could be distinguished from contact with the rest of the individual's body; however, it did not pierce the skin or cause any pain. These movements continued for approximately 30 sec. The individual released a small quantity of cloacal fluid with a faint foul-smelling odor when first handled; however, it did not appear as pungent as that produced by other species handled previously. The tail-pricking behavior was briefly observed again when the snake was subsequently examined.

The use of the tail spine as a defense mechanism has not previously been identified for any *Anilios* species and it is unknown at what point it is used and how effective it is against predators. This behavior is likely to be more effective defense against smaller species where the tail spine is more likely to cause discomfort or come into contact with a predator's eye or other sensitive areas, particularly in combination with the odiferous cloacal excretions acting as a deterrent. The terminal tail spine is present on all *Anilios* species other than *A. aspina*, a species

that may have adapted alternative defense strategies. While our observation sheds further light on the behaviour and ecology of Australian blindsnakes, it also identifies knowledge gaps requiring further study.

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***APOSTOLEPIS DIMIDIATA*. REPRODUCTION.** *Apostolepis dimidiata* is a small snake (to 630 mm SVL) found in Cerrado and Chaco areas from southeastern Brazil, eastern Paraguay, and northern Argentina (Lema 2001. Cuad. Herpetol. 15:29–43). It belongs to the tribe Elapomorphini, a monophyletic group containing nearly 48 species of poorly-known fossorial snakes widely distributed in South America (Uetz and Hošek [eds.], The Reptile Database, http://www.reptile-database.org; accessed 17 March 2015). Herein, we present the first reproductive information (reproductive mode, clutch size, egg size, and reproductive timing) for *A. dimidiata*.

At 1100 h on 13 December 2009, an adult female *A. dimidiata* (SVL = 319 mm; tail length = 31 mm; and mass = 4.1 g) was found emerging from the soil, after the passage of a bulldozer associated with construction of the Anhanguera Hydroelectric Dam (20.5011°S, 47.8647°W, WGS84; 547 m elev.), situated in the municipality of São Joaquim da Barra, São Paulo state, southeastern Brazil. The animal died later that day, and during the necropsy we found it to contain two extremely elongated eggs (31.0 × 4.8 mm and 31.8 × 5.3 mm), one in each oviduct (Fig. 1). Eggs were surrounded by an opaque, thick, and coriaceous eggshell, indicating oviparity. Dissection of one egg revealed a developing embryo at stage 21 (Zehr 1962. Copeia 1962:322–329), within the range of stage at oviposition in most snakes (Blackburn 1995. J. Theor. Biol. 174:199–216), indicating that egg-laying was near to occur. Reproductive traits reported here (low clutch size, elongated eggs, and timing of gravidity) are similar to other Elapomorphini (Braz et al. 2014. Herpetol. J. 24:49–57).



FIG. 1. Female *Apostolepis dimidiata* collected on 13 December 2009 in São Joaquim da Barra (São Paulo, Brazil) containing two elongated oviductal eggs. The arrow indicates the orientation of the head.

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***BOTHROPS DIPORUS* (Southern Pitviper). DIET / OPHIOPHAGY.** Ophiophagy has been reported for at least 10 species in the genus *Bothrops* (*sensu lato*) (Martins et al. 2002. *In* Schuett et al. [eds.], Biology of the Vipers, pp. 307–328. Eagle Mountain Publ., Eagle Mountain, Utah; Marques et al. 2004. Herpetol. Rev. 35:58; Duarte 2008. Herpetol. Rev. 31:45–46). Here we report for the first time a predation event by *Bothrops diporus* upon an adult *Chironius maculoventris*.

At 0235 h, on 24 February 2012, during fieldwork near the Paraguay River in "Estancia La Emilia" (25.94096°S, 57.89160°W; WGS84), northeast of Formosa Province, Argentina, we observed a female *B. diporus* in the process of swallowing an adult *C. maculoventris* (Fig. 1A). The event took place on a dirt road that runs through mixed palm-tree savannah in the Wet Chaco eco-region. The racer had been taken head first and was approximately half swallowed at the time it was found. The head and anterior portion of the *C. maculoventris* were mutilated and exhibited evident external damage and hemorrhaging, particularly in the heart region (Fig. 1 B). Both snakes were collected immediately but only the viper was properly measured (SVL = 73.9 cm), fixed, and deposited at the Universidad Nacional del Nordeste as a voucher specimen (UNNE JRG-197); the size of the racer was estimated (SVL ca. 91 cm) and the specimen later discarded due to the poor quality of the specimen.

Chironius maculoventris is a terrestrial-arboreal, slender, relatively long snake, with largest specimens measuring about



FIG. 1. A) *Bothrops diporus* swallowing an adult *Chironius maculoventris*. B) Predator and prey size comparison.

1.8 m in total length. It is a forest dweller species but can also be found in adjacent open areas (Dixon et al. 1993, Revision of the Neotropical Snake Genus *Chironius* Fitzinger (Serpentes, Colubridae), Monografie XIII, Museo Regionale di Scienze Naturali, Torino, Italy. 279 pp.). As with other vipers of the *Bothrops newiedii* complex, *B. diporus* are mainly forest dwellers and usually considered mammal specialists (Martins et al., *op. cit.*). We were not able to confirm whether this was a predatory event or a case of scavenging upon a road-killed specimen, but *Bothops diporus* is very common at this location and the road has almost no traffic at all. Thus, it seems plausible that this arboreal racer had been predated when crossing the road to move between forest patches.

We wish to acknowledge the personnel of Estancia La Emilia (MSU Río Porá SA) and to José Augusto Ruíz García from the Universidad Nacional del Nordeste for properly identifying and measuring the snakes.

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***BOTHROPS ERYTHROMELAS* (Jararaca Dry). ENDOPARASITE.** Snakes are parasitized by a wide variety of invertebrates (Silva et al. 2001. Rev. Bras. Par. Vet. 10:91–93). The endoparasite *Cephalobaena tetrapoda* (Heymones, 1922) is a species of Pentastomida that infects the respiratory tract of snakes (Almeida et al. 2007. Braz. J. Biol. 67:759–763; Almeida et al. 2008. Braz. J. Biol. 68:193–197). Only four species of snakes have been recorded as hosts for these species of Pentastomida: *Bothrops (Lachesis) alternatus* (Viperidae), *Lygophis lineatus* (Colubridae), *Oxybelis aeneus* (Colubridae), and *Phylodrias nattereri* (Colubridae) (Almeida et al. 2006. Braz. J. Biol. 66:559–564; Almeida et al. 2008, *op. cit.*). All of these species of snakes feed on small vertebrates, mainly lizards and frogs (Mesquita et al. 2013. Pap. Avul. Zool. [São Paulo] 53:99–113), which therefore should represent the intermediate hosts for *C. tetrapoda* (Almeida et al. 2006, *op. cit.*; Almeida et al. 2008, *op. cit.*). The genus *Bothrops*, belonging to the subfamily Crotalinae, has a wide distribution in South America, occurring from Mexico to Argentina (Valdujo et al. 2002. J. Herpetol. 36:169–176). In November 2012 a male *B. erythromelas* (SVL = 362 mm; Tail Length = 58 mm; 17 g) was captured on Sítio Pedra Preta – municipality of Farias Brito (39.533194°W, 06.783278°S, WGS84; 309 m elev.), Ceará, northeastern Brazil. The specimen was euthanized and deposited in Herpetological collection of Universidade Regional do Cariri (URCA H 4996). The respiratory tract of the snake was removed for analysis of parasites under a stereoscopic microscope. A specimen of *C. tetrapoda* was identified. This represents the first record of *B. erythromelas* as definitive host for *C. tetrapoda* (collection among the Regional University of Cariri-URCA P 389). *Cephalobaena tetrapoda* causes lesions in the lung tissue (Almeida et al. 2008, *op. cit.*), obstruction in the trachea (Paré 2008. J. Exo Pisto Med. 17:285–294), reduced fertility, and increased mortality, and may act to control populations of infected snakes (Riley 1986. Adv. Parasitol. 25:45–128; Pence and Selcer 1988. Copeia 1988[3]:565–572).

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***CROTALUS HORRIDUS* (Timber Rattlesnake). COLORATION, PATTERN, EXOPHTHALMIA, AND ENOPHTHALMIA.** On 24 July 1885, an adult *Crotalus horridus* variously described as having skin "white as milk" and "white as paper" was discovered by John Sheridan near the rural hamlet of Ladow's Mills, in the vicinity of Corydon, McKean Co., Pennsylvania, USA (Anonymous 1885. The New York Times, July 31). This represents the earliest known written description of an abnormally colored *C. horridus*. The interest of the general public in such an animal is attested to by the fact that, within a week, an account of the discovery was published in one of the country's largest metropolitan newspapers.

Since that time, 10–12 (two are likely the same specimen) *C. horridus* characterized as exhibiting some lack of pigmentation (albino, amelanistic, or xanthic) have been reported in the literature (Hensley 1959. Publ. Mus., Michigan State Univ. Biol. Ser. 1:133–159; Dyrkacz 1981. SSAR Herpetol. Circ. No. 11. 31 pp.; Hudson and Carl 1985. Herpetol. Rev. 16:28–29) and more recently on internet websites. Most of these specimens exhibited faint, but discernable, normal dorsal banding patterns and tended to have a yellow or tan skin coloration. Two of these snakes were also collected from Pennsylvania. E. Cheuvront and S. Harwig found a "xanthic" *C. horridus* with "brassy iris" in 1954 (Hensley, *op. cit.*; S. Harwig, pers. comm.). Although preserved for over 60 years, this specimen (CMNH, CM 34696) still shows the vestiges of a normal pattern (H. K. Reinert, pers. obs.). The second specimen, collected in 1962, exhibited a reduction in pigmentation, but retained a clearly discernable pattern, black tail, and normal colored iris (Grube 1963. Turtox News 41:70).

On 28 May 2001, a male *C. horridus* with aberrant coloration was collected in western Pennsylvania. This snake was 34 cm (total length) with a single rattle segment (terminal button) indicating that it had been born the previous fall. The skin of the snake was slightly translucent and appeared light pink or white in coloration. The snake was patternless with the exception of two very small black spots on the dorsum (Fig. 1A). On 25 August 2002, in the same general vicinity, a litter of newborn *C. horridus* was observed that included another anomalous individual along with 6–7 normal patterned siblings. This snake, a 32 cm female, was also white or light pink with slightly translucent skin. It too was patternless with the exception of a small (<1 cm diameter) dark patch on the dorsum (Fig. 1B).

At the time of capture, both snakes displayed bilateral exophthalmia, white irises, abnormally large, round pupils that were non-responsive to light, and pink tongues (Fig. 2A, B). H. Bernard Bechtel examined photographs of the male snake and concluded that it displayed a form of leucism (H. B. Bechtel, pers. comm.) similar to that exhibited by *Pantherophis obsoletus* [*Elaphe obsoleta lindheimeri*] (Bechtel and Bechtel 1985. J. Hered. 76:7–11). Reportedly, several leucistic specimens of *P. obsoletus* also displayed exophthalmia (Bechtel and Bechtel, *op. cit.*).

Both rattlesnakes have been maintained in captivity. The male has grown to 106 cm and the female to 92 cm in total length. Over time, the skin of both snakes has become less translucent and whiter in appearance, likely due to thickening of the epidermis. The amount of skin pigmentation has also increased greatly in both snakes. However, no semblance of normal pattern has emerged. Instead, both snakes have become increasingly spotted with black, brown, orange, and pale yellow in a seemingly random

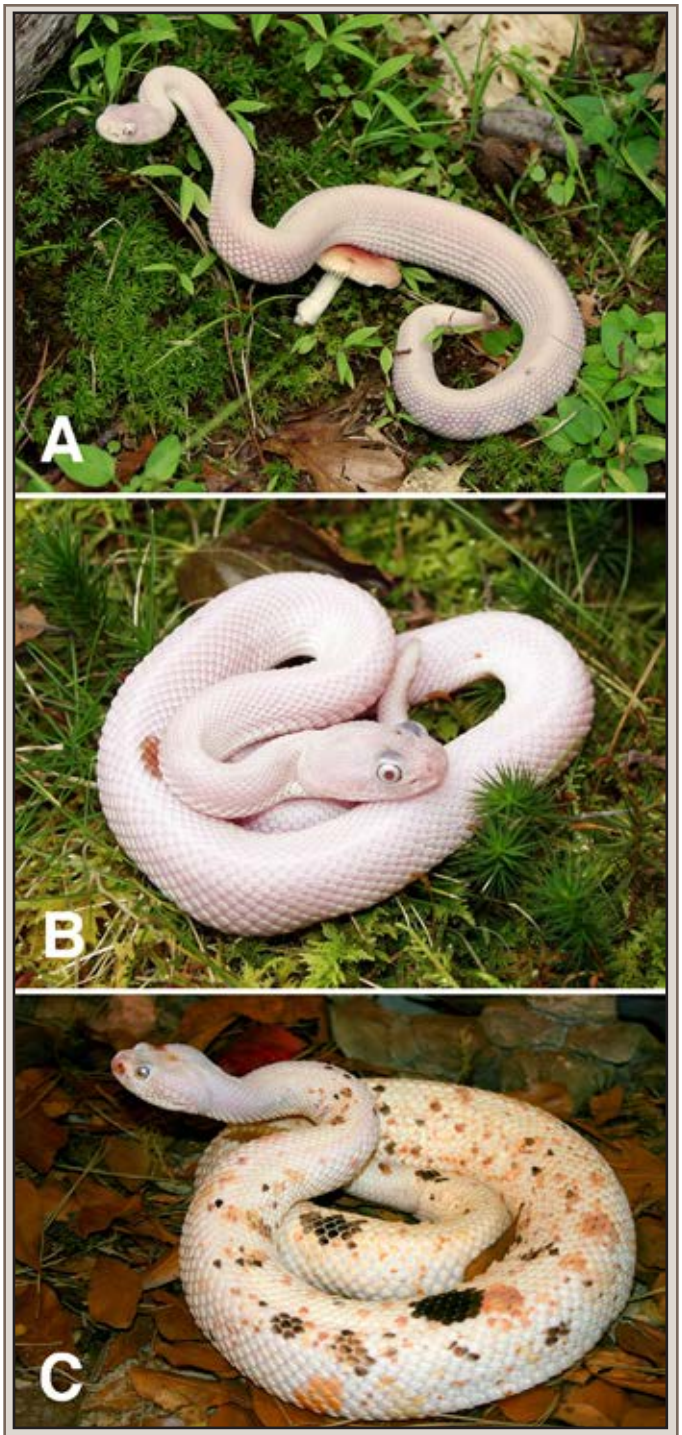


FIG. 1. General appearance of the male *Crotalus horridus* when captured in 2001 (A), the female when captured in 2002 (B), and the female as an adult in 2014 (C).

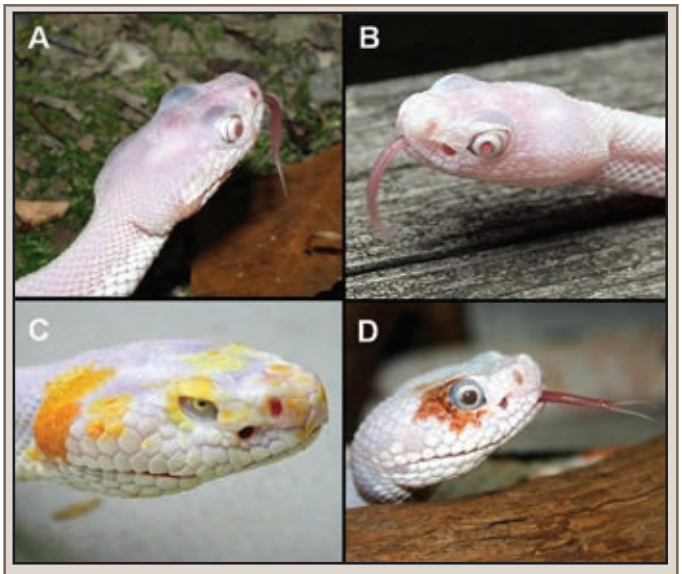


FIG. 2. Exophthalmia in the male *Crotalus horridus* in 2001 (A) and the female in 2002 (B) when captured. Enophthalmia in the adult male (C) and exophthalmia in the adult female (D) in 2014. Rounded pupils, white irises, and pink tongue are also evident.

manner (Fig. 1C). It is unlikely that leucism correctly describes the anomaly displayed by these snakes because chromatophores typically do not develop in the epidermis of leucistic organisms (Bechtel 1995. Reptile and Amphibian Variants: Colors, Patterns, and Scales. Krieger Publishing, Malabar, Florida. 206 pp.).

The eyes of the male did not continue to grow in proportion to the head and body. They remained small and have become enophthalmic (Fig. 2C). The eyes of the female, however, have continued to grow and remain exophthalmic (Fig. 2D). Both snakes have severely impaired vision and do not appear to visually track movements. However, both are responsive to warm prey, strike accurately, and eat regularly. The male has become progressively less flexible and mobile. He moves laboriously, typically using rectilinear locomotion and cannot balance on a snake stick. He also does not coil, but always lays out-stretched suggesting spinal ankylosis. He has not suffered any known spinal injury. The female, however, shows normal movement ability and regularly coils in resting and foraging postures typical for this species (Reinert et al. 2011. Copeia 2011:430–442).

The two snakes described in this report appear to be the first wild-caught *C. horridus* to exhibit such unique combinations of color, pattern, and ocular anomalies. Both were captured as neonates, and considering that their births were separated by two years, it is possible that they have shared parentage (Martin 1993. J. Herpetol. 27:133–143). Although the male snake apparently overwintered successfully, their lack of both cryptic coloration and eyesight makes it unlikely that either snake would have survived long under natural conditions.

Both specimens are currently maintained at Clyde Peeling's Reptiland, Allenwood, Pennsylvania. Gian Rocco, James Chestney, Stephen Rogers (CMNH), and Steve Harwig provided field assistance and information. Robert T. Zappalorti photographed adult snakes. We thank Christopher Urban (Pennsylvania Fish and Boat Commission) for required collecting and holding permits.

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***CROTALUS OREGANUS* (Northern Pacific Rattlesnake). SCAVENGING.** Scavenging of carrion has been documented in numerous species of snakes (DeVault and Krochmal 2002. Herpetologica 58:429–436) including pitvipers of the genus *Crotalus* (Dornburg and Weaver 2009. Northwest. Nat. 90:55–57). Dornburg and Weaver (*op. cit.*) observed a juvenile *C. oreganus* attempt to remove a road-killed *Peromyscus maniculatus* (Deer Mouse) from a road surface in Washington State, USA. Herein, we provide an



FIG. 1. An adult *Crotalus oreganus* consuming a *Tamias quadrimaculatus* (Long-eared Chipmunk) as carrion in Amador Co., California, USA.

additional observation of *C. oreganus* scavenging and consuming road-killed prey.

At 1743 h on 21 August 2013, while driving along Panther Creek Road (38.507294°N, 120.358098°W; NAD 83) in Amador Co., California, USA, an adult *C. oreganus* (ca. 85 cm total length) was observed scavenging a dead *Tamias quadrimaculatus* (Long-eared Chipmunk) (Fig. 1). Following our initial observation, the rattlesnake retreated off the road into the vegetated shoulder, with the chipmunk in its mouth and always faced us during this movement. Once in the vegetated shoulder, the rattlesnake began swallowing the chipmunk head-first and we departed after it was approximately 75% consumed. The chipmunk appeared flattened and crushed and was covered with approximately 15–20 yellowjacket wasps (*Vespula* sp.), suggesting that it died from being crushed by a car, rather than from envenomation by a rattlesnake.

We thank Harry W. Greene who encouraged us to publish this observation and reviewed this note.

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***CROTALUS WILLARDI* (Ridge-nosed Rattlesnake). PREGNANCY / MATERNAL CARE / MALE ACTIVITY.** The phenomenon of post-partum maternal care has been described in North American pitvipers, which includes rattlesnakes (Greene et al. 2002. *In* Schuett et al. [eds.], Biology of the Vipers, pp. 179–206, Eagle Mountain Publishing, Eagle Mountain, Utah; Hoss and Clark 2014. Ethology 120:933–941). Here, we describe several cases of pregnancy and maternal care in *Crotalus willardi* from Arizona at a single location on a single day. Additionally, we report on male activity associated with pregnant and post-partum females.

On 10 August 2008, at 0950 h, two of us (BPO, BTL) arrived at a small hillside (1646 m elev.) in the Patagonia Mountains (Arizona, Santa Cruz Co., USA; 31.416°N, 110.733°W, Conus 27). Weather conditions were mild (26°C) and the sky was partly cloudy. The ground was damp and there appeared to have been recent rainfall. At 1010 h, a large, pregnant *C. willardi* (female-1) was observed basking along the edge of dense bunch grass. At 1025 h, about 30 m from the first female, a second pregnant *C. willardi* (female-2) was observed retreating into loose rock which formed a gradual slope. At 1040 h, about 15 m downhill from first two females, a single exposed (coiled) adult male *C. willardi* (male-1) was observed. At 1105 h, a third female *C. willardi* (female-3) was located on the hillside that was post-partum and was with six neonates. Since no other female was with her, we assumed that the neonates associated with female-3 were her genetic progeny (see Parker et al. 2013. Herpetol. Rev. 43:658–659). The offspring were in close contact with female-3; when we approached, she retreated deeper into the rock shelter and all the neonates followed her (Fig. 1A). Most of the neonates had "blue" eyes, indicating they had not yet undergone their first shed (Greene et al., *op. cit.*). A fourth female (female-4) *C. willardi* was located about 8 m from female-3 and also appeared to be pregnant. She quickly retreated into rocks when approached.



PHOTOS BY BRENDAN P. O'CONNOR

FIG. 1. Maternal care and male behavior of *Crotalus willardi*. (A) Neonates of female-3. Female-3 was present beneath neonates. (B) Male-2 (yellow arrow) that was found in close association with female-2. Note distended body of female, which is indicative of pregnancy. (C) Neonates positioned on top of female-3.

At 1200 h, we returned to check on females 1 and 2, and both were found at their original locations. However, a young, adult male *C. willardi* (male-2) was located coiled next to female-2 (Fig. 1B). The male performed some light courtship acts (head-jerking, tongue-flicking) on female-2. At 1323 h, female-3 and her neonates had shifted toward the surface beneath a palm-sized rock; most of the neonates were coiled on top of female (Fig. 1C).

On several occasions, Greene et al. (*op. cit.*, p. 190) found femae *C. willardi* with their litters in the Huachuca Mountains. Tanner (1985. Great Basin Nat. 45:615–676) reported a female *C. w. silus* with a litter from western Chihuahua, Mexico. Our observations of male *C. willardi* occurring with or nearby pregnant or post-partum females are intriguing. This type of male behavior has been witnessed by us (BPO, BTL) on several other occasions in this species and under similar conditions. Male "visitation behavior" (of pregnant and postpartum female) has been documented in other rattlesnake species (see Holycross and Fawcett 2002. Amer. Midl. Nat. 148:181–184). Genotyping studies are planned for *C. willardi* to better interpret the social behavior of males visiting both pregnant and post-partum females with neonates.

Ryan Sawby kindly prepared the figure.

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***DRYMARCHON COUPERI* (Eastern Indigo Snake). HISTORICAL RELATIVE ABUNDANCE.** *Drymarchon couperi* is one of North America's largest native snake species and has the largest reported home range size of any native snake on the continent (Breininger et al. 2011. J. Herpetol. 45:484–490). *Drymarchon couperi* uses a diverse array of natural and human-altered upland and wetland habitats that varies seasonally, by sex, and by body size (Breininger et al., *op. cit.*). *Drymarchon couperi* is diurnal and is known to consume at least 47 species, individually dominated in descending order by snakes, anurans, rodents, and turtles or their eggs (Stevenson et al. 2010. Southeast. Nat. 9:1–18). As large, wide-ranging, terrestrial apex predators that must feed often to meet energy requirements (Stevenson et al. 2010, *op. cit.*), *D. couperi* may substantially affect the composition and abundance of its prey base, particularly other snake species (Steen et al. 2014. Herpetologica 70:69–76). Here I report that in the mid-1970s *D. couperi* was the most commonly encountered snake species at two coastal sites in Lower Tampa Bay, Florida, USA.

As an environmental consultant, I and others surveyed amphibians and reptiles (diurnal visual encounter surveys, turning surface objects, etc.) and small mammals (live traps) at least monthly (April 1974 through March 1975) at two proposed electric power plant sites owned by Tampa Electric Company. The two sites (Big Bend: 27.7938°N, 82.3990°W, WGS 84; Beacon Key: 27.6654°N, 82.5171°W) were each about 607 ha and located 18.4 km apart. Habitats were similar, consisting of coastal strand and mangroves along Lower Tampa Bay, and transitioning inland into salt pans and black rush marshes, hardwood hammocks, flatwoods, oldfields, and active vegetable fields intermixed with drainage ditches, freshwater marshes, and small ponds. U.S. Hwy 41 bordered both sites on the east and neither contained any internal paved roads. Gopher Tortoises (*Gopherus polyphemus*) were present, but uncommon, at both locations.

During the study a total of 18 snakes of 10 species were collected: 6 *D. couperi*, 3 *Coluber constrictor*, 2 *Crotalus adamanteus*, 2 *Nerodia fasciata*, and 1 specimen each of *Lampropeltis elapsoides*, *Pantherophis alleghaniensis*, *P. guttatus*, *Thamnophis sauritus*, and *Diadophis punctatus*. The six *D. couperi* were 1.03 m, 1.40 m, 1.94 m, 1.98 m, 2.00 m, and 2.11 m in total length, and included three of each sex. Months of capture were November (1), December (2), January (1), and June (2). One snake contained a *Sigmodon hispidus* (Cotton Rat), the most commonly trapped small mammal. *Drymarchon couperi* were observed in coastal strand, hardwood hammock, flatwoods, oldfield, and on a dirt road between cucumber fields, suggesting wide use of available habitats.

Although the sample sizes are small, to my knowledge this is the first reported example of the seemingly numerical dominance of *D. couperi* in a snake faunal assemblage. In 50+ years of snake hunting in Florida, I have no comparable data. However, during this same historic time period, Paul Moler (pers. comm.) received several reports that *D. couperi* were exceedingly common along canal banks in citrus groves near Ft. Pierce, St. Lucie Co., Florida, and Terry Whitaker (pers. comm.) captured more *D. couperi* than any other snake species along canal banks in sugar cane fields near Pahokee, Palm Beach Co., Florida. It is possible that *D. couperi* only reached such high abundance in human-altered habitats, or that their large body size and active diurnal hunting behavior makes them the most detectable snake in such habitats. Given the potentially significant predatory effects of *D. couperi*, these findings have implications for evaluating prey populations in the current, fragmented range of indigo snakes and for the reintroduction of this species into Alabama and North Florida.

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***DRYMOBIUS MARGARITIFERUS* (Speckled Racer). DIET.** The diet of *Drymobius margaritiferus* is known to consist of anurans and their eggs, lizards, reptile eggs, and small mammals (Pérez-Higareda 2007. Serpientes de la Región de los Tuxtlas, Veracruz, México. Guía de Identificación Ilustrada. UNAM, México. 189 pp.; García 1994. Guía de Campo de los Reptiles y Anfibios de la Costa de Jalisco, México. Fun. Ecol. de Cui. AC, IBUNAM, México. 184 pp.), but few anurans have been identified to species. Here we report the first account of a *D. margaritiferus* consuming



FIG. 1. Two *Craugastor occidentalis* recently preyed upon by a *Drymobius margaritiferus*; all of them road-killed shortly thereafter.

Craugastor occidentalis (Taylor's Barking Frog) from the municipality of Cuauhtemoc, Colima, Mexico.

On 16 June 2014, a *D. margaritiferus* was found dead on the Cuauhtemoc–Buenavista freeway in the municipality of Cuauhtemoc, Colima, Mexico (19.291019°N, 103.594888°W, WGS84; elev. 794 m). The snake was still moving and most likely had been hit by a car. Two dead *C. occidentalis* were found right next to the exposed stomach of the snake (Fig. 1). The frogs had different degrees of digestion but they were still complete enough to be identified. The freeway where the snake was found is surrounded by patches of tropical deciduous forest and sugar cane and rice fields.

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***ERYX JACULUS* (Javelin Sand Boa). REPRODUCTION.** *Eryx jaculus* is widely distributed and is known from eastern Europe, Greece, Turkey, Transcaucasia, the Middle East and Africa north of the Sahara (McDiarmid et al. 1999. Snake Species of the World, A Taxonomic and Geographic Reference. Vol. 1, The Herpetologists' League, Washington, D.C. 511 pp.). It is ovoviviparous (Disi et al. 2001. Amphibians and Reptiles of the Hashemite Kingdom of Jordan, An Atlas and Field Guide. Edition Chimaira, Frankfurt am Main, Germany. 408 pp.). There is variation in reports of number of young produced, however, several authors have published a range of 6–20 (Disi et al., *op. cit.*; Sorenson 1988. Bull. Chicago Herpetol. Soc. 23:21–25; Szczerbak 2003. Guide to the Reptiles of the Eastern Palearctic. Krieger Publishing Co., Malabar, Florida. 260 pp.). Bar and Haimovitch (2011. A Field Guide to Reptiles and Amphibians of Israel. Herzilya, Israel. 245 pp.) reported *E. jaculus* parturition occurred in October and November in Israel. In this note I report on a histological examination of *E. jaculus* gonads from Israel in order to ascertain the timing of events of the reproductive cycle.

A sample of 29 *Eryx jaculus* collected in Israel consisting of 7 adult males (mean SVL = 427.1 mm ± 82.7 SD, range = 350–603 mm); 13 adult females (mean SVL = 550.5 mm ± 47.6 SD, range = 493–639 mm); 9 sub-adult females (mean SVL = 436.4 mm ± 35.9 SD, range = 370–473 mm) and deposited in the Natural History Collections of Tel Aviv University (TAUM), Tel Aviv, Israel, was examined. Specimens examined by region were: HaSharon (TAUM 6, 1179, 1675, 2272, 2886, 4069, 8274, 8660, 16761), Jordan Valley (TAUM 4515), Karmel Ridge (TAUM 8), Northern Coastal Plain (TAUM 8661), Northern Negev (TAUM 1414, 1714, 3092, 4532, 9390), Southern Coastal Plain (TAUM 4, 3887, 4573, 4967, 5194, 5937, 16761), Upper Galil (TAUM 14306), Yizreel Valley (TAUM 3, 5, 7, 9). The left testis or ovary was removed, embedded in paraffin and cut into sections of 5 µm. Enlarged ovarian follicles (> 5 mm) were counted. Histology slides were stained with Harris hematoxylin followed by eosin counterstain and were deposited in TAUM.

Three stages were present in the monthly testicular cycle (Table 1): 1) regression, the germinal epithelium in the seminiferous tubules is reduced to a few layers, consisting of spermatogonia and Sertoli cells; 2) recrudescence, there is a proliferation of germ cells for the next period of spermiogenesis. Primary spermatocytes predominate, occasional secondary spermatocytes were noted; 3) spermiogenesis, the lumina of the seminiferous tubules are lined by sperm or metamorphosing spermatids. The period of sperm production occurred in spring-summer (Table 1). This supports the time of mating in the literature for *E. jaculus*: May (Arakelyan et al. 2007. Herpetofauna of Armenia and Nagorno-Karabakh. SSAR, Ithaca, New York. 149 pp.; Valakos et al. 2008. The Amphibians and Reptiles of Greece. Edition Chimaira, Frankfurt am Main, Germany. 463 pp.) or summer (Schleich et al. 1996. Amphibians and Reptiles of North Africa, Biology, Systematics, Field Guide. Koeltz Scientific Publishers, Koenigstein, Germany. 630 pp.). The smallest mature male (spermiogenesis) measured 350 mm SVL (TAUM 2272) and was collected in June.

TABLE 1. Stages in the monthly testicular cycle of 7 adult male *Eryx jaculus* from Israel.

Month	N	Regressed	Recrudescent	Spermiogenesis
February	1	0	1	0
April	1	0	1	0
June	2	0	0	2
July	2	0	0	2
September	1	1	0	0

TABLE 2. Stages in the monthly ovarian cycle of 13 adult female *Eryx jaculus* from Israel. *Follicles were squashed and could not be reliably counted.

Month	N	Quiescent	Enlarged follicles > 5 mm
January	3	2	1
March	2	2	0
May	2	0	2
July	2	2	0
September	1	0	1*
November	1	1	0
December	2	2	0

Two stages were present in the monthly ovarian cycle (Table 2): 1) quiescent, no yolk deposition; 2) enlarged ovarian follicles (> 5 mm). Litters (N = 3) were 6, 9, 10 which to my knowledge, are the first *E. jaculus* litter sizes reported from Israel. The smallest reproductively active female (TAUM 3887) measured 511 mm and was collected in January. One slightly smaller female, SVL = 493 mm (TAUM 1414) was arbitrarily considered to be an adult. Female *E. jaculus* from May and September with enlarged ovarian follicles (Table 2) supports reports in the literature that young are born in summer (Sorenson, *op. cit.;* Lafti 1992. The Snakes of Iran. SSAR, Oxford, Ohio. 159 pp; Stojanov et al. 2011. Die Amphibien und Reptilien Bulgariens, Edition Chimaira, Frankfurt am Main, Germany. 588 pp.; Schleich, *op. cit.*) or autumn (Bar and Haimovitch, *op. cit.*). The presence of four reproductively inactive females of adult size (Table 2), suggests that not every *E. jaculus* female produces young each year. One January female with enlarged follicles (Table 2) suggests it may take as long as six months for an *E. jaculus* female to produce young.

I thank Shai Meiri (TAUM) for permission to examine *E. jaculus*, Erza Maza for facilitating the loan, and the National Collections of Natural History at Tel Aviv University for providing *E. jaculus* for this study.

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***EUTRACHELOPHIS BASSLERI*. COLORATION AND PHOTOGRAPHS IN LIFE.** *Eutrachelophis basssleri* is a recently described species of a new genus belonging to the family Dipsadidae. Currently, *Eutrachelophis* contains three species—*E. bassleri, E. steinbachi*, and an undescribed species—known from the lowland rainforest in western Amazonia (Myers and McDowell 2014. Bull. Am. Mus. Nat. Hist. 385:1–112). Color in life of *E. bassleri* is only known from field notes (Dixon and Soini 1977. The Reptiles of the Upper Amazon Basin, Iquitos Region, Peru II. Crocodilians, Turtles and Snakes. Milwaukee Public Museum, Wisconsin. 154 pp.) that were used in Myers and McDowell (*op. cit*). Here, we publish the first color photograph of a living specimen, an adult male deposited in the herpetological collection of Centro de Ornitología y Biodiversidad (CORBIDI 09224) from the Chambirillo check point at Cordillera Azul National Park (7.069139°S, 76.015333°W, WGS 84; elev. 1122 m), Picota Province, San Martín Department, Peru, collected on 6 May 2011 by P. J. Venegas.

As can be observed in the photographs (Fig. 1), the specimen has a head that is brown dorsally, rostral scale pale brown, loreal region brown, and labial scales white. A triangular postocular white marking forming a ventrolateral stripe connected with the lateral side of neck collar and nape bearing two conspicuous white ocellar markings. Dorsal surface of neck dark brown, from posterior edge of parietals to a thin incomplete white neck collar; first quarter of the body dark green changing to brown up to the tail; dorsolateral lines of dark spots, conspicuous on first quarter of the body becoming vague and disappearing at the tail; and pale dorsolateral flecks from midbody to the tail. Ventral surfaces white becoming yellow from first third of the body to the tail. Iris dark brown with coppery brown coloration on upper region.

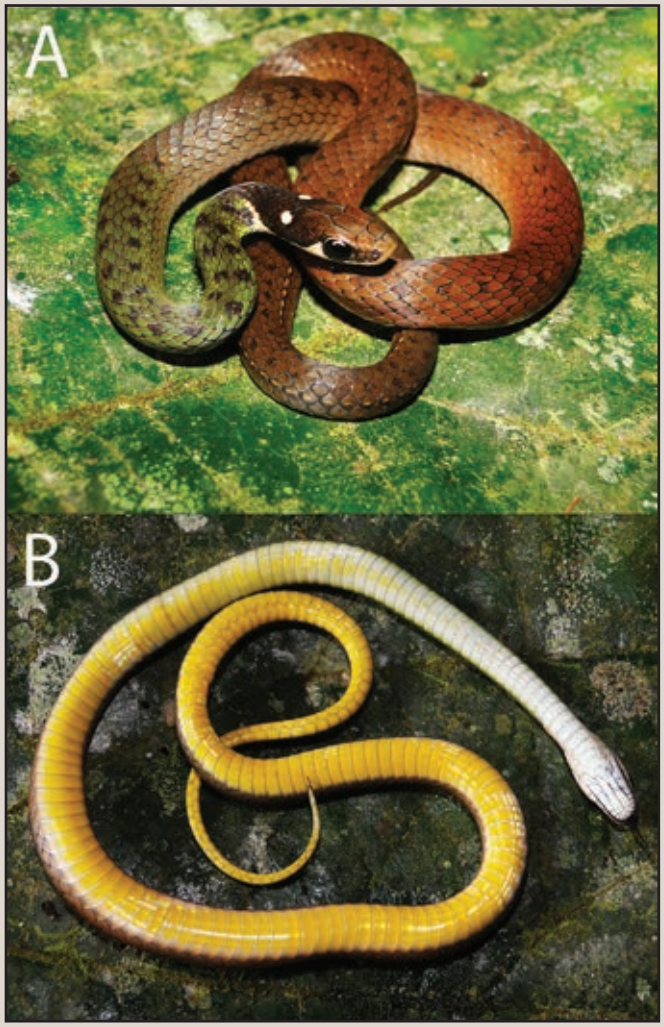


FIG. 1. Dorsolateral and ventral views of *Eutrachelophis bassleri* (CORBIDI 09924), collected at Cordillera Azul National Park, Peru.

This snake was found and photographed thanks to the Servicio Nacional de Áreas Naturales Protegidas por el Estado (SERNANP). We are especially grateful to the rangers P. Saldaña and C. Savedra of SERNANP for their logistic support and company in the field. Fieldwork was supported by a grant from the Mohamed bin Zayed Species Conservation Fund (project number 0925417).

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***FARANCIA ABACURA* (Red-bellied Mudsnake). FEEDING BEHAVIOR.** *Farancia abacura* are semi-aquatic colubrid snakes found in the southeastern United States (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Books, Washington D.C. 668 pp.). Although their diet can consist of frogs and salamanders, *F. abacura* are typically thought to specialize on elongate aquatic salamanders, *Amphiuma* and *Siren* (Guidry 1953. Herpetologica 9:49–56; Gibbons and Semlitsch 1991. Guide to the Reptiles and Amphibians of the Savannah River Site. University of Georgia Press, Athens, Georgia. 131 pp.). Consequently, a feeding event may involve subduing and swallowing prey items that can equal or exceed the snake's body length. Because a prey item equal to the total length of the snake will be approximately 50% longer than the distance from the snake's snout to the end of its stomach (Jackson et al. 2004. Zoology 107:191–200), relatively long prey pose challenges to ingestion and prey storage during digestion. Here we report two observations of feeding behavior that shed light on mechanisms by which *F. abacura* may overcome these challenges.

On the 15 March 2008 at approximately 1330 h, two *F. abacura* were found struggling with an *Amphiuma tridactylum* (Three-toed Amphiuma) at the surface of a large ephemeral pool (ca. 0.5 m deep) at Lake Martin, St. Martin Parish, Louisiana, USA. One snake was biting the amphiuma by the snout while the other snake was biting the tail. While attempting to move the snakes and amphiuma to higher ground for observation, the snake at the tail end of the amphiuma released its hold and escaped. The other snake continued to feed and the event was observed for approximately 2 h in the field before the snake was collected and returned to the lab. The primary mode of prey ingestion appeared to be pterygoid walks with conspicuous lateral movements of the snake's head. Some concertina-like compression and extension of the snake's vertebral column was also observed. When ingestion of the prey item was nearly complete, the Mud Snake regurgitated a significant portion of the meal and immediately began consuming it again. We presume this was to "adjust" the prey, rather than a response to disturbance.

Following the feeding event, the snake (SVL = 675 mm; head width = 14.5 mm) was measured and size of the *A. tridactylum* (total length = 494 mm; diameter = 26.2 mm) was estimated from photographs, yielding an estimated body length ratio of 73% and an ingestion ratio of 180.4% (Greene 1983. Am. Zool. 23:431–441; Jackson et al., *op. cit.*). The following day the snake was x-rayed

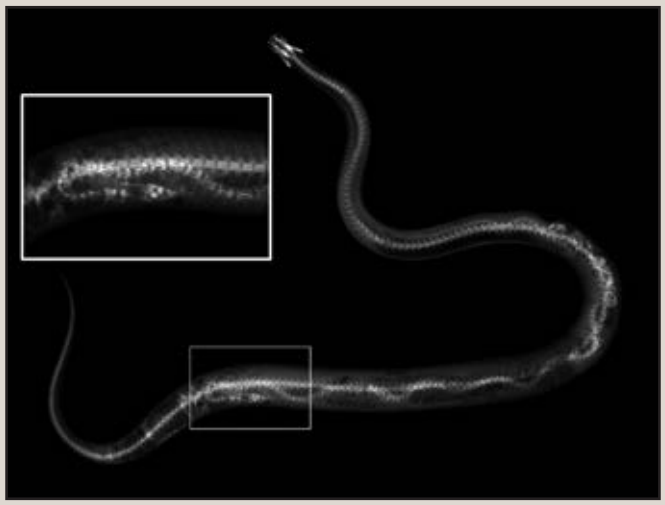


FIG. 1. X-ray of consumed *Amphiuma tridactylum* within the gut of the captured *Farancia abacura*. Note the vertebral waves of the prey item and the hairpin curve near the cervical region.

to examine the orientation of the prey item by Dr. Duane Griggs, DVM, at the Bertrand Drive Animal Hospital in Lafayette, Louisiana. The vertebral column of the amphiuma was compressed into both lateral and horizontal waves with a small hairpin curve in the cervical region (Fig. 1).

On 10 July 2014 at approximately 1000 h, an *F. abacura* (female; SVL = 775 mm; mass = 160.13 g) was captured in a plastic minnow trap set in a floodplain wetland on the U.S. Department of Energy's Savannah River Site, Barnwell Co., South Carolina, USA. At the time of capture, the snake was in the process of swallowing an *Amphiuma means* (Two-toed Amphiuma; SVL = 270 mm; mass = 37.27 g) tail-first. As the *F. abacura* continued swallowing the *A. means* past mid-body, the salamander attempted to bite in defense, but within minutes was completely consumed. Following consumption, the snake was removed from the trap and returned to the laboratory. Approximately 2 h later the snake was processed, which included forcing regurgitation of the prey item. However, regurgitation revealed two surprising results: 1) the *A. means* was still alive, active, and in good body condition; 2) the position of the salamander was now oriented head-first within the snake (i.e., the tail was regurgitated first). Evidently, the position of the *A. means* had completely reversed within the snake's stomach following consumption. It is unclear whether the *A. means* independently changed positions within the snake's stomach or if it was actively manipulated by the *F. abacura* in order to conserve space or facilitate digestion. Nonetheless, folding and compressions of the vertebral column may alleviate some constraints on consuming such long slender prey.

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***FARANCIA ABACURA ABACURA* (Red-bellied Mudsnake). REPRODUCTION / COURTSHIP.** Due to the secretive nature of snakes in the genus *Farancia*, reproductive behavior is rarely observed in the wild and courtship behavior has not been reported (Ernst and Ernst 2003. Snakes of the Unites States and Canada. Smithsonian Press, Washington, D.C. 668 pp.). On 15 June 2013, at 1420 h, I discovered a pair of *Farancia a. abacura* ~2 m off of the New Holland Trail at Mattamuskeet National Wildlife Refuge, Hyde Co., North Carolina, USA. The pair was found in a dry section of Bald Cypress forest approximately 80 m from the marsh edge which still contained water. The pair included a large, thick-bodied individual that I assumed to be female and a smaller individual I assumed to be male based on their behavior (Fig. 1A). The male was biting the female mid-body and twisting himself upside down in what appeared to be an attempt to reposition her. He slowly repeated this behavior for ~30 min (with brief pauses and repositioning of himself), biting the posterior portion of the female's body. He used his biting strategy very gently and she made no to attempt to leave the area. They slowly moved around cypress knees and eventually retreated into a pile of leaves and dried Bald Cypress foliage out of sight. Full copulation was not observed; the female did not appear receptive during my observation of the courtship. The male had ~10 small bulging growths on his tail and just anterior to the vent, which could have impeded his ability to copulate (Fig. 1B).



FIG. 1. Courtship of *Farancia abacura* in North Carolina, USA. A) Male biting the female mid-body and twisting to the point that he was upside-down. B) Unidentified bulges that were present on the male, just anterior to the vent.

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***HETERODON PLATIRHINOS* (Eastern Hog-nosed Snake). PREDATION.** On 21 September 2014, in Carvers Creek State Park (ca. 1.6 km NE Manchester, Cumberland Co., North Carolina, USA; 35.204170°N, 78.975688°W, WGS84), a partially-eaten juvenile *Heterodon platirhinos* was found pinned on a barbed wire fence, presumably by a Loggerhead Shrike (*Lanius ludovicianus*). The actual predation was not observed, but shrikes are well known for pinning prey in such fashion, and the site was known to be within a shrike's territory; one was observed frequenting the



FIG. 1. Juvenile *Heterodon platirhinos* pinned on barbed wire by Loggerhead Shrike (*Lanius ludovicianus*), Cumberland Co., North Carolina, USA.



FIG. 1. Adult male *Lampropeltis extenuata* from Hernando Co., Florida, exhibiting defensive behavior characterized by a sharply cocked head that is rapidly twitched laterally.

immediate area before and after the snake was found. Loggerhead Shrikes are known to prey on small snakes of several species (Clark 2011. Son. Herpetol. 24:20–22). Previously documented avian predators of *H. platirhinos* include various hawks, owls, and crows (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Books, Washington, DC. 668 pp.). To our knowledge, this represents the first published report of predation on *H. platirhinos* by a shrike.

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***LAMPROPELTIS EXTENUATA* (Short-tailed Kingsnake). DEFENSIVE BEHAVIOR.** *Lampropeltis extenuata* is a state-threatened species endemic to Florida, USA, that inhabits xeric upland habitats from Columbia Co. south to Highlands Co. When first encountered in the wild, a *L. extenuata* will often cock its head sharply upwards with its dark chin facing the observer and then twitch it rapidly from side to side (Fig. 1). Sporadic head twitching can last for several minutes, and it can be elicited again when the snake detects movement by the observer. Woolfenden (1962. Copeia 1962:648–649) mentioned that an excited captive *L. extenuata* would occasionally hold its head vertically and jerk it repeatedly to the side. He speculated that this behavior was related to its fossorial habits, because *L. extenuata* burrows into sand by pressing its nose to the substrate and moving its head up and down. However, burrowing and head-jerking motions differ in their speed and orientation. We believe these rapid lateral head movements mimic those of the *Sistrurus miliarius barbouri* (Dusky Pygmy Rattlesnake), which *L. extenuata* resembles in coloration and pattern, although it is much more slender and has a small head approximately the same diameter as its body. We have frequently observed disturbed *S. miliarius* twitching their upward-angled heads, although we could find no mention of this behavior in the literature. We have also observed this head-twitching defensive behavior in wild-caught *L. calligaster occipitolineata* (South Florida Mole Kingsnakes), another Florida endemic taxon that resembles a robust *L. extenuata.*

In 2013–2014, we found 10 juvenile and adult *L. extenuata* on sand roads during the daytime in April, May, October, November, and December in Hernando (N = 9) and Marion (N = 1) counties. Eight of these snakes remained motionless and exhibited head twitching when approached. An adult male (SVL = 450 mm, total length = 495 mm, 8.2 g) that GC observed being attacked by a *Corvus ossifragus* (Fish Crow) on 30 April 2014 at 0945 h in Hernando Co. (28.6247°N, 82.5060°W; WGS 84) crawled rapidly away after the vehicle flushed the bird. Although this snake did not twitch its head initially, it did so once it stopped fleeing.

Lampropeltis extenuata exhibits other defensive behaviors. The lateral head-twitching behavior is sometimes accompanied by spasmodic tail waggling and curling that resembles the caudal luring performed primarily by juvenile *S. miliarius* (Rabatsky and Waterman 2005. Herpetologica 61:87–91). *Sistrurus miliarius* seldom rattles defensively; its diminutive rattle is relatively ineffective as a warning signal because it is readily shed and produces barely audible rattling sounds when intact (Rowe et al. 2002. *In* Schuett et al. [eds.], Biology of the Pit Vipers, pp. 385–404. Eagle Mountain Publishing, Eagle Mountain, Utah). The defensive tail movements of *L. extenuata* do not resemble the rapid, continuous tail vibrations of many nonvenomous snake species that are thought to deflect attention of a predator away from the more vulnerable head (Greene 1988. *In* Gans and Huey [eds.], Biology of the Reptilia, Vol. 16, Ecology B, pp. 1–151. Alan R. Liss, New York). An excited *L. extenuata* often strikes repeatedly, typically with a closed mouth and a short hiss. These rapid strikes are delivered while the anterior portion of the body is S-shaped, and the posterior portion is partially coiled like a spring or stretched out in a series of tight S-curves. The anterior half of the body often leaves the ground during these lunging strikes. Preparatory to striking, a *L. extenuata* may rapidly bob its head vertically instead of laterally. After a period of time in captivity, these defensive behaviors were seldom observed in *L. extenuata*, except for occasional head twitching when startled or being posed for photographs.

The Florida Fish and Wildlife Conservation Commission granted permission to collect information on wild and captive *L. extenuata.*

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***LAMPROPELTIS POLYZONA* (Milksnake). PREDATION.** It is well known that numerous birds prey on snakes. *Buteo jamaicensis* (Red-tailed Hawks) are known to be generalists, preying on a variety of small and medium mammals, some birds and reptiles; *Accipiter cooperi* (Cooper's Hawks) however, prey primarily on birds; *Buteo plagiatus* (Gray Hawks) prey on lizards, insects and small rodents (Dunn and Alderfer [eds.] 2011. Field Guide to the Birds of North America, 6th ed. National Geographic Society, Washington, DC. 576 pp.). Here, we report an account of predation on *Lampropeltis polyzona* involving these three raptor species in the municipality of Xalisco, Nayarit, Mexico.

On 27 February 2014, a juvenile *L. polyzona* was observed being taken from the ground by an *A. cooperi* in the locality of El Pantanal in the municipality of Xalisco, Nayarit, Mexico (21.417950°N, 104.826449°W, WGS84; elev. 922 m). As the Cooper's Hawk flew with its prey, a *B. plagiatus* knocked the snake back down to the ground. A few seconds later, a *B. jamaicensis* swooped down to the ground, picked up the dead snake, and flew off with the prey. The area surrounding the road was tropical secondary vegetation and sugar cane fields.

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***LEPTODEIRA ANNULATA* (Banded Cat-eyed Snake). DIET.** *Leptodeira annulata* is a medium-sized (total length to 600 mm), arboreal, and nocturnal species (Vitt 1996. Herpetol. Nat. Hist. 4:69–76; Ávila and Morais 2007. Herpetol. Rev. 38:278–280), with a wide distribution from Mexico to eastern South America (Duellman 1958. Bull. Am. Mus. Nat. Hist. 5:114–152; Rodrigues 2003. *In* Leal et al. [eds.], Ecologia e Conservacao da Caatinge, pp. 181–236. Ecologia e Conservação da Caatinga, Editora Universitária, Universidade Federal de Pernambuco, Recife, Brazil). The diet is composed mainly of anurans especially those in the families Bufonidae, Hylidae, Leptodactylidae, and Microhylidae (Vitt, *op. cit.*; Cantor and Pizzatto 2008. Herpetol. Rev. 39:462–463). On 29 October 2010, at 2100 h, in Fortuna II farm (9.820056°S, 58.460722°W, WGS 69; elev. 225 m), municipality of Cotriguaçu, state of Mato Grosso, Brazil, we observed an adult *L. annulata* amidst leaf litter ingesting an adult *Leptodactylus mystaceus* (Fig. 1). The frog was caught headfirst, and ingestion took 10 min. Anurans are important prey for a wide variety of vertebrate and invertebrate predators (Toledo et al. 2007. J. Zool. 271:170–177; Oliveira et al. 2013. Herpetol. Notes 6:299–300). Several species of amphibians have been reported as prey of *L. annulata* (Mesquita et al. 2013. Pap. Avul. Zool. 53:99–113; Nascimento et al. 2013. Herpetol. Bras. 2:20–22; Santos-Silva et al. 2014. Herpetol. Notes 7:123–126). Due to their wide distribution and abundance, *Leptodactylus* spp. may represent a significant prey resource for snakes.



FIG. 1. An adult *Leptodeira annulata* preying upon *Leptodactylus mystaceus*, state of Mato Grosso, Brazil.

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***NINIA HUDSONI* (Hudson's Coffee Snake). MAXIMUM SIZE.** *Ninia hudsoni* is a small, leaf litter-inhabiting snake found in the Amazon basin of Ecuador, Peru, and Guyana (Valencia et al. 2009. Herpetozoa 21:190–192). The largest specimen of *N. hudsoni* previously known was 419 mm total length and was collected in Ecuador (Valencia et al., *op. cit.*). On 7 July 2013, I collected a female *N. hudsoni* (Fig. 1) that measured 427 mm total length (SVL = 338 mm; tail length = 89 mm; 21 g). The specimen was found in a pile of wooden boards at approximately 1030 h CST in lower montane secondary forest at Wildsumaco Wildlife Sanctuary in eastern Napo Province, Ecuador (0.68745°S, 77.60076°W, WGS84; elev. 1427 m). The specimen (QCAZ 11991) was deposited in the Museo de Zoologia of the Pontificia Universidad Catolica del Ecuador in Quito.

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FIG. 1. Dorsal view of an extremely large *Ninia hudsoni* (QCAZ 11991) from Napo Province, Ecuador.

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***OPHEODRYS VERNALIS* (Smooth Greensnake). NEST SITE SELECTION.** *Opheodrys vernalis* is a poorly known colubrid with a patchy, largely boreal distribution in the United States (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Press, Washington, D.C. 668 pp.). This snake is considered primarily terrestrial, showing little inclination to climb (Conant and Collins 1998. A Field Guide to Reptiles and Amphibians of Eastern and Central North America. 3rd ed., expanded. Houghton Mifflin Co., Boston, Massachusetts. 616 pp.). Reported nest sites have been limited to terrestrial habitats, such as rotting logs (Cook 1964. Herpetologica 20:206), sandy soils (Fowler 1966. Herpetologica 22:231), grassy fields (Sexton and Claypool 1978. J. Nat. Hist. 12:365–370), and garbage bags (Lawson 1983. Herpetol. Rev. 14:20). Here we report an arboreal oviposition site for *O. vernalis*.

At 920 h on 27 May 2013, in the northwestern part of the Powdermill Nature Reserve, Westmoreland Co., Rector, Pennsylvania, USA (40.163707°N, 79.267080°W, WGS84; elev. 460 m), we captured a gravid female *O. vernalis* (SVL = 35 cm; tail length = 14.5 cm; 6 oviductal eggs) on a tree, emerging from a crevice of decaying bark, 1.5 m above the ground (Fig. 1). At 1020 h on 4 June 2013 the female was recaptured at the same location. Upon recapture, the female was no longer gravid and a clutch of eggs was observed inside the opening in the tree. During release of this individual, a second gravid female *O. vernalis* (SVL = 35.5 cm; tail length = 14 cm; 8 oviductal eggs) was detected in the same crevice of the tree. Neither female was recaptured during subsequent surveys at the site. Yet, a larger assemblage of eggs (> 6) was observed in the tree crevice after the second female was released, likely indicating communal nesting. To avoid disruption of natural embryonic development, the eggs in the tree were not counted or moved.

Communal nesting is common in *Opheodrys* spp. (Graves and Duvall 1995. Herpetol. Monogr. 9:102–119). However, oviposition sites differ between species and likely reflect the arboreal or terrestrial lifestyles of *O. aestivus* (Rough Green Snake) and *O. vernalis*, respectively. Nest sites of *O. aestivus* have been characterized as narrow vertical slits in tree interiors as a result of rotting (Plummer 1990. Herpetologica 46:190–195). The arboreal nesting behavior and nest sites of *O. aestivus* described by Plummer (*op. cit.*) are analogous to our observations of *O. vernalis*. To the best of our knowledge this report represents the first record of an arboreal nest site for *O. vernalis*.



FIG. 1. Gravid female *Opheodrys vernalis*, exhibiting arboreal behavior leading to a previously undocumented nest site for the species, Westmoreland Co., Rector, Pennsylvania, USA.

We thank the staff of the Powdermill Nature Reserve (PNR) and the Carnegie Museum of Natural History, especially the Director of PNR, John W. Wenzel.

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***PTYAS NIGROMARGINATA* (Green Ratsnake). DIET.** Despite the wide geographic range of *Ptyas nigromarginata* and its attention in systematics research (Vogel and Hauser 2013. Asian Herpetol. Res. 4:166–181), very little was known about its natural history. The known diet of *P. nigromarginata* includes only rodents and anurans (Zhao et al. 1998. Fauna Sinica Reptilia Squamata Serpentes. Science Press, Beijing. 522 pp.).

At 1339 h on 3 July 2013, an adult *P. nigromarginata* was observed and photographed swallowing an adult female *Japalura yunnanensis* (Yunnan Mountain Lizard) along a country road near Zhiziluo Village of Fugong County, Nujiang Lisu Autonomous Prefecture, western Yunnan Province, PR China (Fig. 1). The snake fled with the prey in its mouth shortly after the image was taken. This record adds lizards to the natural diet of *P. nigromarginata*.



FIG 1. Adult *Ptyas nigromarginata* swallowing an adult female *Japalura yunnanensis* in Fugong County, western Yunnan, PR China.

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***SISTRURUS CATENATUS* (Massasauga). DIET.** On 20 June 2014 we found a road-killed sub-adult (mass = 22.7 g) female *Sistrurus catenatus* on a sandy access road in Kalkaska Co, Grayling, Michigan, USA. During necropsy, a damselfly (suborder Zygoptera) nymph was discovered in the snake's stomach (T. Cooley, pers. comm.). Given the range of taxa reported as *S. catenatus* prey items, it is apparent that this species is a fairly indiscriminate predator (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Books, Washington, DC. 668 pp.). To our knowledge, this is the first instance any damselfly species has been recorded as part of the diet for *S. catenatus*. The damselfly was the only item in the snake's gut, so it is not likely the result of secondary ingestion. As damselfly nymphs are fully aquatic,

it is especially interesting that a *S. catenatus*, a terrestrial snake, consumed one. However, this species is known to swim and consume other aquatic prey (Ernst and Ernst, *op. cit.*).

We thank the Michigan Department of Military and Veterans Affairs, the Michigan Society of Herpetologists, and the Fort Wayne Children's Zoo for project funding, and Thomas Cooley and collaborators at the Michigan DNR Wildlife Disease Laboratory for necropsy assistance. All research was conducted under a Scientific Collector's permit from the Michigan Department of Natural Resources and an approved Purdue Animal Care and Use Committee protocol.

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***SISTRURUS CATENATUS* (Massasauga). OVERWINTERING SITE.** On 12 April 2014 in Kalkaska Co., Grayling, Michigan, USA, we observed an adult *Sistrurus catenatus* overwintering inside a PVC pipe (pipe length = 152.0 cm, diameter = 5.0 cm). The pipe extended vertically over a meter into the ground, was open on top and the lip protruded 3.0 cm from the ground surface. It had been placed near a known hibernaculum several years ago to allow monitoring of water table depth (Smith 2009. MS Thesis, Purdue Univ., Fort Wayne. 61 pp.). The *S. catenatus* was mostly submerged in groundwater, which was 19.0 cm below the opening of the pipe (Fig. 1). When approached, the snake retreated under the water. While this individual appeared to be alone, it was ca. 3 m from a natural burrow where we observed at least three *S. catenatus* and two *Thamnophis sirtalis sirtalis* (Eastern Gartersnakes) communally overwintering. No telemetered *S. catenatus* had yet emerged from overwintering, and thus it was unlikely that the snake in the tube had moved there recently. When we returned to the location on 26 April 2014, the *S. catenatus* was no longer in the pipe, suggesting it had successfully emerged.

Although several snake species have been previously recorded overwintering in anthropogenic structures (Shoemaker et al. 2009. *In* Mullin and Seigel [eds.], Snakes: Ecology and Conservation, pp. 221–243. Cornell University Press, New York), this is the first time a *S. catenatus* has been recorded overwintering in a PVC pipe. Considering that artificial overwintering site construction may have utility as a conservation strategy, further research employing PVC pipes in a more systematic manner is warranted.



FIG. 1. A *Sistrurus catenatus* overwintering inside a PVC pipe in Kalkaska Co., Michigan, USA.

We thank Kristin Tetzlaff for field assistance and photographs. Funding was provided by the Michigan Department of Military and Veterans Affairs, the Michigan Society of Herpetologists, and the Fort Wayne Children's Zoo. All research was conducted under a Scientific Collector's permit from the Michigan Department of Natural Resources and an approved Purdue Animal Care and Use Committee protocol.

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***SISTRURUS MILIARIUS BARBOURI* (Dusky Pygmy Rattlesnake). ALBINISM.** On 30 June 2014, two amelanistic and three normal phenotype *Sistrurus miliarius barbouri* neonates were observed in a screened-in enclosure behind a building in Lee Co., Florida, USA (Fig. 1). The mother had been observed in the area for a couple of months and was present with her offspring, which had apparently already undergone postnatal ecdysis. On 1 July, a third amelanistic neonate was observed (Fig. 1). The background color of the amelanistic neonates was pale pink, and the dorsal blotches were a pale yellowish orange separated by reddish orange pigment. The snakes were photographed in situ and not disturbed. The equal sex ratio of amelanistic and normal-colored neonates in the litter suggests that the father was amelanistic. Albinism has not been reported in *Sistrurus*, but an amelanistic adult was captured south of Tampa, Pinellas Co., Florida, in 2013 and died in captivity (Paul Moody, pers. comm.).



FIG. 1. Three amelanistic *Sistrurus miliarius barbouri* neonates observed in Lee Co., Florida, USA.

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***TANTILLA SUPRACINCTA* (Banded Centipede Snake). REPRODUCTION.** *Tantilla supracincta* is known from Nicaragua to central Panama, south to western Ecuador (Savage 2002. The Amphibians and Reptiles of Costa Rica, a Herpetofauna Between Two Continents, Between Two Seas. University of Chicago Press, Chicago, Illinois. 934 pp.). Other than being oviparous, the reproductive cycle of *T. supracincta* is unknown (Solórzano 2004. Snakes of Costa Rica, Distribution, Taxonomy and Natural History. Instituto Nacional de Biodiversidad, Santo Domingo de Heredia, Costa Rica. 791 pp.). The purpose of this note is to present the first reproductive data for *T. supracincta*.

Two female *T. supracincta* from Costa Rica were examined from the herpetology collection of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California, USA. One oviductal egg was found in LACM 154396 (SVL = 282 mm) collected November 1974 at the vicinity of Palmar Norte (8.96666°N, 83.46666° W, WGS 84), Puntarenas Province. The right ovary of LACM 154398 (SVL = 252 mm) collected June 1964 at Silencio (10.16500°N, 84.47194°W, WGS 84), Guanacaste Province was removed for histological examination. Histological sections were cut at 5 µm and stained with hematoxylin followed by eosin counterstain. Microscopic examination revealed it had commenced yolk deposition as evidenced by basophilic granules in the ooplasm. The histology slide was deposited in LACM. One is the first reported clutch size for *T. supracincta*.

I thank G. Pauly (LACM) for permission to examine *T. supracincta*.

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***THAMNOPHIS PROXIMUS* (Western Ribbonsnake). REPRODUCTION.** *Thamnophis proximus* ranges from Wisconsin, Indiana, and the Mississippi Valley to Colorado and New Mexico, southward through eastern Mexico to central Costa Rica (Rossman 1970. Cat. Amer. Amphib. Rept. 98.1–98.3). The reproduction of *T. proximus* has been well-studied in North America (Tinkle 1957. Ecology 38:69–77; Clark 1974. Herpetologica 30:372–379) however information on reproduction of this species in Central America is limited. Neill 1962. (Quart. J. Florida Acad. Sci. 25:234–253) reported a litter of six for *T. proximus* (as *T. sauritis rutiloris*) born in July in Belize. In this note I report two litter sizes for *T. proximus* from Nicaragua.

Five female *T. proximus* from Nicaragua were examined from the herpetology collection of the Natural History Museum of Los Angeles County, Los Angeles, California, USA: LACM 21036 (Región Autónoma del Atlántico Norte); 38082 (Managua Department); 38084, 38085 (Jinotega Department); 38089 (Rivas Department). Two females were reproductively active: LACM 21036, collected February 1962 (SVL = 382 mm) contained six enlarging follicles (> 7 mm); LACM 38089, collected November 1966 (SVL = 407 mm) contained eight developing embryos. Ernst and Ernst (2003. Snakes of the United States and Canada. Smithsonian Books, Washington, D.C. 668 pp.) reported parturition in *T. proximus* occurred from late June to early October, with most neonates born from July to early September. The presence of *T. proximus* female reproductive activity in February and November suggests an extended reproductive cycle in Nicaragua in comparison to North America (Tinkle, *op. cit.*; Clark, *op. cit.*).

I thank G. Pauly (LACM) for permission to examine *T. proximus*.

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***THAMNOPHIS SAURITUS SACKENII* (Peninsula Ribbonsnake). DEFENSIVE BEHAVIOR / DEATH FEIGNING.** Death-feigning behavior (thanatosis) is best known in Hog-nosed Snakes (*Heterodon* spp.) but has been reported in other snake genera (Gehlbach 1970. Herpetologica 26:24–34). On 3 February 2015, an adult female *Thamnophis sauritus sackenii* (SVL = 438 mm) was found on a sidewalk in Gainesville, Alachua Co., Florida, USA. When picked up, the snake thrashed vigorously with its mouth open. Approximately 30 sec after being restrained, the snake ceased moving, becoming stiff and unresponsive in a contorted position (Fig. 1). Snakes feigning death typically gape and may extrude their tongues; their limp bodies may be partially or totally supine (inverted) (Gehlbach, *op. cit.*). Death feigning by the *T. sauritus* was unusual in that its mouth remained closed and its body exhibited total rigor when experimentally placed in various positions for ca. 5 min before being placed in a cloth bag. The *T. sauritus* behaved normally when examined 1 h later. During two weeks in captivity, it would thrash with its mouth open when grasped firmly but failed to feign death when I tried replicating the initial capture events. I could find only one report of tonic immobility in *Thamnophis*. When released after handling, some *T. elegans* (Terrestrial Gartersnakes), particularly gravid females, remained immobile, sometimes on their backs, for up to 10 min (Gregory and Gregory 2006. J. Comp. Psychol. 120:262–268). *Natrix natrix* (Grass Snake) is also in the subfamily Natricinae, and 66% of wild-caught specimens feigned death, with the most dramatic cases involving voluntary supination and/or lack of muscle tone (Gregory et al. 2007. J. Comp. Psychol. 121:123–129).



FIG. 1. Death feigning by an adult female *Thamnophis sauritus sackenii* that kept its mouth closed and its body rigid for at least 5 min.

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ADDENDUM—In a recent natural history note concerning the interaction of *Hydrophis platura* (Yellow-bellied Seasnake) with Bottlenose Dolphins (Durso et al. 2015. Herpetol. Rev. 46:104), we overlooked an earlier report of similar behavior involving the same two species (Ineich and Loyer 1998. Bulletin de la Société des Études Océaniennes 276:86). We thank Ivan Ineich for bringing this earlier publication to our attention.

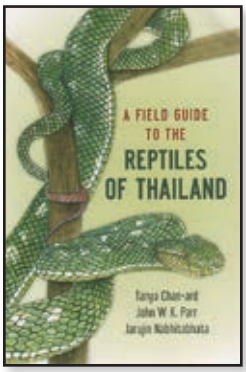
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BOOK REVIEWS

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A Field Guide to the Reptiles of Thailand

Tanya Chan-ard, John W. K. Parr, and Jarujin Nabhitabhata. 2015. Oxford University Press, New York (http://global.oup.com). xxix + 314 pp. Softcover, US $39.95. ISBN 978-0-19-973650-8. Hardcover, US $125.00. ISBN 978-0-19-973649-2.



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During the last two decades the known Thai herpetofauna has much increased due to new species descriptions and to additions of species recorded from neighboring countries, and species are still regularly added today (Kunya et al. 2015; Pauwels et al. 2015; Sumontha et al. 2015). The Thai reptile list is also still going through important taxonomic changes (see the most recent change by David et al. 2015). Under these circumstances, one might wonder if this was the best time to produce a field guide. On the other hand, existing guides on the Thai herpetofauna are really outdated or incomplete (David et al. 2004; Pauwels and David 2005, 2011), and an easily accessible update on the current status of knowledge on the reptiles of Thailand would certainly be good support for further research and conservation management.

This courageous task of compilation has been jointly attempted by three authors. Tanya Chan-ard has dedicated his whole career to the study of the reptiles and amphibians of Thailand, and his field knowledge on these faunas is unrivalled. John Parr is a conservationist with experience in Southeast Asia but is not a herpetologist, hence his participation in such a challenging enterprise is a surprise. Jarujin Nabhitabhata was one of the leaders in herpetological research in Thailand, but he tragically died during minor surgery in 2008 (Chan-ard et al. 2009), i.e., seven years before the guide under discussion here was published.

The guide's size makes it easy to bring in the field, with good quality binding and paper. It is divided into six main parts: an unnamed section (pp. i–xxix) including a glossary and a key to the major groups of Thai reptiles; an introduction (pp. 1–17) containing a history of herpetology in Thailand; a half-page section on physiography; very general sections on habitats (without figures), zoogeography, and conservation; species accounts (pp. 18–298); a selected bibliography (pp. 299–306); an index of scientific names and an index of common names. The authors included keys to genera for most families, and keys to species within each multiple-species genus.

The glossary does not include a number of terms that are used in the identification keys (alveolar rim, amphicoelian, cornified, entoplastron, pentadactyl, pores, precentral scute, pterygoideum, etc.). Some of the glossary's definitions are erroneous or misleading (for example "anal plate" is defined as the "terminal ventral scale or scute" while the drawing on page xxix mentions that the last ventral precedes the anal; "scansorial" is defined as "both arboreal and terrestrial;" "superciliary" is defined as "small scale bordering orbit"). No methodology is provided to explain how to count supralabials, infralabials, lizard midbody scales, etc. There is no distinction made between snake preventrals and ventrals (see drawing p. xxviii). The way shown to measure the plastron length (p. xxv) is erroneous.

The section on the history of herpetology in Thailand is a major disappointment. The guide being co-authored by two Thai herpetologists, one would have hoped to find much information on the contributions by their compatriots. However, after long paragraphs dedicated to the biography of foreign herpetologists, including only information already available in the literature, the single thing said about Thai herpetologists is "currently, there are about 20 Thai nationals with a keen interest in herpetology supported by a network of more than 100 experts in particular field of hepetological [sic] taxonomy"! Not a single word about pioneers such as the late Wirot Nutphand who wrote the first Thai reptile guides and described several taxa including the iconic *Chitra chitra*, Kumthorn Thirakhupt who trained a large part of the current generation of Thai herpetologists, Lawan Chanhome who made significant progress in the study of Thai snake venoms and husbandry, Piboon Jintakune who initiated an important snake reference collection at the Thai Red Cross, Yodchaiy Chuaynkern or Montri Sumontha, to mention a few. There is not even a mention of the fact that Jarujin died in 2008!

The habitats and zoogeography sections of the introduction are very general and make a single reference to reptiles ("turtle") but refer five times to mammals; its seems like these sections have been just copied and pasted from a general guide on Thai mammals. The map showing the Thai provinces is outdated, and Bueng Kan Province, cited in the guide, won't be found on the map.

Within the families, the order of genera seems more or less random, as does the order of species within genera, making it very impractical to find a given taxon. The text for the family Typhlopidae has been placed by mistake in the Sauria section. The introduction to Agamidae tells us that this family includes the genus *Takydromus*!

The key to the major groups of Thai reptiles states that in lizards "the tail is equal to or longer than snout-vent length (unless regenerated);" this obviously does not always apply, for example, to *Dibamus* and some *Isopachys*. The keys to trionychid and skink genera are largely based on osteological characters, inappropriate for a field guide. The key to genera of the Geoemydidae lacks an entry to couplet 4, and the key is partly based on osteological characters. The key to the genus *Malayemys* erroneously states that the front of the upper jaw of *M. subtrijuga* has three vertical lines, while it actually has three pairs of vertical lines. The key to the lizard families erroneously states that all legless skinks have an ear-opening and implies that Anguidae do not. The keys to trionychid genera, agamid genera (*Acanthosaura*, *Calotes*, *Draco*, *Pseudocalotes*), gekkonid genera (*Cnemaspis*, *Cyrtodactylus*, *Dixonius*, *Ptychozoon*), skink genera (*Eutropis*, *Isopachys*, *Scincella*, *Sphenomorphus*), *Dibamus*, *Boiga*, *Oligodon*, Crotalidae, *Disteira*, homalopsid genera, *Asthenodipsas*, etc., contain numerous mistakes regarding character variation, with considerable discrepancies between variation given in the species accounts, variation given in the keys, and characters visible on the drawings. One of many examples is that the character "no gular fold or pouch" leads to *Aphaniotis* in the key to agamid genera, but the species account for *A. fuscus* mentions "the gular pouch is black." The first choice in the agamid genera key is between "body depressed" and "body compressed"—the first leads, after some additional steps, to *Leiolepis*, while the account for that genus states "members of this genus have a compressed body," in complete contradiction with the key. The last point of the key for *Bronchocela* leads to *B. cristellata*, the last point of the key to *Xenochrophis* leads to *X. flavolineatus*, while these two species don't exist. There is no key to snake families nor to colubrid genera. There is no drawing nor definition to explain the peculiar head scales of the scolecophidians, rendering the use of their key very difficult. The key to Hydrophiidae lacks an entry to couplet 11, and does not include the genus *Praescutata*, which is, however, recognized by the authors. The key to *Dendrelaphis* does not include *D. subocularis*, which is, however, included in the guide. These very numerous mistakes and missing keys will make the identification of sea turtles, terrapins, softshell turtles, skinks, and of all snakes particularly challenging. It should be noted that the body lengths of *Laticauda colubrina* and *Trimeresurus sumatranus* are erroneously indicated at 360 cm and 256 cm, respectively.

Relative species' sizes within genera are often inconsistent. For example *Lycodon fasciatus* is said to have a body length of 89.5 cm and be a medium-sized snake, while *L. cardamomensis* is said to have a body length of 89.6 cm and be a small snake. *Oligodon catenatus* is said to have a body length of up to 60.7 cm and to be "one of the larger Kukri snakes," while *O. fasciolatus* is said to have a body length of up to 80.7 cm and to be a "small Kukri snake."

A number of important references cited in the text are not included in the literature section. The literature section includes 156 references (one is listed twice), i.e., only a small part of the existing literature on Thai reptiles. The arrangement of references is not consistent: it is sometimes purely by alphabetical order, sometimes by chronological order within a series of references with the same first author, thus not following strict alphabetical order. The selection of references is mysterious, as many major revisions and herpetofaunal inventories are missing, while many obsolete and insignificant contributions were included, even several publications that deal exclusively with Thai amphibians. The introduction of the guide explains that it "includes species accounts for all of the 352 reptile species currently with confirmed records in Thailand as of December 31, 2010." However, there is only one reference for 2010—the revision of the Thai *Cnemaspis* by Grismer et al., in which seven new species were described, of which only one, *C. narathiwatensis*, was included in the guide! For 2009 there is also only a single reference listed, the description by Bauer et al. of *Cyrtodactylus erythrops*, a species that was, however, not included in the guide! For 2008, the authors listed only five references (not repeated in the literature cited below), including Bauer et al. (2008) who described *Gekko nutaphandi* from Kanchanaburi Province, David et al. (2008) who described *Oligodon pseudotaeniatus* from central Thailand, and Grismer et al. (2008) who described *Cnemaspis biocellata*—but none of these species was included in the guide! The authors also listed Murphy et al. (2008) who rediscovered and redescribed *Parataphinophis praemaxillaris* giving a maximal known snout–vent length of 770 mm, while in the guide it is stated "a very small snake …body length: up to 22.7 cm"! With only two references for 2009 and 2010 combined, and five references for 2008 that have not been integrated in the text, it would thus have been more honest to write that the literature was included until the end of 2007, even if many important references are also missing for that year. The authors gave the number of Thai protected areas "as of December 2008." Thus, there is a gap of about seven years between the finalization of the guide contents and its publication.

The guide is totally outdated regarding snake and lizard classification, having not benefitted from the numerous phylogenies and revisions published in the 2010s. For example, snake genera like *Aplopeltura*, *Pseudoxenodon*, *Sinonatrix* and even *Xenodermus* are still included in the Colubridae in the guide and the anguid *Dopasia gracilis* is still under *Ophisaurus*. The classification used in the guide thus gives an outdated picture of the currently recognized taxonomic diversity of Thai reptiles.

Among the 352 species presented, 22 (ca. 6%) were not illustrated (*Draco haematopogon*, *Sphenomorphus grandisonae*, *S. helenae*, *S. lineopunctulatus* and *S. mimicus*, *Argyrophis roxaneae*, *Indotyphlops ozakiae*, *Lycodon butleri*, *Oligodon jintakunei*, *Acalyptophis peronii*, *Chitulia bituberculata*, *C. inornata* and *C. lamberti*, *Disteira nigrocincta*, *Hydrophis obscurus*, *Microcephalophis cantoris*, *Polyodontognathus caerulescens*, *Thalassophis anomalus*, *Enhydris chanardi*, *Opisthotropis spenceri*, *Xenochrophis punctulatus,* and *Plagiopholis blakewayi*). Drawings vary greatly in quality from one species to another, probably because they were executed by three different artists (there is no indication as to which artist made what drawings). Sometimes several specimens are illustrated for a single species, differing from each other, but as there are no figure captions, one does not know if the differences correspond to age, sexual dimorphism, breeding condition, subspecific or individual variation. The drawings of pitvipers, *Boiga* spp. and cobras are superb and deserve special mention. The drawing for *Cyrtodactylus sumonthai* definitely does not illustrate that species. *Gonyosoma floweri*, a brown morph of *G. oxycephalum* (David et al. 2004), is however recognized as a distinct species in the guide, but illustrated with a drawing of *Orthriophis taeniurus ridleyi*. The drawings of *Gongylosoma longicauda* and *Liopeltis tricolor* have been mixed up, as well as the drawings of *Oligodon joynsoni* and *O. taeniatus*. These are obvious, but there may be others, as there are very numerous discrepancies between the color descriptions in the species accounts and the drawings. In the era of digital photography, drawings should be used only if they offer something more than

photographs, such as accurate scalation outlines or color variations that are not available on photographs.

Species missing in the guide include at least the agamids *Acanthosaura cardamomensis*, *Pseudocalotes kakhienensis,* and *P. khaonanensis*, the gekkonids *Cnemaspis biocellata*, *C. chanardi*, *C. huaseesom*, *C. kamolnorranathi*, *C. niyomwanae*, *C. omari*, *C. punctatonuchalis,* and *C. vandeventeri*, *Cyrtodactylus astrum*, *C. auribalteatus*, *C. doisuthep*, *C. dumnuii*, *C. erythrops*, *C. inthanon*, *C. khelangensis*, *C. kunyai*, *C. lekaguli*, *C. macrotuberculatus*, *C. phuketensis*, *C. ranongensis*, *C. saiyok*, *C. samroiyot*, *C. sanook*, *C. surin,* and *C. wangkulangkulae*, *Gekko lauhachindai* and *G. nutaphandi*, *Hemiphyllodactylus chiangmaiensis,* and *Ptychozoon kaengkrachanense* (see, for example, Grismer et al. 2010, 2012, 2014), the skinks *Jarujinia bipedalis*, *Larutia nubisilvicola*, *Lygosoma angeli,* and *L. frontoparietale* (this last species is in the identification key for the genus, but its species account has been omitted), the colubrids *Dendrelaphis nigroserratus*, *Lycodon ophiophagus*, *Oligodon pseudotaeniatus,* and *Ptyas nigromarginata,* the homalopsids *Cerberus schneiderii* and *Homalopsis mereljcoxi*, the natricids *Amphiesma boulengeri*, *A. leucomystax,* and *Sinonatrix yunnanensis,* and the viperids *Trimeresurus cardamomensis* and *T. phuketensis*. There is no mention of the emydid *Trachemys scripta elegans* and the trionychid *Pelodiscus sinensis*, although both have been abundantly released in the wild in Thailand, and are possibly locally reproducing (Vidthayanon 2005).

Leiolepis ocellata, regarded as a subspecies of *L. belliana* in the guide, was raised to species level by Pauwels and Chimsunchart (2007). Without any justification, a number of subspecies are not recognized in the guide, such as those of *Oreocryptophis porphyraceus*. *Dryocalamus davisonii tungsongensis* is recognized in the guide as a subspecies of *D. subannulatus*, while these taxa had been synonymized in a work coauthored by Tanya Chan-ard (Pauwels et al. 2006). There are many more taxonomic comments that could be made, but this would go far beyond the scope and the space allowed for a book review.

The section "Identification of Reptiles" states that the "international conservation status is provided at the end of each species account," while this section appears in only 44 (12.5%) of the species accounts. For these species this section only mentions the IUCN and/or the CITES category, without any comment, thus not explaining what threats the species face. In some cases the IUCN conservation status attributed has been made up ("Insufficiently Known" p. 23 [presumably "Data Defficient"]). The guide, thus, does not provide any new information on the conservation status of Thai reptiles and does not even present the data already available on the subject, with the exception of the CITES and IUCN listings as they were in 2007.

Based on the available published literature, it is obvious from the first look that more than a fourth of the maps presented in the guide are grossly incomplete or erroneous. There are numerous contradictions between the text and the maps; one among many examples is found in *Batagur borneoensis*, where the text says it inhabits in Peninsular Thailand as far north as Bangkok while the map shows a distribution in Thailand limited to Yala Province.

There are serious mistakes in the behavior and habitat sections within some species accounts. For example *Cyrtodactylus tigroides* is indicated as a cave-dweller (this mistake is also in the identification key for the genus); its common name is even given as "Tiger Cave Gecko." Regarding *Draco blanfordii*, the authors stated "prefers hilly habitats, although young are found at lower elevations." *Leiolepis* are presented as insect-eaters, there is no mention of the fact that their diet also includes plants.

The index to common names is extremely impractical. For example, the Selangor Striped Skink can be found only under "Skink, Striped, Selangor"; there is no entry under Striped or Selangor. In the conservation section of the introduction, the common names for seven species differ from the ones used in their respective species accounts; only the latter names are in the index. In the index to common names, a number of common names differ from the names appearing in the species account, among others the Slender Blind Snake name found in the species account is replaced by the Doi Pui Blind Snake in the index. The common name Malayan Snail-eating Turtle is applied to *Malayemys subtrijuga* in the introduction, and to *M. macrocephala* in its species account; in the latter case it is definitely an inappropriate common name given the species' distribution. Other inappropriate common names include "Tailed Skinks" for *Plestiodon*, "Western Legless Skink" for *Isopachys borealis*, or "Clouded Pit Viper" for *Trimeresurus nebularis*, the two latter being based on misunderstandings of the species' scientific epithets. The common name "Common Softshell Turtle" is given for the genus *Amyda* which contains a single species, but that species receives the name "Asiatic Softshell Turtle," none of these names appear in the index. Throughout the guide there is a disturbing lack of consistency regarding the common names when they are used without the corresponding scientific name, making it often impossible to deduce what species the authors were writing about. The index to scientific names is badly designed, with entries to genera then species within genera, not entries to species, which makes it more difficult for readers who do not know to which genus a species they are looking for currently belongs.

Oxford University Press is to be held responsible as much as the authors for the numerous shortcomings of the guide. Even a very superficial review of the manuscript by a non-specialist would have revealed that the data are seven years old and thus mostly outdated, that mistypings, not limited to scientific names, are numerous (more than 280), that all figure captions are missing, that many of the references cited in the text are not in the bibliography, that 79% of the references in the bibliography are not mentioned in the main text, that some numberings within identification keys are wrong, etc. A slightly more careful review would have shown that even the 2008 status of knowledge on Thai reptiles is not properly reflected in the guide. Because about 50 species from at least seven families are missing, many identification keys are erroneous or obsolete, the taxonomy and the conservation data are outdated and many maps are incomplete or erroneous, and in spite of the obvious efforts the authors have put into the making of this good-looking book, we definitely cannot recommend the use of this guide. We hope that a new, completely revised version will soon be produced.

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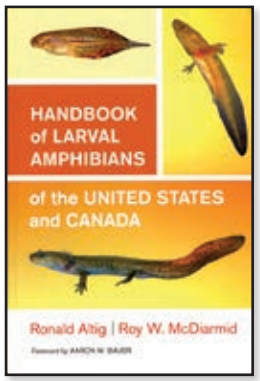
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Handbook of Larval Amphibians of the United States and Canada

Ronald Altig and Roy W. McDiarmid. 2015. Comstock Publishing Associates, Cornell University Press, Ithaca, New York (www.cornellpress.cornell.edu). xvi + 345 pp., 130 illustrations. Hardcover. US $75.00. ISBN 978-0-8014-3943-8.

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One can't help but marvel at a scholar who can stick with a challenging project for close to half a century. In 1970, Ronald Altig published "A key to the tadpoles of the continental United States and Canada" in the journal *Herpetologica*. The key was neither perfect nor complete. Altig was determined to make it better. Now, after 45 years of commitment, his original 27-page paper has expanded into a 368-page book. This volume culminates a productive career and is a profoundly comprehensive work.

Altig's co-author on the book, Roy McDiarmid, has not spent his career so singly focused on amphibian larvae, but has spent much of the last 20 years studying tadpoles. The collective devotion of Altig and McDiarmid was first demonstrated by their important reference book, *Tadpoles: The Biology of Anuran Larvae*, published 16 years ago (McDiarmid and Altig 1999).

Many more species are included in this new book than in Altig's 1970 key. Most of those result from legitimate revisions or discovery of cryptic species. Other species are exotics that now make their home not only in the continental United States, but also in Hawaii.

The title of this book does not do justice to its depth and breadth. For example, it doesn't mention the 40 pages dedicated to a key to the eggs and embryos of amphibians. The book also includes a detailed glossary and a huge literature cited section. Species accounts for all amphibian taxa currently recognized in North America are included, organized by family. Each species account includes information under the headings: Identification, Natural History, Range, and Citations. Within the Citations for each species the references are clustered under the subheadings: General, Development/Morphology, Reproductive Biology, and Ecobehavior. For well-studied species, the accounts fill a page or so largely because of the extensive list of references. For lesser-known species, the accounts run a third to half a page in length.

Illustrations are included for every species that can be visually distinguished from other species. Not only are there photos of the larvae in lateral view, but also photos (and some line drawings) of key body parts, most notably the oral disc of tadpoles. Some accounts include images of the eggs and labial teeth. Habitat shots are included for a few species. All those illustrations are black-and-white, but the book also contains 12 colored plates, each showing 12 species.

Two working principles were used in developing the key to the larvae in this *Handbook*: 1) the keys are not necessarily dichotomous; and 2) to identify the taxa one has to know where

the larvae were collected. Both principles are practical realities of what one must accept to identify amphibian larvae in much of the USA, for there are simply too many taxa that have tadpoles that look alike.

The problem of keying out tadpoles has not become easier since Altig's first effort to construct a key back in 1970. If anything, identifying tadpoles has become even more challenging because many more taxa that are morphologically similar have been identified by molecular methods. Another challenging fact that has been increasingly appreciated over the last decade or two is that amphibian larvae, in particular tadpoles, have considerably more phenotypically plastic morphology than was appreciated in the past (Relyea 2001). Not a lot of attention is given to these problems in the *Handbook*, nor will I linger on them here. Rather, much like the authors, I accept them as unavoidable noise in the system.

Without a doubt my biggest criticism of this book relates to the illustrations. In trying to obtain images of the larva of every taxon, the authors searched widely, and some 70 people are acknowledged for contributing photographs to the project. But sadly most of the black and white photographs are frankly terrible. Presumably some cost constraint and/or production principle required a standardized dull gray background for all the black and white photos. The result is a multitude of dreary, blurry photographs. Collectively, the photographs take the life out of the larvae and the vigor from the volume. I fear that such washed-out images will do little to inspire folks raised in the world of endless amounts of animated color images to want to study tadpoles. It's sad that so much diligence went into this encyclopedic work yet so few of the photographs draw one's attention in a positive way.

It is odd that the authors accepted such poor quality photographs for their book considering that they provide in their *Tadpole* volume a treatise on how to take good photographs of tadpoles. Perhaps the authors were trapped by cost constraints from the publisher to accepting poor quality images. Perhaps they trapped themselves by trying to produce at a relatively low cost a single handbook that covered the larvae of all amphibians in the United States and Canada.

From the practical view of field biology, it is unlikely that many naturalists will ever need to identify tadpoles from across the continent. As such, this single volume could have been split into four or five smaller volumes that covered more restricted geographic regions, such as those identified on the landform map of the United States and Canada provided in this book. That map identifies the broad geographic regions used in the keys. The keys distinguish, for example, whether one is east or west of the Rockies, in the Mississippi Embayment, on the Southeast Coastal Plain, etc. If I were a herpetologist working in any of those regions, I think I would have been happier to buy a guide for the amphibian larvae restricted to my region. I would have been willing to pay $30 or more for the smaller handbook for my region with the understanding that the high price was used to provide high quality photographs and illustrations in the regional guide. The whole set would, of course, be priced much above the $75 that is the list price for this single massive volume. But it could then have included higher quality illustrations and photographs.

Altig and McDiarmid use throughout their *Handbook* the contemporary names for North American taxa following Frost et al. (2006). Thus we have *Lithobates*, *Anaxyrus*, and *Rhinella* rather than *Rana* and *Bufo*. I have no problem with the newer names. But I think that a Handbook as exhaustive as this would have benefited from a table giving both the old and new names. Without that in immediate reach, those new to herpetology and working with older field guides for the adult amphibians, might be slowed down a bit as they assure themselves that what older volumes call *Rana catesbeiana* is indeed *Lithobates catesbeianus*.

Given the many decades it took to compile the massive amount of information in this volume, one cannot realistically expect the co-authors to produce a second edition expanded to include, say, the table just mentioned and, more importantly, better photographs. So this raises the question of how one could build upon this volume to produce a resource that is both more inspirational and more effective as a field guide. In that regard, I hope that the authors, or others following in their footsteps, make an effort to link the book's contents to a website where additional information, particularly better images, could be posted.

The authors, in fact, have a website "Tadpoles of the United States and Canada: A Tutorial and Key" (www.pwrc.usgs.gov/tadpole/) that has many lovely color photographs and a very good primer to help neophyte herpetologists get started in keying out tadpoles. But that website is limited to anuran larvae and the taxonomy is not up to date.

One could envision, though, information in both the *Handbook* and on that website linked to a database like AmphibiaWeb (www.amphibiaweb.org). AmphibiaWeb already includes videos of live animals in the field. Having video of the larvae in the wild would be an aid not just in identifying the larvae, but for gaining a sense of the organisms' behavior and ecology. It is in that field setting, for instance, that one can tell whether a larva's color pattern is cryptic or aposematic. Such information may be accessible from the papers cited in this *Handbook*, but being able to just click on a link that immediately brings up a good video would help bring the information in the *Handbook* into the 21st century.

In truth, when many of us approach a body of water in search for amphibian larvae, we are beginning to identify those organisms before we even see them. We are attentive, for example, to the landscape that we are in, the type of vegetation in the area, how fully canopied the water bodies are; how deep, wide, still or flowing the water is. We are on the lookout for tadpole predators. We are listening for frog calls that may give us a clue as to what species are breeding now or might have bred recently at that site. We use all of that information in a gestalt fashion to predict what tadpoles we might see once we get to look in the water. In a similar way, it would be great if the factual information in this book could be embellished with all that additional information. And it certainly can be done with audio and video tracks accessible via the Internet.

To go one step further, because so much of the ability to distinguish morphologically similar taxa depends on one's location, one can imagine a smartphone app that turns the Altig and McDiarmid encyclopedic volume into a convenient field guide. Right now the book is too big and too reliant on library-based information to fill that role. But one could build that field resource for one's smartphone from information in this book. I can imagine an app that takes into consideration my GPS coordinates, the time of year, the type of aquatic body before me, and perhaps the acoustical environment around me, and then gives me a list of the amphibian larvae that most likely to be in the water before me at that time.

Bird guide apps with this sort of information have been available for some time. The *Handbook* has the core information that one would need to start to build such a useful application.

Writing this review gave me a chance to reconsider where I think tadpole taxonomy is likely to go in the next decade or two. When I consider how difficult it was to identify amphibian larvae in the field back in 1970 and realize that the problem has not gotten any easier with the proliferation of species, I have little faith that greater attention to morphological detail will resolve the problem. I'm optimistic, however, that we will be moving toward the ability to do genetic screening in the field and that will certainly be a help for biologists, who have to know for sure what species they have at hand. As noted in an essay I wrote built around the first book on tadpoles that Drs. McDiarmid and Altig co-produced, tadpoles are typically more numerous than adult anurans and often easier to find and catch (Wassersug 2000). As such, when we get to the point that we can do genetic identification of amphibians in the field, it is as likely that biologists will be getting tissue for testing from larvae as well as adults. In that regard, the app that I have envisioned above may be particularly useful in narrowing down the number of taxa to be considered at any particular site at any particular time.

In sum, this book has an historic feel to it, and, given its prodigious bibliography, can lead one back to pretty much all that is known about the natural history of North American amphibian larvae acquired over the last two-hundred years. It also can be used to build a much more powerful tool for identifying amphibian larvae in the future.

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Fotoatlas der Amphibienlarven Deutschlands

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The last couple of decades have seen an increasing number of high quality guides to the amphibians and reptiles of many parts of this world. Even tadpoles, which have long lingered in comparative obscurity, have recently been the subject of comprehensive, lavishly produced guides (e.g., Channing et al. 2012; Anstis 2013; Ambrogio and Mezzadri 2014). Continuing this trend, Burkhard Thiesmeier has produced a pictorial atlas to the larval amphibians of Germany. Now, compared to other parts of the world, the German amphibian fauna can be considered well known with plenty of guides available. Even for tadpoles a dedicated guide exists that is currently in its eleventh edition (Berninghausen 2012), which leaves the question whether this new book really offers anything new. The answer to that is simple: it absolutely does!

Compared to conventional guidebooks, the pictorial atlas follows a somewhat different concept. It is not so much a standalone guide but is rather meant to supplement other guides to help identify live larvae in the field, although it should be sufficient in most cases. As such, it does not contain much traditional information, for instance labial keratodont formulae of tadpoles are not provided, and the verbal description is limited to just a couple of short paragraphs highlighting the most significant characters observed in living larvae and some pertinent information on size, distribution, or general ecology. The focus is instead on providing detailed photographs and it is here that the book excels. Altogether, more than 500 photographs of consistently very high quality depict larvae at various stages throughout their development, usually covering about ten to twelve different stages per species from hatching to the end of metamorphosis. Often multiple photographs of different specimens of the same stage and/or different views of the same individual are provided. For most species, additional pictures are provided of specimens from different localities or different habitats, which give some idea about the range of natural variation in pigment patterns etc.

The atlas covers all German amphibians, except the viviparous Alpine Salamander (*Salamandra atra*). All species are treated in separate accounts, except *Lissotriton helvetica* and *L. vulgaris*, which are very similar and easily confused. Larvae of these two species are depicted side by side and seeing them this way really highlights the subtle, but distinct, differences between them. One of my favorite illustrations is found here, a plate of sixteen rather charming portraits of larvae of different ages of both species. Some other remarkable pictures include an image of a squirming mass of freshly hatched *Rana temporaria*

tadpoles with exceptionally long external gills, making them almost look like newt larvae, or of *R. arvalis* tadpoles with rather beautiful gold flecking.

Although the book is written in German, there is little text and for these parts it is easy to understand (or to translate), and anyone with a modest command of the language should have no trouble. All covered species are more or less widespread throughout Europe, so this book should be of use not only to herpetologists working in Germany, but well beyond her borders. Furthermore, anyone with an interest in amphibians and their larvae will appreciate this book and enjoy the beautiful photographs.

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Amphibians of Ohio

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When I first received a copy of *Amphibians of Ohio*, the first thing that hit me was the size of this volume. At 916 pages and a mass of over 3.5 kg, this beast certainly won't be accompanying any but the most masochistic of herpetologists in their field pack. With this massive volume, Ohio joins the ranks of states that have been producing quality publications on their native herpetofauna over the last decade that target herpetologists but can also serve the novice herp enthusiast. It has been over a quarter-century since Pfingsten and Downs published the *Salamanders of Ohio* (1989) and nearly 80 years since C. F. Walker's *Amphibians of Ohio. Part I. The Frogs and Toads* (1946). Such a complete and comprehensive guide to Ohio's amphibians has been long overdue.

This book begins with a brief Abstract, Preface, Dedications, Acknowledgements, Editors and Contributors, and a very brief description of the maps. This page also provides a very useful map of Ohio's Lake Erie Islands. As mentioned on this page, included with the volume is a pull-out map of Ohio's townships and counties. This map is also reproduced on the final four pages. The book is then broken down into 12 sections: Introduction, History of Herpetology in Ohio, the Ohio Environment, Amphibian Systematics, Salamanders, Frogs and Toads, Potential Occurrences and Exclusions, Developing Priorities for Conservation of Ohio's Amphibian Diversity, Amphibian Conservation, Ohio Amphibian Distributions, Environmental Applications, and Summary and Outlook. Following these sections are two Appendices, a Glossary, Literature Cited, and finally the Index.

The Introduction is short and comprehensive. Of greatest interest to me were the tables breaking down the exhaustive work conducted by each of the editors over the years that ultimately contributed to this volume. To produce a volume such as *Amphibians of Ohio* takes a massive amount of work and I can't recall seeing a book such as this providing detailed information on the effort put into gathering the data to produce it. I think a great many take for granted the sheer amount of work and dedication it takes to pull off something like this.

Section II reviews the history of herpetology in Ohio, which is quite storied. This includes a short synopsis of how our own international Society for the Study of Amphibians and Reptiles began as The Ohio Herpetological Society. Included as well are contacts for all of Ohio's extant herpetological societies. Given the general decline in herpetological societies over the years, it is nice to see that Ohio still has several up and running.

Section III and its six subsections describe all aspects of the environments in Ohio. These are straightforward, yet detailed enough to provide the reader with more than just the brief overview found in some guides. Section IV covers amphibian systematics. There is also an introduction to the species chapters, which make up the majority of the book.

The next two sections cover salamanders and frogs (Sections V and VI, respectively). Each section begins with a detailed discussion of each order's biology. This portion also includes a key for all species of Ohio salamanders and frogs. Section VI also includes a very detailed discussion on anuran calls. There are written descriptions of each species calls, including the various kinds of call that may be produced (advertisement, aggressive, etc.). There are even sonograms of each species' advertisement call, which is a nice detail missing from many state guides. Then the sections move into the real meat of this tome, the species chapters, of which there are 37. The authors have made every effort to make each chapter as detailed as possible. For example, the chapter on the relatively poorly known Four-toed Salamander (*Hemidactylium scutatum*) by Timothy A. Herman is over 19 pages long. Each chapter also includes a number of quality color photographs, although there are a handful that appear a bit grainy or somewhat pixelated (e.g, Fig. 33-1 C and D, Fig. 33-2, and F33-7). Thankfully, it is a small number of images and detracts little from the overall book.

Section VII includes potential occurrences and exclusions. The one potentially occurring species, the Southern Leopard Frog (*Lithobates sphenocephalus*), is discussed with the same care and within the same format as the regular species chapters. In most state guides, potentially occurring species are covered with little more than a short paragraph. The exclusions were interesting to me as I have not seen a guide that goes out of the way to point out species that do not occur in the state. However, the section makes perfect sense as all of these species live nearby in surrounding states and had been previously claimed as possibly entering Ohio.

Section VIII, titled Developing Priorities for Conservation of Ohio's Amphibian Diversity, is valuable for those wanting to know how species are ranked for research and conservation needs within a state. The methods and materials are laid out

clearly. This is followed by Section IX which discusses conservation of Ohio's amphibians and the threats faced. Section X discusses the distribution of amphibians in Ohio in a contextual way, pointing out the fact that many of the state's amphibians are at periphery of their ranges. Section XI has three subsections discussing amphibians as indicators of wetland quality and using salamanders to classify headwater streams.

Section XII rounds out the book with a summary of what lead to the creation of this book as well as comments on the future of amphibian work in Ohio. The two appendices are very useful, covering field techniques, proper documentation, and preparation of voucher specimens. Included is a photo-documentation form that can be copied and used by those in the field to turn into the Ohio Department of Natural Resources Division of Wildlife. Directions on where to send it, something that many amateur herpers are often unsure of when they make a potentially new observation, are also provided. There are also recommendations for the photo-documentation of each species. Following this are the Glossary and the Literature Cited, which is a whopping 72 pages! In my estimation, this massive reference section is almost worth the price of the book on its own.

If you work with, or have more than a passing interest in, any of the species covered in *Amphibians of Ohio* you would do well to purchase this masterpiece no matter what part of that species' range you are in. Even if you are extralimital, this is a fantastic addition to any herp library. And of course, if you are a herp enthusiast at any level residing in Ohio, this book should definitely be on your bookshelf. You are unlikely to find a better referenced or more thorough treatise on any state's amphibians. What makes *Amphibians of Ohio* even more of a triumph is that while massive and incredibly detailed, it is as accessible to the amateur field herper or naturalist as it is to the most seasoned of herpetologists. *Amphibians of Ohio* is well worth the cost and I eagerly await the upcoming sister volume on the reptiles of Ohio.

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Art in Herpetology

As space and available material permit, we will occasionally publish examples of historical as well as contemporary herpetological art. We welcome the submission of historical material under the following conditions:

- The work should be copyright-free and be provided as a high-resolution digitized file (consult Herpetological Art and Illustration Coordinator or Editor for specifications).
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- Accompanying text should provide information about technique, media, or other information likely to be of interest, especially to other artists. Other details of interest include the source of illustration subject (e.g., scientific name, geographic origin, etc.) or the work (e.g., book publication, etc.) for which the illustration was produced.
- Artists are welcome to include contact information (e.g., email address, website location), as well as indicating whether original art or prints are available for sale or if the artist is available for commissioned work.

Material may be submitted for review to Jackson Shedd, Herpetological Art and Illustration Coordinator at jackson_shedd@sbcglobal.net.

ZOO VIEW

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Studies on Lizards and Tuataras in Zoos and Aquariums. Part I—Introduction, History, Families Iguanidae, Agamidae, Chamaeleonidae, and Infraorder Gekkota

People often ask, "What good are lizards?" to which we respond with "What good are people?" Such anthropocentrism is abhorrent. Lizards have as much of a place on the planet as any living creature, including humans. Indeed, they have successfully inhabited Earth for much longer than humans have – lizards will undoubtedly persist long after humans and most other mammals have gone extinct. Lizards are spectacular products of natural selection and have diversified to fill an amazing variety of ecological niches. They are extremely good "model" organisms for study, and understanding their ecology and diversity can be exceedingly informative. What we have learned about lizards is applicable to nearly every conceptual area in modern biology; indeed, in many cases development of entire fields of biology had their origins in the study of lizards. Because many lizards are quite beautiful, they are very popular as pets among herpetoculturists around the world, and some people make their living by breeding many species of lizards in captivity for resale.

Eric R. Pianka & Laurie J. Vitt,
Lizards: Windows to the Evolution of Diversity, 2003

Curator of herpetology at the New York Zoological Park, Raymond L. Ditmars in his book, *Reptiles of the World* (1933), marveled at the diversity of lizards, "Looking down upon the vast Order now engaging the student's attention, even the most passive of observers cannot refrain from expressing amazement at the array of varied forms. In a subdivision, the *Sauria*, we shall consider creatures twelve feet long, with claws as long as those of a leopard—animals strong and active enough to leap at the throat of a young gazelle, tear, dismember and devour the prey; and passing such we stop to realize that tiny, limbness and worm-like, slow-moving things, burrowing their life away deep in the ground where they need no eyes—in fact, have none—are also true lizards." (Figs. 1, 2)

In this two-part paper, I follow the organizational framework of McDiarmid et al. (2012) as a taxonomic review of extant lizard groups. Part II will appear in the next issue. Original standard and scientific names are used. To update these names, use *The Reptile Database* (Uetz and Hošek 2013) and *Standard English and Scientific Names*: *Checklist of the Standard English Common Names of Amphibians & Reptiles* (Crother 2012) if occurring in North America. A complete reference called *Grzimek's Animal Life Encyclopedia* was published on all reptiles in 2003, with chapters written by experts in herpetology (Hutchins et al. 2003). Some lizard families have been only superficially investigated in zoos: Anguidae, Agamidae, Dibamidae, Amphisbaenidae, Bipedidae, Rhineuridae, Trogonophidae, Lacertidae, Gymnophthalmidae, Teiidae, Cordylidae, and Xantusiidae.

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History

In May 1849, the London Zoo, founded in 1828, opened the first zoo reptile building in the world, a modified carnivorous mammal facility which used the dens as enclosures for lizards and other reptiles (Keeling 1992). The second zoo reptile building at London, designed and constructed specifically for reptiles, was opened in August 1883 (Guillery 1993) and is currently a



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Fig. 1. Chromolithograph from *Kunstformen der Natur* [*Art Forms in Nature*], by Ernst Haeckel (1904).

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FIG. 2. Illustration in Gotthilf Heinrich von Schubert's *Naturgeschichte des Thierreichs. . .*, published in 1869.

tropical bird building today. The newest London Reptile House was designed by curator Joan Beauchamp Procter in 1926–1927 and is still in use. The building included a center island to house venomous snakes and other potentially dangerous reptiles and a "Reptiliary" housing iguanas. New zoo design features were incorporated: differential heating, "Aquarium principle lighting" (illuminating enclosures from above), elaborate naturalistic displays, and better visitor traffic.

Philip Lutley Sclater, Secretary for the Society (1859–1902), compiled nine editions of an inventory ("List of the vertebrated animals now or lately living in the gardens of the Zoological Society of London") beginning in 1862. In 1872, his revised list included tuataras and many lizard taxa such as the Moloch, Bearded Dragon, mastigure (*Uromastyx*), Shingleback Skink and other skinks, several chameleons, as well as lacertids and iguanids to round out the collection. Books on the husbandry of lizards began to appear during the Victorian era in greater numbers (Murphy and McCloud 2010). For instance, A. D. Bartlett (1899) had written *Wild Animals in Captivity Being an Account of the Habits, Food, Management and Treatment of the Beasts and Birds at the 'Zoo,'* which treated the habits of lizards such as the Stump-tailed Skink, Thorny Devil, iguana, and chameleon. These books had a practical application in that private fanciers used the zoo protocols, particularly those from the London Zoo, though it must be stressed that these Victorian fanciers, mostly women, went on to develop many innovative techniques. Later, London Zoo curator E. G. Boulenger published an excellent book with many photographs called *Reptiles and Batrachians* (1914). He included many observations on lizards living in the collection.

Jon Coote (2001) speculated that many reptiles, especially lizards, arrived at the London Zoo in good condition in the nineteenth century because those responsible for transporting them were given specific instructions for their care: "Correspondents should engage some individual of the ship's company to take charge of the animals on board and guarantee him a handsome recompense on bringing them safely to their destination..." Food was also important for reptiles on the long sea journeys and correspondents were advised: "ants eggs, which are abundant in tropical climates, may be preserved in a jar, well tied down and with the addition of the Blattae or cock-roaches so generally obtainable on board in all their stages of growth, and of meal worms, which are equally abundant in the bread room …"

During that time, there was closer cooperation between zoo workers and private herpetoculturists than there is now. Until 1903, keepers at the London Zoo were able to trade or sell surplus animals to the general public and they supplied herps to amateur British herpetoculturists. Reverend Gregory Bateman (1897) purchased a pair of tuatara from the Zoo for £2.00 ($3.00) and other species were offered for sale in London. Prices were reasonable: small monitor lizards—5 shillings (38 cents US), Common Tegus—about £2.00 ($3.00), Red Tegus—£3.00 to £8.00



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PHOTO BY JESSIE COHEN, NATIONAL ZOO

FIG. 3. Two of the rarest lizards in the world are shown here. Top: The Jamaican Land Iguana (*Cyclura collei*) was described by John Edward Gray as Colley's Cyclura in 1845. Illustration from *Catalogue of the specimens of lizards in the collection of the British Museum*. This species was thought to be extinct until rediscovered in 1970. It now faces another threat due to plans to alter the habitat.
BOTTOM: This male Grand Cayman Island Iguana (*Cyclura nubila lewisi*) allows itself to be groomed with a toothbrush by standing immobile as its entire body is brushed.

($4.50 to $12.00) depending upon size, Bearded Dragons—10 shillings to £1.00 (75 cents to $1.50), Green Anoles—as low as half-a-crown (16 cents), European Chameleons—3 shillings and 6 pence to 7 shillings and 6 pence (30 to 65 cents), British Common Lizards—4 to 6 pence each (6 to 9 cents).

Beginning in 1882, Johann von Fischer from Vienna began to publish a large number of papers on captive lizards: Ringed Agama (*Oplurus torquatus*), European Chameleon (*Chamaeleo vulgaris*), Cape Spiny Lizard (*Uromastix capensis auct.*), Stummelschwanz Lizard (*Trachydosaurus asper*), iguana (*Iguana tuberculata*), Cylindrical Lizard (*Gongylus ocellatus*), Pygmy Lateral Fold Lizard (*Ablepharus pannonicus*), Schleuderschwanz (*Uromastix acanthinurus*), Common Skink (*Scincus officinalis*), Spotted Lizard, *Eremias pardalis*), Worm Lizard (*Trogonophis wiegmanni*), and various lacertids. His seminal book on captive management was called *Das Terrarium, seine Bepflanzung und Bevölkerung* (1884) and includes recommendation for many mixed lizard combinations.

Stanley Smyth Flower published monographs and papers on amphibian and reptile longevities. In his 1937 publication, he mentioned that varanids and large iguanids are often kept in captivity but it is surprising that only two lizard taxa had reached twenty years in captivity—Slow-Worm (*Anguis fragilis*) for 32 years and Cunningham's Skink (*Egernia cunninghami*) for 20 years. In North American collections, Snider and Bowler (1992) listed one anguid, one cordylid, three gekkonids, four iguanids, three skincids, one varanid, and a number of helodermatids passing twenty years in captivity. Carey (1973) provided some notable longevity records for captive iguanas.

In the early twentieth century, papers on lizard husbandry and captive management began to regularly appear, written by London Zoo curators such as E. G. Boulenger (1913, 1920) and Joan Proctor (1928) and many European and New World herpetologists (see Card and Murphy 2000, Murphy 2007, 2009–2010 for descriptions). In 1955, an extraordinary four-volume set by Wilhelm Klingelhöffer named *Terrarienkunde* appeared and was THE husbandry reference book for decades in Europe. Toward the end of the century, zoo herpetologists became better at recognizing signs of reproductive and other behaviors and recording these observations in scientific journals. Many books focused on captive lizards: *Lizards in the Terrarium* (Jes 1987), a two-volume work called *Lizards* (Rogner 1997), *Encyclopedia of Terrarium* (Bruins 1999), *Biology, Husbandry, and Medicine of the Green Iguana* (Jacobson 2003), *Vivarium Life* (Leutscher 1952), *Firefly Encyclopedia of the Vivarium* (Alderton 2007), *Reptiles, Amphibians, and Invertebrates* (Bartlett et al. 2001), *Handbuch der Terrarienkunder* (Stettler 1978), *Das Terrarium* (Kahl et al. 1980), two-volume *Die Terrarientiere* (Nietzke 1969, 1972), *Guide to Lizards, All about Lizards,* and *Giant Lizards* (Sprackland 1977, 1992, 2010), *Breeding Terrarium Animals* (Zimmermann 1983), *The Completely Illustrated Atlas of Reptiles and Amphibians for the Terrarium* (Obst et al. 1988), *Reptiles and Amphibians: Their Care and Behavior* (Vogel 1964), and *The Lives of Captive Reptiles* (Petzold 2008). Exciting new possibilities appeared in the literature such as investigating the evolution of social cooperation in lizards (Dickinson and Koenig 2003; Sinervo and Clobert 2003) and manipulating clutch and offspring size (Sinervo 1994). Ethologists and other researchers from the academic community began working jointly with zoo colleagues on projects in zoos and aquariums, resulting in improved studies (see Sajdak 1983; Chiszar et al. 1993; Chiszar and Smith 2005; Garrett 2005 for reviews). Reviews focusing on the nutrition of carnivorous and herbivorous lizards were published (Allen and Oftedal 1994; Baer 1994). David Crews and Leslie Garrick (1980) provided many examples for inducing lizards to reproduce in captivity. In the United States, researchers such as Gordon Burghardt, Charles Carpenter, David Chiszar, William Cooper Jr., Gary Ferguson, William Gehrmann, James Gillingham, Harry Greene, Thomas Jenssen, Hobart Smith, and Paul Weldon, were pioneers who used zoo and aquarium collections to broaden their studies. William Cooper Jr. has used zoo collections as a resource for his studies on lizard feeding behavior for many years. Examples include varanoid lizards (*Heloderma suspectum* and *Varanus exanthematicus*), geckos (*Rhacodactylus*), and skinks (*Tiliqua scincoides* and *Trachydosaurus rugosus*). Susan Barnard from Zoo Atlanta and her associates have published a number of papers on parasitism and husbandry in zoo lizards (see Murphy 2007). Backues and Ramsey (1994) performed an ovariectomy for treatment of follicular stasis in lizards. Two important overviews by Stamps (1997) and Fox et al. (2003) examined social behavior and spacing patterns in lizards.

The late Thomas Huff from Reptile Breeding Foundation in Canada identified a condition that he called "captive stagnancy." He believed that changing environmental factors was key to improving reproductive behavior and his solution was to change exhibit furniture, potential breeders, temperature, and so on to induce courtship and copulation (see Huff 1980). Warwick et al. (1995) addressed the issue of stress. Methods for egg incubation and raising neonates became more refined (see Packard and Phillips 1994). Earlier, reptile eggs were discarded in many instances because it was believed that hatching them was impossible. The importance and provision of ultraviolet light for reptiles held in indoor enclosures were highlighted in key papers by Gary Ferguson and associates (1996; Jones et al. 1996), William Gehrmann (1971, 1987, 1994), Carol Townsend (1979) and Townsend and Charles Cole (1985), and Jozsef Laszlo (Murphy 2007). Philip Regal (1980) examined temperature and light requirements. From Toledo Zoo, R. Andrew Odum (1984) stressed the importance of water quality.

Lawson et al. (2008) stressed the importance of science in zoos and aquariums. Dave Chiszar, Hobart Smith, and I argued that assessing the competence of captive-produced herps is as important as breeding the animals (Chiszar et al. 1993). We were surprised to discover that captive and wild Komodo Dragons have significantly different body temperatures (Wikramanayake et al. 1999; Walsh et al. 1999). If released into the wild, would captives with lower temperatures adjust thermoregulatory patterns upward? If deficits brought on by captivity are identified, can these be remediated? How can this be done? What necessary studies will be in place to assess survivability in the wild? These challenging issues have only been minimally addressed but there are some impressive exceptions: West Indian iguanas (*Cyclura*) serve as examples of successful field studies and reintroductions.

Family Iguanidae.—West Indian Land Iguanas (*Cyclura*) face a perilous future. Jeffrey Lemm and Allison Alberts from San Diego Zoo Global in California have worked for many years with these iguanid lizards. Their recent comprehensive book (Lemm and Alberts 2012) covers evolution and biogeography, species accounts, natural history, husbandry, nutrition, health and medical management, and conservation. The San Diego Zoo has been an integral player in iguana research and conservation over many years through publication of books and papers by Alberts and colleagues.

The Jamaican Land Iguana (*Cyclura collei*) was described by John Edward Gray as Colley's Cyclura in 1845 (Fig. 3). Four years later, one was donated to London Zoo and lived in the Zoo for 3 years, 4 months, and 29 days (Coote 2001). Concern about the iguana's future accelerated following the introduction of the Indian Mongoose on Jamaica in 1872 and things were critical by 1916 when this iguana was only found on a few small islets off the coast of Jamaica where the predaceous mongoose had not been introduced. In 1940, a total of 22 specimens were brought into captivity to try to save the species from extinction but none ever reproduced. The lizard was later thought to be extinct. A hunter's dog discovered a carcass in 1970 and a later survey located about 100 lizards left in the wild in the Hellshire Hills. There is now a headstarting program at the Hope Zoo in Kingston, which involves other zoos as well (Gibson 1993; Vogel et al. 1996). However, today there exists a sizeable threat to irrevocably develop the Hellshire Hills, the only place where the lizard is found.

The Grand Cayman Blue Iguana (*Cyclura nubila lewisi*) is one of the most critically endangered rock iguanas and Fred Burton (2000) mentioned that perhaps only a few hundred individuals



ILLUSTRATION FROM WILLIAM BEEBE'S *GALAPAGOS: WORLD'S END* (1924)

FIG. 4. Curator Perkins from San Diego Zoo moved 60 Galápagos Land Iguanas (*Conolophus subcristatus*) from Baltra Island, (known also as South Seymour Island) to North Seymour Island, which contained no iguanas in the 1940s. Had this not been done, this species would now be extinct, thanks to human activities. See text.

remained in 2000. Two years later, the population crashed precipitously and only 15–25 lizards were left. In 2003, five iguanas were hatched at the Indianapolis Zoo and two more lizards two years later. Described in 1940, the lizard was widely distributed in dry habitats over most of the island but is now restricted to a few remnant populations, due to human development, feral animals, and habitat destruction. Be sure to read Burton's *Little Blue Book* (2010) about the challenges of conserving this species. He highlights the contribution by retired National Zoo curator Dale Marcellini in developing the conservation strategy. Marcellini suggested to me on many occasions that fieldwork should always be planned in a place where one could sit on the veranda of a four-star hotel with a refreshing drink in hand and watch lizards with binoculars—Dale called this plan "Resort Research"! Another amazing field account was written by Quentin Bloxam, who nearly died while working on conserving this taxon on Grand Cayman Island (see Murphy 2007:63). Sarah Kuppert (2013) described interactive male and female head bob displays at Smithsonian National Zoological Park (SNZP). This adult male allowed itself to be groomed with a toothbrush by standing immobile to allow its entire body to be brushed. The keeper pulled off dried skin by spraying these areas beforehand with water (Fig. 3).

Noegel (1989) reproduced five species of West Indian rock iguanas (*Cyclura*) at the Life Fellowship Bird Sanctuary, Seffner, Florida. Duval and Christie (1990) outlined care for the Cuban Ground Iguana (*Cyclura n. nubila*), based on their experiences at the Indianapolis Zoo. The reproductive biology of Cuban Rock Iguanas (*C. nubila*) has been covered in detail at San Diego Zoo (Shaw 1954; Alberts 1995, 2002; Alberts et al. 1997) and Prague Zoo (Rehák and Král 1993; Rehák 1994, 1995 [1997]; Rehák and Velenský 1997, 2001). Haast (1969) hatched Rhinoceros Iguanas (*C. cornuta*) at the Miami Serpentarium and Rehák (1996)

documented the first captive breeding of the Rhinoceros Iguana in the Czech Republic. In two papers, Boylan (1984, 1985) described captive management of a population at the Taronga Zoo, Sydney, Australia and Petzold (1967) at Tierpark Berlin. Ottenwalder (1980) mentioned that Zoodom released rhino iguanas into the wild and described reproduction in captivity (Sanlley Castro and Duval 1979). Charles Knapp from the Department of Conservation at the John G. Shedd Aquarium in Chicago has published field studies on several West Indian iguanas (Knapp et al. 1999; Knapp 2000, 2001; Knapp and Malone 2003;). Duval (1982) offered suggestions for the captive management of West Indian rock iguanas. Bosch (1991) discussed ground iguanas (*Cyclura cychlura figginsi*) in the Löbbecke Museum (Dusseldorf). See also Bosch and Boscheinen (2001). Murphy (1969) described conspecific grooming behavior in this species.

C. B. "Si" Perkins, Curator of Reptiles at San Diego Zoo, and G. Allan Hancock mounted trips in 1932 and 1933 to the Galápagos Islands to study and collect animals for the Zoo (see Banning 1933 for additional information). Hancock's ship was the state-of-the-art Valero III, nearly 200 feet in length. He was a bit of a prig, insisting that his fellow passengers—a group of scientists including Perkins—dress for dinner and moreover, cease smoking and drinking. For those of us who are not focused on the latest in apparel and enjoy a bit of whisky and strong cigarettes in the evening, this trip would have been unendurable. The notation "No cocktails tonight" appeared daily in the Perkins diaries (Campbell 1978).

During the first trip, Hancock and Perkins decided to move 40 Galápagos Land Iguanas (*Conolophus subcristatus*; Fig. 4.) from Baltra Island (known also as South Seymour Island) to North Seymour Island which contained no iguanas. As Perkins wrote in his diaries, their reason: ". . . in a few years come down and see if anything has happened. A good idea, I believe." (Campbell 1978). Twenty more iguanas were translocated on the second trip.

Baltra was an American airbase during World War II in the 1940s and several thousand military and support personnel were stationed there, in part to guard the Panama Canal. Several factors contributed to the disappearance of these lizards—habitat destruction, introduction of feral animals, and using the lizards for target practice.

There appeared to be virtually no successful reproduction or recruitment on North Seymour for the subsequent 47 years so a pair of adults was brought to the Charles Darwin Research Center on Santa Cruz Island to begin a captive colony; additional iguanas were included in this potential breeding group later (Cayot et al. 1994). These iguanas reproduced and survived, particularly because feral cats and dogs had been reduced on Baltra. In June 1991, 35 five-year old iguanas were repatriated to Baltra and 24 were released the next year. This head-starting program was truly an accomplishment deserving praise, thanks to Perkins and Hancock.

Ray Pawley from Chicago Zoological Park (Brookfield Zoo) maintained a colony of Marine Iguanas (*Amblyrhynchos cristatus*) in a large exhibit in the reptile building (1965, 1966, 1969, 1971). I visited the Zoo on a number of occasions and was impressed by the overall health and activity of these lizards. This species is challenging to maintain successfully in captivity but one of his saurians lived for over six years.

Dennis Desmond told me that his adult female Green Iguana (*Iguana iguana*) would sleep with a furry toy virtually every night and the lizard often wrapped its forelimbs around this unusual object (see photo in Murphy 2007). Dedekind (1977) recorded his observations made during hatching and raising of a Green Iguana in the Berlin Tierpark (Fig. 5.). Mendelssohn (1980) provided recommendations on care, based on reproduction in a colony at Tel Aviv University in Israel. Howard (1980) bred them at the Twycross Zoo and Banks (1984) at Melbourne Zoo. Wallach (1966) described hypervitaminosis D in Green Iguanas. Bosch and Werning (1996) discussed the captive management of Green Iguanas and other iguanids. Wallach and Hoessle (1968) documented fibrous osteodystrophy in Green Iguanas. Zwart and Van de Watering (1969) described pathology and etiology of abnormal bone formation in this species. The reproductive biology of Green (*Iguana*) and Desert (*Dipsosaurus*) iguanas has received attention (Judd et al. 1976). Day et al. (2000) provided a species account of the Lesser Antillean Iguana (*Iguana delicatissima*). Bosch and Werning (1996) wrote a manual on iguana care.

Arnett (1979) reproduced the Fiji Banded Iguana (*Brachylophus fasciatus*) at Knoxville Zoo and over 100 young have been produced at San Diego Zoo (Fig. 6.). In 2008, a new species was described (*B. bulabula*) and a breeding program has been initiated by San Diego Zoo. Boylan (1989) bred the Fijian Crested Iguana (*B. vitiensis*) at Taronga Zoo in Sydney, Australia. Carpenter and Murphy (1978) noticed aggressive behavior and color change between males in the Fiji Island Iguana at Dallas Zoo.

Marcellini and Jenssen (1991) documented avoidance learning by the Curly-tailed Lizard (*Leiocephalus schreibersi*). Petzold (1962) successfully bred the Northern Curly-tailed Lizard (*Leiocephalus carinatus*) at Berlin Tierpark. Gibson and Buley (1996) described captive management and breeding of Madagascar Spiny Iguanas (*Oplurus c. cuvieri*) at Durrell Wildlife Conservation Trust. Vogel (1992) outlined care and breeding of the Serrated Casque-headed Iguana (*Laemanctus serratus*) over several generations in the Exotarium of Frankfurt Zoo. At Dallas Zoo, we received a group of lizards confiscated by U.S. Fish & Wildlife Service, which included Casque-headed Iguanas (*Laemanctus longipes*), Smooth-helmeted Iguanas (*Corytophanes cristatus*), Hernandez Smooth-helmeted Iguanas (*Corytophanes hernandesii),* Common Monkey Lizards (*Polychrus marmoratus*) (Fig. 7), and Tree Runners (*Plica plica*). All but the last taxon was kept at ca. 72°F (22°C) ambient temperature with a basking spot. A colleague told me that he found a Smooth-helmeted Iguana resting on a tree trunk in the field and did not move for over a week until a large beetle passed by. At Dallas Zoo, a group of Baja California Rock Lizards (*Petrosaurus thalassinus)* and Banded Rock Lizards (*P. mearnsi*) were displayed in a large enclosure (Fig. 8). These lizards were hardy and constantly active. Bayard Brattstrom visited and suggested that we arrange two hotspots above two platforms where these lizards would learn to shuttle back and forth between them. A timer would be used for tripping a relay switch to turn one or the other off; both would not be on simultaneously. An intriguing display showing shuttling thermoregulation (see Regal 1980:83 for another view) but we never got around to doing it.

Reproduction and behavior of the Green Crested Basilisk (*Basiliscus plumifrons*) were described by Pawley (1972) at Brookfield Zoo, Blake and Stewart (1980) at Edinburgh Zoo, Olexa (1976) at Prague Zoo, and Banks (1983) at Melbourne Zoo. Kuppert (2013) recorded head bob displays at National Zoo. Stunkard and Gandal (1966) identified a digenetic trematode, *Parahaplometroides basiliscae* from the mouth of a basilisk at New York Zoological Park. At Dallas Zoo, a mixed exhibit of Common Basilisks (*Basiliscus basiliscus*), Western Basilisks (*B. galeritus*), and Brown Basilisks (*B. vittatus*) were visible to the visitor

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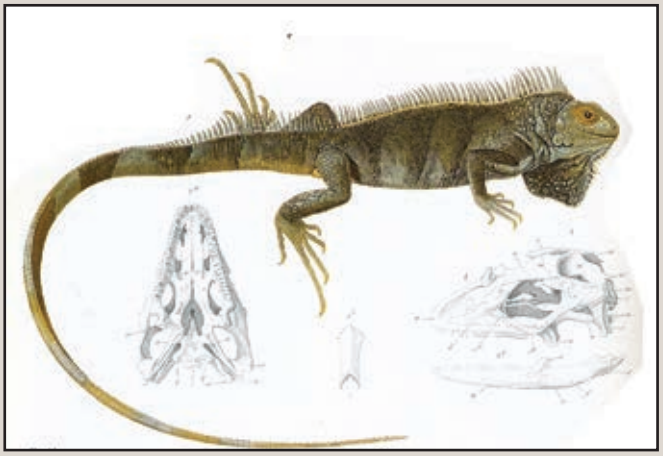


FIG. 5. Illustration of Common or Green Iguana (*Iguana iguana*) in Baron Georges Cuvier's *Le règne animal…*, published in 1836–9. An adult female slept with a furry toy virtually every night and the lizard often wrapped its forelimbs around this unusual object.



FIG. 6. The Fiji Island Iguana (*Brachylophus fasciatus*) here pictured in "Proceedings of Scientific Meetings of the London Zoological Society" is certainly impressive but it is at risk due to human factors. The San Diego Zoo is playing a significant role in developing captive assurance colonies.

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FIG. 7. Illustration of Common Monkey Lizard (top right) (*Polychrus marmoratus*) by H. R. Schinz (1833), *Naturgeschichte und Abbildungen der Reptilien*. I saw one in the wild in Guyana and it was virtually invisible in a bush. It remained immobile when I reached for it and only moved when I grasped it.

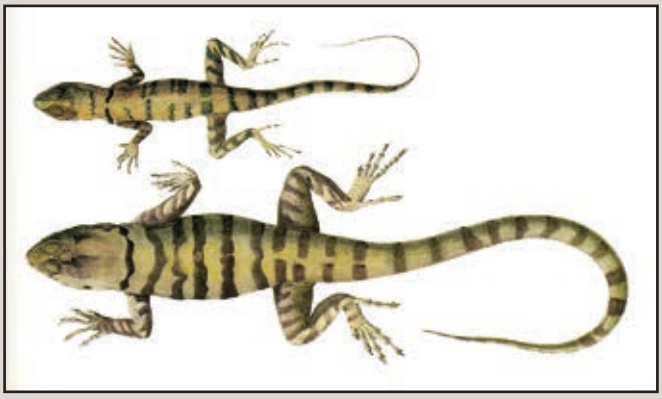


FIG. 8. Illustration of Baja California Rock Lizard (*Petrosaurus thalassinus*) and Banded Rock Lizard (*P. mearnsi*) [above] from *Nouvelles archives du Muséum d'histoire naturelle de Paris,* 1865–1908. An interesting exhibit using these lizards could be developed to show shuttling thermoregulation. See text.



FIG. 9. There are beautiful images in "Proceedings of Scientific Meetings of the London Zoological Society" between 1861–1929. An adult male Frilled Lizard (*Chlamydosaurus kingi*) from Australia flared its frill with open mouth, stood bipedally, made a series of grunts and rushed toward the keeper at Dallas Zoo. New employees found this display to be unsettling when witnessed the first time and, of course, were never forewarned by their perverse co-workers.

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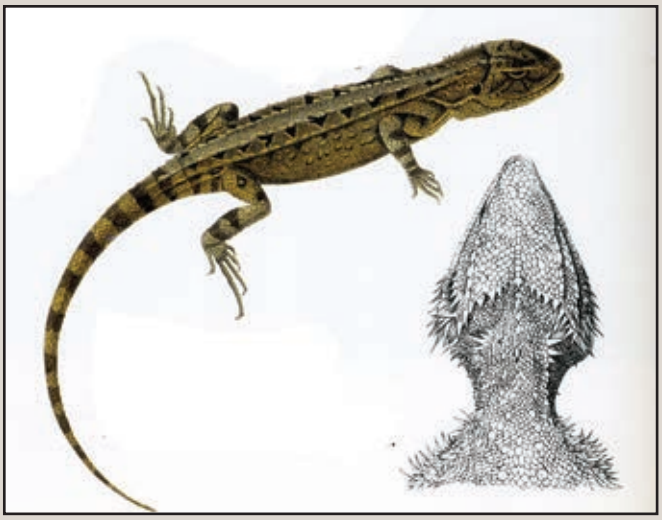


FIG. 10. Illustration of Bearded Dragon (*Pogona barbata*) in Baron Georges Cuvier's *Le règne animal…*, published in 1836–1839. This lizard is hardy in captivity and is highly variable in color.

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FIG. 11. Illustration of Egyptian Spiny-tailed Lizard (*Uromastyx aegyptius*) in Baron Georges Cuvier's *Le règne animal…*, published in 1836–9. The Oklahoma City Zoo was successful at keeping members of this genus in large enclosures with a sandy substrate and high temperatures.



FIG. 12. A small group of Common Flying Lizards (*Draco volans*) was kept at Dallas Zoo where males regularly displayed to each other by extending dewlaps and partially extending wings, and bobbing the body. This illustration represents a different species (*D. lineatus*) but is included to show the head and body of this unique lizard. Publications of London Zoological Society between 1860–1921 had beautiful lizard illustrations such as Flying Lizards (*Draco*). To see a complete list of all amphibians and reptiles, consult *Transactions of the Zoological Society of London: an index to the artists, 1835–1936*, compiled by Nina J. Root and Bryan R. Johnson, and *Proceedings of the Zoological Society of London: an index to the artists, 1848–1900*, compiled by Nina J. Root and Bryan R. Johnson (1986).

when entering the reptile building. The enclosure was large and high; the lizards were active, climbing branches and the rock façade.

At Dallas Zoo, a number of beautiful *Sceloporus* were kept over the years: Adler's Spiny Lizard (*S. adleri*), Yarrow's Spiny Lizard (*S. jarrovii*), Mexican Emerald Spiny Lizard (*S. formosus*), Blue Spiny Lizard (*S. serrifer cyanogenys*), Crevice Swift (*S. torquatus*), Crevice Spiny Lizard (*S. poinsettii*), and Eastern Fence Lizard (*S. undulatus*). Brasfield et al. (2008) examined reproductive and thyroid hormone profiles after a period of brumation and Rich and Talent (2008) recorded the effects of prey species on food conversion efficiency and growth in the Western Fence Lizard (*S. occidentalis*). The Coachella Valley Fringe-toed Lizard (*Uma inornata*) and Colorado Desert Fringe-toed Lizard (*U. notata*) were maintained in a large outdoor exhibit with an extensive sandy area. The lizards were removed to an indoor holding area in the winter. Foster et al. (2015) maintained and reproduced the Yuman Fringe-toed Lizard (*U. rufopunctatus*) at Phoenix Zoo. In central Texas, semi-arid places with limestone ledges and slabs called Texas holey rock (popular in cichlid aquaria) have the most beautiful male Eastern Collared Lizards (*Crotaphytus collaris*) which were kept on display at Dallas Zoo. The Reticulated Collared Lizard (*C. reticulatus*) from the Rio Grande Valley in south Texas was also exhibited. Both species fed well on small lizards (*Uta, Urosaurus, Sceloporus*) and insects. I was surprised when a cage mate (*Sceloporus serrifer cyanogenys*) larger than the Eastern Collared Lizard had been killed and swallowed, later to be regurgitated after being partially digested. This predaceous saurian reminded me of a miniature *Tyrannosaurus rex*.

In 1890 and 1897, three specimens of Ditmars' Horned Lizard (*Phrynosoma ditmarsi*) were collected somewhere near the United States–Mexican border but the site was not recorded. The first lizard was deposited in the collection of the American Museum of Natural History in New York. The second and third specimens were donated to Raymond L. Ditmars who was able to observe one for about a year until it died (Ditmars 1951). Both were preserved and sent to Leonhard Stejneger at United States National Museum in Washington, DC. Stejneger described the lizard in honor of Ditmars (Stejneger 1906). No additional specimens were found alive until 1970. In a brilliant plan to discover the lizards' location, two of the preserved lizards' stomachs were examined, and insect remnants, plant fragments, and small pebbles were saved and sent to specialists for identification and a possible locale was pinpointed, based on known distributions of these animal, vegetable, and mineral clues. With this additional information, Ditmars' Horned Lizard was rediscovered. To pursue this amazing story, consult Ditmars (1951), Roth (1971, 1997), Lowe et al. (1971), Montanucci (1989), and Sherbrooke et al. (1998). Montanucci (1984, 1989) outlined breeding, captive care, and longevity of the Short-horned Lizard (*P. douglassi*) and Ditmars' Horned Lizard. In 2005, the Texas Horned Lizard (*P. cornutum*) reproduced at Fort Worth Zoo.

Lawler et al. (1994) outlined the ecological and nutritional management and Densmore et al. (1994) described a molecular approach for determining genetic variation in captive and natural populations of the Piebald Chuckwalla (*Sauromalus varius*) at Arizona-Sonora Desert Museum. Lawler and Jarchow (1986) presented a captive management plan, At Metro Toronto Zoo, Barker and Cranfield (1988/1989) identified *Schellackia* (*Lainsonia*) sp. in chuckwallas. Aucone et al. (2003) compared two artificial ultraviolet light sources used for Chuckwalla (*S. obesus*, now *S. ater*) husbandry.

Gamble et al. (1996) investigated plasma Itraconazole pharmacokinetics in spiny lizards (*Sceloporus* spp.) at Dallas Zoo. A number of spiny lizards, chuckwallas, and other southwestern U.S. desert lizards were kept in a large outdoor exhibit with a sizeable hibernaculum and rocky crevices. The herbivorous chuckwallas were fed fruits and vegetables in large metal trays, attracting a number of hymenopterans. Granite Spiny Lizards (*S. orcutti*) would congregate around the trays, carefully snatch the insects at mid-body and immediately and violently bang them against the rocks. I watched hundreds of feeding episodes and as far as I could tell, no lizard was ever stung. Keeper Mark Doles studied maternal care in this colony (Doles 1998). He asked two questions: how long would a female continue to rebury her nest if excavated and could she discriminate between her nest and another dummy hole nearby? Read his paper to answer both questions. A hint—females excavated multiple exploratory holes but abandoned all but one for oviposition.

Knight Anoles (*Anolis equestris)* at Dallas Zoo displayed to smaller anoles (*A. sagrei, A. carolinensis*) that were used as food. Instead of trying to flee from the larger lizards, the food anoles sometimes displayed head bobs, lateral compression, and dewlap extension. On rare occasions, they continued the display even while being swallowed. Rosenberg (1941) covered behavior and husbandry in *A. equestris* and *A. ricordii*. One of the most interesting anole exhibits showing their lifestyle was at Lincoln Park Zoo in Chicago during the 1950s where a large planted exhibit housed Brown and Green Anoles from Florida. This stately enclosure was remindful of a Victorian terrarium or Wardian fern case, viewable from all sides, with intricate and ornate ironwork and was the first display visible as one entered the reptile house. These lizards were very active: fighting, courting, ovipositing, hatching, and feeding. One day at Dallas Zoo, I felt a tremendous pain on my left earlobe as I was speaking on the telephone. One of my beloved employees had attached a large male *A. carolinensis* to the lobe and it insisted on hanging on for some minutes. My gentle nature toward my co-workers was seriously challenged.

In my view, the most productive zoo scientist studying iguanid lizards is Allison Alberts, Chief Conservation and Research Officer for San Diego Zoo Global. She is the co-founder and past co-chair of IUCN Iguana Specialist Group and president of International Iguana Foundation. She has studied endangered iguanas in Cuba, Costa Rica, Turks and Caicos Islands, Fiji, and also Komodo Dragons. To prove my point, consult the bibliography at the end of this paper.

Family Agamidae.—Murphy et al. (1978) observed defensive behavior in the Angle-headed Dragon (*Goniocephalus dilophus*, now *Hysilurus dilophus*) at Dallas Zoo. This spectacular adult lizard emitted a series of grunts and hissing sounds as it leaped bipedally toward an intruder. Specialized motor patterns included lateral presentation with open mouth, tongue rolled forward, gular sac expanded, sidehopping, tail lashing, and color change. An adult male Frilled Lizard (*Chlamydosaurus kingi*) from Australia flared its frill, stood bipedally, made a series of grunts and rushed toward the keeper at this Zoo (Fig. 9). In 2004, nine Javan Hump-headed Lizards (= Chameleon Forest Dragon, *Gonocephalus chamaeleontinus*) hatched at Denver Zoo.

Almandarz (1969) placed Bearded Dragon (*Amphibolurus barbatus*) eggs in a portable baby incubator and seven hatched at Lincoln Park Zoo (Fig. 10). Van Aperen (1969) bred them at the Melbourne Zoo. Sherriff (1989) outlined the maintenance and breeding of the Inland Bearded Dragon (*Pogona vitticeps*) at Edinburgh Zoo. Morley (1992) bred the Nobbi (*Amphibolurus*

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FIG. 13. Illustration of Common Chameleon (*Chamaeleo vulgaris*, now *C. chamaeleon*) in Albert E. Brehm's *Illustrirtes Thierleben für Volk und Schule. Brehm's Illustrirtes Thierleben für Volk und Schule; bearb. von Friedrich Schödler. Mit, Abbildungen nach der Natur, ausgeführt unter leitung von R. Kretschmer. Neue Stereotypausg. Bibliographisches institut, Leipzig, 1875–1883* (Illustrated Animal Life for the People and the Schools; edited by Friedrich Schödler. With Illustrations from Nature, Made under the Direction of R. Kretschmer. New Stereotypical Edition, Bibliographic Institute, Leipzig.).

nobbi) at Adelaide Zoo. Montali et al. (1975) diagnosed dermatophilosis in Australian bearded lizards at National Zoo. Weigel (1989) maintained and bred the Superb Dragon (*Diporiphora superba*) at Australian Reptile Park, Gosford. He has also published a helpful book on the care of Australian lizards (1988).

Demeter (1981) reported on husbandry and breeding of the Chinese Water Dragon (*Physignathus cocincinus*) at National Zoo, Dedekind and Petzold (1982) bred the species in the Berlin Tierpark, and Frolov and Sanoyan (1986) in Moscow Zoo. The National Aquarium in Baltimore has a large exhibit devoted to Lesueur's Water Dragon (*Physignathus lesueurii*). Both *Hydrosaurus* and *Physignathus* should be kept in large, semi-aquatic exhibits or the lizards will likely abrade their rostrals by banging into the exhibit glass. Lederer (1931) published an early paper on ethology of the Sailfin Lizard (*Hydrosaurus amboinensis*). Visser (1984) described husbandry and reproduction of the Sailfin Lizard at Rotterdam Zoo. Mitchell (1986) reproduced the Philippine Water Dragon (*Hydrosaurus pustulatus*) at Dallas Zoo. At Dallas Zoo in the 1970s, two Sri Lankan lizards were displayed: Mountain Horned Iguana (*Ceratophora stoddartii*) and Sri Lanka Horned Agama (*C. aspera*). At the same time at Fort Worth Zoo, a spectacular adult pair of Lyre-headed Lizards (*Lyriocephalus scutatus*) was exhibited in a large planted enclosure.

In 2004, 20 Mali Spiny-tailed Lizards (*Uromastyx maliensis*) hatched at Detroit Zoological Institute. Watson (1969) outlined the care of Mastigure Lizards (*Uromastyx*) at Jersey Wildlife Preservation Trust. Wheeler (1990, 1991) described husbandry of Mastigures at Oklahoma City Zoo. Morales and Dunker (2001) found tuberculosis, *Mycobacterium marinum*, in a group of Egyptian Mastigures (*Uromastyx aegyptius*) at Steinhart Aquarium (Fig. 11). Raphael et al. (1999) evaluated vitamin D concentrations in *Uromastyx* spp. with and without radiographic evidence of dystrophic mineralization at New York Zoological Park.

Coburn (1975) described post-mortem removal and artificial hatching of Rainbow Lizard eggs (*Agama agama*) at the Cotswold Wildlife Park, Oxfordshire UK. A small group of Common Flying Lizards (*Draco volans*) was kept in a large planted exhibit at Dallas Zoo where they lived for several years (Fig. 12). Males regularly displayed to each other by extending dewlaps and partially extending wings, and bobbing the body but I never saw them lock jaws or bite each other. Some ant colonies lived in the enclosure and were intermittently picked off by the lizards.

Family Chamaeleonidae.—Most chameleons have been difficult to keep for extended periods in captivity (Fig. 13). In 1818, the Menagerie of the Imperial Cabinet (Vienna) had chameleons from North Africa and eggs were laid in 1845 but did not hatch. The menagerie received many chameleons as gifts from various sources between 1818–1851. Duméril (1854–1855) found that captive chameleons fared poorly between 1851 and 1855 at the Menagerie Jardin des Plantes, Paris for although more than 160 were kept, none lived more than 13 months. Females often died from reproductive complications—no eggs were ever hatched. See Andreone et al. (2005), Andrews (2005, 2008), Andrews and Donoghue (2004), Andrews et al. (2004), Andrews et al. (2008), Ferguson et al. (2003, 2007), Karsten et al. (2008, 2009) for recent success stories.

Johann von Fischer was the first to document copulatory behavior and reproduction in Common Chameleons (*Chamaeleo vulgaris*, now *C. chamaeleon*) in 1882 and 1884 (see Murphy 2005 for English translation; Fig. 14). He attempted to incubate nearly 800 eggs but most never hatched. The first Veiled Chameleon (*Chamaeleo calyptratus*) obtained by the London Zoo was caught in Aden, South Yemen, on 15 March 1885 and donated on 3 June 1885 by Lt.-Col. J. W. Yerbury (Coote 2001). Sarah Kuppert (2013) described color changes during courtship in this species at Smithsonian National Zoological Park (SNZP) (Fig. 15). Gary Ferguson and colleagues published a book on care of Parson's, Panther, Veiled, and Jackson's Chameleons in 2007.

At the now-defunct Belle Vue Zoo in England (see Bennett and Barnaby 1989 for this sad story), average longevity for 24 chameleons between the years 1898–1901 was slightly over three months and none survived for one year (Flower 1925). Raymond L. Ditmars had problems with chameleons which rarely survived longer than five or six months (Ditmars 1933). Flower (1925) found that chameleons rarely lived one year in captivity. An exception was the South African Dwarf Chameleon (*Bradypodion pumilum*) which have live young. In 55 years, only 15 chameleons of many species out of nearly 770 survived over one year, a rather depressing situation. By 1928, sixteen different species of chameleons had been exhibited alive in London but mortality



FIG. 14. Illustration of Common Chameleon (*Chamaeleo chamaeleon*) from John Anderson's *Zoology of Egypt Volume First. Reptilia and Batrachia* (1898). Early records show that this species was very difficult to keep in captivity.



FIG. 15. Illustration of Veiled Chameleon (*Chamaeleo calyptratus*) from John Anderson's *Zoology of Egypt Volume First. Reptilia and Batrachia* (1898). This species is very hardy in captivity.

rates were high. At the Giza Zoological Gardens in Egypt where Flower was director, 200 chameleons were maintained at the zoo between 1898–1924 but none lived for as long as four years.

See Ferguson et al. (2004) for color variation, natural history, conservation, and captive management of the Malagasy Panther Chameleon (*Furcifer pardalis*). This work included reproductive and nutritional data on five captive generations at Texas Christian University; an overall history of chameleons in captivity was included. Gary Ferguson has worked in a zoo setting for many years to investigate the captive biology of chameleons (Ferguson 1994; Ferguson et al. 1993, 1996, 2004). Early on when he brought his herpetology class to Dallas Zoo for the annual visit I asked him if he had ever seen a living chameleon. He replied no, which he said was saddening for an avid lizard ecologist. Luckily, we had a female Jackson's Chameleon (*Trioceros jacksonii*) that had recently given birth and the neonates were being maintained outside in a large screened cage. When he viewed these tiny lizards—going into I would characterize as a catatonic state, staring motionless on his haunches with no perceptible movement—I knew he was doomed. I offered some to keep in his lab in Fort Worth and he jumped at the opportunity—the rest is history!

These young Jackson's Chameleons were inaccurate at first as they tried to catch live crickets, often missing wide right or left. Occasionally, the tongue tip stuck firmly to the cage so the chameleon had to walk to the tip to reel in the tongue. The adults were kept in a large planted enclosure that covered the entire lobby of the reptile building at Dallas Zoo. Some of the trees were over 20 feet (6 m) high. When new males were first put into the enclosure, they spotted each other immediately and quickly moved toward each other to engage in male-male combat (Kommentkampf). After the struggle, the dominant chased the subdominant around the entire enclosure and eventually drove it to the very top of the highest tree. As the dominant lizard came closer, the loser released its grip, fell to the substrate, and quickly dashed away. We tested this multiple times with a series of males and the outcome was always the same; no loser suffered injuries. Females did not flee but rejected male advances by opening mouths, lateral body compression, color change, and rocking back-and-forth.

On the floor of this exhibit, a number of large *Ficus* trees were placed—each with a single chameleon—and encircled with a sheet metal barrier at the base to keep the lizards separated as these highly territorial lizards were incompatible. Daily feeding demonstrations were held and were exceedingly popular with visitors. Occasionally, sarcophagid fly larvae would be missed by the chameleons and would escape into the flower pots whereupon these insects hatched in the exhibit and were later plucked off by the lizards. One day, a fly landed on the inside of the glass at an adult human's eye level and a visitor witnessed the chameleon tongue up front and personal. She emitted a scream rivaling the decibel level of a jet plane and fell backwards into the crowd, taking a few small children to the floor with her.

Gary Ferguson, Rick Hudson from Fort Worth Zoo, and I traveled to Kenya to collect specimens for Texas zoos and preserve a series of Jackson's Chameleons for a description of what became a new taxon, now *Triceros jacksonii xantholopus* Eason, Ferguson, Hebrard 1988 (see Ferguson et al. 1991). We were hosted by Nairobi Natural History Museum, which includes a snake park. Chameleons were regularly collected as food for mambas and boomslangs living in a large pit. Jim Hebrard, then in the zoology department at University of Nairobi, kindly allowed us to stay at his apartment in the city but the space was so packed with other herpetologists—Butch Brodie, Ron Nussbaum, Tom Madsen, Ken Dodd, and a couple of other persons—that the living quarters were mindful of a homeless shelter. Gary, Rick, and I spent much time collecting on Mt. Kenya. Gary brought along some tree-climbing equipment to scale trees but the first trial was less than impressive—he ascended about six feet, lost his balance, and fell to the ground. The equipment remained unused for the rest of the trip. We hired local villagers to help collect for us but virtually all were terrified of chameleons, believing that the lizard's sharp claws were deadly poisonous. They were clearly conflicted, a few Kenyan shillings per lizard versus instantaneous death. Only one person actually held a chameleon—all of the others carried these saurians on the end of very long branches, both holding on for dear life. The villagers were stunned when we allowed these creatures to crawl on us—women screaming and children running away at full speed. One surprising and unexpected fact was the



FIG. 16. Illustration of Flying Gecko (*Ptychozoon kuhli*) from *A contribution to the zoögeography of the East Indian islands,* by Thomas Barbour (1912). At Dallas Zoo, we tested the gliding behavior but we were rather unimpressed with the outcome. The lizards did not crash to the ground when released from the top of a high ladder but the trajectory was not dramatic.

High-casqued Chameleons (*Trioceros hoehnelii*) were spaced about 3 m (10 ft) apart within juniper bushes and hedge-rows at the vet station a few miles out of town and the bongo acclimation center at the base of Mt. Kenya. Jackson's Chameleons were usually found higher in trees, especially at night, and several males might be found in the same tree. An exciting followup to our research in the 1980s was recently published by Jan Stipala. He has completed a really interesting book called *Mountain Dragons: In Search of Chameleons in the Highlands of Kenya* (2014). He has found two additional clades on the west side of Mount Kenya and at higher elevations than where we looked.

Studying chameleons in Africa is unique. One night we were using flashlights and headlamps to spot chameleons since when sleeping they become much lighter in color and stand out against the vegetation. As we walked on the trail, we could hear large mammals crashing through the bush. A Tree Hyrax suddenly emitted a call that was blood-curdling and nearly caused cardiac arrest for all of us. At that moment, we realized that this was our first field experience where we potentially could be killed and eaten by animals and so we decided to retire from collecting at night in dangerous settings. When we reached the lodge for a few drinks, elephants, cape buffalos, rhinos, wart hogs, and other mega-mammals were gathered around a pool illuminated at night for the tourists, and a leopard ran in front of our car as we left. Returning to our small hut for another well-needed drink on the patio after a starry night of chameleon stalking, a group of hyenas encircled us and they were much too close; we decided to retire earlier than planned. What was interesting was these predators were absolutely silent in their approach and we only knew of their presence when we turned on a flashlight and spotted eye-shine.

Brodie and Nussbaum were studying caecilians (*Afrocaecilia = Boulengerula taitana*) in the Taita Hills near Nairobi and suggested that we enlist the villagers to help with collecting because they were not afraid of chameleons but rather viewed these lizards as a source of income. When we arrived at the village, adults and children rushed the car and gave us a verbal price list using scientific names, reproductive condition, health, and sizes; for example, a gravid female Böhme's Two-horned Chameleon (*Kinyago boehmei*) was a steal at two Kenyan shillings. Soon, we were inundated with hundreds of herps, made our choices and purchased them, and were frantic to leave since the locals insisted that we buy all of the remaining ones. As we left the village, people ran after the car and threw more animals through the open windows on us, free of charge! Once we were out of sight, these animals were released.

The introduced Hawaiian stock of Jackson's Chameleon was definitely *Chamaeleo j. xantholophus,* the taxon described by Ferguson and colleagues. At Dallas Zoo, chameleons from this place seemed to adapt more easily to captivity when compared to the Kenyan lizards. Perhaps one reason is the daily temperature fluctuation is much less dramatic in Hawaii. It was so cold at night on Mt. Kenya, we slept in our jackets inside of heavy sleeping bags.

At San Diego Zoo, Charles Shaw recorded his observations on the reproductive biology of *Chamaeleo basiliscus* (now *C. africanus*) (Shaw 1959). Castle (1990, 1991) described husbandry and breeding of several chameleons at the Oklahoma City Zoo. Barrie et al. (1993) documented diseases of chameleons at this Zoo. Scott Stahl (1996) covered medical management.

Why do some chameleons do poorly in captivity? Here is a hint from a section in one of my earlier papers (Murphy 2009): "A new challenge is the recent study by Karsten and associates which explains why some imported animals could probably never have been successfully kept in captivity for extended periods. They found that Labord's Chameleon (*Furcifer labordi*), from arid southwestern Madagascar, is an "annual" lizard living mostly as an egg for about nine months and then only four or five months outside the egg. These lizards reach sexual maturity in two months. This may mean that the brief life span of chameleons in captivity might, for some species, actually represent the natural adult life span. So questions are asked and suggestions given by the authors in their abstract: 'Consequently, a new appraisal may be warranted concerning the viability of chameleon breeding programs, which could have special significance for

species of conservation concern. Additionally, because *F. labordi* is closely related to other perennial species, this chameleon group may prove also to be especially well suited for comparative studies that focus on life history evolution and the ecological, genetic, and/or hormonal determinants of aging, longevity, and senescence.' Flower's statement about chameleons being short-lived reptiles written over 80 years ago was prophetic."

Final thought: When Gary Ferguson and I traveled to Madagascar to do research for our books (2004, 2007), we spent one evening looking at a list of all chameleons in the country in order to predict the likely future for all of them. This was not a detailed scientific study but rather based on our observations in the field, discussions with colleagues, and literature. We concluded, much to our horror, that probably two-thirds were at serious risk of extinction and these were mostly taxa that lived in primary forest or fragile areas modified by humans. Weedy species such as the Panther Chameleons were common even in places with high human densities so they may well provide a starting point for a new chameleon radiation.

Infraorder Gekkota.—Dale Marcellini from National Zoo published several papers on acoustics, vocal and visual displays of geckos (1977, 1978). Demeter and Marcellini (1981) recorded courtship and aggressive behavior of the Streak Lizard (*Gonatodes vittatus*) at National Zoo. Heinrich Dathe (1942) recorded the birth of a Panther or Tokay Gecko (*Gecko gecko*) at Leipzig Zoo, Brodský (1969) at Prague Zoo, and Petzold (1963) bred this species at Berlin Tierpark. I witnessed a Tokay Gecko's biting power in person as I watched the San Antonio Zoo's curator pick one up whereupon it turned and bit him on the finger. The pressure was so great, the lizard's eyes sank into their orbits. It held on for one hour and nothing was successful at dislodging it, including holding it under water, until it released my colleague, probably from boredom. Frolow (1981, 1987) outlined reproduction of the Skink Gecko (*Teratoscincus scincus*) in Moscow Zoo. As part of initial keeper training at Dallas Zoo, new employees were told to clean this gecko's enclosure and the impressive defensive display was startling to all—we were accused of being sadists. Benefield et al. (1981) propagated Western Banded Geckos (*Coleonyx variegatus*) at Tulsa Zoo. From the Houston Zoo, Neitman (1983) described captive husbandry of the tuberculate geckos of the genus *Coleonyx*. Risley (1989) observed breeding of the Namib Gecko (*Chondrodactylus angulifer*) at London Zoo. Astreiko and Popovskaya (1999) from Tula Exotarium in Russia investigated the potential of breeding and raising the African Fat-tailed Gecko (*Hemitheconyx caudicinctus*) under laboratory conditions. At Dallas Zoo, we kept the Namib Sand Gecko (*Pachydactylus rangei*) and a group of Flying Geckos (*Ptychozoon kuhli*; Fig. 16). Both taxa did well in captivity. We also maintained several Cayman Island geckos with the strange standard name of Woodslave (*Aristelliger praesignis*) in the family Sphaerodactylidae. We displayed the lovely Marbled Bow-fingered Gecko (*Cyrtodactylus marmoratus*) from Peinsular Malaysia, Marbled Velvet Gecko (*Oedura marmorata*) from Australia, and Walberg's Gecko (*Homopholis walbergii*) from Africa.

Several papers on the long-term Madagascar Giant Day Gecko (*Phelsuma madagascariensis*) colony at National Zoo have been published by Béla Demeter and colleagues (1976, 1994). Bloxam and Townson (1980), Bloxam and Vokins (1978), Langebaek (1979), Wheler and Fa (1995) and Cooper et al. (1998) described breeding, research, and medical management at Jersey Wildlife Preservation Trust with the endangered Round Island Gecko (*P. guentheri*), the largest species in the genus. Howard



Fig. 17. Illustration of Common Flat-tailed Gecko (*Uroplatus fimbriatus*) [above] and Mountain Horned Lizard (*Phyrnosoma orbiculare*) from *Histoire naturelle de Lacépède. Nouvelle Édition par Cuvier* in 1841. Many of the gekkonid species in Madagascar are at serious risk of extinction due to human causes.

(1980) bred the Flat-tailed Day Gecko (*P. laticauda*) at Twycross Zoo. Rundquist (1980) reproduced Koch's Day Gecko (*P. madagascariensis kochi*) at Oklahoma City Zoo. Malagasy Flat-tailed Geckos (*P. serraticauda*) reproduced at Central Park Zoo in New York in 2003. In 2005, the endangered Yellow-throated Day Gecko (*P. flavigularis*) hatched at Wildlife Conservation Society. Linnetz et al. (1996) found gout in Giant Day Geckos. The late Sean McKeown from Fresno Zoo published many studies on Malagasy and Indian Ocean geckos (1982, 1984, 1985, 1989, 1992, 1994; McKeown and Miller 1984). Tytle (1994) presented an overview of the genus *Phelsuma*. Scott Pfaff and Sean Foley have developed an impressive program at Riverbanks Zoo, Columbia, South Carolina, breeding many species of the endangered group of flat-tailed geckos (*Uroplatus*) from Madagascar (Fig. 17). One realized goal of this initiative is the distribution of many lizards to various zoos.

Leopard Geckos (*Eublepharis macularius*) are so prolific in captivity, one could consider them a laboratory animal (see Thorogood and Whimster 1979; de Vosjoli et al. 2005). Author Philippe de Vosjoli considers this species to be the first domesticated lizard, like goldfish and parakeets. An array of color and

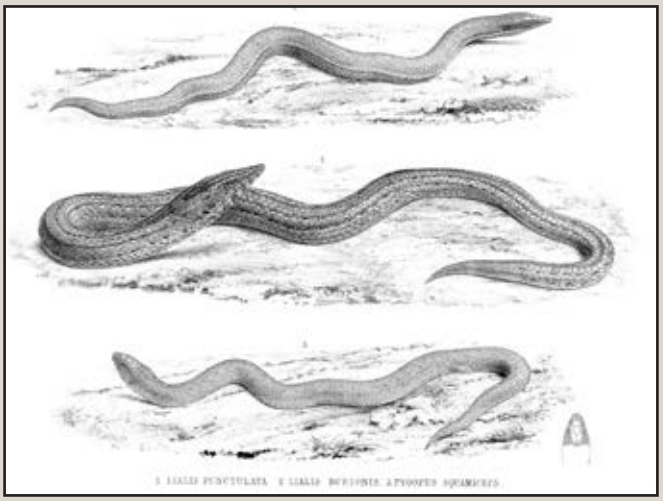


FIG. 18. Illustration of Burton's Legless Lizard (*Lialis burtonis*) in *The Lizards of Australia and New Zealand* by John Edward Gray in 1867. This lizard suffocates lizard prey by encircling the thoracic region with its flexible jaws. It is an extremely variable species.

pattern morphs are now available on dealers' pricelists—a pair of amelanotic lizards was being offered for US $1000 each. Ernie Wagner from Seattle Zoo wrote an interesting and important paper in 1980 showing skewed sex ratios based on egg incubation temperatures. See also his other papers (1974, 1979).

Kaverkin et al. (1994) described husbandry and reproduction of a eublepharid gecko, *Goniurosaurus kuroiwae splendens*, at Moscow Zoo. We kept the African Fat-tailed Gecko in the late 1960s at Dallas Zoo, which has now become a staple with herpetoculturists. One of the most spectacular eublepharids at Dallas Zoo was the Cat Gecko (*Aeluroscalabotes felinus*). A small group was kept in a cool room ca. 72°F (22°C) ambient temperature with a damp paper towel substrate. These lizards were very secretive and could not be placed on exhibit. As they grew, they all regularly pulled off skin with their mouths and swallowed it.

Some of the rarest geckos in zoo collections are any of the eight species of the genus *Naultinus* from New Zealand. There was a colony of eleven male and ten female Green Tree Geckos (*N. elegans*) at the National Zoo maintained by Béla Demeter and colleagues. These geckos were wild-caught and sent by Auckland Zoo in 1985. All of these smallish lizards in the genus are spectacularly colored and relatively easy to maintain in captivity, much like day geckos. All of the *Naultinus* survived over a minimum of several years. The National Zoo specimens were kept as groups of four in cages measuring ca. 3 ft × 3 × 2 h (1 m × 1 m × 0.6 m) with an ambient temperature of 72°F (22°C) and a small lamp provided as a thermal gradient. No courtship was observed so the lizards were watched throughout the night for two consecutive days to see if things improved—they did not and no reproduction occurred. Many examples are pictured in Sharell (1966).

One of my most exciting experiences was seeing the New Caledonian Giant Gecko (*Rhacodactylus leachianus*) at the Zürich Zoo for the first time in 1969. Curator René Honegger pulled a huge tame one from its enclosure and it rested quietly on his arm. I was truly thunderstruck. I vowed that we must have this species in Dallas so when a pair became available from a dealer for a princely sum, we jumped at the chance. I called gecko expert and Villanova University professor Aaron Bauer and asked for recommendations as to how to maintain this taxon successfully. He provided relevant environmental data and suggested cage furniture such as vertical tree limbs for a large display. Soon the geckos began to lay eggs, which we incubated at ca. 80°F (26°C). At least 60 hatched but all were males, suggesting Temperature Dependent Sex Determination. The adults vocalized when threatened, a deep guttural croaking noise. I long to see a living example of the world's largest gecko, named Kawekaweau (*Hoplodactylus delcourti*) of Maori legend, the presumably extinct giant from New Zealand (Bauer and Russell 1986). The type specimen was found in the basement of the Marseille Museum of Natural History, unlabeled and likely there for over a century. What was intriguing was this lizard was 54% larger than *R. leachianus*—about two feet long and thick as a man's wrist. What an awesome display that creature would make! I tried to convince my bosses to fund a collecting trip to try and find this gecko but I was summarily dismissed as a lunatic, who had taken complete leave of his senses.

At Dallas Zoo, we kept two pygopodids: Burton's Legless Lizard (*Lialis burtonis*) and Common Scaly-foot (*Pygopus lepidopodus*) (Fig. 18). We fed anoles, geckos, and skinks to the *Lialis* and I was constantly amazed by the cranial kinesis that allowed the jaws to wrap around the prey in the thoracic region to prevent breathing—this flexibility was very efficient in causing death. Banks et al. (1999) managed and bred the Striped Legless Lizard (*Delma impar*) at Melbourne Zoo.

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Mating Gila Monsters
by Randall D. Babb — Color pencil on illustration board 15" x 10"

An air of mystique has always surrounded the Gila Monster. Its very name, *Heloderma suspectum*, is a reflection of this. The specific epithet is an artifact of the uncertainty of its venomous nature when first described: it was "suspected" to be venomous. Remarkably this debate still lives among a surprising portion of southwestern U.S. residents who believe it is bad oral hygiene that gives the Gila Monster's bite its punch. Venom is produced in a four-lobed gland located in the lower jaw and transmitted into the mouth via ducts that open into a groove between the gums and lip. Venom is "stabbed" into wounds by the teeth, which are grooved to facilitate its transmission. Bites are notoriously painful but seldom, if ever, fatal. Gila Monsters are quite common through much of their range in northwestern Mexico and the adjacent southwestern U.S., though secretive and seldom seen. They were the first venomous reptile in the United States to gain protection due to fears of over exploitation and are protected everywhere they occur. This illustration by Randall D. Babb, which appeared in *Biology of Gila Monsters and Beaded Lizards* by Daniel Beck (2005. University of California Press, Berkeley, California. 211 pp.), depicts Gila Monsters copulating in an underground retreat.

Randy Babb is a native of Arizona and works for the Arizona Game and Fish Department. His interests are broad. Along with herpetological topics his research has included opossums, porcupines, elf owls, masked bobwhite, and most recently the ecology of antelope jackrabbits. Since 2006 he, along with a team of U.S. and Vietnamese biologists, has been participating in surveying herpetofauna and bats at various localities in Vietnam. Several new distributional records and a few new species have resulted from their efforts. In addition to his work in the southwestern United States, Babb has also worked on various studies and projects in the southeastern U.S., Mexico, Central America, Namibia, Zimbabwe, and South Africa, often assisting other biologists with their research.

Babb does not consider himself to be an artist but does enjoy photography and working in color pencil, ink, and watercolors. He often takes time to illustrate specimens captured during field work while overseas, but finds that time constraints make this nearly impossible at home. His work can be found in pamphlets, on t-shirts, and in numerous books including *Venomous Reptiles of Arizona, Biology of Gila Monsters and Beaded Lizards, Amphibians and Reptiles in Arizona, Deer of the Southwest, Lizards of the American Southwest, Vampiro: Vampire Bat In Fact & Fantasy, Inland Fishes of the Greater Southwest: Chronicle of a Vanishing Biota, What's that Snake; a Starter's Guide to the Snakes of South Africa, Traveler's Wildlife Guide series; Southern Africa, Natural History of the Sonoran Desert*, and even on an old cover of *Herpetological Review*.

ABOUT OUR COVER: *Spinomantis aglevei*



Madagascar, often referred to as the "eighth continent," harbors a remarkable fauna notable for extraordinary levels of endemism. For example, 100% of the native species of frogs occur nowhere else (Brown et al. 2014. Nat. Commun. 5:5046; doi: 10.1038/ncomms6046), and the rate of discovery of new species shows no signs of decline. The island's large size, complex topography, and long period of isolation have promoted extensive diversification of amphibian and reptile lineages.

Among the anurans, *Spinomantis aglevei* (Mantellidae) inhabits primary mid and low-elevation rainforest along the eastern slopes of Madagascar (Glaw and Vences 2007. A Fieldguide to the Amphibians and Reptiles of Madagascar. Third edition. Vences & Glaw Verlag, Cologne. 496 pp.). Although individual frogs are easily heard calling among the nocturnal cacophony, they are extremely difficult to see on their overhead perches along forest streams and swamps (Nussbaum and Vallan 2008. The IUCN Red List of Threatened Species. Version 2015.2. <www.iucnredlist.org>, accessed 26 Oct 2014).

Like many of the amphibians and reptiles inhabiting Madagascar, *Spinomantis aglavei* has evolved a highly advanced form of crypsis that allows it to blend in perfectly with its surroundings. Its granular skin and dermal fringes break up the outline of this arboreal frog, allowing it to disappear on the lichen-covered tree trunks and branches during the day.

Clutches of 30–38 eggs are deposited on vegetation overhanging streams. Larvae hatch and drop into the water where they complete their development (Glaw and Vences, *op. cit.*).

Like many of the denizens that rely on intact rainforest in Madagascar, this and many other species are threatened by deforestation, agricultural conversion, and increased habitat fragmentation. Fortunately, many of these remaining forests are now protected as national parks and community forests.

Our cover image was recorded by **Rob Schell** in the Mitsinjo Preserve near Andasibe in 2014, using a Canon EOS 5D Mark III and an EF 100mm f/2.8L Macro IS USM lens, at settings of f/11.0, 1/125 sec, and ISO 100. Illumination was provided by a Canon 580EX II master and two 320EX II slaves mounted on a RRS macro ring. Schell is a wildlife biologist based in the San Francisco Bay area of California. Through his photography, he has been able to share field experiences with colleagues and the general public.



PHOTO BY DANIEL CHASE

SSAR BUSINESS

SSAR Roger Conant Grants-in-Herpetology Award Winners for 2015

An award in the amount of US $500 was made to each of the following individuals:

Conservation.— **Pamela Clarkson**, Southeastern Louisiana University, "Rehabilitation stress dynamics of incidentally caught Kemp's Ridley Sea Turtles (*Lepidochelys kempii*)." Advisor: Roldan Valverde. **Madeline Cooper**, Humboldt State University, "Examining invasive Bullfrog (*Rana* [*Lithobates*] *catesbeiana*) movement patterns on the Trinity River." Advisor: Sharyn Marks.

Education.— **Valentine Kheng**, Surya University (Indonesia), "HEAR: Hello Amphibians and Reptiles!!!"

The Andrew H. Price Field Research Grant In Herpetology.— **Samantha Rumschlag**, Miami University, "Toads in Peril? Assessing the risk of American Toad populations to an emerging infectious disease, Chytridiomycosis." Advisor: Michelle Boone. **Hannes Schraft**, San Diego State University, "Infrared prey sensing in rattlesnakes (*Crotalus* spp.)." Advisor: Rulon Clark.

Laboratory Research.— **Sean Harrington**, San Diego State University, "Constructing the pitviper tree of life." Advisor: Tod Reeder. **Alexander Novarro**, University of Maryland, "Will intraspecific variation buffer the effects of climate change in lungless salamanders? Measuring the effects of adult body size on the thermal physiology of *Plethodon cinereus* across an elevation gradient." Advisor: Karen Lips.

Travel.— **Kyle Hovey**, John Carroll University, "Alkaloid-based chemical defenses of the Strawberry Poison Frog *Oophaga pumilio*: do variable defenses provide equal protection from microbial pathogens? Advisor: Ralph Saporito. **John Phillips**, University of Tulsa, "Comparative genomics of eyes in Spelerpine Salamanders." Advisor: Ronald Bonnett.

International.— **Ivan Camilo Beltran Arevalo,** University of Los Andes (Colombia). "Autoresistance to batrachotoxin (BTX) in *Phyllobates bicolor*: a molecular and physiological approach." Advisor: Adolfo Amezquita. **Saeed Hosseinian**, Ferdowsi University of Mashhad (Iran), "Biogeography and phylogenetics of the *Paraklaudakia caucasia* species complex." Advisor: Eskandar Rastegar-Pouyani and Mansour Aliabadian.

Undergraduate Research.— **Mark Herr**, Penn State University, "Thermoregulation and predation trade-offs by gravid Timber Rattlesnakes, *Crotalus horridus*, at gestation sites." Advisor: Tracy Langkilde.

SSAR thanks Committee Chair, Joshua M. Kapfer (University of Wisconsin-Whitewater), and the following reviewers for their service: Christine Bishop (Environment Canada, Science and

Technology Branch), Rebecca Christoffel (Snake Conservation Society), Peter Lindeman (Edinboro University of Pennsylvania), Cynthia Paszkowski (University of Alberta), Marion Preest (Claremont Colleges), Steven Price (University of Kentucky), Hendrik Mueller (Institut für Spezielle Zoologie, Universität Jena), Sara Ruane (American Museum of Natural History), and Jeff Tamplin (University of Northern Iowa).

Details concerning the Roger Conant Grants-in-Herpetology program for 2016 can be found below.

Roger Conant Grants-in-Herpetology Program: Guidelines for Proposal Submission

Proposals will be accepted for the 2016 SSAR Roger Conant Grants-in-Herpetology Program starting on 15 September 2015. This program is intended to provide financial support for deserving individuals (with a primary emphasis on student researchers) or organizations involved in herpetological research, education, or conservation.

Who Can Apply?

All applicants must be students AND members of SSAR with the following exceptions:

- Those applying for the International category must be students but DO NOT have to be SSAR members.
- Those applying for the Herpetological Education category DO NOT have to be a student or SSAR member.
- Those applying for support of regional herpetological society projects DO NOT have to be SSAR members.

In keeping with the Society's goal of encouraging participation by the broadest possible community of applicants, preference may be given to individuals who might not have access to other funding sources. Applications must be submitted by individuals only (but see special considerations for education categories below).

Grant Amounts and Deadlines

Successful applicants in each of the categories listed below will receive an award in the amount of US $500. A total of 12 proposals will be selected each year through peer review, to receive funding. The deadline for submission is 15 December 2015 (see special note on membership dues below). The awards will be announced by May or early June 2016.

Grant Proposal Categories

- ***Conservation of Amphibians and Reptiles.***—Proposals should outline a conservation-oriented research project. This project may focus on species endangered or threatened at the state, national, or international level, or address research on potentially threatened habitats or species, or on introduced injurious species.
- ***Field Research in Herpetology.***—Proposals may address needs for field station fees or equipment and materials in field oriented projects, or the field work portions of broader studies. This might include in-situ behavioral studies, ecological, life history, or sexual selection studies. Survey work by individuals or regional societies may be submitted here or in TRAVEL below depending on how the funds are to be used.
- ***Laboratory Research.***—Proposals may address needs for equipment or materials in laboratory projects or laboratory portions of broader projects. This might include studies in behavior, biochemistry, molecular biology, biomechanics, or physiology.
- ***Travel.***—Proposals may address support for travel to field study sites near or far, or to utilize distant collections or facilities. If funding is sought to get from one place to another, proposals should be submitted in the TRAVEL category. Proposals normally submitted in the CONSERVATION or FIELD RESEARCH categories should be submitted here if travel funding is being sought.
- ***International.***—Proposals may address needs in any of the above five categories. The applicant must be a student, but not necessarily a SSAR member. Preference will be given to students with limited access to research funds and in countries where herpetological research has historically been under-funded. Note Regarding Eligibility in the International Category: In 2011, the SSAR Board of Directors decided that proposals in this category would only be accepted if they were submitted from institutions OUTSIDE of the United States. Proposals from students who are primarily affiliated with United States institutions are not eligible for this category.
- ***Herpetological Education.***—Proposals may address an educational project or start up support for an educational program in a zoo, museum, park, nature center, regional herpetological society, etc. The project must focus on a herpetological topic. Note: Although proposals for institutional projects are accepted, education proposals must be submitted by an individual (either sole applicant or principal contact person for the project). Applicants need not be students or SSAR member.
- ***Undergraduate Research in Herpetology.***—Proposals in this category can outline any research project focused on questions related to amphibian or reptile taxonomy, biology, ecology or conservation. Funding can be used to purchase equipment, materials, or as re-imbursement for travel to conduct research (i.e., offset the cost of gas for trips to field sites, museums to investigate specimens, etc.). Applicants must be currently seeking a Bachelor's Degree at an institution of higher learning. Applicants need not be affiliated with US institutions, and international applicants need not be SSAR members. Students that apply for this award must be working directly with a research advisor at an academic or professional institution (i.e., University, Regulatory Agency, Zoological Garden, Museum, etc.). This advisor must submit the letter of support for the student's work. This letter of support must explicitly confirm that the applicant is currently a student and has the time, ability and guidance to successfully complete the proposed project. Strong preference will be given for applicants that have limited funding from other sources.

Additional information and requirements are posted on the SSAR website at: ssarherps.org/pages/GIH.php. All proposals must be submitted electronically to kapferj@uww.edu as a single pdf file named "lastname-category.pdf" not later than 15 December 2015 to be considered (letter of support may be included with the proposal or sent separately). Exceptions to electronic submission and file format may be allowed for special cases with prior approval by SSAR-GIH Chair. Failure to meet these guidelines may result in elimination of a proposal from consideration.

Successful applicants are encouraged to submit the results of their research for publication in the *Journal of Herpetology* or *Herpetological Review*, and/or to present their findings at the annual meeting of SSAR. Submit proposals or questions regarding application procedures to: Joshua M. Kapfer, Chair, SSAR Grants in Herpetology, Department of Biological Sciences, University of Wisconsin-Whitewater, Whitewater, Wisconsin 53190, USA (e-mail: kapferj@uww.edu).

Grants-in-Herpetology Donor Information

Financial contributions by SSAR members, institutions, and other benefactors support this program significantly, and can increase the number and/or size of awards. Your tax-deductible (for US taxpayers) contribution to this program will directly benefit meritorious research and education in herpetology. Contact the SSAR Treasurer for additional information about contributing to the Grants-in-Herpetology Program. If you are employed by an organization that will match donations made to nonprofit organizations, please notify your employer that you have made a donation to the Grants-in-Herpetology Program.

SSAR would like to thank the many grant reviewers and donors that have been instrumental in the success of this committee for the last several decades. In particular, we wish to thank **Tom Beauvais** for his generous financial support of this program. We also thank **Dr. Rebecca Christoffel**, whose comments and suggestions greatly improved the guidelines for grant submissions in the Education Category.

NEWSNOTES

David J. Morafka Memorial Research Awards 2016

In honor and memory of Prof. David J. Morafka, distinguished herpetologist and authority on North American gopher tortoises, the Desert Tortoise Council, with the aid of several donors, has established a monetary award to help support research that contributes to the understanding, management and conservation of tortoises of the genus *Gopherus* in the southwestern United States and Mexico: *G. agassizii, G. morafkai, G. berlandieri*, and *G. flavomarginatus.*

Award Amount: US $2,000 to be awarded at the Desert Tortoise Council's Annual Symposium, depending on the availability of funding and an appropriate recipient.

Eligibility: Applicants must be associated with a recognized institution (e.g., university, museum, government agency, non-governmental organization) and may be graduate students, post-doctoral students, or other researchers. They must agree to present a report on the results of the research in which award funds were used at a future symposium of the Desert Tortoise Council.

Evaluation Criteria: Applications will be evaluated on the basis of the potential of the research to contribute to the biological knowledge of one or more of the above gopher tortoise species, and to their management and conservation. Important considerations are the significance and originality of the research problem, design of sampling and analysis, preliminary data supporting the feasibility of the research, and the likelihood of successful completion and publication.

Application Procedure:

1. Download and open an application form from the Desert Tortoise Council's website www.deserttortoise.org. The form is electronically interactive.

2. Provide all information requested on the application, including a description of the research project in no more than 1200 words.

3. Submit the completed application to grstewart@csupomona.edu as a pdf document.

4. Applications must be supported by the applicant's CV and three letters of recommendation, one of which must be from the applicant's research advisor, supervisor, or a knowledgeable colleague. Instruct the recommenders to submit their letters to grstewart@csupomona.edu as pdf documents.

5. All application materials and letters of recommendation must be received by **1 December 2015**. They will be evaluated by a committee of gopher tortoise biologists appointed by the Desert Tortoise Council Board of Directors.

6. The research award recipient will be notified of his/her selection by **19 January 2016** and the award will be presented at the 2016 Desert Tortoise Council Symposium, 19–21 February 2016.

Reptile Database Update

As of 12 August 2015, the Reptile Database (http://www.reptile-database.org) now contains 10,269 species, an increase of 91 species from the previous update in March 2015, including 72 new species described in 2015 and another 19 revalidated or elevated from subspecies status. There are now 37,093 references, including 761 published this year and an increase of 815 since March.

Selected Taxonomic News and Changes

2014 was hottest year in history.—As with climate change, the last 10 years were the hottest in history, but especially in reptile taxonomy. Every year in the past decade had at least a 100 new

species described, a number that was reached only five times before 2005 (namely in 1758 with Linnaeus himself, then in 1854, 1863, 1864, and 1887). It turns out that a record 180 species were described in 2014.

New checklists.—We have updated several species lists based on recently published checklists, e.g., those for chameleons and *Phelsuma* geckos (after Glaw and Rösler 2015. Vertebrate Zoology 65[2]:247–283), lizards of the Amazon (Ribeiro-Júnior 2015a,b), lizards of Togo (Segniagbeto et al. 2015. Zoosystema 37[2]:381–402), lizards of the Mexican states of Jalisco (multiple sources), Morelos, Hidalgo (Lemos-Espinal and Smith 2015. Check List 11[3]:doi: 10.15560/11.3.1642), and Oaxaca (Mata-Silva et al. 2015. Mesoamerican Herpetology 2[1]:6–62, and pythons (Barker et al. 2015. Zoological Journal of the Linnean Society 175[1]:1–19; doi: 10.1111/zoj.12267).

Herpetological bibliography of Europe.—The Field Herpetology special interest group of the German Herpetological Society (DGHT) has released an illustrated Herpetological bibliography of Europe that features almost 900 illustrations of European herps (in German). Access the bibliography here: http://www.feldherpetologie.de/herpetologische-bibliographie-europas/.

—Contributed by Peter Uetz

Wildsumaco Biological Station



Wildsumaco Biological Station is now open for use. The station is located in the Napo Province of Ecuador on the south flank of the Sumaco Volcano at about 1450 m asl on the eastern slope of the Andes. This equatorial field station can sleep 18 people and has 2.5 bathrooms, a common area for lecturing, and a kitchen. The station is a joint initiative of Francis Marion University and the University of North Carolina at Wilmington and is operated by the Wildsumaco Lodge. The lodge is a popular birding destination and is located about 0.5 km from the field station. A diverse herpetofauna is being documented at this premontane forest site. Numerous trails are available for both teaching and research that traverse elevations of 1300–1500 m in both primary and secondary forest. The property lies within the Gran Sumaco Biosphere Reserve, near Sumaco National Park. Reservation information can be found on the web site at wildsumacobio.org and there is also a Facebook page.

Slowinski Award Winner Announced

The Center for North American Herpetology has announced that the winner of the Joseph B. Slowinski Award for Excellence in Snake Systematics for 2015 is Paola A. Carrasco. Paola is affiliated with the Universidad Nacional de Córdoba, Argentina, and is recognized based on publication of the following paper: Morphology, phylogeny and taxonomy of South American bothropoid pitvipers (Serpentes, Viperidae). 2012. Zoologica Scripta 41:109–124. The paper was co-authored with Camilo I. Mattoni, Gerrardo C. Leynaud, and Gustavo J. Scrocchi.

Amphibian Disease: *Bsal* North America Call to Action

Issue.—A new amphibian fungal pathogen "*Bsal*" was identified in 2013 from a wild salamander die-off in Europe. Studies show that *Bsal* kills North American salamanders. *Bsal* is not known to occur in North America currently, but pathways for its entry do exist. Interagency and international collaboration and action will be essential to prevent or reduce risk of *Bsal* introduction to the United States, Canada, and Mexico.

Background.—*Batrachochytrium salamandrivorans*, or *Bsal*, is native to Asia, and Asian salamanders carry the fungus without showing signs of disease. Asian salamanders are held in international captive collections, and are common pets; of the nearly 3 million salamanders imported to the U.S. over the past decade, >85% were Asian salamanders. First detected and identified in the Netherlands, in the last year *Bsal* has been detected in captive salamanders in the United Kingdom. This pathogen has proved to be lethal to multiple species in both captive and wild situations. It is an emerging infectious disease that is at an



PHOTO BY MARTY SILVER

Eastern Newt eft (*Notophthalmus viridescens*)

early stage of global transmission. Wildlife scientists and managers aim to contain or treat infected animals in captive situations, and preempt the pathogen's introduction to wild populations outside its Asian range.

Why we care.—North America is a global hotspot for salamander diversity, home to nearly 50% of all species. Salamanders play key ecosystem roles, as they are centrally nested in food webs and occur both in water and on land. We use salamanders as metrics of environmental change, and they are critical to biomedical research that seeks human health benefits. Numerous threats affect amphibians, and despite the potentially dramatic impacts of the *Bsal* threat, it is controllable at this time.
PARC's Disease Task Team will develop a Strategic Action Plan that will outline approaches to protect our North American natural heritage, our native species, and ecological functions, as well as ecosystem services for human goods and services that these species provide.

***Bsal* Strategic Action Plan components**
1. Identify *Bsal* entry routes into the United States, Canada, and Mexico.

2. Develop strategies to prevent the risk of *Bsal* entry to North America, and specifically its introduction into wild populations.

3. Develop continental surveillance strategies for wild and captive populations.

4. Develop and improve response and intervention strategies (containment, treatment) if *Bsal* is detected.

5. Identify education and outreach strategies to enhance public awareness and biosecurity compliance.

For more information, consult the PARC Disease Task Team Information Portal:
http://www.parcplace.org/parcplace/resources/disease-task-team.html

Charles W. Painter Grants in Herpetology



The Chiricahua Desert Museum (CDM) has announced the establishment of the Charles W. Painter Grants in Herpetology, to support research and education on the herpetofauna of New Mexico. Charlie Painter (1949–2015) was a well-known, respected, and beloved expert on the reptiles and amphibians of the southwestern United States. Professionally, he is perhaps best remembered for serving as the first State Herpetologist for New Mexico, where he worked for over 25 years. He was a co-author of the 1996 book *Amphibians and Reptiles of New Mexico*, the definitive resource for the herpetofauna of that state. He served for many years as a section editor for *Herpetological Review*, and in 2013 was the recipient of the Alison Haskell Award from Partners in Amphibian and Reptile Conservation.

The deadline for applications is 1 November 2015. For details of this new grant program and to download an application, please visit: http://www.chiricahuadesertmuseum.com/#!charles-w-painter-grant/cbfy

MEETINGS

Meeting announcement information should be sent directly to the Editor (herpreview@gmail.com) well in advance of the event. We also welcome brief reports of meetings; please consult the Editor for details.

3–6 November 2015—IV Congreso Nacional Sobre la Investigación y Conservación de los Anfibios y Reptiles, Villhermosa, Tabasco, Mexico. Information: aicar2015@yahoo.com and www.Facebook.com/aircar.mexico.

6–8 November 2015—42nd Annual Meeting of the Kansas Herpetological Society, Hays, Kansas, USA. Information: http://www.cnah.org/khs/meetings.aspx

19–21 February 2016—Desert Tortoise Council Symposium, Las Vegas, Nevada, USA. Information: www.deserttortoise.org.

14–17 April 2016—63rd Annual Meeting of the Southwestern Association of Naturalists, Mexico City, Mexico. Information: http://www.biosurvey.ou.edu/swan/annualm.html

23–27 May 2016—1st National Congress of Mexican Pitvipers and Ophidism, Monterrey, Nuevo León, Mexico. Information: davidlazcano@uanl.mx or congresoviperidos@gmail.com

6–10 July 2016—Joint Meeting of Ichthyologists and Herpetologists, New Orleans, Louisiana, USA.

15–21 August 2016—8th World Congress of Herpetology, Hangzhou, China. Information: http://www.wch2016hangzhou.com/

OBITUARIES

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Samuel Booker McDowell, Jr. (13 Sept 1928–31 Dec 2014)
The Most Important Herpetologist You Never Knew

One of the greatest joys of life is helping others and watching from the sidelines as those you help become successful, influential, and accomplished. The irony of this satisfying joy is that it happens at a stage in life when those who set you on your own path die. The feeling of this loss is magnified by the sense that you never really managed to adequately express your gratitude for their many kindnesses and generous mentoring. As prelude, this explains the next few lines meant as appreciation, as well as a scientific and personal biographic chronicle, of my friend and advisor, Sam McDowell (Fig. 1). For these and other reasons, this account might seem an odd mix of description of a scientific career, a fascinating and complex person, and the strangeness of life in general.



PHOTO COURTESY OF EDWARD I. SAIFF

FIG. 1. Samuel Booker McDowell in the 1964 Rutgers Yearbook.

Samuel Booker McDowell, Jr. was the only child of his father and Elizabeth Valentine Dickinson McDowell. Everyone knew him as "Sam." His father was born in Kentucky and his mother was born in Birmingham, Alabama. Sam's father was a Presbyterian minister who left the church after an argument and became a book salesman for John C. Winston Company. Sam never spoke of his father in my presence. His mother waited to marry until after she finished her PhD at Columbia Teacher's College (CTC), where she taught. When I first met Sam, his mother was still alive, and retired in Trenton, New Jersey. He often mentioned plans to take the train south for a visit, although he never indicated if these visits were dreaded or anticipated.

Sam's early years were in Morningside Heights, a neighborhood of the northern part of Manhattan that included Columbia and Barnard College. While his mother was teaching at CTC, Sam attended the Horace Mann School. The motto of the school—*Magna est veritas et praevale* ("Great is truth and it prevails")—is a motto that Sam embraced. The family eventually moved to a farm in Bucks County, Pennsylvania, near the town of Lahaska. Sam's "country" education included attending the Buckingham Friends School for his primary education and the Solebury School for his secondary schooling. All these schools were and remain elite prep schools.

Sam must have been a fast learner, for he entered Columbia University a few days shy of his 16th birthday and graduated at 19 in 1947. He stayed at Columbia for his graduate work and received his PhD in 1957. The ten years between B.A. and PhD were very full, both personally and professionally.

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Sam met Rosa, his future wife, when he was the fourth for a bridge game. She was the oldest of three siblings and worked as a bookkeeper for a skirt maker in the Garment District. Her father came from Lithuania and may have been part of the Jewish Eastern European Diaspora of the late 19th and early 20th centuries. Rosa was born in Brooklyn and when she met Sam her family lived in Baldwin on Long Island. I met Rosa in the mid-1970s on my first visit to the American Museum of Natural History. Rosa suffered from arthritis, which rendered her posture bent, her knees swollen and stiff, and her hands twisted. This always gave me the impression that she was often in pain. But her beauty still radiated unabated, and I believe one of the great gifts granted to Sam was his life with her. She seemed to have Sam's number and was one of the few who could defuse one of his rants with a simple "Oh, Sam."

They were married 27 June 1952, and first lived in the Highbridge section of the Bronx, where their two children were born—Edward Drinker Cope McDowell in 1955 and Janet Anne McDowell in 1957. Ed is a now a professor of mathematics at Rhode Island College, and Janet is a graphic artist in New York City. I have never met Ed, although I feel I know something about him, because during my first trip to the AMNH, Sam and Rosa let me stay in his vacated room. They lived in a high-rise apartment building perched above the throughway leading to the George Washington Bridge in the Washington Heights neighborhood of Upper Manhattan—convenient for access to public transportation, but from my perspective at the time (a southern California beach/desert stoner) distinctly post-apocalyptic. My views of New York neighborhoods dramatically changed after I looked into average rents. I was always impressed by how much more Janet knew about art, music, culture, and baseball than I did. She seemed to have Sam's brilliance and Rosa's *joie de vive*.

Sam's eventful personal life was matched by a very productive scientific period. In 1948, his first paper was published, on the palaeognathous palate of birds (McDowell 1948). This paper was to be a part of an ambitious series devoted to the anatomy of birds. He was 20 years old, but his youthful ambition for a series of papers was never realized. Three decades later, one of Sam's distinctive letters, written on legal yellow lined paper, impressed Storrs Olson (Curator of Birds at the National Museum of Natural History) so much that Olson arranged for its publication (McDowell 1978). This letter suggests a radically different and very plausible hypothesis that might explain bird palatal homologies and lack of teeth. Alas, citations to this paper are as "rare as hen's teeth."

He next co-wrote a paper on the plastron of soft-shelled turtles with Ernest E. Williams, late Curator of Reptiles at Harvard's

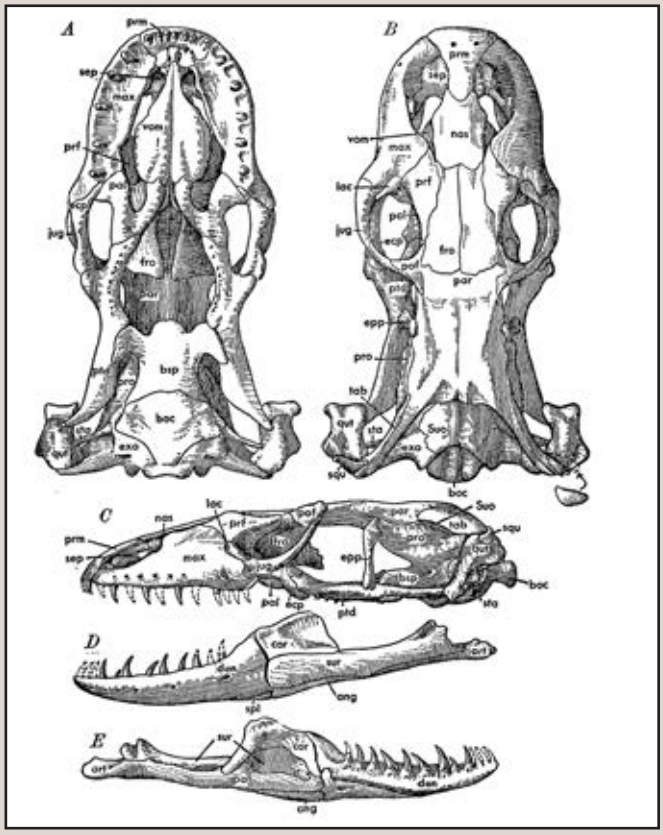


FIG. 2. This is figure 2 from Bogert and McDowell (1954) and illustrates the skull of *Lanthanotus borneensis*. At the time rare in collections, this is an example of Sam's ability to make the most of limited material. Only one example of the skull and lower jaw was examined for this monograph and it was dissected and cleaned from an MCZ preserved specimen by Sam.

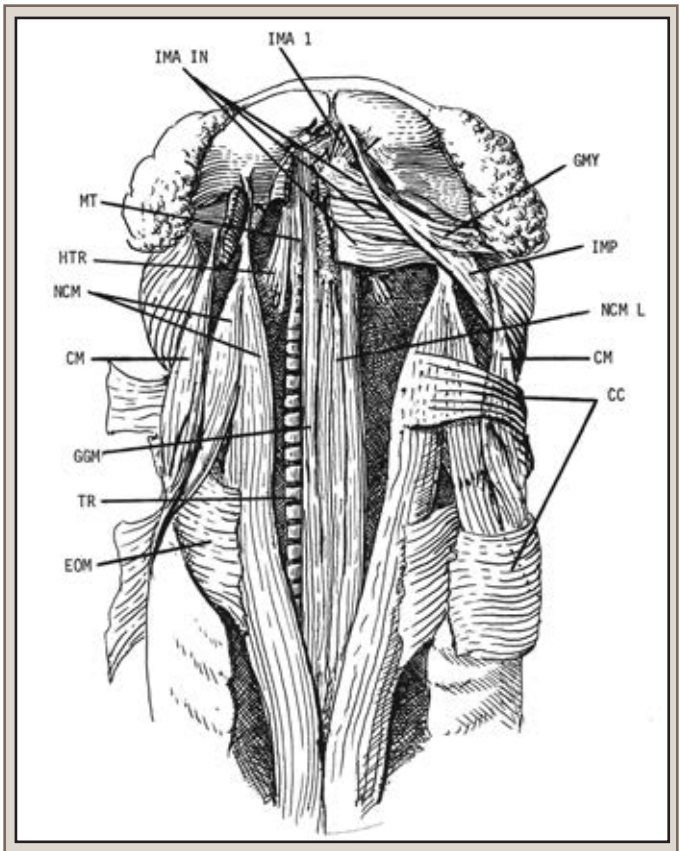


FIG. 3. This is figure 17 from McDowell's (1972) influential paper on the tongue of snakes published in a volume honoring his PhD advisor, George Gaylord Simpson. Pictured are the throat muscles of the tiny snake *Leptotyphlops humilis*. (now *Rena humilis*). Superficial muscles are illustrated on the right side and deeper muscles on the left.

Museum of Comparative Zoology (Williams and McDowell 1952). He also drafted the illustrations for Williams's PhD dissertation (1950). In later years, several other papers on turtles appeared (McDowell 1961, 1963, 1964, 1983; Hotaling et al. 1985); his papers from the 1960s are the most important and influential published on turtle systematics. Who can forget the "batagurine process"? The phylogenetic works of Gene Gaffney, Peter Meylan, Walter Joyce, myself, and many others benefited immeasurably from Sam's insights. Many of his careful anatomical observations were eventually simplified by others for the purposes of computer-based cladistic analysis.

Sam was able to use detailed descriptions of the seemingly narrow and prosaic to generate broad and influential ideas. Another of his early papers is an example of this almost preternatural skill. Along with the physiologist Charles Bogert he published on *Lanthanotus* (Bogert and McDowell 1954). At the time, this was a very rare animal, and only a handful of specimens were available among all the collections of the world. The *Lanthanotus* monograph is important. It is a detailed and in-depth review of the comparative anatomy of a lineage of squamates—the Anguinomorpha—that includes snakes. It is an example of character description and analysis that presaged and contributed data to cladistic analyses conducted decades later. And, it is explicitly comparative and phylogenetic in both execution and goals. It is a worthy successor and the equal of Camp's famous work of 30 years earlier (Camp 1923) and Underwood's influential work on snakes (Underwood 1967). The *Lanthanotus* monograph, written four years before Sam received his PhD, is a work for the ages because it is a peerless example of scholarly comparative anatomy; it should rank as one of the top ten most important papers on squamate relationships published in the 20th century. Of course, Camp's and Underwood's seminal works belong on that list and so does Estes and Pregill (1988). Filling out the top ten is a matter of opinion and likely fruitless (Beatles vs. Rolling Stones), but the *Lanthanotus* paper will be on everyone's list. All the anatomical descriptions and most of the drawings are Sam's work. His densely detailed anatomical description, characteristic of all his scientific output, is on display (Fig. 2).

In the preface to his dissertation on Antillean insectivores (McDowell 1958), Sam explained that the British paleomammalogist Percy Butler also reported some of his results independently. Sam also thanked his major PhD advisor—none other than George Gaylord Simpson. Others thanked were a "Who's Who" of 20th century luminaries in vertebrate paleontology, including Bobb Schaeffer (also on his PhD advisory committee), Glenn Jepsen, Joseph T. Gregory, Malcolm McKenna, Karl Koopman, Ernest Williams, and Bryan Patterson.

Both of these two monographs illustrate several reasons why Sam's work was relatively unsung. His writing is spare and almost painfully efficient. It is easy to spend a day on a single page of Sam's anatomical description, trying to make sure you completely understand his observations and inferences. It is also easy to become impatient because specimens need to be at hand, and often other relevant published work must be reviewed

simultaneously in order to fully grasp his intentions. The result can be in equal parts frustrating and rewarding. It took me two days, simultaneously reading DeBeer's big book on vertebrate head development, to understand his letter sent to Olson (McDowell 1978)—although maybe this says more about me than I would like to admit.

In 1957, with the birth of Janet and the completion of his PhD, Sam started at Rutgers, the State University of New Jersey. Rutgers has three campuses: the main campus in New Brunswick, and smaller campuses in Newark and Camden. Sam worked at the Newark campus, a convenient walking distance from Penn Station-Newark. Downtown Newark during most of the latter half of the 20th century could be a rough place. Imagining Sam's trip from home to campus may reveal something important about whom he was. Sam never owned a car, had a driver's license, or learned to drive—so he saved a lot of money and did his part to spare the environment. Public transportation, his life-long preferred means of travel, from Washington Heights via the A train to Penn Station, transferring to the New Jersey Transit train to Newark, followed by a 15-minute walk to campus was, and still is, a sampling of human diversity as seen through the unique lens of New York, the world's most exciting city. I took almost the same trip every time I went to Newark during my years as Sam's graduate student. It was an education for me; Sam took that trip for 38 years before retiring in 1995 as Professor Emeritus.

During most of the 1960s, Sam's scholarly output was modest. He had a new family and a relatively new job; both may have required much of his time. Also, his research focus changed—he became interested in snakes. His first snake paper was a review of Malnate's book on *Natrix* (McDowell 1961). His commentary on the persistent problems of lumping and splitting anticipated a give-and-take that persists to this day: "Theorists in taxonomy … have drawn much attention to the villainy inherent in splitting, but have said little about the dereliction of the taxonomist's duty implicit in a very large genus. As a result, almost any paper proposing to lump genera is accepted and cheered, but any proposed splitting of a genus meets with hostile suspicion and the assumption that the author must wear spats and a celluloid collar." With the advent of abundant molecular evidence supporting the identification of myriad independent lineages, would Sam be surprised that spats and celluloid collars are in fashion once more?

The humor of this quote reveals a part of Sam's life not widely known: from April 1962 to November 1963, Sam wrote for *The New Yorker*. His uncredited columns appeared in the *Talk of the Town* section at the front of each issue. They are funny, pithy, teasing of pretention, self-deprecating, and loaded with an ironic sense of humor that only a few of us were lucky enough to appreciate. His initial contribution was on the first *Latimeria* received by the AMNH. He noted that the transit from the airport to the museum took three hours: "… an indication that living fossils fare no better than anyone else in getting from the airport to midtown Manhattan." In his account of this arrival, Sam mentions Donn Rosen, Bobb Schaeffer, Ned Colbert, James Oliver, Richard Zweifel, Marjorie Courtney-Latimer, J. L. B. Smith, and a few others on slightly more than one magazine page. This was a lot of name-dropping, especially for Sam. His next column, in May, began with noting the unfortunate case of Enos, the first chimpanzee in space. Apparently, through some sort of NASA mistake, a mild shock, meant to keep Enos pulling a lever to confirm the continuation of his life, was issued whether the correct or incorrect lever was pulled. Sam used the torturing of poor Enos to complain of other evil forms of technology: "… a demented or simply spiteful coffee-vending machine … rejecting a first rate dime for a cup of third rate coffee." What would Sam have thought of a mocha decaf double-shot non-fat latte with a shot of hazelnut—all for only $5.00? Included in Sam's anti-automation rant were complaints of inadequately grounded phone booths (what's a phone booth?), self-service elevators (are there any other kind?), and automated long distance calling (alas, still with us). In February 1963, he continued his dislike of technology. Automated postage cancellation machines unable to handle the return of bottle caps (who remembers why these needed to be returned?) were singled out: "The machine has taken on the role of infallible arbiter of right and wrong that was formerly filled by the dog." Electric typewriters needed scolding for failing to impart the Anger intended by the typist in the depression of the letter "A." An automated pitching machine throwing only fastballs deserved rebuke—"Is it because they lack the guts to go to the curve with a three ball count?"

During his time as a *New Yorker* humorist, Sam became friends with A. J. Liebling, a journalist and frequent contributor to the magazine. In a brilliant Liebling piece (*The New Yorker*, Oct. 27th, 1962) about bouillabaisse, Sam is a hero: "It is a mistake to mention anything unclear to McDowell, because he will go to entirely extravagant lengths to clarify it." Liebling quotes heavily and revealingly from Sam's letters. For example, in a letter thanking Liebling for a fine lunch Sam needed to explain:

> "I want to … apologize for the peculiar way I squirmed in my chair and bulged my eyes whenever a busboy cleared a nearby table. Because of years of exposure to tobacco smoke and formaldehyde preservative, my taste buds are in no condition to make me a judge of the delicacies of fine cookery, but I am a connoisseur of fine fishbones. The sight of that menu, with its marvelous variety of fishes, immediately suggested to me what delights in fishbones there must be in the kitchen garbage cans. I could visualize a huge can of codfish skulls, with striking enlarged intercalary bones; Spanish-mackerel vertebral columns, with articulating processes designed with fine precision and economy; and the skull of my own red snapper, with magnificent supraoccipital crest. Through the years, I have learned not to follow the busboy out into the kitchen and rummage through the garbage, but desire still comes over me, and I am not quite myself when the seductive hints of fishbone-connoisseur's paradise pass before my eyes …"

There may be a link between Sam's complaints of the pitfalls and idiocy of technology and the letters he wrote. They were always hand-written, never on a typewriter. As far as I know, Sam didn't use a typewriter, electric or manual. And I don't think he ever owned a computer or had an email address. At home, he wrote his papers and letters on lined yellow legal pads, sitting in a recliner with his feet on an ottoman. He always wrote using a rapidograph India ink pen and almost never edited or scratched out what was written. None of the letters he wrote to me ever included insertions, strikeouts, or deletions.

From the late 1960s until his last paper published in 2008, most of Sam's scholarly output was devoted to snakes. His work had an effect on almost anyone with serious interests in snake anatomy and evolution. Any snake expert who has not read about the architecture of the corner of the mouth of colubrids

PHOTO BY BRANDON STANTON

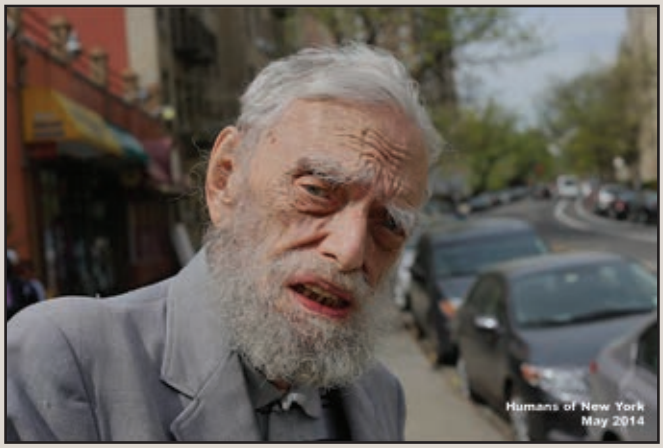


Fig. 4. Samuel Booker McDowell, Jr.—a photo from the *Humans of New York* project taken 8 May 2014. http://www.humansofnewyork.com/post/85118270706/ive-taken-over-five-thousand-portraits-of-people

should be ashamed. He was especially proud of his last paper, which was devoted to the skull of snakes (McDowell 2008, but probably written years earlier)—over 150 pages of dense anatomical description.

In 1973, Sam took a break from snakes and published a series of four papers devoted to the Heteromi. These papers appeared in volume 6 of the monumental *Fishes of the North Atlantic* (Memoir, Sears Foundation for Marine Research, Number 1, Fishes of the Western North Atlantic, part 6). Sam's 228 folio-size pages appeared just before Donn Rosen's cypriniform chapter.

As a comparative anatomist, Sam is certainly best known for his work on snakes. This work has always been difficult because all of the typical anatomy of squamates is crammed into a sometimes pencil thin (or even pencil-lead thin) snake body. Sam's large hands would not have seemed able to tease apart such diminutive detail. And yet his observations and the illustrations he drafted are detailed and beautiful (e.g., see Fig. 3, his illustration of the throat muscles of a tiny *Leptotyphlops*). Many of the skulls illustrated in his work were meticulously—almost miraculously—dissected from preserved specimens. He was often in unexplored territory and his observations were the foundation for the research of others such as David Cundall, Fran Irish, and Alan Savitzky, to mention just a few. The titles of many of Sam's papers were obscure and gave scant clues of the importance of the content. For example, the Bishop Museum series (McDowell 1974, 1975, 1979) dealt with most of the basal lineages of snakes and represents an extraordinary source of anatomical insight. Sam's work is widely regarded as perceptive; even some of his more unlikely systematic conclusions and outrageous ideas of homology have been confirmed by his astonished successors. For example, in 1968, Sam revealed that two "*Elaps*" (the type genus of Elapidae), were not even elapids, and today these two species are *Homoroselaps*. Thus, in a modestly titled paper on two misclassified snakes, Sam redefined the Elapidae and suggested relationships among African burrowing colubrids and atractaspids which have since been corroborated by molecular data (McDowell 1968).

Sam never made it easy on his readers. He had a visceral abhorrence of over-simplification and felt that anatomy for its own sake was worthwhile. He rejected the "least publishable unit" and often buried important observations and hypotheses in larger works. For example, Sam suggested that *Ramphotyphlops bramina* might be the only all-female snake species. This gem glitters in his first of Bishop Museum series of papers (1974). Binary characters—required for cladistic analysis—were, in his view, intellectually dishonest. Boy, did we fight about this. He never generated a character matrix leaving it for others to mine his work for veins of anatomy gold. For any serious student of squamate anatomy, the best advice possible would be: "read and understand the work of Sam McDowell."

I met Sam during my first visit to the AMNH in the summer of 1977. Sam and Rosa let me stay with them during my time in New York. Sam did not attend meetings very often and spent most of his life in New York City. Thus, many people never got an impression of Sam's physical stature. When we met he would have been about 50 years old—tall, at least my height (6'3"), robust, already grey-bearded and grey-headed. I never saw him without a beard. He had large hands and long, slightly re-curved fingers, stained with tobacco and preservatives from pickled snakes (he never wore latex gloves during his dissecting). His fingers seemed to arch backwards even more when holding an often-present cigar away from his body. Although not tanned, his complexion was dark and his gaze was direct and intense; he could seem very intimidating. His expression often reflected concentration, but might have been perceived as irritation or even anger. When really listening, he would slightly close his eyes while twisting his beard. His smile was gentle, but coffee and tobacco took an inevitable toll. Sam's laugh was reserved, and punctuated with small deep chuckles that seemed to come from his chest. He almost always wore a jacket, and short-sleeved button-down shirts, often with small holes from old fallen cigar embers. His wardrobe seemed an afterthought, a classic academic anti-fashion statement. His tie might bear a water mark from dipping into some jar or vat of specimens. On the surface, Sam was the picture of an absent-minded professor with a bit of stubborn honesty that disguised a deeply compassionate and passionate humanist.

For someone whose mind was so well organized, his office and research spaces were almost catastrophically disordered. Piles of papers, bottles of specimens, dissecting equipment—all mixed with a light dusting of cigar ash—gave the mistaken impression of neglect. His rotary telephone at the AMNH was a victim, covered in ash except for the dial, which was polished clean by the need to dial numbers.

Sam was not an extravagant person. He lived modestly, enjoyed watching those damn Yankees win, and liked to thrash me in a friendly game of chess. In fact, in days when communication involved writing letters, his notes to me often began with a chess move—P to Q4. His wardrobe changed little over the years. Even his cigars were cheap. In spite of the importance of his scientific contributions, he was never one for self-promotion. After retirement in 1995, Sam lived quietly in his Manhattan, New York neighborhood. He shared four more years with Rosa before she died; they were married for 47 years. Sam lived another 15 years and he was healthy and fit until the last few days of his life. He lost some weight without Rosa and age bent him a bit. He was napping while Janet sat nearby, knitting neglected, when he peacefully and gently died.

Sam only had two graduate students: me and Edward Saiff (Ramapo College of New Jersey). He had mixed feelings about Rutgers-Newark as a grad school and only encouraged me to come because he was able to arrange for me to be a student researcher at the AMNH.

There are very few pictures of Sam. His daughter Janet tells me he disliked having his picture taken. In May 2014, seven

months before he died, a photographer took his picture as a part of the *Humans of New York* project (Fig. 4). The photographer explained to Sam that he had taken thousands of pictures of New Yorkers and he had learned a little something about each person he photographed. Sam responded: "Well, you're not finding out a thing about me!"—as Rosa would say with a little smile and upward glance "Oh, Sam"—true to himself—always.

Acknowledgments.—Reconstructing a life through the concatenation of vignettes is an entirely unsatisfactory process. Thus, I have felt inadequate to the task of characterizing my friend and mentor. I have tried to be honest and understanding. This was helped by the kindness and generosity of those who knew Sam and some who didn't. I am especially grateful for Janet McDowell's help. She provided details, read drafts, and corrected mistakes. Most of all, she liked what I had written, thereby soothing my worries and insecurities. I am also very grateful to Kevin Padian for his deft editorial hand; the result is so much better thanks to his help. Thanks to my long-time friend Douglas Preston. He read a draft and made my head spin with a few words of encouragement. David Cundall and Alan Savitzky usefully provided excellent and thought-provoking evaluations of Sam's scholarly contributions to snake systematics and comparative anatomy. They allowed me to freely crib from their comments. Harry Greene provided generous commentary and the story of a watermarked tie. Jay Cole shared his recollections of Sam's practice of including important findings in larger works. Others who helped include Elizabeth Hotaling and Douglas Morrison, both colleagues of Sam at Rutgers-Newark, as well as other snake researchers including Fran Irish and Olivier Rieppel. And I thank Doris Crumly, who knew Sam almost as long as I did and listened to "Sam" stories—often the same stories years after year.

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James Albert Organ (1931–2015)

James (Jim) Albert Organ was considered a great educator by his students and peers. He made significant contributions to the field of plethodontid salamander courtship and ecology, and will be long remembered as an ambassador for plethodontid salamander conservation in the Mount Rogers National Recreation Area in southwestern Virginia. Unbeknown to most, Jim played a pivotal role in the establishment of the Society for the Study of Amphibians and Reptiles.



FIG. 1. Jim Organ at MacDill Air Force Base, Florida, processing snakes he had collected (1950).

Jim Organ was born on 29 March 1931 in Newark, New Jersey. He developed his passion for science while participating in the junior museum program at the Newark Museum; he became a life member at the age of nine. Initially, Jim was more interested in building airplane models, but a field trip to a local swamp stimulated his passion for natural history. At ten years of age, Jim was introduced to salamanders by Frankie Culpepper Georges from Cornell University. From her, Jim gained an understanding of how little was known about this animal group. Many years later Jim thanked Dr. Georges for inspiring him to study salamanders.

In the eighth grade, while attending St. Michael's Catholic School, he wanted to read Charles Darwin's *Origin of Species* for a book report, but the school's nuns deemed the book inappropriate. The Newark Museum staff then recommended to Jim that he attend the engineering program at Central Commercial Technical High School. He graduated in June 1948. Immediately after high school Jim enlisted in the U.S. Air Force. He wanted to be a pilot, but his young age prevented him from entering the program and he was later assigned to supply and logistics. Jim completed training at Mitchel Air Force Base on Long Island, and spent the last years of his military service at Air Force bases in Florida where he was able to continue to pursue herpetology in his down time (Fig. 1). He was honorably discharged in 1952 at the rank of staff sergeant.

After serving in the Air Force, Jim attended the Newark College of Arts and Sciences at Rutgers University where he focused on natural history. He earned an A.B. degree, graduating with high honors in the natural history curriculum and special honors in biology. At Rutgers, Jim meet Della Sprague, a fellow biology major, in an embryology course. Jim and Della were married in 1956, and the couple enjoyed 57 years of marriage until Della's death in 2013 (Fig. 2). Della was almost always with Jim during his field trips and for most of his laboratory courtship trials. Jim credited his accomplishments to a lifetime of help from Della. In 1956, the couple moved to Ann Arbor, Michigan, so Jim could begin graduate school and Della could complete a B.S. in Zoology. They had two daughters Linda Joyce, born in 1960, and Sylvia Fawn, in 1961.

Jim obtained his M.S. (1958) and Ph.D. (1960) degrees from the University of Michigan under the direction of Charles M. Walker. Jim's graduate research was conducted on Whitetop Mount and Mount Rogers in the Jefferson National Forest in southwestern Virginia. Walker initially suggested that Jim work on systematics in Mexico or Guatemala, but Jim had fallen in love with salamanders and southwest Virginia. In 1956, Jim took a field trip to the southern Appalachian Mountains to follow the trail, literally and figuratively, established by Emmitt Reid Dunn. After he and Della were married, they revisited the Southern Appalachians to scout for research locations. They decided that Whitetop Mountain would be his primary research location. He sensed that herpetologists often felt they had to explore other countries because everything had been accomplished in the United States. However, he was the first to acknowledge that there was an immense amount of knowledge lacking for southern Appalachian plethodontid salamanders. He was always delighted when young scientists became dedicated to research Appalachian salamanders. Jim encouraged natural history students of all ages to pursue their passion even in an age where natural history and field work were often considered inferior to molecular work. In an interview with Rick Van Noy for his book *A Nature Sense of Wonder*, Jim said "The best scientists are the ones that never quite grow up. They retain a kind of wonder about them" (Van Noy 2008). This quote is very fitting because Jim always wanted to learn more about herpetology in general and Appalachian salamanders in particular. He read each new issue of the *Journal of Herpetology*, *Herpetological Review*, and *Copeia* until the end of his life.

Jim's master's thesis was on the courtship and reproduction of *Plethodon jordani* (now *montanus*) and *P. glutinosus* (now *cylindraceous*), as well as the life history of *P. welleri* (Organ 1958, 1960a, 1960b). Jim and Della observed courtship of *P. montanus* during their first field trip to Whitetop Mountain in 1956. He wrote a manuscript detailing courtship including drawings of spermatophores. However, Walker would not allow Organ to publish the manuscript because he thought the spermatophore resembled a phallus. During the next season, Jim observed courtship again, but this time he took photographs. Once Walker observed the photographs, he then agreed to allow Jim to publish the manuscript which became Jim's first scientific paper (Organ 1958).

For his dissertation, Jim wanted to expand upon the work of Nelson Hairston (1949) in North Carolina where he had documented elevational gradients of plethodontid salamanders. He established elevational transects at 100 ft intervals on northern

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and southern slopes of Whitetop and Bluff Mountains, as well as on Mount Rogers. Jim's dissertation work created the foundation for a long term study to examine elevational distributions in what is now called the Mount Rogers National Recreation Area (MRNRA) established by congress in 1966. Additionally, his dissertation research included life histories, population ecology, and reproduction of five species of desmognathine salamanders (Organ 1961a). During his research, he collected over 12,000 specimens, 7,000 of which were *Desmognathus*. All specimens are in the University of Michigan Museum of Zoology where Jim worked during his graduate degree. Jim published his elevational distribution research with *Desmognathus* salamanders in his 1961 *Ecological Monographs* paper (Organ 1961a). It was later included in the 1964 edition of *Readings in Population and Community Ecology* (Hazen 1964).

Jim and Della Organ's lifetime of research on plethodontid salamander courtship and reproduction created a foundation that researchers continue to build upon. In addition to Jim's publication on the courtship of *Plethodon montanus*, he also documented the reproduction and life history of *Gyrinophilus porphyriticus* and *Desmognathus wright* (now *organi*) (Organ 1961b, 1961c). From his work at the University of Virginia's Mountain Lake Biological Station (MLBS) and City College of New York, Jim published three additional papers on salamander behavior and reproduction of *Eurycea lucifuga*, *Plethodon glutinosus*, and *Pseudotriton ruber* (Organ 1968a, 1968b; Organ and Organ 1968).

Jim continued to work within the MRNRA and focused on his long term studies of salamander distributions. He published an abstract from the 1967 SSAR symposium in which he pointed out the absence of long term salamander population studies (Organ 1968c). In 1990 and 1991, the U.S. Forest Service (USFS) contracted with Jim and Della to repeat his dissertation surveys and to survey additional areas within the MRNRA, including Beech Mountain (Fig. 3; Organ 1990, 1991). Based on his research and recommendations, the Forest Service created and then almost doubled the size of its salamander management zone that protects most areas above 4,000 ft within the MRNRA and additional sensitive areas at lower elevations. Jim recommended that commercial collection of salamanders for fishing bait be prohibited long before others had considered the conservation practice. Jim also suggested the MRNRA staff examine collection requests carefully to ensure they had scientific merit. *Desmognathus organi* (formerly *D. wright*; Northern Pygmy Salamander) was named after Jim Organ for lifetime of salamander conservation (Crespi et al. 2010).

For 31 years (1961–1992) Jim was a faculty member at The City College of the City University of New York, his only academic position in his career. During his tenure, Jim served as the department chair for six years, as well as head of the executive office of the Ph.D. program from 1981–1984. Jim had a reputation for being a rigorous professor and was awarded college teacher of the year in 1989. Jim taught a variety of courses, including general biology, zoology, and anatomy. He developed a lab manual for his vertebrate biology course (Organ 1972). Students who completed his course were thankful for his rigor and thoroughness. Later in life, Jim developed health concerns and visited a new doctor in Marion, Virginia. After the visit, the doctor left the examination room and returned a few minutes later with a smile on his face. "I thought you might be that Jim Organ," the doctor stated. One of the doctor's friends in medical school was a graduate of the City College and had successfully completed Jim's anatomy course. After leaving the room, the doctor had quickly called his friend to confirm Jim's identify and said his friend had noted the rigor in Jim's classes.



FIG. 2. Jim and Della Organ at the Mount Rogers Naturalist Rally, Konnarock, Virginia (2003).



FIG. 3. Jim Organ working in his Konnarock, Virginia, cabin during his 1990–1991 resurveys of the MRNRA (note the map of the MRNRA and sampling areas on the wall above the desk).

Kraig Adler and Jim shared lab space at MLBS in 1966 and 1967. Adler had mentioned to Jim that he and others were having trouble naming a new national herpetology society that had been formed in 1958 as the Ohio Herpetological Society. Jim suggested the "Society for the Study of Reptiles and Amphibians." After a brief discussion, Jim and Kraig thought it would be better to follow taxonomic order and the name was modified to the Society for the Study of Amphibians and Reptiles. Kraig presented the potential name for the society at the 1966 meeting in Pittsburgh where it was adopted. Jim co-chaired the SSAR meeting at Mountain Lake Biological Station in 1968.

Later in retirement, Jim and Della continued to share their love and knowledge of southern Appalachian salamanders. They often led interpretive hikes and presented programs on salamanders. Jim was the keynote speaker for the Mount Rogers Naturalist Rally in 1996 and the Tennessee Herpetological Society in 2007. Jim guided many researchers working in the MRNRA and provided advice and insight for modern resurveys of his

historical datasets conducted by Hamed. Jim and Della would open their home to visiting researchers, as well as college and university field trip groups. Everyone who spent time with the Organs relished their knowledge of plethodontid salamanders, as well as their stories of a lifetime of field work. Jim and Della were also great salamander ambassadors to the local community surrounding the MRNRA. Fears of endangered species and land seizures were often calmed with Jim's knowledgeable discussions and personal conversations. Based on his research, Jim felt a few areas within the MRNRA lacked woody cover objects. While eating at a local restaurant, Jim was approached by a Konnarock, Virginia, resident who stated "you want to cut down trees for salamanders?" Jim promptly began a discussion about his recommendation and the need for cover objects. Local residents knew Jim and Della and they were well respected. Some local residents coined the nickname the "salamaster", which was fitting.

Jim Organ died on 16 January 2015 in Konnarock, Virginia, in the cabin he and Della built and where they spent summers until his retirement when it then became their permanent residence. Jim was surrounded by family and friends during his last few months. His impact on his students and the field of plethodontid salamander behavior and ecology, especially in the MRNRA, will be long remembered and serve as a testament to a lifetime of hard work dedicated to a salamander-rich area.

Portions of this obituary were derived from Walls et al. (2014).

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Walls, S. C., K. Hamed, and J. C. Mitchell. 2014. Historical perspectives: James and Della Organ. Copeia 2014:248–250.

CURRENT RESEARCH

The purpose of Current Research is to present brief summaries and citations for selected papers from journals other than those published by the American Society of Ichthyologists and Herpetologists, The Herpetologists' League, and the Society for the Study of Amphibians and Reptiles. Limited space prohibits comprehensive coverage of the literature, but an effort will be made to cover a variety of taxa and topics. To ensure that the coverage is as broad and current as possible, authors are invited to send reprints to the Current Research section editors, Ben Lowe or Chava Weitzman; e-mail addresses may be found on the inside front cover.

Freezing as a Method for Euthanasia

Over the last few decades, methods for euthanizing small reptiles and amphibians have been under scrutiny. One method widely used historically, though currently out of favor, is a combination of cooling and freezing. Concerns about ice crystals forming while the animals are still conscious and therefore exposed to severe pain have led to a perception that this method is not sufficiently humane. The authors of this study investigated the effects of freezing on Cane Toads (*Rhinella marina*) in Australia, where an efficient method for disposing of large quantities of toads is needed and where the freezing method is frequently employed. The authors initially implanted electroencephalogram electrodes to anesthetized toads. Ten days after recovery from surgery, the toads were implanted with a thermocouple wire to monitor body temperature, and then subjected to cooling and freezing. Toads were initially cooled to 5°C in a refrigerator, after which they were placed in a freezer. These experiments revealed a linear decline in braid activity with declining temperature, and no evidence of brain activity spikes consistent with pain associated with freezing. The authors also investigated pertinent literature, demonstrating that research contradicts anti-freezing arguments. Specifically, the brain temperature reflects air temperature, body tissues freeze at temperatures below 0°C, cold is a general anesthetic, and, at least in Cane Toads, brain function effectively ceases at 3.2°C. The authors argue that experiments and literature support freezing (when combined with cooling) to be a humane method of euthanasia comparable with other widely used methods. However, they caution that these findings may not reflect the effects of freezing euthanasia in larger or cold-adapted species.

Shine, R., J. Amiel, A. J. Munn, M. Stewart, A. L. Vyssotski, and J. A. Lesku. 2015. Is "cooling then freezing" a humane way to kill amphibians and reptiles? Biology Open (*in press*) doi: 10.1242/bio.012179.

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Middle Triassic Stem Turtle Provides Insights into Turtle Evolution

In 2008, the discovery of a Late Triassic stem turtle, *Odontochelys*, provided important insights into the evolution of turtles. At 220 million years old, *Odontochelys* represented a transitional stage in turtle evolution. In lieu of a carapace, *Odontochelys* had wide, flat ribs lacking intervening bone, though small neural plates were present adjacent to the vertebrae. Additionally, *Odontochelys* had teeth on the maxilla, premaxilla, dentary, and palatal bones. Like modern turtles, *Odontochelys* possessed a fully developed plastron and its skull lacked temporal fenestrae. The authors of the paper described here announce the discovery of an even older stem turtle. Named *Pappochelys*, it was retrieved from 240 million year old sediments in Germany. Like *Odontochelys*, *Pappochelys* bears teeth on the maxilla, premaxilla, and dentary (dental condition of palatal bones is uncertain). It also possesses expanded ribs but lacks the small neural plates of *Odontochelys*. In place of a plastron, *Pappochelys* possesses a series of enlarged, paired gastralia, forming a jagged lateral margin akin to the margin seen in the plastron of later turtles. Perhaps most exciting is the presence of temporal fenestrae, the diagnostic feature of Diapsida; this is in line with recent molecular analyses recovering turtles as a clade nested within Diapsida. In light of this finding, turtle stem lineages had paired temporal fenestrae which were lost in the lineage leading to *Odontochelys* and extant turtles. The sediments and associated fossils (fish, temnospondyl amphibians, terrestrial diapsids) indicate *Pappochelys* occurred at a lacustrine-terrestrial interface, suggesting either an aquatic or amphibious lifestyle. This discovery lends further support to existing hypotheses regarding the phylogenetic placement of turtles, as well as turtle skull and plastron evolution.

Schoch, R. R., and H.-D. Sues. 2015. A Middle Triassic stem-turtle and the evolution of the turtle body plan. Nature (*in press*) doi:10.1038/nature14472.

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Arboreal Snakes have Disproportionately Long Tails

Previous work has demonstrated a correlation between certain anatomical characteristics and arboreality in snakes, with the theory that they reduce the gravitational effects on the cardiovascular system experienced during vertical climbing. Such potential adaptations include small body width to length ratios, anteriorly positioned hearts, and tissues within the tail resistant to edema. The latter has cascading effects on climbing snakes, as edema reduces blood pressure, thus robbing the brain of vital blood flow. In an effort to determine whether long tails relative to body length can be added to this list, the authors of this paper collected data on 226 species spanning the snake phylogeny. Data was taken from female snakes to standardize the comparisons and to avoid issues associated with the presence of hemipenes. Total, tail, and body length measurements were made, and from these, a relative tail length (RTL) was calculated. Species were assigned to one of three "gravitational habitat" categories: obligatorily arboreal, facultatively arboreal and terrestrial, and non-arboreal (terrestrial and/or aquatic) (saxicolous species were not represented). ANCOVA and ANOVA methods were employed to identify if RTL and total body length varied significantly among the treatments, respectively. As phylogenetic relatedness could itself lead to a correlation between ecology and morphology, a phylogenetic independent contrast (PIC) analysis was conducted. For this, the authors constructed a "supertree" for the included taxa by pulling together phylogenetic information from several previous studies; as the information was derived from different analyses, the branch lengths were set to equal. In this analysis, the discrete gravitational habitat categories were treated as continuous data, with obligatorily arboreal, facultatively arboreal and terrestrial, and non-arboreal forming a continuum from high to low gravitational stress, respectively. These analyses revealed the three categories did indeed differ in RTL; post-hoc analysis found RTL declined with declining arboreality. Meanwhile, non-arboreal snakes were shorter than obligatorily and facultatively arboreal snakes (the latter two categories did not differ in total length). The PIC analysis demonstrated that when phylogenetic relatedness is accounted for, RTL is still positively correlated with increasing arboreality. The authors argue that by increasing RTL, arboreal snakes increase the proportion of the body possessing edema-resistant tissues, thereby counteracting the effects of gravity-induced cardiovascular stress. Further, they point out that total length appears to be constrained in obligatorily arboreal snakes (given selection for longer tails), and that in addition to gravitational stress, selection for maximal gap- spanning ability may be contributing to this, as gap-spanning ability relative to body length decreases with increasing body length.

Sheehy III, C. M., J. S. Albert, and H. B. Lillywhite. 2015. The evolution of tail length in snakes associated with different gravitational environments. Functional Ecology (*in press*) doi: 10.1111/1365-2435.12472.

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New Insights into the Evolution of Temperature-Dependent Sex Determination

The potential consequences of climate change for species with temperature-dependent sex determination (TSD) are of pronounced concern to conservation biologists. These concerns

extend to species with otherwise genotypic sex determination (GSD) that exhibit a "temperature override," where certain temperatures cause embryos to undergo sex reversal relative to their genotypic sex. Through analysis of wild populations and experiments in the lab, the authors of this paper aimed to determine the potential effects of climate change for a known temperature override species: Australia's Central Bearded Dragon (*Pogona vitticeps*). In this ZZ/ZW species (where females are the heterogametic sex), high temperatures cause genetic males to develop as females. Blood samples were collected from wild dragons across a swath of their distribution from the northern corner of Victoria to the southwest corner of Queensland. Phenotypic sex was determined through visual inspection and physical manipulation, and genotypic sex was determined via PCR. The PCR procedure involved amplifying a gene on the W chromosome and an autosomal gene (control); in the ensuing gel electrophoresis, PCR product from genetic females would have two bands while those from sex-reversed females would have one. These studies revealed a region with a high proportion of sex-reversed females straddling the border between New South Wales and Queensland. Despite numerous laboratory-based demonstrations of sex reversal in amniote species, this study represents the first documentation of this phenomenon in a wild population. Back in the lab, the authors of this paper subjected clutches of eggs from genetic and sex-reversed females to a suite of temperatures, and raised the resulting offspring to determine genotypic and phenotypic sex. Analysis of the offspring data from the genotypic females indicated the temperature above which sex reversal begins to skew the sex ratio is about 33°C, corroborating previous studies. The sex ratios of the offspring of sex-reversed females followed a common pattern seen in species with TSD: males only at low temperatures and females only at high temperatures. The sex-reversal mechanism in sex-reversed female offspring was more sensitive, with the pivotal temperature being a full degree below that of genetic female offspring. Most surprisingly, eggs from sex-reversed females exhibited a higher frequency of successful hatching. While previous attempts to explain the existence of TSD have focused on adaptive processes, these experiments suggest a novel pathway to TSD, where rising temperatures alone can eliminate genetic females from a temperature-override population in a single generation. Further, if sex-reversed females possess greater fitness than their genetically female counterparts, this may also serve to eliminate GSD from a population.

Holleley, C. E., D. O'Meally, S. D. Sarre, J. A. Marshall Graves, T. Ezaz, K. Matsubara, B. Azad, X. Zhang, and A. Georges. 2015. Sex reversal triggers the rapid transition from genetic to temperature-dependent sex. Nature 523:79-82.

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Environmental Conditions of Yellow-Spotted Monitor Nests

Female Yellow-Spotted Monitors (*Varanus panoptes*) are known to excavate nests in close proximity to one another, forming communal "warrens." These nests serve no additional purpose (e.g., adult estivation) as they are filled with loose soil subsequent to ovipositing. A study researching the nesting behavior of this species was published in 2014 that revealed the nesting burrows of *V. panoptes* to be corkscrew-shaped and up to 3.6 m in depth—the deepest cavities dug strictly for nesting ever recorded for a living vertebrate. The paper described here (from the same research group as the aforementioned 2014 paper) aims to shed light on the function of these deep, spiraled burrows. Noting that they bear a striking resemblance to fossil burrows of a Permian therapsid (*Diictodon*) and a Miocene beaver (*Palaeocastor*), they propose that studying deep helical burrows in an extant species may provide insights into these fossil "*Daimonelix*" (or "devil's corkscrews"). The team found and excavated 52 nests, fifteen of which had viable eggs and the remainder of which were presumably from previous years. In an effort to test the hypothesis that deep, helical burrows served to optimize thermal and/or moisture conditions experienced by eggs, the authors placed data loggers along the length of the rebuilt egg-containing burrows to collect temperature data, and took soil samples for moisture quantification. These temperature data were analyzed using linear mixed-effects models with depth and season as fixed effects and specific burrow as a random effect. Non-linear regression was employed to identify a correlation between moisture and depth. These experiments revealed variation in temperature decreased with increased depth. Relative to deeper depths, shallower depths were not only warmer in the warm season, but also colder in the cold season. Interestingly, despite being of variable depth, there was no significant correlation between nest depth and temperature, suggesting nests are constructed to achieve optimal temperatures. A significant positive correlation between moisture and depth was found. The moisture-content increase from one to three meters was small in an absolute sense but relatively large (37%) as these desert soils are exceptionally dry. The authors discuss in depth other hypotheses attempting to explain helical burrows in *V. panoptes* and other taxa; however, their experiments do support the hypotheses that these burrows serve to optimize temperature and maximize moisture experienced by developing eggs.

Doody, J. S., H. James, K. Colyvas, C. R. McHenry, and S. Clulow. 2015. Deep nesting in a lizard, *déjà vu* devil's corkscrews: first helical reptile burrow and deepest vertebrate nest. Biological Journal of the Linnean Society (*in press*) doi:10.1111/bij.12589.

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Underpinnings of Reduced Fertilization Success in Explosive Breeding Males

Although female reproductive output limitation due to gamete depletion is well documented in explosive-breeding anuran species, the degree to which males of these species exhibit this is less understood. The authors of this paper set out to study this phenomenon in Wood Frogs (Ranidae: *Lithobates sylvaticus*). Wood Frogs are among the earliest breeders throughout their range (northern, eastern North America), and while at the breeding sites males do not eat and instead subsist solely on energy stores remaining from the previous fall. With such limited

energy available, it would seem these males would have a limited supply of sperm during a given season. Previous studies of explosively breeding anurans have demonstrated both decreased sperm count and decreased fertilization success with successive matings; however, whether a reduction in sperm count or energy is to blame for this reduced success is unknown. To test this, the authors allowed male frogs to successively mate with three to four gravid females over the course of a few days during two breeding seasons. Prior and subsequent to mating, females were weighed to determine the mass of the eggs, and males were weighed and measured to determine a body condition index. Subsequent to mating, egg masses were brought into the laboratory and allowed to develop to the initiation of hatching, at which point the number of fertilized eggs was determined. These data were analyzed using linear mixed models, with number of fertilized eggs as the dependent variable and mating order, year, mass of eggs, and male body condition as fixed effects. A logistic regression was also run to determine if male condition was correlated with fertilization failure. The authors hypothesized that reduced reproductive success due to diminishing sperm count would result in a gradual decline of fertilization success (as sperm count tapers off gradually), while that due to energy-store depletion would result in complete failure to fertilize following reproductive bouts of normal success. The only significant effect detected was the order of the mating; however, this disappeared when complete fertilization failures were removed, indicating a pattern expected if energy-store depletion is affecting fertilization. Additionally, males that failed to fertilize did not differ in size or body condition from those that successfully fertilized consistently. Taken together, these findings illustrate that despite reduction in sperm count with successive matings, other factors may still underlie the reduced fertilization success seen in explosive breeders.

Swierk, L., J. B. Tennessen, and T. Langkilde. 2015. Sperm depletion may not limit male reproduction in a capital breeder. Biological Journal of the Linnean Society (*in press*) doi:10.1111/bij.12603.

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Testing Predatory-Bite Protection Hypothesis for Lizard Armor

Though body armor is commonly assumed to serve to protect soft bodies from crushing predatory bites, this hypothesis is infrequently evaluated in a rigorous fashion. As degree of armament is generally conserved within clades, few 'natural experiments' exist allowing for the testing of these hypotheses. The authors of this paper chose to test hypotheses of armor function in one clade that does show considerable armor diversity: lizards of the family Cordylidae. Lizards in this family possess both dermal bone and keratinized epidermal armor which have been hypothesized as a defense against predatory bites. They chose to investigate five species, including single populations of *Karusasaurus polyzonus*, *Namazonurus peersi*, *Cordylus macropholis*, and *C. cordylus*, and three populations of the Armadillo Lizard (*Ouroborus cataphractus*), which are known to vary in degree of armament. Frozen/thawed but otherwise unpreserved skins were subjected to simulated bites from skulls of four sympatric species of herpestid mongooses that are likely predators of these lizards. This involved attaching a mammal cranium to a force transducer, and determining the force required for each skull to pierce each skin. The authors also used light microscopy to quantify the degree of dermal bone and keratinized epidermis in each skin, indicated by thickness of osteoderm and -keratin thickness, respectively. Using an established protocol, estimates of potential bite force were generated for the skulls based on morphometrics. Two ANOVAs were performed; one using the bite force/skin strength data to identify significant differences in skin strength and bite force, and any interactions between the two, and another to determine if there is variation in armor among the lizard species/populations. Finally, a Spearman rank correlation analysis was performed to determine whether skin toughness and degree of armor are significantly correlated. These analyses demonstrated significant variation among bite forces and skin strengths. Post-hoc tests revealed the skins to be of similar toughness with the exception of the *O. cataphractus* populations, which had significantly tougher skin. Further, significant differences in skin toughness were detected among the *O. cataphractus* populations. Similarly, bite force varied among herpestid species. Taken together, all mongoose species have sufficient bite force to puncture the skin of *K. polyzonus*, *N. peersi*, *C. macropholis*, and *C. cordylus*; as for *O. cataphractus*, one or two populations have skin of sufficient strength to withstand the bite of the three weakest mongooses, though the strongest (*Herpestes ichneumon*, the Egyptian Mongoose) is capable of puncturing the skin of all cordylid species examined. Little difference was detected in the degree of keratinized epidermis, while degree of dermal bone showed more variation and mirrored the observed variation in skin toughness. These experiments demonstrate that dermal bone is the primary contributor to skin strength, though even the toughest skin is susceptible to at least one local predator, implying there may be other factors driving the evolution of armament, including (the authors suggest) aiding in thermoregulation, prohibiting extraction from rocky retreats, and serving as mineral reservoirs.

Broeckhoven, C., G. Diedericks, and P. L. F. N. Mouton. 2015. What doesn't kill you might make you stronger: functional basis for variation in body armour. Journal of Animal Ecology (*in press*) doi:10.1111/1365-2656.12414.

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Researchers Reveal Insights into Social Dynamics of Cottonmouths

Recent studies have greatly expanded our understanding of viperid social behavior, for instance revealing that Timber Rattlesnake (*Crotalus horridus*) individuals can recognize kin and preferentially associate with them. The authors of this paper chose to explore how postnatal maternal attendance affects these behaviors in the Cottonmouth (*Agkistrodon piscivorous*). Gravid females were collected from the wild and allowed to give birth in captivity. Upon birth, clutches were assigned to one of two

treatments: they were either allowed to remain with their mother and their siblings until their first shed (maternal attendance, or MA, treatment) or were removed and placed into solitary confinement (separated, or SE, treatment). In the former treatment, subsequent to shedding, the offspring were also placed in solitary confinement. After six months, snakes were assigned to same-sex pairs so that half were paired with a littermate and half were paired with an unrelated snake. To ensure all paired snakes were either full sibs or unrelated, snakes were paired from different localities, and multiple-paternity clutches were identified via genetic testing. Pairs were recorded interacting and average distance and time entwined was calculated; these data were analyzed using general linear modeling and post-hoc tests. This experiment revealed female kin in the MA treatment showed a high affinity to one another while those in the SE treatment avoided each other. Male kin showed the exact opposite pattern, while the non-kin treatments showed no pattern. These same patterns were also reflected in the time spent entwined. Subsequent to these experiments, the same juveniles were subjected to similar trials with either their mother or an unrelated mother. Analyzed using linear mixed models, these experiments revealed regardless of sex, related juveniles and mothers in the MA treatment showed a higher affinity than their unrelated counterparts. In contrast, pairs in the SE treatment showed highly variable degrees of affinity. Further, the only group that showed a greatly reduced propensity to entwine included mothers and unrelated females, regardless of treatment; thus, contrary to what was seen for siblings, maternal attendance appears much less important for mother-offspring relationships. The authors stress that this and similar studies show that "cryptic sociality" is more widespread than generally recognized, and more investigation into the dynamic of facultative parental care is warranted.

Hoss, S. K., D. H. Deutschman, W. Booth, and R. W. Clark. 2015. Post-birth separation affects the affiliative behaviour of kin in a pitviper with maternal attendance. Biological Journal of the Linnean Society (*in press*) doi:10.1111/bij.12604.

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Brazilian Frogs Found to be Venomous

Venom, toxin aligned with a delivery system, is common among snakes but has evolved infrequently across the vertebrate tree. And though the presence of poison glands is a synapomorphy of Amphibia, few amphibians exhibit an associated delivery mechanism. Two closely-related hylid frogs in Brazil, *Aparasphenodon brunoi* from the Atlantic Forest ecoregion and *Corythomantis greeningi* from the Caatinga ecoregion, do fall in the venomous category, as they have potent secretions and affiliated cranial spines which pierce through glands to deliver venom to potential predators. The authors of this study set out to further characterize the venom systems of these frogs. Their experiments revealed secretions from *A. brunoi* had LD50 values of ~4 µg while those from *C. greeningi* were ~50 µg. Compare those scores to those of sympatric pitvipers (*Bolthrops*), who average ~100 µg. Further, experiments wherein mice were injected in the paw with one of several toxin dosages and monitored for changes in volume via a plethysmometer showed that maximum edema from *A. brunoi* and *C. greeningi* occurred in 30 and 60 minutes, respectively, and edema persisted for at least 70 hours. SDS-PAGE experiments demonstrated that venom glands of both species possess diverse protein profiles. Experiments aimed at identifying specific enzyme categories found little evidence for proteases in either species' head glands, but hyaluronidase activity was seen in both; these enzymes are well known in squamate venom for their toxin-dispersing properties, but hitherto unknown in amphibians. Scrutiny of photographs and SEM images established both species possess extensive spines on their skulls serving to deliver toxins, with those of *C. greeningi* being the more dramatic of the two. These spines are particularly conspicuous in the rostral region. Histological sections showed that the head glands of *C. greeningi* are exceptionally large; despite having weaker venom than *A. brunoi*, larger glands and more substantial spines make *C. greeningi* similarly formidable. The authors discuss how when captured, these frogs aggressively flex their head, jabbing their venom-fortified spines into the collector's hand. They argue that other frogs with cranial ornamentation (including several rhacophorid species) should be investigated for similar venom apparatus.

Jared, C., P. L. Mailho-Fontana, M. M. Antoniazzi, V. A. Mendes, K. C. Barbaro, M. T. Rodrigues, and E. D. Brodie, Jr. 2015. Venomous frogs use heads as weapons. Current Biology (*in press*) doi:10.1016/j.cub.2015.06.061.

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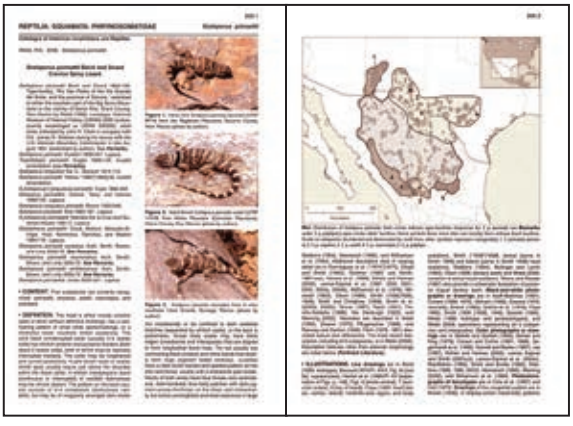
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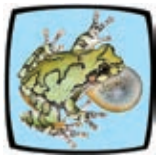
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Discovery of the Critically Endangered Golden Tree Frog, *Phytotriades auratus* (Boulenger, 1917), in Eastern Venezuela, with Comments on its Distribution, Conservation, and Biogeography

The enigmatic hylid *Phytotriades auratus* (Boulenger, 1917), commonly known as the Golden Treefrog, is thought to be an endemic restricted to the two highest peaks in the Northern Range of Trinidad, the main island of the Republic of Trinidad & Tobago:[1] Cerro del Aripo (940 m) and Mount El Tucuche (936 m). In his original description, Boulenger (1917) highlighted the similarity of *P. auratus* with *Amphodus wuchereri*, and described it as *A. auratus*. Bokermann (1966) determined that the genus *Phyllodytes* Wagler, 1830 had priority over *Amphodus* Peters, 1873 and resurrected the former, allocating the two known species (*wuchereri* and *auratus*) to *Phyllodytes*. Since then, nine other species have been added to the genus and all, with the exception of *P. auratus*, are restricted to eastern Brazil (Mata Atlântica). Over 75 years after its initial description, Clarke et al. (1995) provided the first population estimate for *P. auratus*, surveying populations. Their study confirmed the presence of *P. auratus* at El Tucuche and Aripo, ruling out the existence of populations on the other two peaks. Jowers et al. (2008) demonstrated that the genus *Phyllodytes* is paraphyletic on the basis of evidence from mitochondrial genes. They showed that levels of divergence between *P. auratus* and Brazilian *Phyllodytes* were greater than intergeneric distances within the tribe Lophiohylini and erected the genus *Phytotriades* to accommodate the Trinidadian species.

Phytotriades auratus is a bromeliad-dwelling hylid, closely associated with the tank bromeliad *Glomeropitcairnia erectiflora*. Clarke et al. (1995) undertook the first population estimates for the species, surveying Cerro del Aripo (940 m), Mt. Tucuche (936 m), Chaguaramal (859 m), and Morne Bleu (848 m). The study confirmed the presence of Golden Treefrogs on Aripo and El Tucuche. Chaguaramal and Morne Bleu were excluded as possible localities due to the absence of *G. erectiflora*. However, *G. erectiflora* has been mentioned for Chaguaramal, but now this plant seems to have been extirpated from that locality (Clarke et al. 1995).

[1] The term Trinidad & Tobago, with the ampersand, denotes the country. When Trinidad and Tobago is used, connected by the word "and," this refers to the two islands as geological features.

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The Discovery of *Phytotriades auratus* in Venezuela

We visited the summit of Cerro Humo, Península de Paria, Sucre State, Venezuela (62.631284°S, 10.692359°W, 1250 m elev.) on 31 August 2014 (ca. 1100 h), to conduct a survey of its conservation status. The summit consists of a very narrow ledge that decreases in width towards the north and is flanked by two steep drop-offs facing east and west, respectively. The widest area of this corridor (ca. 0.5 ha) was cleared in the past to make way for a heliport and communication infrastructure, aimed at finding oil and gas deposits in the Caribbean Basin and the Gulf of Paria, and has subsequently become colonized by herbaceous plants. The southeast face of the ridge is exposed to the trade winds, which allows a high-altitude tropical elfin forest, composed mainly of small trees and epiphytes, to thrive. At present, this elfin forest is confined to the southeastern corner of the summit, extending across no more than 2 ha in size, but having likely occupied most of the area of the summit that was cleared. The main epiphyte bromeliad present within the elfin forest is *Glomeropitcairnia erectiflora*. Below the summit, a moderately disturbed (mostly on the southern face) Tropical Montane Cloud Forest (TMCF) of 208 ha in size surrounds Cerro Humo and its elfin forest.

As we began to document the status of Cerro Humo's summit photographically, the path was blocked by a recently fallen tree trunk with several mature-sized *G. erectiflora* growing on it. Upon closer inspection, we observed movement on one of the *G. erectiflora* and discovered two *P. auratus* moving across the fallen trunk (Fig. 1 A–D). A third specimen was spotted on a nearby *G. erectiflora* growing 40 cm above the ground. Due to the

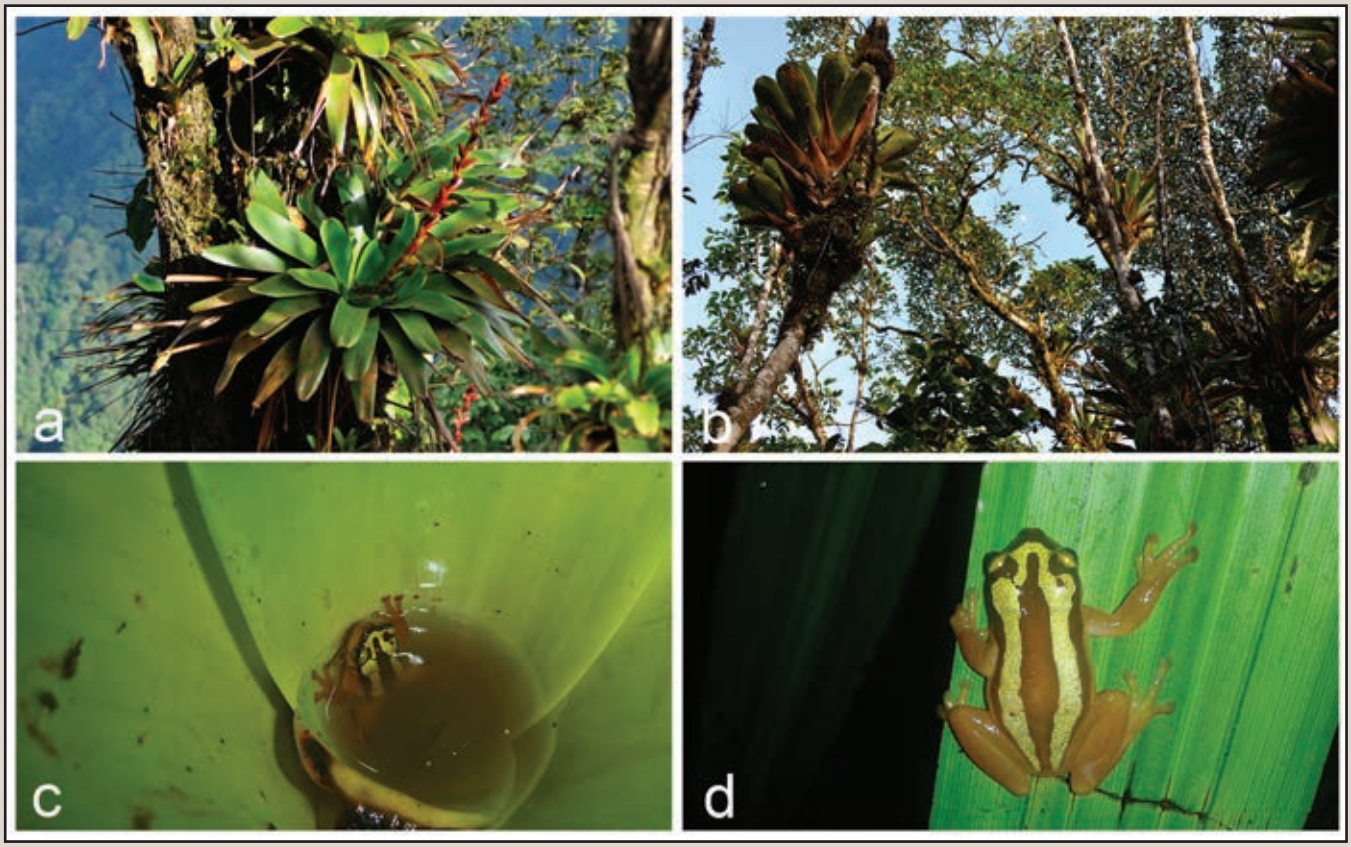


FIG. 1. Communities of *Glomeropitcairnia erectiflora* at the summit of Cerro Humo (A, B). Individual of *Phytotriades auratus* photographed in Cerro Humo and inside the tank of a *G. erectiflora* (C). Dorsal view of same specimen outside the bromeliad (D).

inaccessibility of most bromeliads from the forest floor and our reluctance to begin an invasive survey, no further inspection was carried out; no specimens were collected.

The discovery of this population on Cerro Humo is hardly surprising. Geologically, the Northern Range of Trinidad is considered an extension of the Venezuelan Coastal Cordillera (Beard 1948), and examples of shared flora and fauna between northeastern Venezuela (Turimiquire massif and Península de Paria), and Trinidad and Tobago abound: the gecko *Gonatodes ceciliae* and the marsupial frog *Flectonotus fitzgeraldi* are common both in Península de Paria and on Trinidad. The centrolenid *Hyalinobatrachium orientale* and the White-tailed Sabrewing, *Campylopterus ensipennis,* are both present in Paria, Turimiquire, and on Tobago. Recent herpetofaunal studies in the Península de Paria (e.g., Mijares-Urrutia et al. 2000; Schargel et al. 2005; Rivas et al. 2005; Barrio-Amorós et al. 2006, Manzanilla et al. 1996, 2007; Myers et al. 2009) support the close relationship among northern Trinidad, the Central Coastal Range, the Turimiquire massif, Amazonia, and the Guiana shield. The Península de Paria is catalogued as a "plant refuge" along with the Turimiquire massif, with a large number of representative species also distributed in Trinidad and/or Tobago (Beard 1948; Steyermark 1974, 1979, 1982). It is also an Important Bird Area (IBA VE019, Birdlife) and, along with the Turimiquire massive, is part of a greater Endemic Bird Area (EBA, Birdlife). Lastly, two endangered bird species (*Myioborus pariae* and *Hylonympha macrocerca*) function as trigger species for the Alliance for Zero Extinction (AZE) site VEN8.

Circumstantial evidence might also point to the existence of *P. auratus* on Isla Margarita, Venezuela. In 1964, Janis Roze reported the discovery of three frogs in the axil of a bromeliad on Cerro El Copey (960 m). Although Roze (1964) did not specifically mention the bromeliad species where the frogs were observed, *G. erectiflora* is the most likely candidate, since is the dominant and most abundant bromeliad on the summit of Cerro El Copey, where it even grows at ground level (Hoyos 1985; González 2007). Roze (1964) tentatively assigned the specimens to *Hyla rubra* (= *Scinax ruber*) since Brongersma (1948) had earlier identified a specimen from Guatamare (elev. 50 m) as *S. ruber* but he did so with reservation and called them *Rana del Copey* (the Copey frog); they may represent an undescribed species. More recently, Ugueto and Rivas (2010) reported two specimens of *S. x-signatus* from Juan Griego and Salamanca, respectively (elevations 30 and 50 m). It is very likely that the specimen reported by Brongersma was in fact *S. x-signatus,* and not *S. ruber.* In any case, both *Scinax* species are lowland forms associated with anthropogenic disturbance and floodplains, and it is doubtful that the specimens collected by Roze belonged to either of them. Unfortunately, it is impossible to clarify this, since Roze's specimens were lost. We are inclined to believe that due to the intrinsic synchrony between *G. erectiflora* and *P. auratus,* the *Rana del Copey* might be a *Phytotriades.*

PENÍNSULA DE PARIA, TURIMIQUIRE MASSIF, TRINIDAD AND TOBAGO, A BIOGEOGRAPHICAL CONNECTION

The complex biogeography of Turimiquire/Paria/Trinidad/Tobago is marked by two different events: (A) the "refuge" status with its connection between the flora and fauna of the Amazon, Venezuelan Guayana (Guiana Shield), and the Coastal Range, including its easternmost portion and Trinidad, and (B) the historical detachment of Trinidad and Tobago from

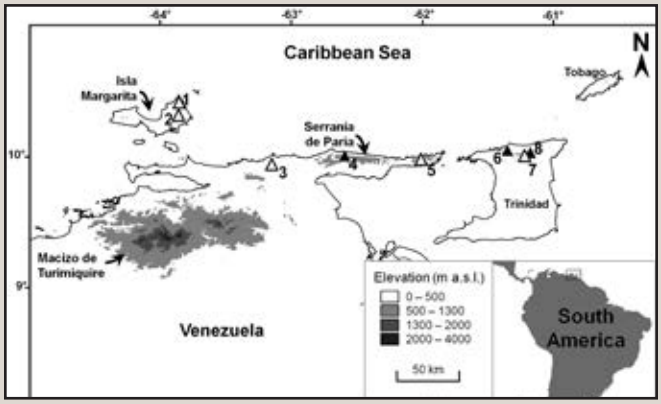


FIG. 2. Map of northeastern Venezuela (including Isla de Margarita), Trinidad, and Tobago showing the known geographic distribution of *Phytotriades auratus* and *Glomeropitcairnia erectiflora.* Black triangles represent localities where *P. auratus* has been recorded from *G. erectiflora* (Kenny 1969; Read 1982; this paper). Open triangles are records of *G. erectiflora* only. Numbers indicate localities as follows: (1) Cerro Tragaplata, (2) Cerro El Copey, (3) Cerro La Cerbatana, (4) Cerro Humo, (5) Cerro Patao, (6) Mount Tucuche, (7) Chaguaramal, (8) Cerro del Aripo. Records of *G. erectiflora* from Venezuela come from Hoyos (1985), Steyermark and Agostini (1966), and Grande and Meier (2012).

the mainland, with later cyclic connections and isolations. Several hypotheses have been put forward to explain the first event: 1) expansion and contraction of tropical forest during humid and dry interglacial and glacial periods respectively, isolating populations of remnant forests, called Quaternary paleoecological refuges; 2) sea transgressions and the formation of the Amazon lagoon during interglacial epochs that could have isolated ancestral populations in elevated areas such as the Atlantic Forest, the Andes, and the Guiana Shield. In both cases, genetic differentiation may have been promoted, allowing allopatric speciation to occur (Grau et al. 2005). The islands of Trinidad and Tobago are not part of the Antillean arc. In fact, Trinidad is part of the continental shelf, while Tobago belongs to the Caribbean Plate, which explains why the latter has been moving eastwards while Trinidad has remained in place. Both islands are reputed to have been connected with the mainland during glacial maxima, when sea levels were lower during the Pliocene and Pleistocene, estimated to have been as low as 180 m below present levels. By that time, between 7 and 4 Myr ago, Tobago was located further west, positioned much closer to the Península de Paria and possibly Isla Margarita, and thereby offered a better position to exchange faunal elements through land connections with the peninsula, as opposed to Trinidad (see Jowers et al. 2014). Such hypotheses cannot fully explain the absence of *H. orientale* and *C. ensipennis* from Trinidad, but particular habitat requirements and/or the ability of different organisms to disperse might have played an important role; nor can local extinctions be discarded.

Conservation Challenges for the Species

Clarke et al. (1995) reported no more than 206 ha of suitable habitat for *P. auratus* in Trinidad. In Venezuela, *P. auratus* has been found in the elfin forest that crowns part of the summit of Cerro Humo. The permanent cloud cover at the summit and its steepness make difficult an exact estimation of the total extension of ideal habitat for the species, but based on field observations we concluded the total area is no more than 20,000 m^2. Nevertheless, the other locations where *G. erectiflora* has been reported in Venezuela, namely, Cerro Patao (elevation 1000 m) and La Cerbatana (elevation 1000 m) in the Península de Paria, and Cerro El Copey on Margarita Island, are potential places where *P. auratus* could be found, and must be surveyed before assessing the taxon at regional scale.

The government of Trinidad & Tobago listed the Golden Treefrog as an Environmental Sensitive Species (ESS) through the Environmental Management Act (EMA) of 2013 (Legal Notice No. 32). The movement was highly anticipated due to the public interest in the EMA, and it represented a major development in terms of the conservation of *P. auratus.* One of the isolated populations of *P. auratus* is already protected as it occurs in habitat included in the Northern Range Game Sanctuary, popularly known as El Tucuche Reserve. Even though *G. erectiflora* is not formally protected, the EMA prohibits any collection, destruction, or removal of *G. erectiflora,* or interference with it and other bromeliad(s), which the ESS inhabits and/or depends on for its survival (EMA 2013).

Despite having important legislation in place to protect sensitive ecosystems and species alike, the Government of Trinidad & Tobago confronts significant declines at both levels, with anthropogenic activities among the main causes. Poor enforcement, inadequate resource allocation, and lack of coordination among stakeholders, were recognized as the main culprits for the tepid performance of Trinidad & Tobago in fulfilling the 2010 Biodiversity Targets (Convention on Biological Diversity 2010).

The discovery of *P. auratus* in Venezuela represents an important development for the conservation of this species, adding another apparently viable population to the initial two from Trinidad, although an extended period of isolation could have resulted in both populations becoming distinct and genetic studies must be undertaken in order to confirm this. Part of the Venezuelan population is located within the boundaries of Península de Paria National Park, which facilitates its conservation. However, the boundary of the park covers only the north face of the peak, leaving more than half of the habitat of *G. erectiflora* and *P. auratus* outside of such protection. The park does not have a code of rules and regulations, and enforcement is, in practice, nonexistent.

The status of Venezuela's environmental decision-making process is a source of utmost concern, particularly its practical implications for research and species conservation. The arrangement of scientific permits has become increasingly difficult, even for members of state's institutions (Rodríguez 2014). The official list of endangered species dates from the 1990s (prohibition of hunting and endangered species) covering 52 mammals, 80 birds, 18 reptiles and 6 amphibians, totaling 156 species (República de Venezuela 1996a, b). The existing conservation programs managed by official institutions cover no more than 12 species (Convention on Biological Diversity 2011), or 8% of the fauna officially listed as endangered. By comparison, the latest version of the national red list, compiled by the Venezuelan NGO Provita and published as the Red Book of Venezuelan Fauna (Rodríguez and Rojas-Suárez 2008), listed 65 mammals, 117 birds, 159 reptiles, 187 amphibians, 221 fishes, and 265 invertebrates as threatened, totaling 1014 species.

The IUCN category of Critically Endangered B1ab(iii)+2ab(iii), accorded by the Global Amphibian Assessment (GAA) to *P. auratus* in 2004, seems to be the most appropriate status for the

Venezuelan population. However, an assessment of the Venezuelan localities for *G. erectiflora* (Cerro Copey in Margarita Island, Cerros La Cerbatana, Patao, El Olvido and Azul in Paria) is needed. Cerro Humo is the highest (1250 m) peak of all of the known locations for *P. auratus* and it provides the largest habitat and therefore may host the largest population of Golden Tree frogs, despite a significant amount of past disturbance from the construction of telecommunications infrastructure and conuco (slash and burn) agriculture. There are just two park guards to oversee 37,500 ha, and the only equipment available are a motorbike and a boat. We have encountered conucos at an elevation of 1000 m on the southern slope of Cerro Humo. More worrisome is the fact that several conucos do not belong to local villagers but to people from remote cities, who are increasingly looking for higher and fresher locations for their crops. Therefore, the lack of enforcement and the precarious situation of the Península de Paria National Park, must be taken into consideration when assessing the taxon. It is also important to note that the state-owned oil company PDVSA is developing a gigantic liquefied gas project on the Península de Paria (PDVSA 2009), and some areas of the national park have already been rezoned to allow infrastructure development. A significant portion of the summit of Cerro Patao (1040 m) has been cleared to allow the installation of telecommunications equipment and a provisional heliport. This could be one of the reasons why *G. erectiflora* was reported for Cerro Patao by Steyermark and Agostini (1966) but appears no longer to be present (De Freitas, unpubl. data). In Venezuela, *G. erectiflora* is considered vulnerable (Delascio et al. 2003).

A recent study of the conservation status of Caribbean Island herpetofauna previews the forthcoming challenges for species such as *P. auratus* in the form of climate change (Hailey and Cazabon-Mannette 2011). The distribution of *P. auratus* is already restricted to the summits of three mountains, and movement to higher elevations in response to rising temperatures is not an option. Likewise, climate change could result in increasing competition from lowland species, as these climb up to higher elevations to seek lower temperatures. Chytridiomycosis could also be an imminent problem; recent research has demonstrated the presence of the causative agent *Batrachochytrium dendrobatidis* in the Aripo River at 447 m on Cerro del Aripo. With an average temperature on the summit of Cerro del Aripo of 18°C, this is within the optimal temperature range (17–25°C) for the growth of *B. dendrobatidis* (Alemu et al. 2013). Populations of *P. auratus* might therefore face extinction, even if global temperature increases are limited to 2°C, the target of the Copenhagen Accord and the *United Nations Framework Convention on Climate Change*. The *P. auratus* population on Cerro Humo, located at 1250 m elevation, might be in a position to withstand a global temperature increase of 1°C, but data reporting the changes in climatic conditions in this locality are lacking. Lastly, the development of an *in situ* conservation program based on the conservation of its fragile habitat could be the best option for the conservation of the species in the long term.

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Evaluation of Skin Temperature Measurements as Suitable Surrogates of Body Temperature in Lizards under Field Conditions

Temperature is a crucial factor for ectotherm biology and one of the most accurate methods to study body temperature (T_b) in reptiles is the measurement of cloacal temperature using thermocouples. Albeit being long established, this method has practical limitations as it requires capturing and handling the animal. This may falsify temperature records in smaller species if the animal moves between microhabitats during capture and impedes repeated T_b records under natural, undisturbed conditions. Furthermore, it often restricts sample sizes to small numbers per hour (e.g., Hertz and Huey 1981; Hertz 1992; Grbac and Bauwens 2001). Therefore, cloacal T_b measurements are increasingly replaced by non-invasive thermal measurements that allow repeated temperature records of undisturbed animals in their natural (thermal) environment (Tattersall and Cadena 2010). Two of these alternatives are infrared thermometers (IRT) and the attachment of external temperature loggers (ETL), e.g., Thermochron iButtons. Both methods measure skin temperature (T_{sk}) instead of the actual T_b. Although these methods clearly provide several advantages compared to measurements of cloacal T_b, their use necessitates a validation of the accuracy of such indirect T_b measurements. IRTs allow the measurement of T_{sk} from a relatively large distance (up to 1.5 m, depending on the IRT model) without disturbing the animal. This eases the data collection considerably and facilitates larger sample sizes per hour as well as continuous surveys of single individuals. While ETLs still require the capture and handling of the animal for attachment and removal, they can repeatedly record T_{sk} for

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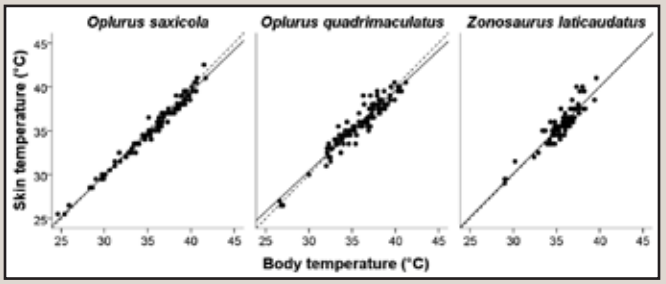


Fig. 1. Comparison of T_{sk} measured with ETLs and T_b measured rectally with a thermocouple. The black line is the regression line (R^2 = 0.979 for *Oplurus saxicola*; R^2 = 0.907 for *O. quadrimaculatus*; R^2 = 0.835 for *Zonosaurus laticaudatus*) and the dotted lined represents a one-to-one line for reference.

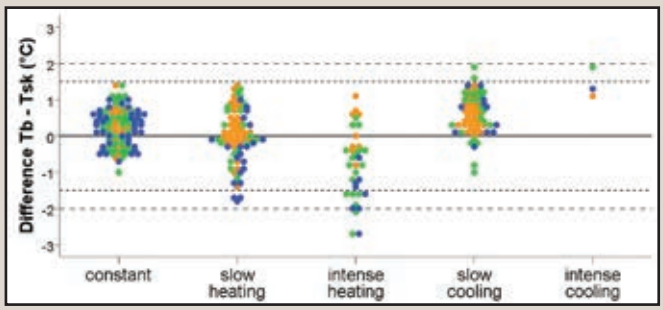


FIG. 2. Discrepancy between T_{sk} measured with ETLs and rectal measurements of T_b according to phases of constant T_b, slow or intense heating and slow or intense cooling of the animal (exemplary also for data from IRTs). The different phases were defined based on the amount of change in T_b during the last five minutes before the measurement of T_{sk}. Constant: $\Delta T_b \leq 0.5$°C, slow heating or cooling: ΔT_b 1.0–4.5°C, intense heating or cooling: $\Delta T_b \geq 5.0$°C. Orange dots show data from *Oplurus saxicola*, green dots from *O. quadrimaculatus*, and blue dots from *Zonosaurus laticaudatus*.

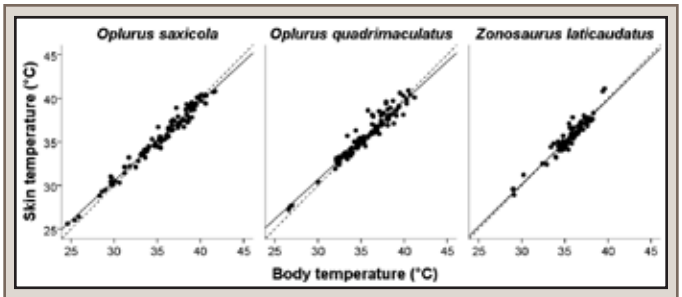


FIG. 3. Comparison of T_{sk} measured with an IRT and T_b measured rectally with a thermocouple. The black line is the regression line (R^2 = 0.974 for *Oplurus saxicola*; R^2 = 0.926 for *O. quadrimaculatus*; R^2 = 0.899 for *Zonosaurus laticaudatus*) and the dotted lined represents a one-to-one line for reference.

several days (and longer) of undisturbed behavior around the clock and even in retreat sites.

Both methods have been applied in previous studies (e.g., Christian et al. 1998; Revell and Hayes 2009; Vasconcelos et al. 2012), but most of the few calibration studies of T_{sk} measurements as surrogates for T_b in reptiles were conducted under laboratory conditions (IRT: Shine et al. 2002; Werner et al. 2005; Herczeg et al. 2006; Hare et al. 2007; Besson and Cree 2010; Carretero 2012; ETL: Shine et al. 2003; Dubois et al. 2008). The laboratory results generally report T_{sk} to be an accurate estimate of T_b, except those reported by Carretero et al. (2012), who report inaccurate results from IRT records in small lacertids (four *Podarcis* spp.) and predict the bias to be even higher for field data. Available field data are scarce and results from Hare et al. (2007) show a significant relationship between T_{sk} and T_b but only with a moderate determination coefficient and sometimes large discrepancies of up to 12.9°C, possibly due to a strong dependence of IRT measurements on the orientation of the device.

The aim of our study was therefore to assess the accuracy of indirect T_b measurements in lizards of different body sizes (20–120 g) under field conditions and to evaluate the suitability of IRT and ETL measurements as an alternative for cloacal temperature records in field studies.

MATERIALS AND METHODS

We chose two iguanid lizards, *Oplurus saxicola* and *O. quadrimaculatus*, and one plated lizard, *Zonosaurus laticaudatus*, all of different body sizes and body mass, to cover a comprehensive range for our calibration study. All three species are endemic to Madagascar and occur sympatrically in rocky habitats. All are diurnal and saxicolous, although *Z. laticaudatus* also searches for its prey in leaf litter and crevices. The study took place in the Andohahela National Park in southeastern Madagascar between November 2009 and April 2012. *Oplurus saxicola*, the smallest of the three species, reaches an average snout–vent length (SVL ± SD) of 8.8 cm ± 0.5 cm and a body mass (BM ± SD) of 21.1 g ± 4.2 g (N = 183). *Oplurus quadrimaculatus* is the largest species of Iguanidae of Madagascar with a SVL of 12.8 cm ± 0.6 cm and a BM of 76.5 g ± 10.5 g (N = 310). The medium-sized gerrhosaurid *Z. laticaudatus* reaches an average SVL of 15.3 cm ± 0.78 cm and a BM of 113.5 g ± 15.9 g (N = 191; W. Berg and O. Theisinger, unpubl.).

Calibration measurements.—We first tested the accuracy of T_{sk} measurements as surrogates for T_b by comparing ETL and IRT records with cloacal T_b measurements in captured *O. saxicola* (101 measurements from six individuals), *O. quadrimaculatus* (102 measurements from eight individuals), and *Z. laticaudatus* (84 measurements from seven individuals). After capturing the animals by noosing, we fixed a temperature logger (iButton model DS1921G; accuracy ± 0.5°C; Maxim Integrated Products Inc., San Jose, California, USA) at the rear end of the animals' backs using a small stripe of duct tape (cut and fitted around the ETL, leaving the top uncovered to avoid insulation). We used unmodified ETLs during this study, weighing 3.3 g each. This corresponds to less than 5% of the body mass for *O. quadrimaculatus* and *Z. laticaudatus* but exceeds the generally recommended 5–10% of the body mass for *O. saxicola* (BM ~20 g). We still attached ETLs to the last species for the duration of the calibration measurements in the box as the additional load did not have any negative effects on the animals' survival or well-being but provided additional information about the comparability of skin and rectal body temperature measurements. The animal was then placed into a transparent plastic box and left in the shade for at least 15 minutes before the start of the calibration. During the test, we moved the box with the animal between sun and shade to create heating and cooling curves. The ETL was programmed to record T_{sk} every minute. At intervals of 5–7 minutes, we took the animal from the box and immediately measured T_{sk} with the IRT (Voltcraft IR 1200 – 50 D; distance to spot ratio 50:1, range from –50°C to +1200°C, resolution 0.1°C, precision ± 1%; Conrad Electronic SE, Hirschau, Germany) from a distance of about 0.5 m to approximate measurements of free ranging animals as closely as possible, which are usually taken from 1–1.5 m distances. Following that, we recorded cloacal T_b using a digital precision thermometer (Greisinger GTH 175/Pt; range from –199.9 to +199.9°C, resolution 0.1°C, precision 0.1°C ± 1 digit; GREISINGER electronic GmbH, Regenstauf, Germany) and returned the animal to the box. Although we avoided hand contact of the ETL and the back of the animal, where IRT records were taken, the animal (and with it the ETL) was exposed to the (differing) ambient temperature for a short time while outside the box. To ensure the comparability of T_{sk} and T_b records, we used the ETL temperature that had been stored immediately before the animal was taken from the box, the IRT record that was measured directly after that and the T_b measurement that was taken within no more than 30 sec after the IRT record.

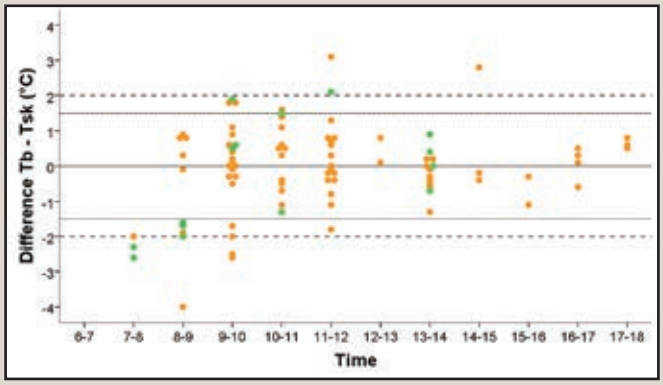


FIG. 4. Discrepancy between T_{sk} measured with an IRT and rectal measurements of T_b in free ranging *Oplurus* according to the time of data collection. Orange dots show data from *O. saxicola*, green dots from *O. quadrimaculatus*.

IRT control measurements of free ranging animals.—To further examine the relationship between T_{sk} and T_b and to ensure the usability of an IRT in the field, we also calibrated this method in free ranging animals of *O. saxicola* (N = 76) and *O. quadrimaculatus* (N = 15). After measuring T_{sk} using the IRT from distances of 1–1.5 m, we also recorded the animals' cloacal T_b if the animals could be captured within no more than 30 s. These control measurements were undertaken at different times of the day and in different microhabitats to maximise the temperature range and compensate for differing environmental conditions.

All devices were calibrated before the measurements and a correction value was subtracted from all IRT temperatures prior to further calculations. Data were processed using IBM SPSS 20 and all means are given with standard deviation.

RESULTS

We recorded a total of 101 paired T_b–T_{sk} calibration measurements from six individuals of *Oplurus saxicola* (7–22 measurements / ind.), 102 paired measurements from eight individuals of *O. quadrimaculatus* (9–22 measurements / ind.), and 84 paired measurements from seven individuals of *Zonosaurus laticaudatus* (4–19 measurements / ind.). During the calibration measurements, T_b ranged from 24.6–41.7°C for *O. saxicola*, 26.6–41.2°C for *O. quadrimaculatus*, and 29.0–39.6°C for *Z. laticaudatus*. This is a comprehensive representation of temperatures found in active individuals of all three species, as our minimum and maximum records of free-ranging individuals show similar activity temperature ranges (28.2–43.6°C for *O. saxicola*, 24.7–41.5°C for *O. quadrimaculatus*, and 28.3–37.4°C for *Z. laticaudatus*).

External temperature loggers.—T_{sk} records from ETLs are highly correlated with T_b (*O. saxicola*: Spearman correlation $r_s = 0.987$, $P < 0.001$, N = 101; *O. quadrimaculatus*: $r_s = 0.933$, $P < 0.001$, N = 102; *Z. laticaudatus*: $r_s = 0.883$, $P < 0.001$, N = 84) and show no differences between paired measurements for *O. quadrimaculatus* (t = 1.315, df = 101, p = 0.191, mean deviation 0.11 ± 0.88°C, max. deviation 2.7°C) and *Z. laticaudatus* (t = –0.637, df = 83, p = 0.526, mean deviation –0.06 ± 0.86°C, max. deviation 2.7°C). However, in *O. saxicola* paired measurements of T_b and T_{sk} differ significantly (t = 6.038, df = 100, p < 0.001, mean deviation 0.33 ± 0.55°C, max. deviation 1.4°C) (Fig. 1). When we assign the paired T_b–T_{sk} measurements to heating and cooling phases of the animals, we can see that the discrepancy is in most cases (98%) smaller than 1.5°C, except for phases of intense heating or cooling, when the ETL heats up or cools down faster than the animal and deviations range up to 2.7°C (Fig. 2).

Infrared thermometer.—T_{sk} readings measured with IRTs are also highly correlated with T_b in all three species (*O. saxicola*: Spearman correlation $r_s = 0.980$, $P < 0.001$, N = 100; *O. quadrimaculatus*: $r_s = 0.943$, $P < 0.001$, N = 102; *Z. laticaudatus*: $r_s = 0.910$, $P < 0.001$, N = 83) and show no differences between paired measurements of T_b and T_{sk} (*O. saxicola*: t = –0.122, df = 99, p = 0.903, mean deviation -0.01 ± 0.66°C, max. deviation 1.7°C; *O. quadrimaculatus*: Wilcoxon test: p = 0.507, mean deviation –0.08 ± 0.78°C, max. deviation 2.8°C; *Z. laticaudatus* Wilcoxon test: p = 0.195, mean deviation 0.04 ± 0.64°C, max. deviation 1.9°C) (Fig. 3).

As in the ETL measurements, deviations of more than 2°C occur only during phases of intense T_b changes and only few measurements (2%) deviate more than 1.5°C during phases when T_b is constant or changes only slowly.

IRT control measurements of free ranging animals.—We took control measurements with the IRT of free ranging *O. saxicola* and *O. quadrimaculatus*. Both species show a high correlation of T_{sk} and T_b also under natural conditions (*O. saxicola*: Spearman correlation $r_s = 0.795$, $P < 0.001$, N = 76; *O. quadrimaculatus*: $r_s = 0.753$, $P < 0.001$, N = 15). Deviations are higher than in the calibration measurements though, with a mean deviation of –0.02 ± 1.14°C and max. deviation of 4.0°C for *O. saxicola* and a mean deviation of –0.29 ± 1.57°C and max. deviation of 2.6°C for *O. quadrimaculatus*. To further analyze these data, we plotted the deviations between T_b and T_{sk} according to the time of data collection (Fig. 4). Of all temperature records of free-ranging *Oplurus* (N = 91), 91% deviate less than 2°C and 78% less than 1.5°C. If records from the early morning (before 0900 h), when animals often heat up 10°C or more within a short period of time, are excluded, 94% of the remaining data (N = 78) deviate less than 2°C and 85% less than 1.5°C.

DISCUSSION

The suitability of ETLs and IRTs as alternatives for cloacal temperature measurements in reptiles largely depends on the applicability of T_{sk} as a substitute for T_b. Our data show a highly significant correlation between T_{sk} and T_b in all three species over a range of body sizes (20–120 g) and neither ETL nor IRT measurements show significant differences between paired T_{sk} and T_b records in *Oplurus quadrimaculatus* and *Zonosaurus laticaudatus*. In *O. saxicola*, ETL measurements of T_{sk} differ significantly from T_b records but T_{sk} measured with an IRT does not. While IRT records show an even distribution of positive and negative deviations, there is a bias in the ETL records of *O. saxicola* towards measurements with $T_{sk} < T_b$ (no bias during heating phases but $T_{sk} < T_b$ during cooling). This is a species-specific problem and due to a loose fit of some of the ETLs during cooling phases, when the animal may switch to thigmothermy and press itself flat against the ground, causing the ETL to partially lose contact with the skin. However, mean deviations are close to 0.0°C in records from both methods and across all three species. Large deviations of more than 2°C occurred only during phases of intense changes in T_b, while phases of slow heating and cooling mostly show deviations < 1.5°C in ETL and IRT measurements (Fig. 2). Our data from free-ranging *Oplurus* confirm this observation and show large deviations with $T_{sk} > T_b$ during morning basking periods, when the animals often heat

up 10°C or more within a short period of time (Theisinger et al., unpubl. data), while large deviations of $T_{sk} < T_b$ were found around midday and in the early afternoon, when the animals retreat from the heat to colder crevices (Fig. 4). Nevertheless, 80% of the records deviated less than 1.5°C and over 90% less than 2°C, confirming ETLs and IRTs as valuable approaches for field measurements of free-ranging animals when potential constraints by rapid changes in T_b, especially in field studies, are considered.

Internal gradients between the surface and the body core are considered to be negligible in models of small reptiles (< 30 g; Bakken 1992). This is generally confirmed by our results from the more standardized calibration tests, during which the skin of *O. quadrimaculatus* (BM ~80 g) and *Z. laticaudatus* (BM ~120 g) heated up faster than the core body during phases of intense heating, while *O. saxicola* (BM ~20 g) shows no clear deviation between T_{sk} and T_b (Fig. 2). However, data from free-ranging individuals show that even animals with a BM of less than 30 g may occasionally experience considerable differences between T_{sk} and T_b when undergoing intense changes in T_b (Fig. 4). Lags between surface and core body temperature during warming phases were also found in small lacertid lizards (BM < 10 g) using an infrared camera (Luna and Font 2013). A thermal inertia between surface and core body in small species thus depends not only on the actual body size but also on the rate of heating.

The use of ETLs is mostly limited by their dimensions. Depending on the model, modifications may be possible that make the device suitable for many smaller species (e.g., in iButtons: a reduction in weight from 3 g to about 1.5 g; Lovegrove 2009) but might affect their functionality. Exceptions are saxicolous species like *O. saxicola*, which live in crevices barely higher than the animals themselves. An external attachment of even just a few millimeters height would restrain these animals from returning to their retreat sites. Furthermore, unmodified ETLs attached to *O. quadrimaculatus* showed such a high degree of abrasion and scratches that a modified logger, usually coated only in wax or silicone instead of a stainless steel capsule, would not last long. To further increase their accuracy, we also tried to color the ETLs according to the animals' backs in order to mimic solar reflection and absorption. We did not find notable differences between painted and unpainted devices and thus continued with unpainted ones, which already show a high and satisfying accuracy. It might, however, be possible to even further increase the accuracy of this method through different types of paint and color. Compared to IRTs, ETLs offer the crucial advantage that they also record the temperature when the animal is out of sight in retreat sites or during times of inactivity and may record the completely undisturbed animal's "thermal behavior" over several days or even weeks, provided that the logger can be recovered.

Technical aspects to consider when using IRTs include animal size in comparison to the IRT metering point. Previous field studies on McCann's Skinks (*Oligosoma maccanni*) found a rather low relationship between T_{sk} and T_b ($r^2 = 0.586$) and great individual differences of up to 12.9°C (Hare et al. 2007) and similar problems were reported for several *Podarcis* forms (Carretero et al. 2012). Despite their effort to ensure that the target laser sights all fell on the posterior abdomen or pelvic region of the animal, Hare et al. (2007) still found a high influence of background temperature on IRT readings and reported better results if the IRT was oriented in line with the skink's body axis. Although we cannot report similar problems from our study (probably due to the larger body size of our study species), this clearly presents a limitation for IRT measurements (and should be considered when choosing a device), especially under field conditions where the difference between background and body temperature is often much greater than in laboratory studies with more consistent temperature regimes. A further consideration when using an IRT in the field is the operating temperature of the device. Depending on the device, the IRT may show abnormal temperatures if it becomes too hot (e.g., through use in direct sunlight). Although our device recovered quickly and continued to show accurate temperatures after cooling down, we recommend protecting the IRT from direct sunlight when using it in environments with extremely high temperatures. If these aspects are considered, IRTs provide a quick and easy way to measure T_{sk} in reptiles and have the advantage that measurements can be taken from larger distances without disturbing the natural behavior of the animals (and those in close proximity). Hence a much larger number of indirect T_b measurements can be recorded per hour in contrast to conventional cloacal T_b records. For example, by implementing IRT measurements during transect walks we took up to 58 indirect T_b records per hour for *O. saxicola*.

In conclusion, our results show a close relationship and high accuracy between T_{sk} and T_b in lizards of different body sizes and thus a high applicability of both methods, ETLs and IRTs. Considerable differences between T_{sk} and T_b occurred only during phases of intense changes in T_b, and were detectable even in lizards with a BM of ~20 g, suggesting that the thermal inertia depends not only on body size but also on the rate of heating. Both methods proved to be easy to use under field conditions if certain limitations are considered. We therefore generally validate the use of T_{sk} measurements as surrogates for cloacal T_b measurements in small to medium sized reptiles (20–120 g) also for field studies, but have to emphasize the importance of restrictions related to the rate of heating, which is not necessarily apparent under standardized lab conditions. The increasing application of IRTs and other external measurements of body temperature in reptiles will expand the potential of field studies by facilitating repeated temperature records of undisturbed animals, larger sample sizes and the collection of data over several days including night times and in retreat sites.

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Diet of the Northern Pacific Rattlesnake (*Crotalus o. oreganus*) in California

Data from museum specimens are used to inform a wide range of studies from taxonomy and physiology, to how climate change affects animal distributions (e.g., Moritz et al. 2008; Suarez and Tsutsui 2004; see Pyke and Ehrlich 2010 for review). Analysis of the gut contents of museum specimens is a straightforward and low-cost method of determining the dietary habits of species in the wild, and these data may then be used to help inform conservation programs of at-risk species.

The feeding habits of many species of rattlesnakes have been elucidated with museum studies (for recent examples see Glaudas et al. 2008; Dugan and Hayes 2012). These studies provide initial data that form the backbone for other lines of inquiry such as the relationship between diet and venom composition (Mackessy 1988; Mackessy et al. 2003) and the evolutionary arms race between rattlesnakes and their prey (Biardi et al. 2005; Barlow et al. 2009). We analyzed data on the diet of Northern Pacific Rattlesnakes (*Crotalus o. oreganus*) from California by identifying prey items recovered from dissection of museum specimens. *Crotalus o. oreganus* ranges from central California to northern British Columbia (Stebbins and McGinnis 2012). Several field studies on diet have been conducted near the northern boundary of the range (Macartney 1989; Wallace and Diller 1990), and several were centered closer to the southern edge of the range (Fitch and Twining 1946; Mackessy 1988). Ernst and Ernst (2011) provide an extensive review of the diets of many North American rattlesnakes, including *Crotalus o. oreganus* in various parts of its range. Our museum study included specimens from throughout the California range of this taxon with the goal of filling in a geographical gap. Combined with other published dietary accounts, our study helps contribute to a more robust understanding of the feeding habits of *C. o. oreganus*.

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Methods.—Remains of prey were present in the gastrointestinal tracts (stomach and intestines) of 85 specimens of *Crotalus o. oreganus* collected in California and deposited in the Museum of Vertebrate Zoology (MVZ, Berkeley, California) and the Santa Barbara Natural History Museum (SBNHM, Santa Barbara, California). In some cases prey had already been removed from snakes, and in other cases we removed prey items from the stomach and intestines and stored them in ethanol in glass vials. We attempted to avoid snakes from possible intergrade zones with other subspecies (based on range maps). The snout–vent length (SVL) of each snake was measured with a cloth measuring tape. Each snake was categorized as male (N = 45), female (N = 30), or neonate (N = 10). Neonate snakes were identified based on their single rattle segment and uniform small size (range: 245–290 mm SVL).

Prey items were identified to the lowest possible taxon level. In the 85 snakes, 88 prey items (3 snakes had two different prey types present) could be positively identified at least to the level of vertebrate class. These prey items were categorized as amphibians based on presence of identifiable amphibian tissue (e.g., bones),

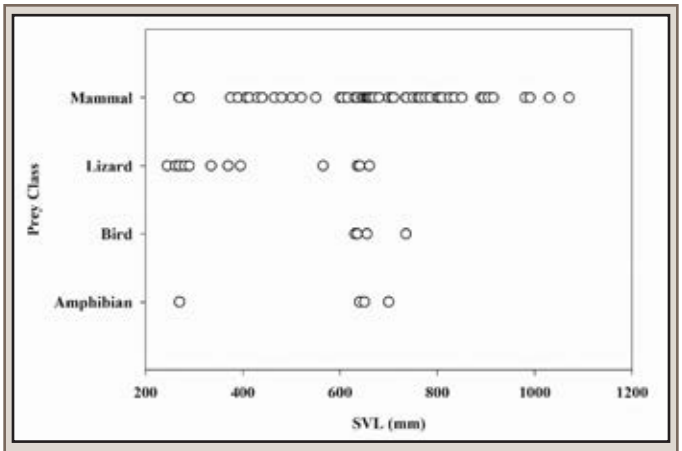


FIG. 1. Prey type distribution based on snout–vent length (SVL) of *Crotalus o. oreganus* in the present study. Each data point represents an individual snake. Snakes that ate lizards were smaller in SVL than snakes that ate mammals and birds; snakes that ate amphibians were not different in size from those that ate other prey types.

as mammals based on presence of hair and/or mammalian teeth, as lizards based on presence of lizard scales, and as birds based on presence of feathers. The majority of prey items were found highly digested in the intestines. However, in cases where prey items were intact or other reliable structures (e.g., teeth) were well preserved (N = 52), we identified prey to taxonomic levels below class (e.g., order, family, genus, or species).

The size of snakes that consumed each prey class was compared by ANOVA on square-root-transformed snake SVL. Post hoc Tukey's tests were used for pairwise comparisons. To test the hypothesis that juvenile snakes consumed lizards more frequently than adults, snakes were assigned to two groups: immature/juvenile (< 520 mm [Diller and Wallace 2002], including neonates) and adult (520 mm or greater). Chi-square likelihood-ratio tests were used to compare the proportion of individuals containing lizard prey within the two groups. The effect of sex on diet composition was also examined using likelihood-ratio tests using adults only. The presence of sexual size dimorphism was tested using a student's t-test on log-transformed data. All analyses were conducted in JMP Pro 11 (SAS Institute Inc.).

Results.—Prey from three vertebrate classes were represented: Amphibia, Reptilia (lizards and birds), and Mammalia (Table 1). We broke down reptilian prey into lizards and birds for the purpose of analysis. Mammal prey were most common (76.1%), followed by lizards (14.8%), birds (4.5%), and amphibians (4.5%). Only 3 snakes contained prey items from more than one prey class; we treated them as independent samples because deleting these data did not affect the results of the analysis. There was a significant difference in the size of individuals that preyed upon the different prey classes ($F_{3,87} = 11.06$, $P < 0.001$; Fig. 1). Post-hoc analyses showed that snakes that consumed lizards were significantly smaller compared to those that ate mammals and birds, which were not different in size from each other or from those that consumed amphibians. Compared to adults, snakes classified as juveniles based on SVL preyed more on lizards ($\chi^2 = 15.0$, $P < 0.001$). Adult males and females did not significantly differ in size ($T = 1.45$, $P = 0.15$), or diet (All classes: $\chi^2 = 2.44$, $P = 0.49$, Proportion lizard: $\chi^2 = 2.15$, $P = 0.14$). The majority of neonates (60%, 6 of 10) examined had consumed lizard prey, followed by small mammals (30%, 3 of 10) and amphibians (10%, 1 of 10).

Of the 88 prey items, we were able to identify the following specific prey taxa (See Table 1 for details): Anuran (species not identified), Arboreal Salamander, *Aneides lugubris*, Gilbert's Skink, *Plestiodon gilberti*, Western Skink, *P. skiltonianus*, Sagebrush Lizard, *Sceloporus graciosus*, Western Fence Lizard, *S. occidentalis*, *Sceloporus* sp., Side-blotched Lizard, *Uta stansburiana*, Warbler, family Paruidae, Rabbit, *Sylvilagus* sp., American Pika, *Ochotona princeps*, Mountain Beaver, *Aplodontia rufa*, California Vole, *Microtus californicus*, *Microtus* sp., Dusky-footed Woodrat, *Neotoma fuscipes*, Southern Grasshopper Mouse, *Onychomys torridus*, *Onychomys* sp., Deer Mouse, *Peromyscus maniculatus*, Western Harvest Mouse, *Reithrodontomys megalotis*, Kangaroo Rat, *Dipodomys* sp., and California Ground Squirrel, *Otospermophilus beecheyi*.

Discussion.—The diet of *C. o. oreganus* has been studied in several field studies (Fitch and Twining 1946; Macartney 1989; Wallace and Diller 1990). Each of these studies examined one or a small group of populations in restricted geographic localities (central California: Fitch and Twining 1946, northern Idaho: Wallace and Diller 1990; British Columbia, Canada: Macartney 1989; Central Washington: Weaver and Lahti 2005). Our goal in the present study was to conduct an investigation of the diet of *C. o. oreganus* in its range throughout California (central California to the Oregon border) using museum specimens, which will help to fill in gaps in our knowledge of types of prey consumed by *C. o. oreganus* in the southern part of its range.

Our study agrees with previous field studies that the majority of the diet of *C. o. oreganus* consists of small rodents. A report on diet in central Washington shows a similar prey class distribution compared to our results for California populations (74% mammal, 20% lizard, and 6% bird; Weaver and Lahti 2005). Studies at the far northern part of the range found that the diet consists almost entirely of mammals, primarily rodents, and a small number of birds and lizards (Macartney 1989; Wallace and Diller 1990). In these studies, neonates ate mainly small mammals such as shrews; in our study, neonates also ate small mammals but ate lizards at a higher frequency than mammals. The higher prevalence of lizard prey found in our California snakes compared to snakes in northern populations could reflect a greater abundance of lizards in California than in northern parts of the range. Mackessy (1988) also found that lizards made up a large portion of the diet of juvenile *C. o. helleri* in central California, and that snakes larger than 500 mm total length ate mammals rather than lizards. In our study, we found that some juvenile *C. o. oreganus* (< 520 mm SVL) ate mammals and some snakes larger than 520 mm ate lizards; nevertheless, the general trend of an ontogenetic shift from a diet primarily of lizards to one primarily of mammals is supported (Fig. 1). Mackessy (1988) also showed that the venom composition of *C. o. helleri* and *C. o. oreganus* changes ontogenetically, with smaller snakes having higher venom toxicity. The ontogenetic shift in venom composition in *C. o. oreganus* may relate to a change in diet from primarily lizards to primarily mammals. Such a shift in diet was first suggested by Fitch and Twining (1946) and is evidenced in our study by the fact that neonates ate many lizards but adults did not. It is therefore possible that neonate *C. o. oreganus* at the southern part of the range have evolved venom more suited towards eating lizards compared to neonates at the northern end of the range, which may encounter lizards more rarely. This hypothesis could be tested by obtaining data on lizard densities as well as the toxicity of neonate venom along a latitudinal cline from central California to southern Canada.

TABLE 1. List of food items consumed by *Crotalus o. oreganus* throughout its range summarized from four studies conducted on populations throughout the range, including this study on California snakes. Prey taxa are listed within vertebrate class, alphabetically by family and then genus and species. Percentages in bold are range-wide percentages for each vertebrate class. Percentages not in bold are those reported in each study. Blank values indicate information was not available.

Class	Order	Lowest taxonomic rank identified	Family	N	% of diet	Source	State/province
Amphibia			Total	4	**0.8**		
	Anura						
		Spadefoot Toad, *Spea hammondii*	Scaphiopodidae		2	1.1	Fitch and Twining 1946 CA
		Unidentified anuran		2	3.8	This study	CA
	Caudata						
		Arboreal Salamander, *Aneides lugubris*	Plethodontidae		1	1.9	This study CA
Reptilia			Total	37	**7.1**		
	Squamata						
		Sagebrush Lizard, *Sceloporus graciosus*	Phrynosomatidae	4	7.7	This study	CA
		Western Fence Lizard, *Sceloporus occidentalis*	Phrynosomatidae	7	4.0	Fitch and Twining 1946	CA
		Western Fence Lizard, *Sceloporus occidentalis*	Phrynosomatidae	8	15.4	This study	CA
		Sceloporus sp.	Phrynosomatidae	1	1.9	This study	CA
		Side-blotched Lizard, *Uta stansburiana*	Phrynosomatidae	2	3.8	This study	CA
		Side-blotched Lizard, *Uta stansburiana*	Phrynosomatidae	5	2.8	Fitch and Twining 1946	CA
		Gilbert's Skink, *Plestiodon gilberti*	Scincidae	2	1.1	Fitch and Twining 1946	CA
		Gilbert's Skink, *Plestiodon gilberti*	Scincidae	1	1.9	This study	CA
		Western Skink, *Plestiodon skiltonianus*	Scincidae	1	0.9	Wallace 1990	ID
		Western Skink, *Plestiodon skiltonianus*	Scincidae	2	3.8	This study	CA
		Whiptail Lizard, *Aspidoscelis tigris*	Teiidae	4	2.3	Fitch and Twining 1946	CA
Aves			Total	≥ 12	**2.3**		
	Passerifomes						
		Bushtit, *Psaltriparus minimus**	Aegithalidae	≥1		Macartney 1989	BC
		Dark-eyed Junco, *Junco hyemalis**	Emberizidae	≥1		Macartney 1989	BC
		California Towhee, *Melozone crissalis*	Emberizidae	2	1.1	Fitch and Twining 1946	CA
		Song Sparrow, *Melospiza melodia*	Emberizidae	1	1.1	Wallace 1990	ID
		Spotted Towhee, *Pipilo maculatus**	Emberizidae	≥1		Macartney 1989	BC
		Warbler, family Parulidae	Parulidae	1	1.9	This study	CA
		European Starling, *Sturnus vulgaris**	Sturnidae	≥1		Macartney 1989	BC
	Galliformes						
		California Quail, *Callipepla californica*		2	1.1	Fitch and Twining 1946	CA

TABLE 1. Continued.

Class	Order	Lowest taxonomic rank identified	Family	N	% of diet	Source	State/province
Mammalia			Total	466	**89.8**		
	Lagomorpha						
		Desert Cottontail, *Sylvigagus auduboni*	Leporidae	17	9.6	Fitch and Twining 1946	CA
		Mountain Cottontail, *Sylvilagus nuttallii*	Leporidae	5	4.7	Wallace 1990	ID
		Sylvilagus sp.	Leporidae	1	1.9	This study	CA
		American Pika, *Ochonta princeps*	Ochotonidae	1	1.9	This study	CA
	Rodentia						
		Mountain Beaver, *Aplodontia rufa*	Aplodontiidae	2	3.8	This study	CA
		California Vole, *Microtus californicus*	Cricetidae	7	13.5	This study	CA
		California Vole, *Microtus californicus*	Cricetidae	4	2.3	Fitch and Twining 1946	CA
		Vole, *Microtus* sp.	Cricetidae	2	3.8	This study	CA
		Vole, *Microtus* sp.	Cricetidae	56	52.8	Wallace 1990	ID
		Vole, *Microtus* sp.	Cricetidae	86	46.3	**Macartney 1989	BC
		Bushy-tailed Woodrat, *Neotoma cinerea*	Cricetidae	1	0.5	**Macartney 1989	BC
		Dusky-footed Woodrat, *Neotoma fuscipes*	Cricetidae	5	2.8	Fitch and Twining 1946	CA
		Dusky-footed Woodrat, *Neotoma fuscipes*	Cricetidae	1	1.9	This study	CA
		Southern Grasshopper Mouse, *Onychomys torridus*	Cricetidae	1	1.9	This study	CA
		Grasshopper Mouse, *Onychomys* sp.	Cricetidae	1	1.9	This study	CA
		Deer Mouse, *Peromyscus maniculatus*	Cricetidae	7	13.5	This study	CA
		Deer Mouse, *Peromyscus maniculatus*	Cricetidae	24	22.6	Wallace 1990	ID
		Deer Mouse, *Peromyscus maniculatus*	Cricetidae	41	22.1	**Macartney 1989	BC
		White-footed mouse, *Peromyscus* sp.	Cricetidae	14	7.9	Fitch and Twining 1946	CA
		Western Harvest Mouse, *Reithrodontomys megalotis*	Cricetidae	3	5.8	This study	CA
		Western Harvest Mouse, *Reithrodontomys megalotis*	Cricetidae	3	2.8	Wallace 1990	ID
		Pocket gopher, *Thomomys bottae*	Geomyidae	10	5.6	Fitch and Twining 1946	CA
		Northern Pocket Gopher, *Thomomys talpoides*	Geomyidae	2	1.9	Wallace 1990	ID
		Northern Pocket Gopher, *Thomomys talpoides*	Geomyidae	19	10.3	**Macartney 1989	BC
		Heermann's Kangaroo Rat, *Dipodomys heermanni*	Heteromyidae	29	16.4	Fitch and Twining 1946	CA
		Kangaroo Rat, *Dipodomys* sp.	Heteromyidae	1	6.8	This study	CA
		Great Basin Pocket Mouse, *Perognathus parvus*	Heteromyidae	3	1.5	**Macartney 1989	BC
		Pocket mouse, *Perognathus* sp.	Heteromyidae	12	6.8	Fitch and Twining 1946	CA
		California Ground Squirrel, *Otospermophilus beecheyi*	Sciuridae	60	33.9	Fitch and Twining 1946	CA
		California Ground Squirrel, *Otospermophilus beecheyi*	Sciuridae	3	5.8	This study	CA
		Yellow Pine Chipmunk, *Tamias amoenus*	Sciuridae	4	2.0	**Macartney 1989	BC
		Yellow Pine Chipmunk, *Tamias amoenus*	Sciuridae	1	0.9	Wallace 1990	ID
		Red Squirrel, *Tamiasciurus hudsonicus*	Sciuridae	14	7.3	**Macartney 1989	BC
		Yellow-bellied Marmot, *Marmota flaviventris*	Sciuridae	1	0.5	**Macartney 1989	BC
		Vagrant Shrew, *Sorex vagrans*	Soricidae	13	12.3	Wallace 1990	BC
		Cinerus Shrew, *Sorex cinereus*	Soricidae	9	4.9	**Macartney 1989	BC
		Unidentified "mouse"		2	1.1	Fitch and Twining 1946	CA

*Sample size was not reported in the study.
**Raw sample sizes not reported, numbers were back-calculated from reported percentages and rounded to the nearest whole number.

Several unusual prey records have been recorded for *C. o. oreganus*. Bullard and Fox (2002) report an adult male *C. o. oreganus* that had eaten a Rubber Boa (*Charina bottae*). Cannibalism has not been reported in *C. o. oreganus*, but there are several reports of closely related species eating conspecifics (Gloyd 1933; Lillywhite 1982). Our study revealed two new prey genera for *C. o. oreganus*: Mountain Beavers, *Aplodontia rufa*, and Grasshopper Mice, *Onychomys*. Two individuals consumed Mountain Beavers (based on identification of claws in gut contents). That Mountain Beavers have not previously been identified in studies of *C. o. oreganus* diet is likely because few field studies have been conducted at montane sites within the range of this prey taxon. This highlights the importance of museum studies in filling in the gaps in our knowledge of the feeding habits of species over large geographic areas. Taken together, the results of range-wide studies (summarized from four comprehensive studies in Table 1 and reviewed in detail in Ernst and Ernst 2011 and Klauber 1956), reveal that adult *C. o. oreganus* prey upon diverse mammalian taxa throughout their range and that juveniles in the central and southern portions of the range prey more frequently on lizards compared to adults and juveniles from northern populations.

Specimens examined.—MVZ 747-48, 2079, 2772-73, 2775-76, 2778-79, 2781, 2783, 2785, 3820, 5326-27, 5561, 6839, 6841-42, 6845, 8651, 9469, 9989, 10215, 10537-38, 11190, 11428, 12364, 13099, 14597, 14599-600, 15208, 16339, 16341, 16422, 16439, 16461, 16463-64, 16855, 17572, 17585, 17619, 18191, 18405–07, 20562, 21380–82, 21574, 21917, 24125, 24253-54, 24398, 24840, 29281, 29335, 33913, 34111, 34116-17, 34936, 35358, 35466, 37131, 39057, 43709, 45739, 50213, 50974, 51708-09, 58265, 62064, 64143, 64148, 66426-27, 75833, 78072, 80771, 80933, 83654-55, 85225, 85486, 92684, 92685, 149388, 158972, 170801, 176163-64, 179788, 179969, 191384, 191413, 191863, 192218, 193426–30, 193432-33, 193435, 202295, 204238–40, 204243-44, 206223, 215726, 217434, 223168, 228714, 229507, 229847–49, 244367, 370905; SBMNH 983, 1351, 2346.

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Courtship Behavior of *Bokermannohyla alvarengai*, a Waltzing Anuran

Courtship in anurans may be very unpredictable, which renders it considerably difficult to observe. Consequently, we lack courtship information for the majority of the currently recognized species. That is the case for the genus *Bokermannohyla* Faivovich, Haddad, Garcia, Frost, Campbell and Wheeler 2005, which is composed of 32 species (Frost 2015), for which information on courtship behavior is limited to two species, *B. ibitiguara* (Cardoso 1983) and *B. nanuzae* (Bokermann and Sazima 1973) (Nali and Prado 2012; Lima et al. 2014). *Bokermannohyla* is included in the tribe Cophomantini, with *Aplastodiscus, Hyloscirtus, Hypsiboas,* and *Myersiohyla* (Faivovich et al. 2005). Among these there are no literature records about courtship behavior in *Hyloscirtus* and *Myersiohyla*; there is some information for *Hypsiboas* (Hödl 1977; Kluge 1981; Martins and Haddad 1988; Menin et al 2004; Camurugi and Juncá 2013; Landestoy 2013); and *Aplastodiscus* is better known (Haddad and Sawaya 2000; Hartmann et al. 2004; Haddad et al. 2005; Carvalho Jr. et al. 2006; Zina and Haddad 2007). Herein, we provide information about the courtship behavior of *Bokermannohyla alvarengai* (Bokermann 1956) in attempt to fill the void of information on courtship behavior within this clade.

Bokermannohyla alvarengai (Fig. 1) is a large treefrog (up to 140 mm snout–vent length, SVL; see Lugli and Haddad 2006) inhabiting rocky meadows at elevations above 1000 m in southeastern Brazil. Its natural history is poorly understood, including reproductive biology, with most of the information available based on a few reports (e.g., Sazima and Bokermann 1977; Eterovick and Sazima 2000; Eterovick and Sazima 2004). This frog breeds in temporary, rocky-bottomed streams running on the low and sparse vegetation typical of its habitat at that altitude. As previously reported by Sazima and Bokermann (1977), *B. alvarengai* is a skittish species ceasing all its activities at the slightest disturbance, making it difficult to observe its courtship and mating behavior.

We were able to observe part of the courtship behavior of *B. alvarengai* under natural conditions at Serra do Cipó (19.290783°S, 43.582400°W, SAD69; 1196 m elev.), Minas Gerais state, Brazil. The courtship description is based on one pair of frogs observed during the rainy season on the night of 17 November 2012. The reproductive event lasted about four hours from 2040 h to 0030 h. We used low illumination to minimize disturbance of the frogs. The male was 88.7 mm in SVL and the female, smaller than male, could not be measured as she escaped at the end of the observation. Air temperature was 19.2°C, relative humidity was 75.6%, and wind speed varied from 0.4 to 1 m/sec.

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The courtship behavior of *Bokermannohyla alvarengai* differed markedly from the congenerics *B. ibitiguara* and *B. nanuzae*, as well as from the other species of Cophomantini. The most striking difference was observed after the more trivial behaviors, such as acoustic, visual, and tactile interaction, when the couple exhibited a unique and previously unreported sequence of complex waltz-like movements in the water. The stages with the sequential progress of the courtship behavior of *B. alvarengai* are described as follows (Fig. 2).

The male was in a small cavity at a vertical earthen wall (ca. 1 m from the ground) eroded by water on the stream edge, facing the watercourse. He was 1.5 m distant from a small shallow puddle (ca. 0.9 x 1.2 m width) surrounded by stones and vegetation, disconnected from the stream by the decrease of water level. Courtship began at 2040 h with the approach of a female into the male's territory. When first sighted, the female was sitting on a small rock near the ground about 1.2 m in front of the male. Ten minutes later, she turned toward him and leapt in his direction, bounced off the earthen wall, and returned to the ground. After a while, the female moved to the same wall remaining 0.5 m below the male in the diagonal (Fig. 2A). The male started calling 20 min after the beginning of observation at 2100 h, and kept calling with long intervals (ranging from 18 to 80 min) between calls until 2325 h. At 2325 h both were observed inside the puddle facing each other with the digits on both front legs interlaced. The frogs were touching and repeatedly bumping their chests. As we did not keep the lights on all the time (between 2040 h and 2325 h), we lost the information about which gender led the partner to the oviposition site. The couple then moved around the puddle using their hind legs to sustain the body describing circular movements with hands still clasped, like dancing a waltz (Fig. 2B). After 1–2 min, they separated and the female submerged 0.2 m deep and the male hid himself under a clump of grass on the opposite edge of the puddle. The male resumed calling and within a



FIG. 1. *Bokermannohyla alvarengai* from Serra do Cipó, state of Minas Gerais, Brazil.

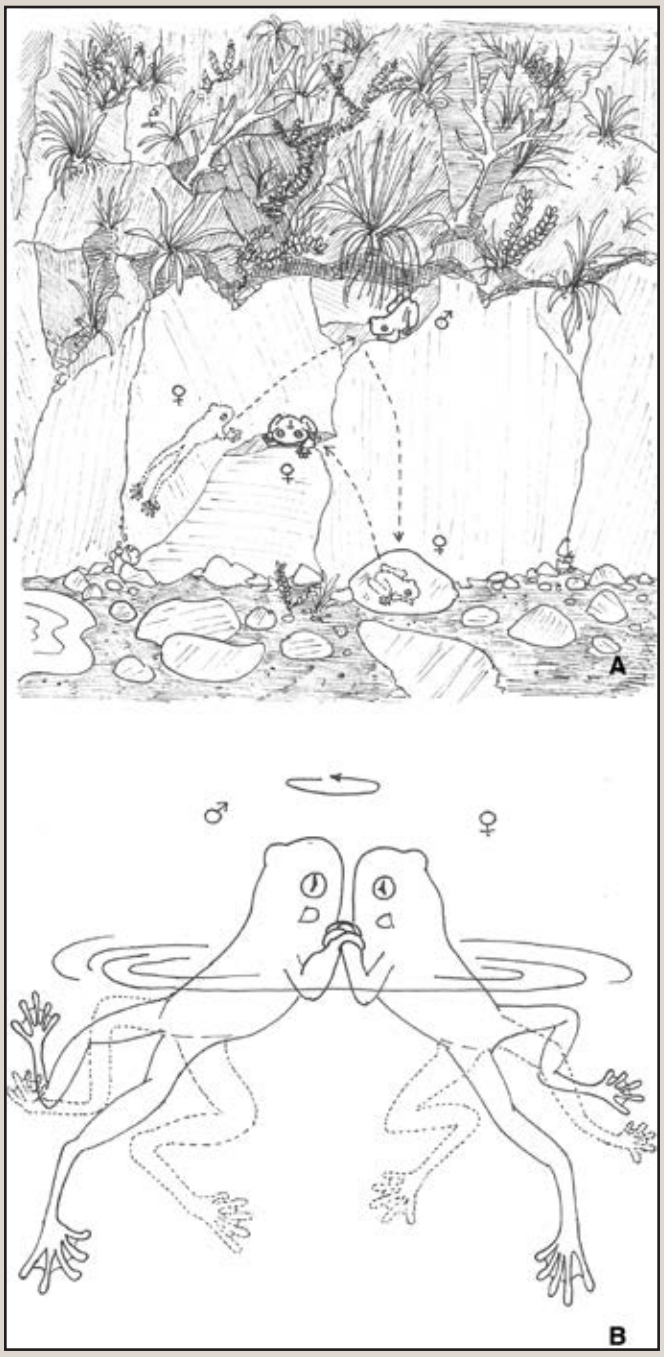


FIG. 2. Courtship in the treefrog *Bokermannohyla alvarengai*. A) female approaches a calling male, leaps to his direction and bounces off the wall, returns to the ground, and moves to the same wall; B) female and male in the puddle with holding hands and toes interlaced in a clasp touching and bumping their chests, and whirling the puddle by treading water using hind legs.

few minutes, the female emerged and followed him to the clump. Both left the grass clump with the front digits again interlaced and moved back to the center of the puddle where they resumed the waltz-like movements circling the puddle for about one minute. Next, the male used his hypertrophied forearms to vigorously try to pull the female underwater while maintaining her in a belly-up position. We interpreted this as an amplexus attempt. At this moment, the female escaped to the puddle edge and slowly moved away by the stream. The male chased her to the edge of the puddle and resumed calling, while watching the female, who apparently ignored his calls and left. The female entered into a crevice of a rock and disappeared while the male continued to call far apart in time. The entire action in the water lasted 20 min after the initial physical contact (at 2325 h).

Despite the fact that the courtship behavior concluded with an unsuccessful attempt of amplexus, we believe that the behavioral sequence observed is a valid description of the pre-mating courtship behavior of *Bokermannohyla alvarengai*. As this species utilizes the reproductive mode number two, laying its eggs in lotic water (Haddad and Prado 2005), it is quite likely that egg deposition would occur in that site. Furthermore, records about clutches in the same study area confirm this kind of oviposition site as preferred by the species (Centeno, pers. obs.).

The courtship of *B. alvarengai* seems to be distinct from other species of Cophomantini. In *B. ibitiguara*, the courtship is more aggressive, with the male hitting the female with his arm to conduct her to the oviposition site (Nali and Prado 2012). In *B. nanuzae*, the female chooses a calling male during courtship behavior, then the male guides the female to the egg-laying site (a natural crevice) using visual, acoustic, and tactile stimuli (Lima et al. 2014). Similarly, in *Aplastodiscus*, the couple exchanges many soft touches with chin, hands, and feet while the male conducts the female to the nest built by him (Haddad and Sawaya 2000; Hartmann et al. 2004; Haddad et al. 2005; Carvalho Jr. et al. 2006; Zina and Haddad 2007). The genus *Hypsiboas* presents a more variable array of courtship behaviors. In general, vocalization is the first step to attract females and could be followed by a direct jump by the male, followed by amplexus (e.g., *H. goianus*; Menin et al. 2004) or by a kind of visual or tactile signaling by the female indicating her receptiveness for mating (Hödl 1977; Kluge 1981; Martins and Haddad 1988; Camurugi and Juncá 2013; Landestoy 2013). Despite variations in the courtship behavior within the Cophomantini, none of them exhibit the complex waltz-like interaction herein reported for *B. alvarengai*. However, since our report corresponds to the third available for the genus, other congenerics may share this feature.

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Microhabitat Use of Recently Metamorphosed Mexican Treefrogs in Palo Verde National Park, Guanacaste Province, Costa Rica

Amphibian habitat use is driven by trade-offs between food acquisition, predator avoidance, reproductive behavior, temperature regulation, and water balance (Blomquist and Hunter 2009; Beyer et al. 2010; Köhler et al. 2011). Additionally, the distinct requirements of different life stages of amphibians can result in ontogenetic shifts in habitat use (Semlitsch 2000; Babbitt et al. 2006). Knowledge of habitat use of each life stage is critical for identifying habitat features essential to amphibians so that successful conservation and management strategies can be developed. However, information on the habitat use of all life stages is lacking for most species of amphibians in the tropics.

The Mexican Treefrog (*Smilisca baudinii*) is a nocturnal, arboreal, pond-breeding frog that ranges from southern Texas to southern Costa Rica (Santos-Barrera et al. 2010). Despite being both common and conspicuous throughout much of its range (Duellman 2001), limited information is available documenting *S. baudinii* habitat use, especially for juveniles (Malone 2005). Adult *S. baudinii* occupy habitats near ephemeral bodies of water and are often associated with disturbed sites and secondary forests (Savage 2002). In dry conditions, *S. baudinii* takes refuge under tree bark and in tree holes, in leaf axils of various plants, and in burrows (Meyer and Wilson 1971; Duellman 2001; Savage 2002). *Smilisca baudinii* is known to exhibit explosive breeding in temporary shallow bodies of water cued by heavy rains (Savage 2002).

Juvenile dispersal and habitat use of *S. baudinii* is largely unknown (Malone 2005). It is assumed that post-metamorphic migrations consist of movement from breeding ponds to upland cover sites (Malone 2005). Juvenile habitat use has only been briefly described in a study characterizing the reproductive assemblage of amphibians in a lowland wet forest site in northwestern Costa Rica (Donnelly and Guyer 1994). Donnelly and Guyer (1994) observed four juvenile *S. baudinii* on three different substrate types, two individuals on the grass *Panicum grande* and two individuals on other substrate types not specified. The objective of our study was to determine microhabitat use of recently metamorphosed *S. baudinii* individuals along the edge of the Palo Verde Marsh in Palo Verde National Park, Costa Rica. Our study is the first to describe habitat use of recently metamorphosed *S. baudinii* in tropical dry forest habitat in northwestern Costa Rica.

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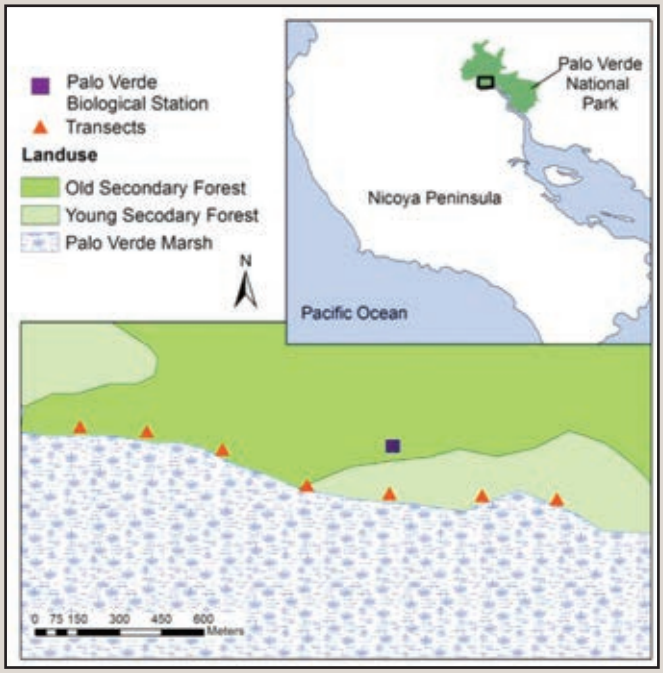


FIG. 1. Map of study location in Palo Verde National Park, Guanacaste Province, Costa Rica.

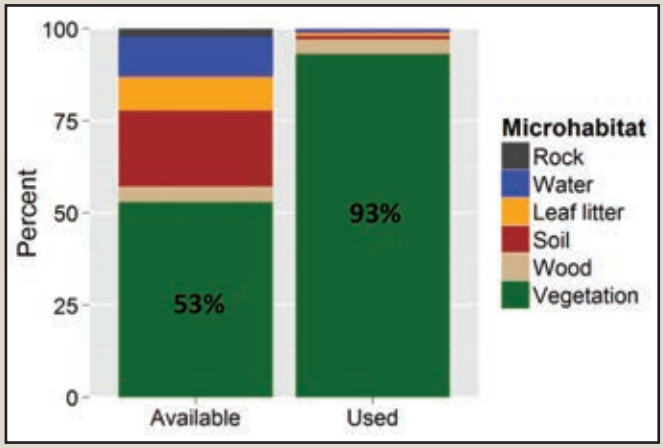


FIG. 2. Percent of microhabitat available and microhabitat used by recently metamorphosed *Smilisca baudinii* observed during surveys, N = 103.

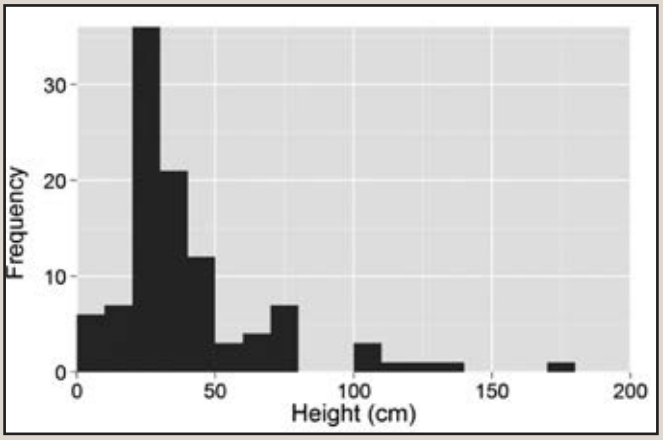


FIG. 3. Histogram of observed perch height of recently metamorphosed *Smilisca baudinii*, N = 103.

METHODS

Study site.—We conducted our study at Palo Verde Biological Station (10.3451°N, 85.3387°W) in Palo Verde National Park. The park is located in the lower portion of the Tempisque River drainage basin in Guanacaste, Costa Rica and is composed of semi-deciduous tropical dry forest (Hartshorn 1983). Within the park, a large seasonal freshwater marsh located between the Tempisque River and tropical dry forest serves as an important breeding habitat for at least 13 anuran species (Mora et al. 2012).

Surveys.—We conducted nocturnal transect surveys on 12 June and 13 June 2013 between 2000 and 2430 h. We searched for amphibians along seven 50 x 2 m (by 2 m high) transects laid perpendicular to the Palo Verde Marsh shore for 30 min in each transect (Fig. 1). We surveyed each transect once during the study period. The first ten meters of each transect included aquatic vegtation and standing water and the remaining 40 m included terrestrial habitat. The location for the first transect was randomly selected and each additional transect was separated by 300 m. Transects were representative of both early (N = 4) and late secondary forest (N = 3) that borders the marsh (Fig. 1). For each *S. baudinii* individual sighted, we recorded perch height and microhabitat type (rock, vegetation [narrow-leaf, broad-leaf], wood [fallen logs, tree trunks, and branches], water, and soil).

To estimate the availability of each microhabitat type, every ten meters along the transect (at 0, 10, 20, 30, and 40 m) we rotated blindly several times and dropped a meter stick in a total of four places (for a total of 20 microhabitat samples per transect). The microhabitat types the meter stick touched by this method were used as a random sample of availability of the different microhabitat types (Smith et al. 2003). To determine if microhabitat types were used by *S. baudinii* differently than expected at random, we used a chi-square test.

RESULTS

We observed 103 recently metamorphosed *S. baudinii*, most still showing remnants of a tail from the larval stage. We did not detect any adult *S. baudinii* during transect surveys (although a few adults were observed outside of transect surveys). Mean number (± SD) of *S. baudinii* observed per transect was 15 ± 12 (N = 7). We observed similar abundances of *S. baudinii* in transects located in young secondary forest (14 ± 14, N = 4) and old secondary forest (16 ± 11, N = 3). Vegetation was the most dominant microhabitat available (Vegetation = 53%; Wood = 4%; Leaf litter = 9%; Soil = 21%; Water = 11%; Rock = 2%; Fig. 2). *Smilisca baudinii* metamorphs used microhabitats disproportionately to availability ($\chi^2 = 70.2$, df = 5, $P < 0.001$; Fig. 2). We found the highest percentage of *S. baudinii* on vegetative microhabitat (Fig. 2). Among vegetation types, we observed a higher percentage of *S. baudinii* on broad-leaf plants (83%) than narrow-leaf plants (17%). Average perch height of *S. baudinii* was 34 ± 29 cm (mean ± SD, N = 103). We observed the majority of inividuals on perches less than 50 cm in height (Fig. 3).

DISCUSSION

Our study provides information on habitat use of recently metamorphosed *S. baudinii* in a Costa Rican tropical dry forest during the wet season. We found similar abundances of recently

metamorphosed *S. baudinii* in young and old secondary forest habitats. Recently metamorphosed *S. baudinii* along the edge of the Palo Verde Marsh do not use microhabitat at random but instead, predominantly use vegetation. Our microhabitat-use results are intuitive given the fact that *S. baudinii* is an arboreal species. However, it is notable that we found a higher percentage of use of herbaceous vegetative microhabitat compared to woody plant substrate, and that the majority of *S. baudinii* were perched on broad-leaf rather than narrow-leaf vegetation. We report a lower average perch height than reported in tropical lowland wet forest (approximately 46 cm for juveniles); however, both our study and Donnelly and Guyer (1994) report high variation in perch height. Our observation of a high number of recently metamorphosed *S. baudinii* but no adults in transects likely reflects the seasonality of breeding. Amphibians that have seasonal breeding bouts tend to have little overlap in peak numbers of adults and juveniles (Donnelly and Guyer 1994; Savage 2002).

Pond-breeding amphibians require wetland habitat for breeding and suitable upland habitats for foraging (Semlitsch 2000; Babbitt et al. 2006; Babbitt et al. 2009). Therefore, the connection between wetland and upland habitat is important to facilitate dispersal of juveniles to upland habitat and adults from upland habitat to suitable breeding locations (Pope et al. 2000; Herrmann et al. 2005; Babbitt et al. 2006). The connection between terrestrial and aquatic habitat is not only thought to be important to sustaining pond-breeding amphibian populations but also essential to nutrient transfer and ecosystem function (Regester et al. 2006). Seasonal movements of amphibians can result in production and movement of a large amount of biomass between aquatic and terrestrial habitats. For example, Mora et al. (2012) estimated a seasonal total of 6730 g/day of biomass produced by the marsh in the form of recently metamorphosed frogs in a 300-m stretch of marsh edge in Palo Verde National Park, suggesting that the marsh habitat is a critical component of nutrient transfer and overall function of the surrounding tropical dry forest ecosystem.

In addition to habitat use along the marsh edge, future research should also document habitat use of juvenile and adult *S. baudinii* and other amphibian species in the Palo Verde Marsh in both upland habitat and interior marsh habitat, especially in relation to current active management types (cattle grazing and mechanical removal of *Typha* spp. [Trama et al. 2009]). Our study was limited to a short survey period and one life stage (recently metamorphosed individuals) at the Palo Verde Marsh. Long-term research of multiple life stages over the range of *S. baubinii* is required to make broad generalizations of microhabitat use of *S. baudinii*. Knowledge of habitat use of all life stages of amphibians is important to increase the understanding of the interaction between habitat, behavior, and fitness of these organisms and to work towards developing successful conservation and management strategies.

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Use of an Agroecosystem by the Threatened Dart Poison Frog *Andinobates virolinensis* (Dendrobatidae)

Conversion of forested habitats to human land-uses is a primary cause of amphibian declines in tropical regions (Alford and Richards 1999; Vié et al. 2009; Robinson et al. 2013; Kurz et al. 2014). Amphibians may be susceptible to habitat alterations because of their sensitivity to microclimate changes, limited dispersal capacities, and high susceptibility to desiccation (Nowakowski et al. 2013; Robinson et al. 2013; Mendenhall et al. 2014). Previous studies at tropical latitudes have shown that human habitat disturbance generates changes in the structure and composition of amphibian ensembles, promotes the spread of generalists and alien species, and probably leads to local extinctions of species (Urbina-Cardona et al. 2006; Isaacs and Urbina-Cardona 2011; Cortés-Gómez et al. 2013). Given the unprecedented rate of habitat loss in many tropical regions, scientists have focused on assessing the potential of human-altered landscapes, such as agroecosystems, as an alternative approach to biodiversity conservation (Schroth et al. 2004; Somarriba et al. 2004).

Shaded coffee plantations resemble forest-like habitats in terms of vegetation structure and density, including several levels of vertical stratification of arboreal elements and a complex canopy that modulate the microclimates of the coffee understory, which are likely to be critical to maintain levels of biodiversity comparable with those found in adjacent native forests (Perfecto et al. 1996; Moguel and Toledo 1999; Somarriba et al. 2004; Philpott et al. 2008; Urrutia-Escobar and Armbrecht 2013). In Colombia, shaded coffee plantations are known to harbor a high species richness of birds, bats, arthropods, and plants, including forest species (Castaño et al. 2004; Peraza et al. 2004; Sánchez-Clavijo et al. 2007; Urrutia-Escobar and Armbrecht 2013). However, current knowledge about how natural populations of Colombian amphibians interact in these agroforestry systems remains poorly understood.

A first approach suggests that the herpetofauna in agroecosystems (mainly on coffee and banana plantations) of the Colombian Coffee Belt are less biodiverse than nearby forests, grasses, and even human infrastructures (Hoyos-Hoyos et al. 2012). In contrast, studies from montane landscapes in Mexico suggest that the capacity of shaded coffee plantations to support amphibian species are related to the proportion of canopy cover and patch size (Pineda and Halffter 2004; Pineda et al. 2005). It appears that a decrease in patch area and canopy cover results in a reduction of the structural complexity and availability of microhabitats for amphibian species (Pineda and Halffter 2004). In this sense, understanding how species maintain viable populations in modified agricultural systems is urgent for undergoing integrative management and conservation strategies (Perfecto et al. 1996, 2003, 2007; Anaya-Rojas et al. 2010).

Andinobates virolinensis, commonly referred to as the Santander Dart Poison Frog, is a diurnal, aposematic dendrobatid leaf-litter inhabitant. This species belongs to the *Andinobates bombetes* species group (Brown et al. 2011), and like many other species in the clade it is restricted to disjunct forest fragments within the 1300–2300 m elevation range (Amézquita et al. 2013). Most of the altitudinal distribution of these species occurs within the Colombian coffee belt, between 1000–2000 m elevation (Rueda-Almonacid et al. 2006; Amézquita et al. 2013). The forests within this elevational belt have been severely modified from extensive cattle ranching and intensive agricultural activities that include traditional and exotic crops, as well as coffee production (Rueda-Almonacid et al. 2006; Amézquita et al. 2013; Luna-Mora and Guayara-Barragan 2014). Because the elevational range of frogs in the *bombetes* group overlaps with intensive agricultural production, they face serious conservation threats (Amézquita et al. 2013).

Andinobates virolinensis has a restricted range along the northwestern slope of the Cordillera Oriental of Colombia (Brown et al. 2011). The species inhabits primary and secondary Andean forests between 1700–2000 m, which are characterized by the presence of oaks (*Quercus humboldtii* and *Trigonobalanus excelsa*), arums, and abundant epiphytes (Ruiz-Carranza and Ramírez-Pinilla 1992; Stuart et al. 2008; Valderrama-Vernaza et al. 2010). *Andinobates virolinensis* is listed as Endangered B1ab (iii) according to the IUCN Red List because the species' estimated extent of occurrence is less than 5000 km^2, it is known to exist at no more than five confirmed locations, and the population trend is apparently decreasing due to a continuous decline in the quality and extent of its natural habitat (Amézquita and Rueda-Almonacid 2004).

Here, we report the first record of a natural population of *A. virolinensis* inhabiting a young plantain plantation and a mature mixed culture of shaded coffee and plantain trees in the Serranía de los Yariguíes, Santander Department, Colombia. These traditional cultures have the structural and vertical complexity features of a traditional polyculture system *sensu* Moguel and Toledo (1999). We provide preliminary data about habitat use and population density in these human-managed systems. This information is crucial to improve our understanding about natural history traits of the species and provide an opportunity to evaluate the impact of human activities on *A. virolinensis* populations.

Materials and methods.—The study area is located in the northwestern slope of the Colombian Cordillera Oriental, in the municipality of San Vicente de Chucurí, Vereda La Colorada

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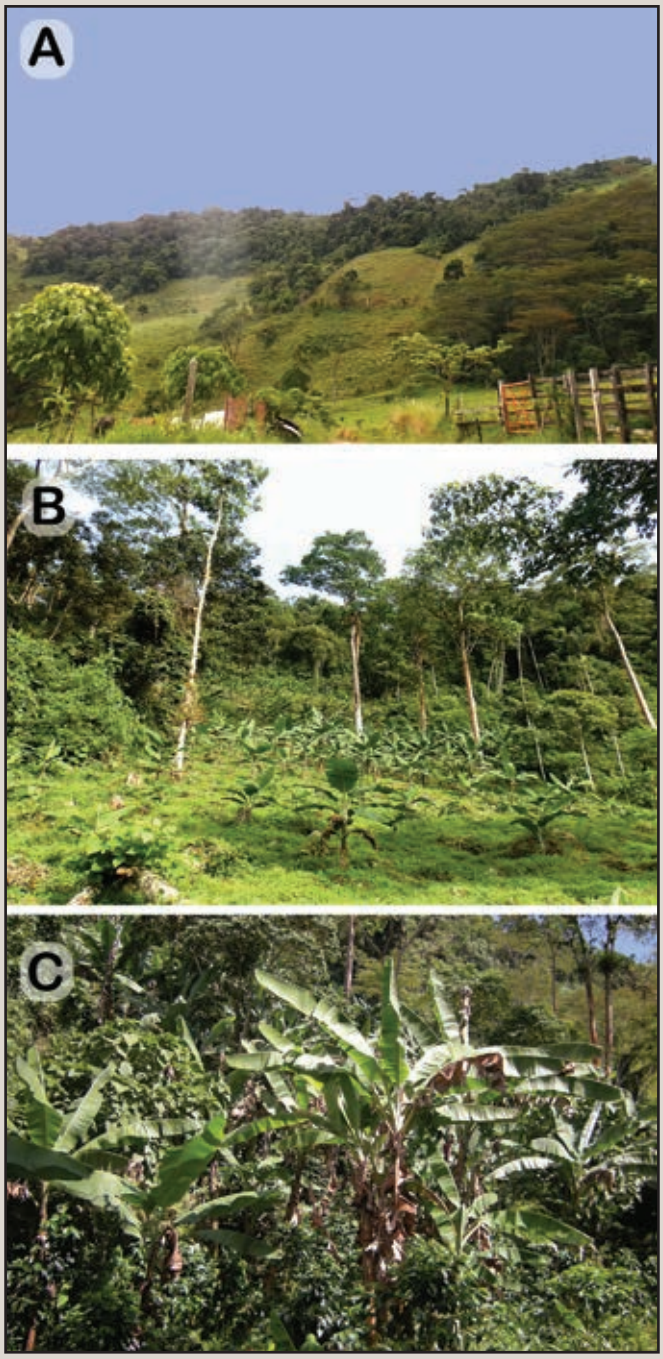


FIG. 1. Habitats sampled in the study site. A) Disturbed Andean cloud forest patch. B) Young plantain culture with sparse native shade. C) Mature plantation with a mix of plantain and coffee with dense native shade.

(Santander Department, 6.784°N, 73.468°W, 1450 m elev.). The area lies within the Distrito de Manejo Integrado Serranía de los Yariguíes, adjacent to Parque Nacional Natural Serranía de los Yariguíes. Historically, this zone has two peaks of rain (March to June and August to November), with a mean annual temperature of 21°C and a mean annual rainfall of 1928 mm (Hijmans et al. 2005).

We identified three habitats with different anthropogenic disturbance in the study area (Fig. 1). The first habitat (H1, Fig. 1a) consisted of a cloud forest patch of nearly 1 km^2 area, disturbed by selective cutting and surrounded almost completely by cattle-grazing grasslands. Structurally, this forest fragment is complex, with a dense canopy of trees up to 30 m high, dominated by trees of the genera *Erythrina* (Fabaceae), *Nectandra* (Lauraceae), and *Cordia* (Boraginaceae). Bromeliads were predominant on large trees. The second habitat (H2, Fig. 1b) corresponded to a young (<1 yr old) plantain plantation (*Musa* spp.) with a sparse canopy of native tree (15–25 m height) species (primarily *Erythrina* spp.) with abundant bromeliads. The third habitat (H3, Fig. 1c) was a mature mixture of shade grown (>5 yr old) plantain trees (*Musa* spp.) and coffee trees (*Coffee arabica*) with a dense canopy of *Erythrina* trees with abundant bromeliads.

We conducted fieldwork from April to August 2012, which consisted of three field surveys. Frog sampling was conducted using two standardized methods: visual encounter surveys (Crump and Scott 1994) and plot or quadrant sampling (Jaeger and Inger 1994), as well as opportunistic observations. Surveys were carried out during the day, between 0800–1800 h.

During the first sampling period on 5 April 2012, we conducted visual encounter surveys along randomly selected transects covering the whole extent of the study area (i.e., H1, H2, and H3). Surveys were carried out during the day by five persons looking carefully for *Andinobates virolinensis* in all potential microhabitats available during a period of three days, totaling 120 h of sampling effort (24 h/person). Because of the low encounter rate of frogs in the first habitat (H1) during this sampling period, we excluded this area from further surveys.

We performed two additional survey periods on 23 May 2012 and 28 August 2012, each of three days, using plot or quadrant sampling. This method provides fairly accurate estimates of density and allows comparisons between studies and sites (Allmon 1991; Rödel and Ernst 2004). For this, we set up 15 quadrants (8 x 8 m) on the floor of each habitat for a total of 960 m^2 of sampled area. During every sampling period, each plot was visited once for about 1.5 h by two persons moving side-by-side, checking for frogs in all potential microhabitats available. Special attention was paid to potential hiding places and reproductive sites. To avoid recounting of individual frogs, each frog was captured by hand and kept in plastic bags with moist leaf litter. Then, the frogs were released nearby the same area at the end of the plot survey.

For estimates of relative density of adults, only the data obtained by plot or quadrant sampling were considered. The relative density was calculated as the number of individuals per total area of sampling, averaged for the period of sampling to obtain a mean density for each habitat. Relative density between habitats was compared with a Mann-Whitney U test.

The microhabitat usage was assessed for all observed frogs, including data obtained from the two sampling methods (e.g., visual encounter surveys and plot or quadrant sampling), plus those collected during opportunistic encounters. For every frog seen, we recorded the type of habitat, substrate (e.g., rock, leaf-litter, vegetation, wood, etc.), height above ground, distance to potential tadpole deposition sites, and activity (feeding, calling, amplexus, nursing, or jumping).

Bromeliad abundance was estimated by counting the number of bromeliad ramets (i.e., clusters of individuals) in each plot, irrespective of substrate (ground, tree trunks and branches). Bromeliad abundance between habitats was compared with a Mann-Whitney U test. To test the relationship between number of frogs and bromeliad abundance per plot we conducted a Spearman's rank correlation.

Results.—During fieldwork we recorded 54 individuals of *Andinobates virolinensis* (24 adults, 4 juveniles, and 26 tadpoles on



FIG. 2. The dart poison frog, *Andinobates virolinensis*. (A) Male parents transport their offspring attached to the back, to phytotelmata in bromeliads. Male nurse carrying (B) one, (C) two, and (D) four tadpoles simultaneously.

the nurse frogs' backs) as follow: 2 males in the first habitat (H1); 7 males, 1 female, 3 juveniles, and 5 tadpoles in the second habitat (H2); 10 males, 4 females, 1 juvenile and 21 tadpoles in third habitat (H3). Based on the results from the plot sampling, we calculated a relative density of 42 ± 15 adult individuals per ha in the second habitat (H2) and 73 ± 15 adult individuals per ha in the third habitat (H3).

The density of adult individuals differed significantly among habitats (Mann-Whitney, $Z = -2.16$, $P = 0.026$), and habitat H3 exhibited the highest density. The abundance of bromeliads found in each habitat varied significantly (Mann-Whitney, $Z = -1.92$, $P = 0.047$). H3 presented the highest values of bromeliads abundance. As expected, there was a relationship between number of adult frogs and bromeliad abundance in each plot (Spearman, $R = 0.88$, $P < 0.001$).

The spatial distribution of frogs within this agroecosystem was not homogeneous. Instead, the frogs were always found associated with areas adjacent to large native trees with abundant and large bromeliads. No frogs were found within treeless areas, or even in areas with trees lacking large bromeliads. Frogs were recorded mainly in moist rock and tree-root cavities covered with leaf-litter, no more than 3 m away from trees' stems. Two adult males were recorded calling inside moist rock cavities with small water pools. We observed 12 male nurse frogs carrying 1–4 tadpoles at a time (Fig. 2). The tadpoles were at the same stage of development.

Some males partially used plantain and coffee plants only to walk onto adjacent native trees with bromeliads. No tadpoles were observed in the small bromeliads located on the trees below 8 m height or on ground bromeliads. Although bromeliads above 15 m height were not searched for tadpoles, we observed 3 male nurse frogs transporting tadpoles from the ground to bromeliads between 10 and 15 m. During the fieldwork, we did not find eggs laid or frogs engaged in courtship. However, the fact that males were found calling between rock cavities where small water bodies form between the litter and that several male nurse frogs were also found transporting tadpoles near these water pools suggest that these sites might represent a potential microhabitat for females to deposit their eggs.

Discussion.—The density of *Andinobates virolinensis* was significantly lower in the habitat corresponding to a young traditional plantain plantation (H2) than in the habitat corresponding to a mature mixed plantation of coffee and plantain (H3). In this

sense, the low number of bromeliads in H2 relative to H3, could limit its potential to harbor high population densities. Similar results have been documented for *A. virolinensis* inhabiting forested areas, where the density of adult males is apparently related to density of bromeliads for tadpole deposition (Cáceres 2007). These results agree with those from other studies in the dart poison frog *Andinobates bombetes* (Vargas-Salinas and Amézquita 2013) and *Oophaga pumilio* (as *Dendrobates pumilio*, Donnelly 1989; Pröhl 2002), which indicate that the density of reproductive resources, such as bromeliads, represent a good predictor of density of adult frogs. In contrast, in *A. opisthomelas* (as *Ranitomeya opisthomelas*) there is no apparent association between density of frogs and number of bromeliads (Ríos et al. 2011).

It seems that remnant native trees with bromeliads represent key features to the presence of the species in this agroecosystem. Moreover, it is possible that density differences between the studied habitats could be influenced by canopy cover of remnant native vegetation, as well as percentage of leaf litter, leaf litter moisture, depth of soil cover, and leaf litter mass. Remnant native vegetation are considered keystone structures of altered landscapes because of their capacity to harbor native species of fauna and their contribution to ecosystem functioning, representing an invaluable feature that must be actively protected and managed (Manning et al. 2006; Sekercioglu et al. 2007; Fischer et al. 2010; Robinson et al. 2013; Mendenhall et al. 2014).

The presence of juveniles, females, calling males, and nurse males carrying tadpoles to bromeliads indicates that this population of *Andinobates virolinensis* is successfully breeding within this agroecosystem. This can be explained by the persistence of suitable microhabitats provided by native trees with high abundance of bromeliads, tree-root cavities, leaf litter, and moist rock cavities, which provide adequate conditions for shelter, sites for calling, mating, and egg-laying, as well as phytotelmata for tadpole development. The fact that these frogs can breed in these traditional plantations is important because it increases the conservation and management opportunities for the species. In this sense, resource management activities (e.g., supplementation of reproductive resources, like bromeliads or artificial pools) may play a critical role in the management of populations where these resources are limited.

Recent studies suggest that forest conversion to coffee plantations could represent a primary threat for species of the *bombetes* group (Rueda-Almonacid et al. 2006; Amézquita et al. 2013; Luna-Mora and Guayara-Barragan 2014). In fact, such agroecosystems have been thought of as unsuitable habitats for *Andinobates tolimensis* (Bernal et al. 2007). However, traditional shaded coffee plantations, such as those in most of Santander Department (Colombia), are complex agroforestry systems that maintain a high biodiversity, including migratory and threatened species of birds (Peraza et al. 2004; Sánchez-Clavijo et al. 2008), bats (e.g., Castaño et al. 2004), and frogs (this study). However, it is still unclear whether these plantations are suitable forest-like habitats for native species or if they simply represent secondary habitats to avoid the deleterious effects of habitat loss, as recognized by Faria et al. (2007) for cacao-producing landscapes in Brazil.

The natural history traits reported in the studied population of *Andinobates virolinensis* differed from other studied populations. These differences could be the result of different selective pressures or a bottleneck effect in this isolated population, as proposed by Lima and Eterovick (2013) in a population of the dendrobatid frog *Ameerega flavopicta* in Brazil. Under both scenarios, the surviving individuals of the population happened to be phenotypically successful in the novel altered habitat. Nevertheless, additional studies are necessary to test these hypotheses. In general, the results of this study show that our understanding of the long-term impacts of environmental change on populations of *A. virolinensis* is still in an early stage of understanding.

Agroecosystems can be viewed as complementary habitats in a broader conservation scheme in which fragments of native forests represent the keystone in regional conservation efforts (Perfecto et al. 1996; Somarriba et al. 2004; Perfecto et al. 2007). Unfortunately, under current management practices, the habitat quality of shaded coffee plantations in Colombia is likely to decline over time due to agricultural and pastoral land-use intensification, which may have a negative effect on biodiversity (Rojas et al. 2012; Urrutia-Escobar and Armbrecht 2013). In this sense, working with agriculture practitioners can both promote local economic development and species conservation initiatives.

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Upstream Dam Passage and Use of an Eel Ladder by the Common Watersnake (*Nerodia sipedon*)

Seasonal movement patterns, an important aspect of the ecology and life history of the Common Watersnake (*Nerodia sipedon*), may be altered in areas of anthropogenic habitat modification (Roe et al. 2006; Roth and Greene 2006). Reservoir dams represent a common and widespread habitat modification and can influence movement patterns of reptiles in riverine and riparian habitats (Hunt et al. 2013). Common Watersnakes often move along river corridors (Pattishall and Cundall 2008) but also disperse along riparian corridors (Tiebout and Cary 1987). Although reservoir dams are prevalent within riverine systems (Graf 1999; Poff and Hart 2002), little is known about how dams affect movement patterns of Common Watersnakes. Dams are documented barriers to upstream movement of many fish species (Liermann et al. 2012), and fish passage facilities have been installed on some dams (Schilt 2007; Roscoe and Hinch 2010). Passage facilities are used occasionally by non-target aquatic species, such as crustaceans, lampreys, and turtles (Meehan 2003; Keefer et al. 2013), but we know of no previous studies that have documented upstream passage by Common Watersnakes.

In this study, we report the use of an eel ladder (a fish passage facility targeting upstream migrant American Eels) by Common Watersnakes in the lower Shenandoah River, a large tributary of the Potomac River drainage, USA. Our study objectives were to document dam passage and the use of an eel ladder by Common Watersnakes, and examine the association of passage events with environmental variables. This study is relevant to understanding movements of Common Watersnakes at a dam tailwater and the potential for dam passage in a regulated river.

Methods.—The Shenandoah River drains approximately 7870 km^2 of the Valley and Ridge and Blue Ridge physiographic provinces in Virginia and West Virginia (Jenkins and Burkhead 1994). A 296-m wide by 5-m high low head hydroelectric dam is located on the lower Shenandoah River at Millville, West Virginia (95 m elev.; 39.2689°N, 77.7820°W; Fig. 1). Millville Dam is approximately 9 river km upstream from the confluence of the Potomac and Shenandoah rivers. A fish ladder, designed for upstream dam passage of 15–80 cm total-length American Eels is located on the western end of Millville Dam (Welsh and Liller 2013; Fig. 2). This 11-m long eel ladder is a covered stainless steel sluice (13 cm depth x 41 cm width) with a 50° slope. Inside the ladder, a peg board of three vertical rows of 5.1-cm diameter ABS plastic pipes provides climbing substrate, which is designed for serpentine movements of American Eels (Welsh and Liller 2013). The eel ladder is typically removed in November and reinstalled the following year during late spring to early summer (Table 1). Removal of the eel ladder, which occurs at the discretion of the hydropower company, is a preventative measure to reduce ladder damage from large woody debris associated with high river discharges during late fall through early spring.

To obtain data associated with ladder passage events, American Eels and Common Watersnakes are collected and counted from a net bag (3.2 mm stretched mesh) on the upstream end of the ladder. Also, an infrared-triggered eel ladder camera, which photographs each American Eel or non-target species that passes through the ladder, is used for monitoring passage events. Individuals are photographed when passing through a plexiglass chamber, which is spliced into a PVC pipe leading from the top of the ladder. Using digital photographs (date and time stamped) from the eel ladder camera, we obtained data on counts of

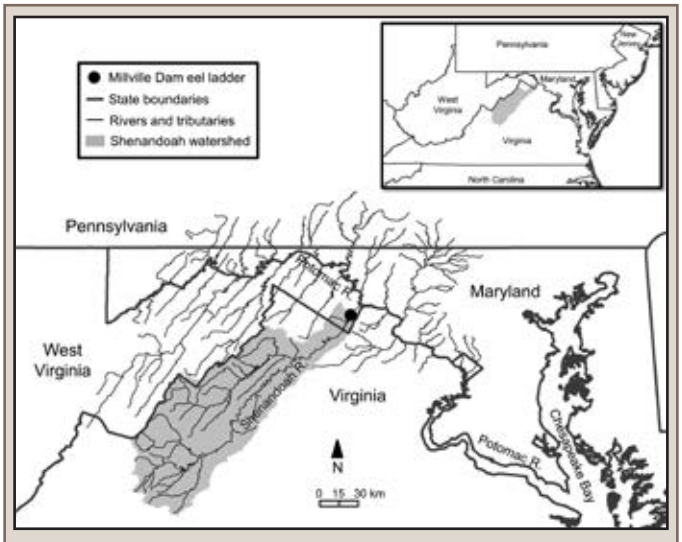


Fig 1. Location of the eel ladder at a hydroelectric dam on the lower Shenandoah River at Millville, West Virginia, USA.

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FIG 2. The Millville Dam eel ladder on the lower Shenandoah River, West Virginia, USA.

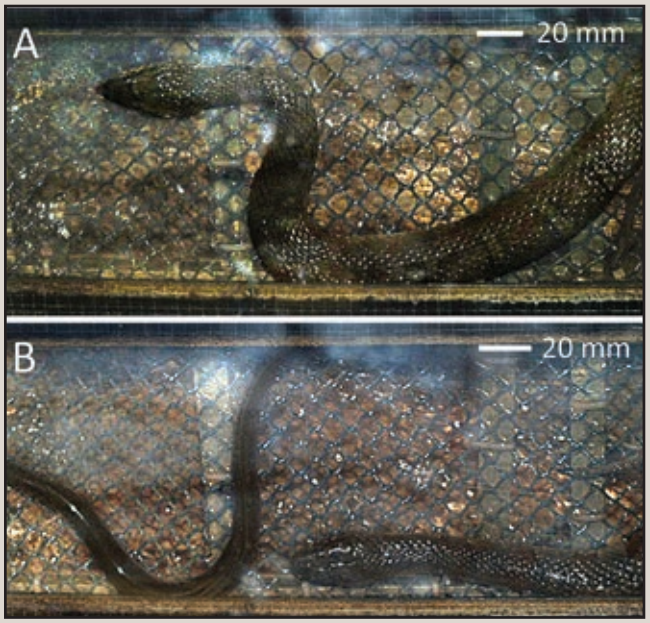


FIG 3. Photographs of (A) a Common Watersnake and (B) a Common Watersnake and an American Eel passing though the Millville Dam eel ladder.

TABLE 1. Annual passage counts of Common Watersnakes and American Eels at the Millville Dam eel ladder, Shenandoah River, USA.

Year	Sample period	Sample days	American Eel count	Common Watersnake count
2007	10 May–6 November	181	852	3
2008	6 June–6 November	154	1616	1
2009	22 June–9 November	141	1311	0
2010	6 May–9 November	188	5394	0
2011	28 June–7 November	133	1255	0
2012	9 May–12 November	188	4263	1
2013	1 July–21 October	113	2470	2
2014	22 July–5 November	106	1054	5

individuals, timing of passage, and head width measurements using photogrammetric methods with digital imaging software (Welsh and Aldinger 2014).

To examine environmental variables associated with passage events of Common Watersnakes, we calculated mean values and recorded ranges of river discharge (m^3s^{-1}), lunar illumination, and water temperature (°C). River discharge data were obtained from a U.S. Geological Survey gauge at Millville, West Virginia. Lunar illumination, measured as fraction of the moon face ranging from 0 (new moon) to 1 (full moon), was calculated from an astronomical algorithm (Meeus 1991). Water temperature at Millville Dam was recorded with a StowAway Tidbit Temp Logger (Onset Computer Corporation).

Results.—During 2007–2014, the Millville Dam eel ladder passed 18,215 American Eels and 12 Common Watersnakes (Table 1). Passage events of Common Watersnakes occurred in 2007, 2008, 2012, 2013, and 2014. Eleven individuals passed during summer months (28 June–August 28), and one individual passed during fall on 5 October 2013. During 2007–2008, four Common Watersnakes were collected from the net bag on the terminal end of the eel ladder and were released without measurement. From 2012–2014, eight Common Watersnakes were photographed by the eel ladder camera (Fig. 3), and head width was measured for seven individuals (mean ± SE = 18.5 mm ± 0.96, range 14.8–21.6 mm). Seven Common Watersnakes passed during daylight hours between 0628–1726 h. One Common Watersnake, however, entered the ladder at night and was photographed 97 times from 0337–0810 h, a time period that included passage of 18 American Eels (Fig. 3). Based on timing of passage and the number of photographs for each individual, most watersnakes quickly passed through the plexiglass photographic chamber of the ladder.

River discharge, water temperature, and lunar illumination were recorded for passage events of 12 common watersnakes. Watersnakes used the eel ladder during periods of low river discharge (mean ± SE = 24.5 m^3s^{-1} ± 1.4, range 16.3–32.6 m^3s^{-1}). During the time period of 2007 through 2014, the annual mean ± SE of daily river discharge values at Millville Dam was 62.0 m^3s^{-1} ± 3.8 (range 13.2–606.0 m^3s^{-1}). Common watersnakes used the eel ladder during a narrow range of water temperatures (mean ± SE = 26.5°C ± 0.53, range 23.5–30.9°C; Table 1). Data on lunar illumination associated with passage events were bimodal, with four events at a new moon (lunar illumination ranged from 0.00–0.06), five at a full moon (0.94–1.0), two near a waxing quarter moon (0.43–0.52), and one near a waning quarter moon (0.43).

Discussion.—Our data documented the use of an eel ladder by Common Watersnakes at Millville Dam on the lower Shenandoah River, West Virginia. It is not known if individuals entered the ladder for sheltering, foraging, upstream movement, or alternative reasons. A total of 12 passage events during an eight-year period does not suggest the eel ladder is an effective method of reducing a "dam barrier effect" on upstream movements of watersnakes. Our study, however, is the first to report that Common Watersnakes will occasionally use an eel ladder, which allows a more direct route of dam passage relative to travel along riparian corridors.

Common Watersnakes may have used the eel ladder as a thermal refuge or as a cover shelter to avoid predation and human risks. The eel ladder, which is a covered stainless steel sluice, may attract Common Watersnakes during daylight hours because of its warm conductive surface. Also, the tailwater of Millville Dam

is primarily bedrock with relatively few large cobbles or boulders available for cover objects, thus Common Watersnakes may use the ladder as a cover shelter to reduce predation risk (Gregory 2009). Furthermore, angling occurs commonly at the Millville Dam tailwater, and because Common Watersnakes often exhibit escape behavior when approached by humans (Cooper et al. 2008), the eel ladder may be used as a shelter to avoid perceived threats from humans.

Ladder use and dam passage of Common Watersnakes occurred across a narrow range of river discharges and water temperatures. Most passage events occurred when river discharge was low (< 33 m^3s^{-1}), which may be explained by either reduced movements during high river discharges or the inability of Common Watersnakes to find the ladder base when the dam spillway is inundated by high water levels. Eleven of 12 passage events occurred during summer, with water temperatures ranging from 24.7 and 30.9°C, whereas one passage event during fall occurred at 23.5°C. Use of the ladder during summer is consistent with expected times of increased activity and movement, because Common Watersnake activity is positively correlated with water temperature (Andreadis 1997; Finkler and Claussen 1999), and the preferred body temperature of the Common Watersnake has been reported at approximately 28.0°C (Lillywhite 1987; Lutterschmidt and Reinert 1990).

Lunar phase was associated with ladder use by Common Watersnakes, where most passage events occurred on or near new moons or full moons. It is unclear, however, if illumination associated with moon phase influenced behavior or if the activity of these Common Watersnakes was controlled by an endogenous circalunar clock. Watersnakes and many other snakes are often less active on or near the full moon (Madsen and Osterkamp 1982; Houston and Shine 1994; Kronfeld-Schor et al. 2013), although the terrestrial Florida Cottonmouth (*Agkistrodon piscivorus conanti*) has been shown to increase nocturnal foraging activity near the full moon (Lillywhite and Brischoux 2012). Andreadis (1997) found that foraging activity of Common Watersnakes increased during low levels of lunar illumination near new or waxing moons. Nocturnal activity during periods of reduced moonlight may assist Common Watersnakes with capturing prey as well as reduce predation risk (Andreadis 1997). In our study, however, most individuals used the ladder during daylight hours, suggesting that a circalunar biorhythm may influence activity associated with moon phase.

Agostinho et al. (2012) found that fish ladders may attract fish predators. Common Watersnakes are piscivorous (Raney and Roecker 1947) and are known to eat American Eels (Gibbons and Dorcas 1994). Thus, it is possible that high abundances of American Eels at the base of the eel ladder or eel scent from the eel ladder attracts Common Watersnakes. However, as previously emphasized, most Common Watersnakes used the eel ladder during daylight hours, and American Eel passage occurred primarily at night. One Common Watersnake that used the ladder at night remained in the photographic chamber for 4.8 h, a time period when 18 American Eels passed through the ladder, but it is unknown if this individual consumed American Eels when inside the eel ladder.

This study demonstrated that an eel ladder can aid upstream dispersal of Common Watersnakes. It is not known, however, if the watersnakes were using the eel ladder for the purpose of upstream passage. Use of the eel ladder may benefit Common Watersnakes by allowing upstream access within the river corridor. However, once upstream of the dam, individuals would likely require the riparian corridor to reaccess the dam tailwater. Our data on eel ladder use and dam passage are relevant to understanding activity and movement patterns of Common Watersnakes in the vicinity of dams.

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Eye Color and Chin Pattern in the Turtle *Graptemys pseudogeographica* in the Calcasieu River Drainage of Louisiana, with Comparison to Adjacent Drainages

Eye coloration is a characteristic of freshwater turtles that is little noted in field guides and formal descriptions of taxa, probably because it cannot be assessed in preserved specimens. In the genus *Graptemys* (map turtles and sawbacks), three predominant patterns of eye coloration occur (Lindeman 2013): a) a yellow or b) white iris, bisected by a black stripe, and c) a white iris without a bisecting stripe. The striped white iris typifies *caglei*, *ouachitensis*, *sabinensis*, and *versa*, while southern populations of *pseudogeographica* (the subspecies *kohnii*) are most frequently reported to have white irises without bisecting stripes. Yellow irises with black stripes typify populations of the nominate northern subspecies of *pseudogeographica* as well as the remaining species, *barbouri*, *ernsti*, *flavimaculata*, *geographica*, *gibbonsi*, *nigrinoda*, *oculifera*, *pearlensis*, and *pulchra*.

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Graptemys species all have yellow to light-orange stripes, spots, and blotches against a darker ground color on the head, neck, and limbs. Three predominant patterns of light chin markings occur and are used as reliable diagnostic characteristics of species (Carr and Marchand 1942; Cagle 1952, 1953a, b, 1954; Haynes and McKown 1974; Lovich and McCoy 1992; Vogt 1993; Ennen et al. 2010b; Lindeman 2013): a) three spots, one anterior and medial and the other two, which are often elongated, below the angles of the jaw (*ouachitensis*, *pseudogeographica*, *versa*); b) a medial longitudinal blotch or stripe and two spots under the angles of the jaw, also often elongate (*ernsti*, *geographica*, *gibbonsi*, *pearlensis*, *pulchra*); and c) a transverse chin bar, essentially a curving stripe along the lower margin of the chin (*barbouri*, *caglei*, *flavimaculata*, *nigrinoda*, *oculifera*, and *sabinensis*).

In a published conference abstract, Jackson and Shively (1983) briefly described distinctive characteristics of *Graptemys pseudogeographica* from the Calcasieu River drainage, which drains portions of seven parishes in southwestern Louisiana. In particular, the authors described two distinctive characters: 1) dark pigmentation of the entire iris, causing the irises to appear black, and 2) variation in the chin pattern, with individuals having both three-spot and barred patterns on the chin. Chin patterns were thus a mix of two of the predominant patterns used as diagnostic features of many congeners.

During wide-ranging freshwater turtle survey efforts on the Calcasieu drainage and its two adjacent drainages, the Sabine to the west and the Mermentau to the east, we encountered *G.*

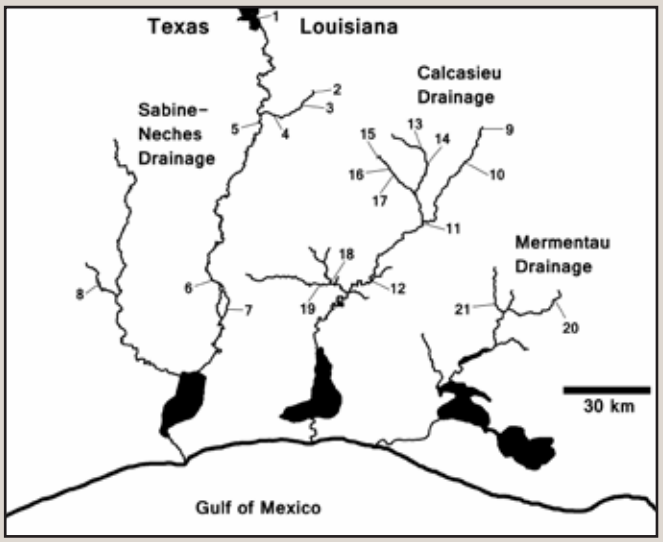


FIG. 1. Trapping and photographic localities for *Graptemys pseudogeographica* on the Sabine-Neches, Calcasieu, and Mermentau drainages of southwestern Louisiana and southeastern Texas. Numbers correspond to sites listed in Appendix I.



PHOTOS BY SHS AND PVL

FIG. 2. Three *Graptemys pseudogeographica* exhibiting the dark-brown iris found in most specimens caught in the Calcasieu drainage. Top, juvenile, Whiskey Chitto Creek near Hwy. 26 crossing in Allen Parish, Louisiana. Middle, female, midline plastron length 209 mm, West Fork Calcasieu River at Sam Houston Jones State Park in Calcasieu Parish, Louisiana. Bottom, female, midline plastron length 187 mm, Serpent Bayou <1 km from its confluence with the mainstem Calcasieu River in Calcasieu Parish, Louisiana.

pseudogeographica at several sites. Here we report on patterns of iris coloration and chin patterns for specimens in these drainages to quantify the patterns noted by Jackson and Shively (1983) and make comparisons among the adjacent drainage populations.

Study Areas and Methods.—We surveyed turtles in the Calcasieu drainage in four parishes, the Sabine drainage in four parishes, and the Mermentau drainage in four parishes (Fig. 1). The Calcasieu and Sabine drainages have a mix of very low-elevation downstream reaches—less than 1 m above sea level (asl), according to Google Earth—that are uniformly deep and sluggish, contrasting with upstream reaches that have gradients that promote a riffle-run organization with currents that maintain abundant sandbars. The entire Mermentau drainage is uniformly deep and sluggish, with surface levels that are <1 m asl throughout the reaches we surveyed, according to Google Earth.

Turtles were captured in 2010–2013 using fykenets (Vogt 1980), basking traps (Lindeman 2014; Selman et al. 2012), and baited hoop nets (Legler 1960), with occasional opportunistic dipnetting or hand capture, mostly of juveniles. Eye color and chin pattern of captured *Graptemys pseudogeographica* were photographed with zoom or macro lenses. Turtles were marked on their marginal scutes (Cagle 1939) to avoid double-counting; however, no recaptures were registered for the species, even when trapping was conducted over several days at some sites. Additional photos of captured *G. pseudogeographica* were also available from previous studies (Shively and Vidrine 1984; Shively and Jackson 1985). Additional lower-resolution evidence for eye color and chin pattern was sometimes available from photographs of basking turtles taken using zoom lenses (up to 45x) on tripod-mounted cameras between 2008 and 2013. Based on geographic distances between sites, sampling dates, and details of turtles visible in photos, we feel confident that basking photos did not contain any duplicate photos of the same individual.

Fisher's exact tests were used to compare the Calcasieu drainage with its two adjacent drainages for frequency of iris and chin characters in *G. pseudogeographica*. For these analyses, dark-brown irises were compared against a combined category for lighter colors and chin pattern was scored as complete bar, three spots or spot-line-spot, or intermediate (see below).

Results.—A total of 46 *G. pseudogeographica* were captured and photographed for iris color, with 34 of these also photographed for chin pattern. Thirty-two other individuals photographed during basking surveys had discernible iris color and 7 of these showed discernible chin patterns in their photos.

PHOTOS BY PVL



FIG. 3. Dark-brown irises evident in two basking *Graptemys pseudogeographica* photographed in the Calcasieu drainage. Top, female, Bundick Creek at Morrow Bridge Rd. in Allen Parish, Louisiana. Bottom, male, Calcasieu River at at Hwy. 10 crossing in Allen Parish, Louisiana.

PHOTOS BY PVL



FIG. 4. Two *Graptemys pseudogeographica* from the Sabine drainage exhibiting a light-yellow iris suffused with gray speckling along the outer margins with prominent horizontal black bars bisecting the iris, as seen in all adult females of the Sabine drainage specimens. Top, female, midline plastron length 233 mm, East Sabine River upstream of Niblett's Bluff, Calcasieu Parish, Louisiana. Bottom, female, midline plastron length 192 mm, Sabine River upstream of Palmer Lake Rd. boat ramp, Beauregard Parish, Louisiana/Newton County, Texas.

Localities for these encounters in the three drainages are shown in Fig. 1 and listed with character data in Appendix I.

At six sites on the Calcasieu drainage, we captured 32 *G. pseudogeographica*, of which 30 (94%) had dark-brown irises, with a black horizontal bar bisecting each iris that was visible upon close inspection (Fig. 2). A hatchling and a juvenile female had lighter, barred irises (white in the hatchling, light yellow in the female) that were suffused with speckled gray along the outer rims in both.

Photographs of basking turtles showed evidence of dark-brown irises for 14 *G. pseudogeographica* at 7 sites throughout the Calcasieu drainage (Fig. 3). No other eye color pattern was evident in any basking photographs of the species from the Calcasieu drainage.

In the Sabine drainage, we captured 14 total *G. pseudogeographica* at 4 sites. None exhibited a dark-brown iris. The pattern observed in 8 of 9 females, including the 7 largest females (PL range 116–233 mm), was a light-yellow iris suffused with speckled gray along the outer rim, with a wide horizontal black bar bisecting the iris (Fig. 4). The second-smallest female (PL 137 mm), 3 males, and 2 juveniles likewise had gray speckling around the outer rim of the iris, but the background color of the iris was white rather than light yellow. Black bars bisected the iris in all but one of these 14 turtles; an adult male lacked iris stripes. No *G. pseudogeographica* were among 435 total turtles we captured in the Mermentau drainage (including 326 individuals of a congener, *G. sabinensis*).

Sixteen basking *G. pseudogeographica* were photographed at six total sites in the Sabine drainage. None exhibited a dark-brown iris. Eight females, all of which appeared to be of adult size, appeared to have the yellow and gray, black-barred iris type shown in Fig. 4, while the remaining female—the only clearly juvenile female—had a white, black-barred iris. In Lindeman (2013), two of the adult females appear in Plate J5 and the juvenile female appears in Plate J1. Three unsexed juveniles and three of the four males had white irises with black bars, while the remaining male had a white iris without a bar. The unbarred male appears on the back jacket cover of Lindeman (2013). Two basking *G. pseudogeographica* were photographed at separate sites in the Mermentau drainage. A published photograph of one individual from the Mermentau drainage shows a white iris without a horizontal black bar (Ilgen et al. 2014), although additional photographs of the same turtle suggest it may have had a very thin black horizontal bar through each iris (PVL, unpubl. photos). The other photograph from the Mermentau drainage is of poorer quality due to greater distance of the camera from

PHOTOS BY PVL



FIG. 5. Variable chin patterns of *Graptemys pseudogeographica* in the Calcasieu drainage. Top, three-spot pattern with elongate side spots, adult female, 209 mm midline plastron length. Bottom, transverse chin bar, adult female, 195 mm midline plastron length. Both specimens from the vicinity of Sam Houston Jones State Park, near the confluence of the Houston River with the West Fork Calcasieu River.

the turtle, but shows a white iris with no evidence of a horizontal bar. Combining captured turtles and turtles photographed while basking, the difference in iris color between the Calcasieu drainage (46 dark brown vs. 2 lighter) and its two adjacent drainages (0 dark brown vs. 30 lighter) was highly significant (Fisher's exact test, $p < 0.0001$).

In the Calcasieu drainage, we photographed chin pattern for 22 of the 32 captured turtles (Fig. 5). Nine exhibited a round medial spot at the point of the chin and elongate spots on either side, under the angles of the jaw; 1 had two elongate spots on either side and a central spot that was merged with a neck line; 9 had transverse chin bars instead of spots; and 3 had intermediate patterns. Intermediate patterns were essentially transverse chin bars that had small gaps near the point of the chin (on both sides in 2 turtles, suggestive of 3 elongate spots that almost merged into a bar; on the left side only in the other turtle, suggestive of an incomplete bar; all patterns labeled intermediate lacked the several intervening light lines or whorls between the medial and side spots that were typical of the three-spot pattern). There was no ontogenetic component evident in the variation, as the chin bars were exhibited by 4 adult females, 1 juvenile female, 1 unsexed juvenile, and 3 hatchlings. Chin pattern was visible and clearly discernible in only two photographs of basking individuals in the Calcasieu drainage, both of which had the three-spot pattern.

In the Sabine drainage, chin pattern was photographed for 12 of the 14 turtles we captured. Nine individuals exhibited a three-spot chin pattern, two had the anterior, medial spot elongated as a longitudinal blotch, and one had an incomplete bar, with a small gap on the right side near the point of the chin. In photographs of basking individuals, three individuals exhibited the three-spot pattern. Likewise, both basking individuals photographed on the Mermentau drainage exhibited the three-spot chin pattern. Combining captured turtles and turtles photographed while basking, the difference in chin pattern between the Calcasieu drainage (12 three-spot or spot-line-spot patterns, three intermediate patterns, and nine complete bars) and its two adjacent drainages (16 three-spot or spot-line-spot patterns, one intermediate pattern, and 0 complete bars) was highly significant (Fisher's exact test, $p = 0.0037$).

Discussion.—Almost all of the *G. pseudogeographica* captured in the Calcasieu drainage exhibited dark-brown irises bisected by black lines and all basking specimens photographed on the Calcasieu drainage were consistent with the same coloration. No specimens from the two adjacent river drainages had dark-brown irises and the coloration has never been reported from other localities, thus iris color appears to be a highly consistent diagnostic feature of Calcasieu populations. Localities exhibiting the dark-brown iris that are reported herein encompass virtually the entire range of the species within the drainage (Fig. 1 and Appendix I), thus the dark-brown color is not merely a local anomaly, but appears to be indicative of a trait that is nearly fixed throughout the Calcasieu drainage. To date the genetic basis of iris color in *Graptemys* has not been studied.

There is only one previous report quantifying variation in eye color in species of *Graptemys*, for two syntopic species in the lower Tennessee River drainage in western Kentucky (Lindeman 2003). *Graptemys ouachitensis* was consistent in having a striped white iris, while most *G. pseudogeographica* had an unstriped white iris, with low incidence of black stripes (5%) or small black dots anterior or posterior to the pupil on the iris of one or both eyes (16%). Both species also had low incidence (<5%) of light-yellow coloration invading the white iris. Together with the present report and unpublished observations of other species by PVL, these results suggest that it is typical for *Graptemys* species to have fixed or nearly fixed conditions for iris color and markings at the levels of both local population and drainage-wide metapopulations.

In contrast to iris color and markings, chin patterns were highly variable within the Calcasieu drainage. Of 24 specimens examined or photographed while basking, nine had chin bars and three had intermediate, interrupted patterns more suggestive of a chin bar than of the three-spot pattern that is typical of *G. pseudogeographica* (Vogt 1993). The two adjacent drainages did not show variability, with none of 17 turtles captured or photographed while basking showing a chin bar. A chin bar has not been reported from any other population of *G. pseudogeographica*. Vogt (1993) did not report the condition among large samples of *G. pseudogeographica* collected from several localities throughout the species' range (not including the Calcasieu drainage). He did report that *G. ouachitensis* hatched under laboratory incubation conditions sometimes exhibited a chin bar instead of the three-spot pattern that is also characteristic of that species, but found no chin bars in wild-caught *G. ouachitensis*

specimens taken range-wide. There are also no reports in the literature of any of the 6 *Graptemys* species that are characterized by chin bars having any individuals exhibiting a three-spot pattern (Carr and Marchand 1942; Cagle 1952, 1953a, b, 1954; Haynes and McKown 1974; Lovich and McCoy 1992). However, Ennen et al. (2010b) reported lack of the chin bar (without details regarding alternate patterns) at low frequencies in *G. flavimaculata* and more commonly in *G. oculifera*; in addition, in *G. sabinensis*, an intermediate pattern of interrupted chin bars forming two or three separate markings—albeit not spots widely separated by several intervening light lines or whorls—sometimes occurs (PVL, unpubl. data). For a mix of *G. barbouri* (typically a chin bar), *G. ernsti* (typically a spot-line-spot pattern), and their hybrids in the Choctawhatchee drainage, Godwin et al. (2015) reported a mix of chin patterns but unfortunately did not report which animals had which pattern according to their genetic classification as one species or the other, or a hybrid.

Overall, chin patterns appear to be highly consistent species characteristics in *Graptemys*, except in the case of the Calcasieu drainage populations of *G. pseudogeographica*. As with iris color and patterning, the genetic basis of chin patterns is unknown and awaits further study.

The genus *Graptemys*, as currently recognized, has 14 species, nine of which are confined to single Gulf Coastal drainages, with three others distributed in 2–3 adjacent drainages (Lindeman 2013). Only *G. pseudogeographica* and *G. geographica* are distributed over more drainages (seven and five, respectively; Lindeman 2013). One group of drainage-endemic species was long considered conspecific, as *G. pulchra*, with a distribution spanning four adjacent drainages in eastern Louisiana, Mississippi, Alabama, Georgia, and the panhandle of Florida (Baur 1893; Cagle 1952). Detailed analysis of morphological variation resulted in the splitting of *G. pulchra* into three species, with one of them, *G. gibbonsi*, occurring in two adjacent rivers (Lovich and McCoy 1992), but subsequently a combination of morphological and molecular genetic analyses resulted in *G. gibbonsi* also being split into two species by drainage (Ennen et al. 2010a). The variable characters reported here appear to be indicators of unique variation in the Calcasieu drainage and further detailed morphological and molecular genetic analyses are warranted.

Irrespective of any possible taxonomic implications of the variation described herein, the unique dark eyes of Calcasieu-drainage *G. pseudogeographica* likely pose a conservation challenge. Species of *Graptemys* are highly regarded in the pet trade and collectors have recently become aware of "black-eyed" Mississippi map turtles, with both online and pet expo dealers offering them for sale (C. Lechowicz, pers. comm.). Trade in herpetofauna has been known to spike coincident with the discovery and description of new variants (e.g., Stuart et al. 2006; Phimmachak et al. 2012). Monitoring of both commerce and field collecting will be necessary to assess the threat that the pet trade poses to Calcasieu populations of *G. pseudogeographica*.

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Appendix I

Graptemys pseudogeographica captured and photographed while basking, sorted by drainage and eye color and markings, with chin markings and photo voucher numbers in the University of Florida Museum of Natural History also given. NR = not recorded. NO = not observable.

UF#	Drainage	Stream	Fig. 1 #	Class	PL	Data source	Iris color	Stripe	Chin
170269	Calcasieu	West Fork	18	F	209	Capture	Dark brown	Stripe	Dash-Dot-Dash
170270	Calcasieu	Houston	18	F	195	Capture	Dark brown	Stripe	Bar
174743	Calcasieu	West Fork	18	F	209	Capture	Dark brown	Stripe	Dash-Dot-Dash
174744	Calcasieu	West Fork	18	M	100	Capture	Dark brown	Stripe	Intermediate (3 dots)
174745	Calcasieu	Serpent	12	J	38	Capture	Dark brown	Stripe	Dash-Dot-Dash
174746	Calcasieu	Serpent	12	M	94	Capture	Dark brown	Stripe	Dash-Dot-Dash
174747	Calcasieu	Serpent	12	J	82	Capture	Dark brown	Stripe	Bar
174748	Calcasieu	Serpent	12	F	187	Capture	Dark brown	Stripe	Dash-Line-Dash
174749	Calcasieu	Serpent	12	J	48	Capture	Dark brown	Stripe	Bar
174750	Calcasieu	Serpent	12	M	84	Capture	Dark brown	Stripe	Dash-Dot-Dash
174751	Calcasieu	Serpent	12	F	178	Capture	Dark brown	Stripe	Dash-Dot-Dash
174752	Calcasieu	Calcasieu	12	M	102	Capture	Dark brown	Stripe	Intermediate (2 dots)
174753	Calcasieu	West Fork	18	F	191	Capture	Dark brown	Stripe	Dash-Dot-Dash
174754	Calcasieu	West Fork	18	F	136	Capture	Dark brown	Stripe	Dash-Dot-Dash
174755	Calcasieu	West Fork	18	J	39	Capture	Dark brown	Stripe	NR
174756	Calcasieu	Calcasieu	12	J	62	Capture	Dark brown	Stripe	Bar
174757	Calcasieu	Calcasieu	12	M	94	Capture	Dark brown	Stripe	Dash-Dot-Dash
174758	Calcasieu	Calcasieu	12	F	209	Capture	Dark brown	Stripe	Bar
174759	Calcasieu	Calcasieu	12	J	45	Capture	Dark brown	Stripe	Bar
174760	Calcasieu	Calcasieu	11	J	66	Capture	Dark brown	Stripe	NR
174761	Calcasieu	Houston	19	J	58	Capture	Dark brown	Stripe	NR
174762	Calcasieu	Houston	19	J	56	Capture	Dark brown	Stripe	NR
174763	Calcasieu	Whiskey Chitto	17	F	NR	Capture	Dark brown	Stripe	NR
174764	Calcasieu	Whiskey Chitto	17	J	NR	Capture	Dark brown	Stripe	NR
174765	Calcasieu	Whiskey Chitto	17	J	NR	Capture	Dark brown	Stripe	NR
174731	Calcasieu	Whiskey Chitto	16	F	NR	Capture	Dark brown	Stripe	Bar
174732	Calcasieu	Whiskey Chitto	16	F	NR	Capture	Dark brown	Stripe	Intermediate (3 dots)
174733	Calcasieu	Whiskey Chitto	16	F	NR	Capture	Dark brown	Stripe	Bar
174734	Calcasieu	Whiskey Chitto	17	F	NR	Capture	Dark brown	Stripe	NR
174735	Calcasieu	Whiskey Chitto	17	J	NR	Capture	Dark brown	Stripe	NR
174766	Calcasieu	Houston	19	M	NR	Basking photo	Dark brown	NO	
170267	Calcasieu	Bundick	15	M	NR	Basking photo	Dark brown	NO	
174767	Calcasieu	Bundick	15	F	NR	Basking photo	Dark brown	NO	
170267	Calcasieu	Bundick	15	J	NR	Basking photo	Dark brown	NO	
170267	Calcasieu	Bundick	15	J	NR	Basking photo	Dark brown	NO	
170267	Calcasieu	Bundick	15	J	NR	Basking photo	Dark brown	NO	
170281	Calcasieu	Bundick	16	F	NR	Basking photo	Dark brown	NO	
170283	Calcasieu	Bundick	17	F	NR	Basking photo	Dark brown	NO	Dash-Dot-Dash

Appendix I — Continued

UF#	Drainage	Stream	Fig. 1 #	Class	PL	Data source	Iris color	Stripe	Chin
174768	Calcasieu	West Fork	18	F	NR	Basking photo	Dark brown	NO	
174770	Calcasieu	West Fork	18	J	NR	Basking photo	Dark brown	NO	Dash-Dot-Dash
174771	Calcasieu	Calcasieu	10	F	NR	Basking photo	Dark brown	NO	
170271	Calcasieu	Calcasieu	9	J	NR	Basking photo	Dark brown	NO	
174772	Calcasieu	Calcasieu	9	M	NR	Basking photo	Dark brown	NO	
174773	Calcasieu	Calcasieu	9	F	NR	Basking photo	Dark brown	NO	
174774	Calcasieu	West Fork	18	J	41	Capture	White/Gray	Stripe	NR
174775	Calcasieu	West Fork	18	F	105	Capture	Yellow/Gray	Stripe	Bar
166405	Mermentau	Plaquemine Brule	20	M	---	Basking photo	White	Stripe	Dash-Dot-Dash
166403	Mermentau	Nezpique	21	M	---	Basking photo	White	None?	Dash-Dot-Dash
174776	Sabine	Sabine	1	J	---	Basking photo	White	Stripe	
174777	Sabine	Sabine	5	M	---	Basking photo	White	Stripe	
174778	Sabine	Anacoco	3	J	---	Basking photo	White	Stripe	
174779	Sabine	Anacoco	3	J	---	Basking photo	White	Stripe	
174780	Sabine	Anacoco	3	F	---	Basking photo	White	Stripe	
174781	Sabine	Anacoco	2	M	---	Basking photo	White	Stripe	
174782	Sabine	Anacoco	4	M	---	Basking photo	White	Stripe	
174784	Sabine	Sabine	5	M	---	Basking photo	White	None	
174786	Sabine	Sabine	5	M	110	Capture	White/Gray	Stripe	Dash-Dot-Dash
174787	Sabine	Sabine	5	M	102	Capture	White/Gray	Stripe	Dash-Dot-Dash
174788	Sabine	Sabine	5	J	38	Capture	White/Gray	Stripe	Intermediate (2 dots)
174789	Sabine	East Sabine	7	J	47	Capture	White/Gray	Stripe	Dash-Dot-Dash
174790	Sabine	East Sabine	7	F	137	Capture	White/Gray	Stripe	Dash-Line-Dash
174791	Sabine	East Sabine	7	M	99	Capture	White/Gray	None	Dash-Dot-Dash
174792	Sabine	Sabine	5	F	143	Capture	Yellow/Gray	Stripe	Dash-Dot-Dash
174793	Sabine	Sabine	5	F	192	Capture	Yellow/Gray	Stripe	Dash-Dot-Dash
174794	Sabine	Sabine	5	F	159	Capture	Yellow/Gray	Stripe	Dash-Dot-Dash
174795	Sabine	East Sabine	7	F	233	Capture	Yellow/Gray	Stripe	Dash-Dot-Dash
174796	Sabine	East Sabine	7	F	200	Capture	Yellow/Gray	Stripe	Dash-Dot-Dash
174797	Sabine	Sabine	6	F	116	Capture	Yellow/Gray	Stripe	Dash-Line-Dash
174736	Sabine	Anacoco	2	F	NR	Capture	Yellow/Gray	Stripe	NR
174737	Sabine	Anacoco	2	F	NR	Capture	Yellow/Gray	Stripe	NR
166437	Sabine	Village	8	F	---	Basking photo	Yellow/Gray	Stripe	Dash-Dot-Dash
166437	Sabine	Village	8	F	---	Basking photo	Yellow/Gray	Stripe	Dash-Dot-Dash
174798	Sabine	Sabine	5	F	---	Basking photo	Yellow/Gray	Stripe	
174799	Sabine	Sabine	5	F	---	Basking photo	Yellow/Gray	Stripe	
174800	Sabine	Sabine	5	F	---	Basking photo	Yellow/Gray	Stripe	
174802	Sabine	Anacoco	3	F	---	Basking photo	Yellow/Gray	Stripe	
174803	Sabine	Anacoco	2	F	---	Basking photo	Yellow/Gray	Stripe	Dash-Dot-Dash
174804	Sabine	Anacoco	2	F	---	Basking photo	Yellow/Gray	Stripe	

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Discovery of the Critically Endangered Finca Chiblac Salamander (*Bradytriton silus*) in Northern Chiapas, Mexico

Plethodontid salamander diversity and distributions in the Neotropics are active areas of research that are hindered by the increasing scarcity of species due to habitat destruction and disease (Rovito et al. 2009). Discoveries of species thought to be extinct, as well as of new localities for narrowly endemic species, provide new hope that these species will persist into the future. One of the most unique and enigmatic species of Neotropical salamanders is *Bradytriton silus*. Unlike any other species of Neotropical salamander, this species has a robust body, small feet, and a short snout. After its initial discovery in 1974 by Paul Elias at Finca Chiblac in the Sierra de los Cuchumatanes of Guatemala, *B. silus* was collected again in 1975 and 1977, but not thereafter (Wake and Elias 1983). The International Union for Conservation of Nature's (IUCN) Red List of Threatened Species list the species as Critically Endangered (CR) due to the destruction of natural habitat in and around the type locality, the lack of sightings, and the very limited range (Acevedo et al. 2008). *Bradytriton silus* thwarted researchers' efforts to rediscover the species until January 2009. Biologists from the Museum of Vertebrate Zoology, UC Berkeley and the Museo de Historio Natural, Universidad de San Carlos de Guatemala found nine individuals of *B. silus* while surveying Finca Ixcansán, near the small town of Yalambojoch, just under 29 km NW of Finca Chiblac (Papenfuss et al. 2010). This was the first sighting of the critically endangered species in 32 years. Another specimen was collected a year later near San José Maxbal, approximately 9 km NW of Finca Chiblac. These discoveries proved that *B. silus* was not yet extinct, and that it occurred outside of the type locality.

In June 2012, as part of an endeavor funded by the National Science Foundation to conduct biotic surveys of the vertebrate fauna in Nuclear Central America, a team of researchers from the Autonomous National University of Mexico (UNAM) and UC Berkeley visited a poorly explored region of northern Chiapas, Mexico. After trekking for two hours through secondary rain forest, the group reached the mountaintop village of San Francisco Jimbal, inhabited by only 62 individuals of indigenous Ch'ol heritage. The next morning, the herpetological faction of the survey team began searching for salamanders under cover objects and among vegetation. They found eight specimens of *Bradytriton* (Fig. 1) in leaf litter among the roots of a tree and under logs and boards in the forest. San Francisco Jimbal is 200 km NW of the type locality of *B. silus*, near the border of the Mexican states of Chiapas and Tabasco (Fig. 2). This collection is a new country record for Mexico and currently is the only record of *Bradytriton* outside of Guatemala.

Given the discovery of a population of *Bradytriton* so far outside its previously known range and the low likelihood that a salamander with such a stocky body and reduced limbs would have the ability to disperse across large distances, we examined mitochondrial sequence data to determine the level of genetic



PHOTO BY SEAN M. ROVITO

FIG. 1. *Bradytriton silus* collected near San Francisco Jímbal, Chiapas, Mexico.

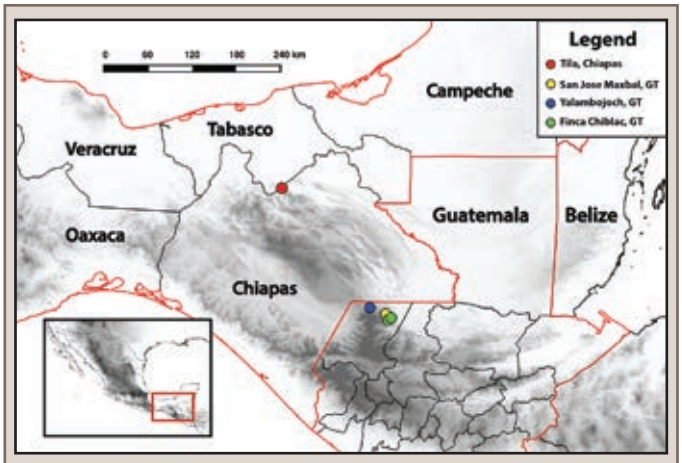


FIG. 2. Map of the known collecting localities of *Bradytriton silus*. Red – June 2012, San Francisco Jímbal, near Tila, Chiapas, Mexico. Yellow – January 2010, San José Maxbal, Huehuetenango, Guatemala. Blue – January 2009, Finca Ixcansán, Yalambojoch, Huehuetenango, Guatemala. Green – September 1974, Finca Chiblac, Huehuetenango, Guatemala.

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TABLE 1. Locality information, voucher numbers, and GenBank accession numbers for samples used. Voucher numbers with asterisks were originally sequenced by the authors of this study.

Taxon	Locality	Voucher Number	16S	cytb
Bradytriton silus	Guatemala: Huehuetenango	MVZ 265366*	KP337339	KP337342
Bradytriton silus	México: Chiapas	MVZ 256828*	KP337340	KP337343
Bradytriton silus	México: Chiapas	MVZ 256829*	KP337341	KP337344
Bradytriton silus	Not recorded	MVZ 244269	DQ640058	DQ640023

divergence from other populations of *Bradytriton*. We sequenced both the 16S and cytochrome b genes using primers 16Sar/16Sbr and MVZ15/MVZ16 (Moritz et al. 1992; Palumbi 1996). Voucher numbers, locality information, and Genbank accession numbers for sequences used are summarized in Table 1. The Jukes-Cantor (JC) distance between Mexican *Bradytriton* and specimens from Finca Ixcansán, Guatemala based on an alignment of 16S and cytb is only 0.006, much lower than one would expect over a large geographic distance. Current knowledge of where *B. silus* occurs almost certainly does not represent the species' full range, but its discovery in Chiapas shows that the species is more widespread than previously thought. The IUCN's current classification of *B. silus* is partially based on its restricted range. If more extensive surveys of areas between the Sierra de los Cuchumatanes and the newly discovered locality in northern Chiapas show that *B. silus* occurs between these two points, its current CR classification by the IUCN may no longer be justified, especially considering that the species is thought to live in both natural and disturbed habitats (Acevedo et al. 2008).

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TECHNIQUES

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Tracking Toads Using Photo Identification and Image-Recognition Software

Vital demographic information about animal populations in support of ecological research and endangered species management can best be gathered by tracking known individuals over time. In a great many animal species, patterns of spots, blotches, dots or stripes on the skin are sufficiently variable between individuals that they can be used for identification (Auger- Méthé and Whitehead 2006; Gilkinson et al. 2007; Chim and Tan 2012; Faber et al. 2013). For dealing with just a few individuals, all that may be required is a set of images or drawings that can be matched to the animals' markings by eye. Employing these patterns effectively for recognizing more than a small number of individuals over time, however, invariably requires photographs, a searchable archive for the photographs and an expeditious means of comparing the photographs to find matching patterns (Bolger et al. 2012). Larger numbers of individuals that have been photographed multiple times present a prohibitive difficulty for manual searching as it becomes exponentially more time-consuming and error-prone as the number of surveyed individuals increases. The method therefore requires digital photographs stored in a digital archive, searched by image-recognition software (Kelly 2001; Arzoumanian et al. 2005; Speed et al. 2007; Van Tienhoven et al. 2007; Martin-Smith 2011).

Though the value of software-based photo-recognition of animals is clear, and many attempts have been made to employ it (Speed et al. 2007; Van Tienhoven et al. 2007; Gamble et al. 2008; Auger-Méthé et al. 2011; Lahiri et al. 2011; Bolger et al. 2012; Petrovska-Delacrétaz et al. 2014), the challenge of building such software is not trivial. In order for software to be able to compare each new picture with every other picture stored in a database and so find every matching color pattern for every animal, it has to discern and store information about the animal's markings in the pictures, and it has to compensate for variation in the size, quality, pixel density, and orientation of the picture while it does so (Kelly 2001; Bolger et al. 2012). It also has to be reasonably easy to use and provide the user with the means to validate both input and output. A secondary requirement for the use of photo-recognition is that the animals' markings remain stable over time. Although this is usually the case, there are exceptions (Gowans and Whitehead 2001; Yoshizaki et al. 2009; Jonas et al. 2011; Waye 2013) and so mark stability should be examined case-by-case. Mindful of previous efforts to program and implement image-based visual recognition systems, we have designed a semi-automated software system, which we have named "Foto-Spottr," that has innovative attributes enabling efficient searching through a database of digital images to find likely matches to a given individual animal.

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We used Fowler's Toads (*Anaxyrus fowleri*) as our focal species for the design of our system. These toads have unique patterns of irregular dark dorsal spots that can identify them like a fingerprint (Fig. 1). A trained researcher can readily recognize an individual toad from photographs, even when the images are taken years apart. A long-term mark-recapture study of this species at Long Point, Ontario, Canada (Smith and Green 2006; Greenberg and Green 2013; Green and Middleton 2013) had used toe-clipping to identify individuals but, in recent years, also took digital photographs to confirm individual identities in cases where the toe-clips were hard to read. Thus a large bank of digital photographs was readily available for our use in designing and testing our software system and for examining the stability of individual markings over time.

To be comparable, photographic images of the animals need to be standardized. That is, they need to show the same part of the animal at the same orientation to the camera and be of the same pixel density, brightness, and contrast. Some of this may be achieved as the photo is taken by holding the animal in a particular way against a particular background and maintaining the camera's settings, orientation, and distance from the subject for all pictures (Doody 1995). Though it is clearly advantageous to have as much consistency as possible among the pictures, maintaining an exact and fully repeatable picture-taking protocol in the field, especially using hand-held cameras, can be difficult and time-consuming. Computational post-processing to align the animals' identifying features among various photographs is unavoidable and we chose to emphasize this aspect of the process to simplify picture-taking in the field as much as possible.

Foto-Spottr is able to use pictures that were not necessarily taken for use in animal identification or were taken under difficult and variable field conditions. We use digital photographs taken in the field, at night, using a small, handheld waterproof camera (e.g., Pentax Optio or equivalent). The image density is

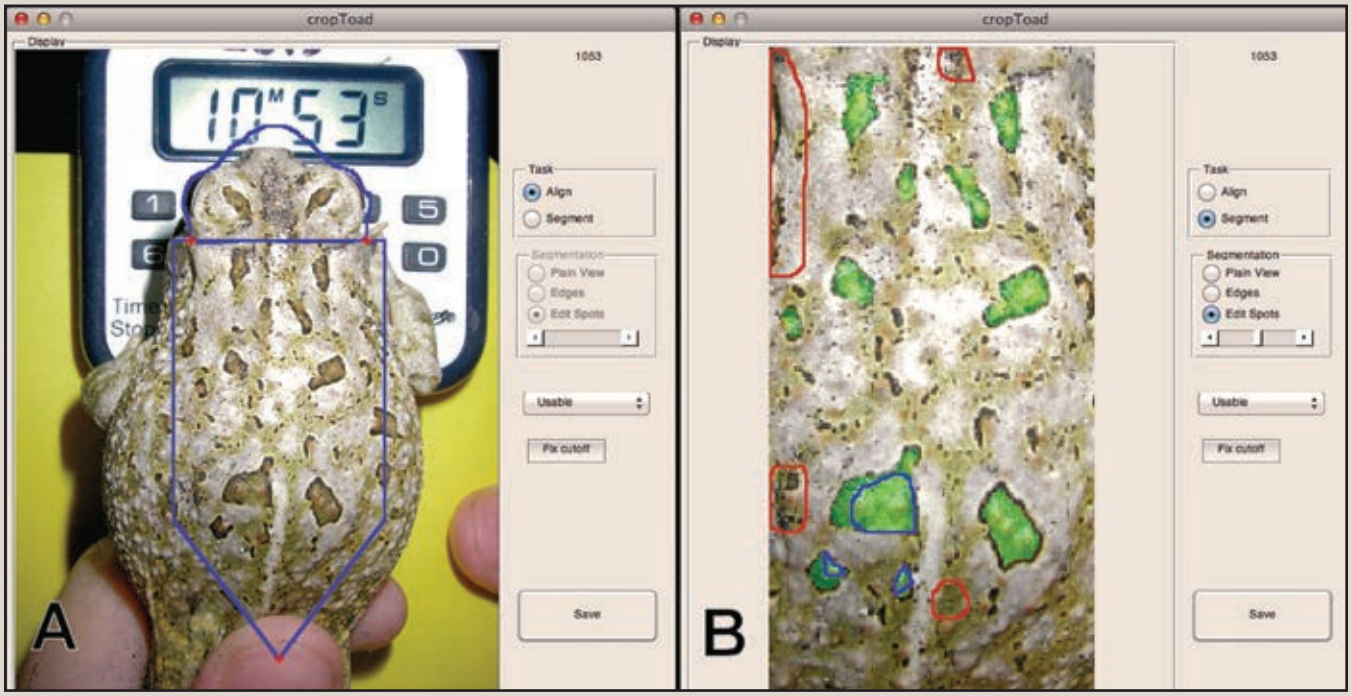


FIG. 1. Input window. A) Standard digital photo of the animal in question, in this case an adult female caught in 2013 and recorded as encounter No. 1053 for that year. The image has superimposed upon it the outline frame (blue) that specifies the region to be analyzed. The frame is placed by clicking on the image behind each eye and on the animal's posterior (red crosses). B) Editing window. Segmentation highlights all probable spots in green. This can be edited manually by outlining undetected spots (blue) or deleting incorrectly highlighted areas (red).

set to 2–4 megapixels/image. Larger images are neither necessary nor desirable as they slow down processing and occupy greater archive space. Each photograph shows the dorsal surface of a single toad against a plain background (Fig. 1A). A lab timer included in each picture serves both as a size standard and a device to record an image identifying number.

The animals in the images vary in size in three ways: the animal's actual body size, the pixel density of the image and the amount of the frame filled by the animal. Also, the animal is not necessary aligned consistently with respect to the frame. To compensate, the user of the software can call up the image into a processing environment and place a generalized animal shape on the image of the animal to roughly specify the region of interest. For toads, the animal's outline could be approximated with a triangle on the head and a pentagon on the body, anchoring the vertices at the posterior corners of the eyes (Fig. 1A). This process takes only a second and compensates for variations in image size and orientation. In the present version of Foto-Spottr, only the rectangular region of the animal's back is used for image matching.

Once the region of interest is specified, an automatic color segmentation routine (Cheng et al. 2001) finds most or all of the spots and highlights them in color (Fig 1B). The user then has the option to review the result and make corrections as necessary. Using the mouse, the user can outline additional spots for the computer, refine the shapes of spots or remove erroneously highlighted areas, generally due to sand or debris adhering to the animal's back or shadows resulting from the uneven surface of the animal. This step may not be necessary for high-quality photographs of animals with well-defined spots, or may take up to a minute or two to compensate for low-contrast photographs of animals with ill-defined spots. The computer then stores a two-color image of the highlighted spots within the specified region of interest, linked to the original image.

At this point, Foto-Spottr automatically searches for matching images by comparing the two-color spot pattern of the target image to that of every other similarly processed image in a database. The match-quality between two images is based on the number of overlapping pixels in the two-color patterns, but the images need to be well aligned before this is meaningful. The step of cutting out a rectangle from the back is sufficient to get the patterns into rough alignment but a more precise alignment is computed in software. Foto-Spottr uses Lucas-Kanade affine template tracking (Baker and Matthews 2004; Schreiber 2007) to compute an affine transform that maximizes the similarity between the two images. This algorithm is designed to track moving objects through subsequent frames of a video, but we found that it is also ideal for correcting the differences between still images taken at different times. The affine transform overcomes many routine misalignment problems between pairs of photos and allows the system to make direct comparisons of images, rather than of data derived from images as is done in various other systems (Auger-Méthé and Whitehead 2006; Speed et al. 2007; Lahiri et al. 2011; Petrovska-Delacrétaz et al. 2014). We used the public domain MATLAB function shared by Dirk-Jan Kroon (MATLAB Central <http://www.mathworks.com/matlabcentral/fileexchange/24677-lucas-kanade-affine-templatetracking>) to implement the robust Lucas-Kanade template tracking algorithm into our system. The final match-quality score is based on the number of overlapping pixels after the final alignment.

Once Foto-Spottr has completed its database search, it displays the ten best matches, based on % pixel overlap, alongside the target image so that the user can visually verify the match (Fig. 2). In the great majority of instances, the best match should be another image of the same individual taken at an earlier time. If not, and the animal has been caught before, then one of the

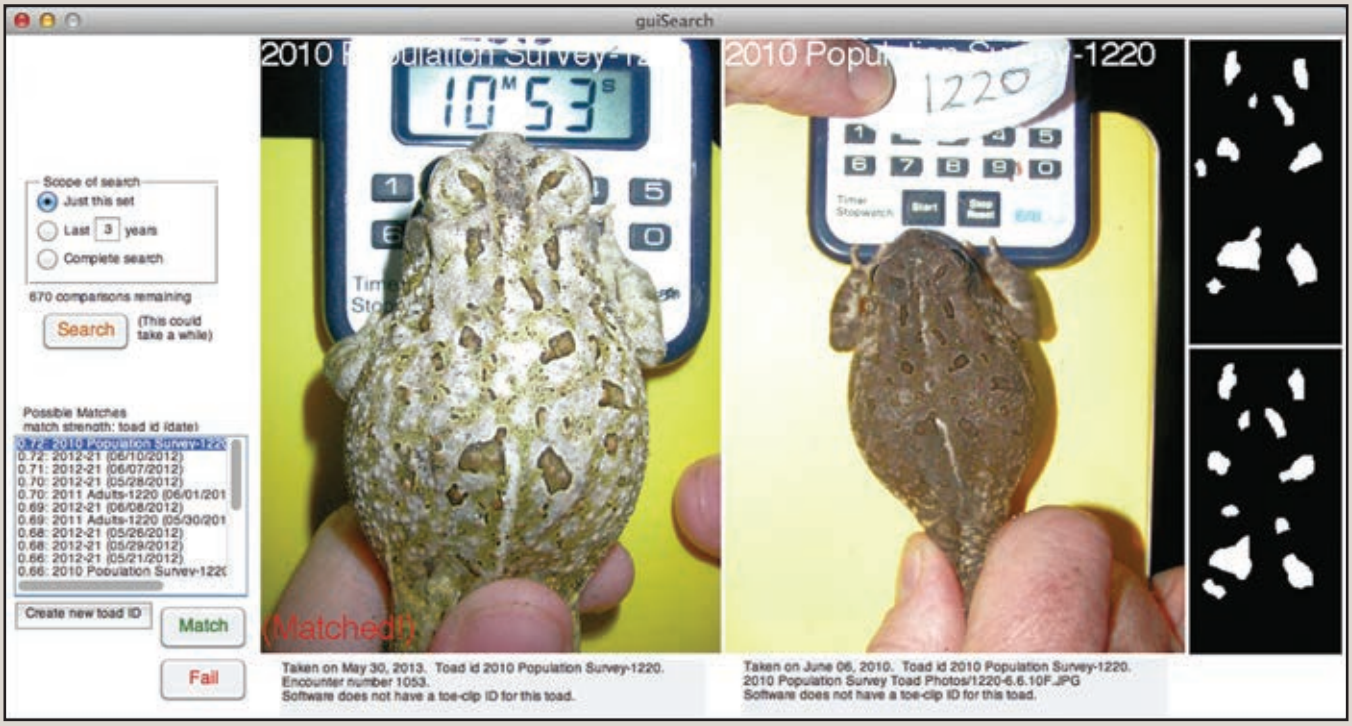


FIG. 2. Output window showing results of computer imaging searching for matches to the target (left image) image. The best match (right image) is clearly of the same toad caught when it was a juvenile three years previously in 2010 and assigned No. 1220. Despite differences in size, alignment and aspect in the two photos, the program found 72% alignment of the animal's spots in each image, as shown in the output window (lower left). To help confirm the match by eye, the aligned two-color spot patterns obtained from each image are displayed (far right).

next two to five best matching images will almost invariably be that individual. If there is no good match among the 10 closest matching images, it can be assumed that the animal is new and Foto-Spottr will indicate its failure to find a match.

Applied to a test set of 560 pictures of Fowler's Toads that had been taken in previous population surveys of toads (Smith and Green 2006), Foto-Spottr required about a minute of manipulation time per image but greatly decreased the number of comparisons that needed to be verified by eye. Applied to pictures of animals that had been identified with toe-clipping, our system placed the correct match among the top five possible matches 91% of the time. This was comparable to the accuracy of the best physical tagging techniques (Bolger et al. 2012). Even so, the pictures we used were not staged for software recognition; they were taken as a routine part of the field protocol of the time. We have since refined our field procedure to get better, more consistent pictures, and our success rate has increased. Foto-Spottr also found matches that were previously missed based on toe-clip identifications and was able to identify animals as they grew (Fig. 2), confirming the temporal and ontogenetic stability of the markings on these animals.

One new property of the process of identifying animals using an image-based system, compared to physically marking them, is that an animal's identity usually cannot be established at the time of capture. Images are therefore tagged with field-given "encounter" numbers and recorded as such in the field notebooks. These later have to be amended with the animal's actual identification number. Thus each encounter with any particular animal had to be recorded and numbered along with the animal's specific ID, and field notes have to be corrected after the fact. Foto-Spottr is designed to streamline this process of logging ancillary data associated with each image, such as existing toe-clip, PIT, VIE, or VI Alpha Tag IDs, biometric information, and the date and location of capture.

There are numerous differences between Foto-Spottr and other available computer-assisted photo-ID systems. Our system is currently implemented in MATLAB 8.0 (The MathWorks, Inc., Natick, Massachusetts, USA) to take advantage of shared functions such as Kroon's Lucas-Kanade algorithm. It is also pixel-based, with automatic recognition of shapes no matter how irregular in outline they may be, and uses position, size, and shape information in searching for matches. These aspects distinguish Foto-Spottr from I^{3}S software (Van Tienhoven et al. 2007) which matches the position of user-selected points on the animal or, in its latest versions, user-drawn ellipses around spots, and from WILD ID software (Bolger et al. 2012) which first uses a Scale Invariant Feature Transform (SIFT) operator to extract point information from images and then takes a "brute-force" approach to compare all such features between pairs of images using a geometric algorithm. Both Stripespotter (Lahiri et al. 2011), which uses a dynamic programming algorithm adapted from signal-processing methods, and Identifrog (Petrovska-Delacrétaz et al. 2014), which employs principal components analysis adapted from machine-learning methods, are also more computationally intensive than Foto-Spottr, and have stricter requirements for the images they can use. All these various systems approach much the same problems with success but we contend that our approach makes input easier and yields results more rapidly.

Our initial results indicate that Foto-Spottr is already as effective as any system currently available (Speed et al. 2007; Bolger et al. 2012). With optimization, its performance could be even further improved. The prototype of the software was initially installed on a Macbook Air (Apple Inc., Cupertino, California, USA)

laptop computer but we have now made a freely available version that can be readily installed in Windows™ systems. It is available for download at http://cnd.mcgill.ca/~aschoen/spottr/ or can be obtained directly from our code repository at https://github.com/toadmann/spottr. We expect to develop Foto-Spottr further as a stand-alone, open-source software system and user interface, which will allow it to be used in the field.

Software-based visual recognition that enables individuals to be identified without harming them makes the extensive use of toe-clipping and other invasive marking methods increasingly difficult to justify. Identifying individual wild animals has typically involved physically marking or tagging them and an assortment of methods has been applied to amphibians and reptiles (Donnelly et al. 1994; Ferner 2007). Such methods include tattooing (Perret and Joly 2002), freeze-branding (Lewke and Stroud 1974), toe-clipping (Waichman 1992; Reaser 1995; Lemckert 1996; Phillott et al. 2007) and injecting either passive integrated transponder (PIT) tags (Ott and Scott 1999; Blomquist et al. 2008; Hamed et al. 2008; Luhring 2009), visual implant elastomer (VIE) marks (Bailey 2004; Moosman and Moosman 2006; Grant 2008), or fluorescent Visible Implant Alphanumeric (VIA) tags (Buchan et al. 2005; Gower et al. 2006; Heard et al 2009) under the skin. Aside from ethical concerns related to these practices (Funk et al. 2005), there is potential for such invasive procedures to alter an animal's behavior, compromise its physical well-being, and threaten its survival (McCarthy and Parris 2004; Bloch and Irschick 2005; Liner et al. 2007). This is a particular concern for work with protected species. Not surprisingly, therefore, visual identification of individual animals based on their natural markings is an attractive alternative (Kurashina et al. 2003; Bradfield 2004; Del Lama et al. 2011; Sharifi et al. 2013), provided those markings are sufficiently discernable and distinctive (Kenyon et al. 2009). Increasingly improved software and hardware for photo-ID systems will represent significant advances in field methods that will be of direct benefit to ecological knowledge and the recovery of threatened species.

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Evaluation of Two Individual Identification Techniques for Spotted Salamanders (*Ambystoma maculatum*)

Introduction.—Mark-recapture (MR) is a widely-implemented and effective method used to monitor amphibian populations over time (MacNeil et al. 2011; Waye 2013). Long-term MR studies allow researchers to collect valuable information about the growth, movement, health, and dispersal of populations (Osbourn et al. 2011) that can ultimately be used to inform decisions regarding management and conservation of amphibians and their habitat.

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Mark-recapture studies often require that each individual be identified as unique from others in the population. Common amphibian identification techniques include visible implant elastomer (VIE) tags (Bendik et al. 2013), visible implant alphanumeric (VIA) tags (Osbourn et al. 2011), toe-clipping (McCarthy and Parris 2004), passive integrated transponder (PIT) tags (Homan et al. 2008; Ousterhout and Semlitsch 2014), and pattern recognition (Loafman 1991; Foster et al. 2007). Each identification technique presents its own set of advantages and disadvantages, and therefore must be carefully considered before selecting a technique for long-term MR studies.

The scope and objectives of a study determine the most appropriate and feasible identification technique. The number of individuals that are likely to be captured, handling time per individual (i.e., amount of time necessary to identify each

individual), potential effects of the marking technique on behavior and health of the organism, longevity of the mark or tag, duration of study, and budget must all be considered (Osbourn et al. 2011). For example, although VIE tags are well-suited for marking very small animals, they offer a limited combination of codes. Even with six possible locations for tags on the body, four colors, and three tags per individual, only 1280 possible combinations exist (MacNeil et al. 2011), which may be insufficient for a multi-year study. VIE tags can also migrate beneath the skin or fragment after injection, making the code difficult to determine (Osbourn et al. 2011). Many techniques, including VIE tags, often require anaesthetization, constant monitoring of anaesthetized individuals, and the injection of a tag, which is time-consuming, invasive, and may have negative effects on behavior and stress levels (Kinkead et al. 2006; Osbourn et al. 2011).

As an identification technique, pattern recognition minimizes the need for invasive tagging methods by using natural color patterns as the primary identifier for each individual. The use of natural skin or fur patterns as markers has been successfully implemented with many different taxa, including polar bear whisker spot patterns, whale shark spot patterns, zebra stripe patterns, and bobcat spot patterns (Anderson et al. 2010; Arzoumanian et al. 2005; Foster et al. 2007; McClintock et al. 2013, respectively). Pattern recognition has also been evaluated before for use in MR studies of amphibians (e.g., *Ambystoma tigrinum*; Grant and Nanjappa 2006; Waye 2013). Assuming an individual's pattern does not change over time once they have reached the adult life stage, pattern recognition can be used for the entire adult life of each individual (Grant and Nanjappa 2006).

Some species of wetland-breeding salamanders (e.g., *Ambystoma* spp.) can serve as model amphibians for long-term MR studies using pattern recognition because of their individually distinctive patterning, relatively low vagility, and predictable movement patterns associated with reproduction (Petranka 1998; Semlitsch 2008). We developed an affordable and less-invasive MR technique for identifying individual Spotted Salamanders (*Ambystoma maculatum*) using spot pattern recognition. Our primary goal for this study was to assess the feasibility of using this pattern recognition (henceforth referred to as "spot code") as an alternative MR technique to VIE. Our assessment included measurement of identification accuracy and handling time for both techniques, where identification accuracy was defined by the percentage of correctly identified individuals by newly trained observers, and handling time was defined as the amount of time necessary to identify each individual.

Methods.— We conducted our study at a 0.93-ha ephemeral wetland located on a peninsula in Mountain Island Lake within Cowan's Ford Wildlife Refuge in Mecklenburg County, North Carolina, USA (35.3775°N, 80.9658°W). The wetland is surrounded by deciduous and pine forest and is dominated by tall grassy vegetation (Pittman et al. 2008). Each day we sampled 40 aquatic traps and 38 pairs of pitfall traps (13-L plastic buckets) placed every 10 m on either side of a 400-m drift fence completely encircling the wetland (Strickland et al. 2014). We sampled Spotted Salamanders from 18 January to 27 February 2014. A total of 253 individuals were processed and given spot codes in 2014. Individuals with VIE markings from previous years were identified as recaptures using the VIE code, but no new VIE codes were administered. Of the 253 individuals processed, 139 were recaptures with VIE codes and 114 were new captures.

The VIE marking technique was used in collection years prior to the current study. Salamanders were anaesthetized by submersion in Orajel® diluted to 1.0 g/L in 1L of water (Brown et al. 2004). A 26.5-gauge needle was then used to inject elastomer in any combination of six body locations (VIEs; Northwest Marine Technology, Inc., Shaw Island, Washington, USA). Salamanders could receive zero, one, or two colors in each location. The colors used were red, orange, yellow, and pink (Cecala et al. 2007; Fig. 1). An ultraviolet flashlight was used when reading the codes to increase visibility of the elastomer marks.

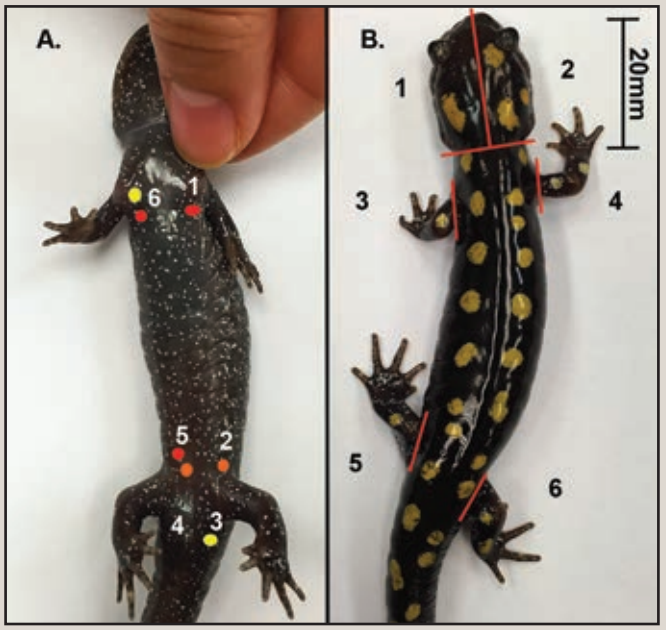


FIG. 1. Images of two Spotted Salamanders (*Ambystoma maculatum*) demonstrating two marking/identification techniques. A) Injection locations for the Visual Implant Elastomer (VIE) technique on the ventral side of a Spotted Salamander. This individual's code is 1R 2Or 3Y 5ROr 6RY—note that colored dots are not actual elastomer but only indicate locations and colors used. B) Demarcation of the six designated regions on the dorsal side of a Spotted Salamander developed for our spot pattern identification technique. This individual's spot code is: 131212. See Methods for a detailed explanation of both identification techniques.

We developed a spot pattern identification technique that relies on the number of spots in six designated regions on the dorsal side of each salamander. These regions are the left and right sides of the head anterior to the gular fold, and the four legs of the animal, from the feet (but not toes) to the top of the appendage where it joins the body (Fig. 1). Thus only head and limb spots, rather than spots on the trunk of the body, are considered in this technique. Orange and yellow spots ≥ 1 mm in diameter were counted in each of the six locations to create a spot pattern code. In order for a spot to be regarded as part of the official coding count, at least 50% of the spot's area must fall within one of the boundaries defined above. Irregularly shaped spots were counted as one spot unless a line of darker pigmentation passed through the spot. We recorded the spot code in a specific order: spot location 1 (left side of head), spot location 2 (right side of head), spot location 3 (left front leg), spot location 4 (right front leg), spot location 5 (left rear leg), spot location 6 (right rear leg). Thus, a salamander with two spots on each side of its head, one spot on each front leg, one spot on its left rear leg, and zero spots on its right rear leg was assigned the code 221110.

Of the 253 individuals processed in the 2014 season, 16 individuals had a shared spot code with at least one other individual,

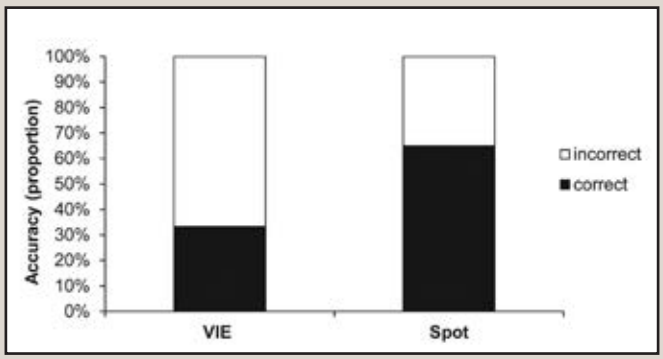


FIG. 2. Comparison of identification accuracy by identification technique. Proportion of trials correct and incorrect was derived from the total number of trials for each identification technique (N = 123 for VIE; N = 171 for Spot).

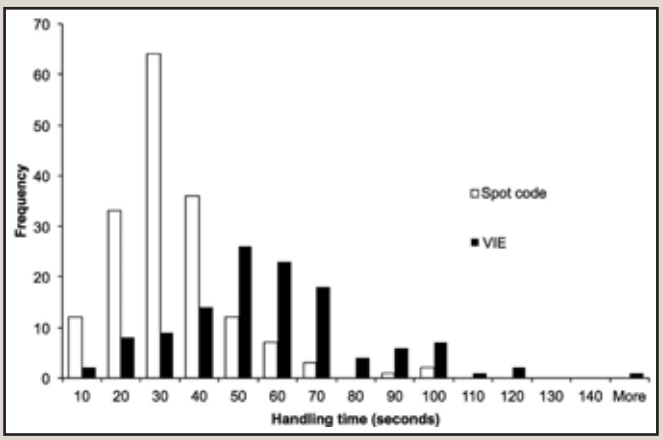


FIG. 3. Frequencies of time in seconds spent identifying individual salamanders (i.e., handling time) for each identification technique.

and one spot code was repeated four times. We accounted for these scenarios when two or more salamanders correctly receive the same spot code by adding a lower-case letter to the end of the spot code. Thus, the first individual captured with a given code would be 111111a, and a subsequent individual salamander with the same spot pattern would be 111111b. To help us differentiate between salamanders with the same spot code upon recapture, we took standardized photographs of the dorsum of each individual. Photographs were consistent with respect to background, angle, orientation, lighting, and distance from salamander. A ruler was also included in each photo to provide scale. These standardized photos were categorized in a computer database by spot code. Each individual spot code had its own folder in the database, and all photographs of a salamander with this spot code were stored in the folder for reference. Each photograph of a recaptured salamander was compared to database photographs to determine the identity of the individual captured. Photographs of each individual were also filed in the computer database under any alternate codes that might be mistakenly assigned to the salamander. Alternate codes were included when individuals had spots slightly smaller or larger than 1 mm or when spots lay on the boundaries of the designated regions, because these individuals are more likely to be misidentified. In the event of a misidentification, the identifier could find the salamander by looking up the mistaken code, but the image file would point them to the correct code.

To measure identification accuracy and overall handling time, we haphazardly selected salamanders that had been captured at our study site and brought back to the laboratory for processing. Processing individuals involved checking for a VIE code, reading the VIE code if it existed, assigning a spot identification code, taking a photograph of the dorsum, and taking the following measurements: mass (g), total length to the nearest mm (TL), and snout-to-vent length to the nearest mm (SVL). After processing, salamanders were haphazardly chosen to be used in our identification test (ID test) in which fifteen participants were asked to individually identify each salamander using both VIE and spot pattern techniques and record their results and handling time. Each identification of a salamander using one of the techniques was considered to be one trial. All participants had been trained in both techniques prior to ID testing, but participants were not informed of the correct VIE and spot codes for the salamanders they were identifying and were not permitted to crosscheck their identifications with the spot code or photo database. Finally, when participants identified an alternate spot code of a salamander, rather than the official code, this trial was still counted as a correct identification. Alternate codes are considered correct because when processing, identifiers would have access to the database where salamanders are cross-listed under both their official code and their alternate code(s).

We used program R (R Core Team 2013) to perform a mixed-effects logistic regression to determine whether identification technique was a significant predictor of identification accuracy. The binary response variable in this model was whether or not the salamander was identified correctly (yes or no) and the fixed predictor variable of interest was the identification type (VIE or spot code). We specified individual salamander as a random effect because individual salamanders were tested repeatedly. We also specified individual observer as a random effect because not all observers identified each salamander. The odds ratio for identification accuracy was used to determine the relative likelihood of correctly identifying individuals with each technique. We conducted a Student's t-test to determine if there was a difference in handling time (i.e., amount of time necessary to identify each individual) between VIE and spot code MR techniques. Alpha was 0.05 for all tests.

Results.—We conducted 171 trials for spot code and 123 trials for VIE on 41 *A. maculatum* individuals, totaling 294 trials. VIE trials matched the correct database codes 33% of the time, while 65% of spot code trials matched the correct database codes (Fig. 2).

We found that overall handling time using the spot code technique was significantly less than handling time using the VIE technique (Fig. 3; mean VIE = 54.2 ± 25.6 sec, mean spot code = 29.6 ± 14.9 sec; t-stat = 29.48; $p \leq 0.0001$). We found identification technique (e.g., VIE and spot code) to be a statistically significant predictor of identification accuracy (z-value = -5.092, $p \leq 0.0001$), with an odds ratio of 0.24 (95% CI 0.14–0.42). The odds ratio indicates that the participants were less likely to correctly identify a salamander when using the VIE technique than when using spot codes.

Discussion.— Our newly developed pattern recognition (spot code) technique for individually identifying Spotted Salamanders resulted in reduced handling time and improved accuracy compared to VIE techniques. Salamanders identified using the spot code technique took, on average, 25 fewer seconds than VIE and were twice as likely to be identified correctly than with VIE. Differences in standard error of handling time revealed our spot code technique to be more consistent than the VIE technique.

After six years of marking 2644 individuals from this *A. maculatum* population using VIE, we had exhausted many of the available code permutations. Our VIE marking technique yields a theoretical total of 6528 code permutations, but the more tags each salamander has, the longer its handling time, making the use of code combinations too time-consuming and expensive to be feasible for a daily trapping schedule. However, the theoretical maximum number of spot code permutations is limited only by the maximum number of spots in each body region. Of the 253 individual salamanders processed and assigned spot codes in the 2014 season, the maximum number of spots observed on any head region was seven, and the maximum number of spots observed on any appendage was five. If we assume these numbers to be the maximum number of spots possible in each location, then spot code yields a theoretical total of 82,944 possible permutations.

Furthermore, we found that the spot code technique is relatively easy to learn. Newly trained laboratory members had little difficulty with spot pattern but struggled through the duration of the study to correctly identify salamanders using VIE. One issue was that VIE colors (e.g., red and pink) were often difficult to discern. Migration and fragmentation of elastomer marks occurred as early as one year after VIE injection, causing some marks to be overlooked and others to move to ambiguous locations outside of the marking areas. With these difficulties, only experienced lab members with access to the full *A. maculatum* database could successfully identify VIE codes on a consistent basis.

Because the spot code identification technique was shown to have a shorter and more predictable overall handling time than the VIE identification technique, it is easier to predict how long processing will take. Low identification accuracy of our technique (65% accuracy) was an unexpected result. Other studies of VIE report identification accuracies of 87%, 83%, 81%, and 69% (Osbourn 2011). Other studies of manual pattern recognition report identification accuracies of 96.5%, 96%, or 97% (Loafman 1991; Grant and Nanjappa 2006). However, our observers were newly trained and thus had little experience in identification. We believe that as participants become more experienced with identification in future sampling seasons, the level of identification accuracy and standard error of handling time will improve rapidly. Further, we predict that ability of participants to crosscheck their observations through access to the database and standardized photographs would greatly improve identification accuracy.

Unlike other commonly used mark-recapture techniques such as toe-clipping, VIE, VIA, or PIT tagging, spot pattern is noninvasive and requires no use of anesthesia. Implementation of our technique is feasible, especially when standardized photos are taken of the dorsal side of each animal and additional alternate codes are given to animals whose spot code represents a borderline case (e.g., spot close to the 1-mm cutoff mark). These standardized photos are categorized in a computer database by spot code, so comparison of photographs to recaptured salamanders is straightforward when confirming salamander identity. The spot code technique is applicable to large populations and provides an easy and more effective way to identify individuals.

One concern with using spot pattern as a mark-recapture technique is that an individual's spot pattern could change over time, rendering spot pattern ineffective as an identification technique. Jonas et al. (2011) emphasize the importance of knowing whether or not body markings are variable before relying on these markings to identify individuals in a study. There are no published studies evaluating ontogenetic change in spot pattern in *A. maculatum,* although such studies do exist for other species: both *A. tigrinum* and *Eurycea longicauda longicauda* exhibit variation in spot pattern and coloration over time (Jonas et al. 2011; Waye 2013). As we accumulate images of recaptured individuals in future years, we can ensure whether or not spot patterns remain consistent over time by comparing images of salamanders identifiable by preexisting VIE tags and noting any changes.

We recommend further investigation into computer-assisted pattern recognition technology for Spotted Salamanders. Many studies have demonstrated the success and effective use of computer software in assigning identities based on unique natural patterns (Arzoumanian et al. 2005; Foster et al. 2007; Gamble et al. 2008; Anderson et al. 2010; Bendik et al. 2013; McClintock et al. 2013), but no software has been developed for this ambystomatid species. This technology could be applied to the standardized photographs taken of each salamander. Development of software to analyze spot pattern and assign individual identities to salamanders would reduce the issue of repeat codes and alternate codes and therefore has the potential to reduce human error in the identification process. A suggested approach would be to emulate the algorithm employed by Gamble et al. (2008) with *Ambystoma opacum*, which compared images based on visual similarity rather than on discrete geometric features. Software systems that extract shapes or distinct patterns and then apply a matching algorithm can struggle to identify large, irregular shapes like the spots of *A. maculatum*, so this visual comparison approach is more likely to yield successful results (Anderson et al. 2010).

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Evaluation of Gastric Lavage Method for Diet Analysis of the Eastern Red-backed Salamander (*Plethodon cinereus*)

Given global declines in amphibian populations, it is important to understand their roles as predators and how changes in their abundance (or local extinctions) may result in trophic cascades within a food web. Terrestrial salamanders are abundant, generalist predators and play a significant ecological role in forest food webs (Burton and Likens 1975a; Davic and Welsh 2004). Plethodontid salamanders act as top-down regulators of the soil invertebrate community and are a food source to higher order consumers (i.e., small mammals, birds, other amphibians), providing a link between below and above-ground food webs (Burton and Likens 1975a; Davic and Welsh 2004; Walton 2006; Walton 2013). Analysis of plethodontid diets allows insights on their top-down effects on soil faunal communities, and in turn, how these effects may indirectly influence ecosystem processes such as decomposition and nutrient cycling (Walton 2013; Best and Welsh 2014). Non-lethal methods to collect diet samples are preferred to sacrificing individuals to lessen the impacts of research activities on salamander populations, especially for rare and threatened species.

Stomach flushing (i.e., gastric lavage) is a non-lethal technique that has been used successfully to collect stomach samples from crocodilians, lizards, chelonians, anurans (Legler 1977; Legler and Sullivan 1979; Fitzgerald 1989; Rice and Taylor 1993; Solé et al. 2005), and caudates (Cecala et al. 2007; Sebastiano et al. 2012). The advantage of gastric lavage is that it does not require animals to be euthanized, so individuals may be resampled and populations monitored over time without impacting local abundances (Crovetto et al. 2012). The method involves gently pushing water into the stomach via a soft tube inserted in the esophagus, which forces the animal to regurgitate its stomach contents. If the procedure is done immediately after foraging the ingested material is still sufficiently intact for identification and estimation of prey volume.

The Eastern Red-backed Salamander (*Plethodon cinereus*) is a highly abundant terrestrial salamander in hardwood forests

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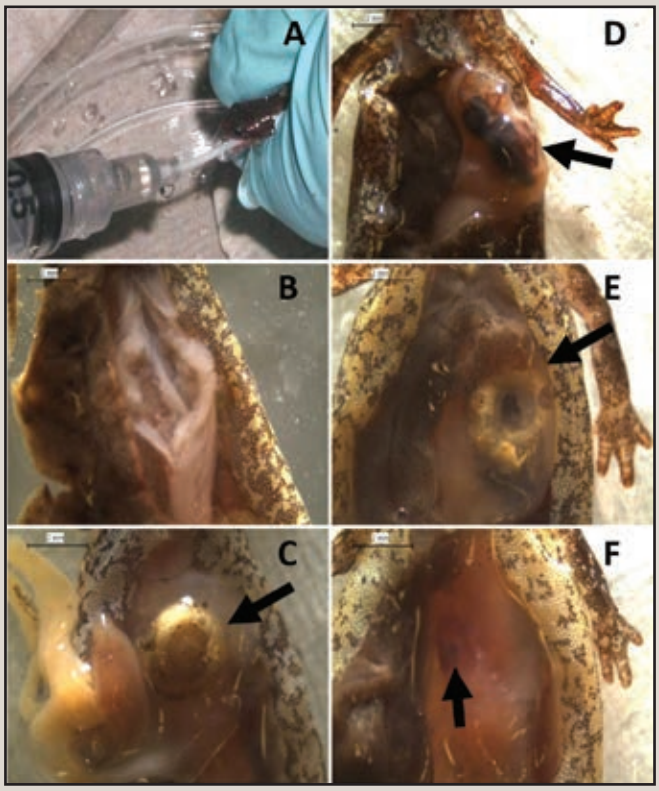


FIG. 1. Stomach flushing procedure on adult *Plethodon cinereus* using catheter tube and distilled water (A; photo by C. Snyder), successful lavage that has completely emptied all stomach contents and with no signs of tissue damage; (B) lavage that did not fully empty the contents of the stomach (C and D), salamander that did not regurgitate stomach contents following lavage but had a full stomach (E), damage to stomach tissue of a salamander that was lavaged and regurgitated all of its stomach contents (F). Scale bar represents 2 mm in plates B–F.

TABLE 1. Summary of 124 dissected *Plethodon cinereus* that had their stomachs flushed before being euthanized. Salamanders are categorized by whether they regurgitated stomach contents due to gastric lavage and if the dissected stomach was completely empty.

Lavage induced regurgitation of diet sample	Stomach empty: Yes	Stomach empty: No	Total
Yes	93 (75%)	12 (10%)	105 (85%)
No	13 (10%)	6 (5%)	19 (15%)
Total	106 (85%)	18 (15%)	124 (100%)

(Burton and Likens 1975b) with a range that extends from North Carolina north to include the Canadian Maritime provinces and southern Quebec, and west to northeastern Minnesota. As a dominant vertebrate predator, *P. cinereus* is the focus of many studies on salamander behavior, resource selection, and trophic interactions in forest food webs. A generalist predator, their diet is composed of microinvertebrates (i.e., Acari and Collembola), and other small invertebrates: arthropod larvae (Coleoptera and Diptera), Hymenoptera, Coleoptera, and Gastropoda (Burton 1976; Fraser 1976; Maglia 1996; Snyder 2011). Gastric lavage has been used extensively to study diet in *P. cinereus* (Fraser 1976; Maglia 1996; Maerz et al. 2005; Anthony et al 2008; Homyack et al. 2010; Ivanov et al 2011; Snyder 2011). However, in only one of these studies was any attempt made to assess the efficacy of the method; and only 10 salamanders were dissected to evaluate the proportion of prey left behind post stomach flushing (Maglia 1996). In another study, Diaz (2010) found gastric lavage ineffective for removing stomach contents for *Eurycea nana*—an aquatic plethodontid. Moreover, it is unknown whether certain prey types have detection bias using the lavage technique. A quantitative assessment of success rate and biases associated with certain prey items is needed to assess uncertainty in plethodontid diet samples collected by stomach flushing.

As part of a larger research project investigating trophic interactions of *P. cinereus* in northern hardwood forest food webs, we collected diet samples from 124 salamanders using gastric lavage and compared these samples to dissected stomach contents. Our objectives were to 1) evaluate the efficacy of gastric lavage at removing the stomach contents of *P. cinereus*, 2) determine which, if any, prey items are less detectable by gastric lavage (which may bias the diet sample), and 3) describe the condition of prey items obtained by stomach flushing.

Stomach flushing and salamander collection.—We conducted surveys for *P. cinereus* at nine northern hardwood sites located in the Green and White Mountains of Vermont and New Hampshire. Surveys were done between 24 June and 6 July 2012 and began at 0515 h each morning. Surveys involved three people searching the forest floor, and under cover objects (e.g. woody debris, bark, fern mats), for 30 minutes. All salamanders captured were placed in plastic bags until processing, but were not held in bags longer than two hours. Each salamander was weighed to the nearest 0.05 g, and total length (TL), snout-to-vent (anterior angle; SVL), and maximum head width (HW) were measured to the nearest 0.1 mm with digital calipers.

Stomach contents were collected from individuals greater than 28 mm SVL using gastric lavage (Fraser 1976). Salamanders were immobilized by wrapping them in a moist paper towel; this also maintained the body in a linear orientation to keep the esophagus straight. The salamander was oriented vertically head-down over a glass dish and the mouth gently opened with forceps. To flush the stomach, a soft plastic catheter, with an outside diameter of 1.0 mm and attached to a 30-cc syringe, was inserted into the esophagus and down into the stomach. Distilled water was gently pushed into the stomach until the salamander regurgitated its stomach contents, which came out in a single bolus (Fig. 1), often immediately following the introduction of water. Any material caught in the salamander's mouth was removed with forceps. All stomach contents were stored in 70% ethanol for identification. If no stomach contents were produced, a second flushing was conducted. For each salamander, we recorded either that the lavage resulted in regurgitation of stomach contents, or that no stomach contents were regurgitated. The same field technician performed stomach flushing on all salamanders and the entire procedure took 3–5 minutes per individual. Salamanders were then euthanized in the field using an application of 20% Benzocaine on the ventral surface of the salamander's body (Chen and Combs 1994). Salamanders were stored on ice during transportation to the lab, where specimens were stored in a -20°C freezer.

Salamanders were dissected using a digital stereomicroscope (Leica Microsystems, Buffalo Grove, Illinois, USA) to assess their stomach contents. All stomach contents were removed and photographed, we identified prey items to the lowest taxonomic

TABLE 2. Morphometric data for 111 *Plethodon cinereus* that were dissected post-gastric lavage and categorized by outcome, excluding those individuals that did not regurgitate contents because the stomach was actually empty (N = 13). Means and standard deviations are reported for SVL (snout-to-vent length), TL (total length), HW (maximum head width), and body mass (M).

Lavage Outcome	N	SVL	TL	HW	M
Removed all	93	37.4 ± 4.5	69.6 ± 10.1	5.5 ± 0.5	0.75 ± 0.3
Removed some	12	37.1 ± 3.3	69.2 ± 7.86	5.4 ± 0.6	0.70 ± 0.2
Removed none	6	36.4 ± 3.2	69.7 ± 9.2	5.5 ± 0.3	0.73 ± 0.2

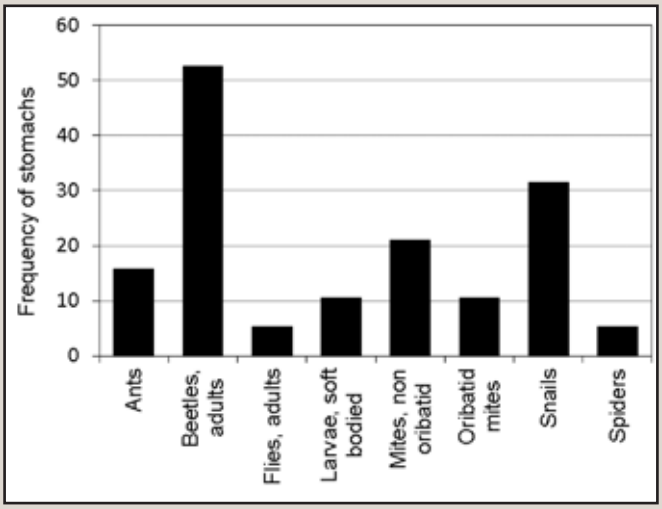


FIG. 2. Frequency of dissected stomachs with prey groups post-lavage (N = 18).

resolution possible (usually order or family), and measured the length and width to the nearest 0.01 mm. We calculated the percent of dissected salamanders that had either: 1) a completely empty stomach, 2) some prey items remaining in stomach, and 3) a full stomach. These data were used to evaluate the efficacy of gastric lavage. To determine whether salamander body size had an effect on efficacy, we used a one-way ANOVA to compare mean SVL, TL, HW, and body mass across outcome groups (i.e., empty, partial, full stomach). We also calculated the frequency of stomachs that contained each prey group to determine whether certain prey types were more commonly missed in stomach flushing samples (detection error).

Results.—Of 124 salamanders that were lavaged and subsequently dissected, 105 individuals regurgitated stomach contents and 19 did not regurgitate anything (Table 1). Ninety-three (75%) salamanders that regurgitated stomach contents were confirmed to have completely empty stomachs (Fig. 1; Table 1). Gastric lavage partially emptied the stomach of 12 (10%) salamanders, although in 7 of these cases only a single prey item was missed. Of the 19 salamanders that did not regurgitate anything after gastric lavage, 13 (10%) were confirmed to have empty stomachs and the remaining 6 (5%) had full stomachs (Table 1). If we exclude the 13 salamanders that did not regurgitate anything because their stomachs were truly empty, than flushing removed all of the stomach contents 84% of the time (93 out of 111), missed some prey items but removed most of the contents 11% of the time, and missed all of the stomach contents for 5% of the salamanders (Table 2). Overall, gastric lavage produced a diet sample 95% of the time.

There were no morphometric differences among salamanders that regurgitated none, some, or all of their stomach contents via gastric lavage (Table 2). The SVL ($F_{2,108} = 0.18$, $P = 0.84$), TL ($F_{2,108} = 0.01$, $P = 0.99$), and HW ($F_{2,108} = 0.06$, $P = 0.94$) were not statistically significant across the outcome groups (Table 2). There was also no difference in salamander body mass across the outcome groups ($F_{2,108} = 0.24$, $P = 0.78$).

We identified 45 prey items from the 18 lavaged salamanders that had remaining stomach contents after flushing. The most frequently missed prey groups were adult Coleoptera and terrestrial snails, which are both large, hard bodied prey (Fig. 2). Adult Coleoptera were present in 56% (10), and snails in 33% (6), of the 18 flushed stomachs that had remaining prey. Adult Diptera and arachnids had the lowest percent occurrence in the stomachs (Fig. 2). We were unable to calculate the prey volume missed because most of the stomach contents collected upon dissection were partially digested. In contrast, the condition of diet samples collected by gastric lavage were intact enough to positively identify invertebrates to functional group (Order) and obtain size and volume estimates.

Discussion.—We found that stomach flushing is an effective, non-lethal method to collect diet samples from *P. cinereus*, removing all or most of the stomach contents 95% of the time. In cases where gastric lavage did not fully empty the stomach, often (58%) only a single prey item was missed. The prey most frequently left behind were adult Coleoptera and Gastropoda (i.e., land snails). Because these are larger-bodied prey, their omission would lower estimates of total prey volume consumed by a salamander.

The majority of salamanders that did not regurgitate anything after stomach flushing did have an empty stomach, but researchers should be mindful that some individuals might have prey in their stomach—which occurred for 30% of the salamanders that did not regurgitate anything. We repeated the procedure if a stomach sample was not produced the first time, but we did not make a third attempt, in order to minimize handling time of the animal. We used a 1-mm plastic catheter tube for stomach flushing; perhaps a thinner plastic catheter would increase lavage success by reducing obstruction of regurgitated material moving through the esophagus by the tube.

Stomach flushing produced diet samples that were in good condition for further identification and measurements. Plethodontid salamanders are nocturnal foragers, so diet samples are best collected in the early morning before stomach contents are digested. We conducted our surveys at dawn and flushed salamander stomachs within 2 h of capture. These stomach samples remained in good condition and we were able to measure the length and width of soft-bodied prey, such as dipteran larvae.

Gastric lavage is an effective and minimally invasive procedure. We observed damage to the stomach mucosa in only 3 of the 124 lavaged salamanders, possibly a result of the plastic tube entering the stomach (Fig. 1). We did not observe salamanders in captivity post stomach flushing, so we do not know whether the procedure changed their behavior or health. Previous research has shown anurans held in captivity after stomach flushing

accepted food within 2 h and were still healthy after one month of observation (Solé et al. 2005), and recaptured ranids that were previously flushed had prey in their stomachs (Rice and Taylor 1993). Recapture rates of stomach-flushed larval *Pseudotriton ruber* did not differ from those that were not flushed, indicating this method had no effect on survival rates (Cecala et al. 2007).

In conclusion, gastric lavage is an effective research technique for studying plethodontid diets without removing individuals from a population. This procedure can be easily performed in the field and animals immediately released in their environment, minimizing negative impacts on a salamander's behavior. Gastric lavage has an advantage over euthanasia when working in remote locations by reducing the materials carried to the study site, as the researcher only needs small vials and ethanol to store stomach samples, compared with transporting a cooler or fixative to store euthanized salamanders. We recommend performing gastric lavage in the early morning, after salamanders have finished foraging and retreated to their cover objects, to ensure stomach contents have not been digested and are in good condition for further analyses.

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AMPHIBIAN DISEASES

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Ranavirus in Three Species of Amphibian and Unisexual *Ambystoma* in Ohio

Amphibian declines resulting from disease caused by chytrid fungus (*Batrachochytrium dendrobatidis; Bd*) and ranavirus have been widely reported (Daszak et al. 2003; Muths et al. 2003). Despite increased reports of disease events there remains a need for increased surveillance efforts (Gahl and Calhoun 2008). Disease surveys are important in discerning spatial patterns of infection, establishing distributional data, and determining geographic spread. Data from these surveys provide important baseline information upon which broader ecological investigations of disease dynamics can be based. We report the findings of a disease survey that documents the first published account of ranavirus in three amphibian species and in unisexual *Ambystoma* salamanders at ponds in northeast Ohio.

In July of 2011, 74 larval amphibians of seven taxa were collected from 11 ponds in northeast Ohio and tested for ranavirus infection. Ponds were located on three museum preserves: four ponds were located on the Mentor Marsh State Nature Preserve (MM) in Lake County while six ponds were located on the Grand River Terraces Preserve (GRT). Additional specimens were collected from Geneva Swamp (GS) in Ashtabula County. The MM is ~48 km NW of the GRT and ~51 km W of the GS. Geneva Swamp is ~11 km N of the GRT. Ponds were selected based on observed declines in egg counts and in larval survival. Larval *Ambystoma jeffersonianum, A. maculatum, A. texanum,* unisexual *Ambystoma, Hyla versicolor, Lithobates clamitans,* and *L. sylvaticus* were randomly collected in breeding ponds using dip-nets from 5–26 July. Because ponds in this study have been the subject of long-term monitoring the amphibian species assemblage is known. No time constraint was placed on search effort because the primary goal was acquisition of specimens for ranavirus testing. Search effort consisted of a team of four conducting an average of ten dips per person per pond. Since ponds were relatively small, effort was considered adequate for acquiring the prescribed number of specimens. Searches were concluded in a pond when either five specimens were collected of each studied species or when no other individuals of a taxon were found.

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Genetic testing performed prior to this study confirmed the presence of hybrid individuals at study ponds, both *A. jeffersonianum* and unisexuals are present at GRT whereas *A. texanum* and unisexuals are present at MM and GS. Identification of larval unisexuals without genetic testing is impracticable, therefore the results include unisexual specimens.

Larvae were euthanized by immersion in 3% ethyl alcohol solution. Internal organs were swabbed to detect systemic infection as opposed to dermal swabs for surface exposure to ranavirus. Swabs were analyzed by Research Associates Laboratories, Dallas, Texas, and ranavirus was confirmed using a SYBR green-based Real-time PCR assay. Primers are the property of Research Associates Laboratories (personal communication 2014). Sterile nitrile gloves were used with each new specimen while scalpel blades and work surfaces were disinfected with a 20% bleach solution between uses. All equipment and boots were disinfected with a 10% bleach solution after each pond to prevent disease transmission (Phillott et al. 2010). All specimens were deposited in the herpetological collection of the vertebrate zoology department of the Cleveland Museum of Natural History. Estimates of disease prevalence were calculated for samples using Wilson Score method with continuity correction for 95% confidence intervals (Newcombe 1998).

Ranavirus infection was detected in 25 (34%) of the 74 animals tested, all of which were from four of six ponds in the GRT (Table 1). Thirty-eight percent of salamanders (*Ambystoma jeffersonianum*/unisexual and *A. maculatum)* and 25% of frogs (*Lithobates sylvaticus*) were infected with ranavirus. Sixteen (64%) of the 25 infected individuals exhibited symptoms of illness (lethargy; petechiation on the ventral surfaces particularly around the hind legs, vent, and mouth; swelling in the gular region; loss of righting response; and absence of predator avoidance) or were moribund, whereas the remaining nine animals showed no symptoms despite infection. Few *L. clamitans* individuals were found over all sites despite being typically abundant in both larval and adult forms. *H. versicolor* was also less abundant and occurred in lower frequency, however, this species only inhabits two ponds in this survey.

Amphibian declines at GRT were first noted in the 1990s, however, reproductive effort at ponds appeared to increase following restoration work in 1994 (TOM, pers. obs.). Routine monitoring of ponds showed a recapitulation of population declines in 2002, although no disease or mass mortalities events were observed. In July 2005 a complete die-off was observed at one pond, and

TABLE 1. Summary of results of ranavirus testing by site, pond, and amphibian species. Confidence intervals were calculated for small sample size using Wilson Score method without a continuity correction (Newcombe 1998).

Location	Pond	Species	Positive/Tested	Prevalence (95% CI)
Ashtabula Co, Morgan Twp				
Grand River Terraces	1	*Ambystoma jeffersonianum*/unisexual	0/5	0 (0–0.435)
		Lithobates sylvaticus	1/5	0.2 (0.036–0.625)
		All species	1/10	0.1 (0.018–0.404)
	2	*Ambystoma jeffersonianum*/unisexual	5/5	1 (0.566–1)
		Ambystoma maculatum	2/2	1 (0.342–1)
		Lithobates sylvaticus	5/5	1 (0.566–1)
		All species	12/12	1 (0.758–1)
	3	*Ambystoma jeffersonianum*/unisexual	0/2	0 (0–0.658)
		Ambystoma maculatum	0/3	0 (0–0.562)
		All species	0/5	0 (0–0.435)
	4	*Ambystoma maculatum*	0/5	0 (0–0.435)
		Hyla versicolor	0/2	0 (0–0.658)
		Lithobates clamitans	0/3	0 (0–0.562)
		All species	0/10	0 (0–0.278)
	5	*Ambystoma jeffersonianum*/unisexual	5/7	0.714 (0.359–0.918)
		Ambystoma maculatum	2/3	0.667 (0.208–0.939)
		All species	7/10	0.7 (0.397–0.892)
	6	*Ambystoma jeffersonianum*/unisexual	5/6	0.833 (0.437–0.970)
		Lithobates sylvaticus	0/1	0 (0–0.794)
		All species	5/7	0.714 (0.359–0.918)
		All samples in GRT	25/54	0.463 (0.337–0.594)
Ashtabula Co, Geneva Twp				
Geneva Marsh		*Ambystoma texanum*/unisexual	0/5	0 (0–0.435)
Lake Co., Mentor				
Mentor Marsh	1	*Lithobates clamitans*	0/2	0 (0–0.658)
	2	*Ambystoma texanum*/unisexual	0/2	0 (0–0.658)
		Lithobates clamitans	0/2	0 (0–0.658)
		All species	0/4	0 (0–0.490)
	3	*Ambystoma texanum*/unisexual	0/2	0 (0–0.658)
		Lithobates clamitans	0/2	0 (0–0.658)
		All species	0/4	0 (0–0.490)
	4	*Ambystoma texanum*/unisexual	0/3	0 (0–0.562)
		Lithobates clamitans	0/2	0 (0–0.658)
		All species	0/5	0 (0–0.435)
		All samples in MM	0/20	0 (0–0.161)
		All samples	25/74	0.338 (0.240–0.451)

sick and moribund individuals were found in five other ponds. Larvae of three salamander taxa and one frog (*A. jeffersonianum*, *A. maculatum*, unisexual *Ambystoma*, and *L. sylvaticus*) exhibited red leg syndrome, the symptoms of which are similar to those of ranavirus. Diagnostic testing of larvae at these ponds showed the presence of red leg syndrome (*Pseudomonas*) in 2006 and *Bd* in 2007 (unpubl. data) but samples were not screened for ranavirus. Results from the current study show ranavirus infecting nearly half of animals tested on this preserve. The presence of these pathogens in GRT ponds may explain the decline of common species, like *L. clamitans*, as well as declines in oviposition and larval survival.

We cannot conclude that ranavirus is responsible for die-offs (and population declines) on this preserve partly due to the detection of other disease agents in previous and subsequent years. Additionally, further study will be needed to determine prevalence of disease, whether these are secondary or opportunistic infections, and to ascertain the extent of their contribution to declines. Moreover, it will be necessary to assess the contribution of environmental factors (e.g., water chemistry, water temperature, crowding, etc.) in driving disease events.

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New Records of the Chytrid Fungus *Batrachochytrium dendrobatidis* in Honduran Frogs

The amphibian chytrid fungus *Batrachochytrium dendrobatidis* (*Bd*) has been implicated as a cause of amphibian declines in Honduras (Wilson and McCranie 2004a, b). However, knowledge about the pathogen's presence within the country is poor, and up to now, it is known only in seven frog species from two localities (Puschendorf et al. 2006; Kolby and Padgett-Flohr 2009; Kolby et al. 2010; Kolby 2011). Both areas, the Pico Bonito National Park and Cusuco National Park, are situated in northern Honduras (Fig. 1). More sampling effort is important to understand the occurrence of *Bd* in Honduran amphibians.

As part of a separate study in which we were collecting museum specimens, we also sampled amphibians for the presence of *Bd* at 23 localities throughout Honduras (Fig. 1) during rainy seasons in 2006, 2008, 2009, and 2010. We sampled 23 frog (N = 107 individuals), three salamander (N = 6 indiv.), and one caecilian species (N = 1 indiv.). Five of the frog specimens (2 *Craugastor lauraster*, *C. noblei*, *Lithobates vaillanti*, and *Pristimantis ridens*) and three of the salamander specimens (*Bolitoglossa longissimi*) sampled were juveniles, all others were adults. Two of the adult frogs sampled were found dead near a stream (*Craugastor laevissimus*; No. 18, Quebrada de Agua, Table 1). All other amphibians were captured by hand and euthanized using Chlorobutanol. A piece of skin (ca. 7–10 x 7–10 mm; depending on the size of the animal) was cut from the abdominal section from each frog and salamander specimen and the caecilian skin was taken from an abdominal section about one-third distance to the tail tip. Skin samples were fixed and stored in 95% high-grade ethanol for later PCR analyses. To minimize cross-contamination between specimens, each individual was kept in a new plastic bag until examination. We also wore surgical gloves that were changed between specimens. Instruments used to take samples were disinfected with high-graded ethanol (flame treated). To prevent the spread of chytrid between the separate field sites, used gloves and plastic bags were burned in a camp fire before leaving a site. There was no or a very small risk of spreading *Bd* zoospores between sample sites, because of the time between each sampling and the distances between the sites (see Fig. 1, Table 1).

DNA was extracted with DNeasy Blood & Tissue Kits (Qiagen) according to the manufacturer's protocol. Finally the DNA was eluted in 50 µl of buffer AE (Qiagen). Extracted DNA was preserved in Eppendorf microcentrifuge tubes containing 98% ethanol. DNA of *Bd* was detected with a modified quantitative real-time (qRT) TaqMan PCR assay according to the protocol of Boyle et al. (2004). In this assay the TaqMan probe was not conjugated with a minor groove binder, but included locked nucleic acid (LNA, N+) bases to elevate the melting temperature (5'-6FAM-CGA GTC+ G+AA+ C+A+A+ AAT-BBQ-3'). All qRT-PCR reactions were performed in a final volume of 20 µl on a LightCycler 480 (Roche Applied Science). The reaction mixtures contained 0.25 µM of each primer (ITS1-3 Chytr and 5.8S Chytr; Boyle et al. 2004), 62.5 µM of each dNTP, 1.5 mM $MgCl_2$, 6% BSA, 2 µl of 10× reaction buffer (BD, Solis BioDyne), 1 unit Taq DNA polymerase (AmpliTaq, ABI) and 1 µl DNA. Cycling profile consisted of

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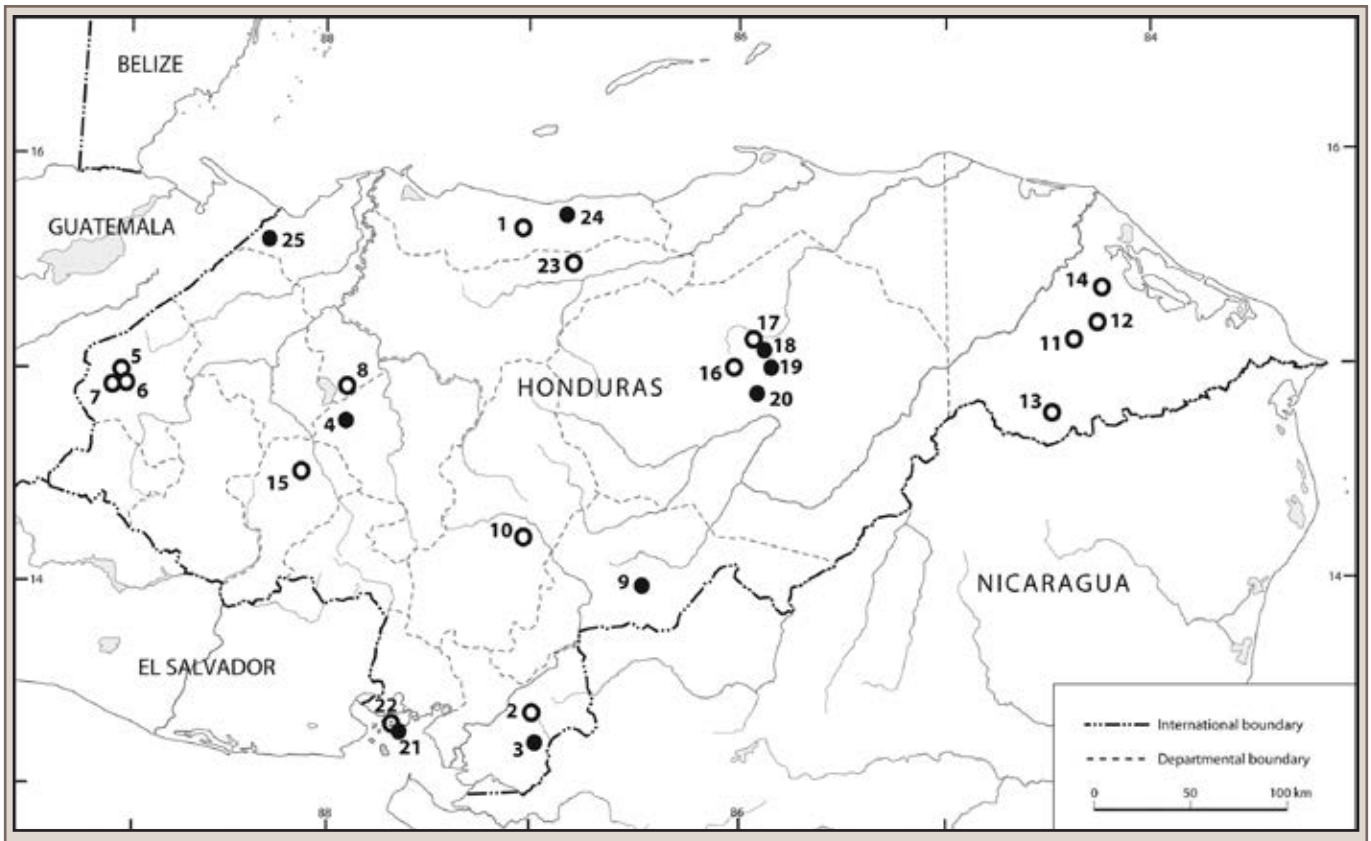


FIG. 1. Amphibian populations in Honduras analyzed for the presence of *Batrachochytrium dendrobatidis* (Bd; No. 1–23, see Table 1). Open circles: *Bd*-negative records; closed circles: Bd-positive records; No. 24: Pico Bonito National Park (Puschendorf et al. 2006), No. 25: Cusuco National Park (Kolby et al. 2009).

an initial denaturation step at 96°C for 5 min, followed by 50 cycles of 10 s at 96°C and 1 min at 60°C. We included negative controls and a positive control for each amplification. The qRT-PCR reactions were performed twice for each sample. A positive result consisted of a clearly sigmoid curve in both replicated samples. There were no discrepancies in the result of the two runs. All positive samples in the first run could be confirmed in the second run.

We found *Bd* in 16 of 114 (14%) specimens tested (Table 1). The *Bd*-positive animals represented ten frog species. No positive PCR amplifications occurred in the six salamanders and the one caecilian. Two of the five juvenile frogs tested were infected (*Craugastor lauraster*, *Lithobates vaillanti*) and the remainder were adults. The two frogs that were found dead were both *Bd*-positive (*C. laevissimus*; No. 18, Table 1); they showed no external defects (e.g., biting marks from predators). None of the specimens found alive showed clinical signs of infection with chytridiomycosis (e.g., external defects, lethargy, or loss of righting reflex).

Positive *Bd* records occurred in 7 of 23 (30%) localities sampled, with elevations that ranged from 10 m to 1850 m (Fig. 1, Table 1). We tested samples from six habitat formations (LMF, LDF, PWF, PMF, LMWF, and LMMF; see Table 1 for abbreviations) and *Bd*-infected frogs were found in all but the LMF habitats.

Our new records extend the known distribution of *Bd* more than 200 km southwards in Honduras from the northern Caribbean coast (Aanensen 2011; Olson et al. 2013). Together with the previous two known sites in the northern portion of Honduras (Puschendorf et al. 2006; Kolby et al. 2010), these results indicate that *Bd* occurrence is widespread throughout the country (Fig. 1), in various habitat formations, and from sea level to montane forest (Table 1).

These are the first published records of *Bd* for the following species: *Craugastor laevissimus, C. lauraster, Dendropsophus microcephalus, Lithobates forreri, L. vaillanti, Incilius luetkenii, I. valliceps,* and *Smilisca baudinii* (Aanensen 2011; Olson et al. 2013). The detection of *Bd* in *Rhinella marina* represents the first Honduran record in this species.

The two infected *Craugastor* species are listed as "Endangered" in the IUCN Red List of Threatened Species (Wilson et al. 2009; Cruz et al. 2010) because of their fragmented and restricted distributions. Most of their populations have declined or disappeared at elevations above 950 m during recent years and chytridiomycosis has been assumed a possible cause. Our data confirm for the first time that *Bd* occurs in populations of both species at the upper elevations of their respective altitudinal ranges (Table 1). Also the widespread frog *Lithobates maculatus* has disappeared in recent years from certain localities, and deforestation and resulting water pollution are probably associated with this decline (Santos-Barrera et al. 2004). We suggest adding chytridiomycosis as one potential threat, because several studies, including ours, have confirmed the widespread presence of *Bd* in this species (Puschendorf et al. 2006; Felger et al. 2007; Kolby et al. 2010).

Due to the opportunistic nature of our study, sampling sizes are too small and too scattered to estimate the effect of *Bd* on amphibian diversity in Honduras. Further research is needed to investigate the reason for the apparent decline in Honduran amphibian populations in addition to the most obvious and unregulated vast destruction of the habitats by the human population.

TABLE 1. Amphibian species sampled for *Batrachochytrium dendrobatidis* in Honduras. Compare No. with Fig. 1. Abbreviations used in the text and in the table: PN = Parque Nacional, LMF = Lowland Moist Forest, LDF = Lowland Dry Forest, PWF = Premontane Wet Forest, PMF = Premontane Moist Forest, LMWF = Lower Montane Wet Forest, LMMF = Lower Montane Moist Forest (McCranie 2011, modified from Holdridge 1967).

No.	Locality / Elevation Coordinates	Habitat	Species	Collection date	No. sampled / No. infected
1	Atlántida: near Santa Ana, 35 m, 15.616667°N, 87.05°W	LMF	*Craugastor aurilegulus*	28.02.09/13.07.09	6 / 0
2	Choluteca: El Madreal, 150 m, 13.373767°N, 87.070817°W	LDF	*Engystomops pustulosus*	10.07.10	1 / 0
3	Choluteca: Cerro Guanacaure, Finca Monterrey, 550 m, 13.253367°N, 87.05345°W	LDF	*Dermophis mexicanus* *Incilius coccifer* *Lithobates maculatus*	11.07.10	1 / 0 1 / 0 2 / 1
4	Comayagua: Cerro El Zarciadero, 1850 m, 14.733333°N, 87.90°W	LMWF	*Craugastor laevissimus*	29.09.10	1 / 1
5	Copán: Cerro Negro, 1780 m, 14.883333°N, 88.95°W	LMWF	*Craugastor charadra*	17.04.06	1 / 0
6	Copán: La Castellona, 750 m, 14.883333°N, 89.00°W	PWF	*Craugastor charadra*	12.04.06	1 / 0
7	Copán: Río Amarillo, 600 m, 14.916667°N, 88.983333°W	PWF	*Craugastor charadra*	11.03.06	1 / 0
8	Cortés: Los Pinos, 750 m, 14.883333°N, 87.90°W	PWF	*Craugastor laevissimus* *Craugastor laticeps*	29.05.08/12.04./01.10.10 01.10.10	5 / 0 4 / 0
9	El Paraíso: Mapachín, 830 m, 13.983067°N, 86.490983°W	PWF	*Agalychnis callidryas* *Dendropsophus microcephalus* *Engystomops pustulosus* *Incilius valliceps* *Leptodactylus melanonotus* *Lithobates forreri* *Smilisca baudinii* *Tlalocohyla loquax*	08.07.10	1 / 0 1 / 1 2 / 0 5 / 1 4 / 0 3 / 1 2 / 2 3 / 0
10	Francisco Morazán: Los Golondrinas, NE of Santa Lucía, PN La Tigra, 1600 m, 14.133333°N, 87.083333°W	LMMF	*Craugastor emleni*	28.03.10	9 / 0
11	Gracias a Dios: Bachi Kiamp, Río Warunta, 40 m, 15.133333°N, 84.40°W	LMF	*Craugastor fitzingeri*	19.06.09	1 / 0
12	Gracias a Dios: Cerro Wisplini, Río Warunta, 30 m, 15.20°N, 84.30°W	LMF	*Craugastor fitzingeri*	16.06.09	1 / 0
13	Gracias a Dios: Sisinbila, 60 m, 14.783333°N, 84.483333°W	LMF	*Craugastor fitzingeri*	16./17.11.09	2 / 0
14	Gracias a Dios: Warunta, 5 m, 15.35°N, 84.233333°W	LMF	*Craugastor fitzingeri*	04.05.10	2 / 0
15	Intibucá: Montaña de Mixcure, 1830 m, 14.483333°N, 88.15°W	LMMF	*Craugastor laevissimus*	27.06.06	2 / 0
16	Olancho: PN Sierra de Agalta, Piedras Blancas, 1100 m, 14.883333°N, 85.90°W	PWF	*Craugastor laevissimus* *Craugastor lauraster* *Craugastor noblei* *Incilius valliceps* *Oedipina quadra*	06.07.10	1 / 0 3 / 0 2 / 0 1 / 0 1 / 0
17	Olancho: PN Sierra de Agalta, Pico La Picucha, 1920–2250 m, 14.946167°N, 85.9126°W	LMWF	*Bolitoglossa longissima* *Oedipina kasios*	02.-04.07.10	4 / 0 1 / 0

TABLE 1. Continued.

No.	Locality / Elevation Coordinates	Habitat	Species	Collection date	No. sampled / No. infected
18	Olancho: PN Sierra de Agalta, Quebrada de Agua, 1300 m, 14.935583°N, 85.904517°W	PWF	*Craugastor laevissimus*	29.06.-04.07.10	5 / 2
			Craugastor lauraster		5 / 2
			Craugastor noblei		5 / 0
			Pristimantis ridens		4 / 0
19	Olancho: PN Sierra de Agalta, Talgua Arriba, 450 m, 14.902417°N, 85.87105°W	PWF	*Craugastor laevissimus*	29.06.10	2 / 2
			Lithobates vaillanti		1 / 1
20	Olancho: Río Catacamas, near Catacamas, 450 m 14.866667°N, 85.90°W	LDF	*Incilius valliceps*	06.07.10	1 / 0
			Rhinella marina		1 / 1
21	Valle: Playa Negra, Isla del Tigre, 10 m, 13.255467°N, 87.6527°W	LDF	*Engystomops pustulosus*	14.07.10	2 / 0
			Incilius luetkenii		3 / 1
			Leptodactylus melanonotus		1 / 0
			Smilisca baudinii		2 / 0
22	Valle: Isla Exposición, 3 m, 13.315067°N, 87.67415°W	LDF	*Incilius luetkenii*	15.07.10	4 / 0
			Smilisca baudinii		2 / 0
23	Yoro: ca. 3 km NNE of La Fortuna, 1610 m, 15.466667°N, 86.783333°W	LMWF	*Craugastor stadelmani*	08.04.10	1 / 0

Acknowledgments.—Collecting (Dictamen DVS-ICF-016-2009) and export permits (Constancia 23 de Octubre 2006, Constancia 4 de Enero 2007, Constancia 4 de Junio 2007, Constancia 4 de Septiembre 2007, Constancia 17 de Diciembre 2007, Constancia 2 de Mayo 2008, Constancia 4 de Agosto 2008, Constancia 042-2011-DVS-ICF) were issued by Lic. Iris Acosta, Lic. Carla Cárcamo, and Lic. Saíd Laínez of the Instituto Nacional de Conservación y Desarrollo Forestal, Áreas Protegidas y Vida Silvestre (ICF), Tegucigalpa. Copies of these permits are on file at the USNM, Washington. Victor Javier Rodriguez provided excellent field assistance. We are indebted to the reviewers whose comments improved the manuscript. Part of the fieldwork of A. Gutsche was supported by the Adolf und Hildegard Isler-Stiftung.

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HERPETOCULTURE NOTES

TESTUDINES — TURTLES

***CUORA MOUHOTII MOUHOTII* (Northern Keeled Box Turtle) and *C. BOURETTI* (Bourret's Box Turtle). CAPTIVE HYBRIDIZATION.** Although "*Cuora serrata*" was originally described as a subspecies of *C. galbinifrons* (Iverson and McCord 1992. Proc. Biol. Soc. Washington 105:433–439), it later received full species status (Fritz and Obst 1997. Zool. Abh. Staatl. Mus. Tierk. Dresden 49:261–279). In 2001 genetic studies showed that it is a hybrid between male *C. mouhotii* ssp. and female *C. galbinifrons* or *C. bourreti* (Parham et al. 2001. Anim. Conserv. 4:357–367; Stuart and Parham 2004. Mol. Phyl. Evol. 31:164–177). "*Cuora serrata*" is now considered a collective noun for hybrids between members of the *C. galbinifrons*-complex and *C. mouhotii* sensu lato. Consequently, questions arose on the origin of this hybrid and in 2003 the first discovery of a wild "*C. serrata*" on Hainan (China) was reported (Shi et al. 2005. Amphibia-Reptilia 26:377–381). This proved at least a wild occurrence, but the possibility of a captive origin could not be excluded. Until now, no records of captive hybridization between members of the *C. galbinifrons*-complex and *C. mouhotii* sensu lato have been reported. Even in Chinese turtle farms there are no such farm-produced specimens (Zhou et al. 2008. Reptilia 61:27–34).

Only a small number of imported "*C. serrata*" are known to be kept in Europe, less than 50 in the USA, and equal numbers in China and Japan. In recent years, several hobbyists have attempted to produce these hybrids, but successful breeding has been limited. However, reproductive events have occurred between "*C. serrata*" specimens on a few occasions (Philippen 2002. Schildkröten 9[4]:14–27; Philippen 2003. Schildkröten 10[1]:12–23; J. Barzyk, pers. comm.; B. Esser, pers. comm.; W. P. McCord, pers. comm; M. Reimann, pers. comm.) as well as between "*C. serrata*" and *C. mouhotii* (M. R. Theiler, pers. comm.). Interestingly, this proves that at least some "*C. serrata*" are reproductively fertile.



FIG. 1. Dorsal and ventral view of parental specimens (*Cuora m. mouhotii* [left], *C. bourreti* [middle]) and the hybrid offspring ("*C. serrata*" [right]).

In the following case, unintentional captive hybridization between a male *C. m. mouhotii* (169 mm SCL [straight carapace length]) and a female *C. bourreti* (156 mm SCL) occurred at the first author's residence. While temporarily housing these specimens together in 2005, several mating attempts were observed. On 9 April 2006, at least five months after the animals had been separated, a single egg (54.84 x 27.67 mm) was produced. The egg was incubated in a Jäger Kunstglucke FB 50 incubator at steady temperatures of 30°C for the first seven weeks and 28°C for the remaining period. After 81 days of incubation, the egg hatched on 26 June 2006. The hatchling measured 42.6 mm (SCL) and weighed 12 g. Remnants of a yolk sac were absent. Serrated hind marginals were clearly present as well as the dorsal and lateral keels (Fig. 1). These features are (nearly) absent in *C. bourreti* hatchlings (and other members within the *galbinifrons*-complex) and are more prominent in hatchlings of *C. mouhotii* sensu lato. At the age of eight years, the specimen has proven to be female. To our knowledge this is the first record of "*C. serrata*" being created in captivity from cross-breeding pure parental specimens. We emphasize that purposely hybridizing different taxa, especially those that are critically endangered, is undesirable and such events should be prevented in captivity.

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CROCODYLIA — CROCODILIANS

***CROCODYLUS INTERMEDIUS* (Orinoco Crocodile). PARENTAL BEHAVIOR.** In April 2014, we were filming a sequence about parental behavior in captive Orinoco Crocodiles for a natural history documentary. Four adults, three females and one male, were maintained in a 1280 m^2 (40 m x 32 m) enclosure at Wisirare Park (4.910397°N, 71.433817°W), Orocué, Casanare, Colombia. The females lay eggs almost every year and the eggs are removed and taken to the incubator room for hatching. On the first day of filming we buried a speaker, connected to a Samsung 3S via a long cable, in one of the artificial beaches and played previously recorded hatchling vocalizations. The female that usually nests on that beach responded to the stimulus and came out of the water to dig in the spot where the speaker was buried; suddenly



FIG. 1. Adult Orinoco Crocodile male digging in a beach in response to recorded hatchling vocalizations.



FIG. 2. Adult female Orinoco Crocodile holding a hatchling in her mouth prior to transferring it to the adult male parent.

the male emerged from the water and aggressively pushed the female into the water. Then, the male began to remove the sand with its fore leg (Fig. 1) until he found the speaker and then he returned into water.

The next day we dug another hole, in a different beach, in which we placed four hatchlings born in the incubator room, they were not covered with sand. After two hours the hatchlings were in the same place and the mother began to pick them up with her mouth (Fig. 2). She carried them into the water where she opened her mouth and released the hatchlings close to the male. The hatchlings swam towards the male (their father), who opened his mouth into which some of the hatchlings entered. Then the male took the hatchlings to a small cave where he released them. Male and female aggressively protected the hatchlings against us, so we had to rope and immobilized both adults to recover the hatchlings.

Nest opening and the carrying of young by adult females is widespread in crocodilians. For the Orinoco Crocodile, these behaviors in females have been suggested (Medem 1981. Los Crocodylia de Sur América Vol I. Los Crocodylia de Colombia. Univ. Nac. De Colombia. Colombia. 270 pp) and confirmed (Thorbjarnarson and Hernández 1993. J. Herpetol. 4:371–379). Nest opening and carrying of young by adult males has been reported for *Caiman crocodilus*, *Crocodylus niloticus*, *C. novaeguineae* and *O. tetraspis* (for a review see Shine 1988. *In* Gans and Huey [eds.], Biology of the Reptilia vol. 16A, pp. 275–300. Alan R. Liss, New York).

To our knowledge, there are no reports of active male parental care for *C. intermedius*, neither in the field nor in captivity. These observations, added to those in which an adult wild male Orinoco Crocodile took food, a dead capybara (*Hydrochoerus hydrochaeris*), to a female guarding its nest (R. Antelo, pers. obs. 2008), suggest that male parental care in this species is far more complex than previously known. In addition these behaviors are more related to birds or mammals than to reptiles.

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***CROCODYLUS RHOMBIFER* (Cuban Crocodile). AGGRESSIVE BEHAVIOR.** A male and two female *Crocodylus rhombifer* are exhibited at the Smithsonian National Zoological Park. The females differ in size by approximately 20 kg. The male (ca. 45 years old) and the smaller female (ca. 33 years old) were both hatched in captivity, whereas the larger female was wild-caught and imported to the United States in 1962. These three animals have been housed together for over a decade in an exhibit measuring approximately 72 m^2. A pool measuring around three meters deep covers approximately half of the exhibit. The male copulates with both females seasonally and in the past three years both have nested and produced eggs. Eggs are removed from the exhibit for artificial incubation and animal keeper staff intentionally destroys nests within days of deposition to reduce the possibility of nest-guarding aggression. The smaller female typically nests in mid-April and the larger female in late April to early May.

Aggressive interactions were observed between the two female *C. rhombifer* following oviposition by both females in 2013 and 2014, with the first observed agonistic behavior occurring in May 2013. Using terminology described by Garrick et al. (1978. Bull. Am. Mus. Nat. Hist. 160:153–192) for *Alligator mississippiensis*, *C. acutus* and *C. niloticus*, the observed social interactions between the two female *C. rhombifer* are described below.

In 2013, oviposition took place on 19 April for the smaller female and 1 May for the larger female. On 29 May the larger female was seen on land in an inflated posture as it bellowed toward the smaller female, who then responded by standing erect from a relaxed position. The smaller female gave a deep grunt, which was shorter in duration and lower in pitch than the larger female's vocalization. Initiated by the larger female whose mouth was agape, the animals then began to circle one another. After a complete circle, the larger female lowered its head with its mouth agape and lunged at the smaller female. Although it appeared to be aiming to bite the smaller female's front leg, the bite occurred on the head. Both crocodiles had their mouths open when the larger female snapped onto the smaller female's head and then released. Following this contact, the smaller female retreated into the pool as the larger female followed. No further aggression was seen at this point. The male remained resting on land during the interaction, and was not involved in this display. This type of interaction was observed on multiple occasions in 2013.

A similar interaction was observed on 18 May 2014, but was shorter in duration than the interactions observed the previous year. In 2014, eggs were laid on 21 April and 10 May by the smaller and larger females, respectively. Eight days after the eggs were removed and the nests destroyed, the larger female was observed exiting the pool and approached the smaller

ILLUSTRATION BY KIM LOVICH

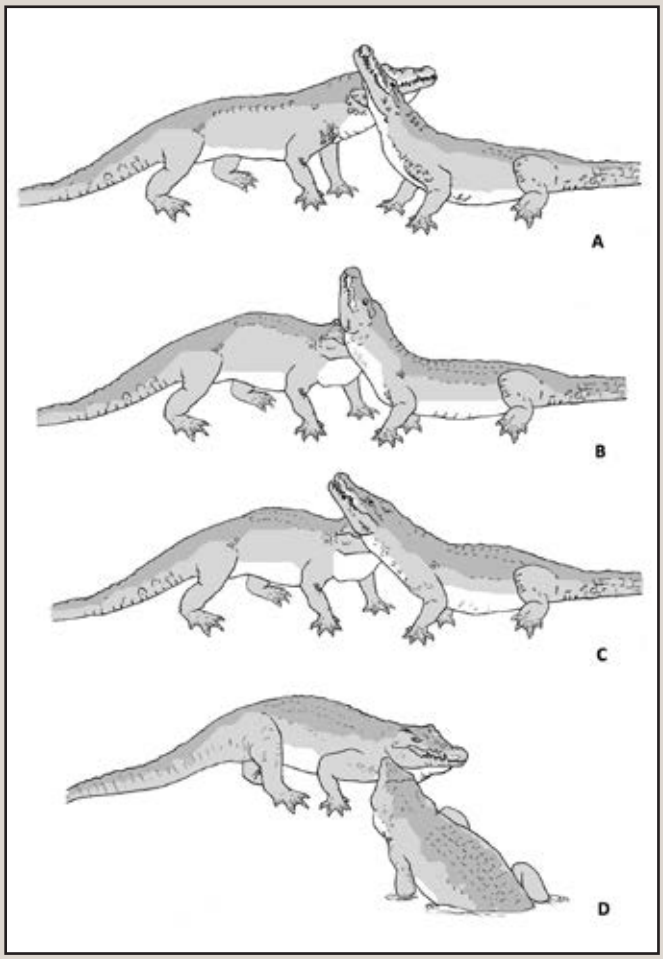


FIG. 1. An illustration of the aggressive interaction observed between two female *Crocodylus rhombifer* in 2014 at the Smithsonian National Zoological Park.

female, who was resting on land in the vicinity of the larger female's nest site. The smaller female then went from a resting position to an inflated position with its back arched and the head angled upward, and let out a low growl (Fig. 1A). The larger female continued to approach the smaller female, who let out two additional growls approximately 25 seconds apart (Fig. 1B). The larger female then used its snout to push the smaller female (Fig. 1C) off land into the pool, and then lowered into a resting position (Fig. 1D). The male remained in the pool for the duration of this interaction, which lasted 73 seconds.

The density of animals housed together in captive environments can affect dominance hierarchies (Barker et al. 1979. Copeia 1979:466–471) and the frequency with which aggressive interactions occur (Wilson 1975. Sociobiology: The New Synthesis. Harvard University Press, Cambridge, Massachusetts. 697 pp.; Arena and Warwick 1995. *In* Warwick et al. [eds.], Health and Welfare of Captive Reptiles, pp. 263–283. Chapman and Hall, London). The aggressive interactions seen between these two female *C. rhombifer* are most likely nest-guarding behaviors as they have only been observed during the month following nesting. Females of *C. acutus, C. niloticus* and *A. mississipiensis* utilize growls and grunts when defending their nests (Garrick and Lang 1977. Am. Zool. 17:225–239). Since the animals are not observed 24 h a day, it is also possible that these interactions occurred more frequently than they were witnessed. Inflated posturing to communicate territoriality has been seen in female *A. mississipiensis*, but not *C. niloticus* or *C. acutus* (Garrick and Lang 1977, *op. cit.*). These types of social interactions for *C. rhombifer* have not been widely reported on, and may have captive management implications when developing housing and breeding recommendations for crocodilians in captivity.

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***CROCODYLUS RHOMBIFER* (Cuban Crocodile). PLAY BEHAVIOR.** Behavior identified as play has only recently been confidently attributed to reptiles, but has been increasingly found to occur when the following abbreviated definition is applied: "Play is repeated, seemingly non-functional behavior differing from more adaptive versions structurally, contextually, or developmentally, and initiated when the animal is in a relaxed, unstimulating, or low stress setting" (Burghardt 2014. Anim. Behav. Cogn. 1:90–98). Object play is the most common type of play reported in crocodilians and is being reported more as captive crocodilians are being provided with unique objects as part of their captive enclosures (Dinets 2015. Anim. Behav. Cogn. 2:49–55).

At the Smithsonian National Zoological Park, a male and two female Cuban Crocodiles, *Crocodylus rhombifer*, are housed on exhibit between a pair of *C. rhombifer* (left) and a female *Gavialis gangeticus* (right) in the Reptile Discovery Center (Fig. 1). These enclosures are divided by metal bar fencing. In July 2014, three cinderblocks were placed along the left fence line in the middle *C. rhombifer* exhibit as a part of an operant conditioning program. The blocks were painted; one black, one white, and one normal gray coloration. The next morning, the black block, weighing 14.24 kg, was found in the pool approximately 4.1 m from its original placement in the exhibit (Fig. 2). Over the next few months the cinderblocks were placed in the exhibit in various orders along the fence line. The black block was consistently found in the pool the days following introduction. When a new black block, weighing 18.1 kg, replaced the old, this block ended



FIG. 1. The front of the three crocodilian exhibits showing the metal bar fencing dividing the enclosures



FIG. 2. The middle crocodilian exhibit with two of the three blocks along the fence line and the black block in the pool where the crocodile(s) moved it.

up in the pool as well, along with the old black block that had not yet been removed. The crocodiles were never seen with the blocks, except for one instance when a keeper servicing the left *C. rhombifer* exhibit saw the male pick up the block and drop it in the pool. The black block was moved from the fence line to the pool by the crocodile(s) seven times in a two-month period.

On 24 October 2014, three black blocks were placed along the fence line. The other two blocks were freshly painted black. Two days later the lightest-colored block, which was faded from being in use since July, was in the pool. This block was left in the pool and no changes were made to the exhibit. At this point the crocodiles were never seen with the blocks, except for one instance when a keeper servicing the left *C. rhombifer* exhibit saw the male pick up the block and drop it in the pool. On 27 October, the male, 46 years old, was seen in the pool with a darker block in his mouth. His lower jaw was through the middle of the block and he appeared to be using the block to sink to the bottom of the pool. Occasionally he would surface, arching his back, head and tail up and would blow bubbles similar to the courtship behavior seen with these animals. Still holding the block an hour later, he was shaking it side to side under water and then rolled with the brick in his mouth. At this point, both of the females became interested in this male's behavior and approached. He attempted to keep the block away from the females, swimming away from them when they approached, demonstrating what appeared to be possessive behavior. Eventually one female mouthed at the block and bumped heads with the male several times under water until the male dropped the block. The block was left untouched until a keeper removed it from the pool days later. Overall, the male had possession of the block for three hours. Part of this behavior was video recorded.

Initially it was thought that the male *C. rhombifer* were combatting through the fence line and the black block was unintentionally moved as a result of these aggressive displays. It was not until the animal was seen carrying and manipulating the cinderblock that this was reconsidered. Keepers investigated the crocodile's specific interest in the black block by first checking the temperature of each block in the exhibit. The temperature differences were minor, with the black block being only 0.3° C warmer than the other two blocks. Another hypothesis was that the brick had some olfactory cue that the crocodile was drawn to, but this was disproven by placing novel black blocks in the enclosure. The sequence of the blocks against the fence also seemed to be insignificant. Three different black blocks were used over the four-month period.

Based on the definition given previously, we conclude that the male *C. rhombifer* was indeed playing with this cinderblock. Play behavior has been documented more prominently in mammals and birds and may be less apparent in reptiles due to physiological and natural history constraints (Burghardt 2005. The Genesis of Animal Play: Testing the Limits. MIT Press, Cambridge, Massachusetts. 501 pp.). Although rarely documented, play behavior in crocodilians may be frequent, including in the wild, but not recognized as such and thus deemed insignificant (Lazell and Spitzer 1977. Copeia 1977:188; Dinets 2015, *op. cit.*).

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SQUAMATA — SNAKES

***LAMPROPELTIS ELAPSOIDES* (Scarlet Kingsnake). SIZE RECORD.** On 23 April 2014, a male *Lampropeltis elapsoides* measuring 740 mm TL (632 mm SVL) died after at least eight years in captivity. This exceeds the maximum reported size of 686 mm TL (Boundy 1995. Bull. Chicago Herpetol. Soc. 30:109122). The snake was caught as an adult (ca. 400 mm TL) near Woodville, Wakulla Co., Florida, USA. The snake is deposited in the Florida Museum of Natural History (UF 174934).

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GEOGRAPHIC DISTRIBUTION

CAUDATA — SALAMANDERS

***AMPHIUMA MEANS* (Two-toed Amphiuma)**. USA: ALABAMA: Autauga Co.: 0.24 air km NNE of junction of Autauga County Road 115 and US 82 (32.52230°N, 86.66108°W; WGS 84). 10 March 2013. C. Davis. Verified by David Laurencio. Auburn University Natural History Museum (AUM 40151). New county record (Mount 1996. The Reptiles and Amphibians of Alabama. University of Alabama Press. 347 pp.). In addition to Mount (1996), VertNet and AUM holdings were searched on 17 February 2015. *Amphiuma means* is assumed to occur throughout the lower half of the state however verified records are lacking for many Alabama counties.

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***CRYPTOBRANCHUS ALLEGANIENSIS ALLEGANIENSIS* (Eastern Hellbender)**. USA: TENNESSEE: Grainger Co.: Richland Creek, 0.07 mile S Indian Ridge Road & 0.03 mi E Richland Creek Road (36.1372ºN, 83.6675ºW; WGS 84). 27 September 2002. Sherry Shisher. Verified by A. Floyd Scott. David H. Snyder Museum of Zoology, Austin Peay State University (APSU 3342, color photo). New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center of Excellence for Field Biology, Austin Peay State University, Clarksville, Tennessee, hard copy and Internet versions [http://www.apsu.edu/amatlas/], the latter including links to information on amphibians in Tennessee that has appeared since 1996, accessed 16 February 2015). One adult (TL = 558.8 mm, SVL = 317.5 mm; 907.2 g) caught on hook and line.

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***EURYCEA QUADRIDIGITATA* (Dwarf Salamander)**. USA: TEXAS: Grimes Co.: 0.23 air km S and 8.55 air km W of Roans Prairie (30.5801°N, 96.0343°W; WGS 84). 10 January 2014. Connor S. Adams and Timothy B. Garrett. Verified by James R. Dixon. Biodiversity Research and Teaching Collections (TCWC 98124). New county record (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 447 pp.). Known from neighboring Brazos, Madison, Montgomery, Walker, and Washington counties, Texas (Dixon 2013, *op. cit.*). Specimen collected under a Texas Parks and Wildlife Scientific Collecting Permit (SPR-0506-662) issued to TJH.

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***GYRINOPHILUS PORPHYRITICUS* (Spring Salamander)**. USA: PENNSYLVANIA: Perry Co.: Patterson Run, 50 m N of Hemlock Rd. in Hemlocks Natural Area, Tuscarora State Forest (40.23562°N, 77.64297°W; WGS 84). 28 September 2014. C. Thawley and F. Graves. Verified by David Laurencio. Auburn University Museum of Natural History (AUM AHAP-D 870 [digital photograph]). New county record (Hulse et al. 2001. Amphibians and Reptiles of Pennsylvania and the Northeast. Cornell University Press, Ithaca, New York).

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***NECTURUS MACULOSUS LOUISIANENSIS* (Red River Mudpuppy)**. USA: OKLAHOMA: Pittsburg Co.: Mud Creek at vicinity of Eufaula Lake off St. Hwy. 31, 1.6 km NE of Richville (34.948502°N, 95.662487°W; WGS 84). 25 February 1988. R. Welsh. Verified by S. E. Trauth. Arkansas State University Museum of Zoology, Herpetological Collection (ASUMZ 33332). New county record (Oklahoma Biological Survey, Distribution of Oklahoma Amphibians and Reptiles by Recorded Sightings [DOKARRS Search], http://www.biosurvey.ou.edu/dokarrs_srch.html; Sam Noble Oklahoma Museum of Natural History Reptile Database [SNOMNH Search], http://www.snomnh.ou.edu). Interestingly, the SNOMNH houses only 14 specimens of *N. m. louisianensis* from Oklahoma in their collection (SNOMNH 2015. *op. cit.*). Specimen previously collected and cataloged into the ASUMZ without permit information.

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ANURA — FROGS

***ALLOBATES TRILINEATUS* (Three-Striped Rocket Frog)**. BRAZIL: ACRE: Municipality of Rio Branco: Rio Branco (9.957222°S, 67.873611°W; WGS 84), 170 m elev. 1 November 2005. Moisés Barbosa de Souza, Elaine Nascimento and Vanessa M. Souza. Herpetological Collection of Universidade Federal do Acre (UFAC-RB 3550). 27 October 2009. Paulo Roberto Melo-Sampaio and Thays de Andrade Farias. UFAC-RB 46054615. Municipality of Senador Guiomard (10.0822°S, 67.06258°W; WGS 84), 180 m elev. 31 July 1985. Adão J. Cardoso. UFAC-RB 0160, 01620164. Municipality of Sena Madureira (9.151528°S, 68.543167°W; WGS 84), 154 m elev. 4 December 2010. Paulo Roberto Melo-Sampaio, Hemerson Gomes da Silva, and Manoel Emir Canizo Dantas. UFAC-RB 47034704, 5557. All specimens verified by Moisés Barbosa de Souza. This species was previously known from the Amazonian lowlands from Ecuador, Peru, and northwestern Bolivia. Within

Bolivia this species is known from Beni, Cochabamba, La Paz, Pando and Santa Cruz departments (Köhler and Lötters 1999. Bonn. Zool. Beitr. 48:259273; De la Riva et al. 2000. Rev. Esp. Herpetol. 14:19164; Kohler 2000. Bonn. Zool. Monogr. 48:1243), and in Peru is known from Amazonas, Huánuco, Loreto, Madre de Dios, and Puno (Grant and Rodríguez 2001. Am. Mus. Novit. 3355:1–24). First country record from the Acre state approximately 280 km from the eastern edge of the previously known range from Rio Curanja, Balta in Peru (Grant and Rodríguez 2001, *op. cit.*) and 160 km northern from Cobija, Pando in Bolivia (Köhler and Lötters 1999, *op. cit.*). Specimen collected under an approved SISBIO permit (#19347-1).

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***ANAXYRUS COGNATUS* (Great Plains Toad)**. USA: TEXAS: Andrews Co.: 5.56 rd km E of jct US 385 on SE 8000 (32.150106°N, 102.410095°W; WGS 84). 8 July 2012. Connor S. Adams. Verified by James R. Dixon. Biodiversity Research and Teaching Collections (TCWC 96946). New county record (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 447 pp.). Known from neighboring Dawson, Gaines, and Martin counties in Texas (Dixon 2013, *op. cit.*).

This specimen was collected during research on *Sceloporus arenicolus* with funding from Texas Comptrollers Office and under a Texas Parks and Wildlife Scientific Collecting Permit (SPR-0506-662) issued to TJH.

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***ANAXYRUS DEBILIS* (Chihuahuan Green Toad)**. USA: TEXAS: Andrews Co.: 21.6 air km S and 15 air km W Andrews (32.11950°N, 102.70708°W; WGS 84). 14 May 2012. Toby J. Hibbitts and Connor S. Adams. Verified by James R. Dixon. Biodiversity Research and Teaching Collections (TCWC 97150). New county record (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 447 pp.). Known from neighboring Dawson, Martin, Midland, and Winkler counties in Texas and from Lea Co., New Mexico (Dixon 2013, *op. cit.*; Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. University of New Mexico Press, Albuquerque, New Mexico. 431 pp.).

This specimen was collected during research on *Sceloporus arenicolus* with funding from Texas Comptrollers Office and under a Texas Parks and Wildlife Scientific Collecting Permit (SPR-0506-662) issued to TJH.

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***ANAXYRUS SPECIOSUS* (Texas Toad)**. USA: TEXAS: Ector Co.: 11.52 rd km S of TX 115 on FM 181 (32.08018°N, 102.7157°W; WGS 84). 10 July 2012. Connor S. Adams. Verified by James R. Dixon. Biodiversity Research and Teaching Collections (TCWC 96947). New county record (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 447 pp.). Known from neighboring Crane, Midland, Upton, Ward, and Winkler counties in Texas and from Lea Co., New Mexico (Dixon 2013, *op. cit.*; Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. University of New Mexico Press, Albuquerque, New Mexico. 431 pp.). Martin Co.: 1.37 rd km E of Co Rd 3201 on Co Rd 4300 (32.43088°N, 101.92016°W; WGS 84). 9 July 2012. Connor S. Adams. Verified by James R. Dixon. TCWC 96948. New county record (Dixon 2013, *op. cit.*). Known from neighboring Dawson, Gaines, Glasscock, Howard, and Midland counties in Texas (Dixon 2013, *op. cit.)*.

These specimens were collected during research on *Sceloporus arenicolus* with funding from Texas Comptrollers Office and under a Texas Parks and Wildlife Scientific Collecting Permit (SPR-0506-662) issued to TJH.

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***ELEUTHERODACTYLUS CYSTIGNATHOIDES* (= *SYRRHOPHUS CYSTIGNATHOIDES*) (Rio Grande Chirping Frog)**. USA: TEXAS: Fort Bend Co.: Missouri City (29.559254°N, 95.577707°W; WGS 84), 20 m elev. 16 February 2014. Marissa R. Hickel, Zachary C. Adcock, Shawn F. McCracken, and Michael R. J. Forstner. Verified by Toby J. Hibbitts. Biodiversity Research and Teaching Collections (TCWC 100266). New county record (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 447 pp.). This species is documented from neighboring Austin, Brazoria, and Harris counties (Dixon 2013, *op. cit.*). The nearest previously documented record is ca. 20 km to the NE in Harris Co. (TCWC 69332). Adult specimen (21.9 mm SUL) discovered in moist leaf litter under a potted plant in a residential neighborhood. Specimen collected under a Scientific Collecting Permit (SPR-0102-191) issued to MRJF by Texas Parks and Wildlife Department.

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***ELEUTHERODACTYLUS CYSTIGNATHOIDES* (= *SYRRHOPHUS CYSTIGNATHOIDES*) (Rio Grande Chirping Frog)**. USA: TEXAS: Robertson Co.: ca. 11 km E of Hearne (30.881331°N, 96.475100°W; WGS 84), 122.8 m elev. 21 August 2014. Andrew R. MacLaren, Zachary C. Adcock, Shawn F. McCracken, and Michael R.J. Forstner. Verified by Toby J. Hibbitts. Biodiversity Research and Teaching Collections (TCWC 100264, 100265). New county record (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 447 pp.). The nearest previously documented record is ca. 35 km SE in Brazos Co. (TCWC 84165). We consider this to document the continued expansion of this taxon outside its normal distribution in Texas. Species first detected during anuran chorus surveys on 22 May 2014 and on subsequent dates. Two adult specimens (20.0 mm and 18.6 mm SUL) collected and numerous additional individuals were observed during bucket trap and artificial cover object surveys on the property which is located on the Carrizo Sands outcrop in Post Oak savannah habitat. Specimens collected under a Scientific Collecting Permit (SPR-0102-191) issued to MRJF by Texas Parks and Wildlife Department.

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***ELEUTHERODACTYLUS PLANIROSTRIS* (Greenhouse Frog)**. PHILIPPINES: CEBU ISLAND: Cebu Province: Cebu City, Barangay Bulacao (10.273783°N, 123.852098°E; WGS 84). 31 October 2014. Jeremy Salgo. Verified by Fred Kraus. Photographic voucher, Lee Kong Chian Natural History Museum, National University of Singapore (ZRC[IMG] 1.75a–e). Individual photographed in an empty lot within a residential area (SVL 10.1–19.0 mm). This specimen is the first record for Cebu Island. *Eleutherodactylus planirostris* is an introduced species in the Philippines, and has previously been recorded on Mindanao, Luzon, and Negros (Olson et al. 2014. Herpetol. Rev. 45:652–653; Sy et al. 2015. Herpetol. Rev. 45:56).

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***GASTROPHRYNE OLIVACEA* (Western Narrow-mouthed Toad)**. USA: TEXAS: Rockwall Co.: Junction of FM 1141 and N Country Ln (32.960341ºN, 96.433210ºW; WGS 84). 21 May 2013. Connor S. Adams. Verified by James R. Dixon. Biodiversity Research and Teaching Collections (TCWC 97652). New county record (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 447 pp.). Known from neighboring Collin, Dallas, Hunt, and Kaufman counties in Texas (Dixon 2013, *op. cit.*). Specimen collected under a Texas Parks and Wildlife Scientific Collecting Permit (SPR-0506-662) issued to TJH.

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***GASTROTHECA FISSIPES* (Marsupial Tree Frog)**. BRAZIL: SERGIPE: Municipality of Pirambu: Aguilhadas Locality (10.69281°S, 36.84061°W; WGS 84), 76 m elev. 23 April 2014. Maria A. Xavier and Eduardo J.R. Dias. Verified by U. Caramaschi. Herpetological Collection of Laboratório de Biologia e Ecologia de Vertebrados, Universidade Federal de Sergipe, Itabaiana, Sergipe, Brazil (LABEVA 1057). Adult female found in a fragment of *restinga* habitat ca. 1600 h within a bromeliad, releasing 18 froglets from its dorsal pouch. This species is endemic to Brazil and is previously known from the states of Pernambuco, Alagoas, and southern Bahia (Izecksohn et al. 2009. Arq. Mus. Nac. 67:81–91; Mendes et al. 2012. Zootaxa 3312:62–64; Teixeira Jr. et al. 2012. Zootaxa 3437:1–23). First state record and fourth specimen from northeastern Brazil, extending the species distribution ca. 487 km S from the type locality, in Igarassú, Pernambuco (Izecksohn et al. 2009, *op. cit.*) and ca. 238 km from nearest locality to the south, at Maceió, State of Alagoas (Teixeira Jr. et al. 2012, *op. cit.*). Specimen collected under SISBIO/ICMBio permit #6878-1.

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***HYLA GRATIOSA* (Barking Treefrog)**. USA: TENNESSEE: McNairy Co.: Finger, 294 Sherry Lynn Drive (35.357800°N, 88.635583°W; WGS84). 2 May 1997. Brian P. Butterfield. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 05543 [photographic voucher]). First county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Hard copy and Internet versions [http://www.apsu.edu/amatlas/]. Accessed 9 May 2015). Specimen collected on a residential window at a rural subdivision located in an oak/hickory forest. Voucher collected under a Tennessee Wildlife Resources Agency Permit (#1494).

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***INCILIUS NEBULIFER* (Gulf Coast Toad)**. USA: TEXAS: Rockwall Co.: 0.04 air km N of TX 66 at public boat ramp at the end of Willow Bend Rd (32.929079°N, 96.473736°W; WGS 84). 10 June 2012. Connor S. Adams. Verified by James R. Dixon. Biodiversity Research and Teaching Collections (TCWC 96961). New county record (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 447 pp.). Known from neighboring Dallas and Kaufman counties in Texas (Dixon 2013, *op. cit.*). Specimen collected under a Texas Parks and Wildlife Scientific Collecting Permit (SPR-0506-662) issued to TJH.

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***KALOULA PULCHRA* (Asiatic Painted Frog)**. PHILIPPINES: MARINDUQUE ISLAND: Marinduque Province: Municipality of Mogpoc, Barangay Villa Mendez (13.473889°N, 121.860833°E, WGS 84) 10 m elev. 29 December 2014. Don Ashley O. Malabana. Verified by Indraneil Das. Photographic voucher, Lee Kong Chian Natural History Museum, National University of Singapore, (ZRC[IMG] 1.76). This specimen is the first record for Marinduque Island. *Kaloula pulchra* is an introduced species and has previously been recorded on Cebu, Luzon, Mindanao, and Palawan (Sy et al. 2014. Herpetol. Rev. 45:276–277).

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***LEPTODACTYLUS FUSCUS* (Rufous Frog)**. BRAZIL: ACRE: Municipality of Tarauacá: Complexo Florestal do Gregório ponto 5 (7.943889°S, 71.535278°W; WGS 84), 225 m elev. 19 June 2006. Moisés Barbosa de Souza and Marilene Vasconcelos Silva. Verified by Moisés Barbosa de Souza. Herpetological Collection of Universidade Federal do Acre, Rio Branco, Acre, Brazil (UFAC-RB 4324). The species is found in savannas from Panama throughout South America, east of the Andes, south to southern Brazil, Bolivia, Paraguay, and northern Argentina (Frost 2014. Amphibian Species of the World: an Online Reference. Version 6.0. http://research.amnh.org/vz/herpetology/amphibia/; Sá et al. 2014. South Am. J. Herpetol. 9:S1–S128). In Brazil, this species is found in Amazonas, Bahia, Ceará, Distrito Federal, Goiás, Espírito Santo,

Maranhão, Mato Grosso, Mato Grosso do Sul, Minas Gerais, Pará, Pernambuco, Piauí, Rio de Janeiro, Rio Grande do Sul, Rondônia and Tocantins (Heyer 1978. Nat. Hist. Los Angeles Count. Sci. Bull. 29:184; Wynn and Heyer 2001. Trop. Zool. 14:255285; Lima et al. 2006. Guide of the frogs of Reserva Ducke Central Amazonia. Áttema Design Editorial, Manaus, Amazonas. 168 pp.; Silva et al. 2010. Sitientibus, Ser. Cienc. Biol. 7:334340). First state record extending the geographic distribution of *L. fuscus* ca. 890 km W from closest records in São Carlos, Municipality of Porto Velho, Rondônia and 480 km S to Belém do Solimões, Municipality of Tabatinga, Amazonas (Heyer 1978, *op. cit.*).

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***LEPTODACTYLUS THOMEI* (Povoação White-lipped Frog).** BRAZIL: MINAS GERAIS: Municipality of Periquito: Fazenda Coqueria (19.10°S, 42.18°W; SAD 69), 194 m elev. 19–23 November 2008. R. Filogonio and M. A. S. Canelas. Verified by C. S. Cassini. Museu de Ciências Naturais, Pontifícia Universidade Católica de Minas Gerais, Belo Horizonte, Minas Gerais, Brazil (MCNA 11032, 11034, 11035, 11066–11068). *Leptodactylus thomei* is a Brazilian species found in Espírito Santo (Povoação, Mimoso do Sul, and probably Governador Lindemberg), and possibly Bahia (Ilhéus) states (Almeida and Angulo 2006. Zootaxa 1334:1–25; Almeida and Gasparini 2010. Checklist 6:13–14). First state record that extends the known distribution ca. 240 km NW from Mimoso do Sul and ca. 565 km SW from Ilhéus and is the most inland locality of the species. Permissions were conceded by Instituto Brasileiro do Meio Ambiente e Recursos Naturais Renováveis (IBAMA) under licenses nº141/2008 NUFAS/MG Process IBAMA nº02015.011675/2007-25, and nº516/2009 NUFAS/MG Process IBAMA nº02015.011675/2007-26.

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***LITHOBATES CAPITO* (Gopher Frog).** USA: FLORIDA: Flagler Co: Pellicer Creek Conservation Area (29.64744°N, 81.26667°W; WGS 84). 18 July 2014. Kevin M. Enge. Verified by Kenneth L. Krysko. Florida Museum of Natural History (UF 173547, digital photographic voucher). First county record (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final report, Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida. 524 pp.). Juvenile observed at 1520 h inside a Gopher Tortoise (*Gopherus polyphemus*) burrow in sandhill habitat where planted *Pinus clausa* had been harvested eight months earlier.

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***PRISTIMANTIS ORPHNOLAIMUS* (Lago Agrio Robber Frog).** PERU: LORETO: Province of Maynas: Santa Cruz Forest Preserve (3.513797°S, 73.182372°W; WGS 84), 100 m elev. 17 January 2015. Emerson Torres Pacaya and Marisa Ishimatsu. Verified by Santiago R. Ron. University of Kansas Digital Archives, Lawrence, Kansas (KUDA 12336–12338). An adult specimen was discovered after dark approximately 3.5 m up on a spiny palm frond (*Bactris riparia*) over hanging a creek. This arboreal species was previously known from only a handful of specimens at six localities in primary forest of the eastern Ecuadorian provinces of Orellana, Pastaza, and Sucumbíos, from 250350 m in elevation (Lynch 1970. Proc. Biol. Soc. Washington 83:221226; Almendáriz et al. 2004. *Pristimantis orphnolaimus*. www.iucnredlist.org; 7 February 2015). New country record (Almendáriz et al. 2004, *op. cit.*) extending the range of this poorly known taxon 375 km SE from the easternmost record in Ecuador (0.97839°S, 75.42569°W, Museo de Zoologia QCAZ: QCAZA 55245), extends the minimum known elevation to 100 m, and represents the first record outside Ecuador. The area of Santa Cruz Forest Reserve where this specimen was discovered consists of a mixture of primary forest and 10- to 20-year-old secondary growth forest, suggesting the species may be more tolerant to anthropomorphic disturbances than previously suspected (McCracken and Forstner 2014. PLOS ONE 9:e85470).

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***PSEUDACRIS FERIARUM* (Upland Chorus Frog).** USA: Tennessee: Hickman Co.: 11513 Bobby Drive, Lyles, Tennessee (35.935622°N, 87.326296°W; WSG 84). 24 September 2014. Nicole Foster and Diana Foster. Verified by A. Floyd Scott. Austin Peay State University (APSU 19534, photo voucher). New county record (Scott and Redmond 2008. [latest update: 6 January 2015]. Atlas of Amphibians in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/amatlas/, accessed 9 January 2015).

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***PSEUDOPALUDICOLA POCOTO* (Dwarf Swamp Frog).** BRAZIL: PIAUÍ: Municipality of Fronteiras: Fronteiras (7.08°S; 40.60°W; SAD 69). 2 April 2013. I. C. Silva. Verified by U. Caramaschi. Museu Nacional, Rio de Janeiro (MNRJ 8752587530). This species was previously known only from northeastern Brazil in caatinga habitats of the states of Ceará, Rio Grande do Norte, Paraíba, and Pernambuco (Magalhães et al. 2014. Herpetologica 70:77–88). This record is approximately 160 km W from its nearest occurrence in the State of Ceará and represents the first state record. Specimens collected under an approved permit (SISBIO/ICMBio #38966-2).

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***RHINELLA AMBOROENSIS* (Cochabamba Toad).** BOLIVIA: SANTA CRUZ: Province of Manuel Maria Caballero: Verdecillo (17.836397°S, 64.570981°W; WGS 84), 2181 m elev. 29 January 2012. Ronald Sosa and Lorenzo Braga. Verified by Lucindo Gonzales. Museo Historia Natural Noel Kempff Mercado, Santa Cruz, Bolivia (MNKA 10890). Adult found at night at 2230 h. Los Remates (17.880707°N, 64.344516°W; WGS 84), 2053 m elev. 9 February 2012. Ronald Sosa and Lorenzo Braga. Verified by Lucindo Gonzales. MNKA 10903. An adult male and female found in amplexus in a stream. Species previously known only from its type locality, Rio Chua Kocha Parque Nacional Carrasco, Province of Carrasco, Cochabamba (Harvey and Smith 1993. Proc. Biol. Soc. Washington 106:442–449). First record for the department of Santa Cruz, extending the known distribution 43 km SE from its type locality, and extends its elevational range from 2150 m to 2181 m.

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***SCAPHIOPUS HURTERII* (Hurter's Spadefoot).** USA: TEXAS: Guadalupe Co.: ca. 12 km S of Seguin, due east of State Highway 123, at private ranch gate (29.428875°N, 97.950468°W; WGS 84), 201 m elev. 20 December 2013. Michelle E. Curtis, Zachary C. Adcock, Rebekah J. Rylander, and Thomas R. Simpson. Verified by Toby J. Hibbitts. Biodiversity Research and Teaching Collections (TCWC 100268). New county record (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 447 pp.). This record fills a distributional gap among Bexar, Wilson, Gonzales, and Caldwell counties (Dixon 2013, *op. cit.*). The nearest previously documented record is ca. 38 km to the SW in Wilson Co. (TCWC 79028). Adult female specimen (60.15 mm SUL; 29.5 g) discovered injured on a dirt road near the ranch gate. Additional specimen (not vouchered) captured in a Sherman trap on the same day during a small mammal survey of the property. Property is located on the Carrizo Sands outcrop in Post O-ak savannah habitat. Specimen collected under Scientific Collecting Permit (SPR-0993-638) issued to TRS by Texas Parks and Wildlife Department.

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***SCINAX NASICUS* (Lesser Snouted Treefrog).** BRAZIL: RIO DE JANEIRO: Municipality of Porto Real: Porto Real (22.42°S, 44.28°W; SAD 69). 17 November 2013. J. Pederassi. Verified by U. Caramaschi. Museu Nacional, Rio de Janeiro, Brazil (MNRJ 87535–87537). This species is known to occur in Bolivia, Paraguay, Uruguay, Argentina, and Brazil. Within Brazil it occurs in the states of Mato Grosso, Mato Grosso do Sul, Southern Goiás, Western of Minas Gerais, São Paulo, Paraná, Santa Catarina and Rio Grande do Sul, but not previously detected in the East of Serra da Mantiqueira or closer than 230 km from the Atlantic ocean (Natale and Herrera 2006. Herpetol. Rev. 37:360; Carezzano and Cabrera 2010. Check List 6:390–391; IUCN 2013. Red List of Threatened species. Version 2013.2. http://www.iucnredlist.org/details/55980/0; Frost 2014. Amphibian Species of the World: an Online Reference. Version 6.0. http://research.amnh.org/vz/herpetology/amphibia/). First state record, increasing its occurrence beyond the Mantiqueira ridge and at least 160 km SE from its nearest occurrence in the State of Minas Gerais (Municipality of Alfenas). This specimen also represents the nearest occurrence to the Atlantic Ocean in the previously Floresta Atlântica domain, which is now climatically more related to Cerrado domains due to deforestation.

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TESTUDINES — TURTLES

***APALONE SPINIFERA* (Spiny Softshell).** USA: TENNESSEE: Sullivan Co.: Steele Creek Park Lake, Bristol, captured along the shoreline in a cove approximately 80 m NW from Steele Creek Lake dam (36.563956°N, 82.227629°W; WGS 84). 19 July 2004. Chris O'Bryan. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19542, photo voucher). New county record (Scott and Redmond 2008 [latest update: 12 January 2015]. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://www.apsu.edu/reptatlas/, accessed 20 January 2015). An adult female (carapace length: 34.9 cm; plastron length: 23.7 cm; 3750 g), was captured using a finger-throated hoop trap baited with perch and chicken gizzards. BR and JWC had unvouchered records from June–July 1970, and MKH and CJO had unvouchered records from 1997–2003 in the same cove. Specimen collected under Tennessee Wildlife Resource Agency Scientific Collection Permit (#1384) issued to CJO and MKH.

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***KINOSTERNON FLAVESCENS* (Yellow Mud Turtle).** USA: OKLAHOMA: Latimer Co.: vicinity Gowen off US 270 (34.889171°N, 95.473471°W; WGS 84). 19 August 1988. K. Shoemaker. Verified by S. E. Trauth. Arkansas State University Museum of Zoology, Herpetological Collection (ASUMZ 33333). New county record

(Oklahoma Biological Survey, Distribution of Oklahoma Amphibians and Reptiles by Recorded Sightings [DOKARRS Search], http://www.biosurvey.ou.edu/dokarrs_srch.html; Sam Noble Oklahoma Museum of Natural History Reptile Database [SNOMNH Search], http://www.snomnh.ou.edu) and farthest southeast this taxon has been reported in the state. The closest previous record of *K. flavescens* in Oklahoma is a specimen collected to the northwest in October 1969 from 14.5 km SW of Okemah in Okfuskee Co. (DOKARRS 2015, *op. cit.*). Specimen previously collected and cataloged into the ASUMZ without permit information.

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***KINOSTERNON SUBRUBRUM* (Eastern Mud Turtle)**. USA: TEXAS: Rockwall Co.: 0.50 km N of jct TX 66 on FM 549 (32.940741°N, 96.417668°W; WGS 84). 26 May 2013. Connor S. Adams. Verified by James R. Dixon. Biodiversity Research and Teaching Collections (TCWC 97658). New county record (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 447 pp.). Known from neighboring Collin, Dallas, Hunt, and Kaufman counties, Texas (Dixon 2013, *op. cit.*). Specimen collected under a Texas Parks and Wildlife Scientific Collecting Permit (SPR-0506-662) issued to TJH.

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***STERNOTHERUS ODORATUS* (Eastern Musk Turtle)**. USA: TEXAS: Jackson Co.: 23 km NW of Edna on SH 111 (29.08363°N, 96.72182°W; WGS 84). 3 August 2014. Romey L. Swanson. Verified by Travis J. LaDuc. Texas Natural History Collections (TNHC 93300). New county record (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 447 pp.). A single adult (carapace length: 85.00 mm; 90.2 g) was collected live by hand from HW 111. The collection site lies approximately 1400 m from the Navidad River. Aerial imagery displays several earthen ponds within the area between the river and collection site; the closest occurs 60 m from the road. *Sternotherus odoratus* has been previously confirmed within three of five adjacent counties (Matagorda, Colorado, and Victoria; Dixon 2013, *op. cit.*).

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***TRACHEMYS SCRIPTA* (Pond Slider)**. USA: TEXAS: Ector Co.: UTPB Duck Pond on University of Texas Permian Basin campus grounds (31.892115°N, 102.325071°W; WGS 84). 24 June 2012. Connor S. Adams and Drew E. Dittmer. Verified by James R. Dixon. Biodiversity Research and Teaching Collections (TCWC 96956). New county record (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 447 pp.). Known from neighboring Midland Co., Texas (Dixon 2013, *op. cit.)*.

This specimen was collected during research on *Sceloporus arenicolus* with funding from Texas Comptrollers Office and under a Texas Parks and Wildlife Scientific Collecting Permit (SPR-0506-662) issued to TJH.

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SQUAMATA — LIZARDS

***ANOLIS CHLOROCYANUS* (Northern Green Anole)**. DOMINICAN REPUBLIC: PEDERNALES PROVINCE: Laguna de Oviedo, northeastern border of Jaragua National Park, 4 airline km E of Oviedo (17.802429°N, 71.362881°W; determined from Goggle Earth). 12 March 2013. Miguel A. Landestoy. Verified by Jonathan Losos. Museum of Comparative Zoology (MCZ-R-191169, photographic voucher). First record for Pedernales, and 53 airline km SW of Barahona, the previous southernmost extent for the species on Hispaniola's south paleo-island (Powell et al. 1991. Herpetol. Rev. 22:134–135), where it is reported to hybridize with *A. coelestinus* (Garcia et al. 1994. Carib. J. Sci. 30:279281). A second adult male was found nearby in the vicinity of Oviedos town park (17.800573°N, 71.399502°W; determined from Goggle Earth). 26 April 2013. Miguel A. Landestoy. Verified by Jonathan Losos. MCZ-R-191170 (photographic voucher). *Anolis chlorocyanus* is widespread on Hispaniola's north paleo-island, other than in very xeric areas (Henderson and Powell 2009. Natural History of West Indian Reptiles and Amphibians. University of Florida Press, Gainesville, Florida. 495 pp.). Its occurrence around Laguna de Oviedo could be due to lizards colonizing building materials used for construction of Jaragua National Park visitor center or with transported garden plants and soils into the town of Oviedo; both *A. coelestinus* and *A. chlorocyanus* now occur syntopically, at least around the visitor center.

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***ANOLIS SAGREI* (Brown Anole)**. MÉXICO: VERACRUZ: Municipality of Alvarado: Mandinga (19.019603°N, 96.085397°W; WGS 84), near sea level. 11 October 2012. César Toscano Flores. Verified by Adrian Nieto Montes de Oca. Museo de Zoología Alfonso L. Herrera de la Facultad de Ciencias de la Universidad Nacional Autónoma de México, Mexico City (MZFC 27327). First record for the municipality and a range extension of 100 km N from the nearest known locality at Catemaco, Municipality of San Andrés Tuxtla, Veracruz (Benítes 1997. *In* González Soriano et al. [eds.], Historia Natural de los Tuxtlas, pp. 495–500. Instituto de Biología, UNAM, CONABIO e Instituto de Ecología, UNAM, México, D.F.). The lizard was found at 1000 h on a mangrove tree, ca. 40 cm above ground. The specimen was collected under permit # FAUT-0093 issued by SEMARNAT to Adrian Nieto Montes de Oca.

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***ANOLIS SAGREI* (Brown Anole)**. USA: FLORIDA: Levy Co: Seahorse Key, hydric hammock adjacent to beach (29.100580°N, 83.061000°W; WGS 84). 30 June 2014 and subsequent dates (below). Coleman M. Sheehy III, Matthew T. Fedler, Tyler A. Gilbert, and Margarita Hernandez. Verified by Kenneth L. Krysko. Florida

Museum of Natural History (UF 174848–904). First observation and documentation of *Anolis sagrei* on Seahorse Key (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final report, Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida. 524 pp.).

Seahorse Key is a 64-ha island within the Cedar Keys National Wildlife Refuge (CKNWR). The CKNWR is a group of 13 islands in Florida's Big Bend region, located south of the Suwannee River outflow in the Gulf of Mexico. Seahorse Key is approximately 3 km from Cedar Key, the nearest bridge-connected landmass, and 2 km from the nearest island among the group comprising the CKNWR. During multiple trips between 30 June and 12 December 2014, 57 *A. sagrei* specimens representing both sexes and all age classes were collected within a small area of hydric hammock, known locally as East Cove, at the far east of the island. The *A. sagrei* population on Seahorse Key is located adjacent to a beach called Sandy Point, which is commonly visited by people in boats from nearby Cedar Key. Although *A. sagrei* could have floated or rafted to Seahorse Key from Cedar Key (Schoener and Schoener 1984. Oecologia 63:289–294), we consider this scenario unlikely based on slow water currents in the region and the high risk of predation. Instead, we consider incidental boat transport to be the most parsimonious pathway for this introduction. *Anolis sagrei* was not known from Seahorse Key or adjacent islands during the studies of Charles Wharton (1958. The Ecology of the Cottonmouths *Agkistrodon piscivorus piscivorus* Lacépède of Sea Horse Key, Florida. PhD Dissertation, University of Florida, Gainesville, Florida). Furthermore, CMS and colleagues did not encounter this species on Seahorse Key from 2001–2014 despite conducting herpetological research on the island. The introduced population of *A. sagrei* appears to be restricted to a small area on Seahorse Key at present. Efforts are underway to eradicate this introduced lizard before it disperses to the rest of the island.

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***ANOLIS TIGRINUS* (Tiger Anole)**. VENEZUELA: SUCRE: Municipality of Mariño: Península de Paria, trail between Roma and Cerro Humo (10.694265°N, 62.632466°W; WGS 84), 890 m elev. 31 August 2014. C. Astudillo. Verified by María del Rosario Castañeda. Museo de Biología, Universidad del Zulia, Maracaibo, Venezuela (MBLUZ 1290). Adult female collected after a heavy rain within a patch of intervened cloud forest. *Anolis tigrinus* is endemic to northern Venezuelan and occurs in the states of Anzoategui, Aragua, Falcón, Miranda, Vargas, and Yaracuy, and Distrito Capital (central coastal range and Lara-Falcón hill system), and Sucre state (eastern coastal range). It is found in humid premontane and montane forests between 650 and 2000 m (Ugueto et al. 2009. Carib. J. Sci. 45:31–51). In Sucre, the species was known only from a single specimen from San Rafael, near Cumanacoa, in the lower elevations of the Turimiquire Massif, but has not previously been recorded from adjacent Serranía de Paria, a mountainous chain in northeastern Venezuela (Ugueto et al. 2009, *op. cit.*). This record represents the easternmost distribution and the first mention of the species for Península de Paria, expanding its range extension ca. 150 km NE (airline) of San Rafael, the formerly easternmost record. Also this finding supports a past connection between the montane forest from the Central Coastal Range and Serranía de Paria. The distribution of the frog *Strabomantis biporcatus* (Manzanilla et al. 1996. Herpetol. Rev. 27:29; Barrio-Amorós and Kaiser 2008. Salamandra 44:248254) and the birds *Pipreola formosa* and *Aulacorhyncus sulcatus* (Hilty 2003. Birds of Venezuela. Princeton University Press. Princeton, New Jersey. 776 pp.) also supports such connection.

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***DRACO MINDANENSIS* (Mindanao Flying Lizard)**. PHILIPPINES: SAMAR ISLAND: EASTERN SAMAR PROVINCE: Municipality of Taft: Barangay San Rafael (11.953°N, 125.84893°E; WGS 84) 140 m elev. 22 October 2007. Cameron D. Siler and Jason B. Fernandez. Verified by Jimmy A. McGuire. University of Kansas Biodiversity Institute Herpetology Collections (KU 310847). WESTERN SAMAR PROVINCE: Municipality of San Jose de Buan: Mt. Huraw (12.05262°N, 125.03429°E; WGS 84; 209 m elev. 6 July 2014. Cameron D. Siler, Kerry A. Cobb, Dyanne Realubit, Joseph Brown, Nick Huron, Vicente Yngente, and Marvic Yngente. Verified by Jimmy A. McGuire. KU 337396. First vouchered island records, extending the known range a minimum of ca. 162 km NE of nearest known locality represented by catalogued museum specimens of Mahaplag, Leyte Sur Province, Leyte Island (McGuire and Alcala 2000. Herpetol. Monogr. 14:81–138).

Although this Philippine endemic species has been recognized to occur on Samar Island since 1994, the published report referenced a non-vouchered specimen from a private collection (Gaulke 1994. Hamadryad 19:1–10), and a comprehensive literature review returned no published records of vouchered specimens examined from this island (McGuire and Alcala 2000, op. cit.; McGuire and Kiew 2001. Biol. J. Linn. Soc. 72:203–229). To the best of our knowledge, the two voucher specimens reported here represent the only published museum records of populations of this species on Samar Island. Both specimens were collected sleeping at night on low-lying branches of trees in the middle of secondary-growth forest. Fieldwork was supported by NSF DEB 0743491 and NSF EF-0334952 to RMB, and NSF DEB 0804115 and NSF IOS 1353683 to CDS.

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***GERRHONOTUS LIOCEPHALUS* (Wiegmann's Alligator Lizard).** GUATEMALA: HUEHUETENANGO: Municipality of Jacaltenango: vicinity of Cantón Modelo on the road to Pebilpam (15.748086°N, 91.798654°W; WGS 84), 770 m elev. 1 December 2014. José Montejo. Verified by Jonathan Campbell. Amphibian and Reptile Diversity Research Center (UTADC 8473–8482, photographic voucher). First record for the genus in Guatemala, extending the range ca. 56 km NE of the closest known record on Cerro Malé, Porvenir, Chiapas, Mexico (UMMZ 94921), which is the type locality for *G. l. austrinus* (Hartweg and Tihen 1946. Occ. Pap. Mus. Zool. Univ. Michigan [497]:1–16). The adult lizard was found crawling on branches of a bush within tropical deciduous forest. We thank José Montejo and Angela López for providing the photographs of the specimen, and Jonathan Campbell for comments that improved this note.

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***HEMIDACTYLUS PARVIMACULATUS* (Sri Lankan Spotted House Gecko).** USA: LOUISIANA: Jefferson Parish: 931 Industry Road, Kenner (29.9845694°N, 90.2776278°W; WGS 84). 14 November 2014. Timothy Borgardt. Verified by David Heckard and Nick Hanna. Southeastern Louisiana University Vertebrate Museum (2345–2347). Two deceased adults and one neonate collected from pavement outside of an industrial warehouse (air temperature = 4.4°C). These specimens are the first verified *H. parvimaculatus* in Jefferson Parish. The presence of adult and neonate specimens suggests that there is an established population at this location. The nearest verified report is 16 km away at the Audubon Zoo, Orleans Parish, Louisiana (Heckard et al. 2013. IRCF Reptiles and Amphibians 20:192–196). Specimen collected under a Lousiana Department of Wildlife and Fisheries Fishing License (#100-3605-191).

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***HEMIDACTYLUS TURCICUS* (Mediterranean Gecko).** USA: Kansas: Butler Co.: El Dorado, exterior wall at 2525 West Central Avenue, Best Western Red Coach Inn (37.816905°N, 96.88670937°W; WGS 84). 11 September 2014. Jared White. Verified by Greg Sievert. Cameron University Museum of Zoology (CUMZ 237). New county record (Collins et al. 2011. Amphibians, Reptiles, and Turtles in Kansas. Eagle Mountain Publishing, Eagle Mountain, Utah. 312 pp.).**JARED W. WHITE** (e-mail: jwhite16@emporia.edu) and **MICHAEL S. HUSAK**, Department of Biological Sciences, Cameron University, Lawton, Oklahoma 73505, USA (e-mail: michaelh@cameron.edu).

***HEMIDACTYLUS TURCICUS* (Mediterranean Gecko).** USA: OKLAHOMA: Tulsa Co.: City of Tulsa (36.115422°N, 95.982848°W; WGS 84). 15 May 2013. John G. Phillips and Stacey L. Hannebaum. Verified by Stan E. Trauth. Arkansas State University Museum of Zoology (ASUMZ 33349, photographic voucher). New county record (Oklahoma Biological Survey, Distribution of Oklahoma Amphibians and Reptiles by Recorded Sightings [DOKARRS], http://www.biosurvey.ou.edu/dokarrs_srch.html). Known from scattered localities across the state (Sievert and Sievert 2011. A Field Guide to Oklahoma's Amphibians and Reptiles, 3rd ed. Oklahoma Deptment of Wildlife Conservation, Oklahoma City, Oklahoma. 211 pp.). Specimen was found in an apartment complex, which is no longer present at the location. Further investigation revealed at least 30 more individuals of varying sizes. Since 15 May 2013, *H. turcicus* has been seen and heard at other locations within the city of Tulsa.

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***IGUANA IGUANA* (Common Green Iguana).** MÉXICO: BAJA CALIFORNIA SUR: Municipality of Los Cabos: Los Cabos, Estero San José del Cabo (23.050305°N, 109.688080°W; WGS 84), 4 m elev. 22 June 2014. V. H. Luja. Verified by Luis Canseco Márquez. Amphibian and Reptile Diversity Research Center (UTADC 8198, photographic voucher). First state record for this introduced species (Grismer 2002. Amphibians and Reptiles of Baja California: including its Pacific Islands and the Islands in the Sea of Cortez. University of California Press, Berkeley, California. 399 pp.). An adult male was observed perched on a tree in the Estero San Jose Oasis; the lizard subsequently jumped into the water and swam into aquatic vegetation.

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***LIOLAEMUS NIGROMACULATUS* (Many-spotted Tree Iguana).** CHILE: ANTOFAGASTA: Las Terrazas Beach, Paposo (25.1400°S, 70.4613°W; WGS 84). 1 February 2015. Marcos Ferrú González. Verified by Jaime Troncoso-Palacios. Colección Patricio Sánchez Reyes de la Pontificia Universidad Católica de Chile**,** Santiago, Región Metropolitana (SSUC 642, 643). The specimens were captured under rocks on sandy area with shrub vegetation (*Nolana* sp.). The species is known only from Caldera to Huasco in the Atacama Region (Troncoso and Garín 2013. ZooKeys 294:37–56). This new record extends the known range 230 km (airline) N of Caldera, the closest known locality. Specimens collected under an approved SAG permit (Resolución Exenta 9487/2014).

MARGARITA RUIZ DE GAMBOA ASTROZA, Programa de Doctorado en Sistemática y Biodiversidad, Departamento de Zoología, Universidad de Concepción, Barrio Universitario s/n, Concepción, Chile (e-mail: mruizdg@gmail.com); **MARCOS FERRÚ GONZALEZ**, Programa de Magister en Ciencias mención Zoología, Departamento de Zoología, Universidad de Concepción, Luis Acevedo 456, Chiguayante, Chile.

***PHRYNOSOMA CORNUTUM* (Texas Horned Lizard).** USA: TEXAS: Yoakum Co.: The Nature Conservancy's Yoakum Dunes Preserve (33.375015°N, 102.626817°W, NAD 83). 1 August 2013. Texas Natural History Collections (TNHC 92828, 92829; photographic vouchers). A third individual was observed at this locality on 8 September 2013 (TNHC 92831, photographic voucher). The Nature Conservancy's Yoakum Dunes Preserve (33.368384°N, 102.623166°W, NAD 83). 1 September 2013. TNHC 92830 (photographic voucher). New county record filling a distributional hiatus between all surrounding Texas counties and eastern New Mexico (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 447 pp.). Both specimens were found by Jacob Kemmer and verified by Travis J. LaDuc.

We thank The Nature Conservancy of Texas for access to the property and project support. Specimens were collected under a Texas Parks and Wildlife Department Scientific Collecting Permit (SPR-0300-087) issued to ACK.

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***PLESTIODON EGREGIUS SIMILIS* (Northern Mole Skink)**. USA: FLORIDA: Hamilton Co: Suwannee Ridge Mitigation Park Wildlife and Environmental Area (30.44366°N, 83.04613°W; WGS 84). 8 May 2014. Kevin M. Enge. Verified by Kenneth L. Krysko. Florida Museum of Natural History (UF 173275, photographic voucher). First record for the county (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final report, Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida. 524 pp.). Adult male trapped by a drift fence installed in sandhill habitat.

KEVIN M. ENGE (e-mail: kevin.enge@myfwc.com), **CODY D. GODWIN,** and **JONATHAN D. MAYS**, Florida Fish and Wildlife Conservation Commission, 1105 S.W. Williston Road, Gainesville, Florida 32601, USA.

***SCELOPORUS CONSOBRINUS* (Prairie Lizard)**. USA: TEXAS: Robertson Co.: Approximately 11 km E of Hearne (30.872176°N, 96.483453°W; WGS 84), 135 m elev. 7 April 2014. Zachary C. Adcock, Andrew R. MacLaren, Shawn F. McCracken, and Michael R. J. Forstner. Verified by Toby J. Hibbitts. Biodiversity Research and Teaching Collections (TCWC 100267). New county record (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 447 pp.). This record fills a distributional gap within the surrounding Milam, Falls, Limestone, Leon, Madison, Brazos, and Burleson counties. Unreported records of *S. consobrinus* from Robertson Co. exist at the Biodiversity Research and Teaching Collections, but this specimen represents the first confirmed and published *S. consobrinus* record from the county. The nearest (previously unreported) record is 7 km SE (TCWC 61934). Adult male specimen (58.2 mm SVL; 127.0 mm TL) collected during a visual encounter survey. Numerous additional individuals (not vouchered) observed during visual encounter, bucket trap, and artificial cover object surveys on the property. Property is located on the Carrizo Sands outcrop in Post Oak savannah habitat. Specimen collected under Scientific Collecting Permit (SPR-0102-191) issued to MRJF by Texas Parks and Wildlife Department.

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SQUAMATA — SNAKES

***BOIGA NIGRICEPS* (Black-headed Cat Snake)**. INDONESIA: BALI: Tabanan Regency: West Selemadeg, vicinity of Selabih (8.457485°S, 114.918449°E; WGS 84). 19 January 2015. J. Vink. Verified by Jason Luke. Lee Kong Chian Natural History Museum, National University of Singapore (ZRC [IMG] 2.245a–d, photographic voucher). Found on thin branches of a live tree, 5 m up on tree trunk, in a residual rainforest behind houses. First record for Bali (McKay 2006. A Field Guide to the Amphibians and Reptiles of Bali. Krieger Publishing Co., Malabar, Florida. 138 pp.). Indonesian populations are known from Kalimantan (Borneo), Sumatra, and Java (Stuebing et al. 2014. A Field Guide to the Snakes of Borneo, 2nd ed. Natural History Publications [Borneo] Sdn Bhd., Kota Kinabalu, Malaysia. 310 pp.), and its distribution includes southern Thailand, and Peninsular and East Malaysia (Das 2010. A Field Guide to the Reptiles of South-east Asia. New Holland Publishers [UK] Ltd., London. 376 pp.; Das 2012. A Naturalist's Guide to the Snakes of South-east Asia. John Beaufoy Publishing, London. 160 pp.).

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***CEMOPHORA COCCINEA COPEI* (Northern Scarletsnake)**. USA: FLORIDA: Hamilton Co: Suwannee Ridge Mitigation Park Wildlife and Environmental Area (30.44366°N, 83.04613°W; WGS 84). 3 June 2014. Jonathan D. Mays. Verified by Kenneth L. Krysko. Florida Museum of Natural History (UF 173271, photographic voucher). First county record (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final report, Florida Fish and Wildlife Conservation Commission, Tallahassee. 524 pp.). Adult male trapped by a drift fence installed in sandhill habitat.

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***COELOGNATHUS ERYTHRURUS PSEPHENOURUS* (Philippine Gray-tailed Ratsnake)**. PHILIPPINES: TABLAS ISLAND: Romblon Province: Municipality of Odiongan, Barangay Poctoy (12.410418°N, 121.990697°E, WGS 84) 8 m elev. 31 October 2014. Ernest Kurt Tan. Verified by Rafe M. Brown. Photographic voucher, Lee Kong Chian Natural History Museum, National University of Singapore (ZRC[IMG] 2.244a–c). This specimen represents the first record for Tablas Island and Romblon Province (Siler et al. 2012. Check List 8[3]:443–462) and was collected DOR. *Coelognathus erythrurus psephenourus* is an endemic taxon that has previously been recorded on Cebu, Guimaras, Masbate, Negros, and Panay (Leviton 1977. Philippines J. Sci. 106:99–128; Gaulke and Altenbach 1994. Herpetozoa 7:63–66).

EMERSON Y. SY, Philippine Center for Terrestrial and Aquatic Research, 1198 Benavidez Street, Unit 1202, Tondo, Manila, Philippines (e-mail: emersonsy@gmail.com); **ERNEST KURT TAN**, Philippine Native Plant Conservation Society, Inc. Cottage 1, Ninoy Aquino Parks and Wildlife Center, North Avenue, Diliman, Quezon City, Philippines (e-mail: tablasisland@gmail.com).

***COLUBER CONSTRICTOR* (North American Racer)**. USA: NEBRASKA: Cedar Co.: Bow Creek Recreation Area, Missouri National Recreational River (42.77806°N, 97.14611°W; WGS 84). 25 June 2014. Spencer R. Siddons. Verified by Jessa L. Watters. Sam Noble Oklahoma Museum of Natural History (OMNH 44149). New county record (Ballinger et al. 2010. Amphibians and Reptiles of Nebraska. Rusty Lizard Press, Oro Valley, Arizona. 400 pp.; Fogell 2010. A Field Guide to the Amphibians and Reptiles of Nebraska. University of Nebraska-Lincoln, Lincoln, Nebraska. 158 pp.). Previous records exist to the west in Knox Co. and across the Missouri River to the north in Clay Co., South Dakota (Ballinger et al. 2000. Trans. Nebraska Acad. Sci. 26:29–46; Ballinger et al. 2010, *op. cit.*; Fogell 2010, *op. cit.*). The nearest known specimen is from ca. 18 km to the east and across the Missouri River in Vermillion, Clay Co., South Dakota (University of Nebraska State Museum [UNSM] 16108). This specimen fills part of a large gap in the known distribution of this species in northeastern Nebraska. Adult female (872 mm SVL; 218 mm tail length; 225.51 g) collected along trail approximately 150 m NE of parking area and

had recently consumed a large vole (*Microtus* sp.). Specimen collected under a Nebraska Game and Parks Commission Scientific and Educational Collecting Permit (#472) issued to DRD.

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***COLUBER CONSTRICTOR* (North American Racer)**. USA: TEXAS: Floyd Co.: 14.37 rd km E of Junction Hwy 70 and FM 1958 (33.97897°N,101.1702583333°W; WGS 84). 7 November 2014. Toby J. Hibbitts and Connor S. Adams. Verified by James R. Dixon. Biodiversity Research and Teaching Collections (TCWC 100293). New county record (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 447 pp.). Known from neighboring Motley and Swisher counties in Texas (Dixon 2013, *op. cit.*). Specimen collected under a Texas Parks and Wildlife Scientific Collecting Permit (SPR-0506-662) issued to TJH.

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***CROTALUS ATROX* (Western Diamond-backed Rattlesnake)**. USA: TEXAS: Gaines Co.: 1.76 rd km S of Co Rd 426 on Norman Rd (32.523288°N, 102.55939°W; WGS 84). 1 August 2012. Connor S. Adams. Verified by James R. Dixon. Biodiversity Research and Teaching Collections (TCWC 96939). New county record (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 447 pp.). Known from neighboring Andrews, Dawson, Martin, and Terry counties in Texas and from Lea and Roosevelt counties, New Mexico. (Degenhart et al. 1996. Amphibians and Reptiles of New Mexico. University of New Mexico Press, Albuquerque, New Mexico. 431 pp.; Dixon 2013, *op. cit.*).

This specimen was collected during research on *Sceloporus arenicolus* with funding from Texas Comptrollers Office and under a Texas Parks and Wildlife Scientific Collecting Permit (SPR-0506-662) issued to TJH.

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***CROTALUS BASILISCUS* (Mexican West Coast Rattlesnake)**. MÉXICO: AGUASCALIENTES: Municipality of Calvillo: 0.5 km SE El Terrero del Refugio (21.863307°N, 102.839317°W; WGS 84), 2278 m elev. 28 August 2013. Rubén A. Carbajal Márquez and Eric A. Rivas Mercado. Verified by J. A. Campbell. University of Texas at Arlington, Department of Biology, Arlington, Texas (UTADC 8484–8486, photographic voucher). First record for Aguascalientes, with the closest known locality being 80 km SSW from 2.25 km N of Santa Rosa, Moyahua de Estrada, Zacatecas (Ahumada-Carrillo et al. 2011. Herpetol. Rev. 42:397–398). The specimen was found DOR in a tropical deciduous forest and oak forest ecotone.

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***CROTALUS TOTONACUS* (Totonacan Rattlesnake)**. MÉXICO: HIDALGO: Municipality of Nicolas Flores: near El Molino (20.882302°N, 99.149187°W; WGS 84), 1715 m elev. 3 October 2013. Jorge Iván Ángeles Escudero and Josefína Ramos Frías. Verified by Norma Manríquez-Morán. Herpetological Photographic Collection, Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo (CH-CIB 05). First record for the municipality, extending the range within Hidalgo ca.14.25 km SW from the closest known locality at Jacala de Ledezma, Municipality of Jacala de Ledezma (Valencia-Hernández et al. 2007. Acta Zool. Mex. 23:3). The snake was found in pine forest. Municipality of Pacula: near Adjuntas (20.948787ºN, 99.236706ºW; WGS 84), 1925 m elev. 12 October 2012. Josefína Ramos Frías and Melany Aguilar López. Verified by Norma Manríquez-Morán. CH-CIB 06-07. First record for the municipality, extending the range within Hidalgo 7.91 km SE from the closest known locality at Jacala de Ledezma, Municipality of Jacala de Ledezma (Valencia-Hernández et al. 2007, *op. cit.*). It is also the highest elevational record for the species; *C. totonacus* was known previously to occupy elevations up to 1800 m (Valencia-Hernández et al. 2007, *op. cit.*). The snake was found during midday on the ground in oak forest containing secondary vegetation.

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***HELICOPS TRIVITTATUS* (Striped Water Snake)**. BRAZIL: AMAPÁ: Municipality of Macapá: Area de Proteção Ambiental do Curiaú (0.150194°N, 51.038472°W; WGS 84). 11 March 2015. D. S. Oliveira, A. V. Silva, R. C. Santos, J. V. M. Barriga, R. C. Gabrield, and C. E. Costa-Campos. Verified by G. S. Anjos. Herpetology Collection of Universidade Federal do Amapá, Macapá, Amapá, Brazil (CECCAMPOS 1193). *Helicops trivittatus* is previously known from northcentral Brazil from the lower portion of the Amazon and the Araguaia-Tocantins and Xingú rivers in the states of Pará, Mato Grosso, Tocantins, western Maranhão, and probably Amapá (Prudente and Santos-Costa 2005. Bol. Mus. Para. Emílio Goeldi Cienc. Nat. 1:203208; Rossman 2010. Bol. Mus. Para. Emílio Goeldi Cienc. Nat. 5:271278). This specimen (545 mm SVL) represents the first state record, extending the range 265 km NW from the municipality of Cachoeira do Arari, Pará state. Specimen collected in an approved ICMBio permit (#48102-1).

DEISIELE S. OLIVEIRA (e-mail: deisieleoliveira2013@gmail.com), **ADERALDO V. SILVA**, **RAFAEL C. SANTOS**, **JÉSSICA V. M. BARRIGA**, **RAVI C. GABRIEL**, and **CARLOS E. COSTA-CAMPOS**, Laboratório de Herpetologia, Departamento de Ciências Biológicas e da Saúde, Coordenação de Ciências Biológicas, Universidade Federal do Amapá, Campus Marco Zero, 68.903-419, Macapá, AP, Brazil.

***HETERODON SIMUS* (Southern Hog-nosed Snake)**. USA: FLORIDA: Hamilton Co.: County Road 249 (30.45916°N, 83.06802°W; WGS 84). 16 October 2014. Jonathan D. Mays. Verified by Kenneth L. Krysko. Florida Museum of Natural History (UF 174564). First

record for the county (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final report, Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida. 524 pp.). Adult male found DOR.

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***INDOTYPHLOPS BRAMINUS* (Brahminy Blindsnake; Culebra Ciega)**. HONDURAS: ATLÁNTIDA: Salada Barro, Cuero y Salado Wildlife Refuge (15.76668°N, 86.983606°W; WGS 84), 5 m elev. 5 December 2012. James R. McCranie and Leonardo Valdés Orellana. Verified by José Rosado. Museum of Comparative Zoology (MCZ R-191073, 191076–84). First records of this introduced species from Atlántida, with the nearest known mainland locality located ca. 120 km SW in San Pedro Sula, Cortés (McCranie et al. 2014. Herpetol. Rev. 45:285). The species has also been reported from Isla de Utila, Islas de la Bahía, Honduras (Vesely and Köhler 2009. Herpetol. Rev. 40:116). The snakes were below root systems of dead coconut palm stumps. Other uncollected individuals of *I. braminus* were also observed at the site, which indicates a well-established breeding population. We thank Lic Anuar for providing lodging and field assistance during our visit to Salada Barro. This specimen was collected under approved permits (DICTAMEN-ASG-ICF-135-2012, RESOLUCION-DE-MP-102-2012).

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***MALAYOPYTHON RETICULATUS* (Reticulated Python)**. PHILIPPINES: ROMBLON PROVINCE: TABLAS ISLAND: Municipality of Odiongan: Barangay Taboboan (12.355036°N, 121.993219°E; WGS 84). 17 December 2014. Emerson Y. Sy. Verified by Arvin C. Diesmos. Lee Kong Chian Natural History Museum, National University of Singapore (ZRC [IMG] 2.247 a–b, photographic voucher). Live specimen (137 cm total length) donated to the Herpetology Section of the National Museum of the Philippines. First record for Tablas Island and Romblon Province. This is a widespread species in Southeast Asia and within the Philippines and is known from Basilan, Bohol, Bongao, Catanduanes, Cebu, Itbayat, Jolo, Leyte, Luzon, Masbate, Mindanao, Mindoro, Negros, Palawan, Panay, Polillo, Samar, Siasi, Sibutu, and Tawi-Tawi (Leviton 1963. Proc. California Acad. Sci. 31:369–416; Ross and Gonzales 1992. Nat. Museum Papers 2:50–76; Gaulke 1994. Herpetol. J. 4:136–144; Gaulke and Altenbach 1994. Herpetozoa 7:63–66; O'Shea and Lazell 2008. Herpetol. Rev. 39:486)

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***NERODIA SIPEDON PLEURALIS* (Midland Water Snake)**. USA: OKLAHOMA: Wagoner Co.: Lake Fort Gibson (35.950373°N, 95.329828°W; WGS 84). 5 November 1978. R. Jackson. Verified by S. E. Trauth. Arkansas State University Museum of Zoology, Herpetological Collection (ASUMZ 33334). New county record (Oklahoma Biological Survey, Distribution of Oklahoma Amphibians and Reptiles by Recorded Sightings [DOKARRS Search], http://www.biosurvey.ou.edu/dokarrs_srch.html; Sam Noble Oklahoma Museum of Natural History Reptile Database [SNOMNH Search], http://www.snomnh.ou.edu). Additional *N. s. pleuralis* from the state, housed in the SNOMNH, are from adjacent Cherokee, Mayes, and Muskogee counties. Specimen previously collected and cataloged into the ASUMZ without permit information.

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***OPHEODRYS AESTIVUS* (Rough Greensnake)**. USA: ARKANSAS: Boone Co.: town of Zinc, 18.5 km NE of Harrison (36.2825°N, 92.9102°W; WGS84), 272 m. elev. 30 August 2013. John G. Phillips. Verified by Stan E. Trauth. Arkansas State University Museum of Zoology (ASUMZ 33330, photo voucher]). New county record (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville, Arkansas. 421 pp.). This specimen fills in a gap between Carroll and Marion counties in Arkansas and Taney Co., Missouri to the north (Johnson 2000. The Amphibians and Reptiles of Missouri. Missouri Deptment of Conservation, Jefferson City, Missouri. 400 pp.). Specimen found crossing a road. To my knowledge *O. aestivus* has not been recorded in Newton Co. to the south. I thank Kelly J. Irwin for consultation regarding this specimen.

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***OPHIOPHAGUS HANNAH* (King Cobra)**. PHILIPPINES: LEYTE ISLAND: LEYTE PROVINCE: Municipality of Palo: Barangay Barayong (11.195522°N, 124.982578°E; WGS 84) 20 m elev. 25 August 2010. Ronny Boos. Verified by Indraneil Das. Photographic voucher, Lee Kong Chian Natural History Museum, National University of Singapore, (ZRC[IMG] 2.246a–c). First known record for Leyte Island.

EMERSON Y. SY, Philippine Center for Terrestrial and Aquatic Research, 1198 Benavidez Street, Unit 1202, Tondo, Manila, Philippines (e-mail: emersonsy@gmail.com); **RONNY BOOS**, Malaki Subdivision, Purok 3, Barangay 91, Abucay, 6500 Tacloban City, Leyte, Philippines (e-mail: ronnydiba@yahoo.de).

***OPHIOPHAGUS HANNAH* (King Cobra)**. PHILIPPINES: LUZON ISLAND: PANGASINAN PROVINCE: Municipality of Agno: Barangay Gayusan (16.04046°N, 119.78103°E; WGS 84) 31 m elev. 19 October 2014. Emerson Y. Sy. Verified by Indraneil Das. Photographic voucher, Lee Kong Chian Natural History Museum, National University of Singapore (ZRC[IMG] 2.243a–b). Total length ca. 244 cm. First provincial record. Previously recorded on Luzon in the following provinces: Aurora, Benguet, Bulacan, Isabela, Laguna, and Zambales (Devan-Song and Brown 2012. Asian Herpetol. Res. 3:1–20; Leviton et al. 2014. *In* Williams and Gosliner [eds.], The Coral Triangle: The 2011 Hearst Philippine Biodiversity Expedition, pp. 473–530. California Academy of Sciences, San Francisco, California).

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ogy Division, National Museum of the Philippines, Padre Burgos Avenue, Ermita 1000, Manila, Philippines (e-mail: arvin.diesmos@gmail.com).

***PANTHEROPHIS EMORYI* (Great Plains Ratsnake)**. MÉXICO: HIDALGO: Municipality of Tecozautla: District of La Metralla, Tecozautla (20.534278°N, 99.633944°W; WGS 84), 1185 m elev. 24 July 2014. Rafael Alejandro Calzada-Arciniega. Verified by Uri Omar García Vázquez. Museo de Zoología "Alfonso L. Herrera," Facultad de Ciencia, Universidad Nacional Autónoma de México, Ciudad de México, México (MZFC 28742). First municipality record and westernmost record in Hidalgo, extending the known range of the species 22.21 airline km SW from the closest known locality at Yetai (Yethay), Zimapán, Hidalgo (Ramírez-Bautista et al. 2010. Lista Anotada de los Anfibios y Reptiles del Estado de Hidalgo, México. Univ. Autón. Edo. de Hidalgo, CONABIO. 104 pp.). The snake was found on a stone street near downtown Tecozautla. The snake was collected under a permit issued by SEMARNAT (FAUT-0093) to Adrián Nieto Montes de Oca.

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***PANTHEROPHIS SPILOIDES* (Gray Ratsnake)**. USA: TENNESSEE: Lincoln Co.: 195 Bridlewood Drive (35.086744°N, 86.582738°W; WGS 84). 7 August 2014. Joshua Kee. Verified by A. F. Scott. Austin Peay State University (APSU 19508, photographic voucher). New county record (Scott and Redmond 2008 [latest update: 9 January 2015]. Atlas of Reptiles in Tennessee. Available at http://apsu.edu/reptatlas/, accessed 28 January 2015). Adult male found beside residential driveway beside hardwood forest.

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***PITUOPHIS MELANOLEUCUS MUGITUS* (Florida Pinesnake)**. USA: FLORIDA: Hamilton Co: Suwannee Ridge Mitigation Park Wildlife and Environmental Area (30.44366°N, 83.04613°W; WGS 84). 7 April 2014. Kevin M. Enge. Verified by Kenneth L. Krysko. Florida Museum of Natural History (UF 173276, photographic voucher). First voucher for the county (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final report, Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida. 524 pp.). Adult male (1240 mm SVL) trapped by a drift fence installed in sandhill habitat.

KEVIN M. ENGE (e-mail: kevin.enge@myfwc.com), **JONATHAN D. MAYS**, and **CODY D. GODWIN**, Florida Fish and Wildlife Conservation Commission, 1105 S.W. Williston Road, Gainesville, Florida 32601, USA.

***REGINA GRAHAMAE* (Graham's Crayfish Snake)**. USA: TEXAS: Rockwall Co.: 0.08 rd km W of jct John King Blvd on FM 552 (32.965625°N, 96.453362°W; WGS 84). 21 May 2013. Connor S. Adams. Verified by James R. Dixon. Biodiversity Research and Teaching Collections (TCWC 97655). New county record (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 447 pp.). This species is known from neighboring Collin, Dallas, Hunt, and Kaufman counties, Texas (Dixon

2013, *op. cit)*. Specimen collected under a Texas Parks and Wildlife Scientific Collecting Permit (SPR-0506-662) issued to TJH.

TOBY J. HIBBITTS (e-mail: thibbitts@tamu.edu) and **CONNOR S. ADAMS**, Texas Cooperative Wildlife Collections, Department of Wildlife and Fisheries Sciences, Texas A&M University, 2258 Tamu, College Station, Texas 77843-2258, USA.

***SISTRURUS TERGEMINUS EDWARDSII* (Desert Massasauga)** USA: TEXAS: Presidio Co.: Found DOR on U.S. Hwy 90, 17.3 km SE of Valentine on Ryan Flat (30.48109°N, 104.36359°W; WGS 84). 9 August 2014. S. Graham and C. Kelehear. Verified by Harry W. Greene. Sul Ross State University (SRSU 6616). New county record (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 447 pp.). Specimen collected under a Texas Parks and Wildlife Scientific Collecting Permit (SPR-0714-119) issued to SPG.

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***SONORA SEMIANNULATA* (Western Groundsnake)**. USA: TEXAS: Andrews Co.: 21.6 air km S and 15 air km W Andrews (32.11950°N, 102.70708°W; WGS 84). 15 June 2012. Toby J. Hibbitts. Verified by James R. Dixon. Biodiversity Research and Teaching Collections (TCWC 97154). New county record (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 447 pp.). Known from neighboring Midland Co. in Texas and from Lea Co., New Mexico (Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. University of New Mexico Press, Albuquerque, New Mexico. 431 pp.; Dixon 2013, *op. cit.*).

This specimen was collected during research on *Sceloporus arenicolus* with funding from Texas Comptrollers Office and under a Texas Parks and Wildlife Scientific Collecting Permit (SPR-0506-662) issued to TJH.

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***TANTILLA VERMIFORMIS* (Hallowell's Centipede Snake)**. GUATEMALA: ZACAPA: Municipality of Cabañas: Reserva Natural para la Conservación del Heloderma y el Bosque Seco, 4 km W of El Arenal (14.862970°N, 89.788197°W; WGS 84), 590 m elev. 2 May 2014. Daniel Ariano-Sánchez. Verified by Jonathan Campbell. Colecciones Biológicas de la Universidad del Valle de Guatemala, Ciudad de Guatemala, Guatemala (UVG 7000). First record for this species from Guatemala, and a range extension of ca. 127 km N from nearest known locality in the vicinity of Sonsonate, El Salvador (Wilson 1999. Smithson. Herpetol. Info. Serv. 122:134; Köhler 2008. Reptiles of Central America, 2nd ed. Herpeton Verlag, Offenbach, Germany. 400 pp.; Wilson and Johnson 2010. *In* Wilson et al. [eds.], Conservation of Mesoamerican Amphibians and Reptiles, pp. 32235. Eagle Mountain Publishing, Eagle Mountain, Utah). This record joins a list of other recent range extensions that came from Reserva Natural para la Conservación del Heloderma y el Bosque Seco supporting its relevance for conservation of the dry forest herpetofauna of Guatemala (Ariano-Sánchez et al. 2010. Herpetol. Rev. 41:107; Ariano-Sánchez and Dix 2010. Herpetol. Rev. 41:505). The adult female was found

crawling across a sandy clearing at 2300 h within seasonally dry tropical forest. I thank the students of General Ecology course at Universidad del Valle de Guatemala who showed me the unregistered trail passing through the forest where the snake was discovered. ZOOTROPIC and CONAP (033/2014) provided permits to conduct scientific research at the reserve.

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***THAMNOPHIS RADIX* (Plains Gartersnake)**. USA: NEBRASKA: Thomas Co.: NE Hwy 2, ca. 2.2 rd km W jct Spur 86B (41.91366°N, 100.32042°W; WGS 84). 20 October 2014. Drew R. Davis and James W. Stewart. Verified by Travis J. LaDuc. Texas Natural History Collections (TNHC 93510). New county record (Ballinger et al. 2010. Amphibians and Reptiles of Nebraska. Rusty Lizard Press, Oro Valley, Arizona. 400 pp.; Fogell 2010. A Field Guide to the Amphibians and Reptiles of Nebraska. University of Nebraska-Lincoln, Lincoln, Nebraska. 158 pp.). Adult female (574 mm SVL; 151 mm tail length; 92.76 g) collected DOR along highway running along N boundary of the Nebraska National Forest, Bessey District. This species is known from the surrounding counties (Cherry, Blaine, Logan, McPherson) except directly to the west in Hooker County, Nebraska (Ballinger et al. 2010, *op. cit.*; Fogell 2010, *op. cit.*). The nearest known specimen is from ca. 23 km to the NE from northwest Blaine Co., Nebraska (University of Nebraska State Museum [UNSM] 9298). Specimen collected under a Nebraska Game and Parks Commission Scientific and Educational Permit (#472) issued to DRD.

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***TRILEPIDA KOPPESI* (Amaral's Blind Snake)**. BRAZIL: MINAS GERAIS: Municipality of Governador Valadares: São Manoel Island (19.01°S, 42.11°W; SAD 69), 181 m elev. 19–23 December 2008. R. Filogonio and M. A. S. Canelas. Verified by V. Germano. Museu de Ciências Naturais, Pontifícia Universidade Católica de Minas Gerais, Belo Horizonte, Minas Gerais (MCNR 3294–3296). *Trilepida koppesi* is known from Mato Grosso do Sul (Parnaíba and Terenos), Goiás (Mineiros), São Paulo (Mogi-Guaçú, Brotas, Itirapina, and Pirassununga), and Tocantins (Palmas) states (Passos et al. 2006. Amphibia-Reptilia 27:347–357; Pinto and Fernandes 2012. Copeia 2012:37–48). First state record that increases the known distribution ca. 624 km (airline) NE of Mogi-Guaçú, ca. 1100 km E of Mineiros, and is the closest record to the litoral. Permits were issued by Instituto Brasileiro do Meio Ambiente e Recursos Naturais Renováveis (IBAMA) under licenses nº141/2008 NUFAS/MG Process IBAMA nº02015.011675/2007-25, and nº516/2009 NUFAS/MG Process IBAMA nº02015.011675/2007-26.

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***TRIMERESURUS FLAVOMACULATUS* (Philippine Pitviper)**. PHILIPPINES: BILIRAN ISLAND: Biliran Province: Municipality of Almeria, Barangay Sampao (11.607286°N, 124.440411°E; WGS 84). Ronny Boos. Verified by Arvin C. Diesmos. 22 November 2014. Photographic voucher, Lee Kong Chian Natural History Museum, National University of Singapore, (ZRC[IMG] 2.242a–c). First record for Biliran Island. Previously recorded on Babuyan Claro, Bohol, Calayan, Camiguin, Camiguin Norte, Catanduanes, Dalupiri, Dinagat, Jolo, Leyte, Luzon, Mindanao, Mindoro, Negros, Panay, Polillo, and Siquijor (Ross and Gonzales 1992. Nat. Mus. Pap. 2:50–76; Beukema 2011. Herpetol. Notes 4:177–179; Oliveros et al. 2011. Sci. Pap. 43:1–20; Leviton et al. 2014. *In* Williams and Gosliner [eds.], The Coral Triangle: The 2011 Hearst Philippine Biodiversity Expedition, pp. 473–530. California Academy of Sciences, San Francisco, California).

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***TRIMORPHODON LAMBDA* (Sonoran Lyresnake)**. USA: ARIZONA: Mohave Co.: private residence on Candlewood Dr. in Lake Havasu City (34.4523°N, 114.2745°W; WGS 84). 14 October 2014. Daniel J. Leavitt. Verified by Brian K. Sullivan. Arizona State University (ASU 36011). This specimen represents a 100 km range extension that had been speculated by Brennan and Holycross (2006. Amphibians and Reptiles in Arizona. Arizona Game and Fish Department, Phoenix, Arizona. 150 pp.). Specimen found indoors, under a pet dog's bedding, with head trauma resulting in death shortly thereafter.

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New Distributional Records of Amphibians and Reptiles from Nayarit, México

The herpetofauna of Nayarit has received less consideration when compared to most other Mexican states (Flores-Villela et al. 2004). To date, 37 species of amphibians (Luja et al. 2014) and 88 of reptiles (Flores-Villela and García-Vázquez 2014) have been documented from the state. Other studies listing species from Nayarit include: Lewis and Johnson (1955), Zweifel (1959, 1960), McDiarmid (1963), McDiarmid et al. (1976), Casas-Andreu (1992), Canseco-Márquez et al. (2007), de la Torre et al. (2010), and Ahumada-Carrillo et al. (2013). In order to contribute further to the knowledge of the herpetofauna of Nayarit, we conducted field surveys in several locations within the state from 2011 to 2014. Herein we present four accounts for species new to Nayarit; five first municipality records, one of which is for a species previously feared to be extinct; and one other significant range extension. All animals were photographed by V. H. Luja, unless otherwise noted. Voucher specimens were placed in the Museo de Zoología "Alfonso L. Herrera," Facultad de Ciencias, Universidad Nacional Autónoma de México, Ciudad de México, México (MZFC), and photographs of specimens not collected are in University of Texas at Arlington Digital Photograph Collection, Arlington, Texas (UTADC). Locality coordinates were taken with a GPS device using map datum WGS84. Common English names follow Liner and Casas-Andreu (2008).

CAUDATA — SALAMANDERS

***AMBYSTOMA ROSACEUM* (Tarahumara Salamander).** Municipality of Del Nayar: La Cascada, 1.4 km SW Santa Teresa. (22.485653°N, 104.772542°W), 2085 m elev. 22 February 2014. V. H. Luja. Verified by L. Canseco-Márquez. UTADC 8102. First municipality record, filling a distribution gap of 245 km between El Salto, Durango (KU 69268), and Sierra de Alica, Nayarit (Canseco-Márquez et al. 2007). The two larvae were found in a stream passing through a mixture of grassland and pine-oak forest. CIG found an adult in the same municipality in 2008; its unique coloration helped confirm identity of the larvae.

ANURA — FROGS

***PLECTROHYLA BISTINCTA* (Mexican Fringe-limbed Treefrog).** Municipality of Xalisco: Rancho La Noria, 9 km W Tepic (21.483444°N, 104.999028°W), 1546 m elev. 19 July 2013. V. H. Luja. Verified by E. Pérez-Ramos. MZFC 28147, 28166–67. First municipality record, filling a distribution gap of 195 km between Santa Teresa, Nayarit (Duellman 2001) and La Estancia, Jalisco (Reyes-Velasco et al. 2012). Seventy eggs, four adults, and dozens of tadpoles were found in an artificial pond in an ecotone between cloud forest and oak forest. A second population was discovered on 27 September 2013 in the same municipality at El Cuarenteño (21.448889°N, 105.0365830°W), 920 m elev., where 25 juveniles were found on coffee plants alongside a stream.

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SQUAMATA — LIZARDS

***SCELOPORUS POINSETTII* (Crevice Spiny Lizard).** Municipality of Del Nayar: Cerro Sagrado, 1.3 km NE Santa Teresa (22.5077°N, 104.758419°W), 2205 m elev. 22 February 2014. V. H. Luja. Verified by C. J. Franklin. UTADC 8101, 8103. First state records, which fill a 410-km gap in the known distribution between Rancho Las Margaritas, Durango, and Rincon de Manantlán, Sierra de Manantlán, Jalisco (Webb 2006). The lizards were found in the morning under rock piles in pine-oak forest.

***ELGARIA KINGII* (Madrean Alligator Lizard).** Municipality of Xalisco: Sierra San Juan: El Cuarenteño (21.44889°N, 105.036583°W), 920 m elev. 27 September 2013. V. H. Luja. Verified by L. Canseco-Márquez. UTADC 8104. First municipality record and second for the state, extending the known range ca. 78 km W from the Sierra de Alica (Canseco-Márquez et al. 2007). The lizard was found on leaf litter in a coffee plantation. Municipality of Tepic: Km 7 on the road to Rancho La Noria, Sierra San Juan (21.499956°N, 104.988647°W), 1472 m. elev. 6 December 2013. V. H. Luja. Verified by J. Reyes-Velasco. UTADC 8131. First municipality record; the closest known locality is at Sierra de Alica, which lies 75 km to the east. The lizard was found DOR in an ecotone between pine-oak and tropical deciduous forest.

SQUAMATA — SNAKES

***CROTALUS CAMPBELLI* (Campbell's Dusky Rattlesnake).** Municipality of Xalisco: Sierra San Juan (21.4450°N, 104.980514°W), 2010 m elev. 6 October 2013. Victor H. Luja. Verified by Jacobo Reyes-Velasco. UTADC 8108. First record for Nayarit, extending the known range 100 km NNW from Lago de Juanacatlán, Municipality of Mascota, Jalisco (Bryson et al. 2014). The snake was found during the day in a rocky pine-oak forest containing an abundance of ferns.

***GEOPHIS DUGESI* (Dugès' Earth Snake).** Municipality of Tepic: Sierra San Juan (21.497067°N, 104.988494°W), 1522 m elev. 24 July 2013. V. H. Luja. Verified by E. Pérez-Ramos. MZFC 28171. First record for Nayarit, extending the known range ca. 86 km NNW of an unpublished record at 22.4 km NW of Mascota, Jalisco (KU 110100) and ca. 240 km SSE from 19.2 km NE of Santa Lucia, Sinaloa, which was tentatively assigned to this species by Hardy and McDiarmid (1969) and validated by Webb (1976).

PHOTO BY CHRISTOPH I. GRÜNWALD



FIG. 1. Adult *Thamnophis rossmani* observed 3 km S of Pantanal, Xalisco, Nayarit, Mexico on 10 July 2011. This is the first photograph of a live specimen, and first reported observation since 1969.

The snake was found in a rocky shaded area in an ecotone between pine forest and tropical deciduous forest.

***RHADINAEA HESPERIA* (Western Graceful Brown Snake).** MUNICIPALITY OF XALISCO: Rancho La Noria, Sierra San Juan (21.497067°N, 104.995464°W), 1607 m elev. 15 September 2012. V. H. Luja. Verified by J. Reyes-Velasco. UTADC 8105. First municipality record, and westernmost record in Nayarit, extending the known range in the state ca. 80 km W of road from Huajimic to Guadalupe Ocotlán in the Sierra de Alica (Canseco-Márquez et al. 2007). There are two other unpublished records for Nayarit, one from the southeastern slope of a high ridge north of the village of Mesa del Nayar, on road to Santa Teresa (CAS 169688), and another from 22.3 mi (35.59 km) SE of Tepic along Mex. Hwy 15 (LACM 103653). The Rancho La Noria snake was found in the morning moving on leaf litter in a pine-oak forest.

***RHADINAEA TAENIATA* (Pine-Oak Snake).** MUNICIPALITY OF TEPIC: Road to Rancho La Noria, Sierra San Juan (21.497833°N, 104.989142°W), 1500 m elev. 6 December 2013. V. H. Luja. Verified by I. Ahumada-Carrillo. UTADC 8106. First record for Nayarit and northernmost record for the species, representing a range extension of ca. 222 km NNW from La Joya, Sierra Manantlán, Jalisco (Orozco-Uribe 2009). The snake was found DOR in pine-oak forest.

***STORERIA STORERIOIDES* (Mexican Brown Snake).** MUNICIPALITY OF XALISCO: Sierra San Juan (21.454628°N, 104.997947°W), 1479 m elev. 6 October 2013. V. H. Luja. Verified by I. Ahumada-Carrillo. UTADC 8107. First published record for Nayarit, filling a distributional gap of ca. 380 km in its known range between 19.2 km NE of Santa Lucia, Sinaloa (Hardy and McDiarmid 1969), and 14.48 km E of Talpa de Allende, Jalisco (Ernst 2008). There are two unpublished records from Nayarit, one from near Cueva de Las Guacamayas, ca. 10 km E of Lagunitas (UAZ 26389), which is located east of Huajicori, and the other is from the crest of a high ridge north of the village of Mesa del Nayar, on road to Santa Teresa (CAS 169689); the record reported herein lies ca. 144 km S and 92 km SSW, respectively, of those localities. The snake was found under a rock in pine forest.

***THAMNOPHIS ROSSMANI* (Rossman's Garter Snake).** MUNICIPALITY OF XALISCO: 3 km S of Pantanal. (21.409086°N, 104.409086°W), 921 m elev. 10 July 2011. C. I. Grünwald, J. M. Jones, and L. Gallegos-Roman. Verified by Douglas Rossman. UTADC 8122 (Fig. 1). First record for the municipality and first rediscovery since 1969 (Conant 2000) for this imperiled species that apparently is restricted to the San Cayetano Valley of southeastern Nayarit. The snake was found under a piece of trash in a marshy area after searching about 20 minutes; the habitat has been heavily altered by anthropogenic activity.

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Artist Amy Gross

The Isla San Marcos Night Snake (*Hypsiglena marcosensis*) is a rarely observed island endemic known only from Isla San Marcos in the Gulf of California. **Amy H. Gross** painted this species for the San Diego Natural History Museum's (SDNHM) *Amphibian and Reptile Atlas of Peninsular California*. The SDNHM is both a museum and a prolific research facility with working scientists. These scientists work in the Biodiversity Research Center of the Californias (BRCC) through which they conduct field research in southern California and throughout Baja California, Mexico, among other regions. The *Amphibian and Reptile Atlas* is a joint project between scientists at the SDNHM and institutions in Baja California, Mexico, funded by the Institute for Museum and Library Services. It is a growing atlas that uses data collected by museum scientists and the contributing public to better understand the biodiversity of the southern California and Baja California region: http://herpatlas.sdnhm.org/.

Amy helped contribute to the atlas by creating artistic renderings of rare species that either lacked accurate photographs or have never been photographed at all. She digitally painted the Isla San Marcos Night Snake in Adobe Photoshop. The painting process involved using photo references of closely related species and working with descriptions of the Isla San Marcos Night Snake in order to paint a true representation of the species.

Amy initially studied Wildlife Studies at Humboldt State University, but then switched majors to pursue an Art degree. After studying Fine Art Reproduction at a forgery studio in Italy, Amy returned to San Diego and decided to combine her passions in order to become a Scientific Illustrator. She's currently a freelance illustrator and continues to contribute paintings to the SDNHM Reptile and Amphibian Atlas. She also works in the museum's education department, teaching children and adults alike about the importance of our natural world.

Amy can be contacted about commissions through her website: www.amyhgross.com.

NATURAL HISTORY NOTES

CAUDATA — SALAMANDERS

***DESMOGNATHUS FUSCUS FUSCUS* (Northern Dusky Salamander). LARVAL ATTENDANCE.** *Desmognathus fuscus* is a semi-aquatic plethodontid salamander that oviposits in or near water, where aquatic larvae develop. Attendance of eggs by females is well-documented as a vital behavior for successful reproduction in this species; clutches are rarely abandoned, as this frequently results in complete failure (Hom 1987. Copeia 1987:768–777). Female attendance of eggs is expected in plethodontid species that can oviposit terrestrially (Wells. 2007. The Ecology and Behavior of Amphibians. University of Chicago Press, Chicago, Illinois. 1148 pp.). When offspring are direct-developing, such as in *Plethodon cinereus* (Eastern Red-backed Salamander), females have been observed remaining in nest sites with juveniles for weeks (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington and London. 587 pp.). In species with aquatic larvae like *D. fuscus*, females may remain in terrestrial nests for a few days after clutches hatch, before the larvae move to water (Juterbock 1987. Herpetologica 43:361–368; Wells 2007, *op. cit*). This note expands the time period and role of attendance to aquatic larvae in Plethodontids that can oviposit terrestrially, with further observations of female *D. fuscus* and their larvae remaining in nest sites.

Two nests of *D. fuscus* were observed along the dry headwaters of Bower's Spring, Worcester Co., Massachusetts, USA (42.4673°N, 71.6051°W, WGS84). The first nest was found on 4 October 2014, as the clutch was hatching, under a small moss mat overhanging the damp run bed. From 7–9 October 2014, the female and at least 10 larvae were visible in this nest each day, generally in close contact. One larva was unearthed in the mud below the nest on 9 October 2014. On 10 October 2014 the female was barely responsive and dry to the touch; 8 larvae remained in the nest, but appeared to be dispersing rather than grouped as previously observed. A second nest was found slightly downstream on 9 October 2014, under a small log in the mud of the stream bed. When uncovered, a female was standing over the majority of her larvae, facing a *Eurycea bislineata* (Northern Two-lined Salamander) at the back of the nest (Fig. 1). Thirteen larvae were counted after both adult salamanders fled. By 10 October 2014 the female had returned, and 13 larvae were again observed. On the morning of 11 October 2014, both females from the above observations were absent from their nests. No larvae remained in the first nest; 13 were seen in the second, about half of which had begun to burrow into the mud. Female plethodontids may coil around eggs laid terrestrially, to help prevent desiccation (Wells 2007, *op. cit.*). The preceding observations are consistent with the possibility that female*s* may also use physical contact to help prevent the desiccation of aquatic larvae hatched in terrestrial nests, when water is not available.



FIG. 1. *Desmognathus fuscus* with developing larvae.

Larval attendance may also be exhibited by *D. fuscus* nesting in aquatic sites. On 29 October 2014, in the headwaters of an unnamed hillside spring 2.4 km from Bower's Spring (42.4645°N, 71.5759°W; WGS84), a female was found under a rock in a few cm of water with an aquatic larva (total length = 2.4 cm) adhered dorsolaterally above her rear leg. Another adult *D. fuscus* was present in the water at the edge of the cover rock. This observation, in addition to adult *E. bislineata* frequently seen approaching *D. fuscus* larvae at Bower's Spring, are consistent with the possible anti-predatory function of larval attendance. The observations in this note extend the period of aquatic larval parental care observed in *D. fuscus* from a few days to over one week, in the absence of water. The scope of larval attendance is also expanded to potentially include aquatic nest sites (Wells 2007. *op. cit*). Repeated observations of the brooding of aquatic larvae are useful to inform and motivate future studies.

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***DESMOGNATHUS QUADRAMACULATUS* (Black-bellied Salamander). PREDATION.** Trout are known predators on the various life stages of salamanders (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Inst. Press, Washington DC. 587 pp.) and, in some cases, there are strong interactions between trout species and salamanders that can influence co-occurrence within streams (Resetarits 1997. Ecology 72:1782–1793). Most literature reporting these interactions focus on *Oncorhynchus mykiss* (Rainbow Trout) and two salamander species (e.g., *Ambystoma macrodactylum* and *A. gracile*, reviewed by Dunham et al. 2004. Fisheries 29:18–26) from the Western United States.

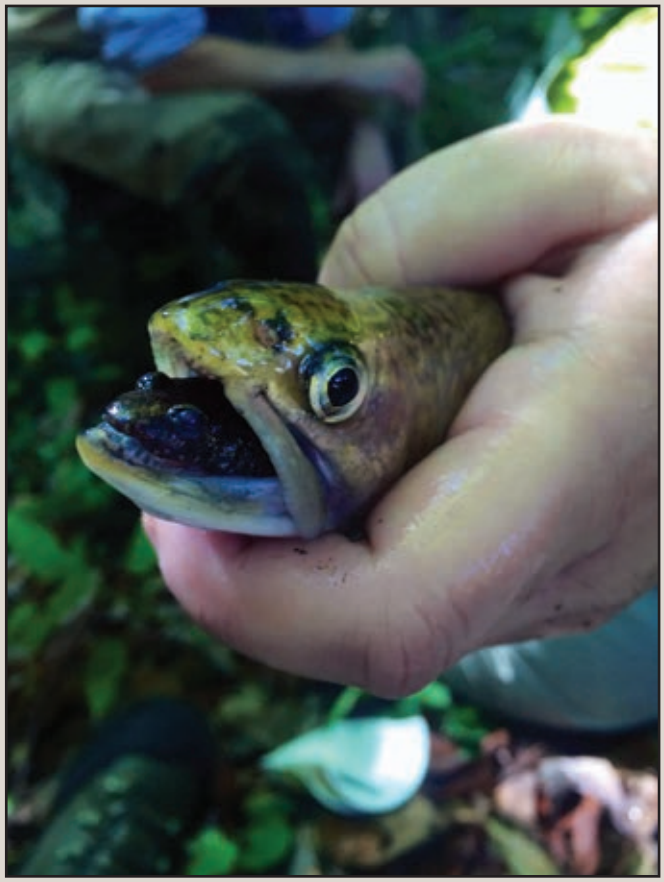


FIG. 1. Predation of an adult salamander *Desmognathus quadramaculatus* by an adult *Salvelinus fontinalis*.

On the afternoon of 08 October 2014, an adult *Salvelinus fontinalis* (Brook Trout; total length = 19.69 cm) was captured via electrofishing in Left Prong Hampton Creek in Carter Co., Tennessee, USA (36.1467°N, 82.0491°W, WGS84; 983 m elev.) with an adult *Desmognathus quadramaculatus* (total length = 10.80 cm) protruding from its mouth (Fig. 1). The salamander was desceased (photo voucher APSU 19530) and its tail was partially digested; therefore, the predation event preceeded our disturbance of the aquatic habitat and this event should be considered natural. This report is the first confirmed predation on *D. quadramaculatus* by *S. fontinalis* (Petranka 1998, *op. cit.*). However, because the elevational distribution of *D. quadramaculatus* (341–1829 m elev.; Dodd 2004. The Amphibians of Great Smoky Mountains National Park. University of Tennessee Press, Knoxville, Tennessee. 283 pp.) overlaps with both *S. fontinalis* and the introduced *O. mykiss* in the southern Appalachian Mountains, our finding is probably more common than reported in the literature.

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***HEMIDACTYLIUM SCUTATUM* (Four-toed Salamander). POLYEMBRYONY.** Polyembryony in amphibians has been examined in vitro, but rarely observed in situ, especially in caudates. Natural observations of twinning in *Ambystoma tigrinum*, as three polyembryonic eggs, each containing two embryos, were observed from 1987–1988 (Lindberg 1995. Herpetol. Rev. 26:142). However, polyembryony has not been documented in Plethodontid salamanders. We report the first known observation of polyembryony in Plethodontid salamanders and specifically from *Hemidactylium scutatum*.



FIG. 1. Polyembryonic egg of *Hemidactylium scutatum*.

From 2007–2012 we located 369 nests of *H. scutatum* and examined 14,379 eggs from a site in Sullivan Co., Tennessee (36.52266°N, 82.11073°W; WGS84). On 09 April 2011 we found a joint nest with a single female (SVL = 38.7 mm; total length = 88.6 mm) guarding eggs in which one egg had two embryos (Fig. 1) while the remaining 64 eggs in the nest, and all other eggs located at the study site, contained a single embryo. At the time of discovery both embryos appeared to be at Harrison stage 36 (Harrison 1969. Organization and Development of the Embryo. Yale University Press, New Haven, Connecticut. 290 pp.).

The polyembryonic embryos differed in size during development and immediately after hatching (on 10 May 2011), when one embryo was 12.7 mm total length and the other was 13.8 mm. Mean total length from a sample of 12 *H. scutatum* larvae, randomly selected from ~600 larvae collected from 56 nests in 2011, was 13.3 mm (range: 12.1–16.0 mm). All eggs within the nest containing the *H. scutatum* polyembryonic egg hatched within one hour of a rain event. Our observations of *H. scutatum* hatching during this project indicated that most (> 90%) eggs from the same nest hatched within one hour of the first egg hatching. Both larvae from the polyembryonic egg were placed in mesocosm pools after hatching and no additional observations were made.

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***SIREN INTERMEDIA* (Lesser Siren). MASS AESTIVATION AND ARTIFICIAL HIBERNACULA.** *Siren intermedia* is a large (max. recorded length 686 mm) eel-like aquatic salamander distributed across the southeastern United States westward to eastern Texas and the lower Rio Grande Valley and northward through the Mississippi Valley to Illinois and Indiana (Martof 1973. Cat. Amer. Amphib. Rept. 127:1–3; Conant and Collins 1998. A Field Guide to Reptiles and Amphibians: Eastern and Central North America. 3rd ed. Houghton Mifflin Co., Boston, Massachusetts. 616 pp.). *Siren*

intermedia exhibits burrowing behavior during winter periods when temperatures become too low for ectothermic activity and also in response to drought conditions (Cagle and Smith 1939. Copeia 1939:232–233; Gehlbach et al. 1973. Am. Midl. Nat. 89:455–463). Large winter aggregations in northern parts of the species' range have been previously reported (Cagle and Smith 1939. Copeia 1939:232–233; Cockrum 1941. Copeia 1941:265).

Herein we report on a large aggregation of aestivating *Siren intermedia* discovered during an excavation on 18 November 2011 in Kleberg Co., Kingsville, Texas, USA (27.5417°N, 97.8803°W, WGS84). The excavated area was ~ 5 x 6 m and 0.25 m deep (Fig. 1) and had been dry for several months. A total of 73 individuals of varying size and sex were recovered from the site (Table 1). Unfortunately, many of the specimens were dead or had received serious injuries meriting euthanasia. For these specimens, primary sex organs were removed and processed for further study. Sex was not determined for the uninjured individuals that were released ~330 m SSW of the original capture site, in a small pond which during periods of higher rainfall is part of the same wetland area.

TABLE 1. Morphometric data of aestivating *Siren intermedia* from Kleberg County, Texas.
A. Mass data collected from specimens without injuries precluding accurate measurements.

Sex	Body mass (g)				Gonad mass (g)			
	N	Mean	s	Range	N	Mean	s	Range
Male	12	267.56	89.8	290.9	16	0.75	0.4	1.3
Female	6	219.05	33.9	94.2	9	5.13	4.4	14.5
Undetermined	34	186.87	79.8	343.3	–	–	–	–

B. Length data collected from specimens without injuries precluding accurate measurements.

Sex	Snout–vent length (cm)				Total length (cm)			
	N	Mean	s	Range	N	Mean	s	Range
Male	14	33.6	4.6	17.0	12	47.6	5.4	19.0
Female	7	33.0	1.6	5.0	7	44.3	2.7	7.5
Undetermined	34	31.1	4.2	18.8	34	44.2	5.9	23.2



FIG. 1. Excavation site of large aggregation of aestivating *Siren intermedia*. The area was ~ 5 x 6 m and 0.25 m deep.



FIG. 2. Concrete block with aestivating *Siren intermedia*.

The excavated area had several shallow cavities or fissures in which sirens had burrowed. In addition, there were numerous concrete blocks distributed throughout the area that contained sirens. The sirens were utilizing the hollow spaces in the blocks as artificial hibernacula (Fig. 2). We hypothesize that the blocks retained moisture and provided refuge from desiccation as well as predation. This is the first report of a large aggregation of sirens in the southern range of the species and the first report from Texas. In addition, this is the first report of artificial refugia utilized by this species.

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***SIREN INTERMEDIA NETTINGI* (Western Lesser Siren). DIET.** A summary of the natural history and ecology of *Siren intermedia* was provided in a species account (Martof 1973. Cat. Amer. Amphib. Rept. 127.1–127.3); information on its food habits were reported by Davis and Knapp (1953. Copeia 1953:119–121), Scroggin and Davis (1956. Herpetologica 12:231–237), and Altig (1967. Amer. Midl. Nat. 77:239–241). Concerning fish prey, lesser sirens have been reported to feed on minnows (Hurter 1911. Trans. St. Louis Acad. Sci. 20:59–274), been caught on hook and line by anglers using minnows as bait (Goin 1957. Herpetologica 13:37–42; Scroggin and Davis 1953, *op. cit.*), and fish scales have been found in their stomach (Altig 1967, *op. cit.*). Herein we document a noteworthy report of a threatened fish species in the diet of *S. i. nettingi*.

Nineteen juvenile and adult *S. i. nettingi* (mean ± SE SVL = 176.4 ± 59; range = 61–264 mm) were collected between June 1990 and April 1994 with minnow traps, dip nets, or by hand from a small tributary of the Caddo River, located 3.2 km W Caddo Gap off St. Hwy 8, at Caddo Hills High School, Montgomery Co., Arkansas, USA (34.4057°N, 93.6248°W, WGS84). Sirens were euthanized with a dilute chloretone solution and dissected for

analysis of stomach contents. Siren voucher specimens were deposited in the Arkansas State University Museum Herpetological Collection, State University, Arkansas (ASUMZ 16448–49, 16769, 17001, 17300–03, 17489–94, 19573–74). Specimens of darters are deposited in the Southern Arkansas University Fish Collection (SAU), Magnolia, Arkansas.

Six of 19 *S. i. nettingi* contained 18 individual vertebrate prey items in various stages of digestion in their stomachs. All items were subsequently identified as adult *Etheostoma pallididorsum* (Paleback Darter). Larger sirens consumed most of the darters; all (N = 6) sirens containing darters in their stomachs were ≥185 mm SVL whereas no sirens ≤173 mm SVL contained darters. Predator SVL (mm) and respective prey numbers are as follows: 185: 4, 190: 1, 232: 1, 235: 1, 250: 6, and 252: 5. Four female darters in the stomach contents of sirens collected in February 1991 were gravid, containing numerous ripe ova, coinciding with reports of spawning in the species in February and March (Robison and Buchanan 1988. The Fishes of Arkansas. The University of Arkansas Press, Fayetteville, Arkansas. 536 pp.). Of the darters eaten by sirens, 100% were consumed in February and March. The Paleback Darter is a threatened species in the state (listed S2) and is globally listed G2 (http://www.natureserve.com; 28 Jan 2015) due to its limited distribution (four counties) and small population size. Predation by sirens at sites known to support spawning of *E. pallididorsum* should now be considered as a possible negative impact on the species. Recent surveys (B. Crump, pers. comm.) have shown that *E. pallididorsum* still persists at the site herein.

We thank the Arkansas Game & Fish Commission for a Scientific Collecting Permit issued to SET, Jacob Sawyer (ASUMZ) for assistance in necropsies, and Betty Crump (Ouachita National Forest) for information on Paleback Darters.

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ANURA — FROGS

***AGALYCHNIS CALLIDRYAS* (Red-eyed Tree Frog) and *CRUZIOHYLA CALCARIFER* (Splendid Leaf-frog). REPRODUCTIVE BEHAVIOR.** *Cruziohyla calcarifer* is a nocturnal canopy tree frog that can be found in primary lowland forests from Honduras to Ecuador. It is a medium-sized frog (males to 81 mm SVL, females to 87 mm) that reproduces in puddles among large fallen trees (Caldwell 1994. Herpetol. Nat. Hist. 2:57–66). It is an under-studied species because it is nocturnal and favors the canopies, however, habitat destruction, pet trade collecting, and crop spraying are believed to be steadily reducing these primary forest obligates (Coloma et al. 2008. www.iucnredlist.org; 6 Apr 2015). *Agalychnis callidryas* is also a nocturnal tree frog that can be found in lowland and premontane slopes from Mexico to Panama. Males can reach up to 59 mm SVL and females 77 mm (Savage 2002. The Amphibians and Reptiles of Costa Rica. University of Chicago Press, Chicago, Illinois. 934 pp.). It deposits eggs on vegetation overhanging puddles and pools of water (Savage 2002, *op. cit.*). Although it is commonly found in the pet trade, it is known to thrive in secondary forests and areas with some human alteration.



FIG. 1. A male *Agalychnis callidryas* in amplexus with a male *Cruziohyla calcarifer* in Sarapiqui, Costa Rica.

Atypical amplexus has been found repeatedly in anurans, ranging from male-male amplexus (Mollov et al. 2010. Biharean Biologist 4:121–125), interspecific amplexus (Lamb et al. 1990. J. Evol. Biol. 3:295–309), necrogamy (Gomez-Hoyos et al. 2012. Herpetol. Notes 5:497–498), and amplexus with inanimate objects (Streicher 2008. Herpetol. Rev. 39:75). While less common than interspecific amplexus, intergeneric amplexus has been reported in both tropical and temperate species (e.g., Grogan and Grogan 2011. Herpetol. Rev. 42:89–90; Manzano and Corzas 2011. Herpetol. Rev. 42:84; Stynoski et al. 2013. Herpetol. Rev. 44:129–130). As a means of reproductive interference, intergeneric amplexus has been found to have adverse fitness and evolutionary effects for at least one of the species and can lead to sexual exclusion, spatial, temporal, or habitat segregation, changes in life history parameters, and reproductive character displacement (Gröning and Hochkirch 2008. Q. Rev. Biol. 83:257–282). Here, we report amplexus between two male individuals from unrelated taxa.

At ca. 1900 h on 21 April 2013 a male *A. callidryas* was observed in amplexus with a male *C. calcarifer* (Fig. 1) in a private forest in Sarapiqui, Costa Rica (10.4358°N, 84.0445°W, WGS84; 35 m elev.). The frogs were found at the edge of a clearing adjacent to a primary forest that has experienced selective logging within the last 20 years. They were sighted about 2.5 m high on a branch.

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***ANAXYRUS AMERICANUS* (American Toad). ARBOREAL BEHAVIOR.** *Anaxyrus americanus*, a species native to the eastern United States and Canada, is highly terrestrial (Dodd 2013. Frogs of the United States and Canada. Johns Hopkins University Press, Baltimore, Maryland. 962 pp.). Few accounts of arboreal behavior or habitat use have been reported for North American bufonids (but see Kornilev 2007. Herpetol. Rev. 38:319). We made the following observation of arboreal behavior by a juvenile (estimated SVL = 2.5–3.0 cm) *A. americanus* the day after a rain event in a mixed deciduous forest near a stream in central Columbia Co., Pennsylvania, USA (41.0710°N, 76.4080°W; WGS84). At 1400 h on 10 September 2014, a juvenile *A. americanus* retreated from the forest floor to a longitudinal

PHOTO BY MARISA M. BUCKLE.



FIG. 1. American Toad (*Anaxyrus americanus*) suspended within a longitudinal crevice in a White Oak (*Quercus alba*) tree.

crevice approximately 50 cm off of the ground on the external surface of the trunk of a mature White Oak tree (*Quercus alba*). The toad braced itself by pushing its feet against opposing walls of the crevice (Fig. 1). The walls of the crevice were textured due to the tree's bark. The toad had been active on the forest floor and was disturbed by our walking near where it had been originally located. Several other juvenile toads were also observed within the same general area (< 2 m from the tree). Even though we did not approach the tree for at least 30 min. following the initial observation and no attempts were made to capture the toad, the toad remained suspended in the crevice until after we left the area. *Anaxyrus americanus* are known to rely on camouflage and immobility as means of predator avoidance (Dodd 2013, *op. cit.*). The observed toad remained immobile and was well camouflaged in the bark-lined crevice. Additionally, by retreating to a location approximately 50 cm above the forest floor, the toad may avoid common terrestrial predators, such as *Heterodon platirhinos* (Eastern Hog-nose Snakes).

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***ECNOMIOHYLA MIOTYMPANUM* (Small-eared Treefrog) and *INCILIUS CRISTATUS* (Large-crested Toad). HETEROSPECIFIC AMPLEXUS.** Overlap in breeding microhabitat and phenology in anurans can lead to male amplexus of heterospecifics (e.g., Yadav and Yankanchi 2014. Herpetol. Rev. 45:683). This behavior appears to be driven, at least in part, by lack of selectivity in male anurans—even to the point of males amplexing dead conspecifics (e.g., Ayers 2010. Herpetol. Rev. 41:192–193) or inanimate objects (Streicher 2008. Herpetol. Rev. 39:75). Heterospecific amplexus by a male *Ecnomiohyla miotympanum* on a female *Charadrahyla taeniopus* has been previously reported (Luría Manzano and Vázquez Corzas 2011. Herpetol. Rev. 42:84). Here, we report the second known case of heterospecific amplexus by *E. miotympanum*, this time on the rare bufonid *Incilius cristatus*.

On 25 November 2013 at 2150 h, we observed a male *E. miotympanum* engaging in axillary amplexus with a male *I. cristatus* (Fig. 1) at Rancho el Jacal, a private reserve 6.2 km NNE of

PHOTOGRAPH BY ADAM G. CLAUSE



FIG. 1. Heterospecific amplexus between male *Ecnomiohyla miotympanum* and male *Incilius cristatus*.

Atzalán, Municipality of Atzalán, Veracruz, México (19.8437°N, 97.2250°W, WGS84; 1170 m elev.). The frogs were occupying the fringes of a ca. 10-m-diameter side pool of the Río Alceseca, on a sandy/silty substrate in water less than 5 cm deep. The *I. cristatus* male did not appear to be disturbed by the *E. miotympanum*; neither frog moved during the 15 min we observed them. Dozens of *E. miotympanum* were chorusing nearby, and seven adult *I. cristatus* also occupied the pool. Multiple conspecific amplexing pairs of both species were present, and we also noted eggs and/or tadpoles of the two species in the pool.

A photographic voucher was deposited in the Natural History Museum of Los Angeles County (LACM PC 1830) and was verified by Joseph R. Mendelson. We thank Sr. Jacobo Alvarez for land access. Financial support provided by a University of Georgia Presidential Fellowship.

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***ENGYSTOMOPS PETERSI* (Peter's Dwarf Frog). PREDATION.** Spiders and other invertebrates are known predators of anurans. Numerous records of *Ancylometes* sp. (fishing spiders) predating neo-tropical anurans exist (e.g., *Dendrophsophis elegans, D. minutus, D. sarayacuensis, Scinax alter, Smilisca sordida*; Prado and Borgo 2003. Herpetol. Rev. 34:238–239; Menin et al. 2005. Phylomedusa 4:39–47; Toledo 2005. Herpetol. Rev. 36:395–400; Rodrigues and Arruda 2007. Herpetol. Rev. 38:437; Serafim et al. 2007. Herpetol. Rev. 38:437; Dehling 2007. Herpetol. Rev. 38:444). Predation events on members of the genus *Engystomops* by invertebrates and vertebrate species such as bats have been recorded (Gray et al. 1999. Herpetol. Rev. 30:93; Toledo 2005, *op. cit.*; Trillo et al. 2013. J. Evol. Biol. 26:216–222). However, records of predation events on *E. petersi* are lacking. We report here an observation of an *Ancylometes* sp. predating a *E. petersi*.

At 2140 h on 12 June 2012 we observed a spider feeding on an adult *E. petersi* (Fig. 1) near a small, closed canopy stream near the San Antonio Guard Station, Heath River, Madre de



FIG. 1. A Fishing Spider, *Ancylometes* sp., preying on a Peter's Dwarf Frog, *Engystomops petersi*, in Peru.

Dios, Peru (12.66008°S, 68.74042°W, WGS84; 181 m elev.). The individuals were approximately 3 m from the stream on a steep muddy bank. When first observed the frog appeared to be dead and bloated with the spider's fangs piercing its lower abdomen. When approached, the spider behaved defensively by rearing back its front legs and spreading its pedipalps. It then attempted to retreat under a cavity of the bank while carrying the frog. The duration of the observation was approximately 7 min.; the frog was collected before the spider could escape and deposited at the herpetology collection of the Centro de Ornitologia y Biodiversidad in Lima, Peru (FF3306).

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***HYLARANA NIGROVITTATA* (Black-striped Frog). DEATH FEIGNING BEHAVIOR.** A wide range of predators, especially snakes, consume frogs. To avoid predation, amphibians have developed various types of defensive strategies such as thanatosis, stiff-leggedness, lung inflation, toxic secretions, contraction and body raising (Duellman and Trueb 1986. Biology of Amphibians. New York, McGraw-Hill. 670 pp.; Toledo et al. 2011. Behavioural Defences of Anuran: An Overview. Ethol. Ecol. Evol. 23:1–25). *Hylarana nigrovittata* is a medium-sized ranid that occurs in Cambodia, China, India, Indonesia, Laos, Malaysia, Myanmar, Thailand and Vietnam (www.iucnredlist.org; 15 Dec 2014). Defensive behaviors have not yet been reported in *H. nigrovittata*. Herein I document for the first time, death feigning behavior exhibited by *H. nigrovittata* from Kedah, Malaysia.



FIG. 1. Death feigning behavior displayed by *Hylarana nigrovittata*.

Between 2100 and 2200 h on 17 May 2014, five adult *H. nigrovittata* were collected near the rockpools at the edge of Sungai Sedim, Kedah (5.2506°N, 100.4651°E, WGS84; <200 m elev.). All specimens were brought back to the laboratory and measured. When handled and approached during photography, two frogs exhibited defensive postures, while the other specimens did not show any. The first frog (SVL = 41.2 mm; 7 g) exhibited death feigning behavior (thanatosis). The specimen leapt away when placed on the ground; after several leaps, the frog suddenly flattened its body, laid down on its back on the dead leaves and stretched out its legs (Fig. 1). The individual remained in this motionless posture with both eyes open for about 90 s before assuming its normal posture and leaping away. The second frog (SVL = 43.4 mm; 8 g) also displayed death feigning behavior. When approached, the frog suddenly turned on its back and inflated its body. It stayed in this motionless position with both eyes open for about 120 s, then assumed normal posture and leapt away. Later the two specimens were euthanized, tagged, fixed with 10% formalin, stored in 70% ethanol and deposited at School of Pharmacy, Universiti Sains Malaysia (14USM-SS-HN01, 02).

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***HYPSIBOAS FABER* (Blacksmith Treefrog). PREDATION.** *Hypsiboas faber* is a medium sized Neotropical hylid that occurs widely in the Atlantic Forest of Brazil, Argentina and Paraguay. Although its natural history is well known, there are few predation events reported (Martins et al. 1993. Amphibia-Reptilia 14:307–309). Antbirds are exclusively Neotropical passerines widely distributed in forested environments and woodlands. They feed predominantly on arthropods, however, larger genera (e.g., *Mackenziaena*, *Taraba*, *Frederickena*, and *Batara*) are known to prey on vertebrates such as small snakes, lizards, frogs, rats, and nestlings (Sick 1997. Ornitologia Brasileira. Editora Nova Fronteira. Rio de Janeiro, Brazil. 912 pp.).

On 18 August 2013, in an Atlantic Forest area at Serra dos Tucanos lodge, Cachoeiras de Macacu municipality, Rio de Janeiro state, southeastern Brazil (22.3143°S, 42.3733°W; WGS84), an adult male *Batara cinerea* (Giant Antshrike) was seen at the forest edge foraging within the leaf litter. Suddenly we heard a continuous and squeaky vocalization. We approached and noticed that the bird was trying to catch an adult *H. faber* that was on a branch about 3 m above the ground. The frog managed to jump to the ground in an attempt to escape from the predator, which then rapidly pursued the prey and approached within about 50 cm of the observers. The frog continued to emit the distress call before being captured by the *B. cinerea*, which began pounding the prey against the leaf litter and a near branch (Fig. 1). After subjugating



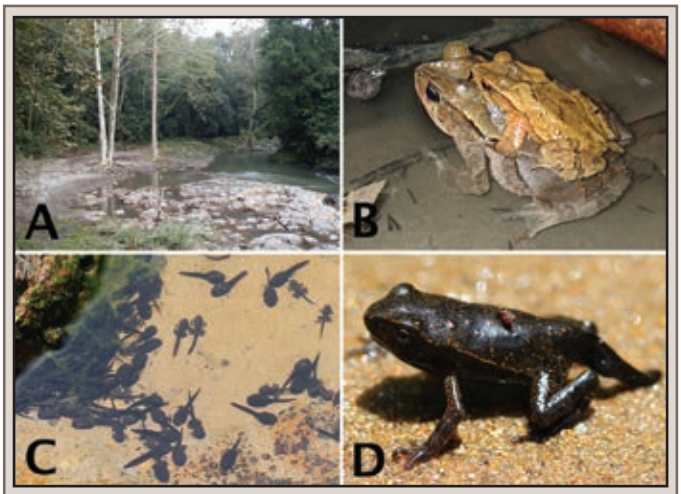
FIG. 1. *Hypsiboas faber* being preyed upon by a Giant Antshrike (*Batara cinerea*)

and killing the frog, the antbird disappeared among the bushes and the subsequent scenes could not be monitored.

This note is only the third documented predation event of *H. faber* by an avian species. The other two records—both unsuccessful—also occurred in Atlantic Forest of southeastern Brazil: a *Tyto furcata* (Barn Owl) was observed attempting to prey upon an adult male (Martins et al. 1993. Amphibia-Reptilia 14:307–309), and the other reported *Micrastur ruficollis* (Barred Forest Falcon) holding an adult of *H. faber*, but it released the prey due to the presence of the researchers (Santos et al. 2013. Herpetol. Not. 6:313–315).

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***INCILIUS CRISTATUS* (Large-crested Toad). REPRODUCTIVE BEHAVIOR.** *Incilius cristatus* is an enigmatic species known only from the cloud forests of central Puebla and Veracruz, México (Mendelson 1998. Cat. Amer. Amphib. Rept. 646:1–2). This species breeds in streams (Mendelson 2011. Zootaxa 3138:1–34), but its reproductive biology and early life stages remain otherwise poorly known (Mendelson 1997. Herpetologica 53:268–286). Altig (pers. comm., cited in Mendelson 1997, *op. cit.*) collected tadpoles of *I. cristatus* from boulders of fast moving streams in late December. Recently, a captive breeding project at Africam Safari in Puebla reported successful laboratory reproduction of *I. cristatus* (Hernández Díaz 2013. Amphib. Ark Newsl. 2013:17). The authors also noted wild breeding at the source population in Barranca de Xocoyolo, Puebla—but provided no specifics (Hernández Díaz 2013, *op. cit.)*. Importantly, only seven extant populations of *I. cristatus* are formally documented: Barranca de Xocoyolo; Cascada de La Gloria, Puebla (Mendelson and Canseco Márquez 1998. Herpetol. Rev. 29:106); 6 km S of Huatusco and 3 km NE of Coscomatepec, Veracruz (Meza Parral 2013. Master's Thesis, Instituto de Ecología, A.C. México); and three populations near Xalapa, Veracruz (Pineda and Halffter 2004. Biol. Conserv. 17:499–507). Here, we provide reproductive data for *I. cristatus* from a newly re-discovered population in east-central Veracruz.



PHOTOS BY ADAM G. CLAUSE

FIG. 1. A) Breeding habitat for *Incilius cristatus*; B) Amplexing *I. cristatus*; C) *I. cristatus* tadpoles; D) *I. cristatus* metamorph.

On 25 November 2013 from ca. 2130–2210 h, we observed breeding by *I. cristatus* at Rancho el Jacal, a private reserve ca. 6.2 km NNE of Atzalán, Municipality of Atzalán, Veracruz, México (19.8437°N, 97.2250°W, WGS84; 1170 m elev.). Occupied microhabitat was a ca. 10-m-diameter side pool of the Rio Alceseca, a tributary to the Rio Filobobos, in old-growth cloud forest (Fig. 1A). In this pool, we counted four lone males, two amplexing pairs, and an estimated 10,000 young tadpoles congregating around spent egg-string jelly. The lone males occupied the fringes of the pool in water less than 5 cm deep. The amplexing pairs were resting on the bottom of the pool in water at least 20 cm deep. We gently moved one pair to shallower water for photographic documentation (Fig. 1B). The spent egg strings were attached to fallen dead branches and leaf litter of Mexican plane trees, *Platanus mexicana*. All eggs were hatched. All tadpoles appeared to be the same age (Gosner Stage 25 or lower), and were resting motionless on the pool's sandy/silty substrate. We conservatively estimate these eggs were laid by a dozen female *Incilius cristatus*, based on a maximum captive output per female of 856 eggs (Hernández Díaz 2013, *op. cit.*). Dozens of *Ecnomiohyla miotympanum* (Small-eared Treefrogs) were also breeding in the vicinity. Although the *E. miotympanum* were actively chorusing, we never heard calls from other anuran species. This supports the prediction by Mendelson (1997, *op. cit.*) that *I. cristatus* may lack an advertisement call. A fine drizzle was falling the night of our observations. Two days prior, a moderate to heavy rain had fallen at the site for ca. 12 hours.

We returned to Rancho el Jacal on 5–10 April 2014 and observed *I. cristatus* tadpoles (Fig. 1C) and metamorphs (Fig. 1D) at the original breeding site and at an eddy 100 m downstream that we had not visited in November. The tadpoles were gregarious, congregating alongside *E. miotympanum* tadpoles on rocks or silty substrate in areas of low-velocity flow, less than 0.5 m deep. We noted two distinct age classes at each site: Gosner Stage 42–45 and 36–39. This evidence suggests that populations of *I. cristatus* may deposit eggs several times per year rather than in a single, explosive event.

We also report *I. cristatus* elsewhere in the vicinity: an adult in Atzaán near the Church of Fatima 6.6 km SSW of Rancho el Jacal in February 2012 (19.78783°N, 97.24508°W, WGS84; 1700 m elev.); two juveniles in a side-pool of the Rio Alceseca 1.3 km SSE of Rancho el Jacal in April 2012 (19.83403°N, 97.22085°W, WGS84; 1220 m elev.); and over two dozen other adults, juveniles, and

metamorphs at Rancho el Jacal from 13 June 2012 to 18 July 2014, all within 0.5 km of the observed breeding sites. These records are the first confirmation of *I. cristatus* from this region since Ronald Altig collected tadpoles of *I. cristatus* near Atzalán in 1969 (UMMZ 151887) and 1970 (UMMZ 151571). Our observations indicate that the Río Alceseca near Atzalán supports a robust *I. cristatus* population, and is of significant conservation importance for this IUCN Critically Endangered species (IUCN Red List 2013, www.iucnredlist.org, accessed 30 January 2014).

Photographic vouchers (LACM PC 1828–1833) were deposited in the Natural History Museum of Los Angeles County and were verified by Joseph R. Mendelson. We thank Sr. Jacobo Alvarez for land access, and Joseph R. Mendelson for his initial review of this note. Financial support was provided by a University of Georgia Presidential Fellowship.

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***LEPTODACTYLUS LABYRINTHICUS* (Pepper Frog). DIET.** We observed a predation attempt on *Erythrolamprus reginae* (Royal Ground Snake) by a *Leptodactylus labyrinthicus* on 15 December 2012 in the Environmental Protection Area in the Serra do Lajeado, Palmas, Tocantins, Brazil (10.1221°S, 48.1911°W, SAD69; 655 m elev.). The predation event was observed at an artificial pond associated with a stream at a forest edge. The snake struggled to escape while the anuran held the prey with its mouth and handled it with its right hand (Fig. 1). We observed the event for ca. 2 min. The snake escaped from the frog and entered the water immediately after the photograph was taken. We presume that the frog released the snake due to the large size of the prey, but it is possible that our presence caused the snake's release. We collected and measured the frog (SVL = 138.2 mm) and deposited it in the Herpetological Collection of the Universidade Federal de Goiás (ZUFG 7454).

Predators can have foraging strategies that maximize energy acquisition, such as capture of large prey. However, bigger prey require longer handling times, larger energy expenditure, and longer exposure to other predators, thus, there are trade-offs associated with acquiring large prey (Sazima and Martins 1990. Mem. Inst. Butantan 52:73–79). Different groups of vertebrates have been recorded in the *L. labyrinthicus* diet, including snakes (Vaz-Silva et al. 2003. Herpetol. Rev. 34:359; Fonseca et al. 2012. Herpetol. Notes 5:167–168). Although we did not observe the consumption of the prey, we considered that *E. reginae* is a potential prey for *L. labyrinthicus*, making our record the first such observation involving these two species.



FIG. 1. Predation attempt on *Erythrolamprus reginae* by *Leptodactylus labyrinthicus* in the APA Serra do Lajeado, Tocantins, Brazil.

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***LEPTODACTYLUS SAVAGEI* (Savage's Thin-toed Frog). REPRODUCTIVE BEHAVIOR.** An explosive breeding event of *L. savagei* was observed on 25–27 August 2004 inside the mature forest of Peninsula Gigante, Barro Colorado Natural Monument, Panama (9.1228°N, 79.8580°W, WGS 84; ca. 35 m elev.). The event took place in a temporary pond (ca. 13 m long, ca. 5 m wide, ca. 0.3 m maximum depth) formed during unusually heavy and continuous rainfall on 25 August 2004. The first night of observation there were between 160–180 active individuals, mainly near the shore of the pond, and almost 75% were males. Other frog species such as *Agalychnis callidryas* (Red-eyed Treefrog), *Dendropsophus ebraccatus* (Hourglass Treefrog), *D. microcephalus* (Yellow Cricket Treefrog), *Trachycephalus venulosus* (Veined Treefrog), *Engystomops pustulosus* (Tungara Frog), and *Chiasmocleis panamensis* (Panama Humming Frog) were also present at high densities.

I saw six *L. savagei* couples in amplexus that were approached closely (0.1–0.15 m) by conspecific satellite males. The amplectant males reacted to the interference by directing toward the satellite males a soft call of lower volume and shorter duration than the usual "whuup" of the advertisement call (Ibáñez et al. 1999. Los Anfibios del Monumento Natural Barro Colorado, Parque Nacional Soberanía y Áreas Adyacentes. Editorial Mizrachy y Pujol, Panamá. 187 pp.). In each display the amplectant males repeated the soft call 5–10 times in a shorter temporal frequency than when they repeat advertisement calls. Satellite males responded immediately with similar soft calls but with fewer repetitions than the amplectant males and the amplectant males again emitted the soft calls. In three of these encounters the satellite males moved away from the couple after the second acoustic display from amplectant males; but in the other three, the satellite males persisted with their soft calls. In one of these observations an amplectant male, separated from the female, repeated again the soft calls and the satellite male retreated. In the other two, the amplectant males also got off the female and repeated the soft calls, but satellite males responded by also displaying the soft calls and then both males commenced physical

combat, standing on their hind legs grappling with each other, scratching one another with thumb and chest spines, and finally each amplectant male grabbed the opponent by its ventrolateral region and threw it back over its head. In both cases the amplectant male then returned to amplex the female. Bloody wounds were clearly visible in the chest and lateral regions of the males involved in the combats, reinforcing the role of these spines as secondary sexual characters for use in male-male combat (Heyer 2005. Arq. Zool. 37:269–348). The combat behaviors observed here are similar to those described previously for *L. pentadactylus* during a similar explosive breeding event (Rivero and Esteves 1969. Breviora 321:1–14). Other congeners display additional calls besides their advertisement call. For example, *L. labyrinthicus* emit encounter calls probably to avoid combat with approaching males (Silva et al. 2008. CH 2008:1–6).

Explosive breeding of *L. savagei* is rarely seen and the interactions described here suggest that during reproductive events males of this species can display additional calls (besides their advertisement calls) that may function as encounter or aggressive calls that drive male-male combat when competing for a female. Further research is required to define the function and acoustic characteristics of these calls.

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***LITHOBATES SYLVATICUS* (Wood Frog). HABITAT USE.** *Lithobates sylvaticus* is the second most widely distributed anuran in North America (Martof and Humphries 1959. Am. Midl. Nat. 61:350–389), and its habitat use reflects the environmental variation that exists across its geographic range (Semlitsch et al. 2009. BioScience 59:853–862). Although *L. sylvaticus* post-breeding habitat selection has been described in Missouri (Rittenhouse and Semlitsch 2007. J. Herpetol. 41:645–653) and Maine (Baldwin et al. 2006. J. Herpetol. 40:442–453; Blomquist and Hunter 2010. Ecoscience 17:251–264), these studies did not report the species' use of glacial erratics, or boulders. We conducted our study in Maine's Nahmakanta Public Reserved Land (45.68210°N, 69.12940°W, WGS84; 407–530 m elev.), which is located in the Quebec/New England Boundary Mountains ecoregion.

We used radio telemetry to monitor 71 *L. sylvaticus* adults between 0635 and 1820 h during 12 May 2011–05 April 2013. Thirty-one frogs were monitored in 2011, 29 in 2012, 10 during 2011–2012, and one during 2011–2013. We observed seven (2011) and 12 (2012) frogs on boulders (maximum diameter > 2 m) during weekly relocations, and four (2012) frogs on large rocks (maximum diameter < 2 m). Most frogs were found on boulders only once or twice, however, one frog was found on multiple boulders during seven of 17 relocations during 13 July –15 October 2012. Boulders typically were covered with polypody ferns (*Polypodium* spp.), mosses, or lichen and leaf litter and downed woody debris. Boulders often had steeply-sloped sides (estimated > 70°) and ranged in height from 0.6 m to 2.1 m.

Boulders provide a unique microhabitat in the study landscape. Frogs on boulders were embedded in moist moss and lichen, which likely promoted thermoregulation and moisture retention via increased moisture availability and decreased solar radiation. We relocated one frog in small pools of water formed in the depressions at the base of boulders during three relocations and within 5 m of these pools during five other relocations. These depressions held water throughout much of the summer. Boulders may also provide refuge from predators. We commonly observed radio-tagged frogs bounding for rock and boulder crevices. Boulders are a microhabitat alternative to forest substrate litter for *L. sylvaticus* during the post-breeding period in Maine's montane landscapes. This unique landscape feature provides a moist refuge from predators not previously reported in habitat use and selection studies for this species.

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***LITORIA CHLORIS* (Red-eyed Tree Frog). PREDATION.** Frogs are important prey items for many vertebrate and invertebrate species but predation by crustacea, such as freshwater crayfish, has rarely been reported in Australia (Pyke et al. 2013. Herpetol. Notes 6:195–199). In a review of the invertebrate predators of amphibians, crustacean predators included crabs and occasionally crayfish (Toledo 2005. Herpetol. Rev. 36:395–400; Wilson and Williams 2014. Toxicon 82:9–17). Here we note the predation of *Litoria chloris* (Red-eyed Tree Frog) by *Euastacus spinifer*, a freshwater spiny crayfish.

Litoria chloris is an arboreal hylid found across the subtropical to temperate forests of the east coast of Australia. Little is known of their ecology but it is suspected that they spend most of their lives foraging and living within the canopy of coastal rainforest and wet sclerophyll forests. As with many other arboreal hylid and rhacophorid anuran species, these frogs descend to the ground following heavy rain events to breed in ephemeral water bodies such as ponds, ditches, and pools (Anstis 2013. Tadpoles and Frogs of Australia. New Holland Publishers, Sydney. 829 pp.).

At 2230 h on 11 December 2014, following heavy rain (ca. 25 mm in less than 24 h), one such breeding event occurred in the Myall River State Forest near Bulahdelah, New South Wales, Australia. Along a 2-km stretch of unsealed road we

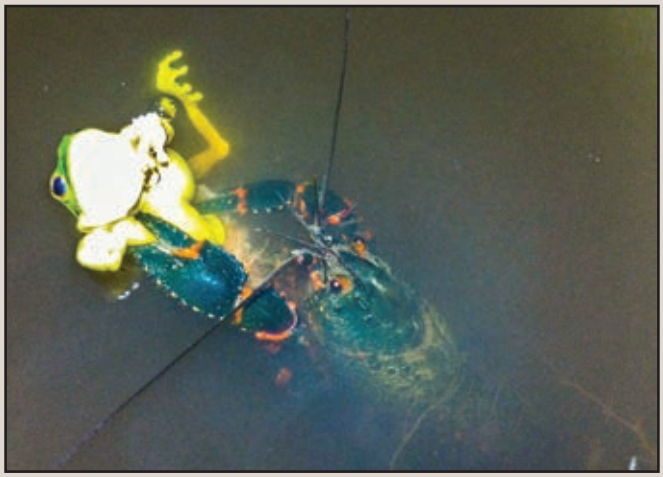


FIG. 1. *Euastacus spinifer* predating upon *Litoria chloris*.

observed several large congregations of breeding *L. chloris* in flooded roadside ditches and wheel ruts. At one site (32.3853°S, 152.1017°E; WGS84) at least 30 individuals were observed calling and amplecting. Amplectant pairs were observed on the ground with many chorusing males scattered around the water's edge and in low vegetation. The temperature was 18°C with 84% humidity. One frog was struggling in a water-filled wheel rut approximately 25 cm deep. On closer inspection we noticed that the frog (SVL = ca. 65 mm) had been seized by an adult freshwater crayfish (*E. spinifer*) approximately 16 cm in length (Fig. 1). The frog was severely wounded below the abdomen where it had been seized by the crayfish's claws. The struggle was observed for several minutes before the crayfish retreated to a deeper part of the pool with the frog and disappeared from sight. It is assumed that the frog was consumed as the next morning the same crayfish was sighted but not its prey.

Euastacus spinifer predominately occur in freshwater rivers and streams but may move away from larger water bodies during rain. They feed primarily on detritus, but are also known to feed on invertebrates and carrion (Turvey and Merrick 1997. Proc. Linn. Soc. NSW 118:175–185). They have also been reported feeding on tadpoles and small frogs (one unidentified species; Turvey and Merrick 1997, *op. cit.*). This instance clearly shows that they are also capable of taking larger vertebrate prey.

The aquatic breeding stage of a frog's life cycle is a significant period for predation by invertebrates (Toledo 2005, *op. cit.*). Given that *L. chloris* only descend from the canopy to breed, this may make them more vulnerable to a range of aquatic predators that do not normally pose a threat.

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***LITORIA WILCOXII* (Stony Creek Frog). INTERSPECIFIC AMPLEXUS.** Interspecific amplexus is most commonly associated with explosive breeding species or those with a strongly male-biased operational sex ratio such as bufonids (Wells 2007. The Ecology and Behavior of Amphibians. University of Chicago Press, Chicago, Illinois. 1148 pp.). During the breeding season (spring to autumn), male *Litoria wilcoxii* gather along creek edges and call for prospective females (Donnellan and Mahony 2004. Aust. J. Zool. 52:1–28). There is a strong male-biased sex ratio within these aggregations (pers. obs.). This species undergoes rapid color change during amplexus, whereby males turn from brown to bright yellow within minutes after initiation of amplexus (Kindermann et al. 2014. PLoS ONE 9:e114120). Due to the strongly male biased sex ratio, access to females may be limited and intense male competition may occur. Here I document two cases of interspecific amplexus involving male *L. wilcoxii* and one native and one introduced anuran. The first observation (Fig. 1) occurred at 2056 h on 21 October 2013, where I observed a male *L. wilcoxii* amplecting a juvenile *Mixophyes iteratus* (Giant Barred Frog) along a rocky section of the Nerang River in Numinbah Valley, Queensland, Australia (28.1770°S, 153.2280°E, WGS84; 155 m elev.). The *M. iteratus* did not attempt to move away from or dislodge the male and the pair remained in this way for several hours. Air temperature was 20.5°C and water temperature was 24.2°C. The second case occurred in the same location at 2025 h on 4 November 2013, this time between a male *L. wilcoxii* and a *Rhinella marina* (Cane Toad). In this case a male *L. wilcoxii* was observed jumping towards the *R. marina*



FIG. 1. Amplexus between a male *Litoria wilcoxii* and juvenile *Mixophyes iteratus*.



FIG. 2. Amplexus between a male *Litoria wilcoxii* and *Rhinella marina*. A) Color at first sighting. B) Color 10 minutes later.

and immediately amplexing it; the *R. marina* made no attempt to dislodge the amplectant male. The pair remained in amplexus for several hours during which time the male *L. wilcoxii* underwent rapid color change from brown to yellow within 10 min. of amplexus initiation (Fig. 2). Air temperature was 19.6°C and water temperature 23.3°C. It is worth noting that several more observations of interspecific amplexus between male *L. wilcoxii* and *R. marina* were made during the breeding season, showing that this may be a common occurrence, despite not being documented in the literature. In all cases the amplected frog was a similar size and color to female *L. wilcoxii*, these observations indicate that males may be choosing females based on body size or color, the lack of females observed in the area might explain why males turn to other species.

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***PELOPHRYNE ALBOTAENIATA* (Palawan Toadlet). MORTALITY.** *Pelophryne albotaeniata* is a small (SVL = 18–23 mm) endemic bufonid occurring in montane forest (1300–1600 m elev.) on Palawan Island, Philippines and is currently

listed as endangered in the IUCN Red List due to its limited distributional range (Diesmos et al. 2014. *In* Heatwole and Das [eds.], Conservation Biology of Amphibians in Asia, pp. 310–336. Natural History Publications [Borneo] Sdn. Bhd., Sabah, Malaysia). A few frog species including *Pelophryne misera* (Malkmus and Dehling 2008. Herpetozoa 20:165–172), *Kalophrynus pleurostigma* (Lim and Ng 1991. Raffles Bull. Zool. 39:209–214), *K. yongi* (Matsui 2009. Zoo. Sci. 26:579–585), *Microhyla borneensis* (Matsui 2011. Zootaxa 2814:33–49), and *M. nepenthicola* (Das and Haas 2010. Zootaxa 2571:37–52) have been documented utilizing carnivorous pitcher plants (*Nepenthes* spp.) as refugia and breeding sites. Herein we report on mortality of *P. albotaeniata* in a pitcher of *N. leonardoi* (Leonardo's Pitcher Plant).

At 1100 h on 23 September 2014, while examining pitcher contents of *N. leonardoi* at Shumkat Peak in Barangay Dumagueña, Narra Municipality, Palawan Province, Palawan Island, Philippines (9.472397°N, 118.383850°E, WGS84; 1365 m elev.), a deceased *P. albotaeniata* (SVL = 20 mm) was observed by EKT on its back inside a globose lower pitcher (Fig. 1A). The frog was fully intact (Fig. 1B) which suggests that it recently drowned in the viscous liquid inside the pitcher. To our knowledge, this is the first reported association of a Philippine frog with pitcher plants. Photographic vouchers were deposited at the Lee Kong Chian Natural History Museum, National University of Singapore (ZRC[IMG] 1.74 a–c).

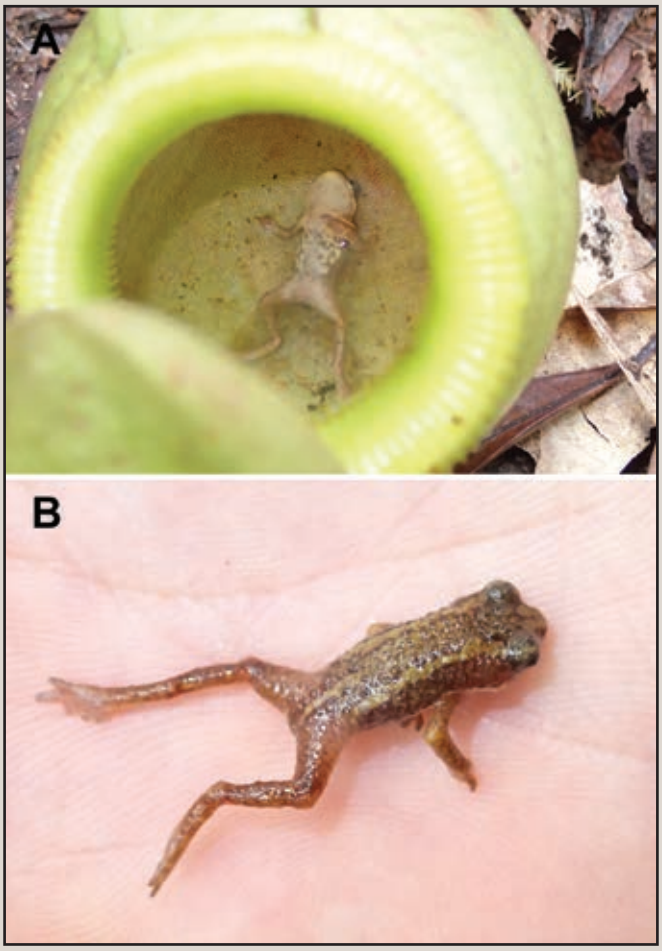


FIG. 1. A deceased *Pelophryne albotaeniata*. A) Inside a pitcher of *Nepenthes leonardoi*. B). Dorsal view of the deceased toadlet.

We thank Rafe Brown for confirming the identity of the frog, Masafumi Matsui for providing references, and Kelvin K. P. Lim for ZRC numbers for this note.

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***RHINELLA CRUCIFER* (Striped Toad). OPPORTUNISTIC SCAVENGING.** Tadpoles are usually considered filter feeding herbivores, but there are some carnivorous species (Duellman and Trueb 1986. Biology of Amphibians. McGraw Hill, New York, New York. 577 pp.). Some tadpoles of the genus *Rhinella* are known to be benthic, inhabit lentic water, and feed on microorganisms (Wells 2007. The Ecology and Behavior of Amphibians. University of Chicago Press, Chicago, Illinois. 1400 pp.; Eterovick 2000. Copeia 2000:210–215). Nevertheless, the description of the tadpole of *Rhinella crucifer* is recent, and little is known about its biology (Ruas et al. 2012. Zootaxa 3299:66–68).

Here, we report an aggregation of *R. crucifer* tadpoles feeding from a carcass of an adult *Hypsiboas faber* (Smith Frog), in a permanent stream (Fig. 1). The event occurred on 30 November 2012 in a fragment of Atlantic Forest, located in Vale da Revolta on Parque Estadual dos Três Picos, municipality of Teresópolis, Rio de Janeiro state, Brazil (22.26000°S, 42.56000°W; "Córrego Alegre"). The frog carcass (ZUFRJ 12866) and one tadpole of the aggregation (ZUFRJ 12865) were captured as vouchers and deposited in the amphibian collection of the Zoology Department of the Universidade Federal do Rio de Janeiro (ZUFRJ).

The tadpole (total length = 20.8 mm; Gosner Stage 30) was identified as *R. crucifer* based on dental formula. The carcass was diaphanized following Taylor and Van Dyke 1985 (Cybium 9: 107–119), and identified as *Hypsiboas faber* based on comparison with a diaphanized specimen (UNIRIO 64) belonging to the herpetological collection of Universidade Federal do Estado do Rio de Janeiro (UNIRIO). To our knowledge, this is the first report of opportunistic scavenging by a tadpole upon an adult anuran. The event also improves the knowledge of the tadpole of *R. crucifer*.

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FIG. 1. Aggregation of *Rhinella crucifer* tadpoles feeding from a *Hypsiboas faber* carcass.

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***RHINELLA MARINA* (Cane Toad). INCIDENTAL TRANSLOCATION.** *Rhinella marina* has a native range spanning from the Amazon River Basin to southern Texas and has been successfully introduced to other U.S. states (Florida and Hawaii) and countries as a pest control measure at the peril of native diversity (Hero and Stoneham 2005. *In* Lannoo [ed.], Amphibian Declines: The Conservation Status of the United States Species, pp. 417–422. University of California Press, Berkeley, California. 1094 pp.).

On 11 January 2014, while shopping in the outdoor lawn and garden section of a home improvement store in Hattiesburg, Lamar Co., Mississippi, USA (31.32028°N, 89.37385°W; WGS84) we discovered a large female *R. marina* (SVL = 138 mm, 375.6 g) hopping between the aisles. Employees stated that this was not the first occurrence and that the toads would occasionally arrive within shipments of potted trees from nurseries based in Texas and Florida. We determined that the distributors in Texas were scattered around the Dallas area, far north of the known range of *R. marina* (Hero and Stoneham 2005, *op. cit.*). However, the company that shipped out of Florida has two nurseries on the southeast side of Lake Okeechobee, Palm Beach Co., where *R. marina* populations have been established from introductions since 1936 (Krakauer 1968. Herpetologica 24:214–221). Translocation via potted plants may also explain the rapid range expansion of Mediterranean Geckos (*Hemidactylus turcicus*) in Mississippi (Lee 2008. J. Mississippi Acad. Sci. 53:184–188). It is unclear how large the distribution network is for these nurseries and if *R. marina* can establish viable populations capable of overwintering in Mississippi, but this could lead to further introductions in Florida and portions of south Louisiana that have similar annual minimum temperatures.

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***RHINELLA MARINA* (Cane Toad). SALINITY TOLERANCE.** *Rhinella marina*, formerly known as the Marine Toad, is in fact an inland/freshwater species native to Central and South America but has been successfully introduced throughout the world (Lever 2001. The Cane Toad: The History and Ecology of a Successful Colonist. Westbury Academic and Scientific Publishing, Otley, West Yorkshire. 230 pp.). Despite being a terrestrial species, it is also one of the few anurans thought to be able to tolerate high salinity levels. Existing evidence comes from laboratory experiments that show that adults can tolerate salinities of ~14‰ (40% seawater; Liggins and Grigg 1985. Comp. Biochem. Physiol. A: Mol. Integr. Physiol. 82:613–619), and field observations of adults in high salinity environments such as tidal flats, beaches, mangrove swamps, and even swimming in the ocean (reviewed in Lever 2001, *op. cit.)*.

Less is known, however, about the salinity tolerance of aquatic stages in the wild. Laboratory experiments have shown that *R. marina* eggs can tolerate salinity concentrations of ~5.4‰ (15% sea water; Ely 1944. Copeia 1944:256) but all tadpoles die within 3 h at salinities of 12‰ (Rios-López 2008. Amphibia-Reptilia 29:7–18); overall survival in the laboratory is limited to salinities below 8‰ (Rios-López 2008, *op. cit.*). Field observations have been more qualitative—even anecdotal. For instance, tadpoles of introduced populations of *R. marina* have been observed in saline environments where there is considerable influx of freshwater such as tidal flats or brackish marshes frequently inundated by rainwater (Pope 1917. Bull. Comp. Zool. 61:117–131; Wingate 1965. Herpetologica



PHOTO BY S. MATTSON

FIG. 2. Toadlets of *Rhinella marina* in a high salinity mangrove lagoon in Playa Brava, Coiba Island, Panama.



PHOTO BY S. MATTSON

FIG. 3. High salinity mangrove lagoon where toadlets and tadpoles of *Rhinella marina* were observed in Playa Brava, Coiba Island, Panama. Tadpoles are present at the lagoon edge adjacent the first author.



PHOTO BY S. MATTSON

FIG. 1. Tadpoles and toadlets of *Rhinella marina* in a high salinity mangrove lagoon in Playa Brava, Coiba Island, Panama.

21:202–218; Covaceich and Archer 1975. Mem. Queensland Mus. 17:305–310; Lever 2001, *op. cit.*). However, none of these studies have reported salinity estimates, making it difficult to infer levels of tolerance in the wild. Furthermore, a field survey of introduced populations of *R. marina* in Puerto Rico did not find larvae or tadpoles along a salinity gradient (Rios-López 2008, *op. cit.*). Therefore, it remains uncertain whether breeding is possible in highly saline water, and the extent to which aquatic stages can successfully develop in such water in the wild.

We here report a quantitative observation of tadpoles and toadlets of a native population of *R. marina* successfully living in a highly saline environment in the wild. On 20 February 2015 we observed a large number (probably thousands) of *R. marina* tadpoles (Fig. 1) and toadlets (Fig. 2) in a large mangrove lagoon (at least 100 m long; Fig. 3) at Playa Brava (7.5558°N, 81.8405°W; WGS 84) on Coiba Island, Panama (for video: https://www.youtube.com/watch?v=Bn6QQV1EqwY&feature=youtu.be). The lagoon was surrounded by tall (> 8 m) mangrove forest, and located ca. 200 m from the ocean and 100 m from the mouth of the Pozo River. Water salinity was 27.5‰ (YSI Professional Plus multiparameter water quality meter), within the standard range for brackish water (0.5–30‰). To our knowledge, this observation is the highest salinity concentration reported for living tadpoles and toadlets of *R. marina* in the wild. We also recorded temperature (29.5°C), dissolved oxygen (2.88 mg/L), pH (7.33), total dissolved solids (27537.50 mg/L), and specific conductance (42453 µS/cm).

Our observation is relevant for several reasons. First, islands often represent a challenge to colonization by amphibians (Duellman and Trueb 1986. Biology of Amphibians. McGraw-Hill, New York. 670 pp.). Coiba Island in particular possesses a rather depauperate amphibian community, with only five anuran species reported so far; of which *R. marina* is the most widespread and abundant (De la Riva 1997. *In* Castroviejo [ed.], Flora y Fauna del Parque Nacional de Coiba (Panamá), pp. 419–432. Agencia Española de Cooperación Internacional, Madrid). Our observation might therefore help explain the success of *R. marina* on Coiba Island, particularly in the dry season when freshwater is reduced. Finally, salinity represents a major physiological limit to amphibian life (Balinsky 1981. J. Exp. Zool. 215:335–350), and only a handful of species are known to tolerate high salinity levels in the wild (Viertel 1999. Amphibia-Reptilia 20:161–171; Liggins and Grigg 1985, *op.cit.*). A relevant example is *Fejervarya cancrivora* (Crab-Eating Frog)—considered the most salt tolerant species in the world—with adults (Uchiyama et al. 1990. Zool. Sci. 7:73–78) and tadpoles (Gordon et al. 1961. J. Exp. Biol. 38:659–678) able to withstand salinities of up to 33‰ and 35‰ in the wild, respectively. To the best of our knowledge, our observation in *R. marina* is also one of the highest salinity tolerance values for tadpoles and toadlets reported in nature, and so this species could provide a rare opportunity to explore the physiological mechanisms allowing such tolerance.

We thank C. Kelehear for assistance in identifying the toadlets from the photos, and for directing us to the relevant literature. D. Sharpe provided useful comments on an early version of the note, S. Mattson provided the photos herein, and A. Endara the video. Funding was provided by the Coiba-Bioblitz Expedition sponsored by the International League of Conservation Photographers. Additional support was provided by Sistema Nacional de Investigación (SNI) and Secretaría Nacional de Ciencia, Tecnología e Innovación (SENACYT), Panama.

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***RULYRANA FLAVOPUNCTATA* (Yellow-spotted Cochran Frog). REPRODUCTION.** Though there is a strong phylogenetic signal in reproductive modes of amphibians (Gómez-Mestre et al. 2012. Evolution 66:3687–3700), if environmental conditions provide the opportunity, reproductive modes of amphibians may be plastic within a given species (Touchon and Warkentin 2008. Proc. Natl. Acad. Sci. USA 105:7495–7499; Toledo et al. 2012. J. Ethol. 30:331–336). On 26 December 2008, 01 March 2009, 10 December 2009, and 22 February 2010 we found egg clutches of the centrolenid frog *R. flavopunctata* on the limestone walls (Fig. 1) of the Cueva de los Tayos ("Cave of the Oilbirds," 32.1110°S, 77.7496°W, WGS84; 670 m elev.), in the Tayuntza River gorge, near Wisui Biological Station, Morona Santiago, Ecuador. Despite its name, it is not a real cave but an extremely narrow deep and dark gorge formed by the river (Fig. 2).

Rulyrana flavopunctata occurs along creeks at elevations between 300 and 1800 m on the Amazonian slopes of the Andes of Colombia and Ecuador (Lynch and Duellman 1973. Occ. Pap. Mus. Nat. Hist. 16:1–66; Castro et al. 2004. www.iucnredlist.org, accessed 18 Dec 2014). Most centrolenids are thought to lay their egg clutches on vegetation (Guayasamin et al. 2009. Zootaxa 2100:1–97). Very few centrolenids are known to lay eggs on rocks; exceptions include *Centrolene geckoideum* (Lynch et al. 1983. Stud. Neotrop. Fauna Environ. 18:239–243), *C. petrophilum* (Ruiz-Carranza and Lynch 1991. Lozania (Acta Zool. Colombiana) 58:1–26), and *Sachatamia albomaculata* (Puschendorf et al. 2004. Herpetol. Rev. 35:52). The egg clutches of other saxicolous glassfrogs, such as other species within *Rulyrana* or *Sachatamia*, have never been described, but in general centrolenid clutches are laid at male glassfrog calling sites (Cisneros-Heredia and McDiarmid 2007. Zootaxa 1572:1–82). In other areas (e.g., Cordillera de los Guacamayos in Ecuador), clutches of *R. flavopunctata* have been observed on vegetation, although these are not formally recorded in any literature (J. M. Guayasamin, pers. obs.). In contrast to the finding that *S. albomaculata* switches from vegetation to rocks at the onset of the dry season (Puschendorf et al. 2004, *op. cit.*) we found *R. flavopunctata* egg clutches on the rock walls during the rainy season.

A possible advantage of using this microhabitat for egg deposition is that these surfaces might be inaccessible to non-flying

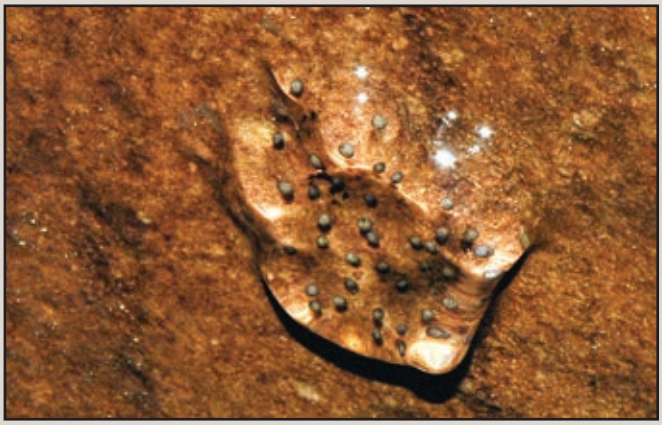


PHOTO CREDIT TO IGNACIO DE LA RIVA.

FIG. 1. *Rulyrana flavopunctata* egg clutch on the limestone walls of the Tayuntza River gorge, Ecuador.

PHOTO CREDIT TO OCTAVIO JIMENEZ-ROBLES.



FIG. 2. Interior of Cueva de los Tayos, Tayuntza River gorge, Wisui Biological Station, Morona-Santiago, Ecuador.

predators (e.g., snakes, lizards, ants and other insects), as they would not have a good grip on these almost-vertical rocky surfaces. Conversely, rock may make it difficult for embryos to detect approaching predators through substrate vibration.

Microhabitat selection for egg clutches is critical to avoid dehydration or direct solar radiation. At Cueva de los Tayos, egg clutches were always found in dark and wet conditions (due to water spray), offering ideal conditions for the development of embryos. Our observations suggest that *R. flavopunctata* lay their eggs on the rock walls of the Tayuntza River gorge probably to reduce predator pressure, avoid direct sun light, and have constant humid conditions (which may allow them to extend their reproductive activity).

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***SCINAX FUSCOVARIUS* (Snouted Treefrog). PREDATION.** *Scinax fuscovarius* is distributed over Southeastern Brazil, northern Argentina, Paraguay, and Bolivia (Dixo and Verdade 2006. Biota Neotrop. 6:1–20). *Leptodactylus latrans* (Criolla Frog) is widely



FIG. 1. *Leptodactylus latrans* preying upon *Scinax fuscovarius*.

distributed in tropical South America and east of the Andes (Ferreira and Tonini 2010. Herpetol. Notes 3:237–238). *Leptodactylus latrans* has a generalized diet, and several studies report anurans as a component of its diet (e.g., Solé et al. 2009. Herpetol. Notes 2:9–15); cannibalism is also reported (Teixeira and Vrcibradic 2003. Cuadernos Herpetol. 17:113–120). The predation of *Scinax fuscovarius* by *Leptodactylus latrans* (Fig. 1) was on 29 September 2013 in the municipality of Vassouras, in the state of Rio de Janeiro, Brazil (43.5233°S, 22.3041°W, WGS84). It occurred at the edge of a large pond, located in a pasture on a farm. *Scinax fuscovarius* was found emitting a distress call while trapped in the mouth of *L. latrans* (Fig. 1). After that, the *L. latrans* jumped into the pond, still holding the *S. fuscovarius*, and we could not see them anymore, although we could still hear the distress call. This is the first record of the genus *Scinax* as prey of *L. latrans*, improving the knowledge on the trophic interactions involving these two tropical anuran species.

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***SCINAX FUSCOVARIUS* (Snouted Treefrog). PREDATION.** *Scinax fuscovarius* is a treefrog widely distributed in Brazil, Paraguay, Bolivia, and northern Argentina (Haddad et al. 2013. Guide to the Amphibians of the Atlantic Forest: Diversity and Biology. São Paulo, Anolis Books. 547 pp.). This species is a known prey item for vertebrates and invertebrates (Furlan and Almeida 2010. Acta Sci. Biol. Sci. 32:121–124; Morais et al. 2013. Herpetol. Notes 6:567–568). The colubrid snake *Philodryas olfersii* (Green snake) has a wide distribution in South America (Leite et al. 2009. N. West. J. Zool. 5:53–60), occupying both open and forested areas (Hartmann and Marques 2005. Amphibia-Reptilia 26:25–31; Almeida and Santos 2011. Bol. Mus. Para. Emilio Goeldi Cienc.



FIG. 1. A) *Philodryas olfersii* immobilizing *Scinax fuscovarius*. B) *Philodryas olfersii* preying on a *Scinax fuscovarius*.

Nat. 6:351–354). On the night of 22 December 2012 in Angélica, Mato Grosso do Sul state, Midwest Brazil (22.1533°S, 53.7718°W, SAD-69), we observed a *P. olfersii* preying on a *S. fuscovarius* (Fig. 1). The *Scinax fuscovarius* was first attacked in the branches of a tree (3 m up), then both the frog and the snake dropped to the ground, where the struggle finished. The entire event lasted around 17 minutes, since the snake's first lunge until the frog was entirely swallowed. This is the first record of *P. olfersii* preying on *S. fuscovarius*; however the congener *P. patagoniensis* is a known predator of this frog (Hartmann and Marques 2005. Amphibia-Reptilia 26:25–31).

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TESTUDINES — TURTLES

***CHELONIA MYDAS* (Green Sea Turtle). PREDATION.** The natural predation of adult sea turtles has received limited attention compared to the impacts of anthropogenic take. Recent reviews of predator-prey relationships (Whiting and Whiting 2011. Chelon. Conserv. Biol. 10:198–205; Heithaus 2013. *In* Wyneken et al. [eds.], The Biology of Sea Turtles, Volume 3, pp. 249–284. CRC Press, Boca Raton, Florida) listed several crocodilians including *Crocodylus acutus* (American Crocodile), *C. porosus* (Saltwater Crocodile), and *Alligator mississippiensis* (American Alligator) as responsible for predation events that involved *Lepidochelys olivacea* (Olive Ridley Sea Turtle), *Dermochelys coriacea* (Leatherback Sea Turtle), *Eretmochelys imbricata* (Hawksbill Sea Turtle), and *Natator depressus* (Flatback Sea Turtle) as prey (most often as hatchlings, but also the adults). However, there appear to be no published accounts of crocodilian predation on Green Sea Turtles (*Chelonia mydas*) in the literature.

Herein we report a documented predation of an adult *C. mydas* by a *Crocodylus porosus*). While boating at Winyalkin Island (14.459°S, 125.527°E) on 28 January 2014 on the Kimberley coast of Western Australia, AK photographed a Green Sea Turtle returning to the water after a nesting attempt. The species identification was clear from the characteristic parallel flipper tracks on the beach. A few moments after the turtle re-entered the water, a large crocodile surfaced near the shore with the captured turtle in its jaws. The crocodile paralleled the shoreline with the captured turtle and the boat steered nearer to continue observations and obtain digital photographs. The images, while not of sufficient resolution for publishing, allowed documentation of diagnostic Green Sea Turtle features, including scute or scale patterns of the head, front flipper and carapace, distinctive coloration, and head morphology. The crocodile and turtle prey were lost to sight as it left the area, so we cannot speculate about final consumption.

The fortuitous images provided no clearly-calibrated visual references for size. However, there are regional data sets that supply helpful estimators of relative prey and predator sizes. The mean size of Western Australia Green Sea Turtles (98.0 = cm curved carapace length, source: B. Prince- DPAW), and a 1:7–1:8 ratio for large *C. porosus* head to body length (Britton et al. 2012. Herpetol. Rev. 43:541–546; Fukuda et al. 2013. J. Herpetol. 47:34–40), allows a judicious guess that the crocodile involved was around 4–5 m in length.

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***CHELYDRA SERPENTINA* (Snapping Turtle). INJURY.** Here we report an observation of a male *Chelydra serpentina* being wounded within a hoop trap. On 8 July 2014 at approximately 1120 h, while checking hoop traps baited with sardines, in Presqu'ile Provincial Park (43.994421°N, 77.720144°W), Ontario, Canada, we found that one hoop trap contained three adult *C. serpentina*: two males (M_1: SCL = 30.9 cm, mass = 7.55 kg; M_2: SCL = 23.4 cm, mass =3.55 kg) and one female (F_1: SCL = 28.2 cm, mass = 5.85 kg). This is not necessarily unexpected; Frazer et al. (1990 Copeia 1990:1150–1152) noted that the presence of a female in a hoop trap may artificially increase capture rates of males. Upon retrieval from the trap, a deep lengthwise tear through skin and muscle along M_1's tail was noted. The wound extended through the cloaca, and was approximately 10 cm in length (Fig. 1). The wound was fresh and still bleeding; neither scabbing nor scar tissue were present. Three explanations for the cause of the wound seem plausible: 1) M_1 was injured before entering the trap, 2) M_1 was attacked by one or both of the other turtles (M_2 and F_1) within the trap, or 3) while attempting to copulate with F_1, she scratched M_1's cloaca with her hind claw. Due to the wound's length, linear pattern, and lack of additional injuries on any of the turtles, we



PHOTO BY SEAN P. BOYLE

FIG. 1. Wound through the cloaca of a large male *Chelydra serpentina* (M_1) after being removed from a hoop trap with two other adult *C. serpentina* (M_2 and F_1).

believe the injury resulted from a struggle within the trap and that a claw was its likely source, potentially sustained while attempting to copulate with F_1. Given that increased body size is often correlated with dominance, both inter- and intra-sexually, in sexually dimorphic turtles (Berry and Shine 1980. Oecologia 44[2]:185–191), the fact that the injured turtle was also the largest, and the only one injured, further supports the conclusion that this injury was related to mating.

Before taking measurements, and before release, the wound was rinsed with water and the edges were cleaned with an alcohol swab. M_1 appeared to behave normally, and upon release, swam normally. Although M_1 was not recaptured again throughout the summer (capture rates decrease by late July at our study site), we do not believe that the wound observed would have led to a severe infection and subsequent mortality.

Male *C. serpentina* are known for intraspecific aggression towards females (White and Murphy 1973. Herpetologica 29:240–246) and males (Brooks and Brown 1983. Herpetologica 49:311–318) during the breeding season, but little is known about wounds caused by females. Male *C. serpentina* may behave aggressively to other males while within close proximity to females (Brooks and Brown 1983, *op. cit.*) and in combat, they have been observed biting and clawing at their opponent's head (Raney and Josephson 1954. Copeia 1954:228). Recent scars on the heads of *C. serpentina* can be seen each spring; however, direct observation of aggression in the wild is rare (Galbraith et al. 1987. Can. J. Zool. 65:2623–2629). To our knowledge, only one (unpublished) study has analyzed long-term wounding trends for *C. serpentina* (Hewitt 2014. Honours Thesis, Laurentian University, Sudbury, Ontario; Keevil, Hewitt, and Litzgus, unpubl.).

Given the known aggressive nature of *C. serpentina*, we believe aggression within hoop traps may be more common than the lack of published accounts suggests. Although hoop traps are a commonly-used technique for the capture of various freshwater turtle species, our observation is an important reminder that live-trapping has ethical significance related to stress or injury of both focal and by-catch species. We recommend, when possible, checking hoop traps frequently (more than once/day), in order to minimize the likelihood of such potentially damaging interactions.

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***CHELYDRA SERPENTINA* (Snapping Turtle). HUNTING BEHAVIOR.** Snapping Turtles are large omnivorous freshwater turtles that are reported to both scavenge and actively hunt for prey (Ernst and Lovich 2009. Turtles of the United States and Canada, 2nd ed. John Hopkins University Press, Baltimore, Maryland. 827 pp.). Relatively large mammals (e.g., Muskrat, *Ondatra zibethicus*) have rarely been reported in gut-content analysis studies (Alexander 1943. J. Wildl. Manag. 7:278–282; Lager 1943. Am. Midl. Nat. 29:257–312), and these findings are usually attributed to scavenging. Only one prior report describes predation on a living *O. zibethicus* (Abbott 1884. A Naturalist's Rambles about Home. D. Appleton & Co., New York. 485 pp.). Predation of waterfowl is better documented in the literature, including predation on large Trumpeter Swan (*Cygnus buccinator*) cygnets (Abel 1992. The Passenger Pigeon 54:209–214). Here we document *C. serpentina* predation on a relatively large living mammal, the North American Porcupine (*Erethizon dorsatum*).

Starting at approx. 1208 h on 4 July 2013, Dana and Elaine Hilmer observed an adult *C. serpentina* capture and prey upon a living *E. dorsatum* while paddling along the Turtle Flambeau Flowage (46.102°N, 90.103°W) in northern Wisconsin. The observation started when they noticed a young *E. dorsatum* feeding along the shore in a small bay that had some floating dead tree trunks drifted up against the shore. Pictures and videos were taken as the *E. dorsatum* moved out over the water onto the logs. The *E. dorsatum* started browsing on a floating mat of water plants that were near the logs. The observers then noticed that something was bothering the animal's foot, and observed it start



PHOTO BY D. AND E. HILMER

FIG. 1. Snapping Turtle (*Chelydra serpentina*) hindlimb protruding out of the water during a struggle with a young North American Porcupine (*Erethizon dorsatum*).

to thrash around (Fig. 1). At first they thought the *E. dorsatum* had fallen off the floating vegetation, or that it was feeding on something in the water. However, after the *E. dorsatum* lay motionless in the water for a few minutes, both observers paddled closer to get a better view. At this point, they observed a large *C. serpentina* feeding on the *E. dorsatum*. The turtle had quills stuck into its neck and forelimbs following the struggle. From the photographs and video recorded during the encounter, it appears certain that the *C. serpentina* had dragged the *E. dorsatum* into the water and drowned it.

E. dorsatum is reported to have few natural predators (Feldhamer et al. 2003. Wild Mammals of North America: Biology, Management, and Economics. 2nd ed. Johns Hopkins University Press, Baltimore, Maryland. 1216 pp.), but this list must now include *C. serpentina*.

A video of this encounter can be viewed online by visiting http://youtu.be/WMbPIS5tulw. In addition, a copy of the video and supplemental photographs are accessioned in the James Ford Bell Museum of Natural History Herpetological Collection (JFBM P487). We thank Dana and Elaine Hilmer for sharing their video and story, and granting us permission to publish this observation.

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***CHELYDRA SERPENTINA* (Snapping Turtle). BASKING HEIGHT.** Aquatic turtles employ aerial basking as a means of thermoregulation and possible epidermal parasite control (Boyer 1965. Ecology 46:99–118). In *Chelydra serpentina*, aerial basking behavior is generally uncommon (Ernst and Lovich 2009. Turtles of the United States and Canada, 2nd ed. Johns Hopkins Univ. Press, Baltimore, Maryland. 827 pp.). Published accounts documenting aerial basking in *C. serpentina* note that individuals utilize shorelines or low-lying rocks, logs, and stumps protruding slightly from the surface of the water as basking platforms (Obbard and Brooks 1979. Can. J. Zool. 57:435–440; Roble and Garriock 1998. Catesbeiana 18:53–54). Herein, I report an observation of an adult *C. serpentina* at an unusually high basking height.

On 23 May 2014, at ~1330 h, I observed an adult *C. serpentina* (visually estimated carapace length ~35 cm) basking in a wetlands area along the Bloomsburg Rail Trail, Bloomsburg, Pennsylvania, USA (41.007975°N, 76.463670°W, WGS84; elev. ~150 m). The individual was basking upon the trunk of a dead tree protruding at a low diagonal angle from a small pond. Notably, the turtle was located at a height of approximately 1 m above the surface of the water. When I approached for closer observation, the *C. serpentina* retreated into the water by means of a vertical plunge. Adult *C. serpentina* of comparable size to the individual observed herein have previously been reported at basking heights of ~0.25 m above the surface of water (Roble and Garriock 1998, *op. cit.*). Additionally, Roble and Garriock (1998, *op. cit.*) observed a young *C. serpentina* in North Carolina basking ~1.3 m above the surface of the water on a vertical stump; however, to my knowledge basking observations of similar height have not previously been reported in adult *C. serpentina*.

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***CHELYDRA SERPENTINA* (Snapping Turtle), *CHRYSEMYS PICTA PICTA* (Eastern Painted Turtle), *STERNOTHERUS ODORATUS* (Eastern Musk Turtle), *TRACHEMYS SCRIPTA ELEGANS* (Red-eared Slider). URBAN POPULATION DENSITY.** We report notably high trapping success for turtles from an urban pond with minimal trapping effort (a single night of trapping and only eight traps). Our study took place at the southern pond of Beaver Pond Park (BPP; 2.67 ha surface area; 41.32737°N, 72.9399°W; New Haven, Connecticut, USA). From 1710 until the late 1800s, the pond was surrounded by cattle grazing. In 1885, a slaughterhouse dumped waste into the pond and from around 1894–1918 the pond was repeatedly filled with dirt, municipal waste, and cinder ash from the Winchester Repeating Arms factory (A. A. Doolittle, pers. comm.). Currently, the southern pond is immediately surrounded by suburban residential neighborhoods, a police firing range, and a high



FIG. 1. 2013 satellite image (ESRI World Imagery Basemap) of Beaver Pond Park (BPP) in New Haven, Connecticut. We studied the southern pond at BPP (indicated by a white arrow). Athletic fields abut the southern perimeter of the southern pond. The dominant landscape features around the pond are roads and residential neighborhoods.

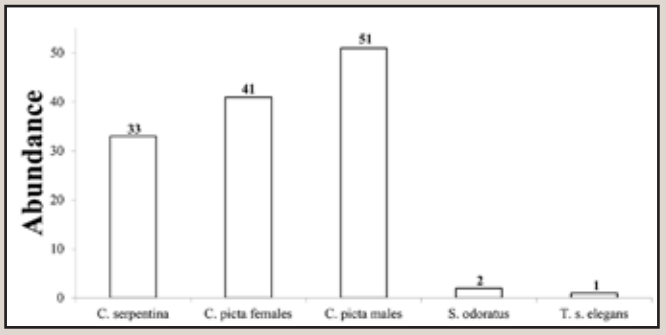


FIG. 2. The abundances of four turtle species caught in a single night with eight hoop net traps at the 2.67-ha southern pond at Beaver Pond Park. Numbers over bars are the total abundance for a given taxon.

school football field and track (Fig. 1). The park is maintained and managed both by the city of New Haven as well as the volunteer organization, Friends of Beaver Pond Park (FoBPP).

We set eight 1-m diameter hoop-net traps baited with frozen mackerel at 1030 h on 31 May 2012 and began checking traps on 01 June 2012 at 1000 h. Each trap was placed ~1 m offshore, parallel to the bank, and submerged with several centimeters of trap above water so turtles could breathe. We sexed all *Chrysemys p. picta* following Ernst and Lovich (2009. Turtles of the United States and Canada. 2nd edition. Johns Hopkins University Press, Baltimore, Maryland. 827 pp.) but did not sex other species. After marking, we immediately released each turtle back into the pond.

We caught 128 unique turtles overnight (species breakdown and abundance, Fig. 2). Abundances equate to densities of 34.5 *C. p. picta*/ha and 12.4 *Chelydra serpentina*/ha in a single night of trapping. For *C. picta*, the adult sex ratio did not deviate from equal proportions of males and females ($\chi^2 = 0.35$, $p = 0.55$).

Urbanization is usually associated with turtle declines (Garber and Burger 1995. Ecol. Appl. 5:1151–1162; Klemens 2000. Turtle Conservation. Smithsonian Inst. Press, Washington DC. 344 pp.) with road mortality (Gibbs and Steen 2005. Conserv. Biol. 19:552–556; Patrick and Gibbs 2010. Landscape Ecol. 25:791–801) and introduced *Trachemys scripta elegans* (Spinks et al. 2003. Biol. Conserv. 113:257–267; Lambert et al. 2013. Chelon. Conserv. Biol. 12:192–199) suggested as likely threats. Even so, urbanized waterbodies can support robust populations of some turtle species (Spinks et al., *op. cit.*; Lambert et al., *op. cit.*).

While our data were acquired from only a single night's trapping, the number of turtles caught is notable. Our data suggest a relatively robust community of native turtles at densities equal to or greater than those reported for other urban ponds (Steen and Gibbs 2004. Conserv. Biol. 18:1143–1148; Eskew et al. 2010. Chelon. Conserv. Biol. 9:244–249). High road density reportedly can cause male-biased sex ratios in urban turtle populations (Gibbs and Steen, *op. cit.*; Patrick and Gibbs, *op. cit.*), but our data do not indicate this effect at BPP. As *T. s. elegans* are often found in high density in urban environments, mostly as released pets (Spinks et al., *op. cit.*; Teillac-Deschamps et al. 2008. *In* Mitchell et al. [eds.], Urban Herpetology. Herpetological Conservation 3:535–537. Society for the Study of Amphibians and Reptiles, Salt Lake City, Utah; Lambert et al., *op. cit.*), we expected to trap numerous introduced turtles. However, we found only one *T. s. elegans* indicating that this urban pond is currently not impacted by introduced turtle species.

Urban ponds have been acknowledged as important arenas for freshwater turtle conservation (Spinks et al., *op. cit.*; Lambert et al., *op. cit.*). It is possible that the current level of robust park stewardship (e.g., FoBPP) and socio-economic dynamics of the community surrounding BPP are maintaining a healthy urban turtle population despite intense land use, both historical and contemporary. Our preliminary data indicate that future longitudinal studies of BPP turtle dynamics could be relevant for studies of urban turtle conservation.

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***GLYPTEMYS INSCULPTA* (Wood Turtle). MORTALITY.** On 29 May 2013 at 1456 h in Kalkaska Co., Grayling, Michigan, USA (44.639594°N, 84.892294°W; datum WGS 84), we observed an adult *Glyptemys insculpta* in a sandy creek bed filled with water ca. 0.5 m deep. We subsequently observed two adult *Chelydra serpentina* (Snapping Turtles) ca. 3 m away on either side of the *G. insculpta*; one was resting in shrubs to the right and the other was to the left submerged.

At approximately 1100 h the following day, the *G. insculpta* was found dead underwater in the creek bed where it had previously been observed. Its head was largely missing, and most of the cervical vertebrae, as well as minimal amounts of muscle and connective tissue were still attached to the body. It appeared as if the head was "stripped" off. We compared photographs of markings on the *G. insculpta* from when it was alive to the carcass to confirm it was the same individual. The *C. serpentina* were not seen again. Due to the lack of any damage to the rest of the *G. insculpta* indicative of predation by a mammalian or avian predator, and because only chelonian tracks were observed in the sand in the area where the event took place, we assume it was killed by a *C. serpentina*.

We speculate that a *C. serpentina* seized the *G. insculpta*, killed it, and consumed most of the head. Punzo (1975. J. Herpetol. 9:207–210) documented unidentified chelonian shell fragments in stomach contents of *C. serpentina* and also noted they will actively pursue and consume larger prey by holding it in their mouths and shredding it with their front claws. However, we cannot be certain if this event represents intentional predation. While the creek bed in this observation was relatively small, it is also possible that a *C. serpentina* may have killed the *G. insculpta* out of aggression or territoriality.

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***GLYPTEMYS INSCULPTA* (Wood Turtle). LONGEVITY IN THE WILD.** The previous published record for oldest male and female *G. insculpta* in the wild was 42 and 46 years old, respectively. Both individuals were from a population in Pennsylvania (Ernst 2001. Chelonian Conserv. Biol. 4:94–99). Here, we report 3 males and 22 females in Minnesota, USA, that exceed the published longevity records (specific locations withheld in compliance with state of Minnesota data practices law). Individuals were originally marked using carapace notches (Cagle 1939. Copeia 1939[3]:170–173) and aged using plastron annuli counts (Harding and Bloomer 1979. Herp: Bull. New York Herpetol. Soc. 15:9–26) between 1990 and 1993 by MDN and RRB. We consider the ages determined between 1990 and 1993 to be minimum ages, as the number of distinguishable annuli for the individuals included here was between 23 and 32, and annuli typically become more difficult to distinguish as *G. insculpta* age (Harding and Bloomer, *op. cit.*). The most recent capture of marked individuals occurred between 2012 and 2014 by MS, DR, and RAM. The oldest minimum-age male recaptured was 48 years old in 2013, and the oldest minimum-age female recaptured was 55 years old in 2014 (Table 1). Thus, our current female record in the wild is nearing the published record of 58 years for *G. insculpta* longevity in captivity (Oliver 1955. The Natural History of

TABLE 1. Minimum ages of *Glyptemys insculpta* in Minnesota, USA, that exceed the previous published longevity records of 42 years (male) and 46 years (female) in the wild. All records are from individuals alive at time of last capture.

Mark	Sex (M/F)	Date (first capture)	Age (first capture)	Date (last capture)	Age (last capture)
47	M	5/21/1990	23	6/9/2014	47
153	M	6/27/1990	24	6/13/2013	47
116	M	6/11/1990	25	6/13/2013	48
43	F	5/18/1990	23	6/11/2014	47
88	F	6/1/1990	24	6/13/2013	47
117	F	6/8/1990	26	6/8/2011	47
303	F	5/31/1991	24	6/11/2014	47
142	F	6/21/1990	24	6/11/2014	48
344	F	6/1/1991	27	6/8/2012	48
1	F	5/3/1990	25	6/11/2014	49
26	F	5/15/1990	25	6/13/2014	49
72	F	5/30/1990	26	6/11/2014	50
690	F	6/11/1993	26	6/13/2014	47
37	F	5/18/1990	25	6/7/2013	48
32	F	5/18/1990	25	6/11/2014	49
86	F	6/1/1990	27	6/7/2013	50
265	F	5/20/1991	27	6/13/2014	50
283	F	5/23/1991	27	6/11/2014	50
318	F	6/3/1991	28	6/13/2013	50
57	F	5/23/1990	28	6/6/2013	51
317	F	6/1/1991	28	6/13/2014	51
701	F	5/28/1992	29	6/9/2014	51
29	F	5/16/1990	28	6/13/2014	52
332	F	6/1/1991	29	6/13/2014	52
342	F	6/1/1991	32	6/13/2014	55

North American Amphibians and Reptiles. Van Nostrand Co., Inc., New Jersey. 359 pp.).

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***GOPHERUS POLYPHEMUS* (Gopher Tortoise). BURROW ASSOCIATE.** Gopher Tortoises are considered a keystone species due to their characteristic burrows; many vertebrate species temporarily occupy these burrows, including nearly all the venomous snakes found within the range of the tortoise (Jackson and Milstrey 1989. *In* Diemer et al. [eds], Proceedings of the Gopher Tortoise Relocation Symposium, pp. 86–98. Florida Game and Fresh Water Fish Commission, Tallahassee, Florida). However, *Agkistrodon contortrix* (Copperhead) has not previously been reported as a burrow associate of *G. polyphemus*. At 1530 h on 16 March 2015 we found an adult *A. contortrix* coiled within the entrance of an active *G. polyphemus* burrow within the Apalachicola Bluffs and Ravines Preserve in Liberty Co., Florida, USA (30.49399°N 84.98351°W; WGS 84). We did not confirm that the burrow was simultaneously occupied by a tortoise; however, the burrow had a well maintained entrance and fresh sand was visible on the apron. The snake appeared to be posed in the characteristic ambush posture of pitvipers (Fig. 1). That this is the first report of *A. contortrix* in the burrow of *G. polyphemus* is not entirely unexpected; the habitat preferences of these animals do not generally overlap. However, at this site, upland *Pinus palustris* (Longleaf Pine) and *Aristida stricta* (Wiregrass) habitats are immediately adjacent to mesic hardwood forests and bottomlands, potentially bringing both species in close proximity.



FIG. 1. *Agkistrodon contortrix* found within the burrow of a *Gopherus polyphemus* burrow in Liberty Co., Florida, USA.

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***PODOCNEMIS EXPANSA* (Giant Amazon River Turtle). POST-REPRODUCTIVE MIGRATION.** *Podocnemis expansa* is a large herbivorous turtle that moves into inundated floodplains to feed during the rainy season. Here we provide preliminary data on the post-nesting movements of adult females in the Lower Xingu River, Amazon Basin, Brazil. Between 9 October and 5 November 2013, eight adult females were captured after completing their nests on Juncal Beach, Xingu River (2.706204°S, 52.022879°W, WGS 84). Satellite transmitters (UHF KiwiSat 101 PTT) were installed on the posterior margin of their shells using Turbolit epoxy. These individuals were then released after 24 hours, at the point of capture. Subsequent positions were recorded daily by the ARGOS (www.argos-system.org) satellites system and processed by CLS (Collecte Localisation Satellites, www.cls.fr). One individual was monitored for 143 days, five individuals for 320 days, and two other individuals were still transmitting signals at this writing. We identified three different routes of dispersion: 1) five females migrated to the Amazon estuary in the Delta Archipelago

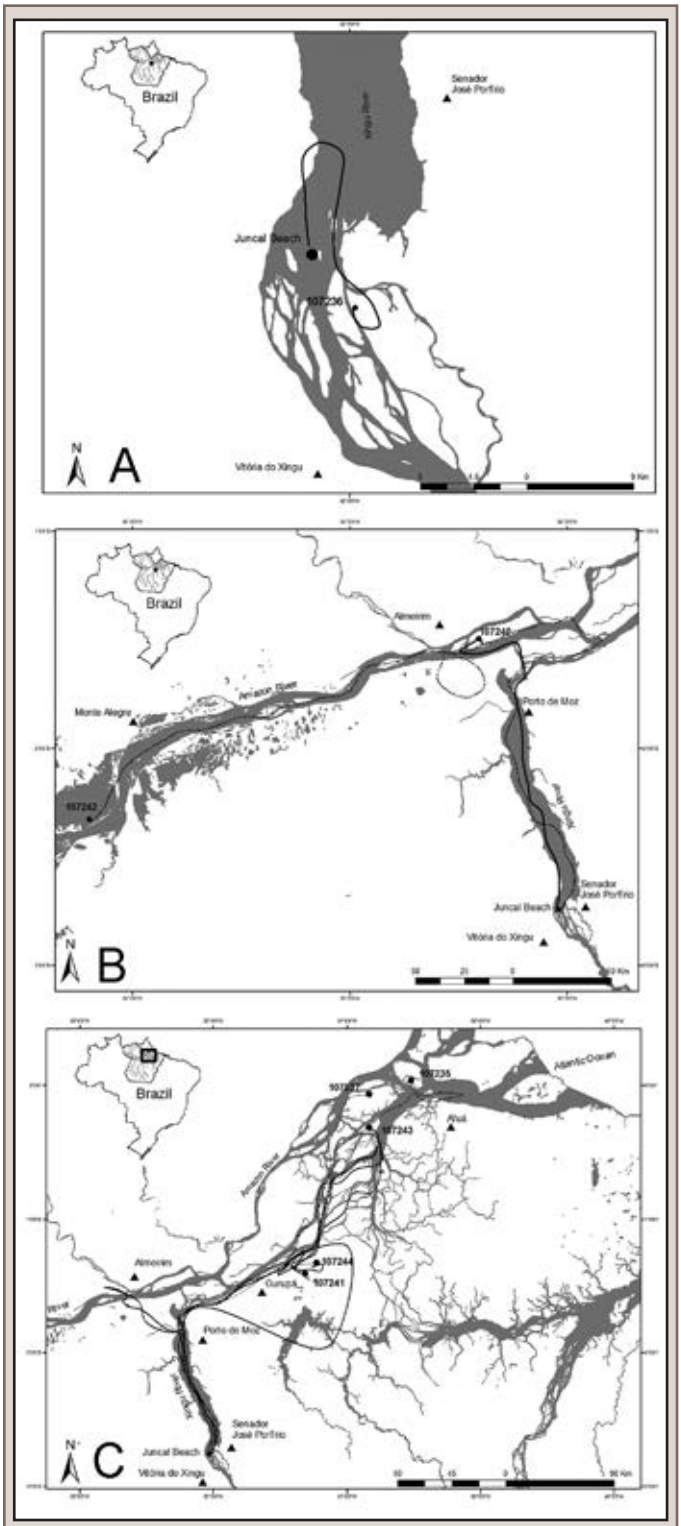


FIG. 1. Movement patterns of adult female *Podocnemis expansa* after nesting in the Juncal Beach: A) area used by one individual within the floodplains close to the nesting beach; B) route of one individual downstream Xingu River and then upstream Amazon River; C) route of six individuals downstream Xingu and Amazon Rivers to the Delta.

after swimming down the Xingu River; 2) two dispersed up the Amazon after swimming down the Xingu River; and 3) the last one stayed within the floodplains relatively close to the nesting beach (Fig. 1).

The average duration of uninterrupted movement from the nesting beaches to the feeding areas in the floodplain was 36.4 ± 20.59 days (9 – 81, N = 7), and the average distance travelled was 405.1 ± 114.7 km (196–725, N = 7). After the initial movements described above, all monitored individuals significantly reduced their movements and remained in the floodplains of the Lower Xingu River (N = 1), Lower Amazon (N = 2), or the Delta Archipelago (N = 5). These findings have important conservation implications, because almost all protective efforts are now restricted to the nesting beaches and surroundings. Conservation policy for Amazon River turtles, and especially for *Podocnemis expansa*, should consider the entire home range of the nesting populations. Considering the size of the area used by the turtles, and also the relatively high density of the human population along the river margins, it will be important to use innovative approaches to turtle conservation that include local communities.

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***STERNOTHERUS ODORATUS* (Eastern Musk Turtle). HOME RANGE.** *Sternotherus odoratus* is a small, highly aquatic freshwater turtle, ranging from the southeastern United States north into the Canadian provinces of Ontario and Quebec (Ernst and Lovich 2009. Turtles of the United States and Canada. The Johns Hopkins Univ. Press, Baltimore, Maryland. 827 pp.).

We surveyed for species-at-risk turtles on the Trent Severn Waterway in Ontario, Canada, from Peterborough (44.3°N, 78.3°W; WGS84) to Trenton (44.1°N, 77.6°W), from May 2007 to May 2009. During this time, we captured and marked 86 *S. odoratus* (51 adult males, 31 adult females, and 4 juveniles). We attached VHF transmitters to four adult turtles (2 males, 2 females) in the Otonabee River (44.16° N, 78.236° W) in the spring and summer of 2008, and radio-located them approximately once per week until September 2008. We calculated home range size as the minimum convex polygon (100% MCP) and home range length (shortest straight line distance between two farthest locations). We also calculated an average daily distance moved as the mean straight line distance between two consecutive locations, divided by the number of days between them. Home range size calculations for *S. odoratus* ideally remove terrestrial habitat from their estimates (e.g., Picard, Carrière, and Blouin-Demers 2011. Amphibia-Reptilia 32:83–92). Thus we removed terrestrial area (not classified as water or wetland in the 1:10000 Ontario Base Map) from MCPs and recalculated area. Results were as follows:

Female (150.643): Followed from 5 June–28 August 2008 (N = 17 locations). Mass = 231 g, midline carapace length = 10.58 cm. Home range: 100% MCP = 17.2 ha, MCP - land = 15.8 ha, length = 657.9 m. Average daily distance moved (range) = 37.0 m (range: 0–121.5 m/day).

Female (151.802): Followed from 10 May–28 August 2008 (N = 22 locations). Mass = 219 g, midline carapace length = 11.50 cm. Home range: 100% MCP = 35.6 ha, MCP - land = 35.2 ha, length = 1529.2 m. Average daily distance moved (range) = 42.2 m (range: 0.8–352.9 m/day)

Male (150.663): Followed from 27 May–26 August 2008 (N = 15 locations). Mass = 216 g, midline carapace length = 11.65 cm. Home range: 100% MCP = 430.1 ha, MCP - land = 204.9 ha, length = 5643.5 m. Average daily distance moved (range) = 84.5 m (range: 0.9–702.6 m/day)

Male (151.813): Followed from 10 May–26 August 2008 (N = 21 locations). Mass = 171 g, midline carapace length = 10.33 cm. Home range: 100% MCP = 7.6 ha, MCP - land = 6.8 ha, length = 332.4 m. Average daily distance moved (range) = 17.9 m (range: 0.6–68.5 m/day)

Male 150.663 has the largest home range size yet reported for *S. odoratus.* This turtle was originally caught in a wetland bordering the Otonabee River in late May 2008. He remained in this area throughout June, then moved across the river into a large side channel wetland in July. In August, he moved over 5 km towards the mouth of the Otonabee River at Rice Lake, presumably where he hibernated (he was located there in October and November 2008). We lost track of this turtle over the winter of 2008, so do not know if these movements represent an annual migration, or if this was directional dispersal to a new site.

Although long distance (> 1 km) movements of *S. odoratus* do not appear to be the norm, Edmonds (1998. M.Sc. Thesis, University of Guelph) reported a similar maximum male home range size of approximately 430 ha. We note, however, that this estimate included terrestrial and deep-water areas the turtle was unlikely to use. The estimated usable habitat area was estimated at 22.2 ha for this home range in Georgian Bay, Ontario (Edmonds 1998, *op. cit.*). Belleau (2008. M.Sc. Thesis, McGill University) reported a maximum average daily movement of 1000 m for *S. odoratus* in Norway Bay, Quebec. Indeed, home range size for *S. odoratus* appears to increase with latitude. Mean 100% MCP ranges from 0.94 ha (females) and 1.75 ha (males) in southeastern Pennsylvania (Ernst 1986. J. Herpetol. 20:341–352) to 48.89 ha (females) and 155.36 ha (males) in Georgian Bay, Ontario, Canada (Edmonds 1998, *op. cit.*). A later study in Georgian Bay, which excluded terrestrial habitat from home range estimates (100% MCP), found a maximum home range size of 205 ha, strikingly similar to our male 150.663, though in this case the turtle was a female *S. odoratus* (Laverty 2010. M.Sc. Thesis, Laurentian University). There are relatively few studies of the movement patterns of this species, thus further investigation into their spatial ecology across their range is necessary for interpretation of the biological relevance of variation in home range size along a latitudinal gradient.

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***TRACHEMYS SCRIPTA ELEGANS* (Red-eared Slider). MORTALITY.** Human-caused mortality for *Trachemys scripta elegans* has included being shot while basking, beheaded by fishermen after being hooked, killed by automotive traffic, and trapped for research and teaching purposes, and the pet and food industries (Ernst and Lovich. 2009. Turtles of the United States and Canada, 2nd ed. Johns Hopkins University Press, Baltimore, Maryland. 827 pp.). This report adds an additional anthropogenic hazard. On 18 May 2009 at 1300 h in Comanche Co., Texas, USA, on Hwy 16 ca. 1.39 mi. S of County Road 2156 (32.193400°N, 98.532396°W; 387 m elev.), an adult female *T. scripta* was found trapped in a cattle guard. The turtle was caught in a vertical position, face down between two of the rails at the bottom of the cattle guard. Both the anterior portion of the carapace and plastron were stuck between the rails (Fig. 1). It is likely that this specimen would have died had it not been discovered. Directly beneath the aforementioned specimen were the skeletal remains of another *T. s. elegans*. However, it is uncertain if this death was caused by a similar circumstance.



FIG. 1. Female *Trachemys scripta elegans* trapped in a cattle guard, Comanche Co., Texas.

The live specimen was photographed as found (UTA DC 8086) and then released. The dead specimen was also photographed (UTA DC 8087).

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CROCODYLIA — CROCODILIANS

***ALLIGATOR MISSISSIPPIENSIS* (American Alligator). NECROTIZING EXFOLIATION.** Effects of a prior severe winter freeze on *Alligator mississippiensis* in Louisiana were documented (Joanen and McNease 1990. Proceedings of the 9th Working Meeting of the Crocodile Specialist Group, IUCN – The World Conservation Union, Gland, Switzerland. Volume 2. pp. 21–32) and behavioral responses to freezing have been described (Hagan et al. 1983. J. Herpetol. 17:402–404; Brandt and Mazzotti 1990. Copeia 1990:867–871). Captive *Crocodylus niloticus* (Nile Crocodiles) can develop "winter sores" when held under cold conditions, wherein blood supply to the skin is reduced and the action of the immune system is impeded, causing erosions between scales (Huchzermeyer 2002. Rev. Sci. Tech. Off. Int. Epiz. 21[2]:265–276). We recently observed a large free-ranging *A. mississippiensis* with necrotizing scale exfoliation possibly due to severe winter weather.

On 24 March 2014 (ca. 1745 h), RME observed an adult alligator that appeared listless on a bank of a canal near the headquarters of Rockefeller Wildlife Refuge (RWR) in Grand Chenier,

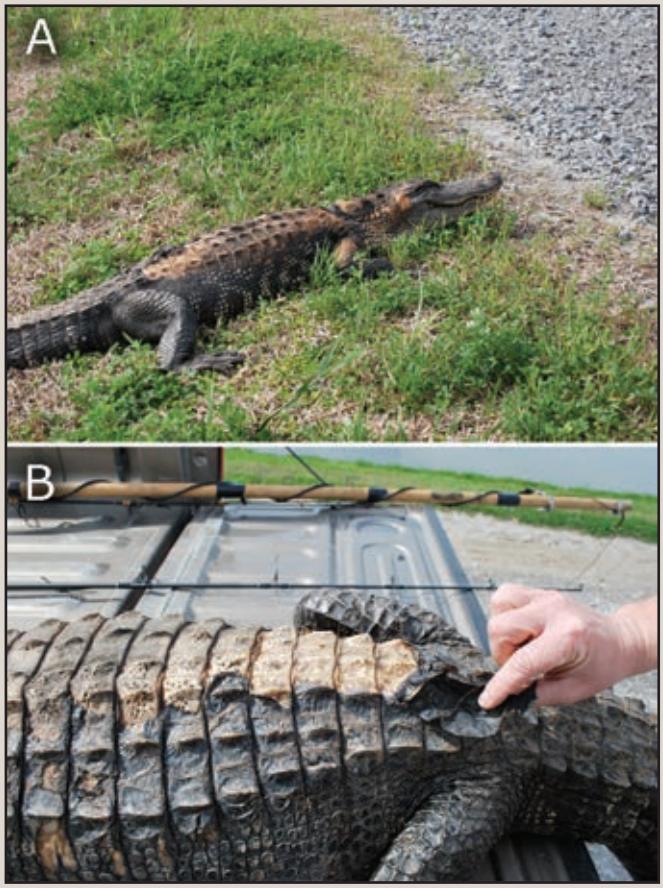


FIG. 1. Adult American Alligator (*Alligator mississippiensis*) immediately upon capture with necrotizing exfoliation (A) and detail of sloughing skin (B).

Louisiana, USA. The skin on the dorsal surface of the alligator was peeling off in numerous locations. Initially it was thought the alligator might be dead; upon gentle provocation it was guided back into the canal. The following morning (ca. 0930 h) the alligator was again observed in the water in nearly the same location. The alligator was readily observed even after submerging, as the exposed white osteoderms were visible as the overlying skin had been lost. After gathering equipment, the alligator was easily caught on the opposite bank of the canal. It did have strength to struggle mildly after capture, but less vigorously than normal for an alligator of comparable size. The male alligator was 239 cm total length, and had skin sloughing off the dorsal surface of the body (Fig. 1), including the head, neck, back, and limbs. The left rear foot had a prior well-healed amputation; likely due to trauma. The right eye was cloudy; when we tried to closely examine the left eye the surrounding skin sloughed off to mild touch. Several biopsies were taken of the skin surface. The animal was placed in a holding tank temporarily, but it was decided the alligator was near death and humane euthanasia was the best option. Arrangements were made for transport and full necropsy to be done at the Louisiana State University School of Veterinary Medicine.

At necropsy, a definitive cause of the condition could not be determined, but multiple abnormalities related to the necrotizing dermatitis and chronic debilitation were described, such as multisystemic thrombosis of small vessels possibly resulting from severe systemic inflammation and/or sepsis. The ulcerated dermis was colonized by moderate numbers of bacteria and fungal hyphae, which extended into the deep dermis, and there was some evidence of a non-severe pneumonia. The lesion in the right eye was thought to be chronic and unlikely to have contributed to the presenting condition. West Nile Virus testing was negative.

We suspect the alligator may have been adversely affected by numerous unusual regional winter freezes. The necrotic areas of the skin were on the surfaces that would have been in contact at the air-water interface for an alligator floating at the water surface. RWR documented three days of below-freezing temperatures from 6–8 January, with -6.67ºC (20ºF) on 7 January. For the ten day period from 22–31 January, nine days had temperatures at or below freezing, including -4.44ºC on 30 January; such extremes are rare in coastal Louisiana with three winter storms (i.e., ice and freezing rain) impacting the region within one month. In February 2014 another four days were at or below freezing, as well as similar freezing temperatures again on 4–5 March.

An adult alligator with similar dermatological abnormalities was observed on nearby private wetlands by RME on 16 December 2010. Temperatures at that time were not nearly as severe as in the present case, but there were six days with temperatures at/below freezing from 1–14 December, with the lowest temperature being -1.67ºC. At the time it was believed the skin lesions might be due to exposure to an environmental irritant or contaminant such as gasoline, or possibly the alligator may have been exposed to a controlled fire in a prescribed autumn/winter burn, which is a common marsh management tool. Indeed, similar skin sloughing was noted in a Saltwater Crocodile (*Crocodylus porosus*) trapped in a bushfire (Webb and Manolis 1989. Crocodiles of Australia. Reed Books Pty. Ltd.).

Deep hypothermia used for anesthesia in alligators caused local sloughing of the stratum corneum where scales were frozen (Kennedy and Brockman 1965. Herpetologica 21:6–15). Necrotic dermatitis and lifting of entire scales was also noted in a juvenile *C. porosus* that had been listless, not eating, and died of a generalized bacterial infection (Buenviaje et al. 1998. Aust. Vet. J. 76:357–363). Frye (1991. Biomedical and Surgical Aspects of Captive Reptile Husbandry. Vol. 1. Krieger Publishing Co. Malabar, Florida) discussed frostbite in reptiles, and noted severe hypothermic injury can cause tissue necrosis and dry gangrene.

Recent studies have shown that the blood of American Alligators has antibacterial (Merchant et al. 2003. Comp. Biochem. Physiol. 136:505–513), amoebacidal (Merchant et al. 2004. J. Parasitol. 90:1480–1483), and antiviral properties (Merchant et al. 2005. Antiviral Res. 66:35–38). However, natural mortalities do occur. To our knowledge, this is one of the rare instances of a wild crocodilian suffering exposure to ice storms and freezing temperatures, which may have been a contributing factor in its debilitated condition. It would be of interest to know how long it may have survived had we not elected to humanely euthanize it. It may be that wild alligators do succumb to extreme weather events, but after death in the wild, carcasses may rapidly deteriorate and are not known or recovered by researchers. It is possible that environmental stressors such as recent hurricanes in Louisiana followed by drought years might suppress the immune system and predispose some alligators to development of abnormal lesions or skin disorders. Additional research investigating such disease mechanisms in valuable crocodilian resources might be warranted.

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***CROCODYLUS POROSUS* (Estuarine Crocodile). FISHING BEHAVIOR.** In all extant crocodilians, the morphology of the skull and feeding structures are strongly linked to the overall dietary preference and niche of a species (Pierce et al. 2008, J. Morphol. 269:840–864). In the case of *Crocodylus porosus*, the species is considered to be a generalist but its diet is dependent on the size of the animal. As a neonate the diet is comprised mainly of insects and other small compliant prey (Webb et al. 1991. J. Herpetol. 25:462–473). Sub-adults consume more robust prey such as birds, fish, small mammals, and carrion (Taylor 1979. Aust. Wild. Res. 6:347–359). Adult *C. porosus* are reportedly large game specialists consuming medium to large mammals and turtles (Webb and Manolis 1989. Australian Crocodiles, Reed Books Pty. Ltd, Sydney; Doody et al. 2009. Herpetol. Rev. 40:26–29). Although the diets of juveniles and sub-adults have been quantified for some areas (see Taylor 1979, *op. cit.*; Webb et al. 1991, *op. cit.*; Shahrul and Stuebing 1996. J. Trop. Ecol. 12:651–662), the diet, hunting strategies, and prey preferences of adults are limited to anecdotal observations and the occasional stomach sample. Recent observations by Britton and Britton (2013. Herpetol. Rev. 44:312) provided the first insight into the use of a unique foraging technique by *C. porosus* that was previously only recorded in *Caiman yacare* (Olmos and Sazima 1990. Copeia 1990:875–877) and *Caiman crocodilus* (Thorbjarnarson 1993. Copeia 1993:1166–1171). Here, we present three additional observations of cross-posture fishing by *C. porosus* and discuss the implications of these observations in terms of understanding the foraging strategies of the species in northern Australia.

On 24 April 2013, a *C. porosus* (total length ~150 cm) was observed in the Hunter River in the north Kimberley region of Western Australia. The *C. porosus* was observed to be herding prey items using the cross-posture fishing foraging technique in a small tributary of the river on the run out tide (Figs. 1–2). The *C. porosus* was observed with its front legs held perpendicular to the body, palms facing outwards and the toes projected above the water. Consistent with the observations of Britton and Britton (*op. cit.*) the jaws were held partially open with the upper jaw positioned just above the surface of the water and the lower just beneath. The *C. porosus* was observed lunging at mudskippers (*Oxudercinae* sp.) and prawns on the exposed mudflats. Occasionally, the animal was observed to lift its tail out of the water, which was thought to be a mechanism to stop prey from escaping the inlet.

On 2 March 2014, two adult *C. porosus* (total length ~ 250 cm and ~430 cm) were observed on the Yellow Waters Billabong region of the South Alligator River in Kakadu National Park, Northern Territory of Australia. Both animals were observed using the same cross-posture fishing technique. Both *C. porosus* were observed at a



PHOTO BY GREG CALVERT

FIG. 1. *Crocodylus porosus* using the cross-foraging posture in the Hunter River in the Kimberley region of Western Australia.



PHOTO BY GREG CALVERT

FIG. 2. Successful use of the cross-foraging posture by *Crocodylus porosus* to capture prey items in the Hunter River in the Kimberley region of Western Australia.

junction locally known as "three ways," which is situated on one of the upper freshwater billabong reaches of the South Alligator River. Despite observing the foraging activity for an hour, neither *C. porosus* was successful in capturing any prey items. It was noted that Ox-eye Herring (*Megalops cyprinoides*) were observed splashing on the surface in the vicinity of the observation. While we suspect that the individuals were targeting this prey item, this could not be confirmed given the lack of observations of successful prey capture.

A further observation was made on 16 May 2014, where an adult *C. porosus* (400–450 cm) was observed with arms outstretched in the Corroboree Billabong within the Mary River Region of the Northern Territory. While the individual was not observed to have caught any prey using this method, it is likely that the individual was also targeting Ox-eye Herring, a locally common fish species and which were observed splashing on the surface at the time near the observation. Ox-eye Herring have been observed to be a frequent prey item of *C. porosus* in this location previously (D. Rhind, pers. obs.). Although the cross-posture fishing technique has been documented previously (Britton and Britton, *op. cit.*), our observations confirm that the technique is not restricted to Cahill's

Crossing in Kakadu National Park and that the species uses this technique in both estuarine and freshwater systems, which are likely to have varying densities of prey. Our observations provides the first evidence of *C. porosus* using the technique to catch prey in freshwater systems in Australia as well as suggesting that this behavior might be more widespread across its range. Unfortunately, we are unable to determine whether these observations are site specific and we cannot rule out the possibility that the animals in the Mary and South Alligator River do not occasionally migrate to the East Alligator River during periods of high prey availability to use this technique. Our observations of this behavior in the Kimberley region confirm that *C. porosus* outside the Top End region of Northern Australia also use the technique when hunting fish. We propose that this behavior is likely to occur across the distribution of *C. porosus*, however further observations would confirm whether this is the case. Through the documentation of hunting behavior in *C. porosus*, it might be possible to better define the dietary preferences of adults as well as identifying the strategies used and quantifying the rate of hunting success.

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***PALEOSUCHUS TRIGONATUS* (Schneider's Smooth-fronted Caiman). FEEDING BEHAVIOR.** *Paleosuchus trigonatus* is a small crocodilian species that primarily inhabits the closed canopy streams and smaller tributaries of the Amazon Basin (Magnuson and Lima 1991. Herpetol. Rev. 25:41–48; Campbell 1973. Herpetol. Rev. 7:318–320). Similar to other crocodilians, the diet includes a range of both terrestrial and aquatic vertebrates, and invertebrates. The diet of young *P. trigonatus* (SVL ca. 15.0–20.0 cm) is similar to that of the adults (Magnusson et al. 1987. J. Herpetol. 21:85–95). Predation events on *Bufo marinus* (Cane Toads) and *Caecilia marcusi* (Marcus' Caecilians) have also been reported (de Assis and dos Santos 2007. Herpetol. Rev. 38:445; Sampaio et al. 2013. Salamandra 49:227–228). Although the diet of this species has been studied, little is known of the foraging and feeding behavior of young *P. trigonatus*. We report here feeding events of juvenile caiman on two aquatic vertebrates and an invertebrate.

During an eight-month study on the ecology of *P. trigonatus* three observations were made of the feeding behavior of juvenile individuals at two research sites located on the Las Piedras River in the Madre de Dios department of southeastern Peru. During the study, individual caiman were tagged using passive induced transponders; transponder signals confirmed the caiman from these three observations as different individuals.

The first observation was made at 2108 h on 9 May 2013 in a shallow, fast-flowing forest stream at the Amazon Research and Conservation Center (12.04734°S, 69.68180°W, WGS84; 236 m elev.). The individual (SVL = 15.5 cm; tail length = 16.0 cm; 95.0 g) was found in rapids approximately 0.30 m from the bank in a hard-clay pool at a depth of 11 cm. The caiman was beside a submerged log masticating a moth approximately 5.0 cm in length. Upon capture the caiman opened its jaws in display, resulting in the moth dropping from the mouth.

The second observation occurred at 1811 h on 12 May 2013, approximately 40 m upstream from the first observation (12.04702°S, 69.68181°W; 240 m elev.). This individual (SVL = 16.0 cm; tail length = 13.0 cm; 91.0 g) was found in a shallow hard-clay pool one meter from the stream's primary channel. The pool was approximately 100 cm across and 50 cm in width with an approximate depth of 12 cm. The caiman was observed eating a fish that had a total length of 11 cm and weighed 20.2 g. Within one minute after we released the caiman, it retrieved the fish; however, we did not observe the caiman consume it.

The third observation was at 0154 h on 1 August 2013 in a stream at the Las Piedras Biodiversity Station (12.07285°S, 69.52499°W; 260 m elev.). The individual (SVL = 17.1; tail length = 16.6; 140 g) was found next to the bank under overhanging green vegetation in clear water with a sandy bottom at a depth of 22 cm. The individual had a *Helicops angulatus* (Brown-banded Water Snake) (SVL = 18 cm) firmly gripped mid-body. When first found, the snake was still alive and the caiman was using the support of a submerged branch. The caiman raised its head above the water and chewed twice before submerging its jaw with the snake under the water. The snake continuously thrashed as the caiman held it slightly submerged under the water. Over the course of two minutes the snake was observed to bite the caiman four times. However the caiman appeared unharmed by the defense. Approximately three minutes following the final defensive strike the caiman swam a distance of approximately one meter upstream with the snake still clutched in its jaws. It then retreated under a bank where it was captured for analysis. Upon capture the snake was found to be dead and despite being submerged in fast-flowing water the musk of the snake could be smelled emanating off of both individuals. During release the caiman was placed with the snake on the bank, however it quickly retreated beneath the opposite bank and out of site.

These observations further demonstrate the diverse prey base of this species and include insights into the feeding behavior of young individuals.

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SQUAMATA — LIZARDS

***AMEIVA EXSUL* (Puerto Rican Ground Lizard). REPRODUCTION.** *Ameiva exsul* is an abundant lizard distributed throughout Puerto Rico, the United States Virgin Islands, and the British Virgin Islands. It was recently introduced to St. Croix, which was a separate land bank that never hosted the species historically (Treglia et al. 2013. Carib. J. Sci. 47:360–365). This diurnal species occupies coastal forests and moves between shade and sun constantly. Lizards from different populations thermoregulate to different optimal temperatures. Eight lizards averaged a body temperature of 39.5 ± 1.42°C in Rosario Poblado, Puerto Rico (Rivera-Vélez and Lewis 1994. J. Herpetol. 28:1–6), while 89 lizards averaged a body temperature of 37.73 ± 0.23°C at the time of capture by noosing in Guana Island, British Virgin Islands (Gifford et al. 2012. J. Therm. Biol. 37:496–501). Females are rarely included in these studies due to low capture rates. The effect of thermoregulatory behavior on reproduction patterns in this species is largely unknown. Individuals reproduce discontinuously in southwestern Puerto Rico, presumably due to environmental



FIG. 1. Five eggs from a female *Ameiva exsul* in St. Croix, USVI.

TABLE. 1. Measurements of five eggs for an *Ameiva exsul* clutch oviposited in St. Croix, USVI.

Egg	Mass (g)	Length (mm)	Width (mm)	Diameter (mm)
1	1.2	18.83	10.77	34.07
2	1.2	17.91	10.14	36.13
3	1.2	18.51	10.99	35.63
4	1.1	18.72	10.41	33.11
5	1.1	17.81	10.11	33.56

cues (Rodriguez-Ramirez and Lewis 1991. Herpetologica 47:395–403). Rodriguez-Ramirez and Lewis (*op. cit.*) examined seven adult female *A. exsul,* which contained one to three oviductal eggs. An additional 18 adult females contained one to six enlarged follicles. Reports of clutches greater than three eggs are unknown, and the cloacal temperatures of a thermoregulating gravid females have not been published.

We captured a shuttling female *A. exsul* by noosing in St. Croix, United States Virgin Islands at 1228 h on 21 July 2014. At the time of capture, we read a cloacal temperature of 31.8°C. The cloacal temperature was below the temperature range of five male lizards that we caught from the same population (mean = 37.16°C, range: 36.3–38.4°C), so we measured the lizard's temperature again at the capture location while the lizard was unrestrained inside a pillowcase to check for accuracy. The second cloacal temperature reading was 31.8°C. At the time of capture, the lizard weighed 42.5 g, and we measured the following morphometric characters: SVL = 101.0 mm, tail length = 273 mm (no regeneration). The lizard was kept alone in a pillowcase overnight. On 22 July 2014, we prepared to take photographs of the lizard at 0830 h. After opening the bag and removing the female, we noticed several eggs in the bottom of the bag. We removed the eggs from the bag (Fig. 1) and external egg dimensions and mass were obtained (Table 1). The eggs were preserved in ethyl alcohol and deposited at the Texas A&M University Biodiversity Research and Teaching Collections.

Clutch size is known to vary among latitudes, seasons, and in response to local conditions (Shine 2005. Annu. Rev. Ecol. Evol. Syst. 36:23–46). In some species of lizards, only older and larger females produce large clutches. Large clutch size could indicate that the introduced population of ground lizards on St. Croix has responded to novel local conditions or that females live longer in St. Croix in the absence of native predators (i.e., predatory snakes are extinct in St. Croix). All of the eggs were viable; to our knowledge this is the largest egg clutch reported for the species. We suggest that this female *A. exsul* oviposited eggs voluntarily as a stress response. We believe that the female was maintaining a cooler body temperature at the time of capture than is normally associated with the species, perhaps for the benefit of the clutch.

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***ANOLIS CAROLINENSIS* (Green Anole). DIET.** On 6 Aug 2014 an adult male *Anolis carolinensis* was observed between 1800 h and 1900 h feeding on the chrysalises of *Agraulis vanillae* (Gulf

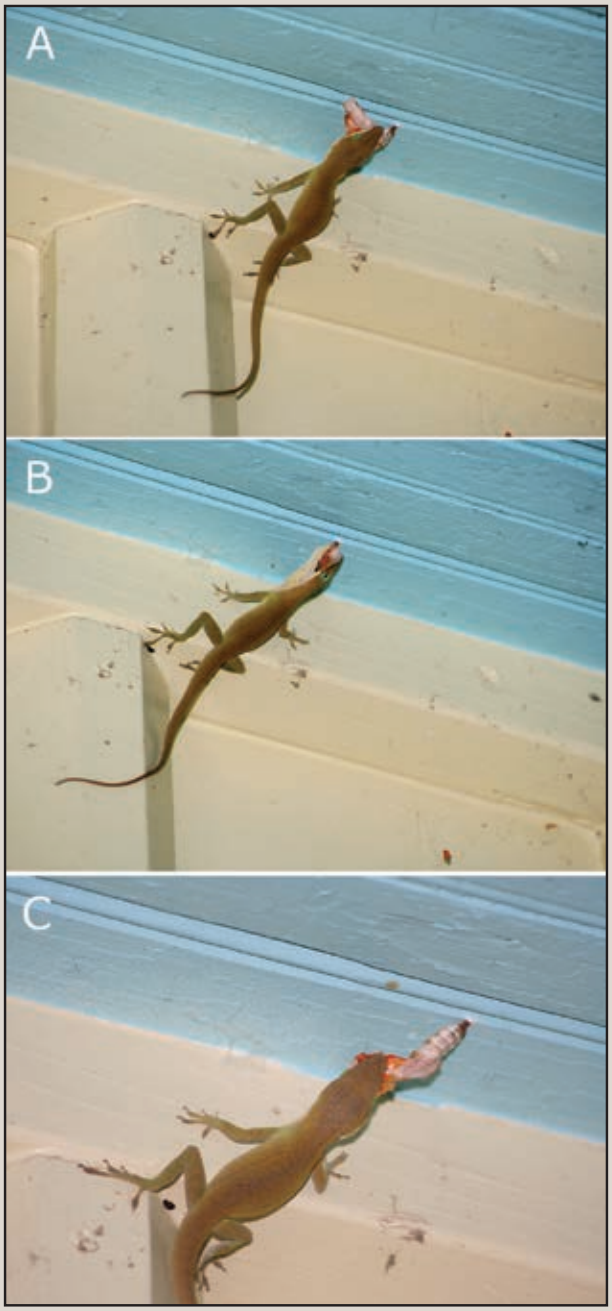


FIG. 1. A) *Anolis carolinensis* feeding on *Agraulis vanilla* chrysalis. B) Feeding on *Agraulis vanilla* chrysalis showing twisting motion. C) Feeding on *Agraulis vanilla* chrysalis showing yellowish liquid.

Fritillary). The chrysalises were located on the back porch of a house (32.514262°N, 85.611764°W; WGS84) and were made by caterpillars that had dispersed from a nearby native Passion Fruit vine (*Passiflora incarnata*) to pupate. During this time the lizard attacked and partially consumed two separate chrysalises. One chrysalis was 174.6 cm above the porch deck (or 254.6 cm above the ground surface) and the other was 327.0 cm (or 407.0 cm off the ground surface). The anole approached each chrysalis and nudged it several times with its nose, perhaps to elicit movement from the chrysalis that would indicate a butterfly had not yet emerged. It then latched onto the unattached end of the chrysalis and alternated between vigorous shaking of its head, twisting, bracing with all four feet and pulling backward, and quick chewing motions (Figs. 1A–B). Neither of the chrysalises detached from their substrate but the lizard did manage to break through the shell and tear off significant pieces, which the lizard then swallowed.

Anolis carolinensis is known to be insectivorous, and is assumed to consume a variety of arthropod species (Smith and Frost 1995. Handbook of Lizards: Lizards of the United States and of Canada. Cornell University Press, Ithaca, New York. 557 pp.). A captive anole was observed to eat butterflies but the species was not mentioned (Palmer and Braswell 1995. Reptiles of North Carolina. University of North Carolina Press. 448 pp.). The Gulf Fritillary is also known to secrete defensive compounds as an adult (Ross et al. 2001. J. Chem. Ecol. 27[6]:1219–1228), primarily 6-methyl-5-hepten-2-one. Ross et al. (*op. cit.*) observed deterred feeding by Green Anoles on the cockroach *Neostylopyga rhombifolia*, which also secretes this compound. Yellow and orange fluid was seen coming from the chrysalis once injured (Fig. 1C) but there did not seem to be any deterrent effect on the feeding behavior of the anole.

This observation is the first diet record of *Agraulis vanillae* being consumed by *A. carolinensis* and also the first documentation of an anole consuming a chrysalis.

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***ASPIDOSCELIS EXSANGUIS* (Chihuahuan Spotted Whiptail). LIFE HISTORY IN MEXICO.** *Aspidoscelis exsanguis* is a widely distributed triploid hybrid-derived parthenogenetic lizard species (Good and Wright 1984. Experientia 40:1012–1014; Reeder et al. 2001. Amer. Mus. Novitat. 3365:1–61) in parts of Arizona, New Mexico, and Texas in the United States and in Sonora and Chihuahua in northern México. Aside from publication of distribution records, the taxonomy and biology of this species have not been studied in México. During extended field expeditions in preparation for publication of the tome on the herpetology of Chihuahua (see Lemos-Espinal and Smith 2007. Anfibios y Reptiles del Estado de Chihuahua, México/Amphibians and Reptiles of the State of Chihuahua, México. UNAM-CONABIO. México, D.F. 613 pp.), JAL-E collected lizards from a site in the northwestern quadrant of the state in late July 2002. We used them to clarify aspects of the life history of *A. exsanguis* in México where it is an entity with a name, but is an enigmatic species that is easily confused with congeners such as triploid parthenogenetic *A. sonorae* and *A. uniparens*, and gonochoristic *A. inornata* and *A. gularis scalaris* at certain stages of color pattern development. This study using ontogeny of color pattern clarifies identification of the species in Chihuahua, but more importantly it provides a basis for interpretation of the life history and age-related color pattern variation in *A. exsanguis*. These were not objectives of studies on the species conducted in the southwestern United States by Taylor and Caraveo (2003. Southwest Nat. 48:685–692) on clutch size and Bateman et al. (2010. J. Herpetol. 44:301–306) on growth rates and survivorship.

The study site (ca. 30.369833°N, 108.23575°W, WGS84; 1682 m elev.) in Chihuahua comprised an area of about five kilometers in length along the Río Piedras Verdes. This is a relatively flat area of ~20 m in width, on both sides of the southeasterly-directed river, which transitions from the bisected canyon floor to rocky hills and mountains. In the relatively flat portion of the site there was an abundance of Álamos trees (*Populus* sp.), with some interspaced oaks (*Quercus* sp.), with the latter being more abundant on the rocky hills and mountains. The dominant shrubs in the flat areas with ample open spaces and a variety of substrate types were manzanita (*Arctostaphylos* sp.), and scattered low-growing junipers (*Juniperus* sp.) which increased in abundance in the higher elevations. Where the river flows through the study site it is known as Red Rock Canyon, and alternatively as Cañón de la Tinaja, because of the large amount of clay in the soil and the reddish color of the rocks. Among the reptiles observed/collected at the site were *Sceloporus jarrovii* (Yarrow's Spiny Lizard), *S. virgatus* (Striped Plateau Lizard), *S. poinsetti* (Crevice Spiny Lizard), *Crotalus willardi silus* (Chihuahua Ridge-nosed Rattlesnake), *C. molossus* (Black-tailed Rattlesnake), *Thamnophis cyrtopsis* (Black-necked Gartersnake), and *Salvadora deserticola* (Big Bend Patch-nosed Snake). *Aspidoscelis exsanguis* was the only whiptail lizard species in this complex community of lizards and snakes, some of the latter being potential predators of Chihuahuan Spotted Whiptail, and it was easily the most ubiquitous and abundant of the species listed. This study site in Chihuahua also provides a noteworthy example of the presence of a parthenogenetic species of *Aspidoscelis* in a geographic area and local landscape devoid of any gonochoristic species of the genus (see Wright and Lowe 1968. Copeia 1968:128–138), a circumstance that was possibly correlated with the local abundance *A. exsanguis*.

Not only was *A. exsanguis* the most commonly encountered of the denizens of the flats in Red Rock Canyon, in numbers that prompted us to use the terminology "super abundance" (i.e., encountered in large numbers without special effort), it was also the least wary, most readily observable during its activities, and the most easily collected species. Consequently, 88 specimens of *A. exsanguis* were collected in late July which were catalogued into the collection of the Laboratorio de Ecología de la Unidad de Biotecnología y Prototipos (LEUBIPRO) in México City using the numbers 9782–9827, 9841–9844, 9849–9886. At the University of Arkansas, JMW measured the SVL of each specimen to the nearest 0.1 mm, and recorded the tail as being either complete or regenerated. The number of the caudal scale whorl immediately proximal to beginning of the regenerated portion was recorded counting distally from the first complete whorl at the base of the tail. Details of color pattern were recorded for each specimen to facilitate the first analyses of ontogenetic changes with growth in SVL in the species. Also noted was the reproductive condition of each specimen, there being only two categories resulting from the late July date of collection, either immature (~31–60 mm SVL) or of adult size and reproductively quiescent for the year (~61–85 mm SVL), the latter range based on clutch data for the species observed in New Mexico by Taylor and Caraveo (*op. cit.*). Statistical analyses were performed at the University of Arkansas on a

PC using institutionally licensed JMP software (Version 11 SAS Institute, Inc., Cary, North Carolina, Copyright © 2013).

As specimens were being collected it seemed that the late July 2002 composition of the array of *A. exsanguis* in Red Rock Canyon continuously ranged in SVL from recent hatchlings (young-of-year; YOY) to large adults of several years in age. However, as they were being measured, a gap in SVL coverage spanning ~3452 mm SVL was noted. Further analyses revealed that each of the lizards was part of one of four SVL groups characterized by consistently different sets of characters of the dorsal color pattern, which had developed from one through either three or four reproductive activity cycles. The dorsal pattern of YOY in the sample of *A. exsanguis* included three pairs of contrasting longitudinal yellow-hued stripes (ventral to dorsal on each side the straight-margined laterals and dorsolaterals and the unevenly margined paravertebrals) and blackish intervening fields with barely visible spots (stage one), which transitioned to less contrast between stripes and fields and more distinct spots (stage two), which transitioned to brown-black fields, yellow-tan stripes, a profusion of tan spots, and a reticulated pattern of pale markings on the hind limbs (stage three), which transitioned to low contrast stripes and fields, profusion of spot on the stripes and in the fields, and spotted hind limbs (stage four). Analysis of SVL data spanning each of the four stages of ontogenetic pattern development revealed that the mean for each one was significantly different from all others ($P = 0.05$). Stage one included only two recent YOY of 31.3 and 32.4 mm SVL (mean 31.8 ± 0.55), though more of them were observed in Red Rock Canyon, but not collected. Stage two included three immature and 27 mature lizards (with similar dorsal patterns) of 53.070.5 mm SVL (mean 64.6 ± 0.85). Stage three included 29 adults of 66.9–81 mm SVL, mean 73.0 ± 0.69. Stage four included 27 adults of 73.7–84.6, mean 79.8 ± 0.57. We found a strong correlation between SVL and stage of dorsal pattern ontogeny (adjusted $r^2 = 0.6954$, $P \leq 0.0001$). The size range in which the transition from group one to two occurred could not be determined because of absence of specimens between 34 and 52 mm SVL, transition of stage two to stage three occurred from 67 to 71 mm SVL, and transition from stage three to stage four occurred from 77 to 78 mm SVL. We hypothesize that these data support the hypothesis that the sample of *A. exsanguis* from Chihuahua comprised four year-classes represented by the stages of ontogenetic dorsal pattern development.

In summary, we propose that the life cycle of *A. exsanguis* at the GPS coordinates noted for Red Rock Canyon proceeds as follows. Hatchlings appear from mid-July into August and grow rapidly until they become inactive for the year in October. Immature lizards with a range of SVL lengths emerge from inactivity for their second growing season in the following April to May; the largest (i.e., earliest) of the previous year hatchlings possibly attain reproductive status (~61 mm SVL; see Taylor and Caraveo, *op. cit.*) in the second summer, whereas the smallest (i.e., latest) hatchlings of the previous year would not attain reproductive maturity until the third summer. Most lizards transition to the fourth and final distinctive stage of pattern ontogeny, and maximum reproductive potential, in the fourth and last summer of life. The largest among the specimens of *A. exsanguis* from Red Rock Canyon was only 84.6 mm SVL, whereas Taylor and Caraveo (*op. cit.*) reported a lizard of 93 mm SVL from New Mexico. Although we note the presence of several potential predators of Chihuahuan Spotted Whiptail in Red Rock Canyon we hypothesize that death by senescence following last clutch production is the usual basis for the end of the life cycle. Only 12 of 88 (13.6%) specimens exhibited regenerated tails, which included ontogenetic stages two (individuals of 54.0, 62.8 mm SVL), stage three (66.9, 69.5, 73.2, 73.5, 76.2, 78.2 mm SVL), and stage four (73.7, 78.2. 82.5, 84.2 mm SVL), distal to caudal whorls 1444, mean 23.8 ± 2.51. These data possibly indicate that predation encounters and escapes by tail autotomy are infrequent occurrences in *A. exsanguis* in Red Rock Canyon, Chihuahua.

Specimens referenced herein were collected in Chihuahua by JAL-E and imported to the United States for study under authority of permits provided by the government of México.

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***ASPIDOSCELIS GULARIS SEPTEMVITTATA* (Mexican Plateau Striped Whiptail). REPRODUCTION.** *Aspidoscelis gularis septemvittata* (Walker 1981a. Copeia 1981:826–849; Walker 1981b. Copeia 1981:850–868) is a moderately large and persistently striped lizard that inhabits parts of the mountainous border region of Trans-Pecos Texas, United States, and similar areas in adjacent Chihuahua State, México. We assessed size and reproductive characteristics for this biologically poorly known species based on 30 specimens from geographically proximate sites in Chihuahua identified by Walker et al. (2001. Copeia 2001:747–765). No other congeners were observed at these sites, which may in part account for the observed abundance of *A. g. septemvittata* by JAL-E. Data for SVL and clutch size based on measurements and dissections of lizards in the sample designated as SEPT-CMX1 (Walker et al., *op. cit.*) are presented herein by ranges of variation, sex, and/or means (to one decimal place) ± 1 SE. Statistical analyses were performed at the University of Arkansas on a PC using institutionally licensed JMP software (Version 11 SAS Institute, Inc., Cary, North Carolina, Copyright © 2013)

The sample collected 6–10 July 1999 by JAL-E, during preparation of the herpetofaunal study by Lemos-Espinal and Smith (2007. Anfibios y Reptiles del Estado de Chihuahua, México / Amphibians and Reptiles of the State of Chihuahua, México. UNAM-CONABIO. México, D.F. 613 pp.), included 14 males and 16 females. All males were sexually mature based on swollen testes and enlarged femoral pores, and they represented more than one year-class based on the wide SVL range of 40 mm (71, 73, 77, 78, 79, 82, 85 [2], 87 [2], 89, 95, 105, 111, mean 86.0 ± 3.04). Based on the content of all five samples of *A. g. septemvittata* collected from Chihuahua by JAL-E and reported by Walker et al. (*op. cit.*), only 14% exceeded 100 mm SVL. Sample SEPT-CMX1 also included one juvenile female (58 mm SVL) and 15 adult females based on the smallest gravid individual [64, 68, 69, 70, 71, 73, 74, 76, 79, 81, 83 (2), 85, 86, 94 mm SVL, mean 77.1 ± 2.12]. They also represented more than one year-class based on the wide SVL range of 30 mm. Based on the content of all five samples of *A. g. septemvittata* collected from Chihuahua by JAL-E and reported by Walker et al. (*op. cit.*), only 10% exceeded 90 mm SVL. The size data indicate that males of *A. g. septemvittata* in Chihuahua can attain a larger mean SVL than females ($P = 0.05$). In the SEPT-CMX1 sample, clutches of two were present in three females (64–70 mm SVL), clutches of three were present in three (71–74 mm SVL), clutches of four were present in five (79–85 mm SVL), and a clutch of six was present in one (94 mm SVL), mean clutch size 3.4 ± 0.84. Linear regression calculated in JMP indicates a nearly

perfect correlation between SVL and clutch size for the 12 gravid Chihuahua females of *A. g. septemvittata* (based on adjusted r^2 = 0.92; $P \leq 0.0001$). We offer the hypothesis that simultaneous July clutch production among the year classes of *A. g. septemvittata* represented in sample SEPT-CMX1 (i.e., 64–94 mm SVL) from Chihuahua allows for the possibility that one late clutch is likely produced in the first activity cycle of maturity and a minimum of an early and a late clutch develop in the second and subsequent years of maturity.

Specimens referenced herein were collected in Chihuahua by JAL-E and imported to the United States for study under authority of permits provided by the government of México. The specimens were deposited in the collections of the University of Colorado Museum of Natural History, Boulder, Colorado, and Laboratorio de Ecología, Unidad de Biotecnología y Prototipos, Facultad de Estudios Superiores Iztacala, UNAM, Estado de México, México. They were represented by JAL-E numbers at the time of the laboratory examinations, and referenced as sample SEPT-CMX1 in a systematic study that included the authors (Walker et al., *op. cit.*) comprising the following: Chihuahua: Polvorillas (= Piedras Encimadas), 28.793389°N, 104.225222°W, 1440 m elev. (6 July 1999 [JAL-E 3606–3612, N = 7], 7 July 1999 [JAL-E 3619–3630, 3654–3656, N = 15]; 9 July 1999 [JAL-E 3744, N = 1]); Llano El Nito, a flat area 1.5 km NW of Polvorillas, 1450 m elev. (8 July 1999 [JAL-E 3699, N = 1]; 9 July 1999 [JAL-E 3708–3711, N = 4]); Rancho Virulento base of Sierra El Virulento, 28.761361°N, 104.335694°W, 1502 m elev. (10 July 1999 [JAL-E 3749–3750, N = 2]).

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***ASPIDOSCELIS INORNATA* (Little Striped Whiptail). NORTHERN LIFE HISTORY.** The geographic distribution of *Aspidoscelis inornata* (Little Striped Whiptail) spans more than 1500 km between the northwestern corner of New Mexico (USA) and southern Zacatecas and San Luis Potosi states, México (see map in Wright and Lowe 1993. J. Arizona-Nevada Acad. Sci. 27:129–157). We assessed size and reproductive characteristics of *A. inornata* from San Juan Co., New Mexico, which marks the northern distributional limits of the species. We undertook the analyses because studies of latitudinally extensively distributed *A. tigris* (e.g., McCoy and Hoddenbach 1966. Science 154:1671–1672; Pianka 1970. Ecology 51:703–720; Burkholder and Walker 1973. Herpetologica 29:7683) have demonstrated the desirability of assessing life history characteristics of whiptail lizard species at different latitudes and altitudes to understand regional adaptations. We did not use the trinomial *A. i. junipera* (sensu Wright and Lowe, *op. cit.*) for the populations of diminutive lizards (maximum observed SVL = 70 mm and body mass 7.8 g) in this area so as to avoid the potential controversy introduced by the revised subspecies allocation based on mtDNA by Sullivan et al. (2014. Copeia 2014:519–529). Our study area was near the ecologically complex Bisti/De-Na-Zin Badlands, administered by the US Bureau of Land Management, in San Juan Co. in the four corners area of the western United States. No other species of whiptail lizards known from San Juan Co. (e.g., triploid parthenogenetic *A. velox* and gonochoristic *A. tigris*) were observed at the sites investigated which may in part account for the exceptional abundance of *A. inornata* in and near the vast Bisti/De-Na-Zin Badlands. Data for SVL, sex, and clutch size based on measurement and dissection of the lizards in the University of Arkansas Department of Zoology (UADZ) sample are presented with ranges of variation, sex as a ratio, and/or means (to one decimal place) ±1 SE.

Numbers of males and females of *A. inornata* (M:F), by size (as 5-mm SVL increments if applicable) were used to track sex ratio by size among the 25 specimens collected in May–June 2013 and 11 collected in early July 2013 (Table 1). According to our observation in San Juan Co., and the study of *A. inornata* by Christensen (1971. Amer. Mus. Novitat. 2442:1–48) in Bernalillo Co., central New Mexico, young-of-year hatch in the last part of July, remain active until early September, and become inactive until April–May at ~38–44 mm SVL. Thus, for lizards collected in May–June 2013 in San Juan Co. (Table 1) we infer that juvenile individuals of 42–48 mm (mean 45.8 ± 1.20, N = 5) were hatched in the summer of 2012. Adult females of 59–68 mm (mean 62.8 ± 1.03, N = 8) and adult males of 57–70 mm (mean 62.1 ± 0.91, N = 12) in the sample are not significantly different in size, and were conservatively estimated to have hatched in the summer of 2011. Numbers of males and females collected near the Bisti/De-Na-Zin Badlands in early July 2013 (Table 1) included five juveniles of 48–53 mm (mean 50.2 ± 0.80) and also six adults of 57–66 mm (mean 61.8 ± 1.25). We concluded that individuals of *A. inornata* at the latitude of the Bisti/De-Na-Zin Badlands do not attain reproductive maturity in the summer following that of hatching. Christensen (*op. cit.*) also concluded that few if any individuals of the species attain sexual maturity in the year following hatching in the Albuquerque area in Bernalillo Co. We could not accurately determine whether either our May–June or July 2013 samples included individuals in the fourth summer of life based on SVL data.

In the May–June sample seven of eight adult females had yolked ovarian follicles; none of the July adult females were gravid. Clutch size was 2.9 ± 0.14 (range 2–3) eggs. The relationship between clutch size and SVL was not significantly correlated for the seven San Juan Co. females of *A. inornata* (based on adjusted r^2 = 0.20; P = 0.1747). We compared it with data for *A. pai* (= *A. i. pai*; Pai Striped Whiptail) from northcentral Arizona. It had a mean SVL of 65.3 ± 1.08 mm, 61–72 mm (N = 11), of which only two females exceeded 70 mm (Walker et al. 2012. Herpetol. Conserv. Biol. 7:265–275). Clutch size was 3.18 ± 0.18 (range 2–4) for *A. pai* and it was not significantly correlated with SVL (adjusted r^2 = 0.27, P = 0.436). Although the maximum clutch size for *A. pai* exceeded that of *A. inornata*, mean clutch sizes for the two were similar.

For this study we examined 36 preserved specimens of *A. inornata* from the UADZ collection obtained by JEC in 2013 as follows:

TABLE 1. Numbers of males and females of *Aspidoscelis inornata* from San Juan County, New Mexico, recorded as 5-mm SVL increments where possible within the total range to track sex ratio by size among specimens collected in May–June and July 2013.

Period	Total SVL Range in 5-mm Increments and Sex Ratio (M:F)							
May–June 2013	42–70 14:11	42–44 2:0	45–49 0:3	50–54 0:0	55–59 2:1	60–64 9:5	65–69 0:2	70 1:0
July 2013	48–66 4:7	—	48–49 0:1	50–54 2:2	55–59 0:1	60–64 2:2	65–66 0:1	—

New Mexico, San Juan Co., jct NM Hwy 371 & CR 7290, 11.2 km N of Bisti/De-Na-Zin access on 371 (36.325639°N, 108.2560755°W, ~1847 m elev.) in an active Prairie Dog town on the E side of Hwy 371, ~47 km S of San Juan River crossing in Farmington on Hwy 371: UADZ 9201–9210 (N = 10), 26 May 2013; UADZ 9213–9222 (N = 10), 27 May 2013; UADZ 9255–9256 (N = 2), 5 June 2013; UADZ 9257–9259 (N = 3), 6 June 2013; UADZ 9334–9338 (N = 5), 8 July 2013; UADZ 9368–9373 (N = 6), 17 July 2013.

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***ASPIDOSCELIS SEXLINEATA VIRIDIS* (Prairie Racerunner). EXTREME COLOR VARIANT.** We have collectively examined >10,000 specimens and numerous photographs of *Aspidoscelis sexlineata* from its vast geographic range in the United States (Trauth 1980. Ph.D. Dissert., Auburn Univ., Auburn, 201 pp.; Trauth 1992. Texas J. Sci. 44:437–443; Trauth and McAllister 1996. Cat. Amer. Amphib. Rept. 628:1–12) and Mexico (Pérez-Ramos 2010. Southwest. Nat. 55:419–225). Although ontogenetic changes and sexual dimorphism occur in each of the three recognized subspecies of *A. sexlineata* (see de Quieroz and Reeder 2012. SSAR Herpetol. Circular 39:32–51), these variations have been within the scope of the respective diagnoses provided for each taxon (Lowe 1966. J. Arizona Acad. Sci. 4:44–45; Trauth 1980, *op. cit.*; Trauth 1992, *op. cit.*; Trauth and McAllister 1996, *op. cit.*; Pérez-Ramos 2010, *op. cit.*). An adult female of *A. sexlineata viridis* from western Nebraska, captured alive on 25 May 2014 and shipped to SET on 28 May 2014 by JBI, ARH, and LCC, exhibited such extreme aspects of dorsal and ventral coloration as to necessitate commemoration of it in the literature. It was the only such individual among the thousands of *A. s. viridis* observed by JBI at the Nebraska site during 35 years of study. The lizard was caught in a bucket trap in a drift fence array of ~1.2 km in length near Road 181 (41.9345°N, 102.4825°W, NAD83; ~1173 m elev.), north of Gimlet Lake, Garden Co., Nebraska, USA. The habitat there consisted of upland naturally open-structured sandhills, but with an active invasion of the widely distributed Asian adventive, Cheatgrass (*Bromus tectorum*). The unique specimen has been catalogued by SET as Arkansas State University Museum of Zoology (ASUMZ) 33235, along with three normally patterned *A. s. viridis* (ASUMZ 33230–33232) also subsequently caught in the same bucket trap. Examined for comparisons were two typical specimens of *A. s. viridis* (ASUMZ 33233–33234), collected in a gravelly ravine (41.6757°N, 102.3852°W, NAD83; 1235 m elev.), ~10.5 km SE of the previously noted site, Garden Co., Nebraska, USA.

The dorsal color pattern in ASUMZ 33235 (SVL = 62 mm; complete tail length = 138 mm) in life was unique because of the absence of the green suffusion on the head and body, which is typically present in adult females of *A. s. viridis*. The striping pattern (ventral to dorsal) consisted of a pair of barely visible and essentially vestigial ventrolaterals, three pairs of primary stripes so termed because they are fixed in position among individuals of this taxon, and a secondary vertebral stripe so termed because of variation among individual lizards (Table 1). The ground color between the stripes, termed fields, consisted of hues of dark brown (Fig. 1-middle; Table 1) rather than the hues of green suffusions on tan or light brown characteristic of normal adult females (Fig. 1-upper) and males (Fig. 1-lower) of *A. s. viridis* from Nebraska. The dorsal tail coloration was dark brown between the dorsolateral and paravertebral stripe extensions in the unusual specimen, but tan in typical specimens.

Stunningly, adult female ASUMZ 33235 had a dusky black chin and throat that has not been observed in the normal color pattern of any other species in the *Aspidoscelis sexlineata* species group in the United States. However, dusky to black throat colorations characterize some populations of *A. costata* in the *A. sexlineata* group in western Mexico (Duellman and Zweifel 1962. Bull. Amer. Mus. Nat. Hist. 123:155210) and of *A. tigris*



FIG. 1. Dorsal color patterns of live specimens of a normal male (ASUMZ 33233, lower) and female (ASUMZ 33234, upper) *Aspidoscelis sexlineata viridis* in contrast to the variant female (ASUMZ 33235, middle).

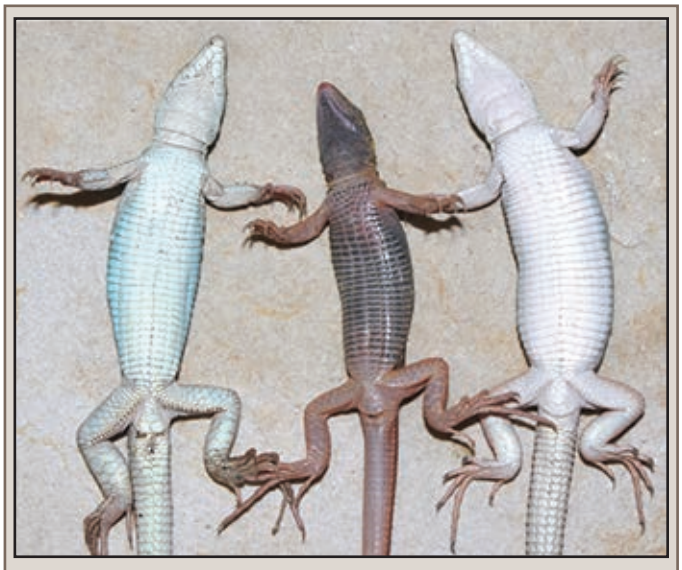


FIG. 2. Ventral color patterns of live specimens shown in Fig. 1 (ASUMZ 33233, at left).

TABLE 1. Dorsal color pattern components in the variant of *Aspidoscelis sexlineata viridis* (ASUMZ 33235) from Garden County, Nebraska, USA.

Pattern Component	Location of Component	Color(s)	Extent of Presence
Paired Ventrolateral Stripes (Vestigial)	Dorsal to Ventral Scales	GrayWhite	Head and Body (Indistinct)
Paired Lateral Stripes (Primary)	Dorsal to Ventrolaterals	GrayWhite to GrayTan	Head and Body
Paired Dorsolateral Stripes (Primary)	Dorsal to Laterals	GrayWhite to GrayTan	Head, Body, and Tail
Paired Paravertebral Stripes (Primary)	Dorsal to Dorsolaterals	GrayWhite to GrayTan	Head, Body, and Tail
Single Vertebral Stripe (Secondary)	Along Midsagittal Plane	Tan to Pale Brown	Head and Body
Fields (= Ground Color)	Between Stripes	Predominantly Dark Brown	Body

(Tiger Whiptail) in the *A. tigris* group in the southwestern USA (Dessauer et al. 2000. Bull. Amer. Mus. Nat. Hist. 246:1148). The dusky black pigmentation was also present in the scalation of the thoracic and abdominal surfaces of ASUMZ 33235 (Fig. 2-middle). Equally unexpected was the ventral distribution of pink-red pigmentation on the entire venter, even involving parts of the scales with dusky black pigmentation, a coloration that has not been reported in *A. sexlineata*. Entirely pink-red pigmentation also characterized the ventral aspects of the legs and tail of the female. The typical adult females from the study area had immaculate white venters (Fig. 2-right), whereas males had predominantly white venters with faint hues of blue in the thoracic and abdominal regions and under the legs (Fig. 2-left).

In ASUMZ 33235 the mesoptychial scales bordering the gular fold were abruptly enlarged and the postantebrachial scales on the posterior aspects of the forearms were only slightly enlarged from granular size in both the typical and atypical females depicted in Fig. 2. Moreover, data for the granules = scales around midbody, 72; granules from occipital scales to first row of caudal scales, 182; granules between the paravertebral stripes, 11; and femoral pores, 15 left/16 right were within known ranges of variation (Trauth 1980, *op. cit.*; J. M. Walker, unpubl.).

Examples of extreme color pattern variants among gonochoristic species in both the *A. sexlineata* and *A. tigris* species groups have been reported. With reference to the *A. sexlineata* group, Christiansen and Degenhardt (1969. Texas J. Sci. 21:95–97) reported a variant of *A. gularis* (Texas Spotted Whiptail) from New Mexico with an unusual dorsal pattern in which all traces of the pale stripes had been replaced by spots, and Walker et al. (1996. J. Herpetol. 30:271–275) reported an individual of *A. inornata* (Little Striped Whiptail) that lacked all traces of stripes collected from a population of normally striped lizards in Chihuahua, Mexico. For the *A. tigris* group, both Acre et al. (2012. Southwest. Nat. 57:206–207) and Ballinger and McKinney (1968. Herpetologica 24:264–266) reported individuals of *A. marmorata* (Marbled Whiptail) from Texas and New Mexico, respectively, that were termed patternless morphs because they lacked a contrasting dorsal pattern. Based on data for color pattern variation in *A. gularis* (Walker 1981a. Copeia 1981:826–849; Walker 1981b. Copeia 1981:850–868), *A. inornata* (Wright and Lowe 1993. J. Arizona–Nevada Acad. Sci. 27:129–157; Walker et al. 2009. Herpetol. Rev. 40:276–282; Sullivan et al. 2013. Copeia 2013:366–377), and *A. tigris* (Hendricks and Dixon 1986. Texas J. Sci. 38:327–402), it is evident that the extreme variant of *A. s. viridis* reported herein is in a class apart from the other examples cited because it represents a categorical departure from all previously reported variation in the species (Figs. 1–2). Although the causation of the extreme color pattern variation in ASUMZ 33235 cannot be ascertained, there are only two possible explanations for its existence. Either it was the product of a rare non-genetic developmental anomaly, from which normally patterned offspring would be expected, or it is the result of one or more mutations, from which the aberrant pattern could have possibly been perpetuated in future generations had reproduction occurred.

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***CROCODILURUS AMAZONICUS* (Crocodile Tegu). DIET**. *Crocodilurus amazonicus* is a medium-sized neotropical lizard widely distributed throughout the Amazon Basin and Orinoco River. It prefers semi-aquatic habitats, often being found near water. There are few published accounts of the ecology and natural history of this lizard. Vanzolini and Valencia (1965. Arq. Zool. São Paulo 13:7–46) described *C. amazonicus* dentition as insectivorous, whereas Presch (1974. Herpetologica 30[4]:344–349) suggested that *C. amazonicus* dentition is adapted for grasping and tearing large prey. Vertebrates have been recorded for the diet of *C. amazonicus*, including anurans, a snake, and fish (Costa et al. 2005. Herpetol. Rev. 36:174–175; Mesquita et al. 2006. J. Herpetol. 40:221–229). The identity of fish species consumed and the method of prey capture remain unknown.

On 25 March 2014 we observed *C. amazonicus* preying on a fish, *Pterophyllum scalare* (Discus Flag) (Fig. 1A, B), on the Rio Solimões in municipality of Iranduba, Amazonas, Brazil



FIG. 1. *Crocodilurus amazonicus* consuming its prey, *Pterophyllum scalare.*

(3.227210°S, 60.004606°W; WGS84). The lizard was seen diurnally active on a lilypad (*Victoria amazonica*) capturing the fish, considerably larger than the lizard's head. On the lilypad and walking on its edges, the lizard quickly stuck its head in the water, grabbing the fish with its teeth. The presence of lilypads might facilitate visualization of prey in the water and prevent the prey from seeing the shadow and reflection of the hunting lizard.

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***CTENOTUS GRANDIS GRANDIS* (Grand Ctenotus). BIFURCATION.** A common anti-predation strategy in many lizard species is the ability to drop all or part of their tail, caudal autotomy, when attempted predation occurs (Arnold 1984. J. Nat. Hist. 18:127–169; Bateman and Fleming 2009. J. Zool. 277:1–14). Loss of the tail, or part of, allows for the lizard to remove itself from the constraints of the predator and retreat, leaving the predator distracted by or to feed on the tail (Arnold 1984, *op. cit.*; Bateman and Fleming 2009, *op. cit.*; Sownes and Shine 2001. Ecology 82:1293–1303). Following the loss of all or part of a tail, it is often regenerated; however, if the autotomy process is not completed and the tail only partially detaches, the regeneration process may still be triggered if sufficient damage has occurred. In the event of a partial autotomy, if enough muscle and/or bone remain intact, the partially autotomized tail portion may remain and a second regeneration tail may begin to grow in addition to the existing tail, resulting in two tails or bifurcation (Bateman and Fleming 2009, *op. cit.*; Dudek and Ekner-Grzyb 2014. Natura Sloveniae 16[1]:65–66). Tail bifurcation has been recorded in a number of reptiles, particularly lizard species that frequently regenerate tails after loss.

Ctenotus grandis grandis is a large (up to 105 mm SVL) intricately patterned scincid that inhabits arid zone habitats, often dominated by spinifex (*Triodia* spp.) on sandy loam substrates in the western interior of Western Australia to central Northern Territory.

On 6 April 2011, an adult *Ctenotus grandis grandis* with a bifid tail was caught in a pitfall trap as we undertook a faunal survey near Davidson Creek, Western Australia (23.302942°S, 120.234872°E; WGS84). The tail bifurcation occurred along the posterior length, originating approximately mid-way along the tail resulting in two morphologically similar bifid tails. The bifurcation resulted in the growth of a dorsal and ventral length of tail. The length of the ventral (48 mm) bifid tail was slightly longer than the dorsal (32 mm). The upper bifid length was morphologically consistent with the remainder of the anterior length of tail while the lower bifid length was mirrored the ventral surface of the upper bifid tail its entire length. A small kink was present in the dorsal tail length indicating it is likely to be the original tail which possibly suffered multiple injuries resulting in the original tail damage that lead to the bifurcation.

The bifurcation did not appear to interfere with any movement or use of the tail by the animal. No caudal use of behavior such as luring or displays by the animal were observed and no other individuals of this subspecies or other *Ctenotus* species were observed performing any caudal displays at the site. However, the extent of caudal use by *C. g. grandis* and congeners is not well known. This is the first record of tail bifurcation in the *Ctenotus grandis* complex. As bifurcation is recognized as the result of previous injury and not caused by deformity of any form (Lynn 1950. Herpetologica 6:81–84; Bateman and Fleming 2009, *op. cit.*), there is no indication that bifurcation affects the natural behavior of specimens with this abnormality.

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***EULAMPRUS QUOYII* (Eastern Water Skink). CANNIBALISM.** *Eulamprus quoyii* is a medium-sized terrestrial diurnal viviparous lygosomine skink widespread in riparian and mesic habitats of the coastal plain, hinterland, and ranges of most of eastern mainland Australia (Cogger 2014. Reptiles and Amphibians of Australia [7th ed.]. CSIRO Publishing, Collingwood, Victoria, Australia. xxx + 1033 pp.). This note documents a case of cannibalism by a large adult *E. quoyii* of a juvenile conspecific and discusses the possible significance of this behavior; parturition of neonates in a clutch at separated sites is also reported.

On 3 January 2014, ~1430 h, on a sunny day, T_A ~31°C, in a suburban backyard in Cooranbong, Lake Macquarie, New South Wales, Australia (33.08°S, 151.45°E, WGS84; 12 m elev.), where *E. quoyii* of all ages and size classes are common, TJA observed a large adult (SVL ~110 mm, total length ~310 mm) *E. quoyii* chasing a recent neonate (SVL ~40 mm, total length ~110 mm) conspecific moving in coarse bark chips in a flower bed, dashing about in a zig-zag fashion. The adult seized the neonate over the midbody and raced off about 3 m to a less exposed area; the adult then bit down hard on the neonate several times, and after ~3 minutes the neonate was limp and apparently dead. This mastication induced caudal autotomy at a point ~50 mm from the tail base, whereupon the adult dropped the body (which did not move), then seized and swallowed the writhing tail indicating a strong attraction towards moving prey. After seizure and swallowing of the autotomized tail portion, the adult searched around, located and picked up the body of the neonate, which it began to manipulate in preparation for swallowing. However, another adult *E. quoyii*, apparently attracted by this activity, attempted to kleptoparasitize the prey item, whereupon the first adult *E. quoyii* ran off on concrete paving around the corner of the house (a distance of ~9 m and out of sight of the pursuing lizard) with the body of the neonate in its mouth, and had almost completed swallowing when it was lost to view. The duration of observation of these events was ca. 10 minutes.

Adult *E. quoyii* at this locality are opportunistic feeders that consume numerous invertebrate species including live and dead spiders and slugs (TJA, pers. obs.); they have also been observed to catch and consume adults of the small lygosomines *Lampropholis delicata* and *Saproscincus mustelina* on several occasions, and have been seen in vigorous pursuit of conspecific neonates (TJA, pers. obs.). Given that neonate *E. quoyii* are only a little larger than adults of these other taxa, this might explain the willingness of adult *E. quoyii* to prey on conspecific neonates and small juveniles. Neonates can run very fast for their size and rapidly learn to hide themselves in narrow crevices when pursued. In over 10 years of observation at the locality, this was the only successful capture of a neonate recorded, although this likely occurs much more frequently. With ontogeny, a size refuge from cannibalism is evidently obtained (at SVL ~60 mm), at which size juvenile *E. quoyii* learn that it is safe to approach mature adults apparently without fear of assault, and also that they can approach adults much more closely from the rear than from head-on (TJA, pers. obs.). There is a reported case of whole-clutch filial

cannibalism by the skink *Eutropis longicaudata* (Huang 2007. Behav. Ecol. 19[6]: doi:10.1093/beheco/arn109), and cannibalism is well known in a number of lizard species including skinks (Pough et al. 1998. Herpetology. Prentice-Hall, London, UK. 577 pp.).

Given good conditions, *E. quoyii* can produce large litters of up to ~12; the neonates are born at intervals at different sites over a period of two, or occasionally three, days (TJA, pers. obs.). For example, in December 2002, around midday in very warm sunny weather at the same locality, TJA observed parturition in a large gravid *E. quoyii*, where the female arched her tail as if to defecate, however instead deposited a neonate on an open flat concrete area next to a fishpond, and then ran into undergrowth at a point ~10 m distant from the parturition site, presumably to deposit another neonate. Neonate *E. quoyii* at this latitude have been observed between early spring and late autumn, indicating that some adult females may produce multiple clutches in one season, although most neonates appear around mid-summer (TJA, pers. obs.); this reproductive mode provides the potential for very rapid increase in local population size. We suspect cannibalism in *E. quoyii* is widespread, and that this species regulates local population sizes through cannibalism of neonates and small juveniles, at least in anthropogenic urban habitats. Further study is required to determine the validity of our hypothesis. We further hypothesize that parturition of neonates in a clutch at separated sites may be a strategy to minimize cannibalism in *E. quoyii*. In the mild climate at this temperate locality, parturition may occur at all times of the year except winter when *E. quoyii* is mostly inactive (TJA, unpubl. data), hence predatory threat to neonates from large conspecifics also exists throughout most of the year.

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***GEHYRA AUSTRALIS* (Tree Dtella) and *GEHRYA PILBARA* (Pilbara Dtella). ENVIRONMENTALLY CUED HATCHING.** Environmentally cued hatching (ECH), whereby hatching competent embryos can choose their own hatching date by assessing and responding to risks, can include early hatching, delayed hatching, or synchronous hatching (Warkentin and Caldwell 2009. *In* Dukas and Ratcliffe [eds.], Cognitive Ecology II. The Evolutionary Ecology of Learning, Memory and Information Use, pp. 177–200. University of Chicago Press, Chicago, Illinois). A recent review has extended ECH to reptiles (Doody 2011. Integr. Comp. Biol. 51:49–61). For instance, early hatching in Delicate Skinks (*Lampropholis delicata*) is likely an antipredator response to egg predation (Doody and Paull 2013. Copeia 2013:160–165). Although a few other lizard species can hatch early in response to being handled, ECH is not known to occur for most lizard species, presumably due to the difficulty in finding their eggs (Doody et al. 2009. Q. Rev. Biol. 84:229–252), and due to the erroneous assumption by researchers that eggs hatching while being handled reflects coincidence. Herein we report on observations of early hatching in response to handling in the Tree Dtella (*Gehyra australis*) and the Pilbara Dtella (*Gehyra pilbara*). We comment on implications for predator avoidance.

During the afternoon of 1 May 2013 at the El Questro Station in El Questro Wilderness Park, Western Australia (16.006398°S, 127.98420°E) some campers inadvertently dislodged bark from a *Eucalyptus* tree while tying off a shelter, exposing two gecko eggs that were laid under the bark. The campers placed the eggs in a small plastic container with a small amount of leaf litter and bark and brought them to us at 0924 h. At this stage one egg had pipped; the eggshell was fractured and pushed outwards at a single point. In anticipation of hatching both eggs were placed on a plate with some leaf litter and bark for photographs. As the first hatchling was being photographed the second egg pipped (0929 h) and its hatchling emerged (0934 h) and was photographed (Fig. 1). Hatching was steady and without any sudden movements for both eggs; in contrast, once the hatchlings emerged from the eggs they quickly dispersed to the nearest cover (leaf litter and bark at edge of plate). The second hatchling was in the process of sloughing its skin (Fig. 1), which is not uncommon in reptiles (Alibardi and Gill 2007. J. Anat. 211:92–103). The hatchlings were identified as *Gehyra australis* based on morphology, location of the nest site coloration, and their brittle-shelled eggs. Both hatchlings were released at site of egg collection the following morning.



PHOTO BY R. ELLIS

FIG. 1. Hatching *Gehyra australis* from the Kimberley region, Western Australia.

During the evening of 11 November 2008 we discovered two gecko eggs in a hole in a termite mound in tropical savannah, about 300 km SE of Karratha, Western Australia (22.459969°S, 118.993245°E). As the eggs were removed from the hole they hatched in hand, and the hatchlings immediately ran quickly in an attempt to escape. The hatchlings were identified as *Gehyra pilbara* based on morphology, coloration, brittle-shelled eggs, and the location of the eggs in a termite mound. The hatchlings were released into leaf litter adjacent to their original termite mound.

The handling-induced hatching in both species likely reflects early hatching in response to an increase in perceived predation risk. There is a misconception that the hatching of eggs during handling reflects a coincidence. In fact, it is highly likely that vibrations due to handling are perceived as stimuli emitted by a predator (Doody and Paull, *op. cit.*). Similar hatching in response to handling has been reported for three Australian skinks: *Lampropholis delicata*, *Acritoscincus platynota*, and *Carlia schmeltzii* (Doody and Paull, *op. cit.*; Doody and Schembri 2014. Herpetol. Rev. 45:494; Doody and Schembri 2014. Herpetol. Rev. 45:693). Early hatching in response to predation risk might be widespread in lizards in general. Further research should determine the prevalence of early hatching across lizard families to determine if early hatching is an ancestral trait or if it has evolved multiple times within lizards.

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***HELODERMA SUSPECTUM* (Gila Monster). PROBABLE COURTSHIP AND MATING BEHAVIOR.** Documentation of reproductive behaviors in wild helodermatid lizards is rare (Beck 2005. Biology of Gila Monsters and Beaded Lizards. University of California Press, Berkeley, California. 211 pp.). Beck (1990. J. Herpetol. 24:54–68) provides detailed descriptions of male-male agonism of *Heloderma suspectum* in nature. However, courtship and mating behaviors in wild *H. suspectum* have not been documented; thus, our understanding of these behaviors is based exclusively on animals in captivity. Courtship and mating in the wild is assumed to take place primarily within burrows or rock shelters (Beck 2005, *op. cit.*). Herein, we report a single observation of probable courtship and mating attempts between two wild *H. suspectum* outside of a rock shelter in the Rincon Mountains, east of Tucson, Arizona, USA (32.2170°N, 110.6757°W, WGS84; 1020 m elev.).

On 17 May 2014, at 0740 h, ERZ observed an adult *H. suspectum* (hereafter, the male) approach a shallow rock shelter that was occupied by another adult *H. suspectum* (hereafter, the female). The male entered the shelter, and < 1 minute later the female left the shelter with the male in pursuit. ERZ observed both individuals for the next 70 minutes, during which time they remained active on the surface. The female walked away from the male repeatedly. In each instance, the male followed in the exact path of the female while tongue-flicking constantly. Occasionally, when the male was < 1 m away from the female, he would follow the circuitous route taken by the female rather than walking directly to her. This behavior suggests the male was following a pheromone trail left by the female (Mason and Parker 2010. J. Comp. Physiol. A 196:729–749).

The pair was in contact 5 or 6 times during the 70 minutes, with each encounter lasting approximately 3–8 minutes. Generally, the male walked around the female before crawling on her and then used his front and hind limbs to alter slightly the position of his body relative to hers (Fig. 1A). The male clasped the base of the female's tail with his hind limb, seemingly rotating her pelvis towards him, a position observed commonly during mating of captive individuals (Fig. 1B; MTS, pers. obs.). During one encounter, the male extruded a hemipenis, but ERZ was unable to determine if he achieved intromission. Coitus under captive conditions lasts for hours (Beck 2005, *op. cit.*), thus it was unlikely in the present case. On 2 or 3 occasions, the male briefly mounted her backwards, with his head above her tail, and tongue-flicked repeatedly (Fig 1C). The female did not appear to be receptive to the male. When the male mounted the female, she flattened her body to the ground, making it difficult for the male to manipulate the positions of their bodies relative to one another. On two occasions, the female responded agonistically towards the male, even biting him as he approached. At 0850 h, the female walked away from the male again, but this time the male pursued her only briefly and then walked in the opposite direction. ERZ ceased observations at 0900 h, when both individuals were on the surface, but separated by >200 m.

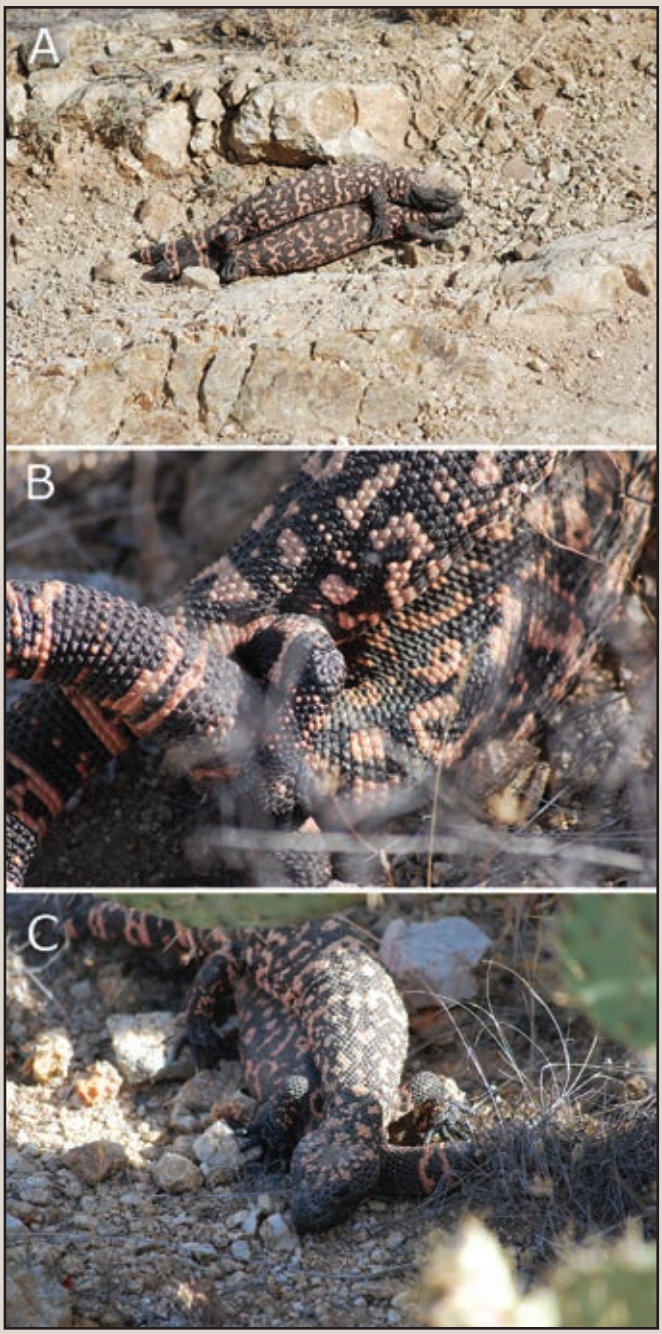


FIG. 1. Probable courtship and mating behaviors between two wild *Heloderma suspectum* in southern Arizona, USA. A) Common position during interactions ("dorsal straddle"), with the male on top of the presumed female. B) Right hind limb of male clasping the base of the female's tail. C) Male on top of the female, with his head positioned above her tail.

Although we were unable to directly verify the sex of the second *H. suspectum* or observe copulation, evidence suggests this was courtship and a failed mating attempt rather than male-male combat. First, the observations were entirely consistent with extensive observations of courting and mating activities of captive *H. suspectum* (Beck 2005, *op. cit.*; MTS and GWS, pers. obs.). Second, most of the observed interactions were not aggressive or typical of combat behaviors observed previously in the wild (Beck 2005, *op. cit.* and references therein). Very few attempts were made by either lizard to dominate the other by

pressing it to the ground (e.g., "head shove," "head raise," or "body twist" described by Beck 1990, *op. cit.*), behaviors that are common in combat rituals. The male repeatedly initiated a "dorsal straddle" (a typical male-male combat behavior; Fig 1A), but the female never did so. In previous observations of male-male combat by *H. suspectum*, both lizards actively participated in dominant behaviors, whereas in the encounter described herein only one lizard, the male, seemed interested in maintaining a superior position or initiating repeated contact. A majority of time was spent with the male in pursuit of the female.

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***LARUTIA TRIFASCIATA* (Three-banded Larut Skink). ENDOPARASITE.** *Larutia trifasciata* is known from parts of the Banjaran Timur and the Cameron Highlands, Malaysia (Grismer 2011. Lizards of Peninsular Malaysia, Singapore and their Adjacent Archipelagos. Edition Chimaira, Frankfurt am Main. 728 pp.). One *L. trifasciata* (SVL = 148 mm) was collected in West Malaysia, Pahang, Cameron Highlands (4.03333°N, 101.36666°E) 25 June 2008 and deposited in the herpetology collection of La Sierra University (LSUHC), Riverside, California as LSUHC 9077. In this note we establish the initial helminth list for *L. trifasciata*.

A midventral incision was made in one *L. trifasciata*. The digestive tract was removed, opened, and the contents were examined for helminths utilizing a dissecting microscope. One nematode was found in the small intestine. It was placed on a microscope slide, cleared in lactophenol, coverslipped, studied under a compound microscope and identified as *Orneoascaris sandoshami*. The sample of *O. sandoshami* was deposited in the Howard W. Manter Laboratory of Parasitology (HWML) University of Nebraska, Lincoln, Lincoln, USA as HWML 64637.

Orneoascaris sandoshami was previously reported in *Megophrys montana* (Megophryidae) (Sprent 1985. An. Mus. Hum. Comp. 60:33–35; Baker 1987. Mem. Univ. Newfoundland, Occas. Pap. Biol. 11:1–325). *Orneoascaris sandoshami* in *L. trifasciata* is a new host record.

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***PLESTIODON EGREGIUS ONOCREPIS* (Peninsula Mole Skink). ALBINISM.** On 30 June 2014, we trapped an amelanistic hatchling *Plestiodon egregius onocrepis* (28 mm SVL) along a drift fence in sandhill habitat in Ocala National Forest, Marion Co., Florida, USA (29.3819°N, 81.7929°W, WGS84; 10 m elev.). Albinism has been reported in *P. fasciatus* (Brungs 1960. Copeia 1960:369–370) and *P. reynoldsi* (Catenazzi et al. 2008. Herpetol. Rev. 39:228) but not in *P. egregius*. Most of the head and sides of the body were pink-colored, the dorsum was a paler pink, and the labial scales were white. The short dorsolateral stripes that ran from the pale snout were cream-colored, the lower hind legs and feet were pale orange, and the irises of the eye were red. The tail transitioned from pale pink to light orange, with the distal half being a reddish pink color (the tip was missing). Some internal organs were faintly visible through its venter and sides. A digital color photograph is deposited in the Florida Museum of Natural History (UF 173267).



FIG. 1. Amelanistic (top) and normal (bottom) phenotype *Plestiodon egregius onocrepis* hatchlings from the same site in Ocala National Forest, Marion Co., Florida, USA.

Although albinism is generally considered a deleterious trait because of increased visibility to predators, this may not be the case for this species because of its semifossorial habits. The brown coloration of the normal phenotype blends with fallen leaves, whereas the light coloration of the amelanistic specimen blends with the sand of its upland habitat (Fig. 1). The colorful tail, which probably distracts potential predators, was slightly less vivid in the amelanistic specimen than in another hatchling from the same site (Fig. 1), but there is individual and ontogenetic variation in tail coloration.

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***PLESTIODON GILBERTI* (Gilbert's Skink). PREDATION.** *Plestiodon gilberti* occurs in a variety of habitats including grasslands, broken chaparral, oak woodlands, and open pine forests (Stebbins and McGinnis 2012. Field Guide to Amphibians and Reptiles of California. University of California Press, Berkeley. 538 pp.). In the Sierra Nevada foothills of California the lizard occurs mainly in the Blue Oak zone and the Blue Oak-Gray Pine zone. Aerial predators, such as Northern Pygmy-Owls (*Glaucidium gnoma*; Sibley 2014. The Sibley Guide to Birds, 2nd ed. Alfred A. Knopf, New York, New York. 599 pp.), are opportunistic



FIG. 1. Northern Pygmy-Owl carrying *Plestiodon gilberti* into a tree cavity.

diurnal predators that takes a variety of mammal, bird, insect, and reptile prey. Documented reptile prey items include Smooth-headed Alligator Lizard (*Gerrhonotus liocephalus*), Eastern Fence Lizard (*Sceloporus undulatus*), Yarrow's Spiny Lizard (*S. jarrovii*), Striped Plateau Lizard (*S. virgatus*), Ornate Tree Lizard (*Urosaurus ornatus*), whiptail lizard (*Aspidoscelis* sp.), and skinks (*Plestiodon* spp.; Holt and Petersen 2000. *In* Poole [ed.], The Birds of North America Online. Cornell Lab of Ornithology, Ithaca, New York; Duncan et al. 2003. Southwest. Nat. 48:218–222). Although *Plestiodon* have been reported previously as prey of the Northern Pygmy-Owl, we provide the first observation, to our knowledge, of the owl predating *P. gilberti*.

On 23 March 2014, a Northern Pygmy-Owl pair was observed on the summit of Black Mountain in eastern Fresno Co., California, USA (37.0130052°N, 119.4523537°W; 1096 m elev.). The female owl was carrying a partially-eaten *P. gilberti*. Eventually she flew into a cavity within a nearby oak (*Quercus* sp.) tree with the skink (Fig. 1). A male Northern Pygmy-Owl followed her into the cavity and they both exited within 5 minutes without the skink. The skink was likely part of a pre-nesting courtship ritual and further observation over the next few weeks revealed that the female had not produced offspring and the skink was likely consumed by the adults.

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***PODARCIS SICULA* (Italian Wall Lizard). HABITAT, INVASION OF SUBURBAN NEW ENGLAND.** *Podarcis sicula* is a widespread invader in North America (Burke and Ner 2005. Northeast. Nat. 12:349–360). In New York State, multiple populations have been documented on Long Island, most commonly in human-dominated urban and suburban environments (Gossweiler 1975. Copeia 1975:584–585; Burke and Ner 2005, *op. cit.;* Fig. 1A). We documented the first populations of *P. sicula* in Connecticut (Donihue et al. 2014. Herpetol. Rev. 45[4]:661–662), and here describe their habitat use and first evidence for their use of railroad tracks as a conduit for northward invasion.

On 9 July 2014, in response to a photo sent to the Connecticut Department of Energy and Environmental Protection (DEEP), we surveyed multiple sites (Fig. 1B) in Greenwich, Fairfield Co., Connecticut, USA, for *P. sicula*. After talking with homeowners and surveying potential habitat for six hours, we (CMD and MRL) found five individuals spread across three sites (Site 1: three individuals, Site 3: one individual, Site 4: one individual) and were shown a photo of one additional individual at Site 2. All lizards were found in residential backyards within 10 m of railroad tracks, though high-quality habitats further from tracks were also surveyed. At each site lizards were seen basking on stonewalls or in undergrowth in the immediate vicinity of similar perches (Fig. 2A). We also found lizards under miscellaneous plastic and metal objects, and homeowner accounts indicate that lizards often use yard vegetation, metal and wood infrastructure, and garden pots for habitat. On a subsequent visit (29 August 2014) to Site 1, we observed 20 young-of-the-year juveniles, and six adult *P. sicula* after one hour of searching (four juveniles added as specimens to the Yale Peabody Museum YPM HERR.019332–019335). Our observations suggest that *P. sicula* may be moving into New England via railroad tracks and capitalizing on suburban backyards.

According to local landowners, *P. sicula* are seen in abundance (more than five per backyard) and have been present in

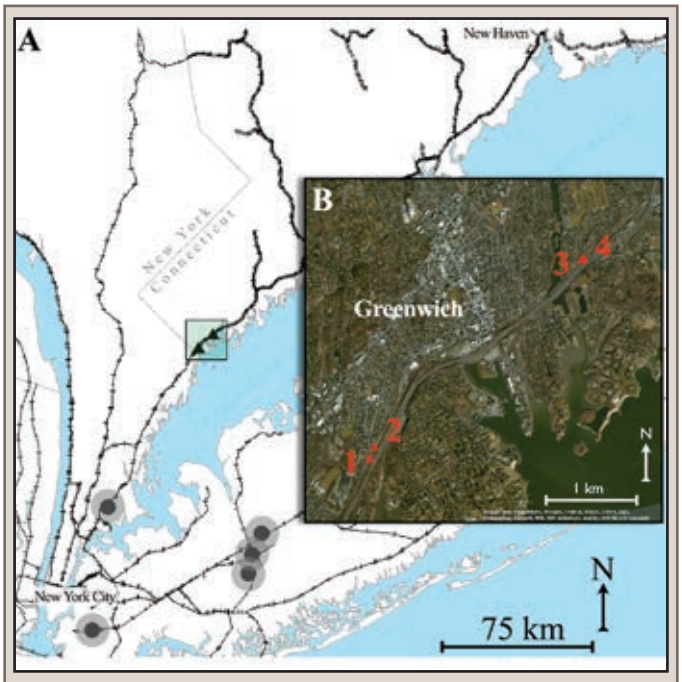


FIG. 1. Map of A) Long Island Sound region with our *P. sicula* sightings in Connecticut (triangles) and previously-reported regions (grey circles) of greater New York City with *P. sicula* populations (Gossweler 1975, *op. cit.*; Burke and Mercurio 2002. Am. Midl. Nat. 147:368–375; Burke and Ner 2005, *op. cit.*; Kolbe et al. 2013. Biol. Invasions 15:775–783. Inset B) details the four new suburban *P. sicula* sites along train tracks in Greenwich, Connecticut, USA.

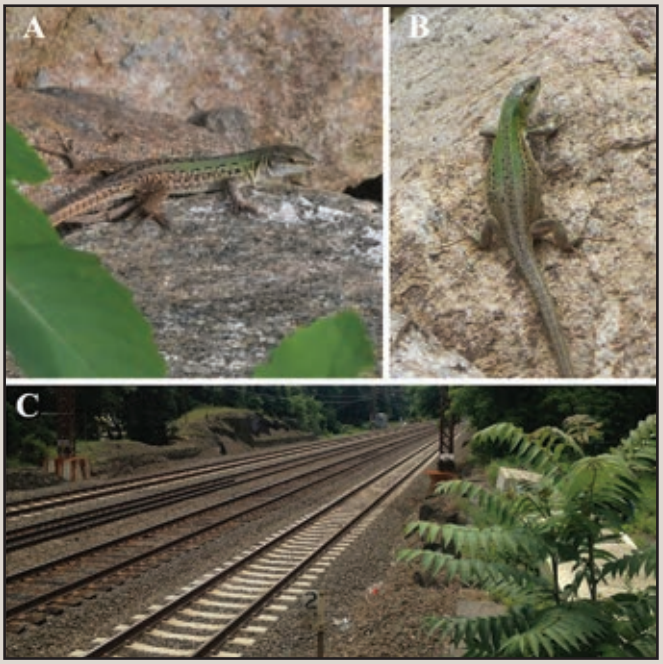


FIG. 2. A) *Podarcis sicula* basking on a rock wall at site 3. This specimen was deposited in the Yale Peabody Museum (YPM HERR.019238). B) A gravid female *P. sicula* at site 3 (photograph courtesy of F. Ceci Jr.). C) Train tracks (adjacent to site A) are the hypothesized avenue of dispersal of *P. sicula* into Connecticut.

this area for multiple years (three years at site 2, two years at site 3) suggesting that they may have reached further north in the state by now. Sites 2 and 3 are separated by 3.04 km of train track, so assuming they were sighted the first summer of their arrival, and train tracks are their conduit, *P. sicula* could very reasonably have already reached Stamford, a dense urban area. Although it is possible that the Connecticut *P. sicula* populations are a result of recent introductions, we think it much more likely that railroads act as a dispersal route from New York City; closely related lacertids are known to use tracks in their native European range (Kühnel 2008. *In* Mitchell et al. [eds.], Urban Herpetology, pp. 171–174. Society for the Study of Amphibians and Reptiles, Salt Lake City, Utah). Existing New York populations are within close proximity of train tracks leading directly to these Connecticut backyards (Fig. 1a). As this represents *P. sicula*'s northernmost occurrence, how they survive the cold New England winters is an important question. The railroad tracks also provide a potential explanation as portions of track are heated throughout the winter to prevent snow and ice buildup. Burrowing in the scree under these heated portions may provide protection from both predators and the elements. Urban areas are also well-documented heat-islands, potentially also providing warm refuges in winter. The extent to which species like *P. sicula* are adapting to live in urban and suburban environments is an emerging question for future study (Donihue and Lambert 2014. AMBIO 44:194–203).

We thank Jenny Dickson at Connecticut Department of Energy and Environmental Protection for her support, along with Frank Ceci Jr. and three additional anonymous landowners for allowing us to survey their properties. Specimen collection was authorized under Connecticut permit number 0116019 and Yale University IACUC protocol number 2012-10681.

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***SCELOPORUS JARROVII* (Yarrow's Spiny Lizard) and *SCELOPORUS POINSETTII* (Crevice Spiny Lizard). PREFERRED BODY TEMPERATURE.** Data on preferred body temperature (T_p) is quite rare (Sinervo et al. 2010. Science 328:894–899). According to Huey (1982. *In* Gans and Pough [eds.], Biology of the Reptilia, Vol. 12, Physiology C, pp. 25–91. Academic Press, New York) measurement in a laboratory thermal gradient under standard conditions is required. The T_p that a lizard voluntarily selects in a laboratory thermal gradient provides a reasonable estimate of what a lizard would attain in the wild with a minimum of associated costs in absence of constraints (biotic and abiotic factors) for thermoregulation (Huey and Slatkin 1976. Q. Rev. Biol. 51:363–384; Pough and Gans 1982. *In* Gans and Pough [eds.], Biology of Reptiles, Vol. 12, pp. 17–23. Academic Press, New York). *Sceloporus jarrovii* and *S. poinsettii* are geographically widespread viviparous lizards that exhibit considerable variation in habitats occupied (Lemos-Espinal and Smith 2007. Anfibios y Reptiles del Estado de Chihuahua, México /Amphibians and Reptiles of the State of Chihuahua, México. UNAM-CONABIO. México, D.F. 613 pp.; Lemos-Espinal and Dixon 2013. Amphibians and Reptiles of San Luis Potosí. Eagle Mountain Publishing, Eagle Mountain, Utah. 312 pp.). There have been several reports detailing thermal ecology in *S. jarrovii* and *S. poinsettii* in different environments (Andrews 1998. J. Therm. Biol. 23:329–334; Gadsden and Estrada-Rodríguez 2007. Southwest. Nat. 52:600–608); nevertheless, data on T_p of these two species are unusual (Mathies and Andrews 1997. Funct. Ecol. 11:498–507; Lara-Reséndiz et al. 2014. Rev. Mex. Biol. 85:744–753). Here, we describe thermal preferences in sympatric species *S. jarrovii* and *S. poinsettii* under laboratory conditions.

During October 2012, we conducted fieldwork in the canyon of Las Piedras Encimadas (25.7022°N, 103.7080°W, WGS84; 1425 m elev.), 25 km NW Gomez Palacio, Durango, Mexico. Vegetation was dominated by *Agave lechuguilla*, *Acacia greggii*, *Opuntia leptocaulis*, and *Jatropha dioica*. Throughout the study site, rock faces with crevices were numerous. The data presented are based on 10 adults (> 60.0 mm SVL) of *S. jarrovii* and 10 adults (> 77.0 mm SVL) of *S. poinsettii* captured by noose.

All lizards were placed in a laboratory thermal gradient to obtain the T_p range. The thermal gradient consisted of a wooden shuttle box of 150 x 100 x 80 cm (length, width, and height) divided into ten tracks with insulation barriers to prevent behavioral influence of adjacent lizards, and filled with 2–3 cm of rocky substrate. The shuttle box was housed in a room with air conditioning at a constant temperature of 20°C. At one end, and at the center of the box, lamps were placed at different heights to generate a thermal gradient from 20 to 50°C. The T_p of lizards was measured every hour from 0900 until 1800 h (activity period) using a digital thermometer Fluke model 51-II. The 25% and 75% quartiles of each species' T_p range (T_{p25} and T_{p75}) were calculated to obtain the lower and upper limit (Van Damme et al. 1990. Oikos 57:61–67; Herts et al. 1993. Am. Nat. 142:796–818). After laboratory experiments, all lizards were released at their capture sites. We applied a nonparametric Kruskal-Wallis one-way test to analyze differences between all measurements of body temperature in the laboratory and we used a Mann-Whitney Rank test to analyze the differences between species.

There were no statistically significant differences between measurements of temperature (H_6 = 9.0, P = 0.17) or between species (U = 5.842, P = 0.41). Mean T_p of *S. poinsettii* was 32.9°C (SE = 0.70, range = 21.7–40.0°C; N = 34). Interquartile of 25% and 75% was 30.6°C and 35.5°C, respectively. On the other hand, for *S. jarrovii*, mean of T_p was 33.6°C (SE = 0.40, range = 25.1–39.8°C; N = 47). Interquartile of 25% and 75% was 32.4°C and 35.6°C, respectively. The preferred body temperature of *S. jarrovii* and *S. poinsettii* were very similar to each other, and temperatures are similar to those previously registered for other closely related species of *torquatus* group as *S. torquatus*, *S. serrifer*, *S. minor*, *S. mucronatus*, *S. ornatus*, and *S. cyanostictus* (Andrews 1998, *op. cit.*; Sinervo et al. 2010, *op. cit.*).

These results suggest that *S. poinsettii* and *S. jarrovii* can be considered eurythermic species due to their wide range of T_p. Future research should evaluate the species thermal efficiency by monitoring mean thermal requirements and microhabitat temperatures across its distribution for understanding effects of global warming on these geographically widespread lizards.

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***SCELOPORUS SINIFERUS* (Long-tailed Spiny Lizard). BIPEDALISM.** Bipedal locomotion has been studied in a wide array of lizard species representing numerous families (e.g., Snyder 1952. Copeia 1952:64–70; Snyder 1962. Am. Zool. 2:191–203; Irschick and Jayne 1999. J. Exper. Biol. 202:1047–1065). However, reports for bipedalism, typically regarded as a flight response to predation or to aid in foraging, are scarce in the literature for *Sceloporus*, having been reported only for *S. undulatus* (*sensu lato*; Snyder 1952, *op. cit.*), *S. woodi* (Tucker and McBrayer 2012. Biol. J. Linn. Soc. 107:813–823), and *S. malachiticus* (Kohlsdorf and Biewener 2006. J. Zool. 270:359–371). All three reports were filmed in laboratory studies. The first two species are members of the *undulatus* group and the latter is a member of the *formosus* group (Wiens et al. 2010. Mol. Phyl. Evol. 54:150–161). Here we report on bipedal locomotion in the field in a member of the *siniferus* group, *S. siniferus*, employed in response to two distinct biological situations: 1) in flight to evade capture and 2) in male-male combat.

On 26 July 2008, two of us (JDS and WHM) observed an adult male *Sceloporus siniferus* run bipedally at a site ca. 10 km north (by air) of San Jeronimito, Guerrero, Mexico (17.6580°N, 101.3330°W, WGS84). The lizard was being pursued for capture and subsequent data collection. It ran along the ground for an extended distance, clearly on its hind limbs, into dense vegetation and evaded our capture. This escape behavior was observed again in this species the following day on 27 July at Parque Ecológico Aztlán in Ixtapa, Guerrero, Mexico (17.6793°N, 101.6223°W; WGS84).

On 12 June 2012, one of us (DKH) was conducting staged territorial intrusions to study male-male aggression in *Sceloporus siniferus,* in the southern portion of Parque Nacional Huatulco, ca. 3 km W of Huatulco, in coastal Oaxaca, Mexico (15.7556°N, 96.1550°W; WGS84). The focal animal, a free-ranging adult male *Sceloporus siniferus* ran bipedally across a dirt road to the location of the stimulus male (intruder) that had been placed at 2 m distant from the focal male along the edge of the vegetation along the road. The males then engaged in aggressive signaling behavior, followed by physical contact (biting). This behavioral response of the focal male is consistent with territorial defense, which we were studying during the first part of the breeding season for this species.

The morphology of *S. siniferus* is such that bipedalism is perhaps not surprising; the hind limbs and feet are extremely well-developed and proportionately large for a species of this genus. Further, the tail is very long (at least twice the length of the body in males) and likely serves as a counter-balance during bipedal locomotion.

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***SCELOPORUS UNDULATUS* (Eastern Fence Lizard). NOVEL VENTRAL ORNAMENTATION.** During the breeding season, adult females of many species in the family Phrynosomatidae express an orange-colored patch (or patches) (Cooper and Greenberg 1992. *In* Gans and Crews [eds.], Biology of the Reptilia, Vol. 18, Hormones, Brain, and Behavior, pp. 298–422. University of Chicago Press, Chicago, Illinois). These patches likely reflect the suites of physiological changes occurring during the onset of the reproductive season (Cooper and Burns 1987. Anim. Behav. 35:526–532), and may therefore serve as a signal of receptivity to a potential mate. Despite the commonality of this social signal in Phrynosomatidae, within the genus *Sceloporus*, the development of orange-colored patches by a female has only been documented in a single species, the Striped Plateau Lizard (*S. virgatus,* Vinegar 1972. Copeia 1972:660–664; Weiss et al. 2012. Comp. Biochem. Physiol. B. 161:117–123). In *S. virgatus*, paired orange patches develop on the throat of a female lizard during vitellogenesis and their expression peaks during ovulation, followed by a period of fading as eggs mature (Weiss et al. 2012, *op. cit.*). Here we document a novel case involving the expression of paired orange patches on the ventral surface of the abdomen, and not the throat, of a gravid adult female *S. undulatus*.

S. undulatus is a medium-sized lizard that ranges throughout the central and eastern United States from southwest Utah to the east coast (adult SVL in Ohio, 75 ± 0.8 mm [mean ± SE], Tinkle and Ballinger 1972. Ecology 53:570–584). Females are receptive from mid-April to late June (Tinkle and Ballinger 1972, *op. cit.*). Males and females of *S. undulatus* are sexually dichromatic (Cooper and Burns 1987. Anim. Behav. 35:526–532). Whereas male *S. undulatus* consistently exhibit blue and black throat and ventral patches, female *S. undulatus* express either no ventral coloration or may display muted blue throat and ventral patches (Cooper and Burns 1987, *op. cit.*).

We captured a female *S. undulatus* by noose pole on an oak (*Quercus* sp.) snag in the Vinton Furnace Experimental Forest in Vinton Co., Ohio (39.202°N, 82.3914°W) on 26 April 2014 at 1137 h. The specimen was large and visibly gravid (SVL = 78.5 mm, mass = 21.5 g), and exhibited a pair of orange patches, each extending approximately half of the distance between her fore- and hind limbs, on her ventral surface. The size and color of these patches did not change in the 48-h period from capture to release

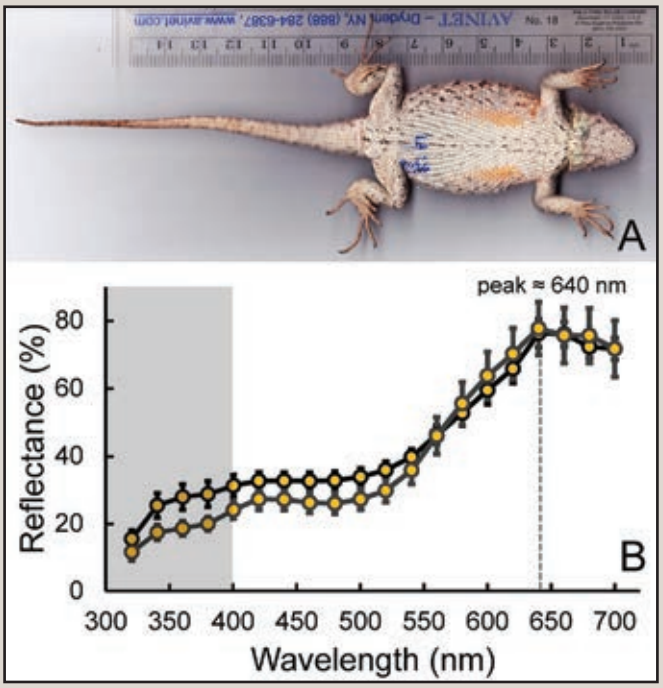


FIG. 1. Ventral surface of the adult female *Sceloporus undulatus* (A) and the percent reflectance (B) of each orange patch on her abdomen, averaged at 20 nanometer (nm) intervals (black line, left patch; grey line, right patch). Points in (B) are mean ± 1.0 standard deviation. Shaded light grey area references the wavelength range of ultraviolet light (320–399 nm), and the dashed vertical line indicates the average peak reflectance across both patches (≈ 640 nm).

back at the field site. We transported the female to our lab facility at Ohio University for processing. Photo documentation of these ventral patches was obtained by scanning the ventral surface of the female lizard in a Canon LiDE flatbed scanner (Canon, Melville, NY, USA). The size (in pixels) of the left and right orange patch was then estimated using the polygon tool in the program ImageJ version 1.44p (http://imagej.nih.gov/ij/). We converted the area of these polygons from pixels to mm^2 with the aid of a ruler affixed to the plate. The average area of these patches was 57.1 mm^2 (left patch: 55.6 mm^2, 35 scales; right patch: 58.6 mm^2, 36 scales) (Fig. 1).

We measured the spectral profile (reflectance, %) of each orange patch using an Ocean Optics USB2000-UV-VIS spectrometer with a pulsed fiber-optic light source (Ocean Optics Worldwide, Dunedin, FL, USA). We took three readings (integration time = 295 ms, boxcar correction = 10) total at cranial, middle, and caudal regions of each patch. Our reflectance data (in 0.3 nm increments) were obtained across a range of wavelengths that encompass the visible range of a lizard (320–700 nm). We then averaged the three readings for each patch and summarized their output in 20-nm increments. Reflectance spectra from these patches are consistent with orange coloration (peak wavelength ≈ 640 nm). The reflectance curves of these patches are also similar in form as published curves of the orange throat patches of *S. virgatus* (Weiss et al. 2012, *op. cit.*). We also note similar degree of reflectance in the ultraviolet range (ca. 30%).

To our knowledge, this is the first documented case of atypical ventral coloration in a female *Sceloporus* species. Data for *S. virgatus* suggest that orange coloration is drosopterin-based, and not derived from carotenoids in the animal's diet (Weiss et al. 2012, *op. cit.*). Further work is needed to elucidate the physiological basis, functional role, and behavioral significance of this novel ornament in female *S. undulatus*, including its prevalence in other females of the species.

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***SCINCUS SCINCUS* (Sandfish Skink). ENDOPARASITES.** *Scincus scincus* is widely distributed in the Middle East, North Africa, Niger, and Nigeria (Bar and Haimovitch 2011. A Field Guide to Amphibians and Reptiles. Herzilya, Israel. 245 pp.). Gamil (2012. World J. Zool. 7:65–74) reported *Ophiotaenia* sp. in *S. scincus* from Sinai, Egypt. The purpose of this note is to add to the helminth list of *S. scincus* as part of an ongoing survey of helminths of Middle Eastern Lizards.

Two adult *S. scincus* were collected and deposited in the Field Museum of Natural History (FMNH), Chicago, Illinois as FMNH 63941, collected in Egypt, Giza, vicinity of Cairo (30.0500°N, 31.2333°E) November 1960 and FMNH 66312 collected in Egypt, Giza, Abu Rabash (30.0319°N, 31.0750°E) February 1951. A mid-ventral incision was made and three larval nematodes were recovered from the body cavity, 2 in FMNH 63941 and 1 in FMNH 66312. Nematodes were cleared in lactophenol on a microscope slide, coverslipped, studied under a compound microscope and identified as larvae of *Physocephalus* sp. Voucher helminths were deposited in the Howard W. Manter Laboratory of Parasitology (HWML), University of Nebraska, Lincoln, USA, as HWML 64636.

Goldberg et al. (1994. J. Wild. Dis. 30:274–276) reported larvae of *Physocephalus* sp. occurred in the gastric mucosa of *Sceloporus cyanogenys* (formerly as *S. serrifer*) from Texas, USA, which cause focal destruction of gastric glands. Adult nematodes of *Physocephalus sexalatus* occur in the stomachs of mainly wild and domestic pigs (Anderson 2011. Nematode Parasites of Vertebrates, Their Development and Transmission. CABI Publishing, Wallingford, Oxfordshire, U.K. 650 pp.). Infective larvae have been recovered from tissues of twenty different genera of dung beetles (Anderson 2011, *op. cit.*). Lizards that habitually feed on dung beetles would likely become infected. As development to the adult *Physocephalus* does not occur in lizards, they are best considered as paratenic (transport hosts). *Physocephalus* sp. in *Scincus scincus* is a new host record.

We thank A. Resetar (FMNH) for permission to examine *S. scincus*.

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***VARANUS PANOPTES* (Yellow-spotted Monitor). DIET.** Determining the diet of large carnivorous animals is important because those species can have considerable regulatory impacts on the food web. However, dietary analysis based on dissections, stomach flushing, and scat can bias dietary information because larger prey are eaten infrequently. It is thus critical to make observations of predation in nature to build a more complete picture of dietary breadth. Herein we report on a case of apparent predation by *Varanus panoptes* on *V. scalaris* (Spotted Tree Monitor) from northwestern Australia.

At ~1500 h on 14 February 2014 we captured an adult female *V. panoptes* in savannah woodland about 150 m from the Margaret River in Western Australia. The animal had hidden in grass thickets upon our approach, but was spotted and captured by hand for a study of the species' spatial ecology. Immediately upon capture the lizard regurgitated an adult *V. scalaris* and five large caterpillars (Sphingidae). The regurgitated lizard was covered in saliva but was not degraded, indicating recent consumption. Protruding from the mouth of the *V. scalaris* was one of the five caterpillars; the other four caterpillars were lying near the *V. scalaris*. All prey items were dead. The *V. panoptes* was taken to the field laboratory and the *V. scalaris* and caterpillars were preserved in 80% ethanol. The *V. scalaris* weighed 94 g, which was 7.3% of the body mass of the *V. panoptes* (1285 g).

In our judgment the *V. panoptes* had consumed the *V. scalaris* within a few minutes or hours of capture, based on the immaculate condition of the latter. Although we cannot eliminate the possibility that the regurgitated lizard was scavenged, predation is more likely due to the condition of the prey. Moreover, *V. panoptes* consumes other species of monitor lizards (Shine 1986. Herpetologica 42:346–360; Christian 1995. Herpetol. Rev. 26:146; Rhind and Doody 2011. Herpetofuna 41:64–65; Doody et al. 2012. Herpetol. Rev. 43:491–492). The caterpillar in the mouth of the *V. scalaris* probably reflected foraging by that lizard; however, the other four caterpillars, which were also in very good condition, may have been eaten and regurgitated by either the *V. scalaris* or the *V. panoptes*. The caterpillars were conspicuously abundant on ground level vegetation during the time of our observation. Regardless, our observation spans three trophic levels, providing insights into the community ecology in the riparian zone of the tropical savannah woodland. It also suggests that *V. panoptes* may regulate *V. scalaris*. When the invasive Cane Toad (*Rhinella marina*) invaded other parts of northern Australia, the ~90% reduction in *V. panoptes* (due to lethal toxic ingestion of toads) caused increases in some of its prey (Doody et al. 2006. Wildl. Res. 33:349–354; Doody et al. 2009. Anim. Conserv. 12:46–53; Doody et al. 2013. Biol. Inv. 15:559–568). It is possible that the same mesopredator release will occur with *V. scalaris* when toads arrive at our site within the next few years. However, *V. scalaris* can also suffer lethal toxic ingestion of cane toads (S. Doody, S. Clulow, and C. McHenry, unpubl. data). Thus, the complex effects of Cane Toads may make predictions of their impacts difficult in this system.

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SQUAMATA — SNAKES

***AGKISTRODON PISCIVORUS* (Cottonmouth). PREDATION.** *Geococcyx californianus* (Greater Roadrunner) is a generalist predator well known for its occasional habit of preying on venomous reptiles. However, to our knowledge *Agkistrodon piscivorus* has yet to be documented as a prey item for this species (Ernst and Ernst. 2003. Snakes of the United States and Canada. Smithsonian Books, Washington, DC. 680 pp.). On 19 September 2014, one of us (TN) observed a *G. californianus* kill and consume a juvenile *A. piscivorus* in the Hagerman National Wildlife Refuge, Sherman, Texas (Fig. 1) on a caliche road approximately 130 m from the nearest body of water. Over the course of 5–6 min, the *G. californianus* pecked at and flung the *A. piscivorus* around until it was unresponsive. At this point, the *G. californianus* swallowed the snake.



FIG. 1. *Geococcyx californianus* (Greater Roadrunner) preying on a juvenile *Agkistrodon piscivorus* in the Hagerman National Wildlife Refuge, Sherman, Texas, USA.

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***AHAETULLA PRASINA* (Asian Vinesnake). DIET AND FEEDING BEHAVIOR.** At 0830 h on the morning of 2 October 2013 on the grounds of Ubud View Bungalows hotel in Ubud, Bali, (8.5167242°S, 115.2647486°E, datum WGS84; elev. 20 m), we observed a juvenile *Ahaetulla prasina* (total length ca. 60 cm) falling to the ground with a gecko (*Hemidactylus platyurus*; total length ca. 10 cm) seized in its jaws by the nape (Fig. 1). The snake and gecko both fell from a height of ca. 3 m from the overhead canopy of a palm tree on to a stone pavement, where they struggled before the snake began retreating backwards dragging its prey away from the exposed area. First it moved ca. 1.5 m across the pavement, then up a small wall ca. 0.5 m high and continued ca. 1 m across a flower bed. During this time, the gecko appeared to have lost most function in its forward and hind limbs. The snake held on to the gecko and continued chewing movements, likely increasing venom delivery (Whitaker and Captain 2008. Snakes of India, the Field Guide. Draco Books, Chengalpattu, India. 385 pp.). After ca. 40 min, the gecko appeared to be completely immobilized and the snake proceeded to swallow it headfirst while continuing to move in a backwards motion up the base of the tree. After reaching ca. 0.5 m up the base of the tree, the snake stopped swallowing and released the gecko having only achieved swallowing the head. The gecko was large in proportion to the snake, but another possibility is that the snake abandoned its prey in response to disturbance from us.

Although vine snakes are typically arboreal they have been observed consuming large prey on the ground, possibly falling after striking prey (Miranda et al. 2013. Herpetol. Notes 6:187–188). Falling from the tree would likely have placed the snake in a situation where it was at an increased risk of predation. Despite



FIG. 1. *Ahaetulla prasina* subduing *Hemidactylus platyurus*, Ubud, Bali.

our presence, the snake did not abandon its prey, but instead, retreated across the pavement backwards while still holding on to its meal. The snake used its tail to pull and guide its body backwards by waving its tail around in a reaching fashion until it found something to grip on to, while dragging the gecko with it. The snake continued to retreat using this technique as it climbed backwards up the small wall, down to a flower bed, and across to the base of a palm tree. Retreating backwards allowed the snake to carry its prey to safety while keeping potential predators, us, in view. Although snakes sometimes retreat during feeding, we deem that the distance moved by this snake of this size was exceptional. This may be a trait specific to specialized arboreal snakes, but can be difficult to observe due to their cryptic nature in the canopy. Also, no evidence was found in the literature of *Hemidactylus* specifically in the diet of *Ahaetulla*; therefore, *H. platyurus* appears to be new diet record for *A. prasina*.

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***AHAETULLA PRASINA* (Oriental Whipsnake). REPRODUCTION.** *Ahaetulla prasina* is widely distributed in South-east Asia; its range includes Myanmar, Thailand, Laos, Cambodia, Vietnam, Peninsular Malaysia, Borneo, Java, Bali, northeastern India, Bangladesh, China and the Sulu Archipelago (Das 2010. A Field Guide to the Reptiles of South-East Asia. New Holland Publishers, London. 376 pp.). We know of no published information on reproduction of male *A. prasina*. In this note, we present information on the minimum size for maturity in male *A. prasina*.

Ten adult male *A. prasina* were examined (mean SVL = 883.0 mm ± 69.6 SD, range = 784-963 mm) and one juvenile male (SVL = 747 mm) from Peninsular Malaysia collected by LLG during 2002-2005, 2011 and deposited in the herpetology collection (LSUHC) of La Sierra University, Riverside, California 92515, USA (by state): Johor, LSUHC 5737, 6402; Kedah, LSUHC 10597; Pahang, LSUHC 4491, 4798, 4551, 5432, 5488, 5507; Penang, LSUHC 8382. The juvenile male (LSUHC 7589) was from Kedah state. The lower part of the body cavity was opened and the left testis was removed, embedded in paraffin, histological sections cut at 5 µm and stained by Harris hematoxylin followed by eosin counterstain. Histology slides are deposited in LSUHC. Two stages were noted in the testicular cycle: 1) regressed, seminiferous tubules are reduced in size, spermatogonia and interspersed Sertoli cells are present; 2) spermiogenesis, seminiferous tubules are lined by sperm or clusters of metamorphosing spermatids.

One juvenile male from August (LSUHC 7589) exhibited a regressed testis. Number of mature males (spermiogenesis) by month were: January (N = 1), March (N = 1), July (N = 6), August (N = 1), October (N = 1). The presence of the smallest (spermiogenesis) mature male (LSUHC 10597) at 784 mm SVL and a subadult male with a regressed testis at 747 mm SVL (LSUHC 7589) suggests male *A. prasina* from Peninsular Malaysia mature at ca. 780 mm SVL. The presence of spermiogenesis during widely separated months suggests *A. prasina* males exhibit a polyestrous reproductive cycle with continuous sperm production (*sensu* Saint Girons 1982. Herpetologica 38:5–16).

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***APOSTOLEPIS CEARENSIS* (Burrowing Snake). DIET.** *Apostolepis cearensisis* is a fossorial snake distributed in the semiarid Caatinga (Lema and Renner 2007. Biociências 15:126–142) and Cerrado biomes in Brazil (Lema and Renner 2012. Neotrop. Biol. Conserv. 7:144–147). Very little is known about its biology and behavior (Mesquita et al. 2009. Pap. Avul. Zool 53:99–113; Mesquita et al. 2013. Herpetol. Rev. 40:440). Herein, we provide a diet record from an *A. cearensis* collected in March or April 2013 at São Gonçalo do Amarante municipality (3,544028°S, 39,126694°W, datum WGS 84; elev. 28 m), Ceará state, Brazil. Dissection of the adult female *A. cearensis* (SVL = 47.0 cm) revealed an adult *Leposternon polystegum* (8.0 g) in the stomach (Fig. 1). Both the *A. cearensis* and the *L. polystegum* specimens were deposited at



FIG. 1. Adult female *Apostolepis cearensis* and its prey, a *Leposternon polystegum*.

Coleção Herpetologica da Universidade Regional do Cariri (URCA-H 8942 and 8986). Species of the genus *Apostolepis* have diverse diets composed mainly of amphisbaenians, small snakes, and invertebrates (Lema 2001. Cuad. Herpetol. 15:29–43; Lema and Renner 2006. Cienc. Mov. 8:13–18). For *A. cearensis*, the snake *Tantilla melanocephala* has been reported as prey (Mesquita et al. 2009, *op. cit.*; Mesquita et al. 2013, *op. cit.*).This is the first record of *L. polystegum* as prey of *A. cearensis*.

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***BITIS CAUDALIS* (Horned Adder). FOG WATER HARVESTING.** Many species of reptiles are capable of drinking rainfall that has collected on their scale surfaces, and this method of water acquisition is likely to be particularly important for those species occurring in xeric environments (Repp and Schuett 2008. Southwest. Nat. 53:108–114; Glaudas 2009. Southwest. Nat. 54:518–521). Additionally, in arid environments where rainfall is scarce, some organisms can harvest and utilize fog or dew from their body surfaces (Malik et al. 2014. Bioinspir. Biomim. 9:1–15). For example, the Namib Desert endemic *Bitis peringueyi* (Peringuey's Adder) is a specialized sand-dwelling viperid that is known to harvest fog water that has condensed on its scales (Robinson and Hughes 1978. Ann. Transvaal Mus. 31:189–193). *Bitis caudalis* is a more widely distributed viperid ranging throughout southern Africa and also occurs extensively throughout the Namib Desert. This species has been photographed drinking water from its skin, but whether this behavior was documented *in situ* and the source of the moisture, are both unknown (Greene 1997. Snakes, the Evolution of Mystery in Nature. Univ. California Press, Berkeley. 351 pp.). Here we report on an observation of *B. caudalis*, drinking condensed fog water directly from its body surface.

At 0710 h on 1 July 2014 at the Gobabeb Research and Training Centre, Namibia (23.56027°N, 15.04037°E, WGS84; elev. 406 m) we observed a small juvenile *B. caudalis* loosely coiled on bare gravelly substrate at the edge of a gravel road. At this time a fog event had occurred depositing 0.9 liters m^{-2} of fog water as measured by vertical standard fog collectors of 1 m^2. The ground surface temperature where the snake was located was 14.3°C and the air temperature 10 mm above the surface was 13.3°C. Though temperatures were cool, the snake was in the open at least 1 m from the nearest rocky shelter and was actively imbibing water that had condensed on its scales (Fig. 1). Although to our knowledge this represents the first unequivocal instance of fog water use in *Bitis caudalis*, we do not think this behavior is unusual, but simply under-reported for this and other species living in fog deserts. We thank Gillian Maggs-Kölling and Theo Wassenaaar as well as the Brain Function Research Group at the University of the Witwatersrand for support, and the Namibian Ministry of Environment and Tourism for permission to work in the Namib-Naukluft National Park. Novald Iiyambo kindly provided the fog water measurements.

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***BOTHROPS ASPER* (Fer-de-Lance). DIET AND FEEDING BEHAVIOR.** *Bothrops asper* is widely distributed throughout Central and northern South America and is considered a dietary generalist, with a diet primarily consisting of rodents, birds, lizards, and anurans (Sasa et al. 2009. Toxicon 54:904–922). Many reports of birds consumed pertain to "unidentified passerines," but *Volantinia jacarina* (Blue-Black Grassquit) and *Cantorchilus nigricapillus* (Bay Wren) have been specifically reported (Sasa et al., *op. cit.*). I observed a *B. asper* preying upon a *Eucometis penicillata* (Gray-headed Tanager) which was following a swarm of army ants (*Eciton* sp.) in Parque Nacional Soberanía near Gamboa, Panamá on 11 March 2013 at 1100 h. I encountered the army ant swarm, which was being followed by several species of birds including *E. penicillata*, *Hylophylax naevioides*, and *Microcerculus marginatus*, near Quebrada Juan Grande off the Pipeline Road. The snake captured the tanager as it came to the ground to forage on insects disturbed by the ant swarm. The bird was consumed head-first (Fig. 1). As I did not see the snake before it captured the tanager, I cannot determine whether the snake was actively foraging around the ant swarm as well or opportunistically encountered it. I observed the snake for approximately 15

PHOTO BY IAN W. MURRAY



FIG. 1. Juvenile *Bitis caudalis* drinking fog water condensed on its body.



FIG. 1. Gray-headed Tanager (*Eucometis penicillata*) that fell prey to a *Bothrops asper* (Fer-de-Lance) while foraging for invertebrates flushed by army ants in Parque Nacional Soberanía, Panamá.

min in which time it had only consumed the bird up to its head (Fig. 1). As the sparse previous reports of *B. asper* predation on birds do not pertain to species that typically follow ant swarms, this observation represents a unique account of a feeding behavior by this species.

I thank J. Ray for confirming the identification of the snake from photos and the Smithsonian Tropical Research Institute for support to work in Panamá. This encounter was observed incidentally during unrelated field work and no organisms mentioned in this note were handled, collected, or disturbed in any way.

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***COLUBER FLAGELLUM* (= *MASTICOPHIS FLAGELLUM*) (Coachwhip). GENERAL ECOLOGY.** *Coluber flagellum* (= *Masticophis flagellum*) is a medium-sized colubrid with a broad geographic distribution and found in a wide variety of habitats, including those in the Chihuahuan Desert (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Institution Press, Washington, D.C. 668 pp.). However, little is known regarding life history characteristics of this species, such as home range and movement rate, habitat, and body temperatures (Secor 1995. Herpetol. Monogr. 9:169–186; Johnson et al. 2007. Southeast. Nat. 6:111–124; Dodd and Barichivich 2007. Florida Sci. 70:83–94; Steen et al. 2007. Herpetol. Rev. 38:90) with no information from populations found in its western distribution. Herein, we provide information on home range, movement rate, habitat and microhabitat, and body temperatures of a single *C. flagellum* in the northern Chihuahuan Desert.

An adult male *C. flagellum* (SVL = 142.5 cm; tail length = 17.4 cm; mass = 660.0 g) fitted with a Holohil Ltd. SI-2 temperature sensor transmitter was radiotracked from 13 July 2008 to 13 June 2009, on Indio Mountains Research Station (IMRS), Hudspeth Co., Texas, USA (30.776953°N, 105.016182°W, WGS 84; 1236 m elev.). The landscape at IMRS consists of rocky slopes at higher elevations formed primarily by conglomerate and sandstone, and at lower elevations by sloping alluvial fans and flats partitioned by arroyos, with typical Chihuahuan Desert scrub covering the surface. This individual was monitored on average 6 d per month and at different times during daylight hours. We physically monitored the snake 60 times (31 times during the inactive [winter] season and 29 times during the active season [warm months]), with the following data recorded: date, time, habitat, microhabitat, facing slope, body temperature (T_b), substrate and air temperature, snake position and behavior (when visible), and distance traveled from the previous reported location. At the end of the tracking period, we estimated the snake's home range based on a minimum convex polygon (MCP) using Hawth's Analysis Tools for ArcGIS (Beyer 2004. http://www.spatialecology.com/htools); daily movement was estimated by dividing the snake's total traveled distance (m) by the total number of days that it was radiotracked (Beaupre 1995. Herpetologica 51:45–56). The home range of this snake was estimated to be 192.5 ha. The total distance traveled during the active season (March–October) was 12,105 m for 168 days, and the average daily movement was 71.6 m. However, the longest distance recorded from one day to the next was 1400 m. May, June, July, and August showed the largest monthly average movement (143.5, 164.2, 123.3, and 122.9 m, respectively). Normally, the snake was found within alluvial slope habitat (21 observations of 29 [73%]), and usually inside rodent burrows (20 observations of 29 [69%]). For 27 (93%) of the 29 observations, burrows contained vegetation on the surface, represented primarily by shrubs and grasses. In general, the surface of microhabitats had composition means of 48% vegetation, 22% gravel, and 15% plant litter. Mean T_b during the active season was 28.1°C (N = 29) and ranged from 16 to 37°C. The highest monthly T_b values were observed in June and July (33.0 and 34.1°C, respectively). The snake overwintered for 150 days (from 26 October 2008 to 4 April 2009) inside a rodent burrow, on a northwestern-facing slope composed mostly of sandstone. Although it remained on the same slope for the entire cold period, movement (ca. 10 m) inside the shelter was still detected as the cold period progressed. Mean T_b during the overwintering period was 13.7°C (N = 31), ranging from 9.4 to 19.3°C, with the lowest T_b values reported in January, and the highest at the beginning and at the end of the cold period (late October and early April). Finally, on 13 June 2009, we found a few remains of the snake along with the transmitter positioned on open ground ca. 20 m from the last reported shelter (under a shrub). We found feathers along with the snake's remains; therefore, we assume it was killed by an avian predator.

More individual snakes from the IMRS population should be monitored, including those of both sexes and various reproductive conditions and with more frequent monitoring intervals, because substantial variation is known to occur among individuals of this species (Secor, *op. cit.*; Johnson et al., *op. cit.*). Nonetheless, we use the information from this individual as an initial step and motivation factor for studies involving other populations of *M. flagellum* found in different landscapes of the Chihuahuan Desert and throughout its entire geographic range.

We thank A. Gandara and L. Miranda for their assistance during monitoring period.

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***COLUBER FLAGELLUM* (= *MASTICOPHIS FLAGELLUM*) (Coachwhip). DIET.** *Coluber flagellum* (= *Masticophis flagellum*) is widely distributed and feeds on a variety of prey, including invertebrates, frogs, turtles, lizards, birds, and small mammals (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Institution Press, Washington, D.C. 668 pp.). They are among the few snakes quick enough to catch an active whiptail lizard (*Aspidoscelis* spp.). However, to date, only three whiptail species (*A. sexlineata*, *A. tigris*, and *A. marmorata*) are documented prey for *C. flagellum* (Reams and Aucone 2001. Herpetol. Rev. 32:108; Ernst and Ernst 2003, *op. cit.*). On 4 October 2014 we collected a DOR juvenile (SVL = 33 cm; 12.5 g) *C. flagellum* 5.0 km ESE of Marfa, in Presidio Co., Texas, USA (30.29898°N, 103.96780°W; WGS84). Upon dissection the snake was found to contain two partially digested juvenile *Aspidoscelis inornata* (Little Striped Whiptail). To our knowledge this species is a novel prey item for *C. flagellum*. The snake and lizards were collected and deposited as SRSU 6649.

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***CORALLUS HORTULANUS* (Amazon Treeboa). DIET.** Predation on bats by snakes is relatively infrequently reported in the literature and records are scarce in Brazil (Esbérard and Vrcibradic 2007. Rev. Bras. Zool. 24:848–853). *Corallus hortulanus* is an arboreal boid with a wide geographic distribution on the



FIG. 1. An adult *Corallus hortulanus* preying on *Glossophaga soricina* (Pallas's Long-tongued Bat) in Reserva Biológica do Parazinho, Amapá, Brazil.

neotropical mainland and several continental and oceanic islands (Henderson 1997. Carib. J. Sci. 33:198–221). *Glossophaga soricina* (Pallas's Long-tongued Bat; Phyllostomidae) is a flower-visiting bat that lives in the neotropics (Volleth et al. 1999. Chromosome Res. 7:57–64). Here we report a predation event on *G. soricina* by *C. hortulanus* in the eastern Amazon.

On 29 August 2011, at 2045 h, in the Reserva Biológica do Parazinho (0.875°N, 49.9875°W; datum WGS84), a fluvial island of the Amazon River basin, municipality of Macapá, Amapá, Brazil, an adult *C. hortulanus* (SVL = 1.6 m) was observed after capturing a *G. soricina*. The *C. hortulanus* was observed on a banana tree (*Musa* sp.) near a refuge of *G. soricina* (Fig. 1). The elapsed time from constriction to complete ingestion was 47 min. This is the first record of predation on *G. soricina* by *C. hortulanus* and our observation extends the list of bat predators in Brazil.

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***CROTALUS ATROX* (Western Diamond-backed Rattlesnake). DIET / ATTEMPTED CANNIBALISM AND SCAVENGING.** *Crotalus atrox* is a well-known, large viperid that is found across much of arid southwestern North America. The diet of this species has been studied extensively (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Books, Washington, DC. 668 pp.). *Crotalus atrox* is a generalist, with the bulk of its diet consisting of small mammals and to a lesser extent, lizards. Klauber (1972. Rattlesnakes: Their Habits, Life Histories, and Influence on Mankind. 2nd ed. University of California Press, Berkeley. 1533 pp.) states that *C. atrox* is known to consume other members of the genus *Crotalus*, at least in captivity; at the San Diego Zoo an adult specimen ate a *C. molossus*, and a juvenile housed in overcrowded conditions ate a conspecific. However, ophiophagy and cannibalism have never been recorded in wild *C. atrox*. Herein I report the first recorded attempted predation by a *C. atrox* on a dead conspecific in a natural setting.

At 0237 h on 1 September 2014, a large *C. atrox* was found in the process of swallowing a smaller conspecific on US Route 385 in Brewster Co., Texas, USA, south of Marathon (30.02859°N, 103.2786°W; WGS84). When first encountered, the live *C. atrox* had approximately one third of the second snake swallowed headfirst (Fig. 1). The predation attempt was watched and photographed for approximately 15 min, however the *C. atrox* regurgitated the dead one, possibly because its body was coiled over itself (Fig. 1). The regurgitated *C. atrox* was collected and preserved (EAM761). Based on the overall condition of this specimen and its location on the highway it is likely that it was hit by a vehicle and was dead before consumption began. Also of note is that the dead individual had a large, partially digested, unidentified small mammal in its gut. Whether the scent of this small mammal was present on the partially consumed *C. atrox* and initiated the feeding event is unknown. This work was conducted under Permit No. SPR-0413-054 issued by Texas Parks and Wildlife and was funded by The Exploration Fund Grant from the Explorer's Club.



FIG. 1. *Crotalus atrox* attempted predation on a dead conspecific.

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***CROTALUS LEPIDUS* (Rock Rattlesnake). DIET / SCAVENGING.** *Crotalus lepidus* is usually considered to be an ambush predator that feeds primarily on lizards (Beaupre 1995. Herpetologica 51:45–56; Holycross et al. 2002. J. Herpetol. 36:589–597). Herein, we provide an account of novel opportunistic scavenging behavior in wild *C. lepidus*.

On 20 September 2014 at 2140 h we observed an adult male *C. lepidus* consume a road-killed adult male *Cophosaurus texanus* (Texas Earless Lizard) on the Indio Mountains Research Station (IMRS) Hudspeth Co., Texas, USA (30.769358°N, 105.009242°W, WGS 84; 1240 m elev.). The *C. texanus* had been an apparent victim of vehicular traffic early that morning on a dirt road on IMRS. As found in the road, the snake had not yet begun consuming the lizard, but was examining the specimen through rapid tongue flicking and physically nudging the lizard with its rostrum. The snake did not seem to be disturbed by our presence. After another brief episode of investigative behavior, the snake began swallowing the road-killed lizard by the head. The lizard displayed advanced levels of rigor mortis and desiccation, thus the snake initially struggled to swallow the specimen due to the stiff and erect position of the limbs (Fig. 1). Approximately 20 min elapsed before the entirety of the lizard was consumed. To the best of our knowledge, there are no records of scavenging by *C. lepidus* in a natural setting, although it has been described in several congeners (DeVault and Krochmal 2002. Herpetologica 58:429–436). However, *C. texanus* is a known prey item of *C. lepidus* on IMRS, and trailing behavior has been observed in *C. lepidus* during some of these predation events (Mata-Silva et al. 2011. Herpetol. Rev. 42:439). Our fortuitous



FIG.1. An adult male *Crotalus lepidus* scavenging a road-killed *Cophosaurus texanus* at Indio Mountains Research Station, Hudspeth Co., Texas, USA.

observation suggests that *C. lepidus* use alternative modes of foraging in addition to an ambush approach.

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***CROTALUS OREGANUS* (Northern Pacific Rattlesnake). NON-RATTLING TAIL DISPLAY.** Rattlesnakes exhibit three main tail displays: 1) rattling, an aposematic signal directed at predators (Klauber 1972. Rattlesnakes: Their Habits, Life Histories, and Influence on Mankind. University of California Press, Berkeley. 1580 pp.); 2) caudal luring, a form of aggressive mimicry used to attract insectivorous prey (e.g., Reiserer and Schuett 2008. Biol. J. Linn. Soc. 95:81–91); and 3) non-rattling defensive displays, exhibited by some species upon tactile stimulation (Rabatsky and Waterman 2005. Herpetol. Rev. 36:236–238). We recorded three instances of adult *Crotalus oreganus* exhibiting a non-rattling tail display. This display consists of snakes slowly flagging their raised tails from side to side (Fig. 1), and does not appear to function in prey capture or defense, making it different from previous reports of non-rattling displays in rattlesnakes. We recorded this behavior in one female and two males using fixed videography (Sony SNC-RZ25N cameras) at our field site, Blue Oak Ranch Reserve, Santa Clara Co., California (37.38208°N, 121.71209°W, WGS84; 800 m elev.). Our video cameras ran over a wireless internet connection and were controlled remotely by field assistants who watched their video feeds in real time at the field site. Their field of view was typically no more than 1.0–1.5 m. Our site's habitat is characterized by mixed oak woodland interspersed by grassland. Video of the tail displays can be viewed on our lab YouTube channel (https://youtu.be/__AXL4FYqIA).

The female (SVL = 79.5 cm) was recorded on 12 June 2011. We had implanted a radio-transmitter in her on 29 May 2011. At the time of the tail display, we considered her not recovered from surgery because she had not moved from the location where we released her and because she exhibited behaviors consistent with recovery (periodically moving in and out of one refuge and using a loosely coiled body position). She had emerged from her rocky burrow refuge at 1514 h that day and was approximately 30 cm from its entrance when the behavior occurred. In addition, she was fully exposed and no other animals were present on camera. At 1523 h, she lifted her tail above her body and proceeded to move it from side to side a total of 9 times over the course of 124 sec. Eighty-six seconds after ceasing this tail display, she moved her head toward her burrow (thus becoming partially elongated) and rested in that position for 33 sec. She retreated to the burrow at 1528 h. She remained at the site, presumably recovering from surgery, until 25 June 2011.

We recorded a tail display in one male (SVL = 71.0 cm) on 9 June 2012. We implanted him with a radio-transmitter on 28 April 2012 and considered him recovered from surgery at the time of his display. This snake was within thick vegetation (mainly Bull Thistle, *Cirsium vulgare*) when the behavior occurred, and he also appeared alone as no other animals were present on camera. He arrived to the site at 1306 h and started the tail display at 1310 h by slowly moving his raised tail to one side (a behavior that lasted 6 sec). He moved his tail to the other side of his body 57 sec later (a movement that lasted 7 sec). He then exhibited two tail side sweeps 242 sec later (the first lasted 6 sec, the second lasted 11 sec). Forty-four seconds after ceasing the tail display, he probed the area for 74 sec by moving his head around and tongue-flicking. He abandoned the site at 1318 h, but only moved approximately 30 cm where he coiled in a new position. He remained at that site for 1–2 days thereafter.

Our recording of the other male that exhibited a tail display is the most striking. This male (SVL = 101.0 cm) was implanted with a radio-transmitter on 29 May 2011 and was considered recovered from surgery. He appeared to exhibit the tail display in response to the presence of another adult male (SVL = 97.0 cm). Their interaction occurred on 2 July 2011, although they had been sharing the same burrow since 1700 h on 1 July 2011. The snake that exhibited the display (called Snake P) emerged from their shared burrow at 1303 h while the other snake (called Snake M), emerged at 1304 h. Snake P quickly assumed an S-shaped body posture approximately 60 cm from the burrow next to a fallen branch, while Snake M continued to slowly emerge from the burrow. The majority of Snake P's body was not within the camera frame when he began the tail display, but we were able to see his tail moving at 1307 h and 54 sec and a field assistant then used the pan/tilt/zoom function of the camera to center his body in the frame. At this time, Snake M remained elongated out of the burrow with his head on top of the body of Snake P. Snake P moved his raised tail from one side of his body to the other a total of 9 times over the course of 14 sec (Fig. 1), and Snake M moved his head over Snake P while tongue flicking. Snake P also tongue flicked during this interaction. Snake M retracted his head from off the body of Snake P, but remained close by. An adult California Ground Squirrel (*Otospermophilus beecheyi*) approached the snakes at 1311 h and immediately ran away (on camera < 4 sec). Snake P exhibited another bout of tail waving at 1313 h, moving his tail from side to side a total of 6 times over the course of 13 sec. At 1313 h and 34 sec, we observed Snake M moving his upper body back toward the burrow while tongue flicking. Snake M immediately began to retreat into the burrow, but then stopped abruptly at 1313 h and 50 sec. Snake M started movement again at 1314 h and 59 sec, but changed directions and moved to the left of the burrow and under the fallen oak branch. Snake P quickly fled the site at 1318 h. Snake P kept his tail raised above his body the entire time after first exhibiting the tail display and before leaving the site. We did not immediately track Snake P after this interaction so we lack data on the distance he moved after exhibiting the tail display. However, we found him with a large food bulge at 1630 h, and we deducted that he had consumed

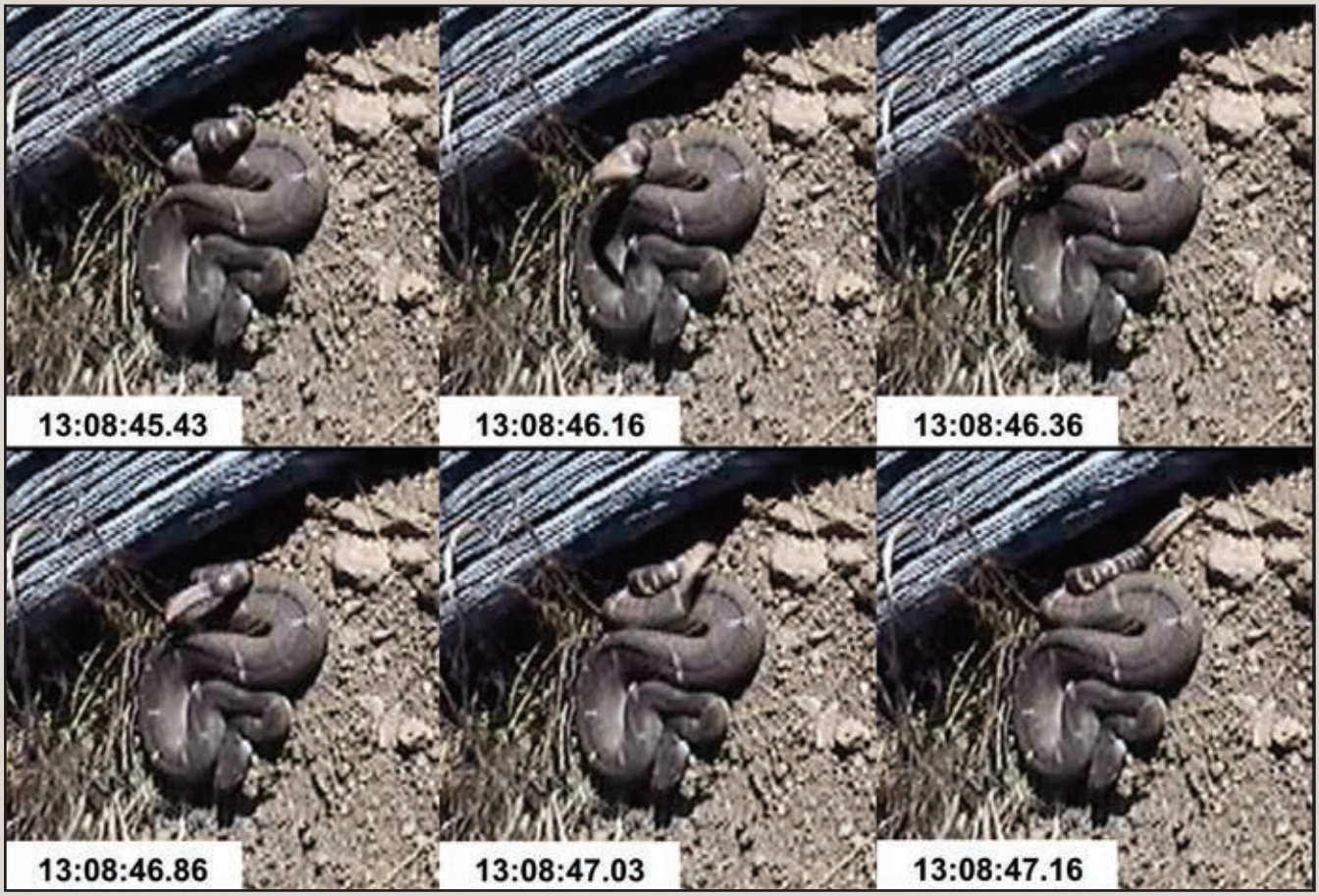


FIG. 1. Time-series of an adult male *Crotalus oreganus* exhibiting two flags from a non-rattling tail display bout. Time flows from left to right, top to bottom.

an adult squirrel because no other prey items at our site are comparable in body size.

Collecting precise descriptions of the contextual stimuli that elicit snake tail displays is necessary to better understand their function. The three instances we report above have a few commonalities. First, all snakes were in a loosely coiled body position. Second, the snakes exhibited the display intermittently over several minutes (approximately 2–6 min), then left their sites almost immediately after. Finally, the cloaca of the snakes appeared swollen when they were displaying, which could indicate that fluids were released from the cloaca and could function in communication. It is unlikely this tail display functions to attract prey because none of the rattlesnakes were in hunting body positions (ambush coil) when they exhibited the behavior. Many snake tail displays have an antipredator function (Greene 1973. J. Herpetol. 7:143–161), but no predatory threat was visible on camera (although predators could have been close by) when our rattlesnakes displayed. Furthermore, when threatened, rattlesnakes typically rely on crypsis before mounting behavioral defenses and many studies have shown that tactile stimulation or intense harassment are needed to induce behavioral defenses in exposed vipers (Glaudas et al. 2005. Copeia 2005:196–200; Maritz 2012. Afr. Zool. 47:270–274). Given that our snakes were not visually disturbed prior to waving their tails, it is unlikely that this display functions in defense against predators.

The tail displays we observed are likely functional considering the deliberate, prolonged movements and the attention they could draw to otherwise cryptic snakes. Other pitvipers use tail displays during conspecific interactions. Tail writhing is displayed by defeated males after male-male combat in *Agkistrodon contortrix* (Schuett 1997. Anim. Behav. 54:213–224). Female *Crotalus molossus* that are disinterested in courting males have been observed exhibiting tail displays similar to what we recorded (E. Taylor, pers. comm.). Non-defensive tail displays in *C. oreganus* may thus be used to communicate with conspecifics, although this idea is speculative given our small sample size. We only captured one recording of two male rattlesnakes interacting when the tail display occurred, although conspecifics could have been close by but not visible in our other recordings due to our restricted field of view. The two males we recorded interacting did not behave aggressively toward each other. In addition, we did not film rattlesnakes during breeding seasons so we cannot associate these displays with mating behaviors. More observations are needed to formulate testable hypotheses concerning this behavior.

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***CROTALUS SCUTULATUS* (Mohave Rattlesnake). MAXIMUM SIZE.** Here, we report the longest accurately measured *Crotalus scutulatus*. The adult male *C. scutulatus* was captured mid-morning on 16 September 2014, in Eloy, Pinal Co., Arizona, USA (32.780383°N, 111.613144°W; WGS84). The snake was coaxed into a clear plastic tube and triplicate measurements were taken with the anterior part of the snake in the tube and the posterior part straightened out by hand along a measuring tape (Fig. 1). Mean measurements (± Standard Deviation) were: SVL = 1136.7 (± 5.7) mm, tail length = 90.3 (± 2.4) mm. Therefore the total length of the specimen (excluding the rattle) is 1236 mm.

Crotalus scutulatus measuring over 1000 mm are not common, and the maximum verified total length (excluding rattle) to date is 1135 mm (Cardwell 2015. Rattlesnakes of Arizona. *In press*. ECO Publishing, Rodeo, New Mexico). While there have been a few previous reports of animals over 1200 mm long, none of these reports have been authenticated (Cardwell 2015, *op. cit.*). A male specimen of length 1231 mm reported by Klauber remains unconfirmed as the datasheet has not been located (Cardwell 2015, *op. cit.*). Tennant (1984. The Snakes of Texas. Texas Monthly Press, Austin, Texas. 561 pp.) initially reported a male measuring 1373 mm from Brewster Co., Texas, USA, but later questioned this due to possible misidentification (Cardwell 2015, *op. cit.*). Finally, Lowe et al. (1986. The Venomous Reptiles of Arizona. Arizona Game and Fish Dept., Phoenix. 115 pp.) described the maximum length of *C. scutulatus* as 1321 mm, but the source of this is untraceable and is suspected to be a digit-switching error while reporting Klauber's data (Cardwell 2015, *op. cit.*). Our specimen, with a total length of 1236 mm is consequently the longest *C. scutulatus* that has been accurately measured and reported. The specimen is now in the live collection of the Chiricahua Desert Museum, Rodeo, New Mexico.

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FIG. 1. Longest recorded *Crotalus scutulatus* being measured.

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***CROTALUS WILLARDI* (Ridge-nosed Rattlesnake). REPRODUCTION / MALE COMBAT.** In certain lineages of snakes, males compete for priority-of-access to females as mates by way of direct fighting, often called male combat (Carpenter et al. 1976. Copeia 1976:764–780; Shine 1978. Oecologia 33:269–277; Schuett 1997. Anim. Behav. 54:213–224). In rattlesnakes and numerous other pitviper species, male combat involves rearing, vertical posturing, entwining, constriction, and thrashing (Schuett, *op. cit.*; Schuett et al. 2001. Acta Ethol. 4:31–49). Here, we report on male combat in *Crotalus willardi* from a population in Arizona. To the best of our knowledge, male combat has not been described in *C. willardi* in the wild or in captivity (Shine 1994. Copeia 1994:526–546; Schuett et al., *op. cit.*; Ernst and Ernst 2012. Venomous Reptiles of the United States, Canada, and Northern Mexico. vol. 2, Johns Hopkins University Press, Baltimore, Maryland. 399 pp.).

On 8 August 2008, at 0955 h, on a small hillside (elev. 1646 m) in the Patagonia Mountains (Arizona, Santa Cruz Co., USA, 31.416°N, 110.733°W; datum Conus 27; highest elev. 2201 m), one of us (BPO) observed two adult *C. willardi* engaged in male combat (Fig. 1A). The snakes were similar in size, but were easily distinguishable by their body color (dark brown vs. light brown) and number of rattle segments (Fig. 1B). Neither individual was captured; thus, sex was not directly confirmed. Combat proceeded in typical stereotypic fashion, with both individuals raising their bodies above the substrate and attempting to attain a superior position (Schuett et al., *op. cit.*). Other acts included swaying, entwining, and falling. After several minutes they would rest then reinitiate combat. Both individuals used a rock and low-lying branches for stability during vertical postures of combat. At 1011 h, observations of the snakes were halted for 20 min; when observation resumed, the light male was found about 7 m up slope along a rock cut where he



PHOTOS BY BRENDAN P. O'CONNOR

FIG. 1. Male combat in *Crotalus willardi* in the Patagonia Mountains, Arizona. A) Males in vertical postures. B) Males entwined, constricting, and one is exhibiting a superior position.

was stretched out and in a relaxed position. The dark male was not located after searching for 10 min. Actual combat was observed for approx. 16 min, and the total duration of the observation was 56 min. Although a female *C. willardi* was not located in the immediate vicinity, this does not preclude a female's presence owing to this species' extremely cryptic behavior. The combat observation we document occurred during the time of summer that is commonly reported as the mating season for this species in the northern region of its range (Holycross and Goldberg 2001. Copeia 2001:473–481; Ernst and Ernst 2012, *op. cit.*).

We thank Ryan Sawby for assistance in preparing the figure.

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***DRYMARCHON MELANURUS EREBENNUS* (Texas Indigo Snake). DIET / SCAVENGING.** *Drymarchon melanurus erebennus* is a state (Texas) protected species with a wide distribution including all of the South Texas Plains and portions of the southern Edwards Plateau eco-regions. *Drymarchon m. erebennus* is an opportunistic generalist that feeds on a broad spectrum of vertebrates including rodents, birds, frogs, small turtles, lizards, and serpents. Smith and Antonio (2007. Herpetol. Rev. 38:88) report carrion feeding by the allopatric *D. couperi* (Eastern Indigo Snake) on a disarticulated shark head. Herein we report, to the best of our knowledge, the first observation of *D. m. erebennus* eating carrion in the wild.

On 27 March 2007, an adult *D. m. erebennus* was observed in the process of swallowing a dead *Crotalus atrox* (Western Diamond-backed Rattlesnake) (Fig. 1). The *C. atrox* had been killed two days earlier and draped over a barbed-wire fence. The carcass was bloated and exhibited an advanced state of decomposition. The carcass hung from a barb, causing the *D. m. erebennus* to rise from the ground during the early stages of consumption. Thereafter we removed the carcass from the fence and observed as consumption proceeded over the next two hours. The observation occurred approximately 4 km W of Yancey, Medina Co., Texas, USA (29.14894°N, 99.18679°W, datum WGS84; elev. 217 m). A photo voucher (TNHC 91021) was deposited in the Texas Natural History Collection at the University of Texas.



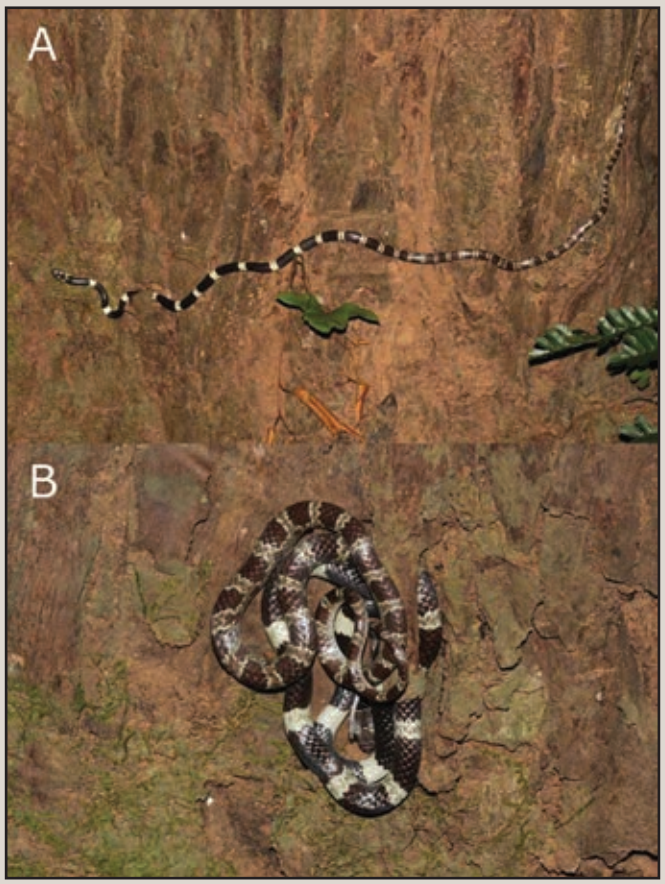
PHOTO BY MICHAEL BOLFING

FIG. 1. *Drymarchon melanurus erebennus* consuming a dead *Crotalus atrox* hanging from barbed-wire fence.

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***DRYOCALAMUS SUBANNULATUS* (Malayan Bridle Snake). BEHAVIOR.** In Southeast Asia, two genera of climbing snakes, *Dryocalamus* and *Lycodon*, are morphological Batesian mimics of the highly venomous kraits in the genus *Bungarus*. *Bungarus* snakes exhibit a dark brown or black background with bands of white, yellow, or tan, which together provide an appearance of alternating dark and light bands. *Dryocalamus* and *Lycodon* snakes, although differing from *Bungarus* species in other morphological characters, mimic this alternating dark and light color pattern. In Thailand, the color pattern of *Dryocalamus subannulatus* is thought to mimic that of *Bungarus candidus*, and the ranges of these two species overlap by at least 50%. Hospitals in Thailand report (Viravan et al. 1992. Trans. Roy. Soc. Trop. Med. Hyg. 86:100–106) that *Dryocalamus* snakes are brought in by snakebite victims believing they have been bitten by a *Bungarus* species.

At 2122 h on 31 July 2014, we observed a *D. subannulatus* in a dry evergreen forest at Sakaerat Environmental Research Station in Nakhon Ratchasima Province, Thailand (14.5060°N, 101.9276°W, WGS84; 435 m elev.). The snake was stretched horizontally (Fig. 1A), 22 cm above the ground, across the trunk of



PHOTOS BY N. KARRAKER

FIG. 1. *Dryocalamus subannulatus* when (A) first observed, and (B) mimicking head-hiding behavior of *Bungarus* species.

PHOTOS BY A. DEVAN-SONG



FIG. 2. *Bungarus candidus* exhibiting head-hiding behavior at Sakaerat Environmental Research Station, Thailand in 2012.

a *Hopea ferrea* tree (52 cm diam at 1.0 m above the ground). As we watched, the snake initially doubled its body back across the trunk and began probing crevices, seemingly searching for cover. Within one minute, and without any physical disturbance by us, the snake began coiling its body on the trunk and tucked its head beneath its body (Fig. 1B), in a behavior similar to that of *B. candidus* (Fig. 2), *B. fasciatus* (Karsen et al. 1998. Hong Kong Amphibians and Reptiles. Provisional Urban Council, Hong Kong. 134 pp.), and *B. multicinctus* (Glass 1946. Copeia 1946:249–252). As we attempted capture, the snake lunged to the side and attempted flight, a behavior similar to the defensive side strike we have observed in *B. candidus* and *B. fasciatus*. We captured the male *D. subannulatus*, at which time it was measured (SVL = 49.9 cm; total length = 69.0 cm) and weighed (17.7 g). The snake was released where it was found.

Some other colubrids exhibit head-hiding behavior, but this behavior has largely been induced in response to a "predatory attack," often involving tapping on the head, by a researcher (e.g., Langkilde et al. 2004. Ethology 110:937–947). We have observed *Bungarus* spp. engage in head-hiding behavior on numerous occasions with no interference from us other than illumination by a headlamp, as was the case with the *D. subannulatus*. Our observations suggest that *D. subannulatus* may be both a morphological and behavioral mimic of *B. candidus*.

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***ELAPHE QUADRIVIRGATA* (Japanese Four-lined Ratsnake). DIET.** *Elaphe quadrivirgata* is endemic to the main islands of Japan, and is known as a general predator of arthropods, amphibians, reptiles, birds, and mammals (Mori and Moriguchi 1988. Snake 20:98–113). However, there are no reports of predation on annelid worms. During fieldwork at Ito campus, Kyushu University, Fukuoka, Japan (33.5983°N, 130.2145°E; datum Analysis by GSIMaps) at 1527 h on 16 June 2014, we recovered an earthworm from an *E. quadrivirgata* (female; SVL = 86.5 cm) by forced regurgitation (Fig. 1); no other stomach contents were obtained from the snake. This is the first report of predation on earthworms by *E. quadrivirgata* in the wild. The earthworm was dissected and



FIG. 1. *Metaphire* sp. recovered from an *Elaphe quadrivirgata* at Ito campus, Kyushu University, Fukuoka, Japan.

identified as *Metaphire* sp. (Megascolecidae). The earthworm specimen was deposited in the Zoological collection of Kyoto University (KUZ Z704).

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***GYALOPION QUADRANGULARE* (Thornscrub Hook-nosed Snake). DEFENSIVE BEHAVIOR / CLOACAL POPPING.** At 2245 h on 16 July 2014, a *Gyalopion quadrangulare* was encountered crossing a road west of Nogales, Santa Cruz Co., Arizona, USA, by RDB. When picked up for examination, the snake writhed, thrashed, and issued a series of 4–6 cloacal pops. The snake repeated this display the following morning when removed from its container. At 2011 h on 20 September 2014, another *G. quadrangulare* was found crossing a road by DDK. When picked up, the snake thrashed wildly, emitted a sharp sneeze or spit, and cloacal popped for 2–3 min, even after being placed in a collecting bag. Cloacal popping is a defensive behavior where contraction of the cloacal muscles forces air over the anal plates producing controlled flatulence and is currently known to be employed by only three species of North American snakes: *Micrurus fulvius* (Harlequin Coralsnake), *Micruroides euryxanthus* (Sonoran Coralsnake), and *Gyalopion canum* (Chihuahuan Hook-nosed Snake; Young et al. 1999. J. Herpetol. 33:557–566).

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***HELICOPS LEOPARDINUS* (Watersnake). DIET.** *Helicops leopardinus* is a Neotropical aquatic snake, frequently found in flooded areas associated with floating vegetation (Hoogmoed 1993. *In* P. E. Ouboter [ed.], Freshwater Ecosystems of Suriname, pp. 199–213. Kluwer Academic Publishers, Amsterdam, Netherlands). It is generally nocturnal and feeds primarily on fish, tadpoles, and adult frogs (Martins and Oliveira 1998. Herpetol. Nat. Hist. 6:78–150; Ávila et al 2006. J. Herpetol. 40:274–279). Here, we describe a diurnal predation event by *Helicops leopardinus* on *Synbranchus marmoratus* (Pisces: Synbranchiformes).

On 15 October 2013, at 1128 h, while conducting a herpetological survey in the Reserva Extrativista Beija Flor Brilho de Fogo (0.804464°N, 52.212533°W, WGS84; 123.5 m elev), municipality of Pedra Branca do Amapari, Amapá state, Brazil, we discovered a female *H. leopardinus* (SVL = 590 mm, tail length = 138 mm) that was preying on a Swamp Eel, *S. marmoratus* (total length = 194 mm), in the water. When found, the *H. leopardinus* was biting the opercula area of the eel, but soon began ingesting the eel headfirst. After 14 min, the snake was captured, causing it to release the eel. Both specimens have been deposited in the Coleção Didática do Laboratório de Zoologia, Universidade Federal do Amapá, Amapá, Brazil. This research was authorized by permit number 41443-1 ICMBio.

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***HELICOPS LEOPARDINUS* (Watersnake). DIET.** *Helicops leopardinus* (Dipsadidae) is an aquatic and nocturnal species, frequently found in flooded areas associated with floating vegetation (Hoogmoed 1993. *In* P. E. Ouboter [ed.], Freshwater Ecosystems of Suriname, pp. 199–213. Kluwer Academic Publishers, Amsterdam, Netherlands). It is a generalist in terms of diet, consuming fishes, tadpoles, and occasionally adult amphibians (Ávila et al 2006. J. Herpetol. 40:274–279). Here we describe a field observation of predation on *Leptodactylus macrostenum* (Anura: Leptodactylidae) by *H. leopardinus* in Eastern Amazonia.

On 27 June 2014, at 1819 h, in the floodplain at Área de Proteção Ambiental do Curiaú (0.153444°N, 51.014972°W; datum WGS84), municipality of Macapá, Amapá, Brazil, we encountered an adult female *H. leopardinus* with an adult male *L. macrosternum* that it had seized and partially ingested, hind limbs first (Fig. 1). For approximately 27 min we observed the snake attempting to consume the frog. During this predation event, the frog emitted a sequence of distress calls. Upon capture, the *H. leopardinus* (SVL = 467 mm; Tail length = 110 mm; 98 g) regurgitated the *L. macrosternum* (SVL = 72.4 mm; 36 g). The frog and the snake were collected and deposited at the Herpetological Collection of the Universidade Federal do Amapá (CECCAMPOS 00864, 00865, respectively; ICMBio collecting permit number 41586-1). This report is the first record of *L. macrosternum* as prey of *H. leopardinus*, suggesting opportunistic feeding on frogs at breeding sites.



Fig. 1. *Helicops leopardinus* feeding on a *Leptodactylus macrosternum* in Eastern Amazonia, Brazil.

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***HYPSIGLENA JANI* (Texas Nightsnake). DIET.** *Hypsiglena jani* is a small dipsadine that is widespread within the Chihuahuan Desert of North America. The diet of nightsnakes has been well studied (Rodríguez-Robles et al. 1999. Copeia 1999:93–100) and consists primarily of phrynosomatid lizards and squamate eggs. Although species of *Phrynosoma* are widely sympatric with species of *Hypsiglena,* these lizards have only been recorded as a prey item once before and never for *H. jani* (*H. chlorophaea;* O'Connor et al. 2010. Northwest. Nat. 91:79–81).

While road-cruising in Eddy Co., New Mexico, USA, we observed an adult *H. jani* attempting to consume a *P. cornutum* (Fig. 1). The specimen was discovered the night of 27 August 2013 on Queens Highway west of Carlsbad (32.42759°N, 104.54283°W; WGS84). When first observed, the *H. jani* was in the process of chewing on the neck of the *P. cornutum*, likely facilitating envenomation of the lizard. The snake made multiple attempts to swallow the lizard; however, given the small size of the snake and the large size of the cranial horns possessed by the *P. cornutum,* actual consumption would have been unlikely. Both snake and lizard were collected and preserved (*H. jani*, EAM199; *P. cornutum,* EAM198); the *Phrynosoma* died before morning presumably as a result of its envenomation. This work was conducted under Permit No. 3559 issued by the New Mexico Department of Game & Fish to EAM.



Fig. 1. *Hypsiglena jani* biting the neck of *Phrynosoma cornutum* west of Carlsbad, New Mexico, USA.

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***MICRURUS DISTANS DISTANS* (West Mexican Coralsnake). DIET.** Endemic to western Mexico, *Micrurus distans* occurs at low to moderate elevations from southwestern Chihuahua and southern Sonora, southward on the Pacific drainage through Sinaloa, Nayarit, Jalisco, Colima, and Michoacán to Guerrero (Ernst and Ernst 2011. Venomous Reptiles of the United States, Canada, and Northern Mexico: Volume 1. Johns Hopkins University Press, Baltimore, Maryland. 392 pp.). The diet of this terrestrial species is comprised predominantly of snakes (Roze 1996. Coral Snake of the Americas: Biology, Identification, and Venoms. Krieger Publishing Co., Malabar, Florida. 340 pp.). Herein, we report the first documented instance of predation on *Drymarchon melanurus* (Central American Indigo Snake) by *M. d. distans*.

At 0940 h on 25 August 2014, we found an adult female *M. d. distans* (SVL = 770 mm; UCM AC-184; Fig. 1A) 1 km E of Alamos, Sonora, Mexico (27.02365°N, 108.92466°W; WGS 84). Later the same day, the snake disgorged a hatchling-sized *D. melanurus* (SVL ca. 457 mm; UCM AC-185) that had been swallowed headfirst (Fig. 1B). To our knowledge, this is the first report of *D. melanurus* in the diet of *M. d. distans*.

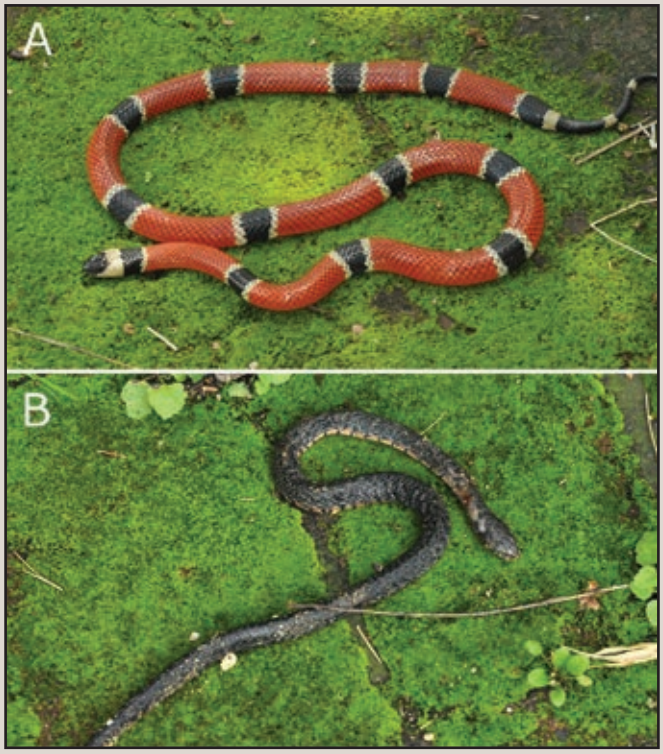


Fig. 1. A) Adult *Micrurus distans distans* from Alamos, Sonora, Mexico, that consumed a juvenile *Drymarchon melanurus*. B) Juvenile *D. melanurus* regurgitated by the *M. d. distans*.

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***MICRURUS MIPARTITUS* (Red-tailed Coral Snake, Coral Rabo de Ají). DIET / OPHIOPHAGY.** Coral snakes are predators of elongate vertebrates such as snakes, fishes, caecilians, lizards, and amphisbaenians (Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna between Two Continents, between Two Seas. University of Chicago Press, Chicago, Illinois. 704 pp.). It is presumed that *Micrurus mipartitus* preys on other snakes in its natural environment (Guyer and Donnelly 2004. Amphibians and Reptiles of La Selva, Costa Rica, and the Caribbean Slope. University of California Press, Berkeley. 367 pp.), with data on consumption of *Atractus* snakes in captivity (Ayerbe et al. 1990. Nov. Colomb. 2:30–41). It has also been reported that *M. mipartitus* feeds upon on amphibians such as *Caecilia thompsoni* (Hernando-Bernal and Milena-Palma 2011. Herpetol. Rev. 42:617) and *Gymnopis multiplicata* (Saporito 2007. Herpetol. Rev. 38:199). Herein, we document the snake *Atractus manizalesensis* as prey of *M. mipartitus* in a natural environment.

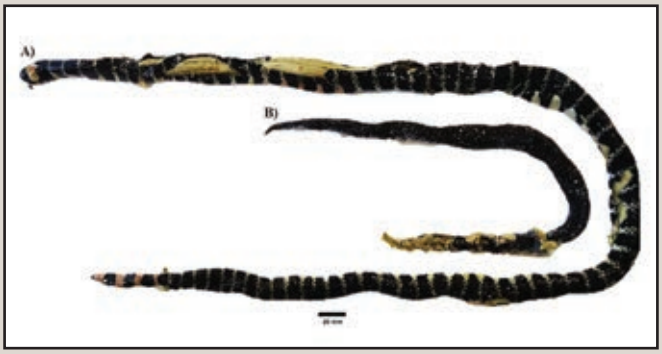


Fig. 1. Adult *Micrurus mipartitus* (A) with stomach contents, an adult female *Atractus manizalesensis* (B).

On 30 July 2013, we found a dead adult male *M. mipartitus* (MHN-UC 255; SVL = 753.7 mm; total length = 758 mm) on an unpaved road at Vereda Floresta, municipality of Villamaría, Department of Caldas, Colombia (5.0205138°N, 75.5225305°W, WGS84; 1790 m elev.). Its stomach contained an adult female *A. manizalesensis* (Fig. 1; MHN-UC 256; total length = 323 mm), partially digested in the anterior region and ingested headfirst; it represented ca. 42.6% of the predator's total length. The specimens are housed in Museo de Historia Natural de la Universidad de Caldas (MHN-UC), Manizales, Colombia.

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***NERODIA SIPEDON* (Northern Watersnake). SCAVENGERS.** Some *Limenitis* species of butterfly are known to feed on carrion (Downes 1973. J. Lepidopterists Soc. 27:89–99), and in the past lepidopterists have used decomposing snakes hung from trees to attract uncommon woodland species (Clark 1932. The Butterflies of the District of Columbia and Vicinity. U.S. Natl. Mus., Bull. 157, 337 pp.). However, here I present the first known observation of *Limenitis* (i.e., *Limenitis arthemis astyanax*; Red-Spotted Purple Butterfly) feeding on *Nerodia sipedon*. On 28 July 2013, a *L. a. astyanax* was observed scavenging on a roadkilled subadult *N. sipedon* in Mahwah City, Bergen Co., New Jersey, USA. The butterfly was observed feeding for approximately 90 min on areas of exposed muscle tissue where skin had been torn away by vehicles. Adult Lepidoptera can only imbibe solutions with particles small



FIG. 1. *Nerodia sipedon* scavenged by *Limenitis arthemis astyanax*, Mahwah City, New Jersey, USA.

enough to pass through the proboscis and exposed muscle tissue provides both minerals and salts of appropriate size. The snake was scavenged for two consecutive days (90 min/day), either by the same returning individual butterfly or by multiple individuals.

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***PANTHEROPHIS SPILOIDES* (Gray Ratsnake), *AGKISTRODON PISCIVORUS* (Cottonmouth), *COLUBER CONSTRICTOR* (North American Racer), *THAMNOPHIS PROXIMUS* (Western Ribbonsnake). AGGREGATION BEHAVIOR.** Observations of multi-species aggregations of snakes are rare (Gregory 2004. Herpetologica 60:178–186) and this behavior remains poorly understood. On 8 November 2013 at 0900 h on a clear, cool, sunny morning (12.8°C) at the Turtle Cove Environmental Research Station of Southeastern Louisiana University on Pass Manchac in southeastern Louisiana, USA (30.294034°N, 90.335046°W; WGS84), a group of students flipped several overlapping pieces of 2´ x 12´ sheets of tin and found six snakes of four species: two *Pantherophis spiloides*, two *Coluber constrictor*, one *Agkistrodon piscivorus*, and one *Thamnophis proximus*. One *P. spiloides* and one *C. constrictor* were entwined and the other *C. constrictor* and *P. spiloides* were in elongate coils less than an inch apart from each other. The *A. piscivorus* was coiled adjacent to the latter four snakes and the *T. proximus* was separated from the others by ~ 1 m.

Multi-species aggregations are rare, as is speculation on why they occur (Gregory et al. 1987. *In* Seigel et al. [eds.], Snakes: Ecology and Evolutionary Biology, pp. 366–395. MacMillan Publ. Co., New York; Gregory 2004, *op. cit.*). Heat retention and water loss prevention have been two proposed explanations. In this case we speculate the snakes shared the cover for thermal reasons. We do not know if the snakes sheltered all night there (all the species mostly exhibit diurnal activity), but it would seem plausible that they used the warm tin as shelter overnight and for rapid warming with the morning insolation. Others have noted that individual snakes in multi-species aggregations are never "strongly dissimilar in size" (Gregory 2004, *op. cit.*). However, of the six individuals, the *A. piscivorus* and *T. proximus* were distinctly smaller than the others. The Cottonmouth was a juvenile still in possession of the characteristic lemon-colored tail.

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***PITUOPHIS CATENIFER AFFINIS* (Sonoran Gophersnake). DIET.** *Pituophis catenifer affinis* is a common species throughout central New Mexico that has been reported to feed primarily on mammals. However, it will opportunistically feed on a variety of prey items including birds (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Books, Washington, D.C. 668 pp.) and bird eggs (Degenhardt et al. 1996. The Amphibians and Reptiles of New Mexico. University of New Mexico Press, Albuquerque, New Mexico. 431 pp.), although eggs might be consumed secondarily (Fitch 1999. A Kansas Snake Community: Composition and Changes over 50 years. Krieger Publishing Co., Malabar, Florida. 165 pp.). At ca. 1030 h on 27 July 2010, while conducting *Coccyzus americanus occidentalis* (Western Yellow-billed Cuckoo) telemetry studies (Sechrist et al. 2012. Western Birds 43:2–11), we recorded a *P. c. affinis* predating a *C. a. occidentalis* nest containing three eggs near The Narrows, Sierra Co., New Mexico, USA (33.2219°N, 107.1048°W; datum WGS84). The nest was located 6.2 m above the ground, nestled in a fork of a live 10.6-m tall *Salix gooddingii* (Gooding's Willow). A remote camera captured a nine-second video of the predation event, although it is likely the event lasted longer. Nest predation was partial; two of three eggs were missing when the camera was removed. The nest was successful in producing one fledgling. To our knowledge, this is the first report of *C. a. occidentalis* nest predation by *P. c. affinis*. We thank the Albuquerque Area Office of the Bureau of Reclamation for funding.

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***REGINA SEPTEMVITTATA* (Queensnake). DEFENSIVE BEHAVIOR / DEATH-FEIGNING.** Death-feigning behavior or thanatosis, a defensive behavior against predation characterized by lack of movement, has been documented in a number of snake species (Gehlbach 1970. Herpetologica 26:24–34). Here we report an observation of death-feigning behavior in juvenile *Regina septemvittata*. At 1400 h on 27 June 2014, two juvenile *R. septemvittata* were captured in Little Hickman Creek in Jessamine Co., Kentucky, USA (37.7715°N, 84.5710°W; WGS84), as part of an ongoing capture-mark-recapture project. Upon handling, the snakes exhibited death-feigning behavior, remaining motionless with the ventral parts of their bodies facing upward (Fig. 1). The behaviors lasted for approximately 10 min before the snakes became active.



FIG. 1. Death-feigning in *Regina septemvittata* from Jessamine Co., Kentucky, USA.

Photographs and video were taken of the event and the snakes were subsequently released at capture locations. Prior accounts of the defensive behavior of *R. septemvittata* have included flight, biting, and expelling musk, but to our knowledge, death-feigning has not previously been described (Layne and Ford 1984. J. Herpetol. 18:496–498; Gibbons and Dorcas 2004. North American Watersnakes: A Natural History. University of Oklahoma Press, Norman. 438 pp.).

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***SISTRURUS CATENATUS* (Massasauga). CLIMBING BEHAVIOR.** A previous study noted six instances of *Sistrurus catenatus* climbing in a shrub-dominated, low-quality habitat (Shoemaker and Gibbs 2010. J. Wildl. Manage. 74:504–513). Those authors proposed that thermoregulation in a basking-site deficient habitat was the motive for this behavior. However, at 1109 h on 25 June 2012 (cloudy, 25.9°C), we observed and documented (Fig. 1) climbing behavior during a mark-recapture survey of *S. catenatus* in the same habitat, which as of 2011 had undergone management efforts by the New York State Department of Environmental Conservation (NYSDEC). The snake was basking ca. 1 m off the ground in a *Vaccinium corymbosum* (Highbush Blueberry) and remained coiled even after our initial approach, at which time we recorded an IR temp of 21.5°C. Upon capture, we noted that this snake was a gravid female (total length = 55.5 cm) initially tagged in 2006. The behavior was observed in habitat augmented by the NYSDEC by cutting vegetation to ground level in 32 plots, each 100 m^2 in area, based on recommendations made by Shoemaker and Gibbs (*op. cit.*). This treatment was followed by cutting of 12 additional 28 m^2 plots in 2012 after field surveys suggested that the rattlesnakes were using cut plots for basking (Johnson 2013. Management and Status of an Endangered Massasauga Rattlesnake Population in New York State. Thesis, SUNY- ESF). Because we observed climbing even after apparently suitable basking habitat had been created, further research is recommended to identify the motivation for this behavior.

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***THAMNOPHIS SIRTALIS* (Common Gartersnake). DIET.** On 30 April 2014 we found a *Thamnophis sirtalis* (SVL = 26 cm) beneath a board on an empty block at the corner of Vine St and Mulberry St, Cincinnati, Hamilton Co., Ohio, USA (39.11919°N, 84.51722°W; WGS84). We palpated the snake and it regurgitated an adult *Podarcis muralis* (European Wall Lizard; SVL = 5 cm; Fig. 1). *Podarcis muralis* was introduced to Cincinnati in 1951 from its native range in Europe and has subsequently established satellite colonies in British Columbia, Kentucky, and Indiana (Kraus 2009. Alien Reptiles and Amphibians: A Scientific Compendium and Analysis. Invading Nature: Springer Series in Invasion Ecology. Number 4. Springer, New York. 563 pp.). Within Cincinnati, *P. muralis* inhabits south-facing hillsides flanking the Ohio River and reaches high densities (Brown et al. 1995. Am. Midl. Nat. 133:344–359). Other known predators of *P. muralis* in the USA include *Felis silvestris catus* (Feral Cats; Brown et al. 1995, *op. cit.*) and *Mimus polyglottos* (Mockingbirds; Deichsel and Walker 2010. Herpetol. Rev. 41:228–229). *Thamnophis sirtalis* is a generalist predator, feeding on invertebrates, fish, amphibians, mammals, birds, and small snakes (Rossman et al. 1996. The Garter Snakes: Evolution and Ecology. University of Oklahoma Press, Norman. 332 pp.; Ernst and Ernst 2003. Snakes of the United



PHOTO BY B. JOHNSON

FIG. 1. Gravid female *Sistrurus catenatus* basking in a (~ 1 m tall) *Vaccinium corymbosum* bush.



FIG. 1. *Thamnophis sirtalis* (Common Garter Snake) with a regurgitated *Podarcis muralis* (European Wall Lizard) collected in Cincinnati, Ohio, USA.

States and Canada. Smithsonian Books, Washington, DC. 668 pp.). To our knowledge, this is the first report of *T. sirtalis* preying upon a lizard; the only published report on this topic describes a *T. sirtalis* pursuing (but failing to capture) an Italian Wall Lizard (*Podarcis sicula campestris*) in New York (Mendyk 2007. Herpetol. Rev. 38:82).

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***THAMNOPHIS SIRTALIS TETRATAENIA* (San Francisco Gartersnake). UPLAND HABITAT USE.** Since *Thamnophis sirtalis tetrataenia* was listed as a federally-endangered species in 1967, unpublished descriptions of its natural history suggest that it prefers relatively open upland habitats in proximity to perennial ponds, but this may be the result of observer bias and lack of field study (U.S. Fish and Wildlife Service 1985. Recovery Plan for the San Francisco Garter Snake *Thamnophis sirtalis tetrataenia*. Portland, Oregon; U.S. Fish and Wildlife Service 2006. San Francisco Garter Snake (*Thamnophis sirtalis tetrataenia*) 5-year Review: Summary and Evaluation. Sacramento, California). Recent research detected *T. s. tetrataenia* up to 215 m away from ponds that provide appropriate prey, although no trap-lines were installed at greater distances and the upland consisted primarily of grassland and open scrub to promote managed burning (Halstead et al. 2011. J. Fish Wild. Manage. 2:41–48).

On 19 April 2012 ca. 2.5 km E of La Honda in the Santa Cruz Mountains, San Mateo Co., California, we hand-captured an adult female *T. s. tetrataenia* in mixed hardwood forest with a closed canopy and native understory (37.3159°N, 122.2377°W, WGS84; 459 m elev.). The nearest known population of *T. s. tetrataenia* was at Mindego Lake, situated 450 m E of the site of capture. This pond, located at the margin of a non-native annual grassland and mixed hardwood forest, supported abundant prey, as well as a breeding population of *T. s. tetrataenia*. Based on the date, sex, and distance from the nearest source of prey, the adult female *T. s. tetrataenia* had likely recently emerged from hibernation and was migrating to a seasonal foraging habitat. It was observed within closed-canopy mixed evergreen forest, which has not been documented as a habitat association. The hibernaculum was presumably no less than 435 m from Mindego Lake, and the nearest secondary pond known to support the subspecies was Knuedler Lake, 1.26 km to the southwest. More research is needed to determine the preferred upland habitat associations and the amount of land necessary to support the life cycle of this cryptic snake. *Thamnophis s. tetrataenia* may travel long distances to reach specific microhabitats that provide hibernacula, and it may also benefit from certain vegetation associations to promote dispersal, migration, and predator avoidance.

We are grateful to the California Department of Fish and Wildlife and U.S. Fish and Wildlife Service for issuing permits to support our research. We thank the Midpeninsula Open Space District for access and funding of the field study that provided the opportunity to report this observation.

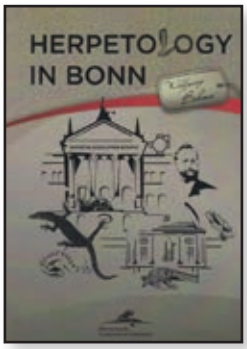
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BOOK REVIEWS

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Herpetology in Bonn

Wolfgang Böhme. 2014. Deutsche Gesellschaft für Herpetologie und Terrarienkunde (DGHT), Mannheim, Germany (www.dght.de). Mertensiella 21. vi + 256 pp. € 39,80 (approx. US $43.00), € 29,80 (approx.. US $32.00) for DGHT members. Softcover. ISBN 978-3-945043-02-8.



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I am especially fond of the history of natural history, including herpetological biography and the history of collections. I am also a sucker for a good type catalogue. *Herpetology in Bonn* has all of this plus it focuses on herpetology in a city that I have known and loved for more than 30 years, so I admit a positive bias. Bonn, the former capitol of the Federal Republic of Germany, is known to many as a herpetological Mecca in Europe and indeed, as described by Kraig Adler in the preface of the book, it is "perhaps the most active herpetological center in Europe." No man is an island but as much as any one institution can owe its reputation to one person, Bonn owes its herpetological fame to Wolfgang Böhme, whose boundless activity and prodigious production of both publications and students transformed Bonn from herpetological backwater to powerhouse.

The book focuses on the history of herpetology in Bonn, especially at the Museum Koenig (ZFMK) and at the University of Bonn. However, it paints a much broader picture of German (and global) herpetology, as Böhme integrates into his narrative the stories of many people whose professional activities intersected with these focal institutions, even if tangentially. The history of herpetology in Bonn predates both the Museum Koenig (opened to the public only in 1934) and the Rheinische Friedrich-Wilhelms University (founded 1818), and begins with the description of a gecko, in 1809, by Dr. Johann Heinrich Crevelt, a personal friend of Bonn's most famous non-herpetologist, Ludwig van Beethoven. For the remainder of the 19th century and into the 20th century, herpetology in Bonn was centered at the University. Among the herpetologists who were associated with the museum were Georg August Goldfuss, a paleontologist and the first to reconstruct fossils, Franz Herrmann Troschel, known to Americans as the describer of *Cophosaurus texanus*, and Franz von Leydig, a prolific anatomist and histologist. However, many other figures made contributions large or small, as students or staff, and all have been captured in this book. They include Johannes Müller, who later gained fame as a faculty member in Berlin, Wilhelm Pflüger, whose *Archiv*, founded in 1868, is the oldest surviving journal in the field of physiology, and Max Weber, who described reptiles from South Africa and Indonesia. Also treated are users of the collections, most notably Giorgio (Georg) Jan, who used snakes from Bonn in his *Iconographie des Ophidiens* (1860–1881).

In the 20th century workers at the university included Wilhelm J. Schmidt, whose numerous papers on the reptile integument remain landmarks, and Fritz Bodenheimer, who left Bonn for Israel and published important herpetological works on Turkey and Palestine. The destruction of Poppelsdorf Castle, home of the zoological museum, in World War II put an end to the importance of the University of Bonn as a site of traditional collections-based herpetological research. However, herpetology has continued to thrive there through the work of Hans Schneider, known for his research on anuran bioacoustics, Steven F. Perry, who has worked extensively on reptile lungs, and Martin Sander, who carries on the long tradition of paleoherpetology in Bonn started by Goldfuss, among others.

The history of herpetology at the Museum Koenig begins with the activities of Alexander Koenig, who grew up in Bonn in the Villa Hammerschmidt, the "White House of Germany" and, until reunification, the primary residence of the German federal president. Koenig was chiefly an ornithologist, but he also collected amphibians and reptiles. Material from his expeditions to Tunisia, Libya, Egypt and Sudan were sent first to Oscar Boettger in Frankfurt and later to Lorenz Müller in Munich for identification. It was not until 1930 that the first herpetological catalogue was initiated at the Museum Koenig (then still a private collection) and not until 1951, when the first herpetologist, Karl Buchholz (1911–1967), was hired. Buchholz worked chiefly in Greece and the Balearic Islands. Greece was also the focus of the second curator Ulrich Gruber, who remained with the small collection for only three years before moving to Munich.

The meteoric rise of herpetology in Bonn began with the arrival, in 1971, of Wolfgang Böhme, a freshly-minted Ph.D. from the University of Kiel, in north Germany. Although his herpetological interests were global, Böhme distinguished himself as an expert in Africa, as well as the Palearctic. He conducted three expeditions to Cameroon in the 1970s, the first in 1973, in the company of Martin Eisentraut, then director of the Museum Koenig. Eisentraut was chiefly a mammologist, but had published extensively in herpetology as well. By the end of the 1970s the herpetological ranks of the ZFMK had grown through the addition of Wolfgang Bischoff, an expert in lacertids from Madgeburg in the then German Democratic Republic, Ursula Bott, Böhme's assistant, and Klaus Busse (ostensibly the ZFMK ichthyologist, but known to herpetologists through his work on Darwin's Frog, *Rhinoderma*).

Growth in the ZFMK collection was augmented by the incorporation of several historical collections from other institutions,

shrewd acquisitions by Böhme that not only enriched Bonn, but saved invaluable material from obscurity and neglect. In 1972, herpetological specimens from the collection of the University of Kiel were obtained in exchange for a neuropteran collection from Bonn. This yielded historically important material from the collection of Friedrich Boie, some of which originated from his brother Heinrich and also Heinrich Kuhl, both of whom died as young men while engaging in the herpetological exploration of Java.

The most important acquisition was that of the Zoologisches Museum of the University of Göttingen in 1977. This collection, rich in types, had been built-up and enriched by generations of curators and donors including Johann Friedrich Blumenbach, Adolph Arnold Berthold, Moritz Wagner, Wilhelm Keferstein, and Jacques von Bedriaga. Göttingen's inclusion in the book has allowed Böhme to discuss important users of this ancient collection, like Johann Gottlob Schneider, Alexander Strauch, George A. Boulenger, Franz Werner, and Willy Wolterstorff, thereby expanding the scope of the volume considerably. This also brings into the book a discussion of the Museum Godeffroy, an institution that sold specimens to museums throughout Europe in the second half of the 19th century. Here I can perhaps resolve a minor mystery outlined by Böhme who mentions (p. 62) a Göttingen specimen of the Fijian iguana, *Brachylophus fasciatus*, supposedly collected by Eduard Graeffe, working for the Museum Godeffroy, in Samoa, where the species is not known to occur. Reference to the now rare published sale catalogues of the Museum Godeffroy reveals that Graeffe visited Viti Levu, Ovalau, Moturiki, Nagarra, Kandavu and the Exploring Group in Fiji and that the single *Brachylophus* for sale came from the "Viti-Inseln" [= Fiji] (Schmeltz 1869). Presumably the same specimen (the same specimen number is listed) appeared in a subsequent catalogue as being from "Viti- u. Tonga-Inseln" [Fiji and Tonga] (Schmelz 1874). If this is the specimen purchased by Göttingen and now in Bonn, the Samoan provenance must be considered an error introduced subsequent to the sale.

More recent acquisitions have included the herpetological collection of the University of Heidelberg (1984), which contained significant historical material and, most spectacularly, the Paul Müller collection of approximately 10,000 specimens, 70% from Brazil, transferred from Saarbrücken within the last decade.

In addition to collection development, the physical arrangement and features of the ZFMK herpetological collection and its live animal facilities are described as are the public exhibits in herpetology. These last are mostly a post-WWII feature of the Museum Koenig, and major modern exhibits with herpetological content, such as a large African savannah exhibit that dominates the ground floor of the museum and a new African rainforest exhibit that is advancing towards completion, were strongly influenced by Böhme.

The growth of the ZFMK collection has been mirrored by a series of type catalogues published over the years. The first (Böhme 1974) listed only 34 names and 22 name-bearing types. Böhme and Bischoff (1984) published a second type catalogue, and a third was prepared in conjunction with Böhme's official retirement (Böhme 2010). The latest type catalogue is included in *Herpetology in Bonn* as Chapter 4. This incarnation includes 663 herpetological types, 337 of them name-bearing.

Although type catalogues are often considered mere compilations, simply copied from museum records, this is a naïve view, held only by those who have never written one. A good type catalogue, and this is a good one, provides a wealth of historical and taxonomic information relevant to the specimens discussed. Indeed, sometimes an individual account can spiral out into the equivalent of a separate paper. Some entries are hugely detailed, including those for *Megophrys montana* Kuhl and van Hasselt, 1822 and *Calamita punctatus* Schneider, 1799—the latter three pages long and illustrated with five photos.

Accounts in the type catalogue give original publication, specimen number, collector, date, and comments on types other collections, current name, and recent relevant systematic or distributional information. A section on lost or missing types is also provided. These comprise only 10 amphibians and 13 reptiles, chiefly from the historical collection of Göttingen, such as the type of *Acanthosaurus gibbosus*, Berthold, 1846, a long forgotten synonym of *Moloch horridus*. A more modern lost specimen is the holotype of *Kinyongia vanheygeni* Nečas, 2009, which was stolen in a car break-in after its ZFMK registration number was assigned, but before it reached the museum!

The catalogue is a rich source of information and reflects Böhme's scholarship and his broad and deep knowledge of nomenclature, history, and all things herpetological. The catalogue of extant types includes material representing 18 nominal salamander taxa, 230 frogs, two caecilians, eight turtles, two crocodylians, 76 snakes, and 331 lizards (dominated by gekkotans – 110; lacertids – 72, skinks – 39, and chameleons – 31). Interestingly, a paratype of *Gallotia intermedia*, ZFMK 62798, was still alive at the time of writing. Among the most noteworthy nomenclatural actions taken in the catalogue is the designation of a lectotype of *Scincus laticeps* Schneider, 1801 (= *Plestiodon laticeps*), one of two original types cited by Schneider and derived from the Göttingen collection.

A list of types by source countries reveals 74 nations of origin, with Madagascar represented by the greatest number of types (64) followed by Indonesia and Vietnam with 20 each, and Spain, Iran, and Colombia close behind. Modern sources of types include many former and current ZFMK students and associates, but also specimens used by other workers from across Germany and Europe and around the world. From the 1990s onward it has largely been students driving the growth of the collections and the regions and taxa of strength, both among the types and in the collection in general, reflecting themes in Böhme's research and that of his students.

The lasting influence of Böhme on herpetology is really shown in a section of the book focusing on teaching and education. He has taught courses at the University of Bonn and for more than 40 years has led a legendary annual field course to Neusiedlersee in Austria. Böhme mentored 142 diploma and masters students and 46 doctoral students, most of them dealing with herpetological themes. Many of these, including Frank Glaw, Thomas Ziegler, Jörn Köhler, Miguel Vences, Andreas Schmitz, Thomas Wilms, Philipp Wagner, André Koch, Dennis Rödder, and Claudia Koch (the last two his successors at the ZFMK), completed two advanced degrees with him. Others students (doctoral degree only with Böhme) have included Mathias Lang, Frank Brandstätter, Mark Auliya, and Nguyen Quang Truong. Numerous postdocs, visiting students, and others have also benefited from Böhme's mentorship and support in Bonn. These include: Scott Moody (USA), Abidin Budak (Turkey), Charles Klaver (Netherlands), Zbigniew Szyndlar (Poland), David Tarkaschvilli (Georgia), and Khalid Baig (Pakistan). For each of these mentees a synopsis of their published works and current positions are provided. Collectively these students—and their

students—have had a tremendous impact upon herpetology in Europe and beyond. They include professors, curators, and institutional directors from across Germany and in other parts of the world.

Another chapter of the book summarizes the organizations associated with the ZFMK and the symposia held there. The Museum Koenig has hosted a series of Tropical Symposia and Varanid Symposia, as well as conferences devoted to agamid lizards, *Zootoca vivipara*, and the herpetology of the Canary Islands. Of greatest importance, however, are the meetings of the DGHT (Deutsche Gesellschaft für Herpetologie und Terrarienkunde) and the SEH (Societas Europaea Herpetologica). The foundational meeting of the latter was held in Bonn in 1979 and Böhme vividly describes the birth of this pan-European society and provides photos of the historic event. The SEH Ordinary General Meetings were subsequently held in Bonn twice, in 1995 and again in 2005, whereas the annual DGHT meetings were hosted in 1977, 1991, 2013, and 2014. The centrality of Bonn for these societies is no accident; Böhme has held both the chairmanship of the DGHT and the presidency of the SEH and for a number of years the DGHT was based in Bonn, with Wolfgang Bischoff serving as editor of its flagship journal, *Salamandra*.

Literature citations in *Herpetology in Bonn* are distributed throughout the chapters and, in all, approximately 1250 references are cited. These serve as a portal to many fascinating publications, many of which will be unfamiliar to American readers. Indeed, I have been working my way through the references, copying or downloading those I am lacking. The citations are wonderfully complete as well—a bibliographer's dream. I noted only one incomplete citation (pagination is lacking for Blumenbach 1779).

There is little to complain about in this book, but I will note a few minor issues, most of which are probably the result of the fact that the book was produced on a tight schedule to allow it to be released in conjunction with the 50th anniversary meeting of the DGHT in October 2014. The English is especially good early in the volume, additional rounds of language proofing were foregone for the rest of the book, so native speakers may find a few awkward phrases, although everything is, of course, fully comprehensible. For example on page 57 "prices" should be "prizes."

There are just a few minor inconsistencies and typographical errors scattered through the text. On page 39 the year of Karl Buchholz's death is given as 1964 (it is correctly noted as 1967 elsewhere) and on page 65 Ferdinando Sordelli's year of birth is given as 1937 (instead of 1837). On page 72, the date of donation of the Paul Müller collection is given both as 2008 and 2010. On page 143, the degree signs (°) in the geographic coordinates for *Echinosaurs brachycephala* appear to be represented by "E"s. Contrary to the implication on page 62, the journal *Brimleyana* was neither founded nor run by the Brimley brothers. It was started in 1979, long after the death of the Brimleys, both of whom died in 1946.

A few additional features would have been handy in the type catalogue. First, I always prefer that type catalogues provide the verbatim type localities, set off in quotes. This is done in some instances, but not consistently. There is also some inconsistency in the listing of current names, if different from the original names. These are generally provided in the "Comment" section of each account, but there are a few exceptions, e.g., *Cyrtodactylus kotschyi* subspecies (p. 136) are currently placed in *Mediodactylus*. Likewise, taxa described with trinomials, but now regarded as specifically distinct, are not noted as such. A separate bold header for current names in the accounts and alphabetized cross references to these names would also have been useful (although admittedly this adds space and current names are liable to change).

Who should buy this book? This is a book that has something of relevance for anyone working on any of the hundreds of taxa represented by types in the ZFMK collection. It is also a book for anyone with even the slightest interest in the history of herpetology. Along with Rieck et al. (2001), this book is an essential tool for understanding the history of German herpetology, and, with the volumes of *Contributions to the History of Herpetology* (Adler 1989, 1995, 2012, 2014), it will be a critical resource for the history of herpetology more globally. Indeed, by providing a single-authored narrative of the interconnectedness of researchers, collections, and institutions it complements these sister works, in which history is told chiefly through separate personal or institutional biographies. Finally, for the literally thousands of herpetologists worldwide who have interacted in some way with Wolfgang Böhme over the years, this book provides a fitting memento of a unique personality and an incredible (and still vibrant) career. The book ends with a short "Outlook and epilogue" chapter about the future of herpetology in Bonn. Regardless of future prospects, one thing is certain—there will never be another Böhme.

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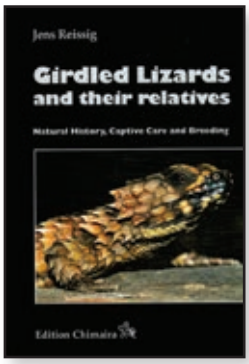
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Girdled Lizards and Their Relatives. Natural History, Captive Care and Breeding

by Jens Reissig. 2014. Edition Chimaira, Frankfurt am Main, Germany (http://www.chimaira.de), 249 pp. Hardcover. €39.80 (approx. US $44.60). ISBN 978-3-89973-437-9.



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This well-produced book, herein referred to as *Girdled Lizards*, forms yet another part of the excellent series of specialist herpetological monographs published by Chimaira. Girdled lizards and their relatives comprise the Cordylidae, armored scincomorph lizards endemic to Sub-Saharan Africa. The family includes two subfamilies and 10 genera, with 80+ recognized taxa (Stanley et al. 2010 and subsequent updates), with the majority of diversity and endemicity occurring in southern Africa, particularly South Africa (50 taxa, 70% endemic). Its members display a wide variety of morphologies, life histories, and behaviors, and have been the subject of numerous recent studies in South Africa (see accounts in Bates et al. 2014 and references therein). Most studies have been directed at the Cordylinae, a group of viviparous, mainly small (maximum SVL *Smaug giganteus* 145 mm), sedentary ambush predators. These characteristics make them ideal candidates for the international pet trade and captive husbandry, and due to concern and perceived threats from the international pet trade to a number of charismatic cordylids (e.g., the Armadillo Girdled Lizard *Ouroborus cataphractus* and Giant Girdled Lizard *S. giganteus*), all *Cordylus* and *Pseudocordylus* species are placed on CITES Appendix 2 (Broadley 2006). This bulk listing has always been controversial as many cordylids are conspicuous components of the Cape herpetofauna, and are among the commonest lizards in the region. The majority of species are of Least Concern (Bates et al. 2014) and the inclusion of all of these unthreatened species on CITES was at best inaccurate, at worst lazy. Moreover, the existing CITES list is now compromised by taxonomic adjustments (Stanley et al. 2011), and also by the most recent conservation assessments that have lowered the threatened status of many of the southern taxa. For instance, the perceived threat of unsustainable collecting for the pet trade of *O. cataphractus* has never been substantiated and the species was, therefore, recently downgraded from Vulnerable (IUCN 2014) to Least Concern in the latest iteration of the South African Reptile Red List (Bates et al. 2014).

The numerous recent research studies on cordylids have resulted in new understanding of phylogenetic relationships, distribution, ecology, behavior, etc., and the time was ripe for a synthetic family summary such as *Girdled Lizards*. However, it is important to note at the outset that despite its title *Girdled Lizards* does not include all cordylids, for it excludes the subfamily Platysaurinae (15 species, 29 taxa) and also the cordyline Grass Lizards (*Chamaesaura*; five species, six taxa). The former includes the oviparous Flat Lizards (*Platysaurus*), famed for their dorsoventrally depressed bodies and the use of stunning sexual dichromism by males in both territorial and mating displays. Grass lizards comprise a small group of elongate, snake-like lizards with long tails and minute limbs; a body form that allows them to move rapidly in long grass and other short vegetation. Why these two genera are excluded from the book is not explained and their omission certainly diminishes the value of *Girdled Lizards*, for these genera exhibit the most extreme morphological specialization and, perhaps, the most interesting biology. Admittedly there have been relatively few ecological studies on grass lizards, but flat lizards are relatively well known following the taxonomic studies of Don Broadley (1978) and the extensive studies of platysaurine ecology and behavior by Martin Whiting and his colleagues and students (see summaries and references in Whiting 2014). Much of this research focused on Broadley's Flat Lizard (*Platysaurus broadleyi*), a delightful species that lives in dense colonies and which "may be unique among lizards because males have an ultraviolet-reflective throat used to signal fighting ability" (Whiting et al. 2006).

Girdled Lizards starts with a Preface by Aaron M. Bauer, followed by a Natural History section. This includes a short Introduction of three pages, two comprising some of the earliest illustrations of cordylid lizards. After a six-page summary of recent developments in the systematics and evolution of the Cordylidae (reviewed by Ed Stanley on whose studies it is based) there are two pages of maps and a three-page tabulation of all cordylids by country. The latter illustrates the extraordinary diversity of the family in the subcontinent. A summary of the Great Describers lists the species named by the three leading historical herpetologists of southern Africa, namely Sir Andrew Smith (1797–1872, 8 species), Vivian FitzSimons (1901–1975, 11 taxa), and Donald Broadley (1932–present, 13 taxa). The wording of the text is ambiguous as it suggests that all the cordylids these authors described are still valid, whereas this is true only of Don Broadley. Both Smith and FitzSimons described taxa that are now placed in synonymy (Smith, three taxa: *Cordylus nebulosus* Smith 1838 = *Ouroboros cataphractus*; *Cordylus algoaensis* Smith 1838 = *Pseudocordylus microlepidotus fasciatus*; *Cordylus* (*Pseudocordylus*) *montanus* Smith 1838 = *Pseudocordylus microlepidotus microlepidotus*); FitzSimons, two taxa: *Zonurus laevigatus* FitzSimons 1933 = *Smaug depressus*; *Zonurus vandami perkoensis* FitzSimons, 1930 = *Smaug vandami*).

The Species Accounts, which form the heart of the book, present a comprehensive summary of the species previously assigned to the genera *Cordylus* and *Pseudocordylus*. Genera are arranged in alphabetical order, as are the species within them. There are useful keys to the new genera, as well as for species within each genus. A table lists old and new scientific names, as well as English and German common names. Each genus has a short introductory summary, followed by the detailed species accounts. These are arranged with common headings, i.e., Synonyms, Etymology, Type Locality, Type Publication, Type Deposition, Description, Colour, Size, Reproduction, and Distribution and Habitat. The latter sections are somewhat terse and do not summarize much of the detailed ecological studies that are available for many species. For over 20 years the Mouton group (Stellenbosch University) has published numerous ecological and behavioral studies on the *Cordylus codylus-niger* complex, *Karusosaurus polyzonus*, and more recently *Ouruborus cataphractus* (e.g., Mouton and van Wyk 1997; Mouton 2011). Incorporation into the species accounts of more details from these studies would have given greater insight into the lives of these interesting groups. An additional perplexing oversight in these accounts

is the lack of a conservation section as many are threatened (e.g., Vulnerable: *Hemicordylus nebulosus* and *Smaug giganteus*; Near Threatened: *Cordylus imkeae, C. macropholis, C. niger, C. oelofseni, Pseudocordylus langi, P. spinosus*, and *P. transvaalensis*).

A comprehensive (40-page) section on Keeping and Breeding these fascinating lizards follows the Natural History section. It has lots of practical advice for captive husbandry and terrarium design, but would benefit from at least some suggestions for disease treatment and control. Admittedly these are technical and complex issues, but the reader would benefit from direction to at least relevant and accessible literature. Finally the book finishes with a one-page list of Museum Details, which lists 14 examples. These are somewhat arbitrary, as it is not obvious why in the USA the Centennial Museum and Gardens, University of Texas should be included in preference to the American Museum of Natural History, New York, while in South Africa, the KwaZulu Natal Museum, Pietermaritzburg is listed (when it has only a minor collection and no herpetologist) in preference to the National Museum, Bloemfontein (with a thriving Herpetology Department, and the fourth largest herpetological collection in the subcontinent!). More useful is Table 4, a synopsis of variation in scalation of all species discussed. A six -page Bibliography gives direction for the major literature on the topic.

With the current intensity of revisionary and phylogenetic studies on southern African reptiles it is little wonder that a number of taxonomic adjustments have occurred in the year subsequent to the release of *Girdled Lizards*. These include a revision of the *Smaug warreni* complex (Stanley and Bates 2014), with the elevation of the three subspecies of *S. warreni* to specific status; i.e., *S. warreni* (Boulenger, 1908), *S. barbertonensis* (Van Dam, 1921), and *S. depressus* (FitzSimons, 1930). A putative new species within *S. warreni* has been signaled (Stanley and Bates 2014), as have additional new lineages within the East African and Angolan *Cordylus* radiations (Branch, Bates, and Stanley, unpubl. obs.). A consequence of the reevaluation of *S. warreni* material previously assigned to other taxa within the complex is that some maps in the *Girdled Lizards* species accounts, and those in the recently launched *Atlas and Red List of the Reptiles of South Africa, Lesotho and Swaziland* (Bates et al. 2014), need readjustment. Stanley and Bates (2014) noted that early records from Blouberg/Makgabeng and farm New York (Jacobsen 1989), previously considered as isolated populations of *S. vandami*, are referable to *S. breyeri* despite confusing coloration in some cases. Sympatry between these two species, therefore, remains unconfirmed as their presently understood ranges do not overlap.

In summary, and despite its constrained coverage, *Girdled Lizards* is a very useful reference. It covers most cordyline genera and documents the diversity and distribution of some of Africa's most interesting and popular lizards. The author, his photographic collaborators, and the publishers are to be congratulated on the preparation of this useful, beautifully illustrated, and informative book.

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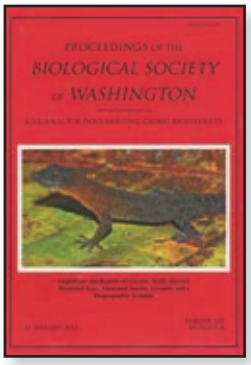
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Amphibians and Reptiles of Guyana, South America: Illustrated Keys, Annotated Species Accounts, and a Biogeographic Synopsis

Charles J. Cole, Carol R. Townsend, Robert P. Reynolds, Ross D. MacCulloch, and Amy Lathrop. 2013. Proceedings of the Biological Society of Washington 125(4):i–iii, 317–620. Paperback. US $10.00. Also available from the Allen Press online bookstore as an e-book (EPUB or Kindle format), or from BioOne as a five-day access for US $25.00.

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Guyana is one of these countries that some may find hard to locate on a map. "Is it in Africa?" or "is it an island?" are common questions when Guyana is mentioned in a casual conversation. Guyana is part of the Caribbean Community and Common Market (CARICOM), which makes things even more confusing because geographically the country is not related to the Caribbean. The Co-operative Republic of Guyana—not to be confounded

with French Guiana (northern South America) or Guinea (western Africa)—is a former British colony that gained its independence in 1966. The country lies along the Atlantic Coast of northeastern South America, between Suriname to the east, Venezuela to the west, and Brazil to the south, and is part of the Guiana Shield biogeographical region. Guyana is fascinating in many ways, from its rich ethnic and cultural diversity (e.g., Levinson 1998) to its extensive pristine forest cover (ca. 18.39 million ha, thus about 85% of the country; Bholanath et al. 2012) and still—but for how long?—well-preserved biodiversity.

Prior to the publication of *Amphibians and Reptiles of Guyana* there was no book or field guide treating the herpetological diversity of Guyana as a whole. The very few existing compendia merely covered amphibians from restricted areas, e.g., Kaieteur National Park (Kok and Kalamandeen 2008) and Mount Ayanganna (MacCulloch and Lathrop 2009). The opus by Cole et al. is, therefore, a long-awaited handbook, not only for researchers working in Guyana, but also for naturalists interested in the region, as well as locals interested in their herpetofauna. Because the authors have all been working on the herpetofauna of Guyana for a long time (sometimes decades), we started reading *Amphibians and Reptiles of Guyana* with great expectations. We are pleased that they were satisfactorily met.

Although *Amphibians and Reptiles of Guyana* can be obtained as a paperback book, it actually is a long article published in Volume 125(4) of the *Proceedings of the Biological Society of Washington*. At the time it was downloaded by PJRK (16 February 2013), the PDF available from BioOne did not include the Contents (pages i–ii) or the Dedication (page iii). The lack of a table of contents in the PDF makes it less easy to use than the printed version. The one-page Dedication was downloadable for an additional $10.00, which sounds quite prohibitive for a less than half-page paragraph. Guyana is the third poorest country of South America (after Bolivia and Paraguay), and $25.00 could be crippling to most Guyanese who are interested in identifying their herpetofauna and want to learn more about it. We heard from the authors that making the PDF free was not possible for copyright reasons, but that several tens of hard copies were sent to Guyana by Charles J. Cole (hereafter CJC) in order to be distributed to students, scientists, and other interested people, including ones in other countries in South America (CJC, pers. comm. to PJRK, Feb. 2013).

Amphibians and Reptiles of Guyana is printed on high quality paper and should resist some mistreatments while being carried out into the field, except maybe for the binding, which is of lower quality. The book is written in very clear English and is readily accessible even to the uninitiated, maybe except for the Key section. The number of misspellings is extremely low for such a long text.

After a two-page abstract, the book offers a 14-page introductory section, which contains four main sections, as follows: Introduction, Methods, Abbreviations of Scientific Collections Used, and Identification of Specimens. These sections provide the reader with a good overview of what the book is offering, and how to use it properly.

The introductory section is followed by a 37-page section containing dichotomous identification keys. High-quality drawings, arranged in five figures (figs. 5–9), are used to highlight characters that could be difficult to visualize for some less experienced readers. The key was extensively used in the field and in the laboratory by several of PJRK's students, and these drawings proved to be useful for those not yet acquainted with all the terms used. In addition to the drawings, some characters are briefly described within the key (e.g., apical pits, ventral scales). This proved to be useful most of the time, but we sometimes regretted the lack of precision in the description of some characters. Ventral scales for instance are described as "wide belly scales from neck to vent," which in our opinion is too imprecise to allow unambiguous comparisons. It would have been better to provide a drawing showing exactly how ventral scales should be counted (e.g., following the method of Dowling 1951).

Some text is added to provide the reference(s) on which a specific identification key section is based, occasionally to provide additional helpful advice to the reader. The Key section proved to be helpful, we only found a few mistakes or weak points in that part of the book:

Key step 6 (p. 332): the possession of "conspicuous toad-like parotoid glands" leads to *Atelopus spumarius*, which lacks such glands.

Key step 21a (p. 335): the possession of a "translucent to transparent belly skin in adults" leads to Centrolenidae or Allophrynidae, while this character is also shared with *Hypsiboas cinerascens* (Spix, 1824) and *H. ornatissimus* (Noble, 1923), which are in Hylidae. An additional step should have been added here to avoid confusion.

Key step 19 (p. 343), step 3 (p. 346) and step 9 (p. 347): maximum body length of adult frogs. This is obviously a useless character when only a juvenile is at hand, and this proved to be a weak point of the key in the field when used by students.

Key step 40b (p. 345) mentions "maximum adult body length 37–50 mm." However, to reach step 40, one has to go through step 38a (p. 345) that specifies "maximum adult body length 32–42 mm. "

The Key section is followed by the largest segment of the book, the species accounts (approximately 160 pages). Seven of the 324 amphibian and reptile species reported from the country were added after completion of the text and are listed in the Appendix 1 (p. 574). We found the way each species is presented very clear and the information provided highly valuable. Each taxon account begins with the scientific name of the species, the authorship, and the number of the plate(s) illustrating the species, when available. This is followed by a few paragraphs named as follows: Type Material (which we found very handy), Distribution (global), Vouchers for Guyana (again a very useful section referring to all Guyanese material identified in collections by the authors), Coloration in Life, and sometimes an additional paragraph named Comments where the authors provide some additional information, e.g., on the taxonomic status of the species, its ecology, or its peculiar morphology.

The exotic invasive *Trachemys scripta* (Thunberg in Schoepff, 1792) is not listed for the country although the species has been reported from Guyana by Lever (2006) (see comment in Meilink et al. 2013).

At least three taxonomic rearrangements appeared before the book was published and were not followed, nor commented upon, by Cole et al. (2013). We heard from the authors that these changes actually occurred after the manuscript was finalized and going to press (CJC, pers. comm. to PJRK, 17 Jan. 2015). These rearrangements are:

The erection of a new genus, *Amazophrynella* Fouquet, Recoder, Teixeira, Cassimiro, Amaro, Camacho, Damasceno, Carnaval, Moritz, and Rodrigues, 2012, for the Amazonian species formerly in *Dendrophryniscus* Jiménez de la Espada, 1870 by Fouquet et al. (2012a, b). *Dendrophryniscus minutus* (Melin, 1941) (p. 375)

should thus have been better treated as *Amazophrynella minuta* (Melin, 1941).

The revalidation by Hedges and Conn (2012) of the genus *Copeoglossum* Tschudi, 1845 and the family Mabuyidae Mittleman, 1952, in which *C. nigropunctatum* (Spix, 1825) is placed on the basis of morphological and molecular data. The species is still treated as *Mabuya nigropunctata* (Spix, 1825) in the family Scincidae Oppel, 1811 in Cole et al. (2013: 463).

The synonymization of *Bothriopsis* Peters, 1861 with *Bothrops* Wagler, 1824 by Fenwick et al. (2009), who confirmed *Bothrops* to be paraphyletic with respect to the genus *Bothriopsis*. *Bothriopsis bilineatus* (Wied-Neuwied, 1821) and *B. taeniatus* (Wagler, 1824) (p. 519) should therefore be treated as *Bothrops bilineatus* and *Bothrops taeniatus*, respectively.

We detected a few taxonomic issues that are not mentioned in the species accounts (some for the same reason explained above):

Oreophrynella dendronastes Lathrop and MacCulloch, 2007 (p. 376) was shown by Kok et al. (2012, in their suppl. info.) to likely be a synonym of *O. macconnelli* Boulenger, 1900.

Stefania ackawaio MacCulloch and Lathrop, 2002 (p. 395) was shown by Kok et al. (2012, in their suppl. info.) to likely be a synonym of *S. roraimae* Duellman and Hoogmoed, 1984. Specimens of *S. ackawaio* have apparently been misidentified with *S. roraimae* and *S. woodleyi*, as shown in the phylogenetic tree provided in Kok et al. (2012, suppl. info.).

The mention of *Stefania scalae* Rivero, 1970 (p. 398) from Guyana is based on a single specimen collected on Mount Ayanganna at 1550 m elevation (ROM 39470, MacCulloch and Lathrop 2002). However, Kok et al. (2012, suppl. info.) showed that ROM 39470 was misidentified, and is actually *Stefania evansi* (Boulenger, 1904). Therefore, although *Stefania scalae* is likely present in western Guyana, its actual presence in the country still needs to be confirmed.

Hypsiboas sp. (Kok and Kalamandeen 2008: 176) is not treated in the book although it is a valid taxon, even if still undescribed. *Hypsiboas* sp. could have been treated in the species accounts as the authors did with *Microcaecilia* sp., and the species should be added to the country list.

Some taxonomic changes occurred after the book was published. These mostly concern:

Allobates spumaponens Kok and Ernst, 2007 (p. 370): the species was considered a synonym of *A. sumtuosus* (Morales, 2002) by Simões et al. (2013). *Allobates spumaponens* should therefore be removed from the list of species endemic to Guyana (p. 546).

Ceuthomantis Heinicke, Duellman, Trueb, Means, MacCulloch and Hedges, 2009 and Ceuthomantidae Heinicke, Duellman, Trueb, Means, MacCulloch and Hedges, 2009 (p. 385): Padial et al. (2014a) revised the systematics of terraranas and transferred *Ceuthomantis* to Pristimantinae Ohler and Dubois, 2012 (subfamily of Craugastoridae). Shortly thereafter, Padial et al. (2014b) realized that Ceuthomantidae actually has priority over Pristimantinae. Therefore, Ceuthomantinae is the correct subfamily name for *Ceuthomantis*.

Osteocephalus cabrerai (Cochran and Goin, 1970) (p. 410): the correct name for that species in Guyana is *O. helenae* (Ruthven, 1919) as demonstrated by Jungfer et al. (2013).

"*Hyla*" *warreni* Duellman and Hoogmoed, 1992 (p. 402): this taxon belongs to the genus *Tepuihyla* as shown in Kok et al. (2012, suppl. info.) and confirmed by Jungfer et al. (2013). The correct species name is therefore *Tepuihyla warreni* (Duellman and Hoogmoed, 1992).

Osteocephalus exophthalmus Smith and Noonan, 2001 (p. 410): this taxon belongs to the genus *Tepuihyla* as shown in Jungfer et al. (2013). The correct name for that species is thus *Tepuihyla exophthalma* (Smith and Noonan, 2001).

Osteocephalus phasmatus MacCulloch and Lathrop, 2005 (p. 412): this taxon belongs to the genus *Tepuihyla* as shown in Jungfer et al. (2013), who demonstrate that it is a synonym of *Tepuihyla exophthalma* (Smith and Noonan, 2001). *Osteocephalus phasmatus* should therefore be removed from the list of species endemic to Guyana (p. 546).

Scinax trilineatus (Hoogmoed and Gorzula, 1979) (p. 417): the species was synonymized with *S. fuscomarginatus* (Lutz, 1925) by Brusquetti et al. (2014).

Tepuihyla talbergae Duellman and Yoshpa, 1996 (p. 418): the species was synonymized with *T. rodriguezi* (Rivero, 1968) by Jungfer et al. (2013). *Tepuihyla talbergae* should therefore be removed from the list of species endemic to Guyana (p. 546).

Chiasmocleis jimi Caramaschi and Cruz, 2001 (p. 430): the species is considered a synonym of *C. hudsoni* Parker, 1940 by Peloso et al. (2014).

Caecilita iwokramae Wake and Donnelly, 2010 (p. 438): the species, originally described as lungless, was later shown to have lungs, and the genus *Caecilita* was synonymized with *Microcaecilia* Taylor, 1968 by Wilkinson et al. (2014). The correct name for that species is thus *Microcaecilia iwokramae* (Wake and Donnelly, 2010).

Riolama leucosticta (Boulenger, 1900) (p. 457): Cole et al. (2013) emphasized that the type locality of that species is in Venezuela, not in Guyana, and that voucher specimens having localities unambiguously located in Guyana are lacking. Kok (2015) formally reports the species from Guyana based on populations from Wei-Assipu-tepui and Maringma-tepui, Cuyuni-Mazaruni District.

Pseustes sulphureus (Wagler, 1824) (p. 506): the species was reallocated to the genus *Spilotes* by Jadin et al. (2013). The correct name for that taxon is therefore *Spilotes sulphureus* (Wagler, 1824).

Rhinobothryum Wagler, 1830 (p. 506): the genus is considered monotypic by Cole et al. (2013), who state that *R. bovallii* (Andersson, 1916) is recognized as a junior synonym of *R. lentiginosum* (Scopoli, 1788) (erroneously reported as Scopoli, 1785 in Cole et al. 2013). However, this was in error as there is no such statement in the literature (CJC, pers. comm. to PJRK, 7 January 2014).

Microcaecilia savagei Wake and Donnelly, 2013 was recently described from Iwokrama, Guyana (Donnelly and Wake 2013), and should be added to the country list. It should also be added to the list of species endemic to Guyana (p. 546).

The authors frequently refer to McDiarmid et al. (1999) for snake taxonomy and/or geographic references, it should be noted that a more recent and comprehensive publication is now available (Wallach et al. 2014).

As the title suggests, the section following the species accounts mainly deals with biogeography. That Discussion section covers 17 pages. The authors mainly discuss sampling issues (most areas having been clearly undersampled) then compare sites within Guyana, based on elevation. Seven lowland sites are compared, as well as three isolated highland sites. Lowland versus isolated highland sites are compared as well. A list of endemic species is provided on pp. 546–547. That list actually represents the species having their type locality in Guyana; some of them have much wider distributions (e.g., *Allophryne ruthveni* Gaige, 1926, *Leposoma guianense* Ruibal, 1952, and *Gonatodes annularis* Boulenger, 1887, to cite a few). After a few comments

about endangered species, the section ends with a useful Summary and Conclusions paragraph, stressing that much work still needs to be done in the area.

The next section, which follows the Acknowledgments (3 pages), the Literature Cited (22 pages), and the two appendices (5 pages), covers 41 pages and comprises the color plates. The book's Abstract (p. 317) and Plate Legends (p. 580) both mention that 62% of the amphibian and reptile species known to occur in Guyana are illustrated. However, we actually counted 192 species being illustrated, which corresponds to 59.3% of the total number of species. Photographs of 15 species (4.6% of the total number of species, 7.8% of the species illustrated) are from outside Guyana, in which case the exact locality is specified. This is important because some might later prove to be distinct species. Among the 229 color figures, about 1/4 are of obviously freshly euthanized animals, and 125 are taken on a white background (54.6%) instead of natural habitat. This is never problematic, and we found the vast majority of the photographs to be of very good to sufficient quality to help with species identification. However, the authors should have specified in the plate captions when the figure illustrates a juvenile specimen. Indeed, for some species there is an ontogenetic change in coloration (as mentioned in the species accounts) and the reader could be misled by the figure, e.g., *Chironius scurrulus* (Wagler, 1824), plate 30D, p. 610 (adult color pattern shown in Starace 2014); *Mastigodryas boddaerti* (Sentzen, 1796), plate 32E, p. 612 (adult color pattern illustrated in Starace 2014); *Pseustes poecilonotus* (Günther, 1858), plate 34E, p. 614 (adult color pattern shown in Starace 2014). Mentioning the page number of the corresponding species account in the figure caption would have been helpful to readers who check the color photographs first.

In many cases we found the absence of any illustration, e.g., *Dendrobates tinctorius* (Cuvier, 1797), *Ceratophrys cornuta* (Linnaeus, 1758), *Clelia clelia* (Daudin, 1803), *Siphlophis cervinus* (Laurenti, 1768), or the lack of illustration of a specimen of Guyanese origin, surprising because either it seems very unlikely that such a photograph was not available, and some of these species are already illustrated by Guyanese specimens in the literature, *e.g.*, *Anomaloglossus praderioi* (La Marca, 1998) (not 1997 as stated by the authors), *Hyalinobatrachium taylori* (Goin, 1968), *Scinax boesemanni* (Goin, 1966) and *Oxyrhopus occipitalis* (Wagler, 1824) to cite just a few (in Kok 2010; Kok and Castroviejo-Fisher 2008; Kok and Kalamandeen 2008; MacCulloch et al. 2009, respectively). It should, therefore, have been possible to provide one. But these are rather minor criticisms, and maybe the authors were limited by space. The caption of *Phimophis guianensis* does not mention any locality; it should be Dubulay (DUB) according to the text.

To conclude, we found *Amphibians and Reptiles of Guyana* to be very well written, extremely useful, nicely illustrated, and we highly recommend it to anyone interested in the Neotropical herpetofauna.

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The Symbol: Wall Lizards of Ibiza and Formentera

Nathan Dappen, Neil Losin, and Valentin Pérez-Mellado. 2013. Day's Edge Productions (www.daysedgeproductions.com/the_symbol/). Softcover. 128 pp. US $19.99.



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The Symbol is a small, four-language book (Spanish, English, Italian, German) that sings the praises of the Ibizan Wall Lizard (*Podarcis pityusensis*). While perhaps not a household name in America, this attractive lacertid is indeed emblematic of the islands of the Pityusic Archipelago (in the western Balearic Islands of Spain), of which Ibiza is the largest and most well-known. In addition to being conspicuous throughout the archipelago, it is the only native, non-volant vertebrate in the archipelago.

The book is beautifully illustrated by many images of this photogenic lizard and its equally attractive habitat. That the lizard is indeed a symbol of the islands is attested by photos of many lizard logos on everything from tee-shirts to shops to tattoos (although many seem to depict geckos!). In addition to nice portrait shots, there are wonderful images of male/male combat, copulation, as well as feeding (on everything, including plant material).

The text is quite short, as it needs to be given that it must be repeated in four languages (in four columns spread across facing pages). Some basic information about lizards in general is provided, but the majority of the book is devoted to *P. pityusensis*. The information is mostly relatively elementary and is organized by questions, the first of which is "What is the current classification of the species?" The geological backdrop to the evolution of the lizard is provided as is basic taxonomic information. Although subspecies are not widely accepted in North American herpetology today, they remain in use in Europe and are a legacy of both different ways of thinking about what a species is and of the in-depth study of a relatively limited fauna. The Pityusic wall lizard has had 45 subspecific forms named—the majority of which were described by German herpetologists, 23 of which are now generally recognized and listed in this book. The occurrence of these on the various islands in the group, most of which are tiny and cluster around Ibiza or the smaller Formentera, is shown on a map, although the island names are not given. At least five of the forms are illustrated, including the especially colorful lizards of Es Vedrà, with bright blue flanks and orange-yellow backs. In some cases the lizards are named, but in others one must guess or at least consult a map to see which species are on which island. The book is clearly not meant for systematists, but more for those wishing to appreciate the lizard they saw while living it up during Ibiza's raucous high season.

Other sections of the book treat thermoregulation, habitat, seasonal activity, communication, aggression, and reproduction. Some useful information is provided, but some questions, like "do these lizards have multiple clutches per year?" that might occur to readers are not addressed. There is a moderately extensive discussion of the role of color in sexual selection and the ontogeny of color, as one would expect with such extravagantly hued lizards. The book advocates for the conservation of these lizards, which are considered vulnerable. This might seem to be contradicted by the statement that the lizards occur at densities of thousands per hectare. However, the overall small area occupied by the species, and especially by the subspecies, if these are treated as separate conservation units, is the explanation for their conservation status.

In general the information provided is accurate and clearly presented. However, it is stated that male lizards (in general) are almost always larger than females (p. 28), whereas Fitch (1981) found that females were as large or larger than males in 36% of the 408 lizard taxa he considered. My only other minor quibbles are that the term "hemipene" is used in place of hemipenis (p. 28) and that the date of description of the focal species is variously given as 1883 (p. 46) and 1884 (p. 48)—it is actually 1883.

The book closes with a two-page spread of short biographies

of the three authors. The first two authors, who also took the stunning photos, may not be familiar to herpetologists, but Valentin Perez-Mellado will be familiar to those who know the Spanish insular herpetofauna. The book was financed through a Kickstarter campaign. Its success suggests that the authors' love for *the symbol* is widely shared. There is a downside to this type of support for a book, however, at least for bibliographers: the book has no stated publisher, city of publication, and no ISBN number. Neither is a date of publication printed in the book (although it is 2013).

A trained herpetologist will not learn much new from the book (for the most up-to-date summary of more technical information about the Ibizan Wall Lizard see Salvador 2014), but an amateur naturalist might and anyone who picks it up will gain an appreciation for the diversity in one species and will wonder about how and why intraspecific diversity is so great in this species.

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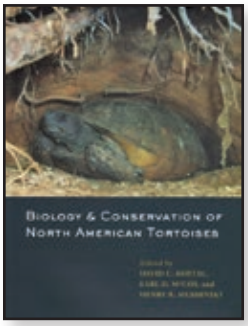
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Biology and Conservation of North American Tortoises

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The charismatic North American tortoises hold a special place in our culture and natural history. Despite the perseverance of these tortoises over millions of years, biologists now question their ability to persist into the future. In light of documented declines, habitat loss, and numerous threats to tortoise populations, the editors gathered a diverse group of researchers to review what we have learned about this group after decades of study, to summarize gaps in the literature, and to reflect on how we may use the current state of knowledge to conserve these fascinating species. Initially intended as a focused review of the two most well-studied species in the genus *Gopherus*, *G. agassizii* (Mohave Desert Tortoise) and *G. polyphemus* (Gopher Tortoise), the book developed into a comprehensive treatment of the entire genus. The editors offer the work as a resource to professional biologists and agencies working with North American tortoises as well as a teaching aid, hobbyist's reference, and casual read for nature-lovers—although we presume that the former group is more likely to benefit than the latter. Although the book's size appears modest, the content delivers an in-depth look at the five recognized tortoise species.

The book comprises eighteen chapters. Although not formally structured in this manner, chapter topics fall within broad categories of evolution, physiology, and health (chapters 1–8), natural history and population ecology (chapters 9–16), and human dimensions and conservation (chapters 17–18). Authors represent numerous universities, state and federal agencies, and research organizations, and include many long-standing experts in this field of research. Within each chapter, authors address a particular topic for all five *Gopherus* species but vary in their approach and style. All chapters begin with a brief introduction of the topic and its relevance to tortoise biology. Then, authors review relevant concepts and data from published articles, white papers, conference proceedings, unpublished studies, and personal observations. While many chapters take stock of the current state of research, some chapters present new findings from novel data compilations and analyses (e.g., Chapter 12, Social Behaviors of North American Tortoises and Chapter 13, Nesting and Reproductive Output among North American Tortoises). Throughout the text, authors often compare traits across species, describe and compare techniques and experimental approaches, examine evidence for ecological theory within existing data, and suggest new avenues for research to advance our understanding of the genus. Illustrative materials include black-and-white photographs, diagrams, data plots and tables, and sample data sheets.

The editors and authors have succeeded in compiling an impressive collection of literature on a group that can be frustrating to study, as some data exist in hard-to-access sources or are entirely unpublished. This compilation, combined with the commentary on the current state of knowledge and identification of further avenues of research, make this text most useful to professionals working with this genus or with related species. Graduate students working with *Gopherus* should also take note: the book not only provides valuable background information about each species, but many chapters review common techniques used in tortoise research. Readers with a more casual interest in North American tortoises may find the *Gopherus* descriptions in "Turtles of the United States and Canada" (Ernst and Lovich 2009) more approachable; however, from Chapter 9 and onwards, this book becomes more accessible to those not already familiar with scientific terminology or specific sub-disciplines.

Many aspects of tortoise biology apply to numerous ecological systems, and interesting biological concepts throughout the book may appeal to a wider professional audience. The extant *Gopherus* species span varied habitats that relate to interesting evolutionary relationships, behavioral and physiological adaptations, and life history trade-offs. Certain chapters reflect the trial, error, and advances made over decades of management that may inform other managers facing similar challenges: the difficulties in documenting trends in cryptic or long-lived species (Chapter 14, Abundance of North American Tortoises), the application of population genetics to species management (Chapter 15, Population and Conservation Genetics of North American Tortoises), and the complexity of threats that deter species and habitat conservation (Chapter 18, Threats and Conservation Needs of North

American Tortoises).

The book presents some challenges, and improving a few key elements would have contributed to its overall cohesiveness and use. Some chapters are closely related and may have benefited from additional chapter structuring (similar to those suggested above), with section introductions tying the elements together. Without this structuring, the book begins abruptly and seems to assume some prior knowledge of *Gopherus*, diving headfirst into the genus with little context or placement in the higher taxa. This dynamic is apparent throughout the book, as chapters vary widely in the amount of background knowledge provided. At times, this variation can hinder how the information is conveyed.

While many chapters provide useful summary tables that efficiently review the breadth of information known about the tortoise species (e.g., review of home range data in Chapter 11), many chapters could be improved by effective use of figures and photographs. Generally, the plots and diagrams are clear and valuable visualizations of the text; however, in a few cases, figures are difficult to interpret or are ill-suited for black-and-white print. Similarly, the informative text of the book varies in its approachability. At times exhaustive lists of the literature available on a topic detract from the general message of the section. Authors clearly faced a trade-off—sacrifice clarity and interpretation of material for thorough lists of facts. Perhaps additional table presentations of references or data numbered within the text would allow sections to read more smoothly but still allow access to detailed information when needed.

Lastly, we believe there is disproportionate emphasis on the organismal biology of *Gopherus,* which comes at the expense of discussing their context within the larger ecosystem. For instance, ecological roles could be further explored. In particular, relationships between tortoises and other vertebrate species in the environment are noticeably lacking. This shortcoming is odd considering some tortoise species act as ecosystem engineers. Conservation issues and initiatives could also be described in more depth. There is little discussion about the unique problems captive tortoise populations pose to conservation or the relative success of management and conservation measures taken to ensure species persistence.

While this tome may not be as approachable to a wide audience as the editors desired it to be, it is a useful reference that many researchers and professionals will want to add to their book shelf. *The Biology and Conservation of North American Tortoises* gathers references and data from a variety of sources to summarize our knowledge of these long-lived reptiles. This mini-library of tortoise resources will benefit professionals and managers working with the genus and provide students with a crash course in tortoise research. The unique biology of North American tortoises presented in this text will no doubt inspire professionals to investigate broader theories within this system and promote conservation of our disappearing species.

Acknowledgments.—CMA wishes to disclose professional affiliation with several chapter authors within the U.S. Geological Survey. Her contributions to this review focused on the use of the book as a whole and chapters by unassociated authors.

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Memorie della Società Italiana di Scienze Naturali e del Museo Civico di Storia Naturale di Milano (http://scienzenaturali.org/), Volume XXXVIII. 12 + [356] pp. Hardcover. €50,00 (approx. US $56.00 plus postage). ISSN 0376-2726.



This is a reprint edition of the classic snake work by Jan and Sordelli known simply as the *Iconographie.* Originally published between 1860 and 1881 it features 300 superb black-and-white plates including 8430 lithographic illustrations. The work was issued in 50 livraisons of six plates each, and attempted to depict all the snakes of the world then known, many for the first time. Most plates show the scalation of the anterior and posterior parts of the body in detail with smaller inset views of the head scales, body cross sections, and occasionally other features. The last five plates depict skulls in various views. The majority of plates illustrate numerous species, but Jan chose as his first plate one that shows only the striking *Erpeton tentaculum.* A colored version of this was used as a promotion for subscriptions to the work and in this edition it is reproduced on the dustjacket. The text of the *Iconographie* is limited to the contents pages, which list the species, their geographic origin and the identity of the collections that provided the specimens illustrated. The work was complemented by a number of monographic works by Jan (not reproduced in this edition), and more were planned but never published.

This edition, edited by Stefano Scali, herpetological curator of the Museo Civico di Storia Naturale di Milano, includes a brief bilingual (Italian/English) introduction of eight pages about Jan, the history of the collection, and the *Iconographie* itself. The introductory material also includes a brief history of the Milan Museum after Jan. Unfortunately, much of the collection was destroyed by incendiary bombs in 1943. The original *Iconographie* is one of the most valuable books in herpetology and even the previous facsimile of the work, published by J. Cramer, Wheldon and Wesley, and Hafner Publishing in 1961 has become uncommon and typically fetches many hundreds of dollars when copies become available. In this edition, published as a special issue of the memoires of the Milan Museum, the plates are reproduced at a slightly reduced size, but the fine details remain visible. The *Iconographie* remains an important work of both artistic and scientific achievement and now that it is once again available, should be on every herpetologist's shelf.

ZOO VIEW

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Identifying Amphibians and Reptiles in Zoos and Aquariums

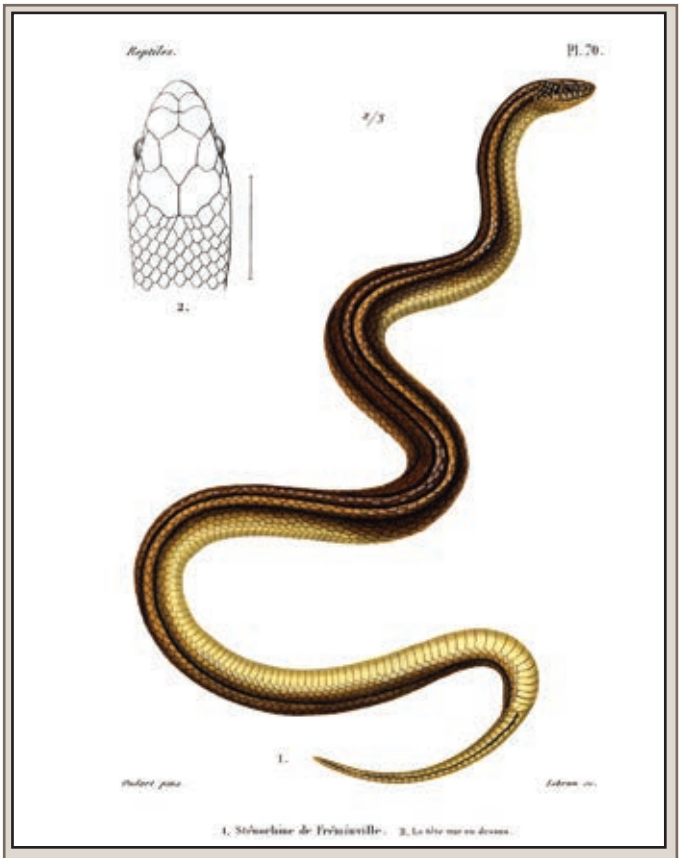
PLUS ÇA CHANGE, PLUS C'EST LA MÊME CHOSE [THE MORE THINGS CHANGE, THE MORE THEY STAY THE SAME]

—*JEAN-BAPTISTE ALPHONSE KARR, 1849*

Reptiles and amphibians are relatively unique in the sense of constantly changing taxonomies. That phenomenon simply is not a big operative problem for bird and mammal zoo personnel. To gain a sense of why this is happening, refer to Frost and Hillis (1990). There is confusion caused by changes in both standard and scientific names in herpetology. The general principle in a zoo is that one wants to be talking about the same species when putting live animals together for breeding or exhibit or analyzing records for genealogy or research. During a visit to the Dallas Zoo when I was there, an academic colleague specializing in snake taxonomy and systematics was chiding me about using a supposed outdated technical name on our graphic panels. I suggested that he consult Hobart M. and Rosella B. Smith's *Synopsis of the Herpetofauna of Mexico, Vol.* III (1976) and look up the number of synonyms for the Slatey Gray Snake (*Stenorrhina freminvillei*). I said that we would have to keep a graphics designer on permanent contract just to deal with the continually fluctuating nomenclatural world. He called a week later, having counted the names, and said point taken. This incident provokes a broader question—what standard and scientific names should we use for amphibians and reptiles in our displays, records, and publications? This is not a trivial issue as virtually all of us can remember some of our colleagues fighting to near death over standard names, taxonomy, and systematics. Who can forget the tension between E. D. Cope and O. C. Marsh in the late 1860s (see Adler 2014)? Or the exchange between Pauly et al. (2009) and Frost et al. (2009)?

I was recently asked by a zoo worker what generic names should be used for some of the various North American ratsnakes: *Elaphe*, *Pantherophis*, *Pituophis*, *Mintonius*, or *Scotophis*, and whether some of these are now recognized as species or subspecies. All New World ratsnakes (and Old World representatives) are listed as *Elaphe* by Schulz (1996); the reason given for this conservative treatment is "…we are of the opinion that the genus *Elaphe* requires an overall revision... Such a revision could reveal aspects, which had been overlooked or not previously recognized, and lead to completely different conclusions." For instance, Collins and Taggart (2008) presented a new alternative generic name for the Eastern (*Mintonius gloydi*) and Western (*M. vulpinus*) Fox Snakes, now synonymized with *Pantherophis* by Crother et al. (2011) and Crother (2012). Corn Snakes and their allies were traditionally placed in the genus *Elaphe* but were recently referred to *Pantherophis* based on their close relationship to other lampropeltine colubrids of the New World (Burbrink and Lawson 2007). Different combinations are used by different authors and my colleagues are struggling with these differences; in other words, which names should they use? Some biologists believe that there is a rule that the most recent taxonomic paper should be the one used but there is no such established convention in the Code (*The International Code of Zoological Nomenclature*). Recently, a convincing description of the dangers of taxonomic vandalism leading to potential destabilization has appeared in the literature (Kaiser et al. 2013) and should be required reading for every zoo biologist. This paper clearly outlines acceptable methods for proper taxonomic and systematic research. Reject any approach that does not adhere to these principles.

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COURTESY OF KRAIG ADLER AND TIM HERMAN

FIG. 1. Illustration of Slatey Gray Snake (*Stenorrhina freminvillei*) from *Erpétologie générale by* A. M. C. Duméril, G. Bibron, and A. Duméril, 1854 (plate 70 in Atlas). This species may hold the record for the sheer number of scientific name changes such as spelling errors since the original description as *Stenorhina Freminvillii* on p. 868. A reprint of this classic multi-volume work is available from SSAR.

I was discussing this potentially confusing issue with Roy McDiarmid from Smithsonian National Museum of Natural History and he recommended that the source for any nomenclatural decision used in any paper or any other purpose be stipulated. Roy, being the senior author of *Snake Species of the World* (1999), has had plenty of experience with conflicting names. He pointed out that there are names currently in use that he disagrees with and will not use, but that his readers need to know his reasoning for the decision. This approach makes sense to me so I am recommending here that the source for any name always be included in the beginning for all zoo animal records and placed in the permanent record for graphics panels (archived copies of the designs underlying all displays) and publications.

As a starting point, I use three sources for verification of current usage—*The Reptile Database* (Uetz and Hošek 2015, an online reference that is regularly upated), *Amphibian Species of the World* (Frost 1985 and its online successor, Frost 2015), and *Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, with Comments Regarding Confidence in Our Understanding* (Crother 2012). However, decisions also had to be made to produce these sources, and decisions sometimes are poorly justified. The SSAR checklist (Crother 2012) is perhaps better in providing more information about the sources of taxonomic usage and reasons for not following certain proposals. Registrars and others responsible for zoo animal records justifiably complain that different names (sometimes misspelled) are often submitted without explanation by curators and keepers to be used for an accession record, and new names sometimes suddenly appear in the daily animal records. While change is inevitable, in these situations retrieval of important data may be compromised. Zoo curators need to check records carefully for names used at their own zoo or elsewhere and take care to ensure that names are consistent or that synonymies are explained. When changes occur, this fact must be highlighted, with the source material, for the zoo's records and also for central databases such as ISIS and studbooks.

A good example of the challenges faced by curators and registrars who might not be trained in herpetology is the taxonomic history of North American ratsnakes (Fig. 2). In a controversial paper in which he applied the then-new Evolutionary Species Concept, Joseph T. Collins (1991) proposed elevating 55 geographically disjunct amphibian and reptile subspecies to species level, including the Fox Snake from *Elaphe vulpina gloydi* to *Elaphe gloydi,* without supporting evidence but simply because these subspecies were, as he wrote, "mapped as allopatric" in various publications and were "in some way morphologically (and presumably genetically) distinct." In the *Catalogue of American Amphibians and Reptiles*, both subspecies (*E. v. vulpina* and *E. v. gloydi*) were recognized (Powell 1990). In *Standard Common and Current Scientific Names for North American Amphibians, Turtles. Reptiles and Crocodilians (fifth edition)* published by The Center for North American Herpetology in 2002 by Collins and Taggart, both Fox Snake taxa are listed as species and the generic name *Elaphe* is used throughout. Although we were friends for many years, I never agreed with Collins about his instantaneous adoption of proposed name changes.

In the IUCN Red List of Threatened Species: "Although Burbrink concluded that the molecular data show that *E*[*laphe*] *alleghaniensis* and *E. spiloides* represent independently evolving units with separate evolutionary histories and thus should be recognized as different species under the evolutionary species concept, contact zones were not critically examined, so the nature and dimensions of clade boundaries, and the precise distributions of *alleghaniensis* and *spiloides* along the length of the Appalachians, remain uncertain. In view of the uncertainties and the need for further study, Burbrink's taxonomic revision has not been adopted in this database" (Hammerson 2007). In *The Reptile Database*, these taxa are listed as Eastern Ratsnake (*Pantherophis alleghaniensis*) and the Midland or Gray Ratsnake (*P. spiloides*). In Crother (2012), this statement justifying the committee's decision is offered: *P. obsoletus* (Say, 1823)—Western Ratsnake. "Based on the congruence of morphological (Burbrink, 2001, Herpetol. Monogr. 15:1–53) and mitochondrial data (Burbrink et al., 2000, Evolution 54: 2107–2118), Burbrink divided *P. obsoletus* into three species (*P. alleghaniensis, P. obsoletus* and *P. spiloides)* with no subspecies." In 2008, Collins and Taggart resurrected the genus *Scotophis* for Burbrink's three taxa, i.e., *S. alleghaniensis*, *S. spiloides*, and *S. obsoletus*, in response to the findings of Burbrink and Lawson (2007) but this has not been followed by subsequent workers (e.g., Pyron and Burbrink 2009). In 2014, Wallach et al. published *Snakes of the World*, a compendium that followed the arrangement of the SSAR checklist (Crother 2012). This classification is also followed by the NCBI (National Center for Biotechnology Information) taxonomy database but there is

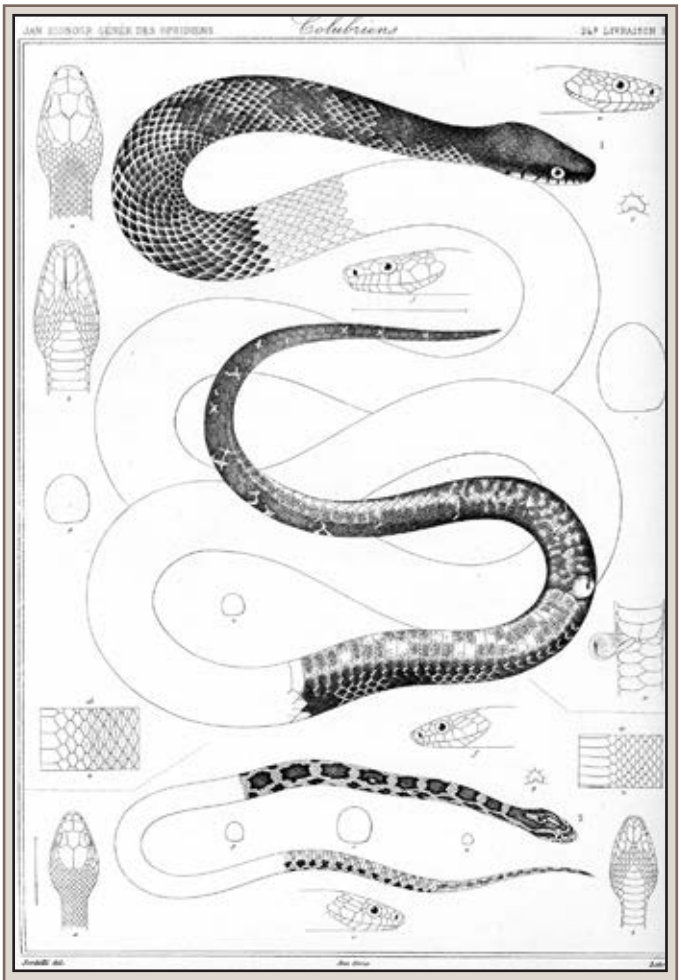


Fig. 2. Fair warning to ophiophobic tourists visiting Washington DC—Eastern Ratsnakes (*Pantherophis alleghaniensis*) are commonly found in the middle of the city at Smithsonian National Zoological Park. Illustration of *Elaphis alleghaniensis* from *Iconographie Générale des Ophidiens* by Georges Jan and Ferdinando Sordelli in 1860–66.

COURTESY OF RON GOELLNER, ST. LOUIS ZOO



FIG. 3. When the beautiful reptile building opened at the Saint Louis Zoo in 1927, R. Marlin Perkins was installed as curator and Moody J. R. Lentz was his assistant. During those early days, one popular feature was force-feeding large constrictors—such as "Blondie," the Reticulated Python shown here—every other week. Huge crowds attended the event as is evident in this undated photograph. Lentz (third from right) is holding the head. Note that a caulking gun is being used to squirt gruel into the snake's esophagus.

a disclaimer stating that this is not an authoritative source for nomenclature or classification. In ISIS (International Species Information System) /ZIMS (Zoological Information Management System), the administrators admit that they cannot keep up with taxonomic changes. As of this writing, it is current to 13 October 2014. Here are the entries: Ratsnake = *Elaphe obsoleta*; Black Ratsnake = *Elaphe obsoleta obsoleta.*

The term "ratsnakes" is currently used in an historical sense, inclusive of both Old and New World representatives that we now know are not closely related (Utiger et al. 2002). In the New World, the generic name *Bogertophis* has been used for the Baja California Ratsnake (*Bogertophis rosaliae*) and Trans-Pecos Ratsnake (*B. subocularis*) since 1988. The generic name *Senticolis* refers to the Green Ratsnake (*S. triaspis*) from SW USA, Mexico, and Central America. Both genera were recognized by Liner (1994) but not Schultz (1996). The Yellow-red Ratsnake or Yucatan Ratsnake, *Pseudelaphe flavirufa*, is found in Mexico and Central America. For most of its taxonomic life this species resided within *Elaphe*, but was transferred to *Pseudelaphe* by Utiger et al. (2002); the vast majority of published references, including Schultz (1996), list it under its older name.

Pet names are a different problem. My wife Judith Block, retired registrar at the National Zoo, once asked several keepers to help identify some primates in the collection: "When I took the gibbon records over to the Monkey House and asked which animal was named 'Spook,' three of them pointed to three different animals. It was also the primate keepers who taught me that an animal's name is very fluid. One macaque started off as 'Mary,' became 'Margie' then 'Mom' then 'Granny.' And all of the keeper staff contributed to my learning that often the formal name given in consultation with the Embassy or as the result of a contest is not what the animal is actually called—or even close. These experiences, along with many others, taught me not to rely on people's memory when creating and analyzing zoo records." I have argued before (Murphy and Card 1998) that for various reasons pet names should not be used in zoos but many of my colleagues disagree with me.

Knowing precisely which live animals are being assembled for breeding has always been critically important for zoos and aquariums. This has often been difficult because locality data for specimens or their ancestors is seldom known (and even if known rarely kept or at least easily retrieved) and DNA paternity/maternity analyses are virtually never conducted. And now, as these institutions focus on captive breeding colonies and conservation programs that might involve releases, precise identification is even more important (see Soulé and Kohm 1989). My overall impression is the importation of live animals from the field has diminished over the past several decades and the importation of biomaterials for research has increased.

Marking reptiles and amphibians for certain identification of individuals in the collection is an important component as well. Methods are described in several publications (Honegger 1979; Heyer et al. 1994, 2001; Ferner 2007; McDiarmid et al. 2012). Using PIT tags and photographs are helpful methods. At Dallas Zoo, we sometimes placed animals with distinct patterns and colors on a color copier to obtain a permanent record.

It is imperative to keep track of individuals, their origin, and genetic/breeding histories. This tracking may become even more complex when creating certain zoo animal colonies in the future. A recent paper by Cole et al. (2014) described a new species called Neaves' Whiptail Lizard (*Aspidoscelis neavesi*). Their abstract: "The first known tetraploid amniote that reproduces through parthenogenetic cloning by individual females is named and described. The species originated through hybridization between *Aspidoscelis exsanguis* (triploid parthenogen) x *Aspidoscelis inornata* (diploid bisexual or gonochoristic species) in the laboratory." It should be mentioned that not all herpetologists agree that a new species developed only in captivity represents a new taxon.

I may be too old to change but I simply cannot bring myself to use some new names even when a strong case is made to do so (see Reynolds et al. 2014). The Reticulated Python (*Python reticulatus*) was described by Fitzinger in 1826 but is now listed as *Malayopython reticulatus* in The Reptile Database. The Fitzinger name has been used for 170 years. At some point, I may be able to adapt to *Malayopython* but it will be challenging (Fig. 3).

It is easy to reject the generic name *Broghammerus* Hoser 2004 and the six Reticulated Python subspecies for the reasons enumerated by H. Kaiser and colleagues (Kaiser et al. 2013). Unfortunately, a number of zoos, governmental agencies and other institutions, and herpetoculturists have been using this generic name in their online and printed materials including promotional, care, and information sheets—the lack of scientific rigor and indifference to acceptable standards for naming animals will certainly cause confusion when lists of taxa are generated for conservation purposes and studies on herpetofaunal biology are undertaken. Several examples: Rawlings et al. (2008) refer to the Reticulated Python as *Broghammerus reticulatus* and subspecies *jampeanus* and *saputrai* (by implication). The U.S. Fish and Wildlife Service (USFWS) listed the Reticulated Python as *Broghammerus reticulatus* or *Python reticulatus* in several Federal Register documents dealing with possible injurious wildlife species. Reed and Rodda (2009) use *Broghammerus reticulatus* in the frontispiece, captions of their figures, and tables in the joint report by USFWS and U.S. Geological Survey (USGS) and recommended the following: "Rawlings and others (2008) opted for splitting, especially as a suitable name was already in use in

the literature for the Reticulated Python. Adherents of this point of view will wish to use the name *Broghammerus reticulatus*."

I recommend again to curators, registrars, and records keepers that in order to remain as accurate as possible and ensure that the conventions and usage for all names are understood over time by all future reviewers of these records, any changes should be documented. If there is inconsistency, then an explanation of how it was resolved must be placed in the records. Any new names advanced by the curators must have the source included; a copy of at least the title page and preferably the abstract of the relevant source information should be required. Copying the entire paper would be helpful. The curator's name and sources are then kept in the permanent records. (I note here that pdf files can sometimes be obtained on the internet through Google Scholar search engine). Lists of protected species—CITES and other international treaties, and local lists such as USFWS—must be consulted as well to guarantee consistency.

Other recommendations:

—To understand reasons for the sometimes-heated debates in herpetological taxonomy, read Vences et al. (2013) and Wüster and Bérnils (2011). These disagreements are unlikely to be resolved in the forseeable future.

—The IUCN Red List is a set of conservation statuses and recommendations. It is not to be used as a source of taxonomic information. It is updated too slowly and sporadically to be used as such.

—The online system AmphibiaWeb is linked to the IUCN list and provides information on amphibian declines, natural history, conservation, and taxonomy. There are differences between the taxonomies of AmphibiaWeb and *Amphibian Species of the World*. One helpful feature is as a source for photographs called "Photobrowser." The section called "Stories from the Field" is interesting reading highlighting the work of amphibian biologists.

—Follow *Amphibian Species of the World* and *The Reptile Database,* plus the SSAR Standard Names List for English names for US/Canadian taxa. *The Reptile Database* is not perfect, but clearly it is the best thing available. Specifically do NOT use field guides, Wikipedia, or any other taxonomy on the web (other than the above).

—Update taxonomies (across ALL zoo records and signage) once a year. This seems more efficient and likely to occur than rushing to the registrar every time a new taxonomic paper is published. Most curators have to file annual collection plans. Complete taxonomic review of the collection—and appropriately annotated changes to all zoo records—should be a mandatory part of this process.

—ISIS and AZA taxonomic lists are outdated to the point of non-functionality. In AZA guidelines, I believe that Frost (1985) is listed as the official taxonomy for zoos to follow for amphibians. By extension, its online descendent (Frost 2015) then is the official list for AZA.

—Read David L. Hull's book *Science as a Process: An Evolutionary Account of the Social and Conceptual Development of Science* (1988).

—Arrange to have an advisor apart from the zoo profession who can suggest proper taxonomies for the records.

—During my zoo career, there has been a reluctance by some zoo biologists to update taxonomies (sometimes for over a decade) for graphics, records, or other purposes, and budget constraints are usually given for one of the reasons. I remember visiting one US zoo with a large herpetological collection where the labels were typed on paper with a barely visible font size and were so old that they were yellowed and turning to dust—the curator said that visitors do not read signs anyway so why should he bother to produce more accurate and aesthetic versions? Another reason offered is that new names are too difficult to learn. When Arnold Kluge changed the generic name of the Green Tree Python from *Chondropython* to *Morelia* in 1993, there was an outcry from some in the herpetological community that was astonishing. Some of my colleagues refuse to use the latter name to this day and will tell anyone who will listen. These are unacceptable excuses for a profession claiming to have a scientific underpinning, especially in this digital world where searching for relevant publications is much easier.

—In summary, evaluate each proposal on its own merits, and also defer to species authorities in cases where you do not have enough knowledge. Clearly there are taxonomic changes that an informed reader can see that warrant immediate adoption given the breadth and depth of evidence (*Natrix* vs. *Nerodia* or *Elaphe* vs. *Pantherophis*), while other proposals, although put forth by experts, probably warrant an extended period of evaluation. Examples of *Lithobates* vs. *Rana*, or *Bufo* vs. *Anaxyrus* come to mind; in these cases there is general agreement on the evidence, but it comes down to whether one wants to carve up a monophyletic group, albeit a large one. In general, I would advocate a conservative approach, make changes when some degree of consensus in the herp community develops, and consult with one or more herpetologists with taxonomic expertise.

As an aside, Kraig Adler told me that as a brash new graduate student at the University of Michigan Museum of Zoology in 1962, he dashed into the office of prominent herpetologist Norman Hartweg waving a newly published paper that made wholesale nomenclatural changes in the Latin names of turtles and insisted that all the labels in the museum collection be changed. Professor Hartweg told this young chap to calm down as no changes were going to be made—the one certainty was that many new changes will prove to be in error and be rejected, and that the older names will return to former prominence. As, in fact, they were.

Acknowledgments.—This contribution is dedicated to René Honegger, Curator of Herpetology at Zürich Zoo in Switzerland between 1960 and 1999, now retired. He was responsible for many innovations in terrarium displays, captive husbandry and management, and national and international conservation issues. René compiled the first IUCN Red Data Book on reptiles (Part 1—Testudines, Crocodylia, Rhynchocephalia) in 1982.

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HERPETOLOGICAL NOMENCLATURE

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The Taxonomic Status of the Snake Name *Tropidonotus roulei* Chabannaud, 1917

Paul Chabanaud was an ichthyologist associated with the Muséum National d'Histoire Naturelle (MNHN) in Paris, from 1915 to at least 1955. Although Chabanaud's primary research was with fish, 37 of his first 41 papers, published from 1915 to 1924, covered herpetological topics. During World War I he was tasked with identifying North African material that had accumulated from a variety of collecting expeditions during the previous decades (Dollfus 1960). From this material, as well as his own collections from West Africa, he named 17 taxa of snakes, only six of which are currently recognized.

One taxon named by Chabanaud (1917), *Tropidonotus roulei*, has managed to escape mention since its description. The description of *T. roulei* is of a juvenile specimen (based on the presence of the umbilical scar), said to have been collected on the "Nil Blanc, près Khartoum," i.e., on the White Nile, near Khartum, in central Sudan by Louis Vossion in 1882. Suggesting that it was related to the Eurasian Natricinae, Chabanaud assigned this new species to the then large genus *Tropidonotus* Kuhl, 1824, and more precisely to the genus "*Tropidonotus* (s. str.)," namely the subgenus *Tropidonotus* as defined by Boulenger (1893).

Because there are no natricines known from northeastern Africa, *T. roulei* could represent either a novel taxon, or could be assigned to an existing taxon with, therefore, erroneous locality data. An examination of the specimen (MNHN 1917.0154; Fig. 1), still in very good condition, proved the latter supposition to be correct—the specimen is a juvenile *Nerodia erythrogaster* (Forster, 1771)—a species of natricine that occurs only in eastern North America. The purported collector, Louis Vossion (1847–1906), was a French consul general who was assigned to numerous posts around the world, including Burma (1877–1880) and Sudan (1880–1882; Hill 1967). His only known stay in the United States was at Philadelphia during the early 1890s (Vossion 1897). The U.S. visit put him in proximity of *N. erythrogaster* populations on the Delmarva Peninsula. However, the holotype of *T. roulei* differs morphologically from Atlantic Coast specimens (see below), and is supposed to have been collected a decade earlier. The holotype is the only herpetological specimen collected by L. Vossion that was reported upon by Chabanaud, so there is no means to associate it with other material. The fact that the specimen was catalogued 35 years after its supposed capture permitted ample opportunity for accidental mixing of the holotype and any collection data with African specimens.

The holotype of *T. roulei* is described as follows (where different, Chabanaud's characters follow in parentheses): neonate; total length 305 mm; tail length 64 mm; nostrils lateral; eye large, equal to the nostril–orbital distance; internasals as wide as long; prefontals longer than wide (Chabanaud's figure shows wider than long); frontal twice as long as wide, with concave sides at suture with supraoculars; nostril lies between two nasals; loreal slightly taller than long; 1 preocular; 3 postoculars; 1 anterior and 3 middle temporals; 8 supralabials, the 4th and 5th bordering the orbit; 9 infralabials; anterior chin shields elongate, bordering first 5 infralabials; anterior chin shields longer than posterior pair (Chabanaud's figure shows them to be about equal in length); 25 dorsal scale rows at midbody, each with a keel; 148 ventrals; anal divided; 64 subcaudals, paired. The subcaudal scale count is within the range of females for *N. erythrogaster*, and lower than known counts for males. The 31 dorsal blotches are dark brown, the lateral bars darker brown, with the lateral interspaces pink tan. The ventral ground color is yellowed cream. The head is marked by fused, black-edged parietal spots, a pale post-parietal bar, and a dark postorbital band on each

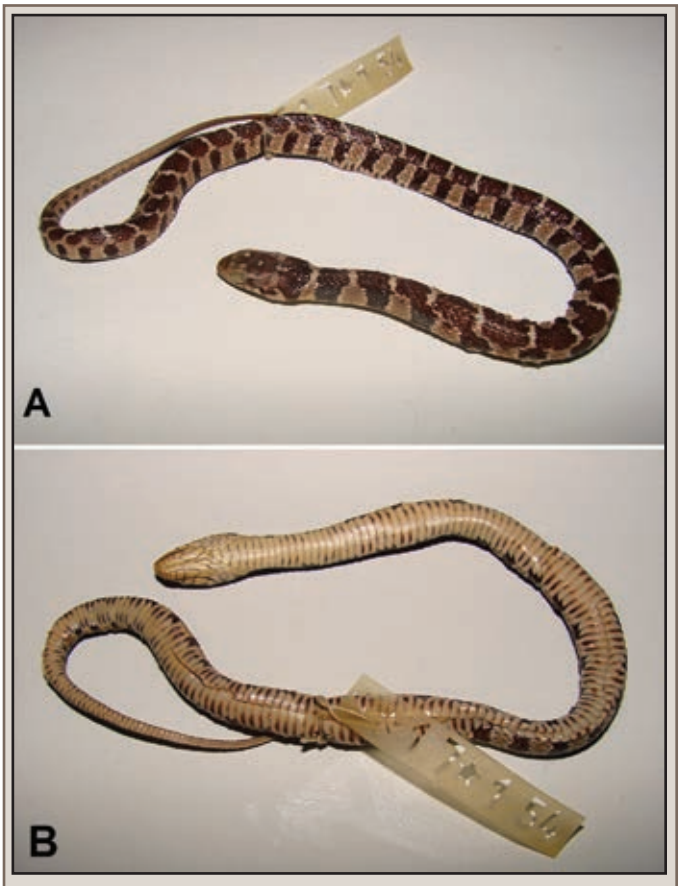


FIG. 1. Holotype of *Tropidonotus roulei*. A) dorsal view. B) ventral view.

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side. All of the preceding characteristics are within the range of normal variation for *N. erythrogaster* (Conant 1949, 1969; McCranie 1990). After over 130 years in preservative the holotype surprisingly retains lifelike coloration. In living neonates the lateral ground color is brick red or reddish brown, the dorsal and lateral blotches and head markings are nearly black or brownish black, and the venter is dull yellow (Fig. 2).

Nerodia erythrogaster was once divided into six subspecies that were based on adult color pattern, with some correlated variation in juvenile color pattern (Conant 1949, 1969; McCranie 1990). However, Makowsky et al. (2010) showed that there was no genetic basis for taxonomic subdivisions, and considered *N. erythrogaster* to be a monotypic, wide-ranging species—an interpretation that was followed in Crother (2012). Although the blotched color pattern exhibited by the holotype of *T. roulei* is common to neonates of all of the former subspecies, we can try to specify to which of them the holotype of *Tropidonotus roulei* could be referred. In *N. e. alta* and *N. e. bogerti* the lateral bars are discretely shorter than those of the other former subspecies, and of the holotype of *T. roulei*. Also, those two morphs occur only in remote sites in the interior of northern Mexico, and were not discovered until the middle 1900s. Unlike the holotype of *T. roulei*, neonates of the former nominate race, of the Atlantic coastal and far eastern Gulf of Mexico drainages, possess a fairly uniform, dark cap that lacks the pale parietal and post-parietal marks, and the cap tends to be coalescent with the dark postorbital bands. Populations from the upper Midwest (subspecies *neglecta*) also lack the pale parietal markings, and usually have 23 midbody scale rows.



Fig. 2. *Nerodia erythrogaster*, neonate living specimen from USA: Louisiana: Baton Rouge. A) dorsal view. B) ventral view.

Other populations were previously assigned to the subspecies *N. e. flavigaster* and *N. e. transversa*, which occur in the south-central United States and northeastern Mexico. We are unaware of any character that will differentiate neonates of these populations, and the holotype of *T. roulei* resembles examples of both (JB, pers. obs.). Therefore, we cannot specify the possible origin of the holotype more proximal than the combined geographic ranges of the two morphs. Three nomina from that area, *Tropidonotus transversus* (Hallowell, 1852), *Nerodia woodhousii* (Baird and Girard, 1853), and *Nerodia couchii* (Kennicott, 1860), have nomenclatural priority over *T. roulei*, whereas *Natrix. e. flavigaster* (Conant, 1949) does not.

Using mtDNA sequence data, Makowsky et al. (2010) derived three primary clades in United States specimens of *N. erythrogaster*. The clades showed an approximate east–west arrangement that only partly followed that of the color-pattern morphs recognized as subspecies by Conant (1949). Their "Western" clade encompassed all of the range of *N. e. transversa,* and nearly all of *N. e. flavigaster*. Because the two subspecies are rendered taxonomically inseparable, we recommend fixing the type locality of *T. roulei* to within the range of the Makowsky et al. "Western clade." As a consequence, we here correct the type locality of *Tropidonotus roulei* Chabanaud, 1917 to a locality in central North America. Furthermore, in order to respect the stability of the systematics of this group, which will prevent *T. roulei* from having priority in the case any potential taxonomic rearrangements within populations of *N. erythrogaster*, we specify it as being "near the banks of the Arkansas [River]", i.e. the type locality of *Tropidonotus transversus* Hallowell, 1852. In so doing, *Tropidonotus roulei* becomes a subjective junior synonym of *Tropidonotus transversus*.

Acknowledgments.—Kenneth L. Williams brought the description of *T. roulei* to Van Wallach's and JB's attention. Wallach asked PD to check the identity of the holotype, who then conveyed to Wallach and JB that it was a specimen of *Nerodia,* and provided the photographs for Fig. 1. We thank Ken and Van for their work in the matter of *T. roulei*, both of whom declined to participate as coauthors. Lastly, JB thanks his son, John-Paul Boundy, for capturing the snake illustrated in Fig. 2.

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ABOUT OUR COVER: *Crotalus cerberus*



In Greek mythology, "cerberus" is the three-headed dog of Hades that guards the gates to the dark kingdom. The Arizona Black Rattlesnake was first described, in somewhat fitting and ominous fashion, as *Crotalus lucifer* by Elliot Coues (1875. Synopsis of the reptiles and batrachians of Arizona; with critical and field notes, and an extensive synonymy. *In* G. M. Wheeler [ed.], Report upon Geographical and Geological Explorations and Surveys West of the One Hundredth Meridian. Volume V: Zoology, pp. 585–633. U.S. Government Printing Office, Washington, DC), with two type specimens originating in Arizona's San Francisco Mountains. For many years thereafter, the Arizona Black Rattlesnake was considered a subspecies in the large *Crotalus viridis* (sensu lato), or "Western Rattlesnake" complex, that was in itself centered in taxonomic debate. Ashton and de Queiroz (2001. Mol. Phylog. Evol. 21:176–189) recommended recognizing the Western Rattlesnake group as two species, *Crotalus viridis* (containing two subspecies) and *C. oreganus* (containing seven subspecies, including *cerberus*). However, Douglas et al. (2002. Phylogeography of the western rattlesnake (*Crotalus viridis*) complex, with emphasis on the Colorado Plateau. *In* G. W. Schuett, M. Hoggren, M. E. Douglas, and H. W. Greene [eds.], Biology of the Pitvipers, pp. 11–50. Eagle Mountain Publishing, Eagle Mountain, Utah) recommended elevating seven of the nine subspecies, including *cerberus*, to full species status. *Crotalus cerberus* is currently recognized as a full species (Crother et al. 2012. Squamata: Snakes. *In* B. I. Crother [ed.], Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, pp. 52–72. Society for the Study of Amphibians and Reptiles Herpetological Circular 39) and identified by Pook et al. (2000. Mol. Phylog. Evol. 15:269–282) and Douglas et al. (2002, *op. cit.*) as the most basal member of its clade.

Arguably, one of the more charismatic of the southwestern rattlesnakes, the Arizona Black Rattlesnake is a resident of various mountain ranges and habitat associated with the Mogollon Rim, a mountainous shelf that extends in a northwestern-southeastern direction across Arizona and southwestern New Mexico. The species is also known from the northernmost Madrean Sky Island ranges in Arizona's Pima, Graham, and Cochise counties. The Arizona Black Rattlesnake is considered a generalist predator, consuming lizards, small mammals, and birds (Lowe et al. 1986. The Venomous Reptiles of Arizona. Arizona Game and Fish Department, Phoenix, Arizona. 115 pp.; Loughran et al. 2012. Herpetol. Rev. 43:144–145). Although the species occurs in a variety of vegetation communities, from Sonoran Desertscrub at 900 m elevation up to Subalpine Conifer Forests at 3000 m, individuals often rely on dense cover provided by woody debris and riparian vegetation (Schofer 2007. Movements, Thermal Biology, Habitat Use, and Natural History of *Crotalus cerberus* in Northern Arizona. Master's thesis, Northern Arizona University, Flagstaff, Arizona; Nowak 2009. Ecology and Management of Venomous Reptilian Predators. Ph.D. Dissertation, Northern Arizona University, Flagstaff, Arizona).

The Arizona Black Rattlesnake is a moderately-sized species with adult females averaging 614.9 ± 77.6 mm SVL and adult males averaging 792.2 ± 94.5 mm SVL. Lowe et al. (1986, *op. cit.*) reported maximum size as approximately 1000 mm SVL. As neonates, Arizona Black Rattlesnakes are light gray with brownish to reddish botches on the dorsum and lateral fields. However, with age, the background color darkens, sometimes to a rich, velvet black, usually with one or two rows of white, yellow, or orange scales on the anterior and posterior edges of the mid-dorsal blotches, but not the lateral aspect. Variation in physical appearance can be quite remarkable among or within populations, and even within individuals. Unique among rattlesnakes and perhaps one of the most emblematic traits of Arizona Black Rattlesnakes is their ability to undergo physiological color change (sometimes referred to as metachrosis)—lightening their background color to a light ashen grey and exhibiting a neonatal-like pattern, and returning again to the darker state. These often-dynamic color changes can occur quite rapidly when individuals are captured or confined (physiological) (J. Servoss, pers. obs.), or on a slower time scale through stages of ecdysis (morphological) (J. Servoss, pers. obs.). Lowe et al. (1986, *op. cit.*) and Meachum (1999. Cold Blooded News 26[3]:1–9) suggest physiological color change may occur in response to diel patterns by lightening their background color at night; however, this is not consistently observed and thus might indicate greater individual control of the process.

Our cover image features a large adult male Arizona Black Rattlesnake, recorded by **Jeff Servoss** in the Sierra Ancha Mountains in Gila County, Arizona, using a tripod-mounted Canon PowerShot G6 with shutter speed set at 1/60, f/8, and using a Canon Speedlite 420 EX in compulsory mode for fill-flash. Jeff is a Wildlife Biologist with the U.S. Fish and Wildlife Service in Tucson, Arizona, working predominantly on species status evaluations and conservation and recovery planning and project implementation for reptiles and amphibians in the southwestern United States. His focus most recently has included the Sonoran Desert Tortoise (*Gopherus morafkai*), and federally threatened species including the Northern Mexican Gartersnake (*Thamnophis eques megalops*), Narrow-headed Gartersnake (*Thamnophis rufipunctatus*), and Chiricahua Leopard Frog (*Lithobates chiricahuensis*).



PHOTO BY THOMAS R. JONES

Editor's note.—Special thanks to Melissa Amarello, Martin Feldner, and Erika Nowak for their editorial assistance.

SSAR BUSINESS

Dean E. Metter Memorial Award for 2015

The Metter Memorial Award winner this year is Carmen Harjoe, a student in the Department of Integrative Biology at Oregon State University. She is a PhD student who is studying the population status of Western Toads, *Anaxyrus boreas*, in southeastern Alaska. Her major professor is Andrew Blaustein. Carmen's undergraduate work was in Fisheries and Wildlife with a minor in Biology at the University of Missouri—Columbia where Metter taught herpetology and other life sciences courses for over 30 years. She took herpetology there from Carl Gerhardt and Richard Daniel and did research in Carl's laboratory.

The Metter Award Committee extends its sincere thanks to all the students who submitted proposals this year. We wish all of you the best and look forward to reading about the results of your graduate work in the herpetological literature.

NEWSNOTES

Landers Student Research Award

The J. Larry Landers Student Research Award is a Gopher Tortoise Council competitive grant program for undergraduate and graduate students. Proposals can address research concerning Gopher Tortoise biology or other relevant aspects of upland habitat conservation and management in the southeastern USA. The amount of the award is variable but has averaged approximately US $1,000 per recipient over the last few years.

The proposal should be limited to four pages and include a description of the project, a budget, and a brief résumé of the applicant. This is an excellent opportunity for students to access funding for their project. Awards are typically recognized at the annual meeting to the Gopher Tortoise Council. Deadline for the application is 15 September 2015. Electronic submission is preferred. Please submit proposals to Bob Herrington (e-mail: bob.herrington@gsw.edu).

Haskell Award 2015



PHOTO BY DIRK STEVENSON

The Alison Haskell Award for Excellence in Herpetofaunal Conservation is presented by Partners in Amphibian and Reptile Conservation (PARC), in memory of Alison Haskell (1956–2006). This award is intended to recognize an individual from North America who exemplifies extraordinary commitment to herpetofaunal conservation, has thus far been an unsung hero, and has shown exemplary commitment to building or strengthening partnerships. Alison was one such person.

We are proud to announce the 2015 recipient of the Alison Haskell Award is **John Jensen.** John is currently the state Herpetologist for the Georgia Department of Natural Resources. John has directly contributed to the conservation of imperiled amphibians and reptiles, in particular Gopher Frogs and Eastern Indigo Snakes, through many successful partnerships. His efforts have also helped protect Georgia's freshwater turtles and rattlesnakes. His commitment and dedication to herpetofaunal conservation, in Georgia and beyond, is widely recognized among his peers. Additional information about John's efforts and achievements can be found on PARC's Alison Haskell Award Winners page (www. Please read more about John's efforts and achievements on PARC's Alison Haskell Award Winners page. (www.parcplace.org/). SSAR congratulation John on this well-deserved recognition.

The 8th World Congress of Herpetology (WCH8) Call for Symposia

The 8th World Congress of Herpetology (WCH8) will be held 15-21 August 2016 in Hangzhou, China. The Organizing Committee is currently inviting proposals for symposia at WCH8. Each symposium will last two hours, with eight 15-min presentations. If you are interested in organizing a symposium, please submit your proposal via e-mail no later than 31 July 2015 to the following addresses:

xiangji150@hotmail.com / jixiang@njnu.edu.cn (Professor Xiang Ji, Nanjing Normal University) and njlihong@outlook.com / njlihong@163.com (Dr. Hong Li, Nanjing Normal University).

The proposal should include:
1) The title of the proposed symposium
2) Names of the organizers and their affiliations
3) A brief description of the theme
4) A tentative list of speakers

All proposals will be evaluated by the Scientific Program Committee chaired by Professor Ya-Ping Zhang, and up to 30 will be selected based on scientific merit and the timeliness of the topic. The selected symposia will be announced by 31 August 2015.

For more information about the 2016 congress (WCH8), please visit the website at:
http://www.wch2016hangzhou.com
Best regards. Xiang Ji
Professor in Ecology & Zoology; President, Chinese Herpetological Society; Secretary General Elect, World Congress of Herpetology; Chair, Local Organizing Committee for WCH8
Nanjing Normal University, China

MEETINGS

Meeting announcement information should be sent directly to the Editor (herpreview@gmail.com) well in advance of the event. We also welcome brief reports of meetings; please consult the Editor for details.

15–19 July 2015—American Society of Ichthyologists and Herpetologists and The Herpetologists' League annual meeting, Reno, Nevada, USA. Information: www.asih.org

27–29 July 2015—World Conference on Monitor Lizards, Bangkok, Thailand. Information: monitor.conference.2015@gmail.com.

30 July–3 August 2015—58th Annual Meeting of the Society for the Study of Amphibians and Reptiles (with Partners in Amphibian and Reptile Conservation, Kansas Herpetological Society, and International Society for the History and Bibliography of Herpetology), Lawrence, Kansas, USA. Information: www.SSAR2015.ku.edu

6–9 August 2015—13th Annual Symposium on the Conservation and Biology of Tortoises and Freshwater Turtles, Tucson, Arizona, USA. Information: http://www.turtlesurvival.org/

18–20 August 2015—Northeast Partners in Amphibian and Reptile Conservation (NEPARC) annual meeting, Greenwich, Rhode Island, USA. Information: http://northeastparc.org/next-meeting-info/

16-20 September 2015—51st Annual Meeting of the German Society for Herpetology and Herpetoculture, Lyss, Switzerland. Information: www.dght.de

25–30 September 2015—18th World Congress of the International Society on Toxinology, Oxford, UK. Information: http://lpmhealthcare.com/ist2015/

6–8 November 2015—42nd Annual Meeting of the Kansas Herpetological Society, Hays, Kansas, USA. Information: http://www.cnah.org/khs/meetings.aspx

15–21 August 2016—8th World Congress of Herpetology, Hangzhou, China. Information: http://www.wch2016hangzhou.com/

OBITUARIES

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John M. Legler 1930–2014: The Old Curmudgeon, the Turtle Biologist's Turtle Man of All Times

John Marshall Legler passed away on 28 March 2014 in Salt Lake City, Utah, of natural causes. He was born on 9 September 1930 in Minneapolis, Minnesota, to Fredrick William Legler and Helen Hertig Legler. He is preceded in death by his daughter Allison K. Legler (1985), and his wife, Avis Johnson Legler (2009), whom he married upon their graduation from Gustavus Adolphus College in St. Peter, Minnesota, in 1952 (Fig. 1). He is survived by their children: Austin F. Legler of Pambula, Australia; Edward P. Legler of Denton Texas; and Gretchen T. Legler of Jay, Maine. Avis was an artist, she cooked and raised the family, and often accompanied John with the children on field trips to Mexico and Central America; Austin learned to tell time and catch turtles at the same time while in the field in Mexico (Fig. 2). The family spent the better part of several years collecting turtles in Australia. He was an educator, a scientist, and a conservationist. He was an Olympic swimmer with four trophies and dozens of medals hanging in his office. Up until the last months of his life he swam daily. His turtle studies in Australia were based on the turtles he collected by diving in clearwater streams. He also painted gourds and built his own straw-bale building at his ranch in the mountains of Montana near a trout stream. I once made a faux paux, asking him when he was going to his cottage, he gruffly responded that "people in the East had cottages, Western men had cabins!"



AVANT GARDE STUDIOS

FIG. 1. John Legler, 1953, a year after completing his undergraduate degree.

John's family settled in Minneapolis, Minnesota after World War I. Their home had three lots with a huge rock pile in the back where his father kept free-roaming non-venomous snakes, and would feed them there. John and his brother used to catch sparrows and take them to the library to give to the snake lady, Grace Wiley, who kept poisonous snake; later she died from getting bitten by a cobra she was posing for a magazine photographer in 1948. John's father always told the boys not to take chances with venomous snakes. John had a whole family of descented skunks as pets; the young

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PHOTO BY AVIS LEGLER



FIG. 2. John Legler, setting turtle traps in Australia.



PHOTO BY PHOTO BY CHUCK SHAFFER

FIG. 3. John Legler and friends, at a party held in the suite of Ian Swingland at Hotel Tropical at the WCH6 in Manaus, Amazonas 2008.

used to follow the mother around. One of the young skunks was not descented completely, but that was ok; that was part of the mystique for people from Dusseldorf coming to live in the Wild Wild West of America, where you were free to do anything, including possessing wild skunks!

John began his academic life at a small liberal arts school in Minnesota. He did not have a raving interest, or even a passing interest for that matter, in turtles until he read Archie Carr's book on the turtles of North America. In going through John's files after his passing, I found a letter to Archie Carr with accolades about the *Handbook of Turtles* and how the book had stimulated John's interest in turtles and requested information about going to graduate school at the University of Florida under the tutelage of Dr. Carr. Carr never responded, only a graduate school secretary who sent him the application forms and stated that Dr. Carr would be in touch with John at a later date; no letter from Carr was found in the files. Imagine how turtle biology might have taken a different course had Legler worked with Carr! Maybe sea turtle conservation would have been more about the biology of the animals had Legler become involved.

He attended graduate school at the University of Kansas and was mentored by E. Raymond Hall, Edward Taylor, and Henry Fitch, despite the fact that those three were not on good terms with one another. Hall had a very stereotyped and eccentric behavior—entering and leaving the museum with a flare, and the same way each day, entering with a flourish and pirouetted bounding up the spiral staircase, and leaving by an old freight elevator, by grabbing a pole and doing a pirouette into it. One night, someone had overridden the safety on the door which prevented the door from opening if the elevator was not there; Hall lived through the fall. At another time Hall flew his body into a low table that was strategically placed in his path, where he entered his customary room with a flourish and greeted his groin with the edge of the table; Legler was positive this was set up by Taylor.

Legler earned his Ph.D. in anatomy and zoology (1959) and served as the Curator of Herpetology at the KU Museum of Natural History from 1955–1959. In 1959 he began teaching at the University of Utah as an assistant professor, achieving full professor status in 1969. In Utah, he developed the undergraduate program in human anatomy, earned the University's Distinguished Teaching Award in 1967, established the Legler Professorship and Chair of Anatomy, and retired in 1997 as Emeritus Professor.

Legler's 82 scientific publications were overwhelmingly focused on turtles, but also included papers on frogs and snakes. He regarded the critically acclaimed book on Mexican turtles (coauthored with Richard C. Vogt, 2013) as his major academic accomplishment. Two other publications have become classics in the turtle world: his PhD thesis (Natural History of the Ornate Box Turtle, *Terrapene ornata ornata* Agassiz [Legler 1960]; and The Life History of a Neotropical Slider Turtle, *Pseudemys scripta* (Schoepff), in Panama (Moll and Legler 1971).

Legler described or co-described new species of tortoises and freshwater turtles on three continents—*Gopherus flavimarginatus* from Mexico, *Kinosternon angustipons* from Panama, *Trachemys scripta taylori* and *Trionyx ater* (now *Apalone spinifera atra*) from Cuatro Cienegas, Coahuila, Mexico, a new genus and species of Australian chelid, *Rheodytes leukops,* as well as other species of Australian turtles. In addition, he described a snake, *Geophis aquilonaris* (now regarded as a subspecies of *G. dugesii*), and the Central American frog *Ptychohyla legleri* was named in his honor.

His main contributions to turtle conservation were the techniques he developed which saved the unnecessary slaughter of countless numbers of turtles to obtain stomach contents for dietary studies and eggs for incubation studies. With his son Austin, he developed a technique while in Australia to flush out stomach contents of turtles without causing life-threatening damage to the turtle (Legler 1977). John and Mike Ewert developed the technique of inducing oviposition in gravid turtles by the injection of 10 units of oxytocin per kg of body weight (Ewert and Legler 1978).

Legler formed strong, and sometimes colorful opinions of other turtle biologists. He regarded Gerald Kuchling as perhaps the most dedicated and brilliant turtle biologist working in Australia. He worked with Mike Ewert in developing the oxytocin technique, and found him to have interesting ideas but quite paranoid about others stealing his data.

A group of well-regarded scientists received their PhD under his guidance at the University of Utah: Jim Berry, Jim Bull, Jim Christiansen, Ed Moll, and Bob Winokur. Postdocs included Dennis Bramble, Eric Charnov, and Rick Shine. A festschrift in his honor was held at the 2010 JMIH meetings in Minneapolis, Minnesota, his home town; all but one of his former students participated.

After our Mexican turtle book was finished, John was at a loss for what to do with his free time and wanted to start on another book. He wanted to do South American turtles with me, but I insisted he do his Australian book and enlist Sean Doody to help him. They were working on the book when John died.

In 2008, John delivered a plenary talk at the 6th World Congress of Herpetology in Manaus, Brazil regarding his views on the most important aspects of turtle biology yet to be studied (Fig. 3). He delivered the keynote address at the Turtle Survival Alliance meeting at St. Louis in 2013, and with a twinkle in his eye showed us a unique and undescribed gland in the esophagus of a chelid turtle.

I first met John at the Turtle Ecology Symposium at the ASIH meeting in Williamsburg, Virginia in 1975. We remained close friends and colleagues over the next 38 years. With his passing, I've lost my best friend and life advisor. He is sorely missed, but his critical eye and perseverance for the finest science possible will always be with me.

Epilogue.—I interviewed John Legler in Salt Lake City on 23 March 2010. Parts of that interview have been incorporated in this obituary. Post-mortem I inherited John's academic life—his library, photographs, serial histological sections of the heads of 46 species of hatchling turtles, dried and stained turtle lungs, archives of published and unpublished data, unfinished papers and books, correspondence files, and his daily journal. I went through all the files and boxed it all up to be shipped to Brazil—93 boxes including six 4-drawer file cabinets, and 43 wooden cases for turtle skeletons.

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Moll, E. O., and J. M. Legler, 1971. The life history of a neotropical slider turtle, *Pseudemys scripta* (Schoepff), in Panama. Bull. Los Angeles Co. Mus. Nat. Hist. Sci. No. 11:1–102.

CURRENT RESEARCH

The purpose of Current Research is to present brief summaries and citations for selected papers from journals other than those published by the American Society of Ichthyologists and Herpetologists, The Herpetologists' League, and the Society for the Study of Amphibians and Reptiles. Limited space prohibits comprehensive coverage of the literature, but an effort will be made to cover a variety of taxa and topics. To ensure that the coverage is as broad and current as possible, authors are invited to send reprints to the Current Research section editors, Ben Lowe or Chava Weitzman; e-mail addresses may be found on the inside front cover.

The Plight of Mitigation-Driven Translocations

Translocations to mitigate animal deaths due to human expansion (mitigation-driven translocation) is an often used, but poorly studied, tool to conform with laws regarding the conservation of species. For any one project, millions of dollars may be spent to relocate thousands of animals. For example, translocations of Mojave Desert Tortoises (*Gopherus agassizii*) for a single solar project could amount to US $22 million. In 2011, approximately 500 permits were issued in Florida alone for translocation of the Gopher Tortoise (*G. polyphemus*). Additionally, more money may go toward mitigation-driven translocations than conservation-driven translocations, which aim to supplement or reestablish populations. In the last 15 years, over AU $14 million has been spent on mitigation-driven translocations of the Green and Golden Bell Frog (*Litoria aurea*) in Australia, while less than a quarter of that amount has been spent on conservation-driven translocations of all other Australian amphibian species combined. Techniques used in conservation-driven translocations are scrutinized through experimental research published in peer-reviewed journals, and though mitigation-driven translocations stem from different motives, the authors argue that these translocations should undergo the same academic scrutiny as translocations for conservation needs. Without further investigation into the success of such mitigation-driven translocations, the authors question whether these animals are "being spared a socially unacceptable death via bulldozer only to perish out of view at a release site." Proper implementation and documentation would not only expose success rates, but could allow for an opportunity to test hypotheses and optimize methods based on empirical evidence. Due to the supply-driven nature of these translocations, the proportion of the population actually collected, along with the effects of these translocations on the local population into which the individuals were translocated, are frequently unknown. As such, and with the implementation of poorly executed techniques, it is likely that survival and establishment are low, and the assumed success rates may often be misguided. The authors urge for the investigation into the success of mitigation-driven translocations to become a responsibility of the developers, consultants, and regulatory agencies.

Germano, J. M., K. J. Field, R. A. Griffiths, S. Clulow, J. Foster, G. Harding, and R. R. Swaisgood. 2015. Mitigation-driven translocations: are we moving wildlife in the right direction? Frontiers in Ecology and the Environment 13(2):100–105.

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Sampling Site an Important Factor in Effects from Parasites and Pesticides

A variety of dynamics might influence the interactions between amphibians, parasites, and pesticides. Although pesticides may weaken vertebrate immune systems, they might also negatively influence the success of parasites. The fragmentation of wetland habitats might reduce transmission of parasites, similar to island effects on the composition of host and parasite

populations and assemblages. An additional conflicting factor might be host body size, as larger hosts might be exposed to higher amounts of pathogens, but might also represent relatively healthy individuals. Studies of Northern Leopard Frog (*Lithobates pipiens*) populations in agricultural and undisturbed wetlands in southern Quebec, Canada, have detected differences in leukocyte profiles and parasitic nematode prevalence and abundance. Here, the authors aim to explain these differing leukocyte profiles by testing for associations with nematode presence, pesticide levels, frog metrics and sex, and positive or negative association between pairs of nematode species. From five wetlands, the authors analyzed 82 blood smears and parasites from 146 frogs. These wetlands were sufficiently far apart to exceed known juvenile Northern Leopard Frog movements. Data were collected from juvenile frogs, ensuring interactions solely with natal environments. Neutrophil:lymphocyte ratios were used to measure potential response to stressors from both parasites and pesticides. Parasites were found in 82% of the frogs examined, with species richness ranging from one (33%) to four (2%), and significant interannual variability was detected when comparing these 2006 nematode abundance results with a 2001 study. While many patterns arose among frog metrics, leukocyte metrics, pesticide levels, and nematode richness and abundance, most of these correlations broke down when analyzing within-wetland patterns in place of pooling the frog sampling sites. These analyses revealed there are likely population differences both in metamorph size and nematode exposure or transmission. In general, pesticides likely did not affect nematode levels in these sites, but rather there is likely a combination of environmental variables impacting nematode abundance at sites with high parasite levels. This study also found lower stress indices in frogs exposed to higher herbicide levels, disagreeing with previous studies, and possibly associated with other variables in the frog populations. The authors stress the importance of incorporating sampling location as a variable in larger, comparative studies. This study illustrates the influence of spatial scale on host-parasite relationships, which is an important consideration as landscape ecology scales are increasingly employed by parasitologists.

Shutler, D., A. D. Gendron, M. Rondeau, and D. J. Marcogliese. 2015. Nematode parasites and leukocyte profiles of northern leopard frogs, *Rana pipiens*: location, location, location. Canadian Journal of Zoology 93(1):41–49.

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The European Newt Arrives in Australia

Australia provides habitat for over 200 native frog species, but there are no known species of salamander or caecilian native to the country. Here, the authors document the invasion and establishment of the European Newt, *Lissotriton vulgaris*, near Melbourne, Australia. Of the seven sites surveyed in 2013 in the Melbourne area, *L. vulgaris* was detected in six, with a total male-to-female ratio of ~2.5:1. Through comparing sequences of two mitochondrial genes from wild-caught *L. vulgaris* in Australia with sequences available on GenBank, the newt was placed in the L2 haplotype group of the *L. v. vulgaris* subspecies, which has been identified in Germany, the Czech Republic, Slovakia, and Hungary. The authors used the software CLIMATE to compare precipitation and temperature variables between the species' native distribution and Australia to estimate the potential distribution in this new habitat. When using distribution of *L. vulgaris*, the authors predict suitable habitat in large portions of New South Wales, Victoria, eastern Tasmania, southern South Australia, and southwestern Western Australia. Much of the potential habitat in South Australia and Western Australia degrades in quality for these newts if only the subspecies *L. v. vulgaris* distribution is included in the model. As the climatic niche of a species might not necessarily be conserved in its invaded range, the authors advocate caution when considering these range predictions. Another important factor to consider is that the invaded area is denser with artificial water sources than the water available in the native range, possibly enabling higher levels of mobility in Australia. It is currently unknown how the establishment of this species could impact Australian biodiversity. They may pose a competitive threat to frog and invertebrate species, due to a similar trophic niche. Additionally, *L. vulgaris* may contain low levels of tetrodotoxin, a neurotoxin present in some species of Salamandridae. As this is the first recorded establishment of a caudate in Australia, the effects of this toxin on naïve predators is not known. To help determine the extent of possible effects of *L. vulgaris* on native species in Australia, the authors urge that the next step and top priority be to delimit the current extent of the species' Australian range.

Tingley, R., A. R. Weeks, A. S. Smart, A. R. van Rooyen, A. P. Woolnough, and M. A. McCarthy. 2015. European newts establish in Australia, marking the arrival of a new amphibian order. Biological Invasions 17:31–37.

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Evidence of *Bd* in Illinois for >125 Years

Although disease caused by *Batrachochytrium dendrobatidis* (*Bd*) has caused die-offs in amphibian populations around the world, no population declines in the eastern or midwestern U.S. have been attributed to chytridiomycosis. Little is known of the evolutionary history of this fungal pathogen, and the origin of *Bd* in the U.S. could have deep historical roots, or could include invasive strains more recently introduced. The authors' objectives here were twofold: to use museum specimens to find the oldest evidence of *Bd* in Illinois, and to determine frequency of infection among species and areas across time. They investigated frog specimens representing 10 species across the state of Illinois and the years 1888–1989. The genera represented included *Acris, Anaxyrus, Hyla, Lithobates*, and *Pseudacris*. *Bd* prevalence was tested using established quantitative PCR assay protocols. Among these samples, prevalence of *Bd* was 13.2%, but *Bd* prevalence varied among species and decade. Specimens of *Lithobates sphenocephala* had the highest prevalence of *Bd*. This pathogen was also detected in *L. pipiens*, *Hyla chrysoscelis*/*versicolor*, and *Acris blanchardi*, while *Bd* was not found in the remaining six species. Prevalence of *Bd* was highest in the 1940s when comparing all frog species, but also within the subset of samples representing *L. sphenocephala*. This increase in prevalence in the 1940s may indicate an epizootic, though more and even sampling among species and years would be necessary to confirm.

From these samples, the earliest incidence of *Bd* detected in southern Illinois was in 1900, in 1888 in central Illinois, and 1892 in northern Illinois. One individual *L. sphenocephala* from 1888 with *Bd* represents the oldest reported record of this pathogen, followed by a Brazilian frog specimen from 1894. These results indicate a historic presence of *Bd* in Illinois, either because it was introduced before 1888, or because it is a native pathogen with deep evolutionary roots in the region. Though the role of *Bd* in past population declines is unclear, its presence suggests a possible explanation of historical declines in some species. As there is no evidence of population declines in *L. sphenocephala*, the high prevalence of *Bd* both presently and historically in this species raises the question of this species' role in *Bd* distributions and dynamics. The authors suggest future studies investigating the evolutionary history of *Bd* should include samples from the midwestern U.S. to evaluate whether this region is a point of origin for this now-widespread pathogen. Importantly, the authors have shed light on the historical prevalence of disease in the midwestern U.S., and documented the earliest known case of *Bd* in a *L. sphenocephala* specimen from central Illinois.

Talley, B. L., C. R. Muletz, V. T. Vredenburg, R. C. Fleischer, and K. R. Lips. 2015. A century of *Batrachochytrium dendrobatidis* in Illinois amphibians (1888–1989). Biological Conservation 182:254–261.

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Denser Lizard Populations Promote Cannibalism in Adult Males

Insular species frequently evolve characteristics that differ from those of their mainland counterparts, due to decreased predation stress, increased population density, and thus increased intraspecific competition. These can include physiological, ecological, and behavioral changes. Behaviorally, high intraspecific competition may lead to an increased incidence of cannibalism and intraspecific aggression. Here, the authors examine the incidence of cannibalism and intraspecific aggression in two populations of Skyros Wall Lizards (*Podarcis gaigeae*) on the main island of Skyros and the satellite islet of Diavates. The wall lizards on Diavates have no interspecific competitors, nor predators, and individuals grow to much larger sizes than those on Skyros. The authors used staged encounter trials to identify frequency and latency of four aggressive behaviors: approach, run, attack, and capture. They hypothesized that males would be more frequently aggressive toward juveniles than females, lizards from Diavates would attack juveniles more frequently than those from Skyros, and adults from Diavates would be more aggressive toward age-peers than adults from Skyros. The trials determined that significantly more males from Diavates performed aggressive behaviors than males from Skyros, and of those that captured the juveniles, the males from Diavates did so in less time. While the proportion of males performing aggressive behaviors toward age-peers did not differ between the two locations, a higher proportion of males from Diavates performed the most aggressive behaviors of attacking or capturing toward age-peers. Few females performed any aggressive behaviors toward either juveniles or age-peers, and there were no significant differences found between female behaviors from Diavates and Skyros. As such, the frequency of aggression was significantly higher in males than females. All three hypotheses were supported in these experiments. While limited food resources has been described as a trigger for increased cannibalism, the Diavates population of wall lizards has an abundant food supply. In these wall lizards, the differences found between aggression levels may reflect increased competition and frequency of interactions between males for territory defense and mate control in a denser population on Diavates than those found on other islands.

Cooper, W. E., Jr., I. Dimopoulos, and P. Pafilis. 2015. Sex, age, and population density affect aggressive behaviors in island lizards promoting cannibalism. Ethology 121:260–269.

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Are Pythons the Cause of Mammal Declines in the Everglades?

Everglades National Park (ENP) in South Florida has experienced declines in mammal populations coinciding with the invasion of Burmese Pythons (*Python molurus bivittatus*), yet whether the Burmese Python has caused these declines is a source of contention. Here, the authors test whether pythons drive the declines of Marsh Rabbits (*Sylvilagus palustris*) in ENP. The mortality risk from different causative agents was compared between rabbits in areas with and without established python populations. Marsh rabbits were collected from donor populations and assigned to one of three sites: a procedural control site in the Greater Everglades Ecosystem (GEE) with no pythons, and two sites in ENP. An additional control site, with few or no pythons, within ENP was also used but not manipulated. Mortalities were classified as a predation from a mammal, bird, non-python reptile, python, or unknown endotherm. A Cox proportional hazards model was used to estimate mortality risks from the various predators. Because pythons are ectotherms, the authors predicted that python predation would vary with environmental conditions, depending on temperature and water depth. A total of 68 rabbit mortalities were documented, 55 of which were attributed to a specific predator type. The rabbits released in ENP had a higher cumulative hazard risk from pythons, which accounted for 77% of their mortalities. In the control sites, however, 71% of the mortalities were due to mammals, and the only snake predation events in the control sites were by native rattlesnakes. Predation events by pythons in ENP were temporally heterogeneous, with higher rates of mortality with increasing temperatures, but water level did not influence predation events by pythons. Alternatively, the mortality events by mammals were not influenced by environmental changes. The lack of predation events by mammals in ENP may be attributed to effects of pythons on other mammalian populations. These data support the claim that Burmese Pythons are the likely cause of population declines in mammalian species in ENP, especially as the study system chosen in this experiment is generally resilient to predation pressure. In order to restore the health of Everglades National Park, mammal populations need to be recovered, and the population of these invasive pythons needs to be reduced.

McCleery, R. A., A. Sovie, R. N. Reed, M. W. Cunningham, M. E. Hunter, and K. M. Hart. 2015. Marsh rabbit mortalities tie pythons to the precipitous decline of mammals in the Everglades. Proceedings of the Royal Society B 282:20150120.

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Changes in the Commercial Reptile Trade: 1996–2012

The exotic pet trade is fueled by biodiversity-rich countries, and the conservation implications of taking wildlife from these regions is poorly understood. Using CITES Appendix II import data from 1996–2012, the authors address questions regarding the changes in the trade of captive-bred, ranched, and wild-sourced animals, and possible consequences of these dynamics for the sustainability of the live reptile trade. Though these data analyzed only represent animals legally traded between countries, CITES data is the only comprehensive global dataset of its type, and is thus a valuable resource. Over 18.8 million live reptiles on CITES Appendix II were imported for commercial purposes globally between 1996 and 2012. With peaks in 1996 and 2001, annual Appendix II reptile imports have decreased during this time frame, with a 32.8% decrease from 2001 to 2012, though the number of different species traded increased from 1996 to 2012. The Green Iguana (*Iguana iguana*) was consistently imported with the highest frequency, and Royal or Ball Python (*Python regius*) with the second highest frequency, and the top ten imported species accounted for over 75% of all trade. From 2001 to 2012, imports of wild-caught reptiles decreased by 71%, while imports of ranched reptiles increased by 4740%. The trade of *I. iguana* drove the decrease in captive-bred reptiles from 2001 to 2012, and excluding this species, the import of captive-bred reptiles increased by 202% between these years. Between 1996 and 2012, the proportion of ranched and captive-bred imports increased, while wild-caught imports decreased. Additionally, the proportion of reptiles from countries in their natural ranges decreased. The three regions exporting the most reptiles were Mesoamerica, sub-Saharan Africa, and South America, while the United States accounted for over half of all imports. The overall decline in the commercial trade of live reptiles could be a consequence of many factors, including an increase of in-country captive breeding, reduced demand, or increased legislative controls. The authors argue that the shift away from wild-caught reptiles and importing species from their native range could jeopardize incentive-based conservation. As the exporting of ranched reptiles has drastically increased, we need to work toward a better understanding of the impacts of ranching on wild populations and the future of commercially traded reptiles.

Robinson, J. E., R. A. Griffiths, F. A. V. St. John, and D. L. Roberts. 2015. Dynamics of the global trade in live reptiles: shifting trends in production and consequences for sustainability. Biological Conservation 184:42–50.

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The Fat of the Matter: Regenerated Tails of Juvenile Leopard Geckos

Many lizard species store fat in their tails, and the loss of those fat stores after autotomy could be costly. Maximum caudal autotomy is frequently exhibited in juvenile lizards, with an accelerated rate of tail regrowth at the expense of normal body growth. After maximal autotomy, the regenerated tail lacks fracture planes and becomes a permanent structure, with possibly enhanced storage capacity. These authors test whether the regenerated tail of juvenile Leopard Geckos (*Eublepharis macularius*) is more effective at storing fat than the original tail. Juveniles were split into two groups: original tail and maximum caudal autotomy. Half of each group was then assigned to either a high or low diet regime. After 14 weeks, tail mass and volume, and cross-sectional areas of subcutaneous and inner fat, muscle, and skeletal (including cartilage) portions were calculated for 24 individuals. The authors predicted that, when accounting for body size, regenerated tails would be heavier (within a dietary regime) and contain more fat (regardless of dietary regime) than original tails. They also predicted that within a diet regime, regenerated tails would have a larger cumulative cross-sectional area relative to tail length than original tails. Lastly, they predicted that the skeletal and muscle components relative to body size of regenerated tails should not be different from original tails, regardless of dietary regime. Each of the first three predictions were supported, with regenerated tails being heavier, with greater cross-sectional area and more subcutaneous fat than original tails. In these analyses, there was no significant effect of dietary regime. Additionally, regenerated tails from individuals on a high dietary regime had more inner fat than all other groups. Regenerated tails had greater cross-sectional areas for all tissue types, not supporting the fourth prediction. Greater areas of muscle and skeletal tissue in regenerated tails may be an associated effect of the more massive, larger tails, or could be a secondary effect of the increased fat storage. The rapid tail regeneration in juvenile leopard geckos, preferentially allocating resources away from normal body growth and toward the tail, supports the occurrence of a trade-off. Juveniles deploy the whole tail, forsaking the ability for future autotomy for greater resource reserves. In contrast, adults autotomize a smaller portion of their tails, and the resultant regenerated tail is smaller in mass and volume than the original. The effects of the altered, regenerated tail form in juveniles on locomotion, reproductive success, and survival still require investigation.

Russell, A. P., S. E. Lynn, G. L. Powell, and A. Cottle. The regenerated tail of juvenile leopard geckos (Gekkota: Eublepharidae: *Eublepharis macularius*) preferentially stores more fat than the original. Zoology (*in press*) doi:10.1016/j.zool.2014.12.003

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Testing the Bogert Effect in *Sceloporus*

Understanding how species adapt to climate change is critical for obvious reasons. Although behavioral thermoregulation might allow species to adapt to rising temperatures, it might also reduce genetic variation underlying physiological thermal tolerance. This hypothesis, dubbed the "Bogert effect" (for Charles Bogert), has been difficult to demonstrate in natural systems. The authors of this paper set out to assess thermal niche conservatism across the *Sceloporus undulatus* complex (Phrynosomatidae), a group of small lizard species distributed across much of the US. The authors first measured three metrics of thermal tolerance (thermal preference, critical minimum, and critical maximum) in the laboratory for eight populations, and gathered field-estimated thermal preference data from the literature. If these thermal tolerances are conserved despite considerable variation in local thermal environment, the authors contend this is evidence in support of the Bogert effect. The authors then generated four hypothetical strategies ranging from full thermoconformer to full thermoregulator, and using climate and thermal tolerance data, they estimated variation in mean thermal tolerances for the four strategies across the distribution of the complex. Finally, they evaluated how the lizards will fare in the face of predicted climate change, assuming their thermal physiology remains conserved. With one exception, the thermal tolerances estimated for these lizards were remarkably consistent, and observed variation was not consistent with climate variation. The one exception was a population from Texas, which had higher empirical thermal limits; this was also reflected in the authors' analyses, which determined that the region was too hot for populations to persist if the lizards were thermoregulators with strict thermal niche conservatism. Further, the extrapolation of expected thermal tolerance showed full thermoregulators could persist across the distribution of the complex with the same tolerances (allowing for conservation of tolerances) while scenarios with various degrees of thermoconformation could not. The predictions of how these populations will fare with projected climate change indicated populations exhibiting strict thermoregulation and conserved thermal tolerances will persist to a point, after which thermal tolerance evolution is necessary. This study shows that for these lizards, thermal niche evolution will be necessary to persist in the face of climate change; however, the buffering effect of thermoregulation may leave the populations with insufficient standing genetic variation for this to be possible.

Buckley, L. B., J. C. Ehrenberger, and M. J. Angilletta, Jr. 2015. Thermoregulatory behaviour limits local adaptation of thermal niches and confers sensitivity to climate change. Functional Ecology (*in press*) doi: 10.1111/1365-2435.12406

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LETTERS TO THE EDITOR

WCH: Developing a Global Communication Network for Herpetologists

The World Congress of Herpetology (WCH) is an international organization whose primary goal is "**to promote international interest, collaboration and co-operation in herpetology.**" To date this has been achieved by successfully hosting seven world congresses in locations around the world (Fig. 1). The 8th WCH will be hosted in Hangzhou, China and will complete the location of these meetings in all zoogeographic regions of the world.

In addition to providing this important role, we are now inviting herpetologists around the world to join an exciting new WCH initiative to develop a global communication network for herpetologists. The objective is to provide a global framework linking individual herpetologists, with local, national, and regional herpetological societies around the world, using an integrated email, www sites, and social media networks.

The WCH Global Communication Network for Herpetologists has been initiated to provide a rapid form of communication among herpetologists around the world, linking students, professors, and professional herpetological organizations through the World Congress of Herpetology (Fig. 2).

Affiliated organizations form an important role within the WCH constitution (Fig. 3) and can facilitate opportunities to connect individual herpetologists around the globe. To promote regional participation in WCH activities, affiliated organizations are encouraged to nominate a member to represent their organization and region on the WCH International Herpetological Committee.

The global WCH communication network will disseminate information about:

- Local and national herpetology labs, and organizations, located within each region;
- Local, national, regional, and WCH conferences and workshops in herpetology;
- Studentships, scholarships, and volunteer opportunities for students in herpetology;
- Career opportunities such as postgraduate scholarships, postdoctoral positions, jobs for herpetologists;
- Research activities that have an international perspectives and global participation.

The WCH communication network will engage with affiliated individuals and organizations using all opportunities available.

JEAN-MARC HERO
Secretary General for the World Congress of Herpetology
Environmental Futures Research Institute, School of Environment, Griffith University, Australia; e-mail: m.hero@griffith.edu.au

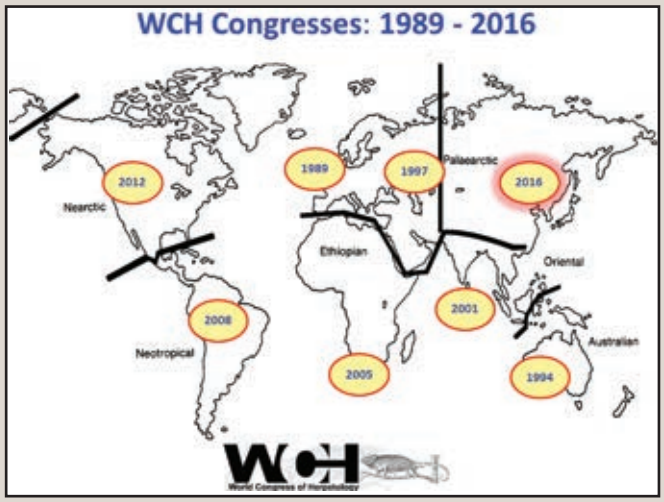


FIG. 1. Years and regional locations of the WCH congresses hosted between 1989 and 2012. The 8th WCH will be held in Hangzhou, China during 15–21 August in 2016.

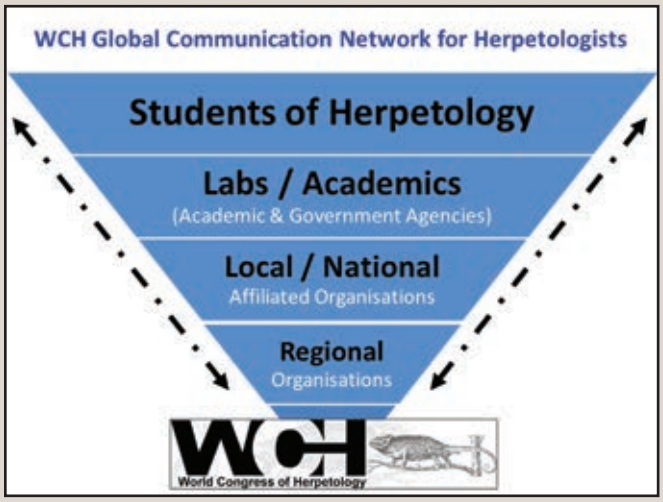


FIG. 2. A conceptual model for developing the WCH Global Communication Network for herpetologists. Individuals can link directly via Facebook and other social media, and organizations can share web pages and e-mail list servers.

Current media include:

1. Active links between websites, including both organizations and individual labs organized within regions, via an interactive global map on the WCH website (WCH URL: http://www.worldcongressofherpetology.org/);
2. Reciprocal sharing of logos on our respective websites;
3. Linking Facebook pages via the WCH Facebook page; (https://www.facebook.com/pages/World-Congress-of-Herpetology/141951465828807).
4. Actively disseminate information using social media networks (e.g., WCH Twitter hashtag: #WCHerpetol);
5. Provide email notifications to individual herpetologists around the world, distributing through individual, local, and regional email list-servers.

In my role as WCH Secretary General, I would like to personally invite individuals and organizations to join this network, and where possible, encourage your local organization to become "Affiliated" with the World Congress of Herpetology.

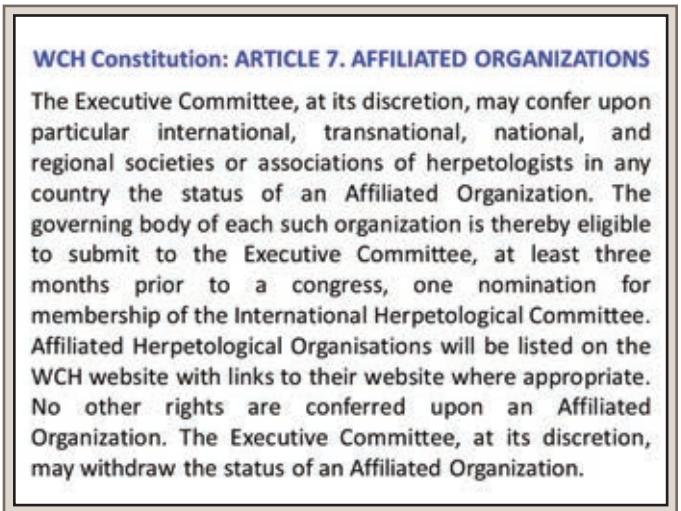


FIG. 3. An extract from the WCH constitution outlining the role of "Affiliated Organizations."



FIG. 4. First advertisement for the 8th World Congress of Herpetology to be held in Hangzhou, China during 15–21 August 2016.

If your organization joins this exciting new initiative, I would also invite your organization to appoint a "WCH Representative" to provide an active link between WCH and your organization. The primary role of the nominated WCH Representative would be to share and pass on information from your society membership to the WCH and vice-versa (through a regional hub). The WCH Representative will be a direct link for communication and will mediate the flow of information to the broader community, and ensure that only relevant professional information is transmitted in either direction. The WCH Representative would organise and nominate regional candidates for other WCH initiatives such as the "WCH awards in Herpetology," and the "WCH Hall of Fame." WCH Representatives are encouraged to nominate for positions on the WCH committees, and attend WCH meetings (Fig. 4).

Please consider this invitation as an inclusive opportunity to internationalize and strengthen herpetology. I look forward to engaging with individuals and organization representatives to develop a WCH communication network linking herpetologists around the world.

FINAL REMINDER !

UNIVERSITY OF KANSAS SSAR MEETING

DATES: THURSDAY, JULY 30 – MONDAY, AUGUST 3, 2015

co-sponsored by Partners in Amphibian and Reptile Conservation (PARC)

together with the herpetological societies of Kansas, Missouri, and Arkansas, the Center for North American Herpetology, *and the* International Society for the History and Bibliography of Herpetology

• For registration and full conference details, visit SSAR2015.ku.edu •

RECEPTION FOR DISTINGUISHED SENIOR HERPETOLOGISTS

At the 1996 SSAR meeting at KU, a special reception that honored Roger Conant, Henry S. Fitch, and Hobart M. Smith allowed students to meet and converse with these giants of our field. We are expanding this highly popular event for the 2015 meeting to enable all participants to meet and honor a distinguished group of today's seniors. The following have confirmed or indicated that they hope to attend:

Bayard Brattstrom
William Duellman
Harold Dundee
Richard Etheridge
Itzchak Gilboa
Harold Heatwole
Victor Hutchison
Alan Leviton
Janis Roze
Jay Savage
David Wake
Kenneth Williams
John Wright

SSAR SYMPOSIA



BONES, FROGS, AND EVOLUTION

Organized by David Blackburn, Anne Maglia, and David Cannatella

•



FRONTIERS IN INTEGRATIVE ORGANISMAL BIOLOGY: HERPETOLOGICAL HORIZONS

Organized by Rich Glor and Rafe Brown

SSAR WILL HOLD ITS 2015 MEETING ON the beautiful and centrally located campus of the University of Kansas in Lawrence. All scientific sessions will be held in the Kansas Union, which is adjacent to the KU Biodiversity Institute and Natural History Museum, the setting of more than a century of research and graduate education in herpetology. The intimate setting will facilitate friendly interactions while lowering fees for registration and lodging.

This unique campus-based meeting will include oral and poster presentations, silent and live auctions, vendor displays, student social, symposia (see left column), and special lectures (see right column).

Conference activity highlights include:

- Redesigned audiovisual shows arranged by David Dennis and Eric Juterbock.
- Reception honoring distinguished senior herpetologists, allowing students to interact personally with luminaries in our field. (see names at left)
- Herpetological Quiz, arranged by the graduate students at the University of Texas at Arlington and KU. Separate student and professional categories, with prizes to the winners.
- Guided tours of herpetological collections and newly renovated laboratories in the Biodiversity Institute.
- Tours of the Fitch Reservation at the KU Biological Fieldstation and Reserves, led by George Pisani.
- Special presentations for the International Society for the History and Bibliography of Herpetology, featuring author Sally Haines of the KU Spencer Research Library.
- Display of live Kansas herps with photographic set-ups.

NOTICE ABOUT PICNIC: Dinner on the final day of the meeting is an outdoor picnic. When registering, keep in mind that *picnic tickets must be purchased before arrival at KU* because final numbers have to be confirmed a week in advance of the event.

FEATURED SPEAKERS

KEYNOTE LECTURER



David Hillis
University of Texas at Austin
Evolutionary Insights from Studying Amphibians and Reptiles

PLENARY LECTURE



Harry Greene
Cornell University
The Life and Times of a KU Herpetological Icon: Henry Fitch and 70 Years of Snake Ecology

PRESIDENTIAL LECTURER



Miguel Vences
Technical University of Braunschweig (Germany)
Inventory of an Imperiled Paradise: Two Decades of Herpetology in Madagascar

PARC SPECIAL SPEAKER



Tyrone Hayes
University of California at Berkeley
From Silent Spring to Silent Night: A Tale of Toads and Men

New Herpetological Circular from the Society for the Study of Amphibians and Reptiles
Herpetological Circular 42





HERPETOLOGICAL COLLECTING AND COLLECTIONS MANAGEMENT
THIRD EDITION
BY
JOHN E. SIMMONS

This is the 3rd edition of this popular herp circular. John Simmons has greatly expanded the information on the history of collections, laws and permits needed for collecting in the US and Internationally. The Collection Management section covers the most up to date techniques for preparing, curating, and storing specimens and associated data.

Appendices provide extensive checklists for herpetological collecting trips, equipment suppliers for specialty field and collection materials, and agency contact information.

June 2015 ISBN 978-0-916984-90-8 191 pp.

HC 42 Prepublication (SSAR members only)			
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We are looking for photographic images to appear on future covers of *HR*. To be considered, preferred images should have the following qualities:

- Should be technically superior photographs (e.g., composition, lighting, etc., should be excellent; subject must be in focus).
- Should be taken in vertical format, or, if in landscape format, permit cropping to achieve a vertical orientation (2550 × 3300 ppi).
- Should be based on film or digital media; if the latter, the native resolution must be sufficiently high to permit cropping and/or enlargement to print publication quality.
- Preference will be given to images that depict poorly known species. These could include recently described taxa or species for which a color illustration has never been published.
- Preference will be given to images that communicate some aspect of the biology of the organism (e.g., predation, feeding, courtship, crypsis).
- Images should not have been published previously nor concurrently submitted for publication elsewhere (print or electronic media).

Images for consideration should be submitted as low-resolution jpg or pdf files. Do not send full resolution images unless requested to do so. All submissions or questions should be directed to the Editor (herpreview@gmail.com).

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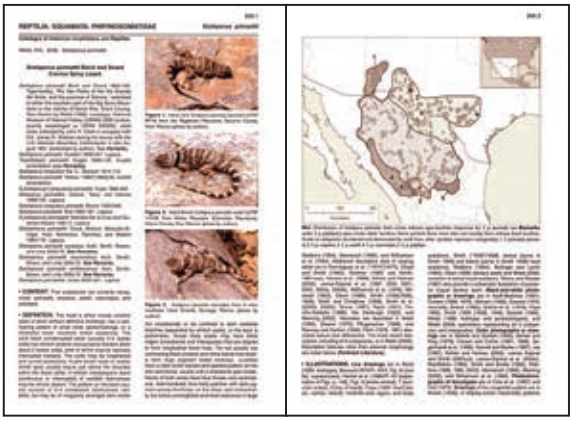
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The *Catalogue* consists of individual accounts of species and genera prepared by specialists, including synonymy, definition, distribution map, and comprehensive list of literature for each taxon. The accounts cover amphibians and reptiles of the entire Western Hemisphere. As of 2014, SSAR is making all CAAR accounts OPEN ACCESS as a service to the herpetological community. To access individual accounts, visit http://www.ssarcaar.com.



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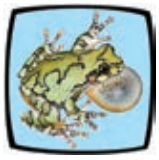
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All members of the SSAR are entitled to vote by mail ballot for Society officers, which allows overseas members to participate in determining the Society's activities; also, many international members attend the annual meetings and serve on editorial boards and committees.

All members and institutions receive the Society's primary technical publication, the *Journal of Herpetology*, and its bulletin, *Herpetological Review*; both are published four times per year. Members also receive pre-publication discounts on other Society publications, which are advertised in *Herpetological Review*.

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A "Trilling" Case of Mistaken Identity: Call Playbacks and Mitochondrial DNA Identify Chorus Frogs in Southern Québec (Canada) as *Pseudacris maculata* and Not *P. triseriata*

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Cryptic species are often difficult to study and recognize, especially when little morphological criteria are available to help distinguish between closely related species. Although congeners may be very similar in appearance, combining genetic analyses with differences in mating calls and breeding phenology may allow for new distinct species to be recognized and properly identified (Newman et al. 2012). Frogs within the genus *Pseudacris* are a good example of this. The Boreal Chorus Frog (*Pseudacris maculata*) and the Western Chorus Frog (*P. triseriata*) are two North American species that are extremely similar in size and coloration, which has created taxonomic confusion in the past (Platz 1989; Klaus and Lougheed 2013). To distinguish the two species, the ratio of the tibia length to the snout-to-vent length (SVL) has been used as a criterion of discrimination. *Pseudacris triseriata* has a slightly larger ratio of 42.6, whereas *P. maculata* has a ratio of roughly 39.3 (Smith 1956). With the two species so similar in size and shape however, tibia/SVL ratios could overlap and lead to species misidentification. An alternate identification criterion often used in the field is the playback of each species' display call during the breeding season. Although each species' song may initially sound very similar, *P. maculata* has been found to have a longer call with a lower pulse rate, whereas *P. triseriata*'s call is much shorter and has double the pulse rate (Platz 1989).

The first studies that delineated the range limits of *P. maculata* and *P. triseriata* were largely based on the morphometric measures of the tibia/SVL ratio, and did not include any song playback analyses (Smith and Smith 1952; Smith 1956). These studies determined *P. maculata*'s range to extend in latitude from the central US into Canada, and in longitude from the Rocky Mountains to northwestern Ontario. *Pseudacris triseriata*'s range included Ontario's extreme southern end, southwestern Québec, and several US states surrounding the Great Lakes (Smith and Smith 1952; Smith 1956) (Fig. 1A). However, recent studies based on species identification through breeding call and molecular-based analyses indicate that *P. maculata*'s range may extend further east than once believed, and raises some important questions about the true range of both species (Fortin et al. 2003; Lemmon et al. 2007a; Ouellet et al. 2009). Furthermore, although contact zones between the two species have not yet been identified, Lemmon et al. (2007b) determined that range overlap is highly likely to occur in southeastern Ontario, and stressed the importance of considering this geographic area when conducting *Pseudacris* biodiversity studies.

Initial range delineation studies did not extend *P. maculata*'s range into southern Ontario nor into Québec. The two species were believed to be allopatric until *P. maculata* populations were identified through song analysis along northern Québec's James Bay area (Fortin et al. 2003; Ouellet et al. 2009). Lemmon et al.'s (2007a) phylogenetic analysis of North American *Pseudacris* species using two mtDNA genes (12S and 16S), also proposed a new distribution of *Pseudacris* tree frogs in the United States and southern Ontario (Canada). According to this study, the distribution of *P. triseriata* would be limited to the United States and to Ontario's extreme southern end, but *P. maculata* would have a larger distribution in southeastern Canada (Fig. 1B). This recent molecular work raises questions as to whether previous range map studies using tibial bone measures may have misidentified *P. maculata* for *P. triseriata* in eastern Canada.

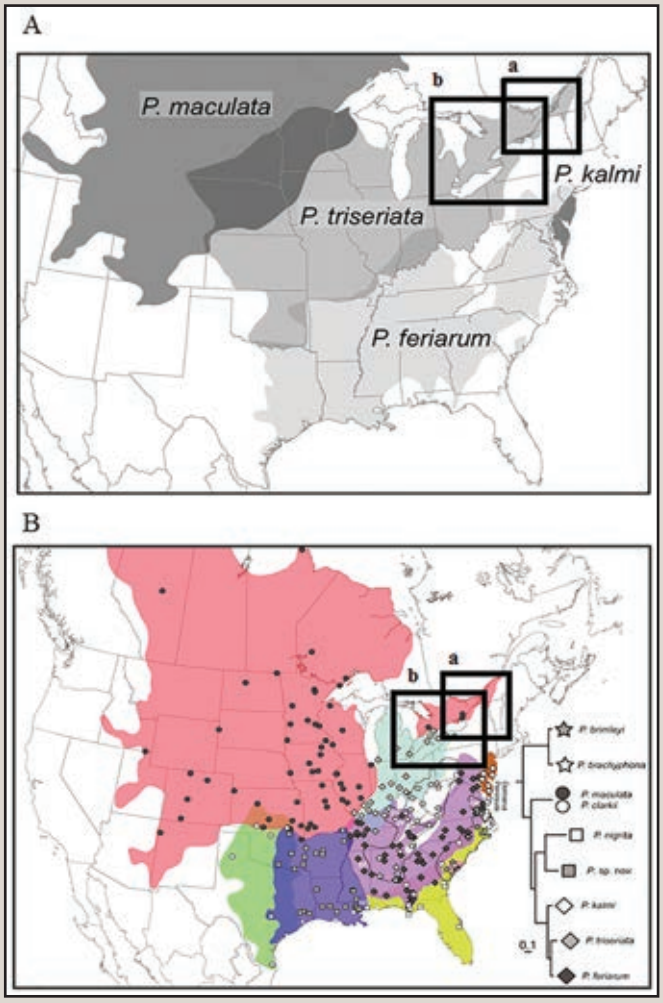


FIG. 1. A) Original *Pseudacris* range maps delineated by Smith and Smith (1952) and Smith (1956) predominantly using tibia/snout-to-vent length ratios. B) New phylogeny-based range delineation suggested by Lemmon et al. (2007a) using mitochondrial DNA. Source of maps: Lemmon et al. (2007a). Reproduced with permission by the copyright owner. Areas labeled as "a" and "b" delineate the location of our study sites within Québec and Ontario, respectively.

In light of Lemmon et al.'s (2007a) work, NatureServe (2014) now identifies chorus frog populations in eastern Canada to be composed of *P. maculata* instead of *P. triseriata*, but thorough revisions of the two species' range boundaries are necessary, especially considering the rapid decline of chorus frogs in Québec and Ontario (Seburn et al. 2008).

As of March 2000, the Québec government classified what was always believed to be *P. triseriata* frog populations as Vulnerable. A recovery plan and several habitat conservation plans have since been created and partially implemented to help conserve remnant populations (Équipe de rétablissement de la rainette faux-grillon de l'ouest 2000; Angers et al. 2007, 2008a, 2008b). Due to the major population declines that have been documented in Québec and Ontario since 2002, the Great Lakes-St. Lawrence-Canadian Shield chorus frog population has been classified as Threatened by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), and is listed in Schedule 1 of the Species at Risk Act (SARA) (COSEWIC 2008). The status of *P. maculata* populations has not yet been evaluated by COSEWIC. They are however, listed as endangered in Vermont (USA) (Ferguson 2013) and critically imperiled in Michigan (NatureServe 2014). Populations have also been found to be declining in New York (USA) (Corser et al. 2012), in Ontario and along James Bay in northern Québec (Desroches et al. 2010).

The objective of this study was to help establish the true eastern distribution of *Pseudacris* chorus frogs by conducting a distance-based clustering analysis of individuals from southeastern Ontario, from along the Québec/Ontario border, and from several sites located in southwestern Québec. Individuals from various parts of the USA were also included in the analysis for comparison purposes. Species identification was further confirmed at each site using a non-genetic method of anuran identification of breeding call playback analysis. Shedding light on the true range of *Pseudacris* in southeastern Canada will help federal and provincial management practices protect the remaining fragile chorus frog populations found at the limit of their distribution, and will help determine the true identity of chorus frogs in southeastern Canada.

METHODS

Sites and sampling.—We sampled various localities within several major regions of Québec and Ontario (Canada). In southern Québec, four sites were sampled in the Outaouais region: two in 2006 near the municipality of Chelsey (U12) and in eastern Gatineau (U3), and two in 2009 in LuskVille (A11) and near Chatham (A12). In southern Québec's Montérégie region, frogs from five sites were collected in the spring of 2007: Boucherville (BOU), Brossard (BRO), Boisé du Tremblay (BT), La Prairie (LP), and Île Perrot (IP). Individuals from four sites in Ontario were also collected in 2009: Almonte (DW), Arnprior (ARN), Lake Opinicon (OP), and Cataraqui Park near Kingston (CA) (Fig. 2). An additional eight sequences of both *P. triseriata* and *P. maculata* individuals were retrieved from GenBank and were included in the dataset for comparison purposes (Table 1).

We played breeding call recordings of both *P. maculata* and *P. triseriata* at each site and noted which species responded. Sites were originally selected by listening to breeding calls from a distance, yet upon arrival at each site, the frogs were disturbed and their calls were silenced. Sitting silently for approximately thirty minutes allowed the frogs to resume their normal activities. We had two different breeding call recordings for each species, stored and played from an Apple iPod touch (©2007 Apple Inc.). The recordings were obtained from the Canadian Amphibian and Reptile Conservation Network, both online (FrogWatch) and on CD (EMAN/RESE). We proceeded to play one *P. triseriata* breeding call recording for three minutes, followed by an additional three minutes of silence used to note whether a response occurred. This was then repeated using the breeding call of *P. maculata*. The entire procedure was subsequently carried out again using the second breeding call recording we had available. To avoid introducing bias, the procedure was immediately repeated playing *P. maculata* recordings first, followed by *P. triseriata* recordings. Additionally, we alternated the order of which species' playback recordings were first played in successive sites. Recordings were played at each site in 2007 and 2009, and were carried out at approximately 1500 h.

A varying number of individuals were caught by hand from each site (N = 19–25); those samples are currently undergoing a population genetics analysis as well (N. Tessier, pers. obs.). For each individual captured, a toe clip was removed with disinfected scissors and stored in 95% ethanol at room temperature. The

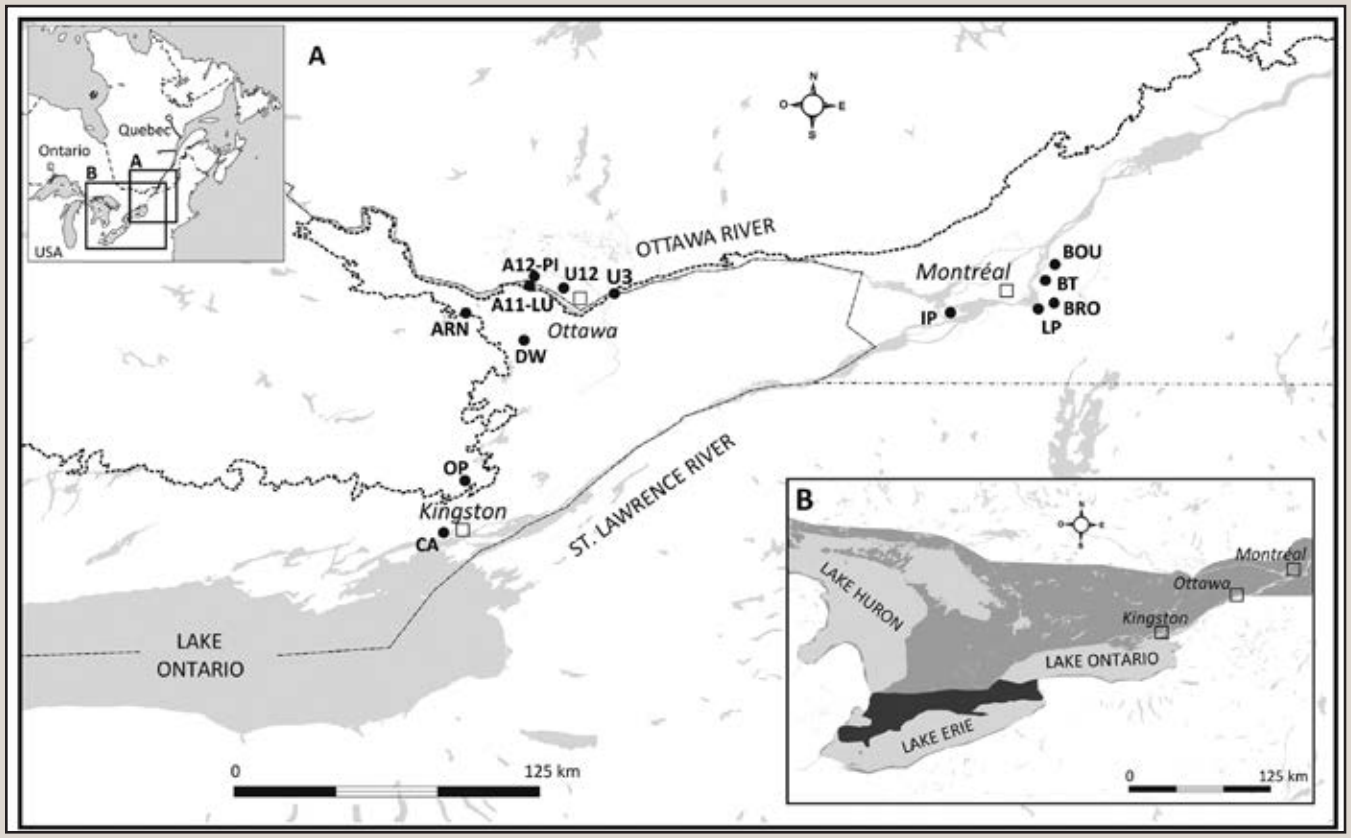


FIG. 2. Geographic location of all chorus frog sampling sites included in this study. In Québec's Outaouais region: Chelsey (U12), Gatineau (U3), LucksVille (A11), and Chawtham (A12). In Québec's Montérégie region: Boucherville (BOU), Brossard (BRO), Boisé du Tremblay (BT), La Prairie (LP), and Île Perrot (IP). Individuals from Ontario: Almonte (DW), Arnprior (ARN), Lake Opinicon (OP), and Cataraqui Park near Kingston (CA). The Carolinian and Great Lakes - St. Lawrence - Canadian Shield faunal provinces are depicted in dark and medium gray, respectively.

TABLE 1. Location and GenBank accession numbers for the 16 reference *Pseudacris* individuals included in this study.

Species	Accession Number	Location	State/Province & Country
Pseudacris maculata	AY291089	McKinley	New Mexico, USA
Pseudacris maculata	AY291090	Douglas	Kansas, USA
Pseudacris maculata	AY291083	Archuleta	Colorado, USA
Pseudacris maculata	AY291082	Lac Seul	Ontario, Canada
Pseudacris maculata	AY291080	Gunnison	Colorado, USA
Pseudacris maculata	EF472135	Christian	Missouri, USA
Pseudacris maculata	EF472122	Jersey	Illinois, USA
Pseudacris maculata	EF472100	Bayfield	Wisconsin, USA
Pseudacris triseriata	AY291091	Berrien	Michigan, USA
Pseudacris triseriata	EF472157	Breckinridge	Kentucky, USA
Pseudacris triseriata	EF472156	Niagara	New York, USA
Pseudacris triseriata	EF472151	Logan	Ohio, USA
Pseudacris triseriata	EF472145	Niagara R.M.	Ontario, Canada
Pseudacris triseriata	EF472139	Daviess	Kentucky, USA
Pseudacris triseriata	EF472138	Perry	Illinois, USA
Pseudacris triseriata	EF472137	Montgomery	Tennessee, USA

scissors were disinfected with ethanol between each individual clipping. All frogs were then immediately released at the exact site of capture and were temporarily monitored to ensure that normal behavior ensued. Subsets of three to four individuals per site were then selected at random and used for further molecular identification.

Molecular analysis.—DNA was extracted using the Invitrogen™ PureLink™ Genomic DNA kit (Version A, February 2007) (Invitrogen™ Inc., Burlington, Canada). To verify the maternal lineage of the chorus frogs in our dataset, a 335-base pair (bp) portion of the 16S mitochondrial gene was sequenced for each individual using the 16S-1F and 16S-4R primers (Johnson et al. 1998). The 16S region is less conserved than the 12S region, thus has greater variability and is usually used for phylogenetic studies at the genus level (Hwang and Kim 1999). PCR amplifications were carried out in 50-mL volumes and included 100–200 ng of genomic template DNA per sample, 1.4X reaction buffer, 2.5 mM of $MgCl_2$, 0.35 mM of each dNTP, 0.22 µM of each primer, 0.5 units of *Taq* DNA polymerase (1 U ≈ 16.67 nkat), and 35.7 µL of sterile H_2O. Thermal cycling was carried out on a GeneAmp® PCR System 9700 (Applied Biosystems) under the following

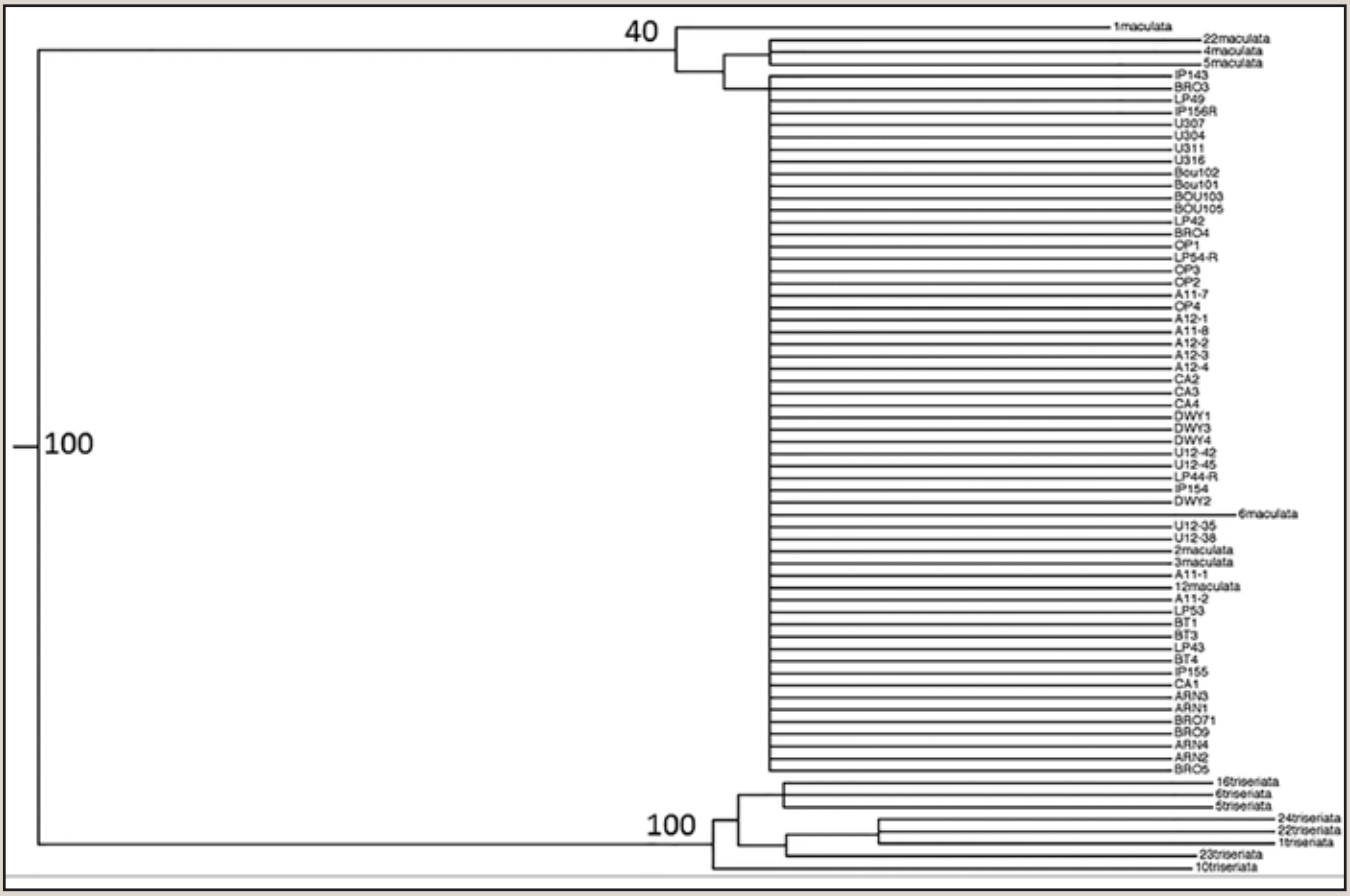


FIG. 3. Neighbor-joining tree constructed from the 335 bp 16S mtDNA gene sequence (strict consensus supported by 1000 bootstrap replicates and distances corrected with a Jukes-Cantor model). All 54 individuals found in Québec and Ontario are grouped with the eight *P. maculata* reference sequences, whereas the eight reference sequences for *P. triseriata* define a distinct group with 100% bootstrap support.

conditions: an initial denaturation of 94°C for 1 minute; 31–38 cycles of 94°C for 45 seconds, 50°C for 1 minute and 45 seconds, and 72°C for 1 minute and 30 seconds; and a final extension step of 72°C for 10 minutes. Amplification success was determined by staining the PCR products with SYBR® Green I nucleic acid gel stain (Invitrogen™ Inc., Burlington, Canada), running them on a 2% agarose gel, and revealing the bands under UV light. All PCR products were sent to the McGill University Génome Québec Innovation Centre for purification and sequencing using an ABI-3730XL DNA Analyzer (Applied Biosystems). Sequences were then visualized with 4PEAKS 1.7.2 (Mekentosj B.V., Aalsmeer, The Netherlands) and aligned with ClustalX (Thompson et al. 1997). All sequences were deposited in the GenBank public repository (accession numbers KM669659-KM669712).

Distance-based clustering analysis and species identification.—Aligned sequences were evaluated with jModel Test 2 v 2.1.5 (Darriba et al. 2012) to compare different DNA substitution models, and the Jukes-Cantor (JC) model (Jukes and Cantor 1969) was determined to be the best fit for our data. Accordingly, a neighbour-joining tree was then estimated from JC-corrected distances with 1000 bootstrap replicates to determine branch support. This tree was then used to determine the identification of the Québec samples with respect to the reference sequences of known identity. All clustering analyses were performed in R (R Development Core Team 2013) using the "ape" package (Paradis et al. 2004).

RESULTS

At every sampled site, chorus frogs responded to the playback recordings of *P. maculata* rather than those of *P. triseriata*. Frogs remained silent after *P. triseriata* recordings were played.

Mitochondrial gene.—The 16 reference sequences (8 *P. maculata* and 8 *P. triseriata* individuals) produced four haplotypes per species, and all Québec (N = 39) and Ontario (N = 15) individuals matched the *P. maculata* 1 haplotype (Table 2). A total of 14 variable sites were used to discriminate the two *Pseudacris* species, and the corresponding neighbor-joining tree is presented in Fig. 3. In this tree, all 54 individuals found in Québec and Ontario were grouped with the eight known *P. maculata* sequences. The eight *P. triseriata* reference sequences produced their own distinct group with 100% bootstrap support, therefore separation between the two species was highly supported.

DISCUSSION

Although the identification of *P. maculata* in Québec has only been observed in recent history, their populations were already established within the province, yet misidentified as *P. triseriata*. A number of studies based on breeding calls have found *P. maculata*'s northeastern range limit to extend 100 km eastward into northwestern Québec (Fortin et al. 2003; Ouellet et al. 2009), and genetic analyses have also confirmed its presence

in southeastern Ontario (Lemmon et al. 2007a). In our present study, 16S mtDNA sequence analysis, as well as chorus frog breeding call inventories in the peri-urban areas of the Greater Montréal and Outaouais regions of Québec, established for the first time that remnant chorus frog populations in southern Québec are actually comprised of *P. maculata* individuals rather than *P. triseriata*.

The aforementioned studies (along with the present one) strongly suggest that tibia/SVL ratios, on which the identification of *P. triseriata* and *P. maculata* individuals were based during the original delineation of their respective ranges, should be reconsidered as a reliable diagnostic criterion for species identification. Tibia/SVL ratios have long been used in taxonomy and systematics, yet little is known in terms of this measure's precision and accuracy. Rogers (2009) found that Boreal Toads required aggressive and awkward handling to take proper tibial and SVL length measurements, but errors in measurement still varied up to 30% within the same individual. He suggested that tibial and SVL measurements should be used to construct rough size indices rather than for precision, and that the gape width measurement method yielded better results. Hayek et al. (2001) also recommend employing anuran morphometrics for rough rather than precise measurements, and to use caution when drawing biological inferences from these data. Climatic conditions may also play a role in intraspecific SVL measurements. *Pseudacris regilla* was found to significantly fluctuate in SVL measurements when exposed to differing weather conditions (e.g., temperature, altitude, and rainfall) (Calhoon and Jameson 1970). With climate change becoming increasingly important to consider in amphibian genotypic/phenotypic studies (Spear et al. 2012), it is a variable that must be taken into account when employing tibia/SVL ratios for species identification purposes.

In the very first studies to delineate *Pseudacris* range limits (Smith and Smith 1952; Smith 1956), all measurements were taken on preserved specimens. However, Bleakney (1959) found that even the most carefully preserved chorus frog specimens will exhibit a body length decrease of 1–3 mm, but whose tibia length will only decrease between 0–1 mm. Furthermore, the initial delineation studies did not incorporate song playback recordings when identifying chorus frogs. Playback methods were first pioneered in the mid-1960s by Capranica (1965; 1966). Breeding call playbacks have shown to successfully identify several different anuran species within the same habitat (Sung et al. 2005; Acevedo and Villanueva-Rivera 2006), however these methods were not as robust for population size and abundance estimates (Corn et al. 2000), even for *P. maculata* (Corn et al. 2011). Call playbacks of a single mating call (rather than a chorus of breeding calls) have proven most efficient in obtaining responses from resident frogs, and allow researchers to easily access a wide range of habitats that otherwise might be physically difficult to work in when using capture methods of identification (Sung et al. 2005). On the other hand, the use of recording devices and speakers may be costly; however, the methods and devices employed in this study proved to be cost-efficient without undermining the effectiveness of the breeding call recordings and responses.

Our findings have several implications for the conservation and research of Canadian *P. maculata* and *P. triseriata* populations. First, they suggest that the Great Lakes-St. Lawrence-Canadian Shield chorus frog population should be renamed a *P. maculata* population. This population was originally named as a *P. triseriata* frog population by the COSEWIC, listed under

TABLE 2. Polymorphic nucleotide positions for the Western Chorus Frog (*Pseudacris triseriata*) compared to its congener species, the Boreal Chorus Frog (*P. maculata*) using the Genbank 16S mtDNA sequences (8 *P. maculata* and 8 *P. triseriata* individuals). The sequences produced four haplotypes per species, but 14 variable sites helped distinguish *P. maculata* from *P. triseriata*. All Québec and Ontario specimens (N = 54) matched the *P. maculata*1 haplotype. Nucleotides identical to the *P. maculata*1 haplotype are indicated with a period (.).

16S Haplotypes	N	17bp	22bp	24bp	74bp	75bp	76bp	77bp	82bp	85bp	97bp	103bp	111bp	118bp	182bp	184bp	186bp	203bp	248bp	292bp	293bp
P. maculata 1	4	G	A	T	T	T	A	T	A	C	G	T	T	C	T	T	G	T	T	C	G
P. maculata 2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	A	.	.	.	.
P. maculata 3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	A	.	.	T	.
P. maculata 4	1	.	.	.	.	.	T	.	.	.	.	.	.	.	.	.	.	.	.	.	.
P. triseriata 1	3	A	.	C	A	C	.	C	T	T	A	A	C	T	C	A	A	C	C	.	.
P. triseriata 1	3	A	G	C	A	C	.	C	T	T	A	A	C	T	C	A	A	C	C	.	.
P. triseriata 1	1	A	G	C	A	C	.	.	T	T	A	A	C	T	C	A	A	C	C	.	.
P. triseriata 1	1	A	G	C	A	C	.	C	T	T	A	A	C	T	C	A	A	C	C	.	A

SARA, and represents an Evolutionary Significant Unit (ESU) for conservation. Considering the scenarios of dispersal routes for *P. maculata* (Lemmon et al. 2007b) and their disjunct population distribution in Canada, the Great Lakes-St. Lawrence-Canadian Shield population may have evolved in isolation, but this assertion requires further investigation. Consequently, this population's status should be re-evaluated separately from that of *P. maculata* populations further west into Canada. Moreover, comparative studies between chorus frogs from Québec and Ontario are needed to determine if locally adapted phenotypic traits (e.g., difference in advertisement call structure), or if differences on a finer genetic scale (e.g., population genetic analyses) have evolved. In their phylogenetic study of the trilling chorus frogs, Lemmon et al. (2007a) found *P. maculata* and *P. clarkii* to show significant differences in morphology and behavior, but were undifferentiated with respect to their mitochondrial DNA. In terms of a fine scale genetic analysis, we are currently employing a population genetics analysis to help determine the level of genetic differentiation and isolation of this important ESU (N. Tessier, pers. obs.).

Although not much is known about *P. maculata*'s overall population stability, individuals located at the edge of their range limits are often found in sub-optimal habitats and experience greater environmental fluctuations, which increases their vulnerability (Gaston 1990; Mott 2010). Therefore, Québec chorus frogs in particular, whose populations have been disappearing and whose situation has become precarious, should be monitored closely. Multiple studies have tracked the rigorous population decline of chorus frogs in the Montérégie and Outaouais regions of Québec, and argued that urgent conservation actions need to be taken to save them from extinction (Bonin and Galois 1996; Picard and Desroches 2004; Angers et al. 2008a, b; COSEWIC 2008; Seburn et al. 2008; Équipe de rétablissement de la rainette faux-grillon de l'ouest 2010). Since the 1950s, Québec has seen a 37% decrease in chorus frog population size every ten years, and the decline is expected to continue (COSEWIC 2008; Équipe de rétablissement de la rainette faux-grillon de l'ouest 2010). Chorus frog population surveys in Ontario indicate a 42.6% decline in abundance over the last decade despite hosting areas where chorus frogs seem relatively abundant (COSEWIC 2008).

The greatest threat to these chorus frog populations is the progressive destruction and modification of their habitat for land use, development, and urbanization—an endless process primarily driven by economic and population growth (Trauger et al. 2003). Currently, less than 10% of viable chorus frog habitats are located in federally or provincially protected parks and refuges, leaving most populations vulnerable to the increased anthropogenic pressures (Environment Canada 2010). The long-term protection of remnant habitats is key for ensuring their continued survival.

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Natural Hybridization of Triploid Normally Parthenogenetic *Aspidoscelis exsanguis* with Gonochoristic *A. inornata* (Squamata: Teiidae) and Identity of an Associated Specimen

Triploid parthenogenetic *Aspidoscelis exsanguis* (Chihuahuan Spotted Whiptail) is an abundant and widely distributed lizard in parts of Arizona, New Mexico, and Texas in the southwestern United States, and Sonora and Chihuahua in northern Mexico (Degenhardt et al. 2005; Dessauer and Cole 1989). It was derived in a two-step hybridization sequence (Table 1) which could have involved either *A. costata* x *A. inornata* → unknown diploid parthenogenetic species then many generations later before extinction x *A. septemvittata* → *A. exsanguis* (see Good and Wright 1984; Moritz et al. 1989) or *A. burti* x *A. inornata* → unknown diploid parthenogenetic species then many generations later before extinction x *A. scalaris* → *A. exsanguis* (see Dessauer and Cole 1989; Moritz et al. 1989).

Only two of the several gonochoristic species with which *A. exsanguis* is syntopic, namely *A. inornata* (Little Striped Whiptail) and *A. sexlineata viridis* (Prairie Racerunner), have been reported to hybridize with this triploid normally parthenogenetic species (Table 1). Walker et al. (2006) reported a tetraploid male of *A. exsanguis* x *A. sexlineata viridis*, based on well-developed reproductive structures, external morphology, and color pattern, from De Baca County, New Mexico, deposited in the University of Arkansas Department of Zoology Collection (UADZ 6241). This report pertains to our study of the only known tetraploid lizard directly verified by a karyotype to have originated as a naturally occurring hybrid of *A. exsanguis* x *A. inornata*, a female deposited in the Harvard Museum of Comparative Zoology (Neaves 1971). It is one of only four genetically confirmed tetraploid hybrids of *Aspidoscelis* reported to date (see Hardy and Cole 1998). In addition to describing the morphology and color pattern of this unique biological novelty (Figs. 1R, 2M) using characters and terminology not considered by Neaves (1971), we compare it with samples of its parental species. We also provide a hypothesis to account for the aberrant dorsal color pattern of the tetraploid hybrid, resulting from identification of another key specimen (Fig. 1L) deemed problematic by Neaves (1971). Finally, the results of this study could also help detect possible natural independently reproducing tetraploid parthenogenetic lineages (= IRTPL) derived from hybridization between these species as have been generated in the laboratory by Lutes et al. (2011).

Materials and methods.—We examined 19 specimens of *Aspidoscelis* loaned by the Harvard Museum of Comparative Zoology (MCZ) collected from Otero County, western New Mexico, in late August 1967 by W. B. Neaves. We measured the snout vent length (SVL) of each specimen to the nearest mm. For assessment of dorsal color patterns in *A. exsanguis*, *A. inornata*, and the hybrid between the two species (Figs. 1R, 2M), we employed terminology for pale stripes, intervening dark-hued fields, and small light-hued markings recommended by Burt (1931), Duellman and Zweifel (1962), and Walker et al. (2009). On each side of the body of a lizard (ventrolateral to dorsal) were lateral, dorsolateral, and paravertebral stripes with the latter exhibiting uneven margins in most specimens of *A. exsanguis* and being straight-edged in most *A. inornata*. With the exception of two six-striped lizards (i.e., each one lacking a vertebral stripe), specimens of *A. inornata* examined from Alamogordo in the MCZ collection either had a partial or a complete seventh stripe, the vertebral, between the paravertebrals (Fig. 2L). A vertebral stripe was not present in any of the *A. exsanguis*, which is typically six-striped (Fig. 2R). The fields on each side of the body in both species were identified as lower lateral (ventral to the lateral stripe), upper lateral (dorsal to the lateral stripe), dorsolateral (dorsal to the dorsolateral stripe) and vertebral (dorsal to the paravertebral stripe). The paravertebral stripes separately extended onto the base of the tail in *A. exsanguis*, but merged into a single stripe on the base of the tail in *A. inornata*



FIG. 1. An aberrantly patterned preserved male of *Aspidoscelis inornata* (MCZ R-100080; 53 mm SVL) is shown on the left; a tetraploid hybrid female of *A. exsanguis* x *A. inornata* (MCZ R-101991; SVL 68 mm) is shown on the right. Both specimens were collected from Alamogordo, Otero County, New Mexico, by W. B. Neaves, and recently photographed in the MCZ by Jon Woodward.

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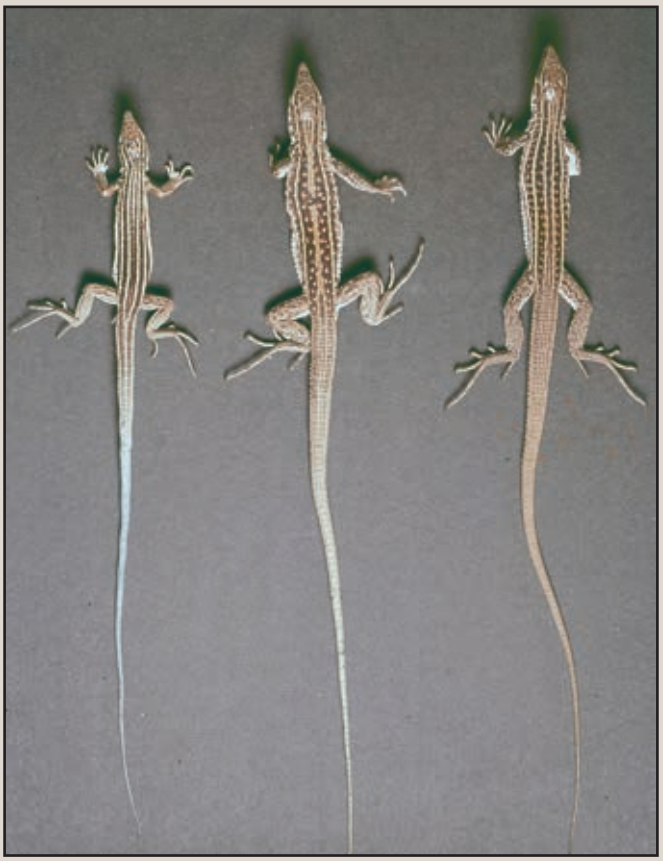


FIG. 2. A karyotyped tetraploid hybrid *Aspidoscelis exsanguis* x *A. inornata* (MCZ R-101991) is shown between its parental species, *A. inornata* (L) and *A. exsanguis* (R). Unlike *A. exsanguis*, the hybrid has larger and more distinct spots, evidence of separate paravertebral stripes only near the head and near the tail and joined in between, and had an intense blue coloration on the tail and ventral surfaces. Males of *A. inornata* typically also have vivid blue on these surfaces, no spots, joined paravertebral stripes only on the base of the tail, and typically a complete or partial vertebral stripe as shown. Females of *A. exsanguis* typically have six-stripes, unevenly margined paravertebral stripes, no vertebral stripe, and smaller spots than the hybrid. A version of this photograph and a description appeared in Neaves (1971).

(Figs. 1L, 2L). Whereas all *A. exsanguis* had a spotted dorsum, all *A. inornata* were unspotted (Figs. 1L, 2L).

Terminology and data for meristic characters examined, based on Duellman and Zweifel (1962), Manning et al. (2005), and Walker et al. (2009), in the hybrid, newly identified problematic specimen, and comparative material of *A. exsanguis* and *A. inornata* from Otero County are included in Table 2. The different numbers of observations for some characters resulted from previous damage to certain MCZ specimens. The qualitative scutellation characters examined in all specimens included size of the postantebrachial scales on the posterior aspect of each forearm, size of the mesoptychial scales along the edge of the gular fold (i.e., abruptly enlarged or not), and anterior extent of the circumorbital scale series on both sides of the head (see Duellman and Zweifel 1962). Statistical analyses of meristic variables (Table 2) in *A. exsanguis* and *A. inornata* were performed using JMP software (Version 11; SAS Institute, Inc., Cary, North Carolina, 2012) to generate a mean ± 1 SE, range of variation for each character, and determine statistical significance starting at $P = 0.05$

Results.—Walker and Lemos-Espinal (2015, *in press*) described four stages in the complex ontogenetic development of the dorsal color pattern in triploid *A. exsanguis*, with stage four in adults consisting of low contrast between either stripes or their fragments and fields, a profusion of spots on the stripes and in the fields, and spotted hind limbs. In the only known genetically confirmed, naturally occurring, tetraploid hybrid (4n = 92) of *A. exsanguis* x *A. inornata* (MCZ R-101991), the striped and spotted dorsal pattern resembled stage four of *A. exsanguis*, but it had been attained at a much smaller than usual body size (68 mm SVL) than described in that species. Moreover, it stood apart from the typical stage four dorsal patterns of *A. exsanguis* in that the elements of the pattern were not low contrast and the paravertebral stripes were consistently separated by a narrow dark-hued vertebral field only at each end of the body (Figs. 1R, 2M). This phenotypic trait of the hybrid, which was one of the characters that provided the basis for Neaves (1971) inferring its hybrid origin even before karyotypic analysis, bears a strong resemblance to the specimen of *A. inornata* (MCZ R-100080) with reference to the pattern of dorsal stripes in Fig. 1L. Another feature of the hybrid noted by Neaves (1971) was the intense blue coloration on the tail and ventral surfaces, which occurs in adult males of *A. inornata*, but not in adult females of either it or *A. exsanguis*.

The hybrid had enlarged and plate-like postantebrachial scales on the forearms, abruptly enlarged mesoptychial scales along the edge of the gular fold, and circumorbital scale series on each side of the head that extended anteriorly to the midpoints of the third supraocular scales. These characters unambiguously aligned MCZ R-101991with maternal parent *A. exsanguis*, albeit with an unusual color pattern. Use of a standard suite of meristic variables in MCZ R-101991 (see Manning et al. 2005; Walker et al. 2009) for comparisons with the samples of *A. exsanguis* and *A. inornata* revealed that data could not be obtained for the PV and PV/GAB because of a lack of separation of the paravertebral stripes at midbody (Figs. 1R, 2M; Table 2). The analyses also revealed that the GAB and COS counts for the hybrid were within the overlap in ranges of variation in these characters in both parental species. The OR count was positioned between the ranges of variation in the parental forms (Table 2). The SDL count for the hybrid exceeded the ranges of variation for both parental forms, and the FP and LSG counts for the hybrid was within the range of variation of only *A. exsanguis* (Table 2). Finally, the ILS count was below the ranges of variation in both parental species.

Neaves (1971) could not resolve the identity of specimen MCZ R-100080, collected from a syntopic association of *A. inornata* and *A. exsanguis* in Alamagordo, because of its unusual dorsal color pattern (Fig. 1L) and rudimentary reproductive organs. In actuality, it is a male of 53 mm SVL with very small testes. The postantebrachial scales on the forearms were granular in size, the mesoptychial scales along the edge of the gular fold were not uniformly abruptly enlarged, and the circumorbital scale series on each side of the head extended anteriorly only to the midpoints of the third supraocular scales. These characters identified MCZ R-100080 as a male of *A. inornata*, albeit with an unusual color pattern. With reference to striping pattern in *A. inornata*, the MCZ sample of eight specimens examined from Alamogordo (including the unusual male) comprised six specimens with seven stripes (i.e., six primary stripes plus either a complete vertebral or nearly so), one with six stripes (i.e., lacking a vertebral), and MCZ R-100080 with aberrantly joined paravertebrals except where separated intermittently and at each end of the body (Fig. 1L).

TABLE 1. Possible modes of origin proposed for the triploid parthenogenetic species *Aspidoscelis exsanguis*, and its hybrids with gonochoristic species.

Authors	Progenitors of Parthenospecies and Parents of Hybrid Combinations
Good and Wright (1984)	*A. costata* x *A. inornata* → 2n parthenospecies (then generations later) x *A. septemvittata* → *A. exsanguis*
Dessauer and Cole (1989)	*A. burti* x *A. inornata* → 2n parthenospecies (then generations later) x *A. scalaris* → *A. exsanguis*
Neaves (1971)	*A. exsanguis* x *A. inornata* → natural 4n ♀ hybrid (N = 1)
Lutes et al. (2011)	*A. exsanguis* x *A. inornata* → laboratory self-sustaining 4n parthenospecies
Walker et al. (2006)	*A. exsanguis* x *A. sexlineata* → natural 4n ♂ hybrid (N = 1)

TABLE 2. Summary of data for meristic characters and SVL for a sample of *Aspidoscelis inornata*, unusually patterned *A. inornata* (MCZ R-100080), tetraploid hybrid *A. exsanguis* x *A. inornata* (MCZ R-101991), and sample of *A. exsanguis* from Alamogordo, Otero County, New Mexico, collected by W. B. Neaves. Data for the two species are mean ± SE (first row) and range of variation and (N) (second row); included for each individual specimen is either a single datum for analyzable characters or ND for no data possible. Means ± SE followed by the same superscripted letters are not significantly different at $P = 0.05$.

Meristic Character	*A. inornata*	100080	101991	*A. exsanguis*
GAB: scales around midbody from one lateral row of ventral scales to opposite row of laterals	63.1 ± 0.67^{B} 61–66 (8)	64	66	69.0 ± 1.02^{A} 65–74 (10)
OR: dorsal granules from the occipital scales to the first row of caudal scales	159.3 ± 2.17^{B} 153–163 (4)	153	170	182.0 ± 1.76^{A} 178–187 (5)
PV: dorsal granules between the paravertebral stripes at midbody	7.8 ± 0.92^{A} 2–10 (8)	2	ND	4.7 ± 0.21^{B} 4–6 (10)
FP: femoral pores summed from both sides of body	31.2 ± 0.79^{B} 28–34 (6)	31	38	35.3 ± 0.24^{A} 33–38 (10)
SDL: subdigital lamellae of the fourth toe of the left pes	29.4 ± 0.92^{B} 28–32 (8)	29	34	30.9 ± 0.23^{A} 30–32 (10)
COS: circumorbital scales, summed from both sides of body	9.5 ± 0.67^{A} 8–12 (6)	12	10	8.9 ± 0.39^{A} 7–11 (9)
LSG: lateral supraocular granules, summed from both sides of body	27.0 ± 1.52^{B} 16–27 (8)	27	30	29.1 ± 0.84^{A} 25–32 (9)
ILS: interlabial scales, summed from both sides of body	26.4 ± 0.70^{A} 21–34 (7)	24	13	17.7 ± 0.60^{B} 15–21 (9)
SVL: snout to vent length	53.5 ± 1.89 45–61 (8)	53	68	67.6 ± 1.20 62–76 (10)

None of these specimens had spots in the dark-hued fields, lack of which is a consistent distinguishing character in *A. inornata* throughout its geographic range (Walker et al. 2009). Data for all meristic characters in the specimen, except the OR (Table 2), either were within the ranges of variation of both species (LSG) or were in the range for *A. inornata*, but within one to three scales of the lower or upper range limits of variation in *A. exsanguis* (i.e., GAB, PV, FP, SDL, COS, ILS). Nevertheless, the meristic alignment of MCZ R-100080 with *A. inornata* was indicated, and would not be unusual for range-wide samples of that species (Walker et al. 2012). In the case of the OR, this datum for the specimen marks the lower range limits for the sample of *A. inornata*, and was 25 scales below the lower range limit for *A. exsanguis* (Table 2); however, we have obvserved much lower OR counts in range-wide samples of *A. inornata*.

Discussion.—Arguably, the tetraploid karyotype confirming the hybrid origin of MCZ R-101991 via *A. exsanguis* x *A. inornata* in Alamogordo, Otero County, western New Mexico (Neaves 1971) provided the evidence for it to become the most consequential voucher in the history of herpetology. Fortunately, the combination of aberrant dorsal and unusual ventral color patterns in live-captured MCZ R-101991, compared to the typical patterns of each of the parental species, drew attention to the significance of the lizard (Neaves 1971). After studying his Fig.

1 and examining the specimen, we initially hypothesized that the unusual dorsal and ventral color patterns were phenotypic consequences of hybrid-derived tetraploidy per se. However, further analysis indicated that it is more likely that the unusual pattern of MCZ R-101991 resulted from a mating between a normally patterned *A. exsanguis* (Fig. 2R) and an aberrantly patterned *A. inornata* as represented by MCZ R-100080 (Fig. 1L). According to W. B. Neaves (pers. comm.), all of the F_1 hybrids generated by the whiptail lizard research group at Stowers Institute for Medical Research, Kansas City (see Lutes et al. 2011; Fig. 1 A and B), in the quest to synthesize hybrid-derived IRTPL have been parented by mothers (*A. exsanguis*; Fig. 2R) and fathers (*A. inornata*; Fig. 2L) with normal color patterns (also see Lutes et al. 2011; Fig 1A). This has resulted in both male and female F_1 hybrids, none of which possessed joined paravertebral stripes as seen in hybrid MCZ R-101991 (Fig. 2-M). Thus, should the potential for production of an *A. exsanguis* x *A. inornata* tetraploid parthenogenetic species be realized in nature, its discovery should not be expected to be based on aberrantly patterned lizards such as MCZ R-101991. Rather, its recognition would be triggered by subtle rather than striking color pattern distinctions from *A. exsanguis* (e.g., Lutes et al. 2011; Fig. A and B). Based on this study, we predict that it will be found that naturally occurring, as well as laboratory synthesized species of this hybrid combination, will closely resemble the maternal progenitor in color pattern (i.e., in having six faint stripes, profuse spotting, and muted contrast between these components and the ground colors). Moreover, we predict that the tetraploid species, as is also true of MCZ R-101991, will not be diagnostically different in either scutellation or meristic characters.

The unique significance of MCZ R-101991 to evolutionary biology is that it was foundational to the laboratory experiments leading to the laboratory synthesis of the first reported IRTPL. Based on the observation of Neaves (1971) that the hybrid female had oviposited putatively fertile eggs during captivity, Lutes et al. (2011), guided by W. B. Neaves some 40 years later, chose to pursue a course of experimentation using the same parental species that produced the possibly fertile lizard reported in 1971 ostensibly to synthesize one or more IRTPL. Indeed, they stunned the scientific community, and none more than us, with the report of the synthesis of three IRTPL descended from three tetraploid hybrids from the same clutch produced by one laboratory hybrid of *A. exsanguis* x *A. inornata* (Lutes et al. 2011). This achievement is all the more remarkable in light of the report of Cole et al. (2010) that they had no success in synthesizing either a triploid or a tertaploid hybrid-derived IRTPL in 29 years of experimentation using a variety of species.

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Appendix 1

Specimens of *Aspidoscelis exsanguis, A. inornata,* and a hybrid female from the Harvard Museum of Comparative Zoology (MCZ) examined in support of this study.

USA: New Mexico: Otero County: weedy area ~20 m wide and >100 m in length between a city park and railroad tracks in Alamogordo, ~32.89944°N, 105.93972°W in late August 1967. *Aspidoscelis exsanguis* (MCZ R-100096 to R-100105, N = 10). *A. inornata* (MCZ R-100081 to R-100083, R-100085, R-100424, R-100425, R-114854, N = 7). Genetically confirmed tetraploid (4n = 92) hybrid of *A. exsanguis* x *A. inornata* (MCZ R-101991, N = 1). Previously unidentified specimen herein assigned to *A. inornata* (MCZ R-100080, N = 1).

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Preliminary Nocturnal Road Survey of Snakes in Northeastern Swaziland: Effects of Agriculture on Relative Abundance

Although the global biodiversity crisis has garnered much conservation attention for some vertebrate groups (e.g., mammals, birds, amphibians), declines of squamate reptiles are evident, but relatively poorly known (Gibbons et al. 2000; but see Sinervo et al. 2010). Population declines may be particularly prevalent in snakes (Reading et al. 2010); however, owing partly to their reclusive nature, studies documenting demographic patterns or shifts in community composition are relatively few (Dorcas and Willson 2009).

Here we report a preliminary survey documenting differences in snake assemblages between subtropical savanna (protected areas) and agricultural (sugarcane plantations) habitats in the Lowveld along a road transect in northeastern Swaziland (Fig. 1). In Swaziland, communal and protected lands occur as a fragmented matrix embedded within agricultural lands. Sugarcane production accounts for 59% of Swaziland's agricultural output, and the total area devoted to sugarcane monoculture has increased steadily over the past fifty years (Knox et al. 2010; USDA 2013). Habitat degradation is likely the primary contributor to snake declines (Dodd 1987), but the specific effects of sugarcane plantations on snake assemblages are poorly understood. Swaziland is densely populated, and is under increasing pressure to convert natural habitats to agriculture. As this conversion continues, information regarding its impacts on snake assemblages will be needed to inform management strategies for threatened species, such as the Southern African Rock Python (*Python natalensis*).

Materials and methods.—Our study area was located in the northeastern Lowveld region of Swaziland (Fig. 1). The Lowveld is characterized by subtropical climate, with annual rainfall of 550–725 mm, and a mean summer temperature of 26°C (Monadjem and Garcelon 2005). Our efforts were concentrated in the Hlane-Mlawula-Mbuluzi reserve network, the system of protected areas in Swaziland (Monadjem and Reside 2008). The reserve network is primarily savanna and dominant tree species include *Acacia nigrescens*, *A. tortilis*, *Dichrostachys cinerea*, *Ficus sycomorus*, and *Ziziphus mucronata* (Monadjem 2005). Characteristic grasses are *Cenchrus ciliaris*, *Digitaria eriantha*, *Panicum maximum*, *Themeda triandra*, and *Urochloa mossambicensis* (Boycott et al. 2007).

We designed a road transect for sampling snakes such that each complete round-trip circuit included equal distances in both protected areas and sugarcane plantations (Fig. 2). In total, our transect route included a 66-km stretch of MR3 with a portion of MR24 and an eight-km extension road, all of which is paved. Highway MR3 is a two lane highway that runs west–east from South Africa to Mozambique and has heavy traffic. Along this transect are Mbuluzi Game Reserve, Mlawula Nature Reserve, and Hlane Royal National Park, which constitute protected savanna habitat. MR3 bisects both sugarcane plantations and a game reserve, Hlane Royal National Park. MR24 traverses only sugarcane plantations, and the extension road off of MR3 passes through portions of both Mbuluzi Game Reserve and Mlawula Nature Reserve. Located along the transect are the small towns of Simunye, Maphiveni, Tabankulu, and Mhlume. The Simunye and Mhlume Estates are major sugarcane plantations along the study transect. In addition, the Mbuluzi River flows underneath a portion of MR3 and the Mlawula River flows parallel to the extension road near the Mlawula Nature Reserve.

We surveyed snakes along the road transect on most nights between 2 January and 12 February 2014, during the summer rainy season. The survey route was driven 1–3 times each night, depending on time constraints and snake activity; importantly, distance traversed in protected and agricultural areas was the same for each survey night. Each night we randomly chose the start direction to avoid biasing the beginning and end times for traversing particular habitats. Surveys were conducted between 1800–0100 h, with an average drive speed of 40 km/h. For each survey, we recorded date, start time, number of round-trip circuits, and end time. For each snake observation, we recorded genus and species, time, GPS coordinates, and condition (alive-on-road [AOR]; dead-on-road [DOR]). Dead snakes were removed from the road to avoid repeated counting, and some of those were preserved as voucher specimens (museum deposition information pending).

We compared relative abundances of snakes (all species combined) between savanna and sugarcane plantations by



FIG. 1. Aerial image of northeastern Swaziland showing the survey transect outlined in red. Sections of natural habitat are outlined in green; all other sections of transect are in agricultural habitat.

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FIG. 2. Photographs of natural habitat (Lowveld bush; A) and homogenous agricultural habitat (sugarcane plantations; B) from along the survey transect.

calculating the number of snakes encountered per kilometer, a common metric used in snake road-survey studies (e.g., Mendelson and Jennings 1992; Sullivan 2000). We tested whether relative frequencies of individuals encountered at the family level (Pythonidae, Atractaspididae, Colubridae, Elapidae, and Viperidae; Table 1) were independent between habitat types using Pearson's chi-square test. We pooled observations into families rather than species because of overall low sample sizes across individual species. We included diurnal species in the analysis because we had no *a priori* reason to assume a bias between habitat types and we had no way to determine time of death for DOR snakes (i.e., diurnal species may be active at night depending on weather conditions).

Results and discussion.—We sampled 33 nights over a 42-day period, covering a total distance of 3234 km (1617 km in each habitat). Over the duration of the study, we observed 85 snakes representing 20 species and five families (collectively, 0.026 snakes per km). DOR snakes comprised 68% of all snakes observed (DOR = 0.018 snakes per km; AOR = 0.008 snakes per km); however, the proportion of DOR snakes is inflated by individuals of diurnal species found after sundown. Of all species encountered during surveys, only six were found in both habitats. The most frequently observed species, *Python natalensis*, was observed exclusively in protected areas, and made up 33% of all snakes encountered.

Snakes were encountered 3.5 times more frequently in protected areas than in agricultural habitats based on number of snakes observed per km (0.039 snakes per km for savanna, 0.011 snakes per km for sugarcane). Furthermore, snake assemblages, based on relative abundances of individuals recorded for each family, differed between protected and agricultural habitats (χ^2 = 22.625, d.f. = 4, P = 0.002). Differences in snake assemblages were driven largely by the dominance of pythons in protected areas and the higher than expected frequency of elapids in agricultural habitats. Observed and expected frequencies for each of the remaining families (Colubridae, Viperidae, and Atractaspididae) were similar between habitats.

Although roads may contribute to high levels of snake mortality (e.g., Rosen and Lowe 1994), they have also proven to be effective tools for surveying snake populations at regional scales (Mendelson and Jennings 1992; Sullivan 2000; Jones et al. 2011; McDonald 2012). In northeastern Swaziland, we found snake species richness to be similar between protected and agricultural areas (14 species in savanna vs. 12 species in sugarcane), but relative abundance overall was much higher in protected areas (Table 1). Taken together, our results were driven primarily by the dominance of pythons in the dataset, and their clear affinity for protected areas over agricultural areas. It is likely that pythons do not dominate the snake assemblage numerically, but are more visible on roads, and may remain on roads longer than other snakes. We attribute the high relative abundance of rock pythons in protected habitats to their specific requirements for refugia and nesting sites, which include large underground burrows

TABLE 1. Total number of snake observations in sugarcane and savanna habitats within the study area, northeastern Swaziland, from 2 January to 12 February 2014. Brackets indicate number of DOR snakes.

Family	Species	Sugarcane	Savanna
Pythonidae	*Python natalensis*		28[22]
Atractaspididae	*Amblyodipsas polylepis*		1
	Atractaspis bibronii		1[1]
Colubridae	*Crotaphopeltis hotamboeia*	3[1]	5[2]
	Dasypeltis scabra	1	4[1]
	Dipsadoboa aulica	2[2]	3[2]
	Lamprophis capensis		8[4]
	Lycodonomorphus rufulus	2[2]	
	Lycophidion capense		1
	Mehelya capensis	1	
	Philothamnus hoplogaster	1[1]	
	Philothamnus semivariegatus	1[1]	
	Prosymna sundevallii		3
	Psammophis mossambicus	1[1]	
	Telescopus semiannulatus		3[3]
	Thelotornis capensis	1[1]	6[6]
Elapidae	*Dendroaspis polylepis*	3[3]	
	Naja mossambica	2[2]	1[1]
Viperidae	*Bitis arietans*	1[1]	1[1]
	Causus defilippii		1[1]
Total		19[15]	66[44]

and cavities in termite mounds. These microhabitat features are largely absent from sugarcane plantations. Furthermore, sugarcane is harvested by first burning and then cutting to ground level, and it is unlikely that these large constrictors would survive this activity.

Our analysis at the family level indicated that the Elapidae (cobras and mambas) may be the only group of snakes that was relatively more abundant in sugarcane plantations (albeit sample size was small). These active, largely diurnal predators may maintain core home ranges in edge or more natural habitats while moving extensively through sugarcane plantations (see Phelps 2002). Alternatively, elapids may use available microhabitats in sugarcane more effectively than do other snakes, and may attain high densities due to competitive release from other species that are adversely affected by agricultural practices. Elapids are generalist predators that frequently take rodent prey, and agricultural areas in Swaziland sustain rodent densities equal to those in more natural habitats (Hurst et al. 2014), and may simultaneously harbor fewer predators of snakes. However, more extensive surveys will be needed to confirm the validity and generality of this potential trend in relative abundance.

Despite the many biases inherent in road-cruising studies and our low survey sample size (e.g., some species may use roads more frequently than others, some species may be more visible on roadways, activity times and microhabitats differ across species; see Sullivan 2012), our data suggest that agricultural habitats, and sugarcane monoculture in particular, have a negative impact on snake assemblages. Our preliminary study adds to previous research showing declines in squamate species associated with habitat alteration in southern Africa (e.g., Branch 1998; Meik et al. 2002; Gardner et al. 2007; Trimble and Aarde 2014) and provides additional evidence that anthropogenic habitat degradation may threaten snake populations globally (Dodd 1987; Dorcas and Willson 2009). In addition, we note that 22 out of 28 pythons encountered were DOR, indicating that automobile traffic may be a significant source of mortality for pythons. These snakes are large and slow-moving, and apparently use roads to thermoregulate. Population viability of snakes related to road mortality is a conservation concern that has been largely neglected (Rosen and Lowe 1994; Dorcas and Willson 2009) and may benefit from increased focus in southern Africa.

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Reptile Use of Trails in the Phoenix Mountain Parks

Urbanization can be a source of habitat removal and degradation threatening some species of herpetofauna (Gibbons et al. 2000; Wolf et al. 2013). Species richness for amphibians and reptiles often declines in areas of high urbanization from loss of suitable habitat (McKinney 2008). However, within urban areas where natural habitats are preserved or protected, herpetofauna often persist (Hamer and McDonnell 2012). The ability to monitor impacts from human interactions on these protected areas can be essential for effective management (Goode et al. 1995).

Protected areas juxtaposed with urban areas can be popular for outdoor recreation and offer many social benefits to city residents. However, outdoor recreation such as hiking, mountain biking, and horseback riding can have both direct and indirect effects on wildlife and their habitats. For example, trail use can directly affect small animals by trampling or by disturbing refuges or breeding sites (Knight and Cole 1995). Indirect effects can alter habitat by compacting soils, introducing weeds, causing erosion, reducing vegetation or ground cover, or cause behavioral responses in wildlife by eliciting a flight response (Cole and Landres 1995). To ensure viable populations and communities, a better understanding of these recreational disturbances on wildlife is crucial.

Studying relationships between reptile abundance and diversity with recreational trails can benefit park managers by providing data on how trail usage and habitat characteristics may affect herpetofauna communities. We compared the reptile community and their habitats along multiuse trails and at off-trail sites. Our research objectives were to investigate how reptile abundance and diversity and habitat characteristics varied in relation to trails. We predicted that locations further away from trails would contain greater reptile abundance and diversity due to less human interaction and habitat modification.

Methods.—For our study, we chose McDowell (33.6952°N, 111.7348°W) and Usery (33.4791°N, 111.6191°W) Mountain Regional Parks, located in the Phoenix Metropolitan Area, Arizona, USA. These parks offer a model system to evaluate the effects of recreational trail use on reptile species. The two parks offer miles of multiuse trails for recreational activities, represent a large variety of plants and animals, and are surrounded by urban development within the Upper Sonoran Desert.

We performed surveys at each park along different trail conditions (high-use and low-use) and types (trail and off-trail). To select high-use and low-use trails, we consulted with park managers to identify trails that were popular with recreationalists and other trails with relatively low visitation rates. In each park, we established 40, 10 m × 20 m plots (N = 80). Of the 40 plots, 10 were high-use plots, 10 were low-use plots, and 20 were off-trail plots. The location of the first plot along trails was randomly selected and subsequent plots placed every 150 m. We placed off-trail plots 150 m perpendicular to trail plots and side was determined randomly. We took care to make sure no off-trail transect interested with other recreation trails within a park and were > 150 m from any other trail.

We quantified reptile abundance and diversity using visual encounter survey methods (McDiarmid et al. 2011). Two trained observers surveyed each plot once in July and once in August 2013 during morning hours (0600–1100 h) when reptiles are most commonly active (Brennan and Holycross 2009). Surveys were area-constrained and we exhaustively searched each plot under suitable debris, logs, and rocks while disturbing vegetation. We recorded all reptile observations by age class (hatchling or adult), location, and species.

Using similar methods to Banville and Bateman (2012), we measured habitat characteristics for each of the 80 plots (Table 1). We quantified percent ground cover (i.e., bare ground, cryptobiotic crust, litter, and woody debris), vegetation cover (i.e., cactus, shrub, succulent, and tree), and burrow density at 10 square-meter intervals. The measured intervals consisted of 10 alternating square-meter sub-plots along a randomly chosen 20 m length of the plot. Using point-intercept methods, we quantified proportion of cacti, shrubs, succulents, trees, and woody debris (> 1 cm in diameter). We measured, at randomly selected quarter-plot intervals (5 m × 10 m), percent cover of boulder, cobble, gravel, and sand, and at randomly selected half-plot intervals (5 m × 20 m) we counted perennial plant species.

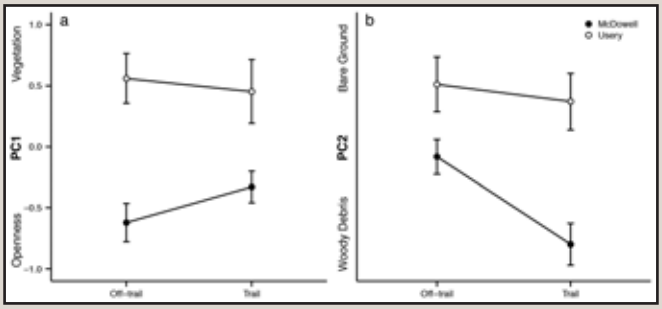


FIG. 1. Principle component factor values (PC1, PC2) depicting differences among park habitats in the Phoenix valley in central Arizona. PC1 values (a) are represented by the absence and presence of vegetation; cacti, shrubs, trees. PC2 values (b) are represented by the presence of woody debris and bare ground.

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TABLE 1. Mean (± SE) of habitat variables along with principal components analysis factor correlation during summer 2013 at McDowell Mountain Park and Usery Mountain Park, central Arizona, USA.

	McDowell Mountain Park		Usery Mountain Park		
Variable	Off-trail (N = 20)	Trail (N = 20)	Off-trail (N = 20)	Trail (N = 20)	Component (correlation)
Bare ground (%)	76.0 ± 3.1	62.5 ± 3.6	65.0 ± 4.4	68.5 ± 3.7	2 (+)
Biotic crust (%)	0.4 ± 0.1	0.2 ± 0.1	1.0 ± 0.2	0.7 ± 0.1	5 (–)
Boulder (%)	–	–	3.5 ± 1.3	2.0 ± 1.0	1 (+)
Cobble (%)	0.7 ± 0.2	0.6 ± 0.1	8.8 ± 3.8	7.0 ± 2.6	2 (+)
Gravel (%)	78.3 ± 2.4	64.4 ± 4.1	77.9 ± 3.0	61.3 ± 5.7	3 (+)
Litter cover (%)	23.0 ± 3.0	36.0 ± 3.6	33.5 ± 4.1	31.0 ± 3.7	2 (–)
Sand (%)	18.2 ± 3.1	31.0 ± 3.4	8.1 ± 2.0	19.8 ± 2.8	4 (–)
Vegetation (%)	18.0 ± 2.4	12.1 ± 2.1	25.9 ± 2.8	27.2 ± 3.2	1 (+)
Number of burrows	0.2 ± 0.0	0.1 ± 0.0	0.3 ± 0.1	0.3 ± 0.1	3 (+)
Number of woody debris	0.2 ± 0.0	2.0 ± 0.5	0.1 ± 0.0	0.8 ± 0.3	2 (–)
Proportion of cacti, succulents	–	–	0.1 ± 0.0	–	1 (+)
Proportion of shrubs	0.2 ± 0.0	0.2 ± 0.0	0.3 ± 0.0	0.3 ± 0.1	1 (+)
Proportion of trees	0.1 ± 0.0	0.1 ± 0.0	0.1 ± 0.0	0.1 ± 0	4 (+)
Vegetation species richness	4.7 ± 0.4	5.0 ± 0.5	7.1 ± 0.3	7.0 ± 0.6	1 (+)

TABLE 2. Presence of lizards as predicted by habitat characteristics (component, PC) from logistic regression in mountain parks from central Arizona. *Callisaurus draconoides* was negatively associated with PC2 (high amount of bare ground, lacking litter and woody debris) and found around areas containing woody debris.

Species	Correlation (+–)	Component	Statistic	Significance (accuracy)
Aspidoscelis tigris	NA	NA	$\chi^2 = 1.271$	P = 0.260 (53.8%)
Callisaurus draconoides	–	PC2	$\chi^2 = 11.203$	P = 0.004 (80.0%)
Uta stansburiana	NA	NA	$\chi^2 = 1.413$	P = 0.234 (75.0%)

We defined abundance as the greatest number of individuals per age class of each species detected during both surveys in each plot. We compared reptile abundance between parks using the Mann-Whitney U test and quantified reptile diversity using the Shannon index. We used Principle Component Analysis (PCA) to reduce habitat variables and summarize variation within plots. To determine differences in habitat, we used a two-way ANOVA to compare scores derived from the PCA between parks and trail type. To evaluate species-habitat relationships, we used logistic regression to correlate species' occurrences with derived PCA component scores. All analyses were conducted using SPSS Statistics (IBM Corp. version 22.0).

Results.—We recorded a total of 205 reptile observations consisting of 10 species with a Shannon's diversity index of 1.144. Species recorded at both parks include *Aspidoscelis tigris* (Tiger Whiptail), *Callisaurus draconoides* (Zebra-tailed Lizard), *Sceloporus magister* (Desert Spiny Lizard), and *Uta stansburiana* (Common Side-blotched Lizard). Species recorded only at McDowell Mountain Park include *Coleonyx variegatus* (Western Banded Gecko) and *Gambelia wislizenii* (Long-nosed Leopard Lizard). Species recorded only at Usery Mountain Park include *Cophosaurus texanus* (Greater Earless Lizard), *Crotalus atrox* (Western Diamond-backed Rattlesnake), *Masticophis flagellum* (Coachwhip), and *Urosaurus ornatus* (Ornate Tree Lizard). *Uta stansburiana* was the most common species at both parks, followed by *A. tigris*, and *C. draconoides* (58%, 23%, and 9% of abundance, respectively). We found *C. draconoides* (U = 666, P = 0.069) and *U. stansburiana* (U = 636, P = 0.102) in marginally greater abundances at trail locations compared with off-trail. However, overall reptile abundance was similar between parks (U = 678, P = 0.231), trail condition (U = 175, P = 0.490), and trail type (U = 763, P = 0.716); therefore, data were pooled for species-habitat analyses.

From the 14 habitat variables (Table 1), we identified five principle components that explained over 70% of the variation (eigenvalues > 1; PCA) in habitat among plots. Plots with high PC1 scores had high vegetation cover, proportions of cacti, shrubs, succulents, and a richness of vegetation species; plots with high PC2 scores had bare ground and lacked litter and woody debris; plots with high PC3 scores had gravel and a high density of burrows; plots with high PC4 scores had a high proportion of trees; and plots with high PC5 scores had few areas with cryptobiotic crust. PC1 values differed between parks ($F_{(1, 76)} = 26.771$, $P < 0.001$), were similar on and off trail ($F_{(1, 76)} = 0.104$, $P = 0.748$), and had no significant park x trail interaction ($F_{(1, 76)} = 0.762$, $P = 0.386$). Usery Mountain Park had greater amounts of vegetation than McDowell Mountain Park (Fig. 1a). PC2 values differed between parks ($F_{(1, 76)} = 20.240$, $P < 0.001$) and between on and off-trail ($F_{(1, 76)} = 4.809$, $P = 0.031$), but had no significant park x trail interaction ($F_{(1, 76)} = 2.178$, $P = 0.144$). McDowell Mountain Park had greater amounts of woody debris than Usery Mountain Park, with most woody debris located along trails (Fig. 1b). PC3

values differed on and off-trail ($F_{(1, 76)}$ = 7.106, P = 0.009), with greater densities of burrows found off-trail.

Only the three most common species, representing 90% of abundance, were included in species-habitat analyses. Of the three species of lizards used in analyses, only *C. draconoides* had conclusive results. This species of lizard was negatively associated with PC2 (areas with high amount of bare ground, lacking litter and woody debris, Table 2).

Discussion.—Overall, we found that lizards did not avoid trails and some species may prefer areas with trails. For example, *C. draconoides* are known to occur in broad, sandy washes (Brennan and Holycross 2009), and this openness is imitated by the desert park trails. We observed twice as many *C. draconoides* at McDowell Mountain Park predominantly along trails where woody debris had been placed by managers. Lining trails with fallen trees and cacti was employed by park management to encourage users to stay on-trail. Modification of trails using woody debris may have contributed to habitat structure used by some lizard species. For example, we observed that *U. stansburiana* used the woody debris as perches. However, further study is needed to determine if reptiles utilizing trails are exposed to greater risks.

Some of the differences in habitat characteristic between the parks can be explained by a wildfire that burned McDowell Mountain Park in July 1995. Caused by lightning, this fire burned a large part of McDowell Mountain Park leaving areas void of large trees and cactus. This lower vegetation cover had no significant effects on reptile abundance and diversity between parks. However, the fire may be the source of woody debris that was placed along trails to keep recreationalists from going off-trail at McDowell Mountain Park (R. Hubbell, pers. comm. 2013); whereas, no woody debris was placed near trails at Usery Mountain Park.

Continuing to allow recreationalist an opportunity to enjoy county regional parks while protecting wildlife is a primary goal for park management (Taylor and Knight 2003). Our investigation of how reptiles respond to park trails allows greater insight for park managers. The research can contribute to effective management decisions for current and future parks. To support the conservation of wildlife and county regional park systems, we encourage further investigations of trails and possible impacts to biodiversity.

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TECHNIQUES

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Using Digital Photographs and Pattern Recognition to Identify Individual Boreal Toads (*Anaxyrus boreas boreas*)

Individual identification of animals can provide an array of useful capture-mark-recapture information, allowing researchers to estimate survival, movement, abundance, recruitment, and capture probability (Williams et al. 2002). This information can yield valuable insight to field investigators regarding a species' life history (Davis and Ovaska 2001; Phillott et al. 2007). Techniques used to identify individuals of many species have been developed and refined to gather this information. Toe clipping, PIT tagging, polymers and pigments, branding, and pattern mapping are all viable techniques for identifying individuals of many amphibian species (Donnelly et al. 1994; Davis and Ovaska 2001).

In addition to its potential utility in field investigations, individual identification is often important in captive populations. Knowing the identity of individuals allows accurate documentation of animal origin and breeding history, providing essential information when selecting individuals to breed in order to maintain a healthy, genetically diverse population. These goals are the impetus for the keeping of studbooks for a number of imperiled and critically endangered amphibian species. Individual identification capability may also facilitate the separation of brood stocks without the need to apply other marks.

Choosing the technique that best suits the species of interest as well as satisfying the questions at hand is important when determining how to identify individuals (Osbourn et al. 2011). In order to use pattern recognition as a capture-mark-recapture technique, the pattern on the animal should be distinguishable, remain stable, and be unique to the individual (Osbourn et al. 2011). These characteristics must be examined in any species for which pattern recognition is evaluated as a method. When not all of these pattern characteristics are present, false identifications may result (Kenyon et al. 2009). However, patterns that are unique and stable constitute the ideal mark because they cannot be lost, and concerns over deleterious marking effects that could affect results are minimized (Beausoleil et al. 2004).

In the past, pattern mapping has been a time consuming, demanding technique because an investigator had to either sketch the pattern of the specimen or wait to develop film (Donnelly et al. 1994; Plăiaşu et al. 2005), accompanied by the uncertainty over the quality of photographs taken. Recently, the affordability and quality of digital cameras have made pattern mapping more feasible. The ability to take, assess the quality, and retake a photograph while the specimen is still available makes pattern mapping and digital photography a suitable option (Bradfield 2004). Furthermore, digital photographs are less intrusive than PIT tagging or toe clipping; there are no wounds or potential infection sites created when taking a digital photo (Carafa and Biondi 2004; Plăiaşu et al. 2005). These advantages make digital photographs for individual identification appealing, especially when working with a state endangered species such as the Boreal Toad (*Anaxyrus boreas boreas*) in Colorado.

Colorado Parks and Wildlife (CPW) maintains a captive population of approximately 700 Boreal Toads at its Native Aquatic Species Restoration Facility (NASRF) for which unique identifications are necessary. Implanting captive toads with PIT tags seemed a logical choice given apparent high retention rates in wild toads (e.g., Scherer et al. 2008; Muths et al. 2010; Pilliod et al. 2010). However, long-term retention rates of PIT tags in our captive population have been much less than 50%, despite being implanted by the same individual who implanted PIT tags into the toads in the Muths et al. (2010) study (K. B. Rogers, pers. comm.). Hatchery toads were smaller on average than wild adult toads, so size at tagging may have had an effect. Whatever the cause of this excessive tag loss, it was clear that CPW would not be able to rely on PIT tags to identify individuals in this captive population. Toe clipping, although a generally reliable, inexpensive method to identify individuals, was deemed unsuitable for identifying the toads housed at NASRF because of the large number of toe removal combinations that would be required.

To find a more viable and reliable option, we explored phenotypic characteristics of the Boreal Toad. The Boreal Toad's ventral morphology consists of a cream-colored belly, creating a contrasting backdrop to the black markings on the belly. The

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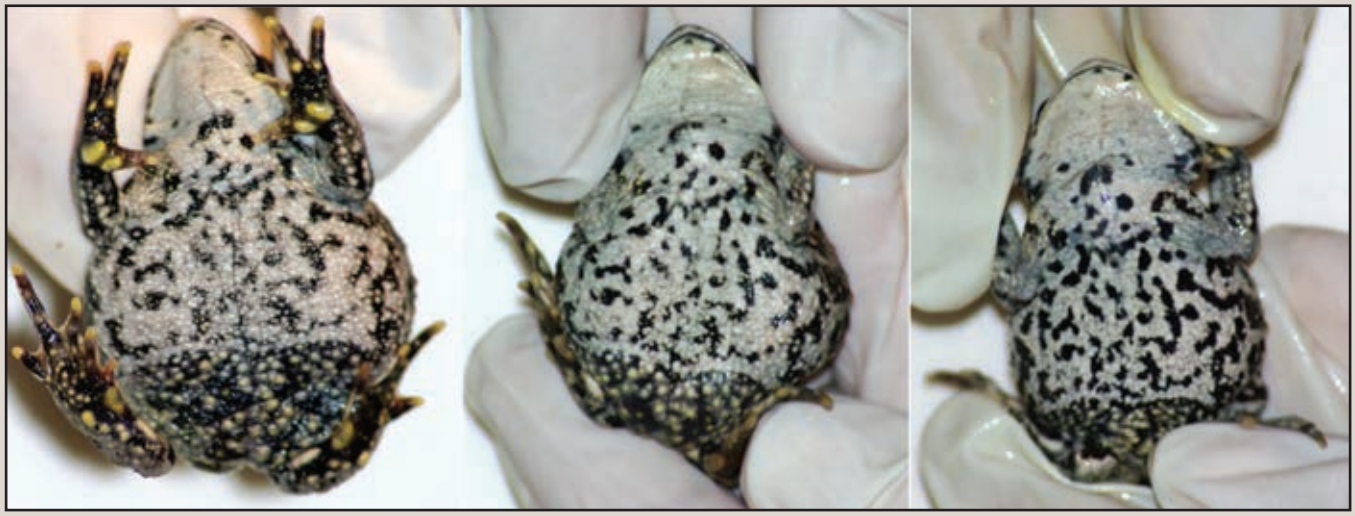


FIG. 1. Three photos taken of the same toad at the Cheyenne Mountain Zoo demonstrate pattern stability over 10 months representing the first year of life, in September 2007 (34 mm SVL, 4.2 g, left, age 2 months post-metamorphosis), February 2008 (44 mm SVL, 8.0 g, middle, age 7 months post-metamorphosis), and July 2008 (47 mm SVL, 9.2 g, right, 12 months post-metamorphosis).

resulting stark contrast makes the Boreal Toad a good candidate for pattern mapping. However, it was unknown if belly patterns remained unchanged as recent metamorphs or yearling toads mature to adults. Our goal was to assess the suitability of belly pattern recognition using photography as an alternative method to identify hatchery brood toads, and to ascertain whether Boreal Toad belly patterns are stable through growth and time.

METHODS

Cheyenne Mountain Zoo.—In August 2007, 38 Boreal Toads originating from a single clutch and aged about 1.5 months post metamorphosis were transferred from NASRF to Cheyenne Mountain Zoo (CMZ) in Colorado Springs, Colorado to assess the uniqueness and stability of the belly patterns as they aged and gained size. There, toads were randomly assigned to one of two rearing tanks (N = 19 each tank). They were photographed, measured (snout–vent length, mm) and weighed (g) initially on September 8 and each toad was assigned a unique identification number that was annotated onto the original digital photographs. These became the reference photographs. All toads were subsequently photographed once each month from October 2007 through February 2008, then in April and July 2008. Eighteen toads in each tank were implanted with PIT tags at the April 2008 photograph occasion, when average weight was 12.1 gm (SE = 0.51). Upon completion of each set of photographs, KZF matched new photographs with the reference set and labeled each of the new photographs accordingly, but maintained the base photograph number as a component of each photograph name. Matches were later evaluated and confirmed by AWN and KGT; thus, three investigators had to agree on each photograph match to be considered a successful match. This series of photographs provided a 10-month window to compare the belly patterns using original photographs against the seven follow-up photograph sets.

We tested whether investigators unfamiliar with the toads could successfully match photographs by asking ten people to match the reference September photos of the toads with one or more of the succeeding sets of photographs. Eight of the ten individuals worked with just one set of succeeding photographs, and two individuals matched reference photographs with two succeeding sets. All seven succeeding sets of photographs were matched against the reference set at least once. These individuals were provided annotated reference photographs, the follow-up candidate photographs they were assigned bearing only the file name generated by the camera, and a data sheet upon which to record candidate photograph numbers next to the individually identified reference photograph numbers. Six of the 10 had no previous toad experience. The individuals were informed what tank the toads belonged in, so we achieved twelve blind photo-matching opportunities on all toads from each tank. AWN and KGT assessed recording sheets for accuracy in identification by checking the base photograph numbers of candidate photos supplied to the ten individuals against the base photograph numbers of the appropriate follow up set of photographs that included individual toad identification.

Native Aquatic Species Restoration Facility.—We initiated the use of belly pattern photographs as the primary method to identify individuals at NASRF in 2007. The toads were housed in tanks and separated into "lots," which usually consisted of 10–15 sibling toads. Over 700 toads ranging from age 1 to age 8, as well as some toads brought in as unknown age adults from the wild prior to the year 2000, were photographed in 2007. In subsequent years the additions to the population were photographed at about age 1, or after their first hibernation. Each toad was assigned a unique ID incorporating its lot number at the time its photograph was taken. The belly pattern photographs were copied to a Powerpoint presentation and arranged by lots with up to six thumbnail photographs per page along with each toad's unique ID added below its photo. The thumbnail pages were printed and laminated to protect and extend the life of the photographs.

The availability of captive toads at NASRF provided the opportunity to further investigate the stability of belly patterns. In 2009 we photographed five lots of yearling toads twice, in March and November. The lots ranged in number from three to 15 toads, and comprised a total of 29 animals. The photographs were then matched between the March and November occasions within each lot to evaluate stability of pattern over eight months during a period of rapid growth. Consensus on general spot pattern and three or more specific match points (e.g., uniquely



FIG. 2. Series of photographs taken at NASRF of two individuals demonstrate pattern stability throughout multiple years of growth. Photographs on the left were taken in September 2009 (average weight 2.5 g, age 13 months post-metamorphosis), middle in March 2010 (average weight 23.8 g, age 19 months post-metamorphosis), and the right in August 2012 (average weight 59.5 g, age 4 years post-metamorphosis).

shaped spots or placement of spots in relations to others) for March and November photographs among three investigators was considered a successful match. We also periodically photographed the bellies of two toads brought into captivity from the wild as they matured from age 1 to age 4, when Boreal Toads generally reach adult size. These animals were housed together, but without other animals, in the display tank at NASRF. At the end of our study the serial photographs of the two display toads were compared both among the photographs taken and with the live toads. Again, consensus on general spot pattern match and three or more specific match points among serial photographs on the part of three investigators was considered a successful match. These trials allowed us to extend observations of belly pattern stability to a longer time period and greater growth difference than we were able to achieve at CMZ.

We also conducted a timed toad identification experiment in 2012 to investigate the efficiency of using belly pattern photographs to ID toads. At NASRF, three separate toad lots were selected for the study; one lot contained 15 animals and the other two lots contained 14 animals each. Each toad lot was assigned to four investigators with varying levels of familiarity using photographs to identify individual toads. The investigators were ranked into three categories: novice, experienced, and expert. "Novice" was defined as having no experience using photographs to ID toads, "experienced" as having used photographs previously for toad ID but not on a regular basis, and "expert" as having used photographs frequently to ID toads, either at NASRF or during field studies in 2009–2012. An investigator compared a toad in hand to the previously described photographs of the lot, which were placed on a counter so that photographs of all toads in the lot were visible at once. As toads were presumptively identified, the investigator placed each into a numbered container corresponding to the last two digits of the unique ID. Once all toads from a lot were identified and in containers, two other investigators verified that the identifications were correct by examining each toad's belly and the photograph it was matched with. Consensus on the general spot pattern and three or more specific match points was considered confirmation of the original identification. Timing commenced when the identifying investigator picked up the first toad and ceased when

the last toad was placed into a container, and did not include the verification procedure. Time to individually identify toads and the accuracy of identifications was compared among categories of investigators using the single factor ANOVA procedure in the statistical software MINITAB (version 14.1, Minitab Inc., 2003).

Results

Cheyenne Mountain Zoo.—Average size of toads on 8 September 2007 was 32.7 mm SVL (SE = 0.36) and 3.5 g (SE = 0.12), the average size of the toads at the end of the study on 17 July 2008 was 52.2 mm SVL (SE = 0.82) and 10.9 g (SE = 0.48). One toad died prior to the April and July photographs. The photographs from each of these months were used once in the matching exercise, so a total of 454 matching opportunities were achieved rather than the 456 possible had all toads survived (12 matching exercises x 38 toads).

Investigators correctly matched 449 photograph pairs in 454 opportunities resulting in 98.9% success. Nine out of the 12 blind tests achieved 100% success matching the reference toad photographs to photographs from one to 10 months later (the final photographs taken, Fig. 1). Three errors were encountered during the study. One experienced investigator transposed two toad identification numbers on the recording sheet, but this was a recording error and not a misidentification resulting from similar patterns. A novice investigator assigned a single follow-up photograph to two different toad reference photographs (one was correct) resulting in misidentification of a single toad. The last error occurred when a novice investigator misidentified a pair of toads. Thus there were three true cases of mistaken identity in 454 opportunities (99.3% success). Clearly, belly patterns are distinguishable even to people who are unfamiliar with Boreal Toads and identification performance may improve with increasing familiarity with the photography system.

The PIT tags implanted in April were poorly retained. By week 9 post-implantation, retention was just 44% in each tank. At the July photography occasion, 13 weeks post-implantation, only four PIT tags remained implanted, with 16.7% retained in one of the toad tanks and 5.6% retained in the other.

Native Aquatic Species Restoration Facility.—Among the five lots of yearling toads photographed twice in 2009, all March photographs were matched successfully to November photographs, and both photograph sets were matched successfully to live toads. In no instance was there disagreement among three investigators over matches. These comparisons were limited to within lots, so there were no opportunities to misidentify toads to different lots.

Over the three-year period using serial photographs of two Boreal Toads held in the display tank at NASRF, the belly patterns of both the subject animals remained stable and identifiable as the toads matured from age 1 to age 4 and increased in mass from 2.5 g average to 59.5 g average (Fig. 2). Even over a three-year period, in no instance was there disagreement between two investigators over the identity of these two toads when assessing general spot pattern as well as multiple specific match points.

Twelve timed ID trials were conducted to identify the toads (three toad lots, with four investigators per lot). Only one investigator (from the category "experienced") failed to achieve 100% correct identification, and all errors occurred within a single lot of toads. One hundred sixty-nine of 172 (98.3%) toad identifications were correct. Single factor ANOVA indicated that investigator experience was not a significant predictor of the time required to sort a lot of toads into individual containers ($F = 1.87$, $df = 2, 9$, $P = 0.209$) or of accuracy in doing so ($F = 1.00$, $df = 2, 9$, $P = 0.405$). Two lots were judged as being easy to identify because of the large, distinct blotches characterizing these animals, whereas the third lot was more difficult to identify because the bellies were characterized more by freckling than distinct blotches. The time required to sort all the toads into individual containers averaged 9.5 minutes (SE = 0.7) for the easy lots and 17.5 minutes (SE = 3.6) for the more difficult lot.

Discussion

Our results supported the use of belly pattern photographs as a viable method to identify individual Boreal Toads. The belly patterns exhibited a high degree of stability, fully sufficient to remain effective for identification over considerable growth and time intervals even when slight changes to pigment density were apparent (e.g., Fig. 2). While we did not use a secondary method of identification in these studies, we found that it was generally easy to reach consensus among investigators when comparing photographs to other photographs or to live toads. Only in rare instances did we have to resort to discussions of specific match points to confirm identifications or to determine a misidentification. The fact that our toads were housed in discrete tanks containing a known number of toads worked to our advantage. There is a possibility that additional error could occur if unknown toads had been introduced to tanks, or if additional photographs of animals not present in the tanks were available. However, staff at NASRF already encounter the latter situation when replacing breeding animals into their assigned tanks after breeding. In such cases the photographs for at least two lots must be used to discriminate the toads and place them where they belong.

Observations of toads over time at CMZ and NASRF strongly suggest there is little likelihood of false identifications of Boreal Toads resulting from changing patterns as observed in other species (Kenyon et al. 2009; Waye 2013). The chance of error is further reduced if the need for individual identification is limited to one or two lots of toads. If false identifications occur, we think it more likely to occur as a result of similar belly patterns. We are aware of just one instance of such a false identification at NASRF, when an animal sent to another institution was identified as a different animal from the same lot (siblings). The mistake was later discovered and corrected. A precaution against such mishaps is the constant participation of a second observer to confirm putative identifications.

Attempts to identify individuals in other amphibian species via pattern recognition work well with species exhibiting distinct blotching that contrast boldly with the body, such as Marbled Salamanders *Ambystoma opacum* (Gamble et al. 2008), Yellow-bellied Toads *Bombina variegata* (Plăiaşu et al. 2005), and Fire Salamanders *Salamandra salamandra* (Carafa and Biondi 2004). Such species compare favorably with the Boreal Toad in pattern distinctiveness and contrast. Among these investigators only Carafa and Biondi (2004) observed changes in pattern over time, and those were slight enough that they did not preclude identification. However, in at least one other boldly marked species, Tiger Salamanders *Ambystoma tigrinum,* marking patterns have been observed to undergo significant changes over time (Waye 2013). We observed no such dramatic changes in the spot patterns of Boreal Toads, despite using many more than the 11 animals observed in the Waye (2013) study. Rather, our

results were more like those of Gollmann and Gollmann (2011), who found that although the patterns of early Yellow-bellied Toad metamorphs changed and solidified with growth, they could still identify individual toads.

The stability of the belly pattern in Boreal Toads over considerable growth is similar to that observed in the Yellow-bellied Toad as well. Plăiaşu et al. (2005) were able to photographically identify individuals that transitioned from subadult to adult stages, with associated weight changes. This stability may provide advantages to those conducting long term studies of Boreal Toad populations by allowing entry of individuals into the marked population at a younger age and smaller size than is presently possible, provided our results could be replicated in field situations when new, previously unknown toads were successfully identified as such. Scherff-Norris et al. (2002) recommended PIT tagging Boreal Toads that weigh a minimum of 10 g, and other investigators have limited PIT tagging to adult-sized Boreal Toads (> 55 mm SVL, Young et al. 2007). Many investigators have not reported minimum sizes tagged, but their primary tagging periods are during and just after breeding seasons so it is likely that tagged toads are predominantly adults (Scherer et al. 2005, 2008; Muths et al. 2006, 2010; Pilliod et al. 2010). In contrast, photographic identification may allow the entry of toads into the marked population as small as 2 g, as in our trial with the two wild-caught toads. This earlier entry into the marked population could be realized even if investigators ultimately wish to use PIT tags on older animals for the benefit of the quicker in-the-field identification.

Another benefit of photographic identification of Boreal Toads would be as an ideal second mark to evaluate the loss of other marks or tags. Despite the widespread and apparently successful use of PIT tags in Boreal Toad field studies, we could find no published evidence of a formal evaluation of PIT tag retention in wild Boreal Toads. That retention is much higher in wild toads than in our captive toads when PIT tags were implanted by skilled individuals is evident, because studies using PIT tags have produced modeled annual apparent survival rates of 0.75 or more (Scherer et al. 2005; Muths et al. 2010; Pilliod et al. 2010). However, Scherer et al. (2005) investigated models that evaluated tagging effects, and indeed tagging effects had support in their data and were included in all top-ranked models. Modeled apparent survival was commonly about 0.20 lower for toads in the first year after tagging than in subsequent years. A follow-up investigation that included a new study area also produced one model ranked among the top three that included a first-year tagging effect for the new study area (Muths et al. 2006). Unfortunately, deleterious effects of tagging that may have caused mortality could not be separated from the effects of potential short-term tag loss in these studies. A second mark allows the separation of tag loss from tagging effects or other factors affecting survival. We believe a study formally evaluating PIT tag retention in Boreal Toads could be achieved by the pairing of PIT tagging with photographic identification.

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Use of an Exemplar Versus Use of a Sample for Calculating Summary Metrics of Morphological Traits in Comparative Studies of *Anolis* Lizards

Comparative morphological analyses of large groups of species are limited by the time needed to perform multiple measurements on several individuals of each studied species. For example, taking complete external morphological data (e.g., Poe 2004) for an individual *Anolis* lizard for phylogenetic analysis takes us approximately 14 minutes. If even five individuals per species are scored for every species in the *Anolis* clade, and we estimate 400 species of *Anolis*, data collection will take over 466 hours. But is it necessary to score lots of specimens to ascertain an informative summary of the population/species? Although more data are nearly always better, researchers must optimize the time spent on data collection relative to the goals of a planned study. If measuring one specimen achieves the same results as measuring (e.g.) five specimens, then measuring one specimen is preferable.

We investigated the efficacy of a time-saving approach for performing comparative morphological analyses of lizard species. In particular, we asked whether use of a single exemplar specimen—the largest male—provides distinguishable results from using means for five conspecific male specimens in some comparative species analyses of traits commonly employed in morphological, ecological, and phylogenetic analyses. We tested for sampling effects related to the number of individuals scored for five commonly used morphological traits and three commonly employed quantitative techniques (e.g., some traits and techniques in Losos et al. 1998; Poe 2004; Latella et al. 2011) in 15 species of *Anolis* lizards.

Five morphological characters for five adult males each of 15 species of *Anolis* lizard were collected using specimens from the Poe Lab and the Museum of Southwestern Biology at the University of New Mexico. The five largest adult males available to us for each species were used without concern for geographic origin. The following characters were collected according to procedures established by Williams et al. (1995) and Poe and Yañez-Miranda (2008): body size measured as snout-vent length (SVL) from tip of snout to anterior edge of cloaca; head length (HL) measured from tip of snout to anterior edge of ear opening; femoral length (FL) measured from the midline of the body laterally to the knee; scales across snout (SNSC) counted between second canthals; and lamellae count on phalanges ii and iii of the fourth toe of the hind foot (see above cited papers for more detailed character descriptions). Measurements were taken with digital calipers to the nearest 0.1 mm.

We performed analyses of species using two sets of these data: means for each species using all measured individuals, and values for the single largest male specimen for each species. We compared summary metrics for these two data sets for three techniques: 1) relationship of traits to body size (SVL vs. HL, FL, and lamellae; slope, R^2); 2) phylogenetic gap-coding (SNSC, SVL; Thiele 1993), a method that converts measurement data to phylogenetic codes; and 3) principal components (scores for PCI and PCII using all five variables).

Results are summarized in Table 1 and Figs. 1 and 2. We found that use of a single exemplar specimen per species produced

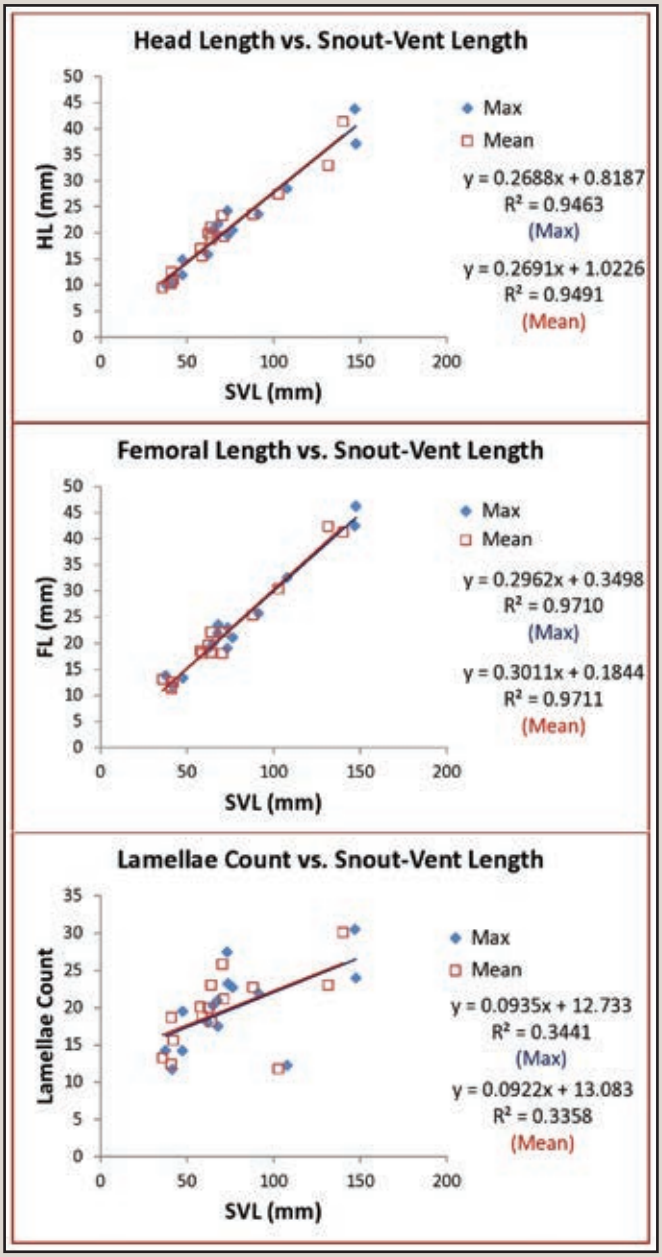


FIG. 1. Comparison of relationships of traits to body size.

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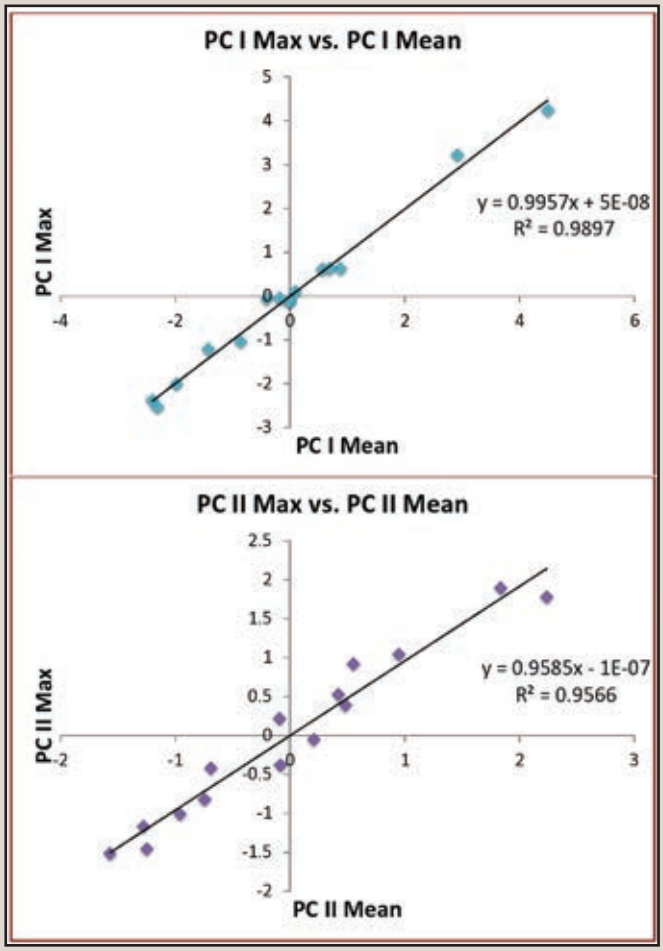


FIG. 2. Comparison of principal component scores.

nearly identical results to using summary statistics from five specimens for body size-trait relationships, phylogenetic coding, and principal component scores. Body size-trait relationships differ by less than 0.005 in slope, and by less than 0.008 in R^2 (Fig. 1). This similarity among datasets occurred both in traits expected to closely track body size (HL, FL) and in a trait known to correlate more weakly with body size (lamellae). The average difference between phylogenetic codes for each dataset was 0.4 on a scale of 0.0 to 5.0 for SVL and SNSC, and 19 of 30 codes were identical between the datasets (Table 1). Principal component scores were very strongly correlated between datasets (Fig. 2).

These results suggest that little would be gained by measuring five specimens rather than one specimen for these analyses (body size-trait relationships; phylogenetic coding; PC scores) for these traits in these *Anolis* species. A five-fold decrease in data collection time is not trivial in comparative studies of large clades. In the case of *Anolis*, the time saved by measuring one specimen rather than five would be on the scale of months, rather than hours. We conclude that some comparative interspecific morphological studies of lizards such as *Anolis* may proceed more efficiently by measurement of a single exemplar per species rather than multiple individuals.

Although results are conclusive for the traits, methods, species, and scale studied here, we do not recommend general extrapolation to other studies. There certainly are studies of morphology—perhaps most studies—wherein measurement of several or even hundreds of individuals per species or population is warranted. Studies of intraspecific variation, of growth within species, and of traits with high variance are obvious examples where many individuals must be measured in order to gain biologically meaningful results. Other cases similar to our study (e.g., interspecific principal component analyses) may produce similar results—i.e., adequacy of use of a single exemplar for some quantitative summary metrics. But these inferences are best made on a case-by-case basis. We believe that the null expectation for a study with unknown variance properties should be that measurement of more than one individual per species/population is warranted. A conservative implication of our results is simply that large sample sizes should not be assumed to be necessary for all studies.

TABLE 1. Comparison of phylogenetic codes for snout–vent length (SVL) and scales across snout (SNSC).

Species (*Anolis*)	SVL (Max)	SVL (Mean)	SNSC (Max)	SNSC (Mean)
baleatus	5	5	1	0
biporcatus	2	3	2	3
concolor	1	2	2	3
cristatellus	1	1	1	1
cybotes	1	1	0	0
frenatus	5	5	5	5
fuscoauratus	0	0	4	5
gingivinus	1	1	0	0
grahami	2	1	4	4
kunayalae	3	3	4	5
limifrons	0	0	5	5
porcatus	1	1	1	0
pulchellus	0	0	1	0
new species	0	0	5	4
townsendi	1	1	4	4

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APPENDIX

Specimens Examined

Anolis baleatus: POE 0373–0375, 0395, 0485.
Anolis biporcatus: POE 1520, 2151, 2155, 2170–2171.
Anolis concolor: UNM 46696, 46703, 46721, 46724, 46746.

Anolis cristatellus: POE 0137–0138, 0155, 0157, 0164.
Anolis cybotes: POE 0453, 0480–0481, 0603, 0610.
Anolis frenatus: EWS 0103, POE 1435, 1639, 1880, 1907.
Anolis fuscoauratus: POE 2715, 2720, 2730, 2775–2776.
Anolis gingivinus: UNM 44410, 44413, 44420–44421, 44425.
Anolis grahami: POE 1314, 1332, 1343, 1349, 1357.
Anolis kunayalae: EWS 0102, POE 1623, 1969–1970, 2100.
Anolis limifrons: EWS 0014, 0091, 0093, 0099, 0104.
Anolis porcatus: POE 0706–0707, 0724–0725, 1117.
Anolis pulchellus: POE 0151–0152, 0238–0239, 3689.
Anolis new species: POE 1426, 1436, 1558, 1580, 1963.
Anolis townsendi: UNM 58081, 58093, 58095, 58097, 58101.

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A New System For Marking Hatchling Turtles Using Visible Implant Elastomer

Turtles are a particularly vulnerable taxonomic group, with 40% of all species currently placed on the IUCN Red List (van Dijk et al. 2014). Many recent conservation efforts for turtles focus on the long-term viability of turtle populations, particularly in light of habitat fragmentation, over-collecting, road mortality, and other anthropogenic stressors (Doak et al. 1994; Heppell 1998; Gibbs and Shriver 2002; Shoemaker et al. 2013). However, to determine long-term population viability, information must be collected on the demography of the target organism, including survivorship of juveniles (Shaffer 1981; Boyce 1992; Akçakaya and Sjögren-Gulve 2000). Mark-recapture methods are well-suited for studies of hatchling survivorship and ecology (Morafka 1994; Heppell 1998). However, many marking techniques for turtles, such as notching, drilling, and branding, may not be practical for use with hatchling turtles since a) the marks may not remain visible as the organism grows, and b) the marking process itself could harm animals of such small sizes (Plummer 1979; Davy et al. 2010).

Davy et al. (2010) recently proposed the use of Visible Implant Elastomer to mark small or hatchling turtles; however, their suggested marking systems do not allow easy identification of individual turtles and focus primarily on designating cohort marks for groups of hatchlings. Here, we present an intuitive, inexpensive, and easily recognizable individual marking system using Visible Implant Elastomer.

Methods.—Visible Implant Elastomer (VIE), available from Northwest Marine Technology, Inc. (Shaw Island, Washington, USA), is a tagging agent that has successfully been used to mark fish and amphibians (Bailey et al. 1998; Bailey 2004; Butt and Lowe 2007; Hutchens et al. 2008). VIE is a bio-compatible material that leaves a well-defined pigment mark that fluoresces under UV light. VIE consists of a two-part system: a colored component and a curing agent. After the two components are mixed, the elastomer is injected into an area of translucent tissue (Fig. 1A), creating a long, distinctive mark (Fig. 1B). If necessary, a small amount of liquid bandage can be applied over the injection site to further ensure that the cured mark is not lost. The Northwest Marine Technology, Inc. (2008) VIE injection manual describes complete VIE application methods.

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Hatchlings of two species of turtles, the Northern Map Turtle (*Graptemys geographica*) and the Bog Turtle (*Glyptemys muhlenbergii*), were collected to test our marking system. All hatchling map turtles were either collected emerging from nest sites on the shores of the Susquehanna River in Maryland or were hand-captured basking or swimming in the river. As Northern Map Turtles overwinter in nests (Ernst and Lovich 2009), all new captures occurred in the months of May and June. Observed hatchling characteristics (i.e., presence of yolk scar and/or egg tooth) strongly suggest that all newly captured hatchlings were freshly emerged from nests during this period. Captured turtles were taken to a nearby field station for measuring and marking. Hatchlings were released within 24 h of marking to allow the elastomer to cure completely. All hatchling Bog Turtles were captured at sites in Maryland (specific site locations withheld for security reasons) emerging from nests in August 2013. Hatchling Bog Turtles were taken from the field for measuring and marking and released within 24 h of capture.

Previous VIE methods used in turtle research have involved injecting the elastomer material into the animal's limbs in various combinations of colors or locations (Park et al. 2007; Davy et al. 2010). Davy et al. (2010) also proposed applying these marks to the pliable plastrons of hatchling turtles. We expanded on this method by adapting the Ernst et al. (1974) marking system to fit the plastron of the turtle, giving each hatchling an individual mark number (Fig. 2). Rather than begin the numbering at the gular scutes, we began at the larger anal scutes and moved up the shell in order to make marking small turtles easier.

Results.—A total of 101 hatchling Northern Map Turtles were marked using VIE between 9 May 2012 and 29 August 2013. Twenty-one individuals were recaptured at least once, and four individuals were recaptured two or more times (Table 1). No juveniles marked in 2012 were recaptured in 2013. The marking scheme was also successfully applied to five hatchling Bog Turtles in August 2013 to test the utility of this marking scheme for another species.

A single *Graptemys geographica* hatchling marked in the 2012 field season was recaptured three times between the months of May and July of that year. When captured on 25 July 2012, the plastral VIE marks had faded somewhat but were still visible to the naked eye. The marks were easily recognizable under UV light. This individual increased in mass and straight-line carapace length from 7.4 g and 33.9 mm on 9 May 2012, to 42.0 g 66.3 mm on 25 July 2012. This equates to a 568% increase in mass and a 95% increase in shell length in 77 days. This is also the only individual in this study recaptured more than two months after marking, as most individuals were either not recaptured at all or were recaptured once within one month of marking.

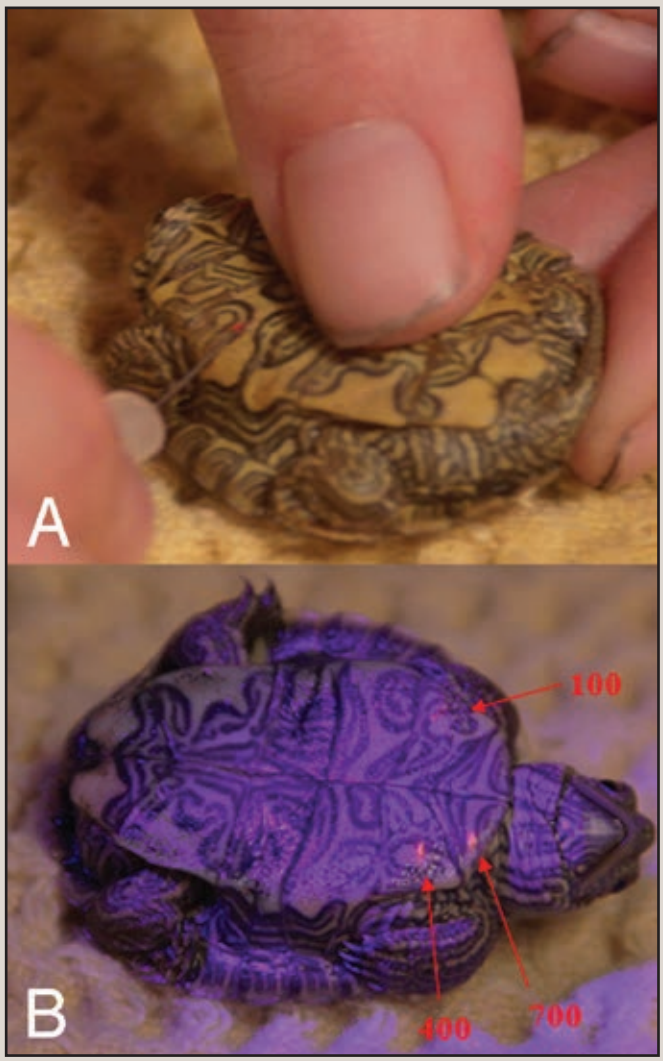


FIG. 1. A) Injection of visible implant elastomer into the plastron. B) Visible implant elastomer tag fluorescing under UV light for hatchling #1200. The dye on the chin is non-injected residual elastomer from the marking process, which quickly fades, leaving only the injection sites marked.



FIG. 2. Adaptation of the Ernst et al. (1974) system for marking turtles. Numbering begins at the bottom of the plastron rather than the top due to scute size.

TABLE 1. Individual hatchling marks and recaptures for 2012 and 2013.

	Marks/season	Recaptures	Repeated recaptures
2012	29	5	2
2013	72	16	2
Total captures	101	21	4

Discussion.—This method is a simple, inexpensive, and quantitative method for marking individual hatchling turtles. The elastomer material is effective for marking small or extremely large cohorts, yet maintains individual identification regardless of the cohort size. Our adaptation of the Ernst et al. (1974) system allows for a large number of individual mark numbers. The highest mark numbers reach into the 1400s for one color of elastomer; however, Northwest Marine Technology, Inc. offers six different fluorescent colors. Once the maximum number has been reached for one color, one can begin at mark #1 with a new color, or introduce combinations of colors.

The Ernst et al. (1974) marking system is a well-established marking scheme, making the numbering used in this marking scheme simple and familiar. Davy et al. (2010) reported that VIE marks may break apart, forming what look like multiple marks. Because the plastral marks are applied to separate scutes in our method, confusion over individual identification is avoided even if the elastomer breaks or changes shape. The VIE kit for this project cost about US $0.80/individual turtle. Costs for using PIT tags are generally no less than US $1–US 2/individual, plus $800–1500 for the PIT tag reader (Smyth and Nebel 2013). Therefore, VIE may represent a more cost-effective marking method than PIT tagging.

No hatchlings from 2012 were recaptured in 2013; the lack of data on captures between years limits any conclusions that can be made about the maximum lifespan of plastral VIE marks. However, Davy et al. (2010) reported at the time of publication that marks lasted at least until the next season. Recapture data from the present study suggest that marks can be retained in plastral scutes even with high rates of individual growth; however, conclusive long-term mark retention and visibility estimates should be a priority for future studies. Additionally, alphanumeric tagging, e.g., as applied by Strain et al. (2013), may represent another potential injectable marking system that could hold merit for hatchling mark-recapture studies. Since our system incorporates the Ernst et al. (1974) marking system, our marking system could easily be adapted to other types of injectable marking tools for hatchlings. Thus, this system represents an intuitive and easy-to-use alternative to currently existing hatchling marking techniques that, due to its flexibility, could easily be adapted to most studies of hatchling turtles.

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A Suture Method to Optimize the Condition of Snake Specimens in Herpetological Collections

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Data derived from the dissection of preserved specimens in herpetological collections have contributed immensely to our understanding of the biology of snakes (e.g., Fitch 1940; Allen and Neill 1957; Hoge and Romano-Hoge 1978; Diller and Wallace 1984; Salomão et al. 1995; Almeida-Santos and Salomão 2002; Pizzatto et al. 2007; Marques 2011; Barros et al. 2012; Rojas et al. 2013). Some museums contain historical specimens that have incalculable value; deciding whether to grant permission to dissect such specimens is a challenge for curators. Regardless of age, many specimens require special care such as when the specimens are damaged prior to collection (such as in roadkills), where body parts are sprawled, or when tissues have been manipulated during prior dissection (e.g., stomach contents, developing follicles, embryos, or eggs). As such, previously dissected specimens that have not been sutured may disrupt future data collection of anatomic features.

Despite such a long history of using preserved specimens for scientific study, little attention has been paid to the best ways



FIG. 1. Specimens dissected: longitudinal incision in which the ventral scales are divided into two relatively equal halves (A). The suture is anchored under the epidermal layer on the right side of the animal between two ventral scales (B). Begin the whip stitch by tying a knot in the end of your thread and alternatively the needle is placed from outside to inside with one bite then going from inside to outside on the next bite (C, D). The suture in the skin of the snake represents a simple continuous pattern or whip stitch (E). The muscular layer and subcutaneous layer are incorporated in the suture and the distance from one point to another is 5–10 mm. The needle used to close the incision was a straight surgical needle with taper point, size 2-3. Kite string was used to suture which when completed, is imperceptible to the naked eye (F). Li: longitudinal incision L: left; R: right; SS: scale space; Ssc: simple suture continues; f: fixation (anchor) point.

to minimize damage to specimens. The focus of this paper is to present a simple method of closing and securing dissected coelomic cavities of snakes that minimizes damage of the specimens in scientific collections.

After dissection (Fig. 1A), a continuous suture is initiated to close the coelomic cavity, by anchoring the suture on one side of the skin (Fig. 1B–D). This suture is characterized by a simple continuous pattern or whip stitch commonly used in medicine (Fig. 1E). In individuals that have been run over or in which the organs were collected from other sources, the pleuroperitoneal cavity is usually fragmented. This disruption causes the drying of tissues, making them fragile. It is important to note that the point of suture is not visible to the naked eye, which provides an aesthetic benefit, and avoids disruption of scale orientation (Fig. 1F).

With the adoption of this technique, researchers can obtain valuable information from specimens of varying condition while minimizing damage and prolonging their usefulness in collections. Scientific collections that do not allow or have restricted access to the dissection of specimens could consider this technique as a model for the upkeep of specimens that might be dissected in the future.

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Using Transillumination as a Technique for Blood Sampling in Small Anurans

Obtaining blood samples is vital to many physiological and immunological studies. However the ease of sampling diminishes as the size of the animal decreases while the potential for harming the study organism increases. This is especially true in amphibians where reproductive adults can be as small as 2 cm and thin skin is prone to tear. Normal venous blood collection techniques for anurans include collection from the ventral abdominal, femoral, or sublingual vein (Hadfield and Whitaker 2005). Cardiocentesis is also a common collection technique particularly for smaller anurans due to small vessel size (Allender and Fry 2008). This technique is performed by inserting a syringe equipped with a hypodermic needle directly into the ventricle of the heart (Brazaitis and Watanabe 1982). Cardiocentesis protocols commonly suggest anesthesia to prevent additional damage to the heart or internal organs (Allender and Fry 2008). However, in most amphibians anesthesia can be precarious due to their sensitivity to anesthetics (Koustubhan et al. 2013) and it can interfere with many physiological measures that may be of interest (Houston et al. 1971; Cathers et al. 1997). If anesthesia is not an option, manual restraint must be used in conjunction with cardiocentesis. Small anurans are notoriously difficult to handle and because the heart presents such a very small target, it is easy to miss and puncture neighboring organs causing more damage than necessary and perhaps mortality. Restraint of smaller subjects without the aid of anesthesia is a difficult task and can cause injury in and of itself. For these reasons, investigators are faced with the challenge of creating a new technique that allows for more accurate location of the heart and less stressful restraint for smaller subjects.

Several techniques have already been established for visualization of internal structures in small subjects. Transillumination, or candling, has long been used to visualize internal structures of fertilized avian eggs and has recently been used to determine the sex of salamanders; a light passed through the abdomen allows for the visualization of the sex organs (Gillette and Peterson 2001). Transillumination is also used to view vessels in limbs of newborn infants to ensure blood collection on the first attempt (Wall and Kuhns 1977). In each of these studies, the use of a light source allowed the investigator to visualize vessels and organs using noninvasive techniques. We are proposing a novel use of transillumination in conjunction with a novel restraint technique to view the heart of small amphibians and to safely obtain a blood sample.

Methods.—Ten individuals each of four species of small anurans (*Pseudacris feriarum, Hyla chrysoscelis, Hyla cinerea,* and *Hyla squirella)* were collected in Macon Co., Alabama, USA, during the breeding season from a man-made pond (32.51529°N, 85.61183°W, WGS84). Snout–vent length (SVL) ranged from 2-4 cm. Upon capture each frog was placed in a clean clear plastic bag. We have found the snack-sized bags to be perfect for this application. The frog was oriented into the corner of the bag so the corner fit snuggly over the snout of the frog (Fig. 1). While holding the bag in the non-dominant hand, the frog was placed ventral side up on the lens of bright flashlight. Light emitting diode (LED) lights are preferable since the diodes will not generate heat like incandescent bulbs. By using the thumb and index finger of the non-dominant hand to limit the area of light like a diaphragm, internal organs, including the heart, are visible through the thorax. With the dominant hand an attempt at a blood sample was made by inserting the hypodermic needle directly through the bag into the ventricle (Fig. 2).

All sampling was performed with 26.5-gauge heparinized needles and 1-ml syringes. We deemed a sample a success if it was collected within 2 min and we were able to collect 50 µl of blood. All frogs were then placed into individual (~500 ml) plastic containers containing a moist paper towel and held for 48 h. After 48 h all individuals were released.

Results.—We were successful in collecting blood in 70% of *P. feriarum*, 80% of *H. squirella*, and 100% of *H. chrysoscelis* and *H. cinerea*. 100% of the frogs sampled by this technique survived to 48 h and no frog exhibited any outward sign of injury or distress.

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FIG. 1. Proper orientation of *Hyla squirella* in the corner of a small plastic bag for cardiocentesis.



FIG. 2. Transillumination of *Hyla squirella* using a light emitting diode head lamp. The frog is restrained using a small plastic bag. The heart is medial (indicated by the needle), located superior to the liver, which is visible as a large dark mass.

Discussion.—Not injuring study animals is important for humane handling and critical in cases where repeated samples are required. Using our technique of bag restraint with transillumination increased the number of successful samples and decreased the potential mortality from cardiocentesis of small individuals. In previous studies we had roughly a 50% success rate in the smallest (2–3 cm) individuals and as high as 5% mortality rate (C. Ward, unpubl.). We feel that handling time was reduced using this method as well. Though we did not measure total handling time, we did see an increase in the number of successful samples within the prescribed 2-min handling period.

Bag restraint also limits skin to skin contact between researcher and frog. This has a few important implications. First, contact with frog skin can be detrimental to the frog and the use of gloves can exacerbate the effects of handling and in some cases cause mortality (Alford et al. 2008; Cashins 2008; Greer 2009; Schock et al. 2009). Secondly, the bags are an easy, disposable means of securing the anurans that could limit the spread/transfer of chytridiomycosis or ranavirus, both leading causes of population declines (Berger 1998; Speare et al. 1998; Chinchar 2002), if a clean bag is used for every sample. Lastly, skin secretions collected in plastic bags during handling can be used for later analysis if desired.

In conclusion, we feel that this technique is a useful tool for hematological studies involving small amphibians and will decrease stress, injury, and mortality while increasing sampling success and potentially decreasing the spread of disease.

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HERPETOLOGICAL HISTORY

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A Critical Evaluation of Two Historic Records of Large *Python*

Humans have long been fascinated by large snakes, which invoke emotions ranging from fear and revulsion to curiosity, wonderment, and at times, veneration and reverence (Minton and Minton 1973; Morris and Morris 1965; Murphy and Henderson 1997; Pope 1961; Strothers 2004). From a scientific standpoint, reports of large reptiles are of interest from both an ecological and evolutionary perspective, and knowledge of asymptotic body size is a necessary prerequisite for understanding patterns of growth (Woodward et al. 1995). Much of what is known concerning the maximum body size attained by various giant snakes (species known to exceed 20 feet [609 cm] in total length *sensu* Murphy and Henderson 1997) is based on anecdotal accounts penned by explorers, travelers, colonial officials, and early naturalists, all with varying degrees of education and biological expertise (Minton and Minton 1973; Murphy and Henderson 1997). As such, these accounts are often difficult to interpret, but nonetheless can provide important insights into the biology of giant snakes (Murphy and Henderson 1997).

We here present two such historic records of large *Python* that have not previously appeared in the herpetological literature, and critically evaluate each based on criteria modified from Forman and Russell (1983) and Bates and Byrne (2007), namely: 1) Was the snake actually measured or is the reported body size simply an estimate?; 2) Is the account based on information recorded at the time of the observation (e.g., journal entry) or was it written from memory at some later date?; 3) Does other natural history information provided in the account suggest the author was a credible observer or one prone to exaggeration and embellishment?

The first record is provided in a travelogue authored by Charles Challié Long (1876) describing his explorations around Lake Victoria in modern-day Uganda. Challié Long, an American serving under General Charles "Chinese" Gordon in the Egyptian army, is credited with becoming the third westerner to visit Lake Victoria, discovering Lake Kioga, and pacifying indigenous tribes in the region (McLynn 1992). As stated in the account, on 13 September 1874 Challié Long was seated at his "accustomed place beneath a tree", when a local chieftain and 10 of his men appeared "dragging something that seemed … [to be] … the body of a tree". On closer inspection "it proved to be a huge boa constrictor they had just killed … and brought to me as a surprise. Supposedly a female, it measured thirty feet [914 cm] in length, and in diameter was the size of a child" (Fig. 1). Challié Long goes on to state that villagers claimed the snake "came nightly to suck … [milk from] … the cows" penned nearby. The discovery of a clutch of "boa" eggs within the walls of a grass hut and "countless small serpents" found the previous night led Challié Long to conclude the female snake had entered the village in search of her offspring.

Elsewhere in his travelogue Challié Long notes that the region surrounding Lake Victoria was "full of these reptiles," which were reportedly so feared that in some areas people slept with their legs either crossed or spread open into a "V" to discourage large snakes from swallowing them. Failure to sleep in this manner meant being "swallowed and digested ere morning" according to Challié Long. While Challié Long seems to consider this tale as nothing more than local folklore, he goes on to describe a personal encounter with another large snake. After having fallen asleep on a stream bank one night, "I was suddenly awakened by the consciousness of the pressure of something horrible. At my feet, its ponderous jaws wet with fatal horrible saliva, lay a huge boa." Only "the natural repulsion that had shocked my nerves … saved me from a Laocoon-like embrace" [reference to a fanciful description by the Roman poet Virgil of sea serpents that attacked Laocoön and his sons; see Strothers 2004] of the giant snake. Despite being "transfixed to the spot" and unable to move, Challié Long was able to alert some accompanying African soldiers who killed the snake, made a "savoury meal" of the carcass, and sliced the skin into strips to be worn "as charms against the devil."

The large constrictors that Challié Long (1876) encountered in Uganda were undoubtedly African Pythons (*Python sebae*) rather than the Common Boa Constrictor (*Boa constrictor*), which is restricted to Central and South America (Lee 1996); labeling any large constrictor a "boa constrictor" seems to have been a common literary convention of Victorian-era travel writers (e.g., Duncan 1847; De La Gironiere 1854). If the body length of 30 feet given by Challié Long is indeed accurate, the specimen he examined ranks among the five largest *P. sebae* ever recorded (Murphy and Henderson 1997). Notably, only one of

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Fig. 1. Illustration from Challié Long (1876) showing a "huge boa constrictor" (actually *Python sebae*) killed near Lake Victoria in modern-day Uganda. The snake reportedly measured 30 feet long [914 cm].

these record-sized pythons was actually measured, a 31-foot [945 cm] specimen killed in West Africa (Duncan 1847).

There is little reason to doubt that Challié Long encountered large *P. sebae* during his African explorations; however, for several reasons we regard the reported body length of 30 feet as dubious at best. First, while Challié Long implies the snake was measured, this is not explicitly stated in the account. Second, the diameter reported for the snake ("the size of a child") is inconsistent with its purported length. According to Broadley (1984), a *P. sebae* measuring 600 cm in length has the girth of "a normal man's waist." Presumably a specimen 914 cm long would have a correspondingly greater diameter, certainly larger than that of a child. Third, there is little else in the travelogue to indicate that Challié Long was a credible naturalist. Other than brief comments on the abundance of dangerous wildlife, his account is notable for its paucity of natural history information, instead being largely devoted to descriptions of physical hardships and interactions with hostile tribesmen. His encounters with giant snakes seem to be just another of the many perils faced by the intrepid author rather than credible natural history anecdotes. Finally, although his travelogue appears to be based on a journal written in the field, modern historians have criticized Challié Long for a lack of accuracy (Clark 1967), casting doubt on the specifics of his narrative. Given these caveats, we are unable to accept the size record for *P. sebae* given by Challié Long (1876). In our view, the principal value of his narrative lies in its portrayal of Victorian attitudes towards large snakes and indigenous peoples and it should not be considered a reliable source of biological information.

The second account of a record-sized *Python* is found in the memoirs of Boris Hembry (2011), a British rubber planter who worked in Sumatra and Malaya (Malaysia) in the 1930s and later became embroiled in the Malayan Emergency after World War II. From January through December of 1931 Hembry managed a rubber plantation in Aceh Province of northern Sumatra, about 240 km north of the city of Medan. According to his account, while having breakfast one morning, Hembry was notified that laborers cutting brush beneath the rubber trees had just found a large snake. Grabbing a rifle, Hembry ran to the spot and found a "giant python fast asleep, having just had a meal—we were to find out later that it was a young pig." Although still alive, the snake had been beaten senseless by the laborers. So massive was the snake that 10 people were required to lift it. The snake was carried but a short distance before it revived and was again rendered unconscious by a rain of blows to its head. Hembry contacted a German professional hunter living nearby who administered a drug (thought to be opium) to "keep the snake unconscious until it could be killed and skinned," which was accomplished in due course. Hembry remarks that the python "was quite a remarkable specimen … its head was a good 12 inches [30.4 cm] across and when we eventually straightened it out it measured 33 feet 6 inches [1021 cm]." According to the German hunter, "it was undoubtedly the largest snake ever caught in the Far East, if not the world." Hembry photographed the snake before and after skinning it, but unfortunately these photographs were left behind in his haste to escape Malaya following the Japanese invasion in December 1941. Copies of the photographs were also distributed to friends and family living abroad, although none could be located by the time Hembry began writing his memoir. The skin of this snake was dried and later presented as a gift to the wife of his plantation manager who is thought to have taken it to Zurich, Switzerland when her husband retired. The current whereabouts of the skin are unknown, although Hembry speculates it "could be in a natural history museum." Interestingly, and in our opinion to his credit, Hembry concludes his account by stating "In retrospect, I am deeply sorry that this magnificent specimen of nature was slaughtered for a keepsake, like so many elephant, tiger and countless other magnificent creatures," a sentiment rarely expressed by those who slay large snakes or other megafauna.

The record-sized python described by Hembry (2011) was no doubt a Reticulated Python (*Malayopython reticulatus*, formerly *Python reticulatus*), a species known to reach lengths exceeding 900 cm and the only giant snake occurring on Sumatra (Murphy and Henderson 1997). If the body length given by Hembry is accepted, his specimen exceeds the previous record of 33 feet [1006 cm] reported for *M. reticulatus* (Raven 1946). It should be noted that the latter record is based on secondhand information obtained by Raven (1946) from a mining engineer who reportedly measured a large python killed on the Indonesian island of Sulawesi.

We see no reason to dismiss Hembry's account of what was apparently a record-sized *M. reticulatus* killed in northern Sumatra. As stated in the preface, the memoir was initially written "solely for his [Boris Hembry] family and not for publication." It was only after Boris Hembry died in 1990 that the memoir was published by the Hembry family, who believed the material was historically noteworthy and warranted a wider readership (John Hembry in Preface of Hembry 2011). Boris Hembry thus appears to have had no obvious motive for self-aggrandizement or embellishment to promote commercial sales or readership of his book; indeed Hembry directly addressed this issue in the Foreword when he stated, "I have made no attempt to romanticize or exaggerate … [when writing this account]." Furthermore, Hembry had considerable experience working outdoors and hunting, and other natural history anecdotes in the book appear to be those of a credible observer. Likewise, his accounts of fighting Communist guerillas in the Malayan Emergency do not appear those of a braggart. Our sole cause for concern is the fact that Hembry wrote his memoir many years after the events described actually occurred (the manuscript was written over a lengthy but unspecified period and completed in 1983). Although Hembry stated in the Foreword that "I have relied on memories, promptings from Jean [wife] and friends,

and *documents that I have retained* [italics added]," we cannot determine if the account of killing the python is based on notes written at the time of the event or memories recalled many years afterwards. The latter would temper our acceptance of the reported body length for as Bates and Byrne (2007) note, the human mind has an active constructional nature making it near-certain that recollections will change if they are recalled repeatedly before being recorded in hard form.

To briefly summarize, we do not dispute that Challié Long (1876) encountered large pythons while exploring what is now part of Uganda, but for reasons outlined above we place little credence in the purported length of the near-record sized *P. sebae* he described. In short, we consider his account nothing more than a highly embellished traveler's tale that nevertheless makes for enjoyable reading almost 140 years later. As a potential source of biological information however, its value is nil. In contrast, the snake described by Hembry (2011) appears to be an authentic size-record, although the possibility the account was written from memory is cause for concern. As is the case with so many accounts of large constrictors (Pope 1961; Murphy and Henderson 1997), there is no way to independently corroborate Hembry's size record. Even should the missing skin be located in a museum collection it would not be considered indisputable proof of the size of the living snake, because skins are easily stretched during preparation and drying (Murphy and Henderson 1997), sometimes by as much as 25% (Oliver 1958). Size estimates of large reptiles (snakes and crocodilians) based on dried skins are therefore ambiguous at best (Oliver 1958; Platt et al. 2009).

Because of logistic difficulties involved in preserving and transporting specimens of large reptiles (Murphy and Henderson 1997) and their notable paucity in museum collections (Barker and Barker 2008), written accounts, many of which are in historic sources rarely perused by biologists and yet to be uncovered, will no doubt remain important in the discussions regarding maximum body sizes attained by giant snakes. Although numerous pitfalls surround the interpretation of these accounts, we concur with Murphy and Henderson (1997) and maintain that careful evaluation based on rigorous criteria can provide valuable insights into the biology of giant snakes.

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AMPHIBIAN DISEASES

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Absence of *Batrachochytrium dendrobatidis* in Eighteen Species of Amphibians from a Variety of Habitats in Tamaulipas, Mexico

Global amphibian declines have been a major concern for the past fifty years, and *Batrachochytrioum dendrobatidis* (*Bd*) is considered to be among the leading causes affecting amphibian populations (Berger et al. 1999; Houlahan et al. 2000; Lips et al. 2003; Stuart et al. 2004; Beard and O' Neill 2005; Brem et al. 2008; Brown et al. 2013; Philips et al. 2013). *Bd* has been detected in different wild amphibian populations in America (Knapp and Matthews 2000; Lips et al. 2004; Frias-Alvarez et al. 2008; Voyles et al. 2012). But currently there are no reports on *Bd* in amphibian populations from northeast Mexico. We were therefore interested to investigate amphibian populations for the presence of *B. dendrobatidis*, with specific focus on the state of Tamaulipas.

Tamaulipas is located in northeast Mexico, bordered by Texas, USA to the north, and the Gulf of Mexico to the east. Portions of four major biogeographic provinces occupy Tamaulipas: Tamaulipan, Sierra Madre Oriental, Chihuahuan Desert in the Nearctic and the Veracruzan in the Neotropical region (Alvarez 1963; Flores-Villela 1993; Morrone et al. 2002). The Tamaulipan province (Fig. 1, Table 1) is a semiarid region, characterized by deciduous and thorny plants interspersed with grassland (Blair 1950; Johnston 1963). The majority of the province is confined to the Gulf coastal plain, with mountains rising to an elevation of 2250 m above sea level in the southwest corner of the state of Tamaulipas. The temperature of the province is relatively high throughout the year, with average highs around 32°C, and lowest temperatures at 15°C. In the lower elevations the vegetation consists mostly of semiarid tropical thorn scrub, with thorn forests of acacia, mesquites, and cacti (Martin 1958; Alvarez 1963; Flores-Villela 1993; Morrone et al. 2002; Cram et al. 2006). The lower mountains have an elevation range between 600–1400 m, surrounded by tropical deciduous forest and montane scrub or pine-oak forest (Martin et al. 1954). Elevations that are over 2250 m such as summits and higher interior slopes support dry oak and dry pine-oak forest, and temperate Madrean pine-oak woodlands (Martin 1958; Gómez-Hinostrosa and Hernández 2000).

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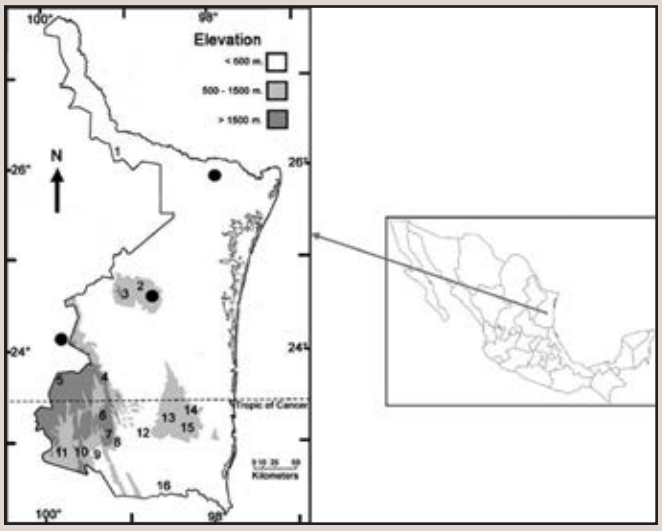


FIG. 1. Map of the state of Tamaulipas, Mexico, with sampling locations for amphibians tested for *Batrachochytrium dendrobatidis*. 1) Miguel Aleman, 2) San Nicolas, 3) San Carlos, 4) Victoria, 5) Miquihuana, 6) Jaumave, 7–8) Gómez Farías, 9) Ocampo, 10–11) Tula, 12) Xicotencatl, 13) Llera, 14–15) Aldama, and 16) Cd. Mante. Black circles are locations of weather stations.

TABLE 1. Amphibian species sampled for *Batrachochytrium dendrobatidis* from 2005–2007 (N = 56) in Mexico. Locality numbers correspond to Fig. 1.

Species	No. Samples	Date	Locality No.	Latitude °N	Longitude °W	Elev. (m)
Lithobates berlandieri	1 (toe)	11-Aug-07	1	26.1541996	99.13379669	75.6
Incilius nebulifer	1 (swab)	10-Jul-07	2	24.72278023	98.87667084	588
Eleutherodactylus cystignathoides	1 (swab)	13-Jul-07	3	24.62861061	98.98249817	731
Smilisca baudinii	1 (swab)	13-Jul-07	3	24.62861061	98.98249817	501
Lithobates berlandieri	1 (swab)	11-Jul-07	3	24.62861061	98.98249817	510
Incilius nebulifer	1 (toe)	13-Oct-06	4	23.60833359	99.23400116	1245
Rhinella marina	1 (toe)	13-Oct-06	4	23.60833359	99.23400116	1245
Spea multiplicata	1 (swab)	18-Sep-07	5	23.43416977	99.70194244	2595
Lithobates berlandieri	1 (toe)	10-Jul-04	6	23.50180054	99.58350372	1544
Hyla eximia	4 (toes)	27-May-05	7	23.05669975	99.20379639	2053
Smilisca baudinii	1 (swab)	19-Aug-07	7	23.05669975	99.20379639	951
Incilius nebulifer	1 (swab)	20-Aug-07	7	23.05669975	99.20379639	895
Eleutherodactylus cystignathoides	1 (swab)	19-Aug-07	7	23.05669975	99.20379639	1004
Eleutherodactylus cystignathoides	1 (toe)	26-May-05	7	23.05669975	99.20379639	1233
Eleutherodactylus cystignathoides	1 (toe)	24-May-05	7	23.05669975	99.20379639	1327
Ecnomiohyla miotympanum	2 (toes)	26-May-05	7	23.05669975	99.20379639	1380
Smilisca baudinii	1 (toe)	24-May-05	8	22.90049934	99.12516785	102.3
Trachycephalus typhonius (*venulosa*)	1 (toe)	28-May-05	8	22.90049934	99.12516785	89
Smilisca baudinii	1 (toe)	28-May-05	8	22.90049934	99.12516785	136
Leptodactylus melanonotus	1 (toe)	22-Sep-06	9	22.80606079	99.56131744	347
Lithobates berlandieri	2 (swabs)	6-Oct-08	10	22.84100914	99.60009766	1073–1089
Eleutherodactylus sp.	1 (toe)	25-Sep-06	10	22.84100914	99.60009766	1211
Craugastor augusti	2 (toes)	25-Sep-06	10	22.84100914	99.60009766	1203–1211
Incilius nebulifer	1 (swab)	6-Oct-08	10	22.84100914	99.60009766	1079
Anaxyrus cognatus	2 (toes)	12-Oct-07	10	22.84100914	99.60009766	1060–1064
Smilisca baudinii	1 (toe)	25-Sep-06	10	22.84100914	99.60009766	1211
Smilisca baudinii	1 (toe)	18-Sep-06	12	23.04172134	98.7959137	127.3
Gastrophryne olivacea	3 (toes)	18-Sep-06	12	23.04172134	98.7959137	127.3
Anaxyrus debilis	5 (toes)	18-Sep-06	12	23.04172134	98.7959137	138
Eleutherodactylus cystignathoides	1 (toe)	17-Sep-06	13	23.3845005	98.99130249	832
Craugastor augusti	1 (toe)	17-Sep-06	13	23.3845005	98.99130249	849
Scinax staufferi	3 (toes)	18-Sep-06	13	23.04172134	98.7959137	127.3
Scinax staufferi	1 (toe)	30-May-05	15	23.15028	98.32419586	242
Smilisca baudinii	1 (toe)	30-May-05	15	23.15028	98.32419586	242
Hypopachus variolosus	1 (swab)	16-Oct-07	15	23.15028	98.32419586	710
Rhinella marina	1 (swab)	16-Oct-07	15	23.15028	98.32419586	832
Lithobates berlandieri	1 (swab)	16-Oct-07	15	23.15028	98.32419586	886
Eleutherodactylus sp.	2 (toes)	21-Sep-06	15	23.15028	98.32419586	952
Eleutherodactylus sp.	1 (swab)	16-Oct-07	15	23.15028	98.32419586	952
Lithobates catesbeianus	1 (toe)	17-Oct-07	16	22.55019951	98.57150269	29.5

We tested a total of 56 wild-caught amphibians from the state of Tamaulipas for the presence of *Bd* (Table 1), sampled from 2005 to 2007. All samples belong to the MRJ Forstner Tissue collection at Texas State University and were collected from adult frogs that appeared to be in healthy condition using swabbing or non-consumptive toe clipping. Temperature data were obtained from the three weather stations that belong to the INIFAP (Instituto Nacional de Investigaciones Forestales Agrícolas y Pecuarias) in Mexico.

DNA was extracted from the swabs using PrepMan assay and from toe clips using a DNeasy Qiagen Kit, tissue protocol (Gaertner et al. 2009; Kilburn et al. 2010). The presence of *Bd* was assessed using a real time Taqman *q*PCR assay (Boyle et al. 2004; Kilburn et al. 2010). The assays were conducted in triplicate for each sample. Only quantifications having an efficiency between 90 and 110% (average of 98.15%) and an R^2 values higher than 0.997 were considered.

None of the samples tested positive for *Bd*. Considering the previous studies done in Mexico that show positive samples (Lips et al. 2004; Frias-Alvarez et al. 2008) we were expecting to find the pathogen present, especially given that species considered carriers of the pathogen were sampled (Garner et al. 2006).

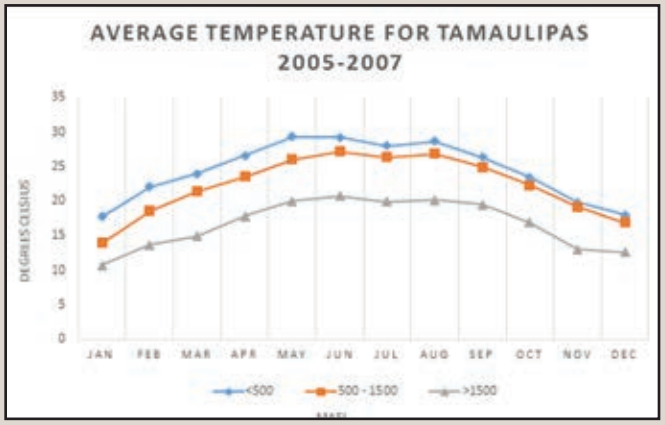


FIG. 2. Average monthly temperatures at three different elevations during 2005–2007 from Tamaulipas, Mexico.

Our results suggest that these amphibian communities have not been in contact with the fungus, or that they have developed different mechanisms that make them immune or resistant to *Bd* infections (Lips et al. 2004; Voyles et al. 2012; Philips et al. 2013). Our evaluation was part of a sampling process for a preliminary biodiversity assessment, consequently our findings should not be seen as definitive for the prevalence of *Bd* in the state of Tamaulipas. It is important to continue surveys in the area as well as the adjacent states, not only looking for presence and prevalence of *Bd*, but also to determine the actual abundance of amphibians in the different regions to assess population status.

To evaluate if temperature was a factor that could have negatively impacted the presence of the pathogen during the time when samples were collected, we analyzed temperature data from 2005 to 2007. During this period the temperature was higher on average during the months of collection for the elevations from 0–1500 m than what has been reported as being optimal for growth of *Bd* (Piotrowski et al. 2004), while for elevations above 1500 m it was between 5°C and 20°C and thus within adequate temperature conditions for *Bd* growth (Fig. 2). Therefore temperature does not seem to be the critical factor acting to explain the absence of *B. dendrobatidis* detections from amphibian species in the region.

Several studies have reported on the spread of *Bd* southward out of Central America and into South America (Pounds et al. 1997; Campbell 1998; Lips 1998; McCranie and Wilson 2002; Lips et al. 2003; Kilburn et al. 2010; Becker et al. 2012; Philips et al. 2013). However, there have not been complementary investigations that seek to track the pathogen northward out of Mexico, and if that is still possible. This investigation of samples from northern Mexico shows no positive samples for *Bd* and no relation between the presence of the pathogen and the optimal temperatures for pathogen growth previously reported in the *Bd* literature (Fig. 2).

In the analyses by Olson et al. (2013), altitude was not considered as a critical factor in the distribution of *Bd* provided factors such as temperature, precipitation, and species richness were favorable. To our knowledge, Olson et al. (2013) is the only paper that includes altitude into the model and found it to be non-significant. In our study it is not possible to determine if altitude has a significant effect on infection variation, but it is possible to infer if temperature variation has an effect in the absence of the pathogen.

Our detection of *Bd* might be affected by the overall small sample size leading to a false negative prevalence. However, studies done in southern Mexico show 84% prevalence of the pathogen (Frias-Alvarez et al. 2008). If we extrapolate those results to our samples in Tamaulipas, then from 56 samples collected at least 48 of them (84%) would be positive. There is another study done in northwest Mexico where the prevalence of *Bd* was 60% (Saenz et al. 2010). If this prevalence rate were to be extrapolated to our results then at least 34 samples would be positive for *Bd*. Further sampling including a larger total number of animals needs to be completed to better assess if the State of Tamaulipas is free of *Bd*. Additional studies with continuous sampling throughout the year could account for seasonal variation, not accounted for in our study, and a different design could take into account factors that might act to prevent widespread prevalence of the disease such as elevation, amphibian abundance studies, and amphibian species richness.

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Batrachochytrium dendrobatidis Prevalence in Two Ranid Frogs on a Former United States Department of Defense Installation in Southeastern Tennessee

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Within the United States, *Batrachochytrium dendrobatidis* (*Bd*) is widespread (Olson et al. 2013) and has been recently introduced into several natural areas (Weldon et al. 2004; Kolby 2014) and it continues to be implicated in the extinction, extirpation, and/or declines of amphibian populations around the world (Daszak et al. 2003; Lips et al. 2006; Longcore et al. 2007; Dodd 2010; Kilpatrick et al. 2010; Eskew and Todd 2013; Olson et al. 2013). The American Bullfrog (*Lithobates catesbeianus*) is the only ranid species from North America that has been cited as a contributing factor in the global spread of *Bd* (Schloegel et al. 2012; Gervasi et al. 2013a). This is largely due to it being farmed or traded internationally (e.g., research, medicinal, food source, pet trade), but this is further exacerbated by it being a potentially invasive species that is resistant toward developing symptoms of the disease chytridiomycosis (Daszak et al. 2004). The latter is presumably due to its host-pathogen interactions (Rollins-Smith et al. 2011), highly keratinized skin, and vagility. Because of these factors, it has been suspected to be a *Bd* carrier (Lannoo et al. 2011) or reservoir (Fisher et al. 2009). Our study objective was to determine the prevalence of *Bd* in two species of frogs from the family Ranidae (*Lithobates catesbeianus* and the Green Frog,

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FIG. 1. An aerial photograph (NAIP Imagery, <1 m spatial resolution, released Aug 21, 2014) depicts the developing landscape surrounding the study site (LT6, Hamilton County, Tennessee, USA) where the prevalence of *Batrachochytrium dendrobatidis* was investigated in two ranid frog species. The wetland boundary is highlighted by the white polygon in the center of the frame.

L. clamitans) at a site in southeastern Tennessee, USA, a region where *Bd* surveys have not yet been conducted. Both species are ideal candidates for co-monitoring because they are sympatric congeners, have similar ecologies (Conant and Collins 1998), and *Bd* has been known to occur in both species (Ouellet et al. 2005). Hence, we tested the hypothesis that *L. catesbeianus* would have relatively equal rates of *Bd* prevalence when compared to an ecological equivalent, *L. clamitans*.

The study site, herein referred to as LT6 (35.104°N, 85.130°W; average elevation of 180 m), is an ephemeral wetland surrounded by mixed hardwood forest and is located on a former United States Department of Defense (DoD) installation (Volunteer Army Ammunition Plant) and lies adjacent to an industrial park, a mixed-use natural area, and an outdoor university classroom (Fig. 1; Armstrong 2012; Simpson 2013). LT6 is owned and managed by the University of Tennessee at Chattanooga. It is nestled in the Ridge and Valley ecoregion (Griffith et al. 1997), and the underlying geology is dominated by limestone and karst formations and the topography ranges from rolling hills to steeper slopes (Griffith et al. 1997). The upland habitat is characterized by approximately 32.8 ha of eastern deciduous forest that is dominated by mixed hardwoods (e.g., *Liriodendron tulipifera* [Tulip Poplar], *Platanus occidentalis* [Sycamore], *Fagus grandifolia* [American Beech], *Ulmus alata* [Winged Elm], *Quercus* spp. [oaks], *Carya* sp. [hickory], *Fraxinus* sp. [ash]), with some interspersed pines (*Pinus* sp.), and an invasive colony of Chinese Privet (*Ligustrum sinense*). The wetland is dominated by a wooded over-story, consisting of three interconnected pools that total 4.1 ha. Hydroperiod varies by year, season, precipitation, and temperature; and during the typical wet season, water depth ranges from 25 to 54 cm. The upland and aquatic habitats at LT6 create a synergy that yields minimally 43 species of amphibians and reptiles (Simpson and Wilson 2009; Simpson et al. 2010; Armstrong 2012; Wilson et al. 2012; Simpson 2013; Wilson, unpubl. data). Prior to 2008, LT6 received some protection from development as a former DoD installation, and was largely buffered on the eastern, western, and southern borders by an additional 230 ha of intact upland forest.

For biosecurity, we wore powder-free nitrile gloves when capturing animals or processing samples. To further minimize *Bd* cross-contamination, all animals were temporarily placed into individual plastic bags in an effort to ease restraint when swabbing, and decrease handling time. All equipment that physically contacted an animal was disinfected using 70% EtOH (Hanlon et al. 2012) before and after use. All gloves, plastic bags, swabs or similar items were changed between subsequent captures or samples and were properly disposed of following approved biohazard protocols. All other equipment was treated with an aqueous solution of chlorine bleach (i.e., 10% by volume; Johnson et al. 2003) and the process was repeated three times for a total soak time of 30 minutes. This latter decontamination procedure was conducted before entering and exiting the study area.

We captured *L. catesbeianus* and *L. clamitans* randomly by hand using visual encounter surveys from 4 October 2012 to 26 December 2012 around the periphery of the wetland at LT6. All frogs were measured for total body length (TBL) via straight-line to the nearest 1.0 mm using dial calipers. We swabbed the ventral and medial surface of the thighs and abdomen, as well as the webbing on the hind feet for a total of 45 sec using aseptic technique (Vredenburg and Briggs 2009). All frogs were individually marked using the scheme of Martof (1953) and photographed after swabbing. The polyester (Dacron) swabs (Fisherbrand, Cat. #14-959-90; Pittsburgh, Pennsylvania, USA) and any transferred *Bd* DNA were placed in 1.5-ml microcentrifuge tubes with screw caps (Fisher Scientific, Cat. # 02-682-557; Pittsburgh, Pennsylvania, USA) containing cold 70% EtOH and stored at -80°C prior to analysis.

Each sample was dried in a speedvac (Labconco, Centrivap DNA Concentrator; Kansas City, Missouri, USA) prior to DNA extraction. The residual was re-suspended in 200 µL of lysis buffer along with 0.3 g of sterile, inert glass beads and 200 µL of Phenol:chloroform:isoamyl-alcohol (25:24:1). This addendum was adapted from a modified yeast DNA extraction protocol (Hoffman 1997) and was used along with a Mini-BeadBeater (BioSpec Products; Bartlesville, Oklahoma, USA) for 45 sec followed by 60 sec on ice and this process was repeated three times to successfully homogenize and extract DNA from all samples. We added 200 µL of Tris-EDTA buffer to the homogenate, vortexed it for 5 sec, and centrifuged it for 5 min at 15,000 rpm. The aqueous solution in the upper portion of the microcentrifuge tube containing the extracted DNA was transferred to a new microcentrifuge tube for purification. The final concentrate of DNA was quantified using a spectrophotometer (Thermo Scientific, Nanodrop 2000C; Waltham, Massachusetts, USA). We used a modified PCR (Eppendorf Master Cycler Gradient) analysis following the initial methods of Boyle et al. (2004) using a controlled reaction containing cloned spore DNA fragments. The *Bd* gDNA clone was obtained from the Center for Wildlife Health at the University of Tennessee-Knoxville (Matt Gray and Debra Miller, pers. comm.). Each plate contained these standards and served as positive and negative controls in our analysis. All samples were run in triplicate and all positives were assayed by PCR independently a total of four times to ensure accurate results.

We used Chi-Square Tests (Exact Binomial Goodness of Fit Test [two-tailed], Yates' correction for continuity [two-tailed]; Sokal and Rolf 1995) to evaluate the presence and absence of *Bd* in two closely related species of ranid frogs from LT6. We calculated probabilities of detection (POD) using DiGiacomo and Koepsell's (1986) equation:

$$C = 1 - (1 - p)^n$$

TABLE 1. Results of *Batrachochytrium dendrobatidis* (*Bd*) sampling in two ranid species from an isolated wetland at a former Department of Defense installation in southeastern Tennessee, USA. POD is the probability of detecting at least one *Bd*-positive individual for a particular species with a disease prevalence of at least 5, 10 or 30%.

Species	Date Sampled	No. *Bd*-positive Total No. Sampled (Prevalence)	POD	
Lithobates catesbeianus	13 Nov. to 26 Dec. 2012	3/51 (0.0588)	p = 0.05	0.929
			p = 0.10	0.992
			p = 0.30	0.999
Lithobates clamitans	04 Oct. to 25 Dec. 2012	10/26 (0.3846)	p = 0.05	0.737
			p = 0.10	0.935
			p = 0.30	0.999

where *C* is the probability of detecting at least one *Bd* positive individual from a representative sample (*n*) and the plausible prevalence of the disease (*p*) expressed as a fraction ranging from 0 to 1 (e.g., 0.05, 0.10, 0.30; Canessa et al. 2013).

We swabbed 77 frogs and detected *Bd* in 5.88% (3 of 51) and 38.46% (10 of 26) of *L. catesbeianus* and *L. calmitans*, respectively (Table 1). *Bd* occurrence differed between the two species (Exact Binomial Goodness of Fit Test p = 0.000254, Yates' correction for continuity $\chi^2 = 14.003$, p = 0.000183, df = 1; Sokal and Rolf 1995). However, based on POD calculations, we are 92.9% and 73.7% confident that *Bd* would be detected in *L. catesbeianus* and *L. clamitans* at a prevalence rate of at least 5%, respectively (Table 1). No ranid frogs showed clinical signs of *Bd* infection (e.g., skin lesions, edema, non-responsiveness).

Our *Bd* survey is the seventh to be conducted in Tennessee (see Rothermel et al. 2008; Venesky et al. 2008; Chatfield et al. 2009; Davis et al. 2012; Hanlon et al. 2012; Rollins et al. 2013), but is the first from southeastern Tennessee (http://www.bd-maps.net) and the only one in the published literature that was conducted on a former DoD property in Tennessee. Although, we detected *Bd* in both species of ranid frogs, *L. clamitans* had higher relative rates of prevalence when compared to *L. catesbeianus*. This result was contrary to our hypothesis that *L. catesbeianus* and *L. clamitans* would have relatively equal rates of *Bd* prevalence due to their ecological similarity. However, other research has suggested that *L. catesbeianus* has higher levels of *Bd* prevalence on average when compared to *L. clamitans* (~27% and ~20% for *L. catesbeianus* and *L. clamitans*, respectively; Ouellet et al. 2005). There are several possible explanations for the difference in *Bd* prevalence for the two ranid species, including temporal patterns of infection, host immunity, competition, or sensitivity to landscape change. *Bd* may be most prevalent during the late spring or summer months (Lannoo et al. 2011) and because our samples were collected during the fall it is possible that with *L. catesbeianus* being somewhat resistant to *Bd*, they could have lower rates of infection when compared to *L. clamitans*. Hence, prevalence at other times of the year may differ from our findings.

Previous research has indicated that there is considerable variation in host susceptibility to *Bd* (Searle et al. 2011; Hanlon et al. 2012) and no clear pattern exists among species except for the idea that some ranid frogs may be more resistant to *Bd* or that their clinical response is more variable when compared to other anurans (Gervasi et al. 2013b). For example, the Mountain Yellow-legged Frog (*Rana muscosa*) is nearing extinction even though it produces a higher amount of total skin peptides that have antimicrobial properties when compared to those of the Northern Leopard Frog (*L. pipiens*; Rollins-Smith et al. 2006). Perhaps, in our scenario, *L. clamitans* at LT6 are stressed due to extrinsic factors from exurban development involving the recent and large-scale loss of habitat from the expansion of the adjacent industrial park (Armstrong 2012; Simpson 2013) or competition from *L. catesbeianus* (or other amphibians) and have become immunocompromised making them more sensitive to *Bd*. If this were the case, *L. clamitans* could have a proportionately higher rate of *Bd* prevalence as seen at LT6. Similarly, others have suggested that the epidemiology of *Bd* within a community is likely driven by a suite of factors and cannot be attributed to one variable alone (Navas et al. 2012). While the aforementioned remains largely untested here, it parallels the ecological findings of others at LT6. Simpson (2013), over a 33-month period observed an increase in the relative abundance of *L. catesbeianus* when compared to other ranid species. The factors that were contributing to the shift in species composition were largely undetermined, but a synergy of intrinsic and extrinsic factors is plausible.

Bd continues to be a concern for conservationists and those who study amphibian communities; therefore, an integrated approach is necessary to adequately address amphibian declines and to develop adaptive conservation and management strategies. Collectively, 16.88% of all frogs tested in our study were positive for *Bd*, and all were found in microhabitats suitable for a variety of amphibian, reptile, and invertebrate taxa. This study, while limited seasonally, geographically, and taxonomically, provides baseline data that furthers our understanding of the distribution and prevalence of *Bd* in the southeastern United States—a biodiversity hotspot. Surveys for *Bd* that incorporate a wider range of taxa and habitats can better elucidate the role of competition, ecological persistence, asymptomatic carriers, and exurban development. Therefore, further investigation is warranted to better determine if *Bd* is endemic and widespread across the amphibian community described here.

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Chytrid Fungus (*Batrachochytrium dendrobatidis*) Undetected in the Two Orders of Seychelles Amphibians

Infection by the fungal pathogen *Batrachochytrium dendrobatidis* (*Bd*) is a major driver in global amphibian declines (Berger et al. 1998; Skerratt et al. 2007) and can occur in all three orders of Amphibia, having been most recently documented in the Gymnophiona (Doherty-Bone et al. 2013; Gower et al. 2013). *Bd* has been detected in 71 countries and 695 amphibian species (Olson and Ronnenberg 2014) but to our knowledge no screening for its presence or anecdotal evidence of chytridiomycosis has been reported from the Seychelles Archipelago, a biodiversity hotspot (Myers et al. 2000) with a very high proportion (86%) of endemic amphibian genera (Poynton 1999) (Fig. 1).

Eleven of the 12 species of Seychelles amphibians (Table 1) are globally significant. The four species of sooglossid frog are unique in being the only amphibian family endemic to an island group, and the endemic radiation of six Seychelles caecilians make them the only Gymnophiona to occur on continental islands. The single hyperoliid frog species occurring here is endemic to the Seychelles, leaving the single ptychadenid frog as the only non-endemic amphibian (Nussbaum 1984). Being primarily fossorial, caecilians are considered difficult study organisms and collection usually requires dedicated

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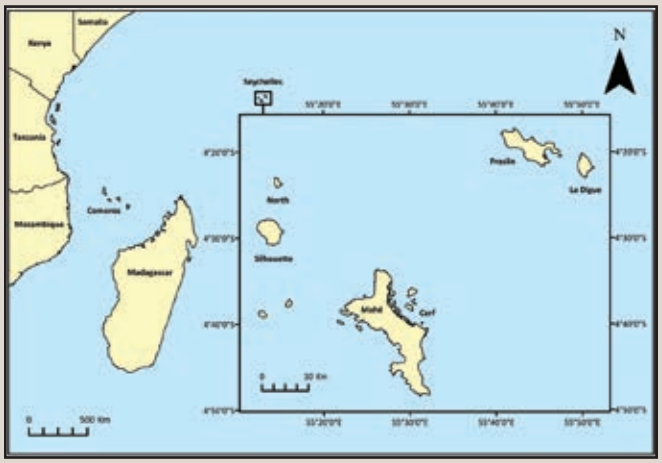


Fig. 1. Location map showing the position of the Seychelles Archipelago in relation to the African coast and Madagascar. Zoomed panel shows the main inner islands. Map generated using ArcMap 10.1 (ESRI 2012).

digging (Gower and Wilkinson 2005), such that there have been few caecilian *Bd* field surveys (Gower et al. 2013). Similarly, sooglossid frogs are cryptic in their habits, undergoing direct development as part of a completely terrestrial life cycle in often inaccessible, elevated areas of moist forest (Nussbaum 1984; Nussbaum and Wu 2007). In contrast, the Seychelles Treefrog (*Tachycnemis seychellensis*: see Maddock et al. 2014), and the likely introduced Mascarene Ridged Frog (*Ptychadena mascareniensis*: see Vences et al. 2004) can be easier to encounter, forming breeding aggregations around marshes, streams, and temporary pools, especially in the evening (*T. seychellensis*) and/or after rain events (*P. mascareniensis*) (Nussbaum 1984). *Bd* is known to infect *P. mascareniensis* in mainland Africa (www.bd-maps.net/surveillance/s_species.asp; accessed 3 March 2014; Goldberg 2007), while Olson et al. (2013) identified a 50% prevalence of *Bd* in African Hyperoliidae, the family to which *T. seychellensis* belongs.

Between May 2010 and March 2013, skin swabs were taken from wild-caught caecilians and metamorphosed anurans at multiple locations across six of the Seychelles' inner islands (Fig. 2). All sampled specimens were swabbed alive and within 24 hours of capture, using rayon-tipped MW100 fine-tip swabs (Medical Wire and Equipment, Corsham, Wiltshire, England). Swabbing protocol generally followed best-practice methods available at the time (e.g., Smith 2011). However, our sampling was undertaken by three separate research groups operating over the period, with differing primary research aims. Therefore, some deviation from standard biosecurity protocol did occur, including capture and initial handling of amphibians without gloves, and (although infrequent) housing more than one animal (but always of the same species) in the same plastic bag upon capture. The principle aim was to gather a representative sample from sites within broadly separate locations, and not to swab every individual encountered or captured. A large proportion of sooglossid frog swabbing was undertaken in the field by a single person (JL). These mostly very small anurans (except for individuals of *Sooglossus thomasseti* measuring greater than 25 mm snout–vent length) were cleaned of debris and soil by transferring them to a small plastic zip-lock bag and rinsing with fresh water sourced at the sampling locality. Although this rinsing may have removed some zoospores, it was performed to reduce the increased likelihood of PCR inhibition. The water was then drained and the animal gently restrained and swabbed within the bag, removing the need for direct handling and minimizing risk

TABLE 1. Distribution of Seychelles amphibians (adapted from Nussbaum 1984), including the 2009 discovery of Sooglossidae on Praslin (Taylor et al. 2012) and their IUCN Red List status (IUCN 2013): LC – Least Concern; EN – Endangered; CR – Critically Endangered. Caecilian taxonomy follows Wilkinson et al. (2011).

Order	Family	Species	Islands present	Conservation status
Anura	Hyperolidae	*Tachycnemis seychellensis*	La Digue, Mahé, Praslin, Silhouette	LC
Anura	Ptychadenidae	*Ptychadena mascareniensis*	Cerf, Curieuse, Frégate, Grand Soeur, La Digue, Mahé, North[a], Praslin, Silhouette	LC
Anura	Sooglossidae	*Sooglossus sechellensis*	Mahé, Praslin, Silhouette	EN
Anura	Sooglossidae	*Sooglossus thomasseti*	Mahé, Silhouette	CR
Anura	Sooglossidae	*Sechellophryne gardineri*	Mahé, Silhouette	EN
Anura	Sooglossidae	*Sechellophryne pipilodryas*	Silhouette	CR
Gymnophiona	Indotyphlidae	*Grandisonia alternans*	Félicité, Frégate, La Digue, Mahé, St. Anne, Silhouette	LC
Gymnophiona	Indotyphlidae	*Grandisonia larvata*	Félicité, La Digue, Mahé, Praslin, St. Anne, Silhouette	LC
Gymnophiona	Indotyphlidae	*Grandisonia sechellensis*	Mahé, Praslin, Silhouette	LC
Gymnophiona	Indotyphlidae	*Hypogeophis brevis*	Mahé	EN
Gymnophiona	Indotyphlidae	*Hypogeophis rostratus*	Cerf, Curieuse, Félicité, Frégate, Grand Soeur, La Digue, Mahé, Praslin, St. Anne, Silhouette	LC
Gymnophiona	Indotyphlidae	*Praslinia cooperi*	Mahé, Praslin	EN

[a] New locality record

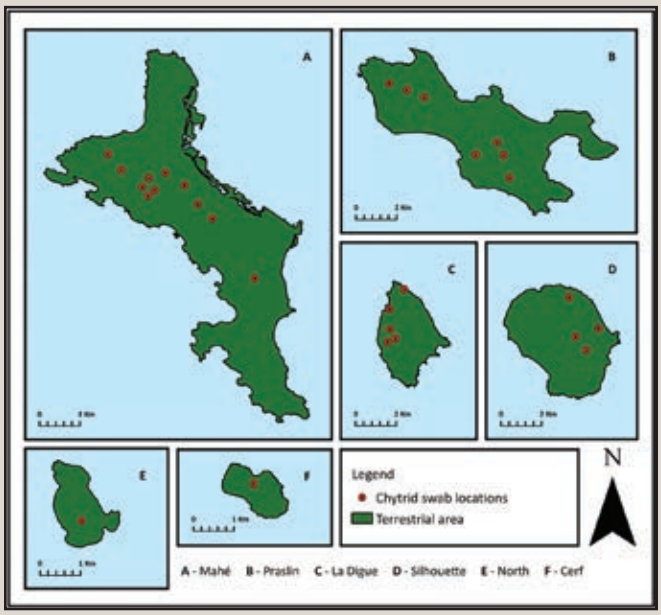


FIG. 2. Sampling localities for *Batrachochytrium dendrobatidis* across the Seychelles inner islands. Map generated using ArcMap 10.1 (ESRI 2012).

IMAGE BY JIM LABISKO



FIG. 3. *Sooglossus sechellensis* from Mahé, Seychelles Archipelago.



IMAGE BY DAVID GOWER

FIG. 4. *Grandisonia alternans* from Silhouette, Seychelles Archipelago.

of cross-contamination. Larger anurans, and sooglossid frogs processed when field assistance was available, were sampled using the standard technique (Smith 2011). Caecilians were swabbed dorsally, laterally, and ventrally along the length of the body, and also around the vent and head. Gloves were changed between each individual except where two or more specimens had been housed in the same plastic bag. All amphibians not retained as vouchers as part of broader research aims were released at their place of capture. Swabs were kept in the dark and transferred to cool storage, mostly refrigerated within 12 h and frozen within one week of completed fieldwork.

DNA extractions and quantitative real time Taqman® polymerase chain reaction (qPCR) assays were performed at the Institute of Zoology (London, UK), using methods adapted from Boyle et al. (2004). DNA was extracted from swabs using bead beating with 0.5 mm silica beads and 60 µl PrepMan Ultra (Hyatt et al. 2007). The qPCR amplifications were performed in 25 µl reactions using *Bd* primers ITS-1 (forward): 5'-CCT TGA TAT AAT ACA GTG TGC CAT ATG TC-3' and 5.8S (reverse): 5'-AGC CAA GAG ATC CGT TGT CAA A-3', specific to the ITS-1/5.8S region of rDNA (Boyle et al. 2004). Standards of 100, 10, 1 and 0.1 *Bd* DNA genomic equivalents and negative controls were used in each run. Bovine serum albumin (BSA) was included in the TaqMan® master mix, to reduce inhibition of the PCR (Garland et al. 2010). Each sample was run in duplicate and no amplification in either replicate indicated a negative result.

A total of 291 skin swabs were obtained from Seychelles amphibians, representing 10 of the 12 species known to occur across the archipelago. All 213 anurans and 78 caecilians tested negative for *Bd* (comprising 66 *Sooglossus sechellensis* [Fig. 3]; 13 *S. thomasseti*, 14 *Sechellophryne gardineri*, 99 *Tachycnemis seychellensis*, 21 *Ptychadena mascareniensis*, 18 *Grandisonia alternans* [Fig. 4], 7 *G. larvata*, 10 *G. sechellensis*, 6 *Hypogeophis brevis*, 23 *H. rostratus*, 14 unidentified caecilians) (Table 2). No macroscopic presentation of chytridiomycosis-like symptoms or associated mortality was observed in any sampled individual, or in any amphibian encountered during the fieldwork. Our results suggest a widespread absence of *Bd* between 2010 and 2013 across six of the eleven amphibian-inhabited islands of the Seychelles archipelago. Some caution should be exercised in interpreting our results as indicating that the Seychelles are free of *Bd*. Many of the locations sampled were in close proximity to one another and/or linked by contiguous habitat, and so could be described as a single location for the purposes of achieving the recommended minimum sample size of 30 amphibians per site (Smith 2011), but the temporal differences between site surveys and overall limited sampling invariably resulted in this not being achieved (Table 2), leading to the possibility of type II errors. Also, the recommendation for sampling >59 individuals to detect *Bd* when infection rate is low (Skerratt et al. 2008) was achieved for only two species sampled (*T. seychellensis*, *S. sechellensis*), two islands sampled (Mahé and Praslin), and for the two pooled samples of all anurans and all caecilians. Prevalence of *Bd* infection in anurans indicates seasonal peaks in the cooler months (Berger et al. 2004; Retallick et al. 2004; Kriger and Hero 2007) even with little seasonal temperature variation (Whitfield at al. 2012). Sampling of Seychelles amphibians was not undertaken during the two (historically) coolest months of July and August. However, housing more than one animal in the same capture bag, although limited in occurrence, increased the opportunity for cross-contamination from chytrid zoospores, making detection of *Bd* more likely by fostering false-positive results for infection.

TABLE 2. Numbers of amphibians sampled for *Batrachochytrium dendrobatidis* across six Seychelles islands. No samples were *Bd*-positive. Sampling localities shown in Fig. 2.

Species	Island	No. of sampling sites	No. of individuals sampled
Ptychadena mascareniensis	Mahé	1	1
	North	1	17
	Praslin	1	1
	Silhouette	1	2
Sechellophryne gardineri	Mahé	2	9
	Silhouette	2	5
Sooglossus sechellensis	Mahé	7	25
	Praslin	4	39
	Silhouette	2	2
Sooglossus thomasseti	Mahé	4	8
	Silhouette	2	5
Tachycnemis seychellensis	La Digue	2	11
	Mahé	3	42
	Praslin	5	32
	Silhouette	1	14
Grandisonia alternans	Mahé	4	6
	Silhouette	2	12
Grandisonia larvata	Mahé	2	2
	Praslin	2	4
	Silhouette	1	1
Grandisonia sechellensis	Mahé	2	6
	Praslin	1	1
	Silhouette	1	3
Hypogeophis brevis	Mahé	2	6
Hypogeophis rostratus	Cerf	1	2
	La Digue	2	4
	Mahé	1	4
	Praslin	2	6
	Silhouette	2	7
Unidentified caecilian	Praslin	2	4
	Silhouette	1	10

Direct development—a reproductive mode adopted by the Sooglossidae and at least one Seychelles caecilian (*H. rostratus*; Nussbaum 1984)—may provide a limiting factor to the transmission of *Bd* between and among amphibians (Todd 2007; but see Longo and Burrowes 2010). The probably more vagile *T. seychellensis* and *P. mascareniensis* require water bodies for aquatic larval development, and potentially present more suitable hosts for the dispersal and spread of *Bd*. Due to previous evidence of human-mediated trans-oceanic dispersal (Vences et al. 2004), *P. mascareniensis* in particular may lend itself to continuing introduction and transportation by way of tourist and/or domestic traffic, especially among the main islands of Mahé, Praslin, and La Digue (Fig. 1). This species' propensity for dispersal was evidenced first-hand during fieldwork following the discovery of a novel, reproducing population on North Island. Similarly, and despite no currently recorded infection or capacity as a host for *Bd* (www.bd-maps.net/surveillance/s_species.asp; accessed 21 September 2014), the recent discovery of Asian Common Toads (*Duttaphrynus melanostictus*) on the east coast of Madagascar, having likely arrived in shipping containers from Asia (Kolby 2014a), highlights a further risk to Seychelles endemic fauna as a potential disease vector. The significantly shorter shipping distances among Madagascar, the Mascarenes, and Seychelles islands undoubtedly elevates the risk of further human-mediated dispersal of this potentially invasive species.

Links between climate, temperature, and *Bd* have been documented (see Pounds et al. 2006; Bosch et al. 2007; Lips et al. 2008; Rohr and Raffel 2010; Olson et al. 2013). In tropical regions, elevated, moist, and riparian habitats are home to amphibian species considered most likely to be severely threatened by *Bd* (Wake and Vredenburg 2008). The endemic Seychelles amphibians fall into at least two, and often all three of these categories which, combined with their restricted range, highlights the requirement for targeted conservation measures (Sodhi et al. 2008). In light of the recent discovery of *Bd* in Malagasy anurans (Kolby 2014b), and given the potential susceptibility of Seychelles amphibians, continued disease monitoring warrants consideration as part of ongoing conservation work for this globally significant amphibian community. Effective implementation of Seychelles' recently approved Biosecurity Act (Animal and Plant Biosecurity Act, 2014) is consistent with maintaining such vigilance.

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HERPETOCULTURE

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Yuman Fringe-toed Lizard (*Uma rufopunctata*) Care and Breeding at the Phoenix Zoo

Fringe-toed lizards (Phrynosomatidae: *Uma* spp.) are a unique genus, highly adapted to the native windblown, fine, sandy habitats of the southwestern U.S. and northwestern Mexico (Stebbins 1985). They possess a flattened body and tail, a countersunk jaw, and a chisel-like snout—all traits that allow them to rapidly burrow under loose sand. Overlapping and inter-locking eyelids, valves in the nostrils (Stebbins 1943), and flaps covering the ears keep the fine sand out of these orifices. Extended, elongated scales on the rear toes allow the species to run more easily on loose sand (Stebbins 1985; Brennan and Holycross 2006; Lemm 2006).

Uma has undergone some recent taxonomic changes (Heifetz 1941; Crother et al. 2003). Although first described by Cope in 1895, the Yuman Fringe-toed Lizard (*U. rufopunctata*) was considered a subspecies of the Colorado Fringe-toed Lizard (*U. notata*) until recently (Trepanier and Murphy 2001). *Uma rufopunctata* is a medium-sized lizard, up to ca. 120 mm snout–vent length (SVL). They are restricted to windblown, sandy dunes, flats, and washes in the most arid areas of extreme southwestern Arizona (Yuma Co.), USA and northwestern Sonora, Mexico (Brennan and Holycross 2006; Turner and Rorabaugh 2009). Both the habitat and lizard are sensitive and threatened by off-road vehicle use (Bury and Luckenbach 1983; Luckenbach and Bury 1983; Jennings and Hayes 1994), climate change, and agricultural and commercial development (Bagne and Finch 2012). Additionally, the geographic range of *U. rufopunctata* is small, encompassing less than 2000 km^2 (Hammerson et al. 2007). Consequently, the Center for Biological Diversity petitioned the U.S. Fish and Wildlife Service to move the classification of this species from Near Threatened (Hammerson et al. 2007) to Endangered in 2012 (Adkins Giese et al. 2012).

Numerous traits of *Uma* spp. have been examined (e.g., Heifetz 1941; Stebbins 1944; Earle 1962; Carpenter 1963; Turner 1998; Turner and Schwalbe 1998). Mayhew examined testes and ovaries of field-collected *U. inornata* (1965), *ornata* (1966a), and *scoparia* (1966b) to determine the breeding cycle of males and females. Similarly, Goldberg (2012) examined preserved specimens to describe the reproductive cycle in *U. rufopunctata*. Still, due to recent taxonomic changes (Heifetz 1941; Crother et al. 2003) and a lack of current research on the genus, much remains unknown about fringe-toed lizards.

The Phoenix Zoo received 3.4 *U. rufopunctata* from the Arizona Game and Fish Department on 12 June 2012. Currently, all animals housed by Association of Zoos and Aquariums (AZA) facilities are animals that originated from our 3.4 founders. We have created a managed breeding program for the species in an attempt to supply animals to interested AZA-accredited zoos across the country, while creating a sustainable *ex situ* population. We have also gained additional information about their needs, natural history, and growth, described here.

Captive husbandry.—During 2013, all animals were maintained either on exhibit (2.3 animals at a time) or in a breeding enclosure (one pair at a time). Both breeding and exhibit enclosures were glass tanks measuring ca. 91 x 46 x 43 cm with sand substrate and rocks for basking under an overhead Exo Terra® 160-watt Solar Glo UV/heat bulb. Temperatures ranged from 43°C on the sand surface under basking lights to 28°C. Although warmer basking was offered via perching, animals would not climb, preferring to bask in the top layer of sand, on the sand surface or on rock surfaces. Each breeding enclosure also contained two nest boxes, 6-qt. plastic, open-topped containers measuring ca. 38 x 23 x 15 cm. One container was

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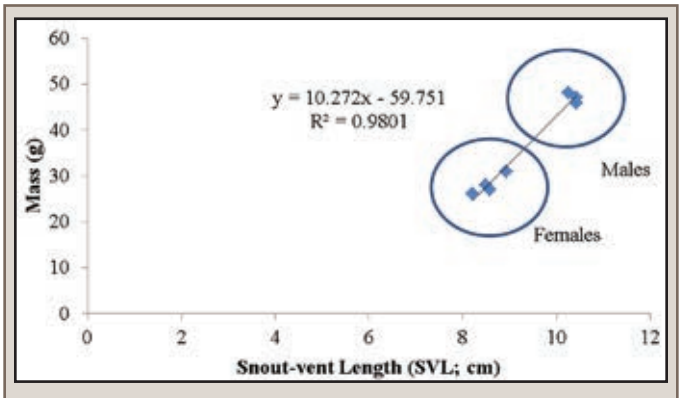


FIG. 1. Mass (g):snout–vent length (SVL; cm) ratio as measured on 10 May 2014 of all adult *Uma rufopunctata* at the Phoenix Zoo.

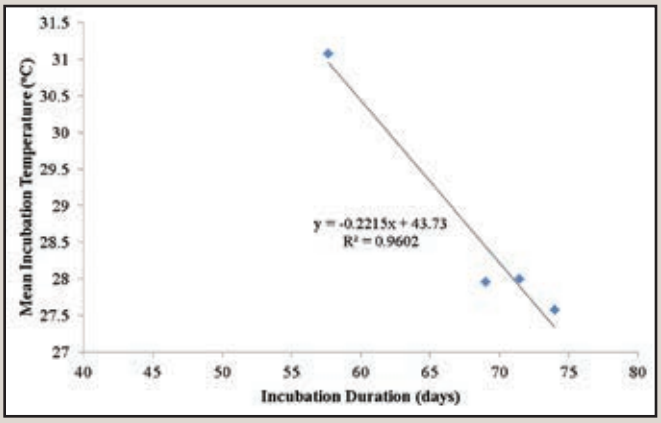


FIG. 2. Incubation duration as a relation of the mean incubation temperature for four *Uma rufopunctata* egg clutches. Note: Clutch #4 was not included as the only egg that was incubated from this clutch died immediately after hatching for unknown reasons; incubation length of clutch #4 was 69 days and mean incubation temperature was 27.6°C.

filled with an 8:1 sand:water mixture and the other was filled with a 16:1 sand:water mixture. Nest boxes received supplemental heating from above via a 40 W radiant heat bulb on 24 h/day. Boxes were weighed weekly and lost water weight was added back to maintain specific saturation levels. Animals were rotated off exhibit, one pair at a time, to allow for known lineage and breeding of multiple animals throughout the year. Copulation was observed on 3 July 2013. Male-male combat was observed among all three males on 12 November 2013 when all males were separated from females and housed together off exhibit while animals were cooled over the winter (Tietgen and Foster, unpubl.). One adult male had to be separated after several weeks due to weight loss and a small rostral abrasion. We now house all mature males separately.

Adult diet has included various invertebrates, such as crickets, roaches, mealworms, and waxworms, offered 4–5 times weekly. Crickets were gut-loaded with Zeigler® cricket diet and all prey was dusted with Repashy® Calcium Plus or TetraFauna Reptocal® reptile supplements. Because the species has been described as omnivorous (Stebbins 1985), a mixture of leafy greens and vegetables was also provided two times per week in addition to occasional natural browse. The lizards did not appear to eat salad mix or natural browse, however, preferring invertebrate food. Neither the exhibit nor the breeding enclosure contained standing water. Lizards were misted once per week to provide small regions of humidity.

This species has been very active in their enclosures and has proven to be an effective exhibit animal at the Zoo. When on exhibit, they have been reliably visible and often observed sand swimming only to re-emerge from beneath the substrate. They cohabitate well in mixed-sexed groups with little apparent aggression (although male-male aggression has been noted) or weight disparities that might indicate high levels of competition for food.

Adults.—Our 3.4 founder animals were less than one year of age when we received them, based on their masses at acquisition; mean (± 1 Standard Error [SE]) was 14.7 g (± 2.37). They were managed as a colony in the exhibit enclosure until our concentrated breeding efforts began in February 2013. At this point we marked them for individual identification with cattle markers (Baumer and Foster 2011) and took photographs of the unique bands on the ventral side of the tail for a secondary means of individual identification. Passive Integrative Transponders (PIT tags) have since also been placed in these animals as well.

Males have a greater SVL than females in other *Uma* species (Mayhew 1965; 1966a, b; Gadsen et al. 2006) and *U. rufopunctata* (Goldberg 2012). Mass of *Uma rufopunctata* had not been described previously. Mass of our adults was recorded on 9 April 2014, and males were significantly larger than females (mean mass [± 1 SE] = 46.1 g [± 1.40] and 28.5 g [± 1.28], respectively; p = 0.0003). Mass and SVL were recorded on 10 May (Fig. 1). Mass was correlated with SVL (r^2 = 0.9801). Both mass and SVL differed between sexes with males being larger in both measures (p = 0.0038 and p = 0.0024, respectively). Notably, one of the 2013 hatchlings had lost its tail, contributing to a lower mass to SVL ratio than would otherwise be expected.

Breeding.—Between 3 March 2013 and 22 September 2013, five clutches of fertile eggs were produced by three females through our managed breeding efforts. Breeding setups were designed without significant knowledge of nesting conditions of wild *Uma;* we therefore provided the thermal heater, deep nesting substrate, and two levels of saturation to allow females a variety of nesting conditions from which to choose. Females consistently deposited eggs in the 8:1 sand:water mixture. As a result, we modified breeding enclosures in 2014 to reflect this preference. Females consistently dug holes several days prior to oviposition and filled the nest hole after completing oviposition. Staff monitored the females closely once they began digging and were able to carefully excavate eggs post-oviposition. All eggs were laid on the bottom of the nest boxes, approximately 14 cm deep. One female developed eggs on exhibit, and was moved to the breeding enclosure with an established pair to nest several days prior to egg deposition on two occasions. These moves were performed to prevent reproductive complications as the exhibit did not offer nesting opportunities; the animal successfully nested on both occasions.

Eggs and incubation.—Mean (± 1 SE) egg clutch size was 3 (± 0.45); range 2–4. This is consistent with clutch sizes of preserved specimens (Goldberg 2012). We took the mass of four individual eggs from two separate clutches; mean was 1.925 g (± 0.165); range = 1.7–2.4 g. All eggs were placed in Suspended Incubation Method (S.I.M.) containers (Squamata Concepts LLC, Staten Island, New York; Baumer et al. 2012) in an Avey® RCAB200 Reptile Cabinet incubator for incubation. Clutches were incubated at 27–31°C with eggs hatching in 58–74 days (Fig. 2). Incubation duration was strongly correlated with mean incubation temperature with higher temperatures resulting in shorter incubation times (r^2 = 0.9537; Fig. 2). Of 14 viable eggs laid, 13 were incubated and one was damaged during excavation. Of the 13 eggs incubated, 10 hatched. The only egg produced from clutch 4 hatched, but the hatchling died immediately afterwards.

Hatchlings.—Mean mass of hatchlings was 2.3 g (± 0.08). All hatchlings were marked with cattle markers for individual recognition, as with the founders. Photographs of the ventral side of the tail were also taken for a secondary means of individual identification until the animals were large enough for placement of PIT tags.

Hatchlings were reared with siblings in glass aquaria modeled after the adult enclosures. Sand substrate was used with large rocks for basking sites underneath an Exo Terra® 160-watt Solar Glo UV/heat bulb. Hatchlings were fed appropriately sized invertebrates 5–7x weekly for the first six months, after which

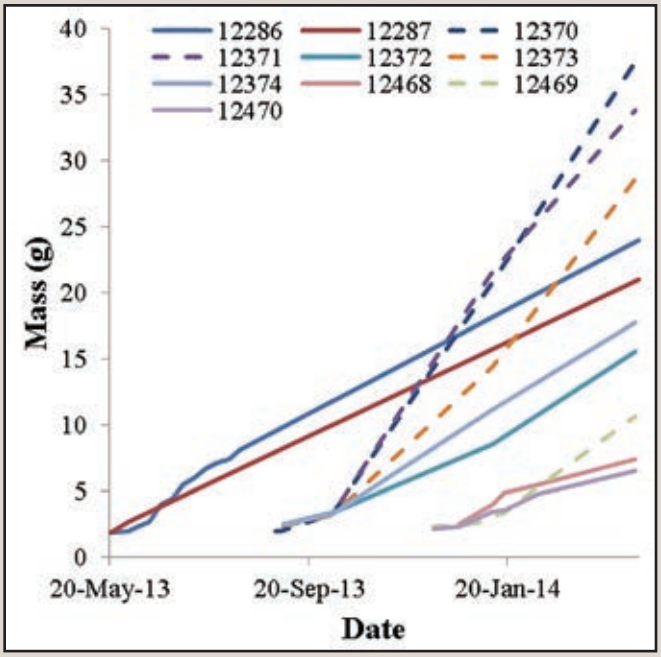


FIG. 3. Growth data of *Uma rufopunctata* hatched at the Phoenix Zoo; females are designated with solid lines and males with dashed lines. Clutch #1 (#12286 and 12287, females) hatched on 8 May 2013. Clutch #2 (#12370, male) hatched on 30 Aug 2013. Clutch #3 (#12371–74) hatched on 4–5 September 2013. Note: #12373 lost its tail and as a consequence has a lower mass than would be expected, but is still heavier than female clutch-mates. Clutch #5, animals #12468–12470 hatched on 4–5 December 2013. Note the more rapid growth rate of males.

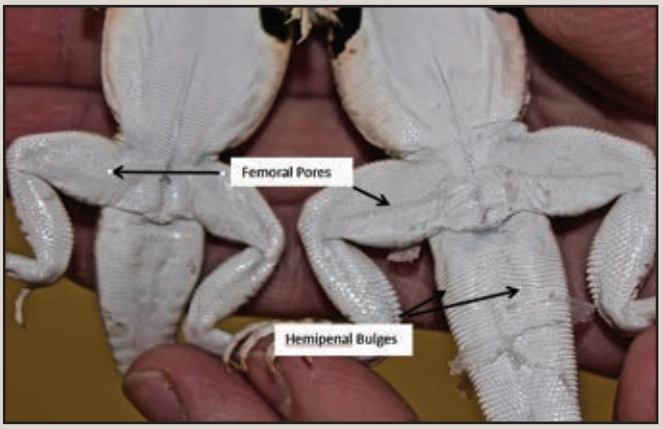


FIG. 4. Photograph comparing ventral side of a nine-month male (right) and thirteen-month female (left) *Uma rufopunctata* noting the more prominent femoral pores and hemipenal bulges of the male.

they were reduced to the adult diet of 4–5x weekly. Hatchlings cohabited well and food competition was minimal. A single animal lost 50% of its tail through a sudden event, although we cannot verify if this injury was caused by an encounter with another hatchling or a mishap involving the tank furniture.

Hatchling growth data were also recorded (Fig. 3). By just over half a year in age, the sex of hatchlings was easily determined. Males were larger than female clutch-mates at this age (Fig. 3), displayed more prominent striping, and had larger, more prominent femoral pores and hemipenal bulges (Fig. 4). On 8 Jan 2014, one of two juvenile females housed together laid infertile eggs at 8 months of age; weights of these animals were 14.4 and 18 g. Observations of *U. notata* by Mayhew (1966) predict that a small number of wild individual *Uma* may breed in the summer following hatching; the abundance of food in a captive setting will likely increase the number of individuals showing such early development.

Uma rufopunctata appears to be an easy-to-breed species under the conditions described above. Their unique adaptations, behaviors, natural history, and high activity levels, make them desirable exhibit animals for zoos. Additionally, this is an important native species to work with. Their small geographic range makes *U. rufopunctata* extremely vulnerable and they are threatened by habitat degradation and climate change (Bagne and Finch 2012).

We can apply what we have learned about captive propagation of *U. rufopunctata* to other fringe-toed lizard species including the endangered Coachella Valley Fringe-toed Lizard (*U. inornata*). This species is restricted to the Coachella Valley, Riverside Co., California, in an area less than 500 km^2. Here the entire species apparently occurs in fewer than five locations and the habitat quality and area, much like that of *U. rufopunctata*, is declining (Hammerson 2007). Our efforts to establish husbandry and breeding protocols for *U. rufopunctata* might allow this species to be a model for its endangered congener.

There is still much information to be gained about *U. rufopunctata* and other *Uma* species. As with many species occupying small geographic ranges in remote areas, much can be learned by working with fringe-toed lizards in captivity. Future research at the Zoo will attempt to investigate temperature-dependent sex determination in *U. rufopunctata*.

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Captive Husbandry of the Arakan Forest Turtle (*Heosemys depressa*) and its Implications for Conservation

The Asian Turtle Crisis, officially identified in the late 1990s (Behler 1997), has resulted in the near or complete extinction of many species of turtle in Southeast Asia in the past few decades. Populations of Asian tortoises and freshwater turtles are under threat from a variety of human impacts including collection for local consumption, habitat degradation and loss, and most significantly, the regional and international trade for food, medicine, and the pet market. In the 1990s, this illegal trade brought in a minimum of 13,000 tons of live turtles each year (Van Dijk 2000). In recent years, the availability of chelonians has decreased as their populations have dwindled due to overwhelming collection pressures, which has increased the value of each turtle. This has brought emphasis to the pet trade, wherein endangered and foreign chelonians are the driving factors in purchases and owning one of these rare animals indicates social status in Asian cultures (Foley et al. 2012). Nonetheless, Asian chelonians continue to be removed from the wild at unsustainable rates.

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Harvesting pressures are so extreme that conservation efforts to save some of these species exclusively in their home ranges may be unsustainable, and *ex situ* populations have arisen as crucial components for long-term conservation of chelonian biodiversity (Horne et al. 2011). The remote location and nature of many endangered turtle species' natural distribution, as well as the rapidity with which the Asian Turtle Crisis has taken place, has created a situation wherein conservation stakeholders have little information about these species' natural history, behavior, habitat preferences, and reproduction. These knowledge gaps present challenges to the development of captive and field conservation efforts. Through the interpretation of limited data on natural histories, regional climates and biomes, trial-and-error approaches, and scientific research, *ex situ* efforts are coming closer to reaching their full, and necessary, conservation potential.

TABLE 1. Clutch size and hatch rate for *Heosemys depressa* at Zoo Atlanta to date. Year of ovipositon is reported here; note that eggs hatched in following calendar year.

Year of ovipostion	Clutch size	# Hatched	% Success
2004 – Female 1	4	1	25%
2005 – Female 1	2	2	100%*
2006 – Female 1	4	2	50%
2007 – Female 1	4	2	50%
2008 – Female 1	4	0	0%
2009 – Female 1/2	9**/8	0/1	0%/12.5%
2010 – Female 2	6	4	66%
2011 – Female 2	4	1	25%
2012 – Female 2	8	1	12.5%
2013 – Female 2	8	5	62.5%

*The two offspring from 2006 (clutch laid in 2005), died within 60 days of hatching from yolk peritonitis. ** Female 1 died due to dystocia from clutch in 2009.

PHOTO BY LUKE WYRWICH



FIG. 1. Adult outdoor enclosure (3 x 5 m). Note overhang along chain link to prevent escape.

PHOTO BY LUKE WYRWICH



FIG. 2. Young juvenile enclosure (0.6 x 1.2 m). Left, screen-top lifted.

Heosemys depressa is an iconic example of a species severely affected by the Asian Turtle Crisis. The IUCN Red List has categorized the species as Critically Endangered and the species was ranked in the Top 25 Most Endangered Tortoises and Freshwater Turtles list in 2003 and 2007 and the top 30 in 2011 (Rhodin et al. 2011). Arakan Forest Turtles were thought to be extinct, with no live specimens observed for over 100 years, until biologists rediscovered the species in a Chinese food market in 1994 (Iverson and McCord 1997). They were not observed in the wild by biologists until the year 2000 (Platt et al. 2003). *Heosemys depressa* is not only rare in the wild, but also rare in captivity. As of August 2014, the Association of Zoos and Aquariums' regional studbook reported the captive population to consist of 24 males, 28 females, and 14 juveniles of unknown sex (24.28.14); of these, only 12.5.0 were wild-caught adults (B. Hughes, pers. comm.).

The natural history and geographic distribution of *Heosemys depressa* are poorly known, but summaries of the available information were provided by Platt and Myo Myo (2009) and Platt et al. (2003, 2010b). Arakan Forest Turtles are endemic to a small region of western Myanmar called the Rakhine Hills (formerly the Arakan Hills or Arakan Yoma [in Burmese yoma translates to hill]). Arakan Forest Turtles have been documented in the southern Rakhine Hills, within the Rakhine Yoma Elephant Range, and were recently found by biologists farther north in the southern Chin Hills (S. Platt, pers. comm.). This mountainous strip extends along the western coast of Myanmar and is characterized by high, steep parallel ridges separated by streams that flow within deep, restricted valleys. The habitat is composed mainly of thick bamboo (~75%) with large evergreen trees scattered throughout (Platt et al. 2010a). The climate is broken into three distinct seasons: a wet season brought on by the southwesterly monsoons occurring from June through October, a cool dry season from November to early February, and a hot dry season from late February to May (Platt et al. 2010b). The habitat preferences of *H. depressa,* according to interviews with local villagers and observations of Platt et al. (2010b), appears to be mainly dense bamboo forests, but they have also been observed in evergreen forests, deciduous forests, second-growth forests, and even sugarcane fields at elevations <500 m (Platt et al. 2003). Arakan Forest Turtles seem to be most active during the wet season and partially dormant during the drier months. They have been observed climbing hills roughly 60° steep and specimens have been found buried deep in forest leaf litter (Platt et al. 2010b).

These observations and natural conditions guide the perception and management techniques used to care for *Heosemys depressa* in captivity. Some of the key aspects of their husbandry are high humidity, constant access to a water source sufficiently large for soaking, proper diet, and annual cycling of adults for breeding. The following has been the approach to captive husbandry of this species at Zoo Atlanta. Considering situational variables such as spatial limitations, budget, and the climate of other areas, husbandry techniques may need modification from what is described here. The geographic location of Zoo Atlanta had significant implications for how the collection was managed. What has worked for us is probably not the only solution to successfully keeping and breeding *Heosemys depressa,* as there still is much to learn about caring for this poorly understood species.

SPECIMEN HISTORY AT ZOO ATLANTA

Zoo Atlanta acquired its first pair of *Heosemys depressa* in 2001. The male had a carapace length of 244 mm, width of 161 mm, and

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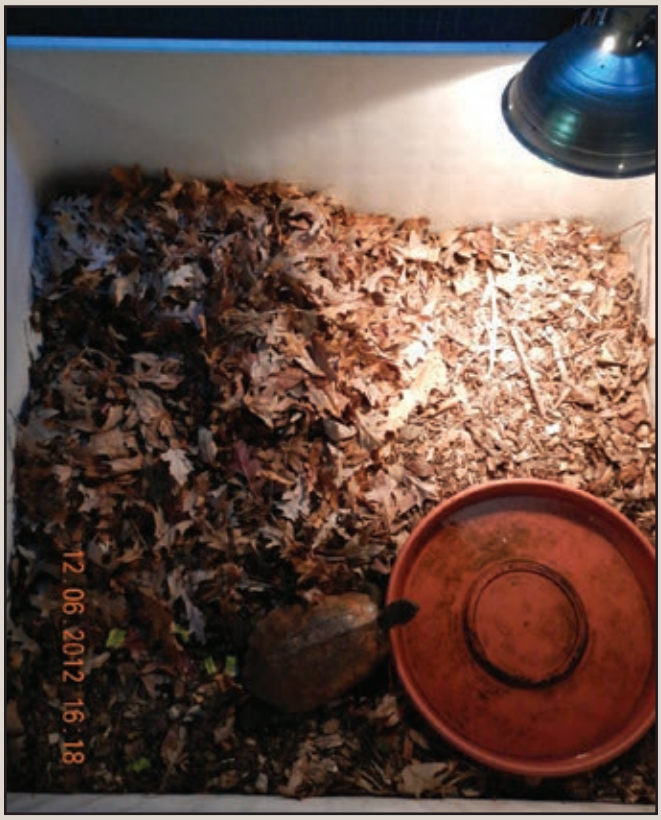


Fig. 3. Adult indoor enclosure. Note pile of leaves in upper left corner in which *Heosemys depressa* often burrowed for long periods.

PHOTOS BY DAVID BROTHERS



Fig. 4. A) Adult in humid pile of leaves, a favorite pastime. B). Close-up view of adult in leaf pile. The turtle's head was usually all that was visible.

mass 2.25 kg. The female had a mass of 2.23 kg. We successfully bred this pair for the first time in 2004/2005 (Table 1). This female died in fall of 2009 due to breeding complications. We acquired an additional female in spring 2009 from Zoo Miami, which acquired her in 2001. She measured a carapace length of 232 mm, width of 164 mm, and a mass of 2.87 kg upon arrival at Zoo Atlanta. We have successfully bred her multiple times with our original male since 2009 (Table 1). An additional male was added to the collection in 2011, which has not yet been in a breeding situation. This male had a carapace length of 228 mm, width of 159 mm and a mass of 1.84 kg. Of the 19 offspring produced thus far, 17 were alive and well at the time of writing (August 2014). The two offspring from 2006 (clutch laid in 2005), died within 60 days of hatching from yolk peritonitis.

Housing, Temperature, and Humidity

Outdoors.—Animals were kept outside during the warmer months of the year typically from April through October. The typical low-temperature threshold for keeping adults outside was 10°C at night, but they have been exposed to temperatures in the 4.4–9.4°C range when the following day forecasted highs of 21–26°C. Hatchlings and juveniles were not pushed to these extremes and were transferred indoors when the night time low was ~13°C.

Our adult pair of *H. depressa* was maintained in an enclosure measuring 3 x 5 m (Fig. 1), and one adult male was kept individually in an enclosure measuring 2.4 x 3 m. Larger juveniles (2 years or older) were kept in enclosures that measured 1.2 x 1.2 m or larger. Smaller juveniles (2 years old or younger) and hatchlings (after yolk was absorbed) were kept in enclosures that were 0.6 x 1.2 m with a screen top to prevent predation (Fig. 2). Arakan Forest Turtles have proven to be great climbers and their ability to escape should not be under-estimated. A screen top or an overhang should be used at the top of enclosure walls to make them secure.

Table 2. Egg masses and dimensions for *Heosemys depressa* at Zoo Atlanta in 2013. Measurements recorded 33 days after oviposition.

Egg	Mass (g)	Length (mm)	Width (mm)
1	54.2	68.52	35.99
2	57.0	64.66	37.68
3	51.9	68.19	35.31
4	35.4	63.67	35.13
5	49.7	63.60	35.38
6	51.8	63.63	36.19
7	47.8	61.14	35.77
8	48.0	63.75	34.49

Ambient temperature and humidity were subject to the local weather conditions in Atlanta. Temperatures normally ranged from 10–38°C while turtles were outside. For the majority of the time spent outside, day-time highs were 29–36°C. Enclosures were placed in a shady area to mediate high temperatures, which also simulated their natural habitat of bamboo forests. Atlanta's hot summers also bring high humidity, which seemed to be

Table 3. Incubation temperature, length, and hatchling morphometrics for *Heosemys depressa* at Zoo Atlanta in 2014.

Egg #	Incubation temperature (°C)	Incubation time (days)	Measurements recorded (days post-hatching)	Weight (g)	Carapace width (mm)	Maximum carapace length (mm)	Maximum plastron length (mm)
5	30	146	27	45.0	54.48	64.95	56.78
6	30	150	23	35.8	52.64	62.78	55.35
7	30	169	4	35.2	51.09	59.13	53.38
8	30	171	2	35.1	51.09	59.66	55.60
3	26.1	174	26	50.3	57.99	68.26	61.86

PHOTO BY LUKE WYRWICH



Fig. 5. Indoor hatchling enclosure.

favored by *H. depressa*. In our facility, humidity was supplemented by a misting system with Rainbird® irrigation heads to maintain humidity during hotter and drier periods.

Indoors.—Adults were kept individually in enclosures ~1.2 x 1.2 m in a room that was maintained at ~21°C with low ambient humidity of about 40–50% (Fig. 3). The low humidity replicated the dry season that they would experience in their natural habitat. They were misted once or twice a week for about 10–60 seconds to induce feeding. Typically, adults ate little to nothing during their "dry" period indoors; this was observed especially with gravid females. Based on our observations, this dry period seems important for annual reproductive cycling and to induce courtship behaviors the following "wet" season. Older juveniles have also done well in this environment. Younger juveniles and hatchlings were kept in a room maintained at 21–26°C and with higher ambient humidity (60–80%). Lighting was used strategically to offer the individuals a thermal mosaic that included hot spots between 29–34°C for basking behavior. Zoo Atlanta specimens spent more than half of the year outdoors exposed to natural UVB, and consequently, they appeared to remain healthy with the use of regular (non-UVB emitting) fluorescent and incandescent bulbs for light and heat when they were indoors. If animals were only kept inside, they might benefit from use of full-spectrum bulbs that produce UVB.

Water source, Substrate, and Enclosure Furnishing

The large outdoor pens included ponds measuring ~1.2 x 1.8 m and 25 cm at their deepest point. These ponds were constructed with a gentle gradation, with one end being shallow (5 cm) to provide easy access. For adult indoor enclosures, a ~60-cm diameter plastic planter drip-catch saucer was used as a water source. For younger animals, smaller saucers were selected following the general rule that the diameter of the saucer be larger than the turtle for which it was intended.

Substrate for animals in large outdoor enclosures was not manipulated and consisted of natural soil. Indoor enclosures for adults were provided with a natural mulch substrate. Juveniles and hatchlings were maintained on a substrate composed of equal parts sand, sphagnum moss, leaves and three parts coconut fiber. Reproductive females were offered a ~20-cm layer of this substrate mix so they could excavate a nest, which usually occurred in November–December. This mix was designed to hold humidity, allow burrowing, and simulate the forest floor. Leaves were used to cover the entire land area of all enclosures.

A pile of leaves was provided in each enclosure, which acted as natural high humidity refugia (Fig. 4). For indoor setups, this pile was misted as needed to maintain high humidity within the pile (~70–95%). This created a microenvironment of high humidity that appeared to be critically important for health and proper shell growth. Based on our experience, this was arguably the most critical aspect of their husbandry. Other materials, such as sphagnum moss, could be utilized to attain a similar micro-environment. Turtles often spent a large period of time in these piles, sometimes continuously for several days. Similarly, it was observed that all of the *H. depressa* in the Arakan Forest Assurance Colony in Gwa, Myanmar, burrowed and remained hidden in a deep layer of leaf litter offered in their enclosures (K. Platt, pers. comm). Larger piles of leaves offered in adult enclosures outside were used to buffer exposure to colder temperatures. Other refugia favored by *H. depressa* included plastic hides, logs, and live plants.

Diet

Animals were offered salad twice weekly, which included coarsely chopped greens, diced tomatoes, soaked Mazuri

Tortoise Chow®, with finely processed vegetables and fruit. Greens consisted of collard greens, romaine lettuce, and bok choy. Vegetables included sweet potato, yellow squash, zucchini, carrots, green beans, butternut squash, and acorn squash. Fruit was offered sparingly and included cantaloupe, bananas, oranges, kiwi, and apples. These ingredients were mixed together thoroughly. A source of protein was almost always added to juvenile salads. Protein sources included mice, earthworms, and soaked Mazuri Crocodilian Chow®, Mazuri Aquatic Turtle Chow®, Nasco Turtle Brittle®, and/or Reptomin® sticks. Protein seemed to be less important for adults (offered once weekly) than for juveniles and was consequently used in moderation. In our experience, excessive protein often appeared to promote the development of large clutches that could have caused egg binding and death of the 2001 female. Mineral and vitamin supplements were added sparingly about once weekly and included the combination of Miner-all® and Vit-all® or Rep-Cal® Herptivite and Calcium with vitamin D3.

Reproduction

Breeding.—Sexes were maintained separately during their dormant period (~October–April), which appeared to be important for the annual reproductive cycle. Once conditions outside were appropriate in the Spring (see above), they were moved outside together where courtship behaviors and copulation started almost immediately. Rain (natural or artificial) almost always prompted courtship behaviors from the male. Reproductive events were observed most often early in this season and decreased in frequency as it continued.

Females typically laid eggs in November or December, although in one instance, eggs were laid in March. D. Lawson (pers. comm.) also observed this discrepancy in his collection. Females excavated holes about 10–15 cm into the substrate to oviposit and often dug test holes prior to oviposition. Usual clutch size was 2–6 eggs. In our experience, captive clutches larger than six have proven to be problematic, leading to serious health concerns for reproductive females. The clutch in 2013 had a mean mass of 49.48 g (Table 2).

Incubation.—Eggs were collected within 48 h of oviposition. Upon collection, the top of each egg was marked with a pencil to serve as a reference point to maintain its original orientation and prevent accidental rotation and death of the embryo. The eggs were then partially buried, with about half of the egg exposed, in a 1:1 ratio of coarse vermiculite to water by weight, in a covered plastic container measuring 20 x 28 x 13 cm. This egg box had one small hole in each side for air circulation and was placed in a large Nature's Spirit Reptiles® incubator. A bowl of water was used at the bottom of the incubator to ensure a high level of humidity throughout incubation. Typical incubation temperatures were 26.7°C for producing males and 28.8°C for producing females; 30°C was also used to produce females. Hatchlings were sexed endoscopically once reaching ≥ 80 g by Zoo Atlanta veterinary staff. Incubation time ranged from 117 to 173 days, with eggs incubated at higher temperatures hatching about a month earlier. One interesting note of development discovered when eggs were candled was that they did not show signs of development for the first several months of incubation. D. Lawson (pers. comm.) produced eggs of *H. depressa* consistently; however, his experiments with diapausing eggs to shorten incubation failed to produce viable offspring.

Hatchling husbandry.—Hatchlings were allowed to fully leave the egg before removal from the incubator. Their exposed yolk sacs were dipped in a dilute betadine solution to prevent infection. They were set up in a tank measuring ~50 x 25 x 30 cm with a thick layer of moist sphagnum moss and a shallow water source (Fig. 5). Hatchlings were not offered food for the first week and usually started feeding two or three weeks after hatching. Hatchlings were offered a salad as described above, but tended to prefer protein. Once their yolk sac was absorbed and plastron completely closed, they were transferred to a more naturalistic setting, similar to that of juveniles described above.

Discussion

What has been described here represents significant institutional development in husbandry techniques for the Arakan Forest Turtle and we continue our breeding program with our 2.1 adults. Though there has been considerable progress toward the captive conservation efforts for this enigmatic species, there is still a substantial amount to be accomplished. Zoo Atlanta's breeding success, measured through hatch rate, has ranged from 0–66 percent/clutch, leaving ample room for improvement. We are fine-tuning and adjusting our management techniques to create a more successful program. There undoubtedly is a need for additional field research on wild populations so we can learn more about the species' natural behaviors, preferences, and needs. This information from the field would impart scientific rigor to our efforts and techniques instead of being based on anecdotal experience. Observations and scientific studies of captive populations may also help us learn about difficult to observe aspects of the biology of this secretive species.

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- Preference will be given to images that depict poorly known species. These could include recently described taxa or species for which a color illustration has never been published.
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- Images should not have been published previously nor concurrently submitted for publication elsewhere (print or electronic media).

Images for consideration should be submitted as low-resolution jpg or pdf files. Do not send full resolution images unless requested to do so. All submissions or questions should be directed to the Editor (herpreview@gmail.com).






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Herpetological Review publishes brief notices of new geographic distribution records in order to make them available to the herpetological community in published form. Geographic distribution records are important to biologists in that they allow for a more precise determination of a species' range, and thereby permit a more significant interpretation of its biology.

These geographic distribution records will be accepted in a **standard format** only, and all authors *must* adhere to that format, as follows: SCIENTIFIC NAME, STANDARD ENGLISH NAME if available (for the United States and Canada as it appears in Crother [ed.] 2012. *Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, with Comments Regarding Confidence in Our Understanding*. 7th ed. Herpetol. Circ. 39:1–92 [available from ssarbooks.com], for Mexico as it appears in Liner and Casas-Andreu 2008. *Standard Spanish, English and Scientific Names of the Amphibians and Reptiles of Mexico*. Herpetol. Circ. 38:1–162), LOCALITY (use metric for distances and give precise locality data, including lat/long coordinates in **decimal degrees** and cite the map datum used), DATE (day-month-year), COLLECTOR, VERIFIED BY (*cannot* be verified by an author; curator at an institutional collection is preferred), PLACE OF DEPOSITION (where applicable, use standardized collection designations as they appear in Sabaj Pérez [ed.]. 2013, *Standard Symbolic Codes for Institutional Resource Collections in Herpetology and Ichthyology: an Online Reference*, ver. 4.0, available at http://www.asih.org/) and CATALOG NUMBER (required), COMMENTS (brief), CITATIONS (brief and must adhere to format used in this section; these should provide a geographic context for the new record). Close with author name(s) in bold, capital letters (give name and address in full—spell out state or province names—no abbreviations, e-mail address after each author name/address for those wishing to provide it—e-mail required for corresponding author). Please include distance from nearest previously known record (provide a citation or refer to existing vouchered material to substantiate your report). If publishing specific locality information for a rare or endangered species has the potential to jeopardize that population, please consult with the Section Editor at time of record submission. If field work and/or specimen collection occurred where permits were required, please include permit number(s) and authorizing agency in the text of the note. Generally, this means that permit information should be included for any specimens COLLECTED. This is unnecessary for photo vouchers.

Some further comments. The role of the "Standard Names" lists (noted above) is to standardize English names and comment on the current scientific names. Scientific names are hypotheses (or at least represent them) and as such their usage should not be dictated by a list, society, or journal.

Additionally, this geographic distribution section does not publish "observation-only" records. Records submitted should be based on preserved specimens that have been placed in a university or museum collection (private collection depository records are discouraged; institutional collection records will receive precedence in case of conflict). A good quality photograph (print, slide, or digital file) may substitute for a preserved specimen. Photographic vouchers *must* be deposited in a university or museum collection along with complete locality data, and the photographic catalog number(s) must be included in the same manner as a preserved record. Before you submit a manuscript to us, check Censky (1988, *Index to Geographic Distribution Records in Herpetological Review: 1967–1986*; available from the SSAR Publications Secretary), subsequent issues of *Herpetological Review*, and other sources to make sure you are not duplicating a previously published record. The responsibility for checking literature for previously documented range extensions lies with authors. **Do not submit range extensions unless a thorough literature review has been completed.**

For reports concerning **introduced species**, it is important to note whether a population has become established or if the report represents an isolated occurrence, such as a released captive. Additionally, it will be helpful to include any information that establishes a timeline for the introduction, such as date of first observation.

Please submit any geographic distribution records in the **standard format only** to one of the Section Co-editors: **David C. Blackburn** (Africa and Europe), **Indraneil Das** (Asia, Australasia, South Pacific), **Jerry D. Johnson** (Mexico and Central America, including the Caribbean Basin), **Alan M. Richmond** (USA & Canada), or **Gustavo J. Scrocchi** (South America). Short manuscripts are discouraged, and are only acceptable when data cannot be presented adequately in the standard format. **Electronic submission of manuscripts is required** (as Microsoft Word or Rich Text format [rtf] files, as e-mail attachments)**.** Refer to inside front cover for e-mail addresses of section editors. A template for preparation of geographic distribution notes is available online at: http://ssarherps.org/wp-content/uploads/2014/07/GeoDistNotes_FormattingGuidelines.pdf.

Recommended citation for new distribution records appearing in this section is: Cabral, H., and A. Caballero. 2012. Geographic distribution: Paraguay, Departamento Central: *Pseudoeryx plicatilis*. Herpetol. Rev. 43:622.

CAUDATA — SALAMANDERS

***ANEIDES AENEUS* (Green Salamander)**. USA: GEORGIA: Chattooga Co.: Dirtseller Mountain (34.37°N, 85.47°W; WGS 84). 16 July 2013. Nate Thomas and Matt Elliott. Verified by N. Castleberry. Georgia Museum of Natural History (GMNH 50426). A second specimen, GMNH 50425, was found on Little Sand Mountain. Floyd Co.: Rocky Mountain (34.35°N, 85.29°W; WGS 84). 10 October 2012. Brett Tyler and Nate Thomas. Verified by N. Castleberry. GMNH 50166. Walker Co.: John's Mountain (34.61°N, 85.09°W;

WGS 84). 13 October 2012. Nate Thomas. Verified by N. Castleberry. GMNH 50427. New county records (Elliott 2008. *In* Jensen et al. [eds.], Amphibians and Reptiles of Georgia, pp. 158–160. University of Georgia Press, Athens, Georgia).

Until the discovery of the records reported herein, *Aneides aeneus* was known to occur only in the widely separated Blue Ridge and Cumberland Plateau physiographic provinces of Georgia (Elliott 2008, *op. cit.*). While conducting general biological and ecological inventories on Rocky Mountain two of us (BT and NT) encountered green salamanders in crevices of both cliff and boulder sandstone outcroppings. Rocky Mountain is in the Ridge and Valley physiographic province and far removed from the Cumberland Plateau to the northwest and the Blue Ridge to the northeast. This discovery spawned further searches for this species on other Georgia mountains within this province resulting in the additional Ridge and Valley records documented above. Ridge and Valley records do not exist from adjacent Alabama, but a record from Grainger County, Tennessee ca. 210 km north of the John's Mountain site in Georgia represents the nearest previously known Ridge and Valley record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, Austin Peay State University. 94 pp.). These records suggest that the species may be more widespread in the southern portion of the Ridge and Valley and surveys in appropriate habitats within this province in Alabama and southern Tennessee are warranted.

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***HEMIDACTYLIUM SCUTATUM* (Four-toed Salamander)**. USA: NORTH CAROLINA: McDowell Co.: Box Creek Wilderness, Vein Mountain Tract (35.55400°N, 81.96539°W, WGS 84), ~330 m elev. 24 March 2014. Christopher R. Wilson. Verified by Jeffrey C. Beane. North Carolina Museum of Natural Sciences (NCSM photographic voucher CRW 14-3). Two additional animals were found in the Box Creek Wilderness, Yonguskas Tract (NCSM photographic voucher CRW 14-4) and Thompson Tract (no voucher). New county records (Jeffrey C. Beane, NC State Museum of Natural Sciences, pers. comm.). All animals were females found tending egg clutches under moss at the edge of small temporary pools within forested seepage areas along drainages. These properties are owned by 130 of Chatham LLC, a private land conservation company.

CHRISTOPHER R. WILSON, Unique Places LLC, 9 Bradford Pl, Hendersonville, North Carolina 28791, USA; e-mail: critterfro@gmail.com.

***SIREN INTERMEDIA* (Lesser Siren)**. USA: TEXAS: Williamson Co.: San Gabriel River, TX Hwy 29 at low water bridge crossing, E of Georgetown (30.6459ºN, 97.5850ºW; WGS 84). 19 March 1995. Mike Bartley. Verified by David Cannatella. Texas Natural History Collections (TNHC 70530). New county record (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 447 pp.). Specimen previously collected and cataloged into the TNHC without permit information.

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ANURA — FROGS

***ANAXYRUS (= BUFO) WOODHOUSII* (Woodhouse's Toad)**. USA: TEXAS: Madison Co.: Midway, 3 mi SE (30.9892ºN, 95.7286ºW; WGS 84). 2 May 1953. W. F. Blair. Verified by Travis J. LaDuc. Texas Natural History Collections (TNHC 35880). New county record (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 447 pp.). Specimen previously collected and cataloged into the TNHC without permit information.

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***ELEUTHERODACTYLUS PLANIROSTRIS* (Greenhouse Frog)**. PHILIPPINES: LUZON ISLAND: METRO MANILA: Quezon City, Barangay Mariana (14.618889°N, 121.033056°E; WGS84). 4–9 July 2014. Emerson Y. Sy and Benjamin Eleazar III; Quezon City, Barangay San Antonio (14.64814°N, 121.01459°E; WGS 84). 28 July 2014. Ronald Achacoso. Quezon City, Barangay Diliman (14.65408°N, 121.04819°E, WGS 84). 7 August 2014. Emerson Y. Sy and Benjamin Eleazar IIII. Verified by Fred Kraus. SVL 18.40–23.90 mm. National Museum of the Philippines (Field # EYS 343–348; EYS 352–353). First records for Luzon Island and second known locality for the Philippines. Eight individuals and clutch of eggs collected from three separate localities in a highly populated urban city. Two specimens found inside potted bromeliad plant (Bromeliaceae) and five specimens within a landscaped garden of residential house. A clutch of 15 eggs found under leaf litter in residential garden. One adult female frog found under wooden plank within public park with ornamental plant market stalls. This species is native to the Caribbean Basin, and was first documented in Southeast Asia on Mindanao Island (Olson et al. 2014. Herpetol. Rev. 45:652–653).

EMERSON Y. SY (e-mail: emersonsy@gmail.com), **BENJAMIN ELEAZAR III**, Philippine Center for Terrestrial and Aquatic Research, 1198 Benavidez Street, Unit 1202, Sta. Cruz, Manila, Philippines; **RONALD ACHACOSO**, Philippine Native Plant Conservation Society, Inc. Cottage 1, Ninoy Aquino Parks and Wildlife Center, North Avenue, Diliman, Quezon City, Philippines; **ARVIN C. DIESMOS**, Herpetology Section, Zoology Division, National Museum of the Philippines, Padre Burgos Avenue, Ermita 1000, Manila, Philippines (e-mail: arvin.diesmos@gmail.com).

***ELEUTHERODACTYLUS PLANIROSTRIS* (Greenhouse Frog)**. PHILIPPINES: NEGROS ISLAND: NEGROS OCCIDENTAL: Bacolod City, Barangay Villamonte (10.67666°N, 122.96150°E; WGS84). 4 September 2014. J. C. Martyr. Verified by Fred Kraus. National Museum of the Philippines (Field # EYS 387–EYS 388). Adult female (SVL 22.75 mm) and clutch of eight eggs collected in residential garden. First record from Negros Island. Introduced species in the Philippines, recently recorded on Mindanao and Luzon (Olson et al. 2014. Herpetol. Rev. 45:652–653; Sy et al. 2015. Herpetol. Rev. 46: this issue)

EMERSON Y. SY (e-mail: emersonsy@gmail.com), **JOHN CLIFTON MARTYR**, Philippine Center for Terrestrial and Aquatic Research, 1198 Benavidez Street, Unit 1202, Sta. Cruz, Manila, Philippines; **ARVIN C. DIESMOS**, Herpetology Section, Zoology Division, National Museum of the Philippines, Padre Burgos Avenue, Ermita 1000, Manila, Philippines (e-mail: arvin.diesmos@gmail.com).

***GASTROPHRYNE CAROLINENSIS* (Eastern Narrow-mouthed Toad)**. USA: MISSOURI: Cape Girardeau Co.: Juden Creek Conservation Area, 4.1 km NNE of Cape Girardeau (37.339195, 89.497261; WGS 84). 6 September 2014. E. J. Kessler. Verified by C. A. Phillips. Illinois Natural History Survey (INHS 2014af, photo voucher). New county record (Daniel and Edmond 2014. Atlas of Missouri Amphibians and Reptiles for 2013. <http://atlas.moherp.org/pubs/atlas13.pdf>). Single specimen found under log in woods at the top of a bluff.

ETHAN J. KESSLER, Illinois Natural History Survey, Department of Natural Resources and Environmental Sciences, University of Illinois at Urbana-Champaign, Illinois, USA; e-mail: ekessle2@illinois.edu.

***INCILIUS (= BUFO) NEBULIFER* (Gulf Coast Toad)**. USA: TEXAS: Erath Co.: Tarleton State University, Stephenville, Texas (32.216621°N, 98.220934°W; WGS 84). 18 September 2014. Jacob D. Owen and Colt Hamilton. Verified by Carl Franklin. Amphibian and Reptile Diversity Research Center (UTA A-63146). New county record (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 447 pp.). Individual (16.4 g) found on Tarleton State University grounds at 0615 h on concrete sidewalk after a rainstorm. Specimen was collected under a Texas Parks and Wildlife Hunting Permit issued to Jacob D. Owen (#776440018849).

JACOB D. OWEN (e-mail: jacob.owen@go.tarleton.edu) and **COLT HAMILTON**, Department of Biological Sciences, Tarleton State University, Box T-0100, Stephenville, Texas 76402, USA (e-mail: gamingninja@ymail.com).

***INCILIUS OCCIDENTALIS* (Pine Toad)**. MÉXICO: HIDALGO: Municipality of Metztitlán: Reserva de la Biosfera Barranca de Metztitlán near Acalometlán (20.46984ºN, 98.67137ºW; WGS 84), 1306 m elev. 8 October 2011. René Flores Vargas. Verified by Irene Goyenechea. Colección Herpetológica Fotográfica, Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo (CH-CIB 04, photo voucher). First municipality record and first record for Reserva de la Biosfera Barranca de Metztitlán. This specimen represents a range extension of 35.57 km NW from closest known, but unnamed locality in the Municipality of Agua Blanca de Iturbide (Ramírez-Bautista et al. 2010. Lista Anotada de los Anfibios y Reptiles del Estado de Hidalgo, México. Univ. Autón. Est. de Hidalgo, CONABIO. 104 pp.). The toad was found in the morning under a rock on the bank of Río Venados, surrounded by desert scrub habitat.

LEONARDO FERNÁNDEZ BADILLO (e mail: cyrtopsis@hotmail.com), and **RENE FLORES VARGAS**, Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo, km 4.5 carr. Pachuca-Tulancingo, Mineral de la Reforma, Hidalgo, México.

***PHRYNOBATRACHUS OGOENSIS* (Ogooué River Frog)**. GABON: OGOOUÉ-IVINDO PROVINCE: Buffer Zone of Lopé National Park, Ramba Village (00.3635°S, 11.7872°E; WGS 84), 220 m elev. 6 June 2013. J. G. Larson. Verified by J. Rosado. Museum of Comparative Zoology (MCZ A-149217). Identification was made via comparison to the original species description (Boulenger 1906. Annali del Museo Civico di Storia Naturale di Genova. Serie 3, 2:157–172) and a topotype (MCZ A-14831). Mitochondrial data from 16S ribosomal DNA (GenBank Accession KP247505), the first genetic data for this species, was compared to all other known species of *Phrynobatrachus* for which comparable genetic data exist and was at minimum 6.19% divergent. This is the first record of this species outside of the type locality "Lambarene, Ogowe," in west-central Gabon, extending the known range approximately 175 km E. It is also the first record of this species in the vicinity of a protected area of Gabon, suggesting that this species is also found within the Lopé National Park boundaries. A single gravid female was collected from leaf litter in secondary forest. The specimen was collected under permits from Centre National de la Recherche Scientifique et Technologique (CENAREST; AR0013/13), Agence Nationale des Parcs Nationaux (ANPN; AE130014) and Direction de la Faune et de la Chasse (82/DGFAP).

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***PIPA CARVALHOI* (Carvalho's Suriname Toad)**. BRAZIL: RIO GRANDE DO NORTE: Municipality of Santa Maria: Agreste region, 60 km W Natal (5.854°S, 35.701°W; WGS 84), 137 m elev. 13 June 2014. Jaqueiuto Jorge. Verified by U. Caramaschi. Coleção Herpetológica da Universidade Federal do Rio Grande do Norte, Natal, Rio Grande do Norte, Brazil (UFRN 4142, 4143). Two adult males (UFRN 4142: 30.65 mm SVL, UFRN 4143: 30.46 mm SVL) collected in pond near a rock outcrop. Municipality of Tenente Laurentino Cruz: Seridó region, 170 km W Natal (6.157°S, 36.731°W; WGS 84), 703 m elev. 13 July 2014. Marcelo Kokubum. Verified by U. Caramaschi. UFRN 3457. Adult female (49.51 mm SVL) collected in a pitfall trap in the Caatinga region. This species is only known from the Brazilian states of Pernambuco, Ceará, Paraíba, Bahia, Sergipe, Minas Gerais and Espírito Santo (Miranda-Ribeiro 1937. O campo 1937:54–56; Myers and Carvalho 1945. Boletim do Museu Nacional do Rio de Janeiro, Nova Série Zoologia 35:1–24; Arzabe 1999. Revista Brasileira de Zoologia 16:851–864; Silvano and Pimenta 2003. *In* Prado et al. [eds], Corredor de Biodiversidade da Mata Atlântica do Sul da Bahia. CD-ROM, IESB/CI/CABS/UFMG/UNICAMP, Ilhéus; Vieira et al. 2007. Oecologia Brasiliensis 11:383–396; Silva et al. 2010. Check List 6:451–453; Santana et al. 2014. Check List 10:407–408). First state record extending the distribution of the species ca. 160 km NE from the Municipality of Boa Vista, Paraíba (Vieira et al. 2007, *op. cit.*) for Santa Maria and ca.120 km NW to Tenente Laurentino Cruz, closing a gap in the distribution of the species. Specimens were collected under permits issued by SISBIO/ICMBio (#12734-1).

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***PIPA PIPA* (Surinam Toad)**. BRAZIL: CEARÁ: Municipality of Fortaleza: Açude Itaperi (3.791714°S, 38.554821°W; WGS 84). 20 January 2014. K. S. Serra. Verified by P.S. Bernarde. Coleção Herpetológica da Universidade Federal do Ceará, Fortaleza, Ceará, Brazil (CHUFC A 6749). This species was previously known from basins of Amazonian biome (Suriname, Guyana, Venezuela, Colombia, Ecuador, Peru, Bolivia and Brazilian Amazon) and the states of Mato Grosso and Goiás in Brazil (Alves-Pinto et al. 2014.

Herpetol. Notes 7:347–353). First state record and extends the known distribution ca. 890 km airline E from Canindé Municipality, Pará, Brazil and ca. 1.650 km airline NE from Bonópolis Municipality, Goiás, Brazil. This species is not native from Ceará and the introduction probably results from an illegal animal commerce that occurs in 2 km around Açude Itaperi. We also saw four other animals in the same place, but they were not captured. The connection of the Açude Itaperi with other lagoons suggests that the species occurs in other waterbodies in the Municipality of Fortaleza. Specimen collected under an approved ICMBio permit (42737-1).

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***PRISTIMANTIS OCKENDENI* (Carabaya Robber Frog)**. BRAZIL: AMAPÁ: Municipality of Serra do Navio: Parque Natural Municipal do Cancão (0.913889°N, 51.999778°W; WGS 84), 120 m elev. 22 April 2012. Yuri B. Silva e Silva. Verified by A.P. Lima. Colecao Universidade da Universidade Federal do Amapá, Macapá, Amapá, Brazil (CECCAMPOS 170). *Pristimantis ockendeni* is an arboreal and nocturnal frog found in primary and secondary forests throughout the upper Amazon Basin of Peru, Ecuador, southern Colombia and northern Bolivia (Padial et al. 2004. Graellsia 60:167–174; http://research.amnh.org/herpetology/amphibia/index.html, 20 January 2014). In Brazil, this species was previously known from two states: Acre and Amazonas (http:// www.iucnredlist.org; accessed 30 December 2013). Two adult males were found (one collected) in an upland forest during the night on leaves of shrubs at 1–2 m of height. First state record, extending the range 986 km NW from the Manaus, Amazonas. Specimen collected under ICMBio/SISBIO permit #32651-1.

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TESTUDINES — TURTLES

***CHRYSEMYS DORSALIS* (Southern Painted Turtle)**. USA: ALABAMA: Bullock Co.: shallow floodplain swamp where Lockhart Creek crosses Highway 51 west of Hurtsboro, Alabama (32.229173°N, 85.463266°W; WGS 84). 27 September 2014. R. Birkhead, M. Birkhead, and S. Birkhead. Auburn University Natural History Museum (AUM 40826). Verified by David Laurencio. New county record; verified records are lacking for many Alabama counties (Mount 1996. The Reptiles and Amphibians of Alabama. University of Alabama Press, Tuscaloosa, Alabama. 347 pp.; www.vertnet.org, 29 Sept 2014). *Chrysemys dorsalis* is assumed to occur primarily in the western portion of the state extending eastward along the Alabama and Tallapoosa River where they intergrade with *C. p. picta*. A previous specimen (AUM 8920) collected from western Bullock County was personally examined by RDB and found to have large yellow blotches on the head and is lacking a dorsal stripe on the carapace but with alternating costal and vertebral seams on the carapace and therefore aligns more closely to *C. p. picta*. This specimen also represents the first record for *C. dorsalis* occurring below the Fall Line from the Chattahoochee drainage (Cowikee Creek). Adult female (126 cm carapace length, straight line) caught in baited ProMar collapsible funnel trap. Specimen was collected under AL General Scientific Collecting Permit #2014063841468680 issued to RDB.

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***TRACHEMYS ORNATA* (Ornate Slider)**. MÉXICO: GUERRERO: Municipality of Zihuatanejo: Ciclopista Playa Linda, 4 km NW of Ixtapa (17.6844°N, 101.6310°W; WGS 84), 16 m elev. 12 July 2008. William H. Mertz. Verified by Edmundo Pérez Ramos. Amphibian and Reptile Diversity Research Center, University of Texas at Arlington (UTADC 3699, photo voucher). New municipality record, extending its range in the state ca. 200 km NW from the vicinity of Acapulco (Iverson. 1992. A Revised Checklist with Distribution Maps of the Turtles of the World. Privately printed, Richmond, Indiana. 363 pp.; Fritz et al. 2011. J. Zool. Syst. Evol. Res. 50:125–136), and also bridges a distributional gap between Acapulco area populations and those at Cabo Corrientes, Jalisco (Legler and Vogt 2013. The Turtles of Mexico: Land and Freshwater Forms. University of California Press, Berkeley, California. 402 pp.). The turtle was photographed during the morning in a mangrove swamp.

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SQUAMATA — LIZARDS

***ASPIDOSCELIS SEXLINEATA* (Six-lined Racerunner)**. USA: ALABAMA: Bullock Co.: Wehle Forever Wild Tract, 6.4 km SE of AL Hwy 51 and Bullock CR 47 (Pleasant Hill Road) intersection (32.03176°N, 85.46720°W; WGS 84). 27 April 2014. J. Trent and E. Soehren. Verified by David Laurencio. Auburn University Museum of Natural History (AUM AHAP-D 857, digital photo voucher). New county record (Mount 1975. The Reptiles and Amphibians of Alabama. Agricultural Experiment Station, Auburn University, Alabama. 347 pp.). Male incidentally captured in permanent snake box trap placed within fire-maintained open pine sandy upland characterized by diverse herbaceous ground cover. Specimen photographed and released. Record fills gap within all surrounding counties in the eastern portion of the upper Coastal Plain region (Mount 1975, *op. cit.*) and was vetted through examination of online museum holdings (VertNet, HerpNET) and literature review.

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CNEMIDOPHORUS CRYPTUS. BRAZIL: ESPÍRITO SANTO: Municipality of Viana: 900 m W of Viana, SW of BR 262 (20.388611°S,

40.50815°W; WGS 84), 30 m elev. April 2009. J. C. F. Oliveira, E. Pralon, and L. Novaes Venerano. Verified by M. S. Hoogmoed. Museu Paraense Emilio Goeldi, Belém, Pará, Brazil (MPEG 31482–31492). RIO DE JANEIRO: Municipality of Rio de Janeiro: Rio de Janeiro Galeão International Airport (22.8000°S, 43.2333°W; WGS 84), 6–40 m elev. No collecting date. Carlos Rodrigo Meirelles Abreu. Verified by A. Silveira. Museu Nacional Rio de Janeiro, Universidade Federal do Rio de Janeiro (MNRJ 21540). Species known from Venezuela, and northern and eastern Amazonia. In Brazil, the species occurs in the states of Amazonas, Roraima, Pará, and Amapá (Ávila-Pires 1995. Zool. Verh. Leiden 299:1–706; Mesquita and Colli 2003. Copeia 2003:285–298; Mesquita et al. 2006. S. Amer. J. Herpetol. 1:61–71). First record of the species in southeastern Brazil, approximately 3700 km from the southernmost known distribution of this species. In Espírito Santo the population seems to be well established due to the presence of newborns. In Rio de Janeiro only one individual was recorded and collected by chance during fieldwork. It probably represents an isolated occurrence. These records probably constitute invasions, likely human-induced, but at this time it is not possible to determine when the introduction occurred. Specimens from the Municipality of Viana were collected under a SISBIO permit (#20007).

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HEMIDACTYLUS TURCICUS **(Mediterranean House Gecko).** USA: CALIFORNIA: Orange Co.: La Habra (33.939652°N, 117.935443°W; WGS 84), 123 m. elev. 14 September 2014. Aaron Wells and Francisco Torres. Natural History Musem of Los Angeles County (LACM 186001, 186002). Verified by Neftali Camacho. New county record. Fills a gap for *H. turcicus* in southern California between San Diego and Los Angeles counties (Beaman et al. 2005. Herpetol. Rev. 36:79; Bernstein and Bernstein 2013. Herpetol. Rev. 44:474). Seven additional *H. turcicus* were collected at this site on 18 October 2014 by GBP, MHE, and REE (LACM 186003–186009). Two additional populations, E Bristol Lane at N Glassell Street, Santa Ana (LACM 186011–186015) and E Saint Gertrude Place at S Wright Street, Santa Ana (LACM 186017–186019), were also found. All three localities are more than 11 km from each other.

In total, four adult females, three adult males, and two juveniles were collected at the La Habra site, indicating an established population. The E Bristol Lane site in Santa Ana was first reported to the Herpetological Education and Research Project (http://www.naherp.com; HERP 124797, 128378) in September and October 2012, indicating geckos have been at this site for at least two years. Geckos were observed in a region spanning 240 m NNW to SSE and 130 m E to W. The broad spatial distribution, lengthy temporal occurrence, and range of size classes indicate that this is an established population. At the E Saint Gertrude Place at S Wright Street site in Santa Ana, geckos were observed in a region spanning 415 m N to S and 115 m E to W. Given this distribution and the various size classes observed, this population also appears to be established.

Sceloporus occidentalis were also observed at the La Habra and the E Bristol Lane sites. At the former site, *S. occidentalis* and *H. turcicus* were found within centimeters of each other using the same retreats (cracks in a cinder block wall). At the latter site, the two species were found in the same urban habitat (structures adjacent to a hedge row) ca. 25 m apart. Although the divergent diel activity periods likely reduce competition between these two species for some resources, these observations suggest they may compete for retreat space, at least in urban habitats. Their close proximity and co-occupation of retreats may also increase the chances for parasite and pathogen transmission. Specimens were collected under California Department of Fish and Wildlife Scientific Collecting Permit #SC4307.

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HEMIDACTYLUS TURCICUS **(Mediterranean House Gecko).** USA: CALIFORNIA: Ventura Co.: Simi Valley, along N bank of Arroyo Simi, at confluence with Bus Canyon Drain, ca. 125 m N of intersection of Los Angeles Avenue and 5th Street (34.272817°N, 118.783861°W; WGS 84), 225 m elev. 3 October 2014. Christian Huntley. Verified by Neftali Camacho. Natural History Musem of Los Angeles County (LACM PC 1852). New county record extending the range of this species ca. 16.6 km W (airline) from the closest vouchered localities in Chatsworth, San Fernando Valley, Los Angeles County (Bernstein and Bernstein 2013. Herpetol. Rev. 44:474). Two adults were uncovered from deep (ca. 30 cm) leaf litter by day along the concrete-channeled stream terrace. A second, larger population (LACM 185981–185994) was also found.

Vouchered specimens include six adult females, four adult males, and four juveniles. These geckos were collected at night (2110–2300 h) from a commercial district along the exterior walls of concrete, stucco, or stone buildings, and along stone or brick retaining walls ca. 0–2 m off the ground. Most collection sites were illuminated by light fixtures attached to buildings and had minimal landscaping. The presence of adults and juveniles across a broad area suggests that this is an established population. Specimens were collected under California Department of Fish and Wildlife Scientific Collecting Permit #SC4307.

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HEMIDACTYLUS TURCICUS **(Mediterranean Gecko).** USA: TENNESSEE: Knox Co.: On retaining walls adjacent to an office building and a commercial distribution facility in Knoxville (35.966133°N, 83.945117°W; WGS 84), ca. 300 m elev. 6 June 2014. Chase L. Hively, Joseph D. Prescott and J. Caleb Stair. David H. Snyder Museum of Zoology, Austin Peay State University (APSU 19503, 19504). Verified by A. Floyd Scott and Arthur C.

Echternacht. First vouchered record for Knox Co. Previously, an unverified observation of a single juvenile was made in Knoxville ca. 2.4 km E of the current location on 10 October 2012. The nearest previously verified record was made in Maryville, Tennessee ca. 24 km southwest of the current location on 17 August 2013 (Nordberg et al. 2013. J. Tennessee Acad. Sci. 88:64–66).

A total of 13 adult (3.8–5.5 cm SVL) specimens (6 males, 7 females) including one gravid female were observed from ca. 0030–0130 h suggesting the presence of an established population. Additional individuals have been observed at this location since the date of collection. Due to the close proximity of these individuals to a commercial distribution facility and a small garden, individuals may have arrived on shipping pallets and/or potted plants. The commercial distribution facility may also facilitate the dispersal of this species to new localities within and beyond Knoxville. Voucher specimens collected under a permit issued by the Tennessee Wildlife Resources Agency (#3812).

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***IGUANA IGUANA* (Green Iguana)**. MÉXICO: SINALOA: Municipality of Ahome: San Miguel Zapotitlan, 5.8 km W of San Miguel Zapotitlán, 12.5 km N of Los Mochis (25.930472°N, 108.9991694°W; WGS 84), 17 m elev. 27 February 2013. Pedro Uriarte- Garzón. Verified by Adriana González-Hernández. Colección Nacional de Anfibios y Reptiles, Instituto de Biología, Herpetología–Referencia Fotográfica at Universidad Nacional Autónoma de México (CNAR IBH-RF 074 a–c, photo voucher). First municipality record, extending the known distribution 219 km airline N from the nearest known record at Costa Rica, Sinaloa, México (Smith and Van Gelder 1955. Herpetologica 11:145–149). The iguana was found in a tree (*Populus mexicana*) within riparian vegetation on the edge of Río Fuerte.

PEDRO URIARTE-GARZÓN (e-mail: uriartegp@hotmail.com) and **VÍCTOR HUGO-REYNOSO**, Colección Nacional de Anfibios y Reptiles, Departamento de Zoología, Instituto de Biología, Universidad Nacional Autónoma de México, Circuito Exterior s/n, Ciudad Universitaria, D.F., C.P. 04510, México.

***PHELSUMA LATICAUDA* (Gold Dust Day Gecko)**. USA: HAWAI'I: Kaua'i: Wailua: ~200 m SW of intersection of Hwy 56 and Hwy 580 at the south end of Wailua Road, which dead ends at the N bank of Wailua River (22.046414°N; 159.336929°W; WGS 84). 26 June 2014. Maxwell Hitchcock Espinoza and Robert E. Espinoza. Verified by Robert N. Fisher. Natural History Museum of Los Angeles County (LACM PC 1823, 1824, digital photographs of two individuals). First island record (McKeown 1996. A Field Guide to Reptiles and Amphibians in the Hawaiian Islands. Diamond Head Publishing, Los Osos, California. 173 pp.; Kraus 2009. Alien Reptiles and Amphibians, a Scientic Compendium and Analysis. Springer, Dordrecht. 563 pp.). Native to Madagascar and introduced and previously known from Hawai'i (Big Island), Maui, and O'ahu (McKeown 1996, *op. cit.*; Kraus 2009, *op. cit.*). Three adults and one juvenile observed at 1000 h along a wooden fence and on the trunk and adventitious roots of a *Pandanus* tree within 4 m of Wailua River. Several other adults and a juvenile were observed at 1630 h on the grounds of Kamokila Hawaiian Village, 5443 Kuamo'o Road, Wailua (22.043712°N, 159.360766°W) 2–3 m off the ground on *Pandanus* and other leafy ornamental vegetation. The different age classes and relatively high density of individuals at both localities suggests that breeding populations are well established.

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***PHRYNOSOMA DITMARSI* (Rock Horned Lizard)**. MÉXICO: SONORA: Municipality of Nacozari de García: Sierra de Nacozari, vic. Mina la Caridad, 1630 m elev. 15 September 2013. Timothy R. Burkhardt and Scott Trageser. Verified by T. J. Papenfuss. Museum of Vertebrate Zoology (MVZObs: Herp 13, 14; photographic voucher). First records for the municipality and the region between the Rio Moctezuma and Rio Bavispe; the closest documented locality is ca. 75 km SW of Cerro La Palma in the Sierra Baviacora (University of Arizona [UAZ] 39530–39543). The record also helps fill a range gap among the four previously documented populations: Sierra Manzanal (Lowe et al. 1971. J. Arizona Acad. Sci. 6:275–277), Sierra Baviacora (Lowe and Howard 1975. Southwest. Nat. 20:264–270), Rio Yaqui, vicinity of Tonichi (Perrill 1983. Herpetol. Rev. 14:123) and El Chorro, Municipality of Nácori Chico (Sherbrooke et al. 1998. Herpetol. Rev. 29:110–111). Both lizards, a male and juvenile, respectively, were observed at 0830 h on a steep and rocky south-facing hillside in a transition zone covered with a dense stand of Sinaloa thornscrub-Madrean oak woodland vegetation.

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***PLESTIODON LYNXE* (Oak Forest Skink)**. MÉXICO: AGUASCALIENTES: Municipality of EL LLANO: Mesa Las Preñadas (21.931920°N, 101.885647°W; WGS 84), 2440 m elev. 11 May 2014. Rubén Alonso Carbajal Márquez, Gustavo E. Quintero Díaz, and Carolina Chávez Floriano. Verified by Bradford Hollingsworth. San Diego Natural History Museum (SDSNH_HerpPC_05238, photo voucher). First municipality record, closing distributional gap of ca. 83 km between Cerro Altamira, Municipality of Tepezalá, Aguascalientes (Vázquez-Díaz and Quintero-Díaz 2005. Anfibios y Reptiles de Aguascalientes, 2nd ed. CONABIO y CIEMA. Ed. México, D.F. 318 pp.) and Villa de Arriaga, San Luis Potosí (Lemos-Espinal and Dixon. 2013. Amphibians and Reptiles of San Luis Potosí. Eagle Mountain Publishing, Eagle Mountain, Utah. 300 pp.). The skink was found beneath a rock next to a stone wall in an oak savanna. Specimen collected under permit SEMARNAT (SGPA/DGVS/05143/14).

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SQUAMATA — SNAKES

***ARIZONA ELEGANS* (Glossy Snake)**. USA: NEW MEXICO: Los Alamos Co.: DOE property; Pajarito Road, 2.25 mi W jct Pajarito Road and NM Hwy 4 (35.83603°N, 106.25773°W; WGS 84). 1 October 2014. Chuck Hathcock. Verified by Tom Giermakowski.

Museum of Southwestern Biology (MSB 95428). New county record (Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. University of New Mexico Press, Albuquerque, New Mexico. 431 pp.). Adult male DOR. Specimen was collected ca. 20 air mi NW of the nearest known locality.

CHUCK HATHCOCK, Los Alamos, New Mexico, USA (e-mail: chuckhathcock89@gmail.com); **CHARLES W. PAINTER**, 707 Griegos Road NW, Albuquerque, New Mexico 87107, USA (e-mail: cwpainter49@gmail.com).

***ARIZONA ELEGANS* (Glossy Snake)**. USA: TEXAS: Parker Co.: Soda Springs Road approximately 0.6 road mi. N of the I-20 frontage road (32.67349°N, 98.03993°E; WGS 84). 21 September 2014. E. Wostl, C. Roelke, and M. Fontenot. Verified by Carl Franklin. Amphibian and Reptile Diversity Research Center (UTA-R 62069). New county record (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 447 pp.). This locality is between the published ranges of the two recognized subspecies in the region. *Arizona e. elegans* is documented to the north and west and *A. e. arenicolor* has been documented to the east and south.

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***BOIGA IRREGULARIS* (Brown Treesnake)**. USA: COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS: Rota: Rota Seaport (14.136502°N, 145.135351°E; WGS84). 3 September 2014. Shelwyn Taisacan, Robert Ulloa. Verified by G. Zug. USNM 581745. Snake (42 g, 810 mm SVL, 1020 mm total length) captured in a mouse-baited trap hung on the fence perimeter of the Rota Seaport. Because the Northern Marianas Islands are historically snake-free, these traps are used around ports and airports for early detection of snakes that may stow away in vessels or aircraft from Guam (60 km to the south), possibly evading quarantine detections. Necropsy revealed no prey items in stomach or gastrointestinal tract. Dissection at USNM confirmed the snake was female. To our knowledge, this is the first incursion of a live *Boiga irregularis* on Rota. Brown Treesnakes previously observed on the island (N = 3) arrived in cargo already dead. The USGS Brown Treesnake Rapid Response Team mobilized 4 September–20 October 2014 to search the focal and surrounding areas for evidence of a possible incipient population; no additional snakes were found during this search effort.

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***CARPHOPHIS AMOENUS AMOENUS* (Eastern Wormsnake)**. USA: TENNESSEE: Unicoi Co.: Rock Creek Road (36.12796ºN, 82.35764ºW; WGS 84). 8 August 2013. Stephen K. Nelson and Joseph T. Altobelli. Verified by A. Floyd Scott. David H. Snyder Museum of Zoology, Austin Peay State University (APSU 19468, color photo). First county record (Redmond and Scott 2008. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. http://apsu.edu/repatlas/, accessed 7 November 2014). Found on alive on the road at night in light rain. Fills distribution gap in east Tennessee.

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***CLELIA SCYTALINA* (Mexican Snake Eater)**. MÉXICO: MICHOACÁN: Municipality of Lazaro Cardenas: 5.24 km NW of La Mira (18.081977°N, 102.337561°W; WGS 84), 56 m elev. 18 November 2012. Ricardo Josué Pérez-Hernández and Ernesto Raya-García. Verified by Rubén Alonso Carbajal-Márquez. University of Arizona, Department of Ecology and Evolutionary Biology, Tucson, Arizona (UAZ 57611-PSV; photographic voucher). First record for Michoacán (Duellman 1961. Univ. Kansas Publ. Mus. Nat. Hist. 15:1–148; Alvarado-Diaz et al. 2013. Amphib. Rept. Conserv. 7:128–170), and a 331.2 km NW range extension from the nearest known locality at Zoquiapan, Guerrero (Pérez-Ramos et al. 2000. Anal. Inst. Biol., Univ. Nac. Autón. México 71:21–24). The sub-adult was found AOR in tropical deciduous forest near a dry stream.

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***CROTALUS ATROX* (Western Diamond-backed Rattlesnake)**. USA: NEW MEXICO: Curry Co.: Broadview, jct Co. Rd 45 and QRP (34.9089°N, 103.3012°W; WGS 84). 16 August 1989. Richard W. Manning. Verified by Travis J. LaDuc. Texas Natural History Collections (TNHC 70746). New county record (Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. University of New Mexico Press, Albuquerque, New Mexico. 431 pp.). Specimen previously collected and cataloged into the TNHC without permit information.

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***CROTALUS CERBERUS* (Arizona Black Rattlesnake)**. USA: ARIZONA: Mohave Co.: Cerbat Mountains ca. 1.2 km SE of Cherum Peak (35.395166°N, 114.125314°W; WGS 84), 1905 m elev. 5 July 2014. Z. R. Mocarski. Verified by George Bradley. University of Arizona (UAZ 57610-PSV, photo voucher). This specimen represents the first vouchered report from the Cerbat Mountains. Previously, this species was known from this range only from unconfirmed reports (Jones et al. 1985. Oecologia 66:595–601). This specimen represents a ca. 25-km range extension to the northwest from the closest known locality in the Hualapai Mountains. No suitable habitat exists between the two ranges. Rather than chaparral, a habitat type frequented by this species, Mohave desert scrub prevails in the lowlands separating the Cerbat and Hualapai mountain ranges. Specimen observed at 1600 h.

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***CROTALUS HORRIDUS* (Timber Rattlesnake)**. USA: ALABAMA: Marshall Co.: 271 Shirt Tail Bend, New Hope (34.50328°N, 86.37999°W; WGS84). 27 May 2013. William E. Dawson. Verified by David Laurencio. Auburn University Museum of Natural History (AUM AHAP-D 714, photo voucher). New county record filling a distributional gap in northern Alabama (Mount 1996. The Reptiles and Amphibians of Alabama. University of Alabama Press, Tuscaloosa, Alabama. 347 pp.). *Crotalus horridus* has been previously recorded in the adjacent counties of Dekalb, Jackson (AUM database; accessed 6 Oct 2014), Blount (www.vertnet.org; accessed 6 Oct 2014), and Madison (Sutton et al. 2014. Herpetol. Rev. 45:293–294). First-year juvenile (ca. 40 cm total length) removed from the inground swimming pool of a private residence. The snake was photographed and released.

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***CROTALUS VIRIDIS* (Prairie Rattlesnake)**. USA: NEW MEXICO: Harding Co.: 2.25 km NNW of junction of NM-39 and US-54 in Logan, New Mexico (35.3903°N, 103.4228°W; WGS 84), 1190 m elev. 24 June 2007. Ian M. Latella and Howard Snell. Verified by J. Tomasz Giermakowski. Museum of Southwestern Biology (MSB 73141). New county record (Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. University of New Mexico Press, Albuquerque. 431 pp.). This record fills a distributional gap in northeastern New Mexico. This species is documented in adjacent Mora, Colfax, Union, San Miguel, and Quay counties (Degenhardt et al. 1996, *op. cit.*). Subadult specimen was found alive crossing NM-39 at 2221 h.

IAN M. LATELLA (e-mail: ilatella@unm.edu) and **HOWARD SNELL**, Museum of Southwestern Biology, MSC03 2020, 1 University of New Mexico, Albuquerque, New Mexico 87131, USA.

***HYPSIGLENA SLEVINI* (Slevin's Nightsnake)**. MEXICO: BAJA CALIFORNIA: Municipality of Ensenada: Sierra Santa Isabel, 2.41 km S of Puertecitos (30.327405°N, 114.648571°W; WGS84), 55 m elev. 14 June 2013. S. Murray. Verified by L. Lee Grismer. La Sierra University Digital Photograph Collection, Riverside, California (LSUDPC 9150–9151). Northernmost record for this species, extending the distribution 177 airline km NNW from Bahía de los Ángeles, Municipality of Ensenada, Baja California (Grismer 2002. Amphibians and Reptiles of Baja California, Including its Pacific Islands and the Islands in the Sea of Cortés. Univ. California Press, Berkeley, California. 399 pp.; Mulcahy and Archibald 2003. J. Herpetol. 37:566–571; Mulcahy et al. 2014. PLoS One 9:e97682). The snake was found surface active at 2205 h in an area comprised almost exclusively of volcanic rock; vegetation was dominated by Brittlebush (*Encelia farinosa*).

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***IMANTODES GEMMISTRATUS* (Central American Tree Snake)**. MÉXICO: TABASCO: Municipality of Emiliano Zapata: Nuevo Pochote (17.83543°N, 91.69940°W; WGS 84), 14 m elev. 27 June 2014. P. Charruau, M. A. Morales-Garduza, J. G. Reyes-Trinidad, and M. A. Ramírez-Pérez. Verified by M. A. López-Luna. Colección de Anfibios y Reptiles de Tabasco, División Académica de Ciencias Biológicas, Universidad Juárez Autónoma de Tabasco (CART 00732). First verified record for Tabasco, although it was expected because of nearby records from surrounding states of Campeche and Chiapas (Lee 1996. The Amphibians and Reptiles of the Yucatán Peninsula. Cornell University Press, Ithaca, New York. 500 pp.) and Veracruz (Pérez-Higareda and Smith 1991. Ophidiofauna of Veracruz: Taxonomical and Zoogeographical Analysis. Publ. Espec. 7, UNAM, Instit. Biol., Mexico, D.F. 122 pp.). Fieldwork was financed by the Consejo Nacional de Ciencia y Tecnología (CONACYT) and Gobierno del Estado de Tabasco through project Fondo Mixto TAB-2012-C28-194316. Specimen collected under an approved SEMARNAT permit (SGPA/DGVS/03484/14).

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***LAMPROPELTIS HOLBROOKI* (Speckled Kingsnake)**. USA: KANSAS: McPherson Co.: Maxwell Wildlife Refuge (38.482721°N, 97.458396°W; NAD 83). 18 September 2014. Daniel J. Martin. Verified by David J. Bender. University of Colorado Museum (UCM AC-186, photographic voucher). First documented record for this species in McPherson Co. (Collins et al. 2010. Amphibians, Reptiles, and Turtles in Kansas. Eagle Mountain Publishing, Eagle Mountain, Utah. 312 pp.). Nearest known records from adjacent counties include: Saline (37 km), Elsworth (47 km), Dickinson (62 km), Marion (45 km), and Harvey (46 km); no records are reported for Reno or Rice counties. A large (ca. >1 m) adult was found during a standardized reptile survey, basking at 1402 h in partial shade under a currant shrub (*Ribes* sp.) next to large stones in mixed-grass prairie. Maxwell Wildlife Refuge manager C. Peterson recalled observing *L. holbrooki* on the Refuge several times around 1999 but not since.

This observation was made as part of the Great Plains Reptile Monitoring Project (www.reptilemonitor.org), with funding and logistical support provided by the U.S. Fish and Wildlife Service, Colorado Parks and Wildlife, Texas Parks and Wildlife, and Colorado State Land Board through a State Wildlife Grant, and from Colorado State University and the U.S. Geological Survey. Work was conducted under Scientific Collection Permit No. SC-000-2014 (State of Kansas) and Colorado State University ACUC #13-4218A.

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***OPHEODRYS VERNALIS* (Smooth Greensnake)**. USA: WISCONSIN: Vernon Co.: Township of Stark (43.606667°N, 90.629444°W, WGS 84). 16 October 2014. Terrell Beck. Verified by Joshua M. Kapfer (University of Wisconsin - Whitewater). Illinois Natural History Survey (INHS 2014ae, photo voucher). New county record. (Casper 1996. Geographic Distributions of the Amphibians and Reptiles of Wisconsin. Milwaukee Public Museum. 87 pp.). An individual adult was photographed basking on a gravel trail

on 16 October 2014 within the Kickapoo Valley Reserve on Star Valley Trail. Associated habitat consisted of old field successional vegetation. Adjacent habitats were a mix of agricultural fields and fallow fields of upland grass and shrubs. This observation complements a specimen collected by K. Teed on 28 July 1990 in Wildcat Mountain State Park (Milwaukee Public Museum, MPM 23475). The individual was found just off State Highway 33 on the road to the lower picnic area (T14N R02W, Sec. 14 NE4).

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***PYTHON REGIUS* (Ball Python)**. USA: LOUISIANA: St. John the Baptist Parish: Town of Ruddock, Old Highway 51, 4.5 km S of Ruddock I-55 ramp (30.149723°N, 90.449167°W; WGS 84). 7 October 2014. Collected by Brian I. Crother and Mary E. White. Verified by David M. Sever. Southeast Lousiana University, Museum of Biology (SLU 02332, SLU-TC 1.78). First record for Louisiana (www.vertnet.org, accessed 10 October 2014; http://specifyportal.flmnh.ufl.edu/herps/, accessed 10 October 2014).

Python regius has been introduced in Florida via pet trade (Krysko et al. 2011. Zootaxa 3028:1–64). This species is known from many sites in Florida, with the closest previous record (UF 169730) being from the City of Pensacola (30.4194°N, 87.276389°W), approximately 309 km E of this first Louisiana record. Collection databases (Herpnet, Vertnet, and the FLMNH database) contain no record of *P. regius* from Alabama, Mississippi, or Texas. There is no evidence that *P. regius* is established in the state of Louisiana, although the species is thought to be established at a similar latitude and longitude in the Florida panhandle, despite a lack of direct evidence in the form of neonates or eggs (K. Krysko and L. Somma, pers. comm.). *Python regius* is known to occur in swamps (Luiselli and Angelici 2009. Ital. J. Zool. 65:183–185) and may be able to successfully overwinter in Louisiana because of its natural tendency to seek out burrows (Aubret et al. 2005. Evol. Ecol. Res. 7:743–758). This specimen is a sexually mature female (94 cm SVL) and appears to have been healthy. The digestive tract contains gray and brown hairs, some of which, at 2.9 cm, are too long to have come from a mouse or rat. Specimen collected DOR.

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***SIBON ANTHRACOPS* (Ringed Snaileater)**. PANAMÁ: Distrito Boquete: 200 m W Caldera (8.38868°N, 82.23274°W; WGS84), elev. 420 m. 16 July 2011. Jessica Van den Burgh. Verified by Jonathan A. Campbell. Amphibian and Reptile Diversity Resarch Center, University of Texas at Arlington (UTADC 7476, photo voucher). First record for Panamá, and extends the range ca. 200 km SW from the closest confirmed locality in Costa Rica (Província de San José, Pozos de Santa Ana [Solórzano 2004. Serpientes de Costa Rica/Snakes of Costa Rica, INBio, Santo Domingo de Heredia, Costa Rica. 792 pp.]).

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***TANTILLA HOBARTSMITHI* (Smith's Black-headed Snake)**. USA: CALIFORNIA: Inyo Co.: Southeastern Argus Mountains, unnamed side canyon of Water Canyon (35.99036°N, 117.40489°W; WGS 84), 1150 m elev. 27 May 2014. Adam G. Clause. Natural History Museum of Los Angeles County (LACM 184721 [entire animal], TC 2082 [tissue], PC 1746–1747 [digital color photos]). New locality and second record from the Argus Mountains, ca. 26 km by air from the nearest known locality at Surprise Canyon, Panamint Mountains (Cole and Hardy 1983. Bull. Amer. Mus. Nat. Hist. 171:199–284; http://herpnet2.org; 11 June 2014). Northern Kingston Mountains, Crystal Spring (35.79444°N, 115.96178°W; WGS 84), 1160 m elev. 31 May–1 June 2014. Adam G. Clause. LACM 184750, TC 2090–2091, 2132, PC 1755–1756. New locality and third record from the Kingston Mountains, ca. 3 km by air from the nearest known locality of Smith Talc Mine, Kingston Mountains (HerpNET2, *op. cit.*). San Bernardino Co.: Southwestern Clark Mountains, Pachalka Spring (35.51806°N, 115.63064°W; WGS 84), 1500 m elev. 29 May 2014. Adam G. Clause. LACM PC 1788. First record from the Clark Mountains, ca. 37 km by air from the nearest known locality of Horse Thief Springs, Kingston Mountains (Cole and Hardy, *op. cit.*; HerpNET2, *op. cit.*). Northeastern San Bernardino Mountains, Hwy 18, 0.8 road km S of Cushenbury Springs (34.35591°N, 116.85161°W; WGS 84), 1320 m elev. 11 June 2013. Philip Clevinger. LACM 185113, PC 1799. First record from the San Bernardino Mountains, ca. 54 km by air from the nearest known locality of Long Canyon, Joshua Tree National Park (Cole and Hardy, *op. cit.*; HerpNET2, *op. cit.*).

All specimens verified by Gregory B. Pauly via examination of head color pattern and/or hemipene structure. Snakes discovered under stones or DOR, associated with spring-fed riparian zones. These records partially fill several gaps in the spotty, relic distribution of *T. hobartsmithi*. They increase the total number of published and/or museum-vouchered California localities for this species to 28 (Cole and Hardy, *op. cit.*; HerpNET2, *op. cit.*; Persons and Nowak 2006. Inventory of Amphibians and Reptiles at Death Valley National Park. USGS Southwest Biological Science Center, Flagstaff, Arizona. 47 pp.; Stebbins 2003. Western Reptiles and Amphibians 3rd ed. Houghton Mifflin Co., New York, New York. 533 pp.). Our work was approved under California Department of Fish and Wildlife Scientific Collecting Permits #011663 and #010579, Bureau of Land Management Ridgecrest Field Office Permit #1110 (CA-6601.26) P, and University of Georgia IACUC AUP #A2012 10-004-Y1-A0. Financial support provided by a University of Georgia Presidential Fellowship.

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***THAMNOPHIS SIRTALIS* (Common Gartersnake)**. USA: OKLAHOMA: Roger Mills Co.: Cheyenne City Park (35.607°N, 99.699°W; WGS 84). 4 October 2014. Alyssa M. Anwar, Rachel L. Flanagan, Elyse S. Freitas, Gregory F. M. Jongsma, and Tucker H. Walton. Verified by Jessa L. Watters. Sam Noble Oklahoma Museum of Natural History (OMNH 44148). New county record (Sievert and Sievert 2011. A Field Guide to Oklahoma's Amphibians and Reptiles. Oklahoma Department of Wildlife Conservation, Oklahoma City, Oklahoma. 211 pp.). Female individual (49.7 mm SVL; 66.2 cm total length) found and collected in the city park's semi-drained pool. The nearest known vouchered specimens are from Ellis Co., Oklahoma (OMNH 38404, 42762–42765). Specimen

collected under a Oklahoma Department of Wildlife Conservation Scientific Collector's permit issued to Elyse S. Freitas (#6081).

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***UNGALIOPHIS PANAMENSIS* (Southern Bromeliad Boa)**. PANAMÁ: PANAMÁ OESTE: Altos del Maria (8.63333°N, 80.06666°W; WGS 84), 700 m elev. 24 June 2006. Julie M. Ray, Edgardo J. Griffith, and Heidi L. Ross. Verified by James L. Knight. Amphibian and Reptile Diversity Research Center, University of Texas at Arlington (UTADC 6977, photo voucher). First record for the former Panamá Province and the new Panamá Oeste Province (Köhler 2008. Reptiles of Central America, 2nd ed. Herpeton Verlag, Offenbach. 200 pp.). The snake was found on the ground in primary premontane cloud forest. I thank the TADS project for logistical support and E. J. Griffith and H. L. Ross for assistance in the field.

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***XENOCHROPHIS VITTATUS* (Striped Keelback)**. USA: PUERTO RICO: Municipality of Carolina: Carolina Pueblo Country Club, 409 Street (18.408226°N, 65.961828°W; WGS84), 3 m elev. 22 July 2013. Brian Ríos-Dróz. MZUPRRP-R-15001. 504 Street (18.418684°N, 65.962445°W; WGS84), 0 m elev. 22 July 2013. Brian Ríos-Dróz. MZUPRRP-R-15002. Both verified by R. Graham Reynolds. First records from the Western Hemisphere for this snake normally native to Indonesia. Several other sightings of reproductively mature adults and juveniles, from separate locations in the Municipality of Carolina made by AH-M and others since 2011, indicate a well-established population on Puerto Rico. Time of introduction is unknown, but anecdotal accounts of "garter snake" sightings in the region are traced back to about 1994 and were thought to be accidental escapees from shipping containers, presumably destined for the pet trade, at the Luis Muñoz Marín International Airport, located ca. 4.5 km NW from collection sites.

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ERRATUM

The latitude coordinates reported by Maxwell and Scott (2014. Herpetol. Rev. 45:466) for a record of *Pituophis m. melanoleucus* in Carroll Co., Tennessee, USA, should read 35.9354ºN instead of 36.9354ºN. The coordinates as published place the record in Marshall Co., Kentucky, whereas the correct coordinates put the record at the "gate to Carroll County Recreation Lake" as stated in the report.

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Preliminary Herpetofaunal Inventory of a Logging Concession in the Upper Baram, Sarawak, Borneo

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The island of Borneo is the largest of the Sundaic subregion (which comprises the Malay Peninsula, Sumatra, Java, Borneo, Bali, and smaller associated islands), and is the second largest tropical island in the world. Previously covered in mixed dipterocarp forest, it contains some of the last remaining continuous tracts of tropical rainforest in Southeast Asia and is recognized as one of the most biodiverse areas of the Indo-Malayan region (MacKinnon et al. 1996). However, Borneo experiences one of the highest deforestation rates in the world, with 1.7% of its forests converted annually primarily through commercial timber harvesting and conversion of forests to monoculture plantations (Koh 2007; Langer et al. 2007). While about 9% of the land area is afforded some level of protection, such protected areas are isolated and dwarfed by the vast areas designated for timber extraction and monoculture plantations (Brodie and Giordano 2011). The viability of such protected areas for the conservation of Borneo's biodiversity is thus questionable (Meijaard et al. 2005).

Borneo boasts high herpetofaunal species richness and endemism, with 290 reptiles and 164 amphibian species currently described, making it the richest in terms of herpetofaunal diversity of the greater Sundas (compared to Sumatra: 218 reptiles and 93 amphibians, Java: 173 reptiles and 36 amphibians and Sulawesi: 115 reptiles and 40 amphibians; Das and van Dijk 2013).

Most herpetofaunal studies in Borneo have focused on protected areas. Little work has been conducted in modified landscapes such as logging concessions and monoculture plantations. In the Malaysian state of Sarawak, only 4% of the total land area is protected, whereas 35% is designated for

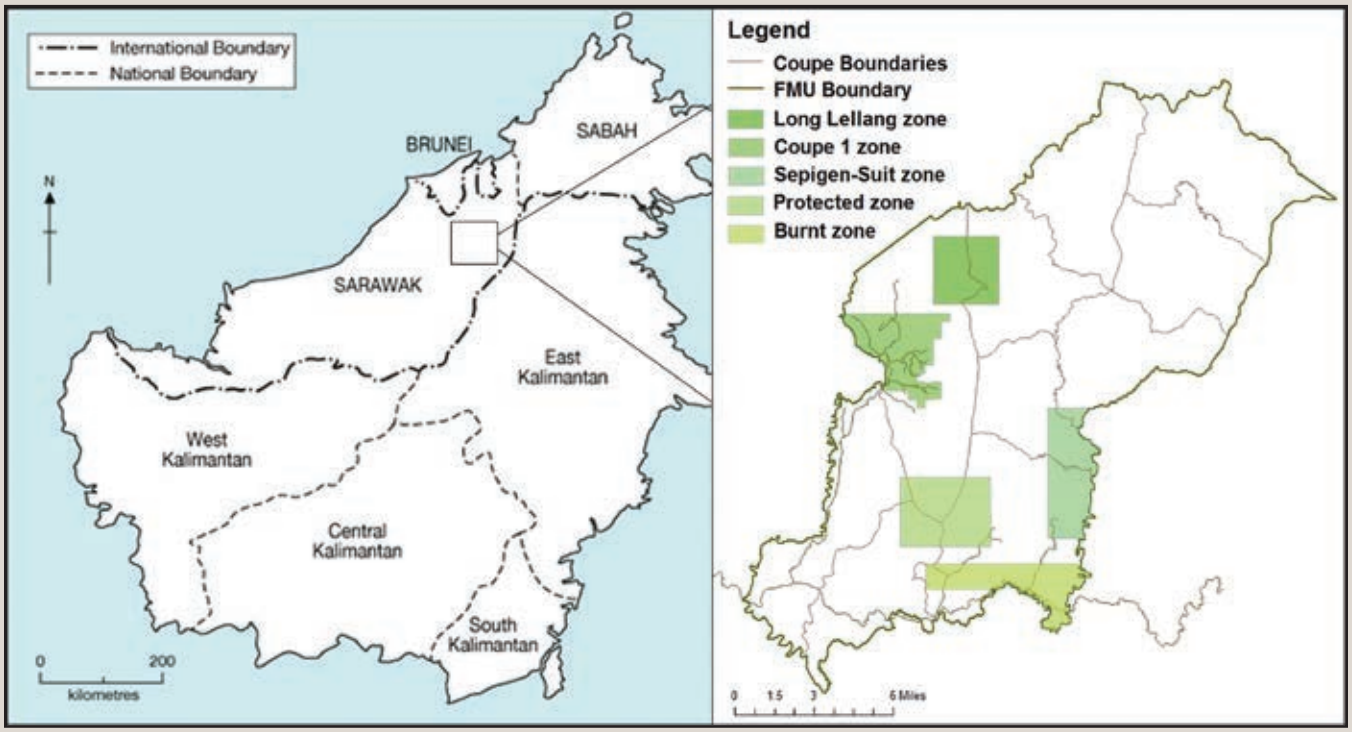


FIG. 1. Map of Borneo featuring the location of the Sela'an Linau Forest Management Unit (FMU) and location of our study sites therein. Study site habitat types, elevation range, and anthropogenic disturbance are as follows (modified from Mathai and Buckingham 2014). Long Lellang: Hill and submontane primary forest with some montane forest in higher elevation areas, 575–1200 m elev., low anthropogenic disturbance. Coupe 1: Secondary-growth lowland forest; the majority of the area was subject to reduced impact logging in 2006 and 2007; some unlogged lowland and hill forest, 500–900 m elev., moderate anthropogenic disturbance. Sepigen-Suit Zone: Lowland (mainly secondary) forest with active *temudas* and rice paddies, 250–475 m elev., high anthropogenic disturbance. Protected Zone: Primary submontane forest with some montane forest in the higher elevation areas, 750–1550 m elev., low anthropogenic disturbance. Burnt Zone: Secondary-growth lowland forest (the majority of the area was burned during the 1997–1998 El Niño event), 250–750 m elev., high anthropogenic disturbance.

logging activities (Sarawak Forest Department 1997). To better manage biodiversity in these modified landscapes, it is essential that assessment and monitoring of ecosystem dynamics and community structure be conducted. Thus providing more comprehensive data for conservation management (Meijaard et al. 2005).

The present study was conducted in the Sela'an Linau Forest Management Unit (FMU), a logging concession of 55,949 ha located in the Upper Baram region of northern Sarawak, Malaysian Borneo (Fig. 1). The licensed concessionaire is Samling. Roughly half the area was conventionally logged in the past and since 2003, a reduced impact logging (RIL) has been applied. The majority of the area supports mixed dipterocarp forest (60%), with some montane forest (4%), tropical heath forest (*kerangas*) (21%), and slash and burn areas (*temuda*) (15%). Roughly 3000 ha of forest was destroyed during the 1997–1998 El Niño event though secondary growth, regenerating forest has now reclaimed the area. Elevation ranges from 250–2000 m above sea level. The area receives high rainfall with 3400–5900 mm falling annually and temperatures averaging 26°C and 14°C in the low and high elevation areas, respectively (Mathai et al. 2010).

Methods.—The herpetofaunal records presented in this paper are opportunistic detections obtained during an ongoing small carnivore camera-trapping and habitat modelling study. Five field trips totalling 178 days were made between April 2013 and July 2014. During this time, opportunistic herpetofaunal surveys were conducted in five survey sites (Protected zone, Burnt zone, Sepigen-Suit zone, Coupe one zone, and Long Lellang zone) each of an area 10–15 km^2. These areas compromised a mix of undisturbed and disturbed lowland, hill, submontane and montane forest with elevations ranging between 220–1300 m elevation (see Fig. 1).

Observations were made during the day (0800–1700 h) while walking transects for habitat analysis and setting of camera-traps. Between three to seven kilometers were walked each day; however, it is acknowledged that as researchers were not specifically surveying for herpetofauna, many specimens may have been missed and microhabitats specific to herpetofauna (tree buttresses, beneath logs/rocks, and within tree cavities) were rarely searched.

When possible, night walks were conducted along streams and old logging roads, specifically targeting herpetofauna. Such walks were conducted mainly after rain and microhabitats specific to herpetofauna were searched.

All specimens detected were photographed. GPS coordinates of detection sites, date, time of encounter, and habitat type were recorded. Snout–vent length (SVL) and brief behavioral notes were taken wherever possible. All voucher specimen photographs have been registered with the Lee Kong Chian Natural History Museum, National University of Singapore.

Results and discussion.—Opportunistic sampling detected 36 reptile species (16 lizards, 18 snakes, and two turtles) comprising 12 families, including 12 species endemic to Borneo. A total

TABLE 1. Herpetofaunal species recorded from Sela'an Linau Forest Management Unit, Upper Baram, Sarawak, East Malaysia, between April 2013 and July 2014. Catalogue number refers to ZRC (Zoological Reference Collection, Lee Kong Chian Natural History Museum, National University of Singapore) digital voucher numbers.

Taxon	Catalogue numbers
Amphibians	
Bufonidae	
Ansonia longidigita Inger, 1960	ZRC(IMG) 1.45-1.46
Pelophryne signata (Boulenger, 1894)	ZRC(IMG) 1.47
Dicroglossidae	
Fejervarya limnocharis (Wiegnmann, 1835)	ZRC(IMG) 1.54
Limnonectes ingeri (Kiew, 1978)	ZRC(IMG) 1.48
Limnonectes kuhlii (Tschudi, 1838)	ZRC(IMG) 1.49
Megophryidae	
Leptobrachella parva Dring, 1984	ZRC(IMG) 1.72a–b
Microhylidae	
Kalophrynus subterrestris Inger, 1960	ZRC(IMG) 1.61
Ranidae	
Hylarana picturata (Boulenger, 1920)	ZRC(IMG) 1.53
Hylarana signata (Günther, 1872)	ZRC(IMG) 1.71
Staurois latopalmatus (Boulenger, 1887)	ZRC(IMG) 1.58
Staurois natator (Günther, 1858)	ZRC(IMG) 1.59
Rhacophoridae	
Feihyla kajau (Dring, 1984)	ZRC(IMG) 1.56
Nyctixalus pictus (Peters, 1872)	ZRC(IMG) 1.69a–b
Philautus hosii (Boulenger, 1895)	ZRC(IMG) 1.70a–c
Philautus ingeri Dring, 1987	ZRC(IMG) 1.50
Philautus macroscelis Boulenger, 1894	ZRC(IMG) 1.57
Philautus petersi (Boulenger, 1900)	ZRC(IMG) 1.51
Polypedates otilopus (Boulenger, 1893)	ZRC(IMG) 1.52
Reptiles	
Agamidae	
Bronchocela cristatella (Kuhl, 1820)	ZRC(IMG) 2.215
Draco cornutus Günther, 1864	ZRC(IMG) 2.188-189
Gonocephalus bornensis (Schlegel, 1848)	ZRC(IMG) 2.184
Gonocephalus grandis (Gray, 1845)	ZRC(IMG) 2.185-186
Phoxophrys spiniceps Smith 1925	ZRC(IMG) 2.187
Anguidae	
Dopasia buettikoferi (van Lidth de Jeude 1905)	ZRC(IMG) 2.232a–c
Eublepharidae	
Aeluroscalabotes felinus (Günther, 1864)	ZRC(IMG) 2.190–191
Gekkonidae	
Cyrtodactylus consobrinus (Peters, 1871)	ZRC(IMG) 2.192
Cyrtodactylus malayanus (De Rooji, 1915)	ZRC(IMG) 2.233a–c
Cyrtodactylus pubisulcus Inger, 1957	ZRC(IMG) 2.234a–b
Gekko smithi (Gray, 1842)	ZRC(IMG) 2.235a–b
Ptychozoon kuhli Stejneger, 1902	ZRC(IMG) 2.236a–d
Scincidae	
Dasia vittata Edeling, 1864	ZRC(IMG) 2.195
Tropidorhorus beccarii Peters, 1871	ZRC(IMG) 2.193
Tropidorhorus micropus van Lidth de Jeude, 1905	ZRC(IMG) 2.194
Varanidae	
Varanus rudicollis Gray, 1845	ZRC(IMG) 2.196

TABLE 1. Continued

Taxon	Catalogue numbers
Colubridae	
Ahaetulla prasina (Boie, 1827)	ZRC(IMG) 2.197
Amphiesma sarawacense (Günther, 1872),	ZRC(IMG) 2.198
Boiga cynodon (Boie, 1827)	ZRC(IMG) 2.199
Calamaria grabowskyi Fischer, 1885	ZRC(IMG) 2.237a–c
Coelognathus flavolineatus (Schlegel, 1837)	ZRC(IMG) 2.238a–b
Gonyosoma oxycephalum (Boie, 1827)	ZRC(IMG) 2.200
Macropisthodon rhodomelas (Boie, 1827)	ZRC(IMG) 2.201
Psammodynastes pulverulentus (H. Boie in F. Boie, 1827)	ZRC(IMG) 2.239a–b
Rhabdophis chrysargos (Schlegel, 1837)	ZRC(IMG) 2.202
Sibynophis melanocephalus (Gray, 1834)	ZRC(IMG) 2.203
Xenochrophis trianguligerus (Boie, 1827)	ZRC(IMG) 2.204
Viperidae	
Parias sumatranus (Raffles, 1822)	ZRC(IMG) 2.205
Popeia sabahi (Regenass & Kramer, 1981)	ZRC(IMG) 2.206
Trimeresurus borneensis Peters, 1871	ZRC(IMG) 2.240a–c
Elapidae	
Naja sumatrana Müller, 1887	ZRC(IMG) 2.216 a–b
Pareatidae	
Aplopeltura boa Boie, 1828	ZRC(IMG) 2.208–209
Asthenodipsas laevis (Boie, 1827)	ZRC(IMG) 2.210–2.211
Pythonidae	
Malayopython reticulatus (Schneider, 1801)	ZRC(IMG) 2.207
Bataguridae	
Heosemys spinosa (Gray, 1831)	ZRC(IMG) 2.214
Notochelys platynota (Gray, 1834)	ZRC(IMG) 2.212–2.213

of 18 amphibian species comprising six families, including 11 species endemic to Borneo, were also detected (see Table 1). This represents 12.41 and 11.92% of all known Bornean reptile and amphibian species, respectively (calculated from Das 2011; Haas et al. 2013). All reptiles encountered (with the exception of two montane species, *Phoxophrys spiniceps* and *Popeia sabahi*) were lowland forest-dwelling species.

Of the 36 reptile species recorded, 10 were detected on more than one occasion: three snake species, *Aplopeltura boa, Asthenodipsas laevis,* and *Parias sumatranus,* and seven lizard species, *Gonocephalus grandis, Cyrtodactylus consobrinus, C. malayanus, C. pubisulcus, Aeluroscalabotes felinus, Draco cornutus,* and *Dasia vittata*; the latter three are often associated with anthropogenically altered habitats (Das 2010). *Draco cornutus* and *Dasia vittata,* as well as *Naja sumatrana* and *Bronchocela cristatella,* were only encountered in a lowland village area.

Of the 18 amphibians detected, all were lowland forest dwellers with the exception of four exclusively montane species: *Ansonia longidigita, Philautus ingeri, Philautus macroscelis,* and *Philautus petersi.* Half of all species detected were exclusively riparian and/or dependent on riparian habitats for breeding (Inger et al. 1997).

A total of nine amphibian species were observed on more than one occasion with five of these observed with considerable frequency. *Philautus petersi, Feihyla kajau,* and *Leptobrachella parva* were commonly heard and sighted at night along riparian margins in the higher elevation areas (800–1200 m elev.), and *Staurois natator* and *Staurois latopalmatus* were commonly sighted by day among fast-flowing rivers in lower elevation areas (350–500 m elev.).

Two amphibians, *Pelophryne signata* and *Kalophrynus subterrestris* are considered lowland species, and have only previously been recorded below 1000 m and 300 m elevation, respectively (Inger et al. 1997). During this study *P. signata* was detected at 1200 m elevation, with *K. subterrestris* detected at 1100 m elevation, significantly increasing the known elevation ranges of these amphibians.

Due to the limited time frame and opportunistic nature of our observations, no inferences can be drawn regarding true herpetofaunal diversity and abundance in the region. As such, it is recommended that more surveys specifically targeting herpetofauna be conducted within this logging concession and other concessions and modified landscapes throughout Sarawak and Borneo. Understanding of herpetofaunal diversity and community dynamics within these large unprotected regions is crucial to identify areas of high conservation priority and identify possible management strategies that could alleviate further biodiversity loss, particularly in the face of Borneo's rapid deforestation, forest conversion, and proposed mega-dam projects.

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NATURAL HISTORY NOTES

The Natural History Notes section is analogous to Geographic Distribution. Preferred notes should 1) focus on observations in the field, with little human intrusion; 2) represent more than the isolated documentation of developmental aberrations; and 3) possess a natural history perspective. Individual notes should, with few exceptions, concern only one species, and authors are requested to choose a keyword or short phrase that best describes the nature of their note (e.g., Reproduction, Morphology, Habitat, etc.). Use of figures to illustrate any data is encouraged, but should replace words rather than embellish them. The section's intent is to convey information rather than demonstrate prose. Articles submitted to this section will be reviewed and edited prior to acceptance.

Electronic submission of manuscripts is requested (as Microsoft Word or Rich Text format [rtf] files, as e-mail attachments). Figures can be submitted electronically as JPG, TIFF, or PDF files at a minimum resolution of 300 dpi. Please DO NOT send graphic files as imbedded figures within a text file. Additional information concerning preparation and submission of graphics files is available on the SSAR web site at: http://www.ssarherps.org/HRinfo.html. Manuscripts should be sent to the appropriate section editor: **Sean P. Graham** or **Crystal Kelehear Graham** (amphibians; grahasp@tigermail.auburn.edu); **James Harding** (turtles; hardingj@msu.edu); **Charles Linkem** (crocodilians, lizards, and *Sphenodon*; herprev.ltc.nhn@gmail.com); and **John D. Willson** or **David A. Steen** (snakes; hr.snake.nhn@gmail.com).

A reference template for preparing Natural History Notes may be downloaded at: http://ssarherps.org/wp-content/uploads/2014/07/NatHistNotes_FormattingGuidelines.pdf. Standard format for this section is as follows: **SCIENTIFIC NAME** in bold, capital letters; standard English name in parentheses with only first letter of each word capitalized (if available, for the United States and Canada as it appears in Crother [ed.] 2012. *Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, with Comments Regarding Confidence in Our Understanding, 7th ed.* Herpetol. Circ. 39:1–92, available from SSAR Publications Secretary, ssar@herplit.com; for Mexico as it appears in Liner and Casas-Andreu 2008. *Standard Spanish, English and Scientific Names of the Amphibians and Reptiles of Mexico.* Herpetol. Circ. 38:1–162); **KEY WORD(S)** referring to the content of the note in bold, capital letters; content reporting observations and data on the animal; place of deposition or intended deposition of specimen(s), and catalog number(s) if relevant. Then skip a line and close with author name(s) in bold, capital letters (give names and addresses in full—spell out state names—no abbreviations, e-mail address after each author name/address for those wishing to provide it—e-mail required for corresponding author). References may be briefly cited in text (refer to this issue or the online template for citation format and follow format precisely). One additional note about the names list (Crother 2012) developed and adopted by ASIH-HL-SSAR: the role of the list is to standardize English names and comment on the current scientific names. Scientific names are hypotheses (or at least represent them) and as such their usage should not be dictated by a list, society, or journal.

Recommended citation for notes appearing in this section is: Goldberg, S. R., and C. R. Mahrdt. 2012. *Bogertophis rosaliae*: reproduction. Herpetol. Rev. 43:655.

CAUDATA — SALAMANDERS

***ANDRIAS JAPONICUS* (Japanese Giant Salamander). DIET.** *Andrias japonicus* is well known as one of the largest extant amphibians. The species is a high-order predator in Japanese river ecosystems and preys on a variety of invertebrates and vertebrates including mammals (Tochimoto 2002. Hyogo Biol. 12:134–139; Okada et al. 2008. Herpetol. Conserv. Biol. 3:192–202). At 1500 h on 30 March 2014, a local person observed a giant salamander regurgitating an embryo of a Sika Deer (*Cervus nippon*) in a small irrigation canal (width = 60–110 cm, depth = 10–20 cm) that originates from the Sayo River, in Sayo Town, Hyogo Prefecture, Japan (35.04861°N, 134.37083°E, datum WGS84; elev. 135 m; Fig. 1). The giant salamander (total length = 830 mm) was found as it was starting to expel its meal. On the following day (1548 h on 31 March 2014), we visited the place and the giant salamander was found to have again swallowed the deer embryo. However, as soon as we began measuring it, it started to regurgitate (Fig. 2), which took ca. 10 sec. to complete. The giant salamander weighed 4650 g before regurgitating the embryo and 3550 g



FIG. 1. Irrigation canal, originating from the Sayo River, Hyogo Prefecture, Japan. Arrow shows where the Japanese Giant Salamander was found.

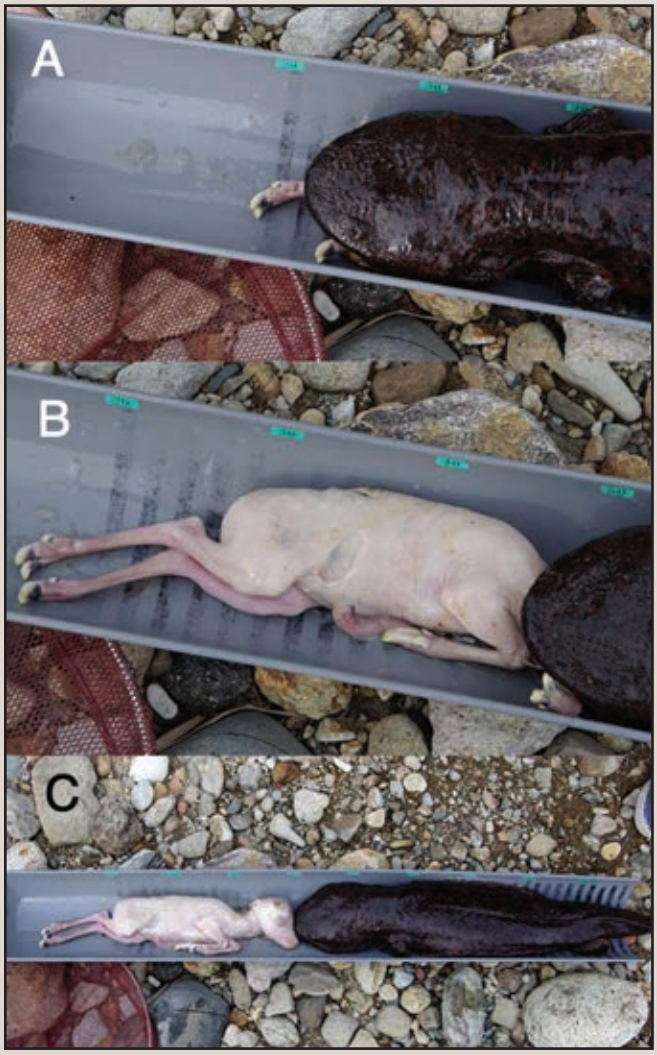


FIG. 2. An adult Japanese Giant Salamander (*Andrias japonicus*) regurgitating the embryo of a Sika Deer (A and B) and finally expelling it (C), on a handmade scale.

afterward. The embryo was 360 mm in length and weighed 1100 g. After measurements, we injected a PIT tag into the left shoulder of the giant salamander and released it to the main stream of the Sayo River (35.05750°N, 134.36694°E, datum WGS84; elev. 145 m). The embryo was probably discarded in the river by a hunter.

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***CRYPTOBRANCHUS ALLEGANIENSIS ALLEGANIENSIS* (Eastern Hellbender). LARVAL/ADULT ASSOCIATION.** Hellbenders are generally considered solitary animals with a single animal primarily found under one rock throughout most seasons (Smith 1907. Biol. Bull. 13:5–30; Nickerson and Mays 1973. The Hellbenders. Milwaukee Public Museum, Milwaukee, Wisconsin. 106 pp.). However, during the breeding season more than one hellbender can be found under the same rock (Smith 1907, *op. cit.*; Bishop 1941. New York State Mus. Bull. 324:1–365; Peterson 1988. Herpetol. Rev. 19:28–29). Further, the fact that hellbenders are cannibalistic is well known (Nickerson and Mays 1973, *op. cit.*; Groves and Williams 2014. Herpetol. Rev. 45:108–109) and might explain the rare instance of more than one hellbender under the same rock when breeding season activities are not apparent. Most reported occurrences of hellbenders sharing a single rock outside the breeding season generally refer to adults of undetermined sizes and sexes (Smith 1907, *op. cit.*; Hillis and Bellis 1971. J. Herpetol. 5:121–126; Nickerson and Mays 1973, *op. cit.*). Because few intraspecific associations of hellbenders of differing age classes have been reported, the following observations are of interest. In each case the specific locality is withheld due to conservation concerns.

On 13 March 2004 in the Hiwassee River drainage, Union Co., Georgia, USA, we encountered an adult male *C. a. alleganiensis* (total length = 37.5 cm) under a rock (c. 0.5 x 0.5 m) with four conspecific larvae. The average total length of the larvae was 3.93 cm (range: 3.8–4.0 cm), and all larvae had noticeable yolk sacs, external gills, well-developed forelimbs, and small hind limbs. Based upon records of oviposition and nest guarding behavior occurring in September at this site (Jensen et al. 2004. Herpetol. Rev. 35:156), and given a 60–80 day incubation period (Hulse et al. 2001. Amphibians and Reptiles of Pennsylvania and the Northeast. Cornell University Press, New York. 419 pp.), it is possible these larvae hatched rather late in the season, within two–three weeks of this observation. However, little is known about embryonic development in the wild and what environmental factors affect development over winter.

On 29 June 2010 in the French Broad River drainage, Transylvania Co., North Carolina, USA, we collected an adult male *C a. alleganiensis* (total length = 42 cm) from under a large, flat rock measuring 1.2 x 1.2 m. Shortly after collecting the adult male, a small, gilled larval hellbender (total length = c. 5 cm) was observed walking and swimming from under the same rock. This rock was in run habitat with 0.5 m water depth and approximately 50–60 m from a large pool at the base of a small waterfall. The larva did not appear to be stressed or injured. After emerging from under the rock, the larva circled and walked back under it in the same area that the adult male returned to upon release. We were unable to capture this larva for processing before it re-entered the large rock.

In a final example, on 08 August 2012 in the Hiwassee River drainage, Cherokee Co., North Carolina, USA, we collected an adult male *C. a. alleganiensis* (total length = 37 cm) from under a large, flat rock measuring 1.2 x 2.1 m in size. During the capture, a gilled larva (total length = 7 cm) was swept into a net positioned on the downstream side of the rock. We noticed no injuries on the larva during processing. The rock was in run habitat with 0.3 m water depth and in a river section with bedrock and sand as the predominant substrate. After processing, both the adult male and the gilled larva were placed at the downstream entrance to the capture rock, where they both crawled back under and remained.

Although we cannot determine how long the larvae from each observation occupied the same rocks as the adult males, it is possible that the larvae were remaining young from the previous season's brood and were still being protected under their natal rocks by the adult males. The size of the larvae suggests that they

were less than one year of age (Bishop 1941, *op. cit.;* Nickerson and Mays 1973, *op. cit.*), which supports this hypothesis. Another possibility is that shelter rocks had separate cavities or compartments within that provided the larvae refuge from being in direct contact with the adults and were thus able to avoid being cannibalized. A third alternative that must be considered is that the larvae observed in the latter two observations may have entered the rocks of the adult males opportunistically immediately prior to our surveys. The hellbender populations at our three localities are robust and appear to be stable which could increase the chance of larval/adult associations.

We thank Shem Unger for encouraging us to report these observations.

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***PLETHODON CINEREUS* (Eastern Red-backed Salamander). MOVEMENT.** Lungless salamanders (family Plethodontidae) are relatively sedentary and are presumed to have limited dispersal ability (Marsh et al. 2004. Ecology 85:3396–3405). Site fidelity in Plethodontidae is high, and individuals displaced 90 m return to home territories (Kleeberger and Werner 1982. Copeia 1982:409–415). Individuals defend territories (Jaeger et al. 1982. Anim. Behav. 30:490–496) and female home ranges have been estimated to be 24.34 m^2 (Kleeberger and Werner 1982, *op. cit.*). Females may seek out suitable subsurface habitat to oviposit eggs, yet little is known about their maximum movement distances (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington. 587 pp.).

On 18 September 2014, a female *P. cinereus* (lead back morphotype; SVL = 44.68 mm; 0.89 g) was found under a coverboard during a standard sampling event and uniquely marked using visual implant elastomer at the S.O. Conte Anadromous Fish Research Center, Massachusetts, USA (42.59280°N, 72.58070°W, datum WGS84; elev. 74 m). This individual was subsequently recaptured at ~1500 h on 8 October 2014 under a coverboard within 3 m of the original capture location and then again ~1430 h on 16 October 2014 under a log, within the same forest patch, though in a 50 x 150 m area adjacent to the original study area. Because we found the marked salamander while collecting multiple individuals for a laboratory study, the exact recapture location of the marked individual is not known. However, the distance between the 8 October capture location and the nearest edge of the 16 October search area (i.e. 50 x 150 m) was 143 m, indicating a minimum movement distance. As far as we are aware, this is the longest recorded movement for *P. cinereus* by more than 53 m (Kleeberger and Werner 1982, *op. cit.*). This finding followed a rain event of 1.63 cm within 24 h and the second largest sustained rain event during October. The movement we observed may have been due to disturbance from handling and marking, although this was minimized in the field.

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***PLETHODON HUBRICHTI* (Peaks of Otter Salamander). BEHAVIOR.** On 13 September 2014, while examining a site located near Onion Mountain, Bedford Co., Virginia, USA, where *Plethodon hubrichti* and *P. cinereus* are sympatric, we discovered a *P. hubrichti* (SVL ca. 48 mm) biting a *P. cinereus* (SVL ca. 30 mm) beneath a rock on the forest floor (Fig. 1). The *P. cinereus* visibly struggled during our observation with no noticeable effect on the *P. hubrichti*. The *P. hubrichti* appeared to have complete physical dominance over the *P. cinereus*. After a couple of minutes of observation, the *P. hubrichti* released its grasp and both salamanders retreated to the leaf litter. Both salamanders appeared to be unharmed.

Interference competition with *P. cinereus*, including agonistic behavior and territoriality, is thought to be a factor influencing the range boundaries of several Plethodontid species, including *P. hubrichti* (Arif et al. 2007. Evol. Ecol. Res. 9:843–854). The range of *P. hubrichti* is limited to a 19-km length of the Blue Ridge Mountains in Virginia and it is sympatric with the wide-ranging *P. cinereus* along the edge of its range (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, DC. 587 pp.). Aggressive behaviors, such as lunging and biting, have been documented between *P. hubrichti* and *P. cinereus*; however, most behavior studies take place in the laboratory and these behaviors are rarely observed in the field. Although there is no dietary evidence that suggests *P. hubrichti* regularly consumes other salamanders (Arif et al. 2007, *op. cit.*) the size difference between the observed individuals suggests that the *P. hubrichti* was capable of swallowing the *P. cinereus*.



FIG. 1. *Plethodon hubrichti* biting a smaller *P. cinereus*.

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***TRITURUS MACEDONICUS* (Macedonian Crested Newt). TAIL AUTOTOMY.** Tail autotomy is one of many anti-predator adaptations and is particularly common in lizards (e.g., Arnold 1988. *In* Gans and Huey [eds.], Biology of the Reptilia, Vol. 16, pp. 253–273 Alan R. Liss, New York; Bateman and Fleming 2009. J. Zool. 277:1–14). The tail plays an important role in defensive behavior in salamanders: it may be elevated, undulated, and wagged or convoluted, and autotomized (Brodie 1977. Copeia 1977:523–535; Jablonski and Balej 2014. Herpetol. Rev. 45:302–303). However, tail loss can result in loss of fitness as many animals, including

salamanders, use the tail to store energy as fat (Arnold 1988, *op. cit.*; Maginnis 2006. Behav. Ecol. 17:857–872; Bateman and Fleming 2009, *op. cit.*). Regeneration of the tail may require an increase in feeding rate and diversion of energy from growth or other life processes (Maginnis 2006, *op. cit.*; Marvin 2013. J. Herpetol. 47:174–178). Tail loss may also affect behavior, reproduction, and movement (e.g., swimming, running, and diving; Fox and McCoy 2000. Oecologia 122:327–334; Maginnis 2006, *op. cit.*; Marvin 2010. Copeia 2010:468–474; Marvin 2013, *op. cit.*). Cases of caudal autotomy in caudate amphibians are not usual; it is well established in salamanders of the family Plethodontidae, which occasionally can shed the end of their tails (e.g., Brodie 1977, *op. cit.*; Ducey et al. 1993. Biotropica 25:244–349; Romano et al. 2010. Acta Herpetol. 5:199–205).

Triturus macedonicus is an endemic and widespread species in western parts of the Balkans (Wielstra et al. 2014. Amphibia-Reptilia 35:376–381). On 4 October 2013, during fieldwork carried out in Albania, we discovered a population (approx. 20 individuals) of this species inhabiting a mountain waterhole in the Korab Mountains (41.6823°N, 20.5210°E, datum WGS84; elev. 1776 m). Several specimens were caught for photography and other documentation. Tail loss was recorded in one adult male during handling. The newt, after twisting movements of the tail, lost approximately 30 mm of the distal portion of its tail, accompanied with a small volume of blood. The discarded part of the tail then undulated approximately for 120 seconds. In other specimens of the same population regenerated tails were not observed. Several specimens (including the adult male) had old injuries on their tails. This observation was photographed and filmed (video available at: http://www.balcanica.info/video/Triturus_macedonicus_Albania_autotomy_131004.avi).

To our knowledge, this is the first observation of voluntary tail loss in the genus *Triturus*. However, we suggest that future research on skeletal morphology in crested newts is necessary.

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ANURA — FROGS

***AMEEREGA TRIVITTATA* (Three-striped Poison-dart Frog). MALE SIZE AND REPRODUCTIVE SUCCESS.** Male *Ameerega trivittata* exhibit parental care by transporting tadpoles on their dorsum (Fig. 1) from their initial oviposition sites under leaves or palm sheaths to larger sources of standing water where they complete their development (Roithmair 1994. Copeia 1994:107–115). Males generally transport the entire brood in a single trip when tadpoles reach approximately 18 days of age (Roithmair 1994, *op. cit.*). Male body size has been used as a measure of mate quality in anurans. For example, larger males may be able to mate with larger and more fecund females (Bowcock et al. 2013. Current Zool. 59:747–753) or transport more tadpoles (Ringler et al. 2013. Front. Zool. 10:67). In dendrobatid species, where males transport their young, one measure of reproductive success is the number of tadpoles a male carries. Here we test the hypothesis that the number of tadpoles transported is positively correlated with male size.

This study was conducted 28 May 2013–03 June 2013 in Brownsberg Nature Park in the Republic of Suriname (4.94799°N, 55.18271°W; datum WGS 84). Twenty-three male *A. trivittata* carrying tadpoles were captured by hand or handheld net as they approached tadpole deposition sites. Deposition sites were water-filled puddles ranging from 3–15 m in the middle of a dirt road surrounded by forest vegetation. We measured SUL of each male to the nearest 0.01 mm using calipers, counted the number of tadpoles present using a 10x magnifying lens, and then released the male with his tadpoles at their point of capture. To statistically assess the relationship between the number of tadpoles transported and male SUL, we used Pearson product movement correlation (Minitab 16 statistical software, Minitab Inc., State College, Pennsylvania). Male SUL ranged from 33.1 to 38.9 mm (mean = 35.7 mm, SD = 1.61). The number of tadpoles transported ranged from 3–28 (mean = 17.6, SD = 7.15). We found a significant positive correlation between the number of tadpoles transported and male SUL ($N = 23$; $p < 0.003$; $r = 0.60$; Fig. 2). In contrast, the number of tadpoles transported was not correlated with male size in male *A. trivittata* in Peru (Roithmair 1994, *op. cit.*). This lack of relationship may simply be due to limited



FIG. 1. Male *Ameerega trivittata* transporting tadpoles to a large puddle in Brownsberg Nature Park, Republic of Suriname.

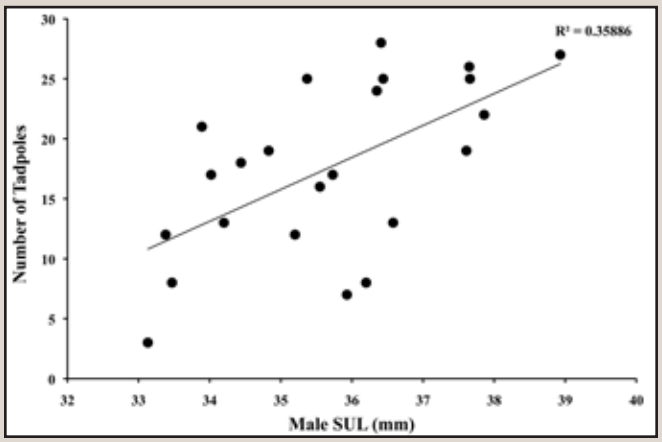


FIG. 2. Correlation between the number of tadpoles transported and male snout–urostlyle length in *Ameerega trivittata* at Brownsberg Nature Park, Republic of Suriname.

sample size (N = 8 versus N = 23 in the current study) or it may represent population differences in female choice, paternal care, clutch size, or predation of eggs or tadpoles before transport. Further research may elucidate whether factors involving female choice or paternal care result in the positive relationship between tadpole numbers and male size.

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***ANAXYRUS WOODHOUSII* (Woodhouse's Toad). NECROPHILIA.** Necrophilia has been reported previously for amphibians (e.g., Meshaka 1996. Florida Sci. 59:74–75; Bettaso et al. 2008. Herpetol. Rev. 39:462; Sinovas 2009. Herpetol. Rev. 40:199; Overvides and Zaidan 2013. Herpetol. Rev. 44:655–656), but these reports documented only the discovery of amplexed pair(s). Herein I report persistence of a male *Anaxyrus woodhousii* amplexing a deceased anuran.

At 1525 h on 10 May 2014 one of us (JCJ) observed a male *A. woodhousii* in axillary amplexus with a dead, bloated toad (Fig. 1) at an abandoned slate mine pool at the Ouachita Mountains Biological Station, Arizona, USA (34.45811°N, 93.99894°W, datum WGS84; elev. 488 m). At 1330 h the following day (11 May 2014) the pair was under a partially submerged stem at the southwest corner of pool, approximately 2.5 m from the original location. The male *A. woodhousii* moved its left hind leg, apparently to maintain an upright position as the carcass seemed to be tilting; the wind created a small clockwise current in the pool. At 1400 h the following day (12 May 2014), the pair was still in the southwest corner of the pool; the male toad was still moving its legs. JCJ was unable to locate the pair on 13 May 2014; there had been 56 mm rain overnight. On 14 May 2014, JCJ discovered the intact, upside down, carcass of the female toad; LMH confirmed the amplexed individual as a female *A. woodhousii.*

Bull (2000. Behav. Process. 51:7–20) reported that a male *Tiliqua rugosa* (Sleepy Lizard) courted a dead female conspecific for two days. The toads reported here were in amplexus for at least 45 h. It is unclear when the toads initially amplexed; the first rain of the month (73.66 mm), which filled the pool, was on 9 May 2014.



FIG. 1. *Anaxyrus woodhousii* amplexing a deceased partner on 10 May 2014.

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***CROSSODACTYLUS GAUDICHAUDII.* PREDATION.** Anuran larvae are an important component of the food web in aquatic ecosystems. Most tadpoles feed on algae, detritus and/or other animals (Altig et al. 2007. Freshwater Biol. 52:386–395), and incorporated nutrients are transferred to the next trophic level when they are consumed by fish and macro-invertebrate predators. Crabs are one of the most important invertebrate predators of anurans, preying on both adults and larvae (Wells 2007. The Ecology and Behavior of Amphibians. University of Chicago Press, Chicago, Illinois. 1400 pp.; Pyke et al. 2013. Herpetol. Notes 6:195–199). However, there is a lack of information about predation on tadpoles by macro-detritivores in Atlantic Forest streams. Here, we report a common freshwater crab species from the Atlantic rainforest feeding on a tadpole in a permanent water body habitat.

At 2230 h on 22 January 2014, during visual encounter surveys near the Cachoeira das Almas waterfall (22.948855°S, 43.286212°W, datum WGS84; elev. 561 m), in Tijuca National Park (a remnant of the Atlantic Forest Biome), Rio de Janeiro, Brazil, we found a *Trichodactylus petropolitanus* (Freshwater Crab) feeding on a tadpole of *Crossodactylus gaudichaudii* (Fig. 1). They were found upon a rock in the stream, close to the water. The tadpole was already partially eaten, so we are unable to describe the predation event, or determine whether the tadpole was alive at the time of predation. However, considering the fresh appearance of its flesh it did not appear to be in decomposition. The *T. petropolitanus* hid itself due to our presence, and did not release the tadpole. Crabs have been reported preying on *Crossodactylus schmidti* (Caldart et al. 2011. North-West J. Zool. 7:342–345). With this finding, we add an additional example of



FIG. 1. *Trichodactylus petropolitanus* feeding on a tadpole of *Crossodactylus gaudichaudii.*

the link in the complex trophic chain in Atlantic Forest streams, where tadpoles are a food resource for freshwater crabs.

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***DENDROBATES AURATUS* (Green and Black Dart-poison Frog). TADPOLE DEPOSITION SITE.** Artificial structures can provide valuable rearing habitat for amphibians. Many frogs use both natural and artificial structures for breeding and parental care. However, little information exists regarding the use and characteristics of larger artificial structures for dendrobatids. *Dendrobates auratus* is widely distributed across Panama (Dunn 1941. Copeia 1941:88–93). Males of this species practice parental care by tending and actively transporting larvae in response to changing water conditions or rainfall (Wells 1978. Herpetologica 34:148–155). Here I report on the use of an artificial structure for tadpole deposition by *D. auratus*.

On 21 August 2014, I observed an adult male *D. auratus* (SVL = ca. 32 mm) with two larvae (Gosner stage 26–30) on its back (Fig. 1A). The adult frog was moving and depositing larvae in an artificial concrete structure (Fig. 1B) at a private residence surrounded by secondary forest and small forest patches in Chiriquí province, Panama (8.202724°N, 82.196791°W, datum WGS84; elev. 31 m). The structure measured 36.8 cm by 8.2 m and was filled with leaf litter with a water depth of 7.1 cm from recent rainfall. I observed seven *D. auratus* tadpoles within the artificial structure. This observation of frogs using larger than usual deposition sites provides information for future management of dendrobatid frogs as an alternative to previously described smaller artificial phytotelmata and tadpole rearing cups attached to tree trunks, which have proven successful as artificial breeding sites (Brown et al. 2009. Anim. Behav. 77:547–554; Stynoski 2009. Anim. Behav. 78:1351–1356).

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FIG. 1. A) *Dendrobates auratus* adult male with tadpoles; B) view of the artificial structure used for parental care in Chiriquí province, Panama.

***LEPTODACTYLUS VASTUS* (Northeastern Pepper Frog). CANNIBALISM.** *Leptodactylus vastus* (recently separated from *Leptodactylus labyrinthicus*) occurs in northeastern Brazil, primarily in Caatinga and adjacent Cerrado habitat (Heyer 2005. Arq. Zool. 37:269–348). Conspecific predation events are reported for a few anuran species, usually among large species (Toledo et al 2007. J. Zool. 271:170–177). Here we report a cannibalism event of *L. vastus*. At 0900 h on 25 May 2014 at Reserva Sapiranga, municipality of Mata de São João, state of Bahia, Brazil (12.570645°S, 38.045959°W, datum WGS84; elev. 18 m) we observed a large adult *L. vastus* in the leaf litter near a pond at the edge of a river (Rio Pojuca). It had the partially ingested left leg of a younger *L. vastus* in its mouth (Fig. 1). The prey was alive but already had most of its thigh eaten. The predator remained still until we tried to capture it; it then fled into the river holding its



FIG. 1. Adult *Leptodactylus vastus* holding and injuring the left leg of a younger conspecific.

prey in its mouth. *Leptodactylus vastus* has preyed on other vertebrates such as bats (Gouveia et al. 2009. Herpetol. Rev. 40:210) and snakes (Ferreira et al. 2012. Herpetol. Rev. 43:147); however, this is the first report of adult cannibalism in this species. Cannibalism has been observed in tadpoles of *L. labyrinthicus* (Silva et al. 2005. J. Nat. Hist. 39: 555–556); under current taxonomy that observation may now be assigned to *L. vastus*.

This observation occurred during a field survey under ICMBio/SISBIO permit Nº 23355-2.

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***LEPTODACTYLUS VASTUS* (Northeastern Pepper Frog). DIET.** *Leptodactylus vastus* is a large terrestrial, nocturnal leptodactylid found in northeastern Brazil (Roberto et al. 2012. Biota Neotrop. 13:320–330); it belongs to the *pentadactylus* group and was recently split from *L. labyrinthicus* (Heyer 2005. Arq. Zool. 37:269–348). In the current work, we present occurrence of predation of *Physalaemus albifrons* (Bahia Dwarf Frog) by *L. vastus*. Five specimens of *L. vastus* (all males; mean SVL = 10.8 ± SD 1.3 cm; range = 9.1–12.6 cm) were collected in the municipality Aiuaba at the Ecological Station of Aiuaba, Brazil (6.573476°S, 40.123564°W, datum SAD69; elev. 466 m) on 27 March 2011 and examined. A total of seven specimens of *P. albifrons* (mean SVL = 2.3 ± SD 0.5 cm; range = 2.1–3.4 cm) were recovered: two in the stomach of one *L. vastus* and five in another. Voucher specimens were deposited in the herpetological collection of the Universidade Regional do Cariri–URCA-H (LZ 1309 and LZ 1320 for *L. vastus* and *P. albifrons*, respectively). *Physalaemus albifrons* is a small anuran, found in northeastern Brazil (Roberto et al. 2012. Biota Neotrop. 13:320–330). To our knowledge, this is the first time *P. albifrons* has been documented in the diet of *L. vastus*.

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***ODONTOPHRYNUS MAISUMA*. ATTEMPTED PREDATION.** *Odontophrynus maisuma* is a recently described fossorial frog restricted to coastal areas of Uruguay and southern Brazil (Rosset 2008. J. Herpetol. 42:134–144). Some information has been published on its ecology, but data on its predators are lacking. During a herpetological survey of a grassland area associated with coastal sand dunes in the municipality of Rio Grande, Rio Grande do Sul, Brazil (32.2175°S, 52.2222°W, datum WGS84; elev. 3 m), we observed a xenodontine snake *Lygophis anomalus* attempting predation on *O. maisuma*. At 1120 h on 17 September 2014, we observed an adult female *L. anomalus* (total length = 55 cm) in grassland with its head burrowed in the ground. The snake was attempting to pull the frog from its burrow, and loops of the snake's body were braced against the grass for leverage. During photography of the event, we disturbed the snake, which immediately released the frog and began to tongue flick rapidly. The frog had inflated its body and was injured on the right portion of its head (Fig. 1). After 10 min. the snake fled, leaving the frog at the burrow entrance. The frog remained inflated for around one minute then retreated to its burrow.



Fig. 1. Adult *Odontophrynus maisuma* and *Lygophis anomalus* following predation attempt.

Lygophis anomalus feeds on a variety of vertebrates, primarily anurans (Panzera and Maneyro 2014. South Am. J. Herpetol. 9:75–82). Panzera and Maneyro (2014, *op. cit.*) found representatives of six anuran families as prey; however, this is the first report of *O. maisuma*. Both *L. anomalus* and *O. maisuma* inhabit wet environments and open grasslands and their distribution overlaps in coastal zones of Uruguay and southern Brazil. Thus, we suggest that predation of *O. maisuma* by *L. anomalus* may be a frequent occurrence in these areas.

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***OSTEOPILUS SEPTENTRIONALIS* (Cuban Treefrog). CANNIBALISM.** *Osteopilus septentrionalis* is an invasive exotic anuran in southwest Florida. The rate at which *O. septentrionalis* has spread across the South Florida landscape and the possible impacts it is having to native treefrogs has been studied with little hope given to any potential control. It has been suggested that one of the major characteristics allowing their spread is a generalized adult diet and the propensity of their tadpoles to employ cannibalism (Babbitt et al. 2000. Copeia 2000:469–474). At 0900 h on 11 October 2014, we witnessed an adult *O. septentrionalis* cannibalizing a juvenile (Fig. 1) in the vegetation near the parking lot of the CREW Marsh Hiking Trails, Collier Co., Florida, USA (26.492096°N, 81.534240°W; datum WGS84). Post-metamorphic cannibalism in this species is often written about in non-scientific literature and species accounts with no evidence presented to substantiate the claims (Johnson 2013. The Cuban



FIG. 1. Adult *Osteopilus septentrionalis* cannibalizing a juvenile.

Treefrog (*Osteopilus septentrionalis*) in Florida. http://edis.ifas.ufl.edu/pdffiles/UW/UW25900.pdf; 8 December 2014). In fact, most use the word "cannibalism" to mean that they eat other frogs rather than conspecifics (http://allaboutfrogs.org/info/species/cuban.html; 8 December 2014). We fully expect that others have observed similar behaviors as our own in this species. And in fact, it has been demonstrated in lab experiments (Wyatt and Forys 2004. Southeast. Nat. 3:695–700). However, definitive proof of post-metamorphic cannibalism has not been scientifically documented in wild populations of *O. septentrionalis*, which is the purpose of this note. Future research should be done to determine if this was an isolated event, a common opportunistic event with little impact at the population level, or if it is a density-dependent prey-switching behavior that represents a new self-regulation system within this invasive population.

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***PELOBATES FUSCUS* (Common Spadefoot). REPRODUCTIVE BEHAVIOR.** Calling in immature amphibian specimens has been observed in several European anurans, including *Pelobates fuscus*. Calling in *P. fuscus* has been observed in pre-adults (SVL = 33–37 mm; Müller 1984. Salamandra 20:121–142). Males generally reach sexual maturity at the age of two and females at the age of three years (Wiener 1997. *In* Hödl et al. [eds.], Populationsbiologie von Amphibien: Eine Langzeitstudie auf der Wiener Donauinsel, pp. 165–181. Stapfia 51). As they mature, male *P. fuscus* develop oval glands on the dorsal surface of the front legs which can appear nine months after metamorphosis (SVL = 37.3–40.4 mm; mass = 5–10 g; Nöllert 1990. Die Knoblauchkröte. A. Ziemsen Verlag, Wittenberg Lutherstadt. 144 pp.). What is notable in *P. fuscus* is that the females also emit vocalizations (Seglie et al. 2013. Bull. Soc. Herpetol. Fr. 145–146:61–72). Here we describe calling activity and the forming of a lumbar amplexus in captive post-metamorphic *P. fuscus*.

On 20 April 2012 small portions (8–10 cm) of eleven *P. fuscus* egg strings were collected from Valthe population in Drenthe province, the Netherlands (52.505747°N, 6.525512°E; datum WGS84) and the subsequent larvae were reared as part of a reintroduction program. The majority of larvae were released into the wild prior to metamorphosis. Some specimens were retained for educational purposes. Metamorphosis occurred at approximately eleven weeks of age after which they were kept terrestrially in groups of up to five animals in small terraria (30 x 38 x 25 cm) with a sandy soil substrate taken from their natural habitat. Invertebrates such as *Acheta domesticus, Alphitobius laevigatus*, and *Lumbricus terrestris* were offered twice a week and water was permanently available in a small bowl. After being kept in these terraria for two weeks, two individuals (SVL = 28 and 30 mm; mass = 3.0 g and 3.2 g) were placed in shallow water (approx. 4 cm deep) from 21–29 July 2012. Oval glands were absent in these specimens so sex determination was impossible. From 24 July 2012 on, calling activity was observed sporadically on a daily basis. During the only three visual observations, calling took place at the water surface; it is unknown if it also occurred in a submerged position, a behavior that *P. fuscus* normally exhibits. Calling was always brief and only observed during the day, mainly between 1000 h and 1700 h. The sound differed from that of adults in duration and pitch but was not recorded and it proved impossible to discern whether both specimens exhibited this behavior. On 27 July 2012, at 1500 h, two longer lasting calling periods were observed. A visual checkup showed the juveniles had formed a lumbar amplexus which lasted approximately 28 minutes. Our case further demonstrates that calling and the formation of lumbar amplexus can be observed in post-metamorphic *P. fuscus* only two weeks post-metamorphosis; thus prior to their first hibernation.

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***PELOBATES SYRIACUS* (Syrian Spadefoot). CANNIBALISM.** Cannibalism has been observed in early life history stages of many amphibian species (Babbitt and Meshaka 2000. Copeia 2000:469–474; Pfennig and Murphy 2000. Evolution 54:1738–1749; Vera Candioti 2005. Acta Zool. 86:1–11); however, less is known about cannibalism in the terrestrial phase of the anuran life cycle. Herein we report cannibalism in a *Pelobates syriacus* . On 12 July 2013 we witnessed an adult male *P. syriacus* (SVL =



FIG. 1. Adult male *Pelobates syriacus* attempting to ingest a conspecific juvenile.

66.2 mm, 35.9 g) trying to swallow a juvenile of the same species (SVL = 37.4 mm, 7.0 g; Fig. 1); while we were taking pictures the adult regurgitated its prey, which seemed to be unharmed, and we were able to measure them both. The observation was made in the southern part of the Danube Delta Biosphere Reserve (Constana Co., Romania), on a natural levee (Grindul Lupilor) separating Lakes Zmeica and Sinoe (44.620194°N, 28.812306°E, WGS84; elev. -2 m). After the mass land migration of newly metamorphosed spadefoots on 18–20 June 2013, a high density of juveniles was recorded at the site (up to 8800 juveniles/ha, unpubl. data). As far as we are aware, our observation is the first record of cannibalism for this species.

This observation is part of our study on *Pelobates* species supported by the Romanian National Authority for Scientific Research, CNCS-UEFISCDI grant, project number PN-II-ID-PCE-2011-3-0173.

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TESTUDINES — TURTLES

***CHELYDRA SERPENTINA* (Snapping Turtle). WATERFOWL PREDATION.** *Chelydra serpentina* is an omnivorous resource generalist that has been observed preying on aquatic and semi-aquatic birds (Ernst and Lovich 2009. Turtles of the United States and Canada, 2nd ed. Johns Hopkins Univ. Press, Baltimore, Maryland. 827 pp.). Numerous species and age/size classes of waterfowl prey have been described in the diet of *C. serpentina*, such as adult *Aechmophorus occidentalis* (Western Grebe) (Igl and Peterson 2010. Waterbirds. 33:105–109), adult *Leucophaeus atricilla* (Laughing Gull) (Alexander 1921. Auk 38:596), and cygnet and adult *Cygnus buccinator* (Trumpeter Swan) (Moriarty 1990. Minnesota Herpetol. Soc. Newsl. 10:4; Lumsden 2013. Can. Field Nat. 127:138–145), among other species (see Coulter 1957. J. Wildl. Manage. 21:17–21; Ernst and Lovich 2009, *op. cit.*; Igl and Peterson 2010, *op. cit.*). Here we report predatory behavior and the first, to our knowledge, documented observation of predation of a *Mergus merganser* (Common Merganser) by *C. serpentina*.

At approximately 1000 h on 31 July 2014, an adult female *M. merganser* and five young-of-the-year juveniles were observed swimming along the shoreline of a shallow bay in Clear Lake, located in central Ontario, Canada (45.2530°N, 79.7877°W; datum WGS84). All individuals were repeatedly submerging their heads underwater, a characteristic definition of food searching behavior in *M. merganser* (Wood and Hand 1985. Can. J. Zool. 63:1260–1270). At approximately 1005 h, the female *M. merganser* was bitten on the lower right abdomen and flank by a *C. serpentina* (Fig. 1). The *M. merganser* silently struggled and beat its right wing and hind foot on the carapace and head of the *C. serpentina*. During this time, the juveniles rapidly swam away and were not observed in the bay again that day. At approximately 1007 h the *M. merganser*, with the *C. serpentina* still biting the lower flank, floated away from the shoreline and into deeper water in the bay. It, however, could not be determined which individual was instigating this movement (i.e., whether the *M. merganser* was moving on its own accord or being forcefully dragged into open water by the *C. serpentina*). Once out into deeper water, the *C. serpentina* began submerging the *M. merganser*, doing this three times over the course of approximately 10 minutes, each time holding the *M. merganser* underwater for approximately 15 seconds. In addition to maintaining a secure grip on the *M. merganser* with its jaws,



PHOTO BY C. B. BOBBIE

FIG. 1. *Chelydra serpentina* biting the lower right flank of an adult female *Mergus merganser*, Clear Lake, Central Ontario, Canada.

the *C. serpentina* used its foreclaws to hold the bird in place (as has been observed previously during oversized prey handling in *C. serpentina*; Igl and Peterson, *op. cit.*; pers. obs.). Initially the *M. merganser* struggled, beating its wings and trying to resurface when submerged. However, by the third submergence the *M. merganser* had stopped struggling. At approximately 1018 h, the *C. serpentina* again completely submerged the *M. merganser*. The bird struggled for approximately 30 seconds while underwater, released a stream of bubbles, then ceased all movement. Within 30 seconds of the bird's death, the *C. serpentina* released the bird from its jaws, abandoning the carcass, and the bird floated up to the surface of the water. We did not directly observe the *C. serpentina* consuming the *M. merganser*, however upon inspection the next day, the head and neck of *M. merganser* were gone from the body. It is unclear if this was by *C. serpentina* or a scavenger. The *C. serpentina* was not captured for measurement but was estimated to have a straight carapace length of ca. 40 cm, likely making the turtle a male (Ernst and Lovich 2009, *op. cit.*). This repeated submergence and drowning of avian prey has been documented in other instances of *C. serpentina* predation (Alexander 1921, *op. cit.*; Igl and Peterson 2010, *op. cit.*). This observation serves as a contribution towards the predatory behavior and feeding ecology of *C. serpentina*.

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***CHELYDRA SERPENTINA* (Snapping Turtle). WINTER MORTALITY.** Turtles in northern latitudes may spend half the year in hibernation. Winter mortality is typically low, but overwintering can be stressful and lead to death due to freezing, prolonged anoxia, or predation (Ultsch 2006. Biol. Rev. 81:339–367). Mortality events can result in the death of many turtles. For example, 186 turtles from eight species died when a pond froze to the bottom in Iowa (Christiansen and Bickham 1989. J. Herpetol. 23:91–94).

On 6 May 2014, six adult Snapping Turtles were found dead at Mud Lake, a permanent waterbody >10 ha in size located in the Britannia Conservation Area in Ottawa, Ontario, Canada (45.371181°N, 75.794249°W, datum WGS84). There were four males (mean carapace length: 32.5 cm, range: 30.5–36.0 cm) and two females (mean carapace length: 28.8 cm, range: 27–30.5 cm). One adult male was found on shore, and the remaining turtles

were found floating just off shore along the southern margin of the lake. All of the turtles appeared to be in good condition, except for the turtle on shore which had bite marks on the head and left front shoulder, which may have occurred after death. No other species of turtle was found dead, even though >100 adult *Chrysemys picta* (Painted Turtle) are known to occur in the lake. It is unclear when the lake became ice free, but on 18 April it was still ~90% iced over.

Average monthly minimum temperatures for the winter were compared with the monthly minimum temperatures of the 30-year (1981–2010) climate normal from the Ottawa International Airport which is <10 km from Mud Lake (http://climate.weather.gc.ca/climate_normals/results_1981_2010_e.html?stnID=4337&lang=e&StationName=ottawa&SearchType=Contains&stnNameSubmit=go&dCode=1). Each month from November to April was colder than the climate normal. On average the monthly minimum temperature was 2.8°C (range: 1.0-5.7°C) colder than the 30-year climate normal. A colder than average winter could result in thicker ice causing some shallow portions of the lake to freeze to the bottom. *C. serpentina* is known to hibernate in shallow water near shore (Ultsch, *op. cit.*) and turtles in these areas may have died from freezing. Alternatively, a cold winter may have resulted in a longer than normal ice cover, causing turtles to die from prolonged anoxia. It is unknown what percentage of the adult *C. serpentina* population died. Adults were not observed less frequently in 2014, suggesting a significant portion of the population survived. It is unclear how often these kinds of mortality events occur, but dead turtles should be searched for after colder than average winters.

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***CHRYSEMYS PICTA* (Painted Turtle) and *CHELYDRA SERPENTINA* (Snapping Turtle). RAILROAD MORTALITY.** Railways can lead to turtle mortality when individuals become entrapped between rails and expire from overheating, dehydration, or train impacts (Kornilev et al. 2006. Herpetol. Rev. 37:145–148; Engeman et al. 2007. Herpetol. Rev. 38:331–332). Herein, I report observational evidence of railroad mortality in two turtle species.

On 3 June 2014, at ~1300 h, I observed a dead adult female *Chrysemys picta* in the center of a railway adjacent to wetlands in Lime Ridge, Pennsylvania, USA (41.024208°N, 76.366718°W, datum WGS84; elev. ~150 m). The turtle's carapace was partially crushed and extensive blood loss was evident. Mortality appeared to have occurred shortly before my observation. No obvious evidence of predation or scavenging was present on the *C. picta* carcass. Due to the nature of the turtle's injuries and frequent locomotive traffic along this railway (pers. obs.), it is likely that mortality resulted from direct impact with a passing train.

In August 2014, I observed the carcass of a medium-sized adult *Chelydra serpentina* in the middle of a railway adjacent to a pond in Espy, Pennsylvania, USA (41.010206°N, 76.416294°W, datum WGS84; elev. ~150 m). The *C. serpentina* carcass had experienced partial decay and desiccation. Because of the state of decomposition, it was impossible discern whether the animal experienced mortality directly from a train impact or had expired from overheating, dehydration, or predation resulting from entrapment between rails (Kornilev et al., *op. cit.*).

In Pennsylvania, *C. picta* nest in late May–June and have been noted to use rocky substrates associated with railroad beds for nesting (Hulse et al. 2001. Amphibians and Reptiles of Pennsylvania and the Northeast. Cornell Univ. Press, Ithaca, New York. 419 pp.; Bieber-Ham 2011. Population and Nesting Ecology of Painted Turtles [*Chrysemys pica*] in Pennsylvania. Honor's Thesis. Dickenson College, Pennsylvania. 37 pp.). Therefore, it is likely that the female *C. picta* became trapped between rails and expired while searching for nesting substrate associated with the railway. Likewise, female *C. serpentina* in Pennsylvania nest in late May–June and often utilize substrate associated with railways, including railway substrate near the location in which the aforementioned *C. serpentina* carcass was observed (Hulse et al., *op. cit.*; pers. observ.). Though the sex of the carcass could not be determined, this individual may have been a female that became entrapped between rails and expired during the nesting season.

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***EMYDID TURTLES.* UNUSUAL BASKING LOCATION.** Emydid turtles are most often observed basking aerially in aquatic settings (Boyer 1965. Ecology 46:99–118). Basking turtles primarily occupy deadwood structure when available (Lindeman 1998. Chelon. Conserv. Biol. 3:137–141), but will also opportunistically use other basking sites such as mammal lodges (e.g., beaver lodges; WS, pers. obs.) and anthropogenic structures (e.g., boat dock crossbeams, rope tethers; Lindeman 2013. The Map Turtle and Sawback Atlas: Ecology, Evolution, Distribution, and Conservation. University of Oklahoma Press, Norman. 460 pp.). Herein, we report an unusual basking location—an active nest of a reintroduced Whooping Crane (*Grus americana*)—used by emydid turtles in southwestern Louisiana, USA.

As part of an ongoing program to monitor the status of a Whooping Crane reintroduction in southwestern Louisiana, periodic monitoring was made of a crane nesting attempt in Avoyelles Parish (Louisiana) during Spring/Summer 2014. The nest was situated in an actively fished, commercial crawfish pond (*Procambarus clarkii*); these ponds are ephemerally flooded to promote crawfish production and often host an abundance of waterbirds (Huner et al. 2002. Waterbirds 25:66–78) and turtles (WS, pers. obs.). On 11 June 2014, a photograph was taken by SZ of the nesting crane via an aerial survey. After review of the photograph, a large emydid turtle was observed basking on the nest mound along with the incubating crane; the

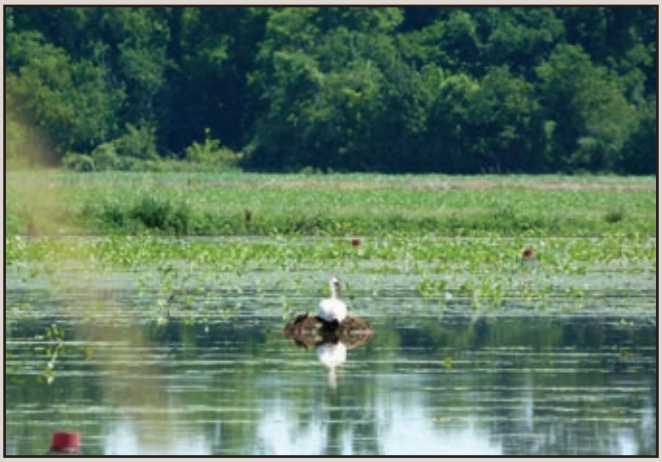


FIG. 1. Deirochelyine turtle basking on active nest of Whooping Crane in southwestern Louisiana.

turtle species could not be identified beyond family Emydidae, subfamily Deirochelyinae. On 12 June 2014, CS and CG made a second observation via ground blind of an emydid turtle basking on the nest mound (1505 h; conditions: 31°C, overcast with light rain). It was basking close to the incubating adult and remained there until 1607 h when the crane stood on the nest to preen and stretch its legs. On 20 June 2014, a third observation was documented by SZ and CS via ground blind of an emydid turtle that emerged to bask on the nest mound (1109 h; conditions: 28°C, sunny with scattered clouds). The turtle basked within 5–10 cm of the incubating crane (Fig. 1) and basked until SZ and CS left the site (1117 h).

Measurements of the nest mound by CG, CS, and SZ could not be taken until nesting had ceased (26 June 2014) to minimize disturbance and potential nest failure. The diameter of the nest measured from 92–96 cm across, with the nest mound protruding 13 cm above the water level. The water depth at the nest measured 29 cm, with mean water depth in the four cardinal directions similar to the level observed at the nest (mean = 30.3 cm, range 29–32 cm). The percent open water surrounding the nest was greater at 1 m (100%) and 5 m (100%), than at 10 m (70%).

Due to the distance between the observer and nest, the species identification was difficult to determine in all three observations beyond emydid subfamily Deirochelyinae. For the third observation, SZ took a photograph (Fig. 1) and upon closer inspection, the turtle has prominent yellow markings on the pleural scutes of the carapace and a short neck, probably eliminating *Deirochelys reticularia* (Chicken Turtle). Based on the characteristics of the turtle in the photograph, the type of habitat, and the abundance of *Trachemys scripta* (Slider) relative to *Pseudemys concinna* (Cooter) in this habitat type (WS, pers. obs.), it appears most likely to be an adult *T. scripta* of unknown sex. This is also the most likely species in observations #1 and #2, but cannot be definitively confirmed.

During these observations, both crane and turtles did not appear to show any aggression towards each other. Whooping Cranes can be quite aggressive towards other bird species and conspecifics within their nesting territory (Allen 1952. The Whooping Crane. Research Report No. 3 of the National Audubon Society. New York, New York. 246 pp.), but also readily accept other nearby birds or non-predatory mammals (Lewis 1995. *In* A. Poole [ed.], The Birds of North America Online. Cornell Lab of Ornithology; http:bna.birds.cornell.edu/bna/species/153; accessed 23 September 2014). For the turtle, however, an emergent nest mound is likely a very desirable basking substrate and similar to the characteristics of mammal lodges. These sites are desirable because they are 1) surrounded completely by water to avoid terrestrial predators; 2) the field of view is unobstructed, thereby lowering predation risks from aerial predators; and 3) it lacks vegetation and increases the thermoregulatory potential of the site early in the spring. Vegetation is thick on the surrounding levees of crawfish fields (see Fig. 1) which likely reduces its desirability as a basking site for all reasons listed above. To our knowledge, this is the first report of emydid turtles using a Whooping Crane nest as a basking site.

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***EMYDOIDEA BLANDINGII* (Blanding's Turtle). JUVENILE DIET.** Adult Blanding's Turtles are known for being primarily carnivorous (reviewed by Ernst and Lovich 2009. Turtles of the United States and Canada. 2nd edition. Johns Hopkins University Press, Baltimore, Maryland. 840 pp.). For example, past reports indicate that crustaceans and insects are important dietary components, but they also consume various vertebrates and vegetation (Lagler 1943. Am. Midl. Nat. 29:257–312; Kofron and Schreiber 1985. J. Herpetol. 19:27–40; Rowe 1992. J. Herpetol. 26:111–114). Although the diet of adult Blanding's Turtles is well known, little is known about the diet of juveniles. Juveniles are secretive, and past studies have noted the difficulty in detecting/capturing them during population research (Congdon et al. 1993. Conserv. Biol. 7:826–833). The difficulty associated with capturing juvenile Blanding's Turtles poses challenges to investigation of their dietary habits. We were able to obtain dietary data on a radio-tracked juvenile Blanding's Turtle that was part of an ongoing study conducted in Rock Co., Wisconsin, USA. These findings apparently represent some of the first published data on diet and feeding ecology for a juvenile Blanding's Turtle.

A radio-tagged juvenile Blanding's Turtle (straight-line carapace length: 122.25 mm, carapace width: 89.71 mm) was removed from the field and brought into the lab on 7 July 2014, to replace a damaged transmitter (3.9 g, model PD-2, Holohil Systems Ltd., Carp, Ontario). Prior to transmitter replacement, the turtle was placed in a large plastic container partially filled with water. While in the water, the turtle defecated and was subsequently removed. The water and fecal sample were next carefully strained through a 1-mm mesh sieve to acquire all available remains from the feces. The retained fecal sample was placed in 70% ethanol to prevent degradation and later investigated. The collected remains were first separated into broad categories (i.e., belonging to an insect, or plant remnants, etc.) by sifting through them under a dissecting microscope. All invertebrate remains were further investigated under a dissecting scope and identified to taxonomic family. This was accomplished by comparing the fragments found in the fecal sample to preserved specimens of local aquatic macro invertebrates that have been previously collected and identified. Given the number of representative fragments observed, it was possible to estimate the number of individuals in each family identified.

The fecal matter contained primarily insect remains and only 2% of the discernable sample contained plant fragments. The insects identified are frequently found in wetlands, and included members of the families Dytiscidae (N = 14 larvae), Belostomatidae (N = 6; adults and various eggs), Corixidae (N = 4), Notonectidae (N = 4), adult Hydrophilidae (N = 2), and Nepidae (N = 1). Members of the families Dytiscidae, Belostomatidae, Corixidae, and Notonectidae can be found in water depths less than 30 cm (Krull 1970. J. Wildl. Manag. 34:707–718; Ward 1992. Aquatic Insect Ecology 1: Biology and Habitat, John Wiley and Sons, Inc., New York. 456 pp.). These insects are considered nektobenthic, meaning they are competent swimmers that also spend substantial time attached to the stems of submergent/emergent aquatic vegetation, rather than the sediments (Ward 1992, *op. cit.*). The insect remains found in the fecal matter contribute to a better understanding of this juvenile Blanding's Turtle's diet and where it fed. For example,

given that many of the insects consumed rest on the stems of aquatic vegetation, the juvenile turtle likely spent time feeding off of vertical structures in shallow water, rather than off of the bottom. This is consistent with the habitats where radio-tracked juveniles are typically found, which contain ample shallow water and emergent vegetation. It is noteworthy that neither hard crustacean (e.g., amphipods and juvenile crayfish) nor gastropod (e.g., snail) remains were found in the fecal sample, despite their abundance in southern Wisconsin wetlands. This is particularly interesting given that crustaceans are commonly consumed by adults (Lagler 1943, *op. cit.*; Kofron and Schreiber 1985, *op. cit.*), which suggests that juvenile and adult diets may vary. We did not find evidence of soft-bodied prey (e.g., annelids and some species of dipteran larvae), which break down prior to defecation and may have been under-represented in our sample. This note is based on one sample, and additional research on the dietary preferences of juvenile Blanding's Turtles is desirable.

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***GLYPTEMYS MUHLENBERGII* (Bog Turtle) and *CLEMMYS GUTTATA* (Spotted Turtle). SHARED NEST SITE.** *Glyptemys muhlenbergii* is a federally-threatened (USFWS) species that inhabits tussock-dominated fens and other early-successional wetlands with deep mucky soil in New York State. Females tend to choose unshaded, vegetated hummocks for nesting sites, laying a clutch of 2–6 eggs (Whitlock 2002. PhD dissertation. University of Massachusetts, Amherst) in a shallow depression that they dig with their hind legs and cover with soil and vegetation. There are numerous observations of female *G. muhlenbergii* sharing hummocks or nesting cavities with conspecific females (Whitlock 2002, *op. cit.*; Janson Tesauro, Suzanne Macey, and Alvin Breisch, pers. comm.), and even ejecting an earlier-laid clutch in the process of digging and laying (A. Whitlock, pers. comm.).

On 12 June 2013, a radio-tracked female *G. muhlenbergii* was observed laying eggs in an excavated nest on the top of a hummock at approximately 1700 h in Putnam County, New York, USA (specific location withheld due to conservation concerns). At that time, there were four eggs already in the nest and she was still actively laying. The following evening, there were seven eggs in the nest, covered with a thin layer of sphagnum.

On 26 August, all seven eggs were intact within the nest. On 4 September the eggs had hatched (100% hatching success), and two hatchling turtles remained in the nest. One was a *G. muhlengergii*; the other was a *Clemmys guttata*. *G. muhlenbergii* and *C. guttata* are known to share hibernacula (Ernst 1976. J. Herpetol. 10:25–33), but to our knowledge this is the first documented instance of nest sharing between these two species.

Other species of freshwater turtle have been shown to place their eggs in microhabitats that differ from random in vegetative cover and nest temperature (Wilson 1998. Ecology 79:1884–1892). The nesting hummock observed in this instance was covered in tussock sedge, sweet flag, other forbs and sphagnum and was not directly shaded by woody shrubs. Although this is consistent with observations of other *G. muhlenbergii* nest locations, the hummock did not seem outwardly unique within this habitat, which abounds with sedge and forb-dominated hummocks. The phenomenon of multiple females using the same hummock or nest cavity, with greater numbers of hatchlings emerging over a longer time window, might predictably increase the predation risk to eggs or hatchlings (Baker et al 2013. Can. J. Zool. 91:451–461); Whitlock (2002, *op. cit.*) found depredation of Bog Turtle nests was highest in the weeks immediately following laying and later during hatchling emergence. This suggests there may be subtle cues that female turtles use to determine the suitability of a hummock that are perhaps similar in these two species, and that are more important than the increased predation risk that using common nesting spaces may create. Perhaps females are attracted to areas visited by other females, especially if similar nest-site characteristics are sought; attraction to other turtle's nests may decrease time spent searching for and testing nest sites and minimize predation risk for exposed females.

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***GOPHERUS POLYPHEMUS* (Gopher Tortoise). NEST AND BURROW DEFENSE.** *Gopherus polyphemus* lives in underground burrows and females often deposit their eggs within the bare sand "apron" at their burrow entrance. *G. polyphemus* has been documented guarding their nests from humans during daylight hours (Grosse et al. 2012. Chelon. Conserv. Biol. 11:148–151) but to our knowledge, defensive behavior has not been documented with non-human predators, or at night. Although not native to the southeastern United States, natural dispersal and translocation by humans since the early 1900s (Fitch et al.1952. J. Mammal. 33:21–37) have drastically expanded the range of *Dasypus novemcinctus* (Nine-banded Armadillo), and it is now abundant throughout much of the Southeast. The following observations of nest and burrow defense occurred at the Joseph W. Jones Ecological Research Center in Baker Co., Georgia, USA.

During the 2014 *G. polyphemus* nesting season, as part of a study on nest predation, we used motion sensing trail cameras (UWAY VH400HD, Norcross, Georgia) to monitor 24 active tortoise burrows (Auffenberg and Franz 1982. *In* R. B. Bury [ed.], North American Tortoises: Conservation and Ecology, pp. 95–126. USDI Fish and Wildlife Service Wildlife Research Report 12) containing artificial nests constructed with chicken eggs and 16 active burrows containing natural tortoise nests. The cameras detected *G. polyphemus* exhibiting aggressive behavior toward *D. novemcinctus* at four (10%) monitored nests. Between 19 June and 20 June 2014 from 2050 to 0210 h, we recorded a female *G. polyphemus* exhibiting aggressive behavior in defense of her burrow, which contained a natural nest (located ~20 cm from the burrow entrance and 15.2 cm below ground) from a *D. novemcinctus*. This tortoise was observed on video lunging toward the *D. novemcinctus* and attempted to bite, but did not leave the entrance of the burrow. Despite the behavior of the tortoise, the *D. novemcinctus* fully depredated the nest during this event. We documented this behavior a second time with a different tortoise of unknown gender on 16 July 2014 at 0558 h. This tortoise was successful in driving the *D. novemcinctus* away from the burrow, and the nest (located ~27 cm from the burrow

entrance and 16 cm below ground) subsequently hatched on 8 October 2014.

On 15 July and 19 July 2014 at 0500 and 0434 h, respectively, we documented two additional *G. polyphemus* exhibiting aggressive behavior toward *D. novemcinctus*. These tortoises were filmed at the entrance of their burrows lunging toward a *D. novemcinctus*, but to our knowledge, no natural tortoise nest was present at their burrows. However, *D. novemcinctus* may have been attracted to these burrows because they contained artificial nests, but we do not expect that the presence of an artificial nest would alter the resident tortoise's behavior. Our observations indicate that *G. polyphemus* defend their burrows and possibly their nests from *D. novemcinctus*.

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***GRAPTEMYS SABINENSIS* (Sabine Map Turtle). KYPHOSIS.** Kyphosis has been described in a number of chelonian species with most occurring in cryptodirans (Rhodin et al. 1984. Brit. J. Herptetol. 6:369–373; Trembath 2009. Chelon. Conserv. Biol. 8:94–95). Among *Graptemys*, kyphosis had previously only been observed in *G. oculifera* (Ringed Sawback; Selman and Jones 2012. Chelon. Conserv. Biol. 11:259–261). During riverine turtle population studies in southwestern Louisiana, two female *G. sabinensis* exhibiting kyphosis were captured in fyke nets, the first records of kyphosis for the species.

Female #1 was captured near Estherwood, Louisiana, USA (30.2027°N, 92.4886°W; datum WGS84) on Bayou Plaquemine Brule, a tributary of the Mermentau River on 28 August 2013 with a midline plastron length (MPL) of 10.9 cm, a carapace height (CH) of 6.6 cm, and a mass of 265 g (Fig. 1A). Female #2 was captured near Mermentau, Louisiana, USA (30.1729°N, 92.9010°W; datum WGS84) on the Mermentau River on 5 September 2013 with an MPL of 16.6 cm, a CH of 9.4 cm, and a mass of 1050 g (Fig. 1B). The deformity of Female #2 also included slight scoliosis (left lateral curvature of the spine at vertebral 2 and 3) suggestive of kyphoscoliosis. Female #1 possessed no additional physical abnormalities (Fig. 1A), while Female #2 had several carapacial scute abnormalities (14 left and 13 right marginal scutes, 6 vertebral scutes, and 5 left plural scutes) and severe damage to the rear plastron (Fig. 1B).

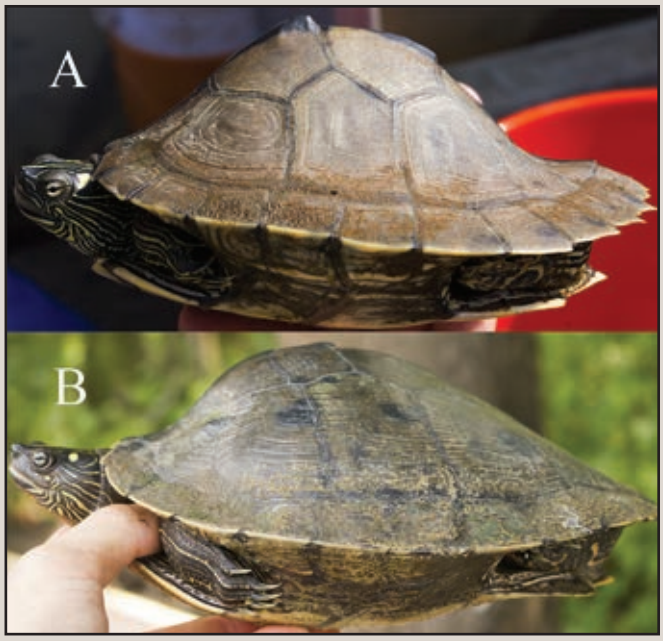


FIG. 1. A) Kyphotic *Graptemys sabinensis* female #1 captured on Bayou Plaquemine Brule near Estherwood, Louisiana. B) Kyphotic female #2 captured on the Mermentau River near Mermentau, Louisiana.

These individuals represented 0.93% of the 216 *G. sabinensis* captured in the Mermentau drainage and 0.38% of the 530 *G. sabinensis* caught across the Sabine, Calcasieu, and Mermentau rivers. The prevalence of kyphosis in *G. sabinensis* appears high relative to other turtle studies documenting kyphosis: 0.10% of 3830 *G. oculifera* (Selman and Jones, *op. cit.*), 0.06% of 21,786 *Trachemys scripta* (Tucker et al. 2007. Herpetol. Rev. 38:337), 0.36% of 833 *Emydura macquarii* (Trembath, *op. cit.*). However, larger sample sizes from the Sabine and Calcasieu rivers would be needed to compare kyphosis prevalence across drainages because kyphosis is rare and our sample sizes were small compared to other studies.

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***KINOSTERNON BAURII* (Striped Mud Turtle). AUTOHIRUDINOPHAGY.** Ecological interactions between turtles and leeches (Hirudinea) are typically viewed in the context of host-parasite relationships (Telford 1984. *In* G. Hoff et al. [eds.], Diseases of Amphibians and Reptiles, pp. 385–518. Plenum Press, New York; Brown et al. 1994. Copeia 1994:228–231; Raedel et al. 2008. Copeia 2008:227–233). However, leeches have also been documented as prey for some chelonians (e.g., *Chelydra serpentina*, *Chrysemys picta*, *Emydoidea blandingii*, *Graptemys ouachitensis*, *G. versa*, *Kinosternon flavescens*, *Macrochelys temminckii*, *Sternotherus odoratus*; Ernst and Lovich 2009. Turtles of the United States and Canada. Johns Hopkins University Press, Baltimore, Maryland. 827 pp.). When observed, these predatory interactions involved turtles consuming leeches that were not attached to a host (Ernst 1986. J. Herpetol. 20:341–352) or turtles of one species (*C. picta*) biting leeches that were attached to turtles of another species (*C. serpentina*) (Krawchuck et al. 1997. Can. Field Nat. 111:315–318). Herein, we describe observations of two *Kinosternon baurii* consuming leeches (*Placobdella parasitica*) attached to their own bodies.

On 1 June 2014 at approximately 1500 h, we captured one adult male (80 mm CL) and one adult female (62 mm CL) *K. baurii* in a pond on the Santa Fe College campus in Gainesville, Florida, USA (29.68279°N, 82.43869°W, WGS84; elev. 52 m) as part of a long-term mark-recapture study. Prior to measuring the turtles, we observed their behavior while they were temporarily housed in a plastic container (65 x 43 x 39 cm) filled with pond water to a depth of approximately 10 cm. At 1545 h, we observed the male bite at his own right hind limb and consume an attached leech. The male then fully extended his neck, turned his head 180°, and bit at the skin beneath the anterior edge of his carapace two times, each time consuming an attached leech. At 1555 h, we observed the female also extend her neck, turn her head 180°, and consume four leeches attached to the skin near the anterior edge of her carapace. Our observations represent the first report of

leeches in the diet of *K. baurii* and the first report of this species eating leeches attached to its own body. We term this behavior autohirudinophagy. Bourque (2011. Herpetol. Rev. 42:232–234) reported two captive *Sternotherus minor* removing leeches from their shells and limbs but could not tell if they were consumed; some leeches were attached to the inside of their mouths. No leeches remained in the mouths of the *K. baurii* we observed. Novelli et al. (2009. Herpetol. Rev. 40:435–436) observed four Brazilian Snake-necked Turtles (*Hydromedusa maximiliani*) removing dead skin and turbellarian ectosymbionts from their own axillary and inguinal pockets in the laboratory. Consumption was not noted. Atmospheric and terrestrial basking that may aid in ectoparasite removal only rarely occur in these species (Ernst and Lovich 2009; Novelli et al., *op. cit.* and references therein; Mitchell and Johnston 2012. Herpetol. Rev. 43:127). Autohirundinophagy and grooming may be alternatives to using basking as a means of removing leeches and skin in bottom-walking turtles that seldom bask (Novelli et al., *op. cit.*; this study).

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***KINOSTERNON HIRTIPES* (Rough-footed Mud Turtle). MAXIMUM SIZE AND HABITAT.** *Kinosternon hirtipes* occurs from extreme western Texas, south into northern and central Mexico (Ernst and Lovich 2009. Turtles of the United States and Canada. 2nd edition. Johns Hopkins University Press, Baltimore, Maryland. 827 pp.). In Texas, *K. hirtipes* is restricted to the Alamito Creek drainage in Presidio Co. and classified as a threatened species by the Texas Parks and Wildlife Department owing to its limited distribution and continuing habitat degradation (Texas Parks and Wildlife Department 2013. Species of Conservation Concern. Available from: www.tpwd.state.tx.us). *Kinosternon hirtipes* is considered among the least-studied of North American turtles and very little is known concerning its natural history (Ernst and Lovich, *op. cit.*; Lovich and Ennen 2013. Amphibia-Reptila 34:11–23). We here report a new maximum size record for *K. hirtipes* and describe the habitat where this turtle was captured.

On 9 March 2013, one of us (JLS) captured a large male *K. hirtipes* in a double-throated wire mesh trap (1 m long × 30 cm wide) baited with canned sardines (packed in soybean oil) and set in a livestock pond located on a private ranch approximately 57 km SE of the town of Marfa, Texas. The straight-line carapace length (CL) of this turtle measured 195 mm; other measurements were: carapace width = 120 mm; plastron length = 145 mm; plastron width = 78 mm; shell depth = 80 mm; body mass = 982 g. Because the plastral annuli were worn and no longer visible, we were unable to estimate the age of this turtle (Iverson et al. 1991. J. Herpetol. 25:64–72). The turtle was permanently marked by notching a unique series of marginal scutes (Cagle. 1939. Copeia 1939:170–173) and released about 10 minutes after being captured and measured. The CL of this turtle exceeds the previously reported size maximum for *K. hirtipes* (CL = 185 mm; Ernst and Lovich, *op. cit.*) by 10 mm. Furthermore, the CL of this turtle is considerably larger than the asymptotic CL of 188 mm calculated by Platt et al. (unpubl.) for a sample (N = 27) of recaptured *K. hirtipes* from another wetland in the Alamito Creek drainage.

The pond (elevation approximately 1100 m) where the record-sized turtle was captured is a spring-fed natural wetland within the Alamito Creek drainage that was modified by damming to provide water for livestock. The pond is steep-sided with an estimated surface area of 6418 m^2 and averages 5.0 m deep; the substrate is mud. Because the pond is fed by an artesian spring, water levels remain relatively constant throughout the year, even under drought conditions. Water temperature ranged from a high of 23.7°C in summer to a low of 15.8°C in winter. The water is relatively clear and the bottom of the pond (5 m) is readily visible; Secchi depth was measured at 5.0 m. The pond supports dense stands of emergent aquatic vegetation (*Scirpus*, *Typha*, and Poaceae) and approximately 30% of the surface area is dominated by *Typha*. Notably, this is one of the few ponds in the area to support dense stands of *Typha*, which are typically eradicated by landowners to maintain open water. Mats of *Chara* and filamentous algae are present in open water. The surrounding landscape was formerly arid grassland (Wilde and Platt 2011. J. Big Bend Studies 23:85–106), but is now dominated by Honey Mesquite (*Prosopis glandulosa*) and Creosote Bush (*Larrea tridentata*). In addition to the record-sized *K. hirtipes*, five other large adult males (mean CL ± 1SD = 166 ± 8.8 mm; range = 156–178 mm), but no females were trapped in this pond from 2011 through 2014 as part of an on-going population study (Smith et al., unpubl. data). The nearest other pond known to harbor *K. hirtipes* is located approximately 8.7 km away. There is no connectivity between these populations, which are isolated by intervening desert landscape. Populations of Red Shiner (*Cyprinella lutrensis*), sunfish (*Lepomis* spp.), largemouth bass (*Micropterus* spp.), and catfish (Siluriformes) are present in the pond after having been stocked for recreational fishing by the landowner; the latter two fish represent likely predators of neonate and hatchling *K. hirtipes*. Although Yellow Mud Turtles (*Kinosternon flavescens*) are present in both ephemeral and permanent waterbodies in the Alamito Creek drainage (Platt et al., unpubl. data), none were captured in the pond during four years of trapping.

There are few other published descriptions of *K. hirtipes* habitat for comparison to our data. Iverson et al. (*op. cit.*) found a large population of *K. hirtipes* inhabiting a springfed stream flowing through arid grassland in Chihuahua, Mexico. The stream was described as clear and fast-flowing, 100–200 cm wide (average width = 100 cm) and 10–100 cm deep (average depth = 50 cm) with a sand-gravel substrate and deeply undercut banks where turtles sought refuge. Dense stands of *Typha* were established along the bank in backwater areas where the current was reduced. Similarly, Ernst and Lovich (*op. cit.*) describe a population of *K. hirtipes* inhabiting a livestock pond in Texas (480 m^2 and 4.0 m deep) that was "choked" with muskgrass (*Chara* sp.). Collectively, these reports and ours suggest that springfed permanent wetlands with an abundance of submerged and emergent aquatic vegetation are required by *K. hirtipes*. Additional ecological studies of this poorly known species are warranted.

Turtles were collected under a Scientific Research permit (SPR-0307-844) issued to SGP by the Texas Parks and Wildlife Department. We thank the various landowners in Presidio County, Texas for allowing us to study turtles on their properties. Support for SGP was provided by Wildlife Conservation Society. Comments by Lewis Medlock improved an early draft of this manuscript.

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***LISSEMYS PUNCTATA VITTATA* (Indian Flapshell Turtle). CLUTCH SIZE.** The clutch size of *Lissemys punctata* sensu lato is reported to be 2–15 (Bhupathy et al. 2014. *In* Rhodin et al. [eds.], Conservation Biology of Freshwater Turtles and Tortoises: A Compilation Project of the IUCN/SSC Tortoise and Freshwater Turtle Specialist Group. Chelonian Research Monographs No. 5, pp. 076.1–12). However, little is known of the reproductive attributes of *Lissemys punctata vittata*, a subspecies occurring in peninsular India. Four specimens of *L. punctata vittata* were confiscated by authorities in Kolkata, West Bengal, on 12 December 2014 and were housed at the Wildlife Rescue Centre (Saltlake), Kolkata. On 18 December 2014 at ca. 1830 h we found a clutch containing 12 eggs in the turtle's enclosure. Egg diameter ranged from 26.06–30.24 mm (mean = 27.68 mm) and the weight ranged from 10.8–14.6 g (mean = 12.45 g). We kept the eggs in a batch of six in two plastic boxes with vermiculite as substrate for artificial incubation. Unfortunately, facilities to maintain suitable incubation temperatures for the eggs were lacking at the rescue center and the eggs appeared non-viable. We thank the Forestry Department of West Bengal for their co-operation.

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***MALACLEMYS TERRAPIN LITTORALIS* (Texas Diamond-backed Terrapin). SOCIAL OR GROUP BURROWING.** Social behavior in turtles is often seemingly related to limited resources, and is presumably beneficial if it increases mating success or access to resources. For example, Snapping Turtles (*Chelydra serpentina*) display territorial behavior that may allow them to defend resources and potential mates (Galbraith et al. 1987. Can. J. Zool. 65:2623–2629). *Malaclemys terrapin* has been observed participating in mating aggregations (Hauswaldt and Glenn 2005. Mol. Ecol. 14:723–732) and lekking (Estep 2005. Thesis: College of Charleston), however, social burrowing behavior has not been reported to date.

We observed "social burrowing" behavior of *Malaclemys terrapin littoralis* during an ongoing mark-recapture population monitoring study on South Deer and North Deer Islands, as well as in a marsh along Sportsman's Road on Galveston Island, in West Galveston Bay, Texas, USA between 2010–2011. A literature review indicates that this is the first reported occurrence of social or group burrowing in *M. terrapin littoralis*. Burrows were found during randomized terrestrial line transects and varied in location between creek beds, lowland frequently-submerged marsh, and upland vegetated marsh. These burrows were typically located in a natural occurring depression in the marsh, but were also dug by the terrapins in a few cases. We observed social burrows during December through September, but did not locate any social burrows in October and November. Burrows contained 3–15 terrapins, and sex ratios in the burrows varied between months. Sex ratios favored females in every month with the exception of September, with the average number of females being more than double the average number of males from May through August. In some cases, groups of individual terrapins were recaptured together in separate burrowing events. Spatial and temporal distribution of burrows did not appear to be related to available habitat and resources, such as vegetation density, composition, or distance from water. This suggests that these burrows could potentially be indicative of mating aggregations rather than a resource-dependent behavior. We found that 95% of the burrows occurred less than 6.5 m from a waterbody, which includes the open bay as well as tidal creeks within the interior of South Deer island,, and that the average vegetation cover at the site of the burrow was 71.8%. Females found in these social burrows were frequently gravid as determined with ultrasound imaging. On average, we observed more terrapins per burrow in August and a greater number of burrows in June compared to other months.

Further investigation into the cause and temporal and spatial distribution of these social burrows is desirable. Any trends we observed were statistically insignificant, which was mainly due to small sample size and high variance. Discovering the cause of social burrowing could increase our understanding of terrapin mating and social behavior, and could help us better describe key habitats for conservation.

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***MANOURIA EMYS PHAYREI* (Asian Brown Tortoise). FIRE SCARRING.** Fire scars on turtle shells result from burn injuries sustained during exposure to the extreme heat of fires (Ernst et al. 1995. Herpetol. Rev. 26:185–187; Dodd et al. 1997. Herpetol. Nat. Hist. 5:66–72). Fire scars are characterized by an obvious blanching of the scutes caused by damage and subsequent repair of the keratin layers (Dodd et al., *op. cit.*). Regeneration after severe fire injuries can result in complete disappearance of sutures between the scutes, as well as extensive remodeling and gross distortion of the underlying bone (Dodd et al., *op. cit.*). Fire scars can occur anywhere on the shell, but are most commonly observed on the carapace (Mitchell et al. 2005. Herpetol. Rev. 36:169). Fire scars have been reported on the shells of various chelonians in Southeast Asia, including *Sibenrockiella crassicollis* (Mitchell et al., *op. cit.*), *Cuora amboinensis* (Platt et al. 2001. Chelon. Conserv. Biol. 4:154–159; Ives et al. 2008. Chelon. Conserv. Biol. 7:240–248), *Melanochelys trijuga* (Mitchell and Rhodin 1996. Chelon. Conserv. Biol. 2:66–72), *Geochelone platynota* (Platt et al. 2003. Oryx 2:66–72), and *Indotestudo elongata* (van Dijk. 1998. The Natural History of the Elongated Tortoise *Indotestudo elongata* [Blyth, 1853] [Reptilia: Testudines] in a Hill Forest Mosaic in Thailand, with Notes on Sympatric Turtle Species. Ph.D. dissertation, National University of Ireland at Galway. 255 pp.; Platt et al. 2001. Chelon. Conserv. Biol. 4:172–177). We here report on the incidence of fire scarring among a group of adult *Manouria emys phayrei* held at two conservation-breeding facilities (assurance colonies) in Myanmar.

These *M. emys* were originally confiscated by the Myanmar Forest Department from illegal wildlife traffickers in 2007. Although their specific provenance could not be determined, given our understanding of regional wildlife trafficking networks (Platt et al. 2000. Chelon. Res. Monogr. 2:95–100), we believe the tortoises were harvested within Myanmar, most likely from the western hill tracts (Rakhine [= Arakan] and Chin Hills) or southern Tanintharyi Region (formerly "Division"); however, we cannot rule out the possibility that some members of this group originated in neighboring countries (e.g., Bangladesh or Thailand). After confiscation the tortoises were housed in outdoor pens at the Yadanabon Zoological Gardens in Mandalay



FIG. 1. An extreme case of fire scarring on an adult male *Manouria emys phayrei* (CL = 417 mm) confiscated from wildlife traffickers in Myanmar.



FIG. 2. A partially buried adult *Manouria emys phayrei* at an assurance colony in Myanmar. This concealment behavior may explain the distribution of fire scars on the carapace of many burned *M. emys*.

from 2007 through early 2013. Because ambient environmental conditions in this extremely arid region of Myanmar proved unsuitable for *M. emys*, new facilities were constructed in Gwa (Rakhine State) and Maymyo (Shan State) where the prevailing climate is more appropriate for the propagation of this forest-dwelling tortoise (Chan-ard et al. 1996. Chelon. Conserv. Biol. 2:109–113).

In May 2013, prior to transferring *M. emys* into the new assurance colonies, we weighed, measured (straight-line carapace length [CL]), and permanently marked each individual. We also carefully inspected the carapace and plastron of every tortoise for shell damage. Seven (12.2%) of 57 tortoises (25 males and 32 females) exhibited shell damage consistent with published descriptions of fire scarring (Rose 1986. Southwest. Nat. 31:131–134; Ernst et al., *op. cit.*; Dodd et al., *op. cit.*). To our knowledge, this is the first report of fire scarring among *M. emys*. Fire scarring was noted on the shells of three females (CL = 481–504 mm) and four males (CL = 399–472 mm), and varied from a few blanched and discolored scutes to extensive remodeling and ossification of the carapace. In the most extreme case, an adult male (CL = 417 mm) exhibited fire damage over >50% of its carapace; sutures between most costal and marginal scutes had disappeared, the anterior-most marginal scutes were missing, and massive distortion of bony carapacial elements was evident (Fig. 1).

Fire scars on the other six tortoises were located on the medial and posterior regions of the costal and vertebral scutes; some distortion of the sutures was noted in four individuals. The marginal scutes of three of these six tortoises also exhibited fire scarring, but in two cases the damage appeared minor and consisted of discoloration or loss of keratinized laminae; only one tortoise had damage to the underlying bone. Another tortoise also had patches of exposed bone on the costal and vertebral scutes where the laminae apparently failed to regenerate over parts of the fire-damaged carapace. For the most part, fire scarring was confined to the carapace of tortoises; however, plastral scarring was observed in two individuals. In one tortoise, a small area of exposed bone on the distal edge of the left pectoral scute appeared associated with minor fire scarring on the adjacent plastral bridge. A second tortoise with fire scars on the rearmost vertebral and three left costals, exhibited plastral damage at the junction of the right pectoral and abdominal scutes, although this did not appear to be the result of a fire injury.

The pattern of fire scars on tortoise shells that we observed is probably best explained by the concealment behavior of *M. emys*. In the assurance colonies we frequently find *M. emys* partially buried in loose soil with only the upper part of the carapace exposed aboveground (Fig. 2). This behavior seems especially commonplace during the dry season (mid-November through late May) and probably both reduces evaporative water loss and confers protection from fires. Should a brushfire pass over the buried tortoise, the costal and vertebral scutes would seem most likely to sustain fire injuries, while the buried plastron and marginal scutes would not be exposed to flames. By withdrawing the head and legs into the shell, the tortoise would also avoid soft tissue burns.

Our observations of fire scarring suggest that wildfires pose a danger to *M. emys* in Myanmar and perhaps elsewhere within its geographic distribution. Fire has not previously been considered a threat to *M. emys* because these tortoises generally inhabit tropical evergreen forests (Thirakhupt and van Dijk 1994. Nat. Hist. Bull. Siam Soc. 42:207–259; Chan-ard et al., *op. cit.*), which are not prone to natural burning except under extremely dry conditions that infrequently occur during the dry-wet season transition when lightning strikes can cause ignition (Stott 1988. Geogr. J. 15:337–350). Because tropical evergreen forests rarely burn under natural conditions, most fires in *M. emys* habitat are thought to be anthropogenic in origin, resulting from the deliberate ignition of dried fuels by shifting agriculturalists, pastoralists, and hunters (Rabinowitz 1990. Nat. Hist. Bull. Siam Soc. 38:99–115; Platt et al. 2010. Bamboo Sci. Cult. 23:1–12).

How anthropogenic burning might impact *M. emys* at the population level remains unknown, reflecting in part, a general paucity of information on the fire ecology of chelonians (Russell et al. 1999. Wildl. Soc. Bull. 27:374–384). However, there is no doubt that on occasion, fires cause significant mortality among populations of terrestrial chelonians (Platt et al. 2010. Nat. Areas J. 30:254–260). For example, in Florida, USA, fire-related mortality among *Terrapene carolina bauri* inhabiting pine forests subjected to different prescribed burning regimes ranged from

10.2 to 21.6%, depending on season (Platt et al. 2010, *op. cit.*). In Southeast Asia where anthropogenic burning is common during the dry season (Mitchell et al., *op. cit.*), fire-related mortality has been documented in *Geochelone platynota* (Platt et al. 2003, *op. cit.*), *Indotestudo elongata* (Thirakhupt and van Dijk, *op. cit.*), *I. forstenii* (Platt et al. 2001. Chelon. Conserv. Biol. 4:154–159), and *Melanochelys trijuga* (Mitchell and Rhodin 1996. Chelon. Conserv. Biol. 2:66–72). Although reports of fire-caused mortality appear lacking for *M. emys*, the extent of fire scarring we observed in one individual suggests that such injuries at least occasionally result in death. Because the ability of turtle populations to withstand even moderate levels of increased mortality among larger size classes is doubtful (Congdon et al. 1993. Conserv. Biol. 7:826–833; Congdon et al. 1994. Amer. Zool. 34:397–408), mortality due to anthropogenic burning together with over-harvesting and habitat destruction potentially threatens the continued survival of *M. emys* in Myanmar.

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***STERNOTHERUS ODORATUS* (Eastern Musk Turtle). FORAGING AND DIET.** Eastern Musk Turtles are known omnivores, eating a variety of both live and dead animal prey, from beetles to tadpoles and fish, as well as algae and fleshy-leaved plants and fruits (Ernst and Lovich 2009. Turtles of the United States and Canada, 2nd edition. Johns Hopkins Press, Baltimore, Maryland. 827 pp.). Seeds of many *Pinus* species are eaten by game birds, rabbits, squirrels, and chipmunks, as well as by coyotes and black bears (Petrides 1986. A Field Guide to Trees and Shrubs, 2nd edition. Houghton Mifflin Co., Boston, Massachusetts. 464 pp.). To the best of our knowledge, herein we document the first report of an Eastern Musk Turtle consuming seeds from a pine tree.

On 21 October 2014 at 1448 h we observed a young adult Eastern Musk Turtle of unknown sex swimming at the surface of a small pond on Charlie Elliott Wildlife Center, 6.7 km S of Mansfield, Jasper Co., Georgia USA (3.45868°N; 83.72326°W; WGS 84). The turtle began to actively chase after and consume the drifting Loblolly Pine (*Pinus taeda*) seeds that were floating at the surface. The turtle approached each seed from below and grabbed it with its jaws, wresting it from the papery samara that allowed the seed to float. The turtle then slowly sank down to the pond bottom where it appeared to crush the seed before swallowing. In this manner the turtle was observed to consume approximately a dozen seeds over the course of three or four minutes.

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***TERRAPENE CAROLINA* (Eastern Box Turtle). DIET.** *Terrapene carolina* consumes a variety of food including insects, plants, and fungi (Strang 1983. J. Herpetol. 17:43–47). Mushrooms have been noted as a common source of food (Stickel 1950. Ecol. Monogr. 4:351–378); however, most published investigations on *T. carolina* consumption of mushrooms fail to identify the mushroom species. The few mushroom species noted in publications include *Russula* spp., *Leccunum scaber*, *Amanita vaginata*, and *Cyathus striatus* (Nichols 1917. Copeia 46:66–88; Dodd 2002. North American Box Turtles: A Natural History. University of Oklahoma Press, Oklahoma. 231 pp.). On 15 July 2014, an adult female *T. carolina* was found consuming a large Bicolored Bolete mushroom (*Boletus bicolor)* in Madison Co., Kentucky, USA (37.57252°N, 84.22002°E, WGS84; elev. 262 m). *Boletus bicolor* is a non-toxic mushroom that is found in eastern North America and is hosted by the Northern Red Oak (*Quercus rubra*) (Homola and Mistretta 1977. Maine Agric. Exp. Sta. Bull. No. 735). We believe this represents the first documented case of *B. bicolor* being consumed by *T. carolina.*

We thank S. Bec for identifying *B. bicolor* and K. Dodd for providing insights into *T. carolina* mushroom consumption.

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CROCODYLIA — CROCODILIANS

***CROCODYLUS ACUTUS* (American Crocodile). DIET.** Crocodilians are considered opportunistic hunters due to their consumption of a wide variety of prey items (Magnusson et al. 1987. J. Herpetol. 21:85–95). Platt et al. (2013. J. Herpetol. 47:1–10) reported the diet of *Crocodylus acutus* in coastal Belize includes insects, birds, amphibians, reptiles, fish, mollusks, and crustaceans (see also Villegas and Schmitter-Soto 2008. Acta Zool. Mex. 24:117–124). Several species of crocodilians, including *C. acutus*, also deliberately ingest fruits (Platt et al. 2013. J. Zool. 291:87–99). Neonates are opportunistic predators (Platt et al. 2002. Herpetol. Rev. 33:202–203) and are largely insectivores (Davenport 2013. Treat. Est. Coast. Sci. 6:227–249), but also eat crustaceans and small fish (Mazzotti 1983. PhD diss. Pennsylvania State University. 161 pp). Magnusson et al. (1987. J. Herpetol. 21:85–95) reported that Amazonian crocodilians consume isopods, and Platt (2013. J. Herpetol. 47:1–10) revealed that *C. acutus* in Belize also consume isopods; however, neither identified this prey item to genus. Here we report the first confirmed evidence of a hatchling *C. acutus* consuming a crustacean from the order Isopoda within the genus *Ligia.*

While collecting data for an ongoing *C. acutus* ecology study on 9 August 2013 at approximately 2115 h, a hatchling *C. acutus* was captured in coastal mangrove habitat of Florida Bay, Everglades National Park, Florida, USA (25.1749°N, 80.6433°W). The hatchling was feeding on a small isopod of the genus *Ligia* (Fig. 1) while researchers collected morphometric data. After



FIG. 1. Hatchling *Crocodylus acutus* feeding on an isopod of genus *Ligia*.



PHOTO BY R. B. NARCISO

FIG. 1. *Leopardus wiedii* preying on an adult *Ameiva ameiva*.

approximately 5 minutes, the crocodile released the isopod. This organism was further narrowed down to two possible species, *L. baudiniana* or *L. exotica*, however it could not be positively identified to species as the photograph provided (Fig. 1) did not show enough key identifying characteristics (William Kern, pers. comm.).

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SQUAMATA — LIZARDS

***AMEIVA AMEIVA* (Green Ameiva). PREDATION.** The medium-sized terrestrial teiid lizard *Ameiva ameiva* (up to ca. 170 mm SVL) is widely distributed throughout South America, occurring in both open and forested biomes (Vitt and Colli 1994. Can. J. Zool. 72:1986–2008; Ugueto and Harvey 2011. Herpetol. Monogr. 25:113–170). On 18 January 2006, during the afternoon, one of us (RBN), witnessed the predation of an adult *A. ameiva* by a Margay Cat, *Leopardus wiedii* (Fig. 1), in Lagoa Santa farm (17.649167°S, 40.352778°W), municipality of Nanuque, state of Minas Gerais, Brazil. This site contains fragments of Atlantic Rainforest surrounded by *Eucalyptus* plantations.

The Margay is widely distributed from northern Mexico through Central and South America south to NE Argentina, southern Brazil, and Uruguay (Eizirik et al. 1998. J. Mol. Evol. 47:613–624). Margays prey mainly on small mammals and birds, but occasionally also on frogs, lizards, and snakes (Wang 2002. Stud. Neotrop. Fauna Environ. 37:207–212; Rocha-Mendes et al. 2010. Biota Neotrop. 10[4]:21–30; Bianchi et al. 2011. Zoologia 28:427–435; Cinta-Magallón et al. 2012. Cuad. Invest. UNED 4:33–40). Regarding predation on squamate reptiles, those studies (which were mostly based on analyses of scats) did not give precise identification of the prey, with only one (Cinta-Magallón et al., *op. cit.*) providing identification to genera and (tentatively) to species. The present note documents the first record of predation on *A. ameiva* by *L. wiedii*. Although Margays are widely regarded as primarily arboreal felids, there is increasing evidence (including the present report) that they may forage on the ground and prey on terrestrial vertebrates frequently (Cinta-Magallón et al., *op. cit.*; Wang, *op. cit.*; T. G. de Oliveira, pers. comm.).

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***ANOLIS AHLI* (Ahl's Anole). MAXIMUM ELEVATION.** *Anolis ahli* is distributed in Sierra de Trinidad, central Cuba (Rodríguez-Schettino 1999. The Iguanid Lizards of Cuba. University Press of Florida, Gainesville. 428 pp.) within an elevational range of 250–800 m elev. (Estrada 1994. Rev. Acad. Colomb. Cienc. 19:353–360). Herein we report a higher elevation record for *A. ahli*. On 4 October 2013 a specimen of *A. ahli* (MFP 12514: Felipe Poey Natural History Museum, Havana, Cuba) was collected on Pico San Juan (21.9890°N, 80.1475°W; NAD27), Cienfuegos Province, Cuba, at 1030 m elev. This new record is over 230 m higher than the previous record (Estrada, *op. cit.*). Pico San Juan, at 1140 m elev., is the maximum elevation in central Cuba.

We thank Julio León, Raimundo López-Silvero, and Leosveli Vasallo for field assistance, and the Cienfuegos Botanical Garden for logistical support.

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***ANOLIS GUAMUHAYA* (Escambray Bearded Anole). MAXIMUM ELEVATION.** *Anolis guamuhaya* is distributed in Sierra de Trinidad and is apparently confined to the Guamuhaya massif, south of Sancti Spiritus, central Cuba (Garrido et al. 1991. Carib. J. Sci. 27:162–168). This species is found from sea level to

900 m elev. (Garrido et al., *op. cit.*; Henderson and Powell 2009. Natural History of West Indian Reptiles and Amphibians. University Press of Florida, Gainesville, Florida. 496 pp.). Herein we report an elevation record for *A. guamuhaya*. On 8 October 2013 an immature specimen (SVL = 63 mm: MFP 12515: Felipe Poey Natural History Museum, Havana, Cuba) was found basking in secondary vegetation on Pico San Juan (21.98939°N, 80.14956°W; NAD27), Cienfuegos Province, Cuba, at 1015 m elev. This extends the known elevational range by 115 m (Garrido et al., *op. cit.*; Henderson and Powell, *op. cit.*). Pico San Juan, at 1140 m elev., is the maximum elevation in central Cuba.

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***ANOLIS LUCIUS* (Cave Anole). MAXIMUM ELEVATION.** *Anolis lucius* is an endemic Cuban lizard with a wide distribution (Rodríguez-Schettino 1999. The Iguanid Lizards of Cuba. University Press of Florida, Gainesville, Florida. 428 pp.) and an elevational range of 0–800 m (Rodríguez et al. 2010. Poeyana 498:11–20). Herein we report a higher elevation for *A. lucius*. On 26 August 2014, a juvenile individual (MFP 12579: Felipe Poey Natural History Museum, Havana, Cuba) was observed at an elevation of 1080 m, exceeding the previous record by 280 m. The specimen was found at 1030 h sleeping on an upper face of a leaf in a small bush at Pico San Juan (21.988917°N, 80.144556°W; NAD27), Cienfuegos Province, Cuba.

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***APHANIOTUS FUSCA* (Peninsular Earless Agama). ENDOPARASITES.** *Aphaniotus fusca* occurs in southern Thailand southward through Peninsular Malaysia to Sumatra and Borneo (Grismer 2011. Amphibians and Reptiles of the Seribuat Archipelago [Peninsular Malaysia]: A Field Guide. Edition Chimaira, Frankfurt am Main. 239 pp.). To our knowledge there are no published reports of helminths from *A. fusca*. The purpose of this note is to establish the initial helminth list for *A. fusca*.

Twenty-two *A. fusca* from Peninsular Malaysia (mean SVL = 58.5 mm ± 5.6 SD, range = 48–65 mm) deposited in the herpetology collection of La Sierra University (LSUHC), Riverside, California, USA, collected 2002 to 2012 by state: Johor LSUHC 7707, 8120, 8189, 8198, 8209, 9938, 10235; Kedah LSUHC 10307, 10308, 10309; Pehang LSUHC 4853, 4867, 4868, 4869, 4870, 4873, 4883; Perak LSUHC 9192; Selangor LSUHC 4816, 6507; Teregganu LSUHC 8297, 8298 were examined. A lateral incision was made through the body wall and the digestive tract was removed. The esophagus, stomach, small and large intestines were opened longitudinally and searched for helminths utilizing a dissecting microscope. The body cavity was also searched. Helminths were cleared in lactophenol, placed on a microscope slide, coverslipped, and studied using a compound microscope.

Found were three species of Nematoda, four *Cosmocercoides pulcher* (prevalence = number infected/number examined x 100 = 9%; mean intensity = mean number infected lizards = 2.0 ± 1.4 SD, range = 1–2, one *Metetertakis singaporensis* (prevalence = 5%), and one *Orneoascaris sandoshami* (prevalence = 5%). Helminths were deposited in the United States National Parasite Collection, USNPC, Beltsville, Maryland as *Cosmocercoides pulcher* (USNPC 108053), *Meteterakis singaporensis* (USNPC 108054), *Orneoascaris sandoshami* (USNPC 108055).

Cosmocercoides pulcher is widespread in Asian amphibians, and has been reported in two snake species (Baker 1987. Occas. Pap. Mem. Univ. Newfoundland. 325 pp.; Goldberg and Bursey 2002. Comp. Parasitol. 69:162–176; Goldberg et al. 2004. Comp. Parasitol. 71:49–60). *Meteterakis singaporensis* is a common parasite in bufonids in Malaysia (Sandosham 1954. Kuala Liam Malay Inst. 26:210–226), but is also known from *Eutropis multifasciata* also of Malaysia (Singh 1967. Bull. Nat. Mus. Singapore 33:95–100). *Orneoascaris sandoshami* is known from *Megophrys aceras* (Yuen 1963. Parasitology 53:89–94) and *Gonocephalus abbotti* (Goldberg et al. 2005. Herpetol. Rev. 36:450). *Aphaniotus fusca* represents a new host record for *C. pulcher*, *M. singaporensis*, and *O. sandoshami*.

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***ASPIDOSCELIS LAREDOENSIS* (Laredo Striped Whiptail). REPRODUCTION AND LIFE HISTORY.** The diploid parthenogenetic whiptail species *Aspidoscelis laredoensis* comprises clonal complexes A and B which are characterized by marked differences in geographic distributions, color patterns, and meristic variation (Walker 1987a. Amer. Midl. Nat. 117:319–332; Walker 1987b. Texas J. Sci. 39:313–334; Walker et al. 1989. J. Herpetol. 23:119–130). In 1984 and 1985, we sought to extend the known distributions of both of these complexes to the northwest from the vicinities of the Texas-Mexico sister cities Laredo-Nuevo Laredo to as many sites as possible both near the Rio Grande and in outlying sites. We searched for Laredo Striped Whiptails using highways in an area over a straight-line distance (SLD) of ~323 km between Laredo (27.542226°N, 99.502707°W, 124 m elev.), Webb Co., and Langtry (29.808987°N, 101.559678°W, 397 m elev.), Val Verde Co., in Texas, and employed a similar search strategy over a SLD of ~263 km at sites between Nuevo Laredo (27.499922°N, 99.502661°W, 110 m elev.), Tamaulipas State, and Lake Amistad (29.471652°N, 101.058606°W, 366 m elev.), Coahuila State, in Mexico (see map in Walker 1987b, *op. cit.*). During these expeditions, we collected the first samples of *A. laredoensis* B, though A was never present (Walker 1987b, *op. cit.*), to the northwest of Laredo-Nuevo Laredo in the Rio Grande Valley at several sites in the sister cities Ciudad Acuña (29.324167°N, 100.931667°W, elev. 271 m), Coahuila-Del Rio (29.327412°N, 100.927104°W, elev. 266 m), Val Verde Co., and Piedras Negras (28.700000°N, 100.523056°W, elev. 250 m), Coahuila-Eagle Pass (28.705480°N, 100.511720°W, elev. 210 m), Maverick Co. Subsequently, reciprocal skin-grafting experiments (Abuhteba et al. 2000. Can. J. Zool. 78:895–904; Abuhteba et al. 2001. Copeia 2001:262–266) revealed that clonal complexes A

and B were mutually histoincompatible indicating their derivation from separate hybridization events between the gonochoristic species *A. gularis* (Texas Spotted Whiptail) x *A. sexlineata* (Six-lined Racerunner). Evidence of the independent evolutionary histories of *A. laredoensis* A and B (Abuhteba et al. 2000, 2001, *op. cit.*) provided the impetus for our recent use of the samples from Ciudad Acuña and Piedras Negras to assess reproductive and life history attributes of *A. laredoensis* B for comparison with data for clonal complex A provided by Paulissen (2000. Herpetol. Nat. Hist. 7:41–57).

We compiled clutch data from dissections and SVL data from measurements of specimens in the samples of *A. laredoensis* B to reconstruct the life history of this clonal complex of lizards in the northwestern-most part of its geographic distribution. GPS data for sites were taken from Google Earth (datum WGS84). The small sample sizes from Del Rio and Eagle Pass precluded their use in the assessment, and visits to these cities since 1995 have revealed apparent extirpation of the species from previously inhabited sites in both cities resulting from urban development. Moreover, increasing tensions along the border since 1995 have precluded return visits to monitor the ecological status of *A. laredoensis* B in Ciudad Acuña and Piedras Negras. We defined the size of sexual maturity in *A. laredoensis* B as 64 mm SVL based on the smallest specimen containing either yolked ovarian follicles or oviductal eggs. We failed to collect juveniles ranging in size from ~32–40 mm SVL prior to the month of July, and so we assume juveniles in this size range collected in July–September were young-of-year (YOY) hatched in June or July. We further classify juveniles collected before July ranging in size from ~45–54 mm SVL as second-year lizards. Means for SVL and clutch size are reported to one decimal place ± 1 SE. A number in parentheses following a datum for either SVL or clutch size represents the number of observations.

We initially collected *A. laredoensis* B on 30 August 1984 in Ciudad Acuña in a sandy riverfront park with large trees interspersed with patches of weedy/grassy vegetation. On that date, we collected five sexually immature YOY (83.3%; 45, 46, 48 [2], 54 mm SVL) and one reproductively quiescent second year lizard (17.7%; 64 mm SVL). We obtained the second sample in Ciudad Acuña, in a tract of mostly mesquite-dominated habitat laid out for a suburban residential development, on 22 May 1985. Included were five lizards (26.3%; 64 [2], 66, 67, 68 mm SVL) with unyolked follicles, two (10.5%; 66, 71 mm SVL) gravid lizards damaged during collection, 11 (57.9%; 64, 66, 68, 69 [2], 70, 71 [3], 72, 75 mm SVL) with yolked ovarian follicles, and one (5.3%; 78 mm SVL) with shelled oviductal eggs. We assumed the five lizards with unyolked follicles would have developed clutches that year. Based on the 12 undamaged gravid females (mean, 70.3 ± 1.08 mm SVL) we observe clutches of two (6), three (5), and four (1) eggs in *A. laredoensis* B, mean 2.6 ± 0.19.

We obtained the third sample of *A. laredoensis* B in Ciudad Acuña, in a different suburban area with scattered clumps of mesquite, on 19 July 1985. Surprisingly, we also obtained one specimen of gonochoristic *A. marmorata* (Marbled Whiptail; UADZ 2024) at this site, the first of this species found in syntopy with either *A. laredoensis* A or B (Walker 1987a, b, *op. cit.*), along with two specimens of gonochoristic *A. gularis* (Texas Spotted Whiptail; UADZ 1349, 1350). Among the eight specimens of *A. laredoensis* B were three YOY (37.5%; 38, 40, 49 mm SVL, mean 42.3 ± 3.38) and five large second and third year females (62.5%; 74, 75, 79, 80, 81 mm SVL, mean 77.8 ± 1.39) with large clutches of four (4) and five (1) eggs, mean 4.2 ± 0.20.

We separately analyzed the collections of *A. laredoensis* B from Piedras Negras at ~78 km SLD southeast of Ciudad Acuña because of significant differences in meristc characters. We first collected lizards in Piedras Negras on 1 September 1984. They were abundant south of the international bridge along foot trails in a swath of waist-high Russian thistle (*Salsola* sp.) between railroad tracks and a highway; but only two reproductively quiescent adults (71, 78 mm SVL) could be obtained from the more than a dozen mostly large adults observed at the site. We obtained the second sample of the species in Piedras Negras, in a shrubby/weedy suburban area, on 23 May 1985. Included were six gravid females (100%; 65 [2], 67, 72, 73, 77 mm SVL mean, 69.8 ± 1.89). Clutch sizes in these females were one (1), two (1), three (2), five (1), seven (1) eggs, mean 3.5 ± 0.25. We collected the third sample of the species in Piedras Negras, at the same site as the second sample, on 20 July 1985. It included four YOY (21.1%; 42, 43 [2], 48 mm SVL, mean 44.0 ± 1.35) and one gravid female (5.3%; 75 mm SVL) damaged during collection. Also present were 11 females with yolked follicles (57.9%; 66, 72 [5], 73, 75 [2], 77, 80 mm SVL) and three with oviductal eggs (15.8%; 70, 71, 72 mm SVL), pooled mean 72.8 ± 0.88. Clutch sizes in these 14 females were two (2), three (5), four (5), five (2) eggs, mean 3.5 ± 0.25.

Analyzed by collecting period, mean clutch size in May and July samples of lizards from Ciudad Acuña ranged from a low of 2.6 ± 0.19 to a high of 4.2 ± 0.20, respectively. Pooling all samples from Ciudad Acuña and Piedras Negras, 37 gravid females had a mean SVL of 72.2 ± 0.72 (64–81) mm and a mean clutch size of 3.30 ± 0.20 (1–7) eggs. The smallest and largest clutch sizes of one and seven were each represented by one lizard. A positive relationship was noted between SVL and clutch size for the pooled sample (adjusted $r^2 = 0.47$, $P \leq 0.0001$).

Using the samples from the two Mexican cities we reconstructed an approximation of the basic life history of *A. laredoensis* B as follows. By late May first clutch production appeared to be well underway in lizards >68 mm SVL and a second clutch could have developed in these lizards in late July. YOY were present in July samples at the same time as development of second clutches in larger lizards and delayed clutches in smaller individuals. YOY seemed to grow to ~50–60 mm SVL before retiring to end the first activity cycle in late October. Based on our sampling, they emerged in late April from winter inactivity to continue growth to reproductive maturity. Only five females (7.9%) >75 mm SVL were present in our pooled sample of 63 specimens. We concluded that the surface activities and data for most individuals of *A. laredoensis* B fit an annual life cycle as outlined by Paulissen 2000 (*op. cit.*) for an array of diploid parthenogenetic *A. laredoensis* clonal complex A situated approximately 445 km to the southeast in Bentsen Rio Grande Valley State Park, Hidalgo Co., Texas (Walker 1987b, *op. cit.*).

Specimens from the collection of the University of Arkansas Department of Zoology (UADZ) and those transferred to the University of Kansas Natural History Museum (KU) included the following: Mexico: Coahuila: Ciudad Acuña, river-front park ESE of international bridge (across Rio Grande from Del Rio, Texas), site CO-5 (30 August 1984 [KU 200090–200095, N = 6]; 22 May 1985 [UADZ 1011, N = 1]); Ciudad Acuña, suburbs WNW of international bridge (across Rio Grande from Del Rio, Texas), site CO-3 (22 May 1985 [UADZ 1012–1030, N = 19]; 19 July 1985 [UADZ 1291, 1292, N = 2)]; Ciudad Acuña, suburbs WNW of international bridge (across Rio Grande from Del Rio, Texas), site CO-4 (19 July 1985 [UADZ 1264–1271, N = 8]); Piedras

Negras, ~5 km S of international bridge between railroad track and highway (across Rio Grande from Eagle Pass, Texas), site CO-10 (1 September 1984 [KU 200096, 200097, N = 2]); Piedras Negras, W of international bridge (across Rio Grande from Eagle Pass, Texas), site CO-9 (23 May 1985 [UADZ 1036–1041, N = 6]; 20 July 1985 [1273–1290, 1 uncatalogued, N = 19]). Specimens were collected under authority of Texas Parks and Wildlife Department Permit No. 61, and permission granted by appropriate officials in Mexico.

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***COPHOSAURUS TEXANUS* (Greater Earless Lizard). AQUATIC ESCAPE BEHAVIOR.** Many terrestrial lizard species have been observed attempting to escape potential predators by swimming or submerging underwater, including *Aspidoscelis sexlineatus* (Dillon and Baldauf 1945. Copeia 1945:174; Trauth et al. 1996. Herpetol. Rev. 27:20), *Crotaphytus collaris* (Burt and Hoyle 1934. Trans. Kansas Acad. Sci. 37:193–216), *Scincella lateralis* (Akin and Towsend 1998. Herpetol. Rev. 19:43), *Sceloporus clarkii* (Zylstra and Weise 2010. Herpetol. Rev. 41:86), *Uma exsul* (Estrada-Rodriguez and Leyva-Pacheco 2007. Herpetol. Rev. 38:84–85), and *Gambelia wislizenii* (Medica 2010. Herpetol. Rev. 41:354–355). Herein, we report the escape-to-water behavior of *C. texanus*, a species not previously reported to exhibit this behavior.

On 27 September 2013, while conducting field work at Potrero Grande, Hidalgo, Nuevo León, México (26.008392°N, 100.453522°W, WGS84; 609 m elev.), at 1456 h walking beside a small stream we observed a rapid movement. We observed a juvenile male *C. texanus* (42 mm SVL; 5.9 g) moving quickly over the water, and then stop on a small rock in the middle of the stream (ca. 4–50 cm deep, 1–5 m wide), with numerous rocks forming small islands; the temperature of the water and the rocks was not determined). Several photographs of the lizard were taken (Fig. 1) and then each of us stood on opposite sides of the stream making hand movements and trying to capture it. The lizard crossed the stream on three occasions, stopping several times on the protruding rocks inside the stream, where body parts remained in contact with water. Whenever we tried to approach, it launched from the rock into the water. Eventually the lizard was manually captured, probably due to exhaustion or cooling from contact with the water. Although this behavior may have a high energetic cost due to rapid cooling, it represents an efficient strategy to elude predators. In the water it is well camouflaged and immobile, likely to confuse a potential predator.



Fig. 1. Juvenile *Cophosaurus texanus* resting on a rock in the middle of a stream.

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***CYRTODACTYLUS SERIBUATENSIS* (Seribuat Bent-toed Gecko). REPRODUCTION.** *Cyrtodactylus seribuatensis* is known only from islands of the Seribuat Archipelago, Johor State, Peninsular Malaysia (Grismer 2011. Lizards of Peninsular Malaysia, Singapore and their Adjacent Archipelagos. Edition Chimaira, Frankfurt Am Main. 728 pp.). Grismer (*op. cit.*) observed gravid *C. seribuatensis* females carrying two eggs during March, July, and September. In this note we provide additional information on *C. seribuatensis* from a histological examination of museum specimens.

A sample of 39 *C. seribuatensis* consisting of 10 adult males (mean SVL = 59.5 mm ± 9.2 SD, range = 46–72 mm), 16 adult females (mean SVL = 66.2 mm ± 3.2 SD, range = 61–72 mm), 5 subadult females (mean SVL = 48.8 mm ± 6.1 SD, range 41–58, 6 unsexed juveniles (mean SVL = 37.3 mm ± 3.4 SD, range = 33–43 mm; 2 presumably neonates (mean SVL = 26.5 mm ± 3.5 SD, range = 24–29 mm), from islands of the Seribuat Archipelago, Johor State, Peninsular Malaysia collected March 2003, September 2003, July 2004, and deposited in the herpetology collection of LaSierra University (LSUHC), Riverside, California, USA were examined: LSUHC 5191, 5192, 5218, 5221, 5223-5226, 5229, 5522, 5578, 5604, 5778-5780, 5784–5789, 5812, 5813, 6350–6354, 6398, 6413, 6414, 6416–6421, 7516, 7517.

A cut was made in the lower abdominal cavity and the left testis or ovary was removed, embedded in paraffin, cut into 5-μm sections, and stained with Harris hematoxylin followed by eosin counterstain. Enlarged follicles (> 4 mm) or oviductal eggs were counted. Histology slides were deposited in LSUHC.

The only stage noted in the testicular cycle was spermiogenesis in which seminiferous tubules are lined by sperm or clusters of metamorphosing spermatids. Males undergoing spermiogenesis were collected in July (N = 7),

Table 1. Monthly stages in the ovarian cycle of 16 adult female *Cyrtodactylus seribuatensis* from Johor State, Peninsular Malaysia.

Month	N	Quiescent	Early yolk deposition	Enlarged follicles > 4 mm	Oviductal eggs
March	5	4	0	1	0
July	7	4	1	0	2
September	4	2	0	2	0

August (N = 1), September (N = 2). The smallest reproductively active male measured 46 mm SVL (LSUHC 6351) and was collected in July.

Four stages were observed in the ovarian cycle (Table 1): 1) quiescent, no yolk deposition; 2) early yolk deposition, basophilic vitellogenic granules in the ooplasm; 3) enlarged follicles > 4 mm; 4) oviductal eggs. Mean clutch (N = 5) was an invariant 2. The smallest reproductively active female (yolk deposition) measured 61 mm SVL (LSUHC 5225) and was collected in March. There was no evidence that *C. seribuatensis* produces multiple clutches (oviductal eggs and concurrent yolk deposition), although this may reflect our small sample size. While it is clear *C. seribuatensis* exhibits an extended reproductive cycle (Table 1), examination of additional samples will be needed to ascertain if reproduction occurs throughout the year as proposed by Grismer (*op. cit.*).

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***DIPSOSAURUS DORSALIS* (Desert Iguana). URBAN HABITATS.** The geographical distribution of *Dipsosaurus dorsalis* is thought to include much of the Sonoran Desert in the vicinity of the Phoenix Metropolitan area (Brennan and Holycross 2006. A Field Guide to Amphibians and Reptiles in Arizona, Arizona Game and Fish Department, Phoenix. v + 150 pp.). However, it is absent from virtually all of the Phoenix Mountain Preserves, islands of habitat protected over the last 10–40 years. Sullivan and Flowers (1998. Herpetol. Nat. Hist. 6[1]:13–22) suggested that this absence is due to the lack of Creosote (*Larrea tridentata*) flats in these preserves, which are primarily rocky slope habitat. In this report we document the persistence of *D. dorsalis* along various north to south running xero-riparian corridors in the western Phoenix Metropolitan area, even those with extensive habitat alteration including channelization and adjacent housing developments. We confirm its absence from large expanses of Creosote flats to the northeast of these riparian habitats on the northern edge of the Phoenix region. Our observations are consistent with the view that this lizard reaches the northeastern limit of its distribution in the Phoenix area, and is closely associated with the sandy, open Creosote-dominated microhabitats along intermittent desert streams.

We searched for Desert Iguanas using visual encounter surveys during summer 2014. When patches of appropriate (e.g., presence of at least one Creosote shrub) open habitat were found, one or the other of us undertook 15–30 minute surveys by walking in roughly parallel lines until the patch had been covered completely or time expired. In areas with housing, surveys were conducted by driving slowly (20–45 kph) along streets and scanning the roadway edge, under shrubs and for road-killed lizards; because of the wariness of some (but not all) individual lizards, this method was more efficient than exiting the vehicle and walking along the roadway edge. Lizards seemed especially approachable when surveyors remained in a vehicle. Neighborhoods lacking any sign of remnant habitat were excluded; presence of even occasional Creosote plants among houses (e.g., often at the road edge and along driveway entrances) was deemed sufficient for an area to be recognized as "remnant habitat."

Desert Iguanas were found across a variety of disturbed localities in western Phoenix, but were absent from the far north and northeast areas, even in large preserves. We observed them in vacant lots overgrown with Creosote shrubs, among housing developments of various densities (Fig. 1), and even open lots in which the surface had been scrapped bare of all vegetation (Fig. 2). In some of the latter sites, after scrapping, 1–2 m diameter mounds of soil and rock were deposited around the edges; these small hillocks were subsequently used by the lizards for basking (Fig. 2). Surprisingly, they were absent from relatively undisturbed, open Creosote flats north of New River Dam, Adobe Dam (except for one ~ 1-ha patch 4 km N along the creek bed), and Cave Buttes Dam, dams across the New River, Skunk Creek, and Cave Creek, respectively. These Creosote flats lacking Desert Iguanas are large and apparently little disturbed, except for the ubiquitous presence of grazing-induced changes in vegetation, including increased non-native grasses and invasive shrubs (Fig. 3). It appears that historic riparian corridors now dominated by Creosotes attaining ~1 m in height and lacking Bursage (*Ambrosia deltoidea*) are preferred habitat; most of the flats of the Cave Buttes and Sonoran Preserve sites are numerically dominated by Bursage (Fig. 3).

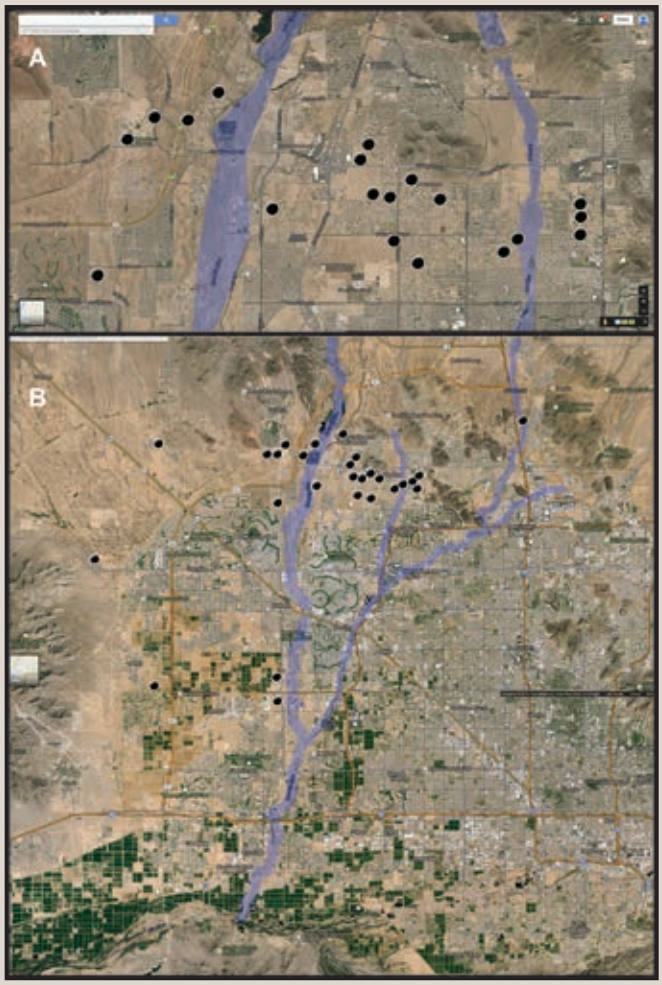


FIG. 1. Satellite image of 14 km x 6 km area of northwest Phoenix showing Desert Iguana localities 12–16 km N of the confluence of the Agua Fria and New rivers (A); note localities between the riparian corridors (shown in blue) among housing developments (center of panel). The entire western Phoenix Metropolitan area with the major xero-riparian corridors highlighted in blue (B). In both panels, Desert Iguana localities (2014 only) are indicated by black circles.



FIG. 2. Desert Iguana on fence in vacant lot (A), northwest Phoenix Metropolitan region. Numerous Desert Iguanas inhabit the adjacent vacant lot with mounds of earth and only a few remnant Creosote shrubs (B) where up to five can be seen basking on the mounds in the mornings. They initially take refuge under Brittlebush and then burrows (center of lower panel).

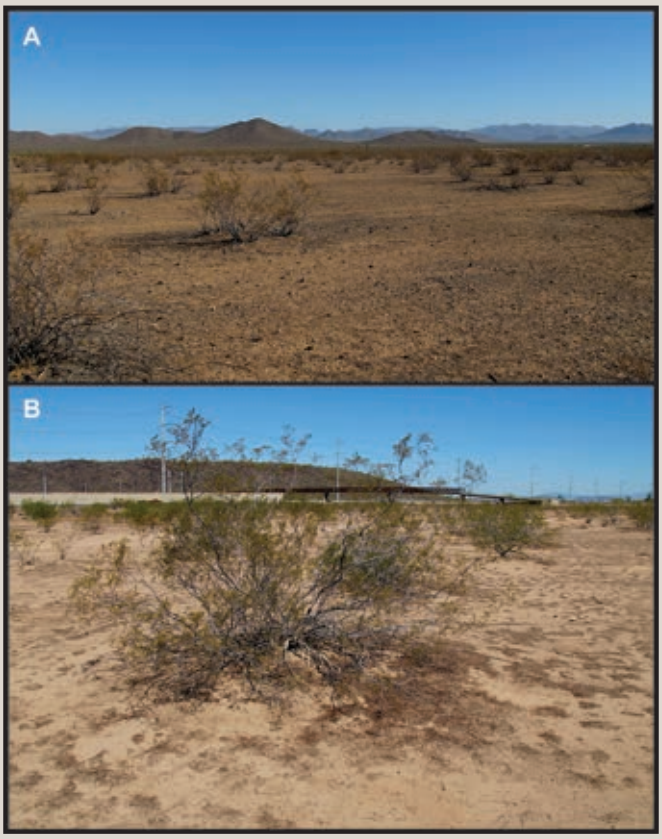


FIG. 3. Intact Creosote flats lacking Desert Iguanas in the Sonoran Preserve near Cave Creek (A). Note the presence of some Bursage but primarily low growing (all < 1 m in height) Creosote on a relatively rocky, gravel substrate. Disturbed (note structures on horizon) habitat with Desert Iguanas along Skunk Creek (B), dominated by relatively large (many > 2.0 m in height) and widely spaced Creosote on a relatively sandier substrate indicative of a xeric riparian corridor.

Overall, Desert Iguanas still occupy remnant habitats in parts of the western Phoenix Metropolitan region, at least in the vicinity of xero-riparian corridors with large, widely-spaced Creosote shrubs and sandy soil with opportunities for burrowing by lizards and presumably rodents (Fig. 1). They persist in low-density housing settings, apparently co-existing with feral cats and a variety of anthropogenic impacts over at least 30 years of direct observation by the senior author (BKS).

We thank Elizabeth, Justin, and Keith Sullivan for assistance in the field. Collecting permits were provided by the Arizona Game and Fish Department (2006–2014, to BKS), and collecting methods were approved as part of IACUC protocols (2006, 2009, and 2011) for surveying and vouchering lizards.

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***ENYALIUS BILINEATUS* (Two-lined Fathead Anole). COURTSHIP BEHAVIOR.** *Enyalius bilineatus* is a species of semi-arboreal lizard that occurs in the states of Minas Gerais, Rio de Janeiro, Espírito Santo, and the southern states of Brazil (Etheridge 1969. Bull. Br. Mus. [Nat. Hist.] Zool. 18:233–260; Jackson 1978. Arq. Zool. [São Paulo] 30:1–79; Zamprogno et al. 2001. Rev. Bras. Biol. 61:91–94). It is found mainly in Cerrado and Altantic Rainforest biomes of Brazil (Bertolotto et al. 2002. Hereditas 136:51–57). Before this report, the details of *E. bilineatus* courtship behavior were unknown. We observed courtship and copulation behavior in *E. bilineatus* in the Cerrado biome in Minas Gerais, Brazil, under natural conditions. Our observations were made in the Reserva Biológica Unilavras/Boqueirão (21.9998°S, 44.2457°W, WGS84; 1250 m elev.), municipality of Ingaí, Minas Gerais, on 16 November 2006 at 0902 h. We observed, at 4 m distance, one adult male *E. bilineatus* following one adult female. Upon detecting the female, the male slowly positioned himself beside the female. He then quickly climbed on the female and held her in the inguinal region using his forelimbs and jaw (Fig. 1). He then bit her neck and immobilized her hind legs using the fourth digit of his feet, which are well developed in this species. The male



FIG. 1. Courtship behavior and copulation of *Enyalius bilineatus* observed in the Reserva Biológica Unilavras/Boquierão, Brazil.

pressed the hind legs of the female to the ground, preventing her from escaping. Copulation between the individuals involved limited movement of sometimes-intertwined tails. Total time from viewing the male approach the female until leaving the female after copulation was ~21 minutes. After the male left, the female remained in place for another 40 minutes and then disappeared into the vegetation. These same behaviors were observed in *Enyalius perditus* (Lima and Sousa 2006. Rev. Bras. Zoociênc. 8:193–197) under captive conditions.

During pre-mating and mating, the male's color pattern changed within the first five minutes, becoming darker dorsally, a phenomenon also reported in *E. perditus* (Lima and Sousa 2006, *op. cit.*). Such a rapid change in color is likely due to hormonal action, melanophores-stimulating hormone that promotes pigment dispersion (Liem et al. [eds.] 2013. Anatomia Funcional de Vertebrados. Cengage Learning. 560 pp.) and may represent a defense strategy (e.g., crypsis) of *Enyalius* species. During mating individuals remain stationary for a considerable time, and are therefore vulnerable to predators. Our observations demonstrate the occurrence of a similar behavioral pattern for courtship and copulation among species of this genus (Lima and Sousa 2006, *op. cit.*; Migliore et al. 2014. Herpetol. Notes 7:273–276). The reproductive events reported here occurred in November, which coincides with reproductive timing of other species of this genus (Sturaro and Silva 2010. J. Nat. Hist. 44:1225–1238; Migliore et al. 2014, *op. cit.*). Our data corroborate the work of Migliore et al. (2014, *op. cit.*) in finding that the process of courtship and copulation is similar between the natural environment and captivity. This is the first record of courtship behavior and copulation under natural conditions in *E. bilineatus*.

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***EULAMPRUS QUOYII* (Eastern Water Skink). PREY COMPETITION WITH BIRD.** *Eulamprus quoyii* is a medium-sized terrestrial diurnal lygosomine skink, widespread in riparian and mesic habitats of the coastal plain, hinterland, and ranges of most of eastern mainland Australia (Cogger 2014. Reptiles and Amphibians of Australia, 7th ed. CSIRO Publishing, Collingwood, Victoria. xxx + 1033 pp.); it is largely arthropodophagous, but occasionally eats smaller lizard species and juvenile conspecifics (pers. obs.). The exotic English House Sparrow, *Passer domesticus*, is common in anthropogenic habitats in eastern Australia; it is largely vegetarian but readily feeds on arthropods especially in the spring-summer breeding period (Frith [ed.] 1982. The Readers' Digest Complete Book of Australian Birds. Readers' Digest Services, Sydney, N.S.W. 615 pp.). This note documents a case of competition between an adult *E. quoyii* and a *P. domesticus* for a spider prey item.

On 13 November 2008, ~1400 h, on a sunny day, T_a = ~26°C, in an urban backyard in Cooranbong, Central Coast region, New South Wales, Australia, (33.08°S, 151.45°E, WGS84; 12 m elev.), where *E. quoyii* is common, the first author (TJA) from within the house through double glass sliding doors observed a male *P. domesticus* (total length ~150 mm) alight on the concrete paving outside and peck at a spider, which jumped away. The spider was most likely a White-banded Jumping Spider (*Hypoblemum albovittatum*: Salticidae), a medium-sized (cephalothorax + abdomen length ~8 mm) species that is the most common salticid at this locality, although the Wattle Jumping Spider (*Sandalodes scopifer*), the Biting Jumping Spider (*Opisthoncus mordax*), and an undescribed species have also been recorded (TJA, pers. obs.). Within seconds of the first peck an adult (total length ~280 mm, SVL ~100 mm) *E. quoyii* raced out from under a nearby flowerpot and also chased the rapidly jumping spider. Both aspiring predators pursued the leaping spider for ~15–20 seconds and each made several, perhaps half a dozen, unsuccessful attempts to seize it. The *E. quoyii* apparently ignored the close proximity and near-miss pecks of the *P. domesticus*, which in turn appeared unconcerned by the close proximity of the *E. quoyii* and its rapid movements. The contest concluded when the *E. quoyii* successfully captured the spider, and ran off, briefly stopping to swallow, while the *P. domesticus* flew back to the roof from whence it had come. *Eulamprus quoyii* may become tolerant to the close proximity of humans where they are not persecuted, but are very wary of local bird predators such as Kookaburras (*Dacelo gigas*) and Pied Butcher Birds (*Cracticus nigrogularis*) (TJA, pers. obs). The above observation provided evidence that exotic *P. domesticus* will directly compete with endemic lizards for arthropod prey; it was also notable that the *E. quoyii* apparently did not perceive the relatively large-bodied *P. domesticus* as a threat despite its sharp and strong beak.

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***LERISTA ARENICOLA* (Bight Slider). VIVIPARITY.** Viviparity has evolved in many vertebrate lineages, but shows the greatest diversity in squamate reptiles, where it has evolved over 100 times (Blackburn 2000. Comp. Biochem. Physiol. A 127:391–409). The transition from oviparity to viviparity is often attributed to the adaptive benefit provided to offspring in cooler environments (Shine 1983. Oecologia 57:397–405). The

TABLE 1. Maternal reproductive and offspring traits for two viviparous semi-fossorial skinks, *Lerista arenicola*.

ID number	Parturition date	Maternal post-partum mass (g)	Offspring number	Offspring mass (g)	Clutch mass (g)
1	9–12 Feb 2007	3.3432	1	0.2826	1.0702
			2	0.2514	
			3	0.2742	
			4	0.2620	
2	5–8 Feb 2007	2.5134	1	0.3054	0.5984
			2	0.2939	

family Scincidae is the largest and most diverse group of lizards globally (Rabosky et al. 2007. Proc. Royal Soc. B 274:2915–2923), and contains both egg-laying (oviparous) and live-bearing (viviparous) species. In Australia, the semi-fossorial scincid genus *Lerista* is the second most diverse lineage of skinks, and ranges from fully limbed semi-fossorial to limbless burrowing species (Skinner et al. 2008. BMC Evol. Biol. 8:310–318). The majority of *Lerista* species are oviparous, with viviparity known only from two southern species: *L. microtis* and two populations of *L. bougainvillii* (Qualls et al. 1995. J. Zool. 237:13–26). However, data on the reproductive mode of other *Lerista* species is insufficient to confirm these as the only cases of viviparity within the genus. Herein, we report the occurrence of viviparity in an additional *Lerista* species from southern mainland Australia.

Two adult female *L. arenicola* were collected from Talia Caves and Venus Bay, South Australia (33.329444°S, 134.800278°E, WGS84; 34 m elev.) on 11 November 2006, and returned alive to the Museum of South Australia. In the museum, both lizards were housed together in a glass aquarium (60L x 35W x 45H cm) with an 8-cm layer of loose sand and dirt with a bark shelter; a 60-watt heat lamp produced a thermal gradient (21–35°C). Lizards were fed small crickets three times weekly, and water was always available. Lizards were checked daily for evidence of eggs or offspring. In early February 2007, each of the two females produced a litter of live offspring. See Table 1 for details on dates of parturition, maternal traits, and offspring traits. While we lack precise data on the duration of embryogenesis in *L. arenicola*, it is clear that both skinks were gravid upon arrival in the lab. The period of gestation within the laboratory was 85 and 81 days for female 1 and 2, respectively. This interval, while a rough indication, is similar for other semi-fossorial *Lerista* species, which ovulate in late summer and produce a single clutch per year (Qualls and Shine 1998. J. Evol. Biol. 11:63–78).

Viviparity in *L. arenicola* supports the "cool climate" hypothesis in occurring more frequently in species from colder climates. Previous work comparing the climate of mainland and island populations of *L. bougainvillii* and populations of *L. microtis*, indicate that these viviparous populations occupy cooler environments than their oviparous relatives, being found predominantly on cool southern islands (Qualls et al. 1995, *op. cit.*). Similar to the other two viviparous species, *L. arenicola* is restricted to leaf-litter microhabitats on pale coastal sands along the Great Australian Bight in southeastern, western, and southwestern South Australia. In the eastern part of its range, *L. arenicola* overlaps with the distribution of *L. microtis*, where it presumably experiences similar environmental conditions and selective forces.

The molecular phylogeny for *Lerista* indicates that *L. bougainvillii* and *L. microtis* occupy two separate clades, and thus represent independent evolutionary origins of viviparity (Skinner et al. 2008, *op. cit.*). However, as *L. microtis* and *L. arenicola* are sister species, it is probable that viviparity in both species may represent a single evolutionary event. The presence of viviparity in *L. arenicola* and within two distinct populations of *L. bougainvillii* (Fairburn et al. 1998. Mol. Phylo. Evol. 10:95–103), suggests the evolution of viviparity and its maintenance may occur readily within members of the genus *Lerista*.

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***PHYMATURUS PALLUMA* (High Mountain Lizard). COPROPHAGY.** *Phymaturus palluma* is a medium-sized, saxicolous, herbivorous, and viviparous lizard that inhabits the Altoandina phytogeographic province in the Andes Highlands, Argentina. During the summer 2014 I observed juveniles of *P. palluma* eating small bites of fecal pellets at the Aconcagua Provincial Park, Mendoza, Argentina (32.8453°S, 69.7619°W, WGS84; 2480 m elev.). After recording this behavior, I approached to get a closer view, and I saw that the feces, based on size, were of adult individuals of this species. This is the first record of coprophagy in *Phymaturus* lizards.

This behavior was reported in the herbivorous lizards *Sauromalus obesus* and *Iguana iguana* (Montanucci 1999. Herpetol. Rev. 30[4]:221–222; Troyer 1982. Science 216:540–542), which shows an association of hatchlings with adults of the same species similar to *P. palluma*. It has been demonstrated that coprophagy in *I. iguana* is related to the transfer of anaerobic gut symbiotic microbes that are utilized for effective degradation of plant materials. Possession of more complex microflora was associated with improved growth rate and digestive efficiency (Troyer 1982, *op. cit.*). Symbiotic microbes of *P. palluma* have not been studied. *Phymaturus palluma* shows social behaviors between juveniles and adults (Videla 1982. Bol. Mus. Cienc. Nat. Antropol. 3:57–62), similar to those in other lizards where transfer of microflora occurs; therefore, transfers of symbiotic microflora from parents to offspring via coprophagy might be possible.

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***PLESTIODON CALLICEPHALUS* (Mountain Skink). REPRODUCTION.** *Plestiodon callicephalus* is known from southeastern Arizona and southwestern New Mexico in the United States, and Sonora, Chihuahua, Sinaloa, south to Nayarit and Jalisco in Mexico (Swann et al. 2009. *In* Jones and Lovich [eds.], Lizards of the American Southwest, pp. 446–448. Rio Nuevo Publ., Tucson, Arizona). Anecdotal information on reproduction exists for this species including clutches of three to six eggs, female guarding of the eggs, and hatchlings measuring 20–25 mm (Swann et al. 2009, *op. cit.*). There is a report that *P. callicephalus* (as *Eumeces*) is viviparous (Taylor 1985. Herpetol. Rev. 16:27). The purpose of this note is to add information on the reproductive cycle of *P. callicephalus*.

A sample of 14 *P. callicephalus* consisting of four males (mean SVL = 57.8 mm ± 8.2 SD, range = 48–68 mm), five females (mean SVL = 64.0 mm ± 5.5 SD, range = 57–68 mm), and five juveniles (mean SVL = 29.4 mm ± 3.8 SD, range = 25–35 mm) were examined



FIG. 1. Gravid *Plestiodon callicephalis* (LACM 99505) collected June 1959 from Nayarit, Mexico. Arrow is on embryo in oviductal egg.

from the herpetology collection of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California. Lizards were collected 1949 to 1966 from the following sites: Mexico: Nayarit LACM 99503–99508; Sinaloa LACM 6768, 6769, 6770; Sonora LACM 99513, 99514; United States: Arizona, Cochise County LACM 99501; Santa Cruz County LACM 5929, 99502.

A cut was made in the lower abdominal cavity and the left testis or ovary was removed, embedded in paraffin, cut into 5-μm sections and stained with hematoxylin followed by eosin counterstain. Oviductal eggs were counted. Histology slides were deposited at LACM.

Two stages were noted in the testicular cycle: 1) regressed, seminiferous tubules are reduced in size and contain spermatogonia and interspersed Sertoli cells; 2) spermiogenesis, seminiferous tubules are lined by clusters of sperm or metamorphosing spermatids. Two males from April were undergoing spermiogenesis, SVL = 48, 58 mm. One male each from June and July, SVL = 68, 57 mm, respectively, contained regressed testes. Two stages were observed in the ovarian cycle: 1) quiescent, no yolk deposition; 2) oviductal eggs with embryos. One female from June, SVL = 68 mm and three from July, respectively, SVL = 57, 59, 68, contained quiescent ovaries. One female from June contained nine oviductal eggs with embryos (Fig. 1). Five subadults were from August. The smallest, SVL = 25 mm is within the range of neonates in Swann et al. (*op. cit.*).

Plestiodon callicephalus reproduces during the Spring as do numerous other North American skinks (for examples see Goldberg 2005. Texas J. Sci. 57:295–301). Nine is a new maximum litter size for *P. callicephalus*. My observations of embryos in LACM 99505 confirm the observation of Taylor (*op. cit.*) that *P. callicephalus* is viviparous. Whether *P. callicephalus* is both oviparous (Swann et. al., *op. cit.*) and viviparous (Taylor, *op. cit.*; this report) will require further study.

I thank Greg Pauly (LACM) for permission to examine *P. callicephalus* and Richard Feeney (LACM) for figure preparation.

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***PLESTIODON GILBERTI* (Gilbert's Skink). MALE COMBAT.** *Plestiodon gilberti* is not known to be territorial (Lemm 2009. *In* Jones and Lovich [eds.], Lizards of the American Southwest, pp. 449–451. Rio Nuevo Press, Tucson, Arizona) and we are not aware of any reports of intraspecific combat or aggression in this species (e.g., Jones 1985. Cat. Amer. Amphib. Rept. 372:1–3), although male aggression is well known in other species in the genus (Cooper and Vitt 1987. Herpetologica 43:7–14). On 21 April 2014 at approximately 1005 h, HDD observed two adult male *P. gilberti* (both approximately 90 mm SVL) on the ground in a *Prosopis glandulosa*, *Populus fremontii*, and *Salix* sp. riparian woodland at Big Morongo Canyon Preserve, 1.2 km E of Morongo Valley, San Bernardino Co., California, USA (34.049837°N, 116.567869°W, WGS84; 765 m elev.). One individual was laying roughly perpendicular to the other and had the other lizard's head grasped in its mouth. Upon approach, the two lizards split up and quickly disappeared into the leaf litter and other debris on the forest floor. Although only one of the lizards was photographed (UAZ 57612-PSV, verified by G. Bradley) and is readily identifiable as a male in breeding colors, the second lizard was very similar to the first with respect to size, proportions, and head coloration and thus we are confident that it was also a male.

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***SCELOPORUS CONSOBRINUS* (Prairie Lizard). MORTALITY.** Discarded bottles have been well documented as fatal traps for small mammals, but few accounts report on other small vertebrates becoming trapped inside such bottles (Morris and Harper 1965. Proc. Zool. Soc. Lond. 145:148–153; Pagels and French 1987. Am. Midl. Nat. 118:217–219; Benedict and Billeter 2004. Southeast. Nat. 3:371–377). Glass bottles inclined with openings pointed uphill >15° render escape almost impossible for small vertebrates and other organisms, as they cannot climb the slippery sides or provide momentum to move bottles (Morris and Harper 1965, *op. cit.*; Gerard and Feldhamer 1990. Am. Midl. Nat. 124:191–194; Benedict and Billeter 2004, *op. cit.*).

On 22 May 2012, we collected a clear glass beer bottle containing a dead *Sceloporus consobrinus* (Fig. 1) in south-central Nebraska, USA, 13.4 km N and 4.9 km E of Smithfield in Gosper Co. (40.6921°N, 99.6821°W; WGS84). The littered bottle was discovered on a grassy slope with scattered trees adjacent to rolling grasslands near an irrigation canal spillway ("Johnson Return to River") on the Central Nebraska Public Power and Irrigation District's supply canal located downstream of the



FIG. 1. A fatally trapped *Sceloporus consobrinus* discovered in a littered glass bottle in south-central Nebraska.

Canaday Steam Plant. The opening of the glass bottle was pointed upward on the slope, and it also contained a single carrion beetle. The lizard was deposited in the natural history collections at the Sternberg Museum of Natural History, Fort Hays State University, Hays, Kansas (FHSM 16552) and verified by Curtis J. Schmidt. To our knowledge this represents the first report of this species trapped in littered debris.

Other reports have described herpetofaunal mortalities associated with littered bottles and cans (Herrington 1985. Herpetol. Rev. 16:113). At least 33 lizards and plethodontid salamanders were reported fatally trapped in littered bottles in the eastern United States, but numbers likely underrepresented actual fatalities of individuals due to decomposition and scavenging (Benedict and Billeter 2004, *op. cit.*). Moreover, remains of 140 Insular Lizards *(Podarcis hispanica atrata*) were observed in discarded bottles and tin cans at dumps in islands off the coast of Spain (Castilla and Bauwens 1991. Biol. Conserv. 58:69–84). As suggested for shrews, small reptiles and amphibians potentially are entering bottles to feed upon trapped insects and other invertebrates (Morris and Harper 1965, *op. cit.*; Gerard and Feldhamer 1990, *op. cit.*).

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***SCELOPORUS UNIFORMIS* (Yellow-backed Spiny Lizard). TAIL REGENERATION.** We report on *Sceloporus uniformis* having two regenerated sections along its tail from an individual captured near the lower Virgin River in Beaver Dam, Mohave Co., Arizona, USA (36.8983°N, 113.9222°W). Similar to many species of lizards, spiny lizards (*Sceloporus* spp.) can regenerate autotomized tails. Intravertebral fracture planes cross each vertebrae, allowing for tail autotomy and regeneration to occur from point of amputation (Jamison 1964. Herpetologica 20:145–149). The regenerated section of an autotomized tail has calcified cartilaginous tubes lacking the intravertebral autotomy fracture planes (Bateman and Fleming 2009. J. Zool. 277:1–14). This would suggest that regenerated tails should not be able to regenerate a second time because of the loss of the specialized fracture planes found in bony vertebrae. However, Alibardi (2014. Prog. Histochem. Cyto. 48:143–244) suggested that lizards with autotomous fracture planes are able to regenerate their tails outside of the fracture planes. Compared to lizard species with non-autotomous planes, Alibardi (2014, *op. cit.*) suggests that species with fracture planes can have a new regeneration of a regenerated tail because stem cells are present in the connective tissue containing fibroblasts in the tail. Despite the histological evidence, there are few examples of lizards with two regenerated sections of their tails and, we believe, this is the first documentation of two regenerated sections in a single tail for *S. uniformis*.

We captured *S. uniformis* in trap arrays established in riparian habitat with cottonwood (*Populus fremontii*), willow (*Salix* spp.), and saltcedar (*Tamarix* sp.) trees as part of a larger project to examine the effects of saltcedar biocontrol and restoration on herpetofaunal communities (Bateman et al. 2014. Biol. Invasions DOI:10.1007/s10530-014-0707-0). On 26 May 2014, we captured a male *S. uniformis* that weighed 44 g, had a snout–vent length of 109 mm, and tail length of 79 mm. The tail was regenerated at two locations with the first regenerated section beginning at 23 mm from the vent and the second section beginning at 61 mm from the vent (each section was 38 mm and 18 mm in length, respectively) (Fig. 1).



FIG. 1. Ventral (A) and dorsal (B) view of *Sceloporus uniformis* having two regenerated sections along its tail, Beaver Dam, Arizona

Bureau of Land Management in the Arizona Strip District permitted access to study site. Scientific collecting permits were issued by the Arizona Game and Fish Department and Institutional Animal Care and Use Committee. This study was funded by the Bureau of Reclamation Southern Rockies Landscape Conservation Cooperative (LCC) and Desert LCC.

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***VARANUS PANOPTES* (Yellow-spotted Monitor). DIET AND FORAGING BEHAVIOR.** Although large predatory animals are capable of capturing and consuming large prey, most regularly consume smaller prey (e.g., Hart and Hamrin 1990. *In* Hughes [ed.], Behavioural Mechanisms of Food Selection, pp. 235–253. Springer-Verlag, Berlin). Large monitor lizards are no exception. For example, *Varanus bengalensis* reaches 1.75 m in total length but 75% of its diet consists of small invertebrates (Auffenberg 1994. The Bengal Monitor. The University Press of Florida, Gainesville. 560 pp.). Generalist predators such as large monitor lizards use different foraging strategies to obtain different prey, a pattern well documented for *V. bengalensis* (Auffenberg 1994, *op. cit.*). One foraging behavior noted was regular searches for dung beetles (Scarabaeidae) in the dung pats of (mainly) large mammals. Herein we document similar foraging behavior

in the Yellow-spotted Monitor, *Varanus panoptes*, in northern Australia.

The Yellow-spotted Monitor is a large lizard (up to 1.5 m in total length) inhabiting riparian areas and floodplains in tropical Australia (Cogger 2000. Reptiles and Amphibians of Australia. Reed New Holland, Sydney. 808 pp.). It is a generalist carnivore consuming mammals, frogs, reptiles, fish, invertebrates, and the eggs of reptiles and birds (Christian 2004. *In* Pianka and King [eds.], Varanoid Lizards of the World, pp. 423–429. Indiana University Press, Bloomington and Indianapolis. 588 pp.). Invertebrates eaten include orthopterans, ants, lepidopterans, spiders, centipedes, roaches, hemipterans, beetles, trichopterans, and crabs (Christian 2004, *op. cit.*). Studies of *V. panoptes* diet are based mainly on dissections of museum specimens, and on stomach flushing of live individuals, although a few observations of feeding and prey capture have recently been published (Shannon 2008. Biawak 2:80–86; Shannon and Mendyk 2009. Biawak 3:85–87; Rhind and Doody 2011. Herpetofauna 41:64–65; Doody et al. 2012a. Herpetol. Rev. 43:339–340; Doody et al. 2012b. Herpetol. Rev. 43:491–492; Rhind et al. 2013. Herpetol. Rev. 44:516–517; Rhind et al. 2014. Herpetol. Rev. 45:335–336). Collectively, these studies and observations indicate that *V. panoptes* is capable of a wide range of foraging behaviors including capturing fast prey, subduing large prey, excavating inactive or hidden prey including eggs, foraging for aquatic prey, raiding poultry pens, and scavenging roadkill and human consumable waste.

At 0935 h on 9 July 2010 we observed, photographed, and videoed a large male *V. panoptes* tearing apart a cattle dung pat on the campground at El Questro Station, El Questro Wilderness Park, in the Kimberley Region of Western Australia (16.006297°N, 127.979819°E) (http://dx.doi.org/10.6084/m9.figshare.1281287). Upon closer examination (within 3 m) we observed the lizard to: 1) tongue-flick in and around the pat; 2) tear apart the pat with alternating forelimbs; 3) press its nose into the pat; and 4) capture small prey items and swallow them. Although we could not confirm it with absolute certainty, the prey items appeared to be dung beetles, which we later found to be relatively common in other dung pats in the area (there were no other similar-sized invertebrates in the 10 pats we examined). After the lizard tore apart the pat, it proceeded in a straight line to another pat 7 m away. In this way the lizard tore apart seven dung pats in a ~30-minute period. The pats were all within a 50-m^2 area. The dung pats were from cattle, which invade the campground to forage on green grass late in the dry season. The campground is encompassed by the Station, a million-acre property that supports ~5000 head of cattle (M. Bass, pers. comm.).

Varanus bengalensis forages for dung beetles in the dung pats of cattle, elephants, rhinoceros, donkeys, camels, blackbuck, nilgai, horses, and canids (Auffenberg 1994, *op. cit.*). In particular, *V. bengalensis* regularly visited bovine dunging sites, which contained a rich and diverse abundance of dung beetles. The lizards also demonstrated spatial memory, visiting but not disturbing fresh dung pats which have few beetles, then revisiting the pats days later when beetle densities were higher. We do not know if the *V. panoptes* knew of the dung pats previously; however, the lizard clearly focused on dung pats exclusively during the feeding bout. Earlier in the year when dung pats are not available at the site, we commonly observe *V. panoptes* foraging in the campground on mowed grass for buried prey including beetle larvae, hymenopteran larvae, and frogs. They also occasionally scavenge on human food items. Other producers of significant amounts of dung in the east Kimberley are feral donkeys, horses, cattle, and pigs. Dung foraging in monitors may be a relic; historically, prominent megafauna would have provided an abundance of dung pats and beetles for ancestral species of large monitors. Auffenberg (1994, *op. cit.*) estimated that the habit of gleaning dung beetles from Bovine pats by Asian monitors extended back into the Pliocene, based on fossil evidence from the Varanidae, Bovidae, and Scarabaeidae.

The great breadth of both food types and foraging strategies in *V. panoptes* probably increases the likelihood of individual variation of both. Individual variation in prey preference may be critical for the viability of *V. panoptes* populations in the Kimberley Region as they face the invading Cane Toad (*Rhinella marina*). *Varanus panoptes* is one of three species of monitor lizards that suffers severe population-level declines, via lethal toxic ingestion, with the invasion of Cane Toads (e.g., 83–96%, Doody et al. 2009. Anim. Conserv. 12:46–53). Toads have since invaded El Questro in 2012–2013. Perhaps individuals that prefer non-frog prey such as invertebrates will comprise the proportion of animals surviving the toad invasion.

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***VARANUS PANOPTES* (Yellow-spotted Monitor). TOXIC PREY AVOIDANCE.** It is well established that toxic Cane Toads (*Rhinella marina*) poison some predator species attempting to ingest them (Lever 2001. Cane Toad: The History and Ecology of a Successful Colonist. Westbury, Yorkshire). In a few species this interaction translates into strong, population-level impacts; for example, *Varanus panoptes* suffers population declines of about 90% upon toad arrival (Doody et al. 2009. Anim. Conserv. 12:46–53; Ujvari and Madsen 2009. Herpetol. Conserv. Biol. 4:248–251). However, it is not known whether the surviving ~10% possessed genetic-based immunity (Ujvari et al. 2013. Evolution 67:289–294), an innate adaptive avoidance of frogs, or whether non-lethal encounters result in lizards learning to avoid Cane Toads (Llewelyn et al. 2013. Austral. Ecol. 39:190–197). Behavioral observations, while insufficient alone to allow distinguishing among those hypotheses, can clarify interactions that can facilitate choosing which hypothesis is the best to pursue. While studying the nesting biology of *V. panoptes* in the Kimberley region of tropical Australia, we captured video of a natural interaction between a *V. panoptes* and a Cane Toad, soon after the arrival of toads to the site.

In April and May 2013 we monitored four *V. panoptes* nesting warrens for female activity using Moutrie I-35® remote game cameras at El Questro Wilderness Park, Western Australia (15.895033°S, 128.132456°E). The site is mainly woodland savannah and is in the wet-dry tropics; the nesting warrens were in the sandhill of a riparian area. Cameras were placed on the trunks of small trees near the burrow entrances of warrens. Two of the cameras were set to take still photographs and two set to take short videos with an associated photograph (30 sec in duration). At 0829 h on 1 May a video captured the interaction of an adult gravid female *V. panoptes* and an adult Cane Toad (http://dx.doi.org/10.6084/m9.figshare.1281314). The video begins by showing the lizard with its head turned towards the toad, which was sitting in shade next to a burrow opening (Fig. 1). The direction of her gaze and repeated tongue-flicking (6 flicks in that posture for 10



FIG. 1. Game camera photograph of a gravid female *Varanus panoptes* near the entrance of her nesting burrow, looking towards a Cane Toad (*Rhinella marina*) that is sitting at the base of a small tree (in shadow). The dust in the air is a result of the lizard's digging action just before the photograph was taken.

seconds), suggested that she was aware of the toad's presence. At 11 seconds the lizard turned away from the toad and burrow entrance, at which time the toad hopped quickly into the burrow, possibly in response to the lizard's movement. The lizard walked slowly about 0.5 m away from the burrow, during which time she flicked her tongue nine times; at 24 seconds the lizard ceased tongue-flicking and flattened out her body and basked in a patch of sunlight for the last 6 seconds of the video. Toads had arrived at the site during the previous wet season, sometime between November 2012 and March 2013. When we excavated the warrens in May and June most of the burrows contained 1–4 adult toads. Over the next few weeks the lizard completed her nesting in the same burrow, and was seen several times during this process, indicating that she was not a victim of toad poisoning. Excavation of her burrow revealed her eggs but no more toads.

As far as we know, this is the first direct observation of the interaction between a *V. panoptes* and a Cane Toad in nature (but see Llewelyn et al. 2013, *op. cit.*, for field experiments in which *V. panoptes* were offered toads from a noose). The lizard, which was clearly large enough to consume the toad, was not toad-naïve, but may not have experienced toad toxin. It is possible that the lizard was satiated, or that *V. panoptes* do not feed while gravid, or during the nesting process. However, it is equally likely that the lizard avoided the toad due to either innate avoidance or a learned response to toad poisoning. Further monitoring of *V. panoptes* nesting warrens as toads arrive could reveal insightful interactions that clarify the behavioral repertoire of *V. panoptes* for dealing with Cane Toads. These interactions could help disentangle competing hypotheses underpinning the surviving 10% of *V. panoptes* during the Cane Toad invasion.

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***WOODWORTHIA MACULATA* (Common Gecko). LEUCISM.** Leucism is a condition where the lack of deposition of melanin in the skin results in a white or pale coloration of the animal, but the eyes maintain normal pigmentation (cf. albinism; Bechtel 1995. Reptile and Amphibian Variants: Colors, Patterns, and Scales. Krieger Publishing Co., Malabar, Florida. 206 pp.). Leucism can vary from partial (<25%, also defined as piebaldism) to completely white individuals (van Grouw 2006. Dutch Birding 28:79–89; Rocha and Rebelo 2010. Herpetol. Notes 3:361–362). Occurrence of leucistic New Zealand geckos in the wild are uncommon (T. Jewell, pers. comm.) and the few observations are generally not recorded.

On 25 February 2014, several *Woodworthia maculata* were caught at dusk, under a pile of rocks close to the shoreline at an island in Whakatane, New Zealand. One of the three individuals was an adult female (SVL = 67 mm) with very pale white

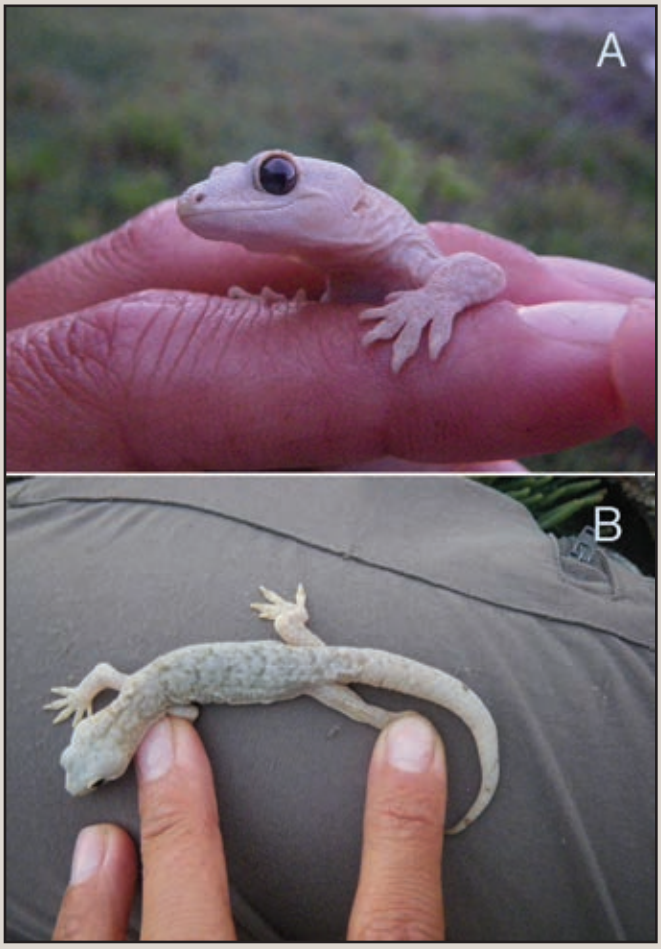


FIG. 1. Leucistic female *Woodworthia maculata*, (A) lateral head showing the pigmented eyes, and (B) light patterning on the dorsal region.

coloration and dark viscera visible through the translucent skin. The eyes were pigmented, indicating that the individual was not an albino (Fig. 1A). The female also had light brown patterns on its dorsal region (Fig. 1B). This nocturnal species is generally grey, brown or olive-green in color with highly variable dorsal patterning, and has a large geographical range in New Zealand (Jewell 2008. Reptiles and Amphibians of New Zealand. New Holland, New Zealand. 143 pp.). This is one of the rare observations of leucism occurring in wild populations of *W. maculata*.

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***XANTUSIA GRACILIS* (Sandstone Night Lizard). DIET AND FORAGING BEHAVIOR.** Occurrence of *Xantusia gracilis* is limited to a small range of sandstone habitat in the Anza-Borrego Desert of southern California. Due to the location and cryptic nature of *X. gracilis*, very little information has been gathered on its natural history. In captivity, these lizards have been observed eating the eggs of *Phyllodactytus nocticolus* (as *P. xanti*) (Grismer and Galvan 1986. Trans. San Diego Soc. Nat. Hist. 21:155–165). While the diet of *X. henshawi* has been extensively examined through the analysis of stomach contents (Brattstrom 1952. Copeia 1952[3]:168–172), to my knowledge, the hunting behavior and prey items of *X. gracilis* have never been observed in the wild.



FIG. 1. *Xantusia gracilis* with beetle immediately before predation.



FIG. 2. *Xantusia gracilis* showing interest in *Trimerotropis pallidipennis*.

On 25 May 2014, we observed an adult *X. gracilis* exposed on a sandstone wall. Light was immediately taken off of the animal in an effort to prevent it from retreating. By the time I readied my camera for a photo voucher, the lizard had disappeared. I approached the last known location of the lizard and discovered it inside the crevice of an exfoliating slab of sandstone. While attempting to take a photo of the lizard through the opening, it exited and consumed an insect on the artificially illuminated sandstone surface. It quickly retreated to the crevice where it was witnessed masticating, and licking its eye. It was observed for about an hour, emerging to prey on various insects, followed by partial to full retreat to the crevice soon after each catch or miss. One of the insects consumed was identifiable as a small beetle (Coleoptera) (Fig. 1). At least one potential prey item was rejected after approach and inspection by the lizard. Interest was shown in a *Trimerotropis pallidipennis* (Pallid-winged Grasshopper) (Fig. 2), with the lizard making a sudden movement in response to the grasshopper leaping. It was difficult to distinguish whether this was a predatory strike or the lizard startled from the grasshopper movement. No physical contact was made with the lizard and it did not appear to be disturbed by human presence or artificial lights. All of the mentioned behavior was video recorded and can be viewed by request to the first author.

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SQUAMATA — SNAKES

***AGKISTRODON CONTORTRIX* (Copperhead). REPRODUCTION.** Robust estimates of lifetime reproduction in female New World pitvipers exist only for several taxa, and in particular *Crotalus horridus* (Timber Rattlesnake). Here, we present data from a wild female *Agkistrodon contortrix* that suggests this species' reproductive lifespan is protracted, similar to *C. horridus* from New York.

On 24 August 2001, a pregnant female *A. contortrix* (SVL = 62.2 cm, tail length = 8.5 cm, mass = 165 g) was captured at our study site (Fig. 1). The area is a 485-ha parcel of basalt trap rock ridge ecosystem located 4.75 km NW of Meriden, Connecticut (Smith et al. 2009. Herpetol. Monogr. 23:45–73). She produced a litter of 3 healthy offspring in the laboratory on 5 September 2001. Her post-birth mass was 99.3 g. She was subsequently PIT tagged and released at the exact location of capture.

The female was subsequently captured at the same site (within 1 m) on 25 July 2008, 28 May 2010, 26 July 2011, and 12 August 2013. On 25 July 2008 she appeared pregnant (SVL = 65.3 cm, tail length = 8.5 cm, mass = 340 g) and produced a litter of 6 healthy offspring in the laboratory on 2 September 2008. Her post-birth mass was 162 g. On 28 May 2010, although she did not appear pregnant (SVL = 65.5 cm, tail length = 9.0 cm, mass = 340 g), she was nonetheless brought back to the laboratory for observation. She did not produce a litter in 2010. On 26 July 2011 she appeared pregnant (SVL = 67.6 cm, tail length = 9.0 cm, mass = 274 g) and was brought to the laboratory. She produced a litter of 8 healthy offspring on 28 August 2011. Her post-birth mass was 199 g. On 12 August 2012 she was recaptured at the same location and appeared pregnant (SVL = 67.8 cm, tail length = 9.0 cm, mass = 262

g). She produced a litter of 6 healthy offspring in the laboratory on 31 August 2013. Her post-birth mass was 155.2 g.

From her initial capture on 24 August 2001 until her last capture on 12 August 2013, we documented production of four litters by this female. Additional unobserved litters are possible from 10 October 2001 (when she was released following her first litter) to 25 July 2008 (when she was captured prior to her second litter). Based on her size and indisputable evidence of sexual maturation at the initial capture, we conservatively estimated her age in August 2013 to be 15 years old. Accordingly, we document her reproductive lifespan to be at least 12 years.

Long-term data on wild female *C. horridus* indicate that reproductive senescence is delayed or absent in this species' life history (Brown 1991. Herpetologica 47:101–115). Our data on *A. contortrix* are consistent with this suggestion. We encourage others to collect long-term data on individuals of other pitviper species to better understand this important life history characteristic.

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***APOSTOLEPIS MULTICINCTA*. DIET.** *Apostolepis multicincta* (family Dipsadidae) is a small, fossorial snake endemic to the inter-Andean dry valleys of Bolivia in the Departments of Santa Cruz (Reiche and Embert 2005. J. Herpetol. 39:379–383) and Chuquisaca (Cortez, *in press*. Kempffiana). Little information is available on the natural history of this species, including its diet. The only known prey item is a blind snake (*Leptotyphlops striatula* = *Epictia striatula*; Embert and Reichle 2003. Salamandra 39:249–252). Herein we document a new prey item for *A. multicincta*. On 16 June 2014 at 1500 h we captured an adult *A. multicincta* (male; SVL = 385 mm; tail length = 50 mm; head width = 5.6 mm) crossing the road in the community of Pacay, Florida Province, Santa Cruz Department, Bolivia (18.039722°S, 64.142222°W, WGS 84; elev. 1294 m). Several hours later, while in captivity, the *A. multicincta* regurgitated a juvenile *Amphisbaena cegei* (male; SVL = 140 mm; tail length = 15 mm). This is the second known prey item for *A. multicincta*, and the first instance of an amphisbaenian in its diet. Both individuals were deposited in the Herpetology Collection in the Noel Kempff Mercado Museum, Santa Cruz de la Sierra, Bolivia (*A. multicincta* MNKR 5355; *A. cegei* MNKR 5356).

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***ASPIDITES MELANOCEPHALUS* (Black-headed Python). DIET.** Pythons (Pythonidae) are among the largest native predators in many Australian terrestrial communities. However, interactions between these species and the suite of introduced mammalian predators that now dominate much of Australia have rarely been reported. On 7 July 2014, we observed a road-killed *A. melanocephalus* (total length ca. 1.5–2 m) on the Gibb River Road, Western Australia, just west of the turnoff to Windjana Gorge Road in open savanna woodland (Fig. 1). Inspection of the stomach contents revealed three feral cat kittens (*Felis catus*). Based on their small size (ca. 150 mm head–body length), folded ears and closed eyes, these cats were less than a few weeks old and had been consumed in one session, presumably when the python found them in a den. The posterior-most cat was near fully digested, while the other two cats were intact.

Australia's mammal fauna has undergone systematic declines across most of the continent and direct predation by introduced predators (i.e., feral cats; red foxes) is widely considered a key threatening process (Short and Smith 1994. J. Mammal. 75:288–297). Populations of some native predators have clearly shifted to prey on comparatively abundant introduced mammals (e.g., rabbits, house mice; Heard et al. 2004. Austral Ecol. 29:446–460). However, although feral cats have played an important role in the decline of many native species, they have not been considered as potential prey for many native predators. This observation suggests that feral cats, which are relatively abundant and widespread throughout Australia, could be a significant food resource for some large native predators, such as *A. melanocephalus*.



FIG. 1. Road-killed *Aspidites melanocephalus* on the Gibb River Road, Western Australia, with three *Felis catus* it had consumed.

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***BOA CONSTRICTOR* (Boa Constrictor). DIET.** *Boa constrictor* is an opportunist and generalist predator occurring throughout Central and South America (Henderson et al. 1995. Herpetol. Nat. Hist. 3:15–27). Its diet includes mainly mammals, reptiles, and birds (Pizatto et al. 2009. Amphibia-Reptilia 30:533–544; Bernarde



FIG. 1. A) *Patagioenas picazuro* (Picazuro Pigeon) predation by *Boa constrictor*. B) Google Earth satellite image showing urban fragment where predation took place (arrow), in Campo Grande, MS, Brazil.

and Abe 2010. Biota-Neotrop. 10:167–173). Although predation on wild birds by *B. constrictor* is well documented (e.g., Pizatto et al. 2009, *op. cit.*; Barbier and Rocha-Santos 2014. Herpetol. Rev. 45:140), herein we provide the first report of *B. constrictor* predation on *Patagioenas picazuro* (Picazuro Pigeon: Columbidae), in an urban forested fragment.

The observation occurred on 20 Sep 2010 in a forest clearing at the Natural Heritage Private Reserve of the Universidade Federal de Mato Grosso do Sul (NHPR/UFMS), Mato Grosso do Sul, Campo Grande, Brazil (20.5082°S, 54.6162°W; datum WGS84). At 0857 h, we found a *B. constrictor* constricting and swallowing a *P. picazuro* (Fig. 1A). The NHPR/UFMS fragment has an area of approximately 50 ha of dense savannah within a highly urbanized landscape. Despite the relatively small size of the fragment (Fig. 1B), our observation highlights the importance of these remaining protected areas as refuges for species and communities threatened by urban development.

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***BOA CONSTRICTOR* (Boa Constrictor). DIET.** *Boa constrictor* is a widely distributed, semiarboreal, mostly nocturnal, large-bodied snake (Greene 1983. *In* Janzen [ed.], Costa Rican Natural History, pp. 380–382. Univ. Chicago Press, Chicago, Illinois). These generalist, opportunistic, sit-and-wait predators are known to feed on a variety of prey, with endothermic animals comprising a large proportion of the diet of adult specimens (Pizzatto et al. 2009. Amphibia-Reptilia 30:533–544). Previous accounts on mammalian prey include opossums, bats, rats and mice, rabbits, squirrels, porcupines, tamanduas, mongooses, agoutis, coatis, armadillos, sloths, deer, ocelots, and monkeys (Reed and Rodda 2009. Giant Constrictors: Biological and Management Profiles and an Establishment Risk Assessment for Nine Large Species of Pythons, Anacondas, and the Boa Constrictor. U.S. Geological Survey Open-File Report 2009–1202, Reston, Virginia. 302 pp.). On 29 May 2012, we obtained an adult female *B. constrictor* (total length ca. 210 cm) from a local farmer (who thought it to be a *Lachesis stenophrys* [Matabuey or Bushmaster]) on the southern slope of Reserva Natural Cerro Musún (12.96°N, 85.23°W, datum WGS84; 650 m elev.), Dept. Matagalpa, Nicaragua. The farmer had killed the snake the previous morning at ground level in his crop field, situated at the edge of a relatively large and well preserved premontane wet forest. In the snake's stomach, we found a recently ingested, full-grown *Potos flavus* (Kinkajou: Procyonidae: Carnivora), a strictly nocturnal and mainly frugivorous and arboreal mammal (Ford and Hoffmann 1988. Mammalian Species 321:1–9). The snake had swallowed the Kinkajou head-first. To our knowledge, this is the first report of Kinkajou in the diet of *B. constrictor*.



FIG. 1. Ingestion of *Potos flavus* (Kinkajou) by *Boa constrictor* at Reserva Natural Cerro Musún, Dept. Matagalpa, Nicaragua.

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***COLUBER* (= *MASTICOPHIS*) *BILINEATUS* (Sonoran Whipsnake). DIET.** Avian nest predation by snakes has been reported infrequently, but may account for as much as 90% of all nest predation (Weatherhead and Blouin-Demers 2004. J. Avian Biol.



FIG. 1. *Coluber bilineatus* swallowing a *Zenaida asiatica* (Mourning Dove) egg in Sonora, México.

35:185–190). *Coluber bilineatus* is a common snake in the Sonoran Desert that is semiarboreal to arboreal and is most commonly observed in brush and trees (Jones 2014. Arizona Wildlife Views: 43). The diet of *C. bilineatus* is known to consist of lizards (Bezy and Enderson 2003. Sonoran Herpetol. 16:16–17) and mammals (Camper and Dixon 2000. Texas J. Sci. 52:83–92). Here we document the first report of bird eggs as food items for *C. bilineatus*.

On 13 August 2013 at 1100 h, we observed an adult *C. bilineatus* (total length ca. 1700 mm) predating the nest of a *Zenaida asiatica* (Mourning Dove) at La Cieneguita, 12 km from Mazocahui, municipality Baviacora, Sonora, México (29.539253°N, 110.015°W; datum WGS84). The snake climbed to the nest ca. 3.5–4 m above the ground of a live mesquite (*Prosopis velutina*). The dove fought for a few seconds but it was unable to protect the eggs and flew away. The snake proceeded to swallow the first egg (Fig. 1), but dropped the second egg while trying to swallow it. It searched for more eggs, but not finding any, eventually departed in response to our presence. Photos are deposited in the Colección Científica de Vertebrados de la Universidad Autónoma de Ciudad Juárez.

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***COLUBER (= MASTICOPHIS) FLAGELLUM* (Coachwhip). DEFENSIVE BEHAVIOR.** Speed and retreat into bushes is the most common escape behavior seen in racers and whipsnakes (BHB, pers. obs.). Here we report an unusual escape behavior of a *Coluber flagellum* crawling up a Giant Saguaro (*Carnegia giantea*). Robert and Jamie Dieterich saw a *C. flagellum* (total length ca. 100 cm) in the shade of the veranda of their house on their Flying D Ranch, near Signal, Mohave Co., Arizona, USA (34.50864°N, 113.6304°W; datum WGS 84) at about l500 h on 17 April 2014. Apparently reluctant to go from the 30°C shade into the hot sun, it



FIG. 1. *Coluber flagellum* crawling up a Saguaro Cactus near Signal, Arizona, USA.

rattled its tail and made strikes at a broom used to move it away from the house. Finally the snake left the shade, traveled 3 m to and up 1.5 m on a 7-m tall Saguaro (Fig. 1). Distractions caused the observers to leave the area for about 5 min and on their return the snake had disappeared. While the snake was still visible, the spines on the cactus would deter most potential predators until further escape was possible.

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***COLUBER (= MASTICOPHIS) MENTOVARIUS* (Neotropical Whipsnake). PREDATION.** Although snake predation by raptors is common and well-documented (Mitche and Fischer 2008. Banisteria 31:54–56), there are no records to my knowledge of *Coluber mentovarius* being part of the diet of any *Buteo* species.



FIG. 1. Head of a *Coluber mentovarious* found with feathers in its mouth, suggesting predation by a raptor.

Knight and Erickson (1976. Raptor Research 10:108–111) reported a high prevalence of snakes in the diet of a population of *Buteo jamaicensis* (Red-tailed Hawk) from north-central Washington, along the Columbia River, USA; *Coluber constrictor* (North American Racer) was the most abundant reptile prey item. Also, Granzinolli and Motta-Junior (2007. Emu 107:214–222) reported eight individual snakes (all of them Colubridae) in a sample of 259 pellets and 3296 prey items from eight species of raptors of the orders Falconiformes and Strigiformes in southeastern Brazil.

On 12 July 2014 at 1802 h, I found the head of an adult *C. mentovarius* with feathers in its mouth in relictual oak forest near Zacatzonapa, Tixtla de Guerrero, Guerrero, Mexico (17.51639°N, 99.3572°W, datum WGS84; 1546 m elev.). Nearby, I saw a *Buteo* sp. resting in an oak tree, suggesting that the snake was preyed upon by the hawk and bit the bird's feathers in defense.

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***CROTALUS LEPIDUS* (Rock Rattlesnake). DIET.** The diet of *Crotalus lepidus* includes arthropods, frogs, small rodents, lizards, and snakes (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Institution Press, Washington, D.C. 668 pp.). Herein we report a new prey item in the diet of this species.

On 24 June 2013 at 1445 h, we collected a male *C. lepidus* with a perceptible diet item in Cañon San Isidro, which is located in Santiago, Nuevo Leon, México (25.378966°N, 100.310179°W, WGS84; elev. 1800 m). The snake was maintained in captivity for eight days until feces were released. Examination of the fecal material revealed numerous black keeled and mucronated scales, as well as a partially digested right leg, and a femur and phalangeal bones of a left leg. A comparison of the scales found in the samples with those from reptiles present in the area indicated that the scales belonged to the lizard *Sceloporus oberon* (Royal Lesser Minor Lizard), a species apparently common in the area. To the best of our knowledge this is the first report of *S. oberon* in the diet of *C. lepidus*. The snake was released at the site of capture.

Special thanks to V. Mata-Silva for reviewing a draft of this note.

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***CROTALUS MOLOSSUS* (Black-tailed Rattlesnake). REPRODUCTION.** Reproductive bimodality has been observed in several North American pit vipers, most notably *Crotalus atrox* (Western Diamond-back Rattlesnake), but has not been documented in *C. molossus molossus* (Ernst 1992. Venomous Reptiles of North America. Smithsonian Institution Press, Washington D.C. 236 pp.). Therefore, we were surprised when we discovered one of our radio-telemetered *C. m. molossus* engaged in courtship with an unmarked female on 5 March 2014 at 1225 h. We observed the snakes on an east-facing talus slope on Tumamoc Hill, a national environmental study site where our lab is located, within 3.2 km of downtown Tucson, Arizona, USA, (32.2169°N, 111.0031°W, datum NAD83). Courtship behavior included persistent chin-rubbing and tongue-flicking by the male along the female's dorsum, even as the female began to move slowly into the talus. We left the site at 1256 h to reduce disturbance to the animals.



PHOTO BY LILY WALSH

FIG. 1. Pair of *Crotalus molossus molossus in copulo*, as evidenced by the bulge immediately anterior to the female's cloaca, 5 March 2014 in Tucson, Arizona, USA.

We revisited the site at 1710 h, at which time we observed the two snakes *in copulo* ($T_{ambient}$ = 23.3°C, $T_{substrate}$ = 33.0°C, relative humidity = 36%, cloud cover = 85%). We were able to determine that the snakes were copulating, because the female had a noticeable bulge immediately anterior to her cloaca (Fig. 1), and she was clearly dragging the male with her as she moved. We left again at 1720 h, when it became apparent that the female was attempting to hide in the talus, possibly in reaction to our presence. The following day at 1139 h, the male had moved ca. 20 m, and the female was no longer present.

Although spring mating in *C. m. molossus* has not been observed in the past, histological findings indicate that males are at least capable of spermiogenesis as early as May, resulting in the presence of viable sperm in the vasa deferentia (Goldberg 1999. Texas J. Sci. 51:321–328). In contrast, males found in March–April were characterized by either regressed or recrudescent testes, which would preclude successful insemination. With regard to females, a few individuals were found with oviductal eggs as early as April; however, fertilization from stored sperm seems a more plausible explanation for early ovulation. Regardless, these histological findings do not coincide with the timing of our observation. Although Goldberg's (*op. cit.*) data include 59 individuals from Arizona, he only provides locality data as county of origin. Therefore, detailed histological information from *C. m. molossus* found at our study site would be required for a more robust interpretation of our observation.

Observations of reproductive behavior in *C. molossus nigrescens* provide additional context. Successful copulation was observed in this species on 1 February 1978, 28 May 1973, and 2 March 1974. The second two observations were made of captive animals, and the first was in the field (Ernst, *op. cit*). The range of *C. m. nigrescens* encompasses central Mexico between the states of Durango and Oaxaca, an area that typically experiences mild winters without hard freezes (Campbell and Lamar 2004. The Venomous Reptiles of the Western Hemisphere. Cornell University Press, New York. 870 pp.). Given the climatic differences faced by the two subspecies, it seems plausible to suggest that spring mating might occur more commonly in low-elevation/low-latitude populations of *C. m. molossus*, such as our study population in Arizona.

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***CROTALUS TOTONACUS* (Totonacan Rattlesnake). DIET.** Like most of the larger members of its genus, *Crotalus totonacus* is known to prey on small mammals and birds. Reports include a juvenile containing rodent hair (Armstrong and Murphy 1979. Univ. Kansas Mus. Nat. Hist. Spec. Publ. 5:1–88), and mammal hair and bird feathers (Klauber 1972. Rattlesnakes: Their Habits, Life Histories, and Influence on Mankind. Vol. I & II. 2nd ed. University of California Press. Berkeley, California. 1533 pp.). Specific prey items documented for the species are limited. Martin (1958. Misc. Publ. Mus. Zool. Univ. Michigan 101:1–102) found a *Neotoma* sp. (cave rat) and a *Sciurus alleni* (Allen's Tree Squirrel) in the stomachs of two specimens from Tamaulipas, México. Here we report the first record of an additional species, *Spermophilus* (*Otospermophilus*) *variegatus* (Rock Squirrel).

At 1342 h on 6 June 2007, 9.37 km (airline) SW of the junction of Mex Hwy 85 and N. L. State Hwy 20, on a dirt pathway S of Hwy 20, in the municipality of Santiago, Nuevo León, México (25.335934°N, 100.192566°W, datum WGS84; elev. 1282 m), one of us (SEOH) observed an adult *C. totonacus* (total length ~1.8 m) eating a squirrel. When first seen, the snake had already swallowed the head of the squirrel (Fig. 1). The snake was observed for about 5 min during which time it dragged the food item about 2 m to some scrub cover and was left alone to finish eating. Additionally we report here the contents of an unpublished thesis (Vallejo-Gamero 1981. Taxonomía y distribución de la familia Crotalidae en el estado de Nuevo León, México. Tesis Inédita, Facultad de Ciencias Biológicas, Universidad Autónoma de Nuevo León, México. 49 pp.) that noted stomach contents of *C. totonacus* included *Neotoma* sp. and *Didelphis* sp. (opossum). Unfortunately the specimens the report was based on are no longer present in the UANL collection for verification. We thank Juan Cruzado-Cortés for help with identifying the squirrel.



FIG. 1. A *Crotalus totonacus* preying on a *Spermophilus variegatus* (Rock Squirrel) in the municipality of Santiago, Nuevo León, México.

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***DRYMARCHON MELANURUS* (Central American Indigo Snake). DIET.** *Drymarchon melanurus* is known to feed on a great variety of prey including fishes, eggs, frogs, turtles, lizards, snakes, birds, and mammals (Scott 1983. *In* Janzen [ed.], Costa Rican Natural History, pp. 380–382. Univ. Chicago Press, Chicago, Illinois). In Nicaragua, the only dietary record of this species includes a *Leptodactylus savagei* (Travers et al. 2011. Herpetol. Rev. 42:399–403). Herein we report the first record of predation by *D. melanurus* on a Swamp Eel.



FIG. 1. Predation by *Drymarchon melanurus* on *Synbranchus marmoratus*, at Lost Canyon Nature Reserve, San Juan de Dios, El Jicaral, Dept. León, Nicaragua.

At 1715 h on 18 February 2014, at Lost Canyon Nature Reserve (12.70582°N, 86.41777°W, datum WGS84; 140 m elev.), San Juan de Dios, El Jicaral, Dept. León, Nicaragua, a *D. melanurus* (total length ca. 180 cm) was encountered pulling a Swamp Eel (*Synbranchus marmoratus*; total length ca. 80 cm) out of a 2.3-m wide stream surrounded by secondary vegetation. The snake firmly grabbed the eel with its posterior teeth while pulling it out of the water by coiling its body uphill. The eel showed evidence of the attack in the middle and posterior part of its body. The snake never tried to constrict and did not release the eel, which hissed and struggled for about 10 min. After ca. 15 min. they were left alone because the snake was clearly concerned with the presence of human observers. At that point, the snake had managed to pull the eel 1 m up and about 50 cm horizontal from the stream to the adjacent spiny vegetation. The habitat was lowland dry forest in transition to arid habitat (Holdridge 1967. Life Zone Ecology, rev. ed. Tropical Science Center, San José, Costa Rica. 206 pp.). We thank Eric van den Berghe for identification of the eel.

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***ERYX JACULUS* (Sand Boa). ALBINISM.** *Eryx jaculus* is a diurnal, burrowing snake and is the only member of the family Boidae in Europe. It ranges from the Balkans, Turkey, and Greece to central Asia, the Middle East, and Mediterranean North Africa. In Greece it is present on the mainland and many islands of the Aegean and the Ionian Seas (Valakos et al. 2008. The Amphibians and Reptiles of Greece. Edition Chimaira, Frankfurt am Main, Germany. 463 pp.). On 14 May 2014, at 1908 h, we found an albino adult *E. jaculus* under a stone near the port of Aghios Georgios, Iraklia, Greece (36.8611°N, 25.4701°E; datum WGS84). The specimen (Fig. 1; SVL = 300 mm; tail length = 30 mm; 31.6 g) was found 50 m from another adult *E. jaculus* with a typical pattern. Although

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FIG. 1. Albino *Eryx jaculus* found near the port of Aghios Georgios, Iraklia, Greece.

albinism has been reported to occur in other boid species (e.g., *Lichanura trivirgata;* Klauber 1972. Rattlesnakes: Their Habits, Life Histories, and Influence on Mankind. University of California Press, Berkeley, 2 vols. 1533 pp.), we know of no other cases of albinism in this species.

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***HYDROPHIS* (= *PELAMIS*) *PLATURA* (Yellow-bellied Seasnake). INTERACTION WITH DOLPHINS.** *Hydrophis platura* is the only fully pelagic sea snake. It is thought to be predominantly a passive drifter that concentrates around ocean slicks, where it sometimes forms aggregations into the millions (Campbell and Lamar 2004. Venomous Reptiles of the Western Hemisphere. Cornell University Press, Ithaca, New York. 870 pp.). Little is known about biotic interactions of *H. platura*. It eats fishes and probably has few predators because it is unpalatable to many fishes and may have toxic flesh (Campbell and Lamar, *op. cit.*).

At ~1015 h on 7 November 2013, one of us (EL) was swimming with a pod of about half a dozen *Tursiops truncatus* (Common Bottlenose Dolphins) in Banderas Bay, Jalisco, Mexico (20.7031078°N, 105.3278205°W; datum WGS84), when two of the dolphins began interacting with an adult *H. platura* (Fig. 1; total length ca. 70 cm based on photographs). Over a period of 6–7 min, the two dolphins pushed the snake around in the water with their heads and repeatedly threw it into the air using their tails. The snake did not react in any obvious way, only continued to swim.

Although wild and captive delphinids occasionally manipulate other animals for functional purposes (e.g., Smolker et al. 1997. Ethology 103:454–465), the majority of reports of these kinds of interactions seem to serve no particular purpose and are categorized as play. Social object play using plants or animals that do not serve as prey often involves pushing these animals around, passing them from one part of the body to another or among individuals, or chasing and grabbing them only to release them before chasing again (Janik 2015. Current Biol. 25:R7–R8). These behaviors are often accompanied by splashing, aerial displays, and social interactions (Mann and Smuts 1999. Behaviour 136:529–566). Because the behavior of the dolphins we observed fit this description, we suggest that the dolphins were playing with the snake. If this was indeed the case, this is the first documentation of dolphins playing with a marine reptile.

Dolphins do not appear to prey upon *H. platura*. Kropach (1972. PhD dissertation, The City University of New York), reporting the unpublished data of other investigators, stated that

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FIG. 1. *Tursiops truncatus* (Common Bottlenose Dolphins) seemingly playing with a *Hydrophis* (= *Pelamis) platura* (Yellow-bellied Seasnake) in Banderas Bay, Jalisco, Mexico.

stomach contents of 214 dolphins examined from areas of the eastern Pacific where *H. platura* was plentiful contained no sea snakes, and Heatwole (1975. *In* W. A. Dunson [ed.], The Biology of Sea Snakes, pp. 233–249. University Park Press, Baltimore, Maryland) concluded that *H. platura* are nearly free from predation. Two reports of pinnipeds, both of which became ill, consuming *H. platura* suggest that the snakes are unpalatable to marine mammals. In addition, the venom of *H. platura* is largely neurotoxic and is probably highly potent. Although only a few fatal bites to humans have been reported, the potential for fatal bites to marine mammals exists.

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***LEPTODEIRA SEPTENTRIONALIS* (Northern Cat-eyed Snake). DIET AND PREDATION.** Beginning at 1838 h on 30 May 2014 at the Caves Branch Jungle Lodge in Belize, we observed an encounter between a *Leptodeira septentrionalis* and an *Incilius valliceps* that appeared to have initiated as a predation attempt by the toad on the snake. The toad (SVL ca. 9 cm) had the dorsal portion of the snake's head in its mouth (Fig. 1); however, the toad was motionless and the snake (with its head in the toad's mouth) was retracting backwards up a stone wall into a crevice, pulling the toad with it. The snake's lower jaw was beneath the lower jaw of the toad, meaning that teeth of the snake's upper jaw were undoubtedly imbedded in the toad's lower mouth, thereby allowing the snake to envenom the toad, indicated by the toad's lack of motion (for information on toxicity of venom within

PHOTOS BY RICHARD ENGEMAN



FIG. 1. *Leptodeira septentrionalis* found with the dorsal portion of its head in the mouth of an *Incilius valliceps* in Belize.



FIG. 2. In a quick motion 20 min after observations were initiated, the *Leptodeira septentrionalis* removed its head from inside the mouth of the *Incilius valliceps* and captured the toad's snout in its mouth.

genus *Leptodeira* see Weinstein et al. 2014. Clin. Toxicol. 52:277–282). Within 2 min the snake had retracted nearly its whole body into the crevice, but it was also clear that the toad would not fit into it (Fig. 1). At approximately 1858 h, the snake made a quick motion to simultaneously extract its head from the immobilized toad and put the toad's snout in its mouth. It then began an attempt to swallow the toad (Fig. 2). To do so the snake gradually began to exit the crevice and stretch downwards. By 1941 h, the snake had engulfed nearly the whole head of the toad. The next morning the toad was found dead about 2 m from where the encounter was first observed. There was no indication of the fate of the snake. Our only explanation for the encounter was that the toad attempted to predate the snake, but the snake was able to bite inside the toad's mouth to envenom and kill the toad. This provided the counter-opportunity for the snake to attempt to eat the toad, which may have been too large to consume.

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***OXYRHOPUS OCCIPITALIS*. MELANISM.** Melanism is an unusually high amount of black pigment within a particular individual (Gilhen and Scott 2014. Can. Field-Nat. 128:63–71). Melanism may provide advantages for thermoregulation and reproduction (Clusella-Trullas et al. 2007. J. Therm. Biol. 32:235–245) and has been described as common and highly variable in snakes (Lorioux et al. 2008. Amphibia-Reptilia 29:1–5).

On 16 October 2013 at 1128 h, a melanistic adult female *Oxyrhopus occipitalis* (Fig. 1; SVL = 680 mm; tail length = 198 mm) was collected at the upland forest in Reserva Extrativista Beija Flor Brilho de Fogo (0.8044°N, 52.212692°W, datum WGS 84; elev. 98.4 m), municipality of Pedra Branca do Amapari, Amapá state, Brazil, and deposited in the herpetology collection of Universidade Federal do Amapá (CECCAMPOS 00911). This record constitutes the first published account of melanism in *O. occipitalis* (Dipsadidae, Xenodontinae, Pseudoboini) from the eastern Amazon.

We are grateful to Edmilson G. Coelho (Secretaria Municipal do Meio Ambiente e Turismo) for providing logistic help in the Reserva Extrativista Beija Flor Brilho de Fogo. We thank Paulo S. Bernarde for help with the identification of the snake, and ICMBio for the license number 41443-1.

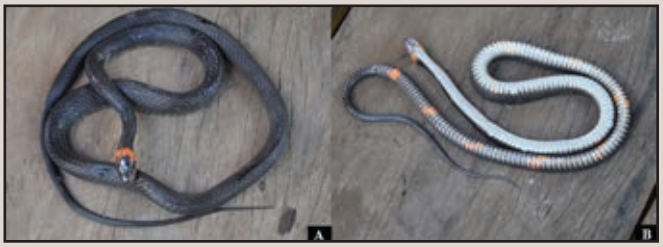


FIG. 1. Dorsal (A) and ventral (B) views of an adult female *Oxyrhopus occipitalis* displaying melanistic coloration.

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***PANTHEROPHIS GUTTATUS* (Red Cornsnake). DIET.** *Pantherophis guttatus* is a common predator of small mammals and of



FIG. 1. *Pantherophis guttatus* with ingested *Falco sparverius* (American Kestrel) nestlings, Marion County, Florida.

bird eggs and nestlings, including those of *Colinus virginianus* (Northern Bobwhite) and various songbirds (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Inst. Press, Washington, D.C. 668 pp.; Miller and Leonard 2010. Southeast. Nat. 9:395–402). Circumstantial evidence suggests that *P. guttatus* might occasionally prey upon eggs or nestlings of larger birds such as cavity-nesting birds of prey. We report here the first documented case of *P. guttatus* preying on *Falco sparverius* (American Kestrel) nestlings in a nest box located ca. 1 km W of Sparr, Marion Co., Florida, USA. Kestrels began incubating a clutch of five eggs on 21 March 2012, and three healthy 5-day-old nestlings and two unhatched eggs were observed on 24 April. When we returned on 14 May to band the 25-day-old nestlings, the nest box contained one unhatched egg and a *P. guttatus* (ca. 1.1 m total length) with three visible lumps from its ingested prey (Fig. 1). Kestrel nestlings typically average 100–105 g as they approach fledging. The nest box was located 4.6 m above ground on a utility pole surrounded by pastures and linear fencerows of oak woodlands.

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***PLATYCEPS NAJADUM* (Dahl's Whip Snake). MAXIMUM SIZE.** *Platyceps najadum* is found throughout the Balkans, Cyprus, the Middle East, and the Caucasus Mountains in dry, xeric habitat from sea level to 2000 m elev. An individual from Bulgaria is the largest known specimen with a maximum total length (TL) of 152 cm (Stojanov et al. 2011. Die Amphiben und Reptilien Bulgariens. Chimaira, Frankfurt am Main. 588 pp.).

Here we present a new maximum body size for *P. najadum* based on a female specimen found on the road in the vicinity of Rustavi, Kvemo Kartli Region, Georgia, near an industrial zone of a nitrogen fertilizer plant (41.536530°N, 45.067462°E; elev. 320 m), 25 September 2012. The specimen was identified by N. Ananjeva and measured 172 cm TL with a tail length of 53 cm.

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***POPEIA FUCATA* (Thai Peninsula Pit Viper). REPRODUCTION.** *Popeia fucata* is known from parts of Myanmar, Thailand, and Peninsular Malaysia (Das 2010. A Field Guide to the Reptiles of South-east Asia, Myanmar, Thailand, Laos, Cambodia, Vietnam, Peninsular Malaysia, Singapore, Sumatra, Borneo, Java, Bali. New Holland Publishers, UK. 376 pp.). *Popeia fucata* (as *Trimeresurus popeiorum*) has litters of 7–12 young (Cox et al. 1998. A Photographic Guide to Snakes and other Reptiles of Thailand and South-east Asia. Asia Books Co., Ltd. Bangkok. 144 pp.). We know of no published information on reproduction of male *P. fucata*. In this note we present information on the minimum size for maturity in male *P. fucata*.

Seven *P. fucata* males were examined (mean SVL = 450.4 mm ± 124.8 SD, range = 242–592 mm) from Peninsular Malaysia collected by LLG during 2002, 2004 to 2006, and 2012 and deposited in the herpetology collection (LSUHC) of La Sierra University, Riverside, California, USA (by state): Kedah, LSUHC 6872, 7565, 7566, 6832; Perak, LSUHC 10664, 10665; Selangor, LSUHC 5098. The lower part of the body cavity was opened and the left testis was removed, embedded in paraffin, histological sections cut at 5 μm and stained by Harris hematoxylin followed by eosin counterstain. Histology slides are deposited in LSUHC.

Two stages were noted in the testicular cycle: 1) regressed, seminiferous tubules are reduced in size, spermatogonia and interspersed Sertoli cells are present; 2) spermiogenesis, seminiferous tubules are lined by sperm or clusters of metamorphosing spermatids. Juvenile males exhibiting regressed testes were LSUHC 242, SVL = 242 mm from July; LSUHC 10664, SVL = 364 mm from July; and LSUHC 7565, SVL = 403 mm from August. Adult males exhibiting spermiogenesis were LSUHC 6872, SVL = 452 mm from September; LSUHC 7566, SVL = 535 mm from August; LSUHC 6832, SVL = 565 mm from September; and LSUHC 5098, SVL = 592 mm from November. Thus, it appears that male *P. fucata* mature at ca. 450 mm SVL.

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***PSEUSTES POECILONOTUS* (Bird-eating Snake). PREDATION.** *Herpetotheres cachinnans* (Laughing Falcon) is a relatively common and widespread bird found in woodlands throughout Central and South America and has a diet consisting primarily of snakes (86% of the diet in a well-studied population in Guatemala [Parker et al. 2012. *In* D. F. Whitacre [ed.], Neotropical Birds of Prey: Biology and Ecology of a Forest Raptor Community, pp. 265–280. Cornell University Press, Ithaca, New York]). However, to our knowledge, *Pseustes poecilonotus* is not a known diet item (Sazima and Abe 1991. Stud. Neotrop. Fauna Environ. 26:159–169; Laurencio 2005. Herpetol. Rev. 36:188; DuVal et al. 2006. Biotropica 38:566–568; Parker et al., *op. cit.*). On 04 March 2014, at the Organization for Tropical Studies, La Selva Biological Station in northeastern Costa Rica (Heredia Province), we observed an *H. cachinnans* capture and then drop an adult *P. poecilonotus* (total length ca. 1.5 m) along the Sendero Surá trail, within the arboretum. AS initially spotted the falcon attacking the snake; the falcon flew 2 m off the ground with the snake, but dropped it as the snake struggled. RAS and AWJ arrived and observed the bird and snake for an additional 30 min. After dropping the snake, the falcon perched on a horizontal branch at the edge of the arboretum clearing, approximately 10 m above snake. It appeared that the falcon could no longer locate the snake, and after 30 min, the bird flew away without the snake. The snake was still alive after the bird flew, but its left eye was pierced, there were two punctures on the dorsal region of its head, a few

displaced dorsal scales ca. 5 cm from the nuchal region, blood on its broken jaw, and multiple punctures at ca. 1/3 the length of its body. We returned to the site at 1320 h and the snake remained coiled up in the same spot and was marginally responsive. We returned again the following morning at 0800 h and the snake was no longer present.

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***SISTRURUS CATENATUS CATENATUS* (Eastern Massasauga) AND *NERODIA SIPEDON SIPEDON* (Northern Watersnake). DIET AND FOREIGN OBJECT.** We examined the gut contents of *Sistrurus catenatus catenatus* (N = 13) and *Nerodia sipedon sipedon* (N = 17) found dead on a highway in Magnetawan First Nation, Ontario, Canada between 1 May and 31 August 2013. Necropsies determined that 5/13 (38.5%) *S. c. catenatus* and 3/17 (17.6%) *N. s. sipedon* had prey within their digestive systems. For *S. c. catenatus*, all identifiable prey items were parts of small mammals (fur, paws, and bones; average wet mass = 13.64 g), excluding a single adult *Opheodrys vernalis* (Smooth Greensnake), found in the gut of a juvenile *S. c. catenatus* (body size of both snakes could not be measured due to vehicular damage). Prey items identified from *N. s. sipedon* were both fish (whole, scales, and bones; average wet mass = 9.1 g) and unidentified small mammals (bones, tissue, and fur; average wet mass = 8.4 g). A similar (*S. c. catenatus*) or lower (*N. s. sipedon*) percentage of snakes we collected on a roadway had prey within their digestive tracts when compared to previous field studies that examined gut contents in individuals of these snake species collected from sites not associated with roads (Keenlyne and Beer 1973. J. Herpetol. 7:383–384; Shepard et al. 2004. Am. Midl. Nat. 152:360–368).

Both the presence of small mammal fur within *N. s. sipedon* and an *O. vernalis* within a juvenile *S. c. catenatus* are noteworthy as although these prey items have been documented previously, they are uncommon (Rowell 2012. The Snakes of Ontario: Natural History, Distribution, and Status. Art Bookbindery, Winnipeg, Manitoba. 411 pp.). However, an even more interesting item recovered from the necropsies was a fishhook (4.4 cm long) found within the intestines of a male *S. c. catenatus* (Fig. 1). The fishhook appeared to be a small J-hook with barbed end, typically used for fishing with bait. The fishhook had considerable corrosion, either from exposure to water or as a result of the stomach acid of the snake. The diet of adult *S. c. catenatus* is thought to consist predominately of small mammals; however, fish, crayfish, and amphibians have been documented as prey (Rubio 2010. Rattlesnakes of the United States and Canada. ECO Herpetological Publishing & Distribution, Rodeo, New Mexico. 307 pp.; Ernst and Ernst 2011. Venomous Reptiles of the United States, Canada and Northern Mexico. John Hopkins Univ. Press, Baltimore, Maryland. 352 pp.). As fish are known prey of this species, the snake may have inadvertently ingested the hook while consuming a living or dead fish previously hooked on a fishing line. Partially digested prey, consisting of mammal hair (wet mass = 10.74 g), was also recovered from the gut of this *S. c. catenatus*. The snake appeared to be in good body condition and the presence of relatively fresh prey in the gut suggests that it was still actively feeding despite having a fishing hook lodged in its intestines. To our knowledge this is the first documented account of a fishhook being recovered from the digestive system of *S. c. catenatus*.



PHOTO BY P. MOLDOWAN

FIG. 1. A small fishhook with barbed end (4.4 cm in length), typically used for fishing with bait, found within the gut of a *Sistrurus catenatus catenatus*.

We thank Jen Baxter-Gilbert, Geoff Hughes, and Liv Monck-Whipp for their field assistance and students in the 2013 Laurentian University herpetology course for their laboratory assistance. Financial support for this research was provided by Magnetawan First Nation, Laurentian University, the Ontario Ministry of Natural Resources and the Ontario Ministry of Transportation. All research was conducted under an approved Laurentian University Animal Care Committee protocol, and authorized by Magnetawan First Nation's Chief and Band Council and the Ontario Ministry of Natural Resources.

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***SISTRURUS TERGEMINUS EDWARDSII* (Desert Massasauga). DIET.** Massasaugas feed on a variety of prey, including invertebrates, frogs, lizards, and small mammals (Campbell and Lamar 2004. Venomous Reptiles of the Western Hemisphere. Comstock Publishing Associates, Ithaca, New York. 870 pp.), and their diet varies across their large geographic distribution. *Sistrurus catenatus* (Eastern Massasauga) feeds primarily on small mammals, while *S. tergeminus* (Western Massasauga) includes more lizards in the diet (Werler and Dixon 2000. Snakes of Texas. University of Texas Press, Austin. 437 pp.; Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Institution Press, Washington D.C. 668 pp.). At ~ 0030 h on 9 August 2014 we found a recently road-killed *S. tergeminus edwardsii* on U.S. Hwy 90, 17.3 km SE of Valentine, in Presidio Co., Texas, USA (30.48109°N, 104.36359°W; datum WGS84). Upon dissection the snake was found to contain two partially digested individuals of *Aspidoscelis inornata* (Trans-Pecos Striped Whiptail). To our knowledge this species is a novel prey item for *S. tergeminus* (Greene and Oliver 1965. Herpetologica 21:226–228; Werler and Dixon 2000, *op. cit.*; Ernst and Ernst 2003, *op. cit.*; Campbell and Lamar 2004, *op. cit.*). The snake and lizards were collected and deposited as SRSU 6616.

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***STORERIA DEKAYI* (Dekay's Brownsnake). DIET.** *Storeria dekayi* is a small North American natricine snake that preys predominantly upon slugs and earthworms (Judd 1954. Copeia 1954:62–64; Gray 2013a. Herpetol. Rev. 44:527). Snails have also been reported as prey items of *S. dekayi* (Surface 1906. Pennsylvania Dept. Agric., Div. Zool., Monthly Bull. 4:114–208). However, observation of snails or their remains in the diet of free-ranging *S. dekayi* are scarce. In this note, I provide evidence of snail predation by free-ranging *S. dekayi* from northwestern Pennsylvania, USA.

Between 23 April and 13 June 2014, 20 fecal samples were collected from free-ranging *S. dekayi* from a site in Erie Co., Pennsylvania, USA (42.09375°N, 80.14180°W; datum WGS84). Fecal samples were placed in 70% isopropyl alcohol and examined with a dissecting microscope as per Gray (2013b. Bull. Chicago Herpetol. Soc. 48:157–165). Fecal samples from two female (SVL = 274 and 279 mm) and one male (SVL = 140 mm) *S. dekayi* each contained 1–2 jaws characteristic of snails in the family Succineidae (Fig. 1), 1–2 unidentified radulae, and plant material. The jaws of succineid snails have a median process on the cutting edge, and are unique among the terrestrial gastropods found in northeastern USA in having a relatively large squarish dorsal process (Pilsbry 1948. Land Mollusca of North America [north of Mexico], 2[2]. Acad. Nat. Sci. Philadelphia, Monogr. 3:i–xvii + 521–1113). Amber snails (*Succinea* spp.) are relatively abundant along the edge of a palustrine forest immediately west of the Erie Co. site.

No succineid shells were present in any of the fecal samples examined. In a previous study it was observed that slug shells, which are very brittle, pass through the digestive tract of *S. dekayi* intact (Gray 2013b, *op. cit.*). Therefore, if a shell or shell fragments from a succineid snail were ingested, they should have passed through undigested. Thus, it is most likely that the gastropods consumed by the three *S. dekayi* were extracted from their shells. Rossman and Myer (1990. J. Herpetol. 24:434–438) documented the process by which wild-caught *S. dekayi* extracted snails from their shells. The body of succineid snails is relatively large and barely retractable within the shell (Kerney and Cameron 1979. A Field Guide to the Land Snails of Britain and North-West Europe. William Collins Sons and Company, Ltd., London. 288 pp), offering little protection from gastropod-eating snakes. While preparing specimens for preservation, I observed that the body of succineid snails seemed to be easier to extract from their shells than snails with heliciform shells (e.g., snails in the family Polygyridae).

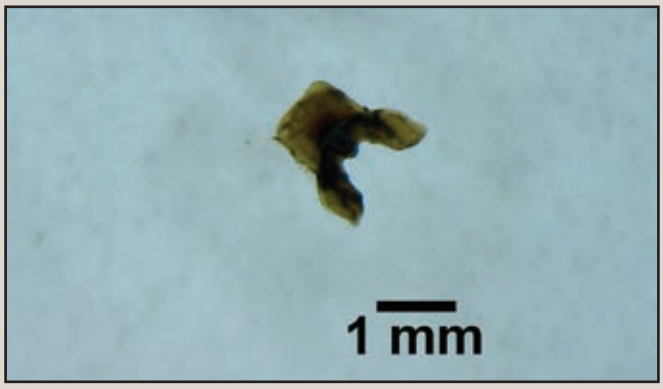


FIG. 1. A succineid snail jaw found in a fecal sample from a *Storeria dekayi*, Erie County, Pennsylvania, USA.

Storeria dekayi at this site preys predominantly on non-native slugs (e.g., *Arion hortensis* complex and *Deroceras reticulatum*) and to a lesser extent on the exotic earthworm *Lumbricus rubellus* (Gray 2013a, *op. cit.*; Gray 2014. J. N. Amer. Herpetol. 2014:28–39). The discovery of succineid jaws in three fecal samples demonstrate that these snails are also occasionally consumed and corroborate the importance of detecting this prey type using remnants of the body rather than those of the shell.

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***TELESCOPUS FALLAX* (European Cat Snake). REPRODUCTION.** *Telescopus fallax* is widely distributed in parts of the Middle East and southern Europe (Uetz and Hošek [eds.], The Reptile Database, http://www.reptile-database.org, accessed 14 June 2014). Bar and Haimovitch (2011. A Field Guide to Reptiles and Amphibians of Israel. Herzilya, Israel. 245 pp.) reported that *T. fallax* deposited clutches of seven eggs starting in June. The purpose of this note is to add information on the reproductive cycle of *T. fallax* from a histological examination of museum specimens from Israel, including the first information on timing of the testicular cycle.

A sample of 22 *T. fallax* consisting of 9 adult males (SVL = 450.9 mm ± 39.2 SD, range = 410–523 mm), 10 adult females (SVL = 460.9 mm ± 60.3 SD, range = 353–530 mm), 3 juvenile males (SVL = 359.3 mm ± 32.3 SD, range = 330–394 mm) collected 1948–2013 in Israel and placed in the Zoological Museum of Tel Aviv University (TAUM), by region was examined: HaGolan: (TAUM) 12432; HaSharon: (TAUM) 1421, 1650, 1673, 2851; HaShefla: (TAUM) 88; Shomeron (TAUM) 12858, 15281, 15728, 15732, 15735, 16482, 16709; Southern Coastal Plain (TAUM) 89, 2810, 9479, 13213; Upper Galil: (TAUM) 86; Yizreel Valley: (TAUM) 85, 1896, 3063; Yehudah Mts: (TAUM) 13618. A small slit was made in the left side of the abdomen and the left gonad was removed for histological examination. Enlarged ovarian follicles (> 4 mm) or oviductal eggs were counted only. Gonads were embedded in paraffin. Sections were cut at 5 μm and stained by Harris' hematoxylin followed by eosin counterstain. Histology slides are deposited at TAUM.

Three stages were observed in the testicular cycle (Table 1): 1) regressed, seminiferous tubules are reduced in size and contain spermatogonia with interspersed Sertoli cells; 2) recrudescence, a proliferation of germ cells occurs for the next period of spermiogenesis (= sperm formation), primary or secondary spermatocytes predominate; 3) spermiogenesis, seminiferous tubules are lined by sperm or clusters of metamorphosing spermatids. The period of sperm formation (spermiogenesis) occurred in summer and autumn (Table 1). The presence of regressed or recrudescent testes in spring with vasa deferentia packed with sperm, suggests *T. fallax* breeding occurs in the spring. The smallest reproductively active male (TAUM 1421) measured 415 mm SVL and was collected in March. It had a regressed testis, with a vas deferens containing sperm. *Telescopus fallax* males follow a testicular cycle similar to that exhibited by *Masticophis taeniatus* and *Pituophis catenifer* (reported as *P. melanoleucus*) from Utah, USA in which sperm formation occurs in autumn and mating occurs in spring when testes are regressed, utilizing sperm stored over winter in the vas deferens (Goldberg and Parker 1975. Herpetologica 31:317–322). This timing fits the

TABLE 1. Monthly stages in the testicular cycle of nine adult male *Telescopus fallax* from Israel; * = vas deferens containing sperm. These are the only vasa deferentia examined.

Month	N	Regressed	Recrudescent	Spermiogenesis
March	4	1*1*1*	1	0
April	1	0	1*	0
August	1	0	0	1*
September	1	0	0	1
October	1	0	0	1*
November	1	1	0	0

TABLE 2. Monthly stages in the ovarian cycle of ten adult female *Telescopus fallax* from Israel; * = squashed oviductal eggs could not be counted.

Month	N	Quiescent	Yolk deposition	Enlarged follicles > 4mm	Oviductal eggs
January	1	1	0	0	0
April	2	0	0	0	2
May	1	0	0	0	1*
June	4	2	1	0	1
July	1	1	0	0	0
October	1	0	1	0	0



FIG. 1. An adult *Thamnophis scalaris* and a *T. eques* found at the University Autonomus of State of Mexico. Both were found dead; the *T. scalaris* by unknown factors and *T. eques* by ophiophagy.

"aestival spermatogenesis" of Saint Girons (1982. Herpetologica 38:5–16).

Four stages were observed in the ovarian cycle (Table 2): 1) quiescent, no yolk deposition; 2) yolk deposition, basophilic yolk granules in ooplasm; 3) enlarged follicles > 4 mm; 4) oviductal eggs. The main period of female reproductive occurs in spring. The presence of one October female exhibiting yolk deposition in October may suggest some females commence ovarian activity in autumn. Clutch sizes were 5, 5, and 11. The smallest reproductively active female (TAUM 15281) measured 353 mm SVL, contained squashed oviductal eggs and was collected in May. In contrast to the report in Bar and Haimovitch (*op. cit.*) egg laying in *T. fallax* may begin as early as April (Table 2).

I thank Shai Meiri (TAUM) for permission to examine *T. fallax*, Erez Maza (TAUM) for facilitating the loan and the National Collections of Natural History at Tel Aviv University for providing samples of *T. fallax* for study.

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***THAMNOPHIS SCALARIS* (Mexican Alpine Blotched Gartersnake) and *T. EQUES* (Mexican Gartersnake). PREDATOR-PREY RELATIONSHIPS.** At Área de Conservación e Investigación Ecológica, Bordo las Maravillas, in the El Cerrillo campus of the University Autonomus of State of Mexico (17 km NW of Toluca City, México; 99.68°W, 19.4°N, datum WGS84, elev. 2614 m), on 2 June 2012 (1159 h), we found an adult *Thamnophis scalaris* (SVL = 37 cm, tail length = 9.8 cm) that had eaten a *T. eques* (SVL = 22 cm SVL, tail length = 5.5 cm), near a seasonal pond bordered with *Salix* sp. The habitat was grassland surrounded by cultivated fields. The *T. scalaris* died by unknown causes; it had an injury from which the other snake was emerging (Fig. 1). *Thamnophis* spp. are poorly studied in México and *T. eques* has not been reported as part of the diet of *T. scalaris*. Several studies have determined that *T. scalaris* feed on frogs (*Hyla plicata*), salamanders (*Pseudoeurycea bellii* and *P. leprosa*), lizards (*Barisia imbricata* and *Sceloporus aeneus*), and rodents (*Peromyscus maniculatus*; Fouquette and Rossman 1963. Herpetologica 19:185–201; Sanchez-Herrera 1980. Bull. Maryland Herpetol. Soc. 16:9–18; Lemos-Espinal and Ballinger 1992. Herpetol. Rev. 23:117; Manjarrez et al. 2007. Southwest. Nat. 52:258–262). Previous reports at the same location found that *T. scalaris* preys on *Crotalus triseriatus* and that *T. scalaris* is consumed by *T. eques* (Venegas-Barrera and Manjarrez 2001. Herpetol. Rev. 32:187 and Manjarrez et al. 2007. Southwest. Nat. 52:258–262). This observation of ophiophagy among these sympatric snakes demonstrates that the predator-prey relationship is reciprocal.

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BOOK REVIEWS

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Contributions to the History of Herpetology, Volume 1 (Revised and Expanded)

Kraig Adler. 2014. Society for the Study of Amphibians and Reptiles, Ithaca, New York (www.ssarbooks.com). [4] + 172 pp., 21 leaves of black and white plates, 27 leaves of color plates. US $60.00. Hardcover. ISBN 978–0–916984–19–9.



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I think all herpetologists know Kraig Adler, and many have received his generous help when it came to locating an obscure and ancient reference, or have been contacted by him asking about someone who, at some time, dealt with amphibians and reptiles around our places of residence. Adler's latest opus is the new edition, *aucta et reformata*, of the first volume of his *Contributions to the History of Herpetology*.

This series, which includes three published volumes (Adler 1989, 2007, 2012), began in 1989 when the SSAR and Adler presented the first volume during the First World Congress of Herpetology, held in Canterbury, England. Its formal aspects are outlined in the header of this review and on the last printed page of the book, so I will not dwell on it longer; instead, let's consider its contents. The two Latin words in the previous paragraph, *aucta* and *reformata*, were usually used by earlier herpetologists (even before the development of the word and the concept of herpetology) to indicate that the new work or edition was enhanced and revised with respect to a previous one. In fact, the main body (pages 5 to 133) is almost a facsimile of the first edition, with only few changes; the pagination is the same, and there are only two readily observable changes. One is the presence of several underlined names, a helpful reference to indicate that there is a biography related to each of them in some volume of the series, and the other is the presence of a myriad of footnotes, that frequently add valuable information to the already valuable content. Removed from the book are the sections by Applegarth (on the authors in taxonomic herpetology) and Altig (on the lineages of doctoral degrees in herpetology), both of which have been updated from the original and included in the third volume of the series, published in 2012.

The first thing that stands out is the portrait of John Edwards Holbrook which serves as the frontispiece of the book. This is complemented by a photograph, placed between the two columns of the editor's note, of Daniel Huntington, painter of the portrait, and an unnumbered color plate on page 4, consisting of four additional images of the father of North American herpetology (plus their respective captions). After this Holbrookmania, there are 42 black-and-white, full-page plates, printed on recto and verso of 21 pages, with their own pagination, scattered in the main text. The majority reproduce letters from renowned herpetologists, others show facsimiles of plates or texts of special value, and others illustrate curious, miscellaneous things, like Vaillant's diploma. In all but one case the epigraphs are a delightful source of new information, and this alone is worth the inclusion of this new edition in our libraries. Next, the Index to Biographies was enhanced to include all names from all the volumes in the series, and after that, seven pages of corrections and annotations for volumes 2 and 3 are included, mostly adjusting some dates of birth and/or death, but also including seven previously unpublished portraits and one signature.

The real wonder, however, is at the end of the book, where 54 full-color, full-page plates, numbered from 43 to 96 have been added. The selection is exquisite and the captions, as usual, very enriching. The entirety, including the 42 black-and-white plates and the additional portraits and signatures, constitutes a kind of *Thesaurus* of Adler's magnificent collection and library.

If I may digress, not long ago, while re-reading Schneider's (1799) *Historiae Amphibiorum*, I was struck by a comment of this German author that referred to the plates of "our lizards" drawn by Roesel von Rosenhof, and shown to him by his friend, Iohann Hermann. In his words, "... Learned men should pray that these plates, along with their annotations, will be published by public subscription, or by the desire of a bookseller who wanted to invest the money, not only because the genius of Roesel deserves public praise, but also because they will greatly increase our knowledge of lizards, those four-legged animals whose history other wise men and scholars already learned to admire ...." Plate 45 in Adler's new edition is palpable evidence that Schneider's desire remains valid more than two hundred years later.

A few paragraphs above I suggested that information related to one plate had a problem. This is the comment on plate 2, illustrating an individual of the Emerald Tree Boa from Surinam, taken from Linnaeus' (1754) description of the collection of the Swedish King, Adolf Frederick. Adler mentions that the specimen was collected by Daniel Rolander, and this is not so. It is true that Rolander commented on that snake under the name *Cenchris viridis*; in his words, "... a snake of large bulk, had climbed some tall trees in several places. Its head more often than not looked down. Its open jaws reveal a capacious circumference. It's said to swallow down small deer, squirrels, rabbits, small anteaters, mice and opossums. It looks like the trunks, branches and leaves of trees. And so, walking through the forest, as you touch a tree trunk, you sometimes encounter this snake at the same time. It is extremely cold, as all amphibians, and causes a chill in

whoever touches it ....” But it is also true that Rolander arrived in Surinam on June 20, 1755 (old style), and the observation on the snake was on August 1 (Rolander 2008). It is probable that Linnaeus’ (1758) comment on *Boa canina*, attributed to Rolander (the snake was “adored by the Americans”) misled Adler. An old adage says that perfection is restricted to the gods, and this misinterpretation does not alter the quality of the work.

Before concluding, I want to ask a rhetorical question. In times in which we care so much about the latest innovations, to the point that many journals make available pre-publications of their will-be articles in electronic format, is it not anachronistic not only to edit, but to re-edit a volume on the history of herpetology?

The short answer is no, it is neither an anachronism nor wasteful, although this may be considered just a matter of my personal preferences. The long answer was probably given, in the twelfth century, by John of Salisbury in his *Metalogicus* (circa 1130; see Joannis Saresberiensis 1848), when he wrote: “...Bernard of Chartres used to say that we were like dwarfs seated on the shoulders of giants. If we see more and further than they, it is not due to our own clear eyes or tall bodies, but because we are raised on high and upborne by their gigantic bigness....” The phrase has become a cliché, but the virtue of common phrases is that they frequently are tested truths (something unthinkable in science). Furthermore, since the advent of the rules of nomenclature, the past is present in all our studies. This is so because the Codes of Nomenclature, due to the inclusion of the principle of priority, are the only set of “laws,” at least that I know, that have retroactive application. Consequently, whenever we want to step forward in taxonomic studies, we must look back to 1758 and beyond. And that “beyond” goes back to the first printed description of an amphibian or reptile because, at least in zoology, although the names prior to 1758 are not valid, their content may form part of the definition of the species of which they are synonyms.

But, what is the real value of this book (and of the whole series)? Reading this first volume of compiled biographies, portraits, and signatures of 152 herpetologists, from Conrad Gessner to Avelino Barrio, is almost like spying through a keyhole (an increasingly difficult thing because fewer locks have a hole), on the how, when, where, why, and what of some of those who preceded us in order to better understand and interpret their work. These include women and men who were aristocrats who led an almost dilettante life—with amphibians and reptiles as a hobby, clergy and soldiers, peripatetic exiles who changed countries every few years, and others who never moved from their own neighborhoods; those who died young, those who reached old age, and even someone who, while waiting for a ride to the museum, was surprised by the first nuclear attack. All of which reminds me of Foucault’s (1977) concept of genealogy, of which the French philosopher wrote “...Genealogy (...) requires patience and a knowledge of details and it depends on a vast accumulation of source material. Its ‘cyclopean monuments’ are constructed from ‘discreet and apparently insignificant truths’ and according to a rigorous method (...). In short, genealogy demands relentless erudition...” This book illustrates this well.

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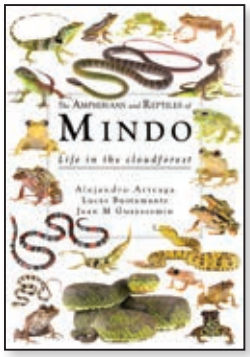
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The Amphibians and Reptiles of Mindo: Life in the Cloud Forest

Alejandro Arteaga, Lucas Bustamante, and Juan M. Guayasamin. 2013. Serie de Publicaciones Científicas 1, Universidad Tecnológica Indoamericana, Quito, Ecuador (www.tropicalherping.com). [6] + 3–257 pp. Hardcover. US $59.00. ISBN 978-9942-13-496-7.

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I have always been a fan of herpetology books. I enjoy reading them carefully and evaluating and critiquing their content, often in the pages of *Herpetological Review*. Only a few times in my experience have I found a book that is a jewel… an impeccable book (because such thing as a perfect book does not exist)—a book that inspires and reminds you why you are drawn to herpetology in the first place. This book has clear but entertaining text, excellent images, and exquisite design. In other words, it is a masterpiece!

The book is the work of three young friends whose careers I have followed since the beginning. Two of them, Alejandro Arteaga and Lucas Bustamante, are still in their early 20s. I have had the great fortune to be with them in the field and to see the efficiency with which they work. It is a pleasure to see their work come to fruition in this book about a herpetological community in the cloud forests of Mindo, in western Ecuador.

The book cover is an attractive compilation of images of reptiles and amphibians of Mindo, all on a white background. This is a common presentation for all photographs in the book. The authors, who are known as superb herp photographers, have chosen, for mostly taxonomic reasons, to illustrate every species on a white background, avoiding the distraction of other elements, and focusing the reader on the subject of the account.

The book starts with a foreword by Jonathan Losos, a well-known herpetologist from the Museum of Comparative Zoology at Harvard. Alejandro Arteaga, the first author, follows with a preface explaining the motivation behind the book. The acknowledgments are worthy of note as they are presented on a beautifully designed page (p. 7) with the name of each colleague appearing at a size proportionate to the importance of his or her contribution. Following this is the Introduction, including some tips for herping in Mindo (usable throughout the tropics), and how to identify herps. This is facilitated by illustrations showing the salient features of amphibians (fig. 2), the groin pattern in rainfrogs (fig. 3), the principal scale types of lizards (fig. 4), the dewlap coloration of anoles (fig. 5), and the basic terminology for snake scalation (fig. 6). An explanation about the plan and use of the book is found afterwards.

Each species account includes several paragraphs as follows: recognition of the species (size, coloration, characteristic features), natural history, local and general distribution, conservation status, etymology (they make an extraordinary effort to show the origin and meaning of the scientific names, which I deeply appreciate and enjoy), and when significant, taxonomic notes. This is the only book I know where each account has been so carefully cone that all reviewers that contributed by commenting or correcting are named (superfluous perhaps, but an indication of the care taken by the authors). Lastly all references are cited in order of appearance through the text, where they are numbered.

The description of coloration deserves explanation. The authors decided to use a palette of colors like that used by a painter. Descriptions of coloration are commonly so subjective that a purplish green can be also greenish fuchsia depending on the eye and the experience of the descriptor. To avoid this, they present a visual reference showing the amount of variation in their "painter's palette," which I see quite useful.

A short but well-informed section is devoted to the study area, putting Mindo and its surroundings on the map, and commenting about its touristic importance.

101 species of herps are included in this book. First are amphibians. The first photo, one of *Atelopus longirostris*, a species considered extinct, looks somewhat strange. Alejandro Arteaga explained that it was a preserved individual, for which the eye was digitally manipulated to give a more life-like appearance. Illustrations, all exquisite, of extinct or critically endangered amphibian species (*Atelopus mindoensis*, *Rhaebo caerulostictus*, *Cochranella balionota, Strabomantis helonotus, S. necerus, Hyloxalus lehmanni, Gastrotheca guehtheri*) were made by Rita Hidalgo or Silvia Cevallos.

Some interesting new information is embedded in the accounts. About *Epipedobates darwinwallacei*, there are two interesting points. One is that the females are the ones carrying the tapoles (which has only been reported in *E. anthonyi* and *E. tricolor*, Lötters et al. 2007), but the authors do not give any reference about this. The second is that the tadpoles are cannibalistic! The reference is the field notes of Alejandro Arteaga. As it is an interesting rarity within Dendrobatidae (only corroborated for *Dendrobates* (*Ranitomeya*) *imitator* and *D.* (*R.*) *variabilis*; J. C. Santos, pers. comm.), this aspect should be further commented on or better explained.

I really like plates with several individuals depicting the intraspecific variation, like that for *Pristimantis hectus*. However, the authors do not comment if the individuals are depicted at the same scale. The same applies on page 152 for a composite plate of the snake *Atractus dunni*.

Among the reptiles, the authors state that *Basiliscus galeritus* is omnivorous, feeding on invertebrates, fishes, seeds, and fruits. I observed a subadult basilisk in Itapoa, Esmeraldas Province, preying upon and almost swallowing an adult *Pristimantis* sp., suggesting an even broader diet. For a few figures the captions are incomplete, as on page 129: "Adult *Anadia rhombifera* from" (locality lacking). This also happens on page 137 for *Anolis aequatorialis*. Although I appreciate the excellent photography, it seems that in some cases the selected photographs are not sufficient to show the most striking characters of some species. When certain characters are the only ones that can externally distinguish close relatives, those characteristics must be depicted. In the case of *Anolis lyra*, I really wanted to see the "lyre-like" mark on its back of the head; in the case of *Dendrophidion clarkii*, the nuchal collar, which is the only easy character to separate it from *D. graciliverpa*, it is not clearly visible. Also, I would like to see the "anchor-like" mark on the back head of *Micrurus anchoralis* more clearly.

The authors do not use the family Dipsadidae, despite its proven evolutionary value (Zaher et al. 2009; Pyron et al. 2013). The distribution of *Erythrolamprus epinephelus* also includes Costa Rica, which is not included in the distribution section. However, many authors are clear that subspecies of this highly polychromatic species deserve full species status, and thus, Costa Rican and Ecuadorian *epinephellus* would be different species (*juvenalis* for Costa Rica and *albiventris* for western Ecuador; Dixon 1983). That last comment applies for many amphibians and reptiles.

With the snake *Saphenophis boursieri*, I could not see the white postocular stripe mentioned in the Recognition section for the depicted specimen, but rather a black one! The white I see is a labial bar continuing to the throat (all spotted with black). There is no mention of ventral patterning (except for the photographs that illustrate the throat and tail). I do not personally know this snake and thus, I cannot be sure if the specimen photographed is aberrant, or if the text is misleading. The *Tantilla* "*melanocephala*" depicted is indeed very different from those I have seen in other Neotropical countries, and, as the authors comment wisely, surely a species complex. When representing *Urotheca lateristriga*, a small and harmless snake, the authors say that they are rarely fatal to humans. This means that even in rare cases, there are deaths due to this snake. Such assertions should be further discussed or at least referred to some authoritative paper.

The maps constitute a real plus for this book. Not only are they neatly prepared, but they also include all localities known and the potential area of distribution is illustrated for species represented by more than 10 localities. However, being a book

about Mindo, a very discrete area, I believe in a future edition the authors can add a local map, like the one on page 28, with precise localities for all species. In the distribution section, however, they mention all known localities in Mindo where the species have been seen.

I usually do not deal with common names, but I am trying to advocate for a change in them. It has been very popular to call the Terrarana "rainfrogs." However, terraranans are direct developers and breed on land and often vocalize when there is no rain. The straight translation of Terrarana is landfrog, and they should be called by this common name (Barrio-Amorós et al. 2013). To choose common names can be tricky and in some cases there are odd results. For example, I would like to know why *Pristimantis laticlavius* is called in English "Bacon Rainfrog." Is it tasty? Another strange common name is the "Spring Rainfrog"—why Spring? There is no such discrete season in the tropics. This problem also occurs in Spanish. If the authors call *Pristimantis nyctophyllax* "Cutín celador," what vernacular name would they apply to *Pristimantis celator*? If new common names are coined by the authors, they should explain them in the etymology section. I do acknowledge, however, the difficulty of selecting useful common names for animals that are rarely going to be referred to by non-specialists. I did it too in my work on Venezuelan amphibians (Barrio-Amorós 1998) and it was a nightmare!

Something I have not seen before is the synergy of an internet web page (www.tropicalherping.com) with the book itself. There are complementary data, like the recorded calls of 33 species of amphibians that are shown on the web under each species account.

Despite all the positives, I also have a few complaints. Figure 1 is a schematic habitat drawing with various microhabitats indicated by small letters. In order to determine which species occur in which microhabitats one must scan down a list of more than 100 taxon names. This is cumbersome; an alternative might be to number each species and provide a list of numbers corresponding to each microhabitat.

In figure 2, the principal identification features for amphibians are illustrated on a number of different drawings. These could be more effectively combined and illustrated on just one or two stylized frogs. Also, the letter "ñ" is used in figures 1, 2, and 6; this letter does not occur in the English alphabet, and, with small print, resembles "n," which is also used in these figures. In each chapter, the figures start again with number 1, rather than being numbered continuously. This is confusing as there are four figure 1s (five including the one in the addendum describing a new species of *Pristimantis*).

There are some inconsistencies in citations; for example, author names and dates that appear in the text without parentheses; for example: Savage 2002, rather than Savage (2002) or (Savage 2002).

As a herpetology book, *The Amphibians and Reptiles of Mindo* stands out for its beautiful design, white background photography of all 101 species in the area, clear and informative text, and a manageable size and weight. However, it is not usable in the field. A second edition could be improved by printing on waterproof paper. Dichotomous keys and a more in-depth treatment of tadpoles as well as a short chapter dealing with the prevention and treatment of snakebite would also be desirable.

Also, some vital data are missing in my opinion, specifically the type locality of each species. In an area where new species resembling known forms might be expected to be found, this is important to help determine which population represents the described form.

The book includes the description of a new species of landfrog (or rainfrog), *Pristimantis mindo*, in an addendum by Arteaga, Yanez-Muñoz, and Guayasamín. Although I prefer well-known journals for such actions, the presence of this description does not bother me. It has been made with great accuracy; it is very detailed, based on a suitable number of specimens, appropriate comparison with similar species, bioacustic and genetic data. The only minor detail that the authors seem to forget is to give common Spanish and English names, to be consistent with the rest of the book.

I like the efficient use of technical words. This could be a little off-putting to non-specialist readers, but there is a glossary at the end of the book to solve this potential issue. However, not all terms appear at the glossary (e.g., scutcheon, holocrine, cathemeral, cryophobic, molluscivorous, lumbricophagous, etc.). The glossary is followed by an impressive list of 1935 references—one of the most complete I have seen for a small book like this. Finally, the last pages introduce the authors in a humorous way, complete with their "scientific names" and funny photographs.

With the kind of data presented in this book, the general area of Mindo, a great touristic attraction for those looking for adventurous activities as well as relaxation (plus one of the best bird watching areas in the world), will be now a top destination for herpers, thanks to the detailed work of the young authors of this book. I only hope a second edition incorporating the potential improvements suggested above will be possible. This book will be a real jewel in any herpetologist's library.

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Sound Guide of the Calls of Frogs and Toads from Southern Brazil and Uruguay

Axel Kwet and Rafael Márquez. 2010. Alosa, Barcelona, Spain (www.sonidosdelanaturaleza.com). 2 audio CDs + 56 pp. booklet. €11.90 (approx. US $14.65). ISBN 978-84-613-8920-9.



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Bioacoustics has long been an interesting field of study for herpetologists. Calls are one of the most characteristic traits of anurans, perceived and used to distinguish species well before the animals themselves are spotted. Although many field herpetologists carry a recorder as a mandatory piece of equipment, the recorded calls of many species are still not available. The *Sound Guide of the Calls of Frogs and Toads from Southern Brazil and Uruguay* compiled and edited by Axel Kwet and Rafael Márquez, advances our knowledge of the anuran calling repertoire.

This guide presents the calls of 109 anurans, although 16 of the species were undescribed and/or uncertain as of 2010 when the guide was published. The calls are divided into two audio-only compact discs: one with 55 species belonging to the family Hylidae, and the other with 54 species belonging to ten additional families. Each species is represented by a single track, generally divided into different cuts with overall good quality recordings. The listener can follow the tracks and their cuts using a color print booklet provided with the audio CDs. The booklet, 56 pages long, contains scientific name (ordered by species group at the genus level), photograph, distribution map, and natural history information for each species. The photographs provided are small, but this is to be expected for a sound guide. The maps are very simple but somewhat confusing because of the recurrent change of scale, but they are still a nice addition for this type of publication.

The level of detail for the calls is noteworthy. First of all, more than one cut is presented for most species, stating, for example, the social context in which the call was emitted and/or emphasizing when more than one type of note occurs. Thus, even if the call is not sufficiently understood to receive a definitive classification (Toledo et al. 2014), the guide provides a valuable starting point for natural history and behavior studies. Moreover, additional descriptions are given in the audio and/or booklet, for instance, background noise, different species participating in the chorus, air temperature, time of recordings and type of recording filter, factors that may influence the calling activity of frogs and the quality of the recordings.

The accessibility to the text is very convenient. Every piece of information is given in English, Spanish, and Portuguese, which is great for use in undergraduate courses, where students might not be comfortable with the English language, as well as anybody else that may fall into this category. Although there is not an upfront definition of the bioacoustic terms used throughout the booklet, the language is intuitive and accurately utilizes the scientific terminology of this field.

At least four other sound guides for Brazilian species have been published (Atlantic Forest domain: Haddad et al. 2005, Toledo and Haddad 2011; Cerrado, Campo Rupestre, and Pantanal domains: Toledo et al. 2007; Rio Claro Farm, São Paulo state: Maffei and Ubaid 2014), but each of these contain 76 species at most. At the same time, this is the first sound guide for frogs in Uruguay, including over 30 out of 48 known anurans (Maneyro 2012), which is a huge contribution to the field of herpetology in that country. Furthermore, the geographic range of almost 20 species included in the guide extends to northern Brazil, as well as Bolivia, Paraguay and Argentina. The result is a comprehensive overview of frog calls from habitats on the border between Brazil and Uruguay (e.g., coastal dune zone and grassland; Maneyro and Kwet 2008), and also from a variety of habitats throughout Brazil, Uruguay, and additional countries.

Although some open access websites make frog calls available (e.g., AmphibiaWeb), the content is usually not as detailed or standardized across researchers. In this guide, in particular, most of the 109 species were recorded by Axel Kwet, which diminishes the recording setting and equipment variation. In conclusion, the *Sound Guide of the Calls of Frogs and Toads from Southern Brazil and Uruguay* is a well-done and welcome project. Because this guide was released in 2010, we believe that within a few years it would be promising to have an updated — and maybe interactive—sound guide, incorporating the resolution of the undescribed and/or uncertain species. This would represent an even more useful contribution to South American herpetology to which the scientific editors Kwet and Márquez are clearly committed.

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Amphibian Conservation: Global Evidence for the Effects of Interventions

Rebecca K. Smith and William J. Sutherland. 2014. Pelagic Publishing, Exeter, United Kingdom (http://www.pelagicpublishing.com). xviii + 276 pp. £29.99 (approx. US $47.00). Softcover. ISBN 978-1-907807-85-5.



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Almost everyone now knows that amphibians are in trouble. Some concerned individuals are in positions to stem or even halt declines in the areas in which they work or live. Many simply want to help. However, conservation of amphibians is complicated, many sided, and must be approached from many different angles. People involved in the movement, especially those not trained in conservation biology, need guidance to help them solve their specific problems and meet their goals. This book joins the procession of books and documents offering practical information that can direct positive actions on the ground.

The authors of this book used an evidence-based approach to aid biodiversity conservation. This approach uses current best evidence to make decisions about, in this case, amphibian conservation. The umbrella organization is the Centre for Evidence-based Conservation (CEBC, www.cebc.bangor.ac.uk) in the United Kingdom. CEBC is a source of advice on evidence-based practices and coordinates the Collaboration for Environmental Evidence program. Program staff help others to undertake systematic reviews on issues of concern to policy and practice in a variety of fields. Systematic reviews of specific conservation interventions that have had proven benefits are their primary tools to support projects that rely on the decision-making process. "Intervention" appears to mean actions taken to thwart a particular type of threat (e.g., agriculture). It is equivalent to "management guidelines" in the Habitat Management Guidelines (HMGs) series produced by Partners in Amphibian and Reptile Conservation (PARC, www.parcplace.org), a conservation NGO based in the United States. This book is a synopsis of the result of a global search of the amphibian conservation literature, including dissertations, theses and available gray literature.

This small book (234 x 156 mm) is one in a series entitled *Synopses of Conservation Evidence* produced by the CEBC. Others have been published on bee, bird, farmland, and bat conservation. The authors of this book summarize evidence relevant to the practical conservation of amphibians to provide a global list of interventions that could benefit amphibians (from the information page that accompanied the review copy). They claim the book is a thorough summary of what is known, or not known, about the effectiveness of amphibian conservation actions across the world. The target audience includes land managers, conservationists in the public or private sector, farmers, campaigners, consultants, policymakers, and researchers and land owners seeking to protect local wildlife. The book is based on scientific conservation literature derived from complete series of 18 herpetology journals (but not *Herpetological Review*), 30 conservation journals, and web searches using ISI Web of Science and Google Scholar. To be included, the paper must report an intervention actually applied in the field and subsequently monitored quantitatively. The authors found 416 studies that met these criteria.

The book's outline and chapter titles are based on the International Union for the Conservation of Nature (IUCN) Unified Classification of Direct Threats (www.iucnredlist.org/technical-documents/classification-schemes/threats-classification-scheme). However, understanding the book's organization requires some effort. Each of the first ten chapters focuses on a particular threat (e.g., transportation and service corridors, pollution, climate change and severe weather). These are followed by four chapters with general headings (e.g., Habitat protection, Species management). A shaded box that begins each chapter includes a brief statement about the threat and where it is addressed in other chapters. A list of "Key messages" (= interventions) follows with a single sentence or a paragraph that briefly summarizes results of the literature search. These messages (interventions) then form the titles of a series of individually-numbered sections with their own bulleted summaries followed by a background box and a single paragraph or several pages of text. Boxes and text sections that include references to particular papers are followed by their own literature cited list. Each paragraph in the text section summarizes information in one published paper. The information in these paragraphs includes methods and numeric results but no conclusions or how the reader should interpret the results. Each paragraph starts with phrases such as "A before and after study… found that", "A review … found that", and "A controlled, before and after study … found that." Not much writing creativity here. The last four chapters based on IUCN Classification of Conservation Actions start out as just described, but additional text is added on anurans and/or salamanders, as well as selected, mostly European, species. Paragraphs summarizing each study in these sections are structured as above.

Some of the chapters contain extensive text and numerous citations. Others contain no useful information. For example, Chapter 6 on the threat of human intrusions and disturbance has one preselected intervention: "Use signs and access restrictions to reduce disturbance" and a sentence noting they found no literature-based evidence on this topic. The intervention and the note in Key messages are repeated verbatim in the section just below it. The authors would claim that including topics lacking literature is useful. But why is there only one intervention and why this one? There are many other ways humans intrude on amphibian habitats that could have been included. Several management guidelines in the PARC HMGs would have nested nicely in this chapter. However, I assume they did not use the HMGs because as yet no publications include results of monitoring studies.

Chapter 3 on the "Energy production and mining" threat contains a single intervention that fits one species in a restricted location. The Kihansi Spray Toad (*Nectophrynoides asperginis*) in Tanzania is critically endangered from loss of habitat below a hydroelectric dam that blocked the montane stream and eliminated 90% of the spray zone. The authors cite one before-and-after study that describes the effectiveness of a sprinkler system installed to aid the toad's recovery. The single intervention included in this chapter, "Artificially mist habitat to keep it damp," might be appropriate in this and perhaps a few other similar locations, but it is not useful to a global audience as implied.

The lack of information on how to apply the interventions and information in this book to conservation issues in specific habitats weakens the book's usefulness. The authors do note the synopsis is not intended "to make decisions for you" but provide support for those decisions. But how can land managers, land owners, and others in their list of target audiences interpret the information in this book for their conservation projects without guidance from professional conservation biologists or ecologists? For this reason the book's usefulness will be limited to those who understand the science and are able to interpret the interventions for on-the-ground actions.

Several minor points should be mentioned. Chapter 5 (Threat: Biological resource use) was omitted from the review copy, and even from the Table of Contents, but this was apparently a printing error and has been rectified in copies subsequently distributed. No reviewers were acknowledged. Some of the writing would have benefited substantially from their edits. There is no summary or conclusions chapter. The pricing structure seems unusual. Why would anyone buy the hardback version of this book for US $114.99 when he could have an electronic version for US $16.99? The paperback version is more affordable, but in my view is still overpriced for what you get. One can also download individual interventions on a searchable database (www.conservationevidence.com), apparently for free.

The practical interventions and associated background literature are useful contributions to conservation and management efforts on behalf of amphibians. I found many publications of which I was not aware. The authors deserve credit for conducting the extensive literature search and providing summaries within the intervention (management guidelines) context. Unhappily, as Roger Conant would say, they fell short of their goal to provide information readily understood by a broad audience. I would recommend this book to practicing conservation biologists but not to consultants (unless well trained), campaigners, farmers, land managers, policymakers, or private land owners.

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The Biology of Chameleons

Krystal A. Tolley and Anthony Herrel (eds.). 2014. University of California Press, Berkeley and Los Angeles, California, USA, and London, United Kingdom (www.ucpress.edu). xii + 275 pp. Hardcover. US $65.00. ISBN 978-0-520-27605-5.



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The content of this book exceeds its title remarkably. *The Biology of Chameleons and its Morphological, Physiological, Paleontological and Evolutionary Basis*, though cumbersome, might be more appropriate. The book comprises 10 chapters written by authors who are well respected in their special fields. The subjects of these chapters, apart from the introductory one, are: (2) anatomy, (3) physiology, (4) function and adaptation, (5) ecology and life history, (6) sensory systems and communication, (7) evolution and biogeography, (8) systematics, (9) fossil history and (10) conservation—truly a wide array of topics!

Chapter 1, written by the two editors, is a mere introduction to the following chapters, but the great fascination Krystal Tolley and Anthony Herrel have for chameleons is clearly discernable. The first and overall impression of this book is certainly excellent, and the list of contents looks absolutely complete. However, some comments may nonetheless be warranted. These concern some suggestions on what has been overlooked, mainly in respect to certain literature references which I regard to be important, and thoughts and interpretations on some aspects which, in my view, have not been fully discussed or synthesized.

An example of a missing reference concerns the paragraphs *Microstructure* (p. 39) and *Ear* (p. 45) in Chapter 2. A very recent detailed study by Marlene Spinner (Spinner et al. 2013) if already available to the editors (they did cite other papers from 2013), would have been a useful addition. Another matter of citation is the correct information that the apical structures of chameleonid hemipenes may vary not only ontogenetically but also seasonally (p. 54). This is credited to Klaver and Böhme (1986), however, it was first mentioned and documented by Böhme (1988), a title not cited in the book.

An example of the second point is seen in the paragraph about the *Ear*. Here, I find no mention of the "Cranoliti" (calcified endolymphatic sacs in the otic region) described in detail by Siebenrock (1893) for *Brookesia superciliaris*. These were described in the same paper as the uniquely derived structure of the vertebral column, which Siebenrock stated would only be understood when the biology of this chameleon was better known. In the meantime, we have had the opportunity to learn much more about the biology of *Brookesia*, one aspect of which, "freeze and roll" antipredator behavior, is discussed in Chapter 6 (p. 127) of the present book. However, a direct link between the endolymphatic system, the aberrant vertebral structure and this behavior in *B. superciliaris* has not been made. As has been argued in an earlier paper (Böhme 1982), the "Cranoliti" seem to function as a static organ, since calcified endolymphatic sacs are restricted to lizards with a climbing life style (Kluge 1967; Moody 1980). In *Brookesia*, a cataleptic antipredator mechanism (freeze and roll) should be directed against visually—rather than olfactorially-oriented enemies, i.e., against birds with strong visual accommodation capabilities rather than against scent-sensitive carnivorous mammals or even tongue-flicking snakes. So, when a prey item such as a *Brookesia* abruptly stops moving and thus disappears from the bird's visual field, the predator will well try to check with some pecks whether the now motionless object is edible or not. And here, the double-protected vertebral column of *Brookesia* can be life-saving only if the chameleon orients this heavily ossified backbone, and not the vulnerable flanks or belly, towards the predator. That the calcified endolymphatic system can actually work as a static organ in the context of the cataleptic freezing behavior, was corroborated by Schmidt et al. (1989) in both wild and captive *Brookesia*. When grasped by a bird bill, many *Brookesia* species exhibit a high-frequency body vibration which is likely to affect a bird, with its pneumatisized skull bones, more than other potential predators (Böhme 1982). In the book by Tolley and Herrel (p. 112), the generalist feeder *Brachypteracias leptosomus* is listed as a bird that searches the leaf litter for *Brookesia*. This species would be the ideal candidate for an experimental *in situ* test of the above hypothesis.

The short paragraph on "Sexual dimorphism: body size and ornamentation" (p. 126) also misses some interesting correlations. It is only stated that sexual size dimorphism (SSD) is either female-biased or male-biased, and ornamentation is dealt with separately. However, there is a clear interconnection between male-biased SSD and head ornamentation in that males in species with head ornamentation are markedly larger than in those without such ornamentation. The best examples are the horned species of *Trioceros* in Africa, where the adorned males are always considerably bigger than the corresponding females. Within the Cameroon radiation of *Trioceros*, in the so-called *T. cristatus* group, in the horned species *T. quadricornis, T. montium,* and *T. pfefferi,* the male grows much larger than the female, but the opposite is true in the hornless *T. cristatus* in which the female grows much bigger than the male (for data see Klaver and Böhme 1992). The same is true for the East African horned species. The same principle also applies in the genus *Chamaeleo* where horns are functionally replaced by an extremely high casque in, for example, *C. calyptratus* males, which are much larger than conspecific females. Conversely, in casqueless species of the *C. dilepis* complex, most extremely in *C. roperi*, adult males are really dwarfs in respect to females. An even more comprehensive correlation between ornamentation and hemipenial structure has been discovered: species with ornamented males tend to have similar hemipenes while those resembling each other in external morphologically, show deep divergences in hemipenial structure (Ziegler and Böhme 1997, fig. 113). This means that female choice depends on the external form of males (i.e., a pre-mating signal) in the first case, but on hemipenial structures in the other.

This aspect leads directly to the question brought up on page 130, viz., "whether the degree of different visual signals (coloration, ornamentation, and behavior) among closely related species is positively related to the number of sympatric species." Here, the paper by Rand (1961) should have been cited, since it already demonstrated that there is no sympatry (or more precisely, no syntopy) of chameleon species in East Africa with identical head ornamentation (in this case, three horns). Likewise, Parcher (1974) demonstrated experimentally in Madagascar that males with head ornamentations artificially removed are no longer recognized as conspecific by their respective females. In another study it was shown that in cases of emerging syntopy, males of a horned species will reduce their horns when a second horned species expands into its range and habitat; this character displacement can be demonstrated to have occurred in a sequential fashion, due to historical climate change (Böhme and Klaver 1981).

My next remark concerns the chapter on systematics. The listing of species in the generic arrangement follows the most recent revisions, it is, however, not always consistent. As an example, *Trioceros eisentrauti* is still listed on Table 7.1 as a valid species, but is missing in the enumeration of *Trioceros* species on p. 171, obviously because it was downgraded to a subspecies of *T. quadricornis* by Barej et al. (2010). Here it becomes clear that it was disadvantageous to leave all subspecific taxa out, because the current checklists (Mertens 1966; Klaver and Böhme 1997) demonstrate how many taxa originally described as subspecies subsequently received full specific rank. This also concerns the taxon *quilensis* Bocage, left out in this book obviously because the editors regard it as conspecific with *C. dilepis*. That it has a hemipenial ornamentation dramatically different from that of *C. dilepis* has been demonstrated by Ullenbruch et al. (2007). This may also have relevance for the color figures 1.3 and 8.5, which show the same individual of "*Chamaeleo dilepis*." However, due to its small rudimentary neck flaps, this specimen is certainly not true *C. dilepis*, but rather—if South African (the locality is not mentioned)—*C. quilensis*, underlining my statement above.

I should like to add here that the etymology given for the name *Chamaeleo* (or *Chamaeleon,* respectively) as derived from ancient Greek and meaning "ground lion" does not gain more sense and probability by repeating it again. Rather, the alternative etymological derivation from the old Semitic word "gamal" (camel) with the diminutive ending "-ún," i.e., "gamalún"—little camel by Keller (1913) should also be considered. The dorsal hump of resting chameleons (see, for example, figs. 8.4. and 8.5. in the present book) indeed resembles a little camel much more than a terrestrial lion (Keller 1913; Böhme 2011), although the Greek "chamai" may also mean "dwarf" or "dwarfish" instead of "on the ground."

Finally, just a few comments on the list of references. It is clear that the great majority of titles of this rather complete bibliography are in English, but is inconsistent in respect to other languages cited. In several German, French, Spanish, Portuguese, etc. titles the name of the respective language is added in parentheses, but in others not; I regard this as unnecessary because it is self-explanatory when reading the title itself. Some references missing in this list and, in my view worthy of being cited, have already been discussed above. In some citations the titles are incorrectly reproduced, in other instances the journal names have errors. For instance Moody's (1980) thesis is cited as "The phylogenetic relationships of taxa within the lizard family Agamidae" but the correct title is "Phylogenetic and historical biogeographical relationships of the genera in the family Agamidae." Parcher (1974), is said to have been published in "Zeitschrift für Tierzuchtung und Zuchtungsbiologie (sic!)" (a journal for breeders of domestic animals!) instead of "Zeitschrift für Tierpsychologie" which is the famous forerunner of "Ethology," where it actually appeared (although the volume number and pages are correct). Klaver, C. and Klaver, C.J.J. are treated as two different authors in this list although they refer of course to the same person who, according to the acknowledgments, together with Bill Branch reviewed the systematics chapter of this book.

Despite these small corrections, amendments, and additions, the present book by Tolley and Herrel is a great achievement in chameleonology. It will certainly have a great influence on future research on these fascinating creatures, and it will be nice if my comments above on some evolutionary aspects will also stimulate some further discussion.

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ZOO VIEW

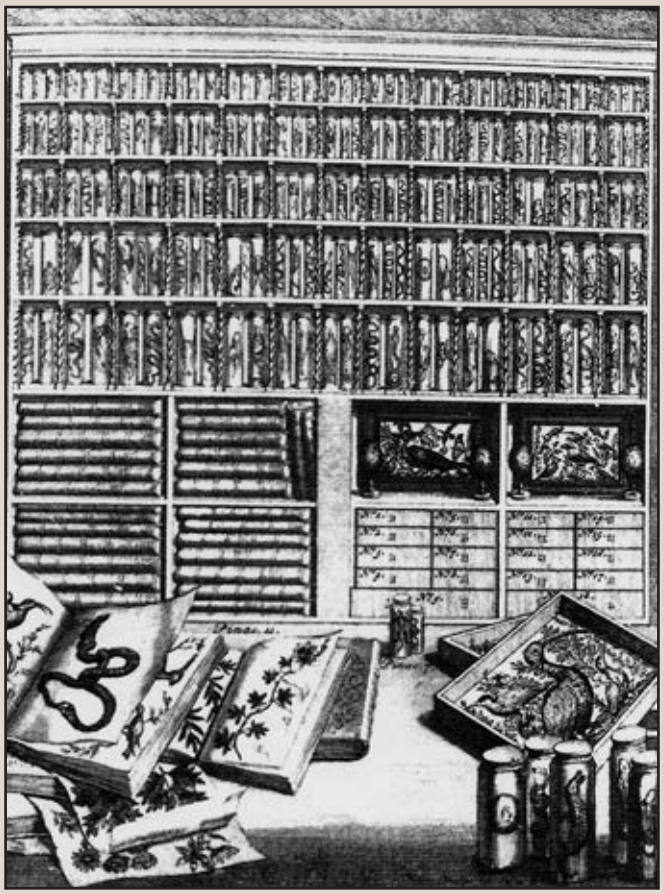
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Studies on Non-venomous Colubrid Snakes and a Few Other Families in Zoos and Aquariums

> So general is the repugnance of mankind to the animals composing these classes, that their study has been overlooked, and they have usually been considered as beings which it was not only necessary but meritorious to destroy. A part of this vulgar prejudice is derived from education, and perhaps some of it may originate from the fact that several of them are furnished with venomous fangs, capable of causing intolerable sufferings and death. To the naturalist and physiologist, however; to those who study nature through her various modification of form and structure, they present some of the most interesting objects of contemplation. Their utility, either in diminishing various noxious animals, or in furnishing food themselves to others, has been lost sight of; and because they were cold to the touch, with a naked slimy skin without hair or feathers, they have been considered as loathsome and hideous, although their structure displays as much of the omnipotence and care of the Creator as can be seen in those which are considered to be the most gorgeous and beautiful of his animated beings.
>
> *Zoology of New-York or the New-York Fauna, Part III. Reptiles and Amphibia.* by James E. DeKay, 1842

This article is last in a four-part series on the history of snakes kept in zoos and aquariums. In each article, I focus on taxa that have been regularly displayed in zoos and aquariums. Certainly there are many other species that have been kept but in generally limited numbers. I would be remiss if I did not acknowledge the enormous contributions of our academic and museum colleagues over many centuries. Without their inspiration, guidance and assistance, we would not know what to call our animals or how these creatures live and die in the wild. Without knowing these facts, we would have been virtually helpless in maintaining them in captivity. Starting with lavishly illustrated books, cabinets of curiosities and operating theaters of anatomy, luminaries like Albertus Seba, Frederik Ruysch, Oleus Worm, Adam Oleareus, Konrad Gessner, and a host of others showed us the beauty and complexity of our natural world (Figs. 1, 2). Many biologists today have not had an opportunity to see these magnificent works of art and this is why I have included them in my articles.

Considerable advances on properly keeping and reproducing herps have been made by herpetoculturists in the private sector (Murphy and McCloud 2010a, b). Compare the behavioral observations in the first published herpetocultural book by Johann Matthäus (or Matthaeus) Bechstein in 1797 on captive care of reptiles (called Amphibians at that time) and amphibians entitled *Naturgeschichte; oder, Anleitung zur Kenntniss und Wartung der Säugethiere, Amphibien, Fische, Insecten und Würmer, welche man in der Stube halten kann [Natural History or Guide to Knowledge and Care of Mammals, Amphibians, Fishes, Insects and Worms which can be kept at Home]*. In it, he covered the European Grass Snake (*Coluber Natrix*, now *Natrix natrix;* Fig. 3) and here are a few quotes from that tome: "*Positive*



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Fig. 1. Upon death, zoo specimens should be cosmetically necropsied (if a necropsy is necessary), preserved, and placed in a scientific depository. Those lacking locality data can be used as study specimens. Illustration of cabinet of curiosities from Levinus Vincent's collection in 1704. In the 1660s, Robert Boyle published an article in *Philosophical Transactions* where he described using alcohol for fixing and preserving animal specimens. This important discovery revolutionized herpetological descriptions, for herpetologists and artists were able to scrutinize preserved materials and create detailed diagnostic drawings.

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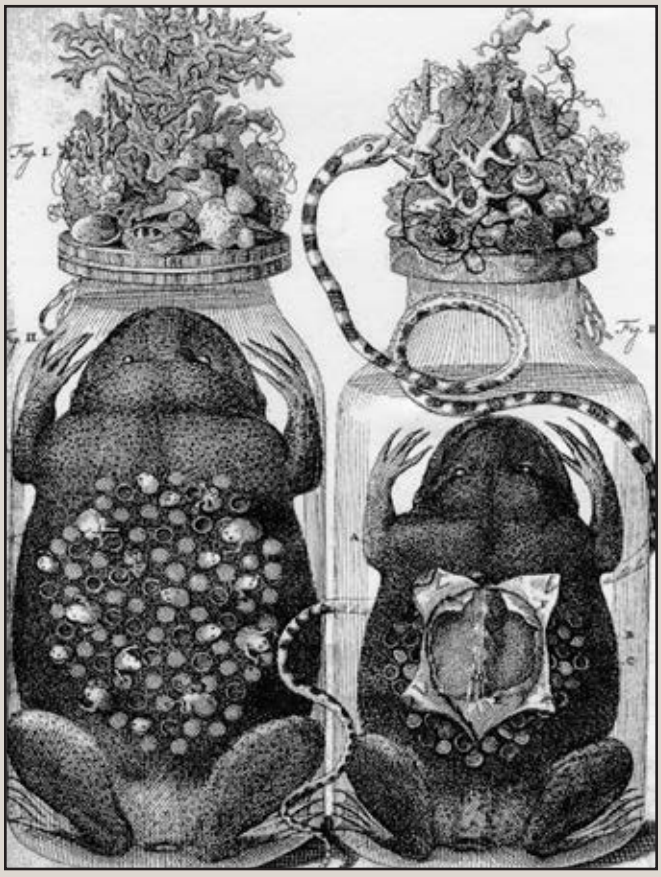


FIG. 2. Snake seems to be Dipsadidae, given New World *Pipa* in the jars. Could be a *Leptodeira* or (very skinny) *Imantodes* based on eating frogs, but is it attacking more diverse prey, including mollusks? Harry Greene suggests that it might be a composite dipsadid. Illustration from Frederik Ruysch's book on a natural history cabinet in 1710—*Frederici Ruischii ... Thesaurus animalium primus = / Het eerste cabinet der dieren / van Frederick Ruysch* ... Imprint: Amstelædami, apud J. Wolters.

Properties—These are certainly endearing animals which can be trained to dance with a stick and the pipe, and to play dead…My friend Mr D. Vognetz has a ringed snake which is so tame that she crawls up and down in the room like a domestic bird, often climbs up on him, crawling up the arms and into the bosom. But it does not easily approach anyone else. He puts it in his pocket, goes into the garden with it and as soon as he emits a loud whistle, similar to the tone with which at mating time they call their mates, it comes to him, crawls up on him, lets him put it in his pocket and remains there without moving until he takes it out again. Since these crawling amphibians often grow exceptionally large, this has provided opportunity for all kinds of fables." (translated from German in Heichler and Murphy 2004).

When I started in the zoo profession in the mid-1960s, I never imagined seeing the amazing numbers of amphibians and reptiles produced by the private community in the following decades. There are several pictures of enormous displays of these animals (Rieck et al. 2001). See Barker and Barker (2014) for a thorough discussion of the topic of the value of animals in captivity and the role that serious amateurs can play in conservation.

Where feasible, I have updated scientific names from those used by the authors in their publications, based on Uetz and Hošek (2014). I follow McDiarmid et al. (1999) for family arrangements.

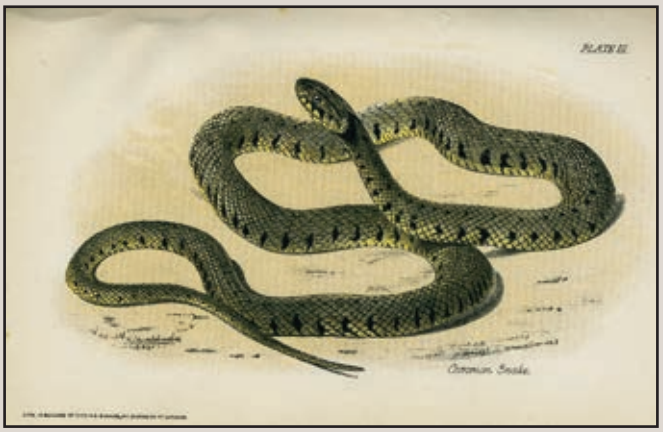


FIG. 3. Common Snake *Tropidonotus natrix* from *Our Reptiles and Batrachians* by M. C. Cooke, 1893. "Everybody shudders at the name of a snake. Very few possess courage enough to attempt staring one out of countenance, or staying to count the number of scales on its head."

TRAVELING THROUGH TIME

As every herpetologist knows, snakes have been the focus of attention of humans for centuries in both positive and negative ways. Brattstrom (1998) postulated that the circular Aesculapian Temple (Tholos) at Epidauros, Greece was likely an early snake pit between 360 and 320 BC. Wajid Ali Shah kept a large menagerie in Calcutta in the 1850s that included tortoises and a large enclosure containing thousands of snakes (Walker 2001). Rulers during this period often kept animals to impress their subjects and competitors. There were many early assemblages of captive snakes, as described in Murphy (2007). One which caught my attention was when Hernando Cortés and his band of soldiers arrived at the Aztec capital Tenochtitlan (now Mexico City) in 1519 and found the Aztec emperor Montezuma's royal menagerie which included snakes. There were over 300 animal keepers so I will remind my herpetological colleagues to continually complain to their bosses about being constantly shorthanded by stressing this factoid. To gain a picture of the relationship of humans and snakes, read Greene (1997), Morris and Morris (1965), and Stutesman (2005).

Arthur E. Brown from Philadelphia Zoo (see Conant 1957) described Marcy's Garter Snake, Trans-Pecos Ratsnake, Gray-banded Kingsnake, Short-tailed Snake, and others (1889, 1890, 1893, 1901a, 1901b, 1902a, 1902b, 1902c, 1903a, 1903b, 1905). Cover and Boyer (1988) bred the endangered and beautiful San Francisco Garter Snake (*Thamnophis sirtalis tetrataenia*) at Dallas and Ft. Worth Zoos. These illegally-collected snakes were confiscated from private persons by the US Fish & Wildlife Service for the purpose of providing captive-born neonates to other zoos to stress the species' precarious state in California and develop assurance colonies. We were told that plans were being considered to clear prime habitat proximal to the airport to be used for additional landing strips and should this become a reality, immediate action for intervention would be needed. The snakes proved to be prolific and many were distributed to institutions throughout the world. In 2005, the Eastern Plains Garter Snake (*Thamnophis radix radix*) reproduced at Cleveland Metroparks Zoo. The same year, the Exiled Garter Snake (*Thamnophis exsul*) produced a litter at San Antonio Zoo. Many years ago, curator Ray Pawley showed me a

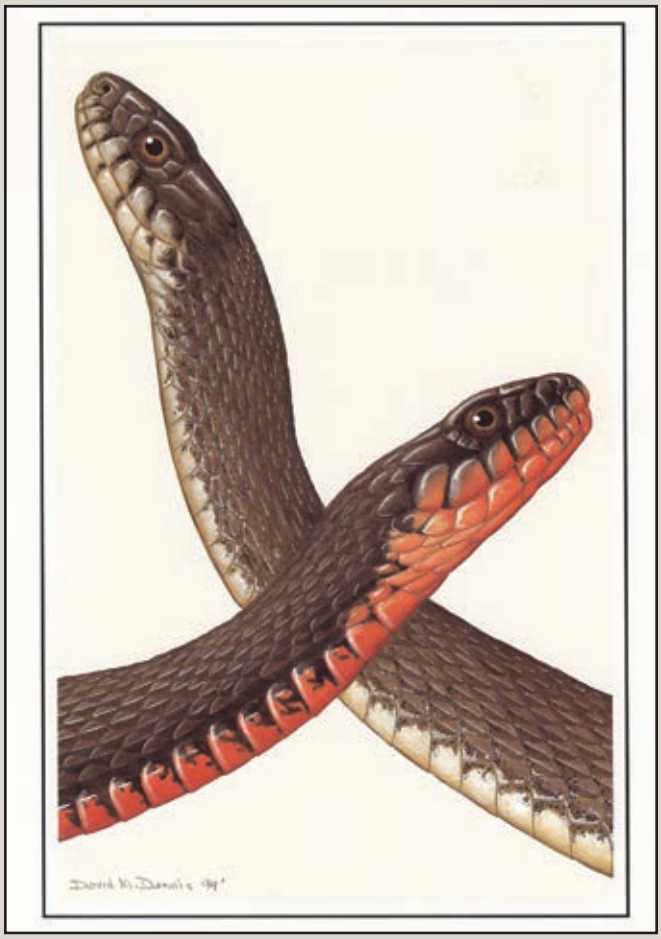


FIG. 4. Two endangered water snakes described by Roger Conant: Northern Copperbelly Water Snake (*Nerodia erythrogaster neglecta*) and Lake Erie Water Snake (*Nerodia sipedon insularum*). Reproduced from a watercolor by David M. Dennis in 1994 from the SSAR book *Captive Management and Conservation of Amphibians and Reptiles.*



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FIG. 5. Eastern Garter Snake (*Thamnophis s. sirtalis*) in *The Natural History* by Mark Catesby in 1743.

unique and effective garter snake exhibit at Chicago Zoological Park. The enclosure was filled with human detritus often found strewn in wild areas and vacant lots in the city—rusty tin cans and bed springs, broken shards of glass, discarded food wrappers and newspapers, and junk of all types. Ray's message was simple—we are littering our world with our garbage! North American Queen Snakes (*Regina septemvittata*) produced 48 young between 1872 and 1880 at London Zoo (Coote 2001). Fox et al. (1961) described the morphological effects of low temperatures during the embryonic development of the garter snake, *Thamnophis elegans*. In 1942, Conant reported on young of Brazos Watersnake (*Natrix harteri*) as well as Southern Black Racer (*Coluber constrictor priapus*), and Texas Patchnose Snake (*Salvadora lineata*), and Arid Land Ribbon Snake (*Thamnophis proximus diabolicus*) and Aguanaval Watersnake (*Natrix erythrogaster alta*) (Conant 1965). Lederer (1949) published a lengthy study on the Viperine Snake (*Natrix maura*) and hybrid ratsnakes (Lederer 1950). Reichling (1974) reported upon a new record-size *Natrix erythrogaster flavigaster* x *neglecta*. Petzold bred the Indian Striped Snake (*Amphiesma stolata*) at Tierpark Berlin (Petzold and Stettler 1972) and reported observations on the breeding biology and keeping of *Tretanorhinus variabilis*, a water snake of Cuba (Petzold 1967). Roger Conant was the most prolific researcher on natricine snakes in the zoo community (Conant 1938, 1943a, 1943b, 1945, 1946, 1949, 1950, 1951, 1953, 1958, 1961, 1963, 1965, 1969, 1975; Conant et al. 1945). As a nonagenarian, Roger sent me a copy of his last paper in 2003 on the garter snakes of the *Thamnophis eques* complex from Mexico from data compiled in the 1960s—simply extraordinary productivity. His accomplishments were recognized in an SSAR volume in 1994 (Adler 1994; Fig. 4.) and other publications (Conant 1957, 1980, 1997; Conant and Collins 1991). It bears repeating that Roger was the only herpetologist who returned cloth shipping bags cleaned, pressed, and folded to me (Adler 2004). There are several other excellent references on garter snakes and water snakes (Rossman et al. 1996; Gibbons and Dorcas 2004, Fig. 5).

The late John Werler was director of Houston Zoo for many years (Kawata and Murphy 2004). At Houston Zoo, common Diamondback Watersnakes (*Nerodia rhombifer*) were periodically obtained as living food snakes from a reptile dealer for the King Cobras—they were not frozen until used because Werler felt that the cobras deserved living prey; they were kept in a large enclosure in the rear section. In 1953, Roger Conant described a new taxon in honor of Werler (*Nerodia rhombifer werleri*) from Mexico and a few living ones were collected by him and kept on display to honor John. Just before Conant was to visit, a prankster in the herp department convinced a newly-hired keeper that he had fed all of this very rare subspecies to the cobras by using the ones in the holding enclosure. To continue the ruse, John contacted Roger and they both confronted this terrified keeper for many minutes about his sheer incompetence feeding off these priceless serpents until they both started laughing uproariously and admitted their nefarious deed—the poor keeper had a near-death experience. As an aside, I have collected the nominate form and experiencing them up close and personal is a miserable experience—multiple bites with flowing blood, unpleasant musk, and staggering amounts of metabolic by-products. See Werler and Dixon (2000) for an exhaustive treatment of Texas snakes, including natricines.

Kingsnakes and milksnakes (*Lampropeltis*) have been popular zoo ophidians due to their beauty and hardiness in captivity (Fig. 6). Beginning in the mid-1960s, we began to specialize in this group at Dallas Zoo. We reported on courtship and copulatory behavior in the Mexican Milk Snake (*Lampropeltis triangulum sinaloae*) by looking at three elements—Tactile-Chase, Tactile-

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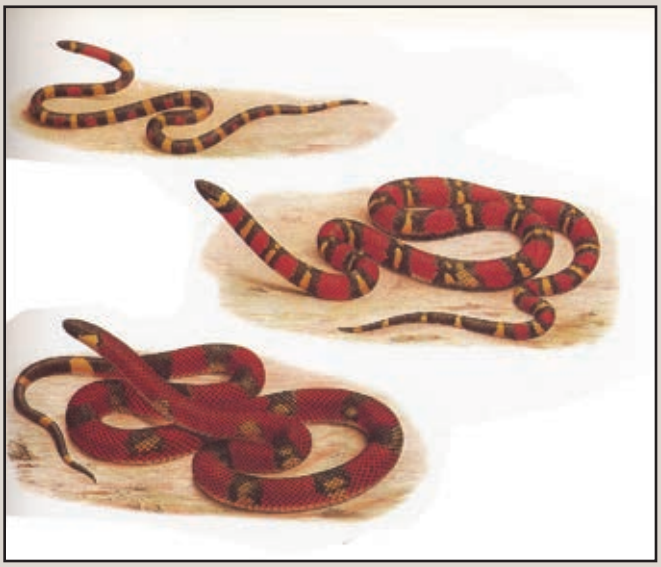


FIG. 6. Varieties of kingsnakes (*Coronella annulata*) from *Biologia Centrali Americana: Reptilia and Bathrachia* in 1885–1902 by Albert Günther—top to bottom—Yucatan, Mexico, Tehuantepec.

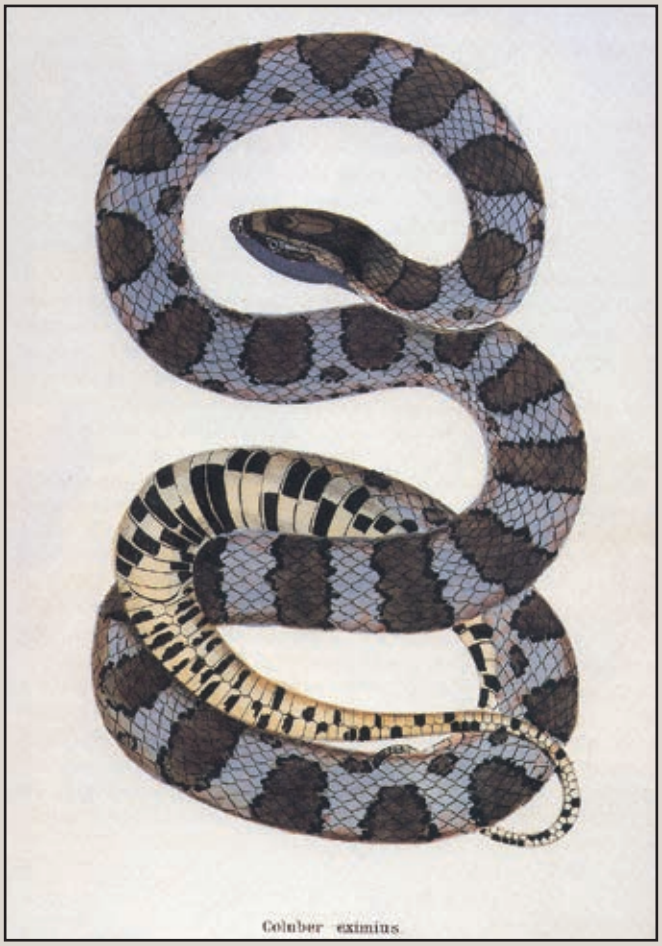


FIG. 7. John Edwards Holbrook published *North American Herpetology,* beginning in 1836, covering all herps found east of the Mississippi River at that time. Shown is Eastern Milksnake *(Lampropeltis t. triangulum*).

Alignment, and Intromission and Coitus—and by creating this new terminology for a generalized colubrid pattern (Gillingham et al. 1977). Murphy et al. (1978) provided an inventory of reproduction and social behavior in Gray-banded Kingsnakes (*L. alterna*). At San Antonio Zoo, Laszlo (1984) discussed reproduction in captives utilizing environmental parameters. After these snakes were cooled to as low as 9°C in the winter, successful reproduction did occur—in both the Tryon colonies (window left open in unheated room) and the Dallas Zoo group (hibernaculum) (Radcliffe et al. 1974; Murphy et al. 1978; Tryon 1984a). Tryon and Murphy (1982) investigated the reproductive biology of thirteen varieties of kingsnakes (species *mexicana, triangulum,* and *zonata*). Jon Campbell brought some beautiful milksnakes to our Zoo collected from Zapotitlan, Puebla, Mexico, found in desert terrain at 1500 m, and listed in our paper as *L. t.* ssp. Hugh Quinn (1983) later described these as *L. triangulum campbelli.* These snakes proved to be incredibly prolific. Hammack (1989) reproduced the Colombian Milk Snake (*L. t. andesiana*) at Dallas Zoo. Radcliffe and Murphy (1984) described precopulatory and related behaviors in captive kingsnakes and other reptiles. Paul Weldon presented kingsnake secretions to assess the ophiophage defensive response in a large number of crotaline snakes (Weldon and Burghardt 1979). In some cases, the defensive body bowing behavior exhibited by the pitvipers was dramatic as bodies were lifted in an inverted U-configuration with head and tail on the substrate and mid-body pressed to the top of the enclosures. Because it was reported in the literature, we assumed that the pitviper might use body blows directed to the kingsnake swabs but I did not notice this behavior. Later, Chiszar et al. (1993, pers. comm.) felt that this was a strategy used by the pitvipers to wedge themselves tightly into burrows to avoid being seized by the kingsnakes.

When private kingsnake breeders learned about the extent of our collection, many visited the Zoo but often focused only on kingsnakes even though we had a very diverse collection. Some particularly desirable forms which we were reproducing in numbers but were unavailable at that time in the private herpetocultural community were Jaliscan Milksnake (*L. t. arcifera*; these were actually Ruthven's Kingsnake [*L. ruthveni*]; R. Hansen, pers. comm.), Pueblan Milksnake (*L. triangulum campbelli*), and Colombian Milksnake (*L. t. andesiana*). We also had a group of snakes of the *L. mexicana* complex collected by Jon Campbell and Barry Armstrong (see Garstka 1982 for additional information). Fanciers begged us for some neonates but when I explained that zoo policy required that all propagules had to be offered first to AZA members and there was a very long waiting list, a few unscrupulous ones started calling my keepers at home to try and convince me to change my mind by doctoring records to eliminate hatchlings. It reminded me of the tulip craze in Holland during the 1630s. As the private sector became more proficient at breeding kingsnakes, we later decided to move on to other projects and sent most of them to other zoos.

Tryon and Hulsey (1976) noted reproduction in captive Nelson's Kingsnakes (*Lampropeltis triangulum nelsoni*) at Ft. Worth Zoo. At this Zoo, Ronald Markel worked in the herpetological department. He told me that he was planning an ambitious project illustrating as many milksnakes and kingsnakes in color as possible and he succeeded by locating them all at zoos and other places (1990). Herman (1979a, b) bred the Jaliscan Milksnake (*L. t. arcifera*; again, these were actually *L. ruthveni,* as noted above) and Scarlet Kingsnake (*L. t. elapsoides*) at Zoo Atlanta. Kardon (1979) noted breeding in three

Mexican milksnake subspecies (*L. t. polyzona, L. t. nelson,* and *L. t. sinaloae*) at San Antonio Zoo. Korinek (1997) bred Campbell's Milksnake (*L. t. campbelli*) in the terrarium of Olomouc Zoo. In 2004, five Eastern Milksnakes (*L. t. triangulum*) hatched at the Detroit Zoological Institute (Fig. 7). Tryon and Murphy (1982) and Tryon (1984b) described multiple egg clutches in a single reproductive season; this phenomenon is now known to occur in a number of *Lampropeltis* taxa.

Roger Conant (1934) recorded reproduction in the Black Kingsnake (*Lampropeltis getula nigra*) and discussed milksnakes of the Atlantic Coastal Plain (1943a). Hosono (1982) bred the Florida Kingsnake (*L. getula floridana*) at the Kyoto Municipal Zoo in Japan. Mulder et al. (1979) from Audubon Zoo surgically removed retained eggs from a kingsnake (*L. getula*). Tryon and Carl (1980) reproduced the Mole Kingsnake, *L. calligaster rhombomaculata.*

Zweifel (1980) described techniques for maintaining a colony of *L. getula* at the American Museum of Natural History in New York to study inheritance of color pattern. Shaw (1956, 1959) described two-headed California Kingsnakes (*L. g. californiae*) at San Diego Zoo by name: Dudley-Duplex, Dudley-Duplex II, and Nip-and-Tuck. This Zoo has owned several of these snakes over the years and the first one lived over six and one-half years. Boyer and Baldwin (1997) devised a simple method of preventing self-inflicted injury when feeding a dicephalic California Kingsnake by using a collar around one head (pictured in Murphy 2007). Groves (1964) and Groves and Groves (1972) described swallowing of shed skin by *L. getula.*

Ratsnakes are also popular zoo exhibits. I use the term "ratsnakes" in an historical sense, inclusive of both Old and New World representatives that we now know are not closely related (Utiger et al. 2002). Herrmann (1998) reported on husbandry and reproduction in the Black and Yellow Ratsnake (*Spilotes pullatus*) at Cologne Zoo (Fig. 7). At Ft. Worth Zoo, Campbell (1972) bred the Trans-Pecos Ratsnake (*Bogertophis subocularis*) and Tryon (1976) reported on courtship behavior and second-generation reproduction. Brecke et al. (1976) documented reproduction and social behavior in the Baird's Ratsnake (*Pantherophis bairdi*) at Dallas Zoo, and Dathe and Dedekind (1985) at Tierpark Berlin. Tremper (1981) propagated the Neotropical Ratsnake (*Pseudelaphe f. flavirufa*) at Chaffee Zoo. Engelmann (1984) explained egg-laying behavior of the Yellow Ratsnake (*Pantherophis obsoletus*) at Leipzig Zoo. Retired Detroit Zoo curator Jim Langhammer (pers. comm.) had many snakes at Indiana University during our college years including Ludwig, a large female Yellow Ratsnake: "She was about 5 feet long and totally trustworthy around strangers. Ludwig's dimensions were too small to allow her being on the ground among foot traffic but she was often handled by strangers. I often walked Jordan Halls with her settled quietly around my neck. Many strangers would ask directions/questions of me without ever seeing the snake. To my recollection she never struck at anyone. One indication of her gentleness was her intense fondness for large chicken eggs. She ALWAYS began at the blunt end of an egg. If you held it with the blunt end in your palm, she would work to expose that blunt end but never bit the hand in the process. Once engulfed, she would move it down about 10 inches and then crush the egg against her vertebrae before swallowing it further."

Frolov and Kudryavtsev (1985) and Kudryavtsev and Frolov (1984) kept and bred Russian Ratsnakes (*Elaphe s. schrencki*) at Moscow Zoo. Mamet (1989) outlined the reproductive biology of ratsnakes of the *longissima*-complex from Southern Azerbaijan

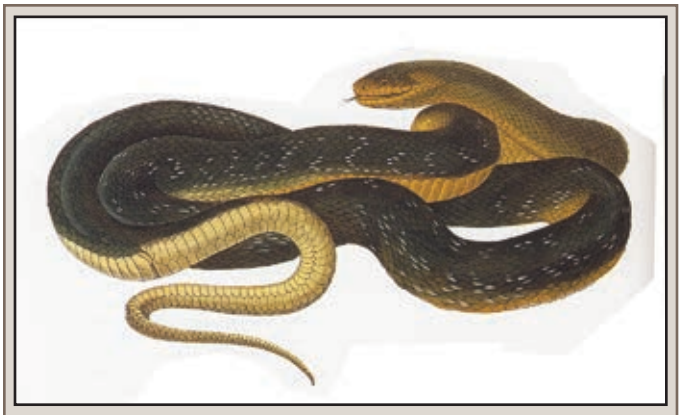


Fig. 8. Baron Georges Cuvier published *Le règne animal…* in 1836–1839. Illustration is Aesculapian Snake *(Elaphe longissima*).



Fig. 9. Yellow and Black Ratsnake (*Spilotes pullatus*) from *Biologia Centrali Americana: Reptilia and Batrachia* in 1885–1902 by Albert Günther. This beautiful and active snake is not often seen in zoo collections.

(Fig. 8). Mamet and Kudryavtsev (1997a) propagated the Mandarin Ratsnake (*E. mandarina*) and Mamet and Kudryavtsev (1997b) provided notes on the reproductive biology of the Asiatic Ratsnake (*Elaphe persica*) at the Moscow Zoo. At Tula Exotarium in Russia, Ryabov (1997) reported upon high productivity in the Radiated Ratsnake (*E. radiata*), natural history, keeping, and breeding the Persian Ratsnake (*E. persica*) (2001), and Ryabov and Popovskaya (2000) provided some comparative data on the breeding of four subspecies of the Stripe-tailed Ratsnake (*Elaphe taeniura*). "This is from Stan Grumbeck who told me that Moellendorf's Ratsnakes (*Orthriophis moellendorffi*) are notably different than the norm in that their eggs feel much more like turtle eggs and that the young do not slit the eggs upon hatching but rather burst or break through the shells" (William Lamar,



FIG. 10. Ferruginous Thrushes (*Turdus rufus*) defending nest from attacking Black Ratsnake (*Pantherophis obsoletus*) from John James Audubon's *Birds of America* from 1827–1830.



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FIG. 11. Bull Snake (*Pituophis melanoleucus*) from *United States Exploring Expedition, Vol. 29. Herpetology* in 1858 by Charles Frédéric Girard.

pers. comm.). Frank Groves described eggs and young (1957) and albinism (1965) of the Corn Snake (*Pantherophis guttatus*) at the Baltimore Zoo. Lederer (1950) discussed hybridization in ratsnakes. Barnard et al. (1979) from Zoo Atlanta followed growth and food consumption in the Corn Snake. Orangutans and gorillas are afraid of Black Ratsnakes (Murphy et al. 2014, Fig. 12). Clarke (1973) recorded longevity in a Great Plains Ratsnake (*Pantherophis guttatus emoryi*). Dowling (1959a) noted egg-eating adaptations in the Chinese Ratsnake, *Elaphe carinata*. During the 1970s, political relationships with China were tense so virtually no herpetofauna from the region was being imported into the US. When relations improved, a few reptile dealers began to bring in some ratsnakes such as *Elaphe dione, E. schrenckii, E. carinata, E. bimaculata,* and *Orthriophis moellendorffi*. Some of these were sent to zoos but after a few weeks, there was unacceptable mortality. Upon necropsy, it was discovered that gall bladders had been removed for the medicinal market and the surgical site stitched so expertly that it was virtually impossible to notice. Two references on ratsnakes are especially helpful: Schulz 1996 and Rhodes 2008.

At Memphis Zoo, Steven Reichling has embarked on a long-term study of the Louisiana Pine Snake (*Pituophis melanoleucus ruthveni*) (1986, 1988a, 1989, 1990a, 1990b, 2008) and the Black Pine Snake (*P. m. lodingi*) in 1981—both taxa are at risk. At Cheyenne Mountain Zoological Park, Connors (1986) described a captive breeding of the Great Basin Gopher Snake (*P. catenifer deserticola*). Charles Shaw and Sheldon Campbell from San Diego Zoo described male combat, courtship behavior and reproduction, feeding, defense, and many other aspects of the Gopher Snake (*Pituophis catenifer*) in their book *Snakes of the American West* (1974, Fig. 11). This is an excellent reference for all the snakes in this area. Shaw (1951) described male combat in American colubrid snakes with remarks on combat in other colubrid and elapid snakes. From the same Zoo, Jeffrey Lemm (2006) has published a field guide to herps of the San Diego region. Chiszar et al. (1989) showed that Bull Snakes (*Pituophis melanoleucus*) discriminated between thermally different rodent carcasses. An adult at Dallas Zoo regularly pinned as many as four live mice at the same time during feeding bouts; the one it was swallowing had been constricted and was dead, the second was being constricted by the first third of the body, the third and fourth were being pressed against the side of the enclosure with such force that they were gasping. I never could answer the question of how a snake could deal with multiple prey items.

At Zoo Atlanta and other institutions, neonates of the Eastern Indigo Snake (*Drymarchon couperi*) were maintained for a captive head-start program (Speake and Smith 1987; Wines 2014). Gravid females were collected in the wild, eggs were hatched, and females released at site of capture. This is an excellent model for a collaborative project; it involved U.S. Fish and Wildlife Service, The Alabama Natural Heritage Program, Alabama Department of Conservation and Natural Resources, Georgia Department of Natural Resources, Zoo Atlanta, The Orianne Society, and the U.S. Forest Service. The researchers examined reproductive ecology, captive propagation, juvenile ecology and restocking potential, including optimal egg incubation temperature, and the effects of diet on growth of hatchlings. After necropsying many indigo snakes, pathologist John Roberts (pers. comm.) was adamant in insisting that these snakes need a predominantly bird diet rather than rodent diet. Serum chemistry values were analyzed for two specimens at Sacramento Zoo (Drew 1994). Hellmuth et al. (2012) used operant conditioning and desensitization to facilitate veterinary care with this taxon at National Zoological Park in Washington, DC. Groves (1960) bred the Eastern Indigo Snake (*D. couperi*) at the Baltimore Zoo.

Some species are rarely kept in zoos and aquariums and thus are poorly studied. There are many reasons why certain taxa do not make their way to zoos and aquariums—availability, specialized food needs, non-attractiveness or other lack of visitor appeal, inability to adapt to captivity, size, secretiveness, poor temperament, lack of managed captive management



FIG. 12. John Anderson published *Zoology of Egypt* in 1898. Some of the finest drawings of reptiles ever produced were by P. J. Smit and John Green in this book. Pictured is Egg-eating Snake *(Dasypeltis scabra).*



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FIG. 13. Andrew Smith published *Illustrations of the Zoology of South Africa* in 1838–1839. Mole Snake (*Pseudaspis cana*) (top and bottom), Green Bush Snake (*Philothamnus semivariegatus*) (middle).

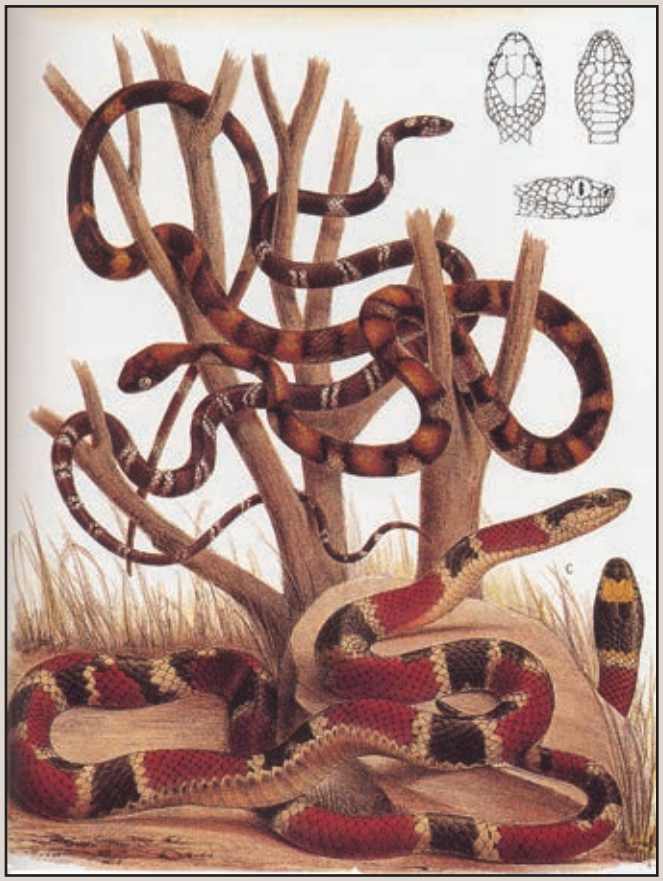
program, lack of space and, of course, curatorial preferences. Cahill (1971) provided observations on a captive Beak-Nosed Snake (*Scaphiophis albopunctatus*) at the University of Ife Zoo in Nigeria. Simmons (1977) reproduced the Chinese Red Snake (*Dinodon rufozonatum*) and Campbell and Murphy (1984) outlined reproduction in five species of Paraguayan colubrids housed at the Fort Worth Zoo—racers (*Liophis*), false cobras (*Hydrodynastes*), green racers (*Philodryas*). At Houston Zoo, Freed (1989) documented delayed fertilization in the African Egg-eating Snake (*Dasypeltis scabra*), a species rarely kept in zoos because of the need for a steady supply of suitably-sized eggs (Fig. 12). Shaw (1961) published photographs of an egg-eating snake swallowing an egg. Boycott (1990) described copulation and parturition in the Mole Snake (*Pseudaspis cana*) at Transvaal Snake Park (Fig. 13). Dathe and Dedekind explained care and breeding of Horseshoe Snakes (*Coluber hippocrepis*) (1988), and Madagascar Hog-nosed Snakes (1996) in the Berlin Tierpark. Campbell and Murphy (1977) described reproductive biology of two colubrid snake species from the Malagasy Republic, Madagascar Hog-nosed Snakes *Leioheterodon madagascariensis* and *Madagascariophis colubrina.*

At Dallas Zoo and a few others, the Southern Hognose Snake (*Heterodon simus*) was maintained but the Eastern Hognose Snake (*Heterodon platirhinos*) was rarely exhibited. This was because the former usually fed on rodents whereas the latter almost always restricted its diet to toads or occasionally frogs, difficult to find during winter. In one case, a beautiful orange-phase Eastern Hognose was on display at another facility but the supply of toads disappeared. In desperation, the caretaker offered a large horned frog (*Ceratophrys*). The battle was epic with the frog trying to swallow the snake for many minutes; at the end, the snake prevailed. The South American Hognose Snakes (*Xenodon dorbignyi, X. pulcher*) are now showing up in zoo collections, due to attractive coloring and hardiness in captivity.

One of the most spectacular snakes in our collection at Dallas Zoo was the Filetail Ground Snake (*Sonora aemula*) from northwestern Mexico. Our specimen, about a foot long, had a brilliant red body with a black head and whitish collar. It lived in a gallon jar with a moist paper towel and small water dish and fed on small insects. The snake remained visible most of the time and always caught the eye of our visitors. Many years ago, we held an open-house tour of the reptile building, complete with wine and cheese in the lobby, for an ASIH meeting held in Fort Worth. While we were enjoying the repast, one of our attending herpetological or ichthyological colleagues slipped into the rear section, opened the jar, stole the snake, and replaced the cover—the snake was never recovered.

At Dallas Zoo and Zoo Atlanta where I started my career, we had several snakes with foul tempers. The most notorious were Wagler's Snake (*Xenodon merremi*), Jackson's Twig Snake (*Thrasops jacksoni*), sipo (*Chironius* sp.), Indian Ratsnake (*Ptyas mucosa*), rear-fanged Mangrove Snake (*Boiga dendrophila*), tropical racer (*Masticodryas*), and several US watersnakes (*Nerodia*). Curator Joe Laszlo at San Antonio Zoo had a few examples of keelback snakes, genus *Helicops,* comprising about 16 species. Although small, they were incredibly skillful at biting and left tiny teeth marks. Joe invited visiting herpetologists to touch the tail without being bitten—these snakes swapped ends so quickly that few were able to avoid being bitten even though forewarned. These episodes helped pass the time for us during my visits. I strongly recommend that all of these noxious creatures be excluded from future collection plans.

I have always been intrigued by snake patterns and colors, especially since many from various parts of the world are similar. One of the most striking combinations are a coralsnake-mimic coloring anteriorly and a unicolored part posteriorly in the colubrid Neckband Snake, *Scaphiodontophis annulatus* (Fig. 14). At Dallas Zoo in the 1970s, an adult was obtained which fed well in captivity on a diet of anoles and skinks, which were swallowed alive at astounding speed. The snake often rested



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FIG. 14. *Mesopeltis dimidiatus* (above) and *Henicognathus venustissimus* from *Biologia Centrali Americana: Reptilia and Batrachia* in 1885–1902 by Albert Günther. *Henicognathus* is now *Scaphiodontophis*; the congener *S. annulatus* (Neckband Snake) was maintained at Dallas Zoo.

with the anterior portion of the body elevated. I decided to test the snake's reactions to potential predators or their scents—European Ferret, Gray Fox, skunk, raptor feathers, and humans. The snake remained motionless rather than thrashing the body as was described in a paper by Henderson (1984). The tail of this species is exceedingly long and breaks easily (likely in response to predators) but this did not happen in our specimen.

Coachwhips (*Coluber flagellum*) and Racers (*C. constrictor*) are rarely kept in zoo collections as they are snappy, nervous, and flighty. In fact, an adult male Racer was the only snake in my career to have aggressively attacked me without provocation. I encountered this male courting a female in the wild during high school and this suitor likely wanted privacy. I retreated and the snake continued to pursue me, wildly striking.

During my college years, I had a perverse streak which, some would say, lasts even to this day. I had captured an adult black-phase Coachwhip in Florida. For my speech class, I gave a riveting presentation in dulcet tones on snakes, using some of my calm live captives as examples. Admittedly, many of the students were apprehensive but fascinated. I finished by talking about the exceptional speed, aggressiveness, and toxicity of black mambas and slowly opened the cloth bag containing my black-phase Coachwhip, which promptly exploded from the bag and shot off the stage into the crowd. There was complete pandemonium as the students rushed toward the exits, scattering chairs in their way—within minutes, I was standing alone in the room. The professor, who bolted as well and peeked around the open door frame to see if the snake had been secured, thought it was hilarious and gave me an A+ for the class. He said that it was one of the few presentations that was not dreadfully boring!

Husbandry and Medical Management

In my earlier papers and books, I listed many titles dealing with these subjects. There is a comprehensive new book that must be on the bookshelf of every person maintaining live herpetofauna—Petzold's *The Lives of Captive Reptiles*. This wonderful compilation, translated into English by Heichler and Murphy (2008), includes aspects of reproduction, development, nutrition, history of zoos, relevance of terrarium observations, and conservation programs in zoos and private terraria. See Peeling's review (2009) for details.

Campden-Main from the Louisiana Purchase Zoo in Monroe wrote a paper on the care of newborn snakes (Campden-Main and Campden-Main 1982). Banks (1985) observed feeding and sloughing in a collection of captive snakes. Greene (1983) collected data from a number of serpents in zoos to strengthen his analysis of the dietary correlates of the origin and radiation of snakes. These data are helpful when considering suitable prey items. Bloxam and Tonge (1986) appraised the breeding program for reptiles at the Jersey Zoo. William Gehrmann discussed lighting requirements in several papers (1971, 1987, 1994). Murphy and Campbell (1987a) provided selected references applicable to the maintenance of snakes in captivity and a book chapter on captive maintenance the same year (Murphy and Campbell 1987b).

Susan Barnard from Zoo Atlanta and her associates have published a number of papers on parasitism in snakes. Camin and associates (1948, 1953, 1964) documented the ravages caused by the snake mite (*Ophionyssus natricis*) in captive reptile collections. Da Paixão Sevá et al. (2011) described occurrence and molecular diagnosis of *Cryptosporidium serpentis* in captive kingsnakes and ratsnakes in São Paulo, Brazil.

Lloyd at the Roger Williams Park Zoo in Rhode Island published three papers on ophidian paramyxovirus and reptilian dystocias (Lloyd and Flanagan 1991; Lloyd 1990, 1992). Reichling (1988b) discussed treatment of dystocia in snakes. Ungureanu et al. (1972) identified hemorrhagic septicemia in snakes in captivity at Zoological Garden of Bucharest. At Philadelphia Zoo, Aronson (1929) described spontaneous tuberculosis (*Mycobacterium thamnopheos*) in garter snakes. Adamy (1966) investigated the therapy of salmonellosis. Mitch Bush and associates from the Smithsonian National Zoological Park published papers on the use of antibiotics in snakes (1976), biological half-life of Gentamicin in Gopher Snakes (1978), and blood collection and injection techniques in snakes (1978). At the same zoo, Nichols and Lamirande (1994) used methohexital sodium as an anesthetic for colubrid snakes. Hilf et al. (1989) investigated pharmacokinetics of Gentamicin and Piperacillin in blood pythons and Hilf et al. (1990) did a comparative study of upper airway flora in healthy boid snakes and snakes with pneumonia at Pittsburgh Zoo. Velayan and Ambu (1991) studied bacterial infections in reptiles at the National Zoo, Malaysia. Flanagan and Harwell (1983) from Houston Zoo discussed pathobiology and management of chronic regurgitation in snakes. At Baltimore Zoo, Cranfield and Graczyk (1995) expanded information on ophidian cryptosporidiosis. Ippen (1980) described mycosis in snakes. Garner et

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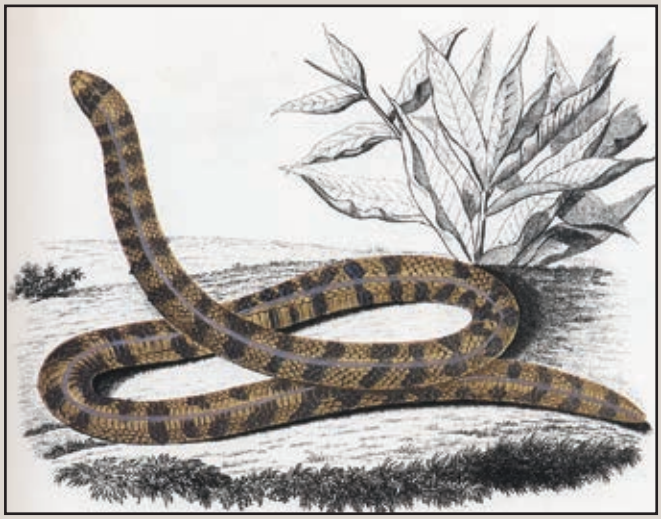


FIG. 15. Coral Pipe Snake (*Anilius scytale*) from *Dictionnaire universel d'histoire naturelle* by Alcide D'Orbigny in 1838–1849.

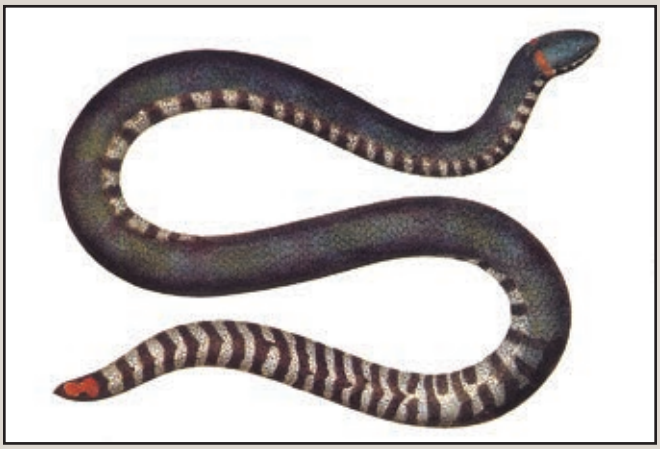


FIG. 16. Illustration of Red-tailed Pipe Snake *Cylindrophis ruffus* from Heinrich Rudolf Schinz, curator of the natural history society of Zürich and author of many important zoological works between 1824 and 1852. Modified image from *Naturgeschichte und Abbildungen der Reptilien* (1833–1834).

al. (1995) diagnosed vertebral chondrosarcoma in a Corn Snake (*Pantherophis guttatus*). Zachiesche et al. (1988) diagnosed lymphoid leukemia with presence of type C virus particles in a Yellow Ratsnake (*P. obsoletus*).

A Few Snake Families Rarely Kept in Zoos

Acrochordidae—Dunn et al. (1987) were successful in exhibiting and breeding the Arafura File Snake *(Acrochordus arafurae*) at Melbourne Zoo. Banks (1989) described skin lesions in *Acrochordus* and *Erpeton,* perhaps caused by excessively bright lighting. Our captives did not have skin lesions, which may be due in part to the presence of aquatic snails in their aquaria or relatively high pH (above 7.2). The snails were often on the heads and bodies of the snakes; algae growth did not occur and there were no shedding problems including eye caps. Curator Louis Pistoia told me that an adult Java Wart Snake (*A. javanicus*) refused food for slightly over four years in the Columbus Zoo collection. Dowling (1960) described feeding habits at Bronx Zoo. In the 1970s, *A. javanicus* was imported in small numbers to the US. The snakes were poor feeders on living fishes at Dallas Zoo until the water temperature was raised to 85°F (30°C) or slightly higher. Dubach et al. (1997) described parthenogenesis in the Arafura File Snake at Chicago Zoological Park.

Aniliidae—The only living zoo examples of Coral Cylinder Snake (*Anilius scytale*) I have seen were a few in collections in South America. This is likely due to specialized dietary requirements: amphisbaenians, caecilians, and snakes. Defensive tail display has been observed at Instituto Butantan (Sawaya 2010, Fig. 15).

Cylindrophiidae—The only living representatives of this group I have seen in zoo collections were a few Red-tailed Pipe Snakes (*Cylindrophis ruffus*) years ago at the Oklahoma City Zoo (Fig. 16). When I asked if the snakes ever displayed the characteristic tail-raising defensive behavior, the caretakers said that the snakes did briefly at first but quickly habituated to captivity.

Leptotyphlopidae—The only living example during my early career was a large snake called Giant Blind Snake (*Leptotyphlops maximus*) from Mexico at Dallas Zoo. The snake had been confiscated by US Fish and Wildlife Service and was given that technical name on the manifest[1]. The feeding behavior corresponded to the description by Kley (2001), known as mandibular raking. Ants, eggs, and larvae were literally sucked up like a vacuum cleaner; I have never seen a snake go into a feeding frenzy quite like this. In the beginning, we fed this snake Carpenter ants collected from nests on Zoo grounds. When fire ants arrived in Dallas, all carpenter ants disappeared and we were unable to find some to feed the snake. In desperation, I tried to collect fire ants to substitute but I regretted that plan immediately after multiple encounters with their defensive behavior. When I offered them to the snake, known as an ant specialist, it immediately went into convulsions. Amazingly, the ants had penetrated the interstitial skin between the scales and

[1]In this shipment, approximately 2000 tarantulas, each in its own small plastic bag, were included. Most were the Red-legged Tarantula but several other types were present as well. The wildlife inspector was worried that the arachnids would dehydrate and suffocate so he asked me to help him transfer the animals to larger containers with air holes and include a damp paper towel for moisture. One of the primary defenses is to flick urticating hairs (bristles), which are extremely irritating, especially to those persons with severe allergies. We had several tarantulas in the Dallas Zoo collection that I handled for demonstrations with no negative reactions but, as these tarantulas were unpacked, the hairs literally coated the room and after several hours of handling the creatures, my whole body began to itch and the result was excruciating. For two days, I soaked in the bathtub at home with Epsom salts added to the water to lessen the pain and diminish swelling, cursing the inspector who seemed to have no negative reaction and was amused by my plight. When I called in sick to the Zoo to explain the circumstances, my boss was quite skeptical. All of the confiscated tarantulas were donated to a university researcher a few days later. Also in this shipment were about three dozen adult spiny-tailed iguanas (*Ctenosaura pectinata* and *C. similis*). We did not have suitable holding space in the reptile building so the lizards were released in the rear section of the spacious aquarium, an antiquated Art Deco concrete structure in Fair Park. They immediately scaled the rough concrete walls and ran around the wide tops of the large cement aquaria, often basking under the display lights. We fed them several times a week and they would descend like ravenous wolves from all directions and snatch vegetables and dog food from the metal trays placed on the floor. They lived for years but avoided the water in the tanks, unlike Green Iguanas, which dive into water to escape predators.



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FIG. 17. Illustration of snake hall (Schlagen-Zaal) at Natura Artis Magistra in Amsterdam from *De Dierentuin van het Koninklijk Zoölogisch Genootschap te Amsterdam* by Hermann Schlegel in 1872.



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FIG. 18. Title page from *Promenade au jardin zoologique d'Anvers par Eugéne Gens* by Eugéne Gens in 1861.

were attached to the snake's body. I immediately put the snake under running water and eventually the ants released their grip. Later, the snake laid three infertile eggs but did not coil around the clutch as mentioned in the literature about some blindsnakes.

Typhlopidae—I have never seen an exhibit of blind snakes (scolecophidians) in a zoo. These snakes are the most basal form for a visitor to compare against advanced snakes (caenophidians), but absence from collections is almost certainly due to difficulty in finding enough food throughout the year and the secretive nature of the animals. We found what we believed to be an adult Flowerpot Snake *Rhamphotyphlops* (now *Indotyphlops*) *braminus* in a pile of mulch outside the back door of the reptile building at the National Zoological Park in Washington DC. I asked the horticulturist who had delivered the pile and she said that the material had been ground into small pieces from branches trimmed from a standing dead tree on Zoo property and almost immediately brought to the building in the bed of a pickup truck. It may have traveled from flower pots delivered to the Zoo but she did not believe that this was the case as there were no pots anywhere near the tree. This invasive species is known from Massachusetts and Florida. My plan was to preserve the snake as a voucher specimen for certain identification but it wriggled through my fingers and catapulted into the adjacent outdoor alligator exhibit, never to be seen again.

Uropeltidae—In the April 2011 issue of Zoo's Print, the magazine of the Zoo Outreach Organization, the list of reptiles assessed during the Conservation Assessment and Management Plan (CAMP) workshop in Western Ghats, India in March 2011 included 20 species of shield-tail snakes (*Uropeltis*). The collected data are being analyzed to determine the conservation needs for reptiles throughout India and will be published in a future IUCN Red List.

Xenopeltidae—McGeorge (1997) bred the Sunbeam Snake *(Xenopeltis unicolor)* at Chester Zoo.

SUMMARY

During the past few decades, there has been an increasingly vocal group of animal rights advocates calling for a ban against keeping live animals in captivity. They claim that animal welfare issues are ignored and the captives live unenriched and unfulfilled lives. Concurrently, there have been objections to collecting and euthanizing animals for scientific research collections. Both of these views are misguided, for if this happened we would not be able to add very much to our current understanding of snake biology.

In reading my four-part series on snakes kept in zoos and aquariums through centuries (Murphy 2014a, b, c; this paper), it should be apparent that many important scientific studies have been generated and replicated in that environment. In fact, many of the questions posed could not have been investigated in the wild. For example, how would we have known that some pythons incubate egg clutches to increase temperatures by twitching? What behaviors are apparent when males court females? What are the communication channels? Which snakes lay eggs and which ones give birth to living young? Does parthenogenesis happen?

What do hemipenes look like and how do they work? Former curator Herndon Dowling at New York Zoological Society published several important studies on the morphology of these structures (1959b, 1959c, 1967; Dowling and Savage 1960). Observations on living Ottoman Vipers (*Vipera xanthina*) at Dallas Zoo documented usage (Murphy and Barker 1980). Dowling also published a paper on zoo record-keeping (Dowling and Gilboa 1966), a critical component for documenting interesting animals doing interesting things.

Because snakes are essentially living tubes without limbs, how do they move and how do snakes find and dispatch their prey? Or swallow prey much larger than themselves? Being ectothermic, how can they digest meals and live and prosper in a world of changing climatic conditions? Several researchers

COURTESY OF KRAIG ADLER

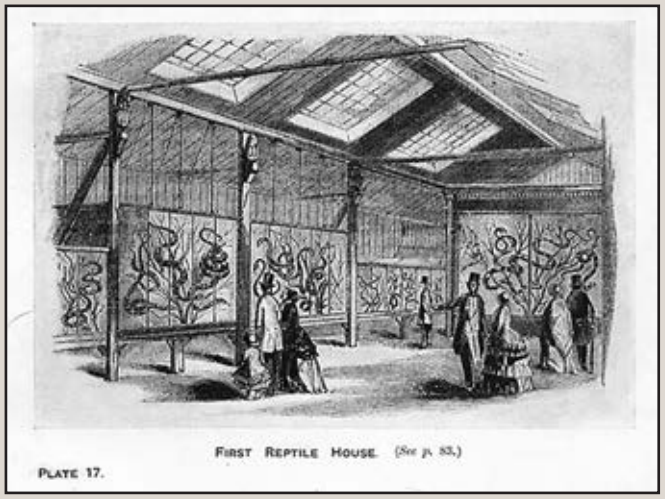


FIG. 19. Illustration of London Zoo reptile building. The beginning of an article from *The Illustrated London News* on 2 June 1849 reads as follows: "The new reptile house in the Gardens of the Zoological Society in the Regent's Park will ultimately form one of the most instructive, as it is the most novel and original feature in this delightful institution. The collection already contained in it is so unexpectedly brilliant, considering the small number of reptiles previously exhibited in the Menagerie, that we cannot but anticipate the most important results in the study of this singularly interesting division of the animal kingdom."

COURTESY OF ROBERT MENDYK



FIG. 20. How did this keeper feed these snakes (probably Reticulated Pythons, *Malayopython reticulatus*) in the same enclosure without them grabing and constricting each other? Possibly that is the reason he is holding a broom. Illustration called "The Meal of Serpents in Museum d' histoire Naturelle" from *Magasin pittoresque* to the 56th année, sér. II, tome VI, p. 241, 1888. The Menagerie Jardin des Plantes is part of the museum, located in Paris (see Murphy 2009a, b for history).

have published important studies that should be consulted: David Chiszar, David Cundall, Alexandra Duefel, Carl Gans, Frances Irish, Ken Kardong, Hamidreza Marvi and associates at Zoo Atlanta, Hobart Smith, Steve Secor, and others.

How can some live underground, others above ground, some in water, and others high in trees? What structural modifications are needed to do this? Harvey Lillywhite (2014) tells us how.

How do serpents defend themselves against predators (Greene 1997)? And against humans who want to chop them into tiny bits? Since human ophiophobia is a real phenomenon (Burghardt et al. 2009), why do we so-called intelligent beings want to wear their skins if ophidians frighten us and many are collected in unsustainable numbers for the fashion industry? When I ask some visitors and acquaintances who hate and fear snakes and other reptiles why they are wearing cobra shoes, python handbags, lizard hatbands, croc wallets and belts, and other reptilian accoutrements, they are clueless and find my question irrelevant and/or offensive. When I say that the fashion industry is responsible for millions of reptile deaths annually, there exists an enormous illegal black market worldwide, reptiles may be brutally dispatched by being skinned alive but cannot scream in pain, and many populations are seriously endangered, they often are completely indifferent. When I suggest that it would be interesting to study these fashion statements as possible subliminal expressions of dominance over a fallen enemy, they simply shrug their shoulders and view me as a lunatic. Would natural selection favoring ugly or nondescript skins be an advantage to survival? Probably not as I have seen plenty of artificially-colored reptile skin products in department stores and boutiques and most are garish, offending my aesthetic sense.

Most humans will never encounter a living snake in the wild. So would they miss seeing their stunning beauty and remarkable morphology unless they visited a zoo or aquarium? At the London Zoo, visitors were asked to rank their favorite exhibits; two of the three most popular were the aquarium and reptile house (Balmford et al. 1996; Balmford 2000). The message here is snakes may be fearful and unsettling but humans are fascinated with them nonetheless and a zoo visit must almost always include seeing them. One day outside a zoo reptile building, I sat on a bench next to an older female visitor who was waiting for her family to exit. I asked why she did not go into the place to see the snakes with her relatives as these creatures were well worth seeing. I was told in no uncertain terms that she could not even tolerate listening to the word "snake" much less view serpents. Even seeing a picture of one would send her to the sick bed for several days. Her family's daily task was to review incoming printed materials to intercept any snake images and remove them. Our interaction was quickly finished, especially since I did not feel like calling the paramedic squad that day should she see an ophidian. She was fortunate that I was not wearing my favorite ball python T-shirt showing a wide range of color morphs coiled together.

These are not questions generated by me. Rather, these are some of the intriguing enquiries over the past centuries explored and answered by our predecessors and we owe them a huge debt of gratitude. And it must be remembered that virtually none of this would have happened without zoos, aquariums, academic institutions, and museums (Figs. 17–20).

Acknowledgments.—This contribution is dedicated to Charles C. (Chuck) Carpenter and his then-graduate student James C. Gillingham from University of Oklahoma in Norman. Beginning in 1975,

we began a collaborative effort to study the behaviors of reptiles in the Dallas Zoo collection—two rattlesnake species, Madagascan Tree Boa, Blue-tongue Skink, Angle-headed Dragon, Gillen's Monitor, Death Adder, Fiji Island Iguana, and kingsnakes. About a decade later, Chuck published a paper on dominance of snakes (Carpenter 1984), based in part on observations at Dallas Zoo. We all learned an important lesson as we spent hours trying to document their lives—under carefully controlled conditions, animals tend to do as they damn well please!

For various courtesies, I thank Kraig Adler, Judith Block, Kristen Bullard, John Edwards, Matt Evans, Kevin de Queiroz, Harry Greene, Robert Hansen, William Lamar, Jim Langhammer, Joe Mendelson, Polly Lasker, Roy McDiarmid, Robert Mendyk, Matt Neff, Leslie Overstreet, Ray Pawley, Chad Peeling, Clyde Peeling, and George Zug.

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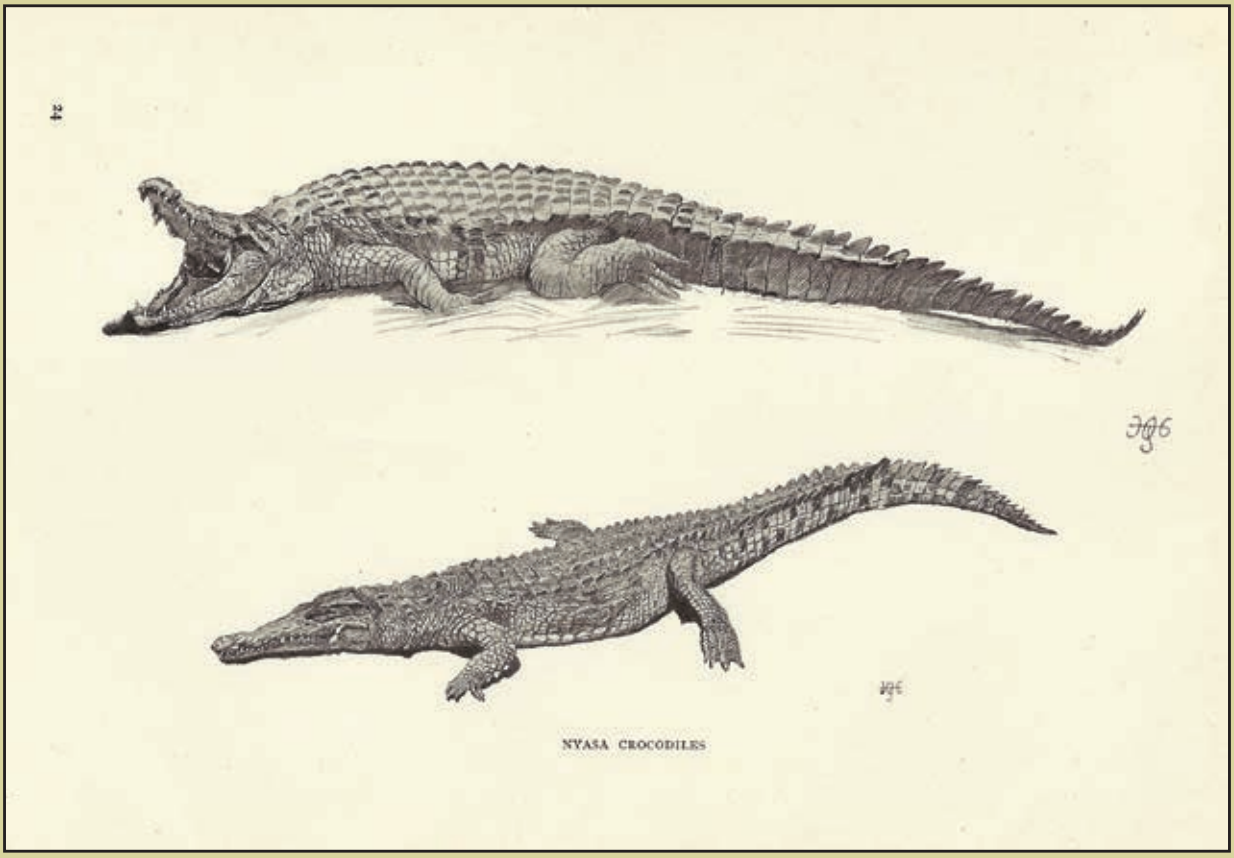
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NYASA CROCODILES
Harry Hamilton — original line drawing

Nyasa Crocodiles (*Crocodylus niloticus*). Original line drawing by Harry Hamilton Johnston (12 June 1858–31 July 1927) appearing on page 357 of his 1897 book *British Central Africa. An Attempt to Give Some Account of a Portion of the Territories under British Influence North of the Zambezi River* (Methuen & Co., London). Sir Harry Johnston was a prolific writer and explorer, and a very important figure in Britain's colonial expansion in Africa during the end of the 19th and beginning of the 20th centuries. He studied painting at the Royal Academy, having early shown an interest in drawing and painting birds. He frequented the Zoological Gardens in London and the British Museum (Natural History), and he independently studied zoology at Regent's Park and anatomy at the museum of the Royal College of Surgeons. After several exploring expeditions in Africa from 1879–1884, he entered the British Foreign Office in 1885 and was posted to Cameroon and the Niger River (1886, as Vice Consul, later Consul), Mozambique (1889, as Consul), Nyasaland (= Malawi) (1891, as British Commissioner for South Central Africa), Tunisia (1897, as Consul General), and Uganda (1899, as Special Commissioner). Johnston was a prolific writer, with more than 600 articles and books to his credit, including extensive accounts of African societies, peoples, languages, history, geography, and natural history, particularly in Liberia, Uganda, and Central and East Africa. He used his artistic talents to illustrate his books, and his natural history illustrations are of particularly high quality.

Nyasa Crocodiles is the only herpetological illustration in *British Central Africa*. Johnston traveled widely around Lake Nyasa and noted the abundance of crocodiles there. He was the first explorer to observe that Nile Crocodiles used their legs to rise-up and run awkwardly into the lake rather than slither as was commonly misperceived at the time. *British Central Africa* contains a short narrative of the reptiles, but not amphibians, recorded from the region (pp. 355–359) and an appendix of all species (pp. 361–362; 1 crocodile, 9 chelonians, 18 lizards, 21 snakes, 10 frogs). The narratives include personal observations of Johnston's encounters with reptiles, as well as native stories and anecdotes. More extensive herpetological observations and illustrations were included in Johnston's 1906 book *Liberia* (see Dodd 2014. Bibliotheca Herpetologica 10:33–43).

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ABOUT OUR COVER: *Celestus hylaius*



The 50 species of the lizard family Diploglossidae ("galliwasps") are distributed among three genera—*Celestus*, *Diploglossus*, and *Ophiodes*—with a collective range from Central to South America, including Caribbean islands. These are small to medium-sized lizards, usually found in forested habitats. Closely related to the Anguidae, they share many characteristics such as heavily armored bodies. The genus *Celestus* contains 29 species (Uetz and Hošek [eds.]. The Reptile Database, http://www.reptile-database.org, accessed 18 Oct 2014) of skink-like lizards defined by exposed claws on the digits, enlarged head scales, and other cranial scale features. *Celestus hylaius*, described in 1993 (Savage and Lips 1993. Revista de Biología Tropical 41:817–842), is a rarely encountered lizard of lowland wet and moist forests of the Atlantic versant of Costa Rica, at elevations of 40–403 m (Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna between Two Continents, between Two Seas. University of Chicago Press, Chicago, Illinois. 934 pp.). The individual depicted on our cover was found at an elevation of 700 m in the leaf litter on a trail at Rara Avis Rainforest Lodge and Reserve.

Several specimens of *Celestus hylaius* have been found over the years at Rara Avis during the course of long-running surveys by Twan Leenders and others. Rara Avis Reserve is located on the northeast border of Braulio Carillo National Park, Costa Rica. It is south of the renowned La Selva Biological Station, which is lowland forest. Rara Avis Reserve consists of primary and secondary forest on the slopes of Volcán Barva, with elevations ranging from 600–750 m. Rara Avis contains an amazing diversity of species such as nearly 400 species of birds, at least 46 species of amphibians, and 85 species of reptiles, including undescribed species.

Our cover subject was recorded in March 2010 by **Tim Paine**, using a Nikon D3 with a Nikon 105mm macro lens and two SB800 speedlights in soft boxes at f/22, 1/60s, ISO 200. Tim has made a substantial number of visits to Costa Rica, many working with Twan Leenders. When not engaged in herpetological and photographic pursuits, Tim serves as a police officer with the San Francisco Police Department, where he has worked for nearly 20 years. He travels often to Latin American destinations to photograph herps and is involved with TreeWalkers International and PrimatesPeru, two non-profits dedicated to research, conservation, and education. More of Tim's images and writing can be found at http://amphibios.org.

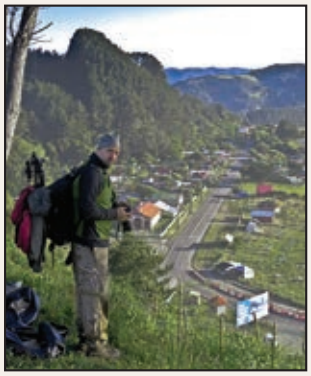


PHOTO BY W. W. LAMAR

SSAR BUSINESS

WELCOME LETTER FROM THE NEW SSAR PRESIDENT

AARON M. BAUER

WITH A SPECIAL MESSAGE FOR STUDENTS



PHOTO BY INDRANEIL DAS

Continuing in the tradition of recent past presidents I am pleased to have this opportunity to introduce myself to the SSAR membership and to lay out some of the upcoming opportunities and challenges that our society will be facing in the next few years. I was born in New York City and grew up on nearby Long Island, in Old Westbury and later in Mineola. I was strongly influenced by visits to the American Museum of Natural History and by the age of five had decided that I wanted to be a herpetologist — a decision that was solidified that year when I caught my first Smooth Greensnake (*Opheodrys vernalis*). When searching for universities, I looked for a place that offered undergraduate courses in herpetology and zoogeography and chose Michigan State University. Despite my interest in herpetology I had no idea what I would actually do with amphibians and reptiles, or how one made a living as a herpetologist. At MSU I took classes from two herpetologists, Jim Edwards and the late Max Hensley. In an advanced morphology course I had the opportunity to be the student host for Carl Gans and this helped point me in the direction of an academic career in reptile morphology. At MSU I also indulged my interest in history and did a second major in this field. Although my concentration at the time was in ancient history, I also did research in the history of science.

Largely through the influence of Jim Edwards, I applied to the University of California, Berkeley for doctoral work and was accepted in the lab of Marvalee Wake. At the time there were a record number of "lizard students" in the Museum of Vertebrate Zoology, including Kurt Schwenk, David Good, Kevin de Queiroz, Jonathon Losos, Claudia Luke, Fabian Jaksic, and Jonathon Carothers, who, along with Marvalee and David Wake, Harry Greene and the other students and faculty in the Department of Zoology and the MVZ, made Berkeley an incredibly exciting place to be. It was also a time when phylogenetic systematics was burgeoning and as I

progressed I realized that I needed to work on the systematics of my organisms before I could really interpret their morphology.

My first field trip was to Chiapas, Mexico, where Marvalee sent me to collect caecilians. I think I must be one of the only people whose first 30 field numbers were assigned to gymnophiones. With the help of small grants from the American Museum and the National Academy of Sciences, I made an extensive museum trip across the U.S. and the following year I did the same in Europe, spending three months in collections before carrying on to Australia, New Caledonia, and New Zealand, where I collected specimens for my dissertation on the systematics, evolutionary morphology, and biogeography of carphodactyline geckos (now Carphodactylidae and Diplodactylidae). I made several return trips to the South Pacific, especially to New Caledonia, and I became a true travel junkie.

Following graduation in 1986 I was hired to teach Comparative Vertebrate Anatomy for a semester at Berkeley, which allowed/forced me to develop a set of lectures for the course. I then moved to the University of Calgary for a postdoc with Tony Russell, a leader in the field of lizard morphology, with whom I had already been collaborating throughout my time at Berkeley. While at Calgary I made my first trip to southern Africa and almost my only foray into North American herpetology, publishing the book *The Amphibians and Reptiles of Alberta* with Tony.

In 1988 I moved to Villanova University, just west of Philadelphia, and have been there ever since. Villanova has no doctoral program, but I am the director of our Masters program, which attracts many excellent herpetology students. My current work centers on the phylogenetics, taxonomy, evolutionary morphology and biogeography of geckos, skinks, lacertids, cordylids, gerrhosaurs, and agamids in the Old World. My students and I work extensively in southern Africa (Namibia, South Africa, Angola, Zimbabwe, Botswana, Swaziland, Malawi), the South Pacific (Australia, New Zealand, New Caledonia), and tropical Asia (India, Sri Lanka, Malaysia, Thailand). I also work in the history of herpetology and herpetological collections from the 16th through the 19th centuries.

Professional Service

I have served the herpetological community in a variety of positions. I have served on the Board of Governors of ASIH and on the ASIH Planning and Finance, Nominations, Resolutions, and Honorary Foreign Member Committees. For The Herpetologists' League I served as a Board of Trustees member, president, and chair of the Symposium Committee, and Associate Editor for *Herpetologica*. I have also been chairman of the Herpetological Association of Africa and Secretary General of the World Congress of Herpetology. With respect to SSAR, I have been a member since 1982 and have served on the Resolutions committee, as chair of the Nominating Committee, as Editor of Facsimile Reprints in Herpetology, Book Review Editor for *Herpetological Review*, and as Associate Editor for *Journal of Herpetology*. I believe strongly in playing an active role in the societies to which I belong and encourage my students to do the same. I believe that even beginning students should choose at least one professional society to belong to and become invested: go to the business meeting, volunteer to review manuscripts or serve on committees, spread the word via social media, etc. This is an important part of becoming a professional in our field. It doesn't matter what society one joins, but participate. Student membership costs no more than a nice meal out or a night at the bar!

Challenges

For more than a decade the model of how herpetological societies support themselves has been undergoing massive changes, and the same is true for most, if not all, organismally-oriented professional societies. Revenue that once came from memberships is being replaced by revenue from electronic access, and with that access, available to most people at universities and museums—at least in developed countries, societies have seen drops in membership. SSAR has suffered less than some societies, but it has suffered nonetheless. When people do not join SSAR because they get *Journal of Herpetology* "for free" through their institution, they are missing much of the point of membership. In addition to the journals, there are meetings and book discounts and other tangible benefits. Then there is the intangible benefit of being part of a society of colleagues who are bound together by shared research and conservation goals and by their interest in a particular group of animals. Membership is a way of sharing in the proud tradition of herpetology as a discipline and of formally associating oneself with this field. It is critical for the continued health of SSAR that we retain and even grow the membership. This is not a purely financial concern. As a society with unpaid officers and editors, our ability to provide the benefits enjoyed by our members is dependent on having a pool of volunteers who will step up and contribute. Student members are vitally important as they are the editors and officers of the future and ensure the continuity of the society and of the products and services that SSAR provides to the herpetological community as a whole.

Another challenge is how we disseminate information about SSAR and how we distribute our publications. SSAR has always been distinguished by its diverse series of publications, featuring *Journal of Herpetology* and *Herpetological Review*, but also including *Herpetological Circulars*, the *Catalogue of American Amphibians and Reptiles* (*CAAR*), and our three book series: *Contributions to Herpetology*, *Facsimiles Reprints in Herpetology*, and *Herpetological Conservation*. Our journals are now distributed both in hard copy and electronically, and CAAR has transitioned to electronic format only. Despite the ubiquity of pdfs, many members still prefer hard copy and for the immediate future we will continue to provide options for journal content delivery. Our other publications remain in high demand and meet the needs of our broad membership, however, book production is changing rapidly and the market for hard copy books has changed in recent years. SSAR will work to continuously evaluate how best to keep costs low, facilitate access, and continue to serve the diverse interests of the herpetological community. Members will have noticed the recent update of the SSAR website (ssarherps.org) and, as a society, we are striving to make the site as useful as possible and to use both it and social media to attract new members and keep current members in contact and up-to-date about publications, services, news, and events.

2015 SSAR Meeting in Lawrence, Kansas

For many years SSAR has annually met jointly with our sister societies, The Herpetologists' League (HL) and the American Society of Ichthyologists and Herpetologists (ASIH). This year, however, we will meet independently of these groups at the University of Kansas in Lawrence and will welcome PARC (Partners in Amphibian and Reptile Conservation), CNAH (Center for North

American Herpetology), the herpetological societies of Kansas, Missouri, and Arkansas, and the International Society for the History and Bibliography of Herpetology, as co-sponsoring societies. While SSAR values its association with HL and ASIH, the Lawrence meeting will provide members with something special. With the 2015 meeting, SSAR returns to its historical origins on a university campus. With fewer participants than a joint meeting and more opportunities to interact, the conference promises to be memorable. For most students, accustomed to hotel and convention center-based meetings, the KU meeting will be a new experience. In addition to traditional activities, like the auction, student social, and president's travelogue, the meeting will feature many special events including a herpetological quiz, live animal display (Kansas species), rare book exhibit, tour of the Henry Fitch Natural History Reserve, and the newly revised and digitized audio-visual shows "Amphibians of the Appalachians" and "Herpetologists Past and Present" not seen for many years. A special reception will honor senior herpetologists, some of whom have not attended our meetings in many years, and will provide students and others with the chance to meet their herpetological heroes. Rounded out by a stellar slate of featured speakers and excellent symposia (see advertisement on pages 150–151 in this issue), the 2015 meetings will be a celebration of herpetology and a showcase for SSAR and its many activities. Thank you for your membership and for your support of SSAR. I look forward to seeing you in Lawrence, Kansas this summer (July 30–August 3, 2015). Be sure to go to SSAR2015.ku.edu to register and see more details about the meeting.



Aaron M. Bauer
President, SSAR

SSAR Student Poster Awards Named for Victor Hutchison



The SSAR Board of Directors recently decided to name its annual awards for the best student posters presented at its meetings in honor of Victor H. Hutchison, the George Lynn Cross Research Professor Emeritus at the University of Oklahoma. Vic is a long-time and active member of the Society, beginning in the 1960s during its primordial stage as The Ohio Herpetological Society. He organized and ran two of our annual meetings: the 1972 session at the Oklahoma Biological Station, located on the north shore of Lake Texoma at the Texas-Oklahoma border, and the 1984 event on the University of Oklahoma's main campus in Norman near Oklahoma City. He was a Director of SSAR in 1986–1988 and served as our President in 1999.

Vic is a native of Georgia and received his master's and doctoral degrees at Duke University under the mentorship of Joseph Bailey and Knut Schmidt-Nielsen. He began his professorial career at the University of Rhode Island and moved to the University of Oklahoma as professor and zoology department chairman in 1970. He had served in the U.S. Army in Korea during 1952–1954 and retired as a full colonel in the active reserve in 1982. His research interests are broad and include environmental physiology; physiological ecology, respiration, and metabolism in amphibians and reptiles; and thermal tolerances in vertebrates. He is perhaps best known to herpetologists for developing the critical thermal maxima concept, research on respiratory gas exchange in amphibians, and for proving experimentally that the heat produced by brooding pythons is due to coordinated spasmodic contractions of the body musculature. He mentored more than 40 graduate students, among them Gustav Engbretson, Terry Graham, Ronald Gratz, James Lazell, Lynette Sievert, Allen Vinegar, and Walter Whitford who received PhDs under his supervision. Vic is a Fellow of AAAS, and he was a Guggenheim Fellow and an NSF Visiting Fellow in Poland. He served as President of ASIH in 1988. He has also been a leader in conservation and science education at the state and national levels. Since 1993 he has served as Editor of the Animal Natural History book series for the University of Oklahoma Press.

It is a distinct honor for SSAR to associate Vic's name with its program to recognize outstanding research conducted by students. Doing so adds greatly to the prestige of these awards.

Herpetological Conservation

A book-length series published by SSAR

Herpetological Conservation is an underused publication outlet devoted to the conservation and management of amphibians and reptiles. Books in this periodic series have been peer-reviewed contributions containing separate chapters and sections. The first two were on Canadian herpetology and the third was on urban herpetology.

I am seeking proposals for the next volume (Number 4). Points that should be addressed: topic is applicable to herp conservation and management, geographic coverage is global in scope or at least broadly regional, and the work makes an important contribution to a topic not well covered by other publications. Send inquiries to Joe Mitchell at dr.joe.mitchell@gmail.com.

NEWSNOTES

Biology of the Reptilia Online Completed



It is with great pleasure that the Gans Collections and Charitable Fund announces that the Biology of the Reptilia is now fully online. This includes all 22 volumes of the set, consisting of approximately 14,000 pages. Visitors to the site CarlGans.org can now browse the full Table of Contents of the series, directly access the Full Content of every volume, and quickly find material through the 26-page A–Z Index of the Entire Series.

Every page is viewable individually in an embedded PDF viewer, where the researcher can quickly jump to the desired page, or browse page by page through an entire volume. Additionally, illustrated plates that were embedded between pages are now available at the end of each volume.

The full series is a major reference work in the areas of Morphology, Physiology, Ecology, Behavior, Neurology, and Development. It is hoped that easy access to this reference guide will inspire and enable further research in these fields.

Posthumous Honor for Ilya Darevsky



IMAGE COURTESY OF IGOR V. DORONIN, RUSSIAN ACADEMY OF SCIENCES, SAINT PETERSBURG

Former SSAR member Ilya Sergeevich Darevsky (1924–2009), academician of the Soviet Academy of Sciences and the discoverer of natural parthenogenesis in reptiles, was recently honored by the Russian Postal Service with a commemorative post card. On December 18, 2014, the 90th anniversary of his birth, a symposium was held to honor him at the Academy of Sciences in Saint Petersburg where he was head of the Division of Herpetology and Ornithology. Darevsky became a member of the society in the mid-1960s. His first published paper in English appeared in the society's Journal in 1966, which introduced his important research to a wide audience in Western countries. For more details on his life, see his obituary in *Herpetological Review*, vol. 40, pages 401–403, 2009.

2014 Sabin Conservation Prizes



Sabin Conservation Prizes for 2014 were awarded at a special luncheon held in New York City on 20 January 2015. Emcee Russ Mittermeier noted that species-based conservation support is generally decreasing, making the awards provided by the Sabin Family Foundation especially important. Each awardee received a US $20,000 honorarium.

The 2014 Sabin Turtle Conservation Prize was awarded to **Margaretha Hofmeyr**, Emeritus Professor in the Biodiversity and Conservation Biology Department at the University of the Western Cape in South Africa. Her research initially focused on large mammals but she switched to chelonians when she resumed her research career after raising three children. In 1996 she initiated and developed a research program on Chelonian Biodiversity and Conservation for South Africa, and that has been her focus ever since. Living in the world's center of tortoise species richness, she has worked and published on many species of *Psammobates, Homopus, Kinixys, Chersina, Stigmochelys* and the turtle *Pelomedusa*. Her work on the Geometric Tortoise (*Psammobates geometricus*) has been critical to the continuing survival of this species. After the 2012 fire that destroyed at



PHOTO BY OF TURTLE CONSERVANCY/M. MAURER

Margaretha Hofmeyr, shown here receiving the 2014 Sabin Turtle Conservation Prize from Andrew Sabin (left) and Eric Goode (center).

least half of the population at the Elandsberg Reserve, she was instrumental in leading the recovery program for that population, formerly the largest known of Geometric Tortoises. She pioneered semi-captive management and breeding and has developed a workable head-start method for this species, which has never been bred in captivity. She collaborates widely with other tortoise biologists and works closely with several governmental conservation agencies. Recently, she led South Africa's submission to the IUCN Tortoise and Freshwater Turtle Specialist Group's Red-listing meeting in Togo for sub-Saharan chelonians. This work has resulted in the uplifting of several South African species, including the Geometric Tortoise. Her combination of broad scale strategic planning and closely focused fieldwork has put her in the front ranks of turtle conservationists. Her current research focuses on the diversity, distribution and niche requirements of southern African tortoises, and the conservation management of Geometric Tortoises.

PHOTO COURTESY OF TURTLE CONSERVANCY/M. MAURER



Carlos Vásquz Almazán is shown here accepting the 2014 Sabin Amphibian Conservation Prize from Andrew Sabin (left) and Robin Moore (center).

The 2014 Sabin Amphibian Conservation Prize was awarded to **Carlos Vásquez Almazán**, a rapidly emerging leader in the conservation of Central America's amphibians. Carlos is effectively bridging the gaps among science, conservation action, and community engagement to identify and protect some of the most critical habitats in Guatemala.

Carlos was instrumental in one of the landmark success stories of recent years: the creation of the Sierra Caral Amphibian Reserve. The reserve, which protects the single most biodiverse forest remnant in Caribbean Guatemala and numerous amphibians found nowhere else, was recently expanded by the Guatemala National Congress to encompass 47,000 acres of lush forest.

Carlos continues to build on the success of the Sierra Caral by working with local and international partners towards the protection of the rich forests of the Cuchumatanes Mountains of northwest Guatemala, home to several endemic and Threatened salamanders and frogs.

SSAR congratulates Margaretha Hofmeyr and Carlos Vásquez Almazán for this recognition, and also acknowledges the critical support from Andrew Sabin for his important role in encouraging these conservation initiatives.

—Submitted by Ross Kiester

The Kenya Reptile Atlas



With initial funding from the Rufford Foundation and supported by the National Museum of Kenya, a team of five herpetologists—Stephen Spawls, Patrick Malonza, Beryl Bwong, Victor Wasonga, and Vincent Muchai—are producing a free online atlas of all of Kenya's reptiles, available at www.kenyareptileatlas.com. For each species there is a map, showing the distribution of that species within Kenya by quarter-degree squares, color illustrations, often several showing different forms, and a description. At present, accounts are available for all of Kenya's vipers, elapids, burrowing snakes (Atractaspidinae and Aparallactinae), chameleons, agamas, and medically important rear-fanged snakes, plus fully updated checklists for all of Kenya's reptiles. To obtain any account go to the website and click on downloads. Eventually, accounts for all Kenyan reptile species will be available, to be followed by regular updates. We encourage herpetologists to please spread the word, download the material, and use it as you see fit. We are particularly keen that schools and other educational institutions make use of the data. Any picture that's not marked as copyright belongs to Steve Spawls and anyone is welcome to use those pictures. Anyone wanting want high-resolution scans of any pictures by Steve, contact him at stevespawls@hotmail.com. We encourage participation and contribution; if you have photographs of any Kenya reptiles, please send them to Kenyareptileatlas@gmail.com. Anyone in Kenya finding specimens is urged to deposit them at the Herpetology Section at the National Museum in Nairobi.

—Submitted by Stephen Spawls

MEETINGS

Meeting announcement information should be sent directly to the Editor (herpreview@gmail.com) well in advance of the event. We also welcome brief reports of meetings; please consult the Editor for details.

2–5 April 2015—62nd Annual Meeting of the Southwestern Association of Naturalists, San Diego, California, USA. Information: http://www.biosurvey.ou.edu/swan/annualm.html

18–19 April 2015—Terrapin, Tortoise & Freshwater Turtle Meeting, Dalaman, Mugla, Turkey. Information: Chelonian1@aol.com (Chuck Schaffer).

19–24 April 2015—35th Annual Symposium on Sea Turtle Biology and Conservation, Dalaman, Muğla, Turkey. International Sea Turtle Society. Information: http://iconferences.seaturtle.org/

27–30 May 2015—38th Annual International Herpetological Symposium, San Antonio, Texas, USA. Information: www.internationalherpetologicalsymposium.com

15–19 July 2015—American Society of Ichthyologists and Herpetologists and The Herpetologists' League annual meeting, Reno, Nevada, USA. Information: www.asih.org

27–29 July 2015—World Conference on Monitor Lizards, Bangkok, Thailand. Information: monitor.conference.2015@gmail.com (and see announcement below).

30 July–3 August 2015—58th Annual Meeting of the Society for the Study of Amphibians and Reptiles (with Partners in Amphibian and Reptile Conservation, Kansas Herpetological Society, and International Society for the History and Bibliography of Herpetology), Lawrence, Kansas, USA. Information: www.SSAR2015.ku.edu

18–20 August 2015—Northeast Partners in Amphibian and Reptile Conservation (NEPARC) annual meeting, Greenwich, Rhode Island, USA. Information: http://northeastparc.org/next-meeting-info/

Brief Review of the XIII National Mexican Herpetological Meeting

From 4–7 November 2014, the XIII National Meeting of Herpetology was hosted by the Universidad Autónoma de Aguascalientes, organized by Sociedad Herpetológica Mexicana A. C. (SHM). The overall event was coordinated by the executive board of 2012–2014: MSc. Gustavo Ernesto Quintero-Diaz (President), Dr. Víctor H. Luja-Molina (Vice President), Dr. Jorge E. Morales-Mávil (Secretary General), MSc. Jazmín Cobos-Silva (Treasurer), MSc. Roberto Luna-Reyes (Southern Representative), MSc. Henry Fahd Carmona-Torres (Central Representative), and Biol. Javier Banda-Leal (Northern Representative). Herpetologists from several countries, including Argentina, Brazil, Colombia, Cuba, Honduras, United States of America, and Mexico, were in attendance to discuss topics on Mexican amphibians and reptiles.



PHOTO BY IVAN AHUMADA-CARRILLO

Bothriechis rowleyi, one of the rarest and most beautiful venomous snakes in Mexico.



PHOTO BY BRUNO ENRIQUE TÉLLEZ-BAÑOS

Agalychnis callidryas, a stunning example of Mexico's amphibian diversity.



PHOTO BY HECTOR F. NIETO-LOPEZ

Attendees at the XIII National Mexican Herpetological Meeting, Aguascalientes, Mexico.

During the meeting five distinguished speakers made presentations invited by the SHM. In addition two symposia and five workshops/courses were offered. In all there were 111 oral and 72 poster presentations, of which 41 were formal degree presentations.

Five new or recently published books were presented. The first was *Theoretical and Methodological Guide on the Information and Handling of Herpetofauna*, by MSc. Gustavo Jiménez-Velázquez, Biol. Jaén Alberto Sandoval-Quintero, and Dr. Nuri Trigo-Boix. Dra. Ireri Suazo-Ortuño gave an overview of the book.

The second was *Amphibians and Reptiles of Hidalgo, Mexico: Diversity, Biogeography and Conservation*, by Dr. Aurelio Ramírez-Bautista, MSc. Uriel Hernández-Salinas, MSc. Raciel Cruz-Elizalde, Biol. Christian Berriozabal-Islands, Biol. Daniel Lara-Tufino, Dr. Irene Goyenechea-Mayer, and MSc. Jesus M. Castle-Ceron. The book was presented by MSc. Guadalupe Gutiérrez-Mayén, who spoke eloquently about the history of the book and received positive comments for the authors.

The third and fourth books were *The Turtles of Mexico. Land and Freshwater Forms*, by John M. Legler and Richard C. Vogt; and *The Turtles of Amazonia*, by Richard C. Vogt. The fifth book, *Guide of Amphibians and Reptiles of Charco Azul, Xichú, Guanajuato*, by Dr. Adrián Leyte-Manríquez and Biol. Matías Domínguez-Laso, was presented by Dr. Jesús Sigala-Rodríguez.

Among the speakers was Dr. Rulon W. Clark, Professor in the Department of Biology, San Diego State University (USA). Dr. Clark focused on predators and anti-predator behavior of rattlesnakes. We also received a presentation by Dr. Sean M. Rovito on the evolution of lungless salamanders. Dr. Rovito is a research professor at the National Laboratory of Genomics for Biodiversity (CINVESTAV) in Mexico and presented a discussion on "New revelations about an adaptive radiation."

Dr. Richard C. Vogt, researcher at the National Institute for Research in the Amazon (Brazil), presented "Acoustic communication in aquatic turtles." Two other presentations were offered, the first by the leading researcher in Mexico on amphibians, Dra. Gabriela Parra-Olea, from the Institute de Biologia (UNAM), who addressed the issue of "Emerging infectious diseases and the decline of amphibians." In the second, Biol. Roberto Arreola-Alemón of CONABIO spoke about "Citizen science, social networks and their contribution to the understanding of the amphibians and reptiles of Mexico."

Worth special mention were two symposia conducted within the XIII Reunion Nacional de Herpetologia. The first symposium was organized by Dr. Oscar Flores-Villela from the Facultad de Ciencias (UNAM). This consisted of an eloquent tribute to Dr. Hobart Muir Smith, prominent scientist from the United States who spent much of his lifetime on the study of the amphibians and reptiles of Mexico. The event was conducted by his son, Bruce Smith (accompanied by wife Dorothy and daughter Rebecca). In addition, we were honored with the presence of Mr. Miguel Cerón-Herrera, now 95 years of age, whose experience as expressed by himself and his daughter, transported the attendees to the mountains of Veracruz, the site where, as children, he and his brother had first been contacted by Dr. Hobart Smith. The Cerón brothers were the ones who guided Dr. Smith and other visiting researchers to many collecting sites in the area.

The second symposium was coordinated by Dr. Jesús Sigala-Rodríguez (Universidad Autónoma de Aguascalientes) and presented topics on "Poisonous Snakes." In the symposium, Dr. Sigala-Rodriguez presented the "Specialist Group" and gave a presentation on viperids and the International Union for the Conservation of Nature. Additional presentations included: Dr. Ana Gatica-Colima (Universidad Autónoma de Ciudad Juárez), "The state of conservation of rattlesnakes in the desert area of northwest Mexico;" Alan Kardon (San Antonio Zoo), "Maintenance and captive reproduction of new world pitvipers at the San Antonio Zoo;" Dr. David Lazcano (Universidad Autónoma de Nuevo Leon, Facultad de Ciencias Biológicas), "Variation in body weight in three mountain species of rattlesnakes, *Crotalus aquilus* (Klauber, 1972), *Crotalus lepidus* (Kennicott, 1861) and *Crotalus willardi* (Meek, 1905), under captive conditions."

Biol Raúl Hernández-Arciga (Herpetario de San Luis de la Paz, Guanajuato) presented a "National snake panorama review;" Dr. Alejandro Carbajal-Suacedo (Herpetario Kuiana) presented "Protocol for safe handling of snakes"; Biol. Guillermo Gil-Alarcón (Departamento de Prevención de Riesgos de la Dirección General de Divulgación de la Ciencia [DGDC], Universum, Museo de las Ciencias, de la UNAM) presented "Network support for snake accidents;" and the last presentation was given by MSc. Gustavo Jiménez-Velázquez (UNAM and Vida Silvestre Cóatl A.C) titled "Geographic and ecological distribution of mountain rattlesnakes via an ecological niche modeling and its application in their conservation."

Additionally, more than 60 photographs of amphibians of Mexico, provided by MSc. Roberto Luna-Reyes, were exhibited to highlight conservation of amphibians in Chiapas.

As a final event, a general plenary of the SHM took place and the outgoing executive board presented its report. In the same assembly, a new executive board was elected for the period

(2014–2016), and consists of Dr. Víctor H. Luja-Molina (President), MSc. Guadalupe Gutiérrez-Mayén (Vice President), Dr. Ana Gatica-Colima (Secretary General), MSc. Jazmín Cobos-Silva (Treasurer), MSc. Roberto Luna-Reyes (Southern Representative), Biol. Guillermo Gil-Alarcón (Central Representative), and MSc. Anny Peralta-Garcia (Northern Representative).

Students who attended and presented their projects could enroll in five different workshops/courses: 1) "Principles of GIS (Geographic Information Systems) maps with quality for publication" (Biol. José Carlos Arenas-Monroy, Laboratorio de Herpetologia, Facultad de Ciencias, UNAM); 2) "Management of poisonous reptiles" (MSc Eric Abdel Rivas-Mercado, Universidad Autónoma de Aguascalientes; 3) "First aid, update on the study of poisons and treatment in snake accidents" (Biol. Guillermo Gil-Alarcón, Dr. Alejandro Carbajal-Saucedo, and MSc. Fahd Henry Carmona-Torres (UNAM); 4) "Methods for estimating biodiversity" (MSc. Victor Hugo González-Sánchez, Universidad Autónoma de Aguascalientes); 5) "Techniques for rock climbing in herpetology" (Biol. Juan Daniel Rendon-Trinidad, Universidad Autónoma de Aguascalientes).

Anyone interested in Mexican herpetology is welcome to become a member of the society. We also encourage researchers interested in working in Mexican herpetology to contact any members of the board for information. For those interested in obtaining copies of the latest program of activities please consult our web page (http://www.sociedadherpetologicamexicana.org/). The new executive board plans to update the web page, as well as publish our new electronic journal (*Revista Mexicana de Herpetologia*) for all members and welcomes contributions to the journal. Our next meeting for November 2016 will be hosted by the Universidad Autónoma de Nayarit; this will be the first time the meeting will take place there. Nayarit, like many states of Mexico, is a beautiful place for any type of academic activity.

We thank Dr. Robert L. Bezy (Natural History Museum of Los Angeles County) and Dr. David Lazcano (Universidad Autónoma de Nuevo León) for their suggestions and helping out with the English version of this manuscript, and for documenting this important event for all of us that enjoy working with Mexican herpetology.

—Submitted by Víctor H. Luja and Gustavo Ernesto Quintero-Díaz

HERPETOLOGICAL NOMENCLATURE

The years 2013–2014 have been especially controversial ones insofar as herpetological nomenclature is concerned. It began with an article in this journal by Kaiser et al. (2013) recommending a standard of best practices for systematic herpetology. The article in particular reviewed the practices of R. T. Hoser and his notorious *Journal of Australasian Herpetology*. In that "journal" he has created hundreds of taxonomic names proposed in ways that most herpetologists think do not meet the conditions for publication required by the International Code of Zoological Nomenclature (International Commission of Zoological Nomenclature 1999). In what is clearly a ploy to legitimatize his journal, Hoser has applied to the Commission in Case 3601 (see below) to endorse his claims that his "journal" meets the requirements of the Code thereby making his multitude of new names available.

Kaiser et al. (2014) countered Hoser's contentions and there is widespread support in the herpetological community for placement of all issues of the *Journal of Australasian Herpetology* on the Index of Rejected and Invalid Works in Zoological Nomenclature. This action is certainly within the purview of the Commission under Arts. 78 and 81 relating to the Plenary Power, which may be invoked to suppress a particular name or works that would "disturb stability or universality or cause confusion."

The problems raised by the Hoser case clearly test the long held notion that the Commission not make judgments on the taxonomic quality of an author's work by applying the Code in as neutral manner as possible. Nevertheless, in ruling on individual cases presented to the Commission, the attempt at neutrality is not uniformly successful. In almost all cases, there are differences of opinion among the Commissioners, hence the requirement that approval of most applications be a simple majority, but where the Plenary Power is involved a two-thirds majority is required for approval. Because of these concerns, Commissioners Harvey and Yanega (2013) prepared a brief, very thoughtful, document requesting advice from the taxonomic community as a whole on possibly changing the guidelines for Commission actions to deal with such extreme cases as Hoser's. They asked that responses address the issues they raise not the specific case that has led to the controversy. The results of their survey have not yet been published and there is still time to comment anonymously on their questions via the Commission website.

While all this activity was going on, major changes took place in the location and operations of the Commission. A major financial crisis led to the dissolution of the International Trust for Zoological Nomenclature that had long been the financial entity supporting Commission activity. In another move, the University of Singapore agreed to provide space and staff for the coordinating activities of the Commission, for three years. A small staff, including the editor of the *Bulletin of Zoological Nomenclature* (BZN), will remain at the Natural History Museum in London. Visit the ICZN website (http://iczn.org/) for more details. The University of Singapore's rescue is temporary and it remains to be seen if the Zoological community will rise to the occasion and develop a funding plan that insures the continuance of the vital functions of the Commission.

Recent Rulings on Herpetological Names
(BZN = *Bulletin of Zoological Nomenclature*)

Opinion 2328 (Case 3571). *Crotalinus catenatus* Rafinesque, 1818 (currently *Sistrurus catenatus*) and *Crotalinus tergeminus* Say in James, 1822 (currently *Sisturus tergeminus*; Reptilia, Serpentes): usage conserved by designation of neotypes for both species. BZN 70(4):282–283.

Opinion 2331 (Case 2331) *Cetiosaurus* Owen, 1841 (Dinosauria, Sauropoda): usage conserved by designation of *Cetiosaurus oxoniensis* Philipps, 1871 as the type species. BZN 71(1):48–50.

Opinion 2350 (Case 3566) *Tropidolaemus* Wagler, 1830 and *Cophias wagleri* F. Boie, 1827 (currently *Tropidolaemus wagleri*) (Reptilia, Squamata, VIPERIDAE): usage conserved. BZN 71(4):271–273.

Pending Cases of Herpetological Interest

Case 3625. *Kinosternon chimalhuaca* Berry, Seidel, & Iverson in Rogner, 1996 (Reptilia, Testudines): proposed confirmation of the publication date. BZN 70(3):190–102.

Case 3628. *Terrapene putnami* Hay, 1906 (Testudines, EMYDIDAE): replacement of the holotype by designation of a neotype. BZN 70(3):193–198.

Case 3601. *Spracklandus* Hoser, 2009 (Reptilia, Serpentes, Elapidae): Request for the confirmation of the availability of the generic name and for the nomenclatural validation of the journal in which it was published. BZN 70(4):234–237.

Case 2641. *Ascalabotes sthenodactylus* Lichtenstein, 1823 (currently *Stenodactylus sthenodactylus*; Reptilia, Gekkota, GEKKONIDAE): proposed conservation of current usage of the specific name by designation of a neotype. BZN 71(1):17–21.

Case 2629. *Vipera latastei* Boscá, 1878 (Reptilia, Serpentes, VIPERIDAE): request for conservation of the original spelling. BZN 71(1):22–25.

Case 3666. Dicroglossidae Dubois, 1987 (Amphibia, Anura): proposed conservation. BZN 71(4):244–249.

Literature Cited

Harvey, M., and D. Yanega. 2013. Call for comments: taxonomic practice and the code. Bull. Zool. Nomen. 70(4):216–217.

International Commission on Zoological Nomenclature. 1999. International Code of Zoological Nomenclature, 4th ed. Larangola, Paudua. 306 pp.

Kaiser, H., B. I. Crother, C. M. R. Kelly, L. Luiselli, M. O'Shea, P. Passos, W. D. Schleip, and W. Wüster. 2013. Best practices: in 21st century, taxonomic decisions in herpetology are acceptable only when supported by a body of evidence and published via peer-review. Herpetol. Rev. 44(1):8–23.

———, W. D. Schleip, W. Wüster, D. G, Broadley, and V. Wallach. 2014. Comments: On *Spracklandus* Hoser, 2009 (Reptilia, Serpentes, ELAPIDAE): request for confirmation of the availability of the generic name and for the nomenclatural validation of the journal in which it was published. Bull. Zool. Nomen. 71(1):30–38.

—Jay M. Savage, Section Editor

CURRENT RESEARCH

The purpose of Current Research is to present brief summaries and citations for selected papers from journals other than those published by the American Society of Ichthyologists and Herpetologists, The Herpetologists' League, and the Society for the Study of Amphibians and Reptiles. Limited space prohibits comprehensive coverage of the literature, but an effort will be made to cover a variety of taxa and topics. To ensure that the coverage is as broad and current as possible, authors are invited to send reprints to the Current Research section editors, Ben Lowe or Chava Weitzman; e-mail addresses may be found on the inside front cover.

Acoustic Mimicry of Vipers in a Natricine Snake

It is generally accepted that snakes hiss to intimidate potential predators and dissuade large herbivores from trampling them. A special case of the former that has been hypothesized is that hissing in harmless snakes may sometimes serve to increase resemblance to a venomous species, principally vipers. To test this hypothesis in a suspected case of Batesian mimicry, the authors of this study made audio recordings of three snake species: Asp Viper (*Vipera aspis*, the model), Viperine Snake (*Natrix maura*, the suspected mimic), and Grass Snake (*Natrix natrix*, not considered a viper mimic and included as a control). Animals were collected along the Lez River in southwestern France, measured and recorded hissing in the laboratory, and released. Hissing in snakes consists of four elements: inhalation, exhalation (generally the loudest element), and brief pauses after each. Focusing on exhalation, various spectral components of this element were teased out and included in a principal component analysis (PCA), and each spectral component was evaluated independently across the species in an ANOVA. Furthermore, in- and exhalation duration variation was investigated with respect to species and size using general linear models. These investigations revealed size was not correlated with exhalation duration, and the species did not differ in exhalation duration. To the contrary, inhalation length of Asp Vipers was significantly longer than for *Natrix*, and while all Asp Vipers and most Viperine Snakes performed the inhale element, only a quarter of Grass Snakes did so. Plotting the first two axes from the PCA showed the Asp Viper and Grass Snake form non-overlapping clusters, while the Viperine Snake occupies a broader space that greatly overlaps those of the other two species. ANOVAs performed on the spectral component data showed the species differed significantly, and post-hoc tests revealed the Grass Snake hiss differed significantly from that of the Asp Viper and Viperine Snake, but that the latter two were indistinguishable. The authors argue this hiss similarity is best explained as selection on Viperine Snakes to resemble Asp Vipers, a similarity which had plenty of time to evolve as phylogeographic evidence suggests the two species have been sympatric for 22 million years.

Aubret, F., and A. Mangin. 2014. The snake hiss: potential acoustic mimicry in a viper-colubrid complex. Biological Journal of the Linnean Society (*in press*) doi: 10.1111/bij.12374

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Factors Associated with Non-Native Reptile Establishment Success Identified

Introduction and establishment of non-native species was a common phenomenon in the twentieth century, and promises to be so in the twenty-first as well. Numerous studies have investigated invasive species with the goal of identifying

characteristics correlated with successful establishment, however, most of these studies focused on regional fauna. With the hopes of bringing a global perspective and rigorous methods to this question, the authors of this paper made use of a previously-published dataset of 1307 reptile introductions (involving 398 species), 708 of which have progressed to establishment. Following supplementation by the authors, this dataset included 32 variables divided between three general categories: 1) ecology/life history, 2) geographic specifics of introduction, and 3) non-geographic specifics of introduction. (The latter category included time since introduction, number of prior introductions, and intentional vs. accidental.) This dataset was analyzed using generalized linear mixed modeling methods, which identify statistically significant correlates from a set of variables. Each of the three categories were analyzed independently to identify important variables within each category, and variables found to meet a relaxed threshold of support in these analyses were subsequently analyzed in a "global" analysis allowing comparisons between categories. The authors found variables that correlate with successful introduction in each of the three general categories: 1) parthenogenesis, an herbivorous diet, a large native range, 2) a small latitudinal differential between native and introduced ranges, the presence of congeners in the area of introduction, 3) longer time since first introduction, and number of introductions. The global analysis found category 2 (geographic specifics of introduction) explained the highest proportion of establishment success variation, followed by the non-geographic introduction specifics, followed by the ecology/life history traits. Two additional ecology/life history characteristics, high fecundity and small size, were identified as important in the global analysis, and one of the category 2 traits found to be important in the category specific analysis (presence of congeners) became non-significant. The authors point out this is the first study to quantify the importance of parthenogenesis in invasive species establishment, and stress the importance of taking life history and ecology into account when considering the risk of non-native reptile introductions.

Mahoney, P. J., K. H. Beard, A. M. Durso, A. G. Tallian, A. L. Long, R. J. Kindermann, N. E. Nolan, D. Kinka, and H. E. Mohn. 2014. Introduction effort, climate matching and species traits as predictors of global establishment success in non-native reptiles. Diversity & Distributions (*in press*) doi: 10.1111/ddi.12240.

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Hot, Dry Costa Rican Peninsula a Climatic Refuge from *Bd*

The persistence of *Bd*-vulnerable frog species in some habitats despite extirpation elsewhere has led researchers to propose the "climatic refuge" hypothesis, in which climatic conditions unfavorable to the growth of *Bd* protect these populations from the fungal infection. One climatic refuge from *Bd* has been demonstrated in Australia's Wet Tropics, and as another region that has experienced devastating amphibian declines, Costa Rica also represents a potential place to find climatic refuges from *Bd*. The authors of this paper surveyed two frog communities for *Bd*: one on the Costa Rica's Santa Elena Peninsula, the country's driest region and most likely a climatic refuge from *Bd*, and the Sector Santa Rosa del Área de Conservación Guanacaste (Santa Rosa), a site 16 km away from the first but considerably cooler and wetter, serving as a control. Areas were surveyed two consecutive years at the beginning of the wet season. This entailed swabbing all frogs encountered as well as checking them for visible pathology related to *Bd*. Of special interest was the species *Craugastor ranoides*, which was widespread across Costa Rica but has recently become extirpated from all but the Santa Elena Peninsula (and is considered highly susceptible to *Bd*). Swabs were assayed for *Bd* presence and load through real-time PCR methods. Additionally, employing temperature and precipitation data layers, GIS methods were performed to determine if the climatic envelope for extant *C. ranoides* populations differed from that of the recently extirpated populations. Out of 310 Santa Elena Peninsula samples (114 of which were *C. ranoides*), only one (a *C. ranoides*) tested positive for *Bd*. Prevalence was higher at Santa Rosa (9 of 100), with the Tungara Frog (Leiuperidae: *Engystomops pustulosus*) being the most frequently infected (6 of 19). At both locations, the highest zoospore counts observed were an order of magnitude lower than the count widely recognized to be fatal and/or representative of a mass outbreak (10,000 zoospores), and no *Bd*-associated pathology was seen. The climatic envelope of the extant *C. ranoides* populations was indeed outside the envelope encompassing the extirpated populations, with the Santa Elena Peninsula localities being drier than all and hotter than most extirpated populations. The low prevalence of *Bd* in the Santa Elena Peninsula, coupled with the persistence of a species considered vulnerable to *Bd* supports the hypothesis that this hot, dry area is serving as a climatic refuge for anurans.

Zumbado-Ulate, H., F. Bolaños, G. Gutiérrez-Espeleta, and R. Puschendorf. 2014. Extremely low prevalence of *Batrachochytrium dendrobatidis* in frog populations from Neotropical Dry Forest of Costa Rica supports the existence of a climatic refuge from disease. EcoHealth (*in press*) doi: 10.1007/s10393-014-0967-2.

Correspondence to: **HÉCTOR ZUMBADO-ULATE**, School of Biology, University of Costa Rica, San Pedro de Montes de Oca, San Jose, Costa Rica; e-mail: hugozu1@yahoo.com

Rapid Thermal Acclimation in Australian Cane Toads

The ecology of Cane Toads (*Rhinella marina*) in Australia has been studied intensely, due to the insights into invasion ecology afforded. Observations of the toads occupying Australian regions cooler than those occupied in most of their native range led the authors of this paper to examine thermal tolerance and acclimation in toads occurring at two cool, high-elevation sites within Border Ranges and Nightcap National Parks, New South Wales. Toads were collected from these sites as well as two nearby warmer, low elevation sites (control) and tested immediately to determine at what low temperature they were unable to right themselves (CTmin). Toads from two high and two low locations were also brought into the laboratory, and animals from each population were split between high- and low-temperature acclimation treatments (24 and 12°C, respectively). After four weeks,

the toads in each treatment were further divided between "test temperature" treatments of 12 and 24°C and left for 12 hours. Subsequently, toads were tested for speed and endurance on a "race track," allowed to rest for an hour, then evaluated for their CTmin. Finally, an ANOVA analysis was performed to identify correlates of CTmin, hopping speed, and stamina among the treatments. High elevation toads evaluated in the field had significantly lower CTmins that low elevation toads. Remarkably, for a given test temperature, toads did not differ in CTmin, regardless of collection elevation or acclimation temperature. The test temperature did affect CTmin: toads held for 12 hours at 12°C had significantly lower CTmins than toads held at 24°C. Conversely, while acclimation temperature had little effect on speed and endurance of toads in the 12°C test temperature treatment, toads acclimated at 24°C performed better in the 24°C test temperature treatment than did toads acclimated at 12°C, and low elevation toads acclimated at the warm temperature performed better in the warm test temperature treatment than did similar toads acclimated at 12°C. Also, high-elevation toads showed similar endurance in both the low- and high-test temperatures. The authors argue the CTmin findings imply that toads are meeting thermal challenges through acclimation rather than adaptation, as only the temperature experienced over the last 12 hours affects CTmin. They also stress that estimates of areas vulnerable to Cane Toad invasion based on data from their native range may be vastly underestimated.

McCann, S., M. J. Greenlees, D. Newell, and R. Shine. 2014. Rapid acclimation to cold allows the cane toad to invade montane areas within its Australian range. Functional Ecology 28: 1166-1174.

Correspondence to: **RICHARD SHINE**, School of Biological Sciences, University of Sydney, Sydney, New South Wales 2006, Australia; e-mail: rick.shine@sydney.edu.au

Two New Philippine Monitors Described

Our collective understanding of herpetofaunal diversity and distribution in the Philippines has increased considerably over the last 15 years, due largely to molecular phylogenetics and unprecedented survey efforts. Recent studies of the *Varanus salvator* species complex (water monitors) have led to descriptions of new Philippine species and identification of other populations that may deserve species status. The authors of this study describe two of those populations as new species. These species are represented as two reciprocally monophyletic and geographically cohesive lineages in a phylogeny generated by an analysis of a concatenated mitochondrial and nuclear gene dataset. Despite morphologically matching a widespread Philippine species, *V. marmoratus*, this phylogeny suggests these new species may be each more closely related to other, morphologically diagnosable members of the complex. One new species, *V. bangonorum*, is restricted to the islands of Mindoro and Semirara, which are southwest of Luzon. The other new species, *V. dalubhasa*, occurs on the Bicol Peninsula of Luzon and several adjacent islands. Despite presumably being in geographic contact with *V. marmoratus*, the specific status of *V. dalubhasa* is not entirely surprising, as the Bicol Peninsula is increasingly being recognized as being biogeographically distinct from the rest of Luzon. These new species are truly cryptic—no morphological characters separate them from *V. marmoratus*. However, each new species exhibits a unique gular pigment pattern not seen in other closely related *Varanus* in the Philippines. The authors argue that these species delimitations are strongly supported by multiple lines of evidence (phenotypic, genetic). Further, they discuss the importance of identifying cryptic species in the Philippines, where wildlife is facing heavy pressure from habitat destruction and illegal harvesting.

Welton, L. J., S. L. Travers, C. D. Siler, and R. M. Brown. 2014. Integrative taxonomy and phylogeny-based species delimitation of Philippine water monitor lizards (*Varanus salvator* complex) with descriptions of two new cryptic species. Zootaxa 3881:201–227.

Correspondence to: **LUKE WELTON**, Department of Biology, Brigham Young University, Provo, Utah 84602, USA; e-mail: lwelton@byu.net

Molecular Investigation of a Continentally Distributed Amphibian Species

Molecular phylogenetic studies in the 21st century have relegated many species once considered continentally distributed to complexes of cryptic species with distinct geographic distributions, leaving few remaining continentally distributed amphibian species in the Neotropics. The Lesser Treefrog, *Dendropsophus minutus* (Hylidae), is one such species. It is distributed across much of northern and central South America in both open and forested habitats, and previous regional studies have hinted at species-level differences in this taxon. The authors of this study used phylogeographic methods to evaluate the genetic diversity and historical biogeography across the distribution of *D. minutus*. In what they call, "a roadmap for future integrative studies," they collected mitochondrial DNA sequence data for 407 *D. minutus* and related species (members of the *D. minutus* species group) to generate a time-calibrated estimate of their phylogenetic relationships. These analyses confirmed the monophyly of *D. minutus*, within which 25 mitochondrial lineages were recovered. Using the branching pattern of the mitochondrial gene tree, they inferred the likely biogeographic history of the *D. minutus* species group, hypothesizing, an origination in the Amazon Basin in the Early to Middle Miocene. This was followed by a Late Miocene dispersal to eastern Brazil, where the lineage leading to *D. minutus* began to diversify in the Atlantic Forest. Subsequently, *D. minutus* expanded its range westward across Brazil to the Andes. The authors stress that subsequent studies are required to determine if any of the mitochondrial lineages within *D. minutus* should be described as distinct species, as the degree of coexistence of divergent mitochondrial clades could alternatively be due to geographic overlapping of previously isolated populations of conspecifics. They conclude by highlighting the need to identify cryptic species in an age of amphibian extinctions, and pointing out that cryptic species within widespread taxa can only be identified through collaborative, multi-national projects.

Gehara, M., A. J. Crawford, J. Köhler, and colleagues. 2014. High levels of diversity uncovered in a widespread nominal taxon: continental phylogeography of the Neotropical tree frog *Dendropsophus minutus*. PLoS ONE 9:e103958.

Correspondence to: **MARCELO GEHARA**, Division of Evolutionary Biology, Zoological Institute, Technical University of Braunschweig, Braunschweig, Germany; e-mail: marcelo.gehara@gmail.com.

Gene Expression Following *Bd* Infection Varies at Both Species and Individual Level

The fungal pathogen *Bd* has recently been shown to suppress the immune system of highly susceptible frog species through lymphocyte activity inhibition. In an effort to determine how susceptible and resistant species compare in this regard, the authors of this paper exposed frogs of four Central American species (five to twelve individuals each) to *Bd*, and analyzed gene expression between experimental and control individuals. One included species, *Atelopus zeteki* (Bufonidae), is highly susceptible and extinct in the wild, while the three remaining species, *A. glyphus*, *Agalychnis callidryas* (Hylidae), and *Craugastor fitzingeri* (Craugastoridae) seem to be less susceptible to *Bd*. On a weekly basis post-exposure, each frog was swabbed, and *Bd* presence and load was determined via quantitative PCR. Frogs were euthanized after several weeks or at first sign of advanced *Bd* infection (loss of righting reflex). Gene expression profile at time of euthanasia was characterized through next generation sequencing of the transcriptome, which allows assessment of both RNA transcript presence and relative abundance in specific tissues. The authors sampled the transcriptomes of both skin (primary site of *Bd* infection) and spleen (site of lymphocyte accumulation and proliferation in frogs). All transcripts present in all four species were identified, their concentration was quantified for each sample, and significant differences in expression relative to controls and heterospecifics were identified. Huge differences in *Bd* infection load (five orders of magnitude) were seen among the four species, with *A. zeteki* exhibiting the highest and *A. callidryas* exhibiting the lowest level of infection. In the skin, an astounding number of gene upregulations were shared by infected *C. fitzingeri* and *Atelopus* spp., many of which were identified as serving an immune function. In contrast, scant genes were found to be upregulated in the skin of infected *A. callidryas*, indicating reduced inflammation. Conversely, a suite of genes important for lymphocyte activity and proliferation was found to be significantly upregulated in infected *A. callidryas*, more so than in the other species. Importantly, expression levels of one suite of skin genes and three suites of spleen genes were correlated with *Bd* load. The authors posit that lymphocyte activity and the ability to avoid the immunosuppressive effects of *Bd* are likely the key to *Bd* resistance. Further, the identification of genes whose activity is correlated with *Bd* infection demonstrates a connection between gene expression and *Bd* susceptibility at the individual level and provides a roadmap for future genomic studies of this pathogen.

Ellison, A. R., T. Tunstall, G. V. DiRenzo, M. C. Hughey, E. A. Rebollar, L. K. Belden, R. N. Harris, R. Ibáñez, K. R. Lips, and K. R. Zamudio. 2015. More than skin deep: functional genomic basis for resistance to amphibian chytridiomycosis. Genome Biology and Evolution (*in press*) doi: 10.1093/gbe/evu285

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LETTERS TO THE EDITOR

Giving Talks at Meetings

Going to scientific meetings is important, even if costly in time, energy, and money. The value in meetings is in hearing about new work in the field, meeting old and making new friends, discussing, gossiping and exchanging information and ideas. If current meetings cost so much and the speakers don't know how to present their papers (so you are in fact not learning anything from them), then attendees are not getting a cost effective deal.

I have attended many meetings of many societies, given papers at most, and been a judge of papers at some. Most (but not all) of the professors that present papers know how to talk to an audience. But most of the other talks, maybe 80% of them, and especially government employees, consultants, and graduate students, are poorly given. They present too much data, don't know how to speak loud, enunciate their words, project their voice, or use the mike! Thus 80% of my time listening to papers is a waste of time, money, and energy!

At a recent meeting, a person presented a paper on an animal that I encounter frequently and wanted to know more about. The person gave the paper with interesting slides. Later I happened to be in a lunch line with the speaker. I introduced myself and said that from the slides (though they had no color code), I gathered that the talk was interesting, but that I had heard hardly any of it. I suggested that the person might try to speak louder, be less monotonic, use the microphone, and talk to the audience, not the slides. The person turned around, probably somewhat discombobulated at my remarks…but teachers always try!

About a year later at another meeting, the same person gave another paper on the same fun animal. I wanted to learn more, so I sat in the front row! By the way, at 85 my hearing is still pretty good! The person went up to the podium, put the mike in front, then stepped BACK a few steps so the mouth was about a meter from the mike. The person then gave the talk in a low, almost inaudible monotone. The slides were good, but still no key to the colors used. I was frustrated, but teachers charge on! So in hopes of improving a better transfer of knowledge, getting something for my money in future meetings, and hopefully helping some people get the jobs or grad school they want, I present here a series of suggestions on how to be a better speaker.

1. If you have something to say, SAY IT LOUD, SO EVERYBODY CAN HEAR IT! This is not a conversation or committee meeting. It is a TALK, a PRESENTATION to an AUDIENCE of dozens or hundreds of people, so speak to them, not to the screen, not your notes, not just your friends in front row, TO ALL OF THEM. And PRACTICE, PRACTICE, PRACTICE!

BAYARD H. BRATTSTROM
Horned Lizard Ranch, P.O. Box 166, Wikieup, Arizona 85360, USA
e-mail: bayard@hughes.net

2. Don't tell the audience what you are going to talk about, JUST START!
3. Do not spend 2/3 of your talk telling us about all the details of your methods and all the statistical tests you used because:
   a. It leaves no time for results.
   b. Nobody cares! There may be one or two people in the audience who do, but they will ask you about it later.
   c. It suggests that your data are so weak that you had to search and search to find a statistical test to finally show that your results are significant.
4. Don't tell unrelated stories about people, or "in" jokes. This is a professional, scientific meeting and the people in the audience have spent a lot of time and money to come to hear what you have to say, so be professional!
5. Try this:
   1 minute: Introduction.
   1 minute: Materials & Methods.
   10 minutes: Results.
   1 minute: Conclusions.
   = 13 minutes, leaving 2 minutes for questions.
6. Scan the audience as you talk. Talk to the whole audience. Tailor your message to this audience. Is anyone in the audience holding their hand up to their ear? If so, speak LOUDER!
7. Pay attention to your moderator and respond quickly when the moderator gives you end-of-the-talk timing clues. PRACTICE YOUR TIMING!
8. If there is a screen monitor, glance at it, not the screen. You should have practiced enough so that you know which slide is going to appear next; a quick glance to see if it is the right one is enough, then talk to your audience.
9. Don't be too nervous, or too relaxed. Do some deep breathing in your seat before you get up to talk.

Pictures, Slides, and Graphs

1. Do not show big complicated tables with lots of statistics. Nobody can read them! Don't use your manuscript tables, instead…
2. Simple bar graphs or simple line graphs are remembered! Remember: SIMPLIFY, SIMPLIFY, SIMPLIFY!
3. Use few words and make one point per slide.
4. People can read faster than you can talk, so don't read numbers on charts. Just say, "The blue line shows…" or "The lower right box shows that this variable is the critical one."
5. Do not use cute pictures and animations on your PowerPoint slides. It distracts! This is a talk for professionals, not middle school students. Of course if your talk is on one or two species, then show their pictures, and…
6. This does not mean not to use as the main point on a slide, a quirky cartoon, a pretty habitat slide, or a critical conclusion in one line (or add lines of conclusions, one after the other).
7. If you must use an acknowledgment slide, then keep it up for only a few seconds! Nobody can read it all anyway, everybody knows from the abstract that you have co-authors and intuitively know that you needed money and had friends helping you! So put the slide up if you must, 10 seconds only, and just say "I want to thank all these people" and then change the slide.

The Mike

1. If you can't project your voice (breathing and talking from your diaphragm, not your throat…go to a live play and watch and listen to the actors), THEN USE THE MIKE! THE MIKE IS YOUR FRIEND! MAKE LOVE TO THE MIKE!
   a. Put your mouth/head about 3" from the mike. Leave it there. Don't move away, just turn your head to see the screen, for a glance… you should know your slides in order.
   b. Move the mike only so that it is 3" from your mouth. Don't move it aside. Speak loud into the mike. If and only If you can project your voice, then you can move your head back to 12".
   c. If you have to ask the audience if they can hear you and half say no, believe them! Not those in the front row.
   d. OPEN YOUR MOUTH, ENUNCIATE YOUR WORDS!
2. Talk to your audience, not the mike, not the slides, not your notes… you should know your slides and notes by now. Remember: PRACTICE, PRACTICE, PRACTICE! It helps to practice in a quiet room, out loud, with nobody else in the room.

Comments

1. Not everything is due to climatic change!
2. People in the audience usually don't speak up when asking a question. If in the audience, SHOUT OUT YOUR QUESTION. If speaker, REPEAT THE QUESTION, so that the rest of the audience can know to what question you are responding.
3. You have 15 minutes. Don't give the audience an overly scholarly, overly data/table-laden talk that they will not remember. Instead go 1, 2, 3, 4, and sit down!

Conclusions

1. Stick to the Big Picture.
2. Define your goal and know your audience.
3. Teach.
4. Speak loud, even shout!
5. Make love to the mike.
6. Simplify, simplify, simplify.
7. PRACTICE! PRACTICE! PRACTICE!

Field Herpetology of the Southwest

Southwestern Research Station — 24 July–2 August, 2015

This 9-day course will introduce participants to an outstanding diversity of amphibians and reptiles of Arizona's Chiricahua Mountains and surrounding deserts.

Labs and lectures will focus on identification and ecology of herps. The majority of time will be spent in the field, hiking through low and high elevation habitat.

For more information about the course, contact Dawn Wilson. Ph: 520-558-2396; email: dwilson@amnh.org; http://research.amnh.org/swrs/herpetology-field-course












Interdisciplinary World Conference on Monitor Lizards

27–29 July 2015 at Phranakhon Rajabhat University, Bangkhen District, Bangkok, Thailand

The Interdisciplinary World Conference on Monitor Lizards will focus on the biology, ecology, natural history, and captive breeding of monitor lizards. For those interested in attending and those who have enquiries are encouraged to contact the conference organizers at: *monitor.conference.2015@gmail.com* to receive the latest information about the conference and accommodations. Manuscripts and posters are also to be submitted to this address.

Conference fee: Has not yet been determined at the time of this announcement, but it is planned to make it less expensive than comparable international conferences. The conference fee is tentatively planned to be US $200. Included with the conference fee is conference attendance, lunch along with coffee breaks on the days of the conference, and the welcome dinner on the first day of the conference. Also included with the conference fee is a copy of the conference proceedings to be published after the completion of the conference.

There are optional events that will be available to those attending the conference, such as a trip to the National Science Museum and Natural History Museum, Dusit Zoo to see an urban monitor population, and a two-day trip to Khao Yai National Park. The costs of optional events are not included with the conference fee.

—Submitted by Michael Cota

Fourth and Final Update!

UNIVERSITY OF KANSAS SSAR MEETING

THURSDAY, JULY 30 – MONDAY, AUGUST 3, 2015

Society for the Study of Amphibians and Reptiles

co-sponsored by Partners in Amphibian and Reptile Conservation (PARC)

together with the herpetological societies of Kansas, Missouri, and Arkansas, the Center for North American Herpetology, *and the* International Society for the History and Bibliography of Herpetology

• For registration and full conference details, visit SSAR2015.ku.edu •

Transportation, Parking and Housing

The Kansas City International Airport is one hour northeast of Lawrence. Shuttle options include vans. See list at www.flykci.com/direction/shuttle/Index.htm.

Ample free parking within a 3-block radius of conference activities will be available in surrounding university lots and nearby streets.

A wide variety of housing options are available ranging from low-cost dormitory rooms that can be shared to local hotels and motels. Options include:

- Springhill Suites by Marriott (downtown)
- The Oread Hotel (1 block away): $149–169
- Holidome (2 miles away): $80 for up to four people including breakfast
- On-campus dormitory housing: $40–$60

•

Registration Fees (Deadline June 30th)

Student members*	US $160
Regular members	$295
Seniors (retired / over 70) (membership not required)	$160
Non-members	$375
Late surcharge for all after June 30	$50

*For this meeting, student members of SSAR, HL, ASIH, and other international, national, and regional herpetological societies are eligible for the SSAR student member rate, but they must provide written evidence of their membership (statement from society officer, student's advisor, or other authority).

•

Deadlines for Presenters (May 15th)

Abstracts for all papers (oral and poster) are due to the conference organizer by May 15th. These should include title, author or authors, and address (both postal and email). Full details on format for abstracts and posters as well as available projection facilities may be found on the SSAR 2015 meeting website: SSAR2015.ku.edu.

•

Meeting website (available March 15)

Visit SSAR2015.ku.edu for the day-by-day meeting schedule, registration, airport shuttle, parking, accommodations, meals, special events, tours, juried prizes, auction donations, committee meetings, socials and other activities associated with this meeting.

SSAR will hold its 2015 meeting on the beautiful and centrally located campus of the University of Kansas in Lawrence. All scientific sessions will be held in the Kansas Union, which is adjacent to the KU Biodiversity Institute and Natural History Museum, the setting of more than a century of research and graduate education in herpetology. The intimate campus setting will facilitate personal and friendly interactions while moderating fees for registration and lodging.

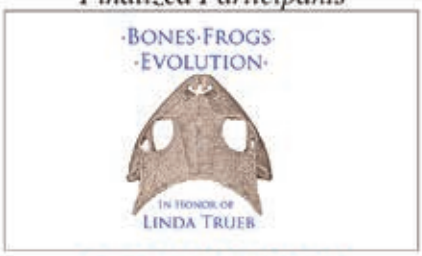
This unique campus format meeting will include oral and poster presentations, silent and live auctions, vendor displays, student social, symposia, and special lectures provided by David Hillis (Keynote), Harry W. Greene (Plenary), and Miguel Vences (President's Travelogue).

Conference activity highlights include:

- Redesigned audiovisual shows arranged by David Dennis and Eric Juterbock
- Reception honoring distinguished senior herpetologists, allowing students to interact personally with luminaries in the field
- The Herpetological Quiz, arranged by the graduate students at UT Arlington and KU, with prizes for winners
- Guided tours of herpetological collections and newly renovated laboratories in the Biodiversity Institute
- Tour of the Fitch Reservation (*see photo on next page*) at the KU Biological Fieldstation and Reserves, led by George Pisani
- Special presentation for the International Society for the History and Bibliography of Herpetology featuring author Sally Haines of the KU Spencer Research Library
- Display of live Kansas herps with photographic set-ups

SYMPOSIA UPDATES

Finalized Participants



Bones, Frogs, and Evolution

Organized by David Blackburn, Anne Maglia, and David Cannatella

This event will celebrate the exceptionally productive 40 years of scholarship of Linda Trueb and will include presentations by Ana Maria Baez, David Blackburn, David Cannatella, Luis Coloma, Eli Greenbaum, Juan Guayasamin, Anne Maglia, Dave McLeod, Greg Pregill, Chris Sheil, Helio de Silva, Erik Wild, and Marvalee Wake. Introduction by Leonard Krishtalka and summary by William Duellman.

•



Frontiers in Integrative Organismal Biology: Herpetological Horizons

Organized by Rich Glor and Rafe Brown

This event will bring together a group of exceptionally research-active herpetologists working at the forefront of evolution-related fields, using amphibians and reptiles as study systems. Topics include speciation, adaptive radiation, convergence, phenotypic evolution, and the evolution of development—all through the lens of genomic approaches to understanding evolution of amphibians and reptiles. Participants include Frank Burbrink, Todd Castoe, Ben Evans, Matt Fujita, Luke Harmon, Ryan Kerney, Adam Leaché, Emily Lemmon, Jim McGuire, Rachael Mueller, Dan Rabosky, Erica Rosenblum, Robert Thompson, John Wiens, and Kelly Zamudio. Summary by David Wake.

continued on next page

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In 1979, SSAR premiered the first of four half-hour audiovisual shows featuring herps, herp habitats, and herpetologists, that became highly popular events at its annual meetings over the next 25 years. These shows have not been seen for ten years and have now been completely revised using high-definition Blue Ray technology. Most of the photography will be completely new. Two of these newly revised shows will debut at the KU meeting in 2015.



Meeting Agenda Highlights
full details at SSAR2015.ku.edu

Thursday, July 30
SSAR Board of Directors Meeting
Registration
Presidential Travelogue Lecture
Welcome Social for all

Friday, July 31
Poster sessions and concurrent papers
Plenary sessions
Keynote Lecture
Plenary Lecture
PARC symposium
Reception for all with distinguished senior herpetologists
AV shows

Saturday, August 1
Poster sessions and concurrent papers
SSAR and PARC symposia
SSAR student social
Live auction and reception for all

Sunday, August 2
Concurrent papers
PARC and SSAR symposia
SSAR business meeting
Outdoor picnic for all

Monday, August 3
Meetings and tours for the International Society for the History and Bibliography of Herpetology, plus day trips and tours



Kansas Biological Survey

PARC
PARTNERS IN AMPHIBIAN AND REPTILE CONSERVATION

PARC-SPONSORED EVENTS

PARC Symposium 1: Identifying Priority Areas for Herpetofauna Conservation
Organizer: Phillip deMaynadier
Moderators: Phillip deMaynadier and Bill Sutton
Confirmed speakers: Ron Sutherland, Phillip deMaynadier, J. J. Apodaca, Stephen Speare, Cyndy Loftin, Bill Sutton, Brian Todd, Kyle Barrett, Robin Moore, James Lewis, Stephen Mockford, Mike Jones, Liz Willey, Priya Nanjappa

PARC Symposium 2: PARC's Partners Focusing on Habitat
Organizer: Jen Williams
Moderators: Jen Williams, David Bender, John Moriarty
Confirmed speakers: Jason Daniels, Therese Conant, Joe Robb, Paul Makela, Mark Vandever, Jeff Holmes

PARC / SSAR Symposium 3: Communicating Herpetofaunal Conservation to the Public
Organizer and moderator: Linda Weir
Special speaker: Tyrone Hayes

PARC / SSAR Workshop: Distilling Your Message
Organizer: Linda Weir
Moderator: presenter from Alan Alda Center

PARC Event: Exploring Non-academic Careers in Herpetology: a lunch time event for students
Organizers: Danny Martin and John Moriarty

FEATURED SPEAKERS

KEYNOTE LECTURER



David Hillis
University of Texas at Austin
Evolutionary Insights from Studying Amphibians and Reptiles

PLENARY LECTURE



Harry Greene
Cornell University
The Life and Times of a KU Herpetological Icon: Henry Fitch and 70 Years of Snake Ecology

PRESIDENTIAL LECTURER



Miguel Vences
Technical University of Braunschweig (Germany)
Inventory of an Imperiled Paradise: Two Decades of Herpetology in Madagascar



HERPETOLOGY AT KANSAS

A Centennial History

by William E. Duellman

THE UNIVERSITY OF KANSAS (KU) HAS long been recognized as one of the world's leading centers for research and education in herpetology. Beginning with the arrival of Edward H. Taylor as a student in 1908, KU has produced a steady stream of students—at both the undergraduate and graduate levels—who focused their work on amphibians and/or reptiles including studies in systematics, ecology, morphology, behavior, biogeography, evolution, and other subject areas. Their studies have been built around the broad-based research programs of the several professors involved: **Edward H. Taylor** and **Henry S. Fitch**, later **William E. Duellman** and **Linda Trueb**, and more recently **Rafe Brown** and **Richard Glor**.

This book chronicles the people—faculty and students alike—who have contributed to maintaining and expanding KU's herpetology program and details their lives, education, research, and fieldwork. The book also describes how a true institutional program, one that transcends individuals, was created and sustained over such a long period through innovative planning and social development. The extensive collections that these faculty and students made in many countries throughout the world are deposited in KU's Biodiversity Institute, which is located in Dyche Hall (*pictured*) on the central university campus. These comprise



one of the largest and most comprehensive museums of amphibians and reptiles in existence, now numbering in excess of 332,000 alcohol-preserved specimens, together with ancillary collections of osteological preparations, color images, frozen tissues, audio recordings, and the associated scientific literature. This book provides an insider's in-depth review of the many successes as well as plans that went awry or even courted disaster. It is **liberally illustrated with 440 photographs**. Altogether, the book represents a substantial and critical chapter in the history of the discipline of herpetology.

Specifications: about 350 pages, format 8.5 × 11 inches (21.5 × 28 cm), 440 photographs, index, clothbound. ISBN 978–0–916984–91–5. • ***To be issued June 2015.***



■ **Prices**: Pre-publication, SSAR members US$28; Institutions and non-members $40. ■ **Shipping**: USA address, add $5; non-USA, at cost. ■ **Send orders to:** SSAR Publications Secretary, P.O. Box 58517, Salt Lake City, Utah 84158–0517, USA (*telephone and fax*: 801–562–2660; *e-mail*: ssar@herplit.com). ■ **Payment:** Make checks payable to "SSAR." Non-USA orders must be paid in USA funds using a check drawn on an American bank or by International Money Order. Books may be charged to American Express, Discover, MasterCard, or Visa (please give account number and expiration date). ■ **SSAR Membership and Other Publications:** Membership information and a list of society publications can be obtained from the Publications Secretary at the address given above or at the Society's website at www.ssarherps.org.

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http://ssarherps.org/publications/journals/herpetological-review/

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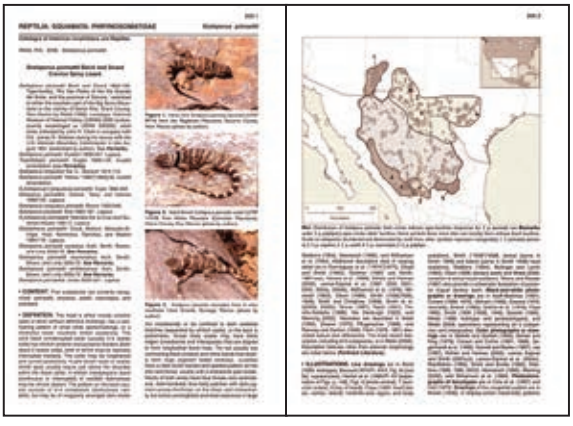
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SSAR publishes seven different series: *Journal of Herpetology, Herpetological Review, Facsimile Reprints in Herpetology, Contributions to Herpetology, Herpetological Circulars, Herpetological Conservation*, and the *Catalogue of American Amphibians and Reptiles* (see below for CAAR details). SSAR members receive pre-publication discounts on all *Facsimiles* and *Circulars* and on volumes in the *Contributions* and *Herpetological Conservation* series. A complete pricelist of Society publications is available at: http://www.ssarbooks.com/.

CATALOGUE OF AMERICAN AMPHIBIANS AND REPTILES

The *Catalogue* consists of individual accounts of species and genera prepared by specialists, including synonymy, definition, distribution map, and comprehensive list of literature for each taxon. The accounts cover amphibians and reptiles of the entire Western Hemisphere. As of 2014, SSAR is making all CAAR accounts OPEN ACCESS as a service to the herpetological community. To access individual accounts, visit http://www.ssarcaar.com.



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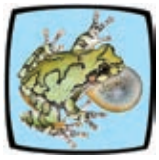
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ARTICLES

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A New Report of Albinism in the Common Garter Snake (*Thamnophis sirtalis*), and a Review of Existing Records: Is There a Geographic Bias in Observations?

Albinism is one of the most striking aberrations of body color in vertebrates, arising from an absence of melanin in the integument (McCardle 2012). Errors at any of several steps in the pathway of melanosynthesis can block the production of melanin in the skin, largely (but not exclusively) as a result of autosomal recessive mutations (Bechtel 1995). In mammals, oculocutaneous albinism is associated with the expression of white skin and pale yellow hair due to a lack of accessory pigments in these structures (Bechtel 1995; Carden et al. 1998). In contrast, squamate reptiles normally possess additional classes of long-wavelength pigment in the integument expressed independently of melanin: pteridines, which are naturally produced in the dermis, and carotenoids, which must be acquired in the diet but may be secondarily stored in the dermis (Bechtel 1995). As a consequence, albino squamates that retain these accessory pigments typically exhibit yellow or red skin (xanthic albinism; "albino" sensu Bechtel 1995). The complete lack of endogenous integumentary pigment in squamates (i.e., no melanin or pteridine) is termed leucism, and the skin of leucistic reptiles is white (Bechtel 1995). Leucistic reptiles are also often referred to as albinos, especially in the older literature (McCardle 2012). However, xanthic albinos and axanthic albinos (i.e., leucistics) are phenotypically distinct, and the latter are especially uncommon (Bechtel 1991).

Reports of albinism in reptiles have been published on an occasional basis throughout the last century (e.g., Hensley 1959; Dyrkacz 1981 and references therein), but multiple records for an individual species remain the exception rather than the rule (Bechtel and Bechtel 1981; Krecsák 2008). The major reason is that albinos are rare: perhaps as few as 1 in 30,000 individuals in wild populations of a given species may exhibit the condition (Bechtel 1995). With the possible exception of species that inhabit aphotic environments (Gross et al. 2009; McCardle 2012), albinos are thought to experience reduced fitness relative to non-albino conspecifics, ensuring that the frequency of albinos remains low (Bechtel 1995; Krecsák 2008). At least partly as a consequence, reports of albinism are scarce for most individual species, limiting the potential to test hypotheses for the biological significance of albinism, and integumentary coloration more generally.

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One exception to this generalization is the Common European Adder (*Vipera berus*). Krecsák (2008) found evidence that albinism in this widely distributed species was more common in the northern part of its range (i.e., Scandinavia) than in the south (central and southern Europe). Several possible explanations were invoked to explain this pattern: high local densities might provide protection to albinos by dilution effect; the reduced species diversity and population sizes of mammalian and avian snake predators at northern latitudes further reduce predation pressure on albinos; and offshore islands, the source of several specimens, may be linked to increased rates of albinism due to genetic drift mechanisms, inbreeding, or both (Krecsák 2008).

Another possible explanation is that populations at northern latitudes may be less vulnerable to negative effects of UV radiation, diminished at northern latitudes relative to the tropics. This hypothesis has been invoked to explain the reduction of integumentary melanin in human populations at northern latitudes as compared with those found near the equator (Jablonski and Chaplin 2010), but conceivably could help explain elevated frequencies of albinism at high latitudes in some other vertebrate groups. We note that some ectothermic organisms exhibit *increased* melanism in populations at higher latitudes, apparently as an adaptation for increased thermoregulatory efficiency (e.g., Clusella Trullas et al. 2007). This overall pattern, however, is not incompatible with relaxed selection on albinos via reduction in UV-induced skin damage.

The Common Garter Snake (*Thamnophis sirtalis*) is one of the most wide ranging reptiles in North America, found from Florida and southern Quebec in the east, to California and British Columbia in the west (Rossman et al. 1996). Isolated populations are known as far south as northern Mexico, and as far north as the Northwest Territories of Canada. The latter populations represent the most northerly known for any snake in the Western Hemisphere (Rossman et al. 1996). Twelve subspecies are presently recognized in this taxon, of which the most widely distributed is the Eastern Garter Snake, *T. s. sirtalis* (Rossman et al. 1996).

In April 2013, a female albino Eastern Garter Snake *T. s. sirtalis* was discovered by one of us (KMD) in a residential neighborhood in Macon, Georgia, USA. Following this discovery, we reviewed existing reports of albinism in natural populations of *T. sirtalis*

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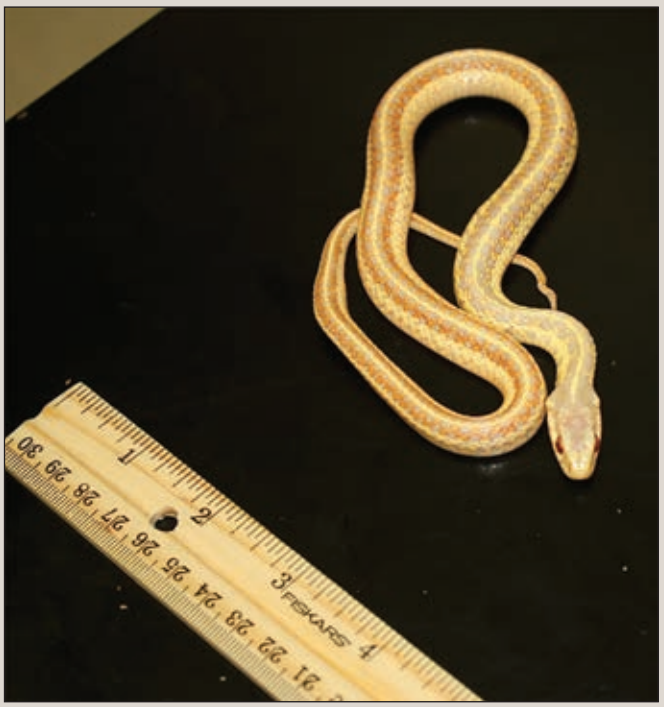


FIG. 1. Subadult albino female Eastern Garter Snake (*Thamnophis s. sirtalis*) from Macon, Georgia.

and other species of *Thamnophis* (Hensley 1959; Gilboa and Dowling 1974; Dyrkacz 1981). In light of Krecsák's (2008) study, and the exceptionally broad latitudinal distribution of *T. sirtalis*, we asked whether albinism in *T. sirtalis* also varies along a latitudinal gradient. We also considered whether observations of aberrant snakes vary along a longitudinal gradient. Given the diversity of eastern and western habitats utilized by this species in North America (e.g., subtropical marshland, montane forest, prairie, oak savannah: see Rossman et al. 1996) and the variable thermal, lighting, and predator-prey regimes experienced across these populations, it is conceivable that selection against albinos might be variable along an east-west gradient, independent of any possible north-south cline.

In this report, we first provide details on the newly discovered albino specimen of *T. s. sirtalis*. We then review existing published reports and museum specimens of albinos and leucistic *T. sirtalis* and other species of *Thamnophis*, and conduct statistical tests of the hypothesis that albinism and leucism vary geographically in *T. s. sirtalis*. We also provide perspective on the opportunities and challenges that await researchers interested in testing hypotheses for the functional significance of albinism in *T. sirtalis* and other reptiles.

MATERIALS AND METHODS

On 27 April 2013, KMD captured a female albino *T. s. sirtalis* (Fig. 1) in the backyard of his residence in Macon, Bibb Co., Georgia (32.85°N, 83.66°E) around 1200 h. This urban environment is an older, well-established neighborhood where most of the houses were built before 1915. The weather was mostly sunny with a temperature of about 20°C; however, the immediate surroundings where the specimen was found remain shady and moist most of the time (KMD, pers. obs.). The snake was discovered when, upon approach, it quickly retreated to a narrow space between a loose pile of red bricks and the wood paneling of the side of the house where it was collected. The appearance of this specimen coincided with other observations of snakes in the immediate area, probably a function of the onset of the spring breeding season in this species (Reed and Gibbons 2008). After capture, the snake was placed in a dark, cool environment until morphometric data could be collected two days later.

We then conducted a review of existing records of albinism and leucism in both *T. sirtalis* (Table 1) and other *Thamnophis* species (Table 2), limiting our search to records described in published reports, as well as searches of museum specimen databases provided in HerpNet2 (www.herpnet2.org). We list only those reports where at least state- or province-level locality data was provided; when subspecies was not given, we tentatively assigned putative subspecies using range maps in Rossman et al. (1996). We did not personally examine any preserved material; in many cases, final disposition of the described specimen(s) was not indicated in the original report. In this report, we use the definitions of Bechtel (1995) and restrict the terms "albino" to amelanistic xanthic specimens, and "leucistic" to amelanistic axanthic specimens. We note that the term "albino" has been applied by various authors to include a wider or narrower range of aberrant phenotypes (e.g., Harris 1970). Thus, it is conceivable that some listed specimens might not represent albinism as defined here (sensu Bechtel 1995).

To test whether the distribution of albino *T. sirtalis* differed from those of non-mutant (putative wild-type) *T. sirtalis*, we also searched HerpNet2 for all records of *T. sirtalis* specifically, including those listed under older genera (*Eutaenia* and *Natrix*). Of a total of 25979 records of this species, 9823 included latitude and longitude data, and were thus available for use in analysis. As HerpNet2 provides fields for entry of significant notes regarding specimens (such as the occurrence of albinism), we assumed that albinism would ordinarily be noted if it was present. Promisingly, we found one record (MSUM 183) in HerpNet2 described as albino that confirmed a literature report (Hensley 1959). However, we also found three records of albinism in the literature that were not described as such in their HerpNet2 specimen records (AMNH 162456, Hensley 1959; CM 48368, Dyrkacz 1981; CM 26259, Barton 1947). Thus, it is likely that some other specimens given in HerpNet2, but lacking supporting literature documentation, and which we assumed were wild-type in our analysis are in fact albino or leucistic. Prior to analysis, two of three records of albinos found in the literature but not described as such in HerpNet2 were removed to prevent their duplicative use in analysis; the third such record did not contain latitude and longitude data in HerpNet2 and therefore was not listed twice in the analyzed data set. One additional record of a putative wild-type *T. sirtalis* had clearly questionable locality data associated with it, and was also removed. We used nonparametric tests, as data for wild-type and albino *T. sirtalis* did not meet conditions for normality. All statistical analyses were conducted using Systat 12 (Systat Software, Inc. 2007).

RESULTS

Albino T. s. sirtalis *from Macon, Georgia.*—Measurements of this specimen were obtained on 29 April, two days after collection. At that time its body mass was 25.5 g, and its total length was 410 mm. Consistent with earlier reports of albino (sensu Bechtel 1995) *T. s. sirtalis*, this specimen exhibits a generalized yellow ground color with orange-red and blue-

TABLE 1. Reports of Common Garter Snakes (*Thamnophis sirtalis*) exhibiting albinism or leucism obtained through literature and museum database searches. Only records where state- (U.S.) or province-level (Canada) locality information was available are listed. An asterisk (*) indicates records where no subspecies assignment was given in the original publication or online museum database record, and is inferred from the geographic range of subspecies of *T. sirtalis* given in Rossman et al. (1996). Morph is indicated only when the source description(s) of the specimen provides sufficient information to suggest either albinism or leucism specifically. Multiple specimens from the same observation are indicated in parentheses under Age Class.

Lat. (N)	Long. (E)	Subspecies	State/ Province	County/ Division/ Reg. County Municipality/ Reg. District	Locality	Year	Month	Morph	Age Class	Total Length	Sex	Last Known Disposition	Specimen ID
32.8	-83.7	*sirtalis*	GA[1]	Bibb	Macon	2013	Apr	Albino	Subadult	420 mm	F	Mercer University	N/A
33.7	-84.2	*sirtalis*	GA[2]	Dekalb	Shoal Creek	1974	July	Albino	Subadult	305 mm	—	Fernbank Science Ctr	—
33.8	-84.2	*sirtalis*	GA[2]	Dekalb	—	1976	Aug	Albino	Subadult	457 mm	—	Fernbank Science Ctr	—
34.4	-81.1	*sirtalis**	SC[3]	Fairfield	—	1991	Sept	Albino	Adult	660 mm	F	Riverbanks Zoological Park	—
34.8	-85.0	*sirtalis*	GA[2]	Whitfield	Dalton	1985	Apr	Albino	Subadult	430 mm	F	Atlanta Zoo	—
38.2	-81.5	*sirtalis**	WV[4]	Kanawha	Cabin Creek	1975	Oct	—	Subadult	—	—	Unknown	—
38.7	-93.2	parietalis	MO[5]	Pettis	Sedalia	1960	Oct	Albino	Adult	673 mm	—	S.L. Kramer	—
38.7	-93.2	parietalis*	MO[4]	Pettis	Sedalia	1965	—	—	Adult	—	—	Unknown	—
38.7	-77.8	*sirtalis*	VA[6]	Fauquier	Warrenton	1992	July	Leucistic	Adult	600 mm	F	S.H. Shively and J. C. Mitchell	—
39.1	-84.5	*sirtalis**	OH[4]	—	Cincinnati	1975	June	—	—	—	—	Cincinnati Zoo	—
39.2	-84.5	*sirtalis**	OH[4]	Hamilton	Cincinnati	1948	Oct	—	Adult	—	—	Cincinnati Museum of Natural History	CMNH 2659
39.3	-76.6	*sirtalis*	MD[7]	—	Westport	1961	Sept	—	—	—	—	H.S. Harris, Jr.	RS333HSH
39.7	-78.9	*sirtalis*	MD[8]	Allegany	Frostburg	1962	May	—	Adult	508 mm	F	R. Franz	—
40.0	-83.0	*sirtalis**	OH[9]	Franklin	Columbus	1956	—	—	—	—	—	Columbus Zoo	—
40.2	-75.5	*sirtalis**	PA[4]	Montgomery	Trappe	1966	—	Leucistic	—	—	—	Unknown	—
40.3	-86.1	*sirtalis*	IN[9]	Tipton	—	1954	Aug	—	—	—	—	American Museum of Natural History	R-162456 (= AMNH 162456)
40.3	-78.9	*sirtalis*	PA[4]	Cambria	Johnstown	1968	Sept	Albino	Subadult	—	—	Carnegie Museum of Natural History	CM 48368

TABLE 1. Continued.

Lat. (N)	Long. (E)	Subspecies	State/ Province	County/ Division/ Reg. County Municipality/ Reg. District	Locality	Year	Month	Morph	Age Class	Total Length	Sex	Last Known Disposition	Specimen ID
40.5	-80.0	*sirtalis*	PA[10]	Allegheny	Pittsburgh	1941	—	Albino	Adult	551 mm	F	Carnegie Museum of Natural History	CM 26259
41.0	-76.6	*sirtalis*	PA[11]	Montour	Danville	1974	Nov	Albino	Subadult	406 mm	F	Philadelphia Zoological Gardens	—
41.3	-72.9	*sirtalis**	CT[9]	New Haven	New Haven	1956	—	—	—	—	—	Not collected	N/A
41.4	-85.4	*sirtalis**	IN[4]	Noble	Albion	1974	—	—	—	—	—	Unknown	—
41.7	-83.6	*sirtalis**	OH[4]	—	Toledo	1972	May	—	Neonate (3)	—	—	Unknown	—
41.7	-83.6	*sirtalis**	OH[12]	Lucas	Toledo	1988	July	Albino	Subadult	220 mm	M	Riverbanks Zoological Park	—
41.7	-83.6	*sirtalis**	OH[12]	Lucas	Toledo	1992	July	—	Neonate (7)	—	—	Unknown	—
41.7	-83.6	*sirtalis**	OH[12]	Lucas	Toledo	1993	June	—	Adult	590 mm	M	Unknown	—
41.7	-85.3	*sirtalis**	IN[4]	LaGrange	Mongo	1974	—	—	—	—	—	Unknown	—
42.1	-78.7	*sirtalis*	NY[13]	Cattaraugus	Allegheny State Park	1944	Aug	Albino	—	—	—	Allegheny State Park Zoo	—
42.4	-78.3	*sirtalis**	NY[9]	Allegheny	Rushford	1947	Nov	—	—	—	—	Buffalo Society of Natural Sciences	BSNS (uncat.)
42.5	-73.2	*sirtalis*	MA[14]	Berkshire	Pittsfield	1979	Aug	Albino	Neonate	190 mm	—	R.D. Bartlett	—
42.9	-79.0	*sirtalis*	ON[15]	Niagara	Fort Erie	—	—	—	—	—	—	Buffalo Zoo	None
43.0	-88.0	*sirtalis*	WI[16]	Milwaukee	—	—	—	—	—	—	—	Milwaukee Public Museum	MPM 2600
43.3	-75.2	*sirtalis*	NY[17]	Oneida	Barneveld	1959	Sept	Leucistic	Adult	559 mm	M	S. Christman	—
43.4	-83.9	*sirtalis**	MI[9]	Saginaw	Bridgeport	1956	Oct	Albino	—	—	—	Michigan State University Museum	MSUM 183 (= MSUM HE.183)
44.5	-77.5	*sirtalis*	ON[15]	Hastings	Moira Lake	1970	—	Albino	Adult	—	—	Not collected	N/A
44.5	-77.5	*sirtalis*	ON[15]	Hastings	Moira Lake	1970	Aug	Albino	Neonate (2)	—	—	Not preserved	N/A
45.4	-75.7	*sirtalis*	ON[18]	Ottawa	Ottawa	1986	Sept	Albino	Subadult	210 mm	—	National Museum of Natural Sciences	NMNS 28723
45.4	-75.7	*sirtalis*	ON1[19]	Ottawa	Ottawa	1988	Aug	Albino	Subadult	205 mm	—	National Museum of Natural Sciences	NMNS 31336
45.4	-75.7	*sirtalis*	ON1[19]	Ottawa	Ottawa	1988	Sept	Albino	Subadult	250 mm	—	National Museum of Natural Sciences	NMNS 31535

(continued on next page)

TABLE 1. Continued.

Lat. (N)	Long. (E)	Subspecies	State/ Province	County/ Division/ Reg. County Municipality/ Reg. District	Locality	Year	Month	Morph	Age Class	Total Length	Sex	Last Known Disposition	Specimen ID
45.7	-75.8	*sirtalis*	QC[19]	Les-Collines-de-l'Outaouais	Val-des-Monts	1988	Mar	Albino	—	—	—	Released at capture site	N/A
48.4	-123.4	*pickeringii**	BC[9]	Capital	Victoria	1956	Aug	—	—	—	—	Royal British Columbia Museum	PMC 910
48.8	-122.5	*pickeringii**	WA[4]	Whatcom	Bellingham	1972	Aug	—	Neonate	—	—	Washington Public Zoo	—
—	—	*sirtalis**	NY[9]	—	—	—	—	—	—	—	—	Bronx Zoo	—
—	—	—	ON[9]	—	—	—	—	—	—	—	—	Royal Ontario Museum	—

[1]This report
[2]Cook 1986
[3]Smith and Schuett 1992
[4]Dyrkacz 1981
[5]Kramer 1960
[6]Shively and Mitchell 1994
[7]Harris 1970
[8]Franz 1968
[9]Hensley 1959
[10]Barton 1947
[11]Groves 1976
[12]Smith 1997
[13]Eaton, Jr. 1945
[14]Bartlett 1981
[15]Weller 1983
[16]Dickinson 1950
[17]Anonymous 1960
[18]Coad and Coad 1987
[19]Coad et al. 1989

lavender color elements arranged in stripes; thus, the overall body color pattern is retained despite the absence of melanin. Scale rows 1–3 are uniform light yellow. Rows 4–8 are orange, with pale blue or lavender rectangular spots on rows 4 and 8 arranged in an alternating checkerboard pattern. A central yellow stripe occupies scale row 9. The ventral scales are a light yellow cream color. The distal portion of the tail exhibits a pronounced sinusoidal kink, suggesting a previous injury.

Albinism and leucism in T. sirtalis.—Including the specimen described here, we found 43 independent observations describing 52 cases of putative albinism or leucism in *T. sirtalis* (Table 1). Three observations described the birth of multiple albino offspring (Dyrkacz 1981; Weller 1983). Most of the original literature reports describing cases of albinism in *T. sirtalis* do not clarify whether a given specimen was specifically albino or leucistic (sensu Bechtel 1995). In 19 of these 43 cases, this distinction was clearly made in the original report, or could reasonably be inferred based on details of description of the specimen (see Table 1). Of these, only 3/19 individuals (16%) were reported to be leucistic, consistent with expectations that this phenotype is much rarer than albinism (sensu Bechtel 1995).

Of these 43 separate observations of aberrant Common Garter Snakes, at least 37 (88%) are definitely or probably the nominate subspecies *T. s. sirtalis*. Either albinism or leucism was reported in only 3 of 11 described subspecies (*sirtalis*, *parietalis*, and *pickeringii*) recognized by Rossman et al. (1996). Two of these (*sirtalis* and *parietalis*) represent the forms with the widest geographic range of any subspecies of Common Garter Snake, and their disproportionate representation among observations of albinism is therefore not unexpected.

Albinism and leucism in other Thamnophis.—We also examined reports of albinism in other species of garter snakes. Overall, we found 16 independent observations representing at least six species of *Thamnophis* exclusive of *T. sirtalis* (Table 2). In 13/16 records, albinism or leucism was specifically noted, and/or a distinction could be made based on a description of the reported specimen(s). Of these 13 specimens, only 1 (8%) was leucistic, again reinforcing the expectation that leucism (sensu Bechtel 1995) is a much rarer phenomenon than albinism in garter snakes more generally.

Geographical variation in albinism.—Inspection of Table 1 suggests that more putative albinos and leucistics have been found in areas towards the northern part of its range. Figure 2A graphically represents this trend, revealing a peak in the number of independent observations around 40°N latitude. However, we found no difference in the latitude of records of albino/leucistic snakes as compared with records of putative wild-type snakes (Mann-Whitney $U = 203269$; $P = 0.91$; albinos/leucistics: $\bar{X} = 41.0$°N, wild-type: $\bar{X} = 41.2$°N). The latitudinal distribution of putative wild-type snakes from the HerpNet2 database (data not shown) exhibits the same general pattern as that observed for albinos/leucistics, supporting the notion that the peak observed in Fig. 2A reflects biased sampling of *T. sirtalis* more generally.

The longitudinal distribution (Fig. 2B) reveals a central peak around -80°E longitude (i.e., from South Carolina to Ontario), though the paucity of records from much of the central and western part of the range of *T. sirtalis* may be problematic (Rossman et al. 1996). Nevertheless, there was a difference in the longitude associated with records of albinos/leucistics as compared with putative wild-type snakes (Mann-Whitney $U = 271642$; $P = 0.0001$); specifically, aberrant snakes were more

TABLE 2. Reports of albinism or leucism in species of *Thamnophis* exclusive of *T. sirtalis* obtained through literature and museum database searches. Only records where state- (U.S.), province- (Canada), or district-level (Belize) locality information was available are listed. An asterisk (*) indicates records where no species assignment was given in the original source. Morph is indicated only when the source description(s) of the specimen provides sufficient information to suggest either albinism or leucism specifically. Multiple specimens from the same observation are indicated in parentheses under Age Class.

Lat. (°N)	Long. (°E)	Species	Subspecies	State/ Province	County/ District	Locality	Year	Month	Morph	Age Class	Total Length	Sex	Last Known Disposition	Specimen ID
17.5	-88.3	*marcianus*	*praeocularis*	—	Belize	British Army Airport Camp	1968	—	Leucistic	—	—	—	Milwaukee Public Museum	MPM 7759
31.5	-97.1	*proximus*	—	TX[1]	McLennon	Waco	1958	Aug	Albino	Adult	420 mm	—	University of Michigan Museum of Zoology	—
37.3	-107.9	*elegans*	*vagrans*	CO[2]	La Plata	Durango	1975	May	Albino	Subadult	276 mm	F	University of Colorado Museum of Natural History	UCM 52728
37.7	-106.6	*elegans*	*vagrans*	CO[3]	Rio Grande	South Fork	—	—	—	Subadult	221 mm	F	—	—
39.2	-108.1	*elegans*	*vagrans**	CO[4]	Grand Junction	Mesa	1960	Aug	—	—	—		University of Colorado Museum of Natural History	UCM 15296
40.0	-105.4	*elegans*	*vagrans*	CO	Boulder	Sugarloaf Mountain	1954	June	Albino	—	—	—	University of Colorado Museum of Natural History	UCM 7068
41.6	-88.4	*radix*	—	IL[4]	Kendall	Yorkville	1975	Oct	—	Subadult	—	—	Brookfield Zoo	—
41.9	-87.6	*radix*	—	IL[5]	Cook	Chicago	1950	Sept	Albino	Neonate	151 mm	—	University of Illinois Museum of Natural History	UIMNH 33858
41.9	-87.6	*radix*	—	IL[6]	Cook	Chicago	1973	Sept	Albino	Neonate	235 mm	F	S. Dyrkacz	SD 058
42.3	-83.1	*butleri*	—	ON[7]	Essex	Windsor	1985	—	Albino	—	—	—	P. Pratt	—
42.4	-114.5	*elegans*	*vagrans*	ID[8]	Twin Falls	—	1961	Aug	Albino	Subadult	592 mm	F	Monte L. Bean Life Science Musuem, Brigham Young University	BYUH 23690
42.6	-88.1	unknown	—	WI	Kenosha	Paddock Lake	1987	Aug	Albino	—	—	—	Milwaukee Public Museum	MPM 95; MPM 96
44.6	-123.9	*ordinoides*	—	OR	Lincoln	Toledo	1966	Sept	Albino	—	—	—	California Academy of Sciences	CAS 121124
46.5	-121.8	*elegans*	*vagrans*	WA[9]	Lewis	Bishop	1934	June	Albino	—	—	—	Charles R. Conner Museum, Washington State University	—
47.0	-122.7	*ordinoides*	—	WA[10]	Thurston	—	—	—	Albino	—	—	—	—	—
47.2	-122.3	*ordinoides*	—	WA[11]	Pierce	Puyallup	1972	Apr	Albino	—	495 mm	M	James R. Slater Natural History Museum, University of Puget Sound	PSM 10200

[1]Rose 1959
[2]Smith et al. 1975
[3]Banta and Hahn 1966
[4]Dyrkacz 1981
[5]May 1952
[6]Dyrkacz 1975
[7]COSEWIC 2010
[8]Tanner 1966
[9]Svihla 1936
[10]Brown et al. 1995
[11]Norman 1997

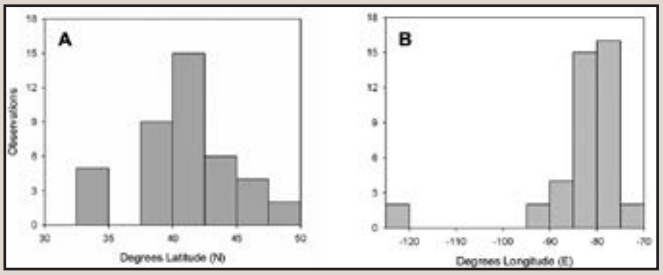


FIG. 2. Frequency histograms of unique observations of albinism and leucism in Common Garter Snakes (*Thamnophis sirtalis)* per degrees North latitude (A) and degrees East longitude (B). The latitude and longitude of each observation site were inferred from details of known site locality in the original source publication or museum description, and assessed using Google Earth. Where only county-level information was provided in the original description, we estimated the site latitude as an arithmetic mean of the most northerly and southerly latitudes associated with the geographical boundaries of each county. Two observations where at least county-level locality data were unavailable were excluded.

commonly reported from the eastern US (albinos/leucistics: $\overline{X}$ = -83.1°E), whereas the mean longitude of records of wild-type specimens was shifted further west (wild-type: $\overline{X}$ = -97.9°E).

We did not perform statistical analysis on the smaller data set of aberrant garter snakes of *Thamnophis* species exclusive of *T. sirtalis* (Table 2),; however, we note that a majority of observations were also found at sites around 40°N latitude.

DISCUSSION

Albino T. s. sirtalis *from Macon, Georgia.*—According to Carpenter (1952), sexual maturity in *T. s. sirtalis* may be attained at a snout-vent length (SVL) around 400 mm. Although we did not measure SVL at the time of capture, populations of *T. s. sirtalis* in Michigan have tails that comprise about 25% of the total length. Assuming that Georgia populations of *T. s. sirtalis* have similar growth patterns, by extrapolating an SVL of ~ 300 cm at the time of collection we interpret that the individual was a subadult when captured, probably born the previous spring or summer (Carpenter 1952). We acknowledge, however, that geographic variation in life history traits in *T. sirtalis* is extensive (Rossman et al. 1996), and growth rates in populations from Georgia might differ from those in Michigan. Interestingly, a snake strongly resembling the specimen described here was seen about two weeks prior to this observation in the same area of the Drace residence (KMD, pers. obs.), suggesting that the same snake may have been resident in the area for at least a few weeks. Although the possibility that it was a separate specimen should not be discounted (e.g., Dyrkacz 1981), we know of no other reports of putative albino snakes from the area.

Albinism in subspecies of T. sirtalis.—Although *T. sirtalis* contains at least 11 described subspecies, albinism has been only reported in just three subspecies, two of which (*sirtalis* and *parietalis*) have the largest geographic ranges of the species. Is albinism less common in subspecies of *T. sirtalis* where it has not yet been reported? Several lines of evidence suggest that this is probably not the case. First, many subspecies of *T. sirtalis* for which albinism has not been recorded have small geographic ranges (Rossman et al. 1996), and several occur in relatively remote areas of western North America. Thus, albinism may be less likely to be encountered in some of these populations, simply because of difficulties in accessing appropriate habitat. In addition, population bottlenecks and associated inbreeding can generate an increase in homozygous recessive traits such as albinism (e.g., Gilhen et al. 2012). As a consequence, some isolated populations of *T. sirtalis* may be subject to higher rates of albinism than those seen elsewhere. Finally, it is also likely, in our view, that some relatively recent observations of albinism in this species have not been published, perhaps due in part to a lack of perceived scientific interest in additional observations. Although this is conjectural, we note that the most recent published report we found for albinism in any population of Common Garter Snake was that of Smith (1997).

Geographical variation in albinism.—We considered whether records of albinism and leucism in *T. sirtalis* indicated a geographic bias to the distribution of albinos and leucistics in this species, as has been described in *V. berus* (Krecsák 2008). A strong test of this hypothesis would compare the frequencies of aberrant snakes in multiple populations across the geographic range of *T. sirtalis,* and test whether these frequencies differ across a latitudinal or longitudinal gradient. Such an approach is not feasible at the present time; the number of records of albinism and leucism we found was too small (Table 1) to generate reliable calculations of aberrant morph frequencies per population (or even per museum). Instead, we simply compared the latitude and longitude of albinos to those of wild-type snakes from a search of museum records. This approach has its own drawbacks: for example, it assumes wild-type specimens are collected or observed at a given locality in direct proportion to their frequency in natural populations, and that albino specimens would be noted as such in HerpNet2, which is clearly not always the case. Nevertheless, this approach offers, in our view, a reasonable starting point to address this question.

All else being equal, we expected that if albinos are encountered at higher frequencies in the northern part of their range as compared with elsewhere—assuming that any such observation bias corresponds to true differences in the frequency of albinism—we would find that the number of observations of albinos was skewed in this direction. The peak number of observations was centered at around 40º N (Fig. 1A), roughly the central part of their latitudinal range (Rossman et al. 1996). However, there was no difference in the median latitude of albinos and wild-type snakes, and the distribution of wild-type snakes in the HerpNet2 database corresponds closely with that of albinos. Thus, we find no support for the hypothesis of a latitudinal gradient of albinism per se, though limited sampling in the northern and southern parts of its range could conceivably obscure a real pattern. It is also conceivable that albinos are more strongly selected against at relatively high and low latitudes, and are more abundant at around 40ºN, but distinguishing between this possibility and observer bias is not presently possible.

The peak distribution of albino and leucistic *T. sirtalis* was centered around -80ºE, with two observations much further west (Fig. 2A). There was a difference in the median longitude of albinos and wild-type snakes, with putative wild-type snakes found further west than albinos. Common Garter Snakes are largely absent from the major deserts of the western and southwestern US (Rossman et al. 1996), and the comparatively small number of records in HerpNet2 of *T. sirtalis* found at sites between the Great Plains and western Nevada found is not unexpected (data not shown). However, it is notable that we found no records for albino *T. sirtalis* from California specifically, despite the large number of records from that state with latitude/

longitude data in the HerpNet2 database (2293/9823 specimens from California, or 23% of the total).

Summary and future directions.—Is there a geographic bias in the occurrence of albino *T. sirtalis*? We found no evidence for a latitudinal bias in observations, but did find evidence of a possible longitudinal bias. If this pattern reflects a real biological phenomenon, perhaps the paucity of albino *T. sirtalis* records from the west reflects underlying differences in thermal, climatic, or predator regimes in western habitats, as compared with those elsewhere in its range.

We caution, however, that there are many possible alternative explanations for this pattern. For example, a small observation/collection rate of albinos at sites in the west might reflect local behavioral plasticity; as one possibility, adoption of crepuscular or nocturnal activity by albinos could conceivably lower detection rates at a given site, even if the frequency of albinos is unchanged. Alternatively, perhaps the majority of western specimens have been collected under study designs that either advertently or inadvertently tended to minimize the chance of encountering (or capturing) aberrant snakes. In addition to collection or observer bias, perhaps museums holding the majority of western specimens of *T. sirtalis* tended to omit supplemental information about a given specimen (such as possible color anomalies) when data were uploaded to HerpNet2. This possibility underscores the importance of direct inspection of individual specimens whenever possible (Krecsák 2008).

Determining which of these factors, if any, is responsible for the limited number of observations of aberrant *T. sirtalis* in the western part of its range represents a significant challenge. However, testing the hypothesis of a longitudinal (or latitudinal) bias might be more feasible in the context of a larger cross-species study. As a possible starting point, we note that albinism has been reported from at least four species of garter snake that have ranges that extend into California (*T. sirtalis*, *T. elegans*, *T. marcianus*, *T. ordinoides*, Tables 1–2; Rossman et al. 1996), but for which we found no confirmation of albinism from any record within that state, either within the literature or in the HerpNet2 database.

More generally, data on color aberrancies from studies of Common Garter Snakes in the north, south and western parts of the range of *T. sirtalis* are needed to provide a better sense of whether the apparent absence of albinos from these areas has a real biological basis. Inspection of individual preserved snakes is also likely to reveal additional specimens not reported here. It is also possible that some reports describing "albinism" in *T. sirtalis* conflated albinism (sensu Bechtel 1995) with other color aberrancies, and inspection of older preserved specimens to confirm and/or reassess aberrant color status is recommended for future studies. Despite the limitations inherent in the approach described here, we believe that we have made steps towards a rigorous analysis of geographic variation in albinism and its possible functional significance.

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Results of Repeated Surveys for the Brazos Water Snake (*Nerodia harteri*) in a Section of the Brazos River in North Texas

The Brazos Water Snake, *Nerodia harteri*, is a medium-sized, semiaquatic snake known from the Brazos River drainage of Texas (Werler and Dixon 2000; Gibbons and Dorcas 2004). *Nerodia harteri*, along with its sister species that was previously considered conspecific, *N. paucimaculata* of the Concho and Colorado River drainages, are the only two snake taxa endemic to Texas. Both are considered to be riffle habitat specialists, especially as juveniles (Werler and Dixon 2000; Gibbons and Dorcas 2004). It is thought that *N. harteri* hunts mostly fish in riffles and that this habitat is critical to the successful feeding strategy of juveniles. *Nerodia paucimaculata* has been the focus of numerous studies, and was previously listed by the United States Fish and Wildlife Service (USFWS) as threatened (Whiting et al. 2008). Populations of *N. paucimaculata* have been monitored and stabilized, and the species has been delisted by the USFWS. Comparatively little work has been done on *N. harteri*, so we attempted to survey for the presence of the species in a section of the Brazos River where it was historically considered abundant to obtain an estimate of local population size and genetic diversity.

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Materials and methods.—An approximately 32 km-long section of the Brazos River was surveyed approximately monthly for the presence of *Nerodia harteri*. This section of river extended from Texas State Highway 16 in the west to Texas State Highway 4 in the east and was chosen for several reasons, but most importantly, it contains the type locality for *N. harteri*. Scott et al. (1989) found *N. harteri* in our study area at the highest density for any stretch of the Brazos River of comparable length. For our surveys, the river was split into two sections nearly equal in length. Surveys were always two days long and both sections of the survey route were run in the same calendar month for consistency. Surveys were run sporadically, but not more than once per month between April and October, the general active season for *N. harteri*. Survey activities consisted of canoeing or kayaking the river and looking for snakes basking or swimming. We also stopped at all likely cover objects (logs, large single rocks) and riffle areas to flip cover objects and visually search for snakes. These are commonly used survey techniques for river-dwelling snakes (Whiting et al. 2008; McBride 2009). When a snake of any

TABLE 1. Schedule of snake surveys and counts of snakes observed.

Calendar year	Calendar month survey conducted	Snakes observed
2011	June	*N. erythrogaster* = 2, *N. rhombifer* = 1, unidentifed *Nerodia* = 1
	July	*N. erythrogaster* = 1
	September	*N. harteri* = 2, *N. rhombifer* = 1, unidentifed *Nerodia* = 1
	October	*A. piscivorous* = 1, *T. proximus* = 1
2012	April	*N. rhombifer* = 5, unidentifed *Nerodia* = 1
	May	*A. piscivorous* = 1, *N. erythrogaster* = 1
	June	*N. rhombifer* = 1, *T. proximus* = 1
2013	May	*N. erythrogaster* = 4, *N. rhombifer* = 6, unidentifed *Nerodia* = 1
	June	*N. erythrogaster* = 2, *N. rhombifer* = 2, unidentifed *Nerodia* = 1
	July	*A. contortrix* = 1
	August	no snakes observed
	September	*A. piscivorous* = 1, *N. erythrogaster* = 2, *T. proximus* = 2
	October	*N. erythrogaster* = 1, *N. rhombifer* = 1

TABLE 2. Collection data for individuals of *Nerodia harteri* captured during this study. CT = cloacal temperature; TOC = time of capture.

	Sex	Mass (g)	SVL (cm)	TL (cm)	CT (°C)	TOC	Date
N. harteri #1	Male	7	21.5	29	18.9	0840 h	20 September 2011
N. harteri #2	Female	13.5	26	34	20.6	0908 h	20 September 2011

species was located, we attempted to move closer to positively identify it to species or capture it. We collected the following data from captured snakes: geographic location (marked by GPS point), physical location and behavior (e.g., under rock, swimming across river, etc.), time of capture, sex (S), snout–vent length (SVL), total length (TL), mass (M), cloacal body temperature (CT). Unique scale clip patterns taken from ventral scales were used to mark individual juvenile snakes for identification in case of recapture. Scale clips were stored dry in marked small plastic bags as tissue samples for DNA analysis. Snakes were then released at the physical point of capture. Adults were to be marked with PIT (passive integrated transponder) tags, but no adult *N. harteri* were located in the course of this study.

Results.—We encountered at least 39 individuals of six species of snakes during our surveys from June 2011 to October 2013 (Table 1). Table 1 shows when surveys were run and the counts of each species encountered during surveys. Exact numbers of *N. erythrogaster* and *N. rhombifer* could not be determined because we could not get close enough to several snakes to make a positive identification (listed as "unidentified *Nerodia*") and some snakes were encountered while basking in contact with each other, which made counting the exact number of individual snakes difficult. We did not presume that any individual unidentified *Nerodia* were *N. harteri*. Table 2 shows the data collected for both individuals of *N. harteri* captured during our surveys, excluding geographic location and physical location of each individual at the time of capture. For conservation related reasons, we have chosen not to reveal the physical locations of collected individual *N. harteri* in print, but will provide that information to those who request it for scientific use.

Discussion.—We encountered many problems with our study design. All planned surveys were not run because of numerous funding and weather related factors. We began surveys at approximately the same time in the morning. This meant we surveyed areas closer to our put in point earlier in the day at cooler temperatures repeatedly. This also means we surveyed portions of the survey route farther from the put in point later in the day during generally hotter temperatures. Snakes were generally easier to locate during the warmest parts of the day early and late in the year and during the early morning hours during the heat of the summer. These factors almost certainly influenced our number of snake encounters. Water conditions varied greatly based on water releases from the Morris Sheppard Dam, holding back Possum Kingdom Lake. During periods of relative high water, most riffle areas on the river were inundated, leaving few rocks and cover objects for us to flip while searching for snakes. This is a proven method for locating both adults and juveniles of *N. harteri*, but was not possible during high water. In light of these limitations, we do not include a rate of catch per unit effort for snakes encountered during our surveys, as we feel these data are unreliable.

Despite these limitations, a number of snakes were located during surveys. However, as show in the results, only two *N. harteri* were captured. Both of these individuals were neonates located under different small rocks on the edge of the same riffle on the same survey day. Based on their different body sizes and geographic locations in the riffle, it is likely they were not from the same litter. We feel that even though our study design had practical limitations, we should have encountered more individuals of *N. harteri* if a reasonably large population

existed in this stretch of river. We originally intended to perform a mark/recapture study and population genetic analysis on *N. harteri* in our study area. This was not possible because of the extremely low number of initial captures and the complete lack of recaptures. We do speculate that *N. harteri* is now very rare in at least the section of the river we surveyed and it may be difficult to accurately assess population size (Krebs 1989).

Anecdotal reports (T. Hibbitts and A. Price, pers. comm.), along with collection records (Trapido 1941; Maxwell 1982; Dorcas and Mendelson 1991; Rossi and Rossi 1999; McBride2009; Rodriguez 2012), and one very thorough survey (Scott et al. 1989) suggest that before approximately 1995 *N. harteri* was not difficult to find in and near our study area. The causes for the apparent decline of *N. harteri* in our study area are probably multifactorial, but may include habitat alteration from both changes in hydrology (McBride 2009) and invasive species (Blackburn et al. 1982; Brotherson and Field 1987). Specifically, during periods of hydroelectric power generation, the Morris Sheppard Dam typically released large amounts of water nearly every afternoon during the summer, creating an unnatural flow regime (McBride 2009). Regarding invasive species, we have noticed an increase in the amount of saltcedar (*Tamarix ramosissima*) from both historical levels as determined by photographs and through our own observations over the course of this project. Scott et al. (1989) also commented on the ability of saltcedar to impact the river ecosystem. Scott et al. (1989) suggests that they considered *N. harteri* to be "relatively secure." We found a very low number of *N. harteri* during the course of our surveys and do not agree that within our survey area populations of *N. harteri* are secure. Based on our results, we recommend more studies be done on the current range wide occupancy of *N. harteri* within its historic range. We also recommend once remaining populations of the snake are located, that efforts are made to quantify the population size of snakes in that location.

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Body Size and Growth of the Eastern Collared Lizard *(Crotaphytus collaris)* in Central Arkansas

The Eastern Collared Lizard (*Crotaphytus collaris*; Fig. 1) is a saxicolous species inhabiting warm, arid habitats common to the southwestern United States (Templeton et al. 2001). Arkansas and Missouri represent the eastern range limit of *C. collaris* (Templeton et al. 1990) where this species is restricted to exposed bedrock (glades) and rocky outcrops within the Ozark and Ouachita mountains (Trauth et al. 2004). Historically, Ozark landscapes were maintained by natural and anthropogenic fire regimes (Strausberg and Hough 1997; Van Lear et al. 2004). However, wildfires were suppressed in the Ozarks throughout the 20th century (Fralish 2004; Verble 2012) which allowed invasion of fire-intolerant plant species into glade habitats (e.g., Eastern Red Cedar, *Juniperus virginiana*), and provided conditions for succession of other woody plant flora (Brisson et al. 2003; Van Zandt et al. 2005). Dense vegetation in glade habitats is correlated with delayed age of maturity, reduced growth rates and adult body size, shortened activity seasons (Sexton et al. 1992), and limited population size and gene flow (Brisson et al. 2003; Templeton et al. 2011) in *C. collaris*. The evidence is compelling that changes in plant assemblages of glade habitats is linked with population declines of *C. collaris* in the Ozark Mountains.

Habitat fragmentation and continued population declines prompted the Arkansas Game and Fish Commission to list *C. collaris* as vulnerable in Arkansas (Anderson 2006). Grimsley (2012) found that of 20 sites where *C. collaris* were documented in the 1970s (Trauth 1974), they persisted at only eight sites three decades later. Remaining populations are geographically isolated, with little opportunity for migration among sites. Because small, isolated populations are at the greatest risk of extirpation, understanding population dynamics of *C. collaris* in the state is vital to conservation and management of the species. However, few data on life history parameters or demographics are available for Arkansas populations since the most recent wave of extirpations (Trauth 2011; Grimsley 2012).

In Arkansas and Missouri, yearling *C. collaris* must attain a minimum SVL of ~77 mm to reproduce in their first full activity season (males 76 mm, Trauth 1979; females 77 mm, Sexton et al. 1992). Similarly, clutch size is positively correlated with body size of adult female *C. collaris* (Trauth 1978; Ballinger and Hipp 1985). Because fecundity is a major component of population dynamics (Gadgil and Bossert 1970; Shine and Scwarzkopf 1992; Dunham and Overall 1994), and body size is linked to fecundity, it follows that age-specific body size and growth are appropriate indicators of the health of *C. collaris* populations.

Research in Missouri demonstrated statistical differences among size and growth (SVL) of *C. collaris* from a single study site (Sandy Ridge, Missouri) when compared across two time periods, one before fire suppression (1960–1965) and the second after fires were suppressed and the habitat was invaded by fire intolerant vegetation (1975–1988; Sexton et al. 1992). Sexton et al (1992) reasoned that the marked difference in size and growth of *C. collaris* between time intervals at Sandy Ridge was due to habitat degradation associated with fire suppression over the later time interval, and Brewster et al. (2013) provided an explanation for how the changing habitat structure could affect growth of individuals in this species.

There are limited published data on body size or growth rates of *C. collaris* in Arkansas (but see unpublished thesis with unreported sample size; Trauth 1974). Thus, the objective of this study was to document the body size and growth of a *C. collaris* population in central Arkansas as a potential baseline for long-term monitoring and comparisons with other populations in the state. To assess the current status of the central Arkansas population, we compared body size and growth data from the central Arkansas population to the Sandy Ridge, Missouri population both post suppression (presumed degraded habitat) and pre suppression (presumed undegraded habitat) of fire.

Materials and Methods.—We performed this study on a privately owned rock quarry near Scranton (Arkansas River Valley ecoregion) in central Arkansas that contains 4–5 adjacent colonies of *C. collaris* interspersed within an area of ~170 ha. Although we found no evidence of migration between the two most spatially separated colonies (~950 m), migration between adjacent colonies is fairly unimpeded (all sites are connected by open dirt roads and corridors of grassland). Thus, for the purpose of this study, we treat all colonies at this site as one population. The majority of the site consists of large areas of exposed bedrock



FIG. 1. Image of an adult male Eastern Collared Lizard *(Crotaphytus collaris)* from a site in Central Arkansas (this study), 2011.

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TABLE 1. T-test analysis of body size (SVL) by age class between central Arkansas and Sandy Ridge, Missouri (Sexton et al. 1992) at both 1960–65 (Pre suppression) and 1975–80 (Post suppression) time intervals. Mean SVL in mm, standard deviation (SD), sample size (N), t statistic (t), and p-value (P).

Sex	Age	Site	SVL	SD	N	t	P
Combined	0	Pre suppression	58	11	59	0.87	0.386
	0	Central AR	55.9	11.8	37		
Female	1	Pre suppression	78.1	6.6	34	2.4	0.096
	1	Central AR	82.2	2.9	8		
Female	2+	Pre suppression	93.7	6	11	1.07	0.295
	2+	Central AR	91.7	3.5	15		
Male	1	Pre suppression	80.6	8.8	28	4.46	0.073
	1	Central AR	88.9	0.6	4		
Male	2+	Pre suppression	100.6	7.9	12	0.19	0.851
	2+	Central AR	101.1	5.5	14		
Combined	0	Post suppression	52.2	8	221	2.46	0.015
	0	Central AR	55.9	11.8	37		
Female	1	Post suppression	69.9	9.6	139	3.6	<<0.001
	1	Central AR	82.2	2.9	8		
Female	2+	Post suppression	92.3	3.1	77	0.67	0.504
	2+	Central AR	91.7	3.5	15		
Male	1	Post suppression	69.6	1.01	138	3.5	<<0.001
	1	Central AR	88.9	0.6	4		
Male	2+	Post suppression	97.1	3.8	85	3.41	0.001
	2+	Central AR	101.1	5.5	14		

and boulder piles, with sparse vegetation interspersed within a prairie-savanna matrix with ~1-m tall grasses and intermittent hardwood forest.

We captured lizards by hand or by noose between May and October 2011. We visited the site three to five times per month for a total of 19 collecting trips. Upon capture, we recorded SVL to the nearest mm, sex, and age class. We palpated the abdomen of females to determine reproductive condition. We did not attempt to distinguish sex of hatchling lizards. The time and date of capture, and any unique scars or wounds were noted. After initial capture, we gave each lizard a unique individual toe-clip to permit future identification (Huey et al. 1990). We also marked lizards with a paint pen (small dot on the back of the head) to distinguish them from un-captured individuals, and released all individuals at their location of capture. Consistent with recommendations for wild taxa (Sikes et al. 2012), our methods followed taxon-specific guidelines approved by the American Society of Ichthyologists and Herpetologists for the use of wild amphibians and reptiles in research (Beaupre et al. 2004).

We were unable to distinguish between adult age classes (i.e., 2-year-olds from 3-year-olds) in this one-year study. However, differences in size and coloration allowed delineation of hatchlings, yearlings (sub adults in their first full activity season), and adults (2-year-olds and older). To increase accuracy of yearling and adult delineation, we developed an equation using body size and age data available in the literature (Sexton et al. 1992; Brisson et al. 2003) to estimate a predicted maximum SVL of yearling lizards:

$$SVL_{max} = g_i * d_i + SVL_{init},$$

Where SVL_{max} is the maximum SVL of a lizard to be classified a yearling, g_i is the mean growth rate of other individuals in the yearling size class (0.22 mm/day), d_i is the Julian date of initial capture for that individual minus the Julian date of initial capture of first group of individuals in yearling size class (160), and SVL_{init} is the greatest SVL of initial group of yearlings captured (80 mm for females and 86 mm for males).

We did not attempt to determine sex of hatchlings, so to make comparisons of mean hatchling SVL between populations we combined sexes. Similarly, we combined all lizards over two years of age to compare mean SVL of adults across populations.

We compared individual growth rates of the central Arkansas population to those from Sandy Ridge post suppression (Sexton et al. 1992). To increase sample size of individual growth rate comparisons of Sandy Ridge post suppression, we combined sexes (0 and 1 year olds did not differ significantly between sexes). Statistical comparisons of individual growth rates of Sandy Ridge pre suppression were not possible due to sample size.

Raw data for the Sandy Ridge pre and post suppression (Sexton et al. 1992) were not available, so we were limited to comparisons using the mean, standard deviation, and sample size for each size/age class. We conducted T-tests (SAS 9.2, 2011) to test for differences in mean body size and growth, within each age class, between populations. We used the pooled standard deviation when classes were combined (Zar 1999). To assess sample sizes used in growth comparisons, we provide the least significant number (LSN; Zar 1999). We use Cohen's *d* (estimate of effect size) with 1- = 0.80 and = 0.05 to calculate LSN (Cohen 1992).

Results.—We recorded a total of 141 captures of 42 yearlings and adults, and 77 captures of 37 hatchlings over the course of the study. We recaptured 76% of adults and yearlings, and 42% of hatchlings at least once.

Body size was similar for all age/size classes between the central Arkansas population and Sandy Ridge pre suppression (Table 1). Except for adult females, body size tended to be larger in the central Arkansas population than lizards from Sandy Ridge post suppression (Table 1).

Sexton et al. (1992) concluded that yearling females must reach a minimum SVL of 77 mm by June 1 to oviposit eggs during their first full activity season. Six of the eight yearling females in the central Arkansas population attained a minimum SVL of 77 mm before June 1. Although we could not verify reproduction, we detected follicles (by palpation) in all but the two smallest yearling females.

Growth rates did not differ significantly between the central Arkansas population and Sandy Ridge post suppression. Five of the seven classes used to test for growth differences were represented by sample sizes of 10 individuals or fewer in the central Arkansas population, so the lack of statistical differences might be due to small sample size. We provide the LSN to assess the impact of small sample size in growth comparisons (Table 2).

Discussion.—The mean body size of *C. collaris* from central Arkansas compares favorably with Sandy Ridge pre suppression. Data for most of the age classes suggest that *C. collaris* in the central Arkansas population are significantly larger than individuals from Sandy Ridge post suppression and do not differ

TABLE 2. T-test analysis of mean growth rates by age and size class between central Arkansas and Sandy Ridge, Missouri 1975–88 (Post suppression; Sexton et al. 1992). Rate represents growth (mm/day) in SVL, standard deviation (SD), sample size (N), t statistic (t), p value (P), and estimated minimum sample size to detect a significant difference (LSN).

Sex	Class	Site	Rate	SD	N	t	P	LSN
Combined	Age 0	Post suppression	0.4	0.17	69	1.32	0.1894	48
		Central AR	0.471	0.3	18			
Combined	Age 1	Post suppression	0.256	0.096	135	1.17	0.2451	258
		Central AR	0.222	0.105	12			
Combined	<55mm	Post suppression	0.411	0.16	71	1.98	0.0513	70
		Central AR	0.531	0.19	8			
Combined	55–74mm	Post suppression	0.265	0.103	121	0.95	0.3459	274
		Central AR	0.299	0.172	10			
Combined	75–84mm	Post suppression	0.191	0.096	19	0.72	0.479	62
		Central AR	0.225	0.135	7			
Female	85–94mm	Post suppression	0.068	0.119	53	1.12	0.2664	86
		Central AR	0.115	0.096	9			
Male	85–94mm	Post suppression	0.149	0.121	29	0.76	0.4528	110
		Central AR	0.185	0.059	7			

TABLE 3. Summary table of mean growth rates (mm/day) and sample sizes (parenthetic, when available) by age and size class of *Crotaphytus collaris* in the periphery of the species range. A = central Arkansas, B = Sandy Ridge, Missouri 1975–88 (Post suppression; Sexton et al. 1992), C = Sandy Ridge, Missouri 1960–65 (Pre suppression; Sexton et al. 1992), D = north central Arkansas (Trauth 1974), E = north Kansas (Malaret 1985).

Class	A	B	C	D	E
Age 0 Combined	0.471 (18)	0.40 (69)			
Age 1 Combined	0.222 (12)	0.26 (135)			
Age 2+ Male	0.09 (7)	0.036 (53)			
Age 2+ Female	0.117 (8)	0.034 (46)			
< 55 mm Combined	0.53 (8)	0.41 (71)	0.52 (8)	1.1	
55–74 mm Combined	0.30 (10)	0.26 (121)	0.30 (41)	0.66	0.34 (33)
75–84 mm Combined	0.225 (7)	0.22 (30)	0.24 (25)	~0.26	0.37 (27)
85–94mm Combined	0.123 (14)	0.10 (82)	0.13 (26)	~0.14	0.22 (37)
95+ mm Combined	0.129 (11)	0.01 (62)	0.05 (18)	~0.18	0.12 (56)

in size from *C. collaris* at Sandy Ridge pre suppression. Although individual growth rates of *C. collaris* from central Arkansas were not significantly greater than growth rates of lizards at Sandy Ridge post suppression (in all but 55 mm SVL or less), the LSN of these classes suggests that sample sizes were simply too small to provide a robust test for statistical differences. A summary of mean growth rates from four other populations (Table 3) suggests that the central Arkansas population is intermediate to high with respect to body growth.

Data on yearling female body size and growth suggest that potential annual fecundity of the central Arkansas yearling females should be relatively high. Six of the eight yearling females (75%) in the central Arkansas population reached the predicted minimum body size (77 mm SVL) necessary for reproduction in their first full activity season. This is a substantial difference from the 46% and 23% of yearling females estimated to reach maturity at Sandy Ridge pre and post suppression, respectively. Further, mean body size of adult females was similar to those from Sandy Ridge pre suppression (Table 1). Thus, assuming a consistent correlation between body size and fecundity, per capita fecundity may be similar between the central Arkansas population and that of Sandy Ridge pre suppression.

This study has provided growth and body size estimates to characterize the status of a central Arkansas population of *C. collaris*. In general, our results suggest that this is a relatively healthy population (compared to other Ozark populations), and provides a suitable baseline for future monitoring of *C. collaris* populations in Arkansas. It is important to point out that population vital rate estimates, such as survival, recruitment and population growth rate are the true proxies of population health (Case and Roughgarden 2000). However, because it is the interaction of life history parameters and population dynamics that ultimately dictates populations (Dunham et al. 1989), combining body size and growth estimates with population vital rate estimates provides a more comprehensive and powerful tool to assessing population status of *C. collaris* in Arkansas. Thus, to monitor and develop effective conservation strategies for *C. collaris* populations in Arkansas, data from other populations are needed.

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TECHNIQUES

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Pattern-Recognition Software as a Supplemental Method of Identifying Individual Eastern Box Turtles *(Terrapene c. carolina)*

Identifying and monitoring individuals is essential in behavioral and ecological studies of wild animals. Traditional methods for permanently marking turtles include shell notching, tagging with aluminum bands, and insertion of passive integrated transponder (PIT) tags (reviewed in Ferner 2007 and Plummer and Ferner 2012). These methods have been shown to be effective, but applying such marking techniques may result in increased stress, altered behavior, or opportunities for infection (McGregor and Peake 1998; Markowitz et al. 2003; Fisher 2007). Therefore, it is desirable to use methods of long-term identification that minimize the potential impact on the organism.

As technology improves, researchers have taken advantage of photographing naturally occurring or conspicuous marks to identify individuals (reviewed in Reisser et al. 2008 and Bolger et al. 2012). Traditionally, pattern-recognition involved comparing hard copies of photographs against catalogues of photographs to identify recaptures. In the case of large image catalogues, the number of images makes pattern-matching a time-consuming process and increases the probability of visual errors (Hammond et al. 1990; Katonas and Beard 1990; Sears et al. 1990; Gamble et al. 2008).

Shell patterns have been suggested to be a viable means of identifying individual box turtles (Budischak et al. 2006; Wynn and Moody 2006; Weiss 2009; D. E. Hoss, pers. comm. 2013). Photo-recognition techniques offer several advantages such as reduced handling time of the animal, an increase in the efficiency of identifying individuals, and elimination of the problems associated with loss of tags or other artificial marks (Reisser et al. 2008). In addition, pattern recognition is inexpensive, less invasive than most of the traditional methods of permanently marking turtles, and lessens the chance of identity failure due to wear or malfunction. As such, pattern-recognition software has the potential to be a cost-effective alternative method of identifying box turtles.

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At our study site in northwestern Ohio, USA, the required method of marking Eastern Box Turtles (*Terrapene carolina carolina*) is use of PIT tags. The expense of using PIT tags and the readers required to confirm the presence of a PIT tag can quickly eat away at the small grants available to fund local mark-recapture studies. Additionally, this method of marking carries the extra complication of making it impossible to identify recaptures without a PIT tag reader. To aid in future mark-recapture studies and to involve the public in local Eastern Box Turtle conservation efforts, we sought to use digital photography to supplement our use of PIT tags. The goals of our project were to: 1) test pattern recognition as a viable method of identifying individual Eastern Box Turtles; 2) to determining if top-down carapace, off-center carapace, or plastron photos were more diagnostic; and 3) to test the ability of a pattern recognition program to identify individuals from different populations.

Methods.—We collected photographs of Eastern Box Turtles from three areas in two states: the Oak Openings Region (OOR) of northwestern Ohio (41.556°N, 83.854°W) from 2004–2013, Ft. Custer Training Center (FCTC) and the adjacent Ft. Custer Recreation Area (FCRA) in Michigan's southwestern Lower Peninsula (42.324°N, 85.298°W) in 2005 and from 2011–2013, and the Manistee National Forest (MNF; 43.875°N, 85.914°W) from 2009–2013. The impetus for obtaining images from multiple states was to determine whether or not images from different locations would result in false matches. Upon capture, top-down pictures were taken of the turtle's carapace and plastron (N = 610 of each; Ohio = 170; FCTC/FCRA = 307; MNF = 133). Additionally, we used a subset of images (194) taken without standardizing (i.e., pictures taken from any angle; hereafter "off-center") to compare the efficacy of these two methods. A minimum bounding rectangle that reduced the amount of visible background present was used to crop each image. The pictures from all locations were combined into carapace, off-center,



FIG. 1. User interface of WildID showing the focal image (bottom left and first in the row along the top), the active comparison window of the top-ranked marching score (bottom right), and the ranked potential images (top row). Note the loss of pleural scute 4 in the recapture image (active comparison window).

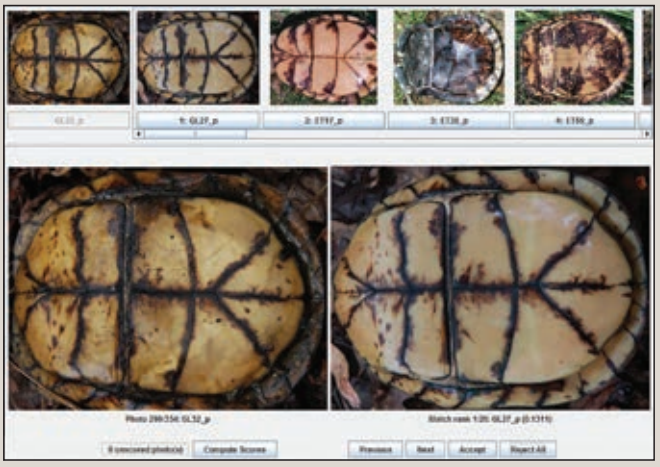


FIG. 2. User interface of WildID showing the focal image (bottom left and first in the row along the top), the active comparison window of the top-ranked marching score (bottom right), and the ranked potential images (top row) for the same turtle in Fig. 1.

and plastron categories within an image database. Turtles with a plastron length less than 7.0 cm were not used because their shell patterns do not appear to be fully developed (D. E. Hoss, pers. comm. 2013).

To identify individual Eastern Box Turtles in our study, we employed the relatively new pattern-recognition software Wild-ID(http://www.dartmouth.edu/~envs/faculty/bolger.html; Bolger et al. 2012). Wild-ID is stand-alone, open-source, multi-platform software that uses Java to implement pattern-recognition. The Wild-ID software uses a Scale Invariant Feature Transform Operator (SIFT; Lowe 2004) to find and extract distinctive features invariant to the scale, rotation, viewpoint, local distortion, and illumination of the image. The geometric arrangements of these SIFT features for each pair of images in the dataset are compared to one another. The program then calculates the goodness-of-fit between the images and assigns a matching score (values range from 0.0000 to 1.0000, where values closer to 1.0000 indicate a stronger match). A full description of these steps can be found in Bolger et al. (2012).

Once Wild-ID has completed the above steps, the user interface displays each focal image along with 20 of the top-ranked images (Figs. 1 and 2). This allows the user to assess the images visually and based on matching scores to conclude whether or not the focal image has a match. Once matching scores were assigned, we used the Kruskal-Wallis procedure and *post hoc* Mann-Whitney U-tests in R (R Development Core Team 2011) to compare carapace, off-center, and plastron matching scores. For this project, a correct response from Wild-ID was recorded if: 1) a successful recapture was identified and 2) if no mismatches between individuals or sites occurred. The individual marking techniques used at the study sites (PIT tags in the OOR; shell notches at FCTC/FCRA and MNF) were used to verify the matches reported by Wild-ID.

Results.—Mean (± SE) recapture matching scores for carapace, off-center, and plastron images were 0.1918 ± 0.0266 for carapace, 0.0396 ± 0.0111 for off-center, and 0.1813 ± 0.0373 for plastron. In no case was the highest-ranked image a different turtle if it was a recapture. Additionally, Wild-ID did not erroneously match images between sampling locations or states and verified recaptures, as confirmed by shell-notching and PIT tagging, at each location. Results of the Kruskal-Wallis tests indicated that there was a significant difference between matching scores of the three image categories ($\chi^2 = 59.91$, df = 2, $P < 0.0001$); *post hoc* tests indicated that there were significant differences in matching scores between carapace and off-center ($P < 0.0001$) and plastron and off-center ($P < 0.0001$), but not between carapace and plastron ($P = 0.6492$).

Discussion.—Overall, Wild-ID performed ideally for identifying Eastern Box Turtle recaptures from carapace and plastron images, but exhibited lower efficacy when off-center images were used. We initially expected plastron images to be less accurate because the plastron occasionally lacks distinguishing patterns (MDC, pers. observ.), but there was no statistical difference between the plastral and carapace images. Plastron images were correctly matched just as often as carapace images and what little pattern may be present was sufficient for the program to identify a match. Because this method has not been tested before with Eastern Box Turtles, we wanted to make sure the program would not mismatch turtles from Ohio with turtles from Michigan; we found no mismatches, suggesting that Wild-ID is in fact suitable for identifying individual adult Eastern Box Turtles from their shell patterns.

Wild-ID represents a cost- and time-effective method of identifying individual eastern box turtles for mark-recapture studies. However, this is not to say that this should be the only means of identifying turtles. For long-lived species like Eastern Box Turtles, whose patterns do not fully develop until later on in life, photo-recognition software alone may not be sufficient for life-long identification and should still be coupled with an additional marking technique until the long-term validity of computer-assisted pattern-recognition has been verified. Additionally, shell damage is a potential source of error, especially in the case of burn scars where a large portion of the shell may be rendered patternless. Photographic mark recapture relies on three conditions: 1) individuals can be photographed, 2) individuals bear some phenotypic pattern variation that easily identifies them from other individuals, 3) an individual's pattern does not vary through time (Bolger et al. 2012). The unique patterns of Eastern Box Turtle shells lend themselves to this method with the exception of the criterion that the pattern remains unchanged.

Many turtles in our study had visible carapace imperfections that appeared to be the result of fires, mower blades, cars, or general wear. Shell damage may influence the results of programs such as Wild-ID, but as we saw with several of our turtles, as long as a majority of the pattern remained, Wild-ID could identify the image as a match. While carapace injuries and subsequent pattern alterations are relatively common, we observed that the plastron pattern remained relatively unchanged in most individuals. Whereas carapace images have been suggested as the minimum requirement to identify a turtle (Wynn and Moody 2006), based on our results, we strongly suggest photographing the plastron as a secondary form of identification, particularly in the case of individuals with damaged carapaces.

Although Wild-ID surpassed our expectations for pattern-recognition with Eastern Box Turtles, we noted that there are a number of ways future studies can improve the probability of the program identifying a positive match. We identified soil and glare on the turtle's shell and amount of background as potential factors contributing to lower matching scores. We recommend that turtles be photographed on a uniform background (e.g., a blank piece of paper) in an area that reduces the amount of glare and shadow on the shell and that soil be cleaned from the shell prior to image-capture. Similarly, for studies specifically seeking to accurately record recaptures, we recommend using cameras with the same resolution. Glare, patterns marred with soil, and images with a disparity in resolution can all lead to reduced matching scores. The SIFT operator, however, will still work with whatever pattern is present in the image (D. Bolger, pers. comm. 2013). Standardizing the method of image-capture in the manner we suggest should lead to increased matching scores, but is not necessary and will depend on the goals of the study. For instance, if the goal of the project is to reduce the amount of handling, off-center photos could be used as long as photos are taken from approximately the same angle. Again, as there is currently no way to confirm a correct identification prior to the development of a pattern on the shell, this method should be considered a supplement to traditional marking techniques.

We encourage researchers and naturalists who have taken photographs of Eastern Box Turtles in the past to utilize this software as a means of rapidly analyzing historical photographs to identify recaptured individuals. This sort of recognition software, combined with citizen-science programs (e.g., Davidson College Herpetology Laboratory's Box Turtle Mark-Recapture Program; Hester et al. 2008), could provide the means for mark-recapture studies of Eastern Box Turtles over a large geographic range.

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An Update to a Bead-Tagging Method for Marking Lizards

Most lizard species lack natural marks, thus impairing our ability to identify individuals by means of visual cues, a prerequisite for many behavioral and ecological studies. Thus, it is often necessary to mark individuals. Toe-clipping (e.g., Waichman 1992) has been a frequently used method to mark lizards, although alternative techniques are often necessary (see Ferner 2007).

The negative impacts of the amputation of lizards' digits is debatable (Paulissen and Meyer 2000; Langkilde and Shine 2006; Grafe et al. 2011); notwithstanding this, toe-clipping has the major disadvantage of not permitting identification at distance and can be an unreliable marking system as lizards frequently lose their toes due to agonistic interactions or when struggling to escape from predators (Passos et al. 2013). Thus, other methods such as implanting of passive integrated transponders—PIT tags—is also advocated to mark lizards (Smyth and Nebel 2013). However, PIT tagging may impair locomotion (Le Galliard et al. 2011) and be stressful (Langkilde and Shine 2006) for lizards; additionally PIT tags cannot be read at distances greater than two meters. Another method used to mark reptiles is the implant of visible elastomers (Schmidt and Schawarzkopf 2010; Waudby and Petit 2011), but despite its advantage of being ethically acceptable this method has relatively high costs. Thus, in many cases, researchers have to rely on other methods to mark individual lizards. Some authors have marked animals with nontoxic ink dots on the lizard's skin (Van Sluys 1997); however, the durability of this technique is relatively short, especially as lizards undergo ecdysis.

Fisher and Muth (1989), hereafter referred to as "FM," developed a technique for permanently marking lizards that avoids the problem of mark loss during skin shedding while also making the mark visible at a distance. This technique involves the surgical attachment of colored beads at the base of the lizard's tail, allowing individuals to be identified by different combinations (i.e., codes) of colored beads. Many studies have used the FM procedure to mark lizards larger than 40 mm in body size (e.g., Martins 1991; Halloy and Robles 2002; Paterson 2002). However, when marking lizards smaller than 40 mm the use of "queen bee marking kits," that consist of cardboard dots coded with a combination of color and numbers that have to be glued to lizards (see Johnson 2005), is a short term alternative.

Since Fisher and Muth's (1989) method was described, new material associated with modern surgical techniques could provide a less harmful procedure for marking lizards. Herein we describe a bead-tagging method for permanently marking live lizards derived from that of FM.

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We developed the present method using dead *Tropidurus torquatus* lizards (snout to vent length range ca. 70–130 mm) from the Herpetological Collection of the Natural Sciences Museum of the Pontifícia Universidade Católica de Minas Gerais. We used surgical 4-0 EP 1.5 sterile black nylon monofilament for skin closure (needle is manufactured already attached to monofilament) to attach up to three colored beads of 2.2 mm diameter × 1.6 mm length on the dorsum of the lizard's tail. After development of the method, and exhaustive tests with dead animals, we applied it in our studies of live animals as described below. As live individuals frequently struggle when being held, we found that marking should be done by two persons to minimize the stress of handling on the animals: one person should hold the animal, and the other person should perform the marking process, hereafter referred to as the marker.

The marking was done by following the surgical instrument tying technique to perform a series of the named square knots (Odland and Murakami 1994) to attach beads at the base of the lizard's tail. Thus, the surgical needle with the attached monofilament is inserted through the dorsolateral skin just behind the base of the lizard's tail (Fig. 1a, b). The needle with the monofilament should be introduced in a caudal–cranial (back to front) direction (Fig. 1a, b). Then, beads are attached to the monofilament by passing the non-needle end of the monofilament through each bead allowing ca. 6 cm of the free suture filament end to lie freely. Following FM, bead code is read front to back; thus, the last bead is strung on first to provide the correct reading sequence. To finish the procedure, the beads were secured with a series of the aforementioned surgical knot techniques as described below.

To firmly tie the monofilament with beads we held a forceps in our right hand perpendicular to the line of and below the needle end of the monofilament (Fig. 3a). Then, we triple-wrapped the needle end monofilament around the forceps in the direction away from the marker-person forming loops around the monofilament (Fig. 1c). Following this, we turned the tip of the forceps to the non-needle end and grasped it, then passed it through the suture loops (Fig. 1d). We tied the knot by moving the two monofilament parts in opposing directions (Fig. 1e; see arrows); at this point, tension has to be applied with both hands (Fig. 1e). In the next step the monofilament is wrapped around forceps in the opposite direction of previous knot (i.e., in the direction of the marker). Following this, this procedure is repeated four more times, always alternating the wrapping loops direction. At the end of procedures the needle-end part of the monofilament has to be cut off leaving ca. 5 mm of the monofilament free (Fig. 1f). We found that by having two persons working together, we could mark an individual lizard in ca. 90 seconds.

We have used the described method to mark five lizard species: *Tropidurus hispidus*, *T. montanus*, *T. semitaeniatus*, *T. torquatus*, and *Eurolophosaurus nanuzae*. In general, such *Tropidurus* species are heliophilous, diurnal, and medium-sized lizards (SVL ca. 70–110 mm). In the case of the Flat Lizard *T. semitaeniatus* a crevice specialist, we attached the beads laterally to avoid loss through abrasion within crevices. For the small-sized species *E. nanuzae* (adult SVL ca. 55 mm), we opted to use a thin (2.0 EP) monofilament and only up to two beads. During

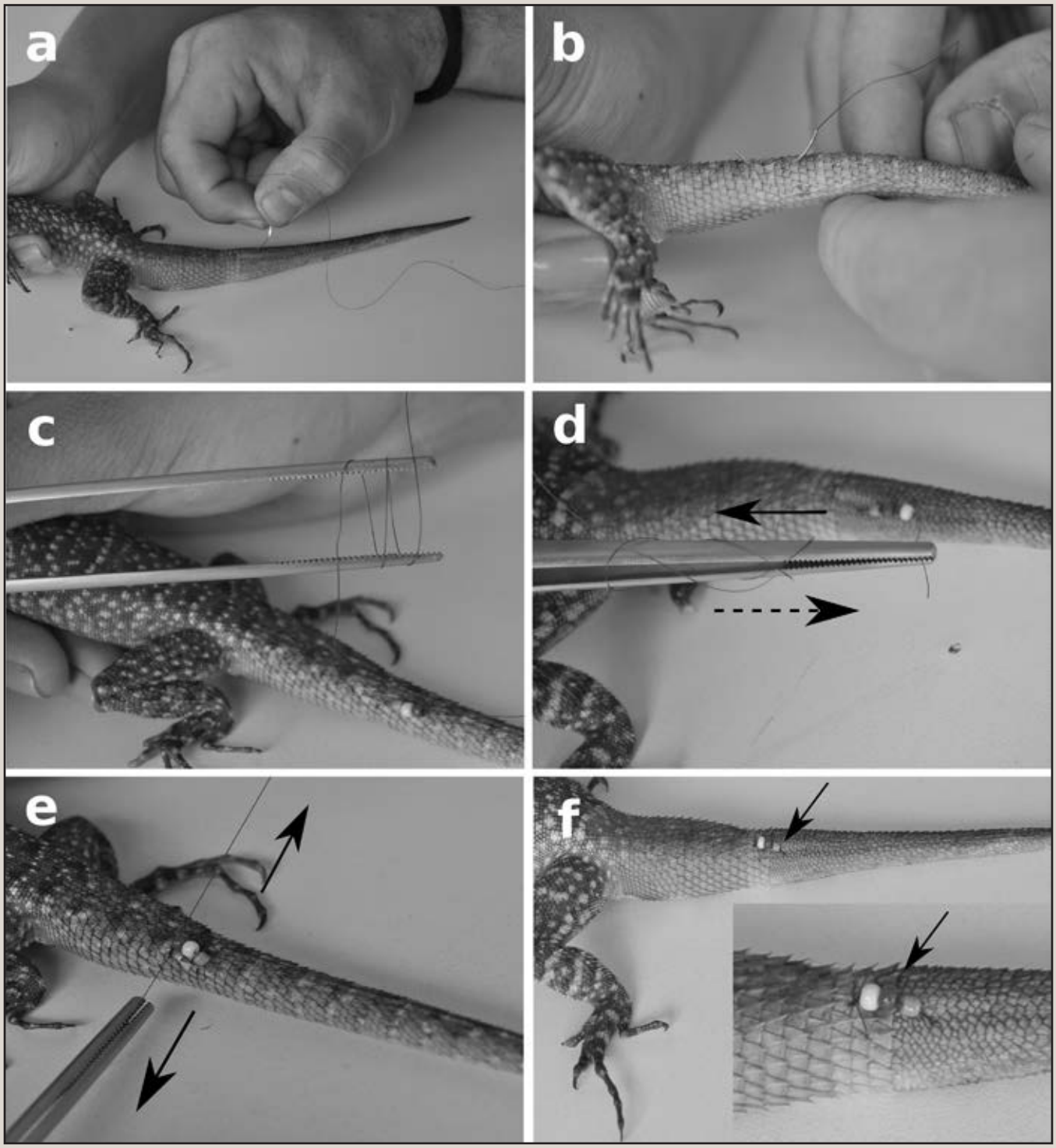


FIG. 1. Procedure to mark lizards through beads attached to tail: a) and b) insertion of the needle with the monofilament in a lizard's tail; c) triple-wrap loops of the monofilament around forceps; d) forceps with loops around grasping monofilament no-needle end, arrows represents the direction that forceps (continuous arrow) and the non-needle end of monofilament (dashed arrow) should be pulled; e) tightening the knot by pulling monofilament parts in opposing direction (arrows); f) manner in which monofilament must be cut off to finish the procedures of bead tagging method for marking lizards.

our studies on the behavior and space use of the aforementioned species, we observed no injuries or necrosis in marked animals. Furthermore, lizards did not seem to lose tail functionality as marked lizards were seen performing tail displays such as "tail extend" and "tail raise" (*sensu* Carpenter and Ferguson 1977). In our behavioral studies, marked lizards were observed to bask normally, forage, and perform assertive head bob displays. No abnormal behavior was observed.

Overall, our modification of the bead-tagging method for lizards developed by Fisher and Muth (1989) had clear

animal welfare benefits over the original method. The nylon monofilament we used had an attached skin closure needle that eliminates the necessity to pierce through the lizard's tail (from the ventral to the dorsum), which in turn should reduce the chance of causing harm to a marked male's hemipenis, its retractor muscle, and its lymphatic chamber, a risk mentioned by FM in their original paper. Moreover, our method reduced the number of needle insertions, reducing by half the number of potential infection points. Thus, welfare gains should outweigh the costs due to the need of two persons to perform markings as required by the technique we presented.

Our marking method, as per the original FM method, appeared not to affect an individual's behavior. After being marked, lizards were seen executing behaviors that were observed in free-ranging non-marked individuals, and no injuries, loss of tail, or necrosis were observed. The method we present is simple to perform and less harmful to lizards. However, as did Fisher and Muth (1989), we advise that those using our method for the first time practice this procedure on dead individuals or artificial models before using it on live lizards.

In summary, the modifications we propose in the FM technique reduce the number of body perforations points and permit the use of a smaller body perforation. Thus, we recommend it to researchers and animal caregivers who need long-term marking solutions.

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Factors Affecting the Accuracy and Precision of Triangulated Radio Telemetry Locations of Eastern Indigo Snakes *(Drymarchon couperi)*

Radio telemetry (i.e., very high frequency or VHF telemetry) has proven an invaluable tool in understanding snake ecology because researchers can locate a telemetered snake virtually at will, thereby obtaining a relatively unbiased view of its behavior and movements (Reinert 1992; Beaupre and Duvall 1998). Researchers generally use homing techniques (Mech 1983) to obtain a visual location of a telemetered snake or its retreat site. As a result, a researcher can obtain very accurate geographic coordinates of the snake's location where accuracy is limited by the resolution and detail of field maps or aerial photos or the accuracy of a GPS unit. In contrast, many studies of mammals or birds use triangulation to estimate the locations of telemetered animals. Triangulation consists of taking directional bearings at two or more locations and then using the intersections of those bearings to estimate the animal's location (White and Garrott 1990). Triangulation introduces additional error to location estimates and the degree of error depends on many factors including the distance between the transmitter and receiver, the orientation or height of the transmitter, topography, vegetation structure, animal behavior, signal interference, or inter-observer variability (Lee et al. 1985; Garrott et al. 1986; Schmutz and White 1990; White and Garrott 1990; Townsend et al. 2007; Bartolommei et al. 2012). These errors may have significant implications for subsequent analyses of space use and resource selection.

Situations may arise where triangulation is necessary to obtain location estimates for telemetered snakes. For example, an individual may move onto property a researcher cannot access, into a large extent of flooded habitat, or into impenetrably thick vegetation. While triangulation may prove useful in these situations, triangulating telemetered snakes features several challenges. Snakes spend large amounts of time underground or in thick vegetation which may interfere with signal strength or direction. They often use the same retreat site for multiple days at a time as well as small-scale or linear habitat features (e.g., forest or wetland edges, Blouin-Demers and Weatherhead 2001; Pattishall and Cundall 2008) and this use may be difficult to detect using triangulated locations. Finally, many snake species spend the majority of their time close to the ground and the low vertical height of their transmitters can reduce triangulation accuracy (Townsend et al. 2007). All of these factors could potentially reduce triangulation accuracy below the level required to adequately address a study's objectives (Samuel and Kenow 1992; Rettie and McLoughlin 1999; Montgomery et al. 2010, 2011). While triangulation is apparently rare in telemetry studies of snakes and other herpetofauna (but see Whiting and Miller 1998), when applied, it may be particularly critical to determine the accuracy of triangulated locations given the aforementioned challenges. However, we are unaware of any studies reporting on the accuracy of triangulated locations for snakes or the factors influencing their accuracy.

Multiple metrics are used to evaluate triangulation accuracy. Many studies report error polygons around estimated locations, such as a 95% confidence ellipse (e.g., Lenth 1981), as a measure of accuracy (Saltz 1994; Withey et al. 2001). However, these polygons provide a measure of precision, not accuracy per se, and field tests have shown that error polygons may not include the true transmitter location (Garrott et al. 1986; Nams and Boutin 1991; Withey et al. 2001). Determining accuracy requires beacon tests in the field using transmitters at known locations either attached to the study organism or placed at similar heights and orientations (Lee et al. 1985; Garrott et al. 1986). This allows a direct measurement of accuracy as either the distance between the estimated and true location (linear error), difference between bearings to the estimated and true location (angular error), or the proportion of true locations contained within an error polygon (coverage, Garrott et al. 1986; White and Garrott 1990). Because the factors influencing accuracy might differ among studies due to study-specific factors, such as study site characteristics, transmitter size, or inter-observer variability, it is necessary that researchers conduct beacon tests prior to each study under the conditions present at their study site (Withey et al. 2001).

We conducted a radio telemetry study of Eastern Indigo Snakes (*Drymarchon couperi*) as part of a movement and resource selection study. During our study, multiple telemetered snakes moved onto private lands where we were unable to obtain access from the landowner. During these instances, we used standard triangulation techniques to estimate the locations of our telemetered snakes. To determine the accuracy and precision of the triangulated locations, we conducted a series of beacon tests using known locations of telemetered snakes. In this paper, we report the accuracy and precision of our beacon tests and the effects of different factors on triangulation accuracy (i.e., linear error). We also compared two different statistical estimators commonly used to estimate triangulated locations, Andrew's estimator (AE) and Lenth's maximum likelihood estimator (MLE, Lenth 1981). Finally, we developed a multiple regression model based on our beacon tests to predict linear error for locations estimated by triangulation and identify locations which met predefined criteria for accuracy based on the spatial resolution of our environmental data.

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Materials and Methods

Study area and species.—We conducted on our study on the southern 40 km of the Lake Wales Ridge in Highlands County, Florida, USA (27.21°N, 81.33°W). Our study area was a mix of natural habitats (scrub, scrubby flatwoods, mesic flatwoods,

TABLE 1. Summary statistics from beacon tests and triangulated locations for Eastern Indigo Snakes (*Drymarchon couperi*). Results are presented for Lenth's maximum likelihood (MLE) and Andrew's estimators (AE, Lenth 1981). Estimated distance is the distance from the observer to the estimated location averaged across all bearings for a given location, ellipse area is the size of the 95% confidence ellipse, predicted linear error is the distance between the true and estimated location predicted by the model-averaged parameter estimates from the multiple regression analysis of the beacon test data, and true linear error is the actual distance between the true and estimated location.

	Estimated distance (m)		Ellipse area (m^2)		Predicted linear error (m)		True linear error (m)	
	MLE	AE	MLE	AE	MLE	AE	MLE	AE
Beacon tests								
Median	134	134	627	656	35	35	41	41
IQR[1]	99–223	99–223	92–2,901	84–2,938	24–64	24–64	18–81	18–82
Range	22–617	22–613	0.2–41,038	0.2–38,393	4–212	4–212	2–265	2–264
Triangulated locations								
Median	155	165	768	795	43	43	NA	
IQR[1]	77–263	78–264	109–5,392	115–5,598	18–85	18–83	NA	
Range	20–743	20–737	1–383,484	1–373,809	4–293	4–282	NA	

[1] IQR = Inter-quartile range (25th and 75th percentiles)

forested and non-forested wetlands), cattle ranches, citrus groves, and rural and urban development. We searched for Eastern Indigo Snakes using road-cruising and visual encounter surveys around Gopher Tortoise (*Gopherus polyphemus*) burrows, although 90% of captures were made opportunistically while tracking other snakes or travelling among field sites. We selected snakes to receive radio transmitters depending on their capture location in order to distribute snakes as evenly as possible throughout our study area. We transported these snakes in large plastic boxes (30.3 L, 50.5 × 35.8 × 30.7 cm) to the Small Animal Hospital at the University of Florida, Gainesville, Florida, for transmitter implantation. We used 9 and 13.5 g SI-2T temperature sensitive transmitters (Holohil Systems Ltd., Carp, Ontario, Canada) with smaller snakes generally receiving the smaller transmitters. Transmitters did not exceed 2% of a snake's body mass. Anesthesia and surgical procedures followed those of Reinert and Cundall (1982) and Hyslop et al. (2009). Once snakes were fully alert and recovered from anesthesia we transported them back to Highlands County and held them in large (121.9 × 147.3 × 45.7 cm), well ventilated terrariums. Snakes were held for 48–72 h after surgery except during cold periods (highs < 25°C and lows < 14°C) in Nov.–Feb. when we held each snake for 7–14 days after surgery (Hyslop et al. 2009) to facilitate healing of the incision. In these instances, snakes were released once the forecasted highs and lows for the next five days were > 25° and > 14°C, respectively. Each telemetered Eastern Indigo Snake was released into the closest burrow or brush pile to its capture location.

Field data collection.—We located each telemetered Eastern Indigo Snake a median of every two days (range 1–60) using a three element Yagi antenna and a R-1000 receiver (Communications Specialists, Inc., Orange, California). We conducted beacon tests in a haphazard manner throughout our study on telemetered snakes whose location we were able to access and which did not appear to be moving on the surface based on their transmitter signal. To conduct the beacon tests, an observer would take a set (3–5) of bearings from known locations towards the telemetered snake's location (recorded with a GPSmap 76CSx, Garmin International Inc., Olathe, Kansas, mean accuracy = 7 m) and then immediately use homing techniques to locate the snake and record its actual location. The observers deliberately varied their distance to the snake, the number of bearings used, the angle between bearings (keeping the angle between the two most extreme bearings < 160°), and the surrounding vegetation conditions in a haphazard manner. This allowed us to understand how triangulation accuracy varied under a range of conditions. When a telemetered snake was on property we could not access at the time, the observer would also take 3–5 bearings towards the snake's location. Our goal in these cases was to maximize the accuracy of the estimated location so the observer tried to get as close to the snake as possible, generally used three or four bearings (depending on the configuration of the property), and maintain an angle of 60–120° between the outermost bearings.

Triangulation.—We used LOAS 4.0 (Ecological Software Solutions LLC, Hegymagas, Hungary) to estimate triangulated locations and 95% confidence ellipses with both AE and MLE. We found that some sets of bearings (i.e., the 3–5 bearings taken for each location) contained apparent outliers which did not intersect the rest of the bearings in the set or were markedly divergent from the other bearings. Because factors such as signal reflectance, polarization, background noise, or observer error may lead to erroneous bearings, even those taken from identical locations (Lee et al. 1985), one must decide at what level this error becomes detrimental to the ultimate goal of obtaining accurate location estimates. Other studies have excluded bearings or triangulated locations based on the angle of the bearing or the size of the error ellipse (Lee et al. 1985; Marzluff et al. 1997; Van Etten et al. 2007). After examining our data, we found that an angular difference between the bearing taken in the field and the bearing to the estimated location (estimated using either AE or MLE) > 20° represented what we felt were outlying bearings. Subsequent examination confirmed that such bearings did not intersect the other bearings in the set or were strongly divergent. We removed outlying bearings from both beacon tests and triangulated locations using the same criterion to maximize the applicability of our predictive model.

Accuracy and precision.—Our primary measure of accuracy for the beacon tests was linear error which was determined by

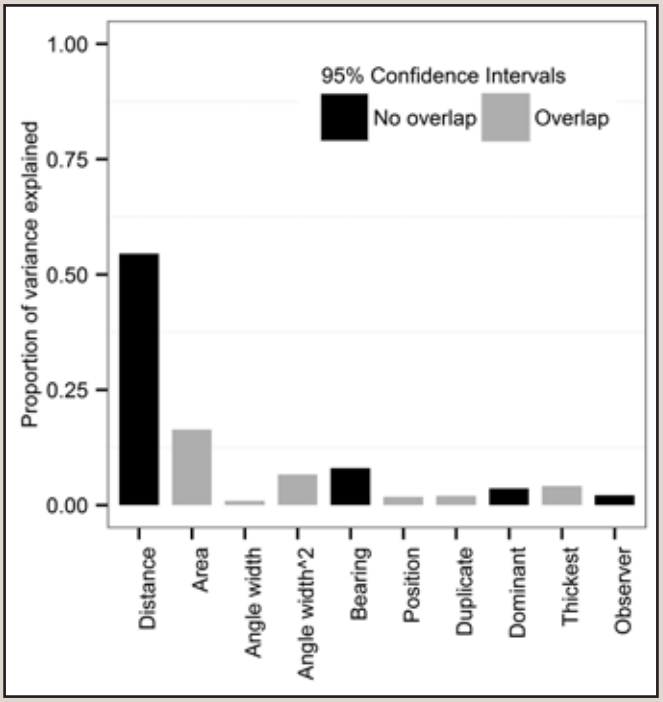


FIG. 1. Proportion of independently explained variance in linear error between true locations and estimated locations estimated using Lenth's maximum likelihood estimator (MLE) from Eastern Indigo Snake *(Drymarchon couperi)* beacon tests (N = 60). Predictor variables are distance to estimated location (Distance), size of error ellipse (Area), angle between the two outermost bearings (Angle width and Angle width^2), number of bearings (Bearing), position of the snake (Position), whether or not the snake was at a previously used location (Duplicate), dominant (Dominant) and thickest (Thickest) vegetation class traversed by the bearings for a given location, and observer (Observer). Dark shaded bars represent variables or levels (categorical variables) whose model-averaged 95% confidence intervals did not overlap zero.

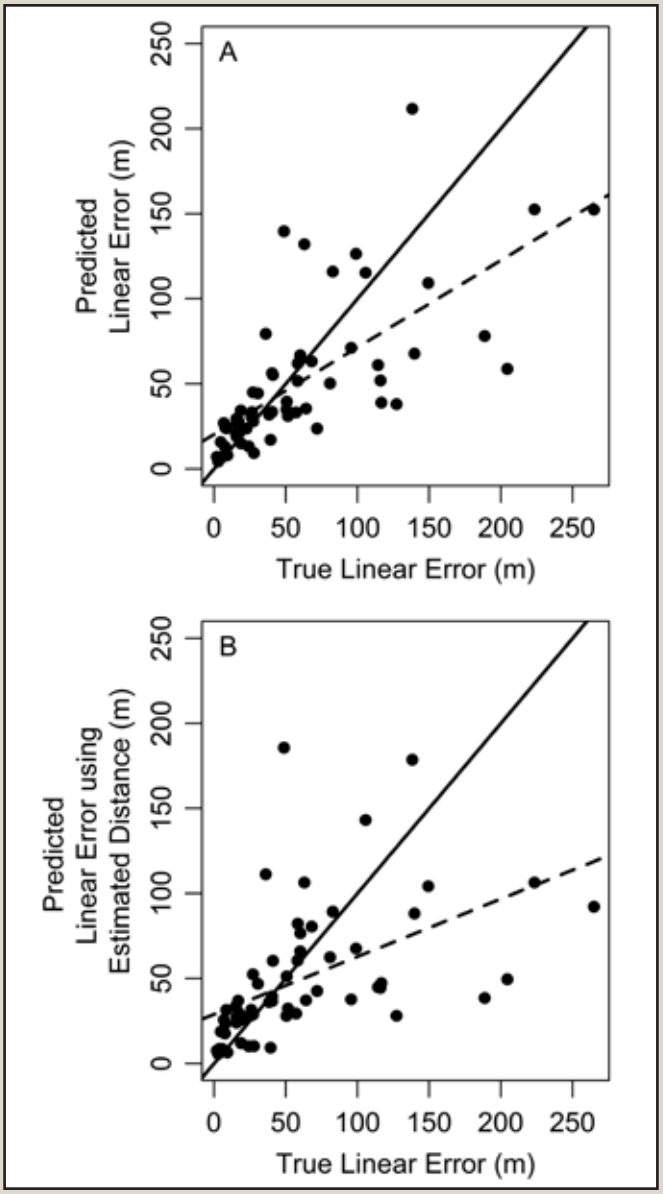


FIG. 2. Relationship between true linear error and predicted linear error using a model-averaged parameter estimates from a multiple regression analysis (2A) and a single-variable regression model containing only estimated distance (2B) from beacon tests (N = 60) of radio telemetered Eastern Indigo Snakes *(Drymarchon couperi)*. The solid line represents a one-to-one relationship between true and predicted linear error and the dashed line represents the observed relationship.

measuring the distance between the snake's actual location and the MLE or AE estimated location. We also assessed accuracy by calculating bias as the angle between the snake's actual location and each bearing (i.e., angular error) averaged across all bearings (N = 211, Withey et al. 2001). We also measured coverage as the proportion of actual snake locations that were contained by their respective MLE and AE error ellipses. To quantify precision, we used the size of the 95% confidence ellipse (ellipse area) and the standard deviation of the angles between the snake's actual location and each bearing across all bearings (angular precision).

Statistical analysis.—For each set of bearings (both beacon tests and triangulated locations), we measured the mean distance from the observer to the MLE or AE estimated location (estimated distance). We also measured the width of the angle between the two outermost bearings within each set (angle width). We characterized the dominant vegetation class (dominant vegetation) for each bearing set as forested (dominated by trees > 4 m tall and including citrus, bayheads, riparian forests, hammocks), shrub (primarily fire suppressed scrub and scrubby flatwoods with vegetation 2–4 m tall), and open (vegetation height < 2 m including scrub, scrubby flatwoods, pasture, and non-forested wetlands) using National Agriculture Imagery Program (NAIP) aerial imagery taken in Dec. 2011. We inspected the length of each bearing within a set using Google Earth and visually estimated the proportion of each vegetation class intersecting each bearing between the observer and the telemetered snake. We assigned each set of bearings to the vegetation class containing the greatest cumulative proportion across all bearings. However, the presence of dense vegetation along one bearing could potentially skew results even if other bearings are unobstructed. We therefore included a separate vegetation variable (thickest vegetation) where we assigned each set of bearings to the thickest vegetation class intersecting > 50% of any bearing in that set. We recorded the total time taken to complete each beacon test or triangulated

location for the 50 (94%) beacon tests and 80 (77%) triangulated locations for which we record time at each bearing. We also recorded the time from when the bearings were taken (measured as the median time between the first and last bearing) and when the snake was located. For beacon tests, we recorded whether or not the telemetered snake was in a location where it had been previously located to evaluate the influence of potential bias in triangulation caused by the snake repeatedly using the same retreat site. We also recorded each telemetered snake's position upon location following a beacon test (underground, on the surface but stationary, or on the surface and moving).

We used the beacon test data to evaluate the effects of estimated distance, angle width, ellipse area, number of bearings (3–5), observer (N = 3), position, previous location, and dominant and thickets vegetation class on linear error for AE and MLE locations. We hypothesized that angle width would have a quadratic rather than a linear effect (Haskell and Ballard 2007) so we only considered the quadratic effect of angle width. Estimated distance, ellipse area, and linear error were log transformed to correct for non-normality. Estimated distance and ellipse area were moderately correlated (Spearman's rank correlation, $r_s = 0.63$) but all other continuous variables had comparatively low colinearity ($|r_s| \leq 0.26$). Although we hypothesized that each of our predictor variables would influence linear error, we had no *a priori* reason to use any particular combination of these variables. Additionally, we were interested in understanding the independent contribution of each variable to the variation in linear error. We therefore fit linear regression models to all possible subsets of our variables. This allowed us to use hierarchical variance partitioning to estimate the independent contribution of each variable to the variance of the global model as a means of identifying the most causal factor (Chevan and Sutherland 1991; Mac Nally 2000). We used the hier.part package (v. 1.0-4, Walsh and Mac Nally 2013) to calculate the independent contributions of each variable. Because our ultimate goal was to predict linear error using data from the beacon tests, we used model-averaging (Burnham and Anderson 2002) across all our models with Akaike's Information Criteria adjusted for small sample sizes (AIC_c) in the MuMIn package (v. 1.10.0, Barton 2014) to obtain model-averaged parameters and 95% confidence intervals. We evaluated the predictive accuracy of our model by comparing the difference between true linear error and predicted linear error for the beacon test data. We then used these model-averaged parameters to predict linear error for the triangulated locations and recorded the number of triangulated locations with predicted accuracy ≤ 15 and 30 m. We selected these cutoffs because these were the pixel sizes of available land cover maps for our study area and thus represent possible minimum accuracies for resource selection analyses. All statistical analyses were conducted in R v. 3.0.2 (R Development Core Team 2013).

Results

We surgically implanted radio transmitters into 32 Eastern Indigo Snakes. Two individuals were lost < 30 days of release, presumably because of transmitter failure. We conducted 63 beacon tests using 19 telemetered snakes. The AE failed to produce estimates for three beacon tests despite the absence of potential outlying bearings so we excluded them from subsequent analyses to facilitate comparison between AE and MLE. Median distance from the observer to the beacon was 145 m (range: 21–606 m). Median angle width was 105° (range: 39–176°). Median time between the first and last bearings for each beacon test was 14 min (range: 5–41 min). The median time between taking the bearings and locating the telemetered snake was 29 min (range: 9–133 min). Excluding the maximum value of 133 min reduced the maximum to 67 min. Forty-one snakes (68%) were underground while 17 (28%) were moving on the surface and two (3%) were stationary on the surface. We used three bearings in 34 (57%) of our beacon tests, four bearings in 21 (35%), and five bearings in five (8%). We classified 38 (63%) bearings as having a dominant vegetation class of open, 16 (27%) as shrub, and 6 (10%) as forested. We classified 19 (32%) bearings as having a thickest vegetation class of open, 29 (48%) as shrub, and 12 (20%) as forested.

The AE and MLE produced similar estimates of accuracy and precision (Table 1). The maximum difference in linear error between each estimator was 3 m although the median difference between the two estimators was marginally significant ($V = 684$, $P = 0.0897$). Mean bias was 1.41° (median = 2.53°) and angular precision was 16.50°. However, a single bearing had an extremely large angular error (102°). Excluding this value changed the mean bias to 1.97° (median = 2.54°) and angular precision to 14.92°. Coverage was low as only seven (12%) and eight (13%) (MLE and AE, respectively) confidence ellipses included the true location. Median ellipse size was greater for AE than MLE (Table 1) but this difference was not statistically significant ($V = 852$, $P = 0.6454$).

Because of the moderate correlation between estimated distance and ellipse area we repeated our beacon test analyses excluding ellipse area from our pool of predictor variables. Our results were similar so we report the results using all predictor variables. Results were also similar between MLE and AE so we report the results of the former because of its lower failure rate. Distance to estimated location was present in all the best supported models ($AIC_c < 2$; Table 2) and explained almost half of the variance in linear error (Fig. 1). Linear error increased with increasing distance from estimated location (Table 3). All other predictor variables explained comparatively little variation in linear error and only the number of bearings, dominant vegetation class, and observer had model-averaged 95% CI that did not overlap zero (Fig. 1). Linear error was greatest when three bearings were used and mean linear error decreased by 42% and 50% when four and five bearings where used, respectively (Table 3). Mean linear error varied by up to 48% among the three observers. Mean linear error decreased by 59% and 47% when the dominant vegetation class traversed by all bearings within a set was shrub and open, respectively, instead of forest.

The median difference between true and predicted linear error for the beacon tests was -1.13 m (range: -91–146 m) and was not significantly different from zero ($V = 1035$, $P = 0.3790$). The median difference between true and predicted linear error for the beacon tests predicted using only estimated distance was -2.34 m (range: -138–173) and was not significantly different from zero ($V = 1001$, $P = 0.5291$). Although the differences between true linear error and predicted linear error using the model-averaged parameter estimates and estimated distance were not significantly different ($V = 948$, $P = 0.8109$), our predictions of linear error were improved by using the model-averaged parameter estimates (Fig. 2). Eleven (18%) and twelve (20%) beacon tests had true linear error ≤ 15 m with MLE and AE, respectively. Nine (15%) and 10 (17%) beacon tests had predicted error ≤ 15 m with MLE and AE, respectively. Twenty-four (40%)

TABLE 2. Top multiple regression models predicting linear error between true locations and triangulated locations estimated using maximum likelihood from Eastern Indigo Snake (*Drymarchon couperi*) beacon tests (N = 60). For each model we report Akaike's Information Criteria corrected for small sample sizes (AIC_c), delta AIC_c (AIC_c), the AIC_c model weight (w_i), and the adjusted R^2. Only models with $AIC_c < 2$ are reported; a total of 381 models were considered. Angle width includes a quadratic effect.

Model	AIC_c	AIC_c	w_i	R^2
Distance + ellipse area + angle width + no. of bearings + observer	138.28	0.00	0.067	0.63
Distance + angle width + no. of bearings + observer	138.93	0.66	0.049	0.62
Distance + no. of bearings + observer	139.25	0.97	0.041	0.60
Distance + angle width + dominant vegetation + duplicate location	139.43	1.15	0.038	0.61
Distance + angle width + dominant vegetation	139.48	1.20	0.037	0.60
Distance + no. of bearings + duplicate location	139.54	1.26	0.036	0.59
Distance + ellipse area + no. of bearings + observer	139.55	1.28	0.036	0.60
Distance + angle width + no. of bearings + observer + duplicate location	139.62	1.35	0.034	0.62
Distance + no. of bearings + thickest vegetation + duplicate location	139.65	1.38	0.034	0.60
Distance + angle width + no. of bearings + dominant vegetation + duplicate location	139.67	1.39	0.034	0.62
Distance + ellipse area + angle width + dominant vegetation	140.08	1.80	0.027	0.60
Distance + no. of bearings + dominant vegetation + duplicate location	140.12	1.84	0.027	0.60

and 22 (37%) beacon tests had true and predicted linear error, respectively, ≤ 30 m for both estimators.

We collected 116 triangulated locations from 16 telemetered snakes. The AE failed to produce estimates for nine beacon tests so we excluded them from subsequent analyses to facilitate comparison between AE and MLE. Distance from observer to estimated location ranged from 20–737 m and 20–743 m for AE and MLE, respectively (Table 1). Median time between first and last bearing was 15 min (range: 3–85 min) and median angle width was 94° (range: 22–178°). We used three bearings for 44 (41%) triangulated locations, four bearings for 52 (49%), and five bearings for 11 (10%) of our triangulated locations. We classified 78 (73%) bearings as having a dominant vegetation class of open, 11 (10%) as shrub, and 18 (17%) as forested. We classified 40 (37%) bearings as having a thickest vegetation class of open, 27 (25%) as shrub, and 40 (37%) as forested. Median ellipse size estimated with AE was significantly greater than median ellipse size estimated using MLE ($V = 1{,}642$, $P = 0.0001$, Table 1).

We used all variables from the beacon test analysis for predicting linear error for our triangulated locations except the snake's position and whether or not it was at a previously used retreat site because these variables were unknown for triangulated locations. Median predicted linear error for the triangulated locations was very similar between AE and MLE (Table 1). Median difference in predicated linear error between the two estimators was significantly different from zero ($V = 4699$, $P < 0.0001$) but the magnitude of this difference was very small (median = 0.28, 25th percentile: 0.04, 75th percentile: 1.21). Predicted linear error was ≤ 15 m for 25 (23%) triangulated locations and ≤ 30 m for 40 (37%) triangulated locations for both estimators.

DISCUSSION

Our results show that distance to estimated location had the strongest effect on linear error, consistent with other triangulation studies (Marzluff et al. 1997; Bartolommei et al. 2012). Additionally, the predictive ability of our multiple regression models was poorest at large distances as indicated by the large residual errors shown in Fig. 2. Angular error is magnified with increasing distance from the transmitter and other factors, such as poor signal quality, may have a greater effect over long distances (Hupp and Ratti 1983; Saltz and Alkon 1985). Reducing distance between the observer and telemetered animal is often used to reduce triangulation error in studies not reporting the use of beacon tests (e.g., Dickson et al. 2005). However, other studies have not reported a strong effect of distance to estimated location on accuracy (Hupp and Ratti 1983; Haskell and Ballard 2007) suggesting that, while reducing estimated distance may reduce triangulation error, it may not guarantee sufficient accuracy for a study's objectives. The size of the 95% confidence ellipse explained the second greatest amount of variation in linear error although the model-averaged 95% confidence intervals overlapped zero. However, these ellipses rarely contained the true location during beacon tests. This result is consistent with previous studies (Nams and Boutin 1991; Withey et al. 2001) and reinforces caution in using the 95% confidence ellipse to infer accuracy. We found relatively little support for angle width although Haskell and Ballard (2007) found a strong quadratic effect of angle width and recommended an angle width of 90–100° to maximize accuracy.

Features common to many radio telemetry studies on herpetofauna likely influenced our triangulation accuracy. In particular, the low vertical height of our transmitters (at or below ground level) may have reduced our accuracy. Townsend et al. (2007) found approximately a four-fold increase in angular error (6.43° to 24.37°) when reducing a transmitter's height from 92 cm to 15 cm above ground-level. Many snakes and other herpetofauna also spend large amounts of time underground or in thick vegetation which could similarly reduce triangulation accuracy (Lee et al. 1985; White and Garrott 1990). Beacon tests taken where bearings primarily passed through shrub vegetation were less accurate than those in forested vegetation. This result could be due to the dense vegetation structure of the habitats we classified as shrub. Snake position had very little influence on linear error despite the fact that most individuals located on the surface during beacon tests were moving (17 of 60 beacon tests). This suggests that any movement between when the bearings were taken and when the snake was located was small relative to the degree of error in our triangulations.

TABLE 3. Model-averaged parameter estimates, standard errors, and 95% confidence intervals from a multiple regression analysis of Eastern Indigo Snakes (*Drymarchon couperi*) radio telemetry beacon tests (N = 60). Log of distance between true location and triangulated location estimated using Lenth's maximum likelihood estimator (MLE) was used as the response variable. The reference levels for number of bearings, observer, dominant and thickest vegetation, and position were five bearings, observer #3, forested, and moving, respectively.

	Estimate	SE	Lower CI	Upper CI
Intercept	0.0130	1.4981	-2.9233	2.9493
Four bearings	-0.5511	0.2391	-1.0197	-0.0825
Five bearings	-0.6872	0.3935	-1.4585	0.0840
Observer 1	-0.2009	0.2447	-0.6804	0.2787
Observer 2	-0.6542	0.3210	-1.2834	-0.0250
Log (estimated distance)	1.0140	0.1473	0.7253	1.3027
Log (ellipse area)	0.0614	0.0501	-0.0368	0.1597
Angle width	-0.0402	0.0231	-0.0854	0.0049
Angle width2	0.0002	0.0001	0.0000	0.0004
Duplicate location	-0.4021	0.2676	-0.9266	0.1225
Dominant vegetation (open)	-0.6301	0.3734	-1.3620	0.1017
Dominant vegetation (shrub)	-0.8882	0.4287	-1.7285	-0.0480
Thickest vegetation (open)	-0.4953	0.3066	-1.0962	0.1055
Thickest vegetation (shrub)	-0.4618	0.2907	-1.0316	0.1079
Position (stationary on surface)	-0.1427	0.5721	-1.2640	0.9786
Position (underground)	-0.0700	0.2542	-0.5682	0.4282

Including these locations improves the applicability of our predictive model, even at the risk of under-predicting accuracy, because such small-scale movements or even whether an animal is underground or on the surface are undetectable during triangulation. Nevertheless, animal movement while bearings are taken can reduce triangulation accuracy (Schmutz and White 1990) and many studies employ multiple observers (Marzluff et al. 1997) or limit the time between bearings (Cimino and Lovari 2003; Dickson et al. 2005) to minimize this error. A post-hoc analysis showed that the median time between the first and final bearing to when the snake was located (i.e., time to location) was positively correlated with linear error ($r_s = 0.67$, $P < 0.0001$) suggesting that accuracy was improved by locating the snake soon after the bearings were taken. However, time to location was also correlated with estimated distance ($r_s = 0.63$, $P < 0.0001$) and these patterns held true when considering underground snakes as well as those moving on the surface. This suggests that the relationship between linear error and time to location may have been an artifact of the observer taking longer to locate snakes that were further away from where the bearings were taken. Additionally, there was no significant difference in time to location between snakes underground or on the surface ($W = 304$, $P = 0.3884$).

We observed very little difference in precision or accuracy between MLE and AE, consistent with other studies (Haskell and Ballard 2007; Withey et al. 2001). However, AE failed to converge in some instances. When reflected signals are common, AE appears to outperform MLE, although both estimators perform similarly in the absence of signal reflection (Garrott et al. 1986; White and Garrott 1990). We observed relatively little signal reflection in our study area although we occasionally had difficulty determining the signal's bearing or recorded bearings that did not intersect the other bearings in a set. This may have been caused by thick or damp vegetation or other unknown factors. These bearings would likely have been removed as outliers so this may have contributed to the similarity of our results. Previous studies comparing MLE and AE do not report the treatment of outliers or included them to test the method's sensitivity. However, outlying bearings were present in only 10 of our 60 beacon tests and 15 of our 107 triangulated locations. In four beacon tests removing the outlier allowed both estimators to converge and removing outlying bearings in another three beacon tests reduced linear error by 4, 37, and 56 m. However, removing outliers increased linear error increased in the remaining three beacon tests by 1, 9, and 91 m. While defining outliers involves subjectivity at some level, erroneous bearings may ultimately become detrimental to the goal of accurately estimating triangulated locations (Garrott et al. 1986).

Less than 40% of our triangulated locations met our criteria for suitable accuracy. The criteria for suitable accuracy will depend on the study objectives, composition of the landscape, and degree of error relative to the study organism's movement. For example, Moser and Garton (2007) found that fixed kernel home range size was relatively robust to triangulation error provided the degree of error is small relative to home range size. They used the median Circular Error Probable (CEP, Moen et al. 1997), the area of a circle with a radius that contains 50% of estimated locations, as a measure of error and found that a ratio of CEP to home range size < 0.01 had relatively little effect on fixed kernel home range estimates. Using our median observed linear error (41 m) to calculate CEP and a mean home range size of 140 ha (J. Bauder, unpubl. data), our error ratio was 0.004. Based on our median observed linear error, home range size would need to be > 53 ha to maintain an error ratio < 0.01. While Eastern Indigo Snake home range sizes regularly exceed this size (Breininger et al. 2011; Hyslop et al. 2014), many snake species maintain smaller home ranges (Bauder et al., *in press*; Row and Blouin-Demers 2006) suggesting that the degree of triangulation error observed in our study may be too great to produce reliable home range estimates for many snake species. These errors may also be compounded in linear or irregularly shaped home ranges. Resource selection analyses can also be sensitive to triangulation error. Montgomery et al. (2011) found that triangulation errors are compounded with fine-resolution (e.g., 10 m vs. 30 m pixels) categorical raster data and small patch sizes. Using their simulation results and our median observed linear error (41 m), accuracy of habitat classification at patch sizes from 0.5–50 ha would range from 52–81% and 62–84% at 10 m and 30 m pixels, respectively. Many snakes use small-scale or linear habitat features (Blouin-Demers and Weatherhead 2001; Pattishall and Cundall 2008) and triangulated locations may require a higher degree of accuracy than we obtained in order to detect use of such features.

Our results suggest that the error associated with triangulation may be insufficient for snake radio telemetry studies. We recommend that researchers avoid triangulation in snake radio telemetry studies and use beacon tests to directly

measure linear error when triangulation is used. Researchers should use data from beacon tests to predict the linear error of triangulated locations to determine which locations are sufficiently accurate given the study's objectives. Our study also offers suggestions for minimizing linear error. The observer should minimize the distance between themselves and the transmitter. Bearings should be taken within the shortest amount of time or simultaneously with multiple observers to minimize the potential for animal movement. The same observers should be used throughout the study because inter-observer variability may be high. Finally, we recommend that observers plot their bearings while in the field using field maps or computers. This will allow them to identify potentially erroneous bearings and reestimate a location while still in the field instead of discarding outlying bearings.

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New Wine in Old Bottles: Using Modified Hoopnets to Catch Bait-Averse Basking Turtles

One of the most popular trap designs for capturing freshwater turtles for research is the baited three-hoop trap, which has a funnel-shaped throat of netting on the front hoop designed to facilitate ingress and block egress (Lagler 1943; Legler 1960; Vogt 2012). Oftentimes, however, certain target species are poorly sampled in baited traps (e.g., *Graptemys* spp., *Pseudemys* spp., *Sternotherus* spp.; Lagler 1943; Cagle and Chaney 1950; Plummer 1979; Browne and Hecnar 2005; Sterrett et al. 2010; Vogt 2012). Many of the bait-averse species are habitual baskers, thus a variety of basking trap designs have been described for catching such species. Many basking traps described in the literature work by inducing turtles to bask on platforms that are a component of the trap and some designs have additional components to prohibit turtles from climbing out of the traps after capture; such traps tend to be relatively cumbersome (e.g., Lagler 1943; Cagle 1950; Ream and Ream 1966; MacCulloch and Gordon 1978; Plummer 1979; Browne and Hecnar 2005; Valdeón et al. 2010) and are difficult to use in lotic habitats. As an alternative, open-top basking traps constructed of netting or PVC-coated crawfish wire have been placed at or just below the water's surface underneath natural basking substrates in lotic habitats; basking turtles are startled into the traps and then removed before they climb or swim out (Plummer 1979; Jones and Hartfield 1995; Horne et al. 2003; Jones 2006; Selman et al. 2012; Vogt 2012).

I describe a modification of the standard three-hoop turtle net that makes an efficient and easily transportable open-top basking trap for basking, bait-averse turtles. I have used the design to catch turtles on four Gulf Coastal river systems and detail some of my experiences with this new trap design, including captures per trap-day and, for one season on one river, captures per turtle observed basking over a trap.

I trapped turtles in the Alabama River in Autauga and Lowndes counties, Alabama, in early July 2011 and mid June 2012 and 2013 and at a variety of sites on the Mermentau, lower Calcasieu, and Sabine river drainages in southwestern Louisiana, including the border with Texas, in May and early June 2012 and 2013. Trapping time on the Alabama was limited to ca. 4–5 hours most days due to water releases from an upstream dam that raised the river level daily by more than 1 m; times spent on the Mermentau, Calcasieu, and Sabine drainages were more variable, but rarely allowed more than 3–5 boat passes per basking trap.

To modify hoopnets as basking traps, I cut the netting at the front of the middle hoop of five 0.9-m diameter hoopnets (2.5-cm mesh) such that the front part of each original trap consisted of a hoop, outside netting to the point cut, and throat, while the back part consisted of two hoops and netting gathered at the back. The throat of each front section was then cut away from the first hoop, sewn to that hoop's outside netting, and tied shut, yielding 10 open-top nets from the original five traps (Fig. 1). In setting the nets as basking traps underneath logs and branches used by basking turtles, I rotated them 90º so that their open ends faced upward and tied them in place with two nylon ropes or pieces of twine so that the opening was approximately flush with the water's surface (Fig. 2). A weight in the bottom of each net



FIG. 1. Two basking traps constructed from a single hoopnet, by removing the two back hoops (left) and cutting the throat out of the inside of the former first hoop and sewing it to its outside netting, such that the former throat is now the bottom of the net (right).

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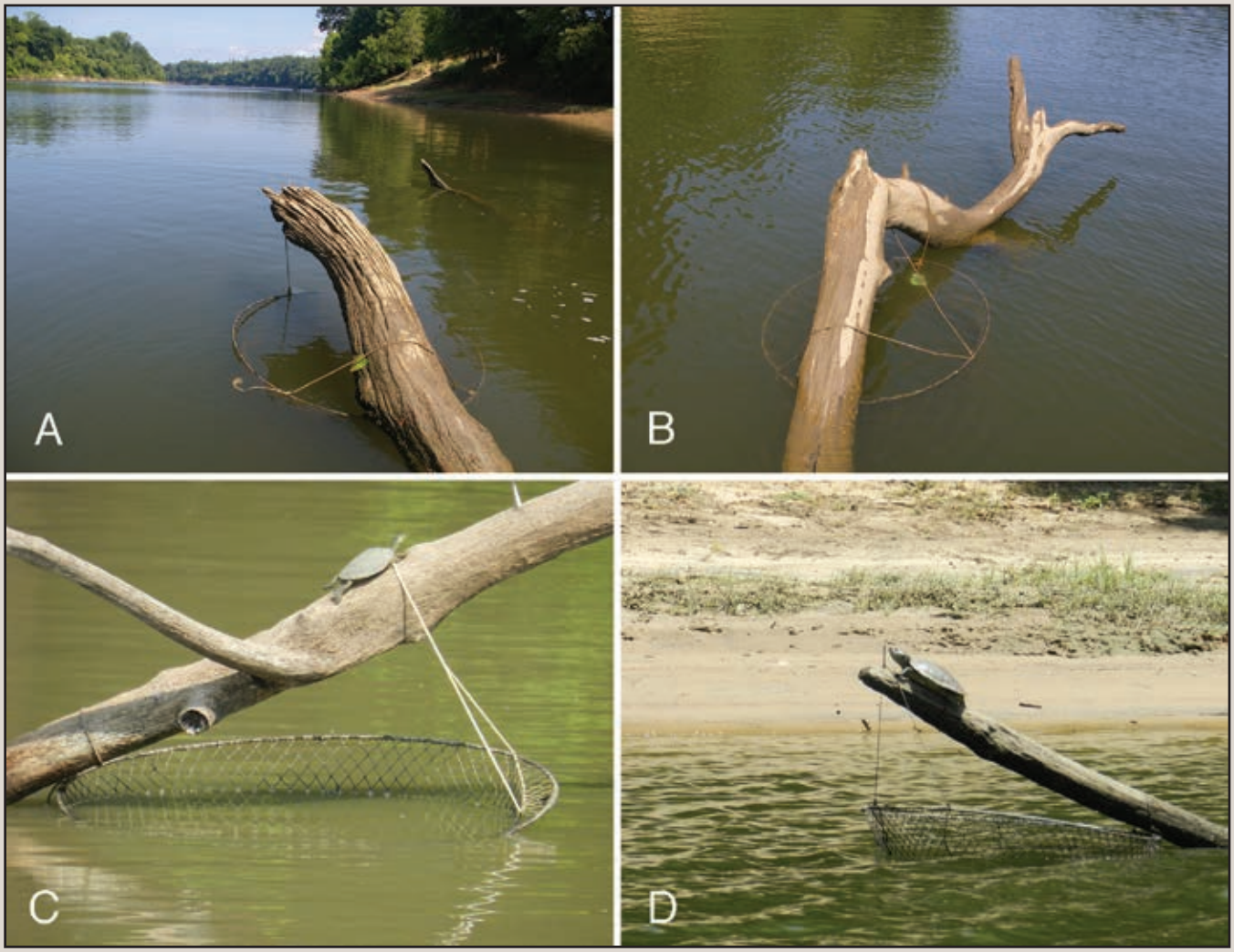


FIG. 2. High-yield basking traps set under (A) a large, angled log and (B) an archway site on the Alabama River and map turtles basking over traps moments before capture: (C) *Graptemys sabinensis*, Bayou Plaquemine Brule on the Mermentau drainage, male, midline PL 90 mm; (D) *Graptemys pulchra*, Alabama River on the Mobile Bay drainages, female, midline PL 188 mm.

extended its depth to ca. 1–1.5 m (deeper for the double-hooped rear sections of the original traps), so that turtles diving into the traps could dive deeply into the nets before encountering confinement. Additional traps deployed were 0.91-m diameter hoopnets baited with canned tuna in Louisiana and unbaited 0.91-m diameter fykenets with 5-m lead nets (Vogt 2012) in Alabama and Louisiana.

Turtles were spotted over traps with the aid of binoculars and approached rapidly in a jonboat, eliciting a flight response (Selman et al. 2012). Due to shallow water that did not allow use of an outboard motor, a canoe and paddles were used in one four-day trapping session on a tributary of the Calcasieu, the Whiskey Chitto River, and another three-day trapping session on the Sabine. During 2012 trapping on the Alabama River, I recorded hours spent on the river, numbers of turtles that I attempted to induce to jump into nets, and numbers captured. I measured the midline plastron length (PL) of turtles I captured, marked them (Cagle 1939), and released them at their sites of capture.

Using hoopnet basking traps on the Alabama River, I captured 82 turtles in 80 trap-days in 2011, 67 turtles in 73 trap-days in 2012, and 59 turtles in 49 trap-days in 2013, for an overall average of 1.03 turtles/trap-day. Pooling years, I captured 125 *Graptemys nigrinoda*, 61 *Graptemys pulchra*, 13 *Pseudemys concinna*, and 9 *Trachemys scripta* on the Alabama. Using hoopnet basking traps on the Mermentau, Calcasieu, and Sabine rivers, I captured 79 turtles in 119 trap-days in 2012 and 92 turtles in 140 trap-days in 2013, an overall average of 0.66 turtles/trap-day, including 141 *Graptemys sabinensis*, 17 *Graptemys pseudogeographica*, 10 *P. concinna*, and 3 *T. scripta*. While some traps caught no turtles on one or more days, at the other extreme, some caught as many as 10 turtles per day. Among the highest-yielding traps, with frequent multiple captures (i.e., more than one turtle at a visit), were those situated under "archway" sites, i.e., deadwood that projected out of the water and then back down into the water, allowing turtles to access the site from either end (e.g., Fig. 2b).

Capture success was for the most part lower for baited hoopnets and unbaited fykenets. In Louisiana, I captured 0.20 turtles/hoopnet-night (21 turtles in 103 trap-nights) and 0.85 turtles/fykenet-night (121 turtles in 143 trap-nights). In Alabama, I captured 0.33 turtles/fykenet-night (50 turtles in 150 trap-nights).

On the Alabama River in 2012, hoopnet basking traps captured 56% of turtles judged to be situated above their openings (67 of 119) and the overall rate of capture was 2.52 turtles/10 trap

TABLE 1. Capture success of basking traps on the Alabama River in 2012, with success rate (percent of turtles observed over traps that were captured) and number of captures per 10 trap-hours (10 being the typical number of traps deployed at one time).

Date	Captures	Misses	Success rate (%)	Trap hours	Captures/ 10 trap hours
11 June 2012	2	2	50	21	0.95
12 June 2012	19	5	79	34	5.59
13 June 2012*	2	6	25	24	0.83
14 June 2012*	2	3	40	16	1.25
15 June 2012*	10	17	37	40.5	2.47
16 June 2012	16	7	70	53	3.02
17 June 2012	7	7	50	43.5	1.61
18 June 2012	9	5	64	33.5	2.69
Total	67	52	56	266	2.52

*Dates when the river was higher and more variable than at normal pool levels.

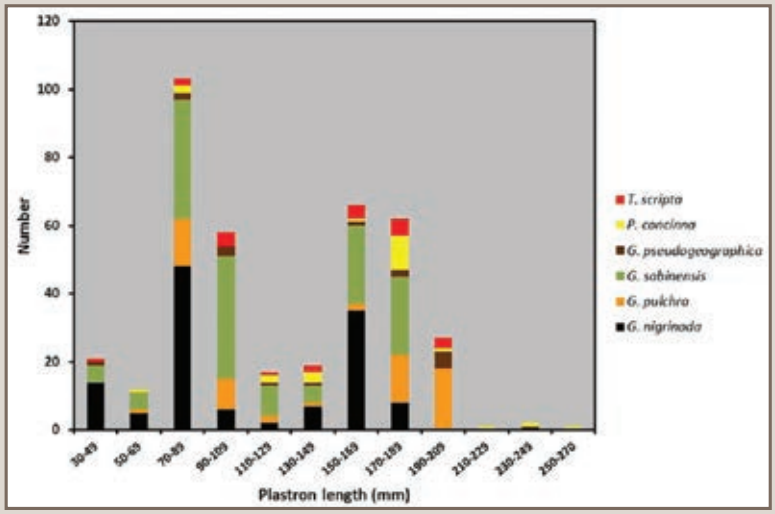


FIG. 3. Length-frequency distribution of six turtle species captured in hoopnet basking traps in the Alabama, Mermentau, Calcasieu, and Sabine river drainages, 2011–2013.

hours, or a turtle every 4.0 hours a trap was in place (Table 1). Most of the 52 misses were probably a result of turtles jumping beyond the trap rims, as I observed no turtles scrambling out over the tops of nets during my approach. Trap success varied considerably by day in total numbers of turtles captured, percentage of turtles over traps captured, and hourly capture rates (Table 1). I believe variability in success was largely a result of unpredictable river levels, because trapping in 2012 followed two days of moderately heavy rain that resulted in variable and less predictable dam releases for three days (13–15 June), which made it difficult to keep traps at optimal heights. Trap success rate and capture rate were low on these three days, with capture rate being significantly lower than it was the other five days in a 2 × 2 Chi-square contingency test (35% for 13–15 June vs. 67% for other days, Table 1; $\chi^2 = 11.11$, $p = 0.0009$). Trap success may thus be partially compromised by river conditions that are influenced by recent precipitation events. The trap described thus has the disadvantage of not adjusting with fluctuating water level, as various designs of floating basking traps do (Plummer 1979), however, floating platform traps do not work well in even moderate river currents (pers. observ.) or in lotic habitats with abundant existing basking substrates (W. Selman, pers. comm.). Hoopnet basking traps should thus be tied to basking substrates in a manner that allows easy and rapid adjustment of their height in the water column.

Turtles were almost always at the bottoms of nets when I reached them. Some care is necessary in pulling up the inside of the nets to retrieve turtles, as two of the "misses" in Table 1 came from trapper error, i.e., allowing turtles to escape over the top hoop as the traps were pulled upward.

The size-frequency distribution of turtles captured in basking traps shows that all size classes were well represented among captures, from a hatchling *G. sabinensis* measuring 36 mm PL to a female *P. concinna* measuring 265 mm PL (Fig. 3). The highly bimodal nature of the distribution is a consequence of the dominance of species of *Graptemys*, which are strongly sexually size dimorphic (Lindeman 2013). The size classes ≥ 210 mm in PL were only lightly populated (3 female *P. concinna* and 1 female *G. pseudogeographica*), because the only species that commonly reaches this size, *P. concinna*, was substantially less common in the basking turtle fauna than the smaller *Graptemys* spp. and *T. scripta*. The traps should capture large *Pseudemys* spp. well in habitats where they are more abundant, although a larger hoop diameter may better target larger turtles.

Paddling a canoe toward traps worked moderately well on the upper Sabine River, where capture rate was 0.4 turtles/trap-day (11 turtles in 27 trap-days), but yielded no captures in 8 trap-days on the Whiskey Chitto River. The difference was likely related to basking frequency, which was markedly lower on the Whiskey Chitto than on the Sabine during trapping days. Checking traps from a canoe meant less of the river could be covered and fewer checks of traps were possible, thus a motorized boat remains the better option in river reaches that are deep enough.

It was not uncommon to recover turtles not seen over traps before approach, demonstrating the ability of traps to occasionally hold turtles for long periods of time. These bonus or "Easter-egg" turtles were captured both when trap rims were slightly above the surface or slightly below and were always at the bottom of the trap when it was pulled up, suggesting that the ca. 1- to 1.5-m depth of the traps may be an added advantage of the design. In my experience, turtles often rapidly escape basking frame traps (the design of MacCulloch and Gordon 1978) with shallower nets (ca. 30–50 cm) and trapping turtles that were not seen on the basking platform of the trap during approach is much rarer.

All nets in the present study were set under logs and branches that projected up from the water at an angle (Fig. 2), so that traps could be set with the opening flush with or just above the river surface in an attempt to limit escapes. In a habitat in which the main basking substrates lie flat at the surface with a substantial underwater portion, as with floating logs, modification will be necessary to avoid setting the opening too low in the water column. Nails and twine can be used to secure a trap alongside a horizontal log, with additional nails on the opposite side of the

log to prevent turtles from escaping into the water on that side, as described by Selman et al. (2012).

Two advantages of the method described over many other basking trap designs are ease of transport and cost. Ten traps collapse to a 1-m circle that stands ca. 15 cm high and thus take up little space in a trailered boat or in the back of a vehicle, in contrast to the bulky three-dimensional shape of crawfish-wire traps and traps with treadles. A 4.3-m jonboat can hold 15–18 nested crawfish-wire traps of various sizes, but they take up the majority of the deck and hull space (W. Selman, pers. comm.). Cost of five hoopnets that can be modified to produce 10 basking traps is ca. US $600 plus shipping (Memphis Net and Twine, Memphis, Tennessee).

Acknowledgments.—I thank W. Selman, who demonstrated the use of jonboat approach with crawfish-wire traps on the Alabama River for me in 2009 and thus helped to motivate the conception of my new trap design. Trapping was ably assisted by A. Fehrenbach and S. McFadden in Louisiana in 2012 and F. Armagost in Louisiana and Alabama in 2013. The manuscript was improved by the comments of J. Godwin and W. Selman. Trapping was carried out under Scientific Collecting Permits issued by the states of Alabama (2011000059266860, 20120000086566860, and 20130000058066860), Louisiana (LNHP-11-076, LNHP-12-070, and LNHP-13-026), and Texas (SPR-0513-059). Field work was funded by a Faculty Professional Development grant from the Pennsylvania State System of Higher Education and a Louisiana State Wildlife Grant.

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AMPHIBIAN DISEASES

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Detection of Ranavirus in Northeast Ohio's Wetlands

Given the role of pathogens, such as *Ranavirus* spp., in amphibian die-offs and declines (Dazak et al. 2003; Stuart et al. 2004) it is important to document their distribution and prevalence. Ranavirus was only recently reported in Ohio, from *Ambystoma maculatum* (Spotted Salamander), *Lithobates catesbeianus* (American Bull Frog), *L. clamitans* (Green Frog), *L. sylvaticus* (Wood Frog), and *Anaxyrus americanus* (American Toad) at Taylor-Ochs Pond in Granville (Homan et al. 2013). Here we document ranavirus in a new geographic location in northern Ohio and add *L. palustris* (Pickerel Frog) as new species to the list of amphibians with ranavirus infection in Ohio (Miller et al. 2011).

While conducting a Cleveland Metroparks district-wide vernal pool inventory on 4 June 2010 an amphibian mortality was observed within Mill Stream Run Reservation. The event involved several hundred amphibian larvae at three separate wetlands less than 200 m apart. Across all three sites we observed a total of approximately 200–300 morbid larval *Lithobates sylvaticus* that appeared emaciated and had sloughing skin, ~15 *Pseudacris crucifer* (Northern Spring Peeper) with red and swollen hind legs, and ~ 5 *Ambystoma* spp. (mole salamander) with no obvious signs of disease. The live *L. sylvaticus* larvae appeared emaciated, with sloughing skin and had difficulty swimming and were near the surface. Five recently dead *L. sylvaticus* larvae were collected and preserved in 70% ethanol. The observation of this mortality event initiated the planning and implementation of additional surveillance of amphibian mortality events and determining the cause.

From April–June 2011 weekly site visits were conducted at three pools in Mill Stream Run Reservation (specimens were collected in only two of the three pools, MSR #1 & 2), three pools in North Chagrin Reservation (NCR #1–3), and three pools in South Chagrin Reservation (ultimately only one had amphibians, SCR) all within Cleveland Metroparks. Surveillance and monitoring continued the following year from April–June, 2012, excluding South Chagrin Reservation due to the low number of amphibians present; however, we added Sanctuary Marsh (SM) a wetland located in North Chagrin Reservation. During each site visit a visual survey of the entire wetland's perimeter was conducted without entering the water during which we searched for apparently ill amphibian larvae (e.g., emaciation or patchy pale coloration) or morbid tadpoles, and those with unusual behavior (swimming slowly near the surface or unable remain upright). Such animals were collected with a dip net and euthanized using Tricaine methanesulfonate (MS-222) and preserved in 70–95% ethanol. In addition, apparently healthy *L. catesbeianus* and *L. clamitans* larvae at SM and NCR#1, respectively, were collected in 2012. In all cases, equipment and boots were decontaminated with a 5% bleach solution between sites and dip nets were only used once per site to protect against cross contamination of samples and spread of the virus to non-infected pools.

The larvae collected in 2010 and 2011 were sent to the Amphibian Disease Laboratory at the San Diego Zoo Institute for Conservation Research to be screened for ranavirus. DNA was extracted from liver and kidney and pooled together in 2010 and the whole body in 2011 with DNAeasy Blood and Tissue kits (Qiagen Inc, Valencia, CA). The laboratory utilized the Taqman qPCR assay described by Pallister et al. (2007) that targets a small

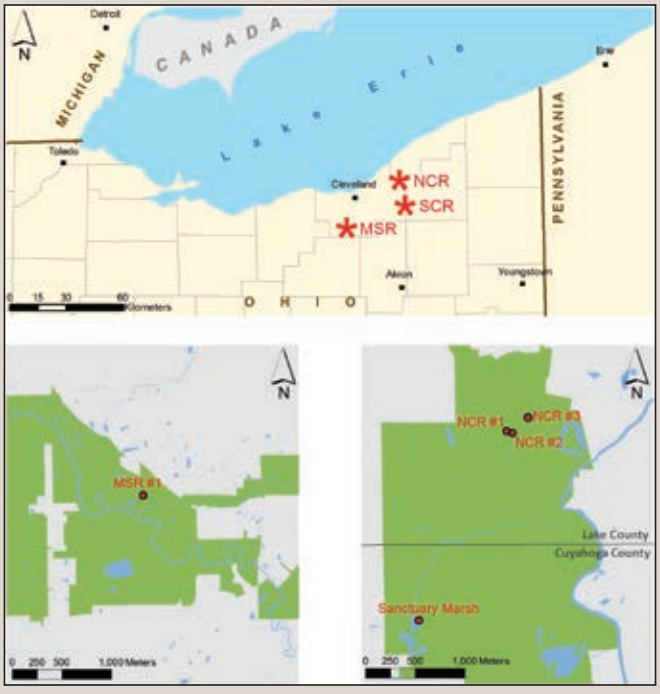


FIG. 1. Locations of ponds with amphibians tested for ranaviruses in northern Ohio from 2010–2012.

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TABLE 1. Summary of ranavirus infection in *Lithobates catesbeianus, L. clamitans, L. palustris,* and *L. sylvaticus* from 2010–2012 in northern Ohio, USA.

Site	Coordinates	Year	Species	Infected/Tested	Range of Ct values
MSR#1	41.30288°N, 81.77437°W	2010	*L. sylvaticus*	3/3	15.5–22.3
		2011	*L. sylvaticus*	5/5	13.3–41.7
MSR#3	41.30249°N,81.77943°W	2011	*L. sylvaticus*	0/1	—
NCR#1	41.58007°N, 81.42421°W	2011	*L. sylvaticus*	2/3	35.7–36
		2012	*L. clamitans*	6/6	—
		2012	*L. sylvaticus*	1/1	—
NCR#2	41.5799°N,81.42344°W	2011	*L. sylvaticus*	1/2	41.6
NCR#3	41.5799°N,81.42344°W	2011	*L. sylvaticus*	1/2	41.8
SCR	41.43604°N,81.41195°W	2011	*L. sylvaticus*	0/1	—
SM	41.56297°N,81.43508°W	2012	*L. catesbeianus*	6/7	—
		2012	*L. palustris*	1/1	—
Total				26/32	

section of the major capsid protein (MCP) gene of ranaviruses. The one modification was that the reaction was run for 55 instead of 40 cycles. Each sample was run in four wells: three to detect ranavirus and one well to detect possible PCR inhibition using a Taqman exogenous internal positive control (IPC; Applied Biosystems). A sample was considered positive when the Ct value was <50 in all three wells. If the Ct value was ≥ 50 the sample was considered negative. If 1 or 2 wells had Ct values < 50 the sample was run again using 5 wells (including one well for the IPC) and scored as positive if ≥ 3 wells had Ct values <50 and negative otherwise.

Samples collected in 2012 were analyzed at Baldwin Wallace University in Berea, Ohio. These samples were analyzed with standard PCR for the major capsid protein (MCP) gene of ranavirus using the primers MCP 4 & 5 and reaction conditions as described in Mao et al. (1997). Samples were scored positive for ranavirus if isolates possessed a prominent band at about 500 bp.

We found a total of 26 of the 32 amphibians tested were positive for the presence of ranavirus DNA (Table 1). This includes 13 of 18 *Lithobates sylvaticus*, 6 of 6 *L. clamitans*, 6 of 7 *L. catesbeianus,* and 1 of 1 *L. palustris* from two networks of ponds located 40.0 km apart (Fig. 1). Note, however, that these animals were selected because of their signs of illness and so these numbers do not reflect the actual prevalence of infection in the population as a whole. While it is unclear if the mortality event observed in 2010 was a direct result of a ranavirus infection, we found ranavirus DNA in all three recently dead *L. sylvaticus* and observed obvious hemorrhaging and edema, which is consistent with, but not diagnostic of, clinical signs of advanced ranavirus infection in amphibians (Miller et al. 2011). In 2011 *L. sylvaticus* at MSR#1 again appeared lethargic, swimming near the surface with pale patchy skin and with a small number of morbid animals observed. Interestingly the *L. catesbeianus* and *L. clamitans* larvae collected at SM in 2012 did not exhibit any gross signs of infection and there was no observable mortality, but these larvae tested positive for ranavirus DNA.

To our knowledge this is the first report of a ranavirus in northern Ohio. While ranavirus has been documented in *L. sylvaticus, L. clamitans,* and *L. catesbeianus* in Ohio, this is the first report of *L. palustris* in Ohio testing positive for ranavirus. We also documented the recurrence of ranavirus over two years in one wetland. This is important as it is believed that long-term presence and exposure within a population can potentially lead to local extirpation (Miller et al. 2011).

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Multi-year Surveillance for *Batrachochytrium dendrobatidis* in Amphibians of Peninsular Malaysia

Chytridiomycosis, caused by the fungal pathogen *Batrachochytrium dendrobatidis* (*Bd*), is a threat to amphibian biodiversity and is causing amphibian population declines in many areas throughout the world (Lötters et al. 2009). Since its identification, this pathogen has been found on every continent where amphibians are present and is continuing to be found in many new countries (Fisher et al. 2009; Olson et al. 2013). Until very recently there have been relatively few surveys for the presence of *Bd* in Asia despite the incredible biodiversity of amphibians in that region. Recent surveys in the Peoples Republic of China have shown that *Bd* occurs with a prevalence of between 7.6% and 15% depending on the region sampled (Bai et al. 2010; Bai et al. 2012). In Japan there is an average prevalence of 27% (Goka et al. 2009) whereas South Korea has been reported to have an average prevalence of 38% (Yang et al. 2009). There also have been sporadic reports of *Bd* incidence in Indonesia (Kusrini et al. 2008). A recent survey of amphibians in Thailand, close to the Malaysia border, found one positive *Bd* sample out of six samples (Vörös et al. 2012).

Peninsular Malaysia has a high level of amphibian biodiversity with many new species still being discovered. The first published survey of *Bd* in Peninsular Malaysia completed in March 2010 detected *Bd* in 10 out of 127 individuals sampled for an overall prevalence of 7.8% (95% confidence interval, 4–14%) (Savage et al. 2011). Although 47 different species from 6 families were sampled from 11 different localities across western peninsular Malaysia at a diversity of elevations, sample sizes were too small to assess meaningful differences among sites, locations or elevations (Savage et al. 2011). We report surveillance data collected over three consecutive years (2008, 2009, and 2010) previous to the first documented *Bd*-positive samples in Peninsular Malaysia. In our surveys, we first observed *Bd* in 2010 but we were unable to detect *Bd* in Peninsular Malaysia prior to this year.

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Amphibian swab samples were collected over a three year period from 2008 to 2010 using the British Columbia Ministry of the Environment *Bd* surveillance protocol (http://www.env.gov.bc.ca/wld/frogwatch/ecology/diseases.htm). All samples were of adult amphibians except for two small metamorphosed juvenile frogs in 2010.

Amphibians were opportunistically sampled from different locations in Peninsular Malaysia and from a diversity of habitats and ecosystems (Fig. 1). Only one site was sampled in 2008 (18 samples), two sites were sampled in 2009 (47 samples), and 11 sites were sampled in 2010 (98 samples). There were 5 sites sampled from 2009 through 2010 at palm oil plantations (177 samples; AF). All other field sites were sampled by Universiti Sains Malaysia researchers in association with the University of Victoria tropical field school program. The samples were collected from 4 m to 272 m elevation (Table 1) and sample sites encompassed different habitats: urban areas, palm oil plantations and forested regions (Table 1).

The samples were assayed using a TaqMan based qPCR approach to assess the presence of *Bd* (Boyle et al. 2004). The TaqMan quantitative PCR was performed on a Stratagene Mx4000 qPCR machine (Stratagene, Santa Clara, California, USA). The primers and probe used are outlined by Boyle et al. (2004). Each of the qPCR reactions was performed in triplicate using serial dilutions of positive control *Bd* strain, JEL 423, as well as a blank sample.

All amphibians sampled were native to Peninsular Malaysia except for two American Bullfrogs, *Lithobates catesbeianus* (Table 1) collected in 2010 in the Bukit Mertajam region of Penang, located on the northwest coast of Peninsular Malaysia. The only species which appeared on the International Union for Conservation of Nature's (IUNC) red-list for endangered species was the near-threatened species *Limnonectes blythii*. The survey also included five other species, *Hylarana glandulosa*, *Hylarana picturata*, *Humerana miopus*, *Hylarana nigrovittata*, *Xenophrys aceras*, which are believed to be decreasing in population size and many others which had insufficient data for conservation status assessment (www.iucnredlist.org). The only positive *Bd* sample was from an adult *Leptobrachium hendricksoni*, sampled in 2010 in the state of Perlis in the northwest of Peninsular Malaysia near the border with Thailand.

Our amphibian survey demonstrated only a single positive sample for *Bd* in 2010 after a three-year period of testing beginning in 2008. The survey published by Savage et al. (2011) demonstrated the presence of *Bd* in samples collected in March 2010. One possible explanation for this discrepancy is that *Bd* may have only recently emerged in Peninsular Malaysia and is now beginning to spread across the country. There have been relatively few studies which have examined the speed at which *Bd* can spread through a region which makes it difficult to explain the differences between the two studies (Lips et al. 2006; Lips et al. 2008). At some locations our study was unable to sample adequate numbers of amphibians to determine

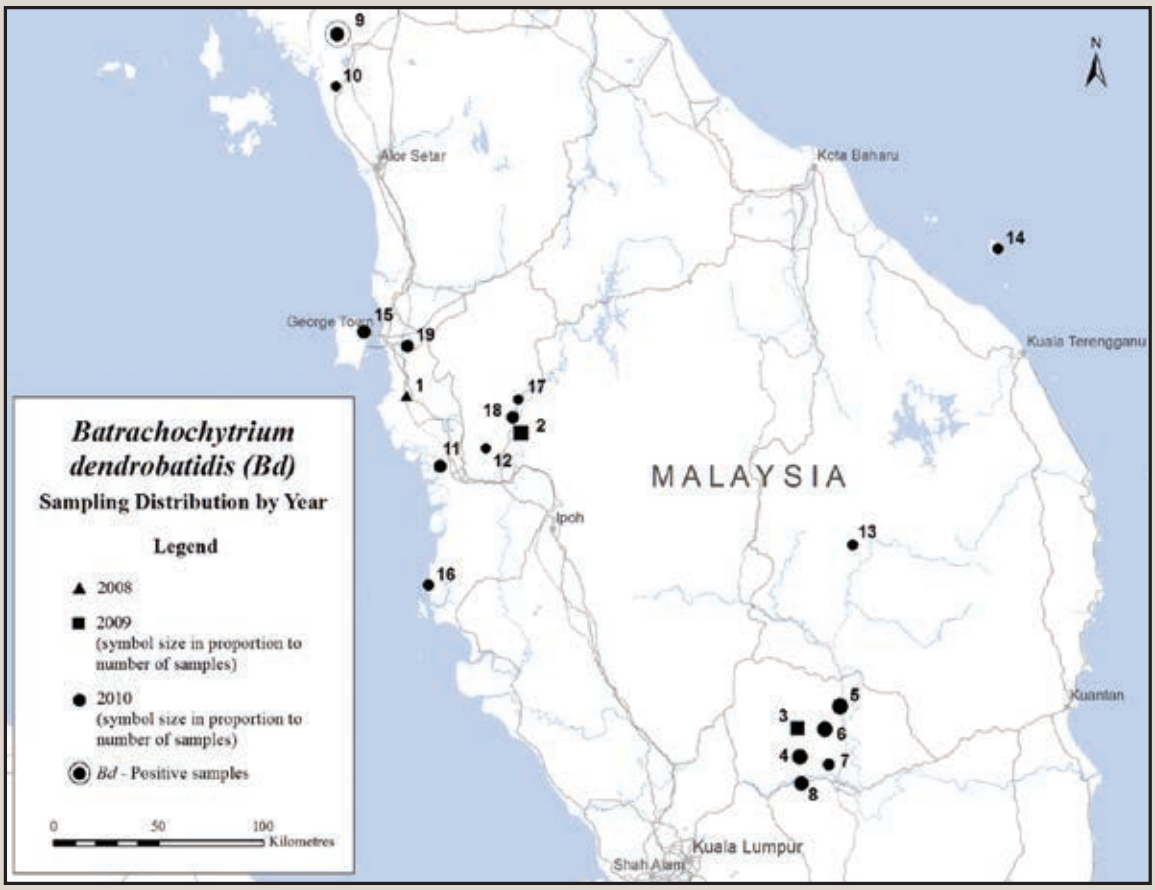


FIG. 1. Distribution of *Batrachochytrium dendrobatidis* (Bd) sample locations in Peninsular Malaysia. The relative size of the symbol indicates sample size. Numbers corespond to locations indicated in Table 1.

conclusive presence or non-detection of *Bd* (e.g., samples with more than 59 animals, Skerratt et al. 2008). The most significant difference between the two studies which may contribute to our results is that the sampling was performed at different altitudes and seasons. Our sampling typically occurred in the month of May or later while Savage et al. (2011) sampled in March which is typically cooler and more suitable for *Bd* growth (Piotrowski et al. 2004). In tropical regions *Bd* has been shown to be found at higher elevations due to the preferred temperature range for this pathogen (Berger et al. 1998; Pounds et al. 2006; Lips et al. 2008). Most of our sites were around 100 m or below, and the survey by Savage et al. (2011) found only two of their ten positive *Bd* detections below 100 m. The only positive *Bd* detection in our survey occurred at the highest elevation site (Table 1). The one positive *Bd* sample out of six amphibian samples found in neighboring Thailand was found at a site around 100 m elevation in August (mean annual temperature 28.3°C [Vörös et al. 2012]).

The geographic area covered by Savage et al. (2011) and our survey was similar. Our lone positive sample was taken in Perlis which was the only state without positive samples in the Savage et al. (2011) survey. However, their detection probability was very low given that there were only four samples from this state. Twenty of our 27 species overlapped with the Savage et al. (2011) survey but low samples sizes in both studies precludes species specific comparisons (Baláž et al. 2013). The positive amphibian in our study, *Leptobrachium hendricksoni*, was also found to be positive in the neighboring state by Savage et al. (2011). Although the two bullfrogs captured in our study were *Bd* negative, the area where these bullfrogs were captured had positive samples in the study done by Savage et al. (2011). The bullfrog is a likely candidate for the world-wide transmission of *Bd* as it is heavily traded in the amphibian market (Fisher and Garner 2007; Schloegel et al. 2009) and is largely asymptomatic (Daszak et al. 2004; Schloegel et al. 2010). Bullfrogs are widely available in live food markets in many Asian countries including Malaysia (Fisher and Garner 2007; Schloegel et al. 2009; Kolby et al. 2014), and may escape or be released into local ecosystems to serve as vectors for *Bd* introduction.

The recent increase in *Bd* surveillance around the world has led to the pathogen being detected in many new countries (Yang et al. 2009; Bai et al. 2010; Savage et al. 2011). The determination of whether this pathogen is endemic or has recently spread to regions in Malaysia will require a more systematic approach to surveillance. Exhaustive multi-year surveys may not be an option for all regions. Information may be gained by assessing historical specimens in museums in order to ascertain when an introduction event had occurred (Weldon et al. 2004; Lips et al. 2008; Soto-Azat et al. 2009; Lips et al. 2011). For well-established and persistent infections the origins of a pathogen may be established by the population genetic structure of the pathogen (Goka et al. 2009; Morgan et al. 2007; James et al. 2009; Farrer et al. 2011). The differences in prevalence values in the survey done by Savage et al. (2011) and our survey suggests that more research is needed to determine the origin of the pathogen in Peninsular Malaysia.

TABLE 1. Sampling site information and amphibian species tested for *Batrachochytrium dendrobatidis* (*Bd*) in Peninsular Malaysia from 2008 through 2010. Positive samples (*Bd*+), total sample size (N), elevation, and prevalence with 95% confidence intervals are indicated. Numbers before site names correspond to location numbers in Fig. 1.

Locality / Species	Coordinates	Elevation (m)	Date of Collection	*Bd*+	N	*Bd* Prevalence (%) by site (95% CI)
1 Nibong Tebal, Pulau Pinang	5.1433°N, 100.49°E	8	28 May 2008	0	18	0 (0–21.88)
Odorrana hosii				0	6	
Limnonectes blythii				0	5	
Hylarana labialis				0	2	
Limnonectes laticeps				0	2	
Phrynoidis aspera				0	2	
Fejervarya limnocharis				0	1	
2 Batu Ring, Lenggong Perak	4.9844°N, 100.9811°E	178	23 May 2009	0	30	0 (0–14.13)
Hylarana erytraea				0	12	
Microhyla butleri				0	6	
Fejervarya limnocharis				0	4	
Occidozyga lima				0	3	
Duttaphrynus melanostictus				0	1	
Hylarana glandulosa				0	1	
Limnonectes blythii				0	1	
Phrynoidis aspera				0	1	
Polypedates leucomystax				0	1	
3 Bukit Rengit, Langchang, Pahang Site 1	3.7147°N, 102.1705°E	120	2 June 2009	0	17	0 (0–22.92)
Hylarana erytraea				0	17	
4 Bukit Rengit, Langchang, Pahang Site 2	3.5930°N, 102.1805°E	98	16 July 2009	0	44	0 (0–10)
Limnonectes blythii			2 June 2010	0	17	
Hylarana labialis				0	5	
Microhyla mantheyi				0	4	
Phrynoidis aspera				0	4	
Hylarana glandulosa				0	3	
Hylarana picturata				0	3	
Microhyla heymonsi				0	3	
Limnonectes malesianus				0	2	
Fejervarya cancrivora				0	1	
Hylarana baramica				0	1	
Ingerophrynus quadriporcatus				0	1	
5 Sungai Mai Oil palm plantation, Pahang	3.8077°N, 102.3525°E	61	13 July 2009	0	59	0 (0–7.62)
Fejervarya limnocharis			26 May 2010	0	15	
Polypedates leucomystax				0	11	
Fejervarya nicobariensis				0	8	
Hylarana erytraea				0	8	
Fejervarya cancrivora				0	6	
Kaloula pulchra				0	4	
Duttaphrynus melanostictus				0	3	
Ingerophrynus parvus				0	1	
Microhyla butleri				0	1	
Microhyla heymonsi				0	1	
Phrynoidis aspera				0	1	

TABLE 1. Continued.

Locality / Species	Coordinates	Elevation (m)	Date of Collection	*Bd*+	N	*Bd* Prevalence (%) by site (95% CI)
6 Kuala Lompat, Pahang	3.7125°N, 102.2863°E	109	14 July 2009	0	39	0 (0–11.17)
Hylarana labialis			19 May 2010	0	24	
Hylarana glandulosa				0	9	
Limnonectes blythii				0	4	
Hylarana picturata				0	1	
Limnonectes malesianus				0	1	
7 Kerdau Oil palm plantation, Pahang	3.5586°N, 102.3058°E	71	15 July 2009	0	7	0 (0–43.91)
Polypedates leucomystax			21 June 2010	0	3	
Fejervarya limnocharis				0	2	
Duttaphrynus melanostictus				0	1	
Microhyla heymonsi				0	1	
8 Lanchang Oil palm plantation, Pahang	3.4777°N, 102.1875°E	77	17 July 2009	0	28	0 (0–15.02)
Polypedates leucomystax			20 May 2010	0	9	
Fejervarya nicobariensis				0	7	
Hylarana erythraea				0	6	
Fejervarya limnocharis				0	4	
Hylarana labialis				0	2	
9 Wang Kelian, Perlis	6.6975°N, 100.1911°E	140–272	17–23 May 2010	1	26	3.85 (0.2–21.59)
Leptobrachium hendricksoni				1	11	
Limnonectes blythii				0	3	
Hylarana glandulosa				0	2	
Microhyla butleri				0	2	
Fejervarya limnocharis				0	1	
Humerana miopus				0	1	
Hylarana nigrovittata				0	1	
Kaloula pulchra				0	1	
Limnonectes hascheanus				0	1	
Microhyla heymonsi				0	1	
Phrynoidis aspera				0	1	
Polypedates leucomystax				0	1	
Xenophrys aceras				0	1	
10 Ujung Bukit, Perlis	6.4733°N, 100.1852°E	36	27 May 2010	0	1	0 (0–94.54)
Phrynoidis aspera				0	1	
11 Matang Mangrove Forest, Perak	4.8433°N, 100.6333°E	4	31 May 2010	0	14	0 (0–26.76)
Fejervarya limnocharis			1 June 2010	0	13	
Fejervarya cancrivora				0	1	
12 Batu Kurau River, Perak	4.9180°N, 100.8313°E	4	1 June 2010	0	1	0 (0–94.54)
Phrynoidis aspera				0	1	
13 Kuala Tahan, Pahang	4.505°N, 102.4088°E	128	4 June 2010	0	3	0 (0–69)
Kaloula pulchra				0	3	
14 Redang Island, Terengganu	5.7769°N, 103.0325°E	11	13 June 2010	0	4	0 (0–60.42)
Duttaphrynus melanostictus				0	4	

TABLE 1. Continued.

Locality / Species	Coordinates	Elevation (m)	Date of Collection	*Bd*+	N	*Bd* Prevalence (%) by site (95% CI)
15 Muka Head, CEMACS, Penang	5.4188°N, 100.3077°E	13	15 June 2010	0	18	0 (0–21.88)
Hylarana erytraea				0	12	
Duttaphrynus melanostictus				0	2	
Hylarana glandulosa				0	2	
Polypedates leucomystax				0	2	
16 Telak Senangin, Perak	4.3316°N, 100.5844°E	14	4 November 2010	0	6	0 (0–48.32)
Hylarana labialis				0	5	
Ingerophrynus parvus				0	1	
17 Gua Asar, Perak	5.1288°N, 100.9705°E	105	5 November 2010	0	2	0 (0–80.21)
Phrynoidis aspera				0	2	
18 Lata Kekabu, Perak	5.0497°N, 100.9455°E	110	5 November 2010	0	11	0 (0–32.14)
Amolops larutensis				0	9	
Hylarana picturata				0	1	
Odorrana hosii				0	1	
19 Bukit Mertajam, Penang	5.3580°N, 100.4933°E	53	26 November 2010	0	12	0 (0–30.13)
Leptobrachium hendricksoni				0	7	
Hylarana glandulosa				0	2	
Lithobates catesbeianus				0	2	
Duttaphrynus melanostictus				0	1	
Totals				**1**	**340**	**0.29(0.01–1.88)**

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Detection of a Frog Virus 3-like Ranavirus in Native and Introduced Amphibians in the United Kingdom in 2007 and 2008

Ranaviruses are considered to be emerging pathogens of amphibians in Europe (Duffus and Cunningham 2010). In the United Kingdom (UK) a frog virus 3 (FV3)–like ranavirus began to emerge in the mid- to late-1980s in populations of Common Frogs (*Rana temporaria*) in the southeast of England (Cunningham et al. 1996), followed closely by cases of infection and disease in some Common Toads (*Bufo bufo*) (Hyatt et al. 2000). Populations of Common Frogs have experienced declines as a result (Teacher et al. 2010). Most investigations of ranavirus in the UK have focused solely on Common Frogs (e.g., Duffus et al. 2013), but there are other species in the UK that are known to be susceptible to ranavirus infections such as larval Common Midwife Toads (*Alytes obstetricans*) and Alpine Newts (*Mesotriton alpestris*), both of which are introduced species in the UK (Balseiro et al. 2009, 2010), and adult Common Toads (Cunningham et al. 2007), a native species. The infection status of these other potential hosts has not been investigated in the UK. Understanding the infection status of syntopic amphibian species is important because ranaviruses are generalist pathogens (e.g., Mao et al. 1999; Schock et al. 2008). Additionally, some of the syntopic species that may be susceptible to the virus are of special interest, such as the Great Crested Newt (*Triturus cristatus*), a European Protected Species and a Herpetile Species of Priority in the UK and the Common Toad, also a Herpetile Species of Priority in the UK (JNCC 2007). The generalist nature of ranaviruses makes it important to investigate all potential amphibian hosts so that we may better understand

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TABLE 1. Presence of the amphibian ranavirus in native and introduced species opportunistically sampled in the UK in both 2007 and 2008. N+ is the number of ranavirus positive individuals, whereas N is the total number of individuals screened. CI is the confidence interval of the proportion N+/N.

	2007		2008	
Species	N+/N	CI	N+/N	CI
Common Toad (*Bufo bufo*)	1/52	0.001–0.1158	0/23	0–0.1781
Great Crested Newt (*Triturus cristatus*)	0/2	0–0.8021	0/13	0–0.2834
Alpine Newt (*Mesotriton alpestris*)	0/4	0–0.6042	—	—
Common Newt (*Lissotriton vulgaris*)	1/17	0.0031–0.3776	1/18	0.0029–0.2938
Common Midwife Toad (*Alytes obstetricans*)	—	—	1/1	0.0546–1

the ecology of the ranavirus present in the UK and better inform conservation and management plans. Here we investigated the infection status of several native and introduced amphibian species in the UK for ranavirus.

In 2007 and 2008 we obtained dead animals opportunistically through citizen reports of mortalities made to Froglife (Registered Charity No. 1093372 in England and Wales, and No. SC041854 in Scotland) and to A.L.J.D., as well as by directly collecting specimens for ranavirus screening. A.L.J.D. arranged for whole carcasses to be delivered for complete post-mortem examination. Any animals that were alive when collected by us were euthanized according to Home Office Schedule One procedures by an overdose of MS-2,2,2 (tricane methylsulfonate, Thompson and Joseph Ltd, Norwich, UK) buffered to pH 7 with sodium bicarbonate. We followed the procedures for DNA extraction from hepatic tissues and PCR screening for ranaviral DNA described in Duffus et al. (2013). The geographic origins of some submitted samples are unknown, but we are certain that in 2007 Common Toads were collected from a minimum of three sites, Common Newts were collected from a minimum of two sites, Great Crested Newts from a minimum of two sites, and Alpine Newts were collected from one site. In 2008, Common Toads and Common Newts were collected from a minimum of different two sites, Great Crested Newts were collected from one site, as was the Common Midwife Toad.

The one adult Common Midwife Toad in our study was infected. It was collected at a garden pond in Brighton, Sussex (on the southeastern coast of England), during a mass mortality of Common Frogs and Common Toads (see Beebee 2012). The mortality in the Common Frogs at this site was associated with a ranavirus infection (Brighton site in Duffus et al. 2013). Common Midwife Toad tadpoles have been involved in mass mortality events associated with outbreaks of the Common Midwife Toad virus (CMTV) in Spain (Balseiro et al. 2009, 2010), but this is the first known infection in an adult of this species with ranavirus. This result underscores the importance of examining all life history stages for the presence of amphibian ranaviruses during a mass mortality event.

We also report the first ranavirus infection in a Common (Smooth) Newt (*Lissotriton vulgaris*). This newt was collected from a mortality event in 2007 that involved only adult Common Newts. However, since only one asymptomatic individual of 12 individuals screened from this event was positive for the presence of ranavirus, it is unlikely that the pathogen was responsible for the mortality event. The other five Common Newts screened in 2007 were from a site where the virus had a long history of infection in the Common Frog population (Teddington site in Duffus et al. 2013, southwest of London). During the collection of the Common Newts, the Common Frogs at the site displayed signs of active ranavirosis (A.L.J.D., pers. obs.). One of these five newts collected displayed large amounts of subcutaneous edema, a sign of ranavirosis in Common Frogs (A.L.J.D., pers. obs.), but none were positive for the ranavirus. Unfortunately, the origin of the one infected Common Newt collected in 2008 was unknown. Prior to Balseiro et al's 2009 report of a mass mortality event of larval Alpine Newts (*Mesotriton alpestris cyreni*) there were no reports of ranavirus infections in European urodeles. The infection that we report in Common Newts is thus the earliest documented occurrence of ranavirus infection in European urodeles.

We also screened for, but did not detect, ranavirus infections in Great Crested Newts, a native species, and Alpine Newts, an introduced species known to be susceptible CMTV (Balseiro et al. 2009, 2010). The Great Crested Newts that were collected in 2008 from a mass mortality event in this species from a site near York in the north of England, but were free of signs of ranavirus infection and tested negative for ranavirus DNA.

In our survey, only one of 52 Common Toads screened had a ranavirus infection. Ranavirus infection and associated mortality has previously been described in UK Common Toad populations (Hyatt et al. 2000). The emergence of the ranavirus in Common Toads has been put forward as an explanation for the widespread population declines observed in this species in the UK (e.g., Cunningham et al. 2007). However, if the emergence of ranavirus was a substantial cause of decline we would have expected more reports of mortalities associated with ranavirus infection. More thorough investigations are needed before a link between the emergence of the ranavirus and the population declines of Common Toads in the UK can be properly made.

Our current report shows that the ranavirus infects at least three additional species in the UK. Understanding the host range of the ranavirus(es) in the UK is a necessary step in the formation and implementation of conservation and management plans of both native and introduced amphibian species. Further studies are needed to understand the geographic distribution of the ranavirus in all potentially susceptible amphibian species in the UK. Experimental determination of the susceptibility of native and introduced species would be very helpful in understanding the dynamics of the pathogen at a European level.

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Amphibian Chytrid Infections in Non-forested Habitats of Katanga, Democratic Republic of the Congo

Numerous studies have documented the presence of the amphibian chytrid fungus *Batrachochytrium dendrobatidis* (*Bd*) in a diverse array of anuran and caecilian species from central, eastern and southern Africa (reviewed in Greenbaum et al. in press). The majority of previous surveys for *Bd* in Africa have focused on forested habitats, and with the exception of South Africa, large areas of non-forested regions of Africa remain unstudied (Olson et al. 2013). Studies that sampled for *Bd* presence in non-forested regions of Central Africa are especially sparse, and few positive records are known (Olson et al. 2013). The largest data set near the region (www.bd-maps.net/) presented 68 samples with no detected chytrid infection in 16 species of amphibians from eight localities in southeastern Zambia. The website also reported a single positive record of a *Xenopus laevis* from a nearby site in Malawi.

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Katanga Province (just under 500,000 km^2) is located in southeastern Democratic Republic of the Congo (DRC), and is bordered by Angola and Zambia (Bobb 1999). Most of the province contains vegetation associated with the Central Zambezian Miombo Woodland Ecoregion (*sensu* Burgess et al. 2004), but the southern extent of the Albertine Rift (containing grasslands and some tiny forest patches) extends along the eastern border of the province at Lake Tanganyika. Although some recent herpetological work has occurred in the region (e.g., Greenbaum et al. 2010, 2012a,b), few surveys have occurred since the colonial era (de Witte 1953; Laurent 1950, 1957; Plumptre et al. 2007; Schmidt and Inger 1959). Despite the "sporadic and patchy" surveys of Katanga's biodiversity in general, Broadley and Cotterill (2004) noted that at least parts of Katanga should be considered a biodiversity hotspot, based on its exceptional reptile endemism.

As part of an opportunistic herpetological inventory in Katanga Province, EG and CK visited 20 localities and collected 56 samples (from adult and post-metamorphic frogs only) for *Bd* analysis between 30 December 2009 and 21 January 2010 (Fig. 1). According to annual rainfall plots for cities in Katanga from Chapin (1932), our sampling period overlapped with the rainy season. Most of the surveyed areas were mid- to low-

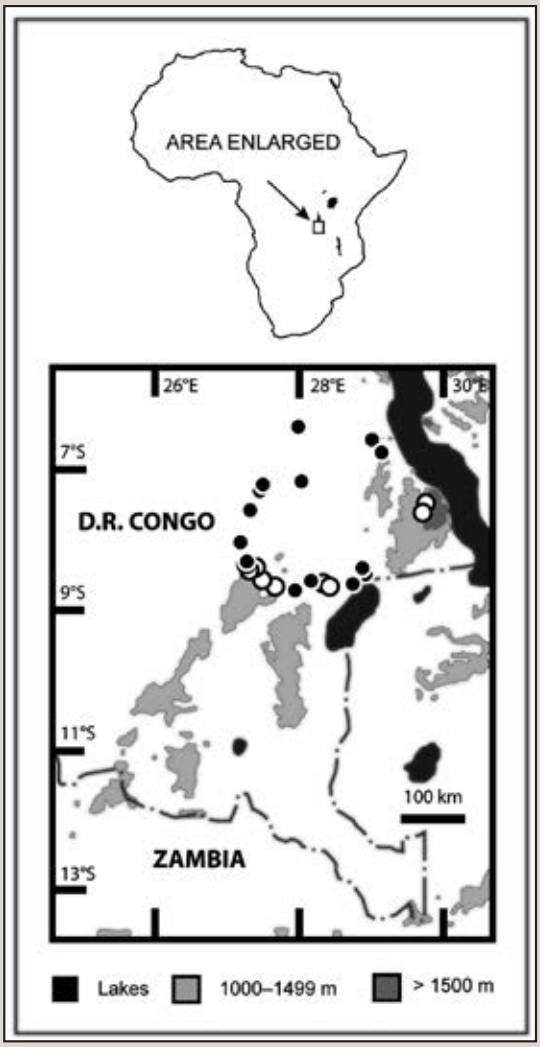


FIG 1. Sampling localities from Katanga Province, Democratic Republic of the Congo. Open circles represent localities with at least one *Bd*-positive sample, and closed circles are localities where *Bd* was undetected.



FIG. 2. Adult female *Hyperolius quinquevittatus* from Pepa, Democratic Republic of the Congo. This individual tested positive for *Bd*.

elevation woodland/savanna mosaic habitats, but the team also sampled villages, lakes, marshes and montane grasslands. Frogs were collected by hand (without gloves) after audio recording of male advertisement calls (in the case of calling males), or during opportunistic visual encounters. Frogs were temporarily stored in well-ventilated plastic containers immediately after capture. Rarely, some individuals of the same species (up to six) were housed in the same container for a few hours before swabbing. Plastic containers were disinfected with a 10% bleach solution after each collection event, minimizing the chance of cross contamination between collection events. While in their containers, a subset of captured individuals were swabbed with sterile swabs (MW100; Medical Wire & Equipment Co, Crosham, UK) for approximately 20 seconds on the ventral surfaces of the abdomen, throat, hands and feet. Swabs were stored individually and dry in shaded containers away from direct sunlight and heat in the field, and transferred to 4°C freezers upon arrival to the laboratory. The QIAmp DNA Mini Kit (Qiagen, Hilden, Germany) was used to extract DNA (manufacturer's protocol) from these swabs. Real-time PCR was performed on a LightCycler 480 (Roche Applied Science, Indianapolis, IN, USA) with the protocol of Boyle et al. (2004), with *Bd* primers specific to the ITS-1/5.8S region of the ribosomal gene. DNA extracted from *Bd*-positive cultures was used as a positive control, and amplicons from two positive frog samples were sequenced to confirm the specificity of the amplification products. We considered samples to be positive if they showed distinct sigmoidal amplification in the real-time PCR, because negative samples and controls do not display this amplification pattern (Soto-Azat et al. 2010).

A total of 56 frogs representing 32 species were swabbed during this study, and 16 of these individuals were *Bd*-positive, for an overall *Bd* prevalence of 28.6% (Table 1). The genera *Afrixalus*, *Amietophrynus*, *Hemisus*, *Hildebrandtia*, *Hoplobatrachus* and *Schismaderma* did not include any positive individuals. Among the remaining genera, *Arthroleptis*, *Leptopelis* and *Kassina* had one *Bd*-positive species each (100% prevalence), *Amietia* was positive for two of three species (66.7% prevalence within the genus), *Xenopus* was positive for one of two species (50% prevalence), *Hyperolius* was positive for three of seven species (42.9% prevalence, Fig. 2), *Phrynobatrachus* was positive for one of three species (33% prevalence), and *Ptychadena* was positive for one of five species (20.0% prevalence). Sample sizes within species were mostly low, and included only a single individual for 19 species, two individuals for five species, and three individuals for seven species. Only *Arthroleptis* cf. *stenodactylus* had a larger sample size, with two of six individuals testing positive for *Bd* (33.3% prevalence). Among the 20 localities visited during the study, eight (40%) contained *Bd*-positive frogs (Fig. 1). Only four of these sites were sampled for five or more species, and with the exception of Pepa (100% prevalence), *Bd* prevalence among the species in these sites was low (Pweto, 0% prevalence; Kabongo, 16.7% prevalence; 7 km S of Manono, 0% prevalence). No dead, dying, or morbid frogs were encountered during the survey.

Several studies have documented the relatively high *Bd* infection rates in amphibian populations that are endemic to cool, montane habitats (e.g., Gower et al. 2012; Pounds et al. 2006; Stuart et al. 2004; but see Olson et al. 2013), and all species and localities sampled from the Marungu Plateau (> 1950 m elev.) in our study were positive. The genus *Amietia* is especially vulnerable to *Bd* infection because it is a prominent member of stream-breeding, montane amphibian faunas in eastern, central and southern Africa (Frost 2014), and we confirmed the

TABLE 1. Summary of *Batrachochytrium dendrobatidis* infections in multiple species of frogs from Katanga Province, Democratic Republic of the Congo, during a three-week opportunistic survey from December 2009 to January 2010.

Site	Date	Coordinates	Elevation (m)	Habitat	Species	Infected/Tested
Road south of Kalemie	30 December 2009	6.68202– 6.71593°S, 29.08110– 29.10493 °E	1472–1561	Woodland/savanna mosaic	*Amietophrynus gutturalis*	0/1
					Hyperolius quinquevittatus	0/1
					Ptychadena cf. *oxyrhynchus*	0/3
					Schismaderma carens	0/1
Kyalengwe, Marungu Plateau	1 January 2010	7.61878°S, 29.78655°E	2037	Montane grassland	*Amietia* sp. 1	1/1
Pepa, Marungu Plateau	1–2 January 2010	7.70938–7.71487°S, 29.76962–29.78100°E	1973–2030	Village, montane grassland	*Amietia* sp. 1	1/1
					Hyperolius nasicus	2/2
					Hyperolius quinquevittatus	1/1
					Kassina cf. *senegalensis*	2/2
					Xenopus laevis	1/1
Pweto, Lake Moero	4–5 January 2010	8.43258–8.48275°S, 28.92273– 28.92493°E	934–960	Lake/flooded grassland	*Hyperolius* cf. *kivuensis*	0/1
					Hyperolius cf. *viridiflavus*	0/1
					Hyperolius nasicus	0/1
					Kassina cf. *senegalensis*	0/1
					Phrynobatrachus cf. *natalensis* 1	0/1
					Ptychadena cf. *nilotica* 1	0/1
					Xenopus muelleri	0/1
Road southwest of Pweto	6 January 2010	8.67782°S, 28.59540°E	1326	Woodland/savanna mosaic	Hyperolius sp.	0/1
Kabongo	6–7 January 2010	8.73308– 8.74190°S, 28.20122– 28.21673°E	1010–1014	Woodland/savanna mosaic	*Afrixalus* cf. *wittei*	0/1
					Hemisus wittei	0/1
					Hyperolius cf. *kivuensis*	1/2
					Hyperolius cf. *viridiflavus*	0/1
					Ptychadena cf. *nilotica* 2	0/1
					Xenopus laevis	0/1
Road 10 km W of Kabongo	11 January 2010	8.70777°S, 28.12780°E	1050	Woodland/savanna mosaic	*Hyperolius* cf. *viridis*	0/1
Kasongomwana	11 January 2010	8.72790°S, 27.85068°E	1157	Woodland/savanna mosaic	*Amietia* sp. 2	0/1
					Hyperolius cf. *friedemanni*	0/1
					Hyperolius cf. *viridiflavus*	0/1
Road ca. 17 km W of Mitwaba	12 January 2010	8.71895°S, 27.42265°E	1445	Woodland/savanna mosaic	*Phrynobatrachus* cf. *natalensis* 2	1/1
Mitwaba	13 January 2010	8.62670°S, 27.33922°E	1568	Woodland/savanna mosaic	*Arthroleptis* cf. *stenodactylus*	
					Leptopelis parbocagii	2/2
Kakunko	15 January 2010	8.47412°S, 27.31540°E	1570	Woodland/savanna mosaic	*Ptychadena* cf. *perreti*	0/1
					Ptychadena cf. *uzungwensis*	1/1
Mayola River, ca. 3 km E of Kakunko	15 January 2010	8.46575°S, 27.33070°E	1428	Woodland/savanna mosaic	*Amietia* sp. 3	1/1
Road in Kibara Mountains	16 January 2010	8.40577°S, 27.28212°E	1328	Woodland/savanna mosaic	*Amietophrynus maculatus*	0/1
					Hyperolius quinquevittatus	1/1

(*Continued on next page*)

TABLE 1. Continued.

Site	Date	Coordinates	Elevation (m)	Habitat	Species	Infected/Tested
Ntambo	16 January 2010	8.31080°S, 27.25517°E	1069	Woodland/savanna mosaic	*Arthroleptis* cf. *stenodactylus*	0/1
Kyolo	17 January 2010	8.01388°S, 27.11285°E	560	Marsh in woodland/ savanna mosaic	*Amietophrynus lemairii*	0/1
					Hoplobatrachus occipitalis	0/1
					Phrynobatrachus cf. *latifrons*	0/1
Mulongo	18 January 2010	7.65509°S, 27.34027°E	875	Woodland	*Arthroleptis* cf. *stenodactylus*	0/2
7 km S of Manono	19 January 2010	7.27773°S, 27.38977°E	627	Woodland/savanna mosaic	*Hemisus wittei*	0/1
					Hildebrandtia ornata	0/1
					Hyperolius sp.	0/1
					Leptopelis parbocagii	0/1
					Xenopus laevis	0/1
Manono	19 January 2010	7.29363°S, 27.39472°E	634	Woodland/savanna mosaic	*Arthroleptis* cf. *stenodactylus*	0/1
Luvua River near Kiambi	20 January 2010	7.33818°S, 28.00878°E	575	River in woodland/ savanna mosaic	*Afrixalus* cf. *wittei*	0/1
Road south of Nyunzu	21 January 2010	6.51240°S, 28.05652°E	799	Woodland/savanna mosaic	*Hemisus marmoratus*	0/1

genus had a high prevalence of infection in Katanga Province. Our results are consistent with several other studies that have documented *Bd* infections in *Amietia* populations elsewhere in Africa (Conradie et al. 2011a,b; Greenbaum et al., *in press*; Kielgast et al. 2010; Viertel et al. 2012; Zancolli et al. 2013). The relatively low prevalence of *Bd* infection in the presumably direct-developing species *Arthroleptis* cf. *stenodactylus* in Katanga is also consistent with previous studies that tested *Arthroleptis* (Bell et al. 2011; Conradie et al. 2011a; Doherty-Bone et al. 2013; Olson et al. 2013) and the presumably direct-developing genus *Balebreviceps* in Ethiopia (Gower et al. 2012).

With the exception of *Hemsius wittei* and *Hyperolius nasicus* (both data deficient), all other recognized species in our study are considered to be "least concern" under the IUCN Red List Criteria (IUCN 2013). However, 18 of the taxa we studied (labeled as "cf." or "sp." in Table 1) are genetically and/or morphologically distinct from their closest named relatives (EG, unpubl. data), and are likely to be threatened because of relatively small geographic distributions. Like many other surveys for *Bd* in Africa (reviewed in Greenbaum et al., *in press*), we did not find any dead or dying frogs, suggesting chytridiomycosis was not causing massive "die offs" in Katanga during the time of this study. As first documented by Greenbaum et al. (*in press*) in the Albertine Rift of DRC, several *Bd*-positive frogs (*Hyperolius* cf. *kivuensis*, *H. nasicus* and *Kassina* cf. *senegalensis*) in Katanga were calling for mates. The parasite load of these calling males is unknown (see below), but it is unlikely that they could expend the energy to attract mates if their infections were severe.

Because our sampling was opportunistic and sample sizes for species and localities were relatively low, it is likely that some *Bd*-positive frogs were not detected in our study (Skerratt et al. 2008). We acknowledge that our results could have been affected by the lack of gloves during capture of frogs in the field, or by housing individuals of the same species together. However, because there are some cases in our data set where *Bd*-negative frogs were collected after *Bd*-positive frogs during a given collection event, the possibility of cross contamination during capture is likely minimal (see also Greenbaum et al., *in press*). We did not attempt to calculate zoospore genomic equivalent estimates, which precludes comparisons of parasite loads to some previous studies. Our results (and probably many other previous studies—see Zancolli et al. 2013) were likely affected by unavoidable exposure of stored swabs to high temperatures (as high as 45°C ambient temperature) during transportation between field sites. Van Sluys et al. (2008) demonstrated that high temperatures can significantly decrease the ability of PCR-based assays to detect *Bd* fungus and quantify associated zoospore loads. Because of these concerns and likely seasonal fluctuations in *Bd* infection (e.g., Conradie et al. 2011b), we recommend that future surveys test Katanga amphibians during cooler times of the year. Given the large number of endemic amphibian species in Katanga (Laurent 1957; Schmidt and Inger 1959; Poynton 1998) and the confirmed presence of *Bd*-positive frogs in the region, additional monitoring should continue to ensure that Katanga's amphibian populations are stable.

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Prevalence of *Batrochochytrium dendrobatidis* in Three Frog Species of the Bighorn National Forest, Wyoming, USA

We determined the prevalence of *Batrochochytrium dendrobatidis* (*Bd*) in three species of conservation concern, *Lithobates pipiens*, *Rana luteiventris*, and *Lithobates sylvaticus*, in the Bighorn National Forest, Wyoming, USA (Fig. 1). The Bighorn Mountains in north-central Wyoming consist of over 450,000 ha of national forest, ranging in elevation from 1500 to 4000 m (http://www.fs.usda.gov/main/bighorn). The Bighorn National Forest is a geographically isolated region that includes a variety of aquatic habitats, such as lakes, ponds, and marshes. The Northern Leopard Frog (*Lithobates pipiens*) has shown distinct range reduction (thought to be caused by habitat degradation and urbanization) in a portion of the range that includes Wyoming, making the Northern Leopard Frog a species of conservation concern (Smith and Keinath 2007). Populations of Columbia Spotted Frog (*Rana luteiventris*) in the Bighorn Mountains are of conservation concern because the species exists as relict populations which are genetically isolated and distinct from the rest of the species' range (Dunlap 1977; Patla and Keinath 2005). The Wood Frog (*Lithobates sylvaticus*) is of conservation concern in Wyoming because it occurs as relict, genetically isolated populations in the Bighorn Mountains, where it is known from only a few localities (Dunlap 1977; Muths et al. 2005). Results of our study will aid future management decisions in the Bighorn National Forest for these three species.

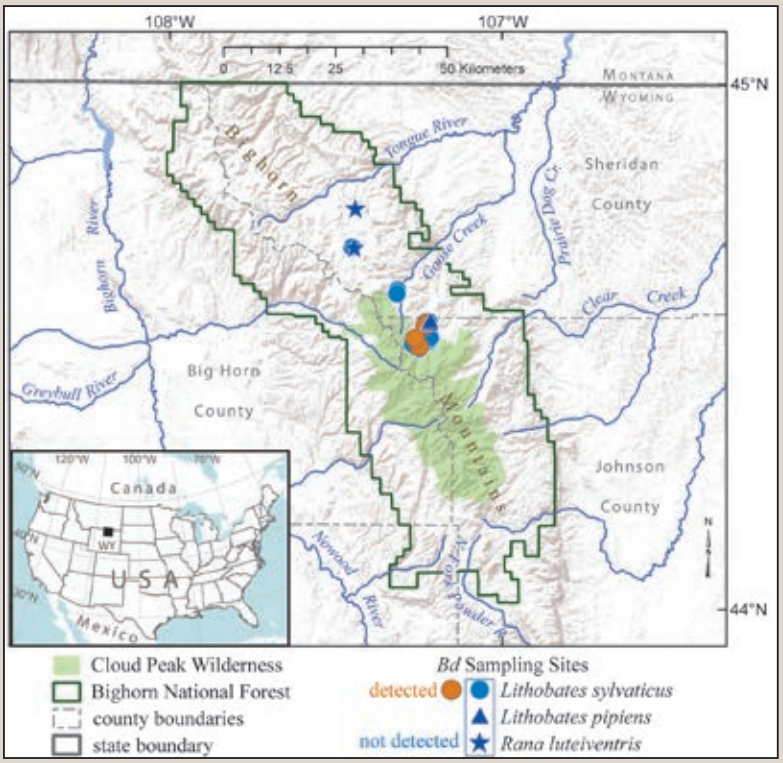


FIG. 1. Locations and infection level of *Lithobates sylvaticus, Lithobates pipiens,* and *Rana luteiventris* in the Bighorn National Forest, Wyoming, USA.

We conducted amphibian surveys from 3–16 August 2010 in the northern portion of the Bighorn Mountains, Johnson County, Wyoming. The majority of the study area was within the northern portion of the Cloud Peak Wilderness of the Bighorn National Forest. The study site included four localities comprised of six previously known frog sites (Dunlap 1977) and 38 new sites within the Cross Creek, Big Goose Creek, and Edelman Creek drainages and surrounding areas. We surveyed ponds, lakes, and wet meadows that were discovered opportunistically or upon review of topographic maps.

We captured metamorphic, sub-adult, and adult frogs by hand or by dip net. Upon capture, we identified species, measured body length (mm) using a ruler, determined age class based on body length reports from the literature, and determined sex based on the presence of nuptial pads on adult males. We swabbed frogs for *Bd* according to the Colorado Division of Wildlife Protocol (Livo 2004). To prevent cross-contamination, we used sterile technique, including changing gloves between captures and disinfecting all equipment between sites according to the Colorado Division of Wildlife Protocol (Livo 2004). We returned samples to Truman State University for analysis using a nested polymerase chain reaction (PCR) adapted from Gaertner et al (2009). We included one positive and one negative control reaction per eight samples for both rounds of PCR, and presence of a 300 bp band in a field-collected sample indicated an individual infected with *Bd*.

We captured and swabbed 107 Wood Frogs, 30 Columbia Spotted Frogs, and four Northern Leopard Frogs. Infection level varied across species, with zero spotted and leopard frogs infected and 6.5% (7/107) Wood Frogs infected (Fig. 1). Within Wood Frogs, there was no significant effect of elevation (Regression; $F_{1,104} = 1.16$, $p = 0.284$), sex (Fisher's Exact Test; OR = 1, $p = 0.313$), or age class (Fisher's Exact Test; OR = 0.426, $p = 0.663$) on *Bd* infection. During field sampling, we did not observe any animals with symptoms of the disease chytridiomycosis.

Overall, within the Big Horn National Forest, Wyoming we detected a relatively low level of *Bd* infection in the three native frog species with conservation concern. However, with only four leopard frogs sampled, it is possible for a relatively high infection

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rate to go undetected (Skerratt et al. 2008). The low rate of infection in Wood Frogs, for which we had a more robust sample, is encouraging for the species. Nevertheless, monitoring of these geographically isolated populations is recommended because the disease-host dynamics are not well known and these animals represent unique diversity.

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First Record of *Batrachochytrium dendrobatidis* in the Arizona Toad (*Anaxyrus microscaphus*) in Southwestern New Mexico, USA

The fungal pathogen *Batrachochytrium dendrobatidis* (*Bd*), which causes the disease chytridiomycosis, is geographically widespread across the United States (Lannoo et al. 2013; Olson et al. 2013). Chytridiomycosis has caused the decline of some North American species (e.g., Southern Mountain Yellow-legged Frog, *Rana muscosa*; Briggs et al. 2010; Vredenburg et al. 2010), yet other species seem relatively unaffected by *Bd* infection (e.g., American Toad, *Anaxyrus americanus*; Longcore et al. 2007). Many arid and desert-adapted amphibian species in the southwest U.S. such as *Rana chiricahuensis*, (Chiricahua Leopard Frog) have experienced declines and are now considered to be high conservation priorities (Bradley et al. 2002; Schlaepfer et al. 2007; Olson et al. 2013). The role of chytridiomycosis in these declines has not been determined but is important to resolve in order to identify vulnerable species that require conservation intervention.

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Within New Mexico, four amphibian species have declined to critically low levels: *R. chiricahuensis, R. pipiens* (Northern Leopard Frog), *R. yavapaiensis* (Lowland Leopard Frog), and *Anaxyrus boreas* (Western Toad). In neighboring states where these species occur, declines have been attributed to chytridiomycosis (Bradley et al. 2002; Muths et al. 2003; Lannoo et al. 2011); hence it is suspected that *Bd* is contributing to the New Mexico declines as well. Recent investigations have found that 53% (9 of 17) of tested species of New Mexican amphibians have tested positive for *Bd* (Painter et al., unpubl.), but there is still not a clear understanding of the distribution and prevalence of *Bd* in New Mexican amphibians (Olson et al. 2013; Painter et al., unpubl.).

The Arizona Toad, *Anaxyrus microscaphus* (Fig. 1), is a riparian species that occurs in scattered populations in Arizona, Nevada, Utah, and New Mexico (Schwaner and Sullivan 2005). Previous studies have indicated that declines of *A. microscaphus* may be due to hybridization between *A. microscaphus* and *A. woodhousii* (Woodhouse's Toad) in Arizona, Nevada, and Utah (Sullivan 1995; Schwaner and Sullivan 2009) and altered water



FIG. 1. An adult *Anaxyrus microscaphus* calling along Little Creek, New Mexico, USA on 29 March 2013.

flow regimes from dam construction and habitat modification (Bradford 2002; Hammerson and Schwaner 2004). To date, *Bd* has not been detected in *A. microscaphus*, and it is unknown if *Bd* poses a yet unrecognized threat to this species.

During a 2013 study of *A. microscaphus* in southwestern New Mexico, we sampled 25 *A. microscaphus* for *Bd* from four sites in the Gila National Forest (Fig. 2): Hells Hole (33.787°N, 108.694°W; 1915 m elev.; Catron Co., nine samples), San Francisco River (33.344°N, 108.902°W; 1461 m elev.; Catron Co., two samples), Little Creek, (33.194°N, 108.220°W; 1724 m elev.; Grant Co., 12 samples), and the upper Mimbres River (33.040°N, 107.980°W; 2081 m elev.; Grant Co., three samples) (Fig. 2). In addition, we monitored *A. microscaphus* at Little Creek weekly from 28 March to 15 May 2013. Previously, 11 years earlier, on 3 June 2002, following a mass die-off of the threatened species *R. chiricahuensis*, two *A. microscaphus* individuals were sampled for *Bd* at the die-off location in the vicinity of Six-shooter Tank (33.518°N, 108.699°W; 2430 m elev.). Following standardized field protocols, we collected and stored *Bd* swab samples in 95% ethanol and a -80°C freezer until processing (Boyle et al. 2004; Hyatt et al. 2007). Samples were submitted in batches of six to Pisces Molecular Laboratory (Boulder, Colorado, USA) for pooled analyses of *Bd* DNA using qPCR.

Bd was detected from one of two batch samples of *A. microscaphus* collected from Little Creek (collected on 29 March 2013). Samples from Hells Hole, upper Mimbres River, and San Francisco River were *Bd*-negative. One *Bd*-positive *A. microscaphus* individual was found at the site of the 2002 die-off of *R. chiricahuensis*. During the March to May 2013 field observations of *A. microscaphus* at Little Creek site, we observed breeding activity among a maximum of 21 toads (15 males, 6 females), including male calling, and pairs in amplexus and laying eggs. We did not observe sick or dead *A. microscaphus* during this monitoring, or during handling for swab collection and measurements at any location.

These *Bd*-positive results from New Mexico are the first records of *Bd* in *A. microscaphus*. Both records are from the Gila National Forest, which encompasses much of the range of *A. microscaphus* in New Mexico (Degenhardt et al. 1995). *Bd* was previously detected on amphibians in the Mogollon Rim of Arizona and New Mexico (Painter et al., unpubl.).

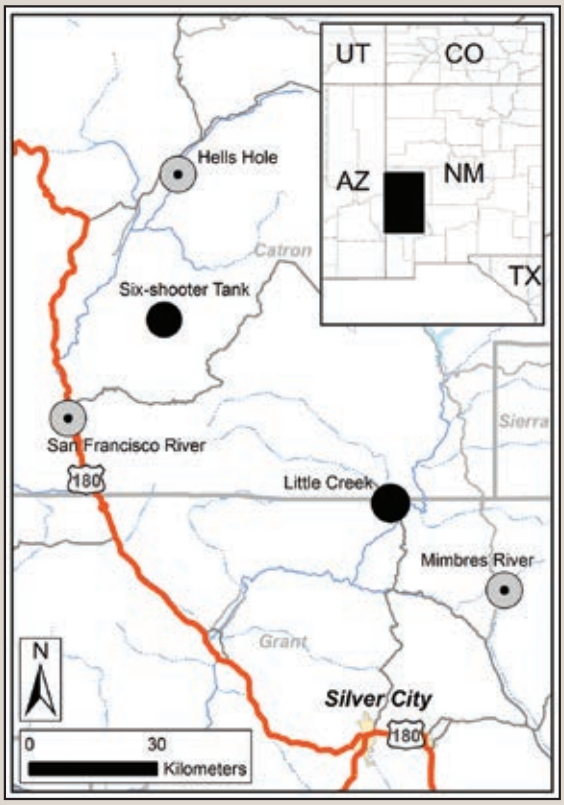


FIG. 2. Distribution of localities in two counties of southwestern New Mexico from which Arizona Toads *(Anaxyrus microscaphus)* were examined for *Batrachochytrium dendrobatidis (Bd)*. Filled circles indicate sites that tested positive, whereas open circles with a dot indicate sites where *Bd* was not detected.

Although *Bd* has been detected in its range, the role of *Bd* in population declines of *A. microscaphus* remains unknown. Populations of *A. microscaphus* have declined in areas of New Mexico where hybridization and altered stream flows from water impoundments are not a threat (Ryan et al., unpubl.), and remain enigmatic. To our knowledge, no mass die-offs characteristic of a *Bd* outbreak have been observed in *A. microscaphus* in Arizona and New Mexico (Bradley et al. 2002), but the possibility of *Bd* as a threat cannot be ruled out. Further studies utilizing museum specimens and reviews of unpublished data and reports may fill in gaps of possible die-offs and the prevalence of *Bd* in *A. microscaphus*.

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On the Thermal Husbandry of Monitor Lizards

Thermal husbandry, the range of temperatures offered to reptiles in captivity, is one of the most basic, yet critical aspects of herpetological husbandry. As poikilothermic ectotherms, reptiles are unable to physiologically maintain constant body temperatures and must instead thermoregulate behaviorally by utilizing the range of temperatures available to them within their environment (Cowles and Bogert 1944; Bogert 1949, 1959). Because reptiles vary considerably in their thermal tolerances, preferences and thermoregulatory strategies, providing taxon-specific husbandry consistent with a species' ecology and thermal biology should be a primary focus of reptile collections and caregivers (Peaker 1969; Arena and Warwick 1995; Lillywhite and Gatten 1995). Although the general importance of providing appropriate thermal gradients in herpetological husbandry has long been emphasized (Peaker 1969; Arena and Warwick 1995), specific data on the thermal biology of most species are lacking, and as a result, captive environments may not provide the diversity and range of microclimates and microhabitats needed by reptiles to thermoregulate properly (Arena and Warwick 1995). Inappropriate thermal regimes, in turn, can have deleterious effects on the health and welfare of captive reptiles (Arena and Warwick 1995; Lillywhite and Gatten 1995).

Monitor lizards (family Varanidae, genus *Varanus*) occur throughout Africa, Asia, and Australia, and occupy a variety of habitats ranging from arid deserts to tropical lowland forests and mangrove swamps (Pianka and King 2004). Largely due to their size, activity levels, and observable intelligence, varanids are frequently maintained in zoos and private collections, where more than 55 species are currently kept in captivity (Eidenmüller 2007; Brown 2012). Despite having been maintained in numerous collections dating back more than 150 years, captive varanids continue to present significant husbandry challenges, with both zoos and private collections experiencing limited long-term maintenance and reproductive success relative to the number of specimens that have been kept (Bennett 1989, 1994; Bennett and Thakoordyal 2003; Mendyk, unpubl.). Recent assessments suggest that many varanid species may not be reaching their full lifespan potentials in captivity (Mendyk, unpubl.), and several authors have identified and discussed problematic areas of their captive management and reproduction (Horn and Visser 1989; Boyer and Boyer 1997; Horn and Visser 1997; Hartdegen 2002; Spelman 2002; Horn 2004; Mendyk et al. 2013). Of the various factors known to affect the health and welfare of varanid lizards in captivity, inappropriate thermal husbandry appears to be one of the most significant, yet highly overlooked issues (Bennett and Thakoordyal 2003; Mendyk et al. 2013). Inadequate thermal husbandry may not be easily recognized or understood, and as a result, some zoos, private herpetoculturists, and research laboratories may not be providing captives with the appropriate conditions needed to thrive.

In this article, we review several aspects of the thermal biology of wild varanid lizards and discuss how these parameters may relate to, and influence their maintenance in captivity. From a historical perspective, we highlight a significant paradigm shift in their thermal husbandry, and discuss how changing attitudes towards their captive management over the last few decades have helped improve keeping and reproductive success. Lastly, we discuss the implications and potential consequences that inadequate thermal husbandry can have on biological research.

The Thermal Biology of *Varanus*

Varanids are unique among extant lizards regarding various aspects of their physiology. Relative to other reptile groups, varanids possess remarkably high aerobic capacities and unique lung morphology, with some of the highest rates of oxygen consumption documented among non-avian reptiles (Bartholomew and Tucker 1964; Bennett 1972; Earll 1982; Becker et al. 1989; Schachner et al. 2014). This, coupled with metabolic rates greater than many other reptiles and efficient behavioral control over heating and cooling, enables them to operate over a much wider temperature range and sustain greater activity levels than other lizards (Earll 1982; Auffenberg 1994; Thompson and Withers 1997; Thompson 1999; Sweet and Pianka 2007). The thermal biology of varanids has been a subject of much interest among researchers, and various aspects of their thermoregulation have been studied in depth through field (e.g., radiotelemetry, mark-recapture) and laboratory investigations over the past several decades (Bartholomew and Tucker 1964; Licht et al. 1966; Stebbins and Barwick 1968; Johnson 1972;

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Brattstrom 1973; Sokolov 1975; McNab and Auffenberg 1976; Meek 1978; King 1980; Auffenberg 1981, 1988, 1994; Gleeson 1981; Buffenstein and Louw 1982; Earll 1982; King et al. 1989; Wikramanayake and Green 1989; Green et al. 1991; Thompson and Withers 1992, 1997; Wikramanayake and Dryden 1993, 1999; Christian and Weavers 1994; Traeholt 1995; Christian and Bedford 1996; Christian and Weavers 1996; Christian et al. 1996; Thompson 1997; King and Green 1999; Thompson et al. 1999; Walsh et al. 1999; Wikramanayake et al. 1999; Ibrahim 2000; Heger and Heger 2007; Smith et al. 2008; Harlow et al. 2010).

Field studies have shown that active varanid lizards have preferred, or average body temperatures (Tbs) which exceed those of many other lizard groups. With the exception of a few semi-aquatic species (*Varanus salvator*, *V. mertensi*, *V. niloticus* and *V. indicus*) which seem to prefer to maintain lower Tbs between 28.9 (84°F) and 34°C (93.2°F) (Wikramanayake and Green 1989; Traeholt 1995; Muhigwa 1998; King and Green 1999; Smith et al. 2008), the majority of varanid species looked at maintain optimal Tbs between 35 (95°F) and 39°C (102.2°F) (Licht et al. 1966; Stebbins and Barwick 1968; Pianka 1970, 1994a; King 1980; Vernet et al. 1988; King et al. 1989; Wikramanayake and Dryden 1993; Christian and Bedford 1996; Christian and Weavers 1996; King and Green 1999; Heger and Heger 2007), but for short periods can withstand core body temperatures above 40°C (104°F) (Auffenberg 1994; Pianka 1994a; King and Green 1999; King et al. 1999; Thompson et al. 1999; Ibrahim 2000). The critical thermal maximum - the core body temperature at which death occurs - has been studied in several species including *V. komodoensis*, *V. olivaceus* and *V. bengalensis*, and ranges between 41.6 (106.9°F) and 44.6°C (112.3°F) (McNab and Auffenberg 1976; Auffenberg 1981, 1988, 1994).

Although morphologically conservative, varanid lizards do exhibit considerable variation in body size between species, ranging in mass by nearly five orders of magnitude (Pianka 1995). Given this disparity, thermoregulation within the genus is heavily influenced by thermal inertia associated with body size (Brattstrom 1973; Harlow et al., 2010). Larger taxa, particularly *V. komodoensis*, semi-aquatic species such as *V. salvator*, *V. niloticus*, *V. mertensi*, and *V. indicus*, and dense forest-dwelling species such as *V. olivaceus* , typically maintain lower, but relatively stable body temperatures throughout the day and night (Auffenberg 1981, 1988; Wikramanayake and Green 1989; Wikramanayake and Dryden 1993; King and Green 1999; Smith et al. 2008). Adult individuals of some larger species can be independent of external heat input for several hours once their preferred Tbs are reached (Wikramanayake and Dryden 1993; Harlow et al. 2010), and some species can maintain relatively stable Tbs in nocturnal retreats and emerge the following morning with body temperatures warmer than ambient air conditions (Auffenberg 1981; Pianka and Vitt 2003). A lower thermal conductance in semi-aquatic species such as *V. salvator* is also believed to enable these animals to more effectively maintain stable Tbs while foraging, traveling, and sheltering in aquatic environments (King and Green 1999).

Not all larger varanids fit this general model. Adult *V. giganteus* (to 2 m in total length [TL]) and *V. bengalensis* (to 1.4 m TL) both experience considerable fluctuations in body temperature throughout the day (Wikramanayake and Dryden 1999; Heger and Heger 2007). In contrast to *V. komodoensis* and *V. salvator*, *V. bengalensis* and many smaller taxa have a higher thermal conductance which enables them to heat up and cool down more quickly, and also tend to experience greater daytime fluctuations in body temperature, that drop considerably at night (Wikramanayake and Green 1989; Wikramanayake and Dryden 1993; King and Green 1999). For this reason, smaller taxa and juveniles of larger species usually require a greater degree of shuttling between shaded and sunlit areas to achieve and maintain preferred Tbs throughout the day (King and Green 1999; Wikramanayake et al. 1999; Harlow et al. 2010).

To achieve and maintain body temperatures that are usually greater than that of the ambient air, varanids require access to fairly high surface basking temperatures (Pianka 1970). Although some varanids have been shown to increase body temperatures through metabolic activity (Bartholomew and Tucker 1964), such increases are negligible and not considered to be a significant factor in thermoregulation (Auffenberg 1981, 1988). As heliotherms, they typically elevate their body temperatures by increasing exposure to solar radiation, but also absorb significant conductive heat through physical contact with substrates, surfaces and shelters heated by the sun. Auffenberg (1994) noted that in open areas, radiation from heated substrates can have a greater impact on thermoregulation in varanids than solar radiation. Unfortunately, few field studies have investigated the actual surface temperatures selected by varanids for basking; therefore, specific data are scarce (Pandav and Choudhury 1996; Ibrahim 2000; Auliya 2006).

It is well established that daytime surface temperatures in sun-exposed environments inhabited by varanids usually exceed both ambient air temperatures and the animals' preferred body temperatures (Auffenberg 1981, 1988, 1994). For example, in open habitats utilized by *V. komodoensis*, daytime substrate temperatures can reach over 50°C (122°F) (Auffenberg 1981). In northern India, Auffenberg (1994) noted that ground temperatures in *V. bengalensis* habitat exceeded 60°C (140°F) for 72% of the species' activity period, and in varanid habitats of northern Australia, surfaces receiving full radiant energy from the sun can exceed 70°C (158°F) (Christian and Weavers 1996). While these temperatures would prove lethal if individuals were continuously exposed to them, varanids tend to only enter sunlit areas for brief periods for basking or while foraging. Wild *V. tristis orientalis* have been observed basking on rocks in exposed sunlit areas with recorded surface temperatures of 60°C (140°F) (J. Lemm, unpub. dat.), and wild *V. varius* have been observed basking atop sun-exposed leaf litter with recorded surface temperatures of 56°C (132.8°F) (D. Kirshner, pers. comm.; Fig. 1). Captive *V. semiremex* maintained outdoors under natural climatic conditions regularly sought out sunlit branches for basking, with surface temperatures as high as 56°C (132.8°F) (Jackson 2005). These limited data suggest that many varanid species select and utilize surface basking temperatures that are far greater than their preferential range of body temperatures.

Basking in exposed areas poses serious risks of predation for many heliothermic reptiles. Minimizing the time spent basking can be advantageous in terms of predator avoidance (Krebs 1999; Wikramanayake and Dryden 1999), and can also allow more time for other important activities such as foraging (Auffenberg 1988; Wikramanayake and Dryden 1999). Therefore, with access to a range of microhabitats and microclimates within their environment, varanids and other heliothermic reptiles can be expected to select greater temperatures for basking in order to facilitate a quicker transition to their optimal body temperatures (Krebs 1999).

Reptiles, including varanids, also regulate their body temperatures by seeking out cooler microhabitats. Accessing

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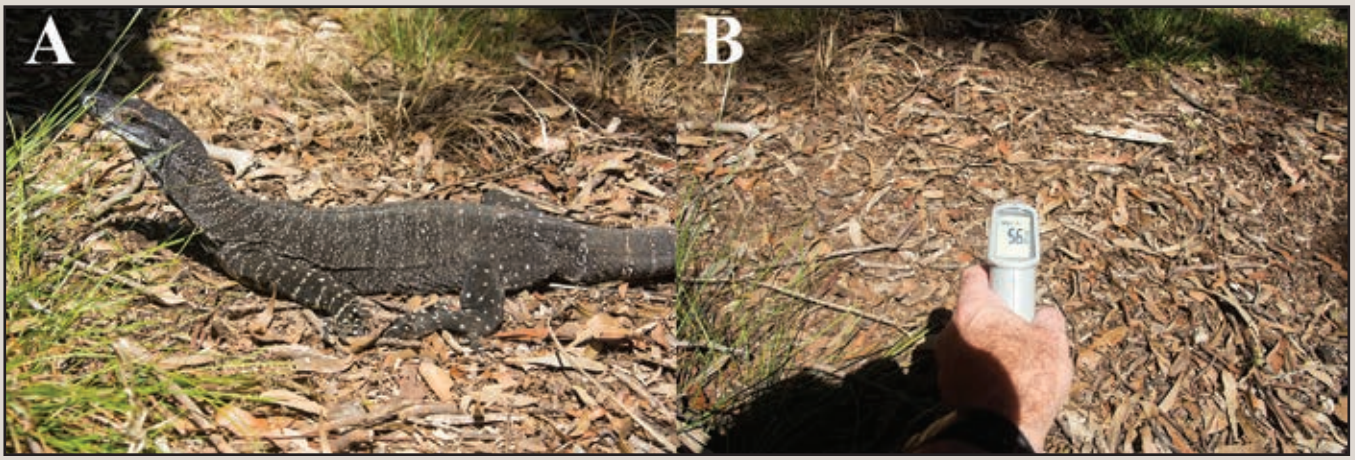


FIG. 1. A) Wild adult *Varanus varius* basking atop leaf litter in a forested area outside Sydney, New South Wales, Australia at 1500 h. B) Surface temperature of the basking site (56°C [132.8°F]; air temperature 26°C [78.8°F]) was recorded immediately after the lizard fled the area (D. Kirshner, pers. comm.).

cooler temperatures can serve as an energy-conserving measure (Huey and Stevenson 1979; Nagy 1983), a way to escape potentially life-threatening temperature extremes, or as a method of reducing evaporative water loss (Avery 1994). Depending on species and habitat, varanids employ various strategies for reducing body temperatures which include entering water (Auffenberg 1994; King and Green 1999; Auliya 2006), moving to shaded areas (Auffenberg 1994; King and Green 1999), seeking out breezy locations (Auffenberg 1994; Heger and Heger 2007), elevating their bodies up off of hot surfaces to increase convection to cool breezes (Heger and Heger 2007), resting atop cool, moist substrates (Auffenberg 1994), retreating to burrows and other refugia (Warburg 1965a; Auffenberg 1981, 1994; Christian and Weavers 1996), and gular pumping (Johnson 1972; Owerkowicz et al. 1999). Some species, particularly those inhabiting arid environments with limited vegetation and cover can be heavily reliant on burrows for regulating and lowering body temperature; for example, studies on the ecology of *V. gouldii* have shown that temperatures inside burrows can be more than 18°C (32.4°F) cooler than aboveground conditions (Warburg 1965a).

THERMAL HUSBANDRY OF *VARANUS*

Successful herpetological husbandry demands that the biological requirements of a species are met, and that the environmental conditions provided in captivity replicate, as closely as possible, those available and familiar to a species in nature (Arena and Warwick 1995; Guillette et al. 1995; Lillywhite and Gatten 1995). Although some reptile species may do well in captivity when provided with minimalistic or "reductionist" husbandry conditions, such conditions are probably inappropriate for most species as they offer less potential to fulfil biological needs (Warwick and Steedman 1995). Given what is known about the ecology and thermal biology of free-living varanid lizards, it is clear that captive specimens require a broad range of temperatures and humidity levels that can be selected as needed to satisfy various physiological needs. However, multiple lines of evidence from the literature suggest that historically, varanids as a whole have not been provided with sufficient thermal conditions in captivity.

From a health perspective, several diseases and complications observed in captive varanids can be linked to inadequate thermal husbandry. Obesity, which is often attributed to excessively rich captive diets in reptiles (Donoghue and Langenberg 1996; Brown 2012), is common among varanid lizards (Boyer and Boyer 1997; Bennett 1998; Bennett and Thakoordyal 2003), but may have deeper roots in chronic exposure to low temperatures (Anonymous 1997, 1998a; Good 1999; Vincent and Wilson 1999; Lemm 2001; Bennett and Thakoordyal 2003). Under conditions in which eating is possible but activity levels and metabolisms are impaired by cooler temperatures, energy from food may be stored as fat, rather than allocated towards growth or reproduction (Bennett and Thakoordyal 2003), and several authors have argued that captive varanids, especially younger individuals, rarely become obese when provided with an appropriate range of temperatures to facilitate efficient digestion, even when offered large quantities of food (Anonymous 1997, 1998a; Retes, in Good 1999; Bennett and Thakoordyal 2003). Although empirical studies are lacking, chronic exposure to inadequate temperatures is also suspected of being etiologically linked to common metabolic disorders of captive varanids such as gout (Mendyk et al. 2013), weakened immune systems (Mendyk et al. 2013), and gastrointestinal diseases (Bacon 1976; Brown 2012).

From an ethological standpoint, captive varanids have rarely exhibited the same levels of activity as their wild counterparts, and their overall behavior in captivity has been described as lethargic by several authors. For instance, Barbour (1943) and Marcellini (quoted in Cohn 1994) both characterized varanids as "phlegmatic" in captivity, and Oliver and Spencook (1956) likened two *V. komodoensis* at the Bronx Zoo to "lethargic dogs". Murphy (1969) remarked that few captives exhibited the "characteristic alertness and activity associated with wild specimens", and that their lethargy was "depressing even to the casual zoo visitor". More recently, Gupta (1997) reported that captive *V. bengalensis* spent an average of 68.2% of their activity period basking, and Walsh et al. (1999) recognized that captive *V. komodoensis* "did not become completely inactive", but never exhibited the foraging activity levels characteristic of wild individuals. Descriptors such as these contradict what has generally been observed in, and reported for wild varanid lizards, which tend to be highly alert and active by nature, with several species known to travel expansive distances each day (Stebbins and Barwick 1968; Auffenberg 1981; Pianka 1994b). While spatial constraints and associated boredom may play some contributing roles in the behavior of captive varanids,

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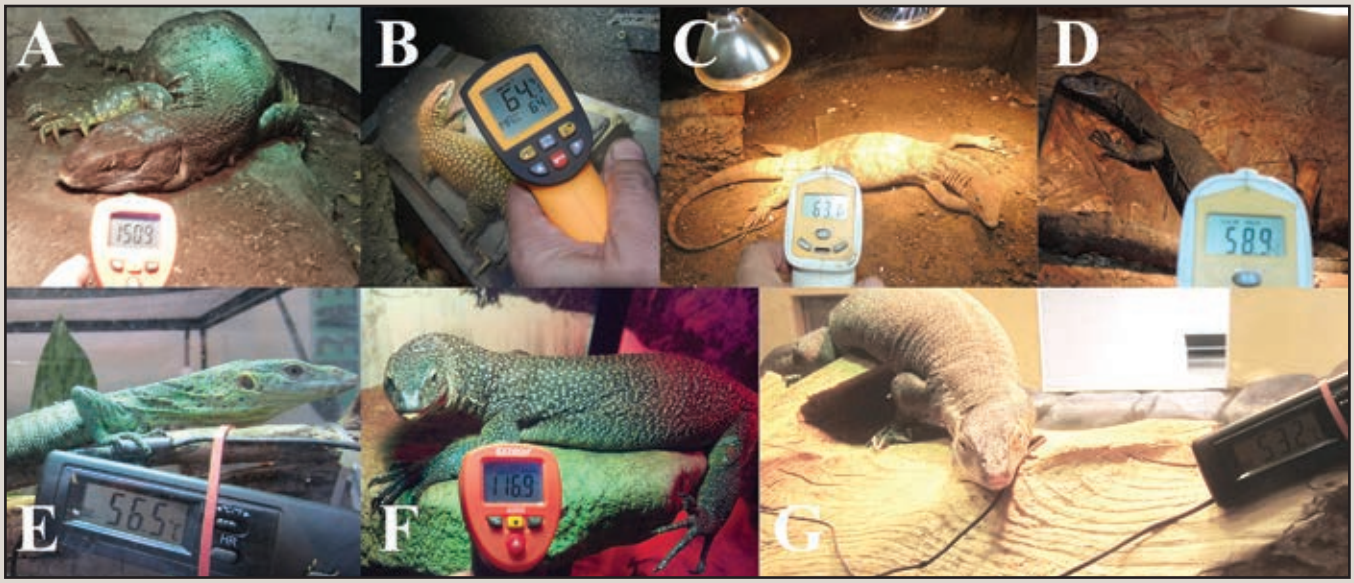


FIG. 2. Examples of elevated surface basking temperatures selected and utilized by different varanid species in captivity. A) *Varanus albigularis* (66.1°C [150.9°F]), private collection; B) *V. acanthurus* (64.1°C [147.4°F]), private collection; C) *V. griseus* (63.1°C [145.6°F]), private collection; D) *V. salvator macromaculatus* (58.9°C [138°F]), private collection; E) *V. prasinus* (56.5°C [133.7°F]), Smithsonian National Zoological Park; F) *V. indicus* (47.2°C [116.9°F]), private collection; G) *V. mertensi* (53.2°C [127.8°F]), Smithsonian National Zoological Park.

lethargy and prolonged basking activity are largely symptomatic of animals experiencing difficulties achieving and maintaining preferred body temperatures (Arena and Warwick 1995).

Despite signs of inadequate thermal husbandry being present in captive collections for decades, there appears to have been little concern or inquiry into why captives behaved markedly different than their wild counterparts, and even less testing and experimentation with the actual thermal preferences and tolerances of specimens in captivity. Surprisingly, many published accounts describing varanid husbandry over the past several decades have not included the specific basking temperatures (Moehn 1984; Sprackland 1989, 2007; Chippendale 1991; Kok 1995; Card 1996; De Lisle 1996; Mehaffey and McGinnity 1996; Wick 1996; Bayless and Dwyer 1997; Kala 1998; McDonald 1999; Hairston-Adams and Reed 2000; Dwyer and Bayless 2001; Eidenmüller 2005; Ryman 2009) or thermal gradients (Moehn 1984; Kala 1998; Eidenmüller 2005, 2007) offered to, or recommended for captives. This general lack of attention or concern for specific basking temperatures and thermal gradients suggests that thermal husbandry has largely been overlooked as an important component of varanid husbandry, especially when compared to other frequently discussed keeping parameters such as enclosure dimensions, diets, lighting, and photoperiod.

Earlier husbandry accounts that have cited specific temperatures often described or recommended surface basking temperatures of 35–40°C (95–104° F) and below (Murphy 1969, 1971, 1972; Behrmann 1981; Barker 1984; Erdfelder 1984; Davis et al. 1986; Radford and Paine 1989; Thissen 1993; Card 1995; Fost 1996; Holmstrom 1996; O'Dell 1996; Strimple 1996; Hartdegen 1998; Kirschner 1999; Gorman 2000; Lee 2000; Lee and Friedman 2000; Grützner 2003). Considering that the preferred active body temperatures of most wild varanid lizards appear to exceed 35°C (95°F), and that active body temperatures over 40°C (104°F) are not uncommon in free-ranging individuals (Auffenberg 1981,1994; King et al. 1989; King and Green 1999; Thompson et al. 1999), surface basking temperatures of 40°C (104°F) and below may prohibit captives from reaching their preferred body temperatures, or prevent them from doing so within a reasonable timeframe. These values also contradict the surface temperatures generally experienced and utilized by varanids under natural conditions, which frequently exceed 50°C (122°F) (Auffenberg 1981, 1994; Christian and Bedford 1996; Christian and Weavers 1996; Jackson 2005; J. Lemm, unpub. dat., D. Kirshner, pers. comm.; Fig. 1). In some published accounts where thermal gradients have been discussed, ranges of less than 10°C (18°F) have been reported (Barker 1984; Zimmermann 1986; Radford and Paine 1989; Sprackland 1989; Card 1995; Kok 1995; Bayless and Dwyer 2001). Considering the heterogeneity of climatic and physical conditions present in wild varanid habitats (Warburg 1965a; Auffenberg 1981, 1988), such limited thermal gradients in captivity may not provide individuals with an appropriate range of temperatures to thermoregulate effectively or efficiently.

A Paradigm Shift.—Beginning in the mid-1990s, a novel approach to the thermal husbandry of varanid lizards began to emerge from the private keeping sector in North America, which focused more on the ecology and thermal biology of free-ranging animals than previous methodologies. American herpetoculturist Frank Retes is credited with pioneering and promoting the use of elevated surface basking temperatures which had not previously been used or considered for varanids (Anonymous 1997, 1998a; Good 1999; Retes and Bennett 2001), perhaps due to fears that they would prove lethal to captives. Retes showed that when given access to a broad range of temperatures, captive individuals of many different varanid species selected surface temperatures in excess of 60°C (140°F) for basking. These elevated basking temperatures reduced the amount of time needed for captives to reach their preferred body temperatures, and led to greater activity levels and faster rates of digestion, growth, and sexual maturation (Anonymous 1997; Retes and Bennett 2001). Additionally, these conditions, in conjunction with the offering of small, but frequent meals have been attributed to marked increases in Retes' captive breeding success not just with diminutive species belonging to the subgenus *Odatria* (Anonymous 1997, 1998a,b; Good 1999;

Retes and Bennett 2001), but larger species such as *V. varius* and *V. albigularis* as well (Anonymous 1998a; F. Retes, pers. comm.).

Captive breeding success with varanids had been experienced by zoos and private keepers prior to this innovation (see Horn and Visser 1989, 1997); however, most occurrences before the mid- to late-1990s were infrequent, and rarely repeated. When adopted, the use of elevated basking temperatures and broader thermal gradients has led to greater activity levels and reproductive success with many species in both zoos and private collections, including multiple captive-bred generations (Fyfe et al. 1999; Good 1999; Bennett 2001; Retes and Bennett 2001; Bennett and Thakoordyal 2003; Husband and Bonnett 2009). For example, Fyfe et al. (1999) reported that a group of *V. brevicauda* initially provided with a basking spot of 35°C (95°F) remained inactive, had poor appetites, and did not engage in any courtship or mating behaviors. Upon increasing the surface basking temperature to 45°C (113°F) following Retes' methodology, activity levels and appetites increased, and courtship was observed within just a few weeks (Fyfe et al. 1999). Today, surface basking temperatures as high as 60°C (140°F) are offered to *V. brevicauda* in captivity (Husband and Bonnett 2009), and similarly high basking temperatures are successfully used for many other varanid species as well (Tables 1 and 2; Fig. 2). Even species with lower preferred body temperatures such as *V. mertensi* and *V. salvator*, and dense-canopied forest dwellers such as *V. prasinus*, *V. rudicollis*, *V. dumerilii*, and *V. olivaceus* will actively seek out and bask at these elevated temperatures when given the option to do so (Fig. 2).

Surface basking temperatures in excess of 45°C (113°F) have been in use with captive varanids and extensively documented in the literature for more than a decade (Visser 1985; Anonymous 1997; Good 1999; Husband and Vincent 1999; Retes and Bennett 2001; Bennett and Thakoordyal 2003). Yet, it appears that many zoos and private keepers are unfamiliar with this innovation or are perhaps following older husbandry guidelines, and several authors have recently reported or recommended the use of substantially cooler basking temperatures and narrower thermal gradients (Downing 2007; Gaikhorst et al. 2010; Donovan 2012; Purser 2014). Preliminary investigations on the thermal husbandry offered to varanids in captivity have also shown that some North American zoos are currently offering surface basking temperatures as low as 25–30°C (77–86°F) (Mendyk et al., unpub. dat.), which are substantially lower than the actual preferred body temperatures of most species. This may be reflective of information presented within outdated taxon management accounts that are still in use today which recommend surface basking temperatures below 45°C (113°F) (Pfaff and Sprackland 1996) or do not recommend any specific basking temperatures at all (Card 1996; Mehaffey and McGinnity 1996; Hairston-Adams and Reed 2000). Moreover, these findings might also reflect a general unfamiliarity with current literature on the biology and husbandry of varanids as well as limited communication between zoos and private keepers. Zoos and private keepers that follow outdated information may be providing inappropriate husbandry that can directly affect the health, welfare and longevity of captive specimens.

Now widely practiced throughout many North American, Australian, and European collections, the use of elevated basking temperatures above 45°C (113°F) does not appear to have been as extensively adopted by zoos and private keepers in Germany, where lower surface basking temperatures continue to be used for many species (Moldovan 2007, 2008; Wesiak 2007, 2008; Berghof 2009; Ziegler et al. 2009, 2010; Mendyk et al., unpub. dat.). While this trend does appear to be changing (e.g., Fischer, 2012; Hörenberg 2013a,b; Ramm 2013a,b; Mendyk et al. unpub. dat.), this more traditional keeping approach may be popular because several pioneering varanid keepers in Germany have reported breeding success with lower basking temperatures and narrower thermal gradients (Stirnberg and Horn 1981; Eidenmüller and Horn 1985; Eidenmüller 1990; Eidenmüller and Wicker 1991,1993; Horn 1991; Kirschner 1999). Although successful reproduction may occur under such thermal conditions, consistent and repeated reproductive success, multi-clutching, and earlier sexual maturation appear to be rare. The elevated basking temperatures and broad thermal gradients highlighted in this, and other reports (see Tables 1 and 2) offer many biological benefits over these more traditional keeping methodologies, and more closely mirror the range of climatic conditions present and familiar to varanids in nature.

Biological Benefits of Elevated Basking Temperatures

When unable to achieve their preferred body temperature, varanids may exhibit reductions in food intake, digestive efficiency and energy conversion, thyroid activity, and growth rates (de Grijis 1899; Buffenstein and Louw 1982; Fyfe et al. 1999; Brown 2012). Whereas elevated body temperatures accelerate enzymatic and mechanical digestive functions in reptiles (Auffenberg 1981), colder temperatures impair digestive abilities (de Grijis 1899). Low temperatures can lead to the putrefaction of food within the gut (Auffenberg 1981) as well as gastrointestinal impactions (Brown 2012), and have also been implicated in two fatal cases of severe gastroenteritis in *V. komodoensis* (Bacon 1976). When given access to broad thermal gradients including elevated basking temperatures, captives exhibit increased activity levels, greater appetites, faster growth rates and earlier sexual maturation, as well as improved reproductive outputs (Fyfe et al. 1999; Retes and Bennett 2001).

Access to a broad range of temperatures can also benefit reproductively active females. For instance, Kuhn and Julander (1999) noted that female *V. acanthurus* bask extensively at higher surface temperatures (to 71°C [159.8°F]) when gravid. Given the histories of low egg viability in captive varanid lizards (Mendyk 2012, unpub. dat.) and inadequate thermal husbandry, it is possible that access to higher temperatures may be important for healthy egg development, as well as normal reproductive cycling (i.e., oogenesis, vitellogenesis and ovulation). Inadequate thermal conditions may also explain, to some extent, the high frequency of reproductive complications and disorders seen among captive females (Mendyk et al. 2013).

Gout, the accumulation of uric acid crystals in the joints and viscera, is a common metabolic disease of reptiles in captivity. Although comparative studies with other reptile groups are lacking, captive varanid lizards have shown a particular susceptibility to gout (Köhler 1992; Hartdegen 2002; Mendyk et al. 2013). Exposure to cold temperatures can inhibit renal tubular function and increase uric acid levels in reptiles (Hernandez and Coulson 1957), and may explain elevated levels of uric acid seen in *V. griseus* during brumation (Haggag et al. 1966; Dessauer 1970) as well as cases of gout in captive varanids, although chronic dehydration has also been proposed as an important causative agent of the disease (Card 1996; Yuyek 2012; Mendyk et al. 2013).

Immunocompromised reptiles often elevate their body temperatures beyond their preferred Tbs, when ill (Kluger

1979; Warwick 1991; Hutchinson and Dupre 1992; Lillywhite and Gatten 1995). Similar observations of wild-caught varanids in captivity suggest that captives select higher basking temperatures for eliminating parasite loads (Sprackland 1989; Mendyk, pers. observ.), perhaps by increasing body temperature beyond the critical thermal maximum of the infective agent. There is also evidence that suggests reptiles purposely seek out colder temperatures during certain stages of illness, perhaps as a way to cope with stress associated with disease (Warwick 1991). Therefore, providing access to a broad thermal matrix including cooler temperatures and elevated basking spots that animals can actively select from as needed is important for facilitating a healthy immune response.

Health Concerns Associated with Elevated Basking Temperatures

Without testing the thermal preferences and tolerances of captive specimens under one's care, it is easy to see why some zoos and private varanid keepers may be reluctant to provide surface basking temperatures in excess of 45°C (113°F), for fear that death or thermal burns might occur (Retes, in Good 1999). Although some varanid groups and species appear to seek out greater surface basking temperatures than others, particularly members of the subgenus *Odatria* (Table 1), if surface basking temperatures are too hot, animals will usually bask at the site's periphery where temperatures are slightly lower. Most burns in captive varanids appear to be related to animals coming into

Table 1. Elevated surface basking temperatures and broad thermal gradients documented in the literature for varanid lizards belonging to the subgenus *Odatria*. Species are clustered based on phylogenetic relatedness (Ast 2001; Fitch et al. 2006; Ziegler et al. 2007). Abbreviations: LT = lowest temperature available in terrarium; MSBT = maximum surface basking temperature; TG = thermal gradient. Temperatures are expressed as: °C (°F).

Taxon	LT	MSBT	TG	Reference
acanthurus	24 (75.2)	71 (159.8)	47 (84.6)	Kuhn and Julander 1999
	25 (77.0)	76 (168.8)	51 (91.8)	Lemm 1999
	28 (82.4)	70 (158.0)	42 (75.6)	Brown 2012
	15 (59)	78 (172.4)	63 (113.4)	van der Reijden 2006
	28 (82.4)	70 (158.0)	42 (75.6)	Brown 2008
baritji	28 (82.4)	70 (158.0)	42 (75.6)	Brown 2012
primordius	28 (82.4)	70 (158)	42 (75.6)	Brown 2012
	—	50 (122)	—	Husband 2001
	—	50 (122)	—	Husband and Bonnett 2008
storri	< 30 (< 86)	50 (122)	20+ (36+)	Richmond 2005
	28 (82.4)	70 (158)	42 (75.6)	Brown 2012
bushi	28 (82.4)	60 (140)	32 (57.6)	Brown 2012
		50 (122)		Husband and Bonnett 2008
caudolineatus	28 (82.4)	60 (140)	32 (57.6)	Brown 2012
	28 (82.4)	66 (150.8)	38 68.4)	Retes and Bennett 2001
	—	50 (122)	—	Husband and Bonnett 2008
gilleni	25 (77)	70+ (158+)	45+ (81+)	Deutscher 2006
	28 (82.4)	60 (140)	32 (57.6)	Brown 2012
	—	50 (122)	—	Husband and Bonnett 2008
brevicauda	—	45 (113)	—	Fyfe et al. 1999
	—	60 (140)	—	Standon 2008
	—	60 (140)	—	Husband and Bonnett 2008
eremius	28 (82.4)	70 (158)	42 (75.6)	Brown 2012
	—	60 (140)	—	Husband and Bonnett 2008
kingorum	28 (82.4)	60 (140)	32 (57.6)	Brown 2012
	28 (82.4)	66 (150.8)	38 (68.4)	Retes and Bennett 2001
glebopalma	28 (82.4)	60 (140)	32 (57.6)	Brown 2012
	< 30 (< 86)	60 (140)	30+ (54+)	Husband and Bonnett 2008
pilbarensis	28 (82.4)	60 (140)	32 (57.6)	Brown 2012
	28 (82.4)	66 (150.8)	38 (68.4)	Retes and Bennett 2001
	24 (75.2)	50 (122)	26 (46.8)	Hörenberg 2013a
glauerti	28 (82.4)	66 (150.8)	38 (68.4)	Retes and Bennett 2001
	28 (82.4)	60 (140)	32 (57.6)	Brown 2012
	26 (78.8)	55 (131)	29 (52.2)	de Zeeuw 2010
	< 30 (< 86)	60 (140)	30+ (54+)	Husband and Bonnett 2008
	28 (82.4)	55 (131)	27 (48.6)	Ramm 2013a
tristis	28 (82.4)	60 (140)	32 (57.6)	Brown 2012
	—	50 (122)	—	Husband and Bonnett 2008
scalaris	28 (82.4)	60 (140)	32 (57.6)	Brown 2012
	—	50 (122)	—	Husband and Bonnett 2008

TABLE 2. Elevated surface basking temperatures and broad thermal gradients documented in the literature for varanid lizards belonging to the subgenera *Varanus*, *Soterosaurus*, *Euprepiosaurus*, *Empagusia*, and *Polydaedelus*. Species are clustered based on phylogenetic relatedness (Ast 2001; Fitch et al. 2006; Ziegler et al. 2007). Abbreviations: LT = lowest temperature available in terrarium; MSBT = maximum surface basking temperature; TG = thermal gradient. Temperatures are expressed as: °C (°F).

Subgenus	Taxon	LT	MSBT	TG	Reference
Varanus	*giganteus*	28 (82.4)	55 (131)	27 (48.6)	Brown 2012
		high 20s (low 80s)	60 (140)	30+ (55+)	Husband and Bonnett 2008
	mertensi	28 (82.4)	60 (140)	32 (57.6)	Brown 2012
	mitchelli	28 (82.4)	60 (140)	32 (57.6)	Brown 2012
	gouldii	28 (82.4)	55 (131)	27 (48.6)	Brown 2012
		high 20s (low 80s)	60 (140)	30+ (55+)	Husband and Bonnett 2008
	panoptes	28 (82.4)	55 (131)	27 (48.6)	Brown 2012
		24 (75.2)	62.8 (145)	38.8 (69.8)	Burokas 2012
		high 20s (low 80s)	60 (140)	30+ (55+)	Husband and Bonnett 2008
	rosenbergi	28 (82.4)	55 (131)	27 (48.6)	Brown 2012
		high 20s (low 80s)	60 (140)	30+ (55+)	Husband and Bonnett 2008
	semiremex	24 (75.2)	56 (132.8)	32 (57.6)	Jackson 2005
		28 (82.4)	60 (140)	32 (57.6)	Brown 2012
	spenceri	28 (82.4)	55 (131)	27 (48.6)	Brown 2012
		high 20s (low 80s)	60 (140)	30+ (55+)	Husband and Bonnett 2008
	komodoensis	25 (77)	45 (113)	20 (36)	Sunter 2008
	varius	—	60 (140)	—	Kirshner 2007
		28 (82.4)	55 (131)	27 (48.6)	Brown 2012
		—	60 (140)	—	Husband and Bonnett 2008
	salvadorii	21 (69.8)	49 (120.2)	28 (50.4)	Waterloo and Bayless 2006
		high 20s (low 80s)	65 (149)	35+ (64+)	Trout 2007
Soterosaurus	*salvator*	—	48.9 (120)	—	Rodriguez 2009
Euprepiosaurus	*beccarii*	28 (82.4)	46 (114.8)	18 (32.4)	Gamble and Hartdegen 2000
		24 (75.2)	45+ (113+)	21+ (37.8+)	Fischer 2012
		23.8 (74.8)	49 (120)	25.2 (45.4)	Mendyk and Horn 2011
	keithhornei	—	50 (122)	—	Husband and Bonnett 2008
	prasinus	27 (80.6)	54 (129.2)	27 (48.6)	Mendyk 2006
		28 (82.4)	54.4 (130)	26.4 (47.6)	Mendyk 2008
		—	50 (122)	—	Husband and Bonnett 2008
	indicus	28 (82.4)	60 (140)	32 (57.6)	Brown 2012
	jobiensis	26 (78.8)	54.4 (130)	28.4 (51.2)	Stefani 2008
	juxtindicus	27 (80.6)	45 (113)	18 (32.4)	Wesiak and Koch 2009
	melinus	29 (84.2)	45 (113)	16 (28.8)	Dedlmar and Böhme 2000
Empagusia	*flavescens*	24 (75.2)	45 (113)	21 (37.8)	Visser 1985
Polydaedelus	*albigularis*	29.4 (85)	54.4 (130)	25 (45)	Markland and Brown 2009
	exanthematicus	24 (75.2)	60 (140)	36 (64.8)	Bennett 2001
		—	66 (150.8)	—	Bennett 2000
		28 (82.4)	57 (134.6)	29 (52.2)	Coiro 2007
		24 (75.2)	63 (145.4)	39 (70.2)	Bennett and Thakoordyal 2003
		21 (69.8)	63 (145.4)	42 (75.6)	Sprackland 2010
	ornatus	25 (77)	45 (113)	20 (36)	Hennessy 2010

direct physical contact with heating elements or protective wire cages surrounding heating elements (Horn and Schurer 1978; Greek 2010; Brown 2012), rather than the heated surfaces themselves. Burns arising through contact with extreme surface temperatures, although rare, may be possible only in certain circumstances where cold lizards maintained under cold ambient conditions are exposed to concentrated hot spots that cover too little an area of an animal's body (Good 1999; Vincent and Wilson 1999; Husband and Bonnett 2008; Brown 2012). An animal's body size should therefore dictate the size and coverage of basking areas, and for larger species, clusters or rows of multiple heating elements, as opposed to just a single fixture, have successfully been used to generate evenly distributed, elevated basking spots which provide entire body coverage (Good 1999; Bennett and Thakoordyal 2003; Kirshner 2007; Burokas 2012). Another potential concern is that some halogen flood lamps feature a clear lens in the center of the bulb which can direct a concentrated, magnified beam of light on a relatively small focal point, and are best avoided as heating fixtures.

Concerns of captives overheating can be dismissed, provided that access to a sufficiently broad range of temperatures is available (see below). A growing trend among private varanid keepers, which seeks to further replicate the conditions familiar to many species in nature, is the use of deep (sometimes up to 1 m), naturally-occurring substrates such as soil, sand, and loam which facilitate burrowing. Deep burrows and similar refuge sites can provide relief from warmer ambient air temperatures, and greatly increase thermal variation within an enclosure. Some zoos, however, may be unable, or reluctant to provide deep substrates for burrowing species, as burrows can interfere with the observation of specimens maintained on public display. In such circumstances, providing cooler refugia may require novel and innovative approaches which take into consideration the ecology and biological requirements of the species as well as display values. Similarly, since most private keepers are unable to accommodate spacious enclosures in their households, creating broad thermal gradients in diminutively sized enclosures presents its own set of logistical challenges, but is possible with careful planning and design.

The relationship between temperature and humidity is often overlooked in herpetological husbandry, even though it is widely established that water loss in reptiles is strongly influenced by both of these environmental factors (Warburg 1965b; Cohen 1975; Thomspon and Withers 1997; DeNardo et al. 2004). Enclosures with liberal screen or wire mesh coverage, and warmer than room temperatures (especially those used for basking) can create a significant air-flow, leading to a loss of humidity, and ultimately drier ambient conditions within the enclosure. Without access to high humidity levels, animals lose water to the captive environment through cutaneous evaporation and respiration, which can lead to dehydration, related health complications, and death. Reducing the amount of ventilation and incorporating deep, moisture-retaining natural substrates can help maintain appropriate ambient humidity levels within enclosures (Mendyk et al. 2013), provided that drainage and airflow are adequate for preventing microbial growth and associated health issues. Moreover, providing a variety of refuge sites with varying levels of humidity that captives can select from as needed further replicates the variation in microhabitats and microclimates experienced in nature, and can help further reduce the risk and health consequences of dehydration.

Implications for Biological Research

Ex situ investigations are frequently used by herpetologists to study various aspects of reptilian biology, particularly biological parameters that may not be possible or logistically feasible to study in the field. Although short-term laboratory investigations typically do not require the longevity that keeping reptiles in zoos and private collections does, biologically appropriate husbandry practices are still necessary for maintaining healthy research subjects. Captive varanid lizards have served as important study subjects in numerous investigations on reptilian physiology, psychology, and behavior (Bartholomew and Tucker 1964; Bennett 1972, 1973; Green 1972; Loop 1974, 1976; Berger and Heisler 1977; Meek 1978; Earll 1982; Cooper 1989a,b; Thompson and Withers 1992; Christian et al. 1996; Kaufman et al. 1996; Secor and Phillips 1997; Thompson 1997; Bennett et al. 2000; Frappell et al. 2002; Clemente et al. 2009; Gaalema 2011; Schachner et al. 2014). The fact that basking temperatures and thermal gradients offered to varanids in captivity have historically been inadequate could have far-reaching consequences which cross over into biological research. Captive conditions that prevent or discourage animals from reaching their preferred body temperatures can have direct effects on their activity levels, behavior, and performance (Christian and Weavers 1996). As a result, thermally compromised individuals may not be operating under optimal physiological conditions, which can skew experimental results and their interpretations.

One particular study, in which thermal husbandry practices may have had an unintended effect on its results and interpretations, compared the active body temperatures of captive *V. komodoensis* to free-ranging wild individuals (Walsh et al. 1999). This study found that captive *V. komodoensis* maintained active body temperatures that were significantly cooler than those recorded from wild conspecifics. Two potentially feasible explanations were offered for these unusual results. The first suggested that captives may have chosen to operate at lower body temperatures because of the reduced energy demands of captivity created by confinement and food provisioning (Walsh et al. 1999). The other suggested that the lower body temperatures in captives may have been a physiological response to the smaller size of prey items and greater frequency at which they are fed when compared to the larger and less frequent meals typical of wild *V. komodoensis*, which might require higher temperatures for digestion (Walsh et al. 1999).

A possible alternative hypothesis, not discussed by Walsh et al. (1999), relates to the range of temperatures available to captives for thermoregulation. Since the 40°C (104°F) maximum surface basking temperature offered to captives in the study (Walsh et al. 1999) is substantially cooler than the surface temperatures individuals would normally have access to for basking in nature (Auffenberg 1981), heating rates among captives were probably slower than in free-living wild individuals. Considering the activity levels, foraging habits, and general inquisitiveness of varanid lizards, particularly *V. komodoensis* (Auffenberg 1981; Burghardt et al. 2002), it is possible that captives chose to forgo reaching their optimal Tbs for other activities simply because it was taking too long to heat up. Field studies on seasonal body temperature variation in varanid lizards have reported similar findings, where several species maintain year-round activity, but operate at lower body temperatures than their optimal range during colder weather (Auffenberg 1994; Christian and Weavers 1996; King and Green 1999; Ibrahim 2000; Rathnayake

et al. 2003). King and Green (1999) showed that wild *V. rosenbergi* spent nearly three times as much time basking to elevate Tbs during colder winter months than in summer, yet never achieved the same active Tbs as in summer (29.3 vs 32.0°C [84.7 vs 89.6°F], respectively). The inability to reach optimal Tbs, or an inability to reach them within a reasonable timeframe would explain why varanids operate at lower Tbs during colder weather, and may explain a similar phenomenon in captive *V. komodoensis*.

Another important consideration is that as heliotherms, varanids largely rely on heat generated by the sun, a visible heat source, for elevating their body temperatures and typically thermoregulate by moving between sunlit and covered areas. Although empirical studies have yet to compare the thermoregulatory behaviors of varanids when given a choice between visible (i.e., natural sunlight, mercury vapor lamps, incandescent lamps, etc.) and non-visible (i.e. infrared heat emitters) heat sources for basking, observations from captivity suggest that at least some species respond differently to basking sites generated by different wavelengths of light (Laszlo 1969; Vincent and Wilson 1999; Deutscher 2006). For instance, when given access to both a non-heat emitting fluorescent coil lamp and a heat-producing halogen flood lamp, two *V. similis* repeatedly sought out and basked for extended periods under the fluorescent lamp, even though it did not emit any heat (Mendyk, unpub. obs.). Similar observations of basking behavior have also been reported for *V. timorensis* when given access to full-spectrum fluorescent lighting (Laszlo 1969). The infrared quartz heaters used by Walsh et al. (1999) to create a basking site for their *V. komodoensis* generated heat without producing visible light, and may have had some unintended effect on basking behavior. Several authors have suggested that captive varanids may not receive the same behavioral cues from non-visible, light-emitting heat sources as they do when basking under a visible light source (Card 1995; Vincent and Wilson 1999; Eidenmüller 2005), and while Walsh et al. (1999) noted that *V. komodoensis* occasionally entered the basking spot during the study period, it is possible that the animals may have been more drawn to basking in natural sunlight filtered through the exhibit's extensive skylights and windows than under the heater itself, which could have also had an effect on selected body temperatures. The tendency of diurnal reptiles to seek out filtered natural sunlight over infrared heat for basking has been observed in other species in captivity including *Astrochelys radiata* and *Phelsuma madagascariensis* (R.W.M. and L.A., pers. observ.), and warrants further investigation, especially since these types of behavioral observations can illustrate the taxon-specific appropriateness of different types of heating elements in herpetological husbandry.

Concluding Remarks

Since captive reptiles are often provided with narrow and inadequate temperature ranges that are based on human-estimated requirements (Arena and Warwick 1995), it is important for keepers to approach herpetological husbandry with an open mind and experimental methodology. By ignoring baseless long-term keeping traditions and "folklore husbandry" (Arbuckle 2013), and actually testing the preferences and tolerances of specimens under their care, keepers can develop and employ more effective biologically-appropriate husbandry practices. Based on our review of the thermal biology and captive maintenance of varanid lizards, several conclusions (see below) can be reached about their thermal husbandry. Applying this information towards current keeping methodologies can help zoos, private keepers, and research laboratories improve the welfare, keeping, and reproductive success of specimens in their care.

1) Surface basking temperatures below 45°C (113°F) and narrow thermal gradients may prohibit animals from reaching their preferred Tbs or prevent them from achieving them within a reasonable timeframe.

2) Broad thermal gradients which extend from 22°C (71.6°F) to elevated basking temperatures in excess of 45°C (113°F) (sometimes as high as 70°C [158°F] for some species) allow captives to select from a wide range of temperatures as needed to satisfy various physiological requirements, and offer many biological benefits over older, traditional keeping methodologies.

3) Access to a range of elevated humidity levels, including those near or at the point of saturation is important for captives to reduce and control evaporative water loss to their environment, and prevent dehydration.

4) Biological research carried out in captivity should consider the ecology and thermal biology of varanids when developing keeping methodologies to ensure that study subjects are provided with climatic conditions that allow them to reach their preferred Tbs and operate under optimal physiological condition.

Finally, in addition to establishing a target set of parameters for zoos, private keepers, and research laboratories to follow and incorporate into existing captive management practices, this study raises many additional questions relating to the thermal biology and thermal husbandry of varanid lizards. For instance, when provided with an unlimited range of basking temperatures, what is the highest temperature that a particular species will select for basking, and do these preferences vary with sex, age, or body size? How does basking behavior and the temperatures selected for basking differ under different ambient humidity levels, and is there a single, optimal body temperature for an individual, or do individual thermal preferences vary with age, reproductive state, physical condition, or season? These questions and others can be answered through carefully designed, captivity-based experiments, and represent a possible avenue for zoos and related facilities to contribute to research.

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Use of an Intensive Care Tank for Treatment of Sea Turtles

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As most sea turtle populations worldwide are declining, conservation efforts are focused on applying effective management plans to save these threatened populations. In order to rank management plans according to their potential benefit for species recovery and cost effectiveness, Heppell et al. (1996) developed models and predicted that small declines in annual survival rates of adult and sub adult Loggerheads (*Caretta caretta*) can have a profound impact on population dynamics. A loss of only a few hundred sub-adult and adult females each year could lead to extinction of a population in less than a century. Survival in the first year of life is relatively less important in these long-lived and slow-maturing animals (Heppell et al. 1996). Attempts to overcome the first year vulnerability by head starting projects have had controversial results (Frazer 1994; Heppell et al. 1996) Conservation measures must therefore prioritize the protection of the adult and last juvenile stages(RAC/SPA 2003).

Consequently, rescue centers are one of the most important tools in sea turtle conservation, elevating the population's survival rate by saving mature individuals struggling for survival against natural and anthropogenic threats and returning them to the wild to reproduce. Furthermore, the work carried out in these facilities helps raise marine conservation public awareness through tourism, media, educational programs and volunteerism, using sea turtles as flagship species.

During the last decade, new rescue centers have been established and developed around the globe. A sea turtle arriving at a rescue center often requires intensive handling and medical procedures. Although this process is extremely important for treating the turtle, it can be stressful for the turtle. We developed an intensive care tank to fit the specific needs of treatment, allowing procedures such as blood drawing, fluid and drug administration, force feeding, and hand feeding to be performed easily, greatly reducing the patient's stress, and elevating its chances of survival while allowing the caregiver accessibility in treatment.

The intensive care tank is ideal for treating sea turtles as well as other large aquatic chelonians (e.g., Nile Softshell Turtles, Alligator Snapping Turtles) on their first days of treatment. Assembly and operation are simple using the instructions presented here, and the low cost of materials enables even remote rescue centers to provide the best possible conditions for treatment of an injured sea turtle upon arrival.

Materials.—To create an intensive care tank unit for distressed sub-adult and adult sea turtles, conditions need to be optimized to reduce handling and stress while keeping the turtle

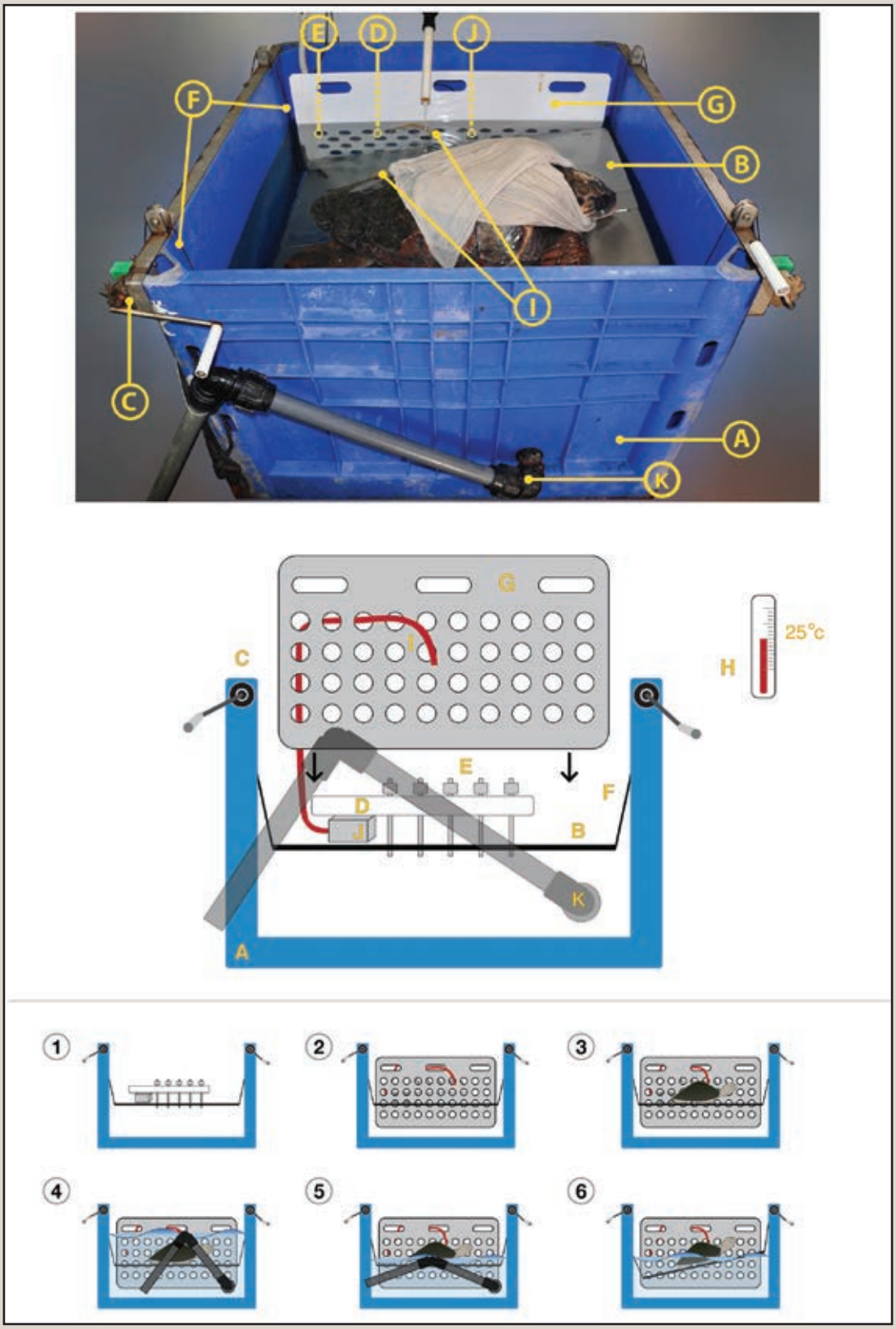


FIG. 1. Intensive care tank unit (ICTU). Detailed view of unit structure: (A–K materials explained in the text); I - ICTU temperature regulation; II - perspex plate separates the turtle from the heater and from entanglement in its electric wires while the warm water pipe extends out to the occupied area of the tank; III - turtle on the platform with warm water flow on its carapace; IV - external standpipe mounted to high water level; V - external standpipe mounted to low water level; VI - platform raised on one side.

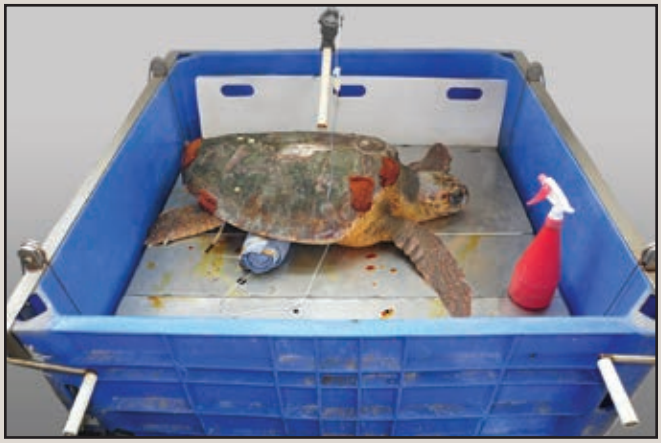


FIG. 2. A Loggerhead Sea Turtle treated with iodine and fluids in the ICTU using the treatment platform to hold it above water level, without taking the turtle out of the tank.

in a supportive environment of heated running sea water. The materials needed for the proposed unit are as follows: A) water tank with a volume of ~ 1 m³ (made of plastic/fiberglass, etc.) (110 cm × 110 cm × 80 cm); B) stainless steel treatment platform (90 cm × 100 cm); C) two axle handles and a sprocket mechanism; D) wooden plate; E) thermostat heaters (total capacity of 1,000—2,000 watts, e.g., five heaters of 300 watts each or three heaters of 500 watts); F) two stainless steel cables, 4 m each; G) polypropylene plate 1 x 0.6 m; H) thermometer; I) warm-water pipe; J) water pump; K) angled PVC standpipe (all shown in Fig. 1)

Mode of operation.—When first arriving at the rescue center, sea turtles are usually lethargic and hardly move. Movement can cause essential energy to be wasted, which can reduce treatment success. Therefore, the intensive care tank should be large enough to accommodate a mature sea turtle, but restrict its movement. A 1 m^3 tank is what we use in the Israeli Sea Turtle Rescue Center. Other rescue centers might need a larger tank to accommodate turtles representing larger individuals or species encountered in their region. Circulation and adjustment of the water level is done using an angled PVC standpipe (Fig. 1 K) exteriorly connected to the bottom of the tank wall, angled to the required water level (which can be different in each stage of the treatment), with its opening pointing to the drain. At the top of the angle, a hole is punctured in the pipe to avoid draining of the tank due to the connected vessels law of physics (Fig. 1; IV, V).

The best treatment conditions in severe and lethargic cases is to keep the turtle's head above water to prevent drowning, with most of the body mass in the water to decrease weight and pressure and to maintain the required temperature. The tank is therefore equipped with a treatment platform (Grade 316; Fig. 1B), connected to a simple sprocket mechanism, allowing it to be raised and tilted (Fig. 1; VI), with two separate axles, cables, and adjustable handles (Fig. 1F,C). By tilting the platform to the required angle, the turtle can be placed on top of it, with most of its body in the water, but the upper jaw is out of the water, protecting it from drowning. To keep the carapace wet and at appropriate temperature while the turtle is in this position, an internal water pump is used within a towel covering the carapace (Fig. 1J). The platform frame is made out of two separate units, allowing cleaning of the tank by removing each unit individually while the turtle is still in the tank. The platform can be used for other treatments which will be discussed later.

Water temperature.—Sea turtles are ectotherms and as such are dependent on externally derived heat to maintain enzymatic activity (Lawrence 1983). The immune response appears to be at a maximum when the turtle has a body temperature within its optimum thermal zone (Tait 1969; Cone and Marchalonis 1972; Jacobson and Origgi 2007). Therefore, the water temperature in the intensive care tank should be maintained between 25–30°C (Campbell 1996). Temperature is also an important factor in drug therapy. Higher temperatures may facilitate distribution of drugs within the body, thus achieving higher concentrations at the site of infection (Wilkinson 2008). Heating the water is also beneficial for treating stranded cold-stunned turtles. Sudden drops in temperature often result in hypothermia in sea turtles. In nature, cold-stunned turtles typically become weak, float, and strand (Paré and Jacobson 2007), or turtles may strand due to other health issues, and become hypothermic on a cold and windy beach.

The water in the tank is heated using thermostat heaters (Fig. 1E) with a total capacity of 1,000–2,000 watts depending on the influx and the temperature of the water entering the tank (Fig. 1; I). The heaters are submerged in the water through a floating wooden plate (Fig. 1D). The tops of the heaters (and the electric cables) are out of the water. To separate the turtle and the heaters, a polypropylene plate is placed vertically (Fig. 1G, II), dividing the tank into two unequal compartments; the smaller containing the heaters and the larger holding the turtle. Finally, a water pump circulates the heated water through the whole tank (Fig. 1J). Water supply should be adjusted to ensure the heaters are effective. If water flow is too fast, the heaters will not be able to keep the water warm enough. To ensure the heaters are effective, a thermostat is constantly regulating and displaying the water temperature (Fig. 1H). The power supply for the heaters is located in a dry place and when draining the tank (for cleaning) the heaters are unplugged and allowed to cool before taken out of the water.

Treatment options using the intensive care tank.—The intensive care tank was developed specifically to fit the needs of treating sea turtle injuries, and therefore can function in different ways to treat different cases. As pointed out above, the tank is equipped with a treatment platform allowing a variety of treatments by adjusting the position of the platform in the tank (Fig. 1; III, VI).

As a first step, the tank is filled with fresh water for rehydration and removal of marine organisms under a controlled temperature of 25–30°C (Campbell 1996). The turtle's buoyancy and breathing is carefully monitored during this period, and the water level should be adjusted accordingly. For example, in cases where the turtle cannot raise its head above water to inhale, the platform can be raised and tilted as described above, to prevent drowning (Fig. 1; IV, V).

After a while, the platform can be lowered again, so the turtle is submerged in water and continued to be monitored by the caregiver. If the platform is no longer necessary, it can be lowered to the bottom of the tank, or removed, while the turtle continues treatment in the intensive care tank.

In the case of nearly drowned turtles, on the first hours of arrival, in a dry tank, the platform is used to tilt the turtle's body downwards, so fluids can drain out of the respiratory system while the turtle is restrained to the platform. Tilting the turtle can also be useful while drawing blood. An angle of 30° is optimal for blood drawing (Owens 1999) and this can also be achieved using the platform, without taking the turtle out of the tank, reducing the stress involved in medical treatments.

When force feeding is required, the platform can be tilted so that the turtle is in an inclined position to help facilitate passage of the feeding tube into the stomach. Following removal of the feeding tube, the turtle is kept in the inclined position with the head and neck extended, until it swallows (Campbell 1996). Hand feeding might be necessary when treating a convalescent turtle and is easily preformed in the intensive care tank due to its small size and adjustable water level.

Fluid and medication injections can be performed with less handling using the treatment platform. It is used to elevate the turtle above water level for medical supplementation and for intra-coelomic injections such as fluids. For that, a towel is placed laterally below the rear plastron of the turtle to elevate one side in order to slide the organs in the coelomic cavity away from the puncture and allow insertion of the needle (Fig. 2).

A sea turtle arriving at a rescue center requires handling associated with medical procedures. Although this is necessary for treating the turtle, it can result in stress. Use of the intensive care tank can dramatically reduce the amount of stress, given that for most treatments the turtle does not need to be handled out of the tank. We have used the intensive care tank for the past 15 years, and believe it has had a major impact on treatment success of endangered sea turtles.

Acknowledgments.—We thank all the sea turtle rescue center volunteers, veterinarians (Itzhak Aizenberg, Yael Grundland, and Roni King), and Israel National Nature and Parks Authority workers. We owe a special thanks to Gabi Gabbay and Ishay Tshuva, who helped in the creation of the unit and its technical support, Meir Paltiel, Gil Cohen, and Shai Zagury, and to the Ministry of Environmental Protection and to the National Nature and Parks Authority for their support.

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HERPETOCULTURE NOTES

SQUAMATA — LIZARDS

***PHRYNOSOMA ASIO* (Giant Horned Lizard). CAPTIVE DIET.** *Phrynosoma* spp. are generally regarded as ant specialists, principally of the genus *Pogonomyrmex* (Pianka and Parker 1975. Copeia 1975[1]:141–162; Whitford and Bryant 1979. Ecology 60:686–694). However, some species are not restricted to an ant diet, being more opportunistic when they have access to a variety of food resources (Lemos-Espinal et al. 2004. Herpetol. Rev. 2:131).

On 29 August 2010, I presented a captive adult female *Phrynosoma asio* (95 mm SVL, 142 mm TL, mass 44 g) and an adult male *P. asio* (94 mm SVL, 147 mm TL, mass 47 g) with a variety of potential food items (ants, crickets, mealworms, and other lizards). The female showed more inclination and preference to feed on a large number of black garden ants (*Lasius niger*) of the various morphs (queen, drone, workers, and soldiers) accompanied by higher levels of activity and vigorous captures. The male also showed more interest in eating all four categories of ants, but appeared to prefer worker ants. During the feeding trials, both lizards also consumed crickets (*Acheta domestica*) and mealworms (*Tenebrio molitor*). However, subsequent trials suggested that, when offered frequently, the level of interest by the lizards toward crickets and mealworms appeared to diminish. Additionally, I introduced two hatchling *Sceloporus grammicus* into the enclosure with the *P. asio* in order to record possible interactions between the two species. Both *P. asio* displayed interest in the other lizards, evidently aroused by their movements, and the female *P. asio* pursued and consumed both of the hatchling *S. grammicus*.

This is the first documented case of a *Phrynosoma* consuming other lizards under captive conditions. With these observations, I suggest that *P. asio*, although it is considered an ant specialist, is an opportunistic generalist in its diet. This should be taken into consideration in order to facilitate their maintenance in captivity, and perhaps also with other species of *Phrynosoma*.

I thank Tania Raya García for support in caring for the individuals in captivity and thanks to Fernando Raya López for providing the food for the horned lizards.

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***UMA RUFOPUNCTATA* (Yuman Fringe-toed Lizard). BEHAVIOR.** *Uma rufopunctata* is a medium-sized (up to ca. 120 mm snout–vent length) species native to sandy dune habitats in southwest Arizona, USA and northwest Sonora, Mexico (Brennan and Holycross 2006. A Field Guide to Amphibians and Reptiles in Arizona. Arizona Game and Fish Department, Phoenix, Arizona. 150 pp.; Turner and Rorabaugh 2009. *In* Jones and Lovich [eds.], Lizards of the American Southwest: a Photographic Field Guide, pp. 274–277. Rio Nuevo Publishers, Tucson, Arizona). *Uma* spp. possess a number of morphological adaptations for inhabiting loose, sandy habitats (Stebbins 1943. Am. Nat. 77:38–52; Stebbins 1985. A Field Guide to Western Reptiles and Amphibians. Houghton Mifflin Co., Boston Massachusetts. 336 pp.; Lemm 2006. Field Guide to Amphibians and Reptiles of the San Diego Region. University of California Press, Berkeley. 326 pp.). Documented behavioral observations of this species are scarce, and to our knowledge, agonistic behaviors have not been described.

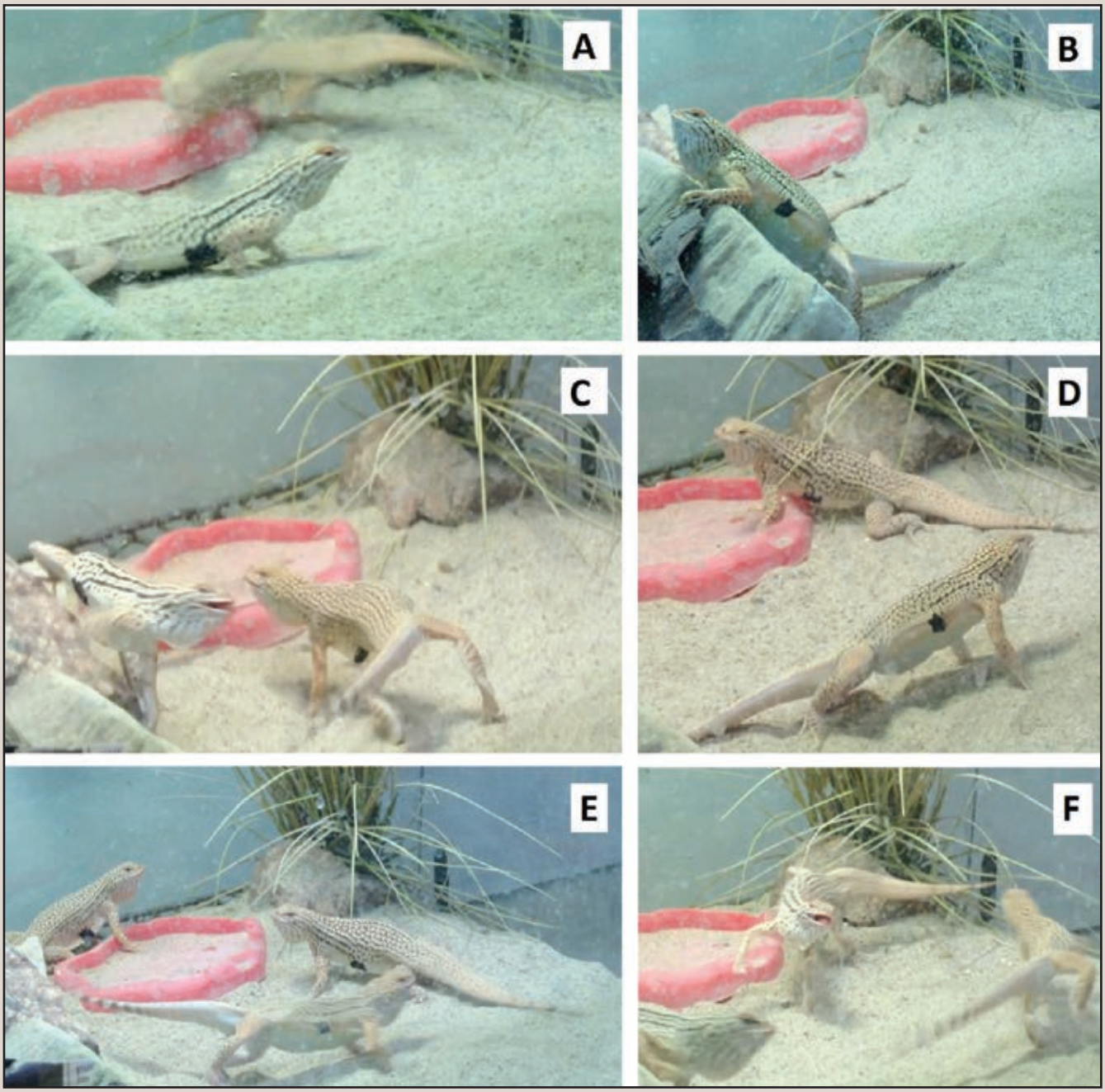


FIG. 1. Time series photographs from a video of agonistic behavior among three male Yuman Fringe-toed Lizards (*Uma rufopunctata*). Video recording began ca. 30 sec after aggression was first noted. A) Aggressor running at other male at 4 sec into the video. B) Male displaying inflated throat at 6 sec. C) Two males in combat; notice the inflated throat, open mouth and elevated and rotated body posture displaying the ventral stripe at 39 sec. D) Male at the top of a push-up at 43 sec. E) All three males displaying with inflated throats, ventral stripe and push-ups at 1 min 31 sec. F) Two males in an encircling combat with the ventral side of the body rotated towards the other combatant. A third male observes in the lower left corner of the picture at 3 min 46 sec.

The Phoenix Zoo received three male and four female (3.4) wild-caught *U. rufopunctata* from the Arizona Game and Fish Department on 12 June 2012. The animals were housed on public display in a group that always contained 2.3, while 1.1 were rotated to an off-display enclosure for breeding. Both breeding and exhibit enclosures were glass aquaria measuring ca. 91 × 46 × 43 cm with sand substrate and rocks for basking under an overhead Exo Terra® 160-watt Solar Glo UV/heat bulb. Temperatures ranged from 43°C on the sand surface under basking lights to 28°C on the cooler side of the enclosure. All animals appeared to cohabitate fine, with no noticeable aggression witnessed until the incident described below.

On 12 November 2013, animals were separated by sex; 0.4 were maintained in the display enclosure and 3.0 were moved into an off-display holding enclosure (also a 91 × 46 × 43 cm glass aquarium with a similar substrate and lighting/heating arrangement to that previously described). This was accomplished prior to cooling the animals over winter in an attempt to entice breeding the following spring. On the same day that the animals were separated, we observed the males in a combat ritual (Fig. 1). The episode started at 1330 h, ca. 4 h after moving the animals into the new enclosure, when two males, positioned approximately 15 cm from each other, began displaying towards one another with inflated throats and bodies while performing push-ups. Many lizard species perform push-ups to communicate with other individuals, displaying patterning/coloring of the ventral portion of their body and demonstrating physical condition, for species recognition, mate choice or attraction and territoriality (Carpenter 1965. *In* Milstead [ed.], Lizard Ecology: A Symposium, pp. 274–277, University of Missouri Press, Columbia; Ferguson 1971. Syst. Zool. 19:79–101). Push-ups were performed in a pattern of four quick push-ups using primarily their front legs followed by one slower and more exaggerated push-up using all four legs. This 4-1 pattern was repeated throughout the entire push-up routine for ca. 25 sec, at which time one participant ran towards the other. The two lizards elevated their ventral surface off of the substrate while rotating their dorsal surface towards and running in a circular motion around the other lizard. This elevated and rotated body posture also displayed the ventral side stripe to the other lizard. While in this motion, their throats were flared and mouths agape. This circling behavior occurred four separate times during the entire episode, with push-up behaviors, again in the 4-1 pattern, occurring between the active circling combat.

Just before the third circling combat, one of the males moved the distal 2-cm tip of its tail from side to side at ca. 10 undulations/sec for 1.5 sec. Caudal movements of squamates have been documented prior to prey capture (Heatwole and Davison 1976. Herpetologica 32:332–336; Murray et al. 1991. Copeia 1991:509–516; Mullin 1999. Great Basin Nat. 59:361–367; Foster and Martin 2008. West. N. Am. Nat. 68:257–259) and as defense mechanisms, be it tail autotomy (Arnold 1998. *In* Gans and Huey [eds.], Biology of the Reptilia, pp. 236–273. Alan R. Liss, Inc., New York) or rattling/vibrating (Greene 1973. J. Herpetol. 7:143–161). Additionally, tail lashing behavior has been documented in *Anolis* during male-male agonistic interactions (Ortiz and Jenssen 1982. Z. Tierpsychol. 60:227–238). The purpose of tail movements in this display could be as a potential distraction mechanism or simply a displacement activity (Tinbergen 1952. Q. Rev. Biol. 27:1–32).

The entirety of the event described lasted ca. 7 min. While the third male approached the two displaying males in the last three min of the event and exchanged push-ups and combat behavior, he remained outside the immediate area of the circling behavior of the two main combatants; remaining ca. 7 cm from the two displaying males. The Zoo now houses all sexually mature male *U. rufopunctata* separately.

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CONSERVATION

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Legislation and Conservation Efforts Concerning Crocodiles in Colombia: A Historical Review

The need to solve specific temporal and/or spatial-ecological problems framed much of the environmental legislation in Colombia before 1950 (Rodríguez 2009). Only after the first regional natural resource management agency was formed (C.V.C. in 1954) and the subsequent development of several national entities (Ministry of Agriculture 1957–1968, Institute for the Development of Renewable Natural Resources INDERENA founded in 1968 and in place until 1994), did Colombia started to have an integrative vision about its natural resources and the problems that a number of these resources faced. Following the Stockholm Convention in 1972, this country developed a renewable natural resources and environmental protection code (Law 2811 [1974]), which was the first comprehensive document that dealt with environmental legislation and management of natural resources. With the completion of a new national constitution (1991), and specifically with Law 99 (in 1993), Colombia established the Ministry of Environment as a regulatory and administrative agency, and also the National Environmental System (SINA). This administrative assembly generated tools that allowed structuring of an effective mechanism for the management and protection of environmental resources (Rodríguez 2009). At this time, fauna, flora, biodiversity, and ecosystems were topics framed as transverse lines in the Colombian legal framework. However, due to conflicts among civilian entities, industry, and supporters of conserving biodiversity that still exist in Colombia, in reality these comprehensive approaches are still not yet being practiced (Anonymous 2009).

Regarding members of the order Crocodylia, Colombia has the greatest diversity (along with Brazil) and is the largest producer of crocodilian skins in the world (Larriera et al. 2004). However, three of six Colombian crocodilian taxa are currently seriously threatened: (*Crocodylus acutus* [American Crocodile] and *Cr. intermedius* [Orinoco Crocodile] both catalogued as Critically Endangered; and *Melanosuchus niger* [Black Caiman] catalogued as Endangered; see Rodríguez 2002a,b; Rodríguez and Ramírez 2002). Another species—*Caiman crocodilus* (Spectacled Caiman)—has a fragmented distribution and depleted populations through its range (Barahona et al. 1996; Rodríguez 2000; Balaguera-Reina and González-Maya 2009). The aim of this study was to carry out a historical review of environmental legislation, conservation efforts, and program management of crocodilians in Colombia to determine their historical and current legislative status, their changes over time, and any projections about the future.

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We conducted an extensive bibliographic search of the web databases of the Ministry of Environment as well as in archives of non-government organizations (NGOs) and research institutions. We recorded a total of 24 national resolutions, one decree, and two agreements between 1959 and 2011 (Table 1), with a maximum of three and an average of 0.51 ± 0.11 (SE) legislative actions per year. We also identified national conservation programs written for two crocodile species (*Cr. intermedius* [MMA 2002] and *Cr. acutus* [MAVDT and CVS 2005]), seven regional and local conservation programs (Maldonado and Ardila 2004; Ulloa-Delgado et al. 2005; De la Hoz et al. 2008; Medrano and Rojano 2008; Hernández-Rangel et al. 2010), and two management plans (Balaguera-Reina et al. 2008; Ulloa-Delgado 2011).

Historically, Colombia developed the first two resolutions about crocodilians between 1957 and 1968 (Acts 387 and 1023 of 1959); these focused on *Caiman sclerops fuscus* (current taxonomy, *Caiman crocodilus fuscus*) hunting regulations on the Magdalena River and its tributaries along the Caribbean coast. These resolutions also restricted live animal export except for permitted scientific purposes. Between 1968 and 1994, eight resolutions, one decree, and two agreements were released (Table 1) that focused on hunting bans on *Cr. acutus*, *Cr. intermedius*, *M. niger*, as well as on *Paleosuchus palpebrosus* (Cuvier's Dwarf Caiman) and *P. trigonatus* (Schneider's Smooth-fronted Caiman), and which regulated both scientific and farming collecting of these species. Finally, between 1999 and 2011, the Ministry of Environment published 14 resolutions concerned with developing management measures to regulate trade in two subspecies of *Ca. crocodilus* trade (*Ca. c. fuscus* and *Ca. c. crocodilus*), with the explicit goal of reducing poaching and illegal trafficking of these organisms.

Currently, five of the six Colombian crocodilian species are covered under a permanent hunting ban in all national territories: *Cr. acutus, Cr. intermedius,* and *M. niger*, Resolution

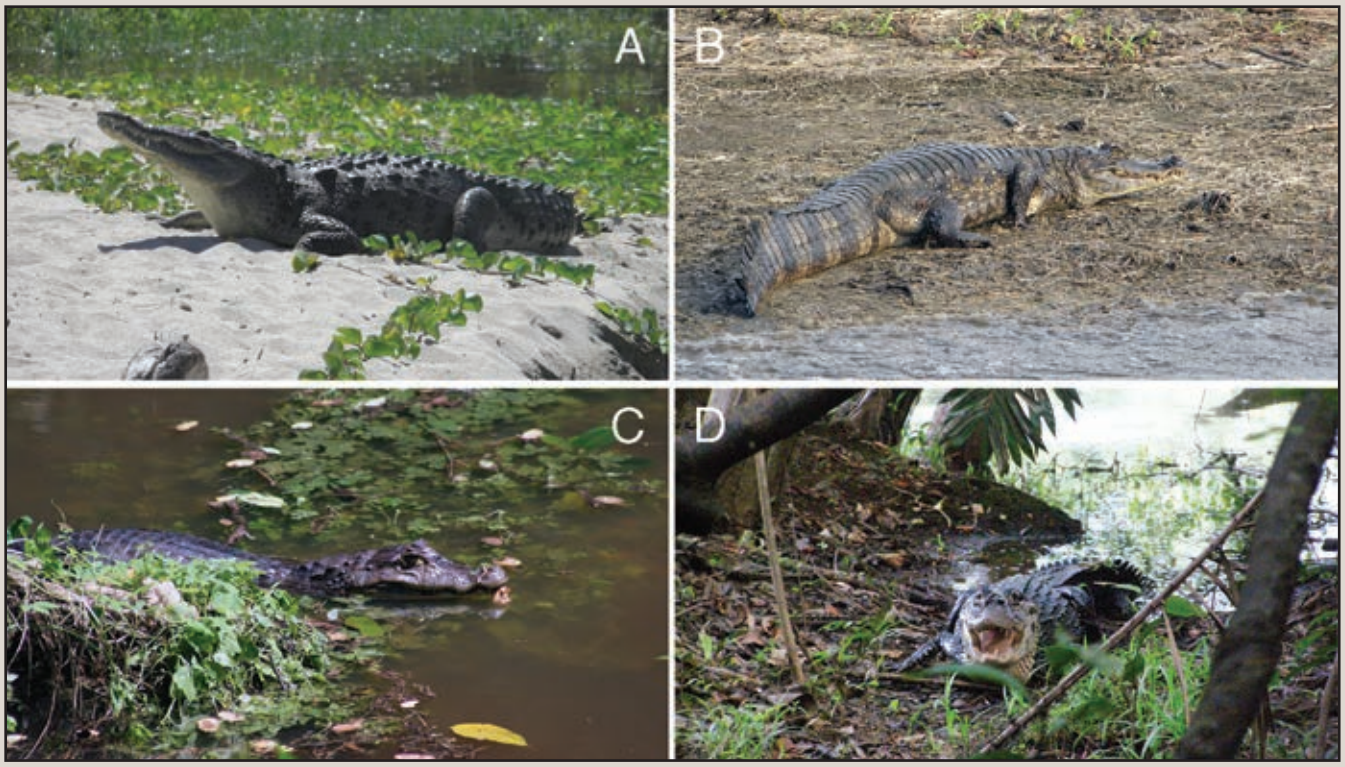


FIG. 1. Four taxa of Colombian crocodilians: A) *Crocodylus acutus* (American Crocodile); B) *Caiman crocodilus crocodilus* (Common or Spectacled Caiman); C) *Caiman crocodilus fuscus* (Brown Caiman); D) *Melanosuchus niger* (Black Caiman).

573 (1969); and *P. palpebrosus* and *P. trigonatus*, Resolution 530 (1970). Interestingly, *Ca. crocodilus* has not been covered under any direct resolution that would ban hunting; only two subspecies (*Ca. c. fuscus* and *Ca. c. apaporiensis*) have specific regulations dealing with this topic. One deals with populations living in the Magdalena River and some adjacent departments (Resolution 847 [1973], see Table 1). The other deals with *Ca. c. apaporiensis* across all of its range (Agreement 39 [1985]). The incorrect or imprecise use of taxonomic nomenclature in nationwide management resolutions or decrees (both at the species and subspecies levels) reduces the possibility to easily apply controls against threats to the conservation of those taxa. In the case of *Ca. crocodilus*, the uncertainty of the ranges of the various subspecies, the lack of general knowledge about the populations and their biology, and the lack of protection, regulation, and management for other subspecies (besides *Ca. c. fuscus* and *Ca. c. apaporiensis*) all serve to complicate this issue.

Farming regulations (Resolution 873 [1974], Decree 1608 [1978]) encouraged scientific studies for all the species (*Cr. acutus*, *Cr. intermedius*, *Ca. crocodilus*, *M. niger*, *P. palpebrosus*, and *P. trigonatus*) significantly increasing our knowledge about the reproductive ecology of some of these (Chiriví 1973; Medem 1981). Currently, while legal farming has been approved for *Cr. acutus*, *Cr. intermedius*, *M. niger*, and *Ca. crocodilus* (except *Ca. c. apaporiensis*; Agreement 39 [1985]), ironically, only *Ca. crocodilus* meets the international requirements necessary to allow it to be traded (*Cr. acutus*, *Cr. intermedius*, and *M. niger* are all Appendix I of CITES; CITES 2012). On the other hand, species such as *P. palpebrosus* and *P. trigonatus*, which currently do not have any recognized commercial value have received little interest from legislators or management programs.

At present, Colombian crocodile market depends exclusively on *Ca. crocodilus* farming (Larriera et al. 2004; Velasco and Ayarzagüena 2010). This activity stimulated the development of specific legislation about this species since farming was at least in part started to protect wild populations. However, large-scale poaching of this species is still occurring throughout the country (Balaguera-Reina et al. 2008). Since 1999, the government and farmers are working together to try to eradicate any skin trade derived from poaching (Resolution 154 [1999]) and to optimize conditions for long-term sustainable production. Actions such as the determination of quotas by the Ministry of the Environment disseminated as national resolutions (Resolutions 706 [2002] and 840 [2003]), forbid the exportation of products not verifiable by legal farming (Resolution 767 [2002]), and mark all legally recognized parental stocks in the country (Resolutions 1172 [2004] and 221 [2005]). Unfortunately, a substantial and unexplained increase (60%) in skin exports in 2006 (based on 2005 data) without a corresponding increase in farming activity (Resolution 1740 [2010]) indicates that poaching and the illegal skin trade remain a major problem. This resolution argued that illegal trade in the country might have been as high as twice the amount of legal skin production between 2005 and 2010. To remedy this situation, Colombia developed more restrictive control measures (Resolution 1740 [2010]) (e.g., shipment inspections, leather certificates, export inventories) in order to eliminate as much illegal activity as possible. The overall picture for *Ca. crocodilus* in Colombia is of concern due to the limited knowledge that we have about the natural history of this species in the wild, the lack of conservation programs throughout its range, and the historical fragmentation and depleted populations documented by several authors (Barahona et al. 1996; Rodríguez 2000, Balaguera-Reina et al. 2008).

TABLE 1. Environmental legislation developed on crocodiles by the Ministry of Agriculture (1957–1968), the Institute for the Development of Renewable Natural Resources (INDERENA) (1968–1994), and the Ministry of Environment (1999–2011) in Colombia.

Type	Year	Aim
Resolution 573	1969	Established hunting ban on Caimán aguja (*C. acutus*), Caimán llanero (*C. intermedius*), and Caimán negro (*M. niger*) in all territory where INDERENA has jurisdiction.
Resolution 530	1970	Established hunting ban and prohibited commercialization of products derived from Cachirre (*P. palpebrosus* and *P. trigonatus*) in all national territory.
Resolution 564	1970	Defined payment amounts for the restocking of wildlife used in and from INDERENA's faunal territories: Caimán aguja (*C. acutus*), Caimán negro (*M. niger*) $ 200 pesos per individual; Babilla (*C. crocodilus*), Cachirre (*P. palpebrosus* and *P. trigonatus*) $ 30 pesos per individual.
Resolution 2	1972	Modified resolutions 574 (1969), 564 (1970), 039 and 110 (1971) and other provisions: Babilla (*C. crocodilus*) $ 3 pesos per individual.
Resolution 847	1973	Established hunting ban on the subspecies *C. c. fuscus* (Babilla del Magdalena) during April–July of every year. 150 cm of total length is determinated as the hunting minimum size in January, February, March, August, September, October, November, and December of every year. Trade in undersized and live animals is prohibited. Hunting in the departments of Boyacá, Cundinamarca, Huila, Meta, Tolima, Arauca, Guainía, Vaupés, and Vichada is banned indefinitely.
Resolution 873	1974	Scientific hunting of some individuals of the Order Crocodylia is temporarily allowed in all territory where INDERENA has jurisdiction: Tulisio *C. c. chiapasius* or *C. s. chiapasius* 100 individuals; Babilla del Magdalena *C. c. fuscus* or *C. s. fuscus* 120 individuals; Caimán del Amazonas *C. c. crocodilus* or *Caiman s. sclerops* 120 individuals; Caimán negro *M. niger* 30 individuals; Cachirre *P. palpebrosus* and *P. trigonatus* 20 individuals of each.
Decree 1608	1978	Established the Renewable Natural Resources Code and the Environmental Protection National Code and Law 23 (1973) on wildlife.
Agreement 039 between Agriculture Ministry and INDERENA	1985	Established list of vertebrate wildlife that can be hunted by farming: Babilla *C. crocodilus* (except *C. c. apaporiensis*) and Caiman negro *M. niger*. These species cannot be hunted without a promotion-hunting license.
Resolution 242	1990	Authorized the sale of Caiman aguja (*C. acutus*) individuals certified as offspring of second generation and marked with a special code of INDERENA's faunal stations for farming within the national territory.
Resolution 552	1994	Authorized the incineration of wildlife products seized.
Agreement 355 between Agriculture Ministry and INDERENA	1994	Authorized the interchange and loan of Caiman aguja (*C. acutus*) parental stock and the regulation of its sale.
Resolution 154	1999	Established export quotas and set criteria for marketing of farmed species.
Resolution 706	2002	Established maximum quotas for *C. crocodilus* for 2001.
Resolution 767	2002	Banned the export of some products of *C. c. fuscus*.
Resolution 840	2003	Established maximum quotas for *C. c. fuscus* for 2002.
Resolution 1172	2004	Established an ex situ Wildlife National Identification and Registration System.
Resolution 221	2005	Modified the 3rd and 6th article of Resolution 1172 of 2004.
Resolution 892	2005	Adopted methodology to allocate the Remainder Exportation Quota by *C. c. fuscus* included in CITES appendices.
Resolution 1660	2005	Established procedure and methodology that Regional Environmental Agencies should take for annual calculation of *C. c. fuscus* and *C. c. crocodilus* individuals to be used by farming.

(*continued on next page*)

TABLE 1. Continued.

Type	Year	Aim
Resolution 2352	2006	Modified resolutions 1172 (2004) and 0221 (2005) on establishing time for marking of parental farming stock of *C. c. fuscus*.
Resolution 923	2007	Modified Resolution 1172 (2004).
Resolution 383	2010	Designated threatened wildlife species in the national territory.
Resolution 1772	2010	Established requirements for commercial sale of farmed animals listed under CITES I.

Regarding *Cr. acutus*, recent efforts to regulate its trade are underway. Resolution 1772 (2010) has encouraged farmers to genotype all the animals maintained in farms in order to have an identification tool and help avoid illegal practices. Moreover, recently Colombia proposed that the CITES commission change the status of *Cr. acutus* populations in Cispatá Bay, Córdoba Department, from Appendix I to Appendix II as a result of the successful outcomes obtained in its conservation program over the last 10 years (Cop16 prop. CITES 2013). However, the CITES commission verdict was that *national* efforts must be developed across the range of the species before any such changes can be made. The Commission focused on the need to determine the current conservation status of the entire species distribution in Colombia, thus allowing the generation of management plans and conservation programs at the national level.

Overall, most legislation concerning crocodilians in Colombia has been the result of case-by-case efforts to reduce both short- and medium-term illegal use of the resource, which has not been a very efficient way to develop nationwide sustainable management approaches. It will be necessary to develop a comprehensive framework, which includes research, population monitoring, and careful management as the basis to use crocodilians (as well as other wildlife) as a sustainable resource.

Species such as *Cr. intermedius* and *Cr. acutus* already have national conservation programs in place, some of which have yet to receive formal approval and in general, not many of the actions described in these programs are currently being enforced. To insure that these species recover, it will be necessary to develop strong political support that will result in governmental efforts that allow the restoration of crocodilian populations and the future regulation of their use. On the other hand, it is curious that *Ca. crocodilus*, the one crocodilian species that supports the entire Colombian skin market, does not yet have a national conservation and management program; this clearly demonstrates the disconnect among the government, the skin industry, and conservation efforts in Colombia.

After the national census (Barahona et al. 1996), which recorded low densities in the majority of crocodilian taxa inhabiting Colombia, there is still considerable research that must be completed regarding species' ranges, population ecology, and actual versus perceived threats before any serious national efforts to conserve and manage the species in Colombia can be undertaken. We did find coupling of some management and conservation activities in areas such as Córdoba, Guajira, Chocó, Antioquia, Amazonas, and Norte de Santander, several of which appear to be highly successful (e.g., Cispatá and Portete Bays), but at the national level such efforts to resolve the conservation status of all crocodilians remains a concern.

Alternatives, for example the inclusion of government-sponsored ranching in Colombia as a production method and the construction of comprehensive legislation might stimulate the conservation of crocodilians in local communities because of the added economic value (Larriera et al. 2004) and should bring new perspectives to sustainable management in the country.

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HERPETOLOGICAL HISTORY

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America's Crocodile Kings With Notes on the Range, Temperature Tolerance, and Nesting of *Crocodylus acutus* in Southwest Florida

America has produced some renowned herpetologists, some of them directors and curators of zoological parks. Men like Archie Carr, Roger Conant, Lear Grimmer, Moody Lentz, Jim Oliver, and Marlin Perkins often visited the two Florida brothers, Bill and Lester Piper, and their wildlife establishment, the Everglades Wonder Gardens, during the last century. These biologists and zoo people highly respected the Pipers and considered the men friends. Bill Piper often guided them on collecting trips and they relied on the Pipers' expertise in Florida's diverse herpetofauna. To a man they were all awed by the Pipers' collection of *Crocodylus acutus*.

> "We present the Everglades Reptiles Gardens without any particular training in showmanship or exploitation. Years of actual experience and contact with wildlife have given us an intimate knowledge of their habitat that we wish to share with you. We have only a sincere desire to give the visitor a clear pictures of the thrilling life, dangers, intrigue and constant struggle for existence that goes on in the depths of the impenetrable and fascinating Everglades. Sincerely, Wilford and Lester Piper"
>
> —*From their brochure, circa 1945*

In the Florida we know today, facilities that cater to the ecotourism industry attract countless enthusiastic visitors. Some of these attractions are publicly owned, others privately. The former generally feature visitor interpretive centers and ancillary educational programs. The most flamboyant of the latter are family entertainment-based and are profit-driven private enterprises. The most notable of these have evolved into major exhibits and have reached empiric proportions. Disney World and Busch Gardens are two of Florida's major attractions drawing in many tourists and resident Floridians; however, in bygone times, before these mega-tourist destinations, educational messages about Florida's wildlife and natural systems were provided by a network of exhibits that were dubbed, and are remembered as, "roadside zoos."

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For more than a century, Florida's major highway network was well endowed with these small, mostly wildlife-based exhibits. A few of them remain part of our landscape, while others have drifted off into oblivion. Few living memories can explain the virtues of these exhibits or speak of their former popularity. Those that originated in the 19th and 20th centuries and are yet part of modern Floridana include: St. Augustine Alligator Farm (established 1893), Gatorland (established 1949), Gatorama (established 1957), and until relatively recently Everglades Wonder Gardens (established 1936).



Fig. 1. Map of pertinent site locations in South Florida. Adapted from Google Earth.

The last of those listed above started out in Southwest Florida 78 years ago as Bonita Springs Reptile Gardens. Unlike those listed above, this attraction was not based solely on a large collection of American Alligators. In 1935, Wilford "Bill" Piper (1900–1989), a resident of Wyandotte, Michigan, partnered with Ensil Ross Allen (1908–1981), the famed rattlesnake exhibitionist who operated Ross Allen's Reptile Institute, part of the popular Silver Springs attraction complex near Ocala. Allen had opened his exhibit in 1929. Bill Piper had spent some of his youth in Florida, near Largo in Pinellas County, where he developed an interest in the state's wildlife. After a couple of hitches in the US Navy, during and just after World War I, Bill made a substantial fortune working as a busy bootlegger on the Detroit River, moving alcohol between Wyandotte and Windsor, Ontario, Canada, during Prohibition in the US. He survived an assassination attempt by a rival gang of rumrunners not long before Prohibition ended and he came back to Florida to hide, mend, and begin a new life. He and Ross Allen invested in a joint venture apart from the Reptile Institute and opened a "wildlife farm" operation about 40 miles east of Ocala. The partnership soon failed because of personal conflicts between the men after a joint herp-collecting trip to Honduras. Bill Piper moved on to settle in Bonita Springs, in Southwest Florida, where he partnered with his younger brother, Lester (1902–1992), who had helped him in the illicit liquor importation business. The pair started collecting local wildlife in 1936 and officially opened their Bonita Springs Reptile Gardens in 1938. Their attraction would evolve through two name changes. In the late 1930s it was called Everglades Reptile Gardens and by the late 1940s the business name had morphed to Everglades Wonder Gardens (EWG). The word "reptile" was dropped from their business name because the brothers thought that the word implied "snakes" to the more squeamish tourists who disliked ophidians and this was a factor that could cause them to lose revenue. This wildlife and botanical exhibit eventually became the premier privately operated wildlife attraction in Florida. By the early 1950s, the Piper brothers' collection of Florida wildlife was nationally renowned, envied by all of their competitors, and admired by directors and curators at major zoological parks nationwide.

PHOTO COURTESY OF ANNA PIPER MACKERETH

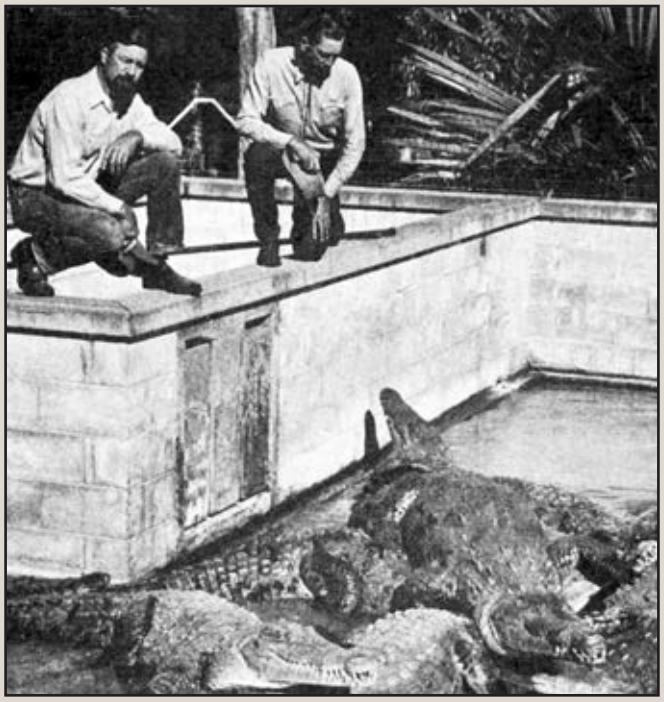


FIG. 2. Lester (left) and Bill Piper admiring their American Crocodile collection, in 1954.

PHOTO COURTESY OF ANNA PIPER MACKERETH



FIG. 3. Some of the adult crocodiles in the Piper collection in 1952. The person standing to the left outside the enclosure is Donald Carroll. He managed the Gardens from 1950 to 1955 until he left and took a position with the Florida Game and Freshwater Fish Commission. In October 1956, while Don was lecturing to a group of schoolchildren in Perry, Florida, he stepped on a loose fresh-caught and "hot" Eastern Diamond-backed Rattlesnake (*Crotalus adamanteus*) to prevent it from dropping off the stage and reaching the children. In an unusual move the rattler slung more than half of its body around and struck Don behind and above his left knee, in his lower thigh, just above the top of his new Gokey snake-proof boots. Despite all efforts at the Tallahassee hospital Don died 22 hours after the bite. Note the male crocodile in the left foreground. Its mouth was tied shut until the individual's aggressive sexual/territorial behavior waned.

Not satisfied with just displaying snakes and alligators to educate and fascinate travelers who stopped and paid their modest entry fee, the brothers expanded the scope of their wildlife presentation. With species diversity as their goal, in 1936 the Piper brothers began to collect a variety of native wildlife including alligators, showy birds, large mammals, and American Crocodiles (*Crocodylus acutus*). Their collection of *C. acutus* would later be advertised as "the world's largest collection of Florida crocodiles in captivity"—and it was. The majority of these crocodilians came from the mangrove forests of upper Florida Bay.

Crocodylus acutus in Southwest Florida

The modern distribution of the American Crocodile in Florida is well described by Kushlan and Mazzotti (1989). Mazzotti (1999) suggests that in the modern era *Crocodylus acutus* has dispersed from its historic range in upper Florida Bay and has moved west to Cape Sable. Today the American Crocodile periodically nests successfully on East Cape (Cape Sable, Everglades National Park) and their nest sites are frequently found in that vicinity (K. Morrison, pers. comm.). Actually this species ranges in growing numbers beyond this southernmost mainland section of the Florida peninsula. Since 1936 individuals of *C. acutus* have historically ranged north through the Ten Thousand Islands into Southwest Florida (LeBuff 1957; LeBuff and Lechowicz 2013). Today the American Crocodile occurs as isolated individuals or in scattered localized populations along the lower Florida Gulf Coast north of Cape Sable (see map, Fig. 1.) This includes a small consolidated group of adults of unknown origin near Marco

Island, Collier County, that may have been there since the 1960s. (J. Vanas, pers. comm.).

The staff at nearby Rookery Bay National Estuarine Research Reserve has monitored this population since 1997. Nesting has occurred every year since record-keeping began. From 1997 to 2014 a total of 64 American Crocodile nests were recorded, with the greatest number (seven) occurring in 2004. When inspected, well past the normal incubation period, none of these nests contained viable eggs. Apparently a lone 426-cm (est. total length [TL]) male crocodile, thought to be sterile, serves an undetermined number of females in this population. These individuals range between 184 and 365 cm (est. TL). The smallest female is in a size class of her own, the others are nearly twice her size. This individual is thought to be a recent recruit into this population (S. Bertone, pers. comm.).

Carr (1940) lists the crocodile as occurring in Collier County, but Duellman and Schwartz (1958) do not include documentation of *C. acutus* in any of the Southwest Florida counties. Today *C. acutus* is known to regularly occur in all of the Southwest Florida counties and its Gulf Coast range has extended to Lake Tarpon in northern Pinellas County (LeBuff and Lechowicz 2013).

Climate change is considered to be causing the Red Mangrove Tree (*Rhizophora mangle*) to migrate north along both coasts of the Florida peninsula (Proffitt and Travis 2014). *Crocodylus acutus* has a close ecological association with the coastal mangroves in Florida and as this tree slowly progresses northward as the climate warms the American Crocodile will likely continue to extend its range north at an equal pace.

Mazzotti (1989) discusses the nesting success of the American Crocodile in Florida Bay. Although a few of the crocodiles north of the National Park on the Gulf Coast construct nests and deposit eggs, to my knowledge none has been viable. An example of this occurred repeatedly on Sanibel Island, Lee County, in recent years. A *Crocodylus acutus* took up residence on the island's J. N. "Ding" Darling National Wildlife Refuge and was photographically documented by a Refuge visitor in November 1979 (Campbell 1985). This sighting was verified with a second observation, and additional photographs, by George Weymouth and me, respectively, on 6 June 1980.

An adult *Crocodylus acutus* took up residence on nearby Pine Island in a residential neighborhood in late 1985 (Combs 2011). It was never verified but it is suspected that this was the individual first documented on Sanibel. In 1986, Paul Moler of the Florida Game and Freshwater Fish Commission (now Florida Fish and Wildlife Conservation Commission [FWC]) captured, sexed, measured, and marked the Pine Island crocodile. He determined it to be a female measuring 284.48 cm TL. Moler surgically removed the keel of a caudal scute for ease of later identification. After capture the crocodile was relocated to Collier-Seminole State Park, Collier County, about 80 km S of Sanibel. Within six months, now recognizable because of the tail disfigurement, the individual returned to Pine Island but soon moved across Pine Island Sound to Sanibel Island where it is assumed it spent the rest of its life. During those 24 years there were some years without documentation of the animal's presence on the island because there were no sightings reported to wildlife officials. The crocodile had started to move about the island's mangrove system on the Refuge and spent more and more time in the interior freshwater wetlands system known as the Sanibel Slough. This inter-habitat movement was verified by confirmed sightings.

In May 1995 this individual constructed a nest mound with landscape mulch as a substrate at a private residence adjacent to the Refuge (about 370 m from where the crocodile was first photographed in 1979) and deposited eggs. Frank Mazzotti of the University of Florida was consulted by the Refuge and in September he visited the site and removed 47 infertile eggs from the nest. Without a conspecific mate this crocodile continued her fruitless nesting efforts several years through 2009 (J. Combs, pers. comm.). One would expect successful nesting by *C. acutus* to occur in Southwest Florida in the future, commensurate with climate change and, over time, a more balanced sex ratio.

The Piper Brothers and American Crocodiles

Soon after opening their wildlife attraction, the Pipers began to enlarge their American Crocodile collection by responding to an occasional public complaint from persons in the region who felt threatened by the mere sight of a rare wild crocodile. They would travel to capture "nuisance" American Crocodiles as far north as Sarasota County. The last documented one was a 243.8 cm leucistic female *Crocodylus acutus* that Lester and his adult son, David, captured near Osprey, Sarasota County, in 1953 (LeBuff 1957).

There is some anecdotal evidence that a large American Crocodile netted by commercial mullet fishermen in 1936 in McIntyre Creek, a red mangrove tidal creek on Sanibel Island, Lee County, ended up in the Bonita Springs collection. It was this individual that initially motivated the Pipers' interest in crocodiles. However, the majority of their *C. acutus* originated from the stocks in southern Dade and northern Monroe counties. The collection grew quickly after the Pipers (Fig. 2.) made it known they would buy any crocodile caught in Florida.

In 1936 *Crocodylus acutus* was not well protected in Florida and was not protected at all in Monroe County until 1947, commensurate with the establishment of Everglades National Park that year. After 1947, with the American Crocodile protected, the primary source for live *C. acutus* in Florida was eliminated. Thereafter few were collected in Florida unless by institutional applicants which the State of Florida granted collection permits; however, Jamaican *C. acutus* were regularly imported for the live animal trade until the species was protected under provisions of the US Endangered Species Act in 1975. In Florida, *C. acutus* was reclassified and its status was changed from Endangered to Threatened in 2007.

The King Maker

The Piper brothers' chief crocodile supplier was a legendary "Gladesman," one William Argyle Hendry (Fig. 4.). Hendry was born in 1869 in Polk County and moved to Monroe County in the early 20th century. In the later part of his life he went to live on Key Largo (Rock Harbor), Monroe County, where he lived until his death in 1954. He regularly robbed American Crocodile nests of their eggs and caught entire groups of neonates. He sold hatchlings to motoring tourists in-season from a roadside stand on US Highway 1 (The Overseas Highway) and advertised them on signage as "baby alligators." At his home, Hendry built a small pole-lined corral in the water in which he placed the large crocodiles he managed to catch alive in the southern Everglades. The adult animals brought him the best prices; in 1939 he sold a 220-cm *C. acutus* for US $35.00, equivalent to US $582.00 in 2014.

The market he reached consisted of zoological parks, museums, and private collectors.

Argyle (his preference) Hendry had an unusual method for landing adult crocodiles. He used a hooking technique that is much the same as modern Licensed Alligator Trappers use in Florida (Faherty 1949). But in the event crocodiles were not adequately impaled by the sharp treble snatch hooks he threw in their direction, and they managed to escape and retreat into their dens, Hendry applied a unique methodology he had in his basket of tricks. He was widely known among his fellow Gladesmen for his quirky labor-intensive approach (Figs. 5 and 6). Few targeted crocodiles evaded Argyle Hendry's clutches. The following description is condensed from *Florida Wildlife* magazine (LeBuff 2008):

"After locating the entrance of a crocodile's underwater burrow, Hendry swung into action. He removed the floorboards from his skiff and used them to blockade the cave's entrance. The boat was pushed against this makeshift fence to reinforce the floorboard plug should a crocodile try to rush the entrance in an escape attempt.

"Several long steel rods were unloaded from his skiff. Hendry stuck one rod into the ground and forced it down until it broke through into the cave. Next, he pressed the steel rod against his throat and grunted with his mouth closed. He was skilled at creating the exact sounds made by crocodiles. This sound traveled down the metal shaft, and was amplified inside the chamber. If a crocodile was in the den, it would grunt in response. This sound would be transmitted up to Hendry's ear and the response vocalization let him know that a crocodile was at home.

"If he heard a grunt, Hendry withdrew the probe and moved further in from the burrow's entrance and again forced the rod into the soil. He methodically surveyed the width and course of the cave and followed the direction of the tunnel. When he felt firm crocodile hide at the end of his probe, he knew he had successfully herded the reptile to the inner end of its den. Hendry worked additional rods down on either side of his probe, until the full width of the tunnel was barred.

"Hendry used an axe and cleared away vegetation then took a shovel and dug until he broke through the den's ceiling. Once the hole was large enough, Hendry dropped a noose on the crocodile's snout. Using a pole, he worked the loop completely around the animal's jaws and pulled it taut. Next, he'd create a series of half-hitches to lock the toothy jaws together." (Fig. 6)

After an individual crocodile was untethered and secure inside his home corral, Hendry would send a letter to whoever had ordered a specimen and was next in line to buy a crocodile. He not only supplied *Crocodylus acutus* to the Pipers but also to major North American zoos and museums. One of his crocodiles was taken to the Milwaukee Public Museum in 1942 (Dickinson 1953). A fabricated replica of this animal remained on display in a habitat exhibit there in 2014 (C. Jacobson, pers. comm.).

The totality of Argyle Hendry's take of live *Crocodylus acutus* over his five-decade hunting career certainly was a serious impact and directly contributed to the decline in the total population and the number of nesting females remaining in the wild after 1947. Hendry's total take of individual crocodiles is unknown. He randomly removed all sexes and size classes of *C. acutus* from the core of its North American population's stronghold in the mangroves of the upper Florida Bay region for a half-century. Although purchasing American Crocodiles was completely legal, Bill and Lester Piper may be considered today to be complicit in the species' decline. They eagerly bought every crocodile Hendry ever offered them for over a decade. The number of nesting female American Crocodiles estimated to exist in the wild in Florida was 20 in the mid-1970s (Ogden 1978). By the late 1950s the Piper collection held twice that number of sexually mature female *C. acutus*.

Crocodile Caretaking

By early 1953 when I became an employee of EWG, the Pipers' American Crocodile collection contained about 50 adults, 80 juveniles, and a dozen or so captive-reared young of the year (LeBuff 1957). The water used in the various enclosures originated from deep artesian wells and the pressure from any one of the five wells on the property was regulated by a series of valves and auxiliary pumps when needed. The temperature of this water as it discharged from the wells was a constant 22.2°C year-round. Logs on their depth and water quality (chloride concentrations) are unavailable, but the well water likely originated in the lower Tamiami aquifer. The water was well-infused with sulfur dioxide gas and patrons often complained about the strong odor. Recent well-monitoring records suggest saltwater intrusion may not have impacted the water's quality 50 years ago, but it has since (Schmerge 2001). Fifty years ago the water flowing into the crocodile enclosure was potable and similar artesian wells were used for households throughout the Bonita Springs community, including the three dwelling units at EWG.

Water temperatures were never recorded in the crocodile enclosures at EWG any distance from their artesian inlets. Once water dispersed from the inlet it eventually drained via a fixed overflow and discharged into a drainage ditch that led to the Imperial River. The enclosure's water would equalize with the ambient air temperature. The water temperature basically fluctuated commensurate with the daily changes in temperature of the sun-heated water.

Lester Piper (Fig. 8.), who managed the day-to-day business operation of EWG, faithfully monitored weather forecasts. This was essential because winter temperatures could suddenly plummet as the result of a cold front and seriously impact many of his cold-sensitive wards. He knew that sufficiently lowered temperatures could cause mortality among his crocodiles unless he took preventive measures.

Each spring there would be a great deal of sexual activity among the captive crocodiles during which major battles raged between rival males. Two >430-cm (TL) males were permanently exiled to smaller enclosures; the first circa 1948, the second in 1956. The second was removed after it grabbed, vigorously shook, and disemboweled the leucistic female noted earlier.

I recall after this happened I asked Bill Piper (Fig. 7.), "In your opinion which would win in a fight between an alligator and a crocodile?" He thought for a moment and responded, "If they were both adult males and of equal length, the crocodile would win. American Crocodiles like to grab hold and shake their adversary to pieces quickly. The alligator gets a tight grip on the tail or a limb and spins on its body's axis. Alligators kill piecemeal. A crocodile usually goes for its prey or opponent's midsection and gets the job done quicker."

There were no dry areas available in the crocodile's enclosure for egg-laying until the mid-1980s when a sand-filled annex with an opening in a common wall was connected and gave gravid females an opportunity to move into the new compartment to nest. Prior to the addition of the nesting area females deposited

their eggs directly into the water. Staff routinely made a serious effort to retrieve eggs before they were broken and even eaten by the crocodiles. In the 1950s a large tin can with drain holes punched in its bottom was attached to a long pole. At dawn, should crocodiles be observed retrieving and eating eggs, I, or another Gardens employee, would spend up to an hour trying to blindly scoop eggs from the concrete bottom of the deepest section of the

PHOTO COURTESY OF THE MILWAUKEE PUBLIC MUSEUM



FIG. 4. William Argyle Hendry operating his boat on Florida Bay while on the hunt for American Crocodiles in 1942.

PHOTO COURTESY OF THE MILWAUKEE PUBLIC MUSEUM



FIG. 5. Argyle Hendry probes the entrance of a crocodile den in 1942 on the bank of East Creek, within today's Everglades National Park Crocodile Sanctuary (established 1980). A 297.18-cm crocodile was taken to Milwaukee from this site.

PHOTO COURTESY OF POPULAR MECHANICS MAGAZINE



FIG. 6. A crocodile that had attempted to escape the hard jab of Argyle Hendry's steel probe found the entrance to its den blocked. Hendry dug open the top of the chamber, roped, and tied the crocodile's mouth shut. He is ready to extract it from its den.

PHOTO COURTESY OF ANNA PIPER MACKERETH



FIG. 7. Bill Piper and his Florida Black Bear (*Ursus americanus floridanus*), "Tom." This photo was taken in Ocala National Forest (Florida) on the movie set during filming of *The Yearling* in 1946. Tom was one of the bears to play the part of "Ol' Slewfoot" in the movie. Visit the EWG link at www.sanybel.com to see a video of Tom in action.

enclosure. It was this section where eggs were usually deposited. Those that were dipped out and were found not to be cracked were buried in an open-air artificial nest mound composed of a sand/sphagnum mixed substrate in hopes of successful hatching. To my knowledge the last clutch of *Crocodylus acutus* eggs produced at EWG that were collected after being submerged yet proved to be viable, were collected in April 1954 and hatched in July. After 1954 there was not a serious continuity in egg retrieval or incubation. Following construction of the nesting annex, crocodiles nested therein at least twice, but the eggs did not hatch (K. Morrison, pers. comm.).

Why captive crocodiles in Bonita Springs produced viable eggs at one time and none are known to do so in the wild today in Southwest Florida warrants investigation. From my experience of over 60 years with Southwest Florida crocodilians most of the *C. acutus* that have moved up the Gulf Coast north of Marco Island, Collier County, during the last half-century are females. More recently, there is evidence that there is a growing number of male *C. acutus* recruits entering the habitat as the species continues to extend its range further north in Southwest Florida (M. Parry, pers. comm.).

In the mid-1990s, Lou Hinds, then manager of J. N. "Ding" Darling National Wildlife Refuge, suggested that a sex-specific translocation effort be made to introduce a male crocodile from South Florida to the Refuge. This proposal never came to fruition because the Florida Fish and Wildlife Conservation Commission (FWC) and the US Fish and Wildlife Service (FWS) had policies in place that prohibited such relocation. It is the opinion of some biologists that FWC considered only that the introduction of a male to Sanibel Island would result in a potential increase in the number of "nuisance" crocodiles that they would have to deal with in the region (M. Westall, pers. comm.). There were several other considerations: 1) During this time there was a known male *C. acutus* nearby in the Caloosahatchee estuary and officials were hopeful that the male and the Sanibel female would find each other without human intervention; 2) State officials were of the opinion an introduced male would immediately move and try to find its way back to its home territory; 3) It was the policy of FWC and FWS not to move any American Crocodile unless that animal exhibited aggressive behavior. Moving an aggressive animal into an area with many people (Sanibel Island) was considered unwise; 4) There was concern by FWC and FWS that relocating a crocodile to a populated area would meet with public concern. This could backlash against endangered species programs, and the latitude to move crocodiles would be lost through politics (L. Hinds, pers. comm.).

The second consideration may not have been valid. An adult female (250.19 cm) nuisance crocodile, considered to be nonaggressive, was captured near Englewood, Charlotte County in May 2010. After magnets were applied to its head, in an experimental attempt to confuse its direction-finding ability, FWC released it on J. N. "Ding" Darling National Wildlife Refuge after approval by FWS. In 2014, this animal remains on Sanibel Island about 8.5 km from its release point (P. Tritaik, pers. comm.).

Introduction of a male crocodile to Sanibel Island, one never exposed to people and therefore an animal which could not be considered a nuisance, would have been an awesome experiment in wildlife management. It is worthy of consideration when such circumstances occur in the future.

PHOTO COURTESY OF ALVIN LEDERER



FIG. 8. Lester Piper in the late 1940s with one of his tame captive-bred Florida Panthers (*Puma concolor coryi*).

American Crocodiles and Winter Cold

In the event of a winter weather forecast that suggested the imminent incursion of cold temperatures, Lester Piper connected a 5.8-cm flexible pipe to the artesian well serving the crocodile enclosure and increased the flow to distribute more of the "warmer" well water into the enclosure as air temperatures fell. Even in December 1962 when air temperatures officially recorded by the National Weather Service at Page Field, near Fort Myers (25.1 km N of Bonita Springs, and the closest temperature-monitoring facility) were -3.33°C and 1.1°C, respectively, for 13 and 14 December 1962. The captive crocodiles at EWG survived without mishap. Mazzotti et al. (2007) mention a small number of crocodile mortalities in extreme southern Florida during hard freezes. In particular they cite such a weather event in late 1989. At Page Field, Fort Myers, on 24 December 1989, the recorded low was -2.22°C with no known crocodile deaths in the region.

In 2010, American Crocodiles in South Florida were again severely impacted by cold weather and according to the media an estimated 200 wild crocodiles in waters south of Homestead, Florida, succumbed to the extremely low temperatures. On 11 January 2010, the low at Homestead (180 km S of Fort Myers) was recorded at -0.61°C. The minimum temperature near Lake Tarpon (Tarpon Springs), Pinellas County, on 11 January 2010 was recorded at -1.66°C. State wildlife officials knew that a crocodile had been there for "about a year" when it was captured for relocation in 2013, but it is unknown if it was present in the lake and managed to survive the 2010 cold.

According to T. Crutchfield (pers. comm.), when *Crocodylus acutus* is cold-stunned while remaining in the water the affected individual loses control of its nasal valves. These relax to an open

position which allows water to enter the crocodile's respiratory system and drown it. A literature search failed to provide any corroborative source (F. Mazzotti, pers. comm.).

The official minimum temperature recorded at Page Field, Fort Myers, by the US Weather Bureau during the 2010 cold spell was -0.55°C on 11 January. A centrally-located weather station on Sanibel Island at J. N. "Ding" Darling National Wildlife Refuge (not present in 1962) registered a low of 0.55°C on the same date (P. Ryan, pers. comm.). This is higher than the mainland temperature, which is normal and expected because of the influence of slightly warmer tidal waters surrounding Sanibel Island. The resident female *Crocodylus acutus* is thought to be a victim of this low temperature event. This individual's bloated remains were discovered in the interior freshwater wetlands of Sanibel on land owned by the Sanibel-Captiva Conservation Foundation (SCCF) on 26 January 2010 by a member of the SCCF staff. This was 15 days after the blast of cold air reached South Florida. When the crocodile died, its body was almost completely out of the water. About 30.5 cm of the tail remained in the water (C. Lechowicz, pers. comm.). To me this is unusual because at EWG the captive group retreated into the water during cold snaps. This was apparently because the amount of well water entering at such critical times was sufficient to maintain the water at a higher temperature than the air. The reverse apparently occurred on Sanibel when the animal retreated from the water and was exposed to the falling air temperature, became immobilized, and possibly died because of hypothermia; however, age may have played a role in this crocodile's demise, which might have been coincidental to the low temperature. It is noteworthy that as far as I have been able to determine this individual was the largest female *C. acutus* ever recorded in Florida—360 cm TL (LeBuff and Lechowicz 2013). The crocodile had grown 85.52 cm since Moler measured and recorded its length 24 years earlier.

This individual's skeletal remains were skillfully rearticulated and are now part of a permanent exhibit in the Education Center at J. N. "Ding" Darling National Wildlife Refuge.

Bill and Lester Piper dissolved their partnership in 1981 and as part of the settlement Lester obtained title to the Gardens property and animals. After Lester Piper's death in 1992, extended Piper family members assumed management of EWG. By this time the original *Crocodylus acutus* caught by Argyle Hendry and most of their captive-bred offspring had died-off and the younger Piper's acquired a few Jamaican *C. acutus* for the Gardens from the Arthur Jones crocodilian collection near Ocala, Florida.

The EWG that the American public knew and enjoyed for 77 years closed in 2013. Most of the animals were sold to other wildlife exhibits in Florida (including any remaining crocodiles) and the property listed for sale by a realtor. Today, a landscape photographer leases the property and exhibits a few birds, turtles, and small alligators. It is primarily a botanical garden and continues to use the name EWG.

Acknowledgments.—I regularly share my crocodile memories with a cadre of fellow former EWG employees. Like me they had the awesome experience of knowing, working alongside with, and being mentored by Bill and Lester Piper, and helping them keep their American Crocodiles. Only one of us (Trew) ever met Argyle Hendry. I had those opportunities as a young man in the 1950s. The following individuals are also surviving Piper employees from that era, and some have been my friends for over 65 years. We still share conversations about our personal interactions with the remarkable group of American Crocodiles and "America's Crocodile Kings." I appreciate knowing Richard Beatty, Warren Boutchia, and Ralph Curtis, my brother Laban LeBuff, Dennis Morgan, Ken Morrison, Don Trew, Jim Vanas, and George Weymouth. We were all American Crocodile wranglers in our youth and share those memories each December when we gather at Lester Piper's graveside on his birthday. We cannot honor Bill Piper in a similar way for he was cremated and his remains were spread over local waters, but he is often thought of fondly by each of us.

Betty Anholt of Sanibel kindly proofread my draft and asked questions that enhanced the final outcome. James Murphy of the Smithsonian National Zoological Park provided valuable commentary as my manuscript developed. Crocodilian specialist Frank Mazzotti of the University of Florida reviewed the final draft and offered some constructive suggestions.

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GEOGRAPHIC DISTRIBUTION

CAUDATA — SALAMANDERS

***AMBYSTOMA TIGRINUM* (Eastern Tiger Salamander)**. USA: GEORGIA: Clay Co.: AOR on Bluffton-Ft. Gaines Rd, 1.6 km WNW of Bluffton (31.52927°N, 84.88230°W; WGS84). 14 May 2014. S. Graham and C. Kelehear. Verified by David Laurencio. Auburn University Natural History Museum (AUM AHAP-D 00837, digital photo voucher). New county record (Jensen et al. 2008. The Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.).

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***ANEIDES AENEUS* (Green Salamander)**. USA: TENNESSEE: White Co.: Bridgestone Firestone Centennial Wilderness Wildlife Management Area (35.82385°N, 85.26751°W; NAD 83). 17 October 2013. Dustin B. Thames. Verified by A. Floyd Scott. David H. Snyder Museum of Zoology, Austin Peay State University (APSU 19501, color photos). New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center of Excellence for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Internet version [http://apbrwww5.apsu.edu/amatlas] accessed 25 May 2014: latest update19 May 2014). One individual was observed on a limestone outcropping in a mixed mesophytic forest approximately one hour after sunset.

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***DESMOGNATHUS AENEUS* (Seepage Salamander)**. USA: GEORGIA: Crawford Co.: 90–150 m E of Rowland Rd. at its crossing of Hartley Branch (32.68513°N, 83.88709°W; WGS84). 08 July 2014. B. Battistella, S. Graham, and S. Riddle. Verified by Carlos Camp, John Jensen, and David Laurencio. Auburn University Natural History Museum (AUM 40692–40694). New county record (Jensen et al. 2008. The Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.).

Locality is ca. 5–6 km SE of the Fall Line (the boundary between the Piedmont and Coastal Plain physiographic provinces), and extends the range ~60 km SE of the nearest known population in Talbot Co., Georgia (Graham 2009. Herpetol. Rev. 40:232–233). Although a few populations of *D. aeneus* are known from the Coastal Plain in Alabama (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn Printing Co., Auburn. 368 pp.), this is the first population known from this physiographic province in Georgia (Jensen et al. 2008, *op. cit.*). There is notable herpetofaunal species richness in the vicinity of this locality, with certain northern/montane-associated species and Coastal Plain-associated species reaching their southernmost and inland-most parts of their ranges, respectively (Graham et al. 2010. Southeast. Nat. 9:19–34). This new record is no exception; it is ca. 12 km further S than the previous southernmost known population in Chilton Co., Alabama (AUM records).

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***NOTOPHTHALMUS MERIDIONALIS* (Black-spotted Newt)**. MÉXICO: SAN LUÍS POTOSÍ: Municipality of Tamasopo: Agua Buena (21.95905°N, 99.392142°W; WGS84), 360 m elev. 10 November 1973. UASLP Agronomy students. Verified by Joel Vázquez Díaz. Zoological Collection, Instituto de Investigación de Zonas Desérticas, Universidad Autónoma de San Luis Potosí (CZIIZD-UASLP 1095 [lot of four samples]). First municipality record, extending the known range ca. 47 airline km W of the closest known locality at 1.6 km E Los Sabinos, Ciudad Valles, San Luis Potosí (Lemos-Espinal and Dixon 2013. Amphibians and Reptiles of San Luis Potosí. Eagle Mountain Publ., Eagle Mountain, Utah. 300 pp.). Although Flores-Villela et al. (2008. The IUCN Red List of Threatened Species. Version 2014.1. <www.iucnredlist.org>. Downloaded 22 July 2014) reported that the species has not been found more than 130 km inland, our record extends that to 176 km inland. However, the possibility exists that the Agua Buena population is extirpated, because none have been found since 1973, even though the site has been visited frequently. The newts were collected in an area covered with tropical semi-deciduous moist forest.

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***NOTOPHTHALMUS VIRIDESCENS* (Eastern Newt)**. USA: TENNESSEE: Sullivan Co.: South Holston Weir Dam Wetland, across from Osceola Island Parking Area along Holston View Dam Road (36.5237°N, 82.1108°W; WGS84). 08 February 2002. M. Kevin Hamed. Verified by A. Floyd Scott. David H. Snyder Museum of Zoology, Austin Peay State University (APSU 3326, photo of live individual). New county record (Redmond and Scott 1996. Atlas

of Amphibians in Tennessee. Misc. Publ. No 12. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Internet version [http://www.apsu.edu/amatlas] accessed 05 August 2014). Adult found in vernal pool with 37 other eastern newts.

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***PARAMESOTRITON HONGKONGENSIS* (Hongkong Warty Newt)**. CHINA: GUANGDONG: Dongguan: Longyandong Forest Park (22.901533°N, 114.226867°E, WGS84; 125 m elev.). 9 April 2014. Teppei Jono and Li Ding. Verified by Jiang Jianping. Chengdu Institute of Biology, Chinese Academy of Sciences (CIB101190–101191). New prefecture record; fills gap in range between coastal area around Hongkong (Hongkong Island, Lantao Island, Mt. Kowloon, and Shenzhen; Goldschmidt and Fu 2011. Zool. Anz. 250:19–31; Gu et al. 2012. Zootaxa 3150:59–68) and northern Guangdong (Huizhou and Longmen; Wu et al. 2010. Zootaxa 2494:45–58). Two adult females (10.7 g and 11.9 g) collected in stream within forest at 2130 h. Supported in part by Fellowship for Young International Scientists of the Chinese Academy of Sciences (Nos. Y4J3011100 and 2013Y1SA0005) to TJ and KN.

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***PSEUDOEURYCEA BELII* (Bell's Salamander)**. MÉXICO: ZACATECAS: Municipality of Nochistlán de Mejía: 9.8 km W Daniel Camarena (21.33501°N, 102. 99448°W; WGS84), 2517 m elev. 6 June 2006. Gustavo E. Quintero-Díaz and J. Jesús Sigala-Rodríguez. Verified by Bradford Hollingsworth. San Diego Natural History Museum (SDSNH HerpPC 05235). First record for municipality, extending the known range of the species ca. 56 airline km SE from the closest known locality, 0.8 km N Mesa de Palmira (La Virgen), Sierra Morones, Municipality of Tlaltenango de Sánchez Román, Zacatecas (Wilson and McCranie 1979. J. Herpetol. 13:271–278). The salamander was found beneath a rock in creek bottom in pine-oak forest.

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***PSEUDOEURYCEA GIGANTEA* (Giant False Brook Salamander)**. MÉXICO: VERACRUZ: Municipality of Altotonga: Atlixco, 1 airline km W of Hwy 131 near the Municipality of Jalacingo border (19.7725°N, 97.2608°W; WGS84), 1890 m elev. 24 November 2013. Adam G. Clause, Malcolm A. Greeley, and Karlo A. Soto Huerta. Verified by Edmundo Pérez-Ramos. Museo de Zoología, Facultad de Ciencias (MZFC 28433). First municipality record located ca. 12 km SSW from the nearest known record 6.4 km (4 mi.) S of Tlapacoyán, Municipality of Atzalán, Veracruz (Reese and Firschein 1950. Trans. Kansas Acad. Sci. 53:44–54), which also partially fills about a 35 km gap in the species' range between Tlapacoyán and La Joya, Municipality of Acajete, Veracruz (Parra-Olea et al. 2005. Herpetologica 61:145–158. We found the juvenile salamander under a log in disturbed cloud forest.

Fieldwork was approved under SEMARNAT permit #FAUT–0093 issued to A. Nieto-Montes de Oca on 17 June 2013, University of Georgia IACUC AUP #A2012 10-004-Y1-A0 issued on 27 February 2013, and with financial support of a University of Georgia Presidential Fellowship We thank Sr. Jose Luis Vazquez Mora for property access, and A. Nieto-Montes de Oca for allowing us to collect under his permit.

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ANURA — FROGS

***AGALYCHNIS DACNICOLOR* (Mexican Leaf Frog)**. MÉXICO: GUERRERO: Municipality of Coyuca de Catalán: Los Placeres del Oro (18.23814°N, 100.902°W; WGS84), 388 m elev. 21 March 2014. Elí García-Padilla. Verified by Jonathan A. Campbell. UTADC 8130. First record for the municipality, extending the range 44 km SW from the nearest locality at Huetamo, Michoacán (Duellman 1961. Univ. Kansas Publ. Mus. Nat. Hist. 15:1–148) and 139 km NW from the nearest locality within Guerrero, at Tecpan de Galeana (Duellman 2001. The Hylid Frogs of Middle America, Vol. 1. SSAR Contrib. Herpetol. 18: i–xvi + 694 pp.). Three adult frogs (one vouchered) were hidden in humid shaded places inside different houses.

ALFONSO HERNÁNDEZ-RÍOS, Laboratorio de Herpetología, Instituto de Biología, Universidad Nacional Autónoma de México, D.F. 04510, México (e-mail: alfonsohrios@gmail.com); **ELÍ GARCÍA-PADILLA**, Andador Jaguares #18 Casa del Sol, Oaxaca de Juárez 68023, México (e-mail: eligarcia18@hotmail.com).

***ANAXYRUS AMERICANUS* (American Toad)**. USA: TENNESSEE: Sullivan Co.: Steele Creek Park Wetlands, ~200 m from Rooster Front Parking Area along the lakeside trail (36.5621°N, 82.2243°W; WGS84). 4 March 2004. M. Kevin Hamed. Verified by A. Floyd Scott. David H. Snyder Museum of Zoology, Austin Peay State University (APSU 19509, photo of live individual). New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No 12. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Internet version [http://www.apsu.edu/amatlas]; accessed 05 August 2014). Adult was observed with ~250 other American Toads of which ~50 pairs were in amplexus and depositing eggs.

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***ANAXYRUS WOODHOUSII* (Woodhouse's Toad)**. USA: COLORADO: Teller Co.: DOR near Fourmile Creek 0.3 km N and 0.17 km W the ghost town of Marigold (38.6628124°N, 105.2237474°W; NAD83; elev. 2093 m). 21 August 2014. Lauren J. Livo, Harry Taylor, and Steve Wilcox. Verified by Bradley Lambert. University of Colorado (UCM Ancillary Collection AC-181 1–3, digital vouchers). First county record (Hammerson 1999. Amphibians and Reptiles in Colorado, 2nd ed. University Press of Colorado, Niwot, Colorado. 484 pp.). Extends the range approximately 16–20 km from the nearest records in Fremont Co.

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***DIAGLENA SPATULATA* (Duck-bill Hylid Frog)**. MEXICO: NAYARIT: Municipio Santiago de Compostela: Sierra de Vallejo (21.02793°N, 105.12292°W; WGS84), 270 m elev. 23 June 2013. Guillermo A. Woolrich-Piña. Verified by Julio A. Lemos-Espinal. Museo de Zoología, Unidad Académica de Agricultura, Universidad Autónoma de Nayarit (MZUAN 158,159). First municipality records and a range extension of ca. 31 km NE of the closest known locality, ca. 6 km SE of Sayulita, Municipality of Bahia de Banderas, Nayarit (Webb 1971. J. Herpetol. 5:185–187). The two adult males were found around 1017 h in a temporary pond formed the previous night.

Field work was supported by the PROMEP project "Los vertebrados de la Sierra de Vallejo" (to JPRS) and CONACyT (postdoctoral fellowship to GAWP).

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***ELEUTHERODACTYLUS* (=*SYRRHOPHUS*) *MARNOCKII* (Cliff Chirping Frog)**. USA: TEXAS: Presidio Co.: Sierra Vieja Mountains, Camp Holland (30.548798°N, 104.660618°W; WGS84). 15 August 2014. Jacob D. Owen and Thomas L. Marshall. Verified by Thomas J. Devitt. Texas Natural History Collections (TNHC 92330). This specimen represents a northwestward range expansion of the previously recognized westernmost boundary of this species in Texas, and represents the first vouchered specimen from the Sierra Vieja Mountains in northwestern Presidio Co. (Jameson and Flury 1949. Texas J. Sci. 1:54–79; T. J. LaDuc, pers. comm.). Adult male (SVL 32 mm; 2.2 g) found crossing dirt road near Carriage House at Camp Holland at 2321 h.

We recognize this specimen as *E. marnockii* based on phenotypic similarity to individuals from the Edwards Plateau, following Milstead et al. (1950. Texas J. Sci. 2:543–562). This species had previously been heard calling in canyons at this locality; however, collection attempts over the last 60 years have been unsuccessful (Jameson and Flury 1949, *op cit.* and T. J. LaDuc, pers. comm.). To the best of our knowledge, only two other voucher specimens of this species have been collected in Presidio Co., both in 1968 from San Esteban Lake (19.3 km SE of Marfa, Texas; Texas Cooperative Wildlife Collections [TCWC] 26056, 26057), ~74 km SW of Camp Holland. The next nearest locality of this species is from two specimens collected in 1964 from Musquiz Canyon, SE of Fort Davis (likely where it bisects the Arkansas and Puertacitas Mountains; TCWC 81651, 81652) in southeastern Jeff Davis Co., ~88 km E of Camp Holland. These four TCWC specimens are currently catalogued as *E. guttilatus*.

Specimen collected under a Texas Parks and Wildlife Scientific Research Permit (SPR-1097-912) issued to Travis J. LaDuc. We thank the Miller family for their continued support and assistance.

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***ELEUTHERODACTYLUS PLANIROSTRIS* (Greenhouse Frog)**. USA: MISSISSIPPI: Hinds Co.: Jackson (32.31342°N, 90.16976°W; WGS84). 11 June 2014. Wenhua Lu, Tom Mann, and Debora L. Mann. Mississippi Museum of Natural Science (MMNS 10386). Verified by Robert L. Jones. New county record (Dinsmore 2004. Herpetol. Rev. 35:403). A second specimen (MMNS 10475) was found on 29 August, 3 km distant.

Introduced species previously recorded in Mississippi from a greenhouse in Oktibbeha Co. (Starkville), about 180 km NE, and from Harrison Co. (Gulfport) (Dinsmore 2004, *op. cit.*), about 238 km SE. Recently also collected in Jackson Co. (Ocean Springs, Jennifer Y. Lamb, pers. comm.). The specimen captured 11 June was calling from a mound of vegetative debris in a steep, wooded ravine in the Belhaven residential neighborhood. A toe was clipped for DNA analysis. Approximately 5–6 individuals were calling concurrently nearby. One that subsequently escaped was photographed on the leaf of a shrub at the height of approximately 1 m. A brief survey for calling frogs was undertaken by car and on foot in the same neighborhood on the night of 14 June 2014. The species was heard at the collection site and at seven other sites within 1 km. MMNS 10475 was captured from the Belhaven site in the Fondren residential neighborhood when it escaped from a cat. Others were heard calling nearby; the species had previously been heard several blocks to the southwest. The presence of the frogs in multiple locations over a distance of at least 3 km suggests that the species is locally established in Jackson. To our knowledge this represents the most northerly and inland established population. The population apparently survived a cold Winter; the US National Weather Service recorded 62 days between October 2013 and April 2014 when the temperature reached 0ºC or lower in Jackson (National Weather Service, Jackson, MS Weather Forecast Office. http://www.srh.noaa.gov/jan/?n=climate_zone_jan_90_100_degs, updated 12 September2014, accessed 12 September2014). The means of introduction is not known; the Gulfport population is suspected to have arrived on nursery stock (Dinsmore 2004, *op. cit.)*.

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***ELEUTHERODACTYLUS PLANIROSTRIS* (Greenhouse Frog)**. PHILIPPINES: MINDANAO ISLAND: Davao City, Ladislawa Villages (7.09697°N, 125.60933°E, WGS84; 32 m elev.). 4 May 2014. Christina A. Olson and Arvin C. Diesmos. Verified by Fred Kraus. National Museum of the Philippines (PNM 9088–9097). First detected through its distinct advertisement call, 24 October 2013, several individuals of both male and female frogs found under landscape plants and garden rocks in residential area of large, urban city. A follow-up survey on 4 May 2014 indicated an established population, with frogs observed in area of at least four blocks (~10 ha). Ten individuals collected. A review of Philippine non-native amphibians did not include records of this species (Diesmos et al. 2010. J. Environ. Sci. Manag. 9:411–53). Because

of its cryptic call and appearance, individuals may be introduced to new localities and overlooked until population is established (Olson et al. 2012. Biol. Inv. 14:889–900). Inquiries with local residents indicate that this population may have been in the area for at least two to five years. First record for Philippines and Southeast Asia, extending its non-native range in Pacific Basin. Nearby localities with introduced populations include Guam and Hawaii; it is native to Cuba, Cayman Islands, and Bahama Islands (Olson et al. 2012. Pac. Sci. 66:255–270).

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***ELEUTHERODACTYLUS* (*EUHYAS*) *PLANIROSTRIS* (Greenhouse Frog)**. HONDURAS: La Paz: Hotel Del Angel, La Paz, (14.321117°N, 87.676800°W; WGS84), 650 m elev. 24 June 2013. Alexander Gutsche and James R. McCranie. Verified by Mark O. Rödel. Museum für Naturkunde (ZMB 79254–79255). First records for La Paz and only the third Honduran record for this introduced frog. The two previously reported populations are from San Pedro Sula, Cortés (McCranie et al. 2007. Herpetol. Rev. 39:362–363), ca. 140 km NNW of La Paz, and on Guanaja Island, Islas de la Bahía (McCranie and Valdés Orellana 2014. Herpetol. Notes 7:41–49). The two juvenile frogs were discovered at night in a well-watered garden on the hotel grounds. Other juveniles and two adults were also observed in a pool at the site, as well as males calling from inside cracks of a concrete-lined basin protecting water pipes; presence of adults and juveniles indicates an established breeding population. The hotel owners told us that the mostly exotic plants in the garden were trucked to the hotel from a nursery in Tegucigalpa, Distrito Central, Honduras.

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***ELEUTHERODACTYLUS RIPARIUS* (Cuban Stream Frog)**. CUBA: MATANZAS: Archipiélago Sabana-Camagüey: Cayo Cinco Leguas, Cinco Leguas Key (23.1305°N, 80.9134°W; WGS84), 28 September 2001. Blas Pérez. Verified by Ariel Rodríguez. Herpetological Collection of the Instituto de Ecología y Sistemática, Habana, Cuba (CZACC 14.482–83). First record for Cinco Leguas Key, northernmost record for the species, and a range extension of 233.3 km from the nearest record on Coco Key (Estrada and Hedges 1998. Carib. J. Sci. 34:218–230). Henderson and Powell (2009. Natural History of West Indian Reptiles and Amphibians, Univ. Florida Press, Gainesville. 495 pp.) assumed that this species is distributed all along this archipelago, but did not cite voucher material. The frogs were found in a riparian habitat and is only one of five anuran species known on the Archipelago from that type of ecosystem (Díaz and Cádiz 2008. AbcTaxa 4:1–294).

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***GASTROPHRYE CAROLINENSIS* (Eastern Narrow-mouthed Toad)**. USA: ARKANSAS: Searcy co.: Off AR 14, ca. 2 km down Ramblewood Trail by private residence (36.056782°N; 92.604386°W; WGS84). 2 July 2014. J. S. Hicks. Verified by S. E. Trauth. Arkansas State University Museum of Zoology Herpetology Collection (ASUMZ 33248 adult). First county record, filling a distributional hiatus among adjacent, Marion, Baxter, and Stone counties (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville. 421 pp.).

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***GASTROPHRYNE CAROLINENSIS* (Eastern Narrow-mouthed Toad)**. USA: TENNESSEE: Hickman Co.: 7570 Pinewood Road, Nunnelly, Tennessee 37137 (35.9134°N, 87.40668°W; WSG 84). 16 June 2014. Derek Weber, Hella Weber, and Nicole Foster. Verified by A. Floyd Scott. David H. Snyder Museum of Zoology, Austin Peay State University (APSU 19513). New county record (Scott and Redmond 2008 [latest update 27 July 2014]. Atlas of Amphibians in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/amatlas/, accessed 15 August 2014).

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***GASTROPHRYNE CAROLINENSIS* (Eastern Narrow-mouthed Toad)**. USA: TENNESSEE: Marshall Co.: Chapel Hill, Moss Road (35.667116°N, 86.754835°W; WGS84). 11 June 2014. Daniel Moss. Verified by A. Floyd Scott. David H. Snyder Museum of Zoology, Austin Peay State University (APSU 19505, acoustical recording voucher). New county record (Redmond and Scott 1996. Atlas of Amphibian in Tennessee. Misc. Publ. No. 12, The Center of Excellence for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Internet version [latest update 19 May 2014]. Available at http://apbrwww5.apsu.edu/amatlas/, accessed 7 July 2014). Calling from edge of puddle and wet grassy area.

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***GASTROPHYRNE OLIVACEA* (Western Narrow-Mouthed Toad)**. USA: TEXAS: Blanco Co.: Bamberger Ranch Preserve (30.200982°N, 98.443348°W; NAD83). 4 June 2011. David O. Ribble. Verified by Travis Laduc. Texas Natural History Collections (TNHC 92239). New county record (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 447 pp.). Nearest record ca. 15 km W in Gillespie County and ca. 20 km E in Hays Co. One individual was caught in a pitfall trap used for assessing the biodiversity at the Bamberger Ranch Preserve.

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***HOPLOBATRACHUS CRASSUS* (Jerdon's Bullfrog)**. BANGLADESH: RANGPUR DIVISION: Rangpur District: Khoragach Village,

Mithapukur (25.6501880°N, 89.1760460°E, WGS84; 35 m elev.). 9 June 2014. Hassan Al-Razi. From paddy field. Adult male. Verified by Jayaditya Purkayastha. Museum of Zoology, Jagannath University, Dhaka, Bangladesh (JnU/ZooM/Amp/2014/0011). First record for Rangpur District, Bangladesh; previously recorded from Saidpur, Nilphamari District (Sarker et al. 2012. Herpetol. Rev. 43:298), and Chittagong (Asmat et al. 2003. Univ. Rajshahi J. Zool. 22:141–143). Current record > 13 km NE from Rangpur and > 35 km NW from Nilphamari, the nearest records. Habitat was *Cynodon dactylon* and *Mangifera indica* plantations.

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***HYALINOBATRACHIUM FLEISCHMANNI* (Fleischmann's Glass Frog)**. MÉXICO: VERACRUZ: Municipality of Las Choapas: Ejido Piedritas (17.55059°N, 94.13993°W; WGS84), 70 m elev. 2 September 2013. Arturo Arellano-Covarrubias, Uri O. García-Vázquez, and Carlos J. Pavón-Vázquez. Verified by Andrés A. Mendoza Hernández. Museo de Zoología, Facultad de Ciencias (MZFC 28393). First record for the municipality (Aguilar-López and Canseco-Márquez 2006. Bol. Soc. Herpetol. Mex. 14:20–37). The closest reported record is from 108 airline km E at 23.1 mi. S of Pichucalco, Chiapas (Muñoz-Alonso and March Mifsut 2003. Bases de Datos SNIB 2010-CONABIO proyectos No. UO14 y P132). The male was captured at night vocalizing on a palm leaf ca. 2 m above the ground, in tropical evergreen forest directly above a riverbank.

The specimen was taken under a scientific collecting permit issued to Uri O. García-Vázquez by the Secretaría de Medio Ambiente y Recursos Naturales.

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***KALOULA TAPROBANICA* (Sri Lankan Bull Frog)**. BANGLADESH: DHAKA DIVISON: Mymensingh District: Bangladesh Agricultural University Campus (24.719625°N, 90.426658°E, WGS84; 147 m elev.). 21 June 2014. Md. Monjurul Islam Talukdar and Md Nurul Islam. Adult at 1930 h from a human-dominated grassland near Fazlul Haque Hall of Bangladesh Agricultural University. Verified by I. Das. Photographic voucher deposited at Lee Kong Chian Natural History Museum (previously Raffles Museum of Biodiversity Research), National University of Singapore (ZRC[IMG] 1.68a–c). Only prior country record is from deciduous forests of Madhupur National Park, Gazipur District, central Bangladesh (Reza and Mahony 2007. Herpetol. Rev. 38:348). This is the first report for Mymensingh District, ca. 160 km E of previous location.

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***LEPTODACTYLUS CHAQUENSIS* (White-lipped Frog)**. BRAZIL: PIAUÍ: Municipality of Floriano: 6.787778°S, 43.041667°W (SAD 69). 6 February 2013, M.S.C.S. Lima. Verified by U. Caramaschi. Museu Nacional, Rio de Janeiro (MNRJ 87532–87534). The species has a wide distribution in South America. Although there are gaps in the known distribution, it has been recorded from Brazil, Paraguay, eastern Bolivia, northern Argentina, and Uruguay. In Argentina and Paraguay, its occurrence is mainly reported to the Gran Chaco formations and its ecotonal regions. In Brazil, its occurrence is known to the states of Acre, Rondônia, Mato Grosso, Mato Grosso do Sul, Minas Gerais, São Paulo, Rio Grande do Sul, and Paraná. More precisely its occurrence in Brazil is confirmed to the ecoregions of Pantanal biome in the states of Mato Grosso and Mato Grosso do Sul and in the Cerrado biome of the states of Mato Grosso, Mato Grosso do Sul, Minas Gerais, and São Paulo, as well as in the transitional ecoregions of the State of Rio Grande do Sul (Frost 2014. Amphibian Species of the World: an Online Reference. Version 6.0. http://research.amnh.org/vz/herpetology/amphibia/; Heyer and Giaretta 2009. Proc. Biol. Soc. Washington 122:292–305). This first state record for Piauí increases the occurrence at least 800 km NE from the Cerrado biomes of Minas Gerais and represents the first record of the species within the Cerrado biome of northeastern Brazil; this suggests that the species is widespread in this Brazilian biome.

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***LITHOBATES CATESBEIANUS* (American Bullfrog)** USA: ALABAMA: Crenshaw Co.: wetland 30 m N of Crenshaw County Rd., 30 and 160 m E of Piney Woods Creek (31.84732°N, 86.21375°W; WGS84). 03 July 2013. M. Herr and S. Graham. Verified by David Laurencio. Auburn University Natural History Museum (AUM AHAP-D 750, digital photo voucher). New county record (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn Printing Co., Auburn. 347 pp.).

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***LITHOBATES CATESBIANUS* (American Bullfrog)**. USA: TENNESSEE: Sullivan Co.: Cedar Creek Wetlands, along Springbrook Drive off Greenfield Place in Bristol, TN (36.5484°N, 82.20933°W; WGS84). 13 May 2005. M. Kevin Hamed. Verified by A. Floyd Scott. David H. Snyder Museum of Zoology, Austin Peay State (APSU 19512, photo of live individual). New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No 12. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Internet version [http://www.apsu.edu/amatlas], accessed 05 August 2014).

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***OCCIDOZYGA BOREALIS* (Northern Frog)**. BANGLADESH: CHITTAGONG DIVISON: Chittagong District: Sitakunda (22.621425°N, 91.674861°E, WGS84; 54 m elev.). 6 September 2013. Md Abdur Razzaque Sarker. Verified by Stephen Mahony. Museum of Herpetology Laboratory, Ichamati College, Dinajpur, Bangladesh (MHLB-OB01). Adult beside rock in slow-moving steam, within dense hill forest, at 2300 h. First record for Chittagong District. Previously reported from the Rangamati Hilly area (Asmat 2005. Bangladesh Wildl. Netwrk. 2[1]:1–33), and from Bandarban District (Ali Reza 2008. Herpetol. Rev. 39:235) of Chittagong Hill Tracts.

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***OSTEOPILUS SEPTENTRIONALIS* (Cuban Tree Frog)**. USA. FLORIDA: Santa Rosa Co.: Eglin Air Force Base, 1.06 km WNW of intersection of SR 87 and Vonnie Tolbert Rd (30.471166°N, 86.921091°W; WGS84). 12 June 2014. B. K. Rincon, K. C. Jones. Verified by Kenneth L. Krysko. Florida Museum of Natural History (UF 173049 photographic voucher and preserved specimen). New county record (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final report, Project Agreement 08013, Florida Fish and Wildlife Conservation Commission, Tallahassee. 524 pp.) Extends the range roughly 44.5 km ENE of the nearest record in Escambia Co. (UF 170528), and roughly 128.0 km WNW of the second nearest record in Bay Co. (UF 142698).

While conducting an aural survey on 9 June 2014 at 2000 h we heard a single male *Osteopilus septentrionalis* calling. On 12 June 2014 at 2000 h we returned to the same site and used an audio recording of *O. septentrionalis* to locate and capture one male at 2030 h. The frog was calling from a *Cyrilla racemiflora* (titi) branch over an approximately 10 m-long ephemeral pool with native emergent herbaceous vegetation, surrounded by dense shrub thickets on a power line right-of-way. We detected seven other anuran species calling in the vicinity, including *Acris gryllus* (Southern Cricket Frog), *Gastrophryne carolinensis* (Eastern Narrow-mouthed Toad), *Hyla andersonii* (Pine Barrens Treefrog), *H. cinerea* (Green Treefrog), *H. femoralis* (Pine Woods Treefrog), *L. clamitans* (Bronze Frog), and *L. sphenocephalus* (Southern Leopard Frog). Historically, *L. okaloosae* was found here as well. This appears to be the first documented case of *O. septentrionalis* using *L. okaloosae* and *H. andersonii* habitat.

We conducted 12 focused surveys in the surrounding area, in addition to the >140 locations on Eglin AFB that we survey three times annually. We detected no additional *O. septentrionalis*. While isolated individuals could be missed, we concluded that multiple males (i.e., a breeding population) were less likely to be missed. We believe that this specimen represents a lone individual that was transported unintentionally (e.g., on a vehicle) to Santa Rosa Co. from a more established population in peninsular Florida.

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***OSTEOPILUS SEPTENTRIONALIS* (Cuban Treefrog)**. USA: FLORIDA: Walton Co.: ~5 km SW Santa Rosa Beach; 0.5 km S jct CR30A/US98 (30.370484°N, 86.274019°W; WGS84). 3 May 2014. M. B. Connior. Verified by S. E. Trauth. Arkansas State University Museum of Zoology Herpetology Collection (ASUMZ 33246, adult male). First record for the county and the northwestern-most record for Florida, with the closest record being Bay County (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final report, Project Agreement 08013, Florida Fish and Wildlife Conservation Commission, Tallahassee. 524 pp.).

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***PSEUDACRIS CRUCIFER* (Spring Peeper)**. USA: TENNESSEE: Sullivan Co.: South Holston Weir Dam Wetland, across from Osceola Island Parking Area along Holston View Dam Road (36.5237°N, 82.1108°W; WGS84). 27 March 2004. M. Kevin Hamed. Verified by A. Floyd Scott. David H. Snyder Museum of Zoology, Austin Peay State University (APSU 19511, photo voucher). New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No 12. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Internet version [http://www.apsu.edu/amatlas]; accessed 05 August 2014). Adult vocalizing in a vernal pool with 75 other Spring Peepers and observed amplexus. I also noted 10 additional adults crossing Holston View Dam Road migrating toward the vernal pool.

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***PSEUDACRIS NIGRITA* (Southern Chorus Frog)**. USA: GEORGIA: Miller Co.: Mayhaw WMA, primary WMA dirt road, 0.43–0.48 road km N of Griggs Road intersection (31.20073°N, 84.79092°W; WGS84). William W. Booker and Steve J. Hromada. 21 March 2014. Verified by Nikole Castleberry. Georgia Museum of Natural History (GMNH 50698–50699). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens, Georgia. 575 pp.). Two adults (one female, one male) captured swimming or calling in vernal pools within a larger ephemeral wetland. Whole-body, tissue, and digital photo vouchers collected.

Work approved under authority of Georgia DNR Scientific Collecting Permit #29-WJH-13-191 issued on 20 June 2013, and University of Georgia IACUC AUP #A2012 10-004-Y1-A0 issued on 27 February 2013. We thank the instructors and students of the UGA Herpetology course for their assistance.

WILLIAM W. BOOKER (e-mail: wbooker14@gmail.com), and **ADAM. G. CLAUSE**, Warnell School of Forestry and Natural Resources, University of Georgia, 180 East Green Street, Athens, Georgia 30602, USA (e-mail: adamclause@gmail.com); **STEVE J. HROMADA**, Joseph W. Jones Ecological Research Center, 911 Crafton Palmer Road, Colquitt, Georgia 39837, USA.

***SCAPHIOPUS HOLBROOKI* (Eastern Spadefoot Toad)**. USA: TENNESSEE: Loudon Co.: Fork Creek Road (35.66727°N, 84.34839°W; WGS84). 9 August 2013. Stephen K. Nelson. Verified by A. Floyd Scott. David H. Snyder Museum of Zoology, Austin Peay State University (APSU 19470, color photo). First county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Internet version, available at http://apsu.edu/amatlas/ [updated 27 July 2014]; accessed 21 September 2014). Several metamorphs found on road in light rain at night. Fills distribution gap within Tennessee Valley.

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***SPEA BOMBIFRONS* (Plains Spadefoot)** USA: TEXAS: Brewster Co.: Found AOR on U.S. Hwy 90, 20.1 km ESE of Alpine (30.30897°N, 103.45970°W; WGS84). 16 August 2014. S. Graham and C. Kelehear. Verified by Toby Hibbits. Sul Ross State University (SRSU-D 1, digital photo voucher and SRSU-D 2, digital audio voucher). A second specimen, SRSU 6639, was collected on 06 September 2014. New county record (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 447 pp.).

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***ZAKERANA TERAIENSIS* (Terai Cricket Frog)**. BANGLADESH: RANGPUR DIVISION: Rangpur District: Khoragach Village (25.6501880°N, 89.1760460°E, WGS84; 35 m elev.). 9 June 2014. Hassan Al-Razi. Verified by Jayaditya Purkayastha. Museum of Zoology, Jagannath University, Dhaka, Bangladesh (JnU/ZooM/Amp/2014/0010). Adult male collected in paddy field. First record from Rangpur District, Bangladesh; previously recorded from Singra National Park, Dinajpur (Sarker 2013. Herpetol. Rev. 44:271), Dhaka (Sarker 2012. Herpetol. Rev. 43:440), Moulvibazar (Rahman 2011. Herpetol. Rev. 42:562), Chittagong, Cox's Bazaar, Noakhali, and Barisal (Rasel et al. 2007. Bannopraní-Bangladesh Wildl. Bull. 4:1–2). Current population is located 67 km NW of Singra National Park, Dinajpur, nearest previously known population. Habitat was *Cynodon dactylon* plantations.

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TESTUDINES — TURTLES

***APALONE SPINIFERA* (Spiny Softshell)**. USA: GEORGIA: Catoosa Co.: South Chickamauga Creek east of Sandstone Creek Drive North of Ringgold (34.936030°N, 85.119756°W; WGS84) 8 July 2014. Joshua R. Ennen, Bernie R. Kuhajda, and Brett Albanese. Verified by Kenneth L. Krysko. Florida Museum of Natural History (UF-Herpetology 173669 digital color photo voucher). New county record (Jensen et al. [eds.] 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). One adult male captured in a seine.

JOSHUA R. ENNEN (e-mail: jre@tnaqua.org), and **BERNIE R. KUHAJDA**, Tennessee Aquarium Conservation Institute, Chattanooga, Tennessee, USA; **BRETT ALBANESE**, Georgia Department of Natural Resources, Social Circle, Georgia, USA (e-mail: Brett.Albanese@dnr.state.ga.us).

***APALONE SPINIFERA* (Spiny Softshell)**. USA: TENNESSEE: Madison Co.: Jackson, Cypress Grove Nature Park, Wood Duck Lake (35.616972°N, 88.866458°W; WGS84). 28 May 2014. Corey L. Albert and Brian P. Butterfield. Verified by A. F. Scott. David H. Snyder Museum of Zoology, Austin Peay State University (APSU 19500 photographic voucher). New county record (Scott and Redmond 2008 [latest update: 19 May 2014]. Atlas of Reptiles in Tennessee. Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/, accessed 28 May 2014). One adult male was incidentally caught with fishing tackle.

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***CHRYSEMYS PICTA* (Painted Turtle)**. USA: IOWA: Plymouth Co.: Deer Creek Wildlife Management Area (42.71898°N, 96.50965°W; WGS84). 12 June 2014. Alice R. Millikin. Verified by Jessa L. Watters. Sam Noble Oklahoma Museum of Natural History (OMNH 44140). New county record (LeClere 2013. A Field Guide to the Amphibians and Reptiles of Iowa. ECO Herpetological Publishing & Distribution, Rodeo, New Mexico. 349 pp.). This specimen fills a gap in the known distribution of this species in Iowa. Previous records exist from surrounding counties in Iowa (Sioux, Cherokee, Woodbury) as well as to the west in Union Co., South Dakota. Juvenile collected from shallow margin of a reservoir. Specimen collected under a Iowa Department of Natural Resources Fishing License.

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***CHRYSEMYS PICTA* (Painted Turtle)** USA: SOUTH CAROLINA: Marlboro Co.: Haire Town Rd. (34.784695°N, 79.799319°W; WGS1984). 18 June 2014. James W. Dillman. Verified by Scott Pfaff. Campbell Museum of Natural History at Clemson University (CUSC 2911 in accession folder 1177, photo voucher). New county record (Beane et al. 2010. Amphibians and Reptiles of the Carolinas and Virginia, 2nd ed. University of North Carolina Press, Chapel Hill. 274 pp.; Jeff Camper, pers. comm.). Adult male DOR between two wet swampy areas associated with Whites Creek.

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***DEIROCHELYS RETICULARIA* (Chicken Turtle)**. USA: ALABAMA: Bullock Co.: Midway, 0.8 km W of AL Hwy 51 intersection (32.07863°N, 85.52514°W; WGS84). 8 August 2011. E. Soehren. Verified by David Laurencio. Auburn University Natural History Museum (AUM AHAP-D 816, digital photo voucher). New county record (Mount 1975. The Reptiles and Amphibians of Alabama. Agricultural Experiment Station, Auburn University, Alabama. 347 pp.). Found AOR in center of U.S. Hwy 82 within Midway town limits. Turtle was missing left forelimb, but otherwise showed no signs of injury or poor health. Individual captured, photographed, and released at a pond near the collection site. This record was vetted through examination of online museum holdings (VertNet; HerpNET) and thorough literature review (Zoological Record).

A second Bullock Co. specimen was encountered on the Wehle Forever Wild Tract (AUM AHAP-D 817, digital photo voucher).

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***GRAPTEMYS OUACHITENSIS* (Ouachita Map Turtle)**. USA: LOUISIANA: West Baton Rouge Parish: southeast side of Addis

(30.356655°N, 91.249009°W; WGS84). 22 March 2014. Brennan Landry. Verified by Jeff Boundy. Louisiana Museum of Natural History (LSUMZ 98350). First parish record (Dundee and Rossman 1989. The Amphibians and Reptiles of Louisiana. Louisiana State University Press, Baton Rouge, Louisiana. 300 pp.). Specimen collected in borrow pit in Mississippi River batture.

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***GRAPTEMYS PSEUDOGEOGRAPHICA KOHNII* (Mississippi Map Turtle)**. USA: LOUISIANA: West Baton Rouge Parish: southeast side of Addis (30.356655°N, 91.249009°W; WGS84). 20–22 March 2014. Brennan Landry. Verified by Jeff Boundy. Louisiana Museum of Natural History (LSUMZ 98351–98353). First parish record (Dundee and Rossman 1989. The Amphibians and Reptiles of Louisiana. Louisiana State University Press, Baton Rouge, Louisiana. 300 pp.). Specimens collected in borrow pit in Mississippi River batture.

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***PLATEMYS PLATYCEPHALA PLATYCEPHALA* (Twist-necked Turtle)**. BRAZIL: AMAZONAS: Municipality of Maraã: Coracizinho stream, at the Amanã Sustainable Development Reserve (2.590833°S, 64.886389°W; WGS84). 01 July 2004. J. Valsecchi. Verified by A. L. C. Prudente. Coleção Herpetológica do Museu Paraense Emílio Goeldi, Belem, Pará, Brazil (MPEG 556), collected in tropical upland forest with a pitfall trap located near a shallow forest pool. Ubim stream, at the Amanã Sustainable Development Reserve (2.4675°S, 64.575278°W; WGS84). 12 April 2014. D. G. Rocha and T. Q. Morcatty. Verified by W. Dutra. Coleção Herpetológica do Instituto de Desenvolvimento Sustentável Mamirauá, Tefé, Amazonas, Brazil (HERPETO 0658), found close to the shoreline of a shallow, muddy, and slow-water stream, in tropical upland forest. Municipality of Jutaí: left margin of Jutaí River, at the Jutaí River Extractive Reserve (3.253056°S, 67.326389°W; WGS84). 11 June 2014. T. Q. Morcatty. Verified by W. Dutra. HERPETO 0659. *Platemys p. platycephala* is potentially distributed in the whole Amazon region (Almonacid et al. 2007. Las Tortugas y los Cocodrilianos de los Paises Andinos del Tropico. Conservacion Internacional, Bogotá, Colombia. 467 pp.) and some specimen collections confirmed its occurrence in Ecuador, Venezuela, Guyana, French Guiana, Surinam, Colombia, Peru, Bolivia, and Brazil (Ernst 1983 J. Herpetol. 17:345–355; Pritchard and Trebbau 1984. The Turtles of Venezuela. SSAR Contrib. Herpetol. No. 2, Oxford, Ohio. 403 pp.; Cisneros 2006 Biota Neotrop. 6:3–16). In Brazil, the species has been recorded from the states of Mato Grosso, Acre, Pará, and Amazonas (Ernst 1983, *op. cit.*; Bernarde et al. 2011 Biota Neotrop. 11[3]:117–144; Molina et al. 2009 Check-List 5[3]:714–716; Ferrara et al. 2009 Herpetol. Rev. 40[2]:236;). In Amazonas state, the species was recorded at the east and west ends of the state, leaving a gap of 1120 km between Manaus and Tabatinga (Ernst 1983, *op. cit.*). The nearest known record to the new records in Maraã is 555 km E, in the lower Amazon River, near Manaus, Amazonas, Brazil (Ernst 1983, *op. cit.*). The new record in Jutaí is 317 km SW of nearest record for the Yavarí River, near Tabatinga, Amazonas, Brazil (Ernst 1983, *op. cit.*). Due to the difficulty of detecting individuals, the distribution of this secretive species is poorly documented, and these records extend its confirmed distribution area to include the central part of the Amazon. License number SISBIO 43620-1 by Instituto Chico Mendes de Conservação da Biodiversidade.

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***PSEUDEMYS CONCINNA* (River Cooter)**. USA: TEXAS: Comal Co.: New Braunfels, Landa Lake Park, Comal Springs. (29.713446°N, 98.135651°W; WGS84). 7–20 April 2014. Verified by Carl J. Franklin. Amphibian and Reptile Diversity Research Center, University of Texas at Arlington (UTADC 8191–8193, photo voucher). New county record (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 447 pp.).

An adult male was captured by hand. This specimen represents a range extension of approximately 350 km from the closest known locality in eastern Texas (Dixon 2013, *op. cit.*). This is not a species that would be considered common in the pet trade. It is unclear if this animal represents an individual release or an established population. We hope that sampling conducted over the next several years will allow us resolve this issue.

North American Freshwater Turtle Research Group (NAFTRG) was conducting its summer long-term turtle population study under permit # SPR-0212-019.

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***STERNOTHERUS CARINATUS* (Razor-backed Musk Turtle)**. USA: LOUISIANA: Cameron Parish: 1.2 km S of Jefferson Davis/Cameron Parish line and 0.3 km E of Cameron Parish Road 123 (30.0283678°N, 92.7700590°W; WGS84). 9 July 2013. Cybil Covic Huntzinger and Katie Cantrelle. Verified by P. Lindeman. Florida Museum of Natural History Herpetology Department (UF 173771, photo archive). New parish record (Dundee and Rossman 1989. The Amphibians and Reptiles of Louisiana. Louisiana State University Press, Baton Rouge. 300 pp.).

Individual was trapped in the Mermentau River using a single-throated hoop net and baited with frozen menhaden. Trap was set in shallow water near riverbank between two Bald Cypress trees (*Taxodium distichum*). This record, in addition to another individual trapped 8 July 2013, extends the previously documented range south approximately 32.5 river km from the town of Mermentau (Jefferson Davis Parish) into Cameron Parish (HerpNet database search, http://www.herpnet.org; J. Boundy, pers. comm.).

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***STERNOTHERUS ODORATUS* (Eastern Musk Turtle)**. USA: ALABAMA: Bullock Co.: Wehle Forever Wild Tract, 6.1 km SE of AL Hwy 51 and Bullock CR 47 (Pleasant Hill Road) intersection. (32.03623°N, 85.46856°W; WGS84). 15 June 2010. E. Soehren and J. Trent. Verified by David Laurencio. Auburn University Natural History Museum (AUM AHAP-D 826, digital photo voucher).

New county record (Mount 1975. The Reptiles and Amphibians of Alabama. Agricultural Experiment Station, Auburn University, Alabama. 347 pp.). Adult female found partially covered in leaf litter along trail in open, mature floodplain forest. Individual captured, photographed, and released. This record fills in county gap adjacent to Montgomery, Macon, Russell, and Barbour counties within the upper Coastal Plain region (Mount 1975, *op. cit.*) and was vetted through examination of online museum holdings (VertNet; HerpNET) and thorough literature review (Zoological Record).

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***STERNOTHERUS ODORATUS* (Eastern Musk Turtle)**. USA: ILLINOIS: Carroll Co.: Thomson Causeway Recreation Area (41.950242°N 90.115769°W; WGS84). 27 July 2014. Sarah M. Mitchell, Julie M. Wiemerslage, Hayley K. Madland, and William A. Manriquez. Verified by Fredric J. Janzen. Iowa State University Amphibian and Reptile Research Collection (ISUA 201401, three digital photographic vouchers). New county record (Phillips et al. 1999. Field Guide to Amphibians and Reptiles of Illinois. Illinois Natural History Survey, Urbana, Illinois. 282 pp.). One adult male (12.2 cm straight line carapace length, 0.79 cm straight line carapace width) was caught in an aquatic hoop trap attached to a 2.5 m seine. The species is documented from adjacent Whiteside Co. to the south (Phillips et al. 1999, *op. cit.*).

Aquatic trapping of turtles has been performed at the Thomson Causeway for approximately 20 years with no previous captures of *S. odoratus*; thus, this specimen may indicate a recent expansion of the range. Alternately, the previous lack of detection of this species could be attributed to trapping bias. Beginning in May 2014, 2.5-cm mesh traps were deployed, which may have increased the likelihood of capture over the 5-cm mesh traps that we used exclusively in the past.

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***STERNOTHERUS ODORATUS* (Eastern Musk Turtle)**. USA: LOUISIANA: Cameron Parish: Lacassine Bayou, 1.36 river km S of Jefferson Davis/Cameron Parish line (30.026396°N, 92.861902°W; WGS84). 27 August 2013. Cybil C. Huntzinger and Will Selman. Verified by P. Lindeman. Florida Museum of Natural History Herpetology Department (UF 173772 photo archive). New parish record (Dundee and Rossman 1989. The Amphibians and Reptiles of Louisiana. Louisiana State University Press, Baton Rouge. 300 pp.).

This record extends the previously documented range southwest approximately 32 km from specimens collected (USNM 100091, 100093) near the town of Mermentau (Jefferson Davis Parish; HerpNet database search, http://www.herpnet.org, accessed 29 May 2014). Individual was captured in a baited, modified crab trap.

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***TERRAPENE CAROLINA* (Eastern Box Turtle)**. USA: TENNESSEE: Lincoln Co.: US Highway 64 (35.200716°N, 86.755596°W; WGS84). 20 June 2011. Joshua Kee. Verified by A. F. Scott. David H. Snyder Museum of Zoology, Austin Peay State University (APSU 19505 photographic voucher). New county record (Scott and Redmond 2008 [latest update: 10 May 2014]. Atlas of Reptiles in Tennessee. Available at http://apsu.edu/reptatlas/; accessed 10 July 2014.

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SQUAMATA — LIZARDS

***ANOLIS CAROLINENSIS* (Green Anole)**. BRAZIL: BAHIA: Municipiality of Salvador: Ondina (13.007524°S, 38.509230°W, WGS84; elev. 33 m). 23 March 2000. M. S. Tinôco. Setor de Herpetologia, Coleção Herpetológica de Referência do Centro de Ecologia e Conservação Animal, Universidade Católica do Salvador, Salvador, Brazil (CHECOA 000040; survey license SISBIO Nº 23355-2; SVL = 55.1 mm, TL = 20.3 mm, HL = 19.6 mm). *Anolis carolinensis* is native to the southeastern United States (Conant and Collins 1998. A Field Guide to Reptiles and Amphibians of Eastern and Central North America, 3rd ed., expanded. Houghton Mifflin Co., Boston, Massachusetts. 616 pp.). It has been introduced and established on numerous islands in the Caribbean Sea, Pacific Ocean, and Spain (Wiles and Guerrero 1996. Pacific Sci. 50[3]:274–284; Pleguezuelos et al. 2002 *In* Pleguezuelos et al. [eds.], Dirección General de Conservación de la Naturaleza-Asociación Herpetológica, pp. 495–526. Madrid, Spain; Okoschi et al. 2006. Bulletin of FFPRI 5[4]:265–269; Nicholson et al. 2010. Zootaxa 3477:1–108; Norval et al. 2012. Herpetol. Notes 5:95–97). The specimen was found at a small Atlantic forest remnant nearby the local Zoo area, and probably it is a pet that escaped from captivity. There is no evidence for the establishment of this species in the wild, and this is the only record of the species in Brazil.

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***ANOLIS SAGREI* (Cuban Brown Anole)**. USA: CALIFORNIA: San Diego Co.: Vista (33.175°N, 117.236°W, WGS84; elev. 158 m) 19 July 2014. C. Mahrdt, E. Ervin, and L. Geiger. Verified by Bradford D. Hollingsworth. San Diego Natural History Museum (SDSNH 76128–76133). New county and state record (Granatosky and Krysko 2013. IRCF Rept. Amphib. 20[4]:190–191).

Four adult males and two hatchling specimens were collected on a one-acre parcel landscaped with palms, cycads, and several species of tropical plants and ground cover. Several boulders scattered throughout the parcel were used as perch sites for male lizards. An additional 16 adults and six hatchlings were observed in the two-hour site visit (1030–1230 h). Adults were also

observed beyond the property indicating that this population is established and likely expanding through the contiguous tropical landscaping of neighboring properties. According to the property owner, he first observed the species in August 2012 shortly after receiving shipments of palm trees in May–August originating from suppliers located in the Hawaiian Islands.

Additional reports from California include Rancho Mirage and Palm Desert, Riverside Co., and Huntington Beach and Santa Ana, Orange Co. (www.californiaherps.com). The status of these populations is undetermined.

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***ENYALIUS CATENATUS* (Wied's Fathead Anole)**. BRAZIL: BAHIA: Municipality of Mata de São João: Reserva Sapiranga (12.566153°S, 38.037281°W, WGS84; elev. 31 m). 16 November 2013. Ricardo Marques. Setor de Herpetologia, Coleção Herpetológica de Referência do Centro de Ecologia e Conservação Animal, Universidade Católica do Salvador, Salvador, Brazil (CHECOA003215; survey license SISBIO Nº 23355-2; female, SVL = 44.8 mm, TL = 83.5 mm, HL = 14 mm). *Enyalius catenatus* is restricted to forested habitats between the municipality of Palmares in southern Pernambuco and the municipality of Ilhéus in southern Bahia, comprising approximately 800 km (Jackson 1978 Arq. Zool. 30[1]:1–79). This record fills a distribution gap between Ilhéus, southern Bahia (276 km SW) and Coruripe in Alagoas (295 km NE) (Silva et al. 2006. *In* Moura [ed.], A Mata Atlântica em Alagoas, pp. 65–76. Ed. Universidade Federal de Alagoas, Maceió).

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***HEMIDACTYLUS MABOUIA* (Wood Slave)**. USA: FLORIDA: Lake Co.: Eustis, 403 Firewood Avenue (28.83761°N, 81.68091°W, WGS84; elev. 35 m). 5 November 2013. Laurence L. Connor. Verified by Kevin M. Enge. Florida Museum of Natural History (photographic voucher UF-Herpetology 171731). New county record (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final report, Project Agreement 08013, Florida Fish and Wildlife Conservation Commission, Tallahassee. 524 pp.). First county record and extends the range ca. 40 km NW of the closest known verified voucher (UF-Herpetology 137123) in Orange Co., Florida. This gecko was collected on a residential building, photographed, but subsequently escaped. A second gecko distinguished from the first by a full tail versus a partial tail was observed 20 m NW of the first location on 9 November 2013.

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***HEMIDACTYLUS TURCICUS* (Mediterranean Gecko)**. USA: KANSAS: Lyon Co.: Emporia, exterior wall at 3032 U.S. 50, Days Inn Emporia (38.411667°N 96.222473°W; WGS84). 18 August 2014. Cameron University Museum of Zoology (CUMZ 233). Jared White. Verified by Greg Sievert. New county record (Collins et al. 2011. Amphibians, Reptiles, and Turtles in Kansas. Eagle Mountain Publishing, Eagle Mountain, Utah. 312 pp.). Multiple adults found on walls of the motel. The nearest documented population is 151 km NE in Johnson Co., Kansas (Hare 2006. J. Kansas Herpetol. 19:9).

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***HEMIDACTYLUS TURCICUS* (Mediterranean Gecko)**. USA: TEXAS: Erath Co.: Stephenville city limits (32.22067°N, 98.20491°W; WGS84). 22 July 2014. Jacob Devlin Owen. Verified by Travis LaDuc, Texas Natural History Collections (TNHC 92222). New county record (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 447 pp.). Juvenile measuring 24+[2] mm and weighing 0.2 g. This record adds to the rapidly expanding range of the introduced *H. turcicus*. Additionally, this species is frequently observed on many structures throughout Stephenville city limits and is potential evidence for an established population. This individual was captured at 2245 h along the wall of the First Baptist Church where the gecko was hunting insects clustering around the lights of the church.

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***HEMIDACTYLUS TURCICUS* (Mediterranean Gecko)**. MEXICO: JALISCO: Municipality of Ocotlán: Ocotlán (20.346244°N, 102.774645°W; WGS84), 1530 m elev. 30 December 2013. Daniel Rigoberto Aceves Lara. Verified by Gunther Köhler. CUCBA, Universidad de Guadalajara, (CZUG-R 305). First record for the state, extending the known range ca. 178 airline km SSW of the nearest locality at Aguascalientes, Aguascalientes (Vázquez-Díaz and Quintero-Díaz 2005. Anfibios y Reptiles de Aguascalientes. CONABIO, CIEMA, A.C., México, D.F. 318 pp.). The adult gecko was found after dark on a building in downtown Ocotlán. Three other adults and two juveniles were also observed at the same locality on the evening of 8 January 2014, which indicates a well-established population.

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***HOLBROOKIA ELEGANS* (Pacific Earless Lizard)**. MÉXICO: DURANGO: Municipio Tamazula: 1.84 km SE Tamazula (24.96583°N, 106.94944°W, WGS84), 267 m elev. 29 September 2013. Raúl Muñiz-Martínez. Verified by Julio A. Lemos-Espinal. CIIDIR-DGO 1402. First record for Durango and a 78 km NNE range extension from the closest known locality, 2 mi. (3.2 km) S Obispo, Sinaloa (Goldberg 2010. Texas J. Sci. 62:281–286). The lizard was found in tropical deciduous forest.

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***MEDIODACTYLUS KOTSCHYI* (Kotschy's Gecko)**. GREECE: South Aegean Pref.: Arki Island, northwest of main port (37.384411°N, 26.732142°E, WGS84; 35 m elev.). 25 September 2013. Stephanos A. Roussos and Ilias Strachinis. Verified by J. Foufopoulos and P. Lymberakis. Natural History Museum of Crete (NHMC 80.3.85.1664) and University of Michigan Museum of Zoology, Division of Reptiles and Amphibians (Digital Image Collection Number 1229, photographic voucher, one individual). New island record that fills a distributional gap of the most northern island in the Kos-Arki Island chain (Chondropoulos 1986. Amphibia-Reptilia 7:217–235; Broggi 2008. Herpetozoa 21:79–84). Seventeen subspecies have been described for the species across the Aegean region and 14 of them are unique to islands (Chondropoulos 1986, *op. cit.*). Based upon the most proximal population that has been given a subspecific identification the new record could tentatively be considered *Mediodactylus kotschyi beutleri*, which is also present on Kalymnos (Schneider 1983. Salamandra 19:61–70). The closest island to Arki where *M. kotschyi* has previously been found is Lipsi Island, about 7 km S of Arki (Broggi 2008, *op. cit.*). *Mediodactylus kotschyi* is widespread and common across the Cycladic archipelago but on mainland Greece it is only common at specific localities. In the Dodecanese archipelago they are common on small, rocky, and arid satellite islands but rare on the larger islands (Foufopoulos 1997. Herpetozoa 10:3–12). The gecko was found at night, traversing a crevice in bedrock.

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***OPHISAURUS ATTENUATUS* (Slender Glass Lizard)**. USA: ALABAMA: Clay Co.: Talladega National Forest, approximately 4 km N of Campbell Springs at intersection of Adams Gap Road and State Route 281 (Talladega Scenic Highway) (33.40432°N, 85.87459°W; WGS84). 4 June 2014. Brian D. Holt and Kevin Carr. Photographic voucher (AUM AHAP-D 819). Verified by David Laurencio. New county record (Mount 1975. Reptiles and Amphibians of Alabama. Agricultural Experiment Station, Auburn University, Alabama. 347 pp.). A single adult, sex unknown, was observed among a small stand of oak-leaf hydrangea at the Adams Gap trailhead. Habitat was dry hardwood forest dominated by oak and hickory with a pine component. This is a species of "moderate conservation concern" for the state (Mirarchi [ed.] 2004. Alabama Wildlife. Volume 1. A Checklist of Vertebrates and Selected Invertebrates: Aquatic Mollusks, Fishes, Amphibians, Reptiles, Birds, and Mammals. University of Alabama Press, Tuscaloosa. 209 pp.). This record fills a gap between Cleburne and Tallapoosa counties within the Piedmont Physiographic Province (Mount 1975, *op. cit.*).

We thank Eric Soehren for reviewing this note and David Laurencio for verifying the identification and confirming the county record.

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***OPHISAURUS ATTENUATUS LONGICAUDUS* (Eastern Slender Glass Lizard)**. USA: ALABAMA: Coosa Co.: Mitchell Lake, island in Hatchet Creek, Alabama Power Company, 5.7 km NW of AL Hwy 22 and Coosa CR 27 intersection (32.85602°N, 86.41414°W; WGS84). 8 May 2009. E. Spadgenske, E. Soehren, and R. Fitch. Verified by David Laurencio. AUM AHAP-D 806 (digital photo voucher). New county record (Mount 1975. The Reptiles and Amphibians of Alabama. Agricultural Experiment Station, Auburn University, Alabama. 347 pp.). Individual captured on island in Hatchet Creek backwater of Mitchell Lake impoundment. Island dominated by mature, montane *Pinus palustris* (Longleaf Pine) under a frequent burn regime. This record was vetted through examination of online museum holdings (VertNet; HerpNET) and thorough literature review (Zoological Record).

A second Coosa Co. specimen (AUM AHAP-D 807),was found on the Coosa Wildlife Management Area.

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***PHRYNOSOMA MODESTUM* (Round-tailed Horned Lizard)**. USA: TEXAS: Kent Co.: Lake Alan Henry Wildlife Mitigation Area (LAHWMA); 13 km S, 25 km W Clairemont (33.059834°N, 101.019776°W; WGS84). 24 June 2013. Stephen Kasper. Verified by Carl J. Franklin. Amphibian and Reptile Diversity Research Center, University of Texas at Arlington (UTADC 8195–8197; digital vouchers). New county record at the eastern extent of its range (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 447 pp.). The lizard was found in a creek tributary of the South Fork of the Double Mountain Fork of the Brazos River on red Holocene sands that were eroded from the Permian formation canyon slopes. In over 14 years of field observations, this is only the second individual identified by me for LAHWMA and the county.

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***PHRYNOSOMA SOLARE* (Regal Horned Lizard)**. USA: ARIZONA: Gila Co.: State Route (SR) 188, 24.2 km SE of SR 87 (33.850°N, 111.311°W, NAD 1927; elev. 715 m). 30 July 2014. Brian K. and Elizabeth A. Sullivan. Verified by T. R. Jones. Museum of Vertebrate Zoology observation (MVZ obs Herp #17 photo voucher). Extends the range ~25 km (by air) E of the recognized range along the western fringe of the Mazatzal Mountains in eastern Maricopa Co. (Brennan and Holycross 2006. A Field Guide to Amphibians and Reptiles in Arizona. Arizona Game and Fish Department, Phoenix. v + 150 pp.). Adult male DOR on the eastern slopes of the Mazatzal Mountains near Lake Roosevelt.

Additional DOR specimens were observed (by BKS) at this precise locality in 2007, and more or less continuously to the north and northwest along SR 188 and SR 87 at additional localities over a distance of 30 km, including one in the vicinity of Rye, Arizona, in 2005 (34.087°N, 111.358°W, NAD 1927; elev. 960 m). Habitats along SR 188 range from diverse upland Sonoran Desert scrub as evidenced by abundant Saguaro (*Carnegiea*

gigantean) and Palo Verde (*Parkinsonia florida, P. microphylla*) near Lake Roosevelt to heavily grazed, semi-desert grassland dominated by Acacia (*Acacia greggii*) and Mesquite (*Prosopis velutina*) at higher elevations (~ 1000 m) near Rye. Seed harvester ant nests (*Pogonomyrmex* spp.) were present at all sites where horned lizards were observed.

Maricopa Co.: Hummingbird Spring Wilderness (33.643°N, 113.139°W; NAD 83; ele. 603 m). 26 August 2013. Keith Sullivan and Hunter McCall. Verified by T. R. Jones. Museum of Vertebrate Zoology observation (MVZ obs Herp #16 photo voucher). The Hummingbird Spring specimen extends the range 32 km SW and 24 km SE of the nearest Arizona localities, the vicinity of Wickenburg and the Harquahala mountains, respectively (Brennan and Holycross 2006, *op. cit.*), and reduces the apparent gap within the distribution of this lizard in western Maricopa Co. and central Arizona. These lizards and others observed over the course of two months of fieldwork were in rocky, upland Sonoran Desert scrub. Specimens from Hummingbird were not collected as they were found in a wilderness area, but both horn number and color pattern clearly distinguishes this taxon from the only other congener in the area, *P. platyrhinos*.

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PHYLLOPEZUS PERIOSUS. BRAZIL: CEARÁ: Municipality of Brejo Santo: 7.55593°S, 38.84170°W (WGS84). 3 May 2014. Municipality of Mauriti: 7.37946°S, 38.64663°W. 12 November 2013. Municipality of Missão Velha: 7.22268°S, 39.14426°W. 20 March 2014. Municipality of Icó: 6.24613°S, 38.66390°W. 21 December 2013. A. F. S. Neta, A. J. M. G. Ferreira, and H. F. Oliveira. Verified by I. J. Roberto. Coleção Herpetológica da Universidade Regional do Cariri, Crato, Ceará, Brazil (URCA-H 8925, 6844, 8204, 9003, respectively; collecting permits ICMBio 29613-1). This gecko is an endemic species of northeastern Brazil, being reported from the states of Alagoas (Piranhas Municipality), Bahia (São João Municipality), Paraíba (Cabaceiras and Congo municipalities), Pernambuco (Sítio dos Nunes, Flores and Ibimirim municipalities), Ceará (Nova Jaguaribara and São João do Jaguaribe municipalities), and Rio Grande do Norte (Serra Negra do Norte Municipality) (Rodrigues 1986. Pap. Avul. Zool. 36:237–250; Freire et al. 2000. Herpetol. Rev. 31:54; Roberto and Brito 2004. Herpetol. Rev. 35:409; Ferreira et al. 2011. J. Threat. Taxa Comm. 3:1990–2000; Lima et al. 2011 Salamandra 47:227–228). These records extend the distribution, taking as reference the municipality of Icó, Ceará, ca. 195 km S airline from the municipality of Nova Jaguaribara, Ceará, ca. 215 km N from Sitio dos Nunes, municipality of Flores, Pernambuco, and ca. 306 km W from Cabaceiras, Paraíba.

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***PLESTIODON FASCIATUS* (Common Five-lined Skink).** USA: GEORGIA: Coweta Co.: Trail along Chattahoochee River, Chattahoochee Bend State Park (33.43067°N 85.00930°W; WGS84). 6 May 2014. C. Thawley and F. Graves. Verified by David Laurencio. Auburn University Natural History Museum (AUM AHAP-D 00821, digital photograph file). New county record (Jensen et al. 2008. The Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.).

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***PLESTIODON LATICEPS* (Broad-headed Skink)** USA: ALABAMA: Escamia Co.: Solon Dixon Forestry Education Center, Conecuh National Forest (31.16470°N, 86.70336°W; WGS84). 08 July 2013. C. Thawley. Verified by David Laurencio. Auburn University Natural History Museum (AUM AHAP-D 741, digital photo voucher). New county record (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn Printing Co., Auburn, Alabama. 347 pp.). Collected near human habitation.

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***PLESTIODON LATICEPS* (Broad-headed Skink).** USA: GEORGIA: Early Co.: Found on trail 0.2 km N of Indian Mounds Rd in Kolomoki Mounds State Park (31.47132°N 84.93688°W; WGS84). 12 May 2014. C. Thawley and F. Graves. Verified by David Laurencio. Auburn University Natural History Museum (AUM AHAP-D 00823, digital photograph file). New county record (Jensen et al. 2008. The Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.).

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***PODARCIS SICULA* (Italian Wall Lizard).** USA: CONNECTICUT: Fairfield Co.: Greenwich (41.026056°N, 73.61085°W; WGS84). 9 July 2014. Colin M. Donihue and Max R. Lambert. Verified by Jacques A. Gauthier. Yale Peabody Museum of Natural History (YPM HERR.019238). New state record (Klemens 1993. Amphibians and Reptiles of Connecticut and Adjacent Regions. State Geological and Natural History Survey of Connecticut, Hartford. 318 pp.). This represents a northern expansion of the distribution for this invasive species previously documented for New York (Gibbs et al. 2007. The Amphibians and Reptiles of New York State. Oxford University Press, New York. 504 pp.). Multiple individuals were seen on the same date at four different sites including gravid females. Specimen collection authorized under Connecticut permit number 0116019 and Yale University IACUC protocol number 2012-10681.

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tory, 170 Whitney Avenue, New Haven, Connecticut 06521 (e-mail: Gregory.Watkins-Colwell@yale.edu).

***POLYCHRUS GUTTUROSUS* (Berthold's Bush Anole)**. COSTA RICA: PUNTARENAS: Cantón de Golfito: Corcovado National Park, near Sirena Biological Station (8.480062°N, 83.590433°W; WGS84), 7 m elev. 17 April 2012. M. Herr and J. Largaespada. Verified by David Laurencio. Auburn University Natural History Museum (AUM AHAP-D 779). First record for Corcovado National Park and the Osa Peninsula (McDiarmid and Savage 2005. *In* Donnelly et al. [eds.], Ecology and Evolution in the Tropics: A Herpetological Perspective, pp. 366–427. Univ. Chicago Press, Chicago, Illinois). It is also the first record for Golfito Cantón and the southernmost locality for this species in Costa Rica, extending the range within the country by ca. 45 km S from the nearest known locality plotted by Savage (2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna between Two Continents, between Two Seas. Univ. Chicago Press, Chicago, Illinois. xx + 934 pp.).

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***SCELOPORUS UNDULATUS* (Eastern Fence Lizard)**. USA: GEORGIA: Coweta Co.: Chattahoochee Bend State Park, found near picnic area (33.42965°N 85.01263°W; WGS84). 6 May 2014. C. Thawley and F. Graves. Verified by David Laurencio. Auburn University Natural History Museum (AUM AHAP-D 00820, digital photograph file). New county record (Jensen et al. 2008. The Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.).

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SQUAMATA — SNAKES

***AGKISTRODON CONTORTRIX LATICINCTUS* (Broad-banded Copperhead)**. USA: TEXAS: Erath Co.: County Road 296 just west of Farm to Market Road 914 (32.037°N, 98.242°W; WGS84), approximately 25.1 km S of Stephenville, Texas. 21 July 2014. Jacob D. Owen, Jesse M. Meik, Maranda McGonigle, and Colt Hamilton. Verified by Travis LaDuc. Texas Natural History Collections (TNHC 92221). New county record (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps, 3rd ed. Texas A&M University Press, College Station, Texas. 447 pp.). Female measuring 513+[86] mm SVL (with incomplete tail) and weighing 124.9 g, found crossing a gravel road (north to south) at 2222 h in habitat dominated by yucca and honey mesquite vegetation surrounded by cattle ranches. This new record fills in a distributional gap between adjacent counties.

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***AGKISTRODON PISCIVORUS LEUCOSTOMA* (Western Cottonmouth)**. USA: ARKANSAS: Marion Co.: ~6 km SE Rush (36.092481°N; 92.503929°W; WGS84). 1 August 2014. M. B. Connior. Verified by S. E. Trauth. Arkansas State University Museum of Zoology Herpetology Collection (photo voucher ASUMZ 33254, adult). First county record, filling a distributional hiatus between adjacent Baxter and Searcy counties (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville. 421 pp.).

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***AGKISTRODON RUSSEOLUS* (Yucatecan Cantil)**. MÉXICO: TABASCO: Municipio Emiliano Zapata: Nuevo Pochote (17.838383°N, 91.693036°W; WGS84), 18 m elev. 19 February 2014. P. Charruau, A. H. Escobedo Galván, and M. A. Morales Garduza. Verified by M. A. López Luna. Colección de Anfibios y Reptiles de Tabasco, División Académica de Ciencias Biológicas, Universidad Juárez Autónoma de Tabasco (CART 00702). First record for Tabasco, extending range in Mexico ca. 190 km SSW from 5 km S Champotón, Campeche (Gloyd 1972. Proc. Biol. Soc. Washington 84:327–334); it is also known from near La Libertad, Petén, Guatemala (Campbell 1998. The Amphibians and Reptiles of Northern Guatemala, the Yucatán, and Belize. Univ. Oklahoma Press, Norman. xix + 380 pp.). The species was recently elevated from a subspecies of *A. bilineatus* to a full species by Porras et al. (2013. Amphib. Rept. Conserv. 7:48–73). The snake was found in an area containing pastures and secondary vegetation. Four other individuals were observed near this locality in rice fields and low semi-evergreen forest of *Haematoxylon campechianum* (Logwood). The species is locally called Nauyaca Guatemalteca, Vibora Cabeza de Jicotea, or Wolpoch.

Field work was funded by the Secretaría de Energía, Recursos Naturales y Protección Ambiental (SERNAPAM), Consejo Nacional de Ciencia y Tecnología (CONACYT) and Gobierno del Estado de Tabasco through project Fondo Mixto TAB-2012-C28-194316.

PIERRE CHARRUAU (e-mail: charruau_pierre@yahoo.fr), **ARMANDO H. ESCOBEDO-GALVÁN**, **JUAN-MANUEL KOLLER GONZÁLEZ,** and **MARCOS A. MORALES-GARDUZA**, Centro del Cambio Global y la Sustentabilidad en el Sureste, A.C., Calle Centenario del Instituto Juárez s/n, 86080 Villahermosa, Tabasco, México.

***ARIZONA ELEGANS* (Glossy Snake)**. USA: TEXAS: Williamson Co.: TX FM 619, ~0.16 km N jct with CR 490 (30.437259°N, 97.259584°W; WGS84). 19 May 2014. Thomas L. Marshall. Verified by Travis J. LaDuc. Texas Natural History Collections (TNHC 92392 [TJL 2648]). New county record (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps, 3rd ed. Texas A&M University Press, College Station, Texas. 447 pp.). This specimen fills a gap in the known distribution of this species in Texas. Previous records exist from adjacent Travis, Bastrop, Lee, and Milam counties. The closest known locality to this recently collected individual is ~15 km S in Bastrop Co. (14.5 km E Elgin; Natural History Museum of Los Angeles County [LACM] 106986). Adult male (SVL: 990 mm, tail length: 174 mm, 361.1 g) found dead on road at 2110 h.

Specimen collected under a Texas Parks and Wildlife Scientific Research Permit (SPR-1097-912) issued to Travis J. LaDuc.

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ARRHYTON TAENIATUM. CUBA: CAMAGÜEY: Municipality of Nuevitas: Sabana-Camagüey Archipelago, Sabinal Key (21.6736°N, 77.2767°W; WGS84). 1999 (complete date not listed). W. Vilató Viamontes. Verified by Luis V. Moreno. Herpetological Collection of the Instituto de Ecología y Sistemática, Habana, Cuba (CZACC 4.5910). First record for Sabinal Key and first from a non-mainland site. The nearest locality on mainland Cuba is 118.3 km SE at Holguín city (Schwartz and Garrido 1981. Ann. Carnegie Mus. Nat. Hist. 50:207–230). The snake was found in a grassland habitat.

ADONIS GONZÁLEZ and **MANUEL ITURRIAGA**, División de Colecciones Zoológicas, Instituto de Ecología y Sistemática, Carretera de Varona km 3 ½, Capdevila, Boyeros, AP 8029, CP 10800, La Habana, Cuba (e-mail: manueliturriaga@ecologia.cu).

***CEMOPHORA COCCINEA COPEI* (Northern Scarletsnake)**. USA: OKLAHOMA: Pushmataha Co.: Clayton off St. Hwy. 2 (34.597217°N, 95.344141°W; WGS84). 15 October 1988. M. Roberts. Verified by S. E. Trauth. Arkansas State University Museum of Zoology, Herpetological Collection (ASUMZ 33274). New county record (Oklahoma Biological Survey, Distribution of Oklahoma Amphibians and Reptiles by Recorded Sightings [DOKARRS Search], http://www/snomnh.ou.edu; Sam Noble Oklahoma Museum of Natural History Reptile Database [SNOMNH Search], http://www.snomnh.ou.edu). Other *Cemophora c. copei* from the state are housed in the SNOMNH from adjacent Atoka, Le Flore, McCurtain, and Pittsburg counties.

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***COLUBER* (= *MASTICOPHIS*) *FLAGELLUM* (Coachwhip)**. USA: ALABAMA: Bullock Co.: Wehle Forever Wild Tract, 5.4 km SE of AL Hwy 51 and Bullock CR 47 (Pleasant Hill Road) intersection (32.03834°N, 85.47552°W; WGS84). 15 May 2007. E. Soehren and J. Trent. Verified by David Laurencio. Auburn University Museum of Natural History (AUM AHAP-D 818, digital photo voucher). New county record (Mount 1975. The Reptiles and Amphibians of Alabama. Agricultural Experiment Station, Auburn University, Alabama. 347 pp.). Individual encountered crossing sandy road within fire-maintained open pine community. Specimen captured, photographed, and released; fills in county gap adjacent to Macon, Russell, Barbour, and Pike counties within the upper Coastal Plain region (Mount 1975, *op. cit.*). This record was vetted through examination of online museum holdings (VertNet; HerpNET) and thorough literature review (Zoological Record).

ERIC C. SOEHREN (e-mail: eric.soehren@dcnr.alabama.gov), and **JOHN A. TRENT**, Elhew Field Station, Wehle Land Conservation Center, State Lands Division, Alabama Department of Conservation and Natural Resources, 4819 Pleasant Hill Road, Midway, Alabama 36053, USA (e-mail: john.trent@dcnr.alabama.gov).

***COLUBER* (= *MASTICOPHIS*) *FLAGELLUM FLAGELLUM* (Eastern Coachwhip)**. USA: FLORIDA: Hamilton Co.: Suwannee Ridge Mitigation Park Wildlife and Environmental Area (30.44366°N, 83.04613°W; WGS84). 4 April 2014. Jonathan D. Mays. Verified by Kenneth L. Krysko. Florida Museum of Natural History (UF 173272, digital photographic voucher). First record for the county (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final report, Florida Fish and Wildlife Conservation Commission, Tallahassee. 524 pp.). Adult male trapped by a drift fence installed in sandhill habitat.

JONATHAN D. MAYS (e-mail: jonathan.mays@myfwc.com), **CODY D. GODWIN,** and **KEVIN M. ENGE**, Florida Fish and Wildlife Conservation Commission, 1105 S.W. Williston Road, Gainesville, Florida 32601, USA.

***CONOPHIS VITTATUS* (Striped Road Guarder)**. MÉXICO: MÉXICO: Municipio de Tonatico: El Zapote (18.7568889°N, 99.61172222°W; WGS84), 1522 m elev. 16 March 2012. Oswaldo Hernández-Gallegos and Juan Manuel Carmen-Cristóbal. Verified by Uri Omar García Vázquez. Museo de Zoología, Facultad de Ciencias (MZFC 26547). First confirmed record for the State of Mexico (Wellman 1963. Univ. Kansas Publ. Mus. Nat. Hist. 15:251–295; Aguilar-Miguel et al. 2009. Ciencia ergo sum 16:171–180), with the nearest reported locality to El Zapote positioned 22.4 km S Ixtapan de la Sal, Guerrero (Wellman 1963, *op. cit.*). Vegetation at the locality is tropical deciduous forest interspersed with agricultural crops.

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***CROTALUS HORRIDUS* (Timber Rattlesnake)**. USA: ARKANSAS: Searcy Co.: vic. Mull, ~3 km S of Jct AR 14/ Ramblewood Trail (36.052048°N, 92.594601°W; WGS84). 31 August 2014. M. B. Connior. Verified by S. E. Trauth. Arkansas State University Museum of Zoology Herpetology Collection (ASUMZ 33270, photo voucher). New county record partially filling a distributional hiatus among previous records in Marion, Baxter, and Stone counties in northern Arkansas (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville. 421 pp.).

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***CROTALUS MOLOSSUS MOLOSSUS* (Northern Black-tailed Rattlesnake)**. USA: ARIZONA: Yuma Co.: Tinajas Altas Mountains, unnamed canyon on public land (32.270475°N, 114.051541667°W; WGS84), elev. 483 m. 2 May 2009. Chip Cochran, Austin I. Steagall, and Myke Clarkson. Verified by George L. Bradley. UAZ Sonoran Herpetological Photographic Voucher Initiative (UAZ 57585-PSV). First record for the Tinajas Altas Mountains and southwesternmost record for this species in USA, extends the known range ca. 37 km SE of the Gila Mountains (UAZ 45465-PSV) and ca. 30 km W of the Cabeza Prieta Mountains (UAZ 55306-PSV, 55308-PSV). The adult male was found with a coil exposed from underneath a rock in a side canyon surrounded by Lower Colorado River Desertscrub, Sonoran Desert Scrub (Brown 1994. Biotic Communities of the Southwestern United States and Northwestern Mexico. University of Utah Press, Salt Lake City. 342 pp.), at 1200 h. Ambient 1.5 m temperature was 25.0°C, humidity at 1.5 m was 34.5%, substrate temperature was 26.6°C, cloud cover was thin and covered 75% of the sky.

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***DIADOPHIS PUNCTATUS* (Ring-necked Snake)**. USA: ALABAMA: Bullock Co.: Wehle Forever Wild Tract, 7.4 km SE of AL Hwy 51 and Bullock CR 47 (Pleasant Hill Road) intersection (32.03019°N, 85.45613°W; WGS84). 31 March 2007. E. Soehren, J. Soehren, A. Williamon, and A. Cochran. Auburn Museum of Natural History (AUM AHAP-D 825, digital photo voucher). New county record (Mount 1975. The Reptiles and Amphibians of Alabama. Agricultural Experiment Station, Auburn University, Alabama. 347 pp.). Individual captured under woody debris within shaded seepage slope adjacent to small stream. This record fills in county gap surrounded by Macon, Russell, Barbour, Pike, and Montgomery counties within the upper Coastal Plain region (Mount 1975, *op. cit.*). Coosa Co.: Coosa Wildlife Management Area: Cahaba & Columbiana Forever Wild Tracts, 4.4 km NNW of AL Hwy 22 and Coosa CR 29 intersection (Kellys Crossroads). (32.87232°N, 86.35636°W; WGS84). 2 May 2007. E. Soehren, J. Trent, and M. Bailey. AUM AHAP-D 824 (digital photo voucher). New county record (Mount 1975, *op. cit.*) Adult encountered actively moving over ground within mature, montane *Pinus palustris* (Longleaf Pine). This record fills in gap within all surrounding counties (Mount 1975, *op. cit.*)

Both records were verified by David Laurencio and vetted through examination of online museum holdings (VertNet; HerpNET) and thorough literature review (Zoological Record).

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***HORMONOTUS MODESTUS* (Brown File Snake)**. GABON: OGOOUÉ-LOLO PROVINCE: Offoué-Onoy Department: Mount Iboundji (1.162609°S, 11.806277°E, WGS84, elev. 726 m). 22 November 2012. P. Carlino. Verified by Z. T. Nagy. Museo di Storia naturale del Salento, Calimera (MSNS Rept 84). Snout–vent length 534 mm; tail length 146 mm, complete; 1+242 keeled ventral scales; 100 divided, keeled subcaudal scales; 15-15-12 smooth dorsal scale rows. Found at 2130 h in dense primary forest on a large tree at 1.8 m above ground. First record for Ogooué-Lolo Province (Pauwels and Vande weghe 2008. Reptiles du Gabon. Smithsonian Institution, Washington, DC. 272 pp.; Pauwels and Sallé 2009. Hamadryad 34[1]:22–27) and for the Massif du Chaillu (Pauwels et al. 2002. Bull. IRSNB 72:47–57).

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***INDOTYPHLOPS BRAMINUS* (Brahminy Blindsnake)** MÉXICO: AGUASCALIENTES: Municipality of Calvillo: Jáltiche de Abajo (21.780225°N, 102.810392°W; WGS84), 1550 m elev. 28 March 2014. Rubén A. Carbajal-Márquez, Gustavo E. Quintero-Díaz, and Armando Cardona-Arceo. Verified by Luis Canseco-Márquez. Universidad Autónoma de Aguascalientes (UAA-CV-R266). First record for the municipality, extending the known range of the species ca. 55 airline km SW from the closest known locality at Ciudad Aguascalientes (Vázquez-Díaz and Quintero-Díaz 2005. Anfibios y Reptiles de Aguascalientes. CONABIO, CIEMA, 2° ed. México, D.F. 318 pp.). Three specimens of this exotic snake (one vouchered) were found between 1700–1800 h beneath rocks near a stream in riparian vegetation surrounded by tropical deciduous forest.

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***LAMPROPELTIS POLYZONA* (Mexican Milksnake)**. MÉXICO: AGUASCALIENTES: Municipality of Jesús María: 1.6 km W of Puentes Cuates (21.866517°N, 102.585826°W; WGS84), 1836 m elev. 21 April 2009. Sergio Rojas Quezada and Gustavo Ernesto Quintero-Díaz. Verified by Luis Canseco-Márquez. Universidad Autónoma de Aguascalientes (UAA-CV-0328). First record for Aguascalientes (Vázquez-Díaz and Quintero-Díaz 2005. Anfibios y Reptiles de Aguascalientes. CONABIO, CIEMA. México, D.F. 318 pp.), extending the species known range ca. 133 km SE from the closest reported locality, 135 km SW Zacatecas (8 km NW Rio Chico at Mezquitic), Jalisco, México (Mitchell 1980. Southwest. Nat. 25:269). The juvenile snake was found during evening hours beneath a flat rock near a stream in riparian vegetation within arid scrub forest. Ruane et al. (2014. Syst. Biol. 63:231–250) recently elevated milk snakes that occupy this portion of Mexico from *L. triangulum* to *L. polyzona*.

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***LAMPROPELTIS SPLENDIDA* (Desert Kingsnake)**. USA: TEXAS: Kent Co.: Lake Alan Henry Wildlife Mitigation Area; 11 km S, 26 km W Clairemont (33.072825°N, 101.024024°W; WGS84). 27 June 2011. Stephen Kasper. Verified by Toby J. Hibbitts. Texas Cooperative Wildlife Collection (TCWC 100195). New county record within its known range (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps, 3rd ed. Texas A&M University Press, College Station, Texas. 447 pp.). DOR collected from a dirt road within the drainage of the South Fork of the Double Mountain Fork of the Brazos River in grassland-mesquite thicket.

STEPHEN KASPER, Lake Alan Henry Wildlife Mitigation Area, Parks and Recreation Department, City of Lubbock, Lubbock, Texas 79401, USA; e-mail: skasper@mail.ci.lubbock.tx.us.

***NAJA PHILIPPINENSIS* (Northern Philippine Cobra)**. PHILIPPINES: LUZON: BENGUET PROVINCE: Municipality of Kapangan: Acop-Kapangan-Kubungan Road (16.552608°N, 120.616156°E; WGS84), 1040 m elev. 2 June 2013. Tony Gerard. Verified by Rafe M. Brown. Lee Kong Chian Natural History Museum, National University of Singapore (ZRC[IMG]2.229a–e, photographic voucher). First provincial record and highest elevational record for species. Previously recorded on Luzon (Aurora, Batangas, Bulacan, Cagayan, Cavite, Ilocos Norte, Laguna, National Capital

Region [Quezon City], Pampanga, Pangasinan, Quezon, Rizal, Zambales), Catanduanes, Mindoro, Marinduque, and Masbate (Brown et al. 1996. Herpetol. Nat. Hist. 4:1–22; Ong et al. 1999. Science Diliman 11:6–20; Brown et al. 2012. Check List 8:469–490; Brown et al. 2013. Zookeys 266:1–120; Leviton et al. 2014. *In* Williams and Gosliner [eds.], The Coral Triangle: The 2011 Hearst Philippine Biodiversity Expedition, pp. 473–530. California Academy of Sciences, San Francisco, California).

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***NERODIA CYCLOPION* (Mississippi Green Watersnake)**. USA: ARKANSAS: Lincoln Co.: Cane Creek State Park, Boat Ramp at Cane Creek Lake (33.916525°N, 91.76517°W; WGS84). 27, 29 June 2014. T. J. Fayton. Verified by V. V. Tkach. Arkansas State University Museum of Zoology, Herpetological Collection (ASUMZ 33420) and Henderson State University Collection (HSU 1743). New county record filling a gap in the Delta among previous records for adjacent Arkansas, Desha, Drew, and Jefferson counties (Trauth et al. 2004. Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.). This snake has now been reported from 19 counties of the state.

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***PANTHEROPHIS EMORYI* (Great Plains Ratsnake)**. USA: TEXAS: Kimble Co.: 3.6 km W on CR 120 from Highway 377 (30.315922°N, 99.952986°W, WGS84; elev. 633 m). 26 May 2012. Stephanos A. Roussos, Michael Sager, and Brandon Gross. Verified by Llewellyn D. Densmore III and Carl Franklin. Amphibian and Reptile Diversity Research Center, University of Texas at Arlington (UTA DC 8133, 8134, photographic vouchers). New county record (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps, 3rd ed. Texas A&M University Press, College Station, Texas. 447 pp.). Fills a distributional gap among Menard, Mason, Gillespie, Kerr, Edwards, Sutton, and Schleicher counties. The species is widespread throughout central Texas and Kimble Co. is in the middle of the known distribution (Dixon 2013, *op. cit.*). The individual was caught, measured and blood sampled (Llewellyn D. Densmore III laboratory collection, Department of Biological Sciences, Texas Tech University; catalog ID LD1281) before being released at the exact location of capture.

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***PANTHEROPHIS GUTTATUS* (Red Cornsnake)**. USA: ALABAMA: Coosa Co.: Coosa Wildlife Management Area: Cahaba & Columbiana Forever Wild Tracts, 4.7 km NNW of AL Hwy 22 and Coosa CR 29 intersection at Kellys Crossroads (32.87600°N, 86.35409°W; WGS84). 21 May 2014. E. Soehren. Verified by David Laurencio. Auburn University Museum of Natural History (AUM AHAP-D 808, digital photo voucher). New county record (Mount 1975. The Reptiles and Amphibians of Alabama. Agricultural Experiment Station, Auburn University, Alabama. 347 pp.). Individual observed in a non-viable *Picoides borealis* (Red-cockaded Woodpecker) artificial cavity insert about 3.7 m up bole of mature *Pinus palustris* (Longleaf Pine). Snake viewed and videoed using a peeper scope while performing cavity checks. The cavity is regularly occupied by *Glaucomys volans* (Southern Flying Squirrel) and likely the reason it was found in the insert. This record fills a gap between eastern Chilton and Clay counties in the Piedmont physiographic province (Mount 1975, *op. cit.*) and was vetted through examination of online museum holdings (VertNet; HerpNET) and thorough literature review (Zoological Record).

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***PANTHEROPHIS GUTTATUS* (Red Cornsnake)**. USA: GEORGIA: Clay Co.: Bluffton Rd., 0.67 km NNW of junction with Mt. Calvary Church Rd., 10 km SE of Fort Gaines (31.54532°N 84.96443°W; WGS84). 12 May 2014. C. Thawley and F. Graves. Verified by David Laurencio. Auburn University Museum of Natural History (AUM AHAP-D 00822, digital photograph file). New county record (Jensen et al. 2008. The Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.).

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***PANTHEROPHIS SPILOIDES* (Gray Ratsnake)**. USA: TENNESSEE: Loudon Co.: Tennessee State Highway 72 (35.73592°N 84.40727°W; WGS84). 2 August 2013. Stephen K. Nelson and R. Michael Ogle. Verified by A. Floyd Scott. David H. Snyder Museum of Zoology, Austin Peay State University (APSU 19467, color photo). First county record (Redmond and Scott 2008. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Internet version, available at http://apsu.edu/repatlas/ [updated 19 May 2014]; accessed 6 July 2014). Fills distribution gap within Tennessee Valley.

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***SIBON LAMARI* (Costa Rican Snaileater)**. PANAMÁ: COLÓN: Distrito de Portobelo: Cerro Bruja, Parque Nacional Chagres (9.458611°N, 79.574444°W; WGS84), ca. 700 m elev. 22 July 2013. Ángel Sosa, Joelbin de la Cruz, and Karla Ramos. Verified by Alejandro Solórzano. Museo de Vertebrados, Universidad de Panamá (MVUP 2133). New district record and second for the Province of Colón, extending its known range ca. 130 airline km NE from Punta Rincón, Distrito de Donoso, Colón, Panamá (Ibañez et al. 2008. Herpetol. Rev. 39:373). The snake was found at night on a bush in cloud forest.

We thank the Fundación Parque Nacional Chagres for providing funding for the project, and Autoridad Nacional del Ambiente for permission to do field work.

ÁNGEL SOSA BARTUANO, Sociedad Mastozoológica de Panamá, Apartado 0835-00680, Panamá, Rep. de Panamá (e-mail: asosa2983@gmail.com); **JOELBIN DE LA CRUZ**, Escuela de Biología, Centro Regional Universitario de Veraguas, Universidad de Panamá, Panamá, Rep. de Panamá.

***STORERIA DEKAYI* (Dekay's Brownsnake)**. USA: TEXAS: Blanco Co.: Bamberger Ranch Preserve (30.207191°N, 98.445521°W; NAD 83). 18 April 2011. David O. Ribble. Verified by Travis Laduc. Texas Natural History Collections (TNHC 92242). New county record (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 447 pp.). Nearest record ca. 15 km W in Gillespie Co. and ca. 20 km E in Hays Co. One female was caught at the residence of S. Fulton.

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***STORERIA OCCIPITOMACULATA* (Red-bellied Snake)** USA: GEORGIA: Lamar Co.: Barnesville (33.080963°N, 84.135032°W; WGS84). 19 May 2014. Amanda Duffus. Verified by Gregory D. Hartman. Gordon State College Collection of Vertebrates (GSC 070). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens, Georgia. 404 pp.; J. B. Jensen, pers. comm.).

Specimen collected under a Georgia Department of Natural Resources Scientific Collecting Permit (29-WJH-159 CN: 25018).

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***STORERIA STORERIOIDES* (Mexican Brownsnake)**. MÉXICO: ZACATECAS: Municipality of Nochistlán de Mejía: 9.6 km W Daniel Camarena (21.344866°N, 102.990869°W; WGS84), 2467 m elev. 8 July 2006. Gustavo E. Quintero-Díaz and J. Jesús Sigala-Rodríguez. Verified by Bradford Hollingsworth. San Diego Natural History Museum (SDSNH HerpPC 05236–05237). First record for municipality and second known locality for Zacatecas, extending the range of the species ca. 44 airline km SE from the closest known locality, 15 km NW of Jalpa, Sierra Morones, Municipality of Tlaltenango de Sánchez Román, Zacatecas (Webb 1982. Herpetol. Rev. 13:132). The two vouchered specimens were found foraging during the evening in a pine-oak forest.

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***THAMNOPHIS MARCIANUS* (Checkered Gartersnake)**. USA: ARIZONA: Santa Cruz Co.: San Rafael Valley, ca.18.5 km SW Patagonia (31.45156° N, 110.58923°W, NAD83; elev. 1480 m). Thomas R. Jones and Amy Bailey. 2 August 2007. Verified by G. Bradley. University of Arizona Herpetological Collection (UAZ 57379). First from the San Rafael Valley headwaters of the mainstem Santa Cruz River. MVZ 76663–76664; HerpNet, http://www.herpnet.org/ [accessed 21 May 2014]; A. T. Holycross, pers. comm.)

Two additional individuals have been observed within the Valley: one unvouchered animal DOR ca. 1.3 km W of this site, 24 July 2007 by R. J. Timmons, and one captured, marked, and released 27 August 2012 on the Santa Cruz River ca. 11 km S, by M. Braun and T. R. Jones. In adjacent Sonora, Municipio de Cananea, *T. marcianus* was observed but not vouchered 18 August 2008 on a dirt road crossing of the Río San Rafael, a tributary to the Río San Pedro, 24.8 km NNE Cananea (31.171870°N, 110.266030°W) by J. C. Rorabaugh, A. D. King, and S. MacVean, and on 21 August 2008 on a dirt road ca. 12 km NNE of Cananea (31.07395°N, 110.24474°W) by J. C. Rorabaugh.

The nearest known records elsewhere in the upper Santa Cruz River drainage are on Sonoita Creek about 18 km NW on the north side of the Patagonia Mountains (MVZ 76663–76664, *op. cit.*), and in the upper San Pedro River drainage near Elgin, beyond the Canelo Hills, about 18 km NNE (numerous recent records; TRJ, pers. obs.). However, *T. marcianus* has not been documented from Sonoita Creek since 1967, (Turner 2007. Son. Herpetol. 20:38–42). The Sonora observations are 37 km and 45 km SE of the southernmost San Rafael Valley site, within a southeastern extension of the grasslands that comprise the San Rafael Valley in Arizona and form a drainage divide between the headwaters of the Santa Cruz and San Pedro rivers. The nearest previously documented *T. marcianus* in Sonora are from "Cananea" (1946, AMNH 67257, 67259) and "Cananea and vicinity" (2005, UAZ 26877–78, 2005) in the Río San Pedro or Río Sonora drainages, ca. 60 km SE of the 2007 record and ca. 20 km S of the 2008 Sonora observation.

All individuals were found in a plains grassland community (Brown 1982. Desert Plants 4:115–121), in an area where aquatic habitats have received considerable scrutiny in the past three decades (e.g., Collins et al. 1988. *In* Szaro et al. [eds.] Management of Amphibians, Reptiles and Small Mammals in North America, pp. s45–53. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado; Jones et al. 1988. Copeia 1988:621–635; Storfer et al. 2004. Copeia 2004:783–796; Rorabaugh et al. 2013. *In* Gottfried et al. [compilers], Merging Science and Management in a Rapidly Changing World: Biodiversity and Management of the Madrean Archipelago III and 7th Conference on Research and Resource Management in the Southwestern Deserts, pp. 103–109, Rocky Mountain Research Station, Fort Collins, Colorado), thus it is highly unlikely *T. marcianus* has been overlooked until recently. The distribution of *T. marcianus* been expanding the last few decades (A. T. Holycross, pers. comm.); in several areas they appear to have occupied habitats that previously supported the now rare *T. eques*. These records provide further evidence that *T. marcianus* is extending its distribution within Arizona and possibly adjacent areas of Sonora.

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The Herpetofauna of the Capanda Dam Region, Malanje, Angola

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Knowledge of Angolan biodiversity, and especially amphibian and reptile diversity, remains highly incomplete. The first comprehensive works on the Angolan herpetofauna were made during the 19th century by J. V. Barbosa du Bocage, who published a series of short papers on the country's amphibians and reptiles, culminating in his magnum opus "*Herpétologie d'Angola et du Congo*" (Bocage 1895). Following Bocage, Ferreira conducted a number of studies of the Angolan herpetofauna (Ferreira 1897a, 1897b, 1900, 1901, 1903, 1904, 1905, 1906) as did Boulenger (1905, 1907, 1915), Angel (1921), Parker (1936), and Mertens (1938). While the majority of these publications were short and descriptive, Albert Monard contributed more methodical and detailed studies of both Angolan amphibians (Monard 1938) and reptiles (Monard 1937). Subsequent contributions include those of the Pulitzer Expedition to Angola (Boulton 1931; Schmidt 1933, 1936), Bogert (1940) and Loveridge (1944) on the herpetological material of the Vernay Expedition, as well as Hellmich (1957a, b) and Fitzsimons (1959). The most extensive recent data are presented in a series of publications by Raymond Laurent (1950, 1954, 1964) based on the rich collections of the Museu do Dundo in northern Angola. Contributions during the late Portuguese colonial period and post-independence have been limited. These include papers by Horton (1972) and Gans (1976) and recent post-civil war contributions from several South African and European herpetologists (Haacke 2008; Conradie et al. 2012, 2013; Ernst et al. 2013). Frétey et al. (2011) recently published a list of Angolan amphibians, but based largely on previously published data. The general lack of recent work is due in part to the violent civil war that devastated the country for decades. New studies on the diversity, distribution, and ecology of Angolan amphibians and reptiles are urgently needed especially for conservation assessments.

As part of a broader program to review existing knowledge of the herpetofauna of Angola, we visited the Museu Nacional de História Natural in Luanda (MNHN), Angola, in December 2012 and December 2013 to study its herpetological collections. The museum's scientific (i.e., non-exhibit) collections are dominated by a single large collection of fishes, amphibians, reptiles, and some mammals made by one of us (A. Lavres), a biologist from the Museum, from January to April 2003 during the construction of a dam in the Capanda region, Malanje Province, as already noted by Kuedikuenda and Xavier (2009). The amphibians and reptiles of this area have not been explored previously and, due to the flooding of the area, the collection constitutes an interesting source of information about this area's herpetofauna prior to this major disturbance. Further, due to the extended period during which the collection was assembled and to the large numbers of specimens collected, the data from this collection may provide important baseline data to understand the impacts of the dam on the fauna in this northern region of the country.

Brief History of the Museu Nacional de História Natural and its Collections

The MNHN is a museological descendant of the Angolan Museum, founded in Luanda in 1938 and established in São Miguel Fort in the Luanda Bay area. The first plan for the creation of the Angolan Museum was published by Fernando Mouta (1936). Mouta, a Portuguese engineer based in Luanda at that time, had been contacted by Swiss zoologist Albert Monard (1886–1952) who had explored Angola on two different occasions: first between July 1928 and February 1929, and second between April 1932 and October 1933. Based largely on the latter expedition, Monard published extensively about Angolan amphibians and reptiles (Monard 1937, 1938), birds (Monard 1934), and mammals (Monard 1935). Inspired by the rich and unexplored biodiversity of the country, Monard devised and presented a plan to erect a Natural History Museum in the region, and offered to direct and manage the museum himself. Mouta (1936) promoted the idea of Monard becoming the director of such an institution, but for unknown reasons this did not happen. In 1938 the Angolan Museum opened to the public in São Miguel Fort. The institution was not exclusively dedicated to natural history; it contained archeological collections, weaponry, religious art, a small ethnographic collection, and a large library with rare books and historical documentation, as well as the nucleus of a natural history collection (Anonymous 1950). These last collections were transferred during the mid-1940s to the *Liceu* (public high school) of Luanda due to a lack of space and appropriate facilities to maintain it, and also to meet the educational need for a collection for use in classes (Anonymous 1950). Only in 1956 did the colonial government decide to build a new museum in Luanda dedicated exclusively to Natural History. There is relatively little published or archival information available about this new building and museum, and its history is yet to be written. What is known from the personal communication of people who knew the museum in that time is that its collections were prepared mostly by a taxidermist from the Museu de História Natural Álvaro de Castro Museum in Lourenço Marques (now Maputo), Mozambique. The museum was designed as a typical twentieth century museum, with the majority of the specimens presented in large, colorful, and well prepared dioramas. Since its inception, the MNHN has

PHOTO BY LUIS CERIACO, DECEMBER 2012



FIG. 1. The diorama halls of the Museu Nacional de História Natural in Luanda, Angola.

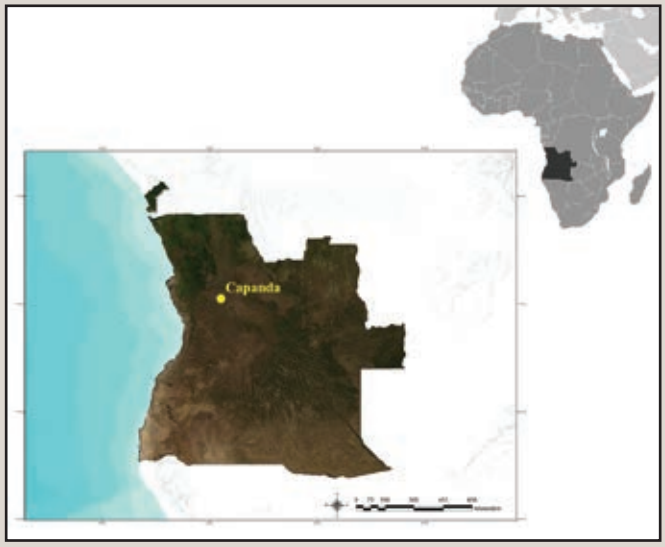


FIG. 2. Map of Angola, with Capanda indicated by a yellow circle.

been mostly devoted to public exposition and education. This stands in contrast to its Mozambican counterpart, as well as to the Museu do Dundo, at which the biological laboratory was directed by the Portuguese entomologist António Barros de Machado (1912–2002) and where the herpetological collections were used for scholarly investigation by several well known scientists, including Raymond Laurent. Pinto (1983) referred to zoological expeditions carried out by the Museu de Angola in 1941, 1944, 1946, 1950, 1956, and 1959, when at least birds were collected. Although some of those birds may have gone to the museum dioramas as exhibition specimens, the vast majority were deposited in the former Instituto de Investigação Cientifico de Angola (IICA), as were specimens collected by subsequent expeditions like those from the Hamburg Museum in 1954 and the British Museum in 1957. All of these scientific collections are now housed in the Lubango Museum in southern Angola (Mills et al. 2010). From the mid-1950s to the independence of the country in 1975, the Museum remained as a public exhibition museum, and after independence it became the MNHN. Since then, it has been maintained primarily as a public exhibition place (Fig. 1). However, in 2003, while conducting environmental impact studies in the Capanda region, Malanje Province, where a dam was to be built, investigators from MNHN collected several hundred specimens of fishes, amphibians, reptiles, and mammals. This collection, besides a small fish collection, constitutes the only scientific collection present at the museum, and was originally discussed in an unpublished report and has not been critically reviewed by herpetologists (Kuedikuenda and Xavier 2009). Additional field trips in other provinces of Angola have also produced small collections, especially of reptiles, in the MNHN that have likewise not been studied. The Museum building is currently facing several structural problems, and urgent repair works are planned.

MATERIALS AND METHODS

Study site.—Capanda Dam is part of the hydroelectrical dam established in the Kwanza River basin in the province of Malanje, Angola (Fig. 2). The entire area is situated between 870 and 1000 m elevation, and the dam is situated in the municipality of Cacuso (the dam wall is located at 9°47.48'S, 15°27.58'E).

With a length of 960 km, the Kwanza River is the longest river with both its source and mouth in Angola. Its source is in the north of Mumbué (Bié Province), at an elevation of approximately 1500 m. The Kwanza has 15 major tributaries: Lucala, Mucoso, Lombe, Cuije, Cuque, Luando, Cuíva, Cuíme, and Chimbamdiango entering the right bank and Gango, Cutato, Cinhinga, Lúbia, Cunje, and Cuquema entering the left bank. The Duque de Bragança Falls in Malanje Province are located on one of these tributaries, the Lucala (Pinto 1983). The complete extent of this hydrographic basin extends to 152,570 km^2. The average annual rainfall of this region varies between 1300–1400 mm, and average annual temperatures range from 18–20ºC (Pinto 1983). The surrounding vegetation in the area of the dam is typical for Malanje. Pinto (1983) refers to this habitat as "open forests, *Brachystegia* woodlands." The vegetation is dominated by approximately 50 large tree species, chiefly *Julbernardia paniculata* (Fabaceae) and five species of the genus *Brachystegia* (Fabaceae). These trees, whose crowns are usually large and sometimes contiguous, can reach heights of 6–18 m, depending on the nature of the soil and amount of rainfall. In addition, there are about 100 small tree and bush species and 300–400 species of grasses, sedges, and non-woody plants (Pinto 1983).

Data collection.—This collection was made by one of us (A. Lavres) and three technicians from the MNHN from January to April 2003 while conducting other field work related to the Capanda Dam project. Searches were made on both banks of the Kwanza River, in the flood zone, during the day, generally from 0800 to 1600 h. Most specimens were collected opportunistically by hand and every specimen was fixed in 20% formalin in the field and later transferred to 70% ethanol. An unpublished list (available in the museum), apparently made immediately after the fieldwork, lists a total of 136 specimens of amphibians, 154 snakes, 8 chelonians (all with the note "released"), and 463 lizards. The majority of the specimens in the collection today (a total of 254 amphibians and 310 reptiles) are associated with reference numbers, either on their bottles or on specimen tags, but these numbers are not linked to any existing catalog in the Museum nor clearly referable to those in the above-cited list. Therefore, for all the specimens present we developed new reference numbers, identified all the bottles with labels bearing the reference number of each specimen, and developed an internal catalogue for the museum. They are cited here by these

new reference numbers. Some specimens stored in jerry cans in the museum are still awaiting catalog numbers due to the lack of material (bottles, tags, etc.) for re-bottling and are here noted as "uncat. JC." The situation is far from ideal but reflects one facet of the reality of biodiversity research in this region of Africa.

Results

Species Accounts

AMPHIBIA
ANURA
BUFONIDAE

Amietophrynus* cf. *regularis (Reuss, 1833)

Material. 182 specimens: MNHNL/ANF/A/Amy 1–182

Comments. These specimens likely represent *Amietophrynus regularis,* which remains a taxonomically challenging species. Multiple species may be present among these specimens but the level of preservation of some specimens precludes more precise identification. The species is widespread within Angola (Monard 1938; Laurent 1964; Ruas 1996), across much of sub-Saharan Africa, and extending north along the Nile Valley (Rödel 2000; Frétey et al. 2011). It has been previously recorded from a diversity of sites across Angola by Bocage (1895), Mertens (1938), Laurent (1950, 1954, 1964), and Hellmich (1957a). Bocage (1895) cited *Bufo regularis* from Pungo Andongo, 20 km NE of Capanda.

HYPEROLIIDAE

Hyperolius parallelus (Günther, 1859 "1858")

Material. 44 specimens: MNHNL/ANF/A/Hyp 1–45

Comments. This species is widespread across Angola and occurs in central Africa from the southern Republic of Congo and Democratic Republic of Congo south to western Zambia, northern Namibia and Botswana, and in the Victoria Falls region of Zimbabwe (du Preez and Carruthers 2009; Frétey et al. 2011). It has been reported from Angola by many previous authors though under a variety of names now recognized as synonyms; (e.g., Bocage 1873; Ferreira 1904, 1906; Mertens 1938), and is recorded for several provinces in the country, namely Lunda Norte (Laurent 1952, 1954), Moxico (Laurent 1954), Zaire (Bocage 1977), Bengo (Boulenger 1882), and Huila (Monard 1938).

Specimens 1–26 present a typical *parallelus* dorsal pattern, consisting of a dark dorsum with narrow white dorsal and lateral lines. Specimens 27–45 present a vermiculated dorsal pattern more similar to that of the holotype of *Hyperolius angolensis* Steindachner, 1867. This latter, initially described from a single specimen from Duque de Bragança, approximately 100 km NE of Capanda, is currently considered a synonym of *H. parallelus* by some authors (Frétey et al. 2011; Frost 2014), part of the *Hyperolius parallelus-marginatus* subgroup (Schiotz 1999), as a subspecies of *Hyperolius marmoratus* (Rapp, 1842) (Poynton and Broadley 1987) and as a full species by Channing (2001). Both *H. parallelus* and *H. marmoratus* are taxonomically difficult species. *H. marmoratus,* which is widespread across southern and eastern Africa, appears to be absent from Angola (Channing 2001), even if it has been previously reported from the country under various names (Ferreira 1906; Mertens 1938; Laurent 1943, 1950, 1964), which can be partly explained by the considerable intraspecific and interspecific variation and consequent confusion among these groups. There are several studies in progress on the genus *Hyperolius* and in these taxonomically difficult groups, and we hope these will contribute some clarifications on their identities. Given the current knowledge, we opt to consider these specimens also as part of *H. parallelus.*

Kassina* cf. *maculosa

Material. 1 specimen: MNHNL/ANF/A/K 1

Comments. This juvenile specimen probably represents *Kassina maculosa* (Sternfeld, 1917) because of characteristic pigmentation around the eye and tympanum and the lack of dorsal markings running continuously from the head to vent (du Preez and Carruthers, 2009; Amiet 2012). If correct, then this is first record of the species in Angola. The species is known from Cameroon, the Democratic Republic of Congo, and Central African Republic (Frétey et al. 2011). This would be the southernmost record of the species. Such southern extensions of the Central African amphibian fauna may be more common than previously believed as indicated by the recent records of the "Hairy Frog" *Trichobatrachus* in Angola (Ernst et al. 2014). Laurent (1964) previously commented on the difficulty of identifying those species of *Kassina* in Angola and Central Africa. Two other species have been previously recorded for Angola, *Kassina senegalensis* (Duméril & Bibron, 1841) by Schmidt (1936), Monard (1938), and Laurent (1964), and *Kassina kuvanguensis* (Monard, 1937) by Monard (1938).

PIPIDAE

Xenopus* cf. *petersii (Bocage, 1895)

Material. 25 specimens: MNHNL/ANF/A/Xe 1–25

Comments. These specimens probably represent *Xenopus petersii,* a widespread species distributed across Angola, Zambia, and northern Namibia and Botswana (Laurent 1964; Channing 2001). There are several localities from the Kwanza River below the Capanda Dam (Ruas 1996). The specimens show the characteristic dark blotches across the ventral surface yet these are not as prominent in other specimens of *X. petersii* (see Appendix). The species has been recorded for the region by several authors (Bocage 1895; Ferreira 1906; Ruas 2002), and Ruas (2002) listed it as occurring at Duque de Bragança, currently Kalandula, approximately 100 km NE of Capanda.

PHRYNOBATRACHIDAE

Phrynobatrachus* cf. *natalensis (Smith,1849)

Material. 1 specimen: MNHNL/ANF/A/Pr 1

Comments. This poorly preserved specimen of *Phrynobatrachus* seems to represent *P. natalensis,* a widespread complex of species extending across much of southern Africa including Angola (Channing 2001; Zimkus et al. 2010). There are many previous records across Angola (Bocage 1895, 1897; Ferreira 1904; Boulenger 1905; Parker 1936; Schmidt 1936; Monard 1938; Laurent 1950, 1954, 1964; Hellmich 1957a; Ruas, 1996, 2002), including several just to the north of Capanda (Ruas 1996). Bocage (1895) cited the species from Duque de Bragança, currently Kalandula, about 100 km NE of Capanda.

REPTILIA
CROCODYLIA
CROCODYLIDAE

Crocodylus niloticus Laurent, 1768

Material. 1 specimen: MNHNL/Rep/A/Croc 1

Comments. This juvenile specimen is referable to *C. niloticus,* which is widespread throughout much of sub-Saharan Africa. However, West African populations previously included within *C. niloticus* are now referred to a separate species, *C. suchus* Geoffroy St.-Hiliare, 1807 (Schmitz et al. 2003). The distribution of

Nile Crocodiles within Angola is poorly documented (Fergusson 2010), but the Kwanza River has long been regarded as having a large population (Hellmich 1957a). Ferreira (1903) cited the species as occurring at Duque de Bragança.

TESTUDINES
PELOMEDUSIDAE

Pelusios rhodesianus Hewitt, 1927
Material. 1 specimen (uncat. JC)
Comments. This specimen has the head coloration reported by Branch (2008) as typical of southern populations. The species is widely distributed in south-central Africa and there are numerous records from throughout Angola exclusive of the arid southwest (Broadley 1981; Iverson 1992; Broadley and Boycott 2008), including from the Kwanza River drainage.

Pelusios nanus Laurent, 1956
Material. 3 specimens: MNHNL/Rep/A/C 1, uncat. JC (2 specimens)
Comments. This species has a relatively limited distribution across central Angola, northern Zambia, and the southern Democratic Republic of Congo (Broadley 1981; Iverson 1992; Branch 2008; Vetter 2011). For Angola, the few available records are from Alto Chicapa (Lunda Norte province) in the northeast, and Calundo Lake and Cazombo (Moxico province) in the east (Laurent 1964). The Capanda records extend the known distribution by more than 100 km from previous records to the northeast, east, and south.

TESTUDINIDAE

Kinixys spekii Gray 1863
Material. 4 specimens: MNHNL/Rep/A/C 8, uncat. JC (3 specimens)
Comments. Capanda is near the northwestern extent of the distribution of this species, which has a broad range across savanna habitats of south-central Africa, including most of Angola (Broadley 1989; Iverson 1992; Branch 2008; Vetter 2011; Kindler et al. 2012). Specimens of *Kinixys belliana* Gray, 1831 reported by Bocage (1895) and Ferreira (1902) from approximately 100 km northeast in Kalandula (formerly Duque de Bragança) and by Laurent (1950) from Muita may also refer to this species.

SQUAMATA: LACERTILIA
AGAMIDAE

Agama cf. *congica* Peters, 1877
Material. 107 specimens: MNHNL/Rep/A/Ag 1–107
Comments. The identity of the large, colorful agamas of Angola has long been problematic and was discussed at length by Monard (1937) and Hellmich (1957a). Hellmich (1957a,b) referred *Agama agama* group specimens from northern Angola (Piri-Dembos, Cuanza Norte) to *A. agama agama* (Linnaeus, 1758). However, the distribution of this species remains poorly defined and has only been confirmed using genetics for populations north of Angola (Leaché et al. 2009; Mediannikov et al. 2012). Other agamas occurring in northern Angola are *A. planiceps schacki* Mertens, 1938, and the recently revalidated *Agama mucosoensis* Hellmich, 1957 (Wagner et al. 2012). Specimens from Capanda resemble *Agama congica*, a taxon currently placed in the synonymy of *A. agama*, but actually differing from that species on the basis of both coloration and scalation (P. Wagner, pers. comm.). Male nuptial color is an important character in distinguishing among *Agama agama* group species and female color is also species specific for the Angolan species (Wagner et al. 2012). Unfortunately, the Capanda specimens have darkened in preservative to the point that life color patterns cannot be discerned; specific identity could easily be verified by fresh material. *Agama mucosoensis* is common at Dondo, Mucoso, and Libolo/Luati (all in Cuanza Norte), at sites only 100 km downstream from Capanda (Hellmich 1957a, 1957b), as well as in the vicinity of Luanda (pers. obs.) and may also be expected in the region.

Acanthocercus cyanocephalus (Falk, 1925)
Material. 25 specimens: MNHNL/Rep/A/Ag 108–126
Comments. *Acanthocercus* species outside of Arabia and the Horn of Africa have long been referred to *Acanthocercus atricollis* (Smith, 1849), which Bocage (1866, 1895), Ferreira (1903), and Boulenger (1905) cited for Duque de Bragança (now Kalandula), about 100 km NE of Capanda. Boulenger (1905) recorded the species for Pungo Andongo, 20 km NE of Capanda. Klausewitz (1957) divided this species into several subspecies, but Angolan material fell into the nominotypical form. Subsequent revisionary work on the genus (Wagner et al., unpubl.) reveals that Angolan *Acanthocercus* are referable to *A. cyanocephalus*, a long-forgotten name proposed by Falk in 1925 based on Angolan material, but without a precise type locality. It occurs throughout most of western Angola, except in the arid southwest, as well as in portions of all neighboring countries. The species has been recorded (as *A. atricollis*) across the center and north of Angola (Boulenger 1905; Schmidt 1933; Monard 1937; Themido 1941; Laurent 1950, 1964; Manaças 1963).

CHAMAELEONIDAE

Chaemaeleo gracilis etiennei Schmidt, 1919
Material. 49 specimens: MNHNL/Rep/A/Ca 1–49
Comments. This subspecies of *C. gracilis* was recognized as distinct by Klaver and Böhme (1997) and Tilbury (2010). There are several records of *C. gracilis* for Angola, some of which represent this subspecies (Bocage 1895; Ferreira 1903; Parker 1936; Laurent 1964). Bocage (1895) and Ferreira (1903) cite *C. gracilis* for Duque de Bragança and Cazengo, but the closest previously published location is Pungo Andongo (Bocage 1895), 20 km northeast of Capanda. The subspecies *etiennei* has been recorded in the northeastern regions of the country by Laurent (1964), and for Pungo Andogo, Congulu, Duque de Bragança, Condo, Marimba, and Canhoca by Parker (1936). Capanda lies near the southwest border of the taxon's distribution. Hellmich (1957a, 1957b) recorded large series (as *C. gracilis*) from Piri-Dembos and Mucoso, Cuanza Norte. Tilbury (2010) plotted numerous localities in northern Angola.

GEKKONIDAE

Chondrodactylus pulitzerae (Schmidt, 1933)
Material. 2 specimens: MNHNL/REP/A/Gec 1–2
Comments. Both specimens were captured in January 2003. This species was originally described from southern Angola and long considered a synonym of *Pachydactylus* (now *Chondrodactylus*) *bibronii* (Smith, 1846). Benyr (1995) clarified the distinction between the more temperate *C. bibronii* and a more tropical *C. laevigatus*/*C. turneri* lineage and transferred *pulitzerae* to the synonymy of *Chondrodactylus laevigatus* (Benyr, 1995). Branch (1998) subsequently used the name *C. turneri* as a senior synonym of *C. laevigatus*, correcting Benyr's oversight of the former name's priority. Heinz (2011) demonstrated that *C. pulitzerae* is a distinct lineage, occurring in sympatry or at least parapatry with

C. turneri in extreme northern Namibia and southern Angola. Monard (1937) reported *Pachydactylus bibronii* from Kampulu and Humbi (Umbi) in Cuanza Sul and these appear to be the northernmost literature records, although Bocage (1895) reported them to be common south of the Kwanza in general. Most records for this species are in the southwest of Angola in Benguela province (Schmidt 1933; Parker 1936; Mertens 1938; Hellmich 1957a,b; Laurent 1964). The Capanda record reflects a northward range extension of approximately 160 km. This species has also been found at Cacuaco, 250 km WNW of Capanda (pers. obs.). It is probable that *C. pulitzerae* is widely distributed throughout the savanna biome of Angola, but perhaps occurs in low density in some areas, as is the case with *C. turneri* in eastern Africa.

Hemidactylus longicephalus Bocage, 1873
Material. 71 specimens: MNHNL/REP/A/Gec 3–71. MNHNL/REP/A/Gec 3–21 collected January 2003, MNHNL/REP/A/Gec 22–44 collected February 2003, MNHNL/REP/A/Gec 45–71 collected March 2003.
Comments. Despite a number of recent studies on the *Hemidactylus* of sub-Saharan Africa (Vences et al. 2004; Carranza and Arnold 2006; Miller et al. 2012), the status of many of the constituent taxa remains unsettled and the taxonomy of the group may be fairly characterized as among the most in need of revision of any geckos in the world. Capanda material appears to be referable to *H. longicephalus*, although the status of this taxon is itself unstable and several names that are currently placed in synonymy (e.g., Loveridge 1947) require further critical investigation. This species is widespread through Angola (Schmidt 1933; Laurent 1964) and into equatorial Africa (Loveridge 1947; Chirio and LeBreton 2007) and is broadly sympatric with the rather similar *Hemidactylus mabouia* (Moreau De Jonnès, 1818), throughout much of its range. Hellmich (1957b) reported on a large series of this species from Piri-Dembos (Cuanza Norte) and Manacas (1963) recorded it from Quizambil, Dande (Bengo Province) and Fazenda Otília, Encoge, and Quitexe (Uige Province). Bocage (1895) noted *Hemidactylus bocagii* Boulenger, 1892, currently considered a synonym of *H. longicephalus*, as occurring at Duque de Brangança and Pungo Andongo, approximately 100 and 20 km, respectively, northeast of Capanda.

GERRHOSAURIDAE

Gerrhosaurus nigrolineatus Hallowell, 1857
Material. 7 specimens: MNHNL/Rep/A/Ge 1–7
Comments. Bates et al. (2013) suggested that *G. nigrolineatus* was not monophyletic and resurrected *G. intermedius* Lönnberg, 1907 for eastern populations. Material from Angola is referable to *G. nigrolineatus sensu stricto*. This species is known from much of southern and central Africa and is widespread in Angola (Monard 1931, 1937; Laurent 1950, 1954; Hellmich 1957a; Manaças 1963), with the nearest location being in Duque de Brangaça, 100 km NE of Capanda (Bocage 1895). The Capanda specimens are from about 160 km SE of the type locality of *G. n. ahlfeldti* Hellmich and Schmelcher, 1956, currently regarded as a synonym of *G. n. nigrolineatus*, and about 100 km SW of the type locality of the taxonomically problematic *G. multilineatus* Bocage, 1866 (Haagner et al. 2000; Adolphs 2006).

SCINCIDAE

Trachylepis maculilabris (Gray, 1845)
Material. 36 specimens: MNHNL/Rep/A/Sc 1–36. MNHNL/REP/A/Sc 1–12 collected January 2003, MNHNL/REP/A/Sc 13–19 collected February 2003, MNHNL/REP/A/Sc 20–35 collected March 2003, MNHNL/REP/A/Sc 36 collected April 2003.
Comments. *Trachylepis maculilabris* has a wide distribution in sub-Saharan Africa as far south as Angola in the west (Trape et al. 2012). Mausfeld et al. (2004) noted that *T. maculilabris* may comprise at least two distinct species—one from West Africa representing the nominotypic *maculilabris*, and other from the East Africa. The Capanda material agrees entirely with the holotype of the species (see Appendix) and West African populations in general. Laurent (1950, 1954) recorded the species from several northern localities within Angola, including Dundo and Muita. Hellmich (1957a) reported it from Mucoso as well in south central Angola at Entre Rios, Bié Province and considered the species to be a human commensal. Bocage (1895) reported the species for Pungo Andongo, only 20 km NE of Capanda. Pungo Andongo is also the type locality of *Euprepes notabilis* Peters, 1879, currently considered as a synonym of *T. maculilabris*. The species has also been observed in human dwellings near Panguila swamp, near Kifangondo, 250 NW of Capanda (pers. obs.).

VARANIDAE

Varanus albigularis angolensis Schmidt, 1933
Material. Uncat JC (2 specimens)
Comments. Bayless (2002) summarized all known Angolan locality records for this taxon. Capanda lies near the northwest margin of the distribution of this subspecies and the species as a whole. It is replaced by *V. exanthematicus* to the north of the equatorial African forest belt. This species was discussed as *V. exanthematicus albigularis* by Monard (1937), Laurent (1954), and Hellmich (1957b).

Varanus niloticus (Linnaeus, 1758)
Material. 5 specimens: MNHNL/Rep/A/V 1–4, uncat JC (1 specimen)
Comments. Angolan material has been discussed by Monard (1937), Laurent (1950, 1954), Hellmich (1957a, b), and Manaças (1963). Bayless (2002) plotted the distribution of this species in Angola and throughout its range. The closest known occurrence lies 100 km NE of Capanda, in Kalandula, formerly Duque de Bragança (Bocage 1895).

SQUAMATA: SERPENTES

Philothamnus heterodermus (Hallowell, 1857)
Material. 1 specimen: MNHNL/Rep/A/0 4
Comments. This species was first recorded for Angola by Parker (1936) and reported from Piri-Dembos by Hellmich (1957b). Its distribution in Angola remains poorly known.

ELAPIDAE

Naja anchietae (Bocage, 1879)
Material. 1 specimen: MNHNL/Rep/A/0 5
Comments. Broadley (1995) regarded this taxon as a subspecies of *N. annulifera* Peters, 1854. Manaças (1982) provided a list of Angolan localities for this species. Known records are from southern Angola, as far north as 12°S (Broadley 1995; Broadley and Wüster 2004), thus the Capanda record represents a substantial northern extension of the species range.

Discussion

The species in this collection represent only a small portion of the expected fauna in this area (e.g., Bocage 1895; Monard 1937,

1938; Laurent 1964; Ruas 1996, 2002). Most of the species reported here are both easily caught and habitat generalists, and there is a notable absence of habitat specialists, such as fossorial species. In addition to the species recorded here, the unpublished list referred to above (see Materials and Methods above) cites 154 additional snake specimens from several taxa: *Elapsoidea semiannulata* Bocage, 1882, *Philothamnus* cf. *hoplogaster* (Günther, 1863), *Bitis arietans* (Merrem, 1820), *Naja nigricolis* (= *Naja nigricollis* Hallowell, 1857), *Telescopus semiannulatus* Smith, 1849, *Lamprophis fuliginosus* (= *Boaedon fuliginosus* (Boie, 1827)), *Naja melanoleuca* Hallowell, 1857, *Dendroaspis polylepis* Günther, 1864, *Python natalensis* Smith, 1840, *Dispholidus typus* (Smith, 1828), *Psammophis* sp. and *Philothamnus* sp. However, these identifications cannot be confirmed given that the associated specimens are no longer present in the collection. Other species noted in this same list but also missing from the collections are *Mabuya* cf. *sulcata* (= *Trachylepis sulcata* [Peters, 1867]), *Agama agama* (Linnaeus, 1758), *Mabuya varia* (= *Trachylepis varia* [Peters, 1867]), *Chamaeleo dilepis* Leach, 1819, *Chamaeleo gracilis* Hallowell, 1844, *Gerrhosaurus flavigularis* Wiegmann, 1828, *Kinixys belliana* Gray, 1831, and *Pelusios* cf. *subniger* (Lacépède, 1789). Some of these clearly represent synonyms or misidentifications, although without specimens their actual identities cannot be confirmed. Yet the collection remains interesting for its considerable numbers and for records of several species not previously known from this region of Angola. While a number of species were known from the region, several here represent important range extensions within Angola, such as *Pelusius nanus*, *Chondrodactylus pulitzerae*, and *Naja anchietae*, or even new records for the country, as may be the case for *Kassina maculosa*. Capanda is located in an interesting region where the boundaries of several different faunal communities meet. Many species more common in the southern regions of the country, such as *Kinixys spekii*, *Varanus albigularis angolensis*, *Chondrodactylus pulitzerae*, and *Naja anchietae* may reach their northern limits in Capanda. Similarly, Capanda represents the southern limit for other species such as *Kassina maculosa* and *Pelusios nanus*. The Capanda region is also close to the type localities of many amphibian and reptile species, especially those described by Franz Steindachner (1834–1919) and José Vicente Barbosa du Bocage (1823–1907) in the nineteenth century. For example, Duque de Bragança (100 km NE of Capanda) is the type locality for many amphibians and reptiles, including *Rana bragantina* Bocage, 1864 (now a synonym of *Hoplobatrachus occipitalis* [Günther 1858]), *Hyperolius angolensis* Steindachner, 1867, *Hyperolius bocagei* Steindachner, 1867, *Rana occipitalis* Bocage, 1866 (now a synonym of *Hoplobatrachus occipitalis* [Günther, 1858]), *Amietia angolensis* (Bocage, 1866), *Ptychadena subpunctata* (Bocage, 1866), *Hyperolius cinnamomeoventris* (Bocage, 1866), *Hyperolius steindachneri* Bocage, 1866, *Hyperolius fuscigula* Bocage, 1866, *Hyperolius tristis* Bocage, 1866 (now a synonym of *Hyperolius cinnamomeoventris* [Bocage, 1866]), *Hyperolius quinquevittatus* Bocage, 1866, and *Amietophrynus funereus* (Bocage, 1866), *Gerrhosaurus multilineatus* Bocage, 1866, *Sepsina angolensis* Bocage, 1866, *Afrotyphlops angolensis* (Bocage, 1866), *Philothamnus dorsalis* (Bocage, 1866), *Prosymna ambigua* (Bocage, 1873). Even this small survey of the Capanda collection at MNHN demonstrates how much remains to be discovered about Angola's biodiversity. Given its large size and diversity of habitat types, Angola remains among the most poorly studied pieces of the African zoogeographic puzzle. Further studies of historical collections within the country will contribute important details to understanding the distributions of Angolan amphibians and reptiles and thus facilitate conservation assessments and management.

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APPENDIX

Specimens used in comparisons

Xenopus petersii:

California Academy of Sciences: *Zaire*: CAS 98206; CAS 98207. *Zambia*: CAS 196563; CAS 196564; CAS 196565; CAS 196566; CAS 196567; CAS 196568; CAS 196660; CAS 196696.

Xenopus laevis:

California Academy of Sciences: *Namibia*: CAS 85933; CAS 160540; CAS 193683; CAS 193684. *South Africa*: CAS 125692; CAS 125693; CAS 195489.

Trachylepis maculilabris

Muséum national d'Histoire naturelle: *Cameroon*: MNHN 1999.9461; MNHN 2000.5200; MNHN 2005.1602; MNHN 2005.1611; MNHN 2005.1624; MNHN 2005.1625; MNHN 2005.1653; MNHN 2005.1654; MNHN 2005.1655; MNHN 2005.1677; MNHN 2005.1681; MNHN 2005.1723; MNHN 2005.1724; MNHN 2005.1726; MNHN 2005.1727; MNHN 2005.1731; MNHN 2005.1739; MNHN 2005.1744; MNHN 2005.1745; MNHN 2005.1762; MNHN 2005.1766; MNHN 2005.1767; MNHN 2005.1774; MNHN 2005.1775; MNHN 2005.1785; MNHN 2005.1788; MNHN 2005.1799; MNHN 2005.1800; MNHN 2005.1801; MNHN 2005.1806; MNHN 2005.1807; MNHN 2005.1808; MNHN 2005.1819; MNHN 2005.1830; MNHN 2005.1832; MNHN 2005.1833; MNHN 2005.1834; MNHN 2005.1835; MNHN 2005.1841; MNHN 2005.1844; MNHN 2005.1847; MNHN 2005.1848; MNHN 2005.1860; MNHN 2005.1861; MNHN 2005.1868; MNHN 2005.1900; MNHN 2005.1904; MNHN 2005.1907; MNHN 2005.1910; MNHN 2005.1915; MNHN 2005.1924; MNHN 2005.1925; MNHN 2005.1926; MNHN 2005.1974; MNHN 2005.1975; MNHN 2005.1977; MNHN 2005.2487; MNHN 2005.2489. *Angola*: MNHN 1888.0065; MNHN 1891.0429; MNHN 1891.0430; MNHN 1891.0431; MNHN 1896.0203; MNHN 1899.0123;bMNHN 1900.0488; MNHN 1900.0489; MNHN 1904.0163; MNHN 1904.0017X; MNHN 1904.0173; MNHN 1907.0256. *Zaire*: MNHN 1966.17599. *Guinea*: MNHN 1921.0325; MNHN 1921.0326; MNHN 1921.0327; MNHN 1921.0328; MNHN 1921.0330; MNHN 1921.0331; MNHN 1921.0332; MNHN 1921.0333; MNHN 1921.0334; MNHN 1921.0335; MNHN 1921.0337; MNHN 1921.0338; MNHN 1951.0103; MNHN 1951.0104; MNHN 1951.0106; MNHN 1951.0107; MNHN 1951.0159; MNHN 1967.0246.

Natural History Museum: "*West Africa*": NHM 1946.8.18.17 (Holotype).

NATURAL HISTORY NOTES

GYMNOPHIONA — CAECILIANS

***DERMOPHIS GLANDULOSUS* (San Isidro Caecilian). PREDATION.** Snakes are considered the main predators of caecilians (Duellman and Trueb 1994. Biology of Amphibians. Johns Hopkins University Press, Maryland. 670 pp.; Kupfer et al. 2003. Amphibia-Reptilia 24:212–215). Moreover, Pérez-Santos and Moreno (1988. Ofidios de Colombia. Museo Regionale di Scienze Naturali Torino, Monografia VI. 497 pp.) suggested that some species of coral snakes, such as *Micrurus nigrocinctus*, *M. spixii*, and *M. lemniscatus*, frequently include caecilians in their diets. At 1045 h on 24 July 2009, an adult *Micrurus multifasciatus* (Many-banded Coral Snake) was found preying upon a *Dermophis glandulosus* (MVUP 2307; total length = 331 mm). The observation took place on the trail to Cerro Brewster, located within the Parque Nacional Chagres, Panamá, Panamá (9.32053°N, 79.28876°W, datum WGS84; elev. ~800 m), which has vegetation typical of a submontane tropical forest. The *Micrurus multifasciatus* was photographed with the caecilian and released. The specimen of *D. glandulosus* showed signs of bites in the neck and nuchal region. This is the second record of predation on *D. glandulosus* by a coral snake (the first report was predation by *Micrurus alleni*; Arias and Chaves 2013. Herpetol. Rev. 44:657–658) and the first report of this species in the diet of *M. multifasciatus*.

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FIG. 1. *Micrurus multifasciatus* captured while preying upon *Dermophis gladulosus*.

CAUDATA — SALAMANDERS

***AMBYSTOMA VELASCI* (Plateau Tiger Salamander). PREDATION.** *Ambystoma velasci* is distributed in the Mexican states of Nuevo Leon on the east and Chihuahua on the west, southward to the Transvocanic Belt, and from Colima to Veracruz (Lemos-Espinal and Dixon 2013. Amphibians and Reptiles of San Luis Potosi. Eagle Mountain Publishing, Eagle Mountain, Utah. 300 pp.). At 1520 h on 26 April 2014, we observed a female *Thamnophis cyrtopsis* (Black-necked Gartersnake; SVL = 59. 2 cm, total length = 76.6 cm, mass = 115.5 g; body temperature = 29.0°C; UANL 7362) capturing, subduing, and consuming a neotenic *A. velasci* (Plateau Tiger Salamander; SVL = 8.89 cm, total length = 16.90 cm, mass = 44.03 g; UANL 7409; Fig. 1). The locality was San Jose de Gonzalez, Galeana, Nuevo Leon, Mexico (24.47847°N, 100.48846°W, datum WGS84; elev. 1846 m). This observation took place on land, very close to a permanent water body known as "Alijibes." The area is a microphyllous desert scrubland plant community. Although salamanders have been reported in the diet of *T. cyrtopsis* (Lemos-Espinal and Dixon 2013, *op. cit.*; Rossman et al. 1996. The Garter Snakes: Evolution and Ecology. University of Oklahoma Press, Norman, Oklahoma. 332 pp.), to our knowledge this is the first record of *A. velasci* as prey of *T. cyrtopsis*.

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FIG. 1. *Thamnophis cyrtopsis* consuming a neotenic *Ambystoma velasci*.

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***EURCYEA BISLINEATA* (Northern Two-lined Salamander). LEUCISM.** Adult *Eurycea bislineata* are wide-ranging stream salamanders that are usually distinguishable by two dark dorsolateral lines bordering a broad yellowish mid-dorsal stripe (Conant and Collins 1998. A Field Guide to Reptiles and Amphibians of Eastern and Central North America, 3rd ed. Houghton Mifflin Co., Boston, Massachusetts. 616 pp.). Amelanism, leucism, and albinism have been reported in other plethodontids, including *Plethodon cinereus* (Moore and Gilhen 2011. Can. Field Nat. 125:58–60; Russell et al. 2011. Can. Field Nat. 123:359–362), and larval *Eurycea cirrigera* (Miller and Braswell 2006. Herpetol. Rev. 37:198). However, to our knowledge leucism has not been reported in a wild adult *E. bislineata.*

On 12 July 2014, we collected a leucistic adult *E. bislineata* (SVL = 3.3 cm; Fig. 1) while conducting a survey for salamanders along a 30-m stream transect in Nathan Hale State Forest, Tolland Co., Connecticut, USA (41.76320833°N, 72.350525°W; datum WGS84). The individual exhibited extremely reduced pigmentation on the head and body, resulting in a translucent appearance. The tail retained some light yellow pigmentation, and the eyes were darkly pigmented. The individual was found under a rock on a mossy bank of a mostly dry first order stream. It was marked using a visible implant elastomer tag and released at the capture location according to the study protocol. Of 68 *E. bislineata* collected since sampling began 29 May 2014, this is the only abnormally colored individual detected.

We thank Tracy Rittenhouse for providing helpful comments.



FIG. 1. Leucistic adult *Eurycea bislineata* from Tolland Co., Connecticut, USA.

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***EURYCEA LONGICAUDA* (Long-tailed Salamander). HABITAT.** *Eurycea longicauda* are often found near water, such as pond edges or streams, but they are also known to make use of caves in many parts of their range (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, D.C. 587 pp.). Surprisingly, there are relatively few observations on how *E. longicauda* use terrestrial habitat when they make moves away from water. Here I report observations of habitat use by *E. longicauda* when they are far from aquatic habitats. In particular, I use observations of their use of cover boards placed along an edge between a second-growth deciduous habitat and an abandoned pine plantation habitat to examine activity in deciduous, mixed coniferous-deciduous, and coniferous habitats.

I recorded *E. longicauda* use of coverboards (pine lumber; 30.5 × 61.0 cm, 4 cm thick) biweekly from late-March/early-April through late-October/early-November from 2003 to 2009. The study area consisted of a mixed mesophytic forest (dominant species = *Acer saccharum*) and an abandoned pine (*Pinus strobus*) plantation on the Denison University Biological Reserve, Granville, Licking Co., Ohio, USA (40.085367°N, 82.509422°W, datum WGS84; elev. 341 m), and is nearly 400 m from the nearest surface water. I classified cover board habitat type based on the proportion of the five closest trees that were deciduous or coniferous (see Grasser and Smith 2014. J. N. Am. Herpetol. 2014:53–58 for details).

I made a total of 44 observations on *E. longicauda* over the course of the study. Observations of *E. longicauda* were highest in June (13) and July (14), with lower numbers observed in May (9), August (6), and September (2), and I never observed *E. longicauda* in March, April, October, or November. I made the most observations of *E. longicauda* in the deciduous habitat (29), followed by the mixed habitat (11), and the coniferous habitat had the fewest observations (4). However, the distribution of observations of salamanders did not differ significantly from what would be expected based upon the number of cover boards in each habitat (χ^2 = 2.598, P = 0.273). Previous descriptions of habitat use by *E. longicauda* are usually relatively vague. For example, several studies refer to these salamanders being found under cover objects near ponds or streams (Martof 1955. Copeia 1955:166–170; Muchmore 1955. Ohio J. Sci. 55:267–270; Holman 1960. Copeia 1960:56–58; Anderson and Martino 1967. Herpetologica 23:105–108), on wooded slopes (Wicknick et al. 2005. Ohio J. Sci. 105:2–7), in forests (Anderson and Martino 1966, *op. cit.*), or in areas with vegetation (Gordon 1953. Tulane Stud. Zool. 1:55–60). My observations suggest that *E. longicauda* will use cover objects in a variety of wooded habitats at a distance from water.

I thank all of the many students who helped check the cover boards throughout this long-term study.

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***PLETHODON CHATTAHOOCHEE* (Chattahoochee Slimy Salamander). HABITAT.** *Plethodon chattahoochee* is a member of the slimy salamander (*P. glutinosus*) complex as delineated by Highton et al. (1989. Univ. Illinois Biol. Monogr. 57:1–78). It is native to the montane deciduous forests of north-central Georgia and extreme southeastern North Carolina. All members of this complex are normally found in moist forest-floor habitats, such as beneath rocks and logs (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, DC. 587 pp.), as well as in caves (Peck 1974. Nat. Speleol. Soc. Bull. 36:7–10), and underneath the bark of standing trees (Thigpen et al. 2010. Herpetol. Rev. 41:159–162). All species of

Plethodon have direct development and with few exceptions are not considered to be tied to aquatic habitats.

At 2030 h on 03 August 2014, we found an adult *P. chattahoochee* perched on top of a small rock in the middle of fast-flowing Mulky Creek in Chattahoochee National Forest, Union Co., Georgia, USA (34.783838°N, 84.055721°W; datum WGS84). The stream was ~5 m wide and ~20 cm deep. We encountered the same salamander twice more over the next 2 h as it moved among different rocks in the stream, seemingly following no particular pattern with respect to the banks or direction of flow of the stream. At no point did we observe it submerged, although it swam capably downstream using its tail for lateral undulation when we dislodged it from its perch. It is uncertain whether this salamander's presence in the stream was intentional or accidental, but it apparently was not actively trying to return to the shore. It is unusual for any member of the *P. glutinosus* complex to be found in such an aquatic habitat.

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ANURA — FROGS

***AGALYCHNIS DACNICOLOR* (Mexican Leaf Treefrog). PREDATION.** *Agalychnis dacnicolor* is a medium-sized tree frog endemic to elevations less than 1000 m in the tropical deciduous forest of Mexico (Duellman 2001. The Hylid Frogs of Middle America, Expanded Edition. Society for the Study of Amphibians and Reptiles, Ithaca, New York, 753 pp.). Possible predators of *A. dacnicolor* include snakes of the genera *Leptophis*, *Drymobius* and *Leptodeira*; however these observations are not formally established in the scientific literature. At 2024 h on 16 November 2011, in the remnants of a temporary pool formed during the wet season (18.001963°N, 98.520717°W; datum WGS84), we discovered an adult male Mexican Blue-footed Tarantula (*Bonnetina papalutlensis*) with a newly metamorphosed *A. dacnicolor* in its chelicerae (Fig. 1). In the general area we also observed a large number of young frogs emerging from the same pool. Most frogs showed signs of a tail, suggesting that this was a recently metamorphosed cohort. This is the first record of predation on *A. dacnicolor* by an arthropod.



PHOTOGRAPH BY ERIC CENTENERO-ALCALA.

FIG. 1. *Bonnetina papalutlensis* predating a metamorph *Agalychnis dacnicolor.*

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***ANAXYRUS DEBILIS* (Green Toad). PREDATION.** Little is known about the natural history of *Anaxyrus* (=*Bufo*) *debilis* except that it breeds in shallow temporary rain pools, fishless ponds, or intermittent streams coinciding with the onset of summer rains (Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. University of New Mexico Press, Albuquerque. 431 pp.). Here I describe predation of *A. debilis* by the Great Horned Owl (*Bubo virginianus*).

On 28 June 2010, a dried carcass of an adult male (approx. SVL = 34 mm, possessing a black throat) *A. debilis* was found while collecting owl pellets under a small nesting cave of a pair of Great Horned Owls at Lake Alan Henry Wildlife Mitigation Area, ca. 13 km S, 26 km W of Clairemont, Kent Co., Texas, USA (33.048429°N, 101.033878°W; datum WGS84). The only visible injury was a wide gouge behind the eyes which incised the left parotoid gland. Based on the previous collection date of owl pellets and the amount of desiccation, the toad was probably preyed upon between 14–24 June 2010. Heavy rains occurred twice during the period, resulting in the filling of many depressions created by cattle and feral hogs, conducive to *A. debilis* breeding (Griffis-Kyle 2009. Herpetol. Rev. 40:199–200). The male *A. debilis* was probably preyed on while calling after the heavy rain, brought to the nestlings, then discarded, likely because its parotoid gland was punctured.

As an opportunistic predator, the Great Horned Owl feeds on a wide variety of nocturnal prey, primarily mammalian, with only a very small percentage of the diet comprising amphibians (Artuso et al. 2014. The Birds of North America Online: http://bna.birds.cornell.edu/bna/species/372). For North America, I found no previous records of the Great Horned Owl preying on any species of toad (Artuso et al. 2014, *op. cit.*) and only few records of owls preying on bufonids. The lack of bufonids in owl prey data and the incident reported herein are contrary to the statement of Olsen (1989. Copeia 1989:391–397) that owls are able to avoid dorsal surface toxins by consuming the vulnerable ventral portions.

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***CTENOPHRYNE ATERRIMA* (Costa Rica Nelson Frog). DIET.** *Ctenophryne aterrima* is a secretive, fossorial, and nocturnal frog that spends much time under surface litter on the forest floor. This species is considered insectivorous, more or less exclusively eating termites and ants (Savage 2002. The Amphibians

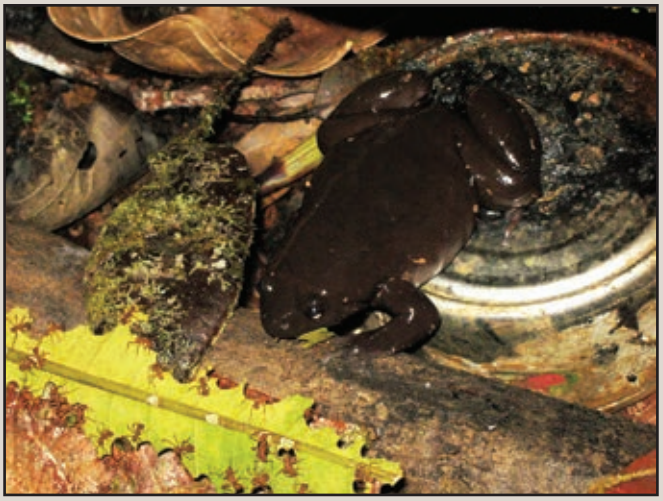


FIG. 1. *Ctenophryne aterrima* feeding on leafcutter ants (*Acromyrmex* sp.) in the cloud forest of Cerro Brewster, Chagres National Park, Panamá.

and Reptiles of Costa Rica: A Herpetofauna between Two Continents, between Two Seas. The University of Chicago Press, Chicago, Illinois. 934 pp.). At 2216 h on 20 July 2009 in the Chagres National Park in Cerro Brewster, Panamá, Panamá (9.31995°N, 79.28871°W, datum WGS84; elev. 800 m), we found a *C. aterrima* preying on leafcutter ants (*Acromyrmex* sp.). This observation was made on a cloudy night (mean temp. = 22.7°C) in a cloud forest within a hole in the ground used for dumping waste. The frog sat on one side of the passing group of ants, observing their movements and employing a sit-and-wait feeding strategy. In a period of approximately ten minutes it only ate two ants and removed pieces of leaves from its mouth with its forelimbs. The frog and ants were photographed and left without disturbance. This is the first report of predation on leafcutter ants of genus *Acromyrmex* by *C. aterrima* in its natural distribution.

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***ELEUTHERODACTYLUS WIGHTMANAE* (Melodious Coqui). REPRODUCTION, PARENTAL CARE, AND CALLING SITES.** *Eleutherodactylus wightmanae* is a small anuran (mean SVL = 20.2 mm) common in high elevation forests and inhabits forest leaf litter (Stewart and Woolbright 1996. *In* Reagan and Waide [eds.], The Food Web of a Tropical Rain Forest, pp. 273–320. The University of Chicago Press, Chicago, Illinois). The species is listed as endangered on the IUCN Red List (Angulo 2008. www.iucnredlist.org, Version 2014; accessed 26 September 2014); however, the Department of Natural and Environmental Resources of the Commonwealth of Puerto Rico does not list the species or consider it to be under any imminent threat (Departamento de Recursos Naturales y Ambientales. 2004. Reglamento para Regir las Especies Vulnerables y en Peligro de Extinción en el Estado Libre Asociado de Puerto Rico. Departamento de Estado Número Reglamento 6766. ELA, DRNA, San Juan, Puerto Rico. 60 pp.).

Male *E. wightmanae* call up to 100 cm above the ground but females rarely climb (Drewry and Rand 1983. Copeia 1983:941–953). Little is known of the reproductive biology of this species (Joglar 1998. Los Coquíes de Puerto Rico: Su Historia Natural y Conservación. Editorial de la Universidad de Puerto Rico, San

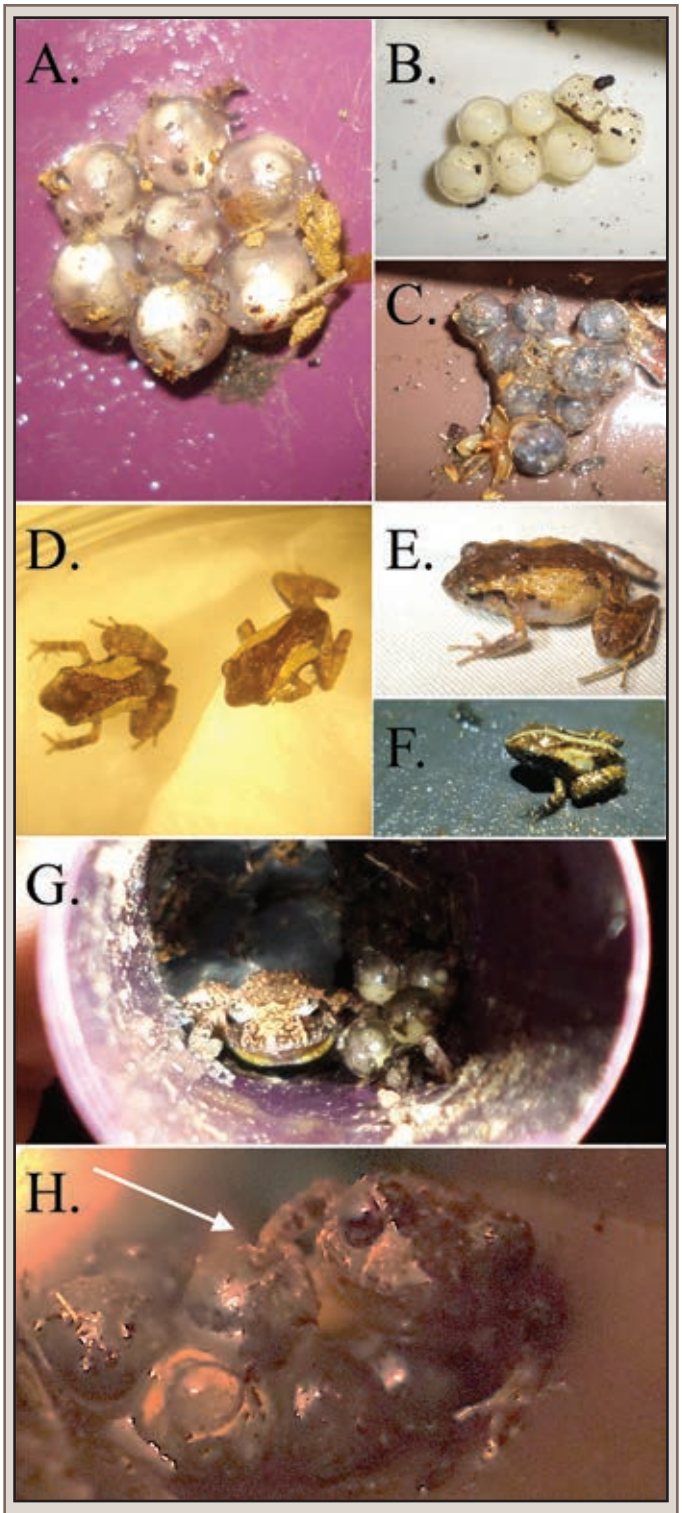


FIG. 1. *Eleutherodactylus wightmanae* in Puerto Rico. A–C) Shape and size characteristics of egg clutches in plastic tubes. D) dorsal coloration patterns in hatchlings in the laboratory. E) dorsal coloration pattern in an adult in the field. F) dorsal coloration pattern in a hatchling in the field. G–H) males guarding egg clutches inside plastic tubes (arrow in (H) highlights guarding male showing brooding behavior, with his fore limb in contact with an egg).

Juan. 232 pp.) and information on its egg clutches is limited to two observations: egg clutches having four and five eggs, one clutch having eggs with a mean diameter of 4.39 mm (N = 3 eggs); and both egg clutches being found inside curled leafs of *Cecropia peltata* or "yagrumo" (Joglar et al. 2005. Herpetol. Rev. 36:433–434). Anecdotal accounts refer to male parental care (Townsend 1996. *In* Powell and Henderson [eds.], Contributions to the West Indian Herpetology: A Tribute to Albert Schwartz, pp. 229–239. SSAR Contributions to Herpetology, Vol. 12, Ithaca, New York; Joglar et al. 2005, *op. cit.*). Herein, we provide data on egg clutch characteristics, parental care, and calling sites that expands our knowledge on the reproductive biology of the species.

This study was carried out between 31 August 2013 and 16 May 2014 in the rainforest of the Sierra de Cayey mountains (Cayey-Guayama municipalities) in southern Puerto Rico (18.054405°N, 66.123019°W, datum WGS84; elev. 817 m). The major vegetative cover (>50% of higher plants in the study area) consists of Sierra Palm (*Prestoea montana*). We placed 121 plastic tubes (diameter = 23.5 mm; length = 150–170 mm) 2 m apart from each other, in each of two 20 × 20 m plots (total tubes: 242) on the forest litter of the study area. The 20 × 20 m plots were approx. 200 m apart. The tubes were used by *E. wightmanae* as retreat and breeding sites and we collected data on clutch size, egg diameter, and clutch shape. Mean (± SD) number of eggs per clutch = 7.04 ± 1.85 (range: 4–11 eggs, N = 24 clutches); mean (± SD) egg diameter was 4.53 ± 0.65 mm (range: 4–5.8 mm, N = 15 eggs from N = 6 egg clutches). The most frequent shape of the egg mass was a radiating arrangement of six eggs around a center egg, all deposited in a single layer (Fig. 1A). Other shapes include an elongated egg mass and eggs spread in a larger non-geometric design (Fig. 1B–C). Basic dorsal coloration patterns for N = 22 adults (in decreasing order of abundance) were: no obvious dorsal pattern (N = 9), reversed comma (N = 7), reversed comma and light mid-dorsal line on a darker background (N = 3), dark inter orbital band on a lighter background (N = 2), light colored snout region on a darker background (N = 1). Likewise, for N = 18 hatchlings from four egg clutches: no obvious dorsal pattern (N = 11), reversed comma (N = 6), and reversed comma and light mid-dorsal band (N = 1). When patterned, recently hatched juveniles had similar coloration and the reversed comma pattern typically found in adults (Fig. 1D–E). On one occasion, however, we found a recently hatched juvenile with the pattern described above along with a mid-dorsal stripe on a darker background (Fig. 1F) which has not been observed in adults so far. Parental care, which is performed only by the male, was observed in seven of the 24 egg clutches (Fig. 1G–H) found during daytime hours (1500–1730 h). Data on calling males were collected between 1859 h and 2115 h during the sampling period. Calling males (N = 28) were found on vegetation at heights between 0.0 m and 0.5 m above the ground (mean ± SD = 0.25 ± 0.14 m). Calling males were found on surfaces that included (in decreasing order of abundance): leaves of short woody plants (8); dry leaflets of *P. montana* leaves on the ground (5); dry sheaths of *P. montana* leaves on the ground (4); fronds of ferns (4); leaf blades of herbaceous plants (3 on Poaceae, also known as Gramineae); tree trunks (2); inside curled dry sheaths of *P. montana* leaves on the ground (1); and leaves of seedlings of *P. montana* (1).

Puerto Rico has two main seasons: a warmer rainy period (approx. from May to late December) and a cooler dry period (approx. from January to April). Between 31 August 2013 and 14 December 2013 we found eight egg clutches (total = 57 eggs), while between 16 January 2014 and 14 April 2014 we found five egg clutches (total = 29 eggs). In only one visit in 16 May 2014 (a month that marks the beginning of the warmer and rainy period) we found 11 egg clutches (total = 83 eggs). The large number of egg clutches recovered in May suggest that peak breeding in this species may coincide with the onset of the warm, rainy season. Therefore, egg clutch production by *E. wightmanae* may follow a seasonal pattern similar to that in other Puerto Rican *Eleutherodactylus* with the exception of the ground-dwelling Puerto Rican Dwarf Coqui, *E. unicolor*, which shows the opposite pattern (reviewed by Joglar 1998, *op. cit.*).

Extensive surveys conducted by our research team since May 2014 in forested mountain areas (>13 sites) throughout Puerto Rico revealed that the species is abundant and frequently found at every site. However, repeated visits to a single site revealed substantial variation in calling intensity for this species, which may lead to false absences if acoustic surveys are not conducted on successive nights at each site.

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***HYLA ARENICOLOR* (Canyon Treefrog). FEEDING ATTEMPT.** Most species of tree frogs consume primarily invertebrates. *Hyla arenicolor* is known to feed on arthropods, mainly insects (Abbadié-Bisogno 2004. Unpubl. thesis. FES, Iztacala; Winter et al. 2007. Herpetol. Rev. 38:323). The predation of lizards by hylid frogs has been previously documented, including lizards of the genus *Anolis* (Campbell 2007. Herpetol. Rev. 38:440; Preston 2010. Herpetol. Rev. 41:199). To our knowledge this is the first account of a predation attempt by *H. arenicolor* on *Anolis nebulosus* (Clouded Anole). At 1711 h on 04 December 2013, at Municipality of Valparaiso, Zacatecas, México (22.664482°N, 103.609491°W, datum WGS84; elev. 1874 m) an adult *H. arenicolor* was found trying to swallow an *A. nebulosus* of similar size. After a few minutes the lizard was regurgitated, possibly because it was too large (Fig. 1).



FIG. 1. Adult *Hyla arenicolor* attempting to eat a similar-sized *Anolis nebulosus*.

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***HYPSIBOAS BOANS* (Giant Gladiator Treefrog). PREDATION.** *Leptophis ahaetulla* is primarily a diurnal and semiarboreal colubrid that inhabits forest, and forages primarily on the ground and in fallen vegetation, where its prey items are likely to be found at rest (Fraga et al. 2013. Guide to the Snakes of the Manaus Region, Central Amazonia. Manaus, Editora INPA. 303 pp.). The diet consists mostly of frogs, lizards, and birds, with dietary preference for hylids, especially those of the genus *Scinax* (Albuquerque et al. 2007. J. Nat. Hist. 41:1237–1243).

At 1417 h on 30 July 2011, we observed an adult *L. ahaetulla* preying upon an adult *Hypsiboas boans*. This event occurred at Reserva Biológica do Parazinho (00.875°N, 49.9875°W; datum WGS84), a fluvial island and part of the Islands of Bailique in the municipality of Macapá, and of the Amazon River basin. The snake attacked the hylid with a bite on the head region (Fig. 1). The predation event took 37 min., and the snake took 14 min. to swallow its prey. *Leptophis ahaetulla* is considered diurnal and semi-arboreal, while *H. boans* is nocturnal and arboreal (Lima et al. 2012. Guide to the Frogs of Reserva Adolpho Ducke, Central Amazonia. Manaus, Editora INPA. 168 pp.), suggesting that *L. ahaetulla* may capture *H. boans* during the day when the frogs are inactive.



FIG. 1. *Leptophis ahaetulla* trying to swallow a *Hypsiboas boans* in Reserva Biológica do Parazinho, municipality of Macapá, North Brazil.

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***LEPTOBRACHIUM HENDRICKSONI* (Spotted Litter Frog). DEATH FEIGNING.** Amphibians are common prey items for a wide range of predators. To escape predation they employ various defensive behaviors such as death feigning, stiff-leggedness, lung inflation, mouth gaping, and body raising (Toledo et al. 2011. Ethol. Ecol. Evol. 23:1–25). *Leptobrachium hendricksoni* is known from Malaysia, Thailand, and Indonesia where it occurs in forest leaf litter, primarily at low altitudes of primary and secondary forests (Berry 1975. The Amphibian Fauna of Peninsular Malaysia. Tropical Press, Kuala Lumpur. 133 pp.; Ibrahim et al. 2008. The Common Amphibians and Reptiles of Penang Island. The Forestry Department of Penang, Malaysia. 116 pp.). Herein we report for the first time death feigning (thanatosis) behavior of this species as a way to avoid predation.

At ~2130 h on 22 November 2013, an adult *L. hendricksoni* (Fig. 1A) was captured while hiding among leaf litter near a tree buttress at Ulu Paip Receational Forest, Kedah, Malaysia (5.242212°N, 100.400635°E, datum WGS84; elev. < 200 m). The specimen was brought back to the laboratory and measured (SVL = 46.25 mm, head width = 21.37 mm, mass = 9 g). When approached for photographs, this specimen exhibited death-feigning behavior. It suddenly turned its belly up, inflated the body, and exposed its ventral surface (Fig. 1B). The frog remained in this motionless position with its eyes open for about 2–3 minutes. It then turned slowly back to its normal position and crawled under dead leaves to hide. The specimen was subsequently deposited at the School of Pharmacy, Universiti Sains Malaysia (13USM-UP-LH01).

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FIG. 1. An adult *Leptobrachium hendricksoni* from Kedah, Malaysia. A) Normal posture. B) Death feigning behavior.

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***LEPTODACTYLUS LATRANS* (Criolla Frog). PREDATION.** *Leptodactylus latrans* is a large anuran that inhabits swamps and streams with lots of vegetation, mostly wet grassland. Its distribution includes central Argentina, southern Brazil, Uruguay, and some parts of Paraguay (Cei 1980. Amphibians of Argentina. Ital. J. Zool., N. S. Monogr. 2, 609 pp.; Gallardo 1987. Anfibios Argentinos: Guía para su Identificación. Biblioteca Mosaico, Buenos Aires. 98 pp.). Tadpoles are gregarious and the female parent remains with the tadpoles until metamorphosis (Vaz Ferreira and Gehrau 1974. Rev. Biol. Uruguay 2:59–62; Vaz-Ferreira and Gehrau 1975. Phys. 34:1–14). *Astyanax eigenmanniorum* is a small fish (85 mm) that inhabits vegetated streams, calm rivers, ponds, and lakes from southern Brazil to central northern Argentina (Acosta et al. 2013. ProBiota, Ser. Tec. y Didac. 19:1–10). It is an omnivorous species, but its diet changes with the season. Its diet includes fish, eggs of the fish *Odontesthes bonariensis*, crustaceans, insects (larvae and adults), Coleoptera, Hymenoptera, spiders, and vegetation (Grosman 1999. Acta Sci. Biol. Sci. 21:267–275; Bennemann et al. 2005. Iheringia Ser. Zool. 95:247–254).

At 1500 h on 21 December 2013 at La Majadita (30.426°S, 67.2942°W, datum WGS84; elev. 979 m), Departamento Valle Fértil, San Juan, within the Parque Provincial Natural Valle Fértil, we observed a female *L. latrans* near a school of tadpoles. The frog was located in the water near the shore of a slow, permanent stream (25 cm deep). The tadpoles were at Gosner stage 20–23. When we came closer in order to obtain a photographic record, the female left the area, leaving the tadpoles alone. Immediately, a group (10–15 individuals) of *A. eigenmanniorum* began to feed on the colony of tadpoles. Fish approached the tadpoles until they were close enough to attack them. This action was conducted from the center to the shore of the stream, perpendicular to the direction of the water. Throughout our observations the female frog did not return to the tadpoles. We did not count how many tadpoles were eaten, but some were still alive when we left the site. This report represents a new prey species for *A. eigenmaniorum* and a new predator of *L. latrans* tadpoles.

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***LITHOBATES AREOLATUS* (Crawfish Frog). PREDATION.** *Lithobates areolatus* is declining and distributed sparsely in remnant prairie habitats of the central United States (Parris and Redmer 2005. *In* Lannoo [ed.], Amphibian Declines: The Conservation Status of United States Species, pp. 526–528. Univ. California Press, Berkeley). Owing to their extensive use of crayfish/small mammal burrows and highly secretive nature, limited data exist regarding the life history of *L. areolatus*, particularly natural sources of mortality. Experimentally, two species of insect (both backswimmers [*Notonecta* spp.]) have been identified as predators of larval *L. areolatus* (Cronin and Travis 1986. Herpetologica 42:171–174). Reported predators of post-metamorphic *L. areolatus* include *Heterodon platirhinos* (Eastern Hog-nosed Snake; Engbrecht and Heemeyer 2010. Herpetol. Rev. 41:168–170), *Coluber constrictor* (North American Racer; Engbrecht et al. 2012. Herpetol. Rev. 43:323–324), *Thamnophis sirtalis* (Common Gartersnake; Heemeyer 2011. Unpubl. MS Thesis. Indiana State University), and *Procyon lotor* (Raccoon; Engbrecht et al. 2012. Herpetol. Rev. 41:475); however, other common predators of ranid frogs such as snakes, birds, and mammals are suspected. Here we report the predation of *L. areolatus* by *Nerodia erythrogaster* (Plain-bellied Watersnake) and *Lanius ludovicianus* (Loggerhead Shrike) in northwest Arkansas, USA.



FIG. 1. Adult female *Nerodia erythrogaster* that regurgitated an adult *Lithobates areolatus* in Washington Co., Arkansas, USA.



FIG. 2. Juvenile *Lithobates areolatus* impaled on a barbed-wire fence by a *Lanius ludovicianus* (Loggerhead Shrike) in Benton Co., Arkansas, USA.

At 1500 h on 4 April 2014 we hand-captured a large adult female *N. erythrogaster* (SVL = 91.8 cm; 541.7 g) that was basking on emergent vegetation at Woolsey Wet Prairie Sanctuary (WWPS), Washington Co., Arkansas, USA (36.067175°N, 94.233639°W; datum WGS84). WWPS is a recently (2006) restored section of remnant prairie, perforated with numerous ephemeral wetlands which are known breeding sites for a population of *L. areolatus*. Upon capture, the *N. erythrogaster* voluntarily regurgitated an adult *L. areolatus* (Fig. 1; SVL = 8.0 cm, 24.55 g). A second well-digested *L. areolatus* was later recovered from the snake's stomach by palpation. On 10 April 2014, a second adult female *N. erythrogaster* (SVL = 75.8 cm; 321 g) was hand captured at WWPS that also regurgitated a single partially digested adult *L. areolatus*. *Nerodia erythrogaster* are thought to feed more heavily on amphibians than other species of *Nerodia* (Gibbons and Dorcas 2004. North American Watersnakes: A Natural History. University of Oklahoma Press, Norman. 438 pp.). Among 62 *N. erythrogaster* captured at WWPS between 15 March 2014 and 10 June 2014, 11 had palpable food items; of these, 100%

regurgitated anurans (*L. areolatus* [N = 2]; *L. sphenocephalus* [Southern Leopard Frog; N = 5]; *L. catesbeianus* [American Bullfrog; N = 3]; *Hyla versicolor* [Gray Treefrog]; N = 1). Although ranid frogs are important prey for *N. erythrogaster* at this site, *L. areolatus* exhibit a relatively short, early spring breeding season, and thus are likely only available for a limited time within the aquatic habitat.

An additional predation event involving a *L. ludovicianus* (Loggerhead Shrike) took place near Maysville, Benton Co., Arkansas, USA (36.406867°N, 94.568393°W; datum WGS84). Because shrikes lack large talons for shredding, they impale prey upon thorns or barbed-wire fences to aid in tearing and consuming. The diet of *L. ludovicianus* is composed primarily of insects (orthopterans, coleopterans), but may also include vertebrate prey (snakes, lizards, amphibians, small rodents, and birds), especially in winter months when invertebrates are a less reliable food source. After observing two *L. ludovicianus* on 6 July 2013, JCN discovered a juvenile *L. areolatus* hanging from a nearby barbed-wire fence (Fig. 2). These observations expand the known predators and sources of natural mortality for *L. areolatus* and support the contention that breeding and post-metamorphic migration present a period of heightened vulnerability for this species (Heemeyer and Lannoo 2012. Copeia 2012[3]:440–450).

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LITHOBATES JOHNI **(Moore's Frog). DIET.** *Lithobates johni* is a poorly-known frog endemic to the southeastern Sierra Madre Oriental of México. The original species description (Blair 1947. Am. Mus. Novit. 1353:1–17) reported spiders, crayfish, and eight insect orders in the diet of 22 dissected *L. johni*, suggesting that it is a generalist consumer of invertebrates. Here, we provide the first record of a vertebrate in the diet of *L. johni*, from a population in the state of Veracruz, México. At 0830 h on 15 January 2014, we observed an adult *L. johni* devouring an adult *Ecnomiohyla miotympanum* (Small-eared Treefrog) in the Reserva Ecológica del Río Pancho Poza, at 2040 m in Municipio de Altotonga (19.73989°N, 97.25072°W; datum WGS84). This reserve is a ca. 57-ha state-protected area, located on the southwestern outskirts of the town of Altotonga. Habitat is mesic cloud forest, transitioning into disturbed vegetation along the shoreline of the river where the frogs were observed. At this site, *R. johni* occurs at high density; between 10 and 20 individuals were seen along a 0.75-km stretch of the river that same day.

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LITHOBATES SPHENOCEPHALUS **(Southern Leopard Frog). DIET.** *Lithobates sphenocephalus* have been reported to feed indiscriminately on a wide variety of insects, arthropods, snails, crayfish, fish, salamanders, and other anurans (Dodd 2013. Frogs of the United States and Canada. Vol. II. John Hopkins University Press. Baltimore, Maryland. 982 pp.). While not unexpected, this is the first record known to us of *L. sphenocephalus* consuming a lizard. At 0024 h on 04 April 2014, a *L. sphenocephalus* was found DOR on Zimmerscheidt Road, 13 km NNE of Columbus, Colorado Co., Texas, USA (29.81751°N, 96.50888°W, datum WGS84; elev. 85 m). The frog carcass contained a *Scincella lateralis* (Ground Skink). The anterior end of the *S. lateralis* was partially digested, and the posterior half of the lizard including the hind legs (tail missing) was largely intact and clearly recognizable. The specimens were deposited at the Texas Natural History Collection (TNHC 90500) and photographic vouchers deposited in the University of Arlington Digital Collection (UTADC-8113, UTADC-8114).

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PHYSALAEMUS CUVIERI **(Barker Frog). PREDATION.** *Physalaemus cuvieri* is a small leptodactylid species that is widely distributed in South America (Maffei and Ubaid 2014. Amphibians of Rio Claro Farm. Lençóis Paulista, São Paulo, Brazil. 123 pp.). *Philodryas nattereri* (Paraguay Green Racer) is a generalist predator, feeding on reptiles, but also mammals and amphibians (Mesquita et al. 2011. Herpetol. J. 21:193–198). At 1933 h on 27 November 2013, we observed a medium-sized adult *P. nattereri* feeding on a *P. cuvieri* male (Fig. 1) on the banks of a permanent pond, in Bonfinópolis municipality, Goiás, Brazil (16.5993°S, 48.8753°W, datum SAD69; elev. 919 m). The air temperature at the site was 23.5°C, water temperature was 29.3°C, and humidity was 81%. While we recorded the advertisement calls of the individual of *P. cuvieri* the snake captured it by the head. The *P. cuvieri* remained alive with an inflated body while being swallowed. The predation event lasted 7 min. To our knowledge this is the first record of predation of *P. cuvieri* by *P. nattereri*.

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FIG. 1. *Philodryas nattereri* preying on *Physalaemus cuvieri*, in a permanent pool, Bonfinópolis municipality, Goiás, Brazil.

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***RAORCHESTES BOMBAYENSIS* (Bombay Bush Frog) and *MICROHYLA ORNATA* (Ornate Narrow Mouthed Frog). INTERSPECIES AMPLEXUS.** When the breeding season of two or more anuran species overlaps spatiotemporally, amplexus between two different species may occur (Hobel 2005. Herpetol. Rev. 36:55–56). Herein we describe the unusual interspecies amplexus between a *Raorchestes bombayensis* male and a *Microhyla ornata* female (Fig. 1). *Raorchestes bombayensis* is endemic to the Western Ghats (elev. 400–1300 m) in the states of Maharashtra and Karnataka, India (Daniels 2005. Amphibians of Peninsular India. Indian Academy of Science and University Press, Hyderabad, India. 260 pp.). This species has direct development, breeds arboreally, and lays its eggs on leaves (Bossuyt et al 2001. Herpetol. Rev. 32:34–35). *Microhyla ornata* is a widespread species in South Asia occurring in lowland shrub forest, grassland and urban areas. It breeds in ephemeral and permanent water bodies and also in modified areas such as agricultural land. At 0126 h on 6 July 2014 we heard a chorus of males of *Microhyla* and *Zakerana* species from roadside water pools. We found more than 23 pairs of *M. ornata* in amplexus, and one case of a *R. bombayensis* male amplexing a female *M. ornata*. These observations took place in a village (Shelap) inside the Radhanagari Wildlife Sanctuary, Kolhapur, Maharashtra, India (16.4894°N, 73.9372°E, datum WGS84; elev. ca. 752 m).



Fig. 1. Amplexus of a *Microhyla ornata* female by a *Raorchestes bombayensis* male.

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***RHINELLA CRUCIFER* (Striped Toad) AND *RHINELLA JIMI* (Cururu Toad). HETEROSPECIFIC AMPLEXUS.** Males of many bufonids are not very selective in their choice of mates, and may clasp other anuran species (e.g., Grogan and Grogan Jr. 2011. Herpetol. Rev. 42:89–90; Machado and Bernarde 2011. Herpetol. Notes 4:167–169), dead conspecifics (Ayres 2010. Herpetol. Rev. 41:192–193; Brito et al. 2012. North-West J. Zool. 8:365–366), and even inanimate objects (Streicher 2008. Herpetol. Rev. 39:75). Here we present the first reported case of heterospecific amplexus involving the neotropical bufonids *Rhinella crucifer* and *R. jimi*.



Fig. 1. Amplexus between male *Rhinella crucifer* and female *Rhinella jimi*.

On 18 July 2010, one of us (RLT) observed and photographed a male *R. crucifer* in amplexus with a much larger female *R. jimi* (Fig. 1) near a creek in the municipality of Ipiaú, state of Bahia, northeastern Brazil (14.0369°S, 39.6631°W, datum WGS84; elev. 160 m). The individuals were not captured. Hybridization between *R. icterica* and *R. ornata* (= *Bufo crucifer*; see Pombal and Haddad 2007, *op. cit.*) has been reported to create aberrant and unviable individuals (Haddad et al. 1990, *op. cit.*). Our report, like that of Haddad et al. (*op. cit.*), concerns one species of the *R. crucifer* group and one of the *R. marina* group, which raises the possibility that the progeny resulting from such a pairing may not be viable.

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***RHINELLA MAGNUSSONI*. BREEDING SITE.** The small bufonids of the *Rhinella margaritifera* group are known to use small temporary ponds as breeding sites, with the exception of *Rhinella castaneotica*, which reproduce in rainwater present inside the fallen fruit capsules of Brazilian Nut Tree (*Bertholletia excelsa*) opened by agoutis (*Cuniculus paca*, *Dasyprocta croconota*). Other amphibian species such as *Adelphobates castaneoticus* and *A. quinquevittatus* are also known to utilize these breeding sites.

On 04 December 2012 at 1236 h and 1921 h, in Amazon National Park, Pará, Brazil, (4.66452°S, 56.61645°W, datum WGS84; elev. 64 m; and 4.66595°S, 56.61757°W, datum WGS84; elev. 60 m, respectively), three amplectant pairs of the recently described *Rhinella magnussoni* were found inside the water of empty fruit capsules of Brazilian Nut Tree, and two of these capsules contained egg clutches (Fig. 1). This species is sympatric with the morphologically similar *R. castaneotica*, requiring a detailed examination of individuals to determine the species. We identified

PHOTO BY LUIS STORTI



FIG. 1. Amplectant pair of *Rhinella magnussoni* with their egg clutch inside a fruit capsule of the Brazilian Nut Tree (*Bertholletia excelsa*).

the specimens of *R. magnussoni* by the greater abundance of spiculated tubercles along dorsum and parotoid glands, as well as a more rounded snout in lateral view. This reproductive behavior is previously known only for *R. castaneotica* (Caldwell 1991. Pap. Avul. Zool. 37:389–400) and was not reported for *R. magnussoni* in the original description (Lima et al. 2007. Zootaxa 1663:1–15). This reproductive behavior may be more important for these small bufonids in the Amazon than previously acknowledged, indicating the importance of maintaining this ecological process through conservation of the multiple species involved, like *R. magnussoni*, *R. castaneotica*, *B. excelsa*, *C. paca*, and *D. croconota*.

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***RHINELLA SCITULA* (Cope's Toad). PREDATION.** Fish are considered major predators of amphibian larvae in aquatic environments (Petranka et al. 1983. Copeia. 1983:624–628; Hecnar and M'Closkey 1997. Biol. Conserv. 79:123–131). However, the vast majority of the reports of vertebrates preying on adult amphibians are about reptiles, with few fish species reported (Toledo et al. 2007. J. Zool. 271:170–177). *Rhinella scitula* is a toad species that occurs primarily on well-preserved riparian forests at the southwest of Mato Grosso do Sul state, and is the most abundant anuran on Serra da Bodoquena Plateau (Uetanabaro et al. 2007. Biota Neotrop. 7:279–289). Nevertheless, there are no reports of predation in this species.

Remnants of an adult *R. scitula*, such as the head, skin, ribs, and femurs, were found in the guts of two *Rhamdia quelen* (Silver Catfish) individuals that were captured on 27 October 2006 within Salobrinha stream (20.6852°S, 56.7788°W; datum WGS84). The toad remnants were photographed and deposited in the Coleção Zoológica de Referência da Universidade Federal de Mato Grosso do Sul (ZUFMS-IMG 0015), as were the two individuals of *R. quelen* (ZUFMS-PIS 3956). *Rhamdia quelen* is an omnivorous, nocturnal catfish whose natural range covers the whole neotropical region. Despite the well-known opportunistic feeding behavior of this catfish (Gomes et al. 2000. Cienc. Rural 30:179–185; Casatti 2002. Biota Neotrop. 2:1–14), this is the first published evidence that they prey upon anurans.

The identification of the toad was provided by Franco Leandro de Souza (Universidade Federal de Mato Grosso do Sul).

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***THELODERMA TRUONGSONENSE* (Truongson Bubble-nest Frog). FOOT-FLAGGING BEHAVIOR.** At 2200 h on 01 June 2011 following heavy rains during the day, a *Theloderma truongsonense* was observed perched approx. 1 m above the ground on a fern along a forest trail through primary forest in a basin laced with creeks at the south end of the Annamite Cordillera, ca. 6.43 km S of the village of Lang Vo, Quang Ngai Province, central Vietnam (14.61502°N, 108.61502°E, datum WGS84; elev. 931 m). The frog was not calling and no other frogs were observed nearby. It was observed to raise and extend its left rear leg, spread its toes, and rotate the extended limb in a wide circular motion (Fig. 1). It repeated this motion a few seconds later. Foot flagging is a visual territorial display used by some frogs in environments where auditory signals would be drowned out by background noise (Richards and James 1992. Mem. Queensland Mus. 32:302; Davison 1994. Sarawak Mus. J. 33:177–178). However, this observation took place in a setting with virtually no noise, save the calling of insects. Prior to this observation, foot flagging has been noted only once before in Rhacophoridae for another species: *Theloderma bambusicolum* (Orlov et. al. 2012. Russ. J. Herpetol. 19:23–64). This new observation may indicate that foot-flagging behavior is more widely represented in the genus *Theloderma* and perhaps the family Rachophoridae than previously known.



FIG. 1. *Theloderma truongsonense* rotating its left hind limb in a foot-flagging signal.

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TESTUDINES — TURTLES

***CHELONOIDIS CHILENSIS* (Chaco Tortoise). PREDATION.** *Chelonoidis chilensis* is the southernmost continental tortoise in the world (Cei 1986. Reptiles del Centro, Centro-oeste y Sur de la Argentina. Herpetofauna de las Zonas Áridas y Semiáridas.

Museo Regionale di Scienze Naturali, Mongr. 4. Torino, Italy). It is distributed from southwestern Bolivia and western Paraguay to northern Chubut, Argentina (Richard 1999. Tortugas de las Regiones Áridas de Argentina. L.O.L.A., Buenos Aires. 200 pp.). This species is threatened by reduced availability of suitable habitat due to agricultural expansion, leading to the destruction and fragmentation of the Espinal and Chaco forest, which are replaced by crops or ranching. Other threats include competition with sheep and goats (Prado et al. 2012. Cuad. Herpetol. 26:375–387), soil compaction by livestock (degrading tortoise nesting sites) (Waller and Micucci 1997. *In* J. Van Abbema [ed.], Proceedings: Conservation, Restoration and Management of Tortoises and Turtles–An International Conference, pp. 2–9. New York Turtle and Tortoise Society, New York); fires set to promote the regrowth of pasture (Richard 1999, *op. cit.*), and the illegal pet trade, as this species is the most traded native reptile in Argentina. This species is included on Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and is considered to have a conservation status of Vulnerable by the IUCN (The IUCN Red List of Threatened Species. Version 2014.2. <www.iucnredlist.org>, accessed 07 August 2014). During the juvenile stage, this species is especially vulnerable to attack by natural predators such as ferrets, skunks, small cats, *Tupinambis* lizards, and many species of birds. Adults have fewer natural predators, which include foxes, Cougars, and Crowned Eagles (Chebez 2008. Fauna Argentina Amenazada 1:219 –231).

Here we report evidence of predation of *C. chilensis* by Wild Boars (*Sus scrofa*) in a natural environment located 45 km N of San Antonio Oeste, Río Negro Province, Argentina (40.396°S, 64.750°W, datum WGS84; elev. 125 m). Since the introduction of the Wild Boar in La Pampa province in the early twentieth century (Jaksic et al. 2002. Biol. Invasions 4:157–173), the Wild Boar population has expanded and become established in a variety of environments, and currently inhabits at least nine provinces of Argentina. In the study site, the presence of Wild Boar increased since 1972 with the construction of the Pomona Channel (pers. obs.), built to supply drinking water to San Antonio Oeste. Until that time, adult tortoise shells found were always intact. In contrast, following the establishment of Wild Boar at the site, we now find shells of adult tortoises with the plastron opened indicative of attack by Wild Boars.

We can include the Wild Boar as another potential threat to the Chaco Tortoise and urge that the presence of Wild Boar be considered during the development of strategies and priority actions to conserve this vulnerable species.

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***CHELYDRA SERPENTINA* (Common Snapping Turtle). NESTING AGGREGATION.** On the evening of 15 June 2014, I witnessed four adult female *Chelydra serpentina* digging nests simultaneously. I arrived at the site (described below), at 2102 h. The skies were overcast and it had recently rained. The air temperature was 11°C and sunset was at 2129 h; I stayed until 2145 h and made several observations. Conditions were similar the previous and following evenings, except that there had been no rainfall on those occasions.

The study site, Dingman's Marsh (45.7025°N, 84.6903°W), is an impoundment formed by a 360-m earthen levy (ca. 3 m in height) built across Mill Creek by the Michigan Department of Natural Resources (MDNR) and Ducks Unlimited in 1959 to increase habitat for waterfowl. The area is managed by MDNR. It is a well-known birding site located ca. 20 km N of the University of Michigan Biological Station (Heinen and Vande Kopple 2003. Nat. Areas. J. 23:165–173), Cheboygan Co. Michigan, USA. The surface area of the marsh is ca. 3.5 km^2, and it drains an area of ca. 25 km^2.

The turtles ranged in size from ca. 26–33 cm total carapace length, estimated visually. The largest female was digging her nest in the middle of the two-track on top of the levy, and the other three were digging nests in short vegetation on the marsh side of the levy, in areas distant from nearby swamp forests such that they receive full sunlight throughout daytime. All four turtles allowed approach to within one meter without showing defensive behaviors (e.g., hissing or mouth gaping). Two of the turtles were nesting within 1 m of each other, and the third was about 10 m to the southwest of them. The fourth turtle, the largest, was another 15 m farther west along the levy two-track.

It was also apparent that all four turtles had dug in several places immediately adjacent to where I saw them. This behavior, described for other species, could be advantageous in odor-masking nests from predators (but see below), or an attempt to find appropriate incubation sites given the heterogeneity of soil particles (silts to coarse gravels) that comprise the levy.

Since I had visited at the same time the evening before, under generally similar weather conditions, and saw no nesting attempts or turtles, I suspect that this may have been a case of synchronous nesting. However, given the size of the marsh and the relative abundance of *C. serpentina*, I was surprised to see only four individuals. On another occasion several years earlier, I saw a simultaneous nesting event for *Chrysemys picta marginata* (Midland Painted Turtles) at the site, and counted over 50 individuals digging nests along the same short (ca. 100 m) stretch of levy two-track. Individual *Chelydra serpentina* are sometimes known to travel long distances overland to nest, and because the adjacent areas are mostly dense *Alnus* sp. (alder) and *Thuja occidentalis* (Northern White Cedar) swamps, other nesting turtles may have been overlooked. Other portions of the marsh are inaccessible except by boat.

Although synchronous nesting is known for a number of turtle species, there is little known about it in this species. Given the tendency of some individual *C. serpentina* to travel long distances overland to nest (Ernst and Lovich 2009. Turtles of the United States and Canada. 2nd ed. Johns Hopkins Univ. Press, Baltimore, Maryland. 827 pp.), it is difficult to conceive how this behavior could provide a predator satiation defense as hypothesized for some other species. Thus, an alternate explanation for this observation could be as simple as female turtles independently drawing on the same cue, such as day length coupled with recent rainfall (which may mask scents; Bowen and Janzen 2005. J. Herpetol. 39:649–652), to emerge and lay eggs.

I returned to the marsh the next night (16 June 2014) at 2050 h and stayed until well after sunset to see if there were any more nesting turtles. There were none observed, perhaps lending support to the previous day's event representing a synchronous nesting. The nests of the two largest turtles were destroyed and the eggs were eaten. From shell remnants, I counted 41 eggs from the largest female's nest, and 35 from the second largest female's nest. The areas were disturbed around the two smaller females' nests, but the chambers were not dug out, and there were no

eggshells nearby, suggesting that either their nests escaped predation, or they did not lay eggs. However, given the keen olfactory capabilities of the presumably mammalian predators, it seems likely that these two nests did not contain eggs. Because I lacked permission to manipulate nests I did not dig up the nests to check for intact eggs. There were no mammal tracks identifiable on the two-track, as several vehicles had driven over it the preceding day, so I could not determine the nest predator. The most common is *Procyon lotor* (Raccoon), but *Mephitis mephitis* (Striped Skunk), *Vulpes vulpes* (Red Fox), *Urocyon cinereoargenteus* (Gray Fox), several *Mustela* species (weasels), and *Didelphis virginiana* (Virginia Opossum) all occur in the area.

More observations on this species are warranted to determine whether *C. serpentina* females engage in synchronous nesting, as opposed to independently responding to similar environmental cues.

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***CHELYDRA SERPENTINA* (Snapping Turtle). RITUALIZED AGGRESSIVE BEHAVIOR.** At approx. 0715 h on 04 September 2014, two adult *Chelydra serpentina* were observed engaging in a ritualized aggressive interaction in a small pond in Champaign, Illinois, USA (40.107666°N, 88.306°W, WGS84; elev. 233 m). The observer (LM) was approx. 15–20 m from the turtles on a balcony overlooking the pond, and thus was able to film the turtles' behavior without impacting them. Sex of the turtles was not confirmed, but the behavior suggests that both individuals were males (Janzen and O'Steen 1990. Bull. Chicago Herpetol. Soc. 25:11; Hurlburt et al. 1999. Herpetol. Rev. 30:39). The two turtles were not captured or measured, but a SVL = ca. 40–50 cm and tail length = ca. 20–30 cm is a reasonable estimate for both turtles.

The two turtles began by facing each other in the middle of the narrow pond (no vegetation in the proximity) with heads submerged and carapaces visible above the water. The turtles floated in this position for a few seconds before one of the turtles lunged at the other, resulting in a collision. The turtles repeated this floating and lunging behavior for the next minute, and then both of their heads emerged from the water. At this point the turtles also cocked their tails out of the water and held them rigid while also holding their heads out of the water. The turtles then swam towards each other with heads and tails aloft, and lunged at each other's heads when they were close together. Following the violent collision, one turtle (A) began blowing bubbles under water and this was immediately reciprocated by the other turtle (B). Turtle A alternated between elevating its head out of the water to look at turtle B and submerging its head to blow bubbles for the next 30 sec, whereas turtle B kept its head out of the water for most of that time with its tail cocked out of the water (Fig. 1) and watched A. Turtle B then lowered its tail and began swimming towards turtle A and when they were close together, B lunged at A and grabbed it by the neck and the two turtles then thrust out of the water and rolled over. They separated briefly, heads emerged and they looked at each other for a few seconds, then A appeared to attempt a dive and B swam to where A was and stopped the dive. B partially mounted the shell of A, and the two faced off again with only the carapaces out of the water. They floated in this manner for approx. 15 seconds and then came together resulting in a collision and immediate parting. They continued to engage in this behavior for another 2–3 min. At this point A elevated its head and tail, and B lunged at A and appeared to grab



FIG. 1. Still image of an adult Snapping Turtle engaging in ritualized posturing with tail and head out of the water, while the other adult Snapping Turtle blows bubbles.

A's neck. When they separated they both elevated their heads and tails, and A appeared to blow a few bubbles. They looked at each other for a few sec and then B began swimming towards A with its head out of the water, and A turned and tried swimming away. B caught up to A and partially mounted A's shell and appeared to lunge for A's tail, causing A to spin around and attempt to protect its extremities. B relented, allowing A to swim off towards the edge of the pond.

Aggressive interactions between Snapping Turtles have been documented (e.g., Raney and Josephson 1954. Copeia 1954:228; Hammer 1969. J. Wildl. Manag. 33:995–1005; Janzen and O'Steen 1990, *op. cit.*), this is the first recorded instance of ritualized agonistic behavior that included both combatants elevating head and tails out of the water during the confrontation. This behavior may allow the rivals to gauge each other's size and perhaps facilitate a non-violent resolution if one is clearly larger. Bubble-blowing is also an example of ritualized behavior and was noted in one other instance (Raney and Josephson 1954, *op. cit.*). It is unclear what role bubble-blowing serves, although it presumably may also be a signal of size. A short video of the described interaction is available at: http://wwx.inhs.illinois.edu/research/videos/snapping-turtle/.

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***CHELYDRA SERPENTINA* (Common Snapping Turtle). UNUSUAL NESTING BEHAVIOR.** Nesting behavior in Snapping Turtles has been widely studied at many locations (Ernst and Lovich 2009. Turtles of the United States and Canada, 2nd ed. John Hopkins Univ. Press, Baltimore, Maryland. 827 pp.), including our study site at Gimlet Lake, Garden Co., Nebraska, USA, on the Crescent Lake National Wildlife Refuge (Iverson et al. 1997. Herpetologica 53:96–117). At this site (as well as at other northern sites; references above), Snapping Turtles are known to oviposit a maximum of only one clutch of eggs per year. We are unaware of a previous published account of a female Snapping Turtle digging and covering a complete nest twice in less than one week.

On 2 June 2012 an individual female *C. serpentina* emerged from the water and engaged in normal nesting behavior. Upon completion of nesting, her body and clutch measurements were taken (maximum carapace length: 35.7 cm, post-nest body mass: 9300 g, clutch size: 56, mean egg mass: 13.44 g) and she was released back to the lake from which she emerged. Five days later (7 June 2012), the same individual emerged and proceeded to dig

and cover a complete nest. Measurements were once again taken as she left the completed nest (post-nest body mass: 9800 g) and she was again released to return to the water. Upon immediate nest excavation, no eggs were present. Because the nest was fully constructed and covered, this observation cannot be considered a "false crawl" (e.g., Rumbold et al. 2001. Restoration Ecol. 9:304–310) or a "false nest" (e.g., Nelson et al. 2009. Chelon. Conserv. Biol. 8:66–73). We have not previously observed this behavior in 34 years of work at this site (>> 650 nests examined).

We have observed Painted Turtles (*Chrysemys picta*) at this site excavate and cover empty nests some days after hormonal induction of oviposition with oxytocin (Iverson and Smith 1993. Copeia 1993:1–21). However, the female Snapping Turtle had never been captured before, so the physiological mechanism that drove her to construct a second, empty nest is unknown.

The staff of the Crescent Lake National Wildlife Refuge permitted and supported our long-term research at this site.

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***DOGANIA SUBPLANA* (Malayan Softshell Turtle). DIET AND ISLAND POPULATION.** *Dogania subplana* is a relatively small (carapace length [CL] to 350 mm) trionychid occurring from southern Myanmar and Thailand south through Peninsular Malaysia and Sumatra to Java, and east to Borneo and possibly the Philippines (Smith 1931. The Fauna of British India, including Ceylon and Burma. Vol. 1. Loricata and Testudines. Taylor and Francis, London. 185 pp.; Iverson 1992. A Revised Checklist with Distribution Maps of Turtles of the World. Privately printed, Richmond, Indiana. 363 pp.). Despite being widespread and even common in many areas (Nutaphand 1979. The Turtles of Thailand. Siam Farm, Bangkok. 222 pp.), the ecology of *D. subplana* remains poorly known. In particular there is a notable paucity of information on diet. Although general accounts suggest *D. subplana* is omnivorous and consumes fish, crustaceans, insects, clams, aquatic snails, fruits, and algae (Bonin et al. 2006. Turtles of the World. Johns Hopkins University Press, Baltimore, Maryland. 416 pp.; Cox et al. 2010. A Photographic Guide to Snakes and Other Reptiles of Thailand and South-east Asia. Asia Book Co., Ltd., Bangkok. 144 pp.), empirical reports based on the analysis of stomach contents or feces appear lacking in the scientific literature.

On 19 December 2013, we found the fresh carcass of a male *D. subplana* (CL = 178 mm; plastron length = 140 mm) on Lampi Island in Lampi Island National Park, Boke Pyin Township, Tanintharyi Region (formerly "Division"), Myanmar. Lampi Island National Park (205 km^2) is located approximately 25 km from the mainland and encompasses parts of the Myeik Archipelago. Lampi Island is characterized by steep terrain (to 455 m) covered in relatively undisturbed tropical evergreen forest (Beffasti and Galanti 2011. Myanmar Protected Areas: Context, Current Status and Challenges. Ancora Libri, Milan, Italy. 153 pp.). The turtle carcass was found in Yeaw Chaung (= creek), a spring-fed, rocky stream with a sand-gravel substrate that drains hills on the eastern side of the island. The carcass was found at an elevation of < 5 m above sea level, approximately 175 m upstream from where the stream empties into the Andaman Sea (10.86660°N, 98.23966°E; India-Bangladesh datum). Yeaw Chaung is similar to hill stream habitat described for *D. subplana* in Malaysia and Thailand (Smith, *op. cit.*; Cox et al., *op. cit.*). We were unable to determine how the turtle died as the carcass exhibited no apparent injuries or signs of predation. We removed the stomach and intestinal tract during a cursory necropsy; the former was filled with the fresh remains of a small crab (pincer length = 15 mm) of an undetermined species. Crabs were abundant among the rocks in the streambed as well as in mangroves at the creek mouth. To our knowledge, this is the first empirically derived report concerning the diet of *D. subplana*.

Our finding is also the first record of *D. subplana* from Lampi Island and represents one of the few specimen-based records from Myanmar. The only previous records of *D. subplana* in Myanmar are from Myeik (formerly "Mergui") and nearby coastal islands (Smith, *op. cit.*; Iverson, *op. cit.*). The occurrence of *D. subplana* on offshore islands in Myanmar is not unexpected. In Malaysia, *D. subplana* occurs on "many smaller islands where other trionychids are never found" (Smith, *op. cit.*). *Dogania subplana* has also been reported on Singapore and offshore islands in Thailand and Indonesia (Iverson, *op. cit.*; Lim and Lim 1992. A Guide to the Amphibians and Reptiles of Singapore. Singapore Science Centre, Singapore. 160 pp.). van Dijk (1998. The Natural History of the Elongated Tortoise *Indotestudo elongata* [Blyth, 1853] [Reptilia: Testudines] in a Hill Forest Mosaic in Thailand, with Notes on Sympatric Turtle Species. Ph.D. dissertation, National University of Ireland at Galway. 255 pp.) speculated that *D. subplana* populations on continental shelf islands are Pleistocene relicts that became isolated on mountains and hilltops by rising sea levels; however, more recent dispersal from mainland freshwater habitats cannot be ruled out.

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***GLYPTEMYS INSCULPTA* (Wood Turtle). NESTING HABITAT AND BEHAVIOR.** *Glyptemys insculpta*, a species native to the northeastern United States and southeastern Canada, is imperiled due to a variety of factors including habitat degradation and loss (Ernst and Lovich 2009. Turtles of the United States and Canada, 2nd ed. Johns Hopkins Univ. Press, Baltimore, Maryland. 827 pp.). Nesting habitat, typified by well-drained, bare sand, gravel, or soil with ample sun exposure, has been implicated as a limiting factor for *G. insculpta* populations (Buech et al. 1997. *In* Proceedings: Conservation, Restoration, and Management of Tortoises and Turtles—An International Conference, pp. 389–391. New York Turtle and Tortoise Society, New York; Ernst and Lovich 2009, *op. cit.*). On 10 June 2014 at 1815 h, we observed a

female *G. insculpta* exhibiting preliminary nesting behavior on a sand patch located approximately 3 m from the edge of a stream within a logged section of Caledonia State Park, Pennsylvania (39.9116°N, 77.4726°W, datum WGS84; elev. 290 m). The sand patch in which the *G. insculpta* was observed and several nearby sand patches appeared to have been created by flood-borne sand deposition around logging-generated deadwood (e.g., logs, stumps). The turtle's tracks in the sand encompassed two depressions that appeared to be incomplete nest cavities excavated by the observed female. These depressions may be consistent with the "false start" sequence of preliminary nesting behavior observed in *G. insculpta* in Michigan by Harding and Bloomer (1979. HERP, Bull. New York Herpetol. Soc. 15[1]:9–26). Additionally, we observed that several portions of the *G. insculpta* carapace were covered in sand. Female *G. insculpta* often coat their carapace with wet sand as a prelude to nesting (Harding and Bloomer 1979, *op. cit.*). Additional turtle tracks were noted approximately 10 m downstream in another sand patch.

Anthropogenic effects on streams and riparian habitats (e.g., damming, channelization, land use alterations) often negatively impact *G. insculpta* nesting habitat (Buech et al. 1997, *op. cit.*). However, in this case, logging debris may have enhanced nesting habitat by leading to the creation of sand patches and increasing sun exposure. This observation may be pertinent to *G. insculpta* habitat conservation as the addition or maintenance of deadwood within stream flood plains may create or enhance suitable *G. insculpta* nesting habitat. However, further research is needed to determine whether nests located within these and similar sand patches are successful.

We thank Cotter Nunan and Robyn E. Woodley for providing transportation to Caledonia State Park. These observations were made during a random encounter while hiking. All observations were conducted visually, and the turtle and habitat were not disturbed during the course of these observations.

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***GOPHERUS AGASSIZII* (Mohave Desert Tortoise) and *CROTALUS MITCHELLII* (Speckled Rattlesnake). BURROW ASSOCIATE.** The burrows of Desert Tortoises (*Gopherus agassizii*) present a unique microhabitat that provides shelter from extreme heat, cold, and aridity, as well as offering protection from predators (Bulova 2002. J. Therm. Biol. 27:175–189). Temperatures inside the burrow are known to be more stable than the ambient environment which can become lethal to most desert species (Walde et al. 2009. Southwest Nat. 54:375–381). A review of commensals reported 31 species (23 vertebrates, 8 invertebrates) using Desert Tortoise burrows (Luckenbach 1982. *In* Bury [ed.], North American Tortoises: Conservation and Ecology. pp. 1–38. Wildl. Res. Report 12, U.S. Fish and Wildlife Service, Washington, D.C.) and few species have been added since (Walde and Lindey 2009. Herpetol. Rev. 40:75; Walde et al. 2009, *op. cit.*; Germano and Perry 2012. Herpetol. Rev. 43:127). However, over 360 commensals for the Gopher Tortoise (*Gopherus polyphemus*) have been reported (Jackson and Milstrey 1989. *In* Diemer et al. [eds.], Gopher Tortoise Relocation Symposium Proceedings. pp. 86–98. State of Florida Game and Fresh Water Fish Commission Nongame Wildlife Program Technical Report No. 5) and as such it is considered to be a keystone species (Eisenberg 1983. *In* Bryant and Franz [eds.], The Gopher Tortoise: a Keystone Species, pp. 1–4. Proceedings of the 4th Annual Meeting of the Gopher Tortoise Council). The large disparity in the number of commensals between these two *Gopherus* species is presumably due to the difference in overall faunal diversity between their ranges. However, although the number of commensal species reported for Mohave Desert Tortoises is comparatively low, it is possible that they are understudied and underreported, and thus their role in desert ecology is not fully known.

During Mohave Desert Tortoise surveys approximately 45 km NE of Barstow, California, USA, on 7 July 2009 at 0838 h, an adult male Mohave Desert Tortoise was observed sharing a burrow with a Speckled Rattlesnake (*Crotalus mitchellii*). The burrow mouth faced due north and was in a caliche formation along the edge of a wash at the base of the Alvord Mountains in the western Mojave Desert. Evidence of an old Desert Woodrat (*Neotoma lepida*) midden was present in the burrow and burrow mouth. Average air temperature for that time of day is approximately 32°C, with ground temperatures of ≈40°C, while burrow temperatures remain stable at around 31°C (Walde et al. 2009, *op. cit.*).

Seven species of snakes are documented to use Mohave Desert Tortoise burrows, including four species of rattlesnakes (Luckenbach 1982, *op. cit.*; Lovich 2011. Herpetol. Rev. 42:421). This is the first documentation of a Speckled Rattlesnake using a Desert Tortoise burrow. Summer foraging activity for Speckled Rattlesnakes is known to be primarily nocturnal due to high temperatures during the day (Ernst and Ernst 2003. Snakes of the US and Canada. Smithsonian Institute, Washington, DC. 668 pp.). It is possible that the Speckled Rattlesnake was foraging in the burrow, perhaps the night before, as several prey species of the Speckled Rattlesnake have been shown to utilize Mohave Desert Tortoise burrows (Luckenbach 1982, *op. cit.*). It could also have been using the burrow as a thermal refuge.

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***MACROCHELYS TEMMINCKII* (Alligator Snapping Turtle). JUVENILE BASKING.** *Macrochelys temminckii* is a large, secretive freshwater turtle found in rivers and associated waters of several southeastern states (Pritchard 1989. The Alligator Snapping Turtle: Biology and Conservation. Milwaukee Public Museum, Milwaukee, Wisconsin. 104 pp.; Lovich 1993. SSAR Cat. Amer. Amphib. Rept. 562.1–562.4; Ernst et al. 1994. Turtles of the United States and Canada. Smithsonian Institution Press, Washington, D.C. 578 pp.). Little is known about the behavior of this cryptic species, and it is rarely observed basking. A recent report documented an adult *M. temminckii* basking (Selman et al. 2009. Herpetol. Rev. 40:79) in Mississippi, and rare instances of observed aerial basking for juveniles have been reported in other locations including Texas and Florida (Ewert 1976. Herpetologica 32:150–156; Farr et al. 2005. Herpetol. Rev. 36:168; Thomas 2009. Herpetol. Rev. 40:336). A hatchling caught in a basking trap in Mississippi was presumably basking, although the behavior was not directly witnessed (Shelby and Jenson 2002. Herpetol. Rev. 33:304). A recent review documented basking by *M. temminckii* in north Louisiana (Carr et al. 2011. IRCF Reptiles & Amphibians. 18:2–5); of note all nine prior instances involved

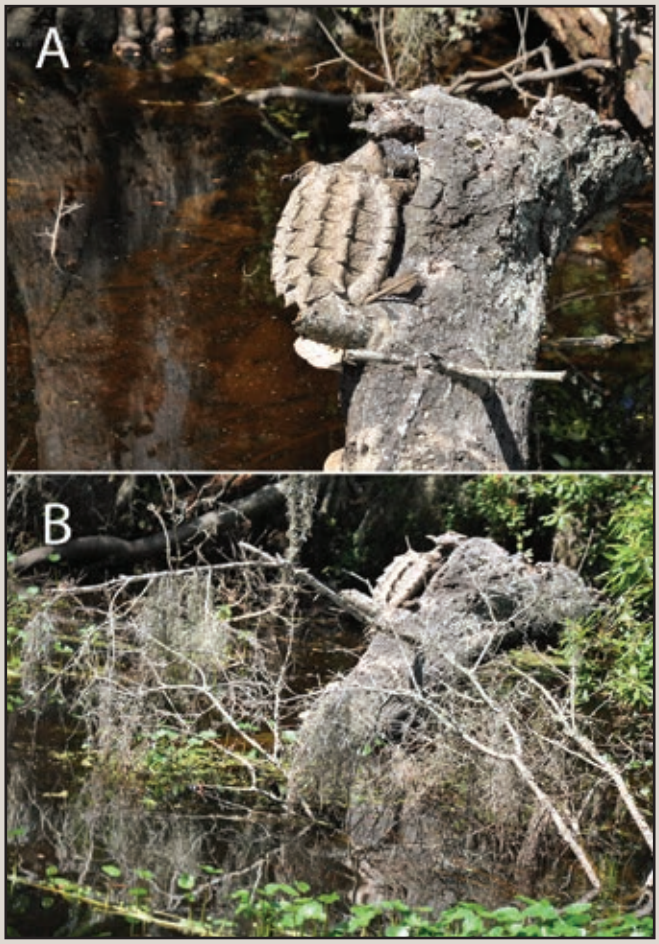


FIG. 1. Alligator Snapping Turtle *(Macrochelys temminckii)* basking in coastal Louisiana.

single individuals basking. Herein we report on two juvenile *M. temminckii* observed basking on the same afternoon in coastal Louisiana.

On 3 May 2014, RB observed two basking juvenile *M. temminckii* (estimated mass less than 4.5 kg) approximately 0.8 km apart in a swamp just south of Centerville, St. Mary Parish, Louisiana, USA. The water depth was approximately 75 cm and clear. It was sunny and the water temperature was 22.2°C. The air temperature was estimated at approximately 28°C by RB; the measured maximum temperature in Grand Chenier, Louisiana (similar latitude) that day was 24.4°C. The first specimen was observed at approximately 1450 h by RB and a companion travelling slowly in an 18-foot flat-bottom boat with a 200-hp motor. The turtle was observed basking on a submerged tree limb that completely crossed the canal; the log was initially overlooked by the boat operator. When the boat motor inadvertently nudged the log upon which the turtle was basking it did not disturb the turtle, but after passing the turtle the observers reversed the boat to attempt to observe it again at a closer distance. At this point the turtle entered the water; it was thus observed for approximately 90 seconds.

The second specimen was seen at approximately 1520 h basking on a log (Fig. 1A) approximately 60 cm above the water (Fig. 1B), despite other limbs at a lower elevation being readily available for resting platforms in the immediate vicinity. The specimen remained motionless and appeared lifeless, and was approached to within approximately 3–4 m, with the boat motor running. It was observed for several minutes, and a series of photographs were taken. The water body was a "dead end" canal and thus the second turtle was observed again as the observers retraced their route to exit the wetlands; each observation period was estimated to last some five minutes. The first of thirteen photographs was taken at 1524 h as RB entered the dead-end canal, and the last photo on the return trip was taken at 1612 h; thus the turtle was presumably basking at least 48 minutes. When seen initially, the turtle's carapace was very dry suggesting it had been basking for some time prior to being observed, and on the return trip the turtle was still completely dry, and the body position was unchanged. Until recently, most prior observations of basking in this species were limited to brief observations lasting only a matter of minutes (maximum about 12 minutes in Farr et al., *op. cit.*); Carr et. al. (*op. cit.*) documented basking for 58 minutes in their third observation reported. In some cases in the accounts previously cited, basking time for the turtle described was interrupted when the turtle was captured and handled by investigators or approached closer for attempted photography, causing it to retreat into the water.

The height above the waterline at which the second turtle was basking is clearly shown in Fig. 1B; both Farr et al. (2005, *op. cit.*) and Selman and Willig (2010. Herpetol. Rev. 41:486) documented similar elevated locations for basking and climbing ability in *M. temminckii* but we are not aware of photographs to document this behavior. Carr et al. (2011, *op. cit.*) provided photo-documentation of this species basking on railroad ties in Ouachita Parish in north Louisiana.

We are not aware of any prior instances of two *M. temminckii* being observed basking on the same day; indeed all nine prior documented cases of basking were of single individuals (Carr et al. 2011, *op. cit.*). To our knowledge this is also the first documentation of basking, including photos, for *M. temminckii* in coastal Louisiana. Researchers have suggested observations of this very rare behavior should be documented (Selman et al. 2009, *op. cit.*) and a number of explanations for basking behavior in this cryptic species were recently reviewed (Carr et al. 2011, *op. cit.*).

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***MALACLEMYS TERRAPIN CENTRATA* (Carolina Diamond-backed Terrapin). TWINNING.** On 3 July 2014 a clutch of 9 eggs collected from a female Diamond-backed Terrapin (carapace length = 195.0 mm, plastron length = 174.0 mm, carapace width = 149.0 mm, depth = 81.0 mm, mass = 1234.0 g) originating from Charleston Harbor, South Carolina, USA (32.748272°N, 79.896714°W), began hatching after incubating for 49 days at a constant temperature of 31°C. Initially, only four eggs hatched successfully, producing four hatchlings that averaged 31.1 mm carapace length, 27.4 mm plastron length, 26.7 mm carapace width, 15.9 mm depth and a mass of 8.7 g. On 4 July 2014 the fifth and final egg of the clutch hatched, revealing two hatchlings joined together by the external yolk (Fig. 1). While both individuals were undersized, one was significantly larger than the other (larger hatchling: carapace length = 25.5 mm, plastron length =



FIG. 1. Twin hatchling Diamondback Terrapins joined by the external yolk.



FIG. 2. Twin hatchling Diamondback Terrapins separated and feeding in water.



FIG. 1. *Melanochelys tricarinata*, male from the campus of the Wildlife Institute of India.



FIG. 2. Portion of tail of *Amphiesma stolatum* defecated by *Melanochelys tricarinata*.

21.3 mm, carapace width = 20.5 mm, depth = 12.7 mm, mass = 4.33 g; smaller hatchling: carapace length = 18.0 mm, plastron length = 14.5 mm, carapace width = 15.7 mm, depth = 10.4 mm, mass = 1.91 g). Both hatchlings were washed with de-ionized water, placed in a plastic container with moist paper towels, and returned to the incubator. Each day, the moist paper towels were replaced, containers were cleaned, and the hatchlings were placed back into the incubator. After 3 days the hatchlings separated from one another naturally. By 9 August 2014 both hatchlings' plastrons were completely healed and they were placed in water and offered food (Fig. 2). By 25 August 2014, both hatchlings had eaten small amounts of fish and periwinkle snails, were alert, and seemed to be in good health.

Identical twin Diamond-backed Terrapins, attached by the external yolk, have been reported once previously (Hildebrand 1938. J. Hered. 29[7]:243–254); however, this was the only example he observed in over 25 years and an estimated 100,000 artificially-hatched Diamond-backed Terrapin eggs in Beaufort, North Carolina. The twins were said to be well formed, although slightly undersized, measuring about 18 mm in length. Shortly after discovery, both individuals were reported to have died.

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***MELANOCHELYS TRICARINATA* (Tricarinate Hill Turtle). DIET.** *Melanochelys tricarinata* is distributed across northern and eastern India, Nepal, Bhutan, and Bangladesh, and inhabits moist deciduous Sal (*Shorea robusta*) forests, evergreen forests, and riverine grassland (Das 2009. Chelonian Res. Monogr. [5]:025.1–025.5; Wangyal et al. 2012. Chelonian Conserv. Biol. 11:268–272). It is omnivorous, feeding on earthworms, insects, and a variety of plant materials (Kumar et al. 2010. Herpetol. J. 20:139–146). As part of an ongoing mark-recapture study, on 10 July 2014, we captured a male *M. tricarinata* (Fig. 1) at 1630 h in a natural *Shorea robusta* forest within the Wildlife Institute of India Campus (77.97411°E, 30.28330°N), Dehradun, Uttarakhand State, northern India. The turtle measured 156.63 mm SCL, 98.50 mm SCW, 131.88 mm PL, and weighed 464 g. Shortly after capture, it defecated seeds of *Ficus* sp. and part of a tail belonging to a snake, *Amphiesma stolatum* (Fig. 2). The identity of the latter item was based on characteristic buff striped mark on tail, and tail stripe length of 64.40 mm and maximum width of 7.12 mm. North American turtle species, such as *Apalone ferox*, *Terrapene carolina*, *Trachemys scripta*, *Chelydra serpentina*, and *Macroclemys temminckii* (Dodd 2001. North American Box Turtles: A Natural History. University of Oklahoma Press, Norman, Oklahoma. xvi + 231 pp.; Ernst and Lovich 2009. Turtles of the United States and Canada. 2nd ed. Johns Hopkins University Press, Baltimore, Maryland. 827 pp.) and the Australian *Chelodina rugosa* (Cann 1998. Australian Freshwater Turtles. Craft Print Pte Ltd and Beaumont Publishing Pvt. Ltd, Singapore. 292 pp.) are known to feed on snakes through predation and/or scavenging. This is the first record of a snake in the diet of an Indian turtle species.

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***MESOCLEMMYS TUBERCULATA* (Tuberculate Toad-headed Turtle). HATCHLINGS.** The chelid turtle *Mesoclemmys tuberculata* occurs in eastern Brazil, in the Rio São Francisco and adjacent drainages, recorded mainly in the Caatinga and at some localities in the Atlantic Forest and Cerrado; it is a medium-sized species that may reach a carapace length of 25–30 cm (Ernst and Barbour 1989. Turtles of the World. Smithsonian Inst. Press, Washington, DC. 313 pp.). This species is used as food and medicinal purposes by humans in this semi-arid region of Brazil (Alves et al. 2012. J. Ethnobiol. Ethnomed. 8:1–29).

On 8 November 2013, during a faunal rescue operation in conjunction with the Project of Integration of São Francisco river (PISF) within the basins of septentrional northeastern, we collected eight eggs belonging to an unidentified species of turtle. The eggs were found at the site of the future dam of the Jati Reservoir (7.703314°S, 39.008587°W), municipality of Jati, state of Ceará, Brazil. The local environment was a small dry area, where a tractor was clearing dense regrown vegetation. After we collected the eggs, the tractor cleared what was left of the area. Of the total of eight eggs collected, two remained intact and were placed in a folded tissue and sealed in a plastic bag for transport to the Laboratório de Morfofisiologia of the Núcleo de Ecologia Molecular (NECMOL) in the Centro de Conservação e Manejo de Fauna da Caatinga (CEMAFAUNA-CAATINGA). The eggs were then placed in a plastic container (2000 ml) on a substrate of vermiculite, and incubated at 27–30°C. Five months later, on 10 April 2014, two hatchlings emerged (Fig. 1). They were identified as *M. tuberculata* (Ernst and Barbour, *op. cit.*), and measurements were taken using a digital caliper (precision = 0.01 mm) and a precision balance (1 g).

The morphometric data for two hatchlings were: carapace length (CL1: 39.0 mm, CL2: 37.1 mm), carapace width (CW1: 25.8 mm, CW2: 25.5 mm), shell height (SH1: 14.0 mm, SH2: 13.4 mm), plastron length (PL1: 31.7 mm, PL2: 29.4 mm), plastron width (PW1: 21.2 mm, PW2: 20.0 mm), and body mass (BM1: 10.0 g, BM2: 8.8 g). Previously reported clutch size for *M. tuberculata* was 4–9 eggs (32 × 26 mm, 11.4–13.3 g), with a hatchling carapace length of 37 mm (Grossmann and Reimann 1991. Sauria 13:3–6), in general agreement with the present report.

The specimens of *M. tuberculata* (MFCH 3564–3565) were deposited in the Herpetological Collection of the Centro de Conservação e Manejo de Fauna da Caatinga (CEMAFAUNA-Caatinga/UNIVASF), Petrolina, Pernambuco, Brazil. We thank the Ministério da Integração Nacional for financial support. IBAMA provided the collecting permit (#95/2012 Process n° 02001.003718/94-54).



FIG. 1. Lateral view of the carapace (left) and plastron view (right) of a hatchling *Mesoclemmys tuberculata* (carapace length 39.0 mm, plastron length 31.7 mm). Note the two chin barbels and the remains of the yolk sac on the plastron.

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***PODOCNEMIS UNIFILIS* (Yellow Spotted Amazon River Turtle). PREDATION.** *Podocnemis unifilis*, like other large river turtles, is characterized by having delayed maturity and low natural adult mortality, with a much higher mortality of eggs and hatchlings, which are reported to be preyed upon by vultures (*Coragyps atratus* and *Cathartes aura*), Carcará (*Polyborus plancus*), Jaburu (*Jabiru mycteria*), tegus (*Tupinambis teguixin*), Coati (*Nasua nasua*), and a mustelid (*Cerdocyon thous*) (Salera Junior et al. 2009. Acta Amazonica 39:207–214). These authors also reported Black Caiman (*Melanosuchus niger*), Jaguar (*Panthera onca*), and Cougar (*Puma concolor*) preying on females during the nesting season on the Javaes River, Tocantins, Brazil. The Jaguar and Cougar consumed the turtles at the nesting beach but it was impossible to determine from their paper if the caiman predation took place on land or in the water. Soares (2000. MS thesis. INPA, Manaus) on the Rio Guapore, Rondônia, Brazil, Emmons (1989. J. Herpetol. 23:311–314) on the Arataye River, French Guiana, and Hildebrand et al. (1997. La Tortuga Charapa [*Podocnemis expansa*] en el Río Caquetá, Amazonas, Colombia: Aspectos de su Biología Reproductiva y Técnicas para su Manejo. Disloque Editores, Ltda., Santafé de Bogotá. 152 pp.) on the Caqueta River, Amazonas, Colombia, all reported *Panthera onca* and *Pa. concolor* consuming nesting *P. unifilis* and *P. expansa*.

The 385,000-ha Rio Trombetas Biological Reserve (1.25°S, 56.83333°W; WGS84) is located in the Municipality of Oriximiná, Pará State, Brazil. During the dry season, sand beaches are exposed as the water level of the river recedes, providing nesting areas for *Podocnemis expansa, P. unifilis*, and *P. sextuberculata*. This is the first documentation of a female *Podocnemis unifilis* apparently leaving the water in an attempt to escape predation by a Black Caiman (*Melanosuchus niger*) in the Trombetas Reserve. At 0840 h on 11 October 2013, during nesting surveys we observed the deep tracks and body drag of a Black Caiman where it had lunged out of the water making a 6-cm deep impression in the wet sand, and 4-cm deep tracks, suggesting a running gait. A turtle was captured within 2 m of the shore line, as evidenced by turmoil in the sand, fresh blood, and egg shells and yolk splattered in a 1.5-m diameter area; only one fragment of the 9th–10th right marginal scute of the turtle remained on the beach. From this carapace fragment, the egg shells, and the tracks, the turtle was identified as *P. unifilis* (Fig 1. A–C). Based on the tracks of the turtle, we believe it was not nesting, nor did it appear to be walking at a leisurely pace looking for a nest site, but rather was running in an attempt to escape predation.

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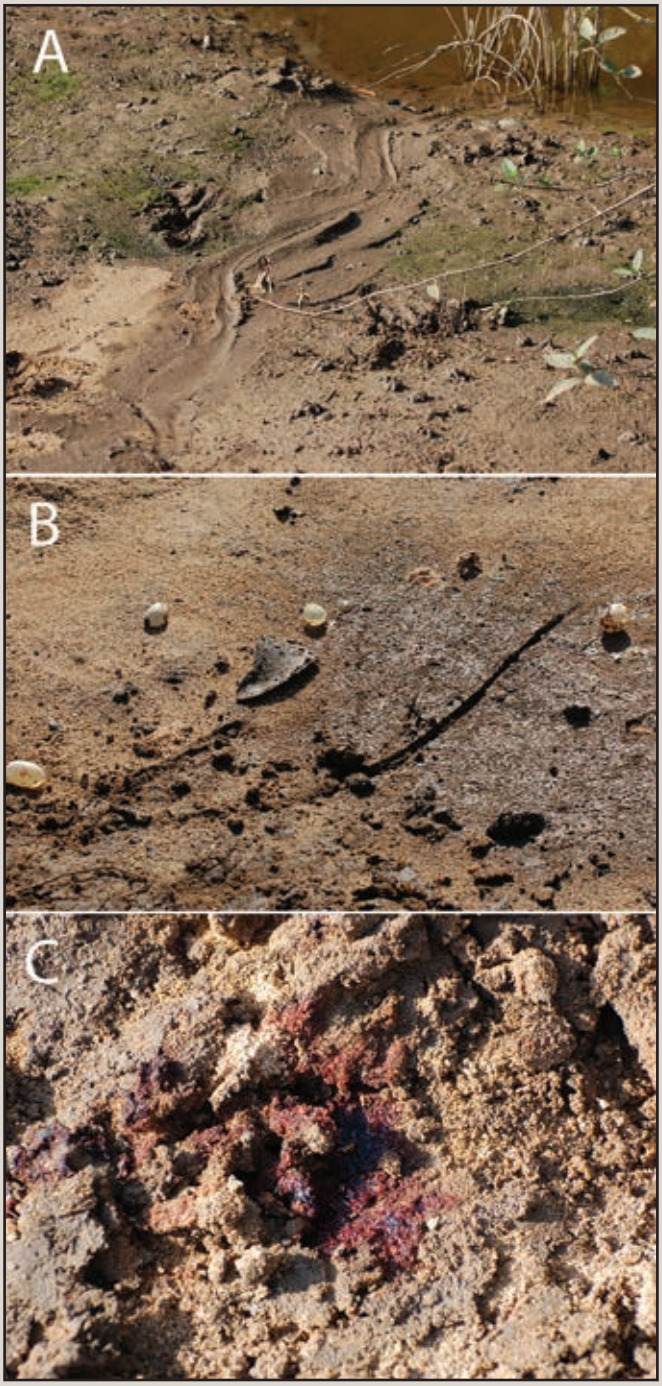


FIG. 1. A) Tracks of *Melanosuchus niger* leaving the water; by the depth of the tracks and body drag it appears as though it was lunging in rapid pursuit of a female *Podocnemis unifilis*, which shows, by its widely spaced tracks, that it left the water in an attempt to escape predation. Note that the caiman's tracks returning to the water were less distinct and the body drag was shallower, suggesting it was moving at a slower pace. B) Broken egg shells and a part of the carapace of the turtle. C) Blood and disturbed soil.

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***PSEUDEMYS ALABAMENSIS* (Alabama Red-bellied Cooter). MAXIMUM SIZE.** The maximum straight-line carapace length (SCL_{max}) for *Pseudemys alabamensis* is currently given as 33.5 cm for a female and 29.5 cm for a male (Ernst and Lovich 2009. Turtles of the United States and Canada. Johns Hopkins University Press, Baltimore, Maryland. 827 pp.; Mount 1975. The Reptiles and Amphibians of Alabama. University of Alabama Press, Tuscaloosa, Alabama. 347 pp.) From 1995 to 2000, we captured, marked, and measured over 500 specimens in Baldwin and Mobile counties, Alabama, USA. In 1999, we captured a female *P. alabamensis* in a hoop trap array near Gravine Island on the Tensaw River in Baldwin Co., Alabama that had a SCL_{max} of 38.3 cm and weighed 7.42 kg. From 1998 to 2001, we trapped 25 females from locations in the Blakeley River and Tensaw River (near Gravine Island), Baldwin Co., Alabama, that exceeded 33.5 cm SCL_{max} (33.8–38.3 cm). During this sampling, we also captured two very large males (29.9 cm SCL_{max}, 3.42 kg and 29.7 cm SCL_{max}, 2.66 kg) that exceeded the 29.5 cm maximum SCL_{max} given for males of *P. alabamensis* in the literature. All of these turtles were marked by drilling their marginal scutes, and their marking patterns may be obtained by contacting the authors.

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***TERRAPENE ORNATA LUTEOLA* (Desert Box Turtle). DIET.** Much of the published information regarding the feeding ecology of *T. ornata* draws from studies on the subspecies *T. o. ornata* (Legler 1960. Univ. Kansas Publ. Mus. Nat. Hist. 11:527–669; Ernst and Lovich 2009. Turtles of the United States and Canada. 2nd ed. Johns Hopkins University Press, Baltimore, Maryland. 827 pp.). Less information is available describing the feeding habits of the westernmost subspecies, *T. o. luteola*. The available literature describes *T. o. luteola* as feeding on beetles, grasshoppers, millipedes, and unidentified plant material (Platt et al. 2012. Herpetol. Rev. 43:640), scavenging on a dead Round-tailed Horned Lizard, *Phrynosoma modestum* (Germano 2009. Herpetol. Rev. 40:80), and feeding on Thread-leaf Groundsel petals (*Senecio flaccidus*; Murray 2013. Herpetol. Rev. 44:134–135). Here we report on additional observations of diet in *T. o. luteola* from several populations in New Mexico, USA. On 20 July 2010 we encountered an adult female *T. o. luteola* feeding on the remains of a road-killed Lesser Earless Lizard, *Holbrookia maculate*, on a dirt road in



PHOTO BY IAN W. MURRAY

FIG. 1. Adult male *Terrapene ornata luteola* feeding on Hot Springs Globemallow, *Sphaeralcea polychroma*.

central New Mexico (34.46878°N, 106.57305°E, datum WGS84; 1615 m elev.). Additionally, while field processing (for an unrelated study) another central New Mexico (34.59945°N, 106.66008°E, WGS84; 1545 m elev.) adult female *T. o. luteola* on 24 September 2007 she defecated the scaled remains of a Greater Short-horned Lizard, *Phrynosoma hernandesi*, which had presumably also been scavenged as carrion. On 2 September 2009 at 1925 h on the Sevilleta National Wildlife Refuge ca. 67 km S of Albuquerque, New Mexico (34.37210°N, 106.68092°E, datum WGS84; 1588 m elev.) we observed an adult male *T. o. luteola* feeding on the flower buds of a Hot Springs Globemallow, *Sphaeralcea polychroma* (Fig. 1). On 10 August 2002 between 0926–0945 h ca. 20 km S of Alamogordo, New Mexico (32.69755°N, 105.97853°E, datum WGS84; 1225 m elev.) we noted an adult female *T. o. luteola* feeding on the pads of a small Purple Prickly Pear Cactus, *Opuntia macrocentra*, as well as an adult male (ca. 60 m away) eating the dried remains of a Long-nosed Snake, *Rhinocheilus lecontei*. We additionally witnessed an adult male *T. o. luteola* eating a road-killed Texas Horned Lizard, *Phrynosoma cornutum*, on a nearby road (32.71292°N, 105.98387°W, datum WGS84; 1224 m elev.) on the morning of 15 July 2002. These observations emphasize the opportunistic nature of foraging in *T. o. luteola* and reflect their proclivity to forage on road-killed carrion, a behavior which likely increases turtle mortality on roads.

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SQUAMATA — LIZARDS

***ACRITOSCINCUS PLATYNOTA* (Red-throated Skink). ENVIRONMENTALLY CUED HATCHING.** In some groups such as amphibians, embryos can choose a hatching date by assessing and responding to risks posed by abiotic or biotic factors (Warkentin and Caldwell 2009. *In* Dukas and Ratcliffe [eds.], Cognitive Ecology II. The Evolutionary Ecology of Learning, Memory and Information Use, pp. 177–200. Univ. of Chicago Press, Chicago, Illinois). Recent research and a review have established that environmentally cued hatching (ECH) occurs in reptiles (Doody 2012. Integr. Comp. Biol. 51:49–61). In one type of ECH, embryos hatch early in response to predator attacks (Warkentin and Caldwell, *op. cit.*). Although a few lizard species can hatch early in response to being handled, ECH is unknown for most lizard species, presumably due to the difficulty in finding lizard eggs (Doody et al. 2009. Quart. Rev. Biol. 84:229–252) and due to the lack of understanding of the adaptive context of hatching in response to handling (i.e., handlers assume that eggs hatching in hand reflects coincidence). Herein, we report on an observation of early hatching in *Acritoscincus platynota* from eastern Australia. We comment on implications for predator avoidance.

In March 2008 at around 1800 h, BS raked seven small skink eggs and one hatched eggshell from a sandy area under a large sandstone rock near Silverdale, New South Wales, Australia (33.905216°S, 150.611240°E). The eggs were gently picked up during which time a small slit appeared on one egg within 10 seconds. Within about 20 seconds an embryo burst through the slit and the hatchling immediately ran across BS's hand. The hatchling was easily confirmed as a Red-throated Skink, based on throat coloration. The remaining eggs were placed back in the sand under the rock.

Our report has two noteworthy implications. First, the nest complement of eight eggs is probably greater than the maximum clutch size in the species, suggesting that the nest was communal; communal nesting has been reported for the species (Doody 2006. Herpetofauna 36:23–24). Second, the handling-induced hatching in *A. platynota* likely reflects early hatching in response to an increase in perceived predation risk, as observed in another Australian skink, *Lampropholis delicata* (Doody and Paull 2013. Copeia 2013:160–165). This observation, along with a similar finding for *Carlia schmeltzii* (BS, unpubl. obs.), suggests that the behavior may be widespread in Australian skinks, or perhaps in skinks in general. Further research should investigate the temporal hatching window (plasticity in hatching age and developmental stage) and the potential predators of *A. platynota*, and how they might elicit early hatching in the species. A comparative study of ECH in skinks would determine if early hatching is an ancestral trait or if it has evolved multiple times within that group.

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***ANOLIS CRISTATELLUS* (Puerto Rican Crested Anole). ABNORMAL DEWLAP COLOR.** *Anolis cristatellus* is native to Puerto Rico and has been introduced to Florida, USA (Krysko et al. 2003. Florida Sci. 66:74–79; Kraus 2009. Alien Reptiles and Amphibians: A Scientific Compendium and Analysis. Springer, Dordrecht, Netherlands. 563 pp.). Typical *A. cristatellus* dewlap color and pattern is yellow with orange borders. In Florida there are two distinct source populations from San Juan and Agua Claras/Ceiba, northeastern Puerto Rico, established in Key Biscayne, Florida and South Miami, Florida, respectively (Kolbe et al. 2012. Ecol. Evol. 2[7]:1503–1516).

On 13 January 2014 at 1109 h, an adult male *A. cristatellus* was observed at Fairchild Tropical Botanical Gardens, Miami Florida,



FIG. 1. Abnormal dewlap color and pattern in *Anolis cristatellus*.

USA (25.403°N, 80.163°W, WGS84; < 1 m elev.). This individual was caught using a noose by WAB, with dewlap subsequently assessed by JTS. This population of *A. cristatellus* corresponds to the population originating from Agua Claras/Ceiba, northeastern Puerto Rico (Kolbe et al., *op. cit.*). This individual had an abnormally colored dewlap, with a large proportion being gray (Fig. 1). Another individual was subsequently caught (~1113 h) which also exhibited gray on its dewlap, however with a lower proportion and a more patchy distribution. A total of ~30 *A. cristatellus* were caught during this time period, with no other lizards displaying this dewlap pattern. Extensive sampling of *A. cristatellus* in this area has been conducted by JTS and no other lizards with this abnormal pattern have been observed previously.

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***ANOLIS SAGREI* (Brown Anole). *GOPHERUS POLYPHEMUS* BURROW COMMENSALISM.** *Anolis sagrei* is native to Cuba and the Bahamas, and has been introduced throughout many tropical and subtropical regions of the world (Kolbe et al. 2004. Nature. 431:177–181). In Florida, USA, *A. sagrei* has established invasive populations across much of the state and occurs in sympatry with native *Gopherus polyphemus* (Gopher Tortoise).

Gopherus polyphemus excavate burrows that are used as refuge sites by approximately 60 species of vertebrates and more than 300 species of invertebrates (Jackson and Milstrey 1989. *In* Diemer et al. [eds.], Proceedings of the Gopher Tortoise Relocation Symposium, pp. 86–98. Florida Game and Fresh Water Fish Commission, Tallahassee, Florida; Witz et al. 1991. Am. Midl. Nat. 126:152–158). We report observations of a previously unreported *G. polyphemus* burrow commensal species.

On three separate occasions during March 2014, we observed *A. sagrei* using *G. polyphemus* burrows as retreat sites on an island in the intracoastal waterway near Marineland, Florida, USA (29.6236°N, 81.2106°W; WGS84). All three *A. sagrei* were adults and two were identified as males based on size and dorsal pattern. One *A. sagrei* was observed basking at the mouth of a burrow at 1000 h on 8 March 2014. It likely used the burrow as a retreat site overnight and had emerged to bask in the sunlight. After photographing the lizard, it retreated about 0.25 m inside the burrow. At 1100 h on 25 March 2014, we observed another *A. sagrei* flee about 2 meters across the ground to a burrow and about 15 cm inside. At 1630 h on 25 March 2014, we observed an adult of unknown sex about 15 cm inside a burrow and oriented facing out of the burrow. The lizard retreated at least 1 m inside the burrow after our approach.

Each *A. sagrei* used a different burrow, which varied in size of opening (N = 3, width = 31.3 ± 2.3 cm, height = 11.0 ± 1.3 cm) and maintenance. Two contained leaves and twigs at the mouth of the burrow, one of which was partially collapsed. The third burrow appeared well maintained at the mouth, but had a 10 cm hole in the top of its tunnel about 0.5 m behind the mouth. We were unable to confirm if the burrows were being actively used by *G. polyphemus*.

Although *A. sagrei* occupy a wide range of habitats, they usually associate with arboreal and semi-arboreal structure. We are unaware of any previously published accounts of burrow use by *A. sagrei*. We provide evidence that *A. sagrei* use *G. polyphemus* burrows as retreat sites, but it is unclear how often this occurs and how *A. sagrei* might affect the ecology and community structure of *G. polyphemus* burrows.

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***BASILISCUS PLUMIFRONS* (Double-Crested Basilisk Lizard). ANTAGONISTIC BEHAVIOR.** The Double-Crested Basilisk Lizard is widely distributed in the Caribbean lowlands of Central America from Nicaragua to Panama (Van Devender 1983. *In* D. Janzen [ed.], Costa Rican Natural History, pp. 378–380. Univ. Chicago Press, Chicago, Illinois). This species is considered a generalist feeder of invertebrates and vertebrates, in addition to various flowers and fruits (Guyer 1994. *In* McDade et al. [eds.], La Selva: Ecology and Natural History of a Neotropical Forest, pp. 210–261. Univ. Chicago Press, Chicago, Illinois; Marquis and Braker 1994. *In* McDade et al., *op. cit.*, pp. 261–281). Unlike other species in the genus, which primarily occupy water-margin habitats, *B. plumifrons* is often observed away from water (van Devender, *op. cit.*). Nothing has been published regarding the interaction of *B. plumifrons* at food sources with other vertebrates (such as birds) with similar diets.

On 10 February 2014, between 1500 h and 1600 h, several species of birds were observed feeding intermittently at a small pile of freshly peeled bananas placed on a wooden tray atop a post about 0.75 m above ground. The feeding station was in an open grassy area approximately 50 m upslope from the Sarapiqui River at La Virgen, Heredia Province, Costa Rica (10.38°N, 84.12°W) and at an elevation of about 200 m. This locality is within premontane tropical wet forest (Holdridge 1967. Life Zone Ecology. Tropical Science Center, San Jose, Costa Rica. 187 pp.). The actual study site is on the grounds of Centro Neotropico Sarapiquis (CNS) where the bird-feeding station has been in place several years.

During the single day of observing birds at the feeder, the following species were present: Clay-colored Robin (*Turdus grayi*), Summer Tanager (*Piranya rubus*), Blue-gray Tanager (*Thraysis episcopus*), Green Honeycreeper (*Chlorophantes spiza*), Shining Honeycreeper (*Cyaneges lucidus*), Passerinis/Cherries Tanager (*Ramphocelus costaricensis*), and Blue Dacnis (*Dacnis cayarea*). Up until 1500 h, the Clay-colored Robin appeared dominant at the bananas as it chased smaller birds whenever it appeared. This apparent dominance was episodic throughout the observation period.

At about 1500 h, a single adult male *B. plumifrons* suddenly appeared at the feeder, approaching from a small cluster of old citrus trees from a distance of about 15 m. At first, the lizard fed on a banana peel in the grass beneath the feeder, devouring the entire peel in about 12 minutes. The lizard's arrival coincided with the departure of all birds except the Clay-colored Robin. Upon finishing the banana peel, the lizard quickly jumped onto the feeder, remaining motionless there for about 10 minutes, and chasing away the Clay-colored Robin. After several minutes, the *B. plumifrons* commenced to devour the fruit on the tray. It fed intermittently in bouts of 2–4 minutes and shifted position on the tray three times. During this period, no birds shared the fruit station platform. At about 1530 h, a Clay-colored Robin landed on the grass near the feeder. It slowly circled around the feeder for a few minutes, flew up to the fruit, chased the *B. plumifrons*, and began to eat the fruit. Within a minute or two, other bird species began to reappear at the feeder. The *B. plumifrons* did not return for the rest of the day.

These observations, while limited, indicate an antagonistic interaction between a frugivorous bird and an omnivorous lizard at a long-standing artificially-placed fruit source. Furthermore, it is an example of one dominant feeder being aggressively replaced with another and then the reverse occurring as well. Both *B. plumifrons* and the Clay-colored Robin deploy a "surprise" tactic in displacing each other at this artificial food source, and perhaps also in nature. Furthermore, each animal invokes a skittish response mediated by visual stalking from the grass towards the feeding site. Local workers at CNS stated that they have observed *B. plumifrons* exhibiting similar behavior many times at the bird feeder. To my knowledge, this is the first report of *B. plumifrons* interacting with birds at a food source. Furthermore, it may demonstrate habituation by *B. plumifrons* to exploit a consistently available food source over time.

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***BRONCHOCELA CRISTATELLA* (Green Crested Lizard). REPRODUCTION.** *Bronchocela cristatella* ranges from the Nicobar Islands of India, eastward through Myanmar and Thailand and south through Peninsula Malaysia and Singapore, eastward through Papua, Indonesia (Diong and Lim 1998. Raffles Bull. Zool. 46:345–359; Hallermann 2005. Russian J. Herpetol. 12:168–183). There are reports on clutch sizes of 1–4 eggs (Das 2010. A Field Guide to the Reptiles of South-East Asia. New Holland Publishers, London, UK. 376 pp.); 1, 2 eggs (Manthey and Grossmann 1997. Amphibien & Reptilien Südostasiens. Natur und Tier – Verlag, Berlin. 512 pp.; Malkmus et al. 2002. Amphibians & Reptiles of Mount Kinabalu [North Borneo]. Koeltz Scientific Books, Königstein, Germany. 424 pp.); 2 eggs (Cox et al. 1998. A Photographic Guide to Snakes and other Reptiles of Peninsular Malaysia, Singapore and Thailand. New Holland Publishers Ltd, London, UK. 144 pp.). Grismer (2011. Lizards of Peninsular Malaysia, Singapore, and their Adjacent Archipelagos, Their Description, Distribution, and Natural History. Edition Chimaira, Frankfurt am Main. 728 pp.) suggested *B. cristatella* breeds year round. The purpose of this note is to report additional information on *B. cristatella* reproduction from a histological examination of museum specimens from West Malaysia.

TABLE 1. Monthly stages in the ovarian cycle of 20 adult *Bronchocela cristatella* from West Malaysia: * = 1 female with oviductal eggs was undergoing concurrent yolk deposition for a subsequent egg clutch.

Month	N	Quiescent	Yolk deposition	Enlarged follicles > 5 mm	Oviductal eggs
March	1	0	1	0	0
June	1	0	1	0	0
July	7	3	0	1	3
August	4	0	0	2	2*
September	6	2	2	1	1*
November	1	0	0	0	1*

A sample of 32 *B. cristatella* collected during 2002–2006 and 2008–2012 in West Malaysia deposited in the herpetology collection of La Sierra University (LSUHC), Riverside, California, USA, was examined. This series consisted of eleven males (mean SVL = 95.1 mm ± 11.2 SD, range = 73–111 mm), 20 adult females (mean SVL = 96.0 mm ± 7.3 SD, range = 84–109 mm) and one juvenile female (SVL = 72 mm). *Bronchocela cristatella* were collected in West Malaysian states: Johor (N = 14), Kedah (N = 3), Pahang (N = 3), Penang (N = 2), Perak (N = 3), Selangor (N = 5), Serak (N = 1), Terengganu (N = 1).

A cut was made in the lower abdominal cavity and the left testis or ovary was removed, embedded in paraffin, cut into 5 µm sections and stained with Harris hematoxylin followed by eosin counterstain. Enlarged follicles (> 5 mm) or oviductal eggs were counted. Histology slides were deposited in LSUHC.

Two stages were observed in the testicular cycle: 1) spermiogenesis, seminiferous tubules are lined by sperm, or clusters of metamorphosing spermatids; 2) regressed, seminiferous tubules are reduced in size and contain spermatogonia and interspersed Sertoli cells. Males were undergoing spermiogenesis in the following months: July (N = 3), August (N = 6), September (N = 1). One male of adult size (SVL = 94 mm) contained a regressed testis (LSUHC 5673). Our male sample sizes are too small to speculate on the significance of this single male with a regressed testis in the yearly male reproductive cycle. The smallest reproductively active male (spermiogenesis) measured 73 mm SVL (LSUHC 6543) and was collected in August.

Four stages were observed in the ovarian cycle (Table 1): 1) quiescent (no yolk deposition); 2) early yolk deposition (basophilic yolk granules in ooplasm); 3) enlarged pre-ovulatory follicles (> 5 mm); 4) oviductal eggs. Mean clutch size (N = 11) was an invariant 2.0. Three females (Table 1) with oviductal eggs were undergoing concurrent yolk deposition for a subsequent clutch indicating *B. cristatella* produces multiple clutches in the same year. The smallest reproductively active female exhibited yolk deposition, measured 84 mm SVL (LSUHC 10660), and was collected in June. One smaller female (SVL = 70 mm) had very small, inactive ovaries and was considered to be a juvenile (LSUHC 10647).

In conclusion, from the presence of female reproductive activity at opposite ends of the year it is apparent *B. cristatella* exhibits an extended reproductive cycle as do other lizards from southern Asia (see Inger and Greenberg 1966. J. Ecol. 47:1007–1021). Our report contains the first data indicating *B. cristatella* produces multiple clutches in the same year.

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***COLEODACTYLUS MERIDIONALIS* (Meridian Gecko). HATCHLING MORPHOMETRICS.** *Coleodactylus* comprises a species complex of miniaturized diurnal leaf-litter inhabiting sphaerodactyl geckos (SVL 20–28 mm; Vanzolini 1968. Arq. Zool. 17:1–84; Avila-Pires 1995. Zool. Verh. 299:1–706). *Coleodactylus meridionalis* occurs in the Atlantic Forest, from the coastal Brazilian states to the more mesic, open formations from Ceará to Bahia (Vanzolini 1957. Pap. Avul. Zool. 13:1–17). Despite the broad geographic range of *C. meridionalis* (Ribeiro et al. 2013. Herpetol. Notes 6:23–27), the small size and cryptic habits have made the sphaerodactyl geckos the most poorly studied lizard group (Gamble et

al. 2011. Zool. J. Linn. Soc. 163:1244–1266). Here, we provide an observation of hatchling size in *C. meridionalis*.

At 1120 h on 2 February 2014, LBR and MLNS collected two eggs of *C. meridionalis* ca. 2 m apart among leaf litter at the Reserva Biológica de Serra Negra (8.6570144°S, 38.0263918°W, WGS84; elev. 1050 m), an Atlantic Forest enclave in the Caatinga formation in the municipality of Floresta, Pernambuco, Brazil. Each egg was placed in an eppendorf tube (2 mL) with a substrate of sand and leaf litter, and maintained at Laboratório de Morfofisiologia of the Núcleo de Ecologia Molecular (NECMOL) in the Centro de Conservação e Manejo de Fauna da Caatinga (CEMAFAUNA-CAATINGA) in Universidade Federal do Vale do São Francisco, Petrolina, Pernambuco. The eggs were kept in the laboratory at ambient temperature and humidity in the collection tubes.

On 15 March 2014 (42 days after collection), two juveniles emerged. Measurements were: SVL 10.6 ± 0.6 mm; tail length 8.2 ± 0.2 mm; forearm length 3.7 ± 0.4 mm; hind limb length 4.2 ± 0.1 mm; head length 4.0 ± 0.2 mm; head width 2.1 ± 0.1 mm; jaw length 2.3 ± 0.1 mm; head height 1.3 ± 0.1 mm; axilla–groin length 4.4 ± 0.9 mm; and mass 0.043 ± 0.001 g. *Coleodactylus meridionalis* has a single-egg clutch (Vanzolini et al. 1980. Répteis das Caatingas. Acad. Bras. de Ciênc. Rio de Janeiro, Brazil. 161 pp.), and this is the first record of hatchling size in this species. Lisboa et al. (2008. Herpetol. Rev. 39:221) reported the weight and size for one hatchling of the congeneric *C. natalensis*, born in a terrarium maintained in the laboratory: SVL 11 mm; tail length 0.8 mm; forearm length 3.1 mm; fourth finger 0.4 mm; hind limb length 3.6 mm; fourth toe 0.7 mm; head length 2.9 mm; head width 2.0 mm; jaw length 1.6 mm; head height 1.1 mm; body width 2.2 mm; pelvis width 1.3 mm; axilla-groin length 4.4 mm; and mass 0.024 g.

Specimens of *C. meridionalis* (MFCH 3521, 3522) were deposited in the Herpetological Collection of Museu de Fauna da Caatinga (MFCH), municipality of Petrolina. We thank the Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio) for the collection permit (number 42485-2).

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***GONOCEPHALUS ABBOTTI* (Abbott's Anglehead Lizard). REPRODUCTION.** *Gonocephalus abbotti* extends from southern peninsular Thailand, southward through Peninsular Malaysia (Grismer 2011. Lizards of Peninsular Malaysia, Singapore and their Adjacent Archipelagos. Edition Chimaira, Frankfurt am Main. 728 pp.). To our knowledge, there is no published information on the reproduction of *G. abbotti*. In this note we present data on the first egg clutch known from *G. abbotti*.

One female *G. abbotti*, SVL = 153 mm, was collected 21 August 2003 in West Malaysia, Perak State, Temengor (5.6000°N, 101.3500°E) by LLG and deposited in the herpetology collection of La Sierra University (LSUHC), Riverside, California, USA, as LSUHC 5678. The body cavity was opened and the ovaries were examined. A total of seven enlarged follicles (> 9 mm) were observed. Four were on the left ovary, three were on the right ovary. Seven is the first clutch size recorded for *G. abbotti*.

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***GONOCEPHALUS GRANDIS* (Giant Forest Dragon). REPRODUCTION.** *Gonocephalus grandis* ranges from southern Thailand throughout Peninsular Malaysia to Sumatra and Borneo (Manthey and Denzer 1991. Sauria 13:3–10). There are two reports of clutch size for *G. grandis*. Manthey and Grossmann (1997. Amphibien & Reptilien Südostasiens. Natur und Tier – Verlag, Münster. 512 pp.) reported clutches of one to six eggs; Hendrickson (1966. Bull. Nat. Mus. Singapore 34:53–71) recorded clutches of two to five eggs. In this note we present evidence that *G. grandis* produces multiple clutches in the same year.

Three female *G. grandis* (mean SVL = 115.0 ± 5.3 SD, range = 109–119 mm) were collected by LLG in West Malaysia, Perak State, Temengor (5.6000°N, 101.3500°E) and deposited in the herpetology collection of La Sierra University (LSUHC), Riverside, California, USA, as LSUHC 6692 (collected August 2004), 8188, 8197 (collected September 2006). The body cavity was opened and the ovaries were examined. All three females contained oviductal eggs, mean clutch size was 3.7 ± 0.58 SD, range = 3, 4. The left ovary of LSUHC 8188 and 8197 were removed, embedded in paraffin, histological sections were cut and stained with hematoxylin followed by eosin counterstain. Histology slides were deposited in LSUHC. The ovary of LSUHC 8188 in addition to oviductal eggs, exhibited concurrent yolk deposition for a subsequent clutch. No histology was performed on LSUHC 6692, which in addition to oviductal eggs, contained an enlarged (5 mm) follicle for a subsequent clutch. From the above observations, we conclude *G. grandis* produces multiple clutches in the same year.

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***GONOCEPHALUS ROBINSONII* (Robinson's Anglehead Lizard). REPRODUCTION.** *Gonocephalus robinsonii* is endemic to Peninsular Malaysia (Grismer 2011. Lizards of Peninsular Malaysia, Singapore and their Adjacent Archipelagos. Edition Chimaira, Frankfurt am Main. 728 pp). There are reports of clutches of five to eight eggs in Manthey and Grossmann (1997. Amphibien & Reptilien Südostasiens. Natur und Tier – Verlag, Münster. 512 pp) and gravid females in July and August with clutches of five to seven eggs (Grismer, *op. cit.*). The purpose of this note is to report new information on *G. robinsonii* reproduction.

Two *G. robinsonii* females (mean SVL = 130.00 ± 12.7 SD, range = 121–139 mm collected in West Malaysia and deposited in the herpetology collection (LSUHC) of La Sierra University, Riverside, California, USA, as LSUHC 7233 collected March 2005 in Pahang State, Cameron Highlands (4.5000°N, 101.5000°E) and LSUHC 5873 collected June 2008 Pahang State, Selangor (3.3333°N, 101.5000°E) were examined. The left ovary of LSUHC 5873 was removed, embedded in paraffin, histological sections were cut at 5 µm and stained with bematoxylin followed by eosin counterstain. This histological slide was deposited in LSUHC.

A cut was made in the lower abdominal cavity and the ovaries were examined. LSUHC contained nine enlarged preovulatory

follicles (5 mm diameter). Nine is a new maximum clutch size for *G. robinsonii*. LSUHC 5873 contained six oviductal eggs. Beside oviductal eggs, follicles in the ovary of LSUHC 5873 exhibited concurrent yolk deposition indicating *G. robinsonii* may produce multiple clutches in the same reproductive season.

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***LEPOSTERNON POLYSTEGUM*. ENDOPARASITES.** Biological aspects of amphisbaenians are poorly known when compared to other reptiles, mainly due to their fossorial habits (Gomes et al. 2009. J. Herpetol. 43:377–384; Filogonio et al. 2013. J. Helminthol. 87:135–140). Regarding parasitism, many studies have shown that amphisbaenians are common hosts of helminths, harboring specific genera of nematodes (Filogonio et al., *op. cit.*). One of these, the nematode genus *Paradollfusnema* Baker, 1982 comprises two species: *P. amphisbaenia,* known to infect *Leptosternon microcephalum* and *L. wuchereri* from Brazil; and *P. telfordi* described infecting *Rhineura floridana* from Florida, USA (Bursey 2002. J. Parasitol. 88:554–556; Ribeiro et al. 2011. J. Herpetol. 6:177–188). *Paradollfusnema amphisbaenia* is a cosmocercid nematode recorded in northeastern and southeastern Brazil (Ávila and Silva 2010. J. Venom. Anim. Toxins. Incl. Trop. Dis. 16:543–572; Filogonio et al., *op. cit.*).

Herein, we report *P. amphisbaenia* infecting *L. polystegum* in northeastern Brazil. On 2 September 2012 an adult individual of *L. polystegum* was collected by pitfall trap in Pinheiros farm, municipality of Barbalha (7.363846°S, 39.339514°W; WGS84), state of Ceará, Brazil. The *L. polystegum* specimen was euthanized, fixed with 10% formalin, and deposited at the Coleção Herpetológica da Universidade Regional do Cariri (URCA-H 3901). The body cavity, esophagus, stomach, lungs, small and large intestines were opened and separately examined for helminths under a stereomicroscope. Endoparasites were cleared in phenol, identified, and deposited in the Coleção Parasitológica da Universidade Regional do Cariri, Brazil (URCA-P 419). Four adult *P. amphisbaenia* (two males and two females) were found in the large intestine. Infection by helminths has been reported only for *Leposternon microcephalum* and *L. wuchereri* (Ávila and Silva, *op. cit.*; Ribeiro et al., *op. cit.*; Filogonio et al., *op. cit.*). Thus, *Leposternon polystegum* represents a new host record and Ceará state a new locality record for *P. amphisbaenia*.

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***LIOLAEMUS PACHA*. DIET.** The Neotropical lizard *Liolaemus pacha,* previously known as *L. quilmes* (Etheridge 1993. Boll. Mus. Reg. Sci. Nat. Torino 11:137–199; Heredia et al. 2013. Zootaxa 3681:524–538), belongs to the *L. darwinii* group, and is one of more than 250 species attributed to this genus (Abdala and Quinteros 2014. Cuad. Herpetol. 28[2]: *in press*). *Liolaemus* species show a great variety of habitat preferences, reproductive strategies, and feeding habits. *Liolaemus pacha* is found at "Los Cardones" (26.6670°S, 65.8180°W, WGS84; elev. 2725 m), Tucumán province, Argentina.

Halloy et al. (2006. Rev. Esp. Herpetol. 20:47–56) found that *L. pacha* was primarily insectivorous, eating mainly ants (Hymenoptera: Formicidae) but also insects from the orders Hemiptera (Heteroptera) and Coleoptera. The authors also reported the presence of unidentified plant material in one male. We filmed individuals of this species with a digital camera (Sony HDR-Cx290) in natural habitat for two years (from September 2012 to March 2014) as part of another behavioral study. During this time we recorded two females and two males, all adults, actively eating sprouts of *Portulaca cf. fulgens* Griseb. (Portulacaceae) and *Amicia medicaginea* Griseb. (Fabaceae). The first two foraging episodes occurred 10 February 2013 at 1115 h and the second two occurred 16 January 2014 between 1130 h and 1200 h. Plant consumption has been reported in another species of the *L. darwinii* group, *L. crepuscularis* (Semhan et al. 2013. South Am. J. Herpetol. 8[2]:102–108), although the plant material could not be identified. Species not belonging to this group have also been reported to eat plants, among these: *Adesmia horrida*, *Hoffmannseggia minor,* and *Glandularia microphylla* in *L. poecilochromus* (Valdecantos et al. 2012. Copeia 2012:204–211); and *Lycium*, *Atriplex*, *Larrea*, and *Portulaca* in *L. cuyanus* (Moreno Azócar and Acosta 2011. J. Herpetol. 45[3]:283–286).

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***LIPINIA VITTIGERA* (Yellow-striped Tree Skink). REPRODUCTION.** *Lipinia vittigera* ranges from southern Myanmar, Thailand, Cambodia, and Laos through the Malay Peninsula to Singapore and Sumatra into northern Borneo (Grismer 2011. Lizards of Peninsular Malaysia, Singapore and their Adjacent Archipelagos. Edition Chimaira, Frankfurt am Main, Germany. 728 pp.). Grismer (*op. cit.*) reported gravid females during March and hatchlings in July. Das (2010. A Field Guide to the Reptiles of South-East Asia. New Holland Publishers, Ltd, London, United Kingdom, 376 pp.) reported *L. vittigera* is oviparous and produces clutches of 2–4 eggs. The purpose of this note is to provide additional information on the reproductive biology of *L. vittigera* from a histological examination of gonadal material.

A sample of nine *L. vittigera* from West Malaysia collected 2003–2006, 2010, 2012 by LLG and deposited in the herpetology collection of La Sierra University, California, USA (LSUHC) was examined. The sample consisted of two adult males (SVL = 34 mm, five adult females (mean SVL = 38.0 mm ± 2.0 SD, range = 35–40 mm), and two subadults (mean SVL = 27.5 mm ± 6.4

SD, range = 23-32 mm) collected in: Johor LSUHC 8211; Kedah LSUHC 10600; Pahang LSUHC 4417, 5148, 5175, 6126, 7254; Penang LSUHC 9991, 9992.

A cut was made in the lower abdominal cavity and the left testis or ovary was removed, embedded in paraffin, cut into 5-µm sections and stained with Harris hematoxylin followed by eosin counterstain. Enlarged follicles > 3 mm were counted. Histology slides were deposited at LSUHC.

Two males (one each from February and September) were undergoing spermiogenesis with seminiferous tubules lined by sperm or clusters of metamorphosing spermatids. Five mature females were collected in February to March. Four contained enlarged ovarian follicles > 3 mm. Mean clutch size (N = 4) was 1.5 ± 0.58, range = 1, 2. The remaining adult female exhibited yolk deposition with the ooplasm containing vitellogenic granules. A smaller female from April (SVL = 32 mm) contained tiny ovaries and was considered a subadult. A presumed neonate from June measured 23 mm SVL. The presence of males undergoing spermiogenesis in widely separated months (February and September) suggests *L. vittigera* has an extended reproductive cycle. One is a new minimum clutch size for *L. vittigera.*

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***OPHISAURUS VENTRALIS* (Eastern Glass Lizard). PREDATION.** Herein we report the first known predation on *Ophisaurus ventralis* by a Coyote (*Canis latrans*). Coyotes are opportunistic predators known to utilize a wide range of prey (Leopold and Krausman 1986. J. Wildl. Manage. 50:290–295; Grigione et al. 2011. Urban Ecol. 14:655–663). We conducted necropsies and analyzed stomach contents of 234 Coyotes collected October 2011–March 2014 throughout Florida, USA. The stomach from an 8.17 kg male collected on 12 September 2013 at Naval Air Station Pensacola, Escambia Co., contained the intact skin of an *O. ventralis* and other items.

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***PHRYNOSOMA MCALLII* (Flat-tailed Horned Lizard). LATE SEASON COURTSHIP BEHAVIOR.** *Phrynosoma mcallii* is a small phrynosomatid with a distinct dark mid-dorsal stripe, double row of fringe scales on its sides, and two median long horns (Brennan and Holycross 2006. A Field Guide to Amphibians and Reptiles in Arizona. Arizona Game and Fish Department, Phoenix, Arizona. 150 pp.). This species has one of the smallest distributions of any horned lizard. It is found in desert areas of Sonora and Baja California, Mexico, and in the United States in southeastern California and extreme southwestern Arizona (Sherbrooke 2003. Introduction to the Horned Lizards of North America. University of California Press, Berkeley. 178 pp.). Here, we describe behavior observed in the late summer of 2013 that was suggestive of late season reproduction in *P. mcallii.*

Mating of *P. mcallii* is thought to occur in May and June (Rorabaugh and Young 2009. *In* Jones and Lovich [eds.], Lizards of the American Southwest, pp. 182–185. Rio Nuevo Publishing, Tucson, Arizona). However, Barrows and Allen (2009. Southwest. Nat. 54:307–316) reported on breeding behavior for *P. mcallii* through the end of August in the Coachella Valley, California 2000–2003. Further, late-season hatching pulses for *P. mcallii* were speculated by Barrows and Allen (*op. cit.*) to not be associated with rainfall patterns.



FIG. 1. Adult *Phrynosoma mcallii* engaging in late-season breeding behavior south of Yuma, Arizona.

On 30 August 2013, we observed two Flat-tailed Horned Lizards displaying courtship behavior in the Yuma Desert ~ 30 km S of Yuma, Arizona, USA (32.45°N, 114.57°W; WGS84). The two lizards (male SVL = 68 mm; mass = 9.0 g; and female SVL = 65; mass = 12.5 g) were initially observed from a distance of 5 m bobbing up and down. We approached the lizards and were able to obtain video (available upon request) and still photos of the event (Fig. 1). The male lizard had its upper right leg over the female's back and was biting the two left side horns, which protrude from the back of the female's head. During this time the female was slowly moving her tail side to side in the sand demonstrating typical bobbing movements with her rear left leg over the back of the male. After five minutes of observation we picked the lizards up and weighed and measured them before releasing them. After release, the female approached the male posturing her tail upwards with her cloaca facing his nostrils (vent flash). He then licked the skin near the vent (vent lick). This continued for a few more minutes before we retreated from the area.

These activities were indicative of late-season mating behavior, which has not been reported for this location and is not well understood for this lizard in general.

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***PTYCHOZOON INTERMEDIUM* (Philippine Flying Gecko). AVIAN PREDATION.** *Ptychozoon intermedium* is a large gecko (82.4–99.8 mm SVL) occurring on the islands of Mindanao, Maripipi, Dinagat, and Leyte, Philippines (Brown et al. 1997. Herpetologica 53:357–373). Fieldworkers seldom encounter this Philippine endemic gecko, presumably due to its cryptic coloration, arboreal habit, and preferred canopy microhabitat (Brown and Diesmos 2000. Slyvatrops 10:107–124). Here we report observed predation on *P. intermedium* by the Mindanao Lowland Scops Owl (*Otus everetti*).



FIG. 1. A Mindanao Lowland Scops Owl (*Otus everetti*) preying upon a Philippine Flying Gecko *(Ptychozoon intermedium*) on Mindanao Island, Philippines.

At 1830 h on 20 March 2014, during a birdwatching trip in Barangay Tabon, Bislig City, Surigao del Sur Province, Mindanao Island, Philippines (8.246033°N, 126.278503°E, WGS84; elev. 109 m), CF observed an owl perched on a bamboo stalk responding to a birdcall produced by a forest guide. In its beak, the owl carried an adult *P. intermedium* by the neck (Fig. 1). The left side of the gecko's body had a puncture wound with visibly everted viscera. The incident was observed for ca. three minutes before the owl flew to another location, thus the actual consumption of the gecko was not observed. To our knowledge, this is the first documented record of avian predation on flying geckos. Photographic vouchers were deposited at the Lee Kong Chian Natural History Museum, National University of Singapore, (ZRC[IMG] 2.223a–d).

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***SCELOPORUS ANGUSTUS* (Santa Cruz Island Sator). REPRODUCTION.** *Sceloporus angustus* is known only from Islas San Diego and Santa Cruz in the Gulf of California where it is ubiquitous (Grismer 2002. Amphibians and Reptiles of Baja California Including Its Pacific Islands and the Islands in the Sea of Cortés. Univ. of California Press, Berkeley. 399 pp.). Grismer (*op. cit.*) proposed that the reproductive season extended through spring and summer based on the presence of bright female coloration during these periods. Clutches consisted of five to seven eggs. The purpose of this note is to present additional information on *S. angustus* reproduction from a histological examination of museum specimens.

A sample of 13 *S. angustus* consisting of six adult males (mean SVL = 78.2 mm ± 7.8 SD, range = 65–86 mm), five adult females (mean SVL = 62.8 mm ± 2.0 SD, range = 61–66 mm), one juvenile male (SVL = 61 mm) and one juvenile female (SVL = 53 mm) from Isla Santa Cruz, Baja California Sur, Mexico was examined from the herpetology collections of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California, USA, LACM 134740, 134741, 134743, 134750, 134753–134755 and the University of Colorado Museum of Natural History (UCM), Boulder, Colorado, USA, UCM 26059, 26063, 26064, 26066–26068. Lizards were collected in May 1982 (LACM) and August 1964 (UCM).

A cut was made in the lower abdominal cavity and the left testis or ovary was removed, embedded in paraffin, cut at 5 µm, and stained with Harris hematoxylin followed by eosin counterstain. Oviductal eggs were counted. No histology was performed on them. Histology slides were deposited at LACM or UCM.

Two stages were observed in the testicular cycle: 1) recrudescence, proliferation of germ cells for the next period of spermiogenesis; 2) spermiogenesis, seminiferous tubules are lined by sperm or clusters of metamorphosing spermatids. Three males from May and two from August were undergoing spermiogenesis. The smallest reproductively active male (spermiogenesis) measured 65 mm (UCM 26067) and was collected in August. One larger male from May (SVL = 78 mm) exhibited recrudescence with spermatogonia and primary spermatocytes present. A smaller male (SVL = 61 mm) was undergoing an earlier stage of recrudescence (spermatogonia, no primary spermatocytes) and was considered to be a subadult.

Three stages were observed in the ovarian cycle: 1) quiescent (no yolk deposition); 2) early yolk deposition (basophilic vitellogenic granules in the ooplasm); 3) oviductal eggs. The smallest reproductively active female (early yolk deposition) measured 61 mm SVL (UCM 26066) and was collected in August. Two females from May exhibited quiescent ovaries. Two females from August exhibited early yolk deposition. One female (UCM 26064) contained four oviductal eggs. One smaller female (UCM 26059) from August measured 53 mm SVL, contained tiny ovaries and was considered a subadult. Histological findings of males undergoing spermiogenesis in May and August support the observations of Grismer (*op. cit.*) that *S. angustus* has an extended reproductive season that includes spring and summer. Four is a new minimum clutch size for *S, angustus*

I thank G. Pauly (LACM) and Emily Braker (UCM) for permission to examine *S. angustus*.

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***SCELOPORUS ARENICOLUS* (Dunes Sagebrush Lizard). ACTIVITY PATTERNS AND FORAGING MODE.** Efforts have been made to gain a greater understanding of lizard activity patterns and foraging modes (Cooper 2005. Herpetol. Rev. 36:367–369). Lizard activity patterns influence our ability to detect them on the landscape and this is inextricably linked to how monitoring efforts are implemented to ensure proper stewardship. Foraging modes are indicative of energetic needs and are often

evaluated in models used to assess biophysical interactions between lizards and their landscapes. Here we describe the activity patterns and foraging mode of a small population (N = 10) of *S. arenicolus* from New Mexico, USA, to contribute to a growing understanding of the place of this lizard within the ecosystem.

Cooper et al. (2005. Herpetologica 61:250–259) described the activity and foraging mode of a small population of *S. arenicolus* from the Mescalero Sands of Chaves Co., New Mexico, USA. They report movements per minute (MPM) for *S. arenicolus* with a relatively high standard error (MPM: 0.80 ± 0.42). In 2010, we conducted 10 observations of individual *S. arenicolus* from Lea Co., New Mexico using a different methodology. Cooper et al. (*op. cit.*) described that they approached lizards and then began their observations. In contrast, we positioned ourselves in folding chairs at prominent places above sand-dune blowouts and waited to observe lizards. Once a lizard was spotted we recorded our data following the methods described by Cooper (*op. cit.*). In brief, these methods estimate MPM and percent time moving (PTM). Between 6 and 20 June 2010 we conducted observations at three separate locations within Lea Co., New Mexico. We measured substrate temperature (T_s) and air temperature (T_a) using a quick-read Schultheis thermometer (Miller & Weber, Inc. Ridgewood, New York) at the beginning of each observation. We recorded behavior for 10-minute intervals, with the exception of one 6-minute observation, for each lizard and categorized behavior as basking, feeding, or moving. We observed lizards with binoculars at a distance of more than 10 m.

Six male and four female *S. arenicolus* were observed for an average of 10:02 minutes per lizard. Observations occurred while T_s was 33.2 ± 0.79°C and T_a was 32.5 ± 0.75°C. During these observations, *S. arenicolus* were not very active (MPM = 0.35 ± 0.11; PTM = 0.01 ± 0.005). Two of the lizards were observed foraging on ants within blowouts. The majority of other lizards were observed basking either beneath shade of Shinnery Oak (*Quercus havardii*) or in direct sunlight. Our numbers are much lower than those reported by Cooper et al. (*op. cit.*) and probably reflect a more realistic value for an undisturbed *S. arenicolus*. This species is the subject of conservation action in both New Mexico and Texas and is threatened with landscape fragmentation (Leavitt and Fitzgerald 2013. Ecosphere 4:97). As such, data regarding their activity patterns will be valuable for conservation practitioners required to establish monitoring guidelines. We recommend that any methods utilized to monitor this species account for its low activity pattern and its ability to avoid being detected.

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***SCELOPORUS OCHOTERENAE*. PREDATION.** The predation of reptiles by birds is well documented and has been reported several times (e.g., Sandoval et al. 2008. Wilson J. Ornithol. 120[1]:214–216). Here we report the predation of *Sceloporus ochoterenae* by an adult male *Crotophaga sulcirostris* (Groove-billed Ani), which to our knowledge has not been previously recorded. This species of bird feeds principally on arthropods, mainly medium-sized grasshoppers and spiders, but also other arthropods as well as *Anolis* lizards (Payne 1997. *In* del Hoyo et al. [eds.], Handbook of the Birds of the World. Vol. 4. Sandgrouse to Cuckoos, pp. 508–607. Lynx Edicions. Barcelona, Spain). During April 2014, we conducted fieldwork studying birds and reptiles at Papalutla, municipality of Copalillo, Guerrero, México (18.012683°N, 98.567821°W, WGS84; 670 m elev.), located in a tropical dry forest near the Balsas River. We collected an adult Groove-billed Ani (total length 355 mm; mass 84 g) using a mist net (ornithological collection MZFC-ALTBAL 095). We found two partially digested adult *Sceloporus ochoterenae* (each with total length > 80 mm) in the gizzard of the bird, occupying ca. 80% of the total volume (Fig. 1). We identified the lizard species by the scales and the color pattern of the dorsum. This observation is the first predation event reported between this bird and *S. ochoterenae*.



FIG. 1. Two partially digested adult lizards of *Sceloporus ochoterenae*.

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***SCELOPORUS UNIFORMIS* (Yellow-backed Spiny Lizard). LIFE HISTORY.** Limited information is available on *Sceloporus uniformis*, formally *S. magister uniformis* (Schulte et al. 2006. Mol. Phylog. Evol. 39:873–880), within the Virgin River Basin in Utah, Arizona, and Nevada, USA. We report on the morphology and activity of 210 captures of 132 individual *S. uniformis* along the lower Virgin River from St. George, Utah (37.0904°N, 113.5354°W; NAD83) to Gold Butte in Clark Co., Nevada (36.5667°N, 114.3333°W). We captured lizards from late May to early August from 2009 to 2013 to examine the effects of Saltcedar (*Tamarix* spp.) biocontrol and riparian restoration on herpetofauna communities (Bateman and Ostoja 2012. Anim. Conserv. 15:294–304). We established 21 trap arrays in riparian habitat with Saltcedar, Cottonwood (*Populus fremontii*), Willow (*Salix* spp.), Mesquite (*Prosopis* spp.), and Russian Olive (*Elaeaganus agustifolia*) trees.

TABLE 1. Morphological characteristics of *Sceloporus uniformis* captured during 2009–2013 from riparian habitat along the lower Virgin River in Nevada, Arizona, and Utah. Data are summarized by captures of individuals ≤ 39 mm SVL (hatchling), 40–79 mm SVL (juvenile), and ≥ 80 mm SVL (adult). Individuals may be present in multiple size classes, though measurements for recaptured individuals were averaged within size class.

Sex	N	SVL Mean (±SE) Range (mm)	VTL Mean (±SE) Range (mm)	Mass Mean (±SE) Range (g)
Hatchling (≤ 39 mm SVL)				
Female	10	34.6 (±1.1) 32–39	45.4 (±2.8) 27–57	1.2 (±0.1) 1–2
Male	5	34.2 (±1.5) 30–38	46.8 (±1.4) 44–51	1.3 (±0.2) 1–2
Unknown	4	33.5 (±1.5) 32–38	47.8 (±2.6) 42–53	1.0 (±0.0) 1
Juvenile (40–79 mm SVL)				
Female	24	71.4 (±1.1) 61–79	95.6 (±3.0) 51–110	11.8 (±0.5) 6–16
Male	21	73.0 (±1.1) 51–79	100.3 (±3.5) 44–118	13.0 (±0.6) 5–19
Adult (≥ 80 mm SVL)				
Female	31	88.0 (±1.0) 80–100	107.5 (±4.0) 40–134	24.2 (±1.3) 16–43
Male	45/45/42	93.3 (±1.3) 80–114	116.5 (±3.7) 28–154	29.5 (±1.5) 13.5–51

Sceloporus uniformis were captured with pitfall traps (51.9%), funnel traps (47.6%), and by hand along drift fences (0.5%). Snout–vent length (SVL), vent–tail length (VTL), mass, and sex were recorded for each capture (Table 1). When sex was difficult to determine (i.e., hatchlings due to their small size), sex was marked as unknown. Size classes were separated based on natural breaks in the data and results from primary literature (Tinkle 1976. Herpetologica 32:1–6; Goldberg 2012. Bull. South. California Acad. Sci. 111:25–28). Hatchlings became active towards the latter half of July with the earliest capture occurring on 16 July 2009. At higher elevations along the Virgin River, Tinkle (*op. cit.*) first observed hatchlings in Utah during early August; however, our first hatchling was captured in Utah on 24 July 2013. Juvenile and adult activity, in terms of total captures, peaked in the latter half of June and first half of July, respectively. Of the total number of juvenile captures, 10.2% (mean SVL = 69.1 mm, range = 51–77 mm, N = 9) occurred from 21–31 May, 23.9% (mean SVL = 71.4 mm, range = 59–79 mm, N = 21) from 1–15 June, 34.1 % (mean SVL = 72.2 mm, range = 59–79 mm, N = 30) from 16–30 June, 19.3% (mean SVL = 73.8 mm, range = 67–79 mm, N = 17) from 1–15 July, and 13.6% (mean SVL = 73.6 mm, range = 69–78 mm, N = 12) from 16–31 July. Of the total number of adult captures, 10.8% (mean SVL = 86.5 mm, range = 84–99 mm, N = 11) occurred from 21–31 May, 11.8% (mean SVL = 90.6 mm, range = 80–102 mm, N = 12) from 1–15 June, 27.5% (mean SVL = 93.4 mm, range = 80–111 mm, N = 28) from 16–30 June, 29.4% (mean SVL = 89.9 mm, range = 80–114 mm, N = 30) from 1–15 July, and 20.6% (mean SVL = 90.5 mm, range = 80–102 mm, N = 21) from 16–31 July. Overall, 28.8% (38 of 132) of marked lizards were recaptured during the study.

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***TROPIDOPHORUS MISAMINIUS* (Misamis Water Skink). NOVEL MICROHABITAT.** *Tropidophorus misaminius* is a large-sized (90–112 mm SVL) endemic water skink known to occur on Mindanao, Camiguin, and Basilan Island, Philippines. The species is usually found in rocky beds and banks of forest streams and occasionally in moist soil and under rotting logs in forests (Brown and Alcala 1980. Philippine Lizards of the Family Scincidae. Silliman University Press. Dumaguete City, Philippines. 264 pp.).This note reports on a novel microhabitat of *T. misaminius* on Mindanao.

At 1200 h on 30 January 2014, five adult *T. misaminius* were observed resting on the bank of a cave stream ca. 12 m into Okbot Cave, Sitio Sambayon, Barangay Suaon, Municipality of Kapalong, Davao del Norte Province, Mindanao Island, Philippines (7.745783°N, 125.667450°E, WGS84; 250 m elev.). To our knowledge, this is the first report of a *Tropidophorus* species utilizing a cave system as microhabitat (Fig. 1) (Ngo et al. 2000. Russian J. of Herpetol. 7:155–158; Honda et al. 2005. Zool. Scrip. 35:85–95; Ziegler et al. 2005. Salamandra 41:137–146; Nguyen et al. 2010. Zoosyst. Evol. 86:5–19). Photographic vouchers were deposited at the Lee Kong Chian Natural History Museum, National University of Singapore (ZRC[IMG] 2.220a–c).



FIG 1. Adult *Tropidophorus misaminius* near a cave stream 12 m from the entrance.

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***UTA STANSBURIANA* (Side-blotched Lizard). PREFERRED BODY TEMPERATURE.** Many species of reptiles use behavioral means to thermoregulate, such as shuttling between patches of vegetation with different thermal characteristics (Cowles and Bogert 1944. Bull. Am. Mus. Nat. Hist. 83:261–296). Moreover, the preferred body temperature (T_p) that a lizard voluntarily selects in a laboratory thermal gradient provides a reasonable estimate of what a lizard would attain in the wild with a minimum of associated costs in the absence of constraints (biotic and abiotic factors) for thermoregulation (Huey and Slatkin 1976. Quart. Rev. Biol. 51:363–384; Pough and Gans 1982. *In* Gans and Pough [eds.], Biology of the Reptilia, Vol. 12, pp. 17–23. Academic Press, New York). *Uta stansburiana* is widely distributed across many habitats in western North American deserts from Baja California, Mexico north to the Columbia Plateau of Washington, USA (Lemos-Espinal and Smith 2007. Anfibios y Reptiles del Estado de Chihuahua, México / Amphibians and Reptiles of the State of Chihuahua, Mexico. UNAM-CONABIO, Mexico, D.F. 613 pp.). There have been many reports detailing thermal ecology in *U. stansburiana* in different environments (Waldschmidt and Tracy 1983. Ecology 64:476–484; Huey and Pianka 2007. Am. Nat. 170:473–478; Clarke and Zani 2012. J. Exp. Biol. 215:1117–1127). However data of preferred body temperature of *U. stansburiana* are rare (Sartorius et al. 2002. Can. J. Zool. 80:1966–1976) and in northern Mexico do not exist. Here, we describe thermal preference in *U. stansburiana* under laboratory conditions.

During June 2010, we conducted fieldwork in Samalayuca Dunes (31.4786°N, 106.4755°W, WGS84; 1180 m elev.) located in a mesquite-stabilized sand hummocks about 24 miles south of Ciudad Juarez, Municipality Juarez, Chihuahua, Mexico. The data presented are based on 16 adults (> 40 mm SVL; 8 females and 8 males) of *U. stansburiana* captured by noose.

All lizards were placed in a laboratory thermal gradient to obtain the T_p range. The thermal gradient consisted of a wooden shuttle box of 150 × 100 × 80 cm (length, width and height) divided into ten tracks with insulation barriers to prevent behavioral influence of adjacent lizards, and filled with 2–3 centimeters of sandy soil. The shuttle box was housed in a room with air conditioning at a constant temperature of 20°C. At one end, and at the center of the box, lamps were placed at different heights to generate a thermal gradient from 20–50°C. Lizards remained in the gradient from 700 to 2000 h; body temperature data were registered every hour starting at 800 h and using a digital thermometer Fluke model 51-II. The 25% and 75% quartile T_p range (T_{p25} and T_{p75}) of each species were calculated to obtain the lower and upper limit (Van Damme et al. 1990. Oikos 57:61–67; Herts et al. 1993. Am. Nat. 142:796–818). After laboratory experiments, all lizards were released at respective capture sites. We applied a nonparametric Kruskal-Wallis one way test to analyze differences between all measurements of body temperature in the laboratory and we used a Mann-Whitney Rank test to analyze the differences between gender.

There were no statistically significant differences between measurements of temperature ($H_6 = 5.000$, $p = 0.416$) or between gender ($U = 79.5$, $p > 0.05$). Mean preferred body temperature was 33.1°C (SD = 3.2, range = 25.5–38.0°C). Interquartile of 25% and 75% was 32.0°C and 35.2°C, respectively. These results suggest *U. stansburiana* can be considered a eurythermic species due to the wide range of T_p in this species. Future research should evaluate the species thermal efficiency by monitoring mean thermal requirements and microhabitat temperatures across its distribution to understanding effects of global warming on this geographically widespread lizard.

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***VARANUS MITCHELLI* (Mitchell's Water Monitor). PREDATION.** Raptors likely regulate some reptile populations because the former are key predators of the latter. Although raptors generally take larger prey for their body size than other birds (Slagsvold and Sunerud 2007. J. Avian Biol. 38:650–661), large prey items can still be infrequent enough to go undetected in dietary studies based on stomach contents, regurgitated pellets, or scats. This is particularly true in the tropics, where the diet of raptors is understudied (e.g., Rangel-Salazar and Enriquez-Rocha 1993. J. Raptor Res. 27:121–122). Thus, observations of raptors preying upon medium to large reptiles in the tropics are an invaluable supplement to our knowledge of trophic interactions that may drive predator-prey interactions of reptiles and raptors. Herein I describe an observation of apparent predation of a Mitchell's Water Monitor by a Little Eagle (*Hieraaetus morphnoides*).

At ~1630 h on 16 February 2014 I spotted a Little Eagle perched about 5 m above ground in a paperbark tree (*Melaleuca* spp.) along the Margaret River, in tropical Western Australia (18.217097°S, 125.863506°E). As I approached to within 15 m the eagle took flight with an adult Mitchell's Water Monitor in its talons. The monitor was identifiable by its markings, coloration, shape and size. The eagle flew out of sight with the lizard; the limp appearance of the lizard indicated that it was dead. The observation occurred during the wet season, but the weather was mostly clear with an air temperature of 34°C.

My observation likely reflected predation, because Little Eagles rarely scavenge (Olsen et al. 2010. J. Raptor Res. 44:50–61). Reptiles vary in their importance as prey for Little Eagles, ranging from 2–82% depending on region (Aumann 2001. Wildl. Res. 28:379–393; Olsen et al. *op. cit.*). The other reported aerial predator of *V. mitchelli* is the Collared Sparrowhawk (*Accipiter cirrocephalus*) (Schultz and Doody 2004. *In* Pianka and King [eds.], Varanoid Lizards of the World, pp. 416–422. Indiana Univ. Press, Bloomington, Indiana). The invasive cane toad (*Rhinella marinus*) is expected to reach the site within the next 2–3 years, and *V. mitchelli* suffer severe population-level declines due to lethal toxic ingestion of cane toads (Doody et al. 2009. Anim. Conserv. 12:46–53). As such, assuming my observation reflected predation, the frequency of *V. mitchelli* in the diet of the Little Eagles may drop when toads arrive, possibly resulting in a dietary shift for those eagles that hunt along water-courses. Both species are common along watercourses, and both are relatively common at the site (pers. obs.).

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***XANTUSIA SIERRAE* (Sierra Night Lizard). REPRODUCTION.** *Xantusia sierrae* is restricted to a few localities along the

western foothills of the Greenhorn Mountains from near Woody south to the Kern River, Kern Co., California, USA (Leavitt et al. 2007. Mol. Ecol. 16:4455–4481). The purpose of this note is to provide information on the timing of the reproductive cycle of *X. sierrae*.

Twelve *X. sierrae* consisting of four males (mean SVL = 44.0 ± 1.2 SD, range = 43–45 mm) and eight females (mean SVL = 46.0 ± 3.5 SD, range = 40–49 mm) collected at Granite Station (35.61389°N, 118.85889°W; 513 m elev.), Kern Co., California were examined from the herpetology collection of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California, USA: LACM 76131, 76133, 76134, 76137, 76138 (collected April 1971); LACM 134549, 134551, 134552, 134554, 134562–134564 (collected June 1982).

Ovaries and testes were histologically examined except for enlarged follicles (> 4 mm), which were counted, and two females (LACM 76137 and 76138), which contained very small ovaries that were not reproductively active. Tissues were embedded in paraffin, histological sections, were cut at 5 µm, and stained with hematoxylin followed by eosin counterstain. Histology slides were deposited in LACM.

Spermiogenesis in which the seminiferous tubules are lined by sperm or clusters of metamorphosing spermatids was observed. The two smallest spermiogenic males of *X. sierrae* both measured 43 mm SVL (LACM 134562, 134564), slightly larger than the average size of maturity in male *X. vigilis* (38–39 mm; Miller 1951. Copeia 1951:114–120).

Five females with quiescent ovaries (no yolk deposition), and three females with enlarged follicles (> 4 mm) were observed. Because the follicles of these three females from late June had not ovulated, parturition likely would have been completed in early fall. Mean litter size (N = 3) was 1.7 ± 0.58 SD, range = 1–2). The two smallest reproductively active females (follicles > 4 mm) both measured 48 mm SVL (LACM 134551, 134554), larger than the average size of maturity in female *X. vigilis* (38–39 mm; Miller, *op. cit.*). Whether two smaller females (SVL 40 mm and 42 mm) were mature is questionable as females of mature size of the congeners *X. riversiana* (Goldberg and Bezy 1974. Herpetologica 30:350–360) and *X. henshawi* (Goldberg 2013. Son. Herpetol. 26:9–11) do not reproduce every year.

Xantusia sierrae is a spring breeder with one to two young produced, likely in early fall. *Xantusia sierrae* follows a reproductive cycle in which timing of events and litter size are similar to the closely related *X. vigilis* (Miller 1948. Univ. California Publ. Zool. 47:197–213; Zweifel and Lowe 1966. Am. Mus. Novitat. 2247:1–57) as well as to *X. henshawi* (Lee 1975. Trans. San Diego Nat. Hist. 17:259–278; Goldberg, *op. cit.*).

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SQUAMATA — SNAKES

***AGKISTRODON PISCIVORUS* (Cottonmouth). DIET.** *Agkistrodon piscivorus* is known to take a variety of prey, including many species of snakes (Graham et al. 2010. Herpetol. Rev. 41:88–89; Ernst and Ernst 2011. Venomous Reptiles of the United States, Canada, and Northern Mexico, Volume 1. Johns Hopkins Univ. Press, Baltimore, Maryland. 352 pp.). Herein we report a prey item novel for *A. piscivorus*.



FIG. 1. *Agkistrodon piscivorus* scavenging an apparently road-killed *Farancia erytrogramma* in Mississippi, USA.

On 30 April 2013 at 1147 h, one of us (AW) observed an *A. piscivorus* in the process of consuming a female *Farancia erythrogramma* (Rainbow Snake; SVL = 91.2 cm; total length = 104.9 cm; 1070 g) along the edge of a roadside ditch that drains into Flint Creek, Wiggins, Stone Co., Mississippi, USA. The *F. erythrogramma* appeared lifeless and had been a quarter of the way ingested (tail first) when first detected. Upon approach the *A. piscivorus* regurgitated the *F. erythrogramma* and fled upstream. The head of the *F. erythrograma* appeared to have been crushed/flattened and maggots (Order: Diptera) were present on the head and first third of the body. The presence of fly larvae suggests that the *F. erythrogramma* was dead prior to partial ingestion by the *A. piscivorus*, and while it is unknown how the snake may have died, a small blood stain on the adjacent road implies that the *F. erythrogramma* was hit by a car. The frequency and propensity to scavenge and the relative contribution that carrion represents in the diet of *A. piscivorus* is unknown. However, carrion probably plays an important supplementary role, as is the case with a number of other snake species (DeVault and Krochmal 2002. Herpetologica 58:429–436).

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***AGKISTRODON PISCIVORUS* (Cottonmouth). DIET and PREY SIZE.** At 1200 h on 9 July 2012, a radio-telemetered *Crotalus horridus* (Timber Rattlesnake) at a field site in Beaufort Co., South Carolina, USA, was found consumed by an *Agkistrodon piscivorus*. The adult female *C. horridus* was implanted on 31 May 2011, at which time it measured 117.0 cm total length and weighed 1012.5 g. The telemetered rattlesnake was previously tracked and visually observed on 26 June 2012 approximately 50

m from the *A. piscivorus* in cane-dominated bottoms at the transition from hardwood forest to saltwater marsh. During the period in which the snake was radio-tracked, no food bulges were observed and the snake's vertebrae were becoming noticeable; this emaciated state likely increased its vulnerability to being depredated or its death upon which it was scavenged.

The *A. piscivorus* was captured and set up overnight in the temperature-controlled treatment room at the Jekyll Island Authority's Georgia Sea Turtle Center on Jekyll Island, Georgia, USA, but was found dead at 0830 h the following morning. A necropsy revealed that the *A. piscivorus* (109.5 cm total length; 1125.6 g excluding the *C. horridus*) was a reproductively-active male in good body condition. A small laceration was noted on the dorsal lower third of the body as well as some tissue damage near the spine and a minor vertebral fracture not compromising the spinal cord, but no puncture wounds or localized tissue necrosis was found. The histopathology report did not provide any further explanation regarding the cause of death for the *A. piscivorus*. The only remains of the *C. horridus* were eleven rattles, caudal scutes, and the transmitter. Therefore, it was determined unlikely that the death was caused or influenced by the *C. horridus*, either through envenomation or digestive impaction. Additionally, due to the advanced digested state of the *C. horridus*, it could not be determined whether the rattlesnake was predated or scavenged.

Agkistrodon piscivorus are dietary generalists feeding on both endo- and ectothermic animals. Further, they exhibit cannibalism (Gloyd and Conant 1990. Snakes of the *Agkistrodon* Complex. SSAR, Oxford, Ohio. 614 pp.) and will readily scavenge carcasses (Gloyd and Conant, *op. cit.*; Berna and Gibbons 1991. Herpetol. Rev. 22:130–131; Lilywhite et al. 2008. BioScience 58:947–955). There are at least two records of *A. piscivorus* feeding on rattlesnakes. An *A. piscivorus* kept in captivity at the Toledo Ohio Zoo killed and ate a *Crotalus oreganus* (Pacific Rattlesnake; Gloyd and Conant, *op. cit.*). On another occasion an *A. piscivorus* from South Carolina reportedly regurgitated a *C. horridus* large enough to have acquired seven rattles, but no further explanation on sizes were provided (Kauffeld 1957. Snakes and Snake Hunting. Hanover House, Garden City, New York. 266 pp.). Although rattlesnakes have been documented in their diet, this is the first we know about involving a large reproductive adult *C. horridus* of comparable size in the wild. The total length of the *C. horridus* (taken a year prior to ingestion) exceeded that of the *A. piscivorus* by 7.5 cm.

No current research suggests that *C. horridus* are immune to the venom of *A. piscivorus*. We suspect this predator-prey association may not be a rare occurrence given the overlap in geographic range, habitat use, and activity patterns of these two species. However, given the abundance of other prey items that would present reduced risk, it seems plausible that these predation events are opportunistic and relatively rare in comparison to consumption of small mammals, fish, lizards, and nonvenomous snakes.

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***AGKISTRODON PISCIVORUS* (Cottonmouth). FIRE MORTALITY.** Periodic fire is an important force maintaining fire-dependent natural communities and associated snake assemblages. Although telemetered snakes have been observed avoiding fire (Withgott and Amlaner 1996. Herpetol. Rev. 27:145–146; Rudolph et al. 1998. Herpetol. Rev. 29:146–148), those inhabiting fire-maintained ecosystems can be vulnerable to fire. For example, searches conducted immediately after North American prairie fires have documented fire-induced snake mortality on multiple occasions (Bigham et al. 1964. Proc. Oklahoma Acad. Sci. 44:47–50; Erwin and Stasiak 1979. Am. Midl. Nat. 101:247–249; Siegel 1986. Biol. Conserv. 35:333–346; Frese 2003. Herpetol. Rev. 34:159–160). Numbers of snakes killed by fire, however, are typically low. Here, I provide observations of *Agkistrodon piscivorus* mortality immediately following a prescribed fire. Insofar as I am aware, this is only the second report of *A. piscivorus* killed by fire (Komarek 1969. Proc. Tall Timbers Fire Ecology Conference 9:161–207) and the first at a communal hibernaculum.

My observations occurred in the Shawnee National Forest, Union Co., Illinois, USA. At this site, large numbers of *A. piscivorus* over-winter in a rocky, west-facing forested hillside dominated by oaks (*Quercus* spp.), hickories (*Carya* spp.), Sweetgum (*Liquidambar styraciflua*), and Tuliptree (*Liriodendron tulipifera*), and summer in an adjacent Buttonbush (*Cephalanthus occidentalis*)-Spadderdock (*Nuphar advena*) wetland. On 26 March 2014, U.S. Forest Service personnel burned approximately 700 ha of forest including the hillside hibernaculum to reduce prevalence of understory mesophytic tree species (Scott Crist, USFS, pers. comm. 28 March 2014). The fire was lit by personnel on the ground and from the air by dropping incendiary devices from a helicopter. On the day of the burn, maximum air temperature was 10°C, the sky was clear, and the wind blew from the SSE at 14.5–18.5 KPH (www.wunderground.com; weather station ca. 14 km from study area). I searched different portions of the burned hillside hibernaculum for snakes on 27 March 2014 (1030–1400 h) and 30 March 2014 (1130–1530 h). I found nine (2 alive, 7 dead) adult *A. piscivorus* on 27 March and four adults (3 alive, 1 dead) on 30 March. Four of the dead snakes were clearly killed by the fire; they were charred and stiff, and died in contorted positions (Fig. 1). Two of the other dead individuals were burned and stiff but not contorted and two, unburned and adjacent to burned leaf litter, may have been killed by the heat of the fire.

At this hibernaculum, *A. piscivorus* typically emerge from dormancy during the latter half of March (pers. obs.) potentially rendering large numbers of snakes vulnerable to fire at this time. The relatively low number of *A. piscivorus* killed by the 26 March 2014 fire was likely due to delayed emergence following a record



FIG. 1. *Agkistrodon piscivorus* killed during a prescribed fire on 26 March 2014 in the Shawnee National Forest, Union Co., Illinois, USA.

cold winter. To prevent mass mortality of *A. piscivorus* at this and other hibernacula, it is recommended that prescribed fires that include dens be conducted during winter months or after snakes have dispersed to summer habitat.

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***ATRACTUS SNETHLAGEAE* (Ground Snake). DIET.** *Atractus snethlageae* is a relatively large member of the genus *Atractus* and is found throughout much of the Amazon Basin up to elevations of 1800 m (Schargel et al. 2013. Zootaxa 3721:455–474). Earthworm chetae and insect remains have been found in the stomachs of *A. snethlageae* in central Amazonia, Brazil (Martins and Oliveira 1998. Herpetol. Nat. Hist. 6:78–150). On 11 July 2010 at approximately 1600 h an adult male *A. snethlageae* (SVL = 328 mm, tail length = 66 mm, 19.51g) was collected in lower montane secondary forest 1500 m elev. at Wildsumaco Wildlife Sanctuary in eastern Napo Province, Ecuador (0.67557°S, 77.60116°W; datum WGS84) that had consumed an earthworm (Fig. 1). The snake appeared to have recently swallowed the earthworm when collected because the worm's posterior end was visible in the snake's throat. The snake's head was 14.6 mm long and 8.2 mm wide. The worm was swallowed head first and measured 157 mm in length and 11.1 mm wide and weighed 5.89 g. The mass ratio for this prey item was 0.302. The snake (QCAZ 10639) and stomach contents are deposited in the Museo de Zoologia of the Pontificia Universidad Catolica del Ecuador in Quito.

We are especially grateful to our Ecuadorian collaborators Santiago Ron and Omar Torres for aid during all aspects of the work. James Olson, Bonnie Olson, and Jonas Nilsson generously allowed access to the Wildsumaco property.



FIG. 1. Ventral view of an adult male *Atractus snethlageae* (QCAZ 10639) with an earthworm that it swallowed prior to capture.

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***BOTHROPS ASPER* (Terciopelo). PARTHENOGENETIC REPRODUCTION.** On 26 November 2012 a female *Bothrops asper* (SVL = 125 cm; tail length = 14.5 cm; 956 g) housed on exhibit in the Dallas Zoo's reptile building gave birth to 11 unfertilized ova and one full term dead neonate. This seven-year old adult female was born at the Dallas Zoo and had never been housed with a male. Although the neonate was stillborn, the body was fully formed thus indicating fertilization. We believe this is the first example of parthenogenesis reported for this species. The male neonate (SVL = 120 mm; tail length = 40 mm; 6.5 g) was deposited at the Amphibian and Reptile Diversity Research Center at the University of Texas at Arlington (UTA R 61066). Because the mother is still living, a recent shed was deposited as well to confirm there were no other DNA contribution except from the female.

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***BOTHROPS MOOJENI* (Brazilian Lancehead). DIET.** *Bothrops moojeni* is a pitviper that is found most often in open areas associated with riparian forests (Araújo and Martins 2006. Herpetol. J. 16:297–303). The species has a generalist diet (Leloup 1984. Acta Zool. Pathol. Antv. 78:177–198) including birds (França et al. 2008. Copeia 2008:23–38); however, to our knowledge there are no studies reporting which bird species are predated by *B. moojeni*. Analyzing stomach contents of pitvipers collected in the municipality of Lucas do Rio Verde, Mato Grosso, Brazil (12.79694°N, 56.01055°E, datum WGS84; Tavares et al. 2012. Herpetol. Notes 5:543–545), we found in the stomach of a female *B. moojeni* (SVL = 104 cm, tail length = 15.5 cm, 402.4 g) a small *Sporophila nigricollis* (body length = 8.2 cm, 27.36 g), a migratory seed-eating bird with diurnal activity (Andrade et al. 2011. Rev. Bras. Ornitol. 19:63–73).We acknowledge Josué da Silva Ribeiro Nunes for the identification of the bird.

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***CARPHOPHIS AMOENUS* (Eastern Worm Snake). ASSOCIATION WITH ANTS.** *Carphophis amoenus* is a small-bodied, largely fossorial colubrid (Barbour et al. 1969. Ecology 50:470–476). Species with a similar ecology (*C. vermis*, *Diadophis punctatus*, *Virginia valeriae*) have been documented utilizing dormant formicid ant nests as hibernacula (Pisani 2009. Trans. Kansas Acad. Sci. 112:113–118). Herein, I present information suggesting a more extensive relationship between formicid ants and *C. amoenus*.

I searched for *C. amoenus* within naturally occurring coarse woody debris (CWD) at two sites (located in Anne Arundel Co., Maryland and Fairfax Co., Virginia, USA) during May, June, and July of 2012 and 2013. Ant colonies were more commonly seen in CWD where *C. amoenus* were present than in CWD where *C. amoenus* were absent (49.5% [47/95] and 26.4% [23/87], respectively; $\chi^2 = 10.2$, $p = 0.001$). There was no association between snakes and termites ($\chi^2 = 3.18$, $p = 0.07$) and significantly fewer snakes were observed in CWD with earthworms ($\chi^2 = 12.3$, $p < 0.001$). Snakes were in close association with ants during all study months. However, it is unknown whether this association reflects an overlap in microhabitat preferences or a commensal

relationship. I observed no aggressive behavior of ants towards the snakes, even when ant colonies were active. Furthermore, snakes regularly used ant tunnels as escape routes in areas where the soil was compacted. *Carphophis amoenus* are poor burrowers (Clark 1970. Univ. Kansas Publ. Mus. Nat. Hist. 19:85–194) and thus may rely on ant tunnels to penetrate compacted soils.

I thank Todd A. Tupper for his helpful comments on the draft of this note.

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***CHARINA BOTTAE* (Rubber Boa). DIET.** *Charina bottae* is a short boa that averages around 0.5 m long and is known to consume small mammals, lizards, birds, and small eggs (Rodriguez-Robles et al. 1999. J. Zool. 248:49–58). On 6 August 2012, at 1300 h, I found a *C. bottae* in the process of killing and consuming a chipmunk (Fig. 1) around basalt columns on bluffs overlooking Lake Tahoe, above CA Hwy 89 running between Truckee and Tahoe City, California, USA (39.166573°N, 120.166026°W, datum WGS84; elev. 2001 m). The chipmunk was identified as *Tamias quadrimaculatus* (Long-Eared Chipmunk) by its white postauricular patches and malar stripe that connects with the postauricular patches (Clawson et al. 1994. *In* Lackey and Koopman [eds.], Mammalian Species, pp. 1–6. American Soc. Mammalogists, no. 469, Auburn, Alabama). The snake killed the chipmunk by constriction and then fully consumed it. To the best of my knowledge, this is the first record of *C. bottae* preying upon *T. quadrimaculatus*. I thank Kerry Foresman for help with chipmunk identification. Also, I thank Chris Feldman and Art Woods for their help in preparation of this note.



FIG. 1. *Charina bottae* constricting a *Tamias quadrimaculatus* (Long-Eared Chipmunk) near Lake Tahoe, California.

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***COLUBER CONSTRICTOR PRIAPUS* (Southern Black Racer). DIET.** *Coluber constrictor* is known to have a varied diet, including anurans. It has been reported to feed on several frogs of the genus *Hyla*, including *H. chrysoscelis*, *H. cinerea*, *H. femoralis*, and *H. versicolor* (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Institution, Washington DC. 668 pp.). On 21 March 2014, we observed an adult female *C. constrictor* (SVL = 113.1 cm; total length = 133 cm; 480 g) in the process of swallowing an adult male *H. gratiosa* (Barking Treefrog; Fig. 1), near an ephemeral pond on the Camp Shelby Joint Forces Training Center, De Soto National Forest, Perry Co., Mississippi, USA. The *C. constrictor* had the *H. gratiosa* about half way ingested when JRL caught it by hand, and at which point the frog was released. Known predators of *H. gratiosa* include dragonfly naiads, Mole Salamanders, and snakes (*Nerodia fasciata, Heterodon simus,* and *Agkistrodon piscivorus*) (summarized by Mitchell 2005. *In* M. Lannoo [ed.], Amphibian Declines: The Conservation Status of United States Species, pp. 455–456. Univ. California Press, Berkeley).



FIG. 1. Adult female *Coluber constrictor* ingesting an adult male *Hyla gratiosa* in Perry Co., Mississippi, USA.

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***COLUBER* (=*MASTICOPHIS*) *FLAGELLUM* (Coachwhip). REPRODUCTION.** *Coluber flagellum* is common in the southeastern United States and often inhabits beach dune systems and interdune swales in coastal areas and barrier islands. Mating generally occurs in spring and females lay clutches of 2–16 eggs



FIG. 1. *Caretta caretta* hatchling and *Coluber flagellum* embryo upon excavation.

in late summer (Force 1930. Copeia 1930:25–39; Goldberg 2002. Texas J. Sci. 54:143–150). The literature suggests that *C. flagellum* nesting in the southeastern USA generally occurs in decomposing vegetation or logs (Guidry 1953. Herpetologica 9:49–56). There are no descriptions of the reproductive habits of *C. flagellum* on barrier islands.

On 5 August 2013, during excavation of a *Caretta caretta* (Loggerhead Sea Turtle) nest on the southern end of Jekyll Island, Georgia, USA (31.0153°N, 81.4231°W; datum WGS84), three *C. flagellum* eggs were found buried in the nest chamber. Eggs had been laid as a slightly lower depth than the recently hatched *C. caretta* eggs. The eggs were oblong, granular in texture, and a size typical of *C. flagellum* and *C. constrictor* (North American Racer) eggs. Upon opening the first oblong egg, a developing *C. flagellum* embryo with a large umbilicus still attached was found. The embryo was almost fully developed and responsive but still too early to survive outside of the egg given the incubation time noted for *M. flagellum* (Behler and King 1979. The Audubon Society Field Guide to North American Reptiles and Amphibians. Alfred A. Knopf, Inc., New York. 744 pp.). The remaining two eggs found were incubated and hatched on 15 August 2013. This is the first documentation of *C. flagellum* reproduction in beach dunes and in a sea turtle nest.

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***CROTALUS ATROX* (Western Diamond-backed Rattlesnake). DIET.** Mammals are the prey most routinely selected by *Crotalus atrox* in Texas, but birds are also infrequently consumed (Beavers 1976. Southwest. Nat. 20:503–515). In other parts of the range, birds are similarly uncommon in the diet (Pisani and Stephenson 1991. Trans. Kansas Acad. Sci. 94:137–141). However, earlier studies have focused on the diet of adult *C. atrox* and species-specific identification details of predation upon birds in previous studies are lacking.

On 21 April 2014, at 1946 h, a mixed group of *Spiza americana* (Dickcissel) and *Chondestes grammacus* (Lark Sparrow) were observed on the entrance road to Laguna Atascosa National Wildlife Refuge (26.173833°N, 97.356222°W, datum NAD83; elev. 6 m), Cameron Co., Texas, USA. A juvenile *C. atrox* emerged shortly thereafter from the adjacent grassland, then envenomed and held a *Ch. grammacus* from the flock. The *Ch. grammacus* began convulsing and was ingested by the snake (Fig. 1). The influence of *C. atrox* predation on *Ch. grammacus* is unclear; however, the similarity of habitat association and the tendency of sparrows to forage on the ground suggests that the frequency of predation could be persistent.



FIG. 1. Juvenile *Crotalus atrox* consuming *Chondestes grammacus* (Lark Sparrow) near Laguna Atascosa National Wildlife Refuge, Cameron Co., Texas, USA.

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***CROTALUS HORRIDUS* (Timber Rattlesnake). COLORATION.** The ground color of *Crotalus horridus* in Minnesota has been described as yellow, tan, brown, reddish brown, "or, rarely, gray" (Oldfield and Moriarty 1994. Amphibians and Reptiles Native to Minnesota. Univ. Minnesota Press, Minneapolis. 240 pp.) and in Wisconsin as yellow, rust-orange, brown, or "very rarely gray" (Vogt 1981. Natural History of Amphibians and Reptiles of Wisconsin. Milwaukee Public Museum, Milwaukee. 205 pp.). Multiple photographs of typical snakes from this region were provided by Keyler (2004. *In* Kaufman [ed.], North: Stories and Photographs, pp. 67–87. Crotalus Publishing, Plymouth, Minnesota). While monitoring den complexes at two sites in Winona Co. and Houston Co. in southeastern Minnesota, USA, and handling nuisance rattlesnakes, I collected data on gray individuals.

Gray *C. horridus* have a gray to light gray ground color and black eyes (Fig. 1), a pattern that perhaps represents retention of newborn coloration. This pattern is similar to that described for southern morph *C. horridus* in the southern USA, where gray snakes are apparently more common, but descriptions from that region emphasize the presence of an orange to reddish brown middorsal stripe (e.g., Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.). A middorsal stripe may be present in Minnesota snakes, but I have not yet observed it in a gray snake. At the Winona Co. site, 2 of 52 nuisance snakes PIT-tagged during 2006–2012 were gray. An upper bound to the proportion of gray snakes is provided by the numbers observed at two den openings (one of eight and one of nine). At the Winona Co. site, four gray individuals observed in 2012 included two males and a female with young. At the Houston Co. site, no gray snakes were observed during 2006–2012. If populations of *C. horridus* in Minnesota have declined and become more isolated from one another, it is not unexpected that some genetic traits have become more abundant in some locations.

I thank the other rattlesnake responders of Winona County and the students who assisted me in the field or in the laboratory.



FIG. 1. A gray *Crotalus horridus* from Winona Co., Minnesota, USA.

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***CROTALUS HORRIDUS* (Timber Rattlesnake). DIEL ACTIVITY.** *Crotalus horridus* in southeastern Minnesota hibernate in dens associated with rock outcrops high on south- or southwest-facing slopes of bluffs (Cochran 2008. *In* Hayes et al. [eds.], The Biology of Rattlesnakes, pp. 441–446. Loma Linda Univ. Press, Loma Linda, California). Most often the hibernacula are found in or near bluff prairies (locally referred to as "goat prairies"). Whereas males and nongravid females disperse during the summer, gravid females remain at dens or in nearby rocky habitat. To monitor daily and seasonal use of this habitat, in 2007 we placed two remote cameras beneath overhanging rock ledges on bluffs in Houston Co. (22 May – 5 October) and Winona Co. (27 July – 6 October). At each location, the camera was set beneath one end of an overhanging ledge and pointed toward the opposite end. At one ledge in Houston Co., substrate temperatures were recorded hourly (HOBO) beneath the overhanging ledge and on the exposed ground surface approximately two meters from the ledge.

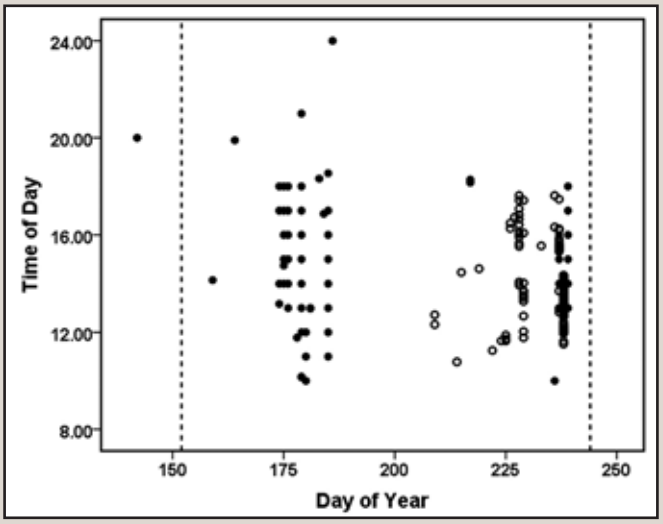


FIG. 1. Times when photographs of *C. horridus* were taken in Houston Co, Minnesota, USA (solid dots) and in Winona Co, Minnesota, USA (open circles). Vertical reference lines indicate June 1 and September 1.

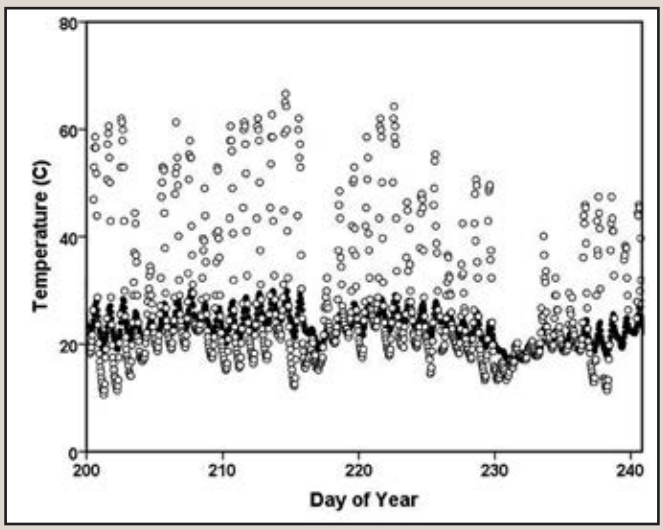


FIG. 2. Ground surface temperature (°C) beneath the Houston Co. ledge (solid dots) and in the open approximately 2 m from the ledge (open circles).

The camera in Houston Co. captured 57 images of *C. horridus*; 103 images were captured in Winona Co. Although distributions of times at which photographs were taken were significantly different between the two sites, *C. horridus* photographs were obtained primarily during the hours 1000 h–1800 h at both locations (Fig. 1). Observed frequencies of photographs in two-hour blocks during the daylight period (0600–2000 h) were significantly different from those that would be expected if photographs were equally likely in any time block (Houston Co.: $\chi^2 = 27.123$, df = 6, $P < 0.001$; Winona Co.: $\chi^2 = 141.906$, df = 6, $P < 0.001$).

Ground surface temperature beneath the Houston Co. ledge had a narrower range of fluctuation than the exposed ground surface outside the ledge (Fig. 2). Temperature beneath the ledge ranged from approximately 20°C at night to approximately 30°C during the day. Temperature of the exposed ground surface outside the ledge often fell below 20°C at night and sometimes climbed above 50°C during the day. Data plotted for a typical day (19 July) reveal that exposed ground surface temperature was lower than the temperature beneath the ledge until sometime between 1000 h and 1100 h, peaked at approximately 1600 h, and dropped below the temperature beneath the ledge at approximately 2000 h (Fig. 3).

Crotalus horridus apparently use overhanging rock ledges as thermal refuges during the hottest part of the day. The times when photographs were obtained correspond well with the period in the day when ground surface temperatures in the open exceed those beneath the ledge (Fig. 3). Cochran and Schmitt (2009. Bull. Chicago Herpetol. Soc. 44:161–165) provided an hourly sequence of photographs at the Houston Co. site depicting how a *C. horridus* kept its body tightly coiled within the shade of the overhanging ledge during a bright sunny afternoon and then moved underground at sundown. It may be especially important for reproductive females to be able to thermoregulate precisely and thereby keep the temperature of their developing offspring within appropriate bounds.

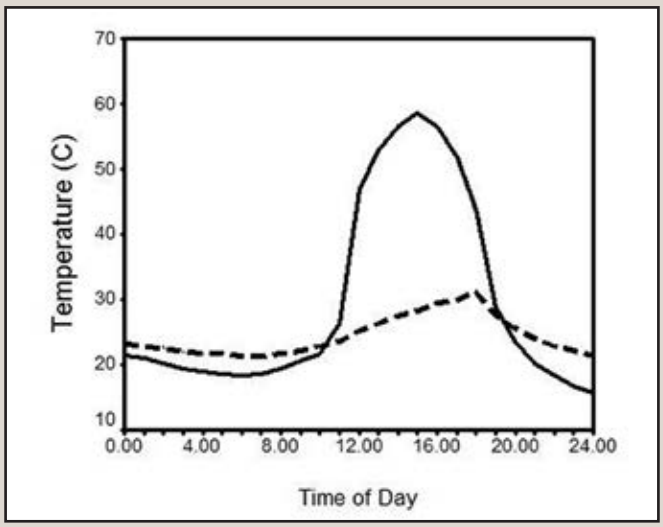


FIG. 3. Ground surface temperature (°C) beneath the Houston Co. ledge (dashed line) and in the open approximately 2 m from the ledge (solid line) on 19 July 2007.

We thank the Chicago Herpetological Society for a grant to purchase a remote camera and Chris Kendall for access to one of the study sites. Stephen Schmitt is grateful to Saint Mary's University of Minnesota for its support of undergraduate research.

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***CROTALUS HORRIDUS* (Timber Rattlesnake). HABITAT USE.** On 6 October 2013, a *Crotalus horridus* was observed under an automated corn feeder hung above a small clearing next to an adjacent forest patch on private property in Columbia Co., Lulu, Florida, USA. The snake was present for at least 5 h, noted from timestamps on images taken on a game camera. At 0711 h, it was still dark, and the snake was coiled in the center of the clearing, which was shaded until approximately 1030 h. As the day progressed, photos show the snake continually shifted its position within the plot to stay just out of direct sunlight, remaining at the interface of sun and shade.

At 1243 h, the snake was in the shade next to the only log within the confines of the clearing. It is assumed to have been foraging, as it was in a compact coil position next to the log with its head facing perpendicular to it (Reinert et al. 1984. Copeia 1984[4]:976–981). *Odocoileus virginianus* (White-tailed Deer) were observed multiple times from early morning to early afternoon feeding on corn within a few meters of the snake (Fig. 1). In addition to this observation, a *C. horridus* was noticed in the same spot five days earlier, and *C. horridus* have been witnessed on this feeder plot on several occasions, as well as at a different feeder in a forested area ca. 300 m away. Whether the same individuals are being repeatedly seen is unknown.

C. horridus often spend long periods of time at ambush sites (Clark 2006. Copeia 2006[2]:181–187) and may have to make tradeoffs between selecting sites for foraging and thermoregulation. Due to the food supply for small mammals, which make up a substantial portion of the diet for *C. horridus* (Clark 2002. J. Herpetol. 36:494–499), as well as the lack of canopy cover, clearings with feeders or planted food plots may offer thermoregulatory benefits for snakes while simultaneously attracting prey (Hampton et al. 2010. Am. Midl. Nat. 163:44–53). Because the clearing in this observation is surrounded by a fence to deter feral hogs, which are known predators of pitvipers, it may also afford added protection from predation.



FIG. 1. *Crotalus horridus* (Timber Rattlesnake) in an ambush position near an *Odocoileus virginianus* (White-tailed Deer) at an automated corn feeder in Columbia Co., Florida, USA.

I thank Ron Benke for assistance. David Tetzlaff and Michael Ravesi provided thoughtful suggestions to the manuscript.

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***DIADOPHIS PUNCTATUS* (Ring-necked Snake). DIET.** *Diadophis punctatus* shows considerable dietary diversity among and within populations. This includes heavy reliance on prey items as diverse as earthworms and other invertebrates, amphibians, or squamate reptiles, which challenges the commonly held assumption that these are earthworm specialists (reviewed by Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Books, Washington, DC. 680 pp.). O'Donnell et al. (2007. Toxicon 50:810–815) reviewed the chemistry of oral secretions and instances of apparent envenomation of prey items by some, but not all, populations of *D. punctatus* across its range (see also chemical analyses by Hill and Mitchell 2000. Toxicon 38:1663–1687). Mitchell (1994. The Reptiles of Virginia, Smithsonian Inst. Press, Washington, DC. 352 pp.) stated that prey items in Virginia, USA, were killed by constriction—a behavior not reported by other authors (e.g., Henderson 1970. Herpetologica 26:520–526; but see also references cited therein). O'Donnell et al. (*op. cit.*) and Ernst and Ernst (*op. cit.*) presented direct evidence of lethal envenomation by oral secretions from *D. punctatus* on several taxa. We (JRM, unpubl. data) once observed a *Plethodon serratus* become motionless and evidently dead (no heartbeat visible) within seconds of a predatory bite by a sympatric *D. punctatus* from LeFlore Co., Oklahoma, USA. There are conflicting reports of human envenomations (e.g., Myers 1965. Bull. Florida State Mus. Nat. Hist. 10:43–90; Henderson, *op. cit.*; Shaw and Campbell 1974. Snakes of the American West. Alfred A. Knopf, New York, New York. 330 pp.).

An adult *D. punctatus* (UCSB 25830; SVL = 148 mm; preserved mass = 6.25 g) found on More Mesa, Goleta, Santa Barbara Co., California, USA, on 11 April 1987 contained a visible abdominal bulge consistent with a large prey item. After capture, the snake regurgitated a subadult *Elgaria multicarinata* (UCSB 25831; minimum SVL = 52 mm; preserved/dry mass = 1.5 g; keeling on dorsal scales evident). This is the first record of *Elgaria* in the diet of *Diadophis* of which we are aware (Ernst and Ernst, *op. cit.*).



FIG. 1. *Diadophis punctatus* from Santa Barbara Co., California, with subadult *Elgaria multicarinata* regurgitated soon after capture.

The lizard prey was sufficiently digested, and missing part of the tail, such that calculation of prey/predator mass ratio can only be approximated (0.24, post preservation). Nevertheless, it is a large prey item for such a diminutive snake (Fig. 1) and *Elgaria* spp. are capable of formidable antipredator bites. We have observed (JRM, unpubl. data) a variety of obligate constricting snakes (e.g., *Lampropeltis* spp.) to become incapacitated, or badly injured, by the antipredatory bite-and-hold response of *E. multicarinata*; furthermore, these observations of *Lampropeltis* spp. included snakes proportionally much larger than is this *D. punctatus* with respect to the intended prey items. All points considered together, we conclude that *D. punctatus* in central California are capable of subduing robust squamate prey species, supporting the suggestion by O'Donnell et al. (*op. cit.*) that venom evolved in this species to facilitate subjugation of larger prey items.

The variety of prey items and feeding behavior and contradictory reports of effects of bites delivered to humans by *Diadophis* suggest that considerable geographic variation in the diet, behavior, and perhaps oral secretions of this snake exists. We emphasize the observation by O'Donnell et al. (*op. cit.*) that snakes referable to *D. p. edwardsii* lack the enlarged rear fangs that are present in the other putative subspecies. We suggest that carefully documented feeding trials involving snakes from various regions and presented with a variety of types of potential prey would reveal a surprising diversity of results perhaps consistent with the complex evolutionary history of these snakes (Fontanella et al. 2007. Mol. Phylog. Evol. 46:1049–1070; Fontanella and Siddall 2010. Zool. J. Linn. Soc. 158:629–640).

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DIADOPHIS PUNCTATUS **(Ring-necked Snake). DIET.** *Diadophis punctatus* is a fossorial species that ranges across much of the United States into southeastern Canada (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Books, Washington, DC. 668 pp.). On 3 June 2011, I found a dead *D. punctatus* in a recently mowed yard at 5823 Spanish Oaks Lane, Naples, Florida, USA (26.265215°N, 81.724880°W; datum WGS84). The *D. punctatus* was apparently hit by a mower and upon discovery I noticed a prey item, a *Ramphotyphlops braminus* (Brahminy Blindsnake), an established exotic species in Florida. Given the condition of the *D. punctatus*, it was likely killed the same day it was found. The lack of significant digestion of the *R. braminus* suggests it was recently consumed (Fig. 1).



FIG. 1. A *Diadophis punctatus* (Ring-necked Snake) that had consumed a *Ramphotyphlops braminus* (Brahminy Blindsnake), discovered after being hit by a lawn mower in Naples, Florida, USA.

Diadophis punctatus primarily feeds on small vertebrates, including other native snake species and conspecifics (Ernst and Ernst, *op. cit.*). While other fossorial snake species have been documented to consume *R. braminus*, such as *Stilosoma extenuatum* (Short-tailed Snake; Godley et al. 2008. Herpetol. Rev. 39:473–474) and *Micrurus fulvius* (Harlequin Coralsnake; Krysko et al. 2010. Herpetol. Rev. 41:501–502), this observation represents the first recorded occurrence of *D. punctatus* consuming a *R. braminus*.

I thank Kenneth Krysko and Kevin Enge for assistance.

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EPICRATES CRASSUS **(Eastern Rainbow Boa). DIET.** *Epicrates crassus* occurs in open grassland habitats in Bolivia, central Brazil, Paraguay, and northern Argentina (Passos and Fernandes 2008. Herpetol. Monogr. 22:1–30). In Paraguay most modern records are from the Cerrado zone and it is classed as vulnerable at the national level (Motte et al. 2011. Cuad. Herpetol. 23:5–18). It is considered to be the most terrestrial member of the genus and feeds mainly on small mammals, and occasionally birds (Pizzatto et al. 2009. Amphibia-Reptilia 30:533–544). At ca. 2100 h on 3 March 2014, a mature female *E. crassus* (estimated SVL = 972 mm) was found dead, apparently deliberately decapitated, on a dirt road ca. 8 km from Santa Rosa del Aguaray, Depto. San Pedro, Paraguay (23.8363°N, 56.3899°W; datum WGS84). The surrounding habitat consisted of wet grassland with nearby eucalyptus plantations. The snake had ingested an adult female *Cavia aperea* (Pampas Cavy; Mammalia: Caviidae; alcohol specimen CZPLT-M 438) with greatest length of skull 23 mm. *Cavia aperea* is a new prey species for *E. crassus* and with mean head–body length of 274 mm (Asher et al. 2004. J. Mammal. 85:788–796), and mean body mass of 523.6 g (Künzl and Sachser 1999. Horm. Behav. 35:28–37), is larger than other prey items previously reported (Pizzatto et al. 2009, *op. cit.*). The *Epicrates* specimen is deposited at the Para La Tierra Colección Científica housed at Reserva Natural Laguna Blanca, Departamento San Pedro, specimen number CZPLT-H 697.

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HETERODON PLATIRHINOS **(Eastern Hog-nosed Snake). REPRODUCTION / NEST SITE FIDELITY.** Nest site fidelity is poorly documented in snakes, and in *Heterodon platirhinos* it has been documented only in Ontario, Canada, near the species' northernmost range limit (Cunnington and Cebek 2005. Am. Midl. Nat. 154:474–478). Here, we present evidence of nest site fidelity of *H. platirhinos* from a population in Saratoga Co., New York, USA. As part of a radio-telemetry study, we observed a large female (SVL = 78 cm, mass = 618 g) nesting in a utility right-of-way (characterized by an open canopy and early successional plant

species) at ~1800 h on 17 Jun 2012. After the female finished oviposition, we excavated the nest and located 39 eggs. We re-buried the clutch and it successfully hatched 51 days later on 7 August. At 1500 h on 20 June 2013, the same female was observed nesting within 1 m of her nesting location the previous year. The snake was not interrupted, and was identified via unique tail pattern markings, as she was no longer being radio-tracked. This clutch was depredated by a mammal the following night. To the best of our knowledge, this is the first report of nest site fidelity in *H. platirhinos* outside of Canada, and suggests this behavior might be widespread in the species. Our study also confirms that annual reproduction can occur in wild *H. platirhinos* in New York.

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***LAMPROPELTIS MEXICANA* (Mexican Kingsnake). MAXIMUM ELEVATION.** On 8 October 2008, an adult female *Lampropeltis mexicana* (SVL = 65.2 cm, TL = 11 cm; UAA-CV-R263) was found in oak-juniper forest ca. 3.6 km WNW of La Congoja, (22.180879°N, 102.588795°W, datum WGS84; elev. 2603 m), Sierra Fría, Municipality of San José de Gracia, Aguascalientes, México. Previous known vertical distribution for this species is 2000–2440 m elev. (Vázquez-Díaz and Quintero-Díaz 2005. Anfibios y Reptiles de Aguascalientes. CONABIO, CIEMA, México. 318 pp.; Bryson et al. 2007. Mol. Phylogenet. Evol. 43:674–684; Hansen and Bryson. 2009. Herpetol. Rev. 40:114). The specimen is phenotypically similar to populations of *L. m. greeri* from Mesa Montoro. This record extends the distribution ca. 18 km N from previous known locality in the state at Mesa Montoro (Quintero-Díaz et al. 2001. Herpetol. Rev. 32:278) and increases the vertical distribution to 2603 m elev.

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***LEPTODRYMUS PULCHERRIMUS* (Striped Lowland Snake). COLORATION.** Blue coloration is found across many groups of organisms and has a variety of utilities such as signaling or crypsis (Bagnara et al. 2007. Pigment Cell Res. 20:14–26; Umbers 2013. J. Zool. 289:229–242). Sometimes, blue coloration can result from a failure to synthesize yellow pigments in typically green species (Bechtel 1978. J. Herpetol. 12:521–532). *Leptodrymus pulcherrimus* is a colubrid snake endemic to the Pacific versant of middle Central America, ranging from Guatemala to Costa Rica. This species typically displays bright green head coloration (green is sometimes seen on the tail also), with a pale dorsal stripe and dark dorsolateral stripes. Around midnight on 30 June 2010, a specimen of *L. pulcherrimus* was collected on the Reserva de la Biosfera Isla de Ometepe, Rivas Dept., Nicaragua (11.51024°N, 85.55843°W, datum WGS84; elev. 32 m). This specimen had dark blue coloration in place of the typical green. Abnormal blue coloration has not yet been reported in *L. pulcherrimus*, but bluish color morphs in other typically green species have been reported (e.g., *Coluber constrictor stejnegerianus*, Webb 1960. Trans. Kansas Acad. Sci. 64:289–298; *Leptophis ahaetulla*, M. E. Acevedo, pers. comm.), and in one documented case, reduced pigment levels caused red coloring to be replaced by blue in *Thamnophis proximus* (Bagnara et al. 1978. Amer. Zool. 18:301–312). We do not currently know what is responsible for the blue coloration in *L. pulcherrimus*, but have observed at least five blue *L. pulcherrimus* on Isla de Ometepe without any records or observations of *L. pulcherrimus* with the typical coloration. We believe our observations to be more than individual abnormalities, and likely a characteristic of the population observed. The specimen (MHUL 161) was collected under the scientific permit DGPN/DB-10–2010 issued by MARENA.



FIG. 1. A *Leptodrymus pulcherrimus* (MUHL 161) from Isla de Ometepe, Nicaragua, displaying blue coloration, unreported for the species, but apparently typical for *L. pulcherrimus* from the island.

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***LEPTOPHIS AHAETULLA* (Parrot Snake). DIET.** *Leptophis ahaetulla* feeds primarily on anuran amphibians, particularly species in the family Hylidae, but occasionally eats lizards, young birds, and salamanders (Albuquerque et al. 2007. J. Nat. Hist. 41:1237–1243). On 15 October 2013, in Dois Irmãos state park (08.0119°S, 34.9489°W, datum WGS84; elev. 44 m) in the city of Recife, Pernambuco, Brazil, a *L. ahaetulla* (SVL = 958 mm; tail length = 296 mm) was captured that had consumed a *Hypsiboas semilineatus* (Anura: Hylidae). The most common anurans in the diet of *L. ahaetulla* are in the genus *Scinax* (Albuquerque et al., *op. cit.*); this is the first record of predation on *H. semilineatus*. These species exhibit different active schedules; the snake is diurnal and the anurans are nocturnal, indicating that the snake uses active foraging to locate inactive prey. Specimens were deposited in the Herpetological and Paleoherpetological Collection of the Federal Rural University of Pernambuco – UFRPE, Recife, Brazil (*L. ahaetulla* CHPUFRPE-3007; *H.semilineatus* CHPUFRPE-3006).

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***LYCODON FUTSINGENSIS* (Fuqing Wolf Snake). DIET.** Although *Lycodon futsingensis* has been described for many decades (Pope 1928. Am. Mus. Novit. 320:1–6), little is known about its biology,



FIG. 1. Adult *Lycodon futsingensis* feeding on a juvenile *Ptyas dhumnades* in Nanling National Wildlife Refuge, Guangdong, China.

including its diet in the wild. Zhang et al. (2011. Chin. J. Zool. 46:128–130) reported that captive *L. futsingensis* fed primarily on lizards, but no observations have confirmed its diet in nature.

At 2130 h on 15 May 2010, an adult *L. futsingensis* was observed swallowing a juvenile *Ptyas dhumnades* in the dry sluiceway in Nanling National Wildlife Refuge, Guangdong, China (Fig. 1). The *P. dhumnades* was alive and struggling as it was swallowed by the *L. futsingensis*. At 2200 h on 21 July 2011, another adult *L. futsingensis* was observed capturing a *Sphenomorphus incognitus* inside a rock crevice along a stream in Liuxihe National Forest, Guangdong, China. The snake was constricting and swallowing the skink, but the snake fled quickly, leaving the dead skink in the crevice.

Our observations on the diet of *L. futsingensis* are consistent with the previous reports that species in the genus *Lycodon* primarily feed on reptiles (Zhang et al., *op. cit.*; Pauwels et al. 2005. Nat. Hist. Bull. Siam. Soc. 53:79–86; Vogel et al. 2009. Trop. Zool. 22:131–182). Additionally, *Ptyas dhumnades* represents a new species of the natural diet of *L. futsingensis*. Based on observations in natural settings and under captivity, we suggest that the diet *L. futsingensis* consists mainly of skinks, geckos, and small snakes, and the species forages primarily at night.

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***PHALOTRIS MATOGROSSENSIS* (Mato Grosso Burrowing Snake). DIET.** Ophiophagy is very common in some snakes, but uncommon in others, and rare in *Bothrops* spp., with only a few records (e.g., Martins and Gordo 1993. Herpetol. Rev. 24:151–152; Oliveira and Martins 1996. Herpetol. Rev. 27:22–23). *Bothrops moojeni* occurs in the Cerrado domain in central and southeastern Brazil (Leloup 1984. Acta Zool. Pathol. Antverp. 78:177–198; Borges and Araújo 1998. Rev. Brasil. Biol. 58:591–601). It is considered a dietary generalist; young feed on small mammals, frogs, lizards, snakes, birds, and centipedes, but adults prefer mammals (Andrade et al. 1996. J. Herpetol. 30:285–288; Nogueira et al. 2003. J. Herpetol. 37:653–659. França et al., 2008. Copeia 2008:20–36). *Phalotris matogrossensis* belongs to the family Dipsadidae and is distributed in semi-deciduous forest of São Paulo State, Brazil (Zaher et al. 2011. Biota Neotrop., pp. 67–81). During the necropsy of a *B. moojeni* specimen (SVL = 940 mm; tail length = 150 mm) captured in Castilho county, in northwestern São Paulo, Brazil, we found in its stomach a *P. matogrossensis* (SVL = 263 mm; tail length = 180 mm). The prey was intact, indicating a recent predation event. This is the first record of *B. moojeni* preying on *P. matogrossensis*.

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***PSEUDOBOA NIGRA*. DIET.** *Pseudoboa nigra* is a nocturnal, terrestrial snake with a wide distribution in South America (Peters and Orejas-Miranda 1970. Bull. U.S. Nat. Mus. 297:1–347; Gaiarsa et al. 2013. Pap. Avul. Zool. 53:261–283). In terms of diet, it is considered a lizard specialist, rarely consuming other types of food (Gaiarsa et al., *op. cit.*). In this note we present data on stomach contents of an adult male *P. nigra* (SVL = 597 mm; tail length = 225 mm; 118.5 g) collected by one of us (CFDR) on 8 November 1999 at 2200 h in the "restinga" habitat of Grussaí (21.683333°S, 41.030556°W; datum WGS84), municipality of São João da Barra, state of Rio de Janeiro, Brazil. After dissection, we found three empty squamate egg shells (length 17.6–19.5 mm; width 7.8–9.3 mm) and the digested remains of a scincid lizard (*Mabuya* sp.). It was not possible to identify the skink to species, but two species of *Mabuya* occur in the area: *M. agilis* and *M. macrorhyncha* (Vrcibradic and Rocha 2002. Rev. Bras. Zool. 19:77–83). The snake was deposited at the reptile collection of the Museu Nacional, Rio de Janeiro, as MNRJ 24638.

Skinks in the genus *Mabuya* have not been previously reported as prey of *P. nigra*, and the present record thus adds a new prey species for this snake. The squamate eggs found in the gut could not have been secondarily ingested with the skink, because *Mabuya* spp. (*sensu* Mausfeld et al. 2002. Zool. Anz. 241:281–293) are viviparous, and thus they must have been consumed directly. Squamate eggs have been previously reported in the diet of *P. nigra* (Orofino et al. 2010. Phyllomedusa 9:53–61; Mesquita et al. 2013. Pap. Avul. Zool. 53:99–113.), suggesting that occasional oophagy may not be uncommon in this species.

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***SISTRURUS CATENATUS CATENATUS* (Eastern Massasauga). DIET.** On 11 June 2013, on the property of the Camp Grayling Army and Air National Guard joint maneuver training base, Kalkaska, Co., Grayling, Michigan, USA, we captured a male *Sistrurus c. catenatus* (mass = 156.8 g without prey item). While releasing the snake at approximately 1100 h the following day, it regurgitated a partially-digested bird (mass = 13.2 g) that was likely swallowed headfirst. The head was the most digested portion and the rest of the body was largely intact, indicating that the bird had recently been consumed (Fig. 1).

To identify the species of bird, DNA was extracted from a tissue sample using a Qiagen DNeasy kit. Quality of DNA was



FIG. 1. A nestling *Toxostoma rufum* (Brown Thrasher) regurgitated by a male *Sistrurus c. catenatus* (Eastern Massasauga).



PHOTO BY KEITH GELUSO

FIG. 1. A *Sistrurus catenatus tergeminus* with a unique dorsal pattern photographed on a gravel road in northwestern Russell Co., Kansas.

assessed by running 2µl of genomic DNA on a 2% agarose TAE gel. Polymerase chain reaction (PCR) was carried out in 10µl amplification reactions for a 548-bp fragment of cytochrome oxidase using conserved avian mitochondrial primers and conditions outlined in Lovette and Rubenstein (2007. Mol. Phylogen. Evol. 44:1031–1056). BLAST searching returned a 99% match to *Toxostoma rufum* (Brown Thrasher). The *T. rufum* (GenBank accession number KF959632) has been deposited at Indiana University-Purdue University Fort Wayne, located in Allen Co., Fort Wayne, Indiana, USA. The mass of adult *T. rufum* ranges from 61–89 g (allaboutbirds.org; accessed 18 Jan 2014). Due to the relatively low mass and the presence of pin feathers from the regurgitated specimen, the bird is presumed to be a nestling. To our knowledge, this is the first recorded account of *T. rufum* in the diet of *S. c. catenatus*.

Adult *S. c. catenatus* primarily prey upon rodents but will also feed on several other taxa, including birds and bird eggs (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Books, Washington, DC. 668 pp.). Given the multiple accounts of avian species consumed by *S. c. catenatus*, we believe birds may be opportunistically taken as a food source in its diet more frequently than currently recognized.

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***SISTRURUS CATENATUS TERGEMINUS* (Western Massasauga). ABERRANT PATTERN.** *Sistrurus catenatus* generally has a ground color of light gray to light brown with a series of large dark brown blotches down the center of the back before becoming cross bands towards the tail (Ernst and Ernst 2011. Venomous Reptiles of the United States, Canada, and Northern Mexico. Vol. 1. John Hopkins Univ. Press. Maryland. 352 pp.). Three rows of smaller brown to black spots occur on each side of the body (Ernst and Ernst 2011, *op. cit.*). Variation in ground and blotch coloration is known (e.g., Woodburne 1956. Copeia 1956:125–126) as well as variation in number of dorsal blotches that range from 21 to 50 with a mean of 40 (Ernst and Ernst 2011, *op. cit.*). Few reports document major differences in dorsal blotching patterns of *S. catenatus*, but melanistic, albinistic, and a partially striped individual have been documented (Lardie and Lardie 1976. Bull. Oklahoma Herpetol. Soc. 1:40; Harris 2006. Bull. Maryland Herpetol. Soc. 42:181–183; Ernst and Ernst 2011, *op. cit.*).

On 2 October 2013, we observed and photographed an aberrantly patterned *S. catenatus* on 182nd Street on the southern end of a stretch between Saline River Road and Luray Road, Russell Co., Kansas, USA (Fig. 1). This individual lacked the familiar pattern but instead had relatively few, but paired, elongated blotches along more than half the total length of the snake. Towards the tail, blotches were single, ending with one elongated blotch that comprised about the last quarter of the total length. The characteristic three rows of smaller spots on the sides of *S. catenatus* were completely absent. Such a unique pattern of blotching appears rare and has not been documented previously in *S. catenatus* to our knowledge.

In northern Oklahoma, a partially striped individual was collected in Major Co. in 1973 (Lardie and Lardie 1976, *op. cit.*). On its posterior end, the young snake (236 mm SVL) had two dorsal stripes that measured 15 and 30 mm in length followed by four close-set blotches that preceded the rattle. No mention was made of any unusual lateral blotches or their absence.

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***STEGONOTUS CUCULLATUS* (Slatey-grey Snake). MORTALITY.** *Stegonotus cucullatus* is a medium-sized mostly nocturnal terrestrial colubrid snake restricted to the northern parts of the Northern Territory and Queensland, Australia (Cogger 2014. Reptiles and Amphibians of Australia, 7th ed. CSIRO Publishing, Collingwood, Victoria, Australia. 1033 pp.); it is one of few endemic Australian snake species reported to consume adults of the invasive exotic bufonid anuran *Rhinella marina* without mortal effect from its skin toxins (e.g., Phillips et al. 2003. Conserv. Biol. 17:1738–1747). This note reports an instance of mortality to a *S. cucullatus* as a result of attempted predation on *R. marina*.

On 30 April 2009 (i.e., in mid-autumn, toward the end of the "wet" season) at an aquaculture facility at 100 Mahaffey Road, Howard Springs, ~23 km E of Darwin, Top End of the Northern Territory, Australia (~12.5165°S, 131.0556°E, datum GDA94; elev. 45 m), DW found a dead adult (total length ~1.1 m) *S. cucullatus* disposed in a series of irregular curves with a dead small adult (SVL = ~60 mm) *R. marina* in its mouth (Fig. 1), in an open grassy

PHOTO BY DAVID N. WILSON



FIG. 1. Dead adult *Stegonotus cucullatus* with partly swallowed dead *Rhinella marina*, Howard Springs, Northern Territory, Australia.

area between aquaculture pools. The head, neck, forelimbs, and anterior body of the *R. marina* had been swallowed by the *S. cucullatus*, and several red mymicine ant workers ~4 mm length, exotic *Solenopsis geminata*, were scavenging on the carcasses. On the basis of condition of the dead animals, it was estimated that mortality had occurred approximately 45 min prior to observation. Habitat in the vicinity comprised a cleared area in former Tropical Monsoon Woodland with aquaculture pools and shadehouses used for cultivation of aquatic plants and aquarium freshwater fish, sheds, and a human dwelling.

This is the first published report of mortality to *S. cucullatus* as a result of attempted predation on exotic *R. marina*; however, several similar cases have been observed. IJM has frequently observed *S. cucullatus* constricting and killing adult *R. marina*, variously swallowing, rejecting, or occasionally choking on prey, in many cases with their heads becoming coated with the toxic exudate from the parotoid glands of the prey. The snakes have appeared to suffer no ill effect from exposure to such large quantities of the exudate, although they wipe it off on the substrate after the interaction (IJM, unpubl. data). As a predator defense, adult *R. marina* inflate the body to a much greater extent than large adults of sympatric endemic anurans, and have more rigid skeletons (pers. obs.). We hypothesize that mortality in *S. cucullatus* reported here and in other similar cases with adult *R. marina* prey could be due to asphyxiation, rather than toxicity.

Anecdotally, there was a large reproductive population of *S. cucullatus* on the property where the above interaction was observed prior to colonization by exotic *R. marina*; however, since the colonization of *R. marina* the snakes are now rare, as is also the case with the large agamid lizard *Chlamydosaurus kingii*, the large varanid lizard *Varanus panoptes*, and several other endemic vertebrate species on the property (DNW, unpubl. data). Similar trends have also been surmised for the wider region (G. Sawyer, pers. comm.).

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***THAMNODYNASTES PALLIDUS* (Amazon Coastal House Snake). REPRODUCTION.** *Thamnodynastes* is a South American genus with viviparous reproduction (Manzanilla and Sanchez 2005. Mem. Fund. La Salle Cien. Nat. 161-162:61–75). *Thamnodynastes pallidus* is a terrestrial and nocturnal species distributed over Bolivia, Colombia, Venezuela, the Guianas, and Brazil that inhabits forested ecosystems in the Amazonia and Atlantic forest biomes (Bailey et al. 2005. Phyllomedusa 4:83–101). Herein, we present possibly the first reproductive report for female *T. pallidus*. On 26 September 2008, in Salvador, State of Bahia, Brazil, a female (SVL = 320 mm, tail length = 130 mm; CHECOA 2673) was captured at the Jardim Botânico do Salvador, a small ombrophilous forest remnant (12.926733°S, 38.425037°W, datum WGS84; elev. 51 m). After examination of oviducts in the laboratory, we observed two oviductual eggs (21.3, 23.0 mm) and no ovarian follicles. On 12 July 2013 another female (SVL = 293 mm, tail length = 119 mm; CHECOA 2963) was captured at the Parque Metropolitano de Pituaçu, a large ombrophilous forest remnant (12.949936°S, 38.413887°W, datum WGS84; elev. 33 m). This specimen contained six ovarian follicles on the right side (≤ 3.4 mm) and four follicles on the left side (≤ 1.9 mm). Animals were collected under SISBIO permit Nº 23355-2 and deposited at the herpetological reference collection at the Centro de Ecologia e Conservação Animal, Universidade Católica do Salvador.

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***THAMNOPHIS PROXIMUS PROXIMUS* (Orange-striped Ribbonsnake). DIET.** The diet of *Thamnophis proximus* consists mainly of fishes and amphibians, with anurans being more often reported than salamanders (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Institution, Washington, DC. 668 pp.). On 3 April 2014, at 1215 h, we captured an adult female *T. p. proximus* (SVL = 63.8 cm; 60.8 g) that was basking in a shrub, approximately 1 m off the ground, at the Tara Wildlife Refuge (private), Vicksburg, Warren Co., Mississippi, USA. The snake had recently fed, as indicated by a large bulge in its stomach, and upon palpating, the snake regurgitated an adult male *Anaxyrus fowleri* (Fowler's Toad). To the best of our knowledge, this is the first documentation of *A. fowleri* in the diet of *T. proximus*.

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***TRIMERESURUS BORNEENSIS* (Bornean Palm Pit Viper). DIET.** *Trimeresurus borneensis* is a pitviper endemic to the island of Borneo. The species is considered common throughout its range and inhabits lowland and submontane forested areas up to 1130 m in elevation. *T. borneensis* feeds primarily on small mammals and birds; although they are suspected to feed on frogs and lizards as well, this behavior has never been documented (Das 2011. A Photographic Guide to the Snakes and Other Reptiles of



FIG. 1. *Trimeresurus borneensis* after regurgitating a *Draco maximus* in Sabah, Malaysian Borneo.

Borneo. 2nd ed. New Holland Publishers Ltd., London, UK. 144 pp.). Here, we provide the first documented observation of predation by *T. borneensis* on a lizard (*Draco maximus*).

At 1809 h on 2 February 2013, a male *T. borneensis* was encountered in the foothills of Mount Kinabalu in primary hill forest, Sabah, Malaysian Borneo. The individual was 4 m from a small stream (6.056498°N, 116.703682°E, datum WGS84; elev. 490 m). The snake had partially ingested a large gliding lizard (later identified as *D. maximus*), but regurgitated the lizard in response to our presence (Fig. 1).

We thank Tom Hewitt, owner of Lupa Masa Jungle Lodge for the use of the site, and Indraneil Das for identification verification. For ZRC voucher numbers we thank Kelvin K. P Lim.

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***TRIMERESURUS STEJNEGERI* (Stejneger's Green Pitviper). DIET.** *Trimeresurus stejnegeri* is a viperid snake found throughout Taiwan and much of Southern Asia. Two stomach content analysis studies (Mao 1970. Herpetologica. 26:45–48; Creer et al. 2002. Zool. Sci. 19:907–913), including a combined total of 526 specimens of *T. stejnegeri* from throughout Taiwan, demonstrated that they prey on a variety of small terrestrial animals including frogs, lizards, rodents, and some arthropods. However, no references could be found providing examples of them preying upon other snakes. Thus, to our knowledge, this observation of ophiophagy in *T. stejnegeri* is novel to the understanding of the pitviper's ecology.

At 2117 h on 26 August 2013 (23°C) an adult *T. stejnegeri* (estimated total length = 700 mm) was observed consuming an adult *Amphiesma sauteri* (estimated total length = 500 mm) vent-first (Fig. 1A). The event was observed within old growth forest along the Bibù Cross-island Highway, southeast of Balíng, Taoyuan County, Taiwan, R.O.C. (24.66380°N, 121.40095°E, datum WGS84; elev. 797 m). When first encountered, the *T. stejnegeri* had already clamped its jaws crosswise on the cloacal section of the *A. sauteri*, but had not yet begun to swallow it. Both snakes were at street level on the concrete curb of the mountain road with the *A. sauteri* alternately trying to crawl away from the *T. stejnegeri* or trying to anchor itself on the embankment or curb to resist

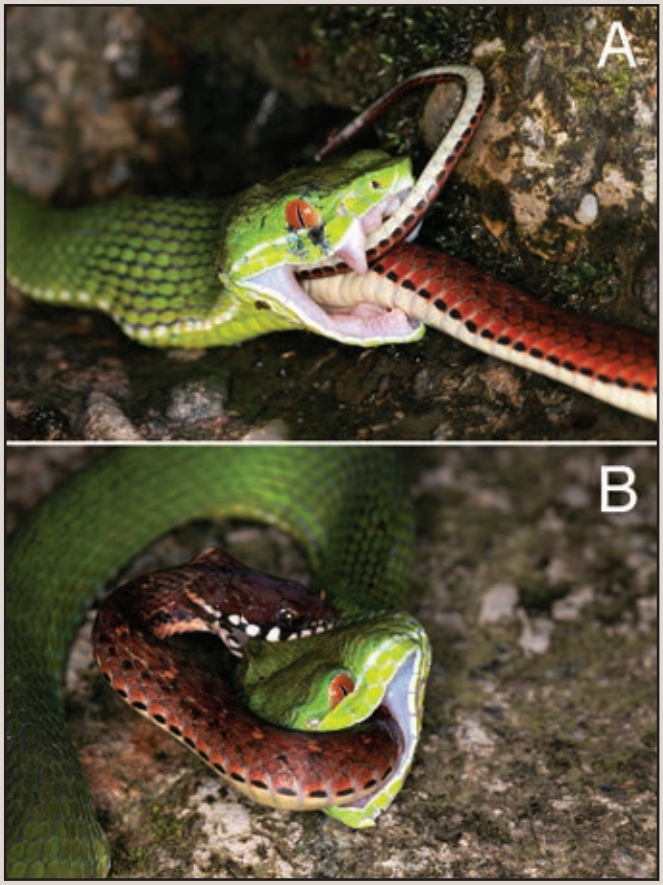


FIG. 1. A) *Trimeresurus stejnegeri* preying upon an *Amphiesma sauteri*, vent first. B) *Amphiesma sauteri* attempting to defend itself from the predatory *Trimeresurus stejnegeri*.

being eaten. By 2125 h the *T. stejnegeri* had managed to bend the *A. sauteri's* tail back against its body and begun to swallow the posterior portion of the *A. sauteri*. For the next 20 min, the *T. stegnegeri* slowly swallowed the *A. sauteri*, working its way up the length of the *A. sauteri*'s body, with the *A. sauteri* actively resisting for the entire battle. In a final act of defiance, the *A. sauteri* attempted to defend itself by biting the *T. stegnegeri*'s head (Fig. 1B). At 2145 h, only the *A. sauteri*'s head and perhaps 2 cm of neck were still visible outside the *T. stejnegeri*'s jaws. With the *A. sauteri*'s jaws clamped down on the T. *stejnegeri*'s head, the *T. stejnegeri* climbed the curb and retreated into a small hole in the embankment.

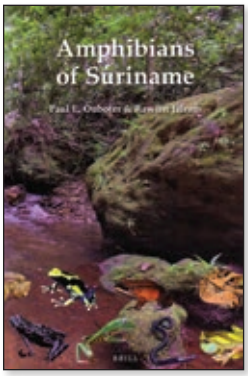
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BOOK REVIEWS

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Amphibians of Suriname

Paul E. Ouboter and Rawien Jairam. 2012. Koninklijke Brill NV, Leiden, The Netherlands (www.brill.com). 376 pp. Hardcover. 110.00 Euros (approximately US $151.00). ISBN 978-9-00420-799-8; Paperback. 34.80 Euros (approximately US $48.00). ISBN 978-9-004 21-075-2.



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In addition to being useful to field biologists, field guides are valuable tools for disseminating information among non-scientists. They also often help decision-makers to identify areas of high biodiversity. Although the Neotropical realm probably harbors the world's greatest biodiversity, the amphibian species richness of many South American countries is not well understood by the general public because synoptic overviews of their batrachofauna are lacking. Field guides to the herpetofauna of the Guiana Shield are scarce despite the fact that the region is characterized by high levels of diversity and endemism, with some of the most iconic herpetofaunal representatives of the Neotropics (e.g., *Dendrobates tinctorius* [Cuvier, 1797]). This situation is exacerbated by incomplete sampling in several parts of the region and by the recognized existence of numerous species waiting to be named. However, a few field guides from some areas within the Guiana Shield are available (e.g., Lescure and Marty 2001; Lima et al. 2006, 2012; Kok and Kalamandeen 2008; the three latter downloadable for free).

Although Suriname was one of the first South American countries to be scientifically explored (Hoogmoed 2013), no compendium of information about the country's batrachofauna was available until recently. Most information is scattered across the scientific literature, which is often difficult, if not impossible to obtain for the local population, amateur naturalists, and visiting tourists.

Amphibians of Suriname by Ouboter and Jairam (2012) is an attempt to remedy this issue, and the authors certainly have to be acknowledged for their efforts. This being said, neither author is known for his experience in amphibian taxonomy and/or biogeography, and most herpetologists working in the Neotropics will probably start reading their book with circumspection. My own reading of Ouboter and Jairam's volume highlights a considerable number of mistakes, including some that I feel necessary to correct in this review.

Amphibians of Suriname is the first volume in the series *Fauna of Suriname*, produced by the well-known publishing group Koninklijke Brill NV with the support of NCB Naturalis (the former Rijksmuseum van Natuurlijke Historie, RMNH, Leiden, The Netherlands). The book is printed on acid-free paper and the binding of my hardback copy seems to be of high quality. The volume totals 376 pages including the preface and three indexes (subject, common names, and taxonomic), and is illustrated by 309 figures, 204 of which are color photographs, and 107 distribution maps (without indication of geographical coordinates). The book is divided into nine main sections. An Introduction (less than 2 pages); "Geography of Suriname" (eight pages); "Methods" (four pages); accounts of the 107 species said to occur in Suriname (316 pages), including the description of two new species and two new subspecies; a two page-section about the amphibian taxa that may occur in Suriname; "Zoogeography" (four pages); a section about conservation of the amphibians in Suriname (six pages); and finally a bibliography (nine pages), followed by a five-page appendix dealing with recent nomenclatural changes.

Although the authors complain in their introduction that no guide to the amphibians of the area (i.e., the Guiana Shield) is available in a language accessible to the Surinamese, the text they provide is written in rather poor English and was obviously not checked by a native English speaker before publication. In addition, the authors seemingly missed a field guide to the amphibians of Kaieteur National Park, located in the neighboring Guyana (Kok and Kalamandeen 2008), which is written in English and deals with many species present in Suriname. Unfortunately, this is not the only important reference missing. The lack of identification keys, even for families or genera, also comes as a surprise in a book intended as a field guide. Identifications can only be made by comparing photographs (many of problematic identification or poor quality, see below) and brief, often incomplete descriptions, which is inconvenient in the field. The lack of a glossary, which is always very useful to non-specialists, is also regrettable.

The Introduction mainly aims at providing a brief history of herpetological research in Suriname, and the current state of knowledge of the number of amphibian species recorded from the country. The introduction does not mention expeditions to collect herpetofauna by Marinus S. Hoogmoed in 1974 and 1975 (throughout Suriname), and in 1979 (Tafelberg) (M. Hoogmoed, pers. comm.). The material collected during these expeditions has been deposited in the RMNH, Leiden. Neither is fieldwork (1975, 1980, 1986) by personnel of the American Museum of Natural History (AMNH, New York) in Suriname mentioned. In their figure 1 the authors present a graph showing the number of species known from Suriname over the years, however the legend

explains it as the rate of descriptions of *new species* of amphibians for Suriname which, of course, would be represented by a radically different graph.

The section "Geography of Suriname" briefly explains and illustrates the geology, geography, climate, hydrology, and different types of macrohabitats found in the country. The map of Suriname represents the country borders as claimed by the Surinamese government, but not as recognized by the international community (Anderson 2003), which poses problems with some species distributions (see below).

In "Methods" the authors mainly explain how to use the book, list localities explored between 1988 and 2010 by P. E. Ouboter, and briefly overview collecting methods. The authors state "In addition to direct observations and collecting, the amphibian collections at NCB Naturalis (Leiden Natural History Museum, Netherlands) and the National Zoological Collection of Suriname [NZCS] form a solid base on amphibians of Suriname." Later on the authors state "The distribution in Suriname is based on all distribution records available," which are said to include the collections of the NZCS and the RMNH, as well as the literature and their own observations. However, as is evident from several maps, many localities of RMNH specimens collected by M. Hoogmoed between 1968 and 1990 have not been incorporated. This is especially evident in the map of *Pristimantis marmoratus* (Boulenger, 1900) (fig. 288, p. 311), a species said to be known only from three localities and thus considered rare in Suriname. However, specimens identified as belonging to that species were collected in dozens of localities in Suriname in large numbers by M. Hoogmoed (pers. comm.), and *P. marmoratus* as currently understood (but see remarks in Kok and Kalamandeen 2008, Fouquet et al. 2013, and Kok 2013) could therefore be one of the most abundant species in the rainforests of Suriname. Indeed, the incomplete use of available data has resulted in several erroneous conclusions being drawn in the conservation portion of the field guide. Apart from the general statement of the authors about the material examined, there is no listing of the material used to compile the book. Similarly, no material used for making the maps is mentioned, except for some of the taxa described as new. This in itself is understandable, but it makes it difficult to check identifications, especially in the light of the mistakes the field guide contains. Given the many misidentifications made by the authors (see below) one might wonder which occurrence records may be fully trusted. Finally, no information is provided on the methods used to analyze the vocalizations of the new species described in the book.

The species accounts section unfortunately contains a large number of problems, of which I will here discuss only the most obvious and important ones. As a first remark, describing new taxa in a field guide is not advisable because field guides are often not properly peer-reviewed and their format usually prevents detailed descriptions. The descriptions of *Anomaloglossus leopardus* and *A. surinamensis* are very brief and far from the current standards of new species descriptions in herpetology. Sexes of holotypes and paratypes are not provided, and diagnoses are limited to comparison with two (*A. leopardus*) to three (*A. surinamensis*) congeneric species. Because nothing is stated about the methods used to analyze the advertisement calls, one might wonder how the authors measured the note length and note intervals in the calls illustrated on p. 41 (fig. 34). Spectrograms show significant background noise, which probably made it very difficult to decide where the note begins and ends. Temperatures at which calls were recorded are not mentioned. These data are especially important since the authors use temporal characteristics to discriminate between the calls of *A. surinamensis* and *A. degranvillei* (Lescure, 1975).

Each taxon account begins with the scientific name of the species and the authorship. Species authors are systematically placed between parentheses, which is incorrect for many of them (authors should be placed between parentheses only when the genus name changed after the original description). The "Short descriptions" indeed are rather short and often do not serve to identify specimens correctly. The "Distribution" section in several cases contains mistakes, and the "Habitat" section is often very brief, the authors apparently having not surveyed the extensive literature that provides a wealth of data on this aspect for several of the species treated. There is usually no information about tadpole morphology and advertisement call of the species.

Regrettably, a number of photographs are wrongly identified. Many show preserved specimens that do not provide a good idea of the species (e.g., fig. 299 of *Microcaecilia rabei* [Roze and Solano, 1963], several are from specimens from outside Suriname (which would not be a problem if the exact localities were mentioned), and the quality of some pictures is not good enough to allow easy identification in a field guide. One noticeable example of a problem related to a photograph is the illustration of "*Dendrobates tinctorius azureus*" on p. 107 (fig. 100). That subspecies is said by Ouboter and Jairam to be endemic to the Sipaliwini Savannah in Suriname. However, the photograph they use to illustrate that endemic subspecies is virtually the same as one provided by Naskrecki (2011: 234), showing a specimen that actually had been photographed in the Acarai Mountains of Guyana (locality confirmed by P. Naskrecki). Ouboter and Jairam wrongly report that the photograph was taken by Russell A. Mittermeier in the Sipaliwini Savannah. The authors thus illustrate an endemic subspecies stated to be only diagnosable based on coloration and a hunched back with a specimen presenting the same characteristics but coming from a neighboring country. In any case, it is surprising that the authors treat *D. azureus* Hoogmoed, 1969 as a subspecies of *D. tinctorius* without any argumentation. Wollenberg et al. (2006) synonymized *D. azureus* with *D. tinctorius*, and nobody has previously treated *azureus* as a subspecies.

The validity of the other two subspecies described as new in Ouboter and Jairam is also doubtful. There is no evidence indicating that *Atelopus hoogmoedi nassaui* is anything other than a color morph of *Atelopus hoogmoedi* Lescure, 1974 (purple specimens are also known from northern Brazil), or possibly of *A. barbotini* Lescure, 1981. Frost (2014) treats *Atelopus hoogmoedi nassaui* as a junior synonym of *Atelopus hoogmoedi*. I believe that the taxonomic status of *A. barbotini* and *A. hoogmoedi* needs to be clarified and that it is premature to assign the population from the Nassau Mountains to any of these taxa. In the same vein, there is no evidence for the validity of *Ameerega trivittata nassaui*, a case already discussed by Hoogmoed (1971a, b). Hoogmoed found no morphological differences between the green and the orange striped morphs, and during fieldwork in 1974 and 1975 noted a rather narrow transitional zone between the green morph and the orange morph on top of the Lely Mountains, where specimens were more yellowish (M. Hoogmoed, pers. comm.). Dendrobatid frogs are well known to show great variation in color and pattern so using these characters alone for taxonomic purposes is problematic. The distribution map of *Ameerega trivittata* (Spix, 1824) (fig. 87, p. 93) does not indicate which localities refer to *A. t. trivittata* or to *A. t.* "*nassaui*." Figure 91 (p. 97) does provide the distribution of *A. t.* "*nassaui*," but

for readers not acquainted with the topography of Suriname it will be difficult to decide where this area is located in the country. Ouboter and Jairam do not mention any of the publications (Hoogmoed, 1971a, b) that have already discussed the orange morph of *A. trivittata* and showed that recognition of a subspecies was not warranted. Moreover, the authors only provide localities in the area of the Nassau Mountains, but the orange morph is also known from a lowland area at the western foot of the Nassau Mountains and from the central part of the Lely Mountains, which in their southern part have green *A. trivittata*. Schouten (2008) mentioned a locality on the Suriname bank of the Marowijne River (possibly Amapoema, cf. Hoogmoed 1971a, b), but its precise location was not specified.

Rhinella granulosa (Spix, 1824) is reported from Suriname (p. 56) although Narvaes and Rodrigues (2009) restricted this name to toads from northeastern Brazil. These authors mention *R. merianae* (Gallardo, 1965) and *R. humboldti* (Gallardo, 1965) from Suriname, but these two putative species are morphologically very similar—potentially synonyms—and their taxonomic status should be confirmed. I would advise the use of the name *R. merianae* for the Surinamese population in accordance with former use of the subspecies names of Gallardo (1965) until the taxonomic status of *R. humboldti* is confirmed, e.g., by molecular data.

Hyalinobatrachium crurifasciatum Myers and Donnelly, 1997 (p. 78) is a synonym of *H. capellei* (van Lidth de Jeude, 1904) (Castroviejo-Fisher et al. 2011).

Eleutherodactylus planirostris (Cope, 1862) is reported for the first time from Suriname (p. 108) and claimed to be part of the Surinamese batrachofauna. Except for the photograph, Ouboter and Jairam do not document any vouchers to support their assertion or to clarify if the species has become established in Suriname.

Hypsiboas dentei (Bokermann, 1967) is also reported from Suriname for the first time (p. 144). No vouchers are reported and the two photographs illustrating the account are obviously not from Suriname (see also Hoogmoed 2013). Instead, Ouboter and Jairam apparently base this new record solely on the map in Lescure and Marty (2001), arguing that the southwesternmost locality of that species lies in Suriname, which is incorrect (Anderson 2003). It would have been better to mention this taxon in the section dealing with the species that may be present in Suriname (as did Hoogmoed 2013).

Scinax jolyi Lescure and Marty, 2001 is "provisionally" reported (pp. 176–178) from localities in the northeast of Suriname. However, Marinus Hoogmoed (pers. comm.) examined the specimen illustrated in figs. 167–168 (in the RMNH collections), directly compared it with three paratypes of *S. jolyi* and identified it as a female *S. nebulosus* (Spix, 1824). Fig. 165 also shows *S. nebulosus* and I come to the conclusion that the report of *S. jolyi* for Suriname is based on incorrect identifications (confirmed by A. Fouquet, pers. comm.).

Leptodactylus bolivianus Boulenger, 1898 is reported from Suriname (p. 224) although the correct name of the taxon in Suriname now is *L. guianensis* Heyer and de Sá, 2011 (Heyer and de Sá 2011).

Leptodactylus ocellatus (Linnaeus, 1758) is reported from Suriname (p. 250) although the correct name of the taxon in Suriname is currently *L. macrosternum* Miranda-Ribeiro, 1926 (Frost 2014). However, figures 236 and 238 do not illustrate *L. macrosternum* but rather likely represent *L. longirostris* and *L. fuscus*, respectively.

Chiasmocleis hudsoni Parker, 1940 is reported from Suriname (p. 272) apparently only on the basis of the holotype (and thus from Guyana, see comments in Peloso et al. 2014) since no additional locality is provided on the map. The type locality actually is further east in the headwaters of Kutari Creek (Hoogmoed 1973), on the border of Guyana and Suriname. Hoogmoed (2013) provides a photograph of a specimen collected on the airstrip at Sipaliwini, and there is more material in RMNH from the Rechter Kabalebo river collected in 1975 (M. Hoogmoed, pers. comm.).

Pipa arrabali Izecksohn, 1976 is synonymized with *P. aspera* Müller, 1924 on the basis of insufficient material and subjective arguments that are not convincing (p. 290). Thus, this synonymization should be rejected and the species *P. arrabali* remains on the list of Suriname species. Both species are well defined by Trueb and Cannatella (1986).

Two species definitely known from Suriname are not dealt with in the species accounts section of the book: *Microcaecilia grandis* Wilkinson, Nussbaum & Hoogmoed, 2010 (Wilkinson et al. 2010), and *Pseudopaludicola boliviana* Parker, 1927 (Hoogmoed 1979, as *P. pusilla*).

Additional problems with wrongly identified photographs are:

On p. 61, the "*Rhinella lescurei* (Fouquet, Gaucher, Blanc and Velez-Rodriguez, 2007)" in fig. 57 is a *Rhinella martyi* (Fouquet, Gaucher, Blanc and Velez-Rodriguez, 2007); the same is true of fig. 59 on p. 63.

On p. 75, the "*Cochranella geijskesi* (Goin, 1966)" in fig. 70 is a *Vitreorana oyampiensis* (Lescure, 1975).

On p. 77, the "*Vitreorana oyampiensis* (Lescure, 1975)" in fig. 72 is a juvenile *Hypsiboas*.

On p. 89, the "*Ameerega hahneli* (Boulenger, 1884)" in fig. 84 is an *Allobates femoralis* (Boulenger, 1884).

On p. 149, the "*Hypsiboas fuentei* (Goin and Goin, 1968)" in fig. 139 is *Hypsiboas crepitans* (Wied-Neuwied, 1824). The authors, however, mention that the former may be a junior synonym of the latter, but still provide a full species account with occurrence records.

On p. 161, the "*Osteocephalus buckleyi* (Boulenger, 1882)" illustrated in fig. 150 is most likely *O. taurinus* Steindachner, 1862.

On p. 209, the "*Phyllomedusa hypochondrialis* (Daudin, 1800)" in fig. 194 is actually *P. tomopterna* (Cope, 1868).

On p. 221, the "*Leptodactylus andreae* (Müler, 1923)" in fig. 206 likely is *Adenomera heyeri* Boistel, de Massary and Angulo, 2006.

On p. 233, the "*Leptodactylus hylaedactylus* (Cope, 1868)" in fig. 216 is likely *Adenomera andreae* (Müller, 1923). In the text (p. 222) the authors state that they could not distinguish between *A. andreae* and *A. hylaedactyla* (but they still provide a description and pictures for both taxa) and that they think *A. andreae* is a junior synonym of *A. hylaedactyla*, although they do not take formal taxonomic action.

On p. 317, the "*Pristimantis zeuctotylus* (Lynch and Hoogmoed, 1977)" in fig. 294 is a juvenile *Scinax boesemani* (Goin, 1966).

Some taxonomic changes occurred when the book was probably in press (e.g., *Amazophrynella minuta* [Melin, 1941] [Fouquet et al. 2012b, c]), or soon after its publication (e.g., in the genera *Osteocephalus* [Jungfer et al. 2013] and *Adenomera* and *Lithodytes* [both removed from *Leptodactylus*, see Frost 2014]); *Scinax trilineatus* (Hoogmoed and Gorzula, 1979) was synonymized with *S. fuscomarginatus* (Lutz, 1925) (Brusquetti et al. 2014), and these are not further discussed here.

The next section (p. 334) deals with seven amphibians that may be present in Suriname, but are not yet recorded or are "known from one specimen collected in the far past only." *Caecilia albiventris* Daudin, 1803 is probably a synonym of *C. tentaculata* Linnaeus, 1758 (Maciel and Hoogmoed 2011). *Anomaloglossus degranvillei* is likely endemic to French Guiana (see Fouquet et al. 2012a). The list could have been extended with some more recently described species from neighboring countries.

The section "Zoogeography" divides the taxa known to occur in Suriname into six groups (contents not listed, but figured in fig. 307) and species with a restricted distribution in Suriname are divided into five groups (Table 9), of which the group "restricted to bauxite capped mountains" can immediately be discarded, as all species in that group are known from other (lowland) localities as well, both in Suriname and elsewhere. Species reaching their limits in Suriname are also dubious, e.g., *Physalaemus ephippifer* (Steindachner, 1864) is said to reach its eastern limit in Suriname, but the species was described from Pará and occurs in northern Pará and in the surroundings of Belém as well. The authors apparently were aware of this distribution, because they mention "mouth of the Amazon" as part of its distribution, and that area is well east of Suriname.

The section "Conservation of Amphibians in Suriname" cannot be trusted because of the methodology used (simply counting specimens collected and localities recorded), because of the fact that the authors did not evaluate all material available in the collections they consulted for distribution data (see above), and because the authors have obviously misidentified several specimens.

The bibliography is not up to date, with many references missing (both old and recent ones).

The Appendix is a simplified (not critical) explanation of the nomenclatural changes proposed by Faivovich et al. (2005) and Frost et al. (2006).

In conclusion, Ouboter and Jairam's book unfortunately has inaccuracies that may mislead the reader and, because of the issues mentioned above, the volume is of limited interest to both professional and non-professional herpetologists.

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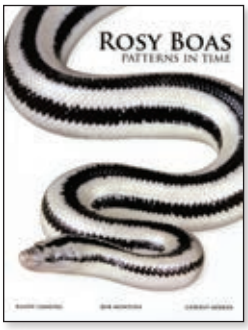
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Rosy Boas—Patterns in Time

Gerold Merker, Bob Montoya, and Randy Limburg. 2011. ECO Herpetological Publishing & Distribution, Rodeo, New Mexico (www.rosyboainfo.com). 184 pp. US $29.95. Softcover. ISBN 978-0-9832789-0-0; Hardcover US $69.95 (ISBN 978-0-9832789-1-7).



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The title of my college geology text, *Rocks: Patterns in Time*, came to mind as I studied the cover of the present work. Rocks and Rosy Boas are two entities that seem inextricably associated over much of the American Southwest. The title led me to imagine panoramic vistas of rocky landscapes, eroding over eons as animals crept over them. Among those creatures were the "slow-moving and peaceful" Rosy Boas of the genus *Lichanura*—a genus dating from at least the late Miocene. The title suggests a dissertation on the evolution of boa color patterns, a potentially fascinating topic, with some populations evolving along habitat gradients and others in isolation. However, the authors state that their work "discusses proven technologies for the successful maintenance and captive breeding of Rosy Boas." My thoughts now disturbingly afflicted with memories of pine shavings saturated in rodent urine, I prepared for literary doldrums.

Though the stated primary focus of the book is Rosy Boas in captivity, the chapter on Captive Care occupies only 12 pages. The guidance for the care and propagation of Rosy Boas seems generic for most live-bearing snakes native to temperate climates, though the average hobbyist may not be aware of the miserly cycling of drinking water every three weeks. Topics discussed include proper housing, temperature control, propagation, feeding, diseases and parasites, and handling, each of which is illustrated by one or more color photographs. I was not aware that there was a technique to waking your boa, or that Rosy Boas will indeed bite under certain circumstances. I do not know what portions of text were composed by which author, but each seems to have a preferred cage temperature: 27–29°C is given on page 10, 25–31°C on page 13, and 25–29°C on page 14. At the end of the book there is a 22-page collection of photographs of unusually or uniquely colored boa "morphs." This pictorial spread is occasionally interrupted with boxes of text that ask such questions as "What is a Snowy Rosy Boa?" The authors add some history to the derivation of the morph lineages, which I gather are cultivated in captivity from off-colored, wild-caught boas.

The refreshing heart of the book, 130 pages, consists of what the authors term a "photographic journey to show how this beautiful reptile has adapted to so many locations." The journey has many stops—40 in California, 16 in Arizona, and 22 in Mexico. Nearly every stop is illustrated by a habitat shot and two or three boas. If you have a favorite spot for finding boas, it is probably mentioned in this book. I am familiar with a number of the localities, and have a perspective on the subtle changes in the habitat and boas one might encounter on a drive from Morongo Valley to Pioneertown, and across to Twentynine Palms. But, I fear that readers unfamiliar with the arid Southwest will not recognize the significance of many of the habitat and pattern morph associations, a situation which could have been improved by a locality map. The arrangement of locales used by the authors, however, does illustrate the gradual, often subtle shift in color pattern over often small geographic increments, illustrating the many ways that a simple theme of a pale snake with three stripes can vary from one place to another.

The book is not a taxonomic treatment and Rosy Boa subspecies are not mentioned (in fact, the words *Lichanura trivirgata* are absent). A map on page 23 shows the ranges of four classic subspecies, which are referred to as "forms," but are not further discussed. An unstated, and perhaps unintentional, theme of the book is the impossibility of assigning many populations of Rosy Boas to one of the traditional subspecies. The long photographic essay is itself a visual argument against the subspecies concept.

The book is nicely produced, 21 x 28 cm, on glossy paper stitched between stiff paper covers. It seems durable, and conveniently remains open when laid flat on its spine. Aside from dozens of scenic habitat photographs, there are 362 photographs of boas, 50 of boa heads and body sections, and 38 of other amphibian and reptile species that might be encountered while searching for Rosy Boas. Most of the boa shots appear to have been taken with use of a soft flash, which perfectly highlights the color and pattern of each snake. For me, the most interesting photographs are those of the "Colonet" Boa, the type "morph" of *Lichanura roseofusca*. Though described nearly 150 years ago, that odd coastal morph from which the name Rosy Boa derives has, to my knowledge, only now been adequately illustrated.

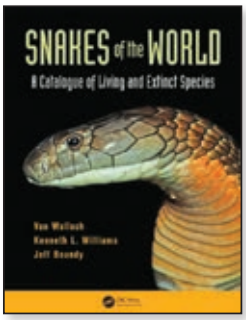
The back cover contains a promotional blurb about the book, emphasizing that it details the maintenance and propagation of boas resulting from over 100 years of combined experience by the authors. The condensed account of their indoor achievements is thorough and nicely illustrated. For some hobbyists, the boa ensconced in its cage of aromatic pine shavings is sufficiently satisfying. Fortunately for the field-oriented, the authors have also assimilated many years afield into a pictorial display of boas in their natural environment. Their visual achievement not only provides a spatial concept of Rosy Boa pattern variation, but

for many, like me, it recalls finger pads rubbed raw from turning granite rocks, and cholla spines embedded in awful places. The journey on which readers are taken is well worth the investment.

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Snakes of the World: A Catalogue of Living and Extinct Species

Van Wallach, Kenneth L. Williams, and Jeff Boundy. 2014. CRC Press/ Taylor and Francis, Boca Raton, Florida (http://www.taylorandfrancis.com). xxvii + 1209 pp. Hardbound. US $142.00. ISBN: 978-1-4822-0847-4; eBook (VitalSource format) $104.97. ISBN 9781482208481.



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Just 15 years ago most textbooks in biology, zoology, or even herpetology claimed that there are ~6000 reptile species (e.g., Becher 1998; Margulis and Schwartz 1998). Some may still use this number today. We do not know where this number came from originally, but we suppose someone must have guessed it in the 1960s when it was about right. In fact, it was only in the 80s and 90s that some of the first "complete" species lists were published, such as Frank and Ramus (1995) who listed ~6700 species of reptiles. This was clearly a step forward but most of these books suffered from a number of shortcomings. Most importantly, they did not provide any references to the scientific literature where the names or the taxonomy came from. Hence one of us [PU] started to compile his own list, partly based on Frank and Ramus (1995), which subsequently became the EMBL Reptile Database (Uetz and Etzold 1996).

Since then numerous checklists, atlases, and catalogs have been published, usually either based on geographic areas (such as *Reptiles and Amphibians of Australia* by Cogger 2014), or on taxonomic group (such as the TTWG turtle checklists, TTWG 2014). These works all represent important updates to the local or global faunas.

However, no book has ever tried to compile a comprehensive *and* annotated checklist of all snakes until Wallach et al. did so in their monumental new *Snakes of the World*. It is a species checklist listing all extant and extinct snake species, including their basic synonymy, type information (primary type and type locality), distribution (by country and subdivisions such as states), and references (sample pages are available on Google Books and other sites). The book lists 3509 extant and 274 extinct species on 794 pages. On top of that it includes a bibliography of 306 pages (with an estimated 11,000 references!), resulting in a total of 1209 pages. The authors also included 26 pages on *species inquirenda*, that is, species of unclear status, and also organized references to the literature geographically on 13 pages. Overall, the book provides a wealth of information essential to any snake taxonomist or layman who is seriously interested in snake taxonomy.

Should you buy this book if you are a "mere" snake enthusiast? It depends. If you like to have six pounds of paper sitting on your bookshelf or your desk you should. Wallach et al. provide a permanent record of snake taxonomy as of December 2012. Unfortunately, this is also the time when the problems began, including for the very first species listed in the book: *Acalyptophis peronii* Duméril 1853. Within days of the deadline that Wallach et al. had set for themselves Sanders et al. (2012) published a phylogenetic analysis of the sea snakes in which they suggested the synonymization of *Acalyptophis* with *Hydrophis*, thus renaming the species *Hydrophis peronii* and rendering the Wallach book obsolete, even before typesetting had begun. You will not find the name *Hydrophis peronii* in the book, nor the index, which does list all synonyms. Luckily, the index distinguishes current names from synonyms by bold and regular typeface, respectively. Unfortunately, in many cases this was not properly copyedited, so that many valid species are listed in regular typeface. Similarly, while extinct species are listed in alphabetical order together with extant species, they are distinguished in the text with a dagger (†) but not in the index. In other words, if you would like to look up more than a few species, e.g., a list of all extinct species, you will have to do a lot of manual searching.

In fact, searching is what makes the book truly difficult to use. If you want to look up a single species or genus you are fine. But as soon as you try to do a more complex search, such as for the rattlesnakes of Mexico, it will become pretty difficult if not impossible. Luckily, there is an eBook version, but it is in a proprietary format of CRC Press, called VitalSource. We have not used the eBook but assume that searching and highlighting is possible as in most eBooks. However, we do not know if this gives you any added benefit, such as linked references from within the text. In the printed book even looking up a few references quickly becomes a drag. Many species entries have several dozen references in the format "Bocage, 1895" which you have to look up one by one in the bibliography, requiring a lot of thumbing back and forth.

Even if the book is up to date until 2012 or early 2013, many of the taxonomic decisions are difficult to track down. For instance, Wallach et al. recognize the genus *Taphrometopon*. They cite Zaher et al. (2012) as source but that paper does not even mention the genus (although Zaher et al. do show three species of *Psammophis* in a tree that correspond to what Wallach apparently considers as the *Taphrometopon* clade).

Similarly, Wallach et al. cite Zaher et al. (2012) as source for the synonymy of many other genera, such as *Rhadinophis* and *Rhynchophis*. Again, Zaher et al. did not formally synonymize the two genera although they do show that *Rhynchophis boulengeri* nests within *Rhadinophis*. Another example is *Rhynchophis prasinus* (now again *Gonyosoma prasinus*). Wallach again cites Zaher et al. (2012), but they show *prasina* in their tree as *Rhadinophis*. In fact, Zaher's analysis is overused; according to Wallach et al. *Stenophis* is a "synonym of *Lycodryas fide* Zaher et al., 2012." However, it was Nagy et al. (2010) who synonymized *Stenophis* with *Lycodryas*.

We could quote many other examples in which the origin of taxonomic decisions is not obvious. We will mention just one: *Xenochrophis vittatus* is placed in the genus *Ceratophallus* (p. 152). Wallach et al. cite Dubey et al. (2012), Guo et al. (2012) (misspelled as Gou), and Zaher et al. (2012) as sources but none of them even mentioned that name (although all of them showed *X. vittatus* in their trees). Hence it is usually unclear who used a combination for the first time. In other words, Wallach et al. often draw conclusions from papers which were not drawn by the authors of those papers.

It is hard to do an overall evaluation of the completeness of the species list without a machine-readable version. One

immediately obvious omission is the absence of subspecies. Wallach et al. simply elevated all subspecies to full species or put them into the synonymy of valid species. We would argue that this unnecessarily conceals the diversity of snakes. For instance, the Reptile Database currently (December 2014) contains 433 snake species that have a total of 917 subspecies (which is the main reason why the number of species in the database—3522—only slightly larger than those in the book, at 3509).

We wondered how many discrepancies exist between Wallach et al. and the Reptile Database. Besides the differences between species and subspecies counts, we compared the 518 snake genera in the database to the 539 listed in the book. Quite surprisingly, more than 130 genera showed differences in species numbers! Only at second glance was this less dramatic than the numbers suggest. As noted, the differences can mostly be explained by subspecies elevated to species level, and more importantly, by relatively few large-scale taxonomic rearrangements. For example, at least 30 genera have been either erected since 2012 or received new species. The genus *Acalyptophis,* as mentioned earlier, was synonymized together with another eight other genera with *Hydrophis* in one fell swoop (Sanders et al. 2012), and all of these genera are kept in the book. Carrasco et al. (2012) synonymized several genera (including *Rhinocerophis, Bothropoides,* and *Bothriopsis* and others) back into *Bothrops.* Similarly, Hedges et al. (2014) split up blind snakes and erected another eight new genera (obviously too late for the book), a nomenclatural act that was partly reversed by Wallach himself recently (Pyron and Wallach 2014). As a last example, *Vipera, Trimeresurus,* and *Naja* were split up by various authors (including Wallach et al.) into many genera whereas the Reptile Database still uses subgenera for these. The bottom line is that pretty much all the species (described up to 2012) are both in the book and the Reptile Database although there may be different generic assignments or different levels (species vs. subspecies). The discrepancies may be confusing to many users, given that many field guides rightfully use subspecies to distinguish morphologically different forms (even though in many cases morphology does not match their phylogeny, but that's another story). We found only a few species missing from the book, such as *Toxicocalamus mintoni* Kraus, 2009 and *Toxicocalamus pachysomus* Kraus, 2009.

To get a better comparison of species names, we compared the "A" section from the index to the Reptile Database. Surprisingly, we could not find about 20% of the species combinations in the database. Again, at second look, this often turned out to be a matter of spelling variants or combinations thereof. For instance, the index lists five spelling variants of *Walterinnesia aegyptia,* of which only one is the Reptile Database (which has yet another one that is not in Wallach's book). However, since the index also includes fossil species without being labeled as such we may have missed many of them when searching. Annoyingly, a number of names are misspelled in the index but not in the actual text, e.g., *Coniophouis* [= *Coniophanes*] *fissidens andresensis, Elphe* [= *Elaphe*] *anomala, Pseudoxenodar augusticeps* [= *Pseudoxenodon angusticeps*], etc.—and these are just some examples from the "A" section of the index, listed under their species epithets. The first example is especially annoying as *andresensis* is listed with *andresiana* and *andreoides* between *almawebi* and *Alopecion*—clearly out of alphabetical order.

Despite its numerous issues, the book is the only comprehensive resource on extinct snakes that we know of and the best available catalog of both extinct and extant snake names in print.

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ZOO VIEW

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Orangutans and Gorillas Just Do Not Like Snakes

"We must concede that the Apes are malicious, cunning, choleric, vindictive, sensual, quarrelsome, irritable and peevish; on the other hand, we must take into account their cleverness, their good humor, their gentleness, their trust in, and kindness to Man, their amusing social qualities, their cheering earnestness, their courage and their readiness to stand by each other in case of need, even against superior enemies, and their inclination to play and tease. In one respect they even rise to greatness, and that is in their love for their offspring, their pity for the weak and defenseless, not only of their own family and kind, but even of other animals."

—Alfred E. Brehm, *The Animals of the World: Brehm's Life of Animals*, 1895

"It is certainly striking that, of all the mammals, only the apes and monkeys, our nearest relatives, show a dread of snakes. Possibly the common prejudice against these exquisite creatures is a dying inheritance from our far-off ancestors."

—Peter Chalmers Mitchell, *Centenary History of the Zoological Society of London*, 1929

". . . I took a stuffed and coiled-up snake into the monkey-house at the Zoological Gardens, and the excitement thus caused was one of the most curious spectacles which I ever beheld. Three species of Cercopithecus were the most alarmed; they dashed about their cages, and uttered sharp signal cries of danger, which were understood by the other monkeys. . . I then placed a live snake in a paper bag, with the mouth loosely closed, in one of the larger compartments. One of the monkeys immediately approached, cautiously opened the bag a little, peeped in, and instantly dashed away. Thus I witnessed what [Alfred E.] Brehm had described, for monkey after monkey, with head raised high and turned on one side, could not resist taking a momentary peep into the upright bag, at the dreadful object lying quietly at the bottom."

—Charles Darwin, *The Descent of Man and Selection in Relation to Sex*, 1871

The history of research on primate ophiophobia goes back almost two hundred years (see Burghardt et al. 2009, Table 1, for examples). Alfred Edmund Brehm, who created the word "Vivarium," was Director of the Hamburg Zoo from 1863 onward and founder of the Aquarium Unter den Linden (Berlin's main street) in 1869. Brehm (1895) mentioned that Captain Smitt had an Orangutan that lived on a ship for three months: "He was never heard to make but two different sounds; a feeble piping one, designed to express agitation, and a dreadful roar, resembling the lowing of a Cow, and denoting fear. Once he uttered the latter at sight of a Whale swimming near the vessel, and again when he caught sight of several Water Snakes that his owner brought from Java. The expression of his face never changed." (Fig. 1).

At the London Zoo and other institutions, P. Chalmers Mitchell and R. I. Pocock (1907) studied the fear of snakes by recording responses to snakes by many mammals and birds—they drew two major conclusions. The first was ". . . there is no such thing as a power of fascination possessed by snakes. Smaller birds and mammals are as inquisitive to a slowly advancing snake as to a slowly moving human hand directed toward them. Sudden or noisy movements elicit a flight response." The second point was that ". . . except in one group, animals have no specific fear of serpents. The vast majority of animals of course frogs, rats and mice, guinea-pigs, rabbits, ruminants, and birds, are totally indifferent to their presence, and even when a snake approaches them directly avoid it, just as they would a stick thrust at them." The excepted group was non-human primates. Corn Snakes, a Tree Boa, and small Reticulated Python were presented to monkeys at the Zoo. Most of the Old and New World monkeys showed varying degrees of threat or escape behaviors, although a few seemed unaffected by the presence of a snake. Baboons, including the Mandrill, ". . . were even more panic-stricken, jumping back in the greatest excitement, climbing as far out of reach as possible and barking." Gibbons were less fearful, which was attributed to their arboreal habits. Lemurs were curious when presented with snakes and advanced toward the reptiles, perhaps to feed upon them. There are reports (Goodman et al. 1993; Karpanty and Wright 2007; Headland and Greene 2011) of snakes such as Madagascan Tree Boas (*Sanzinia madagascariensis*) preying on lemurs so it is somewhat surprising that these primates did not flee.

Chimpanzees were frightened by snakes, except for one baby. These apes fled screaming to the highest reaches of their cages. Interestingly, large nematodes passed during defecation, when viewed by other chimps, elicited similar fear responses. Even earthworms caused a similar reaction, perhaps because of their cylindrical shape. However, not all chimpanzees are afraid of snakes. In the late 1950s, herpetologist Moody Lentz at St. Louis Zoo kept a pet Black Ratsnake at the reptile house. When the staff needed to shift the chimps to a new enclosure (and they refused to do so) someone suggested using a rubber snake to scare them. The rubber snake was presented and ignored. Moody then sent for his snake, and it was presented to the chimps, which started vocalizing and bouncing off the walls. Suddenly one of them ran over, grabbed the snake and beat it to a bloody pulp by bashing it repeatedly against the concrete floor (Lee Jackson, pers. comm.).

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Table 1. Behavioral accounts of primate ophiophobia in the Nineteenth Century.

Source and Relevent Excerpts
WARWICK, J. E. 1832. The habits and manners of the female Borneo Orang-Utan (Simia Satyrus), and the male Chimpanzee (Simia Troglodytes), as observed during their exhibition at the Egyptian Hall, in 1831. The Magazine of Natural History (and Journal of Zoology, Botany, Mineralogy, Geology, and Meteorology) [London]. Vol. 5, May, 1832:305–309.
text from p. 308— second paragraph: "... The timidity of both animals was remarkable, they being exceedingly alarmed even at inanimate objects; a toy-dog, or a cast of one of their own species, that was in the room, if removed the least towards them, was sufficient to drive them to the farthest extremity of the apartment, in their most nimble, though not very quick, pace; and the fear exhibited by the female, at the sight of her deadly enemy, a boa constrictor, was most acutely evinced. It would appear as if they had not the power of distinguishing between the real and artificial, as a toy-snake shown to her produced the same results."
BETTANY, G. T. (Author of Zoology sections). 1884. Zoology. X. Man-like monkeys (continued)- The Gibbons. *In* The Universal Instructor or Self-Culture for all. Volume II, pp. 316–318. Ward, Lock, and Co., London.
text from p. 318, right column, last paragraph: "Monkeys have a remarkable fear of snakes, combined with an irresistible attraction. Even a dead snake exerts this influence, as was found by Mr. A.E. Brown in Philadelphia. A dead snake wrapped up in paper and put into a monkey house containing forty or fifty of various kinds, was carried off for fun by one of the larger specimens. But when the package became loose and the snake was seen, it was dropped at once; all the monkeys in house were attracted, and, displaying intolerable fear, formed a circle round the dreadful object. They remained in this position until a string attached to the snake was pulled, when they all fled precipitately with cries and screams; after a time they approached again, and took up similar positions, which they kept for hours. They showed no fear of a tortoise or a small dead alligator, but played with them quite freely. The dead snake, when shown to the mammals of other groups, was not noticed by them."
HUDSON, W. H. 1893. The bruised serpent. Macmillan's Magazine 67:451–457.
text from p. 451: "Darwin, on the slightest evidence, affirms that monkeys display an instinctive or inherited fear of snakes. There are many who would think any further inquiry into the matter superfluous; for, they would argue, if monkeys fear snakes in that way, then assuredly we, developed monkeys, must regard them with a feeling identical in character and origin... Fear of snakes is merely another example of historical memory, recalling a time when man, like his earliest ancestors the anthropoid apes, was sylvan and solitary; a mighty climber of trees, whose fingers were frequently bitten by birds' nesting colubers, and who was occasionally swallowed entire by colossal serpents of arboreal habits." *This article also mentions the "snake in a bag" experiment highlighted in the Universal Instructor or Self-Culture for All reference above.
BILBY, T. 1887. Simius- The Ape. In Young Folk's Natural History, with Numerous Illustrative Anecdotes, pp. 177–200. John W. Lovell Company, New York.
text from p. 182, "Illustrative Anecdotes": "We have already stated that both the Orang-outang and Chimpanze have, under the education of man, shown themselves grave, docile, and attached to those who were kind to them; but it may here be proper to remark, that in a domestic state at least, they entertain an unconquerable fear of serpents; and we are inclined to believe that this fear is innate, and no less absolute in their native forests, than when they are in captivity, notwithstanding that Labat says, "I have seen these monkeys playing their gambols upon those very branches on which the snakes were reposing, and jumping over them without receiving any injury, although the serpents of the country were naturally vindictive and always ready to bite whatever disturbed them". We should think the monkeys that thus amused themselves felt a consciousness of their own safety; since we have seen exhibitions of both these kinds of animals in the East Indies in the open air, where apes and serpents appeared to be reduced to a state of obedience, if we might judge from their movements (since we did not understand the language of their masters); but, although we have seen both kinds exercised thus, we never saw them exhibited together. One day a young Chimpanze was shown a large snake, for the purpose of ascertaining whether the fear said to be inherent in the genus to which he belongs, was really so or not, the creature never having before seen such a reptile. The instant he saw it, he shrunk up into a corner in the utmost alarm, which could not be mistaken; nor could anything induce him to go near the basket in which the snake lay, although fruit was placed on the lid, when it was shut down, to tempt him. Much, however, as he wished to obtain the fruit, he still kept aloof until the snake was altogether removed; when the apple being placed on a chair, he after a cautious examination, to satisfy himself that his enemy was gone, took the tempting bait to eat in safety. We believe this Chimpanze was under two years old when it died, and it was then, as we are assured cutting its teeth... "
HARTMANN, R. 1886. Anthropoid apes. The Literary World- Vol. 33, No. 844 (January 1, 1886):8–9.
text from page 8 (under "Apes in captivity"): "... She chased the mice which ran about her cage with deadly fury. She was much afraid of snakes, which is not usually the case with chimpanzees."
HARTMANN, R. 1886. Anthropoid Apes. D. Appleton and Company, New York. 326 pp.
text from p. 269, last paragraph: "There is, however, an account given by Broderip of a male chimpanzee, which was brought from the Gambia, and placed in the London Zoological Gardens in 1835... He displayed great terror when an anaconda was brought into the room in a basket, and did not dare to take an apple from off the closed lid of the basket; but as soon as the snake and its basket were removed, he ate the apple and became cheerful again..." [Broderip, W. J. 1835. Observations on the habits of a male chimpanzee. Proc. Zool. Soc. London. 1835:160–168.]

Although Orangutans were not vocal in the presence of snakes, they moved as far away from them as possible at London Zoo—"The Society has at present two examples—a young female which came two years ago as a very small baby, and a large, probably adult male. Both of these are extremely slow and deliberate in their movements, but as soon as they got sight of a snake and long before it was near them, they fled silently but with the utmost rapidity, climbing as far as possible with a ludicrous celerity." Mitchell (1929) saw that a young orang, removed from its mother (perhaps hand-reared?), behaved differently when presented with a large tame snake: "The orang was not in the least alarmed, but took the snake as a new and attractive toy, playing with it, allowing it to coil over him, and treating it with such friendly roughness that I had to remove it." Mitchell (1922) described Orangutan responses: "The instant recognition and betrayal of fear by special sounds and retreat, even in the case of a lethargic old Orang-utan, was so plain that I was disposed to treat them as instinctive, and even went the length of suggesting that the human dread of snakes might be an instinct from our ape-like ancestors." In 1917, a graphic exhibit developed by Mitchell again demonstrated that only some higher primates and a few birds showed fear of snakes.

In August 1872, Darwin finished the proofs for his book *The Expressions of the Emotions in Man and Animals*. In Chapter V, he compared the different responses by monkeys to a turtle and snake: "A living fresh-water turtle was placed at my request in the same compartment in the Zoological Gardens with many monkeys; and they showed unbounded astonishment, as well as some fear. This was displayed by their remaining motionless, staring intently with widely opened eyes, their eyebrows being often moved up and down. They occasionally raised themselves on their hind-legs to get a better view. They often retreated a few feet, and then turning their heads over one shoulder, again stared intently. It was curious to observe how much less afraid they were of the turtle than of a living snake which I had formerly placed in their compartment." When JBM was at the Dallas Zoo, general curator Jack Joy hid a newly hatched Ornate Box Turtle (*Terrapene ornata*) in his hand and presented it to an adult male Western Lowland Gorilla named Jimmy. When Jack opened his fist, Jimmy shrieked, jumped backwards, ran to the far end of the enclosure into an open doorway and peeked out at the turtle. Many years ago, Curator Ed Almandarz from Lincoln Park Zoo in Chicago told JBM that the famous male gorilla Bushman (known as Lord of Lincoln Park and the best known and most popular civic figure in Chicago) got out of his cage in October 1950, roamed through the ape house for three hours, and was tearing the primate building kitchen apart at the end. They tried everything to get it to return to its cage until Ed suggested sliding a live garter snake under the door. Bushman ran back to the cage and closed the door behind.



Fig. 1. Charles Darwin observed Orangutans over many years in the Regent's Park Zoological Gardens in London. He used Alfred Edmund Brehm's engravings from an earlier edition of Brehm's multi-volume work in *Descent of Man*. Illustration of Orangutan from *Brehms Thierleben. Allgemeine Kunde des Thierreichs* (1882–1884).

It is not unreasonable for Orangutans to be leery of snakes. In 1986, William Xanten (2014) from the Smithsonian National Zoological Park (NZP) went to the Sepilok Orangutan Rehabilitation facility in Sabah-Eastern Borneo, which for years maintained both orphaned and injured Orangutans (*Pongo pygameus*) for rehabilitation and eventual release. Two young orangs that appeared to be about two years of age had been kept in an outdoor, barred enclosure. Early one morning, a large Reticulated Python (*Python reticulatus*) approximately 12–15 ft (365–455 cm) in total length was discovered inside the cage with two distinct lumps about halfway down the body. Because the bars were close together, the snake was unable to escape after dinner.

Observations at the National Zoo

In the late morning of 18 June 2014, during a typical shifting routine in the Great Ape House, one of the NZP's Orangutans started acting strangely and refused to shift outside. A 41-year old hybrid Orangutan female named Lucy had climbed the tree in her indoor exhibit to use the upper chute to shift outside but she stopped at the shift door and refused to enter. She began to display piloerection and a unique vocalization that is used by her only in situations when she is extremely agitated. The keeper was unable to identify what was causing Lucy to display, being unable to see into the upper chute. Still displaying, Lucy climbed out of the tree to retrieve a plastic milk crate (an enrichment toy) from the floor of her enclosure and brought it back up into the tree; she used the crate to bang on the metal mesh of the upper chute. The Orangutans are not allowed to bring milk crates into the outdoor yard as they pose an escape hazard due to the glass barrier. These primates also have access to elevated cables to travel from one exhibit to another, called "O-Line," so it would not do to have them drop crates on visitors. The chute shift door is therefore kept partially closed so that the crate would not fit through the opening. It was only after several minutes of displaying—vocalizing and banging on the mesh with the milk crate—that Lucy calmed down enough to shift outside through the chute. Typically the Orangutans walk through the chute, but this day, Lucy held onto the mesh at the top of the chute, never allowing her feet to touch the floor. After Lucy was secured

outside keepers found a juvenile Black Ratsnake (approximately 18 inches [46 cm] in length) on the floor of the chute. Keepers were able to remove the snake and release it unharmed in the Park.

Two days later, another recent hatchling snake was discovered in the keeper section of the Great Ape House. ER presented the snake in front of the mesh screening to three Orangutans. Bonnie (37 years in age) stared intently at this ophidian and she was piloerect. Male Kyle (17 years) ran to the back of the enclosure and climbed to the top, as far as possible from the snake. Lucy stayed close but blew puffs of air toward the snake.

A similar incident had occurred several years earlier at the Think Tank exhibit at NZP. On 13 May 2012, female Orangutans Iris (then 25 years old) and Batang (then 15 years old) were displaying and reacting to something that was high up in their enclosure. A 12-inch (30 cm) juvenile Black Ratsnake could be seen sitting on the upper track of a hydraulic door, approximately 12 feet (3.6 m) above the floor. Both Orangutans were producing a belch vocalization that signified fear or displeasure. Each ape was gathering items from their enclosure such as browse, blankets, and toys, and throwing them at the snake. It was not until the Orangutans were shifted outside that they calmed down and keepers were able to remove the snake and release it into the Park.

Two years earlier, an adult ratsnake approximately five feet (1.2 m) long took up residence near the upper shift chute in the indoor gorilla enclosure but the keepers were unaware of its existence for two weeks. Female Kigali (18 years), male Kojo (11 years), and male Baraka (21 years) stood at the edge of the doorway and peered into the shift but were hesitant to move through for many minutes. Finally, they would sprint full-speed through the chute into the outside yard. They insisted on using another chute to return indoors at the end of the day. During this two-week interval, keepers discovered feces throughout the indoor cage but could not identify them until they found the snake in a mound of hay.



Fig. 2. John Edwards Holbrook published the multi-volume *North American Herpetology* beginning in 1836, covering all herps found east of the Mississippi River at that time. Shown is Black Ratsnake (*Elaphe obsoleta*).

Field Observations by NZP Primate Curator Meredith Bastian

My observations of wild Orangutans reacting to snakes: I have seen wild Bornean Orangutans (*Pongo pygmaeus wurmbii*) notice cobras, pitvipers, and on one occasion a Reticulated Python. I have seen several young Orangutans—still dependent on their mothers, so not yet weaned—attempting to play with sleeping pitvipers. On one occasion a somewhat older but still dependent female Orangutan came down fairly low at the site of a cobra, but her mother grabbed her back up the tree. The reaction of adult Orangutans is different—I have seen adult Orangutans notice snakes and immediately upon noticing the snake, the Orangutans moved further up the tree they were in, kiss-squeak at the snake, and move quickly onto the next tree. On one occasion I observed an Orangutan's reaction to a python that was crossing just over a trail that I was on. The particular Orangutan I was following was extremely well habituated to my presence and was low in the trees eating. As soon as she spotted the python, the Orangutan began kiss-squeaking, throwing branch "missiles," collected her infant, and moved quickly onto the next tree. I remember later that same day the female continuing to exhibit behavior that we normally see only in non-habituated animals,



PHOTO BY DENNIS DESMOND

Fig. 3. Entrance to Reptile Discovery Center at Smithsonian National Zoological Park. Eastern Ratsnakes (*Pantherophis alleghaniensis*) climb the brick façade and have been seen nearly 15 feet (5 m) above ground.

including persistent kiss-squeaking, throwing of branch missiles, and "snag crashing" (she knocked over a dead tree).

I have observed variable reactions of wild White-handed Gibbons (*Hylobates lar*) in Thailand and Agile Gibbons (*Hylobates agilis*) in Indonesia to snakes. While I have seen a juvenile White-handed Gibbon come down to a low branch and slap a sleeping pitviper, I have heard gibbons of both species give alarm calls at the presence of Reticulated Pythons and I remember once seeing a group of White-handed Gibbons alarm call at the presence of a cobra. Based on these observations I am not sure how accurate it is to assume that either gibbons or Orangutans are any less fearful of snakes than other taxa because they are arboreal.

Zoo with a Bunch of Snakes

Black Ratsnakes [also called Eastern Ratsnakes] (*Pantherophis alleghaniensis* = *Elaphe obsoleta*) are common throughout the Zoo (163 acres [66 ha]), which abuts Rock Creek and is an important urban park. This taxon seems to be increasing in numbers over the past ten years, based on the recollections of long-term employees. This may be, in part, a reflection of transient snakes that immigrate into the population through Rock Creek and stay because the prey base is increasing, due to an increase in animal exhibits with additional available food. In the Spring when snakes are most visible, there may be up to three visitor reports of sightings per day and this number is much larger than earlier years even though visitation is relatively constant, averaging over two million people annually. This snake is an excellent climber and sometimes scales considerable heights in animal enclosures to find prey, including collection animals on occasion (Sara Hallager, pers. comm.). In the large flight cage, an adult Mountain Bamboo Partridge (*Bambusicola fytchii*) was discovered inside a ratsnake and the bird weighed 350 g. Snakes have been found in tree tops over 40 feet (12 m) in this exhibit. Eggs sometimes disappear from nests and ratsnakes are the suspected culprits but have not been seen swallowing these packets of protein. A local chicken farmer brought in a living ratsnake to the Zoo with a large swelling at mid-body. He used two golf balls as dummy eggs to increase production and the snake had swallowed one of the spheres. The indentations on the ball could be seen on the radiograph and the ball was surgically removed. A year later, the second ball was found by the farmer in another snake, which understandably was severely emaciated and expired shortly thereafter. A ratsnake swallowed a newly-hatched American Flamingo (*Phoenicopterus ruber*) standing 8 in. (20 cm) and weighing ca. 120 g. Kori Bustards (*Ardeoyis kori*) are afraid of snakes and run from them. Native birds and small mammals are attracted to foods offered to animals in the collection and snakes may intercept them. JBM watched an adult American Robin (*Turdus migratorius*) spar with a ratsnake ca. 24 inches (61 cm) long for well over an hour—a series of attacks and counter-attacks. The snake was striking continually at the bird to grab it in order to throw coils around it; the bird countered with wings outstretched and rapid thrusts with beak attacks, directed mainly at the snake's head after the strike. Neither combatant retreated—the conflict ended in a draw when the bird took flight. An adult ratsnake was climbing up a tree toward a Northern Flicker (*Colaptes auratus*) nest approximately 15 feet (5 m) above ground. As the snake ascended, one of the parents tried to dislodge it by vigorously pecking its body but was unsuccessful. The snake crawled into the nesting cavity and consumed three fledglings. In 2010, a hatchling ratsnake, emaciated and dehydrated, was trying to swallow a dead adult vole killed on the zoo road by a vehicle, but to no avail as it was far too large. A keeper separated the two animals, caught the snake, and put it into a jar. A newborn laboratory mouse was offered and quickly swallowed. An hour later, the mouse was back in the jar. The rodent was again presented and swallowed by the snake. Another hour passed and the mouse was back again. The third time, the keeper watched and the mouse was swallowed but emerged from a major gash on the snake's venter behind the head. Upon closer examination, a scab was found across the dorsum, clearly made with an attacking bird's beak. This snake was euthanized.

In the Fall, ratsnakes may be found in buildings, no doubt searching for hibernation sites. Six juveniles have been found throughout the reptile building. One climbed up the slippery bronze rod door closing mechanism to a height of 5 ft (1.5 m); it entered the building through a small gap under the door. Another young adult crawled through four mouse snap traps in the basement feed room—it did not survive. Adults and juveniles have been found in the Commissary, Amazonia exhibit, Bird House, Elephant House, Invertebrates, and Small Mammal House.

How do ratsnakes climb buildings? JBM once found a young adult snake approximately four feet long (1.2 m) on the flat roof of the two-story reptile building (description by Murphy and Xanten 2007), a distance of approximately 20 ft (6 m) from the ground. There were low trees nearby with overhanging branches—there are two possible explanations: either a raptor may have carried the snake to the roof (there were no visible injuries) or the snake may have climbed these trees at first and continued crawling upward on the brick façade to the roof. Although Robin Saunders (pers. comm.) saw a Red-Tailed Hawk (*Buteo jamaicensis*) snatch a large adult ratsnake in the nearby Zoo parking lot, the latter explanation seems more likely. These birds are often seen hunting in the Zoo and surrounding neighborhoods and may be an important predator upon ratsnakes (see Fitch 1963). Ratsnakes have climbed the reptile building (built in 1931 with large spaces [5/8-inch high or more (15 mm), 1/3-inch deep (8.0 mm)] between bricks filled with mortar) in a stepwise fashion by following these spaces between the bricks and wedging their bodies in these places to secure stability. A snake begins by crawling vertically on the side of a brick until the top is reached, then turning horizontally along the top of the brick until reaching the next vertical space. A young juvenile and three-foot adult (1 m) were found attached to the reptile building nearly 15 feet (5 m) above ground in a zig-zag configuration; there were no trees nearby (Fig. 3).

Carl Gans (1974) discussed lateral force application in North American *Elaphe*. "Progression proceeds by a combination of undulation and concertina, and it is curious to see these animals apply themselves to a [tree] trunk and climb it with their body thrown into thirty or more short-radius bends. Such species derive an obvious advantage by being able to apply these forces as close to the surface as possible; many of the discontinuities against which they stem do not project far. These snakes (no other tetrapod shows this adaptation) have changed their cross section so that the widest point lies at the ventral surface. The wide ventral scutes show a sharp vertical bend on each side, and these lateral keels serve for force application."

How do ratsnakes return to the ground? Harvey Lillywhite (2014) shows a picture of a Yellow Ratsnake (*Pantherophis obsoletus*) clinging to a pine tree and pointing downward— "It is not clear whether snakes are able to proficiently move downward on such a tree trunk, or whether they simply fall (purposely) to the ground."

Summary

These ophidians are occasionally found in indoor primate enclosures. These accounts are not the first times that the zoo's Orangutans have reacted to snakes in their enclosures. Though it is unclear whether the Orangutans intend to kill the snakes or simply move them, the Orangutan's retrieval and use of objects (e.g., pieces of browse, enrichment items) to aid them in each of these interactions with snakes is impressive.

As an aside, studying a population of wild snakes in a zoo setting can be informative, especially since visitors can assist as snake spotters to build a larger database. David Roberts and the herpetological staff began a 13-year mark and recapture study of Texas Ratsnakes (*Pantherophis obsoletus lindheimeri*) at Dallas Zoo (Roberts and Mitchell 1998). Ruston Hartdegen (2004) examined the population dynamics and activity patterns of these snakes throughout the year. A total of 206 snakes were collected during the study period over the course of 395 total capture events. He reported on overall population size distribution, examined the growth rate of recaptured snakes, and evaluated the effects of parameter manipulation on resulting growth data. Such variations in data collection parameters can significantly alter the interpretation of growth data for the species in question.

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Mountain Chicken (*Leptodactylus fallax*),
Laura Hampton — Available at both A3 (11.7″ x 16.5″) and A4 (8.3″ x 11.7″) paper sizes

The critically endangered Mountain Chicken (*Leptodactylus fallax*), or "Giant Ditch Frog," is a large (up to 210 mm SVL), robust anuran native to the Caribbean islands of Dominica and Montserrat. With an average lifespan of 12 years, it reaches breeding maturity at roughly three years of age. Unlike most anurans, which breed in water, this frog deposits its eggs within a terrestrial foam nest in underground burrows about 50 cm deep. This occurs in April during heavy seasonal rainfall. Once the eggs have developed, the adult female will lay many unfertilized eggs to feed her brood. The female will then guard them until they are fully developed and they leave the safety of the burrow.

Unfortunately, like many amphibian species, the Mountain Chicken frog is suffering declines from chytrid fungus. There are other factors contributing to its decline including natural catastrophic events, such as volcano eruptions, as well as mass consumption for food by humans (this frog is the national dish of Dominica) and habitat loss for agricultural practices. In addition, this species has a low reproductive rate and reaches sexual maturity later than many frog species. Due to these impacts, the Mountain Chicken is estimated to have declined by 80% within the past ten years.

There are now several organizations working to save this species. Although hunting is now banned and there are projects in place to help increase populations, there are still only two breeding projects outside Dominica. One of these is at London Zoo, with a successful captive breeding program; the other is a private collector in the United States working with a small collection of frogs.

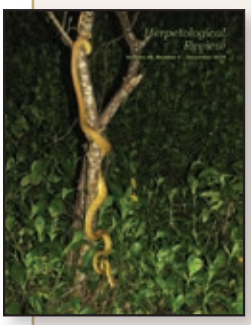
Laura Hampton is 24 years old and has been drawing and painting her entire life, typically working with nature-based subject matter.

Her current personal preference for animal-based pieces includes a mix of different media. The Mountain Chicken Frog piece presented here began with a water color pencil base, and then colored pencil was used for detail. Finally, acrylics were used to add stronger colors and highlights and shading for a bold, eye-catching appearance.

Laura produced this Mountain Chicken Frog piece to help raise money and awareness for the conservation of the species as part of an ongoing project coordinated by the Dominican Mountain Chicken Frog Project. Fifty percent of profits from sales of prints will be donated to that project.

Laura offers commission work, from pet portraits to book illustrations, and has current work for sale, including Mountain Chicken Frog prints, at www.facebook.com/lauraaprilart. She can also be contacted via laura.april.h@gmail.com for more information.

ABOUT OUR COVER: *Corallus grenadensis*



Corallus grenadensis, endemic to the Grenada Bank (Grenada + the Grenadine Islands), is one of two species of *Corallus* that occur in the West Indies (*C. cookii* on St. Vincent is the other). Although the impact of humans on pre-Columbian environments should not be underestimated, it was the arrival of European colonizers on Grenada that led to large-scale deforestation for sugarcane production in the 18th century. Except on the steepest portions of the island, virtually all original forest was cleared and this must have had a profound impact on the distribution and ecology of *C. grenadensis*. Today, Grenada is a mosaic of land cleared for agriculture, small towns and villages, and wooded areas; this patchwork landscape is obvious when flying over the island. Nevertheless, *Corallus grenadensis* is widespread on Grenada from sea level to about 530 m, and it occurs in a wide range of habitats, including xeric scrub, mangroves, orchard trees (e.g., mango, cacao, breadfruit), and lush forests. Finding *C. grenadensis* foraging in proximity to human activity (residential gardens, the grounds of upscale hotels) is not unusual, and it will enter homes and outbuildings and cross urban roads on power lines. In the Grenadines chain, it occurs on at least ten islands, ranging in area from 0.46 km^2 (Petit St. Vincent) to 32 km^2 (Carriacou). These small islands have no original forests (all were cleared for sugarcane and cotton), yet *C. grenadensis* can be abundant in some areas.

Like its close relative *C. hortulanus* on the South American mainland, *C. grenadensis* exhibits a spectacular variety of color patterns. In open, sun-drenched habitats, boas tend to have a yellowish ground color and often lack any discernible pattern. At sites above ~400 m, where temperatures are cooler and heavy cloud cover and rainfall are regular events, boas are very dark brown (verging on black) with a pattern of fine, white, lace-like markings. At moderate elevations, boa ground color may be any of many shades of yellow, orange, red, brown, or gray, with or without a conspicuous pattern.

The diet of *C. grenadensis* undergoes an ontogenetic shift in vertebrate prey from ectotherms to endotherms. Neonates (~300–380 mm SVL) to snakes of about 700–800 mm SVL are nocturnally active foragers that prey almost exclusively on sleeping or resting *Anolis* lizards. Boas in these age/size classes display amazing stealth when approaching a sleeping anole. In two feeding episodes video-taped in the field, boas moved at the rates of 0.8 cm/minute and 1.4 cm/minute, thereby requiring 24 and 14 minutes, respectively, to cover the last 20 cm (Yorks et al. 2003. Studies on the Neotropical Fauna & Environment 38:167–172). Similar behavior has been observed in *C. cookii* and *C. hortulanus*. Large (>1000 mm SVL) *C. grenadensis* become ambush foragers that prey primarily on nocturnally active rodents and, rarely, on birds or Mouse Opossums (*Marmosa robinsoni*).

Over the past 500+ years, *Corallus grenadensis* has had to adapt to new habitats (often dominated by introduced tree species), new prey species (the introduced rodents *Mus* and *Rattus*), and introduced predators (mongooses, opossums). Avoiding a conspicuous human-presence on Grenada is virtually impossible; that this species is as widespread and locally abundant as it is while in close proximity to human activity is testimony to its adaptability.

The snake on the cover is an adult female *C. grenadensis* (1050 mm SVL) that was photographed at a site in central Grenada. It has assumed a posture often seen in adult *Corallus* of several species (Henderson 2015. Natural History of Neotropical Treeboas [genus *Corallus*]. Chimaira). With head angled downward and about 30 cm from the ground, boas wait for passing prey. On Grenada, that is usually *Rattus rattus*. The boa was photographed with a Canon PowerShot SX500IS with 4.4–129 zoom lens and built-in flash. The photographer is **Robert W. Henderson**, Curator of Herpetology Emeritus at the Milwaukee Public Museum. Henderson has been working with West Indian *Corallus* for about 25 years, with the primary focus on *C. grenadensis*. Additional *Corallus*-directed fieldwork has taken place on St. Vincent and on Trinidad (with *C. ruschenbergerii*). His fieldwork with *Corallus* is ongoing.



PHOTO BY PENNY FELSKI

SSAR BUSINESS

2014 Annual Meeting, Chattanooga, Tennessee

The 57th Annual Meeting of SSAR took place from 30 July to 3 August 2014 at the Chattanooga Convention Center in Chattanooga, Tennessee (Fig. 1). This was the first shortened (four-day) JMIH. Organizing societies this year were Society for the Study of Amphibians and Reptiles (in conjunction with the International Society for the History and Bibliography of Herpetology), American Elasmobranch Society (celebrating its 30th annual meeting), American Society of Ichthyologists and Herpetologists (celebrating its 94th annual meeting), and The Herpetologists' League (celebrating its 72nd annual meeting). The local hosts were Anna George (Chair), Josh Ennen, Bernie Kuhajda, and David Neely (all from Tennessee Aquarium Conservation Institute), and Eric O'Neill (University of Tennessee at Chattanooga). They were assisted by the following volunteers: Sarah Hazzard, Kathlina Alford, Heather Boud, Louise McCallie, Lindsay White, and Shawna Mitchell. We thank them, and the KState folks, for all for their hard work and another enjoyable JMIH. Chattanooga was a great place for a meeting. The weather was great, the nearby hills and river were beautiful, the Convention Center was well-laid out, and some of the local restaurants were worth revisiting 2 or 3 times (who'd have though grits with goat cheese was so delicious?).

PHOTO BY M. PREEST



FIG. 1. View of the Chattanooga Convention Center.

Approximately 950 herpetologists and ichthyologists attended the meeting. This number includes 459 students and 349 members of SSAR. SSAR was pleased to sponsor the attendance of two pre-baccalaureate students (Alli Metler and John Erickson) and their chaperones. Alli and John participated in the SSAR Mentor Program (along with 15 graduate students and their mentors). Thanks to Kris Kaiser and Andrew Durso for doing the lion's share of the work again to make this program possible. The meeting included 69 oral sessions, 238 poster presentations, and three symposia. SSAR sponsored a symposium entitled "Infrared Imaging: Cellular/Molecular Mechanisms, Behavioral Biology and Ecology of Pit Vipers, Pythons, and Boas." Thanks to Michael Grace for organizing this afternoon symposium that included seven presentations (Fig. 2). Symposia sponsored by ASIH and HL were "Bridging the Gaps: The Remarkable Career of Gordon M. Burghardt in the Study of Herpetofaunal Behavior" and "Reproductive Biology and Phylogeny of Lizard and Tuatara," respectively.

Social and Professional Events

Following the usual pre-conference day of Board and Executive Committee meetings, the JMIH began officially with the Plenary Session on July 31st. Local Host Committee Chair, Anna George (Director and Chief Research Scientist, Tennessee Aquarium) welcomed us to Chattanooga and oriented us to the layout of the city. She mentioned some of the local attractions—the Creative Discovery Museum, an outdoor climbing gym near the Aquarium, the River Gorge Explorer along the Tennessee River, the Chattanooga Zoo, nearby whitewater rafting, Chicamauga National Park, and Ruby Falls (Fig. 3). Some of these are accessible via a free downtown shuttle that many of us took advantage of during the week.



PHOTO BY M. PREEST

FIG. 2. Some of the participants in the SSAR sponsored Symposium "Infrared Imaging: Cellular/Molecular Mechanisms, Behavioral Biology and Ecology of Pit Vipers, Pythons, and Boas." L to R: Michael Grace, James VanDyke, Sherri Emer, Mari Myrback, William McLamb.

PHOTO BY A. CREE



FIG. 3. Ruby Falls.

PHOTO BY M. PREEST



FIG. 4. David Blackburn, President's Travelogue speaker, in front of the poster advertising his talk.

Various awards were then presented. The ASIH Robert H. Gibbs Award was given to Naericio Menezes and the Robert K. Johnson Award for Excellence in Service to ASIH was presented to Larry Page. The Henry S. Fitch Award for Excellence in Herpetology was presented *in absentia* to Marvalee Wake by Darrel Frost. Darrel nicely summarized Marvalee's amazing career and particularly noted her "signature virtue" as a role model, especially to women, in a traditionally male-dominated field. He was quite correct to say that she has, and will continue to, inspire female herpetologists for decades.

Craig Guyer announced Alan Richmond (UMass, Amherst) as the winner of the 2014 SSAR/HL/ASIH Meritorious Teaching Award in Herpetology. Craig noted that Al has taught herpetology for 20 years, bringing an enthusiasm to the classroom that is reflected in his infectious teaching style and his willingness to main diverse live animals to serve as teaching aids. What was particularly notable was the fact that he has shaped the careers of people well outside the bounds of academic herpetology.

The first Meritorious Teaching Award in Ichthyology was given to Gene Helfman who admitted that he would only use the award to buy more fish t-shirts and thus donated $500 to the ASIH Student Travel Fund. The Joseph Nelson Award for Lifetime Achievement in Ichthyology was presented to Bruce Collette.

Jeremy Monroe (Filmmaker, Aquatic Biologist, and Director, Freshwaters Illustrated) was then introduced as the JMIH Plenary Keynote Speaker. What a treat! Jeremy admitted that he was an "obsessed fishing kid growing up" and read all the fishing magazines and watched the TV shows. However, towards the end of his time in graduate school, he started to question what the popular image of fishing was doing and how it has affected how we perceive freshwater biodiversity. He showed us some of the truly stunning short films he been involved with, particularly in the southeastern US. Jeremy said that the mission of Freshwaters Illustrated is to "educate diverse public audiences about the life, study, and conservation of freshwater ecosystems…and to provide illustrative resources…to scientists, educators, and media specialists."

After a break, ASIH Past President William Matthews gave a presentation on "Synthesizing your Career Data: A Challenge for Old Folks and Suggestions for Young Folks." This was followed by a presentation by Chris Lowe, the AES plenary speaker ("Is 'The-Sky-is Falling' Science Really the Only Solution for Elasmobranch Conservation"), who suggested that we need to start thinking differently in terms of how we "message" our science and warned that if we constantly cry wolf, eventually the public and media will stop listening.

The plenary session was wrapped up by J. Whitfield Gibbons (HL Distinguished Herpetologist). The title of Whit's talk (although not one he made up) was "What We Didn't Know in 1964: Fifty Years of Herpetology." Whit's first piece of advice was to "relax before a talk—no matter how many you give, one will be your best and one will be your worst!" He also said "if you're going to he a herpetologist, enjoy what you're doing. If it's not fun, you shouldn't be doing it!" More seriously, he noted that the world's herpetofauna is "under siege" and that people must know what they have, to know that they could lose it. He spoke about the role of public education and the realization of its importance in conservation efforts. For part of his talk, Whit focused on the work he and his many colleagues carried out at Ellenton Bay at SREL (Savannah River Ecology Lab in Georgia) and the differences in productivity between seasonal and permanent wetlands. He also spoke about research on cottonmouth behavior that questioned the stereotype of these snakes as aggressive.

Following the Plenary Session, we gathered in the main corridor of the Convention Center for the group photo.

David Blackburn (California Academy of Sciences) gave the 2014 SSAR President's Travelogue ("Adventures with African Amphibians") on the evening of July 30th (Fig. 4). David described himself as an "unlikely" herpetologist and spoke of the many projects he has been involved with over the past 12 years, most of them in Africa, particularly Cameroon (but also Angola, Burundi, Tanzania, Uganda, Ethiopia, Egypt, Libya, Nigeria, etc.). He said that this is the time to go to Africa and get involved with biodiversity and conservation studies. Although getting places is not always easy, you are rewarded with amazing biodiversity. David spoke about phenotypic diversity and incredible variation in color patterns in frogs, and even variation in the way they smell. He noted the decline in frog abundance in some areas and the recent appearance of chytrid. He finished by describing some of the efforts of the African Amphibian Working Group in training local herpetologists, including students, in tissue collection.

Over 100 students and 30 professionals attended the SSAR/HL Student Reception held in a rotunda in the Convention Center in the late afternoon on July 31st. SSAR and HL thank the donors of door prizes. The Student Reception was followed by the JMIH Opening Reception at the Tennessee Aquarium. The food was great (many of us ate outside overlooking the Tennessee River) and the exhibits, split between two large buildings, were spectacular. It's not surprising that the aquarium has been rated "Best Aquarium in America" for three consecutive years!

The SSAR/HL live auction was held on August 3rd. We raised just over $6800. After all bills are paid, proceeds will be split 50-50 with HL. Auctioneers Sean Graham, Travis Hagey, and Sara Ruane were assisted by Krista Mougey, Elyse Freitas, Catriona Hendry, Rachel Skinner, and Arianna Kuhn; Figs. 5, 6, and 7). Ann Paterson, Kirsten Nicholson, Meredith Mahoney, Greg Watkins-Colwell, and Samantha Kahl ably handled the logistics and financial side of the evening. Several one-of-a-kind items went up for auction, including several t-shirts made just for the event. These included herp-humor, sometimes directed at specific researchers or projects, but also focusing on interesting anatomical features of some of our favorite species. A t-shirt featuring illustrations of a variety of snake hemipenes sold for several hundred dollars.

Mike Jorgensen (co-Chair Student Travel Awards Committee) conducted the random draw of names for this year's winners of travel awards. Vinny Farallo (co-Chair Student Travel Awards Committee) attended the 2014 JMIH and was able to oversee to silent auction. The auction items were set up in the lobby of the conference center. Once again, the ten recipients of the $400 SSAR Student Travel Awards took turns to work the silent auction table for 2–3 h throughout the course of the meetings. The Silent Auction raised just under $600.



PHOTO BY M. PREEST

FIG. 5. Chris Schalk, attendee at the SSAR/HL Live Auction and proud new owner of alligator salt and pepper shakers. Flanked by Dan Saenz on his right and Laine Giovanetto on his left.



PHOTO BY M. PREEST

FIG. 6. Greg Watkins-Colwell (L) and Darrel Frost (R) at the SSAR/HL Live Auction.



PHOTO BY M. PREEST

FIG. 7. Ross Maynard, Mo Donnelly, and Emily Taylor at the SSAR/HL Live Auction celebrating the announcement that evening of Mo's election as President of ASIH. Congratulations Mo!

Board and Business Meeting Summaries

SSAR Board Meeting

Society President Bob Aldridge called the Board Meeting to order at 0758 h on 30 July 2014 in the Chattanooga Convention Center, Chattanooga, Tennessee. In attendance were the following members of the Board of Directors, Editors, and Committee Chairs: Bob Aldridge (President), Paul Bartelt (co-Editor *JHerp.*), Aaron Bauer (President-Elect; Editor, *Facsimile Reprints in Herpetology*), Rafe Brown (Chair, Seibert Award Committee; Chair,

Local Meeting Committee, 2015), Alison Cree (Board Member, non-US 2016), Brian Crother (Chair, Standard English and Scientific Names Committee), Tiffany Doan (Board Member, Reg. 2014; co-Editor *JHerp.*), Richard Durtsche (Coordinator, Symposium Committee), Vincent Farallo (co-chair, Student Travel Award Committee), Marina Gerson (co-Chair Membership Committee), Ann Paterson (Treasurer; co-Chair, Membership Committee), Marion Preest (Secretary), Al Savitzky (SSAR Representative to AIBS and BioOne), Greg Watkins-Colwell (Board Member, Reg, 2016; Organizer, SSAR/HL Live Auction), and Dawn Wilson (Chair, Student Participation Committee). Additional society members present included Robin Andrews, David Auth, Jim Christensen, Darrel Frost, Rich Glor, Roy McDiarmid, Henry Mushinsky, Erin Muths, Kirsten Nicholson, Todd Pierson, and Robert Powell.

Introductions were made and minutes of the 2013 Board of Directors Meeting (Albuquerque, New Mexico) were approved.

Officers' Reports

President Bob Aldridge reported that he appointed Craig Guyer, Auburn University, as Chair of the Herpetological Education Committee and appointed Tiffany Doan and Paul Bartelt as Co-Editors of *JHerp*. He sent thank you letters to 29 associate editors of *JHerp.*, and signed a letter that the SSAR Conservation Committee wrote to Andy Gluesenkamp, Texas Parks and Wildlife Department, encouraging them to adopt amendment §65.328, banning the use of noxious and toxic substances to collect nongame wildlife (e.g., rattlesnakes). Additionally, he wrote a letter to over 700 members of SSAR who did not renew their membership in 2014. At the request of Dr. Hidetoshi Ota, managing editor of *Current Herpetology*, he wrote a letter to Thomson-Reuters recommending that *Current Herpetology* be included in the index of Thomson-Reuters database. The President signed congratulatory letters to: David Friend, Chair, California Turtle and Tortoise Club on the occasion of its 50th Anniversary; East Texas Herpetological Society on the occasion of its 25th Anniversary; Scott Keogh, Australian Society of Herpetologists on the occasion of its 50th Anniversary; Österreichische Gesellschaft für Herpetologie meiner Gesellschaft on the occasion of its 25th Anniversary; and Deutsche Gesellschaft für Herpetologie und Terrarienkunde Gesellschaft on the occasion of its 50th Anniversary.

President Aldridge met with the JMIH Meeting Management and Planning Committee in Chattanooga, TN, in April 2014. Times and places for the business meetings, sessions, etc., were arranged. All of the rooms at the Chattanooga Convention Center and various hotels were visited.

President Aldridge invited David C. Blackburn, Assistant Curator of Herpetology, California Academy of Sciences, to give the 2014 SSAR President's Travelogue at the JMIH meeting in Chattanooga, TN.

Treasurer Ann Paterson reported that SSAR had a mixed financial year during 2013. Most expenses were close to predictions and our investments did well. However, membership and publications income is down substantially. In part, this reflects lower membership numbers and reduced sales. However, it may also reflect timing of membership deposits to some extent. We overspent our budget this year by $38,092. This closely matches the amount by which we underspent our budget last year ($42,516).

After a year as treasurer, Ann has developed some proposals for things that she thinks will help SSAR manage its finances.

1. We have adopted a new credit card system through Bank of America to increase security of credit card processing and to increase our protection from liability.

2. Ann has developed (based on templates through our PCI compliance provider, Trustwave) a security policy for SSAR. This policy is on file with the secretary. In addition to the general security policy, Ann has arranged with Bob Aldridge to provide him with an updated MDISC of our financial records each year so that more than one person has these records. The records will include financial correspondence, bank statements, invoices, and QuickBookPro files. By having these records on file with the president, rather than just with the treasurer, we will facilitate future transitions between treasurers and ensure that someone can rapidly access important information even if the treasurer is not available for some reason. Additionally, this provides more oversight and transparency for the treasurer position

3. Ann has consulted with our accountant to obtain recommendations for how we can complete our taxes earlier in the year. Having our accountant review our books and complete our taxes is extremely helpful in presenting accurate, up-to-date information at the board meeting.

4. Ann has consulted with our Fidelity advisor twice over the past year about our investments. SSAR now has a substantial investment portfolio that needs to be managed carefully. Either the treasurer or some group of individuals needs to develop an investment strategy to present to the board so that we can decide on an appropriate investment approach, without excessive risk or lack of growth. Treasurer Paterson has obtained information and quotes from several investment managers and thinks that we should consider having an investment manager handle our investments. This would provide transparency and consistency in our investment strategy, even when treasurers are replaced.

The approved 2013 budget was balanced and despite some expenses going over budget, most of our expenses were under budget. We received a profit rather than a loss on the 2013 JMIH meeting, which is a positive development.

Overall, expenses and income were relatively close to expectations except for the substantial drop in membership dues this year. In 2012, total membership dues were $206,532. The board approved an estimate of $200,000 for the 2013 membership dues. While we do not yet have a definite final amount for the 2013 membership dues as Breck Bartholomew and John Psaltos work to determine the cause of some discrepancies in the calculations, the total will be close to $100,000. Although this may be partially explained by timing, it is still a concern and has caused us to run over budget in 2013.

The Society's investments continued to increase during 2013, in keeping with the trends in the global market. The total market value as of 31 December 2013 was $718,539. As of June 2014, we had increased further to $749,585.73. This is an increase of $83,563.73 in one year. Examination of the performance of our funds shows that their percent yields have increased over 2013, and have been increasing over the course of 2014.

Secretary Marion Preest provided Officers, Editors, and Committee Chairs with minutes of the 2013 Board Meeting, summarized the 2013 Annual Meeting for publication in *Herp. Review*, and regularly updated the SSAR letterhead to reflect changes in personnel. She informed the Editors of *Journal of Herpetology* and *Herp. Review* of these changes and provided various updates for Raul Diaz (webmaster). Marion also wrote letters to student winners of various awards and prepared announcements for publication in *Herp. Review*. She compiled the 2014 Annual

Report, prepared agendas for the Board and Business Meetings for the 2014 JMIH, and was again involved in organizing a reception for student members of SSAR and HL to be held at the Annual Meeting. Marion called for votes from the Board on various issues (e.g., proposals regarding use of funds for the Roger Conant GIH Awards and the Student Travel Awards, symposium proposals, etc.), circulated documents that needed to be signed by members of the Board (e.g., Conflict of Interest), confirmed eligibility for participation in various student activities, and dealt with many emails and phone calls from SSAR members and the general public.

Breck Barthlomew (Publications Secretary) reported that sales for the first five months of 2014 have been lower than during any other period since late 2001. He has noticed a similar trend with his bookstore, so doesn't think this is unique to SSAR. Sales during 2013 look quite robust, but these are due primarily to two factors: 1) Sales of *Erpétologie Générale* (which have now dropped off significantly). 2) A clearance sale on many older books, most of which were then remaindered in 2013. During 2014, Breck intends to have another clearance sale and offer some more titles to remainder dealers.

Breck does not think that book sales will ever pick up to where they were historically. Times have changed and few people maintain personal libraries any longer. As an example, the forthcoming *Contributions to the History of Herpetology Volume 1, Revised* has been advertised in an e-mail list, on Facebook, and in *Herpetological Review*. As of 27 June 2014, Breck has received orders for 13 copies.

What does this mean for SSAR? In Breck's opinion, we need to completely rethink our publications series and approach. Breck acknowledges that the publications series have always had room to publish books that were unlikely to make the society money simply because there was a need for the information to become readily available. Without being able to sell an adequate number of copies, the society needs to either move to a very small print run for most titles with the option of printing more as needed—this has been done with some circulars—or perhaps we need to move to an eBook model, or even publish books online in an open access model.

In recent years, SSAR has also received several donations of libraries. In the past these have made a considerable amount of money. However, like our publication sales, it is becoming increasingly difficult to liquidate these libraries—particularly the journals and separates in these collections. Breck is stepping up an effort to get these collections listed and put on the SSARbooks.com website. He will attempt to sell the items through other avenues as well, but some that he thought might be viable have been too risky to try—auction houses tend to expect books to sell at a fraction of their retail value.

Breck's goals for the remainder of 2014 and 2015 are to continue to reduce the overall SSAR inventory of books through sales and remaindering older titles. He intends to list many of the donated books, reprints, and other items on the SSARbooks.com website, and to consolidate the overall SSAR inventory to reduce storage costs.

George Pisani reported that he again filed SSAR's annual corporate report with the Office of the Kansas Secretary of State.

Editors' Reports

Co-Editors of *Catalogue of American Amphibians and Reptiles*, Chris Bell and Travis LaDuc report that the first three new *CAAR* accounts under their watch as co-editors have been published and are available via open access at www.SSARCAAR.com. These accounts are *Graptemys gibbonsi* (#901, Lovich and Ennen), *Anolis smaragdinus* (#902, Les and Powell), and *Cubophis vudii* (#903, Powell). The on-line, PDF format has eased previous concerns on manuscript length and allows the potential for numerous photos. Six additional accounts are currently in various stages of review. Chris and Travis continue to field inquiries for new accounts. They encourage potential authors to not only look at those species for which no accounts exist, but also at many of the published accounts; over half of all existing accounts are 25+ years old and an amazing amount of literature has been published over that same time period.

Chris and Travis assumed all of the editorial responsibilities in an effort to maintain the high standards of the series, particularly in the formatting and completeness of the literature citations, personally vetting every citation just like Andy Price and Bob Powell did before them. In order to streamline this vetting process, they have invested a tremendous amount of time over this past year into collecting, organizing, and indexing large amounts of published, but not-yet-indexed herpetological material. As a result, they have been able to add dozens of citations to accounts under review, further solidifying the relevance of these accounts as the authoritative reference for a given taxon. Bob Powell vouched for the fact that Travis and Chris have been very thorough and have both invested a huge amount of time in this series.

Chris and Travis thank the authors of the first three accounts for their patience as they learned the ropes of desktop publishing. They especially thank Bob Powell, Breck Bartholomew, and Ruthe Smith for their help in navigating through the logistics of editing this series.

Kraig Adler, Editor of *Contributions to the History of Herpetology*, reported that volme 1 (revised and expanded) was distributed to delegates at the first WCH in Canterbury, September 1989, but has been out of print since 2000. With volumes 2 and 3 now available, a reprint will allow purchasers to have a complete set. The reprint, however, will be heavily annotated and also include six portraits missing in volumes 1–3 and corrections to all three volumes. There are also 96 plates (mostly in color) added, with substantial captions. This book is scheduled for publication in August 2014.

Projects beyond 2014 include "Herpetology at the University of Kansas," by William E. Duellman, which will be a detailed history of one of the most distinguished herpetological research and graduate education programs. It includes Henry Fitch's long-term program at the Natural History Reservation, biographies of all herpetological graduates of the KU program, and summaries of major expeditions, meetings, and other activities. This book will be issued in 2015 in the run-up to SSAR's meeting at KU later that year. Also in the pipeline are *A Guide to the Snakes of the Philippines* by Rafe Brown, Alan Leviton, Maren Gaulke, and Arvin Diesmos (to be issued 2016), *Salamanders of Japan* by Ikio Sato (for which a grant for $55,000 was obtained from the Seidell Program at Smithsonian to cover the translation by Richard Goris), *Field Guide to Amphibians and Reptiles of the West Indies* by S. Blair Hedges, *and Lizards of Southern Africa* edited by William R. Branch and Aaron Bauer.

Aaron Bauer (Editor, *Facsimile Reprints in Herpetology*) notes that activity this year has been associated with progress on the production of *The Collected Herpetological Works of Giorgio Jan* with an introduction, annotated bibliography, and extensive systematic comments by Roy McDiarmid and Jay Savage. The

work includes a reprint of a near full-sized facsimile of the *Iconographie Generale des Ophidiens* and Jan's other herpetological 500+ manuscript pages of new material by McDiarmid and Savage. Scanning of the original works of Jan is underway and the major task of scanning the *Iconographie* will be undertaken by a commercial firm in San Francisco identified by the California Academy of Sciences, which has kindly provided their immaculate copy for reproduction and has committed to partially funding the scanning costs. In addition, remaining costs of scanning have been provided by Ronald Javitch and Jay Savage. Re-estimation of costs for production of this volume have increased by several thousand dollars as the Academy's original offer to cover these costs had to be revised. On the other hand, changes in layout and the removal of nearly entirely redundant Jan papers (differing only in pagination) have reduced printing estimates to approximately $18,000 (from an original $30,000) as the entire work can be produced in a single volume of slightly more than 1000 pages at a trim size of 9 x 12 inches. It is still anticipated that this work will appear in 2014, although probably in late Fall.

In 2015, Aaron anticipates the publication of *The Collected Herpetological Works of J. V. Barboza du Bocage (1823–1907)* with an introduction, annotated bibliography, and data on types by Luis Ceríaco. The facsimile will include approximately 150 manuscript pages of new material dealing with Bocage's life and works, his complete bibliography, and short accounts for each of the 104 species of amphibians and reptiles he described. Ceríaco anticipates an interest by the Portuguese Academy of Sciences in supporting the work through co-publishing, which may cover approximately $6,000 of the production costs.

Cantor's *Zoology of Chusan* (1842) and his *General Features of Chusan* (1842) together comprising 70 text pages and 11 leaves of plates, an early treatment of the herpetofauna and other natural history of Zhoushan, Zeijiang Province, China will be prepared as a facsimile give-away for the next World Congress of Herpetology, to be held in nearby Hangzhou, China in 2016.

John Moriarty (Editor, *Herpetological Circulars*) reported that *Herpetological Circulars* 41 (*A Guide to Tissue Collection, Preservation, and Management for Reptiles and Amphibians*) was published Spring, 2014. John is working on revising *HC* 42 – *Herpetological Collecting and Collections Management*.

Editor of *Herpetological Conservation*, Joe Mitchell, reported that he still has not received inquiries for a new publication in this series despite an advertisement in *Herp. Review* 45. Joe proposes placing an advertisement in *Herp. Review* again. If there are still no responses he suggests conducting a review of herp-related conservation publications to see if the book series fills a valuable niche. If it does not, then Joe suggests that we cease publication of the series. If it does, then consider another *Herp Conservation* book with Joe perhaps as a co-editor that would generate enough sales to be profitable to SSAR, e.g., a book focusing on successes and failures in herp conservation that includes critical evaluations of examples in several countries with the explicit goal of elucidating what works or not and why or why not, includes a review of e.g., selected Endangered Species Act (US) and PARC projects, has a clear standard to measure success, and has co-editor(s) and authors who are not afraid of pointing fingers. The Board discussed Joe's proposals. Bob Powell noted that it sent a poor message from SSAR if this book series was discontinued. There was discussion of soliciting new ideas for *Herp Conservation* on the new SSAR website, of compiling independent conservation-related manuscripts sent to *JHerp* into a new volume of *Herp. Conservation* (but, would there be interest, would people be willing to pay for this, and how does the impact factor of *Herp. Conservation* compare with that of *JHerp*?), and of publishing SSAR sponsored, conservation-related symposia.

Robert Hansen, Editor of *Herpetological Review*, reported that Volume 44 consisted of 712 pages (a nearly 44% increase since 2009) and Volume 45 is projected to be even larger. Personnel changes include the resignations of Jodi Rowley, Charles Painter, and Beck Werhle. Personnel added, or those shifting to new roles, include Raul Diaz, Jackson Shedd, Jesse Grismer, Ruthe Smith, Drew Davis, Sean Graham, Crystal Kelehear Graham, and Charles Linkem. Bob wished to particularly acknowledge Charles Painter who has been involved with *Herp. Review* since 1995.

Tiffany Doan and Paul Bartelt became Co-Editors of *Journal of Herpetology* at the beginning of 2014. Outgoing co-editors, Erin Muths and Gad Perry, continue to handle papers submitted during 2013 and before, and Erin Muths will remain an associate editor for special invited perspective papers. The editorial office has moved from Texas Tech University to Waldorf College. Former Editor Geoff Smith remains an Associate Editor (AE) for special projects and Paul Andreadis remains the Index Editor.

The AE roster at the end of 2013 contained 24 continuing AEs: Phil Bishop, Xavier Bonnet, Rafe Brown, Tracey Brown, Russ Burke, Steve Corn, Jennifer Gillette, Evan Grant, Brian Greene, James Harris, Tibor Hartel, Toby Hibbitts, Hinrich Kaiser, Nancy Karraker, Edgar Lehr, Marc Mazerolle, Frank Mazzotti, John Rowe, Christopher Salice, Glenn Shea, Stephen Tilley, Tony Tucker, James Watling, and Eric Wild; all four Editors also function as AEs. David Chapple came on as a new AE during 2013. During 2013 and the first half of 2014 the following AEs resigned: Ximena Bernal, Tracey Brown, Tibor Hartel, Toby Hibbitts, Don Miles, Glenn Shea, and Tony Tucker. Two new AEs will be joining *JHerp.* in the second half of 2014: Rocky Parker and Neil Bernstein. Paul Andreadis remains the Index Editor for the Journal. In addition, the Editorial Board has shrunk, to better represent actual involvement; Dirk Bauwens, David Chiszar, Ellen Dawley, James Plaz, Douglas Rossman, Paul Verrell, and Howard Whiteman left the board and David Cundall, David Green, Joe Mendelson, and Gregory Watkins-Colwell joined in 2013, with Brian Crother, William Dunson, Diana Hews, James Petranka, Rick Shine, John Wiens, and Dawn Wilson remaining from the past Board.

The loss of a large number of AEs is a problem that does not have a simple solution. Some of the resignations had to do with expanding duties that did not allow them time to continue "less important" activities such as being an associate editor. Other resignations were due to lack of interest in papers that they were being assigned. Adding new AEs is critical to the functioning of the Journal. The editors are especially interested in expanding representation from Brazil, a country from which they receive many manuscripts each year, and from Asia, which is not represented.

Overall submissions to *JHerp.* declined again in 2013. Submissions for 2014 (108 as of the end of June) are about the same as the number submitted during the same period in 2013. The overall reduction in submissions is a source of concern. Rejection rates have also remained similar to those in recent years (~ 60%). Although the amount of time needed to reach initial decisions increased in 2013, reflecting the ongoing challenge to obtain timely reviews, the editors have been able to reduce the amount of time required to reach a final decision. The wait between acceptance of a paper and publication is down to approximately 9 months. In addition, the establishment of "Online

First" appearance during 2013 means that readers have access to a near-final version almost as soon as a paper as accepted.

During 2013, *JHerp.* received submissions from 33 countries, compared to 37 in 2012, 48 in 2011, 43 in 2010, and 34 in 2009. The leading countries from which manuscripts originate remain the US and Brazil, ranks both countries have held since data became available in 2006. According to the AP "Member Submissions" report, 35% of all submissions in 2013 had one or more authors who are SSAR members, with 65% having none. This remains virtually unchanged since 2010, despite the 2013 decision that members do not need to pay page charges. The editors acknowledge that they may need to better advertise this policy change.

The quality of *JHerp.*, as reflected by the ISI Impact Factor and total citations reported, cannot be measured as the 2013 data were not available as of the writing of the report. As of 2012, *JHerp.* was ranked 87th in the Zoology category, with a 5-year impact factor of 1.2, ahead of *Copeia*, *Amphibia-Reptilia*, and *Herpetological Conservation Biology*, but behind *Herpetological Monographs* and *Herpetologica*.

Over the past few years the editors have implemented a number of new features:

- Optional second-language abstracts Invited long-term perspective
- Inclusion on the back cover of each issue of a world map indicating countries from which published papers are included.
- Full-color, no-cost for graphics
- No page charges for SSAR members
- Online-early appearance of accepted articles
- New Instructions to Authors.
- Associate Editor Lunch

The editors requested input from the Board on the following issues:

• *Publicizing Unique Journal of Herpetology Features.*—Both free color (which is unique among the major U.S.-based herpetological journals) and "Online First" (which is not available from *Copeia*) are two highly desirable features of which many potential authors are not aware. Publicizing these features may lead to more and higher quality submissions to our Journal.

• *Reward for AE service.*—With the loss of five AEs during the first half of 2014, it is apparent that AEs either do not feel that service as AEs is an important usage of their time, or that they do not feel that they are valued by the Society. In addition to the loss of AEs the editors have found widely varying quality among our AEs. The editors would appreciate the Board reconsidering membership or other suitable reward as token recognition to be granted only to those AEs who have served for over a year and completed their reviews in a timely manner.

• *Difficulties in obtaining qualified and timely reviewers.*—This is a huge challenge to the Journal. In addition to finding willing reviewers, the reviewers that do accept almost always take longer than the allotted 30 days.

Standing Committee Chair Reports

The following SSAR members continued their service on the Conservation Committee in 2013–14: Ross Alford, Nicole Angeli, April Barreca, John Jensen, Nancy Karraker, Cecilia Langhorne, Karen Lips, Joe Mendelson, Gad Perry, and Stephen Richter. Susan Walls joined the committee in 2014 and Betsie Rothermel continued to serve as committee chair. In January 2014, the Conservation Committee helped SSAR President Bob Aldridge draft and submit a letter to Texas Parks and Wildlife Department encouraging them to adopt an amendment that would ban the use of noxious and toxic substances to collect nongame wildlife. The proposal would have prohibited the practice of gassing burrows, a frequently used method to collect rattlesnakes. Facing stiff opposition from organizers and supporters of the annual rattlesnake roundup in Sweetwater, the Texas Parks and Wildlife Commission did not take any action following the initial public hearings. The Conservation Committee is exploring ways to use social media to better engage SSAR members to respond to these kinds of issues. Anyone with expertise in this area and an interest in helping with conservation outreach is encouraged to contact a member of the Conservation Committee.

Chair of the Dean Metter Award Committee, Joe Beatty, received seven proposals this year and **Breanna Forester**, a Ph.D. student at Duke University, was selected as the winner. Breanna's proposal was titled "*Evaluating the Implications of Local Adaptation, Habitat Connectivity, and Gene Flow for Terrestrial Salamanders under Global Change.*" Forester will use molecular techniques to detect adaptation, habitat connectivity, and levels of gene flow in natural populations of two species of plethodontid salamanders that inhabit fragmented and warming habitats. One important goal of the study is to determine actions that will be effective in conserving salamander biodiversity under a global climate change regime

The 22nd annual Seibert Awards Competition (Rafe Brown, Chair) was run at the 56th Annual Meeting of SSAR in Albuquerque. There were 55 eligible presentations. The Seibert Award winners for 2013 were: Systematics/Evolution: **Phillip Skipwith** (University of California), coauthors Aaron Bauer, Todd Jackman, "Diversification Rates of New Caledonian Diplodactylid Geckos Inferred From Concatenated and Coalescent Divergence Time Estimates." Ecology: **Julia Riley** (Laurentian University), coauthors Steve Freedberg, Jacqueline Litzgus "Natural Variation in Incubation Temperatures Influence Locomotor Performance of Snapping Turtle (*Chelydra serpentina*) and Painted Turtle (*Chrysemys picta marginata*) Hatchlings." Conservation: **James Baxter-Gilbert** (Laurentian University), coauthors David Lesbarrères, Jacqueline Litzgus, "On The Road Again: The Effectiveness of Mitigation Structures for Reducing Reptile Road Mortality and Maintaining Habitat Continuity." Physiology/Morphology: **Christopher Peterson** (University of Arkansas), coauthors Jason Ortega, Si Hong Park, Irene Hanning, Jacques Hill, Steven Beaupre, "Gastrointestinal Microbes Do Not Influence Digestive Efficiency in African House Snakes (*Boaedon fuliginosus*)." All winners received a check for US $200 and a book from University of California Press. Honorable mentions were: Systematics/Evolution: **Benjamin Lowe** (University of Minnesota), coauthor Kenneth Kozak "Assortative Mating in Hybridizing Southern Appalachian *Plethodon* and Implications for Hybrid Zone Dynamics." Ecology: **James Nifong** (University of Florida), coauthor Brian Silliman, "Impacts of a Large-bodied, Apex Predator (*Alligator mississippiensis* Daudin 1801) on Salt Marsh Food Webs." Conservation: **Rochelle Stiles** (Indiana State University), co-authors Chris La Rue, Michael Hawkins, Michael Lannoo, "Amphibian Response to Restored Prairie Potholes." Physiology/Morphology: **Shelly C. McCain** (Sam Houston State University), coauthors William Lutterschmidt, Clifford Fontenot, Jr., "Behavioral Sensitivity to Salinity and Osmoregulatory Capacity of the Fully Aquatic Salamander, *Amphiuma tridactylum*."

Craig Guyer, newly-appointed Chair of the Herpetology Education Committee, reported that the biggest HEC project

continued to be the Meritorious Teaching Award in Herpetology (MTAH), sponsored by SSAR, HL, and ASIH. Unfortunately, the transition of leadership from last year to this year was slow and suffered from a lack of a document identifying duties and due dates for the HEC chair and HEC members. For that reason, the announcement for MTAH applicants did not appear in the journals and no new applications appeared. However, the applicant pool from the previous year was large and the chair evaluated MTAH candidates remaining in the applicant pool rather than skipping the award for a year.

The HEC approved two applicants for pre-baccalaureate awards: **Alli Metler** from Bartlett, TN (a 5th grader) and **John Matthew Erickson** from Memphis, TN (a 9th grader). The awards provided $390 to cover meeting materials, refreshments, and opening reception tickets for the student and a parent chaperone. President Aldridge requested that the HEC develop guidelines for how these applications will be evaluated, how many awards can reasonably be supported, and whether the awards should include support for the chaperone. The HEC recommends that a maximum of three awards be given, that the awards be restricted to those in 7th through 12th grade, and that it include support for one individual to serve as chaperone. This is contingent upon agreement by the sponsoring societies to support a maximum of ca. $400 per meeting for pre-baccalaureate awardees.

Craig has agreed to chair the committee for a second year to get it back on track. With much help from Cathy Bevier and Greg Watkins-Colwell, a draft document describing the procedures for the chair and committee members has been produced. A mechanism to establish term limits on the committee and to establish an eventual transition of each committee member to the chair position is being created. Cathy Bevier and Greg Watkins-Colwell have earned transition off of the committee and will do so this year. Craig has solicited potential replacements.

The winning paper for the 2013 Kennedy Award (Lynnette Sievert, Committee Chair) is "Joint Space Use in a Parthenogenetic Armenian Rock Lizard (*Darevskia armeniaca*) Suggests Weak Competition among Monoclonal Females" by **Eduard Galoyanin** (*JHerp*. Vol. 47:97–104). Eduard will receive a check for $200 or $400 in SSAR publications.

Kraig Adler, Chair of the Long Range Planning Committee (LRPC), reported that the committee had a rather quiet year during 2012–2013. There was a formal committee meeting, open to the SSAR membership at the JMIH in Albuquerque on July 13th. The major points and decisions were as follows (developments subsequent to the committee meeting are inserted in brackets):

1. SSAR Website.—Joe Mendelson and Raul Diaz reviewed the status of the website and indicated the key point: it must be easily "updatable" so that officers and editors can keep their respective sections current. Various suggestions were made concerning new departments that could be added to our website. We need to avoid redundancy with the ZenScientist site. The SSAR budget and IRS tax forms should be posted in the interests of transparency. It was suggested that some parts of the website should be made available in other languages

2. SSAR Publications Office.—LRPC reviewed the status of our Publications Office in view of the termination of Bibliomania! Breck Bartholomew offered to step down and another book dealer offered to take over, but on careful comparison of all aspects of the two, the committee unanimously recommended to continue its relationship with Breck with thanks for his excellent and loyal service since 2002. Unfortunately, Breck could not attend and thus did not hear all the accolades. Several other factors were discussed: to reduce the size of our stock of publications and to reduce the size of print runs.

3. Mechanisms for Increasing Membership and SSAR's Visibility.—Many ideas were discussed and debated. A major consideration was getting *Herp Review* picked up by *BioOne* or *JSTOR*. [Ann Paterson, Bob Hansen, and Kraig Adler have been dealing with these possibilities since the meeting] It was suggested that we target the large herp expos in Anaheim, Chicago, and Arlington. [Bob Hansen and Kraig have discussed this with Bob Ashley and he agrees to run our full-page, color ad in his program at all meetings at no cost during the 2014–2015 year, by which we could reach more than 10,000 herpers.]

4. Increasing SSAR's Reach Overseas.—Many suggestions were discussed to promote SSAR overseas and to increase our non-USA membership. A special effort should be made to reach students. [Copies of special SSAR membership ads were sent to several overseas meetings.] We could use additional funds to target overseas members. [See "President Aldridge's Referral," below.] Several members now pay the dues for overseas members, usually research colleagues. Ann Paterson is following up on this and hopes to expand this program.

President Aldridge referred the following question to the LRPC in 2013: "I would like the LRPC to consider the merits of setting up a fund in the SSAR budget for subsidizing the dues for (a limited) number of third world members. This fund would be used to subsidize the on-line membership dues. There are a number of options we could use to ensure equal access to potential members from different parts of the world and how to apply for the subsidy. With the on-line option, all the SSAR funds would go back into the budget. This also solves the problem of having different rates for membership based on income. The wording of this benefit is extremely important. Let me know what you think."

This idea arose from the LRPC meeting in Albuquerque. After fleshing out this idea in correspondence between Bob and Kraig, the issue was discussed by the LRPC. To a person, everyone on the LRPC thought the idea of helping overseas herpetologists was a good one. However, a large number of questions arose, among them:

1. *How do we define "Third World"?*
2. *What would the subsidy be?*
3. *First-come, first-served?*
4. *Who makes the decision?*
5. *Would money donated to this fund be diverted from other SSAR causes?*

It soon became clear that such a new program, despite its philosophical merits, created a very large number of issues. The committee was not able to reach a clear position because there were so many divergent views of what we should do. And as one put it, "we are adding a lot of pain for an unspecified but likely small amount of gain." Because our president was reading the commentaries, he could see the dilemma faced by the LRPC.

In mid-November, President Aldridge sent the following message to Kraig Adler: "I think at this point the idea of another category of membership needs to be shelved. The current categories and fees for membership need to be addressed first. So, bottom line, no further action by the LRPC is needed on this issue at this time.

Rafe Brown is Chair of the Local Committee for the 2015 meeting in Lawrence, Kansas (July 30–Aug 2). In his report, he detailed a number of specifics of the upcoming meeting including estimated costs, housing options, and special events (e.g.,

reception for senior herpetologists, plenary lectures, President's Travelogue, symposia, grad student social, picnic, auction, etc.). Some of the old SSAR favorites will be back—live animal displays, field trips, museum tours, herp trivia quizzes. In addition, updated digital versions of "*Herpetologists: Then and Now,"* and "*Amphibians of the Appalachians*," organized by David Dennis, Eric Juterbock, and Kraig Adler will be presented.

The Membership Committee from 2013–2014 included Ann Paterson and Marina Gerson (co-chairs), Jason Brock, Marina Gerson, Tim Halliday, John Herman, Kris Kaiser, Mark Oliva, George Pisani, and Wulf Schleip. Ann Paterson is stepping down as a co-chair after JMIH due to her treasurer responsibilities and Marina Gerson is stepping down as a co-chair at the end of the year due to other obligations. Both are willing to continue to serve on the committee if needed. However, this means that we need to find a new chair or co-chairs for the committee as soon as possible.

During 2013–2014, the Membership Committee continued to stay less active while waiting to see the results of their 2011 proposals. However, the committee did work on the following things: 1) more closely following membership data to examine patterns; 2) developing proposals for possible correspondence with new members and with members who fail to renew; 3) continuing to compile a list of other herpetological societies (both in the U.S. and internationally); and 4) responding to concerns and comments from members and non-members as needed.

Ann and Marina reported that the number of members continues to decrease. Over the next year, it will be important for the membership committee to closely look at patterns in new member subscriptions and in the loss of old members. It may be helpful to track member publications to see the effects of new page charge policies.

Ann and Marina now receive membership data each month, allowing them to monitor changes in membership and to examine whether different activities (such as mailings) affect membership. Even if these activities do not seem to influence membership numbers immediately, they may still increase awareness and have longer-term effects. Marina has analyzed the data in multiple ways, looking at: 1) numbers of individuals in different membership categories; 2) print versus online-only memberships; 3) numbers of members from different countries; 4) length of membership by subscription date (for this category, we do not know the initial date of subscription for members who renew each year but can begin to follow that in future); and 5) date of subscription. From looking at subscription dates, it is clear that most people join or renew between December and March. From looking at subscriptions by country, it appears that there may be opportunities for growth by considering more ways to promote the society internationally, in particular by making international students more aware of grant opportunities and by promoting the manuscript pre-submission service more.

The Mentorship Committee consists of Kris Kaiser (chair), Andrew Durso, Joe Mendelson, and Marion Preest. In its second year, the Mentorship Program aimed to retain a somewhat small size before scaling up in future years. In 2013, they paired eight students from across the societies with mentors. Mentees in the program ranged from pre-baccalaureate to beginning PhD students, and came from all societies. Mentees were all senior graduate students and postdocs. Follow-up surveys showed a general satisfaction with the program, and gave useful feedback for year three of the program. The program this year was advertised on the SSAR website and on the JMIH registration page under "Graduate Student Information," and applications were accepted for both mentors and mentees. For the 2014 meeting, this committee is working to expand the program to a somewhat larger (yet still manageable) size and is working with organizers to include program registration directly into registration for JMIH. They will also work to include all known pre-bacc students who will be attending to pair them with an appropriate mentor.

The Nominations Committee (Robert Espinoza, Chair) compiled a list of nominees for the positions of President-Elect, Treasurer, Secretary, Regular Board Member (two needed), Conservation Board Member (one needed), and At-Large Board Member (one needed). Ann Paterson and Marion Preest were willing to run again for the positions of Treasurer and Secretary, respectively. The nominees:

President-Elect.—Rafael O. de Sa, Richard Shine
Treasurer.—Ann Paterson
Secretary.— Marion Preest
Board Member (Regular).—Robin Andrews, Sara Ruane, Joshua Kapfer, Emily Taylor
Board Member (Conservation).—Kris Kaiser, Kim Lovich
Board Member (At-Large).—Richard Durtsche, Tony Gamble

Rob Denton (Resolutions Chair) presented resolutions at the SSAR Business Meeting in Albuquerque in 2013. These have been published in *Herp. Review*.

Josh Kapfer (Chair, Roger Conant Grants-in-Herpetology Committee) received 81 proposals. Most applications were in the "Laboratory Research" category. In 2013 the Board agreed to double the potential number of winners in each category and to create a new category (Undergraduate Research in Herpetology, five proposals received for 2014 award).

The winners each received $500 and they are:

Conservation.—**Javan Bauder**, University of Massachusetts, "Conservation Genetics of the Federally Threatened Eastern Indigo Snake (*Drymarchon couperi*) in Central Florida." **Bailey Patillo**, University of Memphis, "Salamander Susceptibility and Response to the Amphibian Fungal Pathogen *Batrachochytrium dendrobatidis*."

Education.—**David Steen**, Alabama Natural Heritage Program at Auburn University, "Living Alongside Wildlife: An Online Resource for Amphibian and Reptile Outreach and Conservation."

The Andrew H. Price Field Research Grant-in-Herpetology.—**Brian Folt**, Auburn University, "Does Leaf-drop Phenology Regulate Abundance Cycles of Terrestrial Amphibians and Reptiles in Wet Neotropical Forests?" **Scott Travers**, University of Kansas, "Adaptive Radiation and Community Assembly of Ceratobatrachid Frogs in the Solomon Islands."

Laboratory Research.—**Andrew Frank**, University of Connecticut, "Testing the Parallel Speciation Hypothesis in Western North American Skinks (*Plestiodon*)." **Sofia Prado-Irwin**, San Francisco State University, "Disease Dynamics of the Fungal Pathogen *Batrachochytrium dendrobatidis* in the California Salamander *Ensatina eschscholtzii*."

Travel.—**Christopher Akcali**, University of North Carolina-Chapel Hill, "The Role of Batesian Mimicry in Divergence and Speciation." **Brenna Forester**, Duke University, "Evaluating the Implications of Local Adaptation, Habitat Connectivity, and Gene Flow for Terrestrial Salamanders Under Global Change."

International.—**Nina Seren,** CIBIO Institute (Portugal), "Genetic Response to Heavy Metal Exposure in Amphibian Larvae Under Laboratory Experimental Conditions." **Marta**

Vidal-Garcia, The Australian National University, "Unraveling Body Shape Evolution in Australo-Papuan Myobatrachid Frogs."

Undergraduate Research.—**Renae Reed**, Peninsula College, "Quantifying an Active Population of Central America's Rarest Turtle, *K. angustipons*."

Since Spring 2013, the Website Subcommittee has been comprised of Carol Spencer, Raul Diaz, Vincent Farallo, Michelle Koo, Joe Mendelson, and Todd Pierson. This committee has accomplished an ambitious agenda with the ultimate goal of a new website and content management system that will benefit both visitors to the site as well as the future committee members who will need to maintain and update the site.

The Committee solicited bids from three experienced website designers. In August, 2013, Trish Roque (University of California Museum of Paleontology employee and independent website designer, who develops in WordPress) was selected. The committee felt Trish provided the most comprehensive and organized estimate and timeline for completion of the website. She designs eye-catching dynamic websites and has experience with academic users who need to keep detailed content current without depending on a coder for all updates. Once her website architecture and design is in place, Philip Kahn, web programmer, was selected to help with website maintenance/programming and to build any database or other programming needs in the future.

The committee has met more than five times in conference calls in 2014, with additional meetings with Michelle and Trish in person. The design and implementation is moving forward; the new website is based on the latest version of WordPress and has many customizations of specialized WordPress plugins to meet our desired features list. Although not designed specifically for mobile devices, the new website will be more compatible and flexible on different devices and platforms (e.g., OS).

As of 8 July 2014, all committee members have contributed to editing content and information for pages and currently Michelle, Raul, and Joe are putting this content into place on the website. Michelle created WordPress accounts for all website committee members and will proceed to create accounts for associated directors and SSAR personnel. These accounts have varying privileges, as some folks are allowed full editing and page changing rights whereas others can only edit and add text to pages. We are still editing the website and plan to make it public on 26 July 2014, four days before the next JMIH meeting and SSAR board meeting on 30 July 2014. The website will be live and replace the old site at http://ssarherps.org. The committee welcomes constructive comments from the public and members of the executive committee, directors, and editors.

Brian Crother, Chair, Standard English and Scientific Names Committee, reported that with the delay in posting the 7th Edition published for the 2012 World Congress, the SESNC developed a 7.1 edition specifically for online access. By the time of the 2014 JMIH, the new edition should be live online and dynamically updateable. Each new update to the online version will be recognized by changing the edition number, e.g., 7.1, 7.2…7.35, etc., until another hard copy version is published. Brian thanks Raul Diaz and his committee for their hard work in making the list a living document. Steven Tilley has been the chair of the Salamander Subcommittee and David Wake has been a member of that committee. They are stepping down after the new e-version is completed. Brian wants to thank them and recognize their excellent work on the Names Committee.

The third annual SSAR Student Poster Awards (Tiffany Doan, Chair) were presented at the Annual Meeting of the SSAR in Albuquerque. There were 40 eligible posters. In recognition of outstanding student poster presentations at the annual meeting, the following awards (a check for US $100 and a book from University of California Press) were made: Evolution, Genetics, & Systematics: **Shuangying Yu**, Texas Tech University, "Endosulfan and alpha-cypermethrin inhibit repair of DNA photo adducts and decrease transcription of nucleotide excision repair genes in *Xenopus laevis* embryos." Conservation & Management: **Katherine O'Donnell**, (University of Missouri), "Initial terrestrial salamander responses to prescribed fire and timber harvest in southeast Missouri." Ecology, Natural History, Distribution, & Behavior: **Kristin Winchell**, University of Massachusetts, Boston, "Phenotypic shifts in urban populations of the tropical lizard, *Anolis cristatellus*."

In 2013, Mike Jorgensen and Vincent Farallo (Co-Chairs, Student Travel Awards Committee) received 14 applications for the travel award, substantially lower than the numbers in previous years. The main role of the Student Travel Awards Committee is to accept applications for the award and coordinate with the awardees to supervise the silent auction table at the annual meeting; however, both Mike Jorgenson and Vincent Farallo were unable to attend the meeting to direct awardees and oversee the silent auction table. Two colleagues, Matthew Lattanzio and Christopher Howey, were kind enough to help take over this duty for the meeting in Albuquerque. Students receiving awards helped supervise the silent auction table as has been done in previous years. The Silent Auction raised $869.

Coordinators' Reports

Election Officer, Dan Noble, reported that no election was held in 2013.

In 2013, the SSAR/HL Live Auction returned to the "normal" operation of generating funds to be split between SSAR and HL. SSAR funds are used to support student travel awards. The Live Auction was organized by Greg Watkins-Colwell, Kirsten Nicholson, and Meredith Mahoney. This year we saw the return of Samantha Kahl, who had served as a student volunteer many times in the past, and returned this year to help organize. Efforts were made to include as many different auctioneers (with different auctioning styles) as possible and to rely upon the help of students who had not helped with the auction in the past. The live auction made $5,758. After all costs, the remainder was split 50-50 with HL, leaving $2,023.07 to help fund student travel awards.

Greg, Meredith, and Kirsten have been in discussion regarding the future of this committee. Greg will step down as the Chair of the Auction Committee following the Live Auction at the 2015 SSAR meeting in Lawrence, Kansas and Kirsten will step down after the 2014 meeting.

Representative to AIBS and BioOne, Al Savitzky, reported that BioOne, a nonprofit electronic publishing consortium, continues to provide online publishing services for the society and to return both royalties and profit-sharing proceeds to its member publishers. After several years, Al has resumed attendance at the P&P meetings as he was elected to the Board of Directors of BioOne. The P&P meetings provide an opportunity for the BioOne staff to report on the status of the organization, describe the financial return to member publishers, and provide background on issues relevant to online publishing and scholarly societies. Details regarding BioOne, including the presentations given from past P&P Meetings, can be found at http://

www.bioone.org/. This year BioOne reported that in 2013, its twelfth year online, the collection exceeded one million pages of content and over 13 million site hits. Net sales increased by 4.7% over 2012. Presentations at the meeting included those on MOOC's, the challenges of marketing scholarly journals in India, *Elementa: Science of the Anthropocene*, a new open-access, online-only journal launched in December 2013 by BioOne, and an algorithm that has been developed to assist society publishers in determining the costs and benefits of open-access publishing, as increasingly mandated by federal funding agencies. The algorithm considers such factors as embargo length and the proportion of content that is federally funded (and thus subject to OA mandate). The algorithm will be made freely available to BioOne member publishers.

The American Institute of Biological Sciences (AIBS) is an umbrella organization that serves about 160 member societies and organizations (MSOs), most of them in the broad areas of organismal biology and ecology. AIBS has been building upon several surveys it has conducted on the interests and activities of both individual researchers and biological societies. The 2013 annual meeting of the AIBS Council involved a discussion of trends, opportunities, and challenges facing the biological sciences and scholarly societies focused on biology. In addition to providing advice to its MSOs through its surveys and explorations of leadership issues in biology, AIBS continues to be active in a number of areas of immediate interest to our society's members. These include activities related to undergraduate and graduate education, natural history collections, and representing the interests of organismal biologists and ecologists to Congress. Society members are encouraged to register with the AIBS Legislative Action Center (LAC; http://policy.aibs.org/), which provides immediate alerts regarding relevant legislation and simplifies contacting individual legislators to express an opinion on those issues, many of which are related to conservation or the federal funding of science. Al's presentation lead into a long discussion of membership issues facing all or most scientific societies, how to reduce competition between societies, how to retain individual identities if societies merge, and what is the future of societies in general.

This year two symposium proposals were submitted to Symposium Coordinator Dick Durtsche for SSAR sponsorship at the 2015 SSAR meetings at the University of Kansas, with only one requesting funding.

The first proposal entitled "*Research Frontiers in Integrative Organismal Biology: Herpetological Horizons*" was submitted by Rafe Brown and Richard Glor. This symposium will bring together an array of mostly early-career faculty who use reptiles and amphibians in integrative studies of evolutionary biology. The organizers seek sponsorship of $1500 for travel and symposium dinner expenses. The symposium proposal was sent out for external review, and reviewer comments and the proposal were submitted to the SSAR Board for consideration of sponsorship.
The second proposal (confidential until the appearance of an announcement in an upcoming issue of *Herp. Review*) was submitted by David Cannatella, Anna Maglia, and David Blackburn as co-organizers. The symposium proposal does not request any funding, only SSAR sponsorship and it was sent to the SSAR Board for consideration.

New Business

Vinny Farallo and Todd Pierson (Wesite Subcommittee) showed the Board the new SSAR website and noted that it will be easy to update. A guideline for editing will be provided. The Board made a few suggestions about layout.

Greg Watkins-Colwell raised the issue of sponsoring pre-baccalaureate students (and their chaperones). Greg will ask the HEC to come up with criteria to determine how to choose which students to sponsor.

There was some discussion of whether SSAR wanted to make available to members an SSAR credit card. SSAR would receive a fixed amount the first time each card is used and then a much smaller amount with subsequent uses. The Board seemed interested in this idea and asked Treasurer Paterson to look into the details of this and come back to the Board with additional information.

President-Elect Bauer presented a request from Kraig Adler to use up to $15,000 from his Publication Reserve to support the attendance of senior herpetologists at the SSAR meeting in Lawrence in 2015. The Board voted unanimously to support this request. In later discussions it was decided to use money from the *Contributions to Herpetology* budget, and then transfer funds from the Reserve budget to the *Contributions* budget.

The Board then turned to brief consideration of ways in which SSAR and Center for North American Herpetology (CNAH) might work together. Although members of the Board seemed in favor of this idea, no specific recommendations were made. Earlier, Peter Uetz had initiated an e-mail discussion of the relationship between SSAR and the Reptile Database. It was agreed that this is a matter for the LRPC to discuss.

Provision of childcare at the annual meeting was then discussed briefly. There was general support from the Board, however the matter of liability was raised. It was recognized that there were questions that needed answering before SSAR could move on this. Erin Muths suggested that a committee be formed to investigate these issues.

The Board then turned to the 2015 budget. A balanced budget of $304,440 for 2015 was approved by the Board.
The meeting was adjourned at 1346 h.

SSAR Business Meeting

The Annual SSAR Business Meeting was called to order by President Aldridge (1800 h, Aug 2nd). Ninety-two members of SSAR were present (Fig. 8). Officers, Editors, and Committee Chairs who were at the Business Meeting introduced themselves

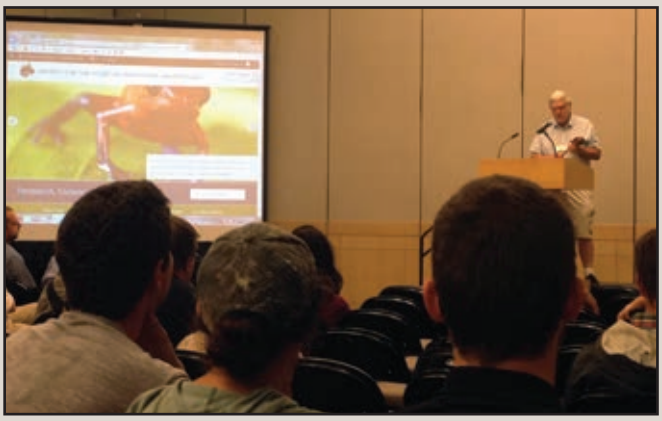


PHOTO BY M. PREEST

FIG. 8. Bob Aldridge presenting the new SSAR website at the SSAR Business Meeting.

PHOTO BY M. PREEST



FIG. 9. Winners of the Henri Seibert Student Paper Awards Awards. Back row L to R: Rafe Brown (Chair, Seibert Award Committee), Rachel Skinner, Drew Davis, Meagan Thomas, Patrick Moldowan, Elyse Freitas; front row L to R; Mark Herr, Chris Thawley, Matt Dickson.

PHOTO BY M. PREEST



FIG. 10. Winners of the SSAR Travel Awards. Back row L to R: Jason O'Connor, Michael Colley, Cameron Eddy, Andrea Long, Patrick Moldowan; front row L to R; Jason Bohenek, Jennifer Fill, Julie Ziemba, William Ternes, Jennifer Singleton.

PHOTO BY M. PREEST



FIG. 11. The traditional turning over of the gavel from President Aldridge to President-Elect Bauer.

to the other attendees and gave brief summaries of their Annual Reports and relevant information from the Board Meeting. There was applause given to acknowledge Erin Muths and Gad Perry who are stepping down as co-editors of *JHerp* and Tiffany Doan and Paul Bartelt who are replacing them. The outgoing and incoming editors mentioned some of the substantial perks of publishing in *JHerp*—free color, no page charges for members, online access immediately available after acceptance of most manuscripts, etc. Rafe Brown and Rich Glor did a great job hyping the 2015 meeting in Kansas. They specifically mentioned the events recognizing senior herpetologists, the live animal displays, the auctions, field trips, and the low cost of accommodation.

Rob Denton then read the following resolutions: "SSAR wishes to thank a large number of individuals for service to the Society. Even though outgoing co-editors of *Journal of Herpetology*, Erin Muths and Gad Perry, remain highly active with the journal, we wish to thank them at this stage for their several years of service to the Society in this capacity. Erin and Gad took over as editors with fairly short notice in 2010, and during their tenure they ushered in some important and very welcome changes to the journal. We would also like to acknowledge incoming co-editors Tiffany Doan and Paul Bartelt and thank them both for stepping unto this role. The following Associate Editors of *JHerp*.— Ximena Bernal, Tracey Brown, Tibor Hartel, Toby Hibbitts, Don Miles, Glenn Shea, and Tony Tucker—stepped down and we thank them for their work. In addition, we are grateful to the following members of the Editorial Board of *JHerp*. who have resigned recently: Dirk Bauwens, David Chiszar, Ellen Dawley, James Plaz, Douglas Rossman, Paul Verrell, and Howard Whiteman. At *Herpetological Review*, Jodi Rowley, Charles Painter, Jackson Shedd, Raul Diaz, and Beck Werhle concluded excellent runs of service. Bob Hansen wishes to particularly acknowledge Charles Painter, outgoing Section Editor for Natural History Notes. The Society joins Editors of *Catalogue of American Amphibians and Reptiles*, Travis LaDuc and Chris Bell, in thanking Bob Powell, Breck Bartholomew, and Ruthe Smith for their help in navigating through the logistics of editing this series. We thank Greg Watkins-Colwell, who was a member of the Herpetology Education Committee for several years, and Cathy Bevier, who was chair of the same committee for many years and then continued as a member. Both are stepping down. We particularly wish to thank the many hard-working members of the Website Committee: Carol Spencer (chair), Joe Mendelson, Raul Diaz, Vincent Farallo, Michelle Koo, and Todd Pierson. The new and extensively redesigned SSAR website is due to go live within a few days or weeks and we look forward to feedback from society members. We thank this year's SSAR President's Travelogue speaker, David Blackburn, for his excellent presentation "Adventures with African Amphibians." Thanks to John Sulzycki at CRC Press for his continued support of Seibert Award and Student Poster competitions. Thanks to both Ann Paterson and Marina Gerson for co-chairing the Membership Committee for the past several years. Thanks to Bobby Espinoza, chair of the Nominations Committee, for generating a strong slate of nominees for the upcoming 2014 election. Congratulations to the fifth winner of the SSAR/HL/ASIH Meritorious Teaching Award in Herpetology, Dr. Alan Richmond. Thanks again to those who served as mentors for students attending JMIH in our new and successful Mentorship Program led by Kris Kaiser and Andrew Durso. SSAR and Standard English and Scientific Names Committee Chair, Brian Crother, wish to acknowledge the long-standing contributions of Steven Tilley and David Wake to that committee. We thank Matthew Lattanzio and

Christopher Howe, who temporarily stepped in to take over Student Travel Awards Committee duties during the 2013 Albuquerque meeting. After tomorrow night's auction, Kirsten Nicholson is stepping down as a member of the Live Auction Committee, a position for which she has served ably and with enthusiasm for many years. We thank her. Finally, we are excited about our 2015 Annual Meeting with PARC, Kansas Herpetological Society, Missouri Herpetological Society, Arkansas Herpetological Society, and CNAH, to be held on the campus of the University of Kansas. We repeat our thanks from last year to the members of the Local Committee —Rafe Brown (Chair), Bill Duellman, Rich Glor, Linda Trueb, and George Pisani—for the extensive work they have put into the planning for this much-anticipated meeting."

Henri Seibert, Student Poster, and Travel Awards were presented by Rafe Brown, Tiffany Doan, and Vinny Farallo, respectively (Figs. 9, 10). There was then a very speedy handing over of the gavel from President-Aldridge to President-Elect Bauer (Fig. 11) and the meeting was adjourned.

List of Abbreviations Used

AES - American Elasmobranch Society
AIBS - American Institute of Biological Sciences
AP - Allen Press
ASIH - American Society for Ichthyology and Herpetology
CNAH - Center for North American Herpetology
HL - The Herpetologists' League
IRS - Internal Revenue Service
JMIH - Joint Meeting of Ichthyologists and Herpetologists
LRPC - Long Range Planning Committee
MOOC - Massive Open Online Course
MSO - Member Societies and Organizations
MTAH - meritorious Teaching Award in Herpetology
OA - Open Access
PARC - Partners in Amphibian and Reptile Conservation

—Respectfully submitted by **MARION PREEST**, *SSAR Secretary*

SSAR Election Results

Results of the 2014 SSAR election are as follows:

President-Elect: **Rick Shine**
Treasurer: **Ann Paterson**
Secretary: **Marion Preest**
Board Members (Regular): **Robin Andrews, Emily Taylor**
Board Member (Conservation): **Kim Lovich**
Board Member (At-Large): **Tony Gamble**

Thank you to all of the nominees who agreed to stand for positions, Robert Espinoza (Chair) and other members of the Nominations Committee, and Dan Noble (Election Officer).

2014 Seibert Awards Announced

The 23rd annual SSAR Seibert Awards were presented at the 57th Annual Meeting of the SSAR with the Joint Meeting of Ichthyologists and Herpetologists, hosted by the University of Tennessee, Chattanooga, 30 July–3 August 2014. These awards are named in honor of Henri C. Seibert, an avid supporter of SSAR who served as an officer for over 20 years. In recognition of outstanding student presentations at the annual meeting, an award was given in each of the following categories: Evolution/Systematics (5 presentations), Ecology (14 presentations), Physiology/Morphology (4 presentations) and Conservation (6 presentations). All awardees received a check for U.S. $200 and a book from CRC Press.

The Winners:

Systematics/Evolution.—**Elyse Freitas** et al. (Villanova University), "Molecular Phylogenetics and Patterns of Limb Loss in the Genus *Scelotes*."

Ecology.—**Chris Thawley** et al. (Penn State University), "The cost and benefits of adaptation: a case study using native fence lizards and invasive fire ants."

Conservation.—**Drew Davis** et al. (University of South Dakota), "Effects of Agricultural Tile Drainage on Amphibians in Eastern South Dakota."

Physiology/Morphology.—**Patrick Moldowan** et al. (Laurentian University), "Turtles with teeth: tomiodont morphology and functional significance in the Painted Turtle (*Chrysemys picta*)."

Honorable Mentions:

Systematics/Evolution.—**Rachel Skinner** et al. (Villanova University), "Phylogenetic Relationships of South African Geckos in *Pachydactylus geitje* Species Complex (Squamata: Gekkonidae)."

Ecology.— **(A) Meagan Thomas** and Steve Mullin (Eastern Illinois University), "Quantifying dietary overlap in a community of invertebrate feeding snakes." *Special undergraduate honorable mention!* **(B) Mark Herr** et al. (James Cook University), "Stressed snakes strike first: hormone levels and defensive behavior in free-ranging cottonmouths."

Conservation.—**Brian Crawford** et al. (University of Georgia), "Does pride work? Evaluating an NGO's integrative model for promoting community conservation behavior."

Physiology/Morphology.—**Matthew Dickson** et al. (California State - Northridge), "Rapidly adapting to the neighborhood: physiological responses of Mediterranean House Geckos to their introduced climates."

SSAR would like to thank this year's Seibert Judges Committee for their service: Jacqueline Litzgus, Laine Giovanetto, Richard Durtsche, Eric Juterbock, Phillip Bishop; William Peterman, David Blackburn, Matthew Klukowski, Richard Glor, Charles Linkem, and Rafe Brown (Chair).

SSAR Student Poster Award Winners for 2014 Announced

The fourth annual SSAR Student Poster Awards were presented at the 57th Annual Meeting of the SSAR and the Joint Meeting of Ichthyology and Herpetology in Chattanooga, Tennessee, 30 July–3 August 2014. This year there were 40 eligible posters. In recognition of outstanding student poster presentations at the annual meeting, a single award was given in each of the following categories: Physiology & Morphology (8 presentations), Ecology, Natural History, Distribution, & Behavior (22 presentations),

and Conservation & Management (10 presentations). Because few students entered the Evolution, Genetics, & Systematics category, those students were placed in other categories and no award was given in that category. All awardees received a check for US $200 and a book from CRC Press.

The Winners:

Physiology & Morphology.—**Krista Mougey**, Texas Tech University, "Thermal ecology and locomotor performance of the critically endangered Stout Iguana *Cyclura pinguis*."

Conservation & Management.—**Grant Connette**, University of Missouri, "Historic timber harvest predicts abundance but not genetic diversity of a terrestrial salamander, *Plethodon shermani*."

Ecology, Natural History, Distribution, & Behavior.—**E. Alexander Rohtla**, Villanova University, "Advertisement calls of the thick-toed geckos (Reptilia: Gekkonidae: *Pachydactylus*)."

SSAR thanks this year's judges: Tiffany Doan (Chair, State College of Florida, Manatee-Sarasota), Marina Gerson (California State University, Stanislaus), Jon Davenport (University of Montana), Bruce Kingsbury (Indiana-Purdue University Fort Wayne), Kristen Cecala (Sewanee-University of the South), Thomas Lozito (University of Pittsburgh), and Frances Irish (Moravian College).

NEWSNOTES

Global Ranavirus Consortium

The scientific community is increasingly aware that emerging infectious diseases pose a significant threat to global biodiversity. A group of viruses in the genus *Ranavirus* (Family Iridoviridae) cause disease in amphibians, reptiles and fish, and appear to be emerging in some populations. *Ranavirus*-associated die-offs in larval and adult amphibians have been documented in the Americas, Europe, and Asia, with death rates often exceeding 90% during an outbreak. *Ranavirus* infections also have been reported in wild and cultured fish populations worldwide. While research on reptiles has been slower to accumulate, recent evidence suggests that ranaviruses are capable of causing morbidity and mortality in free-ranging populations. The capability of ranaviruses causing disease in poikilothermic animals belonging to three vertebrate classes emphasizes the potential risk of these pathogens to global biodiversity.

The Global Ranavirus Consortium (GRC) was formed following the First International Symposium on Ranaviruses. The goal of the GRC is to facilitate communication and collaboration among scientists and veterinarians conducting research on ranaviruses and diagnosing cases of ranaviral disease. Since formation, the GRC has published 3 popular articles on the 2011 Symposium and organized the Second International Symposium on Ranaviruses, which was held 27–29 July 2013 concurrently with the International Conference of the Wildlife Disease Association in Knoxville, Tennessee, USA. The Third International Symposium on Ranaviruses will be held 30 May–1 June 2015 at the University of Florida in Gainesville, Florida, USA. The GRC recently hosted a workshop on ranaviruses in Harbin, China.

The GRC was recently approved to write the first book on ranaviruses, which will be published as an eBook (i.e., chapters can be purchased independently) by Springer. Target publication date is November 2014. The GRC formed global regional discussion groups (see regional contact below) to help facilitate the transfer of information among scientists, and created a website with recent publications. To improve understanding of the global distribution of ranaviruses, the GRC is working to secure funds to create a Global Ranavirus Reporting System. The Executive Board has finalized bylaws for the GRC, and will be offering membership options in 2014.

If you would like to be listed as a GRC scientist or contribute to activities, please contact Dr. Matthew Gray or your regional representative on the Executive Board (see below). We also encourage interested students and scientists to join the GRC LISTSERV.

To post to the GRC listserv, send an e-mail message to GRC@LISTSERV.UTK.EDU. Appropriate content for posting includes (but is not limited to) sharing information on recent ranavirus die-offs, research findings, or publications; asking questions or discussing topics related to ranaviruses or ranaviral disease; and providing information about GRC activities. Anyone can post to the listserv (including non-members) and all postings are archived and can be viewed by the public. If you would like to become a member of the GRC listserv, you can join at this website: http://listserv.utk.edu/cgi-bin/wa?A0=GRC.

GRC Executive Board.—Matthew Gray, Ph.D., Director, University of Tennessee; Jesse Brunner, Ph.D., Associate Director, Washington State University; Amanda Duffus, Ph.D., Secretary/Treasurer, Gordon College; Yumi Une, D.V.M., Ph.D., Asia Representative, Azabu University; Ellen Ariel, Ph.D., Australia Representative, James Cook University; Rachel Marschang, D.V.M., Ph.D., Europe Representative, Universität Hohenheim; Thomas Waltzek, D.V.M., Ph.D., North America Representative, University of Florida; Rolando Mazzoni, D.V.M., Ph.D., South America Representative, Universidade Federal de Goiás; Greg Chinchar, Ph.D., Honorary Advisor, University of Mississippi Medical Center.

Updated Standard Symbolic Codes for Institutional Resource Collections in Herpetology & Ichthyology

A new up-to-date version (v.5) of the *Standard Symbolic Codes for Institutional Resource Collections in Herpetology & Ichthyology* is now available via the ASIH website: http://asih.org (under Resources tab).

The new list contains 1633 abbreviation records including 125 newly added, as well as important corrections to previously listed abbreviations. Authors are encouraged to use/cite the new list. Older versions of the list should be deleted. Citations of <http://www.asih.org/node/204> should be avoided, as that URL no longer links to a list of collection codes.

Please send additions, corrections, and updates, however minor, to Mark Sabaj Pérez at sabaj@ansp.org.

ARMI Receives Special Recognition



The Wildlife Society's Biometrics Working Group provides for a Special Recognition Award meant to highlight a group or individual that has made an outstanding contribution to the development and application of quantitative methods to the fields of wildlife science and management. This year the award is presented to the Amphibian Research and Monitoring Initiative (ARMI), implemented by the U.S. Geological Survey and the U.S. Fish and Wildlife Service. ARMI has shown a deep appreciation for biometrical methods and their importance for drawing inferences about biological populations and communities. Most significantly ARMI propelled forward the development of a class of models (occupancy) that is now used worldwide by ecologists and conservation biologists. This funding support was largely responsible for dozens of papers on the development of occupancy modeling and for the 2006 book (MacKenzie et al. 2006. *Occupancy Estimation and Modeling: Inferring Patterns and Dynamics of Species Occurrence*. Elsevier, San Diego, California; see Acknowledgments in this book) summarizing developments to that time. This development has not only been useful to ARMI projects, but has also benefited the worldwide community of animal ecologists, wildlife managers, and the field of biometrics.

The Wildlife Society Recognizes Ken Dodd



Each year The Wildlife Society, which boasts 10,000 members, selects one authored book to receive its "Outstanding Book Award." This year they honored an anuran title, Ken Dodd's *Frogs of the United States and Canada*. Ken's two-volume work is certainly the most thorough reference available on frogs of the region. Previous winners of this award include Carl Ernst and Jeff Lovich for *Turtles of the United States and Canada (2011)*, James E. Petranka for *Salamanders of the United States and Canada* (1998), E. O. Wilson for *Diversity of Life* (1992), and Walter Auffenberg for *The Behavioral Ecology of the Komodo Monitor* (1983). SSAR congratulates Ken Dodd for this honor.

Vogt Receives 9th Annual Behler Conservation Award

The Behler Turtle Conservation Award is a major annual international award honoring excellence in the field of tortoise and freshwater turtle conservation and biology, and leadership in the chelonian conservation and biology community. The award is co-presented by the Turtle Survival Alliance (TSA), the IUCN/SSC Tortoise and Freshwater Turtle Specialist Group (TFTSG), the Turtle Conservancy (TC), and the Turtle Conservation Fund (TCF, the four organizations most closely tied to the turtle conservation legacy of John Behler. The award honors and commemorates the memory and legacy of John L. Behler (1943–2006), late Curator of Herpetology at the Bronx Zoo, Wildlife Conservation Society, New York. John was also Chair and Co-Chair of the IUCN/SSC Tortoise and Freshwater Turtle Specialist Group and a founding board member of both the TSA and TCF, as well as a founding board member of the Chelonian Conservation Center, later renamed the Behler Conservation Center in his honor by the recently created umbrella organization, Turtle Conservancy.

Not many scientists can say that they have altered the course of an entire field of study; Richard C. (Dick) Vogt can, not once, but now twice! His pioneering work with Jim Bull in the late 1970s on temperature-dependent sex determination (published in the journal *Science*) forever changed how we view the evolution and conservation of chelonians. Astoundingly, he has followed up this incredible career-defining achievement with yet another—his most recent work on chelonian vocalization has again turned the turtle world upside down and is setting a new path for how we practice turtle conservation.

Dick and his students have not only shown that a number of turtle species are "talking", but that there is communication between adult females and hatchlings in the Giant Amazonian River Turtle (*Podocnemis expansa*). This is the first documented evidence of post-hatching parental care in chelonians. Our conservation community must now consider how these findings might affect how we headstart this and other species. We must ask ourselves if we are disrupting important transference of learned behaviors from mother to offspring by keeping hatchlings in captivity for weeks to years before their release. We may unwittingly be doing more harm than good, much like how many early turtle conservationists incubated turtle eggs at cool temperatures, thereby producing only males, before Dick's seminal work demonstrated the error of their ways.

After nearly twenty years of living in Mexico—which culminated in his most recent book *Turtles of Mexico: Land and Freshwater Forms*, co-authored with the late John Legler, Dick yet again decided to challenge himself and begin anew. Dick's next project is to finish John Legler's long-awaited book, *Turtles of Australia*. SSAR congratulates Dick on this worthy honor.

—Excerpted and edited from *Turtle Survival Magazine* (2014:72–73, Brian D. Horne and Andrew Walde).

Reptile Database Update

The latest version of the Reptile Database (released 1 Dec 2014) features 10,119 species (including 139 described this year) and 35,615 references (including 1,203 published this year). The Reptile Database has also established a Scientific Advisory Board (SAB) that will help to make strategic decisions but will also advise with controversial taxonomic issues. For instance, the SAB recommended not to break up the boas into multiple smaller families as recently proposed by Pyron et al. (2014. Zootaxa 3846[2]:249–260). The database now also offers materials for herpetology classes with assignments for students to read and

curate herp papers. This should help students to hone their skills in reading and analyzing the primary literature but also supply the database with new information. For more details see http://www.reptile-database.org.

MEETINGS

Meeting announcement information should be sent directly to the Editor (herpreview@gmail.com) well in advance of the event. We also welcome brief reports of meetings; please consult the Editor for details.

8–9 January 2015—California/Nevada Amphibian Populations Task Force 2015 Meeting, Pepperdine University, Malibu, California, USA. Information: dbradfo@herpconbio.org

20–22 February 2015—Desert Tortoise Council Symposium, Las Vegas, Nevada, USA. Information: http://www.deserttortoise.org/symposium/

2–5 April 2015—62nd Annual Meeting of the Southwestern Association of Naturalists, San Diego, California, USA. Information: http://www.biosurvey.ou.edu/swan/annualm.html

18–19 April 2015—Terrapin, Tortoise & Freshwater Turtle Meeting, Dalaman, Mugla, Turkey. Information: Chelonian1@aol.com (Chuck Schaffer).

19–24 April 2015—35th Annual Symposium on Sea Turtle Biology and Conservation, Dalaman, Muğla, Turkey. International Sea Turtle Society. Information: http://iconferences.seaturtle.org/

27–30 May 2015—38th Annual International Herpetological Symposium, San Antonio, Texas, USA. Information: www.internationalherpetologicalsymposium.com

15–19 July 2015—American Society of Ichthyologists and Herpetologists and The Herpetologists' League annual meeting, Reno, Nevada, USA. Information: www.asih.org

30 July–3 August 2015—58th Annual Meeting of the Society for the Study of Amphibians and Reptiles (with Partners in Amphibian and Reptile Conservation, Kansas Herpetological Society, and International Society for the History and Bibliography of Herpetology), Lawrence, Kansas, USA.

OBITUARIES

Herpetological Review, 2014, 45(4), 746–750.
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Martin John Fouquette, Jr., 1930–2014

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Our major professor, Martin John Fouquette, Jr., or "Jack" as he was known to one and all, provided over 46 years of service to students of three different academic institutions (University of Florida, 1959–1961; University of Southwestern Louisiana, 1961–1965; Arizona State University, 1965–2005, plus 2005–2014 as an emeritus faculty member). As former students, we pay tribute to Jack herein by reviewing his distinctive qualities as a person and a scientist. We draw special attention to his unique approach to mentoring that we shared with all his graduate students from the early 1960s through to the beginning of the 21st Century. From 1960 through 2002, Jack advised 9 PhD and 15 MA students, many of whom went on to successful careers in herpetology. Jack was a life member of all three North America-based herpetological societies (ASIH, HL, SSAR), and he loved going to meetings (Fig. 1), in part because of his affection for his students and his desire to see them do well.

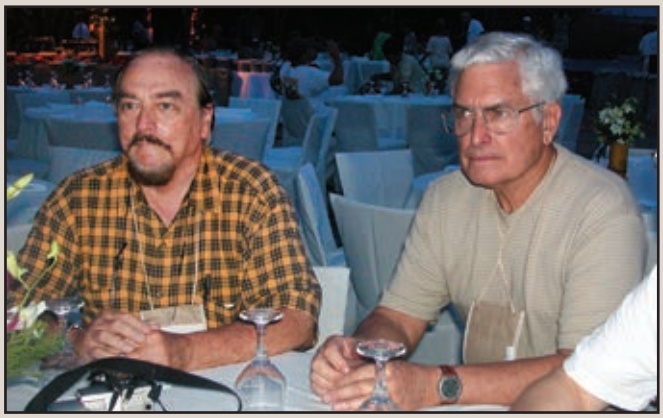


PHOTO COURTESY OF DAVE HARDY

FIG. 1. Jack loved attending meetings; here is Jack, next to Dave Hardy, in Manaus, Brazil, 2003, at the World Congress of Herpetology.

Martin J. Fouquette was born in Philadelphia, Pennsylvania, 14 June 1930, but moved to Huntington, a small town in West Virginia, within two years, before settling in Kerrville, Texas, just five years later. He had no memories of Philadelphia, but did recall a dramatic roof-top rescue by motor boat following the 1936 flooding of the Ohio River in West Virginia when water reached the second story of their house. Perhaps that experience was strongly imprinted—he told us often about how a flood event could be extremely useful for "herping," such as the rare flooding of the Painted Rock Reservoir on the Gila River in the 1970s, which led to the opportunity for his graduate students to collect hundreds of snakes isolated on ever-shrinking islands. Students that knew of Jack's love of early westerns on TV ("Have Gun, Will Travel" was a favorite) always assumed that any appearances to the contrary, Jack was taken with rural Texas where he spent his formative years.

PHOTO COURTESY OF JACK FOUQUETTE AND GIL WEBRE



FIG. 2. Jim Delahoussaye and Jack Fouquette (left), in the field recording chorus frogs somewhere in the southeastern US, 1964. Proofs from a school newspaper article, University of Southwestern Louisiana, 1964.

His early days in Texas led to his matriculation at the University of Texas, Austin, a result of simple geographic proximity. By the finish of high school he loved snakes, but his parents—like those of so many budding herpetologists!—had convinced him there were "no jobs" in herpetology, so he initially majored in chemistry. Shortly after arriving at UT, however, exposure to the lab group under Frank Blair influenced him to change his major to zoology. He finished his BA, and pursued a Masters under Blair, focusing on gartersnakes, his first love (Fouquette 1954). Afterwards, he joined the USAAF to avoid serving in the infantry even though it entailed four years of service instead of two. He requested that he be assigned to Panama, where he served as a navigator on a seaplane, a Grumman S-16, in the air rescue branch of the Air Force, because he imagined it would afford more research opportunities. He discussed matters with Blair. At a time when (apparently) major professors like Frank Blair could provide adequate direction in a few short sentences, Jack was advised to simply purchase the requisite (and newly developed at the time) recording equipment so he could gather data on calling in various hylid frogs in Central America. Blair advised that by purchasing a recorder, he could spend time off in the Canal Zone recording frogs, which he did (e.g., Fouquette 1960a, b, c; Littlejohn and Fouquette 1960); subsequently he used those data to finish his PhD at UT Austin (1959), just two years after his release from the Air Force in 1957.

Living in Austin during the 1950s, Jack roomed with Ralph Axtell; he told Ralph the story of an amazing night-driving experience one stormy evening in Panama: "I found a big snake crossing the road late at night as I returned home; it was dark and I was in a hurry, so I just threw it in the trunk…when I opened it in the morning, there was a huge bushmaster there!" Consistent with his typically understated delivery, Jack never offered any additional details as to the method of capture or subsequent processing of the specimen. After working with tropical hylids (Fouquette 1958, 1961a, b, 1968a,c; Duellman and Fouquette 1968), his subsequent time in the southeastern USA consolidated his interest in the chorus frogs and other hylids of the Gulf Coast states, leading to some of his most important contributions (e.g., Littlejohn et al. 1960), a lifelong interest in the anurans of that region (Fig. 2), and the honor of having a recently described taxon named for him (Lemmon et al. 2008).

Jack had been quite happy in his first two academic positions, the first at the University of Florida and the second at the University of Southwestern Louisiana. Still, he was excited about the prospects of establishing a bioacoustics research program in the arid Southwest, in part because he was already aware of the opportunities the deserts provided given prior pioneering work by both Frank Blair and his brother, A. Pat Blair. His intimate knowledge of what the Blair brothers had accomplished in southwestern Utah paid dividends decades later when he provided one of us (BKS) with detailed information on the mating behavior of Arizona Toads, derived from work by both Frank and Pat, and Jack's firsthand experience with bufonids in the 1960s and 1970s (e.g., Fouquette 1968b, 1970, 1980).

The 1970s were productive for Jack in part because he coauthored a number of papers with students (e.g., Fouquette and Pyburn 1972; Pyburn and Fouquette 1971; Fouquette and Delahoussaye 1977; Mitchell and Fouquette 1978). In 1975 he published one of the few definitive empirical studies of reproductive character displacement, reporting on this rarely documented but widely discussed phenomenon in chorus frogs of the southeastern USA (Fouquette 1975). On either side of that date, as major professor or committee member, he signed off on the dissertations and theses of students that went on to have profound impacts on the herpetology of the Southwest (e.g., Platz and Platz 1973; Congdon et al. 1974). Laurie Vitt, a widely renowned herpetologist with hundreds of publications and thousands of citations to those contributions to his credit, represents one of Jack's most productive students during the decade of the 70s.

"*…Jack was simply one of the nicest people I ever encountered—he wasn't pushy, he wasn't arrogant, and he seemed to have a level of integrity that I now know is much rarer in academia than we would like to think…when I arrived at ASU, Jack's students thought the world of him, which of course was a good sign.*"

—Laurie Vitt

It was also during the 1970s, when interest in sexual selection and speciation was peaking, that Jack's empirical contribution on character displacement in chorus frogs appeared—highly regarded as one of the only examples accepted by one and all within this contentious field. Jack's meticulous and careful approach to data collection was truly tested when during the final stages of his last NSF grant his PhD student was killed in a car crash while returning to Arizona, with the loss of a considerable amount of the data they had collected. We have often wondered if that tragic accident was in part responsible for the fact that after 1979, Jack did not submit any papers for peer-reviewed publication for years.

One of the final peer-reviewed publications by Jack, which appeared in 1980 in the *Journal of Herpetology*, was an ideal

starting point for the early career of one of us (BKS), as it was a careful analysis of the influence of temperature on call variation in the Arizona Toad (*Bufo microscaphus*). Over the next decade as the literature on anuran call variation in relation to sexual selection exploded, literally hundreds of papers would be published on how female frogs and toads select their mates on the basis of variation in call attributes, which were known to be influenced by size and temperature. Many of these contributions were inherently limited because of a lack of detailed analysis of temperature effects—something Jack's contribution clearly addressed. Papers were circulating with untested assumptions of strong relationships between male size and call variables, and those same variables and temperature. Jack's fine attention to detail during data collection impressed his students dramatically. It was because of his insistence that his students understand call variation at the most basic level that one of us (BKS) was able to submit a critique of a widely read publication within a day of its reception. The requisite data were "on hand;" data that showed that the assumptions of size and temperature effects in a bufonid in that manuscript were unfounded. The data for the critique existed solely because Jack required they be available to verify "you're doing it right."



PHOTO BY SANDRA LEANDER

FIG. 3. Max Nickerson and Jack Fouquette, 2012, ASU campus; Max, who received his PhD from ASU in 1970, is holding the award he received as a distinguished alumnus of ASU, awarded by the School of Life Sciences, and presented by Jack, a member of Max's dissertation committee.

The changing job market for field biologists in general, and herpetologists in particular, was a source of worry for Jack beginning in the late 1970s and early 1980s; like his parents decades before, he became concerned about the career opportunities for his students.

"*…hence I learned, at a very young age, that if you hankered for a career as a field biologist you were liable to starve to death.*"
—John Nichols

Jack often described how fortunate he was to have only had to compete with a handful of applicants for the position at Arizona State University in 1965. He knew that he was lucky to have been on the job market in herpetology when positions were relatively common—consequently, he was especially sympathetic to the plight of his graduate students, some of whom applied for dozens of positions prior to receiving even an interview. Some of his students left the academic career path in the 1980s and 1990s as a direct result of the reduction in job opportunities. Jack allowed his students great latitude in the projects they pursued, and he only coauthored manuscripts they published when it was truly a partnership—he knew it was critical they establish an independent record of scholarship.

Jack's horribly (like that of some "hoarders") cluttered office was legendary, as noted by all of his students. The quantity of materials therein reflected the breadth of his interests, which spanned all of herpetology, including snakes (Fouquette and Potter 1961), lizards (Fouquette 1968d; Mitchell and Fouquette 1978), and communities (Fouquette and Delahoussaye 1966; Fouquette and Lindsay 1955). When one of us (BKS) was preparing to depart for Jack's old stomping grounds, Austin, I had an educational experience in Jack's office thanks to having mustered the courage to ask for the return of a pamphlet loaned to Jack precisely four years prior. Fully expecting it was lost for good, and that the request for its return would only embarrass him, it was truly shocking to find that before the item had been fully described, Jack rose, and in as straight a line as could be achieved among the piles of paper leaning this way and that, walked to one towering collection, and from roughly 3 feet off the ground, one third from the top, deftly selected the edge of an item, and in a flurry similar to magician with a tablecloth, extracted it, steadied the remainder with the other hand, handed the pamphlet off all in one motion while returning to his seat with the comment, "Oh...I'd hoped to read that by now."

The great variation in the nature of species boundaries among anuran amphibians interested Jack throughout his professional career. He could recall in detail zones of intergradation and hybridization among dozens of North American bufonids, in part as a result of his association with the Blair lab during the heyday of investigations of species status in the genus *Bufo*. Even though he was "an old timer," he openly embraced new developments in systematics, including cladistics and the rise of the evolutionary species concept. Jack joined the newly formed Willi Hennig Society early. Though he came of age when the subspecies concept was dominant, he often confided that colleagues had "gotten it all wrong" when various forms had been subsumed as subspecies. Nonetheless, he never was one to be outspoken about such "mistakes" and never embarrassed students or colleagues in this respect. The Arizona Treefrog was one of his favorite examples. He was especially happy that one of his academic "grandchildren" (Erik Gergus, a PhD student of BKS and Jack) took on the issue and settled it convincingly, allowing the Arizona Treefrog (*Hyla wrightorum*) to be recognized by one and all as a species (and not a subspecies of *H. eximia*). His urgings led to a number of publications on elevation of subspecies to species, long before Joe Collins argued as much over twenty years ago. By contrast, Jack's last contribution, a "resurrection" of Schmidt's 1953 checklist (Schmidt 1953), coauthored with A. Dubois (Fouquette and Dubois 2014), has been reviewed somewhat less than favorably, both on the pages of this journal (Lannoo 2014) and elsewhere (Hillis 2015). The reviewers of Jack's final contribution, a self-published book, in part were sympathetic to his taxonomic conservatism, but overall, the book's reception has been, at best, lukewarm, largely as result of Jack's inconsistency in his self-avowed commitment to taxonomic stability at higher levels.

One of the oddities of life as an academic scientist is that you can be "adopted" into a family; you can become part of a lineage

by developing a relationship with a faculty member. Jack's major professor, Frank Blair, was an amazingly productive biologist, supervising 49 Ph.D. and 51 M.A. degrees between 1968 and 1982, and as a result was invited to lecture at more than 90 venues worldwide during the same span. As Jack's major professor, he can be viewed as our academic grandfather. Our simultaneous tenure at UT Austin in the mid-1980s was a return to our family roots, after a fashion. The days of large laboratories in which major professors in herpetology have many graduate students throughout their lifetimes are over (Sullivan 2014); nonetheless, Jack was an ideal mentor for those who were lucky enough to have him. When one of us (BKS) established an informal meeting in the Phoenix area in the early 1980s, "herp group" (inspired by, and named for a similar program organized by David and Marvalee Wake at UC Berkeley), the other (JEP) was the first speaker given he happened to be on a trip through his old stomping grounds some half dozen years after he obtained his PhD. Jack Fouquette was the most consistent participant at dozens of Phoenix Area Herp Groups over the next three decades. During his last Herp Group, Jack thoroughly entertained one and all with photographs he'd taken at the last World Congress of Herpetology in Canada in 2012. Jack used the photographs to administer a "herpetologists, then and now" quiz to all that arrived that evening.

Jack loved talking science, and he loved talking about scientists (Fig. 3), though he never said a bad word about anyone—more than one person referred to Jack as the "nicest man I ever met" or "the kindest person, ever," a real rarity for the scientific community. We doubt that there has ever been a more soft-spoken herpetologist than Jack Fouquette. His mild-mannered demeanor was as much his trademark as the rough-as-bark persona of Chuck Lowe was his (Rosen 2004). As different as these two Arizona herpetologists might have been, it is arguable that they both left their marks on herpetology at least in part through the students that they left behind. It might be that his gentle nature prevented Jack from serving as a hard-nosed, strict disciplinarian that could mold and shape students to his wishes. Instead, Jack was one to let students have a free rein, and to influence their growth and development with nuance and subtlety. It was this difficult-to-articulate characteristic that set Jack apart from others, that allowed students and some faculty members at ASU to look with envy at Jack and his relationships with his productive students. We knew we were special. We knew we had something that no one else in the department had: we had a major professor we could count on absolutely, one that was always available to us, come what may, one that would literally open his house to us if personal issues might have made it necessary, even if it meant supporting us for months at a time. It was time that Jack was always ready and willing to provide us. Jack finally had no more time to give on 28 August 2014.

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ERRATA—

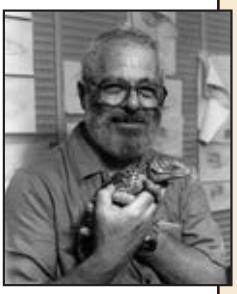
In the Geographic Distribution note by Costa-Campos and Freire concerning *Scinax trilineatus* (2014, volume 45, number 3, p. 459), the second author's name should read Eliza M. X. Freire.

In the Natural History Note by Beaman and Tucker (2014, volume 45, number 3, p. 514, the lat/long coordinates listed are incorrect. The correct coordinates are 38.6459°N, 121.29842°W.



AWARDS FOR STUDENT* ATTENDANCE AT SSAR MEETING (UNIVERSITY OF KANSAS, 2015)

The *Carl Gans Collections and Charitable Fund* (hereafter the "Gans Fund") is pleased to announce that it will support two kinds of awards to students*—both graduate and undergraduate, but not postdoctoral—who are attending the SSAR meeting at the University of Kansas next summer (July 30 to August 3, 2015; for a description of this meeting see page 751 in this issue). There will be 20 awards covering the full student registration fee of US$150 and limited funds to support student travel expenses. Both awards are *open to all students* regardless of nationality*. **The deadline for receipt of applications for both awards is February 15, 2015**.



To be eligible, applicants (1) must certify their student status with a separate message from their professor; (2) must list the herpetological society or societies to which they belong*; (3) must be presenting papers (oral or poster) at the meeting; and (4) the paper's subject area must be within the broad spectrum of research conducted by Professor Gans on the biology of amphibians and reptiles (especially morphology, systematics, faunistics, behavior, physiology, and evolution). Applicants must provide a paragraph (no more than 300 words) describing the work to be presented at the meeting, to enable the selection process. *Award announcements will be made about March 15, 2015*, allowing all applicants to know their status before meeting registrations begin.

• **REGISTRATION AWARDS**. Selections will be made by SSAR. The application, research paper description, and certifications should be sent by email to: Dr. Marion Preest, SSAR Secretary, at mpreest@kecksci.claremont.edu (if by air mail, to her at: Joint Science Department, The Claremont Colleges, Claremont, CA 91711, USA). The award funds will be sent by SSAR directly to the University of Kansas, which will receive a list of the successful applicants.

• **TRAVEL AWARDS**: Selections will be made by the Gans Fund, on the recommendation of its Scientific Advisory Board. The Board consists of: Kraig Adler, Cornell University (USA), Aaron Bauer, Villanova University (USA), Amos Bouskila, Ben Gurion University (Israel), Herbert Rosenberg, University of Calgary (Canada), Linda Trueb, University of Kansas (USA).

A limited number of travel awards will be made. The maximum award for applicants from the USA and Canada is US$500; for all other countries $1000. The application, research paper description, and certifications should be sent to the Gans Fund; application details may be found at: http://www.carlgans.org (click on "Grants" in top menu bar). Submissions will be made via the web. Applicants should detail their expected expenses for the meeting including the travel costs; be sure to indicate the amount you are requesting from the Gans Fund and the amounts received (or applied for) from other sources. The award funds will be distributed by SSAR directly to the successful applicants. Further details may be obtained from the Gans Fund at the on-line address given above.

* For this meeting of SSAR, the meeting organizers have defined "student" as all student members of SSAR, HL, and ASIH, as well as student members of all national and international herpetological societies, who will be allowed to register at the "student member" rate of US$150.

Third Update!

UNIVERSITY OF KANSAS SSAR MEETING

THURSDAY, JULY 30 – MONDAY, AUGUST 3, 2015

Society for the Study of Amphibians and Reptiles

co-sponsored by Partners in Amphibian and Reptile Conservation (PARC)

together with the herpetological societies of Kansas, Missouri, and Arkansas, the Center for North American Herpetology, *and the* International Society for the History and Bibliography of Herpetology

Plenary Update: additional feature presentation by Harry Greene: *"The Life and Times of a KU Herpetology Icon: Henry Fitch and 70 Years of Snake Ecology"*



Set just a few miles from where he conducted seven decades of landmark research in community dynamics of Kansas snakes, this special SSAR event will review the monumental contributions of Henry Fitch, the *undisputed Father of Snake Ecology.*



Additional special activities conceived to honor the contributions of Henry Fitch include a block of talks on snake ecology (to be moderated by Harry Greene) and tours of KU's Fitch Reserve, site of his classic long-term snake ecology work (to be guided by George Pisani).

SSAR will hold its 2015 meeting on the beautiful and centrally-located campus of the University of Kansas. All scientific sessions will be held in the Kansas Union, which is adjacent to the KU Museum of Natural History, the setting of more than a century of research and graduate education in herpetology. The intimate campus setting will facilitate personal and friendly interactions while moderating fees for registration and lodging.

This unique campus format meeting will include oral and poster presentations, silent and live auctions, vendor displays, student social, symposia, and special lectures provided by **David Hillis** (Keynote) and **Miguel Vences** (President's Travelogue). SSAR will resurrect popular activities from the past, including:

- Redesigned audiovisual shows arranged by David Dennis and Eric Juterbock.
- Reception honoring distinguished senior herpetologists, allowing students to interact personally with luminaries in the field.
- Herpetological Quiz, arranged by the graduate students at UT Arlington and KU, with prizes for winners.
- Live Kansas amphibians and reptiles (organized by KHS), with photographic set-ups for use by delegates.
- Guided tours of the newly renovated Biodiversity Institute.

PROJECTED COSTS FOR KU MEETING

■ *Registration fees (member rates):*

Students $150
Regular $295
Seniors, retired / over 70 . . . . . $150

■ *Dorm room rates (on campus, linens included):*

Dual-occupancy rooms or suites, per day . . . . . .starting at $35
Single-occupancy rooms or suites, per day . . . . . starting at $55

There are many motels near campus. Motels allow more persons per room, at lower per-person costs (as low as $25/person). Full details will be included in the *Registration Announcement,* to be posted in Spring 2015.



KANSAS *MASTICOPHIS FLAGELLUM.* PHOTO BY CHAN KINN ONN



CROTAPHYTUS COLLARIS. PHOTO BY CHAN KINN ONN

Symposia Updates: *Finalized Participants*

Bones, Frogs, & Evolution

Organized by David Blackburn, Anne Maglia, and David Cannatella

This event will celebrate the exceptionally productive 40 years of scholarship of Linda Trueb and will include presentations by Ana Maria Baez, David Blackburn, David Cannatella, Luis Coloma, Eli Greenbaum, Juan Guayasamin, Anne Maglia, Dave McLeod, Greg Pregill, Chris Sheil, Helio de Silva, Erik Wild, and Marvalee Wake. Introduction by Leonard Krishtalka and Summary by William Duellman.



Frontiers in Integrative Organismal Biology: Herpetological Horizons

Organized by Rich Glor and Rafe Brown

This event will bring together a group of exceptionally research-active herpetologists working at the forefront of evolution-related fields, using amphibians and reptiles as study systems. Topics include speciation, adaptive radiation, convergence, phenotypic evolution, and the evolution of development—all through the lens of genomic approaches to understanding evolution of amphibians and reptiles. Participants include Frank Burbrink, Todd Castoe, Ben Evans, Matt Fujita, Luke Harmon, Ryan Kerney, Adam Leaché, Emily Lemmon, Jim McGuire, Rachael Mueller, Dan Rabosky, Erica Rosenblum, Robert Thompson, John Wiens, and Kelly Zamudio. Summary by David Wake.

Awards for student attendance at the University of Kansas meeting are being offered by the Carl Gans Fund. See page 750 for details and definition of "student."







Field Herpetology of the Southwest

Southwestern Research Station — 24 July–2 August, 2015

This 9-day course will introduce participants to an outstanding diversity of amphibians and reptiles of Arizona's Chiricahua Mountains and surrounding deserts.

Labs and lectures will focus on identification and ecology of herps. The majority of time will be spent in the field, hiking through low and high elevation habitat.

For more information about the course, contact Dawn Wilson. Ph: 520-558-2396; email: dwilson@amnh.org; http://research.amnh.org/swrs/herpetology-field-course

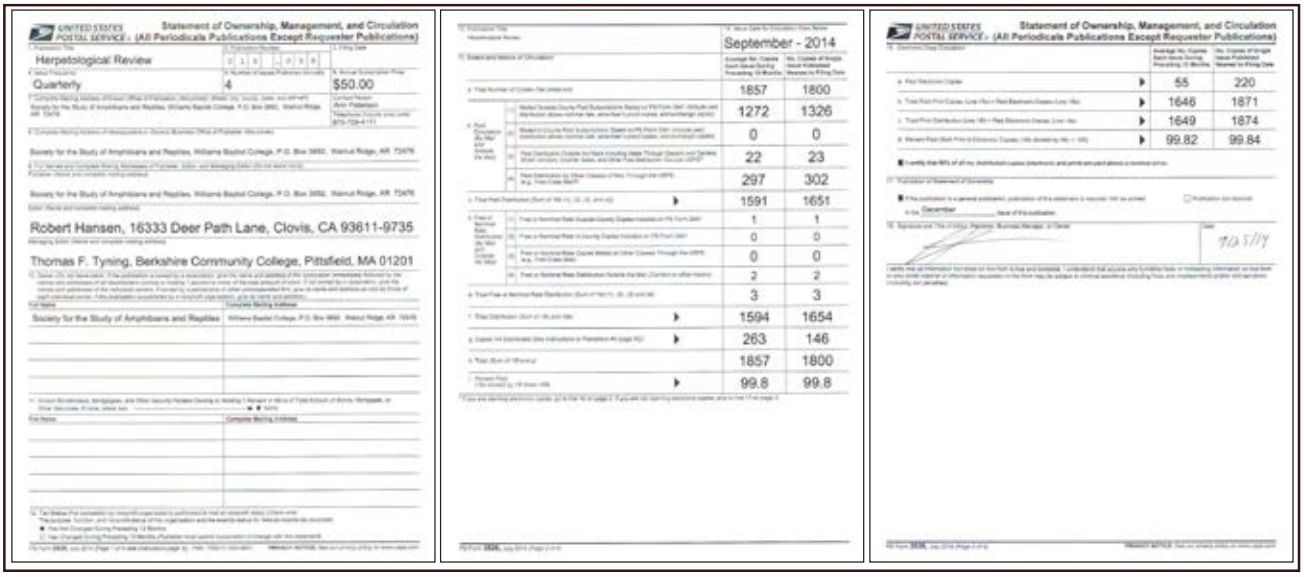












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December

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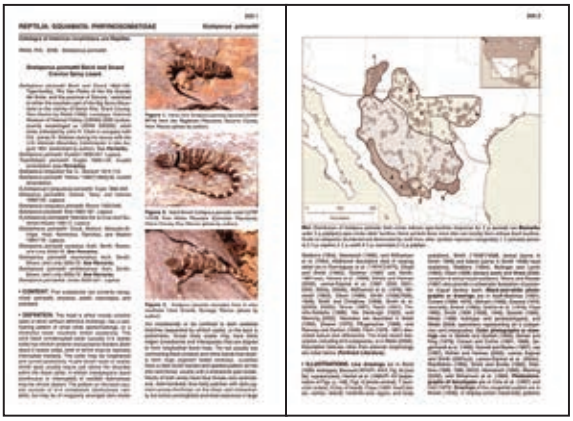
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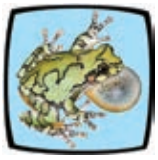
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Ontogeny of Color Pattern in *Aspidoscelis tigris punctilinealis* (Dickerson), Sonoran Tiger Whiptail, in Central Arizona

Aspidoscelis tigris (Tiger Whiptail) is an abundant and widely distributed ground-dwelling heliothermic lizard in deserts and adjacent arid lands in the western United States and northwestern Mexico. The species and/or its derivatives have also colonized islands situated east and west of the Peninsula of Baja California (Walker et al. 1966; Walker and Maslin 1969, 1981; Wright 1993; Grismer 2002). Extensive geographic variation in scutellation, color pattern, and body size is present in the species and several continental and insular subspecies are recognized (Taylor and Walker 1991, 1996; Dessauer et al. 2000). Based on Dessauer et al. (2000), Taylor (1990), and Taylor and Walker (1996), three subspecies of *A. tigris* occur in Arizona: *A. t. punctilinealis*; *A. t. septentrionalis*; and *A. t. tigris* (see map in Dessauer et al. 2000). The geographic range of *A. t. punctilinealis* (= *Cnemidophorus tigris gracilis*; Taylor and Walker 1991, 1996; Reeder et al. 2002) also extends through the Mexican state of Sonora to the type locality on the largest of all Mexican islands, Isla Tiburón (~1200 km^2), Gulf of California, Sonora. Southeastward, it is distributed from Cochise Co., Arizona, into Hidalgo Co., New Mexico, where the only known zones of hybridization (= secondary intergradation) occur between *A. t. punctilinealis* from the west and the taxon from the east variously treated as either *A. t. marmorata* (= *C. t. marmoratus*; Dessauer and Cole 1991; Dessauer et al. 2000) or *A. m. marmorata* (= *C. m. marmoratus*; Hendricks and Dixon 1986).

Sonoran Tiger Whiptail (*A. t. punctilinealis*), diagnosed primarily on the basis of color pattern characters, in desert flat communities has been the focus of several detailed studies pertaining to genetics (Dessauer and Cole 1991; Dessauer et al. 2000), meristic variation (Walker et al. 1966; Taylor 1990; Taylor and Walker 1991; Dessauer et al. 2000), and taxonomy (Walker et al. 1966; Taylor and Walker 1996; Dessauer et al. 2000). Nevertheless, these studies have left substantial gaps in our knowledge of ecology, body size variation, and ontogenetic development of color pattern in the widely distributed and ubiquitous *A. t. punctilinealis*. For example, those who picture Sonoran Tiger Whiptail as a mottled or spotted lizard with stripe fragments dorsally and a black throat and chest ventrally, as described by Dessauer et al. (2000) and Taylor (1990) using specimens in the size range of adults, would find that young-of-year (YOY) individuals have completely different dorsal and ventral patterns that are intriguing exceptions to that image. We infer that such drastic ontogenetic variation in color pattern in *A. t. punctilinealis* is of some unknown adaptive significance to YOY and adults, rather than the mere results of developmental processes. Thus, we conducted this field and laboratory investigation to obtain data pertaining to the complexities of individual and ontogenetic variation in color pattern which were not listed as objectives in other studies of the subspecies (e.g., Walker et al. 1966; Taylor 1990; Taylor and Walker 1991; Dessauer et al. 2000).

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Materials and methods.—We assessed life coloration in YOY individuals either collected or photographed by BKS in 2012 and 2013 in the vicinities of Phoenix, Maricopa Co., and Payson, Gila Co., central Arizona, to describe the juvenile pattern of *A. t. punctilinealis* (Fig. 1; Appendix 1). We also obtained digital photographs of the dorsum and ventrum of a juvenile of *A. t. punctilinealis* from Isla Tiburón, Sonora, Mexico, in the California Academy of Sciences (CAS; Appendix 1). We used a sample of 28 specimens collected by BKS and associates in May and June 2006 from Gila Co., Arizona, to assess and describe individual and ontogenetic variation in adults of *A. t. punctilinealis* (Fig. 2; Table 1; Appendix 1). This sample was also used to determine the mean and range of variation of granular scales between the paravertebral stripes at midbody (PV) and the mean and range of variation in percentage of the granular scales around midbody located between the paravertebral stripes (PV/GAB). A sample of *A. t. punctilinealis* (Fig. 3; Appendix 1) collected from in Maricopa Co. 50 km SW of Phoenix was photographed for comparison with specimens from Gila Co. in the vicinity of Payson (Fig. 4). We used calipers to measure the SVL of each preserved specimen of Sonoran Tiger Whiptail to the nearest mm, some of which were also measured prior to preservation.

Results.—Throughout the vast binational range of *A. t. punctilinealis* gradual ontogenetic changes occur throughout the life cycle (~38 mm to >106 mm) to strikingly transform most aspects of both the dorsal and ventral color pattern components seen in YOY to the different pattern ensembles seen in adult males and females (Figs. 1–3). However, two aspects of the dorsal pattern and scalation are not subject to ontogenetic variation; the number of granular scales (i.e., spacing) between the paravertebral



FIG. 1. Young-of-year *Aspidoscelis tigris punctilinealis*. Top and center: vicinity of Phoenix, Maricopa County, Arizona (SVL = 38 mm [lateral stripes present], 30 June 2012 and SVL = 50 mm [lateral stripes absent], 7 July 2013, respectively). Bottom: vicinity of Payson, Gila County Arizona (SVL = 42 mm [lateral stripes present], 30 July 2013).

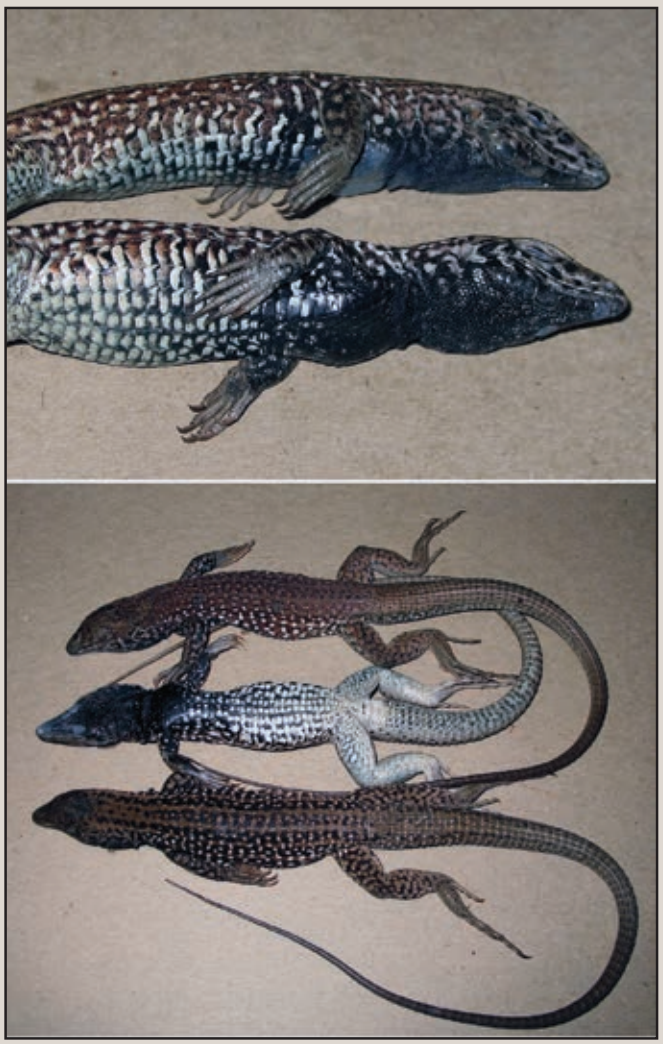


FIG. 2. Adults of *Aspidoscelis tigris punctilinealis* from vicinity of Payson, Gila County, Arizona (elevation = 1600 m), showing variation in dorsal and ventral color patterns (top = 26 May 2006; bottom = 27 May 2006).

stripes at midbody (PV = 7.6 ± SE 0.27, range 5–12, N = 28) and percentage of the granular scales around midbody located between the paravertebral stripes at midbody (PV/GAB = 8.7 ± 0.26, range 6.0–12.0, N = 28). The narrow spacing of the paravertebrals, the dorsal-most pair of pale longitudinal stripes, in all except specimen BKS 1841 with a PV count of 12, is correlated with the absence of a middorsal vertebral stripe.

Consistently present in the dorsal pattern of YOY of *A. t. punctilinealis*, based on individuals collected from Isla Tiburón (March–August 1964, 1967), vicinity of Phoenix (June–July 2012, 2013), and vicinity of Payson (July–August 2013) are white to gray to tan components on the body and limbs set within a brown-black to black ground color. Typically, such juveniles have six vivid pale-colored longitudinal primary stripes (i.e., three on each side of body; Fig. 1), numerous distinct spots of variable shapes in the lower aspect of each side of the body, and incipient (i.e., developing) short bars arranged perpendicularly to the stripes. Also present are elongate gray-white vermiculations of variable shapes on the fore and hind limbs.

The three stripes (ventral to dorsal) described from the right side of the body, and mirrored on the left, of a captured/released YOY from Payson (e.g., the individual of 42 mm SVL in Fig. 1) include: 1) the lateral extending from posterior to the ear opening to the hind limb then posteriorly from it along the side of the anterior third of the tail (the part of the stripe on the trunk is gray-white, very irregularly margined with constrictions, interruptions, and vertical extensions into the intervening fields); 2) the dorsolateral extending from the superciliary scales on the right lateral aspect of the head that continues onto the anterior third of the tail (the part on the trunk is gray-white, moderately irregularly margined with no interruptions); and 3) the paravertebral extending from a parietal scale on the posterior part of the head to the base of tail then onto the tail as a linear series of spots

TABLE 1. Categories of striping patterns in female and male specimens of *Aspidoscelis tigris punctilinealis* from Gila County, Arizona, collected by Brian K. Sullivan (BKS). SV = stripes visible (0 = all primary stripes + vertebral (V) are visible); SD = stripes disrupted: 2 = laterals are disrupted; 4 = laterals and dorsolaterals are disrupted; 6 = laterals, dorsolaterals, and paravertebrals are disrupted.

BKS collection number (N)	Sex and SVL mm (N)	SV	SD
1841 (1)	84 (1)	6 + V	0
1800, 02, 14, 15 (4)	69, 76, 75, 73 (4)	4	2
1837 (1)	88 (1)	2	4
1799, 1801, 03, 10-13, 16, 18, 36, 38, 39, 40 (13)	68. 79, 82, 95, 75, 76, 83, 62, 95, 94, 101, 82, 81 (13)	4	2
1804, 17, 19, 20, 21, 22 (6)	92. 97, 87, 99, 94, 106 (6)	2	4
1805, 09, 35 (3)	91, 96, 100 (3)	0	6



FIG. 3. Adults of *Aspidoscelis tigris punctilinealis* from 50 km southwest of Phoenix = W of Mobile on SR 238 at mile marker 24 (elevation = 350 m), Maricopa County, Arizona, showing variation in dorsal and ventral color patterns (top and bottom, same individuals, from 14 August 2006).

(the part on the trunk is gray-white, only slightly unevenly margined, and has no interruptions). One adult female (BKS 1841; 84 mm SVL) from near Payson has six primary stripes and an unevenly margined vertebral stripe indicating that an occasional YOY of *A. t. punctilinealis* has seven stripes all of which persist into adulthood.

In *A. t. punctilinealis*, the longitudinal areas of dark ground color between the light hued stripes on both sides of the trunk constitute the fields, here described on the right side of the same YOY from Payson. The fields include: 1) a brown-black lower lateral (located ventral to lateral stripe) with a linear array of >20 distinct gray-white spots and incipient vertical bars; 2) a black upper lateral (located dorsal to lateral stripe) with a linear series of 21–22 distinct isolated gray-white spots; 3) a black dorsolateral (located dorsal to dorsolateral stripe) with no evidence of spots; and 4) the right half of the middorsal (between the paravertebral stripes) with no evidence of either spots or a vertebral stripe (Fig. 1). The forelimbs are black with a profusion of gray-white spots and vermiculations. The hindlimbs are black with gray-white streaks, vermiculations, and spots. The head is dark brown with some scales having black edges. The tail is striped anteriorly, becoming a distinctive hue of blue posteriorly. Ventrally the Payson juvenile is mostly gray-white, though some dusky gray-black is evident in the anterior thoracic region.

Comparisons of Phoenix YOY with the description of Payson YOY revealed subtle differences. An individual from Phoenix of 38 mm SVL (Fig. 1) and based on the right side has a straighter and essentially continuous lateral stripe, a paravertebral continuously extending onto the anterior third of the tail, and a lower lateral field marked by an essentially linear series of spots. A slightly larger lizard from Phoenix (50 mm SVL in Fig. 1) was photographed *in situ* from the left side. It differs from the preceding ones from Payson and Phoenix in having no evidence of either a lateral stripe or of the fragments thereof and, thus, no subdivision of lateral ground color into upper and lower lateral fields, though present is a profusion of variable gray-white spots and vermiculations ventral to the dorsolateral stripe. Moreover, this lizard lacks a hue of blue on the posterior part of tail. Two YOY individuals photographed by BKS 10 August 2013 from Phoenix, one of ~42 and one of ~55 mm SVL, have yet additional pattern components including developing spots in the dorsolateral fields and a vertebral stripe to near the forelimbs followed by an alignment of "stripe fragments" more posteriorly, pattern components not apparent in the three YOY previously described. A YOY from Isla Tiburón (CAS 104460) closely resembled six-striped juveniles of the subspecies from Phoenix.

The color patterns in adults of *A. t. punctilinealis* from the vicinity of Payson (Fig. 2; Table 1), and those from the Phoenix area (Fig. 3) ~111 km to the southwest, differ based on individual variation in the same size classes and the stage of ontogenetic development at the time of collection which are not strictly correlated with SVL in either of these areas. In all except one adult from Payson, the seven-striped female, the laterals if present in the juvenile pattern, have become disrupted by development of black ground color in the stripe configuration. However, the dorsolaterals have become disrupted in only seven (87–106 mm SVL; Table 1) and the paravertebrals are also disrupted in only

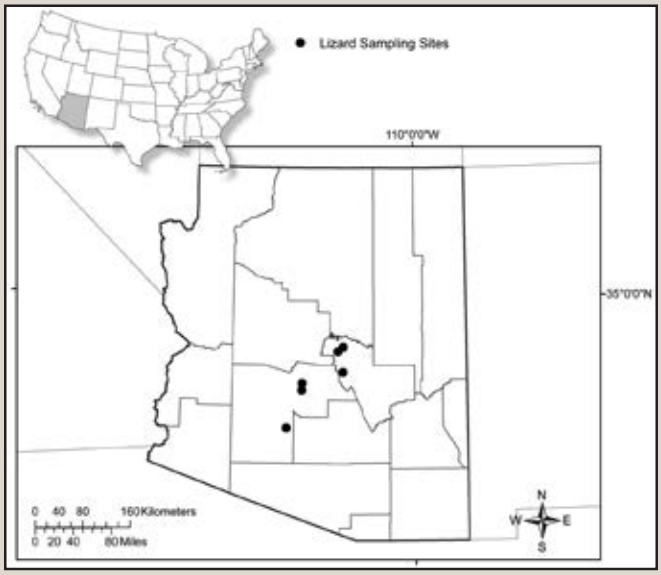


FIG. 4. Three sampling sites for *Aspidoscelis tigris punctilinealis* in Gila County (right) and three in Maricopa County (left), Arizona, referenced in this report.

three (91–100 mm SVL; Table 1). The typical mature dorsal pattern in this form, then, consists of a variable number of brown-tan stripes and stripe fragments, a profusion of gray-white spots of a variety of shapes which occur in all of the black fields and superimposed on stripes and stripe fragments, in addition to the spotted and vermiculated fore and hind limbs (Figs. 2–3; Table 1). The tail becomes brown-black without either evidence of stripes or distinct spots. The head becomes dark brown with scattered black spots. From a distance in the field, large adults of *A. t. punctilinealis* appear as brown-black lizards with gray-white spots. Ventrally, both males and females develop a darkly blotched to solid black throat, gular fold, and thoracic region, and a checker-board pattern of black and gray-white scales on the abdomen (Figs. 2–3). The ventral surfaces of the hind limbs and tail have dusky to black scales and blotches (Figs. 2–3).

Discussion.—Walker and Maslin (1969, 1981) found YOY color patterns and ontogenetic development important in the assessment of taxonomic boundaries, and potentially of adaptive significance, in other taxa of the *A. tigris* species group (sensu Walker and Maslin 1969). Ontogeny of color pattern was not included as an objective in previous studies of *A. t. punctilinealis*. Taylor (1990) analyzed *A. t. tigris* and *A. t. punctilinealis* in a contact zone in northwestern Arizona, but did not consider juvenile patterns because the characters of color pattern analyzed required lizards of adult sizes in the range of 74–101 mm SVL. Similarly, Dessauer et al. (2000) studied a hybrid zone between *A. t. punctilinealis* and *A. t. marmorata* (= *A. m. marmorata*) in Hidalgo Co., extreme southwestern New Mexico, using samples comprising lizards of 62–97 mm SVL. Herein, we used samples spanning ~38–106 mm SVL, with the largest preserved male examined having a record body length for *A. t. punctilinealis* (individuals measured by BKS prior to preservation exceeded 115 mm SVL).

Ontogenetic loss of some or all stripes is not uncommon among species of *Aspidoscelis* (Duellman and Zweifel 1962; Walker 1981a, b; Walker and Cordes 2011), but the adaptive significance of these color pattern changes remains problematic. Given that adults and juveniles of *A. t. punctilinealis* occupy the same habitats whether in the vicinities of Phoenix or Payson (Fig. 4), any adaptive value presumably relates to variation in behavior rather than habitat selection (BKS, unpubl.). The dorsal striped pattern of juvenile lizards may offer protective coloration in areas with grass cover and the broken light of shrubs, whereas the spots mixed with black and brown components in adults would provide a cryptic effect in more open areas dominated by rocks of various sizes and little vegetation. Also of unknown adaptive significance in *A. t. punctilinealis* is the extensive development of black pigment on the ventral surface of adults. North of Payson in Arizona, southern Utah, and southwestern Colorado, the subspecies is replaced by *A. t. septentrionalis* (Plateau Tiger Whiptail) which has a different striping pattern that includes supernumerary stripes and lacks an extensive ventral distribution of black pigment. However, ontogenetic changes in color pattern from hatchling through adulthood have not been assessed in *A. t. septentrionalis*.

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APPENDIX 1

Young-of-year of *Aspidoscelis tigris punctilinealis* from Arizona photographed for inclusion in Fig. 1 and used in descriptions of color pattern. Maricopa County: 1) Cave Buttes, east end of Union Hills, just west of Cave Buttes Dam, 12S 402225E, 3731675N, NAD CONUS, 1927; 2) Phoexix, immediately west of Lookout Mountain Preserve, vicinity of 9th Street, 12S 401604E, 3720058N; 3) Gila County: vicinity of Payson.

Preserved specimens of *Aspidoscelis tigris punctilinealis* from Arizona and Isla Tiburón, Sonora, Mexico, variously examined for construction of Table 1, inclusion in Fig. 2, and used for descriptions of adult color patterns. Gila County: 1) Tonto Creek, 11.2 km SE of State Road = SR 87 along SR 1188, UTM 12S 471296E, 3750378N 1927 (Brian K. Sullivan = BKS 1799–1804, N = 6); 2) Forest Road 414, 5.6 km SW of Payson, UTM 12S 62837E, 3785055N (BKS 1809-1816, 1839-1841, N = 11); 3) Houston Mesa Trailhead, 1.6 km NW of Payson, UTM 12S 471684E, 3792453N 1927 (BKS 1805, 1817-1822, 1835-1838, N = 11). Mexico: Sonora: Isla Tiburón (15 August 1964 [University of Colorado Museum of Natural History = UCM 26634-26678, N = 45]; 19 July 1967 [UCM 35662, N = 1]). We obtained digital photographs of the dorsum and ventrum of a juvenile (California Academy of Sciences 104460) of *A. t. punctilinealis* from Isla Tiburón.

Preserved specimens of *Aspidoscelis tigris punctilinealis* examined and photographed (Fig. 3) from Arizona for comparisons. Maricopa County: 50 km SW of Phoenix = W of Mobile on SR 238 at mile marker 24 (12S 375649E, 3656656N; elev. 350 m).

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Estimating Clutch Size Using Eggshell Fragments in Depredated *Macrochelys temminckii* Nests

Nest predation rates are extremely high in many freshwater turtle populations (Ewert 1979), which limits recruitment and makes it difficult to determine population production patterns. Mean clutch size is a critical component of demographic analyses of turtle populations because it is needed to determine annual fecundity (Congdon et al. 1993, 1994; Reed et al. 2002). Therefore, the ability to reliably estimate clutch size from depredated egg shell fragments could provide a more robust estimate of annual fecundity in turtle populations with very high nest predation rates than would estimates derived from intact nests alone.

In some cases it may be possible to estimate clutch sizes in depredated turtle nests by counting the number of egg shells found in and around the nest cavity. However, depredated egg shells may be crushed or shredded into numerous small fragments (Rearden 1951; Hernandez et al. 1997), and it can be very difficult and time consuming to piece individual eggs back together in order to estimate clutch size. As an alternative, we predicted that the total mass of shell fragments collected around depredated nests could be used to estimate clutch size. Turtle shells consist of an outer calcified layer and two fibrous shell membranes that collectively comprise an average 11–12% (range = 4–25%) of the total egg mass (Miller and Dinkelacker 2008). The contribution of the calcified and fibrous layers to the total mass of the egg shell varies substantially among species, but exhibits low variability within a species (Ewert 1979).

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In an effort to reestablish an extirpated population in southern Oklahoma, USA, 249 adult *Macrochelys temminckii* were released in oxbow lakes at Tishomingo National Wildlife Refuge (TNWR) and surrounding Army Corps of Engineer land in 2007 (Moore et al. 2012). Nesting activity has been monitored every year following the release as part of a larger effort to gauge the success of the reintroduction. As is the case in many turtle populations, predation by raccoons was a major source of egg mortality (Moore et al. 2012; Miller and Ligon 2014). Because nest predation rates approached 100% when nests were not protected (Moore et al. 2012), direct determination of clutch sizes was not feasible. Therefore, we tested the efficacy of using eggshell fragments collected from depredated nests to estimate clutch sizes in this *M. temminckii* population.

Collection of shell fragments.—Shell fragments were obtained from intact nests of known size, depredated natural nests of unknown size, and depredated artificial nests of known size. The intact nests of known size were laid either by brood stock at the Tishomingo National Fish Hatchery (TFNH) or by

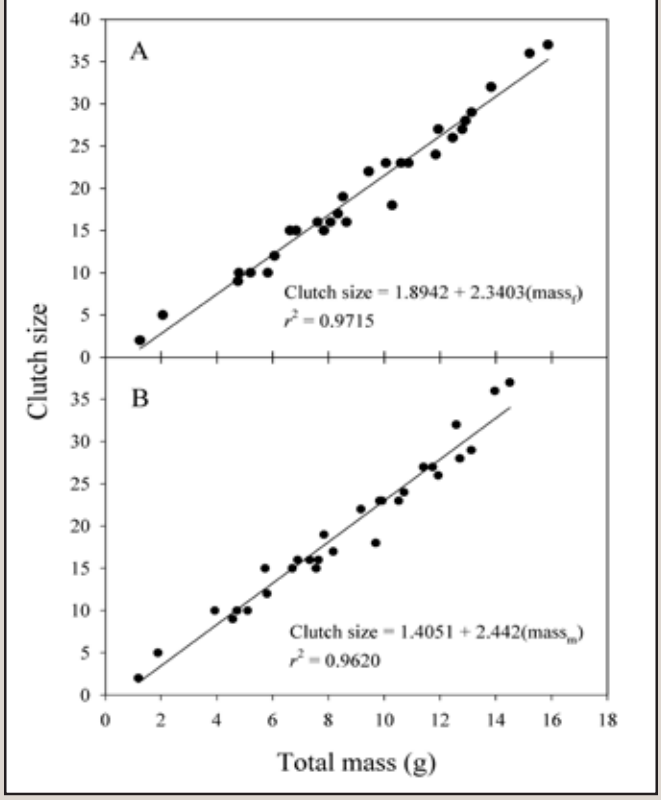


FIG. 1. Clutch size as a function of (A) dried shell fragment mass (mass$_f$) and (B) dried shell membrane mass (mass$_m$).

females released at TNWR in 2007. Reported clutch sizes for intact nests include only hatched eggs (not infertile eggs or eggs with embryos that failed to fully develop) because we used only shell fragments from eggs that hatched to construct our models. The depredated natural nests of unknown size were laid by females released at TNWR in 2007. The depredated artificial nests of known size were composed of inviable eggs laid by brood stock at TNFH and buried at TNWR as part of a separate nest predator study.

Nests laid at TNFH in the summers of 2010 and 2011 were excavated within a few hours of being constructed and the eggs were incubated at a constant temperature of 28.5°C in plastic containers filled with moist vermiculite (1:1 vermiculite:water by mass). We protected intact nests located at TNWR in the summer of 2010 with hardware cloth until the end of July, at which point we excavated the nests, with incubation completed at a constant temperature of 28.5°C as above at TNFH. We collected shell fragments from the plastic containers after the eggs had hatched. Intact nests located at TNWR in 2011 failed to produce hatchlings and were not included in the study.

When we located depredated natural nests at TNWR in 2010 and 2011, we searched within approximately 2 m of the nest cavity for shell fragments. In 2011, we obtained shell fragments collected from depredated artificial nests of varying clutch sizes (range 5–40). These nests were created at TNWR as part of a separate study designed to record raccoon behavior during predation events (Thompson 2013). The eggs that we used came from inviable clutches laid by captive females at TNFH. All shell fragments were stored in labeled plastic bags and frozen until they were processed.

Preparation of shell membranes.—Shell fragments were first rinsed to remove substrate and any remaining egg content. It was possible to reconstruct entire, or nearly entire, egg shells from shell fragments that were at least two-thirds intact. We estimated the percent missing for each reconstructed egg shell within a clutch and labeled it with a unique clutch and egg number combination. We put each reconstructed egg shell in a 50°C drying oven for 24 h and then recorded the mass of each (± 0.0001 g). This included the mass of the membrane and any of the remaining calcified layer, much of which flaked off prior to and during the drying process. Additional shell fragments that could not be assigned back to an individual egg shell within the clutch were dried and weighed together. We soaked each reconstructed egg shell and all additional shell fragments in 75 mL of 5% acetic acid for 24 h to remove the remaining calcified layer. We put each reconstructed egg shell and all additional shell fragments back in a 50°C drying oven for 24 h and then reweighed them. For each clutch, we added the masses of dried reconstructed egg shells and additional shell fragments to obtain the total mass of dried shell fragments for the entire clutch, both with and without residual calcium carbonate. Decalcified shell fragments will hereafter be referred to as shell membranes and those with the calcified layer as shell fragments.

In contrast to shell fragments collected from hatched eggs, most depredated shell fragments were too small to piece together. With the exception of four clutches, we processed depredated nests as an entire clutch instead of as individual eggs. After rinsing, the shell fragments from each depredated clutch were collectively dried, weighed, and soaked in 2 L of 5% acetic acid for 24 h. If calcium remained after 24 h, we placed the shell fragments in an additional 1.5 L of 5% acetic acid for another 24 h. After the calcified layer had dissolved, we dried and reweighed the shell membranes from the entire clutch.

Statistics.—We assessed the relationship between the total mass of shell fragments from intact nests and clutch size and the relationship between total mass of shell membranes from intact nests and clutch size using least-squares means linear regression. The resulting linear equations were then used to estimate clutch sizes of depredated nests. We did not include clutches of depredated artificial nests in our analysis but instead used them to validate the accuracy of our models. All analyses were performed using Sigma Plot 8.0.

Results.—We collected shell fragments from 29 intact clutches of known size, 16 depredated natural nests of unknown size, and 7 depredated artificial nests. Clutch size in the intact nests was 2–37 eggs. We reconstructed 531 eggs from the 29 intact clutches and 46 eggs from four of the depredated clutches. The mass of a reconstructed shell membrane averaged 0.4352 ± 0.0517 g (mean ± SD) and the mass of a reconstructed shell fragment averaged 0.5342 ± 0.2731 g.

Clutch size scaled positively and significantly to both total clutch shell fragment mass and shell membrane mass (Fig. 1). The resulting linear equations were:

$$\text{Clutch size} = 1.8942 + 2.3403 \times (\text{Fragment mass}) \quad \text{(eqn. 1)}$$
$$\text{Clutch size} = 1.4051 + 2.4420 \times (\text{Membrane mass}) \quad \text{(eqn. 2)}$$

Although shell fragments were expected to generate more variable results than membrane mass because of the varying amounts of calcium carbonate that remained adhered, using shell fragments produced a higher correlation coefficient with clutch size than did shell membranes (r^2 = 0.9715 and 0.9620,

TABLE 1. Actual and estimated clutch sizes of seven depredated artificial nests.

Nest ID	Number of eggs	Shell fragment mass (g)	Estimated clutch size	Shell membrane mass (g)	Estimated clutch size
AN 1	17	21.6294	49	7.1654	16
AN 2	40	45.9073	106	16.9766	40
PN 1	15	20.0436	45	6.2449	14
PN 2	5	7.8529	16	2.9483	6
PN 3	15	22.4225	50	7.0504	16
PN 4	15	20.0291	45	7.2535	16
PN 5	5	7.3090	15	2.2667	4
Mean	16.0		46.6		16.0

TABLE 2. Estimated clutch sizes in depredated natural nests based on total membrane weight. Estimated clutch sizes are rounded to the nearest whole egg.

Nest site waypoint	Year	Mass without calcium	Estimated clutch size
122	2010	9.9974	23
132	2010	8.9389	20
137	2010	8.5748	20
133	2010	12.1143	28
482	2010	5.0205	11
139	2010	8.4890	19
436	2010	3.2714	7
134	2010	8.6940	20
7	2011	6.7780	15
3	2011	6.9503	16
246	2011	7.5980	17
299	2011	5.7599	13
282	2011	8.1169	18
13	2011	9.2861	21
67	2011	12.2842	29
57	2011	9.6637	22
Mean			18.6

respectively). However, the difference between the two was very small, and the variability in mass among individual eggs was much greater before the shells were decalcified in acid.

Clutch sizes of depredated artificial nests were calculated using both shell fragments and shell membranes to evaluate the accuracy of each method (Table 1). Shell membranes generated values much closer to the known size of each clutch; therefore, eqn. 2 was used to estimate the clutch sizes in naturally occurring depredated nests at TNFH (Table 2). The mean estimated clutch size from these nests was 18.6 eggs (range 7–29).

Discussion.—Our results indicate that the total mass of shell membranes is a reasonable method for estimating clutch size in depredated *M. temminckii* nests. The regression model based on total membrane mass of eggs from depredated artificial nests generated clutch size estimates that were within one egg of actual clutch sizes. The mean estimated clutch size in depredated natural nests (18.6 eggs) is comparable to mean clutch size in 2010–2011 intact nests from the same population (22.4 eggs) and in the captive population at TNFH (25.5 eggs).

The regression equation calculated from shell fragments was similar to the regression equation calculated from shell membranes, but clutch size estimates using the mass of shell fragments greatly overestimated actual clutch size in depredated artificial nests. This likely resulted from differences in the way depredated shell fragments and hatched shell fragments were processed. Calcium flaked off of shell fragments (predated and hatched) to varying degrees after they were put in collection bags. The calcium that had flaked off of depredated shell fragments into the collection bag was included in the total mass of shell fragments. In contrast, the calcium left in the collection bag after all the hatched eggs were processed could not be added to the total mass of shell fragments for the entire hatched clutch because it was not possible to separate the calcium from the vermiculite that had adhered to the shell fragments after hatchlings had emerged. Therefore, the regression equation based on the total mass of shell fragments from hatched clutches was not a good predictor of clutch size in depredated nests. If the mass of calcium left in the collection bag had not been included in the total mass of shell fragments from depredated clutches, then the total mass of shell fragments may also have been a viable method for estimating clutch size. However, the standard deviation of the mass of a reconstructed shell fragment was an order of magnitude greater than the standard deviation of the mass of a reconstructed shell membrane, so models generated by the mass of shell fragments may still not be as accurate as those generated by the mass of shell membranes even when egg shells from depredated and intact nests are processed the same way.

Although the estimates produced for depredated artificial nests were quite accurate, estimated clutch sizes in depredated natural nests are likely underestimates of actual clutch sizes for two reasons. First, the individual who collected shell fragments from depredated artificial nests was the same individual who buried the eggs and she therefore knew how many shells fragments to look for around the nest cavity. If her hand counts while collecting eggs did not match the number of eggs that were buried, then she continued searching further from the nest until most of the shell fragments were found by her approximation. When collecting shell fragments from depredated natural nests, we did not know how many eggs the nest originally contained and we stopped searching for shell fragments approximately 2 m from the nest cavity. It is especially difficult to find shell fragments when nests are close to the water or there is a lot of leaf litter surrounding the nest. Second, predators may inadvertently consume some of the shell fragments or consume a portion of the eggs away from the nest cavity. Burke et al. (2009) found turtle shell fragments in raccoon scat and we observed the same in 2011.

This method of estimating clutch size in depredated nests is widely applicable to other turtle species and possibly other egg-laying amniotes that can experience high predation rates (e.g., lizards). A relatively large source of nests with known clutch sizes is needed to generate predictive models. We found very few intact *M. temminckii* nests, so we were able to build and test our models only because we had access to infertile eggs. However, assurance colonies are maintained for many turtle species and clutches may be readily available for similar analyses for these species.

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First Documented Use of Underpass Culverts by the Endangered Growling Grass Frog (*Litoria raniformis*) in Australia

Road ecology is now a significant branch of ecology aimed at quantifying the effects of roads and determining means of avoiding, minimizing and compensating for their negative impacts (van der Ree et al. 2011). Roads and other forms of linear infrastructure have long been recognized as having deleterious impacts on wildlife populations, primarily through collision-related mortality and habitat fragmentation (Forman and Alexander 1988; Spellerberg 1998; Trombulak and Frissell 2000; Forman et al. 2002). Amphibians seem to be particularly vulnerable to death on roads (Goldingay and Taylor 2006; Beebee 2013). Fauna crossing structures (overpasses and underpasses) are now being increasingly recommended and implemented in Europe, North America and Australia in particular to mitigate the impact of roads, with varying levels of success (Dodd et al. 2004; Beebee 2013).

Underpasses (e.g., bridge spans, culverts) are one such mitigation measure to facilitate the safe passage of amphibians under roads, often in combination with "funnel fencing" to guide animals to the underpass and to prevent access to the road. The majority of studies of the use of these structures by amphibians have been carried out on migratory species in the Northern Hemisphere (e.g., Langton 1989; Patrick et al. 2010; Beebee 2013). Relatively little attention has been paid to the effectiveness of underpasses for Australian species, which do not undertake mass overland migrations. Despite a general lack of empirical evidence that they are effective at facilitating movement across roads or ameliorating effects at the landscape or population level (van der Ree at al. 2011; Beebee 2013), underpasses are routinely incorporated into road design in Australia to facilitate the movement of amphibians and maintain habitat connectivity (van der Ree et al. 2007). Given this lack of data, it is important to document and monitor the use (or lack of use) of such structures by amphibians in Australia, particularly where they have been built with the specific aim of ameliorating effects of roads on threatened species.

One threatened Australian amphibian for which underpasses have been built is the Growling Grass Frog, *Litoria raniformis* (Fig. 1). *Litoria raniformis* is a large, semi-aquatic frog that grows to 100 mm SVL. It occurs in southeastern Australia, including Tasmania, where it is typically found in still or slow-moving freshwater habitats (Pyke 2002). The species declined markedly across its range late last century and it is now listed as "endangered" in Victoria (DSE 2013), "vulnerable" under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act), and "endangered" in the IUCN 2012 Red List (Hero et al. 2012). The cause of the decline is poorly understood but it is believed a combination of factors are responsible including habitat loss, urbanization, introduced predators, and diseases such as chytridiomycosis (Mahony 1999; Pyke 2002; Heard et al. 2012).

Underpasses for *L. raniformis* have been incorporated into the design of dual and single carriageway roads around Melbourne, Victoria. Typically, the underpasses constructed are culvert-type

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PHOTO BY DANIEL GILMORE



FIG. 1. Growling Grass Frog, *Litoria raniformis* at the farm dam in the study area on the northern outskirts of Melbourne, Victoria, Australia.

designs of various sizes and dimensions and are usually located at low-lying points in the landscape where they perform the additional role of facilitating drainage under the roadway. Despite the construction of numerous underpasses, some designed specifically for the species, it has never been shown conclusively that *L. raniformis* actually uses these structures, so their use as a mitigation measure for the loss of habitat connectivity for this species has been largely experimental (DEWHA 2009a, b; Heard et al. 2010). In this study, the construction of a wetland and underpass as a compensatory measure for the removal of habitat of a population of *L. raniformis* for residential development provided an opportunity to examine the use of underpass culverts by this species.

METHODS

Study area.—This study was undertaken in Wollert, a suburb on the northern outskirts of Melbourne, Victoria, Australia. The region has a temperate climate and experiences cool winters and warm to hot summers. The area is undergoing rapid urban growth associated with Melbourne's expanding population, which has resulted in a number of water bodies supporting *L. raniformis* populations being destroyed. One such site was a farm dam located within land earmarked for residential development, where a population of *L. raniformis* was discovered in 2002 (Costello et al. 2006). The proponent of the development was granted permission to destroy the dam under the provisions of the EPBC Act provided that, as an offset, a new wetland was constructed and the *L. raniformis* population translocated into it beforehand. The new wetland was constructed in 2009 and the dam was destroyed in 2011.

The replacement wetland, situated approximately 500 m SE of the dam, was constructed in the drainage line of Edgars Creek as part of a package of works completed for a two-lane, single carriageway municipal road crossing east to west over the creek. The wetland consists of two "ponds," one on either side of the road. Each pond has a water surface area of approximately 240 m^2. Both ponds have a maximum depth of approximately 1.5 m and are vegetated with emergent, submergent, and floating macrophytes to provide habitat for the translocated *L. raniformis* population. The ponds are connected under the road by four 2.4 m W × 1.2 m H × 20 m L concrete box culverts, situated approximately 1 m below the road pavement and set back under the road pavement by approximately 1.5 m to reduce culvert length and improve the aesthetics of the structure in an urban setting (Fig. 2). The bases of three of the four culverts are below the natural water level and hence are permanently inundated. This ensures the water level is maintained throughout and allows for water to move unimpeded along Edgars Creek during periods of high flow. The fourth culvert has been altered specifically to provide a dry crossing option for *L. raniformis*, although it too is likely to be briefly inundated during periods of high flows (Fig. 3). Four 12 × 12 mm galvanized mesh funnel fences (17 m L × 0.8 m H) were installed on each side of both ponds to restrict frogs from moving onto the road and to funnel frogs towards the culvert entrances. Additionally, a 100-m-wide fenced frog corridor was established to direct the movement of dispersing *L. raniformis* from the dam to the constructed wetland.

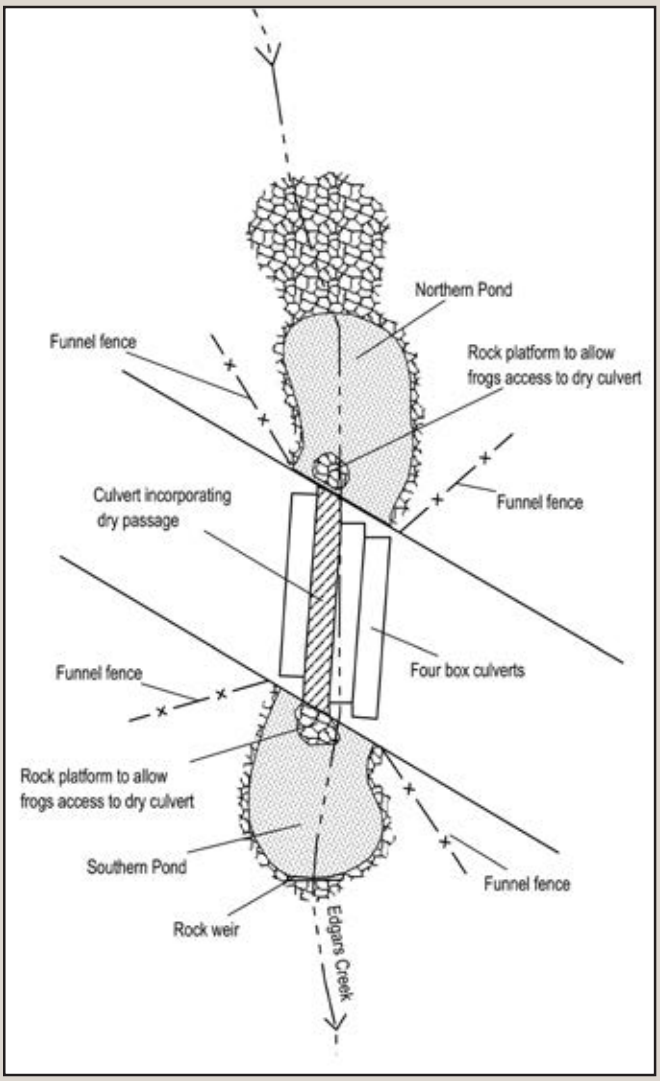


FIG. 2. Design features of the constructed wetland showing the underpass culverts (adapted from a plan produced by Spiire Pty Ltd).

Monitoring of the L. raniformis *population.*—Translocations of *L. raniformis* from the farm dam to the constructed wetland were conducted over five dates. During this period, the population was monitored to assess the efficacy of the translocation program (Koehler and Gilmore, *in prep.*). Searches for *L. raniformis* were undertaken at the farm dam and in both ponds at the constructed wetland (two people per waterbody) using the visual encounter method outlined by Crump and Scott (1994). Searches were conducted on 28–30 November 2010 at the farm dam and on



FIG. 3. The constructed wetland: overview from the north (top) and the culverts (bottom). Note the rock platforms at the end of the dry culvert to assist frogs to exit the water.

17–19 December 2010, 7–9 January 2011, 28–30 January 2011, 15–17 March 2011, and 2 May 2011 at both the farm dam and constructed wetland. On those nights, frogs were captured by hand with the aid of head lamps during a 1-h intensive search which took place between 2100 h and 2300 h Eastern Standard Time. Frog handling followed the "one bag – one frog" approach and equipment was sprayed with a disinfecting solution containing benzalkonium chloride to reduce the risk of spreading infectious pathogens including chytrid fungus (DECC 2008).

Male frogs were identified by the presence of nuptial pads and/or discolored throats (Pyke 2002). Frogs were identified as female if they did not display those secondary sexual characteristics. For some individuals, particularly small specimens without secondary sexual characteristics, the sex of these was classified as "unknown." All 355 captured *L. raniformis* of appropriate size (≥ 50 mm SVL) were implanted with a Trovan Passive Integrated Transponder (PIT) microchip, an approach used successfully to enable the identification of individuals for the congeneric *L. aurea* (Goldingay and Newell 2005). This allowed the movement of translocated frogs to be documented through a mark-recapture program and enabled modeling to estimate survivorship and population size to inform the translocation program (Koehler and Gilmore, *in prep.*).

Marked frogs translocated from the dam were released in both the north and the south pond in roughly equal numbers. Frogs that found their own way to the constructed wetland were released back into the pond where they were captured.

On the basis of the presence of funnel fences and a 100-m-wide fenced corridor linking the northern pond to the farm dam, individual *L. raniformis* were deemed to have moved through the culverts if they were recorded moving from north to south (north pond to south pond or dam to south pond) or south to north (south pond to north pond or south pond to dam).

RESULTS

A total of 158 frogs (64 males, 86 females, and eight frogs whose sex was unknown) captured and marked at the farm dam were translocated into the constructed wetland. Of these, 51 frogs were released into the north pond, 38 into the south pond, and 69 into either the north or south pond (release pond was not recorded; these frogs were excluded from movement calculations unless subsequent captures enabled location to be determined and any future movement documented). An additional 86 frogs (39 males, 43 females, and four unknown) were first found and marked at the constructed wetland (i.e., naturally colonized the wetland or metamorphosed from tadpoles released in November–December as part of the translocation program). Of this latter group, 49 frogs were captured and marked in the north pond and 37 were marked in the south pond. This brought the total number of marked frogs at the wetland to 244 by March 2011.

Movements through the road culvert were documented for 53 individuals (29 males, 23 females, and one unknown, totaling 22% of the total marked population at the constructed wetland). Most of these frogs (43) were recorded as having made one movement while 10 individuals were recorded as having made two movements through the culverts. Collectively, these 53 frogs made a total of 63 movements through the culverts (Table 1). Translocated frogs and frogs that naturally colonized the wetland or metamorphosed from translocated tadpoles contributed almost equally to the number of movements (33 and 30 movements, respectively).

Adult *L. raniformis* were observed on two occasions swimming within and/or floating in the inundated culverts, and two individuals were seen perched on, or in, the outlets of drainage pipes within the culverts at night during the mark-recapture sessions. On another occasion, an adult frog was also observed within the dry passage culvert.

DISCUSSION

We have documented for the first time evidence of the use of an underpass by *L. raniformis*. To our knowledge there are no other published examples of native Australian frogs using box culvert underpasses. To date, only the introduced Cane Toad (*Rhinella marina*) has been recorded using these types of culverts, although native species have been observed at or near culvert entrances (Taylor and Goldingay 2003). We believe our study is the first to document evidence that both male and female *L. raniformis* are capable of using such structures to cross under roads.

A mark-recapture study of *L. raniformis* populations residing either side of the Craigieburn Bypass in northern Melbourne found no evidence of movement of frogs through any of the 10 monitored underpasses built along the road (A. Hamer, pers. comm. 2013). These underpasses included six frog underpasses and four combined culvert and underpass structures, which were

TABLE 1. Movements of marked *Litoria raniformis* through culverts at the constructed wetland between December 2010 and May 2011.*

Sex	Number of frogs making no movement	Number of frogs making one movement	Number of frogs making two movements	Movement north–south	Movement south–north	Total movements
Female	23	23	3	16	13	29
Male	12	29	2	20	13	33
Unknown	0	1	0	1	0	1
Total	35	53	5	37	26	63

* Excludes frogs not recaptured subsequent to first capture or release at the constructed wetland. Frogs considered to have made no movements between ponds may have moved undetected between captures.

TABLE 2. Number of movements made between December 2010 and May 2011 by marked *Litoria raniformis* which colonized the created wetland compared with marked frogs translocated from the dam.

Sex	Translocated from dam		Colonized wetland	
	North – South	South – North	North – South	South – North
Female	8	10	8	3
Male	6	9	14	4
Unknown	0	0	1	0
Total	14	19	23	7

incorporated into the design and construction of the Craigieburn Bypass Project, as a measure to minimize the impacts on the local population of *L. raniformis*. However, in a similar study of a population of *L. raniformis* adjacent to the Pakenham Bypass, Hamer and Organ (2012) recorded a single individual in a wetland on the opposite side of the road to where it was initially marked. They assumed this individual crossed the road by using a bridge underpass at a nearby creek. While it is possible that the frog crossed via the road pavement rather than through an underpass, they considered this was unlikely, since the Bypass has frog-proof fencing installed along its length to prevent *L. raniformis* from accessing the roadway (Hamer and Organ 2012). In this example, the underpass assumed to be used by the frog was an open bridge span over the creek rather than a box culvert type underpass as described here.

Although it is possible that the *L. raniformis* we observed moving between the two ponds did so by exiting the water and traversing overland, we argue that it is far more likely that the majority—if not all—did so by using the box culverts. First, these movements involved a large number of individuals (53), including ten individuals making at least two movements between the ponds. Given the configuration of the frog-proof funnel fences, which both restricted access to the roadway and directed frogs to the culverts, it is unlikely that so many individuals would have crossed the road in this manner. Second, while we did observe one individual (a marked female) on the edge of the roadway on one occasion, we never observed any *L. raniformis* crossing the road or on the road pavement itself. This is despite multiple observers spending many hours over seven months on and near the bridge and roadway at night during the translocation study. Third, several adult *L. raniformis* were observed swimming within and/or floating in the inundated culverts and perched on, or in, the outlets of drainage pipes within the culverts at night, demonstrating that the species did not avoid the interior of the culverts. Last, being a highly aquatic species and a powerful swimmer, we believe *L. raniformis* is well adapted to, and capable of, traversing the inundated culverts of the underpass and we can see no obvious reason why individuals would not readily swim through them.

We believe that the inundation of three of the four culverts in our underpass example, which hydrologically linked constructed aquatic habitat on one side of the road to the other, improved its suitability for use by *L. raniformis*. While it is possible that individuals did use the single dry culvert, only one frog was observed in the dry culvert and on only one occasion. This is perhaps not surprising given the species' largely aquatic habits. A dry culvert was incorporated into the design at Epping North on the basis of recommendations by Robertson (2002). While further study is required, our results suggest that incorporating a dry area into the culvert design of relatively short road crossings may not be necessary for the highly aquatic *L. raniformis*. The inclusion of a dry area within a culvert remains prudent in situations where a culvert is necessarily long and there is a risk of adult frogs drowning or in instances where there are other species that may use the culvert. In these cases, dry refugia can be incorporated within inundated culverts (e.g., through the strategic placement of "islands") as an alternative to a completely dry culvert.

Caution should be exercised before extrapolating the results of this study to the effectiveness of other culverts designed for use by *L. raniformis* (e.g., culverts that are completely dry, culverts with smaller dimensions, culverts located away from drainage lines). The use of underpasses that differ from that described here is yet to be proven and further research is required to determine the effectiveness of different designs. Similarly, the suitability of the culvert design described here for use by other anurans is unknown. This is particularly true for species whose ecology is different from *L. raniformis* (i.e., species whose adult life history stage is largely terrestrial).

Although we have only examined one site, our observations indicate that culverts designed to facilitate the movement of *L. raniformis* may be most effective when they are permanently inundated and are hydrologically linked to aquatic habitat on either side of the culvert. If comparative studies of different culvert designs shows this to be the case, constructed waterbodies on either side of the road could be designed to also provide breeding habitat for *L. raniformis*, as this is likely to increase the number of frogs within the vicinity of the culvert entrances and hence enhance connectivity between populations either side of the road. Inundated culverts may also facilitate the movement of *L. raniformis* tadpoles from one side of a roadway to another, which could further enhance population connectivity.

It is important to emphasize that for *L. raniformis*, the primary reason for constructing wetlands at culvert entrances should be to enhance connectivity of habitats on either side of a roadway. Such wetlands should not be relied upon as compensation for habitat removed elsewhere (e.g., for urban development). Additional wetland habitat should either be retained (preferable) or created (where retention is not possible) away from the vicinity of roadways to account for the potentially negative influences roads may have on this species, such as disturbance, noise, road mortality, and pollution.

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The constructed wetland was collaboratively designed by a team comprised of Biosis, Spiire Australia and MDG Landscape Architects, on behalf of Places Victoria and in consultation with the Department of Sustainability and Environment, Whittlesea City Council and Melbourne Water.

This study of *L. raniformis* was undertaken in accordance with Research Permit 1004816 (live capture and release) and Research Permit 1005625 (PIT tagging) issued by the Department of Sustainability and Environment under the *Wildlife Act* 1975 and approval 03.09 from the Wildlife and Small Institutions Animal Ethics Committee of the Bureau of Animal Welfare, Department of Primary Industries. Salvage and translocation of *L. raniformis* was undertaken in accordance with Management Authorisation no: 10005067 issued under the *Wildlife Act* 1975 by the Department of Environment and Primary Industries.

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Herpetological Research at Primarily Undergraduate Institutions

A tradition exists, extending from colonial days into the 20th and 21st centuries, of herpetologists who have done remarkable work, but who have no formal training in herpetology. Individuals such as Raymond Ditmars, Lawrence Klauber, Joseph Slevin, Roger Conant, Hubert St. Girons, and Ernest Liner come quickly to mind, but many other people could be aligned with this group. These individuals, of course, were never the academic mentors of Ph.D. students in herpetology, but they greatly influenced research in herpetology. Likewise, many other herpetologists in the past and present have held academic positions at institutions where the focus is not on research, publishing, getting grants, and training Ph.D. students. In this perspective, we demonstrate that herpetologists holding positions at strictly undergraduate institutions or those in which the terminal degree is a Master's can nevertheless have productive careers in research. Also, herpetologists at primarily undergraduate universities can impact the future of herpetological research by inspiring undergraduate students to take up herpetology early in their careers.

Collectively, the contributors to this essay have nearly 100 years of experience working for various institutions of higher education. One of us (RP) has spent his entire career at a liberal arts college, another's (SJM) career has been entirely at regional comprehensive universities (RCU) where the M.S. degree is the highest awarded, and the lead author (DMS) has taught at both types of schools. In thinking about what has contributed to our relative levels of success (and enjoyment) in each of our positions, we decided to focus on three elements of maintaining a research program at schools that place greater emphasis on high-quality teaching: 1) Sustaining a long-standing research program; 2) attracting high-quality students (with emphasis on those seeking graduate degrees) to participate in the lab's research productivity; and, 3) collaborations and publishing with student authors. Instead of generating a step-by-step "how-to" guide for our colleagues at primarily undergraduate institutions, we use our experiences to illustrate means of achieving success.

Funding Undergraduate Research – Sever

My lab has concentrated for 40 years on using histological and ultrastructural techniques to study the comparative anatomy and phylogeny of primary and secondary sex characters of amphibians and reptiles. I spent the first 30 years of my career at Saint Mary's College, Notre Dame, Indiana, which is a small comprehensive college (1500 total students, all women) that grants only Bachelor's degrees, and since 2004 I have been at Southeastern Louisiana University (SLU), at which the Masters is the terminal degree. My teaching load has always been 9–12 contact hours per semester, and in addition, I served as department head at both institutions for a total of 16 years. Neither institution has great demands on faculty to do research. Indeed, at both schools, an assistant professor after six probation years can obtain tenure with only one or two publications during that period. I have never been pushed by administrators to get grants or publish papers. Whenever either activity occurred, however, administrators were pleased because they recognized that research, especially involving students, should be an integral part of the undergraduate curriculum.

I will emphasize three ideas in this section: 1) Create a research program that can work at an undergraduate institution. This research program should have the potential to grow and attract funding and students. 2) Submit grants at all levels, from $1,000 travel grants to $400,000 NSF grants. Many granting agencies like to see stipends for undergraduates listed on proposals, and NSF even has a special niche (RUI) for proposals from undergraduate institutions. 3) Get undergraduate students involved in your research. Powell will expand on this topic later in this article, but I will show how success in funding of grants leads to opportunities for undergraduates. The wide-eyed enthusiasm of undergraduates can be contagious around a lab and can make even routine fieldwork more enjoyable. These three ideas are not independent of one another and are interwoven in the narrative below.

I became a "histo-herpetologist" during my doctoral work at Tulane University, where my research involved the light and electron microscopy of secondary sexual characters of salamanders. When I arrived at Saint Mary's College in 1974, the fundamental instruments needed to do histological research were present and all I needed was expendable supplies. As such, my "start-up" cost the school less than $1,000. I needed to obtain some grants to provide money for travel to collect specimens and to replenish expendable items. I also saw the need to explore ways of obtaining an electron microscope for Saint Mary's. I realized that it might help to be unique—I also needed to make my work compelling; why should NSF support this?

My first grant at Saint Mary's came from the Highlands Biological Station, where I had worked during my doctorate, and allowed me to obtain more samples of salamander tissues. Then I discovered that the Indiana Academy of Science was quite generous in awarding modest grants to work on the local fauna, and I started what turned out to be long-term studies on a population of *Ambystoma tigrinum* near campus. Saint Mary's, like many colleges, also had its own internally funded faculty research grant program, and I applied for these frequently. Funds were also obtained from the state Department of Natural Resources and the American

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Philosophical Society. So I actually had enough money to sustain my modest histology lab. The first papers co-authored with undergraduates on *A. tigrinum* (DeNeff and Sever 1977; Couture and Sever 1978) were published in the *Proceedings of the Indiana Academy of Science*. The student authors not only had a publication but also the experience of presenting their work before the Academy.

During the mid-1980s, the College started a renovation project on the Science Hall, and I convinced them that they needed to include an electron microscopy suite. The commitment of the College probably helped the success of my 1987 proposal to NSF, "Electron Microscopy in the Undergraduate Biology Curriculum," which resulted in the addition of a transmission electron microscope (with a scanning electron microscope attachment) and the necessary peripheral pieces of equipment. I immediately began teaching an electron microscopy course in which the undergraduates were trained to conduct ultrastructural research (on amphibians and reptiles, of course). The same year that I received the grant for the electron microscope, I received my first NSF research grant, "Comparative Anatomy and Phylogeny of Cloacal Glands in Salamanders." So 1987 was a pretty good year.

Undergraduate students continued on various projects, including research on *Ambystoma tigrinum* from our study pond (Sever et al. 1987; Platt et al. 1993), but a number of students began working for me on my cloacal gland grant, including some who served as full-time research assistants during the summer. When that grant ended, I received NSF funding in 1991 for a new project, "Comparative Cytology of Sperm Storage Organs in Female Salamanders (Amphibia: Caudata)." This research involved ultrastructural studies on the spermathecae in all families of salamanders that possess the glands. The presence of an electron microscope, made possible by NSF funds, probably was a factor in the success of the proposal. The research included considerable undergraduate student involvement, starting with papers by Sever and Kloepfer (1993) and Sever and Brunette (1993) in the *Journal of Morphology*. During this period, I also began collaborations with graduate students working at the Savannah River Ecological Laboratory (SREL), including John Krenz, Travis Ryan, and William Hopkins. The Department of Energy had a simple process that provided ample travel grants (that included airfare, rental car, and motel) for work at SREL.

Toward the end of my time at Saint Mary's, I became interested in squamate reproductive anatomy. Travis Ryan sent me samples of *Seminatrix pygaea* collected throughout 1998. Tissues harvested from these samples provided the data for seven papers between 1999 and 2010, making *S. pygaea* the most intensely studied reptile in terms of urogenital organ ultrastructure. Again, undergraduate students were critical to accomplishing this research—four from my electron microscopy class were co-authors on one paper (Sever et al. 2000).

I left Saint Mary's to become Department Head of Biological Sciences at SLU in 2004. I will not dwell on my experience with Master's students at SLU, as Mullin will discuss graduate students in the next section. I am pleased, however, that the five MS students I mentored between 2005 and 2011 have gone on to Ph.D. programs, and three have completed their doctorates. Also, I have continued to receive funding from internal sources; such grants are available from SLU and the Louisiana Board of Regents. From NSF, I received funding for a proposal, "The Evolution of Sperm Ducts and Accessory Sex Glands in Squamate Reptiles: An Empirical Study of Cellular Complexity." This support once again allowed me to hire undergraduate students (as well as Master's students) to assist with my research and become co-authors on papers.

In summary, I carved out a niche in comparative anatomy of reproductive structures of amphibians and reptiles that has proved to be very productive over the years. I am pleased that I have mentored students like Dustin Siegel and Justin Rheubert who will carry on this work. My message to graduate students looking for academic positions and to young assistant professors who find themselves at largely undergraduate institutions is simple: If you love your research, you will find time and funding to do it, and you will find undergraduate students who will be eager to participate. You will be as productive as you want to be.

Attracting Graduate Students – Mullin

For the foreseeable future, certain elements of the screening process for graduate students will be constants—things like GPAs, GRE scores, personal essays, and letters of recommendation. Through experience, we assume that successful faculty members have arrived at their own mechanisms by which they comfortably prioritize these metrics in a manner that helps them gauge each student's potential (so I will not write about it here). Having already read Sever's recommendations for supporting a research program through sustained grantsmanship, I have also included little mention about how the successfully recruited student should be funded. Instead, this portion of our article identifies aspects of recruiting and qualitatively evaluating prospective graduate students, with emphasis on elements worth considering for those researchers at RCUs. I focus on four particular attributes: Independence and motivation, good communication skills, prior experience in a related setting, and good camaraderie. In many respects, these attributes are also useful when involving undergraduates in the lab group's research endeavors.

A recurring sentiment of the recent Master's graduates from my lab is that attending an RCU has a distinct advantage over an R-1 school—after the major professor, the Master's students are typically the "top dogs" among lab members. From discussions with their peers in larger labs (that have hierarchies that include post-doctoral researchers and doctoral students), my graduate students find themselves in a fortunate position for several reasons (items worth mentioning as you get to know prospective students): 1) Consistent access to their major professor, without needing to yield time to more senior members of the lab group. 2) First priority in selecting research assistants. Like most researchers conducting field projects, few efforts in my lab are completed without a small army of undergraduate researchers. In the absence of post-docs or Ph.D. students who might pull rank to work with the "pick of the litter," Master's students at RCUs can rarely complain about not having enough assistance available. 3) Greater opportunities for funding research. This might seem counter-intuitive, but Master's students in my lab typically appreciate trying their own hand at writing grant proposals instead of structuring their thesis research to fit within the scope of an existing grant authored by their professor. Whereas RCUs typically do not have as much funding from major agencies like NSF and NIH (see, however, Sever's comments above), opportunities for Master's students to acquire their own funding (especially from intramural sources or extramural agencies that do not allow the school to siphon off overhead costs) can be more numerous than at R-1 schools. 4) More opportunities for intellectual independence and growth. This is a corollary of the

previous point in that, by completing a project that is not tied to an existing research grant (often one with a much larger scope), Master's students at an RCU typically have a little more freedom to pursue those interests that crank their intellectual engines the most.

Implicit in Sever's contribution to this essay is a fortunate paradox—although much of the general public cares little for the organisms that we study (especially snakes; Seigel and Mullin 2009), our focal animals are endowed with a charisma that attracts a steady stream of interest from undergraduates in our academic units. Faculty working at RCUs can exploit this interest when needing help on either their research projects or those of their graduate students. Convincing undergraduates that studies involving amphibians or reptiles are both fun and fulfilling is an easier task than assuring that your lab benefits from steady and reliable help from those students. Two strategies have helped maintain my lab's productivity: 1) I identify students early by recruiting them from lower-division courses; and, 2) I assess the student's commitment level and aptitude by involving them in lab activities that do not necessarily involve interactions with our focal animals. For instance, weekly lab meetings provide the opportunity to discuss a recent publication or critically review a grant proposal. Initial levels of enthusiasm from recruited undergraduates might wane in the face of such activities, and I often use this as a surrogate measure for their level of dedication to an actual project.

Students maintaining or increasing their interest levels in all lab activities gain additional experience, and assure some continuity in the lab's operations—whether a long-term project or the husbandry of a research colony of animals, students who are new to the lab group receive effective training from both experienced undergraduate and graduate students. Herein lies another advantage, but this time for the student: engaged in this manner, research-minded undergraduates gain a variety of experiences, thereby enhancing their chances at succeeding beyond their bachelor's degrees. I not only use this as a selling point when recruiting undergraduates, but I look for evidence of breadth and depth of experience among prospective graduate students, even if they were not able to pursue their own project independently.

One of the best, albeit indirect, pieces of advice from my undergraduate advisor was to experience different settings for my graduate degrees. Compared to continuing an association with what was already familiar to me, exposure to new teaching and mentoring paradigms and to the herpetofauna in different ecosystems better prepared me for a successful academic career. Completing each of my degrees at different universities also helped me develop a sense of independence and self-motivation. I now offer this advice to my own students: Although undergraduate assistants in my lab might have stellar GPAs and an acumen for research that would rival most doctoral students (such that I would enjoy continuing as their mentor), I nevertheless encourage them to move on to another school for their Master's degrees. I also look for the traits that would typically be cultivated by such a move—independence and motivation—in prospective graduate students. When considering students from other schools, I find that those who want to complete a Ph.D. (whether immediately after their tenure in my lab or eventually) are the same individuals who are most successful as Master's students. They recognize that working in my lab group will be a training ground for the greater demands expected at a doctoral program. This recognition also manifests itself in the motivation needed to see a research project through to its logical conclusion (i.e., a peer-reviewed publication).

To end up with the best possible graduate students in a lab, successful professors must first ensure that their efforts are on the radar of the community at large. In addition to a steady publication record, I have found that one of the best ways to make this happen is to attend the joint meetings of the three North American herpetological societies (JMIH). Not only do I renew friendships with colleagues who "grew up" with me as graduate students at previous iterations of this conference, but I typically learn about promising undergraduates from other labs who have expressed an interest in getting experience in other programs. Meeting prospective students in this setting might include opportunities to get a sense of how the students discuss their science (say, if they are presenting undergraduate projects). Given that graduate students are regularly the public face of your lab, you will want to recruit students who can speak clearly and confidently about their own work. Interacting with prospective students at meetings like the JMIH also gives you more information about their potential fit into the current composition of the lab than could be obtained from an email inquiry with an attached CV.

At some point during the bi-directional screening process, I encourage prospective graduate students to visit my lab. A few colleagues at other universities (ranging from R-1s to RCUs) insist on this sort of interview visit as part of the application process, perhaps as a means of assessing the degree of student commitment. I do not feel comfortable making this demand because, typical of an RCU, the school has no funds to help offset the costs of such trips. I do what I can to lessen the outlay in the form of providing housing (usually imposing on a current graduate student) and a few meals. The prospective student not only comes to understand the potential academic aspects of joining your lab, but also learns more about the domestic and social life of a typical graduate student. To help the prospective student realize the most from investing the time and effort into the trip, I arrange brief interviews with other faculty having some overlap in research interests. Thus, the student can appreciate the diversity of expertise that would be available during his or her degree program; meanwhile, I learn of any "red flags" that are raised in the minds of my colleagues that might not have been apparent during my own interactions with the student. As helpful as such a visit can be in ascertaining the chemistry between the major professor and student, it is equally important for me to know that the prospective student will get along well with current lab members. As I have already invested resources into the existing makeup of the lab (and have established good working relationships with those students), I would be doing the group a disservice by accepting a new student whose ideology (e.g., Gregory and Ellis 2009) or personality clashed with those of other lab members.

Collaborations and Publishing with Students – Powell[1]

At small schools that lack graduate programs in the sciences, herpetologists are considered rather generic biologists who are asked to teach courses ranging from introductory biology to upper-level courses such as anatomy, embryology, ecology, and evolution. Once exposed to the charms of amphibians and reptiles, however, reverting to generic biology can be a bitter pill. Furthermore, because teaching is the primary responsibility of

[1] Portions of my contribution are adapted from an essay published in 1998 in *The Newsletter of the Herpetologists' League* (5[1]:5–6).

faculty at such institutions, heavy course loads, plus ancillary responsibilities such as advising and committee work, leave little time for research. That said, "doing" herpetology at a small school is not impossible, but constraints like time, space, and funding are real and must be acknowledged. The impacts of these constraints are lessened by the fact that many small institutions are tuition-driven—meaning that any activity that attracts, involves, and retains students will be viewed positively by administrators. The obvious solution, of course, is to engage students in herpetology. One of the most powerful attractants is participation in field trips. These need not be to exotic climes (although that is nice); local and regional trips are inexpensive, take little time, and can open the eyes of students to realities of nature that most have never experienced.

As a new faculty member at Avila University, I sought to provide my students with some of the same experiences responsible for leading me to a career in academia. I developed what I called a "field biology" course, for which students could earn credit for having a great time and gaining experience. Our first trip was to the Big Bend, and it went so well, I immediately began planning trips to more esoteric destinations even farther south. Over the next few years, I taught field biology classes around trips to Baja California, the Yucatan Peninsula, and various other destinations in México. As acquiring permits in México became increasingly difficult, I began looking for alternative destinations. At the time, I knew no one working in the West Indies, but Bob Henderson, with whom I had corresponded regarding our work in the Yucatan, had been focusing his work on Hispaniolan treesnakes (*Uromacer*). I gave him a call to ask if he thought the Dominican Republic (DR) would be a good place to take students. He not only said it was, he sent me a thick packet of information regarding whom we should see about permits, where to stay, and from whom to rent vehicles. My wife and I took a short "vacation" that January, and I took my first field biology class to the DR that spring.

The early trips were all about finding critters, but I soon began looking for projects that could be implemented during short periods—and these gradually became more sophisticated and elaborate as I became more familiar with the herpetofauna. One day, the advancement office at Avila forwarded an NSF document announcing criteria for a new program titled "Research Experiences for Undergraduates" (REU). I immediately recognized the potential to do an even better job of what we had been doing all along. I sat down with John Parmerlee, who had been a student during my early days but had since earned a graduate degree, returned to the area, and had accompanied me on many of the field biology trips—and we wrote a proposal in a day and a half.

As might be expected, that first effort was pretty marginal. We learned from reviewers' comments, however, and took considerably more time the following year, which resulted in many positive comments—but no grant. So, I contacted the program director and asked for an explanation. I learned that no one on the review panel knew me or had ever heard of Avila. That, combined with the "unusual" nature of our proposal—we proposed keeping the student cohort together in the DR, have them engage in individual or collaborative projects, and publish their results—led to the lack of funding. I think my conversations with the program director led to her giving us a chance.

Focusing on natural history and establishing publication as a goal from the very beginning, we selected our first cohort in 1991. Every participant became an author, we collectively contributed to a growing knowledge base concerning the West Indian herpetofauna, and clearly demonstrated to NSF that we could achieve what we had proposed. We have now conducted 11 iterations involving 101 students from 68 different colleges and universities, all of whom have been at least coauthors of at least one of over 150 publications in peer-reviewed journals[2]—and the great majority have matriculated to graduate programs. Furthermore, several former students have served as faculty in subsequent programs, either while still in graduate school or after having become faculty members at institutions of various types.

Although I still have students developing and implementing projects locally, often relying on museum specimens borrowed for that very purpose, I have adapted much of my research to the REU programs. This allows me to remain actively engaged while simultaneously providing my students with a leg-up toward research careers of their own. I would further suggest that our type of program is not only beneficial to the participating students, but unique to an undergraduate institution. Because I do not have to maintain a lab that meets the needs of graduate students or postdoctoral fellows, I can devote entire summers to research involving undergraduates. Furthermore, by focusing on natural history in its various guises, I can provide students with an entire research experience, from developing and implementing hypothesis-driven projects to publishing the results of their work.

Publication is an important and worthwhile goal for undergraduate research. It represents the culmination of the research process, provides opportunities for teaching (and learning) relevant and essential skills, and it generates a product that not only enhances a student's CV, but validates the research experience and makes a contribution to science. Not all research is appropriate for publishing with undergraduates and hurdles can be substantive. Sometimes the undergraduate lacks the necessary competence, some research protocols are too complex to provide undergraduates with more than a small portion of the process, and the time involved can be daunting—but these obstacles are not insurmountable, especially if publication is established as a goal from the very beginning.

Undergraduate research is more likely to be publishable if it addresses subjects about which little is known, reducing the burden of breaking new ground. Good research does not have to be "cutting-edge" science. My collaborators and I address this in our field-based work by going places where little research has been done, where many of the basic questions remain unanswered (e.g., diets, distributions in variously altered habitats, some aspects of behavior and performance), and abundant data can be generated in relatively short periods of time. Collaborative endeavors further enhance data collection (although they inevitably lead to discussions regarding senior authorship) and conserve time. Time constraints also dictate investigative protocols with shallow learning curves. Those, however, allow us to supplement a core of more advanced and experienced students with bright freshmen and sophomores or students from institutions that lack the means or facilities for research.

Mentors must be willing to invest huge amounts of time and must resist the temptation to simply take over and do the job themselves (although a more heavy-handed approach may be necessary when tackling a first experience with statistical techniques). They also must avoid imposing unrealistic expectations. Like learning any other skill, practice is necessary and

[2] Additional information and a list of publications is available at www.avila.edu/bobpowell/7powreu.htm.

opportunities to practice must be provided. Mentors must work with students as they learn the necessary investigative skills, but be willing to step back when students are capable of taking charge of a project. Finally, even the best students must learn to write for publication. During this process, mentors must be patient—reviewing draft after draft, criticizing without discouraging, encouraging without demeaning, and not streamlining the process to the extent that they think it is easier than it actually is. This often extends well beyond the 10-week summer program, explaining why we schedule our trips in alternate years.

From the early days of weekend field trips and publications dealing primarily with range extensions or county records to increasingly sophisticated studies demonstrating, for example, relationships of laboratory-generated data on performance to real-world situations, the scope of my research has changed—but the emphasis on student engagement has remained the same. So, being a herpetologist at a small undergraduate institution can be challenging, but it can be done and done well. Hard work and accepting and overcoming the inherent obstacles are essential.

Conclusion

Woven into our essay is the important theme of research experience—whether yours or that of students in your lab. We enjoy conducting it, our students enjoy helping us, and, even when the recognition rarely comes in the form of release time or infrastructure improvement, our administrators love to tout the fostering of critical thinking skills in our students when we involve them in research. In this sense, we get some of the same benefits from being research-active without the stress of the "publish-or-perish" environment that typifies most R-1 programs. The lower pressure at a college or RCU also increases the likelihood that a researcher can be successful in the particular niche of conducting long-term studies (e.g., decadal in scale). Prospective students not only express interest in conservation-related research with increasing frequency, but they are easily convinced that long-term studies can better inform conservation strategies because such a perspective accounts for more environmental variability. Because teaching excellence is favored over research output at our institutions, we can publish more comprehensive views of particular systems based on data compiled over multiple years.

Engagement in research provides you with the mechanisms to stay abreast of advances in your field (e.g., through presentations at meetings, current literature, publishing with students, etc.), informs your teaching, and, in theory, keeps you intellectually sharp (responding either to questions or feedback from manuscript reviewers). For students in your lab group, training in a research environment builds critical thinking skills, invests them in the process of scientific discovery (Moslemi et al. 2009), and will help prepare them for many of the next steps in their careers (Fleet et al. 2006). We expect our colleagues have also realized that, by involving students in research early in their development as biologists, the students quickly recognize that careers in herpetology are equally valid to those that focus on other taxonomic groups—our field would perish if new cohorts of students were not impressed by the processes of answering questions about amphibians and reptiles and generating the results that lead to new questions. Admittedly, we have not covered every single aspect that will allow you to remain research-active at a non-R1 institution. Rather, our hope is that the coming cohorts of newly-minted Ph.D.s and post-doctoral fellows will be encouraged by the opportunities at primarily undergraduate institutions, and take comfort in the fact that, in these settings, they can continue to contribute in meaningful ways to our understanding of amphibian and reptilian biology.

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TECHNIQUES

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Utilizing Hydrophobic Coatings for Maximizing Venom Extraction Yields

Reptile venoms and their individual molecular components have evolved to target and control crucial biological functions (St. Pierre et al. 2007; Chaisakul et al. 2014). Understanding how venom manipulates life systems has clinical implications (Earl 2012; Koh et al. 2012; Harvey and Stocklin 2012; McClearya et al. 2013; Utkin 2013; Venkatesh et al. 2013; Vink et al. 2013) as well as ecological and evolutionary implications (Barlow et al. 2009; Richards et al. 2012; Benard-Valle et al. 2014). Mass spectrometry, gene sequencing, and other precise techniques for furthering toxicological research are now commonplace in many biochemistry labs, and novel discoveries are increasingly dependent on the availability of crude venom for analysis (Calvete et al. 2009). The production of antivenoms is also dependent on accessibility of crude venom (Gutiérrez et al. 2011; Gutiérrez 2012). Scientific advancements in these areas will depend heavily on interdisciplinary collaboration to maximize efficiency in the venom research process. The first, and most dangerous step in the process is collecting venom from the individual organisms.

Venom extraction facilities rely heavily on the efficiency of extraction equipment to maximize venom yield per extraction and reduce the number of extractions needed. This in turn reduces risks for the extractor and limits stress on the animal. The general procedure for extracting venom from species exhibiting high pressure delivery systems (e.g., elapids and viperids) has remained unchanged for decades (Willemse et al. 1979; Savanur et al. 2014). The process involves eliciting venom delivery into a glass or plastic collection container through a wax membrane. Since venom is a viscous substance, some of it inherently adheres to the extraction equipment and is lost (Fig. 1). To address this issue the following study was conducted in order to determine if there is a way to reduce venom loss during the extraction process. To minimize residue left on glass during extractions two coatings were tested and their efficacy determined for reducing the adherence of a surrogate venom mixture to glass funnels.

Materials and methods.—Two KIMAX® glass funnels (75 mm diameter with 58°-angle bowls) were thoroughly cleaned (using dish soap, dilute bleach, and a hot water rinse) and sent to Nanotech Coatings© (Glenwood Springs, Colorado 81601, USA; www.nanotechcoatings.com) to be coated with commercially available water-repellant coatings. The coatings were applied by Nanotech professionals using a compressor sprayer to produce even coats on all surfaces of the funnels (application details are available on the Nanotech website). One funnel was coated with the product "NanoTech Coatings Quick Seal & Enhance" (SKU: NANO10061) and the other with the product "NanoTech Coatings Marine Coating" (Marine Coating SKU: NANO10001, Catalyst SKU: NANO10017). These were both chosen for their commercial value of repelling aqueous substances while remaining active after cleaning and moderate abrasion.

Actual venom was not used for testing in order to limit venom waste. To simulate venom, a proteinaceous solution was made consisting of one gram of commercially available unflavored gelatin (Kroger© brand) per 10 ml of warm water (35°C) which was left for 30 minutes to cool to room temperature (25°C). The resulting mixture was a syrupy solution resembling the viscosity of venom, and more was made as needed between tests. A 1-ml syringe and 27-gauge needle (Nipro© brand) served as a substitute venom delivery apparatus (Fig. 2). Expulsion rate was kept at 10 seconds per full syringe and 30 seconds was spent refilling the syringe in between each expulsion. This technique allowed the surrogate venom to dry somewhat just as real venom would while the extractor moves from one specimen to the next during a live extraction session.

One uncoated control funnel and the two coated funnels were compared for yield efficiency using the surrogate venom and substitute delivery system. The testing setup mirrored a typical live extraction setup and included a collection vial and extraction stand (Fig. 2). To quantify the differences, each funnel was subjected to ten mock extractions, five representing a 10-ml extraction and five representing a 3-ml extraction. Ten syringe expulsions were utilized through the 1-ml syringe for each of



COURTESY OF THE KENTUCKY REPTILE ZOO

FIG. 1. Venom residue on the glass funnel after extracting from ten adult *Naja naja* specimens. This venom was collected for clinical research towards developing non-opioid pain relief.

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the 10-ml tests and three expulsions for each of the 3-ml tests. Funnels and collection vials were independently weighed before and immediately after each test using a digital scale (Myweigh© DuraScale D2 300, 0.01 g accuracy). The glassware was thoroughly rinsed with hot water (55°C) and dried in between subsequent tests such that initial weights were consistent (± 0.01 g). A ten-minute grace period between tests allowed the glass to return to room temperature.

The total weight of surrogate venom from each test was determined by subtracting the initial weights of the funnel and vial from the post-mock-extraction weights. The percent lost as residue on the funnel was established using the total surrogate venom and funnel residue weights from each test. Mock extraction tests were completed five times for each treatment (N = 5), where the variables included the three different funnels (control, "Quick Seal & Enhance," "Marine Coating") and two extraction sizes (10 ml, 3 ml). A one-way ANOVA and Tukey post-hoc test was performed on these percent values to determine the statistical effectiveness of the coatings for large and small extractions.

Results.—The one-way ANOVA and Tukey post-hoc test revealed the "quick seal enhance" provided a significant decrease of mock venom residue on the glass funnels ($P < 0.01$) for both the large (F value = 21.68, degrees of freedom = 2) and small (F value = 11.29, degrees of freedom = 2) extractions when compared with the control. The "marine coating" showed a significant decrease in residue only for the large extraction ($P < 0.01$) when compared to the control. Summaries of the performances of the funnels can be seen in Table 1.

Discussion.—The smaller 3-ml tests resulted in larger percentages of total surrogate venom left on the funnel as residue when compared to the percentages from the larger 10-ml tests. This difference was almost 2% between the controls for 10 ml and 3 ml testing sizes (4.83% and 6.54% as residue, respectively). This is important since the venom from species with smaller yields (such as *Micrurus* species) is coincidentally more difficult to study, which makes every drop valuable to both researchers and extraction facilities (J. Harrison and K. Wiley, pers. comm.). From this observation it was concluded that extracting more venom at a given time results in a higher percentage of venom collected and lower percentage lost as residue. The funnel coated with the "quick seal enhance" resulted in the least amount of surrogate venom residue in both the 10 ml and 3 ml tests (1.42% and 3.54% as residue, respectively) and was therefore deemed the superior coating tested. This coating lowered the amount of residue by 3% when compared to the controls for both the 10-ml and 3-ml tests. This translates to a net gain of almost a full gram of dried venom for every 300-ml of liquid venom extracted when utilizing this coating. Under normal circumstances the KRZ collects at least this amount of venom weekly and the director has reported collecting double this amount in one day (J. Harrison, pers. comm.).

The coatings are expected to be inert when exposed to actual venom. However, venom samples should be tested for contamination initially before wide-scale implementation of this technique since some trademark ingredients in the coatings are undisclosed. The coatings may modify certain venom molecular activity and/or structure. In the event that direct fang contact jeopardizes the longevity of the coating from prolonged abrasion, certain preventative modifications can be made such as limiting the coating to just below the fang contact point.

This preliminary study was completed in order to portray the potential of utilizing glass coatings for extraction efficiency. There are countless other hydrophobic coating products available for testing which may outperform the two selected for this study. There may also be high potential in implementing super-hydrophobic technology in venom extractions. Unfortunately a stable and reliable super-hydrophobic product has not yet been made readily available for testing of this sort. Understanding the physical boundaries involved with super-hydrophobic and liquid-tension technology may also have relevant implications (Kleingartner et al. 2013). Behavioral research such as strike behavior and venom expenditure may open doors towards safer and more efficient extractions (Young and Zahn 2001; Deufela and Cundall 2006; Hayes



FIG. 2. Mock extraction set up, courtesy of KRZ. Visible residue on control funnel.

TABLE 1. Summary of the surrogate venom residue values from the 10 ml and 3 ml mock venom extractions. Shown are means of percent values from the five tests completed for each treatment, representing the percent of total mock-venom left on each funnel ± standard deviation (N = 5 for each treatment, 1 = 100%).

Mock extraction amount and funnel treatment		Residue (% of whole), SD
10 ml	Control, no coating	.0483 ± .01523
10 ml	"Bonding Coat" and "Quick Seal & Enhance"	.0142 ± .00427
10 ml	"Bonding Coat" and "Marine Coating"	.0152 ± .00295
3 ml	Control, no coating	.0654 ± .01487
3 ml	"Bonding Coat" and "Quick Seal & Enhance"	.0354 ± .00508
3 ml	"Bonding Coat" and "Marine Coating"	.0489 ± .00723

2008; Hayes et al. 2008; Herbert and Hayes 2008). Modifying the equipment based on physiology may also prove advantageous in studying various species for which extraction may be particularly difficult (e.g. *Atractaspis*).

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Attaching Radio Transmitters Does Not Affect Mass, Growth, or Dispersal of Translocated Juvenile Tuatara (*Sphenodon punctatus*)

The IUCN guidelines for conservation translocation (IUCN/SSC 2013) emphasize the importance of post-release monitoring. Such monitoring provides a feedback mechanism to update and enhance current protocols for translocations (Armstrong and Seddon 2008). Monitoring using radio telemetry can be a valuable method for accruing post-release information, including estimates of survival, habitat use and dispersal distance (Le Gouar et al. 2012). Telemetry is an effective technique for studying lepidosaurs (tuatara, lizards, and snakes), many of which are cryptic and/or have secretive behaviors that make them otherwise difficult to detect. An important assumption of telemetry-derived data is that tagged individuals are not adversely affected by the attached devices (White and Garrott 1990), yet many studies do not specifically address the effects of radio-tagging on animals (Millspaugh and Marzluff 2001). The Tuatara (*Sphenodon punctatus*), an endemic reptile of New Zealand, has been reintroduced to Orokonui Ecosanctuary (hereafter Orokonui; Te Korowai o Mihiwaka; 45.766°S, 170.6°E) in the southeastern South Island of the country. In total 87 animals, including 57 juveniles, have been translocated. Tuatara are diurno-nocturnal, burrowing reptiles with low detection probabilities (Cassey and Ussher 1999), particularly for juveniles (Dawbin 1982). We used radio telemetry to monitor dispersal distance and habitat use of juveniles during the establishment phase (IUCN/SSC 2013). Telemetry has been employed for monitoring adult Tuatara, but has rarely been used on juveniles (Table 1). A pilot study was first performed to try several attachment methods. We then compared the performance of tagged versus untagged juveniles that were free-released into the ecosanctuary. Specifically, we evaluated whether body mass, growth rates, and dispersal behaviors differed between tagged and untagged juveniles over five months following release.

Pilot study methods.—In the pilot study we used dummy transmitters (ovoid beads, clay molds, or non-functional transmitters) that were approximately the same size (23 mm × 12 mm × 7 mm, LWH) and mass (3.9 g) as the functional transmitters (PD-2T, Holohil Systems, Carp, Ontario, Canada, with a 20-cm long whip antenna on the posterior end) used for the free-release of juveniles. Dummy and functional transmitters had cylindrical tubes for the passage of harness material. The juveniles tagged in the pilot study had a mean mass of 93 g (range = 87–107 g), and thus transmitters and harness were < 4.3% body weight. We compared four tag attachment methods on juveniles resident in outdoor enclosures (ca. 2 m × 1 m × 0.8 m, LWH) at Orokonui. Each enclosure had a soil substrate, rocks and logs for cover, and artificial burrows made of drainage pipe (Novoflo™) (Mello et al. 2013).

The first method was a "backpack harness" modified from Ussher (1999). Straps made of 6-mm flat elastic were threaded through the cylindrical attachment tubes, then wrapped around the forelimbs in a "figure 8" manner so as to allow the transmitter to sit slightly to one side of the dorsal surface of the animal, just posterior to the neck. Simple stitches (using "Strong Thread," Sullivan's International®) were made to join the elastic straps together where they crossed on the flanks of the animal. The second method ("surgical-tape") used adhesive tape (Leukopor micropore®; 25 mm wide) that was wrapped around the tail twice to secure the transmitter at the base of the tail, just distal to the cloaca, such that the transmitter sat on the side of the tail leaving the antenna to run alongside it. This method has been used for monitoring New Zealand lizards (e.g., *Oligosoma otagense*) (Germano 2007). The third method ("duct-tape") was a variation on the adhesive tape method, instead using duct-tape (initially 3M©, 24 mm wide) that was used and wrapped only once around the tail. Previous research on reptiles has found that duct-tape lasts longer than other types of tape; however, it may cause superficial scars (Wylie et al. 2011). The fourth method was a pelvic harness (hereafter "pelvic attachment") modified from a design used on Great Basin Collared Lizards (*Crotaphytus bicinctores*; J Cossell, pers. comm.). This method involved placing the transmitter on the dorsal surface of the pelvic girdle, where it was secured with round elastic threaded through the tubes then criss-crossed under the ventral surface such that the cloacal vent was not obstructed. Because Tuatara have a gap in the spines dorsal to the pelvis, the transmitter sat securely on the animals and was held firmly in place with a square knot. The backpack harness, surgical-tape, and duct-tape methods were initially tested on one juvenile each for approximately 35 days and the pelvic attachment

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FIG. 1. A juvenile Tuatara (*Sphenodon punctatus*) with elastic backpack harness and radio transmitter at five months after release.

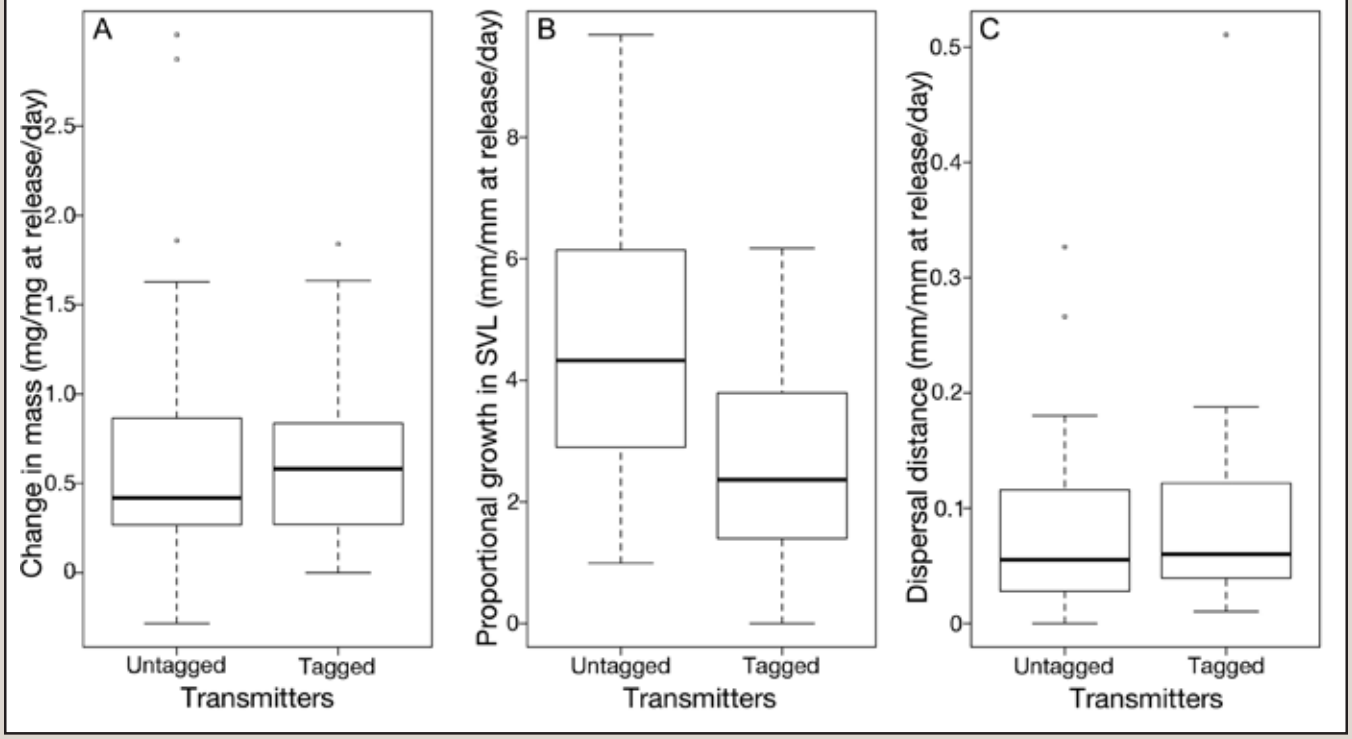


FIG. 2. A comparison of tagged (N = 26) and untagged (N = 29) juvenile Tuatara (*Sphenodon punctatus*) reintroduced to Orokonui Ecosanctuary, South Island, New Zealand: A) change in proportional body mass, B) change in proportional snout–vent length (SVL), and C) dispersal distance corrected for SVL at release. The box shows the median (horizontal bar) and interquartile range; whiskers are 1.5 times the interquartile range and more extreme values are presented outside the whiskers. None of the differences were statistically significant.

method was subsequently tested on two juveniles for 20 days; the pelvic attachment was trialled for a shorter duration due to time constraints.

Pilot study results.—Results from the pilot study showed that the backpack harness remained securely attached; however, it caused minor swelling of the animal's shoulder, which had subsided one month after the harness was removed. By contrast, another juvenile shed the tag that was attached with surgical tape in < 30 days. Initially, the duct-tape method remained attached for < 4 days, but after changing to a more flexible, non-water or UV-resistant tape (Duct-tape II) and wrapping the tape around the tail twice, the attachment stayed on for the remainder of the pilot study (33 days). No injury resulted from the tape methods, and any tape residue was wiped clean with ethanol. Subsequently, the pelvic harness was trialled as we felt that it might offer advantages for Tuatara, including having a more symmetrical placement of the transmitter (better for weight distribution) and possibly less restriction of burrowing; however, juveniles escaped from this attachment in < 4 days. The pilot study informed our decision to use the backpack harness to monitor the translocation of juveniles because of the increased likelihood it would remain attached for the five months of the study, including during molting. We refined this method for the free-release (main study) to try and reduce the possibility of harness-related injury by: 1) using a 3-mm flat elastic (overlocked to reduce elasticity) to permit a better and slightly looser fit of the harness on the juveniles; 2) using a polyester nylon loop threaded through the cylindrical attachment tubes and finished with a square knot to allow elastic straps to be more evenly distributed on the animal; and 3) an additional simple stitch connecting the elastic straps where they crossed on the ventral surface to reduce abrasion by reducing movement of the harness attachment (Fig. 1). Furthermore, we recaptured most tagged juvenile Tuatara at approximately 50-day intervals to check for adverse effects from the harness fit (e.g., skin abrasion and/or swelling).

Main study methods.—The vegetation at the study site for the free-release of juvenile Tuatara comprised mostly regenerating native Kānuka (*Kunzea ericoides*) forest, with remnant patches of podocarp-broadleaved forest (*Coprosma* spp., Lemonwood [*Pittosporum eugenioides*], Mahoe [*Melicytus ramiflorus*], Mapau [*Myrsine australis*]), and modified bush-margins of bracken (*Pteridium* spp.). Juveniles were released in the austral spring, a period of increasing temperature and activity for Tuatara. A total of 14 wild-caught juveniles from Stephens Island (Takapourewa) were released on 17 October 2012. An additional 41 captive-reared juveniles were released on 7 November 2012: 28 from Nga Manu Nature Reserve (hereafter Nga Manu) and 13 from Orokonui. Two more juveniles from Orokonui were released into the same area on 3 December 2012, following completion of additional disease testing. Prior to the free-release of tagged and untagged juveniles, a passive integrated transponder (PIT) tag (11 mm × 2 mm; AVID Identification Systems, Inc., Norco, California, USA) was inserted subcutaneously just anterior to the left rear leg for individual identification. We took several morphometric measurements of juveniles at release and recapture: snout-to-vent length (SVL); vent-to-tail-length; length of the regenerated portion of the tail; and mass. The mass of all juveniles at release ranged from 44–177 g (mean = 93.7 g) and SVL at release ranged from 106–169 mm (mean = 138.9 mm). We attached transmitters onto subsets of the three groups of juveniles: 10 wild-sourced,

TABLE 1. History of telemetry use with Tuatara (*Sphenodon punctatus*) (updated from Ussher 1999).

Adult or juvenile	Attachment	Resident or translocation	Sample size (N)	Period of attachment	Data collected	Negative effects on animals	References
Adult	Surgical tape	Resident (Lady Alice Island)	6	≤ 9 days	Body temperature	Not observed	Tyrrell 2000
Adult	Hind-quarter mount	Resident (Stephens Island)	≤ 4 per trip for 3 trips	≤ 9 days	Body temperature	No data	Barwick 1982
Adult	Backpack	Resident (Stephens Island)	No data	No data	No data	Overloaded animals; entrapment in burrows	Newman 1980
Adult	Backpack	Resident (Taranga Island)	10	≤ 12 months	Habitat use, behavior and body condition	Occasional swollen limbs	L. Anderson, pers. comm., 2013
Adult	Backpack	Resident (Stephens Island)	10	ca. 1 month	Nesting habits	Not observed	J. Moore, pers. comm., 2013
Adult	Backpack	Translocation (Titi Island)	7	ca. 2 months	Dispersal and movements	Not observed	Nelson 1998; N. Nelson, pers. comm., 2013
Adult	Backpack	Translocation (Zealandia™, Wellington)	16	≤ 12 months	Survival, dispersal, and growth	Greater dispersal distances than untagged conspecifics	McKenzie 2007
Adult	Backpack	Translocation (Motohoura Island)	29	≤ 16 months	Dispersal and habitat use	Frequent damage to scales; occasional swollen limbs and broken skin	Ussher 1999
Adult	Backpack	Translocation (Orokonui Ecosanctuary)	10	≤ 4 months	Nesting behavior, body temperature, and dispersal	Occasional damage to scales; occasional swollen limbs and broken skin	A. Besson and S. Adolph, pers. comm., 2013
Adult	Backpack	Translocation (Tiritiri Matangi)	9	< 3 months	Dispersal and habitat use	Occasional swollen limbs	Ruffell 2005
Juvenile	Intraperitoneal implant	Resident (Stephens Island)	4	< 1 month	Movement patterns and habitat use	No data	M. McIntyre, pers. comm., 2013
Juvenile	Backpack	Translocation (Titi Islands)	2	ca. 2 months	Dispersal and movements	Not observed	Nelson 1998; N. Nelson, pers. comm., 2013

10 head-started at Nga Manu, and six head-started at Orokonui. We attempted to match the body size, sex composition (where known), and numbers of individuals in groups as closely as possible. On average, the total package (transmitter and harness) weighed 3.7% of the mass of the released juveniles (range = 2.6–5.4%). All measurements were taken by one author (SJ).

All 26 tagged juveniles were radio-tracked with TR-4 receivers (Telonics, Mesa, Arizona, USA) and hand-held 3-element Yagi folding directional antennas (Sirtrack Electronics, Havelock North, New Zealand) two times per week to minimize disturbance. We removed all transmitters after five months. Untagged juveniles were recaptured opportunistically throughout the duration of the study; only two of the untagged individuals were not recaptured. In addition, we recorded the distance and compass direction of all Tuatara movements. We measured distance (to the nearest cm) using a tape measure and compass direction from the previous sampling point or the release burrow. Distance and direction data were converted to GPS coordinates, relative to several fixed locations at the study site that were established using GNSS technology (Trimble R7 GNSS with Trimble Zephyr™ Geodetic 2 Antenna mounted on a range pole, Sunnyvale, California, USA, with < 3 cm accuracy). GPS coordinates for each animal were then used to calculate post-release dispersal defined as the straight-line distance between the initial release site and final recapture location for Tuatara (measured in ArcGIS 10.1; ESRI, Redlands, California, USA).

Statistical analysis.—We used analysis of variance (ANOVA) to test for effects of transmitters and animal source (i.e., Orokonui, Nga Manu, or Stephens Island) on proportional growth in snout–vent length (mm/mm initial SVL/day), proportional change in body mass (mg/mg initial body mass/day) and proportional dispersal distance (mm/mm initial SVL/day). Data were analyzed using the statistical program "R" (version 3.0.1; R Development Core Team 2013). Statistical significance was assumed at $p < 0.05$. All data satisfied the assumptions of the statistical tests used.

Main study results.—We monitored transmitters attached to 26 reintroduced juveniles for a cumulative total of 3750 animal days (range = 71–158 days per animal). Three juveniles (11.5%) escaped from their harnesses during our study; however, all of these animals were recaptured and had their harnesses replaced within 10 days. There were also three tagged animals (11.5%) recaptured that exhibited skin abrasion and/or swelling of one shoulder and arm; transmitters were removed when this was detected. Harness-induced injury was first noticed ca. four months after release. One tagged individual was found dead at ca. three months post-release, probably as a result of a human-related crush injury that did not occur while radio tracking. Our initial analysis of tagged versus untagged individuals showed that including source population as a factor was not significant in any analysis ($P > 0.05$). Subsequently, we ran our analyses omitting source population; the changes in proportional body mass ($F_{1,53} = 0.252$, $P = 0.618$), proportional growth rates ($F_{1,53} = 1.027$, $P = 0.316$), and dispersal distance ($F_{1,53} = 0.108$, $P = 0.744$) were not significantly different between tagged and untagged juveniles (Fig. 2).

Discussion.—Although radio-telemetry studies require the fundamental assumption that the use of radio tagging does not have a detrimental impact on tagged animals (White and Garrott 1990), many studies, particularly for reptiles, do not quantitatively test this assumption. In our study of reintroduced juvenile Tuatara we used animals that had no transmitters attached as controls. Our results showed that, over the five months post-release, tagging juvenile Tuatara did not negatively impact performance parameters, such as growth, body mass, or dispersal distance. A previous reintroduction of Tuatara to a different site, however, suggested that tagged adults dispersed further than untagged conspecifics, presumably due to disturbance from intensive (daily) monitoring (McKenzie 2007). Dispersal distance, in particular, is a critical issue in reintroduction biology (Armstrong and Seddon 2008), as populations can fail to establish if too many animals disperse far from release areas and are unable to contribute to the breeding population (Le Gouar et al. 2012). The reduced frequency of our monitoring regime, as a result of findings from this earlier study, might have lessened the negative impact of intensive radio-tracking. This illustrates the importance of disseminating post-release data in translocation projects, because while monitoring is important to understand the process of establishment and to improve future programs (Armstrong and Seddon 2008), it should not influence the behavior of released animals.

Our modified backpack harness had no apparent effect on the behavior of juveniles. For instance, we observed tagged juveniles exhibiting the same behaviors as untagged individuals, including foraging and sun-basking. However, one aspect of the welfare of tagged animals that is important to monitor is the presence of harness-induced injury (Millspaugh and Marzluff 2001). In our study three juveniles had skin abrasion and/or swelling of the shoulder and arm; two of these tagged animals had previously escaped their transmitters. It is probable that, when we reattached the harness, the elastic straps were tightened more firmly to prevent future harness loss. This highlights a fine line between having the attachment method too loose, too firm, or just right. Research on lizards has identified similar problems with animals either escaping from the backpack harness (e.g., Fisher and Muth 1995; Price-Rees and Shine 2011) or being injured by this attachment method (e.g., Goodman et al. 2009) despite the duration of monitoring usually being shorter. It should be noted that all of the injured juvenile Tuatara have been recaptured since the transmitters were removed, with the swelling having subsided. Thus, correct fitting and regular visual inspections of animals for abrasions or skin irritations and/or recaptures of tagged animals are important to reduce injuries during the long-term deployment of transmitters, especially when working with growing juveniles.

In summary, we encourage more telemetry studies of reptiles to use comparative data of tagged and untagged animals to evaluate the effects of monitoring, an admittedly difficult task, especially for juveniles due to their cryptic nature and secretive behaviors (Pike et al. 2008). Nevertheless, erroneous conclusions might be reached about the species' ecology, life history, and behavior if tagged animals are not representative of the entire population (White and Garrott 1990; Millspaugh and Marzluff 2001).

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Extracting and Amplifying DNA from Skin Swabs of a Forest Dwelling Tree Frog Species (*Nyctixalus pictus*)

A major contributor to amphibian declines in tropical regions of southeastern Asia is deforestation (Bickford et al. 2010). In Singapore, it is estimated that within the last 200 years, up to 95% of original forest cover has been cleared (Brooks et al. 2003). Despite deforestation, anuran diversity in Singapore is high with almost 30 native species (Baker and Lim 2012) and at least two introduced species (Leong and Lim 2011). Given these high levels of diversity and a recent history of deforestation, Singapore is ideal for genetic investigations of fragmentation effects; however, for forest dwelling species which often have small or dwindling population sizes (Bickford et al. 2010), invasive sampling (i.e., muscle, liver, or toe-clipping) may be counterproductive to conservation management efforts. Thus, we decided to explore the feasibility of using minimally invasive (i.e., non-destructive) sampling to obtain DNA from a vulnerable Singaporean tree frog species.

The phenomenon of global amphibian declines has ushered in a new set of research protocols for performing genetic analyses on endangered and vulnerable species. Many methods for non-destructive sampling techniques have been described. These methods include extracting DNA from buccal swabs (Goldberg et

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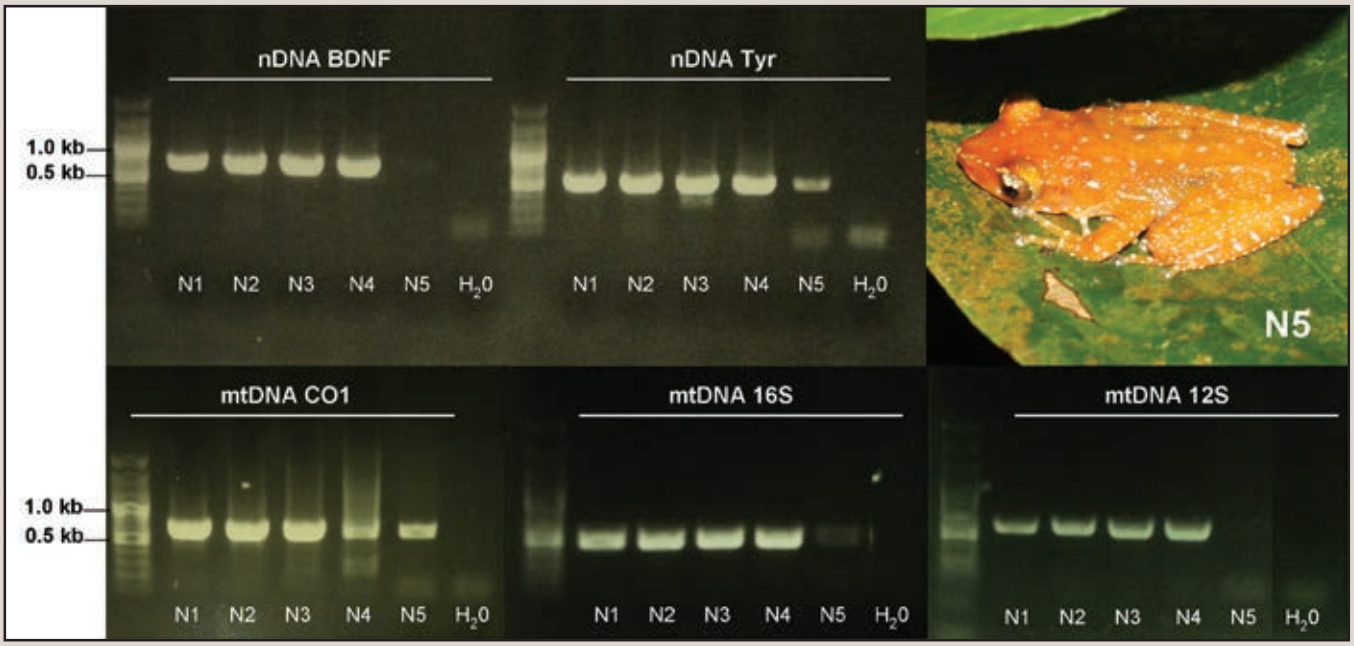


FIG. 1. Successful PCR amplification of two nuclear (nDNA; Brain-derived neurotrophic factor [BDNF] and tyrosinase precursor [Tyr]) and three mitochondrial (mtDNA; 12S and 16S ribosomal subunits [12S & 16S] and cytochrome oxidase I [CO1]) loci from *Nyctixalus pictus* samples from Indonesia, Malaysia, and Singapore. Skin-swabbed adult male specimen of *N. pictus* from the Central Catchment region (N5) is pictured in top right panel.

al. 2003; Pidancier et al. 2003; Broquet et al. 2007), blood (Tapley et al. 2011), and hand or foot swabs (Gallardo et al. 2012). Recently, several studies have successfully employed dorsal and ventral skin swabbing (Mendoza et al., 2012; Prunier et al. 2012; Müller et al. 2013). Given that dorsal and ventral swabbing can be performed quite rapidly while imposing minimal physical restraint, we selected this method for our swabbing protocol. To assess the quality of DNA obtained from this protocol, we attempted to amplify by polymerase chain reaction (PCR) three mitochondrial (mtDNA) and two nuclear (nDNA) gene fragments frequently sequenced from frogs.

Methods.—The Cinnamon Tree Frog (a.k.a. the Spotted Tree Frog), *Nyctixalus pictus* (Anura: Rhacophoridae), is widely distributed throughout the Sunda Shelf region eastward to the Philippines. The combination of a phytotelm breeding ecology and small clutch sizes makes *N. pictus* particularly sensitive to habitat loss. Although considered common by some authorities (e.g., Chua and Lim 2011), the species is listed by the International Union for Conservation of Nature (IUCN) as Near Threatened (Diesmos et al. 2004). Additionally, it is red-listed as Vulnerable in Singapore because it is restricted to the Central Nature Reserves (Baker and Lim 2012). On 21 June 2012 at 2240 h, we located a calling adult male *N. pictus* (Fig. 1) along Old Upper Thompson Road in the Central Catchment Nature Reserve in Singapore (1.38°N, 103.83°E, datum WGS84; elev. 35 m). The individual was captured by hand and swabbed on its dorsal and ventral surfaces (ca. 5–10 times each) using small cotton-tipped swabs. Following this procedure the individual was photographed (Fig. 1) and released. Each swab was placed in a 1.5-mL microcentrifuge tube and transported back to the laboratory.

We stored swabs in the laboratory for ca. 10–15 days at -20°C. Genomic DNA was extracted from swabs using a DNeasy kit (Qiagen) via the same swab-digestion method described in Tupper et al. (2011). For comparison, we also extracted DNA from muscle tissue of four *N. pictus* originating from localities in Malaysia and Indonesia (N1–N4; Table 1). Swab and muscle samples were eluted in 40 and 200 µL of Buffer AE, respectively. Voucher specimens corresponding to samples N1–N4 are housed at the Raffles Museum for Biodiversity Research (RMBR) at the National University of Singapore. To quantify amount of double-stranded DNA we isolated from each sample, we used a Qubit® fluorometer (Invitrogen, Life Technologies). We used a high-sensitivity assay kit in all Qubit® trials. PCR trials were performed using previously published "universal anuran" primers for two nDNA (BDNF and Tyrosinase; de Sá et al. 2012) and three mtDNA (12S and 16S ribosomal subunit genes [12S and 16S]; cytochrome oxidase I [CO1]; Streicher et al. 2009) gene fragments. PCRs were performed in 20-µL reactions that included: 11.9 µL of DEPC water, 2 µL of 5X reaction buffer, 2 µL of dNTPs (2 mM each), 2 µL of primers (1 µL forward primer + 1 µL reverse primer; each 10 µM concentration), 0.1 µL of Dream Taq DNA Polymerase (5 unit/µL; Thermo Scientific), and 2 µL of extracted DNA. We used previously described thermal cycling profiles for each primer set (see Streicher et al. 2009; de Sá et al. 2012). After PCR experiments, amplicons were visualized using 1–2% agarose gels stained with ethidium bromide or SYBR® Safe DNA stain (Life Technologies).

Because we were limited to sampling a single individual of *N. pictus* for this study, we conducted a second study using a frog species from North America to demonstrate the repeatability of our protocol. This validation study used skin swabs of *Hyla arenicolor* (Anura: Hylidae) from the southwestern United States. We extracted DNA from dried muscle (H1) and skin swabs (H2–H4) from frogs sampled at localities in the states of Texas and Arizona (Table 1). We tested two mtDNA primer sets (16S and CO1) and one nDNA primer set (BDNF) on the samples of *H. arenicolor* using the same laboratory protocols described above for *N. pictus*.

Results.—The skin swab DNA extraction (sample N5) had detectable amounts of double-stranded DNA (0.053 ng/µL; Table 1) but, not surprisingly, far less than any muscle tissue samples

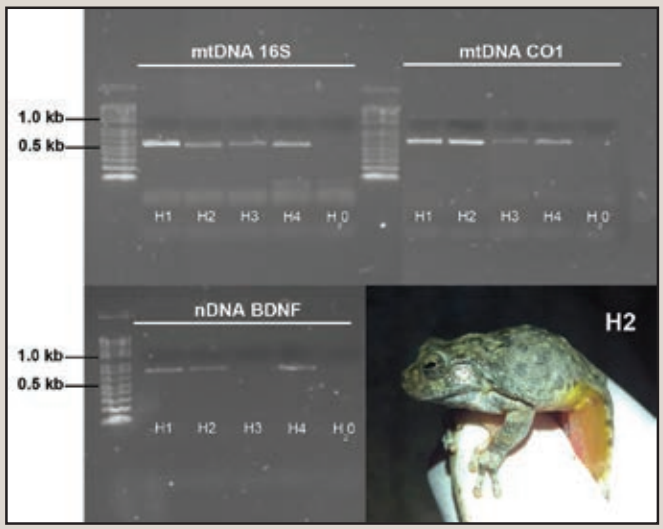


FIG. 2. Successful PCR amplification of one nuclear (nDNA; Brain-derived neurotrophic factor [BDNF]) and two mitochondrial (mtDNA; 16S ribosomal subunit [16S] and cytochrome oxidase I [CO1]) loci from *Hyla arenicolor* samples from the United States. Skin-swabbed adult of *H. arenicolor* from Arizona (H2) is pictured in bottom right panel.

(17.8 to >150 ng/µL; Table 1). PCR amplifications were successful with visible bands in all samples, although substantially less efficient in the skin swab sample (Fig. 1). Notably, the BDNF and 12S experiments produced only small levels of amplification for the N5 sample (Fig. 1). In our study of *H. arenicolor* we found that the dried muscle sample (H1) possessed similar amounts of double-stranded DNA as the fresh swabs (0.15–0.82 ng/µL; Table 1). The mtDNA and nDNA primer set amplified gene fragments across all individuals with the exception of BDNF for sample H3 (Fig. 2). The size of amplicons (in number of base pairs [bp]) matched our expectations for each locus based on previous studies (Streicher et al. 2009; de Sá et al. 2012): BDNF (ca. 700 bp), Tyr (ca. 550 bp), 12S (ca. 500 bp), 16S (ca. 650 bp), and CO1 (ca. 680 bp).

Discussion.—Overall, our ability to successfully amplify several mtDNA and nDNA markers from skin swab samples is a promising result towards feasibility of using this methodology more widely. Although success is not surprising given the known efficacy of this technique (Prunier et al. 2012), it is interesting that the amplification of all five loci was effective enough for amplicons to be visible on an agarose gel despite a very small amount of DNA template (smaller by at least two orders of magnitude than most previous studies; e.g., Müller et al. 2013). However, demonstrating that we can amplify multiple genetic markers from skin swabs of *N. pictus* comes with at least one caveat. Skin swabbing has also been shown to feature inter-individual contamination from when frogs presumably slough epithelial cells onto one another through amplectant or territorial interactions (Müller et al. 2013). While this is not an issue for investigations concerned with deeper relationships (e.g., molecular systematics and phylogeography), population genetics studies may suffer from this limitation. Although we recognize that liver, muscle, and toe-clip samples will typically yield more DNA template, under circumstances when non-destructive sampling must often be used (e.g., conservation priority forest-dwelling frogs from Singapore), our findings are an encouraging reminder that very little template DNA is needed to amplify nDNA and mtDNA markers for genetic analysis.

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TABLE 1. Voucher information for samples of *Nyctixalus pictus* and *Hyla arenicolor* used in this study.

ID	Species	Voucher	Locality	Tissue Type	DNA concentration (ng/µL)
N1	*N. pictus*	RMBR 3272	Malaysia: Krau Wildlife Reserve	Muscle	> 150
N2	*N. pictus*	RMBR 2058	Indonesia: Kalimantan	Muscle	106
N3	*N. pictus*	SP27035	Indonesia: Kalimantan	Muscle	17.80
N4	*N. pictus*	SP27057	Indonesia: Kalimantan	Muscle	35.20
N5	*N. pictus*	JWS T-114	Singapore: Central Catchment	Skin Swab	0.053
H1	*H. arenicolor*	JWS 417	USA: Texas	Dry Muscle	0.292
H2	*H. arenicolor*	JWS T-175	USA: Arizona	Skin Swab	0.152
H3	*H. arenicolor*	JWS T-177	USA: Arizona	Skin Swab	0.106
H4	*H. arenicolor*	JWS T-178	USA: Arizona	Skin Swab	0.818

RMBR = Catalogued specimens at Raffles Museum of Biodiversity Research; SP = Uncatalogued specimens at Raffles Museum of Biodiversity Research; JWS = Jeffrey W. Streicher personal field series; JWS-T = Jeffrey W. Streicher tissue collection. Subsamples of all tissues are available upon request.

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AMPHIBIAN DISEASES

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Extremely Low Prevalence of *Batrachochytrium dendrobatidis* Infection in Eastern Hellbenders (*Cryptobranchus alleganiensis alleganiensis*) in Southwest Virginia, USA

The large, fully aquatic Eastern Hellbender (*Cryptobranchus alleganiensis alleganiensis*) is a phylogenetically unique member of North America's salamander diversity and a focus of increasing conservation concern. Substantial population declines have been reported across much of the Eastern Hellbender's range (Wheeler et al. 2003; Foster et al. 2009; Burgmeier et al. 2011b), and this subspecies is now apparently extirpated from some historical localities (Graham et al. 2011). Exact causes for population declines are unclear, although habitat degradation is often suspected to play a significant role (Wheeler et al. 2003; Foster et al. 2009; Graham et al. 2011). Recently, however, studies have documented *Batrachochytrium dendrobatidis* (*Bd*) infection in both captive and wild hellbender populations (Briggler et al. 2007; Briggler et al. 2008; Gonynor et al. 2011; Bodinof et al. 2012; Regester et al. 2012; Tominaga et al. 2013). This fungal pathogen has been detected on hellbender museum specimens collected as far back as 1969 (Bodinof et al. 2011). *Bd* causes the devastating amphibian disease chytridiomycosis (Berger et al. 1998; Kilpatrick et al. 2010; Eskew and Todd 2013), and evidence from the tropics suggests that disease-driven amphibian declines may have wide-ranging effects on ecosystem functioning in lotic systems (Whiles et al. 2006). However, the prevalence of *Bd* in river- and stream-associated amphibians from temperate latitudes is understudied; the limited data currently available suggests that *Bd* infection is at relatively low prevalence in low-order stream systems in the US (Hossack et al. 2010).

Although many studies suggest that wild hellbenders do not typically manifest clinical symptoms of chytridiomycosis or suffer mortality from the disease (Gonynor et al. 2011; Souza et al. 2012; Tominaga et al. 2013), there is at least one report of hellbender mortality associated with chytridiomycosis (Bodinof et al. 2012). In addition, even if chytridiomycosis rarely causes hellbender mortality in isolation, *Bd* infection might still negatively affect hellbender populations by allowing for detrimental co-infections (Bodinof et al. 2011) or through interactions with other stressors such as habitat alteration (Hopkins and DuRant 2011). In at least some systems, however, the relationship between *Bd* prevalence and habitat disturbance is counterintuitive, with the highest infection risk occurring in the most pristine habitats (Becker and Zamudio 2011). Therefore, we sought to evaluate *Bd* prevalence in Eastern Hellbenders occupying a single stream predominately surrounded by forest but with a gradient of surrounding habitat disturbance. We also report *Bd* infection status of another fully aquatic salamander, the Common Mudpuppy (*Necturus maculosus*), captured incidentally during our study.

We sampled 14 different stream reaches across a 57-km expanse of a single stream (3rd–4th order) within the Tennessee River Basin of southwest Virginia, USA where hellbenders are known to be relatively abundant (Hopkins and DuRant 2011). The name and location of the stream is withheld because of the sensitive conservation status of our study species in Virginia. The watershed is predominately forested (65–76% forest cover across our sampling range), but progressive encroachment of agricultural activity, suburban development, and increased road density pose threats to downstream habitat quality and generate a disturbance gradient within the watershed. For additional information on a subset of the study reaches, including data on land use within the watershed, see Hopkins and DuRant (2011).

Sampling occurred in the summer months between 27 June 2011 and 2 September 2011, and between 9 July 2012 and 6 September 2012. The sex of adult hellbenders is distinguishable at this time due to the swollen cloacae of males. We located animals during visual encounter searches by lifting and searching beneath large rocks while snorkeling. After capture, we swabbed hellbenders and incidentally captured Common Mudpuppies for *Bd* by rubbing a single cotton-tipped swab five times over the dorsal and ventral surfaces, five times on each side, and five times on each foot for a total of 40 swabs per animal. We used disposable vinyl gloves when swabbing animals. We stored swabs in 70% ethanol at room temperature until extractions took place.

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We isolated DNA following the swab extraction protocol of Retallick et al. (2006) with the exception that we removed ethanol from swabs by placing them on a heat block at 55°C until all standing ethanol was evaporated (approximately 48 h). To detect *Bd* DNA, we used the real-time PCR assay described by Boyle et al. (2004). We ran samples on a Step-One Plus Real-time PCR machine (Applied Biosystems, Foster City, California) using the "Presence/Absence" mode as we were only interested in *Bd* prevalence within the hellbender population. For real-time PCR, we used 2.5 µl of diluted DNA in a total reaction volume of 12.5 µl. We ran samples singly (Kriger et al. 2006), and included positive (100 zoospore equivalent *Bd* standards) and negative (molecular-grade water) controls on all plates. All positive and negative controls behaved as expected, producing no false negatives or false positives. To validate our laboratory methods, we also ran seven samples collected in August 2013 from a *Bd*-positive captive population of hellbenders (Virginia Dept. of Game and Inland Fisheries, unpubl. data); results obtained using our methodology (one *Bd* positive hellbender out of seven tested) corresponded with those independently generated by Virginia state biologists.

A total of 230 unique individual hellbenders, 113 from 2011 (76 adults, 37 juveniles) and 117 from 2012 (103 adults, 14 juveniles), were captured and swabbed for *Bd* infection during our study. Captured hellbenders averaged 36.81 ± 0.57 (mean ± SE) cm in total length, 23.81 ± 0.37 cm in snout–vent length (SVL), and 337.30 ± 14.25 g in mass. Only a single hellbender collected in 2011 tested positive for *Bd*, resulting in a prevalence of 0.88% that year. The sample from this individual was re-run and again tested positive, further confirming *Bd* presence. The positive individual was an adult male captured on 11 July 2011 in apparently good condition in a stream reach lying in the middle of the sampled watershed and thus in the middle of the habitat gradient described above and in Hopkins and DuRant (2011). A total of 76 other individuals were sampled from this stream reach in 2011; these samples all tested negative. All hellbenders sampled in 2012 tested negative for *Bd* infection. A total of six Common Mudpuppies were incidentally captured and swabbed during sampling events in 2012. Captured mudpuppies averaged 21.63 ± 1.14 (mean ± SE) cm in total length, 14.52 ± 0.80 cm SVL, and 48.33 ± 7.62 g in mass. All mudpuppies tested negative for *Bd*.

Overall, our study suggests there was an extremely low prevalence of *Bd* infection within an Eastern Hellbender population in southwest Virginia at the time animals were sampled. Only a single hellbender of 230 sampled during the summers of 2011 and 2012 tested positive for *Bd*. The low overall prevalence of *Bd* precluded us from making any general inferences about factors (e.g., age/size, sex, surrounding land use) that might influence *Bd* prevalence in this hellbender population. However, it is important to note that the stream reaches examined in this study are all predominately forested and lack major industrial inputs, and even the most disturbed reaches of this study system have not yet experienced the level of habitat degradation of some other historical hellbender habitats. Thus, sampling across a larger range of stream habitat quality might provide greater insight as to whether anthropogenic factors influence *Bd* prevalence in hellbender populations. Although our sample size for Common Mudpuppies was small, our report of *Bd* absence in this species mirrors the result of Ouellet et al. (2005) who also failed to find evidence of infection in 12 individuals of this species collected from Québec, Canada. However, *Bd* infection has been reported from other fully aquatic *Necturus* species collected in Florida and Louisiana (Chatfield et al. 2012), and more comprehensive studies are needed to elucidate *Bd* infection dynamics in this salamander genus.

Prior reports of *Bd* prevalence within hellbender populations have found the pathogen to be common in some populations (within-population prevalence of approximately 20–50%; see Gonynor et al. 2011; Souza et al. 2012; Tominaga et al. 2013) but rare in others (1.3% prevalence in Burgmeier et al. 2011a). Our results are similar to several other studies of stream-associated salamanders that also found low prevalence of *Bd* (summarized in Hossack et al. 2010). Hossack et al. (2010) hypothesized that their findings of low *Bd* prevalence in many North American stream-associated amphibians might be driven by seasonally cold in-stream temperatures that limit *Bd* growth during cooler winter months. Optimal temperatures for the growth of *Bd* range from 17–25°C (Piotrowski et al. 2004). In our stream system in Virginia, water temperatures are cold (< 6–8°C) during winter months, but at the time we sampled animals, water temperatures typically exceeded the lower limit for optimal *Bd* growth (average during surveys = 18.6 ± 0.3°C; range 14.5–22.0°C). Thus, the low prevalence of *Bd* infection in hellbenders in the present study could partially reflect an inability of *Bd* to thrive in areas that experience suboptimal, cold winter temperatures. However, in light of the fact that other streams throughout the hellbender's range likely have comparable winter temperatures but *Bd* can be prevalent in these systems (Gonynor et al. 2011; Souza et al. 2012; Tominaga et al. 2013), other factors related to surrounding land use, in-stream habitat quality, pollution, community assemblage, and the general health of hellbenders are more likely determinants of *Bd* prevalence that deserve further investigation.

The results of this study add to our basic understanding of the prevalence of *Bd* infection in hellbender populations in one of the remnant strongholds within the range of this imperiled amphibian species. The extremely low prevalence of *Bd* reported here and elsewhere (Burgmeier et al. 2011a), contrasts with the higher prevalence of *Bd* infections in other hellbender populations (Gonynor et al. 2011; Souza et al. 2012; Tominaga et al. 2013). It remains unclear whether *Bd* infections regularly result in disease (chytridiomycosis) in wild hellbenders to a degree that negatively affects hellbender health, reproduction, and survival. However, chytridiomycosis has been a problem in captive populations and may have caused mortality in at least one translocated animal (Bodinof et al. 2012). Broader spatial and temporal monitoring is needed to fully assess the risk that *Bd* poses to wild hellbender populations and to facilitate the early detection and mitigation of any potential chytridiomycosis outbreaks in this unique freshwater amphibian. Additionally, the recent description of another pathogenic fungus, *Batrachochytrium salamandrivorans* (*Bs*), that can cause lethal chytridiomycosis in northwestern European salamanders suggests that pathogen surveillance efforts focused solely on *Bd* may underestimate the threat of fungal disease (Martel et al. 2013). Consequently, future work should use newly developed molecular methods that enable the simultaneous detection of both pathogens in amphibian host populations (Blooi et al. 2013).

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Batrachochytrium dendrobatidis in Virginia Amphibians: Within and Among Site Variation in Infection

Substantial variation in the presence and intensity of *Batrachochytrium dendrobatidis* (*Bd*) infection exists among individuals, populations and species of amphibians (Muths et al. 2008; Knapp et al. 2011; Lannoo et al. 2011; Raffel et al. 2010; Savage et al. 2011). While the factors contributing to this variation are numerous and complex, environmental conditions such as temperature and moisture appear to play a key role in shaping *Bd*'s interactions with its amphibian hosts. Moisture is necessary for infection to occur and essential for the spread of the disease, since the infective zoospore stage is aquatic (Berger et al. 2005; Longcore et al. 1999). The pathogen can grow across a wide range of temperatures (4–28°C), with some variation among isolates (Stevenson et al. 2013), but the optimal range for growth is between 13 and 25°C (Piotrowski et al. 2004).

Due to the physiological limitations of *Bd*, more arid habitats and habitats with temperatures outside the thermal optimum of *Bd* often pose lower risk for amphibian infection (Muths et al. 2008; Forrest and Schlaepfer 2011; Lannoo et al. 2011). Prevalence of the disease can also fluctuate seasonally with changes in temperature and/or precipitation (Berger et al. 2004; Retallick et al. 2004; Kriger and Hero 2006; Russell et al. 2010; Forrest and Schlaepfer 2011; Lannoo et al. 2011; Savage et al. 2011). Thus, the external environment may pose important constraints on infection (e.g., Longo et al. 2010; Pullen et al. 2010), along with any natural amphibian defenses against *Bd* (reviewed by Rollins-Smith and Woodhams 2012).

In eastern North America, where we completed our study, *Bd* has been detected in at least 48 species of amphibians (of 92 tested; Appendix I) and has been present in the region since at least the 1960s (Ouellet et al. 2005). In this region, as elsewhere, the prevalence of *Bd* varies both temporally and spatially. Temporal changes in this region are associated with seasonal variation in temperature (Longcore et al. 2007; Lannoo et al. 2011; Brannelly et al. 2012), as winter temperatures fall below the thermal optimum for *Bd*, and summer temperatures rise above it. Temperature also appears to play a role in spatial variation, with cooler, shaded ponds having the highest infection intensities in early summer (Raffel et al. 2010). However, variation in the species composition of the amphibian community among sites may also contribute to spatial variation in infection. For example, Richards-Hrdlicka et al. (2013) found that the presence of ranids, and in particular Green Frogs (*Lithobates clamitans*), was associated with a higher prevalence of *Bd*.

In this study, we characterized variation in the presence and intensity of *Bd* infection in four species of amphibians commonly encountered in Virginia, USA: Eastern Newts (*Notophthalmus viridescens viridescens*), American Bullfrogs (*Lithobates catesbeianus*), Spring Peepers (*Pseudacris crucifer*), and American Toads (*Anaxyrus americanus*). Prior studies suggest that although *Bd* may be widespread in Virginia, prevalence tends to be low for the focal species in our study (newts: 11%, peepers: 0–23%, bullfrogs: 0–8%, and toads: 6–17%; Pullen et al. 2010; Davidson and Chambers 2011; Goodman and Ararso 2012) as well as for other Virginia amphibians (Hossack et al. 2010; Pullen et al. 2010; Gratwicke et al. 2011).

We collected data on *Bd* infection for a total of 355 amphibians (Table 1) using skin swabbing, which is an effective, nonlethal method for detecting *Bd* infection in amphibians (Hyatt et al. 2007). In April–June of 2010, we swabbed adult newts at three sites (N = 7–27 per site) and, in August 2010, we swabbed juvenile bullfrogs at one site (N = 61). In March–May 2012, we swabbed adult newts at one site (N = 15), adult toads at three sites (N = 9–16 per site), adult peepers at ten sites (N = 7–19 per site), and juvenile and adult bullfrogs at four sites (N = 9–14 per site; Table 1). The bullfrogs varied substantially in size, and represented both juveniles and adults, so we also examined the relationship between *Bd* infection and snout–vent length (SVL) in bullfrogs. In 2012, for Spring Peepers, we recorded water temperature at three sites in each pond near where individuals were calling to examine the relationship between *Bd* infection and water temperature at the time of sampling (between 2000 and 2300 h). These three measurements were averaged for analyses.

Amphibians were caught with a dipnet or by hand, using new nitrile gloves for each individual. All individuals were swabbed immediately or placed in a sterile Whirl-Pak bag or plastic container until swabbing could take place (within ~1 h of capture). Before swabbing, we rinsed all amphibians to remove any dirt and transient bacteria, as we were collecting data on the amphibians' cutaneous microbial communities for other studies. In 2010, we rinsed bullfrogs and newts by placing them in 50-ml plastic containers filled with 25 ml of sterile, deionized water, and repeated this rinse twice for each individual. In 2012, we rinsed all species by pouring 50 ml (peepers, toads, and juvenile bullfrogs) or 100 ml (adult bullfrogs) of sterile, deionized water over their bodies, in part to accommodate the large size of many of the frogs. We used sterile rayon swabs for all collections (MW113, Medical Wire Equipment & Co. Ltd., Corsham, UK). Histological examinations of infection in two species of frogs have found that infections are generally concentrated in the forelimbs, hindlimbs, and ventral surface of the abdomen (Berger et al. 2005; Puschendorf and Bolaños 2006); thus, for all frogs, we swabbed the ventral surface 20 times, each thigh 5 times, and each hind foot 5 times for a total of 40 strokes (similar to Hyatt et al. 2007). We swabbed newts in a similar manner, except we swabbed each lateral surface 5 times instead of the thighs. We placed swabs in sterile, empty 1.5 ml microcentrifuge tubes on ice in the field and transferred them in the laboratory to –20°C or –80°C for storage.

DNA was extracted from swabs using the Qiagen DNeasy Blood & Tissue Kit (Qiagen, Inc., Valencia, CA, USA). We followed the manufacturer's Quick-Start protocol, with the following

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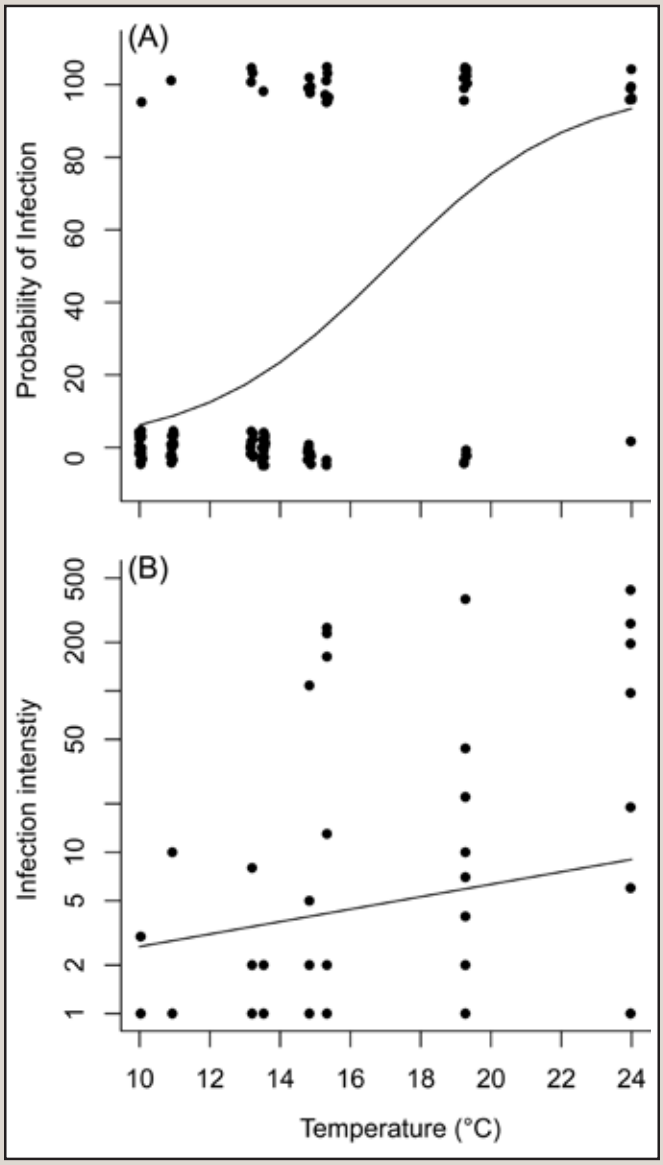


FIG. 1. Relationship between *Batrachochytrium dendrobatidis* infection and pond water temperature for Spring Peepers (*Pseudacris crucifer*) in the spring of 2012. Data in (A) indicate individual infection status of Spring Peepers (points are jittered slightly so that all points are visible). Data in (B) are individual infection intensities, shown on a log scale. Temperatures are the mean pond water temperature determined at the time of sampling for each locality. Uninfected individuals are shown but were not included in analyses of infection intensity. Lines are predictions of generalized linear mixed models.

modifications: 1) we skipped Step 1, which pertains to other types of samples (e.g., tissue, blood, or cultured cells), and instead added 180 µl lysis buffer solution (20 mg lysozyme/1 ml lysis buffer) to each tube and incubated at 37°C for 1 h; and 2) for Step 2, we added 25 µl proteinase K to each reaction in addition to 200 µl buffer AL and incubated at 70°C for 30 min. Our final elution volume was 100 µl.

To quantify amphibian *Bd* infection, we used a quantitative, real-time PCR (qPCR) assay developed by Boyle et al. (2004). Each run included a negative control as well as a series of five dilution standards ranging in concentration by an order of magnitude from 0.1 to 1000 zoospore equivalents. *Bd* strain JEL404, from northeastern North America, was used to create the standards (ITS copy number per zoospore = 39; Longo et al. 2013). Samples were initially run in singlicate (Kriger et al. 2006); however, positive samples were rerun 1–2 more times to confirm the consistency of results and more accurately estimate infection intensity. Standards were always run in triplicate. To confirm that inhibition was not affecting amplification, an internal positive control (Taqman Exogenous Internal Positive Control reagents, Applied Biosystems, Foster City, CA, USA; Hyatt et al. 2007) was added to several randomly selected samples from each species (N = 5 newts, 6 bullfrogs [2 from 3 sites], 6 peepers [3 from 2 sites], and 6 toads). The positive control was added to one of the three triplicate reactions for each of these samples. We considered samples with 0.0 values to be negative for the presence of *Bd* and all other samples positive (as in Briggs et al. 2010). To obtain a relative measure of the intensity of *Bd* infection across individuals, we used the mean number of zoospore genomic equivalents detected in qPCR assays (Kriger et al. 2007).

All analyses were run in R v. 3.0.2 (R Core Team 2013). We estimated disease prevalence as the proportion of individuals that tested positive for *Bd* infection out of the total number of individuals sampled at a given site, calculated separately for each species. We calculated 95% confidence intervals based on a binomial distribution for all prevalence estimates using the Wilson Interval (package binom; Dorai-Raj 2009). We calculated site-level infection intensity as the mean infection intensity of all infected individuals at a site. Bootstrap confidence intervals were calculated for site-level intensity estimates for all sites with sufficient variation in individual infection intensity (> 1 infected individual; method = BC_a, package boot; Davison and Hinkley 1997; Canty and Ripley 2013).

We tested for variation in infection across sites, temperatures, and body size with the various datasets outlined below. We used generalized linear models for analyses of intraspecific variation among sites (GLM; package MASS; Venables and Ripley 2002) and generalized linear mixed models for all other analyses (GLMM; package lme4; Bates et al. 2013). In the GLMMs, we included "site" as a random effect to account for nestedness of individuals sampled at the same site. This approach is analogous to linear regression, except that it utilizes a more generalized form of linear regression that has been developed to accommodate non-normal data such as binary or count data. Our response variables in all analyses were individual infection status (infected or not, testing for differences in the probability of an individual being infected among groups) or infection intensity (infection level based on zoospore equivalents, excluding uninfected individuals). Analyses of infection status were made using an underlying binomial distribution and logit function, and analyses of infection intensity were made using an underlying negative binomial distribution and log function.

First, to assess variation in infection among sampling sites, we compared infection status and infection intensity of peepers, newts, and bullfrogs across all sites where these species were sampled (2010 newts sampled at three sites, 2012 peepers sampled at nine sites, and 2012 bullfrogs sampled at four sites; each species analyzed separately). Second, to assess variation in infection with temperature, we tested for relationships between infection status or infection intensity and pond water temperature using the data we collected for Spring Peepers in 2012. Finally, to assess how infection levels vary across the size range of sampled individuals, we tested for a relationship between infection status or infection intensity and SVL using the data we collected on

TABLE 1. Levels of *Batrachochytrium dendrobatidis* infection, summarized by sampling event, in Eastern Newts (*Notophthalmus viridescens viridescens*), American Bullfrogs (*Lithobates catesbeianus*), Spring Peepers (*Pseudacris crucifer*), and American Toads (*Anaxyrus americanus*). Prevalence is given as the proportion of individuals infected at each site and infection intensity as the mean infection intensity of all infected individuals. Upper and lower confidence intervals, in parentheses, are 95% Wilson and Bootstrap (BCa) for prevalence and infection intensity, respectively. Bootstrap confidence intervals were not calculated for sites with insufficient variation in infection intensity.

Species	Sampling date	Temperature (°C)	Site	County	Habitat	Sample size	Prevalence	Infection intensity
Anaxyrus americanus	20 March 2012	NA	Craig Creek Road, Jefferson National Forest	Craig	Drainage ditch	16	0 (0–19)	0
Anaxyrus americanus	20 March 2012	NA	Coal Bank Hollow Road, Blacksburg	Montgomery	Drainage ditch	15	0 (0–20)	0
Anaxyrus americanus	28 March 2012	NA	FR708, Jefferson National Forest	Montgomery	Flooded field	9	0 (0–30)	0
Notophthalmus viridescens	19 April 2010	NA	Kentland Farm, Blacksburg	Montgomery	Permanent pond	11	91 (62–99)	14 (8–22)
Notophthalmus viridescens	20 May 2010	NA	Pandapas Pond, Jefferson National Forest	Montgomery	Permanent pond	7	78 (45–94)	20 (1–45)
Notophthalmus viridescens	15 June 2010	NA	Station Pond, Mountain Lake Biological Station	Giles	Permanent pond	27	25 (13–43)	2 (1–66)
Notophthalmus viridescens	20 April 2012	NA	Station Pond, Mountain Lake Biological Station	Giles	Permanent pond	15	33 (15–58)	44 (1–128)
Pseudacris crucifer	08 March 2012	10.03	Pandapas Pond, Jefferson National Forest	Montgomery	Permanent pond	15	7 (0–30)	2
Pseudacris crucifer	09 March 2012	13.53	Kroger Pond, Main Street, Blacksburg	Montgomery	Flooded field	19	5 (0–25)	1
Pseudacris crucifer	12 March 2012	15.63	Kentland Farm, Blacksburg	Montgomery	Permanent pond	17	0 (0–18)	0
Pseudacris crucifer	15 March 2012	10.93	Heritage Park / Brown's Farm, Blacksburg	Montgomery	Flooded field	15	7 (0–30)	9
Pseudacris crucifer	21 March 2012	22.1	Airport Pond, Virginia Tech, Blacksburg	Montgomery	Permanent pond	15	0 (0–20)	0
Pseudacris crucifer	27 March 2012	13.2	Glen Alton Wetlands, Pearlsburg	Giles	Flooded field	16	19 (7–43)	3 (1–5)
Pseudacris crucifer	31 March 2012	19.27	Claytor Nature Study Center, Bedford	Bedford	Ephemeral pond	15	67 (42–85)	46 (7–190)
Pseudacris crucifer	01 April 2012	15.33	James River Wetlands, Richmond	Richmond City	Wetland	9	78 (45–94)	95 (29–180)
Pseudacris crucifer	02 April 2012	23.97	Food Lion, Ward's Road, Lynchburg	Campbell	Drainage	7	86 (49–99)	166 (67–303)
Pseudacris crucifer	04 April 2012	14.83	Sylvatica Pond, Mountain Lake Biological Station	Giles	Ephemeral pond	15	33 (15–58)	23 (1–66)
Lithobates catesbeianus	09 August 2010	NA	Station Pond, Mountain Lake Biological Station	Giles	Permanent pond	61	54 (42–66)	2 (2–4)
Lithobates catesbeianus	01 April 2012	NA	Reedy Creek, James River Park System, Richmond	Richmond City	Drainage ditch	12	92 (65–100)	30 (7–111)
Lithobates catesbeianus	02 April 2012	NA	Peak's View Park, Ivy Creek Entrance, Lynchburg	Lynchburg City	Permanent pond	9	67 (35–88)	1
Lithobates catesbeianus	04 April 2012	NA	Station Pond, Mountain Lake Biological Station	Giles	Permanent pond	14	86 (60–100)	10 (3–26)
Lithobates catesbeianus	02 May 2012	NA	Pandapas Pond, Jefferson National Forest	Montgomery	Permanent pond	13	46 (23–71)	4 (2–9)

bullfrogs (four sites in 2012). All Spring Peeper analyses excluded two sites—Airport Pond and Kentland Farm Pond—where all individuals were uninfected. Toads were also not analyzed because they were all uninfected.

All of the species we swabbed, except American Toads, were infected at multiple sites. Prevalence of infection, including all sampling localities and years, ranged from 25–91% in newts, 46–92% in bullfrogs, and 0–86% in peepers (Table 1). We found infected newts and bullfrogs at every locality we sampled (3 and 4 sites, respectively), although the probability of being infected varied among sampling sites (GLM; newts: $\chi^2_{2,45} = 18.8$, $P < 0.0001$, bullfrogs: $\chi^2_{3,44} = 8.3$, $P = 0.04$). For peepers, we also found that the probability of being infected varied across sites (GLM; $\chi^2_{7,103} = 45.3$, $P < 0.0001$). Two of the 10 sites we sampled had no infection (Airport and Kentland Farm Ponds in Blacksburg, Virginia; these were not included in the analysis).

Among the three species with some level of infection, we observed the highest infection levels in peepers (range: 0–421 zoospore equivalents), followed by bullfrogs (0–236 zoospore equivalents), and newts (0–211 zoospore equivalents) (Table 1). Low levels of infection were common, particularly in bullfrogs and newts. At sites where *Bd* was present, infection intensity differed among sites for all three species (GLMM; bullfrogs: $\chi^2_{3,31} = 20.0$, $P = 0.0002$, newts: $\chi^2_{2,21} = 13.6$, $P = 0.001$, peepers: $\chi^2_{7,26} = 9.0$, $P = 0.01$).

Pond water temperature ranged from 10–24°C across 2012 Spring Peeper sampling events across the eight sites with some infection (Fig. 1). Water temperature explained variation in infection status of Spring Peepers (GLMM; $\chi^2_1 = 15.7$, $P < 0.0001$; Fig. 1A), as well as infection intensity (GLMM; $\chi^2_1 = 5.9$, $P = 0.02$; Fig. 1B). Specifically, we found the highest probabilities and intensities of infection at sites with higher temperatures.

Bullfrogs ranged from 3.8–19.7 cm SVL. All sizes of bullfrogs were equally likely to be infected (GLMM; $\chi^2_1 = 3.2$, $P = 0.07$), and infection intensity was relatively low across all sizes of individuals (excluding uninfected individuals; GLMM; $\chi^2_1 = 1.4$, $P = 0.2$). However, individuals larger than ~10 cm always had minimal infections (0–1 zoospore equivalent; N = 7).

Similar to other recent studies from eastern North America (Raffel et al. 2010; Richards-Hrdlicka et al. 2013; Appendix I), we found considerable variation in the likelihood and intensity of *Bd* infection among sites. In addition, we report some of the highest prevalences of *Bd* found thus far in Virginia (but see Pullen et al. 2010). There are likely several factors contributing to the high incidence of *Bd* we found. First, the combination of swabbing and Boyle et al.'s (2004) qPCR assay that we used to detect infection is generally considered to be more sensitive than other approaches, which can miss low levels of infection (< 10 zoospore equivalents; Hyatt et al. 2007; Kriger et al. 2006). Second, we concentrated our sampling efforts during the time of year when *Bd* infection is most prevalent in the region (Longcore et al. 2007; Lannoo et al. 2010; Pullen et al. 2010).

Our survey of the literature found that *Bd* has been detected in a little over half of the amphibian species tested in the eastern U.S., including approximately 61% of frogs and 47% of salamanders (Appendix I). Most genera of frogs and salamanders appear to have at least some susceptible and some resistant members (i.e., *Bd* infection detected versus no infection detected), although sample sizes for a number of apparently resistant species are low and therefore inconclusive (Appendix I). *Bd* has been detected previously in all four species included in the present study; however, not all studies that have sampled these species have found infection. For example, while we found *Bd*-infected Spring Peepers in 8 of the 10 sites we surveyed and in 34 out of 143 total individuals, in prior surveys infection has only been documented in this species in three out of 10 states, and in only 20 of 206 total individuals (Appendix I).

In Spring Peepers, we found that the probability of infection was related to pond water temperature. Much of the variation in temperature is likely attributable to variation in sampling date, as it warmed over the course of the breeding season and sampling. This suggests that many peepers may begin the breeding season with little or no active infection, but that prevalence and infection intensity may change relatively rapidly as temperatures warm to favor *Bd* growth. However, it is important to note that while we considered temperature here because of the prior links that have been demonstrated between *Bd* and temperature (Longcore et al. 2007; Raffel et al. 2010; Lannoo et al. 2011), other factors that change over the course of the breeding season could also play a role. For example, infection levels in a population of breeding males might increase over the course of the breeding season due to increased opportunities for transmission and reinfection. In addition, several of the ponds we sampled later in the spring of 2012 were on the coastal plain of Virginia where it would be consistently warmer than in the mountains, where our other sites were located. The one exception to this pattern was a mountainous site, Sylvatica Pond, at Mountain Lake Biological Station (Table 1). It was the last site we sampled in 2012, but temperatures were still very cool and infection was lower than at the coastal plains sites that were sampled a few days before.

Infection was common in bullfrogs and newts at all of the sites we sampled in early spring. The high prevalence of *Bd* we found during this time corroborates other studies from eastern North America (Ouellet et al. 2005; Longcore et al. 2007; Pullen et al. 2010; Lannoo et al. 2011; Brannelly et al. 2012). However, all three of these studies report a decline in prevalence during the summer, whereas we found that more than half of juvenile bullfrogs sampled in late summer at Mountain Lake Biological Station were infected. At just over 1100 m, this was our highest-elevation site. Although our data are limited, this result is intriguing because it suggests that changes in risk of *Bd* infection associated with variation in environmental conditions along elevational gradients may occur in eastern North America, similar to those in other parts of the world (Berger et al. 2004; Woodhams and Alford 2005; Muths et al. 2008; see also Rollins et al. 2013). Specifically, risk may be greater for populations at higher elevations if pond water temperatures stay cool and favor growth of the pathogen for longer periods of time in comparison to lower elevations.

We found no infection in American Toads at any of our three sampling sites, which is interesting given that several other studies have found infection in this species (Longcore et al. 2007; Davidson and Chambers 2011; Richards-Hrdlicka et al. 2013). The absence of infection in the individuals we sampled could be indicative of resistance in the populations we studied. Alternatively, it may be an artifact of the time during which this species was sampled—just as they were emerging from winter hibernation to breed. Overwintering in terrestrial habitat has been associated with reduced prevalence of infection (i.e., relative to species that overwinter in aquatic habitat; Longcore et al. 2007). This might also partially explain why we found very little infection in Spring Peepers when they first began to appear at breeding ponds.

All of the sites that we sampled contained both infected and uninfected individuals, indicating factors within a pond may

contribute to intraspecific variation in the presence and intensity of *Bd* infection. Of the multiple factors that could potentially interact with infection rates, we believe that size, age, or developmental stage may be important. For example, a study of *Rana boylii* by Lowe (2009) found that *Bd* infection was absent in adults, although present in individuals less than 41 mm. Our data suggest that larger bullfrogs also typically have minimal, if any, infection. Unfortunately, these findings are difficult to compare to previous work because, although many studies have included bullfrogs in their sampling, few report the sizes of bullfrogs sampled (Rothermal et al. 2008; Schloegel et al. 2009; Davidson and Chambers 2011; Goodman and Ararso 2012; Richards-Hrdlicka et al. 2013). Other factors not addressed by this study that may differentially limit infection among individuals include variation in the responses of the animals' immune systems, in the disease-fighting function of the symbiotic microbial communities living on their skin, or in their thermoregulatory behavior (Richards-Zawacki 2009; Rollins-Smith and Woodhams 2012; Rowley and Alford 2013).

This study highlights interesting variation in *Bd* infection in four species of temperate amphibians and offers valuable insight into how disease dynamics may unfold in early spring in eastern North America. Importantly, while we found *Bd* infection to be more common in Virginia than previously thought, none of the animals we encountered during this study had high infections or showed clinical signs of the disease (Hughey, Becker, and Walke, pers. obs.). There are several possible reasons. First, seasonal fluctuations in temperature, including decreases in temperature below the thermal optimum of *Bd* during winter, are probably an important check on *Bd* growth and thus its impact on its hosts. Second, the species we studied may possess critical immune or microbial defenses against *Bd* infection. Third, the strains of *Bd* present in Virginia may be less virulent. Additional studies are needed to develop a more integrative understanding of the complex set of factors contributing to patterns of infection and disease in these and other species.

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Appendix I. List of amphibian species from eastern North America that have been tested for *Bd* infection. We conducted a thorough survey of the literature to create a list of the species of amphibians present in eastern North America have been tested for Bd infection, and of those, which species have tested positive. We included information from the following states: Alabama (AL), Arkansas (AR), Connecticut (CT), Florida (FL), Georgia (GA), Kentucky (KY). Louisiana (LA), Maine (ME), Maryland (MD), Massachusetts (MA), Mississippi (MS), New Jersey (NJ), New York (NY), North Carolina (NC), Ohio (OH), Pennsylvania (PA), South Carolina (SC), Tennessee (TN), and Virginia (VA). In addition, we included one study containing data from eastern Canada. No data were available for Delaware, New Hampshire, Rhode Island, West Virginia, or Vermont. Studies were included only if we could obtain information about sample size, the number of infected individuals, and the state in which study was conducted. Samples representing hybrids or that were not identified to species were not included.

Frogs	Total	Infected	State (States with *Bd*-infected individuals in **BOLD**)	Source
Bd detected (N = 20 species)				
Acris crepitans	515	101	**AR**, GA, **LA**, SC, **VA, OH**	Daszak et al. 2005, Pullen et al. 2010, Goodman & Ararso 2012, Hill et al. 2011, Rothermal et al. 2008, Timpe et al. 2008, Steiner & Lehtinen 2008
Acris gryllus	117	6	**FL**, GA, SC	Daszak et al. 2005, Rizkalla et al. 2009, Rizkalla et al. 2010, Rothermal et al. 2008, Timpe et al. 2008
Anaxyrus americanus	104	14	**CT**, GA, ME, **OH**, TN*, VA	Davidson & Chambers 2011, Pullen et al. 2010, Hill et al. 2011, Krynak et al. 2012, Longcore et al. 2007, Richards-Hrdlicka et al. 2013, Rollins et al. 2013, Rothermal et al. 2008, Timpe et al. 2008
Anaxyrus fowleri	326	11	CT, GA, LA, MA, **TN**, VA	Davis et al. 2012, Pullen et al. 2010, Goodman & Ararso 2012, Richards-Hrdlicka et al. 2013, Rothermal et al. 2008, Timpe et al. 2008, Tupper et al. 2011
Anaxyrus terrestris	106	2	**FL**, GA, LA, SC, NC	Daszak et al. 2005, Rizkalla et al. 2009, Rizkalla et al. 2010, Rothermal et al. 2008, Timpe et al. 2008
Eleutherodactylus planirostris	75	3	**FL**	Rizkalla et al. 2009, Rizkalla et al. 2010, Rothermal et al. 2008
Hyla chrysoscelis	17	3	GA, SC, **VA**	Daszak et al. 2005, Davidson & Chambers 2011, Hill et al. 2011, Timpe et al. 2008
Hyla versicolor	82	1	**CT**, ME, PA, VA, TN*	Pullen et al. 2010, Glenney et al. 2010, Longcore et al. 2007, Richards-Hrdlicka et al. 2013, Rollins et al. 2013
Osteopilus septentrionalis	43	1	**FL**	Rizkalla et al. 2009, Rizkalla et al. 2010, Rothermal et al. 2008

Appendix I. Continued.

Frogs	Total	Infected	State (States with *Bd*-infected individuals in **BOLD**)	Source
Pseudacris crucifer	206	20	CT, GA, **LA**, ME, MA, SC, **OH**, PA, TN, **VA**, GSM N.P.	Chatfield et al. 2009, Daszak et al. 2005, Davidson & Chambers 2011, Pullen et al. 2010, Glenney et al. 2010, Good man & Ararso 2012, Hill et al. 2011, Krynak et al. 2012, Long core et al. 2007, Richards-Hrdlicka et al. 2013, Rothermal et al. 2008, Timpe et al. 2008, Tupper et al. 2011
Pseudacris fouquettei	34	4	**LA**	Rothermal et al. 2008
Pseudacris ocularis	6	1	**FL**	Rizkalla et al. 2010
Lithobates catesbeianus	858	165	**CT, FL, GA**, LA, **MD, ME, MA NC, SC, OH,** TN*, **VA,** GSM N.P.	Chatfield et al. 2009, Daszak et al. 2005, Davidson & Chambers 2011, Pullen et al. 2010, Goodman & Ararso 2012, Grant et al. 2008, Green & Dodd 2007, Hill et al. 2011, Krynak et al. 2012, Longcore et al. 2007, Peterson et al. 2007, Richards-Hrdlicka et al. 2013, Rizkalla et al. 2009, Rollins et al. 2013, Rizkalla et al. 2010, Rothermal et al. 2008, Timpe et al. 2008, Tupper et al. 2011
Lithobates clamitans	1051	359	**CT**, FL, **GA**, LA, **MD**, **ME, MA**, **NC, NJ, NY**, SC, **OH, PA**, TN*, **VA**, GSM N.P., Canada	Boivin 2012, Chatfield et al. 2009, Daszak et al. 2005, Davidson & Chambers 2011, Pullen et al. 2010, Forzan et al. 2011, Grant et al. 2008, Groner & Relyea 2010, Hill et al. 2011, Krynak et al. 2012, Longcore et al. 2007, Monsen-Collar et al. 2010, Richards-Hrdlicka et al. 2013, Rollins et al. 2013, Rothermal et al. 2008, Timpe et al. 2008, Tupper et al. 2011
Lithobates palustris	184	67	**CT, GA, MD, ME,** NJ, **OH, SC, TN, VA**	Davidson & Chambers 2011, Goodman & Ararso 2012, Grant et al. 2008, Hill et al. 2011, Krynak et al. 2012, Longcore et al. 2007, Monsen-Collar et al. 2010, Richards-Hrdlicka et al. 2013, Rothermal et al. 2008, Timpe et al. 2008, Todd-Thompson et al. 2009
Lithobates pipiens	119	33	**CT, ME**, OH, Canada	Forzan et al. 2011, Krynak et al. 2012, Longcore et al. 2007, Richards-Hrdlicka et al. 2013
Lithobates septentrionalis	102	18	**ME**	Longcore et al. 2006
Lithobates sphenocephalus	520	32	FL, **GA**, NC*, **SC, TN, VA**	Daszak et al. 2005, Pullen et al. 2010, Green et al. 2002, Hill et al. 2011, Peterson et al. 2007, Rizkalla et al. 2010, Rothermal et al. 2008, Timpe et al. 2008, Venesky & Brem 2008
Lithobates sylvatica	233	28	**CT, GA**, KY*, **ME**, NJ, **OH**, PA, **TN**, **VA**, GSM N.P., Canada	Chatfield et al. 2009, Davidson & Chambers 2011, Forzan et al. 2011, Glenney et al. 2010, Groner & Relyea 2010, Krynak et al. 2012, Longcore et al. 2006, Monsen-Collar et al. 2010, Richards-Hrdlicka et al. 2013, Rollins et al. 2013, Rothermal et al. 2008, Timpe et al. 2008
Scaphiopus holbrooki	38	1	GA, **MA**, SC, TN*	Daszak et al. 2005, Daszak et al. 2005, Rollins et al. 2013, Timpe et al. 2008, Tupper et al. 2011
Not detected (N = 13 species)				
Anaxyrus quercicus	2	0	FL, SC	Daszak et al. 2005, Rothermal et al. 2008
Gastrophryne carolinensis	5	0	GA, SC	Daszak et al. 2005, Timpe et al. 2008
Hyla cinerea	367	0	FL, GA, LA, SC, NC, VA	Brannelly et al. 2010, Daszak et al. 2005, Pullen et al. 2010, Rizkalla et al. 2009, Rizkalla et al. 2010, Rothermal et al. 2008, Timpe et al. 2008
Hyla femoralis	16	0	FL, SC	Rizkalla et al. 2010, Rothermal et al. 2008
Hyla gratiosa	15	0	FL, SC	Daszak et al. 2005, Rothermal et al. 2008
Hyla squirella	29	0	FL	Rizkalla et al. 2010, Rothermal et al. 2008
Pseudacris feriarum	6	0	GA, TN, GSM N.P.	Chatfield et al. 2009, Rothermal et al. 2008, Timpe et al. 2008

APPENDIX I. Continued.

Frogs	Total	Infected	State (States with *Bd*-infected individuals in **BOLD**)	Source
Pseudacris nigrita	4	0	FL	Rizkalla et al. 2010
Pseudacris ornata	1	0	GA	Timpe et al. 2008
Lithobates capito	21	0	GA, FL	Rothermal et al. 2008, Timpe et al. 2008
Lithobates grylio	21	0	FL, SC	Daszak et al. 2005, Rizkalla et al. 2010, Rothermal et al. 2008
Lithobates heckscheri	1	0	GA	Timpe et al. 2008
Lithobates virgatipes	1	0	SC	Daszak et al. 2005
Total:	5225	870	**AR, CT, FL, GA**, KY, **LA, MA, MD, ME, NC, NJ, NY, OH, PA, SC, TN, VA**, Canada (not tested: AL, MS)	
Salamanders				
Bd detected (N = 28 species)				
Ambystoma jeffersonianum	32	12	**OH**	Krynak et al. 2012
Ambystoma maculatum	117	10	**CT,** GA, NJ, **OH**, TN, VA, GSM N.P.	Chatfield et al. 2009, Pullen et al. 2010, Krynak et al. 2012, Monsen-Collar et al. 2010, Richards-Hrdlicka et al. 2013, Rothermal et al. 2008, Timpe et al. 2008
Amphiuma means	40	17	**FL**, GA, **MS**	Rizkalla et al. 2009, Rizkalla et al. 2010, Timpe et al. 2008
Amphiuma tridactylum	11	2	**LA**	Chatfield et al. 2012
Cryptobranchus allaganiensis	151	38	**GA, TN**, VA, GSM N.P.	Bartkus 2009, Chatfield et al. 2009, Gonynor et al. 2011, Souza et al. 2012
Desmognathus conanti	119	3	**GA**	Hill et al. 2011, Timpe et al. 2008
Desmognathus fuscus	151	18	AL, **CT, MD, OH, VA**	Byrne et al. 2008, Davidson & Chambers 2011, Grant et al. 2008, Gratwicke et al. 2011, Hossack et al. 2010, Krynak et al. 2012, Richards-Hrdlicka et al. 2013
Desmognathus monticola	284	5	**GA**, NC, TN, **VA**	Davidson & Chambers 2011, Gratwicke et al. 2011, Hill et al. 2011, Hossack et al. 2010, Hossack et al. 2010, Keitzer et al. 2011, Rothermal et al. 2008, Timpe et al. 2008
Desmognathus ochrophaeus	26	4	**OH**, TN, **VA**	Davidson & Chambers 2011, Hossack et al. 2010, Krynak et al. 2012
Desmognathus ocoee	252	4	GA, **NC**, GSM N.P.	Hill et al. 2011, Keitzer et al. 2011, Kiemnex-Tiburczy et al. 2012, Timpe et al. 2008
Desmognathus quadramaculatus	198	1	**GA**, NC, TN, **VA**	Bartkus 2009, Davidson & Chambers 2011, Hill et al. 2011, Hossack et al. 2010, Keitzer et al. 2011, Rothermal et al. 2008, Timpe et al. 2008
Desmognathus santeetlah	3	1	**GSM N.P. (NC)**	Caruso & Lips 2013
Eurycea bislineata	102	6	**CT, MD, OH**, TN*, VA	Grant et al. 2008, Gratwicke et al. 2011, Krynak et al. 2012, Richards-Hrdlicka et al. 2013, Rollins et al. 2013
Eurycea cirrigera	130	28	**AL, GA, VA**	Byrne et al. 2008, Davidson & Chambers 2011, Hill et al. 2011, Timpe et al. 2008
Eurycea longicauda	21	1	GA, OH, TN*, **VA**	Davidson & Chambers 2011, Hill et al. 2011, Krynak et al. 2012, Rollins et al. 2013, Timpe et al. 2008
Eurycea lucifuga	67	1	GA, TN*, **VA**	Bartkus 2009, Davidson & Chambers 2011, Hill et al. 2011, Rollins et al. 2013, Timpe et al. 2008

Appendix I. Continued.

Salamanders	Total	Infected	State (States with *Bd*-infected individuals in **BOLD**)	Source
Gyrinophilus porphyriticus	57	1	AL, **CT**, GA, NC, NH, TN, VA, GSM N.P.	Bartkus 2009, Byrne et al. 2008, Caruso & Lips 2013, Gratwicke et al. 2011, Hill et al. 2011, Hossack et al. 2010, Hossack et al. 2010, Keitzer et al. 2011, Richards-Hrdlicka et al. 2013, Rothermal et al. 2008, Timpe et al. 2008
Hemidactylium scutatum	6	1	**CT**, GA, GSM N.P.	Chatfield et al. 2009, Richards-Hrdlicka et al. 2013, Timpe et al. 2008
Necturus alabamensis	15	3	**FL**	Chatfield et al. 2012
Necturus beyeri	3	1	GA, **LA**	Chatfield et al. 2012, Timpe et al. 2008
Notophthalmus viridescens	422	114	**AL, CT**, FL, **GA**, LA, **NC**, NJ, **OH**, **PA**, TN, **VA**	Bakkegard & Pessier 2010, Chatfield et al. 2009, Davidson & Chambers 2011, Pullen et al. 2010, Glenney et al. 2010, Hill et al. 2011, Krynak et al. 2012, Monsen-Collar et al. 2010, Raffel et al. 2010, Richards-Hrdlicka et al. 2013, Rizkalla et al. 2010, Rothermal et al. 2008, Timpe et al. 2008
Plethodon cinereus	260	18	**CT, OH, VA**	Davidson & Chambers 2011, Pullen et al. 2010, Gratwicke et al. 2011, Krynak et al. 2012, Richards-Hrdlicka et al. 2013
Plethodon glutinosus complex	63	1	AL, GA, OH, **VA**, GSM N.P.	Byrne et al. 2008, Caruso & Lips 2013, Davidson & Chambers 2011, Hill et al. 2011, Krynak et al. 2012, Timpe et al. 2008
Plethodon shermani	96	5	**NC**	Keitzer et al. 2011, Kiemnex-Tiburczy et al. 2012
Pseudobranchus axanthus	13	1	**FL**	Chatfield et al. 2012
Pseudotriton ruber	46	5	AL, **GA**, MD, **OH, SC,** VA, GSM N.P.	Byrne et al. 2008, Chatfield et al. 2009, Grant et al. 2008, Gratwicke et al. 2011, Hill et al. 2011, Krynak et al. 2012, Montanucci 2009, Timpe et al. 2008
Siren intermedia	5	2	**LA, MS**	Chatfield et al. 2012
Siren lacertina	10	2	**FL**	Chatfield et al. 2012, Rizkalla et al. 2010
Not detected (N = 31 species)				
Ambystoma laterale	4	0	CT	Richards-Hrdlicka et al. 2013
Ambystoma opacum	57	0	CT, GA, OH, TN, VA	Pullen et al. 2010, Krynak et al. 2012, Richards-Hrdlicka et al. 2013, Rothermal et al. 2008, Timpe et al. 2008
Ambystoma talpoideum	9	0	GA, MS	Rothermal et al. 2008, Timpe et al. 2008
Ambystoma tigrinum	2	0	GA	Rothermal et al. 2008
Amphiuma pholeter	1	0	FL	Chatfield et al. 2012
Aneides aeneus	3	0	GA	Hill et al. 2011
Desmognathus aeneus	5	0	GA	Hill et al. 2011, Timpe et al. 2008
Desmognathus apalachicolae	29	0	GA	Timpe et al. 2008
Desmognathus imitator	38	0	GSM N.P.	Caruso & Lips 2013, Chatfield et al. 2009
Desmognathus welteri	20	0	VA	Bartkus 2009
Desmognathus wrighti	68	0	GSM N.P.	Caruso & Lips 2013, Chatfield et al. 2009
Eurycea chamberlaini	1	0	GA	Timpe et al. 2008
Eurycea guttolineata	23	0	AL, GA	Byrne et al. 2008, Hill et al. 2011, Timpe et al. 2008
Eurycea quadridigitata	12	0	GA	Timpe et al. 2008

APPENDIX I. Continued.

Salamanders	Total	Infected	State (States with *Bd*-infected individuals in **BOLD**)	Source
Eurycea wilderae	120	0	GA, NC, GSM N.P.	Caruso & Lips 2013, Chatfield et al. 2009, Hill et al. 2011, Keitzer et al. 2011, Timpe et al. 2008
Gyrinophilus subterraneus	8	0	VA	Bartkus 2009
Notophthalmus perstriatus	8	0	GA	Hill et al. 2011
Plethodon chatahoochee	58	0	GA	Hill et al. 2011
Plethodon cylindraceus	19	0	VA	Gratwicke et al. 2011
Plethodon jordani	263	0	GSM N.P.	Caruso & Lips 2013, Chatfield et al. 2009
Plethodon metcalfi	117	0	GA, NC, GSM N.P.	Caruso & Lips 2013, Chatfield et al. 2009, Hill et al. 2011, Rothermal et al. 2008
Plethodon nettingi	43	0	VA	Bartkus 2009
Plethodon petraeus	5	0	GA	Hill et al. 2011
Plethodon punctatus	38	0	VA	Bartkus 2009
Plethodon richmondi	5	0	VA	Davidson & Chambers 2011
Plethodon serratus	34	0	GA, NC, GSM N.P.	Caruso & Lips 2013, Chatfield et al. 2009, Rothermal et al. 2008, Timpe et al. 2008
Plethodon teyahalee	29	0	GA, GSM N.P.	Caruso & Lips 2013, Chatfield et al. 2009, Hill et al. 2011
Plethodon ventralis	62	0	GA, GSM N.P.	Caruso & Lips 2013, Timpe et al. 2008
Plethodon websteri	2	0	GA	Timpe et al. 2008
Pseudobranchus striatus	1	0	FL	Chatfield et al. 2012
Pseudotriton montanus	4	0	GA	Timpe et al. 2008
Total:	3788	305	**AL, CT, FL, GA, LA, MD, MS, NC**, NJ, **OH, PA, SC, TN, VA** (not tested: AR, KY, MA, ME, NY, Canada)	

*sample sizes unavailable

GSM N.P. = Great Smoky Mountains National Park, which spans NC and TN. Almost always impossible to determine whether sampling occurred in NC or TN or both.

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First Report of *Batrachochytrium dendrobatidis* Associated with Amphibians in Kansas, USA

Determining the distribution of infectious disease agents such as *Batrachochytrium dendrobatidis* (*Bd*), the pathogenic fungus that causes chytridiomycosis, is important for understanding disease patterns and transmission in populations. In the USA, *Bd* has been broadly sampled and detected throughout most regions (46 of 50 states; *Bd*-maps.net; Gaudreau et al. 2010; Richards-Hrdlicka et al. 2013) with the exception of the northern and central Great Plains region including Kansas. In northeastern Kansas, sampling in 2007 did not detect the occurrence of *Bd* (Steiner and Lehtinen 2008). Failure to detect *Bd* in the state may be due to insufficient survey. Alternatively, it may be due to transmission factors that reduce occurrence including temperatures >25°C that may assist hosts in clearing *Bd* infections (Woodhams et al. 2003) or low human population densities that limit the transfer and reduce the effects of the pathogen in the region (Kriger and Hero 2009; Lane and Burgin 2008). Recent modeling based on global sampling of *Bd* (3,733 sites) predicted low likelihood of the occurrence of *Bd* in the northern and central Great Plains region including the state of Kansas (Olson et al. 2013), thus supporting the hypothesis that amphibians inhabiting the drier interior of the USA may be at less risk of *Bd* (Lannoo et al. 2011). To address this distributional gap of *Bd* in the USA, we surveyed amphibians of south-central Kansas with three objectives: 1) detection or lack of detection of *Bd* in Kansas amphibian populations; 2) comparison of *Bd* infection rates in lotic and lentic habitats; and 3) comparison of *Bd* infection rates in urban and non-urban locations.

Sampling was conducted 10 July 2012, 11 July 2013, and 16–17 August 2013 in south-central Kansas (Sedgwick and Kingman Counties; Fig. 1). Locations were selected to investigate potential impacts of abiotic and micro-habitat variables on *Bd* infection rates in amphibian populations. Each location (Ninnescah Reserve, Gerber Reserve, and Chisholm Creek Park; Fig. 1) included two habitats (lotic/lentic) approximately 500 m apart. Ninnescah Reserve (Ninnescah River 37.5398°N, 97.6790°W, 394 m elev. / pond 37.5369°N, 97.6773°W, 397 m elev.) and Gerber Reserve (Smoots Creek 37.6765°N, 97.9463°W, 439 m elev. / pond 37.6796°N, 97.9476°W, 439 m elev.) are non-urban locations in the Ninnescah River drainage; Chisholm Creek Park (Chisholm Creek 37.7429°N, 97.2704°W, 410 m elev. / pond 37.7422°N, 97.2644°W, 412 m elev.) is an urban location in the Arkansas River drainage. Both drainages are part of the Lower Arkansas watershed. Land use surrounding the locations is primarily non-urban rangeland (Gerber Reserve), non-urban farmland (Ninnescah Reserve), and urban city-center (Chisholm Creek Park). GPS coordinates, air temperature, water pH, and water

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FIG. 1. Locations where anurans were sampled in Kansas, USA. Prior to the present study, *Bd* was not detected in the state. Map (upper left) of USA showing states with *Batrachochytrium dendrobatidis* (*Bd*) detected (brown), undetected (white; Kansas), and not surveyed (green). Map (upper right) of central USA showing south-central counties in Kansas (circumscribed in red) that we surveyed. Survey locations and river drainages in Kansas (lower inset) showing *Bd* prevalence per location (red = % detected, blue = % undetected). Map generated using ArcMap 10 (ESRI 2011).

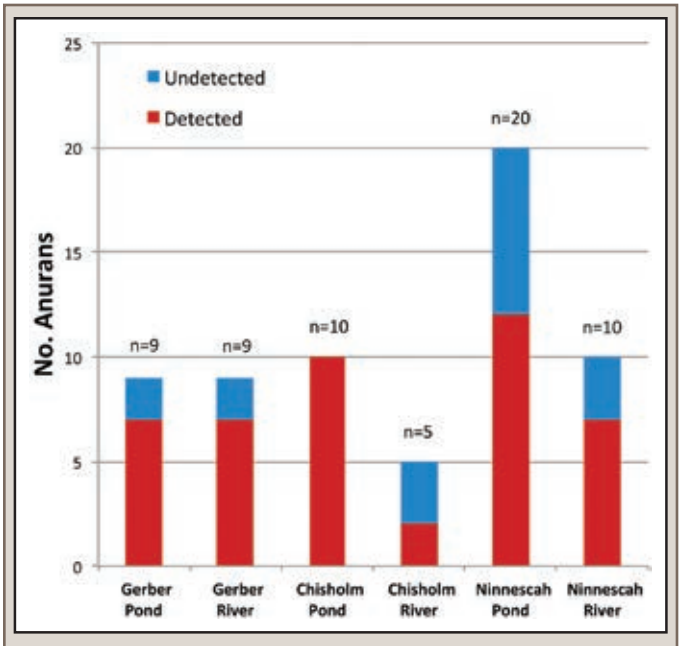


FIG. 2. Prevalence of *Batrachochytrium dendrobatidis (Bd)* detected in anurans at sampling locations (Gerber = Gerber Reserve, Chisholm = Chisholm Creek Park, Ninnescah = Ninnescah Reserve) and sampling habitats (pond = lotic, river = lentic) in Kansas, USA.

temperature were recorded for each site. Anurans were collected within the site, handled using sterile methods, and sampled using standard techniques (Brem et al. 2007). All individuals were image-vouchered (see http://ninnescahlife.wichita.edu). A slight teratological deformity in one distal appendage was observed (see http://ninnescahlife.wichita.edu/node/583); no behavioral abnormalities were observed. Swabs were stored in individually labeled screw cap microcentrifuge tube vials without alcohol at –20°C until analysis. DNA from each swab was extracted using two extraction protocols: Bond's (2013) protocol was used in 2012 and a slightly modified HotSHOT protocol (Truett et al. 2000) was used in 2013. After extraction, a slightly modified version of Annis' (2004) protocol was used, followed by gel electrophoresis. Detection of *Bd* was based on a 300-bp band and a positive control. PCR was conducted in triplicate (2013) or duplicate (2012); if *Bd* was detected for a sample in two of the replicates, the corresponding animal was considered *Bd* positive.

A total of 62 anurans were sampled, with 45 individuals testing positive for presence of *Bd* (72.6%; Table 1). *Bd* was detected in >60% of individuals tested at all three survey locations and at both lotic and lentic habitats within each location (Fig. 2, Table 2). Notably, *Bd* was present in two separate river systems, the Arkansas and Ninnescah River drainages, and in both urban (Chisholm Creek Park) and non-urban (Ninnescah Field Station, Gerber Reserve) localities.

TABLE 1. *Batrachochytrium dendrobatidis* (*Bd*) detected per anuran species sampled in Kansas, USA.

Species	No. *Bd* detected	N	% *Bd* detected
Acris blanchardi	30	41	73.2
Anaxyrus woodhousii	6	11	54.5
Lithobates blairi	7	8	87.5
Lithobates catesbeianus	1	1	100
Undetermined larva	1	1	100
Total	45	62	72.6

TABLE 2. *Batrachochytrium dendrobatidis* (*Bd*) detected by survey location (Ninnescah and Gerber = non-urban; Chisholm = urban), habitat (lotic = pond, lentic = river), and anuran species sampled in Kansas, USA.

Habitat	Location	Species	No. *Bd* detected	N	% *Bd* detected
Lotic	Ninnescah	*Acris blanchardi*	5	7	71.4
		Anaxyrus woodhousii	6	11	54.5
		Lithobates blairi	1	2	50.0
	Chisholm	*Acris blanchardi*	2	5	40.0
	Gerber	*Acris blanchardi*	4	5	80.0
		Lithobates blairi	2	2	100.0
		Lithobates catesbeianus	1	1	100.0
	Total		21	33	63.6
Lentic	Ninnescah	*Acris blanchardi*	3	6	50.0
		Lithobates blairi	4	4	100.0
	Chisholm	*Acris blanchardi*	10	10	100.0
	Gerber	*Acris blanchardi*	6	8	75.0
		Undetermined larva	1	1	100.0
	Total		24	29	82.8

Our sampling represented 4 of 11 anuran species that are distributed in south-central Kansas (Collins et al. 2010), with Blanchard's Cricket Frogs (*Acris blanchardi*) comprising the majority (66.1%) of sampled individuals. For each of the four species (*Acris blanchardi, Anaxyrus woodhousii, Lithobates blairi, Lithobates catesbeianus*), *Bd* was detected in > 54% of individuals sampled. The high percentage of *Bd*-positive bullfrogs is the result of a low sample size (N = 1). One unidentified frog larva was also sampled and tested positive for presence of *Bd*.

We compared amphibian populations at six sites and three locations in south-central Kansas, and our sampling regime detected a high prevalence of *Bd* in all anuran species in urban and non-urban locations as well as in pond and stream habitats. Furthermore, species susceptibility to infection in our survey is consistent with known data (Blaustein et al. 2005). Our results contradict an earlier Kansas survey conducted in 2007 (Steiner and Lehtinen 2008). Their study sampled 5 individuals of *Acris blanchardi* associated with a pond habitat in a non-urban area of Jefferson County (northeastern Kansas) and did not detect *Bd*. In contrast, the diversity of habitats in which we document *Bd* infection, in combination with detection in all surrounding states, make it likely that this pathogen occurs throughout Kansas.

When we initiated our research, it seemed plausible that our sampling would not detect the occurrence of *Bd* due to a lack of detection in 2007 (Steiner and Lehtinen 2008), modeling that predicted low likelihood of *Bd* occurrence in the northern and central Great Plains region (Olson et al. 2013), and numerous additional biotic and abiotic factors. For example, temperatures and arid conditions are major determinants affecting *Bd* virulence and the effects of *Bd* in amphibians (Berger et al. 2004; Woodhams et al. 2003). High ambient temperatures (air and water) are correlated with lower *Bd* infection rates and desiccation of zoospores as well (Gaertner et al. 2012; Johnson et al. 2003; Lannoo et al. 2011). This is relevant because our sampling took place at mid-summer when temperatures were high (lotic habitats 24–25°C; lentic habitats 26–28°C; air temperature 25–30.5°C) and during an extreme drought in 2012. Additionally, survey locations in rural Kansas where habitats are less disturbed may have avoided introduction of *Bd* (Lannoo et al. 2011). In spite of these factors we detected a high prevalence of *Bd* associated with anurans in south-central Kansas. Rather than lack of occurrence of *Bd* in the north and central Great Plains region, our data support the hypothesis that *Bd* is endemic and insufficiently surveyed in the region.

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Detection of Ranavirus in Archival Specimens

The decline of amphibian populations worldwide has garnered considerable attention over the past two decades resulting in the identification of multiple contributing factors. Pathogens, particularly ranaviruses, have been considered among the leading causes of mass mortality in larval amphibians (Green et al. 2002; Daszak et al. 2003). In recent years ranaviruses have been detected in several locations in Ohio, USA (Homan et al. 2013). How long ranaviruses have been in Ohio is an important question, the answer to which offers insight into the impact, persistence, and spread of ranaviruses within a region. Here I report the detection of ranavirus infection in archival specimens collected in northeast Ohio in 1999 the earliest published record of ranavirus infection in Marbled Salamanders (*Ambystoma opacum*) in Ohio.

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The eggs of a single *A. opacum* female were collected from a small moist depression adjacent to a vernal pool located within Indian Point Park that is part of the Lake Metroparks system in September 1999. Three species of *Ambystoma* salamander are known to use this pond for breeding: *A. opacum, A. maculatum, A. jeffersonianum* and *Ambystoma* unisexuals. Amphibians of this pond have been the subject of long-term monitoring beginning with a drift fence study from 1993 to 2002 (Quinn and Matson 2011) followed by subsequent seasonal inspections. Steady declines in population size of all salamander taxa in this pond, as a result of limited recruitment, have been documented but the cause(s) has yet to be determined (Quinn and Matson 2011).

The egg clutch was reared to metamorphosis in a laboratory at the Cleveland Museum of Natural History. Six metamorphosed animals were retained in captivity in isolation from other animals in three separate collections. Animals were housed in pairs as follows: two remained in the museum laboratory and the other four were kept in two separate private collections. The *A. opacum* were housed in pairs at each location. Diets were composed of wild-caught invertebrates such as earthworms, crickets, slugs,

spiders, and store-bought crickets. Animals thrived, appearing healthy and robust, and developed normally until approximately two years of age. The onset of symptoms was consistent among all animals. Initial symptoms were similar, marked by lethargy and cessation of appetite, while later stage infection was defined by accelerated/excessive skin shedding, skin ulcerations, and necrosis of the tissue surrounding digits that resulted in bone exposure. These last two symptoms are characteristic of the ulcerative skin syndrome disease of ranavirus reported by Teacher (2002). Illness progressed rapidly and ended in death 7–12 days from the onset of symptoms. Ranavirus was not initially considered as a disease agent and veterinary diagnoses were inconclusive. Upon death, three specimens, including one from each collection, were fixed in formalin, preserved in 70% ethanol and installed in the Herpetological Collection of the Cleveland Museum of Natural History. Post-mortem examination of animals showed pale enlarged livers that were very fragile and granular in texture. All animals exhibited wart-like lesions on the stomach surface and two animals had lesions extending onto the surface of the small intestine.

The development of new techniques for extracting genetic information from formalin-fixed specimens (Kattenbelt et al. 2000) initiated the testing of the three archival specimens (all female) for ranavirus infection in 2011. Tissue samples from the liver, pancreas, and kidneys were collected and sent for analysis to Research Associates Laboratories, Dallas, Texas. Animals were tested for ranavirus and chytrid fungus, *Batrachochytrium dendrobatidis*. Ranavirus was confirmed using a SYBR green-based Real-time PCR assay. Primers and probes are the property of Research Associates Laboratories (pers. comm., 2014). Each sample was run for 40 cycles and followed by melting curve analysis to assess the specificity of qPCR reaction. Samples were tested a minimum of six times each against known positive and negative controls. All animals tested positive for ranavirus DNA with C_t (cycle threshold) levels between 34 and 37. All samples were negative for chytrid fungus.

The C_t values for these animals indicate a low amount of target nucleic acid in the sample (Rothermel et al. 2013). These values, however, may not be meaningful regarding viral load since these are formalin-fixed archival specimens that are likely to have had some degree of DNA degradation (Kattenbelt et al. 2000).

The results suggest that ranavirus was present in one Ohio pond since at least 1999, assuming that the eggs were infected at the time of collection. Embryos might have been infected horizontally, although vertical or pseudovertical transmission is also possible. Vertical and pseudovertical transmission of ranavirus was suggested by Dufus et al. (2008) in eggs from a pair of wild-collected Wood Frogs (*Lithobates [Rana] sylvaticus*) in which the male and one embryo tested positive. Although no obvious source of contamination can be identified, it is possible that the three *Ambystoma* were infected while in captivity. The concurrent onset of disease in three separate facilities might argue against the possibility of exposure to ranavirus as adults; however, it would explain the two-year period without symptoms followed by disease onset and death. This would place the date of ranavirus in Ohio in 2001. In either case it appears that viruses in the genus *Ranavirus* have been in Ohio at least a decade before the first published report (Homan et al. 2013).

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Swabber Effect: Swabbing Technique Affects the Detectability of *Batrachochytrium dendrobatidis*

The chytrid fungus, *Batrachochytrium dendrobatidis* (*Bd*) has been implicated in amphibian declines in numerous amphibian populations around the world (Lötters et al. 2010). The pathogenic fungus infects the mouthparts of larval anurans, and the skin of adult amphibians, and this may lead to mortality of the host (Berger et al. 1998; Voyles et al. 2011). Quantitative PCR analysis is a widely used technique for estimating the prevalence of *Bd* infection in wild frog populations (Kriger et al. 2006a; 2006b; 2007; Hyatt et al. 2007). Numerous sampling methods, such as bathing (Hyatt et al. 2007), toe clipping (Boyle et al. 2004; Hyatt et al. 2007) and swabbing (Kriger et al. 2006a; Hyatt et al. 2007) have been used to obtain *Bd* samples from amphibians. The swabbing technique is preferred over other sampling techniques as it is highly sensitive, can easily be applied in the field, and meets ethical standards as it is a non-invasive technique (Kriger et al. 2006b; Hyatt et al. 2007). This technique has been used extensively for comparing *Bd* prevalence among populations (e.g., Kriger and Hero 2007a; Kriger et al. 2007; Van Sluys and Hero 2009).

To our knowledge, there have been no studies examining the influence of swabbing effort for estimating the prevalence of *Bd* infection in anuran populations. This is despite evidence from non-diseased related ecological field studies that show increased survey effort results in higher probability of detecting species (Field et al. 2002; de Solla et al. 2005). Similarly, the effect of observer can additionally influence outcomes of ecological surveys with results often differing between observers (Morin and Conant 1994; Thompson and Mapstone 1997; Cunningham et al. 1999; Diefenbach et al. 2003). Similar effects are seen in the microbial field, where studies have shown particular methods for detecting microbes (i.e., *E. coli*) may not work in particular climates or on particular microbes due to variation in detection methods (Scott et al. 2002). With numerous *Bd* studies being conducted worldwide, it is imperative to evaluate if there is an influence of different swabbers (individual humans) on estimates of *Bd* prevalence.

Herein, we compare *Bd* prevalence estimates between two swabbers to evaluate whether bias is caused by individuals when comparing *Bd* prevalence. We also examine the influence of repeated swabbing on *Bd* prevalence estimates. A well-studied site for the presence of *Bd* was chosen within Numinbah Valley, south-east Queensland, Australia (28.178° S, 153.228° E). We surveyed male *Litoria wilcoxii* (Anura: Hylidae) for the presence of *Bd* zoospores one night in early October, 2007, as it is known that prevalence of *Bd* is highest at this time of year for the study site (Kriger and Hero 2007b).

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Two individuals (designated Swabber 'A' and Swabber 'B') swabbed sixty-seven male frogs. Swabber A had several years of experience in *Bd* swabbing while Swabber B had only previously swabbed for *Bd* in one *L. wilcoxii* population. Each frog was swabbed ten times over the ventral surface of the posterior thighs, ten times over both lateral sides of the frog (from groin to armpit), ten times over the ventral surface and five outward strokes on the webbing of both feet (Kriger et al. 2006a), totaling 60 strokes per frog per swabber (see Youtube video "How to swab a frog for chytrid fungus": http://www.youtube.com/watch?v=Ip-urLMLK9k). Sampling alternated between who swabbed first and who swabbed second. In total, 33 *Litoria wilcoxii* were swabbed first by Swabber 'A', followed by Swabber 'B'; and 34 frogs were swabbed first by Swabber 'B', then by Swabber 'A'. All frogs were caught and handled with 250 mm × 200 mm plastic bags which were discarded after a single use to avoid *Bd* transfer and sample contamination. To ensure the same frog was not sampled twice, frogs were not released until all swabbing had been completed. Swabs were stored on ice until return to the laboratory, where they were kept frozen to maintain *Bd* zoospore DNA from degradation (Van Sluys et al. 2008).

Swabs were analyzed for *Bd* presence using quantitative (real-time) PCR techniques as described by Boyle et al. (2004) with the changes recommended by Kriger et al. (2006b). After successful singlicate runs, machine failure occurred and samples were lost during the triplicate analysis. Therefore, only the singlicate method was used to determine positive or negative samples. The use of the singlicate method is valid for *Bd* prevalence, with no significant loss of prevalence accuracy occurring between triplicate and singlicate methods (Kriger et al. 2006b). A Z-test was used to determine if there was a significant difference in *Bd* prevalence between swabbers and swabbing order.

Overall, 17 of 67 (25.4%) frogs were *Bd*-positive (Table 1). There was a significant effect of swabber on *Bd* detection ($Z = 2.281$; $p = 0.023$) with Swabber 'A' detecting *Bd* on 16 of 17 (94.1%) *Bd*-positive frogs and Swabber 'B' detecting *Bd* on 11 of 17 (64.7%) *Bd*-positive frogs. Of the 67 total frogs sampled, Swabber A detected *Bd* on 23.9% and Swabber B detected *Bd* on 16.4%. Swabber 'B' detected *Bd* on one frog that Swabber 'A' failed to detect, despite Swabber 'A' detecting *Bd* on more frogs.

Ten of 17 (58.8%) *Bd*-positive frogs yielded positive results on both first and second swabbing events (Table 1). Of the 7 frogs on which *Bd* was detected by only one swabbing event, the first swabbing tended to detect *Bd* more often, on 5 frogs, while the second swabbing uniquely detected *Bd* on 2 frogs. There was no significant effect of repeated swabbing on *Bd* prevalence ($Z = 1.301$; $p = 0.193$).

Overall, researchers can be confident that a significant proportion of *Bd*-infected frogs will be detected during repeated swabbing events because we found that there was no significant difference in *Bd* prevalence between the first and second swabbing events. This may be important for monitoring changes in prevalence over short time periods. Additionally, this means

TABLE 1. Number of swabs that tested positive for *Batrachochytrium dendrobatidis* (*Bd*) for two swabbers, A and B, during two swabbing events. Prevalence detected by first, second, and both swabbers is presented for number of *Bd*-positive swabs and for the total population sampled.

	Bd detected by		
	only first swabber	only second swabber	both swabbers
Swabber A	4	2	10
Swabber B	1	0	10
Total Positive Swabs	5	2	10
Prevalence (%) for *Bd*-positive frogs (N = 17)	29.4	11.8	58.8
Prevalence (%) for total population (N = 67)	7.5	3.0	14.9

that there is a significant chance that *Bd* will be detected if a frog needs to be swabbed more than once (e.g., due to swabbing error on the first swabbing event).

The significant difference between the researchers conducting the swabbing is important as the swabber can significantly influence the prevalence estimates for the population sampled. Several positive frogs were missed by Swabber 'B', resulting in false negatives. This may be critical when managing captive husbandry populations, especially where threatened species are housed. We recommend that frogs in captivity are swabbed/sampled more than once, preferably by different swabbers, to improve confidence of *Bd* detection. It is also recommended that swabbers have 'swabbing training' prior to swabbing within captive populations.

Why was there a significant difference in *Bd* detection between swabbers? Studies have shown that experienced researchers can obtain different results when compared with inexperienced researchers (Fitzpatrick et al. 2009). Therefore, different levels of swabbing experience between Swabber 'A' and Swabber 'B' may have contributed towards different *Bd* detection levels. The lack of experience by Swabber 'B' may have resulted in the swabbing technique being inadvertently modified (i.e., a slight change in swabbing locations) or a different application of the same methodology (i.e., a decrease in swabbing pressure), which may have resulted in lower *Bd* detection. Therefore, where different swabbers are involved, comparisons of *Bd* prevalence must be undertaken with caution. Further experimentation is required to elucidate these hypotheses.

There are currently numerous swabbing methodologies in use for sampling *Bd* (e.g., Boyle 2004; Kriger et al. 2006a; Hyatt et al. 2007; Schloegal et al. 2009; Hunter et al. 2010; Simpkins et al. 2010; Vredenburg et al. 2011). Most swabbing methods target specific areas of the frog's body (i.e., ventral surface, thighs, feet) that are known to be highly susceptible to *Bd* infection (Berger and Speare 1998). Alternatively, some studies only target a limited area of the frogs body surface (e.g., Schloegal et al. 2009) potentially missing *Bd* infected areas that could produce false absences. Studies use a different number of strokes per frog (e.g., 60 for Kriger et al. 2006a and 30 for Vredenburg et al. 2011) which may influence the likelihood of *Bd* detection through increased swabbing effort. While the effect of 'swabber' would be difficult to control, our results highlight the importance of having a consistent swabbing technique that could be followed by all researchers to maximize the chance of obtaining comparable data. Comparable *Bd* data could help determine the influence of various environmental variables on *Bd* from studies conducted by different researches worldwide (Lötters et al. 2010).

It is logistically impossible to control for the effect of swabbing individuals when comparison of studies from different locations are being made. However, our study demonstrates the importance that individual swabbers can have on *Bd* detection and it is imperative that swabbing methodologies be standardized to allow for comparisons of results.

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Detection of *Batrachochytrium dendrobatidis* in the Eastern Spadefoot, *Scaphiopus holbrookii*, at Cape Cod National Seashore, Barnstable County, Massachusetts, USA

The pathogenic fungus *Batrachochytrium dendrobatidis* (*Bd*) has contributed to the global decline of amphibians (Young et al. 2007) and is widely known for its prevalence in certain anuran populations (Weinstein 2009). Although *Bd* is more commonly associated with permanent-pond-dwelling frogs (Kriger and Hero 2007), it has also been implicated in die-offs of terrestrial toads such as the Boreal Toad (*Anaxyrus boreas*; Muths et al. 2003; Deguise and Richardson 2009), Yosemite Toad (*Anaxyrus canorus*; Green and Sherman 2001), Common Toad (*Bufo bufo*; Garner et al. 2005), and Midwife Toad (*Alytes obstetricans*; Garner et al. 2005). Recently, *Bd* was also documented at Cape Cod National Seashore (Barnstable County, Massachusetts, USA) in a road-killed specimen of another terrestrial species, the Eastern Spadefoot (*Scaphiopus holbrookii*; Tupper et al. 2011). Because *S. holbrookii* are uncommon and protected throughout southern New England (Klemens 1993; Cook 2005), additional data on *Bd* prevalence are important to the successful conservation of this species. Therefore, the goal of this project was to further quantify rates of *Bd* occurrence in *S. holbrookii* at Cape Cod National Seashore.

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Using Google Earth version 6 (www.googleearth.com), we divided the Provincelands (a region of the Cape Cod National Seashore where *S. holbrookii* are most common; Fig. 1; see Tupper et al. [2007] for a more detailed description of the site) into three sampling regions: an east, central and west region. We established separate sampling routes (based on established trails that meandered through dunes and cranberry bogs) within each sampling region to avoid oversampling within a given area of the Provincelands. Each route was sampled weekly. Sampling began within 60 min after sunset and ended by 0200 h. Samples were collected between 1 June and 8 August 2011 and 2013. To assay for *Bd* presence, *S. holbrookii* skin surfaces were thoroughly sampled (using methods described by Hyatt et al. [2007]) with sterile dry swabs (no. MW113, Medical Wire and Equipment Company, Durham, North Carolina, USA). To avoid repeatedly sampling the same individual, the webbing between the outermost toes of the hind right foot was marked with a visual implant elastomer dye (http://www.nmt.us/products/vie/vie.shtml) via 30 gauge BD Ultra-Fine™ insulin syringes (see Hoffmann et al. [2008] for marking procedures). *Scaphiopus holbrookii* were then sexed, measured, weighed, and released.

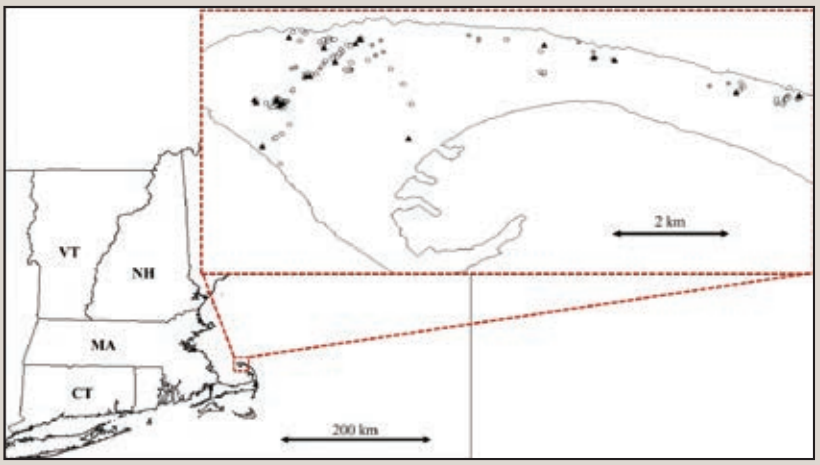


FIG. 1. Outer Cape Cod, Barnstable County Massachusetts, USA. The Provincelands of Cape Cod National Seashore (42.069975°N, 70.173116°W), outlined in red, was divided into three sampling routes based on existing trails to examine the occurrence of *Batrachochytrium dendrobatidis* (Bd) on the Eastern Spadefoot, *Scaphiopus holbrookii*. Open circles in the inset represent Bd-negative individuals, whereas gray circles and black triangles represent individuals of undetermined Bd status and Bd-positive individuals, respectively.

We placed skin swabs in 1.5 mL microcentrifuge tubes and froze the tubes until molecular analyses were conducted. We added twenty µL of proteinase K and 200 µL of digestion buffer to lyse the cells. We then incubated samples at 56°C and agitated (at 550 rpm) for 24 hours. After digestion, we isolated DNA using both BioSprint 96 and QIAcube robotic workstations (Qiagen®, Valencia, California, USA). We prepared samples for DNA purification in the BioSprint 96 with a master mix of 200µL Buffer AL, 200 µL isopropanol, and 30 µL MagAttract Suspension G (Qiagen®). We prepared samples for DNA purification in the QIAcube using the tissue extraction protocol from the QIAamp DNA Mini Kit (Qiagen®). To detect *Bd*, we prepared a PCR reaction with 12.5 µL TaqMan Mastermix (Applied Biosystems, Foster City, California, USA), 2.3 µL primer (ITS1-3Chytr and 5.8sChytr; Boyle et al. 2004), 6.25 µL MGB probe, and 2 µL of extracted DNA. We ran samples on an Applied Biosystems Prism 7700 Sequence Detection System (Applied Biosystems) at 95°C for 3 min, followed by 45 cycles of 95°C for 30-sec and 55°C for 30-sec. Presence of *Bd* was determined by comparing sample amplification rates to amplification rates of *Bd* standards derived from a transgenic *E. coli* culture (U.S. Geological Survey, Reston, Virginia, USA).

We used a Fisher's exact test to assess differences in *Bd* detection rates among sexes, sampling month and sampling region. Size differences between those that were *Bd* positive and *Bd* negative were assessed with independent sample t-tests. Normality was assessed with normal probability plots and KS tests. Equality of variance was assessed with Levene's test for equal variance (Zar 1999). For all statistical tests, $\alpha = 0.05$. Standard error is expressed after the ± symbol.

We located and marked 215 (73 males, 116 females, 26 undetermined) *S. holbrookii* in June, July and August 2011 and 2013. Significantly more were captured in July (59.5%, $\chi^2 = 92.4$, df = 2, $p < 0.001$) and none were recaptured. Only five were found in a wetland. Individuals ranged in mass from < 1 g to 34.5 g (overall $\bar{x} = 17.1$ g ± 0.43). Although the largest individual was a female (29.5 g, 2.4 g heavier than the largest male), on average, males were significantly larger ($\bar{x} = 20.0$ g ± 0.50) than females ($\bar{x} = 15.6$ g ± 0.62; t = -506, df = 187, $p < 0.001$).

Molecular analysis was successful on 190 individuals, 25 of which were *Bd*-positive (13.1%). Nineteen of the *Bd*-positive individuals (76%) were from July ($\chi^2 = 5.91$, df = 2, p = 0.05) and all *Bd*-positive *S. holbrookii* were collected on land. *Bd* was detected in a higher, but non-significant, percentage of males (20%) than females (12.5%; Fisher's exact test $p > 0.10$) and there were no significant differences in mass between individuals testing *Bd*-positive compared to those which were *Bd*-negative (t = 0.24, df = 187, $p > 0.10$), even when accounting for sex (male t = 0.61, df = 64, $p > 0.10$ [males]; = -0.04, df = 97, $p > 0.10$ [females]). Most individuals that were *Bd*-positive were obtained from the westernmost sampling area; however the central sampling area contained proportionately, and significantly, more *Bd*-positive individuals ($\chi^2 = 13.5$, df = 2, $p < 0.001$, Fig. 1).

To the best of our knowledge, this study is the first to identify the presence of *Bd* in live *S. holbrookii*, thus contributing to our understanding of *Bd* distributions and its prevalence across ecological guilds. Although *Bd* was detected in 13.1% of *S. holbrooki* sampled, we did not see potentially visible clinical symptoms of chytridiomycosis infection (abnormal posture, lethargy, loss of righting reflex, abnormal sloughing, epidermal ulceration and hemorrhages; Daszak et al. 1999). We observed a female-biased sex ratio (73 males:116 females), which is consistent with sex ratio differences identified in chytridiomycosis-related population declines in *Anaxyrus boreas* (Muths et al. 2003). However, further sampling is needed to determine if our ratio is accurately descriptive of the population. Our data support the notion that *Bd* is widespread in the northeastern United States and that it may have persisted without causing catastrophic population declines. This may be in part because regional climates are unsuitable for the level of *Bd* proliferation that has been associated with widespread chytridiomycosis (Longcore et al. 2007). It has been suggested that global climate change (Pounds et al. 2006) and the presence of additional stressors (see Davidson et al. 2003) may act synergistically, thus potentially contributing to *Bd*-related amphibian declines (Longcore et al. 2007). Therefore, we recommend that *Bd* sampling be integrated into long-term amphibian monitoring programs at Cape Cod National Seashore and that heightened biosecurity (Johnson et al. 2003) be employed to reduce *Bd* transmission between sites.

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Batrachochytrium dendrobatidis Infection Rates Differ over Short Distances between Natural Lakes and Artificial Ponds in Minnesota, USA

Chytrid infection in North American amphibian populations has been well documented and is known to be widespread. There is, however, insufficient information to assess the importance of spatial and temporal fluctuations in infection rates, and more research is required to identify important anthropogenic impacts on chytrid transmission and pathogenicity.

In 2011, samples collected from two dead anurans confirmed the presence of *Batrachochytrium dendrobatidis* (*Bd*) in a small network of koi ponds in Minnesota, USA (Wolff et al. 2012). Herein, we report our results of a follow up study conducted in 2012. Our findings indicate that infection rates can vary significantly among subpopulations in an area and point to biological simplification as a potential driver of an emerging disease.

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In 2012, we sampled the above mentioned koi ponds, a stormwater pond, and two naturally occurring lakes for *Bd*. The lakes and ponds all lie within or adjacent to Murphy-Hanrehan Park Reserve in southeastern Minnesota, USA (Fig. 1).

Murphy-Hanrehan Park is a 970-ha regional park located approximately 30 km south of Minneapolis, Minnesota. The Park is closely associated with three small to moderately-sized lakes. It encompasses Murphy Lake, borders Hanrehan Lake on three sides, and is situated adjacent to Orchard Lake. Murphy Lake is a shallow natural lake with an approximate maximum depth of 5 m and a surface area close to 18 ha. An aeration system is used to prevent winterkills. Hanrehan Lake is a shallow natural lake with a maximum depth of 2–3 m and a surface area of approximately 27 ha. Orchard Lake is a 95-ha naturally occurring lake with a

maximum depth of approximately 10 m. Three smaller lakes and numerous naturally occurring shallow ponds (surface area < 5 ha) are also located within, or partially within, the boundaries of the Park. Ephemeral pools are common. The Park is situated in the Minnesota River watershed. A small river creates a corridor that connects the Park to extensive wildlife habitat in the nearby Minnesota River Valley. The area surrounding the Park is primarily associated with residential and agricultural developments. Murphy-Hanrehan Park is located in the transitional zone between the temperate grassland and deciduous forest biomes and is characterized by a mix of prairie wetland and mesic forest communities. It supports populations of several Minnesota amphibians including at least 7 anuran and 2 salamander species.

The stormwater holding pond sampled was created in 2007 as part of a new residential development. The pond is approximately 60-m long with an estimated surface area and maximum depth of 600 m^2 and 1.2 m, respectively. The pond has a compacted clay-rich base and holds water throughout the year.

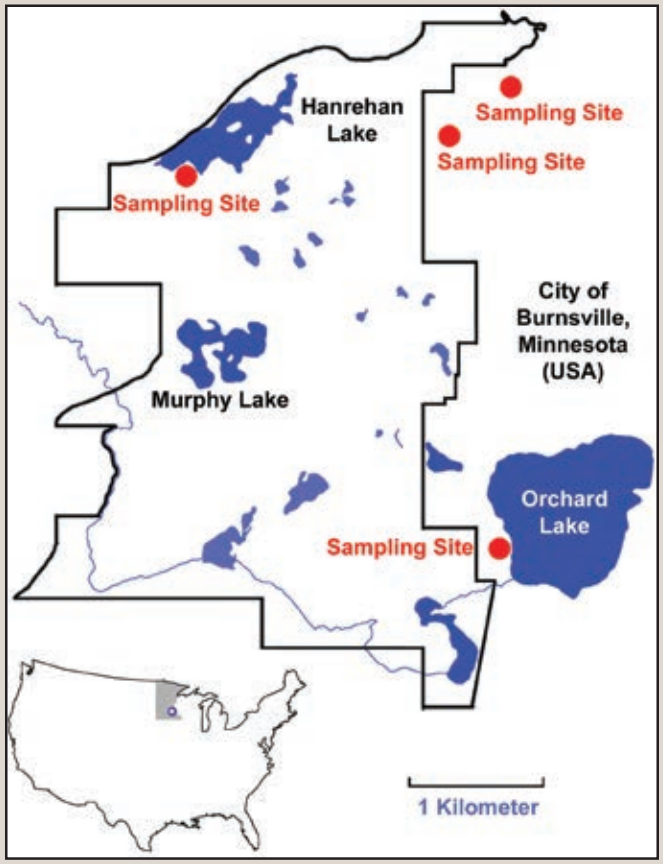


FIG. 1. Map of Murphy-Hanrehan Park Reserve, Minnesota, USA with sampling sites for *Batrachochytrium dendrobatidis* (*Bd*).

The network of small koi ponds has a combined surface area of 30 m^2 and a maximum depth of 1.05 m. The four ponds making up the network are tightly grouped. The maximum distance between ponds is less than 20 m. Water is circulated through three of the four rubber-lined ponds by a pump connected to a simple filtering system employing polyester batting as filter material. A similar system is used to filter water in the fourth pond. Water lost via evaporation is replaced via precipitation and partial refilling from a tap connected to a chlorinated city water line.

Following the mortality event observed in 2011, steps were taken to eliminate *Bd* from all of the koi ponds. Over a four-day period, beginning on 24 October, 2011, the ponds were drained. All anurans encountered in the process of draining the ponds were collected for examination and subsequently euthanized. The ponds were thoroughly dried and were not refilled prior to partial refilling by snowmelt the following spring. Filters, tubing, and pumps were disinfected by submersion in boiling water.

In 2012, frogs were captured on land and in shallow water using fresh disposable gloves, previously unused plastic garbage bags, and double-washed glass jars. Sampling took place between 12 September and 18 October. At this time of year in Minnesota, temperatures routinely drop below 5°C and frogs can be readily collected from roads, fields, pathways, and shorelines by scooping into a plastic garbage bag or jar.

We sampled 34 Green Frogs (*Lithobates clamitans*) and 7 Northern Leopard Frogs (*L. pipiens*) from natural sites at the south side of Hanrehan Lake (44.7246°N, 93.3425°W) and the west side of Orchard Lake (44.7003°N, 93.3158°W), and 30 Green Frogs and 1 Leopard Frog from the stormwater pond (44.7269°N, 93.3199°W) and koi ponds (44.7295°N, 93.3141°W). We observed no dead frogs at any of the sites sampled, or animals displaying symptoms of chytridiomycosis similar to those observed in 2011.

Captured frogs were transported to an indoor location and examined for external parasites, injuries, other peculiarities, and swabbed for *Bd*. Two and three-person teams examined and collected samples from all frogs following roles similar to those prescribed in the field sampling protocol outlined by Brem et al. (2007). Frogs were handled only by individuals wearing fresh, powder-free latex or nitrile gloves. Samples were collected with individually wrapped, plastic-handled, sterile swabs. We swabbed the underside of each rear foot 5 times, the ventral surface of each thigh 5 times, and the lower abdomen 5 times, beginning with the feet and ending with the abdomen. We immediately placed used swabs in pre-labeled vials containing 70% ethanol. Vials were stored in a dark location at room temperature prior to being shipped via FedEx second-day delivery to the Amphibian Disease Laboratory at the San Diego Zoo's Institute for Conservation Research. The samples were analyzed via real-time TaqMan PCR assay, in general accordance with the methods outlined in Boyle et al. (2004).

Because it was assumed that a substantially larger number of

TABLE 1. Results of *Batrachochytrium dendrobatidis* (*Bd*) sampling of *Lithobates clamitans* and *L. pipiens* near natural lakes and artificial ponds in the vicinity of Murphy-Hanrehan Park Reserve, Minnesota, USA.

	Natural Lakes				Artificial Ponds			
	L. clamitans		*L. pipiens*		*L. clamitans*		*L. pipiens*	
	Single	Pooled	Single	Pooled	Single	Pooled	Single	Pooled
Bd+	3	5	1	0	5	11	1	0
Bd-	13	4	0	3	3	0	0	0

specimens would be captured, some samples were pooled to manage costs. In all cases, pooled samples contained swabs from two frogs collected in the same area and belonging to the same species.

Green and Northern Leopard Frogs from the natural lakes and artificial ponds tested positive for *Bd* (Table 1). We employed the Fisher exact test to compare Green Frog infection rates between the natural and artificial sites. Separate contingency tables were used to evaluate the pooled ($p = 0.026$) and non-pooled samples ($p = 0.065$). We also calculated the mean *p*-value obtained by randomly combining the individual samples to produce an all-inclusive contingency table of pooled results ($p = 0.003$). We repeated the calculations incorporating the Northern Leopard Frog results. This increased the significance of the findings in all cases.

Despite our moderate sample sizes, we were able to detect significant differences in Green Frog infection rates between the natural and artificial sites surveyed. Our findings indicate that infection rates can vary significantly between subpopulations separated by relatively short distances. The maximum distance between collection sites was only 4.1 km.

Our results of higher frog infection rates associated with artificial ponds further suggests that *Bd*-host dynamics or *Bd* ecology may differ between artificial and natural systems. It is possible that stormwater holding ponds, decorative ponds, and similar structures serve as more optimal habitat for *Bd*. Cladocerans and other grazers, which have been shown to significantly reduce zoospore densities (Buck et al. 2011; Woodhams et al. 2011; Hamilton et al. 2012), are likely to be largely absent from many of these simplified ecosystems. Anuran predators and scavengers capable of removing infectious dead and dying frogs are also likely to be absent. As a consequence, zoospore densities may be substantially elevated. The absence of common predators may also facilitate disease transmission by permitting the development of abnormally high anuran population densities.

Artificial ponds also differ from natural ponds hydrologically. Many are lined with impervious materials and seldom dry out. There may be little or no flushing to remove *Bd* zoospores. As a result, elevated zoospore densities may be maintained for extended periods. *Bd* has been shown to be viable and infective in lake water for up to 7 weeks without an amphibian host (Johnson and Speare 2003).

Chytridiomycosis is one of a growing number of emerging plant and animal diseases. Such diseases are increasing at a disconcerting rate and pose a growing threat to human health, ecosystem health, and biodiversity (Dobson and Foufopoulos 2007; Jones et al. 2007; Meentemeyer et al. 2012). Although there is general awareness that ecological simplification and subsequent ecological release can play a role in disease emergence (Wilcox and Gubler 2005), few studies linking emergence to anthropogenic ecological simplification have been published. It cannot be determined with confidence from our observations alone that ecological simplification is a contributing factor in the emergence of chytridiomycosis. However, our results are consistent with ecological simplification enhancing *Bd* infection and transmission rates via several mechanisms. The hypothesized link between ecological simplification and disease emergence warrants further evaluation.

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Captive Husbandry and Reproduction of *Phrynosoma asio* (Squamata: Phrynosomatidae) at the Los Angeles Zoo and Botanical Gardens

Since 2003, the Los Angeles Zoo and Botanical Gardens, along with San Diego Zoo, has participated in a cooperative, ongoing study of western Mexican herpetofauna conducted by Universidad Autonoma de Nuevo Leon (UANL). One species of particular interest is the Giant Horned Lizard, *Phrynosoma asio*, which ranges along Pacific coastal forests of western Mexico from Colima south to northern Guatemala. Little is known about the natural history and breeding behavior of Giant Horned Lizards. One of the primary goals of this collaboration is to develop a baseline for successful captive maintenance and propagation of this species. As the first institution to successfully breed this species, Los Angeles Zoo staff has established several important husbandry guidelines.

Materials and methods.—In August 2008, three Giant Horned Lizards (two males, one female) were collected in the Mexican state of Colima and exported to Los Angeles Zoo. Upon arrival they were placed into a three-month quarantine. Fecal material collected during transport was preserved and the contents analyzed in an effort to better understand the natural diet of the lizards. These samples indicated *P. asio* feeds on a variety of terrestrial insects including, but not limited to, ants and termites (Recchio et al. 2009). *Phrynosoma* species generally show a range in dietary habits, but most are strongly myrmecophagous, or ant consumers (Pianka and Parker 1975; Montanucci 1989; Lemos-Espinal et al. 2004; Sherbrooke and Schwenk 2008). The habitat and dietary observations in conjunction with known husbandry protocols for other *Phrynosoma* (N. Atteberry, pers. comm.; J. Judd, pers. comm.; Montanucci 1989) were used to develop a viable captive management plan for this species.

Weekly weighing indicated that the smallest male was not gaining weight at a rate comparable to the others. While the larger pair continued to eat vigorously, the small male refused to feed and began losing weight. This lizard was assist-fed using a small index card to gently open the mouth, which initiated a feeding response. Eventually this lizard began eating voluntarily, but in order to achieve a healthy weight he was assist-fed larger, pre-killed crickets for an additional six months. This assistance with larger prey was necessary apparently due to the unique stereotyped feeding behavior resulting from highly reduced dentition and extensive pharyngeal papillae that produce a mucilaginous coating. These adaptations effectively package ants and other small prey and deliver them directly into the esophagus alive without the need to expend time and energy chewing, a requirement of other iguanids (Sherbrooke and Schwenk 2008).

Fecal tests were run on all three lizards. Each was treated for endoparasitism (unspeciated flagellates and ascarid eggs) with 50 mg/kg oral fenbendazole (Panacur®), and each continued to gain weight throughout the quarantine period. Parasitic nematodes have been found in up to 75% of some wild horned lizard populations (Sherbrooke 2003). The life cycle of *Skrjabinoptera phrynosoma* involves the horned lizard as its definitive host and the harvester ant (*Pogonmyrex* spp.) as the intermediate host,



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FIG. 1. Adult wild-collected *Phrynosoma asio* basking in their enclosure.

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FIG. 2. Adult *Phrynosoma asio* utilizing artificial anthill feeding device.

ensuring a constant cycle of infection. This relationship can be seen in the Texas Horned Lizard (*P. cornutum*) and the Desert Horned Lizard (*P. platyrhinos*) but has not been established in *P. asio* (Sherbrooke 2003; Hilsinger et al. 2011). No other medical issues were observed. Although there is no pathology associated with this parasitism, it is possible that a significant load might adversely affect digestion (Babero and Kay 1967).

Upon release from quarantine, the lizards were placed in an opaque 378-liter Rubbermaid® plastic stock tank with approximately 25 cm of substrate consisting of 80% sand and 20% soil. The ambient temperature was 28°C ± 2°C with relative humidity of 70% ± 10%. A basking area was created utilizing a 160-watt Zoo Med PowerSun® mercury vapor bulb and a 100-watt Zoo Med Repti Halogen® bulb over large stones. These produced surface temperatures ranging from 30–37°C. A 10.0 T8 Zoo Med ReptiSun® fluorescent lamp was placed over the cooler side of the enclosure for additional UVB exposure. Clusters of both live and artificial bunch grasses were planted throughout the enclosure. This provided nesting and hiding places as well as variation in topography. A large shallow water dish was provided for soaking and drinking (Fig. 1).

Many *Phrynosoma* are seasonally crepuscular—diurnal in spring and fall, and bimodal in the summer (Pianka and Parker 1975). To elicit the best feeding response, food items were offered at least twice daily during periods of highest activity. The lizards were offered harvester ants (*Pogonomyrmex* sp.) daily from a specialized feeding device buried in the substrate so as to mimic an anthill (Fig. 2). This was constructed by staff using a 12-cm diameter by 12-cm tall cylindrical plastic storage container. A 5-cm hole was drilled in the lid and a 20-cm long wooden dowel rod was inserted and secured to the bottom of the container, protruding through the lid. The ants were able to climb up the rod but not escape. *Phrynosoma asio* are less sensitive to the stings of *Pogonomyrmex* venom due to a blood plasma factor that aids in detoxifying the venom. However, the venom can become fatal if the lizard is stung too many times (Sherbrooke 2003; Sherbrooke and Schwenk 2008). Therefore, we monitored and removed any uneaten ants daily. If suitable and sustainable local sources for harvester ants are not available, they can be obtained from commercial suppliers, in this case, Life Studies (www.lifestudies.com). Other species of ants such as *Iridomyrmex pruinosus* can be fatal to horned lizards due to a defensive chemical (methyl-n-amyl ketone) that is aerosolized when the ant is disturbed (Blum et al. 1963; Montanucci 1989).

A varied diet is important not only from a nutritional standpoint, but also for enrichment. One study concluded that termites make up the most numerically important single prey item based on stomach content analysis (Lemos-Espinal et al. 2004). These results are consistent with *P. asio* having a more generalized diet than other *Phrynosoma*. Due to insufficient and seasonal availability of termites, crickets (*Acheta domestica*) became the staple daily food item, with wax worms (*Galleria mellonella*) offered several times weekly. Keepers also collected insects from zoo grounds in an effort to mimic natural dietary variation. Prey items offered included carpenter ants (*Camponotus* sp.), termites (Isoptera), red-legged earwigs (*Euborellia annulipes*), European earwigs (*Forficula auricularia*), and the occasional juvenile multicolored centipede (*Scolopendra polymorpha*). One feeding per day was lightly dusted with ReptiVite™ vitamin and calcium powders with D3. Feces were frequently inspected to ensure the lizards were both ingesting ants and properly digesting food items. *Phrynosoma* have a very large stomach in comparison to other iguanids as a function of their dietary specialization on ants, requiring a large volume to meet nutritional needs (Montanucci 1989; Pianka and Hodges 1998; Sherbrooke 2003; Sherbrooke and Schwenk 2008).

Observations and results.—Phrynosoma asio were often seen licking each other, head bobbing, and basking on top of or near each other. No aggressive behaviors have been observed in mixed gender and bachelor groups. These lizards appeared to thrive in a communal environment, potentially due to the need to live in close proximity to anthills and termite mounds. While this species is capable of ocular-sinus blood squirting (Hodges 2004), this behavior has never been observed in this group, which has become accustomed to daily handling.

Every effort has been made to mimic conditions of photoperiod, temperature, humidity, and diet found in *P. asio*'s natural habitat. In the tropical deciduous forests of southwestern Mexico, the dry season lasts typically from November through April and the arrival of rain stimulates breeding. Approximately one year after acquisition, the lizards had reached a sexually mature size: minimum 91 mm snout-to-vent length and weight greater than 70 g (J. Judd, pers. comm.; Pianka and Parker 1975), and were cycled through a winter brumation. This process first entailed lowering basking temperatures and reducing the frequency of misting. Conditions were gradually changed from 28°C with 60–70% humidity to conditions ranging from 24°C during the day to 18°C at night with 40–50% humidity, mimicking natural winter conditions. Hot spots were maintained at approximately 29°C during the day and 26°C at night. A hibernaculum of 8 cm of clean, dry leaves was provided.

During brumation, the *P. asio* were semi-active, utilizing hot spots intermittently. Primarily, the lizards buried themselves under the leaf litter layer on the cool end of the enclosure. When the lizards showed activity, harvester ants were offered, utilizing the feeding device. However, feeding was observed on only a few occasions. The lizards were misted only when active to induce drinking. Due to a significantly reduced metabolic rate during brumation, the lizards may drink, but rarely eat (Mayhew 1965). Water is still necessary and was made available at all times although the substrate was allowed to dry out. The lizards' weights and body condition were closely monitored. During the four-month brumation period, which ended in April 2010, the lizards lost an average of 10.7% of their body weight.

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FIG. 3. *Phrynosoma asio* pipping in incubator.

PHOTO BY IAN RECCHIO



FIG. 4. Male *Phrynosoma asio* showing enlarged post-anal scales (left) Female with no scale enlargement (right).

This was quickly regained and further growth was observed once normal activity and feeding resumed. In June, the summer light cycle was increased from 8 to 12 h.

In wild populations, breeding usually occurs in May and June (Davis and Dixon 1961) or June and July in captivity (Baur 1979). In our group, breeding took place on 20 July 2010. The female displayed to the males by holding her tail up vertically and waving it side to side; head bobbing and arm waving were also seen. Males experienced decreased appetite during the breeding season. The smaller male initiated copulation by chasing the female and licking at the base of her tail. The male then mounted the female, grasping the nuchal folds around her neck with his mouth and then swung his tail under hers to align the cloacae. This entire process took place in a matter of minutes.

Prior to this observed copulation, the female had increased her fat reserves. After breeding she exhibited a decrease in appetite, and her abdomen became distended. She was restless during gestation, which can range from 30–60 days. As she grew closer to oviposition, her abdomen became visibly lumpy. On 18 August, the female laid 20 eggs in a nest about 7 cm deep directly underneath the heat lamp, which was turned off during the laying process to decrease the potential for egg desiccation. The following year, the same female laid 19 eggs. These numbers are consistent with the previously recorded average clutch size for *P. asio* of 16.9 with a standard deviation of 4.9 (Pianka and Parker 1975; Pianka and Hodges 1998).

During the 2010 egg deposition, the female was left in privacy; in 2011 she was monitored closely and video-recorded throughout the process by staff in attendance. The female began excavating a nest in the same location as the previous year, using her forelegs to dig and her hind limbs to push the substrate further away. She was observed rolling individual eggs under her tail so as to coat each with substrate. This may serve both to camouflage the white eggs and to prevent them from sticking together (Sherbrooke 2003). When oviposition was completed, the female covered the eggs with soil. She would scoop a small amount of soil over the nest, then with a jackhammer-like motion pounce rapidly with her forelegs while her hind end remained stationary. The motion was so quick that it appeared as a blur on video recordings. She repeated the scooping and tamping process for several hours. When finished, she resumed basking and consumed a small meal. Her feedings were increased and supplemented heavily with powdered vitamins and calcium. Within 30 days she had returned to her pre-gravid weight. The weight loss observed was consistent with other species in the genus, where the Relative Clutch Mass (RCM) constitutes 13–35% of the female's weight (Pianka and Hodges 1998). All lizards quickly returned to their pre-breeding body condition and activity levels.

The eggs laid in 2010 were excavated and placed on fine vermiculite substrate inside a 3-liter, clear, snap-top plastic container with series of six 4-mm holes punched around the rim of the container. Due to a lack of available baseline data, an initial vermiculite-to-water ratio of 4:1 by weight was chosen to avoid oversaturation with water. This container was placed in an Avey RCAB200 Reptile Incubator™ at 31°C and 92% humidity. After a few days, the eggs began to desiccate. Under these conditions 11 of the 20 eggs withered, appeared nonviable and were discarded. The incubation temperature was reduced to 26.5°C and ambient humidity decreased to 70% in order to compensate for increased substrate moisture. The vermiculite-to-water ratio was doubled to 2:1 by weight, a small water bowl was added to the container, and the lid was gently misted to maintain light condensation. Specific humidity levels were not determined. Under these conditions the remaining nine eggs began swelling and appeared to thrive.

The first egg hatched after 100 days; the last egg after 106 days. The neonates took several days to fully emerge and frequently appeared static and lifeless. As with other reptile species, this is a period of transition during which the neonates absorb their yolk into their abdomen and switch from embryonic breathing to lung breathing. Therefore it is important to avoid interfering with the hatching process (Fig. 3). All nine neonates appeared normal and weighed between 1.8–2.5 g with an average weight of 2.2 g. They remained in the incubator for 24 h in order to fully absorb the yolk sac and gain strength. Preliminary sexing once the male hatchlings' enlarged post-anal scales were large enough to examine with a hand lens (approximately 5 g) suggested that the clutch consisted of eight males and one female (Fig. 4).

The 2011 clutch was incubated in a different manner. Of the 19 eggs, four appeared undersized. As with the 2010 clutch, the eggs were not weighed; however, based on the female's post-oviposition weight loss, the assumed average egg weight was 1.7 g. Two incubation containers were set up with a vermiculite-to-water ratio of 2:1 and a small water dish for added humidity. Six of the eggs were placed in a Percival I-36NL™ incubator set to 28°C. Three of these eggs remained undersized (less than one gram each), and began to shrivel and mold. They were therefore discarded. The remaining 13 eggs were incubated in an Avey RCAB200 Reptile Incubator™ at 26.5°C; after one week, one

undersized egg began to shrivel and mold. It, too, was discarded. The three eggs in the 28°C incubator began hatching between 85–92 days. Individuals ranged in weight from 1.4–1.6 g, with the average weight of 1.5 g. The remaining 12 eggs in the 26.5°C incubator hatched between 107–112 days. These individuals ranged in weight from 1.7–2.1 g, with an average weight of 1.9 g. The clutch incubated at a lower temperature took an additional 16–21 days to hatch and the hatchlings were, on average, 23% larger by weight at hatching than the higher temperature clutch. Once the hatchlings reached approximately 5 g in weight, preliminary sexing revealed that the three incubated at 28°C were females. The 12 hatchlings from the 26.5°C incubator consisted of four males and eight females. Because the smaller male was observed breeding the female, and because we have noted that distinctive skin patterns appear to be hereditary, we conclude that the smaller male sired the 2010 clutch and the larger male (which was the only observed copulation the following year) sired the 2011 clutch.

The 2010 neonates were housed in groups of four and five individuals, divided between two 38-liter glass aquariums. They were placed on moist paper towels with Petri® dishes for water. A large smooth rock was provided for basking and sleeping. A 50-watt Zoo Med Repti Halogen® bulb was placed over the basking rock to achieve 30–37°C. A 10.0 T8 Zoo Med ReptiSun® fluorescent lamp was placed evenly over both tanks to provide additional light and UVB exposure. The neonates were housed in the same room as the adults. No aggression was observed between the neonates and they often basked and slept on top of or next to each other. They were often observed licking each other and their surroundings. When the lizards were housed separately, their activity levels decreased. The neonates from the second clutch were treated in an identical manner as the first hatchings.

The neonates were offered as wide a variety of insects as possible, two to four times daily to ensure equal access for all individuals. The neonates had access to termites throughout the day when available. Pinhead crickets were offered twice daily in quantities that the lizards could consume within 10–15 minutes. The lizards demonstrated definite food preferences and specific techniques were developed to increase consumption of less desirable items to ensure varied and complete nutrition. Although the lizards showed a strong aversion to harvester ants (which could bite and sting them), the formic acid they contain may be an important component of *P. asio*'s diet. Formic acid is known to be an important gut flora component because it lowers pH levels, initiates protein synthesis, and aids in water extraction from consumed ants.

Feeding harvester ants to the lizards was best accomplished as the first feeding of the day and by placing a few in a container with vitamin powder to disguise them, then chilling them for 30 minutes to slow their movement. The smallest ants were then fed to the lizards one or two at a time until the ants become too active. It was not uncommon for the lizards to eat a single ant every few days. If more than a few ants were eaten at a time the lizards snapped their mouths open and shut repeatedly as if they were experiencing irritation inside of their mouths. Neonates appeared to consume ants more readily than their wild-caught parents.

Termites of any variety were the most preferred food items. The termites with their frass and other debris with which they were collected were presented to the lizards on a small dish or on a piece of wood. They often watched the debris or wood for extended periods of time waiting for the termites to emerge, though they did not actively dig to uncover them. If diligent collection efforts fail, termites are available from commercial biological supply companies. Pinhead and crickets up to 5 mm comprised the majority of the captive *P. asio* diet. Black carpenter ants were highly favored compared with harvester ants. Juvenile earwigs were also occasionally eaten. Small wax worms were fed to neonates, though they often tasted but did not consume them.

Neonates were rarely seen drinking from dishes, so, as with the adults, they were misted on their heads with a hand sprayer three to six times daily (and always after feedings) to ensure proper hydration. It was important to avoid oversaturation of their substrate to eliminate the potential for contact sores. They were also soaked twice weekly in shallow water (no more than 5 mm deep) during routine enclosure cleaning to prevent shed skin from remaining on their digits. Under these conditions the neonates thrived and developed adult behaviors as they grew and matured. These lizards require a high level of attention and care in a captive environment.

The purpose of this paper is to establish baseline criteria for the captive management and propagation of *P. asio*. Research continues to improve the husbandry for this charismatic lizard. Captive studies allow for unique insights that would be difficult to obtain under wild and often hostile conditions. The Los Angeles Zoo aims to improve on previous hatching success and to further insure healthy captive populations. Through continued efforts and shared knowledge, Giant Horned Lizards may one day thrive in other facilities, allowing for broader exposure, a greater knowledge base, and a healthy assurance population of this unique species.

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HERPETOCULTURE NOTES

TESTUDINES — TURTLES

***SIEBENROCKIELLA LEYTENSIS* (Philippine Forest Turtle). ARTIFICIAL INCUBATION AND HATCHLING SIZE.** *Siebenrockiella leytensis* is the largest and heaviest Philippine geoemydid turtle attaining > 300 mm in median caparace length and weighing > 3.5 kg. As currently understood, it is the only endemic Philippine turtle and its natural distribution is on Palawan and Dumaran Island, Philippines (Diesmos et al 2012. *In* Rhodin et al [eds.], Conservation Biology of Freshwater Turtles and Tortoises. Chel. Res. Monogr. No. 5:066.1–9).

Since 2008, a few commercial turtle traders in the United States and Europe have offered for sale apparently captive bred *S. leytensis* on the Internet with prices ranging from US $2500–4500 per specimen (pers. obs.). In the Philippines, there were also anecdotal claims made by turtle enthusiasts and private zoological parks of successful hatching of *S. leytensis* eggs from wild-caught specimens and/or captive breeding. One private zoological park in the Philippines claimed to have produced > 100 *S. leytensis* hatchlings in 2010 (S. Schoppe, pers. comm.). Interestingly, no credible evidence is forthcoming such as photographs of hatchling emerging from egg to authenticate purported captive hatching or breeding successes. Herein, I report on the artificial incubation and a full-termed hatchling of *S. leytensis*.

On 10 January 2013, a *Siebenrockiella leytensis* egg was laid by a wild-caught female (SCL = 199 mm) and donated by a private individual to me on the same day for artificial incubation. The female *S. leytensis* was in captivity with no contact with conspecifics for at least 45 days prior to laying the egg. The egg measured 50.35 mm in length × 28.75 mm in width and weighed 26.8 g. The egg size and mass were within the range previously documented for captive *S. leytensis*, which ranged from 41.0–57.8 mm in length × 19.7–29.4 mm in width and weighed 18–30 g (Diesmos et al 2012, *op. cit.*). No data are available on *S. leytensis* eggs from the wild. The egg was immediately placed in a plastic container with a ~5-cm thick layer of moistened vermiculite as incubation medium. Temperature during the entire incubation period ranged from 27°C–31.5°C. Recorded daily variation of incubation temperature was 0°C–3°C.

On 27 April 2013 (day 107), water beads on top of and a slight crack on one end of the egg were observed. Two days later (day 109), a lateral crack was observed, but no attempt was made to assist the hatchling. The following day, the hatchling failed to emerge on its own and upon opening the egg on the same day, a deceased hatchling was observed. The hatchling had the following measurements: 43.2 mm carapace length × 27.1 carapace width × 21.4 carapace height, and mass of 15.3 g. Hatchlings observed in the wild were 41–44.7 mm in median caparace length and weighed 12–15 g (Schoppe 2009. *Siebenrockiella leytensis* over time—are populations stable? Katala Foundation, Palawan, Philippines. 13 pp.). In comparison, the mean size and mass of eggs laid in captivity by the congeneric *S. crassicollis* were 52.1 mm in length × 28.0 mm in width and 27.2 g, respectively (Honegger 1986. Salamandra 22:1–10). *Siebenrockiella crassicollis* eggs incubated at 29°C–30°C hatched after 68–84 days; hatchlings were 43–46 mm carapace length and weighed 14–15 g (Honegger, *op. cit.*). To my knowledge, this is the first recorded artificial incubation of a *S. leytensis* egg to full term.



PHOTOS BY EMERSON Y. SY

FIG. 1. Lateral (top) and ventral view (bottom) of a full-termed *Siebenrockiella leytensis* hatchling.

The specimen was fixed in 10% formalin, preserved in 70% ethanol, and deposited in the herpetological collection of the Philippine National Museum (EYS 295; Fig. 1).

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SQUAMATA — LACERTILIA

***HELODERMA CHARLESBOGERTI* (Guatemalan Beaded Lizard). CANNIBALISM.** *Heloderma charlesbogerti* is a critically endangered species of venomous lizard that occurs only within the Motagua Valley of Guatemala (Beck 2005. Biology of Gila Monsters and Beaded Lizards. University of California Press, Berkeley, California. 224 pp.). Conservation initiatives are underway *in situ* and *ex situ* within Guatemala. In addition, Zoo Atlanta maintains an *ex situ* colony of more than 20 *H. charlesbogerti* of various age classes as part of a conservation breeding program.

On 25 December 2013 at ~0730 h we observed an individually housed female *H. charlesbogerti* shortly following oviposition. This female began laying eggs on 18 December 2013. Because the egg appeared freshly oviposited—still wet—and was positioned adjacent to the female's cloaca, the decision was made to leave the egg in place to prevent disturbance should she continue to lay eggs. At ~ 0850 h she was checked again. The egg was missing and she had changed position within the nest chamber. A thorough search of the entire enclosure was conducted and no eggs were recovered, leaving us with the obvious conclusion that she had eaten the egg. She deposited two more eggs on 26 and 27 December 2013 and was deemed to have completed ovipositing.

At ~0700 h on 2 January 2014 during routine checks, RLH observed two partially digested eggs in her enclosure, confirming that this particular female had consumed not only one, but two of her own eggs (Fig. 1). It is not clear whether these eggs were regurgitated or passed completely through the gastrointestinal tract, however, as no obvious fecal matter was associated with them.

In addition to the observation above, another female in the collection that was also individually housed and confirmed to be gravid with at least six eggs via radiography and ultrasound imaging was observed to deposit only two eggs while the remaining eggs were never found. These eggs were not observed on subsequent radiographs. The assumption was made that she had consumed her eggs as well, but we were unable to directly verify this.

Various studies have shown that reptile eggs are relatively common items in the diet of *H. charlesbogerti* specifically (Beck 2005, *op. cit.*). As there are few data on clutch size and oviposition habits of wild *H. charlesbogerti,* it is unknown if wild females predate their own eggs and if these observations of individuals cannibalizing their own eggs are artifacts of captivity.

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PHOTOGRAPH BY J. DAVID BROTHERS



FIG. 1. Partially digested remains of two eggs consumed by a captive female *Heloderma charlesbogerti.*

SQUAMATA — SNAKES

***BOAEDON* (*LAMPROPHIS*) *FULIGINOSUS* (African House Snake). LONGEVITY.** *Boaedon fuliginosus* are small sub-Saharan lamprophiids with a maximum reported longevity of 7–9 years (Snider and Bowler 1992. Longevity of Reptiles and Amphibians in North American Collections. Society for the Study of Amphibians and Reptiles, Herpetological Circular No. 21; Carey and Judge 2002. Life Spans of Mammals, Birds, Amphibians, Reptiles, and Fish. Odense Univ. Press, Odense, Denmark. 241 pp.; Slavens and Slavens 1999. Reptiles and Amphibians in Captivity—Breeding, Longevity, and Inventory; http://www.pondturtle.com/lsnakec.html). This species reaches sexual maturity remarkably quickly, often in less than one year, and has been used as an exemplar of a short-lived (*r*-selected) species with high fecundity (e.g., Robert et al. 2007. Aging Cell 6:395–404; Bronikowski 2008. Age 30:169–176). We report a captive male *B. fuliginosus* that lived for at least 18 years 5 months.

One of us (DL) purchased the snake as a juvenile from Glades Herp in Fort Myers, Florida, receiving it on 19 October 1994. Most *B. fuliginosus* imported by Glades Herp at this time were of South African origin (R. Roy, pers. comm.). Although there is some taxonomic confusion within this group, this specimen agreed in all scalation characters with the definition given for *Boaedon* by Kelly et al. (2011. Mol. Phylogenet. Evol. 58:415–426). The snake was given to HMH by DL in fall of 1998, by which time it had grown to adult size, and since passed from HMH to AMD and then to SD. Although size records were not kept, the snake appeared to grow very little between 1998 and 2013, when it died on 24 March, apparently of natural causes. It had eaten less than one week before death. Although our individual never reproduced, trade-offs between lifespan and reproduction are expected to be minimal in male animals (e.g., Maklakov et al. 2008. Curr. Biol. 18:1062–1066). At death, it measured 61.5 cm in snout–vent length, 3.5 cm shy of the record.

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GEOGRAPHIC DISTRIBUTION

GYMNOPHIONA — CAECILIANS

***CAECILIA SUBNIGRICANS* (Magdalena Valley Caecilian).** COLOMBIA: DEPARTAMENTO DE NORTE DE SANTANDER: El Cejal creek, about 32.3 km NW of municipality of Toledo (7.16547°N, 72.22698°W; datum WGS 84), 800 m elev. 12 March 2011. A. Acevedo, R. Franco, and K. Silva. Museo de Ciencias Naturales, University of Pamplona, Pamplona, Colombia (MCNUP-170). Verified by J. D. Lynch. Species known from Venezuela (east of the Maracaibo Lake basin, Barinas and Táchira states; Barrio Amorós 2004. Rev. Ecol. Lat. Am. 9[3]:1–48), and from Colombia (Valle del Cauca, Nariño, Risaralda, Tolima, Bolivar, Magdalena, Cordoba, and Sucre states; Lynch 1999. Rev. Acad. Colomb. Cienc. 23:317–337; Acosta-Galvis 2000. Biota Colombiana 1[3]:289–319). First department record, and first from eastern flank of the Eastern Cordillera of Colombia, border with Venezuela; extends the known distribution approximately 350 km SE from the Colombian Caribbean region in Sucre state and approximately 450 km NE from the Colombian Central Cordillera in Tolima state. For Venezuela, this new record is about 105 km to the SW of the nearest locality in Tachira State (Uribante river). The new record partially fills the distributional gap between Colombia and Venezuela.

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CAUDATA — SALAMANDERS

***AMBYSTOMA TIGRINUM* (Eastern Tiger Salamander).** USA: OHIO: Seneca Co.: Adult male found AOR on the E side of County Rd. 57 (County Rd. 57 is along the boundary between Seneca Co. and Hancock Co.), 10.6 km NNW of Carey (41.04354°N, 83.42046°W; WGS 84). 07 April 2014. S. Graham and C. Kelehear. Verified by David Laurencio. AUM AHAP-D 789 (digital photo voucher). New county record (Davis et al. 2013. Amphibians of Ohio. Ohio Biol. Survey Bul. 17:1–899).

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***CRYPTOBRANCHUS ALLEGANIENSIS ALLEGANIENSIS* (Eastern Hellbender).** USA: TENNESSEE: Jackson Co.: Cordell Hull Reservoir at Cumberland River Mile 342 (36.329025°N, 85.766187°W; NAD 1983). 17 May 2014. John M. McCord, Wesley J. Fox. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19495, 19496, color photos). New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Excellence in Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Internet version [http://apbrwww5.apsu.edu/amatlas/title.htm] accessed 22 May 2014; latest update 19 May 2014). Two adults measuring 38 cm and 43 cm, respectively, were incidentally captured on a trotline anchored to the riverbed and baited with chicken breast, chicken liver, and live minnows for catfish. Capture site was a deep (12–17 m) section of the main river channel along a steep rock bluff with mud substrate. Specimens were measured, photographed, and immediately released at the capture site.

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***EURYCEA GUTTOLINEATA* (Three-lined Salamander).** USA: GEORGIA: Floyd Co.: Unnamed spring adjacent to Morrison Campground (34.2758°N, 93.4175°W; WGS 84). 7 June 2000. N. Burkhead, R. Lewis, and C. Skelton. Verified by John Jensen. Georgia Museum of Natural History (GMNH 50654–50656). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp). Three adults were electroshocked out of thick beds of watercress during a fish survey. In this part of the state, the ranges of *E. guttolineata* and *E. longicauda* interdigitate and are not well-established, increasing the importance of this documented occurrence.

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***MERTENSIELLA CAUCASICA* (Caucasian Salamander).** GEORGIA: IMERETI REGION: Bagdati District: Mount Didmaghali (= Didmaghala) (41.841943°N, 42.806339°E), 1800 and 2000 m elev. 24–25 June 2012. D. Bekoshvili. Two adult salamanders were found in mixed forest of beech and conifer near an area with mixed woodlands and subalpine habitat. This is a new locality in Borjomi-Kharagauli National Park and for Imereti Region. GURIA REGION: Ozurgeti District: Mount Gomismta (= Gomi) (41.841708°N, 42.137594°E), 1480 m elev. 17 May 2012. D. Bekoshvili. One adult salamander found in the broad-leaved beech-dominated forest. This new locality is situated at the extreme northern limit of the species distribution (Kuzmin 2012. The Amphibians of the Former Soviet Union. Second ed., revised. Moscow. 370 pp.). Ongoing development of tourism in this area threatens to destroy habitats of these salamanders listed in the IUCN Red List (Conservation status – Vulnerable, IUCN 3.1). All specimens were verified by N. B. Ananjeva.

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***NOTOPHTHALMUS VIRIDESCENS* (Eastern Newt)**. USA: INDIANA: Sullivan Co.: Minnehaha Fish and Wildlife Area (39.097353°N, 87.327778°W; NAD 83). 21 May 2014. Sarabeth Klueh-Mundy and Jason Mirtl. Verified by Chris Phillips. Illinois Natural History Survey (INHS 2014b). New county record for Indiana (Minton 2001. Amphibians and Reptiles of Indiana. 2nd ed., revised. Indiana Academy of Science. vii + 404 pp.).

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***NOTOPHTHALMUS VIRIDESCENS* (Eastern Newt)**. USA: TENNESSEE: Lawrence Co.: 106 Hunter Road, Summertown (35.38856°N, 87.39657°W; WGS 84). 16 June 2013. Kayla Clark and Nicole Foster. Verified by A. Floyd Scott. Austin Peay State University (APSU 19487). New county record (Scott. and Redmond 2008 [latest update: 18 February 2014]. Atlas of Amphibians in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/am-atlas/, accessed 20 April 2014).

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ANURA — FROGS

***CRAUGASTOR AUGUSTI* (Barking Frog)**. MÉXICO: AGUASCALIENTES: Municipality of El Llano: Cerro Juan Grande (21.931731°N, 101.918010°W; WGS84), 2265 m elev. 18 May 2013. Rubén A. Carbajal Márquez, Gustavo E. Quintero-Díaz. Verified by Bradford Hollingsworth. SDSNH HerpPC 05220. First municipality record, which bridges about a 71-km gap between northwestern populations in the Sierra Fría, Aguascalientes and southeastern population 76 airline km N of Lagos de Moreno, Jalisco (Vázquez-Díaz and Quintero-Díaz 2005. Anfibios y Reptiles de Aguascalientes, 2nd ed. CONABIO y CIEMA, México. 318 pp.; HerpNET 2013). The frog was found within a rock crevice in a ravine covered by xerophytic vegetation and oak forest.

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***CRAUGASTOR AUGUSTI* (Barking Frog)**. MÉXICO: JALISCO: Municipality of Ojuelos de Jalisco: ca. 1.8 km (airline) W from Las Negritas, Asientos, Aguascalientes (21.986518°N, 101.896406°W; WGS84), 2173 m elev. 15 June 2013. Rubén A. Carbajal Márquez, Christian M. García Balderas, Ana Gisel Perez Delgadillo. Verified by Bradford Hollingsworth. SDSNH HerpPC 05221. First municipality record, extending the range ca. 6.5 airline km NNE from the closest locality at Cerro Juan Grande, El Llano, Aguascalientes, México (SDSNH HerpPC 05220; Carbajal-Márquez et al. 2014. Herpetol. Rev. 45[3]:457). The frog was found within a rock crevice on a hill slope covered with xerophytic vegetation.

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***CRAUGASTOR OCCIDENTALIS* (Taylor's Barking Frog)**. MÉXICO: AGUASCALIENTES: Municipality of Calvillo: Sierra El Laurel, 4.3 km SE of Jaltiche de Arriba (21.738502°N, 102.772345°W; WGS84), 1913 m elev. 17 May 2011. Gustavo E. Quintero Díaz and Carolina Chávez Floriano. Verified by Luis Canseco Márquez. UAA-CV 0356. First record for Aguascalientes, extending the distributional range of the species ca. 57.2 airline km NE from the closest known locality in the Sierra Morones, 7.74 km WSW of Juchipila, Zacatecas (Arenas-Monroy et al. 2012. Herpetol. Rev. 43:298). The frog was found on the banks of a stream in riparian forest surrounded by oak forest. Its occurrence in Aguascalientes was expected based on habitat similarities with the nearest previously reported sites, all of which are probably influenced by the presence of Juchipila Canyon, a dispersal corridor whose watershed system has allowed tropical biota to disperse upward into highland areas (Baker et al. 1967. Amer. Midl. Nat. 77:223–226).

GUSTAVO ERNESTO QUINTERO-DÍAZ, Universidad Autónoma de Aguascalientes, Centro de Ciencias Básicas, Departamento de Biología, Aguascalientes, Aguascalientes. México. 20131 (e-mail: gequintmxags@hotmail.com); **CAROLINA CHÁVEZ-FLORIANO**, Conservación de la Biodiversidad del Centro de México A. C. Andador Torre de Marfil No. 100, Fraccionamiento Las Torres, C.P. 20229, Aguascalientes, Aguascalientes, México; **RUBÉN ALONSO CARBAJAL-MÁRQUEZ**, Centro de Investigaciones Biológicas del Noroeste, Mar Bermejo #195 Col. Playa Palo de Santa Rita, C.P. 23090, La Paz, Baja California Sur, México.

***ELEUTHERODACTYLUS CYSTIGNATHOIDES* (Rio Grande Chirping Frog)**. USA: TEXAS: Comal Co.: intersection of Ashmore St. and Guada Coma Dr. in New Braunfels (29.70002°N, 98.11390°W; WGS84). 10 October 2013. J. Eric Lee. Verified by Travis LaDuc. TNHC 89687. New county record (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps, Texas A&M University Press, College Station, Texas. 447 pp.). Several frogs were heard chorusing, with a single adult being captured by hand. Frogs were located in residential brush piles and gardens ~ 90–100 m from the Guadalupe River.

J. ERIC LEE, Balcones Wildlife Management, New Braunfels, Texas 78130, USA; e-mail: ericlee@balconeswildlife.com.

***ELEUTHERODACTYLUS CYSTIGNATHOIDES* (Rio Grande Chirping Frog)**. USA: TEXAS: Guadalupe Co.: Sidenberger Property, 3.01 km SSE of jct Hwy 90 and Eden Rd. (29.540868°N, 97.867830°W; WGS 84). 30 July 2013. Drew T. Harvey. Verified by Travis J. LaDuc, Texas Natural History Collections (TNHC 85870). A single specimen was observed under lights and captured by hand, representing the first recorded occurrence of this species in Guadalupe Co. (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 447 pp.).

Multiple individuals were also heard calling along the moist sloping ridge into a pecan bottom running along the Guadalupe River. We suspect this is a range expansion of the Rio Grande Chirping Frog given there were no south Texas plants, exotic to this region, in the area where the specimen was found.

DREW T. HARVEY (e-mail: dh1303@txstate.edu), **DOMINIC L. DESANTIS**, **ROMEY L. SWANSON**, and **THOMAS R. SIMPSON**, Department of Biology, Texas State University, San Marcos, Texas 78666, USA.

***ELEUTHERODACTYLUS PLANIROSTRIS* (Greenhouse Frog)**. USA: FLORIDA: Gilchrist Co.: Trenton, 250 m NNE from the intersection of SE 25th Ave and SE 100th St (29.594233°N, 82.763778°W; WGS 84). 02 February 2010. Cody G. Godwin. Verified by Kenneth L. Krysko. Florida Museum of Natural History (UF 157499). New county record (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final Report, Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida. 524 pp.) Found in a hole in a live oak (*Quercus virginiana*) ca. 3.6 m above ground.

This small anuran (typically 16–32 mm SVL) is native to Cuba. It is one of the earliest recorded non-native species in Florida and is a common resident in the state (Conant and Collins 1998. A Field Guide to Reptiles & Amphibians, Eastern and Central North America. 3rd ed., expanded. Houghton Mifflin Co., Boston, Massachusetts. 616 pp.). Eggs are typically laid in moist leaf litter and soils. An aquatic larval phase is skipped and the egg develops directly into a juvenile frog. This allows them to be stowaways in ornamental plants.

CODY D. GODWIN, University of Florida, Gainesville, Florida 32606, USA; e-mail: codydg1dwin@ufl.edu.

***ELEUTHERODACTYLUS PLANIROSTRIS* (Greenhouse Frog)**. USA: MISSISSIPPI: Jackson Co.: University of Southern Mississippi's Gulf Coast Research Laboratory (GCRL), 759 E Beach Drive, Ocean Springs (30.39428°N, 88.79693°W; WGS 84). 14 May 2014. Jennifer Y. Lamb and Matthew W. H. Chatfield. Verified by Robert L. Jones. Mississippi Museum of Natural Science (MMNS 19383, 23.3 mm SVL; MMNS 19384, 18.0 mm). New county record (Meshaka Jr. 2005. In M. Lannoo [ed.], Amphibian Declines: The Conservation Status of United States Species, pp. 499–500. Univ. California Press, Berkeley; R. L. Jones, pers. comm.).

Closest known locality is ca. 17 miles W in Gulfport, Harrison Co., Mississippi (MMNS 9274–9276). The USGS Nonindigenous Aquatic Species Database has an unconfirmed record for *E. planirostris* from Jackson Co., but the locality is unspecified (Somma 2014. *Eleutherodactylus planirostris*. USGS Nonindigenous Aquatic Species Database, Gainesville, Florida. http://nas.er.usgs.gov/queries/FactSheet.aspx?speciesID=61, Revision date: 1 Nov. 2011).

Two individuals were found and collected at GCRL from beneath an assortment of cover objects at night after heavy rains. The larger of the vouchers is a gravid female, but we did not hear calling males on the premises. These specimens were collected under Mississippi Department of Wildlife Fisheries and Parks Permit 0422131.

JENNIFER Y. LAMB, Department of Biological Sciences, The University of Southern Mississippi, Hattiesburg, Mississippi 39406, USA (e-mail: jennifer.lamb@eagles.usm.edu); **MATTHEW W. H. CHATFIELD**, Tulane-Xavier Center for Bioenvironmental Research, Tulane University, New Orleans, Louisiana 70118, USA (e-mail: mattchat@tulane.edu).

***HUMERANA HUMERALIS* (Bhamo Frog)**. BANGLADESH: RANGPUR DISTRICT: New Adarsha Para, Rangpur City (25.738652°N, 89.25375°E, WGS 84; 32 m elev.). 14 October 2013. Hassan-Al-Razi. Adult near small waterbody. Museum of Zoology, Jagannath University, Dhaka, Bangladesh (JnU/ZooM/Amp/2013/0003). Verified by Kaushik Deuti. Previously recorded from Kabongpuria, Khagrachari, Baghaichari, Rangamati, and Reme Kalenga Wildlife Sanctuary, NE Bangladesh (Kabir et al. 2009. Encyclopedia of Flora and Fauna of Bangladesh. Vol. 25. Amphibians and Reptiles. Asiatic Society of Bangladesh, Dhaka. 204 pp.). Record represents range extension of 405 km N of Khagrachari, 454 km N of Rangamati District, and 298 km NE of Reme Kalenga Wildlife Sanctuary. Habitat was *Cynodon dactylon* and *Enhydra fluetuans* plantations.

HASSAN-AL-RAZI (e-mail: chayan1999@yahoo.com), **MOHAMMAD ABDUL BAKI** (e-mail: mabaki@gmail.com), and **SHAYER MAHMOOD IBNEY ALAM**, Department of Zoology, Jagannath University, Dhaka 1100, Bangladesh (e-mail: shayermia@hotmail.com).

***LITHOBATES* (= *RANA*) *AREOLATUS* (CRAWFISH FROG)**. USA: TEXAS: Delta Co.: Highway 198 (33.45199°N, 95.61932°W; WGS84). 24 March 2010, AOR at 2023 h. C. Roelke and J. Streicher. Verified by Carl Franklin. The University of Texas at Arlington Amphibian and Reptile Diversity Research Center Collection (UTA A 60580). New county record (Dixon 2013. Amphibians and Reptiles of Texas with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. 3rd ed., Texas A&M University Press, College Station, Texas. 447 pp.).

COREY E. ROELKE, University of Texas at Arlington, Department of Biology, Box 19498, Arlington, Texas 76019, USA (e-mail: croelke@uta.edu); **JEFFREY W. STREICHER**, University of Arizona, Department of Ecology and Evolutionary Biology, P.O. Box 210088, Tucson, Arizona 85721, USA (e-mail: streicher@email.arizona.edu).

***NANORANA GAMMII* (Gammii Frog)**. INDIA: SIKKIM: Fambong Lho Wildlife Sanctuary (27.2807°N, 88.50283°E, WGS 84; 1600 m elev.). 27 June 2012. Lily Alley. Verified by Annemarie Ohler. Arya Vidyapeeth College Museum (AVCM A1020–1021). Two adult males in fast-flowing stream, on moist boulder at 1915 h. Air temperature 18°C, relative humidity 99%. An additional specimen (AVCM A1022) from same stream (27.37048°N, 88.57445°E; 1600 m elev.) on drizzling night, 5 July 2012. Air temperature 17°C, relative humidity 80%. First record for Sikkim State, and ca. 40 km range extension NE from nearest known record (Darjeeling; Boulenger 1920. Rec. Indian Mus. 20:1–226).

LILY ALLEY, Government College Rhenock, Rhenock, 737 133, Sikkim, India (e-mail: lilychettri@gmail.com); **SAIBAL SENGUPTA** (e-mail: senguptasaibal@yahoo.co.in), **JAYADITYA PURKAYASTHA**, Department of Zoology, Arya Vidyapeeth College, Guwahati 781 016, Assam, India (e-mail: mail.jayaditya@gmail.com).

***PSEUDACRIS FERIARUM* (Upland Chorus Frog)**. USA: GEORGIA: Lamar Co.: Private residence on Grape Creek Road in Milner (33.109666°N, 84.221003°W; WGS 84). 17 February 2014. M. J. Bender. Verified by Gregory D. Hartman. Gordon State College (GSC-065). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens, Georgia. 575 pp., J. Jensen, pers. comm.). Species has been documented in two adjoining counties. Found calling in ephemeral stream approximately one week after ice storm and hard freeze.

Specimen collected under a Georgia Department of Natural Resources Scientific Collections Permit (29-WJH-13-126).

MICHAEL J. BENDER, Gordon State College, 419 College Drive, Barnesville, Georgia 30204, USA; e-mail: mbender@gordonstate.edu.

***PSEUDACRIS ORNATA* (Ornate Chorus Frog)**. USA: FLORIDA: Lafayette Co.: Lafayette Forest Wildlife and Environmental Area (29.84207ºN, 82.99175ºW; WGS84). 19 February 2014. Anna L. Farmer. Verified by Kenneth L. Krysko. Florida Museum of Natural History (UF 172551). New county record (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final report, Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida. 524 pp.). Collected two tadpoles while dipnetting a depression marsh in mesic flatwoods habitat. Partially fills a ca. 100-km gap between records in Taylor Co. and records east of the Suwannee River.

ANNA L. FARMER, Florida Fish and Wildlife Conservation Commission, 1105 S.W. Williston Road, Gainesville, Florida 32601, USA; e-mail: Anna.Farmer@myfwc.com.

***PSEUDACRIS STRECKERI* (Strecker's Chorus Frog)**. USA: TEXAS: Stephens Co.: Adjacent to County Road 104 (32.6588283°N, 98.5904916°W; WGS84). 30 March 2014. C. Roelke. M. Moseley, E. Wostl, U. Smart, and M. Fontenot. Verified by Carl Franklin. The University of Texas at Arlington Amphibian and Reptile Diversity Research Center Collection (UTA A 62595). New county record (Dixon 2013. Amphibians and Reptiles of Texas with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. 3rd ed., Texas A&M University Press, College Station, Texas. 447 pp.).

COREY E. ROELKE (e-mail: croelke@uta.edu), **MATTHEW MOSELEY**, **ELIJAH WOSTL**, and **UTPAL SMART,** University of Texas at Arlington, Department of Biology, Box 19498, Arlington, Texas 76019, USA; **MALLORY L. FONTENOT**, 1315 West Abram Street, Arlington, Texas 76013, USA.

SCINAX TRILINEATUS. BRAZIL: AMAPÁ: Municipality of Macapá: Experimental Field of the Brazilian Agricultural Research Corporation (0.384722°N, 51.033889°W; datum WGS84). 16 June 2011. C. E. Costa-Campos. Collection of the Universidade Federal do Amapá, Macapá, Brazil (CDLABZOO 00256, male SVL 18.9 mm, calling at 2035 h in a temporal pond. Verified by M. S. Hoogmoed. *Scinax trilineatus* was known from the savannas of El Manteco in Bolívar state, eastern Venezuela, southern Guyana, and Suriname, and from Brazil in the area surrounding Belém, Pará state (Hoogmoed and La Marca 2004. IUCN Red List of Threatened Species, ver. 2013.2 [30 December 2013]. Electronic database accessible at http:// www.iucnredlist.org; Señaris and MacCulloch 2005. *In* Hollowell and Reynolds [eds.], Checklist of the Terrestrial Vertebrates of the Guiana Shield, pp. 9–23. Bull. Biol. Soc. Washington; Cole et al. 2013. Proc. Biol. Soc. Washington 125 [4]:317–578). First state record; fills a large distributional gap of 585 km from Suriname and 350 km NE from Belém, Pará state (M. Hoogmoed, pers. comm.).

Specimen collected under license ICMBio/SISBIO #18243-1.

CARLOS E. COSTA-CAMPOS, Laboratório de Herpetologia, Departamento de Ciências Biológicas e da Saúde, Universidade Federal do Amapá, Campus Marco Zero, CEP 68903-419, Macapá, AP, Brazil; Programa de Pós-Graduação em Psicobiologia, Universidade Federal do Rio Grande do Norte, Centro de Biociências, Lagoa Nova, CEP 59072-970, Natal, RN, Brazil (e-mail: eduardocampos@unifap.br); **ELIZA M. VX. FREIRE**, Laboratório de Herpetologia, Departamento de Botânica, Ecologia e Zoologia, Centro de Biociências, Universidade Federal do Rio Grande do Norte, Campus Universitário Lagoa Nova, CEP 59072-970, Natal, RN, Brazil (e-mail: elizajuju@ufrnet.br).

TESTUDINES — TURTLES

***APALONE MUTICA* (Smooth Softshell)**. USA: MISSOURI: Perry Co.: Brazeau Township, near bank of Mississippi River, 10 m E of BNSF railroad and 0.5 km NW of Cottonwood Island (37.6117°N, 89.5169°W; WGS84). 2 July 2013. Andrew P. Braun and John West. Verified by Dustin S. Siegel. University of Missouri-Columbia (UMC 2392P). New county record (Edmond and Daniel 2014 [latest update: 18 February 2014]. Missouri Herpetological Atlas Project. Available at http://atlas.moherp.org/; accessed 4 June 2014). Male specimen, captured in fyke net.

ANDREW P. BRAUN (e-mail: Andrew.Braun@mdc.mo.gov), and **JOHN WEST**, Big Rivers & Wetlands Field Station, Missouri Department of Conservation, Jackson, Missouri 63755, USA.

***APALONE SPINIFERA* (Spiny Softshell)**. USA: TENNESSEE: Lewis Co.: Dan Maddox Lake near the KOA, Howenwald (35.435486°N, 87.469549°W; WSG 84). 25 July 2013. Sommer Smith and Nicole Foster. Verified by A. Floyd Scott. Austin Peay State University (APSU 19489). New county record (Scott. and Redmond 2008 [latest update: 9 January 2014]. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/, accessed 20 April 2014).

SOMMER SMITH (e-mail: ssmith71@Columbiastate.edu), and **NICOLE FOSTER**, Department of Biology, Columbia State Community College, Columbia, Tennessee 38401, USA (e-mail: nfoster2@Columbiastate.edu).

***CHELYDRA SERPENTINA* (Snapping Turtle)**. USA: GEORGIA: Emanuel Co.: Adrian (32.51183°N, 82.59066°W; WGS 84). 9 March 2014. Chris Murphy, Will Booker, Bridget Altman. Verified by Nikole Castleberry. Georgia Museum of Natural History (GMNH 50675 photo voucher). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). *Chelydra serpentina* had been previously observed in Emanuel Co. but was unvouchered. This individual was found in an inflow stream to a man-made pond near the road.

CHRIS MURPHY, Warnell School of Forestry and Natural Resources, University of Georgia, Athens, Georgia 30609, USA; e-mail: chris987@uga.edu.

***CHRYSEMYS PICTA BELLI* (Western Painted Turtle)**. USA: IDAHO: Madison Co.: Henry's Fork of the Snake River, near Rexburg (43.866337°N, 111.865172°W; WGS 84). 13 September 2010. Caleb L. Loughran. Verified by David M. Darda. CWU Herpetology Collection 14-001, photo voucher. New county record (Groves et. al. 1997. Atlas of Idaho's Wildlife. Idaho Fish and Game, Nongame and Endangered Wildlife Program, Boise, Idaho. 411 pp.). Likely unrecorded distribution of introduced populations in southeastern Idaho (Barela and Olson 2014. Northwest. Nat. 95:1–12).

CALEB L. LOUGHRAN (e-mail: loughranc@cwu.edu), and **ROBERT E. WEAVER** (e-mail: weaverro@cwu.edu), Department of Biological Sciences, Central Washington University, Ellensburg, Washington 98926, USA.

***GRAPTEMYS ERNSTI* (Escambia River Map Turtle)**. USA: FLORIDA: Orange Co.: Wekiwa Springs State Park, approximately 150 m downstream at the edge of the Wekiwa Springs lagoon and the start of the Wekiwa Springs run (28.714071°N, 81.458624°W, WGS84; elev. 6 m). 6 June 2014. Joanne Bolemon and Eric C. Munscher. Verified by Kenneth L. Krysko. Florida Museum of Natural History (UF 173444). New county record (Krysko et al.

2011. Atlas of Amphibians and Reptiles in Florida. Final Report, Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida. 524 pp.).

Adult male observed basking on a log around 1000 h. The abundance of algae on the carapace (75% of surface area) suggests this is not a recently released captive. This is the first reported occurrence of *G. ernsti* in the St. Johns River Basin. This species is native to Florida in the extreme western panhandle over 300 miles distant. Even though this particular species is not sold as frequently in the pet trade as the Red-eared Slider (*Trachemys scripta elegans*) and the False Map Turtle (*Graptemys pseudogeographica pseudogeographica*) it is possible that this animal was a released pet. Wekiwa Springs State Park provides suitable habitat for this species. *Graptemys ernsti* could potentially thrive in such a diverse and turtle-rich ecosystem.

ERIC C. MUNSCHER, Department of Natural Resources, SWCA Environmental Consultants, Houston, Pennsylvania 15017, USA (e-mail: emunscher@swca.com); **JOANNE BOLEMON**, Casselberry, Florida 32707, USA (e-mail: jobol@embarqmail.com).

***GRAPTEMYS GEOGRAPHICA* (Northern Map Turtle)**. USA: TENNESSEE: Hardin Co.: Horse Creek (35.116669°N, 88.157236°W; WGS84). 1 May 2014. Brian P. Butterfield, Lisa M. Raine, and M. Rachel Hobgood. Verified by A. F. Scott. Austin Peay State University (APSU 19490 photographic voucher). New county record (Scott and Redmond 2008 [latest update: 10 March 2014]. Atlas of Reptiles in Tennessee. Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/), accessed 5 May 2014.

BRIAN P. BUTTERFIELD (e-mail: bbutterfield@fhu.edu), and **LISA M. RAINE, M. RACHEL HOBGOOD**, Department of Biological, Physical, and Human Sciences, Freed-Hardeman University, Henderson, Tennessee 38340, USA.

***KINOSTERNON INTEGRUM* (Mexican Mud Turtle)**. MÉXICO: OAXACA: Municipality of Ixtlán de Juárez: border road near Universidad de la Sierra Juárez–Ixtlán (17.316798°N, 96.483373°W; WGS84), 1938 m elev. 3 August 2008. Victor Aguirre Hidalgo and Miriam Illescas Aparicio. Verified by Víctor Hugo Reynoso. Colección Herpetofaunística, Universidad de la Sierra Juárez - Ixtlán (ICAH 141). First record for the municipality and Sierra de Juarez in Oaxaca, extending the know range of this species 45.9 km SW from the nearest known locality at Zoquiapan Boca de los Ríos, Oaxaca (Canseco-Márquez and Gutiérrez Mayen 2010. Anfibios y Reptiles del Valle Tehuacán-Cuicatlán. CONABIO, Cuicatlán, A.C., Benemérita, Univ. Autón. de Puebla, México, D.F. xvi + 302 pp.). This locality also extends the known elevation of the species by 208 m (Canseco-Márquez and Gutiérrez 2010, *op. cit.*). The turtle was DOR in an area originally covered by riparian vegetation.

VICTOR AGUIRRE-HIDALGO (e-mail: victor@juppa.unsij.edu.mx), and **MIRIAM ILLESCAS-APARICIO,** Instituto de Estudios Ambientales, Universidad de la Sierra Juárez, Avenida Universidad S/N, Ixtlán de Juárez, Oaxaca, México, CP 68725 Oaxaca; **ADRIANA J. GONZÁLEZ-HERNÁNDEZ**, Colección Nacional de Anfibios y Reptiles. Instituto de Biología. Departamento de Zoología, UNAM, México D.F. 04510, México.

***KINOSTERNON SUBRUBRUM* (Eastern Mud Turtle)**. USA: TENNESSEE: Chester Co.: Henderson, Freed-Hardeman University (35.434725°N, 88.634°W; WGS84). 15 April 2014. Brian Butterfield, Rachel Hobgood, Eric Hughes, and Joshua Kee. Verified by A. F. Scott. Austin Peay State University (APSU 19486 color photos). New county record (Scott and Redmond 2008 [latest update: 10 March 2014]. Atlas of Reptiles in Tennessee. Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/, accessed 17 April 2014. Adult female captured in a baited hoop net.

BRIAN P. BUTTERFIELD (e-mail: bbutterfield@fhu.edu), **M. RACHEL HOBGOOD**, **ERIC A. HUGHES**, **JOSHUA P. KEE**, and **LEE J. BARTON**, Department of Biological, Physical, and Human Sciences, Freed-Hardeman University, Henderson, Tennessee 38340, USA.

***MALACLEMYS TERRAPIN* (Diamond-backed Terrapin)**. USA: LOUISIANA: Calcasieu Parish: Tidally-influenced, brackish marsh near Turner Bay (30.064848°N, 93.306107°W; WGS84), 4.25 km S of the Calcasieu Point boat launch. 30 April 2014. Will Selman and Chance Baccigalopi. Verified by Peter Lindeman. Florida Museum of Natural History Herpetology Department photographic archive (UF 173242). New parish record (Dundee and Rossman 1989. The Reptiles and Amphibians of Louisiana. Louisiana State University Press, Baton Rouge, Louisiana. 300 pp.; Selman et al., *in press*, Chelon. Conserv. Biol.; HerpNet2 Database search, www.herpnet2.org, accessed 14 May 2014). This record extends the range of *M. terrapin* in the Calcasieu River estuary approximately 21 km N of existing records from east side of Sabine National Wildlife Refuge (Selman et al., *op. cit.*). Individual captured in an unbaited fyke net.

WILL SELMAN (e-mail: wselman@wlf.la.gov) and **CHANCE BACCIGALOPI**, Rockefeller Wildlife Refuge, Louisiana Department of Wildlife and Fisheries, 5476 Grand Chenier Hwy, Grand Chenier, Louisiana 70643, USA.

***PSEUDEMYS CONCINNA* (River Cooter)**. USA: TENNESSEE: Chester Co.: Henderson, Freed-Hardeman University (35.434725°N, 88.634°W; WGS84). 8 May 2014. Brian Butterfield, Rachel Hobgood, Eric Hughes, and Joshua Kee. Verified by A. F. Scott. Austin Peay State University (APSU 19491 color photos). New county record (Scott and Redmond 2008 [latest update: 10 March 2014]. Atlas of Reptiles in Tennessee. Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/, accessed 8 May 2014.). Juvenile captured in a baited hoop net.

BRIAN P. BUTTERFIELD (e-mail: bbutterfield@fhu.edu), **JOSHUA P. KEE**, **M. RACHEL HOBGOOD**, and **ERIC A. HUGHES**, Department of Biological, Physical, and Human Sciences, Freed-Hardeman University, Henderson, Tennessee 38340, USA.

***STERNOTHERUS ODORATUS* (Eastern Musk Turtle)**. USA: ARKANSAS: Calhoun Co.: Locust Bayou off St. Hwy 278 at Locust Bayou (33.557668°N, 92.67574°W; WGS 84). 8 April 2014. Verified by S. E. Trauth. Arkansas State University Museum of Zoology, Herpetological Collection (ASUMZ 33106). New county record filling a gap among previous records for adjacent Dallas, Ouachita, and Union counties (Trauth et al. (2004. Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville, Arkansas. 421 pp.)

CHRIS T. McALLISTER, Science and Mathematics Division, Eastern Oklahoma State College, Idabel, Oklahoma 74745, USA (e-mail: cmcallister@se.edu); **HENRY W. ROBISON**, 9717 Wild Mountain Drive, Sherwood, Arkansas 72120, USA (e-mail: hwrobison@yahoo.com).

***STERNOTHERUS ODORATUS* (Eastern Musk Turtle)**. USA: TEXAS: Montgomery Co.: Peach Creek, 3.5 km S of Splendora (30.20743°N, 95.18189°W, WGS84; elev. 21 m). 26 May 2013.

William L. Farr. Verified by Carl J. Franklin. UTADC 8059–8061. The first county record, partially filling a distributional gap in the greater Houston area of southeast Texas (Dixon 2013. Amphibians and Reptiles of Texas with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. 3rd ed., Texas A&M University Press, College Station, Texas. 447 pp.) and apparently the first record from the San Jacinto River drainage (Iverson 1992. A Revised Checklist with Distribution Maps of the Turtles of the World. Green Nature Books, Homestead, Florida. 363 pp.).

The turtle, an adult male ca. 10 cm in straight carapace length, was observed at 1307 h in clear water ca. 5–10 cm deep where it was caught, examined, photographed, and released. A leach, ca. 25 mm in length, was attached at the seam of the 9th and 10th marginals on the left underside of the carapace. Also of note, Dixon 2013 (*op. cit.*) does not indicate a record for neighboring Harris Co., Texas; however, the specimen illustrated in that same volume is identified as being from Harris Co. I recall observing and collecting *S. odoratus* in roadside ditches, creeks, and ponds in Harris Co. with some regularity in the 1970s; these were distinguished from the sympatric *Kinosternon subrubrum* (Eastern Mud Turtle) by the reduced plastron size, lacking two conspicuous hinges.

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***TERRAPENE CAROLINA TRIUNGUIS* (Three-toed Box Turtle).** USA: ARKANSAS: Cleveland Co.: off St. Hwy. 189, 14.5 km SE of Kingsland (33.772296°N, 92.173963°W; WGS 84). 23 April 2014. H. W. Robison. Verified by S. E. Trauth. Arkansas State University Museum of Zoology, Herpetological Collection (ASUMZ 33152, photovoucher). New county record filling a gap among previous records for adjacent Lincoln (Connior 2013. Herpetol. Rev. 43:444), and Bradley, Calhoun, Dallas, Grant, and Jefferson counties (Trauth et al. (2004. Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville, Arkansas. 421 pp.).

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***TRACHEMYS SCRIPTA* (Pond Slider).** USA: MISSOURI: Ste. Genevieve Co.: Weingarten. Found on roadside at intersection of Glassey Lane and Highway 32 (37.8620°N, 90.2695°W; WGS84). 27 April 2014. Andrew P. Braun and Andrew T. Bueltmann. Verified by Dustin S. Siegel. University of Missouri-Columbia (UMC 2601P). New county record (Edmond and Daniel 2014 [latest update: 18 February 2014]. Missouri Herpetological Atlas Project. Available at http://atlas.moherp.org/; accessed 4 June 2014). Roadkilled female specimen.

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***TRACHEMYS SCRIPTA ELEGANS* (Red-eared Slider).** USA: NEW MEXICO: Lea Co.: Conoco Lake, along an unnamed road ca. 4.0 road miles SE of Maljamar, (32.80973°N, 103.75061°W, NAD 83; elev. 1201 m). 3 July 2013. Austin L. Fitzgerald and Charles W. Painter. Verified by Tom Giermakowski. Museum of Southwestern Biology, University of New Mexico (MSB 95060 and 95074). New county record (Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. Univ. New Mexico Press, Albuquerque, New Mexico. xix + 431 pp.). Two adult females (204 mm and 195 mm SCL) were captured using hoop traps baited with sardines. Both individuals were preserved at time of capture. This locality is a small pond separated from the nearest known locality of native Red-eared Sliders by at least 50 km of arid habitat. These specimens may represent intentionally released individuals.

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SQUAMATA — LIZARDS

***CYTOPODION SCABRUM* (Rough-tailed Bowfoot Gecko).** USA: ARIZONA: Maricopa Co.: 7200 E. University Drive, Mesa (33.423530°N, 111.675416°W, WGS84; elev. 403 m). Four specimens collected between 3 April (UAZ 57586, UAZ 57587) and 7 April 2014 (UAZ 57588, UAZ 57589). Verified by Aaron Bauer. New record for the state (Brennan and Holycross 2009. Amphibians and Reptiles in Arizona. Arizona Game and Fish Department, Phoenix, Arizona. 150 pp.).

Several individuals of *Cyrtopodion* had been sighted and two sets of hatched eggs found, however both were initially mistaken for *Hemidactylus turcicus*. It was not until a lizard was captured and examined closely that it was recognized as something different. A nighttime survey of the building exteriors on 12 April 2014 revealed an established population (N = 47) with nearly all size classes (10–53 mm SVL) represented. The geckos were generally located clinging to walls from a few cm above ground to over 5 m up. They seemed to avoid well-lit areas and a few specimens were located on curbs and on large rocks in the landscaping.

Though it is unclear how this species came to be established here, there are two obvious potential pathways for introduction. The pet trade is the primary source for the introduction of exotic reptiles and amphibians in the United States (Kraus 2009. Alien Reptiles and Amphibians: A Scientific Compendium and Analysis. Springer Science and Business Media B.V., Dordrecht, Netherlands. 563 pp.). But this seems the least likely of the two scenarios imagined. Another far more probable avenue for this species' introduction is as a stowaway in cargo. The collection locality is adjacent to a large industrial complex (Salt River Project) that receives shipments of heavy equipment such as generators from a variety of localities. Kraus (*op. cit.*) cites stowing away in cargo as the second most common way that exotic reptile species are introduced in the United States.

Photos taken in mid-April 2014 of *C. scabrum* from the US Air Force Auxiliary Field in Gila Bend, Maricopa Co., Arizona were forwarded to me by Richard K. Whittle, Biologist, 56th Range Management Office, Phoenix, Arizona. Mr. Whittle stated that he had seen geckos on auxiliary buildings since 2010 but is uncertain if they were this species. The general similarity in appearance and behavior of *C. scabrum* to *Hemidactylus turcicus*, an abundant, secretive, and widespread exotic, makes it easy to overlook. *Cyrtopodion scabrum* differs from *H. turcicus* in many ways, the most obvious of these being the absence of toe pads. *Cyrtopodion scabrum* may be much more widespread in the United States than previous reports indicate. Its nocturnal activity, apparent avoidance of lighted areas, and habit of sheltering in secluded refugia during daylight hours make it easy to overlook. Geckos encountered on buildings should be subjected to close examination to determine species.

Cyrtopodion scabrum is native to the Middle East including Pakistan, Afghanistan, Iraq, Iran, and Turkey. Considering all the

time the USA has been spending in this part of the world in recent decades it is not surprising a species commonly associated with anthropogenic structures such as urbanized areas and shipping yards has made its way to the United States. This species is established in Galveston, Texas, USA (Selcer and Bloom 1984. Southwest. Nat. 29:499–500).

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***DASIA OLIVACEA* (Olive Tree Skink)**. THAILAND: SONGKHLA PROVINCE: Hat Yai District: Ton Nga Chang Wildlife Sanctuary, Headquarters (6.9456°N, 100.2395°E, WGS 84; ca. 160 m elev.). At daytime, adult (lacking yellow bands on dorsum) observed on tree trunk; juvenile observed on ground. Tanet Siangsuwan. 31 July 2013. Khon Kaen University Vertebrate Collection (KKUD 2014.1a–b, 2014.2a–b). Verified by Sunchai Makchai. First provincial record for Songkhla Province; fills distributional gap between Pattani, and Satun provinces. Previously known from the west (Kanchanaburi), northeast (Nakhon Ratchasima), southeast (Chanthaburi, Srakaeo), and south (Nakhon Sri Thammarat, Narathiwat, Pattani, Phangnga, Phuket, Satun, Surat Thani, Trang, Yala) of Thailand (Chuaynkern and Chuaynkern 2012. J. Wildl. Thailand 19:75–162).

We thank Khon Kaen University Vertebrate Collection for cataloging the record in the Digital Photograph Collection (KKUD). Our special thanks to KKU Herpetological Research Group for supporting this work.

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***ELGARIA KINGII* (Madrean Alligator Lizard)**. MÉXICO: ZACATECAS: Municipality of Huanusco: ca. 6 airline km E of El Caracol (21.703370°N, 102.794476°W; WGS84), 2120 m elev. 24 August 2013. Rubén A. Carbajal Márquez, Gustavo E. Quintero Díaz, and Ana Gisel Pérez Delgadillo. Verified by Bradford Hollingsworth. SDSNH HerpPC 05223–05224. First municipality record and second known locality for Zacatecas. The closest reported locality is ca. 6.5 airline km NE at Arroyo Ibañez, Sierra El Laurel, Calvillo, Aguascalientes, and the other Zacatecas locality is 76 airline km SW at 3 mi. NW Teul de González Ortega (Webb 1970. Cat. Amer. Amphib. Rep. 97:1–4; Quintero-Díaz et al. 1999. Herpetol. Rev. 30:233). The lizard was found in a crevice of a rock wall located within an ecotone between oak forest and tropical deciduous forest.

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***EMOIA RUFICAUDA* (Red-tailed Swamp Skink)**. PHILIPPINES: MINDANAO ISLAND: SOUTH COTABATO PROVINCE: Municipality of Lake Sebu: Barangay Lake Seloton (6.255775°N, 124.733772°E, WGS 84; ca. 400 m elev.). 22 September 2013. Jeniel Buday. Photographic voucher, Raffles Museum of Biodiversity Research, National University of Singapore (ZRC [IMG] 2.219a–b). Verified by Rafe M. Brown. Observed on riverbank of Seven Falls. First provincial record. Endemic to Mindanao Island, previously recorded from provinces of Agusan del Norte, Sarangani, Sultan Kudarat, and Zamboanga del Sur (Gaulke and Alcala 2009. Salamandra 45:57–60). Record extends distribution by ca. 31 km NE from nearest locality at Maitum, Sarangani.

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***GERRHONOTUS INFERNALIS* (Texas Alligator Lizard)**. USA: TEXAS: Terrell Co.: Independence Creek Preserve TNC on a road traversing a steep limestone hillside (30.49722°N, 101.78901°W, WGS 84; elev. 2380 m). 13 April 2014. Michael T. Sager. Verified by John Karges and Travis LaDuc. University of Texas at Arlington Amphibian and Reptile Diversity Research Center (Digital Image Collection Number UTADC 8125, photographic voucher). New county record. Previous records exist for Brewster Co. to the west, and Crockett Co. and Val Verde Co. to the east. This record fills the gap bridging these counties.

This animal was found during the Texas Herpetological Society's spring field meeting. The individual was collected active on the surface on a cool, damp, early morning after a night of light but steady rain. Found along a rocky north-facing hillside with open juniper woodlands with some shrubs and grass cover among barren rock ledges and boulders, this juvenile is evidence of a breeding/viable population.

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***HELODERMA SUSPECTUM CINCTUM* (Banded Gila Monster)**. USA: NEVADA: Clark Co.: Lucy Gray Mountains (35.6384°N, 115.3074°W; WGS 84). 24 May 2010. David B. Prival. Verified by C. Mahrdt. Natural History Museum of Los Angeles County voucher photograph (LACM-PC 1604). New record for the species in Nevada; extends range westward ca. 13 km from records in the McCullough Mountains (18 May 2012: 35.7520°N, 115.1499°W; WGS 84; 24 May 2012:35.7586°N, 115.1489°W; WGS 84).

The Lucy Gray Mountains are ca. 32 km E of a known record of *Heloderma* in California (UNLV R665, Lovich and Beaman 2007. Bull. So. California Acad. Sci. 106[2]:39–58) and ca. 40 km from a sight record (no vouchers available) from the New York Mountains (Stebbins and Cohen 2012. Field Guide to Amphibians and Reptiles of California, University of California Press, Berkeley, California. 538 pp.). The close proximity of these records to known locations of *Heloderma* in California suggests a dispersal route from the Colorado River area into southeastern California (as suggested by Lovich and Beaman, *op. cit.*), possibly through mountain passes that may serve as corridors between areas of suitable habitat.

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***HEMIDACTYLUS FRENATUS* (Common House Gecko)**. MÉXICO: TABASCO: Municipality of Macuspana: Holcim-Apasco Field Station (17.65156°N, 92.438858°W; WGS84), 40 m elev. 9 June 2014. Pierre Charruau, Rafael A. Lara-Resendiz, and Aníbal H. Díaz de la Vega-Pérez. Verified by F. Méndez-de la Cruz. CNAR-RF 62-64. First municipality record, extending the range ca. 65 airline km SE from Villahermosa, Municipality of Centro, Tabasco (Schmidt-Ballardo and Mendoza-Quijano 1996. Herpetol. Rev. 27:40; Farr 2011. Southwest. Nat. 56: 256–273). The gecko was found on the wall of a cabin in tropical rain forest.

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***HEMIDACTYLUS TURCICUS* (Mediterranean Gecko)**. USA: CALIFORNIA: San Bernardino Co.: Redlands, State Street, between Center Street (34.03429°N, 117.11466ºW; WGS 84) and Eureka Street (34.03397°N, 117.11176°W; WGS 84), and on Brookside Avenue (34.03276°N, 117.11242°W; WGS 84). 18 August 2013. Kent R. Beaman and Michael D. Wilcox. Verified by Clark Mahrdt. Nine individuals representing adults (N = 4) and juveniles (N = 5) were deposited in the herpetological collections at the Natural History Museum of Los Angeles County (LACM 148427–148435). Represents the third record for San Bernardino Co. (Beaman et al. 2005. Herpetol. Rev. 36:79), extending the range of the species ca. 356 km WSW from the nearest vouchered locality at Needles, San Bernardino Co., California (LACM 155124). The species was also observed at several other locations in Redlands.

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***LYGOSOMA ALBOPUNCTATA* (White-spotted Supple Skink)**. BANGLADESH: SYLHET DIVISION: Habiganj District: Satchari National Park (24.143653°N, 91.438686°E, WGS 84; 80 m elev.). 25 April 2014. Adult. Hassan-Al-Razi. Yard of Student Dormitory, Satchari National Park. Verified by Stephen Mahony. Museum of Zoology, Jagannath University, Dhaka, Bangladesh (JnU/ZooM/Rep/2014/0001). First record for Sylhet Division. Nearest confirmed populations from Berakuti (Nilphamari), Singra National Park (Dinajpur), and Rayer Bazar fish market (Dhaka District) (Sarker 2014. Russ. J. Herpetol. 21:1–4). The new record 135 km E from Nilphamari, 130 km E of Dinajpur, and 130 km NE of Dhaka District. Habitat dry, open soil, without plantations, near human-modified habitat.

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***PHRYNOSOMA BRACONNIERI* (Short-tailed Horned Lizard)**. MÉXICO: GUERRERO: Municipality of Olinala: Xixila (17.993334°N, 98.850278°W; WGS84), 1535 m. elev. 15 October 2011. Víctor Hugo Jiménez Arcos, Salomón Sanabria Urban, and Eric Centenero Alcalá. Verified by Luis Canseco Márquez. IBH-RF 53. First record for Guerrero, extending the known range of the species ca. 70 km SW from Tehuitzingo, Puebla (Garcia-Vazquez et al. 2005. Publ. Soc. Herpetol. Mex. 1:152–169). The lizard was found active on the ground in oak forest.

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***PLESTIODON FASCIATUS* (Common Five-lined Skink)**. USA: MISSOURI: Ste. Genevieve Co.: Weingarten, 1.15 km NE of intersection of Miller Switch Road and Highway 32 (37.8656°N, 90.2588°W; WGS84). 3 May 2014. Andrew P. Braun and Andrew T. Bueltmann. Verified by Dustin S. Siegel. University of Missouri-Columbia (UMC 2598P). New county record (Edmond and Daniel 2014 [latest update: 18 February 2014]. Missouri Herpetological Atlas Project. Available at http://atlas.moherp.org/; accessed 4 June 2014). Adult in rocky upland habitat.

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***PLESTIODON FASCIATUS* (Common Five-lined Skink)**. USA: WISCONSIN: Chippewa Co.: City of Chippewa Falls (44.93854°N, 91.3879°W, WGS84; elev. 256 m). 17 May 2014. Tiffany J. Wogahn. Verified by Robert C. Jadin. UTADC 8161. New county record (Christoffel et al. 2002. Turtles and Lizards of Wisconsin. Wisconsin Department of Natural Resources, Bureau of Endangered Resources; 48 pp.) Closest known record is in Eau Claire Co. to the south. In Wisconsin, *P. fasciatus* is a Species of Special Concern and has a scattered distribution. The lizard was found in a residential yard.

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***PLESTIODON INEXPECTATUS* (Southeastern Five-lined Skink)**. USA: GEORGIA: Lamar Co.: Private residence on Grape Creek Road in Milner (33.108610°N, 84.221679°W; WGS 84). 21 April 2014. Olivia Bender and M. J. Bender. Verified by Gregory D. Hartman. Gordon State College (GSC-066). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens, Georgia. 575 pp.; J. Jensen, pers. comm.). Species has been documented in two adjoining counties (Jensen et al. 2008).

Specimen collected under a Georgia Department of Natural Resources Scientific Collections Permit (29-WJH-14-159).

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***PLESTIODON TETRAGRAMMUS BREVILINEATUS* (Short-lined Skink)**. USA: TEXAS: Archer Co.: North–south oriented sandstone outcrop 6 km NNE of the town of Olney (33.431389°N, 98.733889°W, WGS 84; elev. 375 m). 25 March 2013. Matthew R. Fox. Verified by Raymond E. Willis. The University of Texas at Arlington's Amphibian and Reptile Diversity Center (UTADC 8112, photo voucher). New county record (Dixon 2013. Amphibians and Reptiles of Texas with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. 3rd ed., Texas A&M University Press, College Station, Texas. 447 pp.). Extends range north and east from bordering Young, Throckmorton, and Baylor counties. Adult male specimen, SVL 66 mm, weight 6.6 g, was found under a flat rock on the east-facing side of the outcrop.

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***STENOLEPS RIDLEYI* (Pernambuco Teiid)**. BRAZIL: ALAGOAS: Municipality of Murici: Estação Ecológica de Murici, Mata da Bananeira (9.215888°S, 35,878915°W, WGS84; elev. 583 m). 12 December 2013. J. V. Araújo-Neto and others. Coleção Herpetológica do Museu de História Natural, Universidade Federal de Alagoas, Maceió, Brazil (Mufal 11686; collecting license ICMBio 33507-3). Verified by B. S. Lisboa. The species was previously recorded from Brazilian states of Pernambuco and Ceará (Vanzolini 1974. Papéis Avulsos Zoologia 18 [4] 61-90; Borges-Nojosa and Caramaschi 2003. *In* Leal and Tabarelli [eds.], Ecologia e Conservação da Caatinga, pp. 489–540. UFPE, Recife; Rodrigues et al. 2007. Am. Mus. Novit. 3465:1–27). First state record. The new record extends the known geographic distribution about 100 km S from the locality of Serra dos Cavalos, Pernambuco state (Rodrigues 1990. *In* Waranabe [ed.], II Simpósio sobre Ecossistemas da Costa Sul e Sudeste Brasileira, pp. 404–410. Academia de Ciências do Estado de São Paulo, São Paulo), and represents a new southern limit of species distribution.

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***TARENTOLA ANNULARIS* (White-Spotted Wall Gecko)**. USA: CALIFORNIA: San Bernardino Co.: Redlands. Juvenile collected in alley, junction with 5th Street (34.03660°N, 117.10889°W; WGS 84). 3 September 2013. Kent R. Beaman and David M. Goodward. Verified by Clark Mahrdt. Natural History Museum of Los Angeles County (LACM 148426 and LACM-PC 1678). First state record (Stebbins and McGinnis 2012. Field Guide to Amphibians and Reptiles of California. University of California Press, Berkeley, California. 538 pp.). Other individuals of *T. annularis* were observed and photographed in Redlands on 26 October 2013.

Another species of *Tarentola*, the Common Wall Gecko (*T. mauritanica*), is known to be established in California (Mahrdt 1998. Herpetol. Rev. 29:52; Mahrdt and Hollingsworth, *unpubl. data*).

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***VARANUS RASMUSSENI* (Rasmussen's Water Monitor Lizard)**. PHILIPPINES: SULU PROVINCE: JOLO ISLAND: Municipality of Talipao: Mount Bayug (5.974600°N, 121.083983°E; WGS 84). Romulo Quemado. 7 February 2014. Photographic voucher, Raffles Museum of Biodiversity Research, National University of Singapore (ZRC [IMG] 2.221a–f); Bitinan Island, Municipality of Omar (6.056700°N, 121.445650°E; WGS 84). 5 October 2013. Romulo Quemado. Photographic voucher, Raffles Museum of Biodiversity Research, National University of Singapore (ZRC [IMG] 2.222). Verified by Luke J. Welton. First record for Jolo and Bitinan islands, Sulu Archipelago. Member of the *Varanus salvator* complex, described recently from Tawi-Tawi Island, Sulu Archipelago, Philippines (Koch et al. 2010. Zootaxa 2446:1–54).

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SQUAMATA — SNAKES

***ARIZONA ELEGANS ARENICOLA* (Texas Glossy Snake)**. USA: TEXAS: Colorado Co.: Cat Spring Rd., 21 km ENE of Columbus (29.79052°N, 96.34370°W, WGS84; elev. 83 m). 31 May 2014. William L. Farr. Verified by Carl Franklin. University of Texas Arlington Digital Collection (UTADC 8162–8167). First county record, with previous records for two (Austin to the NE and Fayette to the NW) of the five adjacent counties having been documented (Dixon 2013. Amphibians and Reptiles of Texas with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. 3rd ed., Texas A&M University Press, College Station, Texas. 447 pp.).

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***CARPHOPHIS AMOENUS* (Common Wormsnake)**. USA: TENNESSEE: Hickman Co.: 9137 Betty Belle Lane, Bon Aqua (35.9248477°N, 87.2301613°W; WSG 84). 20 April 2014. Nicole Foster and Mary Christensen. Verified by A. Floyd Scott. Austin Peay State University (APSU 19488). Found among leaf litter. New county record (Scottand Redmond 2008 [latest update: 09 January 2014]. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/, accessed 20 April 2014).

NICOLE FOSTER (e-mail: nfoster2@Columbiastate.edu), and **MARY CHRISTENSEN**, Columbia State Community College, Columbia, Tennessee 38401, USA (e-mail: diz1647@yahoo.com).

***CARPHOPHIS VERMIS* (Western Wormsnake)**. USA: ARKANSAS: Ashley Co.: Carter Cemetery, 13 km NE Crossett off AR St. Hwy 52 (33.16966°N, 91.83768°W; WSG84). 21 May 2014. R. Tumlison. Henderson State University (HSU 1730). Verified by S. E. Trauth. First county record and only the second county in a disjunct southeastern Arkansas population (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville, Arkansas. 421 pp.). Range is extended about 50 km S from nearest Arkansas record (Tumlison and Wiley 1980. Herpetol. Rev. 11:14–15). Record also appears to connect disjunct

southeastern Arkansas population with similar records in northeastern Louisiana, from which this record extends the range about 45 km N from Morehouse Parish, Louisiana (Dundee and Rossman 1989. The Amphibians and Reptiles of Louisiana. Louisiana State University Press, Baton Rouge, Louisiana. 300 pp.).

RENN TUMLISON, Department of Biology, Henderson State University, Arkadelphia, Arkansas 71999, USA; e-mail: tumlison@hsu.edu.

***CLONOPHIS KIRTLANDII* (Kirtland's Snake)**. USA: ILLINOIS: De Kalb Co.: 1.5 mi (2.4 km) W Sandwich (41.635637°N, 88.654220°W; WGS 84). 8 October 1961. H. D. Walley. MSUM 14207. Verified by Chris Phillips. New county record (Phillips et al. 1999. Field Guide to Amphibians and Reptiles of Illinois. Illinois Natural History Survey, Urbana, Illinois. 282 pp.). The alcohol specimen was found in the Michigan State University Museum herpetology collection during an examination of material from the upper peninsula of Michigan. This Illinois state-threatened species was most recently documented from McLean Co. (Capparella et al. 2012. Trans. Illinois State Acad. Sci. 105(3–4):101–105), and this record is the northwestern-most in the state to date.

THOMAS G. ANTON, Division of Amphibians and Reptiles, The Field Museum, Roosevelt Road at Lakeshore Drive, Chicago, Illinois 60614, USA (e-mail: TomAnton@comcast.net); **THOMAS F. BEAUVAIS**, P.O. Box 130137, Ann Arbor, Michigan 48113, USA; **GARY CASPER,** The University of Wisconsin-Milwaukee Field Station, P.O. Box 375, Slinger, Wisconsin 53086, USA.

***DIADOPHIS PUNCTATUS* (Ring-necked Snake)**. USA: CALIFORNIA: Kern Co.: Piute Mountains., Cottonwood Creek watershed, approx. 13.7 air mi. W jct. Jawbone Canyon Rd. × State Hwy 14 (35.30383°N, 118.25253°W, WGS 84; elev. 1364 m). 02 June 2010. L. E. Hunt and C. J. Evelyn. Verified by Samuel S. Sweet. University of California-Santa Barbara, Vertebrate Museum collection 32724. Second record for eastern slope of Sierra Nevada (Hansen and Tobler 2010. Herpetol. Rev. 41:379). Nearest record is from Kern Co., Mill Creek, 1.1 mi E State Hwy 178 (CAS 236215), 42 airline km to the NW. Present specimen is an adult female encountered AOR on dirt road at 1645 h in closed-canopy Interior Live Oak woodland.

CHRISTOPHER J. EVELYN, Department of Evolutionary and Marine Biology, University of California, Santa Barbara, California 93106, USA (e-mail: christopher.evelyn@lifesci.ucsb.edu); **LAWRENCE E. HUNT,** Hunt & Associates Biological Consulting Services, 5290 Overpass Road, Suite 108, Santa Barbara, California 93111, USA (e-mail: anniella@verizon.net).

***DIADOPHIS PUNCTATUS REGALIS* (Regal Ringneck Snake)**. MEXICO: SONORA: Municipio de la Colorada: Rancho La Cuesta, Km 94 on Mexico Hwy 16, 24.9 km (by air) W of Tecoripa, 80 km (by air) ESE of Hermosillo (28.6269400°N, 110.20667°W; NAD27), 410 m elev. 6 August 2009. Juan Jaime. Verified by Erik F. Enderson. Photographic voucher can be viewed at <http://www.madrean.org/symbfauna/collections/individual/index.php?occid=198334>. First record for the municipio and central Sonora, extending the range 128 airline km WNW of Yécora, Municipio de Yécora (Rorabaugh et al. 2008. J. Arizona-Nevada Acad. Sci. 40:20–65), and lowers the elevational range in Sonora by 436 m (review of museum records in Madrean Archipelago Assessment database, Madrean.org). The snake was diurnally active in a flat area in the bottom of a bajío (arroyo) surrounded by foothills thornscrub.

THOMAS R. VAN DEVENDER, Sky Island Alliance, P.O. Box 41165, Tucson, Arizona 85717, USA (e-mail: vandevender@skyislandalliance.org); **EDUARDO GÓMEZ-LIMÓN**, Comisión Nacional de Áreas Naturales Protegidas, Av. Aquiles Serdán No. 180, Hermosillo, Sonora, 83000, Mexico (e-mail: edugomezl@gmail.com).

***DRYMARCHON MELANURUS* (Central American Indigo Snake)**. MÉXICO: MICHOACÁN: Municipality of Ziracuaretiro: 2.6 km NW San Andrés Coru (19.272587°N, 101. 572360°W; WGS 84), 1749 m elev. 25 June 2013. Aldo O. Soria- Pérez and Ernesto Raya-García. Verified by Jorge A. Marroquín-Paramo. UAZ 57570-PSV. First record for the municipality and for the Transverse Volcanic Axis region (Alvarado-Diaz et al. 2013. Amphib. Rept. Conserv. 7:128–170), filling a gap in Michoacán between the nearest confirmed northern localities, ca. 125 km NE La Palma and 123 km NE El Sabino, and confirmed southern localities, ca. 103 km SW Apatzingán and 195 km SW Arteaga (Duellman 1961. Univ. Kansas Publ. Mus. Nat. Hist. 15:1–48). The juvenile snake was found in pine-oak forest near an avocado orchard.

ERNESTO RAYA-GARCÍA, Universidad Michoacana de San Nicolás de Hidalgo, Francisco J. Mujica S/N Ciudad Universitaria, C.P. 58030, Morelia, Michoacán, México (e-mail: tuataraya@hotmail.com); **ROBERT A. VILLA**, 811 N. 10th Ave., Tucson, Arizona 85705, USA (e-mail: cascabel1985@gmail.com).

***HYPSIGLENA JANI* (Chiauahuan Nightsnake)**. USA: OKLAHOMA: Love Co.: (34.008025°N, 97.045644°W; WGS84). 5 April 2014. C. Roelke, W. Roelke, E. Wostl, R. Wostl, and M. Fontenot. Verified by Carl Franklin. The University of Texas at Arlington Amphibian and Reptile Diversity Research Center Collection (UTA R 60745). New county record (Distribution of Oklahoma Amphibian and Reptiles by Recorded Sightings [DOKKARS] and the Sam Noble Museum of Natural History Database, Norman, Oklahoma; Both searched on 05/20/2014.).

COREY E. ROELKE (e-mail: croelke@uta.edu), **ELIJAH WOSTL** and **RACHEL WOSTL**, University of Texas at Arlington, Department of Biology, Box 19498, Arlington, Texas 76019, USA; **MALLORY L. FONTENOT** and **WYATT T. ROELKE**, 1315 West Abram Street, Arlington, Texas 76013, USA.

***LAMPROPELTIS NIGRA* (Eastern Black Kingsnake)**. USA: MISSOURI: Scott Co.: General Watkins Conservation Area, 2.34 km NNE Morley (37.064075°N, 89.604495°W; WGS84). 21 May 2011. Brian S. Edmond and Richard E. Daniel. Verified by Katy E. Klymus (confirmed using mtDNA). University of Missouri-Columbia (UMC 2038P color photograph). First documented record for this species in the state of Missouri (Daniel and Edmond 2014. Atlas of Missouri Amphibians and Reptiles for 2013 <http://atlas.moherp.org/pubs/atlas13.pdf> Updated 30 January 2014.) Adult female found among riprap in fishing lake #3 spillway.

Collection on state land authorized by Missouri Department of Conservation Wildlife Collectors Permit 14853.

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***LAMPROPELTIS NIGRA* (Eastern Black Kingsnake)**. USA: TENNESSEE: Williamson Co.: 100 Farrier Lane, Franklin (35.93121°N, 86.876061°W; WSG 84). 12 May 2014. Brittany Cromwell and Nicole Foster. Verified by A. Floyd Scott. Austin Peay State University (APSU 19492). New county record (Scottand Redmond

2008 [latest update: 10 March 2014]. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/, accessed 14 May 2014).

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***LAMPROPELTIS TRIANGULUM* (Milksnake)**. USA: TEXAS: Callahan Co.: Hwy 283 ca. 16 mi. N of Coleman, only a few meters north of the Callahan-Coleman Co. line (32.14°N, 99.42°W; WGS 84). Christian L. Cox. Verified by Toby J. Hibbitts. University of Texas at Arlington Amphibian and Reptile Diversity Research Center Collection (UTA DC 8135). New county record (Dixon 2013. Amphibians and Reptiles of Texas with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. 3rd ed., Texas A&M University Press, College Station, Texas. 447 pp.). Found under a rock on a roadside hill.

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***LEPTODEIRA SEPTENTRIONALIS* (Cat-eyed Snake)**. USA: TEXAS: Kleberg Co.: ~ 120 m NE jct of TX FM 771 and Kleberg Co. Rd. 1100 (27.2978°N, 97.7576°W; WGS 84). 12 January 2014. Tawni Osborne and Charles Strubhart. Verified by Carl J. Franklin. University of Texas Arlington Digital Collection (UTA-DC 8109). New county record (Dixon 2013. Amphibians and Reptiles of Texas with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. 3rd ed., Texas A&M University Press, College Station, Texas. 447 pp.)

This record confirms this species' presence in Kleberg Co. and extends the range northward along the Texas coastal plain ~ 10 km NE of Sarita, in northern Kenedy Co., where other specimens are known (R. L. Powell, pers. comm.). Dixon (2013, *op. cit.*) noted "an isolated museum record for Kleberg County is questionable." The referenced questionable record is MVZ 75963, a fluid-preserved DOR specimen collected by E. Turner "11 miles SW of Sarita via Hwy 77" on 16 April 1963. This location was recorded as Kleberg Co. in error, but is actually further south in Kenedy Co. (E. Turner, pers. comm., March 2014).

GK made an observation (previously undocumented) of this species crossing FM 771 ~ 5 km E of Riviera in Kleberg Co. shortly after Hurricane Celia in August 1970.

GERALD KEOWN (e-mail: keown@lepidus.net) and **GERARD T. SALMON** (e-mail: gerardtsalmon@gmail.com), Southwestern Center for Herpetological Research, PO Box 624, Seguin, Texas 78156, USA.

***MYRIOPHOLIS BOUETI* (Bouet's Worm Snake)**. REPUBLIC OF CAMEROON: NORTHERN PROVINCE: Kismatari (9.32°N 13.49°E, elev. 190 m), below a cotton plantation in a trap. 11 October 2013. Patrick Prudent. Verified by Jean-François Trape. MNHN 2013.1018. New country record. This Sudanian savanna snake species was previously known from Senegal, Mauritania, Gambia, Guinea-Bissau, Mali, and Burkina Faso with an eastern extension into Niger and western Chad (along the northeast Cameroonian border) (Trape and Mané 2006. Guide des serpents d'Afrique occidentale – savane et désert. IRD éditions, Paris. 226 pp.; Wallach et al. 2014. Snakes of the World, A Catalogue of Living and Extinct Species. CRC Press, Taylor & Francis Group, Boca Raton, London, New York. i–xxvii, 1209 pp.). The species has never been reported from Cameroon (Chirio and LeBreton 2007. Atlas des Reptiles du Cameroun. Muséum national d'Histoire naturelle, IRD, Paris [Patrimoines Naturels 67], 688 pp.). This specimen is likely part of the easternmost population of this species like those from Chad, which is separated from the western population by Nigeria from which the species has not been reported.

IVAN INEICH, Muséum national d'Histoire naturelle, ISYEB (Institut Systématique Biodiversité, Évolution) UMR 7205 CNRS/EPHE/MNHN/UPMC, 57 rue Cuvier (CP 30), 75231 Paris cedex, France (ineich@mnhn.fr); **PATRICK PRUDENT**, CIRAD/IRAD, B.P. 1146, Garoua, Cameroun.

***PANTHEROPHIS EMORYI* (Great Plains Ratsnake)**. USA: COLORADO: Moffat Co.: 0.5 km S Ladore Ranger Station, Dinosaur National Monument (40.723168°N, 108.887675°W, WGS 84; elev. 1640 m). 6 June 2014. Timothy Warfel, Ian Jessup, Ryan Urbanek, Joshua Warfel, and Keian Velasquez. Verified by Lauren Livo. UCM Ancillary Collection (178-1 and 178-2, photo vouchers). New county record (Hammerson 1999. Amphibians and Reptiles in Colorado, 2nd ed. University Press of Colorado & Colorado Division of Wildlife, Niwot, Colorado. 484 pp.). An adult male *Pantherophis emoryi* was observed constricting a small rodent at the base of a rabbitbrush (*Chrysothamnus* sp.) next to the Green River. This record extends the known range of this species approximately 25 km NE in the Green River drainage from a record in Uintah Co., Utah (Bury 1983. Herpetol. Rev. 14[4]:123).

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***PITUOPHIS MELANOLEUCUS MELANOLEUCUS* (Northern Pinesnake)**. USA: TENNESSEE: Carroll Co.: Boyd's Landing Road at gate to Carroll County Recreation Lake (36.9354°N, 88.4612°W; NAD 84). 8 May 2014. John Maxwell, Jr. Verified by Chris Gienger. David H. Snyder Museum of Zoology, Austin Peay State University (APSU 19493). Adult male (total length ca. 153 cm) found DOR in mix of standing hardwoods. New county record (Scottand Redmond 2008 [latest update: 19 May 2014]. Atlas of Reptiles in Tennessee. The Center of Excellence for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/,accessed 28 May 2014).

Voucher specimen collected under Tennessee Wildlife Resources Agency Scientific Collection Permit # 3690.

JOHN MAXWELL, JR., Bethel University, 325 Cherry Avenue, McKenzie, Tennessee 38201, USA (e-mail: jmaxwell07@bethelu.edu); **A. FLOYD SCOTT**, Department of Biology and Center of Excellence for Field Biology, Austin Peay State University, Clarksville, Tennessee, USA (e-mail: scotta@apsu.edu).

***REGINA ALLENI* (Striped Crayfish Snake)**. USA: FLORIDA: Baker Co.: Olustee, National Forest Rd 241(30.243512°N, 82.457107°W, WGS84; elev. 47 m). 6 June 2014. Noah J. Mueller and Shaun M. Duke. Verified by Kevin M. Enge. Florida Museum of Natural History (photographic voucher UF-Herpetology 173429). New county record (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final Report, Project Agreement 08013, Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida. 524 pp.).

This snake was observed crossing a gravel road at dusk near Ocean Pond in Osceola National Forest. Our record represents the first from Baker Co. The next nearest known verified voucher from Florida is > 50 km in Alachua Co. (UF-Herpetology 1308). Although *Regina alleni* has been found in southern Georgia

(Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens, Georgia. 575 pp.), this find helps establish the range of *R. alleni* in north peninsular Florida.

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***SIBON ANTHRACOPS* (Cope's Snail Sucker)**. COSTA RICA: PUNTARENAS: Cabo Blanco Absolute Reserve, Sector Cabuya: (9.581778°N, 85.095186°W; WGS84). 3 m elev. 10 November 2013. Víctor Acosta, Carlos Garita, Karla Conejo, José Ramírez, Beatriz Naranjo, and Andrés Jiménez. Verified by Gerardo Chaves, Adrián García and Alejandro Solórzano. UCR 22020. First record outside the projected range of the species on the southern Nicoya Peninsula (Solórzano 2004. Serpientes de Costa Rica: Distribución, Taxonomía e Historia Natural. INBio, Santo Domingo de Heredia, Costa Rica. 792 pp.). The snake was foraging in low tropical dry forest vegetation, ca. 1.5 m above the ground next to the designated trail, Sendero Danés.

The voucher was collected under resolution No. 007-2013-SINAC.

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***SISTRURUS CATENATUS* (Eastern Massasauga)**. USA: MICHIGAN: Benzie Co.: east edge of Deadstream Swamp on Indian Hill Road, 0.6 km N of US 31 west of Honor, Homestead Twp (T26N R14W, Sec 8; 44.670719°N, 86.038778°W, WGS84; elev. 181 m). 24 April 1976. Thomas F. Beauvais. Verified by Chris Phillips. Illinois Natural History Survey digital photo voucher 2012i. Photo sourced from Traverse City Record Eagle 24 April 1976. New county record (Casper and Anton 2008. An Amphibian and Reptile Inventory of Sleeping Bear Dunes National Lakeshore. Natural Resource Technical Report NPS/GLKN/NRTR–2008/147. 47 pp.; Holman 2012. The Amphibians and Reptiles of Michigan. Wayne State University Press, Detroit, Michigan. 291 pp.) Extends range 56 km N from closest voucher specimen (UMMZ 1474105, Manistee Co.). Photo location is 8.04 km W of locality where an un-numbered teaching specimen (INHS color photo voucher 2012j) was collected and deposited at Benzie Central High School.

THOMAS F. BEAUVAIS, PO Box 130137, Ann Arbor, Michigan 48113, USA; e-mail: catenatus@fastmail.fm.

***TANTILLA PLANICEPS* (Western Black-headed Snake)**. USA: CALIFORNIA: San Luis Obispo Co.: Caliente Mtns., Morales Canyon watershed, approx. 11.6 air mi. SSE Soda Lake (35.08189°N, 119.80571°W, WGS84; elev. 1305 m). 24 April 2011. C. J. Evelyn and L. C. Henry. Verified by Samuel S. Sweet. University of California-Santa Barbara, Vertebrate Museum collection 32732. New county record (museum records [UCSB, Cal Poly SLO, Herpnet.org]. Range maps (Californiaherps.com) drawn to include San Luis Obispo Co. are not based on museum or sight records (G. Nafis, pers. comm.). Nearest record is from Santa Barbara Co., Miranda Pine Mountain Road, 2.5 mi NW of Miranda Pine Mtn. (CAS 190348), 14 airline km to the E/SE. Adult female encountered under a juniper stump in open juniper woodland. Another individual was also seen at the surface but avoided capture.

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***TROPIDODIPSAS FASCIATA* (Banded Snail-sucker)**. GUATEMALA: EL PETÉN: Laguna del Tigre National Park, Estación Biológica Las Guacamayas, Río Sacluc (17.233557°N, 90.283492°W; WGS84), 54 m elev. 30 May 2013. Rowland Griffin. Verified by Eric N. Smith. UVGF 0001. This represents the first record of *T. fasciata* in Guatemala (Wilson and Johnson 2010. *In* Wilson et al. [eds.], Conservation of Mesoamerican Amphibians and Reptiles, pp. 31–235, Eagle Mt. Publishing, Eagle Mt., Utah), and a range extension of ca. 170 km from 1.2 km E Ixbonil, Campeche Mexico (Lee 1996. The Amphibians and Reptiles of the Yucatán Peninsula. Comstock Publ. Assoc., Ithaca, New York. xii + 500 pp.; AMNH R-149561). The male snake was found in a swampy area interspersed by thorn scrub on the eastern bank of the Sacluc River. Our research was conducted under license from CONAP Resolución No.109-2013.

ROWLAND GRIFFIN, Project Chicchan, c/o Estación Biológica Las Guacamayas, Avenida 15 de Marzo, Flores, Petén, Guatemala (e-mail: rowland@project-chicchan.co.uk); **GARY POWELL**, Amphibian and Reptile Conservation Trust, 655A Christchurch Road, Boscombe, Bournemouth, Dorset, BH1 4AP, UK (e-mail: gary.powell@arc-trust.org).

***VIRGINIA VALERIAE* (Smooth Earthsnake)**. USA: GEORGIA: Coweta Co.: Private residence on Bartlett Drive in Sharpsburg (33.397476°N, 84.666830°W; WGS 84). 19 March 2013. Nathan Baker. Verified by Gregory D. Hartman. Gordon State College (GSC-064). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens, Georgia. 575 pp.; J. Jensen, pers. comm.). Species has been documented in four adjoining counties (Jensen et al. 2008, *op. cit.*). Found in leaf litter in residential area.

Specimen collected under a Georgia Department of Natural Resources Scientific Collections Permit (29-WBH-12-122).

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ERRATA

Various county records reported by Duffus et al. (2014. Herpetol. Rev. 45: 88, 92, 94, 97) for *Apalone spinifera*, *Diadophis punctatus*, *Hemidactylus turcicus*, *Lithobates sphenocephalus*, and *Storeria dekayi*, and by Bender et al. (2014. Herpetol. Rev. 45: 86, 93) for *Agkistrodon contortrix*, *Notophthalmus viridescens*, and *Scincella lateralis* in Georgia were not new records but instead represent additional records from the reported counties. Records of *Graptemys geographica* and *Pseudemys concinna floridana* were reported erroneously in Duffus et al. (2014. Herpetol. Rev. 45:90) and do not represent county records or range extensions for either species.

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Noteworthy Distributional Records for the Herpetofauna of Oaxaca, México

Even though there have been several recent accounts on the geographic distribution of the Oaxacan herpetofauna (e.g., Casas-Andreu et al. 1996, 2004; Kohler 2008, 2011 [in part]; Canseco-Márquez and Gutiérrez-Mayén 2010 [in part]; Johnson et. al. 2010 [in part]; Wilson and Johnson 2010 [in part]), presumably many range gaps remain within the state. From 2011 through 2014, we began actively searching for amphibians and reptiles in Oaxaca to fill in those lapses, primarily in the central and southcentral portions of the state. Herein, we report new municipality records for four frogs, three lizards, and five snakes. All specimens were photographed *in situ* and released. Photographic vouchers were deposited in The University of Texas at El Paso Biodiversity Collections (UTEP) and Laboratorio de Herpetología, Facultad de Estudios Superiores, Universidad Nacional Autónoma de México (UNAM FES MCBFES). Taxonomy follows Wilson et al. (2013a, b) and Ruane et al. (2014) and common names are those listed in Liner and Casas-Andreu (2008). Map datum for coordinates was WGS84.

ANURA — FROGS

***CRAUGASTOR PYGMAEUS* (Pigmy Robber Frog).** Municipality of Santa Catarina Juquila: San Marcos Zacatepec (16.145209°N, 97.356447°W), 800 m elev. 21 June 2014. Eduardo Mata-Silva and Isabel Cortez-Cristobal. Verified by Luis Canseco-Márquez. UTEP G-2014.11. This record closes a gap in Oaxaca of ca. 106 km between 11.2 km S of Putla Villa de Guerrero (UTEP 7767–7769; www.herpnet.org, accessed 29 July 2014), in the Municipality of Putla Villa de Guerrero, and 16 km S of San Pedro Juchatengo, Municipality of San Juan Lachao (KU-H 86882, 86883; www.herpnet.org, accessed 29 July 2014). The specimen was found calling in a coffee plantation within remnants of cloud forest.

***DENDROPSOPHUS SARTORI* (Taylor's Yellow Treefrog).** Municipality of San Sebastián Ixcapa: San José Camotinchán (16.554222°N, 98.129144°W), 187 m elev. 20 June 2014. Vicente Mata Silva. Verified by Larry D. Wilson. UTEP G-2014.8. This record closes about a 13 km gap between 20 km ESE of Ometepec, Guerrero, and 9.3 km W of Puerto Escondido, Municipality of San Pedro Mixtepec, Oaxaca (Duellman 2001). The male was found calling in vegetation at the edge of a pond.

***ELEUTHERODACTYLUS NITIDUS* (Shiny Peeping Frog).** Municipality of Santa Catarina Lachatao: Santa Catarina Lachatao (17.264167°N, 96.486944°W), 2100 m elev. 25 August 2013. Haydée Morales Flores and Elí García-Padilla. Verified by Luis Canseco-Márquez. UTEP G-2013.3. This site is ca. 27 km NE from the nearest reported locality, 2 km S of San Mateo Huayapan, Municipality of Tlalixtac de Cabrera (IBUNAM-CNAR-AR 1858; www.herpnet.org, accessed 9 October 2013). However, we were unable to locate any town named San Mateo Huaypan; therefore the distance was an estimate. The specimen was found under a rock in pine-oak forest.

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***LITHOBATES SPECTABILIS* (Showy Leopard Frog).** Municipality of San Pedro Totolapan: Rancho El Jabalín (16.743056°N, 96.313333°W), 1674 m elev. 26 June 2011. Elí García-Padilla. Verified by Luis Canseco-Márquez. UTEP G-2013.4. The location is ca. 35 km E from the closest reported record near Praxedis de Guerrero, Municipality of Ocotlán de Morelos (IBUNAM-CNAR-AR 9048; www.herpnet.org, accessed 9 October 2013). The specimen was found in a pond surrounded by oak forest.

SQUAMATA — LIZARDS

***MARISORA BRACHYPODA* (Central American Mabuya).** Municipality of San Pedro Totolapan: Rancho El Jabalín (16.742778°N, 96.313611°W), 1670 m elev. 26 June 2011. Elí García-Padilla. Verified by Aurelio Ramírez-Bautista. UTEP G-2013.5. The locality is ca. 41 km N of the nearest reported locality at San José Lachiguiri, Municipality of San José Lachiguiri (UCM-Herps-41138; www.herpnet.org, accessed 9 October 2013). The lizard was found active on the ground in oak forest.

***MESASPIS JUAREZI* (Sierra de Juárez Alligator Lizard).** Municipality of Santa Catarina Ixtepeji: La Cumbre Ixtepeji (17.193333°N, 96.639722°W), 2910 m elev. 9 June 2012. Haydée Morales Flores and Elí García-Padilla. Verified by Luis Canseco-Márquez. UTEP G-2013.6. The locality is ca. 31 km SSW from the nearest record, ca. 16.1 km SE Llano de las Flores, presumably in the Municipality of Calpulalpam de Méndez (no coordinates are given) (Karges and Wright 1987). The specimen was found under a rock in pine forest.

***XENOSAURUS PHALAROANTHEREON* (Chin-spotted Knob-scaled Lizard).** Municipality of San Pedro Totolapan: Rancho El Jabalín (16.742889°N 96.313653°W), 1670 m elev. 26 June 2011. Elí García-Padilla. Verified by Luis-Canseco-Márquez. UTEP G-2013.8. This record is located ca. 66 km NNW from the nearest reported locality, ca. 4 km NE of San Juan Acaltepec, Municipality of Santa María Ecatepec (Nieto-Montes de Oca et al. 2001). This species had been previously reported only in floristic-faunistic area 7 (Sierra Madre del Sur) of Oaxaca (Casas-Andreu, *et al.* 2004); the specimen reported here is from area 4 (Valles Centrales). The specimen was observed in oak forest.

SQUAMATA — SNAKES

***LAMPROPELTIS ABNORMA* (Guatemalan Milksnake).** Municipality of San Bartolo Coyotepec: Reyes Mantecón, Paraje Ojo de Agua (16.903789°N, 96.711072°W), 1586 m elev. 6 June 2014. Elí García-Padilla and Haydée Morales-Flores. Verified by Larry D. Wilson. UTEP G-2014.9. The record is ca. 30 km WSW from the closest previously reported locality ca. 3.2 km (2 mi.) NE of Tlacolula, in the municipality of the same name (MSB-Herps-22795; www.herpnet.org, accessed 22 July 2014). The snake was found dead on a dirt road along an arroyo surrounded by secondary growth of tropical deciduous forest.

***OPHRYACUS UNDULATUS* (Mexican Horned Pitviper).** Municipality of Santa Catarina Lachatao: Santa Catarina Lachatao (17.265939°N, 96.491211°W), 1919 m elev. 21 July 2012. Haydée Morales-Flores and Elí García-Padilla. Verified by Luis Canseco-Márquez. UNAM FES MCBFESI- 279. The record is ca. 27 km NW from the closest previously reported locality on Cerro San Felipe, near Oaxaca City (Lynch and Smith 1966). The snake was found alive on a dirt road along a river, in an ecotone between tropical deciduous forest and pine-oak forest.

***PORTHIDIUM DUNNI* (Dunn's Hog-nosed Pitviper).** Municipality of Santa María Huatulco: on road to Playa San Agustín (15.683611°N, 96.265556°W), 128 m elev. 22 December 2012. Haydée Morales-Flores and Elí García-Padilla. Verified by Luis Canseco-Márquez. UTEP G-2013.8. This record fills a distributional gap in Oaxaca between ca. 24 km W of the vicinity of Puerto Angel (USNM-VZAR-30267) and ca. 100 km NNE of a location 83 km (52 mi.) W of Tehuantepec on Mexico Hwy 190 (UCM-Herps-19051; www.herpnet.org, accessed 9 October 2013). The specimen was found dead on a dirt road surrounded by tropical deciduous forest.

***STENORRHINA FREMINVILLII* (Freminville's Scorpion-eating Snake).** Municipality of Oaxaca de Juárez: Agencia de San Luis Beltrán (17.094722°N, 96.689167°W), 1627 m elev. 27 June 2013. Haydée Morales-Flores and Elí García-Padilla. Verified by Aurelio Ramírez-Bautista. UTEP G-2013.9. This record is from ca. 62 km NW from the closest reported locality in San Pedro Totolapan (Smith and Taylor 1945). Municipality of San Lorenzo de Albarradas: Hierve El Agua (16.864285°N, 96.276261°W), 1681 m elev. 18 December 2013. Eduardo Mata-Silva, and Isabel Cortez-Cristobal. Verified by Jerry D. Johnson. UTEP G-2014.11. This record is from ca. 22 km N of the San Pedro Totolapan record; the snake was found in thorn wood land.

***THAMNOPHIS LINERI* (Liner's Gartersnake).** Municipality of Santa Catarina Ixtepeji: Las Cabañas (17.193472°N, 96.639842°W), 2908 m elev. 9 June 2012. Haydée Morales-Flores and Elí García-Padilla. Verified by Douglas A. Rossman. UTEP G-2013.10. This record is from ca. 31 km SSW from the type locality in Llano de las Flores, Municipality of San Juan Atepec (Rossman and Burbrink 2005).

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NATURAL HISTORY NOTES

GYMNOPHIONA — CAECILIANS

***GYMNOPIS MULTIPLICATA* (Varagua Caecilian). BIRTH.** *Gymnopis multiplicata* is a viviparous caecilian that provides post-birth maternal attendance to newborns (McCranie and Wake 2010. Herpetol. Rev. 41:483), which number 2–10 per clutch (Wake 1988. Cat. Amer. Amphib. Rept. 411.1–411.2). At 1715 h on 07 April 2012, we collected an adult female *G. multiplicata* (MVZ 269228, SVL = 328 mm, 115 primary annuli, 92 secondary annuli) and two neonate *G. multiplicata* (MVZ 269229, SVL = 107 mm, 120 primary annuli, 102 secondary annuli; MVZ 269230, SVL = 109 mm, 117 primary annuli, 98 secondary annuli) under a small wooden plank in the backyard of Hotel Río Indio Lodge, Departamento Río San Juan, Nicaragua (10.9303°N, 83.7272°W, datum WGS 84; elev. 20 m). Upon turning the plank with a rake we observed the adult female lying alongside one of the neonates and in the process of giving birth to a second neonate, which was approximately halfway out. Immediately after being exposed, the adult female tried to escape by quickly crawling away and was collected and deposited in a plastic bag. The birth of the second newborn was completed within three to five minutes, and we kept all three specimens together in a plastic bag partially filled with soil for approximately sixteen hours before preservation. No additional young were born. While examining the preserved specimens in the lab, M. H. Wake noticed that the adult female had one more intraoviductal fetus of approximately the same size as the other two newborns. The first two hatchlings came from the female's right oviduct, which was fully evacuated, and the remaining fetus was in the left oviduct. Assuming that these three fetuses constituted the whole clutch, it appears that the adult female *G. multiplicata* emptied one oviduct entirely before the other. Although the Río San Juan is one of the rainiest places in Central America and is included within Lowland Wet Forest formation, this field observation was made during the driest period of the year. This observation occurred on a day with overcast skies, but no rain, and the soil under the plank was relatively dry. No obvious food items were present.

PHOTOGRAPH BY T. W. PIERSON



FIG. 1. Adult female *Gymnopis multiplicata* with two neonates.

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CAUDATA — SALAMANDERS

***ANEIDES AENEUS* (Green Salamander). DEATH FEIGNING/IMMOBILITY.** The evolution of anti-predatory behaviors is an important component of the natural history of plethodontid salamanders. At 1325 h on 15 April 2013 in Powell Co., Kentucky, USA (37.816944°N, 83.680496°W, datum WGS84; elev. 381 m), we observed an adult *Aneides aeneus* (SVL = 5.5 cm) display immobility shortly after capture in a behavior we interpret as death feigning. The animal was gently coaxed from a cliff crevice using a small twig and quickly captured upon egress. Once in hand, within 15 seconds of capture, the animal flipped onto its back and lay limp for over three minutes. After about one minute, the animal gaped its mouth and assumed a more rigid posture. Once returned to the cliff, the animal quickly retreated into a fissure.

Anti-predatory behaviors such as immobility in response to physical contact and flipping onto the back have been reported for hatchling *Aneides* (Brodie et al. 1974. Herpetologica 30:79–85), but to our knowledge this is the first reported instance of death feigning or immobility upon contact in an adult *Aneides*. This genus is highly adapted to an arboreal existence and a primary mode of defense against predators is to wedge the body tightly into cracks and crevices (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Inst. Press, Washington, D.C. 587 pp.). Our observations suggest that death feigning may offer a second line of defense to *Aneides* if animals are extracted from their hiding places by a predator. The behavior we observed resembles Unken reflex but it differs in the strict sense because the ventral surface of *Aneides* is not brightly colored.

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***CRYPTOBRANCHUS ALLEGANIENSIS* (Hellbender). PREDATION.** Predation on all life stages of *Cryptobranchus alleganiensis* by *Lontra canadensis* (River Otter) has been assumed, but evidence of predation has not been published (Briggler et al. 2007. Hellbender Population and Habitat Viability Assessment. IUCN/SSC Conservation Breeding Specialist Group, Apple Valley, Minnesota. 46 pp.). *Lontra canadensis* was presumably common in many *C. alleganiensis* localities, but was largely extirpated in many sites by the early 1900s due to the fur trade. River Otters have been reestablished through reintroduction efforts in many parts of the eastern USA. The effects of reintroductions on *C. alleganiensis* has been of concern due to potential for predation, disease introductions, and food competition (Nickerson et al. 2011. PLoS ONE 6:e28906). On 23 October 2013, one of us (RV) was traveling westbound on State Rt. 73 along the East Prong of Little River in the Tennessee portion of Great Smoky Mountains National Park (precise locality withheld due to conservation concerns). At 1230 h, RV pulled over to observe three *L. canadensis* in the river and photographed the predation of an adult *C. alleganiensis* by an adult *L. canadensis* for approximately four minutes. The *L. canadensis* was originally near the north river bank with the tail of the *C. alleganiensis* in its mouth. The *L. canadensis* carried the *C. alleganiensis* to the middle of the river and climbed on to a large rock where it began to consume it beginning at the tail. The *L. canadensis* went back into the water and climbed onto a second rock further upstream, where it continued feeding on the *C. alleganiensis* (Fig. 1). It stayed there briefly before reentering the river, with the *C. alleganiensis* still in its mouth, and continued upstream until no longer in view. At that time the back portion of the *C. alleganiensis*, including the entire tail, rear legs, and part of the rear body cavity, was mostly consumed. The two other *L. canadensis* were further upstream during the observation. Due to the appearance of the body and skin of the *C. alleganiensis* and changes in the position of the *C. alleganiensis* in photographs, it seems likely that it was alive during the predation event.

We thank Erik Cooper, Tiffany Beachy, and Dana Soehn for providing information about this event.

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FIG. 1. Adult *Lontra canadensis* (River Otter) feeding on an adult *Cryptobranchus alleganiensis* (Hellbender) in Little River, Tennessee.

***CRYPTOBRANCHUS ALLEGANIENSIS ALLEGANIENSIS* (Eastern Hellbender). INTRASPECIFIC AGGRESSIVE BEHAVIOR.** Males of *Cryptobranchus alleganiensis* are known for their aggressive behaviors during the breeding season, especially defending nesting sites (Bishop 1941. The Salamanders of New York. New York State Museum Bulletin. No. 324. Albany, New York. 365 pp.; Nickerson and Mays 1973. The Hellbenders: North American Giant Salamanders. Milwaukee Public Museum, Milwaukee, Wisconsin. 106 pp.; Smith 1907. Biol. Bull. 13:5–39). Such male-to-male intraspecific aggression sometimes inflicts considerable injury to an opponent; resulting in scrapes, gashes, fresh wounds to the limbs, head, flank or tail, and most injuries are likely associated with the breeding season (Hiler et al. 2005. J. Arkansas Acad. Sci. 59:88–94; Miller and Miller 2005. Southeast. Nat. 4:513–520; Pfingston 1990. Herpetol. Rev. 21:48–51). Herein we report two observations of aggressive behavior during the breeding season in male hellbenders, and one of these observations resulted in mortality of a conspecific. To our knowledge, this is the first reported observation resulting in mortality.

While conducting surveys for hellbender nests at 1115 h on 02 October 2008 on the Big Piney River, Missouri, USA (specific locality withheld due to conservation concerns), we encountered a large amount of hellbender slime scattered on the river bottom within an approximately 3 x 3 m area. A hellbender was seen lying within this area on the river bottom with its head poked into a hole under a large rock (mean rock length and width 130 and 210 cm, respectively). Upon grabbing and removing the hellbender from the hole, we observed that another hellbender had its mouth engulfed over the nostrils and half of the head. The hellbender within the hole immediately released the other hellbender and retreated slightly backward within the hole of the large rock. The hellbender that was captured was covered with large amounts of whitish skin secretions, was only slightly active, and was immediately placed in a container with water for short-term observation. The hellbender was an adult male (SVL = 34.0 cm; total length = 46.0 cm; mass = 610 g) and died within 15 minutes of capture. We were unable to remove the adult that was under the rock, but it appeared to be larger in size (i.e., larger head) and was likely a male based upon its behavior of defending the entrance tunnel of a potential nesting site. Based upon copious amounts of whitish skin secretions on the river bottom, it appears that aggressive fighting had occurred in the general area of the rock, but what happened and the length of the fighting is unknown. The animal that died had two snout wounds resembling bite-marks and fresh lacerations on the front and back left limbs indicative of bite marks by another hellbender. Necropsy was performed on the dead body and nothing else unusual was found.

At 0900 h on 24 September 2013, another similar encounter occurred between two adult male hellbenders on the Gasconade River, Missouri, USA (specific locality withheld due to conservation concerns). We observed a hellbender (SVL = 31.2 cm; total length = 47.3 cm; mass = 515 g) with its tail and partial body lying parallel to a rock (mean rock length and width of 86 and 66 cm respectively) and its head under the rock. When the hellbender was grabbed and pulled from the rock, another hellbender (SVL = 29.6 cm; total length = 46.1 cm; mass = 535 g) was immediately removed with its jaws clasped over the upper jaw and head of the visible hellbender. The hellbender released the other and both were alive and in good body condition. Upon inspection of the body, both hellbenders had characteristic snout wounds resembling bite-marks on the head.

Although eggs were not observed during either of these encounters, fierce fighting among male hellbenders during competition for good nesting sites is known to occur (Alexander 1927. Buffalo Soc. Nat. Sci. 7:13–18; Nickerson and Mays 1973, *op. cit.*; Peterson 1988. Herpetol. Rev. 19:28–29). In both of these incidences we report, the males within the holes of these rocks were likely defending nesting sites. The only other documentation with similar aggression was reported in Nickerson and Mays (1973, *op. cit.*) where an incident of strife occurred on the open river bottom between two adult Ozark Hellbenders (*C. a. bishopi*), but no mention of death was reported. Such intraspecific male-to-male aggression, especially during the breeding season, may be somewhat common in *C. a. alleganiensis*, but those resulting in death are likely a rare occurrence.

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***CRYPTOBRANCHUS ALLEGANIENSIS BISHOPI* (Ozark Hellbender). DIET.** The diet of *Cryptobranchus alleganiensis* consists predominantly of crayfish; small fishes (e.g., catostomids, cyprinids, and cottids) are the most common vertebrates in their diet (Nickerson and Mays 1973. The Hellbenders: North American Giant Salamanders. Milwaukee Public Museum, Milwaukee, Wisconsin. 106 pp.). A variety of other foods have also been reported: invertebrates include earthworms, aquatic insect larvae, insects, and snails; while vertebrate prey includes fish eggs, lampreys, hellbender eggs and conspecifics, tadpoles, toads, snakes and small mammals (Groves and Williams 2013. Herpetol. Rev. 44:651–652; Hulse et al. 2001. Amphibians and Reptiles of Pennsylvania and the Northeast. Cornell University Press, Ithaca, New York. 419 pp.; Nickerson and Mays 1973, *op. cit.*; Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, D.C. 587 pp.; Smith 1907. Biol. Bull. 13:5–39). Hulse et al. (2001, *op. cit.*) reported *Cryptobranchus a. alleganiensis* (Eastern Hellbender) occasionally eats *Necturus maculosus maculosus* (Common Mudpuppy). *Necturus m. louisianensis* (Red River Mudpuppy) occurs syntopically with the regionally endemic *Cryptobranchus a. bishopi* (Ozark Hellbender) in rivers of the southern Ozark Plateau of Arkansas and Missouri, and mudpuppies are frequently encountered during hellbender monitoring work. We report here the first recorded instance of an Ozark Hellbender feeding on the Red River Mudpuppy.

While checking a series of artificial nest boxes for the presence of egg clutches on 23 October 2012 in the Eleven Point River, Randolph Co., Arkansas, USA (precise locality data withheld due to federal endangered species status of the Ozark Hellbender), four adult male Ozark Hellbenders were collected within adjacent habitat. All four of these individuals had been previously captured and PIT tagged as part of an ongoing long-term population monitoring project (KJI). One of these males (SVL = 29.5 cm; total length = 45.7 cm; mass = 497 g) was initially captured in 2007, and while temporarily housed in a plastic storage tub it regurgitated an adult *N. m. louisianensis* (ASUMZ 33029; SVL = 18.0 cm; total length = 25.0 cm; mass = 83 g; Fig. 1). The mass of the *Necturus* represents 16.7% of the body weight of the *Cryptobranchus*. The *Necturus* exhibits significant tissue damage along the midline of the dorsum, with some separation of the musculature along the axial plane of the vertebral column, in what appears to be two distinct bite marks. The venter lacks any discernable tissue damage. The orientation of the bite marks suggests that the *Cryptobranchus* approached and grabbed the *Necturus* from the lateral aspect. In over a decade of field work, and many hundreds of *Cryptobranchus* captures, this is the first instance that we have observed predation of *Necturus* by *Cryptobranchus*.



FIG. 1. Adult *Necturus maculosus louisianensis* (on right) regurgitated by an adult male *Cryptobranchus alleganiensis bishopi* (on left), Eleven Point River, Randolph Co., Arkansas, USA.

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***DESMOGNATHUS FOLKERTSI* (Dwarf Black-bellied Salamander). PREDATION.** *Desmognathus folkertsi* is a recently described species (Camp et al. 2002. Herpetologica 58:471484), and predators have not been previously documented. On 01 July 2010 at approximately 1030 h we discovered a subadult *D. folkertsi* as it was being eaten by a juvenile *Nerodia sipedon* (Northern Watersnake). The location was a small, 1st order stream in Habersham Co., Georgia, USA (34.66840°N, 83.36798°W; datum WGS 84). The watersnake had seized the center of the body of the salamander, which writhed and bit, including biting its own leg (Fig. 1). The salamander was re-growing a previously lost tail, possibly indicating that it had survived an earlier predatory attack. Tail autotomy is an anti-predatory behavior characteristic of many salamanders including *Desmognathus* (Labanick 1984. Herpetologica 40:110–118). Although this is a first record of predation



FIG. 1. *Nerodia sipedon* feeding on a juvenile *Desmognathus folkertsi*.

upon *D. folkertsi*, several species of the genus *Nerodia* including *N. sipedon* are known to eat desmognathine salamanders (Gibbons and Dorcas 2004. North American Watersnakes: A Natural History. University of Oklahoma Press, Norman. 438 pp.).

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***EURYCEA CIRRIGERA* (Southern Two-lined Salamander). PAEDOMORPHOSIS.** On 19 January 2014, we discovered what appeared to be a large (SVL = 38 mm; total length = 75 mm), but typically marked, *E. cirrigera* larva in a small, impounded stream in Athens, Clarke Co., Georgia, USA (33.8909°N, 83.3624°W; datum: WGS84). However, the larva was visibly gravid; developing ova could be seen through her transparent ventral skin. The salamander was euthanized and dissected and found to have 27 distinct ova in her right oviduct and 24 ova in her left oviduct. This falls within the typical clutch size of the species (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, DC. 587 pp.). Tissues from the female and her eggs were preserved in 95% EtOH, and deposited as GMNH 50696. To the best of our knowledge, the only other report of neoteny in *E. cirrigera* was from Mount (1975. The Amphibians and Reptiles of Alabama. University of Alabama Press. 268 pp.), who described it as "not uncommon" in Alabama. Rose and Bush (1963. Tulane Stud. Zool. 10:121–128) describe several male and female *E. aquatica* with well-developed testes and ova, but report that all had typical adult coloration and classify their status as representative of "precocious reproductive development and not true neoteny". No other published accounts of neoteny in the *Eurycea bislineata* complex exist. We revisited the site of collection and nearby streams on 26 January 2014 and collected 53 *E. cirrigera* larvae, but all were smaller than the gravid female and none had visible developing ova. Metamorphosed adult female *E. cirrigera* were gravid during this time. Additionally, we examined 74 *E. cirrigera* larvae of at least 30 mm SVL in the GMNH collection, and none of them appeared to be gravid females.

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***EURYCEA TYNERENSIS* (Oklahoma Salamander). TERRESTRIAL OVIPOSITION.** *Eurycea tynerensis* is a plethodontid that inhabits streams of the Ozark Plateau in Oklahoma, Arkansas, and Missouri, USA. This is one of a few species of plethodontids that exhibit alternative life histories, including paedomorphosis and metamorphosis among populations, with some populations displaying both life histories (Bonett and Chippindale 2004. Mol. Eco. 13:1189–1203). Very little is known about the reproductive biology of paedomorphic *E. tynerensis*, and to date, paedomorphic *E. tynerensis* egg clutches have only been observed once in the wild (Trauth et al. 1990. Proc. Arkansas Acad. Sci. 44:107–113). Lack of observations is likely due to their aquatic lifestyle and affiliation with subterranean strata. Therefore, captive specimens may offer the best opportunity to document novel reproductive behaviors. Here we report multiple instances in captivity of a paedomorphic *E. tynerensis* depositing eggs above the waterline.

Our first observation took place in 2012, however no data was recorded. On 24 September 2013, another captive paedomorphic female *E. tynerensis* deposited four eggs on the inside edge of a large cattle tank above the water line. The female believed to have laid these eggs deposited a total of 15 eggs (on both terrestrial and aquatic surfaces), but oviposition was never witnessed. The presumed mother was also observed above the water line. On 12–13 October 2013, terrestrial oviposition by multiple female *E. tynerensis* from the same locality was observed, with a total of 30 eggs being deposited above the waterline and 31 deposited within water. Distance of the eggs from the waterline ranged from 2–16 cm (mean = 6.78 cm). The same captive facility houses seven additional populations of paedomorphic *E. tynerensis* (raised in a similar manner), none of which have exhibited terrestrial oviposition, even though over 20 clutches of eggs have been deposited.

Most *Eurycea* are known to deposit eggs in clutches on the undersides of submerged rocks or other debris in streams (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, DC. 587 pp.). Terrestrial oviposition in *E. tynerensis* appears to be a grave event and eggs that are not transferred into water quickly became desiccated. However, given that this behavior was observed multiple times from at least three individuals, terrestrial oviposition may

PHOTOGRAPH BY T. W. PIERSON



FIG. 1. Dorsal and ventral view of paedomorphic female *Eurycea cirrigera*.

be a recurring phenomenon in certain populations. Additional field observations are needed to determine the adaptive significance, if any, of this phenomenon.

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***NECTURUS MACULOSUS* (Common Mudpuppy). LARVAL GUARDING.** Larval defense and attendance of eggs and young by adults is a widespread behavior among salamanders (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, D.C. 587 pp.). During salamander surveys in the Licking River watershed, Rowan Co., Kentucky, USA (precise locality withheld due to conservation conerns), we observed two separate instances of adult *N. maculosus* attending broods of larvae at different stages of development between 1045 h and 1150 h on 11 September 2013. Both aggregations were found by lifting large flat rocks in a stream approximately one meter in depth. The first adult *N. maculosus* (22 cm SVL) was in attendance of at least 32 larvae ranging from 4–5 cm in total length and the second adult *N. maculosus* (19 cm SVL) was in attendance of at least 25 larvae approximately 3–4 cm in total length. When initially uncovered, both females were coiled around a tightly aggregated group of larvae at the center of the space under the cover rock. Remnants of hatched eggs were evident on the underside of the rock concealing the smaller larvae, but were not detected under the other rock.

Adult *Necturus* have been reported to attend and guard clutches of eggs on the undersides of submerged flat rocks through hatching (Bishop 1941. New York State Mus. Bull. 324:13–65), but to our knowledge this is the first reported instance of larval attending in this species. We feel confident in describing these observations as larval attending rather than recently hatched nest guarding behavior because Bishop (1941, *op. cit.*) described *Necturus* hatchlings as measuring between 2.1–2.5 cm total length and our observed larvae were larger at approximately 3–5 cm total length. Breeding season and date of oviposition vary across the range of *N. maculosus*. Because larvae were found in September in this part of the range, copulation in central Kentucky may occur in the spring and eggs may be deposited in early to mid- summer. Larval *Necturus* may face strong predation pressures from fish, crayfish, invertebrates, and conspecifics, and the expression of larval attendance phenotypes in this species may be more prevalent in portions of the range where egg hatching coincides with low water levels and higher predator densities.

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***NOTOPHTHALMUS VIRIDESCENS* (Eastern Newt). SPERM MOTILITY.** Amphibian sperm have received considerable attention in recent years because of the possibility of conserving genetic information and the propagation of threatened taxa. However, our understanding of sperm physiology in amphibians is rather limited, even on sperm in taxa that have been investigated for the explicit purpose of understanding sperm physiology.

Sperm transport and activation in male *N. viridescens* were studied in detail by Hardy and Dent (1986a. J. Exp. Zool. 240:385–396; 1986b. J. Morphol. 190:259–270). They reported that sperm were immotile in the Wolffian ducts and motile in the periphery of the spermatophore cap (also confirmed in Ambystomatidae and other salamandrids; Russel et al. 1981. Tiss. Cell. 13:609–621; Zalisko et al. 1984. Copeia 1984:739–747). Thus, activation of newt sperm must take place during, or immediately preceding, spermatophore formation. Hardy and Dent (1986a, *op. cit.*) concluded exposure of the spermatophore to pond water (hypoosmotic shock) was the initiating factor for axoneme activation and that sperm motility alone did not account for sperm reaching the simple spermathecae in female *N. viridescens* because sperm in natural inseminations traveled as far as 5 mm in less than 2 minutes. This distance could not possibly be traversed by sperm activated by hypoosmotic shock (Hardy and Dent 1986a, *op. cit.*). Thus, another mechanism modulating sperm swimming speed (or degree of activation) must be present.

While testing hypotheses on the function of secretions from the sexual collecting ducts of *N. viridescens* (see Siegel et al. 2012. J. Herpetol. 46:136–144), we observed an interesting finding: sperm are motile in the Wolffian ducts of *N. viridescens*. This finding contradicts the previous findings of Hardy and Dent (1986a, *op. cit.*). We examined freshly excised sperm from the Wolffian ducts of ten male *N. viridescens* captured on 05 November 2011 from Crawford Co., Missouri (37.94774°N, 91.16793°W; WGS 84). Specimens were euthanized with a lethal dose of MS-222 before sperm excision. We can only conclude that the error by Hardy and Dent (1986a, *op. cit.*) was due to examining desiccated sperm at the periphery of their sperm preparations.

Sperm in the Wolffian ducts of *N. viridescens* are motile, at least during November, in specimens collected from Missouri. Interestingly, Hardy and Dent (1986a, *op. cit.*) also collected salamanders in November. Historic studies on other salamander taxa also noted motility of sperm from the Wolffian ducts; e.g., Smith (1907. Contr. Zool. Lab. Univ. Michigan 109:5–39) stated in reference to sperm from the Wolffian ducts of *Cryptobranchus allegheniensis*, "the spermatozoa were motile; the motion of the shaft is slow as compared with other forms, but that of the undulating membrane is rapid." Smith (1907, *op. cit.*) noted that sperm remained motile longer in seminal fluid mixed with water (4 h) than in water alone (15 min), indicating that pure water might actually have an inhibiting effect on sperm motility. Smith (1907, *op. cit.*) also noted that sperm were not motile from the Wolffian ducts outside of the mating season. Moreover, it has long been suggested that the male excurrent ducts are the sites for maturation of salamander sperm (McLaughlin and Humphries 1978. J. Morphol. 158:73–90; Matsuda 1986. Gam. Res. 14:209–214), and it appears that this maturation includes activation of the axoneme in *N. viridescens*. From a study on *Ambystoma texanum* (Russell et al. 1981, *op. cit.*), sperm activation apparently takes place in the distal portion of the Wolffian ducts, as whorls of motile sperm were described. Sperm were not active more proximally. Furthermore, it has also been proposed that secretory activity of the Wolffian duct epithelium may act to sustain sperm motility while stored (Zalisko and Larsen 1988. Scan. Micro. 2:1089–1095).

We thank the Missouri Department of Conservation for collecting permits for this natural history note (permit #14791).

SUPPLEMENTARY MATERIAL: For a video of sperm excised directly from the Wolffian ducts of *Notophthalmus viridescens*, contact D. Siegel (dsiegel@semo.edu). In the video, motility of the entire mass of sperm and many sperm tails is obvious.

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***NOTOPHTHALMUS VIRIDESCENS* (Eastern Newt). DIET.** *Notophthalmus viridescens* is a common aquatic salamander across the eastern United States, and they are known to play important roles as predators in freshwater ecosystems (Morin 1981. Science 212:1284–1286; Smith 2006. Oecologia 148:342–349). *Notophthalmus viridescens* is known to prey upon aquatic invertebrates, conspecific larvae, anuran tadpoles and eggs, and fish (Burton 1977. Copeia 1977:139–143; Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, DC. 587 pp.). They may also be scavengers, as evidenced by a single report of cannibalism on dead conspecifics (Pitt et al. 2011. Herpetol. Rev. 42:258). Here I describe *N. viridescens* scavenging dead minnows.

On 08 and 15 April 2013, I observed a total of four *N. viridescens* eating, or attempting to eat, dead juvenile *Luxilus cornutus* (Common Shiner) minnows in the shallows of a large pond in Pennsylvania State Game Lands 176, Centre Co., Pennsylvania, USA (40.80200°N, 77.94300°W; datum WGS84). Three *N. viridescens* were seen repeatedly biting floating *L. cornutus* (approximately 5 cm total length), a very common fish in this pond. One *L. cornutus* was also being grasped by a backswimmer (*Notonecta* sp.), which caused the corpse to move periodically as it swam. It did not appear that any flesh was removed when any of these *N. viridescens* bit the dead *L. cornutus*. A fourth, female *N. viridescens* was seen with the posterior half of a *L. cornutus* protruding from its mouth. It was captured with a net but immediately regurgitated the fish. It is doubtful that it could have successfully swallowed the entire *L. cornutus*, and none of the other *N. viridescens* observed appeared to have successfully consumed any of the fish. Live *L. cornutus* that were smaller, and thus might be swallowed by *N. viridescens*, were abundant. These observations provide evidence that *N. viridescens* may also be important scavengers of small fish, in addition to their role as predators, in lentic habitats.

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***PARAMESOTRITON LONGLIENSIS* (Longli Warty Newt). DEFENSIVE BEHAVIOR.** Salamanders and newts are well known to show defensive posture against a predator. Usually they roll up the ventral sides of body and tail to show the bright coloration (Duellman and Trueb 1986. Biology of Amphibians. The Johns Hopkins University Press, Baltimore. 670 pp.). Here we report a defensive behavior of *Paramesotriton longliensis* (Longli Warty Newt). At 2050 h on 30 March 2011, we found an adult female of *P. longliensis* (mass = 15.2 g) in a stream (depth ca. 1.2 m, width ca. 15 m) at Muye, Youyang County, Chongqing Municipality, China (29.27475°N, 109.00044°E; datum WGS84; elev. = 874 m). Water temperature was 15.0°C and air temperature was 11.0°C at capture. Immediately upon capture by a dip net, the newt laterally curved its body and coiled its tail, with its limbs folded and the coiled tail kept on the head (Fig. 1). A noxious smell emitted probably from body, but we could not observe any visible secretion. The newt did not move even in hand and also after kept in a plastic bag with water for more than several minutes. Similar behavior was also reported for other *Paramesotriton* sp. (Brodie 1983. *In* Margaris et al. [eds.], Plant, animal, and microbial

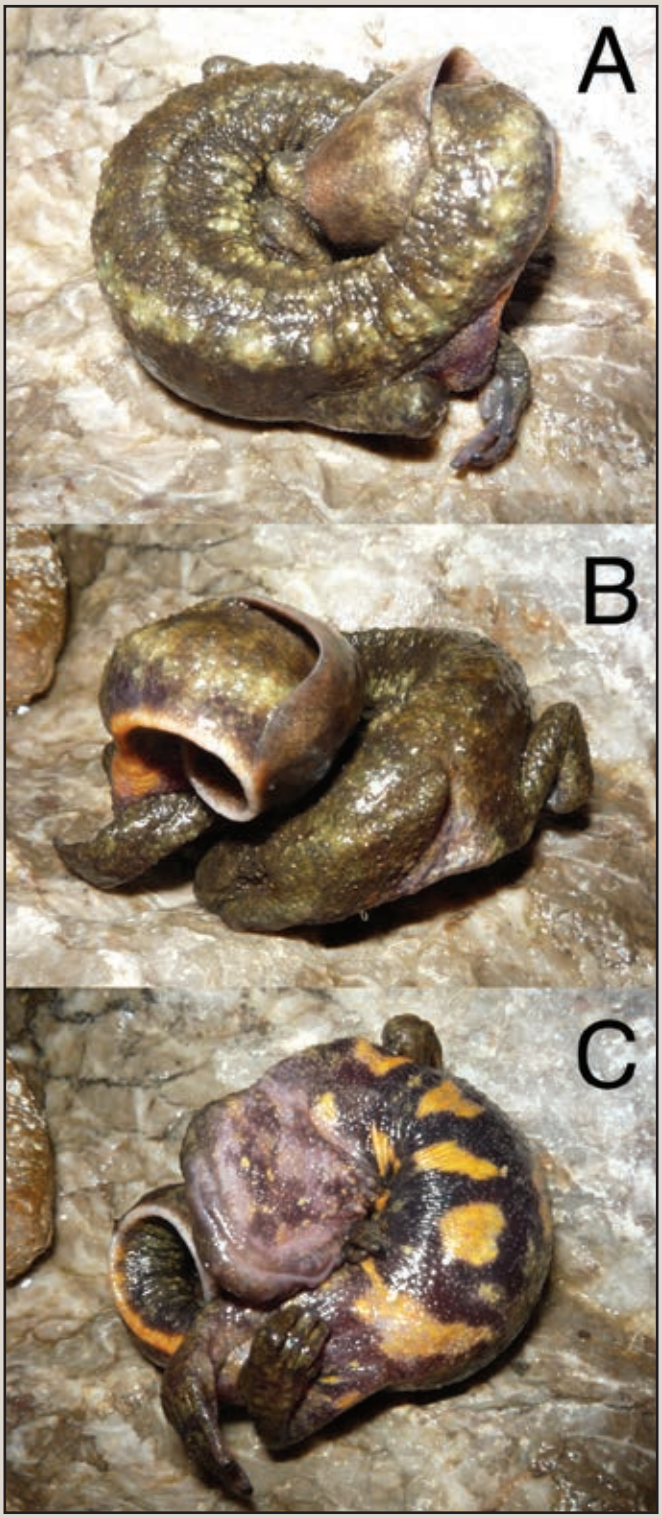


FIG. 1. Antipredator defense of a female *Paramesotriton longliensis*. A) Dorsal, B) lateral, C) ventral views.

adaptations to terrestrial environment, pp. 109–133. Plenum, New York), however, to our knowledge this is the first record of this behavior in this species.

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***SALAMANDRA LONGIROSTRIS* (Prebetic Zone Fire Salamander). DIET.** Non-vertebrate prey are well known to be consumed by *Salamandra longirostris* (García-París et. al. 2004. *In* Ramos et al. [eds.], Fauna Iberíca, Vol. 24, p. 79. Museo Nacional de Ciencias Naturales, CSIC, Madrid, Spain), but vertebrate prey, to my knowledge, have never been reported. Two partially-digested *Pleurodeles waltl* (Spanish Ribbed Newt) larvae, each with a head width of approximately 4.2 mm, were found in the gut of a male *S. longirostris* (CM 54272) collected at 2030 h on 29 November 1970. The salamander was found dead but in otherwise good condition on roadway C-440 approximately 12 km SE of Casas del Castaño, Cádiz Province, Spain (36.21762°N, 5.57583°W, datum WGS84; elev. 107 m). Its total length in preservative is 196.5 mm. In addition to adding larval salamanders to the diet of adult male Fire Salamanders, at least in extreme southern Spain, this finding also suggests the species may actively forage in aquatic environments.

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ANURA — FROGS

***COLOSTETHUS RUTHVENI* (Santa Marta Poison Arrow Frog). DIET.** *Colostethus ruthveni* is an endemic species found from the northwest flank of the Sierra Nevada de Santa Marta, Magdalena, Colombia; its distribution is estimated to be less than 5000 km^2. It resides along streams in cloud forests and dry tropical forests near the Caribbean coast (elev. <1540 m). It is considered endangered on the IUCN Red List of Threatened Species and its greatest threat is habitat loss and degradation due to agriculture, forest clearance, and infrastructure development (González-Maya et al. 2011. JoTT 3:1633–1636; Kaplan 1997. J. Herpetol. 31:369–375; Rueda-Solano and Castellanos-Barliza 2010. Acta. Biol. Col. 15:195–206). The food habits of this species are unknown, as well as many aspects of its ecology.

The study area has humid and wet tropical forests and is known as Bañaderos region and Camarones River's high basin. It is located in the south of the Riohacha municipality in La Guajira department. Sampling (approximately 165 person h effort) was conducted via visual encounter surveys carried out between 0700 h and 1800 h during 05–20 September 2011, in the basins of Camarones and Tapias rivers at three sites (11.0454°N, 72.5329°W; 11.0204°N, 72.5610°W; 11.0322°N, 72.5924°W; datum: D-Magna; elev. 408–710 m). The collected individuals were measured, preserved in ethanol, and dissected for the extraction of stomach contents. The prey was identified to order, family, and genus when possible, and the surface occupied by each prey type was measured using the coverage method (Tresierra and Culquichicon 1993. Manual de Biología Pesquera, pp. 47–56.Trujillo, Perú).

TABLE 1. Composition of prey in the diet of *Colostethus ruthveni* from Bañaderos region, Riohacha, Colombia.

Prey	Area mm^2 (%)	Frequency of occurrence
Arachnida		
Acari	0.5 (0.39)	1
Insecta		
Coleoptera		
Staphylinidae	6 (4.60)	1
Bruchidae	40 (30.8)	1
Curculionidae	4 (3.10)	1
Family Unknown	3 (2.30)	1
Hemiptera	0.5 (0.40)	1
Hymenoptera		
Formicidae		
Neivamyrmex sp.	11 (13.45)	9
Aphaenogaster sp.	11 (13.45)	9
Myrmicinae (Queen)	21 (16.2)	6
Solenopsis sp.	1.5 (1.20)	4
Larvae sp. 1	31 (23.8)	1

We examined 26 stomachs of *C. ruthveni* collected on the banks of streams inside the forest. 73.19% were found with stomach contents (N = 26; SVL = 1.9–2.31 cm, mean SVL ± S.D. = 2.09 ± 0.12 cm; Table 1). The diet consisted mainly of arthropods. Insects (Hymenoptera, Coleoptera, Hemiptera, and an unidentified larva) were the most important prey items (with more abundance and covered surface area), followed by scarce examples of arachnids (especially Acari). Coleopterans were the most important in surface coverage; however, it is worth noting that Bruchidae is represented by a single prey with large size consumed by a single *Colostethus ruthveni* individual. Numerically, the most important prey items were ants. Ants of the genus *Neivamyrmex* and *Aphaenogaster* occurred most frequently in the examined stomachs.

In Cordoba's region, in the north of Colombia, *Colostethus inguinalis* consumes beetles as the most important volumetric prey and ants as the most important numeric prey (Blanco-Torres et al. 2013. Herpetol. Rev. 44:493) which is totally consistent with *C. ruthveni*'s diet; however, the genus of Coleoptera and ants consumed differ between the two species. We also report the ingestion of mites (Acari) by *C. ruthveni*. Our contribution to the knowledge of the diet of *C. ruthveni* may be useful to management and conservation plans for this endemic species and its habitat.

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***DENDROPSOPHUS PSEUDOMERIDIANUS* (Small Tree Frog). PREDATION.** There are reports of spiders preying on tadpoles (e.g., Luiz et al. 2013. Herpetol. Notes 6:451–452; Santos-Silva 2013. Herpetol. Notes 6:193–194), as well as some adults of the hylid genus *Dendropsophus* (e.g., Oliveira et al. 2010. Herpetol. Notes 3:299–300; Toledo 2005. Herpetol. Rev. 36:395–400). The frog *D. pseudomeridianus* occurs in lowlands of Rio de Janeiro and Espírito Santo states, southeastern Brazil. This species reproduces in marshes and deposits eggs on the surface of the water (Izecksohn and Carvalho-e-Silva 2010. Anfíbios do Município do Rio de Janeiro. UFRJ Press, Rio de Janeiro. 198 pp.). The tadpole of *D. pseudomeridianus* is nektonic, inhabits lentic water, and preys upon microorganisms (McDiarmid and Altig 1999. Tadpoles: The Biology of Anuran Larvae. Univ. Chicago Press, Illinois. 444 pp.). Wolf spiders (family Lycosidae) are usually ground-dwelling hunters and many species are diurnal. They use their relatively good vision and strong venom to capture and kill their prey. At 1930 h on 17 February 2014 in the Municipality of Guapimirim, state of Rio de Janeiro (22.35735°S, 42.571943°W; datum SAD69), we noted a young male wolf spider (*Hogna* sp.) capturing a *D. pseudomeridianus* tadpole on the surface of the water of a permanent pond. The spider (length = 6.4 mm) held the tadpole's tail with its chelicerae, but released it when disturbed. The tadpole had a slight tear on its tail and stiffened after being released. The *Hogna* sp. was collected and deposited as a voucher (ZUFRJ 0947). The identification of the spider to species level was not possible, as the copulatory bulb in the pedipalp, an important taxonomic character, was not completely developed, and the species is not a common one in the collecting area. The *D. pseudomeridianus* was also collected (ZUFRJ 14714). To our knowledge, this is the first record of predation upon a *D. pseudomeridianus* tadpole by a spider.

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***HYPSIBOAS ALBOPUNCTATUS* (Yellow-spotted Treefrog). PREDATION.** Herein, we report predation of *Hypsiboas albopunctatus* by the snake *Thamnodynastes hypoconia*. The observation took place at 2230 h on 13 February 2012 (air temperature 27.4°C), in a permanent lentic pond on the edge of a gallery forest in the rural zone of Aparecida do Rio Doce municipality, Goiás state, central Brazil (18.200194°S, 51.069167°W; datum SAD69). We heard alarm calls among shrubs and we observed a *T. hypoconia* capturing a *H. albopunctatus* by the posterior region of the body (Fig. 1). The treefrog stopped the alarm calls before we were able to record them. We continued the observation for 30 min. After predation, the snake continued its foraging activity and did not regurgitate. Specimens were not collected, but photographs were stored in the collections of the Universidade Federal de Goiás. This record reinforces the findings of Bellini et al. (2013. Herpetologica 69:67–79) that anuran amphibians are the main item of *T. hypoconia* diet, especially treefrogs of the family Hylidae. However, to our knowledge this is the first record of *T. hypoconia* feeding upon *H. albopunctatus*.



FIG. 1. Predation on *Hypsiboas albopunctatus* by *Thamnodynastes hypoconia*.

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***LEPTOBRACHIUM PULLUM* (Vietnam Spadefoot Toad). EYE COLORATION.** Eye color is often used to delineate frog species in the field and is generally recognized as a reliable taxonomic character (Glaw and Vences 1997. Herpetologia Bonnensis. SEH Proceedings, Bonn, pp. 125–138). This is particularly true of frogs in the genus *Leptobrachium* of the family Megophryidae, where external morphology is highly conserved across species, but eye color tends to vary interspecifically (Dubois and Ohler 1998. Dumerilia 4:1–32).

Leptobrachium pullum was first described as having the upper half of the iris colored scarlet in life (Smith 1921. Proc. Zool. Soc. London 1921:423–440), although more recent observations indicate that the scarlet coloration is restricted to a scleral arc under the palpebrum (Stuart et al. 2011. Zootaxa 2804:25–40). During multiple, extensive field surveys of the Ngoc Linh Nature Reserve, Kon Tum Province, Vietnam (15.08000°N, 107.92700°E;

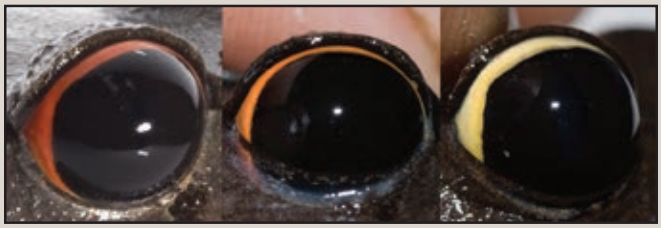


FIG. 1. Variation in sclera coloration in *Leptobrachium pullum* from Ngoc Linh Nature Reserve, Kon Tum Province, Vietnam.

datum WGS84), in 2009 and 2010, *L. pullum* were commonly observed, and photographs and notes were taken regarding eye coloration. While the location of coloration was shown to have little variation among individuals, sclera coloration was variable, ranging from scarlet to pale orange (Fig. 1) even among individuals located within meters of each other. Individuals displayed little other genetic, morphological, or acoustic differentiation (Rowley et al., unpubl. data). Scleral color did not appear to differ between diurnal and nocturnal observations. Nor was there an obvious correlation between sex and/or reproductive status.

Our observations highlight that although eye coloration is a very useful diagnostic character in the genus *Leptobrachium*, care should be taken to record variation within species. These findings may have taxonomic implications for future investigations within species of *Leptobrachium*.

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***LITHOBATES SPHENOCEPHALUS* (Southern Leopard Frog). PREDATION.** Adult Southern Leopard Frogs are preyed upon by a wide variety of vertebrates, including a number of bird species (Dodd 2013. Frogs of the United States and Canada.Vol. 1. John Hopkins University Press, Baltimore, Maryland. 460 pp.). The Barn Owl (*Tyto alba*) is the only documented nocturnal avian predator for Southern Leopard Frogs, however another owl species, the Great Horned Owl (*Bubo virginianus*), is known to predate the similar Northern Leopard Frog (*Lithobates pipiens*; Dodd 2013, *op. cit.*). At approximately 1400 h on 04 February 2014 while cleaning out Wood Duck (*Aix sponsa*) nest boxes on Big Lazer Public Fishing Area, Talbot Co., Georgia, USA (32.769199°N, 84.419635°W; datum WGS84), two of us (BG and JR) discovered a single Eastern Screech-owl (*Megascops asio*) in one of the boxes along with 21 Southern Leopard Frog carcasses, including one that was still in the talons of the sleeping owl (Fig. 1). Most of the frogs were fully intact, although a couple had been partially consumed. The box is in close proximity to the shallow headwaters of a 78-ha impoundment, where large numbers of Southern Leopard Frogs could be heard calling. There were no other prey items in the box, and the owl was alone with no signs of nesting. One other Eastern Screech-owl was found in a nest box closer to the dam (and well away from the frog chorus), but that box did not contain any frogs or other cached prey items.



FIG. 1. Eastern Screech Owl (*Megascops asio*) in nest box with cached carcasses of Southern Leopard Frogs (*Lithobates sphenocephalus*).

Eastern Screech-owls are known to cache large quantities of prey, especially in winter months when decay is slowed by cooler temperatures (Phelan 1977. Condor 79:127). Caching for the purpose of feeding young is also known, but no eggs or nestlings were observed and this observation was well before the known onset of nesting in this species (Gehlbach 1995. *In* Poole and Gill [eds.], The Birds of North America, pp. 1–24. American Ornithologists' Union, Washington, DC). Eastern Screech-owls have symmetrically positioned ears suggesting that vision often plays a greater role in prey location than does hearing, the latter of which is more commonly employed by owl species with asymmetrical ears (Gehlbach 1995, *op. cit.*). Thus, the Southern Leopard Frogs may have been encountered visually rather than by sound triangulation toward their vocalizations. Communal oviposition in shallow water by *L. sphenocephalus* is well known (see Trauth 1989. Proc. Arkansas Acad. Sci. 43:105–108) and makes large numbers of mating frogs quite susceptible to predation. To the best of our knowledge, this observation represents the first documented predation event on Southern Leopard Frogs by Eastern Screech-owls, and the only known caching event by this bird species involving only anurans.

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***LITHOBATES SYLVATICUS* (Wood Frog). EGG PREDATION.** Wood Frogs are abundant amphibians throughout much of northern and northeastern North America, and their eggs are known to be consumed by larval caddisflies (Rowe et al. 1994. J. Herpetol. 28:357–364), *Notophtalmus v. viridescens* (Eastern Red-Spotted Newts; Pitt et al. 2011. Herpetol. Rev. 42:263), larval ambystomatid salamanders (Redmer and Trauth 2005. *In* Lannoo et al. [eds.], Amphibian Declines: The Conservation Status of United States Species, pp. 590–593. Univ. California Press, Berkeley), and leeches (Cory and Manion 1953. Copeia 1953:66). To the best of my knowledge, larval fishflies (Megaloptera: Corydalidae: Chauliodinae) have not been documented as predators of the eggs of *L. sylvaticus* or any other amphibian. Fishflies produce large (up to 65 mm), predatory, aquatic larvae which (along with the larvae of some related megalopterans) are commonly called "hellgrammites" (Flint et al. 2008. *In* Merritt et al. [eds.], An Introduction to the Aquatic Insects of North America, pp. 425–426. Kendall/Hunt Publishing, Dubuque, Iowa).

I collected nine *L. sylvaticus* egg masses from a semi-permanent forest pond in Pennsylvania State Game Lands 176, Centre Co., Pennsylvania, USA (40.765°N, 78.016°W; datum WGS84) in April 2013 for use in a laboratory experiment. Upon return to the laboratory, I noticed that two egg masses had individual fishfly larva (*Chauliodes pectinicornis*) embedded within them. They could only be removed by separating the egg masses by hand. Each larval fishfly was transferred to a small plastic container. Because of how deeply embedded the fishflies were, I suspected they may have been feeding on the eggs. The smaller fishfly (approx. 20 mm) was therefore provided with three *L. sylvaticus* eggs and the larger fishfly (approx. 50 mm) was given nine eggs to test whether they would eat the eggs. After a week, the smaller fishfly was found dead and had not eaten any eggs. However, the larger fishfly had consumed the embryos of seven eggs, leaving the egg jelly relatively intact. I have previously observed *Chauliodes* sp. larvae in at least three other permanent or semi-permanent breeding ponds of *L. sylvaticus*. This is consistent with the long development time of these insect larvae, and many of those I observed were large enough that they had most likely overwintered in the ponds. Together, these observations suggest that fishfly larvae may be important egg predators for *L. sylvaticus* (and potentially other amphibians) in intermediate- to long-hydroperiod ponds.

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***LITHOBATES WARSZEWITSCHII* (Warszewisch's Frog). REPRODUCTIVE BEHAVIOR.** There are numerous reports of interspecific amplexus in anurans from many localities (Medina 2013. Herpetol. Rev. 41:123; Pearl et al. 2005. Am. Midl. Nat. 154:126–134; Ritchie et al. 2008. Herpetol. Rev. 39:80). *Smilisca phaeota* and *Lithobates warszewitschii* are common tropical frogs that can be found sympatrically from Honduras to Panama in lowland and premontane wet and moist forest. Here we report the first observation of amplexus between a native hylid and a native ranid in Panama and the first instance of this behavior between these species. At 2003 h on 20 Jan 2011, a male *L. warszewitschii* was observed in amplexus with an adult *S. phaeota* of undetermined sex in the roadside ditches at Río Luis, in the buffer zone of the Santa Fe National Park, Panama (8.68117°N, 81.217796°W; datum WGS84). Weather conditions were clear without rain and it had been two days since the last rain. The frogs were photographed and observed for six minutes. Two hours later, we returned to the same place and they remained in amplexus.

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***PHYLLOMEDUSA NORDESTINA* (Leaf Frog) and *PHYSALAEMUS CUVIERI* (Dwarf Frog). INTERSPECIFIC AMPLEXUS.** Interspecific amplexus occurs between amphibians overlapping spatially and temporally (Hobel 2005. Herpetol. Rev. 36:55–56; Hobel 2005. Herpetol. Rev. 36:439–440; Waterstrat et al. 2008. Herpetol. Rev. 39:458), and usually occurs between individuals of the same genus or family (Streicher et al. 2010. Herpetol. Rev. 41:208). On 12 March 2012 at 2000 h, on the banks of an artificial lake in Floresta Nacional do Araripe (Flona-Araripe), Barbalha Municipality, northeastern Brazil (7.36543°S, 39.44061°W; 912 m elev.), we observed interspecific amplexus between two individuals from different families when a female *Phyllomedusa nordestina* (Hylidae) was amplexed by a male *Physalaemus cuvieri* (Leiuperidae) (Fig. 1). Both individuals were trapped inside a tank ca. 1 × 3 m with an artificial depth of about 2.5 m. The tank had a water depth of 40 cm; the specimens were on a fallen log, outside of the water. Streicher et al. (2010, *op. cit.*) reported interspecific amplexus between the hylids *Smilisca baudinii* and *Pachymedusa dacnicolor* and members of this family are known to hybridize (Lamb et al. 1990. J. Evol. Biol. 3:295–309).

This study presents the first report of amplexus between the families Hylidae and Leiuperidae. A likely factor may have been stress due to competition for space associated with the reproductive activity of both species in the area. We thank CNPq who provided the scholarship for S. Ribeiro. The study was authorized by IBAMA permit number 29838-2. Field assistance was provided by O. Filho, G. Sousa, and A. Teixeira.

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PHOTO BY SAMUEL C. RIBEIRO

FIG. 1. Interspecific amplexus between *Physalaemus cuvieri* (male) and *Phyllomedusa nordestina* (female) from Floresta Nacional do Araripe, northeastern, Brazil.

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***PSEUDACRIS ILLINOENSIS* (Illinois Chorus Frog). PREDATION.** *Pseudacris illinoensis* is a fossorial anuran of conservation concern throughout its restricted geographic range. Predators of adults are unknown; confirmed predators of tadpoles include fishes and aquatic insects (Shepard et al. 2005. *In* Lannoo [ed.], Amphibian Declines: The Conservation of United States Species, pp. 484–485. University of California Press, Berkeley). Here, I report snake predation of a *P. illinoensis* tadpole. At 1130 h on 30 April 2013 (sunny, 23°C), I hand-captured a *Nerodia erythrogaster flavigaster* (SVL = 47 cm; total length = 66 cm) in a stagnant, shallow (< 25 cm deep), 1-m wide drainage ditch excavated in a cropfield in Alexander Co., Illinois, USA (precise location withheld). Upon handling, the snake regurgitated a *P. illinoensis* tadpole (total length = 4.1 cm). The tadpole was still alive, indicating recent consumption by the snake. I released the snake and tadpole into the ditch.

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***RHACOPHORUS RUFIPES* (Red-legged Tree Frog). MAXIMUM ELEVATION.** *Rhacophorus rufipes* is a small anuran (to SVL = 5.0 cm) endemic to the island of Borneo (Inger and Stuebing 2005. A Field Guide to the Frogs of Borneo. Natural History Publications, Kota Kinabalu. 201 pp.). The species dwells in primary forests in lowlands and hilly terrain (elev. up to 250 m), and congregate in low vegetation 1–3 m above the ground to breed (Inger 2005. The Systematics and Zoogeography of the Amphibia of Borneo. Natural History Publications, Kota Kinabalu. 402 pp.). Herein we report a new elevational limit for *R. rufipes*.

Between 1900–2200 h On 29 September 2008, a juvenile *R. rufipes* (SVL = 1.7 cm; mass = 0.5 g) was sampled via opportunistic examination at Sungai Lidan, Bundu Tuhan, Ranau District, West Coast Division, Sabah, Bornean Malaysia (5.9778°N, 116.5298°E, datum WGS84; elev. 1076 m). Air temperature was 18.4°C, and relative humidity was 80.6%. Sungai Lidan is a rocky-bottomed stream with clear and moderately flowing water. The river banks support much vegetation such as rattan, bamboo and wild ginger (Kueh et al. 2011. Herpetol. Rev. 42:91), and thus, provide preferred breeding habitats for *R. rufipes*. The finding represents an extension of elevational limit for *R. rufipes* to the submontane zone. The specimen (HEP00658) was deposited in BORNEENSIS, the Bornean reference collection of the Institute for Tropical Biology and Conservation, Universiti Malaysia Sabah.

Elevational limit change in anurans could be attributed to climate change that enhances both the surrounding abiotic and biotic constraints mainly caused by increasing air temperature, and decreasing precipitation and moisture, and drives anurans uphill (Colwell et al. 2008. Science 322:258–261; Hargreaves et al. 2014. Am. Nat. 183:157–173). Uphill distribution of anurans narrows their geographical range, and subsequently, pushes anurans towards extinction (Toranza and Maneyro 2013. Phyllomedusa 12:97–106). Further studies on the natural history of anurans, in particular their elevational limit, geographical range, and autecology, becomes necessary for effective conservation endeavors.

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***RHINOPHRYNUS DORSALIS* (Mexican Burrowing Toad). PREDATION.** *Rhinophrynus dorsalis* ranges from southern Texas, USA and Michoacán, México, south along coastal areas to northeastern Honduras on Caribbean slope, and to Costa Rica in the Pacific slope (Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna between Two Continents, between Two Seas. University of Chicago Press, Chicago, Illinois. 934 pp.); in Costa Rica it is found exclusively in the northwest of the country (Savage 2002, *op. cit.*). At approximately 1750 h on 24 May 2013, at Santa Rosa National Park, Guanacaste Province, Costa Rica (10.83333°N, 85.61667°W; datum WGS84), near a flooded zone of the camping area, we observed a *Pulsatrix perspicillata* (Spectacled Owl) through 10x binoculars perched on a horizontal branch about 5 m high, with a *R. dorsalis* pressed down firmly under its left talon (Fig. 1). The toad was motionless, with its body inflated; from our point of view we were unable to see if it was injured, but the yellow spots on the back and very short limbs leave no doubt about species identification. The bird stayed around 15 min in this position, with its eyes almost closed in the first moments, making slow and gentle sideways movements with its head. Then the owl flew toward a nearby tall



FIG. 1. Predation of *Rhinophrynus dorsalis* (Mexican Burrowing Frog) by *Pulsatrix perspecillata* (Spectacled Owl) in Santa Rosa National Park, Guanacaste, Costa Rica.

tree with its prey in its claws, landing out of sight, preventing us from seeing if the owl consumed the toad. The diet of Spectacled Owls includes a wide range of prey sizes, from medium-sized mammals of several kilograms to birds, lizards, and large insects (Stiles and Skutch 2007. Guía de Aves de Costa Rica. INBio. 680 pp.; Voirin et al. 2009. Edentata 10:15–20). Until now an amphibian has never been reported as a diet item for this species of owl. To our knowledge, this is the first known predator on adults of the rare *R. dorsalis* (Dodd 2013. Frogs of the United States and Canada. Vol. 1. John Hopkins University Press, Baltimore, Maryland. 460 pp.).

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***SCAPHIOPUS HOLBROOKII* (Eastern Spadefoot). PREDATION.** Herein we document predation on *Scaphiopus holbrookii* by *Canis latrans* (Coyote), an opportunistic predator known to utilize an extensive array of prey (Grigione et al. 2011. Urban Ecol. 14:655–663; Leopold and Krausman 1986. J. Wildl. Manage. 50:290–295). We conducted necropsies of 201 Coyotes collected October 2011–March 2014 throughout Florida, USA. An 11.57 kg male's stomach collected on 03 June 2012 in southeast Columbia Co., Florida contained the remains of an adult male *S. holbrookii* and other items. This is the first report of predation by the Coyote on *S. holbrookii*, although it is has been reported preying on *Spea intermontana* (Great Basin Spadefoot; Dodd 2013. Frogs of the United States and Canada. Vol. 2. John Hopkins University Press, Baltimore, Maryland. 982 pp.). Opportunistic predation of an explosive breeding species is indicative of a generalist predator.

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***SMILISCA DENTATA* (Upland Burrowing Tree Frog). PREDATION.** *Smilisca dentata* is a medium-sized tree frog that lives in burrows. It is endemic to Central México, between southern Aguascalientes and extreme northwestern Jalisco. It is listed by IUCN as Endangered and by Norma Oficial Mexicana as threatened. In recent years, knowledge about *S. dentata* has increased, including information about its distribution, population dynamics, abundance, reproduction, growth, and diet. There are no reports of predators, including any avian predators (Quintero-Díaz and Vázquez-Díaz 2009. Historia Natural de una Rana muy Mexicana. Sociedad Herpetológica Mexicana, Ayuntamiento de Aguascalientes y SEMARNAT. 169 pp.). Here, we report evidence of predation on *S. dentata* by the bird *Lanius ludovicianus* (Loggerhead Shrike), which preys on a wide variety of vertebrates including amphibians, mainly frogs (Lefranc 1997. Shrikes. A Guide to the Shrikes of the World. Yale University Press, New Haven and London. 192 pp.). At 0158 h on 12 November 2009, at Buenavista de Peñuelas, Aguascalientes, México (21.725166°N, 102.300977°W, datum WGS84; elev. 1872 m), we found a dead juvenile *S. dentata* (SVL = 30 mm; UAA-CV-AN229) impaled on barbed wire by *L. ludovicianus* (Fig. 1). We did not observe the bird capturing or killing the frog but we assume it was the result of shrike predation because this behavior is characteristic of the species. To our knowledge, this is the first record of predation on *S. dentata* by *L. ludovicianus*.



FIG. 1. Juvenile Upland Burrowing Tree Frog (*Smilisca dentata*) impaled on barbed wire by a Loggerhead Shrike (*Lanius ludovicianus*), at Buenavista de Peñuelas, Aguascalientes, México.

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TESTUDINES — TURTLES

***CARETTA CARETTA* (Loggerhead Sea Turtle). PREDATION.** Coyotes (*Canis latrans*) are generalist predators known to opportunistically utilize an extensive array of species (Leopold and Krausman 1986. J. Wildl. Manage. 50:290–295; Grigione et al. 2011. Urban Ecol. 14:655–663) and are reported to be a nest predator of *Caretta caretta* (Kurz et al. 2012. Oryx 46:223). Herein we provide the first definitive observation of predation on *C. caretta* hatchlings by a Coyote. We conducted necropsies of 201 Coyotes collected October 2011–March 2014 throughout Florida, USA. Twenty-six of the Coyote carcasses were collected from coastal areas during the marine turtle nesting season. The stomach of a 14.1 kg male collected on 26 June 2013 from Archie Carr National Wildlife Refuge, Indian River Co. (27.7953°N, 80.4137°W; datum WGS 84), contained the remains of three *C. caretta* hatchlings (Fig. 1).



FIG. 1. *Caretta caretta* hatchlings found in the stomach of an adult male *Canis latrans*.

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***CHELYDRA SERPENTINA* (Snapping Turtle). WINTER DROUGHT REFUGIA.** *Chelydra serpentina* inhabits many freshwater habitats including wetlands, rivers, lakes, and ponds (Ernst et al. 1994. Turtles of the United States and Canada. Smithsonian Institution, Washington D.C. 578 pp.) and has been reported to overwinter in shallow water in lakes and streams and muddy marshes in the northern portion of their range (Meeks and Ultsch 1990. Copeia 1990:880–884; Brown and Brooks 1994. Copeia 1994:222–226). Most reports on *C. serpentina* overwintering are from Canada and the northern USA, and there is little published information on the overwintering habits of this species in the southern portion of its range. The following observations were made at the Joseph W. Jones Ecological Research Center at Ichauway in Baker Co., Georgia, USA.

On 27 January 2012, we captured a hatchling *C. serpentina* (CL = 23.8 mm) swimming in a deep muddy pool within a dry, isolated cypress-gum (*Taxodium ascendens* and *Nyssa sylvatica*) wetland that was located approximately 1.5 km from the nearest permanent open water source. The pool was surrounded by Buttonbush (*Cephalanthus occidentalis*) (Fig. 1), and was located within several meters of an American Alligator (*Alligator mississippiensis*) burrow. We investigated the area further when we noticed bubbles emerging from the mud and excavated two more Snapping Turtles, an adult male (CL = 228 mm) and adult female (CL = 320 mm) (Fig. 2), which were buried one on top of the other >30 cm underneath the mud. Both turtles were marked by notching marginal scutes (Cagle 1939. Copeia 3:170–173) and released that same day. We revisited the site on 2 February 2012 and captured two more unmarked adults, both males (CL = 297 and 389 mm, respectively). Thus we observed a total of five different individuals using this single muddy pool in a wetland that had been dry for the previous 12 months. We revisited the wetland again



FIG. 1. Deep muddy pool in dry cypress gum wetland where multiple *Chelydra serpentina* were found overwintering in January-February 2012 and 2013.



FIG. 2. Adult female *Chelydra serpentina* immediately after being excavated from a deep muddy pool on 27 January 2012.

nearly a year later on 14 December 2012 and captured two adult turtles in the original muddy pool, one of which was a marked male that had been captured the previous winter. We searched for other depressions within the wetland on 21 December 2012 and captured a marked female that had moved from the previous area to a different muddy spot under the roots of a pond cypress. At this point the wetland had been dry for 11 months. We investigated another dry cypress gum swamp 7 km N of the original wetland on 16 January 2013, and found an adult male *C. serpentina* (CL = 316 mm) buried under mud in a low area of the wetland near an *A. mississippiensis* burrow. We placed a radio transmitter on this individual and found that he remained in the same spot until 5 February 2013, when the wetland began to fill due to rainfall and the turtle moved to a different area in the wetland. It is unknown whether these low muddy areas were naturally occurring, or whether they were dug or modified by *C. serpentina*.

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***CHRYSEMYS PICTA BELLI* (Western Painted Turtle). PREDATION.** Temperate aquatic turtles lay eggs in early summer, which hatch 2–3 months later. Rather than departing natal nests in late summer, hatchlings of many species brumate within these nests and emerge the following spring (Costanzo et al. 2008. J. Exp. Zool. 309A:297–379; Gibbons 2013. J. Herpetol. 47[2]:203–214). From oviposition to initiation of the aquatic phase of their life

history, two periods of heavy predation occur. Many eggs are depredated shortly after nest construction, with the risk decreasing over time (i.e., fresh nests are most vulnerable). Second, many hatchlings are depredated during migration from their terrestrial nests to aquatic habitats. A putative advantage of nest brumation by hatchling turtles is avoidance of potentially heavier predation during fall migration compared to spring migration. Over the winter, mortality from abiotic conditions (e.g., extreme cold) may occur in nests, but mortality from predation has apparently not been previously documented. Here we report apparent predation of hatchling *Chrysemys picta* from natural nests during winter.

As a part of our research on nesting ecology of *C. picta*, we had mapped the location of 16 intact nests near Thomson, Illinois, USA (41.9480°N, 90.1163°W, datum WGS 84; elev. 179 m). These nests were targeted for use in a study examining the influence of nest temperature during winter on hatchling mortality. On 3 November 2013, we carefully removed the soil covering these nests, counted the live hatchlings within each nest, and subsequently reburied these nests. We returned on 30 March 2014 to retrieve hatchlings. Of the 16 nests, 13 had no hatchlings. We infer that nests were depredated (rather than experiencing early emergence by hatchlings) for two reasons. First, soil was nearly frozen in November and still frozen in March, suggesting that hatchlings would have been physically unable to emerge during that period (due to low body temperature and frozen soil). Second, the soil plug that typically covers the opening to each flask-shaped nest was gone and the cavity was void of excess soil. When hatchlings emerge, much of that soil from the plug falls into the nest cavity and the cavity is usually partially filled in with loose soil and eggshell fragments. Instead, these "cleaned out" cavities appeared similar to nests that are depredated by mammals shortly after oviposition in spring and early summer.

Potential predators that are common at our site and active during this winter period include squirrels (*Sciurus carolinensis*), raccoons (*Procyon lotor*), opossums (*Didelphis virginiana*), and mustelids (*Neovision vision, Lontra canadensis*). It was a necessary component of our study to un-cover and re-cover nests in November. Consequently, it is impossible for us to determine whether this disturbance enhanced predator detection of the nests. However, we carefully re-covered nests with soil and leaf litter to minimize visual disturbance, which is the primary cue used by predators during nesting season at our site (Strickland et al. 2010. J. Herpetol. 44:467–470). Additionally, in seven other years of this study using identical methods, we never observed predation at this stage. Our novel predation observation indicates another potential mortality source for hatchling turtles during brumation, a critical early life stage, and challenges a previous assumption regarding the adaptive significance of this neonatal brumation behavior.

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***GOPHERUS MORAFKAI* (Sonoran Desert Tortoise). DRINKING BEHAVIOR.** Water-balance in desert tortoises (*Gopherus* spp.) of the arid Southwest USA has received considerable attention since it was first documented that they will drink free-standing water (Medica et al. 1980. Herpetologica 36:301–304). The tortoises often void bladder contents while being examined for morphological measurements or attachment of radio transmitters (30–60% of tortoises handled; see below), and there is evidence that this loss can have negative fitness consequences (Averrill-Murray 2002. Chelon. Conserv. Biol. 4:430–435). Observations on drinking behavior under natural and artificial (i.e., opportunities provided by humankind) may thus be significant. We initiated a radio-tracking study of Sonoran Desert Tortoises in 2011, and have observed natural and artificially induced drinking behavior in free-ranging subjects that voided bladder contents during processing (Sullivan et al. 2014. Chelon. Conserv.Biol. 17 [*in press*]). Here, we report drinking behavior associated with elimination of urate materials over a very short time period.



FIG. 1. Juvenile *Gopherus morafkai* drinking from container (~ 250 ml) at 0857 h (left), immediately prior to voiding urates (right; note pinkish material immediately posterior to tortoise, surrounding by fluid stained soil) at exactly 0902 h.



FIG. 2. Adult *Gopherus morafkai* drinking from catchment at waterfall following brief rainstorm; note that though the mouth remained closed, the head was completely submerged.

In the summer of 2012, we initially captured and tagged (with radio transmitter) a juvenile tortoise (160 mm straight-line carapace length at first capture) that subsequently (Fall 2013) moved almost 1 km to occupy a dike structure maintained by the Maricopa County (Arizona) Flood Control District (MCFCD). In early March 2014, it was relocated to the eastern slope of the Union Hills, exactly four weeks prior to the observations reported herein, as a result of requests by MCFCD personnel (maintenance of the dike required application of herbicides and associated use of heavy construction equipment). When the tortoise was moved, it voided (estimated as approximately 25–50 ml of fluid), and we were concerned that this individual might be compromised.

Thus, when we released the tortoise, we provided an opportunity for drinking by filling a series of rocky catchments at its release site, a small wash with many recently used tortoise refuges nearby, but we observed that it bypassed the artificial pools, and entered a caliche formation refuge without taking any water. Consequently, in the absence of rainfall, each subsequent tracking event was approached as an opportunity to rehydrate the subject (e.g., if found within a refuge, it was deemed unavailable for watering, etc.). On 20 April we located the individual in shade, in a relatively flat area in which we could place a small, round container of water (125 mm diameter, 20 mm deep), immediately anterior to the tortoise, in the hope it would drink despite the artificial nature of the situation.

The container was initially placed at 0840 h (air temp = 22°C) in the shade of large (2 m height) Palo Verde along a small wash on the eastern slopes of the Union Hills (33.72909°N; 112.05661°W, datum NAD27; elev. 527 m) in Maricopa Co., Arizona. Initially, the tortoise withdrew but one of us remained crouched ~ 1 m away so that we could provide additional water and reposition the container (which was tipped over twice by the subject and repositioned each time immediately to its front). On the third placement, after 15 min had elapsed, the tortoise allowed its head to be sprinkled with water as the container was refilled for the third time, and this seemed to finally stimulate a drinking response. The individual lowered its head into the water, tilting it at an almost 90° angle to the ground, and began to drink (Fig. 1), apparently through the nares. As with naturally observed drinking events (Fig. 2), the tortoise submerged the nares and mouth and did not open the mouth significantly; the throat region pulsed regularly during the entire process, once every few seconds. It consumed the entire contents, measured as ~ 200 ml, in 5 min and 11 sec, and then voided a dark, tea stained liquid (estimated as ~ 100 ml based on comparative estimates of water required to moisten a similar sized patch of nearby soil), and a viscous paste of pinkish urates (Fig. 1). The urates were passed immediately upon cessation of drinking, as it lifted its head from the water container, just over 5 min since the initiation of drinking.

Our observations suggest that researchers, if persistent, can achieve re-hydration of subjects that have voided during processing, and presumably mitigate increased mortality effects documented by Averrill-Murray (*op. cit*). In addition, our observations reveal that hydration allows for extremely rapid "flushing" of urate materials and a presumed reduction of any negative physiological consequences of their retention.

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GOPHERUS POLYPHEMUS **(Gopher Tortoise). PREDATION.** Known ophidian predators of *Gopherus polyphemus* eggs and hatchlings include: *Agkistrodon piscivorus*, *Crotalus adamanteus*, *Coluber flagellum*, and *Drymarchon corais* (Ernst and Lovich 2009. Turtles of the United States and Canada, 2nd ed., The Johns Hopkins University Press, Baltimore, Maryland. 827 pp). Additionally, Douglas and Winegarner (1977. J. Herpetol. 11:236–238) state, "Carr (1963) implied the pine snake, *Pituophis melanoleucus*, as a potential predator of the young [*G. polyphemus*] in Florida"; however, upon reviewing Carr 1963 (The Reptiles. Times Inc., New York. 192 pp.) we found no such implication. Herein we report a novel predator of *G. polyphemus* eggs.

On 16 July 2013 at 1210 h an adult female *P. m. lodingi* (SVL = 143.1 cm; tail length = 17.8 cm, 1030 g) was observed crossing a dirt road in the southwestern corner of the Camp Shelby Joint Forces Training Center, De Soto National Forest, Perry Co., Mississippi, USA. While processing the snake it was noted that she was a recapture (original capture date: 9 September 2004, estimated age and SVL at first capture 4 y.o. and 121.1 cm; respectively), overtly gravid, and the decision was made to retain the animal in captivity until oviposition (which took place 6 d later; clutch size = 5 eggs). On 12 September 2013 the snake defecated in the terrarium that she was temporarily housed in, and while examining the scat contents, the inner shell membrane of a *G. polyphemus* egg was found (pieces of the outer shell membrane were present where the egg had been folded over during ingestion/ digestion). To the best of our knowledge this is the first instance of a *G. polyphemus* in the diet of *P. melanoleucus*.

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GRAPTEMYS OUACHITENSIS **(Ouachita Map Turtle). INTERACTION WITH PREDATOR.** The risk of Raccoon (*Procyon lotor*) predation encountered by many North American freshwater turtles during terrestrial nesting forays (reviewed in Ernst and Lovich 2009. Turtles of the United States and Canada. Johns Hopkins University Press, Baltimore, Maryland. 840 pp.) has been suggested to have played a role in nesting schedules (e.g., sensu Congdon et al. 1983. Herpetologica 39:417–429), with larger turtle species that possess sufficient defense mechanisms (e.g., *Chelydra serpentina*, *Emydoidea blandingii*) having a wider temporal overlap with the largely crepuscular or nocturnal raccoons than smaller, diurnally nesting forms (e.g., *Chrysemys picta*). However, it is also understood that mammalian predation risks on adult turtles are but one of several factors that shape reproductive activity patterns (e.g., Bowen et al. 2005. J. Zool., London 267:397–404), including desiccation and temperature-related physiological constraints, and diurnal avian predation risks on turtle eggs and possibly adults of smaller species. The ultimate behavioral pattern that emerges for each species may thus reflect a complex balance of sometimes opposing selection pressures, making interpretations difficult (e.g., the nocturnal nesting of *Clemmys guttata*, one of the smallest of North American emydids and presumably one of the most vulnerable species to nocturnal mammalian predators (Litzgus and Brooks 1998. J. Herpetol. 32:252–259).

It has been suggested that the intensity of Raccoon predation on adult turtles may be skewed toward smaller individuals in some populations (e.g., West-central Illinois *Trachemys scripta*, Tucker and Janzen 1999. Am. Midl. Nat. 141:198–203). However, turtle size did not appear to influence predation likelihood for the large emydid, *Pseudemys concinna suwanniensis*, predated by the small–medium sized Raccoon races of northern Florida (Jackson and Walker 1997. Bull. Florida Mus. Nat. Hist. Biol. Sci. 41:69–167). Raccoon predation risks on nesting female turtles are also likely to be context dependent, differing in intensity with, among others factors, geographic location, meteorological effects on turtle and predator activity schedules, and time spent nesting, size of nesting areas and location within the surrounding land matrix, and local raccoon densities and behavior.

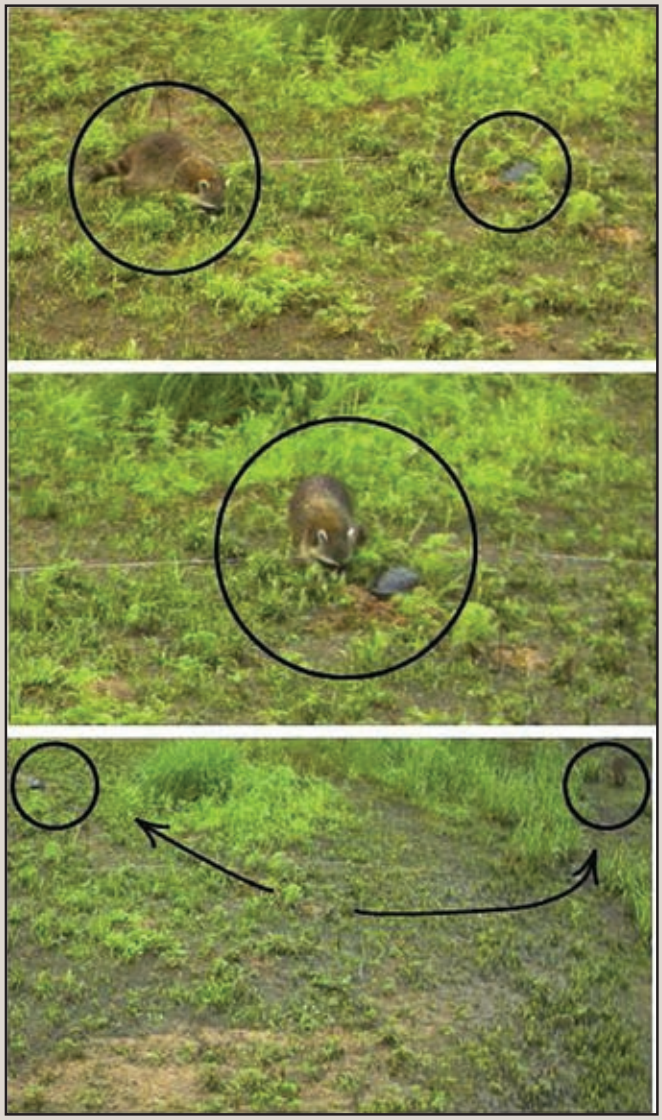


FIG. 1. Images one minute pre-encounter (top), encounter (middle) and one minute post-encounter (bottom) of nesting Ouachita Map Turtle (*Graptemys ouachitensis*) and Raccoon (*Procyon lotor*) interaction; 1940–1942 h, 15 June 2013, Iowa County, Wisconsin, USA.

This note reports observations of diurnally active Raccoons in camera-documented proximity to female Ouachita Map Turtles (*Graptemys ouachitensis*)—without evidence of turtle predation—during June 2013 at a Wisconsin River nesting site in Iowa County, Wisconsin, USA (described as Site A in Geller [2012. Chel. Conserv. Biol. 11:206–213]). Images were obtained using digital trail cameras (1 Reconyx HC600 HyperFire™ programmed to take time-lapse images at 1-min intervals and motion-triggered series; 3 Reconyx Silent Image™ RM30, with 5-min time-lapse intervals and motion-triggered series).

In an encounter on 15 June 2013 (1940–1942 h), a Raccoon detected a turtle approximately 16 minutes after beginning nest construction and possibly just prior to egg deposition, spent < 2 minutes near the nesting turtle, causing nest abandonment, and then both the Raccoon and the turtle departed the field-of-view on separate trajectories (Fig. 1). In Fig. 1 (middle), the raccoon is rearward of the nesting turtle and apparently focused on the ground, indicating an interest in turtle eggs rather than the turtle itself. In other instances, individual Raccoons were either present in the same camera field-of-view with transient turtles (15 June 2013) or within a few minutes of other nesting turtles (16 and 22 June 2013) without camera or subsequent field evidence (e.g., predated turtles near monitored areas) of physical interaction.

The influence of year-to-year variation in Raccoon activity schedules on the likelihood of turtle interaction was demonstrated at this site by the dramatic increase in diurnal Raccoon presence during the 2013 nesting season relative to previous years (31 vs. 2008–2011 mean of 2.25 raccoons, respectively, during 0600–1900 h; raccoon images separated by ≥ 30 min regarded as separate occurrences). The high visitation rates by nest foraging Raccoons and associated short nest survival times at this well-used nesting site (Geller 2012. Chel. Conserv. Biol. 11:197–205) suggest that turtle eggs deposited in this area are a known, dependable food resource to the local Raccoon population. While Raccoon predation on adult *Graptemys* has been reported elsewhere (Lindeman 2013. The Map Turtle and Sawback Atlas: Ecology, Evolution, Distribution, and Conservation. Univ. Oklahoma Press, Norman. 460 pp.), the lack of observed predation on adult turtles noted here may reflect the presence of this protein-rich resource in meeting Raccoon caloric demands (at least for diurnally foraging individuals with the potential to appropriate relatively high proportions of nests), and/or a potentially higher cost/benefit ratio of predating these medium-sized map turtles (females 163–242 mm straight line carapace length [Vogt 1980. Tulane Stud. Zool. Bot. 22:17–48]) relative to excavating and consuming eggs.

I thank John Iverson for his input and review of this report.

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***PHRYNOPS TUBEROSUS* (Peters' Side-necked Turtle). HATCHLING SIZE.** *Phrynops tuberosus* is a medium-sized (to 30 cm carapace length) chelid turtle found in Guyana, the southeastern portion of Venezuela, Suriname, French Guyana, the eastern Amazon basin, and northeastern Brazil (Ernst and Barbour 1989. Turtles of the World. Smithsonian Inst. Press, Washington, DC. 313 pp.; Bonin et al. 2006. Turtles of the World. Johns Hopkins University Press, Baltimore, Maryland. 416 pp.). This species is used for food and medicinal purposes by humans (Alves et al. 2012. J. Ethnobiol. Ethnomed. 8:1–29), but much of its natural history remains poorly known. Here we report the first morphometric data for hatchling *P. tuberosus*.

On 20 November 2013, during faunal rescue operations resulting from the Project of Integration of São Francisco River (PISF), we collected three turtle eggs, hitherto of unknown species. The eggs were located in an area that will be the site of a dam of the Morros Reservoir (7.14726°S, 38.59988°W), in the municipality of São José de Piranhas, state of Paraíba, Brazil. The collection site was a small area with an accumulation of water (approximately 5 m long × 2 m wide), which was already drying, where a tractor was clearing low vegetation that had formed a dense cover over the ground. Of the three eggs collected, two remained intact and were placed in a folded tissue, which was wrapped in a plastic bag sealed with adhesive tape, and taken to the hotel hosting the rescue team. In this condition the eggs were kept at ambient temperature and humidity. On 23 November 2013 two hatchlings were found (Fig. 1) between the tissue and plastic bag. They were taken to the Laboratório de Morfofisiologia of the Núcleo de Ecologia Molecular (NECMOL) in the Centro de Conservação e Manejo de Fauna da Caatinga (CEMAFAUNA-CAATINGA)

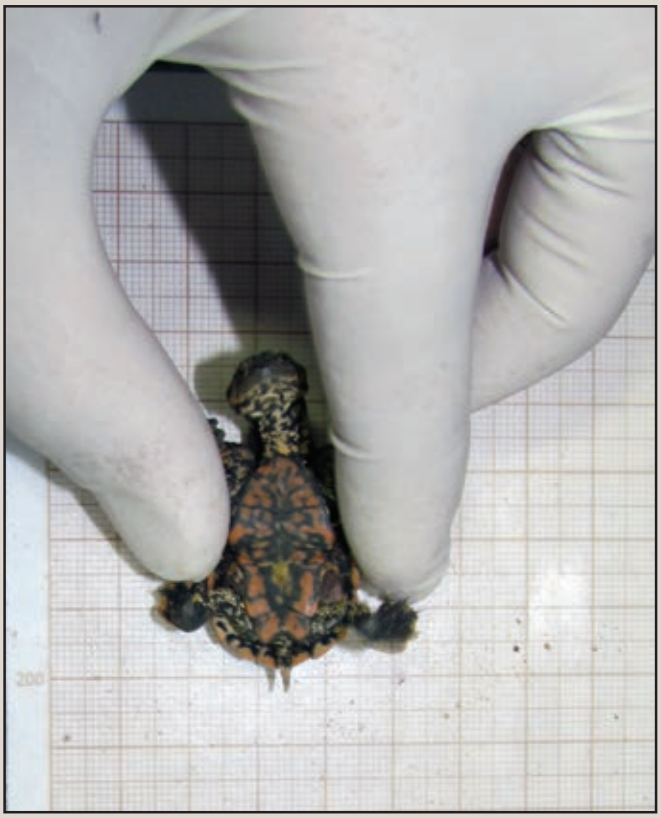


FIG. 1. Plastron view of hatchling *Phrynops tuberosus* (carapace length: 31.9 mm, plastron length: 24.9 mm).

where they were identified (Ernst and Barbour, *op. cit.*; Bonin et al., *op. cit.*), and measured using a digital caliper (precision = 0.01 mm); body mass was measured with a precision balance (1 g).

Morphometric data for the two hatchlings follows: carapace length (CL of turtle 1: 31.9 mm, CL of turtle 2: 30.3 mm), carapace width (CW1: 22.8 mm, CW2: 19.7 mm), shell height (SH1: 10.5 mm, SH2: 9.8 mm), plastron length (PL1: 24.9 mm, PL2: 23.8 mm), plastron width (PW1: 15.4 mm, PW2: 13.8 mm), body mass (BM1: 4.3 g, BM2: 3.9 g). In comparison, Ferreira Júnior et al. (2011. Zoologia 28:571–576) reported the weight and size for 83 hatchlings of the closely related *P. geoffroanus*, hatched in natural nests on sandy beaches along the Upper Xingu River in the Brazilian Amazon Basin: mean carapace length (38.3 ± 2 mm; range = 31.5–41.3), carapace width (30.1 ± 1.83 mm; range = 24.7–33.6), height of shell (13.9 ± 1.06 mm; range = 11.3–16.1), and mean hatchling mass (9.1 ± 1.4 g; range = 6–11.5).

The specimens of *P. tuberosus* (MFCH 3352–3353) were deposited in the Herpetological Collection of the Centro de Conservação e Manejo de Fauna da Caatinga (CEMAFAUNA-Caatinga/UNIVASF), Petrolina, Pernambuco, Brazil. We thank the Ministério da Integração Nacional for financial support. IBAMA provided the collecting permit (# 95/2012 Process n° 02001.003718/94-54).

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***PODOCNEMIS SEXTUBERCULATA* (Six-tubercled Amazon River Turtle). MOVEMENT.** *Podocnemis sextuberculata* is a small Amazonian freshwater turtle found in Colombia, Brazil, and Peru (Vogt 2008. Amazon Turtles. Biblos, Lima, Peru. 104 pp.). This species has a dynamic movement pattern influenced by the variable hydrological regime of its habitat (Fachin-Terán et al. 2006. Chelon. Conserv. Biol. 5[1]:18–24). During the high water season, individuals remain in lakes and flooded forest. As water levels begin to fall, turtles move into the main river channel, where adult males and females concentrate in deep pools near the nesting beaches (Fachin-Terán et al. 2006, *op. cit.*; Vogt 2008, *op. cit.*). As the water level again starts to rise after the nesting season, the turtles return to the lakes and flooded forest.

Since 2006, RCV and collaborators have been systematically monitoring the population structure and movement patterns of freshwater turtles in the Trombetas River Biological Reserve (1.25°S, 56.83°W; WGS84), a reserve maintained by the Brazilian government in Oriximiná, Pará State, Brazil. According to monitoring results, the *P. sextuberculata* female recapture rate is low and the sex ratio is always male-biased. To understand these results, we conducted a radio telemetry study to investigate the post-nesting behavior of female *P. sextuberculata*.

The field study was conducted from September to December, in 2010, 2011, and 2012. This is the dry season in the Trombetas River region, when the water level is lowest and females are easily captured on the nesting beaches or in nearby deep pools along the main river channel. We captured eleven *P. sextuberculata* post-nesting females by hand or using trammel nets; for each we attached a radio transmitter (AVM Instrument Company, California, USA; MP2 Model) on 5th central carapace scute with Turbolit, an epoxy based product. The 164–165 MHz transmitters had a programmed battery life of one to two years. Movements based on radio telemetry were summarized for each individual and all the distances were measured in a straight line from release point to transmitter location point. The females had a mean straight-line carapace length of 289.63 mm (N = 11; SD = 9.83; 286–318 mm) and mean mass of 2805 g, SD = 292 (2150–3200 g).

In 2010, 2011, and 2012 field seasons, five, two, and four females, respectively, were monitored using radio telemetry. In 2010, four turtles were located 98 times, up to ten days after release. After this period we lost the signals. In 2011, one turtle was located three times during six days (last location: 5 October 2011) and the other was located five times during ten days (last location: 8 October 2011). On 22 November 2012 both of the females from 2011 as well as the four marked in 2012 were located in the Pracuuba Stream, a tributary of Erepecu Lake, at a water depth of 1.06–2.54 m (Fig. 1). This area is 10 km in straight line distance from the last location noted in 2011, but these turtles move via water, so the actual distance is about 60 km, following the most direct route within the lake and river channels (Fig. 2).

Females with radio transmitters attached in 2012 were located 29 times during 3 months. One turtle was released on 26 September 2012 and monitored for 12 days until 7 October 2012. Forty-five days later, on 22 November 2012, this turtle was found 10 km away from the last location in the Paracuuba Stream together with the other three marked in 2012 and the two from 2011. All were found in the same small area, where they were probably feeding on mollusks. Notably, we found two of the 2012 females back at



FIG. 1. Pracuuba Stream, a tributary of Erepecu Lake, at a water depth of 1.06–2.54 m, both of the females from 2011 as well as the four marked in 2012 were located here on 22 November 2012.

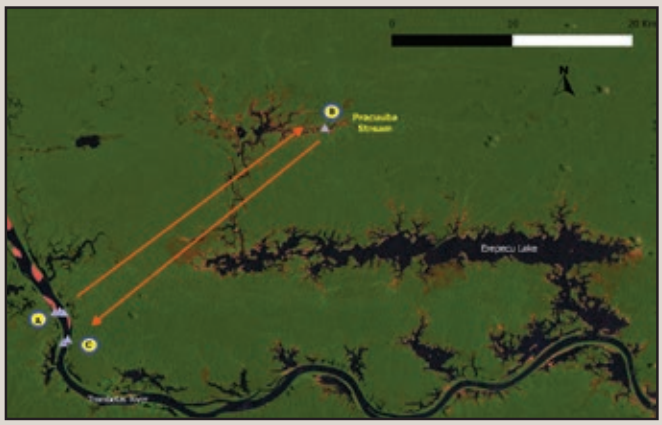


FIG. 2. Satellite image of movement patterns of the *Podocnemis sextuberculata* females from the nesting beach to Pracuuba Stream in Erepecu Lake.

the nesting beaches on 6 December 2012 in the Trombetas River where they were originally marked during the nesting season. This involved a displacement of 60 km upstream against the current in 12 days or less. Nesting had terminated in October, and these females had returned to the nesting beach at the time their eggs were due to hatch. Behavioral interactions and audible communications between adults and hatchlings have recently been described for the Giant South American River Turtle (*Podocnemis expansa*). It is now thought that adults of this species wait off the nesting beaches for their hatchlings to emerge and then migrate downstream with them (Ferrara et. al. 2014. Herpetologica, *in press*). Thus, the possibility of group social behavior must also be studied in *P. sextuberculata*.

Gathering movement data and understanding the detailed patterns of turtle movements are necessary for recommending management or conservation programs for them. Nesting beach requirements are well known, but this new data on home range, which is apparently nearly as great as that of the larger *P. expansa*, is a notable discovery. We lost track of the females marked in 2011 and 2012 because they had ranged much farther than predicted, and into a habitat that they previously were not known to use. Our data show that post-nesting *P. sextuberculata* females migrate to particular feeding areas and that at least some of them return to the nesting beaches at the time the hatchlings are emerging. Describing the social behavior in this species, including the possibility of vocal communication, will warrant further research.

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***RHINOCLEMMYS AREOLATA* (Furrowed Wood Turtle). MAXIMUM SIZE AND MASS.** The maximum size previously reported for *Rhinoclemmys areolata* is a straight-line carapace length of 20.7 cm, obtained from an intact shell of a gravid female found in Belize (Platt et al. 2004. Herpetol. Rev. 35:383). The maximum body mass reported for the species seems to be also from a female from Belize weighting 930 g (Vogt et al. 2009. Chelon. Res. Monogr. 5:022.1–022.7).

On 19 February 2014, during turtle sampling at Pochote (17.76236°N 91.73963°W, datum WGS84; elev. < 10 m), Emiliano Zapata Municipality, State of Tabasco, México, we measured a captive female *R. areolata* with a carapace length of 24.0 cm and a body mass of 1550 g. Other parameters measured were the plastron length (22.7 cm), carapace high (84.33 mm), carapace maximum width (15.8 cm), and head width (30.7 mm). The owners of the turtle told us that the specimen was collected between the Chaschoc lagoon and Nuevo Pochote, about 8 km N of this locality. On 5 March 2014, we measured another captive female of *R. areolata* at the locality of La Isla (17.75756°N, 91.73421°W, datum WGS84; elev. < 10 m) in the same municipality, which surpassed the maximum size given by Platt et al. (2004, *op. cit.*). The individual had a carapace length of 21.1 cm and a mass of 1440 g. The other parameters were plastron length (19.3 cm), carapace high (63.31 mm), carapace maximum width (15.1 cm), and head width (26.0 mm). These females and other individuals of *R. areolata* are kept as pets by local people, and this seems to be the principal use of this species by humans in the region.

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***SIEBENROCKIELLA LEYTENSIS* (Philippine Forest Turtle). DIET.** *Siebenrockiella leytensis* is an endemic geoemydid



FIG. 1. *Siebenrockiella leytensis* fecal pellets with snail shell fragments (EYS 266; square = 5 mm).



FIG. 2. *Siebenrockiella leytensis* fecal pellets with rice grains (EYS 265; square = 5 mm).

turtle from Palawan and Dumaran Island, Philippines. Its diet is known to consist of fish, shrimp (genus *Macrobrachium*), crabs, snails (*Pomacea canaliculata* and family Thiaridae), algae, and fruits (genus *Ficus*) (Diesmos et al 2012. Chelon. Res. Monogr. 5:066.1–9; Diesmos et al 2008. Chelon. Conserv. Biol. 7:157–177). Here we report on additional food items in the diet of this turtle.

While conducting wildlife trade research in a Metro Manila pet center, EYS collected seven fecal pellets between 28 November 2012 and 17 December 2012 from multiple wild-caught *S. leytensis* (SCL 71–193 mm; gender undetermined; N = 30). Snail shell fragments were identified as *Pomacea canaliculata* (an invasive species in the Philippines), *Melanoides* sp. (family Thiaridae) and *Planorbis brunneus* (family Planorbidae) (Fig. 1). Six out of seven fecal pellets also contained rice grains (*Oryza sativa*) (Fig. 2). To our knowledge, this is the first report of rice in the diet of a Philippine turtle.

Voucher specimens were preserved in 70% ethanol and deposited in the herpetological collection of the Philippine National Museum (EYS 263–265, and EYS 267) and malacological collection of the University of the Philippines, Diliman (EYS 262, EYS 266, and EYS 271).

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CROCODYLIA — CROCODILIANS

***ALLIGATOR MISSISSIPPIENSIS* (American Alligator). CANNIBALISM.** Cannibalism, broadly defined as the consumption of conspecifics through predation or scavenging (Fox 1975. Annu. Rev. Ecol. System. 6:87–106; Polis and Myer 1985. J. Herpetol. 19:99–107), has been reported to occur in several species of crocodilians (Pitman 1941. Uganda J. 9:89–114; Polis and Myer, op. cit. and references therein; Messel and Vorlicek 1986. Austral. Wildl. Res. 13:71–111; Richards and Wasilewski 2003. Herpetol. Rev. 34:371; Somaweera et al. 2013. Herpetol. Monogr. 27:23–51), including *Alligator mississippiensis* (Giles and Childs 1949. J. Wildl. Manage. 13:16–28; Rootes and Chabreck 1993. Herpetologica 49:99–107; Delany et al. 2011. Herpetologica 67:174–185). Cannibalism among crocodilians remains poorly understood, but suggested causes include food availability, population density, demographic factors, and habitat characteristics (Rootes and Chabreck, *op. cit.*; Delany et al., *op. cit.*). Cannibalism among crocodilians may regulate population size and serve as an important energy loop (Polis 1981. Annu. Rev. Ecol. System. 12:225–251; Rootes and Chabreck, *op. cit.*; Delany et al., *op. cit.*). Here we report three field observations of apparent cannibalism among wild *A. mississippiensis* from two locations in Louisiana, USA.

The first observation was made during July 1983 on Rockefeller Wildlife Refuge (Cameron Parish, Louisiana, USA) when RME found the carcass of a small alligator (total length [TL] approximately 1.3 m) floating in a drainage ditch adjacent to an active alligator nest. When a coworker attempted to retrieve the carcass with a noose pole, the nesting female alligator (TL ca. 2.1 m) swam rapidly across the ditch from the nest site, seized the carcass at the base of the tail, and swam back to the nest. Once at the nest, the female climbed up the bank dragging the carcass partially out of the water. The nesting female was identified by a series of marked caudal scutes as an escapee from a captive breeding enclosure on the refuge. Based on the behavior of the nesting female, we assume she was responsible for the death of the smaller alligator. Because female alligators actively defend nests against potential predators (Hunt and Ogden 1991. J. Herpetol. 25:448–453), the heightened aggressiveness of the attending female may have played a role in this incident. The ultimate fate of the alligator carcass could not be determined, but we suspect the female may have cached it nearby (Doody 2009. Herpetol. Rev. 40:26–29).

The second observation occurred on 24 June 2013 (1319 h) when PLT and a co-worker were flying in a helicopter at an altitude ≤ 46 m marking alligator nests as part of an on-going research project at Rockefeller Wildlife Refuge. While flying at low level over the Superior Canal System along Josephine Bayou, a large adult alligator was observed beside the carcass of a smaller adult; the latter was floating ventral side up and the tail was missing, presumably eaten by the larger alligator. The bloated condition of the carcass suggested the alligator had been killed at least 24 h prior to our observation. The TL of the larger and smaller alligator were estimated to be 3.3 m and 1.8–2.1 m, respectively.

PHOTOGRAPH BY PHILLIP L. TROSCLAIR, III



FIG. 1. An American Alligator (TL ca. 3.3 m) consuming the carcass of a smaller conspecific near Lake Des Allemands, St. Charles Parish, Louisiana.

Because adult female *A. mississippiensis* in Louisiana rarely exceed 2.7 m in TL (Joanen et al. 1984. Proc. Annu. Conf. Southeast Assoc. Fish Wildl. Agencies 38:201–211), the body size of the larger alligator strongly suggests it was a male.

The third observation was made on 1 July 2013 (1425 h) while PLT and JTL were flying transects and counting alligator nests as part of an annual population census of *A. mississippiensis* in coastal Louisiana (McNease et al. 1994. *In* Crocodiles: Proceedings of 12th Working Meeting of IUCN/SSC Crocodile Specialist Group, pp. 108–120, IUCN Publications, Gland, Switzerland). While flying in a helicopter at an altitude of approximately 46 m over an extensive freshwater marsh surrounding Lake Des Allemands (St. Charles Parish), a large alligator (TL ca. 3.3 m) was observed with the carcass of a smaller alligator held between its jaws (Fig. 1). The larger alligator was consuming the carcass when interrupted by the low-flying aircraft. The condition of the carcass suggested the smaller alligator had been killed only a short time (< 12 h) before our arrival. Although the body size of the carcass was difficult to determine because of extensive damage to the head and torso, we estimate its TL was between 1.8 and 2.1 m. As the helicopter hovered overhead, the larger alligator grasped the carcass and submerged beneath the floating marsh vegetation. As in the previous 2013 observation, the body size of the larger alligator indicated it was most likely a male.

Our observations of cannibalism by *A. mississippiensis* are noteworthy for several reasons. First, previous reports have inferred cannibalism from the presence of alligator remains or metal marking tags in stomach contents (Giles and Childs, *op. cit.*; Delany and Abercrombie 1986. J. Wildl. Manage. 50:348–352; Platt et al. 1990. Northeast Gulf Sci. 11:123–130; Rootes and Chabreck, *op. cit.*; Delany et al., *op cit.*), and direct observations of cannibalistic behavior among wild *A. mississippiensis* appear lacking in the scientific literature. Such observations are important because although stomach contents analyses are useful for determining dietary composition, this methodology reveals little about the foraging mode (i.e., predation vs. scavenging), which is crucial to understanding cannibalism as a trophic pathway (DeVault and Phodes 2002. Acta Theriol. 47:185–192). In this regard our observations are significant, as all three appear to be instances of predation rather than scavenging, a foraging mode that is common among crocodilians (Pitman, *op. cit.*; Atwell 1959. African Wildl. 13:13–22; Platt et al. 2007. Southwest. Nat. 52:310–317). Second, our observations occurred at two widely separated (> 200 km) locations and when combined with other reports from Louisiana (Giles and Childs, *op. cit.*; Taylor 1986. Proc. Ann. Conf. Southeast. Assoc. Game Fish Comm. 40:338–341; Platt et al., *op. cit.*; Rootes and Chabreck, *op. cit.*) suggest that cannibalism probably occurs in alligator populations throughout the state. Finally, our observations support the conclusion of Rootes and Chabreck (*op. cit.*) that large adult alligators (TL > 2.73 m) prey almost exclusively on large subadult and small adult conspecifics (TL = 1.2–2.1 m) rather than juveniles (TL < 1.2 m).

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SQUAMATA — LIZARDS

***AGAMA ANCHIETAE* (Anchieta's Agama). DIET.** *Agama anchietae* occurs from southern Democratic Republic of the Congo, south through Angola, Namibia, and into northwestern South Africa. Although little is known about the diet of *Agama anchietae*, southern African lizards in the genus *Agama* are known to feed heavily on ants, including ants in the genera *Pheidole*, *Crematogaster*, and *Anoplolepis* (Branch 1998. Field Guide to Snakes and Other Reptiles of Southern Africa. Struik Publishers, Cape Town. 399 pp.; Heideman 2002. J. Herpetol. 36:515–520). The only published dietary information for *A. anchietae* is that it feeds on termites and small beetles (FitzSimons 1943. The Lizards of South Africa. Transvaal Museum, Pretoria. 528 pp.). Recent observations made in the Swakop River Valley, in the west-central part of the Namib-Naukluft National Park, Namibia (22.70014°N, 14.91606°W, WGS84; elev. 194 m) extend the known diet of *A. anchietae*. On 12 May 2013 at 0949 h an adult female *A. anchietae* was noosed on a rocky hillside. Body temperature immediately after capture was 34.8°C, ground surface temperature in full sun was 33.9°C, and air temperature 10 mm above ground surface was 25.9°C. Upon capture the lizard regurgitated a large bolus of small ants (> 50 ants) that were later identified to be from the *Lepisiota capensis* species group (Marsh 1986. Madoqua 14:333–344; www.antsofafrica.org, accessed 17 January 2013). Upon closer examination it was revealed that the lizard had been situated adjacent to, and feeding from, a large aggregation of *Lepisiota* ants on the rock face. To our knowledge this is the first report of *A. anchietae* feeding on this small, ubiquitous ant, and adds to the paucity of data concerning its diet.

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FIG. 1. Predation of *Amphisbaena vermicularis* by *Apostolepis cearensis*.

***AMPHISBAENA VERMICULARIS*. PREDATION.** The natural history of amphisbaenians is poorly known, probably due to their fossorial habits (Gans and Amdur 1966. Proc. California Acad. Sci. 33:69–90; Filho et al. 1996. Scitientibus 14:57–68). *Amphisbaena vermicularis* is probably a species mainly of Caatinga and Cerrado that just enters eastern Amazonia (Hoogmoed and Ávila-Pires 1991. Bol. Mus. Para. Emílio Goeldi. sér. Zool. 7[1]:77–94), known from the Brazilian states of Pará to Minas Gerais, Mato Grosso, and Mato Grosso do Sul (Gans and Amdur, *op. cit.*; Vanzolini et al. 1980. Répteis das Caatingas. Acad. Bras. de Ciênc., Rio de Janeiro. 161 pp.; Uetanabaro et al. 2007. Biota Neotropica 7:279–289). Here, we report predation of *A. vermicularis* by the snake *Apostolepis cearensis* (Fig. 1).

On 1 February 2012 at 0700 h in the semiarid region of Bahia (9.876173°S, 41.07277°W), about 50 km from the city of Sobradinho we photographed an *Apostolepis cearensis* consuming an *Amphisbaena vermicularis* in the open and above ground. The recording took place at the time the snake had grabbed the head of amphisbaenian, which in turn revolved around its own axis in an attempt to escape the attack. *Apostolepis* snakes are known predators of amphisbaenians (Gomes et al. 2005. Herpetol. Rev. 36:170). There is one record of predation of *A. vermicularis* by *Micrurus ibiboboca* (Lisboa and Freire 2010. Herpetol. Rev. 41:73). *Apostolepis cearensis* can prey on small snakes such as *Tantilla melanocephala* (Mesquita et al. 2009. Herpetol. Rev. 40:440), but amphisbaenians have not been reported. This is a new predator record for *A. vermicularis* and also a new record of prey for *A. cearensis*.

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***ANOLIS LIOGASTER* (Guerreran Anole). CANNIBALISM.** *Anolis liogaster* is a Mexican endemic (Muñoz-Alonso and Flores-Villela 1990. Cat. Amer. Amph. Rept. 489:1–2) and information on the natural history of this species is lacking. *Anolis* lizards have previously been reported to eat other lizards (Griffith and Wingate 1994. Herpetol. Rev. 25:26) but our observation reported herein is the first known record of cannibalism in *A. liogaster*, although this behavior has been reported in other members of the genus (Gerber 1999. *In* Losos and Leal [eds.], 1999. Anolis Newsletter V, pp. 28–39).



FIG. 1. Adult specimen of *Anolis liogaster* and a partially digested juvenile.

On 19 January 2014, in Chilpancingo, Guerrero, Mexico, we collected a male *A. liogaster* that had previously been captured by a Domestic Cat (*Felis catus*). We noticed the lizard specimen had a food bolus partially protruding from its mouth, which we identified as a partially digested juvenile of the same species (Fig. 1). We hypothesize that this behavior is a response to the disturbed, urban habitat or a consequence of high population density, resulting in the elimination of both natural predators and natural prey items.

The *Anolis liogaster* specimens were deposited in the Museo de Zoología Facultad de Ciencias as MZFC 28671 for the adult and MZFC 28672 for the juvenile prey item.

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***ANOLIS SAGREI* (Brown Anole). ABSCESS.** *Anolis sagrei* is native to Cuba, the Bahamas, and Jamaica, but has been introduced to many Caribbean countries and islands, including the Yucatán Peninsula where it is widespread in coastal areas (Lee 1996. The Amphibians and Reptiles of the Yucatán Peninsula. Cornell Univ. Press, Ithaca, New York. 500 pp.). Recently, it has been reported in the Banco Chinchorro Biosphere Reserve, an atoll located 31 km off the coast of the state of Quintana Roo, México (Charruau et al. Herpetol. Conserv. Biol., *in press*). During fieldwork on the reserve in April 2012, we captured five individual *A. sagrei* with deformations, abscesses, and swelling in their jaws, principally at the point of the mouth. We collected just one lizard (CNAR IBH 26868) for observations and determination of the nature of the wounds in laboratory. Two abscesses were removed via surgery and the lizard was maintained in a terrarium for 10 months, offered mealworms (*Tenebrio molitor*) and water *ad libitum*. Six months after the first surgery, the swelling came back at the same part of the jaw and we removed the tissue for analysis. We sent a swab from the tissue for bacterial culture and antibiogram; these laboratory tests obtained bacterial cultures of the genera *Streptococcus* and *Staphylococcus*, which are considered opportunistic pathogens (Huchzermeyer 2003. Crocodiles: Biology, Husbandry and Diseases. Onderstepoort Veterinary Institute, South Africa. 337 pp.). During the capture of *A. sagrei* we observed that

these lizards fed on the eggs of ants and in some cases the ants bit the lizards, principally in the mouth. We suggest that the wound caused by the ant bites could provoke the swelling and then infection leading to abscess. After eight months the lizard could not feed by itself and was fed manually.

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***ANOLIS SAGREI* (Brown Anole). CANNIBALISM.** *Anolis sagrei* is native to the Bahamas and Cuba, but has been introduced to many tropical regions around the world (Kolbe et al. 2004. Nature 431:177–181). Although *A. sagrei* primarily eats invertebrates, it will sometimes consume other anoles (Losos 2009. Lizards in an Evolutionary Tree: Ecology and Adaptive Radiation of Anoles. University of California Press, Berkeley. 528 pp.). For example, adult *A. sagrei* are more likely to consume heterospecific juveniles than conspecifics given a choice (Gerber and Echternacht 2000. Oecologia 124:599–607). Nevertheless, cannibalism does occur in *A. sagrei* (Nicholson et al. 2000. Herpetol. Rev. 31:173–174), but in most other documented cases of *Anolis* cannibalism, the cannibalistic adult was a male rather than a female. Cannibalism by females is rare and has only been reported twice among anole species, once each in *A. cristatellus* and *A. whitemani*. One record was based on an autotomized tail found in stomach contents of a female, yet anoles will consume their own and others' shed tails (Gerber 1999. *In* Losos and Leal [eds.], 1999. Anolis Newsletter V, pp. 28–39). Additionally, a laboratory experiment demonstrated that adult female anoles ignore juveniles, whereas adult males attempt cannibalism more frequently (Stamps 1983. Behav. Ecol. Sociobiol. 12:19–33).

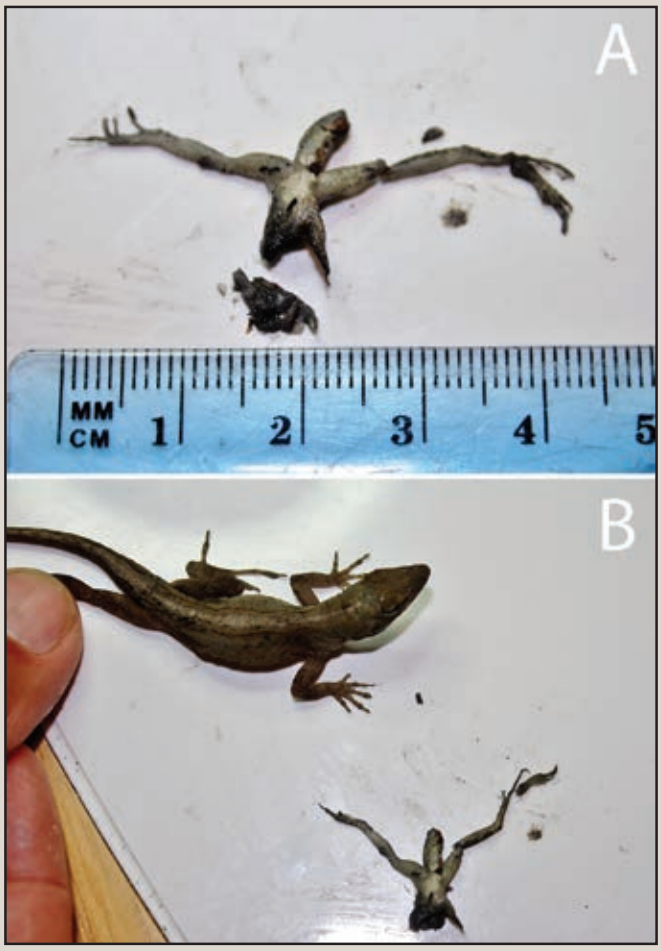


FIG. 1. Regurgitated carcass of a juvenile *Anolis sagrei* (A), and the cannibalistic adult female (B).

During our research on spoil islands in the Matanzas River near Palm Beach, Florida, USA (29.64°N, 81.21°W; WGS84), we collected an adult female *A. sagrei* that regurgitated a partially digested juvenile *A. sagrei* with only the posterior half of the abdomen, the hind legs, pelvic region, and partial tail remaining. The adult female was measured (mass = 2.63 g; SVL = 48 mm; TL = 78 mm) but the remnants of the carcass precluded accurate measurement of the cannibalized juvenile (Fig. 1). However, we identified the juvenile as female based on the absence of enlarged post-cloacal scales. To our knowledge, this is the first report of cannibalism by an adult female *A. sagrei*.

Past studies of *Anolis* suggest that competition is the primary selective force in island populations, whereas predation is more prominent in mainland populations (Calsbeek and Cox 2010. Nature 465[7298]:613–616). Depending on the frequency of cannibalism in *A. sagrei* populations, both forces may be at work because predation on young individuals by adults can influence future competition, and hence impact community structure and population dynamics (Gerber and Echternacht 2000. Oecologia 124:599–607). Thus, the role of cannibalism in driving ecological and evolutionary processes in *A. sagrei* may be particularly strong, and warrants more study.

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***ANOLIS SAGREI* (Brown Anole). EGG PREDATION.** *Anolis sagrei* is native to many islands throughout the West Indies, and invasive populations have expanded throughout Florida primarily over the last half-century (Kolbe et al. 2004. Nature 431:177–181). Similar to other anoles, *A. sagrei* produces a single-egg clutch and oviposits at regular intervals (about every 7–10 days) throughout the reproductive season (Cox and Calsbeek 2010. Evolution 64[5]:1321–1330). At present, little is known about anole oviposition behaviors, but laboratory studies suggest that females choose oviposition sites with suitable conditions for embryo development (Socci et al. 2005. Herpetologica 61:233–240; Reedy et al. 2013. Behav. Ecol. 24:39–46). Although females tend to select sites with proper ambient conditions, some eggs still succumb to mortality. Predation could be a major factor driving variation in egg mortality in the field. For example, studies of *A. limifrons* demonstrate that leaf litter invertebrates (*Solenopsis* ants, *Salasiella* snails) contribute to egg mortality (Andrews 1982. Herpetologica 38:165–171; Chalcraft and Andrews 1999. Oecologia 119:285–292). Here, we report that marsh crabs may be another important predator of *Anolis* eggs.



FIG. 1. *Armases cinereum* with partially consumed anole egg.

While surveying populations of *Anolis sagrei* on spoil islands in the Matanzas River near Palm Beach, Florida, USA (29.64°N, 81.21°W; WGS 84) on 2 October 2013, we observed a Gray Marsh Crab (*Armases cinereum*) actively consuming an anole eggshell. The crab was measured (carapace length: 10 mm, carapace breadth: 1.2 mm, claw length: 8 mm) and photographed (Fig. 1). Gray Marsh Crabs are semi-terrestrial and found from high intertidal zones to 50 m inland. They have a broad distribution along the eastern coast of the United States, and into Veracruz, Mexico (Abele 1992. Smithson. Contrib. Zool. 527:30–31). Gray Marsh Crabs readily eat fresh plant material, carrion, and organic matter picked from sediments, but they also actively stalk small crustaceans and feed on soft-bodied invertebrates and small mollusks (Buck et al. 2003. J. Exp. Mar. Biol. Ecol. 292:103–116). Although we do not know if the crab killed the egg or if it was eating the eggshell after the hatchling emerged, this observation suggests that marsh crabs opportunistically eat anole eggs.

The spoil islands where we work have extremely high densities of Gray Marsh Crabs and fiddler crabs (*Uca* sp.). In addition, because of the high abundance of hatchling *A. sagrei* during late summer, we suspect that egg density at this time is also very high, allowing for crabs to come into contact with both incubating and hatched eggs. Indeed, crabs are often observed in the same microhabitats as anole eggs (Delaney et al. 2013. Herpetol. Rev. 44:314). The ability of *A. cinereum* to eat hard-shelled mollusks suggests that this species could also consume both intact and hatched anole eggs. Because *A. sagrei* lays eggs slightly below the surface of the ground in moist soil (unpubl. data), this oviposition location provides ample opportunity for interactions between eggs and marsh crabs. Although the observed eggshell being consumed could have been from *A. carolinensis*, it is more likely from *A. sagrei* given the substantially higher density of this species at our study site. Native *A. sagrei* populations are outside the geographic range of *A. cinereum*, but similar species of marsh crabs (genera *Sesarma* and *Armases*) in the Caribbean suggest that *Anolis* lizards and *Armases* crabs have probably had interactions over the course of their evolutionary history.

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***ASPIDOSCELIS SEXLINEATA SEXLINEATA* (Six-lined Racerunner). SUPERNUMERARY CAUDAL ANOMALIES AND A BIFID TAIL.** We provide evidence that different types of wounds to the tail of an individual of *Aspidoscelis sexlineata sexlineata* can stimulate a range of responses including simple healing (i.e., closure of the wound), restoration (i.e., regeneration of the tail), development of a bifurcation (i.e., growth of a supernumerary second tail branch, Fig. 1A), or production of a cluster of supernumerary caudal extensions (i.e., growth of multiple tail branches, Fig. 1B–C). Consequently, this report expands the literature on caudal anomalies beyond references to tail bifurcation reported for an increasing number of lizard species (e.g., see Bateman and Chung-MacCoubrey 2013. Herpetol. Rev. 44:663; Vrcibradic and Niemeyer 2013. Herpetol. Rev. 44:510–511). The earliest report of a bifid tail in *A. sexlineata* known to us was published in Scientific American nearly 100 years ago (Anonymous 1915. Sci. Amer., p. 479)—that of a lizard from South Carolina. For a contemporary perspective, the examples of caudal anomalies in the three *A. sexlineata* from Alabama depicted in Fig. 1A–C are the only ones we have collectively observed in this species among several thousand specimens examined from Colorado, New Mexico, Texas, Kansas, Missouri, Louisiana, Arkansas, Oklahoma, Mississippi, Alabama, Georgia, Florida, South Carolina, and Tennessee. The recently published note (Cordes and Walker 2013. Herpetol. Rev. 44:319) on two triploid parthenogenetic *A. velox* from Utah are also the only other examples of bifid tails that can be recalled among the thousands of specimens of other species of *Aspidoscelis* examined by JMW.

From 1976–1979, SET studied the systematics (Trauth 1980. Ph.D. Dissertation, Auburn University) and natural history (Trauth 1983. Amer. Midl. Nat. 109:289–299) of *Aspidoscelis sexlineata* (= *Cnemidophorus sexlineatus*) across much of the southeast and south-central United States (Trauth and McAllister 1996. Cat. Amer. Amph. Rept. 628.1–628.12). In Alabama, only three of 201 specimens of *A. s. sexlineata* examined by SET expressed caudal anomalies other than simple tail regeneration. Two of them exhibited multiple fractures and subsequent growths of supernumerary tails (Fig. 1A–C). The phenotypically altered lizards (SET 2333; Auburn University Museum = AUM 27525; SET 2313) were collected from three south-central counties (Autauga, 32.70166°N, 86.48889°W; Chambers, 32.89288°N, 85.23701°W; Elmore, 32.57513°N, 85.94301°W, respectively). Each lizard was excavated from either activity or hibernation burrows in mostly well-drained red clay exposures, which faced S to W along secondary highways or rural dirt roads.

In SET 2333 (male, 64 mm SVL), the bifurcation developed immediately distal to the ~43rd whorl of caudal scales as the probable result of a moderately severe injury, leaving the original tail capable of growth and with an essentially anatomically normal appearance. The resulting supernumerary tail is almost as long as the original and possesses the types of scales typical of a regenerated portion of a tail (Fig. 1A). The result is what we term the classical bifid tail. In AUM 27525 (male, 74 mm SVL), the supernumerary aggregate of caudal extensions developed as a trifurcation immediately distal to the ~57th whorl of caudal scales as the probable result of multiple wounds, leaving the original tail incapable of normal growth and anatomically abnormal in appearance. A few mm distal to the trifurcation, the original tail has a bifurcation (Fig. 1B), the whole array being what we term supernumerary caudal extensions. In SET 2313 (female, 75 mm SVL), a trifurcation has developed immediately distal to the ~52nd whorl of caudal scales as the probable result of a complex wound, leaving the original tail incapable of normal growth and anatomically

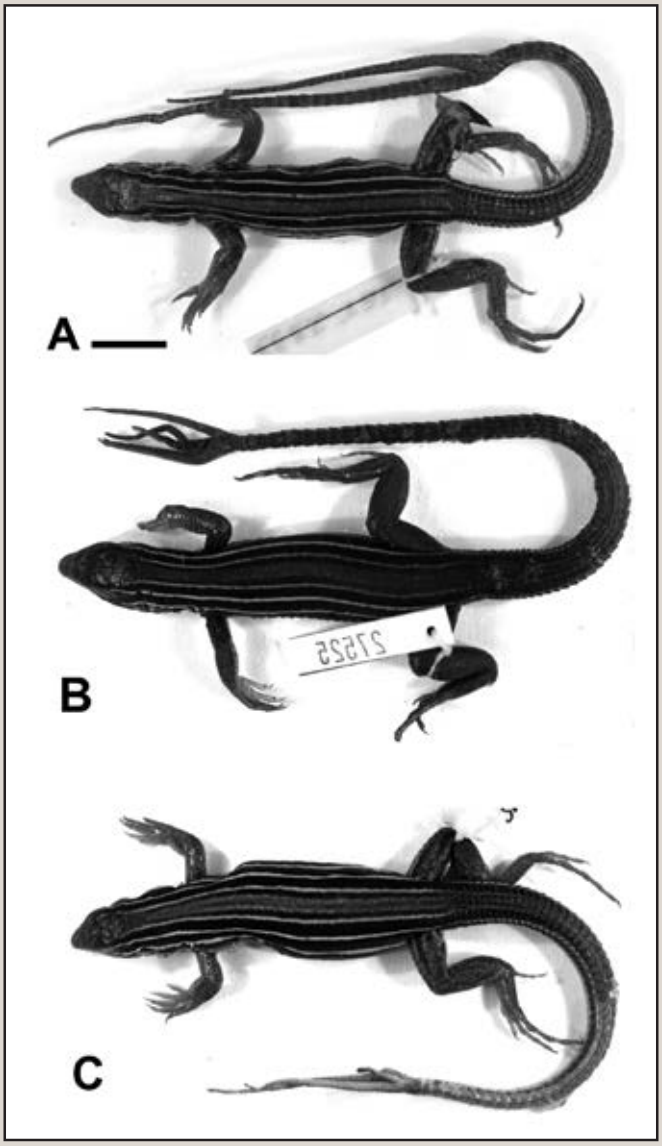


FIG. 1. Specimens of *Aspidoscelis sexlineata sexlineata* from three Alabama counties expressing bifid and multiple supernumerary tails. A) SET 2333; line = 10 mm for A–C. B) AUM 27525. C) SET 2313.

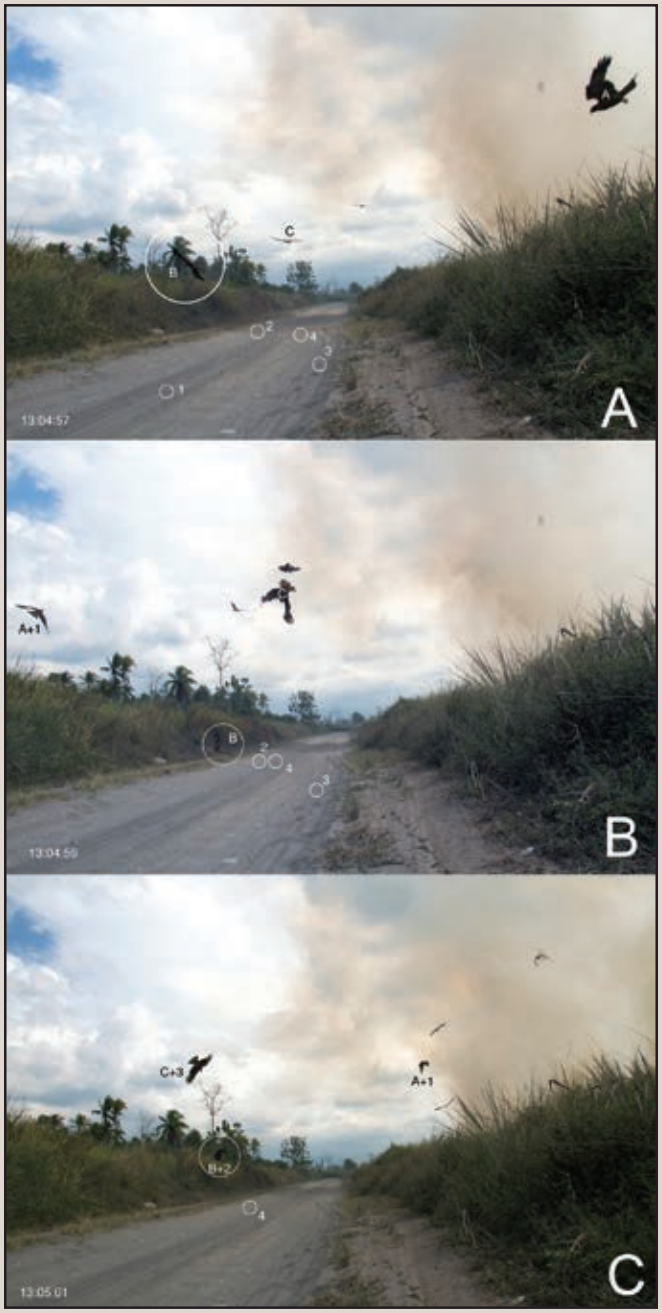


FIG. 1. A) 13:04:57 Hawk A stoops on Skink 1, Hawk B wheels towards Skink 2. B) 13:04:59 Hawk A has taken Skink 1; Hawk B is almost upon Skink 2; Hawk C, approaching from down the road, wheeling to stoop on Skink 3. C) 13:05:01 Hawks A, B and C have all taken skinks, only Skink 4 remains.

abnormal in appearance. The result in this lizard is a trifurcation that has produced a cluster of three supernumerary caudal extensions (Fig. 1C). We conclude that caudal autotomy and regeneration in whiptail lizards are examples of adaptive responses that are stimulated by a traumatic event, the nature of which on rare occasions results in production of non-adaptive structures (i.e., growth of supernumerary caudal extensions).

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***CARLIA CURTA* (Papuan Litter Skink) and *CARLIA MYSI* (Mys' Rainbow Skink). MASS AVIAN PREDATION.** *Carlia curta* and *C. mysi* are common lizards of the grasslands of the northern versant of the Papuan Peninsula, Papua New Guinea, and they occur in abundance on the disused Second World War airstrip at Dobudora, Oro (Northern) Province, Papua New Guinea (8.793950°S, 148.320333°E) located 9.5 km ESE of the provincial capital Popondetta, and 2 km NE of the domestic airport at Girua, on the eastern banks of the Girua River.

The area is low-lying (40–80 m elev.) and largely comprises grassland, swamp, small areas of tropical forest, and oil palm plantations. The grasslands are subjected to frequent and deliberate burns, set by villagers, whether clearing land for gardens, or hunting bandicoots, and fire is an ever-present factor in the

environment. During the present (August 2013) and previous (September 2006) visits to Dobudora there have always been two or three fast-burning fires on the grasslands. Wildlife has to adapt to the constant threat it poses.

Some wildlife benefit from these continual, dry-season daily, grassland fires. Birds of prey, primarily Black Kites (*Milvus migrans*), were seen in very large numbers in the vicinity of Dobudora in August 2013, congregating on trees in close proximity to the fires, or following behind the flames scavenging carcasses. Twenty were seen at any one time wheeling in the sky, up to 12 perching in a single, spindly leafless tree.

Even before the flames reached the dirt road, both species of skinks were observed running out onto its exposed sandy surface, clearly disorientated by the heat, some making the safety of the opposite side of the road, others running in circles, or even back towards the fire. At this point the kites were observed to change their hunting behavior and began predating the skinks in the open. At least a dozen kites were hunting in less than 50 m of the road, swooping down to capture disoriented skinks in their talons. Occasionally a skink was missed but flicked over in the sand, only to be almost immediately taken by a second kite coming in at an angle to the first. Our attempts to collect skinks as voucher specimens were on occasion thwarted as the lizards were snatched from in front of our hands by kites from above. No estimate of the number of skinks taken by the kites was made, or even possible due to the speed and numbers of the birds, but it was probably several dozen during the 30–40 minutes between the skinks' first appearance on the road and the fire dying down. How the number of skinks taken fleeing can be compared to those that die in the fires is also impossible to estimate but with the frequency of fires on the grasslands and the large number of kites in the vicinity it is likely that these two threats play a major part in skink survivorship and population density.

We noticed that the larger species, *C. mysi*, was more vulnerable to predation by kites than the smaller *C. curta*, many of which escaped the notice of the birds in the dusty sand and smoke. One snake was observed, either a treesnake (*Dendrelaphis* sp.) or Brownsnake (*Pseudonaja textilis*), but it crossed the road too quickly for the kites or us to react.

A sequence of three photographs, taken over a four-second period, show four *C. mysi* attempting to cross the road (Fig. 1). Skink 1 is taken by Hawk A which dives from the right, Skink 2 is taken when Hawk B comes in low from in front of camera, Hawk C flies up the road towards the camera then swoops onto Skink 3. At the end of four seconds only Skink 4 remained.

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***CARLIA SCHMELTZII* (Robust Rainbow Skink). ENVIRONMENTALLY-CUED HATCHING.** Environmentally-cued hatching (ECH), in which hatching competent embryos can choose their own hatching date by assessing and responding to risks, can include early hatching, delayed hatching, or synchronous hatching (Warkentin and Caldwell 2009. *In* Dukas and Ratcliffe [eds.], Cognitive Ecology II. The Evolutionary Ecology of Learning, Memory and Information Use, pp. 177–200. University of Chicago Press, Chicago, Illinois). For example, hatching competent frog embryos can hatch early in response to risk of attacks by wasps, snakes, and fungi (Warkentin and Caldwell, *op. cit.*). A recent review has extended ECH to reptiles (Doody 2012. Integr. Comp. Biol. 51:49–61). For instance, early hatching in Delicate Skinks (*Lampropholis delicata*) is likely an antipredator response to egg predation (Doody and Paull 2013. Copeia 2013:160–165). Although a few other lizard species can hatch early in response to being handled, ECH is not known to occur for most lizard species, presumably due to the difficulty in finding lizard eggs (Doody et al. 2009. Quart. Rev. Biol. 84:229–252) and due to the common assumption that eggs hatching while being handled is coincidental. Herein we report on an observation of early hatching in *Carlia schmeltzii* from northeastern Australia. We comment on implications for predator avoidance.

In January 2014 at around 1200 h a maintenance worker discovered two eggs under a rock in a garden in Palm Cove, Queensland, Australia (16.744307°S, 145.670962°E). The worker placed the eggs in a container, and the eggs were rolling around during transit for a few minutes before being presented to one of us (BS). Just after this time one of the eggs hatched rapidly, and the hatchling skink immediately scurried around the container. The second egg was then removed and hatched rapidly in hand, the hatchling immediately running after hatching. The hatchlings were identified as *C. schmeltzii* based upon their appearance and commonness at the site.

The handling-induced hatching in *C. schmeltzii* likely reflects early hatching in response to an increase in perceived predation risk, as observed in two other Australian skinks, *L. delicata* and *Acritoscincus platynota* (Doody and Paull, *op. cit.*; BS, unpubl.). Early hatching in response to predation risk may be widespread in Australian skinks, or perhaps in skinks in general. Further research should investigate the hatching window (plasticity in hatching age and developmental stage) and the potential predators of *C. schmeltzii*. A comparative study of ECH in skinks would determine if early hatching is an ancestral trait or if it has evolved multiple times within that group.

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***CTENOPHORUS CAUDICINCTUS* (Ring-tailed Dragon). PREDATION.** Clarifying the suite of predators can contribute to understanding how populations are regulated, and how predators influence the behavior of prey. Yet, the suite of predators is often poorly known for a given small vertebrate, especially in the tropics. Herein we report an observation of apparent predation of *Ctenophorus caudicinctus* by a Nankeen Kestrel (*Falco cenchroides*) in northwestern Australia.

At ~1100 h on 22 February 2014, we flushed a kestrel from a rocky overhang on a mesa that stood about 50 m above the surrounding savannah in the northern Pilbara region of Western Australia (22.337336°S, 119.625572°E). The kestrel left behind an upside-down dead lizard, which proved to be a gravid female *C. caudicinctus*. Closer inspection revealed two puncture marks, one each through the left shoulder region and through the right

tympanum, although there was little blood. The lizard was left at the site in case the kestrel returned for it. The air temperature at the time of the observation was ~35°C.

Although we did not observe prey capture, kestrels are generally hunters rather than scavengers (Olsen et al. 1979. Emu 79:133–138), suggesting that the raptor caught and killed the lizard just before we arrived (the lizard was in good condition). It is possible that the reproductive condition of the lizard contributed to its vulnerability to capture, as it was heavily egg-laden. Ring-tailed Dragons are common at the site, and are generally common in rocky areas where they forage for insects during the day, often at very hot temperatures. Kestrels are also relatively common at the site, and lizards are generally an important prey item; in one study lizards made up ~90% of prey items by weight (Aumann 2001. Wildl. Res. 28:379–393). In that study agamids were found in 53% of regurgitated pellets, and *C. nuchalis*, a congener of *C. caudicinctus*, was the most common reptilian prey item.

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***DAREVSKIA BRAUNERI* (Brauner's Rock Lizard). DIET.** The diet of *Darevskia brauneri* is known to consist mainly of insects, other invertebrates, berries, and overripe fruit (Darevsky 1967. Rock Lizards of the Caucasus: Systematics, Ecology and Phylogeny of the Polymorphic Groups of Caucasian Rock Lizards of the Subgenus *Archaeolacerta*. Nauka, Leningrad. 214 pp. [in Russian: English translation published by the Indian National Scientific Documentation Centre, New Delhi, 1978]). However, on 28 August 2001 on rocky outcrops of the valley of the Mzymta River in the village of Esto-Sadok, Krasnodar Krai, Russia (43.68093°N 40.27605°E; 550 m elev.) we observed an adult female holding a juvenile specimen of *Lacerta agilis* (Sand Lizard) in its jaws. This is the first recorded case of a lizard of the genus *Darevskia* predating on a vertebrate. An earlier report in the literature recorded the opposite case of *L. agilis* predating upon a lizard of the genus *Darevskia* (*D. pontica*) (Zhukov 1941. K sistematike, rasprostraneniyu i biologii *Lacerta praticola* Eversmann [Reptilia, Sauria] [Systematic, distribution and biology of *Lacerta praticola* Eversmann (Reptilia, Sauria)]. Proc. Krasnodar State Pedagogical Institute named after the 15th anniversary of the Komsomol. Krasnodar. Vol. 8. pp. 326–335 [in Russian]).

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***ELGARIA PAUCICARINATA* (San Lucan Alligator Lizard). FIELD AND PREFERRED BODY TEMPERATURES.** *Elgaria paucicarinata* is a small terrestrial lizard endemic to the mountain and foothill habitats of the Cape Region in Baja California (Grismer 2002. Amphibians and Reptiles of Baja California, Including its Pacific Islands and the Islands in the Sea of Cortés. Univ. California Press, Berkeley and Los Angeles, California. 399 pp.). Little is known about the ecology of this lizard, and even less about the thermal ecology. We present data on *E. paucicarinata* thermal ecology from Sierra de La Laguna Biosphere Reserve on the Cape Region, Baja California Sur, México. We conducted fieldwork at Segundo Valle (23.55251°N, 109.98689°W, WGS84; elev. 1770 m) on 12–14 July and 20–22 September 2011. The site is predominated by pine-oak forest vegetation (e.g., *Pinus lagunae*, *Quercus devia, Arbutus peninsularis*), perennial herbs, leaf litter, and granitic rocks (Arriaga and Ortega [eds.] 1988. La Sierra de la Laguna de Baja California Sur. CIBNOR. Mexico. 247 pp.). Data are based on 20 individuals (adults and juveniles) captured by hand between 0900 and 1900 h. Sex was not determined because of the lack of sexually dimorphic characters. We measured body temperature (T_b) and air temperature (T_a) with a quick-reading thermometer (Fluke 52 K/J type) immediately following capture. The substrate temperature (T_s) was measured with a non-contact infrared thermometer (Raytek Raynger ST®) at the exact point where the animal was first sighted and T_a 2 cm above the substrate. We recorded data on snout–vent length (SVL), time of capture, microhabitat type, and light condition (full sunlight, filtered sunlight, and full shade). We brought five adult individuals into a laboratory thermal gradient to measure the preferred body temperatures (T_p). The thermal gradient consisted of a glass terrarium 76 × 30 × 45 cm (long/wide/high), with soil and leaf litter, located in a room with a controlled temperature of 20°C. We offered a thermal gradient of 20–37°C by placing two 100-W daylight blue bulbs at different heights in one end of the terrarium. We took body temperatures every hour between 0900 and 1500 h, with the same thermometer used in the field.

Mean SVL was 96.8 mm (SD = 20.6, range: 58–120 mm, N = 12). Mean field T_b was 25.4°C (SD = 3.2, range: 20–31.2°C, N = 20). Mean T_a was 20.8°C (SD = 1.5, range: 17.5–24.1°C) and mean T_s was 24°C (SD = 3.6, range: 19.2–31.8°C). Both T_a and T_s were significantly correlated with body temperature (Spearman Rank Correlation, $r_s = 0.80$, $r_s = 0.84$, $P < 0.0001$, respectively). Most lizards were found on leaf litter with plant cover (N = 13), followed by leaf litter on open areas (N = 5), oak logs, and rocks (N = 1); and in full shade microhabitats (N = 11), followed by full sunlight (N = 6) and filtered sunlight (N = 3). The mean T_p was 25.8°C (SD = 3.4, range = 20.5–30.9°C). Interquartile of 25% and 75% was 24.6°C and 27.9°C, respectively. *E. paucicarinata* mean body temperature is higher than other *Elgaria* species (*E. coerulea* = 15.8°C, Brattstrom 1965. Am. Midl. Nat. 73[2]:376–422; *E. multicarinata* = 21°C, Beck 2009. *In* Jones and Lovich [eds.], Lizards of the American Southwest, pp. 484–487. Rio Nuevo Publishers, Tucson, Arizona). Compared with other gerrhonotine lizards, *E. paucicarinata* has a slightly lower T_b than *Barisia imbricata* (26.6°C; Lemos-Espinal et al. 1998. Amphibia-Reptilia 19:95–99). The positive correlation of T_b with T_s and T_a suggests that *E. paucicarinata* is not clearly thigmothermic or heliothermic. Light condition preference data give support to a thigmothermic model where lizards gain heat by moving between microhabitats with different sunlight categories, because lizards were found in open and plant-covered areas. The similarity of T_p and field T_b suggests that *E. paucicarinata* thermoregulates, but an assessment of the thermal environment is needed to determinate the patterns of thermoregulation of this species.

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***GEHYRA LACERATA* (Kanchanaburi Four-clawed Gecko). REPRODUCTION.** *Gehyra lacerata* is known from Chonburi, Kanchanaburi, Khon Kaen, Nakhon Ratchasima, Phetchaburi and Sakaeo Provinces, Thailand and possibly Vietnam (Das 2010. A Field Guide to the Reptiles of South-east Asia: Myanmar, Thailand, Laos, Cambodia, Vietnam, Peninsular Malaysia, Singapore, Sumatra, Borneo, Java, Bali, New Holland Publishers, London, UK. 376 pp.). I know of no published accounts on reproduction of this lizard. The purpose of this note is to report on reproduction of *G. lacerata* from Thailand.

A sample of 24 *G. lacerata* consisting of 11 adult males (mean SVL = 47.1 mm ± 4.1 SD, range = 40–53 mm) and 13 adult females (mean SVL = 53.2 mm ± 5.7 SD, range = 43–59 mm) collected in 1969 and deposited in the herpetology collection of the Field Museum of Natural History (FMNH), Chicago, Illinois, USA, was examined from Thailand (Nakhon Ratchasima Province, Amphoe Pak Thong Chai, Sakerat, 14.50897°N, 101.95379°E, including: FMNH 181335, 181338–181340, 181342, 181347, 181348, 181350, 181352–181354, 181360, 181364, 181367, 181370–181372, 181388, 181393, 181407, 181411, 181414, 181418, 181421.

A cut was made in the lower abdominal cavity and the left testis or ovary was removed, embedded in paraffin, cut at 5 µm and stained with Harris hematoxylin followed by eosin counterstain. Enlarged ovarian follicles > 4 mm or oviductal eggs were counted. No histology was performed on them. Histology slides were deposited at FMNH.

The only stage observed in the testicular cycle was spermiogenesis. There were two stages of this condition: 1) full spermiogenesis in which the layers of germinal epithelium were at maximum cell number and the lumina of the seminiferous tubules were lined by sperm or clusters of metamorphosing spermatids; 2) late spermiogenesis in which the cells of the germinal epithelium were greatly reduced in number and scattered sperm were in the lumina of the markedly smaller seminiferous tubules. Males in full spermiogenesis were found by month: February (N = 1), March (N = 1), April (N = 2), June (N = 1), August (N = 1), November (N = 1), December (N = 2). Two males from September exhibited late spermiogenesis. My monthly samples of males are too small to ascertain whether the finding of late spermiogenesis in September precedes a period of testicular regression. However, my November and December male samples exhibited full spermiogenesis. The smallest reproductively active male measured 40 mm SVL and was from December (FMNH 181414).

TABLE 1. Monthly stages in the ovarian cycle of 13 *Gehyra lacerata* females from Nakhon Ratchasima Province, Thailand. *Indicates concurrent yolk deposition for a subsequent clutch in a female with oviductal eggs.

Month	N	Quiescent	Follicles > 4 mm	Oviductal eggs
February	2	0	1	1
March	2	0	2	0
April	1	0	0	1
May	1	0	1	0
June	1	0	0	1*
July	3	0	2	1*
August	1	1	0	0
September	1	1	0	0
November	1	1	0	0

Three stages were present in the ovarian cycle (Table 1): 1) quiescent = no yolk deposition; 2) enlarged ovarian follicles (> 4 mm); 3) oviductal eggs. Mean clutch size (N = 10) was an invariant two eggs. The smallest reproductively active female (two ovarian follicles) measured 50 mm SVL and was from March (FMNH 181353). I arbitrarily classified one slightly smaller female of 47 mm SVL (FMNH 181393) and two females of 43 mm SVL (FMNH 181411, 181339) as adults, although they could have conceivably been subadults. The presence of two females (FMNH 181364, 181372) with oviductal eggs that were undergoing concurrent yolk deposition for a subsequent clutch indicates *G. lacerata* can produce multiple clutches in the same reproductive season.

It is evident that *G. lacerata* exhibits a prolonged reproductive cycle. Examination of additional specimens will be required to ascertain whether breeding occurs year round as postulated for other lizards from south Asia (Grismer 2011. Lizards of Peninsular Malaysia, Singapore and their Adjacent Archipelagos. Edition Chimaira, Frankfurt am Main. 728 pp.).

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***GEKKO JAPONICUS* (Japanese Gecko). DIURNAL ACTIVITY.** Nocturnal behavior and thermoregulation in *Gekko japonicus* has been described in a number of works but detailed documentation of diurnal behavior is lacking (Hu and Du 2007. Acta Zoo. Sinica. 53:227–232 [in Chinese]). Here I describe diurnal activity by *G. japonicus* based on 69 observations documented at three sites in Fukuoka, Japan (Table 1). Observations took place between 23 July 2011 and 29 October 2013, occurring as early as March and as late as October. All observations occurred between 0909 h and 1745 h. Temperatures during observations ranged from 17°C to 33.9°C, with an average of 24.7°C. Diurnal behavior was most frequently observed in sunny weather, with 50.7% (N = 35) of observations occurring under mostly clear or clear skies, 30.4% (N = 21) taking place in partly cloudy weather, and 18.8% (N = 13) occurring during overcast conditions.

With the exception of one gecko seen on a stone wall, diurnal activity by *G. japonicus* was observed at retaining walls with weep holes (59.4%, N = 41), on trees (29.0%, N = 20), or on wooden signposts (10.1%, N = 7). In most instances, the geckos would almost immediately retreat into their refuge when approached. In 91.3% (N = 63) of the observations, the geckos were positioned at their refuges in one of three ways: At the entrance of the refuge at the edge of direct sunlight and shadow (40.6%, N = 28); at the refuge entrance with anterior portion of the body or head exposed to direct sunlight (37.7%, N = 26); or completely exposed outside of refuge but immediately next to the entrance (13%, N = 9). In 8.7% (N = 6) of the instances the geckos were completely exposed on a wall or the shaded side of a tree trunk with no refuge in the immediate vicinity. Body posture varied from having the ventral surface in contact with substrate to having the anterior portion of the body elevated as high as possible.

In seven instances, aggregations of two to four animals were observed at refuge entrances. All but one of these observations occurred in the months of March and April. Based on prior observations, it is known that an aggregation seen at a weep hole on 27 April 2012 had overwintered together and was in the process of gradually dispersing (Caldwell 2013. Herpetol. Rev. 44:4) and a group of four geckos observed at a signpost on 15 April 2012 is

TABLE 1. Diurnal observations of Japanese Geckos (*Gekko japonicus*) documented from 23 July 2011 to 29 October 2013.

Date	h*	Site	Weather***	°C	Microhabitat	Position	Remarks
23 Jul. 2011	1745	A	Sunny	26	Signpost	EN	1 adult next to 2 eggs adhered to shaded side
28 Sep. 2011	1030	A	Mostly sunny	25	Tree trunk	TE	1 adult
09 Apr. 2012	1717	B	Sunny	20	Weep hole	RM	1 adult
09 Apr. 2012	1717	B	Sunny	20	Weep hole	RM	1 adult
15 Apr. 2012	1609	A	Sunny	20	Weep hole	RM	1 adult
15 Apr. 2012	1700	A	Sunny	19.4	Weep hole	RM	1 adult
15 Apr. 2012	1525	A	Sunny	21	Signpost crevice	AE	2 adults and 2 juveniles
16 Apr. 2012	1300	B	Sunny	22	Weep hole	RM	1 adult
16 Apr. 2012	1309	B	Sunny	22	Weep hole	RM	1 adult
22 Apr. 2012	1514	A	Partly cloudy	22	Tree fork	EN	1 adult
22 Apr. 2012	1537	A	Partly cloudy	22.5	Weep hole	RM	1 adult
22 Apr. 2012	1637	A	Partly cloudy	21.9	Weep hole	RM	1 adult
22 Apr. 2012	1637	A	Partly cloudy	22	Weep hole	RM	1 adult
22 Apr. 2012	1604	A	Partly cloudy	22	Signpost crevice	AE	1 adult
22 Apr. 2012	1450	A	Sunny	21	Signpost crevice	AE	2 juveniles
22 Apr. 2012	1507	A	Sunny	23	Signpost crevice	AE	1 adult
27 Apr. 2012	1545	B	Sunny	19	Weep hole	RM	4 geckos at mouth of weep hole
29 Apr. 2012	909	A	Sunny	21.3	Tree cavity	EN	1 adult
29 Apr. 2012	931	A	Sunny	20	Weep hole	AE	1 adult
29 Apr. 2012	931	A	Sunny	20	Weep hole	RM	1 adult
13 May 2012	1230	A	Cloudy	24	Tree trunk	TE	1 adult
13 May 2012	1110	A	Cloudy	21.8	Weep hole	AE	1 adult
13 May 2012	1110	A	Cloudy	21.8	Weep hole	AE	1 adult
13 May 2012	1110	A	Cloudy	21.8	Weep hole	AE	1 adult
13 May 2012	1030	A	Mostly cloudy	21.1	Signpost crevice	AE	1 adult
20 May 2012	1133	A	Cloudy	20	Tree cavity	RM	1 adult
20 May 2012	1201	A	Cloudy	22.8	Weep hole	RM	1 adult
20 May 2012	1201	A	Cloudy	22.8	Weep hole	RM	1 adult
20 May 2012	1303	A	Mostly cloudy	20	Weep hole	AE	3 geckos at mouth of weep hole
20 May 2012	1303	A	Mostly cloudy	20	Weep hole	RM	1 adult
22 May 2012	1330	C	Partly cloudy	23.5	Weep hole	AE	1 adult
22 May 2012	1330	C	Partly cloudy	23.5	Weep hole	AE	1 adult
22 May 2012	1330	C	Partly cloudy	23.5	Weep hole	AE	1 adult
23 May 2012	1330	C	Partly cloudy	23.5	Weep hole	AE	1 adult
23 May 2012	1330	C	Partly cloudy	23.5	Weep hole	AE	1 adult
24 May 2012	1330	C	Partly cloudy	23.5	Weep hole	AE	1 adult
28 May 2012	1501	C	Sunny	26.3	Weep hole	AE	1 adult
28 May 2012	1501	C	Sunny	26.3	Weep hole	AE	1 adult
03 Jun. 2012	1340	A	Sunny	26	Tree cavity	EN	1 adult
03 Jun. 2012	1420	A	Mostly sunny	28	Weep hole	RM	1 adult
07 Jun. 2012	1307	C	Partly cloudy	26.3	Weep hole	RM	1 adult
07 Jun. 2012	1307	C	Partly cloudy	26.3	Weep hole	RM	1 adult
12 Jun. 2012	1306	C	Mostly cloudy	27.9	Stone wall	TE	1 juvenile on top of low wall with no weep holes
12 Jun. 2012	1346	C	Partly cloudy	27.5	Weep hole	RM	1 adult
12 Mar. 2013	1700	A	Mostly sunny	20.3	Tree cavity	AE	1 adult and 1 juvenile
12 Mar. 2013	1645	A	Mostly sunny	20.3	Tree cavity	RM	2 adults
12 Mar. 2013	1650	A	Mostly sunny	20.3	Tree cavity	RM	2 adults
12 Mar. 2013	1715	A	Mostly sunny	20.3	Tree fork	EN	1 adult
21 Jul. 2013	1316	A	Partly cloudy	33	Tree branch	EN	1 adult retreated into ferns surrounding trunk

(continued on next page)

Table 1. Continued.

Date	h*	Site	Weather***	°C	Microhabitat	Position	Remarks
21 Jul. 2013	1322	A	Mostly cloudy	32.5	Tree cavity	RM	1 adult
21 Jul. 2013	1245	A	Mostly sunny	33	Tree cavity	RM	1 adult
21 Jul. 2013	1254	A	Mostly sunny	33	Tree cavity	RM	1 adult
21 Jul. 2013	1305	A	Partly cloudy	33	Tree fork	EN	1 adult
21 Jul. 2013	1340	A	Cloudy	32	Tree trunk	TE	1 adult
06 Aug. 2013	1330	C	Sunny	33.9	Weep hole	RM	1 adult
14 Aug. 2013	945	A	Partly cloudy	28.5	Tree cavity	AE	1 adult
14 Aug. 2013	1100	A	Mostly sunny	30.5	Tree trunk	TE	1 adult
14 Aug. 2013	1019	A	Partly cloudy	28.5	Tree trunk	TE	1 adult
14 Aug. 2013	1023	A	Partly cloudy	29.7	Weep hole	AE	1 adult
14 Aug. 2013	937	A	Partly cloudy	29	Signpost crevice	AE	1 adult
26 Aug. 2013	1640	C	Mostly sunny	28	Weep hole	AE	1 adult
26 Aug. 2013	1640	C	Mostly sunny	28	Weep hole	AE	1 adult
28 Sep. 2013	1145	C	Sunny	29.9	Weep hole	AE	1 adult
28 Sep. 2013	1144	C	Sunny	29.9	Weep hole	EN	1 adult
01 Oct. 2013	1330	C	Sunny	28.3	Weep hole	AE	1 adult
01 Oct. 2013	1331	C	Sunny	28.3	Weep hole	RM	1 adult
01 Oct. 2013	1332	C	Sunny	28.3	Weep hole	RM	1 adult
10 Oct. 2013	1130	A	Partly cloudy	25.4	Tree fork	EN	1 adult
29 Oct. 2013	1328	C	Mostly sunny	17	Weep hole	RM	1 adult

A = 33.5894°N, 130.4583°E*; B = 33.5973°N, 130.3749°E*; C = 33.5862°N, 130.3861°E*
* All observations overlapping in time occurred at neighboring refuges
** datum WGS84
*** Per terms defined by the National Oceanic and Atmospheric Administration
RM = At refuge entrance just out of direct sunlight
AE = At refuge entrance with anterior portion of body in direct sunlight
NR = Completely outside refuge immediately next to entrance
TE = On tree trunk or wall near no immediate refuge

also known to have overwintered together. In all other instances, single animals were observed.

In five instances I was able to observe geckos at weep holes for extended periods of time, ranging from 15 to 60 minutes from 3–5 m away. All geckos demonstrated the same behavior; each would expose its head or anterior half to direct sunlight, retreat into the hole when a pedestrian or potential predator (e.g., a dog or a bird) would approach, and subsequently return to the same position within ten minutes. The only other movement type observed was changes in body posture. No incidents of predation by or on the geckos were observed.

Gekko japonicus is reported to primarily be a sit-and-wait predator (Werner et al. 1997. Asiatic Herpetol. Res. 7:153–165), and foraging cannot be ruled out here. However, many of these observations, particularly instances in which the geckos in refugia expose the anterior portions of their bodies to direct sunlight and/or exhibit postural changes, are indicative of thermogulatory behavior. Though it is not widely documented, diurnal thermoregulation probably occurs in a large number of nocturnal reptiles (Kearney and Predavec 2000. Ecol. 81:2984–2996). *Christinus marmoratus*, a nocturnal gecko species, is reported to engage in diurnal thermoregulation largely through refuge selection and postural variation (Kearney and Predavec 2000, *op. cit.*) and a study by Dial (1978. Herpetologica 34:191–201) indicated that *Coleonyx brevis*, another nocturnal gecko, actively engages in diurnal thermoregulation while under cover. Much of the activity reported here suggests diurnal thermoregulatory behavior occurs in *G. japonicus* as well.

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***GONATODES HUMERALIS* (Trinidad Gecko). PREDATION.** *Gonatodes humeralis* is a small (max. SVL = 42 mm) sphaerodactylid gecko, common throughout much of the Amazonian region, present both in rainforest and in disturbed habitats like secondary forest and urban parks with trees (Ávila-Pires et al. 2011. Herpetol. Brasil. 1:111–112). It is typically found on tree trunks up to 1.5 m above the ground, but it also occurs in leaf litter and higher up within trees (Ávila-Pires 1995. Zool. Verh. Leiden 299:1–706). This note reports a single observation of predation on *G. humeralis* by a Spotted Puffbird (*Bucco tamatia*).

On 13 March 2012 at 1647 h during fieldwork at Curiau Protection Area (0.238056°N, 51.129444°W; datum WGS84), Macapa, Amapa, northern Brazil, we observed an adult Spotted Puffbird predating an adult female *G. humeralis* (SVL = 35 mm). The puffbird was perched on a tree branch, staring at the trunk of the tree. After locating the gecko, the bird flew to the trunk and captured it, returning to the canopy soon after, with the gecko on

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FIG. 1. A Spotted Puffbird (*Bucco tamatia*) preying on an adult female *Gonatodes humeralis* in Curiau Protection Area, Macapa, Amapa, North Brazil.

its beak (Fig. 1). The bird then began to beat the gecko against the tree branch, killing it shortly thereafter. The Spotted Puffbird is a insectivorous and frugivorous bird (Sigrist 2013. Avifauna Brasileira. Editora Avisbrasilis. 594 pp.). This is another record of a sphaerodactylid gecko in the diet of *B. tamatia*, and the first record of *G. humeralis* predation by this species.

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***GYMNODACTYLUS GECKOIDES* (Naked-toed Gecko, Lagartixa). HATCHLING SIZE/BEHAVIOR.** *Gymnodactylus geckoides* is endemic to Caatinga in northeastern Brazil (Cassimiro and Rodrigues 2009. Zootaxa 2008:38–52). Females appear to produce eggs continuously throughout the year (Vitt 1986. Copeia 1986:773–786) and clutch size is usually comprised of one egg (rarely two) with a calcareous shell, which is deposited under rocks or in hollow fallen logs (Vanzolini et al. 1980. Répteis das Caatingas. Academia Brasileira de Ciências, Rio de Janeiro. 161 pp.; Vitt 1986, *op. cit.*; Vitt 1995. Occ. Pap. Oklahoma Mus. Nat. Hist. 1:1–129).

On 9 October 2013 we collected one adult and one juvenile of *G. geckoides* from Brumado, Bahia state, Brazil, located within Caatinga domain (14.203889°S, 41.665278°W; 422 m elev.). We measured the two lizards with a digital caliper (± 0.01 mm) for snout–vent length (SVL) and tail length (TL). The juvenile had

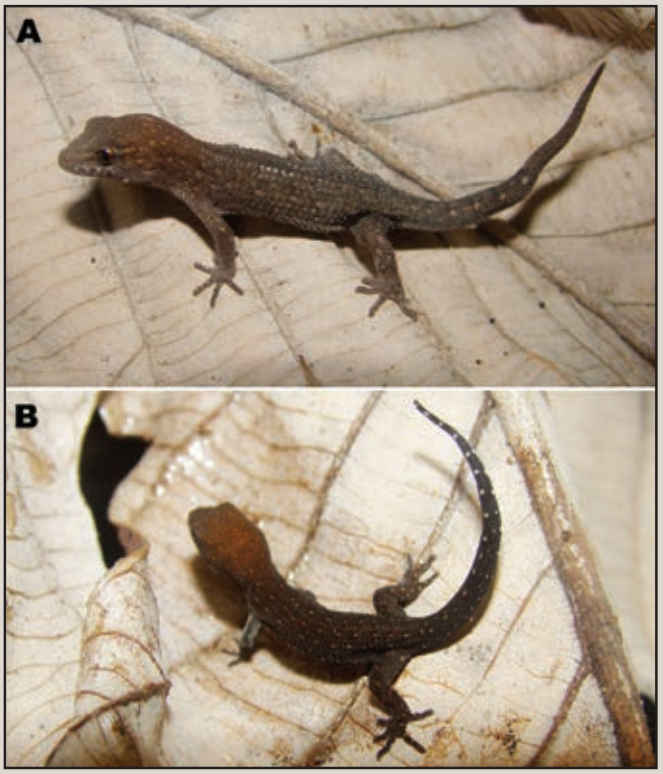


FIG. 1. A) An adult individual of *Gymnodactylus geckoides* (UFMG 1908) and B) a juvenile individual of *G. geckoides* (UFMG 1909) showing defensive tail display.

SVL = 19.41 mm and TL = 20.59 mm, and the adult had SVL = 35.22 and TL = 35.0 mm. It is believed that the juvenile was a recent hatchling due to its smaller size than the minimum SVL reported by Vitt (1986, *op. cit.*) (SVL = 20 mm) in Exu city, Pernambuco state, Brazil. The specimen here reported, probably a recent post-hatchling, represents a new record for minimum body size for a *G. geckoides* juvenile.

A defensive tail display was made by both lizards (Figs. 1A, B), and this behavior apparently is common in some Brazilian geckos (Colli et al. 2003. J. Herpetol. 37:694–706; Brandão and Motta 2005. Phyllomedusa 4:139–145), but it has not been reported for this species. It is evidence for possible mimicry of scorpions, as they use the same microhabitats, are exposed to the same potential predators, and present similar behaviors when threatened (Brandão and Motta 2005, *op. cit.*). There is little published information about the life history and behavior of this species; this report adds to the knowledge of these phyllodactylid lizards from Brazil.

The *G. geckoides* specimens (UFMG 1908–1909) were deposited in the Herpetological Collection of Universidade Federal de Minas Gerais. We are grateful to CAPES for doctorate fellowships awarded to SCG.

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***HEMIDACTYLUS FRENATUS* (Common House Gecko). BICEPHALY.** *Hemidactylus frenatus* is a small gecko species distributed primarily in Southeast Asia (Das 2010. A Field Guide



FIG. 1. Photo of bicephalic *Hemidactylus frenatus* from Koror, Palau.

to the Reptiles of South-east Asia. New Holland Publishers, London. 376 pp.). Individuals are common in urban or otherwise disturbed areas. On 8 February 2014, SK observed a small shedding *H. frenatus* fall from the ceiling of a residence in Koror, Palau (7.342°N, 134.478°E). Upon examination the lizard was found to be bicephalic (Fig. 1), with two heads joined medially directly posterior to the eyes. This abnormality is likely either parapagus, a fusion of two individuals referred to as conjoined twins, or diprosopus, a duplication of facial tissues on the head commonly called craniofacial duplication. The animal appeared healthy and alert, moving with the rapidity found in unaffected individuals. All four eyes appeared to be functional, as did both mouths, but prey capture and handling was not observed. To our knowledge, this is the first published case of bicephaly in this species. The gecko was unharmed and released outside near the point of capture.

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***HEMIPHYLLODACTYLUS TITIWANGSAENSIS* (Titiwangsa Slender Gecko). REPRODUCTION.** *Hemiphyllodactylus titiwangsaensis* is restricted to the Malaysian state of Pahang (Grismer 2011. Lizards of Peninsular Malaysia, Singapore and their Adjacent Archipelagos. Edition Chimaira, Frankfurt am Main. 728 pp.). Grismer (2011, *op. cit*) reported gravid females carrying two eggs during March, May, July, August and October and postulated breeding occurred throughout the year. The purpose of this note is to add information on the reproductive cycle of *H. titiwangsaensis* from a histological examination of museum specimens.

A sample of ten *H. titiwangsaensis* from Cameron Highlands, Panang state, West Malaysia collected during 2005, 2008, 2010, 2011 and deposited in the herpetology collection of La Sierra University (LSUHC), Riverside, California was examined: LSUHC 7208, 7209, 7212, 7213, 9161, 9162, 9076, 9815, 10254, 10273. The sample consisted of eight females (mean SVL = 52.1 mm ± 2.4 SD, range = 48–55 mm), one male, SVL = 58 mm and one subadult, SVL = 38 mm.

TABLE 1. Stages in the ovarian cycle of eight *Hemiphyllodactylus titiwangsaensis* from Cameron Highlands, Panang State, Malaysia.

Month	N	Quiescent	Enlarged follicles > 4 mm	Oviductal eggs
March	3	0	2	1
June	1	1	0	0
August	2	1	1	0
September	1	1	0	0
November	1	0	0	1

A cut was made in the lower abdominal cavity and the left testis or ovary was removed, embedded in paraffin, cut into sections and stained with Harris hematoxylin followed by eosin counterstain. Enlarged follicles (> 4 mm) or oviductal eggs were counted. Histology slides are deposited at LSUHC.

The one male examined was from March and was undergoing spermiogenesis (lumina of the seminiferous tubules were lined by sperm or clusters of metamorphosing spermatids).

Three stages were found in the ovarian cycle (Table 1): 1) quiescent, no yolk deposition; 2) enlarged ovarian follicles > 4 mm; 3) oviductal eggs. Mean clutch size for five females = 1.8 ± 0.45 SD, range = 1–2. Reproductive activity at opposite ends of the year indicates *H. titiwangsaensis* has an extended reproductive cycle as postulated by Grismer (2011, *op. cit.*). Congeners of the parthenogenetic *H. typus* from Hawaii similarly underwent an extended period of reproduction as they exhibited reproductive activity in seven of nine months examined (Goldberg 2012. Gekko 6:23–25).

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***HOLBROOKIA LACERATA SUBCAUDALIS* (Southern Spot-tailed Earless Lizard). REFUGIA AND COMMENSALISM.** The use of ground squirrel and other mammal burrows by many species of lizards has been well-documented. Among those reports: juvenile *Uta stansburiana* (Side-blotched Lizard) in central California stayed in the burrows of *Otospermophilus beecheyi* (California Ground Squirrel) from July to November (Doughty and Sinervo 1994. J. Herpetol. 28:485–490); burrows of *Ictidomys mexicanus* (Mexican Ground Squirrel) are sometimes used by *Holbrookia propinqua* (Keeled Earless Lizard) to escape predation (Cooper 2000. Behaviour. 137:1299–1315); and a positive correlation was found between the number of prairie dog burrows and abundance of *H. maculata* (Lesser Earless Lizard; Davis and Theimer 2003. Amer. Midl. Nat. 150:282–290).

Knowledge of the life history requirements and population dynamics of the rare and elusive *H. l. subcaudalis* is extremely limited. Nearly everything that has been reported on its natural history, from direct observation, comes from the 1950s research of Ralph Axtell, who described two subspecies, *H. l. lacerata* (Northern Spot-tailed Earless Lizard) and *H. l. subcaudalis* (Axtell 1956. Bull. Chicago Acad. Sci. 10[11]:163–179). Axtell reported that *H. l. lacerata* will use tall grass and cracks in the earth

as escape shelters, but that "rocks, tin, boards, etc., are never used..." (Axtell 1954. MS Thesis. Univ. of Texas at Austin). Axtell also reported on the use of mammal burrows by other members of the genus (Axtell 1958. Ph.D. Dissertation. Univ. of Texas at Austin.) but never observed that behavior in *H. l. subcaudalis* (R. Axtell, pers. comm.). This is the first report of the use of ground squirrel or any other type of burrows by *H. l. subcaudalis*. In this note we present evidence that *H. l. subcaudalis* not only uses ground squirrel burrows, but that it is dependent on them at this site.

On 18 March 2013, while surveying for *H. l. subcaudalis* at Laughlin Air Force Base (LAFB) in southern Val Verde County, Texas, we observed two of the lizards retreat into Mexican Ground Squirrel burrows. We observed the behavior again on 16 April and 21 May 2013. Altogether, we observed the behavior eight times (out of 16 total observations). Of the eight lizards not observed to escape into ground squirrel burrows, two attempted to hide under the tires of our vehicle, one dashed across the road ahead of us and we couldn't determine what type of refuge it took, and five were captured by running them down on foot before they could find any type of escape shelter.

The Southern Spot-tailed Earless Lizard occurs on relatively flat substrates composed of soils that are loamy, loamy-clay, clay-loam, clay, rarely sandy loam, and never pure sand (Axtell 1956, *op. cit.*; Duran and Axtell 2010. Rept. to Texas Parks and Wildlife Dept., Contract #199464). The habitat at LAFB where this population occurs includes about 718 ha on and around aircraft runways in the western part of the base. The substrate is flat, loamy, and hard-packed. The site is sparsely vegetated, even when rainfall is near the 43.6 cm yearly average for Del Rio, Texas, but at the time of our visits, the region was experiencing drought, vegetation was even more sparse than usual, and lizards were quite conspicuous when present. The site is mown frequently to about 15 cm, mostly to discourage birds that might collide with aircraft. Several decades of mowing has replenished topsoil, has converted former agricultural fields and overgrazed thornscrub into grassland, and has, inadvertently, restored and maintained habitat for *H. l. subcaudalis*. Another result of the continuous mowing is that, except for an occasional stunted *Prosopis glandulosa* (Honey Mesquite) and a few stands of denser grass in moist depressions, the landscape mostly lacks escape cover, such as tall grass, dead or fallen trees, low growing shrubs, leaf litter, and cacti that might be available under different management regimes. Additionally, LAFB is enclosed by high fencing which excludes people and most medium-sized burrowing mammals. We observed numerous 1.9–2.5 cm diameter burrows, probably created by small rodents, but these burrows may have been too small for utilization by *H. l. subcaudalis*, and we saw no evidence that it was using them. We found no published or anecdotal reports of *H. lacerata* creating its own burrows. We did not observe *H. l. subcaudalis* escaping into refugia other than ground squirrel burrows. That we were able to catch lizards by running them down on foot may be the most informative anecdote to illustrate the paucity of escape cover at this site.

Lacking other types of refugia, *H. l. subcaudalis* appears to be dependent on ground squirrel burrows for escape cover at this location. The relationship between *I. mexicanus* and *H. l. subcaudalis* at this site is an apparent case of commensalism.

The Southern Spot-tailed Earless Lizard has been extirpated from much of its historic range. The observations at LAFB were the first reported observations of the subspecies since one individual was caught in a pitfall trap on the Chaparral Wildlife Management Area in LaSalle Co., Texas, in 1997 (Duran and Axtell 2010, *op. cit.*). The specimens we collected at LAFB were the first since a specimen was taken by Andy Price in Kinney Co., Texas in 1993 (Duran and Axtell 2010, *op. cit.*).

Limited knowledge of the life history requirements of *H. l. subcaudalis* has made planning effective conservation difficult. Evidence of the subspecies' close relationship to ground squirrels at this location may provide an important clue to restoring and maintaining populations, particularly in cases where man-made disturbance has created conditions under which the availability of escape cover may be a limiting factor.

This work was performed under Texas Parks and Wildlife Department Scientific Research Permit #SPR-0302-204. The live specimens were donated to the Fort Worth Zoo in Fort Worth, Texas. The zoo is attempting to breed the subspecies in captivity in hopes of reintroducing it into the wild.

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***JAPALURA SWINHONIS* (Swinhole's Japalura) and *TAKYDROMUS SAUTERI* (Sauter's Grass Lizard). PREDATION.** On 25 September 2013 at 0912 h along the roadside on Orchid Island, Taiwan (22.03333°N, 121.00916°E; 70 m elev.), one of us (CMW) observed and photographed an adult male *Japalura swinhonis* predating an adult *Takydromus sauteri*. The adult grass lizard was being consumed tail-end first (Fig. 1). During our observations, the *J. swinhonis* carried its prey from the ground up onto the trunk of a tree. Other *T. sauteri* individuals were observed on leaves of Japanese silver-grass (*Miscanthus floridulus*) along the forest edge in the vicinity. Most individuals move from leaf to leaf or are active on the ground and at night some individuals rest on the upper surface of a leaf (Huang 2006. J. Herpetol. 40:267–273). *Japalura swinhonis* is a sit-and-wait forager, which perches on tree trunks or on the ground at the edges of forests on Orchid Island. Previously, *J. swinhonis* was known to consume invertebrates exclusively, including ants (50%) and crickets (16.67%)



PHOTO BY C. M. WANG

FIG. 1. Adult male *Japalura swinhonis* consuming an adult *Takydromus sauteri* tail-end first.

(Huang 2007. Zool. Sci. 24:181–188). These two lizard species commonly co-occur along forest edges on Orchid Island, Taiwan (Huang 2004. Ph.D thesis, Cornell University, Ithaca, New York), which could result in substantial overlap between them.

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***LEPIDOPHYMA GAIGEAE* (Gaige's Tropical Night Lizard). ENDOPARASITES.** *Lepidophyma gaigeae* occurs in Querétaro and Hidalgo, Mexico (Bezy and Camarillo 2002. Nat. Hist. Mus. Los Angeles Co., Contrib. Sci. 493:1–41). Goldberg et al. (2002. Texas J. Sci. 54:282–284) previously reported one species of Cestoda, *Bitegmen gerrhonoti*, and two species of Nematoda, *Spauligodon giganticus* and *Ascaridia* sp., in *L. gaigeae*. The purpose of this note is to add to the helminth list for *L. gaigeae*.

Two *L. gaigeae* (mean SVL = 58.0 mm ± 2.8 SD, range = 56–60 mm) collected August 1972 in Querétaro, Mexico and deposited in the herpetology collection of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California, USA as LACM 106808, 106809 were examined for helminths.

The digestive tract was removed through a mid-ventral incision and its contents were examined for helminths using a dissecting microscope. Only nematodes were found, which were cleared in a drop of lactophenol on a coverslipped microscope slide and studied under a compound microscope. One species of Nematoda, *Spauligodon oxkutzcabiensis*, was found in the intestines (N = 21, prevalence [number infected/number examined × 100] = 100%; mean intensity [mean number infected individuals] = 10.5 ± 12.0 SD, range = 2–19. Voucher helminths were deposited in the United States National Parasite Collection, Beltsville, Maryland, USA as USNPC 107882.

Spauligodon oxkyutzcabiensis was described from *Thecadactylus rapicauda* collected in the Yucatán by Chitwood (1938. Publ. Carneg. Inst. Washington 491:52–66) and is commonly found in lizards from Mexico and Central America. The distribution of hosts for *S. oxkutzcabiensis* is summarized in (Goldberg and Bursey 2012. Comp. Parasitol. 79:269–274). Infection occurs from contact with contaminated substrate or conceivably from licking the ground (see Goldberg and Bursey 1992. J. Parasitol. 78:539–541). *Spauligodon oxkutzcabiensis* is separated from the congener *S. giganticus* based on ornamentation of the eggs and number of spines on the tail of the female; eggs of *S. giganticus* with one polar knob, eggs of *S. oxkutzcabiensis* with a knob on each pole; tail of female *S. giganticus* with 10–11 spines, tail of female *S oxkutzcabiensis* with 13–15 spines (Chitwood, *op. cit.*; Read and Amrein 1953. J. Parasitol. 39:365–370). Both *S. giganticus* and *S. oxkutzcabiensis* have previously been reported in different representatives of sceloporine lizards from Mexico, including *Sceloporus grammicus* and *S. mucronatus* (Goldberg et al. 2003. Southwest. Nat. 48:208–217. *Lepidophyma gaigeae* represents a new host record for *Spauligodon oxkutzcabiensis*.

We thank G. Pauly (LACM) for permission to examine *L. gaigeae*.

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***LEPIDOPHYMA SYLVATICUM* (Madrean Tropical Night Lizard). ENDOPARASITES.** *Lepidophyma sylvaticum* occurs along the Sierra Madre Oriental from Nuevo León to Veracruz, Mexico (Bezy and Camarillo R. 2002. Nat. Hist. Mus. Los Angeles Co., Contrib. Sci. 493:1–41). To our knowledge, there are no reports of helminths from *L. sylvaticum*. The purpose of this note is to establish the initial helminth list for *L. sylvaticum*.

Eight *L. sylvaticum* (mean SVL = 79.0 mm ± 7.3 SD, range = 70–90 mm) collected in 1973 and deposited in the herpetology collection of the Natural History Museum of Los Angeles County, Los Angeles, California, USA (LACM 106744–106746, Hidalgo state, Mexico; LACM 106781–106785, Nuevo León state, Mexico), were examined for helminths.

The digestive tract was removed through a mid-ventral incision and its contents were examined for helminths using a dissecting microscope. Only nematodes were found, which were cleared in a drop of lactophenol on a coverslipped microscope slide and studied under a compound microscope. Four species of Nematoda were found: *Aplectana herediaensis (*small, large intestines, N = 1187), prevalence (number infected/number examined × 100) = 100%; mean intensity (mean number infected individuals) = 148.4 ± 99.7 SD, range = 1–292; *Parapharyngodon alvarengai* (large intestine, N = 2), prevalence = 13%); *Physaloptera* sp. (third stage larvae, stomach, N = 5), prevalence = 38%, mean intensity 1.7 ± 1.2 SD, range = 1–3; ascarid larvae (body cavity, N = 2), prevalence = 13%.

Voucher helminths were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland, USA as: *Aplectana herediaensis* (USNPC 107962, 107963); *Parapharyngodon alvarengai* (USNPC 107694); *Physaloptera* sp. (USNPC 107695); ascarid larvae (USNPC 107696).

Aplectana herediaensis was described from *Lepidophyma flavimaculatum* from Costa Rica (Bursey et al. 2006. Carib. J. Sci. 42:164–170) and was later found in *L. flavimaculatum* from Panama (Bursey et al. 2007. Comp. Parasitol. 74:108–140) and *L. micropholis* from San Luis Potosí (Goldberg and Bursey 2011 Herpetol. Rev. 43:648–649). *Parapharyngodon alvarengai* was described from *Mabuya maculata* (currently *Trachylepis atlantica*) from Brazil by Freitas (1957. Mem. Instit. Oswaldo Cruz 55:21–45) and is known from the lizards *Anolis nebulosus, Phyllodactylus lanei, Sceloporus nelsoni* and *Urosaurus auriculatus* of Mexico as well as *Mesoscincus managuae* from Nicaragua and *Ameiva ameiva, Hemidactylus agrius* and the toad *Rhinella icterica* from Brazil (Anjos et al. 2011. Neotrop. Helminthol. 5:285–290; Goldberg and Bursey. 2012. Comp. Parasitol. 79:269–274). There are many reports of amphibians and reptiles containing third stage larvae of *Physaloptera* sp. but no adults (Goldberg et al. 1993. Bull. South. California Acad. Sci. 92:43–51; Goldberg et al. 2009. Comp. Parasitol. 76:258–266). These amphibians and reptiles likely serve as paratenic (= transport) hosts with development completed in a carnivore that feeds on them. Vertebrates typically serve as intermediate hosts for larval ascaroids in which development to the stage infective to the definitive host occurs (Anderson 2000. Nematode Parasites of Vertebrates, Their Development and Transmission. CABI Publishing Oxon, UK. 650 pp.) *Lepidophyma sylvaticum* represents a new host record for *Aplectana herediaensis, Parapharyngodon alvarengai, Physaloptera* sp. (3rd stage larva), and ascarid larvae.

We thank G. Pauly (LACM) for permission to examine *L. sylvaticum*.

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***LEPIDOPHYMA TUXTLAE* (Tuxtla Tropical Night Lizard). ENDOPARASITES.** *Lepidophyma tuxtlae* occurs from the Sierra de Los Tuxtlas of central Veracruz west and southward to northern Oaxaca and northern Chiapas, Mexico (Calderón Mandujano et al. 2007. *In* IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2 downloaded on 13 December 2013). To our knowledge, there are no reports of helminths from *L. tuxtlae*. The purpose of this note is to establish the initial helminth list for *L. tuxtlae*.

Three *L. tuxtlae* (mean SVL = 60.0 mm ± 2.0 SD, range = 58–62 mm) collected July 1984 from Veracruz, Mexico and deposited in the herpetology collection of the Natural History Museum of Los Angeles County (LACM 136354, 136357, 136358) were examined for helminths.

The digestive tract was removed through a mid-ventral incision and examined for helminths using a dissecting microscope. Only nematodes were found, which were cleared in a drop of lactophenol on a coverslipped microscope slide and studied under a compound microscope. One species of Nematoda, *Aplectana herediaensis*, was found in the intestines (N = 209, prevalence [number infected/number examined × 100] = 100%; mean intensity [mean number infected individuals] = 69.7 ± 20.2 SD, range = 58–93). Voucher helminths were deposited in the United States National Parasite Collection Beltsville, Maryland as USNPC 107883.

Aplectana herediaensis was described from *Lepidophyma flavimaculatum* from Costa Rica (Bursey et al. 2006. Carib. J .Sci. 42:164–170) and was later found in *L. flavimaculatum* from Panama (Bursey et al. 2007. Comp. Parasitol. 108–140) and *L. micropholis* from San Luis Potosí, Mexico (Goldberg and Bursey 2012. Herpetol. Rev. 43:648–649). *Lepidophyma tuxtlae* represents a new host record for *Aplectana herediaensis*.

We thank G. Pauly (LACM) for permission to examine *L. tuxtlae*.

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***OPLURUS QUADRIMACULATUS* (Dumeril's Madagascar Spiny-tailed Iguana). PREY AND PREDATORY BEHAVIOR.** Members of the Old World family Opluridae are known to be mainly insectivorous but occasionally include vertebrates and plant materials in their diet (Brillet 1982. Revue d'Ecologie - la Terre et la Vie 36:79–148; Delheusy and Bels 1992. J. Exp. Biol. 170:155–186; Mori and Randriamahazo 2002. Afr. J. Ecol. 40:61–64; Cadle 2003. *In* Goodman and Benstead [eds.], The Natural History of Madagascar, pp. 983–986. Univ. Chicago Press, Chicago, Illinois; Randriamahazo and Mori 2012. Curr. Herpetol. 31:8–13). Specific prey species for the rupicolous species *Oplurus quadrimaculatus* are relatively unknown. Herein, a case of predation on *Palpares amitinus* by *O. quadrimaculatus* is described.

On 14 December 2007, Isalo National Park in the Ihorombe region of Madagascar was visited, which is home to both *O. cuvieri* and *O. quadrimaculatus*. These lizards can be approached and observed from fairly close distances. At 1145 h, the foraging behavior of an adult male *O. quadrimaculatus* was observed. *Palpares amitinus* is an endemic but rather widespread and common species of ant lion in Southern Madagascar. The movement of an airborne adult ant lion caught the lizard's attention at which time it ran after the insect and jumped at it with its mouth open. Only at the third jump was the ant lion grabbed successfully, after which it was eaten whole. Jumps ranged approximately 20–45 cm vertically and 50–100 cm horizontally.

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***PHRYNOSOMA CORNUTUM* (Texas Horned Lizard). MALE-MALE INTERACTIONS.** Male-male interactions in *Phrynosoma* are generally fleeting and aggressive, frequently characterized by head-bobbing, pushups, and reciprocal vent sniffing, followed by the individuals moving away from one another (Whitford and Whitford 1973. Herpetologica 29:191–192; Whitford and Bryant 1979. Ecology 60:686–694; Tollestrup 1981. Herpetologica 37:130–141). Few studies have reported overlap of home ranges (Munger 1984. Oecologia 62: 351–360). Here we report on two adult males who maintained close association over a period of three days.

At 0915 h on 11 July 2013, while conducting a daily resight on a radio-tagged male (SVL = 63 mm) in central Texas, USA (30.579634°N, 99.466518°W; datum WGS84), we encountered and marked a previously untagged adult male (SVL = 60 mm) located approximately 0.5 m away. At 1220 h on 12 July 2013, we returned to the area to resight the individuals. Both were buried in parallel beneath the same Narrow-leaf Yucca plant (*Yucca reverchonii*, Fig. 1). At 1445 h on 13 July 2014, both were again buried beneath the same yucca plant, but their directions had changed and the individuals were now buried facing opposite directions. By 1803 h on 14 July 2013, both individuals were buried greater than 5 m from each other. These observations indicate that male



FIG. 1. Two tagged male *Phrynosoma cornutum* buried in parallel.

P. cornutum may be more tolerant of other males, at least under some circumstances, than previously suggested.

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***PTYCHOGLOSSUS FESTAE* (Peracca's Largescale Lizard). NESTING.** *Ptychoglossus festae* is an uncommon gymnophthalmid lizard distributed from eastern Panama to northwestern Colombia. It occurs in forest leaf litter in areas of lowland tropical rainforest throughout the departments of Chocó, Córdoba, and Antioquia in Colombia, at 30–820 m elevation. Little else is known of the natural history of this species (Harris 1994. Herpetol. Monogr. 8:226–275). Here we report communal egg-laying in *P. festae* within a rotten log in tropical rainforest in the Nature Reserve Civil Society Ormuz, Vereda Las Parcelas Capitán, Corregimiento of Titumate, municipality of Unguia, department of Chocó, Colombia (8.266199°N, 77.089885°W; datum WGS 84) in an area studied from 14–25 September 2013.

At the study site, we found two nests very close to one another, each clutch containing two viable eggs. All eggs were at nearly the same state of development, as all hatched between one to three days following their collection. In addition, a gravid female *P. festae* was found about to lay two eggs next to the other nests. The four eggs weighed on average 0.5 g (range = 0.4–0.6 g), average width 7.33 mm (range = 6.70–8.00 mm), average length 11.14 mm (range = 10.70–11.60 mm). We measured the four neonates, as follows: average LRC 22.86 mm (range = 22.04–23.20 mm), average LC 28.8 mm (range = 26.4–29.10 mm), and average weight 0.30 g (range = 0.28–0.33 g).

This is the first report for conspecific communal oviposition of *P. festae* (Fig. 1). In lizards, communal nests have been observed in various families, including the Gymnophthalmidae (Magnusson and Lima 1984. J. Herpetol. 18:73–75; Radder and Shine 2007. J. Anim. Ecol. 76:881– 887; Doody 2009. Q. Rev. Biol. 84[3]:229–252; Medina-Rangel 2013. Herpetol. Rev. 44:312–313). Although communal oviposition in reptiles has been attributed to scarcity of nest sites offering suitable incubation conditions (direct fitness benefits accruing from the proximity of other eggs; Radder and Shine, *op. cit.*; Doody, *op. cit.*), the tropical rainforest habitat discussed herein provides abundant nesting sites. As affirmed by Doody (*op. cit.*), communal nesting behavior may provide an evolutionary advantage to reptiles, given the lack of parental care in most species, despite the abundance of adequate nest sites. The reproductive aspect of Colombian Gymnophthalmidae is poorly known and information on nests, oviposition, incubation period, and hatchlings is lacking. This report provides the first data on communal nesting for *Ptychoglossus* species in Colombia.



FIG. 1. Eggs at different stages of development and one newly hatched young of *Ptychoglossus festae* observed at a communal oviposition site within a rotten log in Colombia.

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***PYGOPUS NIGRICEPS* (Western Hooded Scaly-foot). TAIL AUTOTOMY.** Some lizards autotomize their tails in response to predatory attacks. Although considerable study has been devoted to understanding the evolution of voluntary tail loss, especially in skinks and geckos (Arnold 1984. J. Nat. Hist. 18:127–169), variation in the "behavior" of the tail among species has not been quantified within a comparative context, at least partly because we lack autotomy observations in nature for a large number of species. Autotomy observations on additional species would thus facilitate our understanding of the phenomenon. Herein we report on an observation of unusual and possibly unique tail autotomy behavior in *Pygopus nigriceps* from tropical Australia.

At ~1900 h on 15 December 2008, while driving along the main highway near Uluru (Ayers Rock), Northern Territory, Australia (25.370503°S, 131.086223°E), we stopped for a lizard that was squirming about on the road. Upon inspection we determined that the lizard was *P. nigriceps*, and had just been run over by a vehicle (one had just sped past us). The lizard appeared to be dead (wounds to the body) but the action of the tail, which had broken from the body but was still connected to it by a small piece of skin, was pulling the body around. At this time, curious about how the tail would move without the lizard, we freed the tail from the body by removing the connecting skin. To our surprise, the tail began to move in a deliberate sinuous fashion like a snake (or legless lizard) away from the body; the anterior end of the tail was raised somewhat, giving the appearance of a head. Remarkably, the tail moved > 3 m from the body, off the road. The path of the tail did not track in a straight line, but also in a somewhat sinuous fashion. After about four minutes, the tail stopped moving horizontally, but continued to wiggle in place, in a back and forth fashion. After about another minute the tail ceased to move, coming to rest on the road shoulder. The body did not move again. The weather was overcast and warm (~25°C); however, a shower had passed through the area that evening, and storms had been present the previous few days.

The tail autotomy we observed in *P. nigriceps* was unusual and possibly unique. Most observations of tail autonomy in lizards involve somewhat random movement patterns within a small area (e.g., within 0.5 m^2, pers. obs.). The tail of the *P. nigriceps*, in sharp contrast, moved well away from the body in a very deliberate fashion, coming to rest meters away. The movement of the tail was reminiscent of a legless lizard or snake, and the pathway would serve to lead the predator well away from the lizard. In our case, we could not observe behavior in the (dead)

lizard as the tail moved away, but future observations should note if the lizard moves in the opposite direction to that of the tail. Further observations are needed to confirm this unusual autotomy in *P. nigriceps*, in congeners, and in other similarly-built pygopodids.

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***SALTUARIUS SWAINI* (Southern Leaf-tailed Gecko). TAIL AUTOTOMY.** Some lizards autotomize their tails in defense of predators, and considerable study has been devoted to understanding the evolution of voluntary tail loss, especially in skinks and geckos (Arnold 1984. J. Nat. Hist. 18:127–169). Variation in the "behavior" of the tail among species has not been quantified within a comparative context, at least partly because we lack autotomy observations for a large number of species (Higham and Russell 2010. Biol. Lett. 6:70–73). Observations for more species are needed to facilitate our understanding of how autotomy is used and how it evolves. Herein we report on an observation of unusual and possibly unique tail autotomy behavior in *Saltuarius swaini*. The tail of *S. swaini* is flat and shaped somewhat like an upside-down tear, with a distinct attenuated tip (Fig. 1).

On 7 May 2001 one of us (SD) inadvertently dislodged the tail from an adult male *S. swaini* while removing the lizard from the road at O'Reilly's Resort in Lamington National Park, Queensland, Australia (28.229462°S, 153.133309°E). The (entire) autotomized tail dropped onto the road and immediately exhibited unusual locomotion for an autotomized tail. The tail, which was an original tail based on the presence of spines (as in Fig. 1), flipped sideways in one direction repeatedly, resulting in an overall rolling action that tracked in a large circle with a diameter of approximately 0.5 m. After about two minutes, movement of the tail slowed considerably, during which time SD noticed that the tail tip was the lever that flipped the tail. At this time SD quickly removed the tip of the tail with a knife, and this caused the tail to cease flipping and thus rolling. The tip-less tail rocked back and forth in place for another minute or so before it ceased movement altogether. The time was 2030 h on a misty night with an air temperature of 18°C.

PHOTOS BY S. MACDONALD

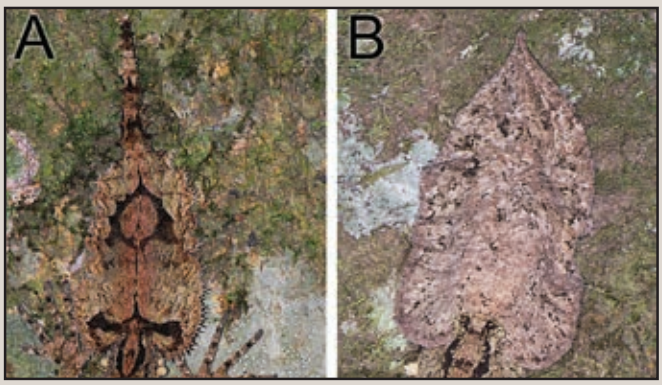


FIG. 1. *Saltuarius swaini*, showing the shape of the (A) original tail and (B) regenerated tail. During autotomy in the original tail, the tip of the tail acts as a lever to continuously flip the autotomized tail in one direction, resulting in the tail 'rolling' in a circular path well away from the body.

The tail autotomy SD observed in *S. swaini* is apparently unique. The flat shape of the tail, along with the tip as a lever, resulted in the tail moving non-randomly over a considerable area, compared to the more usual movements of autotomized lizard tails that generally move rapidly and somewhat randomly within a smaller area (pers. obs.). Although tail autotomy is presumed to have evolved to distract the would-be predator from the lizard, non-random tracking of the tail of *S. swaini* would seemingly provide a more deliberate path away from the lizard. Tests of the lizard's movements immediately following autotomy would be invaluable here. Moreover, the use of the tail-tip as a lever, coupled with little tail movement when the tip was removed, indicates that the tail tip may have evolved explicitly to serve an antipredator function. Comparative study of closely related members of the group with variation in tail shape and tip length could confirm the importance of the tail tip for autotomy in *S. swaini*, as well as determine how autotomy has been modified in this group of arboreal geckos. Also, the regenerated tails in this species exhibits a shorter tail tip, which may influence the behavior of the autotomized tail.

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***SCELOPORUS NELSONI* (Nelson's Spiny Lizard). CESTODE ENDOPARASITES.** *Sceloporus nelsoni* ranges from southwest Chihuahua and southern Sonora, Mexico along Pacific slopes to Jalisco, Mexico (Lemos Espinal and Smith 2007. Amphibians and Reptiles of the State of Chihuahua, Mexico. Comisión Nacional Para Conocimiento y Uso de la Biodiversidad, Universidad Nacional Autónoma de Mexico, Tlalnepantl, edo. de México. 613 pp.). Currently, there are two helminth species known from *S. nelsoni*: *Parapharyngodon alvarengai* and *Strongyluris similis* (Mayén-Peña et al. 1998. J. Helminthol. Soc. Washington 65:108–111). The purpose of this note is to add to the helminth list of *S. nelsoni*.

A sample of 11 *S. nelsoni* (mean SVL = 54.6 mm ± 3.7 SD, range = 44–58 mm) collected in the vicinity of Alamos (27.00275°N, 108.9400°W), Sonora, Mexico in 1960 to 1963, 1966, 1975 and deposited in the herpetology collection of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California, USA was examined for helminths (LACM) 96211, 96216, 96218, 96225, 96226, 96229, 96232, 96234, 96235, 96240, 96241.

The body cavity was opened and the digestive tract removed, opened by a longitudinal incision and examined under a dissecting microscope. Only cestodes (from the small intestines of LACM 96218, 96240, 96241) were found, which were regressively stained in hematoxylin, mounted in Canada balsam, studied using a compound microscope and identified as *Oochoristica scelopori* (prevalence: number infected/number examined × 100 = 27%, mean intensity: mean number infected individuals ± 2.7 SD, range = 1–6). The finding of only one helminth species in *S. nelsoni* may reflect our small sample size. Voucher cestodes were deposited in the helminthological collection of the United States Parasite Collection (USNPC), Beltsville, Maryland, USA as *Oochoristica scelopori* USNPC (107888).

Oochoristica scelopori is common in sceloporine lizards from both Arizona (Goldberg et al. 1994. J. Helminthol. Soc. Washington 61:73–83) and Mexico (Goldberg et al. 2003. Southwest. Nat. 48:208–217) as well as other lizards from southern California

(Telford 1970. Amer. Midl. Nat. 83:516–554). Our diagnosis of *O. scelopori* is based on characters of Nearctic species of *Oochoristica* as listed in Table 2 of Bursey et al. (2010. Zootaxa 2715:45–54): neck present; circular suckers; 22–43 testes present in one cluster; ovary with large number of lobules. *Sceloporus nelsoni* represents a new host record for *Oochoristica scelopori*.

We thank G. Pauly (LACM) for permission to examine *S. nelsoni*.

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***SCELOPORUS OCCIDENTALIS* (Western Fence Lizard) and *SCELOPORUS ORCUTTI* (Granite Spiny Lizard). FEEDING BEHAVIOR AND DIET.** On 17 April 2010 between 1115–1145 h, we observed five *Sceloporus occidentalis* and three *S. orcutti* preying on carpenter ants (*Camponotus*) approx. 6 km NW of Warner Springs, San Diego Co., California, USA (33.30502°N, 116.69444°W, datum WGS84; elev. 890 m). The *Camponotus* were emerging from their nest and swarming the surface of a granite boulder approximately 3 m diameter. The swarm (> 1000) covered approximately 75% of the boulder and consisted of an estimated 85% workers (sterile wingless females) and 15% winged queens and males. The ants are currently being described as a new species of *Camponotus* (P. Ward, pers. comm.).

Both *Sceloporus* species were employing ambush foraging behavior. The lizards were positioned on elevated ambush sites on the edge of an adjacent boulder in clear view of the ants. Occasionally a lizard would jump about 10 cm across a crevice to the adjacent boulder, run among the carpenter ants, capture a single ant, and then quickly retreat to its elevated perch to consume its prey. *Camponotus* are large, fiercely territorial ants. They do not sting, but the workers and soldiers can administer a powerful bite that is often accompanied by the release of formic acid (Hölldobler and Wilson 1990. The Ants. The Belknap Press of Harvard University Press, Cambridge, Massachusetts. 732 pp.). One male *S. occidentalis* (SVL = 75 mm) was collected (SDNHM 68935). Its stomach contents contained several *Camponotus* sp. (*sensu* Ward, *op. cit.*) consisting of one alate queen, two workers and ant fragments; one *Dermacentor occidentalis* (Arachnidae: Ixodidae); an unidentified Coleoptera, and an unidentified Hemiptera.

Jumping to catch insect prey by *Sceloporus occidentalis* (Stone 1942. Copeia 1942:129) and ants as prey for both *S. occidentalis* and *S. orcutti* has been previously reported (Mayhew 1963. Amer. Midl. Nat. 69:310–327; Johnson 1965. Herpetologica 21:114–117; Clark 1973. Herpetologica 29:73–75; Otvos 1977. Herpetol. Rev. 8:6–7). This is the first report of these species consuming *Camponotus*. The feeding behavior described demonstrates an ability to successfully and repeatedly capture and consume potentially harmful prey while minimizing injury. Our observation of the aggregation of feeding in syntopic *S. occidentalis* and *S. orcutti* from the same outcrop suggests that the lizards temporarily suspend interspecific territoriality (Creusere and Whitford 1982. *In* Scott [ed.], Herpetological Communities, pp. 121–127. U.S. Dept. Interior, Fish and Wildlife Service, Research Report 13) to take advantage of an abundant food supply.

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***SCELOPORUS OMILTEMANUS* (Southern Cleft Lizard). ENDOPARASITES.** *Sceloporus omiltemanus* is restricted to Guerrero and Oaxaca, Mexico (Martínez-Méndez and Méndez-De La Cruz 2007. Zootaxa 1609:53–68; Uetz and Hosek [eds.] 2014. The Reptile Database, http://www.reptile-database.org, accessed 03 February 2014). We know of no published reports of helminths for *S. omiltemanus*. The purpose of this note is to establish the initial helminth list for *S. omiltemanus*.

Four *S. omiltemanus* (mean SVL = 87.0 mm ± 12.7 SD, range = 72–98 mm) were examined from the herpetology collection of the Los Angeles County Museum of Natural History (LACM) collected 1973 (LACM 109214) and 1977 (LACM 127038–127040). Specimens were from the vicinity of Carrizal de Bravo (17.621111°N, 99.838056°W, elev. 2400 m), Guerrero, Mexico.

The body cavity was opened and the digestive tract was removed, opened by a longitudinal incision and examined under a dissecting microscope. Cestodes were regressively stained in hematoxylin, mounted in Canada balsam, and studied using a compound microscope. Nematodes were cleared in a drop of lactophenol on a glass slide, cover slipped and studied under a compound microscope. Found were one species of Cestoda: *Oochoristica scelopori* (infection site, small intestine), helminths (N) = 8, prevalence = number infected/number examined × 100 = 50%, mean intensity ± SD, mean number infected individuals with range = 4.0 ± 8.5 SD, range = 1–7, and four species of Nematoda: *Spauligodon giganticus* (large intestine, (N) = 13, prevalence = 100%, mean intensity = 8.5 ± 3.1 SD, 6–13; *Strongyluris similis* (large intestine, (N) = 39, prevalence = 75%, mean intensity ± SD = 13.0 ± 11.8, 3–26; *Oswaldocruzia* sp. (stomach, small intestine), (N) = 5, prevalence = 25%, and *Physocephalus* sp. (stomach wall), (N) = 5, prevalence = 25%. Voucher helminths were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland as: *Oochoristica scelopori* (USNPC 107891), *Spauligodon giganticus* (USNPC 107893), *Strongyluris similus* (USNPC 107894), *Oswaldocruzia* sp. (USNPC 107895), *Physocephalus* sp. (USNPC 107897).

Oochoristica scelopori is common in sceloporine lizards from both Arizona (Goldberg et al. 1994. J. Helminthol. Soc. Washington 61:73–83) and Mexico (Goldberg et al. 2003. Southwest. Nat. 48:208–217) as well as other lizards from southern California (Telford 1970. Amer. Midl. Nat. 83:516–554). Our diagnosis of *O. scelopori* is based on characters of Nearctic species of *Oochoristica* listed in Table 2 of Bursey et al. (2010. Zootaxa 2715:45–54): neck present, circular suckers, 22–43 testes present in one cluster, ovary with large number of lobules. *Spauligodon giganticus* is distinguished from *S. oxkutzcabiensis* which also occurs in Mexican sceloporines (Goldberg et al. 2003. Southwest. Nat. 48:208–217) on the basis of egg morphology: eggs of *S. giganticus* are lanceolate with a knob at the wide end; eggs of *S. oxkutzcabiensis* are lanceolate with a knob at each end (Bursey et al., 2005. J. Parasitol. 91:324–328. *Strongyluris similis* has been previously reported from sceloporines from both Mexico and the United States (Goldberg et al. 2003, *op. cit.*). Species of *Oswaldocruzia* sp. are found worldwide in the intestines of amphibians and reptiles (Anderson 2000. Nematode Parasites of Vertebrates Their Development and Transmission. CABI Publishing, Oxon, UK. 650 pp.). Larvae of *Physocephalus* were previously reported from

cysts in the stomach walls of Mexican sceloporines (Goldberg et al. 2003, *op. cit.*). As no further development occurs, lizards probably serve as paratenic (transport) hosts for larvae of *Physocephalus* sp. *Sceloporus omiltemanus* represents a new host record for *O. scelopori, S. giganticus, S. similis, Oswaldocruzia* sp., *Physocephalus* sp.

We thank G. Pauly (LACM) for permission to examine *S. omiltemanus*.

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***SCELOPORUS PARVUS* (Blue-bellied Lizard). FEMALE AGGRESSION.** Aggressive displays are used by lizards in the genus *Sceloporus* for social communication (e.g., Carpenter 1978. Contrib. Biol. Geol. Milwaukee Publ. Mus. 18:1–71). Previous studies of aggressive signaling have focused mostly on males, but some female *Sceloporus* use aggressive displays in social interactions (Woodley and Moore 1999. Horm. Behav. 35:205–214; Hews et al. 2004. Anim. Behav. 68:1201–1207). Here, I provide what I believe to be the first reported observations of aggressive signaling by female *Sceloporus parvus*. Both observations were made in the breeding season on a population of *S. parvus* located ca. 10 km W of San Joaquín, Querétaro, Mexico (20.89668°N, 99.65568°W, datum WGS84; 2177 m elev.).

On 31 May 2013 I observed a male *S. parvus* basking on a boulder. The lizard abruptly moved to the ground on the opposite side of the boulder and was out of view for ca. 10 sec. When I relocated the focal male, I observed him consuming an unidentified grasshopper with the head protruding from the lizard's mouth. A female *S. parvus* quickly approached the male from ca. 1 m away in a series of three short-distance movements. Each movement was made directly toward the male and interrupted by a bout of 2–3 push-up displays by the female. The push-up displays involved movement of the front two legs with slight dorsolateral compression, a posture typically seen in aggressive interactions of *Sceloporus*. When the female was ca. 15 cm from the male, he retreated beneath the boulder with the partially consumed grasshopper and was followed rapidly by the female.

On 1 June 2013 I observed a *S. parvus* female basking on a rock when a male approached from ca. 4 m away while performing shudder courtship displays. When the male was ca. 2 m away from the female, she turned laterally to present her left side to the male, arched her back, and compressed her body dorsolaterally. Similar postures have been described as courtship rejection displays in other lizards (Cooper and Greenberg 1992. *In* Gans and Crews [eds.], Hormones, Brain, and Behavior, Biology of the Reptilia Vol. 18, Physiology E, pp. 298–422. University of Chicago Press, Chicago, Illinois). When the female assumed the posture, the male terminated a shudder display and moved away from the female. The female remained in the aggressive posture until the male entered a shrub ca. 1.5 m away.

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***SCELOPORUS PARVUS* (Blue-bellied Lizard). REPRODUCTION.** *Sceloporus parvus* is known from the Sierra Madre Oriental of northeastern México; recorded from the highlands of Coahuila, Nuevo León, Tamaulipas, San Luis Potosí, and Hidalgo (Lemos Espinal and Smith 2007. Amphibians and Reptiles of the State of Coahuila. CONABIO/UNAM. 550 pp.). The natural history of this species is poorly understood and no data on reproduction are available. Lemos Espinal and Smith (2007, *op. cit.*) comment that this species is probably oviparous.

On 6 April 2012, one gravid female *S. parvus* (MZFC 29625; Colección Herpetológica del Museo de Zoología Alfonso L. Herrera Facultad de Ciencias UNAM) was collected in oak forest habitat at the Rancho el Chupadero, Municipality Ocampo, Coahuila, México (27.1655°N, 102.5722°W, datum WGS84; 2012 m elev.). The female measured 44.7 mm SVL, body mass was 12.3 g. The female contained a clutch size of 3 eggs: egg mass 0.24–0.28 g (mean = 0.26); egg length 9.38–9.65 mm (mean = 9.52). This information confirms the oviparity of the species and represents the first clutch size reported for *S. parvus*.

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***SCELOPORUS SINIFERUS* (Longtail Spiny Lizard). ENDOPARASITES.** *Sceloporus siniferus* occurs along the Pacific slope of southern Mexico from Guerrero to Guatemala and inland through the states of Morelos, Oaxaca, and Chiapas (Uetz and Hosek [eds.], The Reptile Database, http://www.reptile-database.org, accessed 07 Nov 2013). We know of no helminth records from this species. The purpose of this note is to establish the initial helminth list for *S. siniferus*.

A sample of nine *Sceloporus siniferus* (mean SVL = 51.6 mm ± 4.3 SD, range = 45–49 mm collected in Oaxaca, Mexico during 1957, 1964, and 1965 and deposited in the herpetology collection of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California, USA as LACM 61964–61968, 64494–64496, 97412 was examined.

The body cavity was opened and the digestive tract removed, opened by a longitudinal incision and examined under a dissecting microscope. One nematode was found in the stomach of LACM 61965 and two were found in LACM 64494 (one in the stomach, one in the small intestine). Nematodes were cleared in a drop of lactophenol on a glass slide, coverslipped, studied under a compound microscope and identified as *Physaloptera retusa, (*prevalence: number infected/number examined × 100 = 22%) mean intensity: mean number infected individuals ± 1 SD = 1.5 ± 0.70 SD, range = 1, 2).Voucher helminths were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland as *Physaloptera retusa* (USNPC 107887). *Physaloptera retusa* has the largest latitudinal geographic range of any Western Hemisphere nematode, occurring in lizards from North, Central and South America (Baker 1987. Synopsis of the Nematoda Parasitic in Amphibians and Reptiles. Mem. Univ. Newfoundland 11:1–325; Bursey et al. 2007. Comp.

Parasitol. 74:108–140). *Sceloporus siniferus* represents a new host record for *Physaloptera retusa*.

We thank G. Pauly (LACM) for permission to examine *S. siniferus*.

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***SCINCELLA LATERALIS* (Little Brown Skink). PREDATION.** *Scincella lateralis* is a small skink native to the southeastern USA, where it is depredated by a variety of snakes, spiders, and predatory birds. Other than shrikes (*Lanius*) and corvids, only a few passerine birds have been documented to depredate *S. lateralis*, including Eastern Meadowlarks (*Sturnella magna*; Kemmerer and Cline 1985. Herpetol. Rev. 16:27–28), and Eastern Bluebirds (*Sialia sialis*; Beane and Trail 1991. Herpetol. Rev. 22:99). On 30 December 2013 at 1330 h, I observed an Eastern Phoebe (*Sayornis phoebe*) eating an adult *S. lateralis* at the Falls Lake Dam in Wake Co., North Carolina, USA (35.939897°N, 78.582787°W, WGS84; eBird checklist http://ebird.org/ebird/view/checklist?subID=S16129770). The bird was shaking the lizard violently in its bill and beating it against the branch it was perched on, consistent with prey-killing behavior used by both shrikes and bluebirds. The skink had lost most of its tail, although it could not be determined whether this happened during this predation event or a previous one. Although two separate accounts document Eastern Phoebes eating small fish (Jung 1926. Bird-Lore 28:63–64; Binford 1957. Auk 74:264–265), this is apparently the first account of one eating a tetrapod vertebrate.

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***SPHENOMORPHUS SCOTOPHILUS* (Spotted Forest Skink). REPRODUCTION.** *Sphenomorphus scotophilus* is scansorial and diurnal and is known from southern Thailand south through Peninsular Malaysia to possibly Sumatra (Grismer 2011a. Field Guide to the Amphibians and Reptiles of the Seribuat Archipelago [Peninsular Malaysia]. Edition Chimaira, Frankfurt am Main. 239 pp.). In the Seribuat Archipelago, gravid females carrying two eggs have been found during March, April, July, and September; hatchlings were observed in November (Grismer 2011b. Lizards of Peninsular Malaysia, Singapore and their Adjacent Archipelagos. Edition Chimaira, Frankfurt am Main. 728 pp.). In this note, we add information on the reproductive biology of *S. scotophilus* from a histological examination of gonadal material.

A sample of 48 *S. scotophilus* from West Malaysia collected 2001 to 2007 by LLG and deposited in the herpetology collection of La Sierra University, Riverside, California, USA was examined. The sample consisted of 29 adult males (mean SVL = 47.4 mm ± 4.7 SD, range = 35–58 mm), 18 adult females (mean SVL = 48.4 mm ± 3.0 SD, range = 44–54 mm), and one juvenile (SVL = 28 mm). *Sphenomorphus scotophilus* were collected in West (Peninsular) Malaysia (by state): Johor (N = 13), Pahang (N = 27), Penang (N = 3), Selangor (N = 5).

A cut was made in the lower abdominal cavity and the left testis or ovary was removed, embedded in paraffin, cut into 5 µm sections and stained with Harris hematoxylin followed by eosin counterstain. Enlarged follicles (> 4 mm) or oviductal eggs were counted. Histology slides were deposited in LSUHC.

Table 1. Monthly stages in the ovarian cycle of 18 adult female *Sphenomorphus scotophilus* from West Malaysia. *One oviductal female exhibited concurrent yolk deposition.

Month	N	Quiescent	Yolk deposition	Enlarged follicles > 4 mm	Oviductal eggs
March	5	2	0	1	2
July	13	2	2	0	9*

The only stage present in the testicular cycle was spermiogenesis in which the lumina of the seminiferous tubules were lined by sperm or clusters of metamorphosing spermatids. The following monthly samples of males were examined: March (N = 8), June (N = 2), July (N = 12), August (N = 5), September (N = 1), October (N = 1). The smallest reproductively active male (spermiogenesis) measured 35 mm SVL (LSUHC 8199) and was collected in September.

Four stages were present in the ovarian cycle (Table 1): 1) quiescent, no yolk deposition; 2) yolk deposition (basophilic vitellogenic granules in the ooplasm); 3) enlarged follicles > 4 mm; 4) oviductal eggs. One female with oviductal eggs (LSUHC 7278) was undergoing concurrent yolk deposition for a subsequent clutch indicating *S. scotophilus* can produce multiple egg clutches in the same year. Mean clutch size (N = 12) was 1.8 ± 0.39 SD, range = 1–2. The smallest reproductively active female (oviductal eggs) measured 44 mm SVL and was collected in July (LSUHC 4574). One juvenile (LSUHC 4702) of possible neonate size (SVL = 28 mm) was collected in July.

In view of the extended period in which reproductively active males were found and the observations of Grismer (2011b, *op. cit.*), *S. scotophilous* exhibits an extended reproductive cycle, in which breeding may be continuous.

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***XANTUSIA ARIZONAE* (Arizona Night Lizard). REPRODUCTION.** *Xantusia arizonae* is endemic to Arizona west of the Verde River in the Weaver, Date Creek, and McCloud Mountains (Sinclair et al. 2004. Amer. Nat. 163:396–414). The species has been reported to give birth to one or two young in late August (Klauber 1931. Trans. San Diego Soc. Nat. Hist. 7:1–16; Brattstrom 1951. Herpetologica 7:143–144). The purpose of this note is to provide additional information on reproduction of *X. arizonae*.

Eleven *X. arizonae* consisting of one adult male (SVL = 46 mm), one subadult male (SVL = 43 mm), eight adult females (mean SVL = 55.0 mm ± 1.9 SD, range = 53–58 mm), and one unsexed subadult (SVL = 40 mm) in the herpetology collection of the Natural History Museum of Los Angeles County (LACM) were examined for reproductive activity. Eleven were collected in May 1982; one was collected in June 1982, all from the vicinity of Yarnell (34.2225°N, 112.7496°W), Yavapai Co.: LACM 134510–134516, 134524, 134526, 134530, 169268.

Ovaries and testes were histologically examined. Tissues were embedded in paraffin, histological sections were cut at 5

µm and stained with hematoxylin followed by eosin counterstain. Histology slides were deposited in LACM.

One *X. arizonae* male (SVL = 48 mm SVL) was undergoing spermiogenesis; lumina of the seminiferous tubules were lined by sperm or clusters of metamorphosing spermatids. One smaller male (SVL = 43 mm) exhibited early recrudescence in which seminiferous tubules contained 3–4 layers of primary spermatocytes with spermatogonia in the basal layer. It was considered to be a subadult.

Seven of eight females were undergoing yolk deposition with 1–2 follicles containing basophilic granules in the ooplasm. The other *X. arizonae* female (from June) contained two oviductal eggs; no embryos were visible. Mean clutch size for eight females was 1.8 ± 0.46 SD, range = 1–2. The smallest reproductively active females (vitellogenic granules in follicles) measured 53 mm SVL (LACM 134516, 162968).

In conclusion of this investigation, *X. arizonae* belongs to the group of xantusiids which breed in spring with young produced in late summer to early fall, including the congeners *X. riversiana* (Goldberg and Bezy. 1974. Herpetologica 30:350–360), *X. henshawi* (Lee 1975. Trans. San Diego Soc. Nat. Hist. 17:259–278), and *X. vigilis* (Miller 1948. Univ. California Publ. Zool. 47:197–213).

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XANTUSIA BEZYI **(Bezy's Night Lizard). REPRODUCTION.** *Xantusia bezyi* is an Arizona endemic found east of the Verde River from the Mazatzal and Superstition Mountains east to the northwest base of the Pinal Mountains and south across the Gila River to the Galiuro Mountains (Sinclair et al. 2004. Amer. Nat. 163:396–414). The purpose of this note is to provide information on reproduction of *X. bezyi*.

Twenty-one *X. bezyi* consisting of seven adult males (mean SVL = 50 mm ± 2.4 SD, range = 48–53 mm), 11 adult females (mean SVL = 55 mm ± 4.1 SD, range = 48–63 mm), and three subadult males (mean SVL = 41 mm ± 1.0 SD, range = 40–43 mm in the herpetology collection of the Natural History Museum of Los Angeles County (LACM) were examined for reproductive activity. All were collected May 1982 from Maricopa County (LACM 134498, 134500, 134503, 134504, 134506) and Pinal County (LACM 134478–134480, 134483–134489, 134491–134493, 134495–134497).

Ovaries and testes were histologically examined. Tissues were embedded in paraffin, histological sections were cut at 5 µm and stained with hematoxylin followed by eosin counterstain. Histology slides were deposited in LACM.

Xantusia bezyi males larger than 48 mm SVL were undergoing spermiogenesis (lumina of the seminiferous tubules are lined by sperm or metamorphosing spermatids). Three smaller males measuring 40 mm (LACM 134996), 41 mm (LACM 134497) and 42 mm SVL (LACM 134495), all from May, exhibited early recrudescence (seminiferous tubules contain ca. 4 layers of spermatogonia and primary spermatocytes) and were considered to be subadults.

Seven of eleven females were undergoing yolk deposition (basophilic yolk granules in the ooplasm) for a litter of 1–2 (mean litter size = 1.6 ± 0.53) that likely would have been produced in the fall. The smallest reproductively active female (LACM 134488) measured 53 mm SVL and contained two yolking follicles, As is typical for other xantusiid lizards (Goldberg and Bezy 1974. Herpetologica 30:350–360; Goldberg 2013. Sonoran Herpetol. 26:9–11), not all mature females reproduce each year. Thus, LACM 134056 (SVL = 48 mm), collected in May could have been a mature female that was not breeding.

In conclusion of this investigation, *X. bezyi* is a spring breeder with one to two young produced likely in early fall. Timing of events in the reproductive cycle of *X. bezyi* appear to be similar to the congeners *X. riversiana* (Goldberg and Bezy 1974, *op. cit.*), *X. henshawi* (Lee 1975. Trans. San Diego Soc. Nat. Hist. 17:259–278; Goldberg 2013, *op. cit.*), and *X. vigilis* (Miller 1948. Univ. California Publ. Zool. 47:197–213; Zweifel and Lowe 1966. Am. Mus. Novitat. 2247:1–57).

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XANTUSIA BOLSONAE **(Bolsón Night Lizard). REPRODUCTION.** *Xantusia bolsonae* is known from two localities in the southern Chihuahuan Desert of Durango, Mexico (Webb 1970. Contrib. Sci. 194:1–10; Flores-Villela et al. 1990. Herpetol. Rev. 21:97). In this note we provide information on the timing of female *X. bolsonae* reproduction.

Eight *X. bolsonae* consisting of six adult females, mean SVL = 53.3 mm ± 3.0 SD, range = 48–57 mm, one sub-adult of indeterminate sex, SVL = 34 mm, and one neonate, SVL = 28 mm, in the herpetology collection of the Natural History Museum of Los Angeles County (LACM) were examined for reproductive activity: LACM 116260, 136791, 136792 (May 1975); LACM 76156, 76158, 76159 (September 1971); LACM 106805, 106806 (September 1972); all from the vicinity of Pedriceña, Durango, Mexico.

The specimens (except for the neonate) previously had been opened for the purposes of karyotypic study. Ovaries from the three September females were histologically examined. Tissues were embedded in paraffin, histological sections were cut at 5 µm and stained with hematoxylin followed by eosin counterstain. Histology slides were deposited in LACM. No histology was done on the embryos.

Two females from May contained developing embryos with visible eyes, LACM 136791 (SVL = 57 mm) and LACM 136792 (SVL = 53 mm). LACM 116260 from May (SVL = 55 mm) contained one oviductal egg with no embryo visible. We arbitrarily considered LACM 106805 (SVL = 48 mm) from September as an adult, although we could not determine if parturition had occurred. All September females contained quiescent ovaries with no yolk deposition in progress.

In summary, the presence of well-developed embryos in *X. bolsonae* in May suggests that young are born in late spring to early summer. Thus, the female reproductive cycle of *X. bolsonae* approximates that of the sympatric *X. extorris* (Webb 1965. Amer. Mus. Novitat. 2231:1–16), to which molecular data suggest it is closely related (Noonan et al. 2013. Mol. Phylogen. Evol. 69:109–122) and differs from that of the morphologically similar *X. henshawi* in which parturition occurs in September to October (Lee 1975. Trans. San Diego Soc. Nat. Hist. 17:259–278; Goldberg 2013. Sonoran Herpetol. 26:9–11).

We thank G. Pauly (LACM) for permission to examine *X. bolsonae*.

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***XANTUSIA EXTORRIS* (Durango Night Lizard). REPRODUCTION.** *Xantusia extorris* was described from Durango, Mexico by Webb (1965. Amer. Mus. Novitat. 2231:1–16). It is currently known from Durango and Zacatecas (Baker et al 1981. Southwest. Nat. 25:568–569). Webb (*op. cit.)* reported one or two embryos were present in all females > 38 mm from May and estimated that offspring are born in late May or early June. The purpose of this note is to provide additional information on the timing of events in the *X. extorris* reproductive cycle.

Sixteen females (mean SVL = 37.5 mm ± 2.1 SD, range = 33–42 mm) and six males (SVL = 34.8 mm ± 1.7 SD, range = 33–38 mm) of *X. extorris* from the herpetology collections of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California, USA and the University of Arizona (UAZ), Tucson, Arizona, USA from Durango, Mexico, vicinity of Pedricena (25.1000°N, 103.7833°W, 1325 m elevation) were borrowed: LACM:106802, 116263, 116265–116268; UAZ: 17404, 17405, 17408, 17570, 17563, 17564, 17568, 17569, 17572–17576, 17580–17582. The specimens were collected 1965 to 1975.

Testes were histologically examined. Tissues were embedded in paraffin, histological sections were cut at 5µm and stained with hematoxylin followed by eosin counterstain. Histology slides were deposited in LACM and UAZ.

All six males contained regressed testes in which the seminiferous tubules were very small and contained primarily spermatogonia. It is possible they were all subadults.

Mean litter size for fifteen females with oviductal eggs from April to May was 1.4 ± 0.51 SD, range = 1–2. One female (LACM 116267, SVL = 33 mm) from May contained quiescent ovaries (no yolk deposition) and was either a subadult or an adult that was not breeding. The smallest reproductively active female (UAZ 17581) measured 34 mm SVL, was collected during April and contained one oviductal egg. This is a new minimum size for reproductive activity in *X. extorris* females; Webb (*op. cit.*) reported the smallest gravid female measured 38 mm SVL. An embryo was externally visible in one oviductile female from May (LACM 116268). No eggs were dissected to ascertain the presence of embryos.

In summary, the presence of an embryo and oviductal eggs in female *X. extorris* from April and May suggests that young are born in late spring to early summer confirming the observations of Webb (*op. cit.*). The presence of regressed testes in males from April and May differs strikingly from the reproductive cycle of the spring breeding *X. vigilis* (Miller 1948. Univ. California Publ. Zool. 47:197–213) and is suggestive that *X. extorris* may breed in fall or winter. Our data indicate the timing of events in the reproductive cycles of *X. extorris* and *X. bolsonae* (Goldberg and Bezy 2014. Herpetol. Rev. 45:509–510) are similar. Moreover, molecular data (Noonan et al. Mol. Phylogen. Evol. 69:109–122) suggest these two species are closely related.

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***XANTUSIA WIGGINSI* (Wiggins' Night Lizard). REPRODUCTION.** *Xantusia wigginsi* is found from southern California through Baja California to northern Baja California Sur (Sinclair et al. 2004. Amer. Nat. 163:396–414; Leavitt et al. 2007. Mol. Ecol. 16:4455–4481; Backlin and Fisher 2011. Herpetol. Rev. 42:392). We present the first information on litter size and the timing of events in the reproductive cycle of the species.

Nineteen *X. wigginsi* consisting of three adult males (mean SVL = 34 mm ± 2.0 SD, range = 32–36 mm); thirteen adult females (mean SVL = 36.6 mm ± 2.6 SD, range = 34–43 mm), one subadult male (SVL = 31.0 mm SVL) and two subadult females (SVL = 33.0 mm) in the herpetology collection of the Natural History Museum of Los Angeles County (LACM) were examined from localities between 27.59°N and 31.33°N in Baja California (LACM 3761, 26142, 36569, 62245, 101211, 101213–01224, 101330) and Baja California Sur (LACM 126139). The specimens had been collected between 1954 and 1977.

Ovaries and testes were histologically examined. Tissues were embedded in paraffin, histological sections were cut at 5 µm and stained with hematoxylin followed by eosin counterstain. Histology slides are deposited in LACM.

Two males from May were undergoing sperm formation (spermiogenesis) in which the lumina of the seminiferous tubules were lined by sperm or clusters of metamorphosing spermatids. One male from June was undergoing late spermiogenesis in which the number of cell layers in the germinal epithelium was reduced. The smallest reproductively active male (spermiogenesis) measured 32 mm SVL (LACM 36569) and was from May. One male (LACM 101221) from April (SVL = 31 mm) exhibited testicular recrudescence (proliferation of germ cells for the next period of spermiogenesis). It was classified as a juvenile as it is not known when spermiogenesis would have commenced,

Four stages were observed in the ovarian cycle: 1) quiescent, no yolk deposition; 2) early yolk deposition (vitellogenic granules) in ooplasm; 3) enlarged ovarian follicles (> 4 mm); 4) embryo present (Table 1). Litter size for five females was 1.0 for each. The two smallest reproductively active females (early yolk deposition) each measured 34 mm SVL (LACM 101211, 101225) and were from April. Two April females (each 33 mm SVL) exhibited quiescent ovaries (LACM 101217, 101220) and were classified as juveniles.

In summary, *X. wigginsi* is a spring breeder with young produced in early fall. Timing of events in the reproductive cycle appears similar to *X. riversiana* (Goldberg and Bezy 1974. Herpetologica 30:350–360; *X. henshawi* (Lee 1975. Trans. San Diego Soc. Nat. Hist. 17:259–278; Goldberg 2013. Sonoran Herpetol. 26:9–11) and *X. vigilis* (Miller 1948. Univ. California Publ. Zool. 47:197–213; Zweifel and Lowe 1966. Am. Mus. Novitat. 2247:1–57). Although the sample is limited, *X. wigginsi* may have the smallest litter size (1.0) in the genus.

TABLE 1. Monthly stages in the ovarian cycle of 13 *Xantusia wigginsi.*

Month	N	Quiescent	Early yolk deposition	Enlarged follicles > 4 mm	Embyros
March	1	1	0	0	0
April	9	2	5	2	0
June	2	0	0	2	0
August	1	0	0	0	1

We thank G. Pauly (LACM) for permission to examine *X. wigginsi*.

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***ZOOTOCA VIVIPARA* (Common Lizard). ABNORMAL ACTIVITY.** An activity period of *Zootoca vivipara* in St. Petersburg, Russia region spans about five and a half months. This cold-tolerant species is active from mid-April to late September–early October. The earliest record of spring activity within the St. Petersburg region is 3 April, latest autumn record on surface is 11 October. Populations of this species inhabit slopes of Pulkovo Heights that are covered partly by agriculture and partly by secondary mixed forest.

November of 2013 in St. Petersburg was unusually warm. The average monthly temperature at 2 m above ground was 4.2°C. During two weeks of observations the average daily air temperature was 4.9°C; minimum value 0.0°C; maximum value 8.2°C for period 10–24 November 2013. Maximum air temperature for this period was registered on 17 November (http://rp5.ru/).

On 17 November during a visit to the Pulkovo Heights, St. Petersburg, Russia (59.7722355°N, 30.3190041°E), I found one freshly killed adult male *Z. vivipara* out of its winter burrow. The dead lizard was found on the road along a garden on the western slope near habitat typically used by this lizard. The lizard (now stored in Zoological Institute, ZISP 27409) had been very recently killed on the road by vehicle. On this date the air temperature reached 8.2°C, humidity 53–83%, wind NW, wind speed 7 m/c, cloud coverage 70–80%, stratocumulus.

This unprecedented record of atypical activity in this species can be explained by the abnormally warm autumn season in 2013 in eastern Europe.

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SQUAMATA — SNAKES

***AGKISTRODON PISCIVORUS* (Cottonmouth). DIET.** *Agkistrodon piscivorus* is an abundant semiaquatic pitviper endemic to the southeastern United States. While *A. piscivorus* is a highly generalized opportunist that preys upon a wide variety of taxa, fish and amphibians are the most frequent prey (Ernst and Ernst 2003. Snakes of the United States and Canada, Smithsonian Books, Washington, DC. 668 pp.). On 30 June 2013, at approx. 1500 h, we collected a juvenile *A. piscivorus* along the bank of Pond Creek, Conecuh National Forest, Covington Co., Alabama, USA (31.09768°N, 86.53458°W; datum WGS84). The snake's body was distended due to a large prey item. After manual palpation, the snake regurgitated the remains of an adult *Lithobates grylio* (Pig Frog). The frog was identifiable but in an advanced stage of digestion, so no attempt was made to collect it. *Agkistrodon piscivorus* is a known predator of *Lithobates* species, including *L. catesbeianus, L. clamitans, L. palustris,* and *L. sphenocephalus* (Ernst and Ernst, *op. cit.*). However, to our knowledge this represents the first published record of *L. grylio* in the diet of *A. piscivorus.*

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***AGKISTRODON PISCIVORUS CONANTI* (Florida Cottonmouth). DIET and PHENOTYPE.** *Agkistrodon piscivorus conanti* is a semi-aquatic pit viper native to the southeastern United States (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Books, Washington, D.C. 668 pp.). On 25 June 2013, a nuisance female amelanistic *A. p. conanti* (total length = 58.5 cm; 250 g) was removed from a residential property in Flagler Co., Palm Coast, Florida, USA by staff from the Central Florida Zoo, Seminole Co., Lake Monroe, Florida, USA. The snake was subsequently transported to the Central Florida Zoo on the day of capture. During physical exam, symmetrical internal lumps could be seen throughout the body (Fig. 1), and a large, unknown item inside the snake could be felt via palpation. Due to health concerns for the *A. p. conanti*, it was ultimately decided that surgery was necessary to remove the object that appeared to be lodged in its stomach.

A *Pantherophis guttatus* (Red Cornsnake; total length = 71 cm; 100 g) was surgically-removed from the stomach of the *A. p. conanti* on 30 June 2013. Despite being ingested, the *P. guttatus* was largely intact following several days after capture and was becoming necrotic. While *A. piscivorus* has been known to feed on several snake species (Gloyd and Conant 1990. Snakes of the *Agkistrodon* Complex. Society for the Study of Amphibians and Reptiles, St. Louis, Missouri. 620 pp.; Ernst and Ernst, *op. cit.*), to our knowledge this is the first recorded account of *P. guttatus* in the diet of the species. The *A. p. conanti* has been added to the reptile collection at the Central Florida Zoo.



FIG. 1. A postprandial amelanistic *Agkistrodon piscivorus conanti*, that had consumed a *Pantherophis guttatus* in Flagler Co., Florida, USA.

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***BOTHROPS ASPER* (Fer-de-lance). DIET.** Members of the genus *Bothrops* are diet generalists (Martins et al. 2002. *In* Schuett et al. [eds.], Biology of the Vipers, pp. 307–328, Eagle Mountain Publishing, Eagle Mountain, Utah). Juvenile *B. asper* eat arthropods, frogs, and lizards while adults also consume birds, rodents, and medium-sized mammals (Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna between Two Continents, between Two Seas. Univ. Chicago Press, Illinois. 934 pp.; Sasa et al. 2009. Toxicon 54:904–922). Here we report the first observation of any *Bothrops* consuming a caecilian.

On 15 April 2013, a *Bothrops asper* was observed consuming a *Dermophis parviceps* (Slender Caecilian) on a dirt/mud road bordered by mid-elevation primary forest at Rara Avis Rainforest Reserve bordering Braulio Carillo National Park, Sarapiqui, Costa Rica (10.28201°N, 84.04577°W, datum WGS84; elev. 738 m). At 0725 h MAJ and JRS encountered the *B. asper* (total length = 758 mm) lying across a shallow pool of water in the road. Based on size and lack of a yellow caudal tip the snake could have been a juvenile female or adult male (Savage, *op. cit.*). A nearly immobile caecilian, *D. parviceps*, (SVL = 371 mm) was semi-coiled, also in the shallow pool, 40 cm from the snake. The caecilian's head was first below the surface of the water but rose above the surface during the observation, indicating that this was not a case of scavenging. While no strike by the snake was observed, the caecilian had likely been envenomated. The authors returned to the location at 0830 h. At this point the snake was lying by the side of the pool and the caecilian was coiled in the pool (Fig. 1). The snake removed the caecilian from the water 7 min after the last apparent movement by the caecilian. The caecilian was folded in a U-shape, one-fifth of the way down the body. After 31 min the snake proceeded to consume the caecilian starting at the fold in the body (Fig. 2). The consumption of the caecilian took 21 min. The entire predation event lasted longer than 2.25 h. The presence of the authors and a group of tourists may have increased the duration of the predation event.



FIG. 1. *Bothrops asper* prior to consuming the (presumably) envenomated *Dermophis parviceps*.



FIG. 2. *Bothrops asper* consuming a *Dermophis parviceps* starting at a point one-fifth of the way down the body instead of directly from the head of the caecilian.

This observation is notable for two reasons. First, the novel observation of consumption of a fossorial caecilian by a terrestrial *B. asper*. Second, the snake did not consume the caecilian directly from the head as is often noted when elongate predators eat elongate prey (Jackson et al. 2004. Zoology 107:191–200). It is unclear whether this was a rare event, representing opportunistic predation by *B. asper*, or whether caecilians make up a regular part of their diet.

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***BOTHROPS ASPER* (Terciopelo). DIET.** The genus *Bothrops* is widely distributed in South America and Central America (Campbell and Lamar 2004. The Venomous Reptiles of the Western Hemisphere. Comstock Publ., Ithaca, New York. 870 pp.). The species belonging to this genus are generalists and feed mostly on insects, frogs, lizards, snakes, birds and mammals (Schuett 2002. Biology of the vipers. Eagle Mountain, Utah. 580 pp.). However, references regarding wild prey are scarce.

At 1100 h on 18 June 2013 an adult female *Bothrops asper* (total length = 1780 mm) was found in a patch of tropical evergreen forest in Flavio Alfaro, Ecuador (0.390°S, 79.849°W, datum WGS84; elev. 427 m). The snake had been killed by farmers and was taken to the laboratory where it was dissected. In the stomach we found the whole body of a rat (*Proechimys semispinosus)* in an advanced stage of digestion. This rat was previously cited as prey of *B. asper* in Costa Rica (Sasa et al. 2009. Toxicon 54:904–922). In the intestine we found porcupine quills from *Coendou rothschildi* (Fig. 1) never before reported as prey of *B. asper*. We thank Víctor H. Luja and Rogelio Cedeño for comments on this note.

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PHOTO BY BELÉN BAUS



FIG 1. Dissected *Bothrops asper* with *Proechimys semispinosus* and *Coendou rothschildi* quills found inside.

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***COLUBER* (=*MASTICOPHIS*) *BILINEATUS* (Sonoran Whipsnake). DIET.** The diet of the swift-moving *Coluber bilineatus* has been reported to include birds, small mammals, lizards, snakes, and frogs (Stebbins 2003. A Field Guide to Western Reptiles and Amphibians, 3rd ed. Houghton Mifflin Co., Boston, Massachusetts. 533 pp.) To our knowledge, the only report of a *C. bilineatus* preying upon a frog or any amphibian, is an adult *Lithobates yavapaiensis* consumed by a "large" adult *C. bilineatus* in Buehman Canyon, Pima Co., Arizona (Bezy and Enderson 2003. Son. Herpetol. 16:17). On 18 Sep 2013 at 1608 h, JCR heard a thrashing and a frog squawking in cattails at the edge of a flooded mine adit in Middlemarch Canyon, Dragoon Mountains, Cochise Co., Arizona, USA (31.881429°N 109.953556°W, datum WGS84; elev. 1698 m). An approximately 1.2 m (total length) *C. bilineatus* emerged from the cattails with an adult (~70 mm SVL) *L. chiricahuensis* in its mouth. The snake had grasped the frog by the left hindquarters, but quickly adjusted so the frog's head was in its mouth. JCR approached for better pictures (Fig. 1; UAZ 57569-PSV), and at 1612 h the snake, with the frog still in its mouth, disappeared into grasses at the edge of the pond, or into the water.

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***COLUBER* (= *MASTICOPHIS*) *FLAGELLUM* (Coachwhip). DIET / OPHIOPHAGY.** *Coluber flagellum* is known to take a variety of prey items including snakes (Beaman and Basey 2011. Herpetol. Rev. 42:437). Here we report a snake as a prey item not previously documented for *C. flagellum*.

On 27 April 2012, a *C. flagellum* was encountered ingesting a live *Crotalus ruber* (Red Diamond Rattlesnake; Fig 1) in Sycamore Canyon Wilderness Park, Riverside, Riverside Co., California, USA (33,937083°N, 117.317605°W; datum WGS 84). The *C. ruber* had five rattle segments, including the button, which corresponds to an adult size within the range of 60–80 cm snout-vent length (N = 89; Dugan 2011. Ph.D. Dissertation, Loma Linda University, Loma Linda, California). Digital images were deposited in the herpetological collections of the Natural History Museum of Los Angeles County (LACM PC 1605, 1607)

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FIG. 1. *Coluber bilineatus* with adult *Lithobates chiricahuensis* in its mouth, Cochise Co., Arizona, USA.



FIG. 1. *Coluber flagellum* feeding on *Crotalus ruber*, Riverside Co., California, USA.

***CONTIA TENUIS* (Sharp-tailed Snake). PREDATION.** *Latrodectus mactans* (Black Widow) is known to prey on a variety of organisms, including snakes (Klauber 1940. Trans. San Diego Soc. Nat. Hist. 9:87–162; Jones et al. 2011. Herpetol. Rev. 42:440–441). This is the first arachnid predation documented for *C. tenuis*. On 1 July 2013, at 0645 h, one of us (NGT) observed a snake suspended in the web of a female *L. mactans* beneath a parked vehicle at 4519 Plantation Drive, Fair Oaks, California, USA (34.6480310°N, 121.2995338°W, datum WGS 84; Fig. 1). The spider was positioned to the side of the snake's head, and a pin-sized drop of blood was visible near the snake's mouth. It appeared that the spider was in the process of consuming the snake. Digital images were deposited in the herpetological collections of the Natural History Museum of Los Angeles County (LACM-PC 1668–1672).



FIG. 1. Adult female *Latrodectus mactans* (Black Widow) feeding on *Contia tenuis*, Fair Oaks, California, USA.

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***CROTALUS ANGELENSIS* (Isla Ángel de la Guarda Rattlesnake). DIET and PREDATION.** On 23 June 2012 we found a deceased adult *Crotalus angelensis* (Total length = 770 mm) inside the desiccated corpse of an adult *Lampropeltis getula* (Common Kingsnake; Total length = 1130 mm) on the southwestern coast of Isla Ángel de la Guarda (29.140250°N, 113.297983°W; datum WGS 84) in the Gulf of California, Baja California, Mexico (Fig. 1). It appeared that the kingsnake had died while consuming the rattlesnake because 260 mm of the posterior was emerging from the kingsnake's mouth, but the timing and cause of death



FIG. 1. Deceased and dessicated *Lampropeltis getula* that died while consuming an adult *Crotalus angelensis;* note mass of feathers inside the *Crotalus angelensis*.

are unknown. A mass of black feathers from an unidentified bird was embedded in the stomach of the rattlesnake, the first known record of this species consuming a bird. Little is known regarding the predators and prey of *C. angelensis*, although *Sauromalus hispidus* (Spiny Chuckwalla) has been recorded as a diet item (Grismer 2002. Amphibians and Reptiles of Baja California, Including its Pacific Islands and the Islands in the Sea of Cortés. Univ. California Press, Berkeley. 339 pp.), and insular populations of the closely related Speckled Rattlesnake (*C. mitchellii*) are known to prey upon *Uta stansburiana* (Side-blotched Lizard) and *S. hispidus* (Meik et al. 2012 Herpetol. Rev. 43:556–560). *Lampropeltis getula* is known to prey upon rattlesnakes elsewhere in its range, although its diet has not been studied on Isla Ángel de la Guarda. Geo-referenced photographs are vouchered at the San Diego Natural History Museum, San Diego, CA (SDSNH_HerpPC_05225–05232).

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***CROTALUS ATROX* (Western Diamond-backed Rattlesnake). RAIN HARVESTING BEHAVIOR.** To date, few episodes of the rattlesnake *Crotalus atrox* obtaining water from rain, sleet, and snow in arid habitats have been reported (Repp and Schuett 2009. Southwest. Nat. 53:108–114). However, those episodes have been observed only in late winter; that is, during the inactive season, and only from individuals inhabiting the Sonoran Desert. Herein, we report the first observation of a *C. atrox* harvesting rainwater during the active season (summer) in the northern Chihuahuan Desert.

On 28 August 2010, at 1640 h on a cloudy and breezy afternoon, an adult male *C. atrox* (SVL = 1000 mm; tail length = 80



FIG. 1. Adult male *Crotalus atrox* harvesting rainwater from a pool formed between its coils in late August at Indio Mountains Research Station, Hudspeth Co., Texas.

mm; 689.9 g) fitted with a Holohil Ltd. SB-2 transmitter was radiotracked at Indio Mountains Research Station (IMRS), Hudspeth Co., Texas, USA (30.769358°N, 105.009242°W, datum WGS 84; 1240 m elev.), as part of an ongoing study. Initially the rattlesnake was observed resting in a tightly coiled position at the base of a grass (*Aristida purpurea*) of an alluvial slope (10°). A few minutes later; as a brief rain was taking place in the area, we returned to examine if the snake's behavior was affected by the rain. To our surprise, we found the rattlesnake located in the same location but with its body in a loose coil position with its last two coils flattened dorso-ventrally and tightly in contact with each other (Fig. 1). As rain progressed, a water pool was formed between the latter coils and consequently with the head facing down the rattlesnake proceeded to drink rainwater for ca. 20 min. The latter behavior was clearly detected by the slight rhythmic movements of its jaw musculature. After the sporadic rain episode was over, the rattlesnake continued harvesting the remaining rainwater from its body and then went back to the same resting position until dusk. Rain harvesting during the active season has been observed in *C. molossus* at IMRS (Mata-Silva et al. 2012. Herpetol. Rev. 43:145-146).

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***DROMICODRYAS BERNIERI* (Bernier's Striped Snake). DIET.** Most Malagasy snake species appear to feed primarily on frogs and lizards (Mercurio et al. 2006. Salamandra 42:181-183). *Dromicodryas bernieri* was thought to be strictly saurophagous (Cadle 2003. *In* Goodman and Benstead [eds.], Natural History of Madagascar, pp. 997–1004. Univ. Chicago Press, Chicago; Gehring 2006. Zeitschrift des Kölner Zoo - Heft 49:127–141) but was recently found to feed on amphibians as well (Gandola et al. 2013. Herpetol. Rev. 44:689-690). Here, predation on *Chalarodon madagascariens* by *D. bernieri* is described.

In the late afternoon on 16 December 2007, a *D. bernieri* was observed foraging in heavily degraded spiny forest in Ifaty, Madagascar (23.070806°S, 43.364108°E, datum: WGS84). The specimen was chasing an adult male *Chalarodon madagascariensis*, moving rapidly with its anterior body raised above the ground. Due to the observer, the snake ceased the hunt and fled. On 18 December 2007 at 0910 h, a second *D. bernieri* was found



FIG. 1. *Dromicodryas bernieri* feeding on a *Chalarodon madagascariensis* in Ifaty, Madagascar.

constricting and swallowing a *C. madagascariensis* (Fig. 1). While constricting, the snake did not keep its prey in its mouth and raised its head upwards to observe the surroundings. Constriction continued for approximately 5 min after which the prey was swallowed, head first, in approximately 10 min.

I thank V. J.T. Loehr for reviewing the first draft of this correspondence.

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***ECHIS COLORATUS* (Palestine Saw-scaled Viper). REPRODUCTION.** *Echis coloratus* is known to occur in Egypt east of the Nile, Israel south to western and southern Arabian Peninsula where it frequents rocky ground (Phelps 2010. Old World Vipers A Natural History of the Azemiopinae and Viperinae. Edition Chimaira, Frankfurt am Main. 558 pp.). Up to 10 eggs are laid in August (Bar and Haimovitch 2011. A Field Guide to Reptiles and Amphibians of Israel. Pazbar LTD 1989, Herzilya Israel. 245 pp.); eggs are laid about 75 days after copulation (Phelps *op. cit.*). The purpose of this note is to present data on the monthly events in the testicular cycle and the minimum size for maturity of males.

A sample of ten *E. coloratus* males consisting of eight adults (mean SVL = 545.5 mm ± 67.9 SD, range = 465–663 mm) and two subadults (mean SVL = 447 mm ± 15.6 SD, range = 436–458 mm) collected 1957 to 2012 and deposited in the Natural History Collections of Tel Aviv University (TAUM), Tel Aviv, Israel was examined. Specimens examined by region were: A'rava Valley (TAUM 6112, 6113, 9016), Central Negev (TAUM 2821, 15901), Dead Sea Area (TAUM 4522, 5188, 14116, 16186), Shomeron (TAUM 16488). The left testis was removed, embedded in paraffin and cut into sections of 5 µm. Histology slides were stained with Harris' hematoxylin followed by eosin counterstain and were deposited in TAUM.

Three stages were observed in the monthly testicular cycle (Table 1), 1) regression, the germinal epithelium in the seminiferous tubules is reduced to a few layers, consisting of spermtogonia and sertoli cells; 2) recrudescence, there is a proliferation of germ cells for the approaching period of sperm formation. Primary spermatocytes predominate; 3) spermiogenesis, the lumina of the seminiferous tubules are lined by sperm or clusters of metamorphosing spermatids. The period of sperm production in spring (Table 1) fits within the ca. 75 days needed for

TABLE 1. Monthly stages in the testicular cycle of eight adult males of *Echis coloratus* from Israel.

Month	N	Regression	Recrudescence	Spermiogenesis
March	1	0	1	0
April	1	0	0	1
May	2	0	0	2
June	3	0	0	3
October	1	1	0	0

egg development (Phelps, *op. cit.*). The smallest mature male (spermiogenesis) measured 465 mm SVL (TAUM 6112) and was collected in June. Two other subadult males from June: 1) (TAUM 4552) SVL = 458 mm exhibited recrudescence and 2) (TAUM 6113) SVL = 436 mm exhibited regression.

I thank Shai Meiri (TAUM) for permission to examine *E. coloratus*, Erza Maza for facilitating the loan and the National Collections of Natural History at Tel Aviv University for providing *E. coloratus* for this study.

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***GERARDA PREVOSTIANA* (Gerard's Watersnake). REPRODUCTION.** Although *Gerarda prevostiana* is a fairly common species in coastal mangrove forests and adjacent mudflat habitats from western India to the Philippines (Murphy 2007. Homalopsid Snakes: Evolution in the Mud. Krieger Publ. Co., Malabar, Florida. 260 pp.) and Borneo (Das et al. 2013. Asian Herpetol. Rec. 4:76–78), little has been documented concerning reproduction.



FIG. 1. Adult female *Gerarda prevostiana* with clutch of five juveniles.

TABLE 1. Measurements of adult and five neonate *Gerarda prevostiana*, post-partum.

Animal ID	Mass (g)	SVL (mm)	Tail length (mm)
Adult female	29.52	399	58
Neonate1	2.70	145	25
Neonate2	2.93	158	25
Neonate3	2.69	155	24
Neonate4	2.35	148	26
Neonate5	2.71	145	28
Neonate average (SD)	2.68 (0.21)	150 (6)	26 (2)

On 16 November 2013 at approximately 2130 h, we collected a gravid female *G. prevostiana* at Pasir Ris Park, Singapore (01.378598°N 103.950738°E; datum: WGS 84). On 26 November 2013, the female gave birth to five offspring (Fig. 1; Table 1). The combined post-partum neonate mass was 13.38 g, which is 45.3% of the mass of the mother post-partum or 31.2% of the combined mass of adult and offspring. To our knowledge, this is the first description of relative clutch mass and intra-clutch variation in *G. prevostiana*. This work was conducted under NUS Institutional Animal Care and Use Committee (B01/11(A1)13) and National Parks Board of Singapore (NPRP10-095-2a) permission.

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***LAMPROPELTIS GETULA* (Common Kingsnake). DIET.** *Lampropeltis getula* has long been known to prey on turtle eggs and "so addicted are they to this egg diet, that the natives consider that is a common happening to find snakes awaiting the egg deposition" (Wright and Bishop 1915. Proc. Acad. Nat. Sci. Phila. 67:107–192). Other reports of turtle egg-eating behavior by *L. getula* include a variety of turtle genera in the families Chelydridae, Kinosternidae, and Emydidae (Ernst and Ernst 2003. Snakes of the Unites States and Canada. Smithsonian Press, Washington, D.C. 668 pp.). *Terrapene carolina* have been mentioned as a possible species whose eggs are eaten, but no direct observation appears to have been recorded. Knight and Loraine (1986. Brimleyana 12:1–4) reported finding a female *L. getula* less than 1 m away from a nesting *T. carolina* with its head elevated from the ground and directed toward the nesting female turtle. It was probable, given the circumstances that this snake was intending to ingest eggs from this nest. Reported here is the first direct observation of *L. getula* preying on a *T. carolina* nest.

On 5 July 2012 at 1800 h I observed a female *T. carolina* nesting on my front lawn near Asheboro, in Randolph Co., North Carolina, USA. This turtle dug a shallow nest, deposited 3–4 eggs, covered the nest, and left the nesting site approximately 2 h later. On 9 July 2012, at 1058 h I observed a *L. getula* pushing its



FIG. 1. *Lampropeltis getula* digging into *Terrapene carolina* nest.



FIG. 2. *Lampropeltis getula* drinking contents of *Terrapene carolina* egg.

snout into the ground directly in the center of the nest (Fig. 1). The snake pushed dirt sideways toward the margins of the nesting hole for approximately 20 min in a similar digging method as reported by others (Posey 1973. Bull. Maryland Herpetol. Soc. 9:105; Brauman and Fiorillo 1995. Herpetol. Rev. 26:101–102). The snake then opened the top egg with its rostrum or teeth making several slits in the long axis of the egg shell, drank the contents of the egg (Fig. 2), and ingested the nearly empty egg shell whole. As best I could tell, the remaining two to three eggs were eaten whole and undamaged. Once the snake removed its head from the nest hole, it responded to my presence by orienting its head in my direction and flicking its tongue rapidly and then slowly crawled away from the nest. This entire predation event lasted from 1058 h to 1246 h.

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***LEPTOPHIS AHAETULLA* (Green Snake). DIET.** *Leptophis ahaetulla* is a medium-sized arboreal or semi-arboreal species that feeds primarily on hylid frogs and small lizards (Albuquerque et al. 2007. J. Nat. Hist. 41:1237–1243), and is widely distributed from southern Mexico to northern Uruguai (Oliver 1948. Bull. Am. Mus. Nat. Hist. 92: 157–280). On 11 June 2013, at 0930 h, on the Aiuaba Ecological Station (ESEC Aiuaba; 14.5911°S, 39.0655°W, datum WGS84; elev. ca. 466 m), state of Ceará, Brazil, an adult female *L. ahaetulla* (SVL = 890 mm) was observed perched on branches of a tree ca. 1.8 m from the ground, preying on an adult *Corythomantis greeningi* (SVL = 68.11 mm; 18 g). When first sighted, the snake was swallowing the head of the frog. The remaining ingestion process took 10 min (Fig. 1A), after which the snake was captured. The *L. ahaetulla* and the *C. greeningi* were deposited in the Coleção Herpetológica da Universidade Regional do Cariri (URCA-H 5539 and 5550, respectively; Fig. 1B). To the best of our knowledge, there are no records of predation of *C. greeningi* by *L. ahaetulla*.

Anurans and lizards consumed by *L. ahaetulla* are nocturnal and probably are captured by day when inactive (Martins and Oliveira 1999. Herpetol. Nat. Hist. 6:78–150; Albuquerque et al. 2005. Herpetol. Rev. 36:324–325; Solé et al. 2010. Salamandra 46:101–103). *Corythomantis greeningi* is distributed mainly in Caatinga biome and presents morphological features, such as a dermis that is co-ossified with the underlying cranial bones to

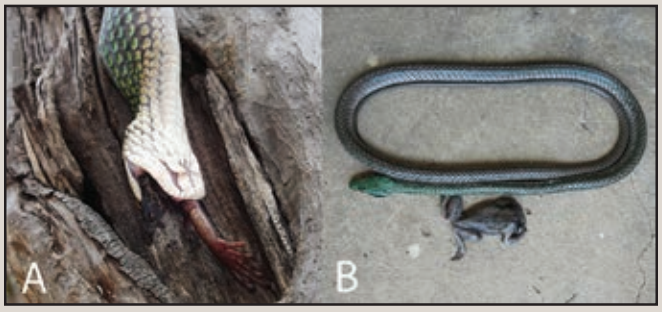


PHOTO BY HERIVELTO F. DE OLIVEIRA

FIG.1. Predation on *Corythomantis greeningi* by *Leptophis ahaetulla*.

form a unified structure (Trueb 1970. Univ. Kansas Publ. Mus. Nat. Hist. 18:547–716), and phragmotic behavior, that play important roles in defense (Jared et al. 2005. J. Zool. Lond. 265:1–8).

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***LEPTOPHIS DIPLOTROPIS* (Pacific Coast Parrot Snake). DIET.** *Leptophis diplotropis* is endemic to Mexico and has been designated as a threatened species (SEMARNAT 2010. Norma Oficial Mexicana NOM-059-SEMARNAT-ECOL-2010. Protección



FIG 1. *Leptophis diplotropis* feeding on *Smilisca baudinii* at Universidad del Mar campus Puerto Escondido, San Pedro Mixtepec, Oaxaca, México.

ambiental-especies nativas de México de flora y fauna silvestre, Categorías de riesgo y especificaciones para su inclusión, exclusión o cambio-lista de especies en riesgo. Diario Oficial de la Federación 6 de marzo: pp. 1–78). This species ranges from Sonora along the pacific cost to the Isthmus of Tehuantepec in Oaxaca and into several central states, including Hidalgo, Morelos and Puebla (Berriozabal-Islas et al. 2012. Check List 8:1370–1372). It is arboreal and feeds primarily on frogs, lizards, snakes, and bird eggs (Canseco-Márquez and Gutiérrez-Mayén 2010. Anfibios y Reptiles de Valle de Tehuacán-Cuicatlán. México. BUAP & CONABIO. 302 pp.; Dixon and Lemos-Espinal 2010. Anfibios y Reptiles del Estado de Querétaro, México. Texas A&M University, UNAM, CONABIO. México. 428 pp.).

At 1550 h on 24 October 2013, on site of Universidad del Mar campus Puerto Escondido, San Pedro Mixtepec, Oaxaca, México (15.88942°N, 97.075757°W, datum WGS84; elev. 75 m) we observed a *L. diplotropis* attack and consume a *Smilisca baudinii* (Mexican Treefrog; Fig. 1) over 11 min. This is the first report of *S. baudinii* as a part of the diet of *L. diplotropis*.

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***MICRELAPS MUELLERI* (Erdviper). REPRODUCTION.** *M. muelleri* is known from the Northern Negev of Israel, northward and also occurs in Syria, Jordan and Lebanon; it is a mildly venomous rear-fanged snake (Bar and Haimovitch 2011. A Field Guide to Reptiles and Amphibians of Israel. Pazbar LTD 1989, Herzliya, Israel. 245 pp.). There is a report that it is viviparous (Arbel [ed.] 1984. Reptiles and Amphibians, Vol. 5. Plants and Animals of the Land of Israel. An Illustrated Encyclopedia. Ministry of Defence and Publishing House for the Protection of Nature, Tel-Aviv, Israel. 248 pp.). The purpose of this note is to report a litter size of two for *M. muelleri*.

One *M. muelleri* female (SVL = 398 mm) deposited in the Tel Aviv University Museum (TAUM) as TAUM 1895, collected June 1955 in the Yizreel Valley Region (35.24166°N, 32.59638°E, datum WGS 84) was examined.

A ventral incision was made in the posterior third of the body. Two oviductal eggs were present, one in each oviduct. The eggs measured 20 × 4 mm and 24 × 4 mm, respectively. The eggs were not dissected, but externally there was no evidence of embryonic development. The ovaries were in quiescent condition (no yolk deposition). This is, to our knowledge, the first published record of a litter size of two for *M. muelleri*.

We thank Shai Meiri (TAUM) for permission to examine *M. muelleri*, Ezra Maza for facilitating the loan and the National Collections of Natural History at Tel Aviv University for providing *M. muelleri* for our examination.

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***OXYBELIS FULGIDUS* (Green Vine Snake). DIET.** *Oxybelis fulgidus* belongs to the group of Ophisoglyph Colubrids, with a neotropical distribution from México through América Central to Bolívia (Cisneros-Heredia and Touzet 2007. Herpetozoa 19:188-189). This species has generally been described as an opportunistic sit and wait predator, however they may also actively forage, feeding principally on lizards and birds, however small mammals are also consumed (Scartozzoni et al. 2009. S. Am. J. Herpetol. 4:81-89; Fraga et al. 2012. Herpetol. Rev. 43:495-496). This note contributes three new species to the list of food items in the diet of *O. fulgidus*, two birds and one lizard.

An *O. fulgidus* was observed predating a *Turdus leucomelas* (Pale-breasted Thrush) on 22 December 2008, an *Iguana iguana* (Green Iguana) on 02 January 2009, and a *Pitangus sulphuratus* (Great Kiskadee) on 24 December 2011 (Fig. 1); the first and third observations were in Parque Residencial Aquariquara I, Manaus, Amazonas, Brazil (3.084111°S, 59.961777°W; datum WGS84) and the second observation was in Praia da Lua, Manaus, Amazonas, Brazil (3.032555°S, 60.134111°W; datum WGS84). The only snake collected was from the third event, now INPA-H-32303 in

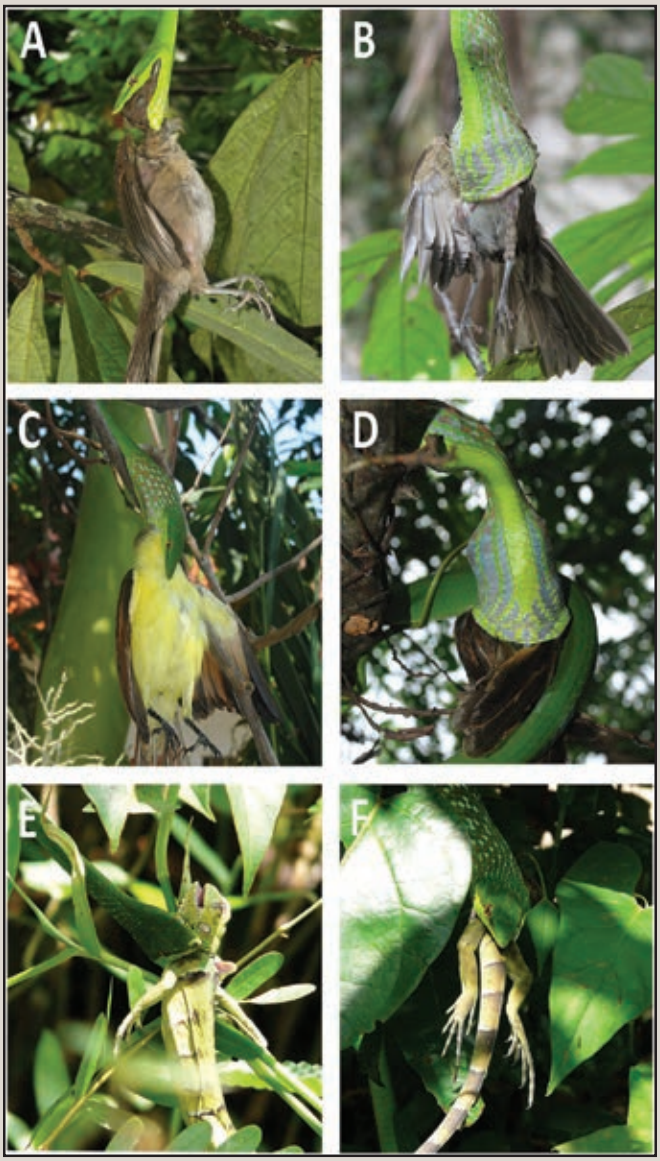


FIG. 1. *Oxybelis fulgidus* consuming their prey, *Turdus leucomelas* (A, B; Pale-breasted Thrush), *Pitangus sulphuratus* (C, D; Great Kiskadee), and *Iguana iguana* (E, F; Green Iguana).

the collection of Reptiles and Amphibians of Instituto Nacional de Pesquisas da Amazônia. The snake began to ingest the prey headfirst with *T. leucomelas* (Fig. 1A, B) and *P. sulphuratus* (Fig. 1C, D) the ingestion time for the latter took 2 h and 20 min while the iguana was swallowed in only 9 min (Fig. 1E, F). The great difference in ingestion time could be due to the difficulty for an ophisotglyph snake to envenomate the bird through the plumage, resulting in a longer processing time (Kardong 1982. Mem. Inst. Butantan 46:105–118).

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***PITUOPHIS RUTHVENI* (Louisiana Pinesnake). GROWTH RATES.** *Pituophis ruthveni* is a large-bodied constrictor endemic to western Louisiana and eastern Texas, USA, and is currently listed as a candidate species under the U.S. Endangered Species Act. Surveys suggest that the species has declined precipitously in recent decades and is now restricted to seven (several possibly recently extirpated) isolated populations (Rudolph et al. 2006. Southeast. Nat. 5:463–472). Although growth rates have been reported for radio-tracked *P. ruthveni* (Himes et al. 2002. J. Herpetol. 36:683–687), no information has been published regarding the growth rates of individuals without implanted transmitters. Here we report data on growth rates of *P. ruthveni* without radio transmitters and briefly compare them to individuals with transmitters.

Pituophis ruthveni were collected via a trapping effort conducted to monitor the species' populations. Data reported here were collected from 2007 to 2013 at multiple sites (Angelina National Forest, Angelina and Jasper counties, Texas; private property in Bienville Parish, Louisiana; and Ft. Polk, Vernon Parish, Louisiana). Snakes were implanted with PIT (Passive Integrated Transponder) tags and measured (SVL and total length to the nearest cm). All snakes were considered adults based on length. We included all recaptures that occurred at least 8 mo after initial capture (N = 8). Average monthly increases in SVL were highly variable ranging from 0 (for an individual monitored for only 8 months) to 0.49 cm/mo (Table 1). We observed a tendency for smaller animals to have higher growth rates than larger animals, a pattern noted by Himes et al. (*op. cit.*).

The growth rates reported in Table 1 are generally similar to those reported in Himes et al. (*op. cit.*). Mean growth rates (total length) of the adult animals in the Himes study were 0.26 cm/mo for males and 0.30 cm/mo for females. In this study mean growth rates (total length) were 0.28 cm/mo for males and 0.12 cm/mo for females. Females in this study were substantially larger than in Himes et al. (*op. cit.*), possibly explaining the lower growth rates. Growth rates of adult *P. ruthveni* without implanted transmitters in our study were generally similar to those of adult individuals with implanted transmitters (Himes et al., *op. cit.*), indicating transmitters may not be a major detriment to growth of *P. ruthveni*. However, other studies have shown negative effects of transmitters on mass gain in *Pantherophis obsoletus* (Weatherhead and Blouin Demers 2004. Wildl. Soc. Bull. 32:900–906) and survival in *P. ruthveni* (Rudolph et al. 1998. Herpetol. Rev. 29:155–156). Despite the lack of an obvious impact of transmitters on growth of *P. ruthveni*, researchers should remain cognizant of the potential for alteration of growth and behavior in snakes implanted with radiotransmitters.

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***SISTRURUS MILIARIUS* (Pygmy Rattlesnake). DIET.** *Sistrurus miliarius* is known to take a variety of endothermic and ectothermic prey items including small rodents (*Microtus pinetorum*, *Oryzomys palustris*, *Peromyscus maniculatus*, *Reithrodontomys humulis*) and snakes (*Carphophis amoenus*, *Coluber constrictor*, *Diadophis punctatus*, *Nerodia* sp., *S. miliarius*, *Storeria dekayi*, *Thamnophis sauritus*, *T. sirtalis*, *Virginia valeriae*; Ernst and Ernst 2011. Venomous Reptiles of the United States, Canada, and Northern Mexico, Volume 1. Johns Hopkins Univ. Press, Baltimore, Maryland. 352 pp.). On 5 September 2013 at 0910 h, JRL and DJN captured an adult male *S. miliarius* (SVL = 39.2 cm; total length = 44.5 cm; 46 g) in a trap array located on

TABLE 1. Measurements and growth rates of *Pituophis ruthveni* from Texas and Louisiana, USA. (*) denotes an estimated SVL based on a regression model of unpublished *P. ruthveni* total lengths (TL) and snout–vent lengths (SVL) (N = 56).

Sex	Date Cap. 1	Date Cap. 2	Interval (mo.)	TL (cm)		SVL (cm)		Change (cm)		Mean growth (cm/mo)	
				Cap. 1	Cap. 2	Cap. 1	Cap. 2	SVL	TL	SVL	TL
M	Apr. 2007	May 2012	61	130	148	114*	130*	18	16	0.30	0.26
M	Jun. 2008	May 2012	47	154	157	136*	139	3	3	0.06	0.06
F	Jun. 2008	Jun. 2013	60	151	152	132*	134	1	2	0.02	0.03
F	Sept. 2008	Jun. 2013	57	130	143	114	126	13	12	0.23	0.21
F	Oct. 2008	Jun. 2009	8	141	142	126	126	1	0	0.13	0.00
M	Jun. 2009	May 2012	35	144	162	123	140	18	17	0.51	0.49
M	Apr. 2009	Apr. 2012	36	135	138	116	119	3	3	0.08	0.08
M	Jun. 2009	May 2011	23	139	149	121	130	10	9	0.43	0.39

the Camp Shelby Joint Forces Training Center, De Soto National Forest, Perry County, Mississippi, USA. The snake had recently fed as indicated by a large bolus in its stomach, and upon palpating, the snake regurgitated a male *Reithrodontomys fulvescens* (Fulvous Harvest Mouse). It is possible that the *R. fulvescens* was consumed in the trap, and therefore it is unknown how frequently *S. miliarius* will take this species as prey under natural circumstances. However, *R. fulvescens* is the second most abundant small mammal captured at this pitcher plant (*Sarracenia* sp.) wetland trap site (JRL, unpubl. data). On 2 December 2013 at 1130 h, JRL and ALS captured a juvenile male *S. miliarius* (SVL = 32.5 cm; total length = 37.1 cm; 27.9 g) basking in close proximity to this same trap array, and upon palpating, the snake regurgitated a female *Virginia striatula* (Rough Earthsnake). To the best of our knowledge these are the first documented occurrences of *R. fulvescens* and *V. striatula* in the diet of *S. miliarius*, and both represent novel food items for the genus *Sistrurus* (Ernst and Ernst, *op. cit.*).

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***THAMNOPHIS COUCHII* (Sierra Gartersnake). PREDATION.** *Thamnophis couchii* is a highly aquatic species that inhabits streams, rivers, meadow ponds, and reservoirs of the Sierra Nevada of California from the Pit River drainage south to the western edge of the Tehachapi Mountains, with several populations east of the Sierran crest at Owens Valley, and along the Walker, Truckee, and Carson rivers in Nevada (Stebbins 2003. A Field Guide to Western Reptiles and Amphibians, 3rd ed. Houghton Mifflin Co., New York. 533 pp.; Rossman et al. 1996. The Garter Snakes: Evolution and Ecology. Univ. Oklahoma Press, Norman, 332 pp.). Although *T. couchii* is frequently encountered within its range, its only documented predators are *Buteo jamaicensis* (Red-tailed Hawk; Fitch 1949. Am. Midl. Nat. 41:513–579), *Coluber constrictor* (Yellow-bellied Racer) and *Diadophis punctatus* (Ring-necked Snake; Wiseman et al. 2007. Herpetol. Rev. 38:344–345). Herein, I report a previously undocumented predator of *T. couchii*.

On 10 September 2012 at 1030 h the posterior portion (ca. 7 cm) of a juvenile *T. couchii* was observed within the scat of a *Lontra canadensis* (River Otter) on the top of a boulder located ca. 3 m from the bank of the North Fork Feather River (Butte Co., CA.; 39.762892°N, 121.459782°W, datum WGS84; elev. 314 m), 0.8 km downstream of Bardee's Bar. The scat also contained the remains of introduced Signal Crayfish (*Pacifasticus leniusculus*). River Otters prey predominately on fish, crayfish, and other invertebrates but will also take amphibians and reptiles (Melquist et al. 2003. *In* Feldhamer et al. [eds], Wild Mammals of North America: Biology, Management, and Conservation, pp. 708–734. Johns Hopkins Univ. Press, Baltimore, Maryland). I thank Justin Garwood for his input and help tracking down literature sources.

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***THAMNOPHIS SIRTALIS DORSALIS* (New Mexico Gartersnake). DIET.** Although avian nest predation by snakes has been infrequently reported, snakes may be predominant nest predators (Stake et al. 2005. J. Herpetol 39:215–222; Thompson III and Burhans 2003. J. Wildl. Manage. 67:408–416). On 10 July 2013 at ca. 1100 h we observed a *Thamnophis sirtalis dorsalis* predating an *Empidonax traillii extimus* (Southwestern Willow Flycatcher) nest with two nestlings near San Marcial, Socorro Co., New Mexico, USA. The *T. s. dorsalis* was anchored posteriorly ca. 7.6 cm below the nest, with the anterior third of its body hanging vertically in the process of ingesting a 13-day-old nestling head first. Given the placement of its body, it is likely the *T. s. dorsalis* predated the nest from below, possibly the best way to approach the nest given typical nestling behavior (positioned in or on the edge of the nest to detect potential predators) of *E. t. extimus* nestlings at this stage of their development (Paxton and Owen 2002. An Aging Guide for Willow Flycatcher Nestlings. U.S. Geological Survey. 18 pp.). Upon approach the snake released the nestling, which was ingested to the cloaca, and retreated into the Rio Grande. The nest was located 3 m above the ground in a 5-m-tall, live *Tamarix* sp. (saltcedar). *Thamnophis sirtalis* is known to predate passerine nests (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Books, Washington D.C. 668 pp). To our knowledge, this is the first report of Southwestern Willow Flycatcher nest predation by *T. s. dorsalis*. Research was conducted under United States Fish and Wildlife Service Permit TE819475-3.

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***THAMNOPHIS SIRTALIS PARIETALIS* (Red-sided Gartersnake). DIET AND ACCIDENTAL MORTALITY.** Snakes occasionally die while attempting to consume prey. For example, an *Agkistrodon contortrix* (Copperhead) apparently died after ingesting the head of a *Corvus ossifragus* (Fish Crow); the bird's beak penetrated through the skin of the snake (Beane et al. 2013. Herpetol. Rev. 44:150–151). Likely the death of a *Pituophis catenifer* (Gophersnake) in New Mexico occurred following consumption of an *Athene cunicularia* (Burrowing Owl; Painter et al. 2012. Herpetol. Rev. 43:152). Moreover, semi-aquatic snakes, such as *Agkistrodon piscivorus* (Cottonmouth) and *Nerodia sipedon* (Northern Watersnake), have died from complications related to the spines and fins of ingested fish (Allen and Swindell 1948. Cottonmouth Moccasin of Florida. Herpetologica 4:1st suppl.; Stafford 1952. Copeia 1952:193).



FIG. 1. A *Thamnophis sirtalis parietalis* that died after consuming a *Sternella neglecta* (Western Meadowlark) in central Nebraska. The single puncture hole is visible and located in the swollen area adjacent to the meadowlark skull.

On 23 June 2012, we discovered a gravid female *T. s. parietalis* (SVL = 590 mm) dead along the edge of a small pond in the flood plain of the Platte River in Hall County, Nebraska (40.7873°N, 98.465°W; datum WGS84). We observed the lower mandible of a *Sternella neglecta* (Western Meadowlark) protruding from one exit hole in the snake. We determined death was caused by the beak puncturing through both the digestive system and skin about 200 mm from the tip of the snake's head (Fig. 1). The meadowlark was consumed head first based on the direction of the beak, and we suspect the lower mandible eventually separated from the cranium causing the fatal puncture. The snake and skull of the meadowlark are deposited in the natural history collections at the Sternberg Museum of Natural History, Fort Hays State University, Hays, Kansas (FHSM 16537). *Thamnophis sirtalis* is known to eat a number of bird species but *S. neglecta* has not previously been documented as a prey item (Ernst and Ernst 2004. Snakes of the United States and Canada. Smithsonian Institution Press, Washington D.C. 680 pp.).

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***THAMNOPHIS SIRTALIS SIRTALIS* (Eastern Gartersnake). DIET.** *Thamnophis s. sirtalis* is a generalist feeder and has been known to consume salamanders of the genus *Plethodon* including *P. albagula*, *P. cinereus*, *P. cylindraceus*, *P. dunni*, *P. glutinosus*, and *P. idahoensis* (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Institution Press, Washington, DC. 668 pp.; Konbalinka and Trauth 2003. Herpetol. Rev. 34:378). On 19 November 2013, an adult female *T. s. sirtalis* (SVL = 35 cm; total length = 46 cm; 17.35 g) was captured in a trap array located on the Camp Shelby Joint Forces Training Center, Forrest Co., Mississippi, USA. As the snake was being handled to morphometric data, it regurgitated a *P. mississippi*. The entire range of *P. mississippi* is within the range of *T. sirtalis* (Conant and Collins 1998. A Field Guide to Reptiles and Amphibians of Eastern and Central North America. 3rd ed., expanded. Houghton Mifflin Co., Boston, Massachusetts. 616 pp.). It is possible that the *P. mississippi* was consumed in the trap, and therefore it is unknown how frequently *T. sirtalis* will take this species as prey under natural circumstances. To the best of our knowledge this is the first documented occurrence of *P. mississippi* in the diet of *T. s. sirtalis*.

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***TRIMORPHODON PAUCIMACULATUS* (Sinaloan Lyresnake). DIET.** Little is known about the natural history of *Trimorphodon paucimaculatus*, but it is thought to consume lizards, rodents, birds, and bats from rocky crevices and tree hollows like other lyresnakes (Scott and McDiarmid 1984. Cat. Amer. Amphib. Rept. 352:1–2; García and Ceballos 1994. Field Guide to the Reptiles and Amphibians of the Jalisco Coast, Mexico. Fundación Ecológica de Cuixmala, A.C. UNAM, D.F. 184 pp.). Here we document a new avian species in the diet of *T. paucimaculatus*.

On 15 July 2013, at 0100 h, a female *T. paucimaculatus* (SVL = 905 mm; tail length = 145 mm) was found dead on road at Las Varas–Chacala road, Municipality of Compostela, Nayarit, México (21.163935°N, 105.211336°W, datum WGS84; elev. 39 m). The habitat was tropical deciduous forest. We dissected the snake and found a partially digested *Icterus wagleri* (Black-vented Oriole) ingested head first (Howell and Webb 1995. Guide to the Birds of Mexico and Northern Central America. Oxford Univ. Press, New York. 851 pp.). Additionally, an unidentified nematode parasite was found in the snake's stomach. The snake and stomach contents were deposited in the vertebrate collection at Universidad Autónoma de Aguascalientes (UAA-CV-R265).



FIG. 1. *Trimorphodon paucimaculatus* that had consumed an *Icterus wagleri* (Black-vented Oriole) in Nayarit, México.

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***UROTHECA GUENTHERI* (Striped Glasstail). ANTIPREDATOR DEFENSE.** *Urotheca* is a genus of poorly known terrestrial snakes that can be found in wet and rain forests of Central and South America (Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna between Two Continents, between Two Seas. Univ. Chicago Press, Illinois. 934 pp.). Most species in this genus are drab-colored shades of brown, likely providing crypsis among forest floor leaf litter. However, a few species are banded, presumably mimicking sympatric coral snake species (Savage and Crother 1989. Zool. J. Linn. Soc. 95:335–362). Although dorsally drab, *U. guentheri* is brightly colored orange to red ventrally. These high contrast colors may serve as anti-predator "flash" colors. Snakes in this genus have long tails (> 33% total length), that are very fragile (Solórzano 2004. Snakes of Costa Rica. INBio, Costa Rica. 792 pp.). Tails do not regenerate, but may fracture successively closer to the cloaca providing multiple escape opportunities over time (Savage, *op. cit.*). Tail waving may be a mechanism for anti-predator defense (Greene 1987. Snakes: The Evolution of Mystery in Nature. Univ. of California Press, Berkeley, California. 365 pp.), and Savage (*op. cit.*) suggests that tail cleavage is common in this genus, with frequencies above 50% of sampled populations. Herein I report behaviors that may further enhance the effectiveness of this anti-predator strategy.



FIG. 1. Reflexively coiled tail fragment of *Urotheca guentheri* pressing a sharp vertebral element into the skin of the author's left thumb.

On 21 June 2012 at 1320 h we observed an adult male *U. guentheri* on a trail in primary forest within the Monteverde Cloud Forest Preserve, Costa Rica (approx. 10.3001°N, 84.7474°E, datum WGS84; elev. ~1000 m). While handling the snake with minimal force, the tail broke ~3 cm posterior to the cloaca. Upon breakage, the snake began to roll its body in an apparent attempt to escape my grasp. Simultaneously, the detached tail began to writhe, and the bright ventral color was a potent visual stimulus. When I released the snake it ceased rolling and began pressing its head low and attempting to burrow under leaf litter. This behavior reduced the visual stimulus provided by the snake's venter, while the tail continued to flash bright orange as it thrashed in the leaf litter.

In addition to the effect of coloration, the separated tail fragment was able to coil around my finger when I picked it up from the leaf litter (Fig. 1). This behavior did not seem indicative of simple bilateral flexion. Either there was a bias so that the fragment flexed more forcibly to one side, or possibly a reflex action integrated in the remnant spinal cord was able to respond to a grasping stimulus and flex towards the side of tactile stimulus. Furthermore, after coiling around my finger, the proximal end of the tail fragment pressed forcibly against my hand. The protruding vertebral element was sharp and had a startling effect. While the snake was in my grasp, the exposed vertebral column of the remaining tail was also pressed into my skin in a comparable fashion. Similar tail-pressing behaviors have been noted in *Contia tenuis* (Sharp-tailed Snake), *Farancia* spp. (mud and rainbow snakes), and *Carphophis* spp. (wormsnakes). However, in these species it is the hardened tip of an intact tail that is used as a lancet as opposed to a vertebral element. The tail musculature surrounding the cleavage zone of the snake's remaining tail contracted, presumably to staunch bleeding. But, an additional consequence was the exaggerated exposure of the vertebral element.

Savage and Crother (1989) suggest that the tails of *Urotheca* species separate between vertebral centra. However, a fracture plane within, rather than between vertebrae has also been proposed (Wilson 1968. J. Herpetol. 1:93–94). Although I did not examine the tail fragment anatomically, the sharpness of the vertebral element may suggest a pointed or diagonal fracture plane within the centra. Further observations on the osteology and behavior of this, and other *Urotheca* species may reveal this behavior to be widespread within the genus, and shed light on the anatomical details of this novel defense strategy.

I thank Rebecca Cossel for her keen eyes in the field; Geiner Alvarado Huertas for GIS assistance; Christian Mena and Sergio Vargas for logistical support, and sharing video footage of the encounter.

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***XENOPELTIS UNICOLOR* (Asian Sunbeam Snake). DIET.** Prey of *Xenopeltis unicolor* include frogs, lizards, snakes, small mammals, birds, and even reptilian eggs (Rooij 1917. The Reptiles of the Indo-Australian Archipelago, vol. II. Ophidia. E. J. Brill, Leiden, Holland. 334 pp.; Bergman 1955. Zool. Mededelingen, XXXIII, No. 22:209–225; Martins and Rosa 2012. Taprobanica 4:48–51). Small skinks and snakes are possibly the most common species in the snake's diet and *X. unicolor* possesses specialized tooth morphology for handling lizard prey. On 13 March 2013 at 1945 h, in the northeastern part of Phi Phi Don, the largest island of Phi Phi Archipelago, Andaman Sea, Thailand (7.770845°N, 98.767326°E; datum WGS84), I discovered an adult *Xenopeltis unicolor* coiled around a live adult male *Kaloula pulchra* near a burrow on the pond shore in an area of secondary tropical forest. The frog may have been attacked and constricted on the pond's shore where numerous male *K. pulchra* congregate for breeding. The snake continued to constrict the prey for 10 min, during which the frog produced a creaking sound (Fig. 1). Upon capture, the snake released the frog, which was alive and appeared undamaged.



FIG. 1. An adult *Xenopeltis unicolor* found preying on a *Kaloula pulchra* on Phi Phi Don island, Andaman Sea, Thailand.

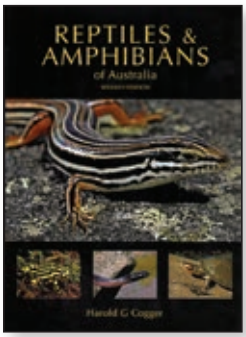
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BOOK REVIEWS

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Reptiles and Amphibians of Australia, 7th Edition

Harold G. Cogger. 2014. CSIRO Publishing, Collingwood, Melbourne, Australia (www.publish.csiro.au). xxx + 1033 pp. Hardcover. AU$150.00 (approx. US $140.00). ISBN 9780643100350.



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The herpetofauna of Australia is one of the most diverse anywhere in the world. As such, a reference work that provides descriptions and dichotomous keys of all known reptile and frog species represents a significant contribution. The most recent edition of Hal Cogger's long awaited *Reptiles and Amphibians of Australia* updates Australia's longest standing, one-stop reference for all currently described herpetofauna. So well known and regarded is Hal Cogger's book that it is often referred to simply as "Cogger" or even "The Bible." Now in its 7th edition, the latest version represents a substantial increase in content since the release of the 6th edition (2000) 14 years ago. Indeed, so long is the interval between editions that used copies of the 6th edition frequently command high prices online (e.g., eBay US $500–800).

There is a significant increase in the number of new species included in the 7th edition, with 168 new reptile and frog species, in addition to a number of useful format changes. In the almost 40 years since the first edition, the documented diversity of Australia's reptile and frog species has almost doubled, growing steadily from 664 species (Cogger 1975) to 703 species (Cogger 1979) to 830 species (Cogger 1983) to 865 species (Cogger 1986) to 951 species (Cogger 1992) to 990 species (Cogger 1994) to 1004 species (Cogger 1996) to 1050 species (Cogger 2000) and finally to 1218 species (Cogger 2014). A new feature of the introduction is a table of all described species of reptiles and frogs by state/territory and bioregion (a total of 15 bioregions) within the Australian continent, including major island provinces (Lord Howe, Norfolk, Cocos [Keeling], and Christmas islands). A page number provides quick access to each species description and corresponding distribution map, facilitating the inclusion or exclusion of candidate species on the basis of geography. An additional change is the shift to a single text column for the species descriptions, bringing the format in line with that of the introduction and generic descriptions. Also new and appropriate to both the "biblical" status and size of the book is the inclusion of a ribbon place mark. An index of species common names in addition to one of solely scientific names is also very handy.

The introduction moves away from the task of the identification of reptile and frog species and includes discussion and maps highlighting biodiversity and conservation "hotspots" for herpetofauna across Australia. Areas with high species diversity are clearly indicated via a color-coded scale for all taxa. Individual biodiversity maps are provided for frogs, lizards and snakes. Hylid frogs and southern frogs (Leptodactylidae) are also mapped separately, highlighting differences in the hotspots of the two groups. There is also a philosophical discussion on conserving phylogenetic biodiversity and the value of one species over another—the fundamental issue of whether conservation efforts should be focused on the preservation of a single taxon of a speciose lineage as opposed to the single representative of a monotypic lineage (e.g., *Ctenotus* with approximately 103 species vs. the monotypic *Gnypetoscincus*).

A consistent feature in all editions of *Reptiles and Amphibians of Australia* is a section on how to locate specimens for photography and/or collection and research. This section provides detailed approaches and equipment for collection and sampling, with a brief section on transportation of live specimens and the correct methods for euthanasia and the preservation and fixation of specimens. There is also a section on introduced reptile and frog species and their impact on species on the mainland and island territories. Fittingly, the final part of the introduction deals with the most recent snakebite and first aid treatment.

As in previous editions, the identification keys for each genus are supported by line drawings illustrating the scales, scutes, and shields that are most relevant to the distinguishing features of each group. A helpful addition to the 7th edition is the use of colored keys to define those features most likely to distinguish a species. Each species is accompanied by its own species description and distribution map. Although subspecies are not defined *per se*, it is nice to see they are at least listed with a description of their known distribution. There has been considerable effort to include most new taxonomic references (through December 2012), with some of the more recent ones included in the addenda.

Species distribution maps often receive critical attention given the influence they can have on reliably identifying species. As Cogger points out (pp. 5–7) the informed user of this book needs to understand how to interpret the range maps provided. There are many approaches available for delineating species distributions. The most commonly used is the convex polygon, which uses the peripheral points in a set of records to estimate species boundaries. This approach does not consider discontinuities within the range and may overestimate distributional areas, particularly where there are large areas of unsuitable habitat or where there are isolated records outside the main distributional

range. Minimum polygon methods, on the other hand, work well when there are many distribution records, but may underestimate ranges when data are insufficient. The maps provided reflect the author's integration of a huge number of museum and literature records and a lifetime of familiarity with the Australian herpetofauna.

For any identification guide photographs of typical examples of species often provide the quickest way to successfully determine a specimen's identity. Unfortunately, the latest edition of *Reptiles and Amphibians of Australia* provides fewer color illustrations than the previous editions. The members of the genus *Ctenotus*—Australia's most diverse vertebrate genus—are provided with a color image in fewer than 60% of cases. While some may argue that this is a minor issue due to the morphological similarity of species within genera such as *Ctenotus*, it is always helpful having more photographic examples to work from. While most images included are of reasonable quality, many appear somewhat over-exposed, particularly those reproduced from previous editions. The use of poor quality photos seems avoidable given the number of competent herpetological and wildlife photographers who would have freely provided high quality images. More than likely, the judicious use of color images appears to have been an effort to maintain a reasonable price and size of the work given its scope. The images provided have been selected to demonstrate the range of color patterns and forms within a particular group and the type of habitats they occupy, with emphasis on the use of images depicting animals in their natural surroundings.

Casually thumbing through a work may not be especially informative—the real test of how well it performs under field conditions. To this end, my first real opportunity to test the latest edition of "Cogger" was on a recent field trip targeting skinks in the Shark Bay area of Western Australia. This location is known for its high scincid diversity, with a particularly high diversity of cryptozoic fossorial species of the genus *Lerista*, in addition to a large suite of surface active species. Here *Reptiles and Amphibians of Australia* really came into its own, with the keys for *Lerista* proving invaluable for distinguishing among the several quite-similar co-occurring congeners, and amply justifying the effort to bring this 3 kg field guide as carry-on luggage!

For any volume of this size, obtaining suitable proofing at the review stage is critical to eliminate obvious errors that can detract from the reader's confidence in the material presented. Unfortunately, the latest issue of the *Reptiles and Amphibians of Australia* has a fair number of obvious and annoying errors. While unproductive to list here, some typical errors include incorrectly labeled source localities for the photographs of specimens (e.g., *Anepischetosia maccoyi*; p. 414) and distribution maps that clearly differ from the in-text description of the species' distribution (e.g., *Lerista edwardsae*; p. 602).

The 14 years since the release of the 6th edition have seen the publication of several useful field guide-sized volumes for reptile and frog identification, which effectively filled the void left by the absence of an up-to-date edition of "Cogger." Most notable has been *A Complete Guide to Reptiles of Australia* (Wilson and Swan 2003). This work provides descriptions and high quality photographic plates, without dichotomous keys, and is now in its 4th revised edition (Wilson and Swan 2013). The identification of Australia's frog fauna has been given a significant boost with the recent release of *Tadpoles and Frogs of Australia* (Anstis 2013), which provides a comprehensive treatment of all known species and their larvae. In addition, several reptile and frog identification apps for both iPhone and Android (e.g., *Frogs Field Guide* by the Australia Museum) have been released. If and when *Reptiles and Amphibians of Australia* will become available in this format is currently unknown.

There is little doubt that producing the 7th edition of *Reptiles and Amphibians of Australia* has been a monumental challenge. Since the publication of the 6th edition there has been a change of publisher (from Reed publishing to CSIRO) and presumably, the associated copyright issues. Hal Cogger's initial motivation for the book was to provide the kind of work he would have liked to have had access to when in high school or at university. In the preface to the current edition he notes that over time the increasing size and cost of the book has tended to limit its access to the general reader and to people with a more general interest in natural history. Although its size may exclude it as an easily portable field guide, there is little doubt that *Reptiles and Amphibians of Australia* continues to promote awareness and appreciation of the national and global significance of Australia's herpetofauna and that it meets or exceeds the author's primary aim "to provide the means to identify the majority of the reptiles and frogs found in continental Australia and Tasmania" (p. xxvii). Now, more than ever, *Reptiles and Amphibians of Australia* represents a worthy addition to the library of anyone interested in Australian herpetology.

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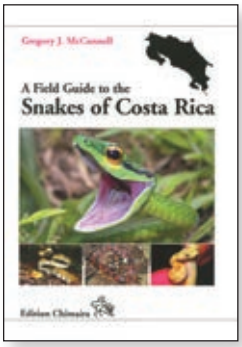
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A Field Guide to the Snakes of Costa Rica

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After being in touch with the editor and providing several photographs for use in this book, I was very curious to see how a new book on Costa Rican snakes would stack-up against the masterworks on the topic by Jay Savage (2002) and Alejandro Solórzano (2004). My expectations were probably too high, but the final result left me disappointed.

The book starts with acknowledgments and a short introduction by the author explaining the gestation of the book. There is no preface or back cover comments by noted herpetologists, as are often seen in books such as this. Unfortunately, there is also almost no introduction to the country, only a political map and no more than two paragraphs about the complex geography of Costa Rica, which is so important for understanding patterns of distribution. Fortunately, Savage (2002) in his encyclopedic volume provides this information, as does Solórzano (2004), although in a more limited way. The introduction about snakes is more in-depth, and covers the general biology and morphology of ophidians. There are five taxonomic chapters, one about Anomalepidae [sic], Typhlopidae and Leptotyphlopidae, another about Boidae, Loxocemidae and Ungaliophiidae, one more about Colubridae (sensu lato), another about Elapidae, and a last one about Viperidae. The final chapter is about snakebite and its treatment. The book continues with the distribution map section, with small schematic but clear maps, and a list of species with "original identifications" (i.e., current names with relevant authorship given) and allocations to subfamily. A far too short literature section closes the volume.

The strength of the book is that it has a great collection of photographs and can certainly be used as a visual catalogue. Herp fanatics and herpetologists, as well as naturalists in general, are always appreciative of good pictures, and this book has them. I also enjoyed the small collection of drawings by Claudia Hahn (see those of *Ninia celata*, p.101, *Rhadinaea pulveriventris*, p. 112, *Thammophis marcianus*, p. 126, *Trimetopon gracile*, p. 127, and *T. simile*, p. 128), some of which remind me of the classic plates of the pre-photographic age. I welcome such a beautiful set of images, and will consult them often.

What I will not consult is the text, which contributes nothing new relative to Savage (2002) and Solórzano (2004). The maps and text summarize the information in these two volumes and do not seem to reflect any new or interesting findings, or if such data are present they are not noted as such. There are a good number of mistakes and much misleading information in McConnell's book. I document some instances below, but also take the opportunity to comment on Savage's (2002) and Solórzano's (2004) works when relevant, and add some new information derived from recent papers not treated by McConnell.

To say that Costa Rica is in the southern part of North America (p. 12) is incorrect; along with Panama, Nicaragua, Honduras, El Salvador, Guatemala, Belize, and Mexico as far north as the Isthmus of Tehuantepec, it is in Mesoamerica, a macro-region that is widely recognized geographically, ecologically, and anthropologically. The reference to taxonomists as either "splitters" and "lumpers" (p. 13) is an outmoded notion that has been superseded as modern workers adopt an integrative taxonomy approach that combine as many possible methods and data sources to make more objective decisions (see Padial et al. 2010). McConnell states that "studies of the structures of the reproductive organs of male snakes (hemipenis) have further contributed to snake taxonomy, but this author [McConnell] questions the validity of the adornments of these as taxonomic features for obvious reasons (consider the differences among the human penis)." Such a view seems misguided in light of the extensive works by Dowling and Savage (1960), Zaher (1999), and Myers (2011), just to name a few.

The author makes the statement that "many venomous snakes of both families (referring to Elapidae and Viperidae), possess dark heads or dark stripes over the venom glands, possibly to prevent the denaturation of the numerous proteins and enzymes from exposure to the sun's ultraviolet rays" (p. 19). Although this theory was proposed long ago (Pough et al. 1978), this key reference is not cited and in Costa Rica, most venomous species have mostly light brown to gray heads (black only in *Lachesis melanocephala* and *Hydrophis platurus*, and generally dark gray in *Porthidium nasutum*, like the rest of the body), or are green, with very thin dark stripes. There is even one species (*Porthidium volcanicum*) that has white stripes over the gland area. Furthermore, in the case of elapids (coral snakes), the black ring on the rear of the head often does not cover the venom glands.

McConnell refers to and bemoans the "trash can" concept of the family Colubridae (p. 18), which was true until recently, but modern molecular methods have partitioned the Colubroidea to yield monophyletic families within the old Colubridae (e.g., Hedges et al. 2009; Zaher et al. 2009). These papers support the recognition of the subfamilies Xenodontinae and Dipsadinae within the family Dipsadidae Bonaparte, 1838, which currently includes many more species than the reduced Colubridae now recognized. Additional new interpretations on the family Dipsadidae have been published by Vidal et al (2010) and Grazziotin et al. (2012), and the phylogeny of all Squamata was recently published by Pyron et al. (2013). Although McConnell cites both Zaher et al. (2009) and Vidal et al. (2010) he does not embrace the new taxonomy that challenges the "trash can" concept.

Neither is the current taxonomy of anurans employed. Two species named in the introduction (p. 19) are both outdated. *Bufo marinus* changed to *Chaunus* based on Frost et al. (2006), and is now referred to *Rhinella* (after Chaparro et al. 2007). *Leptodactylus pentadactylus* is a South American species. The Costa Rican species in the *pentadactylus* group is *L. savagei* (Heyer 2005).

Other issues involving problems with names include the mention of Texan leptotyphlopids as *Typhlops* (p. 23), extremely limited information on certain taxa, including *Leptodrymus pulcherrimus*, *Nothopsis rugosus*, and the genus *Geophis*, and numerous out-of-date or incorrect applications of names.

Chironius carinatus is no longer a Costa Rican species; the subspecies *C. c. flavopictus* was raised to specific level by Hollis (2006). *Dendrophidion vinitor* is no longer considered to occur in Costa Rica, rather the Caribbean former *vinitor* is now known as *D. apharocybe*, and the Pacific "*vinitor*" is now *D. crybelum* Cadle (2012). The "*D. vinitor*" that appears in figures 114 and 116 is *D. crybellum* (based on biogeography), and the "*vinitor*" from Rio San Juan, Nicaragua in figure 113 is *D. apharocybe*. In this case the author probably had no time to add the new data, but he did comment on an observation of *Ungaliophis* made in 2012 and I was in touch with the editor (regarding photographs), who was open to changes as late as the last quarter of 2013.

The discussion of *Dipsas* is confusing. First the author notes three species, then only two, but in the photographic section and distribution map section, there are again three species depicted. Savage and Bolaños (2009) consider three species, *D. articulata, D. bicolor,* and *D. tenuissima*. Regarding *Drymarchon*, McConnell states that "*D. corais* was formerly known as the subspecies *D. melanurus corais*" (actually it was *D. corais melanurus*), and the correct name for the *Drymarchon* inhabiting Costa Rica is *D. melanurus* (Savage and Bolaños 2009). He also notes that many authors split the genus into four species (e.g., Wüster et al. 2001), but does not follow this himself. Regarding *Enulius*, McConnell follows Savage's (2002) point of view that *sclateri* is not *Enuliophis* (after McCranie and Villa 1993), and that the genus has two species in Costa Rica. Solórzano (2004) on the other hand, believes the description of the new genus is convincing and uses *Enuliophis*. This is a matter of opinion, but McConnell is in error in stating that is was *E. flavitorques* rather than *E. sclateri* that had been considered *Enuliophis*.

Erythrolamprus epinephelus has been treated incorrectly by several authors as "*epinephalus*" (including Savage [2002] and Solórzano [2004], and consequently McConnell, but not Köhler [2003]). Savage and Bolaños (2009) explain this error.

Imantodes is a genus represented by three species in Costa Rica. While *I. cenchoa* is generally the most common species and is widespread within the country (except in the drier parts), *I. gemnistratus* is very similar but occurs in more xeric areas and is mostly parapatric with respect to the previous species. In cases of such similarity among close species, a better explanation of their differences would be appreciated. In the case of *I. inornatus* the author states that it is "limited to the Caribbean slope," however, figure 15 depicts a specimen from Quepos (Central Pacific), and even though the locality data were not solicited from the photographer (myself), if one is familiar with the color pattern of Caribbean and Pacific *Agalychnis callidryas* (also in the photo), one can verify that the picture was taken on the Pacific slope. The distribution map of *I. inornatus* fails to reveal its presence (documented by Savage [2002] and Solórzano [2004]) in the southwestern Pacific area (only one place on the Osa Peninsula is plotted).

Though the information would not have arrived in time for the author to incorporate, a recent paper by Ruane et al. (2014) has changed the whole scenario for milksnakes. In Costa Rica, two subspecies of *Lampropeltis triangulum* were known, *L. t. gaigeae*, the black milksnake, and *L. t. stuarti*, a tricolor banded milksnake. Now, two species are known, *L. abnorma* (the old *stuarti*), and *L. micropholis* (the old *gaigeae*).

Leptodeira is a genus with four species in Costa Rica. *L. nigrofasciata* and *L. rubricata* are quite well defined (Savage 2002), but *L. annulata* (one of the most widespread species in the Neotropics) needs further study. Earlier authors made the attempt to distinguish this species from the extremely similar *L. septentrionalis*, but unconvincingly: Solórzano reported a lower ventral count in *annulata*, whereas Savage cited differences in head color pattern, which I have found to be inconsistent, as in my experience *L. annulata* is one of the most variable species known. McConnell does not even attempt to differentiate the two species, but I did find his mention of a bite he suffered from *L. septentrionalis* interesting. Such cases deserve publication in specialized journals. An important paper about evolution in *Leptodeira* is missing in the reference section. Daza et al. (2009) showed that the recognized taxa do not represent natural groupings. The most striking results are that *L. nigrofasciata* should be recognized as a different genus, that *L. rubricata* may be a synonym of *L. annulata rhombifera*, and that the *annulata-septentrionalis* complex is polyphyletic.

Regarding *Leptophis*, five species are known to occur in Costa Rica, of which only four are mentioned by McConnell (the missing one is *L. riveti*, although two pictures of the species appear in the plate section). It is strange that Savage (2002) does not compare *Leptophis nebulosus* with *L. riveti*, which to me seem to be potentially synonymous. The only differences are the longer postocular stripe in *riveti*, and a higher count of ventrals in *nebulosus*. This is not enough for me to distinguish among species alone, and can be due to intraspecific variation.

The genus *Pseustes* is no longer valid, and the Central American representative, *P. poecilonotus* is now in the genus *Phrynonax* (Jadin et al. 2013). The genus *Trimorphodon* is represented in Costa Rica by one species, *T. quadruplex,* not *T. biscutatus*, as reported by McConnell (Devitt et al. 2008). *Tripanurgos compressus* has been placed in *Siphlophis* for some time (Zaher and Prudente 1999), based on hemipenial morphology, and in molecular studies *S. compressus* is embedded with *S. cervinus* (an Amazonian species; Vidal et al. 2010; Grazziotin et al. 2012; Pyron et al. 2013).

The only recent taxonomic change of which I was not aware and that this book brought to my attention, was the split of *Rhadinaea* and the resurrection of the genus *Rhadinella* Smith, 1941 for several species in the former genus, two of them in Costa Rica: *R. godmani* and *R. serperaster*. Unfortunately there is no mention of the source of this action in the book and I needed to dig (with the help of Victor Acosta) to find the relevant reference (Myers 2011).

Pelamis platurus is no longer in the genus *Pelamis*, but rather is embedded in *Hydrophis* (Sanders et al. 2012). McConnell states that a few specimens have been found in the Atlantic Ocean (in the Caribbean Sea near the Panama Canal Zone). Although *H. platurus* is present in the Caribbean, to my knowledge it has not yet been cited in Panama, but only in Colombia (Hernandez-Camacho et al. 2006). Further, recent studies (Solórzano 2011; Sheehy et al. 2012) have identified a pygmy yellow population in the Golfo Dulce. This is one of the most interesting recent discoveries about Costa Rican snakes, but is overlooked entirely in this book.

McConnell incorrectly states that *Agkistrodon* occurs as far south as southern South America! In fact it reaches its southern distribution in northwestern Costa Rica. The species in Costa Rica and neighboring countries (Nicaragua, Honduras), is now referred to as *A. howardgloydi*, having recently been raised from subspecific level under *A. bilineatus* (Porras et al. 2013). The author regards both *Porthidium nasutum* and *P. porrasi* as inhabiting the same area of the Peninsula de Osa. Actually, the "*nasutum*" from southwestern Costa Rica was subsequently described

as *P. porrasi*, and in Costa Rica *nasutum* is recognized only from the Caribbean (Lamar and Sasa 2003; Campbell and Lamar 2004).

As previously noted, the photographs are unquestionably the best part of the book, and credit for this must be given to the editor, Gerold Schipper, who searched for the best pictures of each species over a long period. I did not see a single photograph by the author himself. Figure 9 identifies *Mastigodryas melanolomus* as a *Dryadophis*. While some authors do use *Dryadophis* for this species, the most recent genetic data (Pyron et al. 2013) support the use *Mastigodryas*, as *melanolomus* is embedded within this genus. Indeed, McConnell confusingly uses *Mastigodryas* in the text and other photos. Also in the photographic section, *Ungaliophis panamensis* (correct in the text), is misspelled as *U. panamansis*.

In several places, when referring to the feeding biology of some species, like *Pliocercus* (p. 43), the author states that it feeds on leptodactylid frogs. This use is no longer appropriate unless he means *Leptodactylus* to the exclusion of other so-called rainfrogs (genus *Craugastor* and *Pristimantis*; see Barrio-Amorós et al. [2013] for the rationale of using "landfrogs" rather than "rainfrogs"), now included in the family Craugastoridae or Strabomantidae (depending upon the authority followed).

After carefully reading the text, it appears that the author has not made much effort to modernize his information, but rather followed Savage (2002), Solórzano (2004), and a few others, with no real attempt to incorporate data from other recent sources, or even some more classic papers.

Perhaps most importantly, if this is a field guide to identify species, how are we supposed to identify them? Photographs can certainly help, but in many instances one needs a dichotomous key (like those in Köhler [2003] or Solórzano [2004]), especially if the guide is to be used in the field, and categorically one requires a description of the species, preferably as detailed as possible. Further, regardless of its utility, I do not really believe that the book can actually be considered a field guide; it is neither waterproof, nor does it have the flexible covers and convenient shape of typical field guides.

Even though the book is impeccably edited, as are all volumes published by Chimaira, I am surprised by the quality of the contents. I can enjoy the collection of photos, and can conveniently consult the distribution section but if I need to go deeper into any species I will always need the two classic "bibles" of Costa Rican snakes (plus a third for venomous snakes—Campbell and Lamar 2004). A better solution than a field guide would have been a Terrralog volume (another Chimaira book series with photos and maps but virtually no text!).

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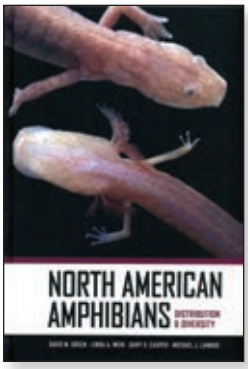
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North American Amphibians. Distribution and Diversity

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Amphibians ought to be of special concern to everyone. Not only are they of interest in terms of biodiversity and conservation, given water or moisture-dependent life cycles and vulnerability to environmental degradation, but they are also one of the best-known groups of vertebrates thanks to extensive studies at multiple levels of biological organization. Some species of amphibians are in decline or have possibly gone extinct due to recent human activity, and yet new species are being discovered every year, and molecular phylogenetic studies continue to reveal cryptic species in which single species are found to actually represent two or more distinct species. Continued resolution of phylogenetic relationships also means that scientific names are constantly changing. A critical component of our knowledge of amphibians is their precise biogeographical distribution. Field guides are very useful in this regard, as are official summaries and inventories, especially for professional herpetologists and other scientists. Also needed, however, are ways to emphasize the beauty and richness of amphibian biodiversity to general audiences as well as to specialists. The book reviewed here, edited by David M. Green and colleagues, fills this niche nicely.

It is a pretty book. The book contains excellent color photographs of every currently recognized species of North American amphibian (with only a single exception of a very rare salamander). Only one of the species (a frog) is represented by a pickled specimen rather than a photograph of the living animal. Another species is represented by a dish containing mere lumps of tissue and a museum tag, the best existing documentation of a very rare species of salamander. The book also includes a distribution map for each species, showing high resolution plots on topographic background maps—yellow dots on different shades of green and brown. The amount of verbal description for each species is kept to the essential minimum—brief, but authoritative, most of it from Lannoo (2005) with original authors listed.

It is a clever book. The book manages to cover the entire range of North American amphibian diversity without getting bogged down in taxonomy and classification. Instead, the taxonomy is treated intuitively (for want of a better word); it is implicit, and it is elegant. So, to begin with, the anurans (frogs and toads) and the caudates (salamanders and newts) are covered in separate sections named, simply, "Frogs of North America" and "Salamanders of North America." It took me a few moments to understand how the species were organized as there are no explicit written guidelines, and there are no blaring titles or subtitles. The families are treated alphabetically (subtly indicated by an inconspicuous footer at the bottom of each page), and then the genera are dealt with alphabetically within each family. Finally, the species are described alphabetically within each genus.

It is a useful book. The authors have taken great care to use up-to-date data on taxonomy and distribution, and the book is rich with resources including primary literature and web sites. It essentially combines the information from two previous reports to the Global Declining Amphibian Populations Task Force (Green 1997; Lannoo 2005). But instead of the usual blob maps seen in most field guides, they have used high-resolution plots on topographic maps, representing distribution data painstakingly gathered from a variety of reliable sources. This allows the reader to relate species distributions to topography in a way that is not possible in most blob maps. The maps also include simple political boundaries with the plots representing "centroids" of counties or equivalent. The only criticism I have of the species distribution maps is that because the dots are placed on "centroids" of various kinds, they are often shown more-or-less evenly spaced in an artificial-looking grid-like fashion making me think that perhaps a more "organic" shading (e.g., translucent yellow) might have been better (but then we would be back to the blob maps).

The book begins with an introduction to amphibians and their distribution, including an interesting map showing the relative densities of amphibian species in North America. For this the dot-plots are very effective. My one problem with this map is that it is so small, and some of the colors are so similar, that I had to use a magnifying glass to distinguish them. The authors include a special section at the end where they explain how the maps were made, and are careful to point out that the book covers only North America north of Mexico. But it deals with this part of North America as a whole continent, with a necessary and interesting northward-shifted perspective that emphasizes more of Canada than most Americans (i.e., U.S. citizens) are used to. I count this healthy shift of perspective as a useful aspect of the

book for understanding amphibian distribution, and no doubt reflects the fact that it is a collaborative effort between researchers from both Canada and the United States.

This is a wonderful book to have on your coffee table, as well as in your office or even in your backpack. It is a useful compendium of information on North American amphibians that manages to be esthetically pleasing as well.

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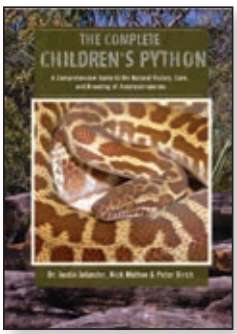
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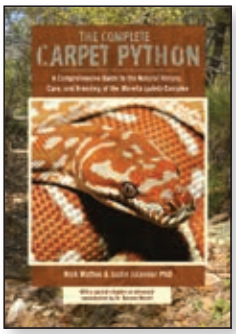
The Complete Children's Python: A Comprehensive Guide to the Natural History, Care, and Breeding of *Antaresia* Species

Justin Julander, Nick Mutton, and Peter Birch. 2013. ECO Herpetological Publishing and Distribution, Rodeo, New Mexico (www.ecouniverse.com). Hardcover. vii + 256 pp. US $49.95. ISBN 978-1-938850-05-9.

The Complete Carpet Python: A Comprehensive Guide to the Natural History, Care, and Breeding of the *Morelia spilota* Complex

Nick Mutton and Justin Julander. 2011. ECO Herpetological Publishing and Distribution, Rodeo, New Mexico (www.ecouniverse.com). Hardcover. ix + 339 pp. US $53.95. ISBN978-0-9832789-2-4.





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Species belonging to the Children's python (*Antaresia*) and carpet python (*Morelia*) groups are among the most sought-after species in Australian herpetoculture and their popularity is growing rapidly in the international market. Their ease of care in captivity and ready availability (in Australia) makes them among the most desirable snakes to keep—comparable, for example, to Ball Pythons in the USA. In particular, the small size of *Antaresia* species (less than 1.8 m, and 60 cm or smaller in *A. perthensis*, the pygmy python), their ease of breeding, and overall adaptability to captivity, combined with a large variety of captive-bred morphs mean that these snakes have something for everyone.

Every now and again a book is published that becomes a "must have" highly valued reference for its target audience. For Australian python herpetoculture these have included *Pythons of the World. Volume 1, Australia* by Barker and Barker (1994), which remains one of the most comprehensive Australian python books, and the more recently published and herpetoculturally-focused *Keeping and Breeding Australian Pythons* edited by Mike Swan (2007). *The Complete Children's Python* and *The Complete Carpet Python* represent the next generation in this tradition. These two books are "must haves" for any *Antaresia* or *Morelia* keeper and breeder, or anyone with a general interest in pythons. The authors are well known Australian python breeders in the US (Justin Julander and Nick Mutton) and Australia (Peter Birch) and all have been enthusiasts from a young age. All three have extensive experience keeping and breeding various species from each group and have a wealth of experience and information to offer the reader. The effort and dedication expended by the authors is inspiring; just a few page flips and it is evident how much they have put into these books. The *Morelia* book has a foreword by Australian python and captive breeding expert John Weigel who states that the authors have "presented a well-researched and fascinating summary of just about everything that is presently known about carpet pythons." He couldn't be more correct, and the same applies for the *Antaresia* book.

Each book offers a smorgasbord of information for the species it discusses as well as a wealth of photos representing one of the best available image collections for the taxa treated. The books are produced using quality materials and will no doubt withstand years or decades of wear and tear. The data presented in the books are accurate for all species and give a good representation of existing knowledge. Spelling or grammatical errors are minor and infrequent.

Both books follow a similar format, although topics do not necessarily parallel one another exactly between the two. Section I of each book contains an introduction that gives a brief general overview of the book and the species discussed therein. In addition, the *Morelia* book has a small subsection in the introduction on Myths and Misconceptions. This is also where those not already confused by the "*Morelia spilota* complex" will be when they see that the authors have made some nomenclatural changes—recognizing some subspecies, but not others, as full species. While some of these changes may be warranted, no clear justification is presented. To confuse matters further, the Rough-scaled Python (*Morelia carinata*) is included in the *M. spilota* book, but other species of *Morelia* (e.g., *kinghorni, oenpelliensis, viridis*) are absent.

Section II (*Morelia*) or chapters 1 through 5 (*Antaresia*) present species accounts providing a natural history overview of the species including information on natural distribution, size, coloration, habitat and natural history, and reproduction. Each species profile is accompanied by many photographs displaying various natural habitats and morphs. Many herpetocultural publications are deficient when it comes to providing background information on behavior and natural history but these two books are an exception. The species profiles provide a wealth of background information that is useful when dealing with captive specimens. However, if you are pulling the book off the shelf and

planning to read a few or all of the species profiles at one sitting you may find the text a bit repetitive for a few profiles.

Of note is the section within the *Antaresia maculosa* species profile "Notes on the recently discovered population of *Antaresia* from New Guinea," which deals with the incredible discovery of an *Antaresia* species with affinities to *A. maculosa* from the Western Province of Papua New Guinea (O'Shea et al. 2004). This is the first record of the genus outside of Australia and provides further evidence of the historic connection between Australia and New Guinea.

Chapter 5—"Pygmy Banded Python *Antaresia* sp."—provides a profile of a suspected new species of *Antaresia*. The species profile does everything but formally describe this putative new species. While it may, in fact, be a new species there is no justification provided to support this and with the limited information presented there is no way to exclude the possibility that these specimens may be hybrids within a zone of sympatry of *A. maculosa* and *A. stimsoni*. Although a new species of *Antaresia* would be wonderful for Australian herpetology, I believe the chapter could have been omitted until such time as the issue has been resolved and more information available.

Following the species profiles are chapters on evolution and taxonomy—"The Evolutionary History of Carpet Pythons" (section III in the *Morelia* book) and "The Evolutionary and Taxonomic History of the Genus *Antaresia*" (Chapter 6 in the *Antaresia* book)—that discuss the origins of snakes, their evolutionary history, relationships within and between the focal genera, and taxonomic history (for *Antaresia*). The subject of evolutionary history can be complex for those new to the subject but the authors do an excellent job in breaking it down so that it is easily digested and the key points are retained. Treatment of the nomenclature is largely lacking in the *Morelia* book and would have been useful, especially in providing justification for the changes in taxonomic rank made by the authors.

Section IV—"Carpet Pythons in Captivity" in the *Morelia* book (chapters 7–9 in the *Antaresia* book)—cover all the key elements for the keeper or breeder, with extensive information provided on all aspects of captive husbandry, including housing, heating and humidity, feeding, and reproduction. Readers will find the sections on reproduction of particular interest; keepers seems to have different results and varying levels of success so it is always good to have detailed records and observations as the basis for comparison. Based on the sheer quantity of information on every page it is clear that the authors are in their element in this section.

All keepers hate to deal with diseases, disorders, and most of all, parasites. The section of each book covering these not-so-enjoyable aspects of the hobby provide great information to prevent, and if necessary, manage these issues. Many new keepers are easily panicked and often jump to conclusions, assuming a major problem when something out of the ordinary (but still normal) occurs. At the end of the day, if in doubt, get it checked out.

The final section of each book deals with morphs. It is one of the largest sections and profiles the natural and captive morphs of species of *Antaresia* and *Morelia* discussed in the book. New morphs will continue to be developed, but this section provides a brilliant display of the possibilities. Whether you are a beginner looking for your first snake or a dedicated breeder looking for ideas for the next big project, this section will be useful. It acts almost as a shopping list; one can only imagine the corresponding price tags. If anything, this section shows how productive the herpetocultural industry is and confirms that whether it be size, color, or pattern, these pythons have something for everyone.

The photos represented in these two volumes cover nearly all species and natural and captive variants and must be one of the most comprehensive published image collections of these pythons. The photos are by a diversity of photographers—a nice change to the monotony of nearly identical poses that can result when images are drawn from a single source. If one is not interested in reading these books, the photos alone will make a purchase worthwhile.

On the other hand, with a photo, or sometimes two, displayed on nearly every page, the reader is sometimes left wanting more text. The quality of some photos makes one wonder if all are really necessary. It is a little annoying to find photos that almost completely crowd out the text. For example, in *The Complete Children's Python*, p. 28 has 17 lines of text, each with a maximum of two words, whereas p. 42 has 35 lines text, none with more than three words, seven of which have been split across two lines.

Reading the book and admiring the numerous photos leads the reader to wonder: if these animals are not easily exported out of Australia, how have so many found their way to other countries. Illegal exportation or smuggling of reptiles is a well-known threat to reptiles across the world, especially in Australia. One could argue that good herpetoculture books can almost act as "smugglers' catalogues" providing a comprehensive summary of all of the amazing snakes that are available. Regardless of the ultimate origin of these reptiles, books like these highlight the impressive scale of captive breeding in the herpetocultural industry, particularly in the United States.

While they may not take pride of place on the bookshelves of naturalists or researchers, both books are essential for any keeper or prospective keeper of these species. Those who purchase pythons, especially beginner or intermediate keepers, will find the book an extremely valuable resource. For the more experienced keeper and breeder, the books will still be worth the purchase, if not for the information then for the vast collection of photos. Especially for the first time keeper, these books should be at the top of your priority list! Don't let the cost deter you, they are worth it.

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ZOO VIEW

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When I was in grammar school, my parents moved to a small suburban town outside of Chicago. A few miles from our house, a beautiful pond and surrounding forest was my favorite haunt. Every few days, I would peddle my bicycle there, and spend hours watching wildlife, including a robust colony of Plains Garter Snakes (*Thamnophis radix*). One day to accommodate a new housing development, the pond was drained and the forest was being cut. A few weeks later, many snakes started showing up in my neighborhood, surprising since the area was highly urbanized. At first, I was delighted as my basement was already filled with living ophidians and these new snakes nicely complemented my collection until I realized that these creatures were driven from their living space, never to return.

A year or so later, I visited the Art Institute in Chicago and saw a large oil painting by Peter Blume called "The Rock." The image was so striking, I was unable to turn away for many minutes; the painting is not about death to humanity, but to nature, and the trouble we continue to have coexisting with it. At that moment, everything became clear—I was watching the planet being dismantled by humans and replaced with far less interesting manmade creations. Even more troubling, the pace was accelerating. I trace this moment to the exact time in my young life when I became a committed environmentalist.

COURTESY OF ART INSTITUTE OF CHICAGO



Peter Blume, American, 1906–1992, Oil on canvas, 146.4 × 188.9 cm. Signed lower left: Peter Blume, 1948.

Books by Current or Former Zoo Workers

Sean Foley has worked for over twenty years in the herpetology department at Riverbanks Zoo and Garden in Columbia, South Carolina. He has written a rip-roaring adventure yarn involving Jamaican iguanas, pirates, lost treasure, the island of Jamaica, a lonely thirteen-year-old girl, and friendships. Pick up a copy for a pleasurable read (*The Iguana's Eyes*, 2013, Columbia Vista Publishing, 301 pp., ISBN 978-0-9899618-0-6). It was refreshing to read a novel that accurately described herps without embellishment or sensationalism and it was certainly unusual to read his plea at the end for Jamaican Iguana conservation. The species was described by John Edward Gray as Colley's Cyclura (*Cyclura collei*) in 1845. The taxon was exceedingly rare in 1916, mentioned in the account by Thomas Barbour and G. K. Noble (A revision of the lizards of the genus *Cyclura*. Bull. Mus. Comp. Zool. Harvard 60[4]:139–164), and was found on a few small islets off the coast of Jamaica where the predaceous mongoose had not been introduced. The lizard was later thought to be extinct. In 1970, a hunter's dog discovered a carcass and a survey later found about 100 lizards left in the wild in the Hellshire Hills. In 1993, Allison Alberts called it the most endangered lizard in the world (Vivarium 5[1]:12–14, 30).

Jeffrey M. Lemm and Allison C. Alberts from San Diego Zoo Global in California have worked for many years with iguanid lizards of the genus *Cyclura*. Their comprehensive book—*Cyclura: Natural History, Husbandry, and Conservation of West Indian Rock Iguanas* (2012, Academic Press, London, San Diego, 221 pp., ISBN: 978-1-43-773516-1)—with contributions from four additional authors, includes chapters on evolution and biogeography, species accounts, natural history, husbandry, nutrition, health and medical management, and conservation. What was indeed hopeful is their description of the successful head-starting program for the Jamaican Iguana at the Hope Zoo in Kingston but one should not be too confident as there exist today sizeable threats to irrevocably alter the Hellshire Hills for human purposes, the only place where the lizard is found. Their future assessment: "Despite the fact that most rock iguana populations have suffered serious declines, there is reason to be optimistic about their future. The IUCN's 1997 decision to sanction the formation of a West Indian Specialist Group (since expanded to become global Iguana Specialist Group) was instrumental in bringing together experts internationally throughout the region to develop a coordinated plan for the long-term conservation of West Indian iguanas." The San Diego Zoo has been an integral player over many years leading this effort; as an example, Tandora Grant has been tireless in her efforts to bring attention to the plight of the Jamaican Iguana.

The Invisible Ark: In Defense of Captivity, by David M. Barker and Tracy M. Barker, was published in 2014 (Vida Preciosa International, Boerne, Texas, 169 pp. ISBN 13:978-0-9785411-1-8). The title explains its contents and is an important primer for those who must defend their interest in maintaining captive amphibians and reptiles. They also cover the important contributions generated from the private sector and suggest ways that this community can contribute to conservation efforts. There is an extensive narrative on the history and challenges of invasive herpetofauna, especially the Burmese Python and other large constrictors in the southeastern United States. Many of their papers on this topic have been published in the *Bulletin of the Chicago Herpetological Society*. Years ago, David and I worked together at Dallas Zoo and Tracy spent time at the National Zoological Park in Washington, DC.

A rarity indeed is any privately-owned herpetological exhibit that survives for a decade or more but one lasting over 50

years is awe-inspiring. The mortality rate for such enterprises is staggering so the book written by Clyde Peeling, *Reptiland; How a Boyhood Dream Became a Modern Zoo* (2014, Peeling Productions, Allentown, Pennsylvania, 132 pp. ISBN 978-0-9960790-0-6), is amazing. This is not a typical private exhibit for it is accredited by the Association of Zoos and Aquariums (AZA), which insists on high standards for accreditation by its members. I have followed Peeling's career for years and his stories about our friends and colleagues certainly resonates with me, although his inscription to me in his book was a bit startling: "To Jim, We may be the last two standing! Your friend, Clyde."

Zoos and Aquariums: What is Next?

Reptile keeping has developed into a science during the past two decades, and the advancements, especially in the fields of medication and captive breeding, are little short of phenomenal. Compared with the sophisticated techniques that are now available, our efforts of half a century ago seem crude in the extreme. In those days we often considered ourselves lucky if a majority of our animals lived a year or two, and what little captive breeding occurred was fortuitous, not planned.

Roger Conant (1980)

Thus captivity will result in intensive selection, molding the animal in a manner quite different from that followed in its natural environment. The final product will be an animal much better adapted to live in close association with humans, in the home or laboratory, but less well adapted for life under natural conditions.

Henry S. Fitch (1980)

Captive breeding isn't designed to save species. It's designed to make humans feel better about ourselves. It's proof that whatever horrors we're wreaking on our planet, we're still willing to make Herculean efforts to save the animals most obviously suffering the consequences. But to effectively assuage our guilt, we need to see results—and truly successful captive breeding programmes, the ones that produce large numbers of wild animals which stay out of humans' way, rarely give us those. Instead, we latch on to the adorable and conscience-soothing spectacle of captive breeding itself. We're riveted by the Panda Cam, we turn up in droves to watch ultralight aircraft lead whooping cranes on their first migration. Puppet-rearing takes our love of captive breeding to the extreme by satisfying two guilt-absolving fantasies at once: it lets us play at being nature's saviour while also symbolically erasing human beings from the face of the Earth.

Reared by puppets. To breed condors in captivity, we must pull on the strings of nature. But does that matter if we save a species?

Lizzie Wade, *Aeon Magazine* (2014)

There are enormous challenges and changes taking place in our profession. Unsettling and penetrating questions are being asked about the value of what we do as zoo and aquarium professionals, both inside and outside our institutions, as evident in the quotes above. This column will discuss preparing for a changing world by using a new book, broad in scope, that addresses this fluid landscape. This book is *Zookeeping. An Introduction to the Science and Technology*, edited by Mark D. Irwin, John B. Stoner, and Aaron M. Cobaugh (2013. University of Chicago Press, Chicago, Illinois. 674 pp., ISBN-13: 978-0-226-92531-8 [cloth]; ISBN-13: 978-0-226-92532-5 [e-book]). In addition to positioning oneself for the future, many of the subjects covered in the 66 chapters, written by luminaries in the field, can be consulted for preparing protocols now required in our institutions; it is an enormously time-saving reference.

I wish to make several points here as to why this book is important. It is no longer possible to restrict one's zoo career to just keeping animals. Sometimes during job interviews, candidates have said that they prefer working with animals rather than humans—their applications immediately go to the bottom of the pile. If one wishes to move up the food chain and compete for higher jobs, then familiarity with administration, fundraising, supervision, public outreach, and other non-animal skillsets is critical. It is almost certain that the ability to read a budget spreadsheet is as important as knowing what current scientific name should be used for any taxon. One example here should suffice. I receive job descriptions from many zoos soliciting applicants to apply for positions beyond the keeper level and virtually all require a minimum of at least one year's supervisory experience and broad familiarity with the needs of zoos and aquariums. The tragedy is that most zoos do not offer learning opportunities to keepers so that these minimal requirements can be met.

We are not preparing the younger generation to be successful as potential curators. This is obvious when a position description is circulated throughout our membership and applicants begin to send résumés. Academics from the research side often have virtually no experience with a variety of living captive animals, public outreach, or personnel management. Some zoo workers who came up through the ranks have little experience in setting up successful research programs, either in the zoo or in the field, which often includes collaborations with those outside the zoo setting. It is striking that many applicants are unfamiliar with the rich history of the zoo and aquarium world, so one fears that



This new book, "*Zookeeping. An Introduction to the Science and Technology*," will certainly become the reference "bible" for the zoo and aquarium professional.

they may well repeat the mistakes made by their predecessors. Curators with a blend of these critical skills are hard to find now, at least this is what I am told by those entrusted with finding suitable candidates.

Our profession is becoming increasingly bureaucratic and much time is spent filling out surveys, answering an enormous number of e-mails, attending unproductive meetings, and preparing a plethora of memos in response to various issues such as visitor safety, personnel problems, and animal welfare. As a result, the time available to focus on biology is shrinking—this is a chronic complaint by my fellow zoo workers and I understand their frustration. I suggest that institutional representatives review all policies, jettison those which no longer apply, refine those that need improvement and keep only those that are proven to be effective and useful.

Zoo administrators now must deal with the internet, such that any incident (animal escape, visitor injury, or untimely animal death) can be instantly communicated worldwide and can affect the zoo's reputation. Some people dislike zoos and aquariums, accuse us of ignoring animal welfare, and do not understand the value of zoo programs to conservation in the broad sense. We may have inadvertently contributed to this perception by personalizing individual animals. Perhaps it seems safer and easier for us to focus on individual animals: we often use pet names for them, try to enrich their lives by interactive play and using manmade objects, and bond with them as if they were surrogate humans without concern for imprinting or other side effects. When animals are near the end, they cannot send us a note saying "Do Not Resuscitate." But we employ dramatic medical interventions and costly procedures to ensure that they live to a ripe old age, and mourn and grieve over their deaths (in a few extreme cases, grief counselors have consoled the animal care staff for an animal death and quasi-memorial services have been held). In sum, we demonstrate that we care and we publicize to our audiences that we do.

Enrichment has become one of the newest trends in the zoo world, but I am not certain how we measure whether our changes to an animal's living space and activities actually improves their lives or whether it just makes us feel better. I do know that if we were keeping animals successfully by fulfilling all of their needs, we might no longer need to resort to techniques like assisted reproduction, cryopreservation of gametes, and hand-rearing. We do not spend enough time trying to understand and convey the need to protect an entire species or larger clade rather than individual animals—confronting and explaining to our visitors thorny issues like the need for euthanasia to deal with limited space in zoos, the issues confronting wild populations, climate change, the sixth mass extinction event, and advent of the Anthropocene—and how our captive colonies should be managed more effectively to accomplish conservation goals.

Many of our zoos are experiencing severe financial shrinkage and the future for some may be problematic. Fundraising, development, and public relations have become an integral part of the zoo scene. Some of my herpetological colleagues complain that their time is spent leading tours, giving public presentations, and interacting with potential benefactors rather than working with the collections. These colleagues have an incredibly short-sighted view; in fact, their programs will disappear if there are no monies to support these initiatives.

Obtaining animals has become much more difficult. Moving animals between zoos and aquariums for our captive management programs has become more time-consuming, due to risk of infectious diseases, lack of quarantine space, and increased paperwork. There are few animal dealers now so zoos may be restricted to mounting their own collecting trips to range countries; these are limited, however, by travel and other expenses, increased paperwork for permits, and lack of reliable in-country associates. Even if these impediments are overcome, there are no guarantees that the animals will be found. While some zoos cooperate with hunting ranches for space to ensure genetic diversity for some large mammals, there is no such program for reptiles. Although an idea like this would have been inconceivable to me a short time ago, I can now envisage a day in the future where zoos could be forced to work more closely with hide dealers producing propagules to maintain large reptiles such as crocodilians, iguanids, varanids, boas, and pythons. Public outcry is certain to be deafening in the herp community, and administrators may need to be ready to defend this practice. As a herpetologist, I find killing any herp abhorrent (unless it goes to a museum collection), especially when their skins are being used in the fashion industry, but we are running out of time and space—and some protected wild populations are shrinking precipitously due to human exploitation. My sense is that convincing people to avoid purchasing animal products to drape on their bodies does not seem to be working effectively over the past decades—I still see plenty of snakeskin belts, handbags, and wallets, as well as shoes made from crocodile skins at the local department store and I suspect that most are collected from the wild. The IUCN Python Conservation Partnership is in favor of commercial python farming to combat the illegal trade for python skins (Natusch and Lyons 2014). For nearly eighty years, the Reticulated Python (*Malayopython reticulatus*) and the Burmese Python (*Python bivittatus*) have been harvested from the wild in Southeast Asia. An astounding nearly 500,000 skins are shipped on the black market every year for use in European fashion, worth an estimated one billion US dollars. This paper evaluates the economic feasibility and viability of captive breeding as a possible way to sustain and conserve them. One possible part of a future plan: do not harvest animals sent by zoos, but only their progeny not needed for sustaining captive populations.

The total of these onslaughts and new expectations is that our community has become defensive and tentative. For example, I have heard few discussions about management euthanasia for my entire career (45+ years) and the topic continues to be discussed rarely because there is great risk involved to those having the courage to act. In the past, zoo directors have lost their jobs over the controversy that erupted when they culled healthy animals that were not contributing to breeding programs. While the Copenhagen Zoo furor—after euthanizing a giraffe and four lion cubs for management purposes—has spurred a useful discussion of the issues among many zoo workers, virtually all of my non-biologist friends have roundly condemned this action. When I try to explain the rationale for doing this, they are unconvinced.

Finally, there is a conundrum. Some administrators, educators, graphics designers, and marketing people insist that the zoo visit must be a pleasant experience, not depressing or disconcerting. Our messages need to be simple, positive, and uplifting. Others maintain that the experience should be unsettling, because the natural world is disappearing at an unprecedented rate and humans need to be aware that their lives will most certainly change by living in an increasingly homogenized natural world. Zoo people have struggled with this

dichotomy for decades. My belief is that visitors are capable of connected thought so we need to address difficult concepts and challenges in a forthright way with our messages, but we also should cater to those who simply want to have a good day out.

So what is likely to happen to those older zoo workers who yearn for the good old days where life in a zoo or aquarium was far less complex? The answer is simple—the world is changing at a frantic pace, biodiversity is quickly leaving us, and those old days will never return. Get over it. But carefully reading this comprehensive new book by Irwin et al. will serve to identify the issues. Further, it shows growth, sophistication, and improvement in many of the things we currently do. Future challenges have been identified which must be addressed to ensure the survival of zoos, which in itself is a good thing.

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JAMES B. MURPHY, *Section Editor*

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Studies on Pythons, Boas and Anacondas, Dwarf Boas, and Round Island Splitjaw Snakes in Zoos and Aquariums

To most people constricting seems one of the most lurid and unpardonable things that snakes do, and through the centuries the habit has evoked a great deal of morbid lore. For example, though I come from an enlightened family, I grew up thinking that a constricting snake snatches up its prey, throws on coils and with chiropractic precision pulverizes each separate bone in its victim's body, licks the pulped prey all over to lubricate it, zestfully engulfs it and then lays up somewhere for a year or more, stupefied by its excesses.

Archie Carr, *The Reptiles*, 1963

Introduction

This wonderful quote by Archie Carr sums up the responses by zoo visitors when they flock around an exhibit to watch a feeding snake, especially a large constrictor. Screams of disgust, amazement, and disbelief are heard ringing through the public area as the prey gradually disappears from view. But in spite of the outcry, virtually no one leaves the building until dinner is finished. They are certainly unsettled when they discover that some reptiles—crocodilians, Komodo Dragons, large constrictors—can kill and eat people so the look of horror on their collective faces is arresting and dramatic. Part of the response is that no one wishes to be eaten of course, but their collective response also suggests to be dispatched by an animal so far down the phylogenetic tree is unacceptable, almost embarrassing.

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In this paper, I show the history of keeping boas and pythons in zoos and aquariums by using early images of many genera and include some personal anecdotes. To avoid repeating myself, I suggest that the reader consult my earlier papers in *Herpetological Review* on venomous reptiles (Murphy 2014). Many of the descriptions of their maintenance, husbandry, behavior, and challenges facing captive managers and conservation biologists in the zoo world also apply here to non-venomous taxa.

To avoid confusion, I am incorporating the original technical names used by the authors in their publications. To update these names, consult McDiarmid et al. (1999), Reynolds et al. (2013), Kaiser et al. (2013), Pyron et al. (2013), and Uetz and Hošek (2013).

Review of the Literature

With regards to large constricting snakes, several notable books should be recognized. An important book by Zdenek Vogel, briefly working for the Prague Zoo, was the major reference book in Europe in 1964: *Reptiles and Amphibians. Their Care and Behaviour*. Frederick William FitzSimons, Director of the Port Elizabeth Museum and Snake Park in South Africa, published *Pythons and Their Ways* (1930). During part of his career at Ft. Worth Zoo in the mid-1960s, John Mehrtens began compiling information and photographs for a large book called *Living Snakes of the World in Color*, published in 1987. In 1999, Eugène Bruins from Natura Artis Magistra in Amsterdam, provided extensive coverage of insects, arachnids, amphibians, and reptiles in his book *Encyclopedia of Terrarium*. Another example is the comprehensive book by John Weigel from the Australian Snake Park, *Care of Australian Reptiles in Captivity* (1992). Richard A. Sajdak, retired herpetological curator at Milwaukee County Zoo in Wisconsin, covered boas and pythons in his book *Hunters in the Trees: A Natural History of Arboreal*

Snakes. Peter Brazaitis from Bronx Zoo wrote a lovely book called *You Belong in a Zoo. Tales of a Lifetime Spent with Cobras, Crocs, and Other Creatures,* detailing his life as a lowly paid reptile and amphibian caretaker, starting in 1954. Brazaitis' book includes one particularly interesting story involving the theft of an African Rock Python (*Python sebae*) and other reptiles at night by three young boys who scaled the roof and climbed into the Reptile House on several occasions to pick through the collection in order to build their private zoo. The python proved to be aggressive, chasing one of them around his dwelling. Keeping that snake fed was another challenge because rats were expensive and the snake had a prodigious appetite—the thieves carried the nasty ophidian back to the Zoo and returned it to its cage. Some baby Boa Constrictors were stolen as well but one boy's grandmother did not like snakes and flushed them down the toilet. Another large boa escaped and was killed by a city bus on a busy street in the Bronx.

There are several important tomes by non-zoo herpetologists. Clifford H. Pope wrote *The Giant Snakes; the Natural History of the Boa Constrictor, the Anaconda, and the Largest Pythons, Including Comparative Facts about other Snakes and Basic Information on Reptiles in General*. Sherman A. Minton, Jr. and Madge Rutherford Minton compiled a book focusing on the big five constrictors and their relatives*: Giant Reptiles*. Their book also covered other large reptiles, helpful as a reference source. Richard Shine has studied many Australian pythons in the field, especially the Water Python *Liasis fuscus*. His book, *Australian Snakes: A Natural History*, described the first detailed study of a python—habitat, density, diet, growth rate, and reproductive biology. Brian Kend accumulated observations and provided photographs in his book, *Pythons of Australia*. A comprehensive book covering size, food and feeding, sex, attacks on humans, exploitation, and conservation was written by John C. Murphy and Robert W. Henderson—*Tales of Giant Snakes: A Historical Natural History of Anacondas and Pythons*. Harry Greene has written an insightful book—*Snakes: The Evolution of Mystery in Nature,* which includes information on classification and general biology. Two beautifully illustrated volumes on Australian Pythons and Ball Pythons were written by David G. Barker and Tracy M. Barker in the series *Pythons of the World* (1994, 2006). Barker et al. (2012) have been researching and correcting published lengths of giant pythons and other large constrictors. They also published information and species descriptions in *Grzimek's Animal Life Encyclopedia* (Hutchins et al. 2003). An excellent book, edited by Robert W. Henderson and Robert Powell and entitled *Biology of the Boas and Pythons,* should be in every herpetologist's library. Harvey Lillywhite has recently published a book that covers physiology of snakes, *How Snakes Work: Structure, Function and Behavior of the World's Snakes* (2014). This is an important reference book for zoo workers, especially helpful when preparing graphics focusing on the intricacies of physiological ecology. One unique feature of this book is the inclusion of Lillywhite's extensive field research.

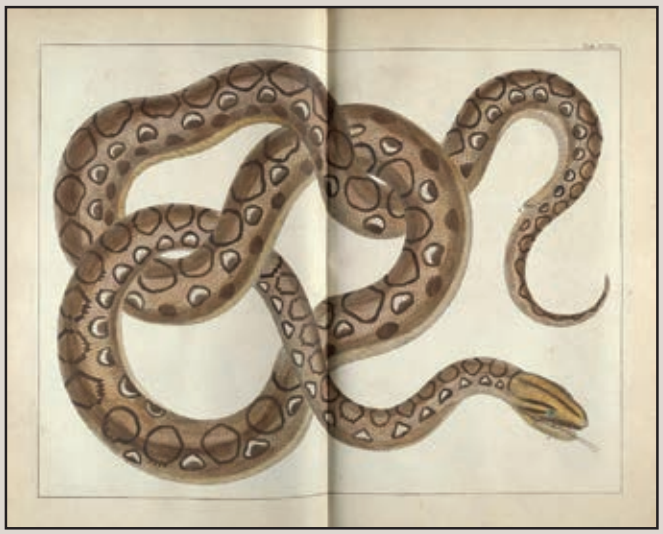
There are several important journals in Europe. Beginning in 1958, the journal *Akvárium terárium* (*Praha*), is now published monthly. This publication features articles on captive maintenance. Another journal, *Živa* (*Praha*), also focuses on papers dealing with herpetoculture. The Prague Zoo (Zoologicka Zahrada Praha) is located in the Czech Republic and supervisor Ivan Rehák has published many papers in both outlets, based on the collection of boas and pythons at the Zoo. Beginning in 1990 (Volume 2), the journal *Scientific Research in Zoological Parks, Moscow* has been an important venue for the staff at the Zoo, and they have published many papers on captive reptiles and amphibians, mostly based on observations of behavior and/or reproduction at that institution. These include studies on various Asian and Asian-Pacific pythons (Odinchenko 1992; Vassiliev and Balakina 2000).

There are papers on medical management: Susan Barnard from Zoo Atlanta and her associates have published a number of papers and books on parasitism and husbandry in boas and pythons (Barnard 1996, 2000; Barnard and Upton 1964–). Camin and associates (1948, 1953, 1964) documented the ravages caused by the snake mite (*Ophionyssus natricis*) in captive reptile collections and boid snakes seem to be particularly plagued by these parasites. Wright (1992) addressed dysecdysis in boid snakes with neurologic diseases. "Mouth rot" (Infectious or Ulcerative Stomatitis) seems to be a disease to which boid snakes are particularly prone. One of the most insidious diseases to infect boas and pythons is Inclusion Body Disease (IBD). It is beyond the scope of this paper to go into a lengthy discussion concerning clinical signs, laboratory diagnosis, route of transmission, and prognosis and treatment but two points must be stressed—snakes showing clinical signs of IBD should be euthanized and strict quarantine should be at least 4–6 months (Mas 2008) and 8 months is recommended by other authors. Consider the negative ramifications for the timely movement of snakes in the families Boidae and Pythonidae—between institutions involved in AZA Species Survival Plans—when quarantine times must be dramatically expanded. I asked pathologist Elliott Jacobson what a reasonable length of time would be to quarantine snakes. He said that as long as possible would be a good plan but cost and practicality should be considered. A 90-day period should be the absolute minimum. For additional information, consult Schumacher et al. (1994) and Chang and Jacobson (2010).

From Melbourne Zoo, Banks (1985) observed feeding and sloughing in a collection of captive snakes, including pythons. Using data from a number of zoos, Greene (1983) strengthened his analysis of the dietary correlates of the origin and radiation of boid snakes. Barton and Allen (1961) recorded feeding, shedding, and growth rates of captive boid snakes at the Highland Park Zoological Gardens in Pittsburgh, Pennsylvania.

Richard Ross created the Institute for Herpetological Research in Stanford, California. His organization worked closely with multiple zoos and published many papers on python and boa reproduction, such as his overview of captive pythons in the SSAR book *Reproductive Biology and Diseases of Captive Reptiles* in 1980. Three signature books were published (the last two with Gerald Marzec) by the Institute: *The Python Breeding Manual* in 1978, *The Bacterial Diseases of Reptiles: Their Epidemiology, Control, Diagnosis and Treatment* in 1984, and *The Reproductive Husbandry of Pythons and Boas* in 1990. The late Thomas Huff from the Reptile Breeding Foundation in Picton, Ontario (1979) was a long-term associate of the Institute and specialized in breeding programs for insular boas of the genus *Epicrates*. The only species now in *Epicrates* is the *cenchria*-complex—all other insular boas are now classified in *Chilabothrus*. He worked with *Chilabothrus*.

Retired Smithsonian National Zoological Park curator Dale Marcellini published two papers on the proper requirements to incorporate when building zoo herpetological collections (1981, 1994). In the first paper, called "Boring is Beautiful," he stressed the need to develop a species selection plan based on exhibit potential, hardiness, longevity, educational value, breeding



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FIG. 1. According to a study on attractiveness of snakes according to human perception, the Brazilian Rainbow Boa (*Epicrates cenchria*) was the winner. Illustration from Albertus Seba, 1734–1765, *Locupletissimi rerum naturalium thesauri.*

potential, availability, and program investment in other zoos. There seems to be another element driving the choices of taxa to be included in our collections which had never occurred to me but surfaced when I read an intriguing paper in 2008 by Jana Marešová and Daniel Frynta: "Noah's Ark is full of common species attractive to humans: The case of boid snakes in zoos." Their abstract reads: "As the fate of endangered species may largely depend on human decisions, we analyzed the effect of species attractiveness to humans on conservation efforts devoted to captive breeding. Our respondents were asked to rank photographs of 56 species of boas and pythons according to perceived attractiveness. Surprisingly, attractiveness, body size and, marginally, also taxonomic uniqueness of the species were the only significant predictors of the size of zoo population. On the other hand, variables putatively associated with species rarity (inclusion in the Red List or protection by international law, geographic range size, and commercial price) had no effect. The range size was, however, positively correlated with attractiveness. As the perceived attractiveness affects at least some components of the conservation effort, it should not be further neglected but should be routinely included into conservation reasoning." The common Brazilian Rainbow Boa was champion of attractiveness (Fig. 1) whereas the poor graceless endangered Puerto Rican Boa was nearly at the bottom.

Here, I must assure the reader that I do not spend waking hours sniffing snake cloacal glands but when one works with a large living collection, the opportunity to be sprayed with musk is ever-present. It is well known that many natricines exude unpleasant musk. Even more pungent is that from some of the larger insular *Chilabothrus*: Jamaican Boa (*C. subflavus*), Cuban Boa (*C. angulifer),* Haitian Boa (*C. s. striatus*), and Bimini Boa (*C. s. fosteri).* In my view, the clear winner is the Oaxacan Dwarf Boa (*Exiliboa placata*)—this diminutive snake expresses the most foul-smelling and nauseating musk imaginable. It was so penetrating that the odor lasted for days on my clothes and remained on my hands, even after repeated hand-washings. I asked Jon Campbell, who had collected the snakes (see Campbell and Camarillo 1992) why the smell was so disgusting and amount so copious. He felt it was an anti-predator mechanism because of the plentiful predators (e.g., weasels [*Mustela frenata tropicalis*?] and various species of opossum [e.g., *Philander* and *Didelphis*]). Weldon and Thomas (1995) and Wood et al. (1995) published a comparative analysis of proteins in the scent gland secretions of snakes, using boas and pythons from many zoos.

History

Liliane Bodson (2003) wrote a fascinating account of the capture of an African Rock Python in the third century B.C. for King Ptolemy II Philadelphus's (reign 282–246 B.C.) collection of exotic or rare animals; this snake was carried from the capture site in a large woven basket constructed of rush and presented to the king in Alexandria. The snake was caught in the present day location covered by most of Sudan and the northern part of modern Ethiopia—"Consequently, when it retreated to its accustomed lair, they closed in upon it, but only so far as not to arouse it still more. And when it came near the opening which had been stopped up, the whole throng, acting together, raised a mighty din with their arms and thus increased its confusion and fear because of the crowds which put in their appearance and of the trumpets. But the beast could not find the opening and so, terrified at the advance of the hunters, fled for refuge into the mouth of the net which had been prepared near by." The actual size of the snake was said to be 13 m which is unlikely but it must have been large. What is amazing is that it was transported overland and by boat, a distance of roughly 2000 km in a straight line if the starting point was modern Khartoum. Herpetologists know that snake sizes are often exaggerated but if the snake was between 19–21 feet (5.7–6.4 m) (or more) in total length, it could weigh a hefty two hundred pounds or more—also remarkable is that it survived the journey, arrived at the zoo in decent shape, eventually fed and became habituated to captivity. A snake that size would not need to be fed during the trip but dehydration would have been a major concern.

Centuries later, Georg Seger (= Segerus in Latin) in Germany (1629–1678) published the first observations on captive snakes (see Daszkiewicz 2001 for his biography). He recorded shedding and egg-laying in "Aesculapian snakes" but it is unclear whether the species described was the ratsnake (*Elaphe longissima*) or the grass snake (*Natrix natrix*). He removed their tongues initially as this organ was thought to inflict mortal wounds, but this procedure did not contribute to a long life in captivity so the practice was discontinued. Seger helped one of his snakes during egg-laying and attributed her success in laying thirteen eggs to his help. In another case, he helped his snake during shedding by holding its skin.

"The reptile house [London Zoo] also catered to a public appetite for menagerie theatre, and the Friday evening feeding sessions when the snakes were fed with live prey were reported to be spectacular events. It was the ability of the boids to kill their victims through processes of constriction, asphyxiation, and deglutition that particularly riveted audiences, igniting a debate that smoldered in the national press from the late 1860s to the turn of the century concerning the extent to which such sights were appropriate for children, and whether the feeding of live animals was in keeping with natural law or just a morbid, sadistic entertainment" (Smith 2005). The feeding of live food to snakes was an issue so inflammatory in London over a century ago that it was discussed in Parliament. A few dramatic quotes from Blunt (1976) should put the controversy in proper perspective: ". . . that a rabbit should be shut up in a cage with

a snake without any chance of his life, deprived of the means of escape allotted to him by nature, and subject to the exquisite torture of terror prolonged by factitious circumstances and enhanced by despair" or ". . . trembling rabbits devoured by a serpent?—a monster reptile maintained and thus feasted for the pleasure of the English—for their children . . ."

In 1882, Catherine G. Hopley published an interesting book called *Snakes: Curiosities and Wonders of Serpent Life*. In Chapter XII called "Ophidian Acrobats: Construction and Constriction," she wrote ". . . So did some young boa constrictors, born alive at the Gardens, June 30th 1877. They were from fifteen to twenty inches in length, and had teeth sufficiently developed to draw blood from Holland's hand, showing fight and ingratitude at the same time. They were exceedingly active, and fed on young mice, which they constricted instinctively. One of them, known as 'Totsey,' subsequently *hung* for her portrait on page 201." Holland was the reptile keeper at London Zoo. The portrait, a line drawing, depicts Totsey coming down from an overhead branch to constrict one of three live sparrows on the floor. In Chapter XXIV, "Do Snakes Incubate Their Eggs?," Hopley provides data and information on the snakes at the London Zoo: getting over 100 eggs ('more than a bushel') from a python in 1862, breeding five 'seven-banded snakes' (*Tropidonotus leberis*) [now *Regina septemvittata*] in August 1872, breeding seven *Coluber* [= *Natrix*] *natrix*) in June 1873, 14 (of which 10 survived) yellow Jamaican boas (*Chilobothrus inornatus*) which crawled to the top of their cage in August 1873, and 20 young from a Panamanian boa constrictor in July 1877, ". . . which displayed ability to take care of themselves forthwith by leaving the marks of their teeth on Holland's fingers."

Watching large constrictors feed is always an exciting time for zoo patrons. In early days, feeding captives, especially large constrictors, was dramatic, indicated by four early accounts. Reverend Gregory Bateman in *The Vivarium* (1897): "No animals, in their manner of taking food, are more capricious than Snakes. Sometimes their desire to feed is so great, that they will eat a meal out of all proportion to their size; and, sometimes, without any apparent cause, they will refuse food, even the most suitable, until they die of starvation. As a rule, these creatures cannot be persuaded to seize any prey but that which is natural to them. For example, a Snake which lives upon frogs will not on any account, as a general thing, take lizards, though the latter might be just as nourishing to the Ophidian as the former, and possibly even more so, nor will a lizard-eating Snake be tempted to swallow a newt."

"Even if Snakes did never refuse their natural food, the supplying of it is not always convenient, nor is it, to most people, pleasant. Young mice and rats, frogs and lizards are not continually at hand, and it is not, by any means, an attractive sight to see a Snake, at evident discomfort to itself, swallowing a live animal or one recently constricted or poisoned." In support of the practice of assisting snakes to feed artificially, Bateman continues . . . "I believe many keepers of reptiles in Zoological Gardens adopt, to a greater or lesser extent, the artificial system of feeding their charges. The largest Snake in the Reptile House, Regent's Park, London, and which is also perhaps the largest Snake in captivity anywhere, has been fed by hand for the last three years at least, and is in splendid condition, weighing probably something like 18 st. This Snake, the Reticulated Python (*Python reticulatus*), receives its food regularly once a week . . . There are several methods of administering food to Snakes. For example 1) some Snakes will swallow a dead animal, or even a piece of meat, when it has been simply placed between their jaws. 2) The Snake's mouth is forcibly opened, and a dead small animal, dipped in milk, is pushed down the throat, and then worked down the gullet by the manipulation of the fingers outside the Snake's body. 3) Pieces of meat, or portions of animals, dipped in milk, are pushed sufficiently far down the opened mouth of a Snake by means of a smooth stick. 4) A tube is filled with suitable food, and passed down the gullet of the reptile, and then the contents of the tube are discharged by means of a piece of cane used as a ramrod." In London at this time, boas and pythons were being sold: Diamond Pythons—between 10 shillings and £3.00 (75 cents to $4.50); African Pythons approximately 4 feet long—25 shillings ($1.88) to £3.00 ($4.50); Ball Pythons—same price as other "pythons;" Anacondas—£30.00 ($45.00).



FIG. 2. A well-dressed Raymond L. Ditmars (right) thrusting a rabbit into the gullet of a Reticulated Python at Bronx Zoo (New York Zoological Park) on 9 April 1913. Some zoos at this time force-fed large constrictors for visitors and in some cases, patrons could pay a fee to hold the snake during feeding. Courtesy of Wildlife Conservation Society headquartered at Bronx Zoo, provided by John Behler.

There is a famous story about Raymond L. Ditmars and his keepers (Fig. 2) by A. W. Rolker in the book *The Story of the Snake* (1956): "A most famous instance of snake feeding happened a year ago in the New York Zoölogical Park when Czarina, a twenty-foot regal python, one of the largest specimens in captivity and known all over among naturalists, was fed against her will . . . For more than six weeks Czarina had not touched food, when Curator R. L. Ditmars, in charge of the reptile house, decided to capture the monster, to take her out of her cage, to stretch her to full length, and to force food down her throat . . . Every keeper in every department of the Park was notified to report to the reptile house that evening, and the snake meal was prepared. Thirty pounds of rabbits were killed, bound together with twine, and fastened to a bamboo pole ten feet long . . . That evening when the visitors had gone the fight began—twelve men against the snake . . .Through a slot in the big door at the back of the cage the Curator peered to locate the snake. Then he threw open the door . . . Then the Curator, only a burlap bag in hand and trusting the eleven to follow, threw himself toward the monster and in an instant the bag was over her head. Blinded and with the hands of a man clutching her throat, like a giant spring hurled herself loose among the struggling men who had piled into the cage and were trying to clutch the wonderful coils. Through the cloud of dust within appeared glimpses of the fighting keepers and flashes of the lashing body, while the scuffle of feet and cries of the men sounded over all. The Curator, still clutching the throat of his

great adversary, staggered about, whipped back and forth like a jackstraw. Grabbing, groping, hugging, and tugging, the others were tossed like chaff here and there only to fall back to their work which now had grown a matter of life and death, for to release the snake and permit all hands to escape in safety would now have been impossible. Through the dust were seen five or six men lying side by side on their bellies trying to pin the snake to earth, but the next instant they were up in the air, tossed by the dreadful spring of those giant coils . . . But even Czarina's tremendous strength was unable to withstand indefinitely the assault of the small army of hardened and trained animal men . . . At the end of another five minutes they had pinned down the snake . . . Mr. Ditmars, still clutching the wicked head, was the first to stagger out of the cage. One by one the others followed, each lugging a share of the snake. The python was stretched full length on the floor of the house. The custody of the head was turned over to an assistant, and the Curator prepared to administer the food. The great jaws were forced apart, and the bamboo pole with its bologna of rabbits was shoved into the mouth and down the endless throat. . . . Still, as if lifeless, she remained, while down, down went the food, until, when nearly the entire pole was buried within the reptile, the rabbits were wriggled loose, and the great snake had been forced to feed."

Curator Edward Boulenger from London Zoo offered this explanation of the challenges of inducing a Reticulated Python to feed in 1914: "It is a savage snake, and usually untamable, but does exceedingly well in captivity; although somewhat capricious in the choice of its food, most specimens feed with some regularity. As an example of its capricious appetite, I would relate the curious story told of a specimen which lived some years ago in the Menagerie of the Jardin des Plantes. The snake in question, a very large one, had been starving for some months, although it had been offered kids, rabbits, guinea pigs, and various fowls, when a goose, which formed part of the collection and which had injured its leg, was put into the cage. The snake at once seized hold of it, and thus made its first meal since its arrival in Paris. It was naturally thought that, having lost its sulkiness, it would henceforth go on feeding. Not so, however; the ordinary bill of fare of captive Pythons was persistently refused, until, as an experiment, a goose was again offered and immediately accepted. So it went on, the snake taking geese, but refusing all other food, such as served for the maintenance of other specimens of the same species."

At the same zoo, Walter Berridge told an interesting story twelve years later: "On one occasion an individual [python] at the London Zoological Gardens dislocated its jaws as the result of swallowing a kid [goat], and this mishap necessitated the attendance of a veterinary surgeon who was called in to operate upon the patient. The snake was held securely by a number of keepers while the surgeon placed the bones into their proper position, after which the greater part of the reptile's head was enveloped in a thick coating of plaster-of-paris, and bound up with a long strip of lint. This treatment eventually proved successful, although the operation had to be repeated a second time, for on the first occasion the snake managed to rub off the dressings that had been applied."

William Lamar sent this email note to me on 1 January 2014, "In the mid-80s Burmese-Retic hybrids made the scene. A clutch was reported on by Matz (in a French journal, with color illustration) and still others (from the wild?) were offered by Louis Porras at The Shed (reptile dealer). Interestingly, the two groups illustrated classic characteristics of hybrids in that phenotypically offspring will generally lean towards one or the other parent. Those reported by Matz were built like retics, with bulging orange eyes, while the ones Porras and others offered were structured like Burms, with an odd olive dorsal color. They were dubbed 'Bornean bat-eating Pythons.' I saw 'boacondas' in 1984 at Blue Ribbon Pet Farm. They were instantly recognizable as anaconda-boa constrictor hybrids. *Epicrates cenchria* and *E. maurus* regularly hybridize in zones of contact in Colombia and Venezuela, and *Corallus caninus* crossed with *C. hortulanus* while both were living in a tree growing in Joep Moonen's patio in Suriname. I have color photos of the *Epicrates* hybrids and of progeny from the Moonen breeding. Fascinating."

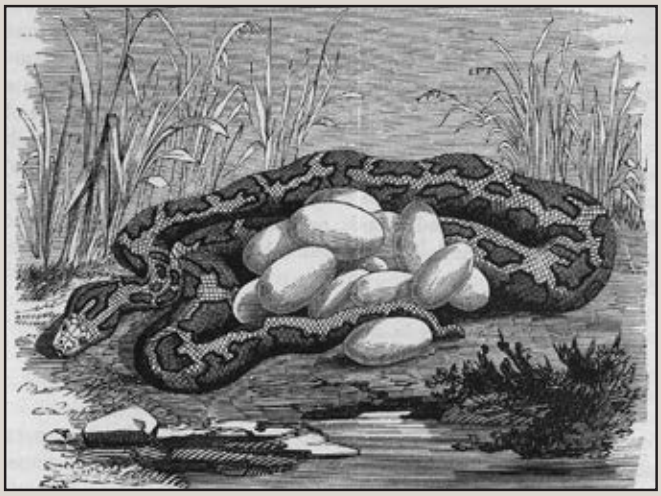
There have been three long-term zoo management programs that deserve recognition. Some of the most unusual boas and pythons ever exhibited in a reptile building were displayed in the collection of Houston Zoo, starting around 1965: all three Madagascan boas (*Sanzinia, Acrantophis*), Angolan Dwarf Python (*Python anchietae*), Calabar Python (*Calabaria reinhardtii*), White-lipped Python (*Leiopython albertisii*), Black-headed Python (*Aspidites melanocephalus*), Bismarck Ringed Python (*Bothrochilus boa*), Panamanian Dwarf Boa (*Ungaliophis panamensis*), all of the Pacific boas (*Candoia*), Argentinian Boa (*Boa constrictor occidentalis*), Boelen's Python (*Morelia boeleni*), and many insular Caribbean forms (*Tropidophis, Chilabothrus*) .

Beginning in 1976, Trooper Walsh from Smithsonian National Zoological Park produced nearly 800 neonates of three species: Brazilian Rainbow Boa (*Epicrates cenchria*), Emerald Tree Boa (*Corallus canina*), and Green Tree Python (*Chondropython viridis*) into the third generation (Walsh 1994). Peter Tolson of Toledo Zoo has the most impressive program ever developed for Neotropical boids of the genus *Epicrates* (Chandler and Tolson 1990; Tolson, 1980, 1982, 1987, 1989, 1991, 1992, 1994, 1996; Tolson and Garcia 1997; Tolson and Henderson 2006, 2011; Tolson and Teubner, 1987; Tolson et al. 1983, 2007). His focus on conservation of this snake assemblage includes captive-breeding, reintroduction, and field studies.

Annually, the Association of Zoos & Aquariums (AZA) offers the prestigious Edward H. Bean Award to recognize a truly significant captive propagation effort that clearly enhances the conservation of the species. Bean was the first director of the Brookfield Zoo (Chicago Zoological Society). Since I lived in Chicago, I met him as a child to ask for advice about being a zoo herpetologist and he kindly and patiently answered all of my questions—he enthusiastically supported my dream. He was proud of the Zoo and we spent a lovely afternoon together as he showed me the majestic fountain named after the 26th president of the United States, Theodore Roosevelt, Baboon Island, Bear Grottos, Bird Exhibits, and the Reptile House. As we left the last building during our walkabout, his final message was—"Go for it, young man!" Recipients for the Bean Award for boas and pythons have been Columbus Zoo for Jamaican Boa (1972), Institute for Herpetological Research for White-lipped Python (1976), Reptile Breeding Foundation for Insular Forms of *Epicrates* (1978), Dallas Zoo for Bismarck Ringed Python (1979), Houston Zoo for Angolan Python (1982), Knoxville Zoo for Papuan Python (1986), and Toledo Zoo for Boa Breeding Program (1987).

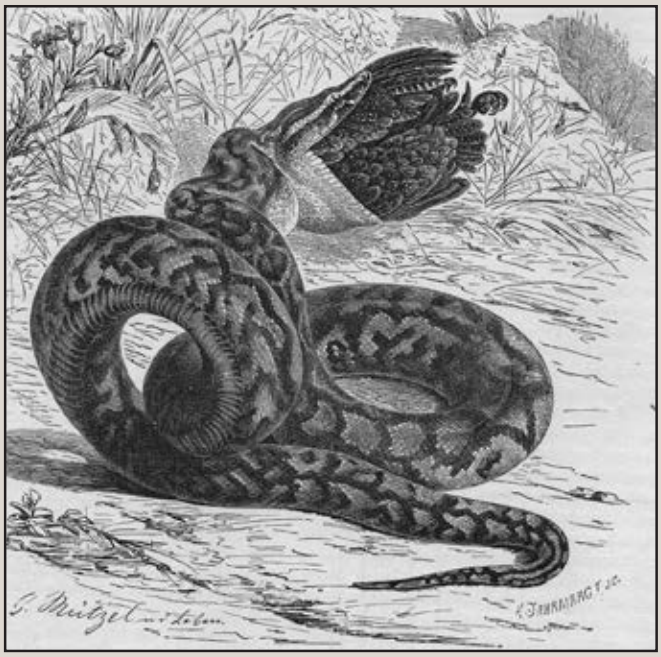
Pythons

As a rule, pythons do well in captivity so it is not surprising that many papers have been published on their biology, such as locomotory components of python feeding behavior (Murphy



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FIG. 3. Indian Python (*Python molurus*) incubating eggs at Menagerie Jardin des Plantes. In the nineteenth century, controversy raged as to whether female brooding pythons elevated temperatures of the clutch by shivering. Illustration reproduced from S. G. Goodrich's *Johnson's Natural History* in 1870.



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FIG. 4. "*Python sebae* is a form often met with in zoological gardens, where it is known as the fetich-snake." Quote and illustration from *The Riverside Natural History. Volume III. Lower Vertebrates* in 1888. "We read that in some parts of Africa the natives erect fetish houses or temples in which the pythons are free to roam unmolested. The reptiles are regarded with veneration, and should any of them stray from the sanctuary their guardians, with much bowing and many prostrations to the ground, do their best to induce them to return." (Berridge, W. S. 1935. *All about Reptiles (including Frogs and Toads).*



PHOTO COURTESY OF PETER TOLSON, TOLEDO ZOO

FIG. 5. Photo of a jaunty Roger Conant (right) and zoo keepers outside the old "Proboscidia" Building ca. 1932. Prior to the opening of that beautiful reptile building at Toledo Zoo, the reptile collection was housed in a series of terraria in the visitor viewing area that was called Antler Hall because of all the trophy heads displayed within. The snake is obviously a python—African Rock Python (*Python sebae*) perhaps?

and Campbell 1987). One question asked during the nineteenth century was did pythons attend and brood egg clutches? This controversy raged for many years. Pierre Bernard mentioned that a female python laid 15 eggs, eight of which hatched in Le Jardin des Plantes in Paris (Bernard, 1842–1843, Fig. 3). According to Edward Turner Bennett (1829), in 1828, a python laid and attended 15 eggs in the Tower Menagerie in London which did not successfully hatch. Bennett described the event, " The individual figured at the head of the present article is a female; a fact which was proved by the remarkable circumstance of her producing in May last, after having been more than two years in the Menagerie, a cluster of eggs, fourteen or fifteen in number, none of which, however, were hatched, although the mother evinced the greatest anxiety for their preservation, coiling herself around them in the form of a cone, of which her head formed the summit, and guarding them from external injury with truly maternal solicitude." This account is one of the first to describe brooding in pythons. Forbes (1881) observed incubation of the Indian python at London Zoo and addressed the issue of increasing temperatures during brooding. Hutchison et al. (1966) convincingly documented thermoregulation in a brooding female Indian python at New York Zoological Park. Three papers by Van Mierop and Barnard (1976, 1978) described reproduction and thermoregulation in the Burmese Python. Murphy (2007) and Petzold (see Heichler and Murphy 2008) presented an historical portrait of experiments to determine whether female pythons produce heat when brooding egg clutches.

There are several papers regarding captive management, reproduction, and brooding behavior in African Rock Pythons (*Python sebae*) (Figs. 4, 5) and other smaller species from the region. Sclater (1862) recorded notes on egg incubation in London Zoo. London Zoo Curator Joan Procter raised several snakes to sexual maturity, about 5 years and 10 months (Flower 1937). Frederick William FitzSimons, Director of the Port Elizabeth Museum and Snake Park in South Africa, published a book *Pythons and Their Ways* (1930) that described reproduction (clutch sizes, egg measurements and weights, incubation durations, and neonatal care, based on data from eleven clutches), brooding behavior, and maintenance in African Rock Pythons. Benedict (1932) studied reproductive biology and maternal brooding behavior by comparing environmental and skin temperatures of a female at Smithsonian National Zoological Park. Meyer-Holzapfel (1969) discussed brooding

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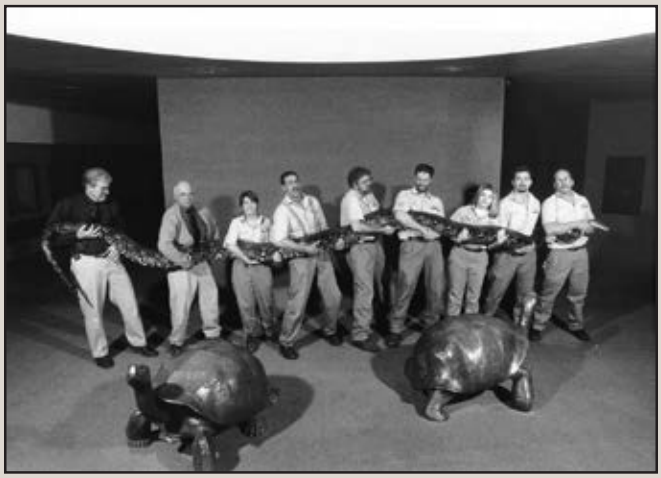
FIG. 6. Head Keeper J. Tyrell with handful of snake ca. 1890 at London Zoo. Many of the larger boas and pythons were kept in zoo collections during this period as these snakes were relatively hardy captives and dramatic exhibits.

behavior at Berne Zoo. Whitworth (1974) followed growth of an African python (and an Indian python) at Cannon Aquarium and Vivarium, Manchester Museum, UK. Branch and Erasmus (1984) described an interspecific hybrid between *P. sebae natalensis* and *P. molurus bivittatus*. Incubation times for *P. sebae* have been reported from 71–77 days at Melbourne Zoo (Dunn 1979), 81–88 days at Transvaal Snake Park (Patterson 1974), and 75–109 days at 30–32.8°C (Ross 1990). Branch and Patterson (1975) described embryonic development in the African Rock Python.

My friend, the late Jack Joy, was General Curator at Dallas Zoo. He had a large collection at home, including an African Rock Python about 13 feet (3.9 m) long. One day while offering a large dead rat with a too short pair of tongs, the snake struck, missed the rodent, latched on to his arm, threw coils around his neck and upper body, and nearly killed him until his terrified wife, screaming all the time, helped untangle him. He admitted that he had been careless and never should have worked with the snake alone; his wife insisted that either he or his snake leave the house immediately but when he hesitated and asked for time to consider the options, she was most displeased —Jack donated the snake shortly thereafter to Dallas Zoo in the interest of marital peace.

Patterson (1974) hatched the African Rock Python and Angolan Python (1978). Branch and Griffin (1996) outlined zoo breeding programs for Angolan Pythons (*Python anchietae*) in the United States and Transvaal Snake Park, South Africa. Ball Pythons (*Python regius*) are also popular zoo exhibits and an extraordinary number of color morphs are being produced in the private sector (see Murphy and McCloud 2010, Barker and Barker 2006). Martin de Camilo et al. (1999) described comparative follicular dynamics between the Ball Python (*Python regius*) and the Brazilian rainbow boa. Reproductive data were provided to Charles R. S. Pitman for his book *A Guide to the Snakes of Uganda* by the Detroit and Houston Zoos in 1974 (see also Logan 1973). Sonibare et al. (2010) provided a case history of eperythrozoonosis (infection with organisms of the genus *Eperythrozoon*, found on erythrocytes and in blood plasmas) in the zoological garden in Ibadan, Nigeria. Richard Ross (pers. comm.) saw brooding female Ball Pythons leave their clutches, crawl into the water bowl, soak for several minutes, and return to coil around the egg mass with moistened bodies. Conant (1993) wrote that a male Ball Python was acquired at Philadelphia Zoo on 26 April 1945 and died on 7 October 1992—reaching the approximate age of forty-seven and one-half years. Jeff Ettling from St. Louis Zoo sent this note—"We do indeed still have the old ball python. It is a female and was accessioned into the collection on 16 February 1958, which makes her 55 yrs, 11 m, 3 d old." This snake is still alive on 20 January 2014.

Indian and Burmese pythons (*Python molurus* and *P. bivittatus*) have been exhibited for many years in zoos (Fig. 6). In the Tower of London, Anacondas, called *Python Tigris* Var. by Bennett, were almost certainly Ceylonese Pythons, *Python molurus pimbura*. One keeper learned the hard way that captive snakes may have impressive feeding responses when one of his pythons grabbed his hand and threw two coils around his neck during feeding. According to Bennett, "His own exertions, however, aided by those of the under keepers, at length disengaged him from his perilous situation; but so determined was the attack of the snake that it could not be compelled to relinquish its hold until two of its teeth had been broken off and left in the thumb." Visser (2003) said that Burmese Pythons (and Boa Constrictors), listed as "creeping animals," were in Rotterdam Zoo collection record in 1858. Lederer (1956) reported upon the reproductive biology and development of the Indian and Burmese Python at Frankfurt Zoo. Golding (1965) followed growth rate of a captive Indian Python at the University of Ibadan Zoo, Nigeria. At Ueno Zoo in Japan, Takahashi (1967) propagated the Indian Python as did Joshi et al. (2001) at Kota Zoo, Rajastan, India. Müller (1970) and Engelmann (1986) documented breeding behavior of the Burmese Python at the Leipzig Zoo. Acharjyo and R. Misra (1976) studied reproduction and growth of the Indian Python at the Nandankanan Biological Park, Orissa, India, followed by another study (Acharjyo and Misra 1980) describing growth rate and age at first egg-laying. Vyas (1996) recorded breeding of the Indian Python at Sayaji Baug Zoo, Vadodara, India. Sekar and Jagnnadha-Rao (1995) outlined management of this taxon at Arignar Anna Sekar Zoological Park, Vandalur, India. Townson (1980) observed reproduction of Indian and Burmese pythons, with interbreeding of the two subspecies. *Python molurus* has been bred to the 3rd generation in Tokyo's Ueno Zoo (Sugiura 1977). At Prague Zoo Rehák (1993, 1994) outlined captive care and breeding of the Ceylon Python (*Python molurus* "*pimbura*") and Indian Pythons. Baskar et al. (1999) examined incubation, feeding and growth of Indian pythons at Arignar Anna Zoological Park, Madras,



COURTESY OF WILDLIFE CONSERVATION SOCIETY HEADQUARTERED AT BRONX ZOO, PROVIDED BY JOHN BEHLER

FIG. 7. An enormous Reticulated Python named "Samantha" was rescued from hide hunters in 1993, was 21 feet (6.4 m) and 175 pounds (79.3 kg) when captured. She grew to over 26 feet (7.9 m) and 275 pounds (124.7 kg) at the Wildlife Conservation Society (Bronx Zoo) until her death in November 2002. Late curator John Behler is on the tail end and his assistant Bill Holmstrom holds the head. This Zoo has offered a reward of US $50,000 for many decades for a snake measuring at least 30 feet (9.1 m) in total length; this reward has never been claimed.

India. Radhakrishnan et al. (2009) listed two species (Sand Boa [*Eryx conicus*] and Indian Python) screened for endoparasitism in captive wildcaught snakes indigenous to Kerala, India. At Smithsonian National Zoological Park, Walsh and Murphy (2003) reported on husbandry, breeding and behavior of Indian Pythons which included neonates with aberrant color patterns. This may have been caused by variable egg incubation temperatures. A captive group of Indian Pythons (4 males,1 female) formed a linear social hierarchy, reinforced by male combat, and bred the female according to their rank (Barker et al. 1979). Fourteen Indian Pythons reared in the Chengdu Zoo in China were trained by gentle human touching and washing snakes with warm water or touching with a warm wet towel. The snakes gradually became tamer and more approachable (Mao et al. 2009). After feeding in the Indian Python at the Smithsonian National Zoological Park, Marcellini and Peters (1982) reported endogenous heat production. Robinson et al. (1978) used radiation therapy for treatment of an intraoral malignant lymphoma in an Indian Rock Python at San Diego Zoo. Barten (1985) described oviductal rupture in a Burmese Python (*Python molurus bivittatus*) treated with oxytocin for egg retention. Groot et al. (2003) presented molecular genetic evidence for parthenogenesis in the Burmese Python at Artis Zoo, Netherlands.

I was visiting some friends from another zoo who had a large tame Burmese Python that was allowed to crawl around the house. One evening, their young son, who reminded me of a miniature Winston Churchill, went into the bedroom to play with the snake. After a few minutes, we heard the words "Bad Snake, Bad Snake" emanating from the bedroom. When we went to check, the child was completely enveloped in coils and it took some time to free him; he survived without any permanent damage. Later, we learned that he had been playing with rabbits in the backyard.

At Dallas Zoo, I was holding a large Burmese Python behind the head while a keeper inserted a catheter tube in its mouth to administer drugs to treat a serious respiratory infection. The snake lunged forward—pulling me along—latched on to his hand, threw coils around both of us, and completely immobilized us. We were unable to extricate ourselves for nearly 30 minutes so we both had to slowly creep on the floor until reaching the snakebite alarm. When we were finally freed by other workers, the now-furious keeper refused to speak to me for several weeks and vividly described my incompetence as a snake wrangler to anyone who would listen, showing his mangled hand with an array of tooth marks as proof.

Lederer (1944) wrote an extensive paper on food supply, development, mating and brood care of the Reticulated Python (*Python reticulatus*) at Frankfurt Zoo. Honegger (1970) published his study on the reproductive biology. In the vivarium of the Château de Thoiry-en-Yvelines near Paris, Panouse and Pellier (1973) recorded oviposition and incubation of the eggs in this taxon. Araki et al. (1982) reproduced this python at the Takarazuka Zoological and Botanical Gardens in Japan and included photographs of the facility and reproductive events. Ovezmukhammedov et al. (1975) diagnosed parasites of the reticulated python from the Ashkhabad Zoo, Turkmenistan. Taiwo et al (2002) found ascaridosis in captive Reticulated Pythons. Baumgartner et al. (1987) diagnosed tubular adeno-cancer in the colon of a Reticulated Python. At Dallas Zoo, a large Reticulated Python was bitten on the tail by a Brown Recluse Spider (*Loxosceles reclusa*). In spite of medical care, the site became progressively more necrotic and the necrosis began expanding and moving anteriorly. The tail was eventually amputated.

An enormous Reticulated Python named "Samantha" was rescued from hide hunters in 1993, was 21 feet (6.4 m) and 175 pounds (79.3 kg) when captured. She grew to over 26 feet (7.9 m) and 275 pounds (124.7 kg) at the Wildlife Conservation Society (Bronx Zoo) until her death in November 2002. Her favorite food was pigs (Fig. 7). Kamuran Tepedelen from Bushmaster Reptiles, Inc. in Colorado located and sent the snake to the Zoo and what follows is his account of the saga of acquiring Samantha in the beginning. In 1993, curator John Behler was contacted by a hide dealer in Borneo, claiming that he had a live 30 foot (9.1 m) Reticulated Python that had been collected in the interior of Borneo. The Zoo had a standing offer for decades to issue a reward of $50,000 for any snake that long but the reward had never been claimed. John was skeptical but Tepedelen was in Indonesia at the time and offered to check the snake's length. The snake was being held in an empty railroad boxcar, along with another male about 16 feet in length; both were coiled together. Kamuran crawled into the dark interior with a bamboo stick and tried to prod the male to move away so he could get an accurate measurement but the smaller snake struck repeatedly at him. Finally, the male moved away and Tepedelen, with two helpers, descendants of the Dayak tribe, tried to entice the snake to crawl into a large burlap bag but it would only move a short distance into the sack and pull back out quickly. This went on for over an hour until he grabbed the snake behind the head and the others grabbed the snake's body. As can be imagined, the snake went ballistic, throwing coils around Tepedelen's body and knocking him to the floor. Samantha was finally stuffed into the bag but it had been uncertain as to whether snake or humans would prevail—the snake was unbelievably powerful. The measuring of the snake (about 22 feet [6.7 m] in length) and initial crate building was done in Borneo at the skin dealer's compound. Kamuran spent an entire day trying to get a phone call back to Behler to let him know the true size of the snake and its condition, before the final



FIG. 8. Illustration of Black-headed Python (*Aspidites melanocephalus*) from *Snakes of Australia* by Gerard Krefft (1869). These snakes regularly excavate burrows by forming the head and anterior trunk into a "J" configuration, moving sideways, and pulling the substrate trapped by the head-neck angle toward the posterior trunk.

deal was struck with the dealer at a much lower price. The hide dealer was disappointed and suggested that the snake be hung by its neck from a tree to stretch it another 8 feet but Kamuran demurred. The first step was to get CITES permits and other documents and this was done. The next was to build a shipping crate but Kamuran was not precise about measurements when dealing with the local carpenter. When the box arrived it was one foot wide and one foot high and twenty feet long (0.3 × 0.3 × 6.0 m). Another crate was quickly built (6 × 3 × 2 ft /1.5 × 1.0 × 0.6 m) and the snake packed for shipment to New York; snake and crate were so heavy, a forklift truck had to be used—the trip was uneventful and took eight days from start to finish—an amazingly short time! In his wonderful book *Tracks and Shadows* (2013; p. 143), Harry Greene from Cornell University describes the awe one feels when viewing this large snake: "About the same time as those Cornell connections were established I met an exceptionally large snake while visiting the Bronx Zoo with my herpetology class. Samantha was a reticulated python, wild caught as an adult and almost twenty-three feet long. She had an enormous head, perhaps for having in youth eaten larger prey than her captive fare of forty-pound piglets, and given inclination and opportunity she surely could have swallowed me. I looked through the glass cage front and imagined her back in Borneo, moving rectilinearly like an immense caterpillar over dank forest substrate. What would it be like in her world of chemical and tactile sensations, I wondered, with one's head so far from one's tail. And out in nature, how would her presence affect other creatures?" Greene's comment about the size of Samantha's head resonated with me as I have seen many captive boas and pythons with seemingly disproportionally small heads. We had a Reticulated Python that grew to nearly 20 feet (6.0 m) in length at Dallas Zoo sent to us by the late Wesley Dickinson in 1966; he shortly thereafter died from a King Cobra bite (see Murphy and Jacques 2006). He said that the snake was raised in captivity throughout virtually all of its life. In a photo in our paper (Murphy and Jacques 2006), the size of the snake's head is small. A group of wild-caught snakes ranging in length between 10–12 feet (3.0–3.6 m) was imported and I compared relative sizes of their heads with our larger snake—they were about equal. I suspect that captives are fed too much food and abnormal body growth outstrips normal skull development.

Thomas Headland and Harry Greene (2011) recorded these snakes preying on 10 species of Old World monkeys, and a Siamang (*Hylobates syndactylus*). There is a radiograph in their paper of two Lion-Tailed Macaque juveniles swallowed headfirst by a Reticulated Python. Anthropoid apes have not been recorded as prey (Greene, pers. comm.). In 1986 during employment with Smithsonian National Zoological Park, William Xanten went to the Sepilok Orangutan Rehabilitation facility in Sabah, Eastern Borneo, which for years maintained both orphaned and injured Orangutans (*Pongo pygameus*) for rehabilitation and eventual release. Two young orangs that appeared to be about two years of age had been kept in an outdoor, barred enclosure. A large snake approximately 12–15 ft (3.65–4.55 m) in total length was inside the cage with two distinct lumps about half way down the body. Because the bars were close together, the snake was unable to escape after dinner. Xanten asked the staff what they intended to do with the python. They shrugged their shoulders and said that the python was only doing what was natural for a snake. They would keep the python on exhibit in another area from which it could not escape (Xanten 2014, pers. comm.). The length of another Reticulated Python named Colossus at Pittsburgh Zoo was often exaggerated. The photo caption in Pope (1961) says that it was 28.5 feet long (8.7 m), 37.5 inches (0.9 m) in girth and has an estimated weight of more than 320 pounds (145 kg). Its true length was 6.35 m (20 ft 10 in) at necropsy (Barker et al. 2012).

In two papers from Dallas Zoo, Murphy et al. (1978, 1981) recorded the reproductive biology of nineteen species of boas and pythons, genera *Acrantophis, Aspidites, Candoia, Corallus, Epicrates, Liasis,* and *Python*. Three pythons were described in the 1978 paper: courtship in Boelen's Python (*Python boeleni*), and oviposition in Carpet Python (*Python spilotus*) and Timor Python (*Python timoriensis*). Wallach (1975) performed a partial gastrectomy in a Timor Python. From Trinidad Zoo, Boos (1979) listed breeding records of Australian pythons. Barker (1984) and Murphy et al. (1981) reproduced Black-headed Pythons (*Aspidites melanocephalus*) at Dallas Zoo (Fig. 8). Johnson et al. (1975) mentioned that a wild snake was removed from a termite mound in Australia—"Upon removal, the python was found 12.5 to 15 cm below the substrate surface packed in a tight, circular coil in what appeared to be a chamber excavated by the python." The snakes (2 males,1 female) mentioned in our 1981 paper regularly excavated the gravel substrate in their enclosures, usually near

an object: "Excavation was accomplished by forming the head and anterior trunk into a 'J' configuration, moving sideways, then pulling the gravel entrapped by the head-neck angle toward the posterior trunk. The female dug continuously from the time of copulation until oviposition." This female is shown wrapped around a clutch of eggs in Barker and Barker (1994). All of our snakes rested on the substrate but elevated their heads at least a foot (30.5 cm) in a vertical plane almost every morning to be nearer the heat lamp on top of the enclosure. Twin Black-headed Pythons hatched at Houston Zoo in 2005.

Ross (1973) described mating and hatching of Children's Python (*Liasis childreni*), Dunn (1979) bred the species at Melbourne Zoo, and reproduction was recorded at Dallas Zoo (Murphy et al. 1981). Ross and Larman (1977) reproduced two species, White-lipped or D'Albert's (*Liasis albertisii*) and Macklot's pythons (*Liasis macklotí*), at Institute for Herpetological Research in California. At Dallas Zoo, courtship behavior and reproduction was reported (Murphy et al. 1981). Banks (1985) reproduced the White-lipped Python at Melbourne Zoo. Porter et al. (2012) reported on natural history and captive management of the Rough-scaled Python (*Morelia carinata*). Ryabov (1999) bred the Stimson's Python (*Antaresia stimsoni orientalis*) at Tula Exotarium in Russia. Bels and Van den Sande (1986) described reproduced the Australian Carpet Python (*Morelia spilota*) at the Antwerp Zoo. Grow et al. (1988) reproduced the Amethystine Python (*Python amethystinus kinghorni*) and Tarbet (1983) the D'Albert's Python (= White-lipped Python) at Oklahoma City Zoo. Korzhov et al. (1995) bred the Indonesian Scrub Python (*Liasis a. amethistinus*) at Moscow Zoo and Boos (1972) described reproduction in captivity that included female body twitching around eggs. Peters (1975) observed body twitching at Taronga Zoo in Sydney. Bryant et al. (1997) used cryosurgery in a Diamond Python (*Morelia s. spilota*) with fibrosarcoma at Taronga Zoo.

Tryon and Whitehead (1988) reproduced the Papuan Olive Python, (*Liasis papuanus*) at Knoxville Zoo, and Odinchenko and Latyshev (2011) at Moscow Zoo. I know of two instances where Olive Pythons have killed and/or swallowed snakes larger than themselves. Alan Kardon from San Antonio Zoo sent the following note to me, "Shortly before my June 1976 arrival, an 11 foot Papuan Python constricted and killed an 18 foot Reticulated Python. They had been housed together in one of our large center exhibits. A large Burmese Python also resided in the same exhibit. The Papuan Python did not consume the retic. Staff pried off the Papuan and the deceased retic was skinned. It was on display for many years in our administrative office. It now resides with San Angelo State College." Richard Ross (pers. comm.) kept an eight-foot (2.4 m) *Apodora papuana* in a large enclosure with a slightly longer Carpet Python (*Morelia spilota*). The cage was subdivided so the two snakes were separated with a plywood barrier attached to the front, top, and bottom. There was a small gap (2 cm) at the back. The Olive Python wedged its head into that tiny space and literally bent the plywood barrier as it squeezed into the Carpet Python's space and consumed it. Its body was so distended, the interstitial skin was visible. The meal was completely digested. This snake bit and constricted Ross. The snake was so powerful and the bite so bloody and painful that he nearly fainted from the ordeal—it was the most serious accident of this nature he ever experienced.

Some years ago, I saw an excellent but sobering presentation at the AZA Snake Taxon Advisory Group (TAG) meeting in Baltimore about the natural history and captive management of the beautiful but poorly known Boelen's Python (*Morelia boeleni*) from New Guinea. This taxon has been extensively studied by Marc Spataro of The Boelen's Python Group <www.boelenspythons.com>. He has experience in the field with this snake; it inhabits forested montane regions of over 1000 m (3300 ft) elevation and the terrain is exceedingly difficult to traverse. What was particularly disconcerting were the photographs in his talk showing the extraordinary damage caused by strip mining at the world's largest gold mine and third largest copper mine, owned by the American mining company Freeport-McMoRan. The whole area looked like a moonscape. I asked Marc to predict the likely future for Boelen's Python if mining continued unabated—he was very pessimistic and I could not help but agree. Austin et al. (2010) studied conservation genetics and warned of reduced genetic diversity and divergence of captive and wild animals. Many zoos donated genetic material for this study. At Dallas Zoo, courtship and reproduction were observed (Murphy et al. 1978, 1981) but unfortunately no full-term neonates were produced. Flagle and Stoops (2007) discussed reasons why this species has been such an enormous challenge to create sustainable reproductive colonies in captivity. West et al. (2001) found meningoencephalitis associated with paramyxovirus infection in a Boelen's Python at San Antonio Zoo.

We had four Bismarck Ringed Pythons (*Bothrochilus boa*) at Dallas Zoo from Rabaul, Great Britain Island and unknown localities—intermittent courtship was seen. Eggs were laid and hatched and the young were spectacularly colored—vivid orange bands which began to disappear around three months and became olive brown three months later (Murphy et al. 1981). Clearly, my bias is showing here but had these pythons retained that dramatic juvenile coloration through adulthood, they would have likely supplanted the Brazilian Rainbow Boa as the most beautiful boa or python.

Several studies by Walsh and associates at Smithsonian National Zoological Park (Van Mierop et al. 1982; Walsh, 1977, 1980) documented behavior, husbandry and breeding of the Green Tree Python (*Chondropython viridis*). Brannian et al. (1980) from the Kansas City Zoological Gardens focused on mortality in captives. Mannion (1996) propagated the Green Tree Python at the Queensland Reptile and Fauna Park. Rundquist (1980) described twinning at Oklahoma City Zoo, likely the first description of this occurrence in pythons. At the same zoo, Blakeley and West (1977) saw no brooding behavior; eggs were scattered throughout the enclosure. At Dallas Zoo, Murphy et al. (1978) observed caudal luring in neonates. Perry-Richardson (1991) described male combat that resulted in death of one of the snakes. Fourteen hybrids between a Green Tree Python (dam) and Carpet Python (sire) hatched (one stillborn) at Baltimore Zoo during February 1997. One female now lives at Catoctin Zoo in Maryland (K. Kranz, D. Middaugh, pers. comm.). Total length is ca. 6 ft (1.8 m) and the snake is heavy-bodied like a wild Carpet Python but its head is shorter and wider like a Green Tree Python; ground color is light lime green with white-tipped scales and pattern remindful of a Carpet Python. Its nickname is "Carpondro."

At Dallas Zoo, Clay Garrett and Brian Smith (1994) wondered if yellow and brown hatchling Green Tree Python morphs would match their color—when given a choice of differently colored backgrounds—to blend in to avoid predation and be less noticeable to prey. For example, would a yellow neonate "know" that it would be more visible to a predator if it rested on a dark branch rather than on a light one and would the snake



Fig. 9. "Note on *Python curtus*" was published by G. A. Boulenger in Proceedings of The Zoological Society of London in 1889 (432–433). As of Jan. 24, 2014; source = ZIMS (ISIS), there are 37 Blood Pythons (*Python curtus*), 11 *P. breitensteini*) and no *P. kyaiktiyo* represented in zoo collections worldwide.



PHOTO BY JACK MUNTZER, COURTESY OF ROBERT ZAPPALORTI

Fig. 10. Carl F. Kauffeld and Boa Constrictor "Blondie," taken at Staten Island Zoo in October 1967. He was one of the most productive authors, as is evident by his chapter entitled "So you own a boa" in *Snakes: The Keeper and the Kept* in 1969.

"know" that the likely better choice would be the light one? One hatchling of either color phase was placed in a large trash can with a T-shaped perch made with painted dowel rods and wooden bases. The snakes were allowed to choose between black and white or yellow and brown halves of the T-perch. Only one perch was used per trial. In the beginning of the experiment, the snakes would crawl around the perimeter of the can for many hours until they found the perch in the center and assumed an ellipsoidal coil on the horizontal bar. Once the snakes were comfortably settled, their location (either light or dark side) was recorded. As the experiment progressed, the length of time to find the perch diminished until the end when the snakes located the perch in less than a minute. Later, when these snakes (both brown and yellow color phases) were given a choice between dark and light perches, most of the snakes more often chose the darker side as a resting site.

One aspect that is interesting to me and was not part of the original study was the snakes learned the location of the perch, rapidly ascended the vertical dowel, and quickly coiled on the horizontal bar by the end of the study. Most studies on learning behavior in snakes use food as a reward but in this case, no food was involved. Our snakes were certainly learning the location of the perch and presumably choosing it as a more secure resting place rather than simply coiling on the bottom of the can. The fact that they more often chose the darker side regardless of their color was unexpected as I had predicted that the snakes would match the background. One of my colleagues told me that he discovered a reddish juvenile Annulated Boa (*Corallus annulatus*) coiled on a large green leaf in plain view in a Costa Rican forest and the snake was virtually invisible because of the dappled sunlight streaming through the canopy. See Wilson (2006) and Wilson et al. (2007) for additional information.

Ettling (1991) elaborated on captive husbandry and reproduction of the Blood Python (*Python curtus*) and Hilf et al. (1989) investigated pharmacokinetics of Gentamicin and Piperacillin at St. Louis Zoo (Fig. 9). Noble (1935) described brooding behavior at New York Zoological Society. Rehák (1994) bred Blood Pythons (*Python curtus breitensteini*) at the Prague Zoo. At Dallas Zoo, we received two wild-caught adult snakes that refused to feed until we added a large pile of dried leaves to the enclosure for security. Hilf et al. (1990) did a comparative study of upper airway flora in healthy boid snakes and snakes with pneumonia at the Pittsburgh Zoo.

Boas and Anacondas

Representatives from the New World are often exhibited in zoos. Müller (1970) bred the Boa Constrictor (*Boa constrictor*) at Leipzig Zoo. Honegger (1970) published a paper on the



Fig. 11. Maria Sibylla Merian understood the importance of careful observations when she drew this Garden Tree Boa (*Corallus hortulana*) with a sizeable meal from *Metamorphosis insectorum surinamensium*… in 1705.

reproductive biology of the subspecies *B. c. imperator* which has been bred through the second generation at Zurich Zoo. Gensch (1969) reported on boa hybrids *Constrictor* (=*Boa*) *c. constrictor* × *C. c. imperator* at the Dresden Zoo. Meyer-Holzapfel (1955) described a cross between *Constrictor c. occidentalis* × *Constrictor c. constrictor* at Berne Zoo. Luttenberger (1964) recorded a *B. c. occidentalis* × *B. c. constrictor* cross at Tiergarten Schönbrunn. A Boa Constrictor (*Boa constrictor*) at Dallas Zoo showed color change over time between feedings (Hedges et al. 1989). After feeding, the ground color was dark and as the interval between feedings increased, the pinkish color became lighter and lighter. This was our signal that it was time to offer food. Moore and McLaughlin (1981) surveyed boid care and use in education programs in American zoos. Carl F. Kauffeld at the Staten Island Zoo was one of the most knowledgeable authors, as is evident by his chapter entitled "So you own a boa" in *Snakes: The Keeper and the Kept* in 1969 (Fig. 10). He addressed feeding and manipulation of odor as an aid in feeding captives, treatment of mouthrot, removal of abnormal eggs by sectioning, mites and ticks, cage sanitation, the effect of altitude, ultraviolet light, and humidity on captive reptiles, shedding, and the importance of environmental factors such as temperature. He stressed the need for security, maintaining them singly, and offering pre-killed food. Using Boa Constrictors and Gaboon Vipers from Zoo Atlanta to study movement, Marvi et al. (2013) found that snakes mimic earthworms by using rectilinear travelling waves.

Blody and Mehaffey (1989), Murphy et al. (1978), and Tryon (1975) documented the reproductive biology of the Annulated Boa (*Corallus annulatus*) at Fort Worth Zoo. At this zoo, courtship, parturition, and neonatal color change for Emerald Tree Boa (*Corallus canina*) were recorded by Murphy et al. (1978). Meyer-Holzapfel (1969) bred this species at Berne Zoo. Richard Ross (1990) described the condition of chronic regurgitation of food in this species as "Regurgitation Syndrome" and believed the malady to be cause by lack of humidity. Others have postulated that the condition is caused by cryptosporidiosis, parasitism, amebiasis, and bacterial or fungal gastroenteritis. Environmental factors have been identified: lack of security, handling after feeding, and temperature. Ross (pers. comm.) recently visited a serpentarium in Quito, Ecuador where he saw these snakes in the peak of health. He asked if the caretakers had ever dealt with this syndrome; the answer was negative. When he explored reasons for this, he discovered that heat tapes had been inserted in hollow branches and the snakes coiled directly over the tapes, even though a thermal gradient was available. Digestion was uneventful. Could this problem, known and discussed by virtually every breeder of these snakes for decades, be solved simply by providing heated branches to improve digestion? Pizzatto and Marques (2007) and Pizzatto et al. (2009) described the reproductive ecology of Brazilian boine snakes, including Garden Tree Boas (*Corallus hortulanus*; Fig 11). Robert W. Henderson and colleagues have written about the genus *Corallus* and West Indian taxa (Tolson and Henderson 1993; Stafford and Henderson 1996; Henderson 2002). Henderson et al. (2013) discussed the sharp declines of Grenada Tree Boas (*Corallus grenadensis*) possibly caused by illegal collecting, based on a study by herpetologists from Milwaukee County Zoological Garden, Buffalo Zoo, and Milwaukee Public Museum.

Thomas Huff from the Reptile Breeding Foundation in Canada published a number of papers on reproduction of insular boids of the genus *Epicrates*: Cuban Boa (1976), Puerto Rican Boa (1978), Jamaican Boa (1979), and an overview of the genus in 1980. Murphy and Guese (1977) observed reproduction in the Hispaniola Boa (*Epicrates f. fordii*) at Dallas Zoo. Murphy et al. (1978) observed reproduction in the Hispaniola Boa (*Epicrates g. gracilis*) at Ft. Worth Zoo and courtship and birth of the Cuban Boa (*E. angulifer*) at Dallas Zoo. Bloxam (1982) reported on the care of the Jamaican Boa in Jersey Wildlife Preservation Trust. Brazilian Rainbow Boas (*Epicrates c. cenchria*) reproduced at Smithsonian National Zoological Park (Walsh and Davis 1983; Walsh 1994). Kinney et al. (2012) described parthenogenesis. A snake from Wacará, Vaupés, Colombia gave birth to 18 live, two dead, and one infertile egg mass at Ft. Worth Zoo (Murphy et al. (1978). Holmstrom and Behler (1981) saw *E. cenchria* feed upon unfertilized egg masses and fetal membranes at Bronx Zoo. Jacobson (1993) sounded an alert concerning infectious diseases for captive propagation and introduction programs of threatened and endangered reptiles. Concern for the future of many insular species such as the Puerto Rican Boa (*Epicrates inornatus* now *Chilabothrus inornatus*) has been identified as a conservation priority by zoo workers (Joglar et al. 2007).

Boas from Madagascar are popular zoo exhibits and there have been a number of papers written about them (Branch and Erasmus 1977; Murphy et al. 1978, 1981; Branch 1981, Morgan 1985; Chai et al. 2004; Hydeskov et al. 2012). Madagascan boas

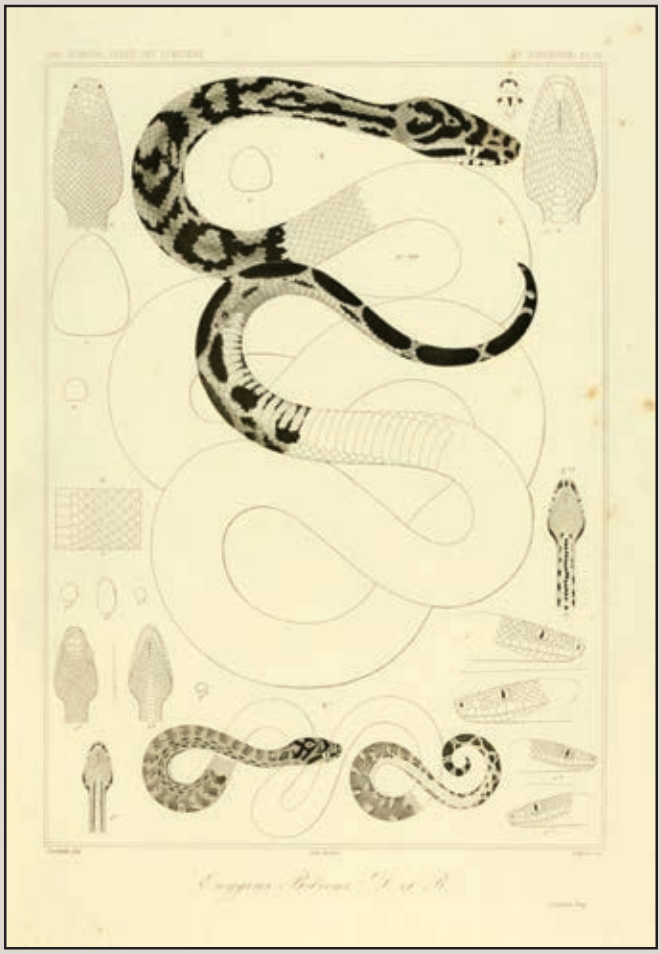


Fig. 12. The Pacific Boa (*Enygrus bibroni* now *Candoia bibroni*) is capable of dramatic daily color changes. Plate from *Iconographie Générale des Ophidiens* by Georges Jan and Ferdinando Sordelli in 1860–1866. This remarkable publication covered snakes of the world and the quality of the illustrations is beyond reproach.

(*Sanzinia madagascariensis*) used pelvic spurs to stab other males during combat at Dallas Zoo (Carpenter et al. 1978). At this zoo, we were interested in breeding them so we had two pair in the collection. Each time we paired them for breeding, the same outcome occurred. One male was accepted immediately by the female and breeding occurred, to the point where the male's hemipenes were ground off by all the frenzied sexual activity. When the other male was placed with the female, both snakes crawled as far away from each other as possible and never bred. Clearly, the snakes recognized each other but I am not sure if it was female choice, male choice, or both. What I do know is that neither snake was interested in breeding and the same result occurred during many trials. Groves and Mellendick (1973) bred this species at Baltimore Zoo as did McLain (1983) at Houston Zoo. A specimen lived for 19 years, 5 months, and 17 days at Philadelphia Zoo (Conant and Hudson 1949). Branch and Erasmus (1976) recorded reproduction in Madagascar Ground Boas (*Acrantophis*) and Tree Boas (*Sanzinia*). Huff (1984) outlined husbandry and propagation of the Madagascar Ground Boa with additional notes on other Malagasy boids at the Reptile Breeding Foundation. Reichling (1983) reproduced the Dumeril's Boa (*Acrantophis dumerili*) at Memphis Zoo. Murphy et al. (1981) saw male combat with biting, constriction on the subdominant snake's trunk, and vigorous spur vibration, followed by the dominant male copulating with the female. At Black Hills' Reptile Gardens in South Dakota, a three-foot (0.9 m) *Acrantophis dumerili* consumed an equal-sized Cuban Boa and another smaller *Acrantophis dumerili* killed and ate a young Boa Constrictor at Catoctin Zoo (Don Middaugh, pers. comm.).

Timmis (1969) observed Pacific boas (*Candoia* spp.) at Taronga Zoo in Australia. At Dallas Zoo, we had an adult Pacific Boa (*Candoia bibroni;* Fig. 12) from Western Samoa that demonstrated dramatic daily color change (Hedges et al. 1989). Each morning, the snake's ground color was blackish and no pattern was visible. As the day progressed, the snake's color lightened until the ground color was light and the pattern clearly defined. We also saw courtship with spur use from males from Kandavu, Fiji Islands. These males used spurs to position female vents for intromission and forced them by repeated jabbing to elevate tails to receive the hemipenes. I was amazed that males knew precisely where to probe female bodies for alignment of cloacae to achieve successful breeding (Murphy et al. 1978). A Pacific Boa (*C. carinata*) from Solomon Islands gave birth to 64 stillborn young (Murphy et al. 1978).

Lederer (1942) described reproduction and development in the Yellow Anaconda (*Eunectes notaeus*) at Frankfurt Zoo. Luttenberger (1984) reported on feeding, husbandry, and reproduction at Tiergarten Schönbrunn in Vienna. Belluomini and Veinert (1967) had breeding Anacondas (*Eunectes murinus*) at São Paulo Zoo and Deschanel (1978) at Lyons Zoo in France. Additional observations were published by Luttenberger (1973). At Dallas Zoo, a large adult living in a semi-aquatic exhibit would only accept freshly-killed geese placed in the water as food. If a goose was placed on land, it was refused. There has been a long-term study of Anacondas in the Zoo and in the wild by employees at the Wildlife Conservation Society (New York Zoological Park, also known as Bronx Zoo. Holmstrom (1981) propagated the Yellow Anaconda and Holmstrom and Behler (1981) recorded post-parturient behavior of the Common Anaconda. Calle et al. (1994, 2001 and Rivas et al. (2007) described studies done in the wild. Raphael et al. (1996) described a technique for implanting transmitters. McNamara et al (1994) found cryptococcosis. Frolov et al. (1986) reproduced the Paraguayan Anaconda in the Moscow Zoo, including second generation births (Kudryavtsev and Odinchenko, 1986). Dunn and Conant (1936) described the Dark-spotted Anaconda *(Eunectes deschauenseei)* and Barbour's Anaconda (*E. barbouri*), which has now been synonymized with *E. murinus*. Retired Detroit Zoo curator Jim Langhammer (pers. comm.) had a large female Barbour's Anaconda which he used for demonstrations while employed as a naturalist in Indiana. He told me that he would release "Annie" among the several hundred visitors and the snake would crawl slowly through the throng until her owner was located, then climb slowly up his trunk and rest its head on his shoulders. The behavior was demonstrated during warm weather at McCormick's Creek State Park and on the campus at Indiana University-Bloomington (IU). She was often called IU's most popular coed by the adoring crowds. She never bit a human even when under medical treatment. Hans-Günter Petzold from Tierpark Berlin wrote the definitive book on the genus in 1983—*Die Anakondas, Gattung* Eunectes—which covers systematics, morphology, natural history, reproduction, and representatives of the genus.

There are limited reports from zoos on some of the smaller boas and pythons, due in large part to their secretive nature which makes them unsuitable for display: Calabar Burrowing Python (*Calabaria*), Rubber Boas (*Charina*), Sand Boas (*Eryx*), Rosy

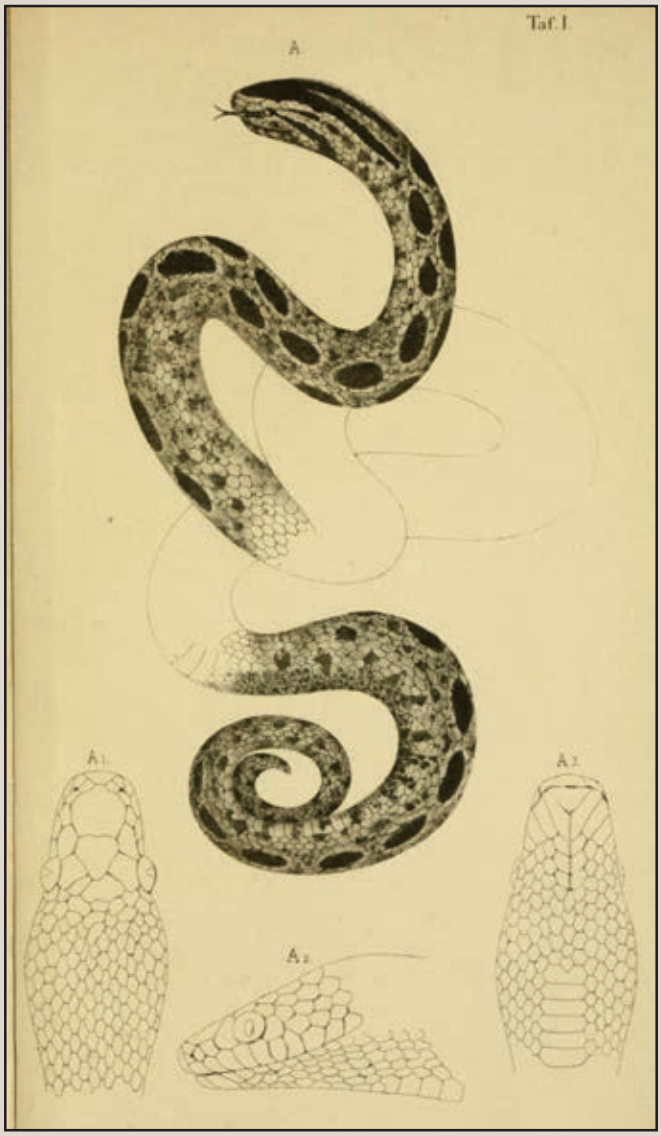


Fig. 13. Holotype of Isthmian Dwarf Boa (*Ungaliophis continentalis*) from Fritz Müller (1878), *Katalog der im Museum und Universitatskabinet zu Basel aufgestellten Amphibien und Reptilien nebst Anmerkungen*. Most living dwarf boas, such as Panamanian Dwarf Boas and Isthmian Dwarf Boas, are no longer represented in any zoo collection worldwide as of Jan. 24, 2014; source = ZIMS (ISIS).

Boas (*Lichanura*), and Mexican Burrowing Python (*Loxocemus*). Odinchenko and Latyshev (2011) kept the last species at Moscow Zoo.

Dwarf Boas

Here I restrict dwarf boas in this section to four New World genera (*Ungaliophis*, *Exiliboa*, *Tropidophis*, and *Trachyboa*). I have been fortunate to see living examples of all in zoo collections and to have worked with all but the last one at Dallas Zoo. In the mid-1970s, M. J. Corn (1974, pers. comm.) told me that he found six Panamanian Dwarf Boas (*Ungaliophis panamensis*) in an area in the Caribbean lowlands in Costa Rica which was being cleared, presumably for agriculture. Only three specimens were known prior to his discovery. These arboreal snakes, living in detritus in epiphytes, were dislodged from their living space and were found by Corn crawling on the ground. I have seen two snakes living at Houston Zoo and we had one in Dallas that adjusted well to captivity. Roger Conant (1966) pointed out that the Isthmian Dwarf Boa (*U. continentalis*) was known from two specimens (Fig. 13). Bogert (1968a) stated, "Since the small boa that became the holotype of *Ungaliophis continentalis* was discovered in Guatemala well over 90 years ago, only six additional snakes of the genus have been reported…These dwarf boas tolerate environments ranging from the lowland rain forest of southeastern Nicaragua to those of the pine woodland of eastern Chiapas, where Conant (1966) discovered one at an elevation of approximately 2100 meters." Imagine my surprise when Barry Armstrong and Jon Campbell brought back three snakes for the Dallas Zoo collection from Chiapas, Mexico—these proved to be hardy in captivity and fed with gusto on small mice and anoles. Both species (*U. panamensis, U. continentalis*) of these Dallas snakes are pictured in the SSAR *Catalogue* account by Villa and Wilson (1990). Burger and Ford (2007), based on the animals at Dallas Zoo, described courtship and reproduction in *U. continentalis*. After decades of field work, Campbell (pers. comm.) has since collected an additional dozen specimens.

I met my first Oaxacan Dwarf Boa (*Exiliboa placata*) at the Southwestern Research Station in Portal, Arizona in 1967. Charles (Chuck) Bogert returned from Mexico with a living one, collected at Valle Nacional at the base of the northern slopes of the Sierra de Juárez, and asked me to identify it. To add to the pressure, he said that if I were unable to do so, it would indicate that I could no longer call myself a competent herpetologist and all of the visiting herpetologists in the room would be aware of my incompetence; the word would be spread widely in the community. He placed the snake in my hand, whereupon it promptly exuded the aforementioned musk. Of course, I could not identify it so Chuck, being somewhat perverse and enjoying my discomfort, continued the ruse for what seemed like eternity until he finally confessed that it was not yet described. Every time we met thereafter, he would laugh heartily at that incident although I was less amused. In subsequent years, Barry Armstrong and Jon Campbell brought back a small number of these snakes to Dallas Zoo and these were an enormous challenge to maintain in captivity. Bogert's captive specimens fed on the frogs *Eleutherodactylus mexicanus* and *E. decoratus* (Bogert 1968b). We tried every food item available (salamanders, frogs, toads, lizards, neonatal mice, small snakes, insects) and all were ignored. Campbell even collected some topotypic frogs (*Craugastor*) and salamanders (*Pseudoeurycea*) to try to stimulate these snakes to feed—only one salamander was accepted. Two gave birth to the tiniest neonates imaginable—we did not even try to feed them but preserved them soon thereafter. William Lamar kept one (pers. comm.), "I kept it in a cage in the refrigeration chamber at UTA and got it to feed on *Acris*. The experiment terminated abruptly when there was a malfunction causing the refrigerator to go from 60° Fahrenheit to around 60° Centigrade."

Edwards (1969) covered care of some tropidophid snakes at Dallas Zoo. The male Cayman Island Boa (*Tropidophis caymanensis parkeri*) he mentioned was received on 1 Feb 1967 and died on 17 Mar 1994 (27 Y, 1 M, 16 D). Rehák (1987) observed color change and captive reproduction (1990) in the Cuban Dwarf Boa (*Tropidophis feicki*) at the Prague Zoo. He also recorded color change in several other *Tropidiphis* and published husbandry observations on the poorly known Ambergris Cay Dwarf Boa *T. greenwayi* (Rehák 1981). Groves (1969) bred the Cayman Island Dwarf Boa (*Tropidophis melanurus caymanensis*)

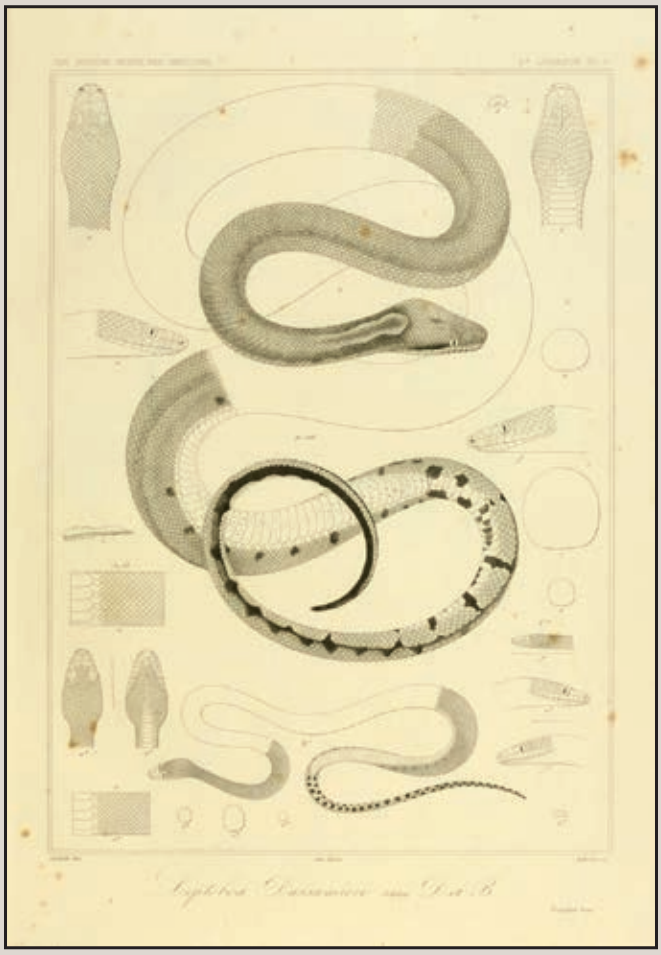


Fig. 14. Illustration of endangered Round Island Splitjaw Snake (*Casarea dussumieri*) from *Iconographie Générale des Ophidiens* by Jan and Sordelli in 1860–66. The only institution holding these snakes, numbering ten specimens, is Jersey Wildlife Preservation Trust as of Jan. 24, 2014; source = ZIMS (ISIS). The Round Island Burrowing Splitjaw Snake (*Bolyeria multocarinata*) is now extinct, due to human causes. Macklot's Python (*Liasis mackloti*) is also pictured.

at Baltimore Zoo. Tolson (1980) covered captive propagation of the Cuban Dwarf Boa (*Tropidophis melanurus*). This taxon was bred at Tierpark Berlin by H.-G. Petzold and adults and young are pictured in Heichler and Murphy (2008). He sent some adults to Dallas Zoo but these did not reproduce there. Petzold also mentioned death-feigning in this genus (Heichler and Murphy (2008).

The only living Eyelash Boas (*Trachyboa*) I have seen were at the Cincinnati and Houston Zoos, described by Arnett et al. (1992) and McLain (1983). The late Johnny Arnett had both species (*T. gularis, T. boulengeri*) in Cincinnati and when he pulled them out from their containers to show me, they were ramrod straight and stiff—these snakes reminded me of the Tentacled Snake (*Erpeton*). Lehmann (1970) pictured this straight (and coiled) defensive posture. I was surprised when Arnett told me that the snakes refused anoles, frogs, and mice but fed on goldfish. The Houston Zoo had *T. boulengeri* in the collection that fed on goldfish.

There is no question that zoo snake collections are becoming homogenized and I now rarely see new taxa when visiting other zoos. As an example, there are no living examples of the following dwarf boas worldwide in ISIS zoos—Panamanian Dwarf Boa (*Ungaliophis panamensis*), Isthmian Dwarf Boa (*U. continentalis*), Oaxacan Dwarf Boa (*Exiliboa placata*), and Eyelash Boas (*Trachyboa gularis, T. boulengeri*). There is one Cuban Dwarf Boa (*Tropidophis melanurus*) at the Wroclaw Zoo and one Haitian Dwarf Boa (*T. haetianus*) at St. Louis Zoo as of Jan. 24, 2014; source = ZIMS (ISIS). The AZA Snake TAG's regional collection plan is from 2010 so I am figuring those numbers are out of date.

Round Island Splitjaw Snakes

For many years, these two snakes (*Casarea* and *Bolyeria*) were considered to be members of the Boidae, perhaps due to similarity of head shape to *Candoia*, but their odd jaw was so unusual that scientists felt that both should be in their own family, Bolyeriidae. Despite listing in its own family, the splitjaw snakes are commonly known in the vernacular as "boas" and are listed as such in The Reptile Database <http://www.reptile-database.org/>. These taxa have an upper jaw bone split into front and back halves that are hinged together at a point just below the eye. Bloxam (1984), Waugh (1988), and Bloxam and Tonge (1986, 1988) reported on the captive management and reproduction of the endangered Round Island Splitjaw Snake (*Casarea dussumieri;* Fig. 14) at Jersey Wildlife Preservation Trust in Channel Islands. Their program included a plan to eradicate the introduced mammals and to restore native vegetation. In 1840, rabbits and goats were released on the island, resulting in damage to the vegetation; this caused soil erosion on the volcanic slopes and deterioration of palm forest habitat. Between 1977–1982, the Trust received a group of 11 snakes on loan from the Mauritian government to establish a captive-breeding program. Although feeding predominately on the Round Island Skink (*Leiolopisma telfairii*), Bojer's Skink (*Gongylomorphus bojerii*), Ornate Day Gecko (*Phelsuma ornata*), and Round Island Gecko (*Phelsuma guentheri*) in the wild, these snakes accepted mice in captivity, unusual since the Mauritian terrestrial vertebrate fauna lacked mammals until introduction of Black Rats (*Rattus rattus*). McAlpine (1981) followed activity patterns of six *Casarea* at the Trust and found that the snakes were primarily nocturnal but occasionally active during the day; the snakes are largely a terrestrial, sit-and-wait, vision oriented predator. Cundall and Irish (1986, 1989) described the function of the intramaxillary joint by analyzing snakes from the Trust colony. They believed that the unusual jaw morphology is an adaptation to subdue slippery or soft-bodied lizard prey. Clutch sizes ranged from 3–11 eggs; neonates averaged ca. seven inches in length (Bloxam 1984; Bloxam and Tonge 1988). We received some adults from the Trust at Dallas Zoo but the reptiles proved to be diffident feeders; Quentin Bloxam told me to stop regularly cleaning the cages and the snakes began feeding immediately (see Chiszar et al. 1980; Wellborn et al. 1982). Bloxam (pers. comm.) told me that the other species—Round Island Burrowing Splitjaw Snake (*Bolyeria multocarinata*)—has been extinct since 1975. His certainty was based on numerous trips to assess the existence of this species. The single individual he saw was identifiable by a scar.

Two Personal Anecdotes

I conclude this paper with two early experiences with boas and pythons that helped determine my life and fate, thus contributing to a financially modest career in the zoo profession.

When I began my less than stellar undergraduate career at Xavier University in Cincinnati, Ohio as a biology major in the late–1950s, I brought along a few snakes from home to keep me company. My plan was to prepare for a zoo career in herpetology so I asked for advice from the departmental chair. He wanted me to do neuroscience on chicks as a senior project, and that was of no interest to me; instead I insisted that my courses and project focus on living herps and include ethology, ecology, physiology, and herpetology. I did offer to use his chicks to feed my snakes. He countered by saying that my life would be nothing more than cleaning cages and aquariums *ad infinitum*—certainly prophetic as it turned out. My dormitory was large and rooms were spacious so there was plenty of room for my Boa Constrictor and Indian Python, each about seven feet (2.1 m) in length. The rooms were constructed of painted concrete block and the door frame was metal. One late evening after a night of debauchery at a local pub, my roommate and I returned to find the door frame and wooden door lying in the hallway surrounded by small chunks of block and concrete dust. We were certain that we had been burglarized but could find nothing missing. The next day, fellow students explained that a new custodian, allegedly a dipsomaniac sipping more than a few pints daily in the broom closet, had entered the room to clean, not knowing that snakes were there as well. When these unexpected inhabitants were sighted, he crashed through the closed door, knocking door and frame into the hallway and landing on top of the door. It was truly an example of superhuman strength, likely fueled with alcohol and reinforced with ophiophobia. He was never seen again. As word spread quickly through the university that I had snakes, our room was packed each week with onlookers to watch the snakes feed. It became obvious that a larger venue was needed. The proctor arranged to have the feeding demonstrations in the enormous common room so hundreds of students, many standing on the couches, could watch the show. Feeding times were published in the school newspaper. A few years ago, I opened my alumni magazine and found that my snake feeding was listed as one of the most memorable events in the history of the university and there was even a picture of a Boa Constrictor.

When one gives talks on snakes to the public, there is usually a predictable response and it is negative—ophidians crawl silently with darting tongue, and are frightening, mute, unblinking, height-challenged, ugly, scary, slimy, unpredictable, and so on, and many attendees are reluctant to touch them (see Burghardt et al. 2009). Dave Barker raised a tame Burmese Python which grew to an impressive size at Dallas Zoo and we used it for presentations. The animal was named "Christian" and we transported him in a large trunk which was always closed on stage until the finale when the snake was introduced to the visitors. One day at a Dallas high school, the audience, numbering over 500 persons, was seated in a large auditorium with a steep sloping floor toward the front. When I finished my slide show, I opened the trunk and pulled out Christian. Primal screams emanated from the throng and a wave of humanity remindful of attacking Huns rushed toward the elevated stage, climbed up the front and sides, pushed me aside, knocked over the podium, microphone, speakers, table, and my props, and began grabbing and petting the snake—a near riot in my view. Envision the final game of the World Series in baseball where the winners are leaping over each other to celebrate victory. After many minutes, teachers and I finally calmed the crowd but the response was so unexpected that I was badly shaken; fortunately, Christian remained calm although the snake had every right to defend itself by biting potential threats. Later, the students sent apology notes (likely forced upon them by teachers) that were stunning—poorly written, grammatically incorrect with creative spelling and punctuation, and virtually incomprehensible—had I not been there, I would not have had a clue as to what had transpired.

Acknowledgments.—This contribution is dedicated to Richard A. Ross, the late Thomas A. Huff, Peter J. Tolson, David G. Barker, Tracy M. Barker, and Trooper Walsh, whose many writings have increased our understanding of the lives of boas and pythons.

I have benefitted from many discussions with Harry W. Greene and Gordon M. Burghardt about the value of zoo collections to advance scientific understanding and the importance of collaborations between academics and zoo workers. A poignant example using boas and pythons in zoos to increase sample size is their seminal paper (Greene and Burghardt 1978).

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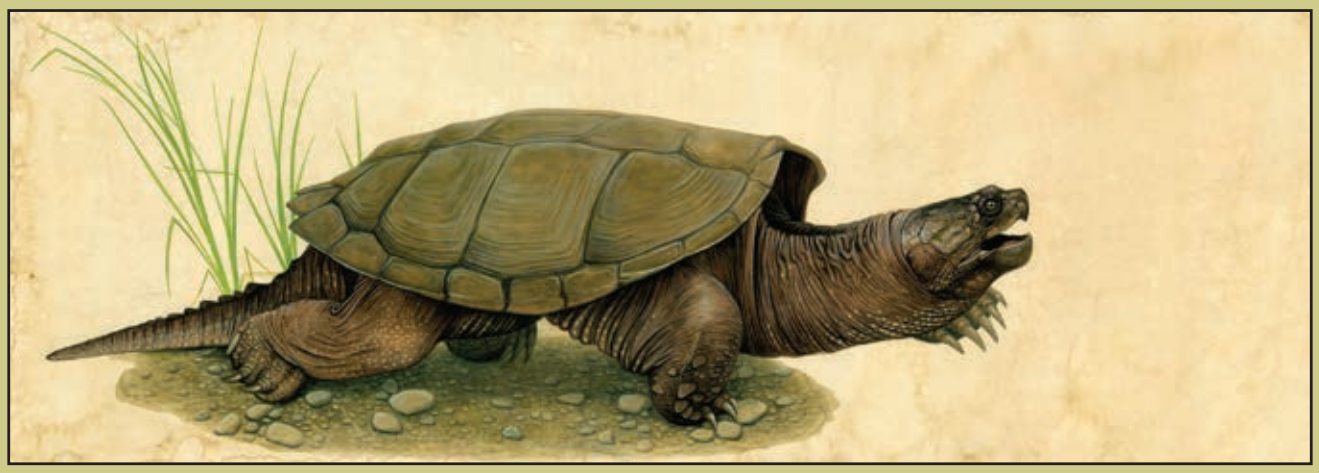
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ART IN HERPETOLOGY



Snapping Turtle (*Chelydra serpentina*)
Matt Patterson — acrylic on vellum illustration board 14" x 42"

Matt Patterson grew up in a small town in New Hampshire, USA. His father was a high school biology teacher, and from an early age Matt was exposed to many different species of animals. As far back as he can remember, he has always had the same two interests: wildlife and art. Today he is a professional illustrator and his work reflects these these passions.

In 2003 Matt graduated from the University of New Hampshire with a BA in Studio Art. In 2006 he received a professional certificate in illustration from the Art Institute of Boston (AIB).

Since graduating in 2006 from AIB, Matt has completed projects ranging from scientific illustration used for posters and books to product illustration. His work has been exhibited nationally. Matt is also a member of the Guild of Natural Science Illustrators. The Common Snapping Turtle painting shown here is currently being exhibited in their members' show.

In 2009, Matt accepted his first contract to illustrate a book for the University Press of New England titled *Freshwater Fish of the Northeast*. This book contains a total of 61 species of freshwater fish. Matt enjoyed many fishing outings in order to gather references needed to complete the illustrations. The book was released in the spring of 2010 and won the National Outdoor Book Award the same year in the artistic merit category.

Matt works in a variety of different mediums ranging from wood carving to digital painting. However, his preferred medium and the majority of his work is completed using acrylic paints. His process first starts with gathering references and other pertinent information on the subjects. He then completes several rough sketches. Once he chooses a composition, he does a pencil drawing on illustration board. Matt works with washes initially and then builds up the layers of paint from thin to thick using acrylics. Often times, he tones the paper or illustration board he is using with coffee prior to painting. This tone gives the illustration a unique texture.

Currently, Matt is illustrating a book on reptiles and amphibians found in the Northeast of North America. Matt is excited about this project and looks forward to its completion.

For information on artwork or commissions, contact Matt at mpatter3@gmail.com or visit www.mpattersonart.com. Artwork is also available for sale at https://www.etsy.com/shop/StoneridgeArtStudios.

ABOUT OUR COVER: *Vipera aspis francisciredi*



Across its broad range in Western Europe, *Vipera aspis* displays variation in color pattern, often including some degree of sexual dichromatism—males are brightly marked with strongly contrasting patterns, while female colors tend to be more muted and well camouflaged. This phenomenon is not unusual among populations of some species of *Vipera*, but is otherwise rare among snakes. Color differences between the sexes are amplified during the breeding season, and likely reflect different selection pressures on wide-ranging males versus sedentary females (Shine and Madsen 1994. Journal of Herpetology 28[1]:114–117).

Vipera aspis francisciredi (Redi's Viper) is one of several distinctive forms of *V. aspis*. This subspecies, which occurs in central and northern Italy and extreme southern Switzerland, also exhibits sexual dichromatism. Additionally, snakes from higher elevation populations, such as in the central Apennines of Italy, may be melanistic, a trait that likely confers thermoregulatory benefit (Castella et al. 2013. Journal of Zoology 290:273–280).

Despite documentation of morphological and genetic diversity across the extensive range of *V. aspis*, recent analyses do not appear to fully support elevating the subspecies to full species, and for the time being the traditional view of a single, polytypic species is retained (Zuffi et al. 2002. Amphibia-Reptilia 23:191–213; Ursenbacher et al. 2006. Molecular Phylogenetics and Evolution 38:546–552; Golay et al. 2008. Amphibia-Reptilia 29:71–83).

Redi's Viper is considered Endangered as a result of habitat loss related to agriculture and other human practices that alter native landscapes (Monney and Meyer 2005. Rote Liste der gefährdeten Reptilien der Schweiz. BUWAL-Reihe: Vollzug Umwelt, 50 S. [BUWAL, Bern, Switzerland]).

The adult male Redi's Viper on our cover was photographed by **Matteo Di Nicola**. This "wide-angle macro" image was recorded using a Nikon D300 camera and a Tokina 10–17mm lens (f/22, ISO 400, 1/100 sec shutter speed, focal length 10mm), with fill flash provided by a Nikon R1 wireless dual flash system. The snake was encountered on stony ground near a birch forest in Ticino, Switzerland at the northern end of this subspecies' range. Residing in northern Italy, Di Nicola notes that despite the fact that Italy offers an enormous variety of nearby easily accessible habitats, the region is densely populated and it is almost impossible to find areas untouched by human activities. For that reason, many Italian wildlife photographers have been forced to look for their photographic subjects abroad as "wild specimens here are frustratingly wary of man and close to unapproachable." Additional images by Di Nicola may be viewed at www.matteodinicola.com.



Editor's note.—Thanks to Louis Porras and Gordon Schuett for editorial assistance.

SSAR BUSINESS

SSAR Roger Conant Grants-in-Herpetology Award Winners for 2014

An award in the amount of US $500 was made to each of the following individuals:

Conservation.—**Javan Bauder**, University of Massachusetts, "Conservation Genetics of the Federally Threatened Eastern Indigo Snake (*Drymarchon couperi*) in Central Florida." Advisor: Kevin McGarigal. **Bailey Patillo**, University of Memphis, "Salamander Susceptibility and Response to the Amphibian Fungal Pathogen *Batrachochytrium dendrobatidis*." Advisor: Matthew Parris

Education.—**David Steen**, Alabama Natural Heritage Program at Auburn University, "Living Alongside Wildlife: An Online Resource for Amphibian and Reptiles Outreach and Conservation."

The Andrew H. Price Field Research Grant In Herpetology.—**Brian Folt**, Auburn University, "Does Leaf-drop Phenology Regulate Abundance Cycles of Terrestrial Amphibians and Reptiles in Wet Neotropical Forests?" Advisor: Craig Guyer. **Scott Travers**, University of Kansas, "Adaptive Radiation and Community Assembly of Ceratobatrachid Frogs in the Solomon Islands." Advisor: Rafe Brown

Laboratory Research.—**Andrew Frank**, University of Connecticut, "Testing the Parallel Speciation Hypothesis in Western North American Skinks (*Plestiodon*)." Advisor: Elizabeth Jockusch. **Sofia Prado-Irwin**, San Francisco State University, "Disease Dynamics of the Fungal Pathogen *Batrachochytrium dendrobatidis* in the California Salamander *Ensatina eschscholtzii*." Advisor: Andrew Zink

Travel.—**Christopher Akcali**, University of North Carolina-Chapel Hill, "The Role of Batesian Mimicry in Divergence and Speciation." Advisor: David Pfennig. **Brenna Forester**, Duke University, "Evaluating the Implications of Local Adaptation, Habitat Connectivity, and Gene Flow for Terrestrial Salamanders Under Global Change." Advisor: Dean Urban

International.—**Nina Seren,** CIBIO Institute (Portugal), "Genetic Response to Heavy Metal Exposure in Amphibian Larvae Under Laboratory Experimental Conditions." Advisor: Ylenia Chiari**. Marta Vidal-Garcia**, The Australian National University, "Unraveling Body Shape Evolution in Australo-Papuan Myobatrachid Frogs." Advisor: J. Scott Keogh

Undergraduate Research.—**Renae Reed**, Peninsula College, "Quantifying an Active Population of Central America's Rarest Turtle, *K. angustipons*." Advisor: Brian Hauge

SSAR thanks Committee Chair, Joshua M. Kapfer (University of Wisconsin-Whitewater), and the following reviewers for their service: David Blackburn (California Academy of Sciences), Ben Cash (University of Central Arkansas), Rebecca Christoffel (Iowa State University, Matthew Fujita (University of Texas-Arlington), Katy Greenwald (Eastern Michigan University), Toby Hibbitts (Texas A&M University), Joe Milanovich (Loyola University), Joanne Ocock (University of South Wales, Australia), Kevin Russell (University of Wisconsin-Stevens Point), Jennifer Sheridan (North Carolina Museum of Natural Sciences), William Sutton (Tennessee State University), Jessica Wooten (University of Findlay, Ohio).

Details concerning the Roger Conant Grants-in-Herpetology program for 2015 can be found in *Herpetological Review* 45:382–383.

Catalogue of American Amphibians and Reptiles Now Open Access

The *Catalogue of American Amphibians and Reptiles* (CAAR) was initiated in 1963 with funding from the National Science Foundation under the auspices of the American Society of Ichthyologists and Herpetologists. The first editor was William J. Riemer. SSAR took over the series in 1971. Over the four-plus decades of its existence, many editors and section editors have overseen the production of hundreds of accounts of Western Hemisphere amphibians and reptiles. As then-Editor Jaime Villa noted in the Foreword to the Index for Accounts 1–400 (published in 1988), the *Catalogue* "represents one of the most important long term cooperative activities undertaken by the American herpetological community and is expected to remain a primary resource for the taxa covered long into the future." Twenty-seven years later that statement still holds. Along the way, the accounts have incorporated improved graphics and full color illustrations of the focal species. The first accounts under new editors Christopher J. Bell and Travis J. LaDuc have just been issued, covering *Graptemys gibbonsi* (Pascagoula Map Turtle), *Anolis smaragdinus* (Bahamian Green Anole), and *Cubophis vudii* (Bahamian Racer). As a service to the herpetological community, SSAR has made the entire series Open Access. Accounts 1–903 may be accessed online at <www.ssarcaar.com>.



NEWSNOTES

Mayr Award Goes to Rayna Bell



PHOTO BY ANDREW STANBRIDGE

The Ernst Mayr Award is given to the presenter of the outstanding student talk in the field of systematics at the annual meetings of the Society of Systematic Biologists (SSB). This is SSB's premier award, and is judged by the quality and creativity of the research completed over the course of the student's Ph.D. program. The 2014 winner of the Mayr Award is **Rayna Bell** of Cornell University. Bell recently completed her PhD under the direction of Kelly Zamudio, and is moving on to a post-doctoral position in the University of California system. Bell's paper, coauthored with Robert Drewes and Kelly Zamudio, was titled: "Comparative population genomics of island endemic reedfrogs: dispersal and diversification in the Gulf of Guinea."

Herpetologists have been especially well represented in the list of Mayr Award winners since the program's inception in 1976. Fully 28% of the award winners to date, which include botanists as well as zoologists of all disciplines, have been herpetologists. Previous winners include Matt Brandley, David Cannatella, Richard Cloutier, Kevin de Queiroz, Linda Ford, Darrel Frost, Anna Graybeal, Adam Leaché, Jim McGuire, Steve Poe, Dan Rabosky, and Jon Richmond.

Reptile Database Update

PHOTO BY TRUONG NGUYEN



FIG. 1. *Cyrtodactylus vilaphongi*, recently described by Schneider et al. (2014. Zootaxa 3835[1]:080–096), from Luang Prabang Province, Laos, is the 10,000th species to be listed in the Reptile Database.

As of 1 August 2014, the Reptile Database (http://www.reptile-database.org) now contains more than 10,000 reptile species. The 10,000th entry is *Cyrtodactylus vilaphongi* Schneider et al., 2014 from Laos (Fig. 1). More precisely, the database now lists 10,038 species (including 79 described this year), up from 9952 in April 2014 (refer to *HR* 45:385). There are now 34,104 references (including 698 published this year), up from 33,558 in April.

Selected Taxonomic News and Changes

New country checklists.—The country checklists for several countries have been updated, namely for Namibia (Herrmann and Branch 2013. J. Arid Environments 93:94–115), Uruguay (Carreira et al. 2012. Bol. Soc. Zool. Uruguay 21:9–29), and Nepal (Kästle et al. 2013. Field Guide to Amphibians and Reptiles of Nepal. ARCO-Nepal).

Agamidae.—All species are now mapped to subfamilies (with help from Philip Wagner and Ulrich Manthey).

Gerrhosauridae.—Now following Bates et al. 2013, including two new genera, *Broadleysaurus* Bates & Tolley gen. nov., and *Matobosaurus* Bates & Tolley gen. nov.

Gekkonidae.—New genera: *Kolekanos* Heinicke et al. 2014, and *Ramigekko* Heinicke et al. 2014.

Gymnophthalmidae.—Now all species mapped to subfamilies (with help from Tiffany Doan).

Turtles.—Now following the turtle checklist by TTWG 2014 (which now has maps, too!).

Typhlopidae.—After Hedges et al. 2014 recently proposed several new genera and other taxonomic changes, many of them have been reverted and otherwise changed by Pyron and Wallach 2014, who also proposed a new genus, *Lemuriatyphlops*.

The Splitting Continues.—Several species groups have been split up, including but not limited to *Pelomedusa subrufa* (now 10 species), *Blanus, Crotalus triseriatus*,, and others.

Global checklist.—An updated global checklist of all reptiles with their higher taxa is now available as an Excel spreadsheet at http://www.reptile-database.org/data/

Please send corrections and additions via the contact link inside the species accounts.

—Submitted by Peter Uetz & Jirí Hošek

David J. Morafka Memorial Research Awards 2015

In honor and memory of Prof. David J. Morafka, distinguished herpetologist and authority on North American gopher tortoises, the Desert Tortoise Council, with the aid of several donors, has established a monetary award to help support research that contributes to the understanding, management and conservation of tortoises of the genus *Gopherus* in the southwestern United States and Mexico: *G. agassizii, G. morafkai, G. berlandieri*, and *G. flavomarginatus*.

Award Amount: US $2,000 to be awarded at the Desert Tortoise Council's Annual Symposium, depending on the availability of funding and an appropriate recipient.

Eligibility: Applicants must be associated with a recognized institution (e.g., university, museum, government agency, non-governmental organization) and may be graduate students, post-doctoral students, or other researchers. They must agree to present a report on the results of the research in which award funds were used at a future symposium of the Desert Tortoise Council.

Evaluation Criteria: Applications will be evaluated on the basis of the potential of the research to contribute to the biological knowledge of one or more of the above gopher tortoise species, and to their management and conservation. Important considerations are the significance and originality of the research problem, design of sampling and analysis, preliminary data supporting the feasibility of the research, and the likelihood of successful completion and publication.

Application Procedure:

1. Download and open an application form from the Desert Tortoise Council's website www.deserttortoise.org. The form is electronically interactive.

2. Provide all information requested on the application, including a description of the research project in no more than 1200 words.

3. Submit the completed application to grstewart@csupomona.edu as a pdf document.

4. Applications must be supported by the applicant's CV and three letters of recommendation, one of which must be from the applicant's research advisor, supervisor, or a knowledgeable colleague. Instruct the recommenders to submit their letters to grstewart@csupomona.edu as pdf documents.

5. All application materials and letters of recommendation must be received by **1 December 2014**. They will be evaluated by a committee of gopher tortoise biologists appointed by the Desert Tortoise Council Board of Directors.

6. The research award recipient will be notified of his/her selection by **19 January 2015** and the award will be presented at the 2015 Desert Tortoise Council Symposium, 20–22 February 2015.

ZenScientist Grant Recipient Named

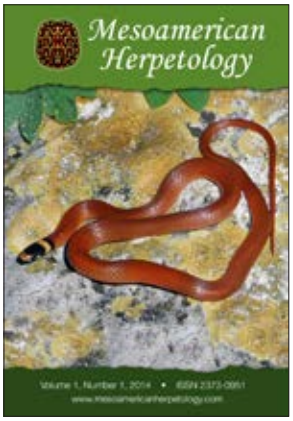
Walter Paulin Tapondjou Nkonmeneck is the recipient of the first ZenScientist Grant. The grant was administered by the Herpetological Association of Africa (HAA) with money donated by ZenScientist.com. Walter will be receiving US $500 for his project titled: "Endemic chameleons of the Cameroon volcanic line: Morphological variation, intra and interspecific gene flow and influence of anthropogenic activities on habitat selection, perch height and feeding ecology." Walter is a Ph.D. candidate studying under Dr. Krystal A. Tolley.

The remaining $250 has been sent to HAA to offer as poster or presentation awards at their annual meeting to be held at the Gogabeb Research & Training Centre, Namibia, 20–22 November 2014. (see: https://sites.google.com/site/12haagobabeb/).

Additionally, Breck Bartholomew and ZenScientist.com will be sending a copy of the classic *The Lizards of South Africa* by V. F. FitzSimons, along with a few smaller publications on African herpetology, to the HAA to auction or use as prizes at the meeting.

The purpose of the ZenScientist Grant is to promote herpetological research by herpetologists who may not have other funding available. The grant will be administered by one of the smaller herpetological societies associated with ZenScientist.com and that typically does not have other funding to offer grants to its members. Persons wishing to contribute to this program may do so online at: http://www.zenscientist.com/index.php/subscriptions-1002

New Journal for Middle American Herpetology



Mesoamerican Herpetology is a peer-reviewed, open-access, electronic journal dedicated to the study of the herpetofauna of Mexico and Central America. Its purpose is to (1) promote herpetological research throughout the region, (2) provide an outlet for the publication of noteworthy papers and notes, and (3) develop a greater level of interaction among biologists, students, conservationists, and other interested parties throughout the region.

Manuscripts on a wide variety of herpetological topics will be considered, including those on taxonomy, systematics, phylogeography, biogeography, conservation, evolution, life history, ecology, behavior, diet, reproductive biology, physiology, diseases, venoms, field studies, techniques, and herpetoculture. Submissions must represent a significant contribution to the field of herpetology for consideration in the journal.

To learn more about the new journal and how to submit manuscripts, please visit http://www.mesoamericanherpetology.com/.

Amphibian & Reptile Conservation

Amphibian & Reptile Conservation (ARC) is an open-access international journal (ISSN: 1083-446X; eISSN: 1525-9153) published twice per year. ARC publishes original peer-reviewed research, reviews, short communications, new species descriptions, country overviews, and more, focusing on a variety of topics relating to the biology, conservation, natural history, and diversity of the world's amphibians and reptiles.

ARC News Alerts provide news and information, including notifications when papers are published online. To subscribe to these brief alerts, visit http://amphibian-reptile-conservation.org/subscribe.html

For a full list of recent papers, as well content planned for future issues, visit the ARC webpage: amphibian-reptile-conservation.org

Smithsonian Herpetological Information Services Publications

The Division of Amphibians and Reptiles of the National Museum of Natural History continues to publish SHIS on an irregular basis. The SHIS series began in 1965 as a "publication" to increase access to indices, translations, bibliographies, and similar materials, which are not published as part of a research project, yet are potentially useful to other herpetologists. We continue this tradition and invite contributions from herpetologists who have developed such materials. If you have such contributions, please contact George Zug [zugg@si.edu] for details of submission.

The more recent ones, 2000 and forward, are:

123 Herpetofauna of Estado Falcón, Venezuela: a checklist with geographical and ecological data. Abraham Mijares-Urrutia & Alexis Arends R. 2000.

124 Checklist and bibliography of Cuban amphibians (Anura). Vilma Rivalta González. 2000.

125 Cuban reptiles: original citations, holotypes, and geographic range. Lourdes Rodríguez Schettino. 2000.

126 Taxonomy of the Liolaeminae (Squamata: Iguania: Tropiduridae) and a semi-annotated bibliography. Richard Etheridge & Robert E. Espinoza. 2000.

127 Type descriptions and type publications of Hobart M. Smith, 1933 through June 1999. Ernest A. Liner. 2000.

128 Bibliography and scientific name index to amphibians and reptiles in the **Occasional Papers of the Museum of Natural History, University of Kansas**, number 1-180, 1971-1995. Harlan D. Walley. 2000.

129 Actualización sisemática y mapas de distribución de los reptiles del Uruguay. Federico Achaval Elena. 2001.

130 Checklist of amphibians and reptiles of the Sagua-Baracoa Mountains, eastern Cuba. Ansel Fong G. & Nils Navarro. 2001

131 Lizards of Ecuador: Checklist, distribution and systematic references. Omar Torres-Carvajal. 2002 [2001].

132 Argentinian snakes: An annotated checklist. Alejandro R. Giraudo & Gustavo J. Scrocchi. 2002.

133 Annotated bibliography of herpetological related articles in the **National Geographic Magazine**, Volumes 1-194, 1890-1998. Ernest Liner & Carl Gans. 2004.

134 Distribución geográfica de la fauna de anfibios del Uruguay. Diego Nuñez, Raúl Maneyro, José Langone & Rafael O. de Sá. 2004.

135 Holotypes of reptiles in the herpetological collection of The Institute of Ecology and Systematics, Cuba. : Ada R. Chamizo Lara, Luis V. Moreno García & Lourdes Rodríguez Schettino. 2005.

136 The beaded lizard (*Heloderma horridum*) and gila monster (*Heloderma suspectum*): a bibliography of the family Helodermatidae. Kent R. Beaman, Daniel D. Beck & Brian M. McGurty. 2006.

137 Specimen locality data & museum numbers/Ubicación y números de museo los especímenes, información complementaria for/a la "**Guía de Campo de los Anfibios de Honduras**" by/por James R. McCranie y Franklin E. Castañeda. James R. McCranie. 2006.
138 Type specimens of amphibians and reptiles in the Natural History Museum of Los Angeles County. John W. Wright, Cynthia A. Weber, Robert L. Bezy & Kent R. Beaman. 2008.
139 Herpetological bibliography & scientific name index to the **Bulletin of the Southern California Academy of Sciences**, volumes 1–90, 1901–1991 & the **Memoirs** 1–10, 1938-1986. Ernest A. Liner. 2009.
140 "**The Reptiles of Maryland and the District of Columbia**": Missing specimen lists. Robert W. Miller. 2009.
141 Data resources for Tropical Asian Dry Forest Amphibians and Reptiles. George R. Zug. 2012.
142 Providing enrichment in captive amphibians and reptiles: Is it important to know their communication? Sarah Kuppert. 2013.
143 Literature resources for "**Reptiles and Amphibians of the Pacific Islands: A Comprehensive Guide**." George R. Zug. 2013.
144 Reptiles of Cuba: checklist and geographic distributions. Lourdes Rodriguez Schettino, Carlos A. Mancina & Vilma Rivalta González. 2013.

Special Publications – SHIS

1 Bibliography of the frogs of the *Leptodactylus* clade – *Adenomera*, *Hydrolaetare*, *Leptodactylus*, *Lithodytes* (Amphibia, Anura, Leptodactylidae). Volume 1. References. Miriam H. Heyer, W. Ronald Heyer & Rafael O. de Sa. 2009.
2 Bibliography of the frogs of the *Leptodactylus* clade – *Adenomera*, *Hydrolaetare*, *Leptodactylus*, *Lithodytes* (Amphibia, Anura, Leptodactylidae). Volume 2. Indices. Miriam H. Heyer, W. Ronald Heyer & Rafael O. de Sa. 2009.

All the preceding SHIS publications are available for download from our webpage, http://vertebrates.si.edu/herps/herps_NMNH_herppubs/herps_herps.html. Some of the earlier ones have not yet been added to this webpage. Those are available in the Biodiversity Library website.

—*Submitted by George R. Zug, Department of Vertebrate Zoology, National Museum of Natural History, Smithsonian Institution, Washington, DC 20013-7012, USA*

MEETINGS

Meeting announcement information should be sent directly to the Editor (herpreview@gmail.com) well in advance of the event. We also welcome brief reports of meetings; please consult the Editor for details.

30 September–4 October 2014 — XIII Iberian Congress of Herpetology, Universidade de Aveiro, Aveiro, Portugal. Information: http://herpe2014.biologiaatua.net/

1–5 October 2014 — 50th Annual Meeting of the German Society for Herpetology and Herpetoculture (DGHT), Bonn, Germany. Information: www.dght.de

10–13 October 2014 — 4th Biology of the Vipers Conference, Athens, Greece. Information: http://www.elerpe.org/viperconf.html

16–18 October 2014 — 36th Annual Gopher Tortoise Council Meeting, Albany, Georgia, USA. Information: www.gophertortoisecouncil.org/annual-meeting

19–23 November 2014 — Herpetological Association of Africa 2014 Conference, Gobabeb Research & Training Centre, Namib Desert. Information: http://www.africanherpetology.org/

20–22 February 2015—Desert Tortoise Council Symposium, Las Vegas, Nevada, USA. Information: http://www.deserttortoise.org/symposium/

2–5 April 2015 — 62nd Annual Meeting of the Southwestern Association of Naturalists, San Diego, California, USA. Information: http://www.biosurvey.ou.edu/swan/annualm.html

15–19 July 2015 — American Society of Ichthyologists and Herpetologists and The Herpetologists' League annual meeting, Reno, Nevada, USA. Information: www.asih.org

30 July–3 August 2015 — 58th Annual Meeting of the Society for the Study of Amphibians and Reptiles (with Partners in Amphibian and Reptile Conservation, Kansas Herpetological Society, and International Society for the History and Bibliography of Herpetology), Lawrence, Kansas, USA.

CURRENT RESEARCH

The purpose of Current Research is to present brief summaries and citations for selected papers from journals other than those published by the American Society of Ichthyologists and Herpetologists, The Herpetologists' League, and the Society for the Study of Amphibians and Reptiles. Limited space prohibits comprehensive coverage of the literature, but an effort will be made to cover a variety of taxa and topics. To ensure that the coverage is as broad and current as possible, authors are invited to send reprints to the Current Research section editors, Beck Wehrle or Ben Lowe; e-mail addresses may be found on the inside front cover.

Testing an Adaptive Hypothesis for Temperature-Dependent Sex Determination

Temperature-dependent sex determination (TSD) has potential costs such as skewed sex ratios with slight climatic shifts. Nevertheless, TSD is widespread among reptiles, suggesting an adaptive basis. An experimental study employing a short-lived agamid lizard showed TSD is advantageous when the sexes develop best at different incubation temperatures. However, demonstrating this in long-lived taxa such as tuataras, crocodilians, and turtles where lifetime fitness is difficult to assess has proven difficult. Noting that many TSD turtle species overwinter as hatchlings in the nest, the authors of this paper conducted an experiment aimed at determining how overwintering temperature affects Painted Turtle (Emydidae: *Chrysemys picta*) hatchlings. *C. picta* is a TSD species: warmer *C. picta* nests produce females and cooler nests produce males, and female nests are also warmer in winter than male nests, with male nests more frequently dipping below freezing. Forty post-hatching nests were dug up in September and the hatchlings were brought into the lab; nests were chosen based on field temperatures with the goal of having a mix of male dominant, female dominant and mixed sex nests. From each nest, two hatchlings were euthanized and their yolk and body mass were measured; the rest were measured and divided between two treatments: warm and cool overwintering temperatures, representing typical female and male nests, respectively. Over the winter, hatchlings were subjected to closed-system respirometry to measure their metabolic activity. At the end of the experiment, the hatchlings were euthanized, and their length and yolk and body masses were recorded. These experiments revealed that cool-treatment males grew more, respired less, and used less yolk than males in the warm treatment and females in the cool treatment. Conversely, females in the warm treatment used less yolk and grew more than cool-treatment females and warm-treatment males, and all females respired less than warm-treatment males. These trends held regardless of whether the turtles were from single- or mixed-sex nests, however, cool-treatment males from single-sex nests used less yolk, grew more, and respired less than their mixed sex counterparts, and warm-treatment females similarly outperformed mixed nest females. These experiments clearly show in *C. picta* that the temperatures that produce each sex provide the optimal overwintering conditions for each sex, supporting an adaptive basis of TSD in this species.

Spencer, R.-J., and F. J. Janzen. 2014. A novel hypothesis for the adaptive maintenance of environmental sex determination in a turtle. Proceedings of the Royal Society B 281: 20140831.

Correspondence to: **R.-J. SPENCER**, Wildlife and Water Ecology Group, Native and Pest Animal Unit, School of Science and Health, University of Western Sydney, Locked Bag 1797, Penrith South, DC New South Wales 1797, Australia; e-mail: ricky.spencer@uws.edu.au

Female Tree Lizard Mate Preference Differs Between Morphs

Several studies have investigated the male behavioral syndromes associated with different throat-color morphs in various lizards of the family Phrynosomatidae; however, little attention has been paid to species with multiple female morphs. To determine if mate preference differences are associated with different female morphs, the authors of this study performed laboratory-based mate choice experiments with Tree Lizards (*Urosaurus ornatus*), a species where females either possess a yellow or orange throat. In this species, males bear blue, yellow, or orange throats, which have been associated with aggressive-territorial, peripheral, and roaming strategies, respectively. Prior to the experiments, in addition to throat color, males were evaluated for their chest patch (size, color intensity) and body condition (mass relative to snout-vent length), none of which were found to be correlated with throat color but may influence female mate choice. The experimental design consisted of a central container for the female flanked by two containers for males (opposite each other). In each trial, males of different throat colors were added to the flanking containers, and the position of the female was scored every half hour over eight hours, with proximity to a male being construed as preference. In these experiments, the authors demonstrated that when presented with a yellow- and an orange-throated male, both female morphs preferred the yellow male, with the orange-throated female also showing preference for males with a large chest patch. In the blue/orange and blue/yellow male trials, females showed no significant preference for either male morph. However, in the blue/orange trials, yellow-throated females showed a preference for males with small chest patches, and both female morphs spent more time near orange-throated males than they did in the yellow/orange trials. The authors posit that the yellow females' preference for small patch size in the blue/orange trials may indicate they are choosing less aggressive males to avoid injury. No preferences for chest patch color intensity or body condition were found. As these lizards may be utilizing olfactory in addition to visual cues, the authors also conducted a series of similar experiments where females were allowed to choose between femoral pore secretions from males of two morphs. In these experiments, the only significant preference was yellow-throated females for yellow-throated males. However, the results of the two experiments were similar (i.e., not significantly different), indicating that visual and olfactory modalities may carry redundant information used in females choice.

Lattanzio, M. S., K. J. Metro, and D. B. Miles. 2014. Preference for male traits differ in two female morphs of the tree lizard, *Urosaurus ornatus*. PLoS ONE 9:e101515.

Correspondence to: **MATTHEW LATTANZIO**, Department of Biological Sciences, Ohio University, Athens, Ohio, USA; e-mail: ML195406@ohio.edu

Genetic Connectivity Despite Anthropogenic Habitat Alterations in Tiger Salamanders

Pond-breeding amphibians have limited options when it comes to oviposition sites, and are often dispersal-limited as well. Therefore, anthropogenic changes at the landscape level have a high potential of disrupting gene flow among amphibian populations. The authors of this paper set out to discover whether gene flow disruption can be discerned within relictual distributions of Tiger Salamanders (*Ambystoma tigrinum*) in the anthropogenically altered Mid-Atlantic region (USA). They collected non-destructive tissue samples from 26 ponds in two regions of *A. tigrinum* persistence: eastern Long Island (New York), and the southern tip of New Jersey. Using these samples, the authors sequenced 12 microsatellite markers and subjected the recovered genotypes to analyses developed to identify the best estimate of the number of metapopulations (STRUCTURE), the results of which were included in an analysis of molecular variance (AMOVA) analysis to establish which levels the observed genetic variation can be attributed to (within ponds, within metapopulations, etc.). These genotypic data were also used to calculate pond effective population sizes, and pairwise F_{ST} values for every pair of ponds within the two regions. Using GIS software, landcover data layers, and understanding of *A. tigrinum* habitat suitability, the authors calculated "surface resistance" distances between ponds. These surface resistance distances represent a realistic distance a salamander would have to travel to disperse from one given pond to another. Using these surface resistance distances as well as straight-line distances, the authors conducted Mantel tests to see if the pairwise F_{ST} values were significantly correlated with either of the geographic distances. This research revealed the best estimate of the number of metapopulations to be three: the New Jersey samples, two of the Long Island ponds, and the remainder of the Long Island ponds. The AMOVA analysis found very little of the genetic structure can be attributed to being among ponds, indicating between-pond but within-metapopulation gene flow is relatively high. Finally, neither straight-line nor surface resistance distances were correlated with genetic structure in any of the regions or metapopulations, further demonstrating significant gene flow. Nevertheless, estimates of pond effective population sizes were very low, ranging from 5 to 44, and overall genetic diversity was low, revealing that despite inter-pond gene flow, these salamanders are still likely threated by population decline and habitat destruction.

Titus, V. R., R. C. Bell, C. G. Becker, and K. R. Zamudio. 2014. Connectivity and gene flow among eastern tiger salamander (*Ambystoma tigrinum*) populations in highly modified anthropogenic landscapes. Conservation Genetics (*in press*) doi:10.1007/s10592-014-0629-5.

Correspondence to: **VALORIE TITUS**, Natural Resource Management, Green Mountain College, One Brennan Circle, Poultney, Vermont 05764, USA; e-mail: valorie.titus@greenmtn.edu

Effects of Warming and Drying on Development Investigated in Three Anuran Species

Climate change is expected to frequently affect a single species in multiple ways at the same time. Such is the case in western Canada, where temperature increases are predicted to coincide with reduced water availability. Unfortunately, the combined effect of these factors on individual species is largely unknown. The authors of this study teased apart the effects of increased temperature and evaporation on amphibian development in a full-factorial mesocosm experiment. Tadpoles of three western Canadian species, Northern Red-legged Frog (*Rana aurora*), Pacific Chorus Frog (*Pseudacris regilla*), and Great Basin Spadefoot (*Spea intermontana*), were divided among cattle tanks and subjected to the following treatments: ambient temperature (control), ~3°C increased temperature, "increased drying" (implemented via water removal), and a combined temperature and drying increase treatment. The tanks were initially filled with tap water and supplemented with pond water, dried leaf litter, plankton, phosphorus, and nitrogen. A mesh was applied to the top of the tank to prevent colonization by larger animals while allowing rain and small arthropods in. Temperature and water depth were measured regularly, and tadpoles were measured on day 31 and again when they metamorphosed or their pond dried to determine rates of growth. Density of periphyton (microscopic organisms occurring on surfaces and serving as tadpole food) was measured twice over the experiment. To analyze these data, the authors used linear mixed-effects modelling to evaluate the effects of warming, drying, and species on four response variables: growth to day 31, size and mass at metamorphosis, and time to metamorphosis. Similarly, generalized linear modelling was performed to evaluate the effect of these three explanatory variables on percentage of tadpoles surviving to metamorphosis and periphyton availability.

Over the experiment, the tanks in the increased drying group completely dried, those experiencing warming dried faster, and the increased drying tanks were warmer than their "permanent" controls. Tadpoles in warmed tanks grew faster, but metamorphosed much earlier, resulting in a smaller-at-metamorphosis trend (only significant in *S. intermontana*). Despite this, *P. regilla* and *S. intermontana* in warming treatments were more likely to survive to metamorphosis than their control counterparts, possibly explained in part by increased periphyton availability. In the drying treatments, *R. aurora* and *S. intermontana* metamorphosed significantly earlier (while only the latter grew faster and was more likely to survive to metamorphosis) and *P. regilla* and *S. intermontana* both metamorphosed at a significantly smaller size. The authors explored the two-way interactions of the explanatory variables, and determined that all interactions were additive or antagonistic (combined effects were less than the sum of the individual effects). For instance, though warming and drying both tended to increase growth rate and chance of surviving to metamorphosis, tadpoles in treatments experiencing both warming and drying grew slower and survived less frequently than expected if the effects were additive. The effects of warming and drying on metamorphosis timing and size were found to be nearly additive. These results indicate *S. intermontana* is the most developmentally flexible of the three. This study highlights the importance of evaluating multiple stressors simultaneously in studies attempting to determine risks to species, as combined effects may not be additive.

O'Regan, S. M., W. J. Palen, and S. C. Anderson. 2014. Climate warming mediates negative impacts of rapid pond drying for three amphibian species. Ecology 95:845–855.

Correspondence to: **SACHA O'REGAN**, Earth to Ocean Research Group, Department of Biological Sciences, Simon Fraser University, Burnaby, British Columbia V5A 1S6 Canada; e-mail: sacha@sachaoregan.ca

Basis of Paedomorphism Revealed in *Eurycea tynerensis*

The biological underpinnings of metamorphosis in amphibians have long been of scientific interest. Researchers have demonstrated that thyroid hormones (TH) are required for metamorphosis; specifically, they combine with thyroid hormone receptor proteins (TRP) to upregulate the transcription of proteins necessary for metamorphosis, including additional TRP. Though it is clear this pathway is important in paedomorphism, how it is altered to achieve this phenomenon is complicated, as the application of TH instigates metamorphosis in some paedomorphic species (e.g., the Axolotl) but not in others (e.g., *Necturus*). To shed more light on this question, the authors of this study examined the effects of TH on larval *Eurycea tynerensis*, a plethodontid species that is comprised of paedomorphic and metamorphic populations. Larval salamanders were collected from two metamorphosing populations and two paedomorphic populations. These four groups of salamanders were each divided into control and TH exposure treatments. After 48 hours, a piece of the tail fin was removed from each salamander and subjected to RNA extraction. From this, a cDNA library was made and sequenced for three transcripts: two TRP isoforms and a third transcript not involved with metamorphosis (as a standard). Additionally, the cDNA libraries underwent expression analysis, where each of the three transcripts were quantified using a qPCR machine. After 21 days, the animals were euthanized, cleared, and stained, allowing evaluation of the degree to which the epibranchial cartilages had metamorphosed into the adult condition. These experiments revealed that TH exposure dramatically elevates TRP levels in metamorphosing populations relative to paedomorphic populations and controls. Paedomorphic salamanders exposed to TH did show an increase in TRP concentration over controls, however these increases were not generally significant. One paedomorphic population exhibited low TRP concentrations overall; interestingly, previous work demonstrated that this population diverged from metamorphosing *E. tynerensis* earlier than did the other paedomorphic population, indicating the possibility of a phylogenetic effect with regard to TH response. The examination of the epibranchials revealed TH exposure caused nearly complete metamorphosis in the metamorphosing salamanders, while the epibranchials of the paedomorphic and control salamanders underwent little or no remodeling. Again, the early-diverging paedomorphic population showed no effects from the TH. This study demonstrates that reduced tissue sensitivity to TH, and not reduced TH production (sensu *Ambystoma*), is underlying paedomorphism in at least this *Eurycea* species.

Aran, R. P., M. A. Steffen, S. D. Martin, O. I. Lopez, and R. M. Bonett. 2014. Reduced effects of thyroid hormone on gene expression and metamorphosis in a paedomorphic plethodontid salamander. Journal of Experimental Zoology (Molecular and Developmental Evolution) 322B:294–303.

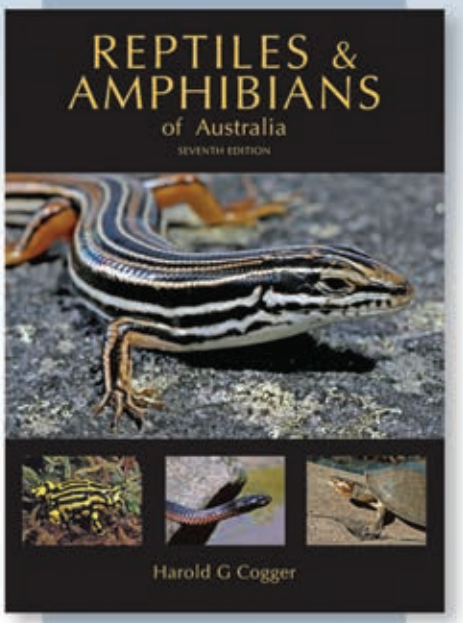
Correspondence to: **RONALD BONETT**, Department of Biological Science, University of Tulsa, Tulsa, Oklahoma 74104, USA; e-mail: ron-bonett@utulsa.edu

Young Skinks Capable of Social Learning

Recent studies have greatly expanded the taxonomic breadth of social learning beyond birds and primates. For instance, tortoises have recently been shown they can learn to navigate obstacles by watching other tortoises. As squamates have never been evaluated for social learning, the authors of this paper subjected Eastern Water Skinks (*Eulamprus quoyii*) to two social learning experiments. In the first, skinks of two age classes (young and old) were assessed for their ability to learn to lift a yellow lid to access a mealworm beneath. Half the skinks in each age class were allowed to observe another skink repeatedly accomplish the task for an hour (social learning treatment), while the other half simply witnessed another skink move around its enclosure for an hour (control). Subsequently, the observer lizards were given 16 opportunities to accomplish the task, and were considered to have learned the task once they accomplished it in five of six consecutive attempts. In the second experiment, the same skinks were tested for their ability to learn that when presented with a blue and a white cap, a mealworm is accessible beneath the blue but not beneath the white. A successful attempt entailed the skink choosing to lift the blue cap first, and they were given 24 tries overall; otherwise the experimental design and learning criteria were identical to that of the first experiment. The authors used generalized linear and generalized linear mixed models to analyze the data. Neither age class nor social learning opportunity significantly affected a skink's probability of learning either experiment's task. However, in the second experiment there was a significant age class × social learning interaction, where young skinks provided a social learning opportunity learned the task faster than old and control skinks. Young skinks in the social learning treatment were also more likely to learn the task from the beginning and never choose a white lid, and to choose the blue lid on the first trial, than old or control skinks. Old, social-learning-treatment lizards showed no performance improvements over their control counterparts. This study demonstrates that in some circumstances young *E. quoyii* can benefit by observing conspecifics, which is surprising as they are not considered particularly social lizards. Furthermore, this social learning ability appears to diminish with age. Certainly, more social learning studies incorporating snakes and lizards are needed.

Noble, D. W. A., R. W. Byrne, and M. J. Whiting. 2014. Age-dependent social learning in a lizard. Biology Letters 10:20140430.

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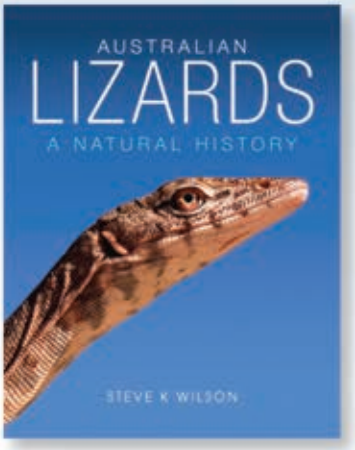
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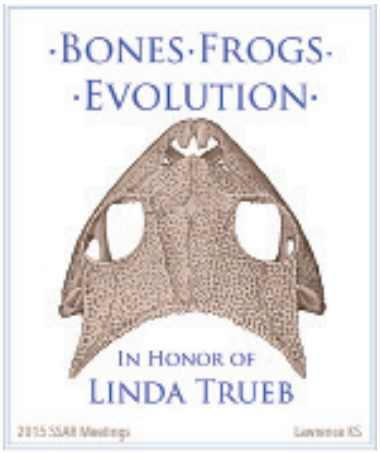
Second Update

University of Kansas Meeting in 2015

Society for the Study of Amphibians and Reptiles

co-sponsored by Partners in Amphibian and Reptile Conservation (PARC)

together with the herpetological societies of Kansas, Missouri, and Arkansas, the Center for North American Herpetology, *and the* International Society for the History and Bibliography of Herpetology



Symposium

Bones, Frogs, & Evolution

Organized by David Blackburn, Anne Maglia, and David Cannatella

This event, kept strictly confidential until now, will celebrate the exceptionally productive career of Linda Trueb, Curator Emerita, KU Herpetology Division. The contributions of Trueb's students, spanning 40 years of scholarship, will include oral presentations from many of her highly successful doctoral mentees. Invited participants include Ana Baez, David Blackburn, David Cannatella, Luis Coloma, Helio da Silva, Eli Greenbaum, Anne Maglia, Dave McLeod, Greg Pregill, Chris Sheil, Erik Wild, and William Duellman.

Projected Costs for 2015

- *Registration fees (member rates):*
  - Students . . . . . US $150
  - Regular $295
  - Seniors, retired / over 70 . . . . . $150
- *Dorm room rates (on campus, linens included):*
  - Dual-occupancy rooms or suites, per day . . . . . starting at $35
  - Single-occupancy rooms or suites, per day . . . . . starting at $55

There are many motels and a major hotel at the edge of campus. Motels allow more persons per room, at lower per-person costs than for the on-campus dorms (as low as $25/person). Full details will be supplied in the formal *Announcement and Registration Information* that will be posted in Spring 2015.

SSAR will hold its 2015 meeting on the beautiful campus of the University of Kansas, one of America's major research universities and a world center for research and graduate education in herpetology. This will be held from **Thursday, July 30 through Monday, August 3.** All scientific sessions will be held in the Kansas Union, which is adjacent to the Museum of Natural History. The intimate campus setting will facilitate personal and friendly interactions while moderating fees for registration and lodging (see projected rates below).

This special event will include oral and poster presentations, silent and live auctions, vendor displays, student social, symposia, and special lectures provided by David Hillis (Keynote) and Miguel Vences (President's Travelogue). SSAR will resurrect popular activities from the past, including:

- Redesigned audiovisual shows arranged by David Dennis and Eric Juterbock.
- Reception honoring distinguished senior herpetologists designed so that students can interact personally with luminaries in the field.
- Herpetological Quiz, arranged by the graduate students at UT Arlington and KU, with prizes for winners.
- Live Kansas amphibians and reptiles (organized by KHS), with photographic set-ups for use by delegates.
- Tours of Fitch Reserve, site of Henry Fitch's classic long-term snake ecology work.
- Tours of the herpetological research laboratories and Biodiversity Institute.



The plenary session, keynote addresses, regular oral and poster presentations, PARC workshops, the ISHBH special session, symposia, and Seibert student award competition will all be held in the Kansas Union (*above*), a modern facility equipped with multiple restaurants, coffee shops, bowling alley, lounge, ballroom, and break-out conference rooms.



PHOTO BY TOM KENNEDY

Symposium

Frontiers in Integrative Organismal Biology: Herpetological Horizons

Organized by Rich Glor and Rafe Brown

This event will bring together a group of exceptionally research-active herpetologists working at the forefront of evolution-related fields, using amphibians and reptiles as study systems. Topics include speciation, adaptive radiation, convergence, phenotypic evolution, and the evolution of development—all through the lens of genomic approaches to understanding evolution of amphibians and reptiles. Participants include Frank Burbrink, Todd Castoe, Ben Evans, Matt Fujita, Luke Harmon, Ryan Kerney, Adam Leaché, Emily Lemmon, Jim McGuire, Rachael Mueller, Robert Thompson, and John Wiens. Summary by David Wake.

Comfortable, air-conditioned, and affordable dorm rooms located 5–15 minutes walk from the meeting venue, will be a welcomed feature of these attendee-friendly meetings. Single, dual, and four-person occupancy suites are available. Amenities include kitchen, laundry, parking, private bath, social room, etc. Naismith Residence Hall allows alcoholic beverages in rooms.



PHOTO BY DAVID M. DENNIS

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Contributions to the History of Herpetology

Volume 1, Revised and Expanded • Edited by Kraig Adler

In 1989, SSAR issued the first volume in what became a series of three containing the biographies (with portraits and signatures) of 786 herpetologists from throughout the world. The biographies provide key details of each person's life and education and their major contributions to herpetology and science generally, all written in an engaging style. As Jay Savage recently wrote in reviewing this series: *There is, of course, a serious problem with this great work. Once one opens it . . . one can't put it down because the next page and the page after that are so inviting!* Volume 1 has now been out-of-print for 15 years; rather than simply reprint it, **we take this opportunity to correct errors and to add 110 pages of plates and other new material**.

Volume 1 covers 152 herpetologists and includes most of the world leaders in our discipline. Their names are immediately familiar to us as authors of major works or as teachers or explorers. Many species have been named in their honor. Among them are:

• Classical authors such as Boulenger, Cope, the Duméril, Mertens, Noble, Schlegel, Schmidt, and Stejneger.

• Great naturalists who published on amphibians and reptiles: Agassiz, Cuvier, Gessner, and Linnaeus.

• Explorers such as Espada, Prince Maximilian, and Spix.

• Collection builders: Baird, Barbour, Gray, Günther, Wilhelm Peters, Seba, Steindachner, and Van Denburgh.

• Ditmars, Kauffeld, and serious amateurs like Klauber and Malcolm Smith, all of whom were popularizers.

• Authors of texts (Goin, Terentjev); great teachers (Myers, Ruthven, Wright); anatomists (Bojanus, Camp, Romer); ecologists and behaviorists (Blair, Cowles, Tinkle); etc.

• Outstanding herpetological artists such as Roesel von Rosenhof and Sordelli.

• Geographic coverage is global: North America (Cochran, Garman, Girard, Holbrook, James Peters, Pope, Taylor); Australia (Kinghorn, Krefft, Waite); Africa (Anderson, FitzSimons, Loveridge, Pitman); Russia (Bedriaga, Chernov); etc.

• Experts on taxonomic groups: frogs (Liu, Okada); salamanders (Bishop, Dunn, Sato); turtles (Carr, Siebenrock); snakes (Amaral, Blanchard, Gloyd, Jan, Maki, Russell, Wall); etc.

• Plus 81 other persons, for a total of 152 biographies.

Two sections—"Taxonomic Authors" by John Applegarth and "Doctoral Lineages" by Ronald Altig—were revised in volume 3 (2012), thus the versions in volume 1 are out-of-date and have been replaced in this new edition of volume 1 with **110 pages of new materials that supplement the biographies in volume 1**. These include original handwritten letters such as one by Linnaeus expressing his surprise at observing a siren for the first time, and another from a 20-year-old G. K. Noble, who had been a bird watcher, exclaiming his conversion: "I am a real honest-to-goodness herpetologist." **There are 60 plates (52 in full color) from classical herpetological books, many of them titles that are locked away in rare book rooms and hardly ever seen by most herpetologists. The plates have extensive captions that contain much new and important information, including details about the many outstanding artists who drew them.** All portraits from the 1989 edition have been scanned with modern laser technology for much improved quality of reproduction. A section of corrections and additions to volumes 2 and 3 is added, together with seven portraits that had been missing from the series. **A new comprehensive index, with more than 5,000 entries**, covers the entire series including all the many new persons added in the revisions to volume 1.



Specifications for Volume 1 (revised): 272 pages (8.5 × 11 inches [21.5 × 28 cm]), bound in library-grade cloth. Color frontispiece, 52 color plates; 155 portraits with signatures. Comprehensive index to series. ISBN 978–0–916984–19–9. • **Published:** August 2014. • **Prices:** Volume 1 (revised) $60. Regular prices for volumes 2 (2007; 285 biographies, 400 pp.) $65; volume 3 (2012; 349 biographies, 570 pp.) $75. **Special price for a complete set, volumes 1 (revised), 2, and 3 to SSAR members $150**; to all others $200. • **Shipping:** Add $5 per volume; non-USA, shipping at cost. • **Orders to:** SSAR Publications Secretary, P.O. Box 58517, Salt Lake City, Utah 84158–0517, USA (*telephone and fax*: 801–562–2660; *e-mail*: ssar@herplit.com). • **Payment:** Make checks payable to "SSAR." Non-USA orders must be paid in USA funds using a check drawn on an American bank or by International Money Order. Books may be charged to American Express, Discover, MasterCard, or VISA (please give account number and expiration date). • **SSAR Membership and Other Publications:** Membership information and a list of society publications can be obtained from the Publications Secretary at the address given above or at the Society's website at www.ssarherps.org.

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- Should be technically superior photographs (e.g., composition, lighting, etc., should be excellent; subject must be in focus).
- Should be taken in vertical format, or, if in landscape format, permit cropping to achieve a vertical orientation (2550 × 3300 ppi).
- Should be based on film or digital media; if the latter, the native resolution must be sufficiently high to permit cropping and/or enlargement to print publication quality.
- Preference will be given to images that depict poorly known species. These could include recently described taxa or species for which a color illustration has never been published.
- Preference will be given to images that communicate some aspect of the biology of the organism (e.g., predation, feeding, courtship, crypsis).
- Images should not have been published previously nor concurrently submitted for publication elsewhere (print or electronic media).

Images for consideration should be submitted as low-resolution jpg or pdf files. Do not send full resolution images unless requested to do so. All submissions or questions should be directed to the Editor (herpreview@gmail.com).







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As space and available material permit, we will occasionally publish examples of historical as well as contemporary herpetological art. We welcome the submission of historical material under the following conditions:

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- Accompanying text should provide information on the subject matter, artist/illustrator, and publication source. Include references as needed to appropriately attribute information from other sources.

Contemporary artists are invited to submit their own work for publication:

- Artist will retain copyright of all submitted material.
- Accompanying text should provide information about technique, media, or other information likely to be of interest, especially to other artists. Other details of interest include the source of illustration subject (e.g., scientific name, geographic origin, etc.) or the work (e.g., book publication, etc.) for which the illustration was produced.
- Artists are welcome to include contact information (e.g., email address, website location), as well as indicating whether original art or prints are available for sale or if the artist is available for commissioned work.

Material may be submitted for review to Jackson Shedd, Herpetological Art and Illustration Coordinator at jackson_shedd@sbcglobal.net.

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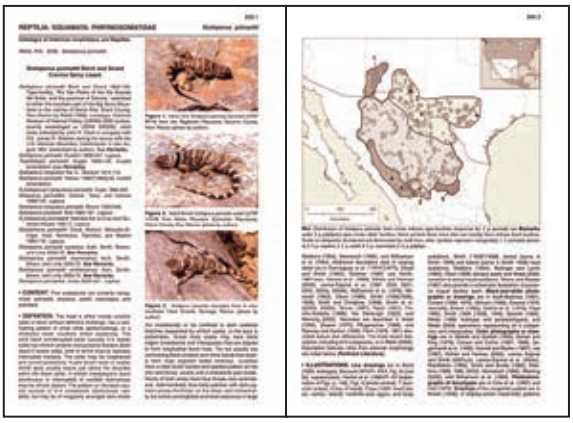
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The *Catalogue* consists of individual accounts of species and genera prepared by specialists, including synonymy, definition, distribution map, and comprehensive list of literature for each taxon. The accounts cover amphibians and reptiles of the entire Western Hemisphere. As of 2014, SSAR is making all CAAR accounts OPEN ACCESS as a service to the herpetological community. To access individual accounts, visit http://www.ssarcaar.com.



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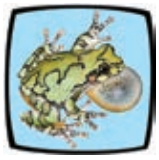
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New Ecological Data on the Family Salamandridae in the Maghreb

North Africa is a biodiversity hotspot, where species of Eurasian, tropical African, and Saharo-Arabian origins co-occur (Oosterbroek and Arntzen 1992; De Jong 1998; Sanmartin 2003). The family Salamandridae originated in Europe (Zhang et al. 2008) and is represented in north Africa by two genera, *Salamandra* and *Pleurodeles* (Schleich et al. 1996). The genus *Pleurodeles* contains three species: *P. waltl* Michahelles, 1830, *P. nebulosus* (Guichenot, 1850) and *P. poireti* (Gervais, 1835). *Pleurodeles waltl* occurs in the Iberian Peninsula and in northwestern Morocco, on the Atlantic plain, in the area delineated by Tangiers, Safi, and Essaouira (Bons and Geniez 1996; El Hamoumi and Himmi 2010), and also extending inland to the Middle Atlas and Rif Mountains (Pasteur and Bons 1959; Mellado and Mateo 1992; Fahd and Mediani 2007), where its range extends locally to an altitude of 1300 m (Bons and Geniez 1996). *Pleurodeles nebulosus* is endemic to northern Tunisia, occurring in the region between Kroumiria, Cap Bon (Ben Hassine et al. 2013), and northern Algeria, and extending westwards as far as Oran according to historical records (Guichenot 1850; Doumergue 1901). In this region, it mainly occupies lowland areas, extending to altitudes of 930 m in northwestern Tunisia (Ben Hassine et al. 2013) and 600 m in Algeria (Samraoui et al. 2012). The third species, *P. poireti*, is a microendemic species, restricted to the Edough Peninsula in northeastern Algeria (Carranza and Wade 2004; Brunet et al. 2009).

Salamandra algira Bedriaga, 1883 occurs in northern Morocco and Algeria, mainly in mountain ranges, usually between 500 and 2010 m in elevation (Doumergue 1901; Geniez and Soto 1994; Escoriza and Comas 2007; Samraoui et al. 2012), although under favorable conditions this species can also occur at lower altitudes (Martínez-Medina et al. 1997; Martínez-Medina 2001). In Morocco, three alloparapatric subspecies have been described: *S. algira tingitana* Donaire-Barroso and Bogaerts, 2003, located in the extreme northwest; *S. algira splendens* Beukema, de Pous, Donaire-Barroso, Bogaerts, Garcia-Porta, Escoriza, Arribas, El Mouden and Carranza, 2013, present in the Middle Atlas and Rif Mountains; and *S. algira spelaea* Escoriza and Comas 2007, occurring on the Beni Snassen Massif (Escoriza and Comas 2007; Beukema et al. 2013). The populations of *S. algira* in Algeria differ genetically from the Moroccan subspecies and the nominotypical

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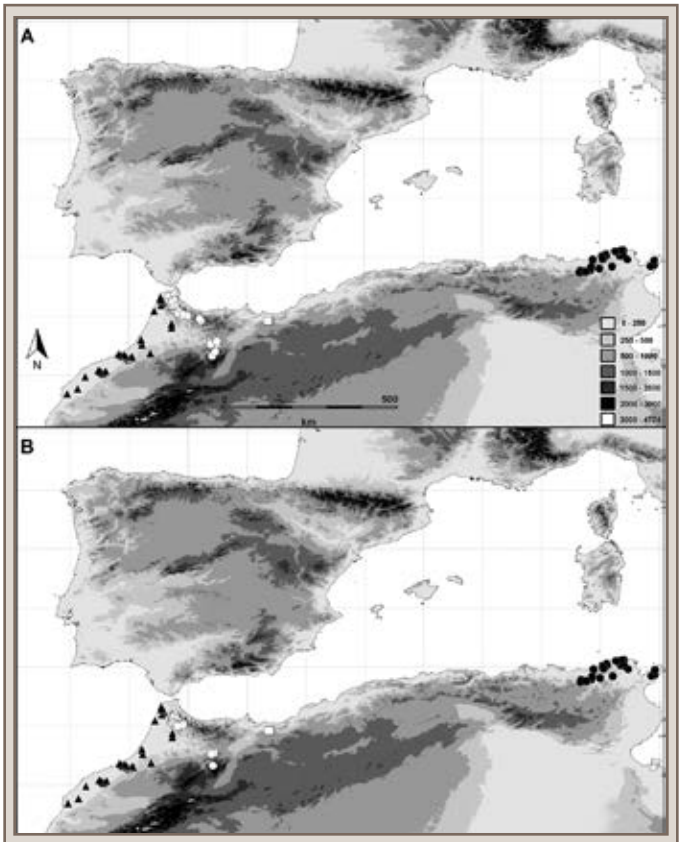


FIG. 1. Species ranges and studied area: Black triangles: *Pleurodeles waltl*; Black circles: *Pleurodeles nebulosus*; White triangles: *Salamandra algira tingitana*; White circles: *Salamandra algira splendens*; White square: *Salamandra algira spelaea*. A) localities included in regional niche characterization. *Pleurodeles waltl* (N = 41); *Pleurodeles nebulosus* (N = 34); *Salamandra algira tingitana* (N = 30); *Salamandra algira splendens* (N = 17); *Salamandra algira spelaea* (N = 4). B) Species ranges and number of sampled aquatic habitats. *Pleurodeles waltl* (N = 68); *Pleurodeles nebulosus* (N = 42); *Salamandra algira tingitana* (N = 11); *Salamandra algira splendens* (N = 11); *Salamandra algira spelaea* (N = 4).

TABLE 1. Climatic and elevational ranges for three North African salamander species, including *Salamandra algira* subspecies. N = number of localities surveyed.

N		*P. waltl* 41	*P. nebulosus* 34	*S. algira tingitana* 30	*S. algira splendens* 17	*S. algira spelaea* 4
Elevation (m)	Mean	177	125	643	1395	974
	Range	0–408	1–917	199–1258	884–1953	822–1286
Mean annual temperature (°C)	Mean	17.8	17.6	15.8	12.6	14.6
	Range	17.1–19.7	13.5–18.2	12.8–18.0	9.5–15.6	13.1–15.2
Maximum temperature of warmest month (°C)	Mean	30.1	32.6	30.3	30.7	31.2
	Range	28.5–35.7	31.1–36.1	28.4–32.0	27.8–33.4	31.0–31.3
Minimum temperature of coldest month (°C)	Mean	6.4	6.0	4.0	-1.2	2.0
	Range	4–8.7	0.9–7.5	0.0–7.1	-5.2–1.7	0.2–2.9
Mean annual precipitation (mm/yr)	Mean	520	644	925	633	393
	Range	333–741	296–1143	717–1121	422–1068	356–469

subspecies may be endemic to Algeria (Steinfartz et al. 2000; Escoriza et al. 2006). These subspecies occur in isolation from each other in sub-humid and humid montane forests (Mateo et al. 2003; Escoriza and Comas 2007).

Here we provided new data on North African salamandrids, examining their regional and local niche based on occurrence data and GIS supported climatic layers. We also describe breeding habitats and determine co-occurring amphibian assemblages and larval ecomorphological guild. These data provide new insights on the autecology of these poorly known species (Stuart et al. 2008), which may help inform their management, particularly as *P. waltl* is classified as a Near Threatened, and *P. nebulosus* and *S. algira* as Vulnerable (IUCN 2013).

MATERIALS AND METHODS

Climate and land-cover data.—We compiled 136 geo-referenced records of the three species across Morocco and Tunisia (Fig. 1A). Presence records were included in this analysis when were separated by more than 1 km, resulting in 92 records in Morocco (41 *P. waltl,* 30 *S. algira tingitana,* 17 *S. algira splendens,* and 4 *S. algira spelaea*); and 34 in Tunisia (all *P. nebulosus*). Locality coordinates were collected using a Garmin Dakota 100 GPS.

Topographic and climatic data were extracted at a resolution of 30 arc seconds from WorldClim layers (Hijmans et al. 2005) using the DIVA GIS 7.5 package (Hijmans et al. 2012). The climatic variables examined were mean annual temperature, maximum temperature in the warmest month, minimum temperature in the coldest month, and mean annual precipitation. These variables describe the thermal ranges and water availability that determine the distributions of amphibians in temperate climates (Buckley and Jetz 2007). These data were interpreted according to the FAO climatic classification (http://www.fao.org/geonetwork), which is based on Penman's method (Tanner and Pelton 1960), for establishing the aridity threshold under Mediterranean conditions; i.e., at a mean annual precipitation around 450–500 mm, defined as semi-arid (conditions above this threshold are defined as humid or sub-humid). The segregation of the three species in the regional niche was analyzed by Constrained Correspondence Analysis (CCA), based on three variables, mean annual temperature (°C), altitude (m) and annual precipitation (mm). The CCA is useful to determine variations in species occurrence in relation to a matrix describing an environmental gradient, and has been

TABLE 2. Type of land cover at terrestrial habitats surrounding North African urodele breeding sites. Land cover types obtained from GlobCover 2009 database.

Species	Land cover type	(%)
P. waltl	Mosaic cropland (50–70%) / vegetation (20–50%)	40
	Rainfed croplands	22
	Mosaic vegetation (50–70%) / cropland (20–50%)	17
	Mosaic grassland (50–70%) / forest or shrubland (20–50%)	12
	Others	9
P. nebulosus	Mosaic cropland (50–70%) / vegetation (20–50%)	45
	Rainfed croplands	44
	Mosaic vegetation (50–70%) / cropland (20–50%)	10
	Closed (>40%) broadleaved deciduous forest	3
S. algira tingitana	Mosaic vegetation (50–70%) / cropland (20–50%)	34
	Mosaic cropland (50–70%) / vegetation (20–50%)	30
	Closed (>40%) broadleaved deciduous forest	10
	Mosaic forest or shrubland (50–70%) / grassland (20–50%)	10
	Closed to open (>15%) shrubland	7
	Others	9
S. algira splendens	Mosaic vegetation (50–70%) / cropland (20–50%)	50
	Mosaic cropland (50–70%) / vegetation (20–50%)	26
	Closed (>40%) broadleaved deciduous forest	6
	Closed (>40%) needleleaved evergreen forest	6
	Mosaic forest or shrubland (50–70%) / grassland (20–50%)	6
	Closed to open (>15%) shrubland	6
S. algira spelaea	Closed to open (>15%) shrubland	50
	Mosaic cropland (50–70%) / vegetation (20–50%)	25
	Mosaic vegetation (50–70%) / cropland (20–50%)	25

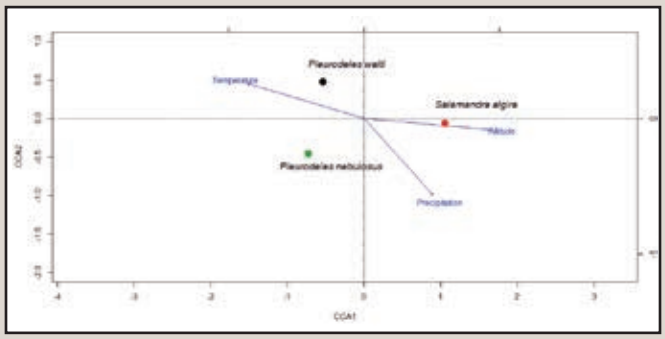


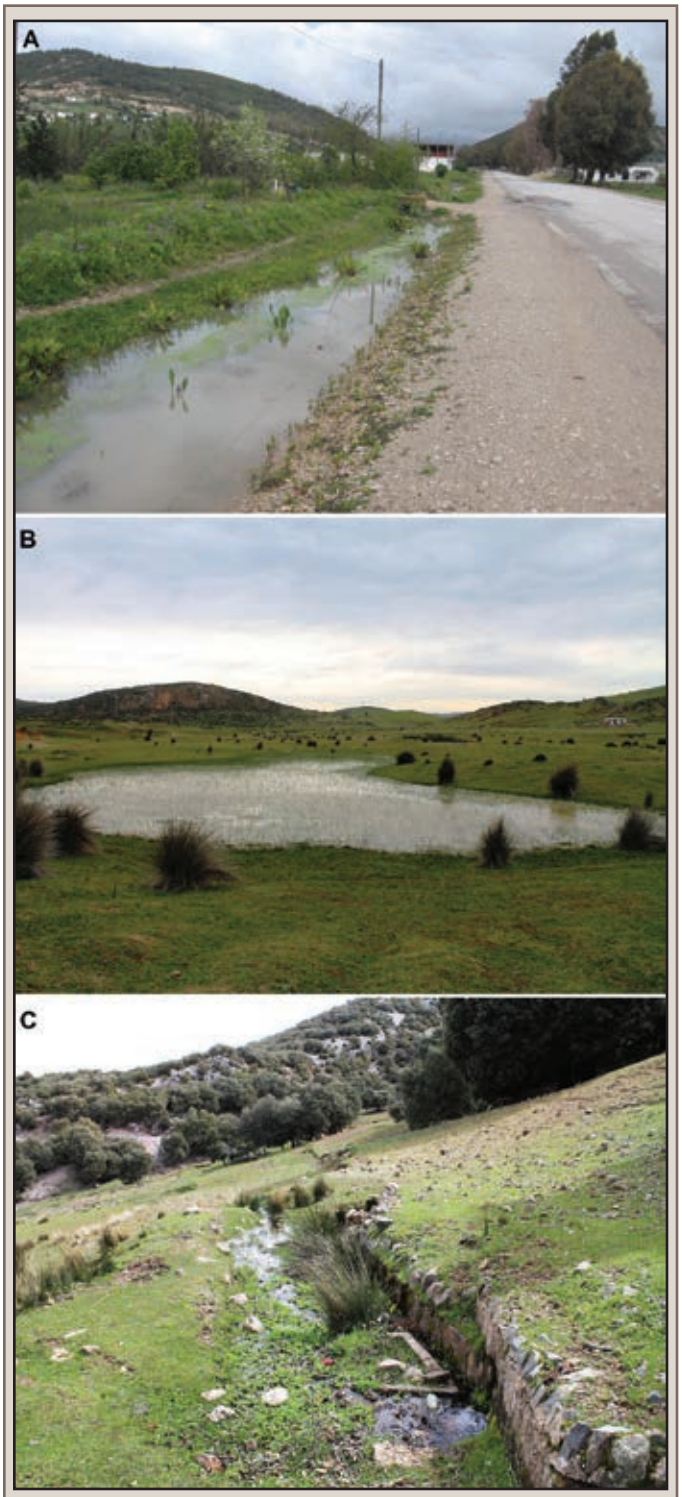
FIG. 2. Constrained correspondence analysis (CCA) ordination diagram with species (points) and environmental variables (arrows). Both CCA axis were highly significant (p = 0.005). Temperature: annual mean temperature (°C); Altitude (m); Precipitation: annual precipitation (mm).

widely used to describe the structure of amphibian assemblages (Pillsbury and Miller 2008; Furlani et al. 2009). The significance of the model was examined using permutation tests (Oksanen et al. 2012). This analysis was performed using the vegan package (Oksanen et al. 2012) for R (R Core Development Team 2011). We also examined the effects of vegetation cover on the occurrence of these species, because vegetation cover is a major influence on the composition of salamander assemblages (Pough et al. 1987). The land-type data were obtained from the database GlobCover (2009), which classifies land cover into 23 categories, from forests to urban areas, based on satellite photographs with a spatial resolution of 300 m (Bontemps et al. 2011). This database provides a classification based on global vegetation types, so these categories are described according to local vegetation communities (Benabid 1985; El Hamrouni 2001; Aafi et al. 2002; Benabib 2002; Brun 2007; Stambouli-Essassi et al. 2007; Valdés et al. 2006).

Breeding habitat characterization.—We encountered urodela species in a total of 136 aquatic breeding habitats (Fig. 1 B) including temporary ponds, permanent ponds, springs, and stream pools. These aquatic habitats were surveyed between December and April in Morocco and between March and April in Tunisia. These times were chosen as *S. algira* breeds in autumn-winter (October to March), but there is increased activity of other amphibian species in spring (March to May) in the Maghreb, with the exception of *Pelophylax saharicus* (Doumergue 1901; Ben Hassine et al. 2013; Mayet 1903; Escoriza and Comas 2007; Ben Hassine et al. 2013). At each breeding habitat, we measured average water body depth (cm), surface area (m²), slope, temperature (°C), dissolved oxygen (mg/L), pH and conductivity ($\mu S \cdot cm^{-1}$). Average depth was taken as the mean value of five successive measurements from the shore to the centre. Surface area was obtained by measuring the maximum length of the longitudinal axis and the length of the transverse axis, and assuming an elliptical shape. In ponds larger than 100 m², surface area was estimated using a Garmin Dakota 100. The pond slope was calculated following the equation:

$$\text{Slope} = \text{maximum depth} / \{\text{sqrt (surface area} / 2)\}$$

Turbidity was assessed using a scale ranging from 1 (transparent waters\10 Nephelometric Turbidity Units; NTU) to 3 (very turbid waters\300 NTU) based on light extinction estimated at Secchi disk depth. The percent of emergent vegetation covering the pond surface was estimated from photographs. Chemical water parameters were measured in situ using a Crison 524 conductivity meter (for conductivity), an EcoScan ph6 (for pH) and a Hach HQ10 Portable LDO meter (for dissolved oxygen). Aquatic habitats were sampled on sunny days between 1200 h and 1500 h in order to maintain maximum homogeneity in the measurements.



PHOTOS BY JIHÈNE BEN HASSINE

FIG. 3. Aquatic habitats of Maghrebian salamanders. A) Temporary pond, habitat of *Pleurodeles nebulosus* (Nefza, Tunisia); B) temporary pond, habitat of *Pleurodeles waltl* (Echrabkha, Morocco); C) spring, habitat of *Salamandra algira* (northern Middle Atlas, Morocco).

TABLE 3. Ranges in parameters of breeding habitat selection for three North African urodele species, including *Salamandra algira* Moroccan subspecies. N = number of sampled ponds, Tp = Temporary pond, Pp = Permanent pond, S = Spring, Sp = Stream pool.

		P. waltl	*P. nebulosus*	*S. algira tingitana*	*S. algira splendens*	*S. algira spelaea*
N		68	42	11	11	4
Water body type (%)	Tp	98	91	45	27	0
	Pp	2	7	18	18	0
	S	0	0	36	45	75
	Sp	0	2	0	9	25
Surface area (m^2)	Mean	40731	555	630	782	18
	Range	160–748440	26–4256	2–2024	1–3168	3–47
Average depth (cm)	Mean	30	24	51	27	7
	Range	11–94	6–80	12–112	5–59	5–9
Slope	Mean	1.3	3.7	31.5	12.3	5.3
	Range	0.04–6.7	0.4–13.9	0.7–123.7	1.3–27.0	1.9–11.3
Temperature (°C)	Mean	17.3	19.4	11.9	11.2	12.8
	Range	11.5–23.0	13.0–27.6	7.8–17.9	6.7–15.8	11.3–14.0
Dissolved oxygen	Mean	8.30	7.94	8.78	9.06	7.72
(mg/L)	Range	1.91–16.99	1.84–17.10	4.72–14.45	7.24–11.61	5.43–9.21
pH	Mean	7.98	7.99	6.55	7.55	7.72
	Range	6.35–10.90	6.60–9.60	5.24–8.30	5.72–8.78	7.27–8.20
Conductivity	Mean	556	1243	78	152	583
($\mu S \cdot cm^{-1}$)	Range	35–4840	44–8700	30–320	27–422	266–929
Emergent vegetation	Mean	79.21	52.66	50	33.33	45
(%)	Range	40–100	1–100	0–100	0–100	0–100
Turbidity	Mean	1.47	1.64	1.09	1.18	1
	Range	1–3	1–3	1–2	1–2	1

Species co-occurrence.—Salamander species are keystone predators, regulating the composition of anuran assemblages in aquatic habitats (Morin 1983; Wilbur 1987; Portheault et al. 2007). For this reason we examined the composition of anurans in the breeding habitats where salamander larvae were observed. These occurrence data were included in a presence–absence matrix, which was used to calculate an overlap metric, Pianka's index (Pianka 1973). This index assumes values between 0 (null overlap) and 1 (complete overlap). This index was computed using the package spaa (Zhang 2013) in R (R development Core Team 2011).

Morphological data.—To classify salamander species into morphofunctional groups, we measured several morphological characters of the larvae. Classification of larvae based on such external traits can serve as a proxy for larval niche, because these characters are related to the selection of specific niches, namely lotic or lentic habitats (Petranka 1998). We included in this analysis specimens of *Pleurodeles* with five well-formed digits on the hind limb and fully developed external gills (stages 54–55; Gallien and Durocher 1967), and all larvae of *S. algira* because part of their larval development is intrauterine (Veith et al. 1998). The morphological data were obtained by the digital analysis of photographs, following the procedure detailed in Escoriza and Boix (2012), using the program SigmaScan Pro vs 5.0.0 (1987–1999 SPSS Inc.).

Variables measured were body length (from the snout tip to the end of the tail), body depth (dorsal–ventral distance measured in the mid-point between the front and hind limbs), and fin length (from the tip of the tail to the end of the dorsal insertion). We calculated the span ratio based on these measurements; i.e., the ratio between the longitudinal (total length) and transverse axes (body depth). These measures are useful for classifying Urodela larvae into two ecomorphs: the stream type (streamlined shape and short caudal fin) and the pond type (more oval shape and extended caudal fin; Valentine and Dennis 1964; Petranka 1998).

RESULTS

Regional niches: climate and land-cover type.—Species appear to be segregated along a climatic and topographic gradient (Fig. 2). The overall test indicated that the model performed better than the random models ($F = 28.73$, $p = 0.005$). The two first CCA axes were significant (CCA 1: $F = 72$, $p = 0.005$; CCA 2: $F = 14$, $p = 0.005$, after 199 permutations). In the first axis (eigenvalue = 0.67) altitude was the variable with the higher score (0.93) compared to annual temperature (-0.86) and annual precipitation (0.51). In the second axis (eigenvalue = 0.13), precipitation was the variable with the higher score (-0.56) followed by temperature (0.26) and altitude (-0.08). This result suggests that altitude and temperature are important factors explaining the occurrence of

Salamandridae species in the region. *P. waltl* and *P. nebulosus* appear in humid to semi-arid zones (Table 1). Both *Pleurodeles* species occur mainly along coastal plains with temperate winters and warm summers. *Salamandra algira* inhabits sub-humid to humid climate areas (although *S. algira spelaea* at the Beni Snassen Massif occurs within the semi-arid zone) with a temperate-to-cold winter climate variant (Table 1).

Land cover categorization and field observations show that *P. waltl* occurs mainly in open landscapes, usually agricultural areas, with some patches of natural vegetation dominated by evergreen oak (*Quercus suber*) forests and isolated trees of wild olive *Olea europea* and carob *Ceratonia siliqua*, associated with a dense to open underbrush formed by dwarf palms *Chamaerops humilis* and *Pistacia* species (Table 2). *Pleurodeles nebulosus* also occurs in mainly agricultural landscapes with some scattered formations of dense shrubs, usually formed by *Q. coccifera*, *Halimium halimifolium*, and *Pistacia* species. In north-western Tunisia, *P. nebulosus* inhabits humid montane forests (800–1100 m in elevation) composed of the deciduous oak *Q. canariensis* associated with *Alnus glutinosa*, and at lower altitudes (below 800 m), mixed formations of *Q. canariensis*, *Q. suber*, *Q. ilex*, and *Q. coccifera* associated with a dense subtropical-like understory of small trees and bushes, such as *Arbutus unedo*, *Laurus nobilis*, and *Erica arborea*.

Salamandra algira inhabits more closed landscapes, usually thermic or mesothermic Mediterranean forests (at altitudes of 0–1400 m) composed of *Q. suber*, *Q. faginea*, *Q. canariensis*, *Pinus halepensis*, *Juniperus phoenicea*, and *Tetraclinis articulata*, as well as supra-Mediterranean forests (1400–1800 m) composed of the Atlas Cedar (*Cedrus atlantica*) and Moroccan Fir (*Abies maroccana*). Locally, it also occurs in more open habitats, such as alpine meadows (in the Bou Iblane region and the Middle Atlas) and in barely vegetated karst formations (Tingitana Peninsula).

Aquatic habitat selection, ecomorphs, and species co-occurrence.—The studied species were found in 136 breeding habitats, described as follows: *P. nebulosus* (N = 42), *P. waltl* (N = 68), *S. algira tingitana* (N = 11), *S. algira splendens* (N = 11), and *S. algira spelaea* (N = 4) in Morocco (Fig. 1B). Species of the genus *Pleurodeles* usually breed in temporary ponds, tolerating large variations in water chemistry, turbidity, and density of aquatic vegetation, although the turbidity is usually high, with a dense layer of vegetation formed by buttercup species of the genus *Ranunculus* (Fig. 3; Table 3). According to our observations, both *Pleurodeles* species breed in water bodies with moderate to large dimensions, appearing to avoid those of small size and running waters. *Salamandra algira* larvae were found in different types of water bodies, ranging from temporary ponds to stream pools, but they were most commonly found in springs. These springs frequently had clear water and low-density aquatic vegetation (Fig. 3; Table 3). In these aquatic habitats, we sampled a total of 334 larvae of urodeles (*P. waltl*: N = 231; *P. nebulosus*: N = 34; *S. algira*: N = 69) (Table 4). Prometamorphic *P. waltl* attained larger body sizes compared to the same stage of *P. nebulosus*, and both species had a compressed shape (i.e., small span ratio), with a dorsal fin extending along the dorsum (Fig. 4A; Table 4). Both species had no members at hatching, and balancers that are lost within a few days of hatching as the limbs and digits develop (Figs. 4A, 5). This corresponds to the pond-type morphology. In contrast, *S. algira* shows a more streamlined morphology (i.e., higher span ratio), with the dorsal fin ending at the base of the tail and members present at hatching (Fig. 4 B), which corresponds to the stream-type morphology. These findings are consistent with those obtained for the characterization of aquatic habitats; i.e., the species of the genus *Pleurodeles* appeared predominantly in temporary ponds, whereas *S. algira* occurred in springs.

The breeding sites used by the two genera differ in the species composition of co-occurring anurans. In the studied areas, *P. waltl* and *P. nebulosus* co-occurred with 100% of the sympatric anuran species (i.e., those found in the same geographic region, but not necessarily in the same habitats) whereas *S. algira* only with 33% of the sympatric species (Table 5).

Discussion

Salamandra and *Pleurodeles* appear to segregate along a thermal and rainfall gradient, both of which are correlated with altitude (Peel et al. 2007), and occupy terrestrial habitats with differing vegetation structures. *Salamandra algira* tends to occupy humid and colder conditions, with relatively dense

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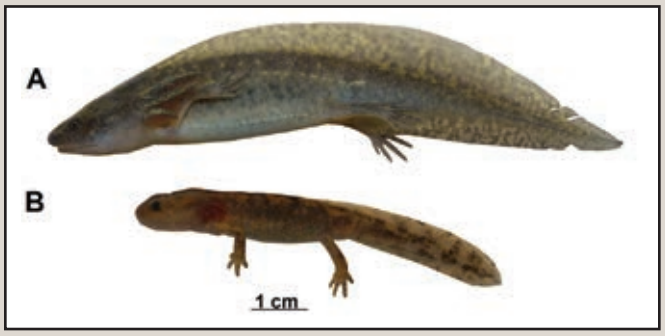


Fig. 4. Larval morphology. A) Pond-type larva of *Pleurodeles nebulosus*; B) Stream-type larva of *Salamandra algira*.

PHOTO BY JIHÈNE BEN HASSINE

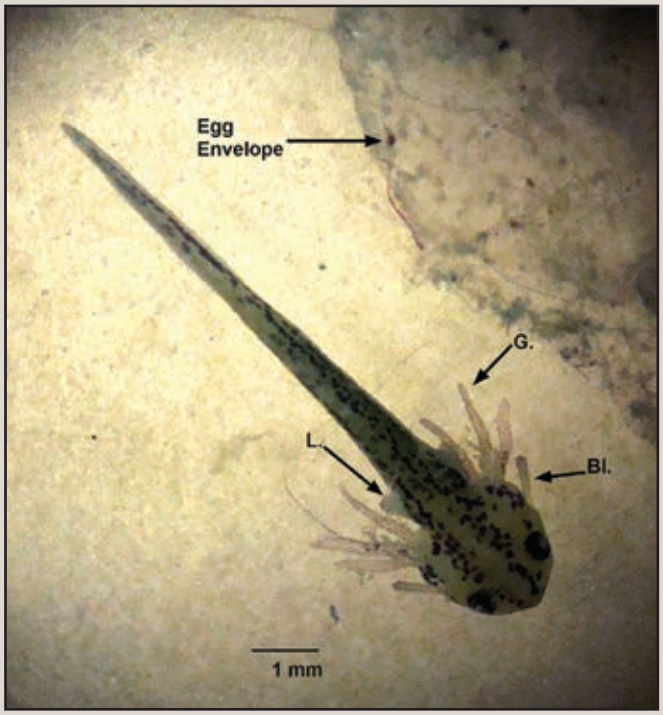


Fig. 5. Hatching larva of *Pleurodeles nebulosus* showing three gills (G.), elongated balancers (Bl.) on the sides of the head and cone-shaped anterior limb bud (L.).

TABLE 4. Morphological traits and guild types of larval salamanders from Maghreb.

		Total length	Body depth	Span ratio	Ratio fin length/ total length	Functional limbs at hatching	Guild type
P. waltl (N = 231)	Mean	66.3	11.4	5.9	0.8	no	pond
	Range	39.2–111.7	6.4–23.2	4.5–7.1	0.7–0.9		
P. nebulosus (N = 34)	Mean	56.9	9.0	6.3	0.8	no	pond
	Range	39.3–73.7	7.0–11.8	5.2–7.4	0.7–0.9		
S. algira (N = 69)	Mean	48.5	6.3	7.9	0.5	yes	stream
	Range	33.8–65.2	4.1–9.5	5.9–9.2	0.4–0.6		

vegetation cover, whereas both *Pleurodeles* species appear well adapted to open anthropic landscapes in warmer maritime climates. Similar patterns also appear in the southwest of the Iberian Peninsula, where the genus *Salamandra* occurs in forests at mid-altitudes, whereas *P. waltl* is more common in lowland agricultural landscapes (Buckley and Alcobendas 2002; García-París et al. 2004). However, in the western Rif (Morocco) and north-western Tunisia, *Pleurodeles* populations occur at mid-altitudes, in humid oak woods (Fahd and Mediani 2007; Ben Hassine et al. 2013). In this mountains region of Morocco, *P. waltl* may appear in sympatry with *S. algira*. This highlights the ecological plasticity of the genus *Pleurodeles*, which is capable of inhabiting both lowland agricultural landscapes and dense montane forests.

Our findings also indicated that *P. waltl* and *P. nebulosus* had a moderate to high degree of habitat overlap with several species of anurans. *Pleurodeles* species breeding sites were frequently associated with anurans that breed in ponds with moderate-long hydroperiods (more than 2–3 months), as is the case of *P. waltl* and *Pelobates varaldii* in Moroccan coastal plains (Escoriza and Ben Hassine 2013), or *P. nebulosus* and *Hyla meridionalis* in northern Tunisia (Ben Hassine and Nouira 2012) but also with more generalist species, like *Discoglossus pictus*, *Discoglossus scovazii*, *Amietophrynus mauritanicus* and *Bufotes boulengeri*. In natural conditions, *Pleurodeles waltl* and *P. nebulosus* could be potential predators on the eggs and larvae of anurans (Diaz-Panigua et al. 2005; Ben Hassine et al. 2013) and under laboratory conditions, *P. waltl* exert intense predation in anuran larvae, at least on small benthic species (Portheault et al. 2007). However, in the field, the size of the anuran larvae (e.g., *P. varaldii*; Escoriza 2013), strategies of predator avoidance (e.g., in the case of *Hyla* species; Chovanec 1992), and large clutch sizes (e.g., up to 1000 for the genus *Discoglossus* and *Hyla*, and up to 20,000 eggs for Bufonidae species in North Africa; Pasteur and Bons 1959; Schleich et al. 1996) can explain the tadpole survival of these co-ocurring anurans. Differences in the breeding timing of other anurans, such as *Pelophylax saharicus* (which start to breed later in the season, usually in mid-spring and breed mainly in permanent ponds; Pasteur and Bons 1959) may explain the absence of breeding habitat overlap with the *Pleurodeles* species. The breeding habitat of *S. algira* overlaps those of fewer anuran species, possibly because *S. algira* usually breeds in smaller water bodies (which support lower species richness; Werner et al. 2007) and can start to reproduce in late autumn, when many anurans have not yet commenced their reproductive season (Pasteur and Bons 1959). Our morphological analysis demonstrates important differences between the larvae of these two Salamandridae genera, and that their larvae correspond to two clear different ecomorphs, suggesting the segregation of their larval niches. All these factors combined (i.e., differences in thermal ranges, land-cover types, and larval habitat selection) act to reduce the habitat overlap between the species of the two genera, in those areas where they co-occur geographically (e.g., in northwestern Morocco; Bons and Geniez 1996).

In recent decades, there have been significant changes in the habitats of the northern Maghreb, which have caused the rarefaction of numerous species of vertebrates (Mehlman 1984; Le Cuziat et al. 2005). Similarly, several wetlands have been destroyed on the Atlantic plains of Morocco (Emberger 1939; Green et al. 2002) and in Tunisia (Mehlman 1984; Ben Hassine and Nouira 2012), and this destruction has been linked to the extinction of many populations of *Pleurodeles* (Werner 1931;

TABLE 5. Habitat overlap values (Pianka's index) among studied urodeles and co-occurring anuran species in the Maghreb. *S. algira** = *S. algira splendens* and *S. algira tingitana*; *S. algira*** = *S. algira spelaea*; A.ma. = *Alytes maurus*, ; D.p. = *Discoglossus pictus*; D.s. = *Discoglossus scovazzi*; P.v. = *Pelobates varaldii;* B.bl. = *Bufotes boulengeri*; A.m. = *Amietophrynus mauritanicus*; H.m. = *Hyla meridionalis*; P.s. = *Pelophylax saharicus.* No = species did not occur in sympatry with the studied species; N = number of localities.

	A.ma.	D.p.	D.s.	P.v.	B.bl.	A.m.	H.m.	P.s.
P. nebulosus (N = 42)	No	0.57	No	No	0.23	0.04	0.53	0.06
P. waltl (N = 68)	0.00	No	0.16	0.23	0.14	0.15	0.75	0.36
*S. algira** (N = 22)	0.00	No	0.16	No	0.00	0.00	0.07	0.13
*S. algira*** (N = 4)	No	0.25	No	No	0.00	0.00	0.00	0.29

Joger 2003; Ben Hassine and Nouira 2012). The degradation of forests (Zaimeche and Sutton 1997) is also related to the local extinction of some populations of *S. algira* (Escoriza et al. 2013). This process of deforestation possibly affect more severely to *S. algira* that to the species of genus *Pleurodeles*, which can succesfully occupy more open landscapes, such as agricultural fields. Other threats include the introduction of exotic species like Pumpkinseed Sunfish (*Lepomis gibbosus*), the Mosquitofish (*Gambusia holbrooki*), and crayfish (*Procambarus clarkii*), which we found even in protected areas, including the Merja Zerga RAMSAR reserve, although they occur over much of the North African wetlands (Samraoui et al. 2012; Ben Hassine et al. 2013). These exotic species usually occur in large ponds (Cruz and Rebelo 2007), as those used by *P. waltl* to reproduce, and can cause a rapid depletion of its populations as is reported in southwestern Europe (Cruz et al. 2008).

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American Alligator Nests as Microhabitat for a Diversity of Vertebrates

The American Alligator (*Alligator mississippiensis*) is a New World crocodilian that builds mound nests using available vegetation and substrate (Joanen and McNease 1989). The geographic range of alligators covers a diverse array of habitats which includes marshes, swamps, upland lakes, bayous, and river backwaters (Giles and Childs 1949; Goodwin and Marion 1979). Alligators significantly alter available habitat by digging holes (Beard 1938; Craighead 1968; Kushlan 1972) and contructing nest mounds (Joanen and McNease 1989). Kushlan (1974) described the use of alligator holes as refugia for aquatic organisms in times of drought, and credits alligator habitat reconstruction for maintaining richness and diversity of southern Florida's unique habitats. Nest construction by a single female also results in considerable habitat alteration. Nests are typically characterized by an area of devegetation, 3–7 m in diameter, uprooted vegetation or substrate, a mound, and usually an associated den(s) in the water nearby the nest (Joanen 1969).

Numerous observations have noted the use of alligator nest mounds as proxy nesting habitat by other reptiles (Dietz 1979; Kushlan and Kushlan 1980). Thus, alligators play a complex role in the ecosystems they inhabit beyond that of an apex predator (Kushlan and Kushlan 1980). This study aims to describe the diversity of vertebrates associated with alligator nests and discuss the nature of their associations using data collected during multiple, studies unrelated to the use of nests by other species.

Methods.—Sixty-six alligator nests were observed at three different sites during the course of this study; 34 at J.D. Murphree Wildlife Management Area in southeastern Texas, 22 in Las Conchas Marsh in southeastern Louisiana, and 6 in Eufaula National Wildlife Refuge in eastern Alabama (all USA). Data for this study were collected during field work for other projects via personal observation and game camera traps employed at nesting sites. Game cameras were set to record one still photograph every 5 minutes using a battery-operated light board that signaled an IR sensor on a camera (Merchant et al. 2013). Nests were visited weekly from the onset of construction until egg hatching from



FIG. 1. Example photographs of bird species recorded at alligator nest sites. A) Great Blue Heron (*Ardea herodias*); B) Mourning Dove (*Zenaida macroura*); C) Limpkin (*Aramus guarauna*); D) Purple Gallinule (*Porphyrio martinica*); E) grackle (*Quiscalus* sp.); and F) Common Gallinule (*Gallinula galeata*).

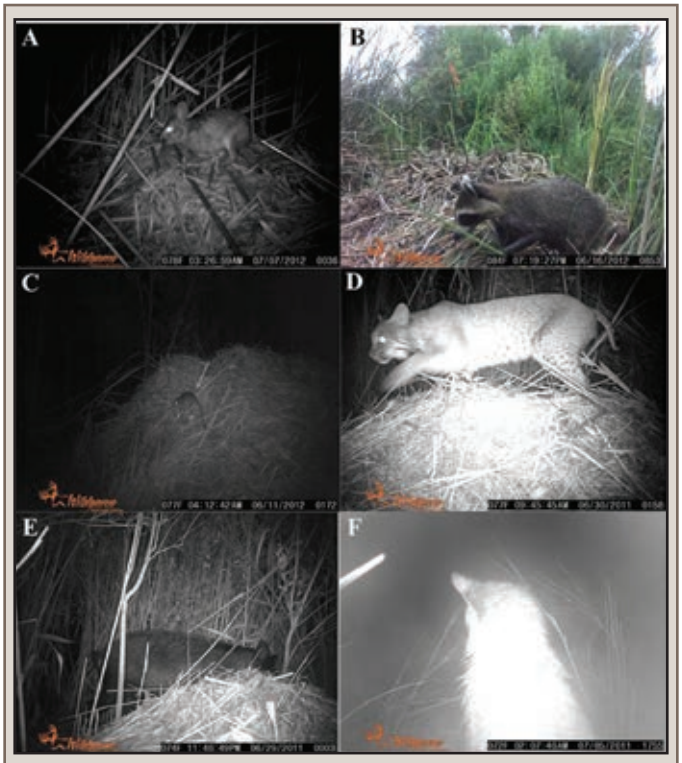


FIG. 2. Example photographs of mammal species recorded at alligator nest sites. A) rabbit (*Sylvilagus aquaticus*); B) Raccoon (*Procyon lotor*); C) Bobcat (*Lynx rufus*); D) Norway Rat (*Rattus norvegicus*); E. Feral Hog (*Sus scrofa*); and F) Gray Fox (*Urocyon cinereoargenteus*).

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TABLE 1. Vertebrates associated with American Alligator nests, and their observed activities.

Class	Species	Association type
Aves	Coot (*Fulica caribaea*)	Feeding
	Purple Gallinule (*Porphyrio martinica*)	Feeding
	Boat-tailed Grackle (*Quiscalus major*)	Feeding
	Great-tailed Grackle (*Quiscalus mexicanus*)	Feeding
	Louisiana Night Heron (*Nycticorax nycticorax*)	Feeding
	Limpkin (*Aramus guarauna*)	Feeding
	Great Blue Heron (*Ardea herodias*)	Feeding
	American Egret (*Ardea alba*)	Feeding
	Snowy Egret (*Egretta thula*)	Feeding
	Cattle Egret (*Bulbulcus ibis*)	Feeding
	Reddish Egret (*Egretta rufescens*)	Feeding
	Least Bittern (*Ixobrychus exilis*)	Feeding
	Little Blue Heron (*Egretta caerulea*)	Feeding
	Black-crowned Night Heron (*Nycticorax nycticorax*)	Feeding
	Glossy Ibis (*Plegadis falcinellus*)	Feeding
	American Bittern (*Botaurus lentiginosus*)	Feeding
	Tricolor Heron (*Egretta tricolor*)	Feeding
	Green Heron (*Butorides virescens*)	Feeding
	Mourning Dove (*Zenaida macroura*)	Feeding
	Belted Kingfisher (*Megaceryle alcyon*)	Feeding
	Mockingbird (*Mimus polyglottos*)	Feeding
Mammalia	Raccoon (*Procyon lotor*)	Feeding
	Feral Hog (*Sus scofra*)	Feeding
	Hispid Cotton Rat (*Sigmodon hispidus*)	Nesting
	Norwegian Rat (*Rattus norvegicus*)	Nesting
	Marsh Rice Rat (*Oryzomys palustris*)	Nesting
	Mice?	Nesting
	Eastern Cottontail Rabbit (*Sylvilagus floridanus*)	Unknown
	Swamp Rabbit (*Sylvilagus palustris*)	Unknown
	Gray Fox (*Urocyon cinereoargenteus*)	Feeding on rodents?
	Bobcat (*Lynx rufus*)	Feeding on rodents?
Reptilia	American Alligator (*Alligator mississippiensis*)	Nesting/Basking
	Red-eared Slider (*Trachemys scripta*)	Nesting/Basking
	Stinkpot (*Sternotherus odoratus*)	Nesting
	Yellow-bellied Water Snake (*Nerodia erythrogaster*)	Nesting/Basking

2010 through 2012 at J. D. Murphree WMA. Data was collected during the same season in 2010 and 2011 at Las Conchas Marsh, and only during the 2012 nesting season at Eufaula NWR. Animal species that were identified from photographs were taxonomically organized for alpha diversity. Abundance was not taken into account.

Results and discussion.—Of 34 vertebrate species observed associated with alligator nest mounds, 22 were birds (Table 1, Fig. 1), 14 of which were wading birds or waterfowl. At least ten mammal species were observed associated with nest mounds (Fig. 2). Three species of murids were identified: the Marsh Rice Rat (*Oryzomys palustris*), the Hispid Cotton Rat (*Sigmodon hispidus*), and the invasive Norway Rat (*Rattus norvegicus*). Other murid species could not be identified because of their small size and the low resolution of the game camera, thus we have characterized the number of mammal species as "at least ten." Aside from nesting female alligators, reptile species identified included two turtle species (*Trachemys scripta* and *Sternotherus odoratus*), representing two different families, one water snake (*Nerodia erythrogaster*), and one juvenile American Alligator (Table 1). Ants and termites (species unknown) were also observed colonizing nests when we excavated the nests, but were not identified to lower taxonomic levels.

The nature of the association between observed species and alligator nests varied among taxonomic groups. Birds were observed primarily using nests mounds as staging grounds to feed in nearby water or directly feed on invertebrates associated with the nests, although the photos selected do not necessarily reflect these activities, as they were chosen on the basis of clarity and position so as to make identification easier for the reader. Of mammal species, raccoons and feral hogs were observed during the predation of alligator eggs. At least three species of murids (and two other unidentified species) were observed nesting within alligator nests (Table 1). Associations of the Bobcat and rabbits with nests were undetermined. We speculate that Bobcat and Gray Fox were hunting rodents that lived within the nests, and that both rabbit species were using the elevated nests for defecation. Both turtle species were observed nesting in old alligator nests, while only one (*Trachemys scripta*) was seen basking on alligator nests. *Nerodia erythrogaster* was also observed in close association with a nest, using it for basking and was later determined to have deposited offspring in the same nest, although the mother is unconfirmed. The use of old crocodilian mound nests by nesting tutles is probably a common event, as several turtles, including *Trachemys dorbigni* and *Phrynops hilari*, commonly use the nests of *Caiman latirostris* in Argentina for deposition of eggs (Alba Imhoff, pers. comm.).

Alligators play a complex role in wetland ecosystems (Kushlan and Kushlan 1980), and this study expands our understanding of that function from the prespective of nest mounds alone. Such architecture may increase available terrestial space in marsh systems and serve as functional refugia or advantageous structures for many taxa. Alligators guarding their nests may deter nesting turtles from using the mounds (Kushlan and Kushlan 1980). However, differences in maternal attendance by individual alligators and differences in maternal nest defense intensity may allow some taxa to associate with alligator mounds, which would protect them from other predators, or allow the predation of alligator eggs.

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Road Effects on Amphibian Populations: Vehicles as a Means of Dispersal in Treefrogs

No matter where we look it is clear to see that humans have altered Earth's ecosystems (Vitousek et al. 1997). Amphibians as a single group have been disproportionately impacted by these alterations (Stuart et al. 2004) and have therefore received an enormous amount of scientific and public attention in trying to understand the mechanisms of decline as well as potential solutions to them (for review see Beebee and Griffiths 2005). One often cited mechanism of decline is habitat loss and fragmentation (for review see Cushman 2006), in particular the effects of urbanization (Hamer and McDonnell 2008) and the roads associated with it (Findlay and Bourdages 2000; Hels and Buchwald 2001).

Roads in general represent one of the most widespread impacts on natural ecosystems and have been shown to have negative effects on a diverse set of organisms (for reviews see Spellerberg 1998; Trombulak and Frissell 2000). A recent synthesis of over 40 years of data concerning road mortality on amphibians clearly demonstrated the profound negative impact roads are having on amphibians and that current mitigation efforts are not likely to ameliorate this threat (Beebee 2013). In addition to direct mortality, roads are a major source of habitat fragmentation leading to decreased connectivity within landscapes and ultimately altering dispersal patterns of wildlife (Clobert et al. 2001). Amphibians are often cited as having low dispersal rates and capacity in an already naturally patchy environment, which exacerbates the negative impact of habitat fragmentation by roads (Cushman 2006; Hamer and McDonnell 2008). Safner et al. (2011) concluded that habitat fragmentation due to roads could lead to demographic and genetic isolation of amphibian populations, which is likely to result in a higher extinction risk.

However, despite the clear negative impacts of roads there are certain instances where roads may positively impact amphibian populations. For instance, amphibians have been shown to utilize roadway ditches, canals, and hedgerows as a means of dispersal through the landscape (Brown et al. 2006; Ficetola and DeBernardi 2005). Frogs of the genus *Eleutherodactylus* have been documented to use the transport of horticultural materials as a means of unintentional dispersal to a number of locations throughout the world (Kraus et al. 1999 and citations therein). Traffic itself has also been implicated as a dispersal mechanism for plant species with particular emphasis being given to the spread of invasive species (Spellerberg 1998 and citations therein). Duffield and Bull (2002) reported on a male Gidgee Skink (*Egernia stokesii*) that was inadvertently transported to a new location by a research vehicle in Australia. But direct traffic dispersal mechanisms have received little to no attention in the amphibian literature. Herein I report on personal observations made over a two-week period in which my vehicle was directly used as a dispersal mechanism for both native and non-native treefrogs and I discuss future directions to explore and expand on these observations.

Observations.—Over a two-week period (16–20 and 23–27 September 2013), I recorded six instances of transporting treefrogs via my vehicle while travelling from my home in

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FIG. 1. An *Osteopilus septentrionalis* juvenile on my driver-side mirror at 0648 h on 25 September 2013. This individual jumped off the mirror shortly after I left my driveway and was not transported to Florida Gulf Coast University.

Southwest Florida to my place of employment at Florida Gulf Coast University (FGCU). My vehicle is a black Nissan Titan pickup truck with an open bed and a black plastic bed liner. In every instance my vehicle had been parked in the same spot during the night and was wet in the morning either from rain, community sprinklers or condensation. The environment surrounding where I was parked is a typical south Florida residential landscape of manicured lawns, ornamental shrubs, trees, and palms, a water retention pond and high house density (average lot size approximately 700 m^2). The observation and travel times were between 0630 h and 0730 h lasting approximately 25 minutes. The route of travel was always the same, resulting in a linear movement of 12 km and a road distance of 22 km.

The first instance of vehicular dispersal involved a juvenile Green Treefrog (*Hyla cinerea*) and an adult Squirrel Treefrog (*Hyla squirella*). The juvenile *H. cinerea* was observed before I left my home and was hiding in-between the plastic housing and the backside of the driver-side mirror. For almost the entire drive to FGCU I was able to make visual contact with the frog. Upon arriving at FGCU as I opened the driver-side door the frog leaped out from behind the mirror and quickly made its way into some tall grass. As I closed the door and began to walk around the truck I observed the adult *H. squirella* in the bed of the truck near the tailgate. I chose not to harass the frog and when I returned at the end of the day the frog was no longer there. So, I assumed that the frog had been there since I left my home and that it left the truck at some point during the morning as the sun rose and made the truck bed an unpleasant thermal environment.

After this first instance I began to do a quick survey of my vehicle before I left each morning. On 9 of the 10 days during the observation period I observed treefrogs on my vehicle, usually on the windshield, in the bed, or in/on the mirrors (Fig. 1). In total I observed 31 frogs (including the 2 from the first instance; Table 1) using my truck as early morning habitat; 5 individuals were *H. cinerea* (all juvenile), 3 were *H. squirella* (2 adults and 1 juvenile), and the remaining 23 were the exotic invasive Cuban Treefrog (*Osteopilus septentrionalis*; 4 adults and 19 juveniles). Only five other times (after the first instance) did I observe the frogs at my house and then again when I arrived at FGCU. The 6 frogs (not including the first 2) that made the whole journey and then were not relocated on my truck at the end of the day were juvenile *O. septentrionalis* (2 on the driver-side mirror, 3 in the bed, and 1 actually made the whole trip on my windshield). I observed 15 of 23 frogs (not including those that made it all of the way to FGCU) leaping from my vehicle when I was still within my housing development and while the truck was moving. The other 8 frogs (1 *H. cinerea* juvenile, 1 *H. squirella* adult, 2 *O. septentrionalis* adults, and 4 *O. septentrionalis* juveniles), I did not directly observe leaving my vehicle nor did I observe them when I reached FGCU. So, they either leapt off at some point during transport, made it to FGCU without my detection, or remained on my vehicle throughout the day and I possibly transported them back to my home or some other unknown destination.

Discussion.—I suspect that all of my observations were highly dependent on weather patterns and time of year. The summer

TABLE 1. Treefrogs observed using my vehicle as early morning habitat and frequency of dispersal from my home to FGCU (a 12-km straight-line distance). J = juvenile; A = adult.

	Hyla cinerea		*Hyla squirella*		*Osteopilus septentrionalis*	
Date (M/D)	# observed	# to FGCU	# observed	# to FGCU	# observed	# to FGCU
09-16	1 J ; 0 A	1 J ; 0 A	0 J ; 1 A	0 J ; 1 A		
09-17			1 J ; 0 A		2 J ; 1 A	1 J ; 0 A
09-18			0 J ; 1 A		3 J ; 0 A	
09-19	1 J ; 0 A				3 J ; 1 A	
09-20					1 J ; 0 A	1 J ; 0 A
09-23	1 J ; 0 A				3 J ; 1 A	2 J ; 0 A
09-24	1 J ; 0 A				2 J ; 0 A	1 J ; 0 A
09-25					1 J ; 0 A	
09-26	1 J ; 0 A				2 J ; 1 A	1 J ; 0 A
09-27					2 J ; 0 A	
Totals	5 J ; 0 A	1 J ; 0 A	1 J ; 2 A	0 J ; 1 A	19 J ; 4 A	6 J ; 0 A

of 2013 was an exceptionally wet and rainy season in Southwest Florida. Additionally, I had seen and heard a lot of reproductive effort from all three of these treefrog species leading up to and during the period of observation, which may account for the prevalence of juvenile treefrogs in my data. This mechanism for dispersal may not be as intense at other times of year or during drier years. However, given the fact that I did observe at least 1 adult being transported, it may still have an impact on population dynamics.

In addition to my data, during informal conversations with colleagues and students regarding these observations, I have had a high percentage of people confirm similar observations of their own. Despite the lack of information available in the literature regarding this mode of dispersal, there is an overwhelming amount of anecdotal evidence of its frequency. Therefore, I must conclude that this may be a significant dispersal mechanism, at least for treefrogs in Southwest Florida. At the very least the mechanism needs to be rigorously examined, possibly through a randomized volunteer system where people can make and record similar observations to what I have done within this manuscript. If the mechanism is confirmed, an experimental project could be designed to determine the likelihood of transported individuals to persist in their new habitat and whether persistence varies by species. Finally, population genetic investigations could be used to elucidate how influential this type of dispersal mechanism is on the various populations.

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Observations of a Remnant Population of the Critically Endangered Hylid Frog *Isthmohyla rivularis* on the Monteverde Cloud Forest Preserve, Costa Rica

Global amphibian declines are recognized as a very serious, wide-spread phenomenon, with over 40% of all amphibian species at risk of extinction and as many as 120 species that may have gone extinct in recent decades (IUCN 2012; McCallum 2007; Stuart et al. 2004). Some regions have experienced more decline than others, and many amphibian populations in Central and South America have decreased. The implications of these declines are compounded by the biodiversity in this region, which is home to approximately half of the amphibian species in the world (Stuart et al. 2008). Costa Rica, with its size considered, has one of the highest diversities of amphibians in the world and the percentage of threatened species is comparable to global levels with 31% either extinct (1%), critically endangered (12%), endangered (12%) or vulnerable to extinction (7%) (IUCN 2012).

A troubling aspect of many of these declines is that they have occurred in protected areas. The Monteverde Cloud Forest Preserve (MCFP) in Costa Rica consists of 4,025 hectares of pristine forest, and is part of a larger complex of 50,000 hectares of protected forest (G. Alvarado pers. comm.) yet even this area has experienced severe population declines and extinctions of amphibians (Pounds 2000). A well-known example is the charismatic golden toad (*Incilius periglenes*), listed as exctinct by

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FIG. 1. Study stream on the Atlantic slope of the Cordillera Tilarán, Costa Rica, within the Monteverde Cloud Forest Preserve. This stream typifies the lower montane cloud forest in which the recently rediscovered local population of *Isthmohyla rivularis* occurs, and where observations and stream surveys were conducted.

the IUCN (2012). A study by Pounds et al. (1997) in the MCFP revealed that ~40% of the species formerly occurring at their study sites were not detected, and were considered by some to have gone locally extinct (Wheelwright 2000).

Amphibian declines have not occurred evenly across taxa in the New World. For example, approximately half of all species in the families Bufonidae (55%) and Leptodactylidae (47%) are threatened as are 27% of Hylidae species (Young et al. 2004). Within the family Hylidae, the genus Isthmohyla is endemic to mountainous regions of Central America and has a high proportion of threatened species, with over half of the species threatened and 7 of 15 species critically endangered (Stuart et al. 2008). One such species, *Isthmohyla rivularis* (Taylor 1952) has experienced severe population declines throughout 80% or more of its range in Costa Rica and was thought to have disappeared from Panama (Solís et al. 2008), although recent survey efforts by Hertz et al. (2012) have documented *I. rivularis* in Panama. This species was once abundant on the MCFP but populations declined sharply and it was considered locally extinct by some until 2007 when it was rediscovered (Solís et al. 2008). The cause of the decline in this species, particularly populations in and near the MCFP is not known. However, there are several hypotheses regarding possible factors of declines worldwide that may also be pertinent to the current situation in the MCFP. These factors include pollution (Davidson 2004), climate change (Pounds et al. 2006) and disease (Lips et al. 2006). Synergistic effects of these various factors are also possible (Pounds and Crump 1994). Other factors such as habitat loss (Gallant et al. 2007), exotic species (Kats and Ferrer 2003), and over harvest (Warkentin et al. 2009) seem to have little applicability to species in the MCFP.

Although this species was once common, very little is known about its breeding ecology. The rediscovery of this species presents a rare opportunity to investigate the ecology and abundance of a critically endangered species at the location of its reappearance within the Monteverde Cloud Forest Preserve.

Materials and methods.—Isthmohyla rivularis is a small, relatively drab, yellow-tan to gray tree frog that is associated with fast-flowing, highland streams in which its tadpoles develop (Duellman 2001; Savage 2002). The chorusing behavior of *I. rivularis* is generally described as occurring in herbaceous vegetation and shrubs at the margin of fast-flowing streams and tadpoles are described as using an oral disk to cling to rocks in the stream (Duellman 2001; Savage 2002; Stuart et al. 2008). The egg deposition and amplexus of this species have not been described.

We conducted a stream survey during 13–15 June 2011 on the MCFP at an area within the preserve known as El Valle (Fig. 1). The site is on the Atlantic slope of the Tilarán Cordillera at an elevation of 1350 m and is comprised of lower montane wet forest (Holdridge 1967). Surveys took place over three consecutive nights and consisted of 42 person-hours during the suspected peak of breeding activity (Savage 2002). Surveys began between 1815 and 1900 h and lasted until 2015 to 2130 h. Precipitation, temperature, and humidity were recorded at a local automated weather station operated by the MCFP staff. The lengths of stream surveyed on June 13, 14, and 15 were 290, 303, and 262 m respectively, and these lengths were consecutive and non-overlapping. We conducted surveys by slowly walking the stream, visually inspecting vegetation for the presence of frogs, and listening for advertisement calls. Calling males were then located and captured. Because this species is critically endangered, we did not feel tissue or voucher specimens were warranted. However, we used morphological and call characteristics to positively identify the species in the field. Our field identification was corroborated by MCFP staff biologists (A. Pounds, pers. comm.). We recorded snout–vent length (SVL) and mass before returning each frog to the flagged capture site. The following day, the distances between calling males, height at calling positions, and distances from the stream edge were determined with a meter tape.

In addition to encounter surveys, we used a bank-to-bank belt transect method (Welsh and Ollivier 1997) to survey 303 m of stream for tadpoles. At 10-m intervals the wetted width and the depth at ¼, ½, and ¾ stream widths were measured to determine stream profile, and we characterized the predominant water class (e.g., riffle, rapid, cascade, glide, pool) (Kaufmann and Robison 1998). The predominant substrate of the stream was noted (e.g., bedrock, boulder, cobble, gravel, sand, mud, organic debris). At each 10-m interval, a 1-m belt transect was searched for the presence of *I. rivularis* tadpoles by carefully disturbing the substrate while visually inspecting for the presence of tadpoles, and using a net to collect any dislodged tadpoles swept downstream.



FIG. 2. Adult male *Isthmohyla rivularis* found in situ, representing the typical advertisement calling site on plant stems, encountered in the Monteverde Cloud Forest Preserve, Costa Rica.

Results.—Climatic conditions during our sampling period were similar to the monthly mean for this site. The daily precipitation during the study period was 3.6, 31.2, and 8.6 mm (June 2011 mean = 9.3 mm) while the mean temperature for each day was 17.6, 17.4, and 16.5°C (June 2011 mean = 17.4°C). The mean temperature for the survey hours each night was 17, 16, and 16°C. The mean humidity during the survey hours each night was 87, 86, and 86% (MCFP, unpubl. data).

Fourteen chorusing males were encountered and 12 were captured during 42 h of survey effort (0.3 frogs per person-hour). Males ranged in size from 30.0 to 33.7 mm SVL and 1.10 to 3.00 g. Of those located, the distances between adjacent chorusing males ranged from 0.1 to 160.9 m with a mean of 73.0 m (SD = 60.3 m). Although not indicated by the mean, six of the chorusing males (3 pairs) were found within 2 m of one another. Calling positions ranged from 0.0 to 10.4 m from the stream edge with a mean of 2.2 m (SD = 2.7 m). They were perched from 0.2 to 1.1 m above the ground with a mean of 0.8 m (SD = 0.6 m). All frogs were found perched on stems (see Fig. 2), mostly the stems of small dicot trees and shrubs (N = 10), but were also encountered on aroid and fern stems (N = 2), but never on leaves.

The section of stream surveyed for tadpoles had a mean width of 2.3 m. The mean depth at the center was 0.2 m and the mean depth at ¼ and ¾ widths was 0.1 m. The stream classes at transects were as follows: riffle (57%), cascade (15%), rapid (12%), glide (12%), and pool (4%). The stream substrate was predominantly cobble with areas of boulders and coarse woody debris. No *I. rivularis* tadpoles were encountered; however, we noted the presence of various stream invertebrates.

Discussion.—Our findings quantitatively support anecdotal accounts of *I. rivularis* calling near the margin of streams and at relatively low perch heights (Duellman 2001; Savage 2002; Solís et al. 2008; Stuart et al. 2008). We also observed one frog calling 10.4 m from the stream margin, which supports anecdotal comments by Duellman (2001) and Savage (2002) that this species utilizes habitat beyond the immediate proximity of the stream. Future research could include focal studies to determine if males initiate chorusing away from the stream and then move toward the stream edge or if they chorus at constant distances from the stream throughout the night. Stems appear to be the preferred perch location, as all of the chorusing males were calling from stems and never leaf surfaces. Observations reported by Hertz et al. (2012) on calling male *I. rivularis* in Panama were similar, with 3 of 4 males encountered being found calling from stems. Due to their perch site selection, calling males were often very well concealed within the interior of each plant. Taylor (1952) described being unable to locate calling males until he removed nearly all the vegetation along 200 m of the stream margin forcing frogs to call from remaining clumps of vegetation. Hertz et al. (2012) also found that calling male *I. rivularis* were well-concealed within dense brush. Consequently, we located all male frogs by cuing in on their advertisement calls and none were located by visual encounter. This suggests that females may be much more difficult to locate. Future work might include intensive visual searching among woody plant interiors to determine if females utilize microhabitats similar to males.

The distances between chorusing males were extremely variable and did not seem to show any trend. Characterization of streamside vegetation might allow the determination of relationships between distribution and microhabitat differences. Our focal observations and an anecdotal account (G. Alvarado, pers. comm.) indicate that it is not uncommon for *I. rivularis* to call in clusters of two or more individuals within a few meters of each other. These previously unavailable observations improve our understanding of the microhabitat use and spatial distribution of calling male *I. rivularis*.

Our results also provide a rudimentary estimate of the relative abundance of this recently rediscovered local population of a critically endangered species. Our survey for tadpoles took place during the supposed peak breeding period (Savage 2002), and both Duellman (2001) and Savage (2002) report that historically tadpoles of *I. rivularis* at all stages of development could be found year round. Consequently, our failure to detect tadpoles may support an estimate of low population density at this site relative to historical abundance (Savage 2002). Continued research on this species is warranted including monitoring of this local population.

The scale of this project was limited spatially and temporally. However, the breeding ecology of *I. rivularis* likely does not vary greatly from site to site and the details we provide on calling site, microhabitat, and distribution along the stream margin should be useful in future survey efforts. To combat the spatial and temporal limitations of this work, future surveys for this species should be completed throughout its historical predicted range including sites where it was formerly documented (e.g., study sites of Pounds et al. 1997) as well as within areas modeled

as having high likelihood of harboring relictual populations (García-Rodríguez et al. 2012). Surveys should also be conducted at varying times of the year. Further aspects of this frog's breeding ecology need to be described including details on amplexus and egg deposition. Additional habitat characterization should be completed in order to improve conservation efforts for this critically endangered species and inform land management practices in areas where it is found. These efforts would not only improve the conservation of *I. rivularis* but potentially other stream breeding amphibians. Finally, explorations of current factors and historical causes of declines in the MCFP might be informative to local conservation efforts, as well as shedding light on other declines.

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Amphibian Diversity on Floating Meadows in Flooded Forests of the Peruvian Amazon

Floating meadows are often associated with Amazonian white-water flooded forests (varzea), where they grow between the tree line and open-water. Seasonal flooding in varzea results in an unstable forest floor for terrestrial species. However, floating meadows may offer a refuge for some species that would otherwise be displaced by rising water. Floating meadows consist of herbaceous water plants that begin growing at the end of the low water period, taking root in the waterlogged soils of river, channel and lake banks. As the water rises, some plant species grow rapidly upwards, others become free-floating and grow horizontally, expanding the surface area they occupy (Junk 1970, 1997). As water levels begin to recede, currents and rainfall can dislodge sections of floating meadows to create rafts that are then transported via the river current.

The importance and diversity of floating meadows has been highlighted for several taxa (Goulding et al. 1996; Junk 1997; Schiesari et al. 2003; Dias et al. 2011; Ferreira et al. 2011), yet studies focusing on amphibian use of floating meadows are relatively scarce. Junk (1973) found that amphibians were rarely encountered on floating meadows. However, methodology was not provided by Junk (1973), and if nocturnal surveys were not undertaken, amphibians were unlikely to have been adequately sampled. Carrying out specific amphibian surveys, Hödl (1977) found 15 anuran species on floating meadows and concluded that this habitat was a potential breeding site. Hoogmoed (1993) published a list of the herpetofauna known to occur on or near to floating meadows in Suriname, Bolivia, and Brazil, adding to Hödl's (1977) list. This research brought the total number of amphibian species recorded on floating meadows to 26 (Hoogmoed 1993). On the Solimoes River, Schiesari et al. (2003) observed 42 individuals comprising eight anuran and one caecilian species, all on floating meadow rafts. They highlighted the importance of rafts of floating meadow vegetation as dispersal vectors for fish and potentially also for amphibians (Schiesari et al. 2003). In a preliminary study of only 18 days, Upton et al. (2011) found 16 anuran species on floating meadows. The amphibians recorded on floating meadow habitats to date are listed in Table 1.

This paper aims to: 1) Update the current list of amphibians found on floating meadows in Peruvian varzea flooded forest, and 2) update the information on reproductive habitat use provided by Hödl (1977), which showed evidence of reproductive behavior on the floating meadow habitat (see Hödl 1977; Fig. 3, Table 1).

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Materials and Methods

Study site.—Our study was conducted in the Samiria River basin of the Pacaya-Samiria National Reserve, Loreto, Peru

Table 1. List of amphibian species that have been recorded on, or near, floating meadows (x = on, [x] = near). Numbers for localities: 1. Brazil, Solimões (Hödl 1977); 2. Suriname, Para River (Hoogmoed 1993); 3. Bolivia, Perserverancia (Hoogmoed 1993); 4. Brazil, Caxiuanã (Hoogmoed 1993); 5. Brazil, Solimões (Schiesari et al. 2003).

Species	1	2	3	4	5
ANURANS (27)					
BUFONIDAE (1)					
Rhinella marina		x		[x]	x
HYLIDAE (23)					
Dendropsophus haraldschultzi	x				
Dendropsophus leucophyllatus		x	x		x
Dendropsophus minusculus		x			
Dendropsophus nanus	x		[x]		
Dendropsophus rossalleni	x				
Dendropsophus triangulum	x				
Dendropsophus walfordi					x
Hypsiboas boans	x	[x]			
Hypsiboas geographicus		[x]	x		
Hypsiboas lanciformis	x				
Hypsiboas punctatus	x	x	x		x
Hypsiboas raniceps	x		[x]		x
Hypsiboas wavrini				x	
Dryaderces pearsoni			x		
Lysapsus boliviana			x		
Lysapsus caraya				x	
Lysapsus laevis	x				x
Scinax boesemani	x				
Scinax nebulosus	x	x	x	x	
Scinax ruber		x			
Sphaenorhynchus carneus	x				x
Sphaenorhynchus dosisae	x				
Sphaenorhynchus lacteus	x		x		
LEPTODACTYLIDAE (2)					
Leptodactylus leptodactyloides					x
Leptodactylus wagneri	x	[x]	x		
PIPIDAE (1)					
Pipa pipa		x			
CAECILIANS (1)					
TYPHLONECTIDAE (1)					
Typhlonectes compressicauda					x
Total species on floating meadows (and adjacent)	15(15)	7(10)	8(10)	3(4)	9(9)

TABLE 2. Species list including number of individuals captured and life stages on the floating meadows of the Samiria River in Pacaya-Samiria National Reserve, during May–June 2009 and March–October 2012. F = gravid female; M = calling male; A = adult (sex unknown); J = juvenile; *above the floating meadow either on a branch or tree trunk; ° not previously recorded on floating meadows.

Species	F	M	A	J	Total 2009	Total 2012
BUFONIDAE (1)						
Rhinella marina			9		1	8
HYLIDAE (15)						
Dendropsophus haraldschultzi		1	29	10	2	38
Dendropsophus leali	1	1	3			5°
Dendropsophus rossalleni		3	23		16	10
Dendropsophus triangulum	12	106	232	21	33	338
Hypsiboas boans		1				1*
Hypsiboas lanciformis		14	8	3		25
Hypsiboas punctatus	30	38	184	62	14	300
Osteocephalus taurinus			1			1°
Scarthyla goinorum			2			2°
Scinax garbei		2	8	4	1°	13
Scinax pedromedinae				2		2°
Scinax ruber			3		1	2
Sphaenorhynchus carneus	2	28	44	6	5	75
Sphaenorhynchus dorisae	2	6	50	2	38	22
Sphaenorhynchus lacteus	1	16	50	3	22	48
LEPTODACTYLIDAE (2)						
Leptodactylus leptodactyloides			23		7	16
Leptodactylus petersii			20		12°	8
PIPIDAE (1)						
Pipa pipa			1			1
Total number of species	6	11	17	10	12	19

(4.893256°S, 74.355526°W). The Pacaya-Samiria National Reserve is one of the largest varzea forests in western Amazonia spanning over 20000 km^2 between the confluence of the Ucayali and Marañon Rivers.

Data collection.—Preliminary data for this study were collected in May and June 2009, with more extensive surveys conducted from March to October 2012. Most surveys were carried out at night from 1800–2400 h, with some daytime searches between 1400–1700 h.

The floating meadows surveyed were located in the Samiria River basin at PV1 Shiringal, PV2 Tacshacocha, Huishto Cocha, and PV3 Hungurahui. These sites cover a small proportion of the Samiria River Basin, which spans a wide area; however, they were chosen as they have varying levels of disturbance by local fishermen and tourism. At each site, surveys were conducted across all river systems, in both the main Samiria River and in adjacent channels and lakes. In total, 221 surveys were conducted, 52 in 2009 and 169 in 2012. The surveys in 2012 were split as follows: 71 in lakes, 60 in channels, and 38 on the main Samiria River. Around the lake edges, floating meadow surveys were conducted at 100-m intervals. Within the channel and main river, less floating vegetation was available to survey, so all sections were surveyed at least once. A 10-m boat with outboard motor was slowly driven into the floating meadow vegetation, causing it to part on either side of the boat with the aim of reducing disturbance. On each sampling occasion, an area of 2 m on either side of the boat (50 m^2 in total) was searched for fifteen minutes. During this time, all frogs encountered were captured and placed in individually marked pots. Time of capture, species, behavior (e.g., calling male) and location (including plant species and height above water), were recorded. All surveys were completed with one local field guide, one biologist, and three or four student volunteers. To locate frogs at night, one main flashlight was used by either a guide or the biologist (CB2-L1 Clubman Deluxe, LI-ION 9.2AH half-million candle power); all students used smaller flashlights such as the Petzl Tikka to search. Species identification was undertaken using several field guides (Ouboter and Jairam 2012; Duellman 2005; Bartlett and Bartlett 2003; Rodriquez and Duellman 1994). Although identification of Amazonian amphibians can be very difficult, many of the species observed on floating meadows are distinctive and can be quickly identified in the hand using identification guides. Voucher specimens were not taken as the collection of specimens from within this protected reserve was prohibited under the permit and authorization being used (Resolucion Jefatural No 005-2013-SENANP-JEF).

Data analysis.—To analyze microhabitat use, the data were separated into the four main genera: *Dendropsophus, Hypsiboas, Scinax,* and *Sphaenorhycnhus.* Kruskal-Wallis tests were then used to determine if there were significant differences in the median calling heights among species in the same genus.

RESULTS

Nineteen amphibian species and 1090 individuals were recorded on the floating meadow habitat representing four families (Table 2). Six species have not been previously recorded on floating meadows: *Dendropsophus leali, Osteocephalus taurinus, Scarthyla goinorum, Scinax garbei, Scinax pedromedinae,* and *Leptodactylus petersii.* Most of the species recorded on floating meadows were hylids (15) compared with only two leptodactylids, one bufonid, and one pipid. The most abundant species were *Dendropsophus triangulum* and *Hypsiboas punctatus* with 371 and 314 individuals, respectively. No other species was represented by more than 100 individuals. *Scarthyla goinorum* and *Scinax pedromedinae* were both represented by only two individuals while *Pipa pipa* and *Hypsiboas boans* were represented by just one individual each (Table 2).

The median height in which amphibians were found and the most commonly used (over 50% of encounters) plant species are presented for all species observed (Fig. 1, modelled after Hödl 1977, figure 3). One species, *Pipa pipa,* was found swimming at the water surface; all others were on the floating meadow or adjacent emergent vegetation. All leptodactylid and bufonid species were most often found on Water Lettuce (*Pistia stratiotes*), a species that floats on the water surface. *Paspalum repens* was the most commonly used plant species on the floating meadows and also the most abundant in the survey area. Only in *Sphaenorhychus* were there significant differences in perch height between species (Kruskal-Wallis chi squared = 16.62, $P < 0.05$, df = 2), with *S. carneus* occupying lower heights than *S. lacteus.* Calling males,

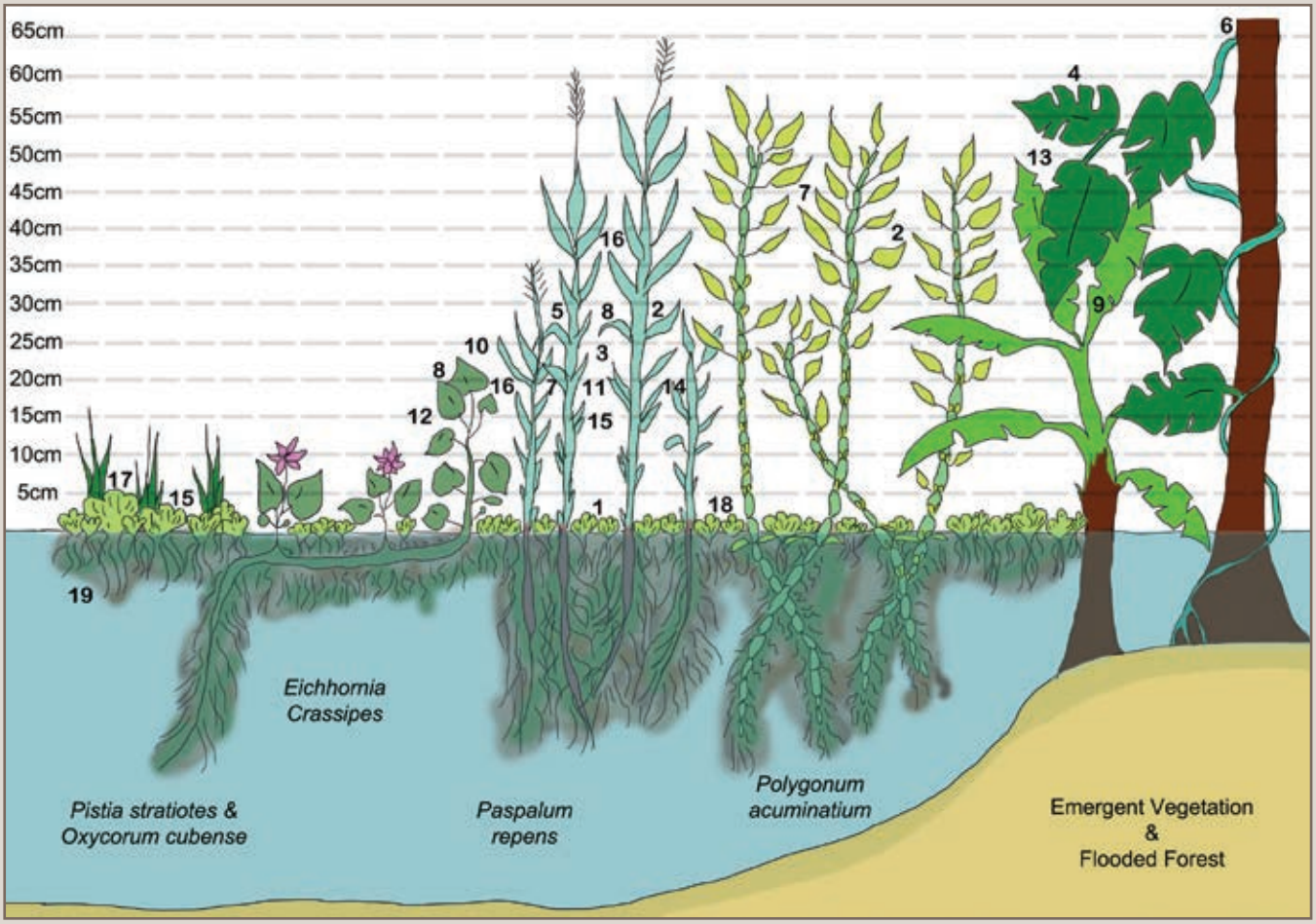


FIG. 1. Anuran species found on floating meadows, the most common plant species on which they were found, and the median height at which they were found. 1) *Rhinella marina* 2) *Dendropsophus haraldschultzi,* 3) *Dendropsophus leali,* 4) *Dendropsophus rossalleni,* 5) *Dendropsophus triangulum,* 6) *Hypsiboas boans,* 7) *Hypsiboas lanciformis,* 8) *Hypsiboas punctatus,* 9) *Osteocephalus taurinus,* 10) *Scarthyla goinorum,* 11) *Scinax garbei,* 12) *Scinax pedromedinae,* 13) *Scinax ruber,* 14) *Sphaenorhynchus carneus,* 15) *Sphaenorhynchus dorisae,* 16) *Sphaenorhynchus lacteus,* 17) *Leptodactylus leptodactyloides,* 18) *Leptodactylus petersii,* 19) *Pipa pipa.*

gravid females, and juveniles were all found on floating meadows, although only for hylids (Table 2, modelled after Hödl 1977). Calling males were observed for 11 of the 15 hylid species while ten species were represented by juveniles and six represented by gravid females. Leptopdactylids were only represented by adults, as were *Rhinella marina* and *Pipa pipa*.

DISCUSSION

Hylids were the most frequently encountered family on the floating meadows. The two most common species, *Dendropsophus triangulum* and *Hypsiboas punctatus*, are either rare or absent from the adjacent terrestrial habitat (pers. obs.), highlighting the importance of floating meadows for some hylid species. Other species were only represented by one or two individuals. One example is *Pipa pipa*, a fully aquatic species that is rarely encountered on land; this individual was caught swimming at the surface of the water. The floating meadow root system potentially offers refuge and cover to aquatic species such as *Pipa pipa*.

Few leptodactylids and bufonids were observed on the floating meadows, as these species are usually terrestrial and are regularly encountered on the forest floor within the leaf litter (Allmon 1991) or on river banks (Bartlett and Bartlett 2003), and it is therefore possible that frogs in these families are only using floating meadows as a refuge during high water periods. In both 2009 and 2012 the water level in Pacaya-Samiria exceeded all records from the last 100 years (Bodmer et al. 2012). During these high water periods up to 95% of the reserve can be inundated, with water levels reaching a depth of several meters within the forest. This reduced availability of terrestrial habitat may have displaced some individuals onto floating meadows.

Hödl (1977) noted frogs showing call site segregation, with most species associated with specific plant species. Calling males were regularly observed on the floating meadows in this study, with most species calling from a certain plant species at similar heights. For example the three *Sphaenorhynchus* species called from significantly different heights on *Paspalum repens*. Anuran morphology may influence plant choice, for example, the small *S. carneus* was sometimes observed calling from *Oxycoryum cubense*, a small grass species. Male *S. carneus* are usually between 15–18 mm and females 22–23 mm SVL, compared to *S. lacteus* males which are 26–29 mm and females 36–40 mm SVL (Rodríguez and Duellman 1994). The latter, larger species may be unable to physically climb up on this smaller grass species. Other species that showed preference for certain plants includes *D. triangulum*, which was most commonly found on *Paspalum repens*, and

H. punctatus, which was found on either *Paspalum repens* or *Eichhornia crassipes*. This is consistent with Hödl's (1977) findings in which *D. triangulum* and *H. punctatus* were both observed on plants in the genus *Paspalum*.

Hylids may potentially be using floating meadows for breeding, as calling males, gravid females, egg masses, and newly metamorphosed juveniles of twelve species were observed. These findings are consistent with Hödl's (1977) observations of calling males and pairs in amplexus on floating meadows. Many hylids are arboreal and are documented to move from higher strata to breed in temporary or permanent pools of water in the terrestrial habitat (Rodríguez and Duellman 1994; Bartlett and Bartlett 2003; Dodd 2010). However the flooded forest in the Pacaya-Samiria Reserve can be inundated for up to 6–9 months a year, resulting in an unstable terrestrial habitat. Additionally, the draining of floodwaters occurs rapidly, with fluctuations of up to 30 cm a day. Thus, temporary pools are only available for short periods, if at all.

Floating meadows may be a more stable habitat, available for the 6–9 months that the terrestrial habitat is flooded, and also offers an opportunity to study species that are not often encountered within the terrestrial habitat. In addition, floating meadows may offer an important refuge for other anuran families during extreme flooding. Marked oscillations in annual water levels are becoming more common due to climate change (Bodmer et al. 2012). The availability of floating meadows is dependent on the water level. Therefore it will be important to further elucidate the role of floating meadows in maintaining amphibian diversity in flooded forests as seasonal flooding becomes more extreme.

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Factors Influencing Habitat Occupancy of the Endangered Barrier Range Dragon (*Ctenophorus mirrityana*: Agamidae)

The habitat requirements of many reptile species worldwide are poorly understood. Yet for threatened and endangered species, this lack of knowledge has the potential to limit the success of species recovery and conservation programs. Further compounding this limitation of knowledge is that the collection of adequate datasets is usually not possible given small population sizes of threatened and endangered species.

Formerly recognized as an outlying population of Tawny Crevice Dragon (*Ctenophorus decresii*) due to similarities in dorsal color pattern and adjacent distribution, recent taxonomic revision of the *C. decresii* complex has revealed that a new species, *C. mirrityana* (Barrier Range Dragon), forms the New South Wales (NSW) populations (McLean et al. 2013). The Barrier Range Dragon is a small agamid measuring 8 cm (snout–vent length) that occurs in rocky hills and gorges of western NSW and is known from only three locations: Mutawintji National Park (Swan and Foster 2005), Koonaberry Mountain (one museum specimen), and the largest known population at Silverton (Sass and Swan 2010). Prior to the discovery of the Silverton population, the species had a highly restricted distribution (Sadlier and Pressey 1994) with the area of known occupancy being less than 1200 ha^2. With the likelihood of the degradation of these habitats by introduced herbivores such as feral goats and the potential risk of population loss due to a stochastic event such as fire, the former NSW *C. decresii* populations were listed as Endangered under the schedules of the NSW Threatened Species Conservation Act 1995 (OEH 2014). With the discovery of the Silverton population, an opportunity to better understand the factors influencing habitat occupancy of this endangered agamid arose with both large numbers of individuals and a large area of occurrence.

The aim of this study is to develop an understanding of the factors influencing habitat occupancy of the Barrier Range Dragon, which can then be used to guide future research and aid in the development of a species recovery plan and conservation program.

Methods

Study area.—The Study Area is located near Silverton approximately 30 km NW of the city of Broken Hill in far western NSW and within the Broken Hill Complex Bioregion (Thackway and Creswell 1995).

Field surveys.—Field surveys were conducted over 6 days in November 2007 for a total of 171 person-hours. Survey teams were comprised of two persons each—an experienced herpetologist and an assisting ecologist. Each team completed transects that were conducted either on foot or with a vehicle slowly driven on tracks that dissected the study area (Blomberg and Shine 1996). While the detectability of this species is the subject of another manuscript currently in preparation, the latter method (by vehicle) was deemed the most successful given that individuals sit high on exposed rocks and are easily visible from a moving vehicle despite the small size of this species. Team members visually scanned areas of potential habitat using high-powered binoculars seeking active and inactive animals. Survey locations were only visited on one occasion to ensure that individuals were recorded only once.

Habitat variables.—Habitat variables were measured at a random subset of sites where the Barrier Range Dragon was present (N = 32) and absent (N = 32) (total of 64 quadrats). Given that specific habitat data for the Barrier Range Dragon were unknown, a range of habitat variables were measured at sites where the species was present and absent. These variables were chosen with consideration of the known and hypothesized ecological requirements of the Tawny Rock Dragon and other members of *Ctenophorus* (Gibbons and Lillywhite 1981; Stuart-Fox and Owens 2003; Swan et al. 2004; Osborne 2005a,b; NGHEnvironmental 2008; OEH 2014) and those known from other studies to have an influence in reptile presence/absence such as grazing and ground microhabitat (Hadden and Westbrooke 1996; Hecnar and M'Closkey 1998; Fischer 2004; Sass 2004). The presence of Gidgee Skinks (*Egernia stokesi*) or their scats was also recorded given that past studies have suggested a negative correlation between this species and habitat occupancy by Tawny Rock Dragons (OEH 2014). This resulted in a total of 18 habitat variables being measured (Table 1). These were measured using a 10 m x 10 m quadrat centered where each individual was first observed or in the case of absent sites, the quadrat was centred on habitat where individuals were not observed. Rock crevice width was measured rock to rock to ensure independent variables, regardless of the presence of scats which could influence crevice width.

Statistical analysis.—Habitat variables were examined to determine potential differences in habitat at sites where Barrier Range Dragons were present and absent. These were analyzed using non-metric multidimensional scaling (nMDS) ordination to create a visual representation of the relationships between each habitat variable (Minchin 1987; Clarke 1993). Ordinations were performed in two dimensions, with 100 iterations for each dimension to guard against dissolute explanation (Wilkinson 1989). nMDS was chosen for the analysis because it is considered more robust to non-lineal effects when compared to other ordination techniques (Minchin 1987). Similarities between present/absent sites were calculated using the Bray-Curtis similarity measure (Bray and Curtis 1957). One-way analysis of similarities (ANOSIM) was then performed to compare each site and the presence of Barrier Range Dragons (Minchin 1987) using a 0.05 level of significance.

Where differences were identified through ANOSIM and the calculated 'R' statistic, these were further examined using

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SIMPER analysis. To facilitate interpretation of the nMDS, Spearman rank correlations were conducted between the scores of each dimension and the habitat variables. This procedure allowed determination of the variables that were most correlated with each of the two dimensional nMDS axes and likely to be variables of importance to the presence of the Barrier Range Dragon.

Results

All Barrier Range Dragons recorded were located on the main ridge systems that comprise the study area. The majority of these were found on the flatter tops of ridges (67%) with the remainder on the downslope away from the ridge top and in one case, in a creek gully. Barrier Range Dragons were more often recorded on an aggregation of rocks (89% of records) than a single, isolated rock. Along existing vehicular tracks that traverse the study area, 15 Barrier Range Dragons were observed displaying or basking on the rock spoil.

The nMDS ordination revealed that two dimensions were sufficient to provide a reliable representation of the 16 site-specific habitat variables specific to microhabitat analysis (stress value = 0.19). Habitat variables could not be separated based on a visual inspection of the MDS ordinations where the Barrier Range Dragon was present or absent, however, a slight pattern appears to be emerging with some grouping in the absent sites. ANOSIM found a statistically significant difference between habitats where the Barrier Range Dragon was present/absent (global R = 1, $p = 0.027$). Further analysis using SIMPER revealed that the percentage cover of exposed rock outcropping contributed to 43% and percentage cover of rocks between 251–500 mm contributed to 14% of the differences in habitat.

Additional nMDS ordination of habitat variables where the Barrier Range Dragon was present, revealed that no particular pattern was evident in habitat variables. Habitat variables were correlated within each nMDS dimension using Spearman-rank correlations which found seven of the 16 habitat variables were significantly correlated to the first dimension, whilst three variables were significantly correlated to the second dimension using a 0.01 level of significance (Table 2).

Significant correlations with the first dimension were percent cover of ground vegetation, level of grazing, rock size (101–250 mm, 501–1000 mm, > 1000 mm), crevice width (51–100 mm) and the degradation of crevices. For the second dimension, the level of grazing, rock size (251–500 mm) and degradation of crevices were significant correlations. Interestingly, some overlap between variables across each dimension occurred. These were the level of grazing and the degradation of crevices which are contributing most to levels of habitat quality.

Discussion

A critical component of conservation and species recovery plans is an understanding of the habitat requirements of species and populations. This paper provides the first study of the factors influencing habitat occupancy of a recently described species, *Ctenophorus mirrityana*. Variables associated with the size and structure of rock outcropping and the level of grazing were found to have the greatest influences on the presence of this lizard.

The influences of rock size and crevice width confirm that the Barrier Range Dragon is a rock-obligate species and we suggest that it is likely to have discrete preferences for microhabitat structure. The results of this study provide a basis for further investigations on the influence of rock and crevice size, two variables likely to be particularly important for habitat restoration and the potential success of translocation.

A key threatening process for many species, the competition and habitat degradation by feral goats (*Capra hircus*) (OEH 2014) is of particular relevance to the Barrier Range Dragon. Feral goats have already been implicated in the degradation of outcrops for other rock obligates such as the Broad-headed Snake (*Hoplocephalus bungaroides*) (Murphy 1996) and the Centralian

Table 1. Summary of habitat variables measured within each quadrat.

Habitat variable	Details
1. Vegetation cover	Percentage cover of ground vegetation
2. Bare ground	Percentage cover of bare ground
3. Rock outcropping	Percentage cover of exposed rock outcropping
4. Fallen timber	Percentage cover of fallen timber
5. Level of grazing	Number of pats (feral or native) as a surrogate for the current grazing level
6. Rock size (0–100 mm)	Percentage cover of rocks between 0–100 mm
7. Rock size (101–250 mm)	Percentage cover of rocks between 101–250 mm
8. Rock size (251–500 mm)	Percentage cover of rocks between 251–500 mm
9. Rock size (501–1000 mm)	Percentage cover of rocks between 501–1000 mm
10. Rock size (>1000 mm)	Percentage cover of rocks greater than 1000 mm
11. Crevice width (0–25 mm)	Number of rock crevices between 0–25 mm wide
12. Crevice width (26–50 mm)	Number of rock crevices between 26–50 mm wide
13. Crevice width (51–100 mm)	Number of rock crevices between 51–100 mm wide
14. Crevice width (>100 mm)	Number of rock crevices greater than 100 mm wide
15. Degradation of crevices	Percentage of crevices with goat scats within
16. Gidgee skink or scats	Presence or Absence of Gidgee skinks or scats
17. Landscape position	Position in the landscape (Ridge, Mid-slope, Valley)
18. Micro-landscape position	Position of the site (Slope, Flat, Gully)

Ranges Rock-skink (*Egernia margaretae*) (NPWS 2000), and given the level of significance in this study, the presence of rock crevices filled, or partially filled with goat scat is negatively contributing to habitat occupancy by *C. mirrityana*. In previous studies, grazing was suggested to be a key factor in determining the level and quality of habitat for many native species throughout the study area (NGHEnvironmental 2008). The impacts of heavy grazing by introduced herbivores are already known to be detrimental to reptile fauna. Hadden and Westbrooke (1996) found that reptiles were affected by changes in vegetation structure by overgrazing as this reduces microhabitat availability and habitat quality. Sadlier and Pressey (1994) identified that grazing was likely to adversely affect reptile species in the western division of NSW. While the results of our study suggest that feral goats are negatively impacting the Barrier Range Dragon, the absence of long-term data on the populations of Barrier Range Dragon and feral goats within the study area suggests that long-term research is required to gain a detailed understanding of these impacts.

Barrier Range Dragons are known from only two disjunct populations approximately 100 km apart; however, dedicated field surveys have not been undertaken in potentially suitable habitat elsewhere in the Barrier Range Complex Bioregion and this species might be more widespread than currently known. Conversely, the two known populations may be relicts from an historically wider distribution. Nonetheless, the previous endangered status applied to *C. decressi* under the NSW Threatened Species Conservation Act 1995 should apply to the recently described *C. mirrityana* in the absence of recent field surveys. Additionally, field surveys of potentially suitable habitat are recommended to determine the current distribution of this newly described species in order to adequately assess its current conservation status as it may qualify for listing as Critically Endangered under NSW legislation and nomination for listing under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999.

For the first time, this study identifies the factors influencing habitat occupancy for Barrier Range Dragon. The development of a species recovery plan, a conservation and land management program, further research of the Silverton population, and field surveys of potentially suitable habitat across the Broken Hill Complex Bioregion are likely to provide a greater understanding of this newly described species, improve the long-term security of known populations, and allow for an adequate assessment of its current conservation status.

Table 2. Spearman-rank correlations coefficients of the 16 habitat variables against the two MDS dimensions. Significance at 0.01 is marked with two asterisks, 0.05 with one asterisk (two-tailed).

Habitat variable	Dimension 1	Dimension 2
1. Vegetation cover	0.376**	0.214
2. Bare ground	-0.075	-0.19
3. Rock outcropping	0.72	-0.218
4. Fallen timber	-0.272*	0.346*
5. Level of grazing	0.469**	0.606**
6. Rock size (0–100 mm)	-0.811*	0.190
7. Rock size (101–250 mm)	-0.767**	0.211
8. Rock size (251–500 mm)	-0.137	-0.486**
9. Rock size (501–1000 mm)	0.725**	0.214
10. Rock size (>1000 mm)	0.809**	-0.030
11. Crevice width (0–25 mm)	-0.42	-0.160
12. Crevice width (26–50 mm)	0.298*	0.227
13. Crevice width (51–100 mm)	0.589**	0.275*
14. Crevice width (>100 mm)	0.527*	0.099
15. Degradation of crevices	0.352**	0.453**
16. Gidgee Skink scats	0.290*	0.430*

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Body Condition Factor Analysis for the American Alligator (*Alligator mississippiensis*)

The American Alligator (*Alligator mississippiensis*) is an integral part of the Everglades ecosystem (Kushlan 1974). Alligators affect and are affected by the landscape and changes in hydrology, which make them an excellent species for use in evaluating current Everglades restoration efforts (Jones et al. 1994; Rice et al. 2005; Mazzotti et al. 2009). The natural history and reproductive patterns of the American alligator are closely tied to its physical environment (Kushlan and Jacobsen 1990; Mazzotti and Brandt 1994) and information on alligators in the Everglades—survey data, capture data, blood chemistry, and reproductive statistics—has been collected since the 1950s (F. Mazzotti and K. Rice, unpubl. data). Historical information for the alligator provides a suite of useful life-history characteristics or population parameters (e.g., health and condition, nesting effort, growth rate and survival, and density) that can be used for restoration success criteria (Mazzotti et al. 2009). However, some life-history traits (e.g., absolute population density and survival rates) are difficult to measure accurately and it may take decades of data to identify trends.

Body condition, however, can be measured using simple indices and requires relatively fewer data for analysis, even between seasons (Lambert and Dutil 1997). If used properly, condition of an indicator species such as the alligator will produce a rapid assessment of population health and consequently the health of the indicator's ecosystem (Stevenson and Woods 2006). Condition can be defined as the "relative fatness of [an animal]. . . . it is a measure of how well that animal is coping with its environment" (Taylor 1979). Condition indices have been used for a range of organisms (Reyer and Bättig 2004; Karraker and Welsh Jr. 2006; Stevenson and Woods 2006) as indicators of ecosystem health and have the added benefit of being a non-destructive and non-invasive method for evaluating health of ap opulation. Condition index, or condition factor, is a function of skeletal length and a volumetric measurement and has been used most frequently in fisheries literature, where it has become deeply entrenched as a research paradigm (Cone 1989). This study evaluates condition indices for the American alligator and recommends the appropriate model for use in applications such as evaluating management or restoration

Study area.—Data for this study were collected from six units within the greater Everglades ecosystem of south Florida, USA (Fig. 1): Arthur R. Marshall Loxahatchee National Wildlife Refuge (LOX), Water Conservation Area 2 (2A), two sites in Water Conservation Area 3, North (3AN) and South (3AS), and two sites within Everglades National Park–Shark Slough (ENP-SS) and the estuarine (ENP-Est) areas located near Flamingo. All sites are freshwater except ENP-Est, which is brackish. All units are managed separately for hydrology (different average annual water depths), which affects the prey base and condition of alligators between units, making the Everglades an excellent system to compare possibly subtle condition changes within different areas of an ecosystem.

Methods.—We captured alligators (N = 384) occupying marsh only (no canals) in October and March from 1999 to 2002 and made efforts to catch approximately equal number of animals from each area per capture event. We did not capture alligators <0.5 m total length (TL), as juvenile growth rates are extremely variable (Brandt 1991), which would increase confounding variation to the analysis, particularly if condition differences were small between units. We measured the following morphometric variables to the nearest 0.1 cm (Zweig 2003): head length (HL), snout–vent length (SVL), TL, right hind foot length (RFL), neck girth (NG), tail girth (TG), and chest girth (CG), and measured body mass (BM) with a spring scale to the nearest 0.1 kg. We sexed alligators and released them at their original capture sites. We excluded animals with deformities or wounds that would affect measurements.

Using Web of Science (http://www.isiknowledge.com), we searched scientific literature databases using the words

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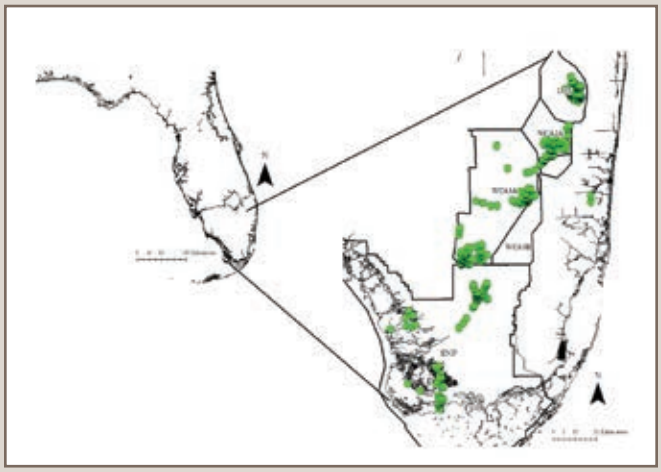


FIG. 1. Capture areas in south Florida within Everglades wetlands core. Green dots represent alligator capture sites from October 1999 to March 2002 (N= 395). ENP-Est = Everglades National Park-Estuaries, ENP-SS = Everglades National Park–Shark Slough, LOX = Loxahatchee National Wildlife Refuge, 2A = Water Conservation Area 2A, 3AN = Water Conservation Area 3A North, and 3AS = Water Conservation Area 3A South.

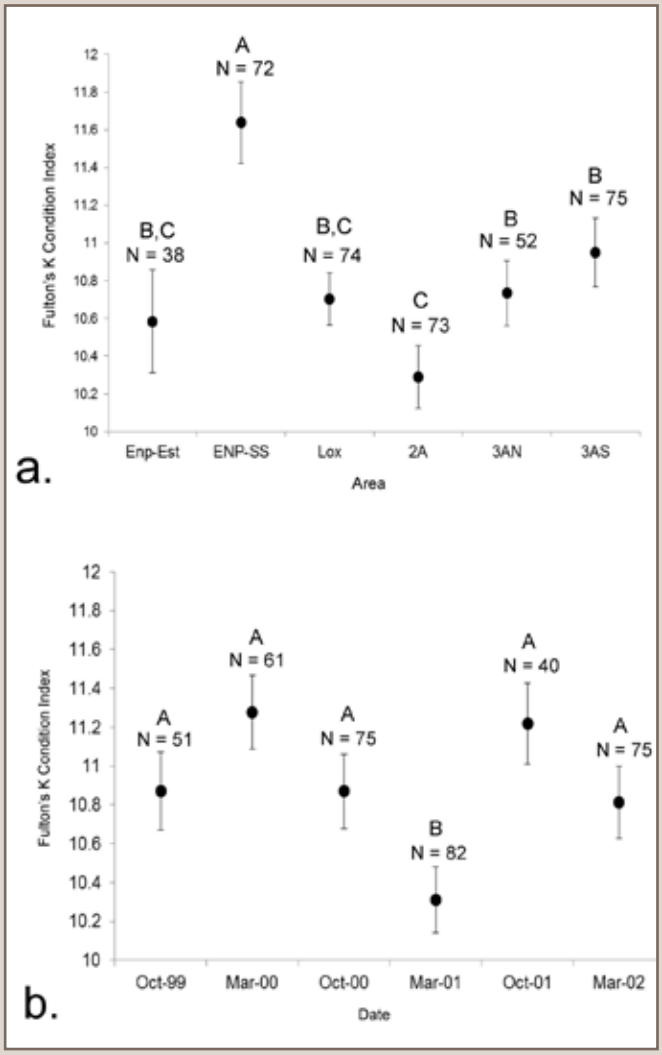


FIG. 2. a) Relative mean condition and standard error of alligators (N = 395) from six management units in the Florida Everglades from October 1999 to March 2002 using Fulton's K analysis. Site labels as in Fig. 1. Means with the same letter were not significantly different. b) Relative mean condition and standard error of alligators (N = 395) in the Florida Everglades by time from October 1999 to March 2002 using Fulton's K analysis. Means with the same letter were not significantly different.

"condition," "condition index," and "condition factor" to locate established methods of calculating condition for all types of animals. Condition is calculated using one straight-line measurement and one mass measurement, e.g., HL and BM. Tail girth in crocodilians is considered a proxy for mass (Hurlburt 1999) and is useful for large alligators that are difficult to weigh. We used the four length/mass combinations recommended by Zweig et al. (2004) to reduce error from measurement variation: HL|TG, HL|Mass, SVL|TG, and SVL|Mass, where "|" represents the combination of two morphometric variables used in calculating the condition index.

Condition indices should be independent of body size indicators or straight-line measurements, to separate the contribution of body size to mass from the contribution of fat stores, which more accurately reflect condition (Green 2001). We chose a Pearson's correlation threshold of 0.30 (any indices with $r > 0.30$ were eliminated) to ensure lack of correlation between body size and condition.

To test the ability of each index to distinguish differences in condition among units, between the sexes, or among time periods (i.e., model Condition index = Area + Sex + Date), we analyzed data with an analysis of variance (ANOVA) and Tukey's *post hoc* test for each index in aov (R Version 3.0, www.r-project.org, accessed 12 Apr 2013). Condition was also modeled with an ANCOVA procedure, glm (R Version 3.0, www.r-project.org, accessed 12 Apr 2013) as a separate indicator of condition.

To understand the biological significance of the ANOVA results, we constructed simulated data sets and tested them with the condition index ANOVA analysis above. This procedure provided background on the sensitivity of the analysis and condition indices, i.e., it indicated what percent difference in condition the analysis can detect. We simulated data sets using morphometric measurements that were identical to the original data set in standard deviation, but varied by the mean. There were 15 populations: 5 populations of 100 individuals with means identical to the original data; 5 populations of 100 individuals with a 5% increase in the mean; and 5 populations of 100 individuals with a 10% increase in the mean. We calculated condition of the modeled populations with the final two indices (Fulton's K and Relative K) and analyzed them using ANOVA and ANCOVA models as above.

We analyzed Everglades alligator capture data with the final recommended condition index (Fulton's K using HL and BM) to determine differences in condition among units. Units were grouped by significant differences in mean condition using Tukey's *post hoc* test.

Results.—We included the following condition indices from the literature in our analysis: ratio (Jakob et al. 1996), relative weight/mass (Wege and Anderson 1978), Fulton's K (Stevenson and Woods 2006), relative K (Le Cren 1951), ANCOVA (García-Berthou 2001; Le Cren 1951), and residuals (Green 2001), and calculated them for all four straight and mass measurement combinations, except Relative mass, which did not include a straight-line measurement and was calculated only for BM and TG (22 indices). We eliminated four indices for which the

Pearson's correlation between condition index and body length was >0.3 (Ratio HL|BM, $r = 0.94$; Ratio SVL|BM, $r = 0.95$; Fulton's K HL|TG, $r = -0.92$; Fulton's K SVL|TG, $r = -0.93$).

Eleven of 18 indices found significant differences in condition ($P < 0.05$) among units of the Everglades. Indices using SVL and HL combinations demonstrated significant differences among units, as did indices using BM and TG. The ANCOVA analysis includes only two significant differences out of four combinations. We chose Fulton's K as the best index to use, due to its ability to distinguish differences in condition among the most units.

The analysis of simulated data sets with Fulton's K did not detect differences in the data among simulated populations with the same mean and standard deviation, indicating that the model did not detect false differences in condition. Populations with the exact mean and standard deviation as the original data were consistently different ($P < 0.05$) than the simulated populations with the 10% increase in the mean. Populations with a 5% increase were not consistently different from the original data populations—only 84% of individuals were indicated by the model to be significantly different.

The Fulton's K index indicated that condition of alligators differed among water management units within the Everglades ($P < 0.05$; Fig. 2a). Alligators in the ENP-SS exhibited the greatest mean condition and their mean condition was significantly greater than that of any other area (Fig. 2). Alligators in areas 3AN and 3AS exhibited poorer condition than ENP-SS, but their condition was still greater than alligators in 2A, which had the lowest condition level of all areas. Mean condition of alligators in LOX and ENP-Est was less than only those alligators in ENP-SS. Condition of alligators in March 2001 was less ($P < 0.05$) than in March 2000 and October 2001, but no other differences between time periods were significant (Fig. 2b).

Discussion.—Condition indices can be a controversial method of comparing the general physical well-being of animal populations (Cone 1989; García-Berthou 2001; Green 2001; Jakob et al. 1996; Kotiaho et al. 1999; Krebs and Singleton 1993; Packard and Boardman 1988; Vila-Gispert and Moreno-Amich 2001). They are not appropriate for every situation and there are strict assumptions that must be met. However, if used prudently, we found that the Fulton's K condition index with HL and BM can be used to measure differences in the relative robustness among alligators or among two or more populations of alligators. Not only did the HL|BM combination of Fulton's K detect the most differences in condition between units (and reliably at a 10% condition difference), it has less stringent assumptions and can be used to compare across as well as within populations (García-Berthou 2001). It could serve as a standard for researchers comparing alligator condition among populations in Florida or across its range.

A shortcoming of Fulton's K is that it does not immediately provide a biologically meaningful number. The Fulton's condition score for this analysis ranged from 1.4 to 3.2, unlike an index like Relative Mass, where 1.0 is an alligator in normal condition and less than 1.0 suggests the alligator is in relatively poor condition (Stevenson and Woods 2006). To overcome a lack of biological meaning in Fulton K numbers, one could identify quartiles of the data and assign the bottom quartile as low condition, the middle two as average condition and the top quartile as good condition. Condition is a very fluid measurement that responds quickly to ecosystem perturbations, and condition indices can capture these short-term changes (Stevenson and Woods 2006). Water management practices and rainfall can change condition of animals in a relatively short amount of time. For the current study, ENP-SS alligators displayed the highest condition of Everglades alligators, but Dalrymple (1996) observed Shark Slough alligators to be in very poor condition five to six years earlier when water levels were higher. This highlights the advantage of using condition factor to assess the health of a population—its ability to use relatively small amounts of data and provide rapid assessments.

Information from the present study has been combined with environmental data to establish correlations among environmental variables and alligator condition and to determine the utility of the alligator as an indicator species for the Everglades (Fujisaki et al. 2009; Mazzotti et al. 2009). It was incorporated into the U.S. Army Corps of Engineers Comprehensive Monitoring and Assessment Plan for the Everglades and used for other crocodilian species (Mazzotti et al. 2012). It could also be used to compare crocodilian populations globally and has already been implemented in Belize for Morelet's Crocodile, *Crocodylus moreleti* (Mazzotti et al. 2012).

Acknowledgments.—We performed all captures under the auspices of the University of Florida's Institutional Animal Care and Use Committee guidelines. We would like to acknowledge A. Woodward for his careful review. The use of trade, product, industry or firm names or products or software or models, whether commercially available or not, is for informative purposes only and does not constitute an endorsement by the U.S. Government or the U.S. Geological Survey.

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TECHNIQUES

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Development and Validation of a Non-lethal Method for Monitoring Steroid Hormones in Plethodontid Salamanders

The analysis of steroid hormones is an important method for obtaining information about an animal's reproductive state or social status, as well as determining environmental factors that elicit stress responses. In large salamanders, blood sampling for steroid analysis has traditionally been conducted by either cardiac puncture (Church and Okazaki 2002; Lecouteux et al. 1985; Woodley 1994; Zerani et al. 1991) or decapitation (Specker and Moore 1980). In small salamanders with extremely low blood pressure and volume, however, samples are often taken from un-anesthetized and restrained animals (E. J. Crespi, pers. comm.). Although effective, these methods are likely painful and often lethal. In an effort to avoid lethal sampling or stressing endangered or sensitive animals, methods have been developed to extract steroids from tissues and bodily excretions, such as feces, urine, saliva, milk, ocular and respiratory secretions, and in the case of large spotted salamanders, ventral caudal scrapings (Homan et al. 2003; Rodrigo 2010).

Tail autotomization (self-amputation) is a defense mechanism employed by many salamanders to avoid predation. If sampled appropriately, tail tissue may be used to discern information about an animal's genotype, physiological condition, and ecological interactions. For instance stable isotopes, which may be used to study animal's diets, habitat use, and movement patterns, were recently measured from three species of Plethodontid salamander tail tissue (Milanovich and Maerz 2012). Variables such as species differences and amount of tail loss preclude making broad generalizations about the long-term health and fitness effects of autotomization (Bernardo and Agosta, 2005) but in an experimental comparison, brooding success was not different in tailless or control *P. cinereus* mothers (Yurewicz and Wilbur 2004). The purpose of the present study was to validate a non-lethal radioimmunoassay (RIA) for steroid hormones from autotomized tail tissue. To do so, we established seasonal hormone profiles for both male and female red-backed salamanders and compared them to plasma concentrations cited in the literature.

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Materials and Methods

Sampling.—Striped and lead-backed (unstriped) Redback Salamanders (*Plethodon cinereus*) were collected during the spring (April), summer (July), and autumn (September) from hardwood forests in the immediate vicinity of the University of New Hampshire, Durham, New Hampshire, USA (43.14°N, 70.93°W), by carefully hand-searching under fallen logs**.** Only intact individuals with undamaged tails were collected, and the presence or absence of eggs was observed during the summer sampling. Gender and reproductive status of each individual was determined by "candling," as the animals are nearly transparent and their gonads and eggs are easily visible when backlit (Gillette and Peterson 2001). Inter-nares distance (the distance between nares at the tip of the snout), was further used to verify gender (Quinn and Graves 1999). Samples consisted of spring males (N = 5), summer males (N = 5), autumn males (N = 5), spring gravid females (N = 5), spring non-gravid females (N = 5), summer brooding females (N = 3), summer non-brooding females (N = 4), and autumn females (non-gravid, non-brooding, N = 5)**.** Salamanders were weighed to the nearest milligram and measured for total length and snout–leg length (to posterior of the hind legs) for rapid processing (Szuba et al. 2002). Within two hours of field collection, autotomization of tails was induced by pinching with a forceps approximately 6–9 mm posterior to the cloaca. Autotomized tails were weighed, and the tail section was flash frozen on dry ice and stored at -20 degrees for use in the assay. Following sampling, all animals were released at their original collection sites.

Extraction and Radioimmunoassay.—Tail samples (range 0.12–0.36 g, mean = 0.19 g, s.e.m. = 0.01) were finely minced with a razor blade and homogenized for three minutes using a Kinematica CH-6010 Kriens-LU tissue homogenizer (Brinkman Instruments, Westbury, New York) in 17 x 100 mm polypropylene tubes with phosphate buffered saline (PBS; 0.1M PBS + 140 nM NaCl, pH 7.0; 4:1 PBS: tissue). The homogenates were centrifuged (3,000g) for 10 min at 4°C and the supernatant was decanted for extraction. Steroids were extracted three times from the supernatant with ethyl ether (J. T. Baker, Phillipsburg, New Jersey) by vortexing for 10 seconds in 12 x 75 mm glass tubes, snap freezing in liquid nitrogen, and decanting. The samples

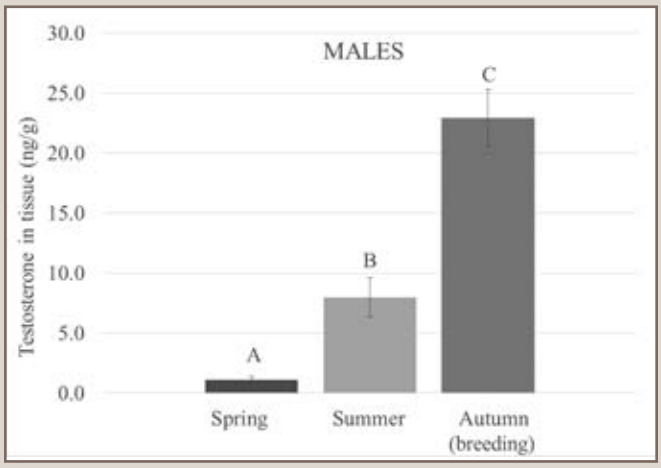


FIG. 1. Mean testosterone concentrations and standard errors for male *Plethodon cinereus* by season. Different letter superscripts indicate significant differences (P < 0.05)

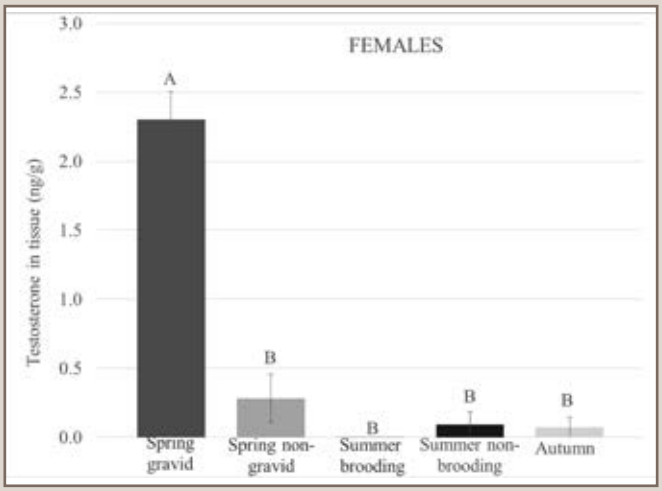


FIG. 2. Mean testosterone concentrations and standard errors for breeding and non-breeding female *Plethodon cinereus*, by season. Different letter superscripts indicate significant differences (P < 0.05).

were dried under a stream of nitrogen in a water bath at 37°C and frozen at -20°C prior to analysis.

The RIA protocol was modified from Sower and Schreck (1982). Extracts of homogenates were re-suspended in 200 µl assay buffer (PBS and 0.1% unflavored gelatin) vortexed vigorously for 10 sec, and duplicate aliquots (30 and 100 µl, male and females respectively) were assayed. Aliquots of testosterone (T) antisera (T3-125, Esoterix, Austin, Texas) diluted to a final concentration of 1:750, and 7400 dpm [1, 2, 6, 7- ^{3}H] testosterone (Perkin Elmer, Boston, Massachusetts) were added to the tubes, vortexed briefly and incubated for 90 minutes at room temperature. The tubes were placed in an ice bath, ice-cold charcoal/dextran [(100 ml 0.1M PBS; 1.0 g Norit neutral; Norit Americas, Inc. Marshall, Texas) and 0.1 g dextran (MW ~70000) (Sigma St. Louis, Missouri)] was added, and tubes were centrifuged (1,907 g) for 15 min at 4°C. The supernatant was decanted into vials, vortexed, and counted for 10 minutes (Beckman LS6500 liquid scintillation counter).

Cross reactivities of the antibody have been previously reported (Howell et al. 2003). Steroids with a cross reactivity >5.0% were: delta-1-testosterone (52%) and dihydrotestosterone (20%). Extraction efficiency, determined by the recovery of tritiated T from a homogenate of PBS and chopped tail sample (4:1), was 27.1%. Serial dilutions of homogenate extracts inhibited binding parallel to the standard curve. The intra and inter-assay coefficients of variation were 3.2% (N = 12) and 6.7% (N = 5), respectively and sensitivity of the assay was 4 pg/ tube.

Statistics.—Estimates for T concentration in the samples were calculated using AssayZap (BioSoft, GB-United Kingdom). Seasonal testosterone concentrations were log transformed and analyzed using ANOVA (SYSTAT 10; Systat Software Inc. Port Richmond, CA). Significant differences (P < 0.05) were identified with Tukey's post-hoc tests. Statistical outliers were determined using SYSTAT, and were retained in all analyses.

Results and Discussion

Seasonal T tissue concentrations for males differed significantly, increasing from spring to autumn (df = 2, F = 44.75, P < 0.03) (Fig. 1). Female tissue T levels were generally an order of magnitude lower than male's, except gravid females. Spring gravid females had significantly higher testosterone than any other female groups (df = 4, F = 4 2.49, P < 0.001), which did not differ from each other (P > 0.75 for all comparisons) (Fig. 2).

The results of this study indicate that steroid hormones can be extracted and measured from autotomized salamander tails and that seasonal concentrations reflect those previously measured in plasma. Church and Okazaki (2002) measured seasonal plasma testosterone concentrations from male *P. cinereus*, and similar to the present study, found highest and lowest concentrations from August–October and May–July, respectively. The elevated concentrations were concomitant with reported periods of increased aggression in this species and overlapped with mating activity (Sayler 1966; Wise 1995). Woodley (1994) also reported similar steroid expression and behavioral patterns in two other members of the family Plethodontidae (*Desmognathus ochrophaeus* and *Plethodon jordani)*. The plasma testosterone concentrations (296 ± 59.3 ng/ml Autumn; 9.8 ± 6.6 ng/ml Spring) reported by Church and Okazaki (2002) were approximately an order of magnitude higher than those found in the present study. These results are not unexpected, as gonadal steroids are typically synthesized and secreted into the systemic circulation, so plasma levels should be greater than the small amounts extracted from the tail vasculature. In females, significantly elevated T concentrations were only detected in gravid individuals, which is consistent with results found with *Salamandra salamandra*. In that species, plasma testosterone, estradiol and progesterone were all significantly higher in gravid compared to non-gravid females (Degani et al. 1997). It is possible that elevated testosterone concentrations in gravid females may be related to increased competition for a suitable nesting territory in which to lay eggs. Although few studies have compared seasonal steroid profiles between males and females, in *Pleurodeles waltl*, androgen concentrations (primarily T) were several fold higher than estradiol and paralleled increases in estradiol. Similar to the present study, androgen concentrations were considerably lower in females compared to males throughout the annual reproductive cycle (Garnier 1985 a and b).

Although steroids have been extracted from a number of animal tissue types (Hines et al. 1990; Taves et al. 2010), these procedures generally require lethal sampling, and comparisons to circulating plasma levels are unavailable. Corticosteroids are

often measured in salamanders as indicators of environmental and social stressors (Cooperman et al. 2004; Schubert et al. 2009). As plasma concentrations of these hormones can be relatively high (Schubert et al. 2009), autotomized tails may provide a non-lethal sampling method. Several methods are available for optimizing the extraction efficiency (Makin et al. 2010) prior to steroid analysis, and this may be necessary for species with low steroid concentrations.

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Duration of Marking Tags on American Alligators (*Alligator mississippiensis*)

Ecological studies of wildlife populations require individuals to be uniquely marked through the use of internal or external identification tags. Although marking tags are commonly used in ecological studies of the American Alligator (*Alligator mississippiensis*), little is known about tag retention in this species. Tagging techniques have been used extensively in research on crocodilians and have included passive integrated transponder (PIT) tags (Dixon and Yanosky 1993; Saalfeld et al. 2008), foot webbing tags (Rootes et al. 1991; Saalfeld et al. 2008; Temsiripong et al. 2006), and tail tags (Kushlan and Mazzotti 1989). Tagging crocodilians like the American Alligator and having them retain the tags may be more difficult than with other species as a result of the aquatic environments they inhabit, which have many underwater obstructions (e.g., sunken trees, logs, debris, etc.) that can catch on tags. Therefore, tag retention and durability may be compromised, which can be problematic for researchers. However, there has been little research to determine the magnitude of this problem.

We have developed a tagging technique for crocodilians that is similar in concept to the method used for fish species using the tags and tag applicator reported by Dell (1968). This method utilizes uniquely numbered and colored Floy® T-Bar anchor fish tags (Floy® Tag, Inc., Seattle, Washington, www.floytag.com; model FD-68B). The T-Bar anchor fish tag is constructed of heavy duty monofilament enclosed in colored vinyl tubing on which a unique number is printed. The tag measures 7.62 cm in length and 0.3 mm in diameter. Individual tags are inserted subcutaneously at the base of the skull with the Floy® Mark II rapid tag-fed applicator. The tag is inserted via an applicator equipped with a 14.5-gauge needle. The tags and applicator needles can be purchased in a variety of sizes. This improves the utility of this tagging strategy across a wide array of crocodilian size classes. This tagging strategy reduces further stress to an animal after capture, reduces the size of tags employed during research, increases the durability and longevity of tags, and provides a tagging strategy that is still as adequately useful, if not more so, than strategies that are currently in use. Our method uses tags that are much smaller in size, yet more visible than other types of tags that have been used on crocodilians. By employing this method and using fluorescent colored tags, researchers can easily spot tagged individuals, even when the majority of the animal's body is submerged beneath the water's surface. During nighttime searching, spotlighting causes the fluorescent tags to reflect light, yielding a visible tag even in low light conditions. This allows observers to determine the proportion of the population that is tagged and has the potential to be used in mark-resight studies on crocodilian species. However, it should be noted that in certain scenarios it is possible for tagged individuals to be overlooked. For example, areas of dense aquatic vegetation or poor visibility certainly have a negative effect on the visibility of these tags. Also, in the event that an individual is at an improper angle from or is facing an observer, or if eyes and tags are not properly exposed, visibility of tagged individuals may become compromised. The challenge of tag visibility is common among marking tags and this strategy is certainly no exception; however, T-bar anchor tag visibility is nevertheless enhanced in comparison to other tag types.

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Tag failure can bias estimates of survival and population size (McDonald et al. 2003). Estimation of life-history parameters relies on the assumptions that the tags are retained for the duration of the study and that tagging has no adverse effect on the reproduction, growth, or survival of the individual (Fokidis et al. 2006). These assumptions are often considered when using marking tags on alligators; however, they have yet to be verified on the species. The objectives of the present study were to determine retention rates of three commonly used tags and one novel tag and determine the most cost- and time-effective tagging strategies.

Materials and Methods.—The present study was conducted in the southwestern portion of the American Alligator's range at Brazos Bend State Park (BBSP), located in Fort Bend County, Texas, USA. Brazos Bend State Park is approximately 32 km SW of Houston, Texas, USA. The park encompasses 1982 ha, with an eastern boundary of 5.2 km along the Brazos River on the southeast border of Fort Bend County. Of the 11 bodies of water located within the park, seven were included in this study: Elm Lake, Forty-acre Lake, Old Horseshoe Lake, New Horseshoe Lake, Pilant Lake, Creekfield Lake, and Hale Lake, all of which are inland freshwater lakes that are characteristic of the area.

A mark-recapture analysis of American Alligator populations was conducted using the mark-recapture methods outlined by Chabreck (1963). Alligators were captured through the use of several techniques (e.g., snake tongs, pole snares, hand capture, and swim-in live traps). Upon capture, individuals were restrained with duct tape. Sex of individuals ≥ 50 cm in length was determined using the cloacal examination method developed by Chabreck (1963). Sex of individuals < 50 cm was not determined due to the difficulty of using available methods in the field. The morphological measurement of total length (TL, cm; ventral tip of snout to tip of tail) was taken for each alligator with a flexible tape measure. Each captured individual was uniquely marked with a numbered and colored livestock ear tag (Allflex USA, Inc., Dallas/Ft. Worth Airport, Texas) that was inserted in the tail, a uniquely numbered Kemco ear tag (Ketchum Mfg. Co., Inc., Lake Luzerne, New

Table 1. Marking specifications and retention rates of American Alligators tagged with four types of marking tags during 2012–2013 in southeast Texas.

	T-bar anchor tags	Foot tags	PIT tags	Tail tags
Total num. tagged	206	123	178	146
Total num. recaptured	43	19	40	26
Num. retained (%)	40 (93%)	15 (79%)	39 (97%)	19 (73%)
Sex				
Number males	5	4	4	21
Number females	29	15	27	5
Number unknown	9	0	9	0
Size				
≤ 50 cm TL	1	0	1	0
50–100 cm TL	29	6	26	12
101–150 cm TL	9	9	9	10
151–200 cm TL	2	2	2	2
201+ cm TL	2	2	2	2
Tagging time (average person-minutes)	0.3	2.25	4.5	6
Recapture required	No	Yes	Yes	Yes
Tag cost (US $)	$0.90/tag	$0.08/tag	$7.50/tag	$0.82/tag
Tagging equipment cost (US $)	$55.00	$20.00	$1,685.00	$21.00
Total equipment cost per tag (100 tags)	$1.45	$0.28	$24.35	$1.03

York) that was placed in the webbing between two toes, and an individual MUSICC Chip PIT tag (AVID Identification Systems Inc., Norco, California; www.AvidID.com) that was inserted subcutaneously at the base of the tail. Additionally, individuals were marked using T-bar anchor tags inserted under the skin at the base of the skull. Daytime and nighttime visibility distances for the T-bar anchor tags were determined through the use of a Bushnell yardage pro 800 rangefinder (Bushnell Performance Optics, Lenexa, Kansas; www.bushnell.com). Tag visibility measurements were taken under multiple field conditions including at night from a boat (i.e., under conditions typically experienced during alligator surveys and capture events), at night on land, and during the daytime. Due to size limitations and morphology of young alligators, foot webbing and tail tags were placed only on alligators ≥ 50 cm TL. One year subsequent to the initial capture and tagging effort, individuals were recaptured to determine the retention of marking tags. In an attempt to eliminate bias in our estimation of tag retention, we captured all individuals, regardless of whether tags were visible. When tagged alligators were recaptured, they were measured again for TL and data on the presence or absence of tags was recorded. Chi-square analysis was used to determine if distributions of tag retentions differed among tag types at $\alpha = 0.05$.

Results.—In 2012 we marked 206 American Alligators (Table 1). Marked individuals ranged in size from 20.3 to 365.8 cm TL. In 2013 we recaptured 43 alligators that had been tagged during the previous year (Table 1). Retention rates differed among tag types ($\chi^2 = 11.87$, df = 3, $P < 0.01$). Retention rates were greater for PIT tags than for foot and tail tags and the retention rate of T-bar anchor tags exceeded that for tail tags (Table 2). The foot webbing tags were the most cost effective, followed by the tail tags and T-bar anchor tags (Table 1). The most expensive method however, was PIT tagging (Table 1). Tail tags required the most assistance and effort followed by PIT tags and foot webbing tags (Table 1). The T-bar anchor tags required the least amount of assistance and effort (Table 1).

Of the 43 recaptured alligators, 40 had been tagged with PIT tags in 2012. A total of 39 (97%) of the 40 tagged alligators retained a working PIT tag implant upon recapture. The one failed PIT tag was from a male alligator that measured 69.3 cm TL. The time required to insert and scan the PIT tag and record the PIT tag number averaged 1.5 minutes. When inserting PIT tags, one person was needed for alligators ≤ 1 m TL, two people for alligators 1–1.5 m TL, and three for alligators > 1.5 m TL. The technology of the PIT tags was the most expensive of the four tags, costing $7.50/tag and the tag scanner cost $1685 (all prices quoted are as of 2013, in US dollars).

Forty of the 43 recaptured alligators (93%) retained the T-bar anchor tags from the previous year. The three tags that were lost were from females that ranged in size from 50 to 100 cm TL. Average time to successfully insert a T-bar anchor tag was < 10 seconds. Alligators < 2 m TL could be tagged by a single researcher, however individuals ≥ 2 m TL required additional restraint by field assistants. Day and nighttime visibility of T-bar anchor tags to the unaided eye of an experienced observer was determined to be ~37 and ~20 m, respectively. Floy T-bar anchor tags can be purchased in lots of 100 for $0.90/tag or in lots of 1000 for $0.67/tag. The tagging gun, which is required for the insertion of this tag, can be purchased for $55.00.

A total of 26 of the recaptured 43 alligators had been previously tagged with tail tags. Only 19 (73%) of the tagged alligators retained the tail tags. The seven failed tags were all from female alligators. Four missing tags were from alligators that were 50 to 100 cm TL, two from alligators 101 to 150 cm TL, and one from an individual that was 248 cm TL. The time required to insert a tail tag averaged 2 minutes. Individuals < 2 m TL required the assistance of one additional person while individuals ≥ 2 m TL

required the assistance of two additional field assistants. These tags are relatively inexpensive and can be purchased for $0.82/tag. The tail tags also require a tag applicator gun that can be purchased for $20.95.

Nineteen of the 43 recaptured alligators had been tagged with the Kemco foot webbing tags during the previous year and 15 (79%) retained the foot webbing tag after one year. Of the four lost tags, three were from females and one was from a male alligator. Two lost tags were from individuals that ranged in size from 150 to 200 cm TL and two were from individuals that measured ≥ 200 cm TL. On average the foot webbing tags could be inserted in 45 seconds. Alligators ≥ 2 m TL required assistance in tagging, while smaller alligators could be tagged easily by a single person. These tags were the least expensive of the four tags used in this study and can be purchased for $0.08/tag. Additionally, the tagging pliers, which are a necessity for this method, can be purchased for $20.00.

Discussion.—PIT tagging has been widely accepted as an efficient technique to uniquely mark and identify individuals across a wide array of taxa. PIT tags have been found to have high retention rates in a variety of species such as giant salamanders (*Cryptobranchus alleganiensis*; Unger et al. 2012), Muskellunge (*Esox masquinongy*; Jennings et al. 2009), and Rainbow Trout (*Oncorhynchus mykiss*; Meyer et al. 2011). We determined that T-bar anchor tags and PIT tags had high retention rates for the American Alligator. Although T-bar anchor tags have a high initial retention rate, retention rate decreased through time in the Gulf Sturgeon (*Acipenser oxyrinchus desotoi*) while PIT tag retention rates remained relatively constant (Buzby and Deegan 1999; Clugston 1996). The high rates of PIT tag and T-bar anchor tag retention are likely due to tag characteristics. The PIT tag is an internal tag that is not subjected to the exterior rigors of the daily environment of the American Alligator. Additionally, retention rate of T-bar anchor tags was greater than for tail tags, which could be the result of tag placement. Moreover, the T-bar anchor tags were placed at the base of the skull, which allows the tag to conform to the streamlined morphology of the individual and adhere to the contours of their movement throughout a rugged environment. The foot webbing tags are one of the most widely used tags in crocodilian research; however, retention was less than for other tag types. Tail tags were the least reliable tag, most likely due to tag size and insertion site. This is a likely explanation as to why the T-bar anchor tags had higher retention rates than other external tags. External tags are at a disadvantage for retention because of the likelihood of becoming entangled in surface and underwater debris present in alligator habitat. Entanglement may cause the tags to be avulsed from the insertion site, resulting in a failed tag and potentially causing injury to the animal. One case was noted in this study in which a recaptured individual was missing not only the tail tag, but also the tail scute that had served as the site of tag attachment (CBE, pers. obs.). The tail scute appeared to be avulsed from the alligator's body as the result of entanglement. Although the wound had healed and did not appear to inhibit the individual in any way, the injury may have caused unnecessary stress and damage to the alligator. The tail and feet are essential for locomotion both in the water and on land; the frequent movement of these anatomical components can cause increased stress and wear on tags, yielding missing, broken, or illegible tags, which can diminish or completely void the usefulness of the tags. Another probable cause of loss of foot webbing tags is growth of the individual. Although we were unable to determine it in this study, individuals may grow to a point at which the foot webbing tags become loose and fall out or are pushed out of the alligator's foot webbing. In addition, Bellini et al. (2001) found that corrosion was a factor in the loss of metal tags in sea turtles. Although a possibility, this was not likely a cause of tag loss in our study, as inspection of the retained tags did not indicate any signs of corrosion. Alligators tagged in this study inhabit freshwater wetlands and although freshwater also will corrode metal tags, they were not exposed to high salinity levels that are more conducive to the accelerated corrosion of metal.

When tagging larger alligators, it was necessary for field assistants to aid in the restraint of the animal while the PIT, tail, or foot webbing tags were inserted. By inserting tags into the tail or foot webbing, the person that is inserting the tag has very limited control of the animal's head. This introduces the risk of personal injury. By utilizing a tag insertion site closer to the head of the animal, as is done with the T-bar anchor tags, the person inserting the tag has more control of the alligator's head.This allows a single person to tag individuals that are much larger in size without the risk of personal bodily injury. Also, since T-bar anchor tags require less time for insertion, this method can reduce stress on captured alligators by reducing the amount of handling time, thereby allowing field crews more time to potentially tag more individuals. This method is unique in the fact that an alligator can be successfully tagged in a relatively short amount of time. The tag applicator can be loaded with multiple tags and does not require each tag to be loaded into the tag applicator individually. The rapid cartridge-fed applicator decreases the amount of time required to tag an individual and results in a quicker release. An alligator can be successfully tagged with this method in a matter of seconds by an experienced researcher. These other methods required more time to successfully tag an individual due to each tag having to be loaded into tag applicators and PIT tag syringes individually. Although the T-bar anchor and PIT tags could be used on all alligators regardless of size, this was not the case for tail and foot webbing tags.The diameter of the dermal hole (0.7 cm) created by tail tag insertion is too large to employ the tail tags for use on smaller alligators without causing unneeded harm to the individual. Due to the small amount of foot webbing on smaller alligators, the same can be said for the foot webbing tags.

A great disadvantage to the PIT, tail, and foot webbing tags is that in order to determine if an individual has been previously tagged, the individual must first be recaptured, restrained, and checked for a tag, which results in more effort for field crews and more stress on the captured animal. The visibility of these tags is minimal, or in the case of the PIT tags, completely nonexistent. Therefore, to identify an alligator that has been tagged with tail or foot webbing tags, researchers must spot them at an exceptionally close distance on land or in very shallow and clear

TABLE 2. Chi-square and P-values for pair-wise comparisons of alligator tag retention for four types of tags. Asterisks indicate significant differences.

	T-bar anchor		Foot		Tail	
	χ^2	P	χ^2	P	χ^2	P
PIT	0.86	>0.3	5.78	<0.025*	8.55	<0.005*
T-bar anchor	–	–	2.68	>0.10	5.18	<0.025*
Foot	–	–	–	–	0.41	>0.50
Tail	–	–	–	–	–	–

water. The T-bar anchor tag method is unique in the fact that these tags can be seen from a distance of ~37 m during the daytime and ~20 m during nighttime conditions, even if the majority of the individual's body is submerged beneath the water's surface. In mark-recapture studies, this allows researchers to determine from a distance if an individual was tagged without having to recapture the animal. This significantly reduces time required in handling animals and allows for more time searching for tagged individuals. This visibility allows observers to determine the proportion of the population that is tagged and has the potential to be used in mark-resight studies on crocodilian species. During nighttime searching, spotlighting causes the fluorescent tags to reflect light at a distance of up to ~20 m, yielding a visible tag even in low-light conditions.

Conclusions.—We suggest the use of the Floy T-bar anchor fish tags and PIT tags as a tagging strategy for the American Alligator primarily because the retention rate for each is >90% after one year. However, the T-bar anchor tags are also a good tagging strategy because they require less personnel to tag individuals; are a quicker method of tagging alligators; do not appear to harm alligators; do not cost substantially more than the cheaper methods, especially when accounting for cost of additional personnel for the other tagging methods; and do not require recapture of individuals to estimate marked populations. Due to the lower retention rates of the Kemco foot webbing tags and the tail tags, coupled with the physical stress for alligators and effort required of field crews, we do not suggest their use in studies on the American Alligator. Although the present study was conducted on American Alligators, the results of tag retention, as well as our novel tagging technique, should be applicable to the majority of crocodilians.

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AMPHIBIAN DISEASES

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Evaluation of Helminths Associated with 14 Amphibian Species from a Neotropical Island Near the Southeast Coast of Brazil

Brazil harbors a great diversity of amphibians, with approximately 877 species recorded (Segalla et al. 2012). The Atlantic Rain Forest (Mata Atlântica) biome significantly contributes to this high biodiversity, on the Brazilian coast and in fragments inside the country; more amphibian species live here than any other Brazilian biome, including many endemic species (IUCN 2006; SOS Mata Atlântica and INPE 2002). Some islands along the São Paulo State coast are priority areas for Atlantic Forest conservation, with unique biota for scientific investigations.

In island environments, information on helminth parasites associated with populations or communities remains scarce. Lent et al. (1946) researched helminth parasites of *Rhinella schneideri* (Werner, 1894) (syn. *Bufo paracnemis*) specimens from Isla Valle, Paraguay, and found two species of Digenea (*Catadiscus freitaslenti* Ruiz, 1943 and *Mesocoelium incognitum* Travassos, 1921) and one nematode species (*Ochoterenella digiticauda* Caballero, 1944), increasing the knowledge concerning the helminth fauna of anurans. Torres and Puga (1996) reported for the first time *Centrorhynchus* sp. (Acanthocephala) associated with *Eupsophus roseus* (Duméril and Bibron, 1841) from Isla Teja, and *Eupsophus calcaratus* (Günther, 1881) from Chiloé Island, Chile, increasing to ten the number of helminth species record in anurans of Chile. Ramalho et al. (2009), researching helminth parasites of lizards from the Fernando de Noronha Archipelago, Brazil, discovered three helminth species associated with an introduced lizard, *Salvator merianae* Duméril and Bibron, 1839 (syn. *Tupinambis merianae*), and seven helminth species associated with endemic lizards, *Trachylepis atlantica* (Schmidt, 1945) and *Amphisbaena ridley* Boulenger, 1890, suggesting that introduced lizards can carry other helminths to locations where they had not existed before, and that endemic lizards share parasite species with lizards that have been introduced.

Island research is interesting due to geographic isolation and the potential of endemic species (MacArthur and Wilson 1967; Vitousek et al. 1995). However, it is questionable whether Anchieta Island, an island near the north coast of São Paulo, Brazil, is in fact isolated, due to its distance of only 8 km from the continent and receiving visitors of 80,000 people annually to Anchieta Island State Park (www.iflorestal.sp.gov.br). The environment of this island, as well as fragments of Mata Atlântica, has been altered by human development. Unfortunately, there is little information about the endemic fauna of this area. In a herpetofaunal survey of Anchieta Island, Cicchi et al. (2009) reported the following anurans: *Fritziana fissilis* (Miranda-Ribeiro, 1920) (syn. *Flectonotus fissilis*) (Hemiphractidae); *Haddadus binotatus* (Spix, 1824) (Craugastoridae); *Ischnocnema bolbodactyla* (Lutz, 1925); *Ischnocnema parva* (Girard, 1853) (Brachycephalidae); *Rhinella ornata* (Spix, 1824); *Dendrophryniscus brevipollicatus* Jiménez de la Espada, 1870 (Bufonidae); *Hypsiboas albomarginatus* (Spix, 1824); *Scinax hayii* (Barbour, 1909) (Hylidae); *Hylodes asper* (Müller, 1924); *Hylodes phyllodes* Heyer and Cocroft, 1986 (Hylodidae); *Leptodactylus* cf. *marmoratus* (Steindachner, 1867); *Leptodactylus latrans* (Steffen, 1815) (Leptodactylidae); *Chiasmocleis carvalhoi* Cruz, Caramaschi, and Izecksohn, 1997; and *Myersiella microps* (Duméril and Bibron, 1841) (Microhylidae). It is likely that many other anurans are not yet discovered.

The helminth fauna associated with amphibians comprises general parasites (Aho 1990) with a low specificity with their hosts. Therefore, there are frequently new records of hosts harboring parasites that have not previously been related to them. Herein, this study reports the helminth fauna associated to 14 amphibian species, of the Mata Atlântica biome occurring in Anchieta Island Park State an insular environment, of a biome with high endemism and biodiversity in which very little is known. Moreover, we also summarize the known distributions of these helminth parasites in South America to present the state of knowledge about biodiversity of helminthes associated to amphibians from South America. This source will be important for futures studies on this subject.

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TABLE 1. Prevalence of helminths infection in 14 anuran species from Anchieta Island, north coast of São Paulo State, Brazil. Taxon codes: FAMA = *Falcaustra mascula*; OSSP = *Oswaldocruzia* sp.; OXOX = *Oxyascaris oxyascaris*; PHSP = *Physaloptera* sp.; RHSP = *Rhabdias* sp.; LARV = Larvae of Nematoda; CYAM = *Cylindrotaenia* cf. *americana*; ACAN = Acanthocephala; COSM = Cosmocercidae.

Hosts	N	FAMA	OSSP	OXOX	PHSP	RHSP	LARV	CYAM	ACAN	COSM	Total
Bufonidae											
Dendrophryniscus brevipollicatus	3	—	—	—	—	—	—	—	—	66.7	66.7
Rhinella ornata	20	—	10.0	—	20.0	40.0	10.0	—	15.0	65.0	75.0
Brachycephalidae											
Ischnocnema bolbodactyla	4	—	—	—	—	—	25	—	—	—	25
Ischnocnema parva	20	—	—	—	—	—	—	20	—	70.0	70.0
Craugastoridae											
Haddadus binotatus	9	—	22.2	—	33.3	22.2	22.2	—	—	77.8	88.9
Hemiphractidae											
Fritziana fissilis	18	—	—	—	16.7	—	11.1	—	5.6	—	27.8
Hylidae											
Scinax hayii	23	—	—	—	8.7	4.3	4.3	—	—	—	13.0
Hypsiboas albomarginatus	18	—	—	—	22.2	11.1	5.6	—	—	—	38.9
Hylodidae											
Hylodes asper	2	—	—	—	—	—	—	—	—	50.0	50.0
Hylodes phyllodes	3	—	—	—	33.3	—	66.7	33.3	—	66.7	66.7
Leptodactylidae											
Leptodactylus latrans	4	25.0	—	50.0	25.0	—	—	—	50.0	50.0	100
Leptodactylus cf. *marmoratus*	42	—	—	—	2.4	2.4	33.3	—	2.4	9.5	38.1
Microhylidae											
Myersiella microps	3	—	—	—	—	—	—	—	33.3	—	33.3
Chiasmocleis carvalhoi	26	—	—	—	7.7	3.8	7.7	—	30.8	88.5	92.3
TOTAL	195										52.8

Anurans were collected from the preserved area of Mata Atlântica, Anchieta Island State Park (23.45°S, 45.033°W), Ubatuba municipality. The island consists of 828 ha of Dense Rain Forest and Restinga forests (Veloso et al. 1991). Its regional climate is typically tropical humid, with no dry season (Nimer 1989). Anurans were collected monthly from July 2005 to June 2006, using pitfall traps, a visual encounter survey, and opportunistic collection. The specimens were identified, fixed (10% formaldehyde), maintained in alcohol and deposited in the Coleção de Vertebrados Dr. Jorge Jim (CVJJ) of the Universidade Estadual Paulista (UNESP/Botucatu). For parasitological studies, 194 anurans of 14 species were necropsied: *F. fissilis* (N = 18); *H. binotatus* (N = 9); *I. bolbodactyla* (N = 4); *I. parva* (N = 20); *R. ornata* (N = 20); *D. brevipollicatus* (N = 3); *H. albomarginatus* (N = 18); *S. hayii* (N = 23); *H. asper* (N = 2); *H. phyllodes* (N = 3); *L.* cf. *marmoratus* (N = 40); *L. latrans* (N = 5); *C. carvalhoi* (N = 26); and *M. microps* (N = 3).

During necropsy, hosts were sexed and the body cavity, digestive tract, accessory organs and musculature were examined for helminth parasites. The helminth parasites were counted and preserved in 70% ethyl alcohol. For identification, the helminths were examined as temporary mounts: nematodes were cleared with lactophenol, whereas acanthocephalans and cestodes were stained with carmine and cleared with eugenol or creosote. The helminths were analyzed using a computerized image analysis system (Qwin Lite 3.1; Leica Microsystems, Wetzlar, Germany).

The systematic determination of the helminths was conducted following the methods of Yamaguti (1959, 1961, 1963), Vicente et al. (1991), Anderson et al. (2009), and Gibbons (2010). The infection prevalence, mean abundance (MA) and mean intensity of infection (MII) were calculated for helminths according to Bush et al. (1997). MII and MA are presented as mean values with their standard errors.

A total of 2058 helminths were collected from 103 of 195 anuran specimens examined, representing an overall prevalence of 52.82% (Table 1) and an MA of 10.55 ± 4.87. The parasitized individuals were infected with an average of 19.98 ± 9.24 helminth indivuduals per host. In the anuran community, we identified a species of Cestoda, *Cylindrotaenia* cf. *americana* Jewell, 1916 (N = 7), a species of Acanthocephala (N = 54) and 12 species of Nematoda including: *Falcaustra mascula* (Rudolphi, 1819) (N = 2); *Oxyascaris oxyascaris* Travassos, 1920 (N= 9); *Oswaldocruzia* sp. (N = 6); *Rhabdias* sp. (N = 31); and *Physaloptera* sp. (N = 86), and a total of 1078 cosmocercids. Of the cosmocercids samples that were male, it was possible to identify the following species: *Aplectana pintoi* Travassos, 1925 (N = 5); *Aplectana crucifer* Travassos, 1925 (N = 3); *Aplectana* sp. (N = 13); *Cosmocerca brasiliense* Travassos, 1925 (N = 11); *Cosmocerca parva* Travassos, 1925 (N = 1); *Cosmocerca travassosi* Rodrigues and Fabio, 1970 (N = 11); and *Cosmocerca* sp. (N = 14). Unidentified nematode larvae (N = 784) parasitized nine of the 14 anuran species examined. Each parasitized individual was infected with an average of 1.56 ± 0.08 helminth species.

Overall, cosmocercids were the most common helminth, with a prevalence of 35.38% and an MA of 5.53 ± 10.37. The next most-common helminth was *Physaloptera* sp., with a prevalence of 11% and an MA of 0.4 ± 0.18. The other helminth species had low prevalence, MA and MII (see Appendix).

Among the analyzed hosts, the *L. latrans* specimens were highly parasitized (100%), followed by *H. binotatus* (88.9%) and

TABLE 2. Overall Prevalence (P%), number of recovered helminths (RH), mean abundance (MA), mean intensity of infection (MII) followed by standard error (SE), of helminths associated to 14 anuran species from Anchieta Island, São Paulo State, Brazil.

Hosts	P(%)	RH	MA ± SE	MII ± SE
Brachycephalidae				
Ischnocnema bolbodactyla				
(N = 4)	25	1	0.25 ± 0.25	1.0
Ischnocnema parva				
(N = 20)	70.0	30	1.5 ± 0.3	2.1 ± 0.3
Bufonidae				
Dendrophryniscus brevipollicatus				
(N = 3)	66.7	6	2 ± 1.2	3.0 ± 1.0
Rhinella ornata				
(N = 20)	75.0	190	9.5 ± 3.8	12.7 ± 4.8
Craugastoridae				
Haddadus binotatus				
(N = 9)	88.9	705	78.3 ± 70.7	88.1 ± 79.4
Hemiphractidae				
Fritziana fissilis				
(N = 18)	27.8	15	0.8 ± 0.4	3.0 ± 0.9
Hylidae				
Hypsiboas albomarginatus				
(N = 18)	38.9	31	1.7 ± 1.0	4.4 ± 2.5
Scinax hayii				
(N = 23)	13.0	705	30.6 ± 30.5	235.0 ± 233.5
Hylodidae				
Hylodes asper				
(N = 2)	50	17	8.5 ± 8.5	17
Hylodes phyllodes				
(N = 3)	66.7	11	3.7 ± 1.9	5.5 ± 0.5
Leptodactylidae				
Leptodactylus latrans				
(N = 4)	100	40	10 ± 3.1	10 ± 3.1
Leptodactylus cf. *marmoratus*				
(N = 40)	38.1	87	2.1 ± 0.6	5.4 ± 1.1
Microhylidae				
Chiasmocleis carvalhoi				
(N = 26)	92.3	217	8.3 ± 1.6	9.0 ± 1.7
Myersiella microps				
(N = 3)	33.3	3	1.0 ± 1.0	3.0

TABLE 3. Countries and localities reported for helminths associated with anurans from South America. Abbreviation of Brazilian States is informed within brackets.

Countries	Localities (states, cities or provinces)
Brazil	Amazonas (AM), Bahia (BA), Distrito Federal (DF), Espírito Santo (ES), Goias (GO), Mato Grosso do Sul (MS), Para (PA), Paraná (PR), Rio de Janeiro (RJ), Rio Grande do Sul (RS), Santa Catarina (SC), São Paulo (SP), and Tocantins (TO)
Argentina	Corrientes
Chile	Locality not reported
Colombia	Central Cordillera
Ecuador	Pastaza and Santa Cecilia
French Guiana	Comté
Guyana	Rupunini
Paraguay	Assuncion, Chaco-I, and Remanso Castillo
Peru	Cuzco, Lima, Piura, and Ucayali

R. ornata (75%). *Haddadus binotatus* had a high MA of helminths (78.3 ± 70.7) as well as MII (88.1 ± 79.4). *Scinax hayii* had a high MII due to many nematode larvae parasitizing one individual host (MII = 235 ± 233.5). On the other hand, *I. bolbodactyla* specimens had both a low MA (0.25 ± 0.25) and MII (1.0) (Table 2).

In an Appendix, we list the helminth species of this study with the percentage prevalence and MII per host species, together with the status distribution of these helminths in South American hosts. The localities, as cities or states, are indicated within parentheses followed by the reported host. In all, 27 localities were reported in nine countries from South America (Table 3). The bibliography of helminth species reported for anurans from South American continent were based on information from both online databases (such as BioOne, Isi, Jstor, PubMed, Scielo, Scopus, and Web of Science) and published monographs (Yamaguti 1959, 1961, 1963).

We present the first report of helminth fauna from nine anuran species (*F. fissilis*, *I. bolbodactyla*, *R. ornata*, *D. brevipollicatus*, *H. albomarginatus*, *S. hayii*, *H. asper*, *C. carvalhoi*, and *M. microps*). Only five host species (*H. binotatus*, *I. parva*, *H. phyllodes*, *L.* cf. *marmoratus*, and *L. latrans*) have been reported on the continent; however, this study is the only one that has been performed in South America regarding helminths associated with anurans from an insular environment. All helminths found here were previously reported in anurans from the South American continent; however, there were 12 helminth species recorded in new hosts. Only *Oxyascaris oxyascaris* and *Falcaustra mascula* have been reported parasitizing *Leptodactylus latrans* (Stumpf 1982; Baker and Vaucher 1985; Rodrigues et al. 1990; Vicente et al. 1991). Anchieta Island is currently a conservation area, where the parasitic fauna of anurans has never been studied; for some helminthes, we present the parasitism in anurans species for the first time: 1) *Haddadus binotatus* is a new record for *Oswaldocruzia* sp., *Rhabdias* sp., *Physaloptera* sp., *A. pintoi* and *C. brasiliense*; 2) *H. phyllodes* is a new record for *Rhabdias* sp., *C. brasiliense* and *C.* cf. *Americana*; 3) *L.* cf. *marmoratus* is a new record for *Rhabdias* sp.

Of all the helminths reported in this study, acanthocephalans were the least frequent (Smales 2007). This is due to the transmission of acanthocephalans to anurans occurring by ingestion of invertebrates parasitized with cystacants that infect the gastrointestinal tract (Kennedy 2006), making the anuran a definitive or paratenic host (Smales 2007; Pinhão et al. 2009; Santos and Amato 2010b). The cestode *Cylindrotaenia* cf. *americana* is a Western-hemisphere species known to infect anurans of the families Bufonidae, Ranidae, Hylidae, Leptodactylidae, and Dendrobatidae (Jones 1987; Bursey et al. 2001). The parasitism of this cestode in *H. phyllodes* and *I. parva* adds two anuran families, Hylodidae and Brachycephalidae, to this list. The nematodes of Cosmocercidae family are transmitted directly; the final host is infected by ingestion of eggs containing infective larvae (*Aplectana* spp.) or by infective larvae that penetrate actively in the host's tegument (*Cosmocerca* spp.) (Anderson

2000). These parasites were highly prevalent, and had high MA and MII, corroborating the general pattern of these helminths of amphibians (Aho 1990; Bursey et al. 2001). This is due to the fact that these helminths have to infect their hosts directly, without intermediate hosts to complete their biological cycle (Anderson 2000; Hamann et al. 2006b). The infection by *Rhabdias* spp. and *Oswaldocruzia* spp. occurs similarly, transmitted directly by larvae that penetrate actively in the host's tegument. *Rhabdias* spp. infection occurs only by parthenogenetic females that alternate between free-living and parasitic existence on amphibian lungs (Anderson 2000). About the Kathlaniidae (*F. mascula* and *O. oxyascaris*), a nematode family, very little is known concerning their indirect transmission; Anderson (2000) suggests that possibly kathlaniids in the lower vertebrates develop to the third stage outside the host and then invade various invertebrates which serve as paratenic hosts.

Physaloptera spp. parasitize mammals and reptiles, and do not complete their life cycle in amphibians. Larvae of *Physaloptera* sp. are found in the stomach mucosa of amphibians that ingest larvae-infected insects, so the amphibian can be an intermediate or paratenic host (Anderson 2000). We did not find these larvae in five host species: *D. brevipollicatus* (N = 3), *I. bolbodactyla* (N = 4), *I. parva* (N = 20), *H. asper* (N = 2), and *M. microps* (N = 3). Excepting for *I. parva*, this can due to the fact that there were low sample sizes of these anurans. Also, the absence of infection with *Physaloptera* sp. in these anurans can be explained by their feeding, which may not transmit *Physaloptera* spp. larvae. The anurans have a generalized diet, eating any arthropods, but some, as those cited above, frequently feed ants and isopods (AmphibiaWeb 2014). Studies concerning the life cycle of *Physaloptera* spp. indicate the more commum intermediate hosts are cockroaches (*Blatella germanica*) (Alicata 1937; Hobmaier 1941; Lee 1955). Thus, we may consider that the absence of *Physaloptera* sp. is related to diet of anurans.

We found at least 14 helminth species associated with anurans from Anchieta Island; of these, four species have an indirect life cycle, where an intermediate host is required for completion of the parasite's cycle. The other 10 species are transmitted directly, and do not require an intermediate host. So, in this way, they have success in their life cycle. Digenean trematodes, with two or more intermediate hosts, were not found in anurans from Anchieta Island, possibly due to the absence of the intermediate hosts required for the biological cycle of these helminths. Even though trematodes have been found frequently on the continent in Brazilian anurans (Travassos et. al. 1969), it is likely that parasites with heteroxenic cycles have difficulty establishing themselves in insular environments. On the other hand, the composition of anuran helminth fauna of Anchieta Island is similar to the mainland, all helminth species are commonly associated to anurans from continent.

Anchieta Island has a continental origin, occurring on the Brazilian continental shelf, and it exists now as an island due to one or more of the several oscillations of sea level during the Pleistocene (Martin et al. 1986), the last of which occurred about 11,000 yrs ago (Souza et al. 2005). The common geological origin and the short distance to the mainland (8 km) have consequences such as the island and mainland having the same vegetation (Atlantic Rain Forest - "Mata Atlântica") and climatic conditions which are similar to littoral coast, allowing the development of the same species. It is expected that continental islands present a similar fauna to the continent, since this isolated portion of land has been directly connected to the continent. Thus, there is still a need for zoological studies in insular environments, allowing observations of the similarity to the continent or to neighboring islands, as well as detection of possible introduced species or local extinctions.

The knowledge of parasite communities in amphibian hosts and the patterns and processes underlying their structure has grown, but most of the studies have been performed with species from temperate latitudes (Aho 1990). Our study addresses helminths associated with 14 anuran species from Mata Atlântica reports nine new records species, is the first report of helminth fauna associated to insular anurans, and represents a contribution to the knowledge of amphibian helminth fauna from the Neotropical region.

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APPENDIX I

Nematoda
Rhabdiasidae
***Rhabdias* sp.**

Host, P% and IMI: *R. ornata* (P= 40%; IMI=2.1 ± 0.4), *H. binotatus* (P = 22.2%; IMI = 2.5 ± 1.5), *S. hayii* (P = 4.3%; IMI = 2.0), *H. albomarginatus* (P = 11.1%; IMI = 2.0 ± 1.0), *L. cf. marmoratus* (P = 2.4%; IMI= 2.0) and *C. carvalhoi* (P = 3.8%; IMI = 1.0).

Site of infection: lungs.

Other reported hosts and locality: *Hypsiboas albopunctatus* (Spix, 1824) (GO, DF), *Leptodactylus chaquensis* Cei, 1950 (Corrientes), *L. latrans* (syn. *Leptodactylus ocellatus*) (PA, RJ), *Leptodactylus podicipinus* (Cope, 1862) (MS), *Pseudis platensis* Gallardo, 1961 (MS), *Rhinella bergi* (Céspedez, 2000) (Corrientes), *Rhinella crucifer* (Wied-Neuwied, 1821) (syn. *Bufo crucifer*) (RJ), *Rhinella icterica* (Spix, 1824) (syn. *Bufo ictericus*) (ES) and *Rhinella marina* (Linnaeus, 1758) (syn. *Bufo marinus*) (PA).

Geographic range: Argentina (González and Hamann 2007b; Hamann et al. 2006b) and Brazil (Campião et al. 2009, 2010; Fabio 1982; Holmes et al. 2008; Rodrigues 1986; Rodrigues et al. 1982, 1990; Travassos et al. 1939; Travassos and Freitas 1964; Vicente et al. 1991; Vicente and Santos 1976).

Remarks: *R. ornata, H. binotatus, S. hayii, H. albomarginatus, L.* cf. *marmoratus* and *C. carvalhoi* represent new host records for the genus *Rhabdias*; Anchieta Island is a new locality record.

Molineidae
***Oswaldocruzia* sp.**

Host, P% and IMI: *R. ornata* (P = 10%; IMI = 2.0 ± 0) and *H. binotatus* (P = 22.2%; IMI = 1.0 ± 0).

Site of infection: small intestine.

Other reported hosts and locality: *Hypsiboas boans* (Linnaeus, 1758) (syn. *Hyla boans*) (AM), *Hypsiboas* sp. (MS), *Leptodactylus bufonius* Boulenger, 1894 (Corrientes), *Leptodactylus fuscus* (Schneider, 1799) (syn. *Leptodactylus sibilatrix*) (ES), *L. latrans* (syn. *L. ocellatus*) (PA), *Leptodactylus pentadactylus* (Laurenti, 1768) (Comté), *Lysapsus limellum* Cope, 1862 (syn. *Pseudis limellum*) (PA), *Physalaemus albonotatus* (Steindachner, 1864) (Corrientes), *Rhinella crucifer* (syn. *B. crucifer*) (RJ), *Rhinella fernandezae* (Gallardo, 1957) (RS), *R. icterica* (syn. *Bufo ictericus* and *Chaunus ictericus*) (ES, RJ, SC), *Rhinella granulosa* (Spix, 1824) (syn. *Bufo granulosus*) (PA), *R. marina* (syn. *Bufo marinus*) (AM, PA) and *Rhinella schneideri* (syn. *Chaunus schneideri*) (MS).

Geographic range: Argentina (González and Hamann 2006b, 2012), Brazil (Gonçalves et al. 2002; Luque et al. 2005; Lux Hoppe et al. 2008; Rodrigues et al. 1982; Rodrigues 1986; Santos and Amato 2010a; Travassos et al. 1939, 1964; Travassos and Freitas 1941, 1964; Vicente et al. 1991) and French Guiana (Ben Slimane and Durette-Desset 1996).

Remarks: *R. ornata* and *H. binotatus* represent new host records for *Oswaldocruzia* sp.; as species determination was based on male characteristics, it was not possible to assign a species designation for our nematode. Anchieta Island is a new locality record.

Physalopteridae
***Physaloptera* sp.**

Host, P% and IMI: *R. ornata* (P = 20%; IMI = 2.7 ± 1.2), *H. binotatus* (P = 33.3%; IMI = 12.0 ± 8.5), *F. fissilis* (P = 16.7%; IMI = 1.7 ± 0.7), *S. hayii* (P = 8.7%; IMI = 1.0), *H. albomarginatus* (P = 22.2%; IMI = 5.7 ± 4.4), *H. phyllodes* (P = 33.3 %; IMI = 1.0), *L. latrans* (P = 25%; IMI = 5.0), *L. cf. marmoratus* (P = 2.4%; IMI = 1.0), *C. carvalhoi* (P = 7.7%; IMI = 1.0 ± 0) and *M. microps* (P = 10%; IMI = 2.0 ± 0).

Site of infection: stomach.

Other reported hosts and locality: *Allobates marchesianus* (Melin, 1941) (syn. *Colostethus marchesianus*) (Cuzco), *Ctenophryne geayi* Mocquard, 1904 (Cuzco), *Dendropsophus leali* (Bokermann, 1964) (syn. *Hyla leali*) (Cuzco), *Dendropsophus leucophyllatus* (Beireis, 1783) (syn. *Hyla leucophyllatus*) (Cuzco), *Dendropsophus marmoratus* (Laurenti, 1768) (syn. *Hyla marmorata*) (Cuzco), *Edalorhina perezi* Jiménez de la Espada, 1870 (Cuzco), *Hamptophryne boliviana* (Parker, 1927) (Cuzco), *Hypsiboas boans* (syn. *Hyla boans*) (Cuzco), *Hypsiboas faber* (Wied-Neuwied, 1821) (syn. *Hyla faber*) (RJ), *Hypsiboas cinerascens* (Spix, 1824) (syn. *Hyla granosa*) (Cuzco), *Hypsiboas fasciatus* (Günther, 1858) (syn. *Hyla fasciata*) (Cuzco), *Leptodactylus bolivianus* Boulenger, 1898 (Cuzco), *L. bufonius* (Corrientes), *L. latrans* (syn. *Leptodactylus caliginosis* and *L. ocellatus*) (RJ, TO), *Leptodactylus leptodactyloides* (Andersson, 1945) (TO, Cuzco), *Leptodactylus lineatus* (Schneider, 1799) (syn. *Lithodytes lineatus*) (Cuzco), *L. marmoratus* (syn. *Adenomera marmorata*) (RJ), *Leptodactylus mystaceus* (Spix, 1824) (RJ, Cuzco), *L. pentadactylus* (Cuzco), *Leptodactylus petersii* (Steindachner, 1864) (TO), *Leptodactylus rhodonotus* (Günther, 1869) (Cuzco), *Osteocephalus taurinus* Steindachner, 1862 (Cuzco), *Oreobates cruralis* (Boulenger, 1902) (syn. *Eleutherodactylus curalis*) (Cuzco), *Phyllomedusa tomopterna* (Cope, 1868) (Cuzco), *P. albonotatus* (Corrientes), *Physalaemus santafecinus* Barrio, 1965 (Corrientes), *Physalaemus signifer* (Girard, 1853) (RJ), *Physalaemus soaresi* Izecksohn, 1965 (RJ), *Pristimantis fenestratus* (Steindachner, 1864) (syn. *Eleutherodactylus fenestratus*) (Cuzco), *Proceratophrys appendiculata* (Günther, 1873) (RJ), *Proceratophrys boiei* (Wied-Neuwied, 1824) (RJ), *Pseudis paradoxa* (Linnaeus, 1758) (Cuzco), *R. fernandezae* (Corrientes), *R. granulosa* (Corrientes), *R. icterica* (SP), *Rhinella margaritifera* (Laurenti, 1768) (syn. *Bufo typhonius*) (Cuzco), *R. marina* (syn. *B. marinus*) (AM, PA, Cuzco), *R. schneideri* (Corrientes), *Scinax acuminatus* (Cope, 1862) (Corrientes), *Scinax ictericus* Duellman and Wiens, 1993 (Cuzco), *Scinax nasicus* (Cope, 1862) (Corrientes), *Scinax ruber* (Laurenti, 1768) (Cuzco), *Trachycephalus coriaceus* (Peters, 1867) (syn. *Phrynoyas coriacea*) (Cuzco) and *Trachycephalus typhonius* (Linnaeus, 1758) (syn. *Phrynohyas venulosa*) (Cuzco).

Geographic range: Argentina (González and Hamann 2006a, 2006b, 2007a, 2008, 2010, 2012; Hamann et al. 2010), Brazil (Boquimpani-Freitas et al. 2001; Fabio 1982; Goldberg et al. 2009; Gonçalves et al. 2002; Klaion et al. 2011; Pinhão et al. 2009; Travassos 1925; Travassos and Freitas 1964; Vicente et al. 1991) and Peru (Bursey et al. 2001).

Remarks: *R. ornata, H. binotatus, F. fissilis, S. hayii, H. albomarginatus, H. phyllodes, C. carvalhoi* and *M. microps* represent new host records for larvae of *Physaloptera* sp., but larval characteristics did not allow a species designation for our nematode. Anchieta Island is a new locality record.

Kathlaniidae
Falcaustra mascula

Host, P% and IMI: *L. latrans* (P = 25%; IMI = 2.0)

Site of infection: large intestine

Other reported hosts and locality: *Crossodactylus gaudichaudii* Duméril and Bibron, 1841 (RJ), *Hylodes nasus* (Lichtenstein, 1823) (Brazil), *Hypsiboas albopunctatus* (DF), *H. faber* (syn. *H. faber*) (Brazil), *Ischnocnema guentheri* (Steindachner, 1864) (syn. *Eleutherodactylus guentheri*) (RJ), *I. parva* (syn. *Eleutherodactylus parvus*) (RJ), *Leptodactylus vastus* A. Lutz, 1930 (syn. *Leptodactylus labyrinthicus*) (BA), *Leptodactylus labyrinthicus* (Spix, 1824) (BA, RJ), *L. latrans* (syn. *L. ocellatus)* (PR, RJ, Assuncion, Chaco-I, Remanso Castillo), *Leptodactylus rhodomystax* Boulenger, 1884 (PA), *Rhinella granulosa* (syn. *B. marinus*) (RJ), *Rhinella icterica* (syn. *Bufo marinus ictericus* and *Bufo ictericus*) (RJ) and *R. schneideri* (Corrientes, Assuncion, Chaco-I, Remanso Castillo).
Geographic range: Argentina (González and Hamann 2008), Brazil (Fabio 1982; Fahel 1952; Freitas and Lent 1941; Goldberg et al. 2007; Holmes et al. 2008; Luque et al. 2005; Martins and Fabio 2005; Rodrigues et al. 1982; Stumpf 1982; Travassos 1925; Vicente and Santos 1976; Vicente et al. 1991,) and Paraguay (Lent et al. 1946, McAllister et al. 2010b).
Remarks: Three species of *Falcaustra* have been reported from South America. Anchieta Island is a new locality record for *F. mascula*.

Oxyascaris oxyascaris
Host, P% and IMI: *L. latrans* (P = 50%; IMI = 4.5 ± 0.5).
Site of infection: large and small intestines.
Other reported hosts and locality: *I. guentheri* (syn. *E. guentheri*) (RJ), *Leptodactylus fuscus* (MS), *Leptodactylus macrosternum* Miranda-Ribeiro, 1926 (Paraguay), *L. mystaceus* (RJ), *Leptodactylus mystacinus* (Burmeister, 1861) (MS), *L. latrans* (syn. *L. ocellatus*) (PR, SP), *Physalaemus signifer* (RJ), *P. soaresi* (RJ), *Pleurodema diplolister* (Peters, 1870) (BA), *Proceratophrys boiei* (RJ) and *Rhinella schneideri* (Paraguay).
Geographic range: Brazil (Fabio 1980, 1982; Klaion et al. 2011; Martins and Fabio 2005; Rodrigues 1986; Rodrigues et al. 1990; Travassos 1920, 1925; Vicente and Santos 1976; Vicente et al. 1991) and Paraguay (Baker and Vaucher 1985).
Remarks: Anchieta Island is a new locality record for *O. oxyascaris*.

Cosmocercidae
Cosmocercidae gen. sp.
Host, P% and IMI: *S. hayii* (P = 4.3%; IMI = 1.0), *C. carvalhoi* (P = 88.5%; IMI = 7.5 ± 1.6), *H. asper* (P = 50%; IMI = 17.0), *H. phyllodes* (P = 66.7%; IMI = 3.5 ± 0.5), *L. cf. marmoratus* (P = 9.5%; IMI = 5.0 ± 2.2), *L. latrans* (P = 50%; IMI = 10.0 ± 9.0), *R. ornata* (P = 65%; IMI = 11.6 ± 5.2), *D. brevipollicatus* (P = 66.7%; IMI = 3.0 ± 1.0), *I. parva* (P = 70%; IMI = 1.7 ± 0.2) and *H. binotatus* (P = 77.8%; 94.1 ± IMI = 89.9).
Site of infection: stomach, large and small intestines.
Other reported hosts and locality: *Dermatonotus muelleri* (Boettger, 1885) (MS), *Eupemphix nattereri* Steindachner, 1863 (MS), *Hypsiboas prasinus* (Burmeister, 1856) (SP), *Leptodactylus latrans* (syn. *Leptodactylus ocellatus*) (MS, RJ), *L. pentadactylus* (RJ), *L. podicipinus* (MS), *Phyllomedusa azurea* Cope, 1862 (MS), *Rhinella crucifer* (syn. *Bufo crucifer*) (RJ), *R. granulosa* (MS) *R. icterica* (SP and RJ), *R. marina* (MS), *R. schneideri* (syn. *Bufo marinus*) (MS) and *Stereocyclops incrassatus* Cope, 1870 (syn. *Hypopachus incrassatus*) (MS).
Geographic range: Brazil (Campião et al. 2012, 2014; Chabaud 1978; Madelaire et al. 2012; Pinhão et al. 2009; Rodrigues et al. 1982, 1990; Travassos and Freitas 1942; Vicente et al. 1991).
Remarks: This nematode is a very common parasite of amphibians, but *S. hayii, C. carvalhoi, H. asper, H. phyllodes, R. ornata* and *D. brevipollicatus* represent new host records for cosmocercids, and this study is the first report regarding helminth fauna of these anurans; only *H. phyllodes* has an acanthocephalan species reported: *Anuracanthorhyncus tritaxisentis* Bursey, Vrcibradic, Hatano and Rocha 2006. Specimens reported here as Cosmocercidae gen. sp., as well as prevalence and MII correspond to females and males of this helminth family. Congeneric females are very similar and specific identification was not possible based on morphological characteristics. Only males were identified based on morphology and size of taxonomic characteristics; these species identified are listed as follows. This segregated view between males and females for the present study is due to uncertainty of whether females belong to the same species as males, as well as the scarce research descriptions of female specimens.

Aplectana crucifer
Host: *R. ornata*
Site of infection: large intestine
Other reported hosts and locality: *R. crucifer* (syn. *Bufo crucifer*) (RJ).
Geographic range: Brazil (Travassos 1925, 1931; Vicente et al. 1991) and Paraguay (McAllister et al. 2010b).
Remarks: *R. ornata* represents the second host record for *Aplectana crucifer* in South America, and this study is the first report concerning helminth fauna of this anuran.

Aplectana pintoi
Host: *I. parva* and *H. binotatus*
Site of infection: small and large intestines.
Other reported hosts and locality: *Craugastor gollmeri* (Peters, 1863) (syn. *Eleutherodactylus gollmeri*) (RJ) and *Ischnocnema guentheri* (syn. *Hylodes guentheri*) (RJ).
Geographic range: Brazil (Travassos 1925, 1931; Vicente et al. 1991).
Remarks: *I. parva* and *H. binotatus* represent the third and fourth host records for *Aplectana pintoi* in South America. Anchieta Island is a new locality record for *A. pintoi*.

***Aplectana* sp.**
Host: *C. carvalhoi*
Site of infection: large intestine
Other reported hosts and locality: *Ceratophrys cranwelli* Barrio, 1980 (MS), *Dendropsophus microps* (Peters, 1872) (syn. *Hyla microps*) (Brazil), *Dermatonotus muelleri* (MS), *Haddadus binotatus* (syn. *Hylodes binotatus*) (Brazil), *Hypsiboas albopunctatus* (DF), *Hypsiboas pardalis* (Spix, 1824) (syn. *Hyla pardalis*) (Brazil), *Leptodactylus bufonius* (Corrientes), *L. chaquensis* (Corrientes), *Leptodactylus elenae* Heyer, 1978 (MS), *L. fuscus* (MS), *L. marmoratus* (syn. *Adenomera marmorata*) (RJ), *L. mystacinus* (MS), *L. podicipinus* (MS), *Leptodactylus syphax* Bokermann, 1969 (MS), *Physalaemus signifier* (RJ), *Rhinella granulosa* (syn. *Bufo granulosus*) (PA), *R. icterica* (syn. *Bufo ictericus*) (ES, RJ), and *R. marina* (syn. *Bufo marinus*) (PA), *Scinax acuminatus* (syn. *Hyla phrynoderma*) (MS), *Thoropa miliaris* (Spix, 1824) (Brazil) and *Trachycephalus mesophaeus* (Hensel, 1867) (syn. *Hyla mesophaea*) (Brazil).
Geographic range: Argentina (González and Hamann 2006b, Schaefer et al. 2006), Brazil (Chabaud 1978; Fabio 1982; Holmes et al. 2008; Luque et al. 2005; Rodrigues et al. 1990; Travassos 1925; Travassos et al. 1939, 1964; Travassos and Freitas 1964; Vicente and Pinto 1981; Vicente et al. 1991;) and Paraguay (Baker and Vaucher 1986).
Remarks: *C. carvalhoi* represents a new host record for *Aplectana* sp., and this study is the first report concerning helminth fauna of this anuran. There are 23 Neotropical species of *Aplectana*, but characteristics did not allow a species designation for our nematode. Anchieta Island is a new locality record for *Aplectana* sp.

Cosmocerca brasiliense
Host: *R. ornata, H. binotatus* and *H. phyllodes*.
Site of infection: small and large intestines.
Other reported hosts and locality: *Ameerega parvula* (Boulenger, 1882) (syn. *Dendrobates parvulus*) (Santa Cecilia), *Dendropsophus brevifrons* (Duellman and Crump, 1974) (syn. *Hyla brevifrons*) (Cuzco), *Dendropsophus cachimbo* (Napoli and Caramaschi, 1999) (PA), *Dendropsophus koechlini* (Duellman and Trueb, 1989) (syn. *Hyla koechlini*) (Cuzco), *D. leali* (syn. *Hyla leali*) (Cuzco), *D. leucophyllatus* (syn. *Hyla leucophyllata*) (Cuzco),

D. marmoratus (syn. *Hyla marmorata*) (Pastaza), *Dendropsophus parviceps* (Boulenger, 1882) (syn. *Hyla parviceps*) (Cuzco), *Dendropsophus rhodopeplus* (Günther, 1858) (syn. *Hyla rhodopepla*) (Cuzco), *Dendropsophus sarayacuensis* (Shreve, 1935) (Santa Cecilia), *Dendropsophus schubarti* (Bokermann, 1963) (syn. *Hyla schubarti*) (Cuzco), *Edalorhina perezi* (Cuzco), *Eleutherodactylus* sp. (Santa Cecilia), *Hamptophryne boliviana* (Cuzco), *Hypsiboas boans* (syn. *Hyla boans*) (Cuzco), *Hypsiboas calcaratus* (Troschel, 1848) (syn. *Hyla calcarata*) (Cuzco), *H. cinerascens* (syn. *Hyla granosa*) (Cuzco), *H. fasciatus* (syn. *Hyla fasciata*) (Cuzco), *Hypsiboas geographicus* (Spix, 1824) (Santa Cecilia), *Hypsiboas lanciformis* Cope, 1871 (Santa Cecilia and Pastaza), *H. faber* (syn. *Hyla faber*) (RJ), *Hypsiboas punctatus* (Schneider, 1799) (Pastaza), *Ischnocnema guentheri* (syn. *Hylodes guentheri* and *Eleutherodactylus guentheri*) (RJ), *Leptodactylus andreae* Müller, 1923 (syn. *Adenomera andreae*) (Cuzco), *L. bolivianus* (Cuzco), *Leptodactylus hylaedactylus* (Cope, 1868) (syn. *Adenomera hyeleadactyla*) (Cuzco), *L. latrans* (syn. *Leptodactylus ocellatus*) (Rupunini), *L. pentadactylus* (Cuzco), *L. petersii* (Cuzco), *L. podicipinus* (Rupunini), *Oreobates cruralis* (syn. *Eleutherodactylus cruralis*) (Cuzco), *Oreobates quixensis* Jiménez de la Espada, 1872 (Cuzco), *Osteocephalus taurinus* (Cuzco), *Phyllomedusa atelopoides* Duellman, Cadle, and Cannatella, 1988 (Cuzco), *Phyllomedusa palliata* Peters, 1873 (Cuzco), *Phyllomedusa tarsius* (Cope, 1868) (Cuzco), *P. tomopterna* (Cuzco), *Phyllomedusa vaillanti* Boulenger, 1882 (Cuzco), *Pristimantis altamazonicus* (Barbour and Dunn, 1921) (syn. *Eleutherodactylus altamazonicus*) (Santa Cecilia), *P. fenestratus* (syn. *Eleutherodactylus fenestratus*) (Cuzco), *Pristimantis lanthanites* (Lynch, 1975) (syn. *Eleutherodactylus lanthanites*) (Cuzco), *Pristimantis peruvianus* (Melin, 1941) (syn. *Eleutherodactylus peruvianus*) (Cuzco), *Pristimantis toftae* (Duellman, 1978) (syn. *Eleutherodactylus toftae*) (Cuzco), *Proceratophrys appendiculata* (RJ), *Rhinella crucifer* (syn. *Bufo crucifer*) (RJ), *R. marina* (syn. *Bufo marinus*) (Cuzco), *Scarthyla goinorum* (Bokermann, 1962) (syn. *Scarthyla ostinodactyla*) (Cuzco), *Scinax garbei* (Miranda-Ribeiro, 1926) (Cuzco), *S. ictericus* (Cuzco), *Scinax pedromedinae* (Henle, 1991) (Cuzco), *S. ruber* (Pastaza), *Sphaenorhynchus lacteus* (Daudin, 1800) (Cuzco), *Thoropa miliaris* (RJ) and *Trachycephalus coriaceus* (syn. *Phrynohyas coriacea*) (Cuzco).

Geographic range: Brazil (Boquimpani-Freitas et al. 2001; Goldberg et al. 2007; Martins and Fabio 2005; Travassos 1925, 1931; Vicente et al. 1991), Ecuador (Dyer and Altig 1976, 1977; McAllister et al. 2010a), Guyana (McAllister et al. 2010d) and Peru (Bursey et al. 2001).

Remarks: *R. ornata*, *H. binotatus* and *H. phyllodes* represent new host records for *Cosmocerca brasiliense*. Anchieta Island is a new locality record.

Cosmocerca parva

Host: *D. brevipollicatus*

Site of infection: large intestine.

Other reported hosts and locality: *Ameerega picta* (Bibron, 1838) (syn. *Epipedobates pictus*) (Cuzco), *Ameerega trivittata* (Spix, 1824) (Rupunini and Ucayali), *Colostethus fraterdanieli* Silverstone, 1971 (Cordilheira Central), *Dendropsophus sanborni* (Schmidt, 1944) (Corrientes), *Edalorhina perezi* (Cuzco), *Elachistocleis ovalis* (Schneider, 1799) (Cuzco), *Hamptophryne boliviana* (Cuzco), *Hypsiboas boans* (Rupunini), *H. fasciatus* (syn. *Hyla fasciata*) (Cuzco), *Hypsiboas raniceps* Cope, 1862 (Corientes), *Hylodes nasus* (syn. *Elosia nasus*) (RJ), *Leptodactylus bufonius* (Corrientes), *L. chaquensis* (Paraguay and Corrientes), *L. elenae* (Paraguay), *L. fuscus* (RJ), *Leptodactylus latinasus* Jiménez de la Espada, 1875 (Corrientes), *L. latrans* (syn. *Leptodactylus ocellatus*) (RJ and SC), *L. leptodactyloides* (Cuzco), *L. marmoratus* (syn. *Adenomera marmorata*) (RJ), *L. mystaceus* (RJ, Cuzco), *L. podicipinus* (RJ), *Leptodactylus* sp., *Odontophrynus americanus* (Duméril and Bibron, 1841) (Corrientes), *Oreobates quixensis* (Ucayali), *Phyllomedusa atelopoides* (Cuzco), *Phyllomedusa hypochondrialis* (Daudin, 1800) (Rupunini), *Physalaemus albonotatus* (Corrientes), *Physalaemus cuvieri* Fitzinger, 1826 (SC), *P. santafecinus* (Corrientes), *P. signifer* (RJ), *P. soaresi* (RJ), *Pristimantis fenestratus* (Cuzco), *P. peruvianus* (syn. *Eleutherodactylus peruvianus*) (Cuzco), *P. toftae* (syn. *Eleutherodactylus toftae*) (Cuzco), *Proceratophrys boiei* (RJ), *Rhaebo glaberrimus* (Günther, 1869) (syn. *Bufo glaberrinus*) (Cuzco), *Rhinella bergi* (Corrientes), *R. crucifer* (Paraguay), *R. fernandezae* (RS, Corrientes), *R. granulosa* (Corrientes), *R. margaritifera* (syn. *Bufo typhonius*) (Cuzco), *R. marina* (syn. *Bufo marinus*) (Cuzco), *Rhinella major* (Müller and Hellmich, 1936) (Corrientes), *R. schneideri* (Paraguay and Corrientes), *Scarthyla goinorum* (syn. *Scarthyla ostinodactyla*) (Cuzco), *Scinax acuminatus* (Paraguay and Corrientes), *Scinax fuscovarius* (Lutz, 1925) (Paragauy and SC), *S. garbei* (Cuzco), *S. ictericus* (Cuzco) and *S. nasicus* (Corrientes).

Geographic range: Argentina (González and Hamann 2006a, 2006b, 2007a, 2007b, 2008, 2009, 2010, 2011, 2012; Hamann et al. 2006a, 2006b, 2009, 2010; Mordeglia and Digiani 1998; Schaefer et al. 2006), Brazil (Fabio 1982; Klaion et al. 2011; Santos and Amato 2010a, 2013; Travassos 1925, 1931; Vicente et al. 1991), Colombia (Sánchez et al. 2010), Guyana (McAllister et al. 2010d), Paraguay (Baker and Vaucher 1984; Masi Pallares and Maciel 1974; McAllister et al. 2010b) and Peru (McAllister et al. 2010c).

Remarks: *D. brevipollicatus* represents a new host record for *Cosmocerca parva*, and this study is the first report regarding helminth fauna of the anuran. Anchieta Island is a new locality record.

Cosmocerca travassosi

Host: *I. parva*.

Site of infection: stomach and large intestine.

Other reported hosts and locality: *Hypsiboas faber* (syn. *Hyla faber*) (RJ).

Geographic range: Brazil (Rodrigues and Fabio 1970; Vicente et al. 1991).

Remarks: *I. parva* represents the second host record for *Cosmocerca travassosi* in South America. *Aplectana membranosa* and *Falcaustra mascula* were the only helminth species previously reported for *I. parva*.

***Cosmocerca* sp.**

Host: *S. hayii* and *C. carvalhoi*.

Site of infection: stomach, small and large intestines.

Other reported hosts and locality: *Eupsophus roseus* (Chile), *Hypsiboas albopunctatus* (DF), *Physalaemus biligonigerus* (Cope, 1861) (syn. *Pleurodema fuscomaculatum* and *Paludicola fuscomaculatus*) (MS), *Pseudopaludicola boliviana* Parker, 1927 (Corrientes), *Rhinella margaritifera* (syn. *Bufo typhonius*) (AM) and *T. typhonius* (syn. *Trachycephalus nigromaculatus* Tschudi, 1838) (MS).

Geographic range: Argentina (Duré et al. 2004), Brazil (Gonçalves et al. 2002; Holmes et al. 2008; Travassos et al. 1939; Travassos and Freitas 1941; Vicente et al. 1991) and Chile (Puga and Torres 1999).

Remarks: *S. hayii* and *C. carvalhoi* represent new host records for *Cosmocerca* sp., and this study is the first report concerning helminth fauna of these anurans. There are 10 South American species of *Cosmocerca*, but characteristics did not allow a species designation for our nematode. Anchieta Island is a new locality record.

Acanthocephala

Cystacanths of undetermined Order, Family genus and species

Host, P% and IMI: *R. ornata* (P = 15%; IMI = 1.0 ± 0), *L. latrans* (P = 50%; IMI = 2.0 ± 1.0), *L. cf. marmoratus* (P = 2.4%; IMI = 1.0), *F. fissilis* (P = 5.6; IMI = 4.0), *M. microps* (P = 33.3%; IMI = 3.0) and *C. carvalhoi* (P = 30.8%; IMI = 4.9 ± 1.6).

Site of infection: muscle of stomach, mesentery, urinary bladder and muscle of body cavity.

Other reported hosts and locality: *Leptodactylus latrans* (syn. *Leptodactylus ocellatus)* (PR) and *Dendropsophus nanus* (Boulenger, 1889) (syn. *Hyla nana*) (Corrientes).
Geographic range: Argentina (Hamann and Kehr 1998) and Brazil (Stumpf 1982).
Remarks: *R. ornata, F. fissilis, M. microps* and *C. carvalhoi* represent new host records for acantocefalans, and this study is the first report regarding helminth fauna of these anurans. For *Leptodactylus* cf. *marmoratus*, the acanthocephalan *Centrorhynchus* sp. has been reported (Fabio 1982). The specimens' proboscises were inverted, so specific identification was not possible. Anchieta Island is a new locality record.

Cestoda
Nematotaeniidae
Cylindrotaenia* cf. *americana
Host, P% and IMI: *H. phyllodes* (P = 33.3%; IMI = 1.0) and *I. parva* (P = 20%; IMI = 1.5 ± 0.5).
Site of infection: small intestine.
Other reported hosts and locality: *Allobates marchesianus* (syn. *Colostethus marchesianus*) (Cuzco), *Atelopus bomolochos* Peters, 1973 (Piura), *Hypsiboas prazinus* (SP), *Rhinella fernandezae* (RS), *R. marina* (syn. *Bufo marinus*) (Colombia and Cuzco), *R. icterica* (PR), *R. margaritifera* (Ucayali), *R. schneideri* (Paraguay), *Scinax pedromedinai* (Cuzco) and *Telmatobius jelskii* (Peters, 1873) (Lima).
Geographic range: Brazil (Madelaire et al. 2012; Santos and Amato 2010a; Stumpf 1981), Colombia (Brooks 1976), Paraguay (McAllister et al. 2010b) and Peru (Bursey et al. 2001; Iannacone 2003a, 2003b; McAllister et al. 2010c).
Remarks: *H. phyllodes* and *I. parva* represent new host records for cestodes. Anchieta Island is a new locality record.

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Prevalence of *Batrachochytrium dendrobatidis* in Pond-breeding Amphibians of the Fall Line Sandhills Region of Georgia, USA

The Fall Line Sandhills region of Georgia, USA is an area of high herpetofaunal diversity (Graham et al. 2010), with over 30 amphibian species documented in the region (Jensen et al. 2008). Over a dozen of these are known to occur on the ~355-ha Fall Line Sandhills Wildlife Management Area (FLSWMA) in Taylor Co., Georgia (32.578298°N, 84.269315°W; WGS 84), including the Gopher Frog (*Lithobates capito*) and Striped Newt (*Notophthalmus perstriatus*). The Gopher Frog and Striped Newt are two of Georgia's rarest amphibians, known from only a few sites in the state (Jensen et al. 2008). The emergent infectious disease chytridiomycosis, caused by the fungus *Batrachochytrium dendrobatids* (*Bd*), is still not well understood despite having been implicated as factor in local and global amphibian declines (Fisher et al. 2009; Rosenblum et al. 2013). This pathogen has been detected at numerous sites in the southeastern United States, including Georgia (Green and Dodd 2007; Hill et al. 2011; Hossack et al. 2010; Rothermel et al. 2008; Timpe et al. 2008). Our goal was to determine *Bd* prevalence at a single site within the FLSWMA over multiple years during late winter and spring breeding events. The study site experienced drought conditions in 2011 and 2012 with the focal pond completely drying down in the spring of both years and not refilling until the following winter. The pond retained water through most of 2013. Here we describe prevalence of *Bd* infection over these natural cycles of pond-filling rains and droughts from 2011–2013.

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We conducted visual encounter surveys from February–April 2011 (five), February–March 2012 (three), and in February–March 2013 (two). In 2011, surveys ended with the April sampling due to complete pond drying. The pond almost completely dried by early April 2012, thus sampling ended in March of that year. Although the pond remained full through the spring of 2013, surveys were concluded following the March sampling. Sampling was biased toward the most readily collected species during each survey, though all individuals of any species captured were sampled for *Bd*. All surveys took place in and along the edges of a large ephemeral pond on the FLSWMA. The pond serves as a breeding site for a number of amphibians (12+ species) including *Lithobates capito* and *Notopthalmus perstriatus,* which are both protected in Georgia (Jensen et al. 2008). We captured individuals by dip net or by hand within the pond or within 2 m of the water's edge. Only metamorphosed amphibians were sampled, with the exception of one paedomorphic *N. perstriatus*. After capture, individuals were placed singly into Ziploc® plastic bags for a period not exceeding 12 hours for on-site processing. A new pair of powder-free nitrile gloves was worn while processing each animal during all sampling efforts. Field equipment was disinfected between surveys (Miller and Gray 2009).

Following survey completion, individuals were swabbed for *Bd* (Pessier and Mendelson 2010). Swabs were placed into individually numbered plastic vials with one drop of 95% ethanol for storage and shipped to the diagnostic lab at the College of Veterinary Medicine at North Carolina State University, Raleigh. Each sample was processed using *Bd*-specific real-time Taqman (Applied Biosystems, Foster City, CA) Polymerase Chain Reaction (Boyle et al. 2004).

In total, we sampled 368 amphibians between 2011 and 2013. In 2011 127 amphibians representing seven anuran and two caudate species were sampled, with *Bd* being detected in 48 samples from four species, including the Striped Newt (*N. perstriatus*). (Table 1). No evidently diseased animals

TABLE 1. Samples collected per species from 2011–2013 for *Batrachochytrium dendrobatidis* (*Bd*) at Fall Line Sandhills Wildlife Management Area in Taylor County, Georgia, USA.

Species by year	No. *Bd*-Positive/ Total Sampled
2011	
Anurans	
Acris gryllus	44/89
Anaxyrus terrestris	0/3
Hyla femoralis	0/1
Hyla gratiosa	0/2
Lithobates catesbeianus	0/3
Lithobates sphenocephalus	1/13
Pseudacris crucifer	1/8
Caudates	
Notophthalmus perstriatus	2/7
Notophthalmus viridescens	0/1
2011 Total	48/127
2012	
Anurans	
Acris gryllus	12/37
Anaxyrus quercicus	0/1
Anaxyrus terrestris	0/11
Lithobates capito	0/4
L. sphenocephalus	13/45
Pseudacris crucifer	4/30
P. ornata	6/11
Caudates	
Ambystoma talpoideum	0/2
Notophthalmus perstriatus	0/1
2012 Total	35/142
2013	
Anurans	
Acris gryllus	2/5
Anaxyrus quercicus	0/2
Anaxyrus terrestris	0/28
Hyla femoralis	0/22
H. gratiosa	1/29
Pseudacris crucifer	2/10
P. nigrita	0/1
P. ornata	0/1
Caudates	
Ambystoma talpoideum	0/1
2013 Total	5/99
Total for 2011–2013	88/368

were encountered. In 2012, 142 samples were collected from seven anuran and two caudate species, of which 35 samples representing four species were *Bd*-positive (Table 1). Again, all specimens appeared outwardly healthy, although four individuals showed mild ventral redness or small lesions. In 2013, 99 samples were collected from seven anurans and one caudate species, with five samples testing positive for *Bd* (Table 1). Ten specimens showed some mild ventral redness and/or tiny lesions.

Although some opportunistic sampling has occurred in previous years (Timpe et al. 2008 ; Hill et al. 2011), this study represents the first concerted multi-year effort to determine *Bd* prevalence within the Fall Line Sandhills region of Georgia. Our results indicate that *Bd* is quite prevalent in several species at FLSWMA. While some individuals exhibited small lesions or slight ventral redness (N = 18), none exhibited other obvious symptoms of chytridiomycosis. Of those with lesions or ventral redness, only one tested positive for *Bd*. Although we did not test for the presence of ranaviruses, the redness and lesions observed did not appear consistent with those described for ranaviral disease (Gray et al. 2009) and no individuals showed signs of morbidity. The prevalence of *Bd* appeared to be lower in 2013 when all potential breeding ponds at FLSWMA were full and the focal pond had larger boundaries than in either 2011 or 2012. Perhaps this was a result of more available breeding or calling sites, which would reduce any potential crowding effect within the pond (see Longo et al. 2010). Lower *Bd* prevalence in 2013 may also be related to sampling bias, as the species with the highest overall *Bd* occurrence during the first two years (*A. gryllus*) was collected in lower numbers than in previous years.

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Occurrence of the Chytrid Fungus *Batrachochytrium dendrobatidis* in Amphibians in Illinois, USA

Several reports have documented the occurrence of *Batrachochytrium dendrobatidis* (*Bd*) in Illinois (Lannoo et al. 2011; Steiner and Lehtinen 2008; Talley et al. 2011) but chytridiomycosis has not been implicated in any declines within the State. Efforts to sample for *Bd* continue to be of importance in order to provide a complete understanding of this emerging infectious disease.

We sampled amphibians at 13 lentic habitats throughout Illinois, USA in the winter and spring of 2011 for prevalence of *Bd*. We swabbed 11 different species using a variety of capture methods; adult salamanders were captured in minnow traps; adult and juvenile frogs were captured by hand by placing a clean plastic zipper bag in front of the individual and coaxing them to jump into the bag; larvae were collected in a similar manner except that the bag was placed in the water so that the larva swam into the bag. Amphibians were processed on site and released at the completion of the survey.

We swabbed adult and juvenile anurans by coaxing the animal to the top of the bag, gently grasping the hind leg through the plastic bag, then opening the bag. As the animal tries to escape through the opening it presents itself for thorough swabbing. We used a new pair of lab gloves to remove and hold adult and larval salamanders and larval anurans for swabbing. Swabbing technique followed standard protocols for all salamanders and adult anurans (Skerratt et al. 2008). For larval anurans, only the keratinized mouthparts were swabbed. We stored swabs at room temperature in 70% ethanol in pre-labeled individual cryovials. Upon arrival in the laboratory, samples were stored at -20°C until testing. Total DNA was extracted using the Qiagen DNeasy Blood and Tissue Kit (Germantown, Maryland) according to the manufacturer's protocol. A nested PCR approach was used to increase specificity and sensitivity of *Bd* detection as described by Gaertner et al. (2009). Nested PCR has been found to be 10-100 times more sensitive than single-round PCR (Garland et al. 2011) and as sensitive as the real-time TaqMan PCR assay (Goka et al. 2009). Each diagnostic PCR run included a positive and a no DNA control. A sample was only deemed positive if both the initial and the secondary PCR amplifications resulted in the appropriate sized amplicon. A number of randomly selected positive samples were sequenced to confirm that the amplified products were in fact from *B. dendrobatidis*.

Overall prevalence was 12.8% for 227 individuals (Table 1) and averaged 20.9 % across the 13 sites. None of the amphibians sampled displayed symptoms indicative of chytridiomycosis such as skin lesions or discoloration (Berger et al. 1998; Pessier et al. 1999; Rachowicz and Vredenburg 2004). At one site, Cattail Slough, both the individuals swabbed tested positive for *Bd*. Eliminating the Cattail Slough results reduces the average site prevalence to 14.3%. The remaining sites ranged from 6.7% to 42.9% (Table 1). Eleven species of amphibians were swabbed (Table 2) with a prevalence of 6.9% for salamanders (N = 72) and 15% for anurans (N = 155). *Ambystoma platineum* and *A. tigriunum* were the only species that did not have at least one individual test positive for *Bd*.

Prevalence of *Bd* in all animals swabbed in this study is similar to results from previous surveys of amphibian populations of Illinois and neighboring Midwestern states (Kinney et al. 2011; Lannoo et al. 2011; Steiner and Lehtinen 2008). Due to the opportunistic nature of the study, sample sizes are too small to get an accurate determination of prevalences for each pond or each

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TABLE 1. Ponds surveyed for *Batrachochytrium dendrobatidis* (*Bd*) in Illinois, USA in 2011, sample size (N), number and percent *Bd*-positive.

County	Pond	GPS coordinates	Date	*Bd*- Positive/N	% *Bd*-Positive
Cass	6-mile Rd	39.96941°N, 90.39231°W	9 Jun	2/22	9.1
Crawford	CCCA 4	39.08627°N, 87.71019°W	24 Feb	1/5	20.0
Crawford	CCCA 11	39.08819°N, 87.72054°W	24 Feb	1/8	12.5
Edgar	Pipeline 2	39.51470°N, 87.58595°W	25 Feb	1/10	10.0
Edgar	Pipeline 5	39.51677°N, 87.57904°W	25 Feb	3/45	6.7
Effingham	Wildcat 23	38.98891°N, 88.61175°W	2 Mar	1/11	9.1
Effingham	Wildcat 25	38.99125°N, 88.60734°W	2 Mar	1/11	9.1
Effingham	Lauren's Pond	38.99608°N, 88.62060°W	2 Mar	3/22	13.6
Henderson	Gladstone	40.88678°N, 90.95087°W	9 Jun	3/20	15.0
Madison	TNI	38.92334°N, 90.22218°W	1 Jun	6/40	15.0
Monroe	Kidd Lake	38.14181°N, 90.16273°W	2 Jun	3/7	42.9
Scott	Sandpit	39.63535°N, 90.53967°W	1 Jun	2/24	8.3
Whiteside	Cattail Slough	41.83340°N, 90.16921°W	8 Jun	2/2	100
Totals				29/227	12.8

species. However, these results reinforce the notion that *Bd* occurrence is widespread throughout Illinois and across species lines. This is the first published record of *Bd* for small-mouthed salamander *Ambystoma texanum* and eastern narrow-mouthed toad *Gastrophryne carolinensis* (Olson et al. 2013). Additionally, 11 of the 29 positive samples were collected in late February and early March with sampling date temperatures varying from -3°C (daily low) to 7°C (daily high). Previous studies have shown a strong correlation between seasonality and *Bd* prevalence with detection rates higher in the spring and lower in the summer (Kinney et al. 2011; Kriger and Hero 2006; Lannoo et al. 2011). This suggests that individuals might be able to clear infection as the summer progresses and temperatures increase (Richards-Zawacki 2009; Rowley and Alford 2013; Woodhams et al. 2003). However, it is unclear what happens to *Bd* prevalence during the winter, as these surveys are conducted during the warmer months (March to October) when amphibians are most active. Do infection rates increase dramatically in early spring as temperatures increase? Is the fungus able to re-infect during the winter as a result of a suppressed immune response (Maniero and Carey 1997; Raffel et al. 2006) in overwintering amphibians? Further research is necessary to answer these questions, but this study shows that *Bd* is present during winter months.

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TABLE 2. Species and life stages of amphibians surveyed for *Batrachochytrium dendrobatidis* (*Bd*) in Illinois, USA in 2011.

Pond Name	Species	Life Stage	*Bd*-Positive/N
6-mile Rd	*Acris blanchardi*	adults	2/22
CCCA 4	*Ambystoma platineum*	adults	0/4
	Lithobates catesbeianus	adults	1/1
CCCA 11	*Ambystoma texanum*	adults	1/1
	Ambystoma tigrinum	adults	0/7
Pipeline 2	*A. texanum*	adults	1/10
Pipeline 5	*A. texanum*	adults	3/45
Wildcat 23	*A. texanum*	adults	0/1
	Pseudacris crucifer	adults	1/8
	Lithobates sphenocephalus	adults	0/2
Wildcat 25	*A. texanum*	adults	0/2
	P. crucifer	adults	0/4
	L. sphenocephalus	adults	1/5
Lauren's Pond	*A. blanchardi*	adults	2/4
	P. crucifer	adults	0/13
	Pseudacris maculata	adults	1/5
Gladstone	*A. blanchardi*	adult	0/1
	P. maculata	immediately post-metamorphic	0/5
	L. catesbeianus	adult	1/1
	Anaxyrus americanus	immediately post-metamorphic	2/13
TNI	*A. blanchardi*	adults	4/30
	P. crucifer	late-stage larvae	0/6
	L. catesbeianus	larvae	2/4
Kidd Lake	*A. blanchardi*	adults	1/3
	L. catesbeianus	adult	1/1
	Gastrophryne carolinensis	adults	1/3
Sandpit	*A. tigrinum*	larvae	0/2
	A. blanchardi	adults	2/21
	L. catesbeianus	adult	0/1
Cattail Slough	*L. catesbeianus*	adult	1/1
	Lithobates clamitans	post-metamorphic juvenile	1/1

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Sudden Mass Die-off of a Large Population of Wood Frog (*Lithobates sylvaticus*) Tadpoles in Maine, USA, Likely Due to Ranavirus

Starting in early April 2013, a 0.23-ha spring-fed, fish-free pond in Brunswick, Maine, USA (43.919°N, 70.040°W) was informally surveyed at least every other day until the end of August. The first Wood Frogs (*Lithobates sylvaticus*) appeared at the pond on 11 April; three days later the adult frogs numbered several thousand, mostly males. On 16 April we counted 550 Wood Frog egg masses, with an average clutch size of ca. 600 eggs. All adults left the pond within several weeks. Based on counts from photographs of tadpoles swimming near the surface of the pond taken in late May, we estimated that there were more than 100,000 Wood Frog tadpoles. The main predator of Wood Frog eggs at this site, the freshwater leech *Macrobdella decora*, was notably scarce in 2013 compared to most years, which may have contributed to the unusually large tadpole densities in May and early June. At 1600 h on 14 June 2013, we noted huge densities of tadpoles. Twenty-one hours later, on the afternoon of 15 June, a few surviving tadpoles were observed swimming slowly near the pond surface, but none was found alive by the end of the day. Tadpole carcasses were present on the pond bottom (1–2 m depth) at a density roughly estimated at 1300/m^2 around the entire 210-m perimeter of the pond (2250 m^2 area), based on qualitative observations and detailed counts from photographs at several haphazardly selected sites (Fig. 1). Assuming that all of the Wood Frog

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FIG. 1. Dead Wood Frog tadpoles on the bottom of a pond in Brunswick, Maine showing the representative density (ca. 1300/m^2) along the entire 210 m-perimeter of the pond on 15 June 2013.



FIG. 2. Dead and dying Wood Frog tadpoles showing hemorrhages in their well-developed legs and around their throats, as well as skin shedding. Tadpoles were photographed on the afternoon of 15 June 2013.

mortality was restricted to within 1 m of the shore and using a more conservative estimate of 1000 dead tadpoles/m^2, more than 200,000 tadpoles died in less than one day. Dead tadpoles had hemorrhages in their well-developed legs and around their throats (Figs. 1, 2). Skin sloughing was also observed on both dying and freshly dead tadpoles (Fig. 2). Repeated sampling of the pond through early September revealed no Wood Frog tadpoles.

During the die-off, there were no obvious stressors other than possible overcrowding. During the second week of June, White Pine (*Pinus strobus*) pollen had covered much of the pond; Wood Frog tadpoles formed especially dense congregations in the few pollen-free areas. Otherwise, weather conditions over the two-day period were typical for the season, with daily highs 23–25°C. It was sunny and there was no precipitation.

No other species of amphibian or reptile appeared diseased or experienced noticeable mortality. In informal censuses through September, densities of adult and larval Green Frogs (*L. clamitans*), Grey Treefrogs (*Hyla versicolor*), Spring Peepers (*Pseudacris crucifer*), Spotted Salamanders (*Ambystoma maculata*), and Eastern Newts (*Notophthalmus viridescens*) appeared to be unaffected. Bullfrogs (*L. catesbeianus*), which were scarce before the Wood Frog die-off, continued to be present all summer. Adult Painted Turtles (*Chrysemys picta*) were also apparently unaffected. Considering the isolation of the pond and the fact that we found no carcasses of other amphibian and reptile species and their population densities appeared to be unaffected, chemical contaminants or other human-caused stressors seem unlikely causes of the sudden die-off of Wood Frog tadpoles. In April 2014, the density of Wood Frog egg masses was normal, and on 3 June 2014, almost one year after the die-off, tadpoles seemed abundant and healthy.

Four freshly dead tadpoles were haphazardly collected on 15 June, frozen at –20°C, and submitted to the University of Tennessee Center for Wildlife Health. Given that gross signs were indicative of ranaviral disease (Miller et al. 2011), we tested for infection by this pathogen using real-time quantitative polymerase chain reaction (qPCR). Portions of the liver and kidney were removed from each tadpole, gDNA was extracted and quantified, and real-time qPCR was performed on a tissue homogenate using identical procedures as Richter et al. (2013). We used an ABI 7900 Real-time PCR System, and amplified and tested for a 70-bp of the major capsid protein of ranavirus, because this pathogen is frequently associated with die-offs of wood frog tadpoles (Greer et al. 2005; Harp and Petranka 2006; Brunner et al. 2011; Miller et al. 2011). A standard curve developed from our PCR system was used to predict the quantity of virus (plaque-forming units, PFU) in 0.25 μg of gDNA. Four controls also were run with samples: DNA grade water, negative and positive tadpoles (*Lithobates sylvaticus*), and an FV3-like virus grown in cell culture (GenBank accession no. EF101698; Miller et al. 2007). All four tadpoles tested positive for ranavirus infection. Virus concentrations in the liver-kidney homogenate were between 10 and 115 PFU per 0.25 μg of gDNA (Table 2).

To our knowledge, this is only the second published account and location of ranavirus-associated mortality in Maine, and the biggest and most sudden mortality event reported in the region. The first report of ranavirus in Maine was in Acadia National Park (Gahl and Calhoun 2008; Gahl and Calhoun 2010). Die-offs from ranavirus have been reported from New Brunswick, Canada, and many states in the eastern United States (Miller et al. 2011). Assuming that this die-off was caused by the ranavirus we identified, this would be the largest and most rapid event reported in amphibians. Increasing surveillance for ranavirus and estimating population impacts are important conservation directions (Gray and Miller 2013).

TABLE 1. Results of real-time qPCR estimating the quantity of ranavirus from four Wood Frog tadpoles. Ct = qPCR cycle threshold values (mean of two test runs); Concentration = PFU (plaque-forming units) of ranavirus per 0.25 micrograms of gDNA.

Specimen number	Ct	Concentration
1	27.05	24.55
2	28.47	9.98
3	24.62	115.00
4	25.03	88.83

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Prevalence of the Amphibian Chytrid Fungus among Zoo and Pet Store Collections in the Northeastern United States

Recent studies suggest that the amphibian trade has promoted the global transmission of the amphibian chytrid fungus, *Batrachochytrium dendrobatidis* (*Bd*) (Fisher and Garner 2007; Goka et al. 2009; James et al. 2009; Farrer et al. 2011), which is a pathogen implicated as a cause of global amphibian declines (Berger et al. 1999; Daszak et al. 1999; Skerratt et al. 2007; Kilpatrick et al. 2010). In particular, pet shops and zoos constantly acquire and exchange animals depending on their needs and exhibitions, making amphibian collections vulnerable to harboring and transmitting *Bd*. For instance, one study determined 28% of amphibians sold in a number of Japanese pet stores were infected with the fungus (Goka et al. 2009) and several studies reported *Bd*-positive samples among zoo amphibians (Longcore et al. 1999; Miller et al. 2008; Jones et al. 2012; Churgin et al. 2013; Goeroff et al. 2013). Despite the role that pet stores and zoos may play in propagating the disease agent, there is a paucity of studies investigating such possibilities in the United States. Thus, the purpose of this study is to enhance the current knowledge about *Bd* infection among traded amphibians in the United States by examining the prevalence of *Bd* in a variety of pet store and zoo amphibian collections.

A large number of pet stores are widely distributed throughout the United States that internationally and domestically import and sell amphibians. For example, Petco Inc. and Petsmart Inc. are the two largest pet store chains, each of which owns over 1000 stores throughout the United States (Petco: available from http://www.petco.com/ [Accessed 19 August 2013]: Petsmart: available from http://www.petsmart.com/ [Accessed 19 August 2013]). These numbers translate into the distribution of on average 40 or more pet stores per state between these two companies alone. It is likely that some pet owners have disposed of dead or alive purchased amphibians into wild habitats, making it possible that alien *Bd* strains carried by pet amphibians (e.g., Goka et al. 2009) can be transmitted to native amphibian populations. Zoos also may serve as a pathway for bringing *Bd* into amphibian collections and possibly into the local amphibian community, as they receive amphibians from a variety of sources. However, many zoos and aquariums have an Association of Zoos and Aquariums (AZA) accreditation, which sets standard procedures for the acquisition and husbandry of animals which should counter the risk of spreading disease (Poole and Grow 2012). These standards should decrease the likelihood of both presence and transmission of *Bd*.

In November 2012, we collected swab samples of 20 adults of four amphibian species from five different pet stores throughout Pennsylvania (three stores) and Massachusetts (two stores). The pet stores from which we sampled animals included several privately owned and recognized chain stores. From pet stores, we sampled 14 *Bombina orientalis* (Oriental Fire-belied Toads, native to the northeastern Asia), two *Lithobates catesbeianus* (American Bullfrogs, native to the eastern USA), three *Hyla cinerea* (Green Treefrogs, native to the southeastern USA), and one *Ceratophrys ornata* (Bell's Horned Frog, native to South America). Additionally, 30 adult amphibians of nine species were tested for *Bd* from a zoo located in Pennsylvania with AZA accreditation in September 2012. From this zoo we sampled three *L. catesbeianus*, three *Pyxicephalus adspersus* (African Bullfrogs, native to the southern Africa), three *Phyllobates terribilis* (Golden Poison Frogs, native to South America), four *Dendrobates tinctorius* (Dyeing Poison Frogs, native to South

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TABLE 1. Prevalence of *Bd* infection for each species in zoo and pet store amphibian collections.

Zoo (Z) or Pet store (P)	Species	No. infected / No. swabbed
P	*Bombina orientalis*	0/14
P	*Lithobates catesbeianus*	0/2
P	*Hyla cinerea*	1/3
P	*Ceratophrys ornata*	0/1
		Total (P): 1/20 = 5%
Z	*Lithobates catesbeianus*	3/3
Z	*Pyxicephalus adspersus*	0/3
Z	*Phyllobates terribilis*	0/3
Z	*Dendrobates tinctorius*	0/4
Z	*Rhinella marina*	0/1
Z	*Ambystoma mexicanum*	0/1
Z	*Trachycephalus resinifictrix*	0/6
Z	*Phyllomedusa bicolor*	0/2
Z	*Polypedates otilophus*	0/7
		Total (Z): 3/30 = 10%
		Total infected: 4/50=8%

America), one *Rhinella marina* (Cane Toad, native to Central and South America), one *Ambystoma mexicanum* (Axolotl, native to Mexico), six *Trachycephalus resinifictrix* (Boatman Frogs, native to South America), two *Phyllomedusa bicolor* (Waxy-Monkey Tree Frogs, native to South America), and seven *Polypedates otilophus* (File-eared Tree Frogs, native to the southeastern Asia). In total, 50 adult individuals of 13 amphibian species were analyzed.

Each individual was swabbed five times on the ventral side of each limb and abdominal surface using a cotton-tipped swab. In order to avoid cross contamination, nitrile gloves, together with cotton swabs, were replaced between each specimen. Skin swabs were stored dry in a 2.0-mL screw cap vial and kept in a -20°C freezer until DNA extraction. DNA was extracted from swabs using PrepMan Ultra (Life Technologies, Grand Island, New York, United States) and 1:10 diluted DNA samples for the subsequent PCR assay were prepared. The PCR primers and cycle were determined based on Annis et al. (2004), consisting of an initial denaturation (94°C for 5 min), followed by 30 cycles of replication and final extension (72°C for 10 min). Each cycle consisted of denaturation (30°C for 45 s), annealing (55°C for 30 s), and extension (72°C for 1 min). PCR products were ran on ethidium bromide stained agarose gels using electrophoresis and visualized under UV light. These products included both a positive control from a known *Bd* source and a negative control containing sterile distilled water. Conventional PCR combined with agarose gel electrophoresis was used instead of real-time PCR, as a recent study recommended this technique for studies that require only prevalence data (Garland et al. 2011). PCR and gel electrophoresis were repeated three times for all positive samples to prevent any false negative or positive results.

Four of 50 (8%) amphibians tested positive for the presence of *Bd* (Table 1). Three *L. catesbeianus* from the zoo were *Bd* positive, and one *H. cinerea* from a national chain pet store in Pennsylvania was *Bd* positive. These samples consistently showed positive results in the three replicates of the PCR assays.

Whereas only 8% of individuals and 2 of 13 (15%) species were infected with *Bd*, this could have profound effects on *Bd* transmission given the scale of the amphibian trade. The infection that we found in *H. cinerea* sold at the chain pet store poses a potentially devastating risk, because the species is native to the central and southeastern United States and is a commonly sold pet amphibian in the United States and around the world. For instance, between 1998 and 2002 at least 87,536 Kg of *H. cinerea* were exported from the United States as pets (Schlaepfer et al. 2005). Given the high *Bd* infection rate detected among traded amphibians (Goka et al. 2009; Schloegel et al. 2009), the large vendors and breeding centers responsible for rearing and trading these amphibians, as well as the pet stores themselves, likely have lax regulations and protocols in place to prevent the spread of *Bd*. Additionally, some state regulators have not passed specific laws protecting harvested or imported amphibians, particularly concerning amphibians infected with *Bd* (Wilson 2005). Thus, our results predict that the number and distribution of infected pet amphibians in the United States could be substantial.

The instances of infection in the three *L. catesbeianus* were not surprising, as this species is a globally well-known vector of *Bd* (Garner et al. 2006; Schloegel et al. 2010). Some zoos acquire their amphibians from a variety of sources, including many of the centers responsible for breeding amphibians for the pet trade. The zoo staff revealed that the *L. catesbeianus* individuals examined in our study were obtained from a commercial bullfrog farm (L. Brennan, pers. comm.). Acquiring amphibians from such sources comes with the risk of bringing *Bd* into the zoo collection. Despite no clinical signs of *Bd* infection shown by the *L. catesbeianus*, however, the zoo managed their amphibian collection properly and prevented *Bd* from spreading from those *L. catesbeianus*, which all were kept in the same container. The AZA Amphibian Husbandry Resource Guide details preventative and treatment procedures against *Bd* (Poole and Grow 2012). Although we examined only one zoo, our case exemplifies a quality husbandry standard followed by an AZA accredited institution. Meanwhile, it is important to note that if zoos maintain collections that contain *Bd* as detected in our study, they run the risk of counteracting any sorts of conservation breeding efforts (De Paula et al. 2012).

A study like the present one is important as it disseminates critical information about *Bd* prevalence among zoo and pet store amphibians. Our results suggest that stricter protocols and routine *Bd* screens are warranted to protect traded and captive amphibians from disease infection and transmission. A similar type of protocol was implemented when *Salmonella* infection in humans became prominent due to lenient regulations protecting reptiles in the pet trade, which dramatically decreased the number of reported *Salmonella* cases associated with handling reptiles (de Jong et al. 2005). Continued monitoring on the prevalence of *Bd* among traded amphibians at a larger scale is essential to promote amphibian conservation.

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Prevalence and Spatial Distribution of Frog Virus 3 in Free-Ranging Populations of Northern Cricket Frogs (*Acris crepitans*), American Bullfrogs (*Lithobates catesbeianus*), and Northern Leopard Frogs (*Lithobates pipiens*) in Western Illinois and Wisconsin, USA

Disease is a major contributing factor to amphibian declines (Daszak et al. 1999; Gray et al. 2009). More than 30% of the world's amphibian species are threatened with over 480 species on the critically endangered list (Stuart et al. 2004; IUCN 2009). Such staggering numbers warrant investigations to determine how diseases, such as those caused by ranaviruses, may affect wild animals and their declining populations. Prior to our study, no ranavirus-associated mortality events have been reported in Illinois. However, approximately 800 amphibians, including Green Frogs, Northern Leopard Frogs, and Bullfrogs, were reported to have ranavirus-related deaths in Wisconsin in 2009 (National Wildlife Health Center 2011). Frog virus 3 (FV3), was also first isolated from Northern Leopard Frogs collected in Wisconsin or Minnesota in the early 1960s (Granoff et al. 1965). Due to their lethal nature and threat to declining populations,we set out to explore the prevalence and spatial distribution of ranaviruses in western Illinois and Wisconsin, along the eastern side of the Mississippi River.

For this study, we chose to study an area on the western borders of Wisconsin and Illinois along a major watershed, the Mississippi River. Sample sites were chosen based on accessibility and the presence of large frog populations. We sampled eight sites in Illinois and four sites in Wisconsin in late May and early June of 2011 (Table 1, Fig. 1). We recorded each site with a handheld GPS unit (eTrex Vista, Garmin, Olathe, Kansas) and we used geographic software to analyze the data (ArcMap 10.1, ESRI, Redlands, California). We captured free-ranging Northern Cricket Frogs (*Acris crepitans*) by placing a plastic zipper bag in front of each frog and waiting for it to jump into the bag. We collected American Bullfrogs (*Lithobates catesbeianus*) and Northern Leopard Frogs (*Lithobates pipiens*) using a dipnet. We removed these frogs from the net with a plastic zipper bag. New zipper bags were used for each capture. Within 15 minutes of capture, we performed a physical examination to identify any clinical signs consistent with FV3, including edema, erythema, loss of pigment, ocular and nasal discharge, papules and plaques, epithelial sloughing, hemorrhage, and petechiation. We swabbed the oral cavity, then the cloaca, of each frog using a single cotton-tipped applicator. We immediately stored the swabs in a cooler (1–2°C) or refrigerator (3–5°C), and then transferred them to a –20°C freezer within four days. All animals were released at the site of capture immediately after swabbing and nets were rinsed with pond water between each capture. At the time of the survey, there was no indication that infectious disease was present any of the sites and strict biosecurity of boots and nets was not part of our routine sampling protocol, but have since implemented measures to disinfect gear between sites.

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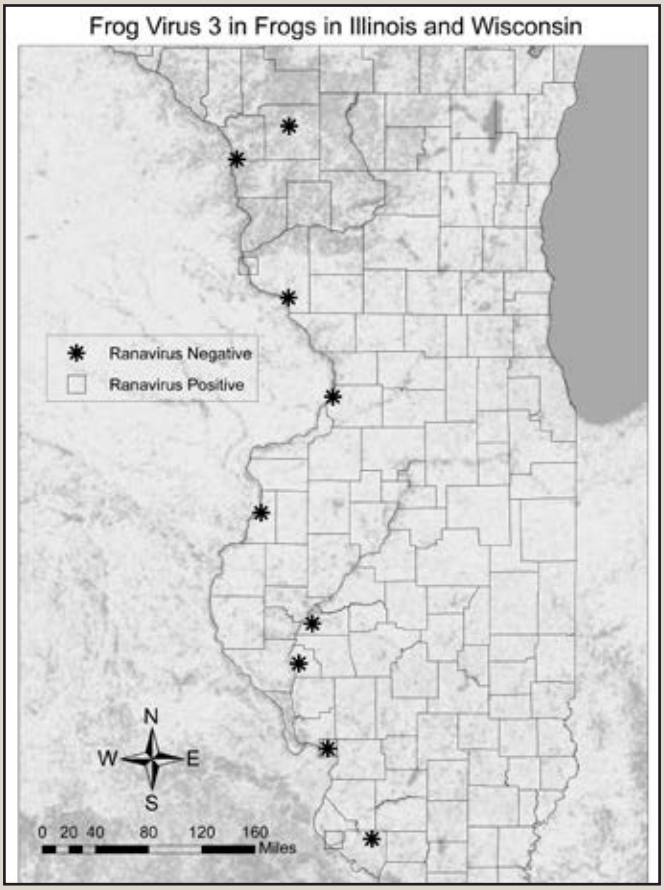


FIG. 1. Spatial distribution of locations from which frogs or tadpoles were caught, examined and assayed for Frog Virus 3 (FV3). Open squares represent sites at which a positive sample was collected. Asterisks denote sites from which no samples were positive.

TABLE 1. Frogs captured and tested per sampling site.

Site	State	Stage	*Acris crepitans* Positive / Tested	*Acris crepitans* Captured & Observed	*Lithobates catesbeianus* Positive / Tested	*Lithobates catesbeianus* Captured & Observed	*Lithobates pipiens* Positive / Tested	*Lithobates pipiens* Captured & Observed
Sand Pit	IL	Adult	0 / 6	21	—	—	—	—
N39.63535° / W90.53967°		Juvenile	—	1	0 / 1	1	—	—
TNI pond 2	IL	Adult	0 / 2	9	—	—	—	—
N38.91800° / W90.22423°		Juvenile	—	—	—	—	—	—
TNI cypress pond	IL	Adult	1 / 18	21	—	—	—	—
N38.92334° / W90.22218°		Juvenile	—	—	0 / 4	4	—	—
Kidd Lake Marsh	IL	Adult	0 / 1	2	—	—	1 / 2	2
N38.14181° / W90.16273°		Juvenile	—	—	—	—	—	—
Sparta training center Turtle Pond	IL	Adult	0 / 8	15	—	—	—	—
N38.15038° / W89.74424°		Juvenile	—	—	—	—	0 / 10	10
6 Mile Road pond	IL	Adult	0 / 15	22	—	—	—	—
N39.96941° / W90.39231°		Juvenile	—	—	—	—	—	—
Tree farm north of Gladstone, IL	IL	Adult	—	1	0 / 1	1	—	—
N40.88678° / W90.95087°		Juvenile	—	—	—	—	—	—
Cattail Slough	IL	Adult	—	—	0 / 1	1	—	—
N41.83340° / W90.16921°		Juvenile	—	—	—	—	—	—
Banfield Bridge	WI	Adult	—	—	—	—	0 / 4	5
N42.63112° / W90.65375°		Juvenile	—	—	—	—	—	—
Goose Island	WI	Adult	—	—	—	—	0 / 3	3
N43.72963° / W91.21515°		Juvenile	—	—	—	—	—	—
Jay's Landing	WI	Adult	—	—	1 / 1	1	0 / 6	9
N42.88548° / W91.08745°		Juvenile	—	—	—	—	—	—
Fort McCoy Stillwell Pond	WI	Adult	—	—	0 / 1	1	—	—
N43.99043° / W90.64613°		Juvenile	—	—	0 / 16	17	—	—

TABLE 2. Prevalence of FV-3 positive results in frogs captured and tested.

	Tested	Prevalence	Positive	95% CI
Individuals	100	3%	3	1–9%
Acris crepitans	50	2%	1	1–12%
Lithobates catesbeianus	25	4%	1	0–22%
Lithobates pipiens	25	4%	1	0–22%
Sites sampled	12	25%	3	9–53%

We extracted DNA from the cotton-tipped applicators following the manufacturer's spin protocol for DNA purification from oral swabs (QIAGEN QIAamp® DNA Blood Mini Kit, QIAGEN Inc., Valencia, California). We tested the concentration and purity of the DNA extracts using spectrophotometry (NanoDrop, Wilmington, Delaware) to ensure high quality samples in the face of limitations such as a small sample size and inability to collect and test internal tissues. We performed real-time PCR assays targeting a highly conserved major capsid protein of ranaviruses using sense (AACGCCGACCGAAAACTG) and anti-sense (GCTGCCAAGATGTCGGGTAA) primers and TaqMan-MGB probe (CCGGCTTTCGGGC) from Allender et al. (2013a).

We tested 100 frogs, which included 50 Northern Cricket Frogs (all from Illinois), 25 American Bullfrogs (seven from Illinois and 18 in Wisconsin), and 25 Northern Leopard Frogs (12 in Illinois and 13 in Wisconsin; Table 1). None of the captured frogs showed clinical signs related to ranavirus, but one bullfrog tadpole had signs of a bite wound to the ventral aspect of the tail and one leopard frog had a lesion on the front left leg that appeared to be trauma-induced. This leopard frog tested positive for *Ranavirus* DNA (~2.58×10^6 genome copies), as did one adult male Northern cricket (~3.4×10^3 copies), and one male American bullfrog (~2.5×10^3 viral copies). The overall ranavirus prevalence was 3% (95% CI = 1–9%), and the prevalence in cricket frogs, bullfrogs, and northern leopard frogs was 2% (95% CI = 1–12%), 4% (95% CI = 0–22%), and 4% (95% CI= 0–22%), respectively. The positive cricket and leopard frogs were found in Illinois in different ponds. The positive bullfrog was found in Wisconsin. Three of the 12 sites (Prevalence: 25%; 95% CI = 9–53%) had a positive sample (Table 2).

While our samples were swabs of the oral cavities and cloacas of the frogs, and thus represent environmental samples, we have no reason to suspect that our positive results are from contamination. Brunner and Collins (2009), for instance, found that tiger salamander larvae that died of experimental ranavirus-

exposures had viral titers in their tissues in the millions of copies, such as we found in the Northern Leopard Frog, and earlier in the infection shed hundreds to tens of thousands of viral copies in skin scrapes, similar to the titers we observed in the cricket frog and bullfrog. Even if the positive-testing frogs in our study fed on contaminated material and thus contained high concentrations of viral DNA in their oral cavity or cloaca, it is clear that the virus is present in the environment, if not causing active disease. In previous work, the assay that we used in this study had shown 100% specificity and 83% sensitivity in both oral and cloacal swabs in Red-eared Sliders (Allender et al. 2013b). The effectiveness of the assay supports the possibility of infection of the positive frogs without clear indication of clinical signs. While the DNA purity as measured by the A260/A280 ratio differed between positive and negative samples (mean = 2.04 and 1.79, respectively, with an ideal range of 1.7–1.9), the DNA concentrations were similar indicating that these were true negative results rather than a lack of DNA. Future investigations may determine the presence or absence of an anuran housekeeping gene to increase the negative predictive value of the result.

This study documents FV3-like virus in Illinois and Wisconsin amphibians in 2011, and thus should be included in conservation plans aimed at protecting all susceptible species. There is still a paucity of information on the ecology of this virus in natural settings, but surveillance and prevention is justified in light of these findings. Future investigations should expand the range of species tested, as well as impact this virus has on native wildlife.

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Reproductive Biology of the Mona Coqui (*Eleutherodactylus monensis*) in Captivity

The Mona Coqui (*Eleutherodactylus monensis*) is a medium-sized (49.4 mm maximum SVL for females), terrestrial frog endemic to Mona Island, Puerto Rico (Joglar 1998). The Puerto Rican archipelago is home to 17 species of native *Eleutherodactlyus*, however, the Mona Coqui is the only amphibian known to inhabit Mona Island, a small (57 km²) subtropical dry forested island located close to the center of the Mona Passage between Hispaniola and Puerto Rico. *Eleutherodactylus monensis* is currently listed as Vulnerable due to its restricted range (IUCN 2013), emerging amphibian disease, habitat alteration, and climate change (R. Joglar, L. Santiago, and P. Burrowes, unpubl. data). Although the systematics and evolution of the species within the genus *Eleutherodactylus* have been extensively studied, very little is known about their reproduction, ecology, and behavior (Burrowes 2000). Since there is no published information on its karyotype, pattern of activity, call, reproductive biology, or current population status (Joglar 1998), *E. monensis* is probably the least-studied of all the 17 *Eleutherodactylus* species in Puerto Rico. An *ex-situ* captive breeding program for *E. monensis* was started in order to 1) establish a captive assurance population; 2) learn about its reproductive biology; and 3) increase awareness of the global amphibian crisis through the use of an exhibit dedicated to *E. monensis*, amphibian-based zoo events, and publications. Herein we report several aspects of this species' reproductive biology, direct observation of nesting behaviors, as well as challenges with neonate survivorship during this study.

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FIG. 1. Male *Eleutherodactylus monensis* observing female *Eleutherodactylus monensis* as she digs nest concavity.

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Specimen acquisition and husbandry methods.—In May 2012, five adult male/female pairs were collected from Sardinera, Mona Island, and transported to Albuquerque BioPark Zoo. Females measured an average snout–vent length (SVL) of 37.1 mm (33.3–40.5 mm, SD = 2.5; N = 5), and males 23.4 mm (21.1–25.0 mm, SD = 1.8; N = 5). All specimens underwent a 30-day

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FIG. 2. Male *Eleutherodactylus monensis* digging concavity after female has vacated site.

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FIG. 3. *Eleutherodactylus monensis* egg mass deposition three days post-oviposition, moss covering removed.

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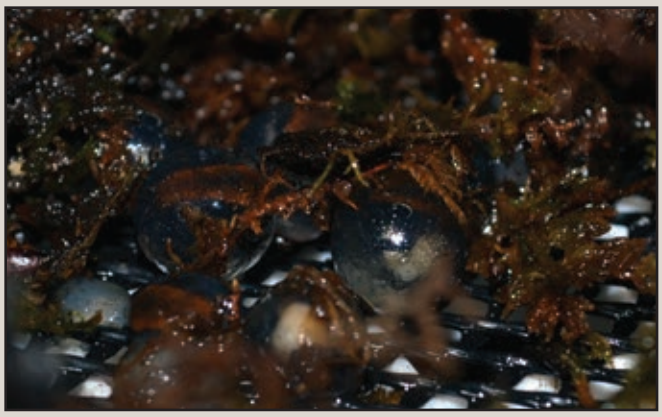


FIG. 4. *Eleutherodactylus monensis* eggs pre-hatching, moss covering removed.

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FIG. 5. *Eleutherodactylus monensis* two days post-hatching.

quarantine period where they tested negative for the amphibian chytrid fungus (*Batrachochytrium dendrobatidis*) and *Ranavirus*. Specimens were sampled for the amphibian chytrid fungus and *Ranavirus* as per Pessier and Mendelson (2010). All samples were tested at the San Diego Zoo's Institute for Conservation Research Wildlife Disease Laboratories (Allan P. Pessier, DVM, Dipl. ACVP, Associate Pathologist). Appropriate biosecurity measures were taken to prevent pathogen transfer and contamination as recommended by Pessier and Mendelson (2010).

One pair of *E. monensis* were kept per a 30 × 30 × 46 cm terrarium made by ZooMed Laboratories©, model NT-2 (San Luis Obispo, California). Drainage holes were drilled in the bottom of each terrarium and a false bottom consisting of plastic egg crate and plastic mesh was placed 3 cm above the bottom of the tank. The substrate, a mixture of sand, sphagnum moss, and peat moss, was 5 cm deep. Limestone rocks and a bromeliad (*Guzmania* sp.) were placed on the substrate in each terrarium as refugia. An automated rain system was set to mist the enclosures every three hours (eight times during a 24-h period) for ten seconds each interval. All water initially used for the rain system was municipal water run through a filtration system (Whirlpool© [WHED 20] Benton Charter Township, Michigan). Post-filtration pH was 7.8. In early 2013, the water used on these frogs was switched to reverse osmosis filtered water (Whirlpool© [WHER 25]) reconstituted with calcium using dissolved cuttlebone to remove fluoride. Ambient room temperature ranged from 23°C in the evening to 26°C during the day. Fluorescent lights above the enclosures were turned on at 0800 h and off at 1700 h every day to mimic a natural photoperiod. Frogs were fed a rotation of live crickets (*Acheta domesticus*) dusted with Rep-Cal brand (Los Gatos, California) vitamin supplement, fruit flies (*Drosophila hydei*), Blue Bottle House Flies (*Calliphora vomitoria*), termites (*Reticulitermes tibialis*) when available, and pill bugs (*Isopoda* sp.) three times per week.

Reproductive biology.—Very little is known about the reproductive biology of *E. monensis* in the wild, but a single reproductive event was documented on Mona Island in September 2012 (Joglar et al. 2012). Initial observations during our captive study documented that these direct-developing frogs utilize axillary amplexus. Since acquisition, we observed six successful captive reproductive events from three different pairs. Although it has been suggested that *E. monensis* breed year round, similar to other species of *Eleutherodactylus* native to Puerto Rico (Joglar 1998), 83% of nesting activity in our captive population occurred in late summer with three oviposition events in July and two in August. This time of year coincided with New Mexico's wet season, which runs May through September, and there were notable decreases in barometric pressure coinciding with these reproductive events. During the initial stages of mating, the male began vocalizing early in the evening (1700–1800 h) and continued until approximately 0100–0200 h. Based on one previous study involving one female and two males of *E. monensis*, it was documented that both the male and the female frogs aid in digging an oviposition site overnight (Numazawa and Sengoku 2011). We observed similar behavior during our study in which six pairs of frogs spent 7–10 days preparing the nest site. Nest concavities during our study measured approximately 44.6 mm width (38.1–50.8 mm, SD = 4.6; N = 6) and 25.4 mm in depth (24.6–26.7, SD = 0.8; N = 6). The male reduced the frequency and volume of evening vocalization considerably during nest site excavation. Video footage obtained on multiple nights clearly identified the female

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FIG. 6. Newly hatched *Eleutherodactylus monensis* with MBD.

digging the nest concavity directly next to a bromeliad set horizontally for refugia by rotating and using her rear legs to push out the substrate (Fig. 1). This continued for several evenings, at which time the male would stay near the nest site observing the females' activity. Three to five days into the construction of the nest, the female would leave and the male would continue digging in the same fashion as the female (Fig. 2). These actions were documented using night vision videography (Sony© [HXR-NX70U] Digital HD Video Camera Recorder, Knan Minato, Tokyo). Amplexus occurred within a few days of the male entering the nest concavity. Although it was not captured on film, the egg mass was then covered by the same substrate, post-oviposition, by the following morning. This reproductive behavior occurred on substrates including sand, peat moss, and sphagnum moss. Average number of eggs laid for each clutch during ovipositon was 21 eggs (12–30 eggs, SD = 7.2; N = 7). The eggs were deposited and stacked together with no apparent pattern. Average diameter of eggs at oviposition (Fig. 3) was 5.3 mm (4.7–6.0 mm, SD = 0.3; N = 12). No further parental care was observed from either the male or the female during any of these reproductive events. Incubation period averaged 21 days (13–28 days, SD = 5.8; N = 7). On two occasions and with two different pairs, the female deposited her second egg mass on the same day as the first clutch hatched. The concavity constructed for the second clutch was within 5.1 cm of the previous concavity. The number of eggs to hatch per clutch averaged 16 eggs (3–30 eggs, SD = 9.4; N = 7). The average size of the egg within a few days prior to hatching was 6.9 mm diameter (6.1–7.0 mm, SD = 0.2; N = 13 [Fig. 4]). Upon hatching, all offspring were separated into groups of three and placed into 1-liter clear plastic deli cups with holes (4–5 mm) punched into the lids. Average SVL of post-hatching individuals (Fig. 5) was 8.6 mm (8.2–9.7 mm, SD = 0.4; N = 48). Hatchlings were kept on moist sphagnum moss and misted daily with the reverse osmosis filtered water, reconstituted with calcium. Hatchlings were fed a daily diet of two collembolan species and flightless fruit flies (*Drosophila melanagaster*) dusted with Rep-Cal brand vitamins until they were large enough to consume other commercial invertebrates such as crickets (*Acheta domesticus*), large fruit flies (*D. hydei*), termites (*Reticulitermes tibialis*) and pill bugs (*Isopoda* sp.).

Notably, on two occasions females were observed consuming several eggs when left in the enclosure. After witnessing these actions, we began removing the female from the enclosure. We kept the male in the enclosure with the egg mass to look for parental care as documented in *E. cooki* (Burrowes 2000), but which was not witnessed during any of the six reproductive events. Another observation was the duration the pair of adult frogs spent working together on the nest site. During this study, we have documented both male and female frogs digging the concavity between 7–10 days. In this time period, the male greatly reduces vocalization to only a few short clicks in the evening, as opposed to the rapid, frequent clicks encountered prior to nest excavation. This behavior indicates that this species might not significantly advertise call during the duration from nest building through oviposition. More work needs to be done to study this potentially unique reproductive characteristic.

Challenges with neonate survivorship.— In 2012, the first year of this study, 100% of the offspring died within the first 3 months of hatching. Since changing the water filtration system to reconstituted reverse osmosis water, we have had two successful reproductive events yielding 52 hatchlings, with only one froglet mortality by the time of ms. submission (December 2013). Froglet mortality was found to be due to severe metabolic bone disease (MBD), possibly caused by fluoride exposure, inhibiting the absorption of calcium during egg development (A. Pessier, pers. comm.; Fig. 6). Diet was ruled out as a potential cause of mortality due to the variety of invertebrates and supplementation schedule used for both the adult frogs and offspring. All municipal water was originally run through a filtration system that did not remove fluoride (F- 0.38 mg/l reporting limit .05; 31.59 Ca mg/l). In 2013, all water used on these frogs went through a reverse osmosis filter to remove fluoride and was then reconstituted with calcium (F- 0.00 mg/l reporting limit .05; Ca 27.4 mg/l). We feel that the water change made in 2013 had a direct result in our higher success rate with neonate survivorship.

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Successful Captive Breeding of *Necturus beyeri* through Manipulation of Environmental Cues and Exogenous Hormone Administration: a Model for Endangered *Necturus*

Necturus is a genus of aquatic salamanders endemic to the eastern United States. Over half of amphibian species demonstrating preference for a "flowing water" environment have populations in rapid decline (Stuart et al. 2004). Presently, there are at least five recognized species of *Necturus* (Viosca 1937; Neill 1963; Ashton 1985; Guttman et al. 1990; Bart et al. 1997). The International Union for the Conservation of Nature (IUCN 2013) categorizes *N. alabamensis* as endangered and *N. lewisi* as near threatened, with the other three species (*N. maculosus*, *N. beyeri*, and *N. punctatus*) classified as least concern. Although *N. maculosus* has served in laboratory research for over a century (DeNardo 1995), its use has been supported by capture of individuals from the wild, with only a single incident of captive reproduction formally reported in the literature (Raffaelli 2000). Breeding species with a dedicated aquatic life history, cryptic activity patterns, and highly seasonal reproductive nature like *Necturus* can be challenging *ex-situ*. To expand reproductive research of such taxa, with the intent of applying successful results to propagation efforts for the endangered *N. alabamensis*, a surrogate or model species of "least concern" should be established. Given the phylogenetic relationship of *N. alabamensis* to *N. beyeri*, similar biological and habitat requirements and size, we hypothesized that *N. beyeri* could serve as an effective model species (Guttman et al. 1990; Neill 1963).

As in many other salamanders, *Necturus* reproduce via internal fertilization, with the males producing spermatophores (Selmi et al. 1997; Sever 1992; Sever 2002). Male *N. maculosus* display swelling of the cloaca from September–April, with peak cloacal protuberance observed in December–March (Bishop 1926). In male *N. beyeri*, timing of peak cloacal swelling is shifted by one month earlier (Cagle 1954; Shoop 1965), presumably due to the lower latitude in which this species lives. Motile sperm have been observed in the Wolffian ducts of *N. maculosus* and *N. beyeri* as early as December (Baker 1963; Shoop 1965). The transfer of spermatophores from male to female *Necturus* occurs several months prior to oviposition (Sever 2002; Shoop 1965). Nest size varies depending on species (Eycleshymer 1906; Smith 1911; Bishop 1926; Shoop 1965), and attempts to rear offspring *ex-situ* from eggs collected from the wild has been met with low success (Shoop 1965).

Administration of exogenous hormones has proven effective for captive breeding of many amphibian species, most notably anurans (Roth and Obringer 2002; Browne and Zippel 2007; Kouba et al. 2009). Limited information exists in this regard for salamanders. Gametes have been collected after hormone injection of male (Bishop 1932) and female (Fitch 1958) *N. maculosus*. Extract of whole sheep pituitaries administered to wild-caught males during the breeding season resulted in spermatophore deposition (Bishop 1932). Infertile eggs have been deposited following treatment of female *N. maculosus* with chorionic gonadotropin (CG) and pituitaries from *Lithobates pipiens*; however, such treatments produced variable responses and mortalities. These same methods did not stimulate *N. beyeri* to deposit eggs (Shoop 1965). More recently, researchers have been able to manually collect sperm and strip eggs from the axolotl (*Ambystoma mexicanum*) using Ovopel® pellets and human chorionic gonadotropin (hCG; Mansour et al. 2011).

The objectives of this project were to 1) establish a captive population of *N. beyeri* at the Center for Conservation and Research of Endangered Wildlife (CREW) at the Cincinnati Zoo & Botanical Garden to serve as model research species for *N. alabamensis*; and 2) manipulate environmental cues and administer exogenous hormones to stimulate successful breeding, production, and rearing of offspring. Biotic and abiotic water conditions were adjusted to model *in-situ* seasonal changes, including manipulation of artificial lighting to mimic the natural day/night cycle throughout the year. Finally, we administered luteinizing hormone-releasing hormone (LHRH) to induce a pituitary response in male and female *N. beyeri* to promote spermatophore deposition and ovulation/oviposition over a 2.5-yr period.

Husbandry and feeding.—In January 2011, 1 male and 2 female *N. beyeri* (ISIS #s CWF12-02629, CWF12-02620, CWF12-02601) were accessioned into a glass tank measuring 91.44 × 45.72 × 30.48 cm at CREW (Fig. 1). As animals were brought in during the middle of their normal breeding season, we will hereafter refer to Yr 1 as Fall 2011–Spring 2012 and Yr 2 as Fall 2012–Spring 2013. The tank was

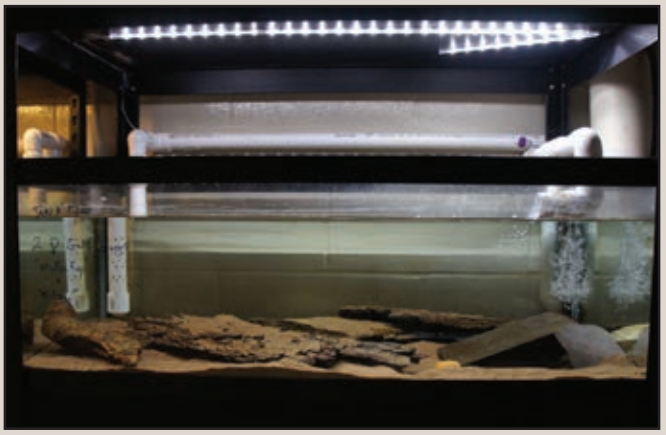


PHOTO BY CHRISTOPHER DECHANT

FIG. 1. Captive husbandry conditions for *Necturus beyeri* at Cincinnati Zoo's Center for Conservation and Research of Endangered Wildlife.

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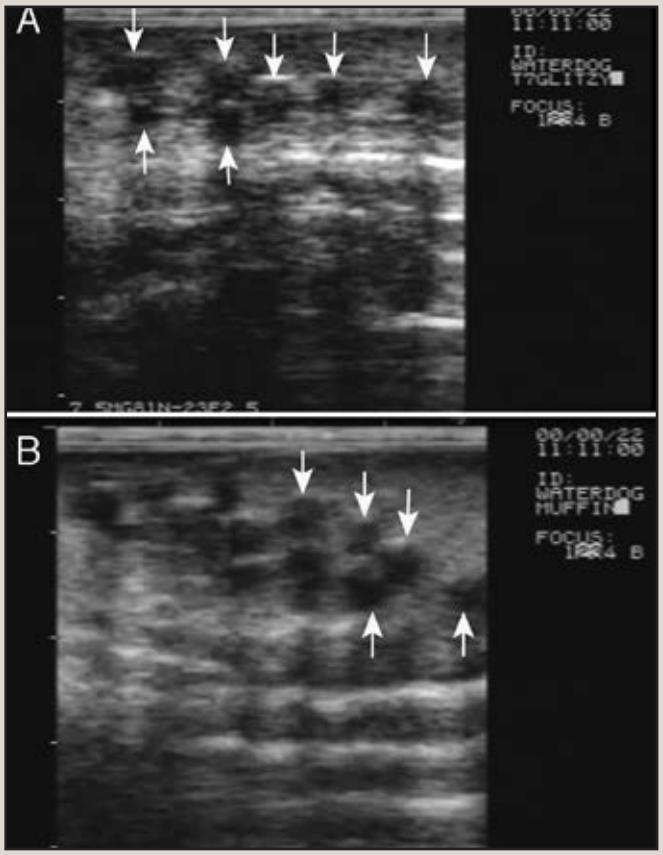


FIG. 2. Ultrasound images of ova (indicated by arrows) from LHRH-treated (A) and untreated (B) female *Necturus beyeri*.

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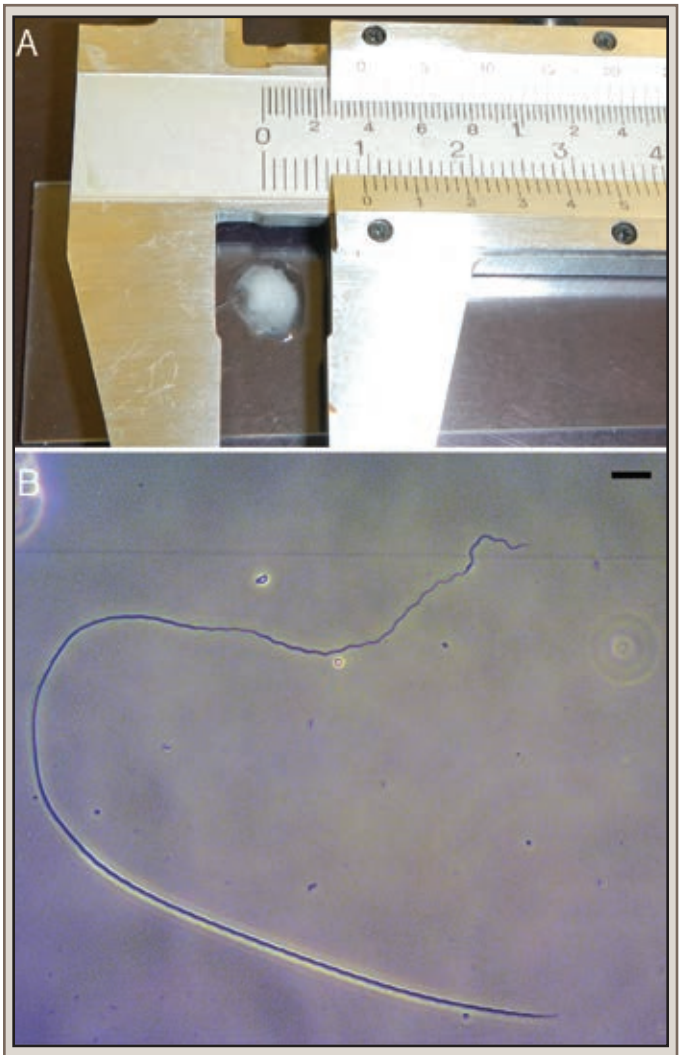


FIG. 3. Spermatophore (A) and individual spermatozoon (B) from *Necturus beyeri*. Scale bar in B represents 20µm.

connected to a water chiller and UV sterilization unit (Model 2606; Current USA, Vista, California) via PVC pipe (2.54 cm diameter, sch 40). Filtration was achieved through a carbon spunfiber filter (GE FXUSC). Substrate consisted of extensively weathered quartz sand collected from Bankhead National Forest, Alabama. Sandstone, slate and limestone slabs were provided as cover objects for the animals. Additionally, red oak and white walnut bark, extensively soaked in deionized (DI) H_20 were provided. Weekly, 10–15% of tank water was removed and exchanged with (DI) H_20. In the fall, leaves (1/gallon, not exceeding 10 leaves) were introduced and allowed to partially decay to about half the starting area. Species included oak, tulip poplar, and sycamore.

Diet consisted of frozen-thawed shrimp (*Litopenaeus setiferus*) and live redworms (*Eisenia fetida*). Seasonally, as animals became more active (shortened day length/colder temperature), live Greenside Darter (*Etheostoma blennioides*), Black-spotted Topminnow (*Fundulus olivaceus*), Silver Shiner (*Notropis photogenis*), and Creek Chub Minnows (*Semotilus atromaculatus*) were provided after being treated with parasite tablets (Tetra™, ParasiteGuard®, Blacksburg, Virginia) 30 days prior to being offered. An infrared day/night camera system (#68332; Bunker Hill Security, Camarillo, California) recorded tank activity continuously. Animals were housed together, with the exception of the male being removed on 31 March 2013 in preparation for potential egg laying.

Temperature and photoperiod.—Water temperature was manipulated to mimic natural conditions. During Yr 1, the average water temperature was 18°C, with seasonal low and high temperatures of 12°C and 22°C occurring on 1 January and 25 July 2012, respectively. In Yr 2, the average water temperature was 16°C, with seasonal low and high temperatures of 11°C and 19°C achieved on 3 January and 6 April 2013, respectively. From January 2011 to April 2012 a fluorescent light strip mounted 25.4 cm from the surface of the water tank was set to a timer matching natural seasonal sunrise and sunset times. In May 2012, the fluorescent lights were replaced with LEDs (IKEA, #16670) powered directly by a south-facing, 45-watt solar panel set providing local seasonality and variable light intensity (i.e., light output corresponded to time, position of sun, cloud cover). The system was designed to operate at 45W of output (minus system loss of 5% to wiring and panel age). A custom 12V charge controller limited output to 14V max, so the LED would show most intensely as the conditions dictated (ie, midday sun, summer, no clouds). As the angle of incidence of light to the PV panels changed (sunrise, sunset, rain or clouds), power generation dropped off and the LEDs responded proportionally. The system had no extra power generation capacity and the room was completely free of any other light source. The result was a novel lighting system that responded to real-time variation in daylight intensity and day length variation.

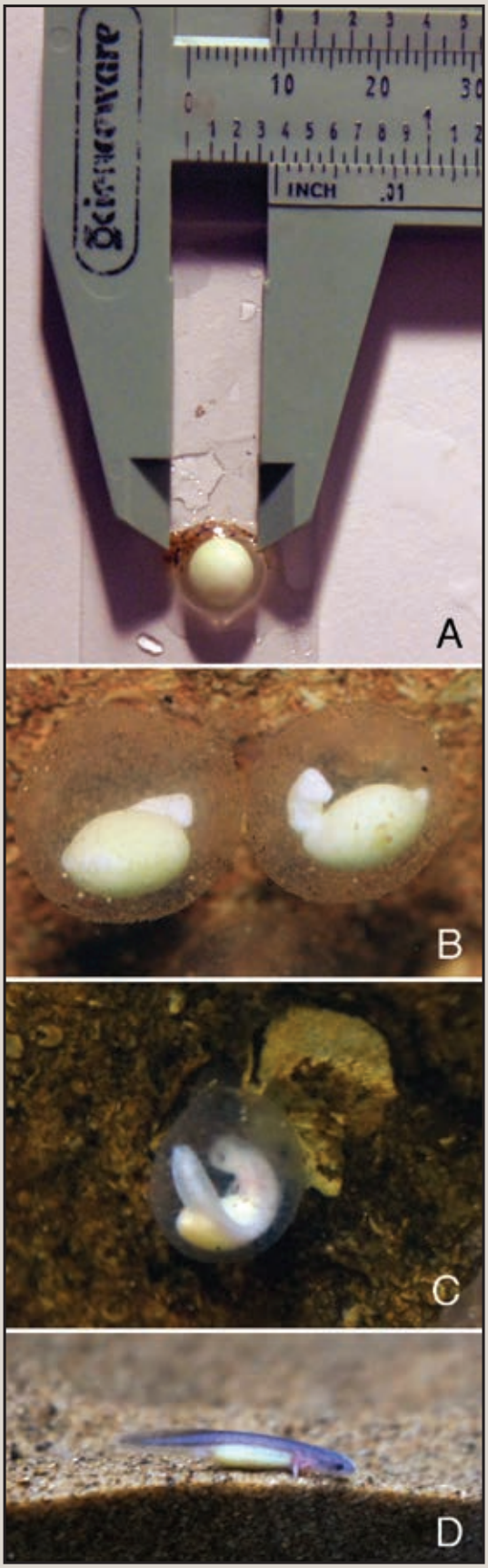
Anesthesia, exogenous hormone, and ultrasonography.—All procedures were approved by the Cincinnati Zoo and Botanical

Garden's Institutional Animal Care and Use Committee (IACUC; 11-110). Prior to administration of exogenous hormones, animals were anesthetized in 0.5g/L (Fellers et al. 1994) buffered (0.5M $NaHCO_3$) Tricaine Methanesulfonate (Western Chemical, Ferndale, Washington). Two 4.1-L rectangular containers (Rubbermaid™ TakeAlongs® #7F55) with air stones (2.54 cm) and pumps (Fusion 200 Air Pump) were used for anesthetic procedures. Animals were handled with non-powdered, pre-moistened nitrile gloves (Kimberly Clark; Cole-Parmer, Vernon Hills, Illinois). Transport, anesthetic, and recovery tanks contained original tank water. Induction was determined by failure of the animal to respond to being turned over. Animals were removed from the induction tank and held on a disposable piece of surgical drape (JorVet, Jorgensen Laboratories, Loveland Colorado) with the body tilted at a 45° angle (head down) for intraperitoneal (IP) injection (27 gauge needle) in the posterior quadrant of the abdomen. Animals were injected with [des-Gly10, D-Ala6]-LH-RH ethylamide acetate salt hydrate (L4513, Sigma Aldrich, St. Louis, Missouri) in sterile H_20 (Table 1). Skin and gills remained moistened during injection, after which animals were placed in a recovery tank. Once animals were moving normally and regained a righting response, they were returned to their original tank. The average induction time to IP injection was 6 min 38 sec (Table 1). Conscious control of gills, body, and legs were regained at an average of 14 min 21 sec, 20 min 30 sec, and 24 min 39 sec, respectively (Table 1).

An Aloka 500 ultrasound (Aloka, Wallingford, Connecticut) connected to a portable digital video recorder (MediaMate, Blue Raven, Wilmington, Massachusetts) and a 7.5-mHz linear array probe was used for transabdominal ultrasonographic examination of females during Yr 2 (31 March 2013). Ultrasound was performed on the LHRH-treated female (CWF12-02620) while she was under anesthesia. The untreated female (CWF12-02601) was manually restrained for the procedure. Ultrasound revealed multiple eggs of similar size (5–6 mm) in both females (Figs. 2A, B).

Spermatophore deposition.—Despite evidence of cloacal swelling, no spermatophores were deposited either prior to or following LHRH administration of the male in Yr 1. During Yr 2, the male exhibited cloacal swelling beginning 8 November 2012. The act of spermatophore deposition was captured on video 33 days (4 January 2013) following LHRH administration. However, evidence of spermatophore deposition, as observed by the presence of mucous strands, was noted 27–35 days post-injection (29 December 2012, 31 December 2012 and 6 January 2013). The spermatophore deposited on 4 January 2013 was removed from the tank within 30 min of deposition, measured (approx. 12 mm diameter; Fig. 3A), and examined under a microscope. Tightly bound aggregates of sperm were observed, but individual sperm motility was not detected (Fig. 3B).

Oviposition, embryonic development, and hatching.—Although it was suspected one female was gravid, no eggs were deposited during Yr 1. In Yr 2, both females deposited eggs over a three-day timeframe (4–6 April 2013). The untreated female (CWF12-02601) was the first to deposit, quickly followed by the treated female (CWF12-02620). Eggs were deposited on the underside of wood (CWF12-02601; N = 33) and stone (CWF12-02620; N = 25). Eggs that began to show a cloudy or swollen appearance were removed from the nest by the attending female and floated loose in the tank or were consumed. Unconsumed loose eggs were manually removed from the tank. Over time, fertilized eggs changed in shape from round (Fig. 4A) to



PHOTOS BY MONICA STOOPS (A,C,D) AND BRIAN JORG (B)

FIG. 4. Freshly deposited egg (A), developing embryos (B; Day 35, C; Day 63) and hatchling (D) *Necturus beyeri* produced at Cincinnati Zoo's Center for Conservation and Research of Endangered Wildlife.

Table 1. Exogenous hormone (LHRH) and anesthetic recovery data for captive *Necturus beyeri* (N = 3). The induction time to IP injection and first observation of conscious control of gills, body, and limbs are given in minutes and seconds (min:sec).

Date	ID/Sex	LHRH Dose/Volume	IP Injection (min:sec)	Gills (min:sec)	Body (min:sec)	Limbs (min:sec)
5 March 2012	CWFF12-02629/M	100ug/500uL	7:38	18:52	26:15	33:30
2 December 2012	CWF12-02629/M	100ug/100uL	4:55	10:51	16:36	18:56
31 March 2013	CWF12-02620/F	150ug/150uL	6:00	12:40	17:20	21:32

compact and ovoid in appearance. Around day 31, embryos were visible inside the eggs (Fig. 4B). Females were allowed to guard and tend nests up to day 33 post-oviposition. After that time, females began to show aggression and predate conspecific nests. To minimize risk of injury to adults and the developing embryos, females were removed from the tank and housed individually. Thereafter, the stone and wood structures containing N = 6 and N = 1 developing embryos, respectively were adjusted to provide a clear view from the front of the tank. Efforts were taken to remove (using a restricted 1.27 cm Tygon® tube) sand and organic material that became attached to the eggs, in order to emulate brooding female behavior, but the siphon-generated suction was observed to be too aggressive and risked pulling eggs off their supporting structure. Additional filtration and manual cleaning of the tank was undertaken to preemptively remove organic particles before they could find their way to the eggs. The one remaining embryo from the untreated female developed normally up to day 50, after which the embryo took on a swollen appearance, was deemed nonviable and subsequently removed from the tank. After day 50, a piece of panty hose was placed over the outtake valve to ensure hatched larvae would remain safe. One of the six embryos became dislodged from the stone structure and was placed in a 1000-mL sterile glass beaker in the tank. At day 55, embryo movement was detected (Fig. 4C). Hatching (N = 6) occurred 73–75 days post-oviposition. Hatched larvae were maintained in the glass beaker until day 77 before being released into the larger tank (Fig. 4D).

Although global efforts to save amphibians have intensified, so have threats to their survival (Stuart 2004). The cool, flowing water habitat (Stuart et al. 2004) preferred by *Necturus* spp. has declined across many regions of the United States. Despite this, several populations *(N. maculosus*, *N. punctatus*, and *N. beyeri)* appear secure, if not abundant (IUCN 2013). However, there is strong evidence to support declining populations of *N. lewisi* and *N. alabamensis* (IUCN 2013). A number of North American zoological institutions hold *N. maculosus* and *N. beyeri*, but the other three species have either not been held or are held at only a few institutions and in small numbers. Several captive breeding programs for endangered amphibians have benefited from the application of husbandry and reproductive techniques developed in more common species (Obringer et al. 2000; Uteshev et al. 2012). Through this project, *N. beyeri* was established as a potential surrogate species for captive research efforts aimed at one of the most endangered salamander species in North America, *N. alabamensis*.

Because *Necturus* demonstrate reproductive seasonality *in situ*, seasonal changes in water temperature and day length occurred *ex situ* in an effort to mimic the natural environment and stimulate reproduction. Comparable seasonal temperature extremes were achieved over the 2.5-Yr period. The lighting modification made during Yr 2 not only emulated natural changes in sunrise and sunset, but also daily intensity variations that may play a role in triggering reproductive events. In addition to manipulating environmental cues, we administered exogenous hormones. At present, the two most common hormones used to promote amphibian captive breeding efforts are LHRH and hCG (Roth and Obringer 2002; Browne and Zippel 2007; Kouba et al. 2009). Significant species differences exist in regard to hormone use for gamete production in amphibians (Roth and Obringer 2002; Browne and Zippel 2007; Kouba et al. 2009). We administered LHRH at dosages (extrapolated per ug/g body weight) similar to those used to induce spermiation and ovulation in anurans (Waggener and Carroll 1998; Obringer et al. 2000; Browne and Zippel 2007; Kouba et al. 2009). Intraperitoneal injection of hormone was achieved by the use of anesthetic. We used MS222 at a concentration (0.05%, Fellers et al. 1994) lower than that used for anesthesia of terrestrial salamanders (Wright 2001), but similar to what has been reported in larval (Gentz 2007) and paedomorphic salamanders (Crook and Whiteman 2006; Mansour et al. 2011). Induction was fast and recovery was noted by the conscious control of gills along with the ability to swim and mobilize limbs. Anesthetic events in *N. beyeri* did not appear to interfere with subsequent reproductive behaviors of spermatophore deposition, ovulation, oviposition, and egg brooding.

To help stimulate spermatophore deposition during the breeding season, the male *N. beyeri* was treated with LHRH between December and March. Dosage remained the same over the two years of treatment. During the first year, we tested the ability of the male to respond at the end of the breeding season and were unsuccessful in obtaining spermatophores. In Yr 2, the male was treated with LHRH in early December and we did not see evidence of spermatophore deposition until 27 days post-injection. While axolotls treated with Ovopel or hCG release spermatophores 36–40 h post-injection, researchers could manually collect sperm > 10 hr after injection (Mansour et al. 2011). Similarly, wild caught *N. maculosus* treated during the breeding season with whole sheep pituitaries deposited spermatophores within 1–2 days (Bishop 1932). It is possible that the male *N. beyeri* deposited spermatophores in similar time to the aforementioned studies and were just not observed.

The spermatophore and spermatozoa of *N. beyeri* were similar to those described for *N. maculosus* (Bishop 1932; Baker 1963). Microscopic examination of the spermatophore revealed no motility of individual sperm. Studies have reported motility of *Necturus* sperm when harvested from the testes, sperm duct, and cloaca (Baker 1963; Shoop 1965). We are not aware of any report regarding sperm motility in naturally occurring spermatophores of *Necturus*. It remains unknown if substances in the spermatophore inhibit/retard sperm motility upon deposition. It has been shown that sperm are inactive during storage in the spermathecae (Hardy and Dent 1986). Although motility was not detected in the one spermatophore examined, fertile spermatophores were deposited as viable offspring were produced by both *N. beyeri* females. Even if sperm storage occurred beyond the predicted 6 months (Sever

and Bart 1996), parentage would not change as the same male was housed with both females over the 2.5-Yr period.

Despite warming of water temperatures and lengthening daylight, ovulation and oviposition did not occur in Yr 1. Mature unovulated eggs likely underwent degeneration (Kessel and Panje 1968). Exogenous administration of LHRH occurred in one female during Yr 2 to promote ovulation and oviposition. The male was removed from the tank following hormone treatment, as males and females appear to segregate during egg laying *in situ* (Eycleshymer 1906). Ultrasonography was found to be a useful tool in diagnosing gravid status in *N. beyeri*. Egg measurements were similar to what has been reported for *Necturus in situ* (Shoop 1965). *Necturus* exhibit high synchronicity in egg deposition in the wild (Smith 1911), and this is what we observed *ex situ*. Likewise, egg deposition occurred over the span of many hours to days (Eycleshymer 1906). The *N. beyeri* female deposited eggs 72–96 h after LHRH, a bit longer than the 36–48 h noted for female axolotls treated with Ovopel or hCG (Mansour et al. 2011). Because the untreated female *N. beyeri* also deposited eggs and did so prior to the treated female, we cannot conclude hormone treatment was responsible for egg deposition. Time from oviposition to hatching was slightly longer than what has been reported for *N. beyeri* nests obtained *ex situ* and subsequently raised to hatching *in situ* (Shoop 1965). Prior to our study, attempts to artificially brood *Necturus* eggs were limited (Shoop 1965). It is hypothesized that female *Necturus* aerate eggs by rapid gill movement and this movement helps destroy fungal hyphae (Salthe and Mecham 1974). We observed greater levels of egg loss from the nest of the female that deposited eggs on wood versus stone surfaces. For reasons unknown, females may cannibalize their own clutch (Salthe and Mecham 1974). While we did not find this to be the case, females did cannibalize conspecific nests and had to be isolated from the remainder of developing eggs. Interestingly, it did appear as if females were able to detect nonviable eggs/embryos within their own clutch. Of the six *N. beyeri* embryos that successfully hatched, none exhibited any abnormalities (Shoop 1965).

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HERPETOCULTURE NOTES

SQUAMATA — SNAKES

***CARPHOPHIS AMOENUS AMOENUS* (Eastern Wormsnake). LONGEVITY.** *Carphophis a. amoenus* is a small, secretive, semi-fossorial colubrid snake occurring in much of eastern North America (Ernst et al. 2003. Cat. Amer. Amphib. Rept. 774:1–7). Possibly because of this species' burrowing and secretive habits, it is rarely maintained in captivity (Rossi 1992. Snakes of the United States and Canada: Keeping them Healthy in Captivity, Vol. 1, Krieger Publishing Co., Malabar, Florida. i–xiv + 209 pp.). Snider and Bowler (1992. Longevity of Reptiles and Amphibians in North American Collections. SSAR Herpetol. Circ. 21:1–40) reported the captive longevity record for a wild-caught adult to be 1 year 1 month and 10 days.

On 1 May 2005, I acquired a wild-caught adult male *C. a. amoenus* (240 mm+ TL; missing tail tip). The snake was housed and fed as reported by Gray (2007. NC Herpetol. Soc. Newsltr. 30[2]:15).

On 13 March 2014, the *C. a. amoenus* was found dead in its enclosure after 8 years 10 months and 12 days in captivity, greatly exceeding the previous captive longevity record for this species. At the time of its death the snake had attained a snout–vent length of 245 mm and 278 mm TL. This *C. a. amoenus* was maintained under permit no. 15-07 issued by the Pennsylvania Fish and Boat Commission. The specimen was deposited in the reptile collection of the Natural History Museum at the Tom Ridge Environmental Center (TREC – 00107).

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Best Practices in Herpetological Taxonomy: Errata and Addenda

In a recent issue of *Herpetological Review*, my co-authors and I published a *Point of View* article outlining a set of best practices for workers in the field of herpetological taxonomy (Kaiser et al. 2013). The goal of that article was to defend modern herpetology from "taxonomic vandalism" (see Jäch 2007), and it has generated considerable discussion among zoological taxonomists (e.g., in the online listserv *Taxacom*). There is broad, although not unanimous, agreement on the part of herpetologists with our proposed solutions for how to handle taxonomic vandalism, and there is widespread recognition amongst zoological taxonomists in general that (1) taxonomic vandalism in zoology occurs and can pose a problem for users, (2) that the *International Code of Zoological Nomenclature* (ICZN 1999; hereafter, the *Code*) in its function as an accounting system outside of the scientific method cannot safeguard scientific output from interference by authors who do not conform to scientific principles (see Kaiser 2013), and (3) that the adjudication of taxonomic decisions ultimately remains in the hands of authors, editors, and, in terms of the resulting nomenclature but not the taxonomic decisions, the International Commission on Zoological Nomenclature (hereafter, ICZN). I am pleased to report that authors (e.g., Bates et al. 2013; Reynolds et al. 2014) as well as editors (e.g., Measey 2013) are now applying the recommendations we made. It is the purpose of this follow-up paper to correct four minor errors made in the earlier paper's list of taxonomic recommendations (Kaiser et al. 2013: Table 1), augment that list with a new set of recommendations for 255 unscientific names presented by Hoser (2013a–ag[1]), and provide some clarification of the earlier paper regarding the relationship between scientific taxonomy and the *Code*.

Errata

Recommendation for Costinisauria couperi *Wells 2009*.—Kaiser et al. (2013) erroneously recommended the use of *Lampropholis couperi* in place of *Costinisauria couperi*. Instead, they should have listed *Eulamprus kosciuskoi* as the correct recommendation. The original listing of *C. couperi* in Wells (2009) shows that the author intended to separate his purported species from *C. worrelli* Wells and Wellington 1985, a name in the synonymy of *E. kosciuskoi* (see Shea and Sadlier 1999).

Recommendation for Cyrtodactylus abrae *Wells 2002*.—Kaiser et al. (2013) erroneously recommended the use of *Cyrtodactylus tuberculatus* in place of *C. abrae*. Instead, they should have listed *C. pulchellus* as the correct recommendation. The authors overlooked an important recent paper, in which Shea et al. (2011) investigated the status of *C. abrae*. By designating the lectotype of *C. pulchellus* as the neotype of *C. abrae* (a poorly described taxon based on a photograph, and for which the nominal holotype did not exist), Shea et al. (2011) permanently relegated the name *C. abrae* to the status of junior synonym of *C. pulchellus*.

Recommendation for Zeusius sternfeldi *Wells 2007*.—Kaiser et al. (2013) erroneously recommended the use of *Cyclodomorphus casuarinae* in place of *Zeusius sternfeldi*. *Zeusius sternfeldi* is, in fact, a synonym of *C. venustus*. In his description of *Z. sternfeldi* Wells (2007) listed, without attribution, diagnostic characters from Shea and Miller (1995) for a population these authors considered conspecific with *C. venustus*.

Typographical error.—In Table 1, Kaiser et al. (2013) list the name Calloselasma, without italic lettering, as a new tribe presented by Hoser (2012b). This name should have been listed as Calloselasmiini. Hoser (2013m) described this putative tribe as new for the second time, both times in violation of the Principle of Coordination (Article 36 of the *Code*).

Addenda

In the course of writing the recent *Point of View* paper, my co-authors and I fully anticipated the production of additional taxon names by Raymond Hoser, but we were nevertheless dumbfounded by the sheer number of new names he created in five recent issues of his self-published *Australasian Journal of Herpetology* (hereafter *AJH*). In these issues, Hoser proposes a globe-spanning series of 255 new names for snakes and turtles at the family, subfamily, tribe, subtribe, genus, subgenus, species, and subspecies level. Following the standard of Kaiser et al. (2013), I here list these new names with recommendations for scientifically valid names (Table 1). In this list I also identify taxa violating Article 29 (proper formation of family-group names) and Article 36 (Principle of Coordination) of the *Code* and present corrections. I wish to note that, contrary to the exclamations by Hoser (2013n), the recommendations by Kaiser et al. (2013), and the ones presented herein are not formal taxonomic decisions underpinned by new evidence, but simply the most appropriate names to be used in place of dubious taxon names presented by Hoser since the year 2000; I consider Hoser's post-2000 names non-existent for the purposes of taxonomy and nomenclature. The names coined by Hoser (2003), inadvertently omitted by Kaiser et al. (2013), are included in this new listing.

Best Practices Revisited and Reaffirmed

There are two fundamental issues when dealing with non-peer-reviewed, unscientific contributions in taxonomy. The first of these is to clearly define the line separating taxonomy and nomenclature, as defined and differentiated by Pyle and Michel

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[1] As for the year 2012 (see Kaiser et al. 2013), due to the large number of works produced by Raymond Hoser in 2013 (N = 33), I continued the enumeration of citations by beginning the alphabet anew. Thus, in addition to Hoser (2013a–z), nine additional references exist (Hoser 2013aa–ai).

TABLE 1. List of 255 herpetofaunal taxa published as new by Raymond Hoser from April–September 2013, plus one set of names from Hoser (2003) that was inadvertently omitted by Kaiser et al. (2013). I follow Kaiser et al. (2013) in considering the manner in which these names were produced unscientific, in violation of Articles 8.1.1, 29, 36 and the *Code of Ethics* of the *International Code of Zoological Nomenclature* (ICZN 1999); these dubious names therefore have no standing in taxonomy and nomenclature. Readers *should not use these names* but instead revert to those listed in the column titled "Recommendation," where nomenclaturally available and taxonomically suitable scientific names are provided. For clarification, the Recommendation column shows subgenera in parentheses with their corresponding genus name, according to standard nomenclatural usage. The Recommendation column may include several scientifically valid names when a nonscientific higher group taxon (e.g., tribe, subtribe) encompasses multiple lower ranked taxa. All other capitalized and italicized names are genera or subgenera. These recommendations do not constitute synonymies under the rules of the *Code*, but serve as substitutes for Hoser's names until a formal, scientific treatment for the groups under consideration is published. A name formed incorrectly according to Article 29 of the *Code* is identified by the superscript A29. A name, whose description as new violates the Principle of Coordination of the *Code* (Article 36) and therefore is not new, is identified by the superscript A36. In these cases, a corrected version of the name and/or the proper authorship is provided after the taxon name. The footnotes list a variety of incongruities, including some with formal relevance.

Taxon	Taxon Rank	Citation	Recommendation
Acrantophiidae[A29, A36] [Acrantophidae; *Acrantophis* Jan 1860]	fam. nov.	Hoser 2013a	Boidae (part)
Acrantophiini[A29, A36] [Acrantophini; *Acrantophis* Jan 1860]	trib. nov.	Hoser 2013a	*Acrantophis* [1]
Acrantophis sloppi	sp. nov.	Hoser 2013a	*Acrantophis dumerilii*
Adelynhoserboa	gen. nov.	Hoser 2013j	*Tropidophis* (part)
Adelynhoserboa (*Adelynhoserboa*)	subgen. nov.	Hoser 2013j	*Tropidophis taczanowskyi*
Adelynhoserboa (*Merceicaboa*)	subgen. nov.	Hoser 2013j	*Tropidophis paucisquamis*
Adelynhoserboa (*Pattersonboa*)	subgen. nov.	Hoser 2013j	*Tropidophis battersbyi*
Adelynhoserboaiina[A29] [Adelynhoserboaina]	subtrib. nov.	Hoser 2013j	*Tropidophis*
Adelynhosersaur	gen. nov.	Hoser 2013ad	*Hypsilurus spinipes*
Adelynhosersaurini[2]	trib. nov.	Hoser 2013ad	*Hypsilurus spinipes, H. dilophus*
Adelynhoserserpenae wellsi	sp. nov.	Hoser 2013e	*Atropoides occiduus*
Adelynhoserserpenina[3]	subtrib. nov.	Hoser 2013m	*Atropoides* (part)
Adelynhoserserpenini	trib. nov.	Hoser 2013m	*Atropoides, Cerrophidion, Porthidium*
Ahaetulliini[A29, A36] [Ahaetullini; *Ahaetulla* Link 1801]	trib. nov.	Hoser 2013i	*Ahaetulla, Chrysopelea*
Amphibolurini[A36] [*Amphibolurus* Wagler 1830]	trib. nov.	Hoser 2013ad	Amphibolurinae (part)
Anomochilus marleneswileae	sp. nov.	Hoser 2013f	*Anomochilus leonardi*
Antaresia brentonoloughlini [4]	sp. nov.	Hoser 2003	*Antaresia maculosa*
Atractaspis (*Benjaminswileus*)	subgen. nov.	Hoser 2013v	*Atractaspis boulengeri*
Atractaspis (*Lowryus*)	subgen. nov.	Hoser 2013v	*Atractaspis duerdeni*
Bennettsaurini	trib. nov.	Hoser 2013ac	*Platysaurus mitchelli, P. maculatus*
Bennettsaurus	gen. nov.	Hoser 2013ac	*Platysaurus mitchelli, P. maculatus*
Bennettsaurus (*Bennettsaurus*)	subgen. nov.	Hoser 2013ac	*Platysaurus mitchelli*
Bennettsaurus (*Lucysaurea*)	subgen. nov.	Hoser 2013ac	*Platysaurus maculatus*
Bitis (*Klosevipera*)	subgen. nov.	Hoser 2013o	*Bitis caudalis, B. peringuey, B. schneideri*
Bitis (*Klosevipera*) *caudalis kajerikbulliardi*	subsp. nov.	Hoser 2013o	*Bitis caudalis*
Bitis (*Klosevipera*) *caudalis swilae*	subsp. nov.	Hoser 2013o	*Bitis caudalis*
Bitis (*Kuekus*)	subgen. nov.	Hoser 2013o	*Bitis parviocula* [5]
Bitis brianwallacei	sp. nov.	Hoser 2013o	*Bitis arietans*
Bitis funki	sp. nov.	Hoser 2013p	*Bitis gabonica*
Bitis hoserae	sp. nov.	Hoser 2013p	*Bitis nasicornis*
Bitis lourenceklosei	sp. nov.	Hoser 2013o	*Bitis arietans*
Bitis matteoae	sp. nov.	Hoser 2013o	*Bitis atropos*
Bitis oflahertyae	sp. nov.	Hoser 2013o	*Bitis arietans*
Bitis pintaudii	sp. nov.	Hoser 2013o	*Bitis arietans*

Table 1. Continued

Taxon	Taxon Rank	Citation	Recommendation
Bitis tomcottoni	sp. nov.	Hoser 2013o	*Bitis arietans*
Bitis wellingtoni	sp. nov.	Hoser 2013p	*Bitis gabonica*
Bitis wellsi	sp. nov.	Hoser 2013p	*Bitis gabonica*
Boigaiini[A29, A36] [Boigaini; *Boiga* Fitzinger 1826]	trib. nov.	Hoser 2013b	*Boiga* (part), *Dipsadomorphus, Toxicodryas*
Bothrocophias (*Pughvipera*)	subgen. nov.	Hoser 2013s	*Bothrocophias campbelli, B. myersi*
Bothrocophiina[3, A36] [*Bothrocophias* Gutberlet and Campbell 2001]	subtrib. nov.	Hoser 2013m	*Bothrocophias*
Bothropina[3, A36] [*Bothrops* Wagler, 1824]	subtrib. nov.	Hoser 2013m	*Bothrops* (part)
Bothropoidina[A36] [*Bothropoides* Fenwick et al. 2009]	subtrib. nov.	Hoser 2013m	*Bothrops* (part)
Bothrops lenhoseri	sp. nov.	Hoser 2013r	*Bothrops asper*
Bothrops mexicoiensis [sic][6]	sp. nov.	Hoser 2013r	*Bothrops asper*
Bothrops mexicoiensis maccartneyi [sic][6]	subsp. nov.	Hoser 2013r	*Bothrops asper*
Boulengerina adelynhoserae	sp. nov.	Hoser 2013t	*Naja* (*Boulengerina*) *melanoleuca*
Boulengerina jackyhoserae	sp. nov.	Hoser 2013t	*Naja* (*Boulengerina*) *melanoleuca*
Brachyophidiini[A36] [Brachyophidium Wall 1921]	trib. nov.	Hoser 2013l	*Brachyophidium*
Broghammerus (*Wellspython*)	subgen. nov.	Hoser 2013d	*Malayopython timoriensis*
Broghammerus reticulatus dalegibbonsi[7]	ssp. nov.	Hoser 2013d	*Malayopython reticulatus*
Broghammerus reticulatus euanedwardsi[7]	ssp. nov.	Hoser 2013d	*Malayopython reticulatus*
Broghammerus reticulatus haydnmacphiei[7]	ssp. nov.	Hoser 2013d	*Malayopython reticulatus*
Broghammerus reticulatus neilsonnemani[7]	ssp. nov.	Hoser 2013d	*Malayopython reticulatus*
Broghammerus reticulatus patrickcouperi[7]	ssp. nov.	Hoser 2013d	*Malayopython reticulatus*
Broghammerus reticulatus stuartbigmorei[7]	ssp. nov.	Hoser 2013d	*Malayopython reticulatus*
Brucegowus	gen. nov.	Hoser 2013aa	*Dendelaphis caudolineolatus*
Calliophis (*Benmooreus*)	subgen. nov.	Hoser 2013k	*Calliophis bibroni, C. haematoetron, C. melanurus*
Calliophis (*Paulstokesus*)	subgen. nov.	Hoser 2013k	*Calliophis beddomei, C. castoe, C. nigrescens*
Calliophis (*Swilea*)	subgen. nov.	Hoser 2013k	*Calliophis maculiceps*
Calloselasmiinae[A29, A36] [Calloselasminae; *Calloselasma* Cope 1860]	subfam. nov.	Hoser 2013s	*Calloselasma, Hypnale*
Calloselasmiini[A29, A36] [Calloselasmini; *Calloselasma* Cope 1860]	trib. nov.	Hoser 2013m	*Calloselasma, Hypnale*
Candoia (*Erebophis*) *aspera iansimpsoni*	ssp. nov.	Hoser 2013a	*Candoia aspera schmidti*
Candoidiini[A29, A36] [Candoiini; *Candoia* Gray 1842]	trib. nov.	Hoser 2013a	*Candoia*[8]
Candoiidae[A29, A36] [Candoiidae; *Candoia* Gray 1842]	fam. nov.	Hoser 2013a	Boidae (part)
Carstensus	gen. nov.	Hoser 2013y	*Atractus clarki*
Causus perkinsi	sp. nov.	Hoser 2013q	*Causus lichtensteini*
Ceratrimeresurus (*Lowryvipera*)	subgen. nov.	Hoser 2013s	*Protobothrops cornutus, P. jerdonii, P. xiangchengensis*
Cerrophodionina [sic][9]	subtrib. nov.	Hoser 2013m	*Atropoides* (part), *Cerrophidion*
Chamaelycus euanedwardsi	sp. nov.	Hoser 2013w	*Chamaelycus fasciatus*
Charlespiersonserpeniidae[A29] [Charlespiersonserpenidae]	fam. nov.	Hoser 2013i	*Ahaetulla, Dendrelaphis, Chrysopelea*
Charlespiersonserpeniinae[A29] [Charlespiersonserpeninae]	subfam. nov.	Hoser 2013i	*Ahaetulla, Dendrelaphis, Chrysopelea*
Charlespiersonserpenini	trib. nov.	Hoser 2013i	*Dendrelaphis*
Charlespiersonserpens (*Macmillanus*) *jackyhoserae*[10]	sp. nov.	Hoser 2013m	*Dendrelaphis lorentzi*
Chondropython shireenae[11]	sp. nov.	Hoser 2003	*Morelia viridis*
Chrismaxwelliini[A29] [Chrismaxwellini]	tribe nov.	Hoser 2013x	*Coluber zebrinus, Bamanophis, Macroprotodon*
Chrismaxwellus	gen. nov.	Hoser 2013x	*Coluber zebrinus*

TABLE 1. Continued

Taxon	Taxon Rank	Citation	Recommendation
Chrysopelea (*Wellsserpens*)	subgen. nov.	Hoser 2013b	*Chrysopelea taprobanica*
Conantvipera	gen. nov.	Hoser 2013s	*Gloydius* (part)
Cordylus (*Hulimkacordylus*)	subgen. nov.	Hoser 2013ac	*Cordylus* (part)
Cottonsaurini	trib. nov.	Hoser 2013ac	*Zonurus* (part), *Chamaesaura, Pseudocordylus, Smaug*
Cottonsaurus	gen. nov.	Hoser 2013ac	*Zonosaurus* (part)
Cottonvipera	gen. nov.	Hoser 2013s	*Ovophis zayuensis, O. tonkinensis*
Craspedocephalus (*Borneovipera*)	subgen. nov.	Hoser 2013s	*Trimeresurus* (*Craspedocephalus*) (part)
Crotalina[A36] [*Crotalus* Linnaeus 1758]	subtrib. nov.	Hoser 2013m	Crotalidae (part)
Crottyserpens	gen. nov.	Hoser 2013l	*Rhinophis fergusonianus, R. sanguineus, R. travancoricus*
Crottyserpens (*Ackyserpens*)	subgen. nov.	Hoser 2013l	*Rhinophis fergusonianus, R. sanguineus*
Crottyserpens (*Crottyserpens*)	subgen. nov.	Hoser 2013l	*Rhinophis travancoricus*
Crottyvipera	gen. nov.	Hoser 2013s	*Protobothrops mucrosquamatus, P. elegans*
Ctenophorini[A36] [*Ctenophorus* Fitzinger 1843]	trib. nov.	Hoser 2013ad	*Ctenophorus*
Cummingvipera	gen. nov.	Hoser 2013s	*Protobothrops kaulbacki, P. himalayanus*
Cylindrophis (*Cylindrophis*)	subgen. nov.	Hoser 2013f	*Cylindrophis* (part)
Cylindrophis (*Macgoldrichea*)	subgen. nov.	Hoser 2013f	*Cylindrophis maculatus*
Cylindrophis (*Motteramus*)	subgen. nov.	Hoser 2013f	*Cylindrophis* (part)
Cylindrophis (*Motteramus*) *wilsoni*	sp. nov.	Hoser 2013f	*Cylindrophis boulengeri*
Dannycoleus	gen. nov.	Hoser 2013aa	*Dendrelaphis bifrenalis, D. girii*
Dasypeltis saeizadi	sp. nov.	Hoser 2013ag	*Dasypeltis scabra*
Drewwilliamsus	gen. nov.	Hoser 2013y	*Atractus zidoki*
Drysdalia (*Staszewskius*)	subgen. nov.	Hoser 2013ab	*Drysdalia rhodogaster*
Drysdalia mastersii andrewlowry	subsp. nov.	Hoser 2013ab	*Drysdalia mastersii*
Drysdalia mastersii robwatsoni	subsp. nov.	Hoser 2013ab	*Drysdalia mastersii*
Edwardssaurus	gen. nov.	Hoser 2013ac	*Platysaurus maculatus*
Edwardssaurus (*Edwardssaurus*)	subgen. nov.	Hoser 2013ac	*Platysaurus* (part)
Edwardssaurus (*Macgoldrichsaurus*)	subgen. nov.	Hoser 2013ac	*Platysaurus* (part)
Edwardssaurus (*Vrljicsaurus*)	subgen. nov.	Hoser 2013ac	*Platysaurus ocellatus*
Empugusia (*Dendrovaranus*) *salvator woolfi*	subsp. nov.	Hoser 2013af	*Varanus* (*Soterosaurus*) *salvator bivittatus*
Empugusiini[A29, A36] [Empagusini; *Empagusia* Gray 1838]	trib. nov.	Hoser 2013af	*Varanus* (*Empagusia*)
Euprepiosaurus indicus wellingtoni	subsp. nov.	Hoser 2013af	*Varanus indicus*
Euprepiosaurus indicus wellsi	subsp. nov.	Hoser 2013af	*Varanus indicus*
Ernieswileus	gen. nov.	Hoser 2013f	*Anomochilus monticola*
Funkisaurus	gen. nov.	Hoser 2013ac	*Broadleysaurus major*
Funkisaurusiini[A29] [Funkisaurusini]	trib. nov.	Hoser 2013ac	*Broadleysaurus major*
Furina ornata toddpattersoni	ssp. nov.	Hoser 2013g	*Furina ornata*
Georgekonstandinouiini[A29] [Georgekonstandinouini]	tribe nov.	Hoser 2013v	*Atractaspis* (part)
Georgekonstandinouous [sic][12]	gen. nov.	Hoser 2013v	*Atractaspis* (part)
Georgekonstandinouous (*Georgekonstandinouous*)	subgen. nov.	Hoser 2013v	*Atractaspis irregularis*
Georgekonstandinouous (*Slatteryaspus*)	subgen. nov.	Hoser 2013v	*Atractaspis congica, A. reticulate*
Georgekonstandinouous (*Wellingtonaspus*)	subgen. nov.	Hoser 2013v	*Atractaspis engdahli*
Gerrhopilus carolinehoserae[13]	sp. nov.	Hoser 2013m	*Gerrhopilus hedraeus*

Table 1. Continued

Taxon	Taxon Rank	Citation	Recommendation
Gerrhosauriina[A29, A36] [Gerrhosaurina; *Gerrhosaurus* Wiegmann 1828]	subtrib. nov.	Hoser 2013ac	Gerrhosaurinae (part)
Gerrhosauriini[A29, A36] [Gerrhosaurini; *Gerrhosaurus* Wiegmann 1828]	trib. nov.	Hoser 2013ac	Gerrhosaurinae (part)
Gongylosoma (*Avonlovellus*)	subgen. nov.	Hoser 2013z	*Gongylosoma nicobariensis*
Gongylosoma (*Paulelliotus*)	subgen. nov.	Hoser 2013z	*Gongylosoma longicauda, G. mukutense*
Hallabysaurus	gen. nov.	Hoser 2013ac	*Zonosaurus trilineatus, Z. quadrilineatus*
Hapsidophrys daranini	sp. nov.	Hoser 2013w	*Hapsidophrys lineatus*
Hapsidophrys pintaudii	sp. nov.	Hoser 2013w	*Hapsidophrys smaragdina*
Hawkeswoodelapidus	gen. nov.	Hoser 2013ab	*Elapognathus*
Hawkeswoodsaurus	gen. nov.	Hoser 2013ac	Zonosaurinae (part)
Hawkeswoodsaurus (*Hawkeswoodsaurus*)	subgen. nov.	Hoser 2013ac	Zonosaurinae (part)
Hawkeswoodsaurus (*Nussbaumsaurus*)	subgen. nov.	Hoser 2013ac	*Zonosaurus tsingy*
Hawkeswoodsaurus (*Raselimananasaurus*)	subgen. nov.	Hoser 2013ac	*Zonosaurus aeneus*
Hawkeswoodsaurus (*Raxworthysaurus*)	subgen. nov.	Hoser 2013ac	*Zonosaurus brygooi*
Helodermini[A36] [*Heloderma* Wiegmann 1829]	trib. nov.	Hoser 2013ae	*Heloderma*
Hemachatus haemachatus macconchei [sic][14]	subsp. nov.	Hoser 2013u	*Hemachatus haemachatus*
Hulimkini[15]	trib. nov.	Hoser 2013m	*Suta*
Hydrophis (*Crottyhydrophis*)	subgen. nov.	Hoser 2013c	*Hydrophis donaldi*
Hypsilurini[A36] [*Hypsilurus* Peters 1867]	trib. nov.	Hoser 2013ad	*Hypsilurus* (part)
Intellagamini[A36] [*Intellagama* Wells and Wellington 1985]	trib. nov.	Hoser 2013ad	*Intellagama*
Jackyhoserboa	gen. nov.	Hoser 2013j	*Tropidophis greenwayi, T. haetianus*
Jackyhoserina[3]	subtrib. nov.	Hoser 2013m	*Bothrops* (part)
Jackyhoserini[3]	trib. nov.	Hoser 2013m	*Bothrops, Bothrocophias*
Jackyhosersaur	gen. nov.	Hoser 2013ad	*Diporiphora superba*
Karusasaurini	trib. nov.	Hoser 2013ac	*Karusasaurus, Ouroborus*
Katrinahoservipera	gen. nov.	Hoser 2013s	*Gloydius* (part)
Katrinus jackyae[16]	sp. nov.	Hoser 2003	*Liasis fuscus*
Libertadictus (*Adelynhosertyphlops*)	subgen. nov.	Hoser 2013g	*Anilios* (part)
Libertadictus (*Bennetttyphlops*)	subgen. nov.	Hoser 2013g	*Anilios pinguis, A. bicolor*
Libertadictus (*Buckleytyphlops*)	subgen. nov.	Hoser 2013g	*Anilios aspinus*
Libertadictus (*Jackyhosertyphlops*)	subgen. nov.	Hoser 2013g	*Anilios* (part)
Libertadictus (*Jackyhosertyphlops*) *adelynhoserae*	sp. nov.	Hoser 2013g	*Anilios grypus*
Libertadictus (*Jackyhosertyphlops*) *cliffrosswellingtoni*	sp. nov.	Hoser 2013g	*Anilios grypus*
Libertadictus (*Kerrtyphlops*)	subgen. nov.	Hoser 2013g	*Anilios proximus*
Libertadictus (*Mantyphlops*)	subgen. nov.	Hoser 2013g	*Anilios* (part)
Libertadictus (*Pattersontyphlops*)	subgen. nov.	Hoser 2013g	*Anilios* (part)
Libertadictus (*Robinwitttyphlops*)	subgen. nov.	Hoser 2013g	*Anilios unguirostris*
Libertadictus (*Robinwitttyphlops*) *jackyhoserae*	sp. nov.	Hoser 2013g	*Anilios unguirostris*
Libertadictus (*Sheatyphlops*)	subgen. nov.	Hoser 2013g	*Anilios batillus*
Libertadictus (*Silvatyphlops*)	subgen. nov.	Hoser 2013g	*Anilios silvia*
Libertadictus (*Slopptyphlops*)	subgen. nov.	Hoser 2013g	*Anilios* (part)
Libertadictus (*Slopptyphlops*) *richardwellsi*	sp. nov.	Hoser 2013g	*Anilios ammodytes*
Libertadictus (*Suewitttyphlops*) *sloppi*	sp. nov.	Hoser 2013g	*Anilios ligatus*

Table 1. Continued

Taxon	Taxon Rank	Citation	Recommendation
Libertadictus (*Suewitttyplops*) [sic]	subgen. nov.	Hoser 2013g	*Anilios* (part)
Liopeltis tricolor borneoiensis [sic][17]	subsp. nov.	Hoser 2013z	*Liopeltis tricolor*
Liopeltis tricolor brummeri	subsp. nov.	Hoser 2013z	*Liopeltis tricolor*
Liopeltis tricolor philippinesiensis [sic][18]	subsp. nov.	Hoser 2013z	*Liopeltis tricolor*
Liophidium (*Mattborgus*)	subgen. nov.	Hoser 2013k	*Liophidium pattoni, L. rhodogaster*
Liopholidophis (*Chrisnewmanus*)	subgen. nov.	Hoser 2013k	*Liopholidophis dimorphus, L. rhadinaea*
Lycophidion woolfi	sp. nov.	Hoser 2013w	*Lycophidion irroratum*
MacrochelyiiniA29, A36 [Macrochelysini[19]; *Macrochelys* Gray 1856]	trib. nov.	Hoser 2013h	*Macrochelys*
Macrochelys maxhoseri	sp. nov.	Hoser 2013h	*Macrochelys temmincki*
Macrochelys temmincki muscati	ssp. nov.	Hoser 2013h	*Macrochelys temmincki*
Manserpens	gen. nov.	Hoser 2013f	*Cylindrophis engkariensis*
Maxhosersaurus	gen. nov.	Hoser 2013ae	*Heloderma suspectum*
Maxhoserviperina[3]	subtrib. nov.	Hoser 2013m	*Daboia*
MelanophidiiniA29, A36 [Melanophidini; Melanophidium Günther 1864]	trib. nov.	Hoser 2013l	*Melanophidium*
MicrelapiidaeA29, A36 [Micrelapidae; Micrelaps Boettger 1880]	fam. nov.	Hoser 2013i	*Micrelaps*
MicrelapiinaeA29, A36 [Micrelapinae; Micrelaps Boettger 1880]	subfam. nov.	Hoser 2013i	*Micrelaps*
MolochiniA29 [Moloch Gray 1841]	trib. nov.	Hoser 2013ad	*Moloch, Chelosania*
MontiviperinaA29 [*Montivipera* Nilson et al. 1999]	subtrib. nov.	Hoser 2013m	*Macrovipera, Montivipera*
Morelia macburniei[20]	sp. nov.	Hoser 2003	*Morelia spilota imbricata*
Morelia mippughae[20]	sp. nov.	Hoser 2003	*Morelia spilota*
NamazonuriniA29 [*Namazonurus* Stanley et al. 2011]	trib. nov.	Hoser 2013ac	*Namazonurus*
Namazonurus (*Atikaea*)	subgen. nov.	Hoser 2013ac	*Namazonurus lawrenci, N. peersi*
Namazonurus (*Slatterysaurus*)	subgen. nov.	Hoser 2013ac	*Namazonurus namaquensis*
Ninivipera	gen. nov.	Hoser 2013s	*Gloydius himalayanus*
Ninsaurus	gen. nov.	Hoser 2013ac	*Ninsaurus langi*
Notopseudonaja modesta wellsi	ssp. nov.	Hoser 2013g	*Pseudonaja modesta*
Odatria honlami	sp. nov.	Hoser 2013af	*Varanus semiremex*
Odatria hoserae	sp. nov.	Hoser 2013af	*Varanus glauerti*
Odatria (*Odatria*) *tristis nini*	subsp. nov.	Hoser 2013af	*Varanus tristis orientalis*
OxyrhabdiumiidaeA29, A36 [Oxyrhabdiumidae; *Oxyrhabdium* Boulenger 1893]	fam. nov.	Hoser 2013i	*Oxyrhabdium*
OxyrhabdiumiinaeA29, A36 [Oxyrhabdiuminae; *Oxyrhabdium* Boulenger 1893]	subfam. nov.	Hoser 2013i	*Oxyrhabdium*
Oxysaurus	gen. nov.	Hoser 2013af	*Varanus spinulosus*
OxyserpeniiniA29 [Oxyserpenini]	trib. nov.	Hoser 2013l	*Uropeltis* (part)
Oxyserpens	gen. nov.	Hoser 2013l	*Uropeltis* (part)
Oxyserpens (*Jealousserpens*)	subgen. nov.	Hoser 2013l	*Uropeltis broughami, U. grandis*
Oxyserpens (*Oxyserpens*)	subgen. nov.	Hoser 2013l	*Uropeltis* (part)
Pailsus hoserae	sp. nov.	Hoser 2013g	*Pseudechis australis*
PhysignathiniA36 [*Physignathus* Cuvier 1829]	trib. nov.	Hoser 2013ad	*Physignathus*
Piersonina[3]	subtrib. nov.	Hoser 2013m	*Crotalus ravus*
PlatysauriniA36[*Platysaurus* Smith 1844]	trib. nov.	Hoser 2013ac	*Platysaurus* (part)
PlectruriiniA29, A36 [Plectrurini; *Plectrurus* Duméril 1851]	trib. nov.	Hoser 2013l	Uropeltidae (part)
PolydaedaliiniA29, A36 [Polydaedalini; *Polydaedalus* Wagler 1830]	trib. nov.	Hoser 2013af	*Varanus* (part)

TABLE 1. Continued

Taxon	Taxon Rank	Citation	Recommendation
Porthidium (*Davievipera*)	subgen. nov.	Hoser 2013s	*Porthidium dunni, P. ophryomegas*
Porthidiumina[A36] [*Porthidium* Cope 1871]	subtrib. nov.	Hoser 2013m	*Porthidium*
Psammodynastiidae[A29, A36] [Psammodynastidae; *Psammodynastes* Boie 1827]	fam. nov.	Hoser 2013i	*Psammodynastes*
Psammodynastiinae [A29, A36] [Psammodynastidae; *Psammodynastes* Boie 1827]	subfam. nov.	Hoser 2013i	*Psammodynastes*
Rhinocerophiina[A36] [*Rhinocerophis* Garman 1881]	subtrib. nov.	Hoser 2013m	*Bothrops* (part)
Rhinocerophis (*Blackleyvipera*)	subgen. nov.	Hoser 2013s	*Bothrops* (part)
Rhinophiini[A36] [*Rhinophis* Hemprich 1820]	trib. nov.	Hoser 2013l	*Rhinophis, Uropeltis*
Rossnolaniini[A29] [Rossnolanini]	tribe nov.	Hoser 2013z	*Cyclophiops, Liopeltis, Gongylosoma, Oreocryptophis*
Rossnolanus	gen. nov.	Hoser 2013z	*Liopeltis rappi*
Ryukyuvipera	gen. nov.	Hoser 2013s	*Ovophis okinavensis*
Shaneblackus	gen. nov.	Hoser 2013aa	*Dendrelaphis* (part)
Shanekingus	gen. nov.	Hoser 2013y	*Atractus wagleri, A. attenuates, A. sanguineus*
Shireenhosersaurea	gen. nov.	Hoser 2013af	*Varanus* (*Euprepiosaurus*) (part)
Shireenhosersauriini[A29] [Shireenhosersaurini]	trib. nov.	Hoser 2013af	*Varanus* (part)
Sivadictus (*Ackytyphlops*)	subgen. nov.	Hoser 2013g	*Anilios* (part)
Slopboiga	gen. nov.	Hoser 2013b	*Boiga kraepelini*
Sloppvipera	gen. nov.	Hoser 2013s	*Tropidolaemus huttoni*
Swilesauriina[A29] [Swilesaurina]	subtrib. nov.	Hoser 2013ac	*Matobosaurus validus*
Swilesaurus	gen. nov.	Hoser 2013ac	*Matobosaurus validus*
Swileserpeniidae[A29] [Swileserpenidae]	fam. nov.	Hoser 2013i	*Buhoma*
Swileserpeniinae[A29] [Swileserpeninae]	subfam. nov.	Hoser 2013i	*Buhoma*
Swilevipera	gen. nov.	Hoser 2013s	*Trimeresurus* (*Parias*) *hageni*
Tetradactylusiini[A29, A36] [Tetradactylusini; *Tetradactylus* Gray 1838]	trib. nov.	Hoser 2013ac	*Tetradactylus, Cordylosaurus*
Thermophiidae[A29, A36] [Thermophidae; *Thermophis* Malnate 1953]	fam. nov.	Hoser 2013i	*Thermophis*
Thermophiinae[A29, A36] [Thermophidae; *Thermophis* Malnate 1953]	subfam. nov.	Hoser 2013i	*Thermophis*
Tracheloptychina[21]	trib. nov.	Hoser 2013ac	*Tracheloptychus*
Trachyboaiini[A29, A36] [Trachyboaini; *Trachyboa* Peters 1860]	trib. nov.	Hoser 2013j	*Trachyboa*
Tropidolaemusiinae[A29, A36] [Tropidolaemusinae; *Tropidolaemus* Wagler 1830]	subfam. nov.	Hoser 2013s	*Deinagkistrodon, Garthius, Tropidolaemus*
Tropidophiinina[A29, A36] [Tropidophiina; *Tropidophis* Bibron 1843]	subtrib. nov.	Hoser 2013j	*Tropidophis* (part)
Tropidophiinini[A29, A36] [Tropidophiini; *Tropidophis* Bibron 1843]	trib. nov.	Hoser 2013j	*Tropidophis*
Tropidophis (*Eseraboa*)	subgen. nov.	Hoser 2013j	*Tropidophis canus*
Tropidophis (*Robertbullboa*)	subgen. nov.	Hoser 2013j	*Tropidophis caymanensis*
Tropidophis (*Rodwellboa*)	subgen. nov.	Hoser 2013j	*Tropidophis melanurus*
Ungaliophis panamensis lovelinayi	ssp. nov.	Hoser 2013j	*Ungaliophis panamensis*
Varaniini[A29, A36] [Varanini; *Varanus* Merrem 1820]	trib. nov.	Hoser 2013af	*Varanus* (part)
Varanus (*Aquativaranus*)	subgen. nov.	Hoser 2013af	*Varanus* (*Varanus*) *mertensi*
Varanus (*Arborhabitatiosaurus*)	subgen. nov.	Hoser 2013af	*Varanus* (*Odatria*) *gilleni, V.* (*O.*) *bushi, V.* (*O.*) *caudolineatus*
Varanus (*Honlamus*)	subgen. nov.	Hoser 2013af	*Varanus* (*Odatria*) *semiremex, V.* (*O.*) *mitchelli*
Varanus (*Honlamus*) *mitchelli hawkeswoodi*	subsp. nov.	Hoser 2013af	*Varanus* (*Odatria*) *mitchelli*
Varanus (*Kimberleyvaranus*)	subgen. nov.	Hoser 2013af	*Varanus* (*Odatria*) *glebopalma*
Varanus (*Parvavaranus*)	subgen. nov.	Hoser 2013af	*Varanus* (*Odatria*) *brevicauda, V.* (*O.*) *eremius*

TABLE 1. Continued

Taxon	Taxon Rank	Citation	Recommendation
Varanus (*Pilbaravaranus*)	subgen. nov.	Hoser 2013af	*Varanus* (*Odatria*) *pilbarensis*
Viridovipera (*Simpsonvipera*)	subgen. nov.	Hoser 2013s	*Trimeresurus* (*Viridovipera*) *medoensis*
Viridovipera (*Yunnanvipera*)	subgen. nov.	Hoser 2013s	*Trimeresurus* (*Viridovipera*) *yunnanensis*
Wellingtonboa	gen. nov.	Hoser 2013j	*Tropidophis haetianus*
Wellingtonsaurus	gen. nov.	Hoser 2013ac	Zonosaurinae (part)
Wellsboa	gen. nov.	Hoser 2013j	*Tropidophis* (part)
Wellsboa (*Tonysilvaboa*)	subgen. nov.	Hoser 2013j	*Tropidophis hendersoni*
Wellsboa (*Wellsboa*)	subgen. nov.	Hoser 2013j	*Tropidophis* (part)
Wellsboa (*Wittboa*)	subgen. nov.	Hoser 2013j	*Tropidophis fuscus, T. pilsbryi, T. wrighti*
Wellssaurus	gen. nov.	Hoser 2013ac	*Zonosaurus boettgeri, Z. maramaintso, Z. maximus*
Wellssaurus (*Wellssaurus*)	subgen. nov.	Hoser 2013ac	*Zonosaurus boettgeri, Z. maramaintso*
Wellssaurus (*Lukefabasaurus*)	subgen. nov.	Hoser 2013ac	*Zonosaurus maximus*
Woolfsaurini	trib. nov.	Hoser 2013ac	*Platysaurus pungweensis*
Woolfsaurus	gen. nov.	Hoser 2013ac	*Platysaurus pungweensis*
Worrellisaurus storri makhani	subsp. nov.	Hoser 2013af	*Varanus storri*
Zonosaurina[22,A36] [*Zonosaurus* Boulenger 1887]	subtrib. nov.	Hoser 2013ac	*Zonosaurus*
Zonosaurini[A36] [*Zonosaurus* Boulenger 1887]	trib. nov.	Hoser 2013ac	*Zonosaurus, Tracheloptychus*

[1] Fig. 4 in Vidal and Hedges (2009) shows that Malagasy boine snakes are part of an unresolved polytomy.
[2] Hoser (2013ad) includes in this group the species *Hypsilurus spinipes* and the genus *Tiaris* Duméril and Bibron 1837 (now known as *H. dilophus*). In the original description of their species *Lophyrus dilophus*, Duméril and Bibron (1837:421) list in their observation section that the name "*Tiare dilophe*" applies to the specimen figured on Plate 46 of their *Atlas*. There, it is denoted as *Tiaris dilophus*. However, the genus name *Tiaris* Duméril and Bibron 1837 was preoccupied by the genus *Tiaris* Swainson 1827, a taxon erected for a genus of songbirds in the tanager family (Thraupidae). The use of this genus in the definition of a tribe is incorrect.
[3] The taxon listed here was previously described by Hoser (2012b) and rejected by Kaiser et al. (2013).
[4] The taxon was also described as *Antaresia maculosus brentonoloughlini* by Hoser (2004) and rejected by Kaiser et al. (2013).
[5] The definition of this subgenus by Hoser (2013o) is confusing because of poor grammar, and no species content is formally presented. While the author states that the type species for the subgenus is *Bitis parviocula*, the later text appears to confound the subgenera *Macrocerastes* and "*Kuekus*."
[6] The entire first paragraph of the putative diagnosis for *Bothrops* "*mexicoiensis*" is a verbatim copy of the diagnosis for *B.* "*lenhoseri*." This is also the case for the diagnosis of *B. m.* "*maccartneyi*." Furthermore, to indicate a Mexican origin, the proper form for the name would be *mexicoensis*. To create a patronym for an individual with last name McCartney, as stated in the etymology, the proper form is *mccartneyi*.
[7] The subspecies of *Malayopython reticulatus* listed here were previously described by Hoser (2004) and rejected by Kaiser et al. (2013).
[8] According to Vidal and Hedges (2009:Fig. 4), "the phylogenetic position of the Pacific Island endemic genus *Candoia* remains uncertain."
[9] This taxon was previously described by Hoser (2012b), without the lapsus in spelling. It was rejected by Kaiser et al. (2013).
[10] The taxon listed here was already described by Hoser (2012d) and rejected by Kaiser et al. (2013).
[11] Also described as *Chondropython viridis shireenae* by Hoser (2004) and rejected by Kaiser et al. (2013).
[12] Given that the name derives from an individual named George Konstandinou, a proper spelling for such a group would be *Georgekonstandinous*.
[13] This is the second description of a species named *Gerrhopilus carolinehoserae*. The first was by Hoser (2012a), which was rejected by Kaiser et al. (2013).
[14] Given that the name derives from an individual named Lachlan McConchie, a proper spelling for such a group would be *mcconchiei*.
[15] The taxon listed here was already described by Hoser (2012c) and rejected by Kaiser et al. (2013).
[16] Also described as *Katrinus fuscus jackyae* by Hoser (2004) and rejected by Kaiser et al. (2013).
[17] A proper name indicating a Bornean origin would be *borneensis*.
[18] A proper name indicating Philippine origin would be *philippinensis*.
[19] The name Macrochelidae is preoccupied by a group of mites.
[20] Also described by Hoser (2004) and rejected by Kaiser et al. (2013).
[21] Hoser (2013ac) lists this as "Subtribe Tracheloptychina trib. nov." The subtribe ending -ina conflicts with the designation of this name as a tribe.
[22] Hoser (2013ac) lists this as "Subtribe Zonosaurina trib. nov." The subtribe ending -ina conflicts with the designation of this name as a tribe.

(2008), to determine which aspects of a body of work are in the purview of science and which are not. Taxonomy is based on data and argument (a scientific process), and if a disagreement occurs over evidence or its interpretation, then alternative taxonomies may coexist. Nomenclature, in contrast, is a system of rules based on general principles, through which the application of taxon names is regulated. It is not based on science, but for the system to be meaningful *there must be sound scientific principles underlying the creation of any new taxon name*. Thus, the workflow for proposing new taxon names automatically and invariably involves first science, using an explicit and transparent scientific process (i.e., a peer-reviewed publication), and then accounting, with all subsequent information regarding the status of a taxon name derived from accounting (Kaiser 2013). While it is true that the *Code* applies only to nomenclature, given its overall presentation (including its *Preamble, Introduction,* and *Code of Ethics*), it seems reasonable to assume that reliable scientific processes ought to underlie nomenclature.

The *Code* states that its application will be subservient to the "promotion of stability and universality in the scientific names of animals" (*Preamble* of the *Code*; ICZN, 1999). I interpret this as an attempt by the original authors of the *Code* to ascertain that scientific processes must govern the interactions between taxonomy and the *Code*. In my opinion, that is how Article 8.1.1 must be understood. If it can be shown that scientific principles are violated (i.e., data and argument for the specific case are not merely poorly interpreted, but missing, erroneously or deliberately misrepresented, or entirely outside of acceptable scientific principles), then the taxonomy and names produced by such means are unscientific. Names produced in this manner should therefore be considered nomenclaturally void, and should neither be permitted to receive approval via the *Code*, nor be able to subsequently re-enter the realm of science after having been "laundered" by the *Code* (Kaiser 2013).

The best practices presented by Kaiser et al. (2013) were designed to help taxonomic herpetologists and users of herpetological taxonomy recognize and sort post-2000 taxon names, and the publications in which they appeared, into acceptable and unacceptable columns. These recommendations are universally applicable: a user can take any article and check it against the listed criteria, then make a determination regarding the validity of any taxonomic decision it might contain. Using this approach, Kaiser et al. (2013) were able to declare the post-2000 output by the Australian snake aficionado Raymond Hoser void for nomenclatural purposes and provided a corresponding list of taxon names with nomenclatural validity. The particular issue with Hoser's output is not only the proposal of taxonomically unfounded and superfluous reptile names (more than 200 in 2013 alone; Hoser 2013a–ag), it includes attacks on professional and non-academic herpetologists who disagree with Hoser's concept of taxonomy, something I perceive to consist of little more than a competitive naming game to him. Following the publication of Kaiser et al. (2013) in March of 2013, Hoser worked the online social media circuit to discredit the authors and supporters of that paper, along with the journal and its editor, as well as the scientific societies that voted in support of the presented ideas (e.g., Hoser 2013n). His deportment is in clear violation of the *Code of Ethics* of the *Code*, as has frequently been stated in online venues. This is perhaps most significantly demonstrated by an exchange between Hoser and ICZN Commissioner Douglas Yanega in the listserv *Taxacom* (Hoser 2013ah). These exchanges are the source of gross misinformation about the relevant issues and scientific processes, and they have caused significant discontentment among taxonomists.

A key issue emerging in this discussion is the position of the *Code* and the ICZN. At their root, the rules and their governing body provide zoological taxonomists with a mechanism for the accounting of taxon names and for resolving disputes arising from the publication of available names. Alas, this mechanism is by design not scientific, and it is perhaps better likened to a system of legal oversight (Kaiser 2013). These entities were not established to influence the scientific processes by which taxonomic decisions are made. While this has fostered the independence of two important regulatory aspects of taxonomy, it has also created a problem: although the nonscientific component is strictly governed, the scientific one is not. I therefore feel I must preface the discussion of the *Code*'s specifics by stating that I am a firm proponent of the scientific process, a grand, yet imperfect human endeavor by which we produce knowledge. If the *Code*, a tool created by scientists for use by scientists to sort out nomenclature, does not unequivocally support this scientific process (which is the ultimate reason for the *Code*'s very existence), then the *Code* becomes irrelevant to science. While the *Code* provides a very valuable service, its application must always be congruent with scientific principles, and not for the protection of the *Code* in and of itself. The *Code* has adapted (e.g., ICZN 2012), and must continue to adapt, to the realities and demands of modern science, and it must do so as the situation demands it (see Harvey and Yanega 2013). The broader issue, therefore, is the use of the scientific method for creating knowledge, and the relevance of the *Code* to that goal.

Article 8.1.1 of the *Code* exemplifies how working within the framework of the *Code* and the ICZN creates challenges for those contending with names produced by taxonomic vandals. This article states that for a work to be considered published for the purposes of zoological nomenclature, "it must be issued for the purpose of providing a public and permanent scientific record" (ICZN 1999). Kaiser et al. (2013) and Schleip (2014) discuss this article in relation to Hoser's output in the *AJH*. Based on the online discussions that have followed (e.g., on *Facebook* pages and in *Taxacom*), as well as the presentation of *AJH* issues 16–18, it is instructive to revisit the ramifications of this article.

On the surface, glossy presentation and overall production of pseudoscientific[2] materials, such as the *AJH*, may closely mimic a scientific journal and can lead to confusion on the part of users, particularly in an applied setting where taxonomic minutiae may not be verified (e.g., Wüster and Bernils 2011). On the back pages of the two most recent issues of the *AJH*, it is even stated that articles are published "in a peer reviewed journal for permenant public scientific record" (grammar and spelling as in original). However, presentation and proclamation alone do not a scientific journal make. Even statements touting compliance with scientific rules cannot compensate for a lack of rigor in data presentation. For example, Hoser states multiple times in each issue of the *AJH* that his articles are designed to be "in accordance with the Zoological Code" (e.g., Hoser 2013ac:18), yet they fail scientific principles in even the most basic aspects

[2] Pseudoscience is an attempt to clothe nonscientific fact in scientific attire to validate fictional, non-reproducible information. Pseudoscience does not pose a question and seek an explanation; it begins with the explanation and then seeks supportive data. Pseudoscientific statements are generally easy to recognize by the vocal defense that typically accompanies their presentation, unlike science, where the evidence can speak for itself. In contrast to science, there is no knowledge gained through pseudoscience.

of reproducibility and data disclosure. While Hoser indeed works hard to make the *AJH* a public and permanent record, it is the term "scientific" where he fails the test of Article 8.1.1. In light of this, it is highly questionable whether the *AJH*, in the absence of the *Code*, would ever obtain permanence in the Scientific Record (see Dayrat 2005; Minelli 2005).

Following the best practices of Kaiser et al. (2013), the contents of the *AJH* are clearly noncompliant with broadly accepted scientific standards. From an administrative or oversight perspective, both an editorial board and associate editors are lacking. Hoser's role as the only contributor creates a conflict of interest for the peer-review process given his role as the *AJH*'s Editor. In terms of editorial quality, a reading of any article in the *AJH* demonstrates that there is no peer review despite Hoser's attestations to the contrary: no person upholding scientific principles and standards of collegial discourse (not to mention familiarity with English grammar, paragraph structure, or scientific writing) would accept *AJH* contributions (Carraway 2009). A scientific journal is not created by proclamation, but by the consistent production of quality, demonstrably peer-reviewed scientific output.

Regarding the taxonomic details of the articles in *AJH* issues 16–21, Hoser provides ample evidence that the names he proposes are not based on the scientific study of specimens or offered out of scientific necessity, which violates the scientific tenets of taxonomy and eliminates the utility of any resulting names. The main interest of Hoser is to have his proposed names endure, with the help of the *Code*. They are not the products of the scientific process, but generated "for completeness" (e.g., Hoser 2013a:3), which results in names for ranks that are not informative or useful. Indeed, most appear to be named for the sake of naming them: (1) naming clades for which molecular data from peer-reviewed publications may be preliminary or provide weak support, (2) names proposed from holotypes and paratypes that Hoser designates, yet has never examined himself, or (3) listing long strings of in-text citations rather than critically reviewing the relevant data from such papers (invariably ending with the phrase "and sources cited therein;" this occurs 38 times in the 33 papers comprising *AJH* issues 16–21). Hoser even states periodically that he does not want to rehash prior work (e.g., Hoser 2013a:4, 2013z:34, 2013ae:38), even when such work would support his taxonomic proposals.

Some may consider it impossible to differentiate scientific from nonscientific works so that it can be objectively determined which taxonomic decisions should have nomenclatural impact. I disagree. Based on the fundamental processes of science accepted today, developed and refined over centuries, it is a simple task to separate poorly executed science from pseudoscience. These are not matters of free speech or freedom of expression, which in science are restricted by evidence (Kaiser 2013). If it is not science, then it shall not be known as such. This has been amply and successfully demonstrated as evolutionary science defended itself against Intelligent Design, and it is certainly possible and appropriate in applications to taxonomy. This is not just a question of publishing outlet, but more specifically a question of whether basic scientific principles are followed or not.

Perhaps Hoser's most recent output is *Code*-compliant when it comes to the "public" or "permanent" aspects of Article 8.1.1. After all, the issues of the *AJH* are bound, available for purchase, and are distributed to some public libraries. But the output is by no measure "scientific" and clearly in violation of Appendix A of the *Code* (the *Code of Ethics*).

I have encountered the argument that Hoser's output merely represents exceptionally poor taxonomy, like that of some taxonomic vandals outside of herpetology, but with the addition of the many slanderous interpersonal transgressions and name-calling, and that over time scientists will correct the record. However, Hoser's prolific output, which as of this writing includes well over 600 new taxon names since 2000 (the exact number would require close scrutiny because the author tends to describe taxa as new more than once, and he calls higher taxon names "new" even when their authorship was already established according to Article 36 of the *Code*), creates significant instability for users of taxonomy in the herpetological community. Thus, the *Code*, whose explicit mandate includes the oversight of stability of scientific zoological nomenclature, is being co-opted by Hoser as a tool to create confusion in herpetological taxonomy[3]. The issue of taxonomic vandalism therefore is not merely a matter of working within the *Code* and exploiting its loopholes; it amounts to an example of treasonous conduct in the framework of zoological science.

A significant segment of the herpetological community is on record as rejecting the post-2000 names coined by Hoser (Kaiser et al. 2013), and given that these recommendations are being implemented in recent papers (e.g., Bates et al. 2013; Reynolds et al. 2014; Schleip 2014) and by editors (e.g., Measey 2013), this is likely to become the *status quo* for reptile taxonomy: science forges ahead as nonscience is overwritten. Despite this trend, the position of the *Code* and the ICZN vis-à-vis Hoser's nomenclature remains unresolved. Those interested in this issue can comment on Case 3601 filed by Hoser (2013ai) to preserve the genus name *Spracklandus* Hoser 2009 (published in the *AJH*) over *Afronaja* Wallach et al. 2009 (published in *Zootaxa*). This could prove to be a landmark case insofar as it pits the value of the scientific process against pseudoscience in nomenclature (Kaiser 2013, 2014).

I assert that one of the best options to resolve the issue of taxonomic vandalism in general, and of the situation described herein in particular, is for the ICZN to use its plenary powers under the *Code* to declare names proposed by Raymond Hoser unavailable for the purposes of nomenclature (Kaiser 2013). To resolve the problem in herpetology, it would suffice to do so with names proposed in the *AJH*, because that is where the most egregious offenses against scientific taxonomy have occurred. While this would not prevent Hoser from launching another outlet, it would set the precedent that the ICZN will not stand by as the system it safeguards is subverted and compromised.

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Note to the reader: In the following list, publications by Raymond Hoser have all errors in punctuation or spelling preserved.

[3] The most recent example for such confusion is listed in the newest edition of *Reptiles and Amphibians of Australia* (Cogger 2014). The author highlights in the account for the genus *Silvascincus* that readers will likely encounter two names for these lizards, of which the earlier name was rejected by Kaiser et al. (2013); in the account, the older name is nevertheless only listed second and in parentheses.

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The Bold Taxonomic Hypotheses of Collins (1991): 23 Years Later

> "**Bold ideas,** unjustified anticipations, and speculative thought, are our only means for interpreting nature: our only organon, our only instrument, for grasping her. And we must hazard them to win our prize. Those among us who are unwilling to expose their ideas to the hazard of refutation do not take part in the scientific game." Popper (1959:280).

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In the pages of this journal in 1991, Joseph T. Collins published a set of bold hypotheses under an innocuous sounding title: "Viewpoint: A new taxonomic arrangement for some North American amphibians and reptiles." This paper proposed 55 hypotheses about species. Specifically, Collins proposed the elevation of 55 nominal subspecies to species based on the application of the evolutionary species concept (ESC). As defined by Wiley (1978:18), evolutionary species are "... a single lineage of ancestral descendant populations of organisms which maintains its identity from other such lineages and which has its own evolutionary tendencies and historical fate." Wiley (1978:18–19) was quite explicit with regard to the development of

hypotheses based on his definition, "The definition is empirical in that it permits hypotheses from which can be tested…For example, we may frame the hypothesis, 'these two populations (or groups of populations) maintain separate identifiable evolutionary lineages.' Evidence used to test such an hypothesis can come from a variety of sources depending on the nature of the organism and the genetic, phenetic, spatial, temporal, ecological, biochemical and/or behavioral evidence which is available to test the question. *Whether a group of organisms is or is not a species then becomes an hypothesis to be tested*" (emphasis added). In many ways, the above quote forms the foundation of this retrospective of Collins' (1991) proposals.

The year before, Frost and Hillis (1990) published an influential paper on the ESC and its application in herpetology. One of the conclusions that Frost and Hillis (1990:93) reached, and certainly the most relevant for Collins, was that "where allopatric populations have not been demonstrated to be parts of a monophyletic group of very similar populations (e.g., *Bufo m. microscaphus* and *B. m. californicus*), we consider them to be distinct evolutionary species and name them as binomials (i.e., *B. microscaphus* and *B. californicus*)." Frost and Hillis (1990) gave numerous other examples where allopatric populations had been investigated and found to be multiple species, which led them to predict (p. 94), "... most of the large 'polytypic' species left (such as *Ambystoma tigrinum, Necturus maculosus, Sceloporus jarrovii, S. undulatus, Diadophis punctatus, Pituophis melanoleucas, Lampropeltis getula, Tantilla rubra, Thamnophis sirtalis*, and *Crotalus durissus*) will be found to be composed of several evolutionary species." The claims of Frost and Hillis (1991) at that time were bold, and presumably emboldened Collins.

Applying the arguments of Frost and Hillis (1991; which were an extension of Wiley [1978]), Collins (1991:43) made the philosophical and operational leap to treat allopatric North American amphibian and reptile subspecies as species as lineages: "the following taxa exhibit two characteristics which reveal their specific distinctiveness: 1) They are mapped as allopatric (based on the best published evidence available), and 2) they are in some way morphologically (and presumably genetically) distinct." Of course, like all change, this leap was controversial and did not go unchallenged. Three response papers (Lazell 1992; Montanucci 1992; Van Devender et al. 1992) appeared in *Herpetological Review* that argued strongly against Collins's hypotheses (for many reasons) and these rebuttals were in turn answered (Collins 1992; Frost et al. 1992). The debates were lively and enlightening and led to an awakened interest in the nature of species among herpetologists.

My purpose here is not to rehash the debates and the battles already fought and, frankly, won by proponents of the ESC, but instead to ask the empirical question: How many of Collins' hypotheses have been falsified? In my opinion, answering this question should be an important addition to the debates. Was Collins' trust in the ESC justified? Were the theory and philosophy behind the ESC well-founded? If the predictions of Collins were not rejected, then the answers to these questions should be "yes."

To address the question of how many of Collins' 1991 hypotheses have been falsified, I took the list from Collins (1991) and reviewed the systematics literature for each species. Based on the literature since 1991 (with a couple exceptions), the hypotheses were designated as either (1) failed to falsify, (2) failed to falsify but different from proposed, (3) falsified, and (4) unstudied. Failed to falsify means the hypothesis of Collins (1991) was corroborated as originally proposed. Failed to falsify but different means that although Collins (1991) was correct in proposing multiple species present, the discovered patterns were different, and more complicated than he predicted. Falsified hypotheses mean that the allopatric subspecies were found to be part of a single species. Unstudied hypotheses are precisely that; no work has been done to address what Collins proposed.

Of the 55 subspecies-to-species elevations proposed by Collins (1991), 40 (73%) had been studied by other investigators as of March 2014. Of those 40, 23 of Collins's hypotheses were corroborated (or were not rejected), six others had more complicated patterns of species distributions than predicted, and 11 were falsified (Table 1). Several of the decisions were not straightforward; it was not my intention to reinterpret the work of others, but simply to tally results. Some had actually been proposed as species prior to the publication of Collins's (1991) viewpoint. For example, Packard (1971) argued that regardless of reproductive compatibility, the disjunct population of *Anaxyrus* [then *Bufo*] *hemiophrys* recognized as *A. h. baxteri* was evolving independently of *A. h. hemiophrys* and should be recognized as a distinct species. Recognition of *A. baxteri* was supported later by Smith et al. (1998). *Thamnophis couchii gigas* is a similar case, where Rossman and Stewart (1987) previously had shown *T. gigas* to be a diagnosable lineage separate from *T. couchii*. These cases were included in the tally simply because Collins (1991) included them.

Is there any meaning that can be ascribed to only 11 hypotheses (out of the 40 tested) being falsified? Yes. Collins (1991) is an important paper because it challenged all of us to deal with the practical application of evolutionary science to taxonomy. Collins (1991) also strongly promoted further discussion on the nature of subspecies and their importance/relevance in understanding biodiversity. As circumstantial evidence, consider that from 1956 to 1990 (34 years), the number of subspecies recognized in nominal species of reptiles and amphibians in the USA dropped by 61, but from 1990 to 2012 (22 years), the number of subspecies dropped by 165 (Collins 1990; Conant et al. 1956; Crother 2012). Was this dramatic decline in the number of recognized subspecies caused by Collins (1991)? As noted above, Collins' (1991) polarizing paper was an empirical extension of the arguments of Frost and Hillis (1990), and coincident with the rise of molecular phylogenetics (e.g., Hillis and Moritz 1990), which provided new data and tools that spurred on phylogenetic research of North American amphibians and reptiles. While it can be argued that the philosophical and methodological advancements played a more important role in the decline of recognized subspecies, if Collins (1991) did not contribute to that decline, he certainly saw it coming (Collins 1991:42): "Besides providing recognition of the real species diversity in nature, a rigorous application of the evolutionary species concept (as discussed in Frost and Hillis 1990) would also reduce the number of arbitrarily defined subspecies dramatically…"

Collins (1991) exposed the false worry that nomenclatural instability may lead to chaos (see Pauly et al. [2009], Crother [2009], and Frost et al. [2009] for a recent debate of this issue); this "chaos" actually reflects the shock of change within the taxonomic community (Hedges 2013). Rarely considered, but of significance nonetheless, the results of the tests of Collins' hypotheses reflect the seeming fact that geographic disjunction, both allopatric and peripatric, are important drivers of speciation (Mayr [1963] was arguably the key work that solidified this orthodoxy). In the same vein, the results also supported a prediction of the ESC (Frost and

TABLE 1. Status of subspecies elevated by Collins (1991). 1 = Failed to falsify, 2 = multiple lineages but different than hypothesized, 3 = falsified, 4 = unstudied. See text for further explanation.* = determined there was not enough evidence to support or reject (C. Austin, pers. comm.).

Subspecies	Proposed Species	Status	Key Publications
Caudata			
Ambystoma macrodactylum croceum	*Ambystoma croceum*	4	NA
Cryptobranchus alleganiensis bishopi	*Cryptobranchus bishopi*	2	Tonione et al. (2010), Crowhurst et al. (2011)
Gyrinophilus palleucus gulolineatus	*Gyrinophilus gulolineatus*	1	Niemiller et al. (2008)
Necturus maculosus louisianensis	*Necturus louisianensis*	1	Chabarria et al., unpubl. data
Plethodon dorsalis angusticlavius	*Plethodon angusticlavius*	1	Highton (1997)
Plethodon vandykei idahoensis	*Plethodon idahoensis*	1	Howard et al. (1993)
Pseudotriton montanus diastictus	*Pseudotriton diastictus*	4	NA
Taricha torosa sierrae	*Taricha sierrae*	1	Kuchta (2007)
Anura			
Anaxyrus [*Bufo*] *hemiophrys baxteri*	*Anaxyrus baxteri*	1	Packard (1971), Smith et al. (1998)
Anaxyrus [*Bufo*] *microscaphus californicus*	*Anaxyrus californicus*	1	Gergus (1998)
Pseudacris streckeri illinoensis	*Pseudacris illinoensis*	1	Moriarty and Cannatella (2004)
Lithobates [*Rana*] *areolatus capito*	*Lithobates capito*	1	Young and Crother (2001)
Lithobates [*Rana*] *sylvaticus maslini*	*Lithobates maslini*	4	NA
Scaphiopus holbrooki hurteri	*Scaphiopus hurteri*	4	NA
Testudines			
Kinosternon flavescens arizonense	*Kinosternon arizonense*	1	Serb et al. (2001)
Kinosternon flavescens spooneri	*Kinosternon spooneri*	3	Serb et al. (2001)
Pseudemys concinna gorzugi	*Pseudemys gorzugi*	1	Seidel (1994), Spinks et al. (2013)
Pseudemys concinna suwanniensis	*Pseudemys suwanniensis*	3	Spinks et al. (2013)
Squamata: Lizards			
Aspidoscelis [*Cnemidophorus*] *burti xanthonotus*	*Aspidoscelis xanthonotus*	4	NA
Crotaphytus insularis vestigium	*Crotaphytus vestigium*	1	McGuire (1996)
Plestiodon [*Eumeces*] *egregius insularis*	*Plestiodon insularis*	1	Branch et al. (2003)
Plestiodon [*Eumeces*] *gilberti arizonensis*	*Plestiodon arizonensis*	3	Richmond and Reeder (2002)
Plestiodon [*Eumeces*] *septentrionalis obtusirostris*	*Plestiodon obtusirostris*	*	Fuerst and Austin (2004)
Holbrookia lacerata subcaudalis	*Holbrookia subcaudalis*	4	NA
Ophisaurus attenuatus longicaudus	*Ophisaurus longicaudus*	4	NA
Sceloporus graciosus arenicolus	*Sceloporus arenicolus*	1	Wiens and Reeder (1997)
Sceloporus graciosus vandenburgianus	*Sceloporus vandenburgianus*	1	Wiens and Reeder (1997)
Uta stansburiana stejnegeri	*Uta stejnegeri*	1	Upton and Murphy (1997)
Xantusia vigilis utahensis	*Xantusia utahensis*	3	Sinclair et al. (2004)
Squamata: Snakes			
Arizona elegans occidentalis	*Arizona occidentalis*	4	NA
Carphophis amoenus vermis	*Carphophis vermis*	4	NA
Cemophora coccinea lineri	*Cemophora lineri*	4	NA
Coluber constrictor mormon	*Coluber mormon*	2	Burbrink et al. (2008)
Coluber [*Masticophis*] *bilineatus lineolatus*	*Coluber lineolatus*	3	Camper and Dixon (1994)
Diadophis punctatus acricus	*Diadophis acricus*	2	Fontanella et al. (2008)
Diadophis punctatus amabilis	*Diadophis amabilis*	2	Fontanella et al. (2008)
Drymarchon corais couperi	*Drymarchon couperi*	1	Wüster et al. (2001)
Pantherophis [*Elaphe*] *vulpinus gloydi*	*Pantherophis gloydi*	2	Crother et al. (2011)
Farancia erytrogramma seminola	*Farancia seminola*	4	NA
Lampropeltis triangulum taylori	*Lampropeltis taylori*	3	Ruane et al. (2013)
Lampropeltis calligaster occipitolineata	*Lampropeltis occipitolineata*	4	NA
Lampropeltis pyromelana infralabialis	*Lampropeltis infralabialis*	3	Burbrink et al. (2011)
Lampropeltis zonata multifasciata	*Lampropeltis multifasciata*	1	Rodríguez-Robles et al. (1999), Myers et al. (2013)
Lampropeltis zonata parvirubra	*Lampropeltis parvirubra*	3	Rodríguez-Robles et al. (1999), Myers et al. (2013)
Lampropeltis zonata pulchra	*Lampropeltis pulchra*	3	Rodríguez-Robles et al. (1999), Myers et al. (2013)
Micrurus fulvius tener	*Micrurus tener*	1	Campbell and Lamar (2004)
Nerodia harteri paucimaculata	*Nerodia paucimaculata*	1	Densmore et al. (1992)
Pituophis melanoleucus catenifer	*Pituophis catenifer*	1	Rodríguez-Robles and de Jesús-Escobar (2000)
Pituophis melanoleucus ruthveni	*Pituophis ruthveni*	1	Reichling (1995)

TABLE 1. Continued.

Subspecies	Proposed Species	Status	Key Publications
Tantilla relicta pamlica	*Tantilla pamlica*	4	NA
Tantilla rubra cucullata	*Tantilla cucullata*	2	Dixon et al. (2000)
Tantilla rubra diabola	*Tantilla diabola*	3	Dixon et al. (2000)
Thamnophis couchi gigas	*Thamnophis gigas*	1	Rossman and Stewart (1987)
Thamnophis sirtalis dorsalis	*Thamnophis dorsalis*	4	NA
Virginia valeriae pulchra	*Virginia pulchra*	4	NA

Hillis 1990; Frost and Kluge 1994; Wiley 1978): if two populations are disjunct, and diagnostically distinct, the evidence suggests that they are on independent evolutionary trajectories and thus are species. And finally, Collins (1991) implicitly embraced Popperian (Popper 1959, 1962, 1972, 1983) logic by not waiting for the slow accumulation of inductive statements before proposing his hypotheses, but instead was bold in his proposals and risked the "hazard of refutation" (Popper 1959:280) with his hypotheses.

Although many of Collins's predictions were correct, this kind of taxonomy is not encouraged. I do not advocate nomenclatural changes that are not based on data (see Kaiser et al. 2013). However, it would advance our knowledge of biodiversity if biologists were less reticent about naming discovered lineages they identify in their phylogenies. After all, the phylogenetic system was originally developed for the specific purpose of classification (Hennig 1966; Wiley 1980).

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GEOGRAPHIC DISTRIBUTION

CAUDATA — SALAMANDERS

***AMBYSTOMA OPACUM* (Marbled Salamander)**. USA: TENNESSEE: Henderson Co.: Natchez Trace State Park. (35.81743°N, 88.22875°W; NAD 83). 2 November 2011. Jeremy Dennison. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19457). New county record (Scott and Redmond 2008. Atlas of Amphibians in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://www.apsu.edu/amatlas [updated 11 November 2013; accessed 3 January 2014]).

ROBERT COLVIN (e-mail: Rob.Colvin@tn.gov) and **JEREMY DENNISON**, Tennessee Wildlife Resources Agency, Region I, 200 Lowell Thomas Drive, Jackson, Tennessee 38301, USA (e-mail: Jereemy.Dennison@tn.gov).

***AMBYSTOMA TALPOIDEUM* (Mole Salamander)**. USA: ARKANSAS: Craighead Co.: Lake City Township: 0.01 km N of St. Hwy 18 (35.82098°N, 90.43948°W; NAD 83). 14 March 2008. Phillip Jordan. Verified by Stan Trauth. Arkansas State University Museum of Zoology (ASUMZ 30959). New county record (Trauth et al. 2004. Amphibians and Reptiles of Arkansas. Univ. of Arkansas Press, Fayetteville. 421 pp.); known previously from adjacent Greene and 15 other Arkansas counties.

PHILLIP N. JORDAN, 1607 Tanglewood Drive, Jonesboro, Arkansas 72401, USA; e-mail: phillipnjordan03@hotmail.com.

***AMBYSTOMA TALPOIDEUM* (Mole Salamander)**. USA: GEORGIA: Glascock Co.: DOR on Steephollow Rd. at Duhart Creek (33.25161°N, 83.49158°W; WGS 84). 22 December 2013. S. Graham and C. K. Graham. Verified by David Laurencio. AUM AHAP-D 00778 (digital photo voucher). New county record (Jensen et al. 2008. The Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.).

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***AMBYSTOMA TALPOIDEUM* (Mole Salamander)**. USA: TENNESSEE: Crockett Co.: Horns Bluff Refuge (35.85133°N, 89.091167°W; NAD 83). 23 June 2011. Robert Colvin and Jeremy Dennison. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19136). New county record (Scott and Redmond 2008. Atlas of Amphibians in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://www.apsu.edu/amatlas [updated 11 November 2013; accessed 3 January 2014]).

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***AMBYSTOMA TEXANUM* (Small-mouthed Salamander)**. USA: INDIANA: Lawrence Co.: Fort Ritner Community Center (38.770650°N, 86.281200°W; NAD 83). 22 August 2013. Sarabeth Klueh-Mundy and Jason Mirtl. Verified by Chris Phillips. Illinois Natural History Survey (INHS 2013e photo voucher). New county record for Indiana (Minton 2001. Amphibians and Reptiles of Indiana. 2nd ed., revised. Indiana Academy of Science. vii + 404 pp.).

SARABETH KLUEH-MUNDY (e-mail: sklueh-mundy@dnr.IN.gov) and **JASON MIRTL**, Wildlife Diversity Program, Indiana Department of Natural Resources Division of Fish and Wildlife, 5596 East State Road 46, Bloomington, Indiana 47401, USA

***AMBYSTOMA TIGRINUM* (Eastern Tiger Salamander)**. USA: GEORGIA: Peach Co.: Moseley Rd, 50 m E of Barrett Rd intersection, 2.7 km WSW of Byron (32.64451°N, 83.78680°W; WGS 84). 26 November 2013. S. Graham and C. K. Graham. Verified by David Laurencio. AUM AHAP-D 00773 (digital photo voucher). New county record (Jensen et al. 2008. The Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). Adult male found AOR.

Washington Co.: S side of Prosser Rd (Prosser Rd forms the boundary between Washington Co. and Hancock Co.), 100 m W of Friendship (33.08128°N, 83.03645°W; WGS 84). 22 December 2013. S. Graham and C. K. Graham. Verified by David Laurencio. AUM AHAP-D 00777 (digital photo voucher). New county record (Jensen et al. 2008, *op. cit.*). Found AOR.

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***AMPHIUMA MEANS* (Two-toed Amphiuma)**. USA: ALABAMA: Chilton Co.: 0.40 road miles SE of AL 22 on AL 6, beaver pond just west of highway (32.76174°N, 86.87677°W; WGS84/NAD83). 13 April 2013. C. Davis. AUM 40194. Verified by David Laurencio. New county record (Mount 1996. The Reptiles and Amphibians of Alabama. University of Alabama Press. xi+347 pp.). Caught with baited funnel trap.

Dallas Co.: 0.34 miles WSW of AL 14 along train tracks (32.42926°N, 86.95938°W; WGS84/NAD83). 30 June 2013. C. Davis. AUM 40282. Verified by David Laurencio. New county record (Mount 1996, *op. cit.*). Caught with baited funnel trap,

A. means is assumed to occur throughout the lower half of the state; however, verified records are lacking for many Alabama counties.

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***BATRACHOSEPS CAMPI* (Inyo Mountains Salamander)**. USA: CALIFORNIA: Inyo Co.: southwestern Inyo Mountains, an

unnamed canyon between Fossil Hill to the north and Union Wash to the south (36.72°N, 118.02°W; WGS84). 9 June 2013. Adam G. Clause. LACM TC 1582 (tissue), PC 1656 (digital color photo). 21 December 2013. Adam G. Clause, James Erdman, Nicholas G. Buckmaster, Justin K. Clause. Natural History Museum of Los Angeles County (LACM 184466 [entire animal], TC 2058–2061, and PC 1721–1724). Verified by Gregory B. Pauly. Five salamanders were collected under rocks among herbaceous riparian vegetation, at two sites within the canyon. This is the twentieth known locality for this species range-wide, and just the seventh locality from the west-slope Inyo Mountains. It fills a ca. 5-km gap in the species' range (California Natural Diversity Database RareFind Data, California Department of Fish and Wildlife, 2013). Precise GPS coordinates for this record are held by the LACM, to prevent unauthorized disturbance of this protected species.

Work was approved under California Department of Fish and Wildlife Scientific Collecting Permit #011663 issued on 24 April 2013, Bureau of Land Management Bishop Field Office Permit #1110 (CA-170.31) issued on 24 January 2014 (retroactive), and University of Georgia IACUC AUP #A2012 10-004-Y1-A0 issued on 27 February 2013. Financial support provided by a University of Georgia Presidential Fellowship.

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EURYCEA CHAMBERLAINI **(Chamberlain's Dwarf Salamander)**. USA: GEORGIA: Lamar Co.: Cherokee Drive in Barnesville (33.046534°N, 84.144869°W; WGS 84). 11 April 2013. Laura A. West. Verified by John Jensen. Gordon State College Collection of Vertebrates (GSC 048). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens, Georgia. 575 pp.). This species has not been documented in any of the adjoining counties (Jensen et al. 2008, *op. cit.*). Salamander was found alive beneath a plywood board during mid-afternoon.

Specimen collected under Georgia Department of Natural Resources Scientific Collecting Permit (29-WJH-13-126, CN 25018).

LAURA A. WEST (e-mail: lw125587@gordonstate.edu) and **GREGORY D. HARTMAN** Gordon State College, Barnesville, Georgia 30204, USA (e-mail: ghartman@gordonstate.edu).

EURYCEA CIRRIGERA **(Southern Two-lined Salamander)**. USA: TENNESSEE: Madison Co.: Jackson (35.61566°N, 88.87083°W; WGS84). 31 December 2013. Joshua M. Hall. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19473 [photo voucher]). New county record (Redmond and Scott 1996. [updated 2008; latest update: 11 November 2013]. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12. Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Available at http://www.apsu.edu/amatlas/, accessed 4 February 2014). One adult specimen found beneath fallen timber in a shallow wetland.

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EURYCEA GUTTOLINEATA **(Three-lined Salamander)**. USA: GEORGIA: Floyd Co.: Unnamed spring adjacent to Morrison Campground (34.2758°N, 93.4175°W; WGS 84). 7 June 2000. N. Burkhead, R. Lewis, and C. Skelton. Verified by John Jensen. Georgia Museum of Natural History (GMNH 50654–50656). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). Three adults were electroshocked out of thick beds of watercress during a fish survey. In this part of the state, the ranges of E. guttolineata and E. longicauda interdigitate and are not well-established, increasing the importance of this documented occurrence.

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EURYCEA GUTTOLINEATA **(Three-lined Salamander)**. USA: TENNESSEE: Madison Co.: Jackson (35.61485°N, 88.86722°W; WGS84). 31 December 2013. Joshua M. Hall. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19474 [photo voucher]). New county record (Redmond and Scott 1996. [updated 2008; latest update: 11 November 2013]. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12. Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Available at http://www.apsu.edu/amatlas/, accessed 4 February 2014). One adult specimen found beneath fallen timber in a shallow wetland.

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GYRINOPHILUS PORPHYRITICUS **(Spring Salamander)**. USA: GEORGIA: Coweta Co.: unnamed stream 1.05 km S of jct Clover Pond Road and Bud Davis Road (33.408033°N, 84.995538°W; WGS 84). 4 January 2014. Noah Fields and Philip Higgins. Verified by John B. Jensen. GMNH 50426. First county record (Jensen et al. [eds.] 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.).

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HEMIDACTYLIUM SCUTATUM **(Four-toed Salamander)**. USA: GEORGIA: Jefferson Co.: State Rt. 242 at Salter Branch (32.87984°N, 83.50334°W; WGS 84). 07 March 2014. Crystal Kelehear and Sean Graham. Verified by David Laurencio. AUM AHAP-D 780 (digital photo voucher). New county record (Jensen et al. 2008. The Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). Found beneath log near vernal pool and seepage wetland.

Funding for this collection trip was provided by a grant from the Georgia Department of Natural Resources.

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HEMIDACTYLIUM SCUTATUM **(Four-toed Salamander)**. USA: TENNESSEE: Humphreys Co.: 4.0 km SSW of McEwen (36.0764°N, 87.6584°W). 23 February 2014. Daniel Hodges.

Verified by A. Floyd Scott. David H. Snyder Museum of Zoology, Austin Peay State University (APSU 19482, photo voucher). New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center of Excellence for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. [Hard copy and Internet versions, http://apbrwww5.apsu.edu/amatlas/index.html, accessed 26 February 2014]). Specimen found under fallen log in deciduous forest near pond surrounded by patches of sphagnum moss.

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***NOTOPHTHALMUS PERSTRIATUS* (Striped Newt)**. USA: FLORIDA: Osceola Co: Triple N Ranch Wildlife Management Area (28.1123°N, 81.0178°W; WGS84). 9 January 2014. Kevin M. Enge. Verified by Kenneth L. Krysko. Florida Museum of Natural History, UF 172101 (color photo). New county record (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final report, Florida Fish and Wildlife Conservation Commission, Tallahassee. 524 pp.) and extends the range 57 km SSE of records from the University of Central Florida campus, Orlando, Orange County (UCF 0327–0328). Collected 14 paedomorphic and one non-gilled adult while dipnetting a 1.3-ha depression marsh in mesic flatwoods near oak scrub and scrubby flatwoods habitats.

KEVIN M. ENGE (e-mail: kevin.enge@myfwc.com), **JONATHAN D. MAYS,** Florida Fish and Wildlife Conservation Commission, 1105 S.W. Williston Road, Gainesville, Florida 32601, USA; **JAMES C. BLUSH**, Florida Fish and Wildlife Conservation Commission, 5285 N. Kenansville Road, St. Cloud, Florida 34773, USA.

***NOTOPHTHALMUS PERSTRIATUS* (Striped Newt)**. USA: FLORIDA: Taylor Co: Spring Creek Unit of Big Bend Wildlife Management Area (29.9844ºN, 83.6909ºW; WGS84). 19 February 2014. Jonathan D. Mays. Verified by Kenneth L. Krysko. Florida Museum of Natural History, UF 172527 (color photo). New county record (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final report, Florida Fish and Wildlife Conservation Commission, Tallahassee. 524 pp.) and partially fills the distributional gap in Florida between genetically distinct eastern and western populations (May et al. 2011. Biol. Conserv. 144:1441–1450). Found 3 aquatic adults while dipnetting a depression marsh in sandhill habitat. This site is ca. 69 km E of the nearest records in Wakulla Co. (UF 45398–45409) and 84 km W of the nearest record in Gilchrist Co. (UF 93125).

JONATHAN D. MAYS (e-mail: jonathan.mays@myfwc.com) and **KEVIN M. ENGE** Florida Fish and Wildlife Conservation Commission, 1105 S.W. Williston Road, Gainesville, Florida 32601, USA (e- mail: kevin.enge@myfwc.com).

***NOTOPHTHALMUS VIRIDESCENS LOUISIANENSIS* (Central Newt)**. USA: TENNESSEE: Crockett Co.: Horns Bluff Refuge. (35.85208°N, 89.09583°W; NAD 83). 21 December 2011. Robert Colvin and Jeremy Dennison. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19196). First county record (Scott and Redmond 2008. Atlas of Amphibians in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://www.apsu.edu/amatlas [updated 11 November 2013; accessed 7 February 2014].

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***NOTOPHTHALMUS VIRIDESCENS PIAROPICOLA* (Peninsula Newt)**. USA: FLORIDA: Martin Co.: Jonathan Dickinson State Park (27.038238°N, 80.128646°W; WGS 84). Joshua Holbrook, Amanda Berman and Ashley Romnosky. Verified by Kenneth Krysko. FLMNH UF 171110. New county record (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final Report, Project Agreement 08013, Florida Fish and Wildlife Conservation Commission, Tallahassee. 524 pp.). Nearest known records from both northwest, Okeechobee Co., and south, Palm Beach Co. A number (~20) have been encountered via funnel trap and dip net in two semi-permanent, fishless willow sloughs in an upland scrub habitat matrix in the northern portion of Jonathan Dickinson State Park (JDSP). Despite being relatively common in these two willow sloughs, none has been detected in intensive funnel trap surveys in 19 other wetlands in JDSP in a variety of habitats of varying hydroperiod.

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***PLETHODON CINEREUS* (Eastern Red-backed Salamander)**. USA: INDIANA: Hamilton Co.: Conner Prairie Interactive History Park (39.9773°N, 86.0320°W; WGS 84). 8 June, 2013. Robert Brodman, Michael S. Finkler, James Horton, Megan Gramhofer, and Anastasia Marsh. Verified by Alan Resetar. Saint Joseph's College zoological collection (SJCZC A350). New county record (Minton 2001. Amphibians & Reptiles of Indiana, 2nd ed. Indiana Academy of Science, Indianapolis. 404 pp.). Fills gap in distribution in central Indiana. Known from three of six adjacent counties and is 25 km N from nearest known locality in Marion Co.

ROBERT BRODMAN (e-mail bobb@saintjoe.edu), **MEGAN GRAMHOFER** and **ANASTASIA MARSH,** Biology Department, Saint Joseph's College, Rensselaer, Indiana 47978, USA; **MICHAEL S. FINKLER,** School of Sciences, Indiana University Kokomo, PO Box 9003, Kokomo, Indiana 46904-9003, USA (e-mail: mfinkler@iuk.edu); **JAMES HORTON** 10 Catalina Circle, Zionsville, Indiana 46077, USA (e-mail: stardali84@hotmail.com).

***PSEUDOBRANCHUS AXANTHUS BELLI* (Everglades Dwarf Siren)**. USA: FLORIDA: Broward Co.: Water Conservation Area 3A (WCA-3A). (26.077°N, 80.714°W; WGS 84). Joshua Holbrook, Nathan Dorn, Natalie Knorp, and Alexander Chapman. Verified by Kenneth Krysko. FLMNH UF 171109. New county record (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final Report, Project Agreement 08013, Florida Fish and Wildlife Conservation Commission, Tallahassee. 524 pp.; Holbrook et al. 2012. Herpetol. Rev. 43:4) Nearest known records are from Miami-Dade Co. to the south, and multiple populations have been recently discovered in Palm Beach Co. to the north (Krysko et al. 2011, *op. cit.*; Holbrook et al. 2012, *op. cit.*). Eight individuals have been observed in WCA-3A in both Broward and Miami-Dade counties in ridge and slough habitat in January 2013. Individuals have been found in close proximity to predatory fish (e.g., centrarchids), though there is a profusion of emergent and floating vegetation, which may serve as refuge from potential predators. All specimens were captured as by-catch while sampling fishes and invertebrates with 1 m^2 throw traps.

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ANURA — FROGS

***ANAXYRUS PUNCTATUS* (Red-spotted Toad)**. MÉXICO: HIDALGO: Municipality of Tecozautla: La Guadalupe (20.530194°N, 99.588555°W; WGS84); 1946 m elev. 8 September 2012. Rafael Alejandro Calzada Arciniega. Verified by Luis Canseco Márquez. MZFC 27326. First record for Tecozautla, extending the range 20.5 km SW from the nearest locality at Cadereyta de Montes, Querétaro (Dixon and Lemos-Espinal. 2010. Amphibians and Reptiles of the State of Queretaro, México. Texas A&M University, College Station, Texas; UNAM, Tlalnepantla, México, México; CONABIO, México, D.F. ix + 428 pp.). The toad was in a canyon surrounded by xeric scrub vegetation.

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***CRAUGASTOR TALAMANCAE* (Almirante Robber Frog)**. REPUBLIC OF PANAMA: VERAGUAS: Cañazas District: ca. 20 m upstream from the mouth of Las Lajitas Creek where it enters San Pablo River (8.26334°N, 81.26404°W; WGS84), 78 m elev. 15 March 2013. V. Bravo and E. E. Flores. MVUP 2416. First record for the municipality and a 32 km SW range extension from the closest known locality at Alto de Piedra, Santa Fe District, in the central cordillera (Köhler 2011. Amphibians of Central America. Herpeton, Verlag Elke Köhler, Offenbach, Germany. 380 pp.). The frog was found at night on the bank of La Lajitas Creek; this species seems to be common along tributaries of the San Pablo River north of the Interamerican Highway. This project was conducted under the scientific permit (SE/A-26-13) provided by the Panamanian National Authority for the Environment (ANAM).

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***ELEUTHERODACTYLUS CYSTIGNATHOIDES* (Rio Grande Chirping Frog)**. USA: TEXAS: Travis Co.: Austin, Platt Lane, 400 m (by rd) W of TX FM 973 at Austin Water Hornsby Bend Biosolids Management Plant (30.23222°N, 97.63090°W; WGS84). 28 March 2013. Emily A. Powell. TNHC 85894. Verified by Travis LaDuc and James Dixon. New county record (Dixon 2013. Amphibians and Reptiles of Texas. Texas A&M University Press, College Station, Texas. 447 pp.). The frog was found beneath a wooden board along the road leading to the plant. A second unvouchered specimen was found 10 km from the first (approx. 30.36066°N, 97.64674°W; WGS84). 18 March 2013. These populations may be introduced given the urban location, but the distance between these sightings suggests this is not one isolated occurrence.

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***EUPHLYCTIS HEXADACTYLUS* (Indian Pond Frog)**. BANGLADESH: JESSORE DISTRICT: Jessore Jute Industries, Rajghat (23.007458°N, 89.433672°E, 10 m elev.; WGS 84). 15 November 2013. Mohammad Rasel Hossain. Photographic voucher, Museum of Herpetology Laboratory, Ichamati College Dinajpur (MHLB-EH_IMG:01–02). Verified by Ghazi S. M. Asmat. First record for Jessor District. Previously reported from Dhaka and Bagherhat Districts (Mahony et al. 2009. Hamadryad 34:80–94), and Sundarban Mangrove Forest (Reza et al. 2000. Frog Leg 4[2]:1–2). Adult beside old building; surrounding habitat includes *Tamarindus indica* plantations.

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***HYLA GRATIOSA* (Barking Treefrog)**. USA: TENNESSEE: Decatur Co.: 2740 Hwy 641 S at Decatur County Middle School (35.611186°N, 88.122571°W; NAD 83). 21 July 2013. Chad Harden. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19461 photo voucher). New county record (Scott and Redmond 2008. Atlas of Amphibians in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://www.apsu.edu/amatlas [updated 11 November 2013; accessed 30 December 2013]).

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***HYPSIBOAS CREPITANS* (Emerald-eyed Tree Frog)**. REPUBLIC OF PANAMA: VERAGUAS: La Mesa District: ca. 54 m upstream from the mouth of El Bajo Creek where it enters San Pablo River (8.22743°N, 81.24956°W; WGS84), 76 m elev. 13 March 2013. V. Bravo and E. E. Flores. Verified by Andreas Hertz. MVUP 2413. First record for Veraguas Province, extending the range ca. 48 km from the closest record in the Herrera Province (Köhler 2011. Amphibians of Central America. Herpeton, Verlag Elke Köhler, Offenbach, Germany. 380 pp.). The frog was discovered during the morning under dry leaf litter within the riparian forest along El Bajo Creek. This work was conducted under the scientific permit (SE/A-26-1) provided by the Panamanian National Authority for the Environment (ANAM).

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***KALOULA PULCHRA* (Asiatic Painted Frog)**. PHILIPPINES: CEBU ISLAND: Cebu Province: Mandaue City, Barangay Cabancalan (10.348889°N, 123.924444°E; WGS 84). 18 September 2013; Mandaue City, Barangay Subangdaku (10.389178°N, 123.921233°E). 2 December 2013; Cebu City, Barangay Talamban (10.326317°N, 123.924269°E). 2 December 2013; Municipality of Consolacion, Barangay Tilhaong (10.399047°N, 123.963058°E). 31 December 2013. Dominic Villareal and Gilbert C. Gamolo. Photographic vouchers, Raffles Museum of Biodiversity Research, National University of Singapore (ZRC [IMG] 1.62, 1.63, 1.64, and 1.65a–b). Verified by Indraneil Das. First record for Cebu Island. An introduced species in the Philippines, previously recorded on Luzon (Aurora, Bulacan, Cagayan, Ilocos Norte, Isabela, Laguna, and National Capital Region), Palawan (Puerto Princesa), and Mindanao (Diesmos et al. 2006. J. Env. Sci. Manage. 9:41–53;

Fidenci 2009. Herpetol. Rev. 40:446; Siler et al. 2011. Check List 7:182–195; Brown et al. 2012. Check List 8:469–490; Brown et al. 2013. ZooKeys 266:1–120; Sy 2013. Herpetol. Rev. 44: 621).

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LEPTODACTYLUS CHAQUENSIS. BRAZIL: SANTA CATARINA: District of Curitibanos: Floodplain of Canoas River (27.4500°S, 50.6333°W; WGS 84). 09 September 2009. I. F. Machado. Amphibian Collection of Pontifícia Universidade Católica do Rio Grande do Sul, Porto Alegre, Rio Grande do Sul, Brazil. PUCRS (MCP-Anfíbios 9983). Verified by G. M. Funk Pontes. Leptodactylus chaquensis is known from Argentina, Paraguay, Uruguay, lowland Bolivia, and from the Brazilian states of Acre, Mato Grosso, Mato Grosso do Sul, Minas Gerais, Paraná, Rio Grande do Sul, Rondônia, and São Paulo (Garcia and Vinciprova 1998. Herpetol Rev. 29[2]:117–118; Vasconcelos and Rossa-Feres 2005. Biota Neotrop. 5[2]:1–14; Calderon et al. 2009. Check List 5:425–427; Brassaloti et al. 2010. Biota Neotrop. 10[1]:1–17; Oda et al. 2014. Herpetoza 26:195–200). First state record, this new locality is situated among the known sites of the municipality Bossoroca in Rio Grande do Sul state (453 km SW), Guaíra in Paraná state (504 km NW), and the Gália and Alvilândia records in São Paulo state (563 km N).

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LEPTODACTYLUS MELANONOTUS **(Fringe-toed Foam Frog)**. REPUBLIC OF PANAMA: VERAGUAS: La Mesa District: ca. 67 m upstream from the mouth of El Corte Creek where it enters into San Pablo River (8.23352°N, 81.25976°W: WGS84), 66 m elev. 13 March 2013. V. Bravo and E. E. Flores. Verified by Andreas Hertz. MVUP 2414. First record for the district, extending the range of the species ca. 30 km SW of the closest known locality in Santa Fe District (Köhler 2011. Amphibians of Central America. Herpeton, Verlag Elke Köhler, Offenbach, Germany. 380 pp.), and also reduces the geographic gap on the Pacific versant between localities in southeastern Panama and south-central Costa Rica (Köhler 2011, *op. cit.*). The female frog was found at night on the muddy bank of El Corte Creek near water. This work was conducted under the scientific permit (SE/A-26-13) provided by the Panamanian National Authority for the Environment (ANAM).

ERIC ENRIQUE FLORES, Friends of Santa Fe National Park (AMIPARQUE), Apartado 0923-00126, Veraguas, Panama (e-mail: sailax1@gmail.com); **VÍCTOR BRAVO**, University of Panama, School of Biology, Panama City, Panama (e-mail: bravovictor50@yahoo.com); **JUNIER BARRÍA**, Community of Los Llanitos, La Mesa District, Panama.

LITHOBATES CATESBEIANUS **(American Bullfrog)**. MÉXICO: CHIHUAHUA: Municipality of Chihuahua: Río Chuvíscar (28.709860°N, 105.983975°W; WGS84), 1341 m elev. 10 October 2012. Rubén Alonso Carbajal Márquez and Martín Lara. Verified by Lee Grismer. La Sierra University Digital Photo Collection (LSUDPC 6659). First municipality record, extending the known range of the species ca. 269 km (airline) SE from the closest known locality, 2.1 km NW Nuevo Casas Grandes, Municipality of Nuevo Casas Grandes, Chihuahua (Lemos-Espinal and Smith 2009. Anfibios y Reptiles del Estado de Chihuahua, México, 2nd ed. UNAM, Tlalnepantla, México, México; Univ. of Colorado, Boulder; CONABIO, México, D.F. 613 pp.). The frog was found at 2125 h foraging in the river along with other adults and young.

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LITHOBATES CATESBEIANUS **(American Bullfrog)**. MÉXICO: CHIHUAHUA: Municipio Saucillo: Presa Rosetilla (28.2547°N, 105.298753°W; WGS84), 1138 m elev. 9 August 2000. Cesar Muñoz-Rivas and Ana Gatica-Colima. Verified by Héctor Gadsden-Esparza. Sección Herpetológica, Colección Científica de Vertebrados, Universidad Autónoma de Ciudad Juárez, (CCV-UACJ 157–160). First record for the municipality and range extension of ca. 360 airline km SE from the nearest record in Chihuahua, 2.1 km NW Nuevo Casas Grandes (Lemos and Smith 2007. Anfibios y Reptiles del Estado de Chihuahua, México. UNAM, Tlanepantla, México 54090, México and CONABIO, D.F. 14010, México. xiii + 613 pp.). There seems to be an established population at this Presa Rosetilla site, as a second visit to the area during 19–20 June 2003 found four more bullfrogs (CCV-UACJ 420, 427–429). The bullfrog is considered an exotic invasive species that is a ravenous predator of small native wetland animals, so its expanding range in Chihuahua is a cause of concern. Although 1981 records of bullfrogs (e.g., CNAR [IBH] 3998) exist from La Boquilla, Lago Colina, Chihuahua (Casas-Andreu et al. 2001. Ciencia Ergo Sum 8:6–67), Lemos and Smith (2007, *op. cit.*) did not include any La Boquilla records.

Collecting permits were kindly issued by the Dirección General de Vida Silvestre, SEMARNAT (#1445 and #1553).

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LITHOBATES CLAMITANS **(Green Frog)**. USA: ALABAMA: Crenshaw Co.: wetland 30 m N of Crenshaw County Rd. 30 and 160 m E of Piney Woods Creek (31.84732°N, 86.21375°W; WGS 84). 03 July 2013. M. Herr and S. Graham. Verified by David Laurencio. AUM AHAP-D 751 (digital photo voucher). New county record (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn Printing Co., Auburn. 347 pp.).

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***OSTEOPILUS SEPTENTRIONALIS* (Cuban Treefrog)**. USA: LOUISIANA: Jefferson Parish: Bridge City. Animal found in a nursery (29.935453ºN, 90.170697ºW; WGS 84). 30 June 2013. Matt Vance. Verified Eric Rittmeyer. Louisiana State University Museum of Natural Science (LSUMZ 98143). First state record (Dundee and Rossman 1989. Amphibians and Reptiles of Louisiana. Louisiana State University Press, Baton Rouge. 300 pp.).

A single, gravid female was found on a horticultural plant (*Lagerstroemia*; crepe myrtle). Although not indicative of an established population, the discovery of this highly invasive species in Louisiana is cause for concern (McGarrity and Johnson 2009. Biol. Invas. 11:1411–1420; Rödder and Weinsheimer 2009. J. Nat. Hist. 43:1207–1217). The animal was alive and seemingly healthy at the time of collection.

Indigenous to many Caribbean islands, *O. septentrionalis* has been established in Florida at least since 1928 (Barbour 1931. Copeia 1931:140) where it likely has negative impacts on native species (Smith 2005. Biol. Conserv. 123:433–441; Rice et al. 2011. Herpetologica 67:105–117) and is considered highly invasive. Individuals have been reported in Georgia (Johnson 2007. Herpetol. Rev. 38:349; Jensen et al. 2008. Amphibians and Reptiles of Georgia, University of Georgia Press), Maryland (Meshaka 1996. Herpetol. Rev. 27:37–40), Colorado (Livo et al. 1998. Northwest. Nat. 79:1–11), Virginia (Mitchell 1999. Catesbeiana 19:32), and Canada (Meshaka 1996. Herpetol. Rev. 27:37–40) but, like the individual described here, were probably recent imports and, therefore, do not represent established populations.

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***PSEUDACRIS CRUCIFER* (Spring Peeper)**. USA: GEORGIA: Peach Co.: Lakeview Rd, 6.3 km S of Byron (32.58892°N, 83.7711632°W; WGS 84). 26 November 2013. S. Graham and C. K. Graham. Verified by David Laurencio. AUM AHAP-D 00775 (digital photo voucher). New county record (Jensen et al. 2008. The Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.).

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***RHINELLA MARINA* (Cane Toad)**. USA: FLORIDA: Gilchrist Co.: 5880 NE 70th Street, High Springs, Florida (29.84403°N, 82.71016°W; WGS84; elev. 19.5 m). 28 May 2012. Peter L. Butt. Verified by Kenneth L. Krysko. Florida Museum of Natural History (UF 166746). New county record (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final Report, Florida Fish and Wildlife Conservation Commission, Tallahassee. 524 pp.). Female (SVL = 132 mm, mass = 374 g) captured by hand at 2000 h. This non-indigenous species has been reproducing in southern Florida since the 1950s (Duellman and Schwartz 1958. Bull. Florida State Mus. 3:181–324), but a large distribution gap (>150 km) exists between the well-established southern Florida population and the specimen we report. Specimens are also known from Clay and Columbia counties in northern Florida (Krysko et al. 2011, *op. cit.*), but there is no evidence of an established population in this area.

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***RHINELLA MARINA* (Cane Toad)**. USA: FLORIDA: Orange Co.: Apopka, 625 W. Keene Road (28.640233°N, 81.52361°W, WGS 84). 30 January 2014. Bryce Merritt. Verified by Kenneth L. Krysko. Florida Museum of Natural History, University of Florida (UF-Herpetology 172560). Second county record (Krysko et al. 2011a. Atlas of Amphibians and Reptiles in Florida. Final Report, Project Agreement 08013, Florida Fish and Wildlife Conservation Commission, Tallahassee. 524 pp.).

One adult male (SUL = 110 mm) collected from inside propagation house of a horticultural business, and originally turned in to Division of Plant Industry, Florida Department of Agriculture and Consumer Services, Gainesville, Florida; Entomology Log No. E2014-874-1. A subsequent survey of this area of Apopka, by one of us (BM), failed to locate additional specimens.

Over 34 years ago a specimen (UCF 0485) was collected from Fort Wilderness, Walt Disney World, Orlando, on 2 November 1979 approximately 29.77 km to the SSW.

Rhinella marina is indigenous to Central and South America, Mexico, and extreme southern Texas, USA, but has a large worldwide nonindigenous distribution primarily due its misguided use as a biocontrol for insect pests (Easteal 1981. Biol. J. Linn. Soc. 16:93–113; Lever 2001. The Cane Toad: The History and Ecology of a Successful Colonist. Westbury Publishing, Otley, England. 230 pp.; Kraus 2009. Alien Reptiles and Amphibians: A Scientific Compendium and Analysis. Springer, Dordrecht. 563 pp. + CD-Rom; Somma 2011. *In* Fuller [ed.], Nonindigenous Aquatic Species. USGS: http://nas.er.usgs.gov/queries/FactSheet.aspx?speciesID=48; Powell and Henderson [eds.] 2012. Bull. Florida Mus. Nat. Hist. 51:85–166).

In Florida, *R. marina* was originally introduced to control sugarcane pests (Lobdell 1936. Univ. Florida Agric. Exp. Station Annu. Rept. 1936:123–124), and other subsequently successful introductions were made through the pet trade and a zoo release (King and Krakauer 1966. Quart. J. Florida Acad. Sci. 29:144–154; Himes 2007. Herpetol. Rev. 38:473; Krysko et al. 2011b. Zootaxa 3028:1–64). Thus, *R. marina* is established in at least 16 counties in Florida (Krysko et al. 2011a, *op. cit.*; Meshaka 2011. Herpetol. Conserv. Biol. [Monogr. 1] 6:i–iii, 1–101 pp.). Currently, we are unable to determine if our specimen is a single individual brought in through horticultural products or if it represents an undetected, established population in Orange Co. As the nearest populations of *R. marina* occur in adjacent Polk and Brevard counties, to the southwest and east, respectively (Krysko et al. 2011a, *op. cit.*; Meshaka 2011, *op. cit.*), we suggest monitoring to prevent further spread of this invasive, ecologically destructive species in Central Florida.

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***SCAPHIOPUS HOLBROOKII* (Eastern Spadefoot)**. USA: GEORGIA: Peach Co.: Lakeview Rd, 6.3 km S of Byron (32.58892°N, 83.7711632°W; WGS 84). 26 November 2013. S. Graham and C. K. Graham. Verified by David Laurencio. AUM AHAP-D 00774 (digital photo voucher). New county record (Jensen et al. 2008. The Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.).

Washington Co.: South side of Prosser Rd. (Prosser Rd. forms the boundary between Washington Co. and Hancock Co.), 100 m W of Friendship (33.08128°N, 83.03645°W; WGS 84). 22 December 2013. S. Graham and C. K. Graham. Verified by David Laurencio. AUM AHAP-D 00776 (digital photo voucher). New county record (Jensen et al. 2008, *op. cit.*).

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***TERATOHYLA PULVERATA* (Chiriqui Glass Frog)**. REPUBLIC OF PANAMA: VERAGUAS: La Mesa District: ca. 120 m upstream from the mouth of San Bartolo River where it enters into San Pablo River (8.21738°N, 81.25717°W; WGS84). 57 m elev. 11 March 2013. V. Bravo and E. E. Flores. Verified by Andreas Hertz. MVUP 2412. First record for the district, extending the known geographic distribution on the central Pacific lowlands of Panama, 48 km SW from the closest known locality in Santa Fe District (Köhler 2011. Amphibians of Central America. Herpeton, Verlag Elke Köhler, Offenbach, Germany. 380 pp.). The juvenile frog was found at night sitting on the river bank. This project was conducted under the scientific permit (SE/A-26-13) provided by the Panamanian National Authority for the Environment (ANAM).

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CROCODILIA — CROCODILIANS

***ALLIGATOR MISSISSIPPIENSIS* (American Alligator)**. USA: ALABAMA: Bullock Co.: Wehle Tract, 6.75 km SE of Midway (32.03090°N 85.47132°W; WGS 84). 11 March 2014. C. Thawley and F. Graves. Verified by David Laurencio, AUM AHAP-D 782 (digital photograph file). New county record (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn Printing Co., Auburn. 347 pp.). Numerous individuals were observed in a pond, including juveniles, indicating reproduction on site. This record fills a distributional gap along the species' northern range limit in Alabama, where verified records are scarce, with the nearest vouchered localities approximately 42 km SE in Barbour Co. and 156 km WNW in Dallas Co..

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TESTUDINES — TURTLES

***APALONE MUTICA* (Smooth Softshell Turtle)**. USA: MISSOURI: Perry Co.: Brazeau Township. Found near bank of Mississippi River, 10 m E of BNSF railroad and 0.5 km NW of Cottonwood Island (37.6117°N, 89.5169°W; WGS84). 2 July 2013. Andrew P. Braun and John West. Verified by Dustin S. Siegel. University of Missouri-Columbia (UMC 2392P). Male specimen, captured in fyke net. New county record (Edmond and Daniel 2013 [latest update: 5 April 2013]). Missouri Herpetological Atlas Project. Available at http://atlas.moherp.org/; accessed 9 July 2013).

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***APALONE SPINIFERA* (Spiny Softshell)**. USA: INDIANA: Hamilton Co.: Conner Prairie Interactive History Park (39.9816°N, 86.0334°W; WGS 84). 8 June 2013. Robert Brodman, Michael S. Finkler, James Horton, Megan Gramhofer, and Anastasia Marsh. Verified by Alan Resetar. Photo voucher Saint Joseph's College zoological collection (SJCZC R321). New county record (Minton 2001. Amphibians & Reptiles of Indiana, 2nd ed. Indiana Academy of Science, Indianapolis. 404 pp.). Extends range into a nine-county gap 13 km N from nearest known locality in Marion Co.

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***APALONE SPINIFERA* (Spiny Softshell)**. USA: TENNESSEE: Henderson Co.: Darden (35.69640°N, 88.23756°W; WGS84). 1 July 2013. Joshua M. Hall. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19472 [photo voucher]). New county record (Scott and Redmond 2008. [updated 10 January 2014]. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://www.apsu.edu/reptatlas/, accessed 4 February 2014). Voucher specimen was an adult male caught on fishing line.

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***CHELYDRA SERPENTINA* (Snapping Turtle)**. USA: INDIANA: Lawrence Co.: Avoca State Fish Hatchery (38.910419°N, 86.550433°W; NAD 83). 15 October 2013. Sarabeth Klueh-Mundy and Jason Mirtl. Verified by Chris Phillips. Illinois Natural History Survey (INHS 2013f photo voucher). New county record for Indiana (Minton 2001. Amphibians and Reptiles of Indiana. 2nd ed., revised. Indiana Academy of Science, Indianapolis. vii + 404 pp.). Found in a fish-rearing pond.

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***CHRYSEMYS PICTA* (Painted Turtle)**. USA: Alabama: Bibb Co.: Found crossing U.S. 82 in Eoline (32.994498°N, 87.230959°W; WGS84). 10 May 2009. Peter V. Lindeman. Verified by James C. Godwin. Florida Museum of Natural History Herpetology Dept. photographic archive (UF 172128, two photos). New county

record (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn Univ. Agric. Exp. Sta., Auburn, Alabama. 347 pp.). Animal was oriented eastward toward a small pond.

Mount (*op. cit.*) mapped numerous records for the species in Alabama, but none for an 18-county area in the central part of the state, including all six counties contiguous with Bibb Co., hence the new record occurs in the center of the large area of the range he depicted as unoccupied in his range map for the species. The new record calls into question the large range gap shown for the species in central Alabama by Mount and subsequent sources (e.g., Conant and Collins 1991. A Field Guide to Reptile & Amphibians: Eastern and Central North America, 3rd ed. Houghton Mifflin Co., Boston, Massacusetts. 616 pp.; Ernst and Lovich 2009. Turtles of the United States and Canada, 2nd ed. Johns Hopkins Univ. Press, Baltimore, Maryland. 827 pp.).

The new locality and others that may yet be discovered in the central region of Alabama may be vitally important for resolving the question of whether or not the taxon *dorsalis* should be regarded as a separate species or a subspecies of *C. picta*. Ernst (1967. Copeia 1967:131–136) analyzed morphological variation from Arkansas and Louisiana to Georgia and concluded that nearly half of the Alabama specimens he examined were intergrades of two subspecies, *C. p. picta* from the east and *C. p. dorsalis* from the west. Mount considered the region of Alabama east of the Coosa River, beginning ca. 67 km E of the new Bibb Co. record, to be an area of intergradation of the subspecies *C. p. picta* from the east, *C. p. marginata* from the north, and *C. p. dorsalis* from the west (see also Conant and Collins, *op. cit.*). On the basis of mtDNA sequences, Starkey et al. (2003. Evolution 57:119–128.) concluded that *dorsalis* warranted separate species status; two specimens from one site in northern Alabama were sampled and were grouped in a *dorsalis* clade that was strongly supported as sister to a clade of all other *C. picta*. Their conclusion has not been universally accepted (e.g., Ernst and Lovich, *op. cit.*; Fritz and Havaš 2007. Vert. Zool. 57:149–368; Rhodin et al. 2010. Chelon. Res. Monogr. 5:000.85–000.164). The two photos of the Bibb Co. specimen show characters consistent with *C. p. dorsalis*: lack of a dark plastral pattern, a wide reddish-orange dorsal stripe, and relatively strong misalignment of the costal and vertebral scute margins (Ultsch et al. 2001. Can. J. Zool. 79:485–498). Genetic sampling and morphological analysis of painted turtles from central Alabama would be of strong interest in resolving the taxonomic status of painted turtles in the southern United States.

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***GRAPTEMYS OCULIFERA* (Ringed Map Turtle)**. USA: MISSISSIPPI: Pike Co.: Bogue Chitto River, Hwy. 44 bridge east of McComb (31.269688°N, 90.361556°W; WGS84). 27 May 2013. Peter V. Lindeman. Verified by Will Selman. Florida Museum of Natural History (UF 172126 photographic voucher). New county record (Lindeman 2013. The Map Turtle and Sawback Atlas: Ecology, Evolution, Distribution, and Conservation. Univ. Oklahoma Press, Norman. 460 pp.). Extends the range of the species in the Bogue Chitto River 19.9 km NW and ca. 30 river km above the previous most upstream vouchered record, in Walthall Co.

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***GRAPTEMYS OUACHITENSIS* (Southern Map Turtle)**. USA: ARKANSAS: Baxter Co.: Lakeview Boat Dock (36.370576°N, 92.554544°W; WGS 84). 25 May 2013. M. B. Connior. Verified by S. E. Trauth. Arkansas State University Museum of Zoology Herpetology Collection (ASUMZ 33041). New county record (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville. 421 pp.). This juvenile (carapace length [cl] = 57 mm) is a new county record; yet, this species has been captured in the same body of water (Bull Shoals Lake) in adjacent Marion Co.

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***GRAPTEMYS PEARLENSIS* (Pearl River Map Turtle)**. USA: MISSISSIPPI: Lincoln Co.: Bogue Chitto River, Bogue Chitto Rd. SE east of Bogue Chitto (31.438606°N, 90.446853°W; WGS84). 27 May 2013. Peter V. Lindeman. Basking hatchling. Florida Museum of Natural History (UF 172124 photographic voucher). Verified by Will Selman. New county record (Lindeman 2010. Herpetol. Rev. 41:105; Lindeman 2013. The Map Turtle and Sawback Atlas: Ecology, Evolution, Distribution, and Conservation. Univ. Oklahoma Press, Norman. 460 pp.). Extends the range of the species in the Bogue Chitto River 33.5 km NW and 58 river km above the previous most upstream vouchered record in Pike Co. A second specimen (UF 172125 photo voucher) was also found.

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***GRAPTEMYS PSEUDOGEOGRAPHICA KOHNII* (Mississippi Map Turtle)**. USA: ARKANSAS: Poinsett Co.: Bearitage Farms, 4.25 km S. of State Hwy 214 (35.446727°N, 90.797688°W; NAD 83). 20 Sept 2010. P. Jordan, J. Czerwonky, P. Dill, and J. Myer. Verified by S. E. Trauth. Arkansas State University Museum of Zoology (ASUMZ 31563). New county record (Trauth et al. 2004. Amphibians and Reptiles of Arkansas. Univ. of Arkansas Press, Fayetteville. 421 pp.); known from many other counties throughout Arkansas.

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***KINOSTERNON SUBRUBRUM* (Eastern Mud Turtle)**. USA: ALABAMA: Dallas Co.: Hwy 14, 6.3 km E of Selma and 550 m E of Indian Way intersection (32.4319166°N, 86.9579444°W; WGS84). 22 August 2009. Peter V. Lindeman. Verified by James C. Godwin. Florida Museum of Natural History (UF 172294 photographic voucher). New county record (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn Univ. Agric. Exp. Sta., Auburn, Alabama. 347 pp.). Specimen found crossing road.

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***PELODISCUS SINENSIS* (Chinese Softshell Turtle)**. PHILIPPINES: MINDANAO ISLAND: South Cotabato Province: Koronadal City, Barangay Zone 3 (6.492400°N, 124.841683°E; WGS 84). 17 July 2012. Emerson Y. Sy. Photographic voucher, Raffles Museum of Biodiversity Research, National University of Singapore (ZRC [IMG] 2.218a–c). Verified by Indraneil Das. Observed in Bulok

Creek. SCL 28 mm. First provincial record. An introduced species in the Philippines, previously recorded on Luzon, Mindoro, Panay, Cebu, Bohol, Leyte, and Mindanao (Diesmos et al. 2008. Chelon. Conserv. Biol. 7:157–177; Sy et al. 2004. Turtle & Tortoise Newsl. 7:17–18). Record extends distribution by ca. 309 km from Zamboanga City, the first record on Mindanao.

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***PSEUDEMYS CONCINNA* (River Cooter)**. USA: ALABAMA: Choctaw Co.: Two-track dirt road next to Okatuppa Creek (31.8306833°N, 88.2291138°W; WGS 84). 27 May 2008. Peter V. Lindeman. Verified by James C. Godwin. Florida Museum of Natural History (UF 153480 photographic voucher). New county record (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn Univ. Agric. Exp. Sta., Auburn, Alabama. 347 pp.). Nesting adult female.

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***PSEUDEMYS NELSONI* (Florida Red-bellied Cooter)**. USA: FLORIDA: Suwannee Co.: Ichetucknee Springs State Park, Ichetucknee River near W bank 3 km NE of the Highway 27 bridge crossing (29.96922°N, 82.76069°W; WGS84). 22 February 2014. Jonathan D. Mays. Verified by Kenneth L. Krysko. Florida Museum of Natural History (UF 172555 photo voucher). New county record (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final report, Florida Fish and Wildlife Conservation Commission, Tallahassee. 524 pp.). I observed one basking adult while canoeing the spring run through a wide marshy area. A previous study reported *P. nelsoni* from the Ichetucknee (Chapin and Meylan 2010. Herpetol. Conserv. Biol. 6:51–60), but no museum vouchers were submitted for either Columbia or Suwannee counties, which are divided by the Ichetucknee River.

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***TRACHEMYS SCRIPTA ELEGANS* (Red-eared Slider)**. USA: INDIANA: Hamilton Co.: Conner Prairie (39.9820°N, 86.0309°W; WGS 84). 9 June 2013. Robert Brodman, Michael S. Finkler, James Horton, Megan Gramhofer, and Anastasia Marsh. Verified by Alan Resetar. Saint Joseph's College zoological collection (SJCZC R322). New county record (Minton 2001. Amphibians & Reptiles of Indiana, 2nd ed. Indiana Academy of Science, Indianapolis. 404 pp.). Extends range into a nine county gap 13 km N from nearest known locality in Marion County.

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***TRACHEMYS SCRIPTA SCRIPTA* X *ELEGANS* (Pond Slider intergrade)** USA: Pennsylvania: Berks Co.: Reading, Carsonia Park (40.337691°N, 75.872571°W; WGS84). 21 Sept 2013. Carl Maiese. Verified by Walter Meshaka. Kutztown University Museum of Zoology (KUMZ 1001). New county record (Hulse et al. 2001. Amphibians and Reptiles of Pennsylvania. Cornell University Press, Ithaca, New York. 419 pp.). The online Pennsylvanian Amphibian and Reptile Survey (PARS, http://www.paherpatlas.org [accessed 8 Oct 2013]) noted *Trachemys scripta elegans* (online photo voucher only) and *Trachemys scripta* (no subspecific designation) observations, but *T. scripta scripta* and T. *scripta scripta* × *elegans* have not been confirmed from Berks Co. One *T. scripta* photographic entry from PARS suggested a possible *T. s. elegans* × *T. scripta* observation; however, our specimen is the first verified *T. s. scripta* × *T. s. elegans* intergrade documented in this county for which there is a preserved voucher. The male turtle was found in a pond in Carsonia Park; subsequent surveys uncovered an additional specimen and suggests that a breeding population of this introduced species has been established at this site.

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***TRACHEMYS SCRIPTA SCRIPTA* (Yellow-bellied Slider)**. USA: ALABAMA: Bullock Co.: basking in pond on the Wehle Tract, 8.4 km W of Comer, Alabama (32.03081°N 85.47115°W; WGS 84). 11 March 2014. C. Thawley and F. Graves. Verified by David Laurencio. AUM AHAP-D 785–786 (digital photograph files). New county record (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn Printing Co., Auburn, Alabama. 347 pp.). This record fills a distributional gap between the nearest vouchered localities approximately 10 km E in Barbour Co. and 29 km N in Macon Co.

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SQUAMATA — LIZARDS

***AMPHISBAENA FULIGINOSA* (Speckled Worm Lizard)**. BRAZIL: AMAPÁ: Municipality of Laranjal do Jari: Água Branca do Cajari (0.578314°S, 52.326769°W, 136 m elev.; datum WGS84) 10 July 2013. C. E. Costa-Campos, D. W. Silva-Silva, and K. J. Gaya Corrêa. Verified by A. P. Lima. Collection of Laboratório de Zoologia of the Universidade Federal do Amapá, Macapá, Amapá, Brazil (CDLABZOO 28, photo voucher). Amphisbaena fuliginosa was known previously from Panama, Peru, Ecuador, Colombia, Bolivia, Guyana, Suriname, Trinidad, and Brazil (Vanzolini 2002. An. Acad. Bras. Ciênc. 74[4]:609–648). In Brazil, the species was reported in the states of Pará (Ávila-Pires et al. 2010. Bol. Mus. Para. Emílio Goeldi 5[1]:13–112), Goiás (Colli et al. 2002. In Oliveira and Marquis [eds.], The Cerrado of Brazil: Ecology and Natural History of a Neotropical Savanna, pp. 223–241. Columbia University Press, New York), Minas Gerais (Silveira 2007. Herpetol. Rev. 38[4]:481; Nogueira-Costa et al. 2013. Check List 9[1]:167–168), Maranhão, Mato Grosso, Rondônia, Roraima, and Manaus (Vanzolini, *op. cit.*). First state record, extending the range 325 km NW from the municipality of Alenquer, Para state.

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AMPHISBAENA IGNATIANA. BRAZIL: PARAÍBA: Municipality of João Pessoa: 7.1653°S, 34.8694°W. May 1984. Verified by S. da Silva.

Departamento de Sistemática e Ecologia da Universidade Federal da Paraíba, João Pessoa, Brazil (CHUFPB 5454). Previously known only from the type locality Santo Inácio municipality (11.1000°S, 42.7333°W), state of Bahia (Vanzolini 1991. Pap. Avul. Zool. 37[17]:259–276), in the east side of the São Francisco River. First state record, extends the known distribution of the species ca. 970 km NE from type locality. Furthermore, João Pessoa is situated in the west side of the São Francisco River, which suggests that the river is not a barrier for this species.

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***ANOLIS CAROLINENSIS* (Green Anole)**. USA: ALABAMA: Bullock Co.: The Wehle Tract, 7.9 km W of Comer (32.02959°N 85.46646°W; WGS 84). 11 March 2014. C. Thawley and F. Graves. Verified by David Laurencio. AUM AHAP-D 783 (digital photograph file). New county record (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn Printing Co., Auburn, Alabama. 347 pp.). This record fills a distributional gap among the nearest vouchered localities approximately 46 km WSW in Pike Co., 33 km E in Barbour Co., and 35 km NE in Russell Co.

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***ANOLIS SAGREI* (Brown Anole)**. USA: TEXAS: Angelina Co.: Lufkin, 4211 S Medford Drive (31.3103°N, 94.7202°W; WGS 84). 15 October 2012. Cory Adams. Verified by Toby J. Hibbitts. Biodiversity Research and Teaching Collection, Texas A&M University (TCWC 96833). New county record (Dixon 2013. Amphibians and Reptiles of Texas. 3rd ed., Texas A&M Univ. Press, College Station. 447 pp.). The adult male specimen was collected on a metal plant display in the garden center at The Home Depot in Lufkin, Texas. This was the only individual we observed. The nearest documented record for *A. sagrei* is from Nacogdoches Co. (Saenz et al. 2013. Herpetol. Rev. 44:474), which was collected in the garden center of Lowes in Nacogdoches, Texas. This species has been introduced through the interstate plant trade; however, no individuals have been found outside the initial introduction areas in Texas (Dixon 2013, *op. cit.*). As a result, we agree with Saenz et al. (2013, *op. cit.*) who suggested that the Brown Anoles observed in eastern Texas likely represent new introductions rather than a range expansion of established populations in Texas.

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***BACHIA GUIANENSIS* (Guyana Bachia)**. COLOMBIA: META: Vista Hermosa, Vereda Madroño, Finca Paimore (2.968804°N, 73.616181°W; datum Bogotá WGS 84). 11 December 2013. Y. R. López Perilla. Colección de Reptiles, Instituto de Ciencias Naturales, Universidad Nacional de Colombia (ICN 12430). Verified by J. E. Carvajal-Cogollo. This lizard was only known from Colombia in the department of Vichada, Corregimiento de Santa Rosa in the Natural National Park El Tuparro (locality Centro Alto Tuparro), department of Guainía in municipality of Inírida and department of Guaviare in the surroundings of San José del Guaviare (Medina-Rangel and Calderon 2013. Herpetol. Rev. 44[3]:474), and Venezuela in the Territorio Federal of the Amazonas state in Río Guapuchi, tributary of Río Ventuari (Hoogmoed and Dixon 1977. Zool. Med. 51:25–31; Gorzula and Señaris 1999. Contribution to the Herpetofauna of the Venezuelan Guayana I: a Data Base. Scientia Guaianae, Caracas, No. 8, 269 pp.; Ávila-Pires 2005. *In* Hollowell and Reynolds [eds.], Checklist of the Terrestrial Vertebrates of the Guiana Shield. Bull. Biol. Soc. Washington 13:25–42; Uetz 2012. TIGR Reptile Database [version Oct 2007]. *In* Bisby et al. [eds.]. Species 2000 and ITIS Catalogue of Life, version 2012. <www.catalogueoflife.org/col/>; Rivas et al. 2012. Zootaxa 3211:1–64). This record extends the range ca. 120 km NW from the nearest known population (San José del Guaviare, Guaviare department, Colombia) (Medina-Rangel and Calderon, *op. cit.*). The extent of distribution to the west near the foothills of the Serranía de la Macarena (ca. 25 km to the foothills of this mountain range) may indicate that this species has a more extensive range than present records suggest, and that it likely occurs throughout the Colombian Guyana shield up to the transition zone of the Amazonian and Andes foothills.

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***DAREVSKIA PONTICA* (Pontic Lizard)**. RUSSIA: KRASNODAR KRAI: Korenovsky District: vicinity of Komsomolsky (45.61644°N, 39.46769°E), 40 m elev. 22 Marh 2014. Slavyansky District: Slavyansk-na-Kubani (45.2646781°N, 38.10118682°E), 5 m elev. 20 April 2014. I. V. Doronin. Verified by N. Ananjeva. These new localities are new extreme northern records for this species (Stugren 1984. *In* W. Böhme [ed.], Handbuch der Reptilien und Amphibien Europas. Band 2/I, Echsen II (Lacerta), pp. 318–331. Aula Verlag, Wiesbaden) that extends the range of this species (sometimes considered a subspecies of *D. praticola*) by 70 km to the north. This record of *D. pontica* comes from Kuban-Azov lowland, where people have destroyed forests in historical times. These populations are synanthropic being found in gardens, orchards, and cemeteries, and often are associated with piles of wood and twigs, similar to their natural habitat (forest litter, fallen trees in the forest). In these habitats, *D. pontica* occurs with *Lacerta agilis*.

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***HOLCOSUS LEPTOPHRYS* (Delicate Ameiva)**. REPUBLIC OF PANAMA: VERAGUAS: Cañazas District: San Pablo River (8.29497°N, 81.26454°W; WGS84), 96 m elev. 17 March 2013. V. Bravo and E. E. Flores. Verified by Andreas Hertz. MVUP 2115. This locality helps fill in the distributional gap between populations occurring in extreme southwestern Chiriqui Province, and

those ca. 55 km SE in extreme eastern Veraguas Province (Köhler 2008. Reptiles of Central America, 2nd ed. Herpeton, Verlag Elke Köhler, Offenbach, Germany. 400 pp.). The juvenile lizard was found at night on a sandy riverbank under leaf litter; the presence of adult specimens was confirmed by visual observations along the San Pablo River. This project was conducted under a scientific permit (SE/A-26-13) provided by the Panamanian National Authority for the Environment (ANAM).

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***OPHISAURUS ATTENUATUS* (Slender Glass Lizard)**. USA: FLORIDA: Clay Co.: Middleburg, at Jennings State Forest Headquarters, near the end of Long Horn Road (30.128692°N, 81.964958°W; WGS84; elev. 35 m). 19 November 2013. Elizabeth A. Smith. Verified by Kevin M. Enge. Florida Museum of Natural History (photographic voucher UF-Herpetology 172086). New county record (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final report, Project Agreement 08013, Florida Fish and Wildlife Conservation Commission, Tallahassee. 524 pp.). The lizard was found in sandhill habitat. It was first seen on a sidewalk between the two buildings. It then crawled into mulched vegetation and disappeared underground.

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***PHRYNOSOMA BRACONNIERI* (Short-tailed Horned Lizard)**. MÉXICO: GUERRERO: Municipality of Olinala: Xixila (17.993334°N, 98.850278°W; WGS84), 1535 m elev. 15 October 2011. Víctor Hugo Jiménez Arcos, Salomón Sanabria Urban, and Eric Centenero Alcalá. Verified by Luis Canseco Márquez. IBH-RF 53. First record for Guerrero, extending the known range of the species ca.70 km SW from Tehuitzingo, Puebla (Garcia-Vazquez et al. 2005. Publ. Soc. Herpetol. Mex. 1:152–169). The lizard was found active on the ground in oak forest.

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***PHYLLODACTYLUS DAVISI* (Davis's Leaf-toed Gecko)**. MÉXICO: COLIMA: Municipality of Manzanillo: Hwy 200 from Manzanillo to Cihuatlán (19.1366°N, 104.3382°W; WGS84), 41 m elev. 20 September 2006. F. R. Méndez-de la Cruz, A. H. Díaz de la Vega-Pérez, and R. A. Lara-Resendiz. Verified by Christopher Blair. ROM 46394–46396. First report of this species since it was described by Dixon (1964. New Mexico State Univ. Res. Cent. Sci. Bull. 61-1: i–iv, 1–139), who considered the species as occurring in coastal lowlands of Colima and Michoacán, and removed it from *P. lanei* as treated in part by Duellman (1958. Occ. Pap. Mus. Zool. Univ. Michigan [589]:1–22). Murphy et al. (2009. S. Am. J. Herpetol. 4:17–24) recognized *P. davisi*, but added no new information on its distribution. The new record reported herein indicates that more searches for this species are needed from within its purported range (Dixon 1964, *op. cit.*) to assess its present distribution. Collections were made under a permit issued by SEMARNAT (# 03489/07).

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***PLESTIODON FASCIATUS* (Common Five-lined Skink)**. USA: INDIANA: Hamilton Co.: Delaware Township, Conner Prairie Interactive History Park (39.989073°N, 86.033413°W; WGS 84). 8 June 2013. Robert Brodman, Michael S. Finkler, James Horton, Megan Gramhofer, and Anastasia Marsh. Verified by Alan Resetar. Indiana State Museum (INSM 71.2013.129). New county record (Minton 2001. Amphibians & Reptiles of Indiana, 2nd ed. Indiana Academy of Science, Indianapolis. 404 pp.). Extends range 13 km N from Marion Co. and fills gap in distribution in north-central Indiana. Known from two of six adjacent counties.

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***SCELOPORUS UNDULATUS* (Eastern Fence Lizard)**. USA: ALABAMA: Bullock Co.: The Wehle Tract, 7 km W of Comer (32.02932°N 85.45753°W; WGS 84). 11 March 2014. C. Thawley and F. Graves. Verified by David Laurencio, AUM AHAP-D 784 (digital photograph file). New county record (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn Printing Co., Auburn, Alabama. 347 pp.). This record fills a distributional gap between the nearest vouchered localities approximately 7 km SSE in Barbour Co. and 32 km NNW in Macon Co.

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***SCELOPORUS UNDULATUS* (Eastern Fence Lizard)**. USA: GEORGIA: Lamar Co.: 432 Bush Road in Barnesville (33.033012°N, 84.089471°W; WGS 84). 13 April 2013. Laura A. West. Verified by Michael J. Bender. Gordon State College Collection of Vertebrates (GSC 049). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens, Georgia. 575 pp.). This species has been documented in three (Upson, Monroe, and Butts) of the five adjoining counties (Jensen et al. 2008, *op. cit.*). Lizard was killed and abandoned by a domestic cat and found in late afternoon with little external trauma other than a single puncture wound.

Specimen collected under Georgia Department of Natural Resources Scientific Collecting Permit (29-WJH-13-126, CN 25018).

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***SCINCELLA LATERALIS* (Little Brown Skink)**. USA: TENNESSEE: Carroll Co.: Natchez Trace Wildlife Management Area (35.87588°N, 88.26580°W; NAD 83). 4 April 2013. Jeremy Dennison. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19456). New county record (Scott and Redmond 2008. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://www.apsu.edu/reptatlas [updated 15 February 2013; accessed 3 January 2014]).

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***THECADACTYLUS RAPICAUDA* (Turniptail Gecko)**. MÉXICO: QUINTANA ROO: Municipality of Bacalar: Instituto Nacional de Investigaciones Forestales Agrícolas y Pecuarias, Sitio Experimental San Felipe Bacalar (SESFB), Zona 1 (18.747589°N, 88.324531°W; WGS84), 11 m elev. 12 March 1991. Juan Nava-Solorio. Verified by J. Rogelio Cedeño-Vázquez. Colección Herpetológica del Museo de Vida Silvestre "Juan Nava Solorio," SESFB, Quintana Roo (SESFB-H-102). New municipality record that bridges a 209-km distributional gap on the eastern Yucatán Peninsula between Sian Ka'an Biosphere Reserve (48 km N of Felipe Carrillo Puerto) to the north (Calderón-Mandujano and Mora-Tembre 2004. Herpetol. Rev. 35:295–296) and Nueva España Lagoon (23 km S Ejido Caobas) to the southwest (Luja and Calderón-Mandujano 2005. Herpetol. Rev. 36:80). The specimen is an adult male, found in tropical deciduous forest. On 25 December 2010, one of the authors (SATJ) photographed an adult specimen in the same area, living in an abandoned construction site.

We thank J. Rogelio Cedeño-Vázquez and Jorge Ramírez-Silva for assistance and staff of Sitio Experimental San Felipe Bacalar for logistics support. Funding came from Project Mantenimiento de la Infraestructura de Investigación en la Colección de Fauna Silvestre de San Felipe Bacalar (652154A-SINCOPT).

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***VARANUS FLAVESCENS* (Yellow Monitor)**. BANGLADESH: RANGPUR DISTRICT: Khoragachh village, Mithapukur Upazila, Rangpur (25.650188°N, 89.174946°E; 35 m elev.; WGS 84), 4 July 2012. Hassan-Al-Razi. Adult at 1730 h in paddy field, beside large water body. Photographic voucher, Raffles Museum of Biodiversity Research, National University of Singapore (ZRC[IMG] 2.217). Verified by I. Das. First record for Rangpur District, Bangladesh; previously recorded from hill forests of Sylhet and Chittagong Divisions (Islam 2009. Kabir et al. [eds.]) and Netrokona District (Reza et al. 2010. Herpetol. Bull. 112:38–39). Current population in agricultural land, 14 km N of Rangpur and > 440 km NW of Chittagong, < 284 km W of Sylhet, and < 178 km W of Netrokona; surroundings included *Cynodon dactylon* plantations.

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SQUAMATA — SNAKES

***AGKISTRODON TAYLORI* (Taylor's Cantil)**. MEXICO: TAMAULIPAS: Municipality of Victoria: Cañón de la Peregrina (23.778560°N, 99.215161°W; WGS 84), 393 m elev. 14 September 2004. Sergio A. Terán-Juárez. Verified by William L. Farr. UTADC 8110. Municipality of Gómez Farías: Ejido El Nacimiento (23.092778°N, 99.136944°W; WGS 84), 123 m elev. 28 September 2008. Felipe Villegas-Ruiz. Verified by William L. Farr. UTADC 8111. First published records for both municipalities, although the Victoria report confirms another for the species (voucher specimen presumably lost) from that municipality (Farr et al. 2013. Herpetol. Rev. 44:631–645). These records help verify that *Agkistrodon taylori* in Tamaulipas occurs throughout most of the lower eastern slopes of the Sierra Madre Oriental and Gulf lowlands (Martin 1958. Misc. Publ. Mus. Zool. Univ. Michigan 101:1–102; Burchfield 1982. J. Herpetol. 16:376–382; Farr et al. 2013, *op. cit.*). UTADC 8110 was a juvenile found in riparian habitat and UTADC 8111 was discovered DOR in tropical deciduous forest.

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***CONIOPHANES LATERITIUS* (Stripeless Snake)**. MÉXICO: MICHOACÁN: Municipality of Coahuayana: on road to Coahuayana-Palos Marías (18.781169°N, 103.6062°W; WGS84), 126 m elev. 21 July 2011. José Gil Paz Gutiérrez. Verified by Javier Alvarado Díaz. Colección de Herpetología del Instituto de Investigaciones sobre los Recursos Naturales, Universidad Michoacana de San Nicolás de Hidalgo (INIRENA 1069). First record from Michoacán, extending its known range 189 km SE of Tenochtitlán, Jalisco (near Ameca) (Ponce-Campos and Smith 2001. Bull. Maryland Herpetol. Soc. 37:10–17). The snake was found AOR at 0200 h in tropical deciduous forest.

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***CHRYSOPELEA ORNATA* (Golden Tree Snake)**. THAILAND: KHON KAEN PROVINCE: Muaeng District: Khon Kaen University. Khon Kaen University Vertebrate Collection (KKUC 00623–624): KKUC 00623 (16. 476737°N, 102.826676°E; WGS 84; ca. 200 m elev.). Adult male, SVL 995 mm, dead on road in front of Faculty of Humanities and Social Sciences. August 2012. Pongsathorn Thongpun; KKUC 00624 (16.476907°N, 102.825681°E; WGS 84; ca. 200 m elev.). Adult male, SVL 1176 mm, dead on road in front of Department of Biology, Faculty of Science. 5 July 2013. Pechrkawin Nurngsomsri. Verified by Sunchai Makchai. First provincial record for Khon Kaen Province. Previously known Northeast (Chaiyaphum, Nakhon Ratchasima Loei and Ubon Ratchathani), Central (Lop Buri, Nakhon Nayok, Saraburi and Uthai Thani), East (Chachoengsao, Chanthaburi, Rayong, Sa Kaew and Tard), West

(Kanchanaburi), and South (Pattani, Phangnga Prachuap, Krabi, Khiri Khan, Narathiwat, Songkhla, and Trang) Thailand (Chuaynkern and Chuaynkern 2012. J. Wildl. Thailand 119:75–162).

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***CROTALUS HORRIDUS* (Timber Rattlesnake)**. USA: TENNESSEE: Tipton Co.: Naifen Road 1.09 km E of intersection with Hatchie River Road (35.53691°N, 89.47222°W; NAD 83). 15 June 2013. Patricia Lane 0.3 km E of Milton Road (35.415226°N, 89.92224°W; NAD 83). 30 August 2013. Jake Yoes. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19458, 19459 photo vouchers). First county records (Scott and Redmond 2008. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://www.apsu.edu/reptatlas [updated 11 November 2013; accessed 30 December 2013]).

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***ENULIUS OLIGOSTICHUS* (Mexican Long-tailed Snake)**. MÉXICO: JALISCO: Municipality of La Huerta: Estación de Biología Chamela (19.499694°N, 105.04675°W; WGS84), 81 m elev. 3 October 2012. Víctor Hugo Reynoso. Verified by Carlos Balderas Valdivia. CNAR-IBH 26163. First municipality record as well as for both the well-studied Chamela-Cuixmala Biosphere Reserve and Jalisco Pacific Coastal Plain, extending its known range 243 km SW from San Blas, Nayarit (McDiarmid and Bezy 1971. Copeia 1971:350–351) and 234 km SW of Guadalajara, Jalisco (Ponce-Campos 2003. Herpetol. Rev. 34:169). The snake was found under a fallen 10 cm-wide tree trunk lying in loose grass surrounded by tropical deciduous forest.

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***GEOPHIS PETERSII* (Peters' Earth Snake)**. MÉXICO: GUERRERO: Municipality of Tuxpan: Las Antenas (18.386361°N, 99.473806°W; WGS 84), 1705 m elev. 24 October 2010. Fahd Henrry Carmona Torres and Ricardo Bolaños Martínez. Verified by Luis Canseco Márquez. CNAR IBH 24550. First record from Guerrero, extending the range 256 km SE from closest record at Pátzcuaro, Michoacán (Downs 1967. Misc. Publ. Mus. Zool. Univ. Michigan [131]:i–iv, 1–193). The snake was found on a little-used rocky trail in oak forest.

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***INDOTYPHLOPS BRAMINUS* (Brahminy Blindsnake; Culebra Ciega)**. HONDURAS: CORTÉS: Residencial Campisa, San Pedro Sula (15.53567°N, 87.98900°W; WGS84), 65 m elev. 28 October 2012. Pablo R. Bedrossian. Verified by Addison Wynn. USNM 580698. First record of this introduced species from Cortés, with the nearest known Honduras locality located ca. 55 km SW near San José de Colinas, Santa Bárbara (McCranie et al. 2010. Herpetol. Rev. 41:518). The snake was found DOR in a residential area.

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***LYCODON SUBCINCTUS* (Banded Wolf Snake)**. INDONESIA: EAST NUSA TENGGARA: FLORES: West Manggarai Regency (08.51856°S, 119.95436°E; WGS84). 18 April 2013. Photographic vouchers, National Museum of Natural History, Smithsonian Institution, USNM 2814–2815. N. Baker. Verified by Hinrich Kaiser. Found at night, on bank of rocky stream passing through mixed hill forest and agricultural area. First record for Flores Island. Known distribution includes Thailand, Cambodia, Laos, Vietnam, China (including Hainan and Hongkong), Peninsular Malaysia, Borneo, Sumatra (including Nias, Siberut, and Simeulue), Java, Lombok, Sumbawa, the Philippines (Manthey and Grossmann 1997. Amphibien und Reptilien Südostasiens. Natur und Tier Verlag, Münster. 512 pp.), and Timor-Leste (Kaiser et al. 2011. Zookeys [109]:19–86).

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***LAMPROPELTIS NIGRA* (Eastern Black Kingsnake)**. USA: TENNESSEE: Dyer Co.: 0.8 km N of 412 and 104 intersection (36.03242°N, 89.34085°W; NAD 83). 16 April 2013. Jeremy Dennison. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19455). First county record (Scott and Redmond 2008. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://www.apsu.edu/reptatlas [updated 12 November 2013; accessed 30 December 2013]).

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***LAMPROPELTIS TRIANGULUM GENTILIS* (Central Plains Milksnake)**. USA: COLORADO: Sedgwick Co.: 40.905285°N, 102.517941°W (WGS84). 8 June 2013. Brian Hubbs. Verified by Neftali Camacho. Los Angeles County Museum LACM PC 1665 (photo voucher). New county record (Hammerson 1999. The Amphibians and Reptiles in Colorado. University Press of Colorado. Niwot, Colorado. 484 pp.; Colorado Herpetofaunal Atlas <http://ndis.nrel.colostate.edu/herpatlas/coherpatlas/>; accessed 01 April 2014).

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MICRURUS CAMILAE. COLOMBIA: DEPARTAMENTO DE ANTIOQUIA: Municipio de Tarazá: Vereda El Rayo (7.495638°N, 75.372868°W; WGS84), 160 m elev. 22 April 2012. E. Alzate. Museo Herpetológico Universidad de Antioquia, Medellín, Colombia (MHUA-R 14894; collected on the edge of a stream, 50 m from

the edge of premontane forest). Verified by J. Daza. Species previously known only from type locality (hydroelectric power plant Urrá I, Municipio de Tierra Alta, Departamento de Córdoba, Colombia; Renjifo and Lundberg 2003. Rev. Acad. Colombiana Ciencias Exactas Fisicas Nat. 27[102]:141–144). Second record of the species and first Department record, extends range 106 km SE of the type locality (Renjifo and Lundberg, *op. cit.*).

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***MICRURUS FULVIUS* (Harlequin Coralsnake)**. USA: FLORIDA: Hamilton Co.: Twin Rivers State Forest, Blue Spring Longleaf tract, ~2.07 km NE of jct of CR-6 and CR-143 (30.5013°N, 83.2067°W; WGS 84). 9 March 1994. Dale R. Jackson and Cathleen NeSmith. Verified by Kenneth L. Krysko. UF 172491 (2 digital photographic vouchers). New county record (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Florida Fish and Wildlife Conservation Commission, Tallahassee. 524 pp.).

A juvenile coral snake ~24 cm SVL was captured beneath a log in a high quality upland pine forest that is regularly managed with prescribed fire to limit hardwood encroachment. Although the species occurs statewide, this is one of five counties for which no previous record exists although specimens are known from adjacent counties just across the Suwannee (UF 120515, 12.2 km SSE, Suwannee Co.) and Withlacoochee (LSUMZ 82096, 11.7 km NNW, Madison Co.) rivers.

The 799-ha Blue Spring Longleaf tract was acquired by the state of Florida in 1993 and added to Twin Rivers State Forest to protect one of the premier examples of upland pine forest in the state.

We thank Kenneth Krysko for providing distance estimates of nearest known specimens taken from Krysko et al. (2011, *op. cit.*).

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***NERODIA SIPEDON* (Common Watersnake)**. USA: ILLINOIS: Lee Co.: Nachusa Grasslands, 5.9 km NW Franklin Grove (41.891657°N, 89.379020°W; WGS 84). 13 September 2010. T. G. Anton and P. W. Willink. Verified by Chris Phillips. Illinois Natural History Survey (INHS 23596; shed skin fragments). New county record (Phillips et al. 1999. Field Guide to Amphibians and Reptiles of Illinois. Illinois Natural History Survey, Urbana, Illinois. 282 pp.). Shed skin found in Franklin Creek in Tellabs Savanna Unit during fish survey. The species is documented from adjacent Ogle Co., where an individual was observed at the Flagg Rd. bridge crossing Clear Creek in Ogle County on 21 June.

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***SISTRURUS MILIARIUS STRECKERI* (Western Pygmy Rattlesnake)**. USA: TENNESSEE: Decatur Co.: Hwy 412 approximately 3.2 km E of Parsons (35.6445°N, 88.0998°W; NAD 83). 17 October 2013. Keith Byrd. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19462 photo voucher). First verified county record (Scott and Redmond 2008. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://www.apsu.edu/reptatlas [updated 1 May 2008; accessed 3 January 2014]). The snake was found basking on the side of the road. Jacob (1981. Unpubl. report to Tennessee Wildlife Resources Agency. Memphis State University, Memphis, Tennessee. PCAN 0064/60. 45 pp.) reported a sighting for Decatur Co., but it was unverified and therefore not listed in the Atlas of Reptiles in Tennessee.

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***STORERIA OCCIPITOMACULATA* (Red-bellied Snake)**. USA: GEORGIA: Laurens Co.: juvenile found in leaf litter along the floodplain of Indian Branch at U.S. Hwy 80 (32.87984°N, 82.50334°W; WGS 84). 07 March 2014. Crystal Kelehear and Sean Graham. Verified by David Laurencio. AUM AHAP-D 781 (digital photo voucher). New county record (Jensen et al. 2008. The Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.).

Funding for this collection trip was provided by a grant from the Georgia Department of Natural Resources.

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***THAMNOPHIS SAURITUS* (Eastern Ribbonsnake)**. USA: TENNESSEE: Crockett Co. Horns Bluff Refuge (35.85209°N, 89.09635°W; NAD 83). 12 March 2013. Jeremy Dennison. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19454). First county record (Scott and Redmond 2008. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://www.apsu.edu/reptatlas [updated 22 October 2009; accessed 3 January 2014]).

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***TRIMORPHODON QUADRUPLEX* (Central American Lyresnake; Colcuate)**. HONDURAS: GRACIAS A DIOS: Mavita (14.75°N, 84.45°W; WGS84), 60 m elev. 24 December 2012. James R. McCranie. Verified by Steve W. Gotte. USNM 580692. First record for Gracias a Dios and from the Mosquitia of northeastern Honduras, and about an 80 km range extension from the closest locality in the Mosquitia of northeastern Nicaragua (McCranie et al. 2006. The Amphibians and Reptiles of the Honduran Mosquitia. Krieger Publ. Co., Malabar, Florida. x + 291 pp.). The nearest Honduran locality for this species is ca. 250 km to the NW near Coyoles, Yoro (McCranie 2011. The Snakes of Honduras. SSAR Contrib. Herpetol. 26, Ithaca, New York. x + 714 pp.). The snake was crawling on the ground shortly after nightfall in denuded pine savannah.

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Notable Records of Amphibians and Reptiles from Colima, Nayarit, Jalisco, and Zacatecas, México

We conducted herpetofaunal field surveys in the western Mexican states of Colima, Jalisco, Nayarit, and Zacatecas from 21 June 2008 through 7 October 2012. Our efforts were focused on areas where little or no previous sampling had been done. During that time we visited seven different areas, including lower elevations of Volcán de Colima (Colima); the Tepalcatepec Valley, Sierra del Alo, Sierra de los Huicholes, Sierra Quila and Sierra del Tigre (Jalisco); Mesa del Nayar and Sierra Pajaritos (Nayarit); and near Santa Catarina (Zacatecas). All geographic coordinates were taken with a Garmin Etrex Legend Hcx, using datum WGS84. Photographic vouchers were deposited in the digital collection of The University of Texas at Arlington (UTADC). In some instances, more than one specimen was found at different localities within a municipality. Those are identified in the species accounts with UTADC numbers; full locality information for them can be acquired from records in The University of Texas at Arlington (UTA) collections database. Because some of the species are under phylogenetic review, we will mention in those accounts which geographic population variant (e.g., subspecies) our samples would have been referred to in previous literature; some of those populations will most likely be elevated to full species in the near future. All specimens were verified by Eric N. Smith and/or Luis Canseco-Marquez. Common names in English were taken from Liner and Casas-Andreu (2008).

CAUDATA — SALAMANDERS

***AMBYSTOMA ROSACEUM* (Tarahumara Salamander).** JALISCO: Municipality of Bolaños: Sierra de los Huicholes, 29 km NW of Bolaños on road to Huejuquilla (21.897844°N, 103.860368°W), 2440 m elev. 14 September 2011. I. Ahumada-Carrillo and M. A. Iñiguez. UTADC 7518, 7575. First record for Jalisco; the closest known locality for this species is ca. 60 airline km WSW in the Sierra de Alica, Nayarit (Canseco-Márquez et al. 2007). The salamander was found in a permanent stream in pine-oak forest. Shaffer et al. (2013) state that it occurs in Jalisco, but do not reference any specific locality. The geographic population variant the specimen would have been referred to in the past was *A. r. nigrum*.

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***PSEUDOEURYCEA BELLI* (Bell's False Brook Salamander).** JALISCO: Municipality of Bolaños: Sierra de los Huicholes, 29 km NW of Bolaños on road to Huejuquilla (21.897917°N, 103.860525°W), 2445 m elev. 14 September 2011. I. Ahumada-Carrillo. UTADC 7632. First municipality record and an extension of its known range ca. 75 km W from the closest known locality, 0.8 km N of Mesa de la Virgen, Sierra Morones, Zacatecas (Wilson and McCraine 1979). The salamander was found in pine-oak forest. Another sample of this species (UTADC 7503) was recorded from an additional locality within the municipality; full locality information can be assessed from the UTA collections database. The geographic population variant the specimen would have been referred to in the past was *P. b. belli*.

ANURA — FROGS

***CRAUGASTOR AUGUSTI* (Barking Frog).** JALISCO: Municipality of Mezquitic: Sierra de los Huicholes, 85.5 km NW of Bolaños on road to Huejuquilla (22.305712°N, 103.931551°W), 2150 m elev. 14 September 2011. I. Ahumada-Carrillo. UTADC 7515. First municipality record, extending the known range in Jalisco ca. 61 km NW from the closest known locality at La Laguna (= Laguna Grande) (Zweifel 1956). The frog was found under a rock in oak forest. Two additional samples were recorded from localities within the municipality (UTADC 7495, 7497); full locality information can be accessed from UTA collections database. The geographic population variant the specimen would have been referred to in the past was *C. a. cactorum*.

***ELEUTHERODACTYLUS NIVICOLIMAE* (Nevado de Colima Chirping Frog).** JALISCO: Municipality of Tecalitlán: 16 km SE of Tecalitlán on road to Jilotlán de los Dolores (19.448328°N, 103.226213°W), 1635 m elev. 25 July 2011. C. Grünwald and I. Ahumada-Carrillo. UTADC 7635. Municipality of Concepcion de Buenos Aires: 1.2 km E (by trail) of 5.5 km S (by road) of La Manzanilla de la Paz, on road to Concepcion de Buenos Aires (19.965875°N, 103.194664°W), 2115 m elev. 21 August 2010. I. Ahumada-Carrillo. UTADC 7633, 7634. Only the fourth and fifth reported records for this species, and first municipality records that extend the range in Jalisco, respectively, 33 airline km SE of El Floripondio, Nevado de Colima, Municipality of San Gabriel (Lynch 1970) and 37 airline km NW of 21 km SE of Mazamitla, Municipality of Quitupan (Reyes-Velasco et al. 2012). Both specimens were found calling on understory plants in Pine-oak forest. While a black and white photograph was given in the description of this species, the one included herein is the first published color image of this species in the literature (Fig. 1).

***INCILIUS PERPLEXUS* (Confusing Toad).** JALISCO: Municipality of Jilotlán de los Dolores: 7.7 km NW of Tepalcatepec, Michoacán

PHOTO BY IVAN TRINIDAD AHUMADA-CARRILLO



FIG. 1. *Eleutherodactylus nivicolimae* 16 km SE of Tecalitlán on road to Jilotlán de los Dolores, Jalisco, México (UTADC 7635).

PHOTO BY CHRISTOPH I. GRÜNWALD



FIG. 2. *Incilius perplexus* from 7.7 km NW of Tepalcatepec, Michoacán, México (UTADC 7509).

(19.251069°N, 102.866913°W), 498 m elev. 24 July 2011. C. Grünwald and I. Ahumada-Carrillo. UTADC 7509. First record for Jalisco, extending the known range 53 airline km W of the closest known locality at Apatzingán, Michoacán (Duellman 1961). The toad was found AOR in tropical deciduous forest. Although this species appears to be widespread in the "Tierra Caliente" region of Jalisco, Michoacán, Guerrero, Estado de México, Morelos, and Puebla, there exist no published photographs of this species, thus we include one of the voucher specimen (Fig. 2).

***LEPTODACTYLUS FRAGILIS* (Mexican White-lipped Frog).** JALISCO: MUNICIPALITY OF PIHUAMO: 1.5 km S of Puente de Fatima (19.132729°N, 103.386994°W), 430 m elev. 29 July 2012. C. Grünwald and I. Ahumada-Carrillo. UTADC 7622. First record from Jalisco, which fills a gap in the known distribution of this species between northeastern Colima and western Michoacán (Heyer et al. 2006). The frog was found calling in a flooded field surrounded by tropical deciduous forest.

***LITHOBATES NEOVOLCANICUS* (Transverse Volcanic Leopard Frog).** JALISCO: MUNICIPALITY OF BOLAÑOS: Sierra de los Huicholes, 13.5 km W of Bolaños, on road to Huejuquilla (21.87503°N, 103.81775°W), 1580 m elev. 13 May 2011. I. Ahumada-Carrillo. UTADC 7507. First record for the municipality, extending the range 41 airline km WNW from Cerrito Pelón, Atolinga, Zacatecas (Ahumada-Carrillo et al. 2011). The frog was found in an earthen cattle tank surrounded by oak forest.

***SMILISCA FODIENS* (Lowland Burrowing Treefrog).** JALISCO: MUNICIPALITY OF BOLAÑOS: Sierra de los Huicholes, 13.8 km W of Bolaños, on road to Huejuquilla (21.875403N, 103.819072°W), 1600 m elev. 20 June 2012. I. Ahumada-Carrillo. UTADC 7619. First municipality record that also fills a northern distributional gap between localities in Nayarit (Duellman 2001) and Municipality of Trinidad García de la Cadena, Zacatecas (Ahumada-Carrillo et al. 2011).

SQUAMATA — LIZARDS

***ELGARIA KINGII* (Madrean Alligator Lizard).** JALISCO: MUNICIPALITY OF MEZQUITIC: Sierra de los Huicholes, 88.9 km NW of Bolaños, on road to Huejuquilla (22.315394°N, 103.930005°W), 2075 m elev. 4 October 2011. I. Ahumada-Carrillo. UTADC 7496. First municipality record, and first for this species in the Sierra de los Huicholes, extending the known range ca. 70 km NW from Atolinga, Zacatecas (Ahumada-Carrillo 2010). The lizard was found active on leaf litter in oak forest. The geographic population variant this specimen would have been referred in the past was *E. k. ferruginea*.

***CTENOSAURA CLARKI* (Michoacán Club Tail).** JALISCO: MUNICIPALITY OF JILOTLÁN DE LOS DOLORES: Corongoros (south shore of Presa Constitución de Apatzingán), 10 km NNE of Tepalcatepec, Michoacán (19.265664°N, 102.793933°W), 420 m elev. 24 July 2011. C. Grünwald and I. Ahumada-Carrillo. UTADC 7510, 7511. First record from Jalisco; the closest known locality is 9.2 km SSW at Tepalcatepec, Michoacán (Duellman 1961). Numerous other individuals were observed within tropical deciduous forest in hollowed-out tree trunks that were being used as fence posts.

***HELODERMA HORRIDUM* (Beaded Lizard).** JALISCO: MUNICIPALITY OF BOLAÑOS: Sierra de los Huicholes, 4 km W of Bolaños, on road to Huejuquilla (21.838889°N, 103.805111°W), 1095 m elev. 19 July 2011. I. Ahumada-Carrillo. UTADC 7494, 7523, 7524. First municipality record, extending the known range ca. 95 airline km SW from the closest known locality, a dirt road between San Juan Capistrano, Zacatecas, and San Rafael de las Tablas, Durango (Avila-Villegas 2007). The lizard was found DOR in tropical deciduous forest. Reiserer et al. (2013) elevated all subspecies of *H. horridum* to full species, and discussed the uselessness of using subspecies designations in modern phylogenetic taxonomy. The geographic population variant the specimen would have been referred to in the past was *H. h. horridum*.

***SCELOPORUS SHANNONORUM* (Shannon's Spiny Lizard).** ZACATECAS: MUNICIPALITY OF VALPARAISO: 8 km NE of Santa Catarina (22.211831°N, 103.872749°W), 2370 m elev. 14 September 2011. I. Ahumada-Carrillo. UTADC 7587. First record for Zacatecas; the closest known locality is ca. 32 airline km S at Rancho la Berberia, Jalisco (Smith et al. 2006). The lizard was found in pine forest.

SQUAMATA — SNAKES

***ADELOPHIS COPEI* (Cope's Mountain Meadow Snake).** JALISCO: MUNICIPALITY OF TECOLOTLÁN: Sierra de Quila, 5 km NW Quila el

Grande (20.375999° N, 14.112879°W), 1876 m elev. 7 October 2012. I. Ahumada-Carrillo. UTADC 7623. First municipality record that fills a large range gap in Jalisco between La Quemada (Municipality of Magdalena) to the north and 8.7 miles (13.9 km) E of Tapalpa (Municipality of Tapalpa) to the south. (Taylor 1942; Rossman and Blaney 1968). The snake was found under a rock near a permanent stream in an ecotone between oak forest and grassland.

***GEOPHIS DUGESI* (Duge's Earth Snake)**. JALISCO: Municipality of Bolaños: Sierra de los Huicholes, 29 km NW of Bolaños, on road to Huejuquilla (21.898278°N, 103.859972°W), 2430 m elev. 21 June 2008.R. Mederoz, J. Padilla and I. Ahumada-Carrillo. UTADC 7520, 7521. First record for the municipality, extending the range 126 airline km WNW from the closest known locality, on Sierra del Laurel, Municipality of Villa Hidalgo, Jalisco (Rodriguez and Vázquez 1994). The snake was found under a rock in pine-oak forest. The geographic population variant the specimen would have been referred to in the past was *G. d. aquilonaris*.

***GEOPHIS SIEBOLDI* (Siebold's Earth Snake)**. COLIMA: Municipality of Villa de Alvarez: 7 km N of turn off to El Chivato, on Chiapa–Montitlán road (19.393047°N, 103.672008°W), 1320 m elev. 11 July 2012. J. Reyes-Velasco. UTADC 7629, 7631. First record for Colima, extending the known range of the species 18.5 km W from an unpublished record (KU 129232) at 19.8 km S of Tecalitlán, Jalisco (KU 129232). The snake was found AOR at night in a sugarcane field surrounded by secondary vegetation. JALISCO: Municipality of Tecalitlán: 16 km SE of Tecalitlán on road to Jilotlán de los Dolores (19.448328°N, 103.226213°W), 1635 m elev. 25 July 2012. C. Grünwald and I. Ahumada-Carrillo. UTADC 7626–7628. First published record for this species in Jalisco, which is located ca. 17 km E of an unpublished record (KU 129232) from 19.8 km S of Tecalitlán, Jalisco. The snake was found DOR in pine forest. The original holotype and syntypes of this species were lost or destroyed during World War II (Downs 1957). Since the original description, this species is known from only eight specimens, one from Coalcomán, Michoacán (UMMZ 104698), one from Amula, Guerrero (BMNH 90.4.24.12), the aforementioned unpublished record from Jalisco (KU 129232), and five specimens without specific locality data (Zoologisches Museum, Berlin; ZMB 1555–1559). Aside from extending the known range, our localities constitute the first recent records for this species, and the photograph (Fig. 3) is the initial one to appear in the literature.



PHOTO BY JACOBO REYES VELASCO

Fig. 3. *Geophis sieboldi* from 7 km N of turnoff to El Chivato on Chiapa-Montitlán road. Colima, México (UTADC 7629, 7631).

***LAMPROPELTIS MEXICANA* (San Luis Potosí Kingsnake)**. JALISCO: Municipality of Bolaños: Sierra de los Huicholes, El Astillero, 27 km NW of Bolaños on road to Huejuquilla (21.888062°N, 103.855821°W), 2300 m elev. 22 June 2010. R. Mederoz. UTADC 7519. First municipality record. Municipality of Mezquitic: 2.2 airline km SE of Bajío las Gallinas (22.042667°N, 103.894444°W), 2446 m elev. 28 July 2011. J. Jones, I. Ahumada-Carrillo, C. Grünwald, and J. Reyes-Velasco. UTADC 7501. First municipality record. Both sites fill a distributional gap for the species between locations west of Atolinga, Zacatecas (Ahumada-Carrillo et al. 2011), and Mesa del Nayar–Santa Teresa Hwy, Nayarit (Hansen et al. 2011). The first snake was found DOR in pine-oak forest; the second one was crossing a paved road at night in pine forest. Two additional samples (UTADC 7512, 7516) were recorded from localities within the Municipality of Mezquitic; full locality information can be accessed from the UTA collections database. The geographic population variant that all mentioned specimens would have been referred to in the past was *L. m. greeri*.

***LEPTODEIRA SPLENDIDA* (Splendid Cat-eyed Snake)**. JALISCO: Municipality of Bolaños: Bolaños (21.83576°N, 103.777757°W), 892 m elev. 20 June 2012. I. Ahumada-Carrillo. UTADC 7618. First municipality record, extending the range of the species 80 airline km NW of the closest known locality at Mezquital del Oro, Zacatecas (Ahumada et al. 2011). The snake was found AOR in tropical deciduous forest. The geographic population variant the specimen would have been referred to in the past was *L. s. bressoni*.

***LEPTOPHIS DIPLOTROPIS* (Pacific Coast Parrot Snake)**. JALISCO: Municipality of Villa Guerrero: 9 km SW Villa Guerrero (21.959250°N, 103.684500°W), 1924 m elev. 25 October 2011. I. Ahumada-Carrillo. UTADC 7588, 7589. First municipality record and northernmost record in Jalisco, extending the known range ca. 140 airline km N from the closest known localities near Zapopan, Jalisco (Reyna-Bustos et al. 2007). The snake was found DOR in tropical deciduous forest. The geographic population variant the specimen would have been referred to in the past was *L. d. diplotropis*.

***MASTIGODRYAS CLIFTONI* (Clifton's Lizard Eater)**. JALISCO: Municipality of Bolaños: Sierra de los Huicholes, Sierra Los Huicholes, 22.4 km NW of Bolaños, on road to Huejuquilla (21.886000°N, 103.845389°W), 2080 m elev. 20 July 2010. I. Ahumada-Carrillo and J. Padilla. UTADC 7522. First municipality record and first for the Sierra de los Huicholes. The closest known localities are 93 airline km SW at Laguna de Santa Maria del Oro, Nayarit, and ca. 140 km SE in the Barranca de Oblatos-Huentitan, Jalisco (Ponce-Campos and Huerta-Ortega 1998). The snake was found in pine-oak forest. NAYARIT: Municipality of El Nayar: near El Maguey, El Venado – Mesa de Nayar Hwy (22.145892°N, 104.752247°W), 1750 m elev. 14 August 2010. C. Grünwald and C. Rodriguez. UTADC 7586. This record fills a gap in the distribution of the species, between Plomosas, Sinaloa, 127 km N, and Laguna de Santa Maria del Oro, 87 km S (Hardy and McDiarmid 1969; Ponce-Campos and Huerta-Ortega 1998). The snake was found during a foggy morning while crossing the highway in oak forest.


PHOTO BY CHRISTOPH I. GRÜNWALD

FIG. 4. *Rena bressoni* from 17 km NW of Tepalcatepec, Michoacán, Mexico (UTADC 7513).

***MICRURUS DISTANS* (West Mexican Coralsnake).** NAYARIT: MUNICIPALITY OF LA YESCA: Sierra Pajaritos, 5.7 airline km NW of La Yesca (21.352639°N, 104.052194°W), 2369 m elev. 28 August 2010. I. Ahumada Carrillo, C. Grünwald and J. Jones. UTADC 7571. First municipality record, first record for the Sierra Pajaritos, and by far the highest recorded elevation reported for this species (Roze 1996). The closest known records are from 40 airline km E at Magdalena, Jalisco, and 50 km W at Laguna de Santa Maria del Oro, Nayarit (Roze 1996). The snake was found in pine-oak forest. JALISCO: MUNICIPALITY OF CAÑADAS DE OBREGON: Presa EL Zapotillo, 17 km W Cañadas de Obregon (21.139630°N, 102.806214°W), 1708 m elev. 9 July 2012. I. Ahumada-Carrillo and J. Orozco. UTADC 7625. First municipality record, extending the range ca. 53 airline km SE from Mezquital del Oro, Zacatecas (Ahumada-Carrillo and Vazquez-Huizar 2012). The snake was found in tropical deciduous forest. The geographic population variant all specimens would have been referred to in the past was *M. d. zweifeli.*

***THAMNOPHIS ERRANS* (Mexican Wandering Gartersnake).** JALISCO: MUNICIPALITY OF MEZQUITIC: Sierra de los Huicholes, Bajío Las Gallinas (22.056736°N, 103.906512°W), 2560 m elev. 29 July 2011. C. Grünwald, J. Jones, I. Ahumada-Carrillo, and J. Reyes-Velasco. UTADC 7572. First record for Jalisco, extending the known range of the species 70 airline km S from the closest known locality at Valparaiso, Zacatecas (Rossman et al. 1996). The snake was found in pine forest.

***THAMNOPHIS PULCHRILATUS* (Mexican Highland Gartersnake).** JALISCO: Municipality of Mezquitic: Sierra de los Huicholes, Bajío Los Amoles (22.060218°N, 103.930936°W), 2480 m elev. 5 July 2011. I. Ahumada-Carrillo. UTADC 7508. First municipality record, and first for the Sierra de los Huicholes. The closest known localities are 101 airline km W at Santa Teresa, Nayarit, and 50 km SE at Atolinga, Zacatecas (Ahumada-Carrillo 2010). The snake was found in a bunch grass meadow surrounded by pine-oak forest.

***RENA BRESSONI* (Michoacán Slender Threadsnake).** JALISCO: Municipality of Jilotlán de los Dolores: 17 km NW of Tepalcatepec, Michoacán (19.307670°N, 102.909775°W), 630 m elev. 24 July 2011. C. Grünwald and I. Ahumada-Carrillo. UTADC 7513, 7514. First record for Jalisco, extending the range 96 airline km W from the closest known locality at Hacienda El Sabino, SW of Uruapan, Michoacán (Duellman 1961). The snake was found AOR in tropical deciduous forest. This species appears to be known only from the type specimen and possibly one lost sample from Aguililla, Michoacán (Duellman 1961), and we include the first photograph of this species to be published in the literature (Fig. 4).

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First Departmental Records of Amphibians and Reptiles from Intibucá, Lempira, and Ocotepeque in Southwestern Honduras

McCranie (2007, 2011) demonstrated that the departments of Intibucá, Lempira, and Ocotepeque in southwestern Honduras were among the most understudied departments in the entire country in respect to their amphibian and snake faunas; the same holds true for the lizards and turtles in those three departments (McCranie, *in prep.*). On 24 November 2011 and from 14 to 20 June 2012, first departmental records for 20 species were documented from various localities, resulting in one for Intibucá, 10 for Lempira, and nine for Ocotepeque. All samples were collected by J. R. McCranie. John C. Murphy verified the identification of the FMNH specimens, except for *Incilius valliceps* and *Holcosus undulatus*, which were verified by Alan Resetar; Steve W. Gotte verified the USNM specimen. Coordinates for all localities were taken with a GPS device using map datum WGS84. Ecological life zone vegetation formations used herein (placed in parentheses) are those classified by Holdridge (1967); others refer to specific vegetation associations at collecting sites.

ANURA — FROGS

Lempira

***INCILIUS VALLICEPS* (Southern Gulf Coast Toad; Sapo Común de Crestas Grandes)**. Near pond just S of Gracias (14.566847°N, 88.583409°W), 860 m elev. 19 June 2012. FMNH 283705. Closest known locality for this species is ca. 25 km NW at a site 8 km SE of Santa Rosa de Copán, Copán (McCranie 2006). The toad was active on the ground at night in a pasture adjacent to the pond in denuded pine-oak forest (Premontane Moist Forest).

***DENDROPSOPHUS MICROCEPHALUS* (Small-headed Treefrog; Ranita Trepadora Amarilla)**. Pond just S of Gracias (14.566847°N, 88.583409°W), 860 m elev. 19 June 2012. FMNH 283723–27. Closest known locality for this species is ca. 25 km NW at a site 8 km SE of Santa Rosa de Copán, Copán (McCranie 2006). Two males were calling at night on water hyacinths (*Eichhornia crassipes*) floating on surface of the pond surrounded by pasture in denuded pine-oak forest (Premontane Moist Forest).

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***SCINAX STAUFFERI* (Stauffer's Long-nosed Treefrog; Ranita Trepadora Nariguda)**. Pond just S of Gracias (14.566847°N, 88.583409°W), 860 m elev. 19 June 2012. FMNH 283743–44. Closest known locality for this species is ca. 25 km NW at a site 8 km SE of Santa Rosa de Copán, Copán (McCranie 2006). This species is now known from all 18 Honduran departments. Numerous males were calling at night from emerging grass stalks in flooded areas adjacent to the pond surrounded by pasture in denuded pine-oak forest (Premontane Moist Forest).

***SMILISCA BAUDINII* (Mexican Treefrog; Rana Trepadora Común)**. Near pond just S of Gracias (14.566847°N, 88.583409°W), 860 m elev. 19 June 2012. FMNH 283745–47. Closest known locality for this species is ca. 27 km NW at a site 6.4 km SE of Santa Rosa de Copán, Copán (McCranie 2006). This species is now known from all 18 Honduran departments. Males were calling at night from small isolated trees and on the ground in a pasture adjacent to the pond in denuded pine-oak forest (Premontane Moist Forest).

***LEPTODACTYLUS MELANONOTUS* (Sabinal Frog; Ranita de Charco de Dos Espinas)**. Near pond just S of Gracias (14.566847°N, 88.583409°W), 860 m elev. 19 June 2012. FMNH 283720–22, 283749. Closest known locality for this species is ca. 75 km NW at Copán, Copán (McCranie 2006). Males were calling at night from inside grass clumps in flooded pasture adjacent to the pond in denuded pine-oak forest (Premontane Moist Forest).

***HYPOPACHUS VARIOLOSUS* (Sheep Frog; Ranita Oveja Común)**. Near pond just S of Gracias (14.566847°N, 88.583409°W), 860 m elev. 19 June 2012. FMNH 283728–29. Closest known locality for this species is ca. 25 km NW at a site 8 km SE of Santa Rosa de Copán, Copán (McCranie 2006). Males were calling at night from burrows below grass clumps in and around flooded pasture adjacent to the pond surrounded by denuded pine-oak forest (Premontane Moist Forest).

***LITHOBATES BROWNORUM* COMPLEX (Brown's Leopard Frog; Rana de Charco Manchada)**. Pond just S of Gracias (14.566847°N, 88.583409°W), 860 m elev. FMNH 283733. Closest known locality for members of this species complex is ca. 25 km NW at 8 km SE of Santa Rosa de Copán, Copán (McCranie 2006). The frog was active at night in shallow water at edge of pond. This species complex is now known from all 18 Honduran departments. The Lempira population appears to represent an undescribed species related to *L. brownorum* and *L. forreri* as discussed by McCranie and Castañeda (2007).

Ocotepeque

***LEPTODACTYLUS MELANONOTUS* (Sabinal Frog; Ranita de Charco de Dos Espinas)**. Near Río Lempa at Antigua (14.40009°N, 89.200067°W), 725 m elev. 17 June 2012. FMNH 283718–19. Closest known locality for this species is ca. 8 km S at San Ignacio, Chalatenango, El Salvador (Köhler et al. 2005); the closest known Honduran locality is ca. 55 km N at Copán, Copán (McCranie 2006). Males were calling at night on ground in and adjacent to inundated areas in denuded dry forest converted to pastures (Premontane Dry Forest).

SQUAMATA — LIZARDS

Intibucá

***SCINCELLA CHERRIEI* (Brown Forest Skink; Eslaboncillo Pardo)**. Near La Rodadora. (14.500248°N, 88.116708°W), 1600 m elev. 24 November 2011. USNM 580447. Closest known locality for this species is ca. 35 km NE at Siguatepeque, Comayagua, Honduras (UF 124825). The skink was under a log during the day in a coffee grove carved from broadleaf forest mixed with pine-oak forest (Lower Montane Moist Forest).

Lempira

***HEMIDACTYLUS FRENATUS* (Common House Gecko; Besucona)**. Hotel Finca El Capitán, Gracias (14.566901°N, 88.583448°W), 855 m elev. 20 June 2012. FMNH 283709–11. Closest known locality for this species is ca. 75 km NW at Copán, Copán, Honduras (FMNH 282557–59). The gecko was active at night on the hotel walls.

***SCINCELLA CHERRIEI* (Brown Forest Skink; Eslaboncillo Pardo)**. Villa Verde. (14.550237°N, 88.616669°W), 1105 m elev. 20 June 2012. FMNH 283734. Closest known locality for this species is ca. 55 km ESE at La Rodadora, Intibucá, Honduras (see *S. cherriei* note above). The lizard was under a rock during the day in second growth pine-oak forest (Premontane Moist Forest).

Ocotepeque

***COLEONYX MITRATUS* (Tropical Banded Gecko)**. Between Antigua and Río Lempa (14.40009°N, 89.200064°W), 730 m elev. 17 June 2012. FMNH 283716. Closest known locality for this species is ca. 35 km SW at Lago de Güija, Santa Ana, El Salvador (Köhler et al. 2005); closest known Honduran locality is ca. 150 km NE at Lago de Yojoa, Cortés (UF 11626). The gecko was under a rock during the day within a pasture transformed from dry forest (Premontane Dry Forest).

***HEMIDACTYLUS FRENATUS* (Common House Gecko; Besucona)**. Nuevo Ocotepeque (14.43348°N, 89.683353°W), 835 m elev. 16 June 2012. FMNH 283707–08. Closest known locality for this species is ca. 55 km N at Copán, Copán, Honduras (FMNH 282557–59, UF 166346). These lizards were active at night on walls of a hotel surrounded by denuded dry forest (Premontane Dry Forest).

***SCINCELLA INCERTA* (Stuart's Forest Skink; Eslaboncillo de Hojarasca)**. Las Hojas (14.450173°N, 89.283431°W), 1600 m elev. 15 June 2012. FMNH 283730–32. Closest known locality is ca. 150 km NNE at La Fortuna Camp, Santa Bárbara, Honduras (Townsend 2005). The skinks were under pine needles during the day in second growth pine forest mixed with broadleaf forest (Lower Montane Moist Forest).

***HOLCOSUS UNDULATUS* (Rainbow Ameiva; Largartija Metálica)**. Near Río Lempa at Antigua (14.40009°N, 89.200067°W), 725 m elev. 17 June 2012. FMNH 283706. Closest known locality for this species is ca. 5 km S at Citalá, Chalatenango, El Salvador (Köhler et al. 2005); closest known Honduran locality is ca. 55 km N near Copán, Copán (USNM 563572). The lizard was active during a sunny period on rock wall in a pasture transformed from dry forest (Premontane Dry Forest).

SQUAMATA — SNAKES

Lempira

***NINIA DIADEMATA* (Ring-necked Coffee Snake; Dormilona de Collar)**. Bonilla. (14.566705°N, 88.583459°W), 900 m elev. 19 June 2012. FMNH 283717. Closest known locality for this species is ca. 65 km NW at Río Amarillo, Copán, Honduras (McCranie 2011). The snake was under a rock during the day adjacent to a rock wall in second growth pine-oak forest (Premontane Moist Forest).

Ocotepeque

***EPICTIA ATER* (Threadsnake; Culebra Lombriz)**. Near Río Lempa at Antigua (14.40009°N, 89.200067°W), 725 m elev. 17 June 2012. FMNH 283735–37; between Antigua and Río Lempa (14.40009°N, 89.200064°W), 730 m elev. 18 June 2012. FMNH 283738–40. Closest known locality for this species is ca. 35 km WSW at 6 km S of Metapán, Santa Ana, El Salvador (Köhler et al. 2005); closest known Honduran locality is ca. 55 km N at Copán, Copán (McCranie 2011). The snakes were under rocks in pastures altered from dry forest (Premontane Dry Forest).

***INDOTYPHLOPS BRAMINUS* (Brahminy Blindsnake; Culebrilla Ciega)**. Near Río Lempa at Antigua (14.40009°N, 89.200067°W), 725 m elev. 17 June 2012. FMNH 283712–14. Between Antigua and Río Lempa (14.40009°N, 89.200064°W), 730 m elev. 18 June 2012. FMNH 283715. Closest reported locality for this introduced blindsnake is ca. 95 km S at San Salvador, San Salvador, El Salvador (Köhler et al. 2005); closest known Honduran locality is ca. 120 km NE near San José de Colinas, Santa Bárbara (McCranie 2011). The snakes were under rocks in pastures converted from dry forest (Premontane Dry Forest), one of which (FMNH 283715) was under the same rock and in direct contact in a "ball" with three *Epictia ater* (FMNH 283738–40).

TESTUDINES — TURTLES

Ocotepeque

***RHINOCLEMMYS PULCHERRIMA* (Painted Wood Turtle; Casco Rojo)**. Near Río Lempa at Antigua (14.40009°N, 89.200067°W), 725

m elev. 17 June 2012. FMNH 283551. Between Nueva Ocotepeque and Antigua (14.416736°N, 89.183476°W), 800 m elev. 18 June 2012. FMNH 283550. Closest known locality for this species is ca. 28 km SW near Metapán, Santa Ana, El Salvador (Köhler et al. 2005); closest known Honduran locality is ca. 50 km N at Copán, Copán (UNAH 425; also *R. pulcherrima* not previously reported from Department of Copán). The Antigua specimen (FMNH 283551) was foraging during afternoon on small plants and shrubs located adjacent to a diminutive muddy temporary pond within a pasture transformed from dry forest (Premontane Dry Forest). The other specimen (FMNH 283550) was crossing during morning hours, a highway passing through badly disturbed dry forest (Premontane Dry Forest). Of three others from the Río Lempa locality that were not collected, two were feeding on human feces during the afternoon and the other was active at night in a small temporary pond.

***KINOSTERNON SCORPIOIDES* (Scorpion Mud Turtle; Tortuga Escorpión)**. Near Río Lempa at Antigua (14.4009°N, 89.89.200067°W), 725 m elev. 17 June 2012. FMNH 283748. Closest known locality for this species is ca. 28 km SW near Metapán, Santa Ana, El Salvador (Köhler et al. 2005); closest known Honduran locality is ca. 60 km NE at a site NW of Gracias, Lempira (Meyer and Wilson, 1973). Numerous adults and hatchlings were active at night in and around several small temporary ponds in pastures converted from dry forest (Premontane Dry Forest).

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New Records of Amphibians and Reptiles from Alabama, USA

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With 165 recognized amphibian and reptile species, Alabama possesses some of the highest herpetofaunal diversity in North America. This species diversity is due in part to the seven recognized geographic provinces that comprise the state. Many of the records we report here are primarily from Lawrence and Winston counties (i.e., William B. Bankhead National Forest), Madison Co., and Jackson Co. of northern Alabama. We completed searches of museum records (Auburn University Herpetological Collection), Herp-Net records, and prior documented records (Mount 1980) to identify gaps in amphibian and reptile locality data for these counties. Locality records for this account were primarily obtained during a four-year study examining forest management impacts on amphibians and reptiles and through incidental encounters during road cruising and field trips. All GPS coordinates are datum WGS 84. All specimens were verified by Craig Guyer and represent new county records.

CAUDATA — SALAMANDERS

***AMBYSTOMA TIGRINUM* (Eastern Tiger Salamander)**. Lawrence Co.: At the intersection of Alabama State Highway 33 and Alabama State Highway 36 (34.434923°N, 87.292159°W). 1 January 2006. Lamaar Marshall. A single *A. tigrinum* was found climbing a gas pump outside the Black Warrior Trading Post after a rain event. Individual was released after being photographed. AUM AHAP-D 649.

ANURA — FROGS

***ANAXYRUS AMERICANUS* (American Toad)**. Lawrence Co.: Bankhead National Forest, Forest Service road 204 leading to Basin Creek, approximately 100 m from intersection with County Road 2 (34.313048°N, 87.511576°W). 15 May 2010. H. A. Czech, K. Pursel, and D. Sollenberger. Individual was captured on the road and released after being photographed. AUM AHAP-D 651.

***HYLA CINEREA* (Green Treefrog)**. Lawrence Co.: Bankhead National Forest, approximately 1 mile from the Lawrence/Winston county line marker on Alabama State Route 33 South (34.309862°N, 87.33326°W). 3 May 2008. W. B. Sutton. Individual was deceased after being captured in a drift-fence array. AUM AHAP-D 658. Jackson Co.: Boxes Cove, AL Hwy 79 near intersection with Old Larkinsville Road (34.709578°N, 86.107335°W). H. A. Czech. Individual was found on road and released after being photographed. AUM AHAP-D 657.

***HYLA GRATIOSA* (Barking Treefrog)**. Lawrence Co.: Bankhead National Forest, approximately 500 m from Black Warrior Ranger Station on Alabama State Highway 33 South (34.343684°N, 87.342857°W). 25 May 2008. W. B. Sutton and R. Hardman. Individual was found on Alabama State Highway 33 South across from a large open wetland. AUM AHAP-D 659.

***LITHOBATES CLAMITANS* (Green Frog)**. Madison Co.: Beaverdam Creek, approximately 200 m upstream from Monroe Road overpass (34.863390°N, 86.597894°W). 23 September 2010. H. A. Czech, H. Howell, and A. B. Bohlman. AUM AHAP-D 661.

TESTUDINES — TURTLES

***GRAPTEMYS GEOGRAPHICA* (NORTHERN MAP TURTLE)**. Jackson Co.: State Route 146 at the bridge over the Paint Rock River (34.861087°N, 86.196032°W). 1 June 2003. H. A. Czech. Adult female, released after being photographed. AUM AHAP-D 293.

SQUAMATA — LIZARDS

***HEMIDACTYLUS TURCICUS* (Mediterranean House Gecko)**. Covington Co.: Analusia Econolodge, 1421 Martin Luther King Junior Expressway, Andalusia, Alabama 36420 (31.319210°N, 86.456571°W). 6 November 2010. H. A. Czech. AUM AHAP-D 656.

***PLESTIODON INEXPECTATUS* (Southeastern Five-lined Skink)**. Lawrence Co.: Bankhead National Forest, approximately 1 mile from the Lawrence / Winston county line marker on Alabama State Route 33 South (34.309862°N, 87.333263°W). 29 March 2009. Individual was captured underneath an artificial cover object and was released after being photographed. AUM AHAP-D 666.

***PLESTIODON LATICEPS* (Broad-headed Skink)**. Lawrence Co.: Bankhead National Forest, approximately 4 miles down Pine Torch Road from Alabama State Highway 33 South, nearly one-half mile down the yellow horse trail (34.356267°N, 87.299911°W). 19 May 2005. W. B. Sutton. Individual was captured in a drift-fence array and was released after being photographed. AUM AHAP-D 667.

***OPHISAURUS ATTENUATUS LONGICAUDUS* (Eastern Slender Glass Lizard)**. Jackson Co.: The Old Fabius Coal Mine, between the towns of Fabius and Falt Rock (34.80006°N, 85.759213°W). 25 March 2011. T. Barrentine and T. Barrantine. Individual was released after being photographed. AUM AHAP-D 663.

SQUAMATA — SNAKES

***AGKISTRODON P. PISCIVORUS* (Eastern Cottonmouth)**. Jackson Co.: County Road 220 as it crosses through Roseberry Bottoms Swamp, near Scottsboro, AL (34.702476°N, 86.092360°W). 22 March 2012. H. A. Czech. DOR adult male observed and photographed. AUM AHAP-D 647.

***CEMOPHORA COCCINEA COPEI* (Northern Scarletsnake)**. Lawrence Co.: Bankhead National Forest, approximately 1.5 km W of the Black Warrior Ranger Station near Alabama State Route 33 (34.344820°N, 87.354832°W). 23 May 2006. W. B. Sutton. Individual was captured in a drift-fence array and was released after being photographed. AUM AHAP-D 652.

***CROTALUS HORRIDUS* (Timber Rattlesnake)**. Madison Co.: Monte Sano State Park, approximately 1.0 km down firehouse trail from hiking trails parking lot (34.747308°N, 86.503525°W). 15 August 2009. W. B. Sutton and R. H. Hardman. Individual was found dead in the middle of a hiking trail and was photographed. AUM AHAP-D 654.

***PANTHEROPHIS GUTTATUS* (Red Cornsnake)**. Jackson Co.: Near intersection of Alabama Highway 79 and County Road 23 (34.653053°N, 86.109679°W). 23 November 2008. H. A. Czech. Individual was found dead on the road and was photographed. AUM AHAP-D 294.

***PANTHEROPHIS SPILOIDES* (Gray Ratsnake)**. Lawrence Co.: Bankhead National Forest, approximately 1.3 km SSW of the Black Warrior work station, (34.331961°N, 87.339782°W). 13 June 2006. W. B. Sutton. Individual was found crossing a small dirt road within a harvested pine stand. Individual was released after being photographed. AUM AHAP-D 665.

***HETERODON PLATIRHINOS* (Eastern Hog-nosed Snake)**. Winston Co.: Bankhead National Forest, approximately 1.5 km from the intersection of Alabama County road 60 and Kinlock Road north (34.289010°N, 87.493877°W). 30 May 2007. W. B. Sutton. Individual was found on the road near a Loblolly Pine (*Pinus taeda*) plantation and was photographed. AUM AHAP-D 655.

***STORERIA O. OCCIPITOMACULATA* (Northern Red-bellied Snake)**. Lawrence Co.: Bankhead National Forest, approximately 1 km SE of the Black Warrior Work Station (34.335951°N, 87.337106°W). 2 November 2005. W. B. Sutton. Individual was located in a pine-hardwood forest stand in a drift-fence array. Individual was released after being photographed. AUM AHAP-D 670.

***VIRGINIA V. VALERIAE* (Smooth Earthsnake)**. Lawrence Co. Bankhead National Forest, approximately 1 km SE of the Black Warrior Work Station (34.335951°N, 87.337106°W). 10 April 2009. W. B. Sutton. Individual was captured under an artificial cover object in a harvested pine stand. Individual was released after being photographed. AUM AHAP-D 672.

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New County Records of Amphibians and Reptiles Resulting from a Bioblitz Competition in Southwestern Georgia, USA

Since the publication of Amphibians and Reptiles of Georgia (Jensen et al. 2008), many new county-level distribution records for amphibians and reptiles have been reported for the state (e.g., Stevenson et al. 2009; Jensen et al. 2011; Stevenson et al. 2011; Butler et al. 2012). Additional contributions to the knowledge of the distribution of amphibians and reptiles have been made through annual bioblitz competitions held primarily between the University of Georgia and Auburn University. A bioblitz competition is an attempt to find and document as many species of defined taxa in a given area, often over a relatively short time period (Graham et al. 2007; Graham et al. 2010a; Graham et al. 2010b; Folt et al. 2013).

From 4–6 October 2013, we organized a bioblitz to search public and private lands in Seminole and Decatur counties, Georgia, USA, which fall in the Upper Coastal Plain. Search efforts focused largely on two large tracts of private land owned by the Reynolds family—Capachequi (Decatur Co.) and Camp Pastures (Seminole Co.). Both tracts include well-managed longleaf uplands, seasonal wetlands, and permanent ponds, and Capachequi borders the Flint River. The bioblitz competition involved more than 30 participants from the University of Georgia, Abraham Baldwin Agricultural College, Clemson University, Western Carolina University, Florida State University, and Sewanee College.

We detected 17 species of amphibians and 33 species of reptiles during of the bioblitz. This included ten new county-level distribution records, which we report here. We vouchered all records with digital photographs. Records were verified by John Jensen and deposited in the Georgia Museum of Natural History. The datum for all GPS locations is WGS 84.

ANURA — FROGS

***ELEUTHERODACTYLUS PLANIROSTRIS* (Greenhouse Frog)**. Seminole Co.: Boat ramp on north shore of Lake Seminole; off of Seminole Sholes Dr. (30.7778°N, 84.8424°W). 5 October 2013. E. Hernandez, S. Horsley, J. Hunt, and E. Jennings. GMNH 50552.

SQUAMATA — LIZARDS

***ANOLIS CAROLINENSIS* (Green Anole)**. Seminole Co.: Near inlet of Lake Seminole; near intersection of Sportsman Rd. and Paradise Dr. (30.8181°N, 84.8797°W). 5 October 2013. E. Hernandez, S. Horsley, J. Hunt, and E. Jennings. GMNH 50554.

***PLESTIODON FASCIATUS* (Common Five-lined Skink)**. Decatur Co.: Capachequi; property of John Reynolds (30.9948°N, 84.5378°W). 5 October 2013. A. Clause, B. Hudson, and K. McEntire. GMNH 50557.

***PLESTIODON INEXPECTATUS* (Southeastern Five-lined Skink)**. Seminole Co.: Camp Pastures; property of John Reynolds (30.8677°N, 84.8047°W; WGS 84). 5 October 2013. D. Filipiak, E. P. Hill, and K. Stohlgren. GMNH 50549.

SQUAMATA — SNAKES

***AGKISTRODON CONTORTRIX* (Copperhead)**. Mitchell Co.: GA 311 near intersection with Sardis Rd. (31.1765°N, 84.4284°W). 6 October 2013. T. Pierson. GMNH 50555. Seminole Co.: River Rd. approximately 300 m S of Fennell Rd. (30.8485°N, 84.9144°W). 5 October 2013. W. Booker, S. Drukker, C. Murphy, B. Romm, and D. Thompson. GMNH 50553.

***AGKISTRODON PISCIVORUS* (Cottonmouth)**. Seminole Co.: Near Dresser Tract of Silver Lake WMA; boat ramp at end of Dresser Landing Rd. (30.8893°N, 84.9343°W). 5 October 2013. J. Barrett, T. Colter, K. Davis, S. Dismuke, W. Moore, K. Pursel, and D. Sollenberger. GMNH 50558.

***NERODIA TAXISPILOTA* (Brown Watersnake)**. Seminole Co.: Boat ramp on north shore of Lake Seminole; off of Seminole Sholes Dr. (30.7778°N, 84.8425°W). 5 October 2013. E. Hernandez, S. Horsley, J. Hunt, and E. Jennings. GMNH 50551.

***OPHEODRYS AESTIVUS* (Rough Greensnake)**. Mitchell Co.: GA 311 approximately 1.2 km SW of intersection with Deer Hole Rd. (31.1150°N, 84.4866°W). 6 October 2013. T. Pierson. GMNH 50556.

***PANTHEROPHIS GUTTATUS* (Red Cornsnake)**. Seminole Co.: Camp Pastures; property of John Reynolds (30.8576°N, 84.8167°W) 5 October 2013. R. Herrington and M. Riddle. GMNH 50550.

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New County Records of Amphibians and Reptiles Resulting from a Bioblitz Competition in North-Central Georgia, USA

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Since the publication of Amphibians and Reptiles of Georgia (Jensen et al. 2008), many new county-level distribution records for amphibians and reptiles have been reported for the state (e.g., Stevenson et al. 2009; Jensen et al. 2011; Stevenson et al. 2011; Butler et al. 2012). Additional contributions to the knowledge of the distribution of amphibians and reptiles have been made through annual bioblitz competitions held primarily between the University of Georgia and Auburn University. A bioblitz competition is an attempt to find and document as many species of defined taxa in a given area, often over a relatively short time period (Graham et al. 2007; Graham et al. 2010a; Graham et al. 2010b; Folt et al. 2013).

From 12–14 April 2013, we organized a bioblitz to search public and private lands in Fannin, Gilmer, and Murray counties, Georgia. Most of this focal area lies near the southwestern terminus of the Blue Ridge ecoregion, with western Murray Co. in the Ridge and Valley, and much of our search effort took place within the Chattahoochee National Forest. The region holds a high diversity of salamanders, and despite being relatively well-studied, a number of herpetofaunal distribution gaps existed—especially for turtles (Jensen et al. 2008). This bioblitz competition involved more than 30 participants from the University of Georgia, Auburn University, the University of Alabama, Virginia Tech, and Pennsylvania State University.

We detected 24 species of amphibians and 20 species of reptiles during the bioblitz. All of the following 14 accounts represent new county records. Ten of these records were collected during the three-county bioblitz, and four were records found outside of the time period and specific geographical bounds of the bioblitz but were obtained within the same general region. We vouchered all records with digital photographs. Records were verified by John Jensen and deposited in the Herpetological Collections of the Auburn University Museum (AUM/AHAP).

CAUDATA — SALAMANDERS

***AMBYSTOMA MACULATUM* (Spotted Salamander)**. Fannin Co.: Old Dial Road, 0.3 road miles N of Tilley Bend Lane (34.80391°N, 84.24628°W; WGS 84). 13 April 2013. T. Pierson, E. White, C. Murphy, W. Lattea, and M. Rajeev. AHAP-D 693. Egg mass. Gilmer Co.: West of Whitepath Road, 1.3 road miles S of Boardtown Road (34.79022°N, 84.42278°W; WGS 84). 12 April 2013. T. Stratmann, C. Carter, K. Fouts, and E. Hernandez. AHAP-D 694.

ANURA — FROGS

***LITHOBATES PALUSTRIS* (Pickerel Frog)**. Murray Co.: Old CCC Camp Road, 4.1 miles W of Mulberry Gap Road (34.81235°N, 84.66039°W; WGS 84). 12 April 2013. B. Folt and J. Jenkins. AHAP-D 698.

***PSEUDACRIS CRUCIFER* (Spring Peeper)**. Fannin Co.: Intersection of Ballewtown Road and Appalachian Highway (34.8478°N, 84.33690556°W; WGS 84). 12 April 2013. H. Vogel, M. Knoerr, D. Drewett, and D. Steen. AHAP-C 0017. Murray Co.: Old CCC Camp Road, 0.8 road miles W of Mulberry Gap Road (34.80223°N, 84.62951°W; WGS 84). 12 April 2013. B. Folt and J. Jenkins. AHAP-D 697.

TESTUDINES — TURTLES

***CHELYDRA SERPENTINA* (Snapping Turtle)**. Towns Co.: Approximately 100 m (airline) WSW of the intersection of Many Forks Road and Many Forks Spur (34.97426°N, 83.93671°W; WGS 84). 12 July 2010. T. Stratmann and B. Hudson. AHAP-D 703.

***CHRYSEMYS PICTA* (Painted Turtle)**. Gilmer Co.: West of Whitepath Road, 1.3 miles S of Boardtown (34.79000°N, 84.42464°W; WGS 84). 12 April 2013. T. Stratmann, C. Carter, K. Fouts, and E. Hernandez. AHAP-D 695. Murray Co.: Highway 225, 0.4 road miles S of Temple Grove Road (34.92406°N, 84.79374°W; WGS 84). 12 April 2013. M. Herr and S. Graham. AHAP-D 701.

***STERNOTHERUS ODORATUS* (Eastern Musk Turtle)**. Gilmer Co.: West of Whitepath Road, 1.3 miles S of Boardtown (34.79022°N, 84.42278°W; WGS 84). 12 April 2013. T. Stratmann, C. Carter, K. Fouts, and E. Hernandez. AHAP-D 696. Union Co.: North of Goose Island Lake, approximately 250 m east of Cozy Acres Lane (34.78914°N, 84.40023°W; WGS 84). 7 June 2010. T. Stratmann and B. Hudson. AHAP-D 705.

SQUAMATA — LIZARDS

***PLESTIODON INEXPECTATUS* (Southeastern Five-lined Skink)**. Gilmer Co.: Alongside East Mountaintown Creek under Chatsworth Highway 52 bridge (34.75033333°N, 84.55582778°W; WGS 84). 13 April 2013. D. Drewett and D. Steen. AHAP-D 674.

***SCINCELLA LATERALIS* (Little Brown Skink)**. Gilmer Co.: South of Woodring Branch Road, 3.5 road miles S of Highway 76 (34.63038°N, 84.64907°W; WGS 84). 13 April 2013. A. Clause, D. Blount, W. Booker, and J. Hunt. AHAP-D 699.

SQUAMATA — SNAKES

***LAMPROPELTIS CALLIGASTER* (Yellow-bellied Kingsnake)**. Towns Co.: Gum Log Road, 0.3 road miles S of Julie Hollow Road (34.96643°N, 83.93502°W; WGS 84). 7 June 2012. T. Stratmann and G. Brown. AHAP-D 704.

***THAMNOPHIS SAURITUS* (Eastern Ribbonsnake)**. Gilmer Co.: Approximately 0.8 miles (airline) NW of the intersection of Lebanon Road and Colwell Church Road (34.92912°N, 94.43818°W; WGS 84). 17 July 2010. T. Stratmann and B. Hudson. AHAP-D 702.

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Recent Distribution Records for *Hyla cinerea* (Green Treefrog) from Tennessee, Southern Kentucky, and Northern Alabama, USA

Most of the following records are vouchered by specimens collected in 2006 as part of a study on the range limits and peripheral range expansion of *Hyla cinerea* in the north-central part of its range. The exceptions are the Benton and Wilson counties, Tennessee records, and two of the Morgan Co., Alabama records. All but two of the voucher specimens and photographs are in the David H. Snyder Museum of Vertebrate Zoology (APSU) at Austin Peay State University, Clarksville, Tennessee. The two exceptions are in the Auburn University Museum (AUM). Vouchers in the APSU collection were verified by A. Floyd Scott; Craig Guyer verified the identification of the Auburn University Museum specimens. County record status was determined using Mount (1975) and Redmond and Scott (1996, with updates online). Datum for geographic coordinates is WGS 84.

ALABAMA

Colbert Co.: North shore of Colbert Bay, bay of Pickwick Lake (impounded Tennessee River) (34.8394°N, 87.9472°W). Adult perched on branch of small tree. 22 September 2006. Nathan Parker and Larry Derrick. APSU 18793 (color photo). First county record.

Lauderdale Co.: Near Lauderdale CR-2 bridge across Colbert Creek (34.8517°N, 87.9261°W). Adult perched on Cattail (*Typha latifolia*) and juvenile found dead on road (DOR). 22 September 2006. Nathan Parker and Larry Derrick. APSU 18794-95 (color photos). First county record.

Lawrence Co.: Just south of inundated Mallard Creek, bay of Pickwick Lake (impounded Tennessee River) (34.6861°N, 87.1631°W). Juvenile alive on road (AOR). 24 September 2006. Nathan Parker. APSU 18800 (color photo). First ounty record.

Limestone Co.: Road through marshy area along unnamed tributary to Limestone Slough (34.6303°N, 86.8583°W). AOR juvenile. 23 September 2006. Nathan Parker. APSU 18796 (color photo). First county record.

Madison County: Road through marshy area, inundated lower Barren Fork Creek, bay of Wheeler Lake (impounded Tennessee River) (34.6153°N, 86.7344°W). AOR juvenile. 23 September 2006. Nathan Parker. APSU 18797 (color photo). First county record.

Morgan Co.: Beaver swamp at Cold Spring near edge of Tennessee River floodplain (34.5469°N, 86.8506°W). Two juveniles climbing on tree trunk and woody vine. 23 September 2006. Nathan Parker. APSU 18798–99 (color photos). Wheeler National Wildlife Refuge, south side of Tennessee River (34.5433°N, 86.8471°W). Specimen on shrub. 21 April 2003. W. R. Gates and T. Petty. AUM 36423. First county records.

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KENTUCKY

Trigg Co.: Shoreline of inundated lower Little River, bay of Lake Barkley (impounded Cumberland River) (36.8317°N, 87.9311°W). Adult male calling from blackberry cane (*Rubus* sp.). 12 July 2006. Nathan Parker. APSU 18203 (color photo). First Little River drainage record.

TENNESSEE

Benton Co.: Mouth of Harmon Creek, bay of Kentucky Lake (impounded Tennessee River) (36.1472°N, 87.9514°W). Three adult males taken at night from willow (*Salix* sp.) bushes in ca. 1 m deep water, ca. 30 m from bank. 28 June 2001. Scott Williamson. APSU 3277 (alcohol specimen). First county record.

Cheatham Co.: Cheatham Lake Wildlife Management Area, Cumberland River floodplain, Marks Creek Slough adjacent to Cumberland Bicentennial Trail (36.2914°N, 87.0953°W). Adult male calling from Buttonbush (*Cephalanthus occidentalis*). 23 June 2006. Nathan Parker. APSU 18183 (color photo). First county record.

Davidson Co.: 1) Scottsboro area, floodplain of Cumberland River near river mile 168.5, east bank (36.1875°N, 86.9378°W). Adult male calling from Black Willow (*Salix nigra*) sapling. 23 June 2006. Nathan Parker. APSU 18184 (color photo). 2) Nashville, west side of Cumberland River just north of the Briley Parkway (TN Hwy. 155) Bridge (36.1833°N, 86.8669°W). 18 August 2006. Vic Scoggin. APSU 18212–13 (color photos). 3) Shelby Bottoms Nature Center (36.1933°N, 86.7037°W). Adult observed sitting on leaf of *Vitus* sp. 28 August 2012. Denise Weyer. APSU 19374. First Davidson Co. records; first records from Outer Nashville Basin (EPA Ecoregion 71h- Griffith et al. 1998).

Dickson Co.: Floodplain of Harpeth River near confluence of Harpeth and Cumberland rivers, on Dozier Boat Dock Road (36.2986°N, 87.1514°W). AOR adult. 28 August 2006. Nathan Parker. APSU 18792 (color photo). First county record and first Harpeth River drainage record.

Hardin Co.: Mouth of Bruton Branch, bay of Pickwick Lake (impounded Tennessee River) (35.0697N, 88.1836W). Two adult males, one calling from base of Buttonbush, the other from Halberd-leaved Rose Mallow (*Hibiscus laevis*). 5 August 2006. Nathan Parker. APSU 18191, 18192 (color photos). Augments the only other published record for the county (Summers 2010).

Humphreys Co.: Two new records that augment the only published record for the county (Scott et al. 2000): 1) Mouth of Bear Creek, bay of Kentucky Lake (impounded Tennessee River) (36.1131°N, 87.9136°W). Two adult males calling from Black Willow and Buttonbush. 4 July 2006. Nathan Parker. APSU 18207–08 (alcohol specimens). 2) Floodplain of Duck River near SR-13 bridge (35.9369°N, 87.7628°W). Adult male calling from beneath thatch at edge of inundated grassy area. 5 July 2006. Nathan Parker. APSU 18200 (alcohol specimen). Furthest upstream record in Duck River drainage.

Montgomery Co.: Several new records that augment the only published record for the county (Sutton et al. 2004): 1) Dotsonville community, Buckner Pond (36.4817°N, 87.4853°W). Adult male calling from leaf of swamp iris (*Iris* sp.). 3 June 2006. Nathan Parker. APSU 18787 (color photo). 2) Shelton Ferry Wildlife Management Area (SFWMA), beaver marsh on Dawson Creek near edge of Cumberland River floodplain (36.4139°N, 87.2939°W). Adult male calling from Buttonbush. 19 June 2006. Nathan Parker. APSU 18788 (color photo). First record from SFWMA, which was the subject of a herpetofaunal survey in 1994 (Rozelle and Scott 1995). 3) Clarksville, Cumberland River floodplain near Clarksville Fairgrounds (36.5119N, 87.3672W). Amplectant pair and lone adult male, both on stems of Silver Maple (*Acer saccharinum*). 28 June 2006. Nathan Parker. APSU 18789-90 (color photos). 4) Haynes Bottom Wildlife Management Area (HBWMA), north shore of slough in floodplain of Cumberland River (36.4514°N, 87.4917°W). Adult male calling from introduced bush honeysuckle (*Lonicera* sp.). 14 August 2006. Nathan Parker. APSU 18791 (color photo). First record from HBWMA, which was the subject of a herpetofaunal survey in 1998–1999 (Scott and Williamson 1999).

Perry Co.: Southern Lobelville/ Beardstown area, along SR-13 just above edge of Buffalo River floodplain (35.6978°N, 87.8017°W). Adult male calling from herbaceous vegetation at margin of small cattle pond. 10 July 2006. Nathan Parker. APSU 18201 (alcohol specimen). First Perry Co. record; southernmost Buffalo River drainage record.

Rutherford Co.: Poole Knobs Recreation Area, peninsula in Percy Priest Lake (impounded Stones River) (36.0400°N, 86.5067°W). DOR, gravid female. 11 August 2006. Nathan Parker. APSU 18204 (alcohol specimen). First county record, first Stones River drainage record, easternmost record in Cumberland River drainage, and first record from Inner Nashville Basin, (EPA Ecoregion 71i- Griffith et al. 1998).

Tipton Co.: Centennial Island (35.3908°N, 90.1589°W). Two individuals, one adult male and one juvenile, in grassy puddle in cotton field. 8 July 2006. Nathan Parker. APSU 18202, 18206 (alcohol specimens). First county records. Augments the only published record for the county (Summers 2010).

Wilson Co.: Mt. Juliet, Clovercroft Trail (36.2622°N, 86.5611°W). 23 June 2012. Dennis Crumby. APSU 19255 (color photo). First county record.

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NATURAL HISTORY NOTES

CAUDATA — SALAMANDERS

***DESMOGNATHUS QUADRAMACULATUS* (Black-bellied Salamander). DIET.** *Desmognathus quadramaculatus* (Plethodontidae) is found in mountainous regions from southern West Virginia south to northern Georgia (Petranka 1998. Salamanders of the United States and Canada, pp. 282–287. Smithsonian Institution Press, Washington, DC, 587 pp.). Herein I report on the inclusion of yellow jacket wasps (*Vespula* sp.) in the diet of a wild *D. quadramaculatus*.

At ~0840 h, on 25 October 2012, I observed a young adult *D. quadramaculatus* after turning a stone in a small first-order stream in Rich Mountain Wildlife Management Area, Gilmer Co., Georgia, USA (34.77847°N, 84.30125°W, datum WGS84; elev. 681 m). Upon capture, the specimen regurgitated its stomach contents, which included the partial remains of at least two yellow jacket wasps (*Vespula* sp.; Fig. 1). Hymenopterans and "aerial prey" have been documented in dietary studies of *D. quadramaculatus* (Martof and Scott 1957. Ecology 38:494–501; Davic 1991. J. Herpetol. 25:108–111). However, no predation on *Vespula* has been previously reported and to my knowledge this is the first documentation of this genus in the diet of *D. quadramaculatus*. Of further interest is that the salamander showed no obvious symptoms or injuries related to anti-predatory wasp stings.

PHOTO BY ROBERT L. HILL



FIG. 1. *Desmognathus quadramaculatus* with regurgitated remains of *Vespula sp.*

Editorial assistance provided by J. R. Mendelson, III, and wasp identification confirmed by M. Goodisman.

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***NECTURUS MACULOSUS* (Mudpuppy). DIET.** Our surveys for *Necturus maculosus* (see below; Cochran and Borash 2014. Herpetol. Rev. 45:301–302) provided data on diet in a region where little information is available. Mudpuppies were collected by backpack electrofishing (pulsed DC) at three locations in tributaries of the Mississippi River in Minnesota, USA: Salem Creek, Dodge Co., 14 May 2009 (N = 5; mean total length = 24.5 cm); Upper Iowa River downstream, Fillmore Co., 07 April 2009 (N = 1; total length = 29 cm); Upper Iowa River upstream, Fillmore Co., 02 June 2009 (N = 1; total length = 17.4 cm). For precise locations of these sites, see Cochran and Borash 2014 (*op. cit.*) Gut contents were obtained by gastric lavage with a plastic squirt bottle, and, in one case, from a fecal pellet released by a specimen held overnight.

Based on previous reports (e.g., Harris 1959. Field and Laboratory 27:105–111; Cochran and Lyons 1985. Herpetol. Rev. 16:53), it was not surprising that six of seven mudpuppies had eaten aquatic insects (Table 1). However, all five Mudpuppies from Salem Creek had eaten Green Frog (*Lithobates clamitans*) tadpoles, and one contained an earthworm and a slug on a day when a recent rain had washed many of both taxa into the stream. One 25-cm Mudpuppy from Salem Creek contained a 46-mm Rainbow Darter (*Etheostoma caeruleum*), and another contained small ctenoid fish scales that were most likely from a darter. The freshness of the darter raised the possibility that it

TABLE 1. Prey items recovered from Mudpuppies (*Necturus maculosus*). The total number of prey of each type is indicated, along with the fraction of stomachs in which each prey type occurred and the lengths of individual prey items that were relatively intact. * = from walking legs.

Prey type	Number	Frequency	Prey length (mm)
Earthworm	1	1/7	84
Slug	1	1/7	13
Crayfish	2 claws*	1/7	
Heptageneid mayfly nymphs	13+	4/7	5,9,10
Caddisfly larval cases	2	2/7	
Tipulid cranefly larva	1	1/7	36
Chironomid midge larvae	4	2/7	5,6
Arthropod fragments	N/A	1/7	
Rainbow Darter	1	1/7	46
Ctenoid fish scales (darter?)	6	2/7	
Green Frog tadpoles	7	5/7	25,45

had been eaten in the collecting bucket; however, Mudpuppies are known to feed at least occasionally on fish (Thomas et al. 2007. Herpetol. Rev. 38:433–434, and references therein).

We thank Melissa Markert, Cassandra Hulett, and Rebecca Snyder for assistance in the field. Liz Harper of the Minnesota Department of Natural Resources facilitated our Mudpuppy survey, which was funded by a contract from that organization.

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***NECTURUS MACULOSUS* (Mudpuppy). HABITAT.** Our surveys of streams in southeastern Minnesota, USA in 2009 provided data on distribution and habitat of *Necturus maculosus* in a region where little information is available. Mudpuppies were collected by backpack electrofishing (pulsed DC) in several drainages tributary to the Mississippi River (Table 1). Habitat data for most stream reaches where Mudpuppies were captured were obtained at equally-spaced intervals along a series of 10 randomly selected transects across the stream. Current velocity in the water column (0.6 × depth) and at the bottom was measured when possible with an Owen River Hydroprop. Substrate within a 30-cm radius of each point was categorized by visual estimation of percentage composition of bedrock, boulder (> 30 cm), large cobble (15–30 cm), small cobble (2.5–15 cm), gravel (0.2–2.5 cm), sand (< 0.2 cm), silt (suspendable sediment), and "other" (usually organic debris). Single measurements of temperature, dissolved oxygen, and specific conductance were obtained at most stream reaches.

Stream reaches with Mudpuppies were relatively large in comparison to streams without Mudpuppies. They tended to be relatively wide and to be dominated by coarse, hard substrate (Table 1). They usually were dominated by riffles and runs and were well oxygenated. Within each stream reach where Mudpuppies occurred, the actual sites of collection tended to be within runs in areas where slab rock was present, often exposed as shelving outcrops along the bank margins. Electrofishing was not efficient at pulling Mudpuppies from beneath the cover of large rock slabs; we sampled the North Branch Root River site five times before collecting a Mudpuppy.

During surveys in 2009, we sampled 25 sites on 17 streams, and during similar sampling in 2008, we sampled 53 sites on 30 streams. We did not find Mudpuppies in any of the 22 coldwater trout streams we sampled. Fish species collected at each of the sites with Mudpuppies are typical of cool- or warm-water streams: Common Shiner (*Notropis cornutus*), stoneroller

TABLE 1. Habitat data for stream reaches where Mudpuppies (*Necturus maculosus*) were collected in 2009. Number of measurements is indicated in parentheses after each mean, and for some measurements ranges are also provided. At the North Branch Root River, a single transect was established at the site of Mudpuppy capture.

Stream	Salem Creek	Upper Iowa River, downstream	Upper Iowa River, upstream	North Branch Root River
County	Dodge	Fillmore	Fillmore	Olmsted
Coordinates (datum WGS 84)	43.96550°N 92.73780°W	43.50370°N 92.11480°W	43.50160°N 92.14080°W	43.92280°N 92.36510°W
Date	14 May	07 April	02 June	01 October
Total Lengths (cm)	18,25,25.5,26,28	29	10.9,11.6,17.4	9.5
Habitat Date	18 May	19 May	6 June	1 October
Reach Length (m)	300	120	300	–
Width (m)	10.5 (10) 7.9–16.0	29.7 (10) 23.9–34.5	27.3 (10) 23.1–29.2	14.7 (1)
Depth (cm)	29 (30) 4–63	37 (44) 0–82	35 (47) 7–52	19 (4) 3–27
Current Speed (m/sec)	0.20 (23) 0.05–0.52	0.43 (41) 0.07–0.84	0.52 (47) 0.30–0.95	
Bottom Current Speed (m/s)	0.14 (25) 0.05–0.49	0.21 (41) 0.07–0.41	0.36 (48) 0.09–0.63	
Dissolved Oxygen (mg/l)	14.2	13.3		
Specific Conductance (µS/cm)	501	440		544
Temperature (°C)	13.3	20.5		12.5
% Bedrock	21.2 (29)	0.0 (44)	0.0 (48)	0.0 (4)
% Boulder	21.2 (29)	0.0 (44)	5.7 (48)	22.5 (4)
% Large Cobble	16.4 (29)	8.8 (44)	17.3 (48)	23.8 (4)
% Small Cobble	6.4 (29)	20.1 (44)	20.8 (48)	28.8 (4)
% Gravel	4.3 (29)	34.4 (44)	23.6 (48)	0.0 (4)
% Sand	8.1 (29)	27.3 (44)	28.6 (48)	22.5 (4)
% Silt	9.5 (29)	7.4 (44)	2.3 (48)	1.3 (4)
% Other	13.6 (29)	2.5 (44)	1.1 (48)	1.3 (4)

(*Campostoma* spp.), Hornyhead Chub (*Nocomis biguttatus*), Bluntnose Minnow (*Pimephales notatus*), White Sucker (*Catostomus commersoni*), Rock Bass (*Ambloplites rupestris*), and Johnny (*Etheostoma nigrum*), Rainbow (*E. caeruleum*), and Fantail Darters (*E. flabellare*). Stonecats (*Noturus flavus*) were found with Mudpuppies at all but one of the Upper Iowa River sites; like the Mudpuppy, this species is strongly associated with rock slabs or boulders.

We thank Melissa Markert, Cassandra Hulett, and Rebecca Snyder for assistance in the field. Liz Harper of the Minnesota Department of Natural Resources facilitated our Mudpuppy survey, which was funded by a contract from that organization.

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PLETHODON CHATTAHOOCHEE **(Chattahoochee Slimy Salamander). PREDATION.** Relatively few instances of predation upon members of the *Plethodon glutinosus* complex have been reported. To our knowledge, predation by *Thamnophis sirtalis* (Common Gartersnake) has been reported for *P. cylindraceus* (Uhler et al. 1939. Trans. Am. Wildl. Conf. 4:605–622), *P. albagula* (Konvalinka and Trauth 2003. Herpetol. Rev. 34:378), and *P. glutinosus* (McCoard 2008. Unpubl. MS Thesis. Marshall University). Here, we report the first documented instance of predation of *P. chattahoochee* by *T. sirtalis*. At approximately 1400 h on 13 April 2013, we encountered a small adult *T. sirtalis* swallowing the last few inches of the tail of an adult *P. chattahoochee* in Fannin Co., Georgia, USA (34.73923°N, 84.141092°W, datum: WGS 84). Upon being discovered, the snake rapidly swallowed the remainder of the salamander and crawled away (Fig. 1). Soil and leaf litter were stuck to the face and snout of the snake presumably due to the defensive skin secretions produced by the salamander.

PHOTOGRAPH BY MALAVIKA RAJEEV.



FIG. 1. *Thamnophis sirtalis* swallowing *Plethodon chattahoochee*, showing debris stuck to the face of the snake.

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SIREN LACERTINA **(Greater Siren). HABITAT.** Typically, *Siren lacertina* is associated with permanent or semi-permanent freshwater marshes, rivers, lakes and other freshwater bodies throughout the southeastern United States (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Books, Washington, DC. 587 pp.). Though some salamanders have displayed salt tolerance, including *Siren lacertina* (Neill 1958. Bull. Mar. Sci. Gulf Caribb. 8:1–96) and the closely related *S. intermedia* (Asquith and Altig 1986. Comp. Biochem. Physiol. 84:683–685), observations of estuarine water habitat usage by caudates is rare in the literature.

On 04 May 2013, while conducting aquatic surveys using standard aquatic funnel traps in Everglades National Park, Dade Co., Florida, USA, two *S. lacertina* were trapped at a sampling site directly adjacent the Main Park Rd near the Hell's Bay canoe trail launch (25.232367°N, 80.823283°W; datum WGS 84). The habitat was a monoculture of Red Mangrove (*Rhizophora mangle*), and salinity was measured with a refractometer (Cole-Parmer RHS-10/ATC). Salinity at the time of capture was 4 ‰, indicative of the oligohaline mixing of upper estuaries typical in the southern Everglades (Davis et al. 2005. Wetlands 25:832–842). Specimens were photographed, but not vouchered due to permit constraints. This represents the first documented instance of mangrove swamp habitat usage and one of only two (Neill, *op. cit.*) known instances of tolerance of saline conditions by *S. lacertina*. Red mangrove provides a highly structured habitat that *S. lacertina* may prefer given its well-known preference for such microhabitats (Petranka, *op. cit.*).

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TRITURUS IVANBURESCHI **(Buresch's Crested Newt). DEFENSIVE BEHAVIOR.** Defensive behaviors of salamanders have been well reviewed (Brodie et al. 1974. Herpetologica 30:79–85; Brodie 1977. Copeia 1977:523–535). *Triturus ivanbureschi* is a member of the *T. karelinii* group (Salamandridae), which is distributed over the south-eastern Balkan Peninsula, covering most of Bulgaria, eastern parts of Greece, eastern Republic of Macedonia, Serbia, European and Asian Turkey (western parts up to ca. 300 km inland; Wielstra et al. 2013. Zootaxa 3682:441–453). To date, the defensive behavior of this species has not been described.

On 5 April 2005, one of us (PB) found and photographed a subadult specimen of *T. ivanbureschi* near Primorsko in southeastern Bulgaria (42.31435°N, 27.75773°E, datum WGS 84; elev. 103 m). The specimen was found under a stone together with a specimen of the snake *Malpolon insignitus*. The salamander coiled its tail and upper part of the body while was being handled. After releasing it on the ground, the salamander remained in the same position, then it also crooked its front and back finger tips, closed its eyes, lifted up the back part of its body above ground at which time we observed the aposematic coloration on the ventral part of its body (Fig. 1A, B). It remained in this position for two minutes and after that it returned to its normal position.

We observed three of the basic antipredator behaviors typical of salamandrids: defensive posture, immobility, and presentation of ventral aposematic coloration (Brodie et al. 1974, *op. cit.*; Brodie 1977, *op. cit.*; Grillitsch 1983. Salamandra 20:61–63; Marco and Leguía 2001. Rev. Esp. Herpetol. 15:5–11). By exposing brightly colored parts of the body, individuals warn (or possibly confuse,



FIG. 1. *Triturus ivanbureschi* in defensive posture. A) lateral view. B) dorsal view.

see Batesian mimicry) their potential predators about noxious or toxic skin secretions, which is well known in many species of amphibians (cf. Brodie et al. 1974, *op. cit.*; Brodie 1977, *op. cit.*; Toledo et al. 2011, *op. cit.*). In addition, by coiling in an immobile position, the salamander probably hampers recognition as prey by a snake, bird, or mammal predator.

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ANURA — FROGS

***ANAXYRUS BOREAS* (Western Toad). PREDATION.** Unpalatability to predators is a well-documented defense mechanism found in several families of amphibians (Peterson and Blaustein 1990. Ethol. Ecol. Evol. 3:63–72). However, there is some debate over whether larval amphibians benefit from chemical defenses. A review of the palatability of amphibian larvae revealed they were consumed by predators in 89% of experimental trials. Furthermore, even though bufonid larvae are often considered unpalatable, they were consumed at similar rates as all other species (Gunzburger and Travis 2005. J. Herpetol. 39:547–571). Nonetheless, bufonid eggs and hatchlings may be less palatable than older larval stages (Brodie and Formanowicz 1987. Herpetologica 43:369–373).

Anaxyrus boreas is an example of a species that uses chemical defenses against predators (Peterson and Blaustein 1990, *op. cit.*). On 23 May 2013, we observed a congregation of nine adult Barred Tiger Salamanders (*Ambystoma mavortium*) consuming recently-hatched boreal toad larvae (Gosner stage 20–23) at a constructed wetland near Moran, Wyoming, USA (43.832443°N, 110.35512°W, datum: WGS 84). After capturing three salamanders (all males) for a mark-recapture study we observed that their stomachs were noticeably engorged. The salamanders were anesthetized with MS-222 prior to PIT-tagging. As the salamanders were recuperating, but still unconscious, we observed tadpoles swimming out of their mouths. We monitored the salamanders for another hour after they awakened but no other tadpoles emerged. All tadpoles appeared un-masticated with no visible injury.

Previous accounts have suggested larval tiger salamanders might prey upon *A. boreas* tadpoles (Dodd 2013. Frogs of the United States and Canada, Volume 1. The Johns Hopkins University Press, Baltimore, Maryland. 460 pp.), which our observations now verify. Perhaps because the salamanders are suction feeders that engulf, rather than chew their prey, they were less affected by toxins that may have been present in the hatchlings (Pearl and Hayes 2002. Am. Midl. Nat. 147:145–152).

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***BUFO BUFO* (Common Toad). PREDATION.** On 22 March 2012, during an amphibian survey in Cuenca province, in eastern Spain (40.02250°N, 1.98288°W, datum: WGS84), an Ardea cinerea (Grey Heron) was found trying to swallow a large, female Bufo bufo. The heron flew to the top of a nearby tree. The heron had pierced the body cavity of the toad with its beak, revealing egg strings dangling from the injury. After a few minutes the heron came back to the pond, and continued trying to clean the toad in the water. Handling of the prey continued for more than ten minutes, and later the heron fled away from the pond with the toad in its beak. Throughout the predation event the toad appeared motionless and we assumed it was dead. We are uncertain whether the heron eventually consumed the toad. Taking into account that the observation was coincident with the breeding season of A. cinerea in Spain, it is possible that the toad could be transported to the nest to feed the fledglings.

Ardea cinerea is opportunistic predator; its diet consists mainly of fish, but it can prey on amphibians, reptiles, birds, and even mammals (Kushlan and Hancock 2005. The Herons. Oxford University Press, Oxford, U.K. 433 pp.). Usually its prey is swallowed without handling. But during this observation we witnessed a long period of handling of the prey by the heron. This was probably due to the presence of parotid glands, and also due to the presence of eggs protruding from the female toad, which are also unpalatable and toxic (Litch 1968. Herpetologica 24:93–98). *B. bufo* is usually discarded by predators due to its toxicity.

Some predators are able to cope with this problem using specific handling techniques, e.g., "progressive skinning" (Slater 2002. IUCN Otter Spec. Group Bull. 19:25–29), as in Eurasian otters (*Lutra lutra*; Ayres and García 2011. Mammal. Biol. 76:90–92). *A. cinerea* harpoons its prey, and the only handling technique that is used is washing the prey before swallowing it.

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***HYLOSCIRTUS PALMERI* (Palmer's Treefrog). PREDATION.** Anurans are often the most abundant terrestrial vertebrates in tropical regions, and they are widely available as prey for other vertebrates (Vitt and Caldwell 2009. Herpetology: An Introductory Biology of Amphibians and Reptiles. Third Edition. Academic Press, San Diego. 697 pp.) and invertebrates (Toledo 2005. Herpetol. Rev. 36:395–400). Among invertebrates, spiders are potential predators of anurans (Toledo et al. 2007. J. Zool. 271:170–177). Few reports have documented arboreal anurans as prey of spiders (e.g., Ortega-Andrade et al. 2011. Pap. Avulsos Zool. 51:1–19; Almeida-Reinoso and Coloma 2012. Herpetol. Rev. 43:126).

At 2120 h on 19 January 2009, during a field survey in El Palmar Creek, La Sonrisa village, municipality of Samaná, Department of Caldas, Colombia (5.61500°N, 74.95720°W, datum: WGS84, elev. = 714 m), an individual of *Xenesthis immanis* (Araneae: Theraphosidae) was observed carrying an individual of *Hyloscirtus palmeri* (Hylidae) in its chelicerae and moving between rocks along the creek. We did not collect the spider and frog, because the spider escaped with its prey and jumped into the water when we tried to capture them. Both species are widely distributed and well-represented in the region, and we have over five years' experience researching the ecology of frogs and spiders in the area. The spider is a large species with a conspicuous coloration (metallic purple) facilitating its recognition in the field. LER-O confirmed the identity of the spider.

Globally, wandering spiders (Ctenidae) and fisher spiders (Pisauridae) have been recorded as the most common predators of anurans (Da Costa et al. 2006. Herpetol. Rev. 37:337–338; Melo-Sampaio et al. 2012. Herpetol. Rev. 43:636–637), whereas predation by tarantulas on anurans is not frequently documented (e.g., Ortega-Andrade et al. 2011, *op. cit.*). To our knowledge, this is the first report of predation on the frog *H. palmeri* by the tarantula *X. immanis*.

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***LEPTODACTYLUS MACROSTERNUM* (Rã-Caçote). DIET.** *Leptodactylus macrosternum* is a medium-sized nocturnal anuran with a diet consisting mainly of arthropods. Species of this genus are considered generalists and can adapt to disturbed areas. Studies on the natural history of leptodactylidae indicate that crustaceans are present in their diet (De-Carvalho et al. 2008. Biota Neotrop. 18:105–115). These include amphipods and isopods, and less frequently, decapod crustaceans. To investigate the diet of *L. macrosternum*, we collected 30 specimens of *L. macrosternum* on 12 September 2011 in one weir (located in the municipality Milagres, Ceará State, northeastern Brazil (7.301872°S, 38.98416°W; WGS 84). The analysis of the stomach contents of the frogs showed the presence of the shrimp *Macrobrachium jelskii* (Crustacea: Decapoda), in one of the specimens of *L. macrosternum* collected. This constitutes the first decapod known in the diet of this species.

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***LITHOBATES CATESBEIANUS* (American Bullfrog). HABITAT.** *Lithobates catesbeianus* is common throughout its native range in eastern North America. They are highly aquatic frogs and are usually associated with permanent bodies of water where breeding occurs (Casper and Hendricks 2005. *In* Lannoo et al. [eds.], Amphibian Declines: The Conservation Status of United States Species, pp. 540–556. Univ. California Press, Berkeley). However, *L. catesbeianus* is occasionally encountered in terrestrial, upland habitats (Bohnsack 1952. Copeia 1952[2]:114; Bennett et al. 1980. Am. Midl. Nat. 103:412–416; McLeod and Gates 1998. Am. Midl. Nat. 139:164–177), which is likely often the result of juvenile dispersal (Casper and Hendricks, *op. cit.*). These few reports of the use of the terrestrial environment by *L. catesbeianus* indicate that this may be an underappreciated aspect of its ecology that requires further documentation. Here, I report juvenile *L. catesbeianus* occupying refugia in a dried temporary pool. On 22 October 2013, I visited the dry basin of an ephemeral pond located in a forest in State Game Lands #176, Centre Co., Pennsylvania, USA (40.795478°N, 77.952322°W; datum WGS 1984). This small pond (<0.1 ha) is typically dry throughout the summer and autumn but supports the larvae of the vernal pool specialists *L. sylvaticus* (Wood Frog), *Ambystoma maculatum* (Spotted Salamander), and *A. opacum* (Marbled Salamanders). I overturned approx. 20 stones (ranging from approx. 15–45 cm in length), which were partly sunk into the soil, while searching for *A. opacum* nests. Under 4 stones, I instead found individual juvenile *L. catesbeianus* (approx. 4 cm SVL). They were crouching in depressions under the stones and were relatively inactive despite the disturbance. There was no standing water or any excess moisture under these or any stones in the pond basin. The short hydroperiod of this pond makes it almost certain that these frogs underwent their larval period in another, more permanent pond; the nearest such pond known to support *L. catesbeianus* is approx. 750 m away. Given the apparent age of the frogs, I assume they probably metamorphosed several months prior in the summer and were dispersing through upland habitats to locate new breeding ponds (Willis et al. 1956. Copeia 1956:30–41) and may have been hibernating in this location during their post-metamorphic dispersal. *L. catesbeianus* are likely capable of

successfully overwintering in dried ephemeral ponds. Although aquatic hibernation is typical, one report of terrestrial hibernation of *L. catesbeianus* supports this possibility (Bohnsack, *op. cit.*), and the number of individuals I observed within the pond basin suggests that they may select terrestrial refuges in locations likely to be inundated with water.

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***LITHOBATES CLAMITANS MELANOTA* (Northern Green Frog). MYIASIS.** At 1300 h on 22 July 2013, southwest of the Powdermill Nature Reserve, Westmoreland Co., Pennsylvania, USA (40.155243°N, 79.288798°W, datum WGS84; elev. 461 m), I observed and photographed an adult female *Lithobates clamitans melanota* exhibiting widespread symptoms of ectoparasitism by dipteran eggs (2–4 mm). The frog was 86 mm SVL and 45 mm in tibia–fibula length. Cursory examination of the specimen from a distance showed it to be alive, ambulatory, but with obvious signs of tissue damage, impaired motor skills, and other physical stresses (Fig. 1). When approached, the frog would make quick spasmodic movements displacing several adult dipterans. Intermittent and sequential stops by the frog would result in the return of the mature flies. After capture and closer examination, the cloaca, axillary creases, groin folds, and various mid-body lacerations exhibited an extensive degree of infestation. This pathological condition is technically known as myiasis. The frog exhibited an extensive degree of wound and cutaneous myiasis (Fig. 1). For this individual, the high levels of soft tissue damage and the clear signs of morbidity appeared to be reaching fatal stages. The dipteran species responsible for this condition was not identified.

Several cases of amphibian myiasis have been described in North America. For instance, in Colorado, *Anaxyrus boreas* (Boreal Toad) was parasitized by the blowfly larvae of *Bufolucilia elongata* (James and Maslin 1947. J. Washington Acad. Sci. 37:366–368). In California, *L. catesbeianus* (American Bullfrog) was observed exhibiting ophthalmic myiasis by the larvae of *B. silvarum* (Anderson and Bennett 1963. Can. J. Zool. 41:1169–1170). In Wisconsin, several individuals from a population of juvenile *L. sylvaticus* (Wood Frog) were observed exhibiting fatal myiasis induced by larvae of *B. silvarum* and *B. elongata* (Bolek and Janovy 2004. J. Parasitol. 90:1169–1171). To my knowledge the observation reported herein represents the first record of fatal myiasis in *L. c. melanota*.

I thank the staff of the Powdermill Nature Reserve (PNR) and the Carnegie Museum of Natural History, especially the Director of PNR, John W. Wenzel.

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***LITHOBATES HECKSCHERI* (River Frog). MASS METAMORPHOSIS.** River Frog tadpoles are well known for their unique (among eastern North American ranids) schooling behavior (Altig and Christensen 1981. J. Herpetol. 15:151–154), which likely contributes to relatively equal growth of siblings because each tadpole within a school is exposed to similar water temperatures and foraging conditions. Consequently, near-synchronous metamorphosis of entire cohorts in this species should not be unexpected. Several observations of mass emergences have indeed been made (Wright and Wright 1933. Handbook of Frogs and Toads. Comstock Publishing Associates, Ithaca, New York. 652 pp.; Herrington 2009. Georgia J. Sci. 67:38) but only rough guesses (e.g., "thousands") as to the number of froglets involved were attempted.

On 31 May 2013 in Lee Co., Georgia, USA, in a swamp associated with a tributary of Muckalee Creek (31.816036°N, 84.132703°W; WGS 84), one of us (JW) encountered a tremendously large aggregation of transforming frogs along and adjacent to the bank of the wetland. Photographs were taken and sent to JBJ for positive identification as River Frogs. JW estimated that frogs seen depicted here (Fig. 1) represented about one-fifth of the entire aggregation. At least 856 individual river frogs were counted in the Fig. 1 photograph, which makes the full aggregation likely in excess of 4000 individuals. The same large aggregation was observed again on 06 June 2013, but when next visited on 15 June 2013 it had completely disappeared because the froglets likely dispersed (or were eaten). The clutch size of a single female River Frog ranges from 5000–14,000 eggs (Dodd 2013. Frogs of the United States and Canada. Johns Hopkins University Press, Baltimore, Maryland. 1032 pp.), so it is quite possible that many, or perhaps all, of the frogs observed were siblings. Schooling



FIG. 1. Lateral view of an adult female Northern Green Frog, *Lithobates clamitans melanota*, exhibiting widespread symptoms of myiasis.



FIG. 1. Recently transformed River Frogs, *Lithobates heckscheri*, in a Lee Co., Georgia, USA swamp.

behavior facilitated by kin recognition has been documented in American Toads (*Anaxyrus americanus*) and other species (Dodd 2013, *op. cit.*), but this not been studied in River Frogs.

Despite the abundance and availability of prey, neither Herrington (2009, *op. cit.*) nor we saw any anuran predators (such as wading birds) among our observed emergence aggregations, suggesting that perhaps metamorphosing River Frogs are noxious or distasteful, as has been suggested though unproven of their tadpoles (Altig and Christensen 1981, *op. cit.*). Alternatively, such mass emergences could be adaptive and result in predator satiation, as with periodic cicadas (Williams et al. 1993. Ecology 74:1143–1152). Further research is clearly needed to explain the mechanisms involved in, and the survival strategies of, such synchronous emergences of metamorphosing River Frogs.

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***LITHOBATES PALMIPES* (Green Rana). FORELIMB MALFORMATION.** The considerable increase in the number of records of malformations in amphibians has drawn the attention of many researchers (Meteyer et al. 2000. Teratology 62:151–171). On 22 May 2011, 16 *Lithobates palmipes* tadpoles were collected from a pond located in the São Nicolau Farm in the municipality of Cotriguaçu, Mato Grosso, Brazil (9.819417°S, 58.258639°W, datum WGS 84; elev. 199 m). The tadpoles were kept in captivity for later identification. However, one of the individuals (ABAM-H 612, SVL = 3.86 cm) developed one extra forelimb. For this reason, its growth was measured in different stages (Fig. 1). More studies should be performed to shed light on the scope, incidence, characteristics, and cause of anuran malformations (Meteyer 2000. Field Guide to Malformations of Frogs and Toads with Radiographic Interpretations. U.S. Department of the Interior, U.S. Geological Survey, National Wildlife Health Center. 18 pp.).

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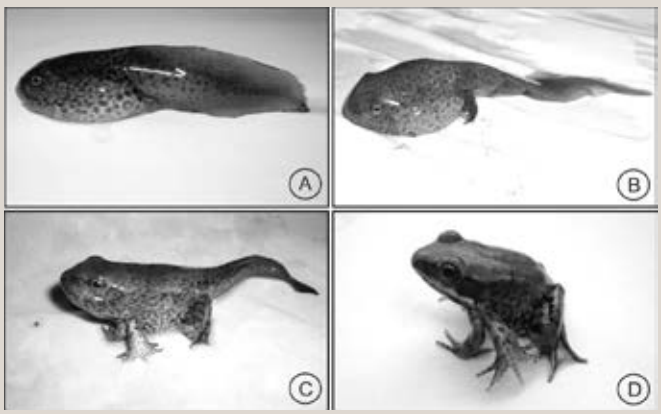


FIG. 1. A) Recently captured *Lithobates palmipes* tadpole, ± 20 days after hatching. B) Tadpole ± 24 days after hatching. C) Tadpole ± 30 days after hatching. D) Juvenile ± 35 days after hatching.

***NOTADEN BENNETTII* (Crucifix Frog). PEDAL LURING.** Prey luring behavior has been recorded in various squamate groups such as vipers, pythons, elapids, and skinks, as well as some cheloniids (Vitt and Caldwell 2013. Herpetology: An Introductory Biology of Amphibians and Reptiles. 4th ed. Academic Press, London. 757 pp.). In amphibians such as salamanders (Bavetz 1994. J. Herpetol. 28:504–506), pedal luring involves utilizing the toes and feet as the lures. Pedal luring has also been recorded in anurans, such as the terrestrial leptodactylid frog *Ceratophrys calcarata* (Murphy 1976. Herpetologica 32:339–341), the tree frog *Phyllomedusa burmeisteri* (Bertoluci 2002. Phyllomedusa 1:93), and possibly occurs in dendrobatids (Murphy 1976, *op. cit.*).

Notaden bennettii (Myobatrachidae) appears to also exhibit this behavior. We observed captive individuals kept at the Australian Museum (in Sydney) wiggling the tips of the fourth and fifth toes when they are in the proximity of prey. Both back feet were usually wiggled at the same time while the rest of the frog was immobile.

Although in the past apparent pedal luring was seen when the frogs were given ants, it was also seen in response to cricket prey. *Notaden bennettii* readily feeds on other small invertebrates, although ants are the main prey (Cogger 2001. Reptiles and Amphibians of Australia. New Holland/Reed, Sydney. 808 pp.). We recorded this behavior, which can be viewed at: http://www.youtube.com/watch?v=JujxVr2immk.

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***PSEUDIS PLATENSIS* (Paradox Frog). PREDATION.** Amphibians are common prey for a great variety of vertebrates, arthropods, and even carnivorous plants (Duellman and Trueb 1986. Biology of Amphibians. McGraw-Hill, New York. 670 pp.; Pough et al. 1998. Herpetology. Prentice-Hall, New Jersey. 577 pp.). Known predators of *Pseudis platensis* are *Caiman yacare* (Santos et al. 1996. Herpetol. J. 6:111–117.), *Tigrisoma lineatum* (Prado 2003. Herpetol. Rev. 34:231–232), and *Guira guira* (Landgref Filho et



FIG. 1. *Pseudis platensis* being preyed on by *Hoplias* (*gr. malabaricus*) in Corumbá, Mato Grosso do Sul State, Brazil.

al. 2011. Herpetol. Rev. 42:90). At 1900 h on 26 May 2013, on the margin of a pond in the municipality of Corumbá, Mato Grosso do Sul State, Brazil (18.232492°S, 55.745097°W, datum: SAD 69), we observed *P. platensis* predation by *Hoplias* cf. *malabaricus* (Fig. 1). The diet of *Hoplias* is made up mostly of fishes (Lowe-McConnell 1975. Fish communities in tropical freshwaters: their distribution, ecology and evolution. Longman, London. 337 pp.), however, one study confirmed their predation on *Rhinella ornnata* (Haddad and Bastos 1997. Amphibia-Reptilia 18:295–298). This is the first record of *P. platensis* being consumed by *Hoplias*.

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***RHINELLA CRUCIFER* (Sapo Cururuzinho; Striped Toad). HINDLIMB MALFORMATION.** The widespread occurrence of deformities of frogs has recently been perceived as a major environmental problem and should be reported in the scientific literature (Johnson et al. 2003. Cons. Biol. 17:1724–1737.). During a nocturnal survey on 10 July 2004, RBF collected a calling male of *Rhinella crucifer* (SVL = 63 mm) at the margin of a 3 × 3 m natural pond in the district of Alto Nova Almeida, municipality of Marechal Floriano, Espírito Santo state, Brazil (40.828208°W, 20.404561°S, datum WGS84; elev. 835 m). This specimen (MBML 7640) is deposited in the Zoological Collection of Museu de Biologia Mello Leitão, Santa Teresa municipality, Espírito Santo state, Brazil. This specimen has an abnormal right leg with a 3 mm outward curved, swollen, and calcified projection on the joint formation of its tibiofibula-tarsus (Fig. 1A). A radiography revealed that the right leg (27.3 mm) has a longer distal portion of its tibiofibula compared to the left leg (23.3 mm; Fig. 1B). It is likely that these anomalies originated during either embryonic or metamorphic stage of this *R. crucifer* due to the curvature of the distal portion of these bones. However this limb deformity did not prevent this specimen from reaching adulthood.

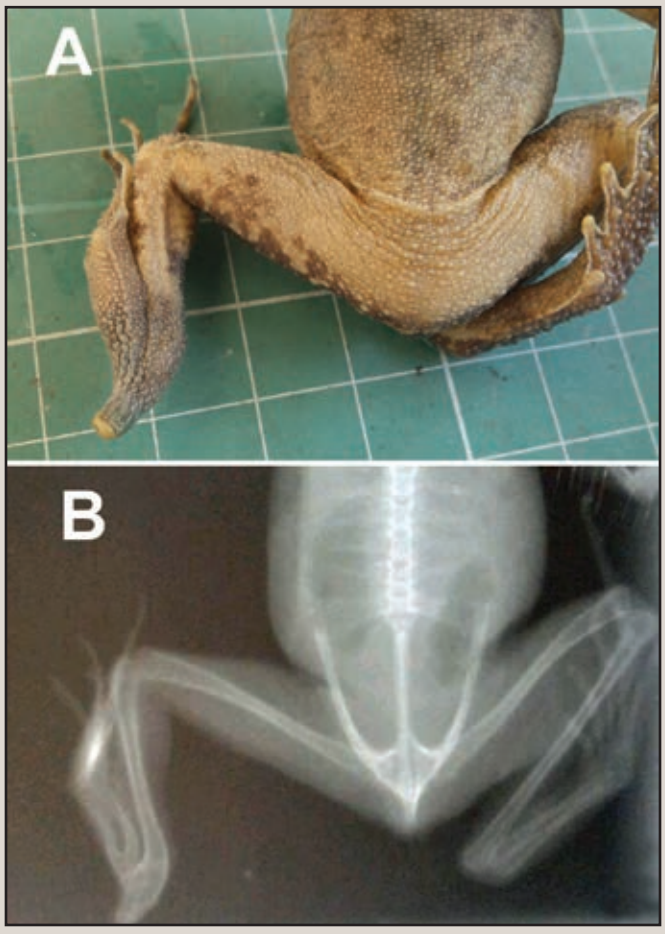


FIG. 1. Ventral view of an abnormal right limb of *Rhinella crucifer* from Espírito Santo state, Brazil. A) Photograph and B) radiograph.

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***TRACHYCEPHALUS TYPHONIUS* (Common Milk Frog). PREDATION.** Frogs are preyed upon by a great variety of invertebrates (Toledo 2005. Herpetol. Rev. 36:395–400), vertebrates (Centeno et al. 2010. Herpetol. Rev. 3:91–92), and even carnivorous plants (Duellman and Trueb 1994. Biology of Amphibians. Johns Hopkins University Press, Baltimore. 670 pp.). Herein, we describe an *in situ* observation of predation of a juvenile *Trachycephalus typhonius* (Hylidae) by the mantis *Stagmatoptera binotata* (Mantidae: Stagmatopterinae). At 0938 h on 18 March 2013, in a residence in the municipality of Santana, State of Amapá, Brazil (0.036311°N, 51.162481°W, datum WGS84; elev. 26 m), we observed the mantis holding the frog with its raptorial forelegs. The observations lasted 15–20 min. The mantis was an adult female measuring 68 mm. The role of mantis predation is well known in literature; however, reports of mantids preying upon anurans are scarce and only occasional (Pombal Jr. 2007. Rev. Bras. Biol. 24:841–843). Data here presented constitute the first record of *S. binotata* preying upon *T. thphonius*.

We are grateful to Cesar Augusto Favacho of Emilio Goeldi Paraense Museum for her help with the identification of the mantis.

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TESTUDINES — TURTLES

***ACTINEMYS MARMORATA* (Western Pond Turtle). NEST PREDATION ASSOCIATION.** *Actinemys marmorata* is one of two native turtles in California, and a Species of Special Concern (Jennings and Hayes 1994. Amphibian and Reptile Species of Concern. California Department of Fish and Game, Sacramento, California. 255 pp.). This turtle also occurs in Oregon and Washington, where it is listed as critically sensitive and endangered, respectively. The species has experienced significant

habitat loss, alteration, and fragmentation over a majority of its range (Bury et al. 2012. Northwest Fauna 7:1–128). Habitat disturbances frequently occur in the uplands associated with the turtle's nesting habitat, limiting nest-site access and reducing recruitment rates. We report an additional confounding impact: an unexpected association between manmade infrastructure (fencing) and a high level of nest-site predation on a population of *A. marmorata*.

Moorhen Marsh, part of the Peyton Slough Marsh Complex, is a 21-acre constructed freshwater wetland owned and operated by the Mt. View Sanitary District (MVSD) in Martinez, California. Built in 1974, Moorhen Marsh is bordered by the Shell-Martinez Oil Refinery, MVSD's wastewater treatment plant, and Interstate 680 (Fig. 1). The marsh is managed by the MVSD primarily as habitat for native wildlife, including migratory birds and sensitive species, and for environmental education and research. *Actinemys marmorata* has been a focus of study on this site for several years, including efforts to determine the timing, location, and extent of nesting habitat. In the course of this study, we observed significant predation of recently constructed nests (predation was assumed based on excavated nests and empty and/or fragmented eggshells). A total of 18 predated turtle nests were found over a nearly two-month period (8 June–22 July 2013). Sixteen nests were determined to be those of *A. marmorata*; the other two were believed to have been made by *Trachemys scripta* (Red-eared Slider), a nonnative in California. All predated nests were located within 10 m of open water. Three *A. marmorata* nests were on a 3-m wide levee, within 1 m of the water's edge. A single *A. marmorata* nest was on a slope that borders the aquatic habitat and the treatment plant, within 5 m of the water. The remaining 12 *A. marmorata* nests and the two *T. scripta* nests (i.e., the great majority of predated nests) were found along the western and southern boundaries of the refinery's chain-link security fence that borders the project site (Fig. 1).



FIG. 1. Locations of predated Western Pond Turtle nests (red dots) within Moorhen Marsh, east of Martinez, California. Yellow dots indicate predated Red-eared Slider nests. Dashed blue line delineates chain-link boundary fencing.

We determined—through tracks, trails, direct observation, and camera stations—that the fence line was functioning to direct and concentrate potential predators along the western and southern borders of the marsh. Coincidentally, the fence impeded the upland extent to which *A. marmorata* could travel within the project site. Common use of the fence-line route by Red Fox (*Vulpes vulpes*), Gray Fox (*Urocyon cinereoargenteus*), Striped Skunk (*Mephitis mephitis*), Raccoon (*Procyon lotor*), and other species had created areas of patchy soil along the fence. This combination—open soil/grassland microhabitat, conditions ideal for turtle nesting—likely caused *A. marmorata* to nest in sites closely associated with predator pathways. Although we do not know the overall percentage of nests lost to predation, we observed the loss of 16 *A. marmorata* nests in 45 days. We speculate that approximately 30 adult female *A. marmorata* occupy the marsh; if our count is accurate, this attrition would represent a significant level of predation to nesting turtles on the site.

It appears clear that some barriers to movement (e.g., low-hanging chain-link fence) may be associated with increased predation events for nesting turtles. We recommend, when feasible, increasing the gap between fencing and the ground to allow turtles increased access to upland areas for nesting. If other barriers are constructed in the presence of turtle habitat, careful consideration should be given to reducing the potential for concentrated predation, particularly for declining species such as *A. marmorata*.

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***APALONE FEROX* (Florida Softshell). TOLERANCE TO FIRE ANTS.** Many species of terrestrial reptiles are reported to have had fatal encounters with red imported fire ants (*Solenopsis invicta*) (Allen et al. 2004. Am. Midl. Nat. 152:88–103). The ants prefer disturbed areas in full to partial sun (Tschinkel 1988. Ann. Entomol. Soc. America 69:76–81), which coincides with preferred nesting habitat for many turtles (Ernst and Lovich 2009. Turtles of the United States and Canada. 2nd ed., Johns Hopkins Univ. Press, Baltimore, Maryland. 827 pp.). Hatchlings of numerous turtle species have fallen victim to fire ants, particularly once eggs have pipped (Landers et al. 1980. Herpetologica 36:353–361; Mount et al. 1981. J. Alabama Acad. Sci. 52:71–78; Conners 1998. Herpetol. Rev. 29:235; Buhlmann and Coffman 2001. J. Elisha Mitchell Sci. Soc. 117:94–100). Montgomery (1996. Bull. Chicago Herpetol. Soc. 31:105–106) reported several observations of adult *Terrapene carolina* killed by fire ants. Whiting (1994. Herpetol. Rev. 25:25) observed a *Pseudemys texana* female abandon her nest prematurely after being stung by about 150–200 fire ants, and Ferrell (2006. Herpetol. Rev. 37:343) observed a female *Trachemys scripta* abandon her nest with one egg after being stung by fire ants. In all of these cases, adults and nests were a meter or more away from nearby ant mounds. Here we report an observation of an *A. ferox* that tolerated numerous fire ant stings while nesting directly on a fire ant mound. On 17 April 2009, we observed an adult female (CL 385 mm, PL 304 mm, 5932



FIG. 1. Raised pustules from fire ant stings on the left inguinal area on a female *Apalone ferox*.

g) attempting to nest in a fire ant mound adjacent to a drainage impoundment on the Santa Fe College campus, Gainesville, Alachua Co., Florida, USA (29.680072°N, 82.436349°W; WGS 84). Numerous stings by the fire ants had accumulated on the skin of her head, forelimbs, and hindlimbs. Each sting formed the typical raised pustule commonly observed on humans after fire ant stings (Fig. 1). The female was in the process of laying her eggs but was caught before she completed the process and was returned to the pond after being measured. This is the first report of an *A. ferox* attempting to lay eggs in a fire ant mound (Meylan and Moler 2006. *In* P. A. Meylan [ed.], Biology and Conservation of Florida Turtles, Chelonian Res. Monogr. 3, pp. 160–168). We thank Matt Kail for help with this observation.

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***APALONE SPINIFERA* (Spiny Softshell Turtle). CHELONIOPHAGY.** Turtles of the family Trionychidae are predominately carnivorous and known to consume a wide range of prey items. In the wild, some species (*Aspideretes gangeticus* and *Lissemys punctatus*) have been known to occasionally include turtles in their diets (Moll and Moll 2004. The Ecology, Exploitation and Conservation of River Turtles. Oxford University Press, New York. 303 pp.). Herein we present the first documentation of the Spiny Softshell as a cheloniophage. On 3 April 2010 at 1242 h in Leonhardt Lagoon, Dallas Co., Texas, USA (32.777428°N, 96.761484°W), an adult *Apalone spinifera* was photographed as it emerged from the water onto a basking surface. In its jaws was a hatchling Red-eared Slider (*Trachemys scripta elegans*) (Fig. 1). Ingestion was not observed, as the *A. spinifera* returned to the water, still holding its prey, within three minutes of its emergence. A photo voucher has been deposited at the University of Texas at Arlington Digital Collection UTADC 7649.

PHOTO BY JULIE COLLINS



FIG. 1. Adult *Apalone spinifera* holding a hatchling *Trachemys scripta elegans* in its mouth.

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***APALONE SPINIFERA* (Spiny Softshell), *CHELYDRA SERPENTINA* (Snapping Turtle), and *STERNOTHERUS ODORATUS* (Eastern Musk Turtle). HOMING BEHAVIOR.** Homing ability (i.e., the ability of a species to return to a home range after being moved or displaced) has been reported in several freshwater turtle species, for example: *Chrysemys picta* (Cagle 1944. Univ. Michigan Mus. Zool. Misc. Publ. No. 61:1–34); *Terrapene ornata ornata* (Legler 1960. Univ. Kansas Publ. Mus. Nat. Hist. 11:527–669); *Graptemys pulchra* (Shealy 1976. Bull. Florida St. Mus. Biol. Sci. 21:47–111); *Trachemys scripta elegans* (Tucker and Lamer 2008. Chelon. Conserv. Biol. 7[1]:145–149); *Sternotherus odoratus* (Andres and Chambers 2006. Amer. Midl. Nat. 156:45–51; Smar and Chambers 2005. Southeast Nat. 4[3]:527–532; Williams 1952. Copeia 1952:76–82); and *Glyptemys insculpta* (Carroll 1978. Copeia 1978:117–126).

Little is known about the homing ability of *Apalone spinifera* and *Chelydra serpentina*. *A. spinifera* has been found to possess the orientation mechanisms required for long migrations (DeRosa and Taylor 1980. Behav. Ecol. Sociobiol. 7[1]:15–23; DeRosa and Taylor 1982. Copeia 1982:394–399). Female *C. serpentina* may undertake extensive nesting migrations, traveling 4–14 km away from their home range, often to sites upriver, but return to their original home range once nesting is completed (Obbard and Brooks 1980. Herpetologica 36[2]:158–162). To our knowledge, there are no published reports of *C. serpentina* demonstrating homing behavior after being released in an unfamiliar location.

In August and September 2010, as part of turtle rescue and recovery efforts following an oil spill affecting approx. 57 km of the Kalamazoo River in Calhoun and Kalamazoo counties, Michigan, USA, five adult *A. spinifera* (three males and two females), six adult *C. serpentina* (three males and three females), and five *S. odoratus* (three males and two females) were captured in the Kalamazoo River. Captures were made using a combination of hoop traps and hand collecting from multiple locations within the spill area. Turtles were cleaned of oil, implanted with a passive integrated transponder (PIT) tag, and released. Due to crude oil contamination at their original capture location, it was necessary to release turtles various distances from their original capture location in areas not affected by the oil. Release locations were chosen based on the presence of suitable habitat and distance from contamination. Each of the following turtles was subsequently recaptured and all exhibited presumed homing behavior.

Apalone spinifera.—An adult female *A. spinifera* (35.2 cm straight-line carapace length [SCL], 3800 g) was captured on 27 August 2010 (42.3046°N, 85.1363°W; NAD83) and housed overwinter in a wildlife rehabilitation facility. The turtle was

released on 12 May 2011 in the Kalamazoo River (42.2933°N, 85.1235°W), approximately 2.4 linear channel km from its original capture location. It was recaptured on 10 August 2011 in the Kalamazoo River (42.3062°N, 85.1384°W) approx. 1.9 linear channel km downstream of its release point and less than 0.5 linear channel km from its original capture location.

An adult male *A. spinifera* (16.5 cm SCL, 426 g) was captured on 27 August 2010 (42.3022°N, 85.1329°W) and released on 30 August 2010 in Rice Creek (42.2952°N, 84.8873°W), a small tributary of the Kalamazoo River, approximately 25.25 linear channel km from its original capture location. The turtle was recaptured on 23 June 2011 in the Kalamazoo River (42.3021°N, 85.1328°W), having traveled approx. 25.25 linear channel km downstream (8.0 linear channel km Rice Creek; 17.25 linear channel km Kalamazoo River) of its release point, crossing a 4.57 m retired hydroelectric dam, where it was recaptured less than 20 m from its original capture location.

An adult female *A. spinifera* (31.5 cm SCL, 2500 g) was captured on 29 August 2010 (42.3606°N, 85.2988°W) and released on 9 September 2010 in the South Branch of the Kalamazoo River (42.2028°N, 84.7945°W), approximately 64.5 linear channel km from its original capture location. The turtle was recaptured on 30 July 2011 in the Kalamazoo River (42.2703°N, 85.0618°W), having traveled approx. 37.5 linear channel km downstream of its release point and crossing three retired hydroelectric dams (2.12 m, 4.27 m, and 4.57 m respectively), where it was recaptured approx. 27 linear channel km from its original capture location.

An adult male *A. spinifera* (19.7 cm SCL, 632 g) captured on 2 September 2010 (42.3026°N, 85.1809°W) was released on 9 September 2010 in the South Branch of the Kalamazoo River (42.2028°N, 84.7945°W), approximately 48.8 linear channel km from its original capture location. The turtle was recaptured on 1 September 2011 in the Kalamazoo River (42.3045°N, 85.1481°W), having traveled approx. 45.4 linear channel km downstream of its release point and crossing three hydroelectric dams (2.12 m, 4.27 m, and 4.57 m respectively), where it was recaptured approx. 3.4 linear channel km from its original capture location. To our knowledge, this is one of the longest homing movements reported for a freshwater turtle in the United States.

Another adult male *A. spinifera* (17.2cm SCL, 432 g) was captured on 23 September 2010 (42.2725°N, 85.0658°W) and released on 24 September 2010 in the Kalamazoo River (42.2886°N, 85.4059°W), approximately 43.5 linear channel km from its original capture location. The turtle was recaptured on 12 July 2011 in the Kalamazoo River (42.3526°N, 85.2845°W) approx. 19.5 linear channel km upstream of its release point and approx. 24 linear channel km from its original capture location.

Apalone spinifera has been shown to move up to 13.7 km between activity areas (Galouis et al. 2002. J. Herpetol. 36(3):402–411). However, to our knowledge, this is the first report of presumed homing behavior. Three individuals reported here made movements of nearly two to three times the distance reported by Galouis et al. (*op. cit.*) (25.25 km, 37.5 km, and 45 km, respectively), representing to our knowledge the furthest reported movement of *A. spinifera*.

Chelydra serpentina.—An adult female *C. serpentina* (24.2 cm SCL, 3.8 kg) was captured on 26 April 2011 (42.3021°N, 85.1370°W; NAD 83) and released on 11 May 2011 in the Kalamazoo River (42.2932°N, 85.1235°W), approximately 2.1 linear channel km from its original capture location. The turtle was recaptured on 20 June 2011 in the Kalamazoo River (42.3062°N, 85.1384°W) approx. 2.0 linear channel km downstream of its release point and less than 100 m from its original capture location.

An adult male *C. serpentina* (39.5 cm SCL, 12.4 kg) was captured on 10 July 2011 (42.3058°N, 85.14571°W) and released on 20 July 2011 (42.3085°N, 84.1398°W), approximately 0.9 linear channel km from its original capture location. The turtle was recaptured on 16 September 2011 in the Kalamazoo River (42.3046°N, 85.1481°W) approx. 0.7 linear channel km downstream of its release point and approx. 200 m from its original capture location.

An adult male *C. serpentina* (31.0 cm SCL, 7.1 kg) was captured on 18 August 2010 (42.2699°N, 85.0614°W) and an adult female (28.5 cm SCL, 6.0 kg) was captured on 2 October 2010 (42.2702°N, 85.0611°W), approx. 40 m from where the male caught on 18 August had been captured. Both turtles were released on 12 May 2011, approx. 2.0 linear channel km from their original capture locations (42.2742°N, 85.0813°W). Both turtles were recaptured on 2 August 2011 in the same trap in the Kalamazoo River (42.2728°N, 85.0660°W), approx. 1.9 km upstream from their release point and less than 200 m from their original capture locations.

An adult male *C. serpentina* (28.5 cm SCL, 5.2 kg) was captured on 21 September 2010 (42.2927°N, 85.1205°W) and an adult female (23.0 SCL, 3.1 kg) was captured on 22 September 2010 (42.3361°N, 85.2272°W). Both were released on 27 September 2010 in the same location in the Kalamazoo River (42.3357°N, 85.3455°W), approx. 29.4, and 15.5 linear channel km, respectively, from their original capture locations. Both turtles were recaptured on 18 July 2011 in the Kalamazoo River in the same trap (42.2863°N, 85.4083°W), approx. 9.5 linear channel km downstream from their release point. Both turtles traveled the "wrong" direction from their original capture location; however, it appeared they both traveled together downstream. To our knowledge, this is the first report of both sexes of *C. serpentina* apparently moving a long distance together.

Although *C. serpentina* exhibits some degree of natal homing ability, prior to this note no examples of homing ability from relocation have been reported. Female *C. serpentina* have been known to migrate great distances to nest. Obbard and Brooks (*op. cit.*) reported one individual traveled 16 km round trip. Two individuals reported here (one male and one female) traveled approximately 9.5 km, representing to our knowledge the furthest reported movement of *C. serpentina* not associated with nesting.

Sternotherus odoratus.—An adult male *S. odoratus* (11.1 cm SCL, 158 g) was captured on 21 September 2011 (42.2668°N, 85.0536°W; NAD83) and was housed overwinter in a wildlife rehabilitation facility. The turtle was released on 12 May 2011 in the Kalamazoo River (42.2933°N, 85.1235°W), approximately 6.3 linear channel km from its original capture location. It was recaptured on 26 August 2011 in the Kalamazoo River (42.2701°N, 85.0623°W) approx. 5.6 linear channel km upstream of its release point and less than 0.7 linear channel km from its original capture location.

An adult female *S. odoratus* (10.1 cm SCL, 181 g) was captured on 14 October 2010 (42.2702°N, 85.0610°W) and was housed overwinter in a wildlife rehabilitation facility. The turtle was released on 12 May 2011 in the Kalamazoo River (42.2743°N, 85.0813°W), approximately 2.1 linear channel km from its original capture location. It was recaptured on 1 September 2011 in the Kalamazoo River (42.2703°N, 85.0618°W) approx. 2.0 linear channel km upstream of its release point and less than 60 m from its original capture location.

An adult male *S. odoratus* (10.6 cm SCL, 170 g) was captured on 6 October 2010 (42.3494°N, 85.2688°W) and released on 8 October 2010 in the Kalamazoo River (42.3504°N, 85.2759°W), approximately 0.7 linear channel km from its original capture location. The turtle was recaptured on 10 October 2010 in the Kalamazoo River (42.3494°N, 85.2683°W) approx. 0.67 linear channel km upstream of its release point and less than 30 m from its original capture location.

An adult male *S. odoratus* (11.2 cm SCL, 200 g) was captured on 17 October 2010 (42.2769°N, 85.0680°W) and was housed overwinter in a wildlife rehabilitation facility. The turtle was released on 11 May 2011 in the Kalamazoo River (42.2743°N, 85.08133°W), approximately 1.2 linear channel km from its original capture location. It was recaptured on 30 August 2011 in the Kalamazoo River (42.2702°N, 85.0610°W) approx. 2.0 linear channel km upstream of its release point and 0.8 linear channel km from its original capture location. Although close to its original capture location, this turtle moved 1.2 km past its original capture location before recapture.

An adult female *S. odoratus* (9.9 cm SCL, 168 g) was captured on 14 October 2010 (42.2702°N, 85.0610°W) and was housed overwinter in a wildlife rehabilitation facility. The turtle was released on 12 May 2011 in the Kalamazoo River (42.2743°N, 85.0813°W), approximately 2.1 linear channel km from its original capture location. The turtle was recaptured on 1 September 2011 in the Kalamazoo River (42.2957°N, 85.1242°W). It had traveled downstream approximately 6.7 linear channel km from its release point and approximately 4.6 linear channel km past where it was originally captured.

Three previous studies (Williams, *op. cit.*; Smar and Chambers, *op. cit.*; Andres and Chambers, *op. cit.*) all conducted in lentic habitats (lakes, ponds), demonstrate the homing ability and site philopatry of *S. odoratus* at average distances of about 200–1100 m. To our knowledge no previous reports discussed movements or homing abilities of *S. odoratus* in lotic habitats. Two individuals reported here (one male and one female) traveled approximately 6.7 and 5.6 linear channel km, respectively, representing to our knowledge the furthest reported movement of *S. odoratus*.

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***CHRYSEMYS PICTA PICTA* (Eastern Painted Turtle). LORDOSIS.** The most commonly reported morphological malformation of the spine in freshwater turtles is kyphosis. Most cases involve vertebrals 2 or 3 resulting in a dorsally convex hump of varying sizes on the carapace (Rhodin et al. 1984. Brit. J. Herpetol. 6:369–373; Tucker et al. 2007. Herpetol. Rev. 38:337; Iverson 2007 Herpetol. Rev. 38:334). The frequency of occurrence of kyphosis in natural populations, however, is low with a range of < 0.1–0.5% in sea turtles (Rhodin et al. 1984, *op. cit.*) and 0.004–2.56% in freshwater turtles (J. Iverson, pers. comm.). The opposite of kyphosis is lordosis ("sway-back"). This is a concave deformity of the spine in the sagital plane at the approximate middle of the carapace (Rhodin et al. 1984, *op. cit.*). Previous cases of chelonian lordosis have been reported only for sea turtles. This



FIG. 1. A male *Chrysemys picta picta* from an urban lake in Henrico County, Virginia with lordosis.

malformation occurs in *Caretta caretta*, *Chelonia mydas* (or *Eretmochelys imbricata*, identification unclear), and *Lepidochelys olivacea* (Deraniyagala 1939. The Tetrapod Reptiles of Ceylon. Vol 1. Testudines and Crocodilians. London; Rhodin et al. 1984, *op. cit.*; Glazebrook and Campbell 1990. Diseases Aquat. Org. 9:83–95; Kochinsky et al. 1995. Herpetopathologia 2:105–120; Oros et al. 2005. Diseases Aquat. Org. 63:13–24). All observations have been of single individuals in samples ≥ 93. A thorough review of shell malformations in turtles is in Rothschild et al. (2013. *In* Brinkman et al. [eds.], Morphology and Evolution of Turtles, pp. 501–534. Springer Publ. Co., New York) but he only notes the lordosis cases in Rhodin et al. (1984, *op. cit.*). On 24 August 1979, I captured an adult male *C. p. picta* (77 mm CL, 75 mm PL, 65 g) in an urban pond in Henrico Co., Virginia, USA, with lordosis (Fig. 1). This turtle was part of a study of the population ecology of *C. picta* and *Sternotherus odoratus* and was the only turtle with this type of malformation in 818 *C. picta* marked during 1979–1981 (Mitchell 1988. Herpetol. Monogr. 2:40–61). The male was marked and released but never recaptured. This may be the only case of lordosis in freshwater turtles reported to date.

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***CHRYSEMYS PICTA* (Painted Turtle) and *CHELYDRA SERPENTINA* (Snapping Turtle). INTERSPECIFIC INTERACTIONS.** A recently reported case of commensalism between *Chrysemys picta* and *Chelydra serpentina* involved the former feeding on scraps of food made available by the latter (Himes 2013. Herpetol. Rev. 44:501). Other reported interactions between these species include predation by *Chelydra* on *Chrysemys* (Ernst and Lovich 2009. Turtles of the United States and Canada, 2nd ed. Smithsonian Institution Press, Washington, D.C. 827 pp.), an apparently mutualistic cleaning symbiosis by which *Chrysemys* removed algae and leeches from *Chelydra* (Krawchuk et al. 1997. Can. Field-Nat. 111:315–317), and the use of *Chelydra* for basking by *Chrysemys* (Legler 1956. Trans. Kansas Acad. Sci. 59:461–462). We observed additional interactions between *Chrysemys* and *Chelydra* in Brown Co., Wisconsin during the summer of 1991 in a stretch of the Suamico River that was mostly shallow and partially shaded by riparian forest. A high steep bank above one of the few relatively deep pools in the river (> 1.5 m deep and 22 m across when measured during a period of low water) provided a vantage point to observe the following: 6 June, 1245 h – large *Chelydra* basking on dead floating tree entered water, swam to another downed tree, and climbed up to bask without disturbing two *Chrysemys* already basking; 11 June, 1215 h – large *Chelydra*

attempted four times to climb floating log to bask but rolled it over, each time tumbling two basking *Chrysemys* into water; 1320 h – two *Chrysemys* underwater with mouths near hind legs of large *Chelydra*, sometimes appearing to make contact with their mouths (possibly removing algae or leeches?); later same afternoon (time not recorded) – large *Chelydra* basking at surface (submerged) with adult *Chrysemys* basking (partly submerged) on rear of its carapace; second *Chrysemys* tried unsuccessfully to climb on *Chelydra*; 13 June, 1410 h – large *Chelydra* at surface (submerged) with large *Chrysemys* basking (partly submerged) on posterior of carapace, oriented perpendicular to *Chelydra*; after ~ 2 min, *Chrysemys* fell off when *Chelydra* began swimming slowly upstream. As many as five *Chrysemys* were observed in the pool at the same time on some occasions, and as many as two *Chelydra*, so we cannot be sure that it was the same turtles that we observed interacting on each occasion. As noted by Himes (2013, *op. cit.*), *Chrysemys* associating with *Chelydra* may stay to their rear to avoid predatory attacks. In addition to basking on *Chelydra*, *C. picta* have been reported by Gelatt and Kelley (1995. Can. Field-Nat. 109:456–458) basking on a nesting loon (*Gavia immer*).

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***DEIROCHELYS RETICULARIA CHRYSEA* (Florida Chicken Turtle). KYPHOSCOLIOSIS.** Freshwater turtle populations occasionally include a small percentage of individuals with kyphosis or, even more rarely, scoliosis. Most of the cases reported have been on species of cryptodires, although a few have been published for pleurodires (Plymale et al. 1978. Southwest. Nat. 23:457–462; Trembath 2009. Chelonian Cons. Biol. 8:94–95; Rothschild et al. 2012. Herpetological Osteopathology. Springer Science, New York. 550 pp.; J. B. Iverson, pers. comm.). Only a few cases of scoliosis have been reported. Rhodin et al. (1984. British J. Herpetol. 6:369–373) stressed the need for accurate terminology and coined the term kyphoscoliosis for turtles that have both types of deformities. There has been only one report of kyphosis for *D. reticularia*, by Mertens (1940. Senckenbergiana 22:236–243), who noted the condition in a captive individual but gave no additional information.

We captured an adult female *D. reticularia chrysea* with kyphoscoliosis in a small pond on the urban Santa Fe College campus in Gainesville, Alachua Co., Florida, USA (Fig. 1). She was captured three times between 2009 and 2013. Measurements taken at each capture (24 May 2009 – CL = 159 mm, PL = 135 mm, mass = 725 g; 1 March 2010 – CL = 172 mm, PL = 145, mass = 897 g; 19 April 2013 – CL = 187 mm, PL = 157 mm, mass 1177 g) demonstrate what appears to be a normal pattern of growth of 10 mm PL for the first year and an average of 4 mm PL annually during the subsequent three years. This pattern is similar to that reported for *D. reticularia* in South Carolina (Buhlmann et al. 2009. Herpetologica 65:39–53). Growth in turtles with kyphosis appears to be similar to growth in individuals in the same population lacking this deformity (Selman and Jones 2012. Chelon. Conserv. Biol. 11:259–261). Scoliosis is evident in the posterior half of the animal. The vertebral midline starts to curve to the right at the posterior third of the second vertebral scute and then curves slightly left starting at the suture between the third and fourth vertebral scutes (Fig. 1). All but the first vertebral scute are deformed. The pleural scutes on the right are larger than those on the left, suggesting that the right side grew faster than the corresponding scutes on the left side during embryonic growth. The process of premature and asymmetrical fusion of thoracic vertebrae that results in disproportionate shell growth described by Rhodin et al. (*op. cit.*) may apply to the *D. reticularia* described here.



FIG. 1. Lateral and dorsal views of female *Deirochelys reticularia chrysea* from Alachua Co., Florida, with kyphoscoliosis.

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***EMYDOIDEA BLANDINGII* (Blanding's Turtle). MASS MORTALITY.** Mass mortality of freshwater turtles as a result of controlled, accidental, or natural wetland drying and/or drawdown is uncommon, or under-reported in the literature (but see Hall and Cuthbert 2000. Chelon. Conserv. Biol 3[4]:643–649). Here we report mass mortality of *Emydoidea blandingii* in a shallow, 90-ha rich fen where water outflow is uncontrolled; outflow is via several shallow, slow-moving stream channels, and water levels



FIG. 1. A) Intact shell, weathered, found on dry land. B) Typical placement of turtle shells near edge of open water habitat.

and flow are generally dictated by snowmelt and rainfall accumulation.

Misery Bay Provincial Park is a 760-ha Nature Reserve on the south side of Manitoulin Island, Ontario, Canada, on the north shore of Lake Huron (45.800503°N, 82.726107°W). The park is characterized by limestone alvar and patterned fen over limestone pavement, as well as fine sand beach, a key-hole bay, ephemeral wetlands, streams, and mixed-wood forest. Development surrounding the park is relatively limited, and includes one farm property (hay fields), one low-use two-lane highway, and a few cottages/cottage roads.

In a May 2012 field visit to Misery Bay, 13 Blanding's Turtles, three Painted Turtles (*Chrysemys picta)*, and evidence (tracks) of one Snapping Turtle (*Chelydra serpentina*), were observed in a small fen and in a vernal pond. All observations were made in roadless areas generally not used or accessed by park visitors. No turtle mortality was observed at this time, and no further visits were made in 2012.

During May and June 2013, target wetlands were searched weekly for Blanding's Turtles. Areas searched included three distinct wetlands totalling less than 75 ha: two fens and a wet beach with connecting tributaries totalling 30 ha, 16 ha, and 25 ha, respectively. Also searched was one 0.8-ha vernal pond adjacent to but hydrologically separate from the fen/beach system, and two isolated vernal ponds (1.5 km from the fen/beach), averaging 0.6 ha each. Thirty-two individual turtles were encountered during the search period, including 29 Blanding's Turtles, two Snapping Turtles, and one Painted Turtle. Regular bi-weekly and monthly searches and tracking continued between July and October 2013, during which the entire 90 ha of fen was searched.

In addition to over 30 living turtles, 59 dead turtles (49 Blanding's Turtles and 10 Painted Turtles) were found in the two adjoining fen areas of the park. Nearly all dead turtles were found on the edges of shallow ponds and streams, in graminoids and/or at the base of shrubs. Few turtle remains were found in open water (shallow fen ponds). All remains appeared weathered: little to no soft tissue remaining, small amounts of moss or algae growing on scute seams and surfaces, and some or no keratin peeling or falling off (depending on exposure to water). Carapace and plastron condition varied: shells were either intact, separated, broken into pieces, or missing parts. There were no obvious signs of predation (i.e. bite marks on the carapace or plastron). Park staff and visitors also reported three (additional) dead turtles on the beach or just north of the beach in late summer 2012. The condition of these three additional dead turtles was as follows: one adult Painted Turtle desiccated but otherwise intact, one adult Blanding's Turtle "picked clean," and one adult Blanding's Turtle recently dead with predator bites on the neck and a missing hind limb. The weathering and condition described above suggests the turtles did not die over the winter 2012/2013, but sometime earlier. All but eight of the 51 dead Blanding's Turtles were adults; of the 62 known dead turtles, 20 were female, 13 were male, and 29 were of unknown sex (including 10 Painted Turtles, 16 Blanding's Turtles missing plastron sections or too young to sex, and the three reported visitor observations).

Nearly all living turtles, and all dead turtles, were observed in areas not normally accessed by park visitors. Water conditions in the fen in much of 2012 are unknown, but unseasonal drought conditions may have contributed to this mortality event. Low water levels in a normally shallow fen may have resulted in a reduction in suitable foraging, cover and hibernation habitat, and increased predator access. No turtle mortality was observed in the three ephemeral ponds, though they were searched with equal effort.

Blanding's Turtles are at risk throughout almost all of the species' North American range; in Ontario, the species is considered Threatened (Ontario Regulation 230/08 s.3). The Misery Bay Blanding's Turtle population is found in a relatively pristine, protected natural environment, where the typical threats of road mortality, habitat loss, and illegal harvesting/collection are minimal or virtually absent. However, mass mortality events such as was described above can have long-lasting negative effects on even the most protected of populations (Congdon et al. 1993 Conserv. Biol 7:826–833; Brooks et al. 1991. Can. J. Zool. 69:1314–1320).

At present Ontario Parks is monitoring the movements of six turtles in the park using radio telemetry, but qualified outside researchers are welcome to carry on or supplement this study. Please contact the author for more information about conducting research in Ontario's protected areas.

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FRESHWATER TURTLE SPECIES. PREDATION. Shively et al. (2011. Herpetol. Rev. 42:423) reported on turtle shells found beneath a Bald Eagle (*Haliaeetus leucocephalus*) nest near the shore of Kincaid Lake, Rapides Parish, Louisiana, USA. On 24 July

PHOTO BY BY S. SHIVELY



FIG. 1. Skeletal remains of turtles and catfish found beneath Bald Eagle nest.

PHOTO BY S. SHIVELY



FIG. 2. Bald Eagle nest with skeletal remains of catfish and turtles visible.

2013, I climbed the Loblolly Pine (*Pinus taeda*) of this nest tree to install video surveillance cameras above the nest, 30.5–33.5 m above the ground. Here I report on additional turtle and fish remains found in and under the nest.

A search around the base of the nest tree yielded the skeletal remains of turtles of three species along with six Flathead Catfish (*Pylodictus olivaris*). The turtles included 17 *Sternotherus carinatus*, four *Graptemys pseudogeographica kohnii*, and four *Apalone* sp. The *S. carinatus* were mostly adults measuring 10–13 cm in carapace length, the *G. p. kohnii* were mostly large juveniles or young adult males measuring 13–15 cm in carapace length, and the *Apalone* sp. were mostly juveniles measuring 15–18 cm in carapace length. The largest catfish skull appeared to be from a fish approximately 60 cm in total length.

A search of the nest itself yielded a similar assemblage of turtle shells and catfish skulls, scattered throughout the visible portion of the nest, with individual shells/skulls being tucked into pockets in the sticks comprising the nest. There were many more shells and skulls in the accessible part of the nest than was found on the ground, but the proportion of each species was roughly the same in the nest as on the ground.

Turtles are known prey of Bald Eagles feeding young. Clark (1982. J. Field Ornithol. 53:49–51) reported that over a five-year period 25% of successful bald eagle nests examined in the Chesapeake Bay region contained turtle shells and that four turtle species were involved. But at least two of the three turtle species preferred by the Kincaid Lake eagles are not necessarily what would be expected based on the species most often seen basking on logs around the lake shore. The most common basking turtles around Kincaid Lake are *Pseudemys* sp. and *Trachemys scripta elegans* followed by *G. p. kohnii*. *Apalone* sp. are only occasionally seen basking and *S. carinatus* rarely bask. That might suggest that the eagles are not catching the turtles while basking. Jeff Boundy, herpetologist for Louisiana Department of Wildlife and Fisheries, (pers. comm.) suggests that *S. carinatus* appear to forage unwarily in shallow clear water, rendering them more vulnerable to predation. The size and shapes of the turtle species taken may also make them preferred targets for the eagles. Smaller turtles are more easily encompassed by the eagles' talons than are larger turtles and, obviously, are lighter and more easily carried. The shells of both *S. carinatus* and *G. p. kohnii* have a pronounced mid-dorsal ridge which might make it easier for the eagles' talons to grasp, as opposed to the smoothly rounded carapaces of *Pseudemys* and *Trachemys*. Softshells are probably easily gripped by the sharp talons. Another possible factor influencing turtle species selection may be ease of picking flesh out of the shell. *S. carinatus* have relatively small plastra, which leaves more of their legs, neck, and tail exposed.

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***GRAPTEMYS BARBOURI* (Barbour's Map Turtle). BASKING HEIGHT.** Many freshwater turtles aerially bask on emergent rocky and woody substrate, which is hypothesized to facilitate thermoregulation and to discourage ectoparasites and algal growth (Boyer 1965. Ecology 46:99–118). Basking sites are often limited and can subsequently elicit aggressive competitive behaviors within some turtle species (Lindeman 1999. J. Herpetol. 33:214–219). Many species choose basking sites that extend over water, presumably to increase exposure to light and to allow quick escape from potential predators. Boyer (1965, *op. cit.*) noted a tendency for turtles of the family Emydidae (especially *Graptemys* spp.) to attempt to achieve the highest possible elevation on a chosen basking site.

At 1625 h on 14 August 2013, we observed an adult female *G. barbouri* basking on a leaning Bald Cypress (*Taxodium distichum*) snag over Spring Creek (~7.5 km N of Smith's Landing; 30.94679°N, 84.74577°W) in the Lower Flint River Basin, Decatur Co., Georgia, USA. The turtle was photographed just before it retreated into the water (Fig. 1). Upon measurement, the turtle was found to have been basking 1.9 m above the surface of the water. One end of the snag was anchored on shore; no other turtles were observed on this basking site.

As far as we know, this is the highest vertical basking location noted for *G. barbouri*. Some riverine turtle species, such as *Sternotherus minor* (Loggerhead Musk Turtle), are known for their climbing ability, although fewer reports exist for larger species such as map turtles (Ernst and Lovich 2009. Turtles of the United States and Canada, 2nd ed. Johns Hopkins Univ. Press, Baltimore, Maryland. 827 pp.). A smaller map turtle species, *G. flavimaculata* (Yellow-blotched Map Turtle), has been found to bask as high as 3.7 m above water (Floyd 1973. Int. Tortoise



FIG. 1. An adult female *Graptemys barbouri* basking at a probable record height on Spring Creek in the Lower Flint River Basin, Decatur Co., Georgia.



PHOTO BY ADRIAN LEYTE-MANRIQUE

FIG. 1. Dead individuals of *Kinosternon integrum* found at Presa La Galera, Municipality of Abasolo, Guanajuato, Mexico.



PHOTO BY ADRIAN LEYTE-MANRIQUE.

FIG. 2. Presa La Galera, located in the Municipality of Abasolo, Guanajuato, Mexico.

Turtle Soc. J. 7:8–10). In contrast, Flaherty and Bider (1984. Am. Midl. Nat. 111:259–266) found the average basking sites of *G. geographica* (Northern Map Turtle) to be just 0.2 m above the water's surface. Vogt (1981. Natural History of Amphibians and Reptiles of Wisconsin. Milwaukee Public Museum, Milwaukee, Wisconsin. 205 pp.) noted that map turtles (referring to *G. geographica*) will bask 2–5 m above the water surface and "pose an ominous threat to a canoeist's head."

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***GRAPTEMYS VERSA* (Texas Map Turtle). PREDATION ATTEMPT.** Large catfish are consumers of a wide range of vertebrate and invertebrate prey items. Herein we present the first documentation of a predatory attempt on a *Graptemys versa* by a large Flathead Catfish (*Plyodictus olivaris*). On 10 July 2013 at 2143 h ca. 8 miles W of Menard at the San Saba River, Menard Co., Texas, USA (30.90058°N, 99.91545°W; 602 m elev.), an adult male *G. versa* was observed being attracted to a fishing line baited with a dead minnow in 1.2 m of water. As the turtle bit into the bait it was slowly brought to the surface whereupon a large *P. olivaris* arrived and began to swallow the turtle. The rear quarter of the turtle was drawn partially into the mouth of the catfish before it was suddenly expelled. The expulsion of the turtle may have been prompted by two high intensity flashlights being directed towards the face of the fish. Neither the fish nor turtle were captured. We note that the mouth of the catfish had opened to a gape greater than the length of the turtle.

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***KINOSTERNON INTEGRUM* (Mexican Mud Turtle). MORTALITY.** Currently there is little information on the ecology of many Mexican freshwater turtles, including mud turtles in the genus *Kinosternon* (Canseco-Márquez and Gutiérrez-Mayén 2006. Anfibios y Reptiles del Valle de Tehuacán-Cuicatlán, CONABIO, México, D.F., xvi + 302 pp.). Even less is known regarding the direct effects of human related activities on the habitats used by these species (Ramirez-Bautista et al. 2009. Herpetofauna del Valle de México: Diversidad y Conservación, CONABIO, México, D.F., xxiv + 213 pp.). In one report, pollutants were detected in water bodies inhabited by *K. scorpioides*. The pollutants, attributed to home and industrial sewage discharges, were believed to be among the factors that consequently triggered disease and increased mortality in these turtles (Sampedro-Marin et al. 2012. Rev. Colombiana Sci. Anim. 4:69–88). However, with respect to *K. integrum*, to date there are no reports on fatalities related to pollution in waters they inhabit.

On 1 February 2012, between 1130 and 1600 h, we found 23 individuals of *K. integrum* (Fig. 1) scattered on the shores of the Presa La Galera reservoir (Fig. 2), which is located in the Municipality of Abasolo, Guanajuato, Mexico (2228407.17°N, 233882.16°W, WGS84; elev. 1689 m). Nineteen turtles were represented by empty shells (KiPG5-GTO-FEB-2012 to KiPG23-GTO-FEB-2012), while four shells still contained soft body parts (KiPG1-GTO-FEB-2012 [length and width of carapace "LW"= 152 × 106 mm], KiPG2-GTO-FEB-2012 [LW= 105 × 79 mm], KiPG3-GTO-FEB-2012 [LW= 129 × 103 mm], and KiPG4-GTO -FEB-2012 [LW= 16 × 12 mm]). This mortality may be related to the contaminated water discharged by a brick factory located on land next to Presa La Galera. The brick factory uses discarded car tires

as the main fuel in the brick baking process, and consequently various pollutants end up in the waste water. We suspect that the chemical wastes discharged by this factory could very likely be the main cause of noted mass mortality of *K. scorpioides* in Presa La Galera (Badii-Thabet et al. 2005. CULCyT 2:4–20; Sampedro-Marin et al. 2012, *op. cit.*). More detailed studies are critically needed to determine the impact of this brick factory and its specific contaminants on this turtle population. All specimens (KiPG1-GTO-FEB-2012 to KiPG23-GTO-FEB-2012) are deposited in the Colección Herpetológica de la Estación Biológica del Instituto Tecnológico Superior de Irapuato.

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***KINOSTERNON SONORIENSE* (Sonoran Mud Turtle). WINTER MORTALITY.** Flash floods can have devastating impacts on biota in desert streams (Fisher et al. 1982. Ecol. Monogr. 52:93–110; Grimm and Fisher 1989. J. N. Am. Benthol. Soc. 8:293–307; Crandall et al. 2003. Comm. Ecol. 4:225–232). In particular, flash floods can pose substantial risks to Sonoran Mud Turtles that frequently inhabit perennial and ephemeral streams and impoundments throughout the Sonoran and Chihuahuan deserts. Although some freshwater turtles experience overwintering mortality due to the inability to cope with extreme temperature fluctuation (Cagle 1950. Ecol. Monogr. 20:32–54; Metcalf and Metcalf 1979. Herpetologica 35:93–96; Christiansen and Bickham 1989. J. Herpetol. 23:91–94), little is known about the risks Sonoran Mud Turtles encounter while overwintering. Mortality rates in adult turtles are often relatively low and constant compared to those of juveniles (Gibbons and Semlitsch 1982. J. Anim. Ecol. 51:523–527; Iverson 1991. Can. J. Zool. 69:385–391; Stone 2001. Southwest Nat. 46:41–53), but sporadic increases in mortality rates of adults or juveniles can influence population stability (Brooks et al. 1991. Can. J. Zool. 69:1314–1320; Congdon et al. 1994. Amer. Zool. 34:397–408; Buhlmann et al. 2009. Herpetologica 65:39–53).

From 16–25 March 2013, we collected 14 *Kinosternon sonoriense* carcasses (10 adult females, one adult male, and three juveniles) in the Peloncillo Mountains, Hidalgo Co., New Mexico, USA (31.483°N 109.017°W, WGS84; elev. 1726 m). The area is characterized by narrow canyons containing highly ephemeral and flood-prone streams separated by rugged mountain ridgelines. Some canyons also have impoundments constructed during the 1930s. Dead *K. sonoriense* were salvaged from two impoundments, BW Tank and BH Tank, located in different drainages, ca. 7 km apart. All turtles were previously marked in conjunction with an on-going mark/recapture study (Stone, *op. cit.*). During 17–22 March 2013, we found two adult female and three juvenile *K. sonoriense* carcasses at BW Tank. The adults were floating in the impoundment and the juveniles were found immediately downstream of the impoundment dam. On 18–19 March 2013, nine dead adult *K. sonoriense* (eight female and one male) were found at BH Tank, six were discovered on the bank and three were found just downstream from the impoundment dam. Nearly all carcasses were in the same state of decomposition with scutes still in place, shells intact, and no signs of predation. We also collected several other vertebrate carcasses; six Green Sunfish (*Lepomis cyanellus*) were found 10 m below BH Tank and three dead lizards (*Sceloporus virgatus, S. jarrovii,* and *Aspidoscelis neomexicana*) were found in canyon pools within the study area.

In the two weeks prior to sampling, the study area experienced several hard freezes and a flash flood. Temperature recorders (LogTag® TRIX-8) set throughout study area recorded freezing temperatures until 5 March 2013 (min = -1.7°C), then no recorded freeze until 9 March 2013 (min = -0.2°C). During 5–7 March 2013, daytime highs reached 25.4°C. On 7 March 2013, there was a major rainfall, producing heavy flow in the canyons (M. Carrier, pers. comm.) and signs of flooding were evident at the sites during sampling. During 9–15 March 2013 temperatures fell below freezing every day (min = -5.7°C) and daytime highs reached 29.5°C.

We have marked 79 adult female turtles at BH Tank since 2007 and have not captured an unmarked female there since May 2008. The individuals found dead in March 2013 represent ~10% of the marked adult females in this population. Chronic winter mortality at that level is unsustainable. Necropsied adults from BW Tank showed no signs of malnutrition, disease, or trauma to the shell, skeleton, or lungs, and both had maturing follicles of various sizes in the reproductive tract. The lack of blunt trauma and absence of water in lungs of the necropsied turtles indicates that death was not a direct result of flooding or drowning. However, flooding could have displaced turtles, exposing them to freezing. We hypothesize that a series of warm days caused turtles to move out of secure wintering sites, and then flash flooding followed by several hard freezes may have been the cause of the mortality.

All collected specimens were deposited in the University of Central Oklahoma Natural History Museum (UCONHM): Herpetology - *K. sonoriense* (UCO 1806, 1807, 1809–1820), *S. virgatus* (UCO 1805); Ichthyology - *L. cyanellus* (UCO 63).

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***LEPIDOCHELYS KEMPII* (Kemp's Ridley Seaturtle). ATLANTIC NESTING.** Kemp's Ridley nests almost exclusively on beaches of the western Gulf of Mexico, with a center of abundance at Rancho Nuevo, Tamaulipas, Mexico (Márquez 1990. Sea Turtles of the World. An Annotated and Illustrated Catalogue of Sea Turtle Species Known to Date. FAO Species Catalogue, FAO Fisheries Synopsis. 81 pp.). Kemp's Ridley is considered to be the most endangered sea turtle species in the world, although the number of nests has been increasing exponentially in recent years at



FIG. 1. A *Lepidochelys kempii* covering its nest at Sebastian Inlet State Park, Brevard Co., Florida, USA, 02 May 2013.

Rancho Nuevo (National Marine Fisheries Service, U.S. Fish and Wildlife Service; SEMARNAT 2011. BiNational Recovery Plan for the Kemp's Ridley Sea Turtle, *Lepidochelys kempii*, Second Rev. National Marine Fisheries Service. Silver Spring, Maryland 156 pp. + appendices). Most Kemp's Ridleys show synchronous nesting in large groups called *arribadas*. The oldest estimate of the number of nesting females comes from a film made during an *arribada* in 1947, when 40,000 females were believed to have participated in the single event (Hildebrand 1963. Ciencia Méx. 22:105–112). But the population declined drastically through the 1970s (Márquez 1994. Synopsis of Biological Data on the Kemp's Ridley Turtle, *Lepidochelys kempii*. NOAA Tech. Memorandum NMFS-SEFSC-343, 91 pp.; Turtle Expert Working Group 1998. An Assessment of the Kemp's Ridley (*Lepidochelys kempii*) and Loggerhead (*Caretta caretta*) Sea Turtle Populations in the Western North Atlantic. NOAA Tech. Memorandum NMFS-SEFSC-409, 96 pp.). The reason for the decline was suspected to be egg harvesting, killing of nesting females, and drowning of turtles in trawl fisheries in the Gulf of Mexico (Pritchard and Márquez 1973. Kemp's Ridley or the Atlantic Ridley, *Lepidochelys kempi*. I.U.C.N. Monograph. Marine Turtle Series 2. 30 pp.). After addressing these problems—protecting nests, protecting nesting turtles, and implementing turtle excluder devices in commercial trawling (National Research Council 1990, *op. cit.*; Márquez 1994, *op. cit.*; Pritchard 1997. Marine Turt. Newsl. 76:14–17; Turtle Expert Working Group 1998, *op. cit.*), the number of Kemp's Ridleys nesting increased sharply during the period of 1990 to 2010 at both Rancho Nuevo and Padre Island, Texas, the closest U.S. nesting beach to Rancho Nuevo (National Marine Fisheries Service et al. 2011, *op. cit.*).

In addition to *arribadas*, solitary nestings have occurred on beaches in North Carolina, South Carolina, Florida, Alabama, and, more frequently, Texas, USA (Meylan et al. 1990. Herpetol. Rev. 21:19–20; Palmatier 1993. Herpetol. Rev. 24:149–150; Shaver and Caillouet 1998. Mar. Turt. Newsl. 82:1–5; Williams et al. 2006. Marine Turt. Newsl. 113:8; National Marine Fisheries Service et al. 2011, *op. cit.*). In Florida, Kemp's Ridley nests have been confirmed on the beaches along both the Gulf of Mexico and Atlantic Ocean, including the Florida panhandle (Florida Fish and Wildlife Conservation Commission Statewide Nesting Beach Survey program database). The current note documents a Kemp's Ridley that nested twice near the same location on the Atlantic coast of Florida and provides information on nest locations, nest site fidelity, clutch sizes, incubation periods, and nest productivity.

On two occasions in May 2013, visitors to Sebastian Inlet State Park (Brevard Co., Florida) reported a sea turtle nesting in daylight to park rangers. I was contacted by the rangers and located a nesting Kemp's Ridley (Fig. 1). In this first encounter, the turtle was digging an egg chamber at 1045 h Eastern Standard Time on 02 May 2013 at Sebastian Inlet State Park (27.864°N, 80.448°W), on the north side of Sebastian Inlet. When the turtle had stopped depositing eggs (116 eggs), I applied inconel flipper tags to both front flippers and took measurements: standard straight carapace length = 63.8 cm $SCL_{n\text{-}t}$, minimum straight carapace length = 63.4 cm SCL_{min}, maximum straight carapace width = 61.6 cm, curved carapace length notch to tip = 66.5 cm $CCL_{n\text{-}t}$, curved carapace width = 69.8 cm CCW, maximum straight head width = 13.8 cm (Bolton 1999. *In* Eckert et al. [eds.], Research and Management Techniques for the Conservation of Sea Turtles, pp. 110–114. IUCN/SSC Marine Turtle Specialist Group Publication 4). On the day of nesting, winds were at 15–20 knots from the east north-east, seas were choppy, and the sky was overcast. The same Kemp's Ridley nested again at 1040 h Eastern Standard Time on 25 May 2013, 23 days after the first nesting and just 29 m north of the first nest location. The park rangers confirmed the flipper tag numbers applied during the first encounter. The eggs were not counted for the second nesting. Weather conditions were similar to the day of the turtle's first nesting event—windy with rough seas. The location of each nest was marked with a stake placed on the west side of the dune. The first nest was depredated by raccoon(s) prior to hatchling emergence, on the night of 25 June 2013, the 54th day after egg deposition. Sixty-seven live hatchlings were collected from the nest on the morning of 26 June 2013 by a Sebastian Inlet state park ranger. Sixty-three hatchlings survived and were released offshore (27.8817°N, 80.3750°W), about 7.5 km east of Sebastian Inlet. At least 67 of the 116 eggs in the clutch hatched.

The second nest was caged with a self-releasing screen by park rangers. The hatchlings emerged on the night of 15 July 2013 after 52 days of incubation, but many were depredated outside the cage by raccoons, including 59 dead and 1 live (with a damaged eye), collected by a ranger on the morning of 16 July 2013. All the collected hatchlings had damage to the anterior parts of their bodies, including the neck, head, throat, and eyes. On 19 July 2013, I conducted a nest productivity assessment for the second nest. The nest contained five eggs that died during the early incubation (no obvious embryo), nine eggs that died during late incubation (well-developed embryos), four dead hatchlings (completely out of the egg shells), and 108 empty egg shells (this includes four egg shells from dead hatchlings); therefore, the estimated clutch size of the second nest was 122. Hatching success and emergence success of the nest were 88.5% and 85.2%, respectively. I examined the hatchlings that were killed by raccoons for the number of costal (N = 59) and inframarginal (N = 59) scutes, and for the configuration of prefrontal head scales (N = 21, 38 excluded due to head injuries). A typical Kemp's Ridley would have five pairs of costal scutes, four pairs of inframarginal plastron scutes, and two pairs of prefrontal scales, of roughly similar size and shape, with no extra scute between the first and second pair (Pritchard and Mortimer 1999. *In* Eckert et al. [eds.], Research and Management Techniques for the Conservation of Sea Turtles, pp. 21–38. IUCN/SSC Marine Turtle Specialist

Group Publication 4). Fifty-three of 59 (90 %) had five costals on each side, all 59 had four inframarginal plastron scutes, and all 21 showed typical Kemp's Ridley head scute patterns. Given this evidence, I conclude that there is a low probability that the turtles were hybrids.

The size of the nesting turtle, the nest incubation periods, and the weather conditions under which the turtle nested were all similar to descriptions of Kemp's Ridleys nesting at Rancho Nuevo, Mexico (Hildebrand 1963, *op. cit.*; Pritchard and Márquez 1973, *op. cit.*; Márquez 1990, *op. cit.*). The close proximity of the two nest sites (29 m) was similar to observations made on the beach in Sarasota, Florida, where a Kemp's Ridley deposited two nests 274 m apart (Foote and Mueller 2000. *In* Mosier et al. [compilers.], Proceedings of the Twentieth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Tech. Memorandum NMFS-SEFSC-477. 369 pp.). The Kemp's Ridleys in Mexico also nest within a relatively small area of Rancho Nuevo (National Marine Fisheries Service et al. 2011, *op. cit.*).

The hatchlings from these two nests showed no signs of hybridization, based on visual examination of the carapace, plastron, and head scute patterns. This was also the implication of the genetic analysis of Kemp's Ridley hatchlings that emerged in Volusia Co. (Johnson et al. 1999. Florida Sci. 62:194–204). In Mexico, the mating of Kemp's Ridleys is postulated to occur near the nesting beach (Morreale et al. 2007. *In* Plotkin [ed.], Biology and Conservation of Ridley Sea Turtles. The Johns Hopkins University Press, Baltimore, Maryland. 356 pp.; Rostal 2007. *In* Plotkin [ed.], Biology and Conservation of Ridley Sea Turtles. The Johns Hopkins University Press, Baltimore, Maryland. 356 pp.). I do not know where the female described in this account mated. Because Kemp's Ridleys have an alternating gait and leave a track in the sand similar to the nesting emergence of the more commonly observed Loggerhead, the number of their nests might be slightly underestimated in Florida. Eighty Kemp's Ridley nests have been reported from Florida beaches during 1989–2013, with 17 nests reported from the Atlantic coast (Florida Fish and Wildlife Conservation Commission, Statewide Nesting Beach Survey program data). The nesting of Kemp's Ridley in Florida, outside its principal range, may be a function of the recent overall increase in nesting by the species, although the number of Kemp's Ridley nests in Florida during the period of abundant nesting in Mexico (1940s and before) is unknown.

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***MALACLEMYS TERRAPIN* (Diamond-backed Terrapin). ROAD-KILL.** Roads can be a substantial source of mortality for Diamond-backed Terrapins, especially female turtles searching for nesting sites (Woods and Herlands 1997. *In* J. Van Abbema [ed.], Proceedings: Conservation, Restoration, and Management of Tortoises and Turtles—An International Conference, pp. 46–53. New York Turtle and Tortoise Society, New York). Despite the relatively high number of terrapins killed along roadways, few studies have focused on road mortality in this species (Szerlag and McRobert 2006. Appl. Herpetol. 3:27–37). Here, data are presented from a two-year study of terrapin road mortality along a highway in coastal Virginia that has never been systematically surveyed for such mortality.



FIG. 1. Map depicting the location of the road survey transect (red line) along Route 175 in Wallops Island, Virginia. The black hashes demarcate the different sections of the transect, which were separated by bridges in most cases.

We quantified the total number of terrapins killed along a 9-km stretch of Route 175 in Wallops Island, Virginia, USA for two consecutive years (2012, 2013). We monitored the highway between 37.9227°N, 75.4704°W and 37.9372°N, 75.3844°W, which includes a section of causeway that connects mainland Virginia to Chincoteague Island and crosses an area of extensive coastal salt marsh. This causeway is one of the longest stretches of high-traffic, non-viaduct roadway bisecting coastal salt marsh on the Delmarva Peninsula. Surveys were conducted by automobile twice daily at approximately 0800 h and 1700 h from 25 May 2012 to 27 July 2012 and from 29 May 2013 to 30 July 2013. All observed carcasses were collected and removed from the highway after obtaining GPS coordinates.

We observed a total of 89 and 92 dead terrapins for 2012 and 2013, respectively. Road mortality was consistently biased to a particular section of the causeway, located between the Queens Sound and Wire Narrows bridges (Fig. 1, section 5). This section accounted for approximately 32% of total road mortality, but it was around 16% of the total transect length. As expected, of the terrapins whose sex could be determined, the majority were female (95–98%). In 2012, peak mortality rate occurred 26 May with a total of 12 terrapins killed/day, while in 2013 peak mortality occurred approximately two weeks later (8 June), with 10 terrapins killed per day. Cooler water temperatures observed during the spring of 2013 may account for the observed delay in the timing of peak mortality relative to 2012. The last observed road mortality was similar for both years—12 July for both 2012 and 2013; however, a single live terrapin was observed crossing the causeway as late as 15 July 2013.

We found an average annual mortality of 90.5 terrapins killed per 9-km of highway. This is a conservative estimate of the annual rate of mortality at this site, because we did not take detection probability into consideration. In at least five instances over the two-year period we observed terrapin mortality outside of the normal survey times, but all evidence had disappeared by the time we conducted official surveys. In spite of this,

the mortality rate at this site is greater than that reported by Szerlag and McRobert (2006, *op. cit.*), who documented annual mortality to be 53 terrapins for an 8.1-km road (6.5 terrapins/km/yr); however, their study and ours documented substantially less mortality than that reported in a Cape May, New Jersey study. That seven-year survey documented a total mortality of 4020 terrapins with an annual mortality rate of 22.8 terrapins/km/yr (Wood and Herlands 1997, *op. cit.*). Nevertheless, due to the substantial number of terrapins killed along the Route 175 causeway, we recommend the installation of terrapin barriers to reduce road mortality. We also recommend that conservation resources should be prioritized to section five (Fig. 1) of the causeway, the greatest source of mortality.

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***PODOCNEMIS ERYTHROCEPHALA, PODOCNEMIS EXPANSA, PODOCNEMIS SEXTUBERCULATA, PODOCNEMIS UNIFILIS* (Red-headed Amazon River Turtle, Giant South American River Turtle, Six-tubercled Amazon River Turtle, Yellow-spotted Amazon River Turtle). COEXISTENCE.** Here we report the first record of four species of freshwater turtles of the same genus occurring in the same locality. *Podocnemis expansa* and *P. unifilis* are found in Brazil, Bolivia, Colombia, Ecuador, Guyana, Peru, Suriname, and Venezuela; *P. erythrocephala* can be found in Brazil, Colombia, and Venezuela; *P. sextuberculata* is present in Brazil, Colombia, and Peru (Vogt 2008. Tartarugas da Amazônia. Gráfica Biblos, Lima, Peru. 104 pp.) This note is based on a survey in Amazonas (Brazil), in the Municipality of São Sebastião do Uatumã, Sustainable Development Reserve Uatumã, in Lake Jaraoacá (2.37705555556°S, 58.3048333°W; WGS 84). Between January and August 2012, using trammel nets, we captured 30 specimens of *P. expansa* (238.6 ± 63.9 mm SCL; mean ± standard deviation), 15 of *P. erythrocephala* (212.4 ± 27.5 mm SCL), 14 of *P. sextuberculata* (220.1 ± 11.4 mm SCL), and six specimens of *P. unifilis* (215.7 ± 14.7 mm SCL) distributed among males, females, and juveniles. This is also the first record of *P. sextuberculata* occuring in a black water lake; they usually occur only in white or clear water rivers and lakes.

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***PODOCNEMIS LEWYANA* (Magdalena River Turtle). MERCURY LEVELS.** *Podocnemis lewyana* is an endangered species endemic to northern Colombia, where it suffers from habitat degradation and over-exploitation for its meat and eggs (Páez et al. 2009. Chelon. Res. Monogr. 5:024.1–024.6). Northern Colombia is a globally significant focus for mercury contamination due to its widespread use there in artisanal gold mining activities (United Nations Environment Programme 2002. Global Mercury Assessment. Geneva, Switzerland).

Between January and March of 2012, we obtained samples from eight adult female *P. lewyana* from subsistence fishermen at the time the turtles were sacrificed in Puerto Berrío, Antioquia (6.4942°N, 74.3882°W, WGS84; elev. 105 m). They ranged in size from 28.3 to 45.6 cm straight-line carapace length (mean = 39.3 cm). Samples of blood, muscle, and carapace tissue were held on ice until transported to the laboratory, where they were digested with H_2SO_4, HNO_3, and $KMNO_4$. Total mercury content was then determined by flameless atomic absorption spectrometry, using a Buck Scientific 410 Cold vapor Mercury Analyzer (Buck Scientific, Inc, Norwalk, Connecticut). The mercury concentration averaged 0.79 ± 1.04 ug/g wet weight (mean ± SD) for muscle, 0.69 ± 1.06 ug/g for carapace and 0.13 ± 0.18 ug/g for blood. Thus, humans who consume *P. lewyana* meat run a health risk, since this tissue exhibited mercury concentrations above the maximum level (0.5 ug/g Hg) recommended by the World Health Organization (WHO 2000. Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories. Vol. 2. Risk Assessment and Fish. WHO, Washington, D.C.).

Mercury biomagnifies as it moves up the food chain, but despite being herbivorous, these *P. lewyana* individuals exhibited higher levels of mercury bioaccumulation in their tissues than those documented for the omnivorous Colombian Slider (*Trachemys callirostris*) in this same drainage (Zapata et al. 2014. Bull. Environ. Contam. Toxicol., *in press*. DOI: 10.1007/s00128-014-1198-5). Perhaps the higher levels were related to the larger size of the *P. lewyana* individuals that were sampled, which presumably were older and therefore had experienced longer exposure times to this contaminant than the average adult slider turtle.

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***PODOCNEMIS SEXTUBERCULATA* (Six-tubercled Amazon River Turtle). MORPHOLOGY, EXTRA LIMB.** On 18 October 2013 a female *Podocnemis sextuberculata* laid 18 eggs in a nest on Praia do Farias (Municipality of Oriximiná. Reserva Biológica do Rio Trombetas: Para, Brazil; 1.25°S, 56.833333°W, WGS84). This beach is used annually for nesting by *Podocnemis* (*P. expansa*, *P. unifilis*, and *P. sextuberculata*), from August–December. Eleven of these eggs hatched on 7 December. Mean nest temperature was 32.5°C (temperature recorded hourly by an Onset Tidbit Data Logger placed in the nest). One of the hatchlings had five limbs, two anterior and three posterior. The four in the expected locations were normal, the fifth appendage had its origin at the medial juxtaposition of the femoral and anal scutes; the atrophied appendage has normal skin, scale, and toe morphology, but is about 50% smaller than the other two hind limbs (Figs. 1, 2). The plastron and carapace are disrupted at the insertion point of the extra limb. The turtle was able to walk and swim



FIG. 1. Posterior carapacial view of hatchling *Podocnemis sextuberculata* with supernumerary hind limb.



FIG. 2. Posterior plastral view of hatchling *Podocnemis sextuberculata* with supernumerary hind limb.

without any difficulties. The added appendage is capable of moving up, covering the cloaca with the foot, or down. It is able to spread the toes normally. Usually the appendage is held tight against the plastron with the ventral aspect of the foot covering the cloaca. To our knowledge this is the first report of a pleurodiran turtle with five appendages. A *Chrysemys picta* without hind legs, which died while hatching, has been reported (Ewert 1979. *In* M. Harless and H. Morlock [eds.], Turtles: Perspectives and Research, pp. 333–413. John Wiley and Sons, New York). Hildebrand (1938. J. Hered. 29:243–254) reported a *Malaclemys terrapin* with a rudimentary fifth leg. The turtle described here remains alive at Projeto Tartarugas da Amazônia in Manaus.

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***RHINOCLEMMYS RUBIDA PERIXANTHA* (Colima Wood Turtle). DIET.** *Rhinoclemmys rubida perixantha* is a relatively small terrestrial turtle, native to the tropical deciduous forests of western Mexico, ranging from the states of Michoacán to Jalisco (van Dijk et al. 2007. *In* IUCN 2013. IUCN Red List of Threatened Species. Ver. 2013.1 http://www.iucnredlist.org. Accessed 05 September 2013). Little information exists on the diet of *R. r. perixantha*, however observations of fecal samples from this species on the Chamela-Cuixmala Biosphere Reserve in 2011 indicate the diet of this population consists of cactus (*Opuntia* spp.), isopods, and the seed pits of fleshy fruit (Holcomb 2012. The Tortoise. [The Turtle Conservancy]. 1:57). The closely related *R. r. rubida* is known to feed on cactus (*Opuntia* spp.), fruit, and small arthropods at the Behler Chelonian Center (Liu 2012. The Tortoise. [The Turtle Conservancy]. 1:59). Here we present additional observations on the diet of *R. r. perixantha*.

On four separate occasions in the lowland tropical deciduous forest of the Chamela-Cuixmala Biosphere Reserve (19.49868°N, 105.04449°W) in Jalisco, Mexico, we observed a large quantity of *Guapira macrocarpa* seeds and flesh in the feces of *R. r. perixantha*. The first observation was on 1 July (adult male), followed by three more observations on 3 July (adult male), 19 July (adult female), and 21 July (juvenile), 2012. On three occasions *R. r. perixantha* was observed actively feeding on the fallen fruits of *Guapira macrocarpa* (1, 3, and 21 July; Fig. 1). Upon discovery, specimens were temporarily collected for measurement and collection of fecal samples. In addition to *G. macrocarpa* seeds, fecal samples revealed cactus fiber, and small amounts of unidentified seeds. This appears to be the first record of foraging and identified food sources for *R. r. perixantha*.

Guapira macrocarpa is among the most abundant tree species on the Chamela-Cuixmala Biosphere Reserve and bears fruit during the onset of the four-month rainy season, typically in July (Durán et al. 2002. *In* Noguera et al. [eds.], Historia Natural de Chamela, pp. 443–472. Universidad Nacional Autónoma de México). During this period the fruit from *G. macrocarpa* is known to be an important food source for *Trogon citreolus* (Citreoline Trogon; Renton and Vega 2002. *In* Noguera et al. [eds.], Historia Natural de Chamela, pp. 345–346. Universidad Nacional Autónoma de México) and *Glossophaga soricina* (Pallas's Long-tongued Bat; Stoner 2002. *In* Noguera et al. [eds.], Historia Natural de Chamela, pp. 379–395. Universidad Nacional



FIG. 1. *Rhinoclemmys rubida perixantha* on the Chamela-Cuixmala Biosphere Reserve shortly after eating the red fleshy fruit of *Guapira macrocarpa*.

Autónoma de México). Observations of *R. r. perixantha* foraging on this fruit in the wild and its identification in fecal samples suggest *G. macrocarpa* may also be an important food source for this turtle during the rainy season. In addition, *R. r. perixantha* may potentially be an important seed dispersing agent for *G. macrocarpa*.

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***TERRAPENE CAROLINA CAROLINA* (Eastern Box Turtle). POTENTIAL MODE OF DISPERSAL IN TERRESTRIAL GASTROPODS.** *Terrapene carolina carolina* has been shown to aid in the dispersal of both fungal spores (Jones et al. 2007. Am. Midl. Nat. 157:121–126) and seeds (Braun and Brooks 1987. Am. Midl. Nat. 117:312–318). Both of these instances were accomplished through ingestion and defecation and are something that would be expected based on *T. c. carolina* feeding habits (Dodd 2001. North American Box Turtles: a Natural History. Univ. Oklahoma Press, Norman. 231 pp.). This report describes the dispersal of an additional organism (e.g., terrestrial gastropod) through attachment to the carapace of *T. c. carolina*. Box turtles tend to have varying home range sizes depending on the individual, but generally stay within a small region (Dodd 2001, *op. cit.*), therefore, long distance dispersal by invertebrates via attachment to the carapace is not likely. However, there is potential for dispersal into localized areas where previous colonization has not occurred. There is also an opportunity for re-colonization of areas that have experienced some type of catastrophic disturbance.

On 8 June 2011 while conducting field work at Lilley Cornett Woods Appalachian Ecological Research Station, Letcher Co., Kentucky, USA (37.07692°N, 82.99578°W; NAD 83), I observed a small terrestrial gastropod (*Punctum minutissimum*) that had attached itself to the carapace of a *T. c. carolina*. Although it is unknown whether the terrestrial gastropod intentionally attached itself to the carapace, this represents a potential mode of dispersal in these organisms, even if unintentional. This observation demonstrates a mode through which microsnails (i.e., those that are < 5 mm in diameter), as noted here, may potentially colonize or re-colonize local areas. These organisms have extremely limited mobility and are confined to small home ranges throughout their lives (Baur and Baur 1988. Veliger 30:372–376), thus making them susceptible to localized extinctions during catastrophic events. This may also represent a manner by which terrestrial gastropods could navigate through areas that would generally present a barrier for dispersal, such as shallow water. Though terrestrial gastropods are often consumed by *T. c. carolina* (Dodd 2001, *op. cit.*), this observation demonstrates an instance in which a prey organism could potentially derive benefit from the presence of a potential predator. To my knowledge, this is the first such observation of this phenomenon in this area.

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***TRACHEMYS SCRIPTA ELEGANS* (Red-Eared Slider). MOVEMENT.** Freshwater turtles are capable of long distance movements; such movements may be associated with reproduction, periods of dormancy, and searches of suitable habitat (i.e., ephemeral wetlands; Ernst and Lovich 2009. Turtles of the United States and Canada, 2nd ed., Johns Hopkins Univ. Press, Baltimore, Maryland. 827 pp.).

At ~ 0900 h on 18 July 2012, a female *Trachemys scripta elegans* (carapace length = 195 mm, mass = 1025 g) was captured in a hoop trap on the North Oconee River in Clarke Co., Athens, Georgia, USA, and released at the point of capture. This individual was recaptured at ~ 1100 h on 22 July 2012 in another hoop trap 1.65 km downstream from where it was first captured. Distance of movement was determined using GPS and Google Earth Pro. At the time of trapping, the stream was at base flow (30 cubic feet/sec), with numerous riffle areas, which constricted aquatic movement downstream.

Although long distance movement in turtles is not unusual, our observation might be of interest because this turtle apparently followed the watercourse for a considerable distance at a time when movement was difficult. In addition, females are often considered more sedentary than males (Parker 1984. Am. Midl. Nat. 112:280–293). In Carolina Bays of South Carolina, significantly more males were captured than females of those turtles making overland movements (Morrealle et al. 1984. Can. J. Zool. 62:1038–1042). Additionally, the longest movements were made exclusively by males, supporting a hypothesis that differing reproductive tactics might explain the differences in seasonal activity of males and females. It is possible that the movement we observed might have been associated with disturbance from handling, although this was minimized in the field.

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***TRACHEMYS SCRIPTA* (Red-Eared Slider), *PSEUDEMYS TEXANA* (Texas River Cooter), *CHELYDRA SERPENTINA* (Snapping Turtle). FEEDING BEHAVIOR AND SCAVENGING.** On 25 March 2013 we observed a *Pseudemys texana* consuming algae from the carapace of a *Trachemys scripta* in the Turtle Pond at The University of Texas at Austin. The Turtle Pond contains an urban population of *T. scripta*, *P. texana*, at least two individuals of *Chelydra serpentina*, and a lone individual of *Apalone spinifera* (presumed to be introduced). Algae covers the carapaces of many turtles in the pond; some individuals are entirely covered in algae while others lack it. This is the first time that the consumption of algae from a turtle shell has been documented between these two species; it remains unknown if this represents an opportunistic feeding event or if there is a more substantial symbiotic relationship between these species. Symbiotic cleaning behavior has been noted previously in a single pond in Ontario, Canada, in which several individuals of *Chrysemys picta* were observed eating algae and leeches off of the shell and skin of several *Chelydra serpentina* (Krawchuk et al. 1997. Can. Field Nat. 111:315–317). Individual *Chelydra* in the pond with parasites removed by *Chrysemys* had significantly fewer leeches than *Chelydra* elsewhere, but the effects of algae-removing behavior by the turtles was not mentioned in this regard. Although *Chelydra* is found in the Turtle Pond, no individuals have been observed participating in algae removal. The observed interaction between *P. texana* and *T. scripta* was

captured on video and is available for review (http://dx.doi.org/10.6084/m9.figshare.787749).

On 8 April 2013 we observed multiple adult *T. scripta* cannibalistically scavenging a decapitated adult conspecific in the Turtle Pond. These individuals bit at the exposed flesh between the forelimb and the plastron-carapace bridge, pulling with the head and neck and pushing with the forelimbs to tear off chunks before consuming the flesh. A video was captured of the behavior and is available for review (http://dx.doi.org/10.6084/m9.figshare.787748). This behavior is probably not truly cannibalistic, but rather represents opportunist cannibalistic scavenging. Mitchell (1986. SSAR Herpetol. Circ. No. 15, 37 pp.), in a review of cannibalistic events for turtles, reported eight incidents, seven of which involved adults consuming juveniles; the eighth incident did not report information about the age of participants.

Also on 8 April 2013, we observed an individual of *T. scripta* consuming a juvenile of *Chelydra serpentina* in the Turtle Pond. When the observation was made, the juvenile was already deceased and partially consumed. The feeding behavior was similar to the cannibalistic scavenging described previously. The juvenile *Chelydra* was held in the mouth of the adult *Trachemys*, which pushed with its forelimbs and pulled with its neck to try to destroy the weakly ossified shell and consume the juvenile. This behavior was captured on video, which is available for review (http://dx.doi.org/10.6084/m9.figshare.810515).

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CROCODYLIA – CROCODILIANS

***CROCODYLUS MORELETII* (Morelet's Crocodile). DIET.** Crocodylus moreletii inhabits freshwater wetlands throughout much of the Atlantic lowlands of Mexico, Guatemala, and Belize (Groombridge 1987. In Webb et al. [eds.], Wildlife Management: Crocodiles and Alligators, pp. 9–21. Surrey Beatty & Sons, Pty. Ltd, Sydney). On 18 April 2013 at 2230 h, while conducting a crocodile spotlight survey along the Río Hondo (17.9°N, 88.86°W, datum WGS84; 5 m elev.) on the border between Mexico and Belize, we found a yearling Morelet's Crocodile (32 cm total length, 130 g) that had just captured an adult male Mexican Greater Funnel-eared Bat (*Natalus mexicanus*) near shore. The young crocodile continued holding the bat between its jaws after we captured it (Fig. 1). Crocodilians are mainly nocturnal hunters, so field observations on actual prey species taken are scarce. However, *Crocodylus porosus* and *C. johnstoni* catch flying foxes and other bats in some regions of Australia (Pooley 1989. *In* Ross [ed.], Crocodiles and Alligators, pp. 76–91. Facts On File, Inc., New York). To our knowledge, this is the first documented case of bats being part of the diet of *C. moreletii*. Previous dietary studies reported aquatic and terrestrial insects, arachnids, aquatic gastropods, crustaceans, fish, amphibians, reptiles, birds, and terrestrial mammals, but bats were not included among the prey items recovered from stomach contents (Platt et al. 2006. Herpetol. J. 16:281–290). More interesting is the fact that very small crocodiles such as this one are known to consume mostly



PHOTO BY RAYMUNDO MINEROS-RAMÍREZ

FIG. 1. Morelet´s Crocodile (*Crocodylus moreletii*) preying on a Mexican Greater Funnel-eared Bat (*Natalus mexicanus*) in the Rio Hondo, Mexico-Belize.



PHOTO BY VALENTÍN GONZÁLEZ ÁVILA

FIG. 2. A bat flying (upper left corner) close to a young Morelet's Crocodile, *Crocodylus moreletii* (center) on 6 September 2012 at 1952 h, Chichankanab Lake, Quintana Roo, Mexico.

invertebrates and small fish rather than birds or mammals (Platt et al. 2002. Herpetol. J. 12:81–84). During spotlight surveys to study crocodile populations we commonly observe bats flying above the water (Fig. 2), and this crocodile likely caught the bat when it came low to drink.

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SQUAMATA — LIZARDS

***AMBLYRHYNCHUS CRISTATUS* (Marine Iguana). POLYDACTYLY.** Polydactyly is relatively uncommon in lizards and certainly occurs in wild lizard populations at a frequency near or lower than 1/1000 (II, pers. obs. on Pacific islands of > 10,000 lizards). Thus, each observation is valuable and should be reported. Among reptiles, polydactyly has been reported within chelonians and several lizard families (chamaeleonids, tropidurids,



FIG. 1. Left (on the left) and right (on the right) hands ventral views of *Amblyrhynchus cristatus* (MNHN 1903.0007) showing the supernumerary finger I on both sides of the animal. Note that a mite is present on left side between fingers I and II.



FIG. 2. Left (on the left) and right (on the right) hands dorsal views of *Amblyrhynchus cristatus* (MNHN 1903.0007) showing the supernumerary finger I on both sides of the animal.

lacertids, and gekkonids). Most recent reports concern lizards from distinct families and geographical origin (e.g., Carretero et al. 1995. Bol. Assoc. Herpetol. Esp. 1995:11–13; Megía 2012. Bol. Asoc. Herpetol. Esp. 23:54–56). One report among the Rhynchocephalia has been omitted in all previous papers reporting cases of polydactyly (e.g., Bauer et al. 2009. Herpetol. Notes 2:243–246). This important statement was published in a local herpetological association journal (Anonymous 2007. Society for the Research on Amphibians and Reptiles in New Zealand 33:12). That case of symmetrical polydactyly reported the occurrence of six toes on both front feet in a hatchling *Sphenodon punctatus*. Ineich (p. 228; 1987. Recherches sur le peuplement et l'évolution des reptiles terrestres de Polynésie française. Ph.D. Thesis, USTL Montpellier, France. 511 pp.) also reported the first cases of polydactyly in a skink (*Cryptoblepharus poecilopleurus*; Easter Island) and the first in a gecko (*Gehyra oceanica*; French Polynesia), both also omitted in following reports. Paris Natural History Museum (MNHN) possesses two specimens of *Amblyrhynchus cristatus* (MNHN 1903.0007–8) that were collected together at Gardner Island on the Galapagos Archipelago in the early twentieth century (note, however, that there are two Galapagos Islands named after Lord Gardner, one near Charles Island and another near Hood Island; Slevin 1959. The Galapagos Islands, A History of Their Exploration. Proc. California Acad. Sci. 25:i–x + 1–150). Both female MNHN specimens were donated by Mr. Rosenberg (and perhaps collected by him) on 31 January 1903 to the MNHN collections. Among those specimens, one (MNHN 1903.0007) exhibits polydactyly on both hands, whereas the other has normal fingers and toes. The adult specimen with supernumerary fingers displays six fingers on both hands (SVL = 192 mm, tail length = 305 mm, total length = 497 mm). The aberrant specimen is unique in two ways: First, polydactyly in this specimen is symmetrical and identical on both sides (Figs. 1, 2); secondly, the supernumerary finger is certainly placed before what should normally be finger I. Our specimen was, however, not x-rayed, and consequently, osteological basis for its polydactyly condition cannot be discussed further here. Lazi et al. (2012. Herpetol. Notes 5:277–279) related a case of true polydactyly or brachydactyly in a *Podarcis muralis* (Lacertidae) from Serbia showing six toes on each foot. Their observation concerned hindlimbs contrary to the Marine Iguana reported here, but was symmetrical as in the present case. Our report is the first regarding polydactyly in the Iguanidae. Our observations and all the previous ones together seem to argue that such malformations are not related to phylogenetic or geographic origin of an individual. Note, however, that they seem to have a strong association with islands (e.g., French Polynesia, Easter Island, Palmyra Atoll, New Zealand) and this could be perhaps an artifact linked to low island predation levels allowing individuals with such malformations to grow to adult stage and thus increasing their chance to be sampled.

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***ANOLIS CRISTATELLUS WILEYAE* (Virgin Islands Crested Anole). NOCTURNAL ACTIVITY.** The highly speciose genus *Anolis* is widespread in the New World tropics, with the Caribbean a major center of radiation (e.g., Schwartz and Henderson 1991. Amphibians and Reptiles of the West Indies: Descriptions, Distributions, and Natural History. Univ. Florida Press, Gainesville, Florida. 720 pp.; Roughgarden 1995. Anolis Lizards of the Caribbean: Ecology, Evolution, and Plate Tectonics. Oxford University Press, New York. 200 pp.; Losos 2009. Lizards in an Evolutionary Tree: Ecology and Adaptive Radiation of Anoles. Univ. California Press, Berkeley. 528 pp.). Several *Anolis* spp. have been described as human commensals in that they have colonized and proliferated in anthropogenic habitats such as urban gardens, plantations, and orchards (e.g., endemic *A. trinitatus* and exotic *A. sagrei* on St. Vincent, Windward Islands, Lesser Antilles; Treglia 2006. Iguana 13:252–263; exotic *A. sagrei* on Taiwan; Norval et al. 2002. Zool. Stud. 41:332–336). All species are typically diurnal. This note documents an instance of nocturnal activity in *A. cristatellus wileyae*, which has a widespread distribution in the Virgin Islands, and is known to occur in anthropogenic habitats (MacLean 1982. Reptiles and Amphibians of the Virgin Islands. Macmillan Education Limited, London and Basingstoke, UK. vii + 52 pp.).

Observations occurred in a small ground floor hotel bedroom at Nanny Cay Resort and Marina, on the coast at the east end of Tortola Island, British Virgin Islands (18.400833°N, 64.56888°W, datum WGS84; elev. ~5 m), during a stay by the second author (JEM). On 2 April 2013, 1939 h, JEM entered the unilluminated room, switched on the overhead ceiling light, and observed a small adult (estimated SVL ~50 mm) female *A. c. wileyae* stationary in resting stance with eyes open near the top of the shade of an unilluminated electric lamp, situated ~0.2 m from the bed on a bedside table. The subject was photographed with a digital camera (Fig. 1) but was apparently undisturbed by the flash and the presence of the observer, and remained in the same position on the lamp shade for a further ~7 minutes; it eventually leaped down to the side table, then to the floor, and was lost to

PHOTO BY J. E. METCALFE



FIG. 1. Female *Anolis cristatellus wileyae* on lamp shade in a hotel room, Tortola Island.

view. JEM had been coming and going from the room previously during the day, but had not observed the subject, and had last left the room ~1¼ h previous to observations just after sunset (1832 h on 2 April 2013, Tortola Is.) when the overhead light was switched off and the curtains were closed, leaving the room in darkness. While very low illumination in the room through the window and gaps in the curtains might have been available in the gloaming from outside shortly after we left the room, later perhaps from exterior lights, or under the door from hallway lights, at some point during the intervening ~1¼ h period the lizard had climbed the furniture and the lamp shade, in darkness or near-darkness, as typical of arboreal perching behavior at dusk reported in many *Anolis* spp. (e.g., *A. uniformis* in Mexico; Cabrera-Guzman and Reynoso 2010. Rev. Mex. Biodivers. 81:921–924; *A. grahami*, *A. lineatopus*, and *A. valencienni* in Jamaica; Singhal et al. 2007. Behaviour 144:1033–1052; general discussion, Losos 2009, *op. cit.*), and the lamp shade in the above case was probably the highest accessible point in the room. The subject reported herein was the only *A. c. wileyae* observed on Tortola Island during the brief stay by JEM.

This observation is apparently the first report of nocturnal activity in typically diurnal *Anolis c. wileyae* within a human-occupied building on Tortola Island. Some congenerics (e.g., *A. equestris*) may remain active for a brief period after nightfall via thigmothermy on warm substrates. An alternative explanation is that availability of light rather than heat is the factor limiting activity in *Anolis* spp., if sufficient illumination is provided by incandescent or fluorescent lights, where insects attracted to artificial lights may provide an attraction for opportunistic foraging anoles, as noted in several reviews (e.g., Henderson and Powell 2001. Carib. J. Sci. 37:41–54; Perry and Fisher 2006. *In* Rich and Longcore [eds.], Ecological Consequences of Artificial Night Lighting, pp. 169–191. Island Press, Washington, DC), the most recent and extensive of which reported 17 *Anolis* spp. as engaged in this behavior (Perry et al. 2008. *In* Mitchell et al. [eds.], Urban Herpetology, pp. 239–256. Herpetol. Conserv. Vol. 3. SSAR, Salt Lake City, Utah), and there have been several subsequent reports (e.g., Stroud and Giery 2013. Herpetol. Rev. 44[4]:660–661); these reports indicate nocturnal foraging around artificial lights might be widespread in *Anolis* spp. Nocturnal foraging activity at artificial lights was reported for the nominate race *A. c. cristatellus* in Puerto Rico (Garber 1978. Trans. Kansas Acad. Sci. 81[1]:79–80) and as exotics in the Dominican Republic, Hispaniola (Schwartz and Henderson 1999, *op. cit.*), and for *A. c. wileyae* which were in turn predated by the typically diurnal snake *Liophis portoricensis anegadae* on Guana Island, British Virgin Islands (Perry and Lazell 2000. Herpetol. Rev. 31[4]:227; Perry and Powell 2009. IRCF Reptiles & Amphibians 16[1]:6–17, photograph p. 11:B). The above case of a wild *A. c. wileyae* active in the dark in order to attain a sleeping perch demonstrated that this species will also engage in nocturnal activity other than foraging under artificial lights.

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***ANOLIS SAGREI* (Brown Anole). PREY STEALING BEHAVIOR.** *Anolis sagrei* is native to Cuba and the Bahamas, and has been introduced throughout many tropical and subtropical regions of the world (Kolbe et al. 2004. Nature 431:177–181). Trunk-ground anole ecomorphs (e.g., *A. sagrei*) utilize a sit-and-wait foraging strategy where they detect prey visually by their movement (Losos 2009. Lizards in an Evolutionary Tree: Ecology and Adaptive Radiation of Anoles. Univ. of California Press, Berkeley. 528 pp.). The diet of *A. sagrei* consists primarily of invertebrates, but adults occasionally eat other lizards including young of their own species (Cochran 1989. Herpetol. Rev. 20:70; Gerber and Echternacht 2000. Oecologia 124:599–607).

On 13 October 2013, we observed an adult *A. sagrei* steal a subdued spider from a spider-wasp (Hymenoptera: Pompilidae) on a spoil island located at Tomoka State Park, Ormond Beach, Florida, USA (29.349599°N, 81.090158°W; WGS 84). Spider-wasps paralyze and then lay eggs inside spiders, which subsequently hatch inside the spider host where the larvae feed (Eaton and Kaufman 2007. Kaufman Field Guide to Insects of North America. Houghton Mifflin, New York. 392 pp.).

The wasp attacked a funnel-web spider (Araneae: Agelenidae), which was located on the ground at the base of a small tree. The spider attempted to flee about 0.5 m before becoming motionless, presumably due to venom injected by the wasp. The wasp quickly grabbed the spider and began to drag it backwards towards the site of the initial confrontation. An adult *A. sagrei* had been observing the wasp/spider interaction from about 0.5 m above in the small tree. As the wasp was dragging the spider, the *A. sagrei* jumped to the ground, bit and stole the spider, and quickly returned to its perch where it began to consume the spider. The wasp took flight when the *A. sagrei* bit the spider and fled the area within a few minutes following the event.

Anolis sagrei are important components of tropical and subtropical communities that affect invertebrate populations directly (i.e., depredation) and indirectly (i.e., competition) (Spiller and Schoener 1990. Oecologia 83:150–161; Huang et al. 2008. Ecol. Entomol. 33:569–576). While it is known that *A. sagrei* depredate spiders opportunistically (Spiller and Schoener 2001. Ecology 82:1560–1570), there are no studies to our knowledge that have documented direct competition between spider-wasps and anoles for spider prey. The frequency of these interactions depends upon numerous factors (e.g., wasp density, lizard density) and might contribute to shaping community structure where anoles and spider-wasps occur sympatrically, both in and outside the native range of *A. sagrei*.

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***ASPIDOSCELIS TIGRIS AETHIOPS* (Sonora-Sinaloa Desert Whiptail). SIZE AND REPRODUCTION.** I assessed SVL and reproductive characteristics for *Aspidoscelis tigris* based on a sample from among the southernmost continental areas known for the species, populations which occur in a coastal state of western México. Use of the trinomial *A. t. aethiops* for these populations of diminutive lizards (max. SVL 67 mm) is problematic. Further studies may show that they represent an undescribed subspecies (Walker, unpubl. data). I examined 28 specimens from the California Academy of Sciences (CAS 115648–115675) collected by A. E. Greer and F. W. Burley on 20 July 1963 from ~7 km NE of Topolobampo near the road to Los Mochis (25.69°N, 109.04°W; datum NAD27) in the northern part of Sinaloa State, México. This site is beyond the southern limits of the Sonoran Desert as mapped by Brown and Wright (1994. Herpetology of the North American Deserts. Proc. Symp. Southwest. Herpetol. Soc. Spec. Publ. 5. Van Nuys, California. XX pp.). Data for SVL and clutch size based on dissection of the CAS sample are presented by ranges of variation, sex as a ratio, and/or means (to one decimal place) ± 1 SE.

Numbers of males and females of *A. t. aethiops*, respectively (in parens), by size (as 5 mm increments in SVL where applicable) among the 28 specimens were: 50–54 (2:4), 55–59 (3:0), 60–64 (10:6), 65–67 (3:0), and overall sex ratio from opportunistic collecting (18:10). Among the 10 females in the sample, nine were sexually mature (i.e., >51 mm SVL), seven were gravid, five had yolked ovarian follicles, and two had oviductal eggs. Sexual dimorphism in SVL for the Sinaloa population of *A. t. aethiops* is not apparent at $P = 0.05$, based on data for adult males (60.7 ± 0.91, 53-67, N = 18) compared with adult females (58.7 ± 1.47, 52–63, N = 9). Among females 50–54 mm SVL, 2 (50%) were gravid; clutch size was 1–2 (mean = 1.5). Among females 60-64 mm SVL, five (83.3%) were gravid; clutch size was 1–2 (mean = 1.8). For the single-date Sinaloa sample, two females had clutches of one egg and five females had clutches of two eggs. Clutch size for seven females was 1.7 ± 0.18; there is no relationship between clutch size and SVL for the seven Sinaloa females of *A. t. aethiops* (based on adjusted $r^2 = -0.18$).

The sample of *A. t. aethiops* from the area northeast of Topolobampo, Sinaloa, referenced herein is ~331 km straight line distance southsoutheast of the nearest continental site at Estación Ortiz (28.289972°N, 110.716889°W; datum WGS84), Sonora, from which specimens were previously used to assess SVL and reproductive characteristics at that latitude in this species (Walker et al. 2005. Herpetol. Rev. 36:316–317). The present study revealed a geographic trend from significantly higher means for adult male SVL (71.7 ± 0.71, range 6087, N = 91), adult female SVL (68.5 ± 0.73, 6081, N = 60), and clutch size (2.2 ± 0.09, range 14, N = 43) at Estación Ortiz compared with the aforementioned lower means for the sample from northeast of Topolobampo, Sinaloa.

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***ASPIDOSCELIS TIGRIS PUNCTILINEALIS* (Sonoran Tiger Whiptail). UPLAND HABITATS.** The geographical distribution of *Aspidoscelis tigris punctilinealis* (= *Cnemidophorus tigris gracilis*; see Reeder et al. 2002. Amer. Mus. Novitat. 3365:161; Taylor and Walker 1996. Copeia 1996:140–148; Walker et al. 1966. Copeia 1966:498505) includes Isla Tiburón (type locality), Gulf of California, Sonora, Mexico, and large mainland areas in Sonora and Arizona (see map in Dessauer et al. 2000. Bull. Amer. Mus. Nat. Hist. 246:1148; Taylor and Walker 1996, *op. cit.*; Walker et al., *op. cit.*). In this report we show that the popular conception of *A. t. punctilinealis* (Sonoran Tiger Whiptail) in Arizona as the ubiquitous, moderately large (~95 mm maximum SVL), wary, and rapidly-moving denizen of openstructured Sonoran desertscrub consisting of relatively stable creosote and/or mesquite flats (Dessauer et al., *op. cit.*; Taylor and Walker 1996, *op. cit.*) is inadequate to explain the existence of much larger lizards (>105 mm maximum SVL) in topographically complex upper elevation disturbed ecotones connecting woodland biomes in the central part of the state. Herein, we describe atypical habitats utilized by lizards that apparently represent *A. t. punctilinealis* (based on dorsal and ventral color patterns) at the northern terminus of the range of the subspecies. The descriptions are based on studies conducted by BKS during 2006, 2007, 2012, and 2013 in the vicinity of Sedona, Yavapai County, Arizona (Boynton Canyon, 10 km NW Sedona, UTM 12S 422156E, 3863365N; all NAD 1927) and near Payson, Gila County, Arizona, (including Forest Road 414, 5.6 km SW Payson, UTM 12S 462837E, 3785055N and Houston Mesa Trailhead, 1.6 km NW Payson, UTM 12S 471684E, 3792453N).

At the sites in Gila County, three biomes occur in close proximity, and ecotones between the three blur distinctions easily made in other areas of the state. At elevations of ~1400 to 1800 m, complex mosaics of Great Basin Woodland, Chaparral and Petran Montane Coniferous Forest can be found, with broad to narrow ecotones among the three, resulting in exceptionally high plant diversity relative to typical "pure" stands of these biomes elsewhere. *Aspidoscelis t. punctilinealis* is abundant in these ecotones near Payson, but almost never in pure Chaparral nor pure Woodland nor pure Forest stands. These lizards are especially likely to be present in recently burned areas characterized by newly created open areas with exposed substrate, resulting from both natural and man-made causes. They flourish in these areas as they recover at least for 5-10 years post-burn, with reduced abundance if the community becomes densely vegetated with little exposed substrate (e.g., closed



FIG. 1. Habitat diversity contributing to the presence of *Aspidoscelis tigris punctilinealis* (Sonoran Tiger Whiptail) in the upland (elev. ~1600–1800 m) Houston Mesa area northwest of Payson, Gila County, Arizona showing relatively closed (upper left) and open (upper right) recently burned sites; the granitic boulder site with ample exposed soil (lower left) and the Boynton Canyon area (lower right) near Sedona, Yavapai County, Arizona with a reddish degraded sandstone substrate.

canopy chaparral). Interestingly, as dense Woodland and Forest landscapes are "thinned" to reduce fire risk, available evidence indicates that *A. t. punctilinealis* rapidly colonizes these open structured habitats.

In the vicinity of Houston Mesa situated northwest of Payson (Fig. 1), some vegetation assemblages can be described as lush in a part of Arizona with annual rainfall of ~21.5 inches. *Aspidoscelis t. punctilinealis* is common in what is best termed a Woodland-Chaparral ecotone with plants, in rough order of abundance, to include *Arctostaphylos pungens* (Pointleaf Manzanita), *Quercus turbinella* (Shrub Live Oak), *Mimosa biuncifera* (Wait-a-minute Bush), *Pinus monophylla* (Singleleaf Pinyon Pine), *Juniperus monosperma* (One Seed Juniper), *Cupressus glabra* (Smooth-bark Arizona Cypress), *Quercus emoryi* (Emory Oak), and even *Pinus ponderosa* (Ponderosa Pine) and *Juniperus deppeana* (Alligator Juniper) in small numbers. The soil is primarily graycolored and well-drained, gravelly loam, alluvium of weathered, decomposing granite, with some boulder fields creating open areas devoid of vegetation and abundant thermoregulatory opportunities for squamates (Fig. 1). The only other teiid syntopic with *A. tigris* in these areas is triploid parthenogenetic *A. uniparens* (Desert Grassland Whiptail); *A. velox* (Plateau Striped Whiptail), also a triploid parthenogenetic species, occurs at higher elevations or in pure Great Basin Woodland communities (i.e., exclusive of pinyon/juniper). Other co-occurring saurians with *A. t. punctilinealis* include: *Cophosaurus texanus* (Greater Earless Lizard), *Sceloporus clarkii* (Clark's Spiny Lizard), *Sceleporus tristichus* (Plateau Fence Lizard), *Urosaurus ornatus* (Ornate Tree Lizard), and *Phyrnosoma hernandesi* (Greater Short-horned Lizard). For those who have observed *A. tigris* as the desertscrub teiid, in open creosote flats of the Mohave and Sonoran deserts of the Southwest, these upper elevation habitats are distinct exceptions, more in line with those occupied by *A. t. munda* (California Whiptail) populations found in Coastal Chaparral communities of California. However, *A. t. munda*, like *A. t. punctilinealis*, also inhabits a variety of habitats such as Blue Oak (*Quercus douglasii*) Woodland, *Atriplex-Ephedra* scrublands of the San Joaquin Valley, Panoche Valley, and Carrizo Plain, and Coastal Sage Scrub in southern California.

Near Sedona, Yavapai County, Sonoran Tiger Whiptail was unexpectedly observed along hiking trails with substrate of ample exposed reddish degraded sandstone in canyons and nearby slopes of a similar ecotonal nature to those habitats near Payson. Elements of Great Basin Woodland (e.g., One Seed Juniper, Singleleaf Pinyon Pine), Chaparral (Pointleaf Manzanita, Shrub Live Oak), and Petran Montane Forest (Ponderosa Pine) all co-occur; the lizards there are also associated with relatively open slopes (Fig. 1). It appears that the populations of *A. t. punctilinealis* in these sandstone/canyons with a stunningly reddish substrate (Fig. 1) are derived from the more typical creosote bush habitats occupied along the Verde River to the south.

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***BRONCHOCELA CRISTATELLA* (Green Crested Lizard). REPRODUCTION.** *Bronchocela cristatella* ranges from the Nicobar Islands of India, eastward through Myanmar and Thailand and south through Peninsular Malaysia and Singapore, eastward through Papua, Indonesia (Diong and Lim 1998. Raffles Bull. Zool. 46:345–359; Hallermann 2005. Russian J. Herpetol. 12:168–183). There are reports on clutch sizes of 1–4 eggs (Das 2010. A Field Guide to the Reptiles of South-East Asia. New Holland Publishers, London, UK. 376 pp.), 1–2 eggs (Manthey and Grossmann 1997. Amphibien & Reptilien Südostasiens. Natur und Tier – Verlag, Berlin. 512 pp.; Malkmus et al. 2002. Amphibians & Reptiles of Mount Kinabalu [North Borneo]. Koeltz Scientific Books, Königstein, Germany. 424 pp.), and 2 eggs (Cox et al. 1998. A Photographic Guide to Snakes and other Reptiles of Peninsular Malaysia, Singapore and Thailand. New Holland Publishers Ltd, London, UK. 144 pp.). Grismer (2011. Lizards of Peninsular Malaysia, Singapore, and their Adjacent Archipelagos, Their Description, Distribution, and Natural History, Edition Chimaira, Frankfurt am Main. 728 pp.) suggested *B. cristatella* breeds yearround. The purpose of this note is to report additional information on *B. cristatella* reproduction from a histological examination of museum specimens from West Malaysia.

TABLE 1. Monthly stages in the ovarian cycle of 20 adult *Bronchocela cristatella* from West Malaysia: * = 1 female with oviductal eggs was undergoing concurrent yolk deposition for a subsequent egg clutch.

Month	N	Quiescent	Yolk deposition	Enlarged follicles > 5 mm	Oviductal eggs
March	1	0	1	0	0
June	1	0	1	0	0
July	7	3	0	1	3
August	4	0	0	2	2*
September	6	2	2	1	1*
November	1	0	0	0	1*

A sample of 32 *B. cristatella* collected from 2002 to 2006 and from 2008 to 2012 in West Malaysia deposited in the herpetology collection of La Sierra University (LSUHC), Riverside, California, USA, was examined. This series consisted of eleven males (mean SVL = 95.1 mm ± 11.2 SD, range = 73–111 mm), 20 adult females (mean SVL = 96.00 mm ± 7.3 SD, range = 84–109 mm) and one juvenile female (SVL = 72 mm). *Bronchocela cristatella* were collected by West Malaysian state: Johor (N = 14), Kedah (N = 3), Pahang (N = 3), Penang (N = 2), Perak (N = 3), Selangor (N = 5), Serak (N = 1), Terengganu (N = 1).

A cut was made in the lower abdominal cavity and the left testis or ovary was removed, embedded in paraffin, cut into 5-µm sections and stained with Harris hematoxylin followed by eosin counterstain. Enlarged follicles (> 5 mm) or oviductal eggs were counted. Histology slides were deposited in LSUHC.

Two stages were observed in the testicular cycle: 1) spermiogenesis, seminiferous tubules are lined by sperm, or clusters of metamorphosing spermatids; 2) regressed, seminiferous tubules are reduced in size and contain spermatogonia and interspersed Sertoli cells. Males were undergoing spermiogenesis in the following months: July (N = 3), August (N = 6), September (N = 1). One male of adult size (SVL = 94 mm) contained a regressed testis (LSUHC 5673). Our male sample sizes are too small to speculate on the significance of this single male with a regressed testis in the yearly male reproductive cycle. The smallest reproductively active male (spermiogenesis) measured 73 mm SVL (LSUHC 6543) and was collected in August.

Four stages were observed in the ovarian cycle (Table 1): 1) quiescent (no yolk deposition); 2) early yolk deposition (basophilic yolk granules in ooplasm); 3) enlarged pre-ovulatory follicles (> 5 mm); 4) oviductal eggs. Mean clutch size (N = 11) was an invariant 2.0. Three females (Table 1) with oviductal eggs were undergoing concurrent yolk deposition for a subsequent clutch indicating *B. cristatella* produces multiple clutches in the same year. The smallest reproductively active female exhibited yolk deposition, measured 84 mm SVL (LSUHC 10660), and was collected in June. One smaller female (SVL = 70 mm) had very small, inactive ovaries and was considered to be a juvenile (LSUHC 10647).

In conclusion, from the presence of female reproductive activity at opposite ends of the year it is apparent *B. cristatella* exhibits an extended reproductive cycle as do other lizards from southern Asia (see Inger and Greenberg 1966. Ecology 47:1007–1021). Our report contains the first data indicating *B. cristatella* produces multiple clutches in the same year.

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***CYRTODACTYLUS MACROTUBERCULATUS* (Tuberculate Bent-toed Gecko). REPRODUCTION.** *Cyrtodactylus macrotuberculatus* was recently described by Grismer and Norhayati 2008 (Zootaxa 1924:53–68) from Kedah, West Malaysia and has unofficially been reported from southern Thailand (Grismer 2012. et. al. Zootaxa 3520:1–55). Grismer (2011. Lizards of Peninsular Malaysia, Singapore and their Adjacent Archipelagos. Edition Chimaira, Franfurt am Main. 728 pp.) reported a gravid female with two eggs during September from Perlis state and hatchlings during March, August, and September, suggesting year-round breeding. The purpose of this note is to add information on the reproductive biology of *C. macrotuberculatus*.

Table 1. Monthly stages in the ovarian cycle of seven adult female *Cyrtodactylus macrotuberculatus* from West Malaysia.

Month	N	Quiescent	Early yolk deposition	Enlarged follicles > 5 mm	Oviductal eggs
March	3	1	1	0	1
June	1	0	0	0	1
August	1	0	1	0	0
September	2	0	0	2	0

A sample was examined consisting of 24 *C. macrotuberculatus* collected in West Malaysia during 2004, 2008–2012 deposited in the herpetology collection of La Sierra University, Riverside, California, USA (LSUHC), consisting of eight adult males (mean SVL = 94.0 mm ± 10.4 SD, range = 74–103 mm), seven adult females with quiescent ovaries (mean SVL =106.0 mm ± 4.6 SD, range = 97–109 mm), four sub-adult females (mean SVL = 80.0 ± 7.5 SD, range = 72–89 mm), and five unsexed juveniles (mean SVL = 50.0 mm ± 10.1 SD, range = 44–68 mm). *Cyrtodactylus macrotuberculatus* collected by West Malaysian states were: Kedah (LSUHC) 6829, 7532, 7560, 8334–8337, 9133, 9429, 9432, 9448–9450, 9671–9673, 9693, 10579 and Perlis (LSUHC) 9686, 9687, 9980, 9981, 10037, 10067.

A cut was made in the lower abdominal cavity and the left testis or ovary was removed, embedded in paraffin, cut into 5-µm sections and stained with Harris hematoxylin followed by eosin counterstain. Enlarged follicles (> 4 mm) or oviductal eggs were counted. Histology slides were deposited in LSUHC.

The only stage present in the testicular cycle was spermiogenesis in which the lumina of the seminiferous tubules were lined by sperm or clusters of metamorphosing spermatids. The smallest reproductively active male measured 74 mm SVL (LSUHC 8335) and was collected in March. Monthly distribution of spermiogenic males was: March (N = 4), May (N = 1), June (N = 1), September (N =1), November (N = 1).

Four stages were present in the monthly ovarian cycle (Table 1): 1) quiescent, no yolk deposition; 2) yolk deposition, basophilic yolk granules in the ooplasm; 3) enlarged follicles > 4 mm; 4) oviductal eggs. The smallest reproductively active female measured 97 mm SVL (LSUHC 8337), contained two oviductal eggs, and was collected in June.

Mean clutch size (N = 4) was 1.5 ± 0.58 SD, range 1–2). There was no indication of females producing multiple clutches, as no female with oviductal eggs and concurrent yolk deposition was found which would have indicated production of a subsequent clutch, however this likely reflects our small female sample size.

The presence of reproductive activity in all months sampled indicates *C. macrotuberculatus* exhibits an extended breeding cycle as do other South Asian lizards. See for example, Inger and Greenberg (1966. Ecology 47:1007–1021) and Grismer (2011, *op. cit.*).

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***DASIA OLIVACEA* (Olive Tree Skink). REPRODUCTION.** *Dasia olivacea* ranges from Myanmar eastward to Vietnam and south through the Malay Peninsula and Singapore to Sumatra, Java, Borneo, and some adjacent islands (Inger and Brown 1980. Field. Zool. 3:1–11). There are accounts of *D. olivacea* clutch sizes in Das (2010. A Field Guide to the Reptiles of South-East Asia, Myanmar, Thailand, Laos, Cambodia, Vietnam, Peninsular Malaysia, Singapore, Sumatra, Borneo, Java, Bali. New Holland Publishers, London. 376 pp.; 6–14 eggs) and Manthey and Grossmann (1997. Amphibien & Reptilien Südostasiens. Natur und Tier – Verlag, Berlin. 512 pp.; 9–14 eggs). *Dasia olivacea* females may produce clutches three to four times a year (Malkmus et al. 2002. Amphibians & Reptiles of Mount Kinabalu [North Borneo]. Koeltz Scientific Books, Königstein, Germany. 424 pp.). In this note we report additional information on reproduction of *D. olivacea* from West Malaysia from a histological examination of museum specimens.

A sample of 19 *Dasia olivacea* from West Malaysia collected 2001 to 2006, 2009, and deposited in the herpetology collection of La Sierra University (LSUHC), Riverside, California, USA, was examined. The sample consisted of six adult males (mean SVL = 95.5 mm ± 8.6 SD, range = 80–103 mm), eight adult females (mean SVL = 87.3 mm ± 5.9 SD, range = 80–98 mm), one subadult male (SVL = 73 mm), two subadult females (mean SVL = 72.5 mm ± 0.70 SD, range = 72–73 mm), two unsexed juveniles (mean SVL 42.5 mm ± 13.4 SD range = 33–52 mm SVL). *Dasia olivacea* were collected in West (Peninsular) Malaysia (by state): Johor (N = 8), Kedah (N = 4), Pahang (N = 4), Terengganu (N = 3).

A cut was made in the lower abdominal cavity and the left testis or ovary was removed, embedded in paraffin, cut into 5 µm sections and stained with Harris hematoxylin followed by eosin counterstain. Enlarged follicles (> 4 mm) or oviductal eggs were counted. Histology slides were deposited in LSUHC.

The predominant stage present in the testicular cycle was spermiogenesis in which the seminiferous tubules are lined by clusters of sperm or metamorphosing spermatids. The smallest reproductively active male (spermiogenesis in progress) measured 80 mm SVL (LSUHC 5600) and was collected in July. Other mature males were collected in July (N = 3), August (N = 1), September (N = 1). One smaller male (SVL = 73 mm) contained a regressed testis in which the seminiferous tubules contained spermatogonia and interspersed Sertoli cells (LSUHC 8023). Goldberg (2012. Hamadryad 36:51–53) reported males of the congener *D. vittata* from Borneo exhibited spermiogenesis during all nine months samples were examined.

Four stages were observed in the ovarian cycle of *D. olivacea* (Table 1): 1) quiescent (no yolk deposition); 2) early yolk deposition (basophilic yolk granules in ooplasm); 3) enlarged pre-ovulatory ovarian follicles > 4 mm; 4) oviductal eggs. Mean clutch size (N = 3) was 6.33 ± 1.2 SD, range = 5–7. The smallest reproductively active female (early yolk deposition) measured 83 mm SVL (LSUHC 7576) and was collected in August. Two smaller females (SVL 72, 73) contained very small quiescent ovaries (LSUHC 7495, 9367). The *D. olivacea* reproductive period includes August and September. We lack monthly samples of *D. olivacea* to ascertain the duration of the reproductive period. However, females of the congener *D. vittata* from Borneo exhibited reproductive activity in all months of the year except for December, from which only one female was available (Goldberg, *op. cit.*). Five is a new minimum clutch size for *D. olivacea*.

Table 1. Monthly stages in the ovarian cycle of eight adult *Dasia olivacea* females from West Malaysia.

Month	N	Quiescent	Yolk depositon	Enlarged follicles > 4 mm	Oviductal eggs
July	1	1	0	0	0
August	4	2	1	0	1
September	3	1	0	1	1

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***HEMIDACTYLUS FRENATUS* (Asian House Gecko). PREY.** *Hemidactylus frenatus* is primarily an oriental species, but has spread (often human-mediated) pantropically and its introduced range currently includes parts of South-East Asia, Japan, parts of Central America, Mexico, some localities in southern USA, Madagascar, parts of Africa, Australia, and many islands of the Pacific, Indian, and Atlantic oceans (Case et al. 1994. Ecology 75:464–477; Rödder et al. 2008. North-Western J. Zool. 4:236–246; Hoskin 2011. Austral Ecol. 36:240–251). In Taiwan, this gecko species occurs at altitudes below 1000 m island-wide and on the outlying islets (Lue et al. 2002. The Transition Kingdom — Guidebook of Amphibians and Reptiles of Taiwan. SWAN, Taipei, Taiwan. 347 pp. [in Chinese]).

At ca. 1950 h on 20 August 2013, while preparing the rooftop garden of his residence in Yilan City, northeastern Taiwan (24.7505556°N, 121.7613889°E, datum WGS84; elev. 13 m) for Typhoon Trami that was expected to pass the area the next day, JJM disturbed a resting Globe Skimmer (*Pantala flavescens*) when he turned on an outdoor light. The insect flew to the light, where it was grasped by the head by an adult *H. frenatus* that was sheltering behind the light (Fig. 1). The observations were discontinued at ca. 2030 h, at which point the gecko was still trying to ingest the dragonfly.

Both within its native range and areas where it has been introduced, *H. frenatus* is a nocturnal species that is often attracted to indoor and outdoor lights in areas disturbed by anthropogenic activities, where they can easily feed on insects that are also attracted to the lights (Newberry and Jones 2007. *In* Lunney et al. [eds.], Pest or Guest: The Zoology of Overabundance, pp. 59–65. Royal Zoological Society of New South Wales, Sydney, Australia); Vanderduys and Kutt 2012. Austral. J. Zool. 60:361–367). For such a small lizard, the adults of *H. frenatus* appear to be adept at preying on relatively large prey items. There have been reports of individuals preying on conspecific hatchlings, the hatchlings and juveniles of *Lepidodactylus lugubris*, as well as on *Nactus coindemirensis* of unknown sizes (McCoid and Hensley 1993. Herpetol. Rev. 24:87–88; Cole et al. 2005. Biol. Conserv. 125:467–474). Petren and Case (1996. Ecology 77:118–132) also noted that *H. frenatus* males, in particular, are good at preying on large roaches, and we have observed an adult *H. frenatus* preying on an adult American Cockroach (*Periplaneta americana*) (Norval and Mao 2013. IRCF Reptiles & Amphibians. 20:140–142). The dragonfly described herein is thus yet another example of a relatively large prey item captured, and presumed consumed, by an adult *H. frenatus*. However, because dragonflies are diurnal and alert insects, they are unlikely typical prey for *H. frenatus*. Nevertheless, in some instances dragonflies are attracted to

PHOTOGRAPH BY JEAN-JAY MAO



FIG. 1. *Hemidactylus frenatus* with *Pantala flavescens* (Globe Skimmer) captured at night near an outdoor light.

outdoor lights in residential areas, especially if the residential area is located near a wetland or prior to rains (JJM and GN, pers. obs.), and under such conditions predation on dragonflies by geckos is possible, as reported herein. The observations described herein therefore not only again raise the question of size and shape limits of prey that can be utilized by *H. frenatus*, but also highlight the opportunistic nature of these lizards.

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***IGUANA IGUANA* (Common Green Iguana). PREDATION.** *Oxybelis fulgidus* is an arboreal snake widely distributed in the Americas, occurring from Mexico to tropical South America (Peters and Orejas-Miranda 1970. Bull. U.S. Nat. Mus. 297:1–347). This species has been described as a sit-and-wait predator that feeds mainly on lizards (*Ameiva, Anolis, Basiliscus, Ctenosaura, Mabuya, Polychrus, Sceloporus,* and *Tropidurus* [Scartozzoni et al. 2009 S. Am. J. Herpetol. 4:81–89]) and birds (Fraga et al. 2012 Herpetol. Rev. 43:495–496). In this report we present a new genus of lizard in the diet of *O. fulgidus.*

During the afternoon at 1729 h on 25 June 2012, an *O. fulgidus* was collected at the municipality of Serra do Navio (0.900833°N, 52.013472°W, datum WGS84), on the right bank of the Amapari River, Amapá, Brazil. The individual was killed by local inhabitants and the stomach was partially open containing a juvenile *Iguana iguana.* The snake was an adult female with a SVL of 498 mm, tail length of 245 mm,and head length of 24.9 mm. The iguana measured 128 mm SVL, 296 mm tail length, 25.8 mm head length. This is another record of an iguanid lizard in the diet of *O. fulgidus,* and the first recorded predation of *I. iguana* by this snake.

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***LACERTA SCHREIBERI* (Schreiber's Green Lizard). NATURAL NEST.** Data on *in situ* female nest site selection in Iberian lizards is lacking, while such information is crucial to complement experimental results obtained by captive breeding. Specifically, studies that relate elevational range limits with incubation requirements are in need of validation by information pertaining to nesting locations in the field (Monasterio et al. 2011. Ecography 34:1030–1039). In fact, it is likely that the distribution of *Lacerta schreiberi* is constrained by available thermal conditions for nesting (Monasterio et al. 2013. J. Zool. 291:136–145), and thus, information on natural nest sites is most useful. However, very few observations have been recorded in the wild (Galán 1989. Treb. Soc. Cat. Ictio. Herpetol. 2:250–265). We encountered a single nest of *L. schreiberi* by turning a stone (56 cm × 30 cm × 5–10 cm thickness), while surveying reptiles at the summit of Peña Negra, Spain (40.417534°N, 5.304219°W, elev. 1936 m) on 21 June 2013 (Fig. 1A). The clutch consisted of 13 eggs that were half buried into the ground, but sheltered by the stone. A female was observed next to the nest (i.e., also sheltered by the stone before it was turned), which was totally covered by soil, suggesting that she had very recently laid the eggs. The presence of the female permitted the identification of the eggs. The surrounding habitat consisted of mixed shrubs and large boulders (Fig. 2A), typical for high elevation areas in the Sistema Central Mountain Range.

Such observations as we report here are needed to choose adequate methodology to measure temperature availability for nesting, as well as to validate previous work (i.e., burying loggers under rocks or bare ground at 5 cm depth; Monasterio et al. 2013, *op. cit.*) due to the hitherto total lack of information about female nest site selection in *L. schreiberi.*



FIG. 1. Egg clutch (*in situ*) of *Lacerta schreiberi* (A), and the surrounding habitat (B). The arrow indicates the stone under which the clutch was encountered.

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***PHRYNOSOMA ASIO* (Giant Horned Lizard). CREPUSCULAR AND NOCTURNAL ACTIVITY.** *Phrynosoma asio* is currently distributed in the physiographic provinces of the Balsas-Tepalcatepec Depression and Sierra Madre del Sur (Alvarado-Díaz et al. 2013. Amphib. Rept. Conserv. 7:128–170) It is generally considered to be a diurnal lizard, however, Pianka and Parker (1975. Copeia 1975:141–162) found that the activity time of the members of the genus *Phrynosoma* is variable (i.e., they are typically active earlier and later, and over a longer time span, than most other sympatric species of lizards). Williams (1959. Herpetologica 1:43) established that the majority of the horned lizards are strictly diurnal and are only facultatively nocturnal in response to environmental disturbances and certain thermal conditions. The genus *Phrynosoma* is not physiologically adapted to be a nocturnal animal; in fact it has been demonstrated that their eyes are adapted for diurnal use (Crozier and Wolf 1941. J. Gen. Physiol. 24:317–324). However, in the presence of sufficient light, these lizards can perform certain activities, such as feeding (Milde and Milde 1950. Amer. Midl. Nat. 3:720–741) or even make use of the moonlight to perform activities such as copulation (Lara-Resendiz et al. 2013. Herpetol. Rev. 44:326–327). Here I report the first observation and record of *P. asio* conducting crepuscular and nocturnal activity in Michoacán, México.

During 21 August 2010, while studying the habitat selection of *Phrynosoma asio*, I recorded a gravid adult female (SVL = 94 mm, total length = 150 mm, and weight = 200 g) at 1915 h with crepuscular activity after sunset near a hole (ca. 20 cm in diameter) under a paloverde tree (*Cercidium* sp.) that appeared to be a refuge used by the lizard. The habitat was disturbed with secondary vegetation consisting mainly of xeric shrublands and cacti (*Pachycereus* sp.) near human settlements in the locality Nuevo Centro municipality of La Huacana, Michoacán, México (18.739113°N, 102.009915°W; 211 m elev). This individual tried to escape into the hole but was captured. Data were collected on microhabitat, temperature, and humidity: substrate temperature 33.7°C, air temperature 33.5°C, substrate humidity 72%, air humidity 84%. The distance to the nearest anthill was 12.9 m.

On 29 May 2010, a juvenile female *P. asio* (SVL = 69 mm, total length = 111 mm, weight = 12.7 g) was seen at 2020 h among grasses; when it was illuminated with a lamp, it started to feed on nocturnally active black ants (unidentified species) near the edge of a dry creek (18.733423°N, 102.006502°W; 173 m elev.). I recorded microhabitat data on a square meter from which the lizard was collected: substrate temperature 32.8°C, air temperature 33.2°C, substrate humidity 23.7%, air humidity 25.5%. The distance to the nearest anthill was 16 m.

These observations suggest two things; the first and most interesting is that the presence of light, be it natural or artificial, plays an important role in the delimitation of activity of *P. asio* within its environment and may aid in activities such as feeding. Second is the possibility that *P. asio* sometimes does not complete its daily activities at the termination of daylight, resulting from extremely high daytime temperatures. Therefore, recourse to seize the last hours of light after sunset may help to complete their foraging or other biological activity requirements. In addition, this might be possible as a result of the artificial lighting produced at night by nearby human settlements. Finally, it would be interesting to investigate whether such behaviors are also observed at other localities inhabited by *P. asio* with similar or different thermal and anthropological conditions and establish whether or not these are adaptive responses.

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***PHYLLOPEZUS POLLICARIS* (Brazilian Gecko, Lagartixa). HATCHLING SIZE/BEHAVIOR.** The nocturnal gecko *Phyllopezus pollicaris* (Phyllodactylidae) is widely distributed along the South American great diagonal of open formations (Cerrado, Caatinga, and Chaco) to the coastal Atlantic Forest of northeastern Brazil, and is composed of multiple cryptic lineages (Gamble et al. 2012. Mol. Phylog. Evol. 62:943–953; Werneck et al. 2012. Evol. 66:3014–3034; Recoder et al. 2012. Herpetol. Notes 5:49–58). In many areas, the reproductive activity of *P. pollicaris* is cyclic, occurring from the end of the dry season to the end of the wet season, and gravid females usually have two oviductal eggs (Righi et al. 2012. J. Herpetol. 46: 632–636; Recoder et al. 2012, *op. cit.*). In some Caatinga areas, females appear to produce eggs continuously throughout the year (Vitt 1986. Copeia 1986:773–786). There is little published information about the life history and reproduction of this species.

On 9 October 2013 we collected three eggs of *P. pollicaris* from Brumado, Bahia state, Brazil, located within Caatinga domain (14.203889°S, 41.665278°W; 422 m elev.). The three eggs were in a communal nest under the leaf litter. After being brought to our laboratory, the eggs were placed and maintained in a terrarium in a sand substrate next to a window protected from direct solar radiation, but we made no effort to otherwise control light or temperature; incubation occurred under ambient conditions. Ambient temperatures varied from 13ºC to 31ºC during October and early November 2013. We measured the eggs and surviving hatchlings with a digital caliper (± 0.01 mm) for snout–vent length (SVL) and tail length (TL).

We recorded hatchling emergence of two eggs on 11 November 2013, and the other egg remained unhatched. The sizes of the three eggs were 11.4 × 9.18 mm, 11.71 × 9.38 mm, and 12.80 × 10.15 mm. The first lizard hatched had a SVL = 24.85 mm and TL = 26.82 mm, and the second one had a SVL = 24.79 mm and TL = 26.01 mm. The minimum SVL of these newly hatched geckos were different from those reported by Vitt (1986, *op. cit.*) (SVL = 29 mm) in Exu,



FIG. 1. Newly hatched *Phyllopezus pollicaris* (UFMG 1918) after removing and ingesting shed skin.

Pernambuco state, Brazil, and that found by Recoder et al (2012, *op. cit.*) (SVL = 34.1 mm) in Tocantins state, northern Brazil. Egg sizes were also different from those reported by Vitt (1986, *op. cit.*; N = 12; mean = 13.07 ± 0.34 mm length; mean = 9.38 ± 0.25 mm width). Presumably because of the high climatic unpredictability of the Caatinga (Colli et al. 2003. J. Herpetol. 37:694–706), reproductive parameters of *P. pollicaris* could be affected. In *P. pollicaris* clutch size is always two (Vitt 1986, *op. cit.*; Ávila and Cunha-Avellar 2005. Herpetol. Rev. 36:453–454); therefore, the eggs collected by us probably are evidence of communal oviposition, what seems to be normal for the genus (Vitt 1986, *op. cit.*; Righi et al. 2004. Herpetol. Rev. 35:395–396; Ávila and Cunha-Avellar 2005, *op. cit.*; Lima et al. 2011. Salamandra 47:227–228). The specimens reported here represent a new record for minimum body size for *P. pollicaris* juveniles.

After hatching, one of the neonate lizards ingested its own skin (Fig. 1). This behavior likely provides an extra source of nutrients as noted for other lizard taxa (Bustard and Maderson 1965. Herpetologica 21:306–308). To our knowledge, this is the first reported occurrence of this behavior in *Phyllopezus*.

The *P. pollicaris* specimens (UFMG 1918, 1920) were deposited in the Herpetological Collection of Universidade Federal de Minas Gerais. We are grateful to CAPES for doctorate fellowships awarded to SCG.

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***PLESTIODON FASCIATUS* (Five-lined Skink). SPIDER WEB ENTRAPMENT.** There are numerous examples in the literature of lizards being eaten by spiders (e.g., Whiting et al. 1991. Herpetol, Rev. 22:58; Hamilton 2011. Herpetol. Rev. 42:603; Lazcano et al. 2012. Herpetol. Rev. 43:37–138). However, reports of lizards being entrapped by spider webs are relatively uncommon. Lizards have been found in the webs of spiders in the families Araneidae (Lazell 1995. Herpetol. Rev. 26:205; Mitchell and Ruckdeschel 2013. Herpetol. Rev. 44:136–137), Nephilidae (Filipiak and Lewis 2012. Herpetol. Rev. 43:486), and Theridiidae (Colombo 2013. Herpetol. Rev. 44:320–321; García-Roa et al. 2013. Herpetol. Rev. 44:147; Painter and Kamees 2010. Herpetol. Rev. 41:227). To our knowledge, this is the first report of a lizard becoming entrapped in the web of a spider in the family Tetragnathidae.

On 10 August 2013, two of us (MV and MWHC) observed a juvenile *P. fasciatus* in the web of a male Long-jawed Orb Weaver (*Tetragnatha* sp., Tetragnathidae) beneath a low concrete bridge spanning Lees Creek near the town of Bogalusa in Washington Parish, Louisiana, USA (30.7218°N, 89.8658°W; datum WGS84). The skink was alive, although somewhat unresponsive, with its hind right limb severely entwined in the web. The spider was present on the web and positioned approximately 20 cm away at the time of discovery. The spider was captured and preserved for identification.

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***PLICA PLICA* (Tree Runner) and *PLICA UMBRA* (Blue-lipped Tree Runner). MORPHOLOGICAL ANOMALIES.** Many morphological malformations have been reported in lizards. Structural anomalies and teratogenic defects resulting in unusual appendages and tissue growth are known to occur sporadically among reptiles and

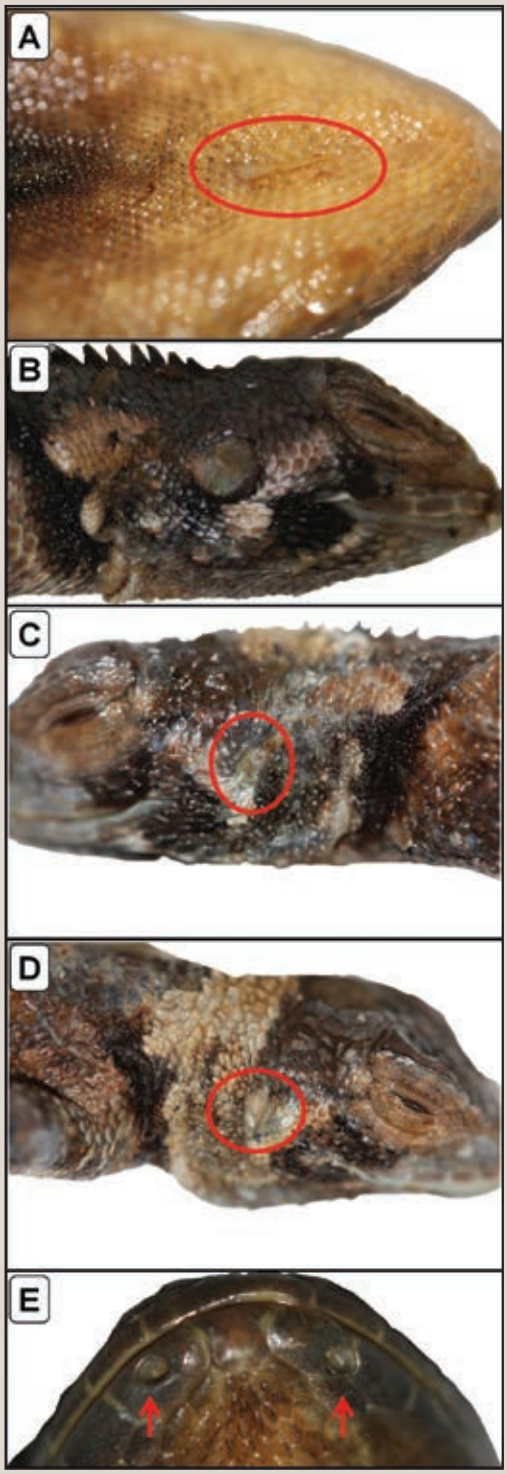


FIG. 1. A) *Plica plica* (MPEG LAG 2612) with a filiform appendix in gular region; B) a normal ear opening in *P. umbra* (MPEG LAG 11278); *P. umbra* (MPEG LAG 11279) with an anomalous ear opening in the left side C) and the right side D); and E) a *P. umbra* (INPA 0006) with symmetrical cavity in the first infralabial scales

amphibians throughout the world (see Chan et al. 1984. Hawaii Volcanoes National Park: Proceedings of the Fifth Conference of National Science, pp. 41–50; Owens and Knapp 2007. Herpetol. Rev. 38:454–455; Gogliath et al. 2012. Herpetol. Rev. 43:129; Avila et al. 2013. Herpetol. Rev. 44:144–145; Conzendey et al. 2013. Herpetol. Rev. 44:145–146; and citations therein). *Plica plica* and *P. umbra* are lizards restricted to the Amazonian rainforest and usually live on tree trunks, although they can occasionally be spotted on shrubs, fallen logs, sleeping on leaves or on the ground (Ávila-Pires 1995. Zool. Verh. Leiden. 1995:1–706).

During a taxonomic study on these lizards, we obtained specimens in the field with some morphological abnormalities that we report for the first time here. The specimens examined are housed in the Museu Paraense Emilio Goeldi (MPEG) and in the Instituto Nacional de Pesquisas da Amazônia (INPA). One of the lizards examined, a male *P. plica* (MPEG LAG 2612; 101.5 mm SVL) from Mazagão, Amapá state, Brazil (0.115°S, 51.288889°W), had a filiform appendix in the gular region (Fig. 1A). A male *P. umbra* (MPEG LAG 11279; 74 mm SVL) from Nova Vida, Maranhão state, Brazil (1.827669°S, 46.100781°W) had a malformation of the ear opening (1C and D). The ear opening is reduced to a small slit (1.5 mm diam) on the right side, and an almost absent opening on the left side. Another male *P. umbra* (INPA 0006; 95.3 mm SVL) examined from UHE Cachoeira Porteira, Oriximiná, Pará state, Brazil (1.440000°S, 56.523889°W), had a symmetrical cavity on the first infralabial scales (Fig. 1E). It is unknown if these abnormalities decreased probability of survival in these lizards, though these specimens had reached adult size and otherwise appeared to be in good health. However, it is also clear that visual, olfactory, and auditory cues are very important to lizards (Chou et al. 1988. J. Herpetol. 22:349–351; Oliver and Hutchinson 2009. Herpetol. Rev. 2009. 40:414–415).

To our knowledge, this is the first report of these conditions in *Plica*. We conclude that these abnormalities are of long-standing condition and may be the result of a congenital defect or defective development at an early stage.

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***PODARCIS ERHARDII* (Erhard's Wall Lizard). BIFURCATED TAIL, POST-AUTOTOMY.** While conducting fieldwork in the Aegean Islands, we came across an Erhard's Wall Lizard with a forked tail. This phenomenon, though not novel, has never been formally documented in this species.

Many lizards rely on caudal autotomy (tail shedding) to escape predation. The tail separates from the body along an intravertebral breakage plane close to the point of attack (Bateman and Fleming 2009. J. Zool. 277:1–14). After autotomization has occurred, the severed tail writhes for several minutes (up to 14 minutes in *P. erhardii*), presumably distracting the predator (Pafilis et al. 2005. Physiol. Biochem. Zool. 78:828–838). In addition, there is some evidence that shedding a bitten tail that has been injected by venom may help avoid lethal exposure to viper predation (Pafilis et al. 2009. Evolution 63:1262–1278). Nevertheless, tail shedding also has important costs, including elevated stress hormone levels (Langkilde and Shine 2006. J. Exp. Biol. 209:1035–1043), as well as declines in social status and reproductive fitness (Simou et al. 2008. Copeia 2008:504–509).



FIG. 1. *Podarcis erhardii* with a post-autotomized, bifurcated tail.

The lizard we observed was found on Gaiduronissi Islet (off NE Paros Island, Cyclades Pref., Aegean Sea, Greece). This uninhabited islet is quite small (< 1 km^2), has limited food availability, yet high lizard density compared to other Cycladic islands of its size (12 lizards per 100 m transect). Gaiduronissi does not harbor vipers, which have been implicated in elevated autotomy rates in the Greek Archipelago (Pafilis et al. 2009, *op. cit.*). We hypothesize the two-tailed individual had experienced an aggressive encounter either with a predator (Black Rat, *Rattus rattus*, the only predatory vertebrate on this island) or a conspecific, and had autotomized its tail. At some point during the regeneration process, the lizard must have again autotomized, this time only partially. Physiological cues triggered tail regrowth at the site of injury despite the incomplete autotomy, thus leaving the lizard with two tails. The bifurcated tail differs morphologically from the base of the tail (Fig. 1): the original unautotomized base of the tail displays the original scalation pattern, while the newly regenerated tail is discolored and does not follow the black striped pattern. These external differences in appearance extend to internal morphology; regenerated tails contain cartilage rather than calcified vertebrae, making this observation especially odd because regenerated tails do not have breakage planes (Bateman and Fleming, *op. cit.*). The specimen was deposited in the Michigan Museum of Zoology Herpetology Division collection (acquisition ID: 20026).

While possessing the ability to shed a body part grasped by an enemy is a powerful and effective escape strategy, having two tails is likely to be disadvantageous to the individual. In addition to potentially being more conspicuous to predators, a lizard with two tails possibly experiences decreased locomotory performance compared to its one-tailed conspecifics.

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***TILIQUA MULTIFASCIATA* (Centralian Bluetongue Lizard). PREDATION.** *Tiliqua multifasciata* is a large lygosomine scincid lizard widespread across much of the northern half of continental Australia except the far north, from the west coast to central western Queensland and the northwest corner of New South Wales (Shea and Peterson 1981. Aust. J. Herpetol. 1:27–28; Shea 1992. The Systematics and Reproduction of Bluetongue Lizards of the Genus *Tiliqua* (Squamata: Scincidae). 4 Volumes. Unpubl. Ph.D. Thesis, University of Sydney, Sydney, N.S.W. v + 1053 pp. + 167 pp.; Cogger 2000. Reptiles and Amphibians of Australia [6th ed.]. Reed New Holland, Sydney. 808 pp.; Shea 2000. *In* Hauschild et al. [eds.], Blauzungenskinke. Beitrage zu *Tiliqua* und *Cyclodomorphus*, pp. 108–112. Natur und Tier Verlag, Munster, Germany). Few records of its predators exist. This note documents an observation of predation on *T. multifasciata* by a Little Eagle, *Hieraaetus morphnoides* (Accipitriformes: Accipitridae: Accipitrinae).

At ca. 1210 h (Australian Western Standard Time) on 5 April 2012, MP observed an adult dark morph *H. morphnoides* sitting on an upper branch of a ca. 7 m high *Acacia aneura* (Mimosaceae) tree ca. 4 m above the ground, on an upland plateau in the upper Fortescue River drainage, ca. 110 km west-northwest of Newman, northern Pilbara region, northwest Australia (22.803033°S, 118.86225°E, datum WGS84; 706 m elev.); beneath the feet of the eagle was a freshly killed adult *T. multifasciata* draped venter-uppermost over the branch (Fig. 1); total length of the carcass was estimated at ca. 25 cm (not collected). The *T. multifasciata* had been nearly decapitated, with the head attached by only a thin band of skin draped over the branch; the throat had been opened, exposing the tongue, and the left body opened ventrolaterally, with the forelimbs and most of the viscera removed, hence feeding had commenced and was largely completed, although the hindlimbs and tail were still intact. The *H. morphnoides* continued to pick at the carcass during early observations, but flew off to another tree ~200 m distant on approach of observers to within 50 m for closer photography. Habitat was a damp red-brown clay floodplain with surface ironstone pebbles and stones, supporting a sparse woodland comprised of scattered tall *Acacia* spp. and *Corymbia* spp. trees with an open *Triodia pungens* hummock grassland understorey; air temperature was ca. 25°C, with some high diffuse cloud cover and no wind.

Hieraaetus morphnoides occurs over all of mainland Australia (absent from Tasmania) and some large northern offshore islands. It is typically known as a predator of small to medium sized mammals and birds, however reports of predation on reptiles are sparse (e.g., at Armidale, N.S.W., eastern Australia, prey items at 3 nests mammals 60%, birds 25%, lizards 15%, in fecal pellets mammals 55%, birds 25%, lizards 20%, Debus 1984. Emu 84:87–92), and as far as we are aware this is the first record of predation by this raptor on *T. multifasciata*, although a predation attempt on a *T. multifasciata* by an Australian raptor recorded as a predator of several species of snakes and lizards, *Falco berigora* (Falconidae), was reported in Uluru National Park, Northern Territory, in central Australia, that was unsuccessful due to intervention of the observer (Fyfe 1981. Herpetofauna 13:31). Another Australian eagle, *Aquila audax*, was reported as a predator of the large, closely related lizard *Trachydosaurus rugosus asper* (Scincidae; regarded as congeneric with *Tiliqua* by some authors, e.g., Shea 1992, *op. cit.*) as well as an adult snake *Pseudonaja textilis* (Elapidae) in the Riverina region of New South Wales, eastern Australia (Metcalfe and Driver 2008. Herpetol. Rev. 39:229), and at the other end of the raptor prey size scale, there is a report of predation by *F. berigora* on the small skink *Carlia munda* in Western Australia (Metcalfe & Peterson 2005. Herp. Rev. 36(4):445). The above record is also notable as a possible case of lardering of prey by an Australian raptor; lardering of prey including lizards in Australia is usually associated with butcherbirds *Cracticus* spp. (Artamidae: Cracticinae) (e.g., on *Ctenotus regius*, Fitzsimons and Thomas 2010. Herpetol. Rev. 41:76–77).



PHOTO BY D. STOVANOVIC

FIG. 1. Dead *Tiliqua multifasciata*, prey item of Little Eagle (*Hieraaetus morphnoides*).

We thank Dejan Stovanovic for telephotography of the *T. multifasciata* on our behalf.

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***TROPIDOPHORUS BERDMOREI* (Berdmore's Water Skink). DIET.** Berdmore's Water Skink is known to be closely associated with water (Taylor 1963. Univ. Kansas Sci. Bull. 44:687–1077). It feeds principally on water insects, small crustaceans, and worms along the banks and under rocks in the stream bed (Cox et al. 1998. A Photographic Guide to Snakes and other Reptiles of Thailand and South-East Asia. Asia Book, Bangkok. 144 pp.). However, Das (2010. A Field Guide to the Reptiles of Southeast Asia. New Holland, London. 376 pp.) noted that the diet of *Tropidophorus*

berdmorei was unstudied. Here we report prey items of *T. berdmorei* from the Por-Por-Por Waterfall, Doi Suthep-Pui National Park, Muaeng District, Chiang Mai Province, northern Thailand.

An individual *T. berdmorei* was caught at 2030 h on 30 October 2013 in a hilly stream in evergreen forest (18.80642°N, 98.976694°E, WGS 84; 1140 m elev.). It was kept overnight in a plastic bag and a fecal pellet was collected from the bag the next morning. The pellet was composed of three discernable items, including an individual of *Jalysus* sp. (Berytidae: Hemiptera), an individual of a harvestman spider (Sclerosomatidae: Opiliones), and a section of a cricket leg belonging to the family Glylidae (Orthoptera). As information concerning the diet of *T. berdmorei* is presently poorly known, the results of the present work provide preliminary data on the diet of this skink and imply that further study is needed.

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***TROPIDURUS TORQUATUS*. MELANISM.** Melanism is the expression of darker skin color of an individual when compared to conspecifics because of an increase in epidermal pigments known as melanins (Kettlewell 1973. The Evolution of Melanism. Claredon Press, Oxford. 448 pp.). This characteristic may provide some advantages for ectotherms as dark coloration of the skin implies thermoregulatory (Clusella-Trullas et al. 2007. J. Therm. Biol. 32:235–245) and performance advantages (Castella et al. 2013. Ecology 90:2297–2312). Although melanism has been reported for several reptile species (e.g., Silva et al. 1999. J. Ven. Anim. Tox. 5:91–97; Pearse and Pogson 2000. Evol. 54:1041–1046), reports for melanism in a tropidurid lizards are, to our knowledge, unknown. Herein we provide the first record of melanism for the lizard *Tropidurus torquatus*, a heliophilous species widely distributed along open sites from South America.



FIG. 1. A) Dorsal and B) ventral views of melanistic *Tropidurus torquatus*.

Although a common feature in reptiles, expression of melanism in natural populations is infrequently observed (e.g., Jambrich and Jandzik 2012. Herpetol. Notes 5:219–221). Thus, our report of the first melanistic *T. torquatus* is noteworthy.

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***UMA RUFOPUNCTATA* (Yuman Desert Fringe-toed Lizard). ENDOPARASITES.** *Uma rufopunctata* is restricted to southwestern Arizona and northwestern Sonora where it is associated with windblown sand deposits (Turner and Rorabaugh 2009. *In* Jones and Lovich [eds.], Lizards of the American Southwest: A Photographic Field Guide, pp. 274–277. Rio Nuevo Publishers, Tucson, Arizona). To our knowledge there are no published accounts of helminths for *U. rufopunctata*. In this note we establish the initial helminth list for *U. rufopunctata*.

A sample of 11 *Uma rufopunctata* (mean SVL = 71.87 ± 12.2 SD, range = 60–101 mm) collected 40 km E of San Luis (32.4841229°N, 114.7890582°W), Sonora, Mexico, May 1966 and deposited in the herpetology collection of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California, USA as LACM 8946, 8952, 8962, 8963, 8968, 8969, 8976, 8977, 8985, 8997, 8998 was examined for helminths.

The digestive tract was removed, opened, and the esophagus, stomach, small and large intestines and their contents were examined under a dissecting microscope. Twelve cestodes were found in the small intestines of *U. rufopunctata*. They were regressively stained in hematoxylin, destained in acid alcohol, dehydrated in an ascending series of ethanol, mounted in balsam, on a glass slide, cover slipped, studied under a compound microscope, and identified as *Oochoristica macallisteri*. Prevalence = number infected/number examined × 100 = 33%; mean intensity (mean number of helminths per infected lizard = 2.4 ± 1.3, SD, range = 1–4). Two hundred-twelve nematodes were found in the stomachs of *U. rufopunctata*. Nematodes were cleared in a drop of lactophenol on a microscope slide, cover slipped, studied under a compound microscope and identified as *Skrjabinoptera phrynosoma* (prevalence = 100%; mean intensity = 20.1 ± 16.2 SD, range = 1–96). Voucher helminths were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland, USA as *Oochoristica macallisteri* (USNPC 107267) and *Skrjapinoptera phrynosoma* (USNPC 107268).

Oochoristica macallisteri was described from *Uta stansburiana* from California (Bursey and Goldberg 1996. Folia Parasitol. 43:293–296) and was also found in *Hemidactylus turcicus* from Arizona (Goldberg et al. 2000. Herpetol. Rev. 31:240). *Oochoristica scelopori* has been reported from *Uma* congeners *U. notata* and *U. inornata* (Telford 1970. Am. Midl.

Nat. 83:516–554). The two species, *O. macallisteri* and *O. scelopori* differ in length, shape of strobila, and number of testes per proglottid: *O. macallisteri*, 25 mm in length, greatest width at posterior end, 12–20 proglottids; *O scelopori*, 120 mm in length, posterior half of body with equal width, 22–43 testes per proglottid. Because our specimens averaged 20 mm in length, greatest width at posterior end with continual narrowing toward scolex and less than 20 testes per proglottid, we have assigned them to *O. macallisteri*.

Skrjabinoptera phrynosoma was reported in the *Uma* congeners *U. inornata*, *U. notata*, and *U. scoparia* (Telford 1970, *op. cit.*) and is the most common helminth in members of the genus *Phrynosoma* (Goldberg and Bursey 1991. Southwest. Nat. 36:365–368; Goldberg et al. 1993. J. Helminthol. Soc. Washigton 60:234–238). A host list for *S. phrynosoma* is in Goldberg and Bursey (*op. cit.*). *Uma rufopunctata* represents new host records for *Oochoristica macallisteri* and *Skrjabinoptera phrynosoma*.

We thank G. Pauly (LACM) for permission to examine *U. rufopunctata*.

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***UROSTROPHUS VAUTIERI* (Brazilian Steppe Iguana). ENDOPARASITES.** *Urostrophus vautieri* is a lizard native to southern and southeastern regions of Brazil (Santos et al. 2009. Check List 5:533–536; Souza-Filho 2011. Check List 7:876–877). There are no reports of helminth parasites for *U. vautieri* prior to this study.

The intestine of one adult female *U. vautieri* (SVL = 592 mm) deposited in the Coleção de Répteis do Laboratório de Zoologia (CRLZ), Centro Univesitário de Lavras – UNILAVRAS, Minas Gerais, Brazil, as CRLZ 256, was examined. This specimen originates from Reserva Biológica Unilavras – Boqueirão (RBUB) (21.346°S, 44.990°W, datum WGS84; 1250 m elev.), municipality of Ingaí in riparian forest associated with Cerrado, state of Minas Gerais, Brazil, and was collected in November 2010. The intestine was examined for helminths using a stereomicroscope. For identification, nematodes were cleared in Amann's lactophenol (1:1:2:1 phenol: lactic acid: glycerine: water) on a microscope slide, and observed with light microscope. Nematodes were identified according to Anderson et al. (2009. Keys to the Nematode Parasites of Vertebrates. CAB International, Wallingford, UK. 463 pp.).

Eleven individuals of one unidentified species of *Strongyloides* (Rhabditida, Strongyloididae) were found. Voucher specimen was deposited in the Instituto Oswaldo Cruz Helminthological Collection (CHIOC), Rio de Janeiro, Brazil, as CHIOC 35898.

To date, the only species of *Strongyloides* reported parasitizing lizards of Brazil is *Strongyloides cruzi,* collected in the small intestine of *Hemidactylus mabouia* (a non-native species) from the municipality of Rio de Janeiro (Rodrigues 1968. Atas Soc. Biol. Rio de Janeiro 12:31–32; Vicente et al. 1993. Rev. Bras. Zool. 10:19–168; Ávila and Silva 2010. Journal of Venomous Animals and Toxins including Tropical Disease 16:543–572). The current report is a new host record for *Strongyloides* sp. in Brazilian lizards, and the first report of helminths in *Urostrophus vautieri*.

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***VARANUS PANOPTES* (Yellow-spotted Monitor). DIET AND BEHAVIOR.** *Varanus panoptes* is a large terrestrial lizard that inhabits much of northern Australia (Christian 2004. *In* Pianka and King [eds.], Varanoid Lizards of the World, pp. 423-429. Indiana Univ. Press, Bloomington). The species is a generalist predator and will consume a wide range of invertebrates and small to medium-sized vertebrates (Shine 1986. Herpetologica 42:346–360). *Varanus panoptes* is a voracious predator and exploits some prey species to the extent that it can regulate prey populations and their recruitment success (Doody et al. 2006. Wildl. Res. 33:349–354; Doody et al. 2009. Anim. Conserv. 12:46–53). This species is highly seasonal, with declines in foraging activity during dry conditions between June and October attributed to a reduction in the availability of free standing water and prey items (Christian et al. 1995. Oecologica 103:349–357; Blamires 2004. Copeia 2004:370–377). Despite the clearly defined patterns of foraging activity in *V. panoptes*, some studies have found continued activity in individuals during the dry season in Northern Australia. For example, JSD (pers. obs.) observed a large male *V. panoptes* foraging for frogs in the late dry season along the Chamberlain River in the East Kimberley, Western Australia. Christian et al. (*op. cit.*) found that *V. panoptes* living on the floodplain during the early dry season remained active for longer than those living in woodland areas. A study by Blamires (*op. cit.*) also found that individual *V. panoptes* at Fog Bay in the Northern Territory would remain active during the dry season, but restricted that activity to habitats that were rich in prey. In northern Australia, the availability of *V. panoptes* prey items appears to be linked to seasonal changes including temperature and rainfall (Griffiths and Christian 1996. Aust. J. Ecol. 21:386–398). These factors, together with the variety of habitats used by *V. panoptes*, could potentially result in competing and as yet unknown factors that influence activity patterns at the local scale. By understanding the dietary preferences of individual *V. panoptes* during the dry season, we can understand why some individuals continue to remain active and what factors influence that activity. Here, we present two observations of active feeding by *V. panoptes* during the dry season and present an arboreal prey item that has not previously been recorded in the diet of the species. We also discuss the implications of this prey item for maintaining activity in these individuals during the dry season in northern Australia.

On 5 August 2013, an adult male *V. panoptes* (SVL 470 mm, total length 1020 mm) was trapped in a modified wire cage trap as part of a monitoring program in the Casuarina Coastal Reserve (12.360557°S, 130.871255°E). Following the release of the animal, a regurgitated food bolus comprising fur and bones was found in the trap. The bolus included a partially digested forefoot identified as being from a juvenile Northern Brush-tail Possum

(*Trichosurus vulpecula*). On 8 September 2013, a different male *V. panoptes* (SVL 395 mm, total length 996 mm) was trapped in a cage trap as part of the same monitoring program. As with the first observation, a regurgitated bolus comprising hair and bones was found in the trap. The second sample was also identified as *T. vulpecula* using the methods of Brunner et al. (2002. Hair ID, An Interactive Tool for Identifying Australian Mammalian Hair. CSIRO Publishing, Melbourne. CD-ROM) and Brunner and Conan (1974. Identification of Mammalian Hair. Inkata Press, Melbourne. 176 pp.). Daily checking of the traps and footage from remote cameras (Moultrie® D-40) confirmed that the food items were regurgitated by the trapped animals. Unfortunately, the state of both samples meant that it was not possible to confirm whether the two observations reflect prey capture or scavenging.

Although previous studies have found other smaller nocturnal and arboreal mammals in the diet of *V. panoptes* (see Shine et al., *op. cit.*), our observations are the first record of *T. vulpecula* in the diet of this species. In addition, our observations provide further evidence of active foraging in *V. panoptes* when conspecifics are generally inactive. In the absence of further diet and movement information, we can only speculate on the factors that are responsible for maintaining activity in *V. panoptes*. Based on the results of previous studies, it is possible that the successful exploitation of certain food items allow individuals to continue foraging through the dry season. These observations are the first to confirm that *T. vulpecula* is included in the diet of *V. panoptes* during the dry season. Further studies should be undertaken to confirm whether *V. panoptes* is an active predator of *T. vulpecula* as well as quantifying the importance of this and other dietary items during the dry season along the coastal reserves in the northern Australia.

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SQUAMATA — SNAKES

***COLUBER* (= *MASTICOPHIS*) *FLAGELLUM* (Coachwhip). DIET / OPHIOPHAGY.** *Coluber flagellum* is known to take a variety of prey items, including snakes (Beaman and Basey 2011. Herpetol. Rev. 42:437). Tabor and Germano (1997. Herpetol. Rev. 28:90) reported a decomposing *Crotalus oreganus oreganus* (Northern Pacific Rattlesnake) in the esophagus of a road-killed *C. flagellum*, but it was not known whether the snake had been taken alive or eaten as carrion. Here we report a *C. oreganus helleri* (Southern Pacific Rattlesnake) as a prey item for *C. flagellum*.

On 25 June 2013, we encountered a *C. flagellum* ingesting a live *C. oreganus helleri* (SVL ca. 40 cm) near San Timoteo Creek, west of Beaumont, Riverside Co., California, USA (33.945918°N, 117.056755°W; datum WGS84). The head and neck of the rattlesnake were in the mouth of the Coachwhip, which had looped its body across the rattlesnake, pinning it to the ground (Fig. 1). As we approached to photograph the snakes, the coachwhip was startled and released the rattlesnake. The stunned rattlesnake thrashed about for a few minutes before resuming its normal behavior. The snakes were photographed and digital images were deposited in the Natural History Museum of Los Angeles County (LACM PC 1674–1675).



FIG. 1. *Coluber flagellum* feeding on *Crotalus oreganus helleri*, near Beaumont, California, USA.

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***COLUBER* (= *MASTICOPHIS*) *FLAGELLUM* (Coachwhip). BEHAVIOR / NOCTURNAL ACTIVITY.** *Coluber flagellum* is a large, slender-bodied colubrine snake that ranges widely across portions of the southern United States and northern Mexico (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Institute Press, Washington, D.C. 668 pp.). *Coluber flagellum* is generally considered a strictly diurnal species that maintains a high and narrow temperature profile by alternating between bouts of active foraging and subterranean inactivity (Secor and Nagy 1994. Ecology 75:1600–1614). Radio-telemetry studies of *C. flagellum* in Florida indicated that no movement occurred at night, save for shifts within burrows (Dodd and Barichivich 2007. Florida Sci. 70:83–94). In addition and despite a number of studies involving this species, accounts pertaining to neonatal activity are lacking. Here, we describe a nocturnal encounter with multiple neonate *C. flagellum*.

At 0033 h on 13 July 2013, we encountered two neonate (1 , 1) *C. flagellum* while driving on Highway 6, approximately 25 km W of Los Lunas (Valencia Co.), New Mexico, USA (34.84474°N, 107.05367°W, datum WGS 84; elev. 1602 m). The first individual was spotted from our vehicle; after pulling over and searching the area, a second neonate was discovered a few meters away. The postures of both snakes indicated they were in the process of crossing the road from the west (i.e., their bodies were straight and angled perpendicular to the road). We did not collect morphometric data from either snake, but based on photographs we estimate that each had a total body length of ca. 25–35 cm, which according to Ernst and Ernst (*op. cit.*) would qualify these individuals as hatchlings. A recent hatching and dispersal event, possibly cued by rain earlier in the day, might provide an explanation as to why these snakes were moving in such close proximity to each other and at such an unusual time of day for the species. The only other hint of nocturnal activity in this species was reported by Medica (2011. Herpetol. Rev. 42:612–613), who inferred that a *C. f. piceus* found basking in a creosote bush at 0610 h had spent the night there. We have

unambiguously documented a rare instance of nocturnal activity in *C. flagellum*.

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***CONOPSIS LINEATA* (Lined Tolucan Ground Snake). DIET.** *Conopsis lineata* is distributed in central and southern Mexico, from 1750 to 3100 m elev., in a variety of habitats (Goyenechea and Flores-Villela 2006. Zootaxa 1271:1–27; Goyenechea 2009. Rev. Mex. Biodiv. 80:721–725). Its diet has been reported to consist of insects, such as grasshoppers and termites (Canseco-Márquez and Gutiérrez-Mayén. 2010. Anfibios y Reptiles del Valle de Tehuacán–Cuicatlán. Comisión Nacional para el Conocimiento y Uso de la Biodiversidad, México, D.F. 302 pp.), but there is no detailed information on the species consumed.

On 27 June 2010, at 1537 h, a *C. lineata* (total length = 245 mm) was found under a rock in oak forest (*Quercus* sp.) on Sierra de Lobos, Municipality of San Felipe, Guanajuato, México (21.328292°N, 101.616183°W, datum WGS84; elev. 2627 m). Following capture, the snake was palpated and regurgitated a partially digested spider, which was identified as a member of the genus *Zorocrates* (Araneae, Zorocratidae), which are common in the area. This is the first record of a *Zorocrates* spider in the diet of *C. lineata*. The snake and the spider were deposited in the Herpetological Collection, Universidad Autónoma de Aguascalientes (CV-0327).

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***DENDRELAPHIS CYANOCHLORIS* (Wall's Bronzeback). ENDOPARASITE.** *Dendrelaphis cyanochloris* occurs in Myanmar, Peninsular Thailand, Laos and Peninsular Malaysia, Bangladesh, and north-eastern India (Das 2010. A Field Guide to the Reptiles of South-East Asia. Myanmar, Thailand, Laos, Cambodia, Vietnam, Peninsular Malaysia, Singapore, Sumatra, Borneo, Java, Bali. New Holland Publishers, London. 376 pp.). One female *D. cyanochloris* (SVL = 803 mm) was collected 2 July 2005 in West Malaysia, Pahang State, Pulau Tioman (2.8167°N, 104.1833°E; datum WGS84) by LLG and deposited in the herpetology collection of La Sierra University (LSUHC 7306), Riverside, California, USA. We know of no published reports of helminths from *D. cyanochloris*.

The body cavity was opened and the coelomic cavity was searched for helminths. One whitish helminth ca.1 × 2 mm was found embedded in coelomic fat. It was identified as a larval tapeworm (cestode cysticercoid), characterized by a fully withdrawn scolex and solid unsegmented body (Bush et al. 2001. Parasitism, The Diversity and Ecology of Animal Parasites. Cambridge University Press, Cambridge, UK. 566 pp.). The cysticercoid was deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland, USA, as USNPC 107219. Development to the adult tapeworm would have occurred when the *D. cyanochloris* was eaten by a final (definitive) host, thus this snake was most likely a paratenic (= transport) host. *Dendrelaphis cyanochloris* represents a new host record for cestode cysticercoids .

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***DENDRELAPHIS CYANOCHLORIS* (Wall's Bronzeback). REPRODUCTION.** *Dendrelaphis cyanochloris* occurs in Myanmar, Peninsular Thailand, Laos and Peninsular Malaysia, Bangladesh, and north-eastern India (Das 2010. A Field Guide to the Reptiles of South-East Asia, Myanmar, Thailand, Laos, Cambodia, Vietnam, Peninsular Malaysia, Singapore, Sumatra, Borneo, Java, Bali. New Holland Publishers, London. 376 pp.). There is a report of *D. cyanochloris* having clutches of 3–5 eggs in Das (*op. cit*). The purpose of this note is to add information on the reproductive biology of *D. cyanochloris* from a histological examination of gonadal material.

A sample of 10 *D. cyanochloris* from Peninsular Malaysia consisting of four males (mean SVL = 586.8 mm ± 57.9 SD, range = 523–663 mm) and six females (mean SVL = 745.5 mm ± 42.8 SD, range = 707–803 mm) deposited in the herpetology collection of La Sierra University (LSUHC), Riverside, California, USA, were examined (by state): Pahang, LSUHC 4493, 4611, 5409, 5416, 6431, 7306, 7307 and Pinang, LSUHC 6768, 6769, 6771. Snakes were collected between 2002 and 2005. The left testis was removed from males and the left ovary was removed from females. Enlarged follicles (> 7 mm diameter) or oviductal eggs were counted. Histology slides were deposited at LSUHC.

The only stage noted in the testicular cycle was spermiogenesis in which the lumina of the seminiferous tubules were lined by sperm or groups of metamorphosing spermatids. Monthly distribution of males was March (N = 1), July (N = 2), August (N = 1). The presence of spermiogenic males in widely separated months (March and August), suggests *D. cyanochloris* has an extended reproductive cycle. The smallest reproductively active male (spermiogenesis) measured 523 mm SVL (LSUHC 4611) and was collected in July.

Three stages were noted in the ovarian cycle of *D. cyanochloris*: 1) quiescent, no yolk deposition; 2) enlarged follicles > 7 mm diameter; 3) oviductal eggs. Four July females, consisted of two with quiescent ovaries, one with four enlarged follicles (> 7 mm and one with seven oviductal eggs. Two August females consisted of one with quiescent ovaries and one with four enlarged follicles (> 7 mm). Mean clutch size for three females was 5.0 ± 1.7 SD, range = 4–7. The smallest reproductively active female (follicles > 7 mm diameter) measured 707 mm SVL (LSUHC 6431) and was collected in July. There was no suggestion (oviductal eggs and concurrent yolk deposition in the same female) to suggest *D. cyanochloris* females produce multiple clutches. Seven is a new maximum clutch for *D. cyanochloris*.

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***EUNECTES MURINUS* (Green Anaconda). BEHAVIOR / SIDEWINDING.** Sidewinding is a form of locomotion unique to snakes. Unlike lateral undulation and rectilinear locomotion,

which rely on static friction, sidewinding allows a snake to move across very loose or smooth terrain efficiently (Gans 1962. Am. Zool. 2:167–182). Unlike other modes of locomotion, in sidewinding the direction of movement is perpendicular to the long axis of the body, resulting in tracks that run oblique to the direction of movement. Sidewinding is also the only mode of locomotion in snakes where there is no sliding point of contact with the substrate. The portions of the body that are moving are lifted above the substrate (Gans 1974. Biomechanics: An Approach to Vertebrate Biology. Lippincott, Philadelphia. 261 pp.). No study to date has described sidewinding in a large bodied constrictor. Here we note the first evidence of sidewinding in a 2.75-m *Eunectes murinus;* this is currently the largest snake ever observed sidewinding in the natural environment.

On 5 June 2011, an ecotourism group in the vicinity of Infierno, Peru, discovered an *E. murinus* and moved the snake onto a small area of grass for photographing. While on the grass, the *E. murinus* was videotaped. After a few strike attempts directed at one of the group members, the snake attempted to escape, transitioning into a rapid sidewinding motion to flee. One member of the group retrieved the snake, returning it the center of the grassy clearing, and it once again attempted to flee via sidewinding. Images taken from the video clearly show the anaconda lifting sections of its body off the substrate as it moves along the ground, while the points on the substrate remain static (Fig. 1). Unlike similar modes of locomotion (e.g., "mud-jumping," Bustard 1969. Herpetologica 25:164–170), the sections of the body elevated are between contact points and are not restricted to the anterior or posterior regions. Elevated regions of the body travel approximately 1 m before returning to the substrate. The movement is perpendicular to the long axis of the body, and the traveling wave moving down the length of the snake occurs at the same speed as forward progression.



FIG. 1. Two still images showing the key aspects of sidewinding behavior in an *Eunectes murinus*. Sections of the body are looped and lifted off the substrate as the snake moves.

Sidewinding is most commonly observed in species moving on loose or smooth terrain, and has been considered an adaptation to these environments (Secor et al. 1992. J. Exp. Biol. 163:1–14). However, the anaconda in our video is moving on a grassy substrate, suggesting that sidewinding may be more widespread in snakes than previously considered, and that this behavior might not be restricted to loose or smooth terrain. An alternative hypothesis, that sidewinding evolved as a rapid escape behavior in open habitat (Cowles 1956. Copeia 1956:211–214), is supported by this observation.

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***HYPSIGLENA JANI* (Chihuahuan Nightsnake). DIET.** The diet of *Hypsiglena jani* primarily includes lizards and small snakes, although lizard eggs, frogs, insects, and worms are occasionally consumed (Werler and Dixon 2000. Texas Snakes: Identification, Distribution, and Natural History. Univ. Texas Press, Austin. xv + 437 pp.; Ernst and Ernst 2003. Snakes of the United States and Canada. Smithson. Inst. Press, Washington, D.C. 668 pp.). On 5 September 2013, at 2110 h, an adult female *H. jani* (SVL = 290 mm; tail length = 56 mm; 21.1 g [with ingested prey]) was discovered subduing and eating an adult *Hemidactylus turcicus* (Mediterranean Gecko) (Fig. 1) in the backyard of VMS's home, located in El Paso, El Paso Co., Texas, USA (30.4635°N, 105.0055°W, datum WGS84; elev. 1215 m). After ca. 25 min the snake released the dead gecko and initially swallowed the detached tail that had been lost as a result of resistance by the lizard after being attacked. Next the gecko's body was consumed headfirst, a process that lasted about 20 min. *Hemidactylus turcicus* is an exotic species that is firmly established in El Paso and many other locations in the southern U.S. However, this is the first record of this species in the diet of *H. jani.*



FIG. 1. Adult *Hypsiglena jani* consuming an adult *Hemidactylus turcicus* in El Paso, El Paso Co., Texas, USA.

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***LEPTOPHIS AHAETULLA* (Parrot Snake). DIET.** *Leptophis ahaetulla* is widespread in Central and South America (Oliver 1948. Bull. Am. Mus. Nat. Hist. 92:157–280). Reported diet of *L. ahaetulla* consists mostly of frogs, but lizards and birds have also been recorded (Teixeira and Port 1991. Herpetol. Rev. 22:132; Albuquerque et al. 2007. J. Nat Hist. 41:1237–1243). On 12 April 2011, at ca. 0900 h, during an ornithological expedition to the woods surrounding the Barreira do Inferno military facility, near the city of Natal, Rio Grande do Norte, Brazil (55.5°S, 10.35°W, datum WGS84; elev. 25 m), we observed an adult *L. ahaetulla* (total length ca. 80 cm) among the branches of a shrub preying on a juvenile *Turdus leucomelas* (Pale-breasted Thrush; Fig. 1). This is the first record of *T. leucomelas* in the diet of *L. ahaetulla*.

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FIG. 1. *Leptophis ahaetulla* preying on a juvenile *Turdus leucomelas* in the coastal region near Natal, Rio Grande do Norte, Brazil.

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***LIOTYPHLOPS ALBIROSTRIS* (White-nosed Blindsnake). PREDATION.** *Liotyphlops albirostris* is a medium-sized (to 223 mm) blindsnake occurring in Panama, Colombia, Venezuela, and Ecuador. This species is considered rare and little is known about its ecology or biology (Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna between Two Continents, between Two Seas. Univ. Chicago Press, Chicago, Illinois. 934 pp.). An adult (snout–urostyle length = 107.6 mm, head width = 42.6 mm) female *Rhinella marina* (Cane Toad) was collected from beneath a house in suburban Clayton, Republic of Panama (9.001667°N, 79.576944°W; datum WGS 84) at 2100 h on 5 September 2013, and retained in a moist cloth bag overnight. The following morning a deceased but intact blind snake (total length = 124 mm) was discovered protruding headfirst from the toad's cloaca (Fig. 1). The snake was preserved in 70% ethanol and identified as *L. albirostris* via examination of its facial scales beneath a dissecting scope (verified by Sean Graham and Roberto Ibáñez).



FIG. 1. *Liotyphlops albirostris* (White-nosed Blind Snake) protruding from the cloaca of a female *Rhinella marina* (Cane Toad) collected in the Republic of Panama.

Interestingly, the specimen was completely undigested. A live *Ramphotyphlops braminus* (Brahminy Blindsnake) was similarly recovered from the cloaca of a *Duttaphrynus melanostictus* (Common Asian toad) in East Timor (O'Shea et al. 2013. Herpetol. Notes 6:467–470). Blindsnakes (*R. braminus*, *R. guentheri*, and *R. unguirostris*) have also been recorded in the diet of *R. marina* (10 of > 3000 toads) in their invasive range in Australia (Pizzatto et al. 2012. Herpetol. Rev. 43:469–471); and blindsnakes of the genus *Typhlops* were discovered in the gut contents of 19 of ~5000 Cane Toads in their invasive range in the Philippines (Rabor 1952. Copeia 1952:281–282). As with the majority of the Australian records (Pizzatto et al. 2012, *op. cit.*), this blindsnake was consumed in the wet season when blindsnakes may be more surface-active due to flooding of fossorial habitat.

I thank Mark Torchin for assistance in capturing the wily toad. My research was supported by an A. Stanley Rand Fellowship.

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***MICRUROIDES EURYXANTHUS* (Sonoran Coralsnake). DIET.** On 15 September 2012, 1848 h MST, we captured an adult *Micruroides euryxanthus* (photo voucher UAZ 57568-PSV; ca. 420 mm SVL) on Forest Road 39, Coronado National Forest, Santa Cruz Co., Arizona, USA (31.400899°N, 111.144186°W, datum NAD83; 1423 m elev.). The snake was maintained overnight and in the morning we found that it had regurgitated an adult female *Plestiodon callicephalus* (Mountain Skink) (UAZ 57462; 63 mm SVL, 58 mm tail). We released the snake on 16 September at the site of capture. Judging from its limb orientation, the skink had been ingested head-first and we discovered two puncture marks (3.62 mm apart) on the tail ventro-laterally, 24 mm posterior to the vent, suggesting that the animal had initially been caught by the tail.

This is the first report of *P. callicephalus* in the diet of *M. euryxanthus*. *Micruroides* are typically ophiophagus (Vitt and Hulse 1973. Herpetologica 29:302–304; Lowe et al. 1986. The Venomous Reptiles of Arizona. Arizona Game and Fish Dept.,

Phoenix. 115 pp.; G. R. Harper, pers. comm.). Although Lowe et al. (*op. cit.*) reported results from "field observations and laboratory experiments on foods and feeding" that "lizards taken" as *Micruroides* prey included skinks whose "young…have blue tails" (which could include *P. callicephalus* or *P. obsoletus*), they did not identify species of skink(s) or identify whether skinks had been fed to coralsnakes or found as natural prey items.

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***MICRURUS SURINAMENSIS* (Aquatic Coralsnake). BEHAVIOR.** Coralsnakes (*Micrurus* spp.) are primarily fossorial and secretive, but arboreal behavior has been reported in *M. circinalis* (Sajdak 2000. Herpetol. Rev. 31:105), *M. fulvius* (Carr 1994. Naturalist in Florida: the Celebration of Eden. Yale Univ. Press, New Haven, Connecticut. 306 pp.), and *M. nigrocinctus* (Schmidt and Schmidt 1943. Field Mus. Nat Hist. Publ. Zool. Ser 12:129–134). *Micrurus surinamensis* is known to have aquatic habits and feeds mainly on fish and eels (Roze 1996. Coral Snakes of the Americas: Biology, Identification, and Venoms. Krieger Publ. Co., Malabar, Florida. 328 pp.). On 13 May 2013, at 1438 h (32°C), during an active search for amphibians and reptiles in the municipality of Cacoal, State of Rondônia, Brazil (11.488094°S, 61.438953°W; datum SAD69), we observed a juvenile male *M. surinamensis* (SVL = 400 mm) climbing on vegetation 2.38 m high within an open rainforest. This appears to be the first record of arboreality in *M. surinamensis*.

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***NERODIA SIPEDON PLEURALIS* (Midland Watersnake). ALBINISM.** Although there are several reports of albinism in *Nerodia sipedon sipedon* (Baker et al. [ed.] 1959. Publ. Mus. Michigan St. Univ. Biol. Ser. 1:133–159; Dyrkacz 1981. SSAR Herpetol. Circ. 11:1–31) we are not aware of any published account documenting albinism in *Nerodia sipedon pleuralis*. An unsexed *N. s. pleuralis* (SVL = 425 mm, Arkansas State University, Herpetological Museum; photo voucher ASUMZ 32763) was collected near Jasper, Newton Co., Arkansas, USA, in June 2012. It was donated to the Arkansas Game and Fish Commission Fred Berry Conservation Education Center (CEC), where it remains for viewing. The specimen is a true albino (Fig. 1). Interestingly, there was another albino specimen of *N. s. pleuralis* collected with the above but its disposition is unknown.

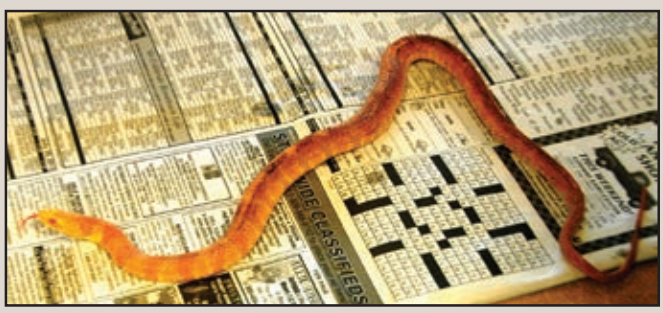


FIG. 1. Albino *Nerodia sipedon pleuralis* from Newton County, Arkansas.

We thank M. Doran, Facility Manager for the Fred Berry CEC, for information on this albino snake.

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***OXYURANUS SCUTELLATUS* (Taipan). HOMING.** Very little is known about the daily behavior of *Oxyuranus scutellatus* under natural conditions (Shine and Covacevich 1983. J. Herpetol. 17:60–69). A serendipitous observation recorded at Wetherby Station (a cattle-raising property popular with eco-tourists, approximately 20 km SW of Port Douglas (16.645368°S, 145.354280°E, datum WGS84; elev. 399 m, 12 Sep 2012) in North Queensland, Australia, suggests homing and burrow re-use in this species.

We arrived at Wetherby Station about 1800 h and were directed to viewing stands on a concrete platform erected for cattle auction attendees. Our horse-mounted host allowed about 12 cattle to enter the viewing pen. When his previously-calm horse became agitated, our host looked into the area between viewing paddock and tree line, approximately 12 m distant, and exclaimed "Taipan." The snake was moving slowly but steadily—seemingly purposeful, head raised only slightly in the direction of the platform. Upon reaching the platform it turned without hesitation and crawled along the ground against the concrete edge of the platform in my direction. Stopping about 0.2 m from my foot, it reoriented and, seamlessly, crawled onto the concrete platform, passed beneath the viewing stand, and entered what was likely a rodent burrow located along the foundation for a barn just behind the viewing stand. Once in the burrow, the ~1.5-m Taipan re-emerged slightly, re-positioned and withdrew, leaving its head facing out from the burrow's entrance (Fig. 1). As this individual passed rapidly, but unhurriedly, through a small herd of cattle to take shelter in a burrow without apparent searching, this observation suggests it was returning to a previous refuge site, thereby demonstrating homing ability.



FIG. 1. *Oxyuranus scutellatus* (Taipan) settled in a burrow following the homing event.

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***PARIAS SUMATRANUS* (Sumatran Pit Viper). DIET.** *Parias sumatranus* is a large (to 1355 mm total length) arboreal crotaline viper from the Greater Sundas (southern Thailand, Peninsular



FIG. 1. Euthanized specimen of *Parias sumatranus* (UNIMAS P0849) and its stomach contents, a *Maxomys baeodon* (UNIMAS P0872).

Malaysia, Sumatra, and Borneo) region of Southeast Asia. Its diet is poorly known, and reported to comprise small mammals, birds, and frogs (Stuebing and Inger 1999. A Field Guide to the Snakes of Borneo. Natural History Publications [Borneo], Kota Kinabalu. v + 235 pp.; Das 2010. A Field Guide to the Reptiles of South-east Asia. New Holland Publishers [UK], Ltd., London. 376 pp.), with no specific information.

On 10 July 2013, at ca. 1100 h, an adult female *Parias sumatranus* (Fig. 1; UNIMAS P0849; SVL = 887 mm; tail length = 28.4 mm; 252 g) was collected up the ridge from Sungei Sembu towards Sembu Waterfall, near the base (01.134556°N, 110.249444°E, datum Timbalai 1948; elev. ca. 250 m) of Gunung Penrissen, Sarawak, East Malaysia (Borneo). It was initially encountered at ca. 1.2 m above the ground on a low tree trunk within a riparian forest. The specimen was returned to the laboratory and euthanized; examination of the stomach contents revealed a recently-ingested rodent, *Maxomys baeodon* (UNIMAS P0872; 128 mm in head body length; 134 mm tail length; 68 g). This Bornean endemic has been reported from a few isolated localities between 900–1400 m elev. in Sabah and Sarawak (Heaney et al. 2008. *In* IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1), and also at least two lowland localities: Sandakan Bay, Sabah (Payne et al. 1985. A Field Guide to the Mammals of Borneo. Sabah Society and World Wildlife Fund, Kota Kinabalu. 332 pp.), and at Planted Forest Zone, Bintulu Division, Sarawak (Ragai and Tuen 2007. *In* Stuebing et al. [eds.], Proc. Regional Conf. Biodiv. Conserv. Trop. Planted Forests SE Asia. pp. 164–168. Sarawak Forest Department, Sarawak Forestry Corporation and Grand Perfect Sdn Bhd., Kuching). It was swallowed head-first, and was estimated to be 26.98% of the body weight of the snake.

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***PELAMIS PLATURA* (Yellow-bellied Seasnake). SHEDDING BEHAVIOR.** Shedding events of *Pelamis platura* have been reported as taking place always in water, either in the sea (Pickwell 1971. Copeia 1971:348–350; Voris 1983. *In* Janzen [ed.], Costa Rican Natural History, pp. 411–412. Univ. Chicago Press, Chicago, Illinois), or as captive individuals (Pickwell, *op. cit.*). Shedding is usually facilitated by the ability of these individuals to knot themselves, creating loops and coils, culminating with inverted and intact shed skins (Pickwell, *op. cit.*). Herein, we report an observation of shedding behavior of *P. platura* on sandy substrate out of the water.



FIG. 1. Male *Pelamis platura* shedding on a sandy beach in Rancho El Neptuno, Santa María Colotepec, Oaxaca, México.

At 1835 h on 7 April 2013 an adult male *P. platura* (Fig. 1) was observed shedding on a sandy beach at Rancho El Neptuno (15.792086°N, 96.959717°W; datum WGS 84) located in the municipality of Santa María Colotepec, Oaxaca, Mexico. The snake came out of the water and started to undulate its body to cause friction against the sand. Once the snake had shed most of the skin, it moved back towards the water and continued to rid itself of the last portion of skin every time it came in contact with the waves; knotting behavior was never displayed. The shedding episode lasted ca. 35 min. Pickwell (*op. cit.*) suggested that the knotting behavior of *P. platura* in aquatic environments evolved not just as a substitute for contact with solid substrate as an aid in shedding, but also for ridding themselves of ectoparasites and possibly freeing themselves from predators. To the best of our knowledge this instance represents the first reported observation of *P. platura* shedding behavior outside aquatic environments.

We thank J. M. Savage, who kindly provided information regarding this subject, and A. Rocha for his important comments on this note.

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***PITUOPHIS CATENIFER SAYI* (Bullsnake). DIET.** *Pituophis catenifer sayi* is a wide-ranging subspecies that inhabits the sandy plains and prairies across the central two-thirds of Texas (Dixon 2013. Amphibians and Reptiles of Texas. Texas A&M Univ. Press, College Station. 447 pp.). Most of its diet in the Great Plains region consists of small mammals (70%), bird eggs (20%), and birds (8%) (Rodríguez-Robles 2002. Biol. J. Linn. Soc. 77:165–183). Herein I describe *P. c. sayi* consuming a previously unknown prey species, *Carpodacus mexicanus* (House Finch).

On 29 May 2011, I collected a *P. c. sayi* (total length ca. 65 cm) inside the city limits of Lubbock, Lubbock Co., Texas, USA. The snake was placed in a container and while being transported

it regurgitated a single *C. mexicanus*. The finch was preyed on recently based on the amount of decomposition; the length of the tail and flight feathers indicated that it was most likely an adult. The area where the Bullsnake was collected is an older residential part of the city with large trees where House Finches and House Sparrows (*Passer domesticus*) are the most numerous small bird species. This account is the first known predation of *C. mexicanus* by *P. catenifer* and the first species from the family Fringillidae (Rodríguez-Robles, *op. cit.*), although the literature summary by Badyaev et al. (2012. *In* A. Poole [ed.], The Birds of North America Online. Cornell Lab of Ornithology, Ithaca, New York; http://bna.birds.cornell.edu/bna/species/046, accessed 17 May 2014) stated that nest predators of House Finches from British Columbia probably included Gopher Snakes.

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***PITUOPHIS CATENIFER SAYI* (Bullsnake). ARBOREALITY.** Although generally considered to be primarily terrestrial and fossorial, *Pituophis catenifer* are on occasion known to climb into bushes and trees (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Inst. Press, Washington, D.C. 668 pp.). In fact, there are several obscure records of members of *Pituophis* hunting for and/or feeding on birds arboreally (Rodríguez-Robles 2002. Biol. J. Linn. Soc. 77:165–183). For example, *P. catenifer* has been found preying on birds in their nests in a hawthorn tree in Washington State (3 m; Marr 1985. Murrelet 66:95–97), a cypress tree in California (2.6 m; Ervin and Rose 1973. Auk 90:682–683), a live oak tree in California (1.8 m; Cunningham 1955. Herpetologica 11:217–220), and an unknown tree in California (ca. 12 m; Eichholz and Koenig 1992. Southwest. Nat. 37:293–298). *Pituophis c. sayi* has been found in a ponderosa pine in Montana (at 7.4 m; Amstrup and McEneany 1980. Wilson Bull. 92:402), a cottonwood in Alberta (3.5 m; Bullock 1981. Bluejay 39:139–140), a willow tree in Colorado (4.6 m; Niedrach 1971. Wilson Bull. 83:317–318), and a bur oak tree in Minnesota (2–3 m, N = 3; Maxson 1981. The Loon 53:61–62). The purpose of this note is to synthesize these earlier records with my observations of arboreal behavior in Nebraska *P. c. sayi*.



FIG. 1. Adult *Pituophis catenifer sayi* (Bullsnake) negotiating the relatively smooth bark of a birch tree, 3.1 m above ground level.

On 29 June 2013 at 1730 h an adult *P. c. sayi* (total length = 140 cm) was first observed moving on the ground ca. 30 m from a large ornamental birch tree (*Betula* cf. *pendula*; DBH 99 cm; height ca. 20 m) in a residential yard in the housing area of the Crescent Lake National Wildlife Refuge, just north of Gimlet Lake, Garden Co., Nebraska, USA. On reaching the tree the snake proceeded to move up the rough lower bark on the tree ca. 3.1 m until that bark transitioned to the smoother upper bark typical of a birch tree (Fig. 1). The snake continued climbing upward in a manner strikingly similar to that of *Pantherophis* species. At 4.0 m, the snake reached the first whorl of branches and proceeded to move laterally through the branches, with frequent tongue-flicking, in a manner that suggested it was foraging. Several *Quiscalus quiscula* (Common Grackle) nests were present much higher up in this same tree, from which the young had recently fledged. The snake repeatedly foraged out 3–4 m from the trunk in these branches for ca. 15 min, and then returned to the trunk and descended to the ground. The snake had reached a maximum height of 4.6 m. It is assumed that the snake was attracted to this particular tree because of the odors associated with the fledging grackles (Eichholz and Koenig, *op. cit.*).

In 2010, at this same site, another large adult *P. c. sayi* was observed attempting to climb a large cottonwood tree (DBH 122 cm), but was accidentally disturbed when its head had reached a height of only 3 m. In addition, Bullsnakes at this site have been observed on two occasions to climb electrical conduit pipes on the sides of residences to reach Barn Swallow nests under the eaves at heights of 3.8 m. Despite the fact that *P. c. sayi* is primarily a prairie inhabitant, the combined records now available suggest that this species is much more scansorial than generally appreciated.

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***PLATYCEPS COLLARIS* (Collared Dwarf Racer). REPRODUCTION.** *Platyceps collaris* is known from Bulgaria, Israel, Jordan, Lebanon, Syria, and Turkey (Bar and Haimovitch 2011. A Field Guide to Reptiles and Amphibians of Israel. Pazbar Ltd., Herlizya, Israel. 245 pp.). Anecdotal information on reproduction of female *P. collaris* is in Bar and Haimovitch (*op. cit*), Baran and Atatür (1998.Turkish Herpetofauna (Amphibians and Reptiles). Republic of Turkey, Ministry of Environment, Ankara. 214 pp.). and Stojanov et al. 2011. Die Amphibien und Reptilien Bulgariens. Edition Chimaira, Franfurt am Main. 591 pp.). In this note I present the first information on the testicular cycle of *P. collaris*.

A sample of 13 male *P. collaris* (SVL = 630.9 mm ± 105.4 SD, range = 437–647 mm) collected 1950–2012 in Israel and placed in the Zoological Museum of Tel Aviv University (TAUM), Israel (by region) was examined: HaSharon TAUM 42, 43, 4540, 4797, 7084, 10329, 13459; Hermon Mountain TAUM 13212; Jordan Valley TAUM 14119; Lower Galil TAUM 16114; Southern Coastal Plain TAUM 2122; Yizreel Valley TAUM 36, 3858. A small slit was made in the left side of the abdomen and the left testis was removed for histological examination. Testes were embedded in paraffin. Sections were cut at 5 µm and stained by Harris' hematoxylin followed by eosin counterstain. Histology slides are deposited at TAUM.

Three stages were observed in the testicular cycle (Table 1); (1) regressed, seminiferous tubules are reduced in size and contain spermatogonia with interspersed Sertoli cells; (2) recrudescence, a proliferation of germ cells occurs for the next period of spermiogenesis (= sperm formation), primary or secondary

TABLE 1. Monthly stages in the testicular cycle of 13 adult male *Platyceps collaris* from Israel.

Month	N	Regressed	Recrudescence	Spermiogenesis
January	2	0	2	0
March	2	0	2	0
April	2	0	0	2
May	3	0	0	3
June	1	0	0	1
July	2	1	0	1
December	1	0	1	0

spermatocytes predominate; (3) spermiogenesis, seminiferous tubules are lined by sperm or clusters of metamorphosing spermatids. The smallest reproductively active male (TAUM 4540) exhibited spermiogenesis and was collected in June. The period of sperm production encompassed April into July. This period of sperm production is compatible with the times of egg deposition in *P. collaris* in Bar and Haimovitch (*op. cit*) (August) and Stojanov (*op. cit*) (July).

I thank Shai Meiri (TAUM) for permission to examine *P. collaris*, Erez Maza (TAUM) for facilitating the loan and the National Collections of Natural History at Tel Aviv University for providing samples of *P. collaris* used in this study.

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***PSEUDOBOA NIGRA* (Black False Boa). ENDOPARASITES.** Pentastomids are common parasites of vertebrate respiratory tracts, especially of reptiles (Riley 1986. Adv. Parasitol. 25:45–128). *Raillietiella furcocerca* is a generalist parasite and is known to infect eight species of snakes (Almeida et al. 2008. Braz. J. Biol. 68:201–205). Herein, we report the presence of *R. furcocerca* as a parasite of a ninth species, *Pseudoboa nigra*. On 28 January 2011, at ca. 2200 h, we collected a road-killed specimen of *P. nigra* near the municipality of Chupinguaia, Rondônia state, Brazil and deposited it at Coleção Zoológica de Vertebrados da Universidade Federal de Mato Grosso, Cuiabá, Brazil (UFMT-R 9504). The respiratory tract of the snake was removed and a search for pentastomids was carried out under stereomicroscopy. One adult female *Raillietiella furcocerca* was found in the nasopharynx. After identification, the material was deposited in the Parasitological Collection of the Universidade Regional do Cariri (URCA-P 400).

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***PYTHON MOLURUS BIVITTATUS* (Burmese Python). MINIMUM SIZE AT MATURITY.** *Python molurus* is one of the largest snakes in the world and has been a mainstay of the pet trade for several decades, resulting in establishment of an invasive population in South Florida. Ironically, the biology of this species in its native range is poorly known and we know considerably more about the invasive population than we do about native populations in Asia. *Python molurus* in Florida are known to grow to over 5 m total length with clutch sizes of up to 87 eggs (Krysko et al. 2012. IRCF Reptiles and Amphibians 19:267–270). However, we still know little about patterns of growth, maturation, and reproduction in wild *P. molurus*. Here we report the smallest gravid female *P. molurus* found thus far in the wild.



FIG. 1. Female *Python molurus bivittatus* measuring 210 cm total length (185 cm SVL) and containing eleven viable eggs collected in Everglades National Park, Florida, representing the smallest known wild gravid female of the species.

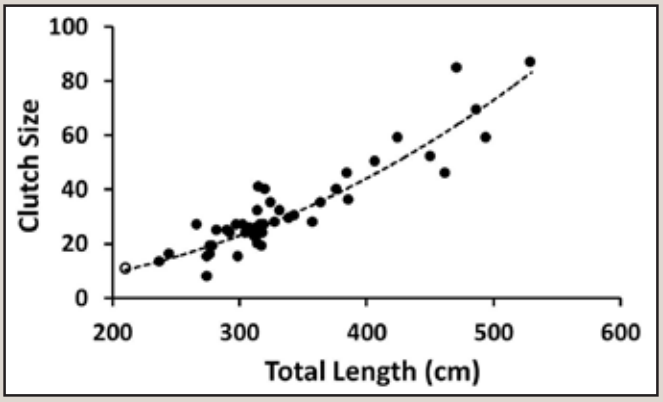


FIG. 2. Relationship between body length and clutch size for 49 female *Python molurus* removed from the invasive population in South Florida. Clutch size includes oviductal and brooded eggs, whether viable or unfertilized. The female described in this note is indicated by an open point.

At 2252 h on 27 May 2013 (22.8°C; light rain) a female *P. molurus* (Everglades National Park Accession # EVER-00888; Catalog # EVER 80679) was captured crossing the Main Park Road in Everglades National Park, in the vicinity of Paurotis Pond (25.28367°N, 80.798355°W; datum WGS84). When euthanized and necropsied, the snake (SVL = 185 cm, total length = 210 cm, mass = 5096 g) was found to contain 11 oviductal, shelled eggs (Fig. 1). All eggs were viable, based on the presence of developing embryos. This is the smallest gravid female *P. molurus* captured in Florida, 23 cm shorter (SVL) than the next smallest gravid female (Fig. 2). The clutch size is among the smallest reported in Florida, but is slightly larger than expected based on body length-clutch size relationships for females in this population (Fig. 2). Older literature sources have reported that female *P. molurus* reach maturity at around 270 cm total length, substantially longer than this individual (Wall 1921. Ophidia Taprobanica or the Snakes of Ceylon. Government Printer, Colombo. 581 pp.; Lederer 1956. Die Aquarien-und Terrarien-Zeitschrift 9:243–248). We are unaware of any other published accounts of size at maturity for this species.

The relatively small size of this female suggests that *P. molurus* in Florida may reach maturity rapidly. Overfed captive individuals can easily attain body lengths greater than 200 cm in

one year (Ross and Marzec 1990. The Reproductive Husbandry of Pythons and Boas. Institute for Herpetological Research, Stanford, California. 270 pp.). Growth rates of wild *P. molurus*, either in Florida or in Asia, are unknown, but are undoubtedly slower. However, a demographic analysis of Florida *P. molurus* suggests that females reach 200 cm SVL by two years of age (Willson et al. 2010. Biol. Invasions 13:1493–1504). Taken together, these data suggest that at least some *P. molurus* in Florida reach reproductive maturity at age two. Rapid growth and high reproductive potential of this species are likely strong drivers of its success as an invasive species (Reed et al. 2012. Integr. Zool. 7:254–270).

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***RHINOCHEILUS LECONTEI TESSELLATUS* (Texas Longnose Snake). PREDATION.** *Rhinocheilus lecontei tessellatus* is a small to medium-sized colubrid snake distributed across the western two-thirds of Texas (Dixon 2013. Amphibians and Reptiles of Texas. Texas A&M Univ. Press, College Station. 447 pp.). Little is known concerning the natural history of *R. lecontei*, which probably reflects its nocturnal nature. The few documented predators of *R. lecontei* include a conspecific (Lane 2009. Herpetol. Rev. 40:358), *Coluber* (=*Masticophis*) *flagellum* (Coachwhip; Kasper 2013. Herpetol. Rev. 44:334), and nesting *Buteo jamaicensis* (Red-tailed Hawk; Steenhof and Kochert 1985. Oecologia 66:6–16). Herein I describe predation of *R. l. tessellatus* by a novel mammalian predator, *Ictidomys parvidens* (Rio Grande Ground Squirrel; previously considered a subspecies of the Mexican Ground Squirrel, *Spermophilus mexicanus parvidens*).

At ca. 0920 h on 22 May 2012, I observed a male *I. parvidens* running along a graded dirt road with an object dangling from its mouth at Lake Alan Henry Wildlife Mitigation Area, ca. 11 km S, 26 km W of Clairemont, Kent Co., Texas, USA. The squirrel came to a stop and fed for 1–2 minutes then dropped the item and retreated after I clapped my hands repeatedly. I salvaged a small section of the cloacal region of a male *R. l. tessellatus*. The very fresh condition of the remains indicated this was a predator-prey event and not carrion feeding. Also of note was the ground squirrel's feeding behavior. Of the 37 mm of remaining carcass, 19 mm was pre-vent and 18 mm was post-vent. Incisor marks indicated that the ground squirrel fed at both ends toward the vent almost evenly, undoubtedly segregating the cloacal area that contained pungent musk and/or feces produced prior to death. Generally an omnivore of seasonal vegetation and insect prey, *I. parvidens* is known to take carrion and some small living vertebrate prey (Davis and Schmidly 1994. The Mammals of Texas. Texas Parks and Wildlife Press, Austin. 338 pp.). This account documents both the first known mammalian predator of *R. lecontei*, and *I. parvidens* preying on any species of snake.

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***SALVADORA BAIRDI* (Baird's Patch-nosed Snake). DIET.** Little is known about the diet of *Salvadora bairdi*. The literature mentions that it consumes amphibians, small mammals, and especially diurnal lizards and their eggs (Lemos-Espinal and Smith 2009. Anfibios y Reptiles del Estado de Chihuahua, México. UNAM, Tlalnepantla, México, México. 613 pp.; Uribe-Peña et al. 1999. Anfibios y Reptiles de las Serranías del Distrito Federal, México. Instituto de Biología, México, Distrito Federal, México. 119 pp.). However, no mammalian prey have been identified to species. Here we report the first record of predation on *Baiomys taylori* (Northern Pigmy Mouse) by *S. bairdi*.

On 28 July 2013, at 2020 h, a female *S. bairdi* (SVL = 585 mm; tail length = 210 mm; 30 g) was found beneath a rock at Mesa del Huarache, Municipality of Calvillo, Aguascalientes, Mexico (21.900171°N, 102.828405°W, datum WGS84; elev. 2321 m). The habitat at the location consists of grassland with patches of oak forest and tropical scrub forest ecotone. Manual palpation caused the snake to regurgitate a partially digested *B. taylori* (UAA-CV-R255), the only pigmy mouse known to occur in the area.

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***THAMNOPHIS PULCHRILATUS* (Yellow-throated Gartersnake). DIET AND DEFENSIVE BEHAVIOR.** Virtually nothing is known about the natural history of *Thamnophis pulchrilatus*, but it is thought to consume leeches, worms, fish, and amphibians, like other mountain garter snakes (Rossman et al. 1996. The Garter Snakes: Evolution and Ecology. Animal Science Series, Univ. Oklahoma Press, Norman, 332 pp.; Ramírez-Bautista et al. 2009. Herpetofauna del Valle de México: Diversidad y Conservación. UAEH, CONABIO. Pachuca. 213 pp.). Additionally, its defensive behavior is unknown. Here we document a new species in the diet of *T. pulchrilatus* and its defensive behavior.

On 28 August 2013, at 2012 h, a female *T. pulchrilatus* (SVL = 434 mm; tail length = 109 mm; 11 g) was found beneath a rock at Mesa del Huarache, Municipality of Calvillo, Aguascalientes, México (21.907151°N, 102.825820°W, datum WGS84; elev. 2332 m). The habitat was grassland with patches of oak forest, and tropical scrub forest ecotone. When we flipped the stone, the snake tried to escape, and finally formed concentric rings, hiding the head, and raising its tail in sinuous movements while secreting musk. Following capture, the snake was palpated and regurgitated a partially digested *Hyla eximia* (Mountain Treefrog; UAA-CV-R257). Similarly, on 15 August 2013 at the same locality, another female (SVL = 510 mm; tail length = 132 mm; 20 g; 21.882258°N, 102.847628°W; elev. 2380 m) was discovered basking in the grass and displayed the same defensive behavior. On 12 June 2010, at Ciénega de Quijas, Sierra el Laurel, Aguascalientes (21.727264°N, 103.709210°W, datum WGS84; elev. 2362 m) another specimen was found beneath a rock. It flattened the anterior half of its body, including the head, showing the bright blue in the interspaces between the scales for at least 30 sec, then tried to escape.

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***TROPIDODRYAS STRIATICEPS* (Jiboinha). DIET.** *Tropidodryas striaticeps* is a semi-arboreal snake widely distributed throughout eastern Brazil (Guedes and Marques 2011. Check List 7:78–82; Sousa et al. 2012. Biota Neotrop. 12:35–49). Despite its wide distribution, little is known about its ecology. *Tropidodryas* spp. are known to feed on lizards, frogs, rodents, and small birds (Vrcibradic et al. 2012. Herpetol. Notes 5:471–472). Here we report two cases of predation by *Tropidodryas striaticeps* on novel prey items.

On 11 March 2009 at the municipality of Juiz de Fora, Minas Gerais, Brazil (21.742667°S, 43.29225°W, datum WGS 84; elev. 709 m), a male *T. striaticeps* (SVL = 513 mm, tail length = 150 mm) was collected in an Atlantic Forest fragment. After being handled, the specimen regurgitated a bird, *Sporophila* sp. (Emberizidae). Both the snake and the bird are deposited in Coleção Herpetológica da Universidade Federal de Juiz de Fora (voucher number: CHUFJF 0598A and CHUFJF 0598B). The advanced stage of prey decomposition precluded species identification but three species of *Sporophila* are known from the study area: *S. frontalis*, *S. falcirostris*, and *S. caerulescens* (Manhães and Loures-Ribeiro 2011. Biota Neotrop. 11:275–286). On 30 January 2013 at the municipality of Castelo, Espírito Santo, Brazil (20.511839°S, 41.090467°W, datum WGS 84; elev. 1453 m), a female *T. striaticeps* (SVL = 761 mm, tail length = 206 mm) was collected in a rock outcrop beside a stream in an Atlantic Forest fragment. We found the snake feeding on a recently dead lizard, identified as *Tropidurus torquatus*. Both the snake and the lizard are deposited in Coleção Herpetológica da Universidade Federal de Minas Gerais (voucher numbers: UFMG 1692–1693).

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***TROPIDOPHIS MACULATUS*. MAXIMUM SIZE.** On 11 February 2007, CAM collected a female *Tropidophis maculatus* in Río Baracoa, Bauta, La Habana, Cuba, resting under a stone in burned grassland. This specimen (MFP 12506, Museo de Historia Natural "Felipe Poey," Facultad de Biología, Universidad de La Habana, La Habana, Cuba) measured 450 mm SVL and 495 mm total length. The maximum length previously reported for this species is 375 mm SVL in a male (Domínguez and Moreno 2006. Herpetol. Rev. 37:355–356), but Bibron (1840. *In* de la Sagra [ed.], Historia Física, Política y Natural de la Isla de Cuba, vol. IV, pp. 1–143, Imprenta y Litografía de Maulde et Renou, Paris), in the original description of this species, measured an individual that was 419 mm SVL. Bibron (*op. cit.*) did not note the sex nor voucher number; he only stated the specimens formed part of Mr. la Sagra's collection. Thus, our specimen appears to be the largest *T. maculatus* on record.

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ZOO VIEW

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Studies on Venomous Reptiles in Zoos and Aquariums: Part II—True Vipers, Fea's Viper, Mole Vipers, Pitvipers, Venomous Lizards, Conclusion

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THERE'S NO DOUBT ABOUT IT: SNAKES *ARE* FASCINATING! THEY MAY NOT INSPIRE MUCH AFFECTION, BUT THEY CERTAINLY GENERATE INTEREST, THE CROWDS THAT THRONG REPTILE HOUSES AT ZOOS THROUGHOUT THE WORLD TESTIFY TO THE EXTRAORDINARY APPEAL OF THESE REMARKABLE REPTILES. I CAN FULLY SYMPATHIZE WITH THIS FASCINATION, BECAUSE I FEEL THE SAME WAY --- EVEN AFTER TWENTY YEARS OF STUDYING THESE MYSTERIOUS ANIMALS.

--RICHARD SHINE, *AUSTRALIAN SNAKES, A NATURAL HISTORY*, 1991.

TRUE VIPERS

Africa is truly blessed by having a number of spectacular true vipers and members of the family Atractaspididae. As a result, zoo herpetologists have focused attention on including them in their collections. One of the most desirable assemblages includes members of the genus *Bitis* (Figs. 1, 2, 3). At Dallas Zoo, we specialized in this group: Puff Adder (*Bitis arietans*), Berg Adder (*B. atropos*), Horned Adder (*B. caudalis*), Many-horned Adder (*B. cornuta),* both species of Gaboon Vipers (*B. gabonica* and *B. rhinoceros*), Rhinoceros Viper (*B. nasicornis*), Peringuey's Viper (*B. peringueyi*), Namaqua Dwarf Adder (*B. schneideri*), and Worthington's Viper (*B. worthingtoni*). All were excellent exhibit ophidians except the Peringuey's Viper, which was small and insisted on burrowing with only eyes visible. Many *Bitis*, *Atheris*, and *Azemiops* were photographed by John H. Tashjian at Dallas Zoo and may be seen in *True Vipers: Natural History and Toxinology of Old World Vipers* (Mallow et al. 2002).

In 1915, Edward Boulenger published notes on feeding captive snakes at London Zoo, including Puff Adders. Biella et al. (1989) recorded the reproductive biology of the Puff Adder and Gaboon Viper and added requirements for nourishment, growth, and care. Meyer-Holzapfel (2007) discussed reproduction of the Puff Adder at Berne Zoo in Switzerland and Almandarz (2007) at Lincoln Park Zoo in Chicago. At Manyeleti Reptile Centre, Eastern Transvaal, South Africa, Haagner (1990) outlined techniques for maintaining captives which led to reproduction and dermatophagy (1991). One lived at San Diego Zoo for 12 years, 10 months. A Puff Adder gave birth to 156 young, two of which were stillborn (Janacek 1976). Murphy (1973) removed a deficient fang mechanism in a captive Puff Adder. Petzold (in Heichler and Murphy 2008) showed a Puff Adder consuming a shed skin. At Brookfield Zoo, Snedigar and Rokosky (1949) reported on newborn Gaboon Vipers (*B. gabonica*). Jacobs and Belcher (1983) noted captive reproduction in the West African Gaboon Viper (*B. rhinoceros*) at Rio Grande Zoological Park. Vandeventer and Schmidt (1977) performed a caesarean section on a Western Gaboon Viper. A specimen fasted for 30 months at Frankfurt/Main Zoo (Petzold, in Heichler and Murphy 2008). Banks (2002) reported on the birth of Rhinoceros Vipers (*B. nasicornis*) at Melbourne Zoo in 1997.

An interesting paper by John Phillips and Allison Alberts at San Diego Zoo in 1992 explored the predatory behavior in hatchling monitor lizards (*Varanus albigularis*) that may encounter snakes, such as Horned Adders, as both predators and prey—they conclude by saying— "Immediately after hatching, monitor lizards are naive to all prey items, thus correct assessment of snake prey is paramount for survival…Attack was inhibited in trials in which unrestrained prey were tongue-flicked, suggesting that chemical cues contained in snake skins mediate avoidance of venomous snakes. Selection for the ability to perceive snake integumental chemicals may be especially strong in species that both consume and are consumed by snakes."

There is little published information on the African vipers of the genera *Atheris, Proatheris,* and *Montatheris*. At Dallas Zoo, the following species were kept; Usambara Bush Viper (*Atheris ceratophora*), West African Bush Viper (*A. chlorechis*), Ashe's Bush Viper (*A. desaixi*), East African Bush Viper (*A. squamigera*; Fig. 4), African Hairy Bush Viper (*A. hispida*), Great Lakes Bush Viper (*A. nitschei*), and Lowland Swamp Viper (*P. superciliaris*). All of the



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FIG. 1. Gaboon Viper (*Bitis gabonica*) from *Reisebilder aus Liberia* by Johann Büttikofer, 1890.



FIG. 2. Boa Constrictor and Rabbit, by Beata Francis in *The Child's Zoological Garden,* 1880. Looks more like a Puff Adder to me! I suspect this rabbit's days may be numbered and the carrot left uneaten.

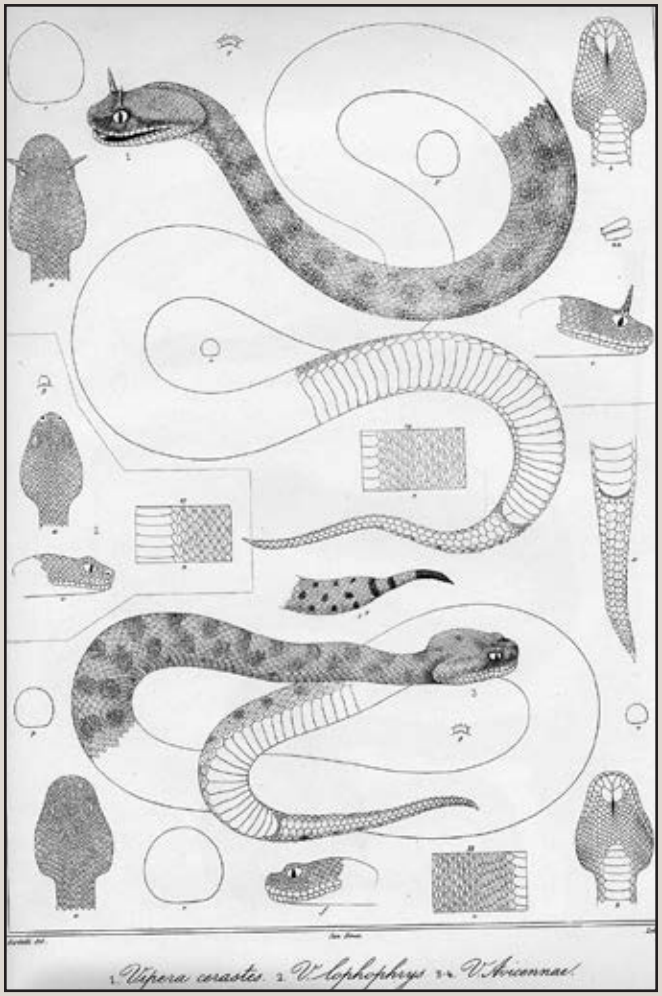


FIG. 3. Illustration from top to bottom of Desert Horned Viper (*Vipera cerastes*, now *Cerastes cerastes*), Many-horned Adder (*Vipera lophophrys*, now *Bitis cornuta*), and Sahara Sand Viper (*Vipera Avicennae*, now *Cerastes vipera*) from *Iconographie Générale des Ophidiens* by Georges Jan and Ferdinando Sordelli,1860–66. This atlas contained 300 plates illustrating the snakes of the world.

above except *hispida* were excellent exhibit snakes; specimens of this species were riddled with internal parasites. Several species (*chlorechis, hispida, nitschei*) occasionally required soaking in water to induce defecation. Some individuals were provoked to strike defensively at small mice in order to elicit feeding; usually the prey was held with the fangs and eventually swallowed. Tom Madsen told me that wild *A. hispida* fed on thin-shelled terrestrial snails which were tried at Dallas Zoo but they were ignored. The only live specimens of Kenyan Mountain Viper (*M. hindii*) I have seen were at Houston and Columbus zoos. Boulenger (1915) discussed feeding in the West African Bush Viper at London Zoo and Freed (1986) from Houston Zoo discussed reproduction. In 1936, specimens of Lowland Swamp Viper were collected by Hugh Cott for London Zoo but all refused to feed. Morgan (1988) provided husbandry information on seven snakes at Transvaal Snake Park. This species produced three litters (5–7 individuals each) at Dallas Zoo and all fed well.

Night Adders (*Causus*) are poorly known from captive specimens. The late John Mehrtens had two types (*C. rhombeatus, C. resimus*) on display in Ft. Worth Zoo collection in the mid-1960s and which fed primarily on anurans (pers. comm.). The same species were kept at Columbus Zoo (E. Smith, pers. comm.) in the 1970s.

At Columbus Zoo, Goode (1979) described reproduction in the Saw-scaled Viper (*Echis colorata*) and Cherlin (1985) explored reproduction of the Iranian Saw-scaled Viper (*E. multisquamatus*) in the Tashkent Zoo. Mehrtens (1950) elaborated on keeping the Saw-scaled Viper in captivity at Ft. Worth Zoo. The late curator Mike Goode at Columbus Zoo told me that the Saw-scaled Viper attained the fourth generation at that institution; this was a significant achievement.

Russell's Vipers (*Vipera russelli,* now *Daboia russelli*) are often kept in zoo collections. Naulleau and Van Den Brule (1981) published an excellent overview on feeding, growth, moult, and venom production in captivity. Meyer-Holzapfel (1969) elaborated on reproduction at Berne Zoo. From the Frankfurt a. M. Zoo, Backhaus (1972) discussed the geographical variation of venom toxicity and antivenin efficacy in Saw-scaled and Russell's vipers.

Many European viper species are at risk. One example is the Hungarian Meadow Viper (*Vipera ursinii rakosiensis*). A Population and Habitat Viability Assessment (PHVA) was held in a workshop on 5–8 November 2001 at Budapest Zoo, Hungary. This collaborative workshop was hosted by the Budapest Zoo, Conservation Breeding Specialist Group (SSC / IUCN), and Zoo Tiergarten Schönbrunn, Vienna. The IUCN recommended the following: "Habitat protection alone is not sufficient if the expressed goal of the World Conservation Strategy, the maintenance of biotic diversity, is to be achieved. Establishment of self-sustaining captive populations and other supportive intervention will be



FIG. 4. Publications of London Zoological Society between 1860–1921 had beautiful snake illustrations such as this Green Bush Viper (*Atheris squamigera*).



FIG. 5. European Viper (*Vipera ammodytes)* from *Vorstellung allerhand Thiere…* by Johann Daniel Meyer, 1752.



FIG. 6. This illustration appears to be Asp Viper (*Vipera aspis*), a taxon native to N Italy where Ulisse Aldrovandi lived. From *Ulyssis Aldrovandi… Serpentum, et draconum historiæ libri duo. / Bartholomæus Ambrosinvs ... opvs concinnauit ... Sumptibus M.A. Bernie* ... in 1640.

needed to avoid the loss of many species, especially those at high risk." (Korsós, Z. 2002. The biology and ecology of *Vipera ursinii rakosiensis*. In *Workshop Report*, p. 61. 2002). Gravid females of this critically endangered snake were maintained and young were raised at the Zoological Garden, Budapest (Újvári et al. 2000).

Petzold (see Heichler and Murphy 2008) described courtship, pre-copulatory and copulatory behavior, combat, feeding, captive management, reproduction, longevity, and other aspects in the Viperidae, including *Vipera ammodytes* (Fig. 5), *V. aspis* (Fig. 6), *V. berus*, *V. kaznakovi*, *V. lebetina*, *V. russelli*, and *V. ursinii*. Naulleau (1971, 1984, 2007; Naulleau and Detrait 1984) discussed fertility and rearing the Asp Viper (*V. aspis*) in captivity. Petzold (1980) provided statistical data on birth weights of the Common Viper (*V. berus*; Fig. 7).

Since 1996, Jeff Ettling from Saint Louis Zoo has focused efforts on the captive management and reproduction of mountain vipers, *Montivipera*, of the Near East. In 2004, the Zoo developed its new Conservation Division, the Wildcare Institute—there are twelve different Conservation Centers focusing on endangered species and their habitats. The Center for Conservation of Near East Mountain Vipers will focus on an initiative to ensure the future of mountain vipers in the wild (Ettling 2005).

There are eight species in the mountain viper *Montivipera xanthina* complex found in southeastern Europe, Asia Minor, Armenia, and western Asia. Nilson and Andrén (2000) have identified risks. Over the past 20 years, the combination of habitat alteration, over-collection, and unnaturally high mortality resulting from human persecution has drastically reduced many mountain viper populations. Five of the eight species are now listed by the IUCN as vulnerable, endangered, or critical.

In June 2004, the Center started an inaugural study on the Armenian Viper, *M. raddei*, seriously at risk because the population has decreased 88% over the past 20 years, due largely to habitat alteration and over-collection (Ettling 2005; Ettling et al. 2013). These radio-telemetry and mark/recapture elements focus on home range size, seasonal activity patterns, habitat preferences,



Fig. 7. Many of the drawings in Bernard-Germain-Étienne de la Ville-sur-Illon, Compte de Lacepède's publications show snakes striking at prey. The Common Viper should handle the anuran prey with ease but the Horned Viper below will certainly have a difficult time swallowing its avian prey. This plate is from *Histoire naturelle deLacépède, comprenant les cétacés, les quadrupèdes ovipares, les serpents et les poissons* in 1860.



Fig. 8. Illustration of True Viper heads with horns from *Erpétologie générale by* A. M. C. Duméril, G. Bibron, and A. Duméril, 1854. Current common and scientific names are #1 Sand Viper (*Vipera ammodytes*); #2 Rhinoceros Viper (*Bitis nasicornis*); #3 possibly Sahara Sand Viper (*Cerastes vipera*); #4 Many-Horned Adder (*Bitis cornuta*); #5 Persian Horned Viper (*Pseudocerastes persicus*).

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and demography, and involve five institutions: Saint Louis Zoo, Detroit Zoological Institute, Russian Academy of Sciences, Armenia Ministry of Nature Protection, and Tula Exotarium, Russia. Studies of captive vipers have provided information on reproduction and behavior (Ettling 1996; Ettling and Marfisi 2002). Dutton and Taylor (2003) compared pre-and post-hibernation morphometry, hematology, and blood chemistry in 31 viperid snakes at the zoo.

The situation is similar in Iran in terms of vipers at risk. Kian et al. (2011, 2013) discussed captive management and reproductive biology of Latifi's Viper (*Montivipera latifii)* and Zanjan Viper (*M. albicornuta*) at Razi Institute and Tehran University. Mamet and Kudryavtsev (1996) bred Latifi's Viper at Moscow Zoo.

In Russia, Sergei V. Mamet and Sergei V. Kudryavtsev from Moscow Zoo have published on Caucasian Vipers (*Vipera ammodytes transcaucasiana* and *V. kaznakovi*) and the latter coauthored a guide for keeping venomous snakes in 1997. Bozhansky and Kudryavtsev (1986) discussed Caucasian Viper ecology and breeding in captivity. Bozhanskyi and Kudryavtsev (1982) outlined special aspects in captive maintenance of rare vipers of USSR. Khutoryansky (1968) diagnosed the cause of death of Levantine Viper (*V. lebetina turanica*) at Moscow Zoo. Kudryavtsev and Mamet (2011) reported on husbandry and reproduction on Field's Viper *Pseudocerastes persicus fieldi* and Armenian Viper (1991) at Moscow Zoo. The Levantine Viper subspecies *V. lebetina turanica* and *V. l. obtusa* reproduced at Leningrad Zoo (Igolkina 1988). At Tula Exotarium, many important articles were written on terrarium science: Orlov (1982), Orlov and Dmitriev (198), Orlov and Ryabov (1991). Other Russian papers included Pestinsky (1939), Vassiliev et al. (1997), and Zinyakova (1964, 1966) and Zinyakova et al. (1972).

At Dallas Zoo, Murphy and Barker (1980) reported on courtship and copulation of the Ottoman Viper (*Vipera xanthina*). Because the snakes were positioned next to the viewing glass, they were able to see the extrusion of hemipenes into the female's cloaca and the color changes of the organ as it became turgid. At the same zoo, Perry and Blody (1986) described courtship and reproduction in Cretan Vipers (*V. lebetina schweizeri*).

Hans-Werner Herrmann, former herpetological curator at Cologne Zoo and Aquarium in Germany, has published



FIG. 9. Bushmaster from *Los ofidios venenosos del Cauca: métodos empíricos y racionales empleados contra los accidentes producidos por la mordedura de esos reptiles,* by Evaristo García in 1896. Cauca is a Department of Colombia, located in the southwestern part of the country.

several papers on molecular phylogeny and systematics of viperine snakes (1987, 1992, 1995, 1997, Fig. 10). Susan Barnard from Zoo Atlanta and Steve Upton covered parasitism in Palestine Vipers (*V. xanthina palaestinae*) and Ottoman Viper (*V. x. xanthina*).

FEA'S VIPER (AZEMIOPINAE)

Our experiences with Fea's Viper (*Azemiops feae*) at Dallas Zoo parallel those reported by Ken Kardong (1986; pers. comm.). He provided five specimens to the Zoo which were maintained per his suggestions but these were diffident feeders. Two of the five fed on dead mice and one took a skink but refused all amphibians, fish, or lizards. These snakes were susceptible to dehydration even though they were kept on damp paper towels and were provided with drinking water. Overall, our success with the group was marginal. Orlov et al. (2002) described courtship and reproduction in this taxon; they commented that dehydration can be a serious problem. Levens et al. (2000) and Fitzgerald et al. (2008) described a Fenbendazole overdose in four snakes. Recent phylogenies suggest that this taxon is not closely related to Viperinae.

Scott Pfaff told me that a specimen at Riverbanks Zoo is now a 14-year captive and has reproduced, resulting in a single hatchling—this is almost certainly the first captive breeding for this species. He found that this species probably does not thermoregulate and does indeed prefer cool temperatures.

MOLE VIPERS (ATRACTASPIDINAE)

Corkhill et al. (1969) described the striking behavior in Mole Vipers (*Atractaspis*): "1) The snakes of the genus *Atractaspis* have an unusual degree of flexibility of the neck which, coupled with their relatively long fangs, makes it dangerous to handle them in conventional fashion by holding them just behind the head; 2) This flexibility, together with the habits of striking with one fang and with the mouth practically closed, partially twining round the object to be bitten, and clinging on, suggest an adaptation suited to the securing of a prey in constricted underground space." I can attest to the accuracy of both statements. The late Bill Haast from Miami Serpentarium told me in 1966 that he tried

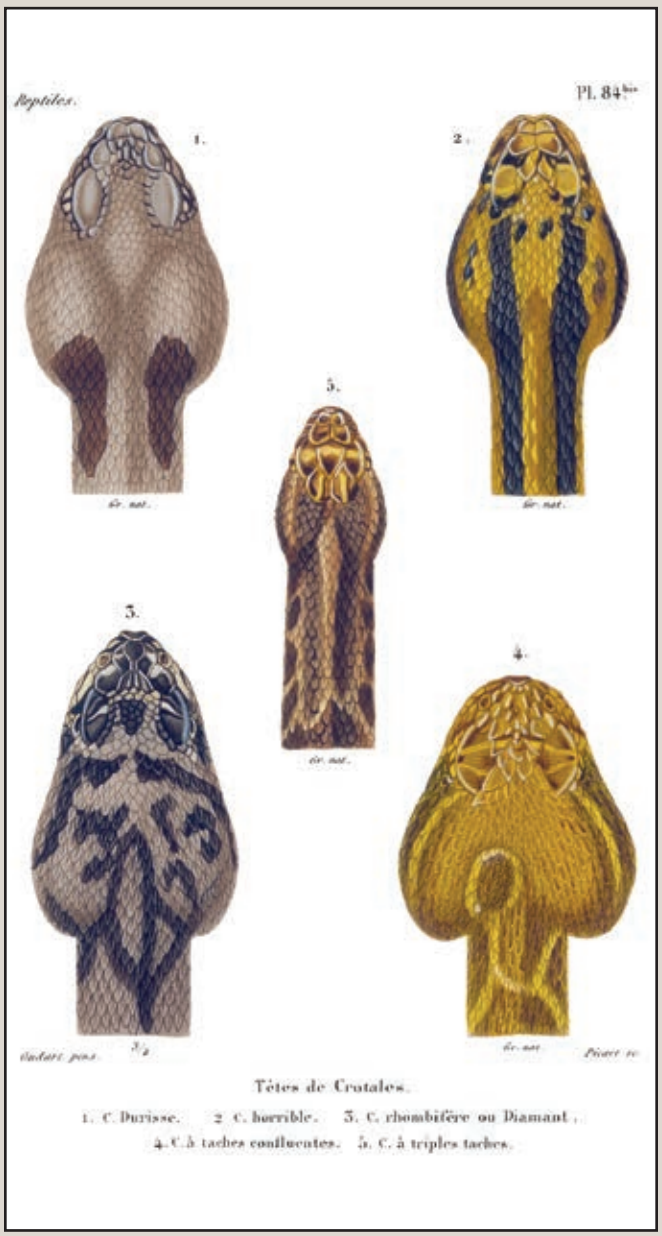


FIG. 10. Illustration of rattlesnake heads from *Erpétologie générale,* by A. M. C. Duméril, G. Bibron, and A. Duméril, 1854. Current common and scientific names are #1 Neotropical Rattlesnake (*Crotalus durissus);* #2 Timber Rattlesnake (*Crotalus horridus*); #3 Eastern Diamondback Rattlesnake (*Crotalus adamanteus*); #4 Western Diamondback Rattlesnake (*Crotalus atrox*); #5 Massasauga (*Sistrurus catenatus*).

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to control the head of two snakes by holding the neck and was bitten twice for his efforts. At Dallas Zoo, I watched a Mole Viper (*A. dahomeyensis*) spear living snake prey many times and it seemed that the mouth was not opened but prey was struck from the side; this ophidian would only accept living snakes (*Storeria, Nerodia, Thamnophis*) as prey.

PITVIPERS

In 1992, Harry W. Greene and Jonathan A. Campbell presented a grim picture about the future of pitvipers in their abstract for the book *Biology of the Pitvipers*: "Less than a dozen pitvipers

are among approximately 200 snake species previously identified as threatened or endangered worldwide, whereas we estimate that more than half of all crotaline species are now vulnerable to extinction. Taxa with small ranges, narrow habitat preferences, and/or substantial human persecution are of special concern; *Bothriechis* spp., *Crotalus polystictus, Lachesis muta,* and *Sistrurus catenatus* illustrate these issues. Certain taxa should receive special attention for biological, cultural, and/or esthetic reasons. Major goals for pitviper conservation include consideration of these animals in planning for reserves, public education, and facilitation of research on their biology." Can anyone argue that their warnings were taken seriously and the situation has dramatically improved today? I think not! Fortunately, the excellent field and captive program established by Alan Kardon at San Antonio Zoo with emphasis on Mexican pitvipers is an example of progressive thinking, but saving these species is an uphill struggle. At the International Collective Arboreal Symposium in Baltimore, Maryland (April 2013), Kardon showed aerial photographs of the extensive habitat changes wrought by humans throughout Mexico and it was staggering and sobering. Virtually all of the high-elevation ecosystems are at risk, particularly at places where members of the genus *Bothriechis* and montane rattlesnakes are found.

One of the most popular and dramatic zoo exhibits are bushmasters (*Lachesis* spp., Fig. 9). In early days, these were considered delicate captives and mortality was high. In 1918, William Beebe traveled to South America and described his encounter with a bushmaster, eventually captured alive and sent to New York Zoological Society. In 1960, the Zoo again maintained bushmasters and kept them at lower environmental temperatures, believing that this contributed to greater success in maintaining this difficult species; the snake died in 1962 (Dowling 1960, 1961, 1962). Other zoos tried to keep them during the late-1960s but results were mixed. Curator Lou Pistoia at Columbus Zoo was exasperated with the high mortality rate and told me that bushmasters could not be successfully kept in captivity. John Mehrtens was equally frustrated with the high turnover rate at Ft. Worth Zoo. When a gravid wild-caught female laid eggs, he put them in a plastic container and placed it on top of an aquatic turtle enclosure to increase humidity; a heat lamp was suspended above the vessel. Mehrtens drew a line on the floor around the tank and forbid keepers to cross that line—to do so risked termination. On his day off, the bulb was ominously dark. One foolhardy keeper crossed the sacred line to screw in a new bulb, lost his balance, fell into the tank with the eggs— which were promptly eaten by the turtles— and learned to his dismay what hell was really like on Earth. Jon Campbell started his career as assistant supervisor at this Zoo. During a visit, he asked if I had ever seen the Black-headed Bushmaster (*Lachesis melanocephala*) and I replied in the negative. He said that some were placid but others were aggressive and proceeded to remove a large one from its enclosure for a closer look. Naturally, it was one of the latter ones and it proceeded to chase us around the cramped rear section; after much drama, Jon was able to secure the snake but the experience was unsettling.

When I was young, I read the fascinating account in L. N. Wood's book about Raymond L. Ditmars and his experience with a bushmaster: "His first look took no more than a couple of seconds and terminated instantly as he realized that the reptile, forming a striking loop with the whole front half of its body, was deliberately pouring itself toward him. Backing inadvertently into one of the chairs, Ray thrust his crook against the snake, by now well out of its cage.

He saw at once, with alarm, that the reptile had a dexterous way of flowing over the outthrust staff. Faster than he could push it away, it gained ground. There was nothing for him to do but continue to back up. He knew that bushmasters were highly venomous, but no one had told him that they were aggressive and fearless, too.

As he backed warily around the room, Ray's mind worked busily. How was he to get out of this worse-than-silly, this dangerous, situation?

'I can't keep on backing around the room the rest of the night,' Ray told himself impatiently. He wasn't exactly frightened, but this certainly was not a situation he would have chosen.

Just then his eye fell on the broom standing, conveniently, within reach of his staff. He gave it a hard jerk, kicked it behind him, farther from the advancing bushmaster, and picked it up. The snake just then was surging, loops reared, between the rungs of a chair. Ray thrust the broom straight in its face.

Surprised by the attack, the serpent paused and pulled in its head. Coiling, it rattled its tail against the floor. Ray followed up his advantage with several more quick pokes. The snake decided, suddenly, that it had had enough. It turned and made for the tier of cages. Guiding it with the pole, Ray directed it into its own cage and slid shut the panel."

I vowed that my passion would be satisfied when someday I could work with them. In the late 1960s, when a large wild-caught snake (*Lachesis stenophrys*) from Costa Rica arrived at Dallas Zoo, my dream was complete. I noticed a considerable bulge in its body; clearly it had swallowed a large prey item. About a week later, it expelled a compacted bolus of large black and white spines, later identified as a prehensile-tailed porcupine (genus *Coendou*). To this day, I cannot imagine how the snake was able to strike without being impaled by spines or why the snake's entire GI tract was not shredded. To appreciate how dangerous an encounter can be with this porcupine, check out the result of a predation attempt by Schneider's Smooth-fronted Caiman (HR 2013, 44:135).

Because bushmasters were such a challenge, we began to add them to the Dallas Zoo collection, mostly *L. muta*. We did not keep them cool and they thrived but did not reproduce in spite of many attempts by us to induce breeding for many years. Then, when they were moved into a large room, males began to trail females and we observed courtship, copulation, and oviposition. Eggs were artificially incubated and the neonates were hardy captives (Boyer et al. 1989). Later, we studied predatory behavior (Chiszar et al. 1989; Boyer et al. 1995) and saw that these snakes covered their eyes and pits by moving facial skin while holding rodent prey, as described by Chiszar and Radcliffe (1989). Although feeding strikes were impressive, I do not remember a single instance where the snakes struck aggressively or defensively at us.

Greenhall (1936) described care at New York Zoological Park. Burchfield (1975) described the history of captive *L. muta* and *L. stenophrys* at Gladys Porter Zoo in Brownsville, Texas. The first captive hatching of *L. muta* from a wild-caught female occurred at Steinhart Aquarium in San Francisco, California (Switak 1969).

I've always liked the look of rattlesnakes (Fig. 10). When I started in the zoo business, we began to add species to the Dallas Zoo collection. When my friends Barry Armstrong and Jonathan Campbell started traveling to Mexico and Central America each spring and summer in the 1970s, they brought back many living rattlesnakes and kindly placed them on loan to us. At one time, we had every species from mainland Mexico except the Autlán



Fig. 11. Cascabel Rattlesnake from *Buffon's Natural History Abridged…Vol. II.* 1821.

Long-tailed Rattlesnake (*Crotalus lannomi*), mostly collected by this pair of superb field collectors. Herpetologists Edward H. Taylor, Hobart M. Smith, Sherman Minton, Charles Bogert, Roger Conant, and Howard Gloyd told me that even though they had worked in Mexico for years, they had never seen such rattlesnake diversity and were amazed by the assemblage. Gloyd traveled to Dallas virtually every year to visit his family and made a point of stopping in to see what new rattlesnakes were in the collection; although he had published a monograph on them in 1940, he did not have many opportunities to see live specimens. I remember one day when he saw his first Mexican Lance-headed Rattlesnakes (*Crotalus polystictus*), a taxon so rare that it was not pictured in Klauber's monumental work on rattlesnakes in 1956. He was stunned by their beauty and spent many minutes gazing at them with admiration. Although he and Carl Kauffeld described the Totonacan Rattlesnake (*Crotalus durissus totonacus*) in 1940, he told me that he had never seen a living example until his visit. Those were heady days, likely to never be repeated.

Thanks to the generosity of Armstrong and Campbell, we were able to study these rattlesnakes at the Zoo (Armstrong and Murphy 1979; Murphy and Armstrong 1978). They also collected many other Neotropical pitvipers (Murphy 1981; Murphy and Campbell 1987; Radcliffe and Murphy 1983; Murphy and Mitchell 1984). Many of these snakes are pictured in color in *The Venomous Reptiles of Latin America* and *The Venomous Reptiles of the Western Hemisphere* by Jonathan A. Campbell and William W. Lamar. We invited a number of academic colleagues to join us to document behaviors and improve captive maintenance in these snakes: Jonathan Campbell, Charles Carpenter, James Gillingham, David Chiszar, Hobart Smith, and Charles Radcliffe (see literature citations below).

Grace Olive Wiley (1929) may have been the first person to breed rattlesnakes in captivity, at least according to a letter sent to her by Raymond Ditmars. At St. Louis Zoo, Hoessle (1963) observed a breeding pair of Western Diamondback Rattlesnakes (*Crotalus atrox*). Petzold (1963) noted reproduction and development in this species and Cottonmouth Moccasin (*Agkistrodon p. piscivorus*) at the Berlin Tierpark. Gillingham et al. (1983) described courtship, male combat, and dominance at Dallas Zoo. Murphy and Shadduck (1976) reproduced the Eastern Diamondback Rattlesnake (*C. adamanteus*) with a two-headed neonate at Dallas Zoo. Burchfield (1975) described experiences with this species and Antonio and Barker (1983) followed by documenting phenotypic aberrancies. Tryon and Radcliffe (1977) presented reproductive data from captive Lower California Rattlesnakes (*C. enyo*) at Fort Worth Zoo and Denver Zoological Gardens. Tryon (1978) bred a pair of captive Arizona Ridge-nosed Rattlesnakes (*C. willardi*). Ramsay et al. (1996) diagnosed *Salmonella arizona* osteomyelitis in a colony of these snakes at Knoxville Zoo. Carl et al. (1982) documented reproduction in captive Aruba Island Rattlesnakes (*C. unicolor*) at Ft. Worth and Houston Zoos. At Houston Zoo, Peterson (1982) bred Speckled and Neotropical Rattlesnakes (*Crotalus m. mitchelli* and *Crotalus durissus*) (Fig. 11). At Dallas Zoo, Murphy et al. (1979) provided information on the reproductive biology of the Uracoan Rattlesnake (*C. vegrandis*). Interestingly, Loomis and Smith (1987) found that an Aruba Island Rattlesnake (*C. unicolor*) was fertile following caesarean section. Tremper (1980) bred the Santa Catalina Island Rattlesnake (*C. catalinensis*) at Roeding Park Zoo. Carpenter et al. (1976) described male combat in the Rock Rattlesnake (*C. lepidus*) at Dallas Zoo. We produced a number of broods of the Speckled Rattlesnake (*C. m. mitchelli*) at Dallas Zoo. When a BBC film crew asked if we had males that would combat for a David Attenborough nature special, we guaranteed that our young snakes would do so reliably and so they did; we were nervous because they brought all of their equipment from the UK. We carried the snakes in a trashcan to a natural setting and dumped them on the ground; surprisingly, they did not try to escape but locked up immediately. The crew shot, in my view, the best snake combat sequence ever recorded on film. They also filmed open-mouth threat postures in the Mexican Black-tailed Rattlesnake (*C. molossus nigrescens*). From San Diego Zoo, Brown et al. (2008) studied spatial ecology, habitat use, and survivorship of resident and translocated Red Diamond Rattlesnakes (*C. ruber*) and Lemm (2006) produced a field guide that included the rattlesnakes of San Diego County. McCrystal and Ivanyi (2008) discussed translocation of venomous reptiles in the Southwest at Arizona-Sonora Desert Museum. The Museum produced a book entitled *A Natural History of the Sonoran Desert* in 2000 that included species accounts by the staff. This zoo holds regular demonstrations with living venomous reptiles for the visitor which have proven to be very popular (Johnson 2007).

Second-generation births of the Neotropical Rattlesnake (*Crotalus durissus terrificus*) occurred in Dresden and Leipzig (Dathe 1951). Mike Goode (pers. comm.) said that Columbus Zoo bred *C. adamanteus* for three generations. Reports of hybrids from San Diego Zoo include *C. scutulatus* × *C. durissus unicolor* and *C. viridis helleri* × *C. r. ruber* (Perkins 1951; Klauber

1956). The Arizona Sonora Desert Museum (1979 Intern. Zoo News 26 (7/8): 42) reported a hybrid from *Crotalus m. molossus* × *C. viridis cerberus*.

During February 1977, two Dallas Zoo herpetologists were privileged to see an extraordinary encounter between a male Totonacan Rattlesnake (*Crotalus totonacus*), measuring 1.7 m in total length, and an adult Ocelot (*Felis pardalis*) in northeastern Mexico, as described in Armstrong and Murphy (1979), "The animals were below a thick canopy of thorn scrub in early afternoon and the ground beneath the canopy supported little vegetation. A distance of 1.3 m separated the combatants, and the snake was in a defensive posture typical of *C. durissus*, and rattling vigorously. The ocelot remained immobile with the right foreleg raised. When the snake was extended fully with its mouth open after a strike, the ocelot raked with its claws within the snake's mouth, then withdrew the paw before the snake could close its mouth. Later examination of the oral cavity and throat of the snake revealed a number of lacerations in the soft tissue and masseter muscles which were inflicted by the ocelot, but the interstitial skin and scales exterior to the lacerations were not affected. Lacerations were found on the dorsal aspect of the head and neck, but not near the punctures within the snake's mouth or throat. The snake's lower jaw was out of alignment and the mandibular bone was visible when the mouth was open. A large female *C. d. totonacus* was located 15 minutes later, within 12 m of the male. The male rattlesnake was treated for its injuries, but sucumbed about two weeks later (KU 174824). The snake regurgitated a large number of ascarids during the two weeks prior to its death."

At Metro Toronto Zoo, Johnson (1988) observed combat and courtship in the Eastern Massasauga (*Sistrurus c. catenatus*) by comparing field and captive behavior. Lindsey (1979) documented combat behavior in the Dusky Pygmy Rattlesnake (*S. miliarius barbouri*) at Monroe Zoo in Louisiana.

At Smithsonian National Zoological Park, Audubon Zoo, and San Diego Zoo, Chiszar et al. (1985) discovered that duration of strike-induced chemosensory searching (SICS) was not compromised by feeding dead prey to long-time captive snakes; this was an important finding if reintroduction is being considered.

Patrick Burchfield (1982), Gladys Porter Zoo, wrote a seminal paper on the natural history of Taylor's Cantil (*Agkistrodon bilineatus taylori*). Peters (1979) had two generations of the Cantil (*A. bilineatus*) at Taronga Zoo in Sydney, Australia. In 2004, five Taylor's Cantils were born at San Antonio Zoo; today, this taxon is part of a long-term cooperative US zoo breeding program. Allen (1949) described caudal luring in the juvenile Cantil (*A. bilineatus*). Water Moccasins or Cottonmouths (*A. piscivorus*) bred at London Zoo between 1860 and 1861 (Coote 2001). Conant (1933) reported on three generations of Cottonmouths—Moscow Zoo had two (Kudryavtsev et al. 1986) (Fig. 12). The Trans-Pecos Copperhead *(A. contortrix pictigaster*) fed on the Texas Long-nosed Snake and Cliff Swallow (McCrystal and Green 1986).

Early reports of some Neotropical pitvipers were listed as members of the genus *Bothrops*, now comprised of a number of different genera (see Campbell and Lamar 2004 for changes). A wild-caught Common Lancehead (*Bothrops atrox*) fasted for 18 months at Brookfield Zoo (Pawley 1969). The Gladys Porter Zoo was the first to breed this species in the US and Burchfield (1975) provided information for raising neonates. At Dallas Zoo, nine types were maintained and successfully reproduced, including Eyelash Viper (*Bothriechis schlegelii*), Urutu (*Bothrops alternatus*), Coffee Palm Viper (*Bothriechis lateralis*), Jararaca Pintada (*Bothrops neuwiedi*), Black-spectacled Palm Pitviper (*Bothriechis n. nigroviridis),*Yellow-blotched Palm Pitviper (*B. nigroviridis aurifer*), Mexican Pitviper (*Ophryacus melanurus*), Jumping Viper (*Atropoides nummifer*), Mexican Horned Pitviper (*Ophryacus undulatus*), and Godman's Montane Pitviper (*Cerrophidion godmani*) (Murphy and Mitchell 1984). Dunn's Pitviper (*Porthidium dunni*) reproduced at San Antonio Zoo in 2005. Roberts and Hammack (1995) documented reproduction of the Speckled Forest-pitviper (*Bothriopsis taeniata*) at Dallas Zoo.



FIG. 12. John Edwards Holbrook published *North American Herpetology* beginning in 1836, covering all herps found east of the Mississippi River at that time. Shown is Cottonmouth (*Agkistrodon piscivorus*).

Leloup (1975) observed reproduction of Brazilian Lancehead (*Bothrops moojeni*). Kudryavtsev (1985) described the reproductive biology of the Malayan Pitviper (*Calloselasma rhodostoma*) and the Brazilian Lancehead Pitviper (*B. moojeni*) (Kudryavtsev, 1986) in Moscow Zoo. Greene and Campbell (1972) provided notes on the use of caudal lures by arboreal green pit vipers and we saw two species (*Bothriechis bicolor, B. lateralis*) do so at Dallas Zoo. Antonio (1980) described courtship and copulation in Eyelash Vipers (*Bothriechis schlegeli)*. A contribution from Instituto Butantan compared ecological and phylogenetic correlates of feeding habits in Neotropical pitvipers of the genus *Bothrops* (Martins et al. 2002).



FIG. 13. Habu (*Trimeresurus flavoviridis*, now *Protobothrops flavoviridis*) in *Senchufu* by Tanshu Kurimoto in 1811.



FIG. 14. Illustration of Gila Monster from *Reptiles of the boundary, 1859 / / by Spencer F. Baird ... with notes by the naturalists of the Survey*…The Gila Monster first became known to science in this publication where it was called *Heloderma horridum* and its range was Sonora. Ten years later, E. D. Cope described the species as *Heloderma suspectum*. He chose the epithet "*suspectum*" because he "suspected" it was venomous.

At Dallas Zoo, Card (1994) recorded the natural history and husbandry of the Temple Viper (*Tropidolaemus wagleri*) and Boyer and Roberts (1998) reported on the predatory strike. At the Zoo, an adult lived in an exhibit terrarium, always resting on the same branch. A spider built a web from the upper corner and attached a strand to one of the snake's scales. Each morning, I checked the viper for slightly over six weeks and the web remained unbroken. I surmised that either the spider re-attached the strand in precisely the same spot or the snake did not move; I prefer the latter parsimonious explanation. A Habu (*Protobothrops flavoviridis*) arrived at Dallas Zoo on 15 January 1968 and died on 6 October 1995 (27 years, 8 months, and 21 days) which is beyond the longevity record listed by Snider and Bowler (1992). This snake was always nervous and had to be removed from its exhibit enclosure and kept in the rear section because it discontinued feeding. In fact, the snake was so defensive that the glass-fronted fiberglass cage (with a rear door opening) had to be turned toward the wall so that the human caretakers were not visible to this ophidian (Fig. 13). At Moscow Zoo, Kudryavtsev and Frolov (1984) bred three generations and attempted sex determination of the Bamboo Pit Viper (*Trimeresurus gramineus*). In 2005, 22 Sumatran Pitvipers (*T. sumatranus*) hatched at the Denver Zoo. The Giant or Mang Pitviper (*Ermia* [= *Protobothrops*] *mangshanensis*) reproduced at San Diego Zoo and Gumprecht et al. (2002) provided information on biology, husbandry, and breeding.

There are a growing number of papers on parthenogenesis (asexual reproduction by bisexual species) in pitvipers. Schuett et al. (1997) described this in the Timber Rattlesnake (*Crotalus h. horridus*) and Aruba Island Rattlesnake (*C. unicolor*); Booth and Schuett (2011) provided a table listing reported cases of Long Term Sperm Storage (LTSS) in female pitvipers and other venomous snakes that are suspected to be the result of Facultative Parthenogenesis (FP): Cottonmouth (*Agkistrodon piscivorus*), Copperhead (*A. contortrix*), Mamushi (*Gloydius blomhoffiii*), Long-nosed Tree Snake (*Ahaetulla nasuta*), Mangrove Snake (*Boiga dendrophila*), and Banded Cat-eyed Snake (*Leptodeira annulata*). In this paper, the Eastern Diamondback Rattlesnake (*Crotalus adamanteus*) was added. FP was thought to be an artifact of captivity but recent information has shown that wild-caught Copperheads and Cottonmouths may reproduce in this manner (Booth et al. 2012). Curator Lou Pistoia from Columbus Zoo told me many years ago that a former keeper collected a baby Bamboo Pitviper (*Trimeresurus stejnegeri*) while stationed in Viet Nam during the war, and which was later sent to Pistoia. This snake lived in isolation in a small terrarium and when it matured, gave birth to a living neonate. Naively, I suggested that this phenomenon be published; he countered by saying that this information did not need to be shared with unworthy colleagues.

VENOMOUS LIZARDS

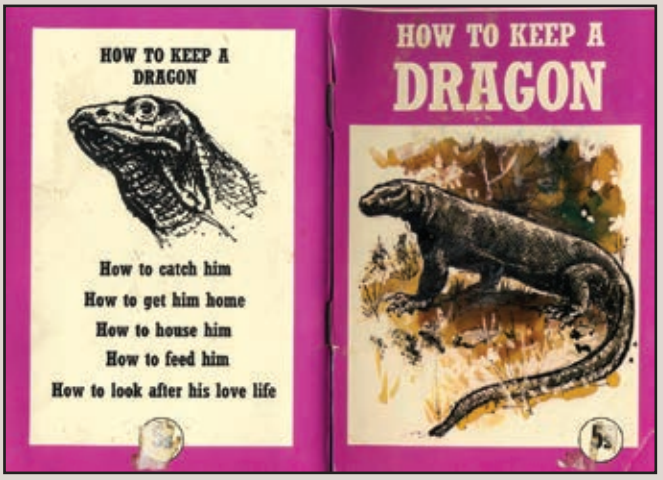
Gila Monsters (Fig. 14) and Beaded Lizards (Fig. 15) have always been prominent zoo exhibits. At Smithsonian National Zoological Park, Demeter (1986) described combat behavior in the Gila Monster (*Heloderma suspectum cinctum*). This behavior is pictured in *Grzimek's Animal Life Encyclopedia* (Hutchins et al. 2003; Beck 2005). At Dallas Zoo, Hartdegen and Chiszar (2001) reported on discrimination of prey-derived chemical cues by the Gila Monster and lack of effect of a putative masking odor. At the same zoo, Garrett et al. (1996) compared chemosensory behavior and prey trail-following in *H. suspectum*.

Anstandig (1983) reported on the breeding and rearing of the Mexican Beaded Lizard (*Heloderma horridum*) and Connors (1993) described the status of the breeding program at the Detroit Zoo, now Detroit Zoological Institute. Honegger (1998) outlined upkeep and breeding in the Zürich Zoo. Peterson (1982) from Houston Zoo and Grow and Branham (1996) at Oklahoma City Zoo reproduced the Gila Monster. Lawler and Wintin (1987) described captive management and propagation of the Reticulated Gila Monster.

Wright et al. (1995) introduced ultrasonographic sexing of helodermatid lizards. Morris and Alberts (1998) and Morris and Henderson (1998) used two-dimensional ultrasound imaging at San Diego Zoo and Lovich and Beaman (2007) chronicled the history of Gila Monster records from California with comments on distribution. Card and Mehaffey (1994) used radiographs to sex Gila Monsters. Espinosa et al. (1996) described a cytogenetic technique for karyotyping Beaded Lizards in Guadalajara Zoo. Morris and Henderson (1998) determined gender in Gila



FIG. 15. Albert Günther was hired at the British Museum in 1857. He was the founder of the *Zoological Record*. This illustration of Beaded Lizard (*Heloderma horridum*, now *H. h. horridum*) is from *Biologia Centrali Americana: Reptilia and Bathrachia* in 1885–1902.



COURTESY OF FRANK AND KATE SLAVENS

FIG. 16. A handy pocket guide for keeping dragons in the home.

Monsters and Beaded Lizards by ultrasound imaging of the ventral tail at San Diego Zoo. *Heloderma h. charlesbogerti* from the Motagua Valley in Guatemala is critically endangered. When Jon Campbell and I visited the site years ago, it was clear that human-activities would soon place these lizards at risk. This lizard is being bred at Zoo Atlanta; Campbell provided all of the founders. Daniel Beck (2005) has written an excellent book on this group which has relevance for zoo workers.

Jack Cover from National Aquarium in Baltimore was bitten by a Beaded Lizard and sent this account to me (pers. comm., 13 July 2013): "It was late in the day. The guy I worked for at the venom supply company in Baltimore was gone in the afternoon so I was alone—I violated the first rule of working with venomous reptiles—never work with them when alone! I was feeding mice to this lizard but could not find the feeding forceps so I proceeded by feeding him dead mice held by the tip of their tails. The room I was in had a wall phone. The moment the beaded lizard started to lunge at the mouse that phone rang and I looked away to the phone. The lizard went past the mouse and on to my hand—would not let go because he thought he had a mouse in his mouth. Trying to pry the mouth open only encouraged him to clamp down even harder. I walked over to a sink and ran cold water over him (could not do the hot water treatment)—still would not let go. I finally placed him on the floor and when his body contacted the floor he felt secure and released me. Washed out the wound in an attempt to wash out venom. Called the guy I worked for and he called the snake bite doctor at Union Memorial Hospital. I felt no symptoms at this point so I decided to drive to the hospital—second mistake/poor decision. Stuck in rush hour traffic—started to feel a tremendous weight on my chest and systemic symptoms, heart racing. I pulled up in front of my friend's house on the way and got his wife to drive me the rest of the way. Got worse, vomiting and had to be carried into the hospital upon arrival, could not walk. Doctor gave me epinephrine which seemed to clear the symptoms of the serotonin. Went from thinking I was about to die to a quick elimination of all symptoms. What a hands-on experience with the wonders of venom and biochemistry… As an aside, a friend found a Gila Monster nest and eggs in the wild and got very ill from a rodent virus that he got from digging up the nest." At National Zoo, we keep a bottle of the mouthwash Listerine Cool Mint Antiseptic© on hand to spray into the mouth of either species in case they latch on to a keeper's hand; the liquid spray causes them to release their grip immediately.

KOMODO DRAGONS—WHY HERE?

Fry et al. (2009) published a provocative paper from which I quote: "Our multidisciplinary analyses paint a portrait of a complex and sophisticated tooth/venom combined-arsenal killing apparatus in *V. komodoensis* and its extinct close relative *V. priscus*. Thus, despite a relatively weak skull and low bite force, we suggest that the combination of highly and very specifically optimized cranial and dental architecture, together with a capacity to deliver a range of powerful toxins, minimizes prey contact time and allows this versatile predator to access a wide range of prey including large taxa. These results indicate that *V. priscus* was the largest venomous animal to have ever lived." Some researchers urged caution until additional evidence is forthcoming that dragons are venomous (see Weinstein et al. 2012; Weinstein et al. 2013). I recognize that scientific conclusions are provisional and may be subject to change—I am taking the liberty of including this taxon in my paper on venomous reptiles because dragons are kept in zoos and aquariums; these lizards remain one of the most popular for visitors.

Varanids have fascinated herpetologists and herpetoculturists (Fig. 16) for centuries but none more so than the giant of them all—the Komodo Dragon (*Varanus komodoensis*)! Described in 1912 by the Dutchman Peter A. Ouwens, little was

COURTESY OF KRAIG ADLER.



Fig. 17. Photograph by F. W. Wood of Sumbawa standing next to two-year-old child at London Zoo from Joan Procter's article "Dragons that are alive to-day," published in *Wonders of Animal Life* in 1928–1929.

known about this lizard for the next 60 years. Most specimens brought into captivity lived relatively short lives (Murphy and Walsh 2006). The largest one was a male that measured slightly over ten feet at St. Louis Zoo.

Curator of reptiles Joan Beauchamp Procter from London Zoo found that their dragon was unusually tame as discussed in her article "Dragons that are alive to-day," published in *Wonders of Animal Life* in 1928–1929: "The dragon, whose name is Sumbawa, walked around a very long table, and without paying attention to the audience ate a large fowl, several eggs, and a pigeon from her hand, allowing itself to be scratched and patted even when swallowing the fowl with enormous gulps, treatment which even dogs will not always permit." and "She [at death proved to be a male] would tear a pig to pieces but can be trusted with children." (Fig. 17). Procter continued, "The question of the ferocity of these lizards is, perhaps, the most misunderstood of all. All the lizards of the genus *Varanus* are savage, predatory, and highly strung, and they use their teeth, claws and slashing tails with great effect, as I have personal cause to know. At the Zoo we consider any large monitor more dangerous to deal with than a crocodile twice its size. But, allowing for this, *V. komodoensis* is the gentlest, most intelligent, and most tractable of them all. This is comparing them with specimens only half their weight of species such as *niloticus, albigularis, bengalensis, salvator, nebulosus, varius*, and so on. It is quite true that they are very nervous, and also that they could no doubt kill one if they wished, or give a terrible bite when taking food from the hand greedily, but there is no vice in them." Sumbawa was the host at children's tea-parties and was perfectly tame with all the guests. This lizard accompanied Procter on strolls through the Zoo during her inspections, ". . . investigating everything which might be of interest." Amazingly, this lizard responded to the voice of its keeper.

When I visited NZP in 1995, biologist Trooper Walsh asked if I had ever seen a reptile play. I told him that animal play was a controversial issue and many researchers felt that reptiles were just too dumb to do so. He entered an enclosure with a young female dragon named Kraken, approximately 2.5 m in total length and hatched at the Zoo three years earlier. Kraken often exhibited play-like behavior—playing tug of war with a plastic cup, removing pieces of cloth and scarves or notebook from his pocket, scraping his shoes with her forearm, and interacting with empty cardboard boxes. Kraken carried Frisbees, shoes, children's plastic toy action figures, and other objects around in its mouth. Even more remarkably, the lizard stood on its hind legs, directed tongue flicks to Walsh's face, rested its head on his shoulder, and closed its eyes. This lizard stuck its head into a plastic bucket, raised its anterior trunk so that the container covered its head and walked around the exhibit. When Walsh whistled, Kraken turned its head toward the source of the sound. Kraken could discriminate between prey and non-prey. I was flabbergasted and immediately called my friends Gordon Burghardt, the late David Chiszar, and Michael Hutchins and asked if they wanted to do a behavioral inventory and quantitative analysis of these stunning behaviors—see Burghardt et al. (2002). I concluded that there was virtually nothing that a dragon would do that was surprising, other than speaking in a foreign tongue. Trooper and I decided that a lizard that special deserved its own book so we invited our friends Colomba de La Panouse from Thoiry Zoo near Paris and Claudio Ciofi to join us to update Walter Auffenberg's earlier work, *Behavioral Ecology of the Komodo Dragon*, published in 1981. Hence the genesis of our book, *Komodo Dragons: Biology and Conservation*, published in 2002.

Walsh et al. (1993) described history, husbandry, and breeding at Smithsonian National Zoological Park. Pether and Visser (2007) described the first breeding in Europe. The next year, Sunter outlined management and reproduction at London Zoo. Visser et al. (2009) documented the third captive generation at Rotterdam Zoo. Merchant et al. (2012) characterized serum complement activity from specimens at Houston and San Antonio Zoos. Aerobic and anaerobic oral bacteriology of 16 captive dragons at Los Angeles, Honolulu, and Houston zoos was described (Goldstein 2013).

Another surprising finding was that dragons are parthenogenic (Watts et al. 2006). Two females at Chester Zoo and London Zoo produced offspring without male fertilization. Genetic fingerprinting identified parthenogenetic offspring produced by the lizards: "This reproductive plasticity indicates that female Komodo dragons may switch between asexual and sexual reproduction, depending on the availability of a mate—a finding that has implications for the breeding of this threatened species in captivity. Most zoos keep only females, with males being moved between zoos for mating, but perhaps they should be kept together to avoid triggering parthenogenesis and thereby decreasing genetic diversity."

There are many relevant papers discussing exhibition, physiology, and captive maintenance (Aresté 2010; Boyer and Boyer 1997; Boyer et al. 1997; Condie and Monseur 1997; Gillespie et al. 2000; Gyimesi and Burns 2002; Horn 2004; Horn and Visser 1989, 1997; Jones 1965; Lemm et al. 2004; Mendyk 2012; Mendyk et al. 2012; Nijboer et al. 2003; Velensky 2007; Walsh et al. 2004; Wickramanayake et al. 1999; Wiechmann 2012). A wonderful and informative contribution for varanophiles is *Biawak—Journal of Varanid Biology and Husbandry*, an on-line journal edited by Robert Mendyk.

Walsh et al. (1999) discovered that the thermal biology of captive and free ranging wild Komodo Dragons differs, suggesting that captivity is altering thermoregulatory behaviors. There is a strong underlying message here—Komodo Dragons are far more complex than we ever imagined and we may be well be giving them a rather sterile environment that suppresses their normal behaviors and way of life in our zoos and aquariums. The message is that animals in zoos, especially complex ones like dragons, need complex environments that match their abilities.

Conclusion

Zoos and aquariums exhibit many rare species, but sustain few for long periods. Demanding genetic, demographic, and behavioral requirements are a part of the sustainability challenge, and historical zoo goals and limiting animal management objectives are another, but they have been overtaken by worldwide wildlife population contraction and endangerment. New policies are essential for zoo continuance and, if vanishing species are to be helped by zoo propagation, they must be given priority.

However, zoos have little animal carrying capacity and propagation must be much more sharply focused. In addition, it is becoming urgent that zoos help to support parks and reserves and, where possible, manage some especially endangered species mutually with parks.

--William G. Conway (2011)

In the mid-1960s when I entered the zoo profession, there was little discussion about conservation. We chose reptiles and amphibians for the collection, mostly because we liked them, they demonstrated interesting behaviors, and there were plenty of different ones available (see Murphy and McCloud 2010 for examples). Many of our efforts centered on keeping them alive and so we almost never accumulated breeding groups—we could barely sex our animals, much less breed them. Oh, how the world has changed! Today, anyone who does not believe that biodiversity is disappearing at an unprecedented rate must have been living in a hermetically-sealed box for the last several decades. The evidence is overwhelming and the conservation literature is filled with papers documenting this loss and reasons contributing to this wholesale disappearance (e.g., Blaustein and Wake 1990; Blaustein et al. 1994; Brooks et al. 2002; Costello et al. 2013; Gibbons et al. 2000; Lips 2013; Mendelson et al. 2006; Pimm and Raven 2000; Purvis et al. 2000; Rohr and Palmer 2013; Wake 2008; Wake and Vredenburg 2008). This situation is so global in scope—requiring dramatic interventions—that when Ronald R. Swaisgood and James K. Sheppard from San Diego Zoo attended the Society for Conservation Biology meeting in 2009 in Beijing, they warned that most attendees were feeling so hopeless— after hearing each paper more gloomy and depressing than the last—that any positive turn-around was questionable and a continuing culture of despair threatened conservation biology. The usual mantra from the younger people is "What's the use?" These authors suggest that all is not lost and I certainly hope that they are right. I know many biologists and virtually all are pessimistic. Some are now calling themselves "Extinction Biologists," a chilling appellation indeed.

Let me count the ways that some of my herpetological friends and colleagues are skeptical about the long-term success of our *ex situ* zoo conservation projects. Ecologists and evolutionary biologists tell me that extinction is part of the natural mosaic—I need to deal with it, get over the loss of biodiversity and give up intervening—I should just trim my fingernails indifferently and watch it happen. Academic and museum scientists tell me that successful reintroduction is unlikely since there are virtually no suitable places likely to be left after man has intruded into the habitats. Even if some relatively pristine protected areas can be found, the bureaucracy of getting permission to release captive-bred offspring is daunting. Besides that, our captive animals have been shaped in a negative way by becoming domesticated, as pointed out by the late Henry Fitch in 1980. There are few careful studies that assess the competence of our propagules. My colleagues ask me that if our captive animals are competent, then why do we need to resort to procedures like assisted reproduction? The possibility of introducing infectious disease harbored by captive animals is always a concern. Some conservation biologists tell me that we should produce as many animals as possible, related and unrelated, dump them into a secure place and let natural selection weed out the unfit. They point out that genetic diversity is not the only measure of success for survival. Others say that we should not bother with captive assurance colonies at all but rather spend our money buying land focused on endemic hotspots and hiring armed guards to protect them. A few say we should only set up breeding colonies in countries of origin. Some of my fellow zoo professionals say that many captive colonies have proven to be wasteful in terms of resources and unsustainable. They point out that some species coordinators take a long period of time to send recommendations to minimize inbreeding depression, that others do not send updated information or respond to the recommended pairings, that shipping costs are skyrocketing, paperwork to transfer animals between zoos is dramatically increasing, and there are not enough founders to sustain many populations over the long haul. Although we may try to deal with the founder issue, many countries are loathe to approve sending animals collected from the wild to zoos and so the requisite paperwork needed to do animal shipments is not issued. Registrars have witnessed a dramatic change in that fewer live animals are shipped now and requests for shipping biological materials have increased exponentially. Is it any wonder that zoo biologists are uncertain about their future role in conservation, especially when criticism and suggestions for improvement—often contradictory—comes from many different directions?

Card et al. (1998) asked an important question—does zoo herpetology have a future? Do we want to be major players in conservation and, if so, where should we marshal our very limited resources of time, space, and money to protect animals at risk? At American Association of Zoos and Aquariums (AZA) meetings in the herp Taxon Advisory Group (TAG) sessions, the reality of putting breeding plans in place to cover amphibians and reptiles in danger of extinction is staggering—there are simply too many species in jeopardy and not enough space in captivity. When I talk with zoo people working with endangered mammals, birds, fishes and invertebrates, it is clear that their experiences parallel ours. We are fighting with each other for a bigger piece of the conservation pie (and that pie is shrinking). Which animal is more important to save—Asian Elephants or Aruba Island Rattlesnakes? And most crucially, is there a realistic chance of success? Are our assurance colonies going to be nothing more than assisted living complexes? If assurance colonies are the end point, then why do we bother? Perhaps the programs and colonies exist only to have animals available for our institutions in the future without the slightest hope of reintroducing them? If this is our purpose, we should say so and not advance the notion that this is conservation. How about a middle ground where we do the assurance colonies with the best outcome being reintroduction and the worst being only in zoos and the middle being 'should conditions in the wild merit it, animals would be available for reintroduction.'

I am confused about all the talk about reintroduction espoused by the zoo community. If a taxon is at risk in the wild, the prime reason seems to be that human activities have changed its living space in some fashion. There are many examples: strip-mining, mountaintop removal, introduction of invasive species,

PHOTO COURTESY OF JONATHAN A. CAMPBELL



FIG. 18. Art Lopez, Jerry Rutledge, and the incomparable Barry Armstrong (left to right) on a collecting trip to Mexico in 1974.

PHOTO COURTESY OF WILLIAM W. LAMAR/GREENTRACKS

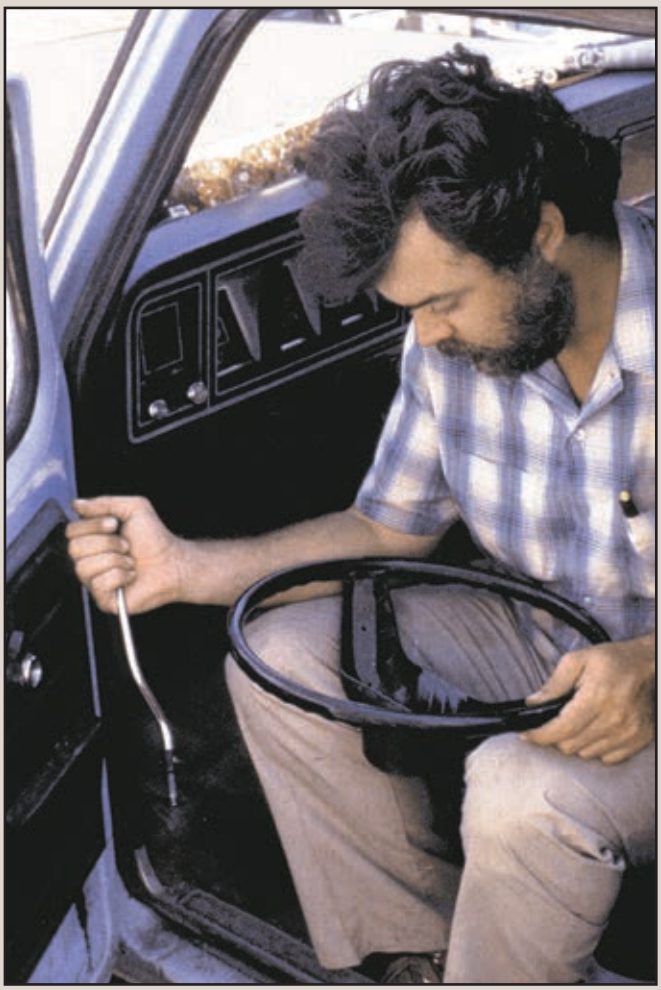


FIG. 19. Jonathan A. Campbell surveying a setback on a collecting trip at Comitan, Chiapas, Mexico. The steering wheel and gear shift fell off as they were driving on a treacherous mountain road in Chiapas. During another trip traveling through Mexico City, Campbell and Barry Armstrong were given a ticket for having a pick-up truck that was too dirty—they were livid at this blatant shakedown. This truck (Ford Ranger F150 Pickup) was called "Blue Goose" and had over 300,000 miles on the odometer, until it was sold to a used car dealer for US $25.

housing developments, oil exploration, clear-cutting forests, water pollution and others equally damaging. If those activities continue, then surely it is illogical to even consider putting captive animals at risk back in original habitat. As I see it, the only other option is reclamation after developers have had their way destroying the land. Studies are needed before the land is ravaged and thought as to what it takes to bring it back or can it even be brought back to its original state. So do we redirect funds to support reclaiming ravaged lands and make this our highest priority?

Scott Pfaff from Riverbanks Zoo told me that he contacted 40 zoos about a decade ago to help develop a breeding program for King Cobras as a way of ensuring that these spectacular snakes would always be available in the future. To do this, a zoo would have to commit to maintaining breeding pairs, incubating eggs, raising neonates, and distributing snakes to other institutions. Only two institutions were willing to participate and most of the others wanted only one large adult for display, expecting Scott to raise their snake until it was large enough for that purpose. Reminds me of the old folk tale: "Who will help me bake the cake?" asked the *Little Red Hen*; "Not I, not I," said all the other animals in the barnyard. "Who will help me eat the cake?" "I will, I will."

Again, I quote William Conway: "Successful specialized propagation programs for bats, beetles, snakes, and fish underscore the point: *Specialization is key to every successful threatened species propagation program."* I here propose a plan for future captive populations in our zoos and aquariums using the Conway model as a guide. In a true Darwinian sense where species are selected against if unfit, we should ruthlessly evaluate all of our current programs, using the Aruba Island Rattlesnake (*Crotalus unicolor*) initiative as a model that includes placement on the *2007 IUCN Red List of Threatened Species, Population and Habitat Viability Analysis, Species Survival Plan* and papers on the project (Odum and Goode 1994; Odum 2010). For new ones, we should insist that an *in situ* component be required—this could include sending money to support scientific studies such as infectious disease, setting up rehabilitation and breeding centers for eventual release, training students and wildlife officials, rebuilding productive collaborations and interactions among the zoo, academic, and conservation biologists, actualizing a plan for public education, developing recommendations for protecting habitats and creating reserves, and a host of other challenges requiring our help. For those now existing without this element, we should consider requiring addition of an in-country plan and if this is not possible, letting them leave the collection through attrition. We must always ask the critical question: are our plans in place consistent with intended results and if not, are we willing to jettison them and try something different?

Conde et al. (2011) recommend a plan that is tangential to mine or even bolsters the idea that species should be ranked: "Because ex situ conservation programs can be challenged when called into action at the last possible moment with only a few remaining individuals of a species, captive breeding should not be simply seen as 'emergency-room treatment.' It is a tool that should be considered before the species has reached the point of no return."

Now that I think of it, perhaps all the discussions taking place—of rewilding and de-extinction and forensic taxonomy—are a measure of just how desperate everyone is feeling. My friend Joe Mendelson sums it up succinctly (2011). Well, we certainly have much to discuss as captive managers and zoo/aquarium conservation biologists and we do not have much time to get it right!

Acknowledgments.—This paper is dedicated to Barry L. Armstrong (Fig. 18) and Jonathan A. Campbell (Fig. 19). When the Pierre A. Fontaine Bird and Reptile Building at Dallas Zoo opened in 1966, the collection was unimpressive and of little interest to academic, museum, and zoo herpetologists; very few of them bothered to stop by to see our charges. About a decade later, Barry and Jon started to go down to Mexico and Central America to collect amphibians and reptiles, based in large part on Campbell's need to have a comprehensive assemblage for his doctoral dissertation. These intrepid explorers were extraordinarily successful at finding rare and unique herps but many were not immediately preserved. To ensure that these living creatures were not left in bags and jars for weeks at a time, they undertook several trips from the collecting sites back to Dallas each year and placed them on loan at our zoo.

Before each trip, we would gather at my home in Dallas and generate desiderata for what might be collected. There were two camps—Campbell and Armstrong who claimed that they would succeed where others failed versus Murphy who stated emphatically that their goals were too lofty and unattainable. The reason for this was to create wagers—the loser(s) had to underwrite the cost of a lobster–steak dinner, amply supplied with libations, at a five-star restaurant. The winner(s) would bask in glory with credit card receipt unsigned and wallet intact!

These sessions were remindful of draft day for a professional football conference as lists were developed and players chosen; our interactions became somewhat heated as the night wore on—we were ethanol-fueled—and we vigorously jockeyed for position to put the other side at a disadvantage. Finally, after much wrangling, we completed the final list and had to live with the results. Campbell claims to this day that he and Barry were the clear winners although I believe that results were about equal. Even if results were equal, I still lost ground because there were two of them and only one of me—they had prodigious appetites!

There is no question in my mind that as our collection began to gain international recognition and herpetologists throughout the world began to regularly visit us, my two friends were the primary reason for our success and I will always be grateful to them.

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Over many years, I have had fruitful discussions with these persons about the role of zoos and future challenges: Colette Adams, Kraig Adler, Fred Antonio, Barry Armstrong, James Bacon, Dave Ball, Chris Banks, Dave Barker, Ben Beck, Charles Beck, John Behler, Randal Berry, Dave Blody, Quentin Bloxam, Don Boyer, Bill Branch, Ed Bronikowski, Kevin Buley, Pat Burchfield, Gordon Burghardt, Jonathan Campbell, Winston Card, David Chiszar, Joe Collins, Roger Conant, Jon Coote, Jack Cover, Béla Demeter, Scott Derrickson, Jeff Ettling, Gary Ferguson, Jack Frazier, Ron Gagliardo, Carl Gans, Clay Garrett, Janis Gerrits, Richard Gibson, Ron Goellner, Brian Gratwicke, Harry Greene, David Grow, Robert Hansen, Gene Hartz, Ron Heyer, Rick Hudson, Tom Huff, Howard Hunt, Michael Hutchins, Warren Iliff, Jeremy Jackson, Elliott Jacobson, Ron Kagan, Alan Kardon, Ken Kawata, Dennis Kelly, Dan Keyler, Sergey Kudryavstev, Bill Lamoreaux, Michael Lannoo, Joe Laszlo, Dwight Lawson, Bill Lamar, Karen Lips, Sergey Mamet, Dale Marcellini, Ed Maruska, Ken McCloud, Roy McDiarmid, Bill McMahan, Joe Mendelson, Don Middaugh, Don Moore, Andy Odum, Ray Pawley, Marlin Perkins, Scott Pfaff, George Rabb, Charles Radcliffe, Dave Roberts, Richard Ross, Steve Sarro, Robin Saunders, Dave Schleser, Frank Slavens, Brandie Smith, Ed Smith, Hobart Smith, Peter Tolson, Bern Tryon, Gerard Visser, Trooper Walsh, David Warrell, Barbara Watkins, Paul Weldon, Judy White, William Xanten, Kevin Zippel, and George Zug. I am grateful to all for stretching my brain.

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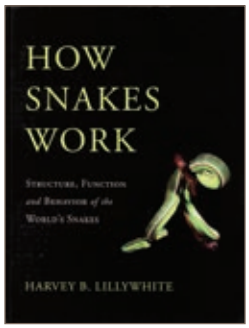
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BOOK REVIEWS

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How Snakes Work: Structure, Function, and Behavior of the World's Snakes

Harvey B. Lillywhite. 2014. Oxford University Press, New York (http://global.oup.com). Hardcover. xiii + 241 pp. US $49.95. ISBN 978-0-19538037-8.



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Randomly flipping open Harvey Lillywhite's new book is likely to land you on one or more fascinating photos or figures. If you are like me, that will begin an exploration of a topic that will have you flipping back and forth through this book to see what Harvey has to say about skin color, or egg form and size, or predator-prey interactions, or any one of innumerable questions that snake enthusiasts think about. As a physiologist with a broad spectrum of interests focused on snakes, Harvey has done serious scientific work on an amazing variety of questions. To communicate his interests and findings to the general public, he has devoted a lot of energy to finding excellent photos or drawings that encapsulate concepts or processes and their structural foundations.

Harvey Lillywhite has managed to convert his scientific prose from many publications into readable and entertaining explanations. The book is profusely illustrated in color, mostly with previously unpublished photos and illustrations by the author, his students, and a host of colleagues. Since this is a review for herpetologists, I'll comment on what I regard as the scientific value of the various parts of the book — and on some of its scientific weaknesses. Because Lillywhite's expertise in many aspects of the physiology of snakes is probably unparalleled, my criticisms focus primarily on those parts of the book with which I have experience.

The book has a foreword by Rick Shine, a brief preface explaining Lillywhite's goals in writing the book, acknowledgments, nine chapters, each with its own selected bibliography, a glossary, and a useful index of taxa and terms. Given the number of popular books on snakes, one might ask whether this book provides anything new. The pithy title turns out to be accurate. The only books I'm aware of that come close to this are Parker's (1965) little book (revised by Grandison, 1977) and Bellairs' two volumes on Reptiles (1970). Ernst and Zug's (1996) volume *Snakes in Question* covers some of the same topics and questions but not in the coherent manner of Lillywhite's book.

The book begins with a brief survey of snake diversity and Lillywhite's current view on snake relationships drawn primarily from recent molecular studies. As with all the following chapters, it begins with a quote, this one from Malcolm Smith's (1943) book on Indian snakes noting the importance of natural history in interpreting structure, function, and phylogeny. To emphasize the potential rigors of meeting this demand, among the many photos of henophidian snakes is a large photo of Jesus Rivas and a friend carrying what looks like a 6-m anaconda. It accompanies neat photos of *Anomochilus monticola*, *Anilius scytale*, a vertebra of *Titanoboa*, and others. Abundant photos of other representative species show the diversity of habitats that snakes have successfully occupied and the diversity of head and body shapes and colors that snakes have evolved. It ends with a cladogram drawn largely from recent molecular analyses that provides the framework for discussions in the rest of the volume. Although many readers may not be interested in the evolutionary relationships of major snake clades, the inclusion of the cladogram could have provided an opportunity to comment on the fact that recent morphological (Gauthier et al. 2012—not cited) and molecular analyses (Pyron et al. 2013—cited) of snake phylogeny are raising important questions about how both sets of characters evolve.

The second chapter covers the physiological aspects of nutrient acquisition—feeding, digestion, and water balance. It starts by noting the major constraints acting on snakes, reminding the reader that snakes are basically animated tubes with a head at one end and a tail at the other. The explanations of how different snakes eat include some descriptions of kinetic skulls in henophidian and colubroid snakes and briefly mentions some of the structural foundations of jaw kinesis. Specialized feeding mechanisms, like mandibular raking in leptotyphlopids, and mandibular transport in snail eaters, are also explained, with credit given to Nate Kley and Beth Brainerd for figuring out the remarkable characteristics of the former. The chapter covers almost all aspects of feeding in snakes, including specializations for restraining prey, venoms and venom delivery systems, digestion and digestive adaptations including beautiful micrographs of stomach and intestinal histology from Jacobson (2007), and sequential x-ray images of a barium-injected chick being digested by a rat snake. It ends with the roles of skin, kidneys, and salt glands in maintaining water balance and with the basic mechanisms of drinking.

Locomotion, the subject of the third chapter, begins by noting the relationship among vertebral number, speed of locomotion, and body form. Skeletal and muscular features are described with the aid of photos of vertebrae and ribs and neat dissections of body segments that make clear the extraordinary length of tendons and some of the complexity of muscle arrangements. However, the photos will also make clear to those who actually know some anatomy why photos are poor substitutes

for good drawings. Sea snakes and swimming are treated first along with some of the experimental approaches to testing relationships between the form and function of swimming snakes. This leads into a brief treatment of terrestrial locomotion and the limited studies of how snakes generate the forces necessary for locomotion, apparently done at human generational intervals (about every 30–40 years). The rest of the chapter focuses on the different kinds of locomotory movements that snakes use and how these relate to the environment, and ends with a brief introduction to snakebots, the use of engineering methods to create robots that move like snakes and also make clear some of the basic functional and structural demands operating on snake-like locomotion.

The next chapter deals with temperature and is introduced with a quote from Michael Angilletta's 2009 book and a photo of a *Crotalus durissus* with arrows and labels showing the various routes and types of heat flow to and from the snake. After explaining in very general terms how heat influences metabolism and molecular structure and function, and how snake bodies limit the kinds of behaviors snakes can use for thermoregulation, we learn about the types of physiological studies that have been done to understand thermal relationships of snakes. Lillywhite discusses both field and laboratory studies and rightly notes the limitations of our current data. He also considers the difficulties entailed in measuring some of the factors influencing regional differences in temperature within snake bodies and responses to temperature extremes. Evidence for thermogenesis during egg incubation in pythons and in colubrids exposed to extreme cooling (below 2–4ºC) is given along with a review of the many studies on heat and cold tolerance and the effects of temperature on activity.

How snakes exchange things between themselves and their environments is really the fundamental theme of the book but Lillywhite has sensibly not focused on all the quantitative physiological aspects of the issue. After discussing heat exchange, and intimating frequently that the skin plays a role, he gets down to explaining exactly how the skin does this in snakes in Chapter Five. As in the other chapters, the basic structure of the skin is introduced first with excellent micrographs by Jacobson (2007). The chapter goes on to explore the basis of color and patterns and how the potential functions of the skin in mimicry and defense have been experimentally tested. A short section on color acquisition from the environment deals primarily with soil adherence in some species like Cottonmouths (*Agkistrodon piscivorus*). A longer section on the genetics of coloration doesn't actually deal with any genetics but describes various polymorphisms, with three color morphs of *Lampropeltis californiae* shown but only one color morph of *Python brongersmai* shown and none of *P. regius*, the species that appears to be the current craze among snake color morph fanciers for its extraordinary range of colors and patterns.

Given Lillywhite's many publications on vascular function in snakes, I was looking forward to his synthesis of how circulatory and respiratory systems of snakes work. Getting into the chapter involved delving through the basics of circulatory system design and terminology written in a style that seems suitable for elementary school students. The anatomy of the snake heart and how its form allows shunting between pulmonary and systemic outflows is covered with some interesting details and then the chapter progresses to vessel patterns and hemodynamics. Lillywhite discusses at length how the design of the snake body should generate major potential problems in hemodynamics due to gravity in terrestrial environments, using sea snakes to show how blood pools in the lower part of the body if the snake is held vertically by its head. Holding terrestrial species in this manner rarely results in changes as observable as those in sea snakes, and Lillywhite comments on some aspects of vascular design that permit maintenance of blood flow to the head regardless of body position in climbing snakes. The last half of the chapter introduces lungs with some photos of fresh lungs, including tracheal lungs, and an excellent micrograph of a resting, uninflated lung, again from Jacobson (2007). The basics of gas transport are developed and the functions of both vascular and non-vascular regions of the respiratory tract (saccular lung, tracheal air sacs) discussed. Numbers appear intermittently to make points—blood pressure values and lung faveolar spacing in various species, but how these fit into a form/function argument are not elaborated. Lillywhite fittingly ends the chapter exhorting readers to contemplate all the unanswered questions about how different snakes may have resolved cardiovascular and respiratory demands.

Perceiving the snake's world, the next chapter, leads into an area about which I have long accepted that I know very little. Inasmuch as my perception of most things differs from my wife's, understanding what a snake perceives has always been to me the equivalent of a leap into an abyss. Others do not accept my view, and they have forged ahead on trying to understand sense organs in snakes. Lillywhite summarizes the years of research on snake sense organs with illustrations of the superficial aspects of the organs only. However, he covers what we know of the physiology of those organs and the correlations with behavioral changes. The many experimental tests on infrared sensing, vomerolfaction, hearing, and tactile receptors combine to show that snakes do sense an extraordinary range of environmental stimuli but how these all lead to 'perception' remains, to me, a puzzle. Lillywhite ends the chapter with "…perhaps our perception of the world around us is not really that different from that of a snake. Think about this." I have, and I have reached a different conclusion.

Anyone who has kept Puff Adders or rattlesnakes knows that some snakes are noisy. Lillywhite must have puzzled over this like many of us. Sound production in snakes amazingly gets a whole chapter devoted to the careful scientific studies by relatively few people, most notably Bruce Young and his teams of students. I can understand Lillywhite's dilemma in conveying the scientific problems involved in rattles, hisses, growlings, and poppings without the physics of acoustics. He manages to cover both the range of sounds made by snakes and the various structures that produce the sounds, but unlike all the other chapters, this one doesn't benefit much from its figures. Reference to some of the excellent photos two chapters previously help to explain the respiratory associated sound-producing structures. However, the photo of an *Echis* doesn't show the scales responsible for sound production clearly and a later photo of the skin of a seasnake is presented without any reference to sound. I was unable to figure out where the circumferential ridges are on the photo of the Gaboon Viper external naris.

The last chapter of the book deals with courtship and reproduction. The "essentials" of reproduction follow a short section on the mythology of snakes and their relationship to various human cultures. After commenting briefly on generations of individuals (here referred to as G_1 and G_2 -instead of the more familiar F_1 and F_2 generations) and the transmission of genetic information as DNA, there is a similarly brief explanation of how

to tell male from female snakes by probing. The description suggests that the probe actually enters a pocket housing the hemipenis, rather than entering the inverted hemipenis itself. Tail is somewhat confusingly misspelled as 'tale' several times in this section. The claim is made that the erected hemipenis is inserted into the cloaca or vagina. I have always assumed, having admittedly watched relatively few mating events, that the hemipenis everted into the cloaca while the vents of the mating pair were pressed together, and I've always wondered how the male regulates which side is everted. Gonads are introduced, and a real puzzle, how sperm get from the ductus deferens (not mentioned) to the sulcus spermaticus of the hemipenis, is not mentioned, possibly because no one has figured it out. Oviparity and viviparity are compared from physiological and environmental perspectives. Egg laying and the attendance and incubation of eggs are reviewed as is the limited available evidence on parental care of neonates. Growth patterns, sexual maturation, and survivorship are all considered although the difficulties of measuring energy flow in natural populations, and the efforts to do it, are not included.

The book is not without its problems and errors. Some of these should have been averted by competent editing prior to publication. Others are clearly the author's responsibility. In a figure showing three frames of a striking *Corallus hortulanus* recorded by Phil Nicodemo, propulsive and reaction forces, and their explanations in the legend, seem reversed and the legend ends with "the head moves forward to bite forcefully and immobilize the prey." After recording over 2000 strikes from about 50 species of boas and pythons, Fran Irish and I can attest that mammals bitten by snakes, even long-toothed *Corallus* or *Morelia*, are rarely if ever immobilized by the bite. Immobilization is the result of death by constriction. One egregious error involves a finding attributed to me. In the feeding chapter, I am cited as saying that "up to 47% of rattlesnake strikes result in neither fang penetrating the prey." What I actually wrote (2002) was "Among the strikes recorded by me, 19/88 (22%) were flawed in some respect and 9/19 (47%) resulted in no fang penetration at all." In other words, almost half the flawed strikes but only 10% of all strikes result in no fang penetration. In a later paper (2009—not cited) based on about 10 times as many strikes, I provided a better estimate of how frequently vipers reposition one or both fangs during a predatory strike, estimates supported by data previously published by Young et al. (2001) for a single species of rattlesnake.

As an anatomist, I was disappointed to see a surprising number of errors in presenting aspects of snake anatomy. In Fig. 2.2, carotid is misspelled (cartotid). Drawings of a lizard and a snake skull (Fig. 2.4) will astound anyone with a basic knowledge of skeletal anatomy in vertebrates. The ostensible reason for the drawing was to show lizard and snake modifications of the diapsid condition, but sutures are randomly included and show bone arrangements unknown in any lizard or snake (Evans 2008; Cundall and Irish 2008). Figure 2.7 supposedly shows a sequence of jaw movements in a king snake (*Lampropeltis californiae*) swallowing a mouse, but the jaws cannot be seen, and the caption ends by noting that "the mouse is positioned within a loose coil of the snake, thereby 'anchoring' the prey so that it does not shift away from the snake during advances of the jaws." …a statement that seems to ignore the fundamental ratchet properties of the pterygoid walk. Figure 2.21, a drawing of tooth implantation in snakes, shows aspects of a lizard pleurodont condition but with no alveolar socket, a much higher labial pleura than is found in most alethinophidian snakes, and ligaments rather than bone of attachment connecting the base of the tooth to the tooth bearing element (Zaher and Rieppel 1999). As noted by Savitzky (1981), only a few hinged-toothed snakes retain ligamentous tooth attachment. Figure 2.27, another drawing, this one copied from Kardong (2006, also 2009), converted what was originally the quadratomaxillary ligament into what appears to be a new bone in front of the quadrate and lying over the venom gland compressor. The intestine is described has having villi (p. 65) despite the fact that Parsons and Cameron (1977) and Luppa (1977) both reviewed snake intestinal anatomy and showed that the small intestines of most snakes lack villi. Even more surprisingly, nutrient absorption from the gut is claimed to take place primarily in the large intestine (p. 65).

Other minor errors abound. The snake heart is claimed to have a "valved interaortic foramen" (p. 143), a structure I cannot find described anywhere, although crocodilians do have a foramen between the left and right systemic arteries, the foramen of Panizza. Perhaps interaortic foramen refers to the space between the ventricular septum and the entries to the systemic and pulmonary arteries? The chapter cites Wallach's (1999) chapter on snake lungs but includes no citations or mention of other chapters in the same volume that review the structure and function of the heart in snakes. The chapter on reproduction contains a figure (9.10) copied from Blackburn and Stewart (2011; not Stewart and Brasch 2003, as stated in the caption) showing placental types in snakes—but done without color so that the vascular nature of the extraembryonic yolk sac and allantois are not clear or labeled. Worse, none of the extraembryonic membranes are shown as having any connection to the embryo—an unfortunate feature of the original drawing and one that makes it unclear as to how anything could be transported between these membranes and the embryo.

The focus of the book is on how things work, not how they are built. Lillywhite has done an excellent job of showing where we are in understanding how things work. However, forging ahead on most of the "how they work" questions is likely to require a much better understanding of how they are built. Lillywhite tacitly acknowledges this by explaining relevant structures in every chapter. In almost all cases, the anatomy could have been developed more carefully and with better illustrations.

The book's cover says "written for both professionals and a more general audience," but trying to satisfy both groups is a serious challenge. Much of the writing is clearly intended for a "general" audience. Not being a publisher, I do not know how a general audience is defined, but I assume it is people not trained in science beyond the high school level. Some parts of the book actually seem to be targeting an audience with no science education at all, but the treatment of snake examples suggests it is intended for the amateur herper. I'm not sure, however, that the amateur herpers of today are like those at the time when Harvey Lillywhite and I were both amateur herpers ourselves. Having spent years going to the local Hambug, Pennsylvania, "herp expo," I have watched a change in the nature of both the types of people attending and the nature of items for sale. What are no longer for sale are books, a change that has occurred just in the last few years. Unlike the bibliophilic amateur herpers of old, the current crowd is apparently not a book-buying population.

In summary, I like the book despite its shortcomings. What Lillywhite has given us is a summary of his life's work and interests. I think he has succeeded in showing both what he and colleagues have discovered and why snakes deserve a lot more

research—including research on the foundations of function, namely, anatomy. He ends the book with a plea to readers to encourage others to appreciate snakes … and the rest of the natural world. One can only hope that the book will be an unbridled commercial success—both to support his plea, and possibly to justify a second edition with a little more polish.

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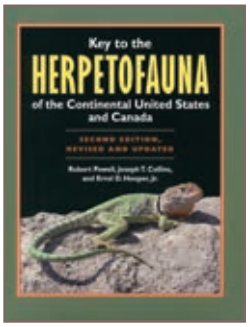
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Key to the Herpetofauna of the Continental United States and Canada, Second Edition, Revised and Updated

Robert Powell, Joseph T. Collins, and Errol D. Hooper, Jr. 2012. University Press of Kansas (www.kansaspress.ku.edu). viii + 152 pp. Softcover. US $19.95. ISBN 978-0-7006-1833-0.

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When presented with a lizard or frog that eludes immediate identification, the first reference for many, interested amateur and professional herpetologist alike, is a field guide. For North American taxa, that usually means referring to the Peterson Field Guides, either Conant and Collins (1998) or Stebbins (2003). However, as field guides are specifically geared toward identification of living individuals and tend to emphasize color pattern, specific identification of preserved specimens often proves impossible, and even live animals can be troublesome to identify when "off-color" due to physiological changes, an approaching skin shed, or other factors. In these cases, identification keys prove their worth. Since 1998 the standard general key to the herpetofauna of North America has been Robert Powell, Joseph Collins, and Errol Hooper's First Edition *Key to the Herpetofauna of the Continental United States and Canada*. Now, a revised and updated second edition, released in 2012, admirably fills the role of comprehensive North American key. Much of the text in the Second Edition is identical to the First Edition; nonetheless this update is sorely needed. As stated in the Second Edition's introduction, coverage of native taxa has increased from 545 to 634 species, while coverage of alien taxa has risen from 39 to 58. In addition to an increase in the number of covered species, there are two other significant changes present in the new edition. Range maps have been contributed by Travis Taggart and are included for select sets of species, and taxon-specific commentary has been significantly expanded, most of which highlights areas of taxonomic disagreement or uncertainty and provides references to the relevant literature in each case.

For readers unfamiliar with the current or earlier edition, the product is exactly as advertised on the cover: the vast majority of pages in the book are devoted to a dichotomous key to the reptiles and amphibians of North America north of Mexico. The key itself is preceded by a short introductory section and followed by a glossary and the literature cited. The four-page introductory section (actually an "Introduction to the Second Edition" and "A Word to Users of This Key," plus acknowledgments and a list of

abbreviations), while short, accomplishes several things. It defines the intended core audience: college-level herpetology students. It defines the taxonomy followed in the key (Collins and Taggart 2009), which may seem trivial, but is not. It defines the intended scope of the key, which is written to allow one to identify an adult individual of every species of amphibian and reptile with established populations in North America north of Mexico. Finally, it includes the admonition that not all specimens can be successfully identified with a key alone, a truism many of us have experienced firsthand.

The heart of the book is of course the 134 pages of dichotomous keys. For any such key, authors must make structural decisions that can ultimately affect utility to particular audiences. What taxa should be included? Should arrangement favor diagnostic simplicity and grouping of phenetic clusters, or should taxonomy rule the day? What types of characters should be used? Powell et al. have made reasonable decisions in all these areas. Upon receiving my copy of the book, I went through several cycles of "I wonder if the authors included *this* species?" Invariably, the answer was yes, whether it was the continental United States' only amphibian listed by the IUCN as extinct (*Plethodon ainsworthi*) or the latest exotic species established in Florida. Even some exotic species that have been reported but have not established populations are mentioned, such as Anacondas (*Eunectes*), though such species are not included in the key. It should be noted that coverage extends only to the species level, and each species receives a single terminal entry, which is generally not problematic but can result in unwieldy couplets when one species is polytypic, a prime example being the couplet differentiating *Ensatina eschscholtzii* from *E. klauberi*. Though each species is associated with a single terminal entry, inner reticulation is used where appropriate, so that, for instance, multiple roads lead to *Lampropeltis*. This allows for a reasonable compromise between producing an idealized diagnostic key versus producing an idealized synoptic key: members of the same genus or family are always grouped together, but by not forcing a single entry to lead to a particular family or genus; concise, easy-to-follow diagnoses are maintained for internal couplets.

Powell et al. have not restricted themselves in the classes of data used to characterize sets of taxa. The major exception is internal anatomy, which is avoided, though characters requiring observation of the inside of the mouth (tooth rows and counts, presence of choanae, tongue shape and attachment site) are used regularly for amphibians, and acrodont tooth attachment is used as the distinguishing trait for Agamidae. Most entries in the key stress external anatomy, however, with geography and color pattern also being important. Occasionally, other classes of distinguishing characteristics are also included where appropriate (e.g., acoustic and karyotypic information for *Hyla chrysosceles* and *H. versicolor*). When color pattern is used, the authors are also careful to note pattern elements that tend to fade in preservative (such as the yellow thigh markings of *Hyla avivoca*). Terminal entries for species also include referrals to each species' accounts and illustrations in Conant and Collins (1998) and/or Stebbins (2003), along with accounts from the *Catalogue of American Amphibians and Reptiles*, if available.

Important morphological characteristics and geographic ranges are illustrated through the use of 279 line drawings and 25 maps. While a few of the maps depict the range of only a single species, most serve to illustrate range differences among members of a species complex. Maps (sometimes two) are included for all the well-known troublesome species complexes: slimy salamanders (*Plethodon* spp.), southwestern leopard frogs (*Lithobates* spp.), Gulf Coast drainage map turtles (*Graptemys* spp.), fence lizards (*Sceloporus* spp.), and kingsnakes (*Lampropeltis* spp.), among others. These prove their worth, especially when, as in the slimy salamanders, identification to species level is impossible based on external morphology alone. Even more so than the maps, the line drawings are exceptional. They are, in fact, my favorite aspect of the entire book. Significant morphological features are illustrated with a level of detail and precision that is difficult to depict in a photograph or field guide illustration. Coupled with captions describing the relevant features, the result is that written descriptions that have the potential to confuse instead enlighten, so that a user of the key need not wonder just how big an enlarged preanal scale is supposed to be, or what a gular crest looks like. Especially notable are the head and body drawings that appear at the start of sections for each major herpetofaunal group, which identify features such as types of head scales in lizards and snakes (oculars, gulars, labials, etc.) or dorsolateral folds in frogs. The identity of these structures is second nature to most professional herpetologists, but can be a source of confusion to non-specialists.

Following the key itself are 14 pages of glossary and literature cited, which together complete the book. The glossary, which spans four of these pages, is exhaustive and as far as I can tell includes entries for all but the most basic of anatomical terms used in the key. For example, while "hand" does not get an entry, "claw" does. Directional terms (distal, dorsal, etc.) are given entries in addition to the many entries describing various anatomical structures. There are also a few non-anatomical terms defined in the glossary (e.g., *sensu lato*). The literature cited is complete, and is actually a good starting point if one were interested in synthesizing the literature on recent taxonomic changes and uncertainty affecting the North American herpetofauna. In this respect, it serves as a reminder of the work done by the late Joseph Collins through the Center for North American Herpetology to disseminate our ever-changing conception of North American herpetofaunal diversity.

There are some features not included in the book, two of which in my opinion would significantly increase its utility. First, the Table of Contents only lists taxa down to the family level, and the book has no index or other comprehensive list of included genera and species. One might think that this list exists outside the book in the form of Collins and Taggart (2009), but that would be inaccurate. Powell et al. did not limit their coverage to species recognized up to 2009, so that there are species in the book than are not listed by Collins and Taggart (2009), and there is no easy way to determine which additional species have been added. For example, among turtles only by paging through entries can one determine that *Graptemys sabinensis* gets its own entry while *Kinosternon steindachneri* does not. In addition, the lack of a numbered taxonomic index makes it more difficult to work backwards in the key from a set of potential species as a means of identifying diagnostic features.

The second major omission is the lack of identification keys for larval amphibians. This significantly cuts into the comprehensiveness of the key, and is especially problematic for salamanders. The decision not to include salamander larvae results in the erection of an artificial morphological distinction between these and the adults of related paedomorphic species. This has a strong potential to lead to misidentifications of aquatic, gilled salamanders. The authors do briefly state their non-inclusion of larval keys in their introductory word to users, but do not

suggest alternatives for larval salamanders or tadpoles. Although becoming dated in nomenclature and species content, such resources do exist, the best of which for North America as a whole are probably Altig et al. (1998) for tadpoles and Altig and Ireland (1984) for larval salamanders.

Despite these non-inclusions, the *Key to the Herpetofauna of the Continental United States and Canada* is ultimately an eminently useful volume that I am glad to have available. The core purpose of any key is to identify organisms to their respective species, and for adult amphibians and reptiles of North America, no resource is better suited to the task than this book. While the authors have specifically pitched their product as an identification aid for university herpetology students, other audiences will find it equally useful. The careful prose, clear illustrations, and large glossary combine to make following the key easily comprehensible to interested amateurs with no formal background or training in herpetology, while the comprehensive coverage makes it by far the most convenient identification resource for herpetological professionals, especially those of us who are at a loss when confronted with a generic plethodontid.

Further, while the book is designed with preserved specimens in mind (even if the authors didn't say so directly in the introduction, the volume's dimensions—nearly identical to the copy of *Herpetological Review* in your hands—would be a giveaway), it is by no means deficient in allowing identification of live animals. This is especially the case when it is used in concert with the relevant Peterson Field Guide, where, thanks to the included cross-referencing, one can easily key out a specimen in hand and then turn to the relevant field guide entry for secondary confirmation. The *Key* is sturdily constructed and should stand up quite nicely to outdoor use, if such use is desired, while for indoor use the pages seem to be able to stand up to the occasional solvent drip. Overall, the *Key to the Herpetofauna of the Continental United States and Canada* is one of those rare volumes that all North American herpetologists and herpetophiles should own, and at a list price of around US $20 (or less online), there is little excuse for not picking up a copy.

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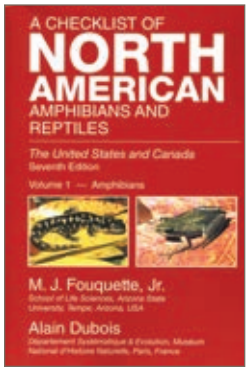
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A Checklist of North American Amphibians and Reptiles: The United States and Canada: Volume 1—Amphibians, Seventh Edition

M. J. Fouquette Jr. and Alain Dubois. 2014. Fouquette and Dubois, Tempe, Arizona and Paris, France. Softcover. 612 pp. US $34.99. ISBN 978-1-4931-7035-7.

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In the America of the 21st century, a baffling 50% of the voting public claim to believe in special creation rather than evolution through natural selection. Therefore, it is curious that more people of the cloth, in their quest to reveal the inner workings of a supreme being, aren't roaming the bowels of our great museums examining specimens and working through nomenclatural history trying to figure out how to name these representatives of the five kingdoms and how they might relate to each other. Absent such divine intervention, it falls to mere mortals—the scientists—to work out the relationships of the tens of millions of species that constitute life on earth.

Fouquette and Dubois' book is the most recent attempt to document the species of amphibians in North America and their relationships to each other. I'll admit that the world of taxonomy and systematics is mostly foreign to me. As a rubber boot field biologist I simply want to insure that people know the species I'm working with, and where I'm working with them, so that should a new diagnostic technique reveal a different taxonomy, my successors can translate. In the one instance where I needed to know the current taxonomic and systematic relationships of North American amphibians (Lannoo 2005), I simply relied on the current authority (Crother 2000). My indifference (based on being very much aware of my shortcomings in understanding the rules of the International Code of Zoological Nomenclature and Hennigian systematics) does not mean that I underestimate the profound importance of taxonomy and systematics on the day-to-day professional lives of all the rest of us. I understand that everything we do rests on this foundation provided by our nomenclature. How can you run a business if you do not know your inventory? More specifically, how can we prevent the loss of a species if we disagree on how to define a species, and how can we prioritize taxa for conservation if we cannot agree on what to call them? My indifference simply means I've got no dog in this fight (although I wonder why Fouquette and Dubois chose to ignore our updated digital distribution maps, given Fouquette was a contributor to the effort). My plea to those who occupy the world of systematics is to provide stable names I can use, not choices that give the impression that I am taking sides in a war I would rather not be fought.

So, the first question is, where are the battle lines? Among the most important practical differences between Fouquette and Dubois and the Standard Names list compiled by Crother

(2012) are the retention (or resurrection, depending on your perspective) of the genus names *Bufo* for *Anaxyrus* and *Rana* for *Lithobates*. *Pseudotriton montanus* is placed in the genus *Gyrinophilus*. Fouquette and Dubois recognize *Batrachoseps aridus*, *Desmognathus aureatus*, *D. melanius*, *Eurycea wallacei*, and *Necturus louisianensis* as valid species. They recognize subspecies within *Bufo boreas*, *Rana clamitans*, and *Pseudacris streckeri*, but not within *Aneides flavipunctatus*, *Bufo debilis*, *Hyla avivoca*, *Rana sphenocephala*, and *Notophthalmus meridionalis*. They recognize as subspecies *Gyrinophilus porphyriticus palleucus* and *Siren intermedia texana*. Fouquette and Dubois also recognize the introduced species *Dendrobates auratus*, *Eleutherodactylus coqui*, *E. martinicensis*, *E. planirostris*, *Litoria caerulea*, *Leptodactylus fragilis*, and *Xenopus laevis*.

The second question then, is why do these battle lines exist? One answer resides in overall nomenclatural philosophy. Without attacking the Crother series directly, Fouquette provides a rationale for hostilities (p. 11):

> " … we firmly hold to the [International Code of Zoological Nomenclature] as the only authority for nomenclature of animals. Every so often some of us become dissatisfied with the *Code*, and introduce an alternative, which may have some advantages, but overall is unsatisfactory as a substitute. The current alternative system of nomenclature that enjoys a significant degree of popularity (which I assume is represented by Crother) is called the *Phylocode*. It purports to be based on the evolutionary history of animals, so that its rules are designed to name taxa that conform to evidence of their phylogenies, providing names for the major clades, in a looser system not requiring hierarchical ranking. We consider the Linnean system of a hierarchy of taxa to be one of the finest concepts that has been contributed to taxonomy. The system has been codified into a complex of rules for the proper naming of taxa, at least for species, genera, and family-series ranks."

Fouquette then goes on to dedicate his contribution to the memory of Stejneger, Barbour, and Schmidt (p. 13), "being the giants upon whose broad shoulders we may stand." Similarly, in their introduction, Crother's (2012) group addresses this same philosophy with a long quote from Stejneger and Barbour (1943) which can be summarized by the embedded sentence "But when the phylogenists begin to play with the nomenclature and want to express their (often very tenuous, sometimes fantastic) ideas in names, then goodbye to stability of nomenclature which we have been sweating for all these years …"

Another front in this war lies in the application of standard common names. Stejneger and Barbour (1943) used common names sparingly, while their successor, Schmidt (1953) used common names but without their emphasis. Three years later, Conant et al. (1956), in the second ASIH publication devoted to nomenclature presented common names as "standardized," in order to be "suitable for use by zoo and museum personnel, other writers of labels, guide books, and popular handbooks, camp counselors, biology teachers, professional zoologists whose chief interest is not herpetology, and anyone else who could make profitable use of such a standard list of names" (Crother 2012). Subsequently, Collins (1997) "strongly urged people to use such standardized common names." Fouquette and Dubois tie their intellectual lineage back to the time before the application of standardized common names with the sentence (p. 9), "The most recent edition of a herpetological checklist for North America (Schmidt 1953) appeared about 60 years ago." (This also explains the curious "seventh edition" designation of the title; Schmidt's 1953 treatise is the sixth edition.) In doing so, Fouquette and Dubois effectively ignore the work of Conant et al. (1956), Collins and his collaborators (first through fourth SSAR editions) and Crother and his collaborators (fifth through seventh SSAR editions; the fifth and sixth editions were also sanctioned by the Herpetologists' League and ASIH; in addition to these sponsors the seventh edition was sanctioned by the Canadian Association of Herpetologists, the Canadian Amphibian and Reptile Network, and Partners in Amphibian and Reptile Conservation [PARC]). Crother (2012) backs away from the term "common names," since such names differ by language.

A final front in this war rests in the use of paper vs. electronic formats for nomenclatural distribution. Fouquette and Dubois argue that a published paper checklist is critical as a nomenclatural document, which should be re-visited and republished on about half-decade intervals. That "when changes are made in an online checklist in 2001, then updated or modified in 2003, the original change may disappear and there is no record of the event." In contrast, Crother and his colleagues publish paper editions (for example, the sixth edition) with frequent online updates (v. 6.1, 6.2, etc.) leading up to a subsequent edition, published in paper (the seventh edition was published in 2012).

And so there lies the rub. As Dylan (1964) sang, "The line it is drawn. The curse it is cast." Where do we go from here, or perhaps the better question is, can we go anywhere from here? These are not trivial questions, because, as I point out above, names matter; and in some cases, where legislative wording leading to legal protection enters into the conversation, what you call something can mean life or death.

In taking a step back from the issues, it is obvious that Fouquette and Dubois face a daunting task in convincing herpetologists to take their side. All of the major in-print North American herpetological societies and a major conservation group (PARC) support Crother's list. And, while it would cost me $35 to purchase Fouquette and Dubois (with a re-purchase necessary every half-decade or so), I can download Crother as a PDF for free. Further, with Fouquette and Dubois being a self-published volume with its only institutional backing originating from Europe, it is unclear who will carry this battle forward, especially after the authors are unable. I sympathize with their struggle because I am a traditionalist (I prefer wool to polar fleece), but I'm also practical, (when I need to travel light I go synthetic). And I sure prefer "*Rana*" to "*Lithobates*" and "*Bufo*" to *Anaxyrus*," but I've gotten over it now and have learned to live with it.

In puzzling through this book, from its oblique introductory material carefully avoiding mentioning the society-sponsored checklists from 1956 to the present, to the "seventh edition" moniker, to the self-publication, I think I finally get it. Schmidt (1953)—the stated intellectual predecessor of Fouquette and Dubois—was published the very same year that Watson and Crick presented their discovery of DNA as the stuff of inheritance. And Fouquette and Dubois set their philosophical foundation squarely on the perspective of Stejneger and Barbour (1943; quoted above) lamenting the use of phylogenetic hypotheses in nomenclatural decisions, thus setting up the battle between the "Code" and the "Phlyocode." But the phylogenetic hypotheses of Stejneger and Barbour's day must have been clunky, or at least incomplete, by the standards of today, and certainly evolutionary hypotheses have been much improved by the application

of molecular tools developed since 1953. Indeed, these various forms of molecular techniques have been largely responsible for the huge increase in North American amphibian species now recognized by both Fouquette/Dubois and Crother/collaborators. It does seem ironic that Fouquette and Dubois recognize the use of molecular data in deciding species designations, but reject the branch-based pattern such molecular data derive.

I imagine way back in 1735, when he first published his newfangled "Systema Naturae," Linneaus had his detractors (especially among the botanists), and now the Phylocode is going through the same birthing pains. I'm reminded of another line, this one from the band Semisonic's (1988) song "Closing Time," borrowed from the Roman philosopher Seneca the Younger: "Every new beginning comes from some other beginning's end." Or, maybe not. Perhaps Fouquette and Dubois' argument has a shot; people of the cloth know an Old Testament story about David and Goliath.

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Amphibians & Reptiles of Sanibel & Captiva Islands, Florida: A Natural History

Charles LeBuff and Chris Lechowicz. 2013. Amber Publishing, Fort Myers, Florida (www.sanybel.com) and Ralph Curtis Publishing, Sanibel, Florida (www.ralphcurtisbooks.com). xxiii + 279 pp. Softcover. US $29.95. ISBN 978-0-9625013-4-0.

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Sanibel and Captiva islands lie in the Gulf of Mexico off Florida's southwest coast near Fort Myers. They are separated from Pine Island and the adjacent mainland by the brackish waters of Pine Island Sound and San Carlos Bay. Charles LeBuff and Chris Lechowicz have nearly seven decades of combined experience living and working on the islands, and their observations form the basis for this herpetofaunal natural history of the islands.

The book is very attractively produced, with a heavy-weight, glossy exterior covered with color photographs of six of the species of reptiles and amphibians found on Sanibel and Captiva islands. The binding is solid, and the book should hold together well.

Part I addresses Location, Geologic Formation, Climate, Land Use History, Hydrology and Water Management, Mosquito Control, Island Ecosystems, Species Recruitment, Environmental and Other Threats to the Island Herpetofauna, Early Herpetological Evidence, and Collection Techniques. This section is especially interesting and informative relative to the history of the islands, knowledge of which is critical to an understanding of their past and present herpetofauna.

Part II presents an Annotated List of the Amphibians and Reptiles of Sanibel and Captiva Islands, Florida. Sections within the species accounts include Other common names, Similar species, General range of the species, Island distribution, Preferred habitat type, Size, Color, Other characteristics, Diet, Reproduction, Call (for frogs), Life history, Population status, Threats, and Comments. Each species account is beautifully illustrated with color photographs by Bill Love, Daniel Parker, and others. Because some species have been seen only rarely on the islands, it is understandable that not all pictures are of Sanibel-Captiva specimens. Nonetheless, given the decades of work with *Caretta caretta* on the islands, I was surprised to see a photograph from South Carolina used to illustrate the hatchling of that species.

As the title suggests, this work is provincial and will be primarily of interest to residents and visitors to Sanibel and Captiva. This is especially so because no general map of the islands is provided. The somewhat anecdotal species accounts refer frequently to local roads and other features that will be known only to longtime residents. Periwinkle Way, Rabbit Road, and Las Conchas Road are intriguing names, but where are they? Perhaps of greatest interest to the non-islander will be 1) the history of the intentional introduction of *Lithobates grylio* or the invasion by *Pantherophis guttatus*, species native to the adjacent mainland

but apparently not to Sanibel-Captiva; 2) the chronicling of the extirpation or near extirpation of *Crotalus adamanteus*, *Drymarchon couperi*, and *Thamnophis sirtalis*; and 3) the surprising absence of *Agkistrodon piscivorus* and *Sistrurus miliarius* from the islands. The absence of *A. piscivorus* from the islands is especially enigmatic, as the species is known to occur on some much smaller offshore islands normally devoid of fresh water (e.g., Wharton 1969; Lazell 1989).

The authors acknowledge two fellow islanders for copyediting the manuscript and proofreading the final draft, and other than several cases of subject-verb disagreement, the text is relatively clean. However, the book would have benefited from the attentions of a good technical editor. It is easy for writers to read what they meant to write rather than what they actually wrote, and the book includes a number of factual errors, many of which the authors themselves would doubtless recognize. Errors are relatively few in those sections dealing with Sanibel-Captiva, but they magnify when the discussion wanders from the islands.

Particular problems arise when the discussion of general ranges becomes confused, leading to gross overstatement of ranges. For example, we read that "The southern ring-necked snake is found throughout the eastern U.S. and southeastern Canada from the Florida Keys to Nova Scotia, and as far west as…Minnesota in the north and Arizona in the south." Similarly, we read that "The southern black racer is found throughout the southeastern U.S. [with]…isolated populations in west Texas and a subspecies that ranges into Mexico from South Texas." In both cases the range of the stated subspecies has been expanded to include the much broader range of the species.

The composite account for *Trachemys scripta* indicates that *T. s. scripta* "ranges from northern Florida to southeastern Virginia." Oddly, the following sentence reads, "It is not native to Florida but is now found throughout the state as a result of escaped or released pets." The latter sentence would have been true of *T. s. elegans*, but *T. s. scripta* is native to the entire Panhandle region of Florida. Also within the *T. scripta* account, we read that females of the species range from 19 to 30 cm in carapace length, with maxima of 28 cm for *T. s. scripta* and 28.9 cm for *T. s. elegans*.

The native range of *Python bivittatus* is said to span the Indian subcontinent, a region instead occupied predominantly by *P. molurus*. The following sentence then correctly outlines the range of *P. bivittatus* as extending from eastern India through Southeast Asia to southern China and into Indonesia.

The venter of *Coluber constrictor priapus* is said to be white, whereas it is actually black, as can be seen in the accompanying photograph. *Caiman* "*crocodilis*" is thrice misspelled. *Hyla squirella* is said to be "found throughout…Florida, excluding some barrier islands and the Keys," whereas it is actually found throughout the Florida Keys (Lazell 1989; Krysko et al. 2011). *Kinosternon baurii* is said to be "…found mostly in the coastal plain of Georgia, the Carolinas, and Virginia", which is presumably not what was intended, as the species occurs commonly throughout peninsular Florida. *Pseudemys peninsularis* is called both peninsula cooter and peninsular cooter. "Picking individual [box] turtles up as pets" is erroneously said to now be prohibited, whereas individuals in Florida may pick up one box turtle per day, with a possession limit of two (Florida Administrative Code 68A-25.002[6]).

Crocodiles often bask with the mouth agape. The book presents the oft repeated but poorly documented explanation that this is a method of thermoregulation. Downs et al. (2008) briefly discussed some of the shortcomings of such an explanation. Is gaping behavior to facilitate heating or cooling? The crocodilian mouth is neither moist nor highly vascularized. Gaping behavior can occur in the early morning and at night. I recall early one cold morning in South Africa walking past a birdbath glazed with ice and then seeing Nile crocodiles basking with mouths agape. Loveridge and Blake (1987, p. 260) provided a photograph of a large *Crocodylus niloticus* immobilized with gallamine; the fully relaxed animal sits with mouth agape, just as seen in basking individuals. The intuitive explanation of thermoregulation seems inadequate.

The glossary that follows the species accounts includes some terms for which definition seems unnecessary (e.g., diminutive, diurnal, erosion, habitat, insular, National Wildlife Refuge System, pathogen). The neologism "deteologic agent" appears in both text and glossary where "etiologic agent" is intended. Watershed is given a definition more apt for drainage divide. And botanists will be surprised to learn that taxonomy is "The science of naming animals".

The book ends with lists of Suggested Reading and Literature Cited. Conant and Collins (1998) is included in the suggested reading, but it is not included in the Literature Cited, despite the fact that the sizes reported in most species accounts were obviously taken directly from that classic work.

In summary, this book is very attractively produced, and it is destined to long grace many a coffee table on Sanibel and Captiva. Visitors to the islands and residents will find the sections on geology, hydrology, and land use history informative. Otherwise, though, the book will not be of particular interest to most readers.

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Guía de Reptiles de España. Identificación, Historia Natural y Distribución

Alfredo Salvador and Juan Manuel Pleguezuelos. 2013. Canseco Editores S.L., Talavera de la Reina, Spain (www.cansecoeditores.com). 462 pp., 454 plates, 281 line drawings, 70 maps. Hardcover. 35 € (approx. US $48.00). ISBN 84-936191-6-9.



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Spain has continental Europe's highest reptile diversity; 71 naturally-occurring species inhabit its borders or visit its shorelines. In comparing the former version of this guide (*Reptiles Españoles*; Salvador and Pleguezuelos, 2002; see Busack 2003) to the current volume, one immediately notices several taxonomic changes. Increased understanding of phylogenetic relationships among Iberian taxa (due primarily to extensive DNA research) has resulted in reassignment of four snake species to different genera: *Coluber hippocrepis* to *Hemorrhois* Boie, 1826, *Coluber viridiflavus* to *Hierophis* Fitzinger *in* Bonaparte, 1834, *Elaphe longissima* to *Zamenis* Wagler, 1830a, and *Elaphe scalaris* to *Rhinechis* Michahelles *in* Wagler, 1830b. In addition, three subgenera formerly considered closely related within *Lacerta,* and now understood to represent evolutionary lineages distinct from *Lacerta sensu stricto,* warrant re-assignment as well. For *Lacerta lepida* its former subgenus, *Timon* Tschudi, 1836, is appropriate, and the species is now correctly known as *Timon lepidus*. Similarly, *Lacerta* is replaced by *Scelarcis* Fitzinger, 1843, for *S. perspicillata,* and by *Zootoca* Wagler, 1830a, for *Z. vivipara*. *Lacerta monticola* and *L. bonnali* are also no longer considered representative of *Lacerta* and are assigned to the recently defined *Iberolacerta* Arribas, 1997 (see also Arribas 1999). Former subspecies elevated to species include *Iberolacerta cyreni* (Arribas, 1996) (formerly within *L. monticola*); *Iberolacerta martinezricai* (Arribas, 1996) (formerly within *L. cyreni,* see Arribas and Carranza 2004); *Iberolacerta aranica* (Arribas, 1993) (formerly within *L. bonnali*); *Podarcis carbonelli* Pérez Mellado, 1981 (formerly within *P. bocagei,* see Sá-Sousa and Harris 2002); *Podarcis vaucheri* Boulenger, 1905 (formerly within *P. hispanica*); *Psammodromus edwardsianus* (Dugès, 1829) (formerly within *P. hispanicus*); and *Chalcides coeruleopunctatus* Salvador, 1975 (formerly within *C. viridanus*). *Blanus mariae* Albert and Fernández, 2009; *Iberolacerta galani* Arribas, Carranza, and Odierna, 2006; *Iberolacerta aurelioi* (Arribas, 1994); and *Psammodromus occidentalis* Fitze, Gonzalez-Jimena, San-Jose, San Mauro and Zardoya, 2012, are recently described additions to the fauna. *Macroprotodon brevis* is now the correct appellation for mainland Iberia's population, and *M. cucullatus* is correctly applied to populations found in the Balearic Islands (Crochet and Dubois 2004). The Canary Island Giant Lizard on Gomera Island (*Gallotia gomerama* in Salvador and Pleguezuelos 2002) is currently assigned to *G. bravoana* Hutterer, 1985 in this *Guía* (see Bischoff 1998, for details).

Teira dugesii from the Archipelago de Madeira, and Portuguese distributions for all species found both in Spain and Portugal are no longer included. Persons interested in distributions for Portugal may consult Loureiro et al. (2008) for coverage. *Saurodactylus mauritanicus* is no longer found on Isla de Alborán and has also been omitted from the current version.

This volume is essentially a 2013 update of the now out-of-print *Reptiles Españoles* and, as with that edition, it is more an informational treatise than the typical field guide. The authors, each a well-positioned professional (Salvador at the Museo Nacional de Ciencias Naturales, Madrid, and Pleguezuelos [currently president of the Asociación Herpetológica Española (AHE) – Spain's answer to SSAR] at the Universidad de Granada, have up-dated natural history information, included both replacement, and additional, photographs, and completely revised distributional information using the AHE's computerized data base of nearly 200,000 records. Each species account is introduced by a generally superb color portrait that often includes an insert illustrating the head. Species identification is facilitated by Salvador's excellent line drawings, both in diagnostic keys and within species accounts. The bibliography guiding the user to additional information found at the conclusion of each species account in the former edition is, however, no longer provided in this edition and readers are encouraged to visit www.vertebradosibericos.org for continually updated information. Errors noted in the former edition have been corrected, but two photographs are labeled incorrectly: the juvenile turtle pictured on p. 44 is *Emys orbicularis,* not *Mauremys leprosa,* and the female *Podarcis carbonelli* pictured on page 245 is actually a male.

The degree of reptile species diversity present in Spain places an elevated responsibility upon the country for facilitating conservation. While both editions address general threats to survival and protective legislative measures among comprehensive introductory materials, species accounts in this version also contain a "State of Conservation" section. Survival status within Spain, as well as status throughout a species' entire range, are each provided and specific threats are elaborated in this section. The stated degree of concern for *Gallotia galloti* (p. 350) is incorrect, it is actually considered to be of "minor concern." Survival of *Iberolacerta aurelioi,* an endangered species restricted to the Pyrenees Mountains, is threatened by ever-increasing vehicular traffic and alteration or destruction of habitat due to the construction and maintenance of infrastructure required to support skiing, trekking, and hydroelectric power generation. Only ten years on the faunal list and already this unique species is being threatened by man's activities in rugged mountainous areas of northern Spain, southern France, and northeastern Andorra.

Introduced species are becoming a disturbing feature of life among the earth's expanding and increasingly mobile human population, and the former edition reported introductions of *Anolis carolinensis, Pelodiscus sinensis, Pseudemys picta,* and *Trachemys scripta*. As serious threats to aquatic systems, all turtle species, in my opinion, should be considered invasive species when introduced to non-native habitats, and be closely monitored and/or controlled where necessary. The 2013 edition reports significant expansion between 2002 and 2013 in localities reporting *Trachemys scripta* (see maps, p. 46, in each edition). This turtle, once ubiquitous in the United States wherever pets are sold, is now more widely-distributed in the autonomous regions Catalonia (especially around Barcelona) and Andalucía

(especially around Sevilla, and coastal portions of Málaga, Granada, Cádiz, and Huelva Provinces) than reported in 2002. In this edition the New World endemic is newly reported from autonomous regions Castilla-La Mancha and Galicia (Pontevedra Province), and appears widely-distributed throughout Madrid Province. A newly added section, "Introduced Snakes in the Canary Islands," informs us that the parthenogenetic *Ramphotyphlops braminus*, discovered on Gran Canary Island in 2004, and *Lampropeltis getula*, discovered there in 1998, can today be considered established introductions. The kingsnake eradication campaign that began on Gran Canary Island in 2007 did locate and remove 92 specimens from the wild in 2008, and an additional 131 specimens in 2009—an indication there is an established population on Gran Canary Island.

Producing a guide to the fauna of any area is extremely complex, and these authors have done an admirable job capturing and incorporating recent data in light of the massive increase in herpetological research being done in Spain today. While new maps suggest a slightly reduced number of records for some species, these maps are more accurate than those previously presented because AHE's database includes only checked and verified distribution data. When I noted some quadrants on sea turtle maps non-randomly colored a darker blue than others, I queried the authors. The darker blue quadrants are those from which fishing boats, etc., had reported at-sea sightings and the small red circles along the shoreline represent records from beaches and harbors. This explanation was inadvertently omitted from the Introduction.

Psammodromus hispanicus is listed in the tables of contents, alphabetical indexes and species keys for each volume as a single entity. In 2002 this species was considered to be represented by two subspecies, but recent investigations by Fitze et al. (2011, 2012) have determined *Psammodromus hispanicus*, *Psammodromus edwardsianus*, and *Psammodromus occidentalis* to be separate lineages and this version incorporates this recent taxonomic rearrangement in a single section (pp. 289–294). The frontispiece, unlike the four color plates in the species account, however, is not labeled as to species but is suggestive of *Psammodromus occidentalis*. Line drawings in this section have been reprinted from the earlier edition and likely represent *Psammodromus hispanicus*, but are not so-labeled. Fitze et al. (2012: Fig. 1) provide a map of "prospective" distribution for the three species but this edition includes only one map for all three species without any suggestion as to which species may be found where. The variation section does present a broad delimitation of ranges as understood for these recently distinguished taxa, however. Explanation for these anomalies of presentation in an otherwise up-to-date, well-presented guide are likely the result of two competing issues: independent genetic lineages (species) identified using DNA techniques are often difficult to distinguish morphologically (see color photographs in the present edition) and placement in the species key may not have been appropriate at the time this volume went to press (all species could have been listed together in the key couplet leading to *Psammodromus hispanicus*, however). The map for the two species of *Blanus* (p. 91) also lacks indications regarding prospective distributions. In any event, users of this guide are informed with regard to these newly discovered taxa and made aware of problems involved with casual identification and determination of precise distribution limits.

In the realm of popular guidebooks, this *Guía* is, as was the earlier edition, lavishly illustrated and very well-presented. If you are already interested in European reptiles you will find it a necessary addition to your bookshelf. If you have not yet visited Spain, or enjoyed this country and experienced the excitement of your first encounter with its reptile fauna, now is the time—and this is the one guide you will find most helpful.

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Collecting and Preserving Genetic Material for Herpetological Research

Tony Gamble. 2014. SSAR Herpetological Circular No. 41 (www.ssarbooks.com). 50 pp. Softcover. US $11.00. ISBN 9780916984885.



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Since publication of the Hillis et al. (1996) classic review *Molecular Systematics*, technological advances in the rate and amount at which various classes of molecular data can be collected, coupled with cost reductions and increased computational power for analyses of large data sets, have fostered a steady expansion of the kinds of biological questions to which molecular data sets are being applied. The dizzying pace at which these advances have occurred challenges investigators to keep abreast, and this review by Gamble provides a thorough but easily accessible review of methods for collecting and preserving genetic material for a broad range of research themes in herpetology.

The publication includes a brief Introduction in which Gamble emphasizes that studies of amphibians and reptiles have been at the leading edge of many of these advances, and given the time and cost of field work, the collection and preservation of samples for molecular studies is the single most important component of these research programs. The text is for people with a basic background in biology, and complements the work of Simmons (2002) on how to collect, euthanize, and preserve voucher specimens for museum collections, and Beaupre et al. (2004) for guidelines to practical and ethical issues in herpetological field and lab research.

The first two of the paper's four chapters are short. Chapter 1, "Why collect genetic material?," summarizes the many uses of molecular data in biological research, what tissues are collected and how they are preserved, whether these will be acquired via loans or field collected, and whether field work is general (as in poorly-sampled regions), or targets specific taxa. Gamble identifies three emerging trends that are likely to increase exponentially: genomics (see Haussler et al. 2009, for details), studies of amphibian pathogens, and species identification via DNA barcoding. Each of these topics is further elaborated in separate paragraphs, and the final point made is that properly archived tissues can also be used to detect environmental contaminants or in stable isotope studies of foodwebs. Embedded Box 1 describes methods for extracting/sequencing DNA and detection of the *Batrachochytrium dendrobatidis* (*Bd*) fungus, as well as targeted enrichment and next-generation technologies for sequencing fragmented DNA from formalin-fixed/ethanol-preserved museum specimens, but emphasizes that most of us will continue to need access to field-collected tissue samples archived for molecular genetic studies. Chapter 2, "The Science of Preserving Genetic Material," describes processes by which DNA and RNA may be degraded if improperly preserved and stored under field conditions, and ways to protect field-collected samples.

Chapter 3 is the longest and devotes 18 pages to "Methods for Collecting and Preserving Genetic Material," and includes eight figures and three boxes. The introductory paragraphs and Box 2 summarize "Things to avoid when storing genetic material." The topical coverage is extensive and begins with a "Permits and Ethics" section that emphasizes laws governing collection and transportation of wildlife, and those related to animal safety and welfare. This is followed by a short "Euthanasia" section summarizing means of humanely killing amphibians and reptiles that are usually acceptable to institutional Ethics Committees for this type of research.

The next three sections, "Documenting Samples," "Sample Containers/Packaging," and "Sampling Tissues from Specimens," offer clear descriptions and illustrations of accepted means of properly documenting collection of specimens. These include taking detailed field notes, geo-referencing localities, and field tagging specimens and tubes in which tissues are stored. Several methods are described for numbering tubes and also for maintaining field-collected samples so as to minimize degradation of nucleic acids. The last section covers types and amounts of tissue to be sampled, storage to minimize degradation, collection of "back-up" samples on filter paper blots, and treatment of scissors, forceps, etc. between excision of tissues to minimize cross-contamination. A separate paragraph is devoted to treatment of samples from which RNA will be extracted.

The "Nonlethal Sampling" section is one of the most extensive, and is justified by the many studies in which individuals must be non-lethally sampled (species of conservation concern, re-sampling of individuals through time, permitting issues in protected areas, etc.). Methods are described for collecting five classes of samples: buccal/cloacal swabs, blood, biopsies/tail/toe clips, shed skins, and "other," which includes DNA from mosquito blood meals (think "Jurassic Park"), frog DNA from carrion flies, dried snake venom, bone fragments taken from notching turtle shells, and reptile eggshells.

A short paragraph describes "Sampling Pathogen DNA," which may include: blood to detect lizard malarial parasites, skin swabs for amphibian *Bd* (which is illustrated in Fig. 7 and presented in detail in Box 3), liver or kidney (preferred) and toe or nail clips (less sensitive) to detect Ranavirus.

The final section in this chapter describes "Cell Culture," which is likely to be the least familiar protocol to most herpetologists; this requires collection of some tissue type under sterile conditions, which is then stored in a cell culture medium for establishing fibroblast cell cultures in a lab incubator. In my own experience, field-collected animals can be euthanized in a lab and tissue excision performed under sterile conditions in a laminar-flow hood. Sterile cells are then minced in a growth medium to establish fibroblast cultures for harvest; cultures may be subdivided to establish new cultures to increase cell populations available for harvest. In my example cultures were treated with colchicine to harvest metaphase chromosomes for cytogenetic studies (Sites et al. 1979), and we successfully extended the protocol to field conditions (sampling/storing mammalian ear clips under sterile conditions in a portable plexiglass field hood; Sites et al. 1981). Ideally, tissues are frozen slowly for LN^2 transport, although before the days of Mr. Frosty, this was not possible or necessary (Sites et al. 1981).

The final chapter, "Storage, Curation and Transportation of Genetic Material," provides thorough coverage of storing tissues, emphasizing the value of fresh tissues above all other kinds of samples for most studies, but also that there is no single preservation method for every possible downstream use. A short "Cryopreservation" section emphasizes flash freezing of tissues in LN^2 as most effective for preserving the highest quality DNA and RNA, and how this can be done. This is followed by short section on "Desiccation," and then an expanded treatment on "Fluid Preservation," which is most relevant to researchers working in remote areas without access to any form of cold storage. Under these conditions high-salt solutions (RNAlater®) or 95–100% ethanol are the preferred media for keeping DNA/RNA intact, but because ethanol is considered a hazardous material (flammable), shipping ethanol-stored tissues requires proper documentation and package labeling. A final section described other fluid preservatives, followed by a short paragraph on "Long-term Tissue Storage." A brief but important section covers "Shipping" of tissue samples, and the last describes "Museum collections"; both of these are rich in detail and will inform researchers from multiple disciplines. Gamble emphasizes archival of tissues in research collections that link to online databases (HerpNet, VertNet, etc.), and eventually standardizing links between published sequences, tissues, and voucher specimens. When voucher specimens are not available (non-lethal sampling), options include use of DNA barcodes to verify identifies. Lastly, because tissue collections are unique in that loans usually not returned after use, amplification of whole genomes (using GenomiPhi) would permit return of the loan as an amplified genomic sample.

I found this contribution to be clearly written, well-organized into a logical sequence, with figures and boxes appropriately placed in the text, and no missed citations. Figure 4 would convey more clarity if it had been a more close-in photo, but overall Gamble has contributed a publication that will be of great service to multiple groups of researches both in and far beyond the taxonomic boundaries of herpetology.

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Mountain Dragons—In Search of Chameleons in the Highlands of Kenya

Jan Stipala. 2014. Privately published (available from the author, at 2 Murtons Terrace, Lanner, Cornwall, TR16 6HW, United Kingdom). 124 pp. Hardcover. £26.00 (approximately US $42.00). ISBN 978-0-9928176-0-2.

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The late Alex Duff-MacKay, senior herpetologist at Kenya's National Museum for 30 years, once wrote that chameleons "can melt the heart of bank managers" (MacKay 1994). Beautiful, brightly-colored charismatic lizards of Africa and its surroundings, chameleons have found their niche in the highlands of eastern and south-eastern Africa. Tanzania has 40 species and Kenya has 24, many endemic. No other mainland African country approaches those sorts of numbers. Those that entered the forests have developed strange, often unfathomable head ornamentation. Chameleons have inspired many enthusiasts, generated Facebook groups and stimulated the production of richly-illustrated books, for example Necas (2004), Tolley and Burger (2007), and Tilbury (2010). The book by Tilbury, a medical doctor and lifelong chameleon enthusiast who travelled the length and breadth of Africa in search of

chameleons, was regarded as the last word. But since its publication several new species have been described. Now biologist Jan Stipala has made his contribution, with this beautifully produced, large format book (30 × 30 cm, an unusual size).

This book is proof of what you can do with a bit of enthusiasm. Stipala spent a year exploring the magical mountain forests of the highlands of Kenya, in a battered Toyota Land Cruiser that he bought cheaply, accompanied by herpetologists from the National Museum of Kenya and game scouts. When the team managed to get the vehicle back from the repair shop and into the field they got stuck in the mud, frozen and soaked at high altitude, had encounters—some scary—with elephant and buffalo, were stalked by a leopard, and had a drunken game scout shoot a hole through the roof of the Land Cruiser. But, in the high country they also located, and described two new species of chameleon (Stipala et al. 2011, 2012), one of which required a wet four-day trek onto Mt Kinangop in the southern Aberdare Range. They also recorded a Tanzanian and a Sudanese species in Kenya for the first time, and documented numerous range extensions. These are all documented here.

The book opens with several full-page and double page photographic spreads of chameleons and their habitats. There follows a preface, introduction and rationale, some useful maps and background information on the landscape, climate, geological history of highland Kenya and fieldwork techniques (including a page on how to catch chameleons). There is a seventy-odd-page travelogue, describing the team's adventures visiting 12 mountain massifs of southern and western Kenya, two pages on chameleon farming, twelve pages of species profiles documenting eleven Kenyan chameleon species, nine pages detailing the research, a page on chameleon photography, an index and a short bibliography of 23 pertinent references. The species profiles have three or four representative pictures, a map with spot localities, an elevation profile and entries under the headings: size, description, distribution, ecology, behaviour, reproduction and taxonomic comments. The maps greatly expand our knowledge of the range of these species within Kenya, every species shows range extensions beyond that documented by Spawls et al. (2002). The research section has some useful phylogenetic trees and maps showing haplotype distributions. I noted with interest that these interlace elegantly with the known dates of uplift of the various sections of the Kenyan Rift Valley and the associated volcanic mountains (Spawls and Mathews 2013).

The text is lucid, entertaining, and informative; Stipala's easy style reads well. The color photos are one of this book's strengths. There are over 360, showing the land and the chameleons. The habitat pictures are superb, with panoramic views that would not be out of place in *National Geographic*. The chameleon pictures are equally good, illustrating some 12 species of Kenyan chameleon, some the first records for the country. Many are finely composed, showing the animal relaxed in the landscape, and all are taken by daylight; a refreshing technique in these days when the general consensus seems to be that chameleons are best photographed by flash, at night, after infuriating them into displaying defensive colors, and then boosting the colors digitally. There is an astonishing sequence of pictures, showing two vivid blue-green and yellow Jackson's chameleons (*Trioceros jacksonii*) from Machakos having a scrap in a coffee bush. It's all here, the attendant female, the confrontation, the horns locking, finally the defeated male changes color and slinks off. And sadly the female then rejects the victor, hissing at him to keep away. The course of true love hardly ever runs smooth!

Stipala concentrated his research on two species, *Trioceros jacksonii* and *T. hoehnelii*, and the morphology section is largely concerned with these two species, with data on body size variation, how it correlates with elevation and a Principal Component Analysis of head morphometrics in *T. hoehnelii*. The bulk of the photographs are of these two species. I thought I knew both but there are color varieties and forms here that I have never seen, from places where I would not have thought of looking. I know the dry coniferous forest of the northern slopes of Mt Kenya fairly well, but have never found a chameleon there. I gnashed my teeth to find out that there is a Jackson's Chameleon there with bright blue and orange skin around the eye!

At £26 or US $42, this book represents remarkable value for money when you consider how much many specialized reptile books cost nowadays. I perceive a few shortcomings; there are 75 pictures of *Trioceros jacksonii* and 63 pictures of *T. hoehnelii*, an indulgence that can creep in when you are your own editor. By cutting some of these Stipala could have covered a few more of Kenya's chameleon species. I would liked to have seen details of the localities shown on the spot maps. There is the odd typo; Stipala has managed to lose one of his own co-authors from the citation of their description of *Trioceros kinangopensis* (Stipala et al. 2012). But overall, this is a bewitching, beautiful book, it brings alive the landscape, the chameleons, and the ordinary citizens of highland Kenya. All chameleon enthusiasts, East African herpetologists, and Kenyaphiles will want it—and many will want to visit. Jan Stipala has taken us into the heart of highland Kenya and its enchanting chameleons.

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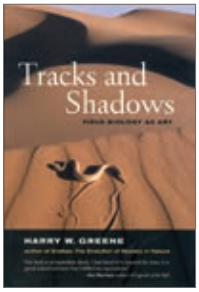
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Tracks and Shadows. Field Biology as Art

Harry W. Greene. 2013. University of California Press, Berkeley & Los Angeles, California (www.ucpress.edu). xiii + 280 pp. Hardcover. US $29.95. ISBN 978-0-520-23275-4.



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For those who don't know, Harry Greene is the Stephen H. Weiss Presidential Fellow and Professor of Ecology and Evolutionary Biology at Cornell University, a recipient of the E.O. Wilson Award from the American Society of Naturalists, and a recently elected member of the American Academy of Arts and Sciences. Previously he spent 20 years on the faculty of the University of California at Berkeley, where he played a seminal role in interpreting the phylogenetic context of reptile behavioral ecology (Greene 1973, 1979, 1983, 1986, 1988, 1994a, 1999). The quality of Greene's writing is superb, as demonstrated by his previous book (1997) — *Snakes: The Evolution of Mystery in Nature* (hereafter referred to as *Snakes*) — which won a PEN Literary Award.

Unless you know Harry Greene or what he does, however, there is not much in the title of this book to signal its herpetological interest. The cover shot of Peringuey's Adder (*Bitis peringueyi*) side-winding across Namibian dunes may give some indication into the scope of the inner essays, but not the blub on the dust wrapper: "Intellectually rich, intensely personal, and beautifully written, *Tracks and Shadows* is both an absorbing autobiography of a celebrated field biologist and a celebration of beauty in nature." This is an accurate and nice summary, but the book could still be about flowers or pretty bovines.

Tracks and Shadows is divided into three parts. The first, 'Descent with Modification,' is a nice play on the forces that influence the trajectory of an individual life. It elegantly interweaves the punctuated equilibria that result from the impact of tragedy and renewal. Whilst in essence this is part autobiography, the story also entwines the lives of other herpetologists, particularly Henry Fitch who mentored Greene in his early studies. Fitch's early, quiet, formative influence is in contrast to Greene's own wild, disrupted youth. Many will be surprised at some of the events relived in these pages. It certainly made me realize how simple and peaceful has been my own journey. Meaning in life is not an objective but a personal perspective, and this section of *Tracks and Shadows* reiterates the impacts of pain and renewal that characterize a life's journey.

In the middle section, 'Conversing with Serpents,' Greene retraces his own broad studies on different groups, particularly the various aspects of what it means to be a snake. It covers the period in which Greene's studies and papers really influenced conceptual thinking in herpetology and in the evolution of behavioral ecology. Henry Fitch had patiently documented the autecology of Kansas reptiles, many of which were summarized in his monograph on *A Kansas Snake Community* (Fitch 1999), and various reviews of reptile biology (1981, 1982). The youthful Greene was more synthetic in his approach, placing these and other observation in a more phylogenetic context. This section, however, is more than historical narrative as it also introduces a more general discourse on what it means to be a field biologist.

On starting this review I glanced at *Snakes*. It is full of good prose and insight. This time I happened to open at the chapter on basal snakes, and noted a sentence on increasing insight into the lives of Boa Constrictors. The section reads: "Some tantalizing chance observations suggest that the best is yet to come, that there is much more to being a huge serpent than we realize." The quote captures both Greene's fresh style and questioning mind, but I bet even he was later gob-smacked when learning that boas (Booth et al. 2011a) and other species (Booth et al. 2011b, 2012) may undergo "virgin births" (facultative parthenogenesis), displaying previously unappreciated reproductive flexibility. Moreover, Indian Pythons are now known to display "homing" abilities (Pittman et al. 2014), admittedly a poignant and problematic term for discoveries made on an introduced Florida population. These are sophisticated behaviors, and highlight how easily our anthropocentric ego confuses "basal" with "primitive." Greene may be right when he notes that "A book that captures the majesty of giant snakes has yet to be written," but his own brief summary (Chapter 9) makes a good start.

In the final section Greene allows himself to ponder larger issues and present his views on the central role of organismal biology and the enlightenment that comes from contemplating nature. Science and the humanities are often juxtaposed as if they were alternate views of Life, as if a scientific outlook somehow deprived the world of beauty and poetry. The distinction between these two cultures (Snow 1959) is artificial, and belies the creativity that attends scientific insight. By fieldwork Greene doesn't mean prosaic mud and fresh air, but rather the opportunity to observe and discover. It is not simply observed natural history, although both Fitch and Greene have defended the value of the anecdote. Rather, it is seeing Life's inter-relatedness, opening oneself to the opportunity for the creative moment when the forest becomes more than the trees. Greene's prose and evocative text ("mud-smudged") says it much better.

It is difficult to find suitable language to describe new discoveries of the rich, subtle complexity of reptile life. In part, Science has been its own enemy, insisting on non-emotive descriptions. Yet, the natural fear associated with snakes because of a venomous minority requires vigorous rebuttal and positive appeals. Too often public perception views evolution as laddered, with "lower vertebrates" primitive, governed by instinct and possessing limited behavioral flexibility. Greene argues against anthropomorphizing animals, but has been challenged (Walker, 2014) for this same "sin" when he notes "that blacktail and timber rattlesnakes hunt mammals, lie around after big meals, search for mates and wrestle with rivals, court and mate, give birth, and attend their young." However, none of these actions (hunt, lie, search, wrestle, court, mate, attend) are anthropomorphic. They are simple verbs that describe the parameters of Life. That they should be considered only applicable to humans, and their use in describing snake behaviors as anthropomorphic, perfectly reflects the modern lack of "connectedness" to wildlife that is one of Greene's major concerns.

Concern for the loss of Natural History as a central axiom of biological science is a common theme in Greene's publications (1993, 1994b), and is increasingly noted in other works (Tewksbury et al. 2014; Wilson 2014). For some, I am sure, it thus seems paradoxical that Greene centers himself within the natural world via hunting, by insisting that he embrace the predator within. Personally I do not find this necessary but as I live in Africa,

perhaps I'm more aware of the coin's flip side. Greene is also an advocate of Pleistocene re-wilding to repair and reintegrate damaged ecosystems. In the North American context it urges the re-introduction of large mammals and their associated predators, or ecological proxies where these have become extinct. This is already happening, albeit in a limited, non-threatening, and easily reversible manner, using giant tortoises as surrogate herbivores (Burney et al. 2012, 2013; Griffiths et al. 2013). These selective grazers are being used to clear island ecosystems of alien vegetation after the extinction of indigenous avian grazers (e.g., the Dodo in the Mascarenes and the *moa nalo*, a flightless duck, in Hawai'i). However, re-introduced large mammalian herbivores and carnivores may come into more direct conflict with humans. In Africa I have stumbled into lion and buffalo whilst herping in the bush, and have also come too close to crocs and hippo when preoccupied with collecting frogs at night. These are real dangers, and although Greene notes that deaths from lion in Tanzania did not make the top 50 mortality categories in the country, this is no solace to the 40 families bereaved by lion kills each year.

This book is subtitled "Field biology as art," and Greene states that "I aim to persuade others to get out there and learn more about themselves." The biggest challenge for many may be finding their place in an indifferent universe, and regaining a lost connectedness to our biological heritage offers a rebuttal to a human arrogance that demands dominion over the whole Earth. In the preface to this beautiful book, Harry writes of the acceptance of personal loss: "Studying predators, I contemplated violence without evil, death without tragedy." Later he delights in finding a lost and favored quote — *The Earth is mostly a bone yard, but pretty in sunlight* (McMurty 1985). This review ends with my own favorite aphorism, anonymous and black, and taken from my son's surfing magazine a generation ago. I offer it in thanks for a book that is timely, thought-provoking and which, more simply, I thoroughly enjoyed.

"It's not that Life is short it's just that you're dead for such a long time."

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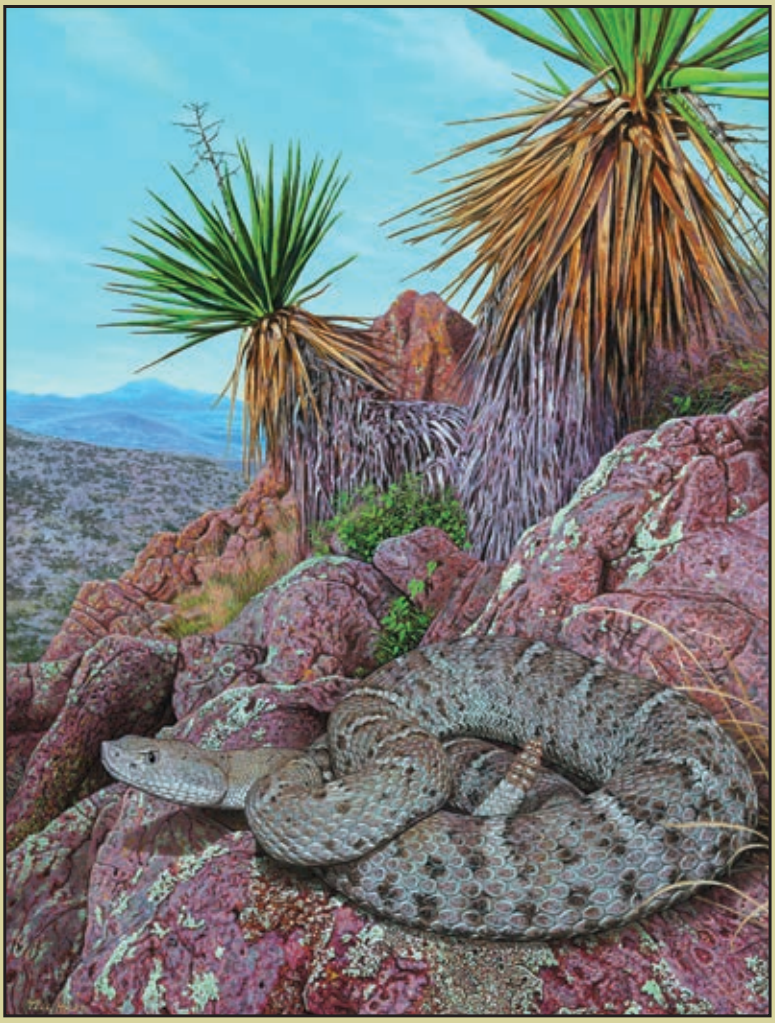
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The New Mexico Ridge-nosed Rattlesnake
Tell Hicks — oil on canvas 26" x 20"

The Ridge-nosed Rattlesnake (*Crotalus willardi*) is one of the smallest rattlesnakes found in the USA and northwestern Mexico. It is a montane species with a very limited distribution. The New Mexico Ridge-nosed Rattlesnake (*C. w. obscurus*), one of five subspecies currently recognized, occurs in the Sierra San Luis in Sonora, Mexico, as well as the Animas and Peloncillo Mountains of New Mexico. Its total range includes the Sierra San Luis, in Mexico, and the Animas Mountains and Peloncillo Mountains of New Mexico and extreme southeastern Arizona. It is listed as a Threatened Species under the U.S. Endangered Species Act and is fully protected.

This painting, by wildlife artist **Tell Hicks**, depicts the snake in typical habitat in the remote Peloncillo Mountains. It will be used as the cover artwork for a forthcoming book, *The Rattlesnakes of Arizona*, edited by Gordon Schuett, Randall Reiserer, and Charles Smith. The book will included peer-reviewed contributions from leading rattlesnake researchers, and will feature over 20 highly detailed illustrations by Hicks. The book's release is set for late 2014 (ECO Publishing; ecouniverse.com).

Tell Hicks is a professional wildlife artist, specializing in reptiles and amphibians. He was born in London and has a studio in Somerset, in the UK, where he lives with his wife and family. A founding member of the International Herpetological Society in the 1960s, he has recently served as its President. He is an active conservationist and in the 1960s assisted with the field study that successfully led to the legal protection of Britain's most endangered amphibians and reptiles.

As a teenager, he worked in British zoos before travelling through Europe and Asia, to Australia, catching and painting reptiles and other wildlife along the way.

His passion for herpetology and natural history continues to take him around the world, gathering material for his highly detailed paintings, and he regularly gives talks to wildlife groups and natural history societies, about his work and travels to such places as Turkey, Cyprus, Canary Islands, Australia, New Zealand, The Galapagos Islands, Peru, and the USA.

Tell has won major awards within the screen-printing industry, for his t-shirt designs, and still produces work for Eco and other leading t-shirt printers in the USA and Europe. Examples of his paintings are on display in several museums, including the Chiricahua Desert Museum, Rodeo, New Mexico, where his large mosaic of a Gila Monster and 16-ft metal sculpture of a rattlesnake tail can also be seen.

Many of his paintings are available as limited edition prints from www.tellhicks.com (Europe), or www.ecouniverse.com (USA) where t-shirts and caps featuring his artwork are also available.

ABOUT OUR COVER: *Eurycea cirrigera*



Salamanders of the genus *Eurycea* are a diverse and widespread group in the eastern and central United States. They vary significantly in natural and life history, including several groups which exhibit paedomorphosis. Bonnett et al. (2014. Evolution 68[2]:466–482) examined the evolutionary history of metamorphosis in spelerpine salamanders and demonstrated a positive correlation between the evolution of paedomorphosis and both cave-dwelling and arid surface environments. In *Eurycea*, several lineages have independently evolved paedomorphosis, including a clade of subterranean species from the Edwards Plateau of Texas, multiple populations of *E. tynerensis* in the Ozark Plateau, the aquifer-dwelling *E. wallacei* of the Southeast, and the recently described *E. subfluvicola* of the Ouachita Mountains (Bonnet et al. 2014, *op. cit.*; Steffen et al. 2014. Zootaxa 3786[4]:423–442). The Two-lined Salamanders (*E. bislineata* complex) are a widespread clade with five described species. Generally, their life history is characterized by a several-year aquatic larval phase followed by metamorphosis into semi-terrestrial adults. Mount (1975. The Amphibians and Reptiles of Alabama. Univ. Alabama Press. 268 pp.) reported that neoteny was "not uncommon" in *E. cirrigera* in Alabama, and Rose and Bush (1963. Tulane Stud. Zool. 10:121–128) described a form of expedited sexual maturity in *E. aquatica* as it approached metamorphosis, but true paedomorphosis is otherwise unreported in the *E. bislineata* complex until now. Pictured here is a paedomorphic *E. cirrigera* containing 51 ova that was found in Athens, Georgia. Return trips to the site of collection revealed gravid, metamorphosed female *E. cirrigera* and many non-mature larvae of a smaller size, but no additional paeodmorphs.

The cover image was captured by **Todd W. Pierson**, an incoming PhD student to Dr. Ben Fitzpatrick's lab at the University of Tennessee. His research interests largely encompass the ecology, evolution, and conservation of plethodontid salamanders. He currently works in Dr. Travis Glenn's lab at the University of Georgia, where he helps develop genomic and environmental DNA tools.

The cover image is a composite of two photographs taken from directly above and directly below a shallow aquarium suspended off the ground—a photographic style adapted from Danté Fenolio. Dust and scratches in the glass were later removed in Photoshop. The image was recorded using a Canon 7D, 100mm Canon macro lens, and two off-board flashes fired through LumiQuest SoftBoxes. The photograph was captured at ISO 200, 1/200-second shutter speed, and f/20 aperture.



PHOTO BY JEFFERY PIERSON

SSAR BUSINESS

Roger Conant Grants-in-Herpetology Program: Guidelines for Proposal Submission

Proposals will be accepted for the 2015 SSAR Roger Conant Grants-in-Herpetology Program starting on 15 September 2014. This program is intended to provide financial support for deserving individuals (with a primary emphasis on student researchers) or organizations involved in herpetological research, education, or conservation.

Important Updates

In Summer 2013, the SSAR Board of Directors allocated additional funds to support this program. As a result, a total of 12 awards, rather than the traditional six awards, will be granted (based on merit) in a given year, starting with the 2014 grant cycle. A new grant category was also approved for the 2014 grant cycle: Undergraduate Research in Herpetology. See the description of this new category below.

Updated criteria and outcomes have been posted for the grant proposals in the Herpetological Education Category. Please see those below.

Reminder: a liability waiver must be submitted with all grant requests. See further details on the SSAR website.

Who Can Apply?

All applicants must be students AND members of SSAR with the following exceptions:

> Those applying for the International category must be students but DO NOT have to be SSAR members.

> Those applying for the Herpetological Education category DO NOT have to be a student or SSAR member.

> Those applying for support of regional herpetological society projects DO NOT have to be SSAR members.

In keeping with the Society's goal of encouraging participation by the broadest possible community of applicants, preference may be given to individuals who might not have access to other funding sources. Applications must be submitted by individuals only (but see special considerations for education categories below).

Grant Amounts and Deadlines

Successful applicants in each of the categories listed below will receive an award in the amount of US $500. It is possible that two grant proposals will receive funding per category if reviewers feel this is warranted. The deadline for submission is 15 December 2014 (see special note on membership dues below). The awards will be announced by May or early June 2015.

Grant Proposal Categories

- ***Conservation of Amphibians and Reptiles.***—Proposals should outline a conservation-oriented research project. This project may focus on species endangered or threatened at the state, national, or international level, or address research on potentially threatened habitats or species, or on introduced injurious species.

- ***The Andrew H. Price Field Research Grant-in-Herpetology.***—Proposals may address needs for field station fees or equipment and materials in field oriented projects, or the field work portions of broader studies. This might include in-situ behavioral studies, ecological, life history, or sexual selection studies. Survey work by individuals or regional societies may be submitted here or in TRAVEL below depending on how the funds are to be used.

- ***Laboratory Research.***—Proposals may address needs for equipment or materials in laboratory projects or laboratory portions of broader projects. This might include studies in behavior, biochemistry, molecular biology, biomechanics, or physiology.

- ***Travel.***—Proposals may address support for travel to field study sites near or far, or to utilize distant collections or facilities. If funding is sought to get from one place to another, proposals should be submitted in the TRAVEL category. Proposals normally submitted in the CONSERVATION or FIELD RESEARCH categories should be submitted here if travel funding is being sought.

- ***International.***—Proposals may address needs in any of the above five categories. The applicant must be a student, but not necessarily a SSAR member. Preference will be given to students with limited access to research funds and in countries where herpetological research has historically been underfunded. Note Regarding Eligibility in the International Category: In 2011, the SSAR Board of Directors decided that proposals in this category would only be accepted if they were submitted from institutions OUTSIDE of the United States. Proposals from students who are primarily affiliated with United States institutions are not eligible for this category.

- ***Herpetological Education.***—Proposals may address an educational project or start up support for an educational program in a zoo, museum, park, nature center, regional herpetological society, etc. The project must focus on a herpetological topic. Note: Although proposals for institutional projects are accepted, education proposals must be submitted by an individual (either sole applicant or principal contact person for the project). Applicants need not be students or SSAR member.

- ***Undergraduate Research in Herpetology.***—Proposals in this category can outline any research project focused on questions related to amphibian or reptile taxonomy, biology, ecology or conservation. Funding can be used to purchase equipment, materials, or as re-imbursement for travel to conduct research (i.e., offset the cost of gas for trips to field sites, museums to investigate specimens, etc.). Applicants must be currently seeking a Bachelor's Degree at an institution of higher learning. Applicants need not be affiliated with US institutions, and international applicants need not be SSAR members. Students that apply for this award must be working directly with a research advisor at an academic or professional institution (i.e., University, Regulatory Agency, Zoological Garden, Museum, etc.). This advisor must submit the letter of support for the student's work. This letter of support must explicitly confirm that the applicant is currently a student and has the time, ability and guidance to successfully complete the proposed project. Strong preference will be given for applicants that have limited funding from other sources.

Additional information and requirements are posted on the SSAR website at: ssarherps.org/pages/GIH.php. All proposals must be submitted electronically to kapferj@uww.edu as a single PDF file named "lastname-category.pdf" no later than 15 December 2014 to be considered (letter of support may be included with the proposal or sent separately). Exceptions to electronic submission and file format may be allowed for special cases with prior approval by SSAR-GIH Chair.
Failure to meet these guidelines may result in elimination of a proposal from consideration.

Successful applicants are encouraged to submit the results of their research for publication in the *Journal of Herpetology* or *Herpetological Review*, and/or to present their findings at the annual meeting of SSAR. Submit proposals or questions regarding application procedures to: Joshua M. Kapfer, Chair, SSAR Grants in Herpetology, Department of Biological Sciences, University of Wisconsin-Whitewater, Whitewater, Wisconsin 53190, USA (e-mail: kapferj@uww.edu).

Grants-in-Herpetology Donor Information

Financial contributions by SSAR members, institutions, and other benefactors support this program significantly, and can increase the number and/or size of awards. Your tax-deductible (for US taxpayers) contribution to this program will directly benefit meritorious research and education in herpetology. Contact the SSAR Treasurer for additional information about contributing to the Grants-in-Herpetology Program. If you are employed by an organization that will match donations made to nonprofit organizations, please notify your employer that you have made a donation to the Grants-in-Herpetology Program.

SSAR wishes to thank the many grant reviewers and donors that have instrumental in the success of the Roger Conant Grants-in-Herpetology program for the last several decades. In particular, we would like to thank Tom Beauvais for his generous financial support of this program. We would also like to thank Rebecca Christoffel, whose comments and suggestions greatly improved the guidelines for grant submissions in the Education Category.

Metter Memorial Award, 2014

This year's Dean E. Metter Memorial Award goes to Brenna Forester, a PhD student at Duke University in the Nicholas School of the Environment. Her dissertation advisor is Dean Urban. Forester's proposal is entitled: *Evaluating the Implications of Local Adaptation, Habitat Connectivity, and Gene Flow for Terrestrial Salamanders under Global Change*. She will use molecular techniques to detect adaptation, habitat connectivity, and levels of gene flow in natural populations of the eastern plethodontid

salamanders *Plethodon cinereus* and *P. welleri,* both of which inhabit areas in fragmented and warming habitats. One important general goal of the study is to determine actions that will be effective in conserving salamander biodiversity under a global change regime.

Like many other Metter Award winners, this proposal has clearly identified research questions, developed working hypotheses to test during the course of the research, and involves both laboratory and field work. Congratulations to Brenna!

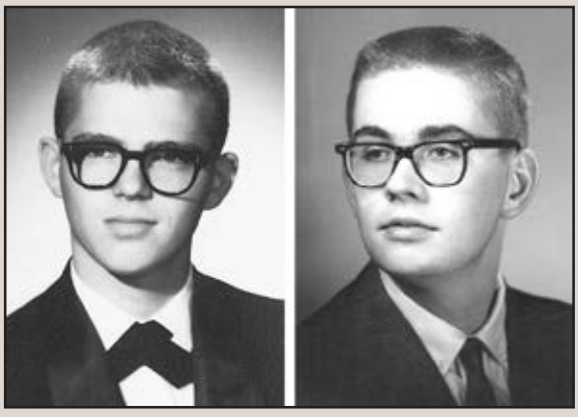
Proposals for the Metter Award are due on 30 March each year. Information about the Metter Award, including application details, may be found on the SSAR website: ssarherps.org/pages/metter.php.

NEWSNOTES

SSAR Members Elected to American Academy

Among the zoological disciplines, herpetologists are unusually well represented in the American Academy of Arts and Sciences, one of the nation's oldest and most prestigious honorary societies, headquartered in Massachusetts. This spring, in the most recent round of inductions, two more of our most outstanding brethren were selected: **Harry W. Greene** (Cornell University) and **Eric R. Pianka** (University of Texas at Austin). Their careers developed with some striking parallels. They both attended small, private colleges in then relatively unpopulated parts of the country: Texas Wesleyan in Forth Worth and Carleton in Northfield, Minnesota, respectively. Both men became professional ecologists—Harry in behavioral ecology and Eric in population ecology—and today are among our most notable writers of serious natural history. Perhaps most significantly, their interest in reptiles began at a very early age. Both joined the Society in the early 1960s (see photos) when it was still called The Ohio Herpetological Society. As the Society matured and became SSAR, they both published in its principal scientific journal, *Journal of Herpetology.*

Harry, moreover, made a signal contribution to SSAR and to our field when, as a graduate student, he had an idea to publish short natural history notes on herps, and wrote to the then-editor of *Herpetological Review*, Herndon Dowling. SSAR has long prided itself on a willingness to try out good ideas, including those of students and serious amateurs, and the result of Harry's idea is today's "Natural History Notes" section. Still running after more than 40 years, it is now greatly expanded and in full color, and it has been imitated in numerous herpetological journals literally around the world.



Harry Greene (left) and Eric Pianka (right), as budding herpetologists in the early 1960s.

SSAR congratulates Harry and Eric on this great honor, which they have so richly earned for their lifetime of work on the ecology of reptiles.



PHOTO COURTESY OF KELLY ZAMUDIO

Greene, admiring a freshly tubed Eastern Diamondback Rattlesnake, Little Saint Simon Island, Florida.



PHOTO BY BRYAN JENNINGS

Eric Pianka in the field in Western Australia, 1996.

Haskell Award 2014



PHOTO BY JEFFREY P. BONNER

The Alison Haskell Award for Excellence in Herpetofaunal Conservation is presented by Partners in Amphibian and Reptile Conservation (PARC), in memory of Alison Haskell (1956–2006). This award is intended to recognize an individual from North America who exemplifies extraordinary commitment to herpetofaunal conservation, has thus far been an unsung hero, and has shown exemplary commitment to building or strengthening partnerships.

We are proud to announce that the 2014 recipient of the Alison Haskell Award is **Dr. Jeffrey T. Briggler**. Jeff is currently the Herpetologist / Resource Scientist for the Missouri Department of Conservation. He has an unwavering commitment to hellbender conservation, which involved development of a head-starting and captive propagation program for Ozark Hellbenders at the Saint Louis Zoo as well as creation and design of artificial nest boxes used by hellbenders. Jeff also employed use of regulatory mechanisms, collaboration with land managers, and public outreach to enhance hellbender conservation. His leadership roles, innovative contributions to herpetofaunal conservation, and skill in building effective partnerships make him a very deserving winner of this award. Jeff is not only committed to hellbender conservation, but displays a continued commitment to further conservation of all other herpetofauna throughout the state of Missouri and beyond. SSAR congratulation Jeff on this well-deserved recognition.

EE Williams Research Grant

The Herpetologists' League is pleased to announce competitive grants for graduarte student research for 2015. These awards are named in honor of the late Ernest E. Williams, the first Distinguished Herpetologist of The Herpetologists' League. Awards of up to US $1000 will be presented to one winner in each of the following categories: Behavior, Conservation, Ecology, Physiology, Morphology/Systematics. Full details, including the application form and rules, are available on the HL web site at: http://www.herpetologistsleague.org/dox/eewilliamsgrant.pdf.

Note that the deadline for the 2015 award cycle is 15 December 2014.

Landers Student Research Award

The J. Larry Landers Student Research Award is a Gopher Tortoise Council competitive grant program for undergraduate and graduate students. Proposals can address research concerning Gopher Tortoise biology or other relevant aspects of upland habitat conservation and management. The amount of the award is variable but has averaged approximately US $1,000 per recipient over the last few years.

The proposal should be limited to four pages and include a description of the project, a budget, and a brief résumé of the applicant. This is an excellent opportunity for students to access funding for their project. Awards are typically recognized at the annual meeting to the Gopher Tortoise Council. Deadline for the application is 15 September 2014. Electronic submission is preferred. Please submit proposals to Bob Herrington (e-mail: bob.herrington@gsw.edu).

Reptile Database Update

A new version of the Reptile Database (http://www.reptile-database.org) was released in April 2014. This brings the total to 9952 species (including 30 described this year), up from 9789 noted here in June 2013. There are now 33,558 references (including 281 published this year), up from 31,315 a year ago.

Note that the 30 new species this year were described in 27 papers, of which an astonishing 25 were published in *Zootaxa*. By comparison, the 123 new species of 2013 were described in 90 papers of which only 49 were published in *Zootaxa*.

Selected Taxonomic News and Changes

Subspecies vs species.—In this release we have again elevated a number of subspecies to species level as these new "species" become more widely accepted (hence we have added more species to this release than were described as "new"). Shannon Torstrom and colleagues (2014. Mol. Phylog. Evol. 76:134–143) discussed the impact of genetics and species concepts in their recent paper, "Shedding subspecies: The influence of genetics on reptile subspecies taxonomy." While it is generally accepted that genetics should help to define species boundaries, Torstrom et al. "found that the midpoint genetic distances used for elevation ranged from 1.0% to 19.4%. However, the large difference between the median genetic distances used to elevate a subspecies (6.4%) compared to collapsing a subspecies (1.0%)" shows that genetic differences have been applied on a case-by-case basis rather than by using absolute numbers. Torstrom et al. also remind us that both mammals and birds have about two subspecies per species, a ratio that is dramatically different from reptiles which have less than 0.3 subspecies per species. It is unlikely that this reflects a biological difference but rather a "sociological" or philosophical one. In any case, we will reach the 10,000 species mark later this year. Notably, Australia will reach its own landmark with 1000 species shortly (currently at 996).

Boas and pythons.—Reynolds et al. (2014. Mol. Phylog. Evol. 71:201–213) proposed some signficant changes to the taxonomy of boas and pythons, including a rearrangement of the genera *Bothrochilus, Liasis, Morelia*, and *Sanzinia*. They also described a new genus, *Malayopython* (including *M. reticulatus, M. timoriensis*) and resurrected the genus *Simalia* for *S.*

amethistina, S. boeleni, S. clastolepis, S. kinghorni, S. nauta, S. oenpelliensis, and *S. tracyae*.

Blindsnakes.—Hedges et al. (2014. Carib. Herpetol. 49:1–61) proposed a new classification of the blindsnakes (Typhlopidae), currently containing 258 species. They erected a number of new subfamilies as well as eight new genera: *Indotyphlops, Malayotyphlops, Sundatyphlops, Xerotyphlops, Madatyphlops, Amerotyphlops, Antillotyphlops*, and *Cubatyphlops*. Note that some common species are also affected, e.g., *Ramphotyphlops braminus* has been renamed to *Indotyphlops braminus*.

Turtles.—Iverson et al. (2013. Mol. Phylog. Evol. 69:929–939) erected the genus *Cryptochelys* for a subset of *Kinosternon*. However, Spinks et al. (2014. Mol. Phylog. Evol. 76:254–260) rejected this genus based on phylogenetic gounds and revalidated *Kinosternon* for the six species of *Cryptochelys*.

Thomas et al. (2014. Zootaxa 3786[2]:141–165) described two new species of *Macrochelys*, or rather split up the Alligator Snapping Turtle, *M. temminckii*, into three species. A similar split has been previously suggested by Raymond Hoser although this was rejected by Thomas et al. See the Taxacom mailing list and other online fora for a debate about priority and related issues in this case.

Skinks.—Blair Hedges (2014. Zootaxa 3765[4]:317–338) proposed a new classification of skinks using a system of nine families: Acontidae (26 species), Egerniidae (58), Eugongylidae (418), Lygosomidae (52), Mabuyidae (190), Sphenomorphidae (546), and Scincidae (273) as well as the two new families Ristellidae fam. nov. (14 species) and Ateuchosauridae fam. nov. (2 species). Members of the Ristellidae (*Lankascincus, Ristella*) have been considered as members of the Mabuyidae (or Mabuyinae) while the family Ateuchosauridae is composed of only one genus, *Ateuchosaurus*, previously included in Scincinae/Scincidae. The seven other skink families suggested by Hedges are equivalent to the current skink subfamilies in the Reptile Database (Acontidae = Acontinae, etc.). A survey among skink specialists revealed some skepticism about the new arrangement and recommended to wait for more data to support the two new families, hence we haven't adopted them yet. However, we did make a few adjustments following Hedges as a few genera were still in the wrong (sub-) family, such as *Ablepharus* and *Lobulia* (previously in Sphenomorphinae, now in Eugongylinae). Note that skink taxonomy remains in flux. For instance, the classification used by Pyron et al. (2013. BMC Evol. Biol. 13:93; doi 10.1186/1471-2148-13-93) included only three subfamilies (Acontinae, Lygosominae, Scincinae), with the large subfamily Lygosominae encompassing most of the Sphenomorphinae as currently listed in the database.

Diploglossidae.—We finally implemented the family Diploglossidae as separate from the Anguidae (Anguinae, Gerrhonotinae) as suggested by various authors (e.g., Vidal and Hedges 2009. C. R. Biol. 332:129–139) but as early as 1890 in Bronn's "Klassen und Ordnungen des Thier-Reichs"). The Diploglossidae contain the genera *Celestus, Diploglossus*, and *Ophiodes*.

New Database Features

NCBI database.—The Reptile Database now displays links to the NCBI taxonomy database in its species entries, which lead you directly to GenBank entries. You can find an example at the bottom of *Acanthodactylus blanfordii*. Currently 5039 species have NCBI taxon IDs, a number that will be updated (and thus increase) shortly. Also, in the example you can also see that we have broken out the etymologies of species names into a separate field.

Photos.—We have a large number of new photos (>1500). However, they are added to the database independently of text, and thus have not been updated. This will probably take another few weeks or so, just in case you do not see the photos that you have submitted. Hint: more photos are always welcome.

Global checklist.—An updated global checklist of all reptiles with their higher taxa is now available as an Excel spreadsheet: http://www.reptile-database.org/data/reptile_checklist_2014_04.xls.zip

Database downloads.—You can now download older versions of the database as tab-delimited text files from Figshare (via our Download page, <http://www.reptile-database.org//data/>). Only a few older versions from 2008–2010 are currently available but more recent ones will follow shortly. These archives may come in handy if publications have cited older versions of the Reptile Database and you try to reproduce their results.

Other Notable Recent Publications

Reptile pet trade statistics.—Herrel and van der Meijden (2014. Herpetol. J. 24[2]:103–110) just published an interesting analysis of the reptile and amphibian trade in the USA and other parts of the world. They found that an average of 7 million individual animals have been imported into the US from 2001 to 2008 while an average of 14 million individuals have been exported during the same time. Of the top-exported species, *Trachemys scripta*, 48 million individuals were exported by the US from 2001 to 2009. For some popular species, captive-bred specimens provide the majority of individuals (e.g., *Iguana iguana*) but for others (such as *Python regius*) the vast majority are from the wild. Another study arrives at somewhat different estimates for exported turtles from the US; Mali et al. (2014. PLoS ONE 9[1]:e86478) estimate that the two top-exporting states (Louisiana and California) exported about 10 million turtles per year from 2002 to 2013.

More details on changed names, etc. are listed on our news page: http://www.reptile-database.org/db-info/news.html.

—Submitted by Peter Uetz & Jirí Hošek

New Online Presence for CaribPARC

Caribbean Partners in Amphibian and Reptile Conservation (CaribPARC), a sub-chapter of Southeastern Partners in Amphibian and Reptile Conservation (SEPARC) is now on Facebook. Check out their new page: https://m.facebook.com/CaribPARC

MEETINGS

Meeting announcement information should be sent directly to the Editor (herpreview@gmail.com) well in advance of the event. We also welcome brief reports of meetings; please consult the Editor for details.

16–20 July 2014 — International Herpetological Symposium, Riverside, California, USA. Information: https://www.facebook.com/InternationalHerpetologicalSymposium

30 July–3 August 2014 — Joint Meeting of Ichthyologists and Herpetologists (SSAR, HL, ASIH), Chattanooga, Tennessee, USA. Information: http://www.dce.k-state.edu/conf/jointmeeting/

2–8 August 2014 — International Symposium Amphibians & Reptiles, Sarapiquí and Costa Ballena, Costa Rica. Information: reservaciones@selvaverde.com

13–15 August 2014 — Northeast Partners in Amphibian and Reptile Conservation (NE PARC) annual meeting, Allegany State Park, Salamanca, New York, USA. Information: http://northeastparc.org/meetings/index.htm

22–24 August 2014 — Midwest Partners in Amphibian and Reptile Conservation (MW PARC) annual meeting, Loretto, Minnesota, USA. Information: www.mwparc.org

30 September–4 October 2014 — XIII Iberian Congress of Herpetology, Universidade de Aveiro, Aveiro, Portugal. Information: http://herpe2014.biologiaatua.net/

1–5 October 2014 — 50th Annual Meeting of the German Society for Herpetology and Herpetoculture, Bonn, Germany. Information: www.dght.de

19–23 November 2014 — Herpetological Association of Africa 2014 Conference, Gobabeb Research & Training Centre, Namib Desert. Information: http://www.africanherpetology.org/

OBITUARIES

Herpetological Review, 2014, 45(2), 387–390.
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Dr. rer. nat. Uwe Norbert Hiller (1942–2008): Pioneer of Experimental Investigation of the Molecular Basis of Adhesion in Geckos

Although expressed in relation to issues of public health and insect control, rather than adhesive capabilities, Loveridge (1947) noted that, "It is probable that we are only on the threshold of discovering the importance of geckos to mankind." That prophetic utterance was made when Uwe Hiller was five years old. By the time of Uwe's death in 2008, geckos had become a major focus of research, not only in the context of their own fascinating biology, but also as inspiration for biomimetic and bioengineering applications. Now physicists, chemists, computer scientists, and engineers, as well as biologists, are avidly studying these diverse lizards with an eye to revealing the secrets of their phenomenal clinging abilities, and to adapting the underlying principles to a wide array of perceived applications. Such efforts have, at their heart, the elucidation of the mechanisms, at the molecular level, that permit geckos to stick to surfaces, using their keratinous setal arrays carried on the underside of their digits. As Henkel and Schmidt (1995) noted, "Mankind has always been fascinated by this ability" and there have been many attempts to determine how such a mechanism operates. Uwe Hiller played a major, if relatively brief, role in solving these mysteries and in paving the way to making this modern research bonanza possible.


PHOTO COURTESY OF BARBARA HILLER

Uwe Hiller, 2007, at home.

Attempts to address how attachment is brought about in geckos stretch back to the latter decades of the 19th century. Throughout this history, the ability to test the ideas set forth

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PHOTO BY YEHUDAH WERNER



Karola Hiller, Nurit Werner, and Uwe Hiller, Late Jurassic dinosaur exhibit, Melle, Germany.

often lagged behind theory, largely as a result of a lack of appropriate technology that could be applied to the problem. Although the presence of setae, the ultimate agents of adhesion, had been established relatively early (Cartier 1872), their structure, morphology, and composition was not particularly well understood until almost one hundred years later. With the advent of scanning electron microscopy, studies of setal morphology (Ruibal and Ernst 1965) and elucidation of the details of their hierarchical structure (Maderson 1964, 1966) led to new theories about the ways in which they may function. This tantalizing backdrop provided Uwe Hiller, a physics-minded herpetologist, the opportunity to move these studies in new and exciting directions.

Born on 23 August 1942 in Hopfental, Germany, Uwe Hiller attended School in Hagen (northern Westfalia), and matriculated from high school [*Abitur*] in 1963. He studied biology at the *Westf. Wilhelms-Universität Münster*, and completed his PhD. dissertation in the *Zoologisches Institut* of that institution. Its title was: "*Untersuchungen zum Feinbau und zur Funktion der Haftborsten von Reptilien*" [Investigations of the detailed structure and function of the adhesive setae of reptiles]. His doctoral examination was held on 3 May 1968 and his specialization subjects were Zoology, Botany, and Inorganic Chemistry. The findings of his PhD investigations were published, in German, very shortly thereafter (Hiller 1968).

The seminal contributions that Uwe Hiller made to advancing the theory and experimental observation of gecko adhesion were undertaken when this subject seemed to reside purely within the domain of curiosity-driven research. Dr. Hiller will be remembered, above all, for conducting the first modern, and carefully controlled, experiments on the role of molecular forces in gecko clinging. Following in the footsteps of a line of German researchers who had made major contributions to elucidating this phenomenon (Cartier 1872; Haase 1900; Weitlaner 1902; Tandler 1903; Schmidt 1904, 1912; Dellit 1934), Uwe was introduced to the topic by his PhD advisor, Dr. Rudolf Altevogt. Altevogt, whose main academic interests focused upon the physiology and ecology of crabs, published a short review article in *Kosmos* (Altevogt 1954) entitled *Probleme eines Fußes*, his only contribution to the phenomenon of gecko adhesion. In that brief article he indicated that new technologies were making novel approaches possible, and published what is likely the first scanning electron micrograph of gecko setae (Altevogt 1954: fig. 3). The species studied in that paper was *Tarentola mauritanica* (the Moorish Gecko), and it was this same species that served as the subject of the majority of Hiller's (1968, 1969a, 1970, 1972) pioneering investigations into the basis of gecko adhesion. Hiller (2000) summarized his contributions to this area, but essentially published no more experimental work on gecko adhesion after the early 1970s.

Uwe Hiller was inspired by the work of Haase (1900), who had first suggested that molecularly-based adhesion forces were responsible for clinging in geckos. Until the 1960s there were no practical ways to test this theory. Uwe was able to exploit new technologies to investigate Haase's (1900) hypotheses. In doing so, he explored the physical nature of surface forces, basing this on recent work on the concept of free surface energy and the molecular polarity of surfaces, and found ways of measuring and manipulating the surface energy of specific substrata (polytetrafluoroethylene films) and of recording the clinging ability of geckos under varying free surface energy conditions. Hiller's (1968, 1969a) experiments revealed that a gecko's ability to adhere was directly related to the surface energy of the substrate, as measured by its water contact angle. He discovered that setae could stick to hydrophilic surfaces (those with a low water contact angle), but were less capable of adhering to hydrophobic surfaces (those with a high water contact angle). This suggested that the adhesive force generated by setae increases with increasing surface energy. Based on this, Hiller (1968, 1969a, 2000) concluded that attachment in geckos occurs by way of intermolecular forces, although he was not able to conclusively determine which type of intermolecular forces dominated.

These explanations remained the most compelling for the understanding of these phenomena for the following 30 years, until the next great technological advances were made, using microelectromechanical sensors (Autumn et al. 2000, 2002; Autumn and Peattie 2002) and newly available and highly controllable materials (Autumn 2006). Through measurement of attachment forces generated by individual setae, it was found that these were consistent with the forces expected to be produced by intermolecular attachment via van der Waals forces, and were inconsistent with other possible mechanisms of attachment, including suction, friction, and micro-interlocking (Autumn et al. 2000). The potential differential ability of setae to attach to hydrophilic versus hydrophobic surfaces was refuted, with Hiller's (1968, 1969a) observations relating to this being attributed to the experimental conditions rather than preferential capability. Later the importance of certain types of frictional forces in attachment were also reassessed (Autumn et al. 2006; Tian et al. 2006). These more recent findings led to the explosion of interest in gecko adhesion that pervades the literature today, but they are firmly founded on Uwe Hiller's insightful studies. Because most of Dr. Hiller's work on this subject was published in German, it is not as well known as it might otherwise have become.

Following his PhD, Uwe Hiller was quickly hired (his position began on 1 June 1968) by Prof. Dr. Rudolf Altevogt, as a technical assistant at the *Zoologisches Institut* in the department of Zoophysiology and Ecology. During his time in Dr. Altevogt's laboratory his research was very productive and he continued to work on gecko adhesion along with venturing into the integumentary sensory mechanisms associated with modulating attachment. He worked in Dr. Altevogt's group until 30 September 1980, at which time he moved to the *Institut für Anatomie der Westf. Wilhelms-Universität Münster*, to join the group of Prof. Dr. Hans-Jost Dieterich as a scientific assistant. Dr. Dieterich's group focused on human anatomy. He was hired specifically for his skills

in scanning electron microscopy. This position provided Uwe with greater academic opportunities and he was able to teach as well as conduct his technical duties.

Associated with this change of position came a hiatus in the output of Uwe's curiosity-driven research. From the late 1970s to the early 1990s he published relatively little related to his own agenda, and during this time his research focus shifted. He was afforded the opportunity to prepare a *Habilitationsschrift*, and for this worked on the eyelids and conjunctive membranes of reptiles. In 1992 he completed his habilitation thesis, "*Die Augenlider und Membrana nictitans der Reptilien*," but was not invited to defend his work at a formal oral examination because the reviews from his external examiners were mixed. In the face of this potential setback, Uwe decided to opt for occupational security rather than continue the pursuit of a professorship, and thus never formally undertook his habilitation examination.

Many of his major herpetological contributions thus proceeded from his PhD work and from his still-born habilitation thesis. He was driven by a curiosity about how animals worked, and was fascinated by structural mechanisms, a trait also reflected in one of his hobbies, watchmaking and horology, for which he maintained a workshop in the basement of his home. He continued to work in his technical position in Dr. Dieterich's group until his retirement on 31 August 2007, at the age of 65. Uwe Hiller thus spent his entire academic career (as undergraduate student, graduate student, and technicial assistant) at the same institution.

For his herpetological contributions, Uwe Hiller seldom strayed far from aspects of the integument, and employed his expertise with SEM to investigate various anatomical problems. Fascinated by how the adhesive mechanism was controlled and how contact with the surface was modulated, he ventured into conducting anatomical and physiological studies of the cutaneous sensilla of reptiles (Hiller 1971, 1976a, 1976b, 1976c, 1977, 1978).

His explorations of various aspects of eye anatomy (Hiller and Dieterich 1986; Dieterich et al. 1988; Hiller 1995, 1998) had their foundations in the research conducted for his ultimately unfulfilled habilitation thesis. At the time of his death he had developed collaborative partnerships to pursue this further, and was working on a major synthesis of what is known about the form and function of reptilian eyelids and their associated glands with Susan Rehorek and Yehudah Werner.

Sometimes happenstance led to new and intriguing studies. While one of us (YLW) was investigating foraging modes in geckos, individuals were marked with adhesive tags to facilitate observations. For introduced populations of *Phelsuma* in Hawai'i, it was found that the adhesive tags, able to be successfully applied to all other geckos investigated, would not stick. Uwe was consulted for his knowledge of squamate skin structure, and this investigation led to the discovery of unicellular skin glands in *Phelsuma* (Hiller and Werner 2008).

His last two published contributions were made in areas that are very topical, the water repellence of gecko skin (Hiller 2009) and feather regeneration in birds (Maderson et al. 2009). Scattered through his publishing career were technical and clinical contributions that focused on methodology (e.g., Hiller and Blacksche 1968; Hiller, 1969b) and on applications related to his work in Dr. Dieterich's group (e.g., König et al. 1987, 1993). He was very respectful of amateurs keen on reptiles, and cooperated with them to encourage their interests. Uwe Hiller enjoyed attending conferences and presenting his work, and was able to communicate widely at European meetings because of his fluency in German, English, and Spanish (as well as Latin!). One presentation that gave him particular satisfaction was delivered in 1993 at the Hebrew University, Jerusalem. On this occasion Uwe spoke in English to a general audience, captivating them with his knowledge and demonstration of gecko adhesion, and using a Teflon®-coated frying pan to reveal the limits of the adhesive capabilities of these lizards. The reason for the satisfaction was that Uwe's father had resisted the policies of the Third Reich in Germany, and this presentation provided Uwe with the occasion to honor that family legacy.

Uwe Hiller died suddenly on 8 Spetember 2008 in Münster, Germany. He is survived by his wife, Karola, three children, Barbara, Martin, and Norbert, and five grandchildren. To those who visited him to conduct collaborative research (including one of us, YLW), Uwe was a welcoming and caring host who willingly made space available in his own home for visitors. There they were able to enjoy Uwe and Karola's passion for gardening, and to partake of the wine Uwe made, often produced from grapes grown in the conservatory attached to their house, a structure also known for its resident population of Moorish Geckos. At the end of a busy day, visitors were also encouraged to join the Hillers in watching a "*Krimmi*," a slang term referring to the German detective story movie genre.

Acknowledgments.—We are indebted to Dr. med. Reinhard Hildebrand, director of the *Institut für Anatomie der Westf. Wilhelms-Universität Münster* at the time that Uwe Hiller was working there, for providing biographical details gleaned from his employment file, and to Karola and Barbara Hiller for providing family and personal information and photographs.

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CURRENT RESEARCH

The purpose of Current Research is to present brief summaries and citations for selected papers from journals other than those published by the American Society of Ichthyologists and Herpetologists, The Herpetologists' League, and the Society for the Study of Amphibians and Reptiles. Limited space prohibits comprehensive coverage of the literature, but an effort will be made to cover a variety of taxa and topics. To ensure that the coverage is as broad and current as possible, authors are invited to send reprints to the Current Research section editors, Jesse Grismer or Ben Lowe; e-mail addresses may be found on the inside front cover.

Reassessment of Crocodilian Species Diversity in Africa

In 2011, a cryptic species of African crocodile, *Crocodylus suchus*, was revealed with the aid of molecular data, indicating that other cryptic species might have been overlooked. To further elucidate African crocodile diversity, Shirley et al. report their findings from an investigation into the morphological and genetic diversity of the Slender-snouted Crocodile, *Mecistops* (formerly *Crocodylus*) *cataphractus*, a species distributed across tropical West and Central Africa. Genetic samples were accumulated from across the species' distribution, and eleven genes were sequenced. These data were incorporated into an analysis employing recently developed Bayesian species delimitation methods (BP&P), as well as other genetic clustering analyses that have previously been used to identify crocodilian species. These analyses offered categorical support for *Mecistops* comprising two parapatric species, one including populations in the West African countries Côte d'Ivoire, Ghana, and the Gambia, and one consisting of populations spanning Central Africa. An exhaustive morphological analysis of 91 *Mecistops* skulls found 13 characters that in combination serve to differentiate the two species, including two for which each species exhibits a fixed difference. These diagnostic characters and the results of a multidimensional scaling analysis allowed the researchers to interpolate the species' ranges where molecular sampling was lacking. Importantly, skulls from Nigeria were identifiable as the western

species while Cameroon samples fell out with the eastern species, suggesting a possible geographic feature separating these two species—the Cameroon Volcanic Line (CVL), a mountainous and geologically active plateau that runs perpendicular to the coast. A fossil-calibrated phylogeny including all recognized crocodilian species places the split between the two *Mecistops* species somewhere between five and ten million years ago. Interestingly, this estimate is temporally congruent with the split inferred for the two previously identified lineages of West African Dwarf Crocodile (*Osteolaemus tetraspis*). The *O. tetraspis* split may also be coincident with the CVL; unfortunately, conserved morphology precludes inferring clade membership of Nigerian *Osteolaemus*. The CVL has long been recognized as an important biogeographic feature for montane organisms, and this study suggests this may be true for lowland taxa as well. This study also highlights regions of conservation priority in West Africa.

Shirley, M. H., K. A. Vliet, A. N. Carr, and J. D. Austin. 2013. Rigorous approaches to species delimitation have significant implications for African crocodilian systematics and conservation. Proceedings of the Royal Society B 281:20132483.

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Lungless Salamanders Thermoregulate Behaviorally

Salamanders have long served as textbook examples of thermoconformers, organisms that use neither metabolic activity nor behavior to modify their body temperatures and instead passively reflect the temperature of their environment. However, common sense indicates there are limits to this—many amphibian species incapable of surviving freezing temperatures nevertheless live in regions that experience freezing winter temperatures. Furthermore, laboratory studies have shown that plethodontid salamanders actively choose optimal temperatures. To investigate this phenomenon in nature, the authors of this study gathered data on two North American plethodontids (*Plethodon glutinosus*, *Eurycea lucifuga*) in the laboratory and in nature. These species are frequently associated with caves (but lack troglobitic characteristics such as reduced eyes and pigmentation) and only distantly related, offering an interesting opportunity to test hypotheses regarding thermal ecology. The authors attempted to survey six caves in northwestern Georgia every spring, summer, and fall for 13 years. Specifically, the researchers surveyed for salamanders outside and far enough into the caves where external climate had limited influence (the twilight zone), and took temperature readings at these points. Representatives of these species were also brought into the laboratory and subjected to trials where they were offered a gradient of temperatures ranging from 10 to 40°C. Finally, locality data for these species were gleaned from museum records, and with temperature, precipitation, and land cover data, ecological niche modeling analyses were conducted to evaluate whether the distributions of these species are defined by different abiotic variables. Consistent across all caves, the twilight zones were always cooler than the area outside, with the greatest temperature differential occurring in the summer. Densities within the caves fluctuated seasonally for both species, with *P. glutinosus* reaching maximum density in the summer and *E. lucifuga* being most abundant in the spring and fall (while *P. glutinosus* is presumably outside the cave). This finding suggests *E. lucifuga* has a lower preferred temperature than *P. glutinosus*, and the laboratory trials confirmed this. The niche modeling exercise showed the factors limiting *P. glutinosus* distribution involve moisture, while five of the six most important variables for *E. lucifuga* pertained to temperature. While the abiotic variables predicted the distribution of *E. lucifuga* with high precision, they overpredicted the range of *P. glutinosus*, suggesting biotic interactions may be important in limiting the range of this species. Taken together, these findings show that these species move around in response to temperature fluctuations, and therefore thermoregulate through behavioral means.

Camp, C. D., J. A. Wooten, J. B. Jensen, and D. F. Bartek. 2013. Role of temperature in determining relative abundance in cave twilight zones by two species of lungless salamander (family Plethodontidae). Canadian Journal of Zoology (*in press*) doi: 10.1139/cjz-2013-0178.

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Snake Spectacles Modulate Blood Flow to Minimize Obstruction of Vision

In lieu of eyelids, snakes and several other squamate lineages possess a clear structure called a spectacle over their eyes. This structure is similar to the vertebrate cornea (which snakes also have), but unlike a typical cornea, the spectacle contains blood vessels. These vessels are transparent, but the blood is not and likely obscures vision. The authors of this paper conducted a study of snake spectacle vascular physiology to identify adaptations that mitigate potentially impaired vision. The spectacles of snakes were observed with near-infrared (NIR) light and a NIR-sensitive video camera capable of resolving individual blood cells. Three Coachwhips (*Coluber* [= *Masticophis*] *flagellum*) a diurnal, visually oriented species, were subjected to seven trials each, wherein an eye was recorded for 70 minutes. The trials employed the following protocol: 30 minutes undisturbed, eight minutes of threat (experimenter moving in the vicinity of the snake), 16 minutes undisturbed, eight minutes of threat, eight minutes undisturbed. Snakes were not tested when their spectacles were clouded due to an impending shed, as preliminary observations revealed that during shed preparation, blood flows continuously across the spectacle. Statistical analysis (ANOVA) of the trial data revealed that when at rest and undisturbed, the flow of blood across snake spectacles is discontinuous, alternating between short periods of flow and long periods of no flow. When snakes detect a potential threat, the duration of the flow periods is reduced further, allowing unperturbed vision. Within trials, patterns of flow did not change between the two threat episodes, indicating threat habituation was not occurring. Though they could not make out the translucent capillaries, the authors posit that capillary constriction is responsible for flow cessation. They also suggest future studies should examine the vascular dynamics of other spectacled squamates and whether vascular responses to a perceived threat are simultaneously occurring in other parts of the dermis.

van Doorn, K., and J. G. Sivak. 2013. Blood flow dynamics in the snake spectacle. Journal of Experimental Biology 216:4190–4195.

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Blue Tails Elicit Attacks from Potential Predators

Aposematism, the presence of conspicuous colors or patterns on an organism that grab the attention of the viewer, is a feature seen in many species of reptiles and amphibians. Often, aposematism serves to alert a potential predator to an otherwise hidden defense (such as a toxin). However, different lizard lineages have independently evolved brightly colored tails, presumably serving to draw a predator's attention to the tail. Most lizards with aposematic tails have the ability to autotomize their tail, and therefore attracting predators to the tail facilitates escape. For those that do not exhibit tail autotomy, an attack to the tail is less life-threatening than an attack to the body or head. To test the hypothesis that aposematic tails serve to attract attacks, the authors of this study made clay models with brown bodies, half with blue tails (aposematic) and the other half with brown tails (non-aposematic), and placed them in the field at the Archbold Biological Station, Florida, USA. These models approximated the Southeastern Five-lined Skinks (*Plestiodon inexpectatus*), a common species at the site. Models were checked daily and scored for predation attempts (rodent vs. bird, location on body of attack). In all, 65 attempted predation events were observed, 92.3% of which could be attributed to birds (likely Florida Scrub Jays, *Aphelocoma coerulescens*). Analysis revealed that the aposematic models received more predation attempts than the non-aposematic models. Furthermore, the proportion of attacks aimed at the tail was significantly higher for the aposematic models. Indeed, most attacks on the non-aposematic models were directed at the head or body, while those on the aposematic models were most frequently aimed at the tail. These findings support the hypothesis that at least in this system, aposematic tails are "risky decoys" that serve to draw attacks to the tail, not discourage potential predators from attacking. The authors hint that the ontogenic change in tail color seen in many of these lizard species reflects foraging style divergence between juveniles and adults.

Bateman, P. W., P. A. Fleming, and B. Rolek. 2014. Bite me: Blue tails as a 'risky-decoy' defense tactic for lizards. Current Zoology (*in press*; *no doi*)

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New Estimate of Origin of Lepidosauria

Recent fossil discoveries and advances in phylogenetics have provided an unprecedented understanding of the history of life on earth. Unfortunately, precise estimates of the timing of Lepidosauria (squamates and rhynchocephalians) origin and diversification have remained elusive. This is due in part to the paucity of early crown lepidosaur fossils. The authors of this paper describe a recently unearthed, 240 million years old (Middle Triassic) fossil rhynchocephalian from the vicinity of Vellberg in southern Germany. This new fossil predates the next oldest lepidosaur fossil by twelve million years. The material consists of two dentaries that exhibit distinctively rhynchocephalian features and closely resemble those of a previously described, younger rhynchocephalian, *Diphydontosaurus*. Morphological phylogenetic analyses corroborate this assignment. Along with other known reptile fossils, the authors incorporated this new fossil as a calibration point in a time-calibrated molecular phylogenetic analysis of nuclear DNA sequence data for *Sphenodon punctatus*, 65 squamate taxa, and eleven outgroup taxa. While previous analyses have placed the origin of Lepidosauria in the Permian, these analyses yield a younger date of 242 million years (range: 238–249.5; Early to Middle Triassic). This finding suggests Lepidosauria diversification occurred subsequent to the Permian extinction event. Furthermore, these analyses find Squamata diversification occurred in the Jurassic in the wake of an extinction event that occurred at the end of the Triassic. These dates suggest these groups may have diversified as they filled vacated niches. The authors contend that this fossil bed spans an important time in the history of life on earth, and that it may hold additional important finds.

Jones, M. E. H., C. L. Anderson, C. A. Hipsley, J. Müller, S. E. Evans, and R. R. Schoch. 2013. Integration of molecules and new fossils supports a Triassic origin for Lepidosauria (lizards, snakes, and tuatara). BMC Evolutionary Biology 13:208.

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Suction-Feeding Turtle Unearthed in Morocco

While suction feeding has evolved in most lineages of marine vertebrates, turtles have been considered an exception. This is remarkable, as suction feeding has evolved independently in two freshwater testudine lineages (Chelidae and Chelydridae). The authors of this paper announce the discovery of a new, apparently suction-feeding turtle from Morocco. They erect a new genus for this turtle and name it *Ocepechelon bouyai*. The fossil bed contains marine fauna and dates to the Maastrichtian, the last age of the Mesozoic. The material consists of one complete skull (no mandible) 70 cm long, ranking among the largest turtle skulls ever recorded. Strikingly, the snout is narrow and tubular, the external nares are positioned dorsally and far back from the anterior margin of the snout (just anterior to the bony orbits), and shearing, crushing, and prey-manipulation structures are lacking. The morphology of the hyoid is not known, though this would serve as a good indicator of feeding strategy. However, the pterygoid possesses large ventral plates and the squamosals flare out laterally in dramatic fashion, providing large attachment surfaces for the musculature required for suction feeding. Together these findings strongly suggest *O. bouyai* was a small-gape suction feeder, similar to living beaked whales and syngnathid fishes (seahorses, etc.). A phylogenetic analysis of a morphological dataset places *O. bouyai* in Dermochelyoidae, a clade that contains several extinct taxa as well as the Leatherback Turtle (*Dermochelys coriacea*) and is sister to the family Cheloniidae. The authors speculate that like *Dermochelys*, *O. bouyai* may have possessed

buccopharyngeal papillae that would have allowed excess water to escape while maintaining prey items. This study adds to our understanding of phylogenetic and morphological diversity of marine reptiles at the close of the Mesozoic.

Bardet, N., N.-E. Jalil, F. de Lapparent de Broin, D. Germain, O. Lambert, and M. Amaghzaz. 2013. A giant chelonioid turtle from the Late Cretaceous of Morocco with a suction feeding apparatus unique among tetrapods. PLoS ONE 8: e63586.

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Famous Frog-Jumping Competition Lends Insights into Estimating Performance

California's annual Calavaras County Fair and Jumping Frog Jubilee features a world-famous frog-jump competition, inspired by an 1865 short story by Mark Twain. In this festival, held in the town of Angel's Camp in the foothills of the Sierra Nevada, causal visitors and competitive hobbyists alike enter frogs into contests, with the winners being those whose frog manages the most prodigious leap. Visitors are allowed to "rent" frogs for these contests (these days, American Bullfrogs, *Lithobates catesbeiana*). The authors of this paper decided this event would be a great opportunity to collect data that could be used to evaluate our ability to estimate a species' maximum capacity for some act, which in this case was a single leap. In 2012, they attended the festival and recorded jumping trials, from which distance measurements were extracted. In the competition, the first three jumps are recorded, and the researchers collected jump-distance data for these and any subsequent jumps. From these data, the researchers generated histograms of jump distance, and used t-tests to determine if there was a jump-distance difference between rented and hobbyist-supplied ("pro") frogs. Overall, 3124 jumps were recorded, investigations of which revealed that most jump measurements exceeded the maximum published distance for *L. catesbeiana* (1.295 m), and the longest distance they recorded was 2.2 m. The distance jumped differed significantly between rented and pro frogs, with pro frog jumps averaging 0.4 m longer than those of rented frogs, indicating either the competitive hobbyists were actively selecting the most prodigious jumpers or their technique for prompting a jump was superior. Interestingly, while the distances jumped by rental frogs were normally distributed, the pro frog jumps were skewed toward short jumps, indicating that the longer jumps were likely approaching a real performance limit. Even with the left-skewed distribution, subsampling of the data revealed that large sample sizes are necessary for consistently observing maximum jump distances. This finding is certainly germane to researchers studying physical performance.

Astley, H. C., E. M. Abbott, E. Azizi, R. L. Marsh, and T. J. Roberts. 2013. Chasing maximal performance: a cautionary tale from the celebrated jumping frogs of Calaveras County. Journal of Experimental Biology 216:3947–3953.

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Pelagic Sea Snakes Tolerate Drought in a Dehydrated State

The pelagic Yellow-bellied Seasnake, *Hydrophis* (formerly *Pelamis*) *platurus* is the most widely distributed squamate, occurring from Africa's east coast, across the temperate and tropical stretches of the Indian and Pacific Oceans, to the west coasts of the Americas. This remarkable distribution is a consequence of this species adopting a pelagic lifestyle, not found in other sea snakes. Nevertheless, like all snakes, *H. platurus* require fresh water to stay hydrated. The primary source of fresh water in the open ocean is a thin freshwater film that exists on the ocean surface following rain, the frequency of which fluctuates with the seasons. To determine if these snakes survive dry periods with an unusual tolerance of dehydration, the authors of this paper collected in excess of 500 snakes from the vicinity of Golfo de Papagayo, northwestern Guanacaste, Costa Rica. These snakes were brought into the lab and evaluated for body condition (weight relative to length) and willingness to drink fresh water. Those that drank water were subsequently weighed to calculate the volume of water consumed. Furthermore, twenty snakes collected at the end of the dry season and 20 collected at the end of the wet season were desiccated in an oven after death or euthanasia to determine water content. These experiments demonstrated that *H. platurus* do indeed experience considerable dehydration during dry spells. Snakes caught after a significant dry period and/or exhibiting poor body condition were more likely to drink, and the quantity of water drunk was inversely proportional to body condition. Total water content of the snakes was significantly lower at the end of the dry season than at the end of the wet season. The percent water content of hydrated *H. platurus* (~80%) is considerably higher than recorded for other snakes (69-77%) and sea turtles (64-66%), indicating a possible adaptation for dealing with droughts. These studies indicate that sea snakes experience wide fluctuations in water content across seasonal changes, and are able to tolerate severe states of dehydration.

Lillywhite, H. B., C. M. Sheehy III, F. Brischoux, and A. Grech. 2014. Pelagic sea snakes dehydrate at sea. Proceedings of the Royal Society B 281:20140119.

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Ambystoma Salamander Found with Developing Eggs in its Oviduct

Amphibians exhibit diverse reproductive strategies, including egg-laying and live birth, internal and external fertilization, and direct development and metamorphosis from a larva. Despite this diversity, it has been assumed that for all egg-laying species that practice internal fertilization, fertilization occurs immediately prior to egg laying. The authors of this paper report an observation of an *Ambystoma* salamander in Massachusetts, USA, with fertilized eggs containing partially-developed embryos in its oviduct. The salamander was encountered deceased on the road during the spring migration. DNA sequence data from the salamander revealed it to be a unisexual triploid (LJJ genotype), which are common at the site. Despite being unisexual,

these salamanders require sperm from a male of one of the parental species to initiate egg development (in this process, the sperm does not contribute genetic material). The eggs were investigated using florescent microscopy and were revealed to be approaching or undergoing gastrulation (developmental stage 10). Given the air temperature and our understanding of *Ambystoma* embryological development, the authors posit that the eggs had been developing for two or three days, long before the salamander met its demise and probably before it initiated its reproductive migration. They suggest development was likely initiated in the absence of sperm or with the assistance of stored sperm. This discovery adds to the list of fascinating reproductive biology exhibited by amphibians.

Charney, D. C., J. J. Castorino, M. J. Dobro, and S. L. Steely. 2014. Embryo development inside female salamander (*Ambystoma jeffersonianum-laterale*) prior to egg laying. PLoS ONE 9:e91919.

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River-Dwelling Painted Turtles Not Affected by Extreme Flooding

With climate change threatening more dramatic and more frequent weather events, understanding how species cope with extreme weather scenarios is critically important. To investigate how different spring flooding scenarios affect Painted Turtle (Emydidae: *Chrysemys picta*) populations in the American Midwest, the authors of this study collected 16 years of mark-recapture data for females belonging to a Mississippi River population. During this time the site experienced four intense flooding events, where water levels were two meters higher and flow rates were as much as six times greater than in non-flood years. Analyses of these data did not recover a significant effect of flood intensity on survivorship, recruitment, detectability or population growth. Indeed, the only period where a population decline was observed was during an unusually long stretch without significant flooding (2003–2008). The authors suggest that this species may have behavioral adaptations that mitigate the potential effects of intense flooding events, despite being more typically associated with ponds and lakes which do not experience such floods. They also caution that their findings have little bearing on the effects of flooding on male and juvenile Painted Turtles or the species' resilience to other severe weather events such as heat waves or flooding outside of the spring season.

Jergenson, A. M, D. A. W. Miller, L. A. Neuman-Lee, D. A. Warner, and F. J. Janzen. 2014 Swimming against the tide: resilience of a riverine turtle to recurrent extreme environmental events. Biology Letters 10:20130782.

Correspondence to: Fredric Janzen, Department of Ecology, Evolution, and Organismal Biology, Iowa State University, Ames, IA 50011, USA; email: fjanzen@iastate.edu

Salamander Size Reduction Linked to Climate Change

The southern Appalachian Mountains are a center of diversity for salamanders of the family Plethodontidae. As montane plethodontid salamanders are limited in their capacity for niche evolution and tracking suitable climates, they are expected to suffer disproportionate affects due to climate change. One hypothesized consequence of climate change is a change in body size due to an altered energy budget. To determine if the effects of climate change are already apparent, the authors of this paper surveyed for and collected morphometric data from 15 *Plethodon* species along the main axis of the southern Appalachian Mountains from Maryland through Tennessee and North Carolina. Importantly, they collected data from 64 sites from which *Plethodon* have been collected at various times across the second half of the 20th century. Together with measurements from historically collected specimens, the authors fit linear models to the data with the purpose of identifying shifts in body size across the study period. These analyses revealed a statistically significant 8% reduction in body size averaged across the fifteen species; this finding remained significant even when the contemporary measurements of live salamanders were removed. Of the fifteen species investigated, six showed significant reductions in size while one species increased in size across the study period. Several possible correlates of body size reduction were evaluated, and the best predictor was found to be latitude. The authors suggest this can be explained by the lower latitudes having experienced disproportionate increases in temperature and decreases in precipitation, and those two phenomena are driving changes in energy expenditure. To test this, they modeled activity time and metabolic energy expenditure for three latitudinally distinct sites and found that while annual activity time has not changed appreciably across the study period, energy expenditure has increased significantly, providing a mechanism for body size reduction. The authors suggest that future research could reveal whether their findings represent a plastic response to increased energy costs or selection acting on body size.

Caruso, N. M., M. W. Sears, D. C. Adams, and K. R. Lips. 2014. Widespread rapid reductions in body size of adult salamanders in response to climate change. Global Change Biology (*in press*) doi:10.1111/gcb.12550.

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ERRATUM —The natural history note by Bovo et al. (2014. Herpetol. Rev. 45:115) for *Rhinella ornata* was accompanied by an incorrect common name, when none should have been listed.

Photos Solicited for the New Show

HERPETOLOGISTS PAST AND PRESENT



For those who don't recognize Joe Mendelson (here in a more serious moment), he was SSAR President in 2011–2012.

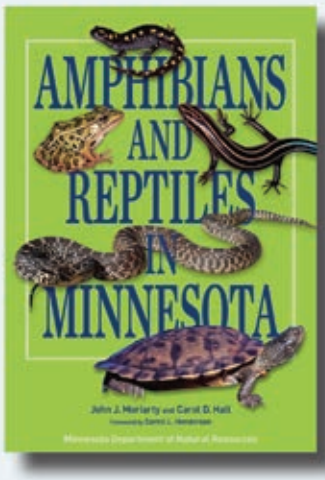
PHOTOGRAPH BY ALISON KELLY

To Be Revised for University of Kansas Meeting in 2015
See meeting notice in *Herp. Review*, March 2014, p. 192.

In 1982, SSAR commissioned an audiovisual slide show to celebrate its 25th Anniversary Meeting in Raleigh (North Carolina). This 30-minute program was later enlarged and became a popular staple at SSAR meetings for nearly two decades. However, the technology used then (6 computer-controlled slide projectors) is now obsolete and must be completely revised using modern digital techniques.

SSAR has commissioned a new program, to debut at its 2015 meeting at the University of Kansas (July 30th through August 3rd). Color slides of herpetologists at work or play are hereby solicited. These may be color slides (which will be returned after scanning) or digital files (at 300 dpi/ppi or higher, preferably in TIFF but JPEGs are OK; best to burn files to CDs or DVDs). *All sources will remain confidential!*

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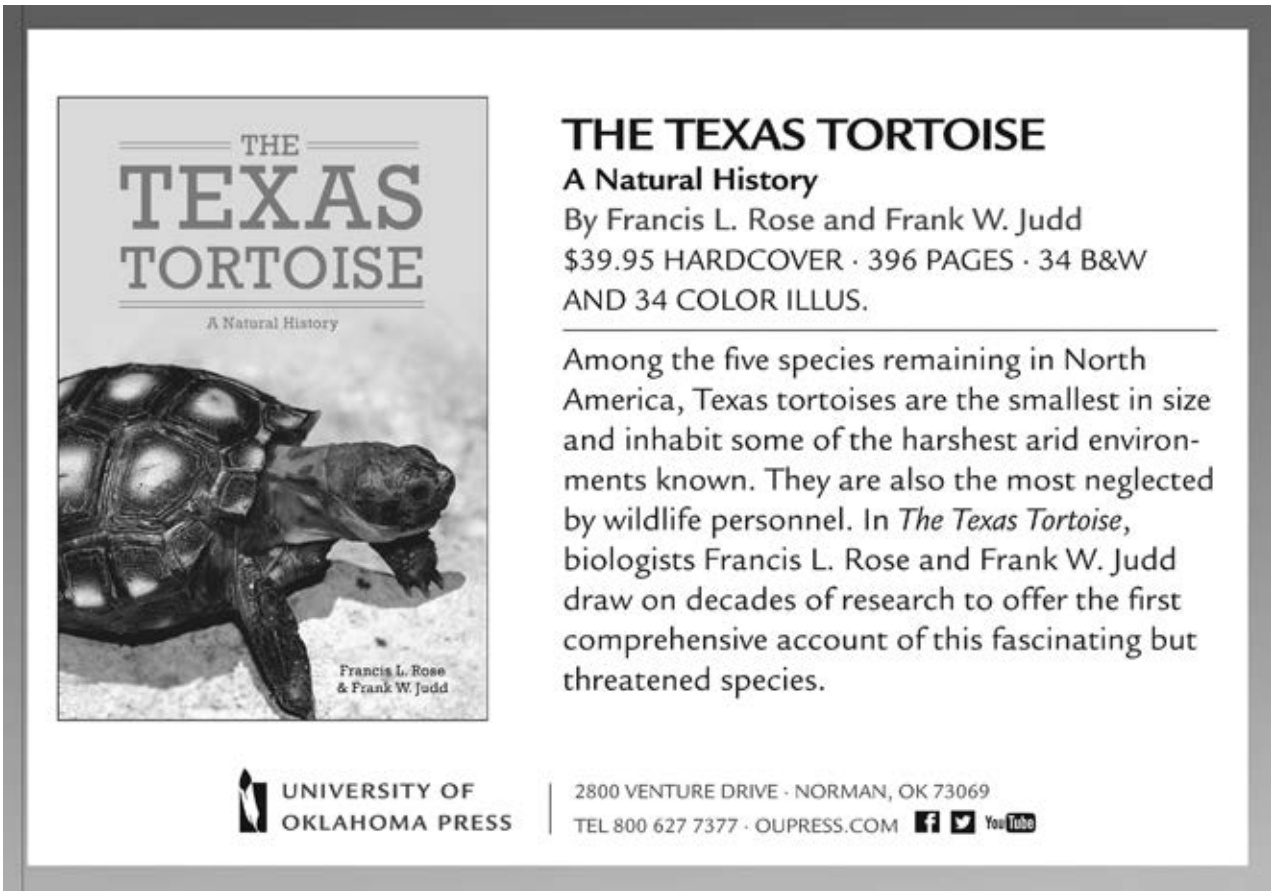


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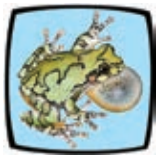
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ARTICLES

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Southernmost Reports of the Hawksbill Sea Turtle, *Eretmochelys imbricata*, in Temperate Waters of Argentina and Evidence of a Hybrid Origin Supported by Mitochondrial DNA Analysis

The Hawksbill Sea Turtle, *Eretmochelys imbricata* (Linnaeus 1766), is the most tropical of all sea turtle species, distributed along the central region of the Atlantic, Pacific, and Indian oceans (Mortimer and Donnelly 2008; Witzell 1983). The species lives in close association with hard-substrate communities such as coral reefs, foraging primarily on sponges, and may also occur in coastal lagoons and bays (Meylan 1988; Plotkin 2003).

For a long time, hawksbills, in contrast to the other species of sea turtles, were thought to not undertake extensive migrations (Carr et al. 1966; Van Dam and Diez 1998; Witzell 1983). However, satellite tracking and mark-recapture studies have provided information about movements of the species, which are on the scale of hundreds of kilometers (Bellini et al. 2000; Marcovaldi et al. 2012; Parker et al. 2009; Troëng et al. 2005; Van Dam et al. 2008; Whiting and Koch 2006).

The main nesting areas are located between the Tropics of Cancer and Capricorn (Pilcher 1999; Pilcher and Ali 1999; Witzell 1983). In the western Atlantic Ocean, they are found in the southeastern United States, along the entire Central American coast, through the Greater and Lesser Antilles, southward to Brazil (Beggs et al. 2007; Bjorndal et al. 1985; Blumenthal et al. 2009; Lagueux et al. 2003; Lara-Ruiz et al. 2006; Marcovaldi and Chaloupka 2007; Meylan and Redlow 2006; Richardson et al. 2006; Tomás et al. 2010; Troëng et al. 2005; Van Dam et al. 2008; Fig. 1). In the southwestern Atlantic, the nesting and feeding grounds of hawksbills are mainly along the northeastern coast of Brazil, the Atol das Rocas and Fernando de Noronha archipelagos, and the Arvoredo and Abrolhos islands (Marcovaldi and Chaloupka 2007; Marcovaldi et al. 1999; Proietti et al. 2012; Sanches and Bellini 1999; Fig. 1). The southernmost recorded feeding ground is in Mostardas (30.88027°S, 50.60666°W) on the coast of Rio Grande do Sul, Brazil, where a live juvenile was found (Valls et al. 2011).

Genetic analyses of hawksbills based on a short mitochondrial DNA (mtDNA) fragment (384 bp of the control region) were used to characterize several Atlantic nesting areas (Bass 1999; Bass et al. 1996; Bowen and Karl 1996; Bowen et al. 2007; Blumenthal et al. 2009; Browne et al. 2007; Diaz-Fernandez et al. 1999) and some feeding areas in the Caribbean (Bowen et al. 1996; Browne et al. 2007; Tröeng et al. 2005; Fig. 1). Recently, genetic studies based on longer mtDNA sequences (760 bp) in western Atlantic nesting areas identified 47 polymorphic sites that determined a total of 25 haplotypes, improving the ability to detect population structure in hawksbills and suggesting probable hybridization events (Lara-Ruiz et al. 2006; Leroux et al. 2012; Vilaça et al. 2013). Specifically, Caribbean feeding grounds showed the likelihood of transoceanic migrations (Bass et al. 1996; Bowen et al. 2007; Velez-Zuazo et al. 2008). Monzón-Argüello et al. (2010) demonstrated the occurrence of young hawksbills from the Caribbean nesting areas in feeding grounds off Cape Verde, corroborating mark-recapture results (Bellini et al. 2000; Marcovaldi and Filippini 1991).

The Hawksbill Sea Turtle is classified as Critically Endangered by the IUCN (Mortimer and Donnelly 2008). The most serious problem this species encounters is harvest by humans. Hawksbills have largely been exploited for their shells, which are used for decorative purposes (Meylan and Donnelly 1999). Effective conservation relies on accurate knowledge of the population distribution, including characterization of nesting and feeding areas and migration patterns. The analysis of hawksbill turtles in the southwestern Atlantic including southernmost reports in

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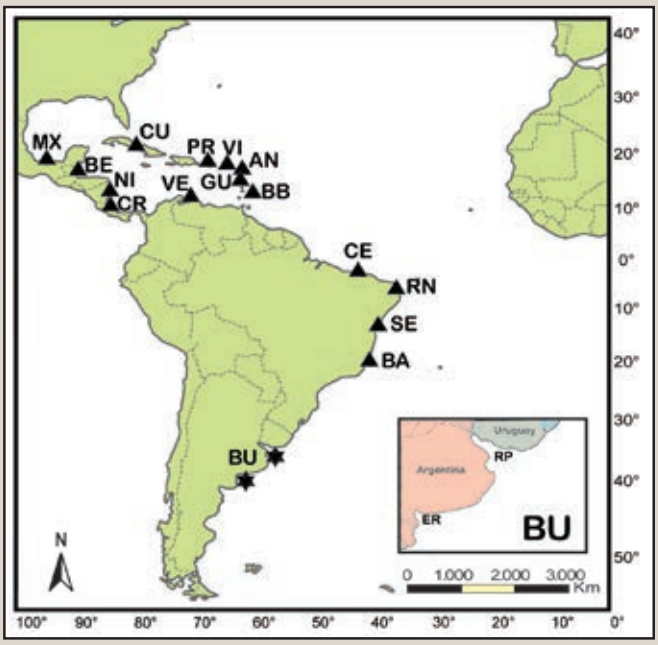


FIG. 1. The map shows the nesting grounds of Hawksbill Sea Turtles throughout the Atlantic Ocean. Individuals collected off the coast of Buenos Aires (BU) in Argentina are symbolized by stars (RP, Rio de la Plata estuary; ER, El Rincon estuary, inset map). References and abbreviations for nesting colonies (indicated by triangles) considered possible sources of turtles found in Argentina are: Cuba (CU), Puerto Rico (PR), Virgin Islands (VI), Antigua (AN), Guadaloupe (GU), Barbados (BB), Venezuela (VE), Costa Rica (CR), Belize (BE), Nicaragua (NI), Mexico (MX) and States of Bahia (BA), Rio Grande do Norte (RN), Sergipe (SE), and Ceara (CE) (Lara Ruiz et al. 2006; Leroux et al. 2012; Vilaça et al. 2013).



FIG. 2. Photo of the Hawksbill Sea Turtle found in San Clemente del Tuyú, Buenos Aires, Argentina.

temperate waters improves our understanding of this aspect of their biology.

In recent years, the Regional Program for Sea Turtle Research and Conservation of Argentina (PRICTMA) has analyzed the presence of sea turtles in the temperate waters of Argentina, identifying life-history stages as well as the genetic diversity and probable origin of individuals (Prosdocimi et al. 2012). Previously, Green (*Chelonia mydas*), Loggerhead (*Caretta caretta*), and Leatherback (*Dermochelys coriacea*) sea turtles have been confirmed in Argentinean feeding grounds (Gonzalez Carman et al. 2011). Here we report analyses of the southernmost records of Hawksbill Sea Turtles in the southwestern Atlantic along the Argentina coast using morphological and mtDNA markers. An extension of the distribution range for this critically-endangered species can reveal novel potential habitats. Such critical information can be combined with knowledge of the species' life cycle in the Southern Hemisphere to further conservation efforts.

Materials and Methods.—Beaches and ports along 2800 km of the maritime and fluvial coast of Argentina were regularly surveyed by PRICTMA from 2009 to 2010. Turtles found were weighed, measured, and sampled for genetic analysis according to Bolten (1999) and Dutton (1996). The specimens for this study were identified as *Eretmochelys imbricata* following morphological keys of Pritchard and Mortimer (1999). To classify individuals in life stages, we considered the criteria of Sanches and Bellini (1999) and Vélez-Zuazo et al. (2008). Turtles below 35 cm curved carapace length (CCL) were considered "small" (juveniles with little swimming capacity and hence subject to being dispersed by oceanic currents), whereas turtles with a CCL 35–65 cm were considered "large" (juveniles that probably have a capacity to swim independent of oceanic currents).

A DNAeasy Tissue Kit was used for DNA extractions, following the manufacturer's instructions for animal tissues (Qiagen, Inc.). A 760 bp mtDNA control region fragment was amplified in both directions using primers LCM15382 (5´-GCT TAA CCC TAA AGC ATT GG-3´) and H950 (5´-GTC TCG GAT TTA GGG GTT TG -3´; Abreu-Grobois et al. 2006). Polymerase chain reaction (PCR; 1.5 mM $MgCL_2$, 1× PCR Buffer, 200 µM each dNTPS, 0.5 µM each primer, 0.6 U Taq from Invitrogen Life Technologies, 1 µl template DNA and H_2O to a total volume of 50 µl) was carried out under the following conditions: 10 min at 95°C, 35 cycles of 1 min at 94°C, 30 cycles of 1 min at 50°C, and 1 min at 72°C, followed by 5 min at 72°C (Shanker et al. 2004), using a MGW Biotech Primus PCR System. The samples were purified and sequenced using the MACROGEN, Inc. (Seoul, South Korea) sequencing service.

Sequences were edited and aligned using the Bioedit V 7.0 (Hall 1999) and Clustal programs (Higgins and Sharp 1988). Polymorphic sites were identified using GENALEX 6 (Peakall and Smouse 2006).

To infer the possible origin of the turtles, we compared our results with data from 13 Caribbean and Brazilian nesting beaches: Cuba (CU), Puerto Rico (PR), Virgin Islands (VI), Antigua (AN), Guadeloupe (GU), Barbados (BB), Venezuela (VE), Costa Rica (CR), Belize (BE), Nicaragua (NI), Mexico (MX), and the Brazilian states of Bahia (BH), Rio Grande do Norte (RN), Sergipe (SE), and Ceara (CE) (Lara Ruiz et al. 2006; Leroux et al. 2012; Vilaça et al. 2013; Fig. 1, Table 1).

Results.—In April 2009, a live turtle was incidentally captured near Bahía Samborombón (36.24405°S; 56.97686°W) in an artisanal coastal gillnet fishery from San Clemente del Tuyú, Rio de la Plata Estuary (RP in Fig. 1 inset map; Fig. 2). In March 2010, a second turtle was found stranded dead on the coast of Monte Hermoso, El Rincon Estuary (38.99005°S; 61.27847°W; ER in Fig. 1 inset map). Morphological studies identified both specimens as large juvenile Hawksbill Sea Turtles, with CCLs of 53.0 cm and 40.8 cm and curved carapace widths of 50.5 cm and 40.3 cm, respectively.

Sequences of 760 bp in the mtDNA control region were successfully amplified from skin samples. Qualitative comparison to published data suggests that the two samples match with the EiBR3 haplotype, which previously had been described only from Brazilian nesting beaches (Table 1).

TABLE 1. Haplotype frequencies of mtDNA in Hawksbill Sea Turtle nesting grounds in the Atlantic based on sequences of 760 bp according Leroux et al. (2012) and Vilaça et al. (2013). N = sample size. References and abbreviations correspond with Fig 1.

Vilaça et al. 2013 nomenclature haplotype	Leroux et al. 2012 nomenclature haplotype	Caribbean Rookeries									Brazilian Rookeries			
		AN	BB	CR	CU	GU	MX	NI	PR	VI	BA	RN	SE	CE
	Ei A3	29	57							2				
	Ei A9		6	3		69			2	2				
	Ei A12			5		1								
	Ei A13				5									
	Ei A18								1					
	Ei A20								34	4				
	Ei A21								6					
	Ei A22						2							
	Ei A23						16			1				
	Ei A29				1									
	Ei A30			1	1									
	Ei A41						1							
	Ei A43						1	16	3					
	Ei A47			6										
	Ei A52			1										
	Ei A65							1						
	Ei A84							5						
Ei BR8	Ei A1	42			62	2			3	8	53	21	1	1
Ei BR17	Ei A2			11				19						
Ei BR13	Ei A11	1	21	33	1	2		54	60	50				
Ei BR2													22	
Ei BR3													21	1
Ei BR4													291	
Ei BR16													16	
Ei BR9													4	
Ei BR10													9	
N		72	84	60	70	74	20	95	109	67	119	27	4	2

Discussion.—The present study details the southernmost records of Hawksbill Sea Turtles in the western Atlantic. Results presented here also provide insight into the morphological and genetic characterization of hawksbills at temperate latitudes, while improving knowledge of the distribution of the species. Indeed, genetic analysis based on 760 bp mtDNA sequences revealed that both specimens from Argentina correspond to the haplotype Ei-BR3 that has been detected only in Brazilian rookeries (Vilaça et al. 2013). Our results suggest that Brazilian nesting colonies might be a main contributor of hawksbills along the Argentinean coast.

Population genetic analysis of nesting beaches in the State of Bahia, Brazil, based on the same mtDNA fragment showed that the third most frequent haplotype (42%) was Ei BR3. This haplotype is phylogenetically close to haplotypes described for *C. caretta* (CC A4), suggesting the existence of hybridization in nature (Lara-Ruiz et al. 2006). Studies of several nesting areas in Brazil using nuclear markers support this view and suggest that hybridization is a recent phenomenon, spanning about two generations or 40 years (Vilaça et al. 2012, 2013). Postulated hybridization events at sea turtle nesting beaches in Brazil might be related to overhunting and environmental changes associated with coastal modifications (Vilaça et al. 2012).

Both specimens analyzed here had the morphology of *E. imbricata*, but exhibited a mitochondrial genome similar to that of *C. caretta*. Thus, a loggerhead female × hawksbill male hybridization event would explain the origin of specimens detected in Argentina. The suspected hybrid nature of the turtles phenotypically identified as hawksbills also might explain the occurrence of individuals of a species with a tropical distribution at temperate latitudes. That both specimens were large juveniles with probable capacity to swim independently of oceanic currents suggests that they did not arrive along the Argentine coast by chance. Indeed, satellite telemetry found that female hybrids derived from an *E. imbricata* × *C. caretta* mating could migrate to feeding areas of either progenitor species (Marcovaldi et al. 2012). Our results identify *E. imbricata* × *C. caretta* hybrids along Argentine coasts, a feeding ground of *C. caretta* (Prosdocimi 2012).

The detection of hybrid individuals of hawksbills in the western Atlantic indicates the need for increased sampling effort in geographical regions not yet analyzed to study hybridization in this critically-endangered species. Moreover, genetic studies using uniparental and biparental markers are required to clarify the genetic structure and demographic history of hawksbill populations necessary to delineate effective global conservation strategies.

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Limb Malformations of the Critically Endangered Stream-breeding Frog *Isthmohyla rivularis* in the Monteverde Cloud Forest Preserve, Costa Rica

Amphibian limb malformations have been known to science as early as the eighteenth century (Ouellet 2000). Common causes of limb malformations include trematodes (Sutherland 2005), chemical pollutants in the water (Taylor et al. 2005), and predation (Ballengee and Sessions 2008). Limb malformations have been documented primarily in North America and Europe (Ouellet 2000; Pinya et al. 2012), and recently in Africa (Hassine et al. 2011) and South America (Peltzer et al. 2011). Malformations have been noted in a number of amphibian families including the family Hylidae (Johnson and Lunde 2005). However, to our knowledge limb malformations have not been documented as occurring in Central America, nor in the genus *Isthmohyla* (Hylidae). Herein we report the first records of limb malformations of *Isthmohyla rivularis* found in Costa Rica.

Isthmohyla rivularis is a critically endangered, small-sized frog endemic to Costa Rica and Panamá (Stuart 2008). They occur in humid premontane and montane cloud forests at elevations ranging from 1210–2040 m, and are normally found in vegetation alongside fast moving streams (Savage 2002). Although amplexus and egg deposition have not been reported for this species, tadpoles develop in streams and may be encountered in riparian pools (Duellman 2001; Savage 2002). *Isthmohyla rivularis* was formerly a common species, but in the late 1980s they experienced severe declines and were not encountered for nearly 20 years in Costa Rica (IUCN 2012). However, a population was

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FIG. 1. Study stream segment and representative habitat of the population of *Isthmohyla rivularis* where limb malformations were detected on the Atlantic slope of the Cordillera Tilarán, Costa Rica.



FIG. 2. Hind limb malformations observed on the frog *Isthmohyla rivularis* representing brachdactyly and syndactyly (A); and brachydactyly and ectromelia of the fibulare, tibiale, and digits (B).

recently discovered in the Monteverde Cloud Forest Preserve (MCFP) and was the source upon which we made our observations.

As part of a larger study investigating the occurrence of the pathogenic fungus *Batrachochytrium dendrobatidis*, we surveyed a stream for *I. rivularis* on the Atlantic slope of the Cordillera Tilarán in the MCFP (10.32°N, 84.77°W, datum WGS84; elev. 1350 m). The stream occurs in primary cloud forest and consists mainly of riffles and glides (69%) with some rapids and cascades (27%) and occasional pools (4%). The 303 m section of stream we surveyed had a mean wetted width of 2.3 m and a mean center depth of 0.2 m. The primary substrate was cobble with some areas of boulders and coarse woody debris (see Fig. 1). Surveys were conducted on 13, 14, and 15 June 2011 between 1815 h and 2130 h. We captured twelve adult *I. rivularis* males; of these, three (25%) were observed to have rear limb malformations of brachydactyly (shortened toes) and syndactyly (fused digits) N = 1, and/or ectromelia of the fibulare, tibiale, and digits (absence of the foot from the ankle down) N = 2 (Meteyer 2000) (see Fig. 2).

Many limb malformations are attributed to limb bud disruption by trematodes of the genus *Ribeiroia* (Johnson and Lunde 2005). However, this seems unlikely in this instance, as we did not encounter intermediate host snails (Planorbidae) during diurnal bank-to-bank belt transect stream surveys (Welsh and Ollivier 1997) aimed at detecting tadpoles. Pinya et al. (2012) suggest *Ribeiroia* as a possible cause of limb malformations they observed in the endangered midwife toad *Alytes muletensis*. However, similarly to Pinya et al. (2012) we were unable to justify sacrificing individuals of a critically endangered species to inspect for metacercarial cysts (Johnson and Paul 2011).

Another possible cause may be trauma as a result of predation attempts. Bowerman et al. (2010) determined that aquatic predators were the probable cause of missing-limb malformations in two different species of frogs in Oregon, USA. In Costa Rica, Warrington and Cossel (2012) described crab predation on the related *Isthmohyla pseudopuma* within the Monteverde

Cloud Forest Preserve. Furthermore, we observed six crabs (*Epibolocera sinuatifrons*) within the stream segment along which the malformed frogs were encountered. However, we presume that malformations caused by crab predation would likely be missing or truncated limbs rather than the apparent developmental abnormalities we observed.

Chemical pollutants are another possible cause of the malformations. Taylor et al. (2005) found the risk of amphibian limb malformations was double when near agricultural land use. Further, only 2% of the malformations they observed were extra limbs, whereas the remaining malformations were either missing (26%) or malformed (72%) limbs (Taylor et al. 2005). The types of malformation we observed were similar to those of Taylor et al. (2005). Chemical pollutants as an etiology are puzzling because our study stream is extremely remote from any point sources of pollution other than an infrequently used cabin operated by the Tropical Science Center. However, LeNoir et al. (1999) reported airborne agricultural pesticide transport in the Sierra Nevada Mountain Range, and the prevailing winds at our study site carry moisture upslope from major agricultural activity along the Atlantic coast. This movement of air and moisture and the concentrating effects of fog and clouds (Hayes et al. 2010) could possibly transport contaminants to our study site and result in deposition at concentrations sufficient to cause limb malformations.

Ultraviolet light has been implicated as a cause of limb malformations in both lab and field settings (Ankley et al. 2000; Pahkala et al. 2001). Malformations caused by UV exposure are often bilaterally symmetric (Ankley et al. 1998). Although not perfectly symmetric, the general type of limb malformations observed on each frog displayed bilateral similarity (see Fig. 2). An assessment of amphibians in northern Wisconsin and Minnesota by Diamond et al. (2002) concluded that the risk of limb malformation caused by UV was low. The ambient levels of UV at our study site are unknown. However, this possible cause should be explored further.

Another possible cause of the limb malformations we observed is congenital defects. The rediscovery of this species after approximately 20 years of not being detected within the reserve may suggest a relictual population and a possible genetic bottleneck. Although there are no studies we are aware of that correlate inbreeding in amphibians with an increased incidence of malformations, observations by Pinya et al. (2012) occurred in populations that had been re-established, and may also represent a scenario where genetic variability was limited.

Our observation of limb malformations in *Isthmohyla rivularis* raises yet another concern for the conservation of this critically endangered frog species. Malformations may reduce recruitment (Hayes et al. 2010) and subsequently have negative impacts on the persistence of small, re-emerging populations. Therefore, understanding the cause of these malformations may be important for future conservation efforts of this critically endangered species.

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Quantification of Color Pattern Variation in the Common Gartersnake (*Thamnophis sirtalis*) from Two Coastal Islands and Mainland, Massachusetts, USA

The Common Gartersnake (*Thamnophis sirtalis*) inhabits a wide variety of ecosystems and has been extensively studied throughout most of North America (Gregory and Larsen 1993; Rossman et al. 1996). Conspecific variation in both morphology (Grudzien et al. 1992; King 1988) and color patterns (Kelley et al. 1997; Mooi et al. 2011) have been documented within and between populations of several *Thamnophis* species (Brodie 1989; Ruthven 1908; Westphal and Morgan 2010). In general, color pattern variation in snakes is presumed to reduce predation risk through interacting mechanisms normally including background matching and color pattern-specific antipredator behaviors (Brodie 1992), mimicry (Brodie 1993), or aposematic coloration (Williams et al. 2004), but it has also been linked to thermoregulatory efficiency (Bittner et al. 2002; King 1988).

Although color patterns are not a definitive method to determine species, subspecies, or distinct genetic lineages, variable patterns are important to consider because differential selective pressures can exist in each population (Brodie 1992). *Thamnophis sirtalis* exhibits population-specific phenotypes without necessarily being genetically distinct (Gregory and Larsen 1996; King 2003; King and Lawson 2001; Mooi et al. 2011; Westphal 2007; Westphal and Morgan 2010). In spite of considerable research on various *T. sirtalis* subspecies from central and western North America and the Maritime Gartersnake (*T. s. pallidulus*) from Nova Scotia, Canada (Allen 1899; Barnes et al. 2006; Bleakney 1959; Gilhen 1984, 2010; Rye 2000), there have been very few quantitative measurements of color patterns comparing populations or subspecies of the Common Gartersnake in the northeastern USA.

Our objectives were 1) to develop a standardized method for measuring color pattern variability, and 2) to compare color patterns between *T. sirtalis* populations from two islands and mainland Massachusetts. To achieve our first objective, we used a pattern analysis similar to that developed by Westphal (2007); however, we based our analysis on macrodigital images of partially stretched skin and scales on two specific regions of live *T. sirtalis*. We then quantified the area of lateral blotches (black) relative to scales and dorsal stripe completeness of *T. sirtalis* from Nantucket and mainland Massachusetts.

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Study Sites and Methods.—We used high-resolution digital macro-photography to examine patterns of pigment on scales and skin of adult *T. sirtalis* from the islands of Nantucket and Tuckernuck and the mainland of Massachusetts. Nantucket Island is 118 km^2 and is the largest of three islands within Nantucket County, Massachusetts. Tuckernuck Island is 3.6 km^2 and approximately 1 km W of Nantucket. These islands are approximately 40 km S of the closest mainland (Cape Cod) and 15 km E of the nearest large island, Martha's Vineyard, Massachusetts.

We analyzed scales for stripe and blotch on 32 Nantucket snakes, 28 Tuckernuck snakes, and 26 specimens from four counties on the mainland of Massachusetts (Middlesex [N = 5], Worcester [N = 16], Hampshire [N = 1], and Hampden [N = 4] counties) between 2008 and 2011 (Fig. 1). All snakes had a body mass of greater than 10 g and a snout–vent length (SVL) greater than 250 mm and were released after being photographed. One person could obtain digital images for analysis in the field by using the following procedure. Snakes were gently pressed against a firm surface, usually the photographer's upper leg, while kneeling on the opposite leg to provide stability for the camera and specimen. While holding the snake, the photographer gently stretched the skin and scales to expose the lateral blotches on the left side of the snake approximately one-fourth the SVL as measured from the snout. Instead of pressing the snake too firmly, holding the snake and watching the expansion and contraction of the skin during breathing provided a passive method of obtaining the best image. When a snake inhales, the anterior portion of the body expands and the skin is exposed between the scales to provide a good image of the lateral skin pattern. After a snake was in position, it relaxed and began breathing rhythmically and we timed the photograph with the breathing. The snake was then slightly rolled on to its ventral scales so that a second set of photographs could be taken of the dorsal stripe in the same region of the snake's body.

Our analysis of the dorsal stripe focused on the amount of black pigment on the scales where we counted seven scales along the dorsal stripe, normally row 10, and estimated the amount of black pigment on each scale (Fig. 2). No black on the scale was scored zero; black on 1–25% of the scale was scored 0.25; 26–50% was scored as 0.5; 51–75% was 0.75; and 76–100% was scored

as 1.0. The total score was summed to provide a stripe score for each snake (range from 0–7). We developed a scoring system for analysis of lateral blotches using the same concepts described by Westphal (2007). We analyzed an area defined by five rows of scales dorsal to the lateral stripe (scale rows 4–8) and seven scales anterior to the site of reference. For each of the 35 scales in this area, we estimated the percent of the scale's border adjacent to dark interscalar skin that formed a dark, pigmented blotch (Fig. 2). If there was no dark pigment on the interscalar skin adjacent to the scale, the score was zero. Any dark pigment on the interscalar skin from approximately 1–25% of the scale's border resulted in a score of 0.25, 26-50% of the scale bordering black pigment was 0.5, 51–75% was 0.75, and 76–100% was 1.0. The total score for each row was summed then divided by five (number of rows scored) to provide an average blotch-per-row score for each snake. In many instances more than one image had to be reviewed, often from the dorsal image, to see around the curve of the snake for rows 7–8.

We used Minitab 12.1 (1999 Minitab, Inc., State College, Pennsylvania) to test the data for normality, examine basic statistics, and compare the two response variables, lateral blotches and dorsal stripe between mainland snakes (pooled all samples) to the island specimens (pooled per island) using ANOVA General Linear Model and Tukey pairwise comparisons. To confirm that the variation in color pattern was not a sexually dimorphic trait, we used a *t*-test to compare stripe and blotch scores between all males and females, and there was no significant difference (Blotch, $P = 0.23$, Stripe, $P = 0.70$). Therefore, we pooled males and females in the color pattern analysis. We used ANOVA General Linear Model to compare mainland and island population data sets. The blotch and stripe data were normally distributed and comparisons were tested at $\alpha = 0.05$.

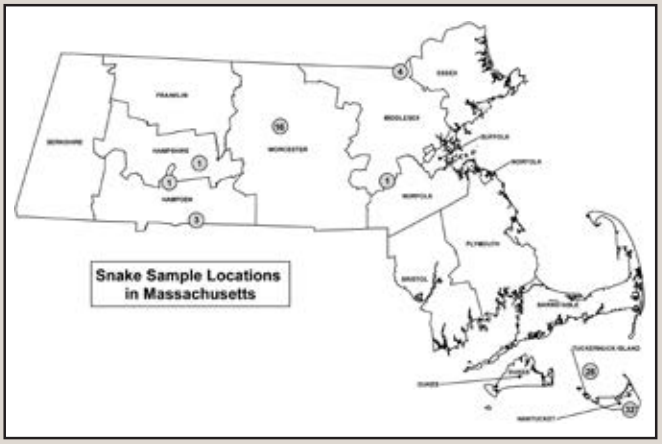


Fig. 1. Approximate location and number of *Thamnophis sirtalis* photographed for color pattern analysis.



Fig. 2. Examples of scores for each scale for the dorsal stripe and black blotches from one mainland snake (A. and B, Holyoke, Hampden Co.) and one island snake (C. and D.,Nantucket, Nantucket Co.).

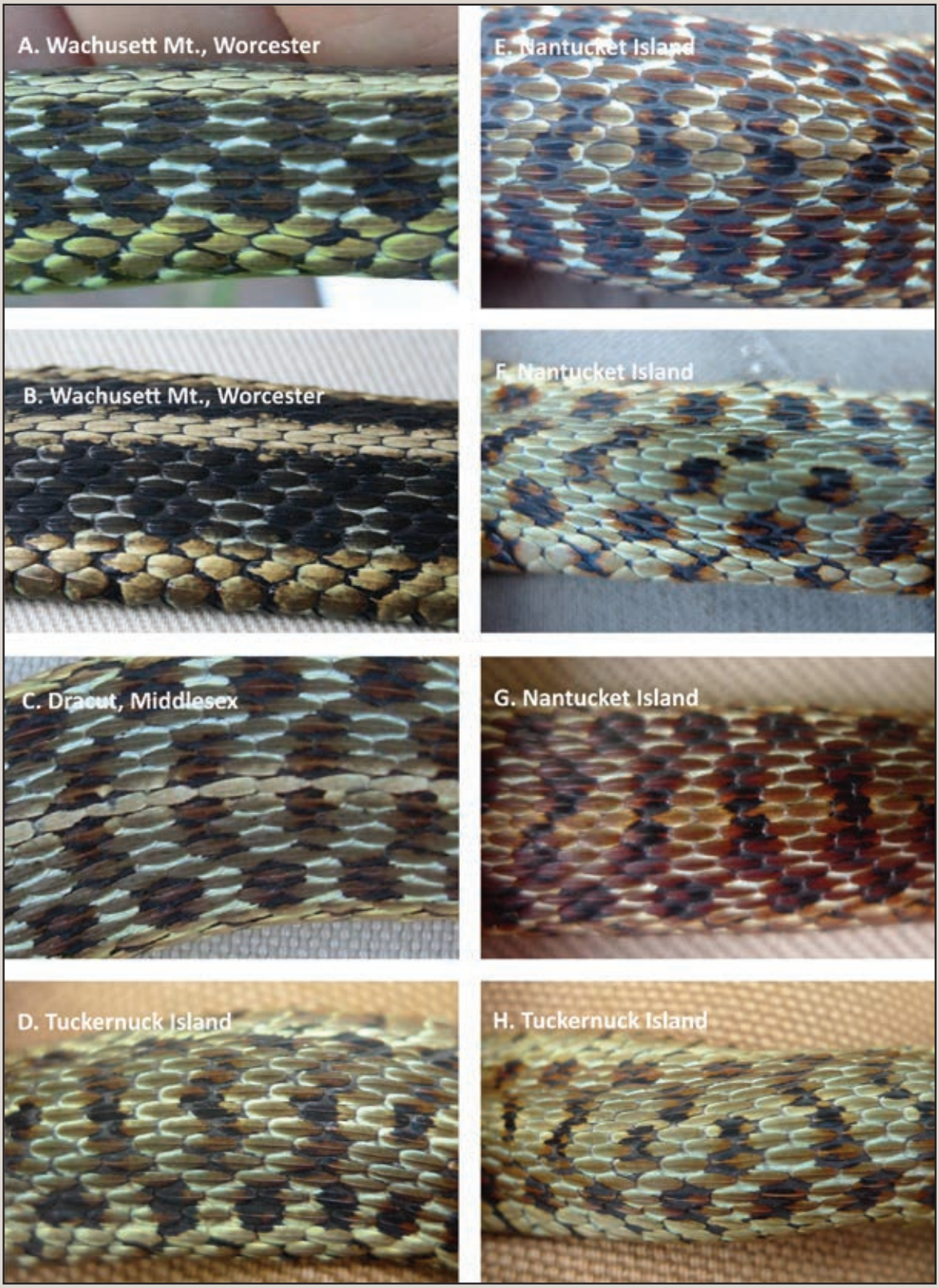


FIG. 3. Representative photographs of patterns of snakes from non-coastal counties and from the islands of Nantucket and Tuckernuck, Massachusetts. The specimens in A-C are from the mainland (A. and B., Wachusett Mountain, Princeton, Worcester Co.; C. Dracut, Middlesex Co.) while those in D-G are from the islands (D. and H. Tuckernuck Island, Nantucket Co.; E-G Nantucket Island, Nantucket, Co.).

Results and Discussion.—There was significantly less dark pigment within the dorsal stripes of mainland snakes (N = 26, 0.63 ± 0.13 (mean ± 1 Standard Error [SE]) compared to snakes from Nantucket (N = 32, mean = 2.20, ± 0.12) and Tuckernuck islands (N = 28, mean = 2.09, ± 0.10, $F_{2, 85} = 58.9$, $P < 0.001$). The stripe scores from Tuckernuck and Nantucket were not significantly different ($P = 0.74$). Lateral blotches on snakes from Nantucket (N = 30, mean = 3.53 ± 0.09) were significantly smaller than snakes from the mainland (N = 25, mean = 4.23 ± 0.083, P <0.001), and Tuckernuck (N = 28, mean = 4.06 ± 0.14, $F_{2, 82} = 11.7$, $P = 0.002$). However, lateral blotches on snakes from Tuckernuck did not differ from those on mainland snakes ($P = 0.532$).

Our results indicate that *T. sirtalis* from two coastal islands have significantly more black pigment on the dorsal stripe compared to snakes from the Massachusetts mainland. The snakes from Nantucket and Tuckernuck had discontinuous stripes with dorsal blotches that were sometimes fused with lateral blotches to form dark cross bands. There was no significant difference between lateral blotch areas of snakes from the mainland compared to Tuckernuck, but snakes from Nantucket had significantly less blotch area than mainland snakes.

There are several possible explanations for the significant differences resulting from our color pattern analysis. The spotted pattern on island snakes may be related to antipredator behaviors, thermoregulation, or genetic drift. A snake's likelihood of fleeing potential visual predators has been linked to color patterns (Brodie 1992; Jackson et al. 1976), and the contrasting pattern exposed when a *T. sirtalis* flattens its body to reveal rows of dark blotches or pigment on the skin between the scales may elicit a startle response from visual predators. Indeed, others have shown that within *Thamnophis ordinoides*, striped individuals are more likely to flee predators compared to spotted individuals which are more likely to remain motionless and rely on crypsis to avoid predation (Brodie 1989). Unlike their mainland counterparts, *Thamnophis sirtalis* from the islands of Nantucket and Tuckernuck are not exposed to mammals that potentially prey upon snakes, though feral cats (*Felis domestica*) are an introduced predator that may or may not be ecologically important in some areas (Massachusetts Department of Fish and Game, 2011). Additional studies investigating antipredatory behaviors could assist in determining the relative importance of predation in maintaining such color pattern variation in *T. sirtalis* on these islands and the adjacent mainland.

Thermoregulation is another possible explanation for differences in lateral blotches between Nantucket and mainland snakes. A study on differences in thermoregulation of melanistic gartersnakes demonstrated that the larger area of black pigment is functionally beneficial to adult snakes and likely most important to gravid females (Bittner et al. 2002). Finally, the varying color patterns may be due to genetic drift, and the varying color patterns are the result of relatively small founding populations, thus have no selective advantage.

Lazell (1976) inferred that color variation of *T. sirtalis* from the coastal islands and Cape Cod Massachusetts may be relict populations of *T. sirtalis pallidulus*, suggesting a postglacial dispersal-driven hypothesis: cold-tolerant snakes advanced north with the glacial retreat and were stranded on the islands as sea level increased and cut off any overland dispersal vectors. Bleakney (1959) provided a detailed review of *T. s. pallidulus* including descriptions of color patterns, scale formulas, and hybrid zones from the northeastern USA and adjacent Canada. Rye (2000) reported a genetically distinct maritime lineage of *T. sirtalis pallidulus* in northeastern Maine and the Maritime provinces of Canada, providing validity to the historic range map of the subspecies by Bleakney (1959). This subspecies has been most thoroughly studied in Nova Scotia, Canada, where morphological variation, life-history, and general ecology have been documented (Gilhen 1984). Populations on smaller islands of Nova Scotia have also exhibited variation in color patterns (Barnes et al. 2006).

Methods used in this study are likely to be useful range-wide for *T. sirtalis* as well as other species. Additional studies of patterns of *T. sirtalis* from other nearby islands and populations along the coast and inland could reveal different patterns than those reported herein. This may provide insight into how population-specific selective pressures influence isolated populations of *T. sirtalis.* Our methods could be used to compare color patterns of *T. sirtalis* and *T. s. pallidulus* from the maritime provinces of Canada or northern New England to determine if historically recognized subspecies are functionally different.

Collecting data from live snakes is advantageous because the elasticity of the skin allows close examination of true color patterns, which is often difficult or impossible when examining preserved specimens. Although the snakes often bite and struggle to escape, by restricting data collection to photographs of a relatively small region of the body, we reduce the specimen's discomfort and overall resistance allowing for a relatively consistent image. We intend to continue studying this species' predisposition to color pattern variability, both on the individual and population level. Future research may lead to a better understanding of how this wide-ranging species not only persists and disperses, but how it is successful throughout variable regions of North America including island habitats.

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TECHNIQUES

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Attaching Radio-Transmitters to Geckos: Trials and Tribulations

Radio-telemetry is considered an important and successful technique for investigating the behavioral ecology of animals under natural field conditions, and for conservation monitoring (Goodman et al. 2009; Warner et al. 2006). The technique relies on attaching radio-transmitters to animals and tracking their location over a period of time in order to study their movement, habitat-use and other behaviours. Several techniques have been employed for attaching transmitters to lizards, including surgical implants (Guarino 2002; Klingerböck et al. 2000; Smith et al. 2010), contact adhesion directly to skin (Mathies and Martin 2008; Sabo 2003), tail mounts (Barr 2009; Germano 2007), collars (Pérez-Buitrago and Sabat 2007) and external harnesses (Flesch et al. 2009; Goodman et al. 2009). Backpack harnesses have shown to be one of the more successful techniques, and have been used effectively on a variety of lizard taxa, including agamids (Doody et al. 2009; Reaney and Whiting 2003; Warner et al. 2006), phrynosomatids (Burrow et al. 2001; Fisher and Muth 1995; Grant and Alberts 2001; Richmond 1998), skinks (Price-Rees and Shine 2011), anoles (Nicholson and Richards 2011), varanids (Guarino 2002; Traholt 1995), and iguanas (Goodman et al. 2009), as well as on tuatara (Ussher 1999). The majority of these groups represent primarily terrestrial lizards (with the exception of *Anolis*) and consequently, backpack designs have focused on utilized materials that are resistent to the force of contact with ground surfaces and wear on harness materials during locomotion (Ussher 1999). The typical heavy keratinized scalation of these groups offers protection against any rubbing or abrasive forces potentially caused by external transmitter harnesses (Goodman et al. 2009).

Geckkonidae on the other hand, differ markedly from other lizard groups in both morphological and behavioral traits. They typically have soft, loose skin with granular scales that do not overlap, and many species are small and arboreal. These characteristics limit the use of standard attachment methods previously mentioned. For example, the small size of most geckos precludes the use of implanted transmitters and their softer skin is likely to be more susceptible to the effects of abrasion by some external attachment methods. Furthermore, the risk of entanglement in foliage and lodgement in crevices is higher in geckos, which tend to seek refuge in tight cracks and fissures. Few published studies have provided details on the methods of attaching radio transmitters to geckos, and fewer still have discussed the successes and/or failures of their techniques (Hare et al 2007; Hoare et al. 2007; Knox and Monks 2013).

New Zealand supports a rich diversity of geckos, with approximately 40 species and undescribed taxa (Hitchmough et al. 2013; Neilson et al. 2011). For the majority of these species, little is known of their natural history due to their cryptic nature, rarity, and often low population densities (Bell 2009). Several studies have trialed radio-telemetry techniques to investigate the behavioral characteristics of some gecko species (Hare et al. 2007; Salmon 2002; Schenyer 2001). Salmon (2002) trialed three different methods for attaching transmitters to geckos, including surgical implants, direct attachment to the dorsal surface with cyanoacrylic glue (Supa Glue®), and a backpack-harness style method. The study recorded poor success with both direct attachment and surgical implants, with transmitters detaching within 24 h and a 50% (4 of 8) mortality of animals following transmitter removal surgery, respectively. Since then most studies have adopted the backpack harness method, trialling a variety of materials and harness designs, and reporting large variations in the longevity of attachment (Table 1). Little value however, has been placed on discussing the beneficial and/or adverse effects of these designs. The lack of published data has hindered progress towards developing effective transmitter attachment methods for geckos.

As part of a wider study aimed at reporting the post-release movements of 39 Duvaucel's Geckos (*Hoplodactylus duvaucelii*) translocated to two protected offshore islands, Tiritiri Matangi Island and Motuora Island, in the Hauraki Gulf, New Zealand, we investigated the effectiveness of radio-transmitter attachment on this species, and discuss our results in the context of previous radio-telemetry studies undertaken on geckos worldwide.

Methods

Radio-transmitter attachment.—Hoplodactylus duvaucelii is a large (up to 320 mm total length, 160 mm SVL, and weight 118 g), nocturnal, terrestrial-arboreal species (Whitaker 1968). They have a propensity to seek small crevices as retreat sites during the day (e.g., holes tree branches and trunks, cracks between boulders, beneath bark, and in sea bird burrows) and emerge at night to forage on the ground, on trees, and in the foliage of

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TABLE 1. Summary of backpack radio-transmitter attachment types on geckos in wild conditions.

Investigators and dates of study (publication)	Species	Material for harness	Length of attachment	Sample size	Injury reported
Schneyer 2001	*Naultinus gemmeus*	Leukostrip ® wound closure strips Hansaplast ® self-adhesive dressing	12–29 days	11	No
Salmon 2002	*Naultinus gemmeus*	Beiersdorf surgical tape CicagrafTM wound closure strips	12–21 days	14	Minor scale loss in captive trials
Hoare et al. 2007	*Hoplodactylus duvaucelii*	Easifix® polyamide & cellulose contour bandage Mefix® hypoallergenic self-adhesive fabric strips	Tracked for 6–7 days only	32	Unknown
DOC* (unpubl. data)	*Toropuku* 'Coromandel'	Mefix®	6 days	1	No
Hare et al. 2007	*Naultinus manukanus*	"Back pack" method	Tracked 5–8 days at one time	5	No
DOC* (unpubl. data)	*Naultinus punctatus*	Polyester/ latex	Tracked for 10 days	2	Unknown
DOC* (unpubl. data)	*Tukutuku rakiurae*	3MTM MicroporeTM tape	7–14 days		Unknown
Gerner 2008	*Phelsuma guntheri*	Gospel CoPoly cohesive bandage	3–58 days	21	Dorsal skin abrasion, death of juvenile.
McClure 2011	*Naultinus gemmeus*	3M™ Vetrap flexible cohesive bandage tape	2 weeks	10	Restricted and altered natural behaviors
Hoare et al. 2013	*Mokopirirakau* 'southern forest'	Micropore self-adhesive tape	5 and 12 days	2	Unknown
Knox & Monks 2013	*Naultinus gemmeus*	USL Dynamic SENSITIVE Rigid White 38mm adhesive strapping tape -for sensitive skin	ca. 3 weeks	19	No

*DOC, Department of Conservation

vegetation. The small single-stage radio-transmitters used in this study measured 20 mm x 10 mm with a 150-mm whip antenna (Sirtrack Ltd, New Zealand) and weight of ca. 1.4 g. The battery life of the transmitters was approximately 80 days.

Transmitters were attached to geckos using a backpack harness design, modified from Fisher and Muth (1995), Richmond (1998), and Warner et al. (2006). The material used to form the harness was selected based on perceived comfort, flexibility, and durability in the environment. Two different materials were trialled, including thin (ca. 1 mm thick) black rubber (bicycle inner tubing) and a more flexible material, Co-Flex® (Andover Healthcare Inc.). Co-Flex® is a stretchable, lightweight material with self-adhering and water resistant qualities. Harnesses were cut from the materials using a cardboard template. The harness consisted of two shoulder straps (5 mm wide x 100 mm long) branching from a central pad (25 x 20 mm) (Fig. 1a). The length of the straps allowed enough material to easily adjust the harness to the size of the lizard. A transmitter was glued to the central pad using cyanoacrylate glue (Superglue ™). The harness was placed across the individual's shoulders with shoulder straps pointing anterior along each side of the head. The straps were wrapped over the shoulders, across the chest in an 'X' pattern (Fig. 1c), and then back up behind the opposite foreleg. The ends were subsequently attached to the dorsal surface of the transmitter with a small amount of cyanoacrylate glue (Superglue ™) and any excess strap material was cut off (Fig. 1b). It was expected that the glue would form a weak link in the harness over time, as exposure to the environment caused the glue to become brittle and crack, allowing the animal to climb free of the harness. A small amount of glue was also placed between the straps, at the point where they crossed the chest, to reduce the independent movement of each strap (Fig. 1c). Care was taken to avoid glue coming in contact with the individual's skin and the procedure was performed in open air to avoid excessive inhalation of vapors that could be harmful to the animals. When attaching the Co-Flex® harnesses to the geckos, two additional shoulder straps (4 mm wide) were applied diagonally over the top of the transmitter and crossing the chest to add further rigidity, in accordance with Hoare (2007) (Fig. 1d). The backpack harnesses were fitted neatly but did not constrict the chest and interfere with breathing (Fig. 2). The complete harness including transmitter weighed approximately 3.5 g and accounted for less than 5% of *H. duvaucelii* body weight. Because the weight of an individual lizard can fluctuate over 5% within a normal seasonal cycle (Telford 1970), backpack harnesses used in this study were considered an acceptable weight.

Transmitters were attached to 20 adult *H. duvaucelii* (10 geckos per island) and captive trials, up to one week prior to release, were undertaken to confirm that the geckos were able to undertake natural behaviors and move freely while wearing backpack harnesses.

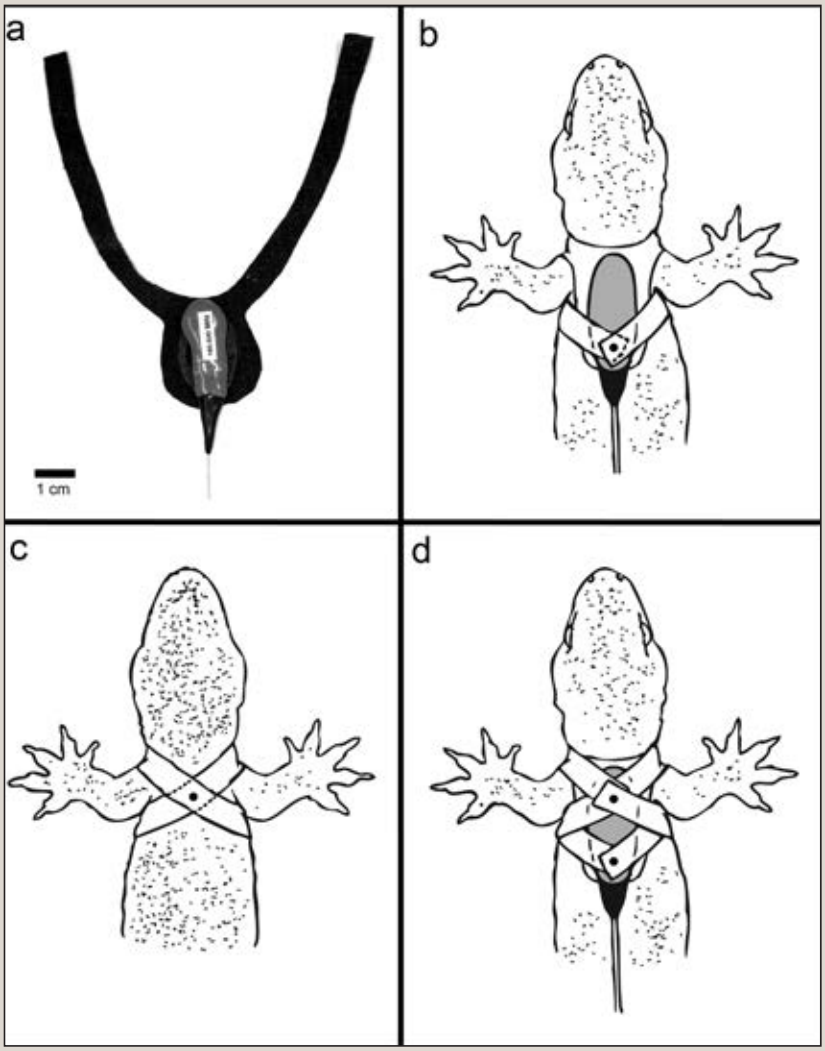


FIG. 1. Attaching a backpack harness to a gecko, a) Co-Flex® harness template with transmitter glued to central pad; b–d) consecutive stages of attachment. See text for details. Black dots (•) indicate where glue was applied to secure straps.

Radio-tracking.—Following the release of the geckos, telemetry signals were received using a hand-held R-1000 telemetry receiver (Communication Specialists Inc.) and a 3-Element Yagi aerial tuned to 160MHz operating frequency (Sirtrack, Havelock North, New Zealand). Transmitters were replaced as their batteries approached the end of their life (i.e. ca. 60 days or within 20% of their battery life) and new transmitters were attached to re-captured animals.

RESULTS

Backpack harness performance.—Backpack harnesses proved a successful method for monitoring the movements and habitat use of *Hoplodactylus duvaucelii* in the present study. On average, the rubber harnesses remained attached for significantly longer periods of time (43 ± 1.6 days; N = 20) compared to Co-Flex® harnesses (12.4 ± 2.4 days; N = 30) ($t = 10.65$, $df = 46$, $p < 0.001$). Body condition indices (weight: SVL ratio), movement, and habitat-use of translocated *H. duvaucelii* did not appear to be negatively affected by radio-transmitter attachment (van Winkel 2008). All geckos carrying transmitters gained body condition and were frequently observed climbing, sprinting at speed, and squeezing through tight vegetation to evade capture. No entanglements in vegetation were recorded. Both harness designs withstood rainfall events, variations in temperatures (12–28°C), and varying degrees of abrasion from rough tree-bark, soil, and rock surfaces.



FIG. 2. Radio transmitter attached to *Hoplodactylus duvaucelii* via a backpack harness, constructed from the flexible Co-Flex® material.

Later in the study, evidence of abrasion became apparent and prompted an immediate abandonment of the rubber material, with all harnesses being replaced with the flexible Co-Flex® material. Injures were recorded in 20% of the geckos wearing rubber harnesses after approximately three weeks of attachment. The injuries were apparent under the armpits and across the dorsal surface of the neckline in areas the rubber material came into contact with the head and moving limbs of the geckos. The injuries ranged from minor abrasions to the skin, resulting in damage or removal of scales, to open lesions in two instances. On one occasion, a small twig (10 mm long) had to be removed from the area between the rubber harness and the gecko's skin. The twig had caused abrasions to the skin after becoming lodged in this space while the gecko was pushing through branches and foliage. The backpacks of wounded individuals were removed immediately and not replaced. Open skin lesions were treated with Betadine® ointment and the rate of healing monitored via opportunistic recaptures of wounded individuals. Monitoring of wounds indicated that lesions took up to three months to heal adequately. In contrast, no injuries were recorded in animals wearing the Co-Flex® harness design. At the completion of the study all transmitters, with the exception of one (due to battery failure), were recovered successfully.

Discussion

Our study verified that the backpack harness design for attaching radio-transmitters to geckos is a convenient and successful technique, provided that consideration is given to selecting an appropriate material for construction of the harness. Backpack harnesses did not appear to constrict or constrain geckos in the present study, with individuals exhibiting natural behaviors typical of the species and showing signs of successful foraging, as indicated by increases in body condition indices. Altered natural behavior and irritation caused by backpack harnesses has been alluded to in previous studies on geckos, immediately following harness attachment (DOC, unpubl. data; Hare et al. 2007; McClure 2011). In most instances the animals soon adjusted to the harness and resumed natural behaviors within periods ranging from 10 minutes (C. Knox, pers. comm.) to a few days (DOC, unpubl. data). Loosening and readjusting harnesses also helped remedy unnatural movements and behaviors in some geckos (C. Knox, pers. comm.).

There were considerable variations in the length of attachment time depending on the type of material used to construct the harness, with rubber harnesses remaining attached to geckos for more than three times as long as the Co-Flex® harnesses. The Co-Flex® material appeared more susceptible to the effects of long-term exposure to environmental conditions than the rubber material, and over time the Co-Flex® lost its elasticity and showed some degree of wear (e.g. fraying and small tears in the material). The difference in durability between the two materials, in relation to the behavioral habits of *H. duvaucelii* (propensity to seek small, tight crevices as retreat sites and move over rough surfaces while foraging) would have contributed to the reduced length of attachment in the Co-Flex® harness. As the material lost elasticity the geckos were able to maneuver out of the harnesses. In comparison, rubber harnesses appeared less susceptible to wear and tear and did not lose flexibility. However, the perceived effects of rubber material on the geckos' skin were severely overlooked as injury was recorded in 20% of the study animals. Considering that injuries were not observed during the short-term captive trials, it is likely that the long-term effect of the rubber material chaffing the soft skin was sufficient to cause abrasion and damage to the skin of the geckos. Furthermore, no evidence was found to suggest that the glue had become brittle allowing the harnesses to detach freely. For these reasons, it is recommended that the rubber material (rubber inner tube) should not be used in future radio-telemetry studies on geckos.

The Co-Flex® material, though more frequently shed by geckos, did not have any detrimental effects on the geckos' skin in the current study. Previous radio-telemetry studies on geckos which used similar cohesive bandage materials have shown that geckos can be tracked for up to two weeks without reported injuries (McClure 2011). However, accuracy and longevity of attachment are likely to be contributing factors to causes of injury. For example, Gerner (2008) reported dorsal skin abrasions and the death of one juvenile *P. guentheri* during a radio-tracking study using a material almost identical to Co-Flex®. However some individuals in the Gerner (2008) study were tracked for up to 58 days, and it is likely that the prolonged effect of movement of the material on the skin may have lead to the adverse effects described. The risks associated with entanglement in vegetation, as well as collection of dirt and debris between the skin and the harness, potentially leading to discomfort and injury also increases with the prolonged attachment time. Gerner (2008) recommended attaching a lightweight padding material under the harness to provide protection against continual movement and rubbing of the harness would be beneficial. Alternative methods to prevent the movement of the harness and transmitter have been trialed by several authors (DOC, unpubl. data; Hoare et al 2007; Knox and Monks 2013; Schneyer 2001; Salmon 2002) using medical adhesive tape or wound closure strips (Table 1). These materials secure the backpack harness to the skin with a light adhesive, reducing damage to the skin and allowing successful harness attachment for up to four weeks in some studies (Schneyer 2001). However it has been suggested that adhesion to scales may interfere with the sloughing process (Schneyer 2001) and Salmon (2002) reported minor scale loss in a study on captive *Naultinus gemmeus*. Light adhesion to the skin would also appear to limit the ability of geckos to maneuver out of harnesses (DOC, unpubl. data; Knox and Monks 2013). However, medical tapes are particularly susceptible to weathering and the glue loses its adhesive qualities over time in the environment, especially if it comes in contact with rainwater (C. Knox, pers. comm.). Adhesive tapes may therefore have limitations where studies are required over longer periods in natural field conditions, and especially in moist environments. Remedying this may rely on close observation to check the integrity of the backpacks and replace the adhesive harnesses as required. An alternative material for attaching backpack harnesses has been trialed on anoles, a group of arboreal lizards with similar behavioral traits and skin morphology to geckos. Nicholson and Richards (2011) used 0.25-in. elastic (Stretch-Rite brand, Rhode Island Textile Company, Pawtucket, Rhode Island 02862) to construct small harnesses. They reported successful results with no interference or disturbance to behavior and no descriptions of injury or other adverse effects.

Understanding the physical and behavioral habits of a gecko, and any limitations caused by environment, is crucial when considering the material and design of a transmitter harness. Our study clearly overlooked the former when selecting the rubber material, leading to high incidences of injury, and as a result this material should not be used in future radio-telemetry studies on

geckos. It is recommended that future studies focus on selecting materials with soft, elastic, and light adhesion qualities to construct backpack harnesses, and that the study period be limited to three to four weeks with regular observations of the individual and harness attachment, to significantly reduce the risk of unwanted injuries. In addition, publishing developments in harness design and reporting both positive and negative results will ensure adaptive development towards a successful and effective method of the highest welfare standards.

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Using Decoys to Estimate Detection Probability for Anuran Amphibians During Visual Encounter Surveys

Understanding spatial and temporal patterns in distribution and abundance is a common goal in amphibian ecology, especially in light of widespread population declines (Schmidt and Pellet 2010). Most studies rely on count data, but often do not account for differences in detection probabilities, which can be highly variable among sites and years (Schmidt 2004; Schmidt and Pellet 2010). If documenting the occurrence of a species is the goal of a survey, repeated visits to a locale can be used to minimize the probability of failing to detect a species that is actually present (Williams and Berkson 2004). The cumulative probability of failing to detect at least one individual of a species declines geometrically with repeated visits, and often approaches a value of zero, or perfect detectability, after several visits (Mackenzie et al. 2002; MacKenzie et al. 2003; Williams and Berkson 2004).

Correction for detectability is more complex when the goal is to determine amphibian abundance, and even the term "detection probability" has a different meaning in this context. When determining occupancy, detection probability is defined as the probability of detecting at least one individual, and therefore increases with abundance (Mackenzie et al. 2002; MacKenzie et al. 2003). When determining abundance, detection probability is the probability that a member of the population is included in the count, and can be considered independent of abundance (MacKenzie and Kendall 2002; Nichols et al. 1998; Williams and Berkson 2004). Because true abundance can rarely be known, counts of individuals corrected for search effort are commonly used (Schmidt and Pellet 2010). Catch-per-unit-effort (CPUE) can be used as an index of abundance if the probability of detecting individuals does not differ among surveys, but this is rarely the case (MacKenzie and Kendall 2002). Detection probability varies with weather, season, time of day, habitat structure and observer, thereby making it unlikely that animals are ever equally detectable at different sites or on different visits to the same site (MacKenzie and Kendall 2002). CPUE can be corrected to account for variation in detection (eg. CPUE/detection probability).

Some researchers have conducted experiments to determine detection probability to create an appropriate correction factor for results of field surveys. To determine detection probability of Red-backed Salamanders (*Plethodon cinereus*), Williams and Berskon (2004) repeatedly searched enclosures containing a known number of individuals. As an alternative to using live animals, Dong Saul (2008) used turkey decoys to determine detection probability of Rio Grande Wild Turkeys (*Meleagris galloparvo intermedia*) for aerial and truck-based surveys in three different vegetation communities. We present a similar technique that uses decoys for estimating the probability of detecting individual frogs during time-constrained visual surveys. Our focal species was the Wood Frog (*Lithobates sylvaticus*), specifically recently metamorphosed young-of-the-year (YOY). We tested for differences in detection probability between two types of wetland habitat, pond shorelines and beaver canals, in Miquelon Lake Provincial Park, in the dry mixed-wood boreal forest of Alberta, Canada (Natural Regions Committee 2006). Survey ponds were pothole wetlands between 0.22 and 2.28 ha in area, with shorelines fringed by emergent vegetation (*Typha latifolia*, and *Carex* spp.) surrounded by riparian meadows of grasses and forbs with scattered willows (*Salix* spp.).

We constructed decoys using biodegradable dough: water, white flour, salt, and cream of tartar with cocoa powder to achieve a pale brown color. Decoys were approximately 2.5 cm long (the size of YOY Wood Frogs at our study sites), with shallow ridges running along the body. Three small, dark blue beads were glued around the "head" region to simulate eyes, thus at least one eye was visible regardless of the orientation of the decoy. Half of a wooden toothpick (~15 mm) was inserted into the hind end of the decoy to mimic a leg (Figs. 1 and 2). All decoys were baked in an oven at 90°C for 3 h to dry the dough and improve durability. Approximately 400 decoys were constructed requiring 4 person-hours, with a cost of approximately US $15 for materials.

We deployed 15 decoys haphazardly along each 3 m-wide and 15 m-long transect, which simulated the highest density of YOY frogs observed at our study during late August 2012, when detectability trials were conducted (Anderson 2013). Location of transects was established using a 15 m-long throwing line (Northwater© "Small Regulation Throw Bag"), and decoys were tossed onto a transect from a few meters to one side to avoid trampling vegetation. Two surveyors, unfamiliar with the location and the number of decoys, were allowed up to 4 minutes to search the 15 m transect (Fig. 3). This pace was similar to that of visual encounter surveys for live frogs. Over 3 days, we conducted searches of 26 transects in each habitat type (i.e., pond shorelines and beaver canals), on three ponds (6, 10, and 10 transects per pond as dictated by pond size), requiring a total of approximately 36 person-hours. Searches were timed, and the proportion of decoys recovered was corrected for search time, standardized to 4 minutes. Using a similar approach to Dong Saul (2008), the probability of detecting decoys was calculated as:

$$p(D) = \frac{N \text{ decoys recovered}}{15 \text{ decoys available}} \times \frac{240 \text{ seconds}}{\text{Search time in seconds}}$$

Mackenzie and Kendall (2002) present reasons for believing *a priori* that detection probabilities differ among sampling episodes, and suggest that where such a difference is not documented, it is more likely the result of low statistical power than equivalence of detection probability. Therefore, we used an alpha value of 0.10, following methods used by Skalski et al. (1983),

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FIG. 1. Comparison of a decoy (left) and young-of-the-year Wood Frog (right). Note the bead that mimics an eye, and the shallow ridge that mimics one of the dorso-lateral ridges of a ranid frog.



FIG. 2. Frog decoy (SUL = 28 mm). A third bead (not visible) was glued to the other side of the decoy's head, and the half toothpick mimics a leg.



FIG. 3. Surveyors searching vegetation for frog decoys along a beaver canal in Miquelon Lake Provincial Park, Alberta, Canada.

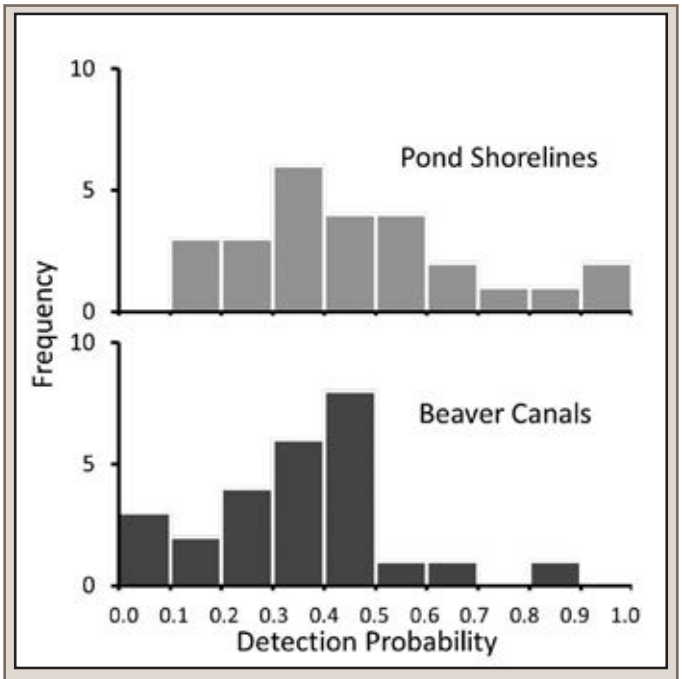


FIG. 4. Frequency histograms of the probability of detecting decoy frogs on 26 transects in each of two habitat types, in Miquelon Lake Provincial Park, AB.

to increase the power of our design and reduce the risk of type II error, *i.e.* concluding that there is no difference in detectability when a difference actually exists. We tested for a difference in mean detection probability between the two habitat types using a paired *t*-test. Detection probability for frog decoys averaged 0.45 (ranging from 0.13 to 0.97) along pond shorelines and 0.35 (ranging from 0.06 to 0.65) along beaver canals (Fig. 4). Detection probability differed significantly between the two habitats ($t_{25} = 2.000$, $p = 0.056$), thus we recommend that CPUE of live frogs for each of these habitat type should be divided by its respective *p(D)* before making any comparison of abundance between habitats. However, the statistical power for our trials was only 0.617 (based on $n = 26$, $\Delta\bar{x} = 0.108$, $s = 0.2756$, $\alpha = 0.10$; using the "stats" package in R version 2.15.1, R Core Team, 2012). If we had not detected a significant difference in *p(D)* between the two habitats, we would not have been able to conclude that *p(D)* was equal without a larger sample size than the 26 trials we conducted (at $\beta = 0.10$, $n = 58$, calculated as previously).

We propose that our approach be applied to visual transect surveys for other fairly conspicuous amphibians or reptiles to increase the accuracy of resultant abundance estimates. However, the fact that decoys do not move should be taken into consideration. Decoy searches may not be realistic if movement strongly affects detectability. Daily or seasonal activity patterns of the study organism should also be considered before using decoy searches, as this technique is best suited to estimating the detectability of animals that are moving on the surface of substrates rather than hiding in refugia. For example, although wood frogs are conspicuous during post-metamorphic dispersal in August, they burrow under leaf litter in fall prior to overwintering (Russell and Bauer 2000).

Using decoys is a simple, inexpensive alternative to using live animals to estimate detection probability and for improving the quality of survey data. Decoy searches can be completed within a short time span in the same locations as visual transect surveys for live animals, and by the same surveyors. We recommend researchers use decoy searches to produce detection probabilities specific for the species, system, and questions under study.

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Pioneering the Utility of a Mineral Oil Mixture for Fluorescent Powder Tracking of Salamanders

The movement patterns of amphibians are important to our understanding of population ecology and behavior. The development of new tracking methods and the improvement of existing methods for amphibians will be valuable for determining the behavior of small amphibians. New tracking methods also will be a crucial component to conservation of amphibian species worldwide. Techniques for tracking behavior of small salamanders are currently quite limited; modern radio-tracking devices are still too large and thread-bobbin techniques are inappropriate for fossorial species (Graeter and Rothermel 2007). Although Passive Integrated Transponders (PIT) tags have been used successfully for some salamander species (Charney et al. 2010; Connette and Semlitsch 2012; Hamed et al. 2008), these have limitations and in some cases fine-scale tracking may be limited.

Fluorescent powder is considered a safe option for tracking small animals (Orlofske et al. 2009; Rittenhouse et al. 2006; Roe and Grayson 2009; Stapp et al. 1994) including snakes, lizards, frogs, and salamanders (Birchfield and Deters 2005; Dodd 1992; Eggert 2002; Furman et al. 2011; Graeter 2005; Stark et al. 2005). A method described by Eggert (2002) combined mineral oil and fluorescent powder as a tracking medium for toads. This medium was reported to improve tracking efforts for spadefoot toads (*Pelobates fuscus*) (Eggert 2002). We wanted to determine whether the addition of mineral oil to fluorescent powder could increase our ability to track salamanders. To our knowledge this technique has not been tested on any other amphibian species, and its only other application was as a tracking medium on track plates associated with drift fences (Popescu and Hunter 2011). Before using this technique in the field, we wanted to determine whether it caused salamanders to react adversely. We chose the Red-backed Salamander (*Plethodon cinereus*) as a study species because it respires cutaneously, likely making its skin more sensitive to the application of any substance. Also, we examined Eggert's (2002) suggestion that the addition of mineral oil to fluorescent powder would increase the distance animals can be tracked. We expected that the mineral oil would improve track length, especially under rainy conditions when many salamanders are most active.

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Materials and Methods

Short-term survival and condition.—We captured Red-backed Salamanders in the Jefferson National Forest near Pembroke, Giles Co., Virginia, USA. Thirty, non egg-guarding adults were captured in the first week of June 2012 with no preference to color morph. Each salamander was housed in an individual sealable plastic bag (17 cm × 17 cm) with moist leaf litter collected at their capture location. Animals were weighed fully hydrated, directly after removal from moist housing. During the entire experiment all individuals were kept in coolers with temperatures ranging from 5–15°C (but tested at room temperature, approximately 20°C). Salamanders were not fed during the experiment but small invertebrates may have been present in the leaf litter.

Before the experiment began each individual was weighed using an Ohaus Scout II portable electronic balance accurate to 0.01 g. For the experiment, individuals were divided into control (N = 15) or treatment (N = 15) groups by random stratified sampling according to their weight. The treatment group had a mixture measured by volume of one part mineral oil (Sigma-Aldrich: Sterile-filtered, BioXtra, suitable for mouse embryo cell culture, Light oil neat) and two parts fluorescent powder (Day Glo Color Corporation: ECO formaldehyde-free fluorescent pigment, Blaze Orange ECO-15,) and was applied with a sterile cotton swab primarily to their legs. Control group individuals were treated in the same way except distilled water was applied instead of the oil and powder mixture. All individuals were placed in clean plastic bags that contained moist unbleached paper towels for the duration of the experiment.They remained in these bags for 12 h, and every 3 h a visual inspection of general health was conducted. After 12 h the treatment group was cleaned using sterile dry wipes to remove any remaining oil/powder and the control group was also wiped. Once all powder was removed the animals were returned to their original bags containing leaf litter for a three day monitoring phase. We checked animals once every 24 h following the experiment. Inspections for physical abnormalities were conducted and each salamander's righting response was confirmed by placing the animal on its back and observing behavior. At the end of the experiment each animal was weighed and measured again, then returned to its original capture location. We used a two tailed t-test assuming unequal variances to examine differences in weight loss between the two groups.

Tracking Efficacy.—We evaluated the interaction of the rain and the utility of plain powder compared to mineral oil and powder mixture. For this test, we did not use live animals, but instead, we cut carrots to even sizes (30 mm × 5 mm × 5 mm), tied a string to them, and pulled them through a substrate of mowed grass (pasture or lawn) 2.5–12.7 cm tall. These paths were marked only at the beginning and measured 65 m long. Carrots either had plain (N = 20 paths) fluorescent powder or a mixture (N = 20 paths) of mineral oil and fluorescent powder (1:2 ratio by volume respectively) applied to approximately 90% of the surface of each carrot. We returned to the paths at night, used the marker placed at the start, and followed each trail until we could no longer detect the fluorescent powder. We used a VI Light (Northwest Marine Technologies, Inc.) to determine the path left by the fluorescent powder and oil-powder mixture. The end of a path was declared when all visible fluorescent powder was absent and the researcher could not confidently determine a further path of travel. We used multiple observers to determine visible path length. Paths were assigned to observers in pairs, so that every observer measured equal numbers of powder only and oil-powder mixture trails. The mineral oil altered the texture and color shade of the fluorescent track, so observers were not blind to the different treatments. During our experiment light rain (~ 2 cm) occurred between the dragging and measuring of 20 trails (10 powder, 10 oil/powder). Rain did not occur between the dragging and measuring of the other 20 trails (10 powder, 10 oil/powder). We used an Analysis of Variance (ANOVA) to evaluate whether the length of a track was different when using powder only or the oil/powder mixture, if rain changed this relationship, and the interaction of rainfall and type of tracking medium. A Tukey HSD was used to evaluate pairwise comparisons. Data from both experiments were analyzed using the statistical analysis software JMP®10 (SAS Institute Inc., Cary, North Carolina) and we set the α-level at 0.05.

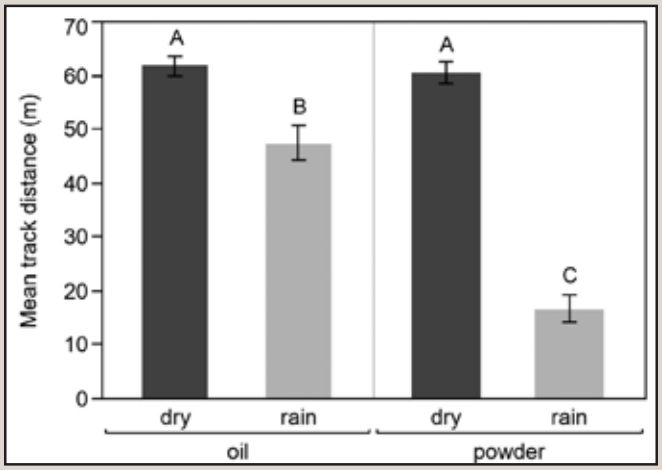


FIG. 1. Interaction between type of tracking medium (powder or oil powder/mixture) and presence (rain) or absence (dry) of rainfall on the distance of tracks through grass (if not connected by the same letter then groups are significantly different).

RESULTS

All salamanders remained alive in both the mineral oil group and the control group. Weight loss during the experiment was small and there was no difference between the control and treatment groups ($t_{df=14} = 1.92$, SE= 0.012, P = 0.06). Overall, the treatment group had a mean weight loss of 0.02g and the control group had a mean weight loss of 0.07g. During the experimental and monitoring phase of our procedure no animals displayed injury and all animals exhibited the ability to right themselves.

The overall ANOVA model was statistically significant ($F_{df=3,36}$= 72.68, P = <0.001), and the interaction between rainfall and marking treatment was also statistically significant ($F_{df=1,36}$= 35.93, P = <0.001; Fig. 1). The Tukey HSD indicated that when conditions were dry the length of tracks from powder only and the oil powder mixture did not differ. Both media left visible tracks for a mean distance of greater than 60 m (over 93% of the course) in dry conditions. If rain occurred following the track being laid down then the length of the track declined for both media. However, following rain, the tracks using the oil/powder mixture were significantly longer ($\bar{x}$ = 47.39 m) than tracks using powder alone ($\bar{x}$ = 16.71 m) (Fig. 1).

DISCUSSION

Before considering the use of mineral oil on wild salamanders, we wanted to ensure that it did not cause any behavioral changes or affect the condition of salamanders. When observing salamanders with the oil/powder mixture, we saw no unusual behaviors (such as attempting to wipe off the mixture), and no reduction in the ability to right themselves. In the three days they were monitored after treatment, we documented no mortality, no skin abnormalities, and no significant weight loss. The weight loss between the treatment and control groups was somewhat different, however not significantly, and a larger sample size may have improved the clarity of this result, but overall weight change was minimal for all animals. These results suggest that there are no short-term negative effects of applying a mixture of mineral oil and fluorescent powder to the legs of plethodontid salamanders. Applying mineral oil to a greater proportion of the body surface

of an animal may have a different effect, as it could interfere with water absorption or respiration. Future study could use a respirometer to measure differences in oxygen consumption (e.g., Orlofske et al. 2009). Documenting rates of water loss and gain would also be of interest. We did not have the opportunity to follow animals in the field to examine how long the oil/powder mixture would remain on the animal. Given that much of the mixture had worn off the salamanders during the 12-hour period when they were enclosed in a resealable bag, we expect that in the field the mixture would not persist more than 24 h.

Although tracks left by amphibians will certainly differ from those left by carrots, we used this technique to assess track length under controlled field conditions. We were not yet ready to apply the oil to wild salamanders as the effect of leaving the mixture on for longer periods of time was still unknown. We found that using the oil-powder mixture allows us to follow tracks for almost three times the distance of plain powder tracks when tracks were exposed to rain. We believe this technique has enough value to warrant further study. Fluorescent tracking can be used in concert with other tracking methods and will allow scientists to collect more detailed movement data on target species.

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Use of Stationary Microchip Reader for Monitoring Interpond Movement of Freshwater Turtles

Studying overland movement patterns of freshwater turtles is critical to understanding population dynamics and establishing buffer zones for species protection (Bodie 2001; Burke and Gibbons 1995; Semlitsch and Bodie 2003). Numerous methods have been applied to investigate different aspects of the movement patterns for freshwater turtles (McDiarmid et al. 2011) such as pitfall traps (e.g., Gibbons 1990; Roe et al. 2009), radio telemetry (e.g., Forsythe et al. 2004; Litzgus et al. 2004), and traditional aquatic trapping methods (e.g., crab pots and hoop nets; House et al. 2010; Roe and Georges 2008; Thomas and Parker 2000). Terrestrial and aquatic traps are associated with capture-mark-recapture techniques that rely on the ability to recapture marked turtles. Trapping is usually seasonal or done at intervals, but rarely conducted continuously, or if so not on a long-term basis (e.g., every day of the year during multiple years). Traps are usually checked daily, but the information on specific times of the day that turtles are likely to be active is lacking. In addition, captured individuals

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remain in traps until the traps are checked, preventing movement or dispersal data aside from differing points of recapture. Radio telemetry can give more precise data on the overland activity and correlate such activity to environmental factors (Roe and Georges 2008). However, the radio tracking period affects such models (Roe and Georges 2008) and high-resolution monitoring of overland activity using radio telemetry would require locating turtles several times/day for extended periods of time.

Passive integrated transponders (PIT) have usually been associated with capture-mark-recapture techniques. However, the technology has evolved to afford identification with stationary readers, reducing the labor to only capture-mark because animals do not have to be physically recaptured, they need only to pass through the stationary reading system. The system has been applied to monitoring the use of drain culverts by desert tortoises (Boarman et al. 1998), monitoring fish through small stream passages (Zydlewski et al. 2007), and monitoring bat movements (Ellison et al. 2007). The purpose of the present study was to test the utility of the stationary PIT tag reader for recording the overland activity of freshwater turtles. We introduce PIT tags and non-invasive stationary reader system for monitoring interpond movement of freshwater turtles, including the addition of camera traps for assisting in determining the direction of the movement alongside detection of individuals. We sought to create a less labor intensive and simultaneously less invasive approach to studying overland activity of freshwater turtles.

Materials and Methods.—For the stationary PIT tag reading system, we used Biomark© Portable Transceiver System, model FS2001F-ISO, that has the ability to store scanned tag codes. This model is not traditionally used as a stationary system; therefore, we purchased the Elpac AC power supply to provide continuous power to the reader. We used the Biomark© OEM Racket Antenna with Line-X coating for durable protection and a 2-m antenna cable. To mark turtles, we used 12-mm AVID© PIT tags. Although the tags and the reader were produced by two different manufacturers, the tags were not encrypted by the producer and the reader was able to recognize the codes. In addition, we used a RECONYX© game camera in order to get images of the turtles as they were passing through the system.

This study was conducted in a complex of ponds within a 7-ha private property parcel in Guadalupe County, Texas (Fig. 1). The primary system includes four ponds that are completely fenced off with a 2 cm × 4 cm horse fence panels that enabled us to restrict global overland movement of adult turtles in and out of the system by opening or closing a series of gates. This primary system is surrounded by a third-order ephemeral stream and three additional ponds. In our initial test of the enclosure system, one pond (Enclosure Pond 1; Fig. 1) was fenced off from the remaining ponds using 152-cm vertical horse panels with 5 cm × 10 cm openings. The Enclosure Pond 1 was pumped dry in the spring of 2009 in order to allow complete removal of turtles to enable this investigation. After the turtles were removed, the pond was visited for an additional week. To ensure there were no turtles left, we searched for tracks exiting the pond or the mud and conducted hand searches of the mud itself. The pond was then refilled and a single unmarked turtle (juvenile male *Trachemys scripta*) was released into the pond. For the months following, no other turtles were observed in the system, but the introduced male was routinely observed basking or at the pond's surface confirming that the pond perimeter fencing was "turtle-proof." In addition, we regularly inspected the fence to ensure its integrity. Then a single 0.36 m × 0.2 m "turtle gate" was created,

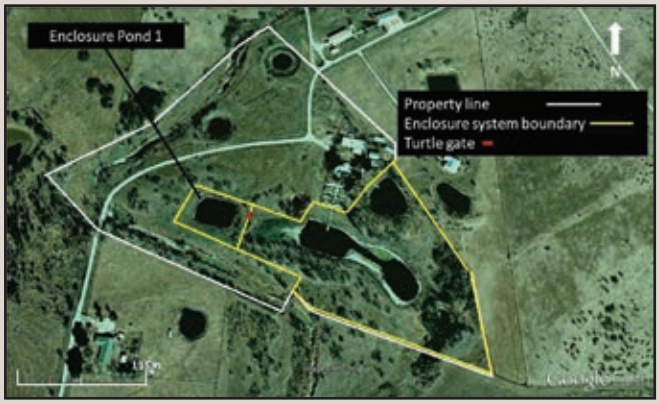


FIG. 1. Aerial image of the study area used to monitor the interpond movement of freshwater turtles. The image shows the enclosure system boundary (primary system) that includes 4 ponds that are completely fenced off with a 2 cm × 4 cm horse fence panels to restrict global overland movement of turtles in and out of the system. In addition, Enclosure Pond 1 was fenced off from the remaining ponds, with a single opening allowing movement (turtle gate).



FIG. 2. Stationary reader system placed at the only opening (turtle gate) of otherwise enclosed area (Enclosure Pond 1). While the reader scanned PIT-tagged turtles that pass through the gate, the game camera recorded the images and the direction of the movement.

enabling interpond turtle movement. In this gate opening we placed the reader antenna just subsurface within the gate. We placed the rest of the reader in a dry box on the shelf built next to the gate to enable long-term protection (Fig. 2). The reader was connected to the power source located ~50 m from the gate using an outdoor run of 120V A/C. We mounted the game camera 1 m vertically above the gate opening and parallel to the ground.

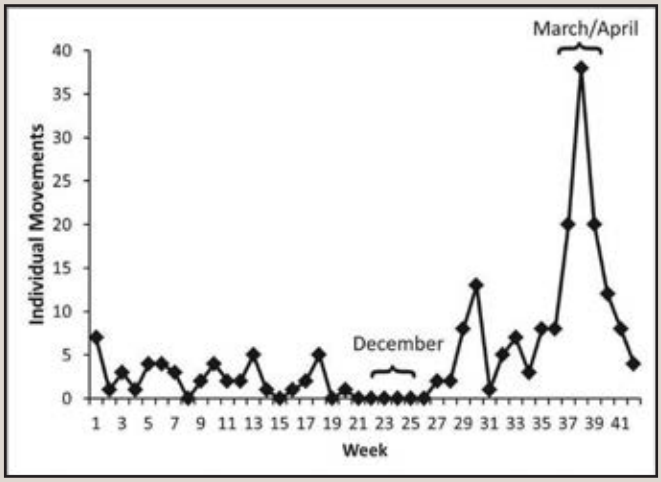


FIG. 3. Number of individual movements recorded by the stationary chip reader sorted by the week since opening the turtle gate in July 2011. The movement activity was seasonal, with very few movements in the winter and the highest activity in spring.



FIG. 4. Red-eared Slider (*Trachemys scripta elegans*) passing through the turtle gate. The image was captured with a RECONYX© game camera that was mounted 1 m vertically above the gate opening.

In the spring of 2011, we captured turtles from the primary and secondary pond systems using baited hoop nets and used the captures to populate Enclosure Pond 1. We PIT tagged captured turtles by injecting the chips into the body cavity in the anterior inguinal region parallel to the spine (Buhlmann and Tuberville 1998). We tagged two Texas Spiny Softshells (*Apalone spinifera emoryi*), four Texas River Cooters (*Pseudemys texana*), and 57 Red-eared Sliders (*Trachemys scripta elegans*). The turtle gate was kept closed for a period of one month after the "stocking" event in an effort to prevent disturbance-related dispersal and then opened in July 2011. This initial test of the system then continued to March of 2012 (9 months).

Results.—The reader proved to be a reliable method for recording the passage of turtles through the gate. For example, within the first 9 months, 46 PIT-tagged turtles (73% of all chipped turtles) passed through the gate and were recorded by the reader on 105 different occasions. Movement did not appear to be sex biased: 23 females, 22 males, and one juvenile were recorded. The number of individuals' movements varied from 1–12. Twenty-eight turtles moved on only one occasion while 18 moved more than once. Six individuals moved in and out of the system on several occasions during a single day (range = 2–4, mean = 2.3). Preliminary results revealed predictable seasonal activity in winter, with 0–1 movement events per week, and highest activity in the spring, with up to 37 passages per week (Fig. 3). All turtles were active during the day, with no nocturnal activities recorded. Out of 105 movement occasions, 42 were recorded in the morning (0630 to 1200 h DST) and 63 in the afternoon (1200 to 2030 h DST). Based on the original placement of tagged turtles (Enclosure Pond 1), we could speculate on the direction of the movement. However, because the reader was set to continuously record the tags, the data often consisted of numerous readings of the same tag within a short period of time (several minutes), which created some level of uncertainty of the final direction of the movement using the reader alone. However, the combination of the chip reader and the camera recording the time enabled us to validate the direction of the movement of each tagged turtle using the camera images (Fig. 4). The camera recorded 31 additional images of untagged turtles.

Discussion.—We demonstrated that it is simple and useful to convert a portable Biomark© chip reader system into a stationary PIT tag reader system enabling us to monitor freshwater turtle interpond movement. This technique requires initial trapping and PIT tagging individual turtles, however it is a subsequently noninvasive way to study fine-scale movement patterns. It is less labor intensive than either consistent trapping or long-term radio telemetry, and if the equipment is properly maintained, the system can run for extended periods of time (several years). Although the reader did not record the exact times turtles exited the water bodies but rather the times of the passage through the gate, this method is likely to be a suitable way to link weather conditions and periods of the day to the turtle movement patterns.

Our study was conducted on a private property with a nearby access to an electric power source. One way to improve this system would be to use solar energy as a source of power, especially for monitoring projects in more remote areas. We constructed only one reader station and used a relatively small enclosed area for proof of concept testing. Our study potentially underestimated the magnitude of movement, due to the possibility that some individuals did not walk along the fence but rather returned to the water. We believe that such occurrence was minimal, due to the small scale of the experiment (e.g., small fence perimeter) and the fence was simply serving the role of the aluminum flashing in commonly used drift fences (Gibbons 1990). This system was designed to be expanded using additional gates that open the primary system to the secondary system and allow the movement between the ephemeral creek and the additional ponds. On even larger landscape level, monitoring movement in this manner would be costly, because it would require enclosing larger sections and purchasing additional chip readers and PIT tags. However, high-resolution interpond movement dynamics of freshwater turtles on a larger landscape level are still poorly understood and expanding this approach to a larger scale could be useful in contributing to the understanding of these movement patterns.

For the resolution we sought on the dynamics of movement, other alternative methods are actually more expensive. For example, while radio telemetry would address these same questions, the labor costs and implementation necessity for shift work across 24-h, everyday schedules is dramatically (and prohibitively) more costly. We evaluated alternatives to achieving the same level of data intensity prior to this installation. One way to reduce the cost for a larger-scale study would be to modify

the way the area is enclosed. For example, Gibbons (1990) used aluminum flashing to enclose several miles of perimeter of experimental water bodies in order to study the interpond movement of slider turtles. Therefore, instead of using a costly fence system, one could use aluminum flashing that is commonly incorporated during the construction of drift fences, with pitfall buckets being replaced with reader systems. Unfortunately, this alternative has its own trade-offs. We consider flashing to be very disadvantageous in its relative instability to tree fall, livestock, and vehicular passage, all of which are overcome using fencing. Further, the urban wildland interface in many states provides an opportunity to create larger scale studies that follow our new approach with relatively minor changes to existing fencing systems (bottom integrity, gate installation, and readers). All methods seeking to document wild animal movements in real time have tradeoffs. We consider this new approach to minimize several negative aspects of radio telemetry costs and provide data at a finer resolution than can be achieved by other methods. Even in the study by Gibbons (1990), once trapped, the animals were contained until release, while in our system they are constrained in an exit point but not in movement beyond that single constraint. While this too is a tradeoff, we argue that it is a lesser one than daily point observations from telemetry or daily capture locations in a large field enclosure with pitfalls.

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Use of Clove Oil as an Anesthetic for PIT Tagging and Surgery with the Three-toed Amphiuma (*Amphiuma tridactylum*) and Determination of Recovery Time as a Function of Body Mass

Amphiuma tridactylum is a large (up to 1 m and 1.5 kg), slimy, aquatic salamander that can deliver a powerful bite, and thus is difficult and potentially dangerous to handle (Fontenot 1999; Fontenot and Seigel 2008). Even simple tasks like PIT (Passive Integrated Transponder) tag implantation and measuring body length are virtually impossible without restraining the animal. Physical restraint is undesirable because it can result in skin abrasion, physical trauma to internal organs (e.g., liver damage), and potentially death. Using a plastic snake tube to restrain *Amphiuma* (Brown and Forstner 2009) can facilitate handling *Amphiuma* in the field, but is of limited use for accurate body

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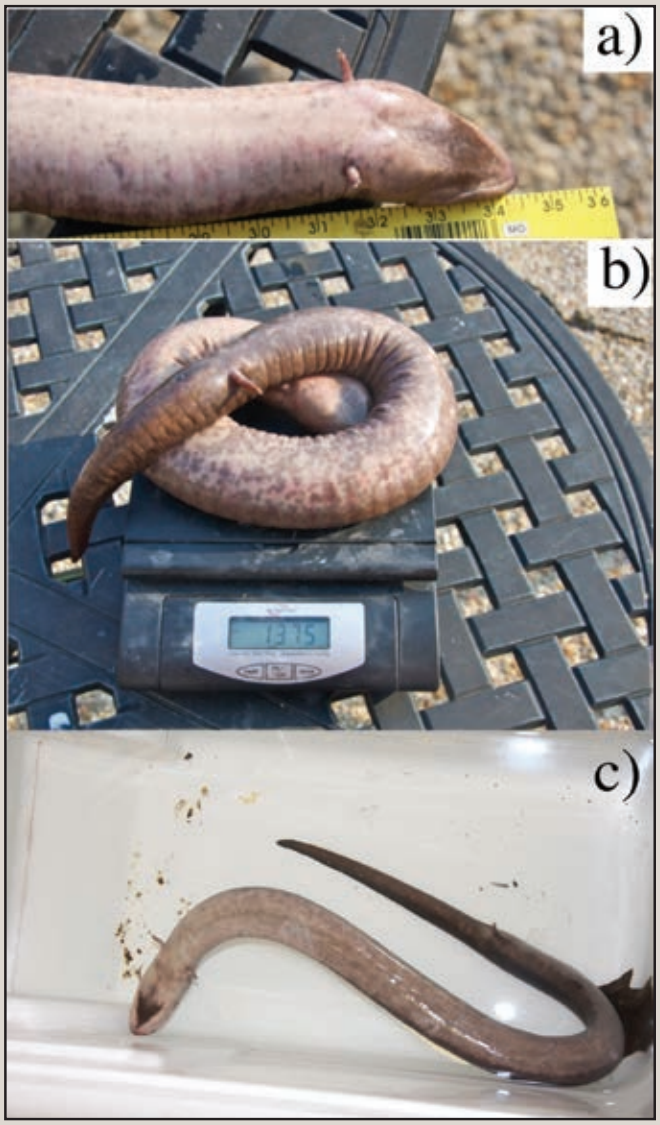


Fig. 1. a) A large *Amphiuma tridactylum* extended for measurement while under anesthesia. b) A large *A. tridactylum* being weighed under anesthesia; note that it is limp, upside down. c) *Amphiuma tridactylum* adult recovering from anesthesia in 10 L of water.

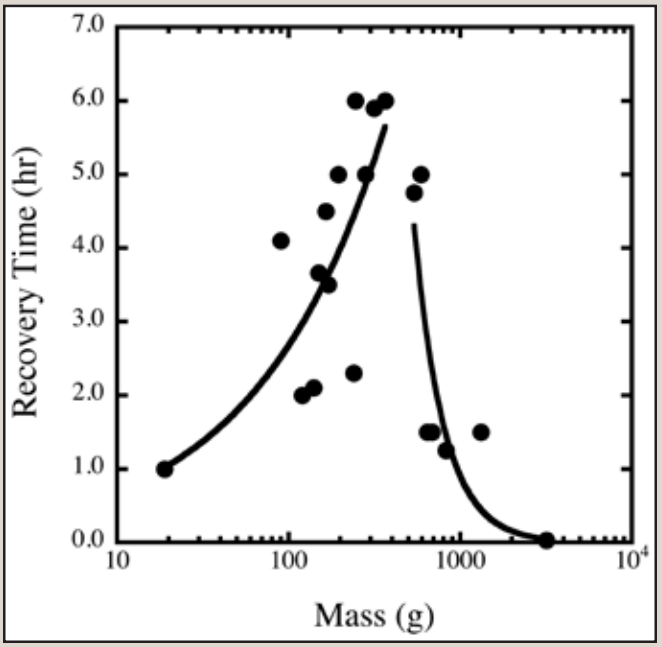


Fig. 2. The significant effects of body mass on recovery time, showing a reverse in trends. The two fit lines correspond to power function fits to the two components of the piecewise regression.

measuring, examining specimens closely, or PIT tagging because the salamanders do not relax and straighten their bodies, and are slimy and impossible to gently restrain by hand. The slippery mucus, reduced limbs, and long cylindrical shape of *Amphiuma* make forced restraint extremely difficult, even with techniques like the "bender" board (Burgmeier et al. 2010). Pojman Sr. et al. (2011) reported immersion in ice water and exposure to isoflurane as effective methods for immobilizing *Amphiuma* for PIT tagging. Immersion in ice water is effective for immobilizing to perform physical measurements and PIT tagging, but it is not suitable for surgery. A variety of anesthetics has been used with amphibians with varying effectiveness and duration of anesthesia, including zolazepam, methoxyflurane, isoflurane, propofol, tricaine methanesulfonate, barbiturates, clove oil, etc. (Lafortune et al. 2001; Mitchell 2009). In addition to efficacy, anesthetic choice may also depend on ease and safety of application. For example, isoflurane may be effective, but it is expensive, difficult to apply (particularly in the field), and its vapors pose a hazard to the investigator. Application of other anesthetics by injection may not be possible in subjects that are difficult to temporarily restrain (e.g., large slimy salamanders).

The phenolic compound eugenol, the active component of clove oil, is an effective anesthetic for amphibians, and can be applied by immersion, potentially making it suitable for work in the field with species that are difficult to handle. However, duration of anesthesia was greater in larger individuals of African Clawed Frogs (*Xenopus laevis*; Goulet et al. 2010). To assess the utility of clove oil as a cheap and readily available anesthetic for *A. tridactylum*, as well as the effect of body size on recovery time, we anaesthetized individuals of various body sizes via submergence in a clove oil solution.

Methods.—Seventeen *A. tridactylum* were collected with baited flexible fish traps (Promar 36 inches × 12 inches with ¼-inch mesh) in East Baton Rouge Parish, Louisiana, USA. Specimens were weighed and measured, and maintained in laboratory aquaria at 25°C and fed one earthworm per day each for 1–3 days, except for two individuals that were maintained for six months and two years, respectively, and one extremely large specimen maintained in captivity for eight years. Experimental trials were conducted February–May 2012, and solutions were prepared from the same bottle of clove oil. Each specimen was placed separately in a solution containing 4 L of water with 2 mL of clove oil for five minutes. Because preliminary observations suggested that eugenol continued to be absorbed from the skin after removal from the solution (i.e., degree of anesthesia increased), the specimen was removed to another container without water for twenty minutes, and then a PIT tag was inserted by subcutaneous injection (except two individuals). After the 20-minute waiting period, the specimen was placed in 10 L of tap water in a cooler. All water and solutions were at 24 ± 2°C. Every 15 minutes, the individual was removed and placed ventral side up to test their righting response. When the animal was able to right itself, it was determined to have recovered.

Six additional specimens, with masses ranging from 140 g to 450 g, were used to test the minimum exposure required to achieve surgical anesthesia, which was determined by the time until specimen did not respond to needle poke in the tail.

Because visual inspection of a scatter plot suggested two distinct trends, we used a piecewise regression to determine the relationship between body mass (x-axis) and recovery time (y-axis). As a basis for dividing the data into two sets (A and B) for the piecewise regression, we sought to identify a breakpoint that explained the most variance (highest R^2 values) for a pair of regressions. We began with a regression analysis on data set A, which was composed of the five smallest individuals, and then on data set B composed of the remaining 14 (larger) individuals. For the next statistical trial, we moved the next larger individual (from set B) into set A, and repeated the regressions. Natural log transformation was applied to both body mass and recovery time, to meet assumptions of regression analysis. Alpha for significance was 0.05.

Results.—For the first 2–3 minutes in the solution, individuals often were agitated, swimming back and forth quickly in the container. By five minutes, the animals were sufficiently sedated that they could be easily picked up by hand and transferred to another container (though they were still mobile and could right themselves. At five minutes of exposure to the clove oil solution, individuals were sufficiently anesthetized to allow easy handling, and some had already lost the righting response. After the 20-minute waiting period, none had a righting response, and each was completely limp (Fig. 1).

We were initially concerned that individuals might drown while still under anesthesia during the recovery period. However, they did not attempt to breathe until their heads were raised above the water when we checked for a righting response. Each time the head was raised above the water surface, it took a breath.

Piecewise regression showed two distinct relationships between body mass and recovery time. Recovery time increased with body mass for individuals that were 19–365 g ($N = 13$, df, = 1, 11, $F = 20.19$, $P = 0.0009$, $R^2 = 0.65$), and decreased sharply for individuals that were 540–3185 g ($N = 6$, df, = 1, 5, $F = 31.38$, $P = 0.025$, $R^2 = 0.86$), suggesting a body mass threshold at some point between 365–540 g for this effect (Fig. 2).

Surgical anesthesia was achieved for all six specimens by a 10-minute exposure to the clove oil-water solution followed by a 20-minute waiting period out of water.

Discussion.—Clove oil is an inexpensive, highly effective, anesthetic for *A. tridactylum*. The exposure time used in this study was sufficient to induce anesthesia at a level suitable for simple noninvasive tasks like taking measurements, or minimally invasive tasks like PIT tag insertion. However, an exposure time of at least 10 minutes to the same solution was required for a level of anesthesia suitable for invasive tasks like intraperitoneal surgery, which we used successfully for transmitter implantation in an ongoing study.

Our dosages were comparable to those reported for other amphibians. Mitchell et al. (2009) used 450 mg/L for Tiger Salamanders (*Ambystoma tigrinum).* They also achieved surgical anesthesia after a 10-minute exposure. Guénette et al. (2007) used eugenol, the active component of clove oil, with *Xenopus laevis.* They found immersion in a bath with 350 mg/L for 15 minutes achieved surgical anesthesia.

The rate of diffusion of the anesthetic into/out of the body of the animals is proportional to the surface area, in this case, of the skin. Because surface/volume ratio decreases with increasing body size, larger animals would be expected to take longer to absorb enough eugenol to reach anesthesia, and longer to expel it by diffusion during recovery, i.e., recovery rate should be inversely proportional to the surface area to volume ratio. However, the fact that the positive relationship was only true for individuals up to 365 g, and reversed for individuals greater than 590 g is puzzling. It might indicate some threshold limiting diffusion, e.g., skin permeability or allometric differences in physiology, and certainly warrants further investigation.

Acknowledgments.—The methods used in this work follow guidelines of the Society for the Study of Amphibians and Reptiles and were approved by the Animal Care Committee at SLU (IACUC, Protocol #0015) and LSU (protocol number 09-072). We thank Barbara Corbett Kermeen of AVM Instrument Company, Ltd. for help with the transmitters. We also thank Brad Lavigne and Julia Morris of the Tickfaw State Park Nature Center for allowing us to make measurements on their specimen.

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AMPHIBIAN DISEASES

This section offers a timely outlet for streamlined presentation of research exploring the geographic distribution, host range, and impact of emerging amphibian pathogens, especially the amphibian chytrid fungus *Batrachochytrium dendrobatidis* (*Bd*) and ranaviruses. *Bd* is an emerging pathogen linked to mass mortality and declines of amphibians worldwide, yet *Bd* has also been detected in amphibians without disease. Ranaviruses also cause mass mortality, but have not yet been linked to large-scale declines. We know relatively little about their global distribution, host range, or impacts on host populations. To improve our understanding of the scope of this issue, we encourage submission of studies that illuminate the geographic distribution, host ranges, and impact of these pathogens on amphibian populations, including research on individual species or groups of species, wild or captive animals, native or non-native species, live animals or museum specimens, environmental samples, and, provided there is sufficient sampling[1], reports of non-detections.

We ask authors to: 1) restrict the Introduction of their paper to a **maximum** of two paragraphs to highlight the context of their study; 2) briefly include both field and laboratory Methods; 3) present Results in a Table, although a map might also be useful, and limited text; and 4) have a short Discussion of a **maximum** of three paragraphs to touch upon key findings. Please include the following information in submissions as appropriate: coordinates and description of sampling areas (or please note if locations are extremely sensitive to reveal, and provide general area instead); species name(s) and life history stages examined, as well as other species present; whether samples were collected randomly or just from dead or moribund animals; date of specimen collection; evidence of unusual mortality; numbers of positive and negative samples; disposition of voucher specimens; name of collaborative laboratory or researcher conducting histological sections or PCR analyses; and names of cooperative land owners or land management agencies. We encourage researchers to conduct post-mortem examinations when possible to identify the cause of death when reporting mortalities. We aim to expedite the review and publication process! Please e-mail *Bd*-focused submissions directly to Associate Editor, Dr. Dede Olson: dedeolson@fs.fed.us. Manuscripts concerning ranaviruses should be directed to Associate Editor Dr. Jesse L. Brunner: jesse.brunner@wsu.edu.

[1] If a sample of thirty individuals of a particular life history stage of a particular species yields no positive results, and the diagnostic test is highly sensitive, one can conclude that the prevalence of infection is less than 10% with 95% confidence. With a sample of 10, an infection in one of four individuals could go undetected. We encourage researchers to collect sufficient samples so that negative results are meaningful.

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Understanding Patterns of Amphibian Chytrid Fungus Infection and Chytridiomycosis through Museum Collections: Maximizing Sampling and Minimizing Damage on Preserved Specimens

For centuries, collections in natural history museums have been essential databases that have given an historical perspective of the distribution, diversity, and general biology of species in space and time. These collections also contain critical data for understanding ecosystem dynamics and for decision-making in the conservation of biodiversity (Cotterill 1995, 1997; Graham et al. 2004). Museum collections are highly valuable tools for documenting our planet's biodiversity, especially when so many species are going extinct, such as the Golden Toad (*Incilius periglenes*) in the highlands of Costa Rica, last observed in the late 1980s (Crump et al. 1992). In recent years, museum specimens have been used as sources of genetic sampling, which is particularly valuable when the collection of new samples becomes difficult or impossible, because the study species is extinct (Payne and Sorenson 2003). Museum collections also substantially

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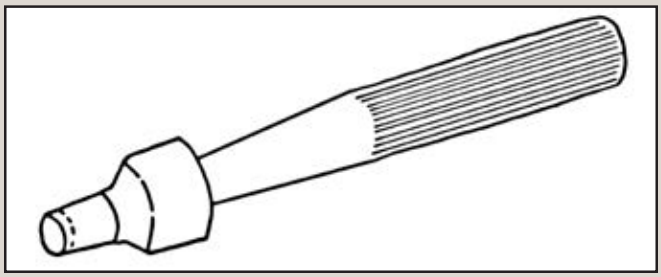


FIG. 1. Skin biopsy punch with lightweight handle.

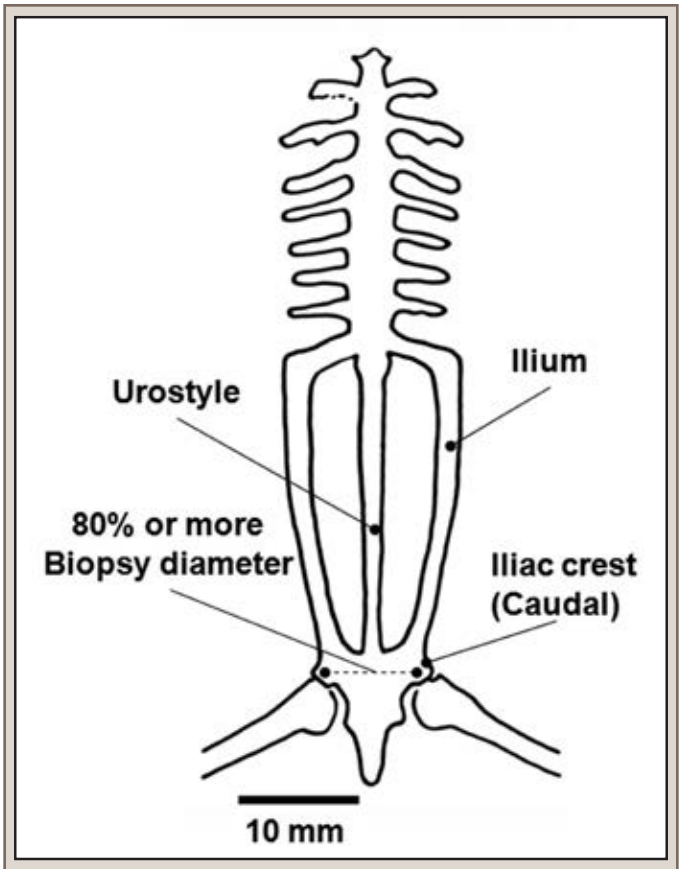


FIG. 2. Ventral view of a typical anuran sacral skeleton.

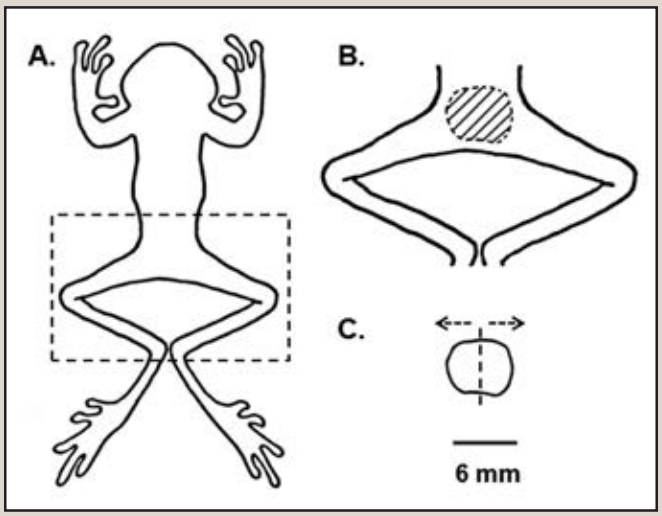


FIG. 3. A) Ventral view of a typical anuran. B) Pelvic patch and skin biopsy area. C) Skin biopsy sample showing proposed initial sectioning.

contribute to the study of pathogens, disease vectors, and environmental pollutants (Suarez and Tsutsui 2004).

Amphibians are declining faster than birds and mammals, giving this group of animals the distinction of being the most threatened major taxonomic group of vertebrates (Stuart et al. 2004; Wake and Vredenburg 2008; Hoffman et al. 2010). One of the possible contributing factors to amphibian losses is the disease chytridiomycosis, caused by the fungal pathogen *Batrachochytrium dendrobatidis* (*Bd*) (Berger et al. 1998; Pessier et al. 1999). Museum collections have a role in understanding the emergence of *Bd*. The existence of herpetological collections in museums around the world has aided identification of the spatio-temporal distribution of *Bd* in many regions (e.g., Ouellet et al. 2004; Puschendorf et al. 2006; Velásquez et al. 2008; Padgett-Flohr and Hopkins 2009), as well as providing support for routes of the pathogen's dispersal through Central and South America (Lips et al. 2006; Lips et al. 2008; Vredenburg et al. 2010; Cheng et al. 2011). In addition, these collections have provided evidence that *Bd* has long been in Africa (Weldon et al. 2004; Soto-Azat et al. 2010), Japan (Goka et al. 2009), and North America (Garner et al. 2006; Padgett-Flohr and Hopkins 2009), facilitating the evaluation of possible sites of the pathogen's introduction to some regions.

Museum curators have conflicting mandates between retention of specimen integrity as a source of scientific information versus specimen uses to aid species conservation efforts (Graves and Braun 1992). Whereas there is a mandate to keep specimens intact, it is also becoming increasingly apparent that they may be useful to gain information that could be vital for preservation of biodiversity, yet that might involve techniques that can inflict damage to specimens. Curators have coined the term "destructive sampling" for the use of skin samples obtained from museums specimens (Graves and Braun 1992), with amphibian skin being of particular interest to scientists interested in *Bd* research.

To address this situation and minimize the conflict many curators experience, we suggest herein a technique for obtaining skin biopsies to diagnose *Bd* infection of museum specimens. We propose the use of a skin biopsy punch (Fig. 1), a commonly used instrument in veterinary medicine. The advantage of using this instrument is that it has a one-piece cutting blade (not seam rolled) to ensure a clean cut, is easy to manipulate due to its lightweight handle, and is available in different diameters for the cutting area (from 1.5 to 8.0 mm). If standardized, this single-punch approach could limit the destructive sampling of museum resources while facilitating comparative studies.

The pelvic patch of the animal is an optimal sampling area for several reasons. First, anurans absorb water from a wet surface only through the ventral skin (Wells 2007), hence this part of anatomy is likely to be in contact with water, where *Bd* zoospores may be free-living. The skin of the ventral region (pelvic patch) has a greater density of blood vessels than the skin of the chest or back, which is consistent among species (Wells 2007), and which could facilitate diagnoses of chytridiomycosis symptoms. The pelvic patch usually exhibits greater osmotic flows than the skin from other ventral regions, which in turn have greater osmotic flow than the dorsal skin (Wells 2007). Disruption of this osmotic flow may occur with *Bd* infection (Voyles et al. 2009), and symptoms of chytridiomycosis include skin tissue anomalies. The pelvic patch has the biggest propensity to become infected with *Bd*; therefore, it is the best area to identify the presence of *Bd*

via histopathology (Puschendorf and Bolaños 2006). The pelvic patch is an anatomical area that facilitates standardization of sampling, as discussed below. Hence, examination of the pelvic patch allows researchers to evaluate not only possible infection by *Bd*, but also the existence of histopathological changes that may compromise the animal's life as symptoms of chytridiomycosis develop (Wells 2007).

Our technique consists of collecting a standardized skin punch sample from the pelvic patch. We suggest calculating ≥ 80% of the distance between the caudal parts of the iliac crests of anuran, and matching this distance to the diameter of the cutting blade (Figs. 2, 3). For a clean cut that does not affect underlying tissues, raise the skin at any point on the circumference of the cut, preferably with forceps, to the iris of the punch apparatus. The next step is to separate the tissue from the few remaining points of attachment between the skin and underlying muscle; curved iris scissors are effective for this step. In this way, only the skin layer is sampled, leaving the muscle intact (Fig. 3). We suggest cutting a midline incision with a sharp blade in one clean cut. After this, the sample can be readily fixed and preserved in 10% buffered formalin, and later, histopathological standard protocols may be used to stain sections (4–6 µm thick) with hematoxylin-eosin (H & E) (Berger et al. 1998; Berger et al. 2000), or any other relevant staining technique. Embedding the two skin segments together in paraffin and perpendicular to the microtome facilitates their subsequent sectioning (Fig. 3C).We suggest making 15 different cuts in each direction, starting from the middle to the sides and leaving a gap of at least 50 µm between each cut.

It is important to take certain precautions when conducting the biopsy: 1) if too much pressure is applied, you can cut the abdominal muscles or even fracture the ilium and urostyle (Fig. 2); 2) in a very large animal, you can make several cuts to cover the desired area; 3) we found that this technique should not be used on specimens with a snout–vent length < 2 cm as the bones are too fragile; 4) depending on the embedding mold size, it is better to wrap the sample in filter paper to prevent losing it; 5) use a mold with mesh; 6) when embedded in paraffin, the cuts must be completely perpendicular.

Whereas histopathology has been used for diagnosis of *Bd* infection in amphibians, it is not usually employed as a source of quantitative information. A small modification to the technique suggested by Berger et al. (2005) allows some useful standard quantification metrics. Once an infected section is identified, measure at least 2000 µm of continuous skin, and from that subsection, quantify the number of *Bd* sporangia, skin thickness, number of cell layers, or number of glands.

Although Cheng et al. (2011) have developed a technique to detect the presence of *Bd* in museum specimens by qPCR, this technique does not provide any other information, such as localized changes in tissues, or other changes that could indicate the actual disease status of the individual sampled. Histopathology is the only approach that allows us to identify skin lesions, such as hyperkeratosis, epidermal cell hyperplasia or atrophy, erosion, ulceration, and vascular and inflammatory changes, all of which are often indicative of a disease state rather than merely an infected state. We could combine both techniques, qPCR and histopathology, yet by histopathology alone we can detect both *Bd* infection and associated physiological symptoms of the disease chytridiomycosis. Our approach offers minimal destructive sampling, with potential standardization to facilitate comparisons among samples.

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Occurrence of *Batrachochytrium dendrobatidis* in Wapanocca National Wildlife Refuge, Arkansas, USA

The amphibian chytrid fungus, *Batrachochytrium dendrobatidis* (*Bd*) is known to have a wide distribution in North America (http://www.bd-maps.net/), but confirmed infections in areas of the American Mid-South are lacking. We surveyed an ephemeral water body in Wapanocca National Wildlife Refuge (WNWR), Turrell, Arkansas, USA. While other surveys have confirmed the presence of *Bd* in Arkansas via histology (Rothermel et al. 2008), no survey thus far has confirmed infections via the more-quantitative real time polymerase chain reaction (qPCR) method (Kerby 2012). Our survey was the first to quantitatively assess *Bd* presence on amphibians and their infection intensities in Arkansas.

On 20 May 2013, we surveyed Pecan Ridge ephemeral depression (35.331133°N, 90.221467°W) within WNWR (Fig. 1). With the assistance of the Ecological Census Techniques class from Christian Brothers University (CBU), we captured amphibians in this area with dipnets, water seines, and by hand. To sample for *Bd*, animals were swabbed using sterile cotton-tipped applicators (Fisherbrand®, Cat. #23-400-116), approximately 30 times along keratinized tissues (ventral surface and hind limbs) where *Bd* zoospores are concentrated (Marantelli et al. 2004). The swabs were placed in 1.5-mL snap-cap tubes (Fisherbrand®, Cat. # 02-681-272) and stored in a -18°C freezer until qPCR analysis was conducted to quantify *Bd* loads and prevalence. To minimize cross-contaminating animals and ensure that our results were accurate, gloves and equipment that contacted frogs were sterilized with 70% ethanol and dried between handling of individuals and all other equipment was sterilized with a 10% bleach solution or discarded after leaving each water body (Johnson et al. 2003).

Infection status (*Bd*+/-) of all animals was confirmed using qPCR following a method by Kerby et al. (2012). DNA was extracted from cotton swabs using Qiagen DNeasy Blood and Tissue Kit (Cat. #69506), and the extracted DNA was used in the qPCR reaction. Standards for the reaction were obtained from Commonwealth Scientific and Industrial Research Organisation laboratories, Australia, and were the same as those used in Boyle et al. (2004). The standards served as the positive controls (versus internal controls, Kerby et al. 2012) and each plate contained a negative control (which tested negative on all plates) and all samples were run in triplicate. For determination of infection status, swabs were categorized as *Bd*-positive when zoospore equivalents were ≥1 (as used by Vredenburg et al. 2010).

We captured and swabbed 46 adult Cricket Frogs (*Acris crepitans*). We detected *Bd* in 42 of 46 (87%) animals. In infected individuals, zoospore loads ranged from ~2 to >200,000 (it must be noted that the highest standard used in our experiment is 100 zoospore equivalents). No frog showed clinical signs of *Bd* infection (e.g., lethargy, skin sloughing), indicating that Cricket Frogs may persist in populations without succumbing to *Bd*-induced mortality (but see Rothermal et al. 2008). Our data is the first to show the presence of *Bd* in Arkansas when confirmed through

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FIG. 1. County map of eastern Arkansas, USA. Wapanocca National Wildlife Refuge is located in Turrell, Arkansas (star within Crittenden Co.). Specific sampling site is indicated by the star within the inset of Wapanocca National Wildlife Refuge.

qPCR (Rothermel et al. 2008). Moreover, our survey is only the third to be conducted in Arkansas (www.bd-maps.net). Because *Bd* can only be detected from laboratory analyses of environmental samples, these efforts are warranted to help us understand its occurrence and risk to native populations, and address the spread of this potentially deadly disease.

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Detection of *Batrachochytrium dendrobatidis* Infections in Amphibian Populations at Edward J. Meeman Biological Field Station, Tennessee, USA

Within North America, *Batrachochytrium dendrobatidis* (*Bd*) infections have primarily been reported in the western and northeastern parts of the United States (http://www.bd-maps.net/, Olson et al. 2013). Infections in other parts of the country (e.g., Tennessee) are currently recorded at a much lower incidence and so further survey data are needed to inform scientists and managers of *Bd* occurrences and risks to native fauna. Chatfield et al. (2009) confirmed *Bd* infections in the Great Smoky Mountains of Tennessee and Davis et al. (2012) confirmed *Bd* infections in Shelby County, Tennessee. Both of these studies confirmed *Bd* infection status via quantitative real time polymerase chain reaction (qPCR), the accepted standard in the field. However, *Bd* also was detected in Meeman-Shelby State Park, Tennessee (Venesky and Brem 2008), but unlike the other surveys in Tennessee, infection was only confirmed in a single individual via histology. To better understand the distribution of *Bd* in areas near Meeman-Shelby State Park, we surveyed ponds and lowlands adjacent to Meeman-Shelby State Park, specifically within the University of Memphis, Edward J. Meeman Biological Field Station (MBFS, 35.366667°N, 90.016667°W, Fig. 1).

On 8 May and 31 May 2013, we captured adult amphibians for *Bd* sampling at four sites within MBFS using dipnets, water seines, and by hand capture. Captures on 8 May were taken to the laboratory at the University of Memphis, Memphis, Tennessee for other projects and thus were not released back into the wild. This ensured that we did not recapture and resample amphibians.

To sample *Bd*, animals were swabbed using sterile cotton-tipped applicators (Fisherbrand, Cat. #23-400-116), approximately 30 times along the ventral surface and hind limbs (areas

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TABLE 1. Results of *Batrachochytrium dendrobatidis* (*Bd*) sampling in adult anurans in Meeman-Shelby State Park, Tennessee, USA. Average zoospore loads (Avg. Zoo. Loads) indicate average *Bd* infection intensities in infected individuals.

Site Location	Date Collected	Species	No. *Bd* +/ No. Sampled	Avg. Zoo. Loads
Levee Pond 35.354831°N, 90.011003°W	08 May 2013	*Lithobates clamitans*	1/1	31.13
The Ditches 35360761°N, 90.01295°W	08 May 2013	*Acris crepitans*	13/14	1231.21
		Lithobates sphenocephalus	5/5	4484.84
Cattle Tank Array 35.362997°N, 90.016981°W	31 May 2013	*Hyla versicolor/ chrysoscelis*	0/27	NA
Student Dorm 35.360433°N, 90.018261°W	08 May 2013	*Scaphiopus holbrookii*	0/2	NA
		Anaxyrus fowleri	0/3	NA

of keratinized tissues) where *Bd* zoospores are concentrated (Marantelli et al. 2004). We captured and swabbed 52 amphibians from 6 species (Table 1). The swabs were placed in 1.5-mL snap-cap tubes (Fisherbrand®, Cat. #02-681-272) and were stored at -18°C until qPCR analysis to quantify *Bd* presence and intensity. To minimize cross-contaminating animals, gloves and equipment that contacted frogs were sterilized with 70% ethanol and dried between handling of individuals, and all other equipment was sterilized with a 10% bleach solution or discarded after leaving a pond (Johnson et al. 2003).

Infection status (*Bd*+/-) of all animals was confirmed using qPCR following the method used by Boyle et al. (2004). DNA was extracted from cotton swabs, and the extracted DNA was used in the qPCR reaction. Standards for the reaction were obtained from Commonwealth Scientific and Industrial Research Organisation labs in Australia and were the same as those used in Boyle et al. (2004). The standards served as the positive controls (versus internal controls, Kerby et al. 2012) and each plate contained a negative control (which tested negative on all plates) and all samples were run in triplicate. We used the same "fast" qPCR technique detailed and proven successful by Kerby et al. (2012). For calculations of prevalence, swabs will be categorized as *Bd*-positive when zoospore equivalents were ≥1 (as used by Vredenburg et al. 2010).

Overall, 19 of 52 (37%) individuals tested positive for *Bd* (Table 1). In infected individuals, zoospore loads ranged from ~28 to >500,000. Only three of six species sampled (Cricket Frogs [*Acris crepitans*], Green Frogs [*Lithobates clamitans*], Southern Leopard Frogs [*Lithobates sphenocephalus*]), tested positive for *Bd*. These species have been found infected previously in the wild (Rothermel et al. 2008). The other three species sampled (Fowler's Toads [*Anaxyrus fowleri*], Gray Treefrogs [*Hyla versicolor/chrysoscelis*], and Spadefoot Toads [*Scaphiopus holbrookii*]) tested negative for *Bd* infections, however our sample sizes were low such that if *Bd* occurred at a low frequency it may not have been detected. For example, Skerratt et al. (2008) recommended sample sizes of >59. *Bd* has previously been detected at low levels in both *A. fowleri* and *H. versicolor/chrysoscelis* populations (Davis et al. 2012; Rothermel et al. 2008), but other surveys also have shown a lack of infection in individuals of these species (Green and Dodd 2007; Longcore et al. 2007; Rothermel et al. 2008; Rodriguez et al. 2009).

The lack of infection in the individuals in our survey demonstrates that environment or some context of the population may play in role in susceptibility of *A. fowleri* and *H. versicolor/chrysoscelis* to *Bd*. Moreover, the lack of infection in *S. holbrookii*



FIG. 1. County map of Tennessee, USA. The Edward J. Meeman Biological Field Station is located in adjacent to Meeman-Shelby State Park (star within Shelby Co.).

corroborates previous surveys that also failed to confirm *Bd* infections in *S. holbrookii* populations (Daszak et al. 2005; Rollins et al. 2013); however, *S. holbrookii* have been experimentally infected in laboratory settings (Brem et al. 2013).

The observed differences in pathogen presence and intensity could also be explained by host immunity. Previous work has shown that amphibians vary in their susceptibility to *Bd*. For example, Gervasi et al. (2013) showed that members of the Ranidae family carried lower infection loads compared to those in Bufonidae and Hylidae. Alternatively, Searle et al. (2011) showed that *Bd*-induced mortality varied greatly, even within family. Such results illustrate the possibility for innate species-specific susceptibly to *Bd*.

Our data is the first to show the presence of *Bd* at MBFS when confirmed through qPCR. Moreover, our survey is only the fourth effort in the state of Tennessee (www.bd-maps.nets). Because *Bd* can only be detected from on-the-ground sampling efforts and laboratory analyses, such efforts to determine the distribution and spread of *Bd* are necessary to assess risk to species, especially considering the occurrence of *Bd* in areas where no documented amphibian declines have occurred.

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Meeman-Shelby State Park (#2010-004) were obtained prior to collecting the animals.

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Spatial Pattern of *Batrachochytrium dendrobatidis* Infection in Green Frogs (*Lithobates clamitans*) in Michigan, USA

Catastrophic amphibian declines occurring in tropical areas as a result of the growth and spread of the pathogenic fungus *Batrachochytrium dendrobatidis* (*Bd*) are well documented (e.g., Berger et al. 1998; Lips et al. 2006, 2008; Skerratt et al. 2007; Wake and Vredenburg 2008), but impacts to temperate zone species remains less well known. The Bd Mapping Group has been synthesizing existing data (Olson et al. 2013) to track the occurrence of *Bd* from all locations from where it has been tested, but data are lacking for many areas and species. Understanding the role of environmental variables in the growth or spread of *Bd* may provide local guidance to inform management efforts to address amphibian populations at risk. Several factors likely affect the establishment and growth of the fungus in different amphibian populations, including temperature. Both an optimal temperature (23°C) for *Bd* growth and a temperature at which growth is inhibited (29°C) has been indicated (Longcore et al. 1999, Piotrowski et al. 2004). Recently, temperature range at a site has been correlated with the odds of *Bd* occurrence at global- and USA-spatial scales (Olson et al. 2013) and can be influenced by environmental disturbance (Becker and Zamudio 2011; Becker et al. 2012). Occurrence of *Bd* is also thought to be correlated with latitude (Kriger et al. 2007) perhaps as a proxy for temperature and/or precipitation. Additional data are required to determine if a local-regional relationship can be established between *Bd* infection patterns and other factors such as latitude.

Very little is known regarding the occurrence of *Bd* within Michigan amphibians nor the factors most important to impacting their susceptibility to *Bd* infection. One study predicted the

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occurrence of *Bd* in Michigan (Ron 2005) and *Bd* has been reported for two Michigan species (*Lithobates sylvaticus* [= *Rana sylvatica*]: Zellmer et al. 2008; *Acris crepitans blanchardi*: Steiner and Lehtinen 2008). However, few individuals and populations were surveyed, and only in southern Michigan.

Our study examined the influence of environmental factors on the prevalence of *Bd* infection in Michigan, USA populations of Green Frogs (*Lithobates clamitans*). This frog is a habitat generalist, its range spans the entire state, and it is typically easy to locate. *Lithobates clamitans* has been documented as a carrier of the fungus in other studies and has exhibited a common infection prevalence of ~20% across several studies (Ouellet et al. 2005). Hence this species is well suited for a study determining whether specific environmental factors, unrelated to the identity of the host species, have an effect on *Bd* infectivity and/or prevalence patterns. By using an organism with a wide geographic range, high prevalence as a resistant carrier, and general habitat preferences, a broad range of environmental variables can be tested and compared, eliminating a host effect which is created when using several different host species to evaluate environmental variables. Our study objectives were to survey for the presence of *Bd* in *L. clamitans* throughout Michigan, and examine whether the prevalence of *Bd* infection is influenced by specific environmental conditions. Simultaneously, we investigated the relationship of pH, temperature, conductivity of the water, and latitude with the prevalence and infection load of *Bd*.

Thirty-three sites in Michigan were sampled between 19 May and 20 September 2009 (Fig. 1; Appendix A). Without prior knowledge of *Bd* occurrence, sites were chosen based on the likely occupancy of *L. clamitans*, the spread of sites with respect to latitude, and accessibility. Most sites were permanent bodies of water ranging in size from small ponds (89 m^2) to large lakes (1214 ha).

Several environmental variables were measured at each site while simultaneously collecting *Bd* samples: water temperature (°C), conductivity (µMhos), pH, humidity, air temperature (°C), and elevation (m). Water temperature and conductivity were collected using a YSI (Yellow Springs Instrument Co. Inc., Yellow Springs, Ohio, USA) Model 33 S-C-T meter with a 3310 probe. The pH data was collected using a Double Junction pHTestr10 (Oakton instruments, Vernon Hills, Illinois, USA). Air temperature and humidity were recorded from the NOAA weather website (www.noaa.gov). Elevation was determined from a GeoPositioning System, TOPO! version 3.4.0 (National Geographic Holdings, Evergreen, Colorado, USA).

The shorelines of the ponds and lakes were surveyed for the presence of *L. clamitans* from 19 May to 20 September 2009 working from southern localities to northern localities as weather permitted and frog activity increased. Frogs were captured using gloved hands or nets. Equipment and vinyl gloves were changed after each capture to avoid cross contamination between specimens. Each frog was kept alive in a plastic bag until it could be sampled. To avoid resampling the same individuals, we continued surveying and capturing approximately 5 m away from the release point, in a direction away from the previous captures. Sampling was considered complete if the entire shoreline had been covered, or more than 35 frogs had been captured. Once sampling at a site was completed, all gear (boots, waders, etc.) was disinfected with a dilute (10^{-1}) bleach solution to avoid cross contamination of sites.

Each frog was swabbed with a sterile Medical Wire MW113 cotton-tipped, plastic shaft swab (Medical Wire & Equipment Co. Ltd., Corsham, Wiltshire, UK). The swab was rubbed in one direction five times on the ventral surface of the body, between the forelimb and hindlimb on each side of the body, on the ventral surface of each thigh, and once between each toe on the ventral surface of the webbing. The swab was then placed in a 1.5 ml centrifuge tube with the screw cap left open to let the swab air dry. Once the swab was dry, the tube was capped and stored at



FIG. 1. Location of 33 sites sampled for *Batrachochytrium dendrobatidis* on *Lithobates clamitans* in Michigan, USA in 2009.

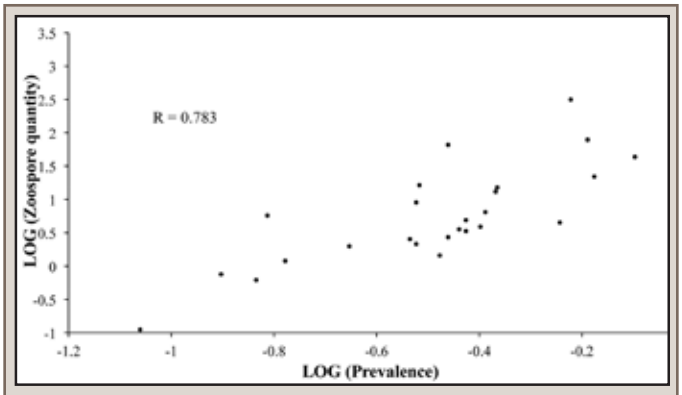


FIG. 2. Correlation between prevalence and average zoospore quantity of *Batrachochytrium dendrobatidis* infections in *Lithobates clamitans* at 29 infected sites in Michigan, USA, in 2009 (r_{27} = 0.783, p < 0.001).

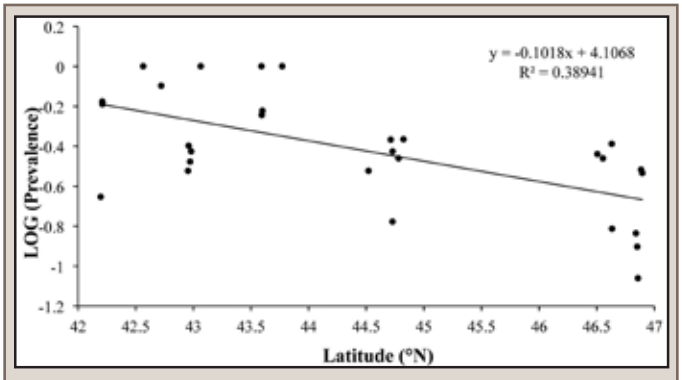


FIG. 3. Relationship between latitude and prevalence (Log transformed) of *Batrachochytriumdendrobatidis* infections in *Lithobates clamitans* at 29 infected sites in Michigan, USA, in 2009.

TABLE 1. Summary of *Batracochytrium dendrobatidis* infection in *Lithobates clamitans* from 33 sites in Michigan, USA, in 2009. Zoospore quantities reported represent the mean, minimum (Min.), and maximum (Max.) of infected individuals only, per site.

Site Name	Number Infected/ Total Sampled (%)		Zoospore Quantity Mean	Min.	Max.
Mill Pond Park	4/7	(57.1)	8	1.84	21.12
Deerfield Park (Pond 1)	4/4	(100)	35	17.52	74.72
Deerfield Park (Pond 2)	3/5	(60)	524	6.72	1525.6
Littlefield Pond	1/1	(100)	7	6.72	6.72
John Ball Park Pond	4/10	(40)	10	4.64	24.72
Grand Valley State Property (Pond 1)	0/2	–	–	–	
Vickie's Marsh/Pond	2/2	(100)	1096	16	2176
Whalfield Mill Creek	0/1	–	–	–	
Seidman Park (Pond 1)	3/8	(37.5)	9	6.48	10.24
Seidman Park (Pond 2)	0/4	–	–	–	
Grand Valley State Property (Pond 2)	1/3	(33.3)	43	4.32	4.32
Ionia State Game (Pond 1)	3/10	(30)	7	4.72	9.2
Ionia State Game (Pond 2)	0/7	–	–	–	
Allegan Dam Pond	3/3	(100)	111	38	169.76
Celery Flats (Pond 1)	11/17	(64.7)	122	2.56	964.8
Celery Flats (Pond 2)	2/3	(66.7)	33	8.88	57.04
Hampton Lake Marsh	2/9	(22.2)	9	7.92	9.84
Shisler Lake	9/26	(34.6)	213	4.64	1546.4
Shavenaugh Lake Swamp	12/28	(42.9)	30	2.72	127.36
Pere Marquette (Pond 1)	2/12	(16.7)	7	4.72	9.6
Pere Marquette (Pond 2)	3/8	(37.5)	13	3.28	30.08
Lindy Road Pond	9/30	(30)	30	0.88	146.8
Rock Cut Pond	12/33	(36.4)	10	0.32	75.12
Harlow Lake	9/22	(40.9)	16	0.08	59.28
County Road 510 Marsh	2/13	(15.4)	37	33.12	41.36
Westwood Mall Drainage	9/26	(34.6)	8	2	22
Florence Pond	2/16	(12.5)	6	1.6	10.4
Ives Lake	6/41	(14.6)	4	2.72	5.76
Trout Lake	2/23	(8.7)	1	0.16	2.4
Rush Creek Dam	7/23	(30.4)	54	7.52	207.36
Howe Lake	7/24	(29.2)	9	3.44	26.48
Louie's Pond	22/51	(43.1)	35	0.64	385.12
Big Lake Road Pond	4/5	(80)	54	1.68	196.24
Total/Mean	160/477	(33.5%)	87.6	6.75	273.99

4°C until it could be processed. Frogs were identified as male, female, or immature (too young to confidently sex). Each frog was weighed to the nearest 0.5 g using a Pesola spring scale (Pesola Scales, Kapuskasing, Ontario, Canada). Snout-vent length (mm) was measured to the nearest 1.0 mm using SPi 2000 dial calipers (Swiss Precision Instruments, Inc., Garden Grove, California, USA). Any abnormalities were also noted, including abrasions, lesions, discoloration, and deformities. Equipment was disinfected with a dilute bleach solution after each use.

To extract DNA, 40 µl of PrepMan Ultra Sample Preparation Reagent was added to the 1.5 ml centrifuge tube containing the swab. The tube was heated to 100°C for 10 min and then allowed to cool for at least 2 min. After cooling, the tube was centrifuged for 3 min at 13,000 rpm, then a minimum of 20 µl of supernatant was transferred to a 200 µl PCR tube. Five µl of the supernatant was diluted 10^{-1} in 0.25xTE buffer (pH 7.6). The diluted samples were then stored at -20°C until they could be analyzed using a validated quantitative real-time PCR (qPCR) assay (Boyle et al. 2004; Hyatt et al. 2007). The primers and minor groove binding (MGB) probe used in the qPCR assay were the same *Bd* DNA specific sequences used in Boyle et al. (2004).

An ABI 7500 Real-Time PCR System (Applied Biosystems, Inc., Foster City, California, USA) was used for the qPCR assay. Conditions for qPCR analysis were as follows: 2 min at 50°C, 10 min at 95°C, and 50 cycles of 15 s at 95°C, 1 min at 60°C. Each 96-well plate contained 4 standards at known zoospore concentrations of *B. dendrobatidis*, 1 negative control without DNA template, and 27 unknown samples in triplicate (triplicate = 3 aliquots from each swab sample extraction). Known DNA concentrations, provided by the Australian Animal Health Laboratory, were used to create 100, 10, 1, and 0.1 zoospore equivalent (zsp) standards. The known concentrations were then used to create a standard curve for each qPCR assay performed. Reaction volumes were 25 µl and contained 1X Taqman Environmental

TABLE 2. Results of a stepwise regression using Log prevalence of *Batrachochytrium dendrobatidis* infections in *Lithobates clamitans* at 29 infected sites in Michigan, USA, in 2009 as the dependent variable and 5 independent predictor variables. A backward elimination with an α of 0.1 was used to remove predictor variables.

Variable	Step	1	2	3	4	5
	Constant	3.053	3.046	3.299	3.469	4.107
Latitude	F5,28 =	-0.085	-0.085	-0.094	-0.099	-0.102
	T23 =	-2.68	-2.76	-3.64	-4.03	-4.15
	p =	0.013	0.011	0.001	0.000	0.000
pH	F5,28 =	0.054	0.051	0.054	0.06	
	T23 =	0.94	0.92	0.99	1.15	
	p =	0.356	0.367	0.330	0.262	
Conductivity	F5,28 =	0.00009	0.0001	0.00008		
	T23 =	0.63	0.7	0.61		
	p =	0.533	0.49	0.55		
Water Temperature	F5,28 =	-0.006	-0.006			
	T23 =	-0.54	-0.56			
	p =	0.593	0.579			
Elevation	F5,28 =	-0.00026				
	T23 =	-0.31				
	p =	0.760				
S		0.232	0.228	0.225	0.222	0.223
R-Sq		43.7	43.46	42.72	41.87	38.94
R-Sq(adj)		31.46	34.04	35.84	37.4	36.68
Mallows C-p		6	4.1	2.4	0.7	-0.1

TABLE 3. Correlation matrix of site variables used in stepwise regression to determine predictor variables for *Batrachochytrium dendrobatidis* infections in *Lithobates clamitans* at 29 infected sites in Michigan, USA, in 2009.

		Water Temperature	pH	Conductivity	Latitude
pH	r =	-0.067			
	p =	0.712			
Conductivity	r =	-0.152	0.152		
	p =	0.398	0.398		
Latitude	r =	0.527	-0.07	-0.325	
	p =	0.002	0.699	0.065	
Elevation	r =	0.134	0.16	-0.229	0.197
	p =	0.457	0.374	0.201	0.271

Master Mix 2.0 (Applied Biosystems, Inc., Foster City, California), 900 nM concentration of each primer, 250 nM concentration of the MGB probe, and 5 µl of DNA template.

An individual frog sample was considered positive if at least one of the triplicate swab samples amplified during the qPCR assay. It was not uncommon for only 1 or 2 replicates to amplify, especially if the quantity was low. The actual quantity of zoospore equivalents for each sample was acquired by comparing critical threshold (Ct) values (the cycle in which a sample has amplified past a set threshold) of unknown samples to the Ct values of the standard curve. The quantity for each sample represented a mean of the PCR analysis of the swab sample, if more than one replicate was positive. The prevalence of positive individuals at each site was calculated by taking the number of positive frogs and dividing that number by the number of frogs sampled. The zsp mean of each site was calculated by taking an average of only the infected individuals from that site.

A correlation between average infection load (log transformed) and site prevalence (log transformed) was performed in Minitab 14 (Minitab Inc., State College, Pennsylvania, USA). Prevalence data was log transformed and tested for normality before and after transformation. To check for colinearity between the independent variables, a correlation matrix analysis was performed prior to the stepwise regression in Minitab 14 and one of two variables with a strong correlation (Pearson correlation value above 0.7) was selected. A stepwise regression was performed in Minitab 14 using the prevalence of positive individuals at a site as the dependent variable and several possible explanatory factors: water temperature (°C), conductivity (µMhos), pH, latitude, and elevation. A backward elimination was used to remove independent variables using an of 0.1 as a threshold. Logistic regression was performed in Minitab 14 using positive or negative infection of an individual as the dependent variable, and mass (g) and sex of the frog as the independent variables. Sex of the frog actually included three categories: male, female, and immature (too young to reasonably determine sex). The quantity of zoospore equivalents data was log transformed and tested for normality before and after transformation. Anderson-Darling test for normality was used for all normality tests using Minitab 14.

We found that *Bd* is widespread in Michigan, being detected on 160 of 477 (35%) *L. clamitans* sampled (Table 1). Only 4 of 33 sites visited were *Bd*-negative. Infected individuals ranged in their infection load from 0.08 to 2,176 zoospores. The site average infection load (log transformed) and site prevalence (log transformed) were positively correlated ($r_{27} = 0.783$, $p < 0.001$; Fig. 2).

Latitude was associated with *Bd* prevalence ($T_{23} = -4.15$, $p < 0.001$; Fig. 3) and explained a significant proportion of the

variance in prevalence between sites ($F_{5,28}$ = -0.102, r^2 = 38.94, p < 0.001; Table 2). Most independent variables were not strongly correlated with each other (Table 3), however, latitude and water temperature had a significant relationship (r_{27} = 0.527; p = 0.002).

The relationship between latitude and *Bd* prevalence was significant when analyzing only the *Bd*-positive animals, so that a subset of sites were included in this analysis. Given that prevalence was 0.335 for all sites combined (160/477 individuals from all sites), 8 individuals would need to be sampled in order to be 96% confident that a site was *Bd*-free, and 12 individuals would need to be sampled to be more than 99% confident that a site was *Bd*-free. Since not enough individuals were collected at sites with 0% prevalence to confidently assume absence of the fungus, they were excluded from this analysis. According to the Anderson-Darling test value (AD) for the site prevalence data, the data was not normal before log transformation (mean = 0.4548, SD = 0.2774, AD = 1.327, p = <0.005). After log transformation, the data was normal (mean = -0.4233, SD = 0.2805, AD = 0.453, p = 0.253).

There was no relationship between an individual frog being infected or not (N = 449) and either mass (g) (z_1 = 0.43, p= 0.665) or sex (χ^2_2 = 0.679,p= 0.712), or both (G_3 = 0.686,p= 0.877). There was no difference in the number of zoospores infecting female and male *L. clamitans* (T_{111} = -0.649056, p = 0.518; Fig. 4). According to the Anderson-Darling test value for the zoospore quantity data for females and males, the data was not normal before log transformation (female: mean = 17.65, SD = 26.31, AD = 6.27, p = <0.005; male:mean = 65.13, SD = 283.7, AD = 20.953, p = <0.005). After log transformation female data was normal, but the male data was not (female: mean = 0.923, SD = 0.522, AD = 0.386, p = 0.377; male:mean = 1.000, SD = 0.670, AD = 2.115, p = <0.005).

Our study indicates that *Bd* has a broad distribution on *L. clamitans* in Michigan, where frogs had a relatively low infection load. This is consistent with the findings of Ouellet et al. (2005) who found infected *L. clamitans* in areas surrounding Michigan and in bordering Canada, as well as the findings for *L. sylvaticus* (Zellmer et al. 2008) and *Acris crepitans blanchardi* (Steiner and Lehtinen 2008) in Michigan. Among those sites where *Bd* was not detected, it was impossible to infer absence due to low sample sizes. Low sample sizes may have resulted from few frogs at a site or low detectability of frogs (e.g., if dense shoreline vegetation made it difficult to catch more than a few frogs). Although there was no obvious reason for some sites to have only a few *L. clamitans* inhabiting them, one possibility is that sites with few individuals could have been subject to a recent *Bd* die-off, with only a few *Bd*-resistant individuals remaining (or perhaps new individuals are colonizing and repopulating). Elsewhere, the species was thought to have been extirpated at sites, possibly due to *Bd*, and have now been rediscovered (Rodriguez-Contreras et al. 2008). Without ongoing monitoring over a long period of time it is not possible to detect such a die-off or recovery event.

One factor, latitude, was associated with *Bd* infection prevalence. As latitude increased, *Bd* infection decreased at our Michigan sites. Our samples at the highest latitudes were somewhat clumped in the Upper Peninsula (UP), but with all UP samples removed the significant relationship was still present at a $p < 0.1$ level (r_{20} = 0.319; p = 0.085). We also examined the relationship when adding in only single UP samples and the relationship was present at much lower p values (p values ranged from 0.05 to 0.003). Latitudinal variation was linked to *Bd* infection prevalence and intensity in other studies (Kriger et al. 2007; Rödder et al. 2008). Kriger et al. (2007) found that a significant relationship between *Bd* infection intensity and latitude was likely due to changes in precipitation along a large-scale latitudinal gradient (15–40°S) in Australia. The latitudinal gradient explored in our study was at a much smaller scale, between 42–47°N. A significant relationship at such a small scale is interesting and deserves further exploration to determine the exact cause of this relationship. Latitude is likely a proxy for one or more environmental factors not explored in this study that influences infection rates at Michigan sites.

Temperature associations with *Bd* infection have been documented (Becker and Zamudio 2011; Becker et al. 2012; Longcore et al. 1999; Andre et al. 2008; Olson et al. 2013). The fungus is known to grow best in a limited range of temperatures (Longcore et al. 1999; Piotrowski et al. 2004) and prevalence and severity of *Bd* has been reported to vary seasonally (e.g., Berger et al. 2004; Kriger et al. 2007). One Michigan study (Zellmer et al. 2008) found support for seasonality in Michigan *L. sylvaticus* but very small samples sizes in only a few, southern localities were sampled and this species is much more terrestrial than is *L. clamitans*. In our study, water temperature at the time a sample was taken did not correlate with infection results. However, it is possible that another temperature variable could be influencing *Bd* infection. One temperature variable that changes with latitude is average yearly temperature at a site. Sites further north have a lower average yearly temperature than sites in southern Michigan, but also a greater range in temperatures. This provides a possible explanation for the decrease in *Bd* prevalence at higher latitudes. It may be that the greater range in temperatures, as well as the lower annual average temperature, allows for *Bd* to grow and persist but not to reach high levels of infection as found in other areas. That remains to be investigated and managers should be aware that the more pristine areas of northern Michigan might be at greater risk for amphibian *Bd* infections.

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Appendix A

Coordinates (decimal degrees) and county locations for 33 sites in Michigan, USA where *Lithobates clamitans* was sampled for *Batrachochytrium dendrobatidis* infection.

Site Name	Sampling Date	County	N	W
Mill Pond Park	19 May 2009	Isabella	43.593466°	-84.893624°
Deerfield Park (Pond 1)	19 May 2009	Isabella	43.590699°	-84.895050°
Deerfield Park (Pond 2)	20 May 2009	Isabella	43.598672°	-84.788758°
Littlefield Pond	20 May 2009	Isabella	43.770861°	-84.948215°
John Ball Park Pond	26 May 2009	Kent	42.959130°	-85.705680°
Grand Valley State Property (Pond 1)	28 May 2009	Ottawa	42.972240°	-85.877908°
Vickie's Marsh/Pond	29 May 2009	Kent	43.063600°	-85.773432°
Whalfield Mill Creek	29 May 2009	Kent	43.089351°	-85.695526°
Seidman Park (Pond 1)	30 May 2009	Kent	42.981054°	-85.468707°
Seidman Park (Pond 2)	30 May 2009	Kent	42.981527°	-85.470234°
Grand Valley State Property (Pond 2)	30 May 2009	Ottawa	42.972472°	-85.878730°
Ionia State Game (Pond 1)	2 June 2009	Ionia	42.954040°	-85.151256°
Ionia State Game (Pond 2)	3 June 2009	Ionia	42.943729°	-85.167543°
Allegan Dam Pond	4 June 2009	Allegan	42.564650°	-85.952683°
Celery Flats (Pond 1)	5 June 2009	Kalamazoo	42.210483°	-85.584717°
Celery Flats (Pond 2)	5 June 2009	Kalamazoo	42.210000°	-85.585350°
Hampton Lake Marsh	5 June 2009	Kalamazoo	42.196267°	-85.634533°
Shisler Lake	8 June 2009	Leelanau	44.780748°	-85.821673°
Shavenaugh Lake Swamp	9 June 2009	Benzie	44.713317°	-85.865181°
Pere Marquette (Pond 1)	10 June 2009	Benzie	44.728417°	-85.958478°
Pere Marquette (Pond 2)	10 June 2009	Benzie	44.729219°	-85.958696°
Lindy Road Pond	11 June 2009	Benzie	44.520913°	-85.905132°

(*continued on next page*)

Appendix A (Continued)

Rock Cut Pond	15 June 2009	Marquette	46.504683°	-87.370450°
Harlow Lake	17 June 2009	Marquette	46.629550°	-87.488733°
County Road 510 Marsh	18 June 2009	Marquette	46.632300°	-87.644383°
Westwood Mall Drainage	19 June 2009	Marquette	46.552750°	-87.449367°
Florence Pond	22 June 2009	Marquette	46.850617°	-87.870700°
Ives Lake	23 June 2009	Marquette	46.839450°	-87.854050°
Trout Lake	24 June 2009	Marquette	46.857433°	-87.892433°
Rush Creek Dam	25 June 2009	Marquette	46.883683°	-87.886350°
Howe Lake	26 June 2009	Marquette	46.894529°	-87.951718°
Louie's Pond	4 August 2009	Antrim	44.823567°	-84.956617°
Big Lake Road Pond	2 September 2009	Oakland	42.721200°	-83.528812°

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Assessment of *Batrachochytrium dendrobatidis* Infection Level in Amphibians of Wakonda State Park, Missouri, USA

We determined the infection level of *Batrachochytrium dendrobatidis* (*Bd*) in the amphibian community of Wakonda State Park, Lewis Co., Missouri, USA, during the summer of 2010. Wakonda State Park consists of 420 ha of sand prairie, deciduous woodland, wetland, and wet prairie habitats, and 130 ha of wetland and deepwater habitats. There is little topographical relief with elevation ranging from 140 to 155 m above sea level (MODNR 2007).

We conducted two-person diurnal and noctural opportunistic surveys on seven different occasions in June and July 2010 and 17 September 2010. We surveyed 8 localities in the central (Cottonwood Pond, Quartz Lake, Agate Lake Road), southern (Main Park Road), northern (Sand Pit Lake, Buttonbush Slough, road to Jasper Lake), and western (Black Willow Marsh) regions of the park. We captured amphibians by hand using sterile technique (Livo 2004) and recorded species, capture date, and location. We swabbed amphibians following Livo (2004). We stored swabs in 70% EtOH solution and returned swabs to Truman State University for PCR analysis (Gaertner et al. 2009).

We captured and swabbed 39 individuals (17 *Lithobates catesbeianus*, 11 *Hyla versicolor*, 7 *Anaxyrus americanus*, and 4 *Acris crepitans*) during the study. Of those, zero individuals tested positive for *Bd*. The apparent lack of infection may be due to the warm, dry conditions, and large temperature range of Wakonda State Park, particularly during our sampling periods (Berger et al. 2004; Olson et al. 2013). Alternatively, *Bd* may occur within the park, but exist at low levels during inhospitable times of the year (Berger et al. 2004), and hence our low sample size may have precluded detection (Skerratt et al. 2008).

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Although we cannot conclude that *Bd* is absent from the park, our data are an important first step in addressing potential infection levels here. A more thorough sampling of the amphibians of Wakonda State Park is warranted, taking into account seasonal variation in climatic conditions, to inform resource management decisions.

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Prevalence of the Amphibian Chytrid Fungus (*Batrachochytrium dendrobatidis*) at Buenos Aires National Wildlife Refuge, Arizona, USA

Information on disease presence can be of use to natural resource managers, especially in areas supporting threatened and endangered species that occur coincidentally with species that are suspected vectors for disease. Ad hoc reports may be of limited utility (Muths et al. 2009), but a general sense of pathogen presence (or absence) can inform management directed at threatened and endangered species, especially in regions where disease is suspected to have caused population declines (Bradley et al. 2002). The Chiricahua Leopard Frog (*Lithobates chiricahuensis*), a species susceptible to infection by the amphibian chytrid fungus (*Batrachochytrium dendrobatidis*, *Bd*) (Bradley et al. 2002), and the non-native, invasive American Bullfrog (*L. catesbeianus*), a suspected vector for *Bd* (Schloegel et al. 2012; Gervasi et al. 2013), both occur at Buenos Aires National Wildlife Refuge (BANWR) and surrounding lands in southern Arizona, USA. Efforts to eradicate the bullfrog from BANWR began in 1997 (Suhre 2010). Eradication from the southern portion of BANWR was successful by 2008 but the bullfrog remains present at Arivaca Cienega and in areas immediately adjacent to the refuge (Fig. 1). Curtailing the re-invasion of the bullfrog into BANWR will require vigilance as to ensure the health of Chiricahua Leopard Frog populations. In conjunction with our regular occupancy surveys on BANWR, as part of the Amphibian Research and Monitoring Initiative, we added sampling for *Bd* to ranids and monsoon-breeding amphibians. The sampling was added to determine if *Bd* was present in Chiricahua Leopard Frog and American Bullfrog populations. We also wanted to determine if the monsoon-breeding amphibians were potential reservoirs for *Bd* since they will breed in pools that have ranids.

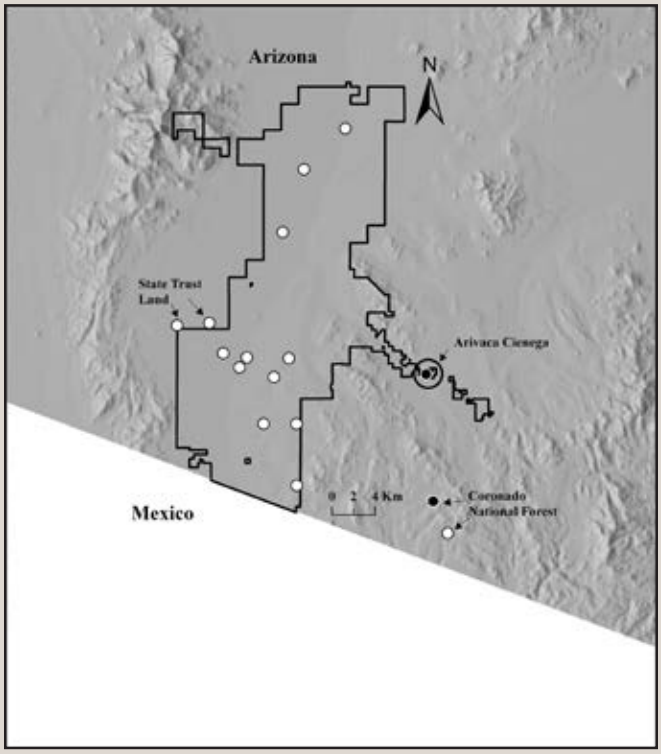


FIG. 1. Arizona, USA sampling locations: Buenos Aires National Wildlife Refuge (outlined), Coronado National Forest, and State Trust Land. Black circles indicate *Bd*-positive sites and white circles indicate *Bd*-negative sites.

In 2008, we collected external skin swab samples from 389 amphibians at BANWR (N = 11 sites), the adjacent State Trust Land (N = 2 sites), and the adjacent Coronado National Forest (N = 2 sites) (Table 1). Samples were collected by swabbing the dorsal, ventral, and feet of each amphibian using sterile swabs. The swabs were then placed in 95% ethanol and kept at or below 23°C. Distance between sites varied from 2 to 30 km. Sites for monsoon-breeding amphibians were selected opportunistically based on storm events and species occurrence. Ranid frogs (American Bullfrog, Chiricahua Leopard Frog) were sampled before the monsoon (June) at known sites; all other species were sampled during the monsoon (July to August). Swabs were tested for presence of *Bd* DNA using PCR (Annis et al. 2004) at the Human Origins Genotyping Laboratory, University of Arizona.

Across all samples, prevalence of *Bd* was low (0.02; Table 1). *Bd* was not detected on non-ranid frogs, perhaps because they are fairly terrestrial (Longcore et al. 2007). Among ranid frogs, *Bd* was not detected in the southern portion of BANWR. Only bullfrogs tested positive for *Bd* on the refuge, and those animals were from Arivaca Cienega (4/132, Table 1). Chiricahua Leopard Frogs tested positive for *Bd* at one site on the Coronado National Forest (6/25, Table 1). Our data parallel earlier reports on Chiricahua Leopard Frogs in Arizona, with *Bd*-positive reports for animals at other refuges around southern Arizona (San Bernadino National Wildlife Refuge, 2 individuals with characteristic lesions [Bradley et al. 2002]; Sycamore Canyon, Coronado National Forest, 1 individual tested positive via polymerase chain reaction (PCR) assay [Rosen and Caldwell 2004, www.bd-maps.net] but a negative result within the refuge [based on histological evaluation by D. E. Green, www.bd-maps.net]). Collectively, these results suggest that Chiricahua Leopard Frogs in Arizona are susceptible to infection by *Bd*.

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TABLE 1. Nine amphibian species sampled for the occurrence of the amphibian chytrid fungus (*Batrachochytrium dendrobatidis*, *Bd*) in 16 water bodies on and adjacent to Buenos Aires National Wildlife Refuge, Arizona, USA. *Bd* prevalence and 95% confidence intervals shown.

Species	Common Name	No. Sampled	No. *Bd*-positive animals		*Bd* Prevalence (95% CI)
			On Refuge	Off Refuge	
Ambystoma mavortium	Western Tiger Salamander	26	1	0	0.00 (0.00–0.11)
Anaxyrus cognatus	Great Plains Toad	90	4	0	0.00 (0.00–0.03)
Gastrophryne olivacea	Western Narrow-mouthed Toad	9	1	0	0.00 (0.00–0.28)
Incilius alvarius	Sonoran Desert Toad	28	3	0	0.00 (0.00 –0.10)
Lithobates catesbeianus	American Bullfrog	142	1	2	0.03 (0.01–0.07)
Lithobates chiricahuensis	Chiricahua Leopard Frog	77	4	2	0.08 (0.03 –0.16)
Scaphiopus couchii	Couch's Spadefoot	8	4	0	0.00 (0.00–0.31)
Smilisca fodiens	Lowland Burrowing Treefrog	2	1	0	0.00 (0.00–0.78)
Spea multiplicata	Mexican Spadefoot	7	4	0	0.00 (0.00–0.35)

Prior to bullfrog eradication efforts, samples were collected from bullfrogs that had skin lesions or appeared unhealthy at a site 7 km from a Chiricahua Leopard Frog population at BANWR. Histological examination revealed *Bd* in 2 of 4 bullfrogs in 2003 and 3 of 7 bullfrogs in 2005 (D.E. Green, unpublished data). The absence of *Bd* on any species on the southern portion of BANWR in our recent assessment may be related to the absence of bullfrogs (Hossack et al. 2013; Longcore et al. 2007). This information should be useful to natural resource managers because extreme storm events causing extensive flooding (e.g., 2007: 30 cm of rain in July and August, 11 cm above average, Western Regional Climate Center, [http://www.wrcc.dri.edu/]) can facilitate dispersal of bullfrogs onto BANWR from outlying areas of the refuge, such as the Arivaca Cienega (Suhre 2010). Such re-invasion may facilitate the presence of *Bd* at ponds that support populations of ranid frogs at risk.

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Captive Management and Breeding of the Stuttering Frog (*Mixophyes balbus*) at Melbourne Zoo

The anuran genus *Mixophyes* consists of six species, five of which are restricted to moist forests of eastern Australia and one to the highlands of New Guinea (Donnellan et al. 1990; Tyler 1992; Tyler and Knight 2009). These moderately large terrestrial myobatrachids are commonly referred to as Barred Frogs due to varying degrees of barred markings on the hind legs. The Stuttering Frog, *Mixophyes balbus,* is restricted to the eastern slopes of the Great Dividing Range, from the Cann River catchment in far East Gippsland, Victoria; north to tributaries of the Timbarra River near Drake, northern New South Wales (NSW) (Gillespie and Hines 1999; Lemkert et al. 1997).

The species is typically found in the riparian zone of permanent streams, but may disperse into surrounding forests outside the breeding season (Daly 1998; B. Lewis, pers. comm.). Reproductive biology is similar to that of its congeners, particularly *M. fleayi* (Knowles et al. 1998). Oviposition has been recorded during the spring and summer months of October to February in shallow riffle zones in stream beds (Anstis 2002; Knowles et al. 1998; Lewis 2000; B. Lewis, pers. comm.). Eggs are laid in a shallow excavated nest, which the female forms by kicking the substrate outwards in a revolving motion (Knowles et al. 1998; Lewis 2000).

Mixophyes balbus has experienced a significant decline throughout its range (Gillespie and Hines 1999; Hunter and Gillespie 2011; Mahony 1996; Mahony et al. 1999; Tyler 1997). The southern portion of its range has experienced the greatest declines and the species may now be extinct in Victoria (Gillespie

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Fig. 1. Breeding enclosure for *Mixophyes balbus* at Melbourne Zoo, with the areas of deep substrate and below-substrate drainage.

2011; Gillespie and Hines 1999). In NSW *M. balbus* is listed as Endangered under the Threatened Species Conservation Act, 1995. In Victoria it is registered as Threatened in the Victorian Flora and Fauna Guarantee Act of 1988 and listed as Critically Endangered in the Advisory List of Threatened Vertebrate Fauna in Victoria 2012 (DSE 2012). Nationally, *M. balbus* is listed as Vulnerable under the Environment Protection and Biodiversity Conservation Act 1999. Globally it is listed as Vulnerable (C1 and 2a (i)) by the IUCN (2012).

A recent genetic study identified two major lineages within what is currently known as *M. balbus*, with an overlap zone in the vicinity of the Barrington Tops region, NSW (Donnellan 2008; M. Mahony, pers. comm.). The level of genetic divergence between these two lineages, hereafter referred to as clades, is greater than that recorded among other *Mixophyes* species, suggesting that more than one taxon currently exists within *M. balbus* (Donnellan 2008). This issue is reflected in the National Recovery Plan for the Stuttering Frog, which recommends that, until this taxonomic issue is resolved, the two lineages of the Stuttering Frog "should be given the highest level of conservation priority and managed independently" (Hunter and Gillespie 2011).

Increased interest in the conservation of native Australian frogs resulted in frogs in the genus *Mixophyes* being identified as a priority taxon for regional management by Australasian zoos in 1996 (Banks 1993; Banks and Meikle 1994; Gillespie et al. 2007). Melbourne Zoo took the lead in this initiative, initially focusing on the Great Barred Frog, *Mixophyes fasciolatus*, to develop the necessary husbandry expertise as an analogue for working with more threatened species in this genus. Commencing in 1993, the husbandry and breeding of *M. fasciolatus* proved straightforward (Banks et al. 2003).

Melbourne Zoo has since maintained and bred both clades of *M. balbus*. The founding sample of the northern clade *M. balbus* was collected as adult frogs in February 2001 at Duncan's Creek in the Malara State Forest on the Timbarra Plateau, north-east NSW, within the boundaries of the Timbarra Gold Project (Mining leases 1386 and 1426), and consisted of 4 males, 3 females, and 20 tadpoles. None of the tadpoles survived the transfer to Melbourne Zoo, despite the containers being buffered from sudden movements and the tadpoles having adequate volumes of water and in-container vegetation. The container was aerated and we believe that the water circulation created too much turbulence for the tadpoles. Post-mortem examination did not reveal a cause of death.

Individuals of the southern clade *M. balbus* were collected as tadpoles in Macquarie Pass National Park, southern NSW, in January 2005. Twenty tadpoles were collected, 10 transferred to Melbourne Zoo and 10 to the Amphibian Research Centre (ARC), in outer Melbourne.

Captive Management

All life stages of both clades of *M. balbus* were maintained under the same conditions at Melbourne Zoo, except where otherwise indicated.

Maintenance of adult frogs: Northern clade.— Adult frogs were maintained in glass aquaria in two groups, group one consisted of 2.1 (two males: one female) and group two of 2.2. These two groups were combined in one group of 3.3 frogs in July 2002, one male having died soon after arrival. Frogs were maintained under Melbourne Zoo amphibian quarantine protocols (Lynch 2001). Each enclosure measured 1800 × 450 × 450 mm tall and was designed to simulate a cross-section of a flowing stream (Fig. 1). Two areas of deep substrate, at each end of the enclosures, were provided to allow for burrowing. The substrate consisted of 50 mm of leaf litter over 250 mm of palm peat, on top of a 50 mm layer of aquarium gravel on fiberglass fly mesh, supported approximately 50 mm above the base to allow drainage. Each deep substrate area contained one permanently plumbed drainage hole of 25 mm diameter. The substrate was regularly flushed and the palm peat was occasionally turned to assist with aeration and reduce compaction.

Water was supplied between the two deep substrate areas. An aquarium power-head pumped the water from a wet trickle filter located below the enclosure on to rocks within the water body. This created a small splash zone; the water then flowed through a simulated riverbed and overflowed back to the filter. A second pump, also located in the filter, pumped water through a spray bar located on top of the enclosure to simulate rain. The rain simulation pump was operated sporadically, coinciding with low-pressure systems and rain events as they occurred in the local (Melbourne, Victoria) area. The riverbed consisted of 10–150 mm river stones, which created pools varying in depth from 5–250 mm. Shallow riffle zones were created using 5 mm aquarium gravel mixed with coarse river sand. Logs and larger rocks were placed along the water's edge to create sheltering sites and locations for males to call from.

From February 2001 until July 2002 the tanks were located beside each other within an off-limit holding area in Melbourne Zoo's Reptile House. Ambient air temperature was 17–23°C during winter and 23–28°C during summer. After July 2002 both enclosures were maintained in an air-conditioned room adjacent to the World of Frogs facility, with an ambient air temperature of 9–16°C during winter and 17–25°C during summer. A large vent in an external door was opened during winter to allow the ambient temperature to drop below the minimum achievable by the air conditioner. Exposure to Melbourne's natural annual photoperiod of 9.5 h daylight during winter and 14.75 h during summer was provided via skylights and windows. Commencing in 2008, all frogs also had two Repistar® 18-watt globes installed above each aquarium, providing UVA and UVB radiation.

TABLE 1. Spawn date, egg and breeding female data for northern clade *Mixophyes balbus* at Melbourne Zoo.

Spawn date	Number of eggs laid	Nest length x width x depth (mm)	Female weight pre-oviposition (g)	Female weight post-oviposition (g)	Water temperature Av. (min/max)°C	Days until hatching commenced	Days until hatching finished	Percent fertile
13.02.01	120	50 x 50 x 20	48.5	35.6	25.5 (21–27)	6	8	95%
15.02.01	140	58 x 58 x 20	55.5	49	25.5 (21–27)	6	8	90%
19.02.01	130	58 x 58 x 20	49	43.3	25.5 (21–27)	6	8	95%
30.05.01	210	55 x 55 x 25	56	46.4	20 (17–22)	8	10	80%
2.09.04	280	50 x 80 x 20	49.2	45.2	18 (15–22)	10	14	95%
5.09.04	310	65 x 65 x 25	56	49.1	18 (15–22)	10	14	85%
9.09.04 (*)	140	50 x 45 x 18	N/R	N/R	18 (15–22)	10	14	20%
6.04.06	532 (**)	N/R	N/R	N/R	18 (15–22)	Eggs not retained	–	–

N/R – not recorded.
(*) – F2 breeding; frogs from spawn laid 30 May 2001.
(**) – possibly more than one spawning.

For the 2004 breeding season a glass aquarium measuring 800 × 750 × 500 mm tall was used specifically for breeding. This simulated a natural riffle zone and was without a deep substrate area. The river area was set up as described for the previous enclosure, although it was slightly larger and hence provided more potential spawning sites for the female frogs. A second pump was used to circulate water through a spray bar to simulate rain throughout the enclosure. The rain simulation pump was operated by a timer and programmed to operate for 15 minutes every hour.

Each frog was implanted with a passive integrated transponder (PIT) in the left inguinal pocket for identification and sex was determined by size. Adult females measured 76–77 mm SVL and males 55–57 mm SVL. Calling males also had well-developed nuptial pads and darker yellow throats and bellies, compared to the white/grey of the females.

Southern clade.—Southern clade frogs were maintained in the conditions detailed above, but in one all-glass aquarium at a sex ratio of 3.2.1 (3 males: 2 females: 1 adult of undetermined sex). This had a recirculation filter and single pump, and the substrate was removed and replaced with fresh materials annually. These frogs were kept in the off-limit section of the World of Frogs at an ambient temperature of 9–16°C during winter and 17–25°C in summer.

Due to their smaller size, only one southern clade frog was micro-chipped. Photographs of dorsal patterns were used to identify all other frogs.

Feeding

Frogs were fed weekly during winter and twice weekly during summer. Food was predominantly commercially available crickets, although locusts were also provided occasionally for variety. One wild-collected adult male northern frog died after eating a large locust approximately twice the width of the frog's head. Gross necropsy and pathology suggested the gut was perforated by the locust's hind leg. Subsequently, locusts no larger than the width of the frog's head were offered. Calcium carbonate or multivitamin powder was dusted on all insects prior to feeding.

Maintenance of Tadpoles

Tadpoles of both clades were reared in all-glass aquaria 450 × 530 × 150 mm deep containing 19 L of water, and 400 × 750 × 180 mm deep containing 50 L. Tadpole tanks had overflow pipes, each with a grill cover to prevent tadpoles from being accidentally flushed down the drain. Water quality was maintained by dripping a constant supply of fresh water into the tank at approximately 2.0 L per hour. Rate of flow was increased or decreased according to stocking density and water quality. Each tank had an aquarium air stone for oxygenation and to aid water movement. No substrate or other internal furnishings were provided.

Water quality was measured using a Master Test Kit® and a Nitrate Test. Municipal tap water was aged in a large 800 L tank for approximately 24 h prior to being used. Once aged, the general water parameters were pH = 6.9, general hardness (GH) = 17.9 ppm, carbonate hardness (KH) = 17.9 ppm, ammonia (NH_3/NH_4+) = 0 ppm, nitrite (NO_2^-) = 0 ppm, and nitrate (NO_3) = 0 ppm. These parameters were similar to water tested from the tadpole collection site (Duncan's Creek tributary, Timbarra Plateau). Water quality in the aquaria was maintained at the same parameters except for nitrate, which varied between 0–5.0 ppm.

Tadpoles were fed a varied diet of frozen (and then thawed) endive 7 times weekly and Saga® tropical fish flakes weekly. Spirulina Pro® was fed *ad libitum*, approximately once every 7–10 days. Once tadpoles reached Gosner Stage 26 (hind limb buds, Gosner 1960), protein was increased by adding either frozen bloodworms or frozen brine shrimp every second day.

Maintenance of Metamorphs and Juvenile Frogs

Newly metamorphosed frogs were maintained in plastic containers 360 × 250 × 270 mm high. Substrate was peat moss to a depth of 100 mm set on top of aquarium gravel and fly wire, with plumbed drainage as described for the adults. Leaves provided surface level retreats and water was provided in a shallow plastic saucer 130 × 10mm. Water was replaced every two days and the substrate was flushed at the same time.

Juvenile frogs were maintained in glass aquaria 400 × 750 × 500 mm deep and furnished as described for newly metamorphosed frogs. Water was provided in a large plastic saucer 15 mm deep and 250 mm in diameter.

The lighting and temperature regime were the same as for the adults, post-July 2002.

Spawning Details

Northern clade.—Males in both northern groups called throughout the first night after arriving at the zoo. A pair in each group was in amplexus the following morning. Females spawned three times over the following seven days (13–19 February), with one female spawning twice—four days apart. Spawning subsequently occurred on 30 May 2001, and then in early September 2004 (Table 1). Spawning also occurred in 2005 and 2006, but none of those eggs were retained.

During June–July 2004, the frogs were maintained in drier conditions than previously, with flushing of the peat moss substrate reduced from every 1–2 days to approximately once or twice a week. The frogs were less active and spent most of their time buried in the peat moss, from just below the surface to 200 mm deep.

Trans-illuminating females with a small torch in early August to September 2004 suggested that they were carrying eggs. Consequently, when the next low pressure system arrived, the frogs were given a three day transition period of wetter conditions. Breeding groups received sporadic daily rain sessions consisting of 15–30 minutes, 2–3 times a day. During these sporadic rain days, plastic was used to cover 95% of the ventilation to raise the humidity within the enclosure. The humidity was increased from approximately 40% to 95%, which brought the frogs to the surface and initiated male calling. Humidity in the spawning enclosure was maintained at 100% for 24 h a day, and under these conditions the activity level of the frogs increased. Once local rain started, one adult pair was removed from the group and placed into

Table 2. Spawn date, egg, and breeding female data for southern clade *Mixophyes balbus* at Melbourne Zoo.

Spawn date	Number of eggs laid	Water temperature (°C)	Days until hatching commenced	Days until hatching finished	Percent fertile
23.10.10	150	18.7	9	12	95%
10.1.11	260	–	–	–	–
09.08.11	361	–	–	–	–
20.09.11	355	–	–	–	–
28.02.12	377	–	–	–	–
27.08.12	299	–	–	–	–

Table 3. Larval duration and metamorph data of a randomly-selected group of same age northern clade *Mixophyes balbus* tadpoles at Melbourne Zoo.

Season (*)	Larval duration (days)	Metamorph snout–vent length (mm)	Metamorph weight (g)	Number of metamorphs	Percentage of the group (N = 45)
1	199–284	23–27 (mean 23.3)	1.10–1.38 (mean 1.21)	9	20%
2	533–688	26–31 (mean 29.5)	1.26–3.74 (mean 2.49)	16	36%
3	881–916	26–32.5 (mean 31.2)	2.56–2.87 (mean 2.80)	5	11%
5	1944	N/R	N/R	1	2%
Average	556 days	28	2.16	N = 30	

*Year following commencement of metamorphosis within the group.

Table 4. Differences recorded between northern and southern clade *Mixophyes balbus* at Melbourne Zoo.

Characteristic	Northern clade	Southern clade
Adult body length (mm)	Males: 55–57 Females: 76–77	Males: 52–57 Females: 60–62
Body length of newly-emerged metamorphs (mm)	23–32	21–23
Eggs per spawn event	120–280	260–390
Eye color	Narrow upper eye pale blue	Pale blue of upper eye less obvious. Generally darker appearance of whole eye
Banding on lower rear legs	6–7 bars and bars faint on front of legs	9–10 bars and bars more distinct
Dorsal patterning	Small number of faint darker blotches on dorsal surface	Small number of more distinct blotches, which are more consistently located along the middle of the back
Facial features	Dark patterning between eyes and nose tip less pronounced	Dark patterning between eyes and nose tip more pronounced. Nose more pointed than northern clade frogs.
Spawn site	Eggs consistently laid among gravel in riffle zone	Eggs laid in various locations, e.g. on and under rocks, among gravel, etc.

the spawning enclosure. Spawning occurred the next day and the frogs were then returned to the group enclosure. This process was repeated with two other pairs, the third pair being F1 frogs 30–34 months old (Table 1). Eggs from all three spawnings were removed and set up in aquaria as described for the tadpoles. The eggs were mixed amongst the gravel and adhered to individual rocks in small clumps of approximately 1–18 eggs.

Spawning also occurred in 2006, 2007, and 2008, but none of the eggs were retained and no data were recorded in 2007 and 2008.

Southern clade.—Frogs were observed in amplexus in mid-December 2010 and 150 eggs were laid on 23 December. The eggs hatched after 9–12 days at a water temperature of 18.7°C. The adult frogs were 5 years and 1 month old at that time. All frogs had been measured earlier in December—the three males averaged 55 mm SVL (52–57 mm) and two females averaged 61 mm SVL (60–62 mm). Nest dimensions and female weights were not recorded for the southern clade frogs. Subsequent spawning occurred in 2011and 2012, but none of those eggs were retained.

Larval Duration and Metamorphosis

Northern clade.—One group of 45 randomly selected tadpoles was taken from one spawning and tracked until each one had metamorphosed (30) or died (15). Metamorphosis took 6–30 months and occurred only between November and April in each year after metamorphosis commenced within the group (Table 2). One individual took more than five years to metamorphose (Hobbs 2014). Average water temperature during winter was 16°C (range 14–18°C) and 18°C (range 16–20°C) during summer.

Southern clade.—Seven of the 10 tadpoles received from the wild on 14 January 2005 metamorphosed from 9–20 November 2005, 300–311 days after arrival at the Zoo. Ten tadpoles from eggs laid on 23 December 2010 metamorphosed after 281–438 days. The rest of the developing tadpoles were not retained. Average weight and length of four of the frogs at metamorphosis was 1.56 g (1.25–2.01 g) and 22.46 mm SVL (21.73–23.05 mm) respectively.

PHOTO BY D. GOODALL



Fig. 2. Female captive-reared southern clade *Mixophyes balbus* at Melbourne Zoo, with very distinct and more numerous rear leg bands.

PHOTO BY M. SWAN



Fig. 3. Female captive-bred northern clade *Mixophyes balbus* at Melbourne Zoo, with less distinct barring on rear legs and more obvious blue of upper eye.

Differences between Northern and Southern Clade *Mixophyes balbus*

Morphological differences were noted between the northern and southern clade *M. balbus* at the Zoo (Table 4). Southern clade frogs had darker eyes, more bands and more distinct banding on lower rear legs, more distinct and consistent dorsal markings and their noses were more pointed. Southern clade females were also smaller, laid more eggs per spawning and laid eggs in more varied locations (Figs. 2 and 3).

Discussion

Northern clade.—The founding individuals were collected in February 2001 towards the end of the breeding season. Males were calling at the time and presumably the females had come down to the stream to breed. Consequently, it was no surprise that spawning occurred shortly after the individuals were placed together following their arrival at the Zoo. Spawning by wild females has been recorded in February (Lewis 2000).

Over the frogs' first winter in Melbourne, it became evident that the frogs at the Zoo were experiencing higher temperatures than would be the case in the wild at that time of year, ie. 18–23°C at the Zoo vs. 7–15°C on the Timbarra Plateau. This probably explains the spawning which occurred in May 2001 during winter, a time that the species is not thought to breed in the wild. It could be construed that the frogs were experiencing an "extended" summer and it was feared that by not experiencing normal winter temperatures, the extrinsically influenced spermatogenetic and ovarian cycles might be negatively affected and detrimental to subsequent breeding seasons (see Duellman and Trueb 1994). Moving the frogs to a room with the required temperature regimes in July 2002 allowed them to experience natural annual temperature cycles from that time.

The frogs received sporadic rain events throughout the 2003/2004 breeding season and although they were observed in amplexus on many occasions, the females failed to spawn. Spawning in the wild follows heavy rains, when the water level of the stream is receding (Knowles et al. 1998; Lewis 2000; B. Lewis, pers. comm.). It was clear that the captive rain conditions did not provide the trigger to instigate spawning and it may be that the captive rain and humidity conditions were not well defined or distinct enough from the non-breeding conditions. Subjecting the frogs to more distinct seasonal conditions, commencing with a dry period in the 2004 winter over the non-breeding season, followed by a "distinct wet season," was successful as three spawnings occurred in late 2004. Similar behavior has

been recorded in leptodactylid frogs in the genus *Ceratophrys* in South America that occur in similar heathland habitat subject to distinct wet and dry seasons (Duellman and Lizana 1994; Ortiz et al., *in press*).

Egg numbers per spawn event increased with increasing female age in northern clade frogs. In most amphibians, egg numbers increase with female weight, which is often correlated with age (Whitaker 2001). This is most likely to have been the case with the *M. balbus* at Melbourne Zoo.

The first northern *M. balbus* tadpoles to metamorphose were smaller and weighed less than their siblings which metamorphosed later. A similar result has been found in Southern Corroboree Frogs (*Pseudophryne corroboree*) bred at Melbourne Zoo and it is suggested that the longer larval period in this species allows for more robust metamorphs, which is beneficial to the later development of those individuals (McFadden et al. 2013). In general, longer tadpole life leads to larger metamorphs and juvenile frogs, although the studies that have experimentally tested this phenotypic plasticity in frogs have done so by investigating the impacts of other factors, such as presence of a predator and food availability, rather than the relationship between length of larval duration and metamorph size in itself (Nicieza 2000; M. Mahony, pers. comm.).

The single northern *M. balbus* tadpole that took more than five years to metamorphose was maintained under the same conditions as its siblings, apart from individual housing after all other siblings had metamorphosed. Environmental factors that can effect larval duration between groups of larvae, such as temperature and conspecific density (Loman 2004), do not explain why this individual did not metamorphose over the same period as its siblings (Hobbs 2014).

Southern clade.—The numbers of eggs laid in each spawning by the females at the zoo were within the range recorded for *M. balbus* in the wild by Anstis (2002). The number of eggs per spawning was higher in the southern clade frogs than the northern clade frogs.

Northern and southern clade frogs both exhibited what appeared to be distinct, but similar, spawning periods, e.g., February, April–May and August–September for the northern frogs; and December–February and August–September for the southern frogs, although the April–May spawning by the northern clade frogs may have been an artifact of captivity, as previously noted. Allowing for the small sample size, this suggests minimal differences in the seasonal pattern of reproduction between the two clades, under the same captive conditions. There are very few published accounts of spawning in the wild in this species (NPWS 1998), so it is not possible to say whether the spawning periods recorded at Melbourne Zoo reflect wild behavior or are an artifact of captivity. Many anuran species have extended 'breeding seasons' over many months, within which individual females may spawn on more than one occasion (see Duellman and Trueb 1994). Multiple spawning in a single season has been recorded in a range of other anurans, including *Chiromantis xerampelina* (Jennions et al. 1992), *Hyla cinerea* (Gunzberger 2005), and *Litoria infrafrenata* (Banks and Leyden 1990). Recognizing how little is known of the annual reproductive cycles of wild *M. balbus*, it may be that this species is capable of breeding from August to February if conditions are suitable. Further field work with this species would help to clarify if the findings reported here are artifacts of captivity, or reflect wild behavior.

Although based on small numbers of frogs collected at single sites, and hence with a high likelihood of being related, differences were observed between the northern and southern clade *M. balbus*. It is not possible to say to what degree these differences reflect consistent differences between frogs in the wild, as wild southern clade *M. balbus* have received very little attention. However, differences in the thickness and number of bands on the legs of wild frogs from the two clades have been observed (M. Mahony, pers. comm.).

Breeding of *M. balbus* at Melbourne Zoo proved to be straightforward, providing the basis to address one of the key actions in the National Recovery Plan for the species should it be needed, ie. "Establish a captive breeding program capable of augmenting reintroductions of Stuttering Frogs at selected extinction sites or for enhancement of extant populations" (Hunter and Gillespie 2011).

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Observations on the Captive Maintenance and Reproduction of the Balcones Barking Frog, *Craugastor augusti latrans*

Craugastor augusti (Anura: Craugastoridae), the Barking Frog, is a direct-developing species ranging from parts of the southwestern United States southward into Mexico. In the northern parts of the range, Barking Frogs are rarely encountered as they are only surface active for a few weeks following the onset of heavy spring and summer rains (Stebbins 2003; Tipton et al. 2012). Because of their secretive nature, Barking Frogs are notoriously difficult to study (Goldberg and Schwalbe 2004a). In the Edwards Plateau region of central Texas, the Balcones Barking Frog (subspecies *C. augusti latrans*; see Zweifel 1956) is active from late February to early April (Conant and Collins 1998). An early and often cited observation is that this subspecies has the behavior wherein males attend the eggs (Jameson 1950). This report contrasts with radio-telemetry data that suggests another subspecies in Arizona (*C. a. cactorum*) has the female as the attending parent (Goldberg and Schwalbe 2004b).

Herein we describe the maintenance of a small colony of Barking Frogs, report an instance of captive reproduction, and describe observations of female parental care in *C. a. latrans* that were collected in early 2013. To the best of our knowledge, this is the first documented captive hatching of *C. augusti*. Given previous reports of male parental care in *C. augusti latrans* (Jameson 1950), our observation of female nest attendance adds a new element to the discussion of parental care mode in this enigmatic frog.

Specimen acquisition and husbandry methods.—During the early spring of 2013 (March–April) we collected 18 adult Barking

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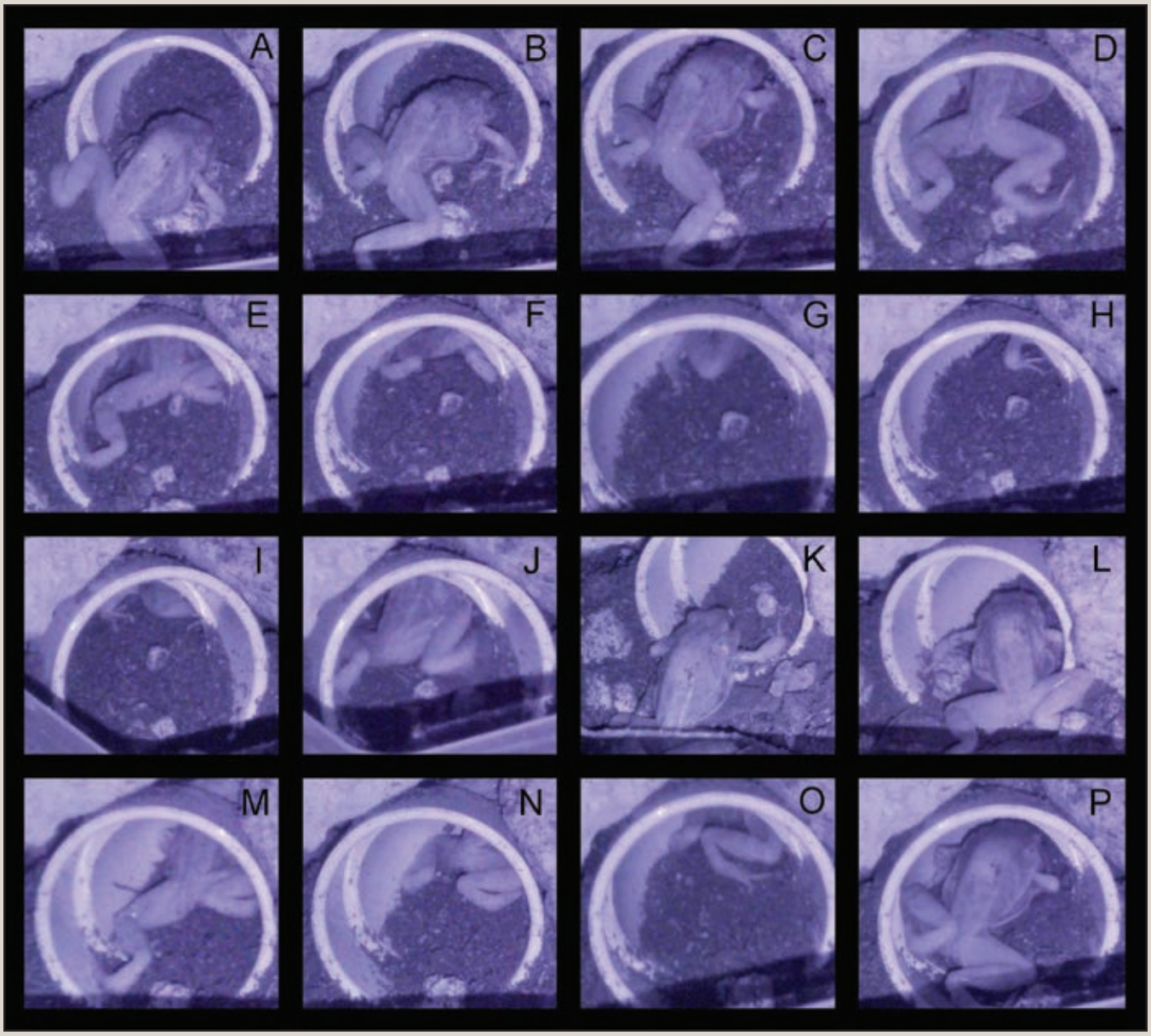


FIG. 1. Images from a video taken of a female *Craugastor augusti latrans* constructing a nest on 24 April 2013 at 2300 h.

Frogs from central Texas. All specimens were collected in Bandera, Edwards, and Real counties. We acquired these individuals by road cruising immediately following heavy spring rains, which often featured substantial hail. Frogs were subsequently maintained at the University of Texas at Arlington (UTA). All frogs were maintained in a large walk-in environmental chamber (Environmental Growth Chambers, Chagrin Falls, Ohio, USA) kept at a constant 22°C with a 12:12 h light/dark cycle. Individual frogs were maintained in plastic shoeboxes (33 cm × 19 cm × 10 cm or 38 cm × 26 cm × 14 cm) with holes drilled to allow ventilation. The typical enclosure contained a hiding area (either a rain gutter pipe or a PVC sewage pipe) and substrate consisting of a mixture of sphagnum moss and soil from central Texas. We kept the room humidity at 40%; humidity levels within individual enclosures were ca. 70%. All enclosures contained a plastic water dish (12 cm × 8 cm × 2 cm) that was changed one to three times a week. We lightly misted enclosures following each water change. All frogs were offered 2–3 adult crickets once weekly. We diagnosed sex based on vocalization (males) and visualizing eggs through the ventral surface (females).

Breeding and nest construction.—Shortly after field collection, captive males were frequently heard calling and most captive females had eggs visible through the ventral surface. Thus, we attempted to observe breeding interactions in captivity. On 4 April 2013, we placed a male (field number: JWS 692) and a female (field number: JWS 688) from Real County together in a large plastic enclosure (38 cm × 33 cm × 33 cm). Based on Jameson's (1950) description of oviposition site, we acquired substrate (soil and rocks) from near the collection locality in central Texas. On 21 April 2013 at ca. 2000 h, we noted the female moving dirt into the PVC pipe. We recorded a portion of the nest construction using an infrared "night-vision" digital video camera (Bell-Howell, DNV16HDZ). Over the course of the evening the female kicked soil into the pipe (Fig. 1; A–E, K–N) and then compressed it using her body and limbs (Fig. 1; F–I, O–P). Unfortunately, we did not directly observe oviposition,

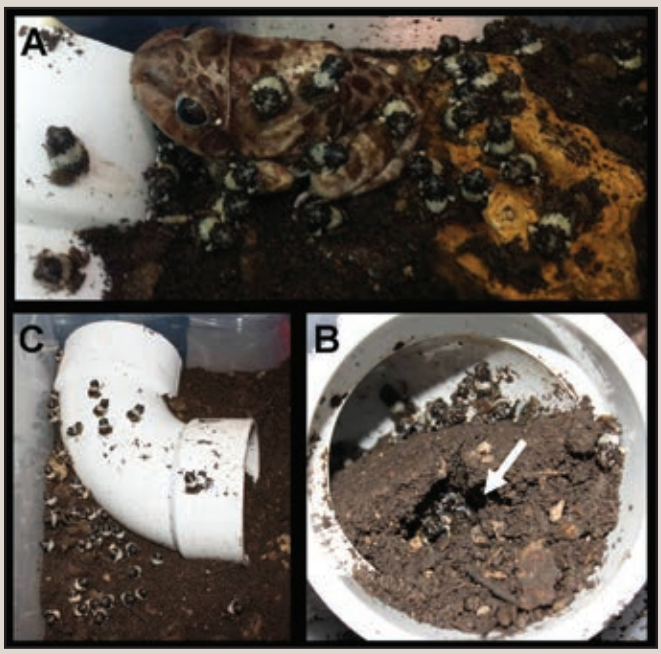


Fig. 2. (Clockwise from top): A) *Craugastor augusti latrans* froglets with female parent shortly after hatching; B) end of PVC pipe where nest cavity (indicated by a white arrow) was exposed; and C) hatchlings moving around the enclosure.

amplexus, or any other reproductive interactions prior to the nest construction.

During the construction of the nest the male remained hidden under a rock in the enclosure. The female sat continuously inside the PVC pipe on top of the nest from 21 April to 04 June (her position was checked several times a day). From 21 April to 05 May 2013, the male remained outside of the PVC pipe and we only observed him entering the pipe when in pursuit of food items. On 06 May 2013 the male was removed to ensure that he would not consume any of the offspring once they hatched, and we removed the water dish to ensure no hatchlings would drown.

Froglet emergence and maintenance.—On 04 June 2013 we discovered 119 froglets in the enclosure with the female. Careful excavation revealed a nest cavity in the back of the PVC pipe (Fig. 2B). In the cavity we found three undeveloped eggs which made the total clutch size 122. We maintained the froglets in groups of ten in large circular deli containers (ca. 20 cm × 10 cm). The deli containers contained sphagnum moss (Besgrow Sphagmoss, Christchurch, New Zealand), soil from central Texas, and an inverted plastic weigh tray as a refugium. Immediately after hatching we offered the froglets wingless fruit flies (*Drosophila melanogaster*) and pinhead crickets (*Acheta domestica*). We also periodically offered a larger flightless fruit fly species (*D. hydei*). Although hatching success was high, froglet mortality was also high and by 10 August 2013, 75% of the brood had expired. As of 15 October 2013, the remaining 30 individuals were growing rapidly and thriving. Discerning whether the high mortality rate was related to issues of husbandry or natural history will require additional trials.

Conclusions.—The large clutch size we report for *C. augusti* (N = 122) is not unexpected given the relationship between body size and clutch size that has been documented across terraranan species (Wake 1978). All hatchlings possessed a striking white dorsal band that is not observed in adults. This trait has been previously described (Stebbins 2003) and is of note because few frog species exhibit distinctive ontogenetic color pattern shifts (Kraus and Allison 2009). Although our observations of captive reproduction in *C. augusti* shed light on some issues such as parental attendance and clutch size, many questions remain including those related to the modality of parental nest attendance and the occurrence of amplectant behavior. Furthermore, *C. a. latrans* occupies some of the most extreme habitat (in terms of aridity and seasonality) experienced by *C. augusti*, so aspects of its natural history and reproduction may be outliers compared to other barking frog subspecies. Thus, future examinations of populations from across the species' range in Mexico and elsewhere in the U.S. will be necessary to elucidate whether the patterns we observed in *C. a. latrans* are broadly applicable to other barking frog lineages.

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Preliminary Experiences with the Husbandry, Captive Breeding, and Development of the Hispaniolan Yellow Tree Frog, *Osteopilus pulchrilineatus* (Amphibia: Anura: Hylidae), with Ecological and Ethological Notes from the Wild

Osteopilus pulchrilineatus (Cope 1839) is the smallest of the four species of hylid frogs in Hispaniola. Females reach 43 mm SVL with males being smaller, at 39.5 mm (Henderson and Powell 2009). This frog is easily distinguished by having a dorsal pattern consisting of three conspicuous yellow lines on different tones and shades of yellow, tan, green or chocolate-brown (Fig. 1). Lower flanks are yellow. Dorsal lines are more or less evident depending on color phase. This species has a scattered distribution throughout the island, from sea level to moderate altitude, and seems to be locally abundant. This frog was considered Endangered (EN) by the IUCN Red List, due to the increasing loss and fragmentation of habitats (IUCN 2013; Stuart et al. 2008). The species was assessed as requiring additional *in situ* conservation action during the Caribbean Amphibian Ark Conservation Needs Assessment of 2011. More recently, *O. pulchrilineatus* has been considered highly vulnerable to climate change by Foden et al. (2013). Eggs and tadpoles of *O. pulchrilineatus* remain undescribed (Henderson and Powell 2009), although it was assumed that early development occurs in still water (IUCN 2013). Vocalizations have been reported (Schwartz and Henderson 1991), but no data on temporal and spectral acoustic parameters exist.

The importance of developing husbandry protocols and captive breeding programs for endangered species of amphibians have been discussed (Gascon et al. 2007; Reid and Zippel 2008; Zippel and Mendelson 2008; Zippel et al. 2011). Captive maintenance and breeding has the dual function of providing basic information on species biology (often absent or hard to obtain in the wild) and, most importantly, to favor conservation by combining complementary *ex situ* and *in situ* actions. This is crucial for amphibians in which populations are fast declining due to loss of suitable habitats, emerging infectious diseases, the impact of introduced species, over-collection, and other threats. It is also a preventive strategy for populations that might continue to decline in the near future due to these and other causes.

Herein, we discuss the first successful experiences with husbandry and breeding of *Osteopilus pulchrilineatus* in captivity, together with some ecological and ethological information obtained from the field. The limited observations and short term of this study determine its preliminary character. However, since this species is endangered and little is known about its biology, the information provided would be useful as a baseline to encourage future efforts to establish a standard protocol for long-term *ex situ* conservation programs.

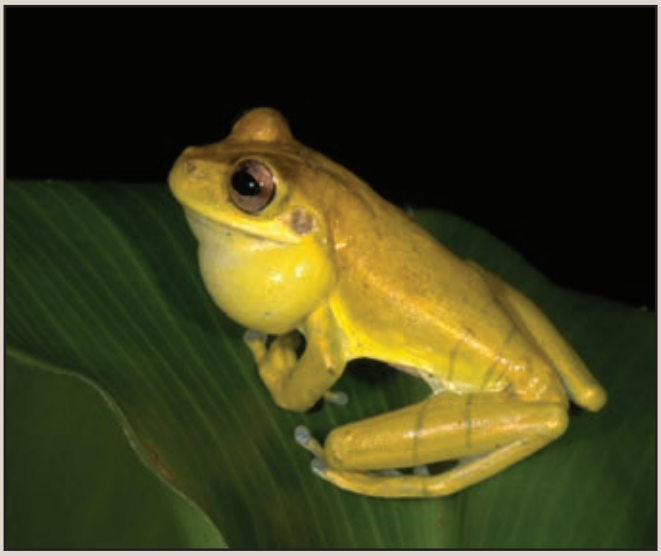


PHOTO BY LUIS M. DÍAZ

FIG. 1. Adult male calling from a leaf in the wild, at surroundings of Río La Travesía, Cordillera Central, Loma La Canela, Duarte Province, Dominican Republic.

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Terms and measurements.—Terminology related to eggs and clutch structure follow Altig and McDiarmid (2007). The Gosner (1960) system was used for larval staging. Measurements were taken with a caliper (0.5 mm accuracy) under a dissecting microscope (Swift M27LED). Frogs were weighed with an AWS® AC-100 Digital Scale (100 × 0.01g). Calls were recorded with a Marantz Professional PMD 661 digital recorder and a Sennheiser ME 66 microphone. Acoustic signals were digitized at 48 kHz and a sample size of 32 bits. Acoustic analysis was performed with the software BatSound 2.1 (Pettersson Elektronic AB © 1996–1999). Sonogram was generated with a FFT (Fast Fourier Transform) of 512 points, using Hanning windows. Temporal variables were all measured on an oscillogram, and the dominant frequency was taken as the highest peak of energy in the power spectrum.

Observations in the wild.—This section has information obtained during fieldwork in the summers of 2011 and 2012. *Osteopilus pulchrilineatus* was observed in a wide range of ecological situations. Frogs were active at night at temperatures of 24–27°C and relative humidity of 82–90%. The species was associated with six types of breeding habitats (Fig. 2): 1) permanent ponds with grassy vegetation and ferns in open grassland; 2) small ponds in forested mountain areas; 3) pools along intermittent streams in

PHOTOS BY NILS NAVARRO (A) AND LUIS M. DÍAZ (B–C)



FIG. 2. Some breeding habitats of *Osteopilus pulchrilineatus*. A) Pond about 100 m long in open grassland at the surroundings of Juana Vicenta, Samaná Province, where species is sympatric with *Osteopilus dominicensis*; B) puddle in grasslands that are often used for rice fields in Río Limpio, Reserva Natural Nalga de Maco, Elias Piña; C) forested edges of Cañada de Quilino, Reserva Natural Nalga de Maco, Elias Piña, breeding place of the four hylid frogs of Hispaniola: *Hypsiboas heilprini, Osteopilus dominicensis, O. pulchrilineatus* and *O. vastus*.

mountain forests; 4) small ephemeral pools along trails in forested areas; 5) pools and puddles in rice fields; and 6) margins of rivers and streams with gallery forests. Breeding sites were always lentic habitats of standing or slow-moving water. In some localities, the species was associated with other hylid frogs like *Osteopilus dominicensis* (lowland and highland habitats), *Hypsiboas heilprini*, and *O. vastus* (highlands). Tadpoles were found sympatrically with those of the other Hispaniolan hylid frogs at Río Limpio, Nalga de Maco Natural Preserve (Elias Piña Province).

Males generally called from small shrubs and grasses, usually less than 1.5 m high, rarely up to 3 m. Advertisement calls of ten males recorded in Loma La Canela, Cordillera Central (100 calls in total) were pulsatile in structure, having 11–19 pulses (Fig. 3) with pulse duration of 3–5 milliseconds. Pulses were narrowly spaced at the beginning of each call (8–9 milliseconds), becoming more spaced in the middle (24–62 milliseconds), and very narrowly spaced in the last 3–5 pulses (4–6 milliseconds). Call duration was 0.3–0.4 seconds. Call intervals were 0.8–1.5 seconds with a repetition rate of 47–64 calls per minute. The dominant frequency was 1.8–3.2 kHz.

Three egg clutches were observed in shallow water (Fig. 4), hidden among grasses at the edge of a forest pond, or fully exposed over beds of algae in pools along intermittent streams. Each clutch was a floating film of eggs. Clutch jelly matrix was somewhat thicker than those observed for *Osteopilus dominicensis* (pers. obs.). Tadpoles were seen swimming in all habitats, in depths that ranged from 2–60 cm. Larvae were exposed on the bottom, or hidden among grasses and algae.

Acquisition of adults and husbandry.— We began with four individuals: one male and a female were collected in the surroundings of Juana Vicenta, Samaná Province on 20 August 2011; one male was collected on 16 September 2011, at Río La Travesía, Loma La Canela, Ébano Verde Natural Preserve (Duarte Province), and an additional female was collected 9 July 2012 from Río Limpio, Nalga de Maco Natural Preserve (Elias Piña Province). After a quarantine period of two months, following general guidelines (Browne et al. 2007; Lynch 2001; Wright and Whitaker 2001), the frogs were accommodated in an all-glass silicone-glued aquarium (75 × 40 × 50 cm) that was modified as an indoor terrarium (Fig. 5). The bottom was drilled out, a bulkhead was installed, and a 19-mm-diameter plumbing system allowed for controlled drainage of the terrarium and the continuous discarding of overflowing water. A false bottom was made from a plastic light diffuser and plastic screening. It raised a basal layer of gravel (diameter ~4–5 mm) about 3 cm from the bottom glass. Half of the terrarium was a 7-cm-depth aquatic section ~17 liters in capacity, delimited from the land section by flat rocks. Water was filtered through the terrarium gravel by using a submerged water-pump (Exoterra©; model PT 2095) with a small waterfall output. The pump was placed inside a plastic chamber for easy access, and two cartridges for chemical filtration (activated carbon and zeolite) were situated in the pump inlet. The pump chamber was made from plastic mesh to allow water flow.

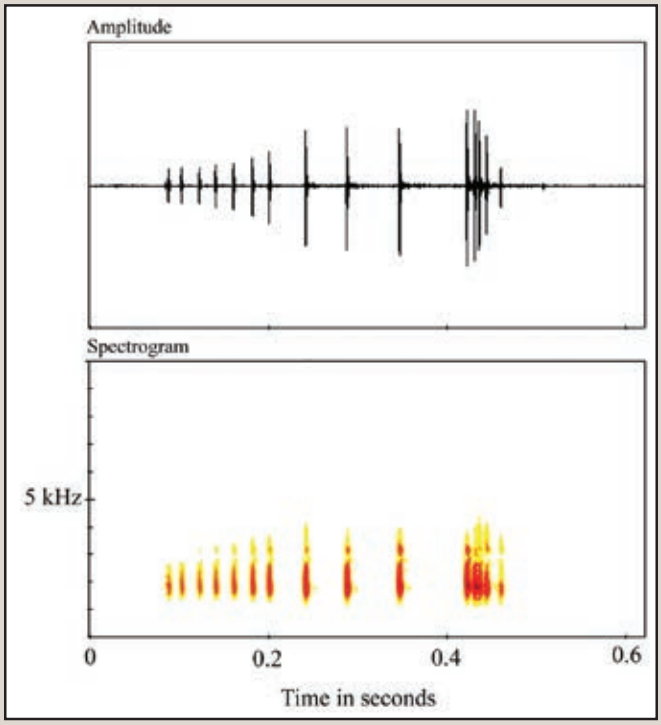


FIG. 3. Waveform and spectrogram of an advertisement call of *Osteopilus pulchrilineatus* from Loma La Canela, Cordillera Central, Duarte Province; 20 h; 15 September 2011; temperature: 25°C.



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FIG. 4. Two egg groups of *Osteopilus pulchrilineatus* photographed in the wild at two localities in the Dominican Republic. A) Embryos around Gosner Stage 16 in a water film over dead leaves in a temporary puddle in an intermittent adventitious slow stream aside Río La Travesía, Loma La Canela, Cordillera Central, Duarte Province. B) Embryos close to hatching, floating over a compact mass of algae in the slow-flowing water of a pool fed by an intermittent stream in the surroundings of Río Limpio, Reserva Natural Nalga de Maco, Elías Piña.

The water had a pH of 7.6, and 660 µS of conductivity. In the land section, the underlying gravel was thicker, covered with tree-fern fiber substrate, and planted with *Scindapsus* sp. and *Calathea* sp. The first plant species became the dominant vegetation. Ammonium, phosphates, nitrites, and nitrates were regularly monitored and kept within safe ranges (Wright and Whitaker 2001). The terrarium cover had an access window and was built from a plastic light diffuser, PVC sheets, and a plastic mesh (3.5 mm). The mesh comprised 50% of the cover, to allow the placement of lights and ventilation. Cooling fans were installed on the terrarium cover to force ventilation, and to avoid over-heating and water condensation on the glass. An artificial rain system (made from a high pressure pump: Lucky Reptile© SR-1, and two nozzles near each end of the terrarium) was activated for one minute twice each day and controlled by a digital timer (Woods© model 59377). Two lamps were used: a Nisso© plant growing fluorescent tube and an Exoterra Repti Glo© 5.0 (15 W). Both fluorescent lamps promoted healthy plant growth; however, Lindgren et al. (2005) documented the low effectiveness of the UVB emission by Exoterra Repti Glo© 5.0 tubes compared with other lamps available for herpetoculture. In March 2012 two Eiko© Halogen lamps were installed over the terrarium cover, and were switched on for two hours at 0900 h and at 1600 h. We have no information on the UVB needs of this species, but for other hylid frogs this factor was demonstrated to be important for normal growth and health (Verschooren et al. 2011). The frog room was kept at ambient temperature and humidity fluctuations. The terrarium was placed in a naturally illuminated room, and lamps were programmed by a digital timer to duplicate a natural photoperiod. A data logger (HOBO© Pro V2 Onset) was installed and programmed to gather data of relative humidity (RH) and temperature every 30 minutes for 1.2 years (Fig. 6).

Terrarium maintenance.—The water was changed twice weekly by partial to full draining of the aquatic section. Fluorescent lamps were replaced after one year. The water-pump filtering sponge was cleaned once weekly. Cartridges for chemical filtration were changed once a month. Dried plant leaves were removed and plants pruned as needed. Frog feces were regularly removed from the surface of leaves, rocks and glass, washing them with manual high-pressure water spraying. Water quality was monitored at least once weekly.

Feeding.—Basic food consisted of captive raised tropical house crickets (*Gryllodes sigillatus*) and cockroach nymphs (*Blatta orientalis*). Adult frogs were fed crickets three times a week and cockroaches only once per week. Prey insects did not exceed 1 cm in total length. Each frog ate 1–5 prey items at each feeding. Females often ate more than males. Insects were gut-loaded with a high protein and calcium food 48 h before being offered to the frogs. Prey items were dusted with Repashy Super Foods© Calcium plus ICB (Repashy Ventures, Inc.). Froglets were fed daily with pin-head crickets and once a week with tiny cockroach nymphs, all dusted with the same supplementation as the adults. Prey size and number was gradually adjusted as they grew.

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FIG. 5. Terrarium designed to house four adult individuals of *Osteopilus pulchrilineatus*.

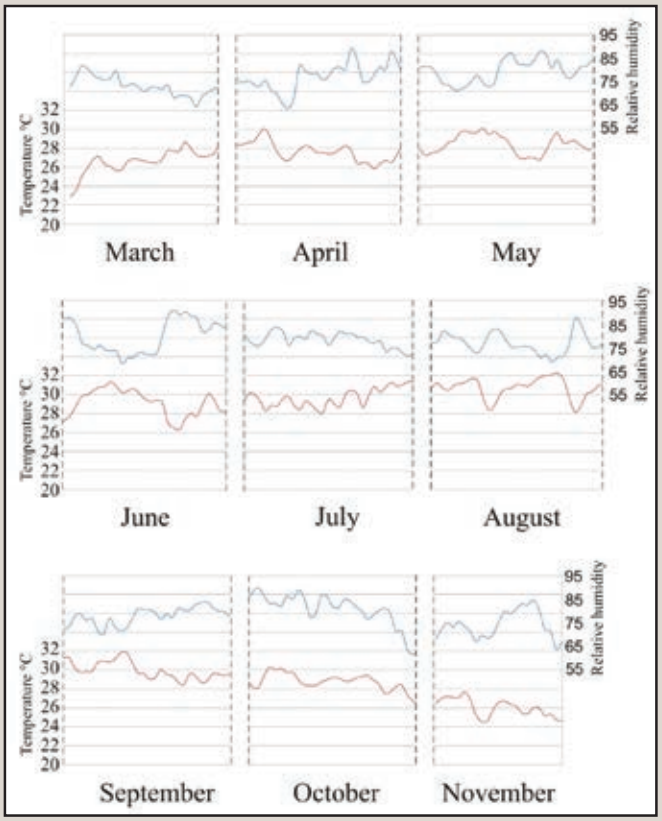


FIG. 6. Variation in temperature and relative humidity from March to November 2012.

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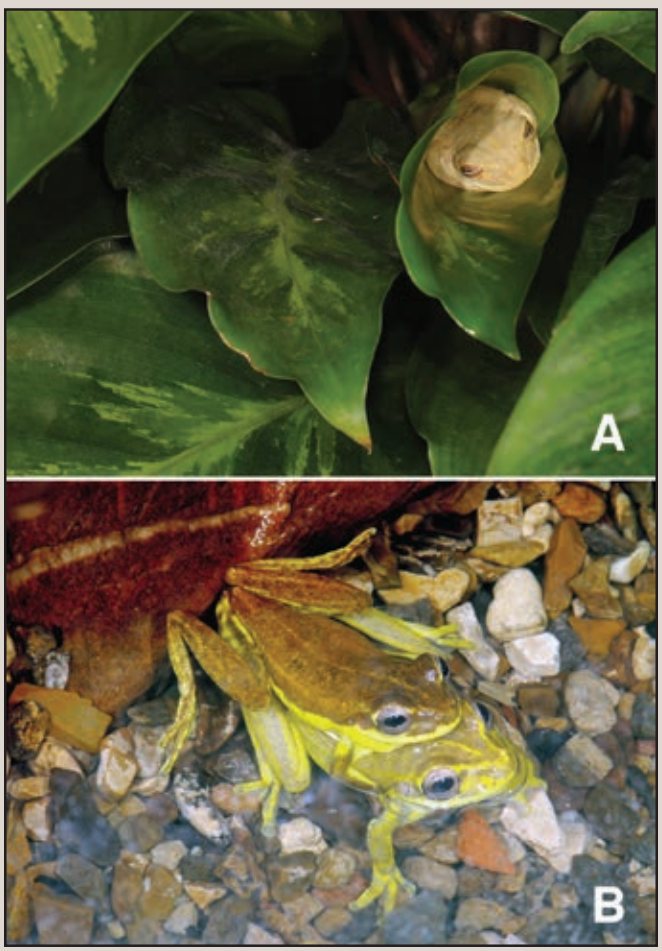


FIG. 7. Female *Osteopilus pulchrilineatus* sleeping in a rolled leaf of *Calathea* sp. (top). Amplecting pair in the water section of the terrarium (bottom).

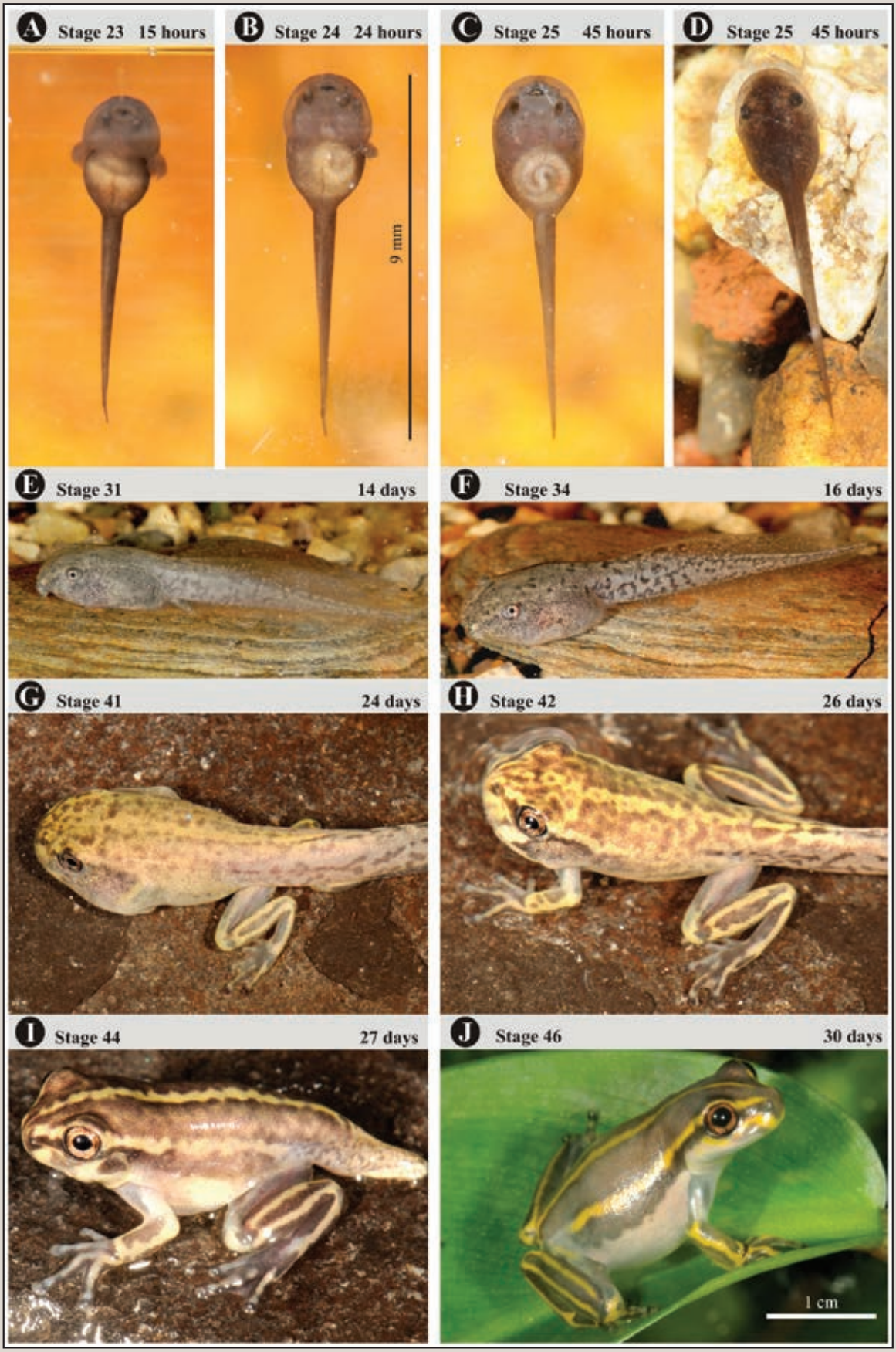
Captive behavior.—Captive specimens were nocturnal. Soon after frogs began waking up they shed and ate the outer layer of skin, moving their legs and opening their mouths to swallow the tissue. During the day, frogs rested on leaves or inside rolled leaves (Fig. 7). Very often frogs were observed sleeping during the day on the concealed side of the leaves away from direct light. Other refuges were among rocks or in pockets at the base of plants. Males called from plant leaves, rocks, or the terrarium glass, distending a single, somewhat laterally lobed, yellow vocal sac (Fig. 1). Calling males sometimes interacted by jumping toward one another, displacing each other from perches, while producing clicking calls. Amplexus occurred at night (Fig. 7). On a few occasions, amplectant pairs were observed resting during the day. Like other hylid frogs, this species was observed catching prey by jumping on them from some distance.

Captive breeding and early development.—In our experience, *Osteopilus pulchrilineatus* was an opportunistic breeder, avoiding reproduction at temperatures that were below 24°C for an extended period and the driest periods. Frogs tended to be lethargic at temperatures that were near 32°C for a long time. Females produced oocytes throughout the year. Frogs were particularly active on warm, cloudy, or rainy days, but reproduction was observed under very dissimilar conditions. They usually bred at temperatures between 25–29°C, and a relative humidity over 75–80%. A decrease in atmospheric pressure seemed to be another stimulus for this species. Oviposition was always preceded by intense vocal activity, with adult males usually changing to a vivid yellow coloration. Amplexus was axillary (Fig. 7). The first egg clutch was found on 2 May 2012, after heavy outdoor rain. Seven egg clutches were obtained from 2 May 2012 to 18 May 2013. The egg clutch laid on 2 May 2012 had 327 eggs and one obtained on 11 February 2013 had 463 eggs. The exact number of eggs from the other clutches was undetermined. Clutches usually consisted of two or three groups of eggs that were apart from each other. Each group often had approximately 100–200 eggs, or less frequently as low as 50 eggs.

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FIG. 8. Larval stages, from recently laid eggs (A) to hatchlings (N–O), in captive *Osteopilus pulchrilineatus*. Each frame specifies developmental timing. In O, AG is the adhesive gland, and AS is the adherent secretion.



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FIG. 9. Larval stages and metamorphs of *Osteopilus pulchrilineatus*. C and D are tadpoles in the same stage of development but in ventral (C) and dorsal (D) views.

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FIG. 10. Tadpole in Gosner Stage 31 with scoliosis.

At least three of the six observed clutches were laid around sunrise.

Clutches were laid on the surface of the water. At the beginning, the egg masses were somewhat compact but soon thereafter expanded as a one-egg-thick layer. Eggs were black (animal pole) and white (vegetal pole) as in other hylid frogs, and measured 1.4–1.6 mm in diameter. The eggs hatched after 25–30 h at 28–30°C. Embryonic development occurred very quickly at these temperatures but might be longer at lower temperatures. Representative embryonic stages in a chronological order are shown in Fig. 8. Hatchlings remained fixed to the vivarium glass, different objects, or even other eggs by means of a mucous secretion from the adhesive glands (Fig 8). After 15–16 h the larvae still had external gills, but 24 h later only one remained (Fig. 9A-B). After 40–48 h from hatching, larvae started swimming and searching for food (Fig. 9C–D).

Tadpoles metamorphosed in 26–40 days at 28–32°C. After 14 days from hatching, tadpoles were usually at Gosner Stages 30–31 and measured 29.3–33.6 mm (mean = 31.4 mm) in total length (Fig. 9E). After 16 days (Fig. 9F) they reached stages 33–35, measuring 33.7–38.4 mm (mean = 35.6 mm). Stages 36–37 were reached in 18 days, and the tadpoles were 36.1–40.8 mm (mean = 38.4 mm) in length. After 24 days (Fig. 9G) most tadpoles were in stages 40–41, and reached 40.0–48.4 mm (mean = 44.2 mm). The first individuals in stage 42 were usually found after 26 days. A tadpole in stage 44 is illustrated in Fig. 9H, and another in stage 45 in Fig. 9I. Two days later, recently metamorphosed frogs measured 13.6–15.1 mm (mean = 14.4 mm) snout–vent length (Fig. 9J). Tadpoles from different clutches, and even from different females, grew at a similar rate and in a quite synchronous way, but a few showed delayed metamorphosis. We estimated a tadpole survival rate of 90–95%, excepting those from the first clutch that developed scoliosis (see tadpole diseases below).

Tadpoles were reddish brown or grayish brown, with a profusion of iridocytes. The caudal muscle was somewhat lighter than the body and speckled or with a vermiculated pattern. Caudal fins had the same pattern as the caudal muscle or were immaculate. The eyes were dark brown from above; golden colored in the lateral view; the pupil was bordered by a yellow ring. Ventral coloration did not differ substantially from dorsal coloration, and was somewhat translucent or had scattered iridocites. The tadpoles raised in spartan tanks were grayish colored and exhibited more conspicuously vermiculated tails than those raised in tanks with gravel on the bottom, which were more reddish-brown in color with more speckled tails. The second condition is almost identical to that of tadpoles found in the wild. Tadpoles after Gosner Stage 36 gradually showed the yellow striping on the dorsum and hind limbs typical of the species (Fig. 9).

Tadpole husbandry, feeding and diseases.—Hatchlings were left in the aquatic section until they started swimming actively for food. At that time they were carefully siphoned and removed to separate tanks. If tadpoles were left in the aquatic section of the terrarium they ate eggs and hatchlings of new clutches. Tadpole rearing tanks were 55-liter Sterilite© plastic boxes (58.7 × 42.9 × 31.8 cm) filled with 30 L of water. Artificial lighting (programmed for 8 hours) was provided by means of Eiko® Supreme halogen lamps hung 55 cm above the water. Tanks were placed near a glass window through which they received diffuse natural light and a natural photoperiod. We kept medium densities (sensu Browne and Zippel 2007) of 5–8 tadpoles per liter. Two husbandry methods were used:

Method 1.—In the first attempt (May 2012), flat rocks were dispersed on each tank bottom to provide a natural substrate, but the tank was essentially spartan for ease of cleaning. Water was filtered by using a synthetic sponge and active carbon. Water quality was monitored every day for nitrites, nitrates, and phosphates. Water temperature ranged from 28–29°C, and pH was 7.8. Partial water changes (50%) were made twice daily, always removing debris from the tank bottom. Tadpoles were fed 3–4 times per day, with a combination of tropical marine fish flake food (Nutrafin® Max) and calcium (~1%, Tetra® Rep Cal). Artificially raised brown algae were also added. Algae remained for a longer time in the tank to allow grazing. After 12 days about 75% of surviving larvae in Gosner Stages 30–31 developed scoliosis (Fig. 9). Immediately, extra supplementation was provided (Repashy Superfoods® Calcium plus ICB). Tadpoles that started with problems became worse and were sacrificed. The remaining tadpoles metamorphosed normally after 30–40 days. A sample of 30 apparently healthy frogs was reared until they reached adult condition.

Method 2.—For all the other experiences, a gravel biological filter was installed on the bottom of tanks. Flat rocks were also added. Partial (50%) water changes were made daily. Active carbon was not used. Food was changed to a formula based on 50% Nutrafin® Basix + New Life Spectrum® color enhancing marine pellets, and 50% Spirulina powder. A homogeneous and compact mass of food was prepared, and small pieces were dispersed in the tank. Repashy Superfoods® Calcium plus ICB was added to the formula. Tadpoles were fed 3 times daily. Nitrite levels were very low, but nitrates increased after 48 h. Under these rearing conditions we do not recommend partial water changes more than two days apart. This husbandry method proved to be excellent for tadpoles; they showed a natural coloration and behavior and metamorphosed within the range of 26–40 days. No sign of scoliosis was observed.

Food consumption increased with larval growth. The turgid shape of tadpoles and activity patterns were used as indicators that they were eating enough. Tadpoles showed cannibalism on growth-retarded individuals. This behavior was observed until the second week after hatching, but greatly diminished later, when differences in size between larvae were smaller. Cannibalism has been observed to be common in tadpoles of the Cuban Tree Frog, *Osteopilus septentrionalis* (Crump 1986).

Development and sexual maturity.—The 30 metamorphosed frogs obtained from the first clutch were split into three groups of 10 frogs each in small (40 × 32.5 × 31 cm) plastic vivaria (Exoterra® Faunarium). The only furnishing was a potted *Scindapsus aureum* that served as refuge and provided perching surfaces. One corner of each terrarium was drilled to provide drainage. The vivaria were inclined to form a small aquatic section on one side. Containers received the same lighting as the adult enclosures and were cleaned three times weekly. In two months, frogs reached 22.2–30.1 mm (mean = 26.7 mm) and weighed 0.6–1.5 g. The first calling males with nuptial excrescences were observed two months post-metamorphosis, and females with evident black oocytes through the groin skin were observed after three months. This suggested reproductive maturity was reached quickly at the temperatures provided. At six months, females measured 32.7–36.2 mm (mean = 34.5 mm) snout–vent length and weighed 2.5–3.8 g (mean = 3.2 g); males 28.4– 31.0 mm (mean = 29.3 mm), and weighed 1.3–1.9 g (mean = 1.7 g). In this sample, sexual proportion was 47% females and 53% males.

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HERPETOCULTURE NOTES

ANURA — FROGS

***MIXOPHYES BALBUS* (Stuttering Frog). LARVAL DURATION.** *Mixophyes balbus* originally occurred from coastal far eastern Victoria to south-east Queensland, Australia, but is now rare or absent throughout much of its former range (Gillespie and Hines 1999. *In* A. Campbell [ed.], Environment of Australia, pp. 109–130. Canberra, Australian Capital Territory; Hunter and Gillespie 2011. National Recovery Plan for the Stuttering Frog *Mixophyes balbus*. Department of Sustainability and Environment, Melbourne, Victoria). In Victoria, it was known from only three locations and may now be locally extinct (Gillespie, unpubl.). The species is listed nationally as Vulnerable and a recent genetic study indicates that it may consist of two distinct clades (S. C. Donnellan, unpubl.; Hunter and Gillespie 2011, *op. cit.*).

Melbourne Zoo has maintained a captive population of *M. balbus* since 2001, when founder animals of the northern clade were collected from the Timbarra Plateau in northern New South Wales to provide material for developing captive reproductive techniques for the species. These frogs have since reproduced successfully on numerous occasions at the zoo (Banks et al. 2014. Herpetol. Rev. 45:43–49).

One spawning on 9 September 2004 comprised approximately 280–310 eggs laid in a "nest" (excavation in the gravel substrate) measuring 65 mm × 65 mm × 25 mm deep in a shallow riffle zone of the enclosure. Mean water temperature was 18°C (range 15–22°C). Tadpoles started to hatch 6–8 days after laying, and were provided with frozen endive and Sera© tropical fish flakes *ad libitum*. Tadpole tanks lacked hides, measured 360 mm × 410 mm × 310 mm (36 L), and had overflow pipes with grill covers to prevent tadpoles being flushed down the drain. Fresh water was supplied constantly to the tanks at approximately 2 L/h, and each tank had an aquarium air stone for oxygenation and water movement. Tadpoles were maintained in groups of 30–50 individuals. Tadpoles from this clutch started to metamorphose in early February 2005, and continued through to January 2006, i.e., 5–16 months after being laid.

One tadpole did not metamorphose during this period, and continued to be housed alone in a 33 L aquarium. Its husbandry remained unchanged, except that its diet was modified during the last few months of its larval life, when drops of Sera-Micron® (fish fry powder) mixed into a paste with water were supplied daily. This tadpole did not start to metamorphose until November 2009 and completed its transformation on 12 December 2009 after 5 years and 4 months as a tadpole. It was not measured at metamorphosis, but it was not significantly larger than tadpoles that metamorphosed earlier from this clutch of eggs.

It is common for frogs in the genus *Mixophyes* to have long larval lifespans, and Anstis (2002. Tadpoles of South-eastern Australia. New Holland Publ., Sydney. 281 pp.) noted that *M. balbus* typically begins to metamorphose after a minimum of 15 months in the wild. The tadpoles at the zoo commenced metamorphosis much sooner, and it is possible that this resulted from the ample food provided daily and the higher water temperatures than this species would experience in the wild; 18–23°C at the zoo versus 7–15°C on the Timbarra Plateau. Higher than normal temperatures during the larval period are known to accelerate metamorphosis (Harkey and Semlitsch 1988. Copeia 1988[4]:1001–1007; Sanuy et al. 2008. Anim. Biodivers. Conserv. 31[1]:41–46). The number of eggs laid was within the recorded range for this species of 132–550 eggs (Anstis 2002, *op. cit.*).

Anurans are well known for their phenotypic plasticity when undergoing metamorphosis, allowing many species to respond to changing conditions in their immediate environment. These include conspecific density in *Rana temporaria* (Loman 2004. Ecology 85[6]:1611–1618), temperature in *Bufo calamita* (Sanuy et al. 2008, *op. cit.*), and synergistic effects of conspecific density and ultraviolet UV-B radiation in *Limnodynastes peroni* (Mitchell et al. 2012. Conserv. Biol. 26[6]:1112–1120). These and other effects have been recognized in comparisons between spawnings rather than within one spawning, and hence do not explain why this individual *M. balbus* did not metamorphose at the same time as its siblings.

Although the last three years of this individual's life as a tadpole, with solitary housing, ample food, and no competition, may have contributed to its extended larval period, why it did not metamorphose with the rest of its siblings remains unclear. It is possible that the change in diet to the Sera-Micron©, with a higher vegetable content than fish flakes, played a role in finally initiating metamorphosis. Sera-Micron© has since been used as a standard supplementary food for all tadpoles in the zoo's collection.

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TESTUDINES — TURTLES

***RHINOCLEMMYS MELANOSTERNA* (Colombian Wood Turtle). LONGEVITY.** No published longevity report exists for *Rhinoclemmys melanosterna*; the record for the genus is 20 yr 5 mo for *R. pulcherrima* (Slavens and Slavens 2000; Reptiles and Amphibians in Captivity: Breeding-Longevity-Inventory. Slaveware, Seattle, Washington). On 15 December 1975, I was given a yearling (one growth annulus; maximum carapace length 107.5 mm; maximum plastron length 102 mm) *R. melanosterna* that had recently been purchased in the food market in Turbo, Antioquia, Colombia by Diderot Gicca. The turtle (a male) was maintained on a diet of trout chow and is still alive and healthy at this writing (25 September 2013), representing a minimum longevity of 37 years, 9 months. This represents the record longevity for the genus. Images of the yearling and adult are available from the author.

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SQUAMATA — SNAKES

***BOIGA IRREGULARIS* (Brown Tree Snake). CAPTIVE REPRODUCTION AND LONGEVITY.** *Boiga irregularis* is a rear-fanged, venomous colubrid native to Australia, New Guinea, the Solomon Islands, and parts of Indonesia. The biology of this species has been intensively studied due to the ecological impact that an invasive population has had on Guam (Rodda and Savidge 2007. Pac. Sci. 61:307–324). Despite this, its reproductive biology

has proven particularly elusive, with few gravid females or wild clutches observed (Savidge et al. 2007. Pac. Sci. 61:191–199). Records of captive reproduction are equally scarce, with only a few instances being recorded (Barnett 1993. Monitor: Bull. Victorian Herpetol. Soc. 5:11–14; Mathies and Miller 2003. Zoo Biol. 22:227–238). In this note, we provide new data from old records on captive reproduction, including a new maximum clutch size, the first report of double clutching and a new longevity record for this species.

On 9 October 1984 a pair of mature *B. irregularis* arrived at Taronga Zoo, Sydney, Australia, from a shipment of bananas from Tully in north Queensland. Unfortunately, there were no weights or lengths recorded for these specimens and the only subsequent mass record was on 15 February 1995, when both individuals weighed 900 g (± 50 g). The pair was housed together after their arrival at the zoo, initially in the existing reptile house until being moved to the newly built Serpentaria building on 3 April 1995.

Between 1984 and 1995, the female produced a total of eight clutches (Table 1). The first clutch of six eggs was laid 36 days after arrival, suggesting that the female was probably gravid when captured. The subsequent clutches beginning after four years in captivity were much larger, ranging from 10 to 16 eggs. The data on the lay date and clutch size for clutch 5 cannot be located, though 13 eggs from this clutch hatched on 14 February 1992. Based on incubation times for clutches 1 and 2, the estimated lay date would be mid-late November 1991. To date, the previous maximal clutch sizes recorded for this species are 12 eggs (McPhee 1979. The Observer's Book of Snakes and Lizards of Australia. Methuen of Australia, Sydney. 157 pp.), 11 eggs in Australia (Shine 1991. Copeia 1991:120–131), and 9 eggs on Guam (Savidge et al. 2007, *op. cit.*). Two of the clutches reported here exceed the largest known clutch of twelve eggs. This may possibly be related to the large mass of 900 g that the female was able to attain in captivity, as clutch size is correlated with female size in this species (Shine 1991, *op. cit.*). A previous study of 34 wild-caught female *B. irregularis* from the Wet Tropics of Queensland recorded a maximum mass of only 750 g (Trembath and Fearn 2008. Aust. J. Zool. 56:173–178).

Seven of the eight clutches were laid in November or December, indicating a regular seasonal cycle. The only exception to this was an instance of double clutching in a single activity season. In March 1992, a clutch of 11 eggs was laid four months after the previous clutch of at least 13 eggs. Although it has not been previously recorded, Savidge et al. (2007. *op. cit.*) suggested that this species may be able to produce more than one clutch per season as reproductive specimens have been recorded in all months and double clutching has been noted in its congener *B. blandingi* (Groves 1973. Int. Zoo. Yrbk. 13:106–108). This provides the first evidence of *B. irregularis* producing two clutches in a season.

Incubation was attempted on four of the eight clutches. This resulted in hatching success of 5 from 6 eggs in 1984, 9 from 12 eggs in 1988, 0 from 11 eggs in 1990 and 13 from an unknown number of eggs in 1991. Data on egg size, incubation conditions, and hatchling morphology was not available.

The female died on 7 May 1997 and the male on 16 December 2000, after 12 years 7 months and 16 years 2 months in captivity, respectively. Savidge et al. (2007, *op. cit.*) indicate that this species does not mature in the wild until 3–4 years. If they were at least 30 months of age when captured, this suggests the male and female attained the age of at least 19 and 15 years, respectively. There are no recent accurate reports on longevity in this species with the only previous published record indicating a captive lifespan of 13 years 1 month in a wild-caught specimen (Slavens and Slavens 2000. Reptiles and Amphibians in Captivity: Breeding, Longevity and Inventory. Slaveware, Seattle, Washington. 400 pp.). Thus, this note substantially increases the known longevity of this species.

Table 1. Clutches of *Boiga irregularis* laid at Taronga Zoo from a single pair of snakes. * For clutch 5, the oviposition date and clutch size are not known, though 13 snakes hatched.

Clutch	Date	Eggs laid (& hatched)
1	14 Nov 1984	6 (5 after 82 days)
2	26 Dec 1988	12 (9 after 88–92 days)
3	27 Nov 1989	12 (N/A)
4	16 Nov 1990	11 (0)
5	Nov 1991	13* (13)
6	22 Mar 1992	11 (N/A)
7	18 Nov 1992	10 (N/A)
8	5 Dec 1995	16 (N/A)

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***LAMPROPELTIS HOLBROOKI* (Speckled Kingsnake). LONGEVITY.** I purchased a male *Lampropeltis holbrooki* 23 April 1975 that was hatched at the Buffalo Zoological Gardens 17 February 1975. It died 18 August 2013, living 38 years, 6 months, and a day, far surpassing the record for this taxon of 14 years, 5 months, 22 days reported by the St. Louis Zoo, St. Louis, Missouri (Snider and Bowler 1992. Longevity of Reptiles and Amphibians in North American Collections. SSAR Herpetol. Circ. 21:1–40) and that for Colubridae of 33 years, 4 months reported by Craig Dible, Marina del Rey, California, USA (Snider and Bowler 1992, *op. cit.*). At death the snake measured an unremarkable 142 cm TL.

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***LAMPROPELTIS KNOBLOCHI* (Knobloch's Mountain Kingsnake). LONGEVITY.** An adult sexual pair of *Lampropeltis knoblochi* was obtained from a private collector 17 March 1983 (as *L. pyromelana woodini*). The female died 21 September 2008. The male died 22 June 2012 having been in my collection for 29 years, 3 months, and 5 days. Based on observed growth rates in captivity for this species, it is reasonable to assume he could have been another 3 years older. The previous longevity record for this species (as *L. p. woodini*) was 19 years and 4 days in the collection of Tom Porter (Snider and Bowler 1992. Longevity of Reptiles and Amphibians in North American Collections. SSAR Herpetol. Circ. 21:1–40). A male *L. p. pyromelana* living 22 years, 5 months, 10 days was reported by the Pittsburgh Zoo, Pittsburgh, Pennsylvania, USA (Snider and Bowler 1992, *op. cit.*).

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CONSERVATION

This section provides a platform to showcase innovative conservation projects, partnerships in achieving conservation and management objectives, and conservation success stories or lessons learned, and to bridge the gap between science and management. Subjects appropriate for this section include the following:

- *In-situ* conservation programs, particularly those involving local communities and governments
- *Ex-situ* conservation programs and success stories, or lessons learned
- Habitat protection or species appreciation and protection via ecotourism, education, and outreach
- Proactive and multi-partner efforts to improve conservation policies or actions, or to increase public awareness of conservation issues
- Point-counterpoint essays on hot topics in herpetofaunal conservation

Manuscripts, ideas, or questions for consideration should be directed to Conservation Section Editor, Priya Nanjappa (pnanjappa@fishwildlife.org). All manuscripts will undergo external peer review. For detailed instructions on manuscript preparation, please consult the SSAR web page at: http://www.ssarherps.org/pages/HRinfo.php. For authors whose native language is not English and who might require assistance with manuscript preparation, we invite you to consult SSAR's Presubmission Manuscript Review service: http://www.ssarherps.org/page/presub.php.

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Rearing the Federally Endangered Reticulated Flatwoods Salamander, *Ambystoma bishopi,* from Eggs through Metamorphosis

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The Reticulated Flatwoods Salamander (*Ambystoma bishopi*) is among North America's most imperiled salamanders. The species is federally listed as endangered (United States Fish and Wildlife Service [USFWS] 2009) and is listed as "vulnerable" by the International Union for the Conservation of Nature (IUCN). Little is known regarding the basic natural history for the species (Jones et al. 2012). An inhabitant of longleaf pine flatwoods habitat, the species once occurred in southwestern Georgia, southeastern Alabama, and across the Florida panhandle. The only remaining breeding populations that are known are located in the Florida panhandle, largely occurring on Eglin Air Force Base. The species has not been observed in Georgia since 2001 (J. Jensen, pers. comm.) and has not been seen in Alabama since 1986 (J. Godwin and S. Graham, pers. comm.). Primary factors behind the decline are habitat alteration, fragmentation, and insufficient hydroperiod in breeding sites with isolated breeding populations being at higher risk of extirpation without possibility of recolonization (USFWS 2009).

In the fall/winter of 2011–12, drought in the Florida panhandle prevented the filling of ephemeral breeding ponds used by *Ambystoma bishopi* on Eglin Air Force Base. The salamanders deposit eggs along what will be the bottom of the ponds, but typically do so before heavy seasonal rains cause the ponds to fill with water (Anderson and Williamson 1976; Hill 2013). As the ponds fill, the eggs hatch and the aquatic larvae develop, if given enough time before the ponds dry out again. Late into the breeding season of 2011–12, the ponds had not filled with water, and the eggs had remained dry through their anticipated hatch dates. A USFWS official made the call to declare the eggs as "salvage material." The declaration made the eggs available for collection in an attempt to hatch and rear the larvae. Collaborators at Virginia Tech requested the development of a protocol for rearing the federally endangered ambystomatid from the amphibian conservation

program at the Atlanta Botanical Garden (the Garden). The Garden sent one of the authors (DBF) to Florida to collect eggs and bring them back to the facilities in Atlanta. Because this species and its sister species, the Frosted Flatwoods Salamander (*Ambystoma cingulatum*) are both declining, one of our primary goals was to make our methods for collecting eggs, hatching larvae, and rearing larvae through metamorphosis readily available.

Egg collection and transport.—In early January 2012, eggs were collected from Eglin Air Force Base under the authority of the USFWS. Eggs are deposited as small groups (from 1–17 eggs have been observed), and we removed the eggs by taking a divot of earth from around each group of eggs that was roughly 5–10 cm out from the edge of the group of eggs. We then placed the excavated divot into small plastic boxes (Fig. 1). By using this approach the eggs were not physically removed from the substrate, did not change orientation and overall disturbance was minimized. The plastic boxes were then stacked inside of portable plastic coolers for transport from Florida to the Garden.

Housing eggs and larvae.—At the Garden, each divot was placed into a larger plastic shoe box. By gradually raising water levels in the plastic shoe boxes, up to a point where the water was just touching the eggs, we were able to hatch the eggs. Water used for this process had been prepared two weeks prior with peat moss pillows to lower the pH of the water from 7 to 5.8, which is near the natural pH for breeding wetlands (Palis 1996). The water had also been carbon filtered prior to pH adjustment to remove potentially harmful chemicals and metals. The eggs were maintained in a conservation greenhouse (used for cultivation of endangered plants from the southeastern United States) with natural lighting and temperature regimes. Mean air temperature ranged from 10°C to 23°C for the larval period (Fig. 2). Once larvae hatch they need to be isolated and placed into individual plastic containers to avoid conspecific aggression. Isolation reduces the risk of cannibalism and spread of disease. Plastic containers of roughly 1L in volume are sufficient. A small plastic plant pot was added to the enclosure to provide cover for the developing larvae. The containers with the developing larvae inside of them were maintained in the same greenhouse as described above.

Larval development in captivity proceeded from hatching in January until May 2012 (roughly 18 weeks), therefore the decision was made to lower the water levels on the developing salamander larvae to 1 cm total depth. It was noted that the larval period was taking longer in captivity than in the wild, where Palis (1995) documented larval development of flatwoods salamanders to last from between 11–18 weeks. Within one week of lowering the water level, three larvae (Fig. 3) started to change color and pattern. The stripes began to fade and a darker gray color replaced the brown coloration of earlier larval stages; furthermore, at metamorphosis pale white or silver spots began to develop over the dorsum of the salamanders (Fig. 4). These three individuals metamorphosed in the third week of May 2012, but one individual drowned in the process. At this point, sphagnum moss was added to the containers to provide metamorphosing salamanders additional substrate on which to exit the water. We still had roughly 15 larvae approaching metamorphosis. Metamorphosed larvae have a gray base coloration with metallic colored dots all over the dorsum. The dots range from a faint blue color to white or silver (Fig. 4). When early metamorphs have blue dots, they fade to white with time.

Feeding larvae and metamorphs.—When larvae hatched they were approximately 1–1.5 cm total length (Fig. 3). Owing to the season, there were no abundant micro-crustaceans available to Garden staff to feed the salamanders; however, we placed frozen fish foods into a blender and we introduced the slurry to larval salamanders. The specific frozen foods used were as follows: San Francisco Bay Brand, Inc. frozen bloodworms ("red dipteran larvae") and glassworms ("white dipteran larvae"), and Bio-Pure brand frozen *Daphnia* and frozen brine shrimp. Hatchling salamanders could be seen eating the viscous mixture of thawed and blended foods. Shortly thereafter, live "black worms" (*Tubifex tubifex*) were purchased from a commercial dealer. We blended and fed the results to the salamanders, which was also accepted as a food item. To diversify the diet, we also fed larval salamanders live *Daphnia magna* that were purchased from Ward's Natural Science Company and another species of *Daphnia* provided by Conservation Fisheries Inc. (Knoxville, Tennessee).

One concern about feeding salamanders following metamorphosis came from J. Mendelson (Zoo Atlanta) who previously attempted to rear several *Ambystoma cingulatum* from the larval stage. While there were no problems feeding and rearing the larvae, following metamorphosis the salamanders would not eat and ultimately died. Taking this into consideration we fed late stage larvae hatchling earthworms (*Eisenia hortensis*) as well as larger earthworms cut to approximately 1 mm pieces from worm colonies at the Garden. After metamorphosis, the same hatchling earthworms were offered as food. Introducing this food item in the larval stage ensured that a familiar food would be available and would hopefully appeal to the salamanders through their metamorphic period. *Ambystoma bishopi* are not known to go through paedomorphosis, like some other ambystomatids, so all individuals go through metamorphosis into the terrestrial life stage. To date, we have not had a problem with salamanders accepting the small earthworms post-metamorphosis. In addition, the salamanders have accepted termites (*Reticulitermes* sp.) and cultured terrestrial isopods (*Trichorhina tomentosa*).

European night crawlers (*Eisenia hortensis*) are known in the aquarium trade and at fishing bait shops as "Euro Drift Worms." They are easily cultured and are a relatively small species of night crawler. One benefit to culturing them is that every size class is available from a colony, and small amphibians can be given newly hatched worms as they are roughly 3–6 mm in total length. Culturing *E. hortensis* involves the use of Care Fresh® pet bedding (use the uncolored version). The media is widely available through the pet industry and online. The material is acceptable to Institutional Animal Care and Use Committees because it is laboratory sterile and does not contain dirt (a consideration for any university-based live animal research program dealing with fossorial amphibians). We used the version of the product that has no added dyes or colors. The material is placed into a bucket with clean, carbon filtered water. Once the paper is saturated, it is placed in a large fish net and gently squeezed to remove excess water. The damp media is then added to plastic tubs to a depth of 12–20 cm. The plastic tub must have a tightly fitting lid. Starter cultures of 50–100 worms are added to the media and maintained in cool locations with daytime temperatures no greater than 23.8°C and night time temperatures no lower than 10°C. Any commercial earthworm food can be used to feed the worms weekly as well as store brand white loaf bread. Turn the substrate over one or two times a month to free trapped pockets of gas. As the media decomposes, add new media. The culture will smell with time as gases from decomposition build up, which is normal. Drain fluids from the bottom of the culture as they develop. One advantage to using cultured earthworms as food items is



FIG. 1. Small divots of substrate were excavated around *Ambystoma bishopi* eggs to reduce physical damage by the egg collection process and were then placed into Tupperware® plastic boxes to limit movement and damage to the eggs during transportation to Atlanta Botanical Garden for rearing.

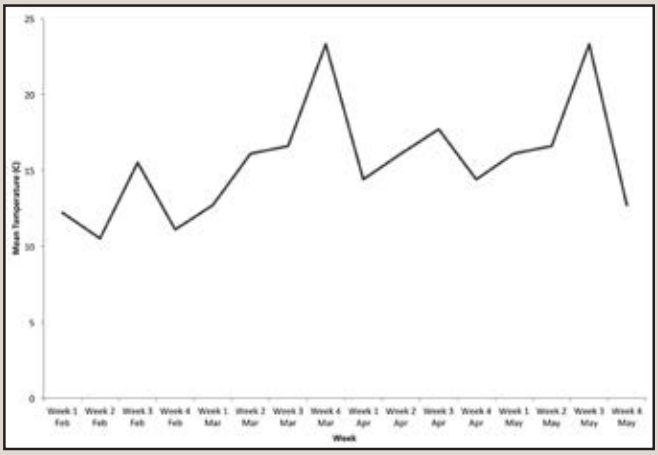


FIG. 2. Mean air temperatures in the greenhouse at the Atlanta Botanical Garden where *Ambystoma bishopi* eggs were hydrated, hatched, and reared from January–May 2012.



FIG. 3. At one hour post-hatch, larval *Ambystoma bishopi* do not have hind limbs and only have partially developed forelimbs and digits.



FIG. 4. A newly metamorphosed *Ambystoma bishopi* demonstrates the mix of larval and juvenile pattern. The body of the animal is now dominated by black and white, whereas the larvae have brown stripes on a tan base coloration; however, the stripes can still be seen in this metamorph, a character that will be lost three to four weeks post-metamorphosis.



FIG. 5. Mid- and late-stage *Ambystoma bishopi* larvae have a well-defined pattern, fully developed hind limbs, and long digits.

that they can also serve as a delivery system for additional vitamins and minerals to captive amphibians. Adult earthworms can be injected with a small gage hypodermic needle with a slurry of amphibian vitamins. We use Repashy Superfoods "Supervite" and dissolve several micrograms of the vitamins in one ounce of filtered water. The vitamin laden worms are then offered directly to the salamanders as food items.

Terrestrial "dwarf white" isopods (*Trichorhina tomentosa*) are readily available and are also relatively easy to culture. Their small size makes them ideal food items for small amphibians, particularly metamorphic animals. E. Kowalski (Philadelphia Zoo) provided the Garden with this procedure for rearing *T. tomentosa*. Ground coconut shell (available online and through the pet trade) is mixed with ground leaves at a ratio of two to one respectively. Oak, maple, ash, or fruit tree leaves are all acceptable for use. Dead leaves are collected below a tree and carefully rinsed with carbon filtered water. The leaves are dried and cut with scissors to slices roughly 4 cm in length and 1 cm in width. These sliced leaves are then thoroughly mixed into the ground coconut. The material is then misted with carbon filtered water until it clumps and is damp to the touch. Isopods can be observed actively crawling around

on the substrate and the food that is offered. One to two cups of the material is added to a plastic deli cup (0.47 L) with a ventilated lid. Isopods are fed flake fish food once or twice a week (sparingly) and a slice of potato is placed into the culture once a month. The potato slices (can use squash or carrots) will have clusters of isopods on them and they can be harvested on this or a small piece of cardboard, on which the isopods will also cluster.

Discussion.—The Reticulated Flatwoods Salamander is experiencing a range-wide decline (USFWS 2009). While localized populations do remain, a lack of dispersal ability or the need for restoration of wetlands (Gorman et al. 2009) and uplands at formerly occupied sites may prevent recolonization. Efforts are underway to restore habitat; however, these efforts take considerable time (Gorman et al. 2013). With the breeding range reduced to a relatively small area, prolonged regional drought, especially in conjunction with anthropogenic alterations of local hydrology, could cause extirpation. These issues highlight the need to develop captive rearing protocols and assurance colonies that can later be used as a source population for restored sites. We have outlined procedures to collect eggs, hatch larvae, and rear larvae through metamorphosis that can be used to develop these assurance colonies. The development of these colonies can then be used as a tool to intervene in the decline, should that measure be called for by the USFWS. Very little is known about dispersal of flatwoods salamanders (see Ashton and Ashton 2005), and a better understanding of genetic variation among local populations is needed before release of captive animals proceeds. Assurance colonies should be initiated sooner rather than later, however, while individuals can still be obtained from the wild. The development of a captive breeding protocol is the next step with our project, and we will publish our results in an effort to disseminate whatever techniques we are able to produce. The development of captive assurance colonies may provide a tool for wildlife biologists to develop methods with which to deal with potential disease and reintroduction programs.

The developmental period for the salamanders in captivity may have lasted longer than those in the wild (11–18 weeks; Palis 1995). One potential cause for the longer captive developmental period might have been a consistent water level and water temperatures. Water had been added to the containers holding the larvae throughout the developmental process to replace loss via evaporation (maintained at approximately 8 cm depth). Without decreasing water levels, larvae may not metamorphose as quickly as in drying ponds in the wild, though deep sections of natural ponds still contained larvae after metamorphs had been observed, so a longer larval stage may not be cause for concern. Furthermore, larger size at metamorphosis has been linked to higher post-metamorphic survival (Scott 1994) and reproductive fitness (Scott 1994; Semlitsch 1988) in closely related salamanders, so a longer larval stage may be desirable, assuming growth is continuing. Prior to metamorphosis, larvae were approximately 3–4 cm total length (Fig. 5).

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The Bornean Frog Race: Raising Conservation Awareness on Amphibians of Sarawak and Malaysia

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The second largest (743,380 km^2) tropical island (after New Guinea), Borneo straddles the equator between coordinates 04°S–07°N and 10–119°E (Fig. 1). Croizat (1958) described Borneo as a geological composite, and the island sits on the eastern margin of the Sunda Shelf, a Laurasian continental plate. Until three decades ago, the island comprised vast swaths of tropical forest, and a diversity of forest types and contrasting habitats, ranging from extensive lowland dipterocarp forests, significant areas of blackwater swamps, and high mountains. The seas around Borneo are generally shallow (< 200 m), contributing to faunal similarities with the faunas of Sumatra (to the west), Java (to the south), and Peninsular Malaysia (in the north), all areas lying on the Sunda Shelf. Exceptionally deep waters (> 2000 m) of the Makassar Strait, to the east of Borneo, separate that island from Sulawesi, which lies on the Sahul Shelf. Wallace's Line, demarcating the Oriental fauna from that of Australasia, is positioned across these deep-water straits

Apart from contemporary habitat conditions, past climates and land connections are linked to present diversity. During the glaciation events of the Pleistocene, sea levels in the northeast approached 140 m below present level in the Sulu Sea (Linsley 1996), while to the north, the north Sunda Shelf was -116 to -114 m (Hanebuth et al. 2000) when the Sundaland formed a gigantic landmass (Molengraaff 1921; Morley and Flenley 1987). Generalized reconstructions of the Southeast Asian archipelago during the Pleistocene have been shown by Voris (2000). Climate change coinciding with this last glacial maxima, ca. 23,000–18,000 years before present, brought in more dry, cool, as well as seasonal environments (Flenley 1997; Earl of Cranbrook 2000), and presumably permitted the movement of biota to and from Borneo (Ashton 1972; Sartono 1973).

The current climate of Borneo is characterized by high, equitable temperatures and heavy rainfall spread throughout the year. The relatively wetter periods are during the Northeast Monsoons (November to April), although the Southwest Monsoons (April to August) bring some rainfall. Daytime temperatures in most low-lying areas are 30–32°C, and humidity is typically above 70%; while in the highlands, such as the 4095 m Gunung Kinabalu, temperatures can reach freezing point at the summit. Annual precipitation is 4,000–5,000 mm. However, localized effects of geomorphological features, including mountain massifs and bays, have significant effects on weather conditions and on the local biotas within the island.

Three independent countries are situated on Borneo, their boundaries demarcated by either high mountains or large river basins, the largest being Indonesia (539,460 km^2, divided into four provinces of Kalimantan), with other significant portions being Malaysia (divided into the states of Sabah, 73,710 km^2 and Sarawak, 124,450 km^2), and the smallest entity is the Sultanate of Brunei Darussalam (5,760 km^2). Forestry practices differ within these political units, influencing the extent and quality of their natural vegetation.

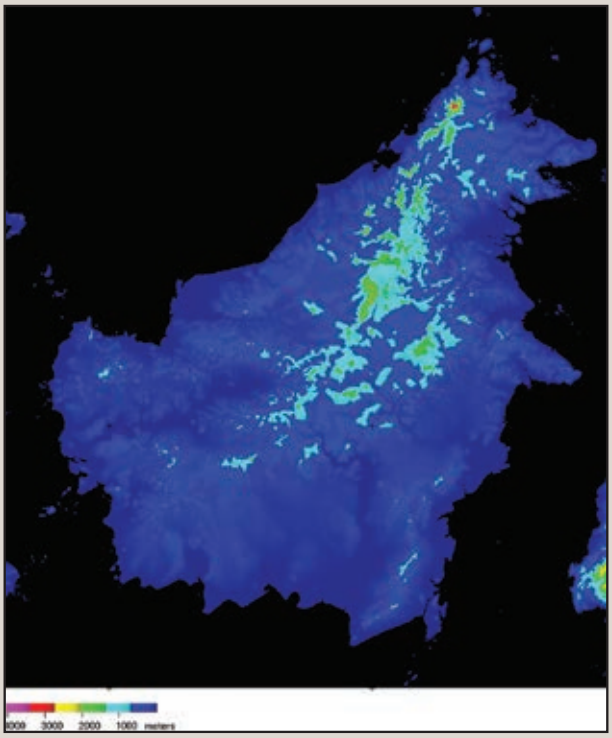


PHOTO COURTESY OF GARY GELLER, JET PROPULSION LABORATORY, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION.

FIG. 1. Digital elevation model map of Borneo.

Borneo's size, location, and geological history have contributed to the high amphibian species diversity (see Table 1). New species continue to be described annually with every significant collecting effort even in well-sampled sites, or when larger species complexes are systematically revisited, particularly using tools of molecular analyses. Amphibians, for their dual requirement of both clean water and forest cover, are surrogates of tropical biodiversity.

Studies of Borneo's amphibian fauna commenced with early European visitors, primarily the British (in northern and western Borneo) and the Dutch (in the southern parts of the island), who were often explorers and natural historians (Das 2004). The frog fauna of the island is currently accessible to a lay audience via the field guide of Inger and Stuebing (2005), now in its second edition. It draws upon the substantial research of these authors, spanning over half a century, that earlier resulted in the monographic revisionary work of Inger (1966).

Of the 178 amphibian species now known from Borneo, 130 (or 73%) are endemic to the island. An additional 43 species are distributed across Sundaland (including the Malay Peninsula, Sumatra, Java, and Bali), but not beyond, these being referred

to as Indo-Malayan elements in the fauna of the island. Among them are several whose extra-Bornean distribution is only peripheral (*Limnonectes palavanensis* and *Microhyla petrigena*). Autochthonous genera on Borneo include *Borneophrys, Leptobrachella, Meristogenys,* and *Sabahphrynus*. Other more widespread Sundan lineages show major radiations here, include *Ansonia* (12 species), *Kalophrynus* (10 species), *Leptobrachium* (six species), *Leptolalax* (seven species), *Pelophryne* (eight species), *Philautus* (19 species), and *Rhacophorus* (15 species). Several essentially Indo-Chinese elements identified on Borneo, possibly relictual from the time of land connection with the Asian mainland, include *Feihyla*, *Ingerana*, and *Odorrana*. Adding to the frog fauna are several species that are human commensals, and suspected to have arrived in the past century, mostly inadvertently with plants and other agricultural products (including *Duttaphrynus melanostictus* and *Kaloula pulchra*), and one is an escapee from frog farms (*Hoplobatrachus rugulosus*).

The most recent assessment of the world's amphibians paints a bleak picture for the Bornean amphibian fauna (see Table 2; IUCN 2013; http://www.iucnredlist.org/). A total of 27 species are classified as NE (Not Evaluated). Of those whose conservation status has been assessed, 15 are DD (Data Deficient), 54 LC (Least Concern), 40 are NT (Near Threatened), 30 are VU (Vulnerable), nine EN (Endangered), and three CR (Critically Endangered). Belonging to the most threatened categories are three species with rather restricted ranges, two of which were described only in the last decade— *Pelophryne linanitensis* and *P. murudensis* (from Sarawak) and *Leptobrachella palmata* (from Sabah). No active conservation measures have been directed thus far to assure their continued survival. Excluding those in the NE, DD, and LC categories, there are 82 threatened species, representing 46%, or nearly half the known amphibian fauna of the island. These figures are, of course, conservative estimates, as species complexes (or biological species nested within morphologically similar species complexes) exist within a number of species that are currently categorized as Least Concern (including, among others, *Limnonectes palavanensis*, *Occidozyga sumatrana, Leptobrachium abbotti*, *L. montanum*, *Megophrys nasuta*, *Chaperina fusca, Kalophrynus heterochirus, K. pleurostigma, Odorrana hosii*, *Kurixalus appendiculatus*, *Philautus petersi*, *Polypedates macrotis*, *Rhacophorus cyanopunctatus,* and *R. pardalis*). These indicate insufficiency in current knowledge of Bornean frogs, and a need for further research on a diverse series of disciplines, from taxonomy and systematics, to ecology, ethology, and distribution.

Rates of deforestation are high in Borneo (Primack and Hall 1992; Bryan et al. 2013); the major driver of deforestation is logging for hardwoods and clearing of land for oil-palm plantations and urbanization. Such landscape change has been instrumental in population fragmentation and extinctions. One recent study reported the persistence of many amphibian species, including Bornean endemics, in secondary forests, but not in plantation forests (Gillespie et al. 2012). On the Indonesian portion of Borneo, an ambitious project of settling people from densely populated islands of Java and Madura into Kalimantan (Fearnside 1997) implies clearing of more forest land for agriculture and settlement. During the dry season, many forests are prone to fire, accidentally started, or used by settlers to clear vegetation to prepare the land for agriculture (swidden cultivation). Other factors that threaten local amphibians are harvest for food and introduction of exotic species from the food or pet trade, which may, on one hand, compete with local amphibians, and on the other, introduce deadly diseases. At least one species (*Hoplobatrachus rugulosus*) is introduced on Borneo, presumably having escaped from frog farms. In the Malay Peninsula, two additional exotic species of frogs can claim residency—the American *Lithobates catesbeianus* and the Chinese *Hylarana guentheri*. The large number of exotic amphibian species offered for sale in local petshops in towns of Sarawak and Sabah (including North American, European, and African frog and salamander species) is a further cause for concern, as several (including *Ceratophrys* spp. and *Xenopus laevis*) have been linked to the deadly fungal pathogen, *Batrachochytrium dendrobatidis* (Phylum Chytridiomycota), often abbreviated as *Bd*.

The Bornean Frog Race is celebrated on the last weekend of April. Since 2012, two editions have been held. The event coincides with the annual "Save the Frogs Day" (www.savethefrogs.com/day), a global action celebrated via 270 events in over 30 countries, to highlight conservation issues facing the world's amphibians. The Race is organized by the students and staff of the Institute of Biodiversity and Environmental Conservation (IBEC) of the Universiti Malaysia Sarawak (UNIMAS). UNIMAS is a federal body within the autonomous Malaysian state of Sarawak, with one of its research areas being tropical biodiversity. This area of research is appropriate given the university's strategic location in the heart of a Southeast Asian biodiversity hotspot. The first Bornean Frog Race was held to coincide with UNIMAS's 20th anniversary, at the Permai Rainforest Resort, on the evening of 28 April 2012. The event comprised exhibitions, talks, and a race to document amphibians in Gunung Santubong National Park. No inventories of this mountain have been published before, although the massif has a long history of zoological explorations, starting with Alfred Russel Wallace (1823–1913), who collected on Santubong in 1855, and during his stay at the village in the foothills, wrote his most famous paper, entitled "On the Law Which has Regulated the Introduction of New Species." The Race was publicized through IBEC's website (http://www.ibec.unimas.my/save-the-frogs-day-2012.html), the Raffles Museum website (http://rafflesmuseum.wordpress.com/2012/04/23/the-bornean-frog-race-2012/), and through Facebook (http://www.facebook.com/TheBorneanFrogRace2012). An exhibit pertaining to amphibian diversity, comprising photographs of frogs, an exhibition of books on frogs, and a display of amphibians depicted in postage stamps of the world. A special philatelic sheet was brought out on the date, in association with Pos Malaysia, under the SetemKu program, featuring the Bornean Rainbow Toad (*Ansonia latidisca*), the subject of a natural history talk given by UNIMAS graduate student, Ong Jia Jet. This is one of the 10 "Lost Frogs" in the list by Conservation International, and considerable media publicity was received upon its rediscovery (Pui et al. 2011). A computer displayed images and played calls of frogs of the world. The Race was attended by 41 participants (many of whom were students from UNIMAS, in addition to members of the Malaysian Nature Society, and staff of the Sarawak Forest Department and Sarawak Forestry Corporation). Participants had about 120 minutes to go up a trail on Gunung Santubong and photographically document amphibians.

Three prizes were awarded for each of the following categories: a) the three best amphibian photos taken; b) the rarest amphibian found; and c) the most species found. Two extra prizes for the Judge's Special Award were given to: a) the youngest participant, and b) the most enthusiastic participant. The main prizes included natural history books, donated by Datuk Chan Chew Lun, proprietor, Natural History Publications (Borneo)

Table 1. Checklist of the amphibians of Borneo, current as of 21 October 2013, annotated with the current IUCN Red List status (IUCN 2013). Abbreviations include: NE = Not Evaluated; DD = Data Deficient; LC = Least Concern; NT = Near Threatened; VU = Vulnerable; EN = Endangered; and CR = Critically Endangered. One introduced species has been indicated with an asterisk.

ORDER ANURA
Family Bombinatoridae
Barbourula kalimantanensis Iskandar, 1978 EN

Family Bufonidae
Ansonia albomaculata Inger, 1960 NT
Ansonia echinata Inger and Stuebing, 2009 NE
Ansonia fuliginea (Mocquard, 1890) VU
Ansonia guibei Inger, 1966 EN
Ansonia hanitschi Inger, 1960 NT
Ansonia latidisca Inger, 1966 EN
Ansonia leptopus (Günther, 1872) NE
Ansonia longidigita Inger, 1960 NT
Ansonia minuta Inger, 1960 NT
Ansonia platysoma Inger, 1960 EN
Ansonia spinulifer (Mocquard, 1890) NT
Ansonia torrentis Dring, 1984 VU
Duttaphrynus melanostictus (Schneider, 1799) LC
Ingerophrynus divergens (Peters, 1871) LC
Ingerophrynus quadriporcatus (Boulenger, 1887) LC
Leptophryne borbonica (Tschudi, 1838) LC
Pedostibes everetti (Boulenger, 1896) DD
Pedostibes hosii (Boulenger, 1892) LC
Pedostibes rugosus Inger, 1958 NT
Pelophryne api Dring, 1984 EN
Pelophryne guentheri (Boulenger, 1882) VU
Pelophryne linanitensis Das, 2008 CR
Pelophryne misera (Mocquard, 1890) VU
Pelophryne murudensis Das, 2008 CR
Pelophryne rhopophilia Inger and Stuebing, 1996 VU
Pelophryne saravacensis Inger and Stuebing, 2009 NE
Pelophryne signata (Boulenger, 1895) NT
Phrynoidis aspera (Gravenhorst, 1829) LC
Phrynoidis juxtaspera (Inger, 1964) LC
Pseudobufo subasper Tschudi, 1838 LC
Sabahphrynus maculatus (Mocquard, 1890) NE

Family Ceratobatrachidae
"Ingerana" baluensis (Boulenger, 1896) LC

Family Dicroglossidae
Fejervarya cancrivora (Gravenhorst, 1829) LC
Fejervarya limnocharis (Gravenhorst, 1829) LC
**Hoplobatrachus rugulosus* (Wiegmann, 1834) LC
Ingerana rajae Islandar, Bickford and Arifin, 2011 NE
Ingerana sariba (Shelford, 1905) NE
Limnonectes asperatus (Inger, Boeadi and Taufik, 1996) NT
Limnonectes finchi (Inger, 1966) LC
Limnonectes ibanorum (Inger, 1964) NT
Limnonectes ingeri (Kiew, 1978) NT
Limnonectes kenepaiensis (Inger, 1966) DD
Limnonectes kuhlii (Tschudi, 1838) LC
Limnonectes leporinus Andersson, 1923 LC
Limnonectes malesianus (Kiew, 1984) NT
Limnonectes palavanensis (Boulenger, 1894) LC
Limnonectes paramacrodon (Inger, 1966) NT
Limnonectes rhacodus (Inger, Boeadi and Taufik, 1996) NT

Table 1. Continued.

ORDER ANURA
Occidozyga baluensis (Boulenger, 1896) NT
Occidozyga sumatrana (Peters, 1877) LC

Family Megophryidae
Borneophrys edwardinae (Inger, 1989) VU
Leptobrachella baluensis Smith, 1931 VU
Leptobrachella brevicrus Dring, 1984 VU
Leptobrachella mjobergi Smith, 1925 LC
Leptobrachella palmata Inger and Stuebing, 1992 CR
Leptobrachella parva Dring, 1984 VU
Leptobrachella serasanae Dring, 1984 VU
Leptobrachium abbotti (Cochran, 1926) LC
Leptobrachium gunungense Malkmus, 1996 VU
Leptobrachium hendricksoni Taylor, 1962 LC
Leptobrachium ingeri Hamidy, Matsui, Nishikawa, and Belabut, 2012 NE
Leptobrachium kanowitense Hamidy, Matsui, Nishikawa, and Belabut, 2012 NE
Leptobrachium montanum Fischer, 1885 LC
Leptolalax arayai Matsui, 1997 VU
Leptolalax dringi Dubois, 1987 NT
Leptolalax gracilis (Günther, 1872) NT
Leptolalax hamidi Matsui, 1997 VU
Leptolalax maurus Inger, Lakim, Biun and Yambun, 1997 NT
Leptolalax pictus Malkmus, 1992 VU
Leptolalax platycephalus Dehling, 2012 NE
Megophrys kobayashii Malkmus and Matsui, 1997 NT
Megophrys nasuta (Schlegel, 1858) LC
Xenophrys baluensis (Boulenger, 1899) NT
Xenophrys dringi (Inger, Stuebing and Tan, 1995) NT

Family Microhylidae
Calluella brooksii (Boulenger, 1904) DD
Calluella flava Kiew, 1984 DD
Calluella smithi (Barbour and Noble, 1916) DD
Chaperina fusca Mocquard, 1892 LC
Gastrophrynoides borneensis (Boulenger, 1897) VU
Kalophrynus baluensis Kiew, 1984 NT
Kalophrynus barioensis Matsui and Nishikawa, 2011 NE
Kalophrynus calciphilus Dehling, 2011 NE
Kalophrynus eok Das and Haas, 2003 DD
Kalophrynus heterochirus Boulenger, 1900 LC
Kalophrynus intermedius Inger, 1966 VU
Kalophrynus nubicola Dring, 1984 NT
Kalophrynus pleurostigma (Tschudi, 1838) LC
Kalophrynus punctatus Peters, 1871 VU
Kalophrynus subterrestris Inger, 1966 NT
Kaloula baleata (Müller in Van Oort and Müller, 1833) LC
Kaloula pulchra Gray, 1831 LC
Metaphrynella sundana (Peters, 1867) LC
Microhyla berdmorei (Blyth, 1856) LC
Microhyla borneensis Parker, 1928 LC
Microhyla maculifera Inger, 1989 VU
Microhyla malang Matsui, 2011 NE
Microhyla nepenthicola Das and Haas, 2010 NE
Microhyla perparva Inger and Frogner, 1979 NT
Microhyla petrigena Inger and Frogner, 1979 NT
Huia cavitympanum (Boulenger, 1893) LC
Hylarana baramica (Boettger, 1900) LC
Hylarana erythraea (Schlegel, 1837) LC
Hylarana glandulosa (Boulenger, 1882) LC

Table 1. Continued.

ORDER ANURA
Family Ranidae
Hylarana laterimaculata (Barbour and Noble, 1916) LC
Hylarana luctuosa (Peters, 1871) LC
Hylarana megalonesa (Inger, Stuart and Iskandar, 2009) NE
Hylarana nicobariensis (Stoliczka, 1870) LC
Hylarana picturata (Boulenger, 1920) LC
Hylarana raniceps (Peters, 1871) LC
Hylarana signata (Günther, 1872) LC
Meristogenys amoropalamus (Matsui, 1986) VU
Meristogenys dyscritus Shimada, Matsui, Yambun and Sudin, 2011 NE
Meristogenys jerboa (Günther, 1872) VU
Meristogenys kinabaluensis (Inger, 1966) NT
Meristogenys macrophthalmus (Matsui, 1986) DD
Meristogenys maryatiae Matsui, Shimada and Sudin, 2010 NE
Meristogenys orphnocnemis (Matsui, 1986) LC
Meristogenys phaeomerus (Inger and Gritis, 1983) NT
Meristogenys poecilus (Inger and Gritis, 1983) NT
Meristogenys stenocephalus Shimada, Matsui, Yambun and Sudin, 2011 NE
Meristogenys stigmachilus Shimada, Matsui, Yambun and Sudin, 2011 NE
Meristogenys whiteheadi (Boulenger, 1887) NT
Odorrana hosii (Boulenger, 1891) LC
Staurois guttatus Günther, 1858 NE
Staurois latopalmatus (Boulenger, 1887) LC
Staurois parvus Inger and Haile, 1959 DD
Staurois tuberilinguis Boulenger, 1918 NT

Family Rhacophoridae
Feihyla kajau (Dring, 1984) NT
Kurixalus appendiculatus (Günther, 1858) LC
Nyctixalus pictus (Peters, 1871) NT
Philautus acutus Dring, 1987 VU
Philautus amoenus Smith, 1931 VU
Philautus aurantium Inger, 1989 EN
Philautus bunitus Inger, Stuebing and Tan, 1995 VU
Philautus davidlabangi Matsui, 2009 DD
Philautus disgregus Inger, 1989 EN
Philautus erythrophthalmus Stuebing and Wong, 2000 VU
Philautus gunungensis Malkmus and Riede, 1996 VU
Philautus hosii (Boulenger, 1895) NT
Philautus ingeri Dring, 1987 VU
Philautus juliandringi Dehling, 2010 NE
Philautus kakipanjang Dehling & Dehling, 2013: NE
Philautus kerangae Dring, 1987 EN
Philautus macroscelis (Boulenger, 1896) NE
Philautus mjobergi Smith, 1925 NT
Philautus petersi (Boulenger, 1900) LC
Philautus refugii Inger and Stuebing, 1996 VU
Philautus saueri Malkmus and Riede, 1996 VU
Philautus tectus Dring, 1987 VU
Philautus umbra Dring, 1987 VU
Polypedates chlorophthalmus Das, 2005 DD
Polypedates colletti (Boulenger, 1890) LC
Polypedates leucomystax (Gravenhorst, 1829) LC
Polypedates macrotis (Boulenger, 1891) LC
Polypedates otilophus (Boulenger, 1893) LC
Rhacophorus angulirostris Ahl, 1927 EN
Rhacophorus baluensis Inger, 1954 NT
Rhacophorus belalongensis Dehling and Grafe, 2008 NE

Table 1. Continued.

ORDER ANURA

Rhacophorus borneensis Matsui, Shimada & Sudin, 2013 NE
Rhacophorus cyanopunctatus Manthey and Steiof, 1998 LC
Rhacophorus dulitensis Boulenger, 1892 NT
Rhacophorus fasciatus Boulenger, 1895 VU
Rhacophorus gadingensis Das and Haas, 2005 DD
Rhacophorus gauni (Inger, 1966) NT
Rhacophorus harrissoni Inger and Haile, 1959 NT
Rhacophorus nigropalmatus Boulenger, 1895 NT
Rhacophorus pardalis Günther, 1858 LC
Rhacophorus penanorum Dehling, 2008 NE
Rhacophorus rufipes Inger, 1966 NT
Theloderma asperum (Boulenger, 1886) LC
Theloderma horridum (Boulenger, 1903) LC
Theloderma licin McLeod and Ahmad, 2007 LC

ORDER GYMNOPHIONA
Family Ichthyophiidae
Ichthyophis biangularis Taylor, 1965 DD
Ichthyophis dulitensis Taylor, 1960 DD
Ichthyophis lakimi Nishikawa, Matsui, and Yambun, 2012 NE
Ichthyophis monochrous (Bleeker, 1858) DD
Ichthyophis nigroflavus (Taylor, 1960) DD
Ichthyophis pauli Nishikawa, Matsui, Sudin & Wong, 2013 NE

Table 2. Conservation status of the amphibians of Borneo, according to the IUCN Red List (IUCN 2013). Abbreviations as in Table 1.

Sl.	Category	Number	Percentage
1	NE	27	15.17
2	DD	15	8.43
3	LC	54	30.34
4	NT	40	22.47
5	VU	30	16.85
6	EN	9	5.06
7	CR	3	1.69

Sdn Bhd., based in Kota Kinabalu. Other prizes were donated by UNIMAS and organizers of the Race, including book vouchers from a leading book shop in Kuching. The event was covered by the local news media (*The Star, Kuching, Borneo Post*, and *Utusan Malaysia*), as well as magazines specializing in tourism and travel.

The second Bornean Frog Race was held on 27 April 2013, and was a larger event (Fig. 2). The venue was Kubah National Park, a part of the Matang Range, close to the city of Kuching. The range is home to nearly 60 species of amphibians (Das et al. 2007), with several undescribed. This version of the Race was organized in collaboration with the Sarawak Forestry Corporation (SFC), towards the end of the Kubah Week celebrations (a week-long education and fun event which included guided tours covering flora, fauna, and heritage walks, to collection sites of Victorian naturalists—Odoardo Beccari [1843–1920] and Wallace). The Race was attended by over a hundred participants and accompanying persons, which was the limit set by the organizers, and comprised a day-long series of events, starting with a parallel junior education program (led by Ramlah Zainuddin,



FIG. 2. Poster of the Bornean Frog Race 2013.



FIG. 4. Frogs on stamps of the world postcard.



FIG. 3. Exhibits and Frog Race 2013 volunteers.



FIG. 5. British artist Paul McNamee with a watercolor of Wallace's Flying Frog, the first prize for the participant with the greatest number of frog records.

Senior Lecturer at the Department of Zoology, UNIMAS) at the Matang Wildlife Centre, where school children from Kuching learned about frogs, tadpoles, and their respective habitats within a wider context of conservation. Talks on amphibians and an amphibian photography workshop were organized at Kubah National Park for participants. The workshop was led by natural history and outdoors photographers, Hans Hazebroek and Ch'ien Lee. An exhibit room with items related to frogs was set up (Fig. 3). These included amphibian books and scientific papers, including an extensive section on works for children, amphibian toys, stamps, coins, postcards, stickers, stationary, fridge magnets, terrarium of live frogs, etc. Special posters were prepared for the Race, one showing frogs on stamps of the world (also reproduced as a postcard; see Fig. 4), another on all the amphibians recorded from Kubah National Park and the Matang Range, the latter reproduced in an A4 format for participants to use as a field guide during the Race. A Saint John's Ambulance, along with four paramedics, were on standby for any medical emergency that might occur during such events (fortunately, their services were not required).

The main prizes—books and frog sculptures—were donated by Datuk Chan Chew Lun of Natural History Publications (Borneo), Sdn Bhd. Additional prizes were donated by Paul McNamee (a watercolor of Wallace's Flying Frog; Fig. 5) and Samuel

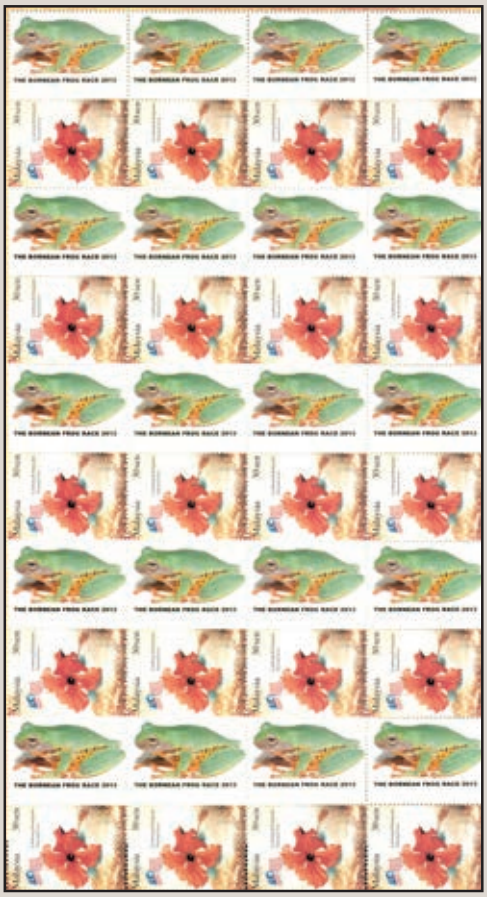


FIG. 6. A sheet of SetemKu personalized stamps for the Bornean Frog Race 2013, issued by Pos Malaysia.



FIG. 7. Participants prepare for the Race (April 2013).

Shonleben (a BBC DVD). Stephen Antang, Wildlife Warden of Kubah National Park, gave a welcoming speech to participants, and also described the Park and its trail systems. Andrew Alek Tuen, Director, IBEC, gave the keynote address, and Indraneil Das gave a brief talk on the beauty and diversity of amphibians, followed by the release of two batrachological items: the official Borneo Frog Race 2013 stamps, released under the Pos Malaysia SetemKu program (Fig. 6) and a demo version of an app for smartphones entitled "Frogs of Kubah." A perspective speech "Why I love frogs" was given by Datuk Chan Chew Lun, followed by the screening of BBC documentary from "Land Invaders" from the "Life in Cold Blood" series (with permission from Sir David Attenborough). The final briefing before dinner was on safety issues by Hans Breuer, friend of IBEC.



FIG. 8. Hans Hazebroek returning to the registration desk after completing the Race.



FIG. 9. Participants and volunteers of the Frog Race 2013 showing "Save the Frogs" poster.

Following an early dinner, served at the cafeteria of the newly opened Interpretation Centre of Kubah National Park, the rules of the Race were laid out by IBEC graduate students, Pui Yong Min and Ong Jia Jet (including time limit, safety issues, and ways to reduce impact on the native fauna and vegetation). Flag-off to the Bornean Frog Race was at 1830 h (Fig. 7), at the head of the Summit Trail. Headlamps and flashlights, as well as the occasional camera light, were seen bobbing up the trail for the next few minutes, until all participants disappeared up the trail in the direction of the Frog Pond, a 45-minute brisk walk along the Trail. Before 2100 h, when the long whistle went out to announce the end of the Race, the participants started drifting back to the registration desk (Figs. 8–9), recording their return and proceeding to one of 10 desks equipped with laptops to download their photographic entries. Thereafter, participants drifted into the lecture theatre, supper in hand, to hear the special talk of the day by Ulmar Grafe, of Universiti Brunei Darussalam (advisor to Stephen Spielberg for the film *Jurassic Park*), "Behaviour and Ecology of Amphibians on Borneo: Foot-flagging, Ultrasound Communication and Species Diversity," the subjects of his life-long research on the ecology and behavior of tropical frogs.





FIG. 10–11. Certificates for the Bornean Frog Race 2013.

Judging of photographic entries and other categories followed, and at 2330 h, the winners were announced in the three categories, as in the previous year. The certificates were in several attractive designs, created by Pui Yong Min (Figs. 10–11). Participation certificates were distributed and after concluding speeches by Andrew Alek Tuen and Oswald Braken Tissen of SFC, the Race came to an end just after midnight.

Several participants overnighted at one of the several chalets of the Park, while others returned the next morning, by 1000 h, before the arrival of Datuk Amar Abg Hj Abdul Rahman Zohari Bin Tun Datuk Abg Hj Openg, Minister of Housing and Minister of Tourism. After the welcoming address by Datu Hj Ali Yusop, Managing Director/CEO of Sarawak Forestry, Abdul Rahman Zohari presented some of the prizes, while others were distributed by the Conference Organizers (Figs. 12–13).

The Bornean Frog Race brings to the fore the great beauty and diversity of amphibians and their larval stages to the general public of Sarawak and Malaysia, as perhaps never before. At the same time, it emphasizes the need for their conservation, via the take home messages, given through talks, exhibits, films, as well as signage, such as 'The Dip', where participants were encouraged to dip their shoes into a tub of potassium permanganate, a solution for removing the deadly *Bd* chytrid fungus that is now linked to amphibian declines worldwide. Exposing the general public, particularly the urbanites of Kuching to the sights and sounds of a rainforest by night, and showcasing the diversity of amphibians and other life at one of Sarawak's less well-known national parks, in a convivial atmosphere, and providing educational material made the event appreciated by the participants. Many came with their entire families. The interest shown by participants (one of whom came all the way from India, another from the eastern Sarawak town of Miri, to take part in this half-day event) and the media is gratifying, and we hope to have a more eventful program in 2014, within Sarawak Government's Ministry of Tourism's Calendar of Events.

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FIG. 12. The winning image for the first prize for the Bornean Frog Race 2013 by Philip Chen Zhao Ching.



FIG. 13. Some of the winners of the Bornean Frog Race 2013.

behavior and ecology. For helping out with the events at the Borneo Frog Race 2013, we thank Hans Breuer, Hans Hazebroek, and Ch'ien Lee. We appreciate the generosity of Datuk Chan Chew Lun, of Natural History Publications (Borneo) Sdn Bhd, in sponsoring the prizes of books and frog sculptures. Other gifts were donated by Samuel Shonlenen and Paul McNamee, and Members of the Frog Race Organizing Committee. We are indebted to Sir David Attenborough and the BBC for permission to show an episode from 'Life in Cold Blood,' and to Plaza Merdeka for being the venue sponsor for our outreach and promotional activities in Kuching. Alexander Haas has been our collaborator on amphibian research for the past decade, and during this period, our inventory of the amphibians of the Matang Range was performed. Our thanks are due to him, and to Volkswagen Stiftung for a research grant (1/79 405).

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HERPETOLOGICAL HISTORY

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Massasaugas, Michigan, and the American Origins of Snakebite Therapy

One day in the Fall of 1886, Joseph B. Steere, a professor of zoology at the University of Michigan and curator of its museum, collected half a dozen Massasaugas (*Sistrurus catenatus*) in a corner of a large tamarack swamp just south of Ann Arbor that came to be known as "Steere's Swamp." He brought them to the university campus in a gunnysack—agitated and "rattling"—and to a dingy, cramped laboratory located beneath an amphitheater in the Medical Building (Fig. 1). Waiting for him was Henry Sewall (Fig. 2), professor of physiology, and his student assistant, Frederick Novy. As Novy later recorded about that small room, "you wouldn't use it for a dog house." Steere entered the lab and released the rattlesnakes onto the floor. Sewall soon began a series of simple but elegant experiments with some of these snakes. These tests required just six months to complete and resulted in an 8-page paper that was to provide the immunological foundation on which snakebite antiserums were produced by others. The methodological procedures that Sewall pioneered have also been used to create the diphtheria antitoxin, an event that resulted in Nobel Prizes for its two discoverers. Yet despite the importance of Sewall's fundamental contribution to snakebite therapy, he received little public attention for it at the time and even today his seminal work is underappreciated.

Henry Sewall (1855–1936)

Sewall was born the son of a Methodist minister in Winchester, Virginia, and educated at Wesleyan University (B.S. 1876) and Johns Hopkins University (Ph.D. 1879), but this resumé does not hint at his very special training in physiology. (For Sewall's biography, see Webb and Powell 1946; also Sabin 1937.) Sewall's Ph.D. was the first one awarded in physiology in the United States. His supervisor, H. Newell Martin (Fig. 3), one of the world's leading physiologists, had been trained in London primarily by Michael Foster, England's leading teacher of practical, that is, experimental, physiology and an associate of, and successor to, Thomas Huxley as professor at the Royal Institution (Hawgood 2008). Indeed, Martin had once been a pupil of Huxley's. After earning his doctor's degree in Baltimore, Sewall went to Europe for a year of additional training in physiology with Willy Kühne in Heidelberg, Carl Ludwig in Leipzig, and with Foster himself, by this time at Cambridge. Ludwig was then regarded as the greatest teacher of physiology in the world. On his return to the USA in 1880, Sewall joined the biology staff at Johns Hopkins. In 1882, he was appointed professor of physiology at Michigan where he conducted his classic work on the action of the nerves of the mammalian heart. Early in 1885, Sewall developed symptoms of tuberculosis, a disease that had plagued his family for generations. Perhaps stimulated by his own affliction but possibly also by the then-recent discoveries in France by Louis Pasteur of immunizations to anthrax and rabies, he turned his attention to immunology and to the rattlesnake as a possible model for the development of antitoxins in general.

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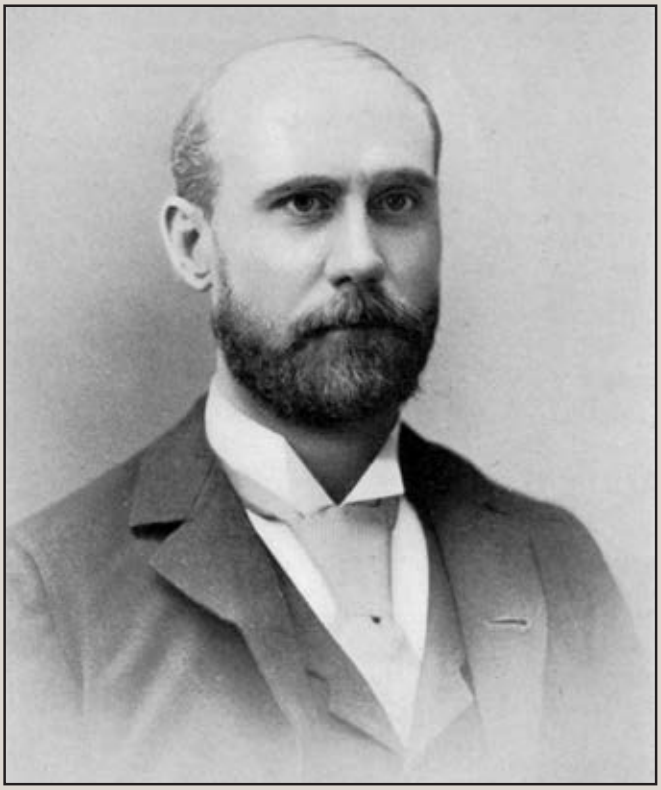
Details of the Experiments

Sewall and Novy needed to obtain some venom, which they accomplished by restraining individual snakes by the neck with a loop fixed at the end of a stick. The snakes were then forced to deposit venom at the edge of a porcelain plate. On at least one occasion, a snake broke loose from the loop, which sent Sewall and Novy scampering up onto the lab furniture for a while until they could decide how to recapture it. They were eventually able to obtain a total of six small drops of venom from three snakes. It is astonishing to recall that all of Sewall's classic experiments with snakes were conducted with such a small amount of original material. They diluted the six drops of venom with 88 drops of glycerine, and various amounts of this mixture were further diluted with distilled water and then injected subcutaneously into pigeons. On November 4, 1886 they began to carefully determine the minimal fatal dose of venom, which was to become the all-important standard for all subsequent tests. After injection, the initial symptom was a weakness in a bird's legs, causing it to sit down or "to move with a tottering gait." If the dose was fatal, the paralysis extended from the legs to the wings and led to general convulsions just before death. Death would occur as soon as three or as late as 20 hours after injection.



SOURCE: BENTLEY HISTORICAL LIBRARY, UNIVERSITY OF MICHIGAN (PHOTO BL005920).

FIG. 1. The Medical Building, in which Henry Sewall conducted his experiments on snake venom antitoxins. The Sewall laboratory was located on the first or second floor of the west wing (the four-story addition on the right), and immediately beneath a two-story amphitheater with tiered seating, which created the sloped ceiling in his rooms. This photograph was taken between 1864 and 1868; the entire building was razed in 1914.



SOURCE: FROM WEBB AND POWELL (1946)

FIG. 2. Henry Sewall at the time he performed his experiments with massasaugas in 1886–1887.



SOURCE: FROM WEBB AND POWELL (1946).

FIG. 3. Johns Hopkins University biological staff in 1880. Henry Sewall is standing, second from right; his mentor, H. Newell Martin, is seated at center. The staff included two specialists on the reproduction and embryology of reptiles: Samuel F. Clarke (alligators) and Kakichi Mitsukuri (turtles), standing at center and seated at left, respectively.



SOURCE: PHOTO BY THOMAS BEAUVAIS, 2013.

FIG. 4. Plaque at the University of Michigan Medical School commemorating Sewall's discoveries on snake venom antitoxins.

The general scheme of the experiments was to inject a glycerine-venom mixture that was dilute enough so that the bird survived, but then to gradually increase the concentration of the mixture injected into the same bird at intervals until it was able to withstand higher and higher concentrations because the bird had developed immunity to the venom. By December 3rd, when the fatal dose of glycerine-venom was 2/3rds of a drop in control birds, they injected as much as 4-1/2 drops, or *about seven times the fatal dose*, into previously inoculated birds without observing any deleterious effects. Later, Sewall and Novy discovered that the resistance to the venom subsided if the birds were not freshly inoculated. One bird, for example, which had shown no effects when 4-1/2 drops were injected on December 3rd, was "… perceptibly weakened by the inoculation on Jan. 6 [1887] of 3 drops of glycerine-venom." The persistence of resistance was shown in another inoculated bird that was injected with "more than 1" drop (i.e., ordinarily a fatal dose) on May 6th. It showed some "weakness" after 24 hours, but ten days later showed no lingering effects at all. All experiments ended on May 19, 1887.

Publication of Results and Responses to Sewall's Paper

Sewall's paper was published in Cambridge, England, in volume 8 (for 1887) of *The Journal of Physiology*, then the leading international journal of its kind. Despite our understanding today of the significance of Sewall's work, there were very few citations to his paper in the literature. However, Albert Calmette, a disciple of Pasteur and the first person to develop snake antiserums,

acknowledged in his book on the venoms of venomous animals and their antivenom serum therapies the primacy of Sewall's discovery (Calmette 1907, p. 253; English edition, 1908, p. 241). (For modern reviews of Calmette's classic work on the development of antitoxic horse serums for use in persons bitten by cobras, see Hawgood 1999, and Adler 2007.) Calmette had followed the techniques he had used in the preparation of diphtheria antitoxins a few years earlier, principles that were in fact pioneered by Sewall.

Calmette's indebtedness to Sewall was formally recognized when he led a delegation of French scientists to the University of Michigan in the early Fall of 1908 to see where Sewall had conducted his experiments with rattlesnakes. Despite the scorching heat that day, the visitors wore formal attire—cutaway coats and silk hats—and carried canes. Novy, Sewall's former assistant, led them to what was by then called the "Old" Medical Building and was able to show them the location of their former laboratory. Sewall, however, was not present because in 1888 he had moved to Colorado where the climate helped to alleviate his tuberculosis. He soon accepted a post at the University of Denver and, by examination, earned his M.D. degree there the next year. He practiced medicine locally and during 1911–1918 was a faculty member at the University of Colorado Medical School. Sewall did, however, return Calmette's favor by visiting him in his lab at the Pasteur Institute in France in 1909. The Old Medical Building suffered an extensive fire in 1911 and was razed in 1914; the site today is occupied by a physics building.

Recognition of Sewall's Classic Studies

Immunizations against disease-causing bacteria and viruses had been known since antiquity. Inoculation for smallpox virus was practiced in India since about 1000 BCE and was well known in China by the late 10th century. In 1796 the British physician, Edward Jenner, was the first to produce a safe method of inoculation for smallpox, by using that virus's close but harmless genetic relative, cowpox. Diphtheria, on the other hand, is caused by an exotoxin, a single polypeptide chain produced by a viral gene inside a bacterial host. In 1890, two German biologists, Emil Adolf von Behring and Paul Ehrlich, announced a method for developing an antiserum against diphtheria; their joint work resulted in Nobel Prizes in 1901 and 1908, respectively. It was Sewall, however, who in 1887 had first demonstrated the principle that immunity can be developed to a chemical molecule, a toxin, by using the complex molecules in snake venom as the stimulus for the immune reaction.

Sewall received many awards for his research including honorary M.D. and Sc.D. degrees in 1888 and 1912, respectively, both from Michigan and a Sc.D. from his *alma mater*, Wesleyan, in 1926. In 1933, a plaque commemorating Sewall's discoveries on rattlesnake antitoxins was erected on a wall in the medical school at Michigan and was dedicated the next year. Today, this plaque is located on the seventh floor of the Medical Sciences II building (Fig. 4). In 1930, Sewall was awarded the Trudeau Medal of the National Tuberculosis Association and the following year, the George Kober Medal of the Association of American Physicians. Thus, Sewall's classic studies, including the first production of antitoxins to snake venoms, were eventually recognized and during his lifetime. He died in Denver of a heart attack in 1936, at the age of 81.

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The Herpetological Contributions of William Beebe: Naturalist, Explorer, and Father of Neotropical Ecology

Few metropolitan regions of the world have produced as rich a legacy of zoo herpetologists as New York City. Together with academic institutions such as the American Museum of Natural History and the city's numerous colleges and universities, zoological parks in New York have played a key role in shaping North American herpetology. Many celebrated herpetologists of the 20th century began their careers with, or became employed mid-career by at least one of New York's six zoological parks, although none of these institutions have supported as a great a lineage of productive herpetologists as the Bronx Zoo (Adler 1989; Brazaitis and Abene 2008; Card and Murphy 2000; Murphy 2007).

For more than a century, reptile curators at the Bronx Zoo (formerly the New York Zoological Park) have made significant

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contributions to the study of reptiles and amphibians through a variety of research activities and publications (see Murphy 2007). Unfortunately, their works have often overshadowed significant contributions made concurrently by staff members of the zoo's parent organization, the New York Zoological Society (now the Wildlife Conservation Society). For example, Charles Haskins Townsend published several important articles on reptiles, particularly Galapagos tortoises, during his tenure as the director of the New York Aquarium between 1902 and 1937, and had several species of reptiles named in his honor (see Grant 1947). William Beebe, the New York Zoological Park's original bird curator and founding director of the society's Department of Tropical Research, was also responsible for many important contributions to herpetology. As colleagues of Raymond Ditmars, the zoological park's original, and perhaps most celebrated reptile curator, Townsend's and Beebe's important work with reptiles and amphibians is often overlooked in part due to Ditmars' many publications and widespread popularity as the chief herpetologist of the society during its early history (e.g., Adler 1989; Murphy 2007; Wood 1962).

Although not a strict herpetologist given his background in ornithology and broad interests in ecology and natural history, William Beebe's important contributions to the study of reptiles and amphibians rivaled those of many professional herpetologists of the period. Yet surprisingly, despite authoring numerous articles and book chapters on the ecology and behavior of reptiles and amphibians and collecting thousands of herpetological voucher specimens, Beebe has seldom been recognized in works on herpetological history (e.g., Murphy 2007, 2008). This is not to say, however, that his name is unfamiliar among herpetologists, as Beebe is perhaps best known as one of America's greatest naturalists and explorers, and for his pioneering work in the fields of ecology, marine biology, and wildlife conservation (Gould 2004; Welker 1975). Here, I highlight the impressive career and herpetological contributions of William Beebe, the father of neotropical ecology. Readers interested in more detailed accounts of his life, travels, and career should refer to the important works of several biographers and historians (Berra 1977; Bridges 1974; Gould 2004; Welker 1975).

Life and Career

Charles William Beebe was born in Brooklyn, New York in 1877. Growing up in rural New Jersey, he developed a strong interest in natural history, and amassed an impressive personal collection of zoological specimens, especially birds (Welker 1975). At Columbia University, he studied within the Department of Zoology from 1896 to 1898, but left before graduating for a position with the newly formed New York Zoological Society (NYZS) (Welker 1975). Although he would eventually receive honorary doctorates from both Colgate University (LL.D) and Tufts College (Sc.D) in 1928 (Berra 1977; Crandall 1964) and was identified as "Dr." in many of his later written works and by peers, Beebe never officially completed a baccalaureate degree. Nevertheless, the lack of a traditional academic background would not hinder his career or literary success, or the scope and magnitude of his scientific achievements.

Beebe was hired by the NYZS in 1899 as the assistant curator of ornithology at its newly established zoological park in the Bronx. During his first few years with the society, he assembled a sizeable collection of live birds and oversaw the design and construction of several new buildings and aviaries, and in 1902 was promoted to curator of birds (Bridges 1974). In 1903, Beebe departed on the first of more than 50 scientific expeditions that he would lead during his career with the NYZS, a self-funded trip to Mexico with his wife to study, identify, and collect birds for the zoological park (Beebe 1905a). This trip was followed by collecting trips to Trinidad, Venezuela, and British Guiana (now Guyana) in the following years (Beebe and Beebe 1910), and in late 1909, he embarked on an extensive year-and-a-half-long expedition to the Far East to study pheasants, which eventually culminated in his monumental and perhaps most celebrated publication, "*A Monograph of the Pheasants*" (Beebe 1918–1922).

Beyond his curatorial duties at the zoological park and his increasing research and collecting activities in the field, Beebe was also interested in paleontology, particularly the ancestry of birds and the evolution of flight (e.g., Beebe 1938a, 1942a). In 1915, he authored a theoretical paper that predicted the existence of an intermediate four-winged, or "Tetrapteryx" stage in the evolution of flighted dinosaurs (Beebe 1915) that preceded *Archaeopteryx*. His ideas were largely dismissed or forgotten for 85 years until the discovery of *Microraptor* (Xu et al. 2000), a small, four-winged therapod whose features nearly mirror those of his original "Tetrapteryx" illustration (Beebe 1915). Since 2000, several species of *Microraptor* have been discovered (e.g., Gong et al. 2012; Xu et al. 2003), and his original idea of avian flight evolving from a four-winged ancestor continues to gain support as additional fossil material is located (e.g., Zheng et al. 2013).

In 1915, he traveled to Brazil to arrange a shipment of birds for the zoological park in New York, and it was during this trip that his research interests began to change (Welker 1975). Stopping to investigate and inventory the organisms found around a large jungle tree (Beebe 1916a,b,c), this study marked a departure from his widespread ornithological collecting to more refined and intimate investigations on the ecology of tropical forest ecosystems (e.g., Beebe 1925b).

> "*Again and again we have proved the value of limited, concentrated investigations over wider-ranging, thinner exploration.*"
>
> —William Beebe, High Jungle, 1949:187

With assistance and support from former US President Theodore Roosevelt, a close friend and founding chairman of the NYZS, Beebe established Kalacoon, an ecological research station located in northeastern Guyana in 1916 (Beebe 1919; Beebe et al. 1917; Gould 2004). Impressed by his research and collecting activities abroad, the NYZS founded the Department of Tropical Research in 1916 and appointed Beebe as its directing curator (Welker 1975). This appointment officially relieved him of all curatorial duties at the zoological park and enabled him to focus chiefly on his fieldwork and writings (Bridges 1974). Over the next four decades, he led numerous expeditions with the department to poorly surveyed terrestrial and marine environments of the neotropics and established field stations at various locations in South America (Beebe 1925b, 1949a,b, 1952; Beebe and Crane 1947). Staffed by naturalists, hunters, artists, and taxidermists, the Department of Tropical Research under Beebe's direction procured tens of thousands of zoological voucher specimens, photographs, artwork, and film footage depicting wildlife encountered through its expeditions. Hundreds of scholarly articles, notes, and reports were produced by the department, and covered a broad range of topics including, but not limited to, taxonomy, ecology, ethology, and marine biology.

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FIG. 1. William Beebe in collecting mode, Guyana, 1917.

Returning to Guyana in 1919, the department established Kartabo, a field research station located just upriver from the former site of Kalacoon (Welker 1975). There, over several seasons, Beebe and his staff intensively studied the ecology of a small tract of jungle roughly 65 ha in size (e.g., Beebe 1925b).

Aside from his interests in tropical forest ecology, Beebe had long been fascinated by marine environments and even experimented with underwater diving equipment (e.g., Beebe 1926, 1934) more than a decade before famed oceanographer Jacques Cousteau. During the late 1920s and throughout the 1930s, Beebe focused the Department of Tropical Research's expeditions heavily on oceanographic exploration. These included expeditions to survey and study the marine life of the Galapagos Islands (Beebe 1926), Haiti (Beebe 1928), Bermuda (Beebe 1932), and the Gulf of California (Beebe 1938b), as well as Beebe's unprecedented and record-setting half-mile (ca. 805 m) descent inside a steel bathysphere in 1934 (Beebe 1934). At this depth in waters off of Bermuda, he became the first biologist to observe deep sea life in situ, including bioluminescent organisms and many species unknown to science (Beebe 1934).

In 1941, Beebe and his department returned to studying terrestrial ecosystems, carrying out ecological investigations in Caripito, Venezuela (Gould 2004), and then later establishing Rancho Grande, a field station headquartered inside the former jungle palace of Venezuelan dictator Juan Vicente Gómez, in 1945. There, the department studied the ecology of the surrounding cloud forest over a period of three years (Beebe 1949a). In 1949, Beebe purchased Simla, an estate located in the Arima Valley of Trinidad's Northern Range, which he established as a tropical research station and later gifted to the NYZS (Gould 2004).

Beebe officially retired in 1952 as Director Emeritus of the Department of Tropical Research after more than 50 years of service with the NYZS, but remained active in field research up until his death in Trinidad in 1962 (Bridges 1974; Gould 2004; Welker 1975).

Publications History

"No American naturalist of recent times has given us so copious and detailed a record of his work, his travels, the challenges he faced and his response to them. These books were not merely of scientific reportage, but of scientific adventure; more important, they were creative works, informed by an intelligence of extraordinary range and a style and consciousness highly literary."

—Robert H. Welker, Natural Man: The Life of William Beebe, 1975:xii

Beebe was a gifted and prolific writer, authoring 24 books and more than 800 articles, reviews, and reports over the span of his career (Berra 1977). Many of his technical works, which numbered in the hundreds (Crandall 1964), were published in *Zoologica*, the official research journal of the NYZS which was initially founded in 1907 as a publishing outlet for Beebe's research (Bridges 1974), and included taxonomic treatises (including the descriptions of some 87 species of fishes and one bird) as well as studies on the ecology and behavior of birds, mammals, amphibians, reptiles, fishes, and arthropods (Berra 1977). Many additional biological accounts and notes on the husbandry of birds at the zoological park were published in the *Bulletin of the New York Zoological Society*, which became *Animal Kingdom* in 1942.

Most of Beebe's books and popular articles shared extensive details of his travels and experiences abroad, gaining him widespread popularity and celebrity status, to the extent where his personal affairs became fodder for headlines in major US newspapers (Gould 2004; Welker 1975). He regularly contributed to several high profile magazines including *Atlantic Monthly*, *Harpers*, and *Ladies Home Journal*, among others, where he popularized science, natural history, and exploration. Many of these works were later republished as chapters in his books.

Herpetological Contributions

The vast majority of William Beebe's herpetological contributions stem from his field investigations and collecting activities in Guyana, Venezuela, Trinidad, and the Galapagos Islands, although some additional accounts briefly described the natural history, occurrence, or behavior of herpetofauna encountered during trips to Asia (Beebe 1927), the Caribbean (Beebe 1918), Mexico (Beebe 1905a,b 1938b), and Central America (Beebe 1942b).

Collections.—As depicted by the iconic 1917 photograph taken of him in Guyana with butterfly net and rifle in hand (Fig. 1), Beebe was a prolific collector of zoological specimens, and made no exceptions for reptiles and amphibians. Inventories of herpetofauna collected by Beebe and his staff during expeditions to South America are vast, and appear in several publications (e.g., Beebe 1919a, 1925b, 1944a,b, 1945, 1946a, 1952). Because his knowledge of reptile and amphibian taxonomy was limited, he frequently sought assistance from G. K. Noble and Charles Bogert at the American Museum of Natural History (AMNH), and

Karl Schmidt at the Field Museum of Natural History, in identifying specimens collected in South America (e.g., Beebe 1944a,b, 1945, 1946a; Myers 2000). Despite tensions arising between Beebe and AMNH staff over the identification of some of his herpetological specimens, most of his collections were eventually gifted to the museum's herpetology department (Myers 2000). In fact, Myers (2000) noted that Beebe's 50-plus years of collections with the NYZS represent the best example of material deposited in the museum's herpetology section by non-AMNH led expeditions. Major collections from Beebe deposited in the AMNH include those from Guyana (>1100 specimens), Venezuela (700 specimens), and Trinidad (>150 specimens) (Myers 2000). Additional voucher material was deposited in several other American museums and institutions abroad including the Georgetown Museum in Guyana (e.g., Beebe 1945). At least ten holotypes were collected by Beebe (Table 1).

In recognition of his contributions, at least five species of herpetofauna have been named after Beebe, although most now represent junior synonyms (Table 2). *Plasmodium beebei*, a protozoal lizard parasite of the gekkonid genus *Gonatodes,* was also named in his honor (Telford 1978).

Besides voucher material, Beebe also collected many specimens that were delivered alive to the New York Zoological Park for display in its reptile house. Noteworthy specimens included *Amblyrhynchus cristatus*, *Conolophus subcristatus*, and *Tropidurus* spp. (now *Microlophus*) from the Galapagos Islands (Beebe 1923a, 1924), and *Platemys platycephala*, *Chelus fimbriatus*, *Testudo tabulata* (now *Chelonoidis denticulata*), *Caiman sclerops* (now *C. crocodilus*), *Polychrus marmoratus, Boa constrictor* (including a 3.8-m long individual), *Bothrops atrox*, *Chironius carinatus, Corallus cooki, Crotalus durissus, Eunectes murinus*, *Helicops angulata* (now *H. angulatus*), *Lachesis muta, Pseustes sulphureus*, *Siphlophis cervinus*, *Spilotes pullatus*, and *Gastrotheca ovifera* from Guyana and Venezuela (Beebe 1918a, 1923c, 1925b, 1946a, 1949a; Beebe and Beebe 1910). From Southeast Asia, he collected and sent back live specimens of gliding reptiles including *Draco volans*, *Ptychozoon* sp., and *Chrysopelea ornata* (Gould 2004).

Field investigations:

Anurans

> *"The humble polliwog in its development is significant of far more marvelous facts than the caterpillar changing into the butterfly, embodying as it does the deepest poetry and romance of evolution."*
>
> —William Beebe, The Log of the Sun, 1906:112

Beebe showed a particular fondness for frogs, especially their development, courtship behaviors, and calls, and devoted several articles and book chapters to these subjects (Beebe 1906, 1921a,b, 1946b, 1947a, 1953). In Guyana, he described the nesting habits and larval emergence of *Phyllomedusa bicolor* from leaves overhanging water (Beebe 1921a), provided information on the ecology of *Leptodactylus caliginosus* (now *L. latrans*) including its behavior and defensive call, described the call of *Hyla maxima* (now *Hypsiboas boans*) (Beebe 1922, 1925a), and provided details on the predator-prey relationships and stomach contents of 36 frog species from the region (Beebe 1925b). In Venezuela, he documented the call, courtship behaviors, and

Table 1. Holotypes collected by William Beebe in the collection of the American Museum of Natural History (AMNH). Current taxonomic conventions for amphibians and reptiles are based on Frost (2013) and Uetz (2013), respectively.

Family	Holotype	AMNH voucher #	Current taxonomy	Locality
Aromobatidae	*Hyloxalus beebei* Noble, 1923	A18683	*Anomaloglossus beebei* (Noble, 1923)	Guyana
Craugastoridae	*Eleutherodactylus riveroi* Lynch & La Marca, 1993	A70599	*Pristimantis riveroi* (Lynch & La Marca, 1993)	Venezuela
Hylidae	*Hyla ornatissima* Noble, 1923	A13491	*Hypsiboas ornatissimus* (Noble, 1923)	Guyana
Leptodactylidae	*Leptodactylus minutus* Noble, 1923	A13495	*Adenomera hylaedactyla* (Cope, 1868)	Guyana
Colubridae	*Chironius multiventris septentrionalis* Dixon, Wiest & Cei, 1993	R98228	*Chironius septentrionalis* Dixon, Wiest & Cei, 1993	Venezuela
Dipsadidae	*Hypsiglena ochrorhynchus unaocularis* Tanner, 1944	R62756	*Hypsiglena ochrorhynchus unaocularis* Tanner, 1944	Mexico
Elapidae	*Micrurus bogerti* Roze, 1967	R96952	*Micrurus bogerti* Roze, 1967	Mexico
Gymnophthalmidae	*Leposoma taeniata* Noble, 1923	R21266	*Leposoma percarinatum* (Müller, 1923)	Guyana
Leptotyphlopidae	*Leptotyphlops tenellus* Klauber, 1939	R14269	*Epictia tenella* (Klauber, 1939)	Guyana
Sphaerodactylidae	*Gonatodes beebei* Noble, 1923	R21251	*Gonatodes annularis* Boulenger, 1887	Guyana

Table 2. Reptile and amphibian taxa named after William Beebe. Current taxonomic conventions for amphibians and reptiles are based on Frost (2013) and Uetz (2013), respectively.

Order	Family	Taxon named after Beebe	Current taxonomy
Anura	Eleutherodactylidae	*Eleutherodactylus beebei* Chochran, 1956	*Eleutherodactylus inoptatus* (Barbour, 1914)
	Bufonidae	*Bufo beebei* Gallardo, 1965	*Rhinella humboldti* (Gallardo, 1965)
	Aromobatidae	*Hyloxalus beebei* Noble, 1923	*Anomaloglossus beebei* (Noble, 1923)
Squamata	Gekkonidae	*Gehyra beebei* De Rooij, 1915	*Gehyra mutilata* (Wiegmann, 1834)
	Sphaerodactylidae	*Gonatodes beebei* Noble, 1923	*Gonatodes annularis* Boulenger, 1887

tadpole carrying behavior of *Prostherapis trinitatis* (now *Mannophryne trinitatis*), as well as the anatomy, defensive behavior, and reproductive biology of *Gastrotheca ovifera* (Beebe 1949a).

In Guyana, Beebe was the first to discover a population of a smaller-sized *Pipa*, which was later identified as a new species, *P. aspera* Müller 1924 (Beebe 1925b).

Saurians

> *"Bound to the ground by their short scales and four limbs, these small lizards are yet remarkably birdlike in their vivacity and their enthusiastic playing of their little game of life."*
>
> —William Beebe, Jungle Peace, 1918:43

Lizards are prominently featured in Beebe's writings on herpetology and appear to have been his most extensively studied group. In his book, *Jungle Peace*, he recalled first being taught how to noose lizards by a 12-year-old girl on the island of St. Thomas, thereby enabling him to more closely study members of this group (Beebe 1918a). In the Gulf of California, he documented the color variation and behaviors of insular lizard populations (Beebe 1938b), and recorded observations on the coloration, activity, and defensive behaviors of *Ctenosaura acanthura* in Mexico (Beebe 1905a, b). In 1919, he described in detail the geographic variation and ontogenetic color changes in lizards of the genus *Ameiva*, and discussed their relevance to Barbour and Noble's (1915) recent taxonomic revision of the genus (Beebe 1919b).

During a brief visit to the Galapagos Islands in 1923, Beebe studied many aspects of the ecology and behavior of the archipelago's lizard fauna (Beebe 1924). He described the differences in coloration between island populations of *Tropidurus* (now *Microlophus*), and discussed the possibility that insular populations of these animals within the archipelago could have originated through rafting on debris (Beebe 1923a). Captivated by the languid behavior and tameness of *Amblyrhynchus cristatus*, he carried out several crude behavioral experiments to study their lack of fear towards humans:

> *"To test the acquisition of fear, I caught an iguana of medium size, jerked him into the air, played with him for a few minutes and then loosened the noose and set him free. He ran off a few feet, turned and looked at me and offered no resistance to being again caught and swung through space. Six times I repeated this, and if anything he was tamer after the rough treatment than before, in the face of a series of experiences which would have driven any ordinary wild creature insane with fright."*
>
> —William Beebe, Galapagos: World's End, 1924:119

In addition to recording information on the diet, activity, and behavior of *A. cristatus*, Beebe also documented parasitism in the species, including the mutualistic removal of ticks by the Scarlet Rock Crab, *Grapsus grapsus* (Beebe 1924). He studied various aspects of the ecology of *Conolophus subcristatus* on Baltra Island, and observed mockingbirds removing ticks from its skin, which were later determined to be a new species (Beebe 1924).

Beebe's most important scientific works on lizards were a series of technical articles that provided extensive ecological data for 41 species collected in Guyana and Venezuela (Beebe 1944a,b, 1945). Particularly noteworthy from these reports were detailed descriptions, measurements, and line drawings of eye and hyoid morphologies for many of the species discussed, as well as a discussion on the termitaria-nesting habits of *Tupinambis*. In an earlier report, he provided detailed information on the ecology of 31 species in Guyana, including a comparison of the stomach contents of *Ameiva* and *Cnemidophorus* (Beebe 1925b).

Serpentes

> *"But their movements are slow, and rather than pursue their prey, their forte in life is waiting, with all the patience in the world, for some small creature to cross the spot which they have rendered more deadly than any pitfall or trap of human devising."*
>
> —William Beebe, Noosing a bushmaster, 1916:1375

Intrigued by bushmasters, Beebe described close encounters with *Lachesis muta* as well as their capture, and provided general information on the natural history and habits of the species (Beebe 1916c, 1918a). Of particular interest, he noted that *L. muta* emitted a delicate, but noticeable odor when alarmed or disturbed (Beebe 1925b), and even asserted his ability to detect the presence of the species by smell while blindfolded (Beebe 1949a)!

In 1925, he provided detailed information on the ecology of 52 snake species collected from a small section of forest in Guyana (Beebe 1925b). A follow-up study that included data from both Guyana and Venezuela yielded extensive data on the ecology of 54 species (Beebe 1946a). Among this information, Beebe (1946a) described a peculiar liana-mimicking behavior and defensive behavior in *Pseustes poecilonotus*. In the Galapagos Islands, he studied the stomach contents, reproductive biology, and geographical variation of *Dromicus* spp. (now *Pseudalsophis*) (Beebe 1924), and in Costa Rica, he recorded notes on the behavior and natural history of *Pelamis platurus* (Beebe 1942b).

As a collector of many snake specimens, Beebe (1947b) became frustrated by the loss of scale coloration through fixation and preservation, particularly with coral snakes of the genus

Micrurus. This prompted him to develop a novel method of preserving and mounting snake skins so that their colors remained vivid as in life (Beebe 1947b).

In 1952, Beebe produced an inventory of snakes native to the Arima Valley of Trinidad, reporting a total of 27 species (Beebe 1952). Many decades later, Boos (2001) noted some mistakes in Beebe's (1952) list, such as his inclusion of *Oxybelis fulgidus* as an inhabitant of Trinidad. As that species has never been collected in Trinidad, Boos (2001) suspected that this error represented a mistaken locality for nearby Patos Island.

Testudines

> *"I have seen these turtles in both hemispheres and along the shores of four continents, but not until my week on Clarion Island did green turtles leave the realm of exclamatory recognition and become exciting individuals, objects of intense interest and wonder."*
>
> —William Beebe, Zaca Venture, 1938: 276

Over the course of his many oceanic voyages with the Department of Tropical Research, Beebe had the opportunity to observe many sea turtles, particularly *Chelonia mydas*. During an excursion to Clarion Island, off the west coast of Baja California, he made extensive observations on *C. mydas*, and described in detail the stomach contents and nesting biology of the species, reviewed earlier accounts of its biology, and clarified anthropomorphic misconceptions regarding its reproduction (Beebe 1938b).

In his book, *Galapagos: World's End*, Beebe (1924) offered an extensive review of historical accounts dating back to 1684 that described encounters with Galapagos tortoises and their exploitation, as well as scientific expeditions that had collected individuals from the archipelago. On Pinzón Island, his crew located and secured a single tortoise, whose behavior and climbing abilities up steep, rocky slopes were studied by Beebe (1924).

Interestingly, Beebe rejected the idea that the terrestrial fauna of the Galapagos Islands had originated by overwater emigration from mainland South America; insisting instead that there must have once been a land bridge connection (Beebe 1924). This position appears to have been reinforced by a crude experiment carried out aboard his ship, whereby the tortoise collected from Pinzón was tossed into open water to see if it could float. Much to Beebe's surprise, the tortoise not only floated upright, but was also capable of controlled swimming as it attempted to climb back aboard a rowboat. Its death aboard the ship one week later, which Beebe attributed to congestion in the lungs caused by the inhalation of sea water while swimming, led him to the conclusion that:

> *"This would negative any possibility of the tortoises being able to make their way over wide expanses of water, either from the mainland or from island to island, in spite of their unusual swimming ability."*
>
> —William Beebe, Galapagos: World's End, 1924:228

In Guyana, Beebe et al. (1917) described the nesting habits and ecology of several species of freshwater turtles, but provided only local names for the species, complicating their identification. Beebe (1925b) collected basic ecological data on eight turtle species in Guyana, and on Trinidad, he recorded the occurrence of two species from the Arima Valley (Beebe 1952).

Crocodilians

> *"Common in many places and actually abundant in a few, these great saurians are far less conspicuous than their infinitely smaller relatives- the lizards which everywhere scamper up tree-trunks or barge clumsily through the fallen leaves."*
>
> —William Beebe et al., The Alligators of Guiana, 1917:283

Although he had observed them in both eastern and western hemispheres, and even collected specimens for museums, Beebe's writings on crocodilians appear to be limited to encounters with caimans in Guyana. There, he and others reported on the ecology and anthropogenic threats to caiman (probably *C. crocodilus*) living in the vicinity of Georgetown (Beebe 1917; Beebe et al. 1917), and briefly described the stomach contents of a young *C. sclerops* (now *C. crocodilus*) (Beebe 1925b). Beebe et al. (1917) reviewed local accounts of attacks on Guyanese villagers by *C. niger* (now *Melanosuchus niger*).

Captivity-based investigations

To supplement their field investigations, Beebe and his staff regularly maintained live reptiles and amphibians in their field station laboratories. In addition to providing opportunities for observing cryptic behaviors and developmental processes, maintaining specimens in the laboratory also served as a way of keeping them alive and healthy in preparation for their delivery to the zoological park in New York.

Frogs were frequently kept subjects, and led to the discovery of many fascinating behaviors and developmental processes that had not been seen or documented before. For example, Beebe (1946b; 1947a, 1949a) was the first to describe the "birth" or emergence of newly metamorphosed froglets from the dorsal pocket of the marsupial frog, *Gastrotheca ovifera*, and described larval development and metamorphosis in *Phyllomedusa bicolor* (Beebe 1921a,b). Several additional frog species were maintained in the laboratory, including *Leptodactylus caliginosus* (now *L. latrans*), *Phyllobates inguinalis* (now *Colostethus inguinalis*) (Beebe 1921a), *Prostherapis trinitatis* (now *Mannophryne trinitatis*), *Bufo marinus* (now *Rhinella marina*), *Atelopus cruciger,* and *Hyla rubra* (now *Scinax ruber*) (Beebe 1925b; 1949a).

Snakes were also regularly kept in terraria. On one occasion, Beebe (1949a) recalled tripping over an escaped coral snake (*Micrurus* sp.) while walking through a dark laboratory at night. A large *Bothrops asper* that was thought to have recently consumed a large meal was captured in the hallways of Rancho Grande and temporarily housed in a terrarium (Beebe 1949a). Several days after its capture, it unexpectedly gave birth to 28 live offspring, yielding important details about the reproductive biology of the species, and possibly representing the first birth of the species in captivity. Additional snake species kept included *Boa constrictor*, *B. canina* (now *Corallus caninus*), *Chironius carinatus*, *Pseustes sulphureus*, and *Tantilla melanocephala* (Beebe 1946a).

Many lizards including *Anolis nitens* (now *A. chrysolepis*), *A. sagrei*, *Cnemidophorus lemniscatus*, *Gonatodes annularis*, *Mabuya mabouya*, *Plica umbra*, *Polychrus marmoratus*, and *Uranoscondon superciliosa* (now *U. superciliosus*) were kept and studied in the laboratory, with eggs from several species laid in

captivity (Beebe 1944a,b, 1945). Although most eggs were dissected to study their development, some were artificially incubated and left to hatch in the lab. For example, Beebe (1945) described the successful captive hatching of *Tupinambis nigropunctatus* (now *T. teguixin*) and documented, perhaps for the first time, that disturbances to the surface of the eggshells prompted the pipping and rapid emergence of hatchlings (1925a). Today, this technique is often used by herpetoculturists to trigger hatching in tegu eggs. *Gonatodes annularis* was also successfully hatched in the laboratory (Beebe 1944a), and neonatal *M. mabouya* (now *Varzea bistriata*) were born to captive females (Beebe 1945).

On the voyage back to New York from the Galapagos Islands, a large group of *C. subscristatus* destined for the zoological park was maintained aboard the ship and fed a diet of lettuce and cabbage (Beebe 1923a). A group of *A. cristatus* was also brought back to New York on the same trip, but not on board the ship. Instead, they were housed for the duration of the two-month journey inside a floating wire cage that was pulled by the ship (Beebe 1923a, 1924). Although the animals survived the trip, they could not be encouraged to feed on any of the seaweed or vegetable matter offered to them (Beebe 1923a).

Miscellany.—Several of Beebe's published works on herpetology were accompanied by skillful illustrations painted by Department of Tropical Research artist Isabel Cooper. These included both color and black-and-white illustrations of *Conolophus subcristatus, Tropidurus albemarlensis* (now *Microlophus albemarlensis*), and *Amblyrhynchus cristatus* in Beebe's (1924) book, *Galapagos: World's End*, as well as nearly 100 black-and-white illustrations accompanying his technical articles on the ecology of lizards and snakes from Guyana and Venezuela (Beebe 1944a,b, 1945, 1946a).

Beebe authored the foreword to Curran and Kauffeld's (1937) popular book, *Snakes and their Ways,* and prepared the introduction to Tweedie's (1956) article on flying lizards of the genus *Draco*. Popular accounts on the etymology of reptile and amphibian common names were also given (Beebe,1905a, 1906).

Closing Remarks

In retrospect, William Beebe's impact on the field of herpetology extends far beyond the observable contributions hitherto discussed. Together with his important fieldwork in other disciplines, including ornithology, ichthyology, and entomology, Beebe's herpetological investigations have helped stress the importance of studying not only the animals, but their ecological roles and relationships with other organisms. His pioneering fieldwork in the neotropics was critical in paving the way for future researchers and studies in the emerging fields of ecology and conservation biology.

Beebe's impressive career demonstrated that an academic background was not necessarily a prerequisite for carrying out important scientific investigations or becoming a leading contributor to a particular field. Indeed, the breadth and extent of his lifetime scientific achievements surpassed those of most of his academic contemporaries.

It is impossible to discuss the impacts of Beebe's contributions on the fields of ecology, conservation biology, or herpetology without noting his critical role in the history and development of the New York Zoological Society. It was largely Beebe's pioneering fieldwork and oversight of the Department of Tropical Research that prompted the society's outward growth from an organization established upon zoological park management to a driving force in wildlife research and conservation. Concerned about the welfare of his zoological park, if founding NYZS director William Hornaday had gotten his way, Beebe would not have been permitted to take such extensive stints away from his curatorial duties at the zoo (Bridges 1974); this would have limited or even prohibited his collecting and research activities in the field. Fortunately, seeing the importance of his fieldwork, influential members of the society's executive committee disagreed with Hornaday's position and fully encouraged and supported Beebe's research endeavors (Bridges 1974). Without Beebe's dedication and investment of his personal finances towards fieldwork abroad (Gould 2004), it is unlikely that the Department of Tropical Research would have been founded and sustained. Without the important work carried out by the department under his direction, it is doubtful that the society would have followed the same trajectory towards becoming the Wildlife Conservation Society (WCS), the world's largest wildlife conservation organization. Today, the WCS supports and manages hundreds of field-based conservation initiatives throughout the world, including many which focus on conserving reptile and amphibian populations and their habitats.

Finally, of the many formal and informal roles that Beebe assumed during his lifetime, perhaps the most important was his popularization of science, nature, and exploration. His writings invited readers of a broad audience to relive his remarkable experiences as a naturalist traveling the world in search of wildlife and wild places, and have been attributed to inspiring and launching the careers of many renowned naturalists, ecologists, and conservation biologists, including Ernst Mayr, E. O. Wilson, Roger Tory Peterson, Rachel Carson, and Sylvia Earle (Gould 2004; Welker 1975; Wilson 1994), as well as many professional and amateur herpetologists (e.g., Bartlett 1988). Beebe's far-reaching influence continues to this day, as reprints and older copies of his books continue to be purchased and read by the next generation of naturalists and conservationists.

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GEOGRAPHIC DISTRIBUTION

Herpetological Review publishes brief notices of new geographic distribution records in order to make them available to the herpetological community in published form. Geographic distribution records are important to biologists in that they allow for a more precise determination of a species' range, and thereby permit a more significant interpretation of its biology.

These geographic distribution records will be accepted in a **standard format** only, and all authors *must* adhere to that format, as follows: SCIENTIFIC NAME, STANDARD ENGLISH NAME if available (for the United States and Canada as it appears in Crother [ed.] 2012. *Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, with Comments Regarding Confidence in Our Understanding.* 7th ed. Herpetol. Circ. 39:1–92 [available from ssarbooks.com], for Mexico as it appears in Liner and Casas-Andreu 2008. *Standard Spanish, English and Scientific Names of the Amphibians and Reptiles of Mexico.* Herpetol. Circ. 38:1–162), LOCALITY (use metric for distances and give precise locality data, including lat/long coordinates in **decimal degrees** and cite the map datum used), DATE (day-month-year), COLLECTOR, VERIFIED BY (*cannot* be verified by an author; curator at an institutional collection is preferred), PLACE OF DEPOSITION (where applicable, use standardized collection designations as they appear in Sabaj Pérez [ed.]. 2013, *Standard Symbolic Codes for Institutional Resource Collections in Herpetology and Ichthyology: an Online Reference*, ver. 4.0, available at http://www.asih.org/) and CATALOG NUMBER (required), COMMENTS (brief), CITATIONS (brief and must adhere to format used in this section; these should provide a geographic context for the new record). Close with author name(s) in bold, capital letters (give name and address in full—spell out state or province names—no abbreviations, e-mail address after each author name/address for those wishing to provide it—e-mail required for corresponding author). Please include distance from nearest previously known record (provide a citation or refer to existing vouchered material to substantiate your report). If publishing specific locality information for a rare or endangered species has the potential to jeopardize that population, please consult with the Section Editor at time of record submission. If field work and/or specimen collection occurred where permits were required, please include permit number(s) and authorizing agency in the text of the note.

Some further comments. The role of the "Standard Names" lists (noted above) is to standardize English names and comment on the current scientific names. Scientific names are hypotheses (or at least represent them) and as such their usage should not be dictated by a list, society, or journal.

Additionally, this geographic distribution section does not publish "observation" records. Records submitted should be based on preserved specimens that have been placed in a university or museum collection (private collection depository records are discouraged; institutional collection records will receive precedence in case of conflict). A good quality photograph (print, slide, or digital file) may substitute for a preserved specimen. Photographic vouchers *must* be deposited in a university or museum collection along with complete locality data, and the photographic catalog number(s) must be included in the same manner as a preserved record. Before you submit a manuscript to us, check Censky (1988, *Index to Geographic Distribution Records in Herpetological Review: 1967–1986*; available from the SSAR Publications Secretary), subsequent issues of *Herpetological Review*, and other sources to make sure you are not duplicating a previously published record. The responsibility for checking literature for previously documented range extensions lies with authors. **Do not submit range extensions unless a thorough literature review has been completed.**

For reports concerning **introduced species**, it is important to note whether a population has become established or if the report represents an isolated occurrence, such as a released captive. Additionally, it will be helpful to include any information that establishes a timeline for the introduction, such as date of first observation.

Please submit any geographic distribution records in the **standard format only** to one of the Section Co-editors: **David C. Blackburn** (Africa and Europe), **Indraneil Das** (Asia), **Stephen Richards** (Australasia, South Pacific) **Jerry D. Johnson** (Mexico and Central America, including the Caribbean Basin), **Alan M. Richmond** (USA & Canada), or **Gustavo J. Scrocchi** (South America). Short manuscripts are discouraged, and are only acceptable when data cannot be presented adequately in the standard format. **Electronic submission of manuscripts is required** (as Microsoft Word or Rich Text format [rtf] files, as e-mail attachments)**.** Refer to inside front cover for e-mail addresses of section editors.

Recommended citation for new distribution records appearing in this section is: Cabral, H., and A. Caballero. 2012. Geographic distribution: Paraguay, Departamento Central: *Pseudoeryx plicatilis*. Herpetol. Rev. 43:622.

CAUDATA — SALAMANDERS

***AMBYSTOMA FLAVIPIPERATUM* (Yellow-peppered Salamander).** MÉXICO: JALISCO: Municipality of Tecolotlán: Presa del Ahogado 3 km S of Quila El Grande (20.318722°N, 104.078320°W; WGS84), 1995 m elev. 13 July 2009. Iván T. Ahumada-Carrillo, Óscar F. Reyna-Bustos, and Carlos Vázquez-Ruiz. Verified by Jacobo Reyes Velasco. UTADC 6908. New municipality record, extending the range 60 km (airline) WSW from type locality at Santa Cruz, Jalisco (Dixon 1963. Copeia 1963:99–101). The salamander was found in pine forest.

IVÁN T. AHUMADA-CARRILLO (e-mail: lepidus320@hotmail.com.), **ÓSCAR F. REYNA-BUSTOS**, and **CARLOS VÁZQUEZS-RUIZ**, Centro Universitario de Ciencias Biológicas y Agropecuarias, Universidad de Guadala-

jara, carretera a Nogales Km. 15.5, Las Agujas, Nextipac, Zapopan, Jalisco, México.

***AMBYSTOMA OPACUM* (Marbled Salamander)**. USA: NORTH CAROLINA: Madison Co.: Pisgah National Forest, 5.4 km airline NW town of Hot Springs (35.92162°N, 82.87714°W; WGS 84). 28 October 2013. Charles R. Lawson. Verified by William M. Palmer. North Carolina State Museum of Natural Sciences (NCSM 81251). First vouchered specimen for Madison County (NCSM files and Beane et al. 2010. Amphibians & Reptiles of the Carolinas and Virginia, 2nd ed. University of North Carolina Press, Chapel Hill. 274 pp.). Collection represents the northernmost known occurrence to date in the Mountain region of North Carolina (Beane et al. 2010, *op. cit.*). Closest previous historical records in the state are from French Broad River floodplain and upland, mixed hardwood forest, Buncombe Co., 54.1 km airline SSE (NCSM 52284, 59016) (NCSM files). Young adult male (TL = 75.1 mm, SVL = 45.2 mm) collected during visual encounter surveys of coverboard arrays at French Broad River floodplain pools.

Two other specimens were found nearby but not vouchered. On 18 October 2011 a gravid female was found 0.51 km airline ENE of vouchered specimen, and on 14 March 2013 two gilled larvae were found 0.25 km airline E of vouchered specimen.

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***AMBYSTOMA TALPOIDIUM* (Mole Salamander)**. USA: NORTH CAROLINA: McDowell Co.: Box Creek Wilderness - Thompson Tract (35.538067°N, 81.963128°W; WGS 84; elev. ~320 m). 11 October 2013. Christopher R. Wilson. Verified by James W. Petranka. NCSM photographic voucher CRW 13-1. New county record (Jeffrey C. Beane, NC State Museum of Natural Sciences). Three paedomorphic larvae, measuring 54–57 SVL and 101–114 TL, were captured using aquatic funnel traps set in floodplain pools within a Montane Alluvial Forest (small river subtype). The property is owned by 130 of Chatham LLC, a private land conservation company.

CHRISTOPHER R. WILSON, Unique Places LLC, 9 Bradford Pl, Hendersonville, North Carolina 28791, USA; e-mail: critterfro@gmail.com.

***DESMOGNATHUS FUSCUS* (Northern Dusky Salamander)**. USA: INDIANA: Floyd Co.: Mt. St. Francis Monastery (38.333706°N, 85.910569°W; WGS 84). 15 June 2013. Andrew Hoffman, Todd Pierson. Verified by Kenneth Krysko. Florida Museum of Natural History (UF-Herpetology 171905 photo voucher). New county record (Minton 2001. Amphibians and Reptiles of Indiana. Indiana Academy of Science, Indianapolis, xiv + 404 pp.). Multiple adults were found under cover in a large, muddy seepage beneath the spillway of Mt. St. Francis Lake.

ANDREW HOFFMAN, Indiana State University, Terre Haute, Indiana 47802, USA (e-mail: ahoffman11@sycamores.indstate.edu); **MICHAEL LODATO**, Evansville, Indiana 47725, USA (e-mail: mikelodato@wowway.com); **TODD PIERSON**, University of Georgia, Athens, Georgia 30602, USA (e-mail: twpierson@gmail.com).

***NOTOPHTHALMUS VIRIDESCENS* (Eastern Newt)**. USA: GEORGIA: Lamar Co.: Milner, Zebulon Road (33.10669°N, 84.21914°W; WGS 84). 1 November 2013. Michael J. Bender. Verified by Gregory D. Hartman, Gordon State College, Vertebrate Collections Manager (GSC-035). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens, Georgia. 575 pp.). This species has been documented in three (Monroe, Spalding, and Upson) of the five adjoining counties (Jensen et al. 2008, *op. cit.*). A terrestrial juvenile (eft) was found crossing Zebulon Road ~0.25 km from a large pond during the day (1630 h) following approximately 16 h of intermittent gentle rain. Specimen collected under a Georgia Department of Natural Resources Scientific Collections Permit (29-WJH-13-126).

MICHAEL J. BENDER (e-mail: mbender@gordonstate.edu) and **AMANDA L. J. DUFFUS**, Gordon State College, Barnesville, Georgia 30204, USA (e-mail: aduffus@gordonstate.edu).

ANURA — FROGS

***ACRIS CREPITANS* (Eastern Cricket Frog)**. USA: TENNESSEE: Dyer Co.: Tigrett Wildlife Management Area at the end of Parker Rd. (35.82778°N, 89.26556°W; WGS 84). 17 August 2013. Michael C. Fulbright and James P. Flaherty. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19437, color photo). New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center of Excellence for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Internet version [http://apbrwww5.apsu.edu/amatlas] accessed 18 August 2013; latest update 1 August 2013)

MICHAEL C. FULBRIGHT (e-mail: mfulbright@my.apsu.edu), **JAMES P. FLAHERTY**, and **C. M. GIENGER**, Center of Excellence for Field Biology/Department of Biology, Austin Peay State University, Clarksville, Tennessee 37040, USA.

***ECNOMIOHYLA MINERA* (Guatemala Treefrog)**. GUATEMALA: HUEHUETENANGO: Barillas: Finca Chiblac, Montaña Los Angeles (15.87341°N, 91.24007°W; WGS 84), 1205 m elev. 20 June 2011. Erick R. López and Timothy A. Herman. Verified by David B. Wake. USAC 3362. First record for Huehuetenango and Sierra de los Cuchumatanes, extending the distribution in Guatemala ca. 133 km W from the nearest documented locality near Purulhá, Baja Verapaz (Global Biodiversity Information Facility 2012. Electronic records for occurrences of *Ecnomiohyla minera*, accessed 20 October 2012 at http://data.gbif.org/species/2428651/). The adult male was found at night following a heavy rainstorm on the trunk of a tree fern (ca. 1 m above ground) alongside a trail in primary cloud forest.

CARLOS R. VÁSQUEZ-ALMAZÁN, Museo de Historia Natural, Universidad de San Carlos de Guatemala, Fundación para el Ecodesarrollo y la Conservación (FUNDAECO), Guatemala City, Guatemala (e-mail: crvasal@yahoo.com.mx); **TIMOTHY A. HERMAN**, Department of Herpetology, Toledo Zoological Society, Toledo, Ohio, USA (e-mail: taherman@gmail.com); **ERICK R. LÓPEZ**, Universidad del Valle de Guatemala, Guatemala City, Guatemala (e-mail: erickrenelo@gmail.com).

***GASTROTHECA PULCHRA* (Marsupial Treefrog)**. BRAZIL: ALAGOAS: Municipality of Murici: Estação Ecológica de Murici

(9.212583°S, 35.879916°W, WGS 84; 533 m elev.) 14 December 2012. B. S. Lisboa, J. V. A. Neto, and I. C. Tiburcio. Setor de Zoologia, Coleção Herpetológica do Museu de História Natural, Universidade Federal de Alagoas, Maceió, Brazil (MUFAL 10829 and 10859 adult females; collecting license ICMBio/SISBIO #33507-1). Verified by F. A. C. Nascimento. This marsupial treefrog is known only from the Brazilian states of Bahia (Caramaschi and Rodrigues 2007. Bol. Mus. Nac. Zool., Rio de Janeiro 525:1–19; Freitas et al. 2009. Herpetol. Rev. 40: 233–234) and Pernambuco (Santos and Santos 2009. Herpetol. Rev. 40:445). First state record, extends the known distribution of the species ca. 53 km S from the closest locality at Private Reserve Frei Caneca, Municipality of Jaqueira, Pernambuco state (Santos and Santos 2009, *op. cit.*) and ca. 865 km N from its type locality at Reserva Biológica de Pau Brasil, Municipality of Porto Seguro, Bahia state (Caramaschi and Rodrigues 2007, *op. cit.*). According to the International Union for Conservation of Nature (IUCN), *G. pulchra* is listed as "Data Deficient," because no information on its population status is available. The presence of this species in a federal conservation unit is significant.

BARNAGLEISON SILVA LISBOA (e-mail: bslgleison@gmail.com), **MIRIAM CAMARGO GUARNIERI**, Programa de Pós-Graduação em Biologia Animal, Centro de Ciências Biológicas, Universidade Federal de Pernambuco, Av. Professor Nelson Chaves, s/n; Cidade Universitária, CEP 50670-420, Recife, PE, Brazil; **TAMÍ MOTT**, Instituto de Ciências Biológicas e da Saúde, Universidade Federal de Alagoas, Av. Lourival Melo Mota, s/n, Tabuleiro, CEP 57072-970 Maceió, AL, Brazil.

***HYALINOBATRACHIUM FLEISCHMANNI* (Fleischmann's Glass Frog)**. EL SALVADOR: MORAZÁN: Municipality of Arambala: Río Sapo Natural Protected Area (13.92896°N, 88.10161°W; WGS84), 665 m elev. 29 September 2012. Vladlen Henríquez and Emanuel Stanley Morán. Verified by William E. Duellman. KUDA 12308–12310. New record for Morazán, extending the species range ca. 25 km S of Marcala, Department of La Paz, Honduras (McCranie and Wilson 2002. The Amphibians of Honduras. SSAR Contrib. Herpetol. 19, Ithaca, New York. x + 625 pp.), and ca. 140 km ESE from the only other known Salvadoran locality at Cantón Montenegro, Santa Ana (Köhler et al. 2006. The Amphibians and Reptiles of El Salvador. Krieger Publ. Co., Malabar, Florida. ix + 238 pp.). The frog was found, along with several calling males, near a slow-moving stream lined with shrubs and trees surrounded by pine-oak forest at the base of the Nahuaterique Mountain Range. It should be noted that we observed many other calling males in the area, located between 665–865 m elevation, along different streams, including one passing through a coffee farm.

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***LITHOBATES BLAIRI* (Plains Leopard Frog)**. USA: INDIANA: Newton Co.: Iroquois River (40.865464°N, 87.326067°W; WGS 84). 5 October 2013. John Burris, Andrew Hoffman. Verified by Kenneth Krysko. University of Florida (UF-Herpetology 167505, 171192, and 171237 photo vouchers). New county record (Minton 2001. Amphibians and Reptiles of Indiana. Indiana Academy of Science, Indianapolis, xiv + 404 pp.). We observed numerous frogs in rip rap below the bridge and along the vegetated river shoreline. We positively identified three adults as *Lithobates blairi* but Northern Leopard Frogs (*Lithobates pipiens*) were also present.

JOHN BURRIS, 437 N Broad Street, Griffith, Indiana 46319, USA (e-mail: john.burris.jm5s@statefarm.com); **ANDREW HOFFMAN**, Indiana State University, Terre Haute, Indiana 47802, USA (e-mail: ahoffman11@sycamores.indstate.edu).

***LITHOBATES BLAIRI* (Plains Leopard Frog)**. USA: TENNESSEE: Lake Co.: Levee Phillipy Rd. 430 m E of Levee Rd. (36.483543°N, 89.400305°W; WGS 84). 17 August 2013. Michael C. Fulbright and James P. Flaherty. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19442). This is the first recorded specimen of *Lithobates blairi* in the state of Tennessee (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center of Excellence for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Internet version [http://apbrwww5.apsu.edu/amatlas] accessed 18 August 2013; latest update 1 August 2013) An adult male was caught with a dipnet on the road.

Extensive flooding events in May 2010 and May 2011 may have facilitated the movement of *L. blairi* across the Mississippi River. *Lithobates blairi* was first documented in Fulton Co., Kentucky, on 15 September 2011 (CMC 12314, Cincinnanti Museum of Natural History), and has been subsequently documented in 2012 and 2013 at sites less than a mile north of the Tennessee state line. Our specimen represents the first *L. blairi* in Tennessee. It appears that *L. blairi* readily hybridizes with the established population of *L. sphenocephalus*. We captured 11 *L. blairi* x *L. sphenocephalus* hybrids, and 65 *L. sphenocephalus* while searching for *L. blairi*.

MICHAEL C. FULBRIGHT (e-mail: mfulbright@my.apsu.edu), **JAMES P. FLAHERTY**, and **C. M. GIENGER**, Center of Excellence for Field Biology/Department of Biology, Austin Peay State University, Clarksville, Tennessee 37040, USA; **JON MacGREGOR**, Kentucky Department of Fish and Wildlife Resources, 1 Sportsman's Lane, Frankfort, Kentucky 40601, USA.

***LITHOBATES CATESBEIANUS* (American Bullfrog)**. USA: GEORGIA: Coweta Co.: Senoia (33.3181°N, 84.5935°W; WGS 84). 19 June 2013. Verified by Michael J. Bende. Gordon State College Collection of Vertebrates (GSC 042). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens, Georgia. 575 pp.). Specimen collected under a Georgia Department of Natural Resources Scientific Collecting Permit (29-WJH-13-126, CN 25018).

AMANDA L. J. DUFFUS (e-mail: aduffus@gordonstate.edu), **NATALIE B. HAYS** (e-mail: hays_beth@yahoo.com), and **GREGORY D. HARTMAN**, Gordon State College, Barnesville, Georgia 30204, USA (e-mail: ghartman@gordonstate.edu) .

***LITHOBATES CLAMITANS* (Green Frog)**. USA: INDIANA: Putnam Co.: Big Walnut Creek (39.786521°N, 86.779480°W; WGS 84). 27 May 2012. Andrew Hoffman, Sierra Shepard. Verified by Kenneth Krysko. Florida Museum of Natural History (UF-Herpetology 171899 photo voucher); New county record (Minton 2001. Amphibians and Reptiles of Indiana. Indiana Academy of Science, Indianapolis. xiv+ 404 pp.). We found numerous adults and juveniles under rocks along the stream.

ANDREW HOFFMAN, Indiana State University, Terre Haute, Indiana 47802, USA (e-mail: ahoffman11@sycamores.indstate.edu); **SIERRA SHEPARD**, St Mary of the Woods College, Saint Mary of the Woods, Indiana 47876, USA (e-mail: sshepard@smwc.edu).

***LITHOBATES PALUSTRIS* (Pickerel Frog)**. USA: INDIANA: Putnam Co.: Big Walnut Creek (39.786521°N, 86.779480°W; WGS 84).

27 May 2012. Andrew Hoffman, Sierra Shepard. Verified by Kenneth Krysko. Florida Museum of Natural History (UF-Herpetology 171900 photo voucher); New county record (Minton Minton 2001. Amphibians and Reptiles of Indiana. Indiana Academy of Science, Indianapolis, xiv + 404 pp.). We found a single small adult under a rock along the stream.

ANDREW HOFFMAN, Indiana State University, Terre Haute, Indiana 47802, USA (e-mail: ahoffman11@sycamores.indstate.edu); **SIERRA SHEPARD**, St Mary of the Woods College, Saint Mary of the Woods, Indiana 47876, USA (e-mail: sshepard@smwc.edu).

***LITHOBATES SPHENOCEPHALUS* (Southern Leopard Frog)** USA: GEORGIA: Lamar Co.: Barnesville, Highway 18 (33.03123°N, 84.18795°W; WGS 84). 6 June 2013. Austin Dean and Ashley Dean. Verified by Gregory D. Hartman. Gordon State College Collection of Vertebrates (GSC 041). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens, Georgia. 575 pp.). Three juveniles. Specimens collected under a Georgia Department of Natural Resources Scientific Collecting Permit (29-WJH-13-126, CN 25018).

AMANDA L. J. DUFFUS (e-mail: aduffus@gordonstate.edu), **ASHLEY DEAN** (e-mail: ad077078@gordonstate.edu), **AUSTIN DEAN** (e-mail: abacer86@hotmail.com), and **MICHAEL J. BENDER**, Gordon State College, Barnesville, Georgia 30204, USA (e-mail: mbender@gordonstate.edu).

***RHINELLA AZARAI* (Azara's Granulated Toad)**. BRAZIL: MATO GROSSO DO SUL: Municipality of Rio Brilhante: Wetland adjacent to the Brilhante River (21.898638°S, 54.029526°W; datum WGS 84). 8 October 2013. F. I. Martins and B. F. Leonel. Coleção Zoológica de Referência da Universidade Federal de Mato Grosso do Sul, Brazil (ZUFMS AMP 03268, male SVL 49 mm, calling at 1900 h in a temporal pond). Verified by F. L. Souza. *Rhinella azarai* is known from northern Argentina, Paraguay, and southwestern Brazil, with most occurrences associated with Chaco lowlands (Narvaes and Rodrigues 2009. Arq. Zool., S. Paulo 40[1]:1–73). In Brazil there are only three reports of the species, all in municipalities of Mato Grosso do Sul state: Bela Vista, Maracajú (Narvaes and Rodrigues 2009, *op. cit.*) and Porto Murtinho (Sugai et al. 2012. Herpetol. Rev. 43[3]:441). The present record extends the species distribution ca. 120 km SE from municipality of Maracajú (21.63333°S, 55.150000°W), the nearest locality previously known, and it is the first report of *R. azarai* in the ecoregion of Alto Paraná Atlantic Forest (Di Bitetti et al. 2003. Uma Visão de Biodiversidade para a Ecorregião Florestas do Alto Paraná: Mata Atlântica. World Wildlife Fund., Washington, D.C. 152 pp.).

FERNANDO IBANEZ MARTINS (e-mail: fimquelonio@hotmail.com), **JOSÉ LUIZ MASSAO M. SUGAI** (e-mail: jlmassao@gmail.com), **BRENO FRANCO LEONEL** (e-mail: brenoleonel@gmail.com), and **SABINE BORGES DA ROCHA** (e-mail: sabineborges@hotmail.com), Programa de Pós-graduação em Biologia Animal, 79070-900, Campo Grande, MS, Brazil.

***SCAPHIOPUS HOLBROOKII* (Eastern Spadefoot)**. USA: TENNESSEE: Washington Co.: Liberty Church Road (36.1420°N, 82.6158°W; WGS 84). Scott and Christopher Bolick. Verified by A. Floyd Scott. APSU 19450. New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center of Excellence for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. [Hard copy and Internet versions, http://apbrwww5.apsu.edu/amatlas/index.html, accessed 11 September 2013]). Two other localities within the county were also identified (ASPU 19451, 19452). All specimens found alive on roads.

SCOTT BOLICK, 379 Cassi Rd., Chuckey, Tennessee 37641, USA (e-mail: Bolickscott@yahoo.com); **CHRISTOPHER BOLICK**, Catawba College, 2300 W Innes St, Salisbury, North Carolina 28144, USA (e-mail: cwbolick@catawba.edu).

***ZAKERANA PIERREI* (Pierre's Cricket Frog)**. BANGLADESH: RANGPUR DISTRICT: New Adarsha Para, Rangpur City (25.738652°N, 89.25375°E, WGS 84; 34 m elev.). 7 August 2013. Hassan-Al-Razi. Verified by Mohammad Sajid Ali Howlader. Museum of Zoology Laboratory, Jagannath University, Bangladesh (MZJLB-FP01). Adult collected beside a small water body, including *Cynodon dactylon* and *Enhydra fluetuans* plantations. Previously recorded from Nilphamari District (Sarker and Howlader 2011. Herpetol. Rev. 42[4]:562), and Chittagong (Hathazari), Cox's Bazar (Himchari), Noakhali (Hatia Island), and Barisal (Sundargaon), southeast Bangladesh (Rasel et al. 2007. Bannoprani- Bangladesh Wildl. Bull. 4:1–2). Present population found near New Adarsha Para, Rangpur City, Adarsha High School, > 50 km E from Nilphamari District and > 448 km NW of Chittagong (Hathazari), < 565 km NW of Cox's Bazaar (Himchari), < 490 km NW of Noakhali (Hatia Island), and < 356 km NW for Barisal (Sundargaon).

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TESTUDINES — TURTLES

***APALONE MUTICA* (Smooth Softshell)**. USA: NEBRASKA: Boyd Co.: Mile 869.4 of the Missouri River (42.93563°N, 98.45551°W; WGS 84). 18 September 2012. Ryan J. Munes. Verified by Travis J. LaDuc. Texas Natural History Collections (TNHC 86195). New county record (Ballinger et al. 2010. Amphibians and Reptiles of Nebraska. Rusty Lizard Press, Oro Valley, Arizona. 400 pp.; Fogell 2010. A Field Guide to the Amphibians and Reptiles of Nebraska. University of Nebraska-Lincoln, Lincoln, Nebraska. 158 pp.). Previous records exist to the east in Knox Co. and to the west in Keya Paha Co. Hatchling found dead on sandbar in river. Specimen collected under a Nebraska Game and Parks Commission Scientific and Educational Permit (# 293) to Drew R. Davis.

RYAN J. MUNES (e-mail: rjmunes@gmail.com) and **DREW R. DAVIS,** Department of Biology, University of South Dakota, 414 East Clark Street, Vermillion, South Dakota 57069, USA (e-mail: drew.davis@usd.edu).

***APALONE SPINIFERA* (Spiny Softshell)** USA: GEORGIA: Fayette Co.: Peachtree City (33.3972°N, 84.5628°W; WGS 84). 25 June 2013. Tiffany Ward. Verified by Michael J. Bender. Gordon State College Collection of Vertebrates (GSC 047). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens, Georgia. 575 pp.). Adult turtle from Huddleson Pond. Specimen collected under a Georgia Department of Natural Resources Scientific Collecting Permit (29-WJH-13-126, CN 25018).

AMANDA L. J. DUFFUS (e-mail: aduffus@gordonstate.edu), **TIFFANY M. WARD** (e-mail ward.tiffany1281@gmail.com), and **GREGORY D. HARTMAN**, Gordon State College, Barnesville, Georgia 30204, USA (e-mail: ghartman@gordonstate.edu).

***APALONE SPINIFERA* (Spiny Softshell)**. USA: INDIANA: Franklin Co.: Whitewater River (39.378934°N, 84.973001°W; WGS 84).

27 July 2011. Andrew Hoffman, Sierra Shepard. Florida Museum of Natural History (UF-Herpetology 171910 photo voucher). New county record (Minton 2001. Amphibians and Reptiles of Indiana. Indiana Academy of Science, Indianapolis. xvi + 404 pp.). A single juvenile was photographed swimming through the shallows. Numerous adults were observed along the river throughout the day.

Putnam Co.: Big Walnut Creek (39.785007°N, 86.778656°W; WGS 84). 27 May 2012. Andrew Hoffman, Sierra Shepard. UF-Herpetology 171898 photo voucher. New county record (Minton 2001, *op. cit.*). A large adult female buried in a very small, but deep patch of sand, below a small riffle, in the shallows of a stream. All records verified by Kenneth Krysko.

ANDREW HOFFMAN, Indiana State University, Terre Haute, Indiana, 47802, USA (e-mail: ahoffman11@sycamores.indstate.edu); and **SIERRA SHEPARD**, St Mary of the Woods College, Saint Mary of the Woods, Indiana, 47876,USA (e-mail: sshepard@smwc.edu).

***CHELONIA MYDAS* (Green Sea Turtle)**. USA: LOUSIANA: Cameron Parish: Salt marsh 100 m S of Louisiana Hwy 82 and 1 km E of Texas-Louisiana border (29.76746°N, 93.88262°W; WGS84). 25 April 2013, 1300 h. Will Selman and Ryan King. Florida Museum of Natural History Herpetology Department (UF 170048, photo voucher). First verified record from southwestern Louisiana (Dundee and Rossman 1989. The Amphibians and Reptiles of Louisiana. Louisiana State University Press, Baton Rouge and London. 300 pp.; HerpNet collections database, www.herpnet2.org, accessed 28 October 2013). A putative skeletal record of *C. mydas* from Cameron Parish exists in the LSU-Shreveport collection (LSUS 8456) from a dead individual that washed onto the beach from offshore. However, based upon the skeletal material available, the specimen cannot be verified to species (J. Boundy, pers. comm.). Juvenile (27.3 cm midline carapace length [MCL]; 2700 g) captured in a salt marsh.

St. Bernard Parish: Salt marsh on the fringe of Eloi Bay approximately 23.3 km ESE of Hopedale, Louisiana (29.78886°N, 89.41930°W; WGS84). 15 May 2013. Dane Cassady and Amy Magro. UF Herpetology 171444 (photo voucher). New parish record (Dundee and Rossman, *op. cit.*; HerpNet collections database, www.herpnet2.org, accessed 28 October 2013). This record fills the distributional gap that existed between an Orleans Parish specimen (near New Orleans, USNM 55569) and a Plaquemines Parish specimen (Breton Island, unpublished literature record cited by Dundee and Rossman, *op. cit.*). Juvenile (approx. 30 cm MCL) captured in salt marsh

Terrebonne Parish: Salt marsh 2.3 km NE of Cocodrie, Louisiana at the north end of Bay Cocodrie (29.26237°N, 90.64619°W; WGS84). 16 May 2013. Ben Stultz and Todd Credeur. UF Herpetology 171449 (photo voucher). New parish record (Dundee and Rossman, *op. cit.*; HerpNet collections database, www.herpnet2.org, accessed 28 October 2013). This record is 70 km W of a Jefferson Parish specimen collected in 1962 on Grand Terre Island (LSU Herpetology 54213). This animal was a juvenile (approx. 22 cm MCL).

All individuals were captured alive in fyke nets, which were placed in tidal bayous while conducting *Malaclemys terrapin* (Diamondback Terrapin) surveys. Trap locations ranged between 0.8–1.4 m deep and 7.6–14 m wide, while water salinities ranged between 5.6–16 ppt and water temperature ranged between 22.3–24°C. Following species documentation and measurements, all individuals were released at the capture site. All photo vouchers were verified by Jeff Boundy.

It seems beyond a coincidence that all three individuals were juveniles of similar size, captured in similar salt/brackish marsh habitat, and all captured within a span of 21 days. Dundee and Rossman (*op. cit.*) considered *C. mydas* a "visitor" to Louisiana. However, Fuller et al. (1987. Sea Turtles in Louisiana Coastal Waters. Report for the Coastal Fisheries Institute and Louisiana Sea Grant College Program. Baton Rouge, Louisiana. 39 pp. with appendix) noted that *C. mydas* is the second most observed species by fishermen/marine-oriented people in Louisiana, with most reports being juveniles in the southeastern portion of the state. Because we cannot determine the validity of the self reported records in Fuller et al. (*op. cit.*), we consider our records from Terrebonne and St. Bernard parishes the first verifiable *C. mydas* records for these parishes. Based on the three individuals reported herein, juvenile *C. mydas* appear to be seasonally utilizing near shore habitats during the late spring and early summer in Louisiana. The sizes we report are also consistent with the estimation that *C. mydas* juveniles leave the "oceanic" stage around 25–35 cm MCL (Reich et al. 2007. Biol. Letters 3:712–714). Because juveniles are more carnivorous than adults (Ernst and Lovich 2009. Turtles of the United States and Canada, 2nd ed. Johns Hopkins Press, Baltimore, Maryland. 827 pp.), it is possible that they are consuming marine invertebrates in salt and brackish marsh habitats.

We thank Steven Pearson for assistance and review of the note.

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***CHRYSEMYS DORSALIS* (Southern Painted Turtle)**. USA: TENNESSEE: Weakley Co.: Greenfield (36.193055°N, 88.762222°W; NAD 83). 18 August 2013. James P. Flaherty and Michael C. Fulbright. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19444). New county record (Scott and Redmond 2008 (latest update: 7 August 2013). Atlas of Reptiles in Tennessee. The Center of Excellence for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/ [accessed 6 September 2013]). Nearest record ca. 26 km distant in Carroll Co. Found dead on road.

JAMES P. FLAHERTY (e-mail: jflaherty1@my.apsu.edu), **MICHAEL C. FULBRIGHT**, and **C. M. GIENGER**, Center of Excellence for Field Biology/Department of Biology, Austin Peay State University, Clarksville, Tennessee 37040, USA

***CHRYSEMYS PICTA* (Painted Turtle)**. USA: FLORIDA: Volusia Co.: Blue Springs State Park, 96 m E of the mouth of St. Johns River inside of the Blue Spring Run (28.94345°N, 81.34102°W, WGS84; elev. 6 m). 4 October 2013. Eric C. Munscher. Verified by Kenneth L. Krysko. Photos and specimen deposited in the Florida Museum of Natural History (UF 171291). New county record (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final Report, Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida. 524 pp.). Female (carapace length = 247 mm, plastron length = 183 mm, mass = 1568 g) captured by hand at 1000 h along the right side of the lower Blue Spring Run toward the St. Johns River. The lack of algae on the carapace

suggests this is a recently released captive pet turtle. This is the first reported occurrence of *Chrysemys picta* in the St. Johns River Basin and only one of several reported within the state. This non-indigenous species is relatively common in the pet trade. At this point we highly doubt there is a mass introduction of this species and expect that this was an isolated incident of someone releasing their pet turtle. Exotic reptiles have been commonly sold in pet stores in Florida for decades. Species such as the Red-eared Slider (*Trachemys scripta elegans*) have been able to establish potential breeding populations and may compete or hybridize with native species.

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***CHRYSEMYS PICTA* (Painted Turtle)** USA: GEORGIA: Lamar Co.: Barnesville (33.03123°N, 84.18795°W; WGS 84) 13 June 2013. Zachary Burke. Verified by Michael J. Bender. Gordon State College Collection of Vertebrates (GSC 045). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens, Georgia. 575 pp.). Adult specimen was captured along a back road crossing between a pair of small ponds. Specimen collected under a Georgia Department of Natural Resources Scientific Collecting Permit (29-WJH-13-126, CN 25018).

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***GRAPTEMYS GEOGRAPHICA* (Northern Map Turtle)** USA: GEORGIA: Fayette Co.: Peachtree City (33.3972°N, 84.5628°W; WGS 84). 10 June 2013. Tiffany Ward. Verified by Gregory D. Hartman, Gordon State College Collection of Vertebrates (GSC 043). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens, Georgia. 575 pp.), with nearest record in Chattooga Co., ca. 113 miles S. Large adult with a fish hook stuck in mouth was submitted to A. Duffus after capture from Huddleson Pond.

Spalding Co.: Griffin (33.1948°N, 84.2846°W; WGS 84). 11 June 2013. Natalie Hays. Verified by Gregory D. Hartman. GSC 044. New county record and possible range expansion (Jensen et al. 2008, *op. cit.*), with nearest record in southern Spalding Co., ca. 127 miles S.

Both specimens collected under a Georgia Department of Natural Resources Scientific Collecting Permit (29-WJH-13-126, CN 25018).

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***MACROCHELYS TEMMINCKII* (Alligator Snapping Turtle)**. USA: MISSISSIPPI: Marion Co.: Pearl River approximately 1.2 river km N of the Columbia Water Park boat launch (31.289867°N, 89.854596°W; WGS84). 7 June 2006. Will Selman. Verified by Tom Mann. Florida Museum of Natural History Herpetology Department photographic archive (UF 171239 photo voucher). New county record (Mississippi Museum of Natural Science Collections, http://www.mdwfp.com/seek-study/bio-collections.aspx, and HerpNet collections database, www.herpnet2.org; both accessed 10 October 2013). This record represents only the third locality from the Pearl River system of central Mississippi, including the Pearl River at Georgetown, Mississippi (Copiah Co., Carnegie Museum Herpetology 84701, 94933, 95032, 96007, 96008, 96348, 96349) and the Pearl River at Jackson, Mississippi (Rankin Co., Mississippi Museum of Natural Science Herpetology 4203). Extends the range of *M. temminckii* in the Pearl River southward 141 river km from the Georgetown, Mississippi records. Individual encountered in a recreational hoop net.

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***PSEUDEMYS CONCINNA* (River Cooter)**. USA: TENNESSEE: Dyer Co.: Tigrett Wildlife Management Area (35.994722°N, 89.265833°W; NAD 83). 17 August 2013. James P. Flaherty and Michael C. Fulbright. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19411 photo voucher). New county record (Scott and Redmond 2008 [latest update: 13 July 2010]. Atlas of Reptiles in Tennessee. The Center of Excellence for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/ [accessed 6 September 2013]). Nearest confirmed record ca. 44 km NW in Obion Co. Observed basking on a floating log in vegetated slough.

JAMES P. FLAHERTY (e-mail: jflaherty1@my.apsu.edu), **MICHAEL C. FULBRIGHT**, and **C. M. GIENGER**, Center of Excellence for Field Biology/Department of Biology, Austin Peay State University, Clarksville, Tennessee 37040, USA.

***PSEUDEMYS CONCINNA FLORIDANA* (Coastal Plain Cooter)** USA: GEORGIA: Fayette Co.: Peachtree City: (33.3972°N, 84.5628°W; WGS 84) 19 June 2013. Tiffany Ward. Verified by Gregory D. Hartman, Gordon State College Collection of Vertebrates (GSC 046, adult male). New county record and possible range expansion (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens, Georgia. 575 pp.), with closest record in Fayette Co., ca. 80 miles N. Specimen collected under a Georgia Department of Natural Resources Scientific Collecting Permit (29-WJH-13-126, CN 25018).

AMANDA L. J. DUFFUS (e-mail: aduffus@gordonstate.edu), **TIFFANY M. WARD** (e-mail: ward.tiffany1281@gmail.com), and **MICHAEL J. BENDER**, Gordon State College, Barnesville, Georgia 30204, USA (e-mail: mbender@gordonstate.edu).

***TERRAPENE CAROLINA TRIUNGUIS* (Three-toed Box Turtle)**. USA: TEXAS: Hardin Co.: Lumberton, Wingfield Dr. (30.228735°N, 94.155508°W; WGS84). Eric C. Munscher and Adrian Barcas. 3 October 2013. Verified by Carl J. Franklin. UTADC 8062–8064 (photo vouchers). New county record (Dixon 2013. Amphibians and Reptiles of Texas. Texas A&M University Press, College Station. 447 pp.). This species is documented in surrounding Jefferson, Orange, Liberty, Polk, and Tyler counties (Dixon 2013, *op. cit.*). One adult female was rescued while crossing road.

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***TRACHEMYS SCRIPTA* (Pond Slider)**. USA: TENNESSEE: Cheatham Co.: Cheatham Wildlife Management Area (36.2029°N, 87.1008°W; NAD 84). 9 June 2010. Terry Hopkins. Verified by A. Floyd Scott. David H. Snyder Museum of Zoology, Austin Peay State University (APSU 19295). New county record (Scott and Redmond 2008 [latest update: 31 August 2013]. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/ [accessed 9 October 2013]).

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SQUAMATA — LIZARDS

***ANADIA OCELLATA* (Ocellated Anadia)**. REPUBLIC OF PANAMA: VERAGUAS: Santa Fe District: Escobal River (8.54511°N, 81.11978°W; WGS84), 432 m elev. 23 September 2011. E. E. Flores. Verified by Gunther Köhler. MVUP 2094. This report confirms a 1980 record for Veraguas Province (AMNH 147802) that lacked exact locality information, and is also the first record for the Santa Fe National Park, located in Panama's central cordillera region (Köhler 2008. Reptiles of Central America, 2nd ed. Herpeton, Verlag Elke Köhler, Offenbach, Germany. 400 pp.). The specimen was captured at 1240 h while active on rocks forming a small islet near the river's shore, which represents a new reported habitat for the species; prior reports indicated that it typically occupies tree canopies (Savage 2005. The Amphibians and Reptiles of Costa Rica: A Herpetofauna Between Two Continents, Between Two Seas. Univ. Chicago Press, Chicago, Illinois. 954 pp.). This work was conducted under the scientific permit (SA/E-62-11) provided by the Panamanian National Authority for the Environment (ANAM).

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***ANOLIS SAGREI* (Brown Anole; Abaniquillo Costero)**. HONDURAS: ISLAS DE LA BAHÍA: Isla de Utila, Utila Town (16.083602°N, 86.883486°W; WGS84). 10 m elev. 24 April 2012. Sofia Nuñez. Verified by Gustavo A. Cruz. UNAH 5567–68. First records for Isla de Utila; previously known on Islas de la Bahía only from Isla de Roatán (McCranie et al. 2005. The Amphibians & Reptiles of the Bay Islands and Cayos Cochinos, Honduras. Bibliomania!, Salt Lake City, Utah. xiii + 210 pp.). The closest known locality on Roatán to our record is ca. 45 km NE at Coxen Hole. The anoles were found on a tree branch at 0900 h.

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***ANOLIS SAGREI* (Brown Anole)**. USA: TEXAS: Matagorda Co.: Courtyard wall of Matagorda Regional Medical Center approximately 2.1 km W of the historic square of Bay City (28.97993°N, 95.99204°W; WGS 84). 22 July 2013. Christian L. Swanson. Verified by Travis LaDuc. TNHC 85948. First documented occurrence of the species within Matagorda Co. (Dixon 2013. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station. 447 pp.). Several (>5) individuals were observed within proximity of the moist, partially shaded courtyard. The presence of *Anolis sagrei* has been documented within counties surrounding important Texas ports and occasionally further inland. This stratified distribution confirms human mediation within Texas and provides an anecdotal predictor for the potential of ongoing colonization. Matagorda Co. is bordered to the east by a cluster of counties (Brazoria, Fort Bend, Galveston, and Harris) where the presence of *A. sagrei* has been previously confirmed.

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***CHALCIDES OCELLATUS* (Ocellated Skink)**. GREECE: SOUTH AEGEAN.: Syros Island, Galissa Bay (37.413856°N, 24.878516°E; WGS 84; 68 m elev.). 10 September 2013. Stephanos A. Roussos and Llewellyn D. Densmore III. Verified by A. Dimitropoulos, M. Dimaki, J. Foufopoulos and P. Lymberakis. Natural History Museum of Crete (NHMC 80.3.80.1127–1130) and University of Michigan Museum of Zoology, Division of Reptiles and Amphibians (Digital Image Collection Number 1228, photographic voucher, one individual). New island record (Chondropoulos 1986. Amphibia-Reptilia 3:217–235). This represents a rare find in the prefecture of the Cyclades as it had only been documented on the islands of Makronissos and Kea (Tzia) (Chondropoulos 1986, *op. cit.*), which are the closest Cycladic islands to the mainland where the species is common. Makronissos and Kea differ from the rest of the archipelago in that they were connected to the mainland fairly recently (10,000 years ago) compared to the other Cycladic islands and thus share different geological histories. The species was recently documented for the first time on the Cycladic island of Naxos (Belasen et al. 2012. Herpetol. Rev. 43:102), which was part of an ancient "super" island that separated from the mainland about 200,000 years ago and then fragmented following the last glaciation (18,000 years ago) into more than 20 islands that make up a large portion of the archipelago. Syros is also one of the islands that fragmented from this ancient "super" island. Seven specimens were found by SAR in 2011 on the northern slopes of Mt. Harasonas, south of Galissa Bay, under rocks, leaf litter, tin, and cement blocks but photo vouchers from these individuals were inadvertently lost. The same site was revisited in 2013 where 17 individuals were found in two hours mid-day (see above for specimen references). Both adults and juveniles were found, indicating a healthy population at this locality.

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***EREMIASCINCUS ISOLEPIS* (Northern Bar-lipped Skink)**. AUSTRALIA: WESTERN AUSTRALIA: Forrester Bay, 87 km E of Karratha (20.66944°S, 117.6825°E; WGS84). 3 December 2012. Ryan Ellis and Sean Doody. Western Australian Museum (WAM R173016, R173018). Verified by Paul Doughty (WAM). Multiple individuals caught in pit traps and funnel traps during faunal survey, two specimens collected and vouchered. Most northeasterly record for the geographically isolated Pilbara population, located approximately 400 km SW of the nearest verified record in the Kimberley population. The two populations may represent different species; however, further work is required to confirm this. This record extends the known range of the Pilbara population 70 km NE along the coastline from the nearest verified locality

near Lake Poongkaliyarra (R135280), south of Roebourne (WAM herpetofauna specimen database, accessed 8 August 2013). The WAM herpetofauna specimen database was accessed to identify the locations of the nearest confirmed specimens in the collection and confirm that those collected represented a distribution extension for the species. An additional search was made in OZCAM (Online Zoological Collections of Australian Museums; http://ozcam.org.au/, accessed 8 August 2013).

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***HEMIDACTYLUS TURCICUS* (Mediterranean Gecko)** USA: GEORGIA: Bibb Co.: Macon, Hillcrest Industrial Boulevard, between Roff Avenue and Hillcrest Avenue (32.84374°N, 83.67290°W; WGS 84). 4 June 2013. Austin Dean and Ashley Dean. Verified by Gregory D. Hartman. Gordon State College Collection of Vertebrates (GSC 036). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens, Georgia. 575 pp.). An adult with a partially regrown tail captured inside a non-climate-controlled, lighted storage warehouse. There appears to be a small population of this introduced species. Specimen collected under a Georgia Department of Natural Resources Scientific Collecting Permit (29-WJH-13-126, CN 25018).

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***HEMIDACTYLUS TURCICUS* (Mediterranean Gecko)**. USA: VIRGINIA: Montgomery Co.: Blacksburg, Derring Hall, Virginia Tech campus (37.229320°N, 80.425633°W, WGS 84). 7 May 2013. Meredith Swartwout. Verified by Robin Andrews. Virginia Museum of Natural History (VMNH 150014). First documented voucher specimen for the county. *Hemidactylus turcicus* has been recorded in Virginia from Richmond, Lynchburg, and Bedford counties (Sattler et al. 2007. Catesbeiana 27[1]: http://www.virginiaherpetologicalsociety.com/reptiles/lizards/mediterranean-gecko/Mediterranean%20Gecko.pdf). Knight (1993. Dactylus 2:49–50) reported *H. turcicus* from the Virginia Tech campus, but did not collect voucher specimens.

A small population of *H. turcicus* was accidentally released in the Virginia Tech Department of Biological Sciences building, Derring Hall, in 1982 (R. Andrews, pers. comm.). Since then, about six or seven sightings (adults and hatchlings) have been reported from the building each year. The voucher specimen captured on 7 May 2013 was an adult *H. turcicus* that was living in one of the animal care rooms. Temperature-controlled animal care rooms and maintenance areas in the building may serve as refuges for these geckos. Knight (1993, *op. cit.*) suggested that the steam tunnels could also support a population of *H. turcicus*, but to this date there have been no reported gecko sightings from the steam tunnels by workers (D. Linzey, pers. obs.)

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***LEPOSTERNON POLYSTEGUM* (Bahia Worm Lizard)**. BRAZIL: PARAÍBA: Municipality of São José de Piranhas: 7.146°S, 38.601°W; WGS84). 14 November 2012. Wildlife Rescue Team from the Project of Integration of São Francisco river (PISF) with the basins of septentrional northeastern. Coleção de Herpetologia do Museu de Fauna da Caatinga, Centro de Conservação e Manejo de Fauna da Caatinga – Universidade Federal do Vale do São Francisco, Petrolina, Pernambuco, Brazil (MFCH 2418). Verified by M. T. Rodrigues. Species previously known from the following Brazilian states: Pará (Belém municipality); Maranhão (municipalities of Igarapé Grande, Santa Luzia do Paruá and locality of Paraquéu); Ceará (Planalto da Ibiapaba: municipalities of Ibiapina, São Benedito, Tinguá and Ubajara; Serra de Maranguape: Maranguape municipality; Serra da Aratanha: Pacatuba municipality; Chapada do Araripe: municipalities of Crato (Floresta Nacional do Araripe) and Barbalha); coastal zones of Rio Grande do Norte and Pernambuco; Alagoas (Piranhas municipality); Bahia (municipalities of Feira de Santana, São Gonçalo dos Campos, Xique-Xique and Casa Nova) and Tocantins (Jalapão microrregion and Lajeado municipality) (Rodrigues 1996. J. Herpetol. 30:513–523; Barros-Filho and Valverde 1996. Sitientibus 14:57–68; Borges-Nojosa and Caramaschi 2005. *In* Leal et al. [eds.], Ecologia e Conservação da Caatinga, pp. 463–512. Ed. Universitária UFPE, Brazil; Perez and Ribeiro 2008. Check List 4:291–294). First state record, extends the distribution ca. 90 km NE from the municipality of Barbalha, state of Ceará, Brazil. We also collected specimens of *L. polystegum* in additional municipalities in the states of Ceará (Brejo Santo and Mauriti), and Pernambuco (Cabrobó, Floresta, Custódia and Sertânia).

Collecting permit was issued by Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (IBAMA) (# 95/2012, process nº 02001.003718/94-54); field work supported by Ministério da Integração Nacional.

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***PLESTIODON FASCIATUS* (Common Five-lined Skink)** USA: GEORGIA: Coweta Co.: Senoia (33.27082°N, 84.6206°W; WGS 84). 19 June 2013. Verified by Michael Bender. Gordon State College Collection of Vertebrates (GSC 040) New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens, Georgia. 575 pp.). Freshly dead adult specimen with a broken tail. Specimen collected under a Georgia Department of Natural Resources Scientific Collecting Permit (29-WJH-13-126, CN 25018).

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***PLESTIODON LATICEPS* (Broad-headed Skink)**. USA: TENNESSEE: Weakley Co.: Big Cypress Tree State Natural Area (36.19228°N, 88.89211°W; WGS 84). 18 August 2013. Michael C. Fulbright and James P. Flaherty. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19463). New county record (Scott and Redmond 2008 [latest update: 1 August 2013]. Atlas of Reptiles in Tennessee. The Center of Excellence for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at

http://apsu.edu/reptatlas/ [accessed 19 August 2013]). Juvenile hand captured under log along nature trail.

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***SCINCELLA LATERALIS* (Little Brown Skink)**. USA: GEORGIA: Lamar Co.: Barnesville (33.03123°N, 84.18795°W; WGS 84). 13 June 2013. Zachary Burke. Verified by Gregory D. Hartman. Gordon State College Collection of Vertebrates (GSC 039). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens, Georgia. 575 pp.). Specimen collected under a Georgia Department of Natural Resources Scientific Collecting Permit (29-WJH-13-126, CN 25018).

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***TROPIDOPHORUS THAI* (Thai Water Skink)**. THAILAND: LOEI PROVINCE: Phu Rue District: Phu Luang Wildlife Sanctuary, Phu Luang Wildlife Research Station (17.342965°N, 101.508783°E, WGS 84; ca. 980 m elev.). Khon Kaen University Vertebrate Collection (KKUD 2013.3a–g). Y. Chuaynkern (KKUD 2013.3a) and Attapol Rujirawan (KKUD 2013.3b–g). 20 October 2013. Verified by Sunchai Makchai. Under rock on bank of artificial reservoir during day. Adult male, SVL 86.3 mm, TL 65.3 mm (tail regenerated), head width 9.7 mm. Scale row at mid-body 34; other morphological characteristics fit description and identification key (Taylor 1963. Univ. Kansas Sci. Bull. 44:687–1077). Released after examination and photography. First provincial record for Loei Province and first record for NE Thailand, ca. 325 km SE of previous nearest locality ("Pa Meang, Me Wang District," Chiang Mai Province; Taylor 1963, *op. cit.*). Previously known from northern Thailand, in Chiang Mai and Mae Hong Son provinces (Chuaynkern and Chuaynkern 2012. J. Wildl. Thailand 19:75–162).

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***TROPIDURUS HISPIDUS* (Peters' Lava Lizard)**. BRAZIL: AMAPÁ: Municipality of Macapá: Campus da Universidade Federal do Amapá (0.006111°N, 51.0825°W; datum WGS84). 26 September 2011. Verified by T. C. S. Ávila-Pires. Collection of the Universidade Federal do Amapá – UNIFAP, Macapá, Brazil (CDLABZOO 111, Chico Mendes Institute for Biodiversity Conservation permission number 31814-2). This species is a widely distributed neotropical lizard, occurring from northeast Brazil in eastern limit in the state of Maranhao, north of the Amazon River (state of Para), central Amazon (state of Amazonas), southern part of French Guiana, Suriname, Guyana, and Venezuela (Ávila-Pires 1995. Zool. Verh. Leiden. 299:1–706). First state record, partially filling the gap between French Guiana and Pará by about 225 km to the northwest.

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***UROSAURUS GRACIOSUS* (Long-tailed Brush Lizard)**. USA: ARIZONA: Maricopa Co.: Hummingbird Spring Wilderness (33.589°N, 113.059°W; NAD 83; elev. 484 m). 13 August 2013. Keith Sullivan and Hunter McCall. Verified by Brian K. Sullivan (Museum of Vertebrate Zoology observation [MVZ obs Herp # 15 photo voucher]). This specimen extends the range 56 km SW of the nearest locality, Wickenburg, Arizona (Brennan and Holycross 2006. A Field Guide to Amphibians and Reptiles in Arizona. Arizona Game and Fish Department, Phoenix. v + 150 pp.). Reduces the apparent gap within the distribution of this lizard in western Arizona. The lizard (and others observed by the authors at this site) was 2 m off the ground in an Ironwood Tree (*Olynea tesota*) in a rocky, upland habitat rather than in a sandy riparian corridor more typically frequented by this species elsewhere in central Arizona. The specimen possessed uniformly enlarged scales over the dorsal mid-line, and a tail length over twice the snout–vent length.

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SQUAMATA — SNAKES

***AGKISTRODON CONTORTRIX* (Copperhead)**. USA: GEORGIA: Lamar Co.: Grape Creek Road in Milner (33.10766°N, 84.22294°W; WGS 84). 30 October 2013. Michael J. Bender. Verified by Gregory D. Hartman, Gordon State College Vertebrate Collections (GSC 034). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens, Georgia. 575 pp.). This species has been documented in three (Monroe, Spalding, and Upson) of the five adjoining counties (Jensen et al. 2008, *op. cit.*). Specimen collected under a Georgia Department of Natural Resources Scientific Collections Permit (29-WJH-13-126).

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***AGKISTRODON CONTORTRIX* (Copperhead)**. USA: TENNESSEE: Gibson Co.: Milan Army Ammunition Plant (35.855833°N, 88.721388°W; NAD 83). 8 August 2013. James P. Flaherty, Michael C. Fulbright, Shawn P. Settle, and Aaron T. Ross. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19449). First vouchered record for county (Scott and Redmond 2008 [latest update: 30 May 2013]. Atlas of Reptiles in Tennessee. The Center of Excellence for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/ [accessed 6 September 2013]).

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APOSTOLEPIS FLAVOTORQUATA. BRAZIL: MINAS GERAIS: Municipality of Manga: ca. 14.75°S, 43.94°W (datum SAD 69). Locality in area of transition between Cerrado and Caatinga biome. July 1998. Adriano Lima Silveira. T. D. L. Museu Nacional, Rio de Janeiro, RJ, Brazil (MNRJ 6476). Verified by R. Fernandes. Species previously known from the states of Pará, Bahia, Tocantins, Goiás, Mato Grosso, Mato Grosso do Sul, and São Paulo, and Distrito Federal, in Brazil (Ferrarezzi et al. 2005. Pap. Avuls. Zool. 45[16]:215–229; Lema and Renner 2005. Biociências 13[2]:163–175). Lema and Renner (2005, *op. cit.*) commented that the species has been seen in state of Minas Gerais, but showed no locality record. This is the first record with specified locality in Minas Gerais, ca. 110 km SE from Coribe (Bahia) and ca. 410 km E from Zoological Park of Brasília (Distrito Federal), the nearest localities of prior registration (Lema 2001. Cuad. Herpetol. 15[1]:29–43; Lema and Rennes 2005, *op. cit.*).

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COLUBER CONSTRICTOR **(North American Racer)**. USA: TENNESSEE: Lauderdale Co.: Gates (35.833055°N, 89.389444°W; NAD 83). 17 August 2013. James P. Flaherty and Michael C. Fulbright. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19443). New county record (Scott and Redmond 2008 [latest update: 30 May 2013]. Atlas of Reptiles in Tennessee. The Center of Excellence for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/ [accessed 6 September 2013]). Nearest record ca. 18 km E in Crockett Co.

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DIADOPHUS PUNCTATUS **(Ring-necked Snake)** USA: GEORGIA: Henry Co.: McDonough, Highway 55 (33.4444°N, 84.1510°W; WGS 84). 31 May 2013. Austin Dean and Ashley Dean. Verified by Gregory D. Hartman. Gordon State College Collection of Vertebrates (GSC 037). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens, Georgia. 575 pp.). Specimen collected under a Georgia Department of Natural Resources Scientific Collecting Permit (29-WJH-13-126, CN 25018).

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DIADOPHIS PUNCTATUS EDWARDSII **(Northern Ring-necked Snake)**. USA: MINNESOTA: Cook Co.: Tofte Ranger Station parking lot (47.569068°N, 90.850293°W; WGS84). 8 August 2013. David Grosshuesch. Verified by Benjamin Lowe. JFBM 18789. New county record (Oldfield and Moriarty 1994. Reptiles and Amphibians Native to Minnesota. Univ. Minnesota Press, Minneapolis. 240 pp.). Range extension of ca. 17.88 km ENE from nearest voucher in adjacent Lake Co. (FMNH 283345). Road kill. Two additional non-vouchered Cook Co. records were acquired from the nearby Temperance River valley: 47.610640°N, 90.905980°W (WGS84), on 17 June 2012; and 47.556112°N, 90.873611°W (WGS84), on 17 September 2012.

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DIADOPHIS PUNCTATUS EDWARDSII **(Northern Ring-necked Snake)**. USA: OHIO: Harrision Co.: Washington Township, Keen Wildlife Area, Craigo Road (40.29527°N, 81.31851°W; WGS84). 23 August 2013. Jeffrey G. Davis. Verified by John W. Ferner. Cincinnati Museum Center (CMC 12366). New county record (Wynn and Moody 2006. Ohio Turtle, Lizard and Snake Atlas. Ohio Biol. Surv. Misc. Contrib. No. 10). Voucher specimen collected under a permit from the Ohio Division of Wildlife.

JEFFREY G. DAVIS, Cincinnati Museum Center – Fredrick and Amye Geier Research and Collections Center, 1301 Western Avenue, Cincinnati, Ohio 45203-1130, USA; e-mail: ohiofrogs@gmail.com.

DIPSAS ARTICULATA **(Red-striped Thirst Snake)**. REPUBLIC OF PANAMA: COCLÉ: Parque Nacional G. D. Omar Torrijos Herrara (8.666667°N, 80.616667°W; WGS84), 718 m elev. 17 January 2012. J. A. Vecchiet, J. M. Ray, J. L. Knight, K. Knight, and J. Wedow. Verified by Jonathan Campbell. UTADC 7415–7416. First record for Coclé and an upper elevation extension of ca. 218 m, from closest previously known localities in Veraguas Province to the west, and Panama Province to the east (Köhler 2008. Reptiles of Central America, 2nd ed. Verlag Elke Köhler, Offenbach, Germany. 400 pp.). The male snake was found coiled on a tree branch ca. 2 m above a narrow foot trail in mid-elevation cloud forest.

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HETERODON PLATIRHINOS **(Eastern Hog-nosed Snake)**. USA: ALABAMA: Wilcox Co.: Wooded area 3.5 miles S of Camden on AL 265 (31.958227°N, 87.268424°W; WGS 84). 14 October 2013. Kristin A. Bakkegard. Verified by David Laurencio (AHAP-D 746 photo voucher). New county record (Mount 1975. Amphibians and Reptiles of Alabama. Auburn University Agricultural Experiment Station, Auburn, Alabama. 347 pp.). A search of 61 museum databases (HerpNET2, http://www.herpNet2.org/ accessed 29 Oct 2013) and the AUM database show no voucher specimens for Wilcox Co., even though this species is supposedly found statewide in Alabama. An adult snake found midmorning; black dorsum and ventral surface and a white chin. Two other live specimens were observed at this locality. I thank Mr. Tommy Lawler for allowing access to his property.

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HETERODON PLATIRHINOS **(Eastern Hog-nosed Snake)**. USA: TENNESSEE: Cheatham Co.: Cheatham Wildlife Management Area (36.2029°N, 87.1008°W; NAD 84). 21 October 2009. Terry Hopkins. Verified by A. Floyd Scott. David H. Snyder Museum of Zoology, Austin Peay State University (APSU 19281). New county record (Scott and Redmond 2008 [latest update: 31 August 2013]. Atlas of Reptiles in Tennessee. The Center for

Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/ [accessed 9 October 2013]). Captured in pitfall adjacent to small man-made pond in woods opening.

TERRY HOPKINS, Department of Biology, Austin Peay State University, Clarksville, Tennessee 37044, USA; e-mail: Terry.Hopkins@tn.gov.

***LAMPROPELTIS TRIANGULUM* (Milksnake)**. USA: TENNESSEE: Cheatham Co.: Cheatham Wildlife Management Area (36.2029°N, 87.1008°W; NAD 84). 21 October 2009. Terry Hopkins. Verified by A. Floyd Scott. David H. Snyder Museum of Zoology, Austin Peay State University (APSU 19282, 19285). New county record (Scott and Redmond 2008 [latest update: 31 August 2013]. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/ [accessed 9 October 2013]). One specimen found alive under metal cover object, the other DOR.

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***MASTICOPHIS* (= *COLUBER*) *TAENIATUS* (Striped Whipsnake)**. MÉXICO: CHIHUAHUA: Municipality of Casas Grandes: Rancho Pilares (29.926099°N, 108.071504°W; WGS84), 1980 m elev. 27 April 2013. Zaira Y. González Saucedo and Federico Mora. Verified by Bradford Hollingsworth. SDSNH HerpPC 05218–219. First municipality record, extending the known distributional range of the species ca. 70.8 airline km W from the closest known locality, 12 km E of Buenaventura, Chihuahua, and ca. 84.6 airline km N from 19.6 km NW of Yepómera, Municipality of Temósachic, Chihuahua (Lemos-Espinal et al. 2007. Anfibios y Reptiles del Estado de Chihuahua. CONABIO, and UNAM, Mexico. 613 pp.). The snake was found basking in oak savanna.

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MICRURUS BRASILIENSIS. BRAZIL: MINAS GERAIS: Municipality of João Pinheiro: ca. 17.75°S, 46.18°W (datum SAD 69). Locality within Cerrado biome. 1997. A. L. Silveira. Verified by R. Fernandes. Museu Nacional / Universidade Federal do Rio de Janeiro, Rio de Janeiro, RJ, Brazil (MNRJ 14977). Species previously known from southwest of Maranhão, Tocantins, Bahia, north of Goiás and north of Minas Gerais (municipalities of Manga and Januária), in Brazil (Cintra et al. 2009. Check List 5[3]:570–576; Lira-da-Silva et al. 2009. Gaz. Méd. Bahia 79[1]:7–20; Recoder et al. 2011. Biota Neotrop. 11[1]:263–282; Roze 1967. Am. Mus. Novit. 2287:1–60.; Silva Jr. 2007. Estudos 34[11/12]:931–956; Silva Jr. and Sites Jr. 1999. Herpetol. Monogr. 13:142–194; Vitt et al. 2005. Spec. Publ. Herpetol., Sam Noble Oklahoma Mus. Nat. Hist. 2:1–24). This is the third record for Minas Gerais and the southern limit of the known geographic distribution of species, ca. 310 km SW of Januária (Minas Gerais), the nearest locality of previous record (Roze 1967, *op. cit.*; Silva Jr. and Sites Jr. 1999, *op. cit.*).

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***NERODIA CLARKII* (Gulf Salt Marsh Snake)**. USA: LOUISIANA: Tangipahoa Parish: Manchac Land Bridge Area (30.24°N, 90.40°W; WGS84). 7 September 2012. Logan D. McCardle, Anthony Haase, and Clifford L. Fontenot. Verified by Brian I. Crother. Southeastern Louisiana University Department of Biological Sciences Vertebrate Museum (SLU 01042). New parish record (Dundee and Rossman 1996. The Amphibians and Reptiles of Louisiana. Louisiana State University Press, Baton Rouge Louisiana).

After the flooding from Hurricane Isaac (August 2012) subsided, we collected three individuals of *Nerodia clarkii* (SLU 01042, 01043, and a juvenile) on U.S. Highway 51, approximately 16.7 km S of the junction between Interstate 55 near the town of Ponchatoula. Three additional specimens were collected during surveys in 2013, but were not preserved because of poor condition. These snakes were encountered during weekly sampling, as part of a snake assemblage monitoring road survey that has been ongoing for 10 years (2003–2013) along a 37-km segment of U.S. Highway 51, the Manchac Land Bridge Area, which transects the wetland that divides Lakes Pontchartrain and Maurepas. All specimens of *N. clarkii* were collected within 10 months following Hurricane Isaac.

There is a known deme of *N. clarkii* in Fontainebleau State Park in St. Tammany Parish approximately 30 km from where these individuals were collected, as well as others much farther south along the Gulf Coast. The appearance of these individuals in the Manchac Land Bridge Area (MLBA) is likely an artifact of record flooding that occurred in the area caused by storm surge and heavy rain events associated with Hurricane Isaac. Such storms often produce sustained east and south wind for several days, which drives water from the Gulf of Mexico westward through Lake Borgne, the Rigolets, Lake Pontchartrain, Pass Manchac, and into Lake Maurepas. The MLBA is normally dominated by fresh water marsh habitat with dynamic elevation gradients throughout. During our study, peak numbers of snakes collected on the road often followed flood events. The maximum elevation gradient in this marsh is 1.5 m; flooding events that exceed this cause snakes to seek refuge in the roadway.

Finding multiple individuals of this species immediately following a heavy flooding event suggests that such disturbances are possible mechanisms of dispersal, and that such events have likely occurred in the past. Because *N. clarkii* is typically associated with brackish marsh, its salinity preferences and other aspects of its ecology may have constrained past founders from establishing viable populations in the fresh marsh of the MLBA. However, salinity of the MBLA is increasing, and projected to continue increasing in the near future.

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***NINIA SEBAE* (Culebrilla del Cafe; Coffee Snake)**. PANAMA: CHIRIQUI: Distrito de Alto Boquete: Boquete (8.681472°N, 82.452567°W; WGS84), 744 m elev. 18 March 2013. Feliberto Quiroz Camarena. Verified by Robert C. Jadin. UTADC 8058. First record for Chiriquí Province, extending the geographic range ca. 80 airline km SE from the nearest location at Changuinola, Finca 8, Bocas del Toro (Ponce et al. 2008. Herpetol. Rev. 39:372). The snake was found on lawn near a house.

RYAN DURAN GEIGER and **NIKOLAS DURAN GEIGER**, 11 Cada de Piedra, La Tranca, Boquete, Chiriquí Province, Republic of Panama; **JULIE M. RAY**, La MICA Biological Station, El Copé de La Pintada, Coclé Province, Republic of Panama (e-mail: julie.ray@lamica.org).

PARAPHIMOPHIS RUSTICUS. BRAZIL: RIO DE JANEIRO: Municipality of Marica: ca. 22.93°S, 42.81°W (datum SAD 69). Locality inserted in the Atlantic Forest biome. 30–31 November 2009. M. C. B. Pereira, H. R. Silva, and R. M. Silveira. Verified by P. Passos. Museu Nacional / Universidade Federal do Rio de Janeiro, Rio de Janeiro, RJ, Brazil (MNRJ 8025). Species was previously known from the states of Minas Gerais, São Paulo, Paraná, Santa Catarina, and Rio Grande do Sul in Brazil, and Uruguay and Argentina (Pérez et al. 2012. Check List 8[4]:796–797; Scott Jr. et al. 2006. Pap. Avuls Zool. 46[9]:77–105.; Zaher 1996. Boll. Mus. Reg. Sci. Nat. Torino 14[2]:289–337). There are records for the state of Rio de Janeiro (Brazil), but with no informed locality (Bailey 1970. *In* Peters and Orejas-Miranda, Catalogue of the Neotropical Squamata: Part I Snakes, U.S. Natl. Mus. Bull. 297:261; Giraudo 2001. Serpientes de la Selva Paranaense y del Chaco Húmedo. L.O.L.A., Buenos Aires. p. 41; Rocha et al. 2004. Publ. Avul. Mus. Nac. 104:3–23). This is the first record with specified locality in Rio de Janeiro, and it expands the eastern limit of the known distribution, ca. 450 km NE from Campo Largo (São Paulo) and 630 km SE of Uberaba (Minas Gerais), the nearest localities of prior registration (Zaher 1996, *op. cit.*).

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PITUOPHIS MELANOLEUCUS **(Pinesnake)**. USA: GEORGIA: Turner Co.: Highway 107, 1 km W of Alapaha River (31.721190°N, 83.466210°W; WGS84). 9 June 2013. Alexander D. McKelvy and Alex Figueroa. Verified by Nicole Castleberry (Field Series # ADM1004, GMNH Voucher # 50415). New county record (Jensen et al. [eds.] 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). Found DOR in good condition and retained as a voucher. Tissue taken. Individuals have been found in similar habitat in nearby counties.

Collected under Georgia Department of Natural Resources Scientific Collecting Permit Number 29-WJH-13-64. Funding for ADM was provided in part by the Theodore Roosevelt Memorial Fund of the American Museum of Natural History.

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RAMPHOTYPHLOPS BRAMINUS **(Brahminy Blindsnake)**. USA: FLORIDA: St. Johns Co.: uptown St. Augustine near The Fountain of Youth (29.907045°N, 81.318962°W; WGS 84). 18 October 2013. Kerry L. Ceglady. Verified by Kevin M. Enge. Florida Museum of Natural History, UF 171460 (color photo). First voucher for the county (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final report, Florida Fish and Wildlife Conservation Commission, Tallahassee. 524 pp.). The northernmost record on the east coast of Florida is in Duval Co. (Krysko et al. 2011, *op. cit.*). Unrecorded from adjacent counties to south and west: Flagler, Putnam, and Clay. A single individual approximately 51 mm TL was discovered while weeding a flowerbed dominated by *Ruellia simplex*.

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REGINA SEPTEMVITTATA **(Queensnake)**. USA: OHIO: Fayette Co.: Concord Township, Rattlesnake Creek at Stafford Road SW (39.43090°N, 83.49605°W; WGS84). 19 August 2013. Greg Lipps, Jr. and Jeffrey G. Davis. Verified by John W. Ferner. Cincinnati Museum Center (CMC 12368). New county record (Wynn and Moody 2006. Ohio Turtle, Lizard and Snake Atlas. Ohio Biol. Surv. Misc. Contrib. No. 10). A second voucher (CMC 12311 with tissue) was taken on 19 August 2013. Voucher specimens collected under a permit from the Ohio Division of Wildlife.

GREG LIPPS, JR., 1473 County Road 5-2, Delta, Ohio 43515, USA (e-mail: GregLipps@gmail.com); **JEFFREY G. DAVIS**, Cincinnati Museum Center – Fredrick and Amye Geier Research and Collections Center, 1301 Western Avenue, Cincinnati, Ohio 45203-1130, USA (e-mail: ohiofrogs@gmail.com).

RODRIGUESOPHIS IGLESIASI. BRAZIL: MINAS GERAIS: Municipality of João Pinheiro: 17.766797°S, 46.152117°W (datum SAD 69), 864 m elev. Locality inserted in Cerrado biome, presenting Cerrado *sensu stricto* phytophysiognomy and sandy soil. 23 September 2008. A. L. Silveira. Verified by R. Fernandes. Museu Nacional / Universidade Federal do Rio de Janeiro, Rio de Janeiro, RJ, Brazil (MNRJ 17338). Species was previously known from the states of Piauí, Bahia, Tocantins, and northern Minas Gerais (Gomes 1915. Ann. Paul. Med. Cir. 4[6]:121–129; Pavan and Dixo 2004. Humanitas 4/6:13–130; Recoder and Nogueira 2007. Biota Neotrop. 7[3]:267–278; Recoder et al. 2011. Biota Neotrop. 11[1]:263–282; Rodrigues 1993. Pap. Avul. Zool. 38[11]:187–198; Vitt et al. 2005. Spec. Publ. Herpetol., Sam Noble Oklahoma Mus. Nat. Hist. 2:1–24). Second record for Minas Gerais state, expands the southern limit of the known geographic distribution of species ca. 140 km SW of Pirapora (Minas Gerais), the nearest locality of previous record (Rodrigues 1993, *op. cit.*).

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SONORA AEMULA **(File-tailed Ground Snake)**. MEXICO: CHIHUAHUA: Municipio de Moris: between Río Moris and Moris (28.174722°N, 108.535556°W; NAD27), 787 m elev. 26 June 1987. P. A. Holm and T. R. Van Devender. Verified by C. H. Lowe. UAZ 47431. First record for the municipio and northernmost locality for the state, extending the range 80 airline km N of San Antonio, Municipio de Chinipas (Lemos-Espinal and Smith 2007. Amphibians and Reptiles of the State of Chihuahua, Mexico. CONABIO, D. F. 14010, México, and UNAM, Tlalnepantla, México 54090, México). The snake was found DOR in tropical deciduous forest.

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SONORA AEMULA **(File-tailed Ground Snake)**. MEXICO: SONORA: Municipio de Hermosillo: Rancho Shanghai, 31.7 airline km E of Hermosillo (29.063056°N, 110.542778°W; NAD27), 419 m elev. 29 January 2012. T. R. Van Devender and A. L. Reina-Guerrero. Verified by E. F. Enderson and R. W. Van Devender. UAZ 57433-PSV. First record for the municipio and westernmost locality for the species, extending the range 109 km WNW of Tónichi (Nevares and Parra-Salazar 1990. Herpetol. Rev. 21:97). The snake was found in soil under a limestone rock located on steep hillside

covered with foothills thornscrub. Municipio de Moctezuma**:** Sierra de la Madera, Rancho Tonibabi, 11.2 airline km WNW of Moctezuma (29.850833°N, 109.5725°W; NAD27), 891 m elev. 7 March 2012. J. R. Hernandez-Jimenez. Verified by Erik F. Enderson. UAZ 57432-PSV. First record for the municipio, northernmost locality in the state, highest reported elevation for the species, and extends the range 139 km N of Tónichi (Nevares and Parra-Salazar 1990, *op. cit.*). The snake was found active on a sunny day at 1245 h on a rocky slope in a mountain canyon covered by mesquite thornscrub. Municipio de San Pedro de la Cueva: Sierra Agua Verde, Rancho Agua Caliente, 12.9 km E of San Pedro de la Cueva (29.276389°N, 109.868611°W: NAD27), 722 m elev. 31 January 2012. T. R. Van Devender and A. L. Reina-Guerrero. Verified by E. F. Enderson and R. W. Van Devender. UAZ 57434-PSV. First record for the municipio, and extends the range ca. 80 km NNW of Tónichi (Nevares and Parra-Salazar 1990, *op. cit.*). The snake was found in soil under a limestone rock located on steep hillside in foothills thornscrub.

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***STORERIA DEKAYI* (Dekay's Brownsnake)**. USA: GEORGIA: Henry Co.: Hampton (33.3658°N, 84.3081°W; WGS 84). 11 June 2013. Sara Croft. Verified by Michael J. Bender. Gordon State College Collection of Vertebrates (GSC 038). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens, Georgia. 575 pp.). Specimen collected under a Georgia Department of Natural Resources Scientific Collecting Permit (29-WJH-13-126, CN 25018).

AMANDA L. J. DUFFUS (e-mail: aduffus@gordonstate.edu), **SARA CROFT** (e-mail:sc164482@gordonstate.edu), and **GREGORY D. HARTMAN,** Gordon State College, Barnesville, Georgia 30204, USA (e-mail:ghartman@gordonstate.edu) .

***STORERIA OCCIPITOMACULATA OCCIPITOMACULATA* (Northern Red-bellied Snake)**. USA: ALABAMA: Escambia Co.: County Road 4, 1 mi. W. of Holley Ln intersection (31.03298°N 86.72265°W; WGS 84). 25 May 2013. J. Williams, B. Battistella, and S. Graham. Verified by David Laurencio. AUM AHAP-D 684 (digital photograph). New county record (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn Printing Co., Auburn. 347 pp.). Specimen collected alive on road. Funding was provided by a Research Experience for Undergraduates (REU) grant to Jennie Williams and a National Science Foundation grant (IOS-1051367, DEB- 0949483) to Tracy Langkilde.

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***UROTHECA FULVICEPS* (Red-headed Glasstail)**. PANAMA: COCLÉ: Distrito de El Harino: El Copé (8.627797°N, 80.579148°W; WGS84), 410 m elev. 20 March 2013. Julie M. Ray. Verified by Robert C. Jadin. UTADC 8057. New record for Coclé Province, and provides a record between known populations in the Panama Canal Zone (ca. 150 airline km NE) and the Osa Peninsula of Costa Rica (ca. 300 airline km SW) (Köhler 2008. Reptiles of Central America, 2nd ed. Verlag Elke Köhler, Offenbach, Germany. 400 pp.). The snake was found crawling on the ground at La MICA Biological Station in tropical wet forest.

JULIE M. RAY and **PABLO SANTANA**, La MICA Biological Station, El Copé de La Pintada, Coclé Province, Republic of Panama (e-mail: julie.ray@lamica.org).

***VIRGINIA STRIATULA* (Rough Earthsnake)**. USA: ARKANSAS: Calhoun Co.: ~10 km N of Calion, 1 km E jct of US 167/ Co. Rd. 29 (33.407788°N, 92.474359°W; WGS 84). 6 October 2013. M. B. Connior. Verified by S. E. Trauth. Arkansas State University Museum of Zoology Herpetology Collection (ASUMZ 32810). New county record filling a distributional hiatus between previous records in Dallas, Bradley, Ouachita, and Union counties in southern Arkansas (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville. 421 pp.).

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***VIRGINIA VALERIAE* (Smooth Earthsnake)**. USA: GEORGIA: Lee Co.: Leesburg, residential area at 276 Creekside Drive (31.658681°N, 84.183572°W; WGS 84). 05 October 2013. Roger Mann and Angel Shepard. Verified by John Jensen. Georgia Museum of Natural History (GMNH 50518). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.).

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A Herpetofaunal Survey of Pike County, Alabama, USA

Recent examinations of historical and current records for Pike Co., Alabama, USA, indicate that there are 35 amphibian and reptile species that have never been accounted for in the county but that might otherwise be expected to occur there (Mount 1975). Of species known to occur in Pike Co., 16 are listed as moderate conservation concern, six species as high conservation concern, and two as highest conservation concern (Alabama Natural Heritage Program 2011). A systematic program of field observation of amphibians and reptiles in Pike Co. started with the field vertebrate zoology course at Troy University, and will continue on public lands with diverse habitats. Pike Co., Alabama is located in the southeastern section of the state, and has a total area of ca. 1740 km^2 or 174,128 hectares (USDA 1997), including the Pocosin Forever Wild Tract.

To obtain an estimate of the herpetological diversity in the county, all major habitats were sampled following all professional and state guidelines for observation, capture, and/or release. Weekly collections (if applicable) and observations were made each month from January through December. Documentation of any observed herpetological specimens include photographs and notes regarding surrounding habitat, specific GPS location of collecting site, the number of specimens observed and/or collected, and sampling methodology (handling procedure). The datum for all GPS coordinates is WGS 84.

With the assistance of Auburn University, records were vouchered as specimens or digital photographs, and deposited in the Troy University Zoological Collections and in the Herpetological Collections of Auburn University. All records were verified by David Laurencio. All specimens reported here represent new county records based on Mount (1975).

The data gathered from this study will provide a better understanding of the status and distribution of amphibians and reptiles in Pike Co., and we hope will promote conservation plans, help establish better land management practices, and be used as baseline data for a long-term monitoring program. Likewise, the results can be used to inform the public of the diversity of amphibian and reptile species in Pike Co.

CAUDATA — SALAMANDERS

***AMBYSTOMA MACULATUM* (Spotted Salamander)**. Beeman Creek (31.884344°N 86.032080°W). 29 February 2012. Jamie Burchill and Alvin Diamond. AHAP-D 721 (digital photograph). Found in leaf litter beneath a fallen log near a wetland.

***DESMOGNATHUS CONANTI* (Spotted Dusky Salamander)**. Pike County Pocosin Forever Wild Land Tract (31.786228°N, 85.890171°W). 10 April 2013. Jamie Burchill and Alvin Diamond. Troy University Zoological (TROY000000013). Found under a fallen log in leaf litter in a wetland area adjacent to ravine stream.

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***PLETHODON GROBMANI* (Southeastern Slimy Salamander)**. Pike County Lake (31.748716°N, 85.994754°W). 27 February 2013. Jamie Burchill. TROY00000009. Found in leaf litter beneath a fallen log.

***PSEUDOTRITON RUBER VIOSCAI* (Southern Red Salamander)**. Troy University Arboretum (31.793722°N, 85.962361°W). 27 January 2000. Alvin Diamond. TROY000000010. Found under a fallen pine log on the Magnolia Loop Nature Trail. Uncommon.

ANURA — FROGS

***ACRIS CREPITANS* (Northern Cricket Frog)**. Beeman Creek (31.884306°N, 86.032083°W). 27 March 2013. Jamie Burchill, Jacob Carnley, and Alvin Diamond. TROY 000000032. In vegetation along creek.

***LITHOBATES SPHENOCEPHALUS* (Southern Leopard Frog)**. Troy University (31.801560°N, 85.957944°W). April 2011. Alvin Diamond. TROY000000017. Found in front of the library on campus.

TESTUDINES — TURTLES

***APALONE SPINIFERA* (Spiny Softshell)**. Conecuh River (31.804663°N, 86.048284°W). 23 April 2011. Jamie Burchill. AHAP-D 728 (digital image). Found caught on fishing line. Removed from line and released into river.

***CHELYDRA SERPENTINA* (Snapping Turtle)**. Troy, Green Drive (31.80289°N, 85.99662°W). 17 April 2012. Jamie Burchill. AHAP-D 722 (digital image). Found in wetland adjacent to private residence.

***GRAPTEMYS ERNSTI* (Escambia Map Turtle)**. Conecuh River (31.803686°N, 86.045512°W). 15 August 2011. Jeremy Browning, Jamie Burchill, Alvin Diamond, and Jonathan Miller. TROY000000057. Hatchling found dead on river bank.

***KINOSTERNON SUBRUBRUM* (Eastern Mud Turtle)**. Beeman Creek (31.88434°N, 86.03208°W). 29 February 2012. Jamie Burchill and Alvin Diamond. AHAP-D 725 (digital image). Collected and released by field vertebrate zoology students using hand and seine nets in vegetation along creek and wetland area.

***STERNOTHERUS MINOR* (Loggerhead Musk Turtle)**. Troy University Golf Course (31.807075°N, 85.955814°W). 6 March 2012. Jamie Burchill and Alvin Diamond. AHAP-D 726 (digital image). Collected and released by field vertebrate zoology students using hand nets in vegetation along creek.

***STERNOTHERUS ODORATUS* (Eastern Musk Turtle)**. Troy University Arboretum (31.793722°N, 85.962361°W). 30 January 2013. Jamie Burchill and Curtis Wortz. TROY000000058. Collected with dip net in vegetation.

***TRACHEMYS SCRIPTA* (Pond Slider)**. Conecuh River (31.804663°N, 86.048284°W). 26 April 2012. Jamie Burchill.

AHAP-D 723 (digital image). Observed basking on fallen log alongside riverbank.

SQUAMATA — LIZARDS

***HEMIDACTYLUS TURCICUS* (Mediterranean House Gecko)**. Troy, First Baptist Church (31.810048°N, 85.973256°W). 15 September 2013. Jamie Burchill. TROY000000062. Found in hallway of church.

***OPHISAURUS VENTRALIS* (Eastern Glass Lizard)**. Troy, Center Street (31.799167°N, 85.965000°W). 6 October 2007. Alvin Diamond and James Lewis. TROY000000056). Killed by a cat.

SQUAMATA — SNAKES

***AGKISTRODON CONTORTRIX* (Copperhead)**. Troy, Green Drive (31.80289°N, 85.99662°W). 21 September 2013. Jamie Burchill. TROY000000063. Found crossing road.

***CEMOPHORA COCCINEA* (Scarletsnake)**. Troy, Green Drive (31.80289°N, 85.99662°W). 23 July 2012. Jamie Burchill. AHAP-D 729 (digital image). Observed basking on sidewalk adjacent to lawn.

***LAMPROPELTIS GETULA* (Eastern Kingsnake)**. Troy, East Madison Street (31.803675°N 85.970897°W). 21 April 2012. Jamie Burchill, Alvin Diamond, and Chelsea Smith. TROY000000039. A student brought in DOR specimen for verification and placement in the collection.

***LAMPROPELTIS HOLBROOKI* (Speckled Kingsnake)**. Highway 29 (31.829722°N, 85.951667°W). 23 April 2003. Jimmie Bull and Alvin Diamond. TROY000000038. A student brought in DOR specimen for verification and placement in the collection.

***NERODIA ERYTHROGASTER* (Plain-bellied Watersnake)**. Conecuh River (31.80466°N, 86.04828°W). 23 April 2011. Jamie Burchill. AHAP-D 732 (digital image). Observed basking along river bank on fallen log.

***PANTHEROPHIS GUTTATUS* (Red Cornsnake)**. Brundidge, County Rd. 3325 (31.635467°N, 85.823783°W). 7 May 2013. Jamie Burchill and Jonathan Miller. AHAP-D 734 (digital image). Observed basking.

***TANTILLA CORONATA* (Southeastern Crowned Snake)**. Troy, Folmar Street. (31.800891°N, 85.962667°W). 1 October 2013. Murray Hyde. TROY000000060. Found in wooded area.

***THAMNOPHIS SAURITUS* (Eastern Ribbonsnake)**. Pike County Lake (31.748716°N, 85.994754°W). 27 February 2013. Jamie Burchill and Brandon Ford. TROY000000045. Caught by hand in wetland area adjacent to the lake.

***THAMNOPHIS SIRTALIS SIRTALIS* (Eastern Gartersnake)**. Troy University Golf Course (31.807075°N, 85.955814°W). 11 April 2009. Jamie Burchill. AHAP-D 735 (digital image). Observed basking in leaf litter next to a fallen log on edge of golf course.

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New Amphibian and Reptile County Records from Eastern Nebraska, USA

Ecoregions are areas which share similar ecosystems and environmental resources, and can provide a spatial framework for land and resource management. There are six distinct ecoregions in Nebraska, with the eastern portion of the state being in the Western Corn Belt Plains ecoregion (Omernik, 1987). Historically, this region was dominated by tallgrass prairie, but over 90% of the land has since been converted to croplands (Griffith et al. 1994, Kaul et al. 2006). Given this high level of habitat modification, much of this region has been poorly sampled for amphibians and reptiles and many distributional gaps likely exist in species' ranges.

Here, we report 16 new county records from the Western Corn Belt Plains of eastern Nebraska which are the result from recent survey efforts. Current county records were determined by examining Baldwin (1965), Ballinger et al. (2010), Fogell (2010), Hubbs (2013), Hudson (1942), Lynch (1985), and through individual records published in *Herpetological Review* since 2009. All voucher specimens were deposited at the Texas Natural History Collections (TNHC), and were verified by Travis J. LaDuc. Locality information was obtained via handheld GPS (WGS 84), and all nomenclature follows Crother (2012). Specimens were collected under a Nebraska Game and Parks Commission Scientific and Educational

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CAUDATA — SALAMANDERS

***AMBYSTOMA MAVORTIUM* (Barred Tiger Salamander).** Cedar Co.: Nebraska Open Fields and Water Program property, ca. 4.81 air km NW of Newcastle, NE (42.67356°N, 96.92579°W). 9 September 2013. Elizabeth A. Berg. TNHC 86205. Specimen collected from bottom of an abandoned cistern. This record fills a gap between Dakota Co. to the east and Cedar Co. to the west.

ANURA — FROGS

***HYLA CHRYSOSCELIS* (Cope's Gray Treefrog).** Cedar Co.: cattle pond on south side of 891 Rd at jct. with 573 Ave (42.74851°N, 97.08061°W). 24 May 2013. Cameron D. Siler. TNHC 86196. Chorusing male collected from vegetation along edge of pond. Dixon Co.: 588 Ave, 0.18 rd. km SW jct. NE Hwy 12 (42.60647°N, 96.78839°W). 29 May 2013. Drew R. Davis. TNHC 89199. Adult female collected from the middle of a gravel road. Previous records exist to the west in Knox Co. and across the Missouri River to the north in Yankton and Clay counties, South Dakota.

***LITHOBATES CATESBEIANUS* (American Bullfrog).** Butler Co.: Redtail Lake WMA (41.08841°N, 96.99875°W). 11 October 2013. Drew R. Davis. TNHC 86209. Juvenile collected along south shore of reservoir. Cedar Co.: Nebraska Open Fields and Water Program property, ca. 4.87 air km NE of Wynot, NE (42.75795°N, 97.11495°W). 7 June 2013. Drew R. Davis. TNHC 86200. Juvenile female collected in ravine between two cattle ponds. Cuming Co.: Black Island WMA (41.99968°N, 97.00950°W). 22 September 2013. Drew R. Davis. TNHC 86206. Adult female collected on north shore of Elkhorn River. Seward Co.: Twin Lakes WMA (40.82618°N, 96.94385°W). 11 October 2013. Drew R. Davis. TNHC 86208. Juvenile collected on SE shore of East Twin Lake. All records fill distributional gaps of this species in Nebraska.

***SPEA BOMBIFRONS* (Plains Spadefoot).** Cedar Co.: 573 Ave, 0.45 rd. km N jct NE Hwy 12 (42.69729°N, 97.07424°W). 27 May 2013. Danielle J. Quist. TNHC 86198. Adult male collected from the middle of a gravel road. Dixon Co.: 578 Ave, 0.98 rd. km NW jct. 8845 Rd (42.65567°N, 96.97668°W). 26 May 2013. Drew R. Davis. TNHC 86197. Adult male collected from the middle of a gravel road. These records fill a gap in their distribution between Dakota Co. to the east and Knox Co. to the west.

TESTUDINES — TURTLES

***APALONE MUTICA* (Smooth Softshell).** Stanton Co.: Wood Duck WMA (41.93866°N, 97.28041°W). 22 September 2013. Drew R. Davis. TNHC 86212. Juvenile collected on south shore of Elkhorn River. Previous records exist to the west in Madison Co.

***APALONE SPINIFERA* (Spiny Softshell).** Saunders Co.: Catfish Run WMA (41.05193°N, 96.33900°W). 31 August 2013. Spencer R. Siddons. TNHC 86211 (photo voucher). Juvenile collected on north shore of Salt Creek. This record fills a gap between Sarpy Co. to the east and Lancaster Co. to the south.

***CHELYDRA SERPENTINA* (Snapping Turtle).** Dixon Co.: NE Hwy 15, 0.09 rd. km S jct 887 Rd (42.69745°N, 96.95703°W). 27 September 2013. Drew R. Davis and Spencer R. Siddons. TNHC 86210. Adult female collected crossing the highway. Stanton Co.: Elkhorn River, ca. 2.71 air km ESE of Pilger, NE (42.00152°N, 97.02183°W). 22 September 2013. Drew R. Davis. TNHC 86207. Adult male collected in the water near the north shore of Elkhorn River. Both records fill distributional gaps of this species in Nebraska.

***CHRYSEMYS PICTA* (Painted Turtle).** Cedar Co.: Missouri River near Bow Creek Recreational Area (42.78109°N, 97.14404°W). 1 August 2013. Drew R. Davis and Spencer R. Siddons. TNHC 86203. Adult female collected in side pool of the Missouri River. This specimen fills a gap from a large area devoid of records in northeast Nebraska.

SQUAMATA — SNAKES

***THAMNOPHIS PROXIMUS* (Western Ribbonsnake).** Nemaha Co.: Langdon Bend WMA (40.34004°N, 95.65984°W). 31 August 2013. Drew R. Davis. TNHC 86204. Juvenile male collected in a culvert along an irrigation ditch. Specimen fills gap between Otoe Co. to the north and Richardson Co. to the south.

***THAMNOPHIS SIRTALIS* (Common Gartersnake).** Cedar Co.: Bow Creek Recreational Area (42.77880°N, 97.14577°W). 3 July 2013. Drew R. Davis. TNHC 86201. Adult male collected in a backwater channel of the Missouri River. This record fills a gap between Dixon Co. to the east and Knox Co. to the west.

Acknowledgments.—We are grateful for collecting assistance from E. Berg, A. Dececchi, K. Ferguson, R. Munes, D. Quist, and C. Siler, and to T. LaDuc for verifying all specimens.

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Hemidactylus turcicus, 15 New County Records from Southeast Texas, USA

The lack of records for the invasive Mediterranean Gecko (*Hemidactylus turcicus*) from several counties in southeast Texas was highlighted with the recent publication of Dixon (2013). Having informally observed them in several of these counties in years past, three evening road trips were made, each transecting three or six consecutive counties lacking records, with the intent of filling these records. Collecting sites were selected opportunistically. All specimens were collected from exterior walls of public structures. Structures made of stone, brick, cinder blocks, stucco, and wood were given preference over metal, corrugated tin, plastic, and vinyl sidings. Likewise, walls with weak, indirect lighting and little or no foot traffic were selected over well lit areas with frequent pedestrian traffic.

As an indication of the ubiquitous nature of *H. turcicus* in southeast Texas, multiple individuals were observed and a specimen was secured within one to two minutes of the first stop in nine (60%) of the counties (Falls, Leon, Madison, Polk, Robertson, Sabine, San Augustine, Waller, Washington). Multiple individuals were observed and a specimen secured within one to two minutes on the second stop in five (33.3%) of the counties (Liberty, Limestone, Newton, San Jacinto, Walker). Excluding Newton Co., in counties requiring two stops, the second stop was within ca. 1 km of the first. Only Austin Co. required three stops, all in the town of Bellville, however multiple individuals were observed and a specimen quickly secured there, too. In a few instances, geckos were observed from the car before coming to a complete stop.

County records are based on Dixon (2013). All specimens were collected by William and Limei Farr, deposited at the TNHC, and identifications were verified by Travis LaDuc. All coordinates are expressed using datum WGS84.

Davis (1974) reported that he was able to easily find about 40 localities with *H. turcicus* in south Texas between 1968 and 1974, although he believed those populations were disjunct and predominantly limited to major trucking routes at that time. My cursory surveys, as well as over 40 years of personal observations made in Texas, indicate *H. turcicus* is established throughout southeast Texas even in many remote areas away from trucking routes. Additionally, I observed *H. turcicus* on the exterior wall of a hotel on the evenings of 26 April–2 May 2013 in Randall Co. in the town of Canyon on Hwy 271 (4th Ave.) (34.98027°N, 101.91031°W; elev. 1077 m); however, no voucher was collected. It is likely that similar surveys to those described above would reveal numerous undocumented county records in other areas of Texas.

Austin Co.: Bellville, Hwy 36, 0.2 km S of intersection of Hwy 159 (29.94700°N, 96.25295°W; elev. 79 m). 6 July 2013. 2203 h. 29°C. TNHC 85898. Collected on shopping center wall.

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Falls Co.: Marlin, Hwy 7, 0.5 km E of intersection with 6 Hwy (31.30641°N, 96.86891°W; elev. 120 m). 20 July 2013. 2245 h. 26°C. TNHC 85907. Collected on wall of night club.

Leon Co.: Centerville, Hwy 45 at intersection of Hwy 7 (31.25879°N, 95.98600°W; elev. 121 m). 20 July 2013. 2105 h. 26°C. TNHC 85905. Collected on wall of restaurant/gas station.

Liberty Co.: Cleveland, Hwy 59 (69), 0.15 km NW of intersection of Hwy 105 (30.33704°N, 95.10070°W; elev. 40 m). 14 July 2013. 0242 h. 23°C. TNHC 85904. Collected on dumpster wall at hotel.

Limestone Co.: Groesbeck, Hwy 164, 2.1 km E of intersection with Hwy 14 (31.51595°N, 96.51572°W; elev. 137 m). 20 July 2013. 2204 h. 26°C. TNHC 85906. Collected on wall of funeral home.

Madison Co.: Madisonville, Hwy 190, 3.7 km SW of Hwy 45 (30.94825°N, 95.91649°W; elev. 83 m). 21 July 2013. 0058 h. 23°C. TNHC 85909. Collected from wall of Texas Farm Bureau.

Newton Co.: Trout Creek, Hwy 87, 0.4 km S of the intersection of Hwy 1004 (30.61347°N, 93.80912°W; elev. 23 m). 13 July 2013. 2139 h. 29°C. TNHC 85899. Collected on wall of convenience store.

Polk Co.: Hwy 59 (69) 15 km NNE of Livingston (30.83892°N, 94.86262°W; elev. 77 m). 14 July 2013. 0134 h. 24.5°C. TNHC 85902. Collected on wall of highway rest area.

Robertson Co.: Calvert, Hwy 6 at intersection with Hwy 1644 (30.97671°N, 96.67364°W; elev. 100 m). 20 July 2013. 2317 h. 26°C. TNHC 85908. Collected on gas station wall.

Sabine Co.: Hemphill, Hwy 87 at intersection with Hwy 184 (31.34270°N, 93.84677°W; elev. 88 m). 13 July 2013. 2258 h. 28°C. TNHC 85900. Collected on wall of grocery store.

San Augustine Co.: San Augustine, Hwy 21, at intersection with Hwy 147 (31.52828°N, 94.10026°W; elev. 119 m). 13 July 2013. 2338 h. 26.5°C. TNHC 85901. Collected on wall of gas station.

San Jacinto Co.: Shepherd, Hwy 59 (69), 1.1 km N of intersection with Hwy 150 (30.51105°N, 94.98815°W; elev. 42 m). 14 July 2013. 0209 h. 24°C. TNHC 85903. Collected on wall of gas station.

Walker Co.: Huntsville, Interstate Hwy 45 (30.71580°N, 95.57006°W; elev. 130 m). 21 July 2013. 0158 h. 24°C. TNHC 85910. Collected on shopping center wall.

Waller Co.: Haley Road 0.13 km W of the intersection with Hwy 362 (30.03155°N, 95.94435°W; elev. 80 m). 6 July 2013. 2031 h. 30°C. TNHC85896. Collected on the front porch of closed restaurant.

Washington Co.: Chappell Hill, Hwy 290 at intersection with Hwy 1155 (30.13645°N, 96.25590°W; elev. 99 m). 6 July 2013. 2057 h.

30°C. TNHC 85897. Collected on dumpster wall at restaurant/gas station.

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New County Records for Amphibians and Reptiles of Georgia, USA

Range maps published in *Amphibians and Reptiles of Georgia* (Jensen et al. 2008) provide a ready source of information on known distributions, as well as distributional gaps, for each species occurring in the state. Accordingly, numerous naturalists and herpetologists have pursued, acquired, and submitted verifiable photographic images or specimen vouchers of amphibians and reptiles to regional museums and to the Georgia Department of Natural Resources that represent county firsts for those species. All records below were verified by Nikole Castleberry (GMNH), Kenneth L. Krysko (UF), and Lance D. MacBrayer (GSU), and datum used was WGS84 except where noted otherwise.

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CAUDATA — SALAMANDERS

***AMBYSTOMA MACULATUM* (Spotted Salamander).** TOOMBS CO.: SR 1 at Altamaha River, 18.2 km NNW Baxley (31.942230°N, 82.355531°W). 8 July 2013. D. Stevenson. GMNH 50359.

***EURYCEA CIRRIGERA* (Southern Two-lined Salamander).** APPLING CO.: Moody Forest Natural Area, 16.7 km NNE Baxley (31.927000°N, 82.312070°W). 23 December 2001. D. Stevenson and R. Owens. GSU 17126.

***EURYCEA LUCIFUGA* (Cave Salamander).** FLOYD CO.: Unnamed cave on Rocky Mountain Public Fishing Area (34.358356°N, 85.270333°W). 11 August 2012. B. Tyler and N. Thomas. GMNH 50171. MURRAY CO: Fincher Bluff Cave (34.71969°N, 84.85356°W). 24 May 2013. J. Spence. GMNH 50345.

***NOTOPHTHALMUS VIRIDESCENS* (Eastern Newt).** GWINNETT CO.: Ivy Creek, Gwinnett Environmental and Heritage Center, 0.3 km NW Mall of Georgia Boulevard & Woodward Mill Road (34.06233°N, 83.99851°W). 4 May 2012. D. Duff. UF 168697.

***PSEUDOTRITON MONTANUS* (Mud Salamander)** TOOMBS CO.: Seepage along Swift Creek at SR 152 3.0 km NE Lyons (32.222052° N, 82.298348°W). 15 May 1999. R. Moulis, R. Moulis, Jr., and J. Blue, Jr. GSU 22179.

***PSEUDOTRITON RUBER* (Red Salamander).** MONTGOMERY CO.: Seepage associated with Cypress Creek at CR 34 3.5 km SSW Tarrytown (32.285722°N, 82.570124°W). 15 May 1999. R. Moulis, R. Moulis, Jr., and J. Blue, Jr. GSU 22195.

ANURA — FROGS

***HYLA SQUIRELLA* (Squirrel Treefrog).** HEARD CO.: Charlie B. Johnston Road 1.6 km S of jct. with Otis Ransby Road (33.287600°N, 84.984683°W). 18 June 2013. J. Fields. GMNH 50356.

***LITHOBATES SPHENOCEPHALUS* (Southern Leopard Frog).** JEFF DAVIS CO.: Bullard Creek Wildlife Management Area, 15.9 km NNE Hazlehurst (31.967075°N, 82.473510°W). 23 September 2012. J. Oguni and D. Stevenson. UF 168714.

***LITHOBATES VIRGATIPES* (Carpenter Frog)**. McIntosh Co.: 5.4 km SSW Eulonia (31.501349°N, 81.469804°W). 29 March 1995. R. Moulis and G. Williamson. GSU 23851.

TESTUDINES — TURTLES

***APALONE FEROX* (Florida Softshell)**. Dodge Co.: Eastman (32.21054°N, 83.16012°W). 14 June 2013. T. Peacock. GMNH 50335. Jeff Davis Co.: 11.8 km SSW Snipesville (31.677867°N, 82.827299°W). 15 May 1985. F. Snow. GMNH 50353. Telfair Co.: 2.5 km SW Lumber City (31.912935°N, 82.697685°W). 2 October 2012. K. Stohlgren. UF 134829.

***APALONE SPINIFERA* (Spiny Softshell)**. Bulloch Co.: 10.3 km ESE Statesboro (32.427596°N, 81.676590°W).1 August 2013. M. Moore. GMNH 50391.

***CHELYDRA SERPENTINA* (Snapping Turtle)**. Murray Co.: Buck Creek (34.666408°N, 84.791914°W). 30 May 2013. J. Spence. GMNH 50343.

***CHRYSEMYS PICTA* (Painted Turtle)**. Murray Co.: Buck Creek (34.832967°N, 84.794275°W). 30 May 2013. J. Spence. GMNH 50344.

***CLEMMYS GUTTATA* (Spotted Turtle)**. Pierce Co.: 17.2 km NW Blackshear (31.389625°N, 82.394549°W). 6 April 2013. W. L. Bond, Jr. GMNH 50392.

***DEIROCHELYS RETICULARIA* (Chicken Turtle)**. Bulloch Co.: Lee Pond, 10.2 km ESE Statesboro (32.428686°N, 81.677453°W; NAD 83). 14 January 2013. M. Moore. UF 169390.

***PSEUDEMYS CONCINNA* (River Cooter)**. Madison Co.: 236 Doe Run Circle, Hull (34.141920°N, 83.279427°W). 1 June 2013. W. L. Bond. GMNH 50333.

***PSEUDEMYS FLORIDANA* (Florida Cooter)**. Talbot Co.: 1.2 km SW Geneva (32.574893°N, 84.562298°W). 27 April 2013. D. Stevenson. GMNH 50389.

***STERNOTHERUS MINOR* (Loggerhead Musk Turtle)**. Laurens Co.: Oconee River at Brickyard Landing Road, Dublin (32.500092°N, 82.874851°W; NAD 83). 26 August 2012. P. Frank. UF 168702. Long Co.: Morgan Lake, 2.3 km NE Doctortown (31.66887°N, 81.813548°W). 22 September 2012. K. Stohlgren. UF 168707.

***STERNOTHERUS ODORATUS* (Eastern Musk Turtle)**. Greene Co.: 3.9 km NNW Greshamville (33.659173°N, 83.338420°W). 30 June 2013. B. Stevenson and D. Stevenson. GMNH 50385. Laurens Co.: Oconee River 1.1 km N of Interstate 16, Dublin (32.48936°N, 82.86544°W; NAD 83). 26 August 2012. P. Frank. UF 168701. Murray Co.: Buck Creek (34.664622°N, 84.782197°W). 30 May 2013. J. Spence. GMNH 50340.

***TERRAPENE CAROLINA* (Eastern Box Turtle)**. Towns Co.: Swallow Creek Wildlife Management Area (34.86076°N, 83.67033°W). 6 July 2011. D. Duff. UF 168713.

***TRACHEMYS SCRIPTA* (Pond Slider)**. Murray Co.: Pettiet Branch (34.686758°N, 84.867027°W). 23 May 2013. J. Spence. GMNH 50341.

CROCODYLIA — CROCODILIANS

***ALLIGATOR MISSISSIPPIENSIS* (American Alligator)**. Jeff Davis Co.: Bullard Creek Wildlife Management Area, 15.9 km NNE Hazlehurst (31.967075°N, 82.473510°W). 28 August 2010. D. Stevenson. UF 168710.

SQUAMATA — LIZARDS

***ASPIDOSCELIS SEXLINEATA* (Six-lined Racerunner)**. Dawson Co.: Dawson Forest Wildlife Management Area (34.36615°N, 84.16686°W). 4 July 2012. J. Flynn. UF 168015. Jeff Davis Co.: Bullard Creek Wildlife Management Area, 15.2 km NE Hazlehurst (31.957625°N, 82.471536°W). 23 September 2012. D. Stevenson and J. Oguni. UF 168709. Spalding Co.: University of Georgia Demonstration Garden, 1109 Experiment Station Street, Griffin (33.261288°N, 84.281476°W). 10 July 2013. T. Johnson. GMNH 50357.

***HEMIDACTYLUS TURCICUS* (Mediterranean Gecko)**. Bartow Co.: Red Top Mountain State Park (34.13837°N,84.70647°W). 27 July 2012. M. Ray. UF 166735. Bryan Co.: 67 Cranston Drive West, Richmond Hill (31.84112°N, 81.33272°W). 12 August 2011. M. Fountain. UF 168260.

***OPHISAURUS VENTRALIS* (Eastern Glass Lizard)**. Appling Co.: 4.3 km S Baxley (31.739033°N, 82.349057°W). 10 August 2013. A. Singer. GMNH 50414.

***PLESTIODON EGREGIUS* (Mole Skink)** Appling Co.: 23.6 km SW Glennville (31.852339°N, 82.160502°W). 25 September 2012. D. Stevenson. UF 168715. Atkinson Co.: 9.7 km NE Pearson (31.342582°N, 82.764895°W). 21 August 2013. D. Stevenson. GMNH 50422.

***PLESTIODON INEXPECTATUS* (Southeastern Five-lined Skink)**. Bacon Co.: 4.1 km N Alma (31.57684°N, 82.461277°W). 21 August 2013. D. Stevenson. GMNH 50423.

SQUAMATA — SERPENTES

***AGKISTRODON CONTORTRIX* (Copperhead)**. Crawford Co.: 15 Greer Road, Ft. Valley (32.600415°N, 83.910517°W). 1 July 2013. B. Bond. GMNH 50351. Stewart Co.: Moore's Store Road (32.16067°N, 84.75452°W). 22 May 2013. T. Schneider. GMNH 50338. Wilkes Co.: Callaway Road (33.846751°N, 82.863896°W). 27 June 2013. D. Duff. GMNH 50350.

***AGKISTRODON PISCIVORUS* (Cottonmouth)**. Bulloch Co.: Lee Pond, 10.4 km ESE Statesboro (32.426672°N, 81.675328°W). 10 April 2009. M. Moore. UF 169380.

***CARPHOPHIS AMOENUS* (Eastern Wormsnake)**. Barrow Co.: 1038 Octavia Court, Winder (33.93901°N, 83.64770°W). 24 September 2012. D. Duff. UF 135102.

***CEMOPHORA COCCINEA* (Scarletsnake)**. Atkinson Co.: 2.8 km N Willacoochee (31.365749°N, 83.041104°W). 6 August 2013. R. Preston. GMNH 50384.

***COLUBER FLAGELLUM* (Coachwhip)**. Berrien Co.: 6.3 km ESE Alapaha (31.370036°N, 83.159876°W). 1 May 2013. D. Stevenson. GMNH 50324.

***CROTALUS HORRIDUS* (Timber Rattlesnake)**. Glascock Co.: Mitchell, SR 123, 0.3 km E SR 102 (33.21934°N, 82.70051°W). 21 August 2012. J. Jensen. UF 168551. Hall Co.: Pierce Road (34.303656°N, 83.761123°W). 25 July 2011. D. Duff. GMNH 50318. Heard Co.: 0.14 km W jct. SR 34 and Jim T. Mickle Road (33.24047°N, 85.20075°W). 4 August 2012. J. Brazeal and M. Hyatt. UF 168595.

***FARANCIA ABACURA* (Red-bellied Mudsnake)**. Jeff Davis Co.: 1.7 km ENE Hazlehurst (31.870232°N, 82.575812°W). 15 July 2013. D. Stevenson. GMNH 50354. Johnson Co.: 16.9 km NE Wrightsville (32.792569°N, 82.555682°W). 26 June 2013. D. Stevenson. GMNH 50387. Telfair Co.: 3.5 km NE Jacksonville (31.816914°N, 82.942401°W). 7 June 2013. D. Stevenson. GMNH 50393.

***LAMPROPELTIS CALLIGASTER* (Yellow-bellied Kingsnake)**. Henry Co.: Jct. N. Green Circle and Green Circle, McDonough (33.515046°N, 84.102760°W). 17 May 2013. M. Varee. GMNH 50330. White Co.: 1537 Thomas Road, Cleveland (34.554892°N, 83.813658°W). 12 May 2013. J. Thomas, Jr. GMNH 50336.

***LAMPROPELTIS GETULA* (Eastern Kingsnake)**. Berrien Co.: 2.6 km SE Nashville (31.19669°N, 83.22078°W). 1 October 2012. D. Stevenson. UF 135101.

***NERODIA ERYTHROGASTER* (Plain-bellied Watersnake)**. Banks Co.: Alto (34.420807°N, 83.508895°W). 26 August 2013. D. Duff. GMNH 50424. Crawford Co: 15 Greer Road, Fort Valley (32.600415°N, 83.910517°W). 13 April 2012. B. Bond. GMNH 50355.

***OPHEODRYS AESTIVUS* (Rough Greensnake)**. Bulloch Co.: 8.9 km SE Statesboro (32.426860°N, 81.692551°W; NAD 83). 17 September 2012. M. Moore. UF 169451. Dawson Co: Nimblewill Gap Road (34. 586377°N, 84.202582°W). 25 June 2013. D. Duff. GMNH 50349. Early Co: Williams Bluffs Preserve (31.201600°N, 85.082369°W). 20 September 2012. J. Jensen and R. Hill. GMNH 50463. Echols Co.: 3.8 km WNW Statenville (30.715453°N, 83.065510°W). 22 October 2012. D. Stevenson. UF 134822. Screven Co.: 14.4 km ESE Hiltonia (32.844583°N, 81.511664°W). 19 June 2013. D. Duff and D. Stevenson. GMNH 50386.

***PANTHEROPHIS GUTTATUS* (Red Cornsnake)**. Whitfield Co.: Riverbend Road (34.721033°N, 84.936522°W). 17 October 2012. J. Spence. GMNH 50170.

***PITUOPHIS MELANOLEUCUS* (Pinesnake)**. Crawford Co.: 7.6 km SW Roberta (32.682354, 84.079395). 3 September 2009. K. Nelson. GMNH 50302. Jeff Davis Co.: 21.0 km SW Hazlehurst (31.799900°N, 82.800598°W). 5 June 2013. S. Caster. GMNH 50390.

***RAMPHOTYPHLOPS BRAMINUS* (Brahminy Blindsnake)**. Glynn Co.: 900 block Union Street, Brunswick (31.142276°N, 81.490287°W). 31 October 2008. C. George. GMNH 50322.

***REGINA RIGIDA* (Glossy Crayfish Snake)**. Stewart Co.: 23.8 km SW Lumpkin (31.99363°N, 85.043914°W). 8 July 2013. M. Riddle. GMNH 50358.

***SISTRURUS MILIARIUS* (Pygmy Rattlesnake)**. Coweta Co.: Martin Girl Road (33.383316°N, 84.991516°W). 27 June 2013. J. Fields. GMNH 50348.

***STORERIA DEKAYI* (DeKay's Brownsnake.)**. Jeff Davis Co.: Bullard Creek Wildlife Management Area, 15.7 km NNE Hazlehurst (31.966123°N, 82.473802°W). 23 September 2012. D. Stevenson and J. Oguni. UF 168706. Tattnall Co.: Big Hammock Wildlife Management Area, 17.7 km SW Glennville (31.858821°N, 82.092688°W). 22 September 2012. J. Oguni. UF 168708.

***STORERIA OCCIPITOMACULATA* (Red-bellied Snake)**. Clayton Co.: Newman Wetlands Center, 2755 Freeman Road, Hampton (33.47193°N, 84.30601°W). 11 August 2012. C. Lambert. UF 168550.

***THAMNOPHIS SIRTALIS* (Common Gartersnake)**. Chattooga Co.: Otting Tract Wildlife Management Area (34.54293°N, 85.46065°W). 12 July 2013. D. Duff. GMNH 50347.

***VIRGINIA VALERIAE* (Smooth Earthsnake)**. Marion Co.: 1.6 km S SR 240 (32.52617°N, 84.520895°W). 22 April 2013. D. Olive. GMNH 50342.

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New Geographic Distribution Records for Herpetofauna in Southwest Virginia, USA

The geographic distribution of amphibians and reptiles in the Appalachian Highlands region of southwest Virginia is relatively well understood. However, portions of this region, particularly the Valley and Ridge and Appalachian Plateau, lack vouchered records for taxa that are typically common and abundant elsewhere in the Appalachian region. Several taxa are also listed as presumably absent from the region in widely-used distributional maps (Conant and Collins 1991; Lannoo 2000), despite being determined as common in adjacent physiographic provinces that lack any logical barriers to dispersal (e.g., Redmond and Scott 1996). Both of these forms of data deficiency preclude more in-depth biogeographic studies of regional taxa and hinder assessments of historical versus current population trends, as is currently of interest given rates of habitat change and pathogen spread across the Appalachian region (Milanovich et al. 2010; Caruso and Lips 2013; Wood and Williams 2013).

We used a combination of opportunistic surveys and a review of previously accessioned but unpublished museum specimens to address these knowledge gaps for the Valley and Ridge and Appalachian Plateau regions of southwest Virginia, USA. All records featuring locality information along the Guest River in Wise Co., Virginia were additionally recorded during a standardized survey of riparian zone herpetofauna during 2012. Survey methods for these records included searching cover objects during area-constrained surveys of twelve one-hectare habitat blocks divided between locations along the Guest River near Norton, Virginia (36.93700°N, 82.60676°W) and within the Jefferson National Forest (36.91888°N, 82.44956°W) on weekly visits from 29 April 2012 to 15 October 2012.

All records reported hereafter build upon the only previous intensive survey of the southwest Virginia region (Mitchell and Pague 1984) and original records published by Burger (1974, 1975). All records represent new county records and have been verified as novel against existing vouchered collections in the Global Biodiversity Information Facility (GBIF) and HerpNET, as well as against reported state-level records with the Virginia Department of Game and Inland Fisheries' Fish and Wildlife Information Service. Vouchers were verified by Philip C. Shelton and are housed at the University of Virginia's College at Wise's Herpetological Collection (UVWHC). Geocoordinates are based on datum WGS84.

CAUDATA — SALAMANDERS

***AMBYSTOMA OPACUM* (Marbled Salamander)**. Wise Co.: Under cover above Guest River at the base of Stone Mountain, 5.8 km WSW of Coeburn (36.93068°N, 82.52680°W). 30 October 2011. Maddison Couch. UVWHC 2013-09. Previously considered absent from Appalachian Highlands (Conant and Collins 1991; Redmond and Scott 1996; Lannoo 2000). First vouchered record from western portion of Virginia.

***AMBYSTOMA MACULATUM* (Spotted Salamander)**. Lee Co.: In pool along unnamed inflow stream of Keokee Lake, 9.5 km SW of Appalachia (36.85308°N, 82.86552°W). 11 January 2013. Walter H. Smith, Katie Dunn. UVWHC 2013-13. Russell Co.: Oxbow Lake inflow, 0.8 km WNW of St. Paul (36.90698°N, 82.31970°W). 31 March 2013. Walter H. Smith, Katie Dunn. UVWHC 2013-12. Wise Co.: Under boulder in margin of mine reclamation wetlands along first-order tributary of Yellow Creek, 1.5 km E of Wise (36.97408°N, 82.55862°W). 4 April 2013. Walter H. Smith. UVWHC 2013-10. Aforementioned records comprise the first vouchered specimens in Virginia west of the Holston River Valley.

***PSEUDOTRITON MONTANUS* (Mud Salamander)**. Wise Co.: Temporary pool within abandoned rail tunnel, 670 m above sea level elevation, Guest River Gorge, Jefferson National Forest, 3.0 km ESE of Coeburn (36.91993°N, 82.44979°W). 14 June 2012. Jennifer N. Fulton, Walter H. Smith. UVWHC 2013-14. Species previously considered absent or questionable from higher-elevation (>550 m) regions of the Appalachian Highlands (Martof 1975; Redmond and Scott 1996; Lannoo 2000).

TESTUDINES — TURTLES

***CHELYDRA SERPENTINA* (Snapping Turtle)**. Wise Co.: Crossing multi-use recreational trail in Guest River Gorge, Jefferson National Forest, 3.4 km SSE of Coeburn (36.91775°N, 82.44445°W). 29 May 2012. Jennifer N. Fulton, Walter H. Smith. UVWHC 2013-04.

SQUAMATA — LIZARDS

***SCELOPORUS UNDULATUS* (Eastern Fence Lizard)**. Russell Co.: Basking on riprap boulders atop Oxbow Lake Dam, 0.8 km WSW of St. Paul (36.90124°N, 82.31869°W). 22 September 2012. Jennifer N. Fulton. UVWHC 2013-06.

SQUAMATA — SNAKES

***CARPHOPHIS AMOENUS* (Eastern Wormsnake)**. Wise Co.: Under rock cover on south-facing bluff within Guest River Gorge, Jefferson National Forest, 3.1 km SSE of Coeburn (36.91833°N, 82.45046°W). 23 April 2012. Jennifer N. Fulton, Walter H. Smith. UVWHC 2013-07.

***HETERODON PLATIRHINOS* (Eastern Hog-Nosed Snake)**. Wise Co.: Clinch Valley College campus, 1.5 km ESE of Wise (36.97105°N, 82.55960°W). 3 September 1970. L. B. Hutzler. UVWHC 1970-07. Originally deposited in herpetological collection but new record never published or reported.

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***NERODIA SIPEDON* (Common Watersnake)**. Wise Co.: Temporary pool along Guest River, 1.9 km ENE of Norton (36.93688°N, 82.60855°W). 30 July 2012. Jennifer N. Fulton. UVWHC 2013-08.

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The Natural History Notes section is analogous to Geographic Distribution. Preferred notes should 1) focus on observations in the field, with little human intrusion; 2) represent more than the isolated documentation of developmental aberrations; and 3) possess a natural history perspective. Individual notes should, with few exceptions, concern only one species, and authors are requested to choose a keyword or short phrase which best describes the nature of their note (e.g., Reproduction, Morphology, Habitat, etc.). Use of figures to illustrate any data is encouraged, but should replace words rather than embellish them. The section's intent is to convey information rather than demonstrate prose. Articles submitted to this section will be reviewed and edited prior to acceptance.

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A reference template for preparing Natural History Notes may be downloaded at: http://www.ssarherps.org/pages/HRinfo.php. Standard format for this section is as follows: **SCIENTIFIC NAME** in bold, capital letters; standard English name in parentheses with only first letter of each word capitalized (if available, for the United States and Canada as it appears in Crother [ed.] 2012. *Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, with Comments Regarding Confidence in Our Understanding, 7th ed.* Herpetol. Circ. 39:1–92, available from SSAR Publications Secretary, ssar@herplit.com; for Mexico as it appears in Liner and Casas-Andreu 2008. *Standard Spanish, English and Scientific Names of the Amphibians and Reptiles of Mexico.* Herpetol. Circ. 38:1–162); **KEY WORD(S)** referring to the content of the note in bold, capital letters; content reporting observations and data on the animal; place of deposition or intended deposition of specimen(s), and catalog number(s) if relevant. Then skip a line and close with author name(s) in bold, capital letters (give names and addresses in full—spell out state names—no abbreviations, e-mail address after each author name/address for those wishing to provide it—e-mail required for corresponding author). References may be briefly cited in text (refer to this issue for citation format and follow format closely). One additional note about the names list (Crother 2012) developed and adopted by ASIH-HL-SSAR: the role of the list is to standardize English names and comment on the current scientific names. Scientific names are hypotheses (or at least represent them) and as such their usage should not be dictated by a list, society, or journal.

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CAUDATA — SALAMANDERS

***AMBYSTOMA RIVULARE* (Toluca Siredon). REPRODUCTION.** *Ambystoma rivulare* is one of the four *Ambystoma* species inhabiting rivers in mountainous areas of Mexico's Transmexican Volcanic Belt, mainly around the Nevado de Toluca and in the boundaries between Michoacan and Mexico State. Here, we present data on reproduction and development of this species. On 28 June 28 2010 we collected six individuals (2 females and 4 males) in Capilla Vieja, Amanalco de Becerra, State of Mexico (19.1308°N, 99.5911°W; datum: WGS 84; elev. = 2785 m). They were transported to the Laboratory of Integrative Biology, Instituto de Investigaciones Biomedicas, UNAM. On 30 June 2010 a female (SVL = 100 mm; Total length = 197 mm; 38 g) oviposited a clutch of 463 eggs. The eggs were removed and placed in an aquarium (40 liters) with aeration and controlled temperature (18.0°C). The average oocyte diameter was 1.96 ± 0.19 mm (range 1.70–2.50) and the outer layer had a diameter of 4.77 ± 0.64 mm (range 4.0–6.0). Oocyte fertility was 86%. Embryonic development of the offspring was 288–312 h at room temperature (14.5–19.0°C). Embryo mortality was 12%. A total of 353 embryos hatched at stage 38, at an average total length of 10–11.5 mm.

Previous reports on reproduction of *A. rivulare* include those of Brandon and Altig (1973. Herpetologica 29:349–51), and Bille (2009. Salamandra 45:155–164) who found and collected eggs in the spring (March and April) and the summer months (July and August). These authors report finding the eggs in different stages of development singly or in clutches and distributed evenly along the stream. Reports on other Mexican endemic *Ambystoma* include those of *A. granulosum*: clutch size 664 eggs (Aguilar-Miguel et al. 2009. Acta Zool. Mexicana 25:443–454); *A. lermaense*: clutch size 841 eggs (Aguilar-Miguel et al. 2002. Herpetol. Rev. 33:197); *A. mexicanum*: clutch size 934 eggs (Armstrong, et al. 1989. *In* Armstrong and Malacinski [eds.], Developmental Biology of the Axolotl, pp. 220–227. Oxford University Press, New York), and *A. andersoni*: clutch size 518 eggs (Huacuz 2001. Estado actual de los ajolotes del género *Ambystoma* del lago de Pátzcuaro, Michoacán. Universidad Autónoma de San Nicolás de Hidalgo de Morelia, Michoacán. 75 pp.) This note represents the first report of clutch size and contributes information on development for *A. rivulare*.

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***ANEIDES AENEUS* (Green Salamander). MAXIMUM SIZE.** *Aneides aeneus* is a partially arboreal cliff specialist distributed discontinuously across the Appalachian Highlands and Cumberland Plateau ecoregions of the eastern United States. Maximum size in *A. aeneus* has been reported as 140 mm, with typical body size ranging from 83–125 mm total length (Conant and Collins 1998. Reptiles and Amphibians and Eastern and Central North America. Houghton-Mifflin, New York. 616 pp.). We encountered a number of individuals exceeding this average size range and approaching the record size for *A. aeneus* during a survey of several populations at the interface of the Appalachian Plateau and Valley and Ridge physiographic provinces in southwest Virginia during summer 2013.

One site, in particular, possessed multiple individuals exceeding this average size range and one individual exceeding the reported record size for the species. This site, located on the High Knob Massif in Wise Co., Virginia, is a previously undocumented locality for *A. aeneus* at a complex system of exposed sandstone outcrops extending over an approximately 3-ha region on a sheltered, north-facing slope of High Knob (36.89253°N, 82.62955°W; datum: WGS 84). We captured two individuals exceeding the typical size range for *A. aeneus* at this site on 8 July 2013 and 20 August 2013 (126.5 mm and 137.0 mm total length, respectively). A third individual, a female captured on 09 October 2013, measured 148.0 mm total length (78.0 mm SVL) and surpasses previously reported size records for the species by 8 mm. This individual appeared to be in the later stages of regrowth of a small portion of an autotomized tail tip, suggesting a potential size of up to 150 mm total length. All body size measurements were made with a set of Vernier calipers in the field, and, when possible, were verified via repeated measurements by two independent observers. Vouchers for all specimens were deposited in the University of Virginia's College at Wise Herpetological Collection (UVWHC 2013-01–2013-03).

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***ANEIDES LUGUBRIS* (Arboreal Salamander). LEUCISM.** Leucism has been reported in a number of plethodontid salamanders: *Plethodon* (Hayslett et al. 1998. Herpetol. Rev. 29:229–230; Mendyk et al. 2010. Herpetol. Rev. 41:189–190), *Desmognathus* (Mitchell 2002. Banisteria 20:70–74), *Phaeognathus* (Graham et al. 2009. Herpetol. Rev. 40:197), *Eurycea* (Miller and Braswell 2006. Herpetol. Rev. 37:198), and *Aneides* (Williams et al. 2013. Herpetol. Rev. 44:114– 115). In the genus *Aneides*, color variation has been documented for *A. ferreus* (Dyrkacz 1981. Herpetol. Circ. 11:1–31; Houck 1969. Herpetologica 25:54), *A. flavipunctatus* (Hensley 1959. Publ. Mus. Michigan State Univ. 1:135–159; Seeliger 1945. Copeia 1945:122), and *A. aeneus* (Williams et al. 2013, *op. cit.*).

Here we present the first record of leucism in *Aneides lugubris*. At 2205 h on 31 May 2013, an adult leucistic *A. lugubris* was found in Cañon Salsipudes, 23 km N of Ensenada, Baja California, Mexico (31.97875°N, 116.76974°W; datum: WGS84; elev. 123 m). The individual exhibited lack of normal pattern and appeared cream colored, except for small dorsal yellow-colored spots and the darkly pigmented eyes (Fig. 1). It was found foraging on the stream bank among riparian vegetation dominated by Arroyo Willow (*Salix lasiolepis*) and Western Sycamore (*Platanus racemosa*).



FIG. 1. Leucistic *Aneides lugubris* from Salsipuedes, Baja California, Mexico.

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***CRYPTOBRANCHUS ALLEGANIENSIS ALLEGANIENSIS* (Eastern Hellbender). CANNIBALISM.** Although cannibalism in the Eastern Hellbender (*Cryptobranchus alleganiensis alleganiensis*) has been previously reported (Nickerson and Mays 1973. The Hellbenders: North American Giant Salamanders. Milwaukee Public Mus. Press; 106 pp.; Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, D.C. 587 pp.; Phillips and Humphries 2005. *In* Lannoo [ed.], Amphibian Declines: The Conservation Status of United States Species, pp. 648–651. Univ. California Press, Berkeley, California), additional cases are worthy of note, since only a few specific reports of this behavior have been recorded from wild caught hellbenders, and there has been no discussion on the possible causes of this behavior. Cannibalism was first reported in *C. a. alleganiensis* by Reese (1903. Sci. Monthly 62:526–531). In captivity, he observed a larger hellbender consuming a conspecific about half the size of the larger one (sizes of either animal were not provided). He was able to remove the ingested smaller specimen with forceps, and it swam away unharmed when released in its enclosure. Smith (1907. Biol. Bull. 13:5–39) reported a two-year-old hellbender in northwestern Pennsylvania, when placed in quiet water after capture, regurgitated a partly digested 6-cm larva of its own kind. The size of the larger specimen was between 12.0 cm and 12.3 cm. The only other reported observation of cannibalism in this species from a wild specimen is that of Humphries et al. (2005. Herpetol. Rev. 36:428) who reported that a larger, wild-caught adult male *C. a. alleganiensis* (37.2 cm TL) regurgitated a smaller individual (18.5 cm TL) in the field. The North Carolina population where this occurred is very dense



FIG. 1. Cannibalized juvenile *Cryptobranchus alleganiensis*, Transylvania Co., North Carolina.

and comprised of all size classes (J. Humphries, pers. comm.; L. Williams, pers. obs.). Here we report another field case of cannibalism from a North Carolina population.

On 29 June 2010 an adult female (39 cm TL) *Cryptobranchus a. alleganiensis* was collected from a fast riffle, in a section of the French Broad River, Transylvania Co., North Carolina (the site is recorded with the North Carolina Wildlife Resources Commission and is withheld to protect the specific location). After data collection, the specimen was held in a mesh bag and lowered into the water in strong, swift current in preparation for its release. During this process and after being subjected to the strong current, it regurgitated a smaller hellbender (21 cm TL) while still in the mesh bag. The consumed hellbender was decaying, and there was a strong odor of rotten flesh (Fig. 1). From our observations and photographs of the carcass, it appears that the adult hellbender grasped the smaller hellbender laterally on its right side (tooth marks identified on dorsolateral surface of body confirmed by North Carolina Zoo pathologist Brigid Trovan). Unfortunately, this regurgitated hellbender was not saved due to its advanced state of decay. The locality where this observation was made contains a robust, reproductively active population of hellbenders of all age classes.

In a similar example, Max A. Nickerson (pers. comm.) informed us of wild caught Ozark Hellbenders (*C. alleganiensis bishopi*) eating smaller conspecifics from the North Fork of the White River in Missouri when they were placed in coolers under crowded conditions. On 12 March 1972 two Ozark Hellbender gilled larvae (9.5 and 13.0 cm TL) were cannibalized when placed in a cooler with 12 adults, between field collection and arrival at Nickerson's laboratory in Milwaukee, Wisconsin. In March 1977, three gilled larvae and eight adults were placed in a cooler which was primarily ice filled and transported to the St. Louis, Missouri, area overnight en route to Milwaukee. Nickerson's purpose of cooling these animals was that it might prevent cannibalism. However, all three larvae had been consumed before water and ice were drained and replaced upon arrival in St. Louis. All of these gilled larvae were reported by Nickerson et al. (2003. Southeast. Nat. 2:619–629), but his observation of their cannibalism was not mentioned in that publication.

Cryptobranchus a. alleganiensis feeds primarily on crayfish but also eats other aquatic food including snails, freshwater crabs, fish (Nickerson and May 1973, *op. cit.*), frogs (Smith 1907, *op. cit.*), and other salamander species (Alexander 1927. Buffalo Soc. Nat. Sci. 7:13–18; Hill 2011. Herpetol. Rev. 42:580; and pers. obs.). Hellbenders are opportunistic foragers and scavengers and are attracted to food by visual, chemical, and tactile stimuli (Nickerson and Mays 1973, *op. cit.*). It is possible that cannibalism in this species is a density-dependent behavior, primarily related to population size. Denser populations may provide adults with more opportunity to find younger, smaller hellbenders during foraging activities. All reported cases of hellbender cannibalism have come from dense populations (Smith 1907, *op. cit.*; Humphries et al. 2005, *op. cit.*) or in captive situations where they were crowded. Another possible contributing factor to hellbender cannibalism is that in denser populations less food may be available and cannibalism may increase due to fewer or more dispersed food resources. A similar explanation of this behavior has been suggested for other salamanders (Duellman and Trueb 1986. Biology of Amphibians. McGraw Hill, New York. 670 pp.). Our observations and reports from other field biologists working with hellbenders suggest that crayfish are less abundant in denser hellbender populations than in smaller or possibly declining hellbender populations.

We thank Max Nickerson for sharing his observations of cannibalism in hellbenders and for allowing us to publish them. Thanks to Brigid Trovan for examining our photographs. We also thank the many volunteers who worked with us throughout our hellbender surveys for their time and efforts.

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***GYRINOPHILUS PORPHYRITICUS* (Spring Salamander). DIET.** Brook Trout (*Salvelinus fontinalis*) can have strong predatory and competitive effects on the survival and growth of *Gyrinophilus porphyriticus* (Lowe et al. 2004. Ecol. Appl. 14:164–172; Resetarits 1995. Oikos 73:188–198). However, *G. porphyriticus* still co-occur with Brook Trout in many headwater streams of the Appalachians (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, D.C. 587 pp.). In this study, we report on the diets of larval and adult *G. porphyriticus* occurring within six headwater streams of New Hampshire, including three streams with Brook Trout and three streams without Brook Trout.

Salamanders were collected from six headwater streams at Hubbard Brook Experimental Forest, New Hampshire, USA (43.93333°N, 71.75000°W; datum NAD 83): Kineo Brook, Falls Brook, Zigzag West Brook, Bagley Trail Brook, Steep Brook, and Cushman Brook. Salamanders were collected from 200 m survey reaches in each stream by overturning all rocks of appropriate size. Salamanders were collected by dipnet from July–August 2012. Three streams had natural barriers that prevented fish from reaching the survey reaches, while survey reaches in the remaining streams were known to have fish (Warren et al. 2008. Northeast. Nat. 15:375–390). Fish presence or absence was confirmed in every stream by deploying minnow traps in survey stretches for 24 h.

Stomach contents of salamanders were collected using a non-lethal and non-anesthetic technique of stomach pumping (Cecala et al. 2007. J. Herpetol. 41:741–745). Before stomach flushing, all salamanders were weighed (± 0.1 g) and measured (SVL; nearest cm). Stomach contents were stored in 95% EtOH and examined under a dissecting scope. Prey items were

TABLE 1. Diet composition of larvae and adult *Gyrinophilus porphyriticus* from streams without Brook Trout and streams with Brook Trout at Hubbard Brook Experimental Forest, New Hampshire, USA. Numbers represent the total number of prey items per all individuals within a stream. Numbers in parentheses indicate the percentage of total diet composition. Prey items were identified to the overall lowest taxonomic level available (Order).

Fishless Streams							
	Bagley		Cushman		Steep		
Order	Adults	Larvae	Adult	Larvae	Adult	Larvae	Habitat
Araneae	-	-	1 (14.3)	-	-	-	Terrestrial
Coleoptera	3 (33.3)	-	2 (28.6)	-	-	-	Terrestrial
Diptera	2 (22.2)	2 (10)	2 (28.6)	-	-	-	Aquatic
Ephemeroptera	-	1 (5)	-	-	-	-	Aquatic
Gerridae	-	-	-	1 (17)	-	-	Aquatic
Hirundinea	-	-	-	-	-	-	Aquatic
Lepidoptera	3 (33.3)	2 (10)	-	-	1 (50)	-	Terrestrial
Megaloptera	-	5 (25)	1 (14.3)	-	-	-	Aquatic
Plecoptera	-	9 (45)	-	2 (33)	-	-	Aquatic
Soleolifera	-	-	-	-	1 (50)	-	Aquatic
Trichoptera	1 (11.1)	1 (5)	1 (14.3)	3 (50)	-	-	Aquatic
Totals	9	20	7	6	2	0	

Streams with Fish							
	Falls		Kineo		Zigzag W		
Order	Adult	Larvae	Adult	Larvae	Adult	Larvae	Habitat
Araneae	-	-	-	-	-	1 (14.3)	Terrestrial
Coleoptera	1 (25)	-	-	-	-	-	Terrestrial
Diptera	-	-	-	-	1 (16.7)	-	Aquatic
Ephemeroptera	-	-	-	-	-	-	Aquatic
Gerridae	-	-	-	-	-	-	Aquatic
Hirundinea	-	3 (50)	-	-	-	-	Aquatic
Lepidoptera	1 (25)	1 (17)	-	1 (11.1)	1 (16.7)	2 (28.6)	Terrestrial
Megaloptera	-	-	-	-	1 (16.7)	-	Aquatic
Plecoptera	1 (25)	2 (33)	1 (100)	5 (55.6)	1 (16.7)	2 (28.6)	Aquatic
Soleolifera	-	-	-	-	-	-	Aquatic
Trichoptera	1 (25)	-	-	3 (33.3)	2 (33.3)	2 (28.6)	Aquatic
Totals	4	6	1	9	6	7	

tabulated and classified to the lowest taxonomic level consistently available (Order).

Forty-eight food items from 59 larval and 38 adult *G. porphyriticus* were obtained (Table 1). Food items were identified to 11 taxonomic prey groups. The most abundant prey items in the guts of larvae were Plecoptera (41.7%). In adults, the most abundant prey items were Lepidoptera (20.7%) and Coleoptera (20.7%). Overall, 72.9% (43 of 59) of larvae *G. porphyriticus* and 91.4% (32 of 35) of adult *G. porphyriticus* contained stomach contents. In fishless streams, the mean percent (± 1 SE) of larval diets consisted of 95.0 % (± 0.04) aquatic prey and 5.0% (± 0.04) terrestrial prey, while the mean percent (± 1 SE) of adult diets consisted of 46.8% (± 0.06) aquatic prey and 53.2% (± 0.06) terrestrial prey. In streams with fish, the mean percent (± 1 SE) of larvae diets consisted of 76.5% (± 0.08) aquatic prey and 23.5% (± 0.08) terrestrial prey and the mean percent (± 1 SE) of adult diets consisted of 78.6% (± 0.12) aquatic prey and 21.4% (± 0.12) terrestrial prey. Although larvae are strictly aquatic, their overall diets across streams consisted of a mean percent (± 1 SE) of 14.2% (± 0.07) terrestrial prey. Our work is congruent with previous work at Hubbard Brook that has shown *G. porphyriticus* are euryphagic predators of invertebrates and that adults tend to take more terrestrial prey than larvae (Burton 1976. J. Herpetol. 10:187–204).

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***URSPELERPES BRUCEI* (Patch-nosed Salamander). DIET.** On 22 September 2013, we discovered an adult male *Urspelerpes brucei* under leaf-litter on a small streamside rock face at the species' type locality (Camp et al. 2009. J. Zool. 279:86–94) in Stephens Co., Georgia, USA. While we photographed it on wet leaves, several springtails (Collembola) caught the salamander's attention. The salamander used its projectile tongue (Camp et al., *op. cit.*) to catch and consume one springtail and unsuccessfully attempted to eat a second. Springtails are common prey for *Eurycea* (Hutchison 1958. Ecol. Monogr. 28:1–20; McMillan and Selmitsch 1980. J. Herpetol. 14:424–426), and their presence in

the diet of *U. brucei* was not unexpected. However, this is the first record of a prey item for *U. brucei*, which was first discovered in 2007 (Camp et al., *op. cit.*). Additionally, we also observed captive adult *U. brucei* feeding on newly hatched house crickets (*Acheta domestica*) and a variety of collembolan species.

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ANURA — FROGS

***DENDROPSOPHUS RUBICUNDULUS* (Lagoa Santa Treefrog). PREDATION.** Amphibians are common prey for a great variety of vertebrates (Toledo et al. 2007. J. Zool. 271:170–177), invertebrates (Toledo 2005. Herpetol. Rev. 36:395–400), and carnivorous plants (Duellman and Trueb 1994. Biology of Amphibians. McGraw-Hill, Baltimore and London. 670 pp.). Belostomatids are medium to large-sized predaceous aquatic insects that occupy many types of aquatic habitats in tropical and temperate regions (Lauck and Menke 1961. Ann. Entomol. Soc. Amer. 54:644–657). *Dendropsophus rubicundulus* is a small tree frog that inhabits the Cerrado biome and occurs on the emergent or marginal herbaceous vegetation in permanent and temporary ponds (Bastos et al. 2003. Anfíbios da Floresta Nacional de Silvânia, Estado de Goiás. Goiânia, 82 pp.; Napoli and Caramaschi 1999. Bol. Mus. Nac., N.S., Zool. Rio de Janeiro 407:1–11). Here, we report the predation of an adult *D. rubicundulus*, by an adult water bug, *Lethocerus annulipes*.

At 2118 h on 07 January 2012, during the field work at the municipality of Chapadão do Céu, state of Goiás, Brazil (18.234944°S, 52.606222°W; datum SAD 69), we observed an adult *L. annulipes* feeding on an adult male *D. rubicundulus* (SVL = 22.28 mm) in a permanent pool. During the observation, the water bug remained submerged in the water to a depth of approximately 4 cm, and was feeding while attached to the frog by its venter. Predator and prey were collected and are housed at the Coleção Zoológica da Universidade Federal de Goiás (ZUFG), Goiânia, Goiás, Brazil (ZUFG 7334). Although there have been some reported cases of predation of amphibians by belostomatids, new cases may help in understanding the relationships between these predators and their anuran prey (Toledo 2005, *op. cit.*), and this note represents the first documentation of a belostomatid predating *D. rubicundulus*.

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***HYLA CINEREA* (Green Treefrog). DORSAL SPOTS.** *Hyla cinerea* have a uniformly white venter and a uniformly green dorsum. Many individuals show a white lateral stripe, and they may also show small white or yellow spots on their dorsum (Conant and Collins 1991. A Field Guide to Amphibians and Reptiles of Eastern and Central North America. Houghton Mifflin Company, New York. 640pp.). Here we provide information on the prevalence, number, size and pattern of geographic variation of these dorsal spots.

We examined 60 mature female *H. cinerea* from multiple locations within Jasper Co. Texas (N = 17), Rapides Pa. Louisiana (N = 21), Perry Co. Alabama (N = 13), and Ben Hill Co. Georgia, USA (N = 9). We took digital pictures of each frog, from which we (i) counted the number of spots of each frog, and (ii) measured the size (area in mm^2) of the largest spot of each frog. Variation in spot number ranged from 0–37 spots (Fig. 1), with the majority of frogs (98%) having at least one spot. Frequently (85%), at least one spot was bordered by a dark line (Fig. 1B, D). The same individual may have spots with and without a dark border (Fig. 1B). Spot size varied from 0.09–3.65 mm^2 (mean ± SD: 0.78 ± 0.6 mm^2). Individual frogs can have only small spots, only large spots, or a mixture of spot sizes. Average number of spots did not vary across sites (ANOVA: $F_{3,59} = 0.53$; $p = 0.66$). There was geographic variation in spot size, however: frogs from Texas had

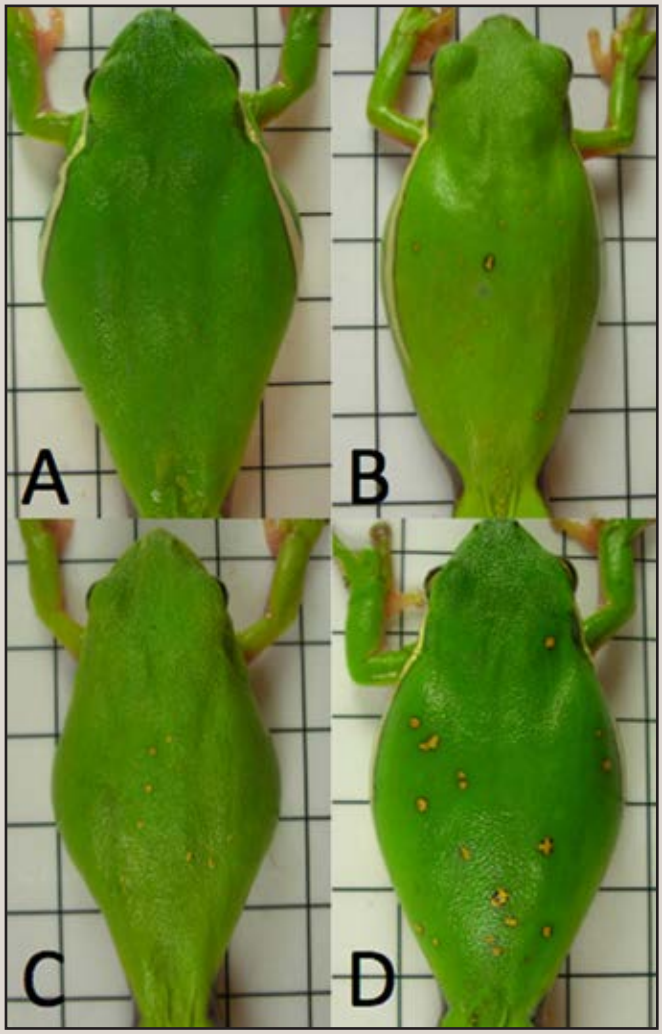


FIG. 1. Variation in dorsal spot number and size in *Hyla cinerea*. A) Individual with two very small spots. B) Individual with small and large spots, only some of which are bordered by a dark margin. C) Individual in which all spots are without dark border. D) Individual in which all spots show a dark border.

larger spots than those from the other three study sites (ANOVA: $F_{3,59} = 4.74$; $p = 0.005$).

To examine whether spots remained constant over time, we repeated the measurements after 3 months (N = 38). Both the number and the size of spots varied over time. Spot number remained constant in 36% of frogs, decreased in 32%, and increased in 32%. Spot size remained constant in 6% of frogs, decreased in 42%, and increased in 52%. Color pattern thus does not lend itself as a characteristic to be used in pattern mapping, a non-invasive method of identifying individuals for long-term studies (Heyer et al. 1994. Measuring and Monitoring Biological Diversity: Standard Methods for Amphibians. Smithsonian Institution Press, Washington, DC. 384 pp.). For spots to be useful for individual identification, they must be unique to each individual and they must remain relatively unchanged over time, and in *H. cinerea* neither spot number nor size fulfilled those criteria. While morphology and mating calls of *H. cinerea* show geographic variation (Höbel and Gerhardt 2003. Evolution 57:894–904), the color pattern (lateral stripe length; spots) is highly variable within populations, but not always different among populations (Aresco 1996. Am. Midl. Nat., 135: 293–298; this study). *Hyla cinerea* is not the only species showing yellow or white spots (also termed dots, warts or pustules because of the elevated shape they sometimes can take). While they appear to be absent from other species of North American treefrogs with a green dorsum, such as *H. andersonii* or *H. squirella*, they do occur in some individuals of *H. gratiosa*, the sister species to *H. cinerea* (pers. obs). Similar spots can also be found in members of the Neotropical genera *Agalychnis* and *Phyllomedusa* (Savage 2002. The Amphibians and Reptiles of Costa Rica: a Herpetofauna between Two Continents, between Two Seas. University of Chicago Press, Chicago, Illinois. 954 pp.). Origin and function of these spots are unknown.

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***HYLA VERSICOLOR* (Eastern Gray Treefrog). LACRIMAL SPOT.** *Hyla versicolor* commonly have a bright spot under the eye, a characteristic they share with *H. chyrsoscelis* and *H. avivoca* (Conant and Collins 1991. A Field Guide to Amphibians and Reptiles of Eastern and Central North America. Houghton Mifflin Co., New York. 640 pp.). This spot is often quite conspicuous in this otherwise well-camouflaged treefrog (Fig. 1). Here we provide information on the prevalence, size, color, and relative brightness of the lacrimal spot, as well as on patterns of sexual dimorphism.

We examined 26 female and 30 male *H. versicolor* treefrogs from a pond near the University of Wisconsin-Milwaukee Field Station in Saukville, Wisconsin, USA (43.39000°N, 88.03000°W; datum: WGS 84). We took digital pictures of each frog (lateral view); each picture included a size reference, and a light and dark standard. We then scored the coloration of the spots (as either white or greenish), and used the program ImageJ (NIH, Maryland, http://imagej.nih.gov/ij/) to measure (i) the SVL (mm), (ii) the lacrimal spot size (area in mm^2), (iii) the lacrimal spot brightness, and (iv) the brightness of the dorsal color.

All except one frog had a clearly defined lacrimal spot. Lacrimal spot size was different between the sexes ($F_{1,52} = 4.16$; $p = 0.047$), with females having relatively larger spots than males (mean ± SD; 10.0 ± 2.2 vs. 7.8 ± 1.3 mm^2; SVL was used as a covariate in the model to account for sexual size dimorphism). Spot coloration was roughly split between white and greenish, and there was no difference between the sexes ($\chi^2 = 0.29$; $p = 0.59$). The absolute brightness of the lacrimal spot was also not different between the sexes ($F_{1,52} = 0.37$; $p = 0.54$). In both sexes the dorsum was darker than the lacrimal spot; contrast (the difference between dorsal brightness and lacrimal spot brightness) was larger in males, but this difference was not statistically significant ($F_{1,54} = 2.80$; $p = 0.099$).



FIG. 1. Variation in lacrimal spot coloration and size in *Hyla versicolor*.

The function of the lacrimal spot in this and other frog species is currently unknown. We suggest several hypotheses that might warrant further investigation. First, because of its conspicuousness the spot may function in intraspecific communication. Signals used in mate choice frequently show sexual dimorphism (Andersson 1994. Sexual Selection. Princeton University Press, Princeton, New Jersey. 599 pp.), and we did find some aspects of the lacrimal spot that differed between the sexes. Second, the lacrimal spot may be involved in camouflage via disruptive patterning, and help draw attention away from the body outline of the frog, or disguise the eye (Stevens and Merilaita 2009. Phil. Trans. R. Soc. B. 364:481–488). Finally, the bright spot might aid in nocturnal vision. Professional baseball and football players use eye black grease to reduce glare and improve contrast sensitivity in conditions of sunlight exposure (DeBroff and Pahk 2003. Arch Ophthalmol. 121:997–1001), and the opposite effect may occur with bright lacrimal spots at night.

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***HYPSIBOAS SEMILINEATUS* (Perereca Semilineada). BROMELIAD ASSOCIATE.** Many frogs use bromeliads as refuges (Peixoto 2005. Rev. Univers. Rural 17: 75–83). Most bromeliads have the capability to store rainwater between the leaves and are abundant across the sandy coastal plain of Brazil. Here we report

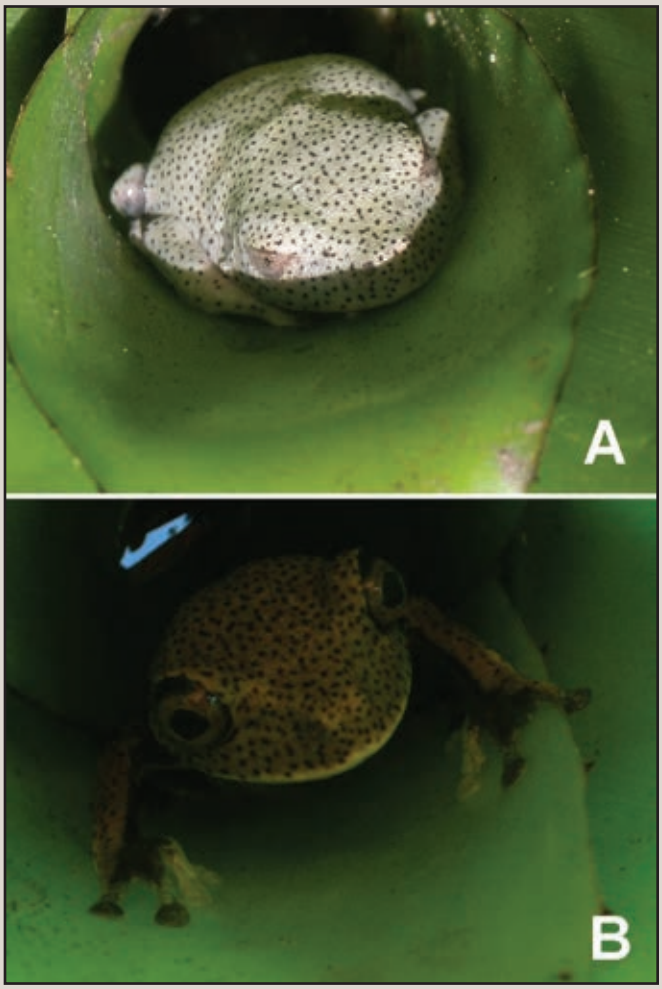


FIG. 1. *Hypsiboas semilineatus* using the bromeliad *Aechmea blanchetiana*. A) At night. B) Diurnal on the following day.

for the first time the use of bromeliad by *Hypsiboas semilineatus*. This observation was made during nocturnal fieldwork on 10 October 2012, at restinga Parque Estadual Paulo César Vinha, municipality of Guaraparí, Espírito Santo state, southeastern Brazil (7720940°S, 351400°E; datum WGS 84; elev. = 5 m). We observed an individual of *H. semilineatus* occupying the center axil of the bromeliad *Aechmea blanchetiana* (Fig. 1A), which remained in place on the following day (Fig. 1B). This frog species has a wide distribution across the coastal region of Brazil (Frost 2013. Amphibian Species of the World: an Online Reference. Ver. 5.6. Electronic database accessible at http://research.amnh.org/herpetology/amphibia/index.html. American Museum of Natural History, New York; accessed 12 Oct 2013) and is known for spawning in swamps and perennial ponds. Because we found *H. semilineatus* occupying bromeliads for purposes other than spawning, this species can be considered a bromelicolous frog.

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***LEPTODACTYLUS INSULARUM* (San Miguel Island Frog). DIET.** This species is known throughout lowland Costa Rica, Panama, and Caribbean drainages of Colombia, Venezuela, and Trinidad and Tobago, and was previously considered a synonym of *Leptodactylus bolivianus* (Heyer 1974. Contrib. Sci. Los Angeles Co. Mus. Nat. Hist. Mus. 253:1–46; Savage 2002. The Amphibians and Reptiles of Costa Rica: a Herpetofauna beween Two Continents, between Two Seas. Univ. Chicago Press, Illinois. 934 pp.), but was resurrected as *L. insularum* by Heyer and de Sá (2011. Smithson. Contrib. Zool. 635:1–58). Little is known about the diet of *L. insularum*, and it has been suggested to feed primarily on arthropods and almost any small animal prey (Savage 2002, *op. cit.*). However, no specific information exists about food habits of this species. Herein we provided detailed information on the diet of *L. insularum* from Río Manso Reserve (5.66600°N, 74.77450°W; datum WGS 84; elev. 220 m) in the municipality of Norcasia, Caldas department, Colombia.

Seven individuals of *L. insularum* (mean 82.7 SVL; range 77.85–88.2 mm) were collected around a wetland between 1900 and 2200 h on 12–20 May 2010. Stomach flushing was used for the extraction of stomach contents and each prey item was identified to order or family, and measured for length and width using manual calipers (nearest 0.1 mm). The prey volume was estimated using the formula for a prolate spheroid. *L. insularum* was confirmed to be a generalist frog (Savage 2002, *op. cit.*). In addition, several freshwater insect families were found in the stomachs (e.g., Belostomatidae, Psychodidae, Lycosidae; see Table 1).

TABLE 1. Prey consumed by *Leptodactylus insularum* from "Reserva Rio Manso," Norcasia, Caldas, Colombia. Volume in mm^3.

Prey	Volume	Number (%)	Frequency
Insecta			
Coleoptera			
Elateridae	17.5 (1.2)	1 (4.5)	1
Erotylidae	83.1 (5.6)	1 (4.5)	1
Melolontidae	22.5 (1.5)	1 (4.5)	1
Passalidae	40.2 (2.7)	1 (4.5)	1
Hymenoptera			
Chaoboridae	0.1 (0)	1 (4.5)	1
Formicidae	9.8 (0.7)	6 (27.3)	2
Hemiptera			
Belostomatidae	837.6 (56.8)	2 (9.1)	1
Blattodea			
Blatiidae	76.4 (5.2)	1 (4.5)	1
Diptera			
Psychodidae	0.8 (0.1)	2 (9.1)	1
Orthoptera			
Tetrigidae	0 (0)	1 (4.5)	1
Unidentified larva	99.5 (6.7)	1 (4.5)	1
Arachnida			
Araneae			
Araneidae	92.1 (6.2)	1 (4.5)	1
Lycosidae	194.8 (13.2)	2 (9.1)	2
Myriapoda			
Chilopoda	0 (0)	1 (4.5)	1
Total	1474.3	22	

L. insularum is a species associated with ponds, explaining why the majority of their stomach contents were aquatic insects, as reported in other frogs found living near lentic waters, such as *L. bufonis*, *L. fragilis*, *L. latinasus*, and *L. poecilochilus* (Duré and Kehr 2004. Herpetologica 60:295–303; Gonzalez– Duran et al. 2011. Herpetol. Rev. 36:583–584; Savage 2002, *op. cit.*).

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***PSEUDIS LAEVIS* (Guyana Harlequin Frog). DIET.** *Pseudis laevis* have strong aquatic habits and often occur in permanent and vegetated water bodies of open flooded savannah areas in South America; they are found from southern Guyana and northern Brazil to north-central Bolivia (Reichle 2004. IUCN Red List of Threatened Species, ver. 2012.2. Electronic database accessible at http:// www.iucnredlist.org; accessed 16 May 2013). The diet of *P. laevis* is composed mainly of arthropods (Vaz-Silva et al. 2005. Comum. Mus. Ciênc. Tecnol. PUCRS, Ser. Zool. 18:3–12). Here, we report on the ingestion of fish as prey for *P. laevis* in the floodplain at Area de Proteção Ambiental do Curiaú (APA Curiaú), in the municipality of Macapá, Amapá, Brazil (0.150194°N, 51.038472°W; datum WGS84).

Twenty-one stomachs were analyzed during February (rainy season; N = 18) and November (dry season; N = 3) 2012. We recognized 17 prey categories in the diet of female *P. laevis*. The most important items in terms of number, frequency of occurrence, and index of relative prey importance were Diptera, Collembola and Hemiptera. Two fish were found in the stomach contents two adult females; to our knowledge this is the first report of piscivory in this species. The first female (20.7 mm SVL) contained an unidentified *Acestrorhynchus* sp. (Characiformes: Acestrorhynchidae; total length = 8.1 mm, width = 1.9 mm, volume = 39.7 mm^3). The second female (18.6 mm SVL) contained a *Hoplosternum littorale* (Siluriformes: Callichthyidae; Total length = 19.7 mm, width = 1.8 mm, volume = 13.5 mm^3). Voucher specimens will be deposited at the Coleção Didática do Laboratório de Zoologia (ICMBio collecting permit number 34238-1).

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***PSEUDOPALUDICOLA MYSTACALIS*. COLORATION.** *Pseudopaludicola* species (Leptodactylidae) are mostly cryptically colored, with light brown/gray pigmentation, and may exhibit three coloration patterns: 1) individuals without vertebral lines or dorsolateral stripes; 2) individuals with two dorsolateral stripes and 3) individuals with vertebral lines with variable colors (Pansonato et al. 2013. Zootaxa 3620:147–162). Herein we report for the first time in the genus a distinct aberrant colored specimen with a partially xanthic pattern.



FIG. 1. *Pseudopaludicola mysticalis* exhibiting a partially xanthic pattern.

At approximately 1900 h on 04 July 2013, we photographed and collected a partially xanthic female of *P. mystacalis* (14.53 mm SVL) at Lagoa da Coruja, Floresta Nacional de Nísia Floresta, Nísia Floresta municipality, Rio Grande do Norte State, Brazil (6.07360°S, 35.17750°W; datum: WGS 84; elev. 11 m). The individual exhibited normal pigmentation on the posterior region of the body, limbs, and ventral surface, whereas the anterior half of body dorsal surface was yellowish with absence of typical pigmentation; iris pigmentation was present (Fig. 1). We observed several hundred individuals in the area, but only one with such pattern was collected. The specimen is housed at Coleção de Anfíbios e Répteis da Universidade Federal do Rio Grande do Norte (AAGARDA 9188).

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***PSEUDOPALUDICOLA MYSTACALIS* (Cope's Swamp Frog). PREDATION.** Herein, we report an observation of the predation of an adult *Pseudopaludicola mystacalis* (Leptodactylidae) by a spider (Ctenidae: *Ancylometes* sp.). The event was observed in a pond of spring water near a permanent lake in pasture area around Goiânia municipality, Goiás state, Brazil (16.58314°S, 49.26983°W; datum: SAD 69). At approximately 2130 h on 13 January 2010, we observed an individual of *P. mystacalis* captured and immobilized by the spider. The spider inserted its chelicerae into the pelvic region of the frog, which tried unsuccessfully to escape using its hind limbs to push and attempt saltatory movements. The frog struggled for 10 min. before stopping all movements, by which time we assumed the frog's death. The complete ingestion of the frog lasted about 15 min. After this period we

captured the spider, and collected the remains of the predated frog. All specimens were deposited in Coleção Zoológica da Universidade Federal de Goiás (ZUFG-7630; anuran with the spider).

Spiders are opportunistic and generalist predators that feed on small fishes, tadpoles, and frogs (Bastos et al. 1994. Herpetol. Rev. 25:118; Menin et al. 2005. Phyllomedusa 4:39–47; Toledo 2005. Herpetol. Rev. 36:395–400), however, this is the first report of a spider feeding on *P. mysticalis*.

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***RHAEBO GUTTATUS* (Amazonian Toad). MALFORMATIONS.** *Rhaebo guttatus* is a relatively widely distributed bufonid found from Amazonian Ecuador, Colombia, Venezuela, Perú, and Bolivia to the Guyanas and central Amazonian Brazil (Lötters et al. 2000. Bonn. Zool. Beitr. 49:75–78). At 0900 h on 12 August 2013 in a secondary forest area near the Suriname River, near Bergendal in the Brokopondo district of Suriname (5.143744°N, 55.067835°W; datum WGS 84), a juvenile (35 mm SVL), abnormal wild specimen of *Rhaebo guttatus* was collected and photographed. The specimen had six digits on the right hand and right foot and the left arm was absent. The left leg was normal and had five toes. Although amphibian malformations are well documented (Lannoo 1998. Malformed Frogs. University of California Press, Berkeley. 270 pp.), this is the first observation of malformed limbs reported for this species.

The specimen was released after photographs and measurements in accordance to the requirements of the owners Bergendal Eco & Cultural River Resort.

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***RHINELLA ORNATA*. (Mexican Spadefoot). PREDATION BY *LEPTODACTYLUS LATRANS*.** Anurans of the genus *Rhinella* (Bufonidae) are known to produce toxic skin secretions, particularly in the parotoid glands, a form of chemical defense against microorganisms (Tempone et al. 2008. Toxicon 52:13–21) and predators (Cardoso and Sazima 1977. Ciência e Cultura 29:1130–1132). However, some invertebrates and vertebrates are known to prey upon species of *Rhinella* (Toledo et al. 2007. J. Zool. 271:170–177) by consuming the entire toad (Bernarde 2000. Rev. Brasil. Biol. 60:695–699), or by avoiding body regions containing more prominent poison glands (Crozariol and Gomes 2009. Atualidades Ornitológicas 149:4–5; Haddad and Bastos 1997. Amphibia-Reptilia 18:295– 298; Loebmann et al. 2008. Amphibia 7:31–34; Röhe and Antunes 2008. Wilson J. Ornithol. 120:228–230; Toledo 2003. Phyllomedusa 2:105–108). Herein, we report on a predation attempt of the toad *Rhinella ornata* by *Leptodactylus latrans* (Leptodactylidae). At 2140 h on 11 October 2011, during a nocturnal herpetofaunal survey conducted at a permanent pond in an Atlantic rainforest, municipality of Ubatuba, state of São Paulo, southeastern Brazil (23.36452°S; 44.82694°W; datum 35 ASL), we observed a nearly completed predation event, which we probably interrupted. The air temperature and relative humidity were 27.7°C and 83%, respectively. The shallow part of the pond had ca. 40 individuals of *R. ornata* and other anuran species engaging in calling activity. We then found a male *L. latrans* (125.02 mm; CFBH 30033; Fig. 1) that was collected in a plastic bag. By checking closely, we noticed a bunch of grass in the Butter Frog's mouth, and also the toes of another anuran. A few minutes later, the *L. latrans* regurgitated a male *R. ornata* (68.75 mm; CFBH 32630; Fig. 1). Because of the prey position when it was found, we assumed headfirst swallowing by *L. latrans*. The diet of *L. latrans* is considered to be generalist (Pazinato et al. 2011. Biotemas 24:147–151), and there are other records of Butter Frogs attempting to predate other toxic frog species (e.g., *Trachycephalus mesophaeus*; Mendes and Solé 2012. Herpetol. Notes 5:163–164). We cannot affirm whether or not the predation attempt we observed would have been successful if we had not interrupted it. Nevertheless, until now, no attempted or successful predations have been reported for *L. latrans* upon *R. ornata*.

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***SPEA MULTIPLICATA* (Mexican Spadefoot). FORAGING SITE SELECTION.** In amphibians, two kinds of foraging strategies are utilized: 1) sit and wait, and 2) active foraging. In anurans, the sit and wait strategy is most common (Duellman and Trueb 1994. Biology of Amphibians. Johns Hopkins Univ. Press, Baltimore, Maryland. 670 pp.). Anurans typically remain stationary and attack mobile prey that move within their field of vision, however, a factor that can be important to success when caching prey is foraging site selection. Livestock dung is a nutrient-rich habitat that is colonized by numerous species of arthropods (flies, beetles, ants, termites, mites and others; Hanski 1991. *In* Hanski and



FIG. 1. Individuals of *Spea multiplicata* (arrows) foraging on the surface of livestock dung.

Cambefort [eds.], Dung Beetle Ecology, pp. 5–19. Princeton Univ. Press, Princeton, New Jersey) and therefore it can represent an excellent foraging habitat for anurans. The use of this resource as anuran foraging sites has been documented in some species, e.g., *Hyla squirella* (Cline 2005. *In* Lannoo [ed.], Amphibian Declines: The Conservation Status of United States Species, pp. 456–458. Univ. of California Press, Berkeley California).

Between 0049–0208 h on 01 September 2013, we observed foraging site selection of *Spea multiplicata* in a livestock pasture located 3.7 km S of the town of San Luis Soyatlán, in the Municipality of Tuxcueca, Jalisco, Mexico (20.16523°N, 103.31288°W, datum WGS 84; elev. 2086 m). Air temperature and humidity were 19.6°C and 69.1%, respectively. We sampled an area of 5251 m^2, where we recorded 105 piles of livestock dung, 80 belonging to cows and 25 to horses. Of these, 17 cow patties (21.25%) had at least one individual of *Spea multiplicata* perched upon it (21 individuals total), in contrast to horse droppings, where only two (8%) had one individual frog each. All livestock droppings were wet due to rain of previous days. All frogs observed were metamorphic juveniles, and they were observed on the surface of the dung feeding on small invertebrates. None of the individuals observed were captured, but we documented the observations with photographs (Fig. 1). This note provides further evidence of the importance of livestock dung as a foraging microhabitat for anurans, and suggests that *S. multiplicata* may show a preference for cow dung as a foraging site.

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FIG. 1. M. Ranaivoharivelo indicating the location of a freshly predated *Astrochelys radiata* nest.

TESTUDINES — TURTLES

***ASTROCHELYS RADIATA* (Radiated Tortoise). NEST PREDATION.** Anthropogenic habitat disturbance can have lasting effects on the wildlife that recolonize the recovering patches. Some animals prefer to use partially disturbed habitats or ecotones for various activities, including nesting for many turtle species. The Critically Endangered Radiated Tortoise (*Astrochelys radiata*; IUCN 2011. IUCN Red List of Threatened Species. Version 2012.2. <www.iucnredlist.org>) in southwest Madagascar may be one of these species. While surveying habitat during an ongoing radiotelemetry study (Ranaivoharivelo et al., unpubl.) on 19 March 2013, we found an approximate 0.9-ha patch of historically cleared forest near the village of Lavavolo (24.6333333°S, 43.9333333°E) where *A. radiata*, especially females, were reported to be in relative abundance. The patch was previously forested Southern Dry Forest (an endemic and highly threatened Malagasy ecosystem) approximately 2.7 km E of the shore, atop the Mahafaly Plateau. The surrounding forest is comparatively untouched and purportedly supports a reasonably healthy population of *A. radiata*.

Upon surveying the disturbed 0.9-ha patch, we found approximately 15 adult female *A. radiata* and five freshly predated nests. The predated nests were found in the sand along the edge of the open patch, just under a row of *Opuntia* cactus that is used as a "fence" to surround the patch (Figs. 1, 2). Nests contained 1–4 predated eggs, the freshest of which had presumably been broken opened and the yolks (not albumin) eaten. We suspect a small mammal predator capable of excavating the nests, such as the Giant-striped Mongoose (*Mungotictis grandidieri*), had depredated the eggs. Due to the freshness of the excavations, the nest predation had likely occurred within the previous few days. It seems reasonable to assume that such predation could occur repeatedly over the nesting season. At least two other instances of nest predation were reported in nearby habitat in May and June the previous year, but snake tracks were found and indicated the probable culprit.



FIG. 2. Freshly predated *Astrochelys radiata* nest with albumin still remaining in the broken eggshells. Excavated nest is under the *Opuntia* plant at the top right of the photo.

It appears that the ecotone provided by this disturbed patch was preferentially used by female tortoises for nesting, and that the relative high concentration of nests and openness of the habitat encouraged the ingress of nest predators. For a critically endangered and locally isolated species, such a repeated threat to reproductive success could lead to local population extirpation.

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***CHELYDRA SERPENTINA* (Snapping Turtle). INTERSPECIFIC BASKING.** On 19 May 2006, at Standing Stone Lake (Standing Stone State Park, Overton Co., Tennessee, USA; 36.47113°N, 85.41553°W), we observed an adult *Chelydra serpentina*, a *Trachemys scripta* (Pond Slider), and a *Graptemys geographica* (Northern Map Turtle) basking on a log at the same time, within about 1.5 m of each other. This observation is noteworthy because Ernst et al. (1994. Turtles of the United States and Canada. Smithsonian Inst. Press, Washington, D.C. 578 pp.) indicated that other species of turtles typically avoid basking sites occupied by *C. serpentina*. However, *Chrysemys picta* (Painted Turtle) has been observed basking on the back of *C. serpentina* (Legler 1956. Trans. Kansas Acad. Sci. 59:461–462). We did not observe any aggressive basking behavior among species (but see Lindeman 1999. J. Herpetol. 33:214–219; Lovich 1988. Herpetologica 44:197–202; Selman and Qualls 2008. Herpetol. Rev. 39:214–215).

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***PSEUDEMYS RUBRIVENTRIS* (Northern Red-bellied Cooter). BOAT PROPELLER MORTALITY.** Injury and death from boat propeller strikes have been reported for several chelonians in North America including *Apalone spinifera* (Galois and Quellet 2007. Chelon. Conserv. Biol. 6:288–293), *Chrysemys picta*, *Trachemys scripta*, and *Graptemys geographica* (Smith et al. 2006. J. Herpetol. 40:180–185; Bulté et al. 2010. Aquat. Conserv. Marine Freshw. Ecosys. 20:31–38), *Malaclemys terrapin* (Gibbons et al. 2001. Chelon. Conserv. Biol. 4:66–74), *Pseudemys floridana*, *P. nelsoni*, and *Sternotherus odoratus* (Bancroft et al. 1983. Misc. Paper A-83-5, U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, Mississippi. 252 pp. + appendices), and *Pseudemys concinna suwanniensis* (Heinrich et al. 2012. Herpetol. Conserv. Biol. 7:349–357), Mortality rates were relatively high in some of these populations. Eleven of 78 *P. rubriventris* captured in the Jug Bay region of the tidal Patuxent River in central Maryland had scars and injuries indicative of propeller strikes (Swarth 2004. *In* Swarth et al. [eds.], Conservation and Ecology of Turtles of the Mid-Atlantic Region, a Symposium, pp. 73–83. Bibliomania! Salt Lake City, Utah) but mortality was not mentioned.



FIG. 1. A female *Pseudemys rubriventris* showing lethal propeller strike damage near Jamestown Island, Virginia.

I found a dead female *Pseudemys rubriventris* on 5 July 2001 floating in Powhatan Creek, a channel in the tidal marsh separating Jamestown Island National Historic Park from the mainland in James City County, Virginia (37.222452°N, 76.781550°W; WGS 84). She was a large adult (268 mm CL, 253 mm PL) with three distinct propeller strikes on her carapace (Fig. 1). The anterior two strikes were deep and the one in the middle appears to have cut into the body cavity. The missing pieces of the marginals on the left rear and lower right portions of the carapace may have also been struck. Most information on injuries on turtles from propeller strikes involves living individuals that survived and were subsequently captured. Opportunities to document turtles killed by propeller strikes are rare. Reports by Bancroft et al. (*op. cit.*) and Galois and Quellet (*op. cit.*) are the exceptions. Observations of turtles killed by this anthropogenic hazard should be reported wherever possible.

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CROCODYLIA — CROCODILIANS

***ALLIGATOR MISSISSIPPIENSIS* (American Alligator). EPIBIOSIS.** *Alligator mississippiensis* has recently been documented to serve as a host for the obligate commensal barnacle *Chelonibia testudinaria* in a coastal estuary in northeastern Florida (Nifong and Frick 2011. Southeast. Nat. 10:557–560). Nifong and Frick (*op. cit.*) reported on two alligators, one of which hosted a single living *C. testudinaria*, and the other alligator bore a wound containing the empty shell of a barnacle. Both alligators were caught in an estuarine impoundment in Guana River Wildlife Management Area in Ponte Verda, Florida, USA. Herein we report on an American Alligator harvested in coastal Louisiana that hosted numerous barnacles from a family previously undocumented as epibionts of *A. mississippiensis*.

An adult male American Alligator (310 cm TL) was harvested on 15 September 2013 as part of the state of Louisiana's annual autumn commercial alligator season. The alligator was caught in Green Island Bayou in coastal Vermilion Parish. The trapper immediately observed numerous barnacles on the alligator's back and took numerous photos of the unusual occurrence. Additional photos were taken when the alligator was received at a check station/processing location. We conservatively estimate that some 120–130 barnacles were present on the alligator, and they were situated along the dorsal surface of the lower back and on the lateral surface edges of the tail scutes. Individual tail scutes hosted 6–8 barnacles (Fig. 1). The aforementioned trapper has never noted barnacles on alligators harvested in the past, and he caught another alligator in the same vicinity, on the same day, that hosted no barnacles.

Regrettably, no barnacles were collected for precise identification, but based on photographs it is apparent that the barnacles belong to family Balanidae and most likely represent *Balanus* sp. or *Amphibalanus* sp. It is unusual to note so many barnacles on an individual alligator, as prior reports of barnacle-crocodilian epibiosis describe only one or two barnacle specimens from each crocodilian host (Monroe and Garret 1979. Crustaceana 36:108; Nifong and Frick, *op. cit.*). The alligator described herein was slightly larger (thus presumably older) than the alligators reported hosting *C. testudinaria* by Nifong and Frick (*op. cit.*) and thus may have accumulated a larger aggregation of barnacles in response to size-related differences in habitat utilization and/or behavior (see Lance et al. 2001. *In* Grigg et al. [eds.], Crocodilian Biology and Evolution, pp. 327–340. Surrey Beatty & Sons, Chipping Norton). Additionally, it is possible that barnacle recruitment and growth differ between *C. testudinaria* and balanid barnacles, and that *C. testudinaria* does not display the high fecundity and fast growth previously documented for most balanid barnacles (Thiyagarajan et al. 2005. Mar. Ecol. Prog. Ser. 299:229–237). Nonetheless, the alligator documented in the present note appeared to be in good health, and showed no sign of emaciation, which may have occurred if the alligator was exposed to high salinities over an extended time period. Some species of balanoid barnacles tolerate low salinities and some thrive in brackish (approximately 15 ppt) waters (Dineen and Hines 1994. Mar. Biol. 119:423–430; Dineen and Hines 1994. J. Exp. Mar. Biol. Ecol. 179:223–234); thus particularly high salinities may not have been needed for the accumulation of barnacles seen in the case described.

In general, alligators prefer fresh to intermediate salinity wetlands, but can tolerate high salinities (Lance et al. 2010. J. Exp. Zool. 313A:106–113) and a single individual was observed in the open marine waters of the Gulf of Mexico ca. 56 km S of Marsh Island, Louisiana (and approximately 63 km from the nearest point on mainland Louisiana; Elsey 2005. Southeast. Nat. 4:533–536). The photograph therein documents an alligator near an offshore platform; the platform is covered with barnacles (family or species unidentified). The nearest border of the trapper's property where the alligator described herein was caught is only 0.33 km minimum distance from Vermilion Bay, and thus it may have been exposed to brackish salinities at some point or for a sufficient (i.e., extended) time period to allow barnacle accumulation. The wetlands on which the trapper is authorized to hunt alligators is categorized as brackish and intermediate marsh (46.6% and 53.4%, respectively).

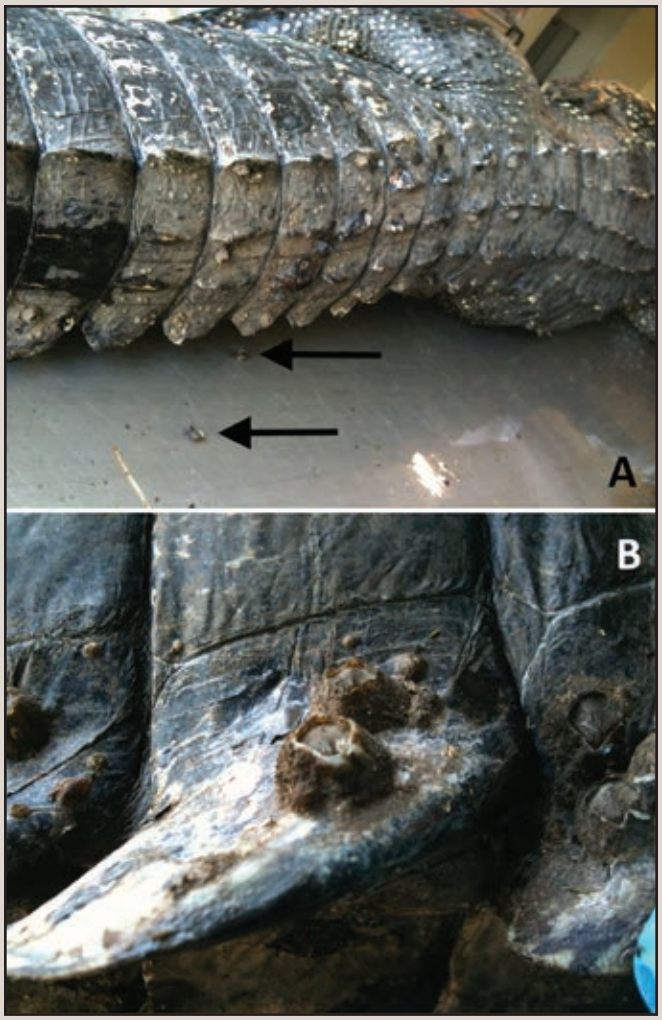


FIG. 1. Adult male American Alligator (*Alligator mississippiensis*) with numerous barnacles on dorsal surface and scutes (Panel A); as well as two barnacles apparently dislodged to the floor (arrows). Several barnacles also visible on lateral aspects of tail scutes (Panel B).

Several species of barnacles have also been reported on the American Crocodile (*Crocodylus acutus*) including *Lepas anatifera, Chelonibia testudinaria* (Cupul-Magana et. al. 2011. Herpetol. Notes. 4:213–214) and *Amphibalanus amphitrite* (Escobedo-Galvan et al. 2012. Crustaceana 85:1145–1148). American Crocodiles are widely distributed and inhabit higher salinity environments for longer time periods than American Alligators (Richards et al. 2004. Ecol. Modelling 180:371–394) and thus may be more prone to barnacle infestation.

Balanoid barnacles have also been found in brackish systems on an Alligator Snapping Turtle (*Macroclemys temminckii*; Jackson and Ross 1971. J. Herpetol. 5:188–189) and on two red-bellied turtle species in Alabama (*Chrysemys alabamensis*; Jackson and Ross 1972. Florida Acad. Sci. 35:173–176) and New Jersey (*Chrysemys r. rubriventris*; Arndt 1975. J. Herpetol. 9:357–359). Three species of barnacles (including *Balanus eburneus*) are documented to attach to Diamondback Terrapins (*Malaclemys terrapin*; Seigel 1983. Am. Midl. Nat. 109:34–39) in Florida, and unidentified barnacles have been seen on Diamondback Terrapins in coastal Louisiana (W. Selman, unpubl. data).

The dealer to whom the alligators were sold reported to us that in over 40 years of processing wild alligators in Louisiana he has only seen barnacles on alligators on three or four occasions (W. Sagrera, pers. comm.). Future efforts might be directed to noting other examples of barnacle infestation on alligators, and collection of additional species if present, to determine exact identification and conduct genetic analyses.

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***ALLIGATOR MISSISSIPPIENSIS* (American Alligator). LARGE PRESUMPTIVE FEMALE: A CASE OF MISTAKEN IDENTITY.** *Alligator mississippiensis* can grow to impressive lengths, with reported maximum total lengths of 426.9 cm (male) and 309.9 cm (female) for alligators measured in Florida between 1977 and 1993 (Woodward et. al. 1995. J. Herpetol. 29:507–513). In South Carolina, a 294 cm female alligator has been documented (Wilkinson 2008. *In* Crocodiles. Proc. 19th Working Meeting of the Crocodile Specialist Group, pp. 182–187. IUCN – The World Conservation Union, Gland, Switzerland and Cambridge, UK). Large female alligators have also been measured during research efforts (a 309.9 cm female caught 12 June 2009) and in the sanctioned wild harvest (304.8 cm) in Mississippi in 2013 (R. Flynt, pers. comm.). In Louisiana, detailed records are kept on sex ratios of harvested alligators, but females over 9 ft TL (274 cm) are rare (Elsey and Kinler 2012. *In* Crocodiles. Proc. 21st Working Meeting of the Crocodile Specialist Group, pp. 136–148. IUCN – The World Conservation Union, Gland, Switzerland and Cambridge, UK).

It is unknown if large alligators reach reproductive senescence (Lance 2003. Exp. Gerontol 38:801–805; Scott et al. 2006. Southeast. Nat. 5:685–692) and we have planned to collect reproductive tracts should we encounter any extremely large females, to determine if those alligators appeared to have recently ovulated or are still capable of nesting. We herein report on an American Alligator harvested in coastal Louisiana that we initially believed to be a near record sized female alligator.

An adult American Alligator (307.3 cm TL) was harvested in coastal Vermilion Parish on 9 September 2013 as part of the state of Louisiana's annual autumn commercial alligator season. The trapper brought the alligators harvested that day to a processing shed where RK was collecting data. The sex of alligators is determined by palpation inside the cloaca to determine presence or absence of the penis (Chabreck 1963. Proc. SE Assoc. Game and Fish Comm. 17:47–53; DeNardo 1996. *In* D. R. Mader, Reptile Medicine and Surgery, pp. 212–224. Elsevier Publishing, New York). This alligator was noted to be a presumptive female by RK and two other persons (a trapper/biologist with 30 yrs experience with alligators and a dealer with 20 yrs experience as an alligator farmer/trapper) based on the lack of a penis in the cloacal vault. RK recognized this as an unusually large female alligator, and notified RME. Arrangements were made to collect the entire viscera, including the reproductive organs to determine if the presumptive female had recently nested, or if there were indications of reproductive senescence. Some reports suggest senescent processes affect female crocodilians (Pitman 1941. Uganda J. 9:89–114; Graham 1968. The Lake Rudolf Crocodile [*Crocodylus niloticus* Laurenti] Population. Report to the Kenya Game Department. 151 pp.; Joanen and McNease 1980. *In* Murphy and Collins [eds.], Reproductive Biology and Diseases of Captive Reptiles, pp. 153–159. SSAR Contributions to Herpetology No. 1, Athens, Ohio), particularly larger (> 290 cm TL), older females (Graham, *op. cit.*). Pitman (*op. cit.*) also reported a 13 ft (396 cm) female and a 14 ft (427 cm) female Nile Crocodile he measured were no longer breeding, but did not note how this was determined. The alligator herein described was missing the right rear leg, but otherwise appeared robust and reasonably heavy for its length.

Upon receipt of the viscera, a fourth person (RME, with 25 yrs experience in alligator research) palpated the interior of the cloaca and also presumed the alligator was a female, due to the absence of a palpable penis. Dissection of the gonads, however, revealed structures more consistent with testes (dense consistency, violet/purple color externally, some tan color internally after bisecting) than ovaries (more cystic/granular with follicles or ova present, white/pink in color) and nothing resembling active or regressed oviducts were observed. A small (approximately one cm) dense oval structure possibly suggestive of a portion of the fibrous penile crurae (Kelly 2013. Anat. Rec. 296:488–494) was palpated on one side. The gonads measured 9.9 mm L × 2.3 mm W and 10.1 mm L × 2.6 mm W. We could not visualize the ductus deferens, though they may have been markedly regressed during the post-breeding season. Both gonads were excised and fixed in neutral buffered formalin for histological examination. Detailed dissection of the kidneys was not done, but no gross abnormalities were observed.

Histological examination (Fig. 1A, B) of the gonad confirmed this alligator was actually a male. The spermatids appeared normal when present (Fig. 1B, S2), but spermatogonia (Fig. 1B, dSpA and B) and spermatocytes (Fig. 1B, dPI) were hypertrophied, degraded, and being sloughed (Fig. 1B, SE) to the lumen (Fig. 1B, L) with spermatogonia undergoing what appeared to be apoptosis. Mast cells (Fig. 1B, Ma) were also present, which likewise indicated that cell death and recycling was taking place within the seminiferous epithelium and also may be why blood vessels were dilated (Fig. 1A, BV). The interstitial tissue (Fig. 1A, IN) was thick compared to normal alligators in quiescence, with disorganized fibroblasts and overabundant collagen fibers. Sertoli cell nuclei (Fig. 1B, dSc) appeared atrophied and underdeveloped compared to spermatogenically dormant normal alligators (Gribbins et al. 2006. Acta Zool. 87:59–69). In light of the abnormal sloughing of the seminiferous epithelium and the apparent cell death of spermatogonia, it is doubtful these testes would be able to function normally and were unlikely to have been able to support a future round of spermatogenesis; it may have attempted spermatogenesis in the past. The alligator was a mature

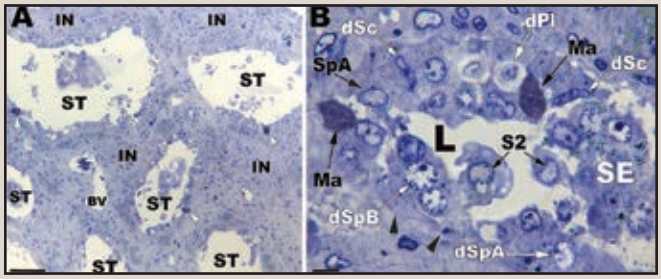


FIG. 1. Histological view of gonad removed from the presumed female American Alligator. A) Scanning view of gonadal tissue consistent with testicular tissue in reptiles. The seminiferous tubules (ST) are dispersed far from each other in cross section with a thick interstitial space (IN). Blood vessels (BV) are often large and dilated most likely because of the presence of mast cells (white arrowheads) within or near the seminiferous tubules. Bar = 50µm. B) Higher power of a single seminiferous tubule showing details of the seminiferous epithelium. The epithelium is being shed (SE) into the lumen (L) and contains mostly spermatogonia and spermatocytes. Spermatids (S2) appear normal when present and spermatogonia A/B (dSpA, dSpB) and spermatocytes (preleptotene, dPl) are hypertrophied and apoptotic in appearance. Sertoili cell nuclei (dSc) are atrophied and mast cells (Ma) are common. SpA, normal spermatogonium; Black arrowheads, basement membrane of seminiferous epithelium. Bar = 5µm.

animal at a length of 307.3 cm, although this male clearly was abnormal reproductively, it is not likely an age-related senescence as it had not obtained the extreme length common in very old male alligators.

Alligators exhibit temperature-dependent sex determination (TSD) (Ferguson and Joanen 1982. Nature 296:850–853); we have no knowledge of the nest cavity temperatures to which this alligator was exposed. A recent case of intersexuality has been noted in a captive adult African Dwarf Crocodile (*Osteolaemus tetrapsis*); the crocodile had a male-typical phenotype, but upon necropsy the gonads were histologically detected as ovotestes, possibly as a result of development in the transition range of temperature for a species with TSD (S. Langer, pers. comm). There may have been a gene mutation that controls sexual differentiation having an adverse effect on the gonadal/phallus development in this alligator. We are not aware of documented cases of congenital absence of the phallus in crocodilians.

A detailed anatomical study of the normal penile anatomy of the adult American Alligator has been published (Kelly 2013, *op. cit.*). Recent reports have documented reduction in penis size (Guillette et al. 1996. Gen. Comp. Endocrinol. 101:32–42) and abnormalities of gonadal morphology in juvenile alligators of both sexes (Guillette et al. 1994. Environ. Health Perspectives 102:680–688) related to endocrine disruption from environmental contaminants in Florida lakes. We have no evidence that a similar mechanism was a factor in this case.

The alligator described herein had loss of a lower limb, possibly due to aggressive intraspecific courtship encounters during breeding, which often involves bites sustained at the base of the hind legs and tail (Joanen and McNease 1975. Proc. SE Assoc. Game and Fish Comm. 29:407–451). Alternatively, trauma such as this specimen's injury may have occurred from a boat propeller strike resulting in limb amputatation; it is possible a penile injury or amputation may have transpired at the same time as the limb trauma. Indeed, we have observed partial penile amputations in captive juvenile alligators provided feed on platforms on commercial alligator farms; we suspect when alligators crawled onto the feeding platform the penis was extruded and bitten by other alligators attempting to gain access to the food. We hypothesize bites to the penis may have become infected and subsequently partially sloughed away, as remnant "nubs" of the penile shaft were palpated in the cloaca of these alligators. Prolapse of the copulatory organ has been described in captive reptiles; the exposed tissues may become swollen and traumatized, leading to desiccation and necrosis (DeNardo 1991, *op. cit.*; Frye 1991. Biomedical and Surgical Aspects of Captive Reptile Husbandry. Krieger Publ. Co., Malabar, Florida. 712 pp.).

In the case of this alligator, without the benefit of necropsy to visualize gonads and confirmation of male gender by histology, we would have incorrectly noted the alligator as a near record-size female if only cloacal palpation had been undertaken. It is possible (though likely very rare) that unusually large "female" alligators noted in field studies might also have been males, as in the present case. Conversely, on three occasions we captured live adult alligators (223.5 cm, 228.6 cm, and 248.9 cm TL) at nest sites, which we would have anticipated to be females in nest defense, whereupon cloacal palpation were determined to be males. Caution must be exercised in assuming the gender of an alligator or other crocodilians in the field based solely on size or location.

We acknowledge Craig Sagrera and Velma Stelly for assistance with obtaining the viscera on the alligator harvested, and thank Steven G. Platt for helpful discussion about these findings.

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***CROCODYLUS ACUTUS* (American Crocodile). FRUGIVORY.** Because crocodilians are generally assumed to be obligate carnivores (Neill. 1971. The Last of the Ruling Reptiles: Alligators, Crocodiles, and Their Kin. Columbia Univ. Press, New York. 486 pp.), frugivory among this group has been under-reported and received little attention in comparison to other reptiles (Platt et al. 2013. J. Zool. 291:87–99). On 6 June 2010, two of us (CCR, VR) captured a large adult male *Crocodylus acutus* (total length = 336 cm) in Ambergris Lake, near San Pedro Town on Ambergris Cay, Belize (17.906764°N, 87.976528°W; datum WGS84). Ambergris Lake is a shallow, man-made lake fringed by mangrove swamp. Local authorities deemed the crocodile a threat to public safety after it attacked and consumed several household pets, and requested the animal be translocated to an area remote from San Pedro. The crocodile died the following day (7 June 2010) while being restrained for translocation. A necropsy performed later that day was inconclusive, but death likely resulted from fatal acidosis, which occasionally occurs when large crocodiles are restrained (Seymour et al. 1987. *In* Webb et al. [eds.], Wildlife Management: Crocodile and Alligators, pp. 253–257. Surrey Beatty & Sons, Chipping Norton, NSW). An examination of the esophagus and stomach during the necropsy revealed one Mango (*Mangifera indica*; Anacardiaceae; Fig. 1) and three Sea Almond (*Terminalia catappa*; Combretaceae) seeds, in addition to the remains of domestic dogs (*Canis lupus familiaris*), chickens (*Gallus* sp.; probably fed by tourists), a mass of unidentified vegetation, and 11 stones of various sizes.

To our knowledge, this is the first reported occurrence of *M. indica* or *T. catappa* seeds among the gastric contents of *C. acutus*



FIG. 1. Mango (*Mangifera indica*) seed found among the gastric contents of an adult male *Crocodylus acutus* collected near San Pedro Town, Ambergris Cay, Belize.

or any other crocodilian (Platt et al. *op. cit.*). In a recent review of frugivory among the Crocodylia, Platt et al. (*op. cit.*) found 34 families and 46 genera of plants represented among fruits and seeds reportedly consumed by crocodilians. The inclusion of *M. indica* and *T. catappa* increases this total to 36 families and 48 genera. The fruits of *M. indica* and *T. catappa* are classified as drupes, and fleshy fruits (aggregate, berry, and drupe) comprise the bulk (52.1%) of reported frugivory among the Crocodylia (Platt et al. *op. cit.*). Our findings in Belize complement previous observations of frugivory in *C. acutus*, which is known to consume fruits of *Rhizophora mangle* (Platt et al., *op. cit.*) and *Brysonima crassifolia* (Platt et al. 2013. J. Herpetol. 47:1–10); unidentified seeds have also been recovered from fecal samples (Casas-Andreu and Quiroz 2003. Anales del Instituto de Biologia, Universidad Nacional Autonoma de Mexico, Serie Zoologica 74:35–42).

Because gastric contents analyses reveal only the composition of the diet and not the foraging mode (DeVault and Rhodes. 2002. Acta Theriol. 47:185–192), it is possible the seeds we recovered from the stomach of *C. acutus* resulted from behaviors other than deliberate consumption of fruits as food. Crocodilians may ingest seeds accidentally during prey capture (Diefenbach 1979. Copeia 1979:162–163), floating seeds could be mistaken for swimming prey (Webb and Manolis 1989. Crocodiles of Australia. Reed Books Pty., Ltd., French Forest. 160 pp.), or hard seeds might be consumed as gastroliths (Platt et al. 2002. Herpetol. J. 12:81–84). Seeds found among stomach contents could also result from secondary ingestion, i.e., the acquisition of items contained in the gut of primary prey (Cott 1961. Trans. Zool. Soc. London 29:211–357). However, secondary ingestion can probably be ruled out in our case because the co-occurring prey (dogs and chickens) are incapable of consuming the large intact fruits or seeds of Mango and Sea Almond.

Given these caveats, there is no doubt that some fruit consumption is attributable to accidental or secondary ingestion; however, there are no *a priori* reasons to assume that fruits are not deliberately eaten by crocodilians as food. Despite early reports to the contrary (Coulson and Hernandez 1983. Alligator Metabolism: Studies on Chemical Reactions *in vivo*. Pergamon Press, New York. 182 pp.), crocodilians are capable of digesting carbohydrates, plant-based proteins, and vegetable fats (Coulson et al. 1987. Biochem. Physiol. 87A:449–459; Staton et al. 1990. J. Nutrit. 120:775–785), strongly suggesting that nutritional benefits accrue from frugivory (Platt et al., *op. cit.*). Our observations of frugivory by *C. acutus* in Belize add to the growing body of evidence suggesting crocodilians should be considered "occasional frugivores" *(sensu* Willson 1993. Oikos 67:159–176), i.e., generalist predators that complement an otherwise carnivorous diet with fruit, which is consumed infrequently but not always in small quantities (Platt et al., *op. cit.*). Whether or not crocodilians play any role as aquatic seed dispersal agents has yet to be determined, and this topic is a worthwhile avenue for future investigation (Platt et al., *op. cit.*).

We thank Josh Buettner and the residents of San Pablo Village, San Pedro, Belize for assisting with the capture and necropsy of this crocodile. Carts Belize provided logistical support, and Tamara Sniffin photographed the seeds. Lewis Medlock brought several important references to our attention. Support for this project was provided by the Rufford Small Grants Foundation and the American Crocodile Education Sanctuary (ACES). Research and collection permits were issued to CCR by the Belize Forest Department. The findings and conclusions in this article are those of the authors and do not necessarily represent the views of the U.S. Fish and Wildlife Service.

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***PALEOSUCHUS PALPEBROSUS* (Cuvier's Smooth-fronted Caiman). HABITAT USE.** *Paleosuchus palpebrosus* occurs along the Orinoco and Amazon River drainages and the Atlantic Coast drainage that lies between these two rivers in Colombia, Ecuador, Peru, western Bolivia, Venezuela, Brazil, French Guiana, Guiana, and Surinam (Magnusson and Campos 2010. *In* Manolis and Stevenson [eds.], Crocodiles. Status Survey and Conservation Action Plan, 3rd ed., pp. 40–42. Crocodile Specialist Group, Darwin, Australia; Rueda-Almonacid et al. 2007. Las Tortugas y los Cocodrilianos de los Países del Trópico. Serie de Guías Tropicales de Campo No. 6. Conservation International, Bogotá, Colombia. 538 pp.). In Brazil this species is also found in the Paraguay, Paraná and São Francisco Basins (Magnusson and Campos 2010, *op.cit.;* Rueda-Almonacid et al. 2007, *op. cit.*), with small populations occupying the upper Paraguay River drainage in Paraguay (Medem 1958. Field. Zool. 39:227–247; Scott et al. 1990. Vida Silvestre Neotropical 2:43–51). *Paleosuchus palpebrosus* is found in shallow muddy streams along a dry forest area at high elevations (620 m), as in small lakes and dams in the lower altitude areas along the Poti River. This generalist occurs in a wide variety of aquatic habitats, including flooded forests, quiet stretches of large rivers and around rapids in Central Amazonia (Magnusson 1985. Amazonia 9:193–204; Magnusson and Campos 2010, *op. cit.*), palm swamps, and streams lined by gallery forests in Venezuela and in headwater rivers and streams of ridges with waterfalls around the Pantanal (Campos et al. 1995. Herpetol. J. 5:321–322; Campos et al. 2010. Amphibia-Reptilia 31:439–442).

Considered one of the least known New World crocodilian species (Magnusson and Campos 2010, *op. cit.*), ecological data

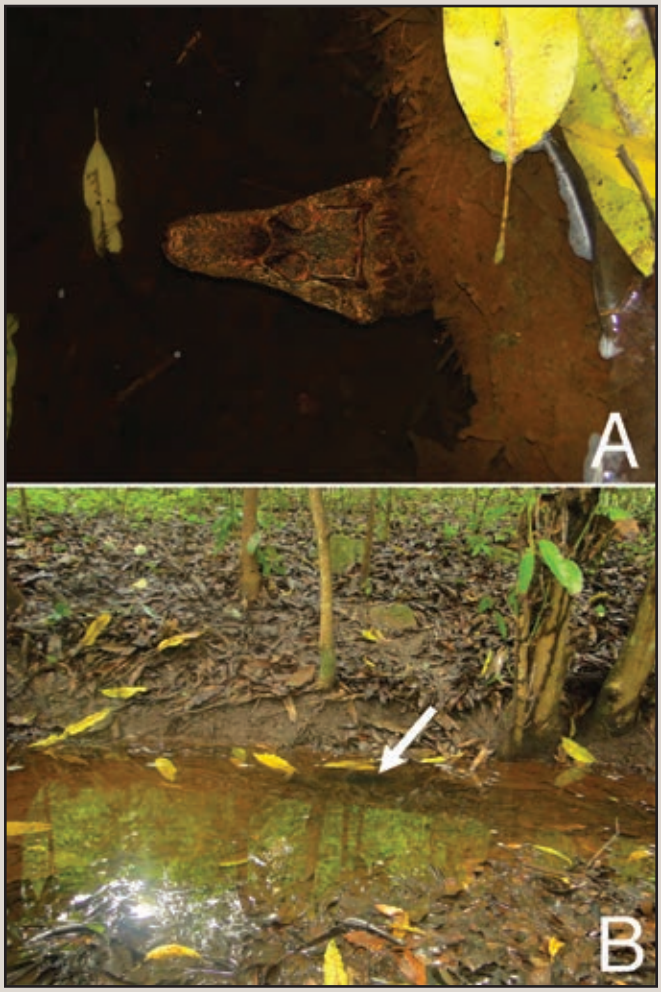


FIG. 1. A) Dorsal view of *Paleosuchus palpebrosus* leaving the underwater shelter; B) view of the burrow utilized by *P. palpebrosus* at the Serra das Almas Reserve, in the municipality of Crateús, Ceará State, Brazil.

for *P. palpebrosus* in Brazil are restricted to the Central Amazonia and Pantanal ecosystems (Campos and Sanaiotti 2006. Herpetol. Rev. 37:81; Campos et al. 1995, *op. cit.*; Campos et al. 2010, *op. cit.*; Magnusson 1985, *op. cit.*; Magnusson et al. 1987. J. Herpetol. 21:85–95). Very little information exists regarding the populations within the Caatinga. Herein we provide ecological data on *P. palpebrosus* habitat use within the Caatinga of semi-arid northeastern Brazil.

The following observations were made at the Reserva Particular de Patrimônio Natural (RPPN), Serra das Almas (05.082720°S, 40.550253°W, SAD 69; 619 m elev.), a Private Protected Area in the municipality of Crateús, state of Ceará. The Reserve encompasses ca. 5646 ha with several different plant communities, from the carrasco and seasonal deciduous forest (dry forest) at higher altitudes (ca. 600–700 m), to the Caatinga (*sensu stricto*) in lower elevations (Lima et al. 2009. Acta Bot. Bras. 23:756–763).

During the dry season (August–December) in the years 2008 and 2009, *P. palpebrosus* individuals were seen walking along trails ca. 5 km away from water, likely searching for available pond habitats. Paolilla and Gorzula (1985. Herpetol. Rev. 16:27) reported extensive terrestrial movements by *P. palpebrosus* searching for ephemeral ponds in Venezuela; Campos et al. (1995, *op. cit.*) found lower densities of *P. palpebrosus* in the streams at Serra do Amolar when the streams in the area were very dry, suggesting the possibility of migrations of those individuals.

On 10 April of 2011, during a nocturnal survey at RPPN Serra das Almas, we found a *P. palpebrosus* inside an underwater burrow (entrance = 58 cm wide; depth = 1.25 m; height = 30 cm) in a bank of a small stream (Fig. 1), with only the head protruding from the burrow entrance below the water's surface. As we attempted to capture it, the individual retreated into the burrow and remained within it for as long 1 hour and 20 minutes, only coming out to breathe and then retreating into the shelter. During the next two consecutive days we found the same individual using this burrow, eluding our capture. This species has been reported to occupy deep burrows in dried out swamps and also in underwater burrows in the river banks (Medem 1958, *op. cit.*), similar to the habitats we observed at the Serra das Almas reserve.

One of us (CGA) visited this same area in 2002 and observed this same burrow occupied by an individual *P. palpebrosus*. Unfortunately, we cannot affirm that is the same individual in our most recent observations. However, it is apparent that this shelter has been utilized by caimans over the last decade. Rueda-Almonacid et al. (2007, *op. cit.*) attest that *P. palpebrosus* is a territorial species inhabiting the same places for a very long time, and that occupancy is related to food availability at a given site. The stream where *P. palpebrosus* was found at Serra das Almas is located in a rich and preserved ecosystem, possessing a wide variety of prey. No other individuals of this species were seen in the area.

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SQUAMATA — LIZARDS

***ACANTHOSAURA ARMATA* (Peninsular Horned Tree Lizard). REPRODUCTION.** *Acanthosaura armata* is distributed through Southern Thailand, south through Peninsular Malaysia to Singapore and Sumatra and is also known from the Andaman Islands (Grismer 2011. Amphibians and Reptiles of the Seribuat Archipelago (Peninsular Malaysia), Edition Chimaira, Frankfurt am Main. 239 pp.). In this note we report additional information on reproduction of *A. armata* from a histological examination of gonadal material.

A sample of 23 *A. armata* from West Malaysia collected from 2002 to 2005, 2008, 2009, and 2012 by LLG and deposited in the herpetology collection of La Sierra University, Riverside, California, USA was examined. The sample consisted of nine adult males (mean SVL = 109.3 mm ± 10.4 SD, range = 98–134 mm), nine adult females (mean SVL = 115.1 mm ± 6.4. SD, range = 104–123 mm), two juvenile males (mean SVL = 92.0 ± 7.1 SD, range = 87–97 mm) and three juvenile females (mean SVL = 86.3 mm ± 14.6 SD, range = 70–98 mm). *Acanthosaura armata* were collected in West (Peninsular) Malaysia (by state): Johor (N = 3), Kedah (N = 1), Pahang (N = 11), Perlis (N = 2), Terengganu (N = 6).

TABLE 1. Monthly stages in the ovarian cycle of nine adult female *Acanthosaura armata* from West Malaysia.

Month	N	Quiescent	Yolk depositon	Enlarged follicles > 5 mm	Oviductal eggs
June	4	2	2	0	0
July	2	2	0	0	0
September	3	3	0	2	1

A cut was made in the lower abdominal cavity and the left testis or ovary was removed, embedded in paraffin, cut into 5 µm sections and stained with Harris hematoxylin followed by eosin counterstain. Enlarged follicles (> 5 mm) or oviductal eggs were Quantified. Histology slides were deposited in the herpetology collection of La Sierra University (LSUHC).

Two stages were noted in the testicular cycle: 1) recrudescent, there is a proliferation of germinal cells in the seminiferous tubules for the next period of spermiogenesis; primary or secondary spermatocytes predominate; 2) spermiogenesis, seminiferous tubules are lined by sperm or clusters of metamorphosing spermatids. The smallest reproductively active male (spermiogenesis) measured 98 mm SVL (LSUHC 9093) and was collected in June. Three adult males, each from June, July, and August were undergoing spermiogenesis. Two juvenile males exhibited recrudescence. They were collected in February (LSUHC 10602, SVL = 87 mm) and July (LSUHC 4731, SVL = 97 mm). It is not known when they would have joined the breeding population.

Four stages were noted in the ovarian cycle of *A. armata* (Table 1): 1) quiescent, no yolk deposition; 2) yolk deposition, vitellgenic yolk granules in the ooplasm); 3) enlarged follicles > 5 mm; 4) oviductal eggs. Mean clutch size (N = 3) was 8.0 ± 1.0, range = 7–9); 7 oviductal eggs in LSUHC 9386; 8 enlarged follicles (> 5 mm) in LSUHC 9405; 9 enlarged follicles (> 5 mm) in LSUHC 9389. The smallest reproductively active female (LSUHC 9405) was collected in September and contained 8 enlarged (> 5 mm) follicles and measured 104 mm SVL. There was no evidence that *A. armata* produces multiple clutches (oviductal eggs and concurrent yolk deposition), although this may reflect our small sample size. Cox et al. (1998. A Photographic Guide to Snakes and Other Reptiles of Thailand and South-east Asia. Asia Books Co. Ltd, Bangkok, Thailand, 144 pp.) reported that females of *A. armata* deposited clutches of 9–15 eggs. Also, there is a report of *A. armata* females depositing 10–12 eggs in Thailand (Taylor and Elbel 1958. Univ. Kansas Sci. Bull. 38:1033–1189). Our report here on clutches of 7 and 8 are new minimum clutch sizes for *A. armata*.

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***ACANTHOSAURA CARDAMOMENSIS*. REPRODUCTION.** *Acanthosaura cardamomensis* was recently described from eastern Thailand and western Cambodia by Wood et al. (2010. Zootaxa 2488:22–38). In this note we report the first information on reproduction in *A. cardamomensis*.

One female (SVL = 143 mm) collected in Pursat Province, Cambodia July 2009 and deposited in the herpetology collection of La Sierra University (LSUHC), Riverside County, California as LSUHC 9328 was examined.

A cut was made in the lower abdominal cavity and the left ovary was examined. The ovaries contained enlarged follicles (> 6 mm) which were quantified. The left ovary contained ten and the right ovary contained eleven, totaling a clutch of 21 eggs. This is the first egg clutch reported for *A. cardamomensis*.

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***ANOLIS CAROLINENIS* (Green Anole). PREDATION.** On 14 August 2013 around 0730 h MCB was observing the birdfeeders and birdhouses at his residence (Harrison Co., Mississippi, USA; 30.387325°N, 89.021624°W, datum WGS84/NAD83) when he noticed a commotion near the potted plants on his front porch. An adult Carolina Wren (*Thryothorus ludovicianus*) was observed smacking and shaking something large and elongated. When the wren flew up to the nearby birdhouse it became apparent that it had a juvenile *Anolis carolinenis* in its beak which it quickly fed to its chicks. This behavior was observed for a second time at approximately 1130 h. A third anole was observed being fed to the chicks at 1619 h (Fig. 1). There were at least two exchanges of food missed while leaving the point of observation to retrieve and set up a camera, but were evidenced by long green tails protruding from the entrance hole of the birdhouse that were longer than the lizard in Fig. 1. Adult wrens were also seen bringing larger unidentifiable pieces of flesh assumed be the remains of a larger dismembered *A. carolinensis*. Similar behavior has been noted for vireos feeding on *A. carolinenis* (Sykes et al. 2007. Wilson J. Ornithol. 119:508–510). Additional observations were made on 15 August and 16 August of both whole lizards and parts being brought in by the adult wrens.

Lizards are identified in the diet of the Carolina Wren as far back as 1916 (Beal et al. 1916. Common Birds of the Southeastern United States in Relation to Agriculture. Farmers Bulletin 755, 40 pp.), but no species identifications were provided. Generally, predation of vertebrates by passerine birds is considered uncommon (Lopes et al. 2005. Lundiana 6:57–66). This observation is the first documented record of *A. carolinensis* being consumed by Carolina Wrens and judging by the frequency of captures



FIG. 1. Carolina Wren (*Thryothorus ludovicianus*) feeding its young a Green Anole (*Anolis carolinenis*).

noted here this wren species may be a significant predator of anoles at least during the bird's nesting season.

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***APHANIOTUS FUSCA* (Dusky Earless Agama). REPRODUCTION.** *Aphaniotus fusca* occurs in southern Thailand southward through Peninsular Malaysia to Sumatra and Borneo (Grismer 2011. Amphibians and Reptiles of the Seribuat Archipelago (Peninsular Malaysia) A Field Guide. Edition Chimaira, Frankfurt am Main. 239 pp.). The purpose of this note is to provide additional information on the reproductive cycle of *A. fusca* from Peninsular Malaysia from a histological examination of gonadal material.

A sample of 73 *A. fusca* from West Malaysia collected 2001 to 2006, 2008, 2011, 2012 by LLG and deposited in the herpetology collection of La Sierra University, California, USA (LSUHC) was examined. The sample consisted of 38 adult males (mean SVL = 61.1 mm ± 5.1 SD, range = 53–72 mm), 29 adult females (mean SVL = 58.1 mm ± 4.1 SD, range = 48–63 mm) and 6 juveniles (mean SVL = 39.2 mm ± 7.8 SD, range = 28–52 mm). *Aphaniotus fusca* were collected in West (Peninsular) Malaysia, including (by state): Johor (N = 30), Kedah (N = 2), Pahang (N = 37), Perak (N = 1), and Selangor (N = 2).

A cut was made in the lower abdominal cavity and the left testis or ovary was removed, embedded in paraffin, cut into 5 µm sections and stained with Harris hematoxylin followed by eosin counterstain. Enlarged follicles (> 4 mm) or oviductal eggs were counted. Histology slides were deposited in LSUHC.

Two stages were noted in the testicular cycle: 1) recrudescence, proliferation of germ cells in the seminiferous tubules prior to spermiogenesis; 2) spermiogenesis, seminiferous tubules are lined by sperm or clusters of metamorphosing spermatids. The following monthly samples exhibited spermiogenesis: March (N = 6), July (N = 19), August (N = 8), September (N = 5). Testes of two other males from July exhibited recrudescence. The smallest reproductively active males (spermiogenesis) measured 53 mm SVL (LSUHC 10307–10309) and were collected in September and (LSUHC 6507) collected in July. Two males exhibiting recrudescence were from July (LSUHC 4558), SVL = 53 mm and (LSUHC 5548) SVL = 54 mm. Because these are close to the minimum size for male maturity, it is conceivable they would have joined the male breeding population shortly.

Five stages were present in the ovarian cycle (Table 1): 1) quiescent, no yolk deposition; 2) yolk deposition (vitellogenic granules in the ooplasm; 3) enlarged follicles > 4 mm; 4) oviductal eggs; 5) oviductal eggs with concurrent yolk deposition for a subsequent clutch. Mean clutch size (N = 24) was 1.04 ± 0.20 SD, range = 1–2. The large number of females with oviductal eggs and yolk deposition in progress is evidence *A. fusca* produces multiple clutches in the same year. The smallest reproductively active female (follicles > 4 mm) measured 48 mm SVL (LSUHC 4816) and was collected in July. *Aphaniotus fusca* has an ovarian cycle reminiscent of *Anolis* lizards (Goldberg et al. 2002. Pac. Sci. 56:163–168) with a prolonged breeding season and production of single eggs in succession.

Table 1. Monthly stages in the ovarian cycle of 29 adult female *Aphaniotus fusca* from West Malaysia.

Month	N	Quiescent	Yolk depositon	Enlarged follicles > 4 mm	Oviductal eggs	Oviductal eggs and yolk deposition
March	2	0	1	0	1	0
July	21	1	1	3	4	12
August	3	0	0	1	0	2
September	3	0	2	1	0	0

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***ASPIDOSCELIS DEPPII* (Black-bellied Racerunner). PREDATION BY TURKEY VULTURE.** *Aspidoscelis deppii* is widely distributed from Veracruz and Michoacan, Mexico, to Costa Rica (Köhler et al. 2006. The Amphibians and Reptiles of El Salvador, Krieger Publishing Company, Malabar, Florida. 238 pp.). Neotropical lizards are abundant and common prey to all classes of terrestrial vertebrates, and bird predation of lizards is well known.

The Turkey Vulture (*Carthartes aura*) is widely distributed from southern Canada south to South America and is present throughout the entire range of *A. deppii*, where it occupies a variety of open and forested habitats and feeds opportunistically on a wide range of wild and domestic carrion. While almost exclusively a scavenger, this species is known to rarely kill small animals or invertebrates (Kirk and Mossman 1998. *In* A. Poole [ed.], The Birds of North America Online. Cornell Lab of Ornithology, Ithaca; accessed 15 August 2013).

An adult Turkey Vulture was collected during avian control to minimize wildlife hazards at the Aeropuerto Internacional de El Salvador (ca. 50 km SE of San Salvador, 13.4408°N 89.0556°W; datum WGS84) on 10 July 2012 and subsequently cataloged (USNM 646876) in the Bird Division at the National Museum of Natural History (NMNH) in Washington, DC. Dissection during preparation of the bird as a museum specimen revealed a male *A. deppii* (ca. 56 mm SVL) in the stomach. It was cataloged at the NMNH in the Division of Amphibians and Reptiles (USNM 580989). Tissue samples were removed from both the lizard and the bird and deposited in the biorepository at the NMNH. To the best of our knowledge, this is the first documented record identifying *A. deppii* as a prey item of the Turkey Vulture.

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***ASPIDOSCELIS DEPPII* (Black-bellied Racerunner). PREDATION BY GREAT EGRETS.** *Aspidoscelis deppii*) is widely distributed from Veracruz and Michoacan, Mexico to Costa Rica (Köhler et al. 2006. The Amphibians and Reptiles of El Salvador. Krieger Publishing Co., Malabar, Florida. 238 pp.). Neotropical lizards are abundant and common prey to all classes of terrestrial vertebrates, and bird predation of lizards is well known.

The Great Egret (*Ardea alba*) is widely distributed across most tropical and warmer temperate regions of the world and is present throughout the range of *A. deppii*, where it forages opportunistically in a variety of wetland and upland habitats; preying mainly on fish, but also invertebrates,

particularly crustaceans, amphibians, reptiles, birds, and small mammals (Mccrimmon, et al. 2011. *In* A. Poole [ed.], The Birds of North America Online. Cornell Lab of Ornithology, Ithaca, accessed 14 August 2013).

Three adult Great Egrets were collected during avian control to minimize wildlife hazards at the Aeropuerto Internacional de El Salvador (ca. 50 km SE of San Salvador, 13.4408°N 089.0556°W; datum WGS84) from April to July 2012 and subsequently cataloged (USNM 646732, 646792, and 646957) in the Bird Division at the National Museum of Natural History (NMNH) in Washington, DC. Dissections during preparation of the 3 birds as museum specimens revealed a total of 13 *A. deppii*, four unidentified fish, and four unidentified grasshoppers in the stomachs, as follows: USNM 646732, four *A. deppii*, two fish, 3 grasshoppers; USNM 646792, one *A. deppii* and one grasshopper; USNM 646957, eight *A. deppii*, two fish. The *A. deppii* included three adults and ten juveniles, ranging in size from ca. 27 mm SVL to ca. 84mm SVL. Eleven of the 13 *A. deppii* were cataloged at the NMNH in the Division of Amphibians and Reptiles (USNM 580978–580988). Two juvenile specimens were discarded because they were too badly decomposed to save as museum specimens. Tissue samples were removed from all cataloged lizard and bird specimens and deposited in the biorepository at the NMNH. To the best of our knowledge, this is the first documented record identifying *A. deppii* as a prey item of the Great Egret.

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***ASPIDOSCELIS LAREDOENSIS* (Laredo Striped Whiptail) × *ASPIDOSCELIS GULARIS* (Texas Spotted Whiptail). MAXIMUM BODY SIZE.** *Aspidoscelis laredoensis* is a hybrid-derived parthenogenetic species (Bickham et al. 1976. Herpetologica 32:395–399; Dessauer and Cole 1989. *In* Dawley and Bogart [eds.], Evolution and Ecology of Unisexual Vertebrates, pp. 49–71. Bull. 466. New York State Museum, Albany, New York; McKinney et al. 1973. Herpetologica 29:361–366; Parker et al. 1989. *In* Dawley and Bogart [eds.], *op. cit.*, pp. 72–86; Wright et al. 1983. Herpetologica 39:410–416) that sustains its existence asexually through development of unreduced diploid eggs. However, there have been reports of sexual reproduction in the species resulting in hybrids from matings with males of *A. gularis* (Trauth et al. 2013a. Herpetol. Rev. 44[2]:314–316; Trauth et al. 2013b. Herpetol. Rev. 44[2]:316–318; Walker et al. 1989a. J. Herpetol. 23:119–130; Walker et al. 1989b. Copeia 1989:1059–1064; Walker et al. 2008. Herpetol. Rev. 39:340).

In this report we describe a preserved specimen (Fig. 1A–C) that is either an individual of *A. laredoensis* (2n = 46) or one of *A. laredoensis* × *A. gularis* (3n = 69) with the largest known body size, be it the one or the other. This lizard (originally catalogued as University of Arkansas Department of Zoology 7220 and recently re-catalogued as Arkansas State University Museum of Zoology 32421) was collected by JEC on 9 June 2004 as follows: Texas: Hidalgo County: 15 km SW of Mission, Bentsen Rio Grande Valley State Park (BRGVSP), site 1 deep within the forest a few m from the Rio Grande (26.159167°N, 98.3875°W, datum WGS84; 13.6 m elev.). We compared it with these specimens identified as

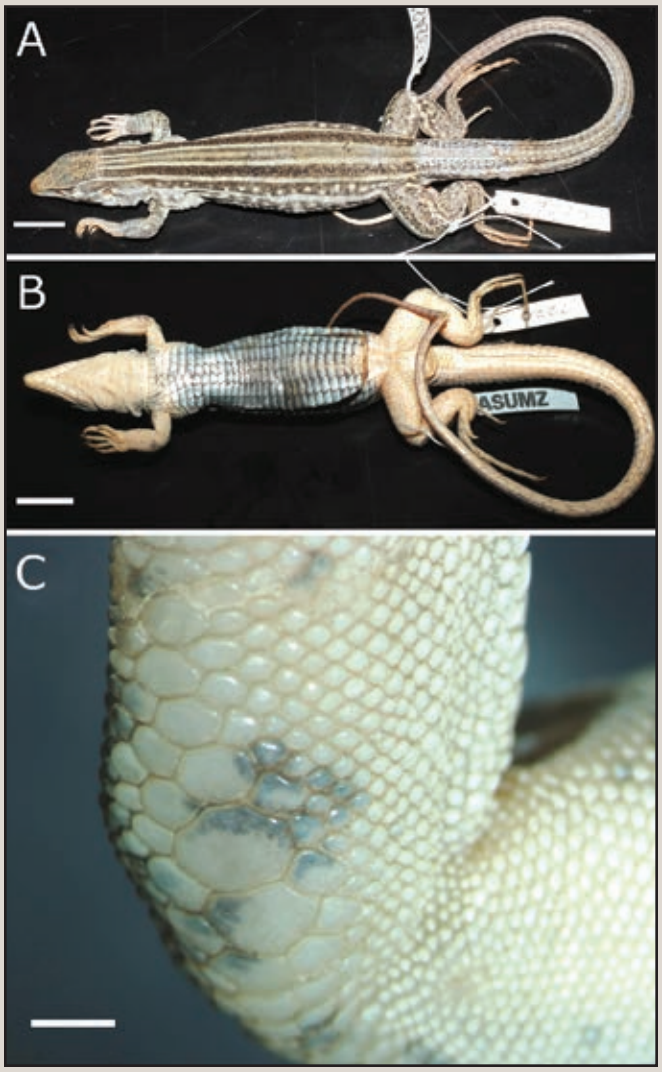


FIG. 1. Color pattern and morphological characteristics of a putative hybrid female specimen of *Aspidoscelis laredoensis* × *A. gularis*. A) Dorsal coloration and pattern of ASUMZ 32421; line = 10 mm. B) Ventral coloration of ASUMZ 32421; line = 10 mm. C) Postantebrachial scales of ASUMZ 32421; line = 1 mm.

A. laredoensis: from site 1 in BRGVSP [30 May 2003 (UADZ 7123–7126, N = 4)]; [31 May 2003 (UADZ 7128–7132, N = 5)]; [9 June 2004 (UADZ 7221–7222, N = 2)]; site 2 BRGVSP (26.169722°N, 98.381944°W, datum WGS84; 27.7 m elev.) [30 May 2003 (UADZ 7120-7122, N = 3)]; [10 June 2004 (UADZ 7223-7229, N = 7)]; [12 June 2004 (UADZ 7235–7236, N = 2)]. Only two specimens of *A. gularis* were collected, one from the site 1 origin of the hybrid [12 June 2004 (UADZ 7230, N = 1)], and one from site 2 in BRGVSP [12 June 2004 (UADZ 7234, N = 1)].

Paulissen (1999-2000. Herpetol. Nat. Hist. 7:41–57) reported that *A. laredoensis* (clonal complex A) is overwhelmingly the numerically dominant whiptail lizard species in BRGVSP (e.g., based on 707 different lizards captured during a six-year study and an estimate of 521–770 lizards/ha in 1996), whereas the gonochoristic species *A. gularis* is quite rare in the park (e.g., only 26 individuals captured over a period of four years). Our data for 2003 and 2004 collections in the park align with his observations on the relative abundance of these species. A consequence of the disproportionate numbers of lizards between these species in

BRGVSP is that there are many opportunities for hybridization given the number of potential encounters between males of *A. gularis* and females of *A. laredoensis*. Narrow roadways through the densely forested park result in concentrations of whiptails in the few corridors of suitable habitat, especially during periods in which the introduced bunchgrass species *Cenchrus ciliaris* is at peak growth. Our hypothesis that ASUMZ 32421 is a heterotic triploid hybrid female of *A. laredoensis* × *A. gularis* is supported by the preponderance of the evidence and comparison of it to genetically confirmed hybrids collected in BRGVSP by one of us (MAP) during the study of *A. laredoensis* in BRGVSP in the 1990s (Paulissen, *op. cit.*).

Large size is the most remarkable attribute of ASUMZ 32421. Prior to preservation it had a SVL of 96 mm, tail length of 302 mm, and body mass (BM) of 20.2 gm. For BRGVSP, Paulissen (*op. cit.*), reported a maximum SVL of 85 mm and BM of 17.4 g for *A. laredoensis*; the largest of our specimens of the species from the park has a SVL of 77 mm. Trauth et al. (2013a, *op. cit.*) reported a hybrid of *A. laredoensis* × *A. gularis*, a gynandromorph from Artesia Wells (28.281274°N, 99.285796°W; datum WGS84), La Salle Co., Texas, with a maximum SVL of 88 mm and BM of 14.0 g. Two morphological characters are also indicative of the hybrid origin of ASUMZ 32421. The postantebrachial scales (Fig. 1C) are closer in size to the enlarged scales of *A. gularis* than the moderately enlarged scales of *A. laredoensis*, and there are a lower number of granules around midbody (88) than within 16 individuals of *A. laredoensis* with a range of variation of 90–94. Three color pattern characters based on other specimens (Trauth et al. 2013a, *op. cit.*; Walker et al. 1989b, *op. cit.*) have also been shown to be indicative of a hybrid origin for the specimen: incomplete vertebral stripe (Fig. 1A); pink-red coloration on the throat region (Fig. 1B); and purple-blue coloration on the thoracic/abdomen (Fig. 1B). Based on internal examination by one of us (SET), ASUMZ 32421 has four enlarged yolked ovarian follicles on each side. They range from 4–8 mm in diameter. The ovaries also had several small immature follicles. The oviducts were partially enlarged and convoluted. No other gonadal tissue was observed on either side. It seems likely that this individual was capable of producing /ovipositing a clutch which would be contrary to findings of complete sterility for hybrids of other species (e.g., *A. tesselata* × *A. tigris* in Chaves Co., New Mexico; Taylor et al. 2001. Am. Mus. Novitat. 3345:1–65), as well as the combination discussed herein (Trauth et al. 2013b, *op. cit.*).

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***CHATOGEKKO AMAZONICUS*. PREDATION.** *Chatogekko amazonicus* is a very small lizard species (males 22 mm, females 24 mm SVL) (Gasc 1981. Rev. Ecol. [Terre et Vie] 35:273–325) inhabiting leaf litter in forests and is distributed in Brazil (Amazonas, Amapa, Para, Rondonia, Acre), southern Venezuela, southern Guyana, French Guiana, Surinam (Uetz [ed.] 2012. The Reptile Database. Online database available at: http://www.reptile-database.org, accessed 2 Feb 2013). Avila-Pires (1995. Zool. Verh. 299: 250) found an example of *Chatogekko amazonicus* in the stomach of the snake *Taeniophallus brevirostris*. Herein we report predation on *C. amazonicus* by a spider of the family Ctenidae.



FIG. 1. A juvenile *Chatogekko amazonicus* being preyed upon by a ctenid spider.

On 29 Jan 2013 at 1200 h, we found a juvenile *C. amazonicus* (14.73 mm SVL) preyed upon by a subadult ctenid spider (10. 61 mm from the anterior tip of the head to the posterior end of the abdomen) in leaf litter of dense forest in the area of Sustainable Development Project (PDS) Virola-jatoba, Anapu – Pará, Brazil (3.17407°S, 51.29803°W; datum WGS84). Few studies are available regarding prey-predator relationships between reptiles and arthropods. This is the first record of a known invertebrate predator for *C. amazonicus*. The lizard (LZA 422) was deposited in the herpetological collection of the Laboratório de Zoologia Universidade Federal do Pará, Campus de Altamira.

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***CNEMIDOPHORUS MURINUS MURINUS* (Laurent's Whiptail). MYIASIS.** On 12 January 2013, east of the Marazul Dive Resort, Sabana Westpunt, Curaçao (12.362547°N, 69.1533°W; approx. 41 m elev.), I observed and photographed an adult male *Cnemidophorus murinus murinus* exhibiting widespread symptoms of ectoparasitism by dipteran eggs (2–4 mm), yet the pathogenic species remains ambiguous. The individual was approximately 17 cm in SVL and 25 cm in total length. Cursory examination of the specimen from a safe distance showed it to be alive, ambulatory, but with obvious signs of tissue damage, impaired motor skills, and other physical stresses (Fig. 1). When approached, the lizard would make quick spasmodic movements displacing several adult dipterans. Intermittent and sequential stops by the lizard would result in the return of the flies. Some basic motor skills persisted in the individual but they appeared to be severely diminished. After capture and closer examination, all facial orifices, several skin folds, and various lacerations exhibited an extensive degree of infestation. This pathological condition is known as myiasis. The lizard exhibited an extensive degree of nasal, ocular, oral, tympanic, and cutaneous myiasis (Fig. 2). For this individual, the high levels of soft tissue damage and the clear signs of morbidity appeared to be reaching fatal stages.



FIG. 1. Laurent's Whiptail Lizard (*Cnemidophorus murinus murinus*) exhibiting myiasis.



FIG. 2. Detail of extensive nasal, ocular, oral, tympanic, and cutaneous myiasis in *Cnemidophorus m. murinus*.

Myiasis varies widely in pathology, often causing serious hemorrhages and deteriorates the overall host's health, frequently becoming fatal. Several genera of calliphorid flies can induce myiasis, including blowflies and screwworms. Maggot infestation is a frequent health concern of livestock and other mammalian hosts. Yet, observations of myiasis in reptiles are rare, and there is only limited information on taxonomic classification of its causative agents, however, some cases of reptilian myiasis have been described. For instance, in Italy, the Greek Tortoise (*Testudo graeca*) was parasitized by blowfly larvae of *Lucilia ampullaceal* (Principato and Cioffi 1996. Int. Congr. Entomol. 8:769). Additionally, an incident of myiasis was described in the Czech Republic involving Hermann's Tortoise (*T. hermanni*) attributed to the blowfly larvae of *Calliphora vicina* (Knotek et al. 2005. Act. Vet. Brno. 74:123–128). To our knowledge the observation reported herein represents the first record of fatal myiasis in *Cnemidophorus m. murinus*.

On Curaçao, myiasis is commonly seen in mammalian hosts, specifically among the ubiquitous and large populations of feral dogs and goats, and *Cochliomyia hominivorax* has been linked to the most documented cases on the island (Tannahill et al. 1980. J. Med. Entomol. 17:265–267). *Cochliomyia hominivorax* can lay up to 400 eggs on exposed wounds and the larvae possess noxious saliva, which stimulates infections, destroys integral tissues, and produces malodourous pus. This ectoparasite prefers to feed on living tissue rather than on carcasses or necrotic tissues. *Cochliomyia hominivorax* was eradicated from Curaçao in 1954 and again in 1977 by means of sterile male introductions (Tannahill et al., *op. cit.*). However, reintroductions have been documented on the island and this observation of myiasis may suggest its presence, yet for this incident the taxonomic classification of the causing agent remains unclear. This specific case also raises health concerns for the reptilian fauna of Curaçao. Presently, large populations of feral dogs and goats exist on the island, thereby providing an abundant reservoir for the larval stage of parasitic dipterans. The presence of an old tail injury on the whiptail lizard may have been the original oviposition site for myiasis in this instance. Accordingly, reptiles on Curaçao may be faced with a negative and potentially life-threatening effect associated with a wound.

We thank Shippensburg University's Geography and Earth Science Department, especially Sean R. Cornell for planning our trip to Curaçao. We also thank Walter E. Meshaka, Jr. for his comments on this note. Lastly, we acknowledge Gregory Paulson and John Miller for their entomological expertise in the identification of the parasite.

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***EUTROPIS LONGICAUDATA* (Long-tailed Sun Skink). ENDOPARASITES.** *Eutropis longicaudata* (= *Mabuya longicaudata*) is known from parts of Thailand, Laos, Vietnam, China, Taiwan, and West-Malaysia (Manthey and Grossmann 1997. Amphibien & Reptilien Südostasiens. Natur und Tier – Verlag, Berlin. 512 pp.). The only endoparasite record for *E. longicaudata* that we are aware of is the pentastome, *Raillietiella frenatus*, reported from an *E. longicaudata* (as *Mabuya longicaudata*), collected in Taiwan (Ali et al. 1981. Syst. Parasitol. 3:193–207). The purpose of this note is to add to the endoparasite list for *E. longicaudata*.

A road-killed male *E. longicaudata* (SVL = 124 mm) was found on a tarred road in an agricultural area in Santzepu (23.4294°N, 120.4836°E, TWD97; elev. 66 m), Sheishan Dustrict,

Chiayi County, Taiwan, R.O.C., on 27 June 2012, deposited in the herpetology collection of the Natural History Museum of Los Angeles County (LACM), California, USA as LACM 183389, and was examined for helminths.

The digestive tract was removed, opened, and examined under a dissecting microscope. Forty-one digenes were found in the small intestine and were regressively stained in hematoxylin, mounted in balsam on a glass slide, cover slipped, studied under a compound microscope, and identified as *Mesocoelium monas*. They were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland, USA as *Mesocoelium monas* (USNPC 106399).

Mesocoelium monas is cosmopolitan in distribution and is known from a large number of hosts (Bursey et al. 2012. Comp. Parasitol. 79:75–132). Infection occurs with the ingestion of an infected snail or vegetation supporting cysts (Thomas 1965. J. Zool. 146:413–446). *Mesocoelium monas* and *Raillietiella frenatus* currently comprise the parasite list for *E. longicaudata*.

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***GYMNOPHTHALMUS SPECIOSUS* (Golden Spectacled Tegu). PREDATION BY GREAT EGRET.** *Gymnophthalmus speciosus* is widely distributed from northeastern Guatemala and the Isthmus of Tehuantepec to Colombia, Venezuela, and Guyana (Köhler et al. 2006. The Amphibians and Reptiles of El Salvador. Krieger Publishing Co., Malabar, Florida. 238 pp.). Neotropical lizards are abundant and common prey to all classes of terrestrial vertebrates, and bird predation of lizards is well known.

The Great Egret (*Ardea alba*) is widely distributed across most tropical and warmer temperate regions of the world and is present throughout the range of *G. speciosus*, where it forages opportunistically in a variety of wetland and upland habitats; preying mainly on fish, but also invertebrates, particularly crustaceans, amphibians, reptiles, birds, and small mammals (McCrimmon et al. 2011. *In* A. Poole [ed.], The Birds of North America Online. Cornell Lab of Ornithology, Ithaca, accessed 14 August 2013).

An adult Great Egret was collected during avian control to minimize wildlife hazards at the Aeropuerto Internacional de El Salvador (ca. 50 km SE of San Salvador, 13.4408°N 089.0556°W; datum WGS84) on 30 June 2012 and subsequently cataloged (USNM 646732) in the Bird Division at the National Museum of Natural History (NMNH) in Washington, DC. Dissection during preparation of the bird as a museum specimen revealed an adult *G. speciosus* (ca. 45 mm SVL) in the stomach. It was cataloged at the NMNH in the Division of Amphibians and Reptiles (USNM 580990). Tissue samples were removed from both the lizard and the bird and deposited in the biorepository at the NMNH. To the best of our knowledge, this is the first documented record identifying *G. speciosus* as a prey item of the Great Egret.

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***HEMIDACTYLUS CRASPEDOTUS* (Frilly House Gecko). ENDOPARASITES.** *Hemidactylus craspedotus* ranges from southern Thailand, south of the Isthmus of Kra, through Peninsular Malaysia and Singapore to northern Borneo; it is a nocturnal, arboreal, cryptic species (Grismer 2011. Lizards of Peninsular Malaysia, Singapore and their Adjacent Archipelagos, Edition Chimaira, Frankfurt am Main. 728 pp.). There are, to our knowledge, no records of endoparasites for *H. craspedotus*. The purpose of this note is to establish the initial helminth list for *H. craspedotus* as part of an ongoing survey of lizard helminths from Southeast Asia.

A sample of eight *H. craspedotus* (mean SVL = 58.8 mm ± 3.1 SD, range = 54–63 mm) collected in West Malaysia 2002 to 2004, 2006 and 2010 by LLG and deposited in the herpetology collection of La Sierra University (LSUHC), Riverside, California was examined for helminths, including (by state): LSUHC 4754, 6330, 8230 Johor; LSUHC 5080, 5081, 9728 Kedah; LSUHC 5613 Perak; LSUHC 6316 Pahang.

The digestive tract was removed from a mid-ventral incision and the esophagus, stomach, small and large intestine were opened and their contents were examined for parasites utilizing a dissecting microscope. Eight nematodes were found. Each was placed in a drop of lactophenol on a glass microscope slide, cover slipped and studied under a compound microscope. Two species of Nematoda were identified: two female *Skrjabinelazia hemidactyli* were found in the lumen of the large intestine; six *Physocephalus* sp. (3rd stage larvae, most likely *P. sexalatus*) were found in cysts in the stomach wall. Prevalence (number infected/number examined × 100) = 25%, mean intensity (mean number infected individuals) = 3.0 ± 2.8 SD, range = 1–5. Voucher helminths were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland, USA, as *Skrjabinelazia hemidactyli* (USNPC 107222; *Physocephalus* sp. (USNPC 107223).

Skrjabinelazia hemidactyli was described from *Hemidactylus brooki* from India by Shamim and Deshmukh (1982. Riv. Parassitol. 43:469–472). The host list includes three gekkonid species from Sri Lanka (Goldberg et al. 2011. Comp. Parasitol. 78:359–366).

Hemidactylus craspedotus represents a new host record for *S. hemidactyli*. West Malaysia is a new locality record. Lizards commonly serve as paratenic (transport hosts) for larvae of *Physocephalus* sp. No further development occurs and the larvae remain dormant until the lizard is eaten by a definitive host. Lizards acquire *Physocephalus* sp. by feeding on infected dung beetles (Anderson 2000. Nematode Parasites of Vertebrates: Their Development and Transmission. CABI Publishing, Oxon, UK. 650 pp.). *Hemidactylus craspedotus* represents a new host record for larvae of *Physocephalus* sp. West Malaysia is a new locality record.

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***HEMIDACTYLUS PLATYURUS* (Flat-tailed House Gecko). PREDATION.** *Hemidactylus platyurus* is a moderate-sized (43–58 mm SVL) gecko with a widespread distribution in Southeast Asia and in the Philippines (Brown and Alcala 1978. Philippine Lizards of the family Gekkonidae. Silliman University Press. Dumaguete, Philippines. 146 pp.). This note reports the observed predation of *H. platyurus* by a dragonfly, *Anax* cf. *panybeus* (Odonata: Aeshnidae).

At 1330 h on 8 September 2013, JA observed a female *Anax* cf. *panybeus* (60 mm right hindwing length), clutching a still struggling *Hemidactylus platyurus*, land on a branch of a tamarind tree (*Tamarindus indica*) in Pueblo de Panay, Barangay Dinginan, Roxas City, Capiz Province, Panay Island, Philippines (11.548572°N, 122.727822°E, WGS84; elev. 112 m). The dragonfly utilized its anterior legs to hold on to its prey while simultaneously chewing the left eye of the gecko for ca. four minutes. To our knowledge, this is the first recorded incident of a dragonfly predating on a lizard in the Philippines. Photographic vouchers were deposited at the Raffles Museum of Biodiversity Research, National University of Singapore (ZRC[IMG] 2.183a–c).

We thank R. J. Villanueva for identification of the dragonfly, Kelvin K. P. Lim for ZRC voucher numbers, and Cameron Siler for comments on this note.



FIG. 1. A female *Anax* cf. *panybeus* preying upon a *Hemidactylus platyurus* in Panay Island, Philippines.

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***IGUANA DELICATISSIMA* (Lesser Antillean Iguana). MORTALITY.** The Lesser Antillean Iguana was originally found in the Lesser Antilles from Anguilla to Martinique, but is rapidly being lost from both large and small islands due to a range of factors (Breuil 2002. Patr. Natur. 54:1–339; Powell and Henderson 2005. Iguana 12:62–77). As populations continue to decline, life history information on the species remains very limited (Knapp 2007. Iguana 14:223–225; Pasachnik et al. 2006. Cat. Amer. Amphib. Rept. 811:1–14). The species is also found on St. Eustatius but in very low numbers (Fogarty et al. 2004. Iguana 11:139–146). During a population assessment for this species from May to December 2012, we collected data on the causes of mortality and endangerment by interviewing 53 local inhabitants and compiling all cases known to staff and volunteers of the National Parks Foundation of St. Eustatius during 2012 (Table 1). Dogs kept in island gardens in areas used by iguanas were the largest source of documented mortality on St. Eustatius. Of the 19 estate owners spoken to during our survey, 10 (52%) kept dogs. This source of mortality could be limited by reducing the number of dogs and cats kept, by restricting their movement to smaller sections of the estates' gardens, and/or by placing suitable shelter bushes in the yard so that the iguanas have access to effective refugia. Hunting, which is illegal and carries maximum penalties up to US $5000, was a minor problem, but remains unenforced in St. Eustatius. Aside from road-kill, which has been identified as problematic in Dominica (Knapp, *op. cit.*), entanglement and entrapment of iguanas in human materials and structures is documented here for the first time as a major endangerment to the species. This appears to be especially true of gravid females getting stuck in the harmonica wire fencing (7.6 cm mesh diam.), a material that is used extensively on the island. People should be encouraged to use standard livestock fencing rather than this harmful material. Abandoned cisterns are numerous on the island and prove to be quite dangerous to iguanas. These should be mapped and equipped with an iron rebar woven into wire mesh to allow for escape. Because of the small and declining iguana population present on the island and the fact that we certainly missed a large part of all mortality sources, our observations suggest that high mortality rates, ultimately ascribable to man, are a key factor limiting recovery of this critically endangered species on St. Eustatius.

TABLE 1. Overview of documented death or endangerment of iguanas in St. Eustatius, April–December 2012.

Source	Mortality	Rescue	Total
Dogs	10	1	11
Traffic	3	–	3
Cistern	1	4	5
Fencing	–	6	6
Hunting	2	–	2
Unknown	1	–	1
Total incidents			28

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***IGUANA DELICATISSIMA* (Lesser Antillean Iguana). REPRODUCTION.** During an eight-month study on the St. Eustatius population of *Iguana delicatissima*, we covered more than 64 km

TABLE 1. Data on documented iguana nesting locations on St. Eustatius.

Site & Location	Altitude (m)	Site type	Site origin	Shading	Orientation of clearing	Available area (m^2)	Number of holes	Date of last digging	Principal threat
1 - S Quill slopes	206	gully ridge	natural	low	E-W	60	9	U*	trampling**
2 - W Quill slopes	124	trail head	semi-natural	medium	E-W	100	1	22 Nov 2012	overgrowth
3 - W Quill slopes	243	trail cut	semi-natural	medium	E-W	18	6	U	overgrowth
4 - W Quill slopes	243	trail clearing	semi-natural	medium	E-W	30	3	1 Jan 2013	overgrowth
5 - Estates	171	fenced garden	man-made	low	NA***	4	1	20 Nov 2012	dog
6 - Estates	200	fenced garden	man-made	high	NA	3	1	10 Nov 2012	cat

*(U) = unknown, **due to goats, *** (NA) = not applicable

of transects and trails, and interviewed more than 53 local island inhabitants to gain insight into reproduction of this critically endangered species (Knapp 2007. Iguana 14:223–225; Powell and Henderson 2005. Iguana 12:62–77). Notwithstanding considerable effort, we only documented six nest sites in use (Table 1). The largest (and only entirely natural) nest site was found was a barren patch of about 5 × 12 m on a ridge between two densely forested gullies on the lower southern flank of the Quill. The area was bare, well-drained, with mull gravel and sand, and had nine holes in all. A dry shell of a successfully hatched egg was found at the site. Overgrowth with shading, higher humidity, and soil compaction were the main threats to the remaining (semi-natural) sites, whereas domestic predators were the main threat to nests deposited in local estate gardens (Table 1). Iguanas were even found to make use of small and narrow forest clearings as long as these were oriented favorably with respect to the sun. Other animals that commonly dig burrows on St. Eustatius include the lizard *Ameiva erythrocephala* and land crab *Gecarcinus ruricola*. These species dig burrows largely for shelter and consequently select moister and more shaded sites. Their burrows also differ importantly in shape and size from iguana nest-related digging. Measurements of four entrances of iguana nesting cavities were as follows (heights/width in cm): site 3: 13/18, 14/15; site 4: 10/14, 14/18. *I. delicatissima* is known for its protracted nesting season but for St. Eustatius this was unknown. Our results show that on St. Eustatius nesting occurs minimally from November through January. Two natural nest sites documented for the period Jan–Aug 2008 by Nicole Esteban (with egg shells seen) on the wind-swept ridges of Gilboa Hill, were visited (by AOD and a National Parks intern) on 26 Nov 2012. Two hours of intensive searching of the area by two persons yielded no signs of any iguana nest-digging activity. Historical anecdotes that "formerly the people swam with iguanas at Venus Bay" suggested that this site was an important iguana locality at one time. However, a field visit to Venus Bay on 24 November 2012 did not yield evidence of any nesting activity. On several islands, female iguanas are forced to migrate (often) long distances to coastal beaches for nesting due to lack of suitable sites elsewhere (Bock and McCracken 1988. J. Herpetol. 22:316–322; Breuil 2002. Patrim. Nat. 54:1–339). Our results and observations suggest likewise that on St. Eustatius, the interaction of vegetation and geology also limit nest site availability to the iguana. Our results further indicate that the sites presently used are vulnerable to humans and their non-native pets, livestock, and invasive weeds (particularly the Mexican Creeper Vine, *Antigonon leptopus*). Mapping, artificial creation and adequate protection of nest sites are recommended as key necessities for recovery of this endangered species on St. Eustatius.

This work was made possible by IMARES Wageningen UR, the Island Government of St. Eustatius, STENAPA and the Dutch Ministry of Economic Affairs, Agriculture and Innovation (project #4308701004, A. O. Debrot, PI). Our special thanks go to Roberto Hensen and Inge Jaspers for their unlimited hospitality.

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***LEIOLEPIS GUTTATA* (Spotted Butterfly Lizard). REPRODUCTION.** *Leiolepis guttata* is currently known from only Vietnam (Van Sang et al. 2009. Herpetofauna of Vietnam. Edition Chimaira, Frankfurt am Main. 768 pp.). In this note we report the first information on reproduction in *L. guttata*.

One female (SVL = 116 mm) collected at Bin Chau (105.83°N, 10.85°E), Bà Rja-Vung Tàu Province, Vietnam, in June 2009 and deposited in the herpetology collection of La Sierra University (LSUHC), Riverside, California (as LSUHC 9239) was examined.

A cut was made in the lower abdominal cavity and the ovaries were examined. A total of three oviductal eggs were present, two in the left oviduct and one in the right oviduct. This is the first egg clutch reported for *L. guttata*.

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***LIOLAEMUS BELLII* (Dusky Lizard). PREDATION.** *Abrothrix andinus* is a small South American field mouse (Rodentia: Cricetidae) with a body length of 10–13 cm, tail length of 4–5 cm, and body mass of 18–31 g (Iriarte 2008. Mamíferos de Chile. Lynx Ediciones, Barcelona, España. 420 pp.). The species is widely distributed and can be found in Peru, Argentina, and Chile. In the Chilean Andes it has been documented from 2500 to 4500 m above sea level in five different regions (Chile's first-level administrative divisions): I to IV and in the Región Metropolitana (Iriarte 2008, *op. cit.*). The species is considered to be omnivorous. In a study conducted during March 2000 at la Quebrada de Cruzaderos (29.783°S, 70.000°W; 3470–3650 m elev.) in the cordillera Doña Ana, north-central Chile, 30 fresh feces (6 per individual, N = 5) were analyzed and the majority of the items consumed were seeds, plant fibers, and insects (López-Cortés et al. 2007. Rev. Chil. Hist. Nat. 80:3–12). In another study where dietary samples were analyzed from Farellones at 2300 m elev.,

in the Andes of central Chile (33.35°S, 70.333°W; 50 km E of Santiago), more than 83% of food items during summer were plant material (Bozinovic et al. 1990. Physiol. Zool. 63:1216–1231). The rest of the food items were insects. Silva (2005. Rev. Chil. Hist. Nat. 78:589–599) reviewed dietary information for 25 species of small mammals inhabiting Chile and published in 11 scientific articles; there were no records of consumption of non-insect animal matter by *A. andinus*. To the best of our knowledge there are no reports of *A. andinus* preying on or consuming any animal species other than insects (e.g., lizards). Here we report a case of *A. andinus* chasing, killing, and consuming part of a male individual of the lizard *Liolaemus bellii* (Figs. 1–2). The observation by ES-B took place near El Colorado, Chile (33.233°S, 70.266°W) on 12 January 2012 at 1600 h when an *A. andinus* chased the lizard for 7–8 minutes in a semi-open area (sandy, gravelly soil with stones, rocks, and boulders of many sizes, and shrub vegetation). The mouse chased the lizard and bit its tail and dorsum several times; the reptile offered some resistance to the attack, fighting back on numerous occasions and trying to bite the mouse (Fig. 1). After struggling for a few minutes and in an obvious attempt to escape, the lizard ran underneath a large rock, but remained visible. The mouse followed it and then held onto it with its mouth. The mouse continued to bite the lizard's dorsum, flipped it upside down, and then bit its throat and abdomen several times. At one point, the lizard escaped the grasp of the mouse and ran some 10–15 cm (still under the rock and visible), but suddenly stopped; it looked exhausted, its eyes were sunken, and it had injuries on the head and body (i.e., dorsum, limbs, abdomen, and tail). Then, the mouse approached the lizard, bit it and flipped it on its back, and began to bite the left side of the abdomen, close to the hind limb. The lizard fought back again several times, but the mouse bit it in various locations on the dorsum, flipped it over again, and continued biting the abdomen and consuming parts of the lizard (Fig. 2). The mouse was aware of ES-B's presence; several times it moved toward him or stared at him, at certain times even as it continued biting the lizard.



FIG. 1. *Liolaemus bellii* fighting back and trying to bite *Abrothrix andinus*.



FIG. 2. *Abrothrix andinus* consuming part of *Liolaemus bellii* after chasing and killing it.

This observation took place while we were conducting studies on the behavioral ecology of the lizards at our study site near El Colorado. Our studies required exhaustive visual searches for the 3 lizard species of the genus *Liolaemus* (*L. leopardinus*, *L. bellii*, and *L. nigroviridis*) found at the study site. The area around El Colorado is characterized by rocky outcrops, open expanses where *Berberis empetrifolia* and *Chuquiraga oppositifolia* are the predominant plant species, and shrubby slopes. We were not studying *A. andinus* nor its diet, thus we did not catch individuals nor analyze their feces. Although previous studies have not listed non-insect animal matter in the diet of *A. andinus*, we suggest that feeding on a lizard may be nutritionally adaptive (Reichman 1977. Ecology 58:454–457). Primary production is probably low in the area where we made this feeding observation. Thus, ingesting an item high in protein might be beneficial, considering nutritional constraints as part of optimal foraging theory (Pulliam 1975. Am. Nat. 109:765–768). This photographic record contributes to the knowledge of food habits of *A. andinus*, a species reported having insectivorous and omnivorous food habits. Our record also adds *A. andinus* as a predator on *L. bellii*, even though we believe predation by this mouse is probably quite rare.

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***PHRYNOSOMA ASIO* (Giant Horned Lizard). PREDATION.** This lizard has a wide distribution in southwestern Mexico, across the states of Colima, Michoacán, Guerrero, Oaxaca, and Chiapas to Guatemala (Reeve 1952. Univ. Kansas Sci. Bull. 34:817–960). Predation on horned lizards of the genus *Phrynosoma* by birds is well documented; examples include Greater Roadrunners (*Geococcyx californianus*, Sherbrooke 1990. Wilson Bull. 102:171–174), Loggerhead Shrikes (*Lanius ludovicianus*, Lemos-Espinal et al. 1998. Herpetol. Rev. 29:168), Burrowing Owls (*Athene cunicularia*, Marti 1974. Condor 76:45–61), Ferruginous Hawks (*Buteo regalis*, Cartron et al. 2004. Southwest. Nat. 49:270–276), and recently Chihuahuan Ravens (*Corvus cryptoleucus*, Murray and Lease 2013. Herpetol. Rev. 44:327). There is little documented information on the natural history of *P. asio*. Recent studies establish that reptiles are prey in the diet of Harris' Hawk (González-Acuña 2006. J. Raptor Res. 40: 164–168; Santander et al. 2011. Southwest. Nat. 56: 419–424), although are represented less frequently in comparison to other prey. Here I report on Harris' Hawk (*Parabuteo unicinctus*) as a newly documented natural predator for *P. asio*.

At 1125 h on 21 August 2010, at Nuevo Centro, La Huacana, Michoacán, México (18.44071°N, 102.00435°W, datum WGS 84; 205 m elev.), I observed at 10 m distance an adult Harris' Hawk

in an open area feeding on half of a carcass of an adult specimen of *Phrynosoma asio* on the trunk of a tree from distance of ca. 10 m. The carcass was not fresh and the hawk was observed to feed from 5–10 minutes and then took flight. Future investigations would be of interest to determine if species of *Phrynosoma* are significant elements in the diet of Harris' Hawks.

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***PHYLLODACTYLUS MARTINI* (Dutch Leaf-toed Gecko). ENDOPARASITES.** *Phyllodactylus martini* is endemic to Curaçao and Bonaire, West Indies (van Buurt 2005. Field Guide to the Amphibians and Reptiles of Aruba, Curaçao. Edition Chimaira, Frankfurt am Main. 137 pp.). We know of no reports of helminths for *P. martini*. The purpose of this note is to establish the initial helminth list for *P. martini*.

A sample of 25 *P. martini* (mean SVL = 47.5 mm ± 5.6 SD, range = 33–55 mm) collected in Bonaire (12.16666°N, 68.28333°W; WGS84), The Netherlands Antilles, in February–March, 2001 by LJV and deposited in the Sam Noble Museum (OMNH), The University of Oklahoma, Norman, USA as OMNH 39506, 39542–39564, 39566 was examined for helminths.

The stomachs, small and large intestines were removed, opened, and examined under a dissecting scope. Only nematodes were found. They were removed, placed separately on microscope slides, cleared in a drop of lactophenol, cover slipped, and studied under a compound microscope. Found were two species of Nematoda, *Spauligodon oxkutzcabiensis* (in the large intestine), number of helminths = 193, prevalence; number infected/number examined × 100 = 72%, mean infection intensity = 10.7 ± 8.3 SD; acuariid gen. sp. (as cysts in the stomach wall), number = 7, prevalence = 12%, mean infection intensity = 2.3 ± 1.3 SD. Voucher helminths were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland, USA as *Spauligodon oxkutzcabiensis* (USNPC 106477) and acuariid gen. sp. (USNPC 106478).

Spauligodon itzocanensis has been reported from lizards from Mexico and South America (Avila and Silva 2010. J. Venom. Anim. Toxins Trop. Dis. 16:543–572; Goldberg and Bursey 2009. Herpetol. Rev. 40:224; Goldberg and Bursey 2010. Herpetol. Rev. 41:84–85). Species of *Spauligodon* have direct life cycles; infection presumably occurs through ingesting eggs (Goldberg and Bursey 1992. J. Parasitol. 78:539–541). Members of the Acuariidae are parasites of the gizzard of terrestrial birds; insects are intermediate hosts (Anderson 2000. Nematode Parasites of Vertebrates: Their Development and Transmission. CABI Publishing, Oxon, U.K. 650 pp.). Their occurrence in lizards most likely results from eating infected insects. Lizards may serve as paratenic (transport) hosts as development does not occur beyond the larval stage. Records of acuariid nematodes in reptiles are listed in Avila and Silva (*op. cit.*) and Goldberg et al. (2007. Comp. Parasitol. 74:327–342). *Spauligodon oxkutzcabiensis* and acuariid gen. sp. comprise the initial helminth list for *P. martini*.

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***PLICA UMBRA* (Blue-Lipped Tree Lizard). SPINE AND TAIL ANOMALY.** There are no reports in the literature regarding spine and tail anomaly in *Plica umbra*. On 20 December 2011 at 2100 h, we found an adult male of *P. umbra* (INPA-H 30446; SVL: 57.37 mm; tail length: 64.81 mm; body mass in life: 10 g), in a mineral exploration area (0.72762°S, 60.17511°W; WGS 84), in the outskirts of the municipality of Presidente Figueiredo, state of Amazonas, Brazil. The specimen was vertically oriented on a tree trunk, about 1.5 m above the ground, in an upland forest fragment that was partially reforested after mining and exhibited a deeply affected spine as a result of an unknown anomaly, and spiraled tail (Fig. 1). We currently have no data on the frequency at which this anomaly occurs in *P. umbra* populations, but we are very impressed by the fact that the specimen reached adulthood, given its very limited ability to move.

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FIG. 1. Spine and tail anomaly in *Plica umbra* (Tropiduridae).

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***POLYCHRUS ACUTIROSTRIS* (Brazilian Bush Anole). PREDATION.** *Philodryas olfersii* is a diurnal and semi-arboreal snake widespread in South America (Peters and Orejas-Miranda 1970. U.S. Nat. Mus. Bull. 297:1–347; Vanzolini et al. 1980. Répteis das Caatingas. Academia Brasileira de Ciências, Rio de Janeiro. 161 pp.). Its diet includes a wide range of vertebrates, such as amphibians, reptiles, birds and mammals (Hartmann and Marques 2005. Amphibia-Reptilia 26:25–31; Rocha and Vrcibradic 1998. Ciência e Cultura 50:364–368; Sazima and Haddad 1992. *In* L. P. C. Morellato [Org.], História Natural da Serra do Japi: Ecologia e Preservação de uma Área Florestal no Sudeste do Brasil, pp. 212–236. UNICAMP/ FAPESP, Campinas; Vitt 1980. Pap. Avul. Zool. 34:87–98). Despite the variety of prey types reported for the diet of *P. olfersii*, to the best of our knowledge there are no records of predation by this snake on the lizard *Polychrus acutirostris*.

Fieldwork was undertaken at Sítio Pinheiros, in the foothills of the Chapada do Araripe municipality of Barbalha, Ceará state, Brazil. Observations were made on 01 September 2012 at 0900 h. The snake, an adult *Philodryas olfersii* (SVL = 774 mm, mass = 89 g) was first sighted in the ground near an artificial lake, striking an adult *Polychrus acutirostris* (SVL = 126 mm, mass = 20.05 g). The lizard was held in the snake's jaws after capture, being constricted with an anterior coil of the snake's body, while biting the snake. After 16 minutes, the lizard died and the snake started ingestion headfirst, and the process took 19 minutes. Both the lizard and the snake were collected, euthanized, fixed with 10% formalin and deposited at the Coleção Herpetológica da Universidade Regional do Cariri (URCA-H 3888, 3894, respectively).

According to Vitt (1980, *op. cit.*) the diet of *P. olfersii* is composed mainly of mammals and amphibians. Lizards are rarely preyed upon, with some recorded species being *Hemidactylus mabouia, Tropidurus torquatus*, microteiids (Thomas 1976. Unpublished Ph.D. Thesis, Texas A&M University. 338 pp.) and *Ameiva ameiva* (Vitt 1980, *op. cit.*). Few snake species (*Chironius multiventris, Rhinobothrium lentiginosum*, and *Siphlophis cervinus*) have been observed preying on *Polychrus marmoratus* (Martins and Oliveira 1999. Nat. Hist. 6:78–150). To the best of our knowledge, only avian predators have been reported as predators on *P. acutirostris* (França and Braz 2009. Biotemas 22:243–245; Vitt 1981. Herpetologica 37:53–63).

PHOTO BY OLIVEIRA, H.F. 2012.



FIG. 1. *Philodryas olfersii* and *Polychrus acutirostris* collected at Sítio Pinheiros municipality of Barbalha, Ceará.

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***SCELOPORUS SINIFERUS* (Long-tailed Spiny Lizard). DIET.** *Sceloporus siniferus* is distributed from the state of Guerrero, Mexico, along the Pacific coast to extreme western Guatemala (Smith 1939. Field Mus. Nat. Hist., Zool. Ser. 26:1–397). To date, very little is known about the ecology of *S. siniferus* (Lemos-Espinal et al. 2001. West. N. Am. Nat. 61:498–500), and information about its diet still remains unknown. Herein, we report a predation event of an individual *S. siniferus* feeding on a centipede (*Scolopendra* sp.) in a tropical deciduous forest of coastal Oaxaca.

On 26 May 2009, at 1407 h, an individual *S. siniferus* with a missing tail was observed on the ground holding a centipede. The event took place in a deciduous tropical forest in the Jardin Botánico de la Universidad del Mar (15.916663°N, 97.076748°W, datum WGS 84; elev. = 91 m), located ca. 6 km N of Puerto Escondido, San Pedro Mixtepec, Oaxaca. The lizard jumped onto the stem of a tree and paused for a few seconds to ingest the centipede (Fig. 1). Once the lizard had swallowed the prey entirely, it continued to climb higher on the tree due to our close proximity. Among lizards of the genus *Sceloporus*, centipedes have been reported to be common prey in the diet of *S. consobrinus* (Lahti and Leaché 2009. *In* Jones and Lovich [eds.], Lizards of



FIG. 1. An individual *Sceloporus siniferus* ingesting a centipede (*Scolopendra* sp.) in a tropical deciduous forest in southern coastal Oaxaca, Mexico.

the American Southwest, pp. 210–213. Rio Nuevo, Tucson, Arizona), *S. poinsettii* (Webb 2009. *In* Jones and Lovich [eds.], *op. cit.*, pp. 246–249); and less frequent in *S. torquatus* (Feria-Ortiz et al. 2001. J. Herpetol. 35:104–112), *S. magister*, and *S. undulatus* (Johnson 1966. Am. Midl. Nat. 76:504–509). Frequency of centipede consumption by *S. siniferus* remains to be investigated.

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***SCELOPORUS TORQUATUS* (Central Plateau Torquate Lizard). AQUATIC ESCAPE BEHAVIOR.** Dropping from overhanging branches to water and then swimming across the surface or descending to the bottom is a common escape behavior observed in iguanids (*Iguana iguana* and *Ctenosaura* spp.) (Pianka and Vitt 2003. Lizards, Windows to the Evolution of Diversity. University of California Press, Berkeley, California. 333 pp.). Other terrestrial lizard species have been observed attempting to escape potential predators by swimming or submerging their bodies underwater, including *Aspidoscelis sexlineatus* (Dillon and Baldauf 1945. Copeia 1945:174; Trauth et al. 1996. Herpetol.Rev. 27:20), *Crotaphytus collaris* (Burt and Hoyle 1934. Trans. Kansas Acad. Sci. 37:193–216), *Scincella lateralis* (Akin and Towsend 1998. Herpetol. Rev. 19:43), *Sceloporus clarkii* (Zylstra and Weise 2010. Herpetol. Rev. 41:86), *Uma exsul* (Estrada-Rodriguez and Leyva-Pacheco 2007. Herpetol. Rev. 38:84–85), and *Gambelia wislizenii* (Medica 2010. Herpetol. Rev. 41:354–355). Herein, we report the escape-to-water behavior of *S. torquatus*, a typically saxicolous lizard.

On 16 November 2008, while conducting field work in Mesa Montoro, Aguascalientes, México (21.988250°N, 102.582304°W, datum WGS84; elev. 2371 m), at 1315 h we heard a noise in the leaf litter and then a splash in a nearby water source. By following the noise we found a male *S. torquatus* (SVL = 770 mm; 14 g) completely submerged in a seasonal pond (ca. 500 mm deep), as we approached, the lizard surfaced and remained at the edge of the pond (Fig. 1) until being captured. This behavior is rare in terrestrial and saxicolous lizards, particularly given the low temperature of the water at that time, which may represent a high energy cost behavior for the lizard.



FIG. 1. Adult *Sceloporus torquatus* at the edge of the pond before being captured at Mesa Montoro, Aguascalientes, México.

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***SCELOPORUS UNDULATUS* (Eastern Fence Lizard). ENVENOMATION.** On 28 April 2012 at 1215 h, a male Eastern Fence Lizard was encountered and perceived to be basking in the sun on a plank of wood in a trailer park in Alabama's Geneva State Forest (31.14084°N, 86.18207°W; WGS 84). Upon further examination, we discovered that the lizard was dead, and had a broken pitviper fang protruding from its dorsum, proximal to the right hind limb (Fig. 1). Necrosis was apparent around the protruding fang, and is obvious in the preserved specimen, which we deposited (along with the fang) in the Auburn University Herpetological Collections (AUM 39668). It is our assumption that a Copperhead (*Agkistrodon contortrix*) was the probable predator of the lizard based on the habitat, geographic location, and fang size. We noticed a large plank of wood lying on the ground not far from where the lizard was discovered, and when lifted, we found a Copperhead coiled underneath. We did not verify if the Copperhead had a missing fang due to concern for the researchers' safety.

Sceloporus undulatus is a documented prey item of Copperheads (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Instituition Press, Washington, DC. 668 pp.). Research suggests that when pitvipers, including Copperheads, bite reptiles and amphibians, they hold onto their prey before consuming it (Ernst and Ernst 2003, *op. cit.*). Conversely, when they bite mammals such as rodents, they release their prey before seeking it out later using strike-induced chemosensory searching (SICS; Stiles et al. 2002. *In* Schuett et. al. [eds.], Biology of the Vipers, pp. 413–419. Eagle Mountain Publ., Eagle Mountain, Utah). We interpret this observation as evidence of a predatory attempt by a Copperhead on a fence lizard that failed when the snake's fang broke after the strike, and the snake was subsequently unable to hold onto its prey. Although pitvipers are



FIG. 1. Dead, recently envenomated *Sceloporus undulatus* shortly after its discovery. Arrow indicates fang which presumably belonged to a nearby *Agkistrodon contortrix*.

known to initiate SICS to find ectothermic prey after failed strike attempts (Stiles et al. 2002, *op. cit.*), they may not when a failed attempt results in a broken fang.

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***SCELOPORUS ZOSTEROMUS* (Baja Spiny Lizard). REPRODUCTION.** *Sceloporus zosteromus* is endemic to Baja California and ranges from Ensenada in the north to Cabo San Lucas in the south (Grismer 2002. Amphibians and Reptiles of Baja California, Including Its Pacific Islands and the Islands in the Sea of Cortés. University of California Press, Berkeley. 399 pp.). Anecdotal information on reproduction of *S. zosteromus* was presented by Bostic (1971. Trans. San Diego Soc. Nat. Hist. 16:237–264), Grismer (*op. cit.*), and Shaw (1952. Herpetologica 8:71–79). The purpose of this note is to add information on the reproductive cycle of *S. zosteromus* from a histological examination of museum specimens from Baja California, and Baja California Sur, Mexico.

A sample (N = 13) of *S. zosteromus* was examined, consisting of 4 males (mean SVL = 85.5 mm ± 5.4 SD, range = 79–90 mm), 6 females (mean SVL = 69.7 mm ± 6.7 SD, range = 61–77 mm) collected in the vicinity of Santiago (23.470°N, 109.720°W), Baja California Sur in August 1964 and 3 additional males (mean SVL = 99.0 mm ± 10.0 SD, range = 89–109 mm) collected near El Arco (28.0301°N, 113.4032°W), Baja California in April 1949 and deposited in the herpetology collection of the Natural History Museum of Los Angeles County, Los Angeles, California, USA as LACM 4539–4541, 17336, 17337, 17339, 17340, 17342, 17344, 17346, 17347, 96159, 128064. The left gonad was removed and embedded in paraffin. Histological sections were cut at 5 µm and stained by Harris' hematoxylin followed by eosin counterstain. Enlarged ovarian follicles (> 5 mm) or oviductal eggs were counted. No histology was performed on them. Histology slides were deposited in LACM.

All 7 males were undergoing sperm formation (spermiogenesis) in which the lumina of the seminiferous tubules were lined by clusters of sperm or metamorphosing spermatids. The smallest reproductively active male (spermiogenesis) measured 79 mm and was from August. All August females were reproductively active. Three stages were noted in the ovarian cycle: 1) yolk deposition, vitellogenic follicles (4 females); 2) enlarged follicles (> 5 mm) (2 females, eggs were damaged in 1 female, clutch could not be counted); 3) oviductal eggs (1 female). Mean clutch size (N = 2) was 6.0. The smallest reproductively active female measured 61 mm SVL (follicles > 5 mm).

Bostic (*op. cit.*) and Shaw (*op. cit.*) reported northern populations of *S. zosteromus* produced eggs in spring and summer. My data show males of *S. zosteromus* from the north are producing sperm in the spring and females from the south are reproducing in August. Further investigations are needed to ascertain when reproduction commences in the south and other possible latitudinal variation in the reproductive cycle of *S. zosteromus*.

I thank G. Pauly (LACM) for permission to examine *S. zosteromus*.

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***SPHENOMORPHUS PRAESIGNUS* (Blotched Forest Skink). REPRODUCTION.** *Sphenomorphus praesignus* ranges from southern Thailand southward to Pahang in Peninsular Malaysia (Grismer 2011. Lizards of Peninsular Malaysia, Singapore and their Adjacent Archipelagos. Edition Chimaira, Frankfurt am Main. 728 pp.). There is a report of gravid females at Pahang in June (Grismer, *op. cit.*). In this note we add information on the reproductive biology of *S. praesignus* from a histological examination of museum specimens.

A sample of ten *S. praesignus* from Peninsular Malaysia (by state): Pahang (6) and Perak (4), collected 2004, 2006, 2008, 2010, and deposited in the herpetology collection of La Sierra University (LSUHC), Riverside, California, USA, was examined. The sample consisted of two adult males (mean SVL = 101.0 mm ± 9.9 SD, range = 94–108 mm; two adult females (mean SVL = 111.00 mm ± 2.8 SD, range = 109–113 mm and six subadults (mean SVL = 49.3 ± 11.4 SD, range = 41–72 mm).

A cut was made in the lower abdominal cavity and the left testis or ovary was removed, embedded in paraffin, cut into 5 µm sections and stained with Harris hematoxylin followed by eosin counterstain. Enlarged follicles (> 4 mm) or oviductal eggs were counted. Histology slides were deposited in LSUHC.

The only stage present in the testicular cycle was spermiogenesis in which the seminiferous tubules are lined by clusters of sperm or metamorphosing spermatids. This condition was noted in one male each from June (LSUHC 9040) from Perak and August (LSUHC 8058) from Pahang. The only two adult *S. praesignus* females present, each contained oviductal eggs: eight oviductal eggs (LSUHC 10593) collected in April from Perak and seven oviductal eggs (LSUHC 9095) collected in June from Pahang. All subadults contained very small gonads indicating reproductive activity had not commenced.

Seven and eight oviductal eggs are the first clutches reported for *S. praesignus*. The duration of the *S. praesignus* reproductive cycle remains to be determined.

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***STENODACTYLUS STHENODACTYLUS* (Elegant Gecko). CESTODE ENDOPARASITES.** *Stenodactylus sthenodactylus* is widespread in northern and northeast Africa and the Middle East (Bar and Haimovitch 2011. A Field Guide to Reptiles and Amphibians of Israel. Pazbar 1989, Ltd., Herzliya, Israel. 245 pp.). To our knowledge, there are no reports of endoparasites in *S. sthenodactylus*. The purpose of this note is to report the presence of larval cestodes in *S. sthenodactylus*.

One male *S. sthenodactylus* (SVL = 48 mm) collected 4 April 1956 at En Hazeva, A'rava Valley Region (30.76794°N, 35.27850°E), Israel and deposited in the Tel Aviv University Museum (TAUM 2187), Tel Aviv, Israel was examined. The body cavity was opened and utilizing a dissecting microscope 18 whitish structures (each ca. 2 mm in length) were collected. Each was regressively stained in hematoxylin, mounted in balsam on a microscope slide, and studied with a compound microscope and identified as cestode larvae. Two forms were present: 1) a plerocercoid (i.e., a spindle-shaped, solid larva) possessing an exposed adult-appearing scolex and similar in appearance to previously reported larvae

TABLE 1. Monthly stages in the ovarian cycle of 16 *Stenodactylus sthenodactylus* from Israel. * = one April female with oviductal eggs exhibited concurrent yolk deposition for a subsequent clutch.

Month	N	Quiescent	Early yolk deposition	Follicles > 4 mm	Oviductal eggs	Corpus luteum and yolk deposition
January	1	1	0	0	0	0
February	1	1	0	0	0	0
April	8	1	0	3	3*	1
May	2	1	0	0	1	0
September	1	1	0	0	0	0
October	1	0	1	0	0	0
November	1	1	0	0	0	0
December	1	1	0	0	0	0

assigned to the Proteocephala; 2) a cysticercoid (i.e., a solid larva consisting of an anterior vesicle containing a non-invaginated scolex with a tail-like posterior region and similar in appearance to previously reported larvae assigned to the Cyclophyllidea (see Olsen 1974. Animal Parasites Their Life Cycles and Ecology. Dover Publications, Inc. New York. 562 pp.). Whether these forms represent infection by two different orders of Cestoda, or sequential stages in the development of an undescribed cestode will require further study. Because the larvae were found in the coelom, it would appear that *S. sthenodactylus* serves either as an intermediate host or a transport (paratenic) host and no further development would be expected from these larvae until they reached the definitive host (currently unknown). Voucher larvae were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland, USA as plerocercoids USNPC (106872) and cysticercoids USNPC (106873). Larval cestodes are the first parasites reported for *S. sthenodactylus*.

We thank Shai Meiri (TAUM) for permission to examine *S. sthenodactylus*, Erez Maza (TAUM) for facilitating the loan, and the National Collections of Natural History at Tel Aviv University for providing the specimen utilized in this study.

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***STENODACTYLUS STHENODACTYLUS* (Elegant Gecko). REPRODUCTION.** *Stenodactylus sthenodactylus* occurs across North Africa from Mauritania to Egypt, Israel, and Syria, south through Sudan to northwestern Kenya (Largen and Spawls 2010. The Amphibians and Reptiles of Ethiopia and Eritrea. Edition Chimaira. Frankfurt am Main. Germany. 693 pp.).

Anecdotal information on the reproduction of this species (clutch sizes of 1–2 eggs, spring egg deposition) is in Disi et al. (2001. Amphibians and Reptiles of the Hashemite Kingdom of Jordan, An Atlas and Field Guide. Edition Chimaira, Frankfurt am Main, Germany. 408 pp.); Schleich, et al. (1996. Amphibians and Reptiles of North Africa. Koeltz Scientific Publishers, Koenigstein, Germany. 630 pp.); Spawls et al. (2002. A Field Guide to the Reptiles of East Africa, Kenya, Tanzania, Uganda, Rwanda and Burundi. Academic Press, San Diego, California. 543 pp.) and Bar and Haimovitch. 2011 (A Field Guide to Reptiles and Amphibians of Israel. Pazbar Ltd, Herzilya, Israel. 245 pp.). In captivity mating begins in March (Rogner 1997. Lizards, Volume 1. Husbandry and Reproduction in the Vivarium, Geckoes, Flap-footed Lizards, Agamas, Chameleons, and Iguanas. Krieger Publishing Co., Malabar, Florida. 317 pp.). In this note I add information on *S. sthenodactylus* reproduction in Israel from a histological examination of gonadal material from museum specimens.

A sample of 30 *S. sthenodactylus* consisting of 14 adult males (mean SVL = 45.2 mm ± 3.3 SD, range = 40–51 mm) and 16 adult females (mean SVL = 48.9 mm ± 2.8 SD, range = 44–53 mm), collected between 1940–1976 in Israel and deposited in the Zoological Museum of Tel Aviv University, (TAUM), Tel Aviv, Israel was examined (by region): A'rava Valley (TAUM) 441, 443, 1852, 2187, 11398, 16612; Central Negev (TAUM) 435, 439, 440, 452, 455, 970, 971, 1000, 1012, 2157, 2182, 2183, 2594, 2989, 3008; Coastal Plain (TAUM) 4536; HaSharon (TAUM) 450, 451; Northern Negev (TAUM) 604, 1956, 445, 8970; Southern Negev (TAUM) 1771; Yehudah Mountains (TAUM) 13704.

A small slit was made in the left side of the abdomen and the left testis was removed from males and the left ovary was removed from females for histological examination. Enlarged ovarian follicles (> 4 mm) or oviductal eggs were counted *in situ*. No histology was performed on them. Removed gonads were embedded in paraffin, sections were cut at 5 µm and stained by Harris' hematoxylin followed by eosin countertstain. Histology slides were deposited in the National Collections of Natural History at Tel-Aviv University.

The only stage noted in the monthly testicular cycle was spermiogenesis (sperm formation) in which the seminiferous tubules are lined by clusters of sperm or metamorphosing spermatids. This condition was noted in males from January (N = 3), March (N = 1) and April (N = 10). The presence of January males undergoing spermiogenesis indicates *S. sthenodactylus* males begin reproduction in winter. The smallest reproductively active male (spermiogenesis in progress) measured 40 mm SVL (TAUM 8970) and was collected in March.

Five stages were noted in the ovarian cycle of *S. sthenodactylus* (Table 1): 1) quiescent (no yolk deposition); 2) early yolk deposition (vitellogenic granules in ooplasm); 3) enlarged ovarian follicles (> 4 mm); 4) oviductal eggs; 5) corpus luteum and yolk deposition for a subsequent clutch. Evidence is presented from two females indicating *S. sthenodactylus* produces multiple clutches in the same reproductive season: 1) TAUM 970 contained oviductal eggs and was undergoing concurrent yolk deposition for a subsequent egg clutch; 2) TAUM 440 contained a corpus luteum from a previous clutch while undergoing concurrent yolk deposition for a subsequent egg clutch. One female from October exhibited early yolk deposition (Table 1). It is not known if it would have completed yolk deposition next spring or if the follicle would have undergone atresia (see Goldberg 1973.

Herpetologica 29:284–289). Mean clutch size for seven females was an invariant 2.0. The smallest reproductively active female (2 enlarged follicles > 4 mm) measured 44 mm SVL (TAUM 3008) and was collected in April.

I thank Shai Meiri (TAUM) for permission to examine *S. sthenodactylus*, Erez Maza (TAUM) for facilitating the loan, and the National Collections of Natural History at Tel Aviv University for providing samples of *S. sthenodactylus* for this study.

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***TRACHYLEPIS VITTATA* (Bridled Mabuya). REPRODUCTION.** *Trachylepis vittata* is a viviparous species widely distributed in the Middle East (Bar and Haimovitch 2011. A Field Guide to Reptiles and Amphibians of Israel. Pazbar Ltd 1989, Herzilya, Israel. 246 pp.). There are anecdotal reports of clutch sizes, time of egg deposition, and parturition for *T. vittata* in Turkey (1–4 young) (Baran and Atatur 1998. Turkish Herpetofauna [Amphibians and Reptiles]. Ministry of Environment, Ankara. 214 pp.); Israel (3–8 young) born April to June (Bar and Haimovtich, *op. cit.*); Jordan (5–10 young) born in summer (Disi et al. 2001. Amphibians and Reptiles of the Hashemite Kingdom of Jordan. Edition Chimaira, Frankfurt am Main. 408 pp.); Cyprus (6 young) (Baier et al. 2009. The Amphibians and Reptiles of Cyprus. Edition Chimaira, Frankfurt am Main. 364 pp.); and Tunisia (6 young) (Schleich et al. 1996. Amphibians and Reptiles of North Africa. Koeltz Scientific Books, Koenigstein. 630 pp.). The purpose of this note is to add information on the reproductive cycle of *T. vittata* from Israel.

A sample of 27 *T. vittata* was examined consisting of 7 males (mean SVL = 66.9 mm ± 12.4 SD, range = 53–85 mm), 19 females (mean SVL = 75.7 mm ± 9.1 SD, range = 58–77 mm) and one juvenile female from March (SVL = 53 mm) collected 1954 to 2012 in Israel, by Region: HaGolan 7529, HaSharon 5905, 5782 HaShefala 4879, 6361, 6362, Hermon Mountain 7088, 7115, 7553, 13374, 13376, 13625, Karmel Ridge 13788, Lower Galil 2548, Northern Coastal Plain 1352, Northern Negev 4854, Shomeron 5927, 13070 Southern Coastal Plain TAUM 784, Upper Galil 1504, 1507, 2970, 6058, Yizreel Valley 785, 794, and deposited in the Zoological Museum of Tel Aviv University (TAUM), Tel Aviv, Israel. Two of the females were maintained in captivity until parturition and were not deposited in TAUM. One female collected in Shomeron Region on 22 May 2012, produced 3 neonates on 7 June 2012 (mean SVL = 33 mm ± 0.75 SD, range = 33–34 mm); the other female, collected in Upper Galil Region on 3 June 2012, produced 5 neonates on 26 June 2012 (mean SVL = 31 mm ± 1.0 SD, range = 30–33 mm).

A small slit was made in the left side of the abdomen in the remaining aforementioned specimens and the left testis was removed from males and the left ovary was removed from females for histological examination. Enlarged ovarian follicles (> 4 mm) or oviductal eggs were counted *in situ*. No histology was performed on them. Removed gonads were embedded in paraffin. Sections were cut at 5µm and stained by Harris' hematoxylin followed by eosin counterstain. Histology slides are deposited at TAUM.

Three stages were noted in the testicular cycle (Table 1): 1) regressed = post breeding (seminiferous tubules contain spermatogonia and Sertoli cells); 2) recrudescence (proliferation of germ cells in the seminiferous tubules for the next period of spermiogenesis; 3) spermiogenesis (seminiferous tubules lined by clusters of sperm or metamorphosing spermatids. The smallest reproductively active male (spermiogenesis) measured 54 mm SVL and was collected in March (TAUM 13788).

Table 1. Monthly stages in the testicular cycle of 7 adult *Trachylepis vittata* from Israel.

Month	N	Regressed	Recrudescence	Spermiogenesis
February	2	0	1	1
March	2	0	0	2
July	1	1	0	0
August	1	1	0	0
October	1	0	1	0

Table 2. Monthly stages in the ovarian cycle of 19 adult *Trachylepis vittata* from Israel.*1 oviductal female contained follicles with concurrent yolk deposition; **1 female contained developing embryos.

Month	N	Quiescent	Early yolk deposition	Enlarged follicles > 4 mm	Oviductal eggs
January	1	1	0	0	0
March	6	0	1	2	3*
April	4	1	1	1	1
May	5	0	2	1	2**
June	1	0	0	0	1
July	1	1	0	0	0
December	1	1	0	0	0

Four stages were noted in the ovarian cycle (Table 2); 1) quiescent (no yolk deposition); 2) early yolk deposition (vitellogenic granules in the cytoplasm); 3) enlarged follicles (> 4 mm); 4) oviductal eggs. The smallest reproductively active female (early yolk deposition) measured 58 mm SVL and was collected in May (TAUM 13376). One female collected in March (SVL = 53 mm) contained quiescent ovaries and was considered a subadult. Mean clutch size (N = 11) was 5.1 ± 1.4 SD, range = 3–8. One female from March (TAUM 6361) collected in March with oviductal eggs was undergoing concurrent yolk deposition for a subsequent clutch. This is evidence that *T. vittata* may produce multiple clutches in the same reproductive season.

We thank Shai Meiri (TAUM) for permission to examine *T. vittata* and the National Collections of Natural History at Tel Aviv University for providing samples of *T. vittata* for this study.

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***TROPIDURUS HISPIDUS* (Peters' Lava Lizard). PREDATION.** Lizards of the genus *Tropidurus* are the most conspicuous species within Neotropical lizard communities, inhabiting a wide variety of habitats (Vitt and Pianka 2004. Recerca 8:139–157). *Tropidurus hispidus* is widely distributed in the Caatinga (i.e., scrub-like vegetation) of northeastern Brazil (Rodrigues 1987. Arq. Zool., S. Paulo. 31:105–230). Few predators of *T. hispidus* have been reported, but include spiders (Viera et al. 2012. Biota Neotrop. 12:4) and tegu lizards (Silva et al. 2013. Herpetol. Notes. 6:51–53). Herein, we provide a case of predation of *T. hispidus* by an anuran.

On 20 March 2013 at 1132 h we observed a juvenile *T. hispidus* (36.74 mm SVL) being preyed upon under a rock (Fig. 1)



FIG. 1. A juvenile *Tropidurus hispidus* being predated upon by an adult *Leptodactylus troglotydes*.

by an adult Pernambuco White-lipped Frog (*Leptodactylus troglotydes*; 52.03 mm SVL) at Olho Dágua Comprido Ranch (Geosite Floresta Petrificada), Missão Velha municipality, Ceara state, northeastern Brazil. The observation lasted at least five minutes and the lizard was ingested tail first. The lizard and frog were collected, measured, fixed in 10% formalin and deposited at Coleção Herpetologica da Universidade Regional do Cariri (URCA-H 5499, 5441, respectively).

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***TROPIDURUS SEMITAENIATUS* (Calango de Lagedo). TAIL BIFURCATION.** The tails of lizards play an important role in locomotor performance, critical for balance (Ballinger 1973. Herpetologica 29:65–66). Since locomotion is directly related to several activities, such as foraging, mating, and escape from predators, tail condition might affect individual fitness (Garland and Losos 1994. *In* Wainwright and Reilly [eds.], Ecological Morphology: Integrative Organismal Biology, pp. 240–302. University of Chicago Press, Chicago, Illinois).

Lizards have an outstanding capability of repair of several tissues, including muscular, osteological, and neuronal, beyond the noteworthy ability to regenerate their broken tails (Alibardi 2010. Morphological and Cellular Aspects of Tail and Limb Regeneration in Lizards. Springer-Verlag, Berlin, Heidelberg. 109 pp.). Herein, we report a case of caudal bifurcation in *Tropidurus semitaeniatus*, a saxicolous lizard, endemic to the caatinga of northeastern Brazil.

On 11 June 2011 during field work investigating spatial ecology in *T. semitaeniatus* in Pentecoste municipality, Ceará state, Brazil (3.81833°S, 39.33722°W), we captured an adult female with a bifid tail (Fig. 1). The bifurcation point was positioned in the posterior region of the tail (42.0 mm from the cloaca) and the left tail branch (29.0 mm) was slightly longer than the right one (27.0 mm). Regenerated region of tail bifurcation was obvious due to the distinct color and shape of re-grown scales, which clearly diverged from patterns of the original portion of the tail.



FIG. 1. Adult female *Tropidurus semitaeniatus* with bifid tail.

Our field observations suggested that the locomotor behavior of this female tended to differ from the usual displacement pattern of its conspecifics, by presenting marked lateral oscillations with its tail. Since lizard tails serve as a balancing organ (Ballinger 1973, *op. cit.*), multiple tails may possibly impact the daily performance of the individual. However, in the case of this specific female, we made multiple recaptures (25 sightings over a 17-month time span), observing its growth and becoming gravid. Hence, our findings suggest that lizards with bifurcated tails can survive and reproduce despite their morphological abnormalities.

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***VANZOSAURA RUBRICAUDA* (Red-tailed Vanzosaur). BIFURCATION AND TRIFURCATION.** *Vanzosaura rubricauda* is a small microteiid lizard (Gymnophthalmidae) with a longitudinally striped body and brightly colored, red tail. It uses caudal autotomy as a means of predation avoidance; a strategy widely utilised by most lizards (Fitch 2003. J. Herpetol. 37:395–399; Pafilis et al. 2009. Evolution 63:1262–1278). Bifurcation is recognized as being the result of injury and not caused by deformity (Lynn 1950. Herpetologica 6:81–84). On occasion when the original tail is damaged during a predation event, but not completely severed, bifurcation, or more rarely trifurcation, can occur (Conzendey et al. 2013. Herpetol. Rev. 44:145–146; Gogliath et al. 2012. Herpetol. Rev. 43:129; Kumbar et al. 2011.

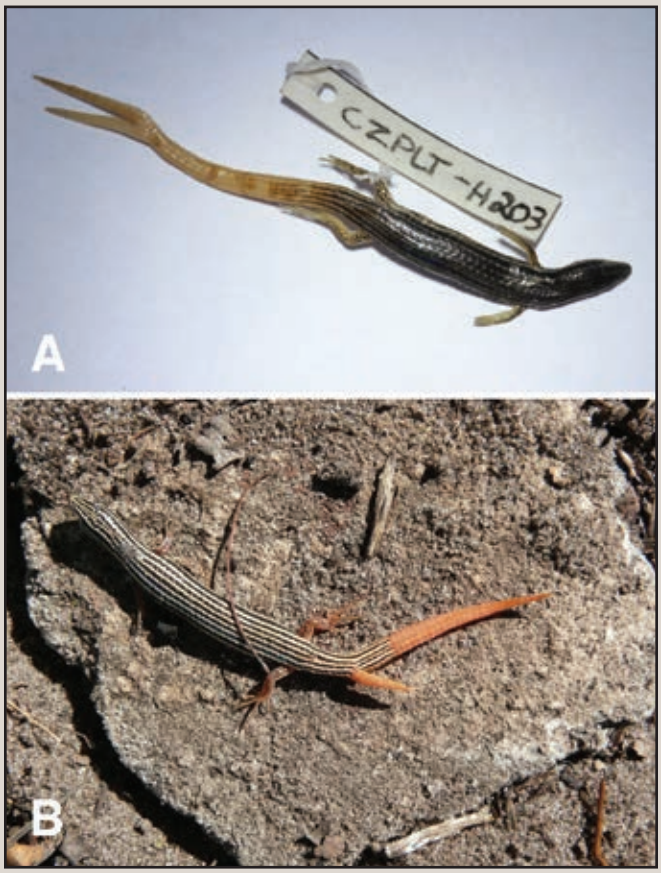


FIG. 1. *Vanzosaura rubricauda* with A) trifurcated tail and B) bifurcated tail.

Herpetol. Rev. 42:94; Tamar et al. 2013. Herpetol. Rev. 44:135–136; Tamar et al. 44:146). Adult *V. rubricauda* with abnormal tails were collected on 6 September 2011 and 2 May 2013 in pitfall trap lines at Reserva Natural Laguna Blanca, San Pedro Department, Paraguay (23.816194°S, 56.292833°W; 203 m elev.) and deposited in the Colección Zoológica de Para La Tierra as CZPLT 203 and CZPLT 472, respectively. CZPLT 203 (SVL = 31mm) had a tail trifurcated at the tip with three divisions measuring 12.5, 4.5, and 15 mm (ventral left to right; Fig. 1A). The short middle section is deflected ventrally and not visible dorsally. CZPLT 472 (SVL = 35.5 mm) shows a complete regenerated tail that is deflected (i.e., due to a putative predation attempt) laterally at the base (10.28 mm from the vent), presumably due to the damage caused during an attempted predation event. This injury resulted in the regeneration of a second red-colored tail measuring 7.5 mm at the site of the deflection (5.43 mm from the vent; Fig. 1B).

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SQUAMATA — SNAKES

***ANILIUS SCYTALE* (Red Pipesnake). PREDATION.** *Anilius scytale* is relatively common in the Amazon, in gallery forests of the northern Brazilian Cerrado and humid forests of the Caatinga region (Martins and Oliveira 1998. Herpetol. Nat. Hist. 6:78–150; França et al 2008. Copeia 2008:23–38). Here, we report predation of *A. scytale* by the elapid *Micrurus leminiscatus* in Nova Canaã, municipality of Porto Grande, Amapá state, Brazil.

On 25 October 2011 at ca. 1535 h, while conducting a herpetological survey in the rural establishment of Nova Canaã (0.70694445°N, 51.421111°W, datum WGS84; elev. = 132 m), we collected a road-killed adult *M. leminiscatus* (SVL = 706 mm) on the Northern Perimeter Highway, km 147. Dissection revealed a female *A. scytale* (SVL = 410 mm) in the stomach. *Micrurus leminiscatus* are known to prey on other coral-snakes (França and Araújo 2006. South Am. J. Herpetol. 1:25–36; Bernarde and Abe 2010. Biota Neotrop. 10:167–173), lizards, and gymnotiform fishes (Cunha and Nascimento 1982. Bol. Mus. Para. Emílio Goeldi 112:1–58). The *M. leminiscatus* specimen (CDLABZOO 087 – collection license Instrução Normativa IBAMA nº154) and its stomach contents were deposited in Laboratório de Zoologia, Campus Marco Zero, Universidade Federal do Amapá (UNIFAP).

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***BITIS ARIETANS* (Puff Adder). FORAGING BEHAVIOR.** Snakes that feed on birds exhibit a variety of strategies to catch avian prey. For example, actively-foraging snakes visit bird nests to feed on eggs, nestlings, and/or the adult birds themselves (Stake et al. 2005. J. Herpetol. 39:215–222; Staller et al. 2005. J. Wildl. Manage. 69:124–132). Additionally, some ambush-hunting snakes increase bird encounter rate by selecting foraging sites that are commonly visited by birds, such as water pools where birds come drink (Nilson et al. 1999. Amphibia-Reptilia 20:355–365), while others use caudal luring to deceive and attract birds to them (Andrade et al. 2010. S. Amer. J. Herpetol. 5:175–180; Fathinia et al. 2009. Russ. J. Herpetol. 16:134–138).

As part of an ongoing radiotelemetric study on *B. arietans* in the Dinokeng Game Reserve, Gauteng Province, South Africa, we observed a "sit-and-wait" behavioral tactic employed by a snake at a bird's nest. On 1 December 2012, we found an adult male in ambush at the nest of a ground-nesting bird of an unknown species. The snake was partially concealed under the vegetation surrounding the nest, which contained a single egg, and the snake's head was clearly aimed toward the center of the nest (Fig. 1). By



FIG. 1. *Bitis arietans* ambush foraging at the nest of a ground-nesting bird. The arrow points toward the head of the snake.

the next day the snake had moved to another location and the egg was still in the nest. We do not know whether the snake actually fed (we did not detect any obvious meal by looking at the snake), but our observation provides—to the best of our knowledge—a previously unreported foraging strategy used by a "sit-a-wait" snake predator to feed on birds.

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***BOA CONSTRICTOR* (Boa Constrictor). DIET.** *Boa constrictor* is a widely-distributed, semi-arboreal ambush predator (Henderson et al. 2005. Herpetol. Nat. Hist. 3:15–17; Greene 1983. *In* D. H. Janzen [ed.], Costa Rica Natural History, pp. 380–382. Univ. Chicago Press, Illinois). It is a generalist in terms of diet, consuming birds, amphibians, mammals, and even other reptiles (Quick et al. 2005. J. Herpetol. 39:304–307; Pizzatto et al. 2009. Amphibia-Reptilia 30:533–544). There are reports of consumption of psittacid birds (e.g., *Ara severus, Aratinga pertinax arubensis*) by *B. constrictor* (Begotti and Filho 2012. Cotinga 34:106–107; Quick et al., *op. cit.*). Here, we increase the list of psittaciform prey of this snake with a predation record of a *Brotogeris chiriri* (Yellow-chevroned Parakeet).

On 18 April 2013, at 1157 h, we observed the capture of a *B. chiriri* by a *B. constrictor* on a tree (*Senna siamea*) 3 m above the ground in Campo Grande, Mato Grosso do Sul, Brazil (20.301418°S, 54.365219°W; datum WGS84). Immediately after the capture, the branch that was supporting the snake broke, making it fall together with the subdued bird. Once on the ground, the parakeet was killed by constriction and swallowed whole, starting from the head, in 7 min (Fig. 1).



FIG. 1. *Boa constrictor* preying on *Brotogeris chiriri* (Yellow-chevroned Parakeet) in Campo Grande, Mato Grosso do Sul, Brazil.

We thank João Paulo Barbosa for photographing the predation event, Ângela Sartori for botanical identification, and the Coordination for the Improvement of Higher Education Personnel (CAPES) for the Masters scholarship.

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***BOA CONSTRICTOR* (Boa Constrictor). DIET.** *Boa constrictor* is a semi-arboreal snake with a generalist diet (Vanzolini et al. 1980. Répteis das Caatingas. Academia Brasileira de Ciências, Rio de Janeiro. 161 pp.). Herein we report the first known predation on *Tangara sayaca* (Sayaca Tanager) by *B. constrictor*. Predation events were recorded on 22 April 2009 and 22 February 2013 in the Campus do Pici, Fortaleza, Ceará, Brazil. In the first observed event, a young *B. constrictor* (SVL = 52.7 cm) was found having difficulty swallowing a half-eaten *T. sayaca*. This difficulty was probably due to the large size of the bird, which we measured after it was regurgitated (total length without legs [TLWL] = 11.27 cm, maximum width [MW] = 3.35 cm). In the second event, a young *B. constrictor* (SVL = 42 cm) killed a *T. sayaca* (TLWL = 11 cm, MW = 3.59 cm) and began to swallow it but the snake regurgitated the prey due to handling by onlookers.

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***BOGERTOPHIS SUBOCULARIS* (Trans-Pecos Ratsnake). MAXIMUM MOVEMENT.** Little has been reported on the movement patterns of *Bogertophis subocularis* (Rhoads 2008. The Complete Suboc: A Comprehensive Guide to the Natural History, Care, and Breeding of the Trans-Pecos Ratsnake. ECO Herpetological Publishing and Distribution, Lansing, Michigan. 291 pp.; Sawyer and Baccus 1996. Southwest. Nat. 41:182–186). Herein we report on movement of a radio-tracked male *B. subocularis* over a 12-month time period on Indio Mountains Research Station (IMRS; centered on 30.75°N, 105.00°W; datum WGS84), Hudspeth Co., Texas, USA. The landscape at IMRS is composed of typical Chihuahuan Desert scrub. On 12 June 2010, the male *B. subocularis* (total length = 1300 mm; 327.1 g) traveled 1746 m (straight line distance) in one successive movement from one diurnal retreat site to another (13 June, 0730 h). This distance is significantly greater than the maximum distance (812 m) reported by Sawyer and Baccus (*op. cit.*), and also presents the first accurate movement patterns of *B. subocularis* in the wild, as those latter findings were based on translocated individuals. The single successive movement distance we report is comparable to or greater than that of *Coluber* (=*Masticophis*) *flagellum*, another large North American colubrid, known to travel great distances (Secor 1995. Herpetol. Monogr. 9:169–186; Johnson et al. 2007. Southeast. Nat. 6:111–124; Steen et al. 2007. Herpetol. Rev. 38:90). Movements of this scale have not been previously documented for *B. subocularis*.

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FIG. 1. Female *Cemophora coccinea coccinea* with 13 eggs oviposited on 5 June 2013, Hillsborough Co., Florida, USA.

***CEMOPHORA COCCINEA COCCINEA* (Florida Scarletsnake). REPRODUCTION.** A *Cemophora coccinea coccinea* (total length = 750 mm) collected on 23 May 2013 from Cockroach Bay Road, Ruskin, Hillsborough Co., Florida, USA (27.6871°N, 82.5083°W; datum WGS 84), oviposited 13 apparently fertile eggs on 5 June (Fig. 1). This exceeds the largest reported clutch for the species of nine eggs (Herman 1983. Herpetol. Rev. 14:119). On 18 June, the total mass of the 13 adherent eggs was 38.2 g, the mean length was 23.7 mm (SD = 1.7, range = 20.6–26.4 mm, N = 12), and the mean width was 14.6 mm (SD = 1.0, range = 12.8–15.9 mm, N = 13). Most of these eggs were shorter and all were wider than 43 eggs of *Cemophora coccinea copei* from North Carolina, which were 25.7–44.8 mm long and 8.2–11.4 mm wide (Palmer and Braswell 1995. Reptiles of North Carolina. Univ. North Carolina Press, Chapel Hill. xiii + 412 pp.). The greater width of our eggs may have resulted from expansion during the 13 days since oviposition or the larger size of our female, which was 286 mm longer than the longest female with reproductive data from North Carolina (Palmer and Braswell, *op. cit.*). All of the eggs spoiled by 4 July.

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***CHILOMENISCUS STRAMINEUS* (Variable Sandsnake). REPRODUCTION.** *Chilomeniscus stramineus* occurs in two disjunct populations, an eastern population ranging from southwestern Arizona, through Sonora, Mexico to northern Sinaloa, Mexico (Grismer 2002. Amphibians and Reptiles of Baja California Including its Pacific Islands and the Islands in the Sea of Cortés. Univ. Calif. Press. Berkeley. 399 pp.) and a western population restricted to Baja California (Grismer, *op. cit.*). Goldberg (1995. Great Basin Nat. 55:372–373) reported on reproduction in *C. stramineus* (as *C. cinctus*) from Arizona. Reproduction occurred mainly in spring with males undergoing spermiogenesis from March to June; two females from June exhibited yolk deposition. Clutch sizes of three and two were recorded from June and July, respectively. The purpose of this note is to present reproductive information for the Baja California population of *C. stramineus*.

A sample of 25 *C. stramineus* from Baja California, Mexico collected 1930–1984 and consisting of 11 adult males (mean SVL = 180.4 mm ± 22.3 SD, range = 147–220 mm), 8 adult females (mean SVL = 197.0 mm ± 18.6 SD, range = 178–237 mm) and 6 juveniles mean SVL = 115.3 mm ± 19.1 SD, range = 88–144 mm) were examined from the herpetology collections of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California and the San Diego Natural History Museum (SDNHM), San Diego, California, USA. The following *C. stramineus* were examined: Baja California: SDNHM 30371, 38663, 42054, 42737, 45973, 48150, 48151, 48152, 62226, 62227; Baja California Sur: LACM 51631, 107910, 138476, SDNHM 3829, 3830, 30372, 30373, 44384, 50173, 50174, 50175, 61289, 61291, 64488, 68734. The left testis was removed from males and the left ovary was removed from females. Enlarged follicles (> 3 mm) or oviductal eggs were counted. Gonads were embedded in paraffin, sectioned to 5 µm, and stained with hematoxylin followed by eosin counterstain. Histology slides were deposited at LACM or SDSNH.

TABLE 1. Monthly stages in the testicular cycle of 11 adult male *Chilomeniscus stramineus* from Baja California, Mexico.

Month	N	Regressed	Recrudescence	Spermiogenesis
April	1	0	0	1
May	5	0	0	5
July	3	1	0	2
December	2	0	1	1

Three stages were present in the monthly testicular cycle of *C. stramineus* (Table 1): 1) Regressed, seminiferous tubules mainly contain spermatogonia and Sertoli cells; 2) Recrudescence, renewal of germinal epithelium for the next period of sperm production has commenced, primary spermatocytes predominate, and 3) Spermiogenesis, lumina of seminiferous tubules lined by sperm or clusters of metamorphosing spermatids. May appeared to be the month of maximum sperm production. The smallest reproductively active male with spermiogenesis in progress measured 147 mm SVL (SDMNH 64488) and was collected in May. One female (SVL = 209 mm) from August (LACM 138476) contained one oviductal egg. The smallest reproductively active female (yolk deposition) measured 193 mm SVL (SDMNH 44384) and was collected in April. The timing of events in the reproductive cycle of *C. stramineus* were similar in the Arizona population (Goldberg, *op. cit.*) and Baja California. In both populations sperm and egg production occurred in spring.

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***CHIRONIUS FOVEATUS* (South American Sipo). DIET.** The genus *Chironius* consists of slender terrestrial or semi-arboreal diurnal snakes, distributed from southern Central America to southern South America (Dixon et al. 1993. Monogr. Mus. Region. Sci. Nat. 13:1–279). *Chironius multiventris* is found in the Atlantic Forest region of eastern Brazil (Bahia to Santa Catarina) (Hollis 2006. Herpetologica 62:435–453) and feeds predominantly on anurans (Martins and Oliveira 1999. Herpetol. Nat.



FIG. 1. *Chironius foveatus* that consumed a *Drymophila squamata* (Scaled Antbird) captured in a mist-net in southeastern Brazil

Hist. 6:78–150; Hartmann et al. 2009. Pap. Avuls. Zool. 49:343–360).

On 27 April 1996, during a study of the bird community of the lowland forest of Serra dos Órgãos, municipality of Guapimirim, state of Rio de Janeiro, southeastern Brazil (22.5233°S, 43.0177°W, datum WGS84; elev. ca. 350 m), a *C. foveatus* was found attached to one of the mist-nets used to capture birds. The snake (> 1.5 m total length) had preyed upon a *Drymophila squamata* (Scaled Antbird; Passeriformes: Thamnophilidae) previously captured in the mist-net. The snake had swallowed the bird wrapped in the mist-net (Fig. 1). After removal of the bird, the snake was released near the site of capture. This episode represents a rare record of opportunistic predation of a small passerine by a primarily anurophagous snake species.

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COLUBER CONSTRICTOR **(North American Racer). EGG PREDATION.** *Solenopsis invicta* (Red Imported Fire Ants) have been implicated as predators of the eggs of many species of reptiles, including turtles, lizards, and snakes (Mount et al. 1981. J. Alabama Acad. Sci. 52:66–70; Diffie et al. 2010. J. Herpetol. 44:294–296). On 21 June 2012, a clutch of 11 snake eggs was discovered underneath a partially rotten pine log at the Solon Dixon Forestry Education Center in the Conecuh National Forest, Covington Co., Alabama, USA (31.13144°N, 86.68134°W; datum WGS84). Fire ants were observed moving in and out of small holes approximately 2 mm in diameter in nine of the eggs. The other two eggshells were also perforated with the same small holes, but the eggs themselves were hollow and their contents completely consumed. Two eggs had evidently been penetrated only recently, as embryos inside were still alive despite perforation of the eggshell by fire ants. These embryos were identifiable as *Coluber constrictor*, and their status indicates that fire ants were not merely scavenging rotten eggs but preying on viable, developing eggs. To my knowledge, this is the first reported instance of fire ants preying on the eggs of *C. constrictor* and is another indication that fire ants are capable of preying on the eggs of a wide range of species in natural situations.

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COLUBER CONSTRICTOR **(North American Racer). MORTALITY.** *Coluber constrictor* is a fast-moving diurnal snake that spends much of the spring and summer actively foraging aboveground (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Books. Washington, DC. 668 pp.). Conspicuous behavior and frequent activity by *C. constrictor* often bring them into contact with a wide range of predators including automobiles. Here we describe the first reported incidence of *C. constrictor* being struck and killed by a train.

On 21 April 2013, on the Savannah River Site, Aiken, Co., South Carolina, USA, an adult *C. constrictor* (SVL = 98 cm, 375 g) being tracked with radio-telemetry was found sliced in two pieces on the rail of a train track (Fig. 1). The snake had been tracked since July 2010 and had been observed to cross these tracks on at least four occasions. Approximately 2 cm of antenna from the implanted transmitter had been sheared off during the collision. It is curious that an animal so sensitive to vibrations (Hartline 1971. J. Exp. Biol. 54:349–371) could be struck by such a conspicuous vehicle. Train-induced snake mortality may be more common than assumed, as investigators typically do not "road cruise" rail lines as they do roads.



FIG. 1. Carcass of an adult *Coluber constrictor* struck and sliced in two by a train on 21 April 2013. The wire antenna of a radio transmitter can be seen protruding from the carcass.

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COLUBER **(=** ***MASTICOPHIS*****)** ***FLAGELLUM FLAGELLUM*** **(Eastern Coachwhip)** and ***PITUOPHIS MELANOLEUCUS MELANOLEUCUS*** **(Northern Pinesnake). DIET** and **PREDATION.**



FIG. 1. *Coluber* (= *Masticophis*) *f. flagellum* attempting predation on subadult *Pituophis m. melanoleucus*, Scotland Co., North Carolina, USA.

At 1117 h on 27 May 2013, in Scotland Co., North Carolina, USA (34.98913°N, 79.52348°W; datum WGS84), I encountered a telemetered adult male *Masticophis f. flagellum* (ca. 180 cm total length) attempting to predate a young male *Pituophis m. melanoleucus* (ca. 80 cm total length; Fig. 1). At my initial approach, the *M. flagellum* quickly dropped its prey and retreated several meters. The *P. melanoleucus* at that point was limp and nearly motionless, with mouth open and head coated in saliva and blood, and I initially believed it was dead. I retreated a short distance and waited for several min, after which the *P. melanoleucus* began to very slowly move away. The *M. flagellum* then approached it again, although aware of my presence. It seized the *P. melanoleucus* just behind the head, shook it vigorously, and began to drag it away. Possibly due to my presence, it released and re-seized the *P. melanoleucus* several times before finally abandoning it and retreating a considerable distance. The *P. melanoleucus* offered little resistance during this ordeal, and some thanatosis may have been involved. I eventually retrieved the *P. melanoleucus*, which fully recovered and was released back near the capture site five days later. To my knowledge, this represents the first report of *M. flagellum* and *P. melanoleucus* interacting as predator and prey. Several snake species have been reported as prey of *M. flagellum*, but these include few, if any, that are powerful constrictors (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Books, Washington, DC. 668 pp.). On multiple occasions I have observed *M. flagellum* and *P. melanoleucus* sharing both surface and subterranean refugia, including hibernacula. On at least two occasions I have observed the two species basking together with their bodies touching, but in neither instance was the *P. melanoleucus* small enough to serve as potential prey for the *M. flagellum*. The mutual tolerance I have observed repeatedly in these two species suggests that predator-prey interactions between them are infrequent.

The North Carolina Herpetological Society, Three Lakes Nature Center, and Wake Audubon supported fieldwork leading to this observation. Jamie M. Smith assisted in extracting still images from my video footage. The North Carolina Wildlife Resources Commission provided permits.

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FIG. 1. An adult *Corallus grenadensis* with a recently predated *Marmosa robinsoni* (Robinson's Mouse Opossum).

***CORALLUS GRENADENSIS* (Grenada Bank Treeboa). DIET.** Previously, 79 prey items recovered from *Corallus grenadensis* included 21 mammals, all of which were species (*Mus*, *Rattus*) introduced to the Grenada Bank sometime after the arrival of Europeans (Henderson and Pauers 2012. S. Am. J. Herpetol. 7:172–180). Here we report the first documentation of predation by *C. grenadensis* on *Marmosa robinsoni* (Robinson's Mouse Opossum), a species we assume to be native to Grenada. Near the town of St. David's (St. David Parish) on or about 23 March 2013 at approximately 2400 h, an adult *C. grenadensis* (SVL ca. 1.3 m) was found on the ground with 2–3 coils around an adult *M. robinsoni* (Fig. 1). A dog's presence caused the snake to relinquish its hold on the dead opossum; it is not known if the snake returned to the prey item and consumed it.

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***CROTALUS VIRIDIS VIRIDIS* (Prairie Rattlesnake). ECTOPARASITES.** More than 100 hard and soft tick species belonging to eight genera of the families Argasidae and Ixodidae have been collected from reptiles worldwide (Pietzsh et al. 2006. Exp. Appl. Acarol. 38:59–65). A total of 51 acari (mites and ticks) are parasites of Mexican amphibians and reptiles (Paredes-León et al.



FIG. 1. *Crotalus viridis* with acari in the anterior portion of eye and another one in the dorsum (arrows).

2008. Zootaxa 1904:1–166). The only record of soft ticks (Argasidae) on rattlesnakes in Mexico is a recent report of *Ornithodoros turicata* (Acari: Ixodida: Argasidae) on wild caught *Crotalus mitchellii* and *C. ruber* from Baja California (Gutsche and Mutschmann 2011. Herpetol. Rev. 42:287–288). Here we report the presence of a tick of the family Argasidae on a wild rattlesnake in Chihuahua.

On 19 May 2009, ca. 0800 h at Ejido San Pedro, Janos, Chihuahua, México (30.880034°N, 108.406044°W, datum WGS84; elev. 1402 m), one of us (EMR) encountered an adult *C. viridis* (total length ca. 700 mm) coiled on the ground. Subsequent examination of photographs deposited in the scientific collection of vertebrates in the Universidad Autónoma de Ciudad Juárez, Chihuahua (CHI-VER-189-08-06) revealed an ectoparasite in the anterior portion of the right eye and another one on the dorsum (Fig. 1). The parasites were identified as members of the family Argasidae based on the presence of a camerostome, a distinguising characteristic of the argasid ticks (Klompen and Oliver, Jr. 1993. Syst. Entomol. 18:313–331). These represents the first report of a member of the Argasidae associated with *C. viridis*, as well as the second record of an argasid tick on a snake in México (Gutsche and Mutschmann, *op. cit.*).

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***CROTALUS WILLARDI AMABILIS* (Del Nido Ridge-nosed Rattlesnake). MAXIMUM ELEVATION.** The maximum elevation for *Crotalus willardi* has been variously reported as 2743 m (Lowe et al. 1986. The Venomous Reptiles of Arizona. Arizona Game and Fish Department, Phoenix. 115 pp.), 2750 m (Campbell and Lamar 2004. The Venomous Reptiles of the Western Hemisphere. Comstock Publishing, Ithaca, New York. 870 pp.), or 2800 m (Ernst and Ernst 2012. Venomous Reptiles of the United States, Canada, and Northern Mexico, Volume 2. Johns Hopkins Univ. Press, Baltimore, Maryland. 391 pp.), although the sources of these elevational maxima were unspecified. *Crotalus w. amabilis*, a subspecies restricted to the Sierra del Nido in northwestern Mexico, has been recorded up to 2554 m elev. (Bryson and Lazcano 2002. Southwest. Nat. 47:310–311). On 30 August 2012, we observed a sub-adult *C. w. amabilis* basking under an oak tree (*Quercus* sp.) in Cañon del Alamo, Sierra del Nido, Chihuahua, Mexico (29.4833°N, 106.7166°W, datum: WGS 84) at an elevation of 2846 m. This exceeds the previously reported maximum elevation for *C. willardi* and also associates the record with a specific locality. A photographic voucher is catalogued at the University of Colorado Museum of Natural History (UCM AC 177).

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***LAMPROPELTIS ZONATA* (California Mountain Kingsnake). DIET.** *Lampropeltis zonata* ranges from Washington to northern Baja California, primarily in pine-oak forests, but also occurs in riparian woodland, chaparral, and coastal sage scrub, at

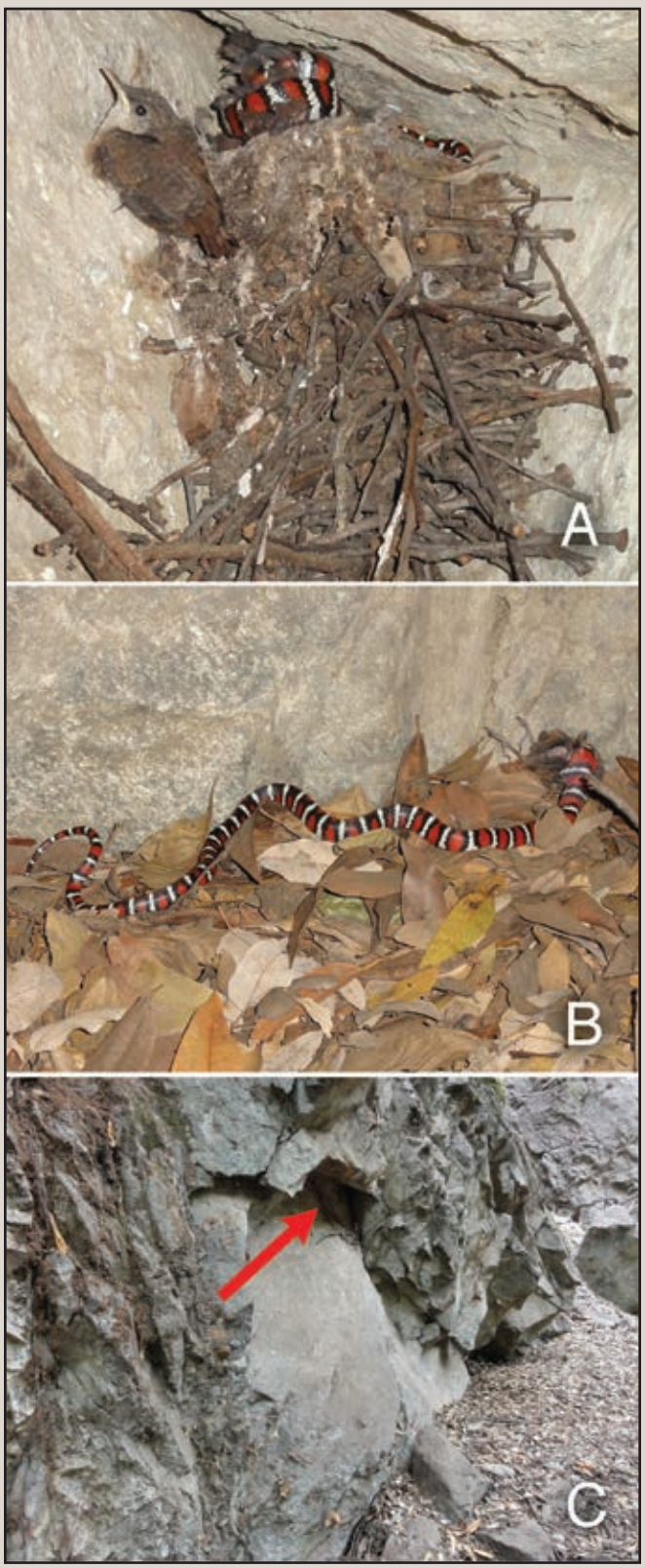


FIG. 1. *Catherpes mexicanus* (Canyon Wren) nest predation by *Lampropeltis zonata*, San Gabriel Mountains, California, USA. A) As first observed, the snake was actively constricting a nestling wren; a second nestling is perched at left margin of nest. B) Snake and prey on ground below nest, where ingestion resumed. C) Arrow indicates position of nest (hidden under rock overhang), 1.2 m above the base of the rock wall.

elevations from near sea level to >2700 m (Stebbins 2003. A Field Guide to Western Reptiles and Amphibians, 3rd ed. Houghton Mufflin Co., Boston, Massachusetts. 533 pp.). Prey items include lizards, squamate eggs, small mammals, and rarely, birds (summarized in Greene and Rodrigues-Robles 2003. Copeia 2003:308–314).

On 21 June 2013 at 1445 h, my attention was drawn to the unusual activity of three adult *Catherpes mexicanus* (Canyon Wrens) on the face of a steep rock wall adjacent to the Falls Trail of Monrovia Canyon, San Gabriel Mountains, Los Angeles Co., California, USA (34.18458°N, 117.98773°W, datum WGS 84; elev. 500 m). The birds were flying to and from a rock cavity in the rock wall. Upon closer inspection I observed a nest in this cavity 1.2 m above the canyon bottom. Within the nest was an adult *Lampropeltis zonata* coiled around a Canyon Wren nestling with two other nestlings visible. I observed the activity at intervals of 10–15 min and noticed that the adult wrens did not appear to be molesting the snake, but rather verifying that it was still there. After about 50 min, the snake dropped out of the nest onto the ground below and continued to feed on its meal, which was still only half consumed. The wren nestling was a rather large meal for the relative size of the snake (estimated at 75 cm total length). The following day I returned to the location and observed that the wren nest had actually contained two additional nestlings for a total of five, including the one previously consumed by the snake. On 09 June 2013, an associate of mine reported that he observed a *L. zonata* ascending the trunk of a large *Umbellularia californica* (California Bay Laurel) at about 1 m above the adjacent canyon floor. These observations extend those described previously for arboreal foraging and nestling bird predation by *L. zonata* (Cunningham 1955. Herpetologica 11:217–220; Goodman and Goodman 1976. Herpetologica 32:145–148; Petrides 1941. Yosemite Nat. Notes 20:36), and represent a first record of predation by this species on *C. mexicanus*.

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***LEPTODEIRA ANNULATA* (Banded Cat-eyed Snake). DIET.** *Leptodeira annulata* has a wide geographic distribution from Mexico (ranging as far north as southern Tamaulipas and Sinaloa), through Central America and into South America as far south as Argentina and Paraguay (Dunn 1936. Proc. Nat. Acad. U.S.A. 22:689–698; Duellman 1958. Bull. Am. Mus. Nat. Hist. 114:5–152). It has generalist feeding habits, consuming frogs (including anuran eggs and tadpoles), lizards, and other snakes (Martins and Oliveira 1998. Herpetol. Nat. Hist. 6:78–150; Cantor and Pizzatto 2008. Herpetol. Rev. 39:462–463). On 14 February 2012, we dissected an adult female *L. annulata* collected from Dianápolis municipality (11.83268°S, 46.7962°W; datum SAD69), located in southeastern region of the Goiás State, Brazil. In its stomach we found two species of anurans, one not identified due to the advanced state of digestion (total length = 39.51 mm; 1.85 g), and a specimen of *Physalaemus cuvieri* (total length = 30.59 mm; 2.10 g). *Physalaemus cuvieri* is common frog found throughout Brazil, some regions of Argentina, eastern Paraguay, and Santa Cruz in Bolivia (Uetanabaro et. al. 2008. Field Guide to the Anurans of the Pantanal and Surrounding Cerrados. Editora UFMT and UFMS, Campo Grande. 129 pp.), with higher abundance in open habitats, such as cerrado and pasture lands. Despite the large distribution of *P. cuvieri*, this frog has not been previously reported in the diet of *L. annulata*.

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***NERODIA RHOMBIFER* (Diamond-backed Watersnake). DIET.** The documented prey items of *Nerodia rhombifer* are moderately extensive (Gibbons and Dorcas 2004. North American Watersnakes: A Natural History. Univ. Oklahoma Press, Norman. 438 pp.) and six species of Ictaluridae (catfish), in four genera (*Ameiurus*, *Bagre*, *Ictalurus*, and *Pylodictis*) have previously been reported. Here we report the first record of an additional genus of catfish, *Noturus* (Madtom), as a prey item. We also provide photographic documentation of a tail-anchoring behavior previously described elsewhere (Gibbons and Dorcas, *op. cit.* and literature cited therein).

Copeland Creek, a tributary of the Trinity River, is a small stream seldom exceeding 50 cm in depth and varying from ~ 2–4 m in width, with clear running water, a moderate current, and a predominately sand and clay bottom. At 1447 h on 18 May 2013 in Copeland Creek in Polk Co, Texas, USA (30.57181°N, 94.89703°W, datum WGS84; elev. 23 m), we observed a *N. rhombifer* (total length = ~70 cm) submerged in the current and anchored with its tail coiled around a stick or root emerging from the side of the stream bed, while the head and perhaps the anterior quarter of its body was inserted into a hole in the side of the stream bed about 30 cm downstream (Fig. 1). It slowly worked its way



FIG. 1. *Nerodia rhombifer* as it appeared when it was first observed, with its tail anchored to an emergent root or stick in the current of the stream and its head and the anterior portion of the body inserted into a hole in the side of the stream.

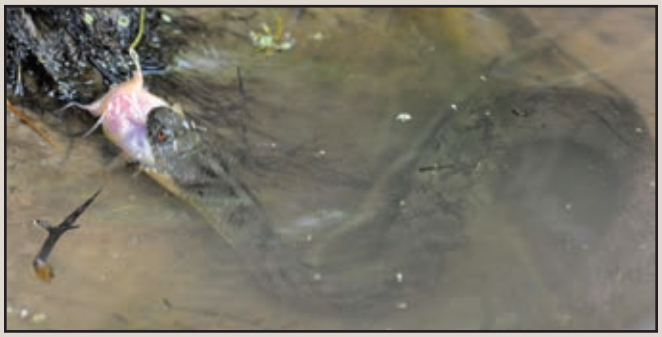


FIG. 2. *Nerodia rhombifer* in the advanced stages of swallowing a *Noturus* sp. (Madtom) tail first.

deeper into the hole up to approximately half of its total length, over a period of about two minutes. When the snake emerged from the hole, it had a fish in its mouth, although it remained anchored and submerged. When the snake began moving away we briefly lifted it to the water surface on the frame of a dip net and identified the fish as a Madtom (*Noturus* sp.), ca. 90–100 mm. in total length. Afterwards, the snake swam ~10 m upstream and swallowed the fish tail first over ca. 10 min., with no apparent ill effects from the dorsal fin and pectoral fins spines of the Madtom (Fig. 2). This behavior is interesting because *N. rhombifer* typically swallow live fish rapidly (Clark 1949. J. Tennessee Acad. Sci. 24:244–261) and head first (Gibbons and Dorcas, *op. cit.* and literature cited therein).

Only two species of *Noturus* occur in the region, *N. nocturnus* (Freckled Madtom) and *N. gyrinus* (Tadpole Madtom) (Lee et al. 1980. Atlas of North American Freshwater Fishes. North Carolina St. Mus. Nat. Hist, Raleigh. 854 pp.). The fish consumed by the *N. rhombifer* was most consistent in character with *N. nocturnus*. We thank Kevin W. Conway (TCWC) for help with fish identification.

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***NERODIA RHOMBIFER* (Diamond-backed Watersnake). DIET.** The diet of *Nerodia rhombifer* is composed principally of fishes (Kofron 1978. J. Herpetol. 12:543–554; Mushinsky et al. 1982. Ecology 63:1624–1629). Amphibians comprise a small percentage of the diet, and the only hylid identified as prey of *N. rhombifer* is *Hyla cinerea* (Gibbons and Dorcas 2004. North American Watersnakes A Natural History. Univ. Oklahoma Press, Norman. 438 pp.). Herein I provide an observation of *N. rhombifer* preying upon *Hyla chrysoscelis*.

At 1118 h, 14 May 2013 (sunny, 26°C), I hand-captured a *N. rhombifer* (approx. 1 m total length) in a seasonally-inundated wetland in Alexander Co., Illinois, USA. Upon palpation, the snake regurgitated an adult male *H. chrysoscelis* that had been swallowed backwards. The frog exhibited no sign of digestion suggesting recent capture by the snake.

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***PANTHEROPHIS ALLEGHANIENSIS* (Eastern Ratsnake). DIET AND FORAGING BEHAVIOR.** *Pantherophis alleghaniensis* has been documented eating a wide range of birds and mammals (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Books. Washington D.C. 668 pp.). Advances in miniature infrared camera technology have provided novel insight regarding predation by ratsnakes on songbird nests (Thompson et al. 1999. The Auk 116:259–264). By contrast, circumstances surrounding predation of mammals by ratsnakes are largely unknown and thus our knowledge of predator-prey interactions between ratsnakes and mammals are based primarily on stomach content analyses. Here we describe first-hand accounts of ratsnakes preying on two mammal species by raiding their nests and consuming juveniles.

At 1452 h on 19 March 2013, on the Savannah River Site, Aiken, Co., South Carolina, USA, an adult female *P. alleghaniensis* (SVL = 100 cm, 368 g) being tracked with radio-telemetry was located coiled atop the burrow of a *Sylvilagus floridanus* (Eastern Cottontail; Fig. 1). After 5 min the snake uncoiled and partially entered the nest. From 1457 to 1535 h the snake could be seen



FIG. 1. *Pantherophis alleghaniensis* coiled atop the burrow of a *Sylvilagus floridanus* (Eastern Cottontail) containing three nestlings. The snake would enter the nest and consume one nestling, partially swallow and then regurgitate a second, and leave the third unharmed.

writhing around, presumably constricting prey, while *S. floridanus* distress calls were heard from within the burrow. At 1535 h the snake emerged with a large bolus, moved 5 m, and began basking atop a brushpile. Inspection of the burrow revealed one deceased, partially swallowed and regurgitated *S. floridanus* nestling and one live, apparently unharmed *S. floridanus* nestling. The live nestling was presumably abandoned and was found the following day, nearly deceased, outside the nest entrance. A motion-activated game camera set up at the site revealed that both remaining nestlings were eaten by a *Procyon lotor* (Racoon) on 21 March 2013.

On 5 July 2013 another radio-tagged *P. alleghaniensis* (male, SVL = 131.4 cm, 980 g) at the same site was located approximately 15 m up a *Quercus latifolia* (Laurel Oak). At 1323 h, while attempting to determine the exact location of the snake, *Sciurus carolinensis* (Gray Squirrel) distress calls were heard. The observer (SRW) witnessed the *P. alleghaniensis* fall from the vicinity of a *S. carolinensis* drey, remaining coiled around a struggling *S. carolinensis* throughout the fall. Although views were obstructed, the *S. carolinensis* was assumed to be a juvenile based on its size. Immediately after the fall an adult *S. carolinensis* ran down the tree, approached to within 0.5 m of the struggling snake and retreated back up the tree after an estimated 10 sec of silent observation. For approximately 90 sec the captured *S. carolinensis* made distress calls and continued to struggle, after which it ceased all activity. The snake released the prey, reoriented itself, and then swallowed squirrel head first within 4 min. Although neither of the prey items are novel additions to the prey list of *P. alleghaniensis,* the observations do provide novel context regarding the foraging habits of this cryptic snake species. Systematic observations of mammal nests are required to determine whether ratsnakes are as important nest predators for mammals as they are for birds.

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***PITUOPHIS CATENIFER SAYI* (Bullsnake). SCAVENGING.** Scavenging is an important, oft-overlooked foraging mode that serves as an integral pathway for energy transfer in terrestrial



FIG. 1. *Pituophis catenifer sayi* consuming a road-killed *Dipodomys compactus* (Gulf Coast Kangaroo Rat).

ecosystems (DeVault et al. 2003. Okios. 102:225–234; Selva and Fortuna 2007. Proc. R. Soc. B. 274:1101–1108). Though carrion was classically thought to be exploited by a narrow group of animals—the scavengers—multiple lines of evidence now support that scavenging is commonplace across a wide range of guilds, including snakes (DeVault and Krochmal 2002. Herpetologica 58:429–436).

On 12 May 2009 at 0837 h, a *Pituophis catenifer sayi* was observed consuming a road-killed *Dipodomys compactus* (Gulf Coast Kangaroo Rat), on a dirt road on the Kenedy Ranch, 19.2 km ESE of Sarita, Texas, USA and ~11 km due east of U.S. Hwy 77 (26.9319°N; 97.6178°W; datum WGS 84). The *D. compactus* was split open, had roadway gravel within its exposed coelom, and was partially flattened, indicating that it was indeed carrion and not killed by the snake (Fig. 1). Though neither the consumption of *D. compactus* nor the utilization of carrion has ever been reported for *P. c. sayi*, both are in line with the behavior and natural history of this species. Verification of scavenging is generally restricted to direct observation of the event, making documenting scavenging difficult (DeVault and Krochmal, *op. cit.*). We therefore encourage others to be vigilant for and report observations of scavenging in this and other snake lineages.

We thank Pamela R. Owen (University of Texas, Austin) for positively identifying the *D. compactus* and Travis J. LaDuc for helpful comments on a previous version of this note.

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***PYTHON RETICULATUS* (Reticulated Python). DIET.** Headlane and Greene (2011. Proc. Nat. Acad. Sci. USA 108:E1470–E1474) recorded snakes preying on 10 species of Old World monkeys, and a Siamang (*Hylobates syndactylus*). Non-human anthropoid apes have not been recorded as prey (Greene, pers. comm.). In 1986, during my employment with the Smithsonian Institution's National Zoological Park, I went to the Sepilok Orangutan Rehabilitation facility in Sabah, Eastern Borneo, to collect small mammals. This facility has for many years received both orphaned and injured Orangutans (*Pongo pygameus*) for rehabilitation and eventual release into the nearby forest. These orphaned animals ranged in age from a few months up to five + years of age. At the time I was working at the facility, there were two young *P. pygameus* that appeared to be about two years of age. Both of these apes were being kept in an outdoor, barred enclosure that had previously held Asian Sun Bears (*Helarctos malayanus*). The floor was concrete and the steel bars of the enclosure were roughly 10.6–12.7 cm apart.

One morning I was awakened at about 0630 h by the sound of staff screaming and yelling. When I arrived at the orang enclosures, I saw a large *Python reticulatus* measuring approximately 365–455 cm total length inside the enclosure that housed the two young orangs. There were two very distinct lumps about half way down the length of the python. It was obvious that the snake had been able to squeeze through the bars of the enclosure sometime during the night, attack and consume both of the orangs, each of which I estimated to weigh between 6.8 and 9.7 kg. The python was kept at the facility on exhibit.

I thank Harry W. Greene for suggesting that I write this contribution.

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***SISTRURUS CATENATUS TERGEMINUS* (Western Massasauga). REPRODUCTION.** *Sistrurus catenatus tergeminus* is on the Missouri Endangered Species list, with isolated populations only known from three disjunct locations in the northern part of the state (Johnson 2000. The Amphibians and Reptiles of Missouri, 2nd ed. Missouri Dept. of Conservation, Jefferson City. 400 pp.). Various literature reports suggest that mating for this species may occur in the late summer, autumn, or spring; however, Ernst (1992. Venomous Reptiles of North America. Smithsonian Institution Press, Washington D.C. 236 pp.) indicated that records of spring mating were, "… based upon conjecture or on observation of mating in captivity." After a two-year study of an Illinois population of *S. catenatus catenatus*, Jellen et al. (2007. J. Herpetol. 41:451–457) documented 128 instances of reproductive behavior; almost all were from July through September. However, they also observed one pair exhibiting "contact behavior" in April. We could find no published observations of copulation in the spring for this species. Herein we provide observations and data on spring mating behavior in a Missouri population of *S. catenatus tergeminus*.

On 30 April 2013 we were conducting our annual survey of the *S. catenatus* population at Squaw Creek National Wildlife Refuge, Holt Co., Missouri. We came across the first mating pair at 1058 h and discovered two additional pairs within the next 20

TABLE 1. Morphometric and environmental data associated with spring mating behavior of *Sistrurus catenatus tergeminus* in Missouri. Air temperature = 25.8°C, Relative Humidity = 52.7%, Wind speed = 4.1 m/s, recorded at 1058 h.

	Time Captured	SVL (cm)	Mass (g)	# Follicles	Soil Temp. (°C)
Pair 1 Male	1058	60.9	312	N/A	17.0
Pair 1 Female	1058	56.6	206	4	17.0
Pair 2 Male	1100	64.5	310	N/A	17.5
Pair 2 Female	1100	54.5	183	3	17.5
Pair 3 Male	1113	46.9	145	N/A	18.0
Pair 3 Female	1113	44.9	100	0	18.0

min. (Table 1). All three pairs were discovered within 50 m of one another in a microhabitat consisting of River Bulrush (*Scirpus fluviatilis*) with scattered small willows (*Salix* sp.) imbedded in 4.8 ha of recently burned lowland grassland. This microhabitat was adjacent to a north–south running dike and was a low area (i.e., saturated soils with some standing water) of approximately 0.62 ha. Pair one was copulating when discovered, and remained attached for at least 3 h. Pairs two and three were coiled together, with bodies and tails intertwined, but were not actually copulating at the time of capture.

The findings and conclusions in this note are those of the authors and do not necessarily represent the views of the U.S. Fish and Wildlife Service.

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STORERIA DEKAYI **(Dekay's Brownsnake). COLD TOLERANCE.** *Storeria dekayi* is a small, cold-adapted natricid snake of eastern North America. In the northern portion of the species' range, these snakes must hibernate at sites that are far enough below ground so that long-term exposure to lethal freezing temperatures is avoided. Failure to do so can result in mortality (Bailey 1948. Copeia 1948:215; Pisani 2009. J. Kansas Herpetol. 32:20–36). Most temperate zone reptiles, however, are able to survive brief periods of supercooling to –1 to –2°C (Vitt and Caldwell 2009. Herpetology. 3rd ed. Elsevier, Academic Press, Burlington, Massachusetts. xiv + 697 pp.). Gray (J. N. Amer. Herpetol., *in press*) recorded a surface body temperature (T_{sk}) of –0.2°C from *S. dekayi* at a site in northwestern Pennsylvania, USA, suggesting that they may have the ability to endure short-term exposure to subzero temperatures. Herein, I report further observations of subzero T_{sk} recorded from wild *S. dekayi* that imply this species may utilize supercooling to survive brief exposure to subzero temperatures.

At 0952 h on 1 April 2013 at a site in Erie Co., Pennsylvania, USA (42.09375°N 80.14180°W; datum WGS84), a male *S. dekayi* (SVL = 159 mm, total length = 210 mm; 2.3 g) was found beneath a thin wooden panel. The snake's surface body temperature (T_{sk}) was –0.6°C; air temperature (T_a) was –0.5°C. When initially picked up the snake was stiff and torpid, but managed to flatten its body dorsoventrally while making slow, swaying motions. This same individual was recaptured on 3 April, 4 April, and 6 April 2013 under the same cover object. The snake's T_{sk} on these dates was –4.2°C, –4.8°C, and –0.2°C respectively. When the *S. dekayi* was found on 4 April 2013 the T_a was –4.0°C and the cover object was frozen to the substrate. The snake was stiff and very lethargic when initially handled, but after ca. 1–2 minutes was able to right itself when placed on its back. In addition to the aforementioned snake, two additional male *S. dekayi* (SVL = 150 mm and 163 mm; 2 g and 2.7 g, respectively) were observed under separate cover objects at the site on 6 April. These snakes T_{sk}s were –1.0°C and –0.6°C respectively; T_a at the time was –2.5°C. Two of these *S. dekayi* were observed under the wooden panel on 8 April 2013 and appeared healthy.

The fact that the *S. dekayi* found at below zero temperatures were able to respond by moving when handled suggests that they were supercooled and not frozen, implying that *S. dekayi* may utilize supercooling to survive brief exposure to subzero temperatures. Such exposure may occur, as in this case, during brief overnight frosts in early spring when snakes are active above ground (Storey 1996. Braz. J. Med. Biol. Res. 29:1715–1733). At least one other natricine, *Thamnophis sirtalis* (Common Gartersnake), has been demonstrated to utilize a combination of supercooling and freeze tolerance (Costanzo et al 1988. Cryo-Letters 9:380–385; Storey 2006. Cryobiology 52:1–16), and is able to survive temperatures as low as –3.3°C for a period of 6 h (Churchill and Storey 1992. Can. J. Zool. 70:99–105). The ability to survive exposure to subzero temperatures may allow *S. dekayi* to have an extended annual activity season; however, it does not totally negate the risk of death from freezing or predation while immobile. As noted by Pough et al (2001. Herpetology. 2nd ed. Prentice-Hall, Upper Saddle River, New Jersey. xi + 612 pp.), freezing of a supercooled solution is an unpredictable event, and deaths may occur. For instance, snakes may die when the time of exposure surpasses a few hours, temperature drops much past –2°C, or equilibrium ice content is achieved (Storey, *op. cit.*). Two *S. dekayi* found at the site under the wooden panel on 9 March 2013 likely died as a result of prolonged exposure to freezing temperatures. Both snakes were in a coiled position and lacked any outward signs of predation.

I wish to offer my gratitude to Jon P. Costanzo, Richard King, and George Pisani for their insightful comments and suggestions regarding a draft of this note.

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THAMNOPHIS EQUES MEGALOPS **(Northern Mexican Gartersnake). MATERNAL TRANSMISSION OF ENDOPARASITES.** On 19 June 2009, we captured an adult female *Thamnophis eques megalops* at Bubbling Ponds Fish Hatchery (Yavapai County, Arizona, USA: 34.764946°N, 111.894014°W; datum NAD 83), that gave birth to 38 live young in captivity on 20 June 2009. The female and young were kept together for several hours while the neonates completed their first shed, and were weighed and processed. Nine of the neonates were then kept in captivity continuously for several months, housed communally in a 75-liter aquarium in a separate room at the animal care facility at Northern Arizona University. Water was provided ad libitum and bedding was Carefresh™ recycled cellulose (Absorption Corporation, Ferndale, Washington). On 1 July 2009, we noticed that one of the neonates (male; SVL = 181 mm, 3.8 g at birth) exhibited a small swelling on the right side at mid-body (Fig. 1A). This swelling had increased to 5–7 mm on 7 July, when we noticed a small drain site on the mass. When squeezed, the cranial end of an approximately 15-mm reddish nematode emerged from the hole and was removed intact with forceps (Fig. 1B). The nematode was preserved in 10% formalin and identified as a nematode, i.e. a filarial worm (*Macdonaldius* sp., Nemotoda, Spirurida, Filaroidea).

The neonates were each fed one to two wild-caught *Gambusia affinis* (Mosquitofish) from Bubbling Ponds Fish hatchery, on 2 July and 4 July, in a clean feeding tank separate from their housing quarters. An additional similar-sized *Macdonaldius* sp. nematode was removed from a second neonate *T. eques* (male SVL = 190, 3.8 g at birth) on 14 July 2009. No other snakes were infected, and new cysts did not develop in either previously-infected neonate. Neither neonate showed obvious signs of distress during infection, and both grew at rates comparable with their tankmates over the next few months.

Infection of wild gartersnakes (*Thamnophis* spp.) by helminths has been observed by Jimenez-Ruiz (2002. J. Parasitol.

PHOTO BY ERIKA NOWAK

PHOTO BY TOM GREENE

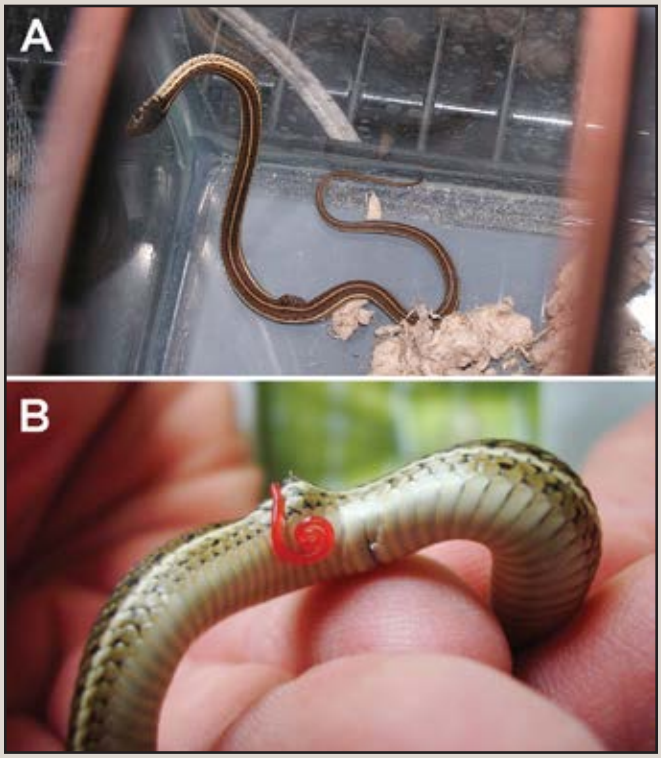


FIG. 1. A) A 10-day old captive-born *Thamnophis eques* with a mass on the mid-body, subsequently documented to contain a nematode (*Macdonaldius* sp.). B) The 15-mm live nematode (*Macdonaldius* sp.) removed from the neonate on 7 July 2009.

88:454–460). Similar lumps have been observed in wild adult *T. eques* at Bubbling Ponds Fish Hatchery and a *Macdonaldius* sp. was removed from an adult specimen in 2009. Neither of the neonates in our study had contact with adult snakes after the initial birthing period, and the first neonate exhibited an infection before being exposed to prey fish. Although it seems evident that the first neonate became infected via maternal transmission, the transmission mechanism remains unknown. Possible explanations include transmission by the mother during the birthing process or in the short time after birth (however, no nematodes were observed during this time, and the dam did not have external swellings characteristic of nematode infection). Alternatively, given that natricines are placental live-bearers (Blackburn and Lorenz 2003. J. Morphol. 256:171–204), it is possible that nematode oocytes could be transferred to developing embryos via the placenta in utero; this mode of infection has been observed in other vertebrates (reviewed by Anderson 1988. J. Parasitol. 74:30–45), including in live-bearing frogs (Rhabditiforms; Gagliardo et al. 2010. Herpetol. Rev. 41:52–58). It is possible that the second neonate became infected after feeding on prey fish.

This research was conducted under protocol #09-004 from the Northern Arizona University Institutional Animal Care and Use Committee. We thank NAU's Animal Care Annex staff for maintaining the neonates, and S. Shuster (Northern Arizona University) for identifying the nematode.

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***THAMNOPHIS PROXIMUS ORARIUS* (Gulf Coast Ribbonsnake). REPRODUCTION.** *Thamnophis proximus orarius* is an ovoviviparous colubrid that forms mating aggregations and is presumed to mate in the spring. However, there are no detailed observations pertaining to the onset of mating activity in these snakes and we lack data about their reproductive biology (Werler and Dixon 2000. Texas Snakes: Identification, Distribution, and Natural History. Univ. Texas Press, Austin. 437 pp.).

At 1220 h on 20 January 2010, at the Edinburg Scenic Wetlands in Edinburg, Texas, USA (26.291944°N, 98.13507°W; datum WGS84), we observed an aggregation of *T. p. orarius* consisting of two females and four males that were engaged in courtship behavior (Fig. 1). The temperature was 25.5°C. The aggregation was observed on top of a pile of branches and other dry vegetation on the edge of a permanent body of water. Repeated observations of the snakes have been made at this site. Individuals remained at the den for several days and were at times observed retreating or exiting from the cavity formed by the vegetation. Males rubbed their chins along the dorsal side of the females and produced caudocephalic waves and tail searching behavior was also evident; both behaviors are characteristic of courtship in garter snakes (Phase II of courtship) as described by Perry-Richardson et al. (1990. J. Herpetol. 24:76–78). Prior to our observation, no reproductive behavior or mating aggregations for this species were known to have taken place in the winter. This is the earliest record of courtship for this subspecies. To our knowledge this is also the earliest report of courtship for a natricine snake in the USA and Canada. We were unable to determine whether the courtship behavior led to reproduction.



FIG. 1. An aggregation of *Thamnophis proximus orarius* engaged in courting behavior in the winter (20 January 2010) in Eidenburg, Texas, USA.

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Ranitomeya defleri
Twomey and Brown, 2009



Andinobates sp. aff. *fulguritus*
(Silverstone, 1975)



Ameerega pepperi
Brown and Twomey, 2009



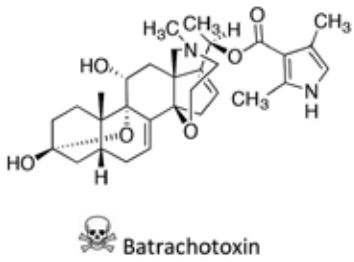
Andinobates viridis
(Myers and Daly, 1976)



Ranitomeya reticulata
(Boulenger, 1884 "1883")



Excidobates condor
Almendáriz, Ron, and Brito M., 2012



About the Art.—Nearly ten years in the making, "*The Field Guide to Aposematic Poison Frogs (Dendrobatidae) of the Andean Countries: Colombia, Bolivia, Ecuador, Peru and Venezuela*," provides species-level profiles of all currently described Andean poison frog species, including full color illustrations. Students and professionals from over eight countries and dozens of institutions and universities collaborated to detail the life history of the poison frog fauna of each Andean country from a diversity of habitats—from high elevation cloud forests to tropical rain-forested lowlands. The book's editors are Ted R. Kahn, Enrique La Marca, Stefan Lötters, Jason L. Brown, Evan Twomey, and Adolfo Amézquita, and is scheduled for publication in Spring 2014 by Conservation International.

Of particular interest, the book includes an "Alkaloid Profile" section that summarizes major alkaloids known from the respective species, and a lengthy Appendix lists all known alkaloids (major, minor, and trace) found in all evaluated Andean poison frog species (many gleaned from the late John Daly's handwritten laboratory notes provided to the senior editor by Ralph A. Saporito).

About the Artist.—Ted R. Kahn has worked professionally in the field of natural history science since the early 1980s when his first illustrations were published, and since the mid-1990s conducting fieldwork and ecological studies in collaboration with, or under contract to, a number of international and national agencies and universities addressing conservation issues. Based upon specimens collected from high elevation cloud forests of Colombia during fieldwork he conducted in 2011, Ted co-authored the description of a new dendrobatid, *Andinobates cassidyhornae* (Amézquita et al. 2013. Zootaxa 3620[1]:163–178). Also in 2013, Ted's illustrations appeared in the description of a new frog genus and species, *Beddomixalus biju* (see Abraham et al. 2013. Zootaxa 3640[2]:177–189). He has contributed illustrations to a number of books and field guides, including *Reptiles and Amphibians of the Pacific Islands* (2013), *Tadpoles: Biology of Anuran Larvae* (1999), and *Ranas Arlequines* (2005). Ted's illustrations are on permanent display in the Smithsonian Institution National Museum of Natural History in the Library of Periodicals by invitation from the Guild of Natural Science Illustrators (GNSI). Ted continues to work as a freelance scientific illustrator and zoologist and is a Research Fellow at the Nicholas School of the Environment, Duke University and an Academic Member of the International League of Conservation Writers (ILCW). He resides in the Washington, DC area where he currently works under contract for the Integrated Taxonomic Information System (ITIS) at the Smithsonian Institution, National Museum of Natural History. For information on artwork, to purchase a copy of the field guide, and to get information on conservation efforts with Andean poison frogs contact Ted R. Kahn at tedr.kahn@gmail.com, or visit his website: tedrkahnartwork.wordpress.com

LETTERS TO THE EDITOR

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Harnessing the Power of a Global Network of Citizen Herpetologists by Improving Citizen Science Databases

Citizen science has become a valuable addition to the tools of many fields of scientific research in recent years (Cohn 2008; Miller-Rushing et al. 2012; Silvertown 2009). Widespread availability of digital tools, including inexpensive high-resolution digital cameras; precise GPS locators in many phones, cameras, and as stand-alone units; and widespread access to the internet away from homes and offices, has created unprecedented access to reference material for identification, as well as allowed for submission of observations to online databases that compile knowledge gained by thousands of amateurs around the world every day (Miller-Rushing et al. 2012; Silvertown 2009). These citizen scientists are, for example, helping astronomers identify distant celestial bodies (http://www.citizensky.org), helping biologists track changes in plant and animal phenology at spatial and time scales never before possible (http://www.usanpn.org), and helping ornithologists monitor bird populations by submitting 92,000 field observations of birds every day (http://www.ebird.org).

Herpetology as a field stands likewise to benefit greatly from contributions by citizen scientists. Indeed, at least 66 citizen science projects are already collecting amphibian or reptile data (Table 1), and 43 of these are specific to amphibians and/or reptiles. These databases have contributed significantly to our understanding of amphibian and reptile distribution and biology (e.g., Jensen et al. 2008; Lepage et al. 1997; Price and Dorcas 2011; Weir et al. 2009). However, the majority of these databases are lacking critical components that would maximize the utility of their data to herpetologists. We argue that important advances in our understanding of reptile and amphibian distribution, abundance, and community ecology could be achieved by improving the collection of citizen science data through the use of a centralized database that uses a checklist-based format to imply non-detections, allows the recording of effort information, and encourages a maximal number of submissions.

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Needs: Non-detections

The first critical component of an ideal citizen science database is that it should have the ability to record both detections and non-detections of species. Seventy-three percent of existing herpetological citizen science databases record only presence data (Table 1), and thus these databases have the same limited utility as museum records for interpreting distributions (Marcot and Molina 2007). Presence-only data are useful for detecting declines in range when reliable samples exist from formerly occupied habitat (Shaffer et al. 1998), but have limited utility for detecting expansions in range, particularly in under-sampled areas, and are of very limited use in monitoring abundance (but see Boundy 2005). Although presence-only databases are useful, a superior system is to enter data in the form of checklists of all potential species, thus implying non-detections (Droege et al. 1998). Although some analytical methods (e.g., maximum entropy; Phillips et al. 2006) only require presence data, the most robust, versatile, unbiased, and universally accepted tools for examining species occupancy at landscape scales require presence/absence data (MacKenzie et al. 2003; Rota et al. 2011; Royle et al. 2012). Furthermore, detecting the contraction of species' ranges, which is just as important as detecting range expansions, is only possible against a thorough background of records of both presence and absence, which is not currently available.

Checklist-based reporting of observations to databases of species occurrence is critical for assessing two unavoidable sources of bias in presence-absence data: imperfect detection and unequal sampling effort (Droege et al. 1998; Mazerolle et al. 2007). The binary nature of presence-absence data presents a central problem: a species is either detected at a given site during a visit; or it is not detected, meaning that it could be present but undetected, or absent. Distinguishing between true and false absences requires repeated visits to the same sites over long time scales. This data structure is generated by observations made in frequently visited local sites such as parks and green spaces, often by different observers in a citizen science network. The impossibility of distinguishing between the two alternative true states when species are not detected caused many researchers prior to the 2000s to dismiss presence-absence data as cheap to obtain, but relatively useless (Williams et al. 2002). However,

TABLE 1. Citizen Science databases included in this study, sorted from global to local scales. This list is not exhaustive, but we endeavored to include all databases that met the following criteria: 1) Included amphibians or reptiles, but may have included other taxa as well. 2) Allowed contributions from the public (may have required registration or training). 3) Included data specific to geographic location and time of observation. 4) Created for the analysis of distribution data (e.g., excluding photo galleries and encyclopedias). "Input search effort" indicates whether the database allows the user to input the amount of search effort (for example, time or distance searched). "Output relative abundance" indicates whether the database provides a user with a measure of relative abundance, such as the number of individuals detected on average or the percentage of submissions including a species. "Implied absences" indicates whether the database collects data with complete checklists, implying the absence or non-detection of species that were not detected. "Embed or link documentation" indicates whether the database allows the user to document their observations with a photograph, audio recording, or other media by embedding the media directly with the record or by linking to media stored elsewhere on the internet. *These are database platforms that house multiple "projects" or "missions." GBIF has no projects specific to amphibians or reptiles, Project Noah has 70 missions specific to amphibians or reptiles, and iNaturalist has 53 projects specific to amphibians or reptiles. †Search effort can be entered, but each individual is entered separately, so average search effort per individual or species cannot be calculated.

Title	URL	Geographic Scope	Implied absences	Input search effort	Output relative abundance	Embed or link documentation
iNaturalist.org*	http://www.inaturalist.org	Global	No	No	No	Yes
Project Noah*	http://www.projectnoah.org/	Global	No	No	No	Yes
Global Biodiversity Information Facility*	http://www.gbif.org/	Global	No	No	No	Yes
International Sea Turtle Observation Registry	http://www.seaturtle.org/istor	Global	No	No	No	Yes
WildlifeBlitzGarneau	http://epicollectserver.appspot.com/project.html?name=WildlifeBlitzGarneau	Global	No	No	No	Yes
RoadkillGarneau	http://epicollectserver.appspot.com/project.html?name=RoadkillGarneau	Global	No	No	No	Yes
Wildlife Sightings	http://www.wildlifesightings.net/	Global	No	No	No	Yes
Sea Turtle Rehabilitation and Necropsy Database	http://www.seaturtle.org/strand/	Global	No	No	No	Yes
Herpetological Education and Research Project	http://www.naherp.com/	North America	No	Yes	No	Yes
Snake Count	http://www.snakecount.org/	North America	No	Yes	No	No
Journey North	http://www.learner.org/jnorth/	North America	No	No	No	No
South African Reptile Conservation Assessment	http://sarca.adu.org.za/	Southern Africa	No	No	No	Yes
Atlas of Living Australia	http://www.ala.org.au	Australia	No	No	No	Yes
Operation Bluetongue	http://www.abc.net.au/local/stories/2008/09/26/2375593.htm	Australia	No	No	No	Yes
FrogWatch	http://www.naturecanada.ca/cwn_naturewatch_fw.asp	Canada	No	No	No	No
ToadNUTS	http://toadnuts.ning.com	South Africa	No	No	No	Yes
Recording Invasive Species Counts	http://www.brc.ac.uk/recording.htm	United Kingdom	No	No	No	Yes
National Amphibian and Reptile Recording Scheme	http://www.narrs.org.uk	United Kingdom	Yes	Yes	No	No
iSpot	http://www.ispot.org.uk	United Kingdom	No	No	No	Yes
Nature's Calendar Survey	http://www.naturescalendar.org.uk	United Kingdom	No	No	No	No
iRecord	http://www.brc.ac.uk/iRecord/	United Kingdom	No	No	No	Yes
Roadkill Project	http://roadkill.edutel.com/	United States	Yes	Yes	No	No
USA National Phenology Network	http://www.usanpn.org	United States	Yes	Yes	No	No
North American Amphibian Monitoring Program	http://www.pwrc.usgs.gov/naamp/	United States	Yes	Yes	Yes	No
National Wildlife Federation Wildlife Watch	http://www.nwf.org/wildlifewatch	United States	Yes	No	No	No
Watch the Wild	http://www.natureabounds.org/Watch_the_Wild.html	United States	No	Yes	No	No
Wildlife Health Event Recorder	http://www.whmn.org/wher	United States	No	No	No	Yes
FrogWatch USA	http://www.aza.org/frogwatch/	28 U.S. states	Yes	Yes	(data not publicly available)	No
NatureMapping	http://naturemappingfoundation.org	15 U.S. states	No	No	No	Yes
Association of South Eastern Field Herpetologists	http://asefh.com	11 southeast U.S. states	No	No	No	Yes

Table 1. Continued

Title	URL	Geographic Scope	Implied absences	Input search effort	Output relative abundance	Embed or link documentation
Marsh Monitoring Program	http://www.birdscanada.org/volunteer/natmmp/	Great Lakes states and province	Yes	Yes	No	No
Alabama Herp Atlas Project	http://www.ag.auburn.edu/~guyercr/ahap/	Alabama	No	No	No	No
Arizona HerpCount	http://www.herpcount.org/	Arizona	No	No	No	Yes
California Roadkill Observation System	http://www.wildlifecrossing.net/california/	California	Yes	Yes	No	Yes
Colorado Herpetofaunal Atlas	http://ndis.nrel.colostate.edu/herpatlas/coherpatlas/	Colorado	No	No	No	Yes
Cuban Treefrog Citizen Science Project	http://ufwildlife.ifas.ufl.edu/citizen_sci.shtml	Florida	No	No	No	Yes
Introduced Reptile Early Detection and Documentation	http://ufwildlife.ifas.ufl.edu/reddy.shtml	Florida	No	No	No	Yes
Georgia Herp Atlas	http://georgiawildlife.com/Conservation/ReptileAmphibianGuide	Georgia	No	No	No	Yes
Kansas Herpetofaunal Atlas	http://webcat.fhsu.edu/ksfauna/herps/	Kansas	No	No	No	No
Maine Audubon Wildlife Road Watch	http://maineaudubon.org/wildlife-habitat/wildlife-road-watch/	Maine	Yes	Yes	No	Yes
Manitoba Herps Atlas	http://www.naturenorth.com/Herps/Manitoba_Herps_Atlas.html	Manitoba	No	No	No	Yes
Save Our Skinks	http://www.naturenorth.com/Skink/SOS_monitoring.html	Manitoba	No	No	No	No
Maryland Amphibian and Reptile Atlas	http://marylandnaturalist.org/mara/	Maryland	Yes	Yes	No	Yes
Massachusetts Herpetological Atlas Project	http://www.massherpatlas.org	Massachusetts	No	No	No	Yes
Amphibian Roadway Crossing Database	http://linkinglandscapes.info/roads/salamander_map.html	Massachusetts	Yes	No	No	No
Michigan Herp Data Entry Framework	http://www.MIHerpAtlas.org/	Michigan	No	Yes†	No	Yes
NH Reptile and Amphibian Reporting Program	http://www.wildlife.state.nh.us/Wildlife/Nongame/RAARP/reporting_NH_herps.htm	New Hampshire	No	No	No	Yes
Amphibian & Reptile Atlas Project	http://www.dec.ny.gov/animals/7140.html	New York	No	No	No	No
Amphibian Migrations and Road Crossings	http://www.dec.ny.gov/lands/51925.html	New York	Yes	Yes	No	No
Newfoundland Nature	http://www.nlnature.com	Newfoundland	No	No	No	Yes
Carolina Herp Atlas	http://www.carolinaherpatlas.org/maps/carolina.aspx	North Carolina, South Carolina	No	No	No	Yes
North Dakota Herp Atlas	http://www.ndherpatlas.org/Home.html	North Dakota	No	No	No	Yes
Vernal Pool Mapping and Monitoring Project	http://www.gov.ns.ca/nse/wetland/vernal.pool.mapping.project.asp	Nova Scotia	Yes	Yes	No	No
Ontario Herpetofaunal Summary Atlas	http://nhic.mnr.gov.on.ca/herps/about.html	Ontario	No	No	No	No
Ontario Turtle Tally	http://www.torontozoo.com/adoptapond/TurtleTally.asp	Ontario	No	No	No	Yes
Ontario Reptile and Amphibian Atlas	http://www.ontarionature.org/protect/species/herpetofaunal_atlas.php	Ontario	No	No	No	Yes
Atlas des Amphibiens et des Reptiles du Quebec	http://www.atlasamphibiensreptiles.qc.ca/	Quebec	No	No	No	Yes
Texas Turtle Watch	http://www.fortworthzoo.org/conservation/fort-worth-zoo-conservation-highlights/texas-turtle-watch/	Texas	Yes	No	No	No
Salamander Crossing Brigades	http://beec.org/?page_id=83	Vermont	Yes	Yes	No	No
Vermont Reptile & Amphibian Atlas	http://community.middlebury.edu/~herpatlas/the_atlas.htm	Vermont	No	No	No	Yes
Washington Herp Atlas	http://www1.dnr.wa.gov/nhp/refdesk/herp/	Washington	No	No	No	Yes
Wisconsin Herpetological Atlas Project	http://www4.uwm.edu/fieldstation/herpetology/atlas.html	Wisconsin	No	No	No	Yes
Loudoun Amphibian Monitoring Program	http://www.loudounwildlife.org/Amphibian_Monitoring.htm	Loudoun County, Virginia	Yes	Yes	No	No
Frog Listening Network	http://www.hillsborough.wateratlas.usf.edu/FLN/	Hillsborough River watershed, Florida	Yes	No	No	No
Chicago Wilderness Calling Frog Survey	http://www.habitatproject.org/frogsurvey/	Chicago, Illinois	Yes	Yes	Yes	No
Lost Lizards of Los Angeles	http://www.nhm.org/site/activities-programs/citizen-science/lost-lizards-project	Los Angeles, California	No	No	No	Yes

in the last decade, advances in statistical approaches to analyzing presence-absence data have permitted rigorous inferences about occupancy and relative abundance to be made using this easily collected form of data (e.g., Hines et al. 2010; MacKenzie and Kendall 2002; MacKenzie et al. 2004; MacKenzie et al. 2003). Although sites are often visited to search for a single species, it is often no more time consuming for observers to keep track of all species detected, and, by omission, those not detected. These absences provide critical information about the probability of non-detection, a parameter that is often of considerable interest for herpetofauna because it is so high.

Estimating parameters such as relative abundance, detection probability, and site occupancy is critical to monitoring populations of species at large spatial scales. Although many amphibian and reptile species exhibit low detection probabilities, with sufficient effort (i.e., large enough sample sizes; Durso et al. 2011) this obstacle can often be overcome and population parameters of greater relevance to conservation (e.g., population growth rate) can be rigorously estimated in order to detect long-term population trends (MacKenzie et al. 2005; Royle and Nichols 2003; Staples et al. 2004). In the last decade, robust-design occupancy models have been developed that offer a powerful framework for obtaining unbiased estimates of three parameters important to metapopulation models: proportion of occupied sites, colonization probability, and extinction probability (MacKenzie et al. 2003). These parameter estimates can then be used to derive estimates for metapopulation-level changes in occupancy—that is, they can be used to assess the health of a species at an ecosystem scale, while accounting for imperfect detection, using only presence-absence data (Hanski and Gilpin 1997). Furthermore, given spatial and temporal metadata available from many environmental data portals (e.g., remotely sensed habitat characteristics), assessments can be made about how changes in habitat or climate affect species colonization and extinction probabilities across a landscape (Schwartz et al. 2006; Sutherst et al. 1996). Checklists encourage reporting information on the presence/absence of multiple species at the same site, rather than just rare species (Droege et al. 1998). At particular locations, checklists should be cross-listed by species, locale, and time of year to determine the 'list of possible species' that could be observed in a community. These default checklists could be refined over time as new data accumulate to inform their contents. Monitoring populations of common species is a major goal of State Wildlife Action Plans and Partners in Amphibian and Reptile Conservation ("keeping common species common"; Kingsbury and Gibson 2011; Mitchell et al. 2006; Oberbillig [no date]). Furthermore, data on patterns of species co-occurrence can be useful in understanding the poorly-known community ecology of amphibians and reptiles (Droege et al. 1998; MacKenzie et al. 2004).

Needs: Relative Abundance

Detecting changes in population abundance is notoriously difficult for amphibians because of large natural fluctuations in population size (Green 2005; Semlitsch et al. 1996). Temporal fluctuations in activity of both amphibians and reptiles, driven by the pulsed phenology of emergence from seasons of torpor, also contribute to these difficulties, especially over long time scales (Cloudsley-Thompson 1999; Gibbons et al. 1997). Most studies of amphibian and reptile abundance are done on single species, using mark-recapture studies at relatively small spatial scales. Estimating abundances across entire communities of amphibians and reptiles is difficult and relatively rare (but see, e.g., Fitch 1999), but an effectively designed citizen science database could greatly increase herpetologists' capacity to make community-wide comparisons of relative abundance.

More than just documenting detections and non-detections, an ideal herpetological citizen science database would also allow observers to record effort data and counts of each species, which are critical for estimating relative abundances (Fellers 1997; Hayek 1994; Mazerolle et al. 2007). Virtually all measures of relative abundance take the form of counts divided by detection probabilities (Loehle and Arghami 2013; Seber 1994; Williams et al. 2002). Not allowing for detectability and solely using a count statistic as an index of abundance is unwise, because changes in the count may be a product of random variations or changes in detectability, making it impossible to make useful inferences (Anderson 2001; MacKenzie et al. 2002). N-mixture occupancy models developed by Royle (2004) would allow herpetologists to estimate reptile and amphibian abundance while accounting for imperfect detection using the same data structures generated by citizen scientists in most cases.

Currently, 74% of databases do not allow users to enter effort, and 97% do not output relative abundance (Table 1). A herpetological database that accounts for observational bias resulting from imperfect detection probability and unequal sampling effort could provide the data necessary to more accurately target herpetological conservation efforts.

Needs: Encourage Use

The greatest advantage that a citizen science database can provide that is not provided by the work of professional herpetologists is the great statistical power that is achieved from the accumulated efforts of thousands of volunteers. A central database could coalesce the power of many observers in determining the distribution and relative abundance of species that have low detectability, especially those that are difficult enough to observe that no single study is likely to amass enough observations alone to significantly contribute to our knowledge of the species (e.g., Hines 2011; Rudolph et al. 2006; Tuberville et al. 2000; Winne et al. 2007). Even very infrequent incidental observations can congeal into a pattern of distribution and activity that reveals new insights into the biology of tough-to-find species when summed across hundreds or thousands of individual observations (e.g., Hoyer et al. 2006). Additionally, many of the more sophisticated models for estimating bias in abundance and occupancy data now available (such as those in program MARK; White and Burnham 1999) require relatively large amounts of data.

The primary reason for using citizen science over "traditional" science is to increase power with large sample sizes and improved spatial and temporal coverage. Towards that aim, an ideal database should be easy to use, both for users entering data and users accessing data. Data should be entered through one or a few simple pages that ask specific questions about where the observations were made, what search effort was exerted, and how many of each species (or which species, if individuals were not counted) on the checklist were detected. Submission of optional data, such as demographics and behavior, should be encouraged. Most data should be available within 24 hours, or even in real time, to anyone, through intuitive displays of coarse-scale distribution maps and changes in frequency of observation through time.

An ideal herpetofaunal database should be also broad in scope; ideally, one database should be capable of accepting and

displaying records of all species from around the world. This would require a large investment of effort in terms of language translations and database management, but if various agencies and organizations could pool their effort, rather than competing for observations, they would be well rewarded. This does not necessarily mean that existing databases need disappear; rather, exchanges of data between a global database and smaller subsets could be automated, so that each database benefits from the others.

Observers should be able to summarize their personal observations and to compare summaries with those of other observers. (The North American Field Herping Atlas is working on a utility that would allow the comparison of lists [D. Becker, pers. comm.], but no herpetological databases currently have this capability.) The ability to summarize one's own records encourages the submission of new records as one tries to reach the next landmark in numbers of species seen (Price and Dorcas 2011). Comparing these numbers with those of other observers provides further motivation for submitting additional records. Thus, competition can be internal (how soon can I get to 100 species in my country?) or external (how many more species do I need to find to be in the top ten herpers in my state?). Either way, it is an important part of ensuring that submissions are as frequent as possible.

Potential Problems

Incorporating each of these traits into an ideal citizen science database for herpetology would present several problems, several of which we can anticipate. First, providing a competitive context to recording herpetofaunal observations invites the submission of falsified records, however rare, and any citizen science project must incorporate ways to protect against misidentifications and falsifications (Bonter and Cooper 2012). A widely-used citizen science project for birds, eBird (http://www.ebird.org), has implemented several methods to combat the submission of inaccurate records, each of which could be adapted for a herpetological database. First, as mentioned above, each geographic region should have a default checklist provided of the species that are expected in that area and at that time of year. Any species that are not expected, or any counts of individuals that are excessively high, are "flagged." When a record is flagged, the user is asked to confirm that the record is indeed correct. This first stage of confirmation primarily guards against typos—adding an extra zero at the end of a number, for example—but it also helps guard against misidentifications because it alerts the user that the record is unusual for that location or time of year. Second, if a flagged record is confirmed by the submitter, it must then be reviewed and approved by a volunteer regional reviewer who is familiar with both the species and citizen scientists in their area. This reviewer might compare the unexpected record to observations of the species by other observers, rare species known to be in the area, and other information that aids in the determination of whether the record is valid. Sometimes a reviewer will contact the user to request more details, such as photographs, audio recordings, or copies of field notes. If a record is rejected at this stage, it will continue to appear in the user's own records, but will not appear in the general outputs of the database that might be used for data analysis. Third, users could embed photos, videos, or audio recordings of their unusual records from the start, so that documentation can be evaluated by both the regional reviewer and any other interested users. Ideally, a database would have direct links to supplementary documentation of any unusual records, and that documentation would be maintained in the same archival manner as the database itself. Currently, 62% of databases for amphibians or reptiles allow documentation to be embedded with records (Table 1).

These methods would probably not catch every erroneous or falsified entry, nor can they be expected to. The principal motivation behind such a large effort is that a few errors here and there would "come out in the wash;" that is, they would be overcome by the sheer volume of data and the trade-off would be worthwhile. The primary purpose of a database like this is for big-picture questions about range-wide distribution, abundance, and seasonal activity, questions that should not be heavily affected by a small number of inaccurate records.

The potential impact of collectors is a danger to herpetofaunal populations (e.g., Means 2009; Stuart et al. 2006), and some U.S. states and other governments limit the ability of hobbyists to search for herpetofauna because of the potential for collection, harassment, and habitat destruction (Nanjappa and Conrad 2011). A publicly accessible database of herpetological observations would need to make some records accessible to the public in only a general form (e.g., at the county level or at a 20 km grid scale). A successful global citizen science project would have to carefully encourage recreational hobbyists to gather data enthusiastically and responsibly, and would likewise have unique considerations in the distribution of that data.

Citizen science databases have other inherent difficulties. Many of these, including correcting for potential observer error, interpreting abundance from count data, and controlling for inconsistent effort, have been discussed extensively elsewhere (e.g., Dunn et al. 2005; Kendall et al. 1996; Link and Sauer 1998; Link and Sauer 1999), including in the context of data analysis (Miller et al. 2011; Royle and Link 2006). Like all datasets, a citizen science database of herpetological observations must only be used in ways that are statistically appropriate to the methods used in data collection. Even a citizen science database that is constructed and used ideally would not replace the rigorous work that is currently being done by trained professional herpetologists. An improved citizen science database is not a cure-all, but rather an important additional tool that is needed in the field of herpetology.

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- Preference will be given to images that communicate some aspect of the biology of the organism (e.g., predation, feeding, courtship, crypsis).
- Images should not have been published previously nor concurrently submitted for publication elsewhere (print or electronic media).

Images for consideration should be submitted as low-resolution jpg or pdf files. Do not send full resolution images unless requested to do so. All submissions or questions should be directed to the Editor (herpreview@gmail.com).






ZOO VIEW

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Studies on Venomous Reptiles in Zoos and Aquariums. Part I. Introduction, Rear-Fanged Colubrid Snakes, Elapids, Sea Kraits and Seasnakes

Introduction

Always carry a flagon of whiskey in case of snakebite, and furthermore, always carry a small snake.

—W. C. Fields

Real, or imaginary, the dangers from snake-bite made it necessary for men to protect themselves. They set about this in a number of different ways. Snakes were appeased by flattery and placated with offerings. Spells, charms and curses were used to drive them away and, acting on the theory that like repels like, men painted snakes on their bodies, or wore serpent amulets in the hopes of gaining immunity. Priests and medicine men strove to obtain protection for their people, by means of special ceremonies, dances and magic formulae.

—Ramona and Desmond Morris, *Men & Snakes* (1965).

Venomous reptiles have been held in captivity for centuries and the literature is replete with descriptions of their maintenance, behavior, and potential danger. Most of the suggestions in the quotes above have not been incorporated into the venomous snakebite protocols in zoos and aquariums although some zoo workers have added tattoos in lieu of painting their bodies. In this two-part series, I show historical illustrations of venomous reptiles held in captivity and list references referring to reproduction, maintenance, medical management, behavior, and other aspects of their biology. Titles have been chosen to demonstrate the wide range of studies accomplished in zoo and aquarium settings but is by no means exhaustive. Included here are references from private operations or exhibits associated with museums because they have contributed to our overall knowledge of venomous reptiles (see Weigel 1992). There are or have been a number of snake parks throughout the world such as Australia Zoo, Black Hills Reptile Gardens, Clyde Peeling's Reptiland, Instituto Butantan, Kentucky Reptile Zoo, Madras Snake Park (Whitaker 1979; Z. Whitaker 1985), Miami Serpentarium (Kursh 1965), Nairobi Snake Park (Nares and Cooper 1971), Port Elizabeth Snake Park (Branch and Schaefer 1987), Reptilandia in Canary Islands, Ross Allen's Reptile Institute (Neill 1949), and San Jose Serpentarium. One example is the fine book by John Weigel from the Australian Snake Park: *Care of Australian Reptiles in Captivity* (1992). Another is Alejandro Solórzano's *Serpientes de Costa Rica/Snakes of Costa Rica* (2004). Consult Card and Murphy (2000) and Murphy (2007) for additional information.

On occasion, I include personal experiences and describe the changes that I have seen during a lifetime of working with many different taxa. Full disclosure: there are a number of references to observations and studies done at Dallas Zoo. Starting in 1966, I was curator there until retirement thirty years later. I relocated to Washington DC, was installed as a Smithsonian research associate at National Zoological Park (NZP), and became curator there in 2009. At the end, I describe the sense of urgency as we confront a changing landscape and outline challenges facing conservation biologists in zoos and aquariums. I conclude by offering suggestions for modifying our approach for keeping captive colonies by using the successful Aruba Island Rattlesnake (*Crotalus unicolor)* program as a model.

I begin by quoting Stephen Mackessy (2010), who describes venoms and toxins: "The definition of venoms has been somewhat contentious, but a venom is here considered to be a simple to complex secretion produced in a specialized gland that is typically delivered via specialized envenomation systems, including a secretory gland, often (but not always) specialized teeth, and a suite of specific behaviors allowing delivery of the venom. Further, venoms must be introduced (commonly injected) into recipient tissues in order for deleterious effects to occur, while poisons are typically ingested. Thus, reptiles representing an envenomation risk to humans and prey animals are referred to as venomous, not poisonous…In snakes, the venom apparatus consists of bilaterally paired specialized glands (a venom gland or Duvernoy's gland, which are homologous structures) located medial to the upper labial scales, posterior to the nostrils, and behind/below the eyes."

The Past to Now

In 1519, Hernando Cortés and his soldiers arrived at the Aztec capital Tenochtitlan where they found the emperor Montezuma's royal menagerie. In his collection were "… vipers and poisonous snakes which had on their tails things that sound like bells. These are the worst vipers of all, and they keep them in jars and great pottery vessels … and there they lay their eggs and rear their young" (in Coote 2001). In 1742, Charles Owen published the following observations on the European Viper: "These vipers are usually put and kept in a box with bran or moss; not that these ingredients serve to feed upon, as some may fancy; because 'tis said, *they never eat after they are taken* and confin'd, but live on the air, and will live so, many months … " (Fig. 1).

In 1797, Johann Matthäus (or Matthaeus) Bechstein wrote the first book on husbandry of amphibians and reptiles—*Naturgeschichte;*

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oder, Anleitung zur Kenntniss und Wartung der Säugethiere, Amphibien, Fische, Insecten und Würmer, welche man in der Stube halten kann. He made the following observation: "It is also possible to tame the common viper (*Coluber berus*, now *Vipera berus*) and at times to remove their venom by letting them bite a cloth or piece of leather, so that it does not easily damage its master who feeds them. But I advise against it because one can never be sure." (Heichler and Murphy 2004).

In 1829, Edward Turner Bennett wrote *The Tower Menagerie: Comprising the Natural History of the Animals Contained in that Establishment, with Anecdotes of Their Characters and History*. The London Tower Menagerie (1245–1832), with its stone walls and barred dens built specifically for large mammals, was not an ideal facility for snakes but over the years, many rattlesnakes lived in the Tower. These were called *Crotalus horridus* Linn. by Bennett. The Tower collection was transferred to the Zoo in 1831.

In May 1849, the London Zoo opened the first zoo reptile building, a modified carnivorous mammal facility (Fig. 2). Coote (2001) said that the London Zoo's earliest record of receiving a Timber Rattlesnake was in either 1842 or 1843. This Zoo has contributed much toward our understanding of captive snakes, including the dangers of snakebite. In 1852, Edward Horatio Girling, a keeper at the Zoo, enjoyed alcohol in prodigious amounts. After consuming a staggering amount, he arrived at the Zoo, announced that he was "inspired," grabbed an Indian Cobra a foot behind its head and was promptly bitten on the nose—he died in an hour. Girling was likely the first zoo snakebite victim!

Superintendent A. D. Bartlett (1899:182) substituted wild brown mice for tame white mice as a way to calm women and children visitors but unless the wild rodents were quickly eaten, they sometimes gnawed their way out of the enclosures. A large Egyptian Cobra escaped through a mouse hole and was discovered the next day beneath the exhibits and was shot (Ball 1982). Another escaped into the next enclosure where it was devoured by a "water-viper." I suspect that the name "water-viper" refers to the Cottonmouth or Water Moccasin (*Agkistrodon piscivorus*). Clearly, changes were needed as some escapees lived for years in the building.

P. Chalmers Mitchell, Secretary of the Society at London Zoo, decided to deal this way about the feeding of live prey, mostly based on visitor sensitivities, "My rule about no living prey being given except with special and direct authority is faithfully kept, and permission has to be given in only the rarest cases, these generally of very delicate or new-born snakes which are given new-born mice, creatures still blind and entirely unconscious of their surroundings" (Mitchell 1929). Mitchell and curator of mammals Reginald I. Pocock (1907) presented dead prey to snakes at the Zoo to see if snakes accepted dead food and found that most snakes did indeed do so; eight years later, curator Edward George Boulenger published a follow-up study to bolster these earlier findings.

Charles Darwin, Mitchell, and Pocock published their observations on the fear of snakes by other vertebrates. I quote here, "It is certainly striking that, of all the mammals, only the apes and monkeys, our nearest relatives, show a dread of snakes. Possibly the common prejudice against these exquisite creatures is a dying inheritance from our far-off ancestors" (Mitchell 1929).

Mitchell and Pocock (1907) were interested in fear responses to snakes by many mammals and birds. Their first conclusion—"… there is no such thing as a power of fascination possessed by snakes." The second one—"… except in one group, animals have no specific fear of serpents. The vast majority of animals of course frogs, rats and mice, guinea-pigs, rabbits, ruminants, and birds, are totally indifferent to their presence, and even when a snake approaches them directly avoid it, just as they would a stick thrust at them."

In 1871, Charles Darwin said, "… I took a stuffed and coiled-up snake into the monkey-house at the Zoological Gardens, and the excitement thus caused was one of the most curious



COURTESY OF SMITHSONIAN INSTITUTION LIBRARIES, WASHINGTON, D.C.

Fig. 1. Illustration from Charles Owen, 1742, *An essay towards a natural history of serpents: in two parts…*



Fig. 2. Illustration from *The Illustrated London News* of World's first reptile building at London Zoo, opened in May 1849.



Fig. 3. Illustration of Rhinoceros Viper (called *Vipera nasicornis,* now *Bitis nasicornis*) from Catherine Hopley, 1882, *Snakes: Curiosities & Wonders of Serpent Life*. This snake gave birth to 46 viperlings on 6 Nov 1881 at London Zoo.



STATEN ISLAND ZOOLOGICAL SOCIETY, COURTESY OF KEN KAWATA

Fig. 4. Reptile wing at Staten Island Zoo pictured in "News Bulletin of the Staten Island Zoological Society" in March 1937.



COURTESY OF WILDLIFE CONSERVATION SOCIETY, HEADQUARTERED AT BRONX ZOO

Fig. 5. Reptile house at New York Zoological Society's Bronx Zoo in 1909.



PHOTO BY KLAUS RUDLOFF

Fig. 6. Reptile Terrarium at Tierpark Berlin, 19 June 1995.

spectacles which I ever beheld. Three species of *Cercopithecus* were the most alarmed; they dashed about their cages, and uttered sharp signal cries of danger, which were understood by the other monkeys." Darwin continued "… I then placed a live snake in a paper bag, with the mouth loosely closed, in one of the larger compartments. One of the monkeys immediately approached, cautiously opened the bag a little, peeped in, and instantly dashed away. Thus I witnessed what Brehm had described, for monkey after monkey, with head raised high and turned on one side, could not resist taking a momentary peep into the upright bag, at the dreadful object lying quietly at the bottom."

In 1872 Darwin published *The Expressions of the Emotions in Man and Animals*, which included a section entitled "The inflation of the body, and other means of exciting fear in an enemy." Based on his observations in the London Zoo, he summarized his findings on defensive behaviors of venomous snakes —puff adder, cobra, South American pitvipers, saw-scaled viper, and rattlesnake by saying, "In the Zoological Gardens, when the rattle-snakes and puff-adders were greatly excited at the same time, I was much struck at the similarity of the sound produced by them; and although that made by the rattle-snake is louder and shriller than the hissing of the puff-adder, yet when standing at some yards distance I could scarcely distinguish the two. For whatever purpose the sound is produced by the one species, I can scarcely doubt that it serves for the same purpose in the other species; and I conclude from the threatening gestures made at the same time by many snakes—, that their hissing,—the rattling of the rattle-snake and of the tail of the Trigonocephalus,—the grating of the scales of the Echis,—and the dilation of the hood of the Cobra,—all subserve the same end, namely, to make them appear terrible to their enemies." Darwin was not immune to fear when a puff adder struck at him: "... as soon as the blow was struck, my resolution went for nothing, and I jumped a yard or two backwards with astounding rapidity. My will and reason were powerless against the imagination of a danger that had never been experienced."

Artists such as John Ruskin and Frederic Leighton studied cobras and other snake movement at the Zoo (Smith 2005). In 1882, Catherine G. Hopley wrote a book called *Snakes: Curiosities and Wonders of Serpent Life*. Her book covers herpetoculture at London Zoo: "If I am so fortunate as to afford instruction or entertainment in the following pages, my readers will join me in congratulating ourselves on the possession of so large and valuable a zoological collection as that in Regent's Park, without which this book could not have been attempted." There are many interesting anecdotes in Chapter XXX called "Notes from the Zoological Gardens." A Rhinoceros Viper gave birth to 46 neonates (Fig. 3).

This list is of zoo herpetologists, or herpetologists otherwise engaged in a zoo milieu:

Raymond L. Ditmars (1876–1942), curator of reptiles for many years at Bronx Zoo, was a well-known author of many books on reptiles and amphibians—popularizing their habits, distribution, and diversity for a broad readership. It is not necessary here to give an exhaustive account of his career as L. N. Wood (1944) published a book entitled *Raymond L. Ditmars. His Exciting Career with Reptiles, Animals and Insects*. The book starts with Ditmars' early childhood and goes on to his interest in natural history and career at the Zoo. "Ditmars also wrote about his excursions in South Carolina, including what is now Jasper County and parts of the Okeetee Club. He was the guest of the Pineland Hunt Club, which still exists, as does the table (complete with a ruler carved into the table by Ditmars himself) upon which he measured snakes" (Scott Pfaff, pers. comm. 19 May 2013).

In Germany, Werner Krause (1905–1970) established the department for venomous snake research by order of the Dessau Hygienic Institute. After World War II, he built a snake farm in Tomau near Dessau; later he went to the serum factory in Bernburg. Krause was known as "Snake Farmer Krause" at the zoological park Tierpark Berlin. In 1956, the snake house (farm) opened at the zoo, housing a large number of venomous species and featuring a combination venom extraction laboratory and public exhibit. The venom extracted was made available for medical research (Leipzig University) and in hospitals. Engelmann and Obst (1982) described the operation in detail.

Laurence M. Klauber (1883–1968) was the first curator of reptiles at the Zoological Society of San Diego in the 1920s, consulting curator beginning in 1931, and served on the Board of Trustees from 1943 to 1968. Presently, smaller herps are kept in a series of small buildings named in honor of Klauber, known especially for his studies on rattlesnakes. In his spectacular two-volume *Rattlesnakes: Their Habits, Life Histories, and Influence on Mankind*, first published in 1956, much of the reported research on these pitvipers was conducted at the Zoo with C. B. ("Si") Perkins and Charles Shaw. Following Perkins (1888–1955) as herpetological curator, Charles E. Shaw (1918–1971) published papers on longevity of snakes in North American collections and husbandry of sea snakes. He studied the male combat "dance" of some crotaline and elapid snakes; before Shaw's papers, combat was confused with courtship. Shaw was a regular contributor for the zoo publication *ZOONOOZ*. In 1974, Shaw and Sheldon Campbell, a Zoo board member and later president, published the book *Snakes of the American West*. For additional information, see Lovich et al (2008) and Klauber (2008).

Major Stanley S. Flower was director of Giza Zoo in Egypt and recorded longevities in two publications, the first in 1925 and the second a dozen years later. C. B. Perkins, curator from the Zoological Society of San Diego, surveyed zoos to compile longevities for snakes from 1947 to 1955 in the journal *Copeia*; many venomous species were listed. His successor Charles E. Shaw followed with longevities as of 1 January 1968. Biegler (1966) compiled records from zoos and aquariums for an article in *International Zoo Yearbook*. In 1977, Kevin Bowler from the Audubon Zoo (New Orleans) published a list of amphibians and reptiles in North American collections and updated the list with Andrew Snider 15 years later. Frank Slavens, from the Woodland Park Zoo (Seattle), and his wife Kate Slavens provided then-current inventories, longevities, and breeding records starting in 1976, and then annually from 1980 to 2000. The final version was issued as hardcopy in 2000, with additional records maintained online until 2002 (www.pondturtle.com). Gilboa and Dowling (1972) prepared a useful compilation of publications concerning longevities.

Carl F. Kauffeld (1911–1974) exhibited many rattlesnakes at Staten Island Zoo (Fig. 4)—the collection reaching 34 forms in 1963 (Kauffeld 1965) and an impressive list of snake longevity records followed. He focused on captive management so his papers addressed a wide range of subjects: feeding captive snakes, treatment of mouthrot in snakes, removal of abnormal snake eggs by sectioning, mites and ticks in captive snakes with remarks on cage sanitation, manipulation of odor as an aid in feeding captive snakes, the effect of altitude, ultraviolet light, and humidity on captive reptiles, shedding, and the importance of environmental factors such as temperature. Kauffeld stressed the need for security, maintaining them singly, and offering prekilled food. His beautifully-crafted writings of collecting adventures throughout the United States were available in two books—*Snakes and Snake Hunting* and *Snakes: The Keeper and the Kept*. There was a downside however; his localities were so precise that many unethical collectors descended on the sites and ravaged them. Interestingly, he included a chapter, "A Plea for Snake Conservation," in *Snakes and Snake Hunting*, much earlier than most herpetologists ever thought about protecting snakes. See Kawata (2003, 2004) for more information.

Eser and Kawata (2010) described the renovation of the reptile wing at the Staten Island Zoo. There are several interesting features. One novel approach, called "The Fear Zone," was incorporated to try and dispel the public's fear of snakes. The goal is to promote conservation by learning about myths associated with snakes. Visitors are given the opportunity to touch a live snake. At the end of the exhibit, a memorial Carl Kauffeld office was constructed, housing his historical artifacts such as snake hooks, rippers and scoops, original desk, letter opener, documents, and art. I repeat this episode from my 2007 book as it is indelibly seared in my brain: "In the late 1960s, I planned to travel to Arizona to collect ridge-nosed rattlesnakes for the Dallas Zoo collection. I wrote a long letter to Kauffeld asking advice about these pitvipers. Although we had never met, I was sure that he would gladly help a fellow zoo worker. To my dismay, he promptly answered that I was not worthy to either see them in the field or collect specimens for our zoo."

During his career, James A. Oliver (1914–1981) was the only person to serve as director at the three natural history institutions in New York: Bronx Zoo, American Museum of Natural History, and the New York Aquarium. In 1951, he became curator of reptiles at the zoo where he oversaw the renovation of the reptile house (Fig. 5). Oliver produced about 30 papers covering a variety of herpetological topics, including reproduction in the King Cobra, and important regional treatments of the herpetofauna of Sonora, Mexico and the Isthmus of Tehuantepec. Two books—*The Natural History of North American Amphibians and Reptiles* and *Snakes in Fact and Fiction*, were issued in 1955 and 1958, respectively.

Hans-Günter Petzold (1931–1982), first as Curator of Lower Vertebrate Animals and later also as Deputy Director at Tierpark Berlin, published a number of herpetological papers that covered the biology of reptiles and amphibians, some from Cuba and Vietnam, in his zoo collection (Fig. 6). His seminal book was first published in 1982 in the zoo journal *Milu, Berlin* and two years



PHOTO BY FRANKLIN WILLIAMSON, COURTESY OF ZOOLOGICAL SOCIETY OF PHILADELPHIA, PROVIDED BY BRINT SPENCER

FIG. 7. Exhibits in old reptile display at Philadelphia Zoo during the 1930s.



COURTESY OF KRAIG ADLER

FIG. 8. This hand-colored woodcut is from the first illustrated surgical book, *Buch der C[h]irurgia* (Book of Surgery), published in 1497 by Hieronymus Brunschwig. Three doctors are attending to a victim bitten by a viper encircling the leg.



COURTESY OF BILL BRANCH

FIG. 9. Postcard of snake handler from Port Elizabeth Snake Park in South Africa holding Puff Adders, Ringhals, and Boomslangs.



FIG. 10. Undated photograph of Grace Olive Wiley bonding with her tame King Cobra. She believed that venomous reptiles could be habituated toward humans. She died from an Indian Cobra bite.

later by BINA, Berlin and is translated from German as *Tasks and Problems Connected with Research into the Life Expressions of the Lower Amniotic Animals* (*Reptiles*). In his book, he thoroughly described important topics relevant to captive management and terrarium science: reproduction, post-embryonic ontogeny, behavior, and nutrition. There is an extensive historical overview of studies accomplished in zoos and aquariums. See Heichler and Murphy (2008) for an English translation of this book.

Naturalist Eric Worrell (1924–1987) founded the Australian Reptile Park in Gosford, NSW, in 1958—a combination tourist attraction and provider of venoms for Commonwealth Serum Laboratories. He published a number of books on venomous snakes such as *Song of the Snake* (1958), *Dangerous Snakes of Australia and New Guinea* (1961), *Reptiles of Australia: Crocodiles, Turtles, Tortoises, Lizards, Snakes; Describing all Australian Species, Their Appearance, Their Haunts, Their Habits* (1963), *Dangerous Snakes of Australia and New Guinea; A Handbook for Bushmen, Bushwalkers, Mission Workers, Servicemen ... on the Identification and Venoms of Australian Snakes, with Directions for First-aid Treatment of Snake-bite and the Use of Antivenenes* (1963). In 1992, owners John and Robyn Weigel decided to relocate the Park. Eight years later, a devastating fire destroyed the

main building and much of the collection of reptiles, amphibians, and spiders. The Park was reopened in abbreviated form two months later.

Heini Hediger (1908–1992), Director of Basel Zoo in Switzerland at the start of his career and Zürich Zoo at the end, was a pioneer in zoo biology. He focused on psychology, psychopathology, and captive management and had a strong interest in herpetology. His doctoral dissertation "Beiträge zur Herpetologie und Zoogeographie Neu Britanniens und einiger umliegender Gebiete (Contribution to the herpetology and zoogeography of New Britain and some adjacent regions, 1934)" is an example of his lifelong interest. Jean Roux (1934) described the venomous snake *Parapistocalamus hedigeri* in his honor.

Between 1932 and 1943, Hediger published many papers in herpetology on a variety of topics, including venomous reptiles: poisonous snakes and snake poison, snakes of Central Europe, and two papers on his herpetological observations in Morocco. *Die Schlangen Mitteleuropas* (1936), was for many years the only available guide for the herpetofauna of Central Europe until *Kriechtiere und Lurche* by Robert Mertens in 1952.

His outstanding book *Wild Animals in Captivity* (1964) included many references to captive and wild herps: space-time rhythm in snakes (sloughing, feeding, digestion, sloughing again), thermoregulation, housing, cage furniture, flight distance and security, space, quarantine, feeding techniques. He noticed that snakes often refuse to feed during the shedding period. One of his interesting observations was that snakes have varied responses to different caretakers, ranging from passivity to aggression. Hediger mounted a challenge to zoo workers—accurate records must be kept. He found many shed fangs when removing scats from cages and advised reptile keepers to be careful of being impaled while removing fecal matter.

In his book *The Psychology and Behaviour of Animals in Zoos and Circuses*, Hediger discussed "fascination" (= hypnosis) of prey when encountering snakes. He stressed that prey animals are not hypnotized but may be attracted to "fascinatory organs" (caudal luring, tongue extension, nasal appendages, and anterior trunk movement)—a prey animal's response is likely not to escape but rather to investigate the snake's puzzling appearance. In another book, *Man and Animal in the Zoo; Zoo Biology*, his account of zoos included a frightening story of the times that he visited these institutions, only to find that antivenin stock had deteriorated, expired, or was the wrong type; in one case, there wasn't even a clean hypodermic needle available to administer the serum! His contributions to the zoo field are covered in detail by Rübel and Honegger (2001).

Roger Conant (1909–2003), herpetological curator at Toledo Zoo and later curator and director of Philadelphia Zoo, continued the tradition of studying and displaying amphibians and reptiles (Fig. 7). The Philadelphia Zoo had the first reptile collection in a zoological garden in the United States, established in 1874. The animals were kept in the library of the building named "Solitude," the former country home of John Penn, William Penn's grandson. Howard Gloyd, Conant's friend and colleague for nearly 50 years, published many studies on venomous snakes of the genus *Agkistrodon*. The culmination of the Gloyd/Conant tandem was the monumental book *Snakes of the* Agkistrodon *Complex. A Monographic Review*, published in 1990. Conant was undoubtedly one of the most respected herpetologists, known for other titles such *as Reptiles and Amphibians of the Northeastern States, The Reptiles of Ohio*, and the *Field Guide* series. See Conant (1997) for his life story and Adler (1994, 2004) for his biography.

George B. Rabb, retired director of Brookfield Zoo (Chicago Zoological Society), is one of the most productive zoo researchers on venomous snakes. Many of his papers were written in collaboration with the late Hymen Marx, who worked at the nearby Field Museum of Natural History. Representative collaborations include works on colubrid snakes morphologically convergent to the vipers, relationships and zoogeography of viperine snakes, and morphology and phylogeny of the curious viperid snake *Azemiops*. Rabb has a considerable sphere of influence in zoos and conservation in general, beyond snakes.

John E. Werler (1922–2004), director of Houston Zoo in Texas, published a number of treatises on venomous snakes and snakebite, as well as a seminal book on Texas snakes with James R. Dixon in 2000 (Kawata and Murphy 2004).

David A. Chiszar (1944–2013), from the Department of Psychology at the University of Colorado, although not a zoo worker directly, collaborated with many zoo biologists on a number of papers germane to keeping amphibians and reptiles in captivity. Some of these broadly addressed important subjects: zoo-academic collaborations, herpetological master planning in zoos for the 1990s, excitation and inhibition of reproductive events in captive reptiles, and ethological approaches to reproductive success in reptiles. Much of his research focused on the feeding behavior of reptiles, especially rattlesnakes and other pitvipers, and resulted in important findings for their care in captivity. See Murphy and Smith (2013) for obituary and selected list of publications.

Peter Brazaitis worked as a herpetologist for many years at the Bronx Zoo and later at Central Park Zoo in New York. For those unfamiliar with the daily tasks and challenges of working in a zoo herpetological setting, his book—*You Belong in a Zoo*: *Tales of a Lifetime Spent with Cobras, Crocs, and Other Creatures*—is a delightful read. He also published *The Fight for Survival: Animals in their Natural Habitats, World of Snakes,* and *Snakes of the World.*

Louis W. Porras started his career working at the legendary Charles P. Chase Company in Miami. Those were exciting days, when world trade was wide open and animals were abundant, and those in the business like Porras saw amazing things. At the same time (mid-1960s) reptiles in Florida were so thick that Porras and others could actually earn their living hunting snakes. Between his extensive field experience in Florida, the Caribbean, and Central America, and his work with herps in captivity, Louis brought great knowledge to the table, especially during stints at the Houston Zoo (1968) and Utah's Hogle Zoo (1982–84). Between zoos, he co-owned an animal dealership called The Shed in Miami. This company specialized in providing rare and unusual amphibians and reptiles for the zoo community. Later, Porras started another company called ZooHerp, Inc., and moved the operation to Salt Lake City. In 1983, he coauthored an important book with Larry David Wilson called *The Ecological Impact of Man on the South Florida Herpetofauna*. He was intrigued with publishing herpetological books so he started a company called Eagle Mountain Publishing, subsequently issuing several important titles: *Biology of the Vipers* (2002), *Rigor Vitae: Life Unyielding: The Art of Carel Pieter Brest van Kempen* (2006), *Biology of the Boas and Pythons* (2007), *Conservation of Mesoamerican Amphibians and Reptiles* (2010), and *Amphibians and Reptiles of San Luis Potosí, Mexico* (2013).

When I visited the herp keepers at Houston Zoo some years ago, supervisor Paul Freed emerged from the rear section of the reptile building with a chunk of meat tied to the top of his head. I asked him if the Zoo had instituted a new uniform dress code

using meat instead of a jaunty cap. Paul had returned from a collecting trip in Belize where he had been parasitized with beefworms, which had burrowed into his head. To try and get these noxious creatures to leave, the meat was used to attract them. He said that there was incredible pain, as explained in his wonderful book *Of Golden Toads and Serpents' Roads*. Read the section "Beefworms in Belize," a pretty amazing account of his travails. The trip was not a complete disaster as he collected a nice Fer-de-Lance and other interesting herps, pictured in his book on his collecting experiences throughout the world.

Safety Issues

Raymond L. Ditmars (1941) was worried about snakebite and extracted venom to produce antivenins. In his article "Snake venom-destroyer and healer," he told the fascinating story of his efforts to provide researchers with venoms for antivenin production but also for therapeutic purposes to counteract human pain. Ditmars understood that the potential for serious repercussions from a venomous reptile bite is not trivial (Fig. 8). Card and Roberts (1996) surveyed 54 North American zoos and discovered that 21 staff members had been bitten between 1970–1995 and several workers were bitten multiple times for a total of 31 incidents. Fifteen occurred during routine handling and six when feeding without tongs. Not surprisingly, four bites were from helodermatids as zoo staffers sometimes treat these venomous lizards too casually. Our academic colleagues working with venomous reptiles are not immune to accidents: 42 envenomations and six dry bites from a total of 20 species—ten occurred from Brown Tree Snake (*Boiga irregularis*) and nine from Copperhead (*Agkistrodon contortrix*) (Ivanyi and Altimari 2004).

Several of our zoo colleagues have been rather cavalier when handling venomous reptiles (Figs. 9, 10). In our paper (Murphy and Card 1998), we describe some rather bizarre examples of treating potentially dangerous snakes casually, but remarkably, no serious accidents occurred. These episodes underscore the need for adult supervision so these careless persons would have been well-served to attend the following training sessions—three Venomous Reptile Safety and Husbandry Training Seminars (2008, 2012, 2013) have been co-hosted by Catoctin Wildlife Preserve and Zoo and Frederick Community College in Thurmont, Maryland. The meeting consists of two days of papers by leading authorities on venomous snake biology and systematics, snakebite, venom extraction, toxinology, handling and captive management, first aid, and acquisition of antivenin. One unique feature is that students have the opportunity to work directly with a wide variety of living ophidians. During these sessions, experienced handlers demonstrate proper techniques for controlling and immobilizing taxa not normally encountered, such as mambas, cobras, true vipers, and pitvipers.

William Altimari from Arizona-Sonora Desert Museum in Tucson described the challenges in working with venomous reptiles in 1998: "The physical skills necessary to work safely with venomous snakes are relatively simple, though it is certainly true that some keepers never acquire them. Working safely with a venomous snake requires grace and finesse coupled with an economy of movement in which maximum effort—in this case the safe moving of an animal—is accomplished with minimal effort. Hooks should be held lightly rather than tightly, and abrupt or unnecessary movements on the part of the keeper should be avoided. Furthermore, venomous snakes should not be overmanaged, which is to say that they should be moved as little as necessary and as gently and delicately as possible." In his book, he covers equipment, general guidelines, snakes in herpetological collections, and venoms. There are several other handy guides by Boyer (1995), Lock (2008), and Bonath (1979).

It is unconscionable to have venomous snakes in the collection without proper antivenin coverage but some zoo workers in my experience have been lax in ensuring that their stock is kept up-to-date. There is no question but that purchasing antivenin can be very cumbersome. Production has been limited in many cases and, even when available, antivenin may be costly. Some countries produce only enough for the needs of the local population. In some cases, the antivenin has expired or is near to doing so upon arrival. Requests for price quotes and availability from the manufacturers often go unanswered. Arranging shipping and transferring funds can be challenging. Some countries such as the US require permits and other extensive paperwork to import these products as they are considered investigatory new drugs. A few manufacturers claim coverage without the proper clinical trials and data to support these products. To mitigate these logistical difficulties, some zoos have successfully bundled their orders and done the importations as a unit.

The Association of Zoos & Aquariums (AZA) publishes an online Antivenin Index which provides a snakebite protocol. This protocol can be used as a template for institutions holding venomous reptiles to modify for their species and circumstances. The Index also contains a listing of appropriate antivenin coverage by taxon, current holdings in zoos, and the names and contact points for manufacturers. The current coordinator for the Index is Don Boyer, curator of herpetology at the Wildlife Conservation Society in New York.

Before adding venomous reptiles to the collection, it should be mandatory for all who will be working with them to read the following publications: Boyer 1995; Boyer and Murphy 2013; Fowler 1979; Gans and Taube 1964; Grenard 1994; Hardy 1985; Leloup1980; Minton 1975, 1979, 1990, 1996; Norris 2004; Russell 1980; Warrell 1986, 1993, 1994, 1999, 2004, 2009, 2010; Warrell and Arnett 1976; Weinstein et al. 2011, 2013; Wright 1996.

Captive Breeding of Venomous Snakes

Olney and Ellis (1991) listed 575 reptilian taxa bred in captivity in zoos and aquariums in 1988/89, many threatened, endangered or rare; a sizeable number (138) were venomous. Eighteen were rear-fanged, twenty-four were elapids, twenty-nine were viperids, fifty-nine were crotalids, no sea snakes and eight lizards. One of the justifications for keeping and breeding them is for eventual reintroduction to the wild, but some researchers were skeptical that this could be sustained over time for herps (Dodd and Seigel 1991). To consider and address their issues, Wiese and Hutchins (1994) outlined the components to successfully maintain captive colonies as a hedge against future catastrophic events—increased research, developing husbandry protocols, resolution of pedigree and taxonomic status, improved veterinary care, development of new technologies, *in situ* conservation, and public education. Educating the zoo visitor will be a major challenge as snakes are the most despised creatures on the planet (see Burghardt et al. 2009 for examples). Now nearly two decades later, how many captive initiatives for venomous species following the Wiese-Hutchins model have been actualized in the US? In my view, of the roughly 138 taxa listed as successfully reproducing in zoos and aquariums reported by Olney and Ellis, only one venomous ophidian program has shown

broadness of scope and long-term stability—the Aruba Island Rattlesnake (*Crotalus unicolor*) program which was started in 1982 (see Odum and Goode 1994; Reinert et al. 2008) and is still going strong. There are others that show promise but it is too soon to tell if these will be sustainable for over three decades.

Honegger (1980) listed species reproducing through several generations and the list is small: Blanding's Tree Snake (*Boiga blandingi*), Aruba Island Rattlesnake (*Crotalus unicolor*), Indian Cobra (*Naja naja*), Puff Adder (*Bitis arietans*), Neotropical Rattlesnake (*Crotalus durissus terrificus*), and Purple-spotted Pitviper (*Trimeresurus purpureomaculatus*). The AZA formed the Snake Taxon Advisory Group (TAG) in September 1989 and its first Regional Collection Plan (RCP) was published in 1995 (revised in 2006, 2009). The fundamental mission is development of Species Survival Plans (SSP) or tracking lineages that are recorded in studbooks—Bushmaster SSP and studbook, Rattlesnakes with SSP and studbook (Aruba Island, Eastern Massasauga, Mexican Lance-headed, and Santa Catalina Island). The Snake TAG lists studbooks for Armenian Vipers (*Montivipera raddei*), Occellate Mountain Vipers (*Montivipera wagneri*), and Philippine Palm Vipers (*Parias flavomaculatus mcgregori*). Space to maintain venomous snake colonies is a significant problem (Quinn and Quinn 1993).

Another issue was feeding certain types of venomous snakes, particularly pitvipers, which was challenging in early days. In the mid-1960s, discussions with colleagues centered on feeding behavior and provision of suitable environments for security. Several researchers studied the predatory behavior of snakes and their observations were exceedingly helpful—Tjard de Cock Buning, Gordon Burghardt, David Chiszar, David Cundall, Harry Greene, Kenneth Kardong, Charles Radcliffe, Hobart Smith, and others. See Murphy and Campbell (1987) for a description of the feeding techniques used at the Dallas Zoo and references applicable for feeding captive snakes.

A major challenge is to assess competence of the propagules. In the past, attention has been paid to genetic diversity but few studies have been done to ensure that the snakes produced are able to survive if reintroduced into the wild. Chiszar et al. (1993) argued that assessing the competence of captive-produced herps was as important as breeding them. A dramatic example of the deleterious effects of breeding over six generations of Western Diamondback Rattlesnakes (*Crotalus atrox*) occurred at Dallas Zoo beginning in the late 1960s. Inbreeding produced a strain of amelanotic and wild-type snakes with extremely variable scalation (Murphy et al. 1987; McCrady et al. 1994). Some neonates possessed anomalous polarity of scale orientation on various parts of the body. Genes for both pigment and scale anomalies were followed through six generations, resulting in great scalation abnormalities. Figures 3–5 in the 1987 paper showed a ventral view of anomalous gastrosteges with scale reversals (half-reversed, reversed, normal-reversed single unit, paired, normal), lateral reversal of scale orientation, and reversal of dorsal scale orientation, respectively. McCrady et al. (1994) described the phenotypic variation in scalation in the sixth generation of inbred snakes that produced some scaleless or partially scaled neonates.

The late Jozsef Laszlo from San Antonio Zoo in Texas focused on thermal requirements, light, mating periods, and other elements for inducing reproductive behavior in captive snakes, including a dozen venomous forms. In a series of papers (1975, 1977, 1979, 1980, 1984), he covered hibernation and mating, physiological rhythms, nuptial cycles, and exhibit design. The staff designed a venomous reptile restraining box and shift training at Henry Doorly Zoo in Omaha, Nebraska (Audi et al. 2006). Quinn and Jones (1974) described a squeeze box technique for safely measuring snakes. Ditmars (1940) reduced the danger of handling venomous snakes by cooling them in an icebox.

Susan Barnard from Zoo Atlanta has written several books and papers of importance to captive managers: *Reptile Keeper's Handbook, A Veterinary Guide to the Parasites of Reptiles*, and *An Annotated Outline of Commonly Occurring Reptilian Parasites*. Patrick Burchfield from the Gladys Porter Zoo in Brownsville, Texas, outlined procedures for maintaining a venomous snake colony (Ashley and Burchfield 1966). Pestinsky (1939) outlined collection and maintenance for venomous snakes. Banks (1985) offered a complete overview of feeding and sloughing of captive snakes. Backhaus (1963) from Frankfurt a. M. Zoo covered housing, husbandry, and diseases in a chapter in the book *Die Giftschlangen der Erde*.

If a colony of vipers is maintained, it is instructive to read the paper by Roelke and Childress (2007). The abstract reads as follows: "All species of pitvipers tested could distinguish between the warm and cool targets, while no tested species of true viper, colubrid or *Azemiops* demonstrated this ability. In addition, pitvipers exhibited behaviors that true vipers or *Azemiops* did not exhibit. Our results suggest that the tested species of true vipers, *Azemiops* and colubrids may not possess the ability to sense infrared radiation or do not use it in a defensive context, and suggest that some defensive behaviors are associated with the pit organ in pitvipers."

Opistoglyphous Colubrids

In "*Venomous" Bites from Non-Venomous Snakes: A Critical Analysis of Risk and Management of "Colubrid" Snake Bites*, Weinstein et al. (2011) call the first chapter of their book "An overview of the artificial assemblage, the Colubridae: A brief summary of taxonomic considerations." In it, they stress the following: "The taxonomy of this former assemblage is in dynamic transition and subject to frequent and often conflicting taxonomic rearrangement. This very large artificial grouping often functioned as a sort of 'disposal depot' (colloquially known as a "taxonomic garbage can" or "rag bag") for taxa of unestablished affinities. This resulted in the incorrect assignment of many diverse and phylogenetically unrelated ophidian species." With this caveat in mind, I press ahead.

The genus *Boiga* is often represented in zoo collections. In 1973, Frank Groves from Baltimore Zoo discussed reproduction and venom in the Blanding's Tree Snake (*Boiga blandingi*) and assayed freeze-dried venom preparations for their effect on the frog neuromuscular junction three years later (Levinson et al. 1976). At Tula Exotarium, Orlov and Ryabov (2002) described reproduction in the Black Mangrove Snake (*Boiga dendrophila gemmicincta*) from Sulawesi (Indonesia). John Groves (1973) described delayed fertilization in the Mangrove Snake (*Boiga dendrophila*) and reproduction at Baltimore Zoo in 2007. Howard (1984) bred this taxon at Twycross Zoo. Murphy (1977) recorded an unusual method of immobilizing avian prey by the Dog-Tooth Cat Snake (*Boiga cynodon*) at Dallas Zoo and Quinn and Neitman (1978) reproduced the snake at Houston Zoo. At Philadelphia Zoological Gardens, *B. blandingi* lived for 2 years and 1 month and *B. dendrophila* was still alive after 8 years and 7 months (Conant and Hudson 1949). Priemer (1980) described cestode larvae of the genus *Mesocestoides* (Tetrathyridia) from

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FIG. 11. In *Contributions to the Natural History of Labuan and the Adjacent Coasts of Borneo, part 1* by James Motley and Lewis Llewelyn Dillwyn in 1855, artist George Henry Ford once lived in South Africa and joined Andrew Smith on his expeditions there—he later moved to London to work at the British Museum. This lifelike drawing of Paradise Tree Snake (*Chrysopelea paradisi*) was a preserved specimen in a jar.

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FIG. 12. H. R. Schinz (1833) published this illustration of the spectacular Madagascar Leafnose Snake (*Langaha madagascariensis*) in *Naturgeschichte und Abbildungen der Reptilien.*

Boiga cyanea in Berlin Zoo. Cannibalism has been observed in this species (Vit 1976). Glenn et al. (1973) used Vermiplex, an antihelmintic agent for snakes including *B. dendrophila* at Hogle Zoo in Salt Lake City, Utah.

Because Brown Tree Snakes (*Boiga irregularis)* are such a catastrophic invasive species on the Island of Guam, introduced during or shortly after World War II, there have been many papers on the biology and control of this snake (see Rodda et al. 1999). Many have been kept as captives in an attempt to develop ways of dealing with this menace which has destroyed the native fauna. Nichols and Lamirande (Nichols et al. 1999) from Smithsonian National Zoological Park described fatal mycotic dermatitis in specimens held at the National Institute of Health and there were two other studies (Lamirande et al. 1999) on hematologic and plasma chemistry values and on the potential for viral controls (Nichols and Lamirande 2001) in this taxon. Greene et al. (1997) recommended this species as a laboratory animal. Anderson et al. (1999) tested propofol as an anesthetic agent in these snakes at Columbus Zoo.

In Russia, the Tula Exotarium was founded in 1987 by Sergei Ryabov and so far has recorded data on six species of *Boiga*. Sergei Kudryavtsev and Sergei Mamet from Moscow Zoo collected the holotype of *B. bengkuluensis* from Rejiang (region around Curup and Kapahiang Towns), Rejianglebong Prefecture, Bengkulu Province, Sumatra, Indonesia (Orlov et al. 2003). Kudryavtsev et al. (1993) reproduced the Black-headed Boiga (*B. trigonatum)* at Moscow Zoo. There are reports on nest building in *B. jaspidea* and *B. drapiezii* by Kopstein (1938) so zoo biologists should try and document this behavior in other species.

Hediger (1932) from Zurich Zoo wrote a paper on flying snakes (Fig. 11). The genus *Chrysopelea*, known as "flying snakes," is comprised of five species. These snakes glide rather than fly. Golder (1972) described age dichromatism in this group; in the book *Petzold's Lives of Captive Reptiles* (translated in 2008), the author points out, "how important, in exceptional cases, the determination of color in young animals can be for taxonomy." We kept the Ornate Flying Snake (*Chrysopelea ornata*) at Dallas Zoo and they were excellent exhibit snakes, spending most of the time in plain view in the branches. It certainly looked like they were envenomating the dead mice being fed, as there were rapid chewing motions, but I was surprised that they constricted the rodents as well. Kaiser et al. (2012) described mating behavior and sexual dichromatism in the Southeast Asian Keel-bellied Whipsnake (*Dryophiops rubescens*).

Campbell and Murphy (1977) observed courtship and oviposition of two species from the Malagasy Republic, Madagascar Hog-Nosed Snake (*Leioheterodon madagascariensis*) and Madagascar Cat-Eyed Snake (*Madagascariophis colubrina*) at Fort Worth Zoo, and Conant described eggs and young of the first taxon in 1938. A specimen lived at London Zoo for 12 years, 6

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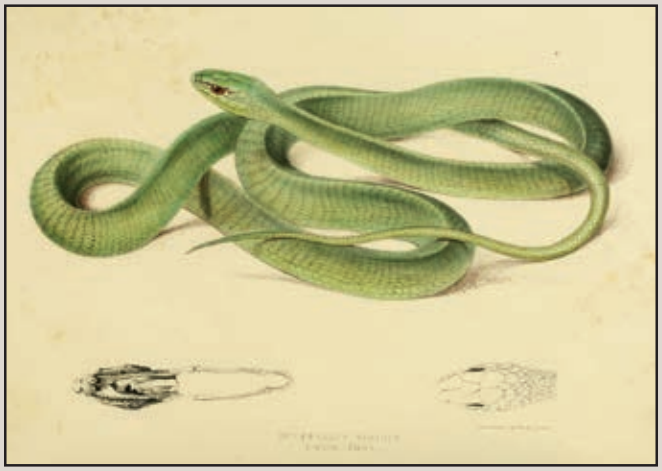


FIG. 13. Illustration of Boomslang (called *Bucephalus viridis* now *Dispholidus typus*) from Andrew Smith's *Illustrations of the zoology of South Africa : consisting chiefly of figures and descriptions of the objects of natural history collected during an expedition into the interior of South Africa…* 1838–1849. This snake has caused human deaths.



PHOTOS COURTESY OF LAUREN AUGUSTINE

FIGS. 14. Target training False Water Cobras (*Hydrodynastes gigas*) at Smithsonian National Zoological Park.

months, 21 days (Flower 1937). Dathe and Dedekind (1996) explained care and breeding of Madagascar Hog-Nosed Snakes in Berlin Tierpark. Another spectacular snake from that country, the Leafnosed Snake (*Langaha madagascariensis*) laid eggs at Dallas Zoo (Reams 1999; Fig. 12).

A number of African venomous snakes have been displayed in zoos, two of which caused the deaths of prominent herpetologists Karl P. Schmidt (Boomslang; Fig. 13) and Robert Mertens (Kirtland's Twig Snake). Schmidt worked at the Field Museum of Natural History in downtown Chicago with Hymen Marx. At the same time, Howard Gloyd was at the nearby Chicago Academy of Sciences. Marx told me that Schmidt misidentified a blackish Boomslang (*Dispholidus typus*), believing it to be a Black Tree Snake (*Thrasops jacksonii*), an active, defensive, flighty species that looks and acts much like a Boomslang. I personally know about Tree Snakes as I worked at Zoo Atlanta with three of them in the same exhibit at the beginning of my career and was bitten constantly, even though I actively tried to avoid this unpleasant outcome. After being bitten and assuming that the snake was non-venomous *Thrasops*, Schmidt went home at the end of the day on the "El," a term Chicagoans use to describe the elevated passenger train. He started having problems while on the train and upon returning to his home in Homewood, south of Chicago, experienced hemorrhaging, nausea, and dizziness. Obviously, the snake was a Boomslang so Schmidt called Marx and asked him to scour the literature to see if the there was any information on treatment of snakebite for this taxon. Gloyd told me that Marx called him in a state of panic and asked him to check as well but neither herpetologist could find any useful information. Schmidt died the next day at his home on 25 September 1957 from the bite. At the Nairobi Snake Park in Kenya, I watched Boomslangs housed in a large outdoor pit being fed many Highcasque Chameleons (*Trioceros hoehnelii*). The snakes actively chased and grabbed the lizards. I was surprised that the chameleons did not rapidly die, in spite of presumably being envenomated. In fact, the lizards were struggling vigorously for many minutes and were eventually consumed while still alive. In some cases, there was a stalemate between chameleon and snake with both biting and holding on to each other. The lizard held on for as long as an hour without evidence of venom effects. I began to suspect that these chameleons might be somewhat immune to the effects of the venom.

Two recently-imported Kirtland's Twig Snakes (*Thelotornis kirtlandii*) arrived at Dallas Zoo and immediately assumed a dramatic open-mouth defensive posture with inflated neck. We wanted to photograph them but waited a month or so after arrival. By that time, the snakes were completely habituated and could not be provoked to show that impressive behavior. At Riverbanks Zoo in South Carolina, Foley (1998) prepared a description on the captive maintenance and reproduction of Oates' Twig Snake (*Thelotornis capensis oatesi*). Schönholzer (1959) described drinking behavior in *Thelotornis capensis*. Boycott and Morgan (1990) described reproduction in the Boomslang (*Dispholidus typus*) at Transvaal Snake Park. Lambiris (1975) described surgery on a specimen held at Port Elizabeth Snake Park, and McAllister et al. (2010) recorded nematode parasites in this species. At Lincoln Park Zoo in Chicago, Almandarz (1969) discovered that Boomslangs and Twig Snakes have different egg incubation periods, 118–122 and 43–47 days, respectively. Cahill (1971) provided observations on a captive Beak-Nosed Snake (*Scaphiophis albopunctatus*) at University of Ife Zoo in Nigeria. Walsh and Davis (1978) and Ernst et al. (1999) documented husbandry and breeding and Catao-Dias and Nichols (1999) recorded neoplasia in the Rufous-Beaked Snake (*Rhamphiophis oxyrhynchus rostratus*) at Smithsonian National Zoological Park. Newman (1965) maintained this taxon at Umtali Snake Park. Stemmler-Morath (1935/36) misinterpreted male/male combat and called it a mating dance in the North African snake *Malpolon monspessulanus*.

The African genus *Psammophis* is rarely kept in zoo collections and so observations are limited. Paul Freed from Houston Zoo in Texas coauthored several papers on the endoparasites of this genus with Chris McAllister and others. At Umtali Snake Park, Newman (1965) described food habits of the Olive Sand Snake (*P. sibilans*) from Namibia. Kudryavtsev et al. (1993) from Moscow Zoo discussed the biology of the Steppe Ribbon Snake (*P. lineolatum*) and Zerig (*P. schokari*). Petzold (2008) described members of this genus feeding on other snakes.

Two species of *Telescopus* were kept at Dallas Zoo—Tiger Cat Snake (*T. semiannulatus*) and Mediterranean Cat Snake (*T. fallax*). The former was an excellent exhibit snake but the latter was smaller, less dramatic in color, and insisted on hiding. Both did well on a diet of small dead mice that were loosely constricted.

Snakes found in the New World are in many collections. Petzold bred the Banded Cat-eyed Snake (*Leptodeira annulata*)

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Fig. 15. US President Theodore Roosevelt handling Mussarana and Jararaca at Instituto Serumthérapico in 1914.

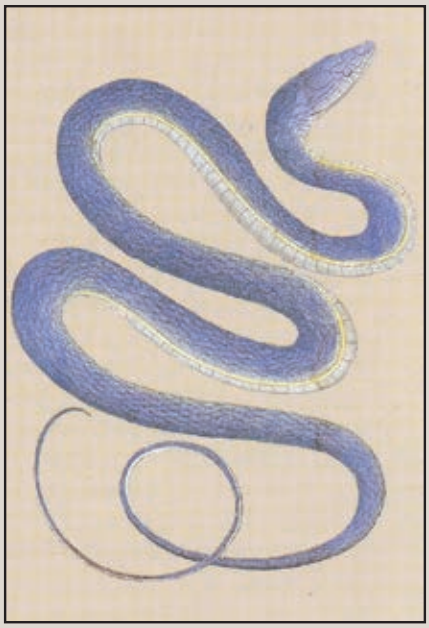
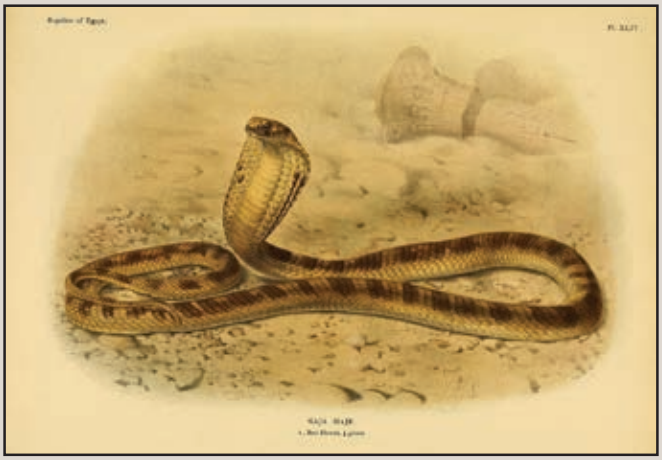


Fig. 16. Illustration of Green Vine Snake (*Oxybelis fulgidus*) from *Buffon's Natural History Abridged…Vol. II.* 1821.



Fig. 17. Illustration of Death Adder (*Acanthophis antarcticus*) from William Elford Leach in *The Zoological Miscellany…* in 1814–17.



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Fig. 18. John Anderson published *Zoology of Egypt* in 1898. Some of the finest color drawings of reptiles ever produced were by P. J. Smit and John Green in this book. Pictured is Egyptian Cobra (*Naja haje*).

(1969), Cuban Racer (*Alsophis cantherigerus*) (1978), and Indian Striped Snake (*Natrix* [=*Amphiesma*] *stolata*) (Petzold and Stettler 1972) at Tierpark Berlin. Bels (1987) observed courtship and mating behavior in the Brazilian False Water Cobra (*Hydrodynastes gigas*). Honegger (1984) from Zurich Zoo and Korinek (1997) at Olomouc Zoo investigated the biology of this snake in the terrarium. At Smithsonian National Zoological Park, Gerrits and Augustine (2013) described two important findings with *H. gigas*: 1) Snakes can be trained to target an unscented buoy and follow it into a can with rodents which makes it far easier to feed them, especially important for this active foraging species; 2) The snakes followed the target into a can according to a linear social hierarchy—male A, then B, and lastly by the female (Figs. 14).

It is surprising that there is not more information on the Mussurana (*Clelia clelia*), a large, impressive snake which would be a good exhibit species; Martínez and Cerdas (1986) from Instituto Clodimiro Picado in Costa Rica, producer of antivenins used in zoos, described captive reproduction. Peter Tolson from Toledo Zoo and Robert Henderson (2006) discussed conservation status. Mitchell et al. (2006) and Weldon et al. (1993) described keratophagy. US President Teddy Roosevelt (1924) visited director Vital Brazil at Instituto Serumthérapico (now Instituto Butantan) in São Paulo, Brazil, and watched a Mussarana feed upon a Jararaca (*Bothrops jararaca*). To get a clearer photograph, he held the snakes against a white background but wisely waited until the viper was partially swallowed before he picked them both up (Fig. 15). In his book *Through the Brazilian Wilderness*, he described the titanic struggle between them that resulted in the eventual demise of the viper. Interestingly, Roosevelt was a snake lover who kept kingsnakes and learned about them through Raymond Ditmars—no wonder I believe he was one of our best presidents. Russell et al. (1999) discussed keratophagy on its shed skin. One specimen lived for 6 years at Philadelphia Zoological Garden (Conant and Hudson 1949).

In 1937, Roger Conant described the colubrid snake *Alsophis vudii picticeps* from Bimini Islands, Bahamas. In 1996, the world's rarest snake —Antiguan Racer (*Alsophis antiguae*)—was in imminent danger of extinction, primarily because of predation by black rats on Great Bird Island. Many snakes showed bite wounds and the population was estimated to be 50–100 snakes in 1995. An eradication program for rats was initiated and was successful. Three females and two males were brought to Jersey Zoo to establish a breeding colony but, unfortunately, only one snake survived. For the complete story of this ambitious initiative, see Daltry et al. (2001) and Murphy (2007:62).

The slender vine snakes of the genus *Oxybelis* (Fig. 16) and other arboreal snakes have been covered in the book *Hunters in the Trees. A Natural History of Arboreal Snakes,* by Richard A. Sajdak, retired herpetological curator at Milwaukee County Zoo in Wisconsin. Shaw and Campbell (1974) recorded feeding and defensive behavior in *Oxybelis*. Groves (1995) described reproduction and feeding behavior of *O. wilsoni*. Fischer (1882) documented the history of the Brown Vinesnake (*Oxybelis aeneus*) in captivity.

Most rear-fanged taxa are rarely kept in zoo collections; this omission is due to a combination of factors. Antivenin is unavailable for many species except Boomslangs and Keelback Snakes, *Rhabdophis tigrinus*. The venom toxicity and the severity of a bite are unknown for virtually all of them (see Minton 1990, 1996 for list of *species*) so there is a reluctance to add them to the collection without antivenin coverage. Some species have specialized dietary requirements and suitable prey is rarely available. Examples of these are *Miodon* (snakes), *Aparallactus* (centipedes), *Crotaphopeltis* (amphibians), *Macroprotodon* (lizards), *Fordonia* (crabs), *Hypsiglena* (lizards), and *Telescopus* (lizards). Others are smallish, secretive, and sometimes drab in color, such as *Micrelaps* and *Chilorhinophis*; they would be rather unimpressive exhibit reptiles. Many are unavailable through the normal channels for acquiring living reptiles or are rarely collected as live specimens. The sum total of these impediments is that our understanding of many of these species is woefully inadequate and zoos will likely continue to work with the larger and more dramatic species (e.g., *Boiga, Thelotornis, Dispholidus, Alsophis, Hydrodynastes, Ahaetulla, Oxybelis*, and *Philodryas*) at the expense of the less flashy ones.

Elapids

Herpetologists in Australia are fortunate to have many elapid snakes represented in the country, such as death adders (*Acanthophis* spp.) (Fig. 17). Bryant et al. (1997) used radiotherapy in a Common Death Adder (*A. antarcticus*) with melanoma at Taronga Zoo. At Dallas Zoo, two studies on caudal luring in *A. antarcticus* were recorded (Carpenter et al. 1978; Chiszar et al. 1990). In the latter paper, caudal movements increased in frequency in the presence of lizards (*Hydrosaurus pustolosus*), which were attracted to the lure. Two caudal movements were seen, one in response to prey and another when no prey was seen by the snake but was visualized as a "probe" to attract unseen prey. Nocturnal observations revealed, not surprisingly, no caudal luring.

In 1972, Uwe Peters from Taronga Zoo in Sydney bred the Taipan (*Oxyuranus scutellatus*) and the egg incubation time was 75–80 days. Chris Banks from Royal Melbourne Zoo described courtship, oviposition, incubation and hatching, and rearing of young. Banks (1981) also noted the seasonal color change in the Western Brown Snake (*Pseudonaja nuchalis*). Two years later, he described reproduction in two forms of *Pseudonaja* in captivity. Fitzgerald and Mengden (1987) discussed captive breeding and oviparity in the Spotted Mulga Snake (*Pseudechis butleri*) at Pacific Reptile Park, Mullumbimby, NSW. The London Zoo exhibited the Red-bellied Blacksnake (*Pseudechis porphyriacus*) in 1862 (Weinland). See Shine (1991) for additional information on Australian elapids.

A number of African elapids have been represented in zoo collections and some, such as recently collected mambas (*Dendroaspis* spp.*)* and Forest Cobras (*Naja melanoleuca*) can be a handful to control. Years ago, the late Lou Pistoia, curator of herpetology at Columbus Zoo, told me that his Gold's Tree Cobras (*Pseudohaje goldii*) were the only venomous snakes that made him nervous when he handled them. I had previously watched him crawl into a mamba cage housing several snakes to clean the glass so I knew this was no idle statement. Some years later, I assisted the curator at Houston Zoo in moving two of these cobras and these were, by far, the most agile, active, alert, uncontrollable, and unpredictable venomous snakes that I have ever had direct contact with during my career; they were scary! William Lamar (pers. comm.) tells a similar story: "In the early 70s I imported a shipment of snakes from Africa that included *Pseudohaje*. Aware that this was a speedy species, and loaded with twenty-something foolishness, I took the daft precaution of closing myself and snake in a small room prior to opening the bag! What happened after that is something I shall never forget: the snake, a big one, appeared as a blur as it exploded from the canvas bag (who put that thing in there?). I had no time to react whatsoever and, in fact, also had no idea where the snake had gone. On the far wall of the room, some 15 feet from me, was a set of shelves the uppermost of which was within a foot of the ceiling. There, coiled tightly in the corner, as far from me as it was possible to go, and looking as though it had been there for days was the *Pseudohaje*. I vividly recall the jolt of awe that struck me upon seeing this; it was as though I was dreaming. Because recklessness and hubris ruled my day, I immediately went after the snake, which proceeded to vanish before my eyes. With growing panic my eyes darted around the room and I saw a plastic waste can—again, as far from me as possible—move ever so slightly. I had the dumb luck to approach this spot from behind and the can prevented the snake from seeing me, so I pinned the body and screamed for help!"

Harrison (1965) from The Kentucky Reptile Zoo described husbandry and reproduction in the Cape Coral Snake (*Aspidelaps lubricus lubricus*). At Manyeleti Reptile Centre, Eastern Transvaal, Africa, Haagner and Morgan (1992) described the captive biology of the Shield-nosed Snake (*Aspidelaps scutatus intermedius*). Chiszar et al. (1989) described discrimination between thermally different rodent carcasses by cobras (*Naja pallida* and *Aspidelaps scutatus*).

Chiszar et al. (1994) described strike-induced chemosensory searching in Eastern Green Mambas (*Dendroaspis angusticeps*) at Central Florida Zoological Park. At Manyeleti Reptile Centre, Haagner and Morgan (1993) propagated the Eastern Green Mamba (*Dendroaspis angusticeps*) (1989) and Black Mamba (*D. polylepis*) four years later. Leloup (1964) described reproduction, combat, and attempted breedings by males in the absence of females in Jameson's Mamba (*D. jamesoni kaimosae*). A specimen lived for 13 years, 5 months at Ft. Worth Zoo. At Dallas Zoo, Green, Black, and Jameson's Mambas were kept together in a large cage but were reluctant to crawl into the shift cage for feeding and cleaning. A number of things were tried to entice them into the shift but nothing worked until I blew cigarette smoke into the enclosure from above. All shot in to the shift immediately and always did so thereafter.

African cobras are popular zoo exhibits. The African Forest Cobra (*Naja melanoleuca*) was bred at Ft. Worth Zoo (Tryon 1979) and the cobra used the tail tip defensively for jabbing (Tryon and Whitehead 1986). Additional observations were described at Durban Snake Park (Armitage 1961). A specimen lived for 29 years, 1 month at San Diego Zoo. Randal Berry (pers. comm.) reported: "Just an anecdote regarding venomous snakes. We had a large (7 foot) Forest Cobra escape. I found it in the storeroom at the facility. I had to pin it, and grab it behind the head to pull



Fig. 19. Illustration of King Cobra (*Ophiophagus hannah*) from *The Thanatophidia of India* by Joseph Fayrer in 1874.

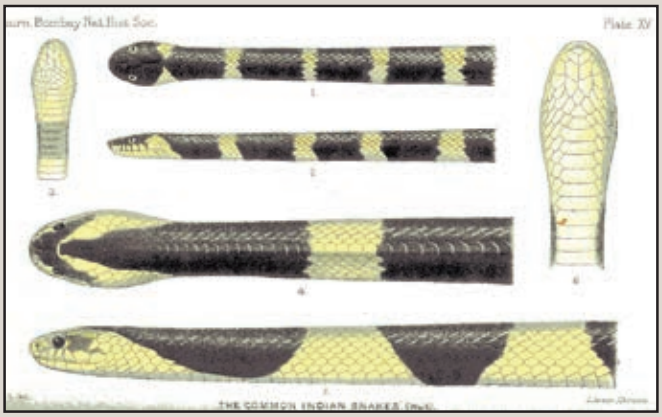


Fig. 20. From *A Popular Treatise on the Common Indian Snakes* issued in serial form between 1905–1919 by Frank Wall.

it out from a clutter of wooden planks and when I finally pulled it out, it had thrown its body around my neck (as I was kneeling on the floor) and I felt this stinging sensation on my chest, right at my heart region. It was a jabbing pain, and I thought in the excitement I was having a heart attack. I didn't know Forest Cobras possessed a conical scale tip, much like a mud snake, for defense!"

Behler and Brazaitis (1974) bred the Egyptian Cobra (*Naja haji*; Fig. 18) at New York Zoological Park where the male reached sexual maturity in 27 months, bred always in February–March, with eggs hatching in July; Vassiliev (2001) described clutch size at Moscow Zoo; Interestingly, this species had been kept in Schönbruun Menagerie in Vienna as early as 1850. Morgan and Haagner (1992) elaborated on husbandry and propagation of the Cape Cobra (*Naja nivea*) at Manyeleti Reptile Centre. Falk Dathe (1997) outlined care and reproduction of the Red Spitting Cobra (*Naja pallida*) in Berlin Tierpark. Chiszar et al. (1987) described cover-seeking behavior, and Chiszar et al. (1993) tested the investigatory behavior in Red Spitting Cobras and two other species [Bull Snakes (*Pituophis melanoleucus*) and Prairie Rattlesnakes (*Crotalus viridis*)]—"The main implications of this line of research are that: 1) snakes are sensitive not only to the chemical content of their living spaces, but also spatial arrangement of objects in it; 2) changes in either dimension result in elevated investigatory behavior; 3) these changes might have stressful concomitants."

Vassiliev (1996) reproduced the Ringhals (=Rinkals) Cobra (*Hemachatus haemachatus*) in Moscow Zoo. At Dallas Zoo many years ago, I enticed a Ringhals Cobra to crawl into a clear plastic tube for examination where it immediately went into a death-feigning posture (see Murphy 1971 for description of tube). It was so convincing, with open mouth and tongue protruded, that I thought that it went into shock and died until I remembered literature accounts of this behavior.

Found in Southeast Asia, King Cobras (*Ophiophagus hannah*) are certainly a major draw for zoo visitors (Fig. 19). There are important publications such as reproduction and nest building at Bronx Zoo by Oliver (1956); Burchfield (1977) bred this snake at Gladys Porter Zoo in Brownsville, Texas. Petzold (see Heichler and Murphy 2008) suggested that "the ovulation period seems to remain fixed independently of external stimuli." He also discussed copulatory behavior (p. 50), egg sizes and weights, and nest building. There are pictures of a King Cobra being fed an eel. Scott Pfaff (pers. comm.) sent this interesting note: "I have an old, 1940s vintage, specimen record for a 4-meter *Ophiophagus* at the National Zoo that apparently ate 450 feet of indigo snakes over a 4-year period. I wonder if the indigos were still alive. What a titanic battle that would have been." Ditmars (1935) described eye cap removal in this species by using a squeeze box contraption. At Dallas Zoo and others, Harry Greene (1976) pulled off skins from food snakes and reversed these on the bodies. He believed that King Cobras generally fed by starting to swallow the head of the prey and that the orienting stimulus was provided by the overlapping ventral scales. He was correct; the cobra began to start feeding on the now-reversed tail and consistently did so. Grace Olive Wiley was curator at Brookfield Zoo (Chicago Zoological Park) in the 1930s until she was fired for free-handling venomous snakes, including King Cobras—she died from an Indian Cobra bite and her protégé Wesley Dickinson died from a bite from a King Cobra (Murphy and Jacques 2006). One King Cobra lived at Lincoln Park Zoo in Chicago for 17 years and 2 months and I remember that snake well from when I visited the Zoo in the mid-1950s. Curator Ed Almandarz took me into the rear section of the building. This facility was a modified aquarium so all entry cage doors were at the top of the displays. Ed lifted the viewing panel door at the top to peer into the enclosure and this enormous snake reared up and looked at us for many minutes through the glass. It was an unforgettable experience. Once, I visited curator Bill Austin at Detroit Zoo and he told a harrowing story. Keeper Sherman Ketchum and others pinned a large cobra to remove eye caps and a stuck shed. As Bill was holding the snake in back of the head while others held the body at different points, it slid through the shed like sausage being squeezed through the casing and looked at him, unencumbered by old skin, at eye level. On Bill's count of three, all of the

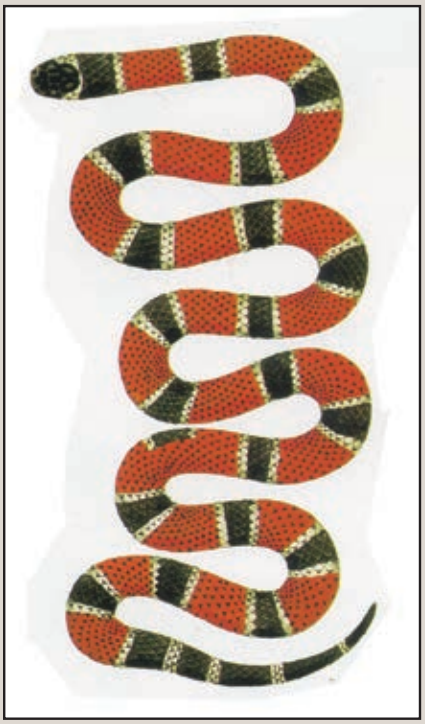


FIG. 21. Painted Coral Snake (*Micrurus corallinus*) in *Abbildungen zur naturgeschichte Brasiliens* by A. P. M. Wied-Neuwied in 1822–31.



FIG. 22. Yellow-lipped Sea Krait (*Laticauda colubrina*) from Georges Cuvier, 1836–1849, *Le règne animal distribué d'après son organisation, pour servir de base à l'histoire naturelle des animaux, et d'introduction à l'anatomie comparée, / par Georges Cuvier. Édition accompagnée de planches gravées, représentant les types de tous les genres, les caractères distinctifs des divers groupes et les modifications de structure sur lesquelles repose cette classification; par une réunion de disciples de Cuvier, MM. Audouin, Blanchard, Deshayes, Alcide d'Orbigny, Doyère, Dugès, Duvernoy, Laurillard, Milne Edwards, Roulin et Valenciennes. Fortin, Masson et cie Paris.*

handlers threw the snake as far away as possible to avoid a bite; this coordinated movement was successful and a potential accident was averted.

There have been reports on reproduction in Asiatic cobras. Petzold (1968) described the reproductive biology of Asiatic Cobras (*Naja naja*) at Berlin Tierpark. At Ft. Worth Zoo, Campbell and Quinn (1975) observed reproduction in a pair of Asiatic Cobras (*Naja naja*) and Quinn and Hulsey (1978) followed growth. Olexa (1975) reproduced the Indian Cobra (*N. naja*) at Prague Zoo. Jennison (1931) described a pair of cobras jointly guarding their egg clutch at Belle Vue Zoo in Manchester, UK. Kopczynski (1993) described reproduction in the Monocellate Cobra (*N. kaouthia*) at Plock Zoo.

Kraits are known to be phlegmatic in captivity and rarely bite (Fig. 20). At Dallas Zoo, we had a Banded Krait (*Bungarus fasciatus*) and Common Krait (*B. caeruleus*) for years and neither ever attempted to bite the handler, although they went into a feeding frenzy when food (snakes and mice) was offered. According to Petzold (1976), a Banded Krait lived at Tierpark Berlin for 14 years and I was surprised that he mentioned that kraits accepted fish as food.

Because coral snakes (*Micrurus* spp.) are predominantly ophiophagus and suitable prey may be hard to find, they are not often kept in zoo collections (Fig. 21). At the Laboratory of Herpetology at Instituto Butantan in Brazil, several papers on *Micrurus* in the field and captivity have been published: Almeida-Santos et al. 2006; Marques 1996, 2002; Marques and Sazima 1997; Marques et al. 2013; Pizzatto and Marques, 2002; Serapicos and Merusse 2002, and other titles. Butantan produces antivenin from taxa for the region. At Ross Allen's Reptile Institute, Allen and Maier (1941) discussed extraction and processing of venom of *M. fulvius* and Pawley (1982) described care at Brookfield Zoo. Campbell (1973) described reproduction and possible brooding behavior in the Texas Coral Snake (*M. fulvius tenere*) and Quinn (1979) discussed reproduction and growth at Fort Worth Zoo. Texas Coral Snakes are sometimes hard to feed in captivity because they will often only accept living snakes or skinks, are secretive, and are under stress on exhibit. At Dallas Zoo, visitors often brought Texas Coral Snakes to us as they were relatively common in the early days, before their living space in nearby Cedar Hill, Texas was converted to housing developments and strip malls. We would scent dead neonatal mice with snake scent to see if they could be converted to this diet. In most cases, this did not work so finding a suitable specimen for display was difficult. Curator Hugh Quinn at Houston Zoo solved the problem by substituting a rubber snake for exhibition. In September 1984, a visitor noticed that the coral snake on display did not move for nine months and called the local newspaper. The zoo spokesperson admitted that the snake was a fake and this story was carried on national media. Clearly, it was a slow news day. Had Hugh moved the snake model occasionally, this public outcry probably would never have happened. An adult Diastama Coral Snake (*M. diastama*) lived for years at Dallas Zoo on exhibit, remained visible, and fed ravenously on dead mice—it was the perfect captive coral snake.

The Moscow Zoo has maintained and bred a sizeable number of elapids: *Naja, Aspidelaps, Boulengerina, Bungarus, Dendroaspis, Haemachatus, Ophiophagus,* and *Oxyuranus* (Vassiliyev and Kudryavtsev 1996; Vassliliyev 1997; Vassiliyev et al. 1999 and others). One striking accomplishment is reproducing the beautiful Red-Headed Krait (*Bungarus flaviceps*) (Sergey V. Kudryavstev, pers. comm).

There is virtually nothing known of the biology of many elapids derived from zoo observations: *Apistocalamus, Aspidomorphus, Cacophis, Calliophis, Cryptophis, Drysdalia, Echiopsis, Elaps, Elapsoidea, Glyphodon, Hoplocephalus, Maticora, Neelaps, Ogmodon, Simoselaps, Toxicalamus, Unechis,* and *Walterinnesia.* Many of these, being fossorial, secretive, small, unimpressive in



Fig. 23. Yellow-bellied Sea Snake (*Pelamis platurus*) from *Buffon's Natural History Abridged…Vol. II.* 1821.

color, rare, restricted in range, and with specialized diets, are not often kept in zoos.

Sea Kraits and Seasnakes

Radcliffe and Chiszar (1980) observed five Yellow-lipped Sea Kraits (*Laticauda colubrina*) at Mystic Marine-life Aquarium in Connecticut (Fig. 22). The snakes were fed live American Eels (*Anguilla rostrata*) that were envenomated as soon as discovered by the snakes. After prey was struck, the snakes became quiescent and the interval between strike and swallowing was about 24 min. Eels were swallowed at an incredibly fast rate—averaging 7 sec after the eel's rostrum was at the back of the mouth. Neither visible jaw movements nor muscular contractions of the body were seen as the eel was consumed. These behaviors were consistent with those seen by Matt Evans (pers. comm.) at National Aquarium in Baltimore. Klemmer (1967) recorded a life span of 5 years, 2 months; the shedding intervals ranged between 1 month, 25 days to 5 months, with a mean of 3 months, 7 days.

At San Diego Zoo, Shaw (1962) set the longevity record for Yellow-bellied Sea Snakes (*Pelamis platurus*), which was alive after two years, 4 months (Fig. 23). The shedding interval ranged from 7 days to a maximum of 27 days, average 13.7. At Dallas Zoo, an adult immediately went into a feeding frenzy whenever live goldfish were offered; these were consumed at a speed and using swallowing movements similar to Sea Kraits. This snake consistently had dermal lesions that disappeared after each shedding; contortive, knotting behaviors during ecdysis as described by Mays and Nickerson (1980) for *Laticauda semifasciata* also occurred during each cycle. To prevent lesions, a mercury vapor ultraviolet lamp was suspended above the aquarium as the snake almost always rested on the surface of the water but this seemed to have no positive effect. The snake lived for over two years but exact dates were not recorded. A female Erabu Sea Snake (*L. semifasciata*) arrived at Himeji Aquarium in 1967 (Kawata 2013).

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BOOK REVIEWS

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Frogs of the United States and Canada (Volumes 1 & 2)

C. Kenneth Dodd, Jr. 2013. Johns Hopkins University Press, Baltimore, Maryland (www.press.jhu.edu). xxvii + 982 pp. Hardcover. US $180.00 (set). ISBN 978-1-4214-0633-6 and 978-1-4214-0633-0.



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Occasionally a technical book is published that has the potential to become a classic reference in its field. On the bookshelf of most professional and serious amateur North American herpetologists and university libraries one can usually find standard species reference works such as Petranka (1998), Ernst and Ernst (2003), and Ernst and Lovich (2009) on salamanders, snakes, and turtles, respectively, of the United States and Canada. Perhaps there may even be a well-worn copy of Wright and Wright's (1933) *Handbook of the Frogs and Toads*. Although several early editions of this latter classic were produced until 1949, and many reprints have been produced, there has not since been an effective synthesis or review of the species-specific anuran literature for both Canada and the United States. Why not? Although the need for an update was long overdue, nobody seemed to have the expertise, time and/or fortitude to attempt such a formidable task. Here we have a new species-specific synthesis and review of the 112 native and established non-indigenous anuran species of the United States and Canada that has the potential to become a standard reference for the upcoming decades. Is it destined to replace the disintegrating copy of Wright and Wright (1933) on our shelves? Considering the magnitude of the global amphibian decline (Stuart et al. 2004) and recent evidence indicating that even the common North American amphibians are declining (Adams et al. 2013), a thorough contemporary reference source on anurans is urgently needed.

The author needs little introduction to those who work with amphibians or reptiles either in North America or globally as his reputation and contributions are widely known. Dodd is a well-seasoned herpetologist who has been an academic and government scientist, and has even done "hard time" as an administrator. In his brief preface, Dodd tells us why he became a biologist—a passion for nature, a keen interest in how it works, and wanting to spend a life outdoors. These motivations are familiar to many of us.

One of the author's objectives, and critical for a book of this kind, is to provide a thorough review of the pertinent literature. Over 4700 publications from the 1700s to mid-2011 were read and cited by the author. Dodd apologizes that he did not cite every paper on North American anurans and quotes Ernie Liner: "You can't get them all." From a careful perusal of the species with which I am most familiar—the 50 or so that range into Canada—I found only a few papers missing that could have been included. However, these tended to be short local natural history notes published in obscure sources. Thus, it appears that Dodd did an all-around excellent job of identifying and incorporating the pertinent literature for each species.

The two attractive volumes that comprise this set are well constructed, with a rugged hardcover binding and acid free pages, and should weather the frequent use to which a key reference is subjected. With a weight of 2.5 kg for the set, carrying these books will provide the owner with fitness benefits, but makes them impractical for use in the field. The printing quality is excellent and the font is easily readable. However, throughout the volumes there are occasional typographical errors. Most of those I noted were real words, but the wrong words, and suggested the use of automatic word replacements that some software packages employ. A live copy editor would likely have done a better job. Fortunately, the errors are not so frequent as to detract significantly from the prose.

This is neither a field guide nor a key to frogs and toads. As Dodd points out, there are a plethora of regional, state, and provincial field guides with keys and identification information available. His goal was to produce an extensive synthesis and review of the published literature on all of the anuran species of North America occurring north of Mexico as of May 2011. In this he succeeds commendably. Despite not being a field guide, the books still do an excellent job of summarizing general identification characteristics.

Volume 1 begins with a brief Preface, Introduction, and List of Abbreviations. It then goes directly into the individual Species Accounts that form the bulk of the material in both books. The accounts are organized alphabetically by family name from Ascaphidae to Rhinophrynidae in the first volume but leaving the more diverse Ranidae for the second. Volume 2 begins by repeating the List of Abbreviations and then completes the species accounts of Ranidae and Scaphiopodidae followed by accounts of established non-native species. The species accounts are followed by a Glossary, Bibliography, Index to Scientific and Common Names, and an Index of Potential Stressors, bringing the complete work to over one thousand very thorough and well-organized pages summarizing what is known about North American anurans. Although the species accounts occupy the bulk of the books and will get the most use, I hope readers will

also carefully read the 'About The Book' section on pages xx–xxv of the Introduction, which contains many insights regarding our current state of knowledge of amphibian biology and insights that can emerge only from researching and writing a work of such scope. This provides direction for those seeking topics or areas for future study or needing a primer on a species new to them, and reveals gaps in the literature where natural history information is lacking. It is surprising that even in developed countries such as Canada and the United States, where the amphibian fauna is relatively well-known and studied, so many gaps in basic natural history and geographic variation exist—even for our most common species. Although natural history is often undervalued, without these data we are left with gaps in basic knowledge that often hamper progress in ecology, conservation and management (Dayton 2003; Bury 2006). Having just served three terms on the Committee On the Status of Wildlife In Canada (COSEWIC) Amphibian and Reptile Species Subcommittee, I know how important a thorough understanding of the natural history of a species is to enable accurate status assessment and just how frustrating it is when species remain unprotected because they are designated as "Data Deficient."

Dodd follows the current but somewhat controversial nomenclature of Frost et al. (2006, 2007). However, he also includes the more widely recognized names used in Conant and Collins (1998) and Stebbins (2003) making it easy for most readers to follow. Dodd stays out of the nomenclature debate, leaving it to systematists and taxonomists to "duke" it out. As most experienced field herpetologists know, it doesn't matter if you call a bullfrog *Lithobates* or *Rana*, it still won't respond. For the seemingly more stable common names Crother (2008), Desroches and Rodrigues (2004), and McKeown (1996) are followed for English, French, and Hawaiian, respectively.

The accounts are well organized, clearly and concisely written, and very thorough. The main subheadings under each species' account are: Nomenclature, Etymology, Identification, Distribution, Fossil Record, Systematics and Geographic Variation, Adult Habitat, Terrestrial and Aquatic Ecology, Calling Activity and Mate Selection, Breeding Sites, Reproduction, Larval Ecology, Diet, Predation and Defense, Population Biology, Community Ecology, Diseases, Parasites, and Malformations, Susceptibility to Potential Stressors, and Status and Conservation. Some of these subheadings are absent, merged, or modified, depending on the amount of information available about each species. Individual species accounts range from about five to over 30 pages, illustrating the unevenness of knowledge about our anuran fauna. Each account includes a black and white political boundary outline map with the species ranges shaded in gray. The author explains that the information on distribution comes from the latest available sources but he provides a caveat in the preface that the maps should be interpreted as approximate. They do appear generally to be a good estimate of the approximate extent of the range for most species. However, I found that the map for Cope's Gray Treefrog (*Hyla chrysoscelis*) could have been more accurate by including southeastern Manitoba as the species' occurrence there is discussed in the text. In checking the source for this map, I found it was from an older published map that did not show the northern distribution beyond the US border. This highlights the author's caveat that all range maps (especially "outline maps"), not just maps in this book, must be interpreted cautiously. As the macroecological literature indicates, the abundance-distribution structure of the range for most taxa is poorly documented but it remains virtually unknown for all amphibian species.

Each species account also contains representative photographs of eggs, larvae, adults, and habitat where available. For the most part these are of good to excellent quality. In a few cases I wished that photographs of egg masses were larger than single column width for better resolution. In some cases line drawings are provided for eggs or important identification characteristics (e.g., cranial crests in toads) presumably where photographs were not available or adequate. Some drawings in the accounts came from other sources but most are high quality pen and ink illustrations made for this set by C. Pizano. These fine drawings demonstrate that at times, the old illustrations of yesteryear can be superior to photographs for identification purposes. For some species accounts multiple photographs are provided to illustrate color phases or variation in habitat. As one views these photographs for species familiar to them, it is sometimes evident that they are not so representative of the tadpoles or adults in one's own study area. This highlights another caveat that the author provided in his introduction about geographic variation in basic features such as color and pattern, and especially his statements that "The identification of tadpoles is truly an art as much as a science" and "Field experience and knowledge of natural history are the best teachers when identifying larvae." This fondly brought back to memory an observation from early in my career of a conference field trip, on a tiny island, with four eminent herpetologists from different regions of North America peering into a dip net and arguing *ad nauseum* over which species of tadpole had just been scooped. A local naturalist with but one degree but decades of experience was able to correctly identify the beast with one quick peek. Although these volumes are no substitute for regional field guides, they nonetheless do a fine job of describing the general basic features.

The section on Fossil Record is typically the shortest in each account and for many species contains just the statement that "no fossils have been identified." Much of this information comes from the extensive work of the late Alan Holman and a few others on North American fossils and sub-fossils but it illustrates the serious gaps for anurans in the fossil record. This likely partly reflects the low probability of small-bodied species becoming fossilized but also highlights the general lack of work on amphibian paleontology relative to other aspects of amphibian biology.

The Systematics and Geographic Variation sections appear to be comprehensive in reviewing the latest primary sources of information and thorough in providing a summary of the evidence for hybridization. This section reminds one not only how much uncertainty we still have of phylogenetic and phylogeographic relationships but also how fast knowledge in this field is increasing. One wonders where the dust will settle once entire genomes can be compared and if our modern analyses will largely confirm the classifications, relationships, and inferred dispersal corridors divined by early herpetologists based on morphology, habits, and years of studying nature *in situ*. The amount of evidence for both natural and lab-produced hybrids shows how valuable anurans can be as model organisms for investigating speciation, especially if reproductive isolation is assumed to have some relationship to the definition of species. Indeed, under Mayr and Ashlock's (1991) biological definition of species, perhaps early taxonomists were premature in many of their classifications.

The sections on Adult Habitat and Terrestrial and Aquatic Ecology are very thorough, reflecting both the variation and the disparity of knowledge among species. Within each species' account the generalities are clearly presented and regional

variation is discussed when known. Likewise, the sections on Calling Activity and Mate Selection and Breeding Sites provide good reviews. The literature has been thoroughly searched to summarize the phenology of activities where known across the ranges of each species.

The Population Biology section reveals little about population growth or trends, but instead provides thorough reviews of what is known of the demographics of each species, emphasizing population structure. The lack of the former data reflects the fact that there are few long-term studies of amphibian populations, despite the recognition of their potential value to conservation, and we still know little of the spatial dynamics of amphibians (Marsh and Trenham 2001; Smith and Green 2005).

The Community Ecology section focuses mostly on what is known about interactions among species, emphasizing competition and habitat partitioning. This section, next to that of the Fossil Record, is generally the shortest for most species and even absent from some of the accounts reflecting the paucity of ecological studies conducted at the community level using anurans. The results of lab and field micro- and mesocosm experiments of the past few decades, some of which are now citation classics influencing community ecology in general, are reasonably well-summarized. There is, however, no mention of the tradeoffs between realism and control in these classic experiments versus observational studies, which often makes it difficult to assess the relative importance of individual ecological interactions in structuring anuran communities. As one who generally works at the community level and focuses on anurans, I concur with Dodd's assessment that very little is generally known about the community ecology of North American anurans.

The sections on Diseases, Parasites, and Malformations are based on a sound assessment of the literature, but again reflect how little we know beyond description of some pathogens and parasites that occur in some anurans. The information presented in this section varies greatly among species. The ecological role of disease and parasitism as ecological interactions is poorly known in most taxa, but particularly so in anurans and amphibians and reptiles in general.

In the section Susceptibility to Potential Stressors a summary of both lethal and sublethal anthropogenic and natural stressors is provided. For some species nothing is known but extensive summaries exist for other species and information is conveniently organized under subheadings such as Metals, Other Elements, pH, Chemicals, NaCl, Nitrate and Nitrite, UV light, and other categories. This is, to my knowledge, the most thorough summary by species of stressors and it will appeal to both herpetologists and ecotoxicologists as a guide to the past literature. Dodd notes the shift to sublethal studies but points out that little is known about differences in effects among species and states, "Clearly, toxicological studies need to be more rigorous." There remain many knowledge gaps with respect to the effects of individual stressors and even less is known about the "chemical soups" to which anurans are exposed, and other multiple stressors.

The final section in each species account is Status and Conservation. The author does not provide a lengthy list of status designations by federal, state and provincial jurisdiction as this information is readily available and kept up-to-date on government and other websites. Instead an excellent review of threats documented in the primary literature is included. Like all other sections the length varies greatly among species reflecting the general relative disparity of knowledge. A short glossary follows the species accounts before the Bibliography. I checked various technical terms used in the text of which some readers may not be familiar and found only one that I would add: "thigmotactic"—response to stimuli resulting from touch.

In reading and comparing the individual accounts, it becomes clear just how much the state of knowledge of natural history varies among species and how much geographic variation exists within species. Dodd points out that many 'facts' about some species are based upon very little empirical evidence and that past misinterpretations or errors are sometimes perpetuated. Thus, there are at least two important take home messages to the reader that are articulated in two statements from the author, first "Researchers need to understand the basis and limitations of the data used to test hypotheses, or their meta-analyses will not be of much value." And second, despite the plethora of knowledge summarized in this set of books, "*Life history traits of North American frogs are poorly known.*" The best overall, and most important message of this book for all to consider lies in a passage on page xxv: "All too often, biologists consciously or unconsciously embrace the concept of ecological typology whereby if a species does something in one location it must do the same thing elsewhere. Such narrow thinking needs to be countered by comprehensive long-term studies in a variety of locations and under varying environmental conditions."

The initial excitement I had upon receiving these books to review did not dissipate as I read them. Readers will learn not only much about the natural history of each species, but comparison of the individual accounts also reveals where gaps exist in the literature, and where more research and reporting needs to be done. This is a monumental contribution that provides an urgently needed review of the literature on the anurans of the United States and Canada. Dodd succeeds in his goal of providing thorough reviews of the literature on each species in well-organized and well-written accounts. It will quickly become the main reference source on frogs and toads of the United States and Canada for decades to come. Its underlying caveats also provide sage advice for improving the quality of research and knowledge. This set should be on every North American herpetologist's bookshelf and in every academic and research institution library on the continent. Both professional biologists and serious amateurs will find the contribution to be the best summary of knowledge on the biology, natural history, and conservation for each species.

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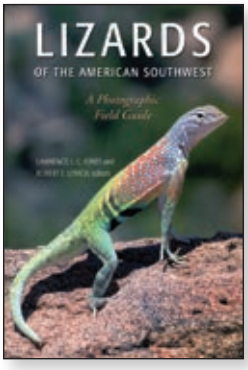
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Lizards of the American Southwest: A Photographic Field Guide

edited by Lawrence L. C. Jones and Robert E. Lovich. 2009. Rio Nuevo Publishers, Tucson, Arizona (www.rionuevo.com). 567 pp. Softcover. US $24.95. ISBN 978-1-933855-35-6.



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This book concentrates on one of the most lizard rich regions of North America—the southwestern United States of California, Nevada, Utah, Colorado, Arizona, New Mexico, and Trans-Pecos Texas, as well as the adjacent Mexican states of Baja California, Baja California Sur, Sonora, and Chihuahua. Not since Hobart Smith's (1946) work *Handbook of Lizards* has there been a publication of this nature, specifically focusing on a North American lizard fauna that incorporates identification, biology, and taxonomy within comprehensive species accounts, thoroughly illustrated throughout. At 567 pages, *Lizards of the American Southwest* contains detailed accounts on 96 lizard species, plus additional introductory sections, family level accounts, and a section on the lizard fauna found in northwestern Mexico, all written by 63 of the most reputed lizard specialists and expert herpetologists. To be fair, this work is more than a field guide; it is a dense reference containing a wealth of information on lizard life history, where they occur, how to find them, and much more.

The book opens with a Foreword by renowned lizard ecologist, Laurie Vitt. Here, Vitt initiates the discussion on lizard diversity in the American Southwest and reflects upon the early years leading to his successful career as a biologist focusing on lizards. Following the Foreword, the editors of the book provide separate Prefaces, each imparting their unambiguous enthusiasm for the Lacertilia. Before delving into the introductory contents, a map of the geographic scope covered by the book is included with total species counts and the number of endemics occurring within each of the seven U.S. and four Mexican states.

A number of opening sections under an initial chapter entitled "Getting Started" help orient the reader with the book's layout and provide an overview of basic lizard biology, diversity, and habitat associations. "About Lizards," authored by Lovich and Jones, discusses species richness within the American Southwest, as well as taxonomy and the importance of lizards in mythology and cultural history. "Lizard Habitat," authored by Jones and Lovich, begins with discussion and definition of ecoregions and is accompanied by a map illustrating the 16 ecoregions found within the coverage area. Plant communities and habitat features are then discussed, narrowing down to microhabitat from there. Scenic landscape and habitat photographs are provided for a few of the ecoregions and habitat types mentioned, but not all. This chapter continues with a detailed account and overview of lizard "History and Behavior." Here, author Stanley Fox conveys his obvious fascination with lizards as he summarizes their different modes of reproduction, the vast array of mating and territorial displays, foraging habits, and predator evasion strategies. "External Anatomy and Identification" by Jones and Randy Babb covers varied external morphology in lizard scalation, color patterns, and body forms, breaking down diagnostic features for each family in the region. This section is complemented by exquisite original line drawings produced by Babb that accurately illustrate markings and anatomy, which aid in identification. "Non-native Species" by Jones and Lovich discusses the relatively small number (when compared to such places as Florida) of lizard species that have become established in the American Southwest following human-facilitated introductions.

Another chapter entitled "Observing Lizards" by Jones and Lovich covers an opening section on "Lizard-watching Basics," offering the reader helpful information on where to locate lizards, when to observe lizards, how to look for lizards, and catching lizards, all of which may vary greatly by species, climate, latitude, season, time of day/night, and habitat, making this very useful content for everyone from the novice lizard-watcher to the "serious lizarder" (a term coined on page 53!). "Public Lands for Observing Lizards" by Jones details numerous places, organized by U.S. state, where lizards can be found and viewed. A sub-section titled "Lizard-viewing Hot Spots" focuses on some of the most notable places that are both rich in lizards and scenic hiking, such as Borrego Palm Canyon Trail in Anza Borrego Desert State Park, California and Marijilda Canyon in the Pinaleño Mountains of southeastern Arizona. Author Kim Lovich addresses "Lizards in Captivity," initially providing alternative approaches to viewing lizards up close on display in zoos or other exhibits rather than collecting and keeping them in the home.

However, recognizing that some readers will be interested in keeping lizards that they'll encounter in the wild, general advice and information pertaining to captive husbandry is offered.

Discussion of collecting and captive care is a nice lead into the next chapter, "Conservation and Legal Issues," as novice readers may be unaware that it is illegal to collect and keep a number of lizard species that are in decline in some regions or fully protected (such as *Heloderma suspectum, Phrynosoma cornutum, P. mcallii,* etc.), and/or listed under the federal Endangered Species Act (such as *Gambelia sila* and *Uma inornata*). Others occur in sensitive microhabitats that can be readily damaged if careless searches are employed (e.g., crevice-dwelling night lizards such as *Xantusia bezyi, X. henshawi,* and *X. sierrae*). In "Environmental Ethics," Lovich and Jones comment on such topics encouraging "non-invasive enjoyment of lizards." This is followed by "Conservation, Management, and Threats," where the authors attempt to educate and enlighten readers as to the impacts some species face and some of the benefits afforded to humans by lizards, thus validating conservation and management practices. "Lizards and the Law" ends this chapter covering regulations readers should be aware, from international (CITES) to federal, state, and local levels.

In a chapter on "Taxonomy and Nomenclature," authors Lovich and Jones begin with a basic history and breakdown of taxonomy for the layperson prior to the species accounts, and it is explained that a standard taxonomy was adopted for the book following de Queiroz and Reeder (2008) for U.S. taxa and Liner and Casas-Andreu (2008) for Mexican taxa. The book is as taxonomically up-to-date as can be for the time of publication in 2009. Notable taxonomic changes in recent years are highlighted in this section, such as the use of the genera *Aspidoscelis* (for the North American whiptails; Reeder et al. 2002) and *Plestiodon* (for the toothy skinks; Smith 2005), after long histories recognized under the genera *Cnemidophorus* and *Eumeces*, respectively, with which some readers may be more familiar.

The real meat of this book is, of course, its species accounts representing 96 lizard species. Each account is accompanied by a range map and two to five color photographs (most accounts include four). Although these accounts cover species found in the American Southwest that also may continue their distributions into adjacent Mexico, species that occur in the contiguous states of Sonora, Chihuahua, and the Baja California peninsula, but that do not extend into the U.S., are not given individual accounts. Instead, three sections on Mexican lizard fauna written by expert researchers of each region follow the main species accounts: "Lizards of Baja California (Norte) and Baja California Sur, México" by Rob Lovich and Lee Grismer, "Lizards of Sonora, México" by James Rorabaugh and Erik Enderson, and "Lizards of Chihuahua, México" by Julio Lemos-Espinal. Within these sections an additional number of Mexican endemics are briefly discussed within their respective ecoregional assemblages.

Following the species accounts, a comprehensive checklist is provided consisting of all species occurring within the U.S. and Mexican states covered by the book, amounting to a total of 177 species. Perhaps for user-friendliness, the species checklist is arranged alphabetically by family and species, whereas species accounts are arranged phylogenetically by family and then alphabetically by species.

Photography is a key element of this book, as indicated by the subtitle, "A Photographic Field Guide." Some authors of species accounts provided their own images while other images were solicited from more serious herp photographers. Outstanding images such as a *Dipsosaurus dorsalis* in habitat on page 132 by Tom Brennan, an elegant *Aspidoscelis pai* on page 375 by Randy Babb, a red-headed *Plestiodon "gilberti"* by Troy and Marla Hibbitts on page 449, a pleasingly postured *Elgaria panamintina* by Brad Alexander on page 472, and a beautiful, basking adult male *Petrosaurus thalassinus* in full breeding coloration by James Rorabaugh on page 503 are among some 380 photographs in total that collectively make this a top-notch volume. Clearly, the images selected for this book were intended not only to serve the purposes of accurate field identification, but to evoke an interest in this spectacular group of reptiles. While some accounts applicably illustrate distinctly polymorphic taxa (e.g., *Sauromalus ater*), other accounts depict widely ranging, highly variable taxa from only a single state (e.g., *Phrynosoma hernandesi*) or depict only two or three subspecies for polytypic taxa when a number of forms occur in the geographic area covered by the book (e.g., *Aspidoscelis tigris*).

There is little concerning criticism to comment on, though some minor inaccuracies or incongruities warrant attention in future editions. For example, a typo on page 52 referring to *Sceloporus varius* is obviously meant to say *Sauromalus varius*. On page 173 *Phrynosoma ditmarsi* is mentioned as having been formerly included as a subspecies of *P. douglasii* prior to being elevated to species status along with *P. hernandesi* (Zamudio et al. 1997). However, *P. ditmarsi* has never been included within the *P. douglasii* species complex. Further, it is stated in this same paragraph that the absence of blood-squirting is a distinguishing feature of the short-horned lizard clade, when in fact members of this group have been reported to exhibit this trait in the literature (Sherbrooke and Middendorf 2001; Hodges 2004, and references therein). In the range map on page 318 the distribution for *Phyllodactylus nocticolus* should not extend to the Baja Cape region, where this species is replaced by its sister taxon, *P. xanti* (Grismer 2002; Blair et al. 2009). Similarly, on page 440 the range map for *Xantusia wigginsi* should not include the distributions of *X. gilberti* and *X. sherbrookei* (Grismer 2002; Bezy et al. 2008). An isolated locality dot on the range map for *X. vigilis* in Sonora represents the type locality for *X. jaycolei* on page 436. Although *X. jaycolei* and *X. sherbrookei* were described just prior to this book's publication (and thus did not make the cut for this first edition), *X. gilberti* (=*X. vigilis gilberti*) has been recognized as a valid taxon occurring in the Sierra la Laguna of the Cape region since its description in the 19th century (Van Denburgh 1895).

Most of the distribution maps produced for this book are generalized for wider-ranging species, but some are much more detailed such as those for habitat specialists or those with significantly reduced distributions due to habitat alteration (e.g., *Phrynosoma mcallii* and *Sceloporus arenicolus*). Other maps for certain species in the same boat (e.g., *Gambelia sila*) do not reflect similar loss of habitat and may be misleading to some readers unfamiliar with current vs. historic distribution in this context.

Other matters of minor criticism concern subspecies delineations within the range maps and written content referring to subspecies within the accounts. A key on page 559 is provided to match the appropriate color code to mapped subspecies, alphabetically, to any given range map within respective species accounts. Some subspecies sections for polytypic species within the accounts provide descriptions of where each subspecies occurs so that one might be able to discern subspecies distributions without having to flip to the back of the book to reference the color key (e.g., *Uta stansburiana*, page 297). However, discussions within other subspecies sections provide information

on diagnosing subspecies, but do not discuss their respective distributions (e.g., *Sceloporus graciosus*, page 221). Still others simply list subspecies without providing any additional information, such as *Urosaurus ornatus* (page 293), or *Coleonyx variegtus*, where in the latter, it is mentioned on page 315 that "the remaining subspecies occur in Mexico," but the region of Mexico in which these occur is covered by this book. At least one range map (*Urosaurus graciosus*, page 282) does not correspond correctly with the subspecies color key. Further, subspecies that occur within the U.S. are discussed in the species accounts, but subspecies occurring in Mexico, including Sonora, Chihuahua, and the Baja California peninsula, are not, despite range maps illustrating additional, unreferenced subspecies distributions within these Mexican states.

This work does a superb job at showcasing the region's diverse lizard fauna, offering an accessible look at lizards as interesting and attractive members of the systems of which they are a part. Editors Larry Jones and Rob Lovich are to be applauded for accomplishing the huge task of bringing together an aggregate of 77 expert authors and skilled photographers to produce such a wonderful look at lizard biodiversity. This book is an essential addition for anyone with an interest in lizards, desert ecology and natural history, the American Southwest, wildlife photography, or herpetology of the region covered. It should be noted that all proceeds from the book are donated to The Herpetologists' League in support of the Jones-Lovich Grant in Southwestern Herpetology, which sponsors research on the herpetofauna of the American Southwest and adjacent Mexico.

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Salamanders and Newts of the World Vol. 1: Salamanders and Newts of Europe, North Africa and Western Asia

Marc Staniszewski. 2011. Terralog Vol. 21. Edition Chimaira, Frankfurt am Main, Germany (www.chimaira.de). 160 pp., Hardcover. 39.80 Euro. ISBN 978-3-89973-369-3.

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Terralog is a book series presenting reptile and amphibian groups in color photos of all species and subspecies of various regions. It gives information on keeping the animals in captivity by means of small symbols under the photos and also provides some data on size, habitat, and protection status, along with maps (41 in this volume) depicting the distributional ranges of each taxon. It is aimed primarily at terrarium hobbyists. Thus far Terralog volumes have appeared on turtles, varanid and agamid lizards, geckos, and venomous snakes.

The present volume is the first devoted to salamanders and addresses the salamander and newt species of Europe, North Africa, and Western Asia. The book starts with an elaborate table of contents that includes distribution data of the taxa depicted in the book. The following introduction, in both German and English, is nine pages long, but is not intended to introduce the novice to salamander biology. Instead it gives a referenced summary of the taxonomy of the species dealt with in the book, and in doing so generally follows Frost (2011). Thus, the introduction is, in fact, a justification of the use of the scientific names in the book. The book is not intended to contribute to the scientific discussion about species or subspecies status of different taxa, so the choices that are made will probably not be of scientific consequence. This is not the place to elaborate this point further, but I find that the views of Dubois and Raffaëlli (2009), which are followed by Frost for a number of European salamander species, are sometimes adopted too readily. Dubois and Raffaëlli in my view often jump to conclusions and propose new taxonomic arrangements that are premature, and sometimes based on questionable grounds, such as an animal's behavior in captivity. Often the scientists who are actually working in the lab or in the field on the taxa under consideration, take a more cautious and conservative approach (a case in point is the use of the name *Lissotriton maltzani* for *L. boscai* from southern Portugal; they raise many *Lissotriton vulgaris* subspecies to species status; for *L. kosswigi* from northern Turkey this may be reasonable, but this is less clearly so for the subspecies *meridionalis*, *graecus*, and *lantzi*). Even so, it is laudable that the author is aware of the taxonomic issues and states explicitly which arrangement

he follows in his treatment of the species and subspecies. Frost (2011, subsequently updated through 2013) is an authoritative default position to fall back on for such a book. The introduction to the book has two pages of references to taxonomic literature. Reference to available textbooks on amphibian biology, or books on captive maintenance of salamanders, is surprisingly lacking.

But rather than dwelling on what the book is not or what it is missing, let me focus on what the book really is: it is a picture book and does not aspire to be anything more than that. As such it is by far the richest collection of color photos (750 of them) of salamanders existing on the book market. Many photos are of excellent quality, and have been made available by people who have studied the animals in the field. The photos taken by well-known herp photographers, such as Benny Trapp, who has made the greatest contribution to this volume, are especially outstanding. Indeed, not only for adult animals, but also for eggs, larvae, juveniles, and for salamander habitats, the book is a treasure trove. Where else can one find all Fire Salamander subspecies depicted in all their varieties? The subspecies of the Algerian Fire Salamander, *Salamandra algira*, are depicted in a large number of good photos (*S. a. tingitana* alone is depicted twelve times, covering two pages!). On the other hand such a dazzling quantity of photos, when presented without description or explanatory context, is not automatically optimally informative. More is not *per se* better. Many photos deserved a larger format in the book, and many others could have been skipped without much loss of information. To my taste, the layout is a bit messy, with too many small pictures on one page, separated by lines with graphic symbols relevant to terrarium information. A number of photos, while spectacular and deserving a better print quality, such as the pictures of the Olm (*Proteus anguinus anguinus* and *P. anguinus parkelj*), are not rendered in optimal quality.

So, for whom is this book intended? Chimaira is a publisher who successfully targets a fairly large market of amphibian and reptile enthusiasts, both German and international. This book will no doubt find its place among salamander enthusiasts, who can appreciate a comprehensive pictorial account of all salamander and newt varieties in the western part of the Old World. It does not serve as an introduction to newts and salamanders in general, nor will it qualify as a guide book to keeping salamanders in captivity. Better books are available for these purposes. This book, I would imagine, would serve wonderfully well as a gift to an American or Asian salamander lover, as a demonstration of the bewildering variety in color and form of the European salamander fauna.

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Amphibians and Reptiles (Naturalist's Handbooks 31)

Trevor Beebee. 2013. Pelagic Publishing, Exeter, United Kingdom (www.pelagicpublishing.com). [6] + 170 pp. Softcover. UK £19.99 (approximately US $33.00). ISBN 978-1-907807-45-9.

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The amphibians and reptiles of the British Isles have been featured in a number of previous publications which have provided a great deal of information on the biology, identification, and conservation of these animals (e.g., Arnold 1995; Beebee and Griffiths 2000; Arnold and Ovenden 2002; Inns 2009). Although relatively low in diversity when compared to its exotic counterparts, British herpetofauna has been afforded substantial attention by a number of dedicated researchers. Of these, Trevor Beebee, Emeritus Professor of Evolution, Behaviour and Environment at the University of Sussex, has published much on the subject. Throughout the book an obvious enthusiasm for the subject is shared, along with a host of research questions either yet to be answered, or to be continued from previous studies.

Where this book differs from previous publications is in its effort to encourage further research. This book appears largely targeted at amateur enthusiasts, but this does not stop it from being a useful text for research students and professionals alike. Moreover, it fulfils its aim of encouraging readers to design and implement their own studies, be it in their own back garden, a local heathland, or in a captive environment. It also encourages all scales of research, from a single individual working alone, groups working together such as in schools, through to developing partnerships with recognized organisations such as the Amphibian and Reptile Groups (ARGs) throughout the British Isles. Moreover, it highlights the need to conduct comparisons between geographic locations. The methods required to undertake such research are discussed throughout. Previously, the encouragement of research has only been briefly mentioned in the appendices of Beebee and Griffiths (2000). It is worth noting that this latest book by Professor Beebee does not focus on non-native and vagrant species to the extent provided in other publications (e.g., Inns 2009).

The book kicks off with an inspiring foreword provided by TV presenter and naturalist Chris Packham. The remainder of the book is separated into ten chapters, containing 92 figures and 20 distribution maps. Species-specific examples are given throughout the book and existing research is put into context. In line with its design for use by amateur enthusiasts, the book helpfully provides an ongoing glossary in the margin of each page to ensure the book is user-friendly.

The chapters start with a brief introduction on what makes reptiles and amphibians so interesting, why more research is needed, and how and what can be done to aid them. A chapter

on basic biology then provides a brief but well-rounded insight into all aspects of amphibian and reptile biology, capped off by a look at their taxonomy and evolutionary history. The third chapter covers the important subjects of ecology and conservation which are central to this book. It includes information on population dynamics, genetics and trends, and regulators of population size such as disease, competition, predation, human influence and environmental change. Community ecology is also covered, followed by a discussion on the conservation of British herpetofauna including the issues faced, and methods to improve their status, such as habitat management.

The subsequent chapter covers survey and monitoring techniques for different types of study, their pros and cons, considerations, and what to do with the data. This is followed by typical methods, a review of research topics and, perhaps most importantly, an array of questions to provide inspiration for studying amphibians and reptiles at their varying life stages (in chapters five and six, respectively). Uniquely, the book then provides an entire chapter on how schools and other enthusiastic groups can get involved by conducting field research or captive studies. Encouraging work by these small groups could make a substantial contribution to managing habitats, developing monitoring and research programs, and of course assisting in educating the next generation of herpetological enthusiasts.

Chapter eight provides information on the identification of British herpetofauna, including a set of keys for the various species and their different life stages, and a set of distribution maps derived from Inns (2009). Quite helpfully, a table of common habitats for each of the species is also provided to aid readers in finding their local herpetofauna in their natural habitats. More information on identifying the sexes of each species, as well as identification of reptiles by their shed skins, as included in some previous publications, would have been a good addition in this section. The distribution maps show ranges at the national scale, and a mention is given on how to find out information on a smaller spatial scale. It may be noteworthy that in contrast to the original distribution maps (Inns 2009), the Channel Islands have been omitted in this text. Furthermore, the Pool Frog, *Pelophylax lessonae*, Edible Frog, *Pelophylax* kl. *esculentus*, and Marsh Frog, *Pelophylax ridibundus*, together known as the water frogs, have been grouped into a single map.

A discussion of the essentials that every enthusiast needs to know for working with British reptiles and amphibians then covers legal considerations, appropriate handling methods (best avoided if possible), notes on general good practice, methods for individual identification and their application. It then goes on to discuss how to plan your research in order for it to be rigorous, and provides a well-written and easily understandable section on statistical methods and uses. Notes on potential publication outlets, and a mention of the regular herpetological meetings in Britain to meet like-minded enthusiasts and discuss ideas are also included. Within this section, it may have been pertinent to mention the statistical package 'R' which is a freely available emerging tool in data analysis. Finally, some very useful contacts, addresses and links are provided before the references and index. Perhaps some notes here discussing funding bodies to assist in the development of projects at varying scales would have proven useful, such as the ARG-UK Research Fund.

Unfortunately, there are a number of minor typographical errors throughout the book that have been overlooked. Nonetheless, as someone currently studying the ecology and conservation of two British reptile species (albeit on Jersey), I have found this book extremely interesting and thought-provoking. This book may be considered Trevor Beebee's retirement gift to the herpetological community in Britain, particularly as the royalties have been donated to Amphibian and Reptile Conservation (ARC)—a national wildlife charity dedicated to the conservation of herpetofauna and their habitats. In summary, this is a fantastic addition to the existing literature on British herpetofauna, and I have no doubt that this book will become a part of many enthusiasts' collections of literature on the subject, both professional and amateur.

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Arnold, E. N., and D. Ovenden. 2002. A Field Guide to the Reptiles and Amphibians of Britain and Europe. HarperCollins, London. 288 pp., 49 pls.

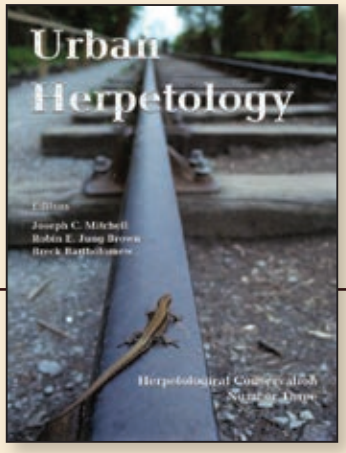
Arnold, H. R. 1995. Atlas of Amphibians and Reptiles in Britain. HMSO, London. [4] + 40 pp.

Beebee, T. J. C., and R. A. Griffiths. 2000. Amphibians and Reptiles. HarperCollins, London. 270 pp., 8 pp. pls.

Inns, H. 2009. Britain's Reptiles and Amphibians: A Guide to the Reptiles and Amphibians of Great Britain, Ireland and the Channel Islands. WildGuides, Old Basing, Hampshire, United Kingdom. 164 pp.

Herpetology Conservation Book Series Seeking Manuscript Proposals

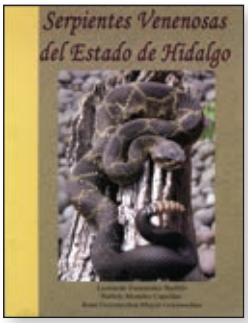
Herpetological Conservation, a book series published periodically by SSAR, is seeing proposals (titles) for the next volume. This is an underused publication outlet devoted to the conservation and management of amphibians and reptiles. The last volume in this series, *Urban Herpetology*, contains 40 chapters and 13 case studies, written by 120 authors from 17 countries. Proposals should address topics broadly applicable to herp conservation and management, geographic coverage should be global in scope or at least regionals, and the work makes an important contribution to a topic not well covered by other publications. All inquiries should be directed to the series editor, Joseph Mitchell (dr.joe.mitchell@gmail.com).



PUBLICATIONS RECEIVED

Serpientes Venenosas del Estado de Hidalgo

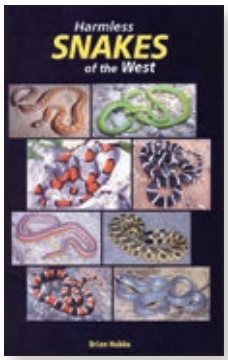
Leonard Fernández-Badillo, Nallely Morales-Capellán, and Irene Goyenechea-Mayer Goyenechea. 2011. Universidad Autónoma del Estado del Hidalgo, Pachuca, Hidalgo, México. 98 pp. Softcover. MXN $150 (approx. US $11.50 plus shipping). ISBN 978-607-482-161-1. [In Spanish, available from authors; e-mail: ventasolmec@hotmail.com]



This book follows closely the publication of a statewide checklist by Ramírez-Bautista et al. in 2010, but focuses on a subset of the herpetofauna—venomous snakes—that generates much interest among biologists and the general public alike. The state of Hidalgo is positioned in east-central México and is dominated by the Sierra Madre Oriental. Despite its small size (ca. 21,000 km^2), Hidalgo's varied landforms (elevations ranging from 18–3490 m), vegetation, and climate have promoted a remarkably diverse venomous snake fauna. The authors list 16 species of clearly venomous species—3 elapids and 13 viperids—as occurring within the state's borders, and also discuss briefly several colubrids known or suspected to be venomous even if their bites are not medically significant (although bites from species of *Coniophanes* often warrant medical attention). Species accounts for each of the 16 venomous species contain descriptions, natural history, habitat and distribution, conservation status, venom type and envenomation symptoms, and include multiple high quality color photos. Various other species are also represented by color photos; these include potentially venomous colubrids, coralsnake mimics, and other harmless species that might be confused with venomous ones. This is a book likely to be of particular interest for those people who live and work in this part of México—biologists, conservationists, medical and public health personnel, teachers, and interested citizens.

Harmless Snakes of the West

Brian Hubbs. 2013. Tricolor Books, Tempe, Arizona. 130 pp. Softcover. US $19.95. ISBN 978-0-9754641-4-4. [Available from the author; e-mail: tricolorbrian@hotmail.com]



This book is written for readers searching for very basic information about snakes in the western half of the United States. However, the exclusive focus on "harmless" species could present a challenge for a reader who observes any of the venomous species within the coverage area, forcing consultation with another source for identification. The author states that "Many people know the difference between harmless and venomous species, and if they don't they should." Tough to do when the latter group is missing from the book! Species accounts include a brief history (when and who described the species), non-standard common names, identification, brood size, range, prey, habitat, and notes. Small, color-shaded distribution maps vary considerably in their level of detail from species to species, with species like the California Mountain Kingsnake mapped in exquisite detail (no doubt reflecting the author's longstanding interest in that species), while other species (e.g., Rosy Boa) are depicted as having a much more generalized range. There are plenty of things in this book that herpetologists will find annoying: using "poison" instead of "venom"; capitalizing the words "Genus" and "Genera"; and suggesting that all snakes have a specific "job, which is helping to control other species of animals so they do not cause environmental problems." The listing of first describers at the start of species accounts (e.g., "*Arizona elegans elegans* Kennicott, 1859") seems out of place in this type of work. The blending of *Coluber constrictor* and *Drymobius margaritiferus* into a single account is perplexing. The inclusion of even the most obscure colloquial names yields appellations like "Rossel Bastard" for hog-nosed snakes (*Heterodon* spp.). Troublesome as these might be, most are likely to go unnoticed by the target reader who will appreciate the photos and colorful maps.

ABOUT OUR COVER: *Salamandra salamandra*



Salamanders of the genus *Salamandra* are represented by seven species whose collective range covers most of central and southern Europe, and extends into western Asia and Northern Africa (Frost 2014. Amphibian Species of the World: an Online Reference. Version 6.0 [accessed 10 February 2014]. Electronic database accessible at http://research.amnh.org/herpetology/amphibia/index.html. American Museum of Natural History, New York; Vences et al. 2014. Molecular Phylogenetics and Evolution, *in press* <http://dx.doi.org/10.1016/j.ympev.2013.12.009>). The Iberian Peninsula is a hotspot for *Salamandra* diversity, harboring the highest concentration of taxa. The best known of these, the Fire Salamander (*Salamandra salamandra*), has the broadest distribution and exhibits considerable diversity, with numerous subspecies having been described (Thiesmeier and Grossenbacher 2004. *In* Thiesmeier and Grossenbacher [eds.], Handbuch der Reptilien und Amphibien Europas, vol. 4/IIB, pp. 1059–1132. Aula-Verlag, Wiebelsheim; Köhler and Steinfartz 2006. Salamandra 42:13–20; Glandt 2010. Taschenlexikon der Amphibien und Reptilien Europas. Quelle & Meyer Verlag).

Much of this diversity is the result of range fragmentation during glacial maxima across Europe followed by post-glacial recolonization (Steinfartz et al. 2000. Molecular Ecology 9:397–410). Obtaining a clear picture of the evolutionary history of this group has been complicated by conflicting phylogenetic signals; García-París et al. (2003. Evolution 57[1]:129–143) noted that the "*Salamandra salamandra* complex represents a challenging morphological, systematic, and biogeographical problem."

Salamandra salamandra is notable for dramatic differences in reproductive biology even within the mountains of northern Spain. Females release small larvae directly into streams (thus bypassing the aquatic egg stage, which occurs within the mothers' oviducts), while females from some populations in northern Spain give birth to terrestrial, fully metamorphosed young following prolonged oviductal retention (Thiesmeier and Haker 1990. Salamandra 26:140–156; Alcobendas et al. 1994. Mertensiella 4:7–23; Dopazo and Alberch 1994. Mertensiella 4:125–137; Salvador and García-París 2001. Anfibios Españoles. Canseco Ed. Talavera de la Reina, Spain). Intrauterine cannibalism of developing siblings and unfertilized eggs has been documented (Dopazo and Alberch, *op. cit.*). Populations in the Cantabrian Mountains and southwestern Pyrenees are notable in displaying both reproductive modes, complexity that is unknown in other amphibians. Adults from viviparous populations are smaller, and often have a striped color pattern (as can be seen in our cover subject), while salamanders from ovoviviparous populations tend to be larger and have a pattern consisting of spots or discontinuous stripes.

The bright colors in all forms of Fire Salamanders signal the presence of highly toxic skin secretions. Remarkably, these can be sprayed at high velocity from large, pressurized skin glands in response to a predatory attack (Brodie and Smatresk 1990. Herpetologica 46[1]:1–7). Moreover, salamanders are able to control the directionality of defensive sprays, specifically targeting the source of the threat. Similar gland arrangements have been found in two other European salamandrids, *Salamandra atra* and *Lyciasalamandra luschani* (Brodie and Smatresk, *op. cit.*)

2014 has been designated the Year of the Salamander (www.amphibians.org), and thus it seems appropriate that our first cover of 2014 should feature this taxon. Our cover image was obtained by **Henrik Bringsøe**, a Denmark-based field herpetologist whose interests are focused mainly on herpetofauna of Europe and Southeast Asia. He is a co-author of the German-language book series *Handbuch der Reptilien und Amphibien Europas*. Bringsøe encountered this adult *Salamandra salamandra* in northern Spain in June 2013, on the southern slopes of the Cantabrian Mountains. The image was recorded with a Canon 7D, using a 24mm 1:1.4 L II USM lens, mounted on a Manfrotto tripod (055 carbon fibre Q90 3-section) with a Light Duty Grip Ball Head (327RC2). ISO was set to 100, shutter speed one second, and a two-second self-timer was used in combination with mirror lock-up. A Speedlite 580EX II was camera-mounted but directed upward to a hand-held white nylon reflector (Dörr), positioned at a 45-degree angle to provide fill light.



PHOTO BY AOI BRINGSØE

Editor's note.—Special thanks to David Buckley for consultation.

SSAR BUSINESS

Call For Symposium Proposals
SSAR 2015 — University of Kansas

Symposia are important components of the Annual Meeting, and especially so at the 2015 SSAR Meetings at KU. These events allow researchers in a given subfield to come together and present the latest research in that area, while society members benefit by engaging in these cutting-edge topics and interacting with the symposium participants. We invite the submission of symposium proposals for the 2015 Annual Meeting of the Society for the Study of Amphibians and Reptiles in Lawrence, Kansas.

Full guideline details can be found on the SSAR website (http://www.ssarherps.org/pages/symposium.php), but a summary of proposal criteria is given below.

Proposal Submission—Symposia proposals (3-page maximum) for consideration by SSAR should contain the following:

1. Symposium Title (or Topic).
2. Name(s) of the Symposium Organizer(s) (phone number and e-mail address).
3. Topic information and background.

4. Benefit of the topic to the Society?
5. List of potential speakers and topics.
6. Length of symposium (1/2 day or 1 day).
8. SSAR funding requested, with a short budget (max = $2,000) and other funding sources.

PROPOSALS DUE TO SSAR COORDINATOR by 1 May 2014. Proposals should be submitted (as PDF, Word, or RTF documents) to Richard D. Durtsche (durtsche@nku.edu)

NEWSNOTES

Latest Edition of *FrogLog* Now Available

The most recent issue (number 109) of *FrogLog*, the online newsletter of the Amphibian Survival Alliance (ASA), is now available for download at: http://www.amphibians.org/froglog/fl109. Each issue is filled with images and information about amphibians and their conservation. Among other topics of interest, this issue highlights 2014 as the "Year of the Salamander."



UC Berkeley Scientist Tyrone Hayes Honored with E.O. Wilson Award

In December 2013, the Center for Biological Diversity announced its second annual E.O. Wilson Award for Outstanding Science in Biodiversity Conservation to Tyrone Hayes, a biology professor at the University of California, Berkeley. Dr. Hayes' research has focused on the threat posed to frogs by pesticides and the role of chemical pollution in the decline of amphibian species worldwide.

"It's a great honor to recognize Dr. Hayes' courageous science and advocacy to protect people and wildlife from pesticides," said Kierán Suckling, executive director of the Center. "His career demonstrates the leadership role scientists must take in helping to protect the irreplaceable biodiversity that sustains life on Earth." Hayes' research found that the herbicide atrazine is harmful to amphibians, turning male frogs into females by disrupting normal hormonal development. He has also worked to highlight the health disparities that occur in minority and low-income populations. He has been heavily criticized by the chemical industry, which has tried to discredit his research in attacks similar to those made on Rachel Carson, Theo Colborn, and Sandra Steingraber in the past. Hayes completed his undergraduate degree at Harvard and his Ph.D. at UC Berkeley before becoming a professor at Berkeley in 1994. "One effect in the relative neglect of biodiversity is the continuing decline and extinction of frog species," said E.O. Wilson, the award's namesake. "Dr. Hayes' work on atrazine is especially relevant to the problem, and I congratulate him on receipt of the E. O. Wilson Award on both his research and the example he sets." The Center presents the award annually to a scientist who has made an outstanding contribution to biodiversity conservation. It is named after renowned scientist Edward O. Wilson of Harvard University, known as "the father of biodiversity." Wilson is considered to be the world's leading authority on ants; his career has focused on promoting worldwide understanding of the importance of biodiversity and the preservation of our biological heritage.

Sabin Award for Amphibian Conservation

Since 2007, Conservation International and the IUCN Amphibian Specialist Group have been offering the Sabin Award for Amphibian Conservation. Recipients have included Luis Coloma (Ecuador), Franco Andreone (Italy), Jonh Jairo Mueses Cisneros (Colombia), SD Biju (India), Herilala Randriamahazo (Madagascar), Alonso Quevedo (Colombia), Karen Lips (USA). The 2013 recipient is Darrel Frost, Curator-in-Charge, Division of Vertebrate Zoology at the American Museum of Natural History.

The award recognizes true leaders in local and global research and conservation efforts toward addressing the ongoing demise of the world's amphibians. The award is sponsored by Andrew Sabin, a conservationist and philanthropist whose efforts and generosity are direct contributions toward global conservation efforts, including significant contributions toward amphibians.



Andrew Sabin (left) presents the 2013 Sabin Award for Amphibian Conservation to Darrel Frost, at a ceremony held in New York City in November 2013.

To quote from one of the nomination letters: "Through the *Amphibian Species of the World* (ASW), Darrel Frost has contributed what many consider to be the most significant single work in the history of amphibian biology. Reliable taxonomic information is essential for amphibian conservation, and for three decades ASW has been the primary reference for amphibian taxonomy. By providing a centralized source of taxonomic and geographic information that is otherwise scattered across a vast literature, ASW facilitates and enables research in systematics and provides easy access to this information for workers in fields like conservation biology and ecology. ASW is also the authority database used by numerous governmental and non-governmental organizations and other online databases to obtain information on amphibian taxonomy."

SSAR greatly appreciates Andrew Sabin's vision and efforts and extends congratulations to the winners of this award, and we applaud our colleague Darrel Frost, particularly with respect to his significant contributions to moving amphibian systematics into the modern era.

MEETINGS

Meeting announcement information should be sent directly to the Editor (herpreview@gmail.com) well in advance of the event. We also welcome brief reports of meetings; please consult the Editor for details.

22–24 April 2014 — Edward O. Wilson Biodiversity Symposium, University of Alabama, Tuscaloosa, Alabama, USA. Information: http://biodiversity.ua.edu/

26 April 2014 — 3rd International Bornean Frog Race, Kubah National Park, Matang, Sarawak, Malaysia. Information: www.theinternationalborneanfrograce.weebly.com

26–30 April 2014 — 4th International Week of Amphibians, Berriozábal, Chiapas, Mexico; together with 2nd National Congress on Amphibians. Information: redanfibioschiapas@hotmail.com, Facebook (Red De Anfibios En Chiapas), or Twitter (@REDdeANFIBIOS).

14–18 May 2014 — East Texas Herpetological Society 25th Anniversary Meeting, Liberia, Costa Rica. Information: http://eths.org/event/costa-rica2014/

18–20 May 2014 — 6th Conference on the Biology of Plethodontid Salamanders, University of Tulsa, Tulsa, Oklahoma, USA. Information: http://plethodontids2014.weebly.com

9–11 June 2014 — Southwestern Partners in Amphibian and Reptile Conservation (SW PARC) annual meeting, San Diego, California, USA. Information: www.swparc.org

4–7 June 2014 — Biology of the Pitvipers 2, Tulsa, Oklahoma, USA. Information: http://www.biologyofthepitvipers.com

16–20 July 2014 — International Herpetological Symposium, Riverside, California, USA. Information: https://www.facebook.com/InternationalHerpetologicalSymposium

30 July–3 August 2014 — Joint Meeting of Ichthyologists and Herpetologists (SSAR, HL, ASIH), Chattanooga, Tennessee, USA. Information: http://www.dce.k-state.edu/conf/jointmeeting/

2–8 August 2014 — International Symposium Amphibians & Reptiles, Sarapiquí and Costa Ballena, Costa Rica. Information: reservaciones@selvaverde.com

22–24 August 2014 — Midwest Partners in Amphibian and Reptile Conservation (MW PARC) annual meeting, Loretto, Minnesota, USA. Information: www.mwparc.org

1–5 October 2014 — 50th Annual Meeting of the German Society for Herpetology and Herpetoculture, Bonn, Germany. Information: www.dght.de

19–22 November 2014 — 12th Symposium of the Herpetological Association of Africa, Gobabeb Research and Training Centre, Namibia. Registration deadline 31 May 2014. Information: www.africanherpetology.org



NEW EDITION

Contributions to the History of Herpetology

Volume 1, Revised and Expanded • Edited by Kraig Adler

In 1989, SSAR issued the first volume in what became a series of three containing the biographies (with portraits and signatures) of 786 herpetologists from throughout the world. The biographies provide key details of each person's life and education and their major contributions to herpetology and science generally, all written in an engaging style. As Jay Savage recently wrote in reviewing this series: *There is, of course, a serious problem with this great work. Once one opens it . . . one can't put it down because the next page and the page after that are so inviting!* Volume 1 has now been out-of-print for 15 years; rather than simply reprint it, **we take this opportunity to correct errors and to add 110 pages of plates and other new material**.

Volume 1 covers 152 herpetologists and includes most of the world leaders in our discipline. Their names are immediately familiar to us as authors of major works or as teachers or explorers. Many species have been named in their honor. Among them are:

• Classical authors such as Boulenger, Cope, the Duméril, Mertens, Noble, Schlegel, Schmidt, and Stejneger.

• Great naturalists who published on amphibians and reptiles: Agassiz, Cuvier, Gessner, and Linnaeus.

• Explorers such as Espada, Prince Maximilian, and Spix.

• Collection builders: Baird, Barbour, Gray, Günther, Wilhelm Peters, Seba, Steindachner, and Van Denburgh.

• Ditmars, Kauffeld, and serious amateurs like Klauber and Malcolm Smith, all of whom were popularizers.

• Authors of texts (Goin, Terentjev); great teachers (Myers, Ruthven, Wright); anatomists (Bojanus, Camp, Romer); ecologists and behaviorists (Blair, Cowles, Tinkle); etc.

• Outstanding herpetological artists such as Roesel von Rosenhof and Sordelli.

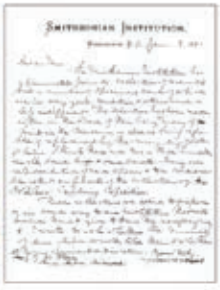
• Geographic coverage is global: North America (Cochran, Garman, Girard, Holbrook, James Peters, Pope, Taylor); Australia (Kinghorn, Krefft, Waite); Africa (Anderson, FitzSimons, Loveridge, Pitman); Russia (Bedriaga, Chernov); etc.

• Experts on taxonomic groups: frogs (Liu, Okada); salamanders (Bishop, Dunn, Sato); turtles (Carr, Siebenrock); snakes (Amaral, Blanchard, Gloyd, Jan, Maki, Russell, Wall); etc.

• Plus 81 other persons, for a total of 152 biographies.

Two sections—"Taxonomic Authors" by John Applegarth and "Doctoral Lineages" by Ronald Altig—were revised in volume 3 (2012), thus the versions in volume 1 are out-of-date and have been replaced in this new edition of volume 1 with **110 pages of new materials that supplement the biographies in volume 1**. These include original handwritten letters such as one by Linnaeus expressing his surprise at observing a siren for the first time, and another from a 20-year-old G. K. Noble, who had been a bird watcher, exclaiming his conversion: "I am a real honest-to-goodness herpetologist." **There are 60 plates (52 in full color) from classical herpetological books, many of them titles that are locked away in rare book rooms and hardly ever seen by most herpetologists. The plates have extensive captions that contain much new and important information, including details about the many outstanding artists who drew them.** All portraits from the 1989 edition have been scanned with modern laser technology for much improved quality of reproduction. A section of corrections and additions to volumes 2 and 3 is added, together with a number of portraits that had been missing from the series. **A new comprehensive index, with more than 5,000 entries**, covers the entire series including all the many new persons added in the revisions to volume 1.








Specifications for Volume 1 (revised): 272 pages (8.5 × 11 inches [21.5 × 28 cm]), bound in library-grade cloth. Color frontispiece, 52 color plates; 155 portraits with signatures. Comprehensive index to series. ISBN 978–0–916984–19–9. *To be published August 2014*. • **Prices: Pre-publication price for Volume 1 (revised) to SSAR members US$48**; to all others $60. Regular prices for volumes 2 (2007; 285 biographies, 400 pp.) $65; volume 3 (2012; 349 biographies, 570 pp.) $75. **Special price for a complete set, volumes 1 (revised), 2, and 3 to SSAR members $150**; to all others $175. • **Shipping:** Add $5 per volume; non-USA, shipping at cost. • **Orders to:** SSAR Publications Secretary, P.O. Box 58517, Salt Lake City, Utah 84158–0517, USA (*telephone and fax*: 801–562–2660; *e-mail*: ssar@herplit.com). • **Payment:** Make checks payable to "SSAR." Non-USA orders must be paid in USA funds using a check drawn on an American bank or by International Money Order. Books may be charged to American Express, Discover, MasterCard or VISA (please give account number and expiration date). • **SSAR Membership and Other Publications:** Membership information and a list of society publications can be obtained from the Publications Secretary at the address given above or at www.ssarherps.org.

A First Update on Our Planning for the

UNIVERSITY OF KANSAS MEETING IN 2015

Society for the Study of Amphibians and Reptiles

***co-sponsored by* Partners in Amphibian and Reptile Conservation (PARC)**

together with the herpetological societies of Arkansas, Kansas, and Missouri
and the International Society for the History and Bibliography of Herpetology

KEYNOTE LECTURER



David Hillis
University of Texas at Austin
Evolutionary Insights from Studying Amphibians and Reptiles

Symposium
Evolutionary Frontiers in Herpetology
Organized by Rich Glor and Rafe Brown

This event will bring together a suite of primarily early-career, exceptionally research-active herpetologists working at the forefront of emerging evolution-related fields, using amphibians and reptiles as study systems. Topics will include, but not be limited to, the fundamentals of adaptation, speciation, adaptive radiation, evolutionary dynamics of infectious disease, convergence, phenotypic evolution, and the evolution of development—all through the lens of genomic approaches to understanding evolution of amphibians and reptiles. ■

SSAR will hold its 2015 meeting on the beautiful campus of the University of Kansas, one of America's major research universities and a world center for research and graduate education in herpetology. This will be held from **Thursday, July 30 through Monday, August 3.** All scientific sessions will be held in the Kansas Union, which is adjacent to the Museum of Natural History and only a 5-minute walk from the air-conditioned student dorms where most persons will stay. The society held highly successful meetings at KU in 1977 and 1996, and we anticipate another memorable event in 2015. The intimate campus setting will facilitate personal and friendly interactions while moderating fees for registration and lodging (see projected rates below).

The structure of the meeting will include the standard oral presentations and poster sessions, silent and live auctions, commercial and non-commercial display booths, student social, topical symposia, and special lecturers (see adjacent columns). In addition, we are resurrecting some activities from earlier SSAR meetings that were extremely popular with delegates. These include the following:

- Audiovisual shows arranged by David Dennis and Eric Juterbock, completely re-done using modern digital technology (see below).
- Tours of the Henry Fitch Natural History Reservation, where Fitch's classic long-term studies were conducted. These tours will be led by George Pisani, who was Fitch's last field collaborator.

PRESIDENTIAL LECTURER



Miguel Vences
Technical University of Braunschweig (Germany)
Inventory of an Imperiled Paradise: Two Decades of Herpetology in Madagascar

- Tours of the newly renovated herpetological research laboratories in the Museum of Natural History and Biodiversity Institute.
- Display of live Kansas amphibians and reptiles, with photographic set-ups for your use.
- Reception honoring distinguished senior herpetologists. This event is being designed specifically so that students will have an opportunity to meet the honorees on a personal level.
- Herpetological Quiz, being arranged by the herpetology graduate students at the University of Texas at Arlington and those at KU. Separate student and professional categories, with prizes to the winners.

NOTE: Other symposia are in the planning stages. These will be announced in future updates.





In 1979, SSAR premiered the first of four half-hour audiovisual shows featuring herps, herp habitats, and herpetologists, that became highly popular events at its annual meetings over the next 25 years. These shows have not been seen for ten years and are now being completely revised using high-definition Blue Ray technology. Most of the photography will be completely new. Several of these newly revised shows will debut at the KU meeting in 2015.



PROJECTED COSTS FOR 2015

- *Registration fees (member rates):*
  - Students ..... US $150
  - Regular $295
  - Seniors, retired / over 70 ..... $150
- *Dorm room rates (on campus, linens included):*
  - Dual-occupancy rooms or suites, per day ..... starting at $35
  - Single-occupancy rooms or suites, per day ..... starting at $55

There are also several local motels and a major hotel at the edge of campus. The motels allow more persons per room, at lower per-person costs than for the on-campus dorms (as low as $25/person). Full details will be supplied in the formal *Announcement and Registration Information* that will be posted on-line in Spring 2015.

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Archbold Biological Station

Roger Conant Grants-in-Herpetology
JOSHUA M. KAPFER
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Long Range Planning Committee
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Nominating
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Yale Peabody Museum of Natural History

Resolutions
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The Ohio State University

Seibert Awards
RAFE BROWN
University of Kansas

Standard English and Scientific Names
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Herpetological Review is a peer-reviewed quarterly that publishes, in English, articles and notes concerning the study of amphibians and reptiles, as well as book reviews, commentaries, regional and international herpetological society news, and letters from readers directed to the field of herpetology. Articles reporting the results of experimental research, descriptions of new taxa, or taxonomic revisions are not published in ***HR***, but should be submitted to the ***Journal of Herpetology*** (for information, please refer to: http://www.ssarherps.org/pages/JHinstr.php). To submit a manuscript to ***HR***, please consult the SSAR webpage at:

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All members of the SSAR are entitled to vote by mail ballot for Society officers, which allows overseas members to participate in determining the Society's activities; also, many international members attend the annual meetings and serve on editorial boards and committees.

All members and institutions receive the Society's primary technical publication, the *Journal of Herpetology*, and its bulletin, *Herpetological Review*; both are published four times per year. Members also receive pre-publication discounts on other Society publications, which are advertised in *Herpetological Review*.

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Future Annual Meetings
2014 — Chattanooga, Tennessee, 30 July–3 August (JMIH with ASIH, HL, and AES)
2015 — Lawrence, Kansas 30 July–3 August (SSAR with PARC and KHS)

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ABOUT OUR COVER: *Lanthanotus borneensis*



Lanthanotus borneensis, the Bornean Earless Monitor, surely among herpetology's "holy grails," is a 200-mm (SVL) varanoid lizard whose common name reflects the lack of an ear opening. This poorly known, enigmatic species is considered to be the sole living representative of the family Lanthanotidae. The only other taxon allocated to the Lanthanotidae is *Cherminotus longifrons*, from the Upper Cretaceous in the Gobi Desert, Mongolia (Borsuk-Białynicka 1984. Palaeontol. Polonica 46:5–105), although this taxonomic allocation has been challenged (Gao and Norell 2000. Bull. Amer. Mus. Nat. Hist. 249:1–118).

The name *Lanthanotus* is derived from Greek, meaning "hidden ears," but a shallow tympanic cavity is present. Males show blunt, rectangular jaws, while females have relatively pointed jaws. The dorsal surface is brownish-orange, sometimes with a dark vertebral stripe, and the venter is yellow with brownish orange and ochre mottling; the tongue is pink.

The Lanthanotidae has been assigned to the anguinomorphan lizards (McDowell and Bogert 1954. Bull. Am. Mus. Nat. Hist. 105:1–142), but the relationships among these families have been the subject of debate. Lee's cladistic analysis (1997. Phil. Trans. Royal Soc. London B 352:53–91), based on osteological characters, reveals that the lanthanotids and varanids are the closest relatives of snakes. An early molecular study of Fuller et al. (1998. Mol. Phylogen. Evol. 9:294–307), using 12S rRNA sequences, showed surprisingly low sequence divergence between these two groups, and a sister-taxa relationship was revealed by Ast (2001. Cladistics 17:211–226). More recent molecular studies of global squamates using nuclear genes confirm the position of the Lanthanotidae within the Anguinomorpha, with a sister relationship with the Varanidae; these two lineages, along with Shinisauridae, are sister to the Helodermatidae and other members of the Anguinomorpha (Wiens et al. 2012. Biol. Letters 8:1043–1046; Pyron et al. 2013. BMC Evol. Biol. 13:93). The most recent common ancestor node for the family corresponds to the Mid-Cretaceous, 108 mya (Douglas et al. 2010. Mol. Phylogen. Evol. 55:153–167).

Described by Fritz Steindachner (1877. Denkschr. Kais. Akad. Wiss., Wien 38:93–96) based on a specimen now in the Vienna Museum of Natural History (Naturhistorisches Museum Wien 16365) from Sarawak, *Lanthanotus borneensis* is known to inhabit lowland forests and low hills of northwestern Borneo, including the states of Sarawak (Malaysia) and Kalimantan Barat (Indonesia), and is seldom encountered. Consequently, little is known of its field biology, and this subfossorial and aquatic species feeds on earthworms and crustaceans, and probably fish. Nocturnal, its daytime retreats include burrows up to about 30 cm, under vegetation, rocks, and litter of rocky stream banks. Semi-torpid by day, at night it forages on land and in water. Typically sluggish, it can flatten its body when touched, and other behaviors associated with threat response includes struggling, defecating, hissing, and biting. Skin is shed in a single piece, similar to that in some other anguinomorphan squamates and snakes. Mating has been observed in early February, females producing 2–5 oval, leathery-shelled eggs that measure ca. 30 mm in length.

Our cover image was captured by **Indraneil Das** in western Sarawak, East Malaysia (Borneo), using a Nikon D600 and AF-S VR Micro-Nikkor 105mm f/2.8G IF-ED lens. Shutter speed set at 1/60 sec, f/18, using an off-camera Nikon SB-910 flash unit, attached to a Lastolite Ezybox Hotshoe.



PHOTO BY PUI YONG MIN

Das is Professor at the Institute of Biodiversity and Environmental Conservation, Universiti Malaysia Sarawak. His current research centers on ecology and conservation of amphibians and reptiles, especially the role of fragmentation and other landscape change, and the systematics and natural history of these species, especially in tropical Asia. His work on *Lanthonotus* was supported by a Mohammed bin Zayed Species Conservation Grant.

SSAR BUSINESS

2013 Annual Meeting, Albuquerque, New Mexico

The 56th Annual Meeting of SSAR took place from 10–15 July 2013 at the Albuquerque Convention Center in Albuquerque, New Mexico, USA (Fig. 1). Organizing societies this year were Society for the Study of Amphibians and Reptiles (along with the International Society for the History and Bibliography of Herpetology), American Elasmobranch Society (celebrating its 29th annual meeting), American Society of Ichthyologists and Herpetologists (celebrating its 93rd annual meeting) and The Herpetologists' League (celebrating its 71st annual meeting). The meeting was hosted by the University of New Mexico and the Museum of Southwestern Biology. The local hosts were Tom Turner, Lex Snyder, Steve Ross, Tom Giermakowski, Steven Platania, Norman Mercado-Silva, and Mason Ryan. They were assisted by a small army of volunteers including Meghan Balk, Olivia Chavez, Tracy Diver, Elizabeth Gallagher, Levi Gray, Victoria Hansen, Angela Hung, Ian Latella, Lorraine McInnes, Tyler Pilger, Jolene Rearick, Mason Ryan, Brad Truett, and Rhiannon West. Thanks to K-State University Division of Continuing Education. We thank all of the above for a fun and successful meeting.

Nearly 900 herpetologists and ichthyologists attended the meeting. This number includes 417 students and 303 members of SSAR. The meeting included 45 oral sessions and five symposia. Symposia topics included "Detectability and Studying Rare Species: When Cryptic Natural Histories Defy both Conventional



FIG. 1. Welcome poster (Native American pottery designs from southwestern Pueblo group) designed by David Dennis and given by SSAR to all who attended the annual meeting. SSAR thanks James and Sarah Christiansen for their sponsorship.



PHOTO BY R. DURTSCHE

FIG. 2. Participants in the SSAR-sponsored symposium "Impact of Energy Development on Amphibians and Reptiles in North America." L to R: Steve Spear, Denim Jochimsen, Doug Keinath, Priva Nanjappa, Wendy Palen, Barry Sinervo, Jeff Lovich, Lee Fitzgerald, Jen Williams, Jessica Homyack, Jackie Guzy.



PHOTO BY M. PREEST

FIG. 3. Some of us escaped from the meeting and the heat for a few hours. Here, Lynn Haugen, Marcus Simons, and Julian Lee enjoy the view from the top of the aerial tramway on Sandia Peak.

and Progressive Statistics," "Fishes and Morphology Today," and "Fish Out of Water: Evolutionary and Ecological Issues in the Conservation of Fishes in Water-Altered Environments." SSAR sponsored a symposium entitled "Impact of Energy Development on Amphibians and Reptiles in North America." This timely topic attracted a diversity of speakers (n = 16) and a large audience (Fig. 2). We thank Jeff Lovich and Priya Nanjappa for co-organizing this symposium.

Following the usual pre-conference day of Board and Executive Committee meetings, the JMIH began officially with the Plenary Session on July 11th. Local Host Committee Chair, Tom Turner, welcomed us warmly to Albuquerque and thanked the other members of the local committee and the many donors who contributed to the 2013 JMIH. He then introduced Ray Powell (New Mexico Commissioner of Public Lands and a veterinarian) who spoke about the importance of scientists engaging actively with government and other elected officials. He noted that these officials don't know who we are or what we have to offer, hence the need for us to approach them, to communicate with them, and to "make them look good!"

Following Commissioner Powell's talk, various awards were presented. Bill Matthews presented the Robert H. Gibbs Award to Lynn Parenti who noted that this was the 37th ASIH/JMIH meeting in a row that she has attended. The Henry S. Fitch Award for Excellence in Herpetology was presented *in absentia* to Roy McDiarmid by Henry Mushinsky. The Robert K. Johnson Ward for Excellence in Service to ASIH was presented *in absentia* to Pat Gregory by Al Savitzky. Steve Mullin announced Craig Guyer as the winner of the 2013 SSAR/HL/ASIH Meritorious Teaching Award in Herpetology. The PARC Alison Haskell Award for Excellence in Herpetological Conservation was given to Charlie Painter and the first Joseph Nelson Award for Lifetime Achievement in Ichthyology was presented to Gerald Smith.

Tom Turner then introduced the Keynote Speaker, William deBuys, a writer and conservation biologist, who entitled his talk "Hotter and Drier: Life in the 21st Century Southwest." The speaker particularly focused on rainfall and water availability, but also spoke about models and observations, record climactic events in the past few years (e.g. according to records, New Mexico has just experienced its driest 24 months and its hottest month in July of 2012), increases in CO_2 concentrations, the impacts of increased energy on the Earth, expansion of Hadley cells, and the recession of sea ice. An interesting point the speaker made was that, unlike other major natural disasters (e.g., tornados and hurricanes),

which tend to bring people together, drought divides people, often bitterly. He finished by noting that, just like the Mount Graham Ground Squirrel, humans also live on a habitat island (in our case, the Earth) and commented that he sees much beauty on Earth in the diversity of organisms and their adaptations, especially in the desert southwest and that as long as there is beauty, there is something to protect. The talk was a fitting way to open a meeting in such a beautiful location (Fig. 3).

Gregor Caillet, the AES plenary speaker, then spoke on "Unravelling the Secret Lives of Sharks and Rays" and David Sever, the Herpetologists' League Distinguished Herpetologist gave a presentation on his career as a "HistoHerpetologist." Dave noted that he started his herp collection at the age of 14 (much of which is now at University of Michigan) and joined SSAR, ASIH, and HL at the age of 15. He then commented on his interest in skin glands in salamanders—a field in which he found his "special niche." His take home message was "if you love research, you'll find the time and the funds to do it."

The ASIH Past Presidential Address officially titled "Physiological Ecology: Past, Present, and Future" was then given by Steve Beaupre. The actual title Steve admitted was "Cool Stuff I've Learned about Rattlesnakes." He decided to become a herpetologist at age 7 and confessed that rattlesnakes had become an obsession. A key aspect of his research is trying to understand the effects of the laws of thermodynamics on organisms, and in his career he has addressed questions on metabolism, bioenergetics, heat budgets, mass budgets, and behavior. He spoke about his work in Big Bend, Texas on two populations of Rock Rattlesnakes, in which he looked at the effects of elevation, temperature, and rainfall on bioenergetics. One of the key things he learned to appreciate was how flexible these snakes are in their ability to cope with the environment. Steve spoke about his postdoctoral research in which he particularly focused on terrestrial ectothermic vertebrates as low energy systems and began connecting energetic costs with behaviors. Steve's research at the University of Arkansas has included long-term studies of Timber Rattlesnakes, focusing on "boom and bust" years for snake populations. He noted dramatic changes in field metabolic rates, growth rates, and reproductive activity over the years and referred to the snakes as classic bet-hedgers, able to tolerate extreme starvation, but with the capacity for rapid physiological upregulation in acorn (and thus small mammal) mast years.

Following the Plenary Session, we congregated on steps in the large Civic Plaza opposite the Convention Center for the group photo (Fig. 4).

Social and Professional Events

Past-President Joe Mendelson, III (Zoo Atlanta) gave the 2013 SSAR President's Travelogue ("The Ballad of Gringo Perdido: The Art of Getting Lost") on the evening of July 10th (Fig. 5). Joe spoke of the role of serendipity and the art of noticing things in his career as a herpetologist. He noted the importance of access to natural history collections and living specimens when trying to answer questions such as "where is it? where is it not? what is it? what does it do?" Joe noted his predilection for turning a hotel room into a lab and a truck into a home and commented that "finding new species never gets old." Based on many years' worth of field work, Joe made the following astute recommendations: put energy not into not getting lost, but into getting "unlost," always check out field sites in the day time, just stop talking after the third day on a long field trip, and if you get sick or stranded in the field, just don't care and then it's not a problem!

One hundred twelve students attended the SSAR/HL Student Reception late afternoon on July 11th. Thanks to the donors of door prizes and the 31 professionals who attended. The Student Reception was followed by the Joint Meeting Reception at the Albuquerque Museum of Art and History. We enjoyed southwestern food and wandering through the exhibits.



PHOTO BY R. W. HANSEN

FIG. 4. Waterfall in the Civic Plaza opposite the Convention Center where the group photo was taken. On the evening of July 12th, a showcase concert and competition of *Mariachi Spectacular de Albuquerque* was held here.

PHOTO BY M. PREEST



FIG. 5. Joe Mendelson, III President's Travelogue speaker in front of the SSAR welcome poster.

PHOTO BY GREG WATKINS-COLWELL



FIG. 6. Pre-auction dinner for some of the volunteers. L to R: Kevin Neal, Catriona Hendry, Kirsten Nicholson, Jeremy Brown, Steve Mullin, Sara Ruane.

The SSAR/HL live auction was held on July 14th. Despite the monsoon rains of New Mexico, it was well-attended and good fun and we raised over $5,000. After all bills are paid, including beer and audio-visuals, proceeds will be split 50-50 with HL. Auctioneers Steve Mullin, Sean Graham, and Sara Ruane were ably assisted by Greg Watkins-Colwell and a number of hard-working students (Elyse Freitas, Catriona Hendry, Kevin Neal, Rachel Skinner, and James Stroud; Figs. 6, 7). Meredith Mahoney and Kirsten Nicholson were also integral to the operations of another successful live auction and we saw the return of Samantha Kahl, who had served as a student volunteer for several years and is now back assisting with the operations of the live auction. Justin Rheubert and Dustin Siegel were also on hand to provide assistance. Highlights included a very special t-shirt featuring some editorial comments on the taxonomy of North American herpetofauna.

Mike Jorgensen and Vinny Farallo (co-chairs, Silent Auction Committee) were unable to attend the meeting. In their absence Chris Howey and Matt Lattanzio did an excellent job organizing the Silent Auction. The auction items were set up in the lobby of the conference center. Once again, the ten recipients of the $400 SSAR Student Travel Awards took turns to work the silent auction table for 2–3 h throughout the course of the meetings. The Silent Auction raised over $800.

This was a very special year for ASIH—the 100-year publication anniversary of *Copeia*. To celebrate this event, ASIH provided meeting attendees with reprints of the first issue of *Copeia*, published in New York on Dec 27, 1913 (Fig. 8). Included was a transcript of the keynote address given by John Nichols (grandson of the founder of the society, John Treadwell Nichols) at the 75th annual meeting of ASIH in 1991. On the evening of July 12th, in a packed meeting room we were treated to another address by John Nichols. He admitted that he knew nothing about fishes, snakes, turtles, or frogs, but was here because his name is John Treadwell Nichols. He spoke of his grandfather as an "old-fashioned naturalist" and described him in the field wearing a white shirt and tie, with a fedora that looked like it had been sat on hundreds of times. He recounted stories of his father and grandfather working together on Long Island doing bird counts and the "pickling and preserving" they did with "formaldehyde and arsenic becoming like heroin and cocaine"—something they couldn't live without. The talk was wonderful, a real highlight of the meeting!

The end-of-meeting banquet was held on July 15th. Prosanta Chakrabarty served as Master of Ceremonies. On behalf of the JMIH societies he thanked the local hosts and the K-State staff for a successful and memorable meeting. He then introduced those at the head table (including SSAR President-Elect Bauer, representatives of SSAR and ASIH, members of the host committee and surprise guest Edward Drinker Cope) and asked past-presidents of the societies in attendance to stand (including several past-presidents of SSAR). ASIH election results were announced, certificates of appreciation were presented, resolutions were read, attendees from 19 countries were recognized, and Prosanta briefly interviewed E. D. Cope. Various awards from ASIH, HL, and Neotropical Ichthyological Association were announced. Prosanta and "Professor Cope" closed the final JMIH banquet with humorous verses and invited those assembled to attend the 2014 JMIH in Chattanooga, Tennessee (July 30–August 3).

Board, Long Range Planning, and Business Meeting Summaries

SSAR Board Meeting

Society President Bob Aldridge called the Board Meeting to order at 0800 hrs on July 10th, 2013 in the Albuquerque Convention Center, Albuquerque, New Mexico. In attendance were the following members of the Board of Directors, Editors and

Committee Chairs: Kraig Adler (Editor, *Contributions to Herpetology*; Chair, Long Range Planning Committee), Bob Aldridge (President), Breck Bartholomew (Publications Secretary), Aaron Bauer (President-Elect; Editor, *Facsimile Reprints in Herpetology*), Rafe Brown (Chair, Seibert Award Committee; Chair, Local Meeting Committee, 2015), Alison Cree (Board Member, non-US 2016), Brian Crother (Chair, Standard English and Scientific Names Committee), Raul Diaz (Webmaster), Tiffany Doan (Board Member, Reg. 2014), Richard Durtsche (Coordinator, Symposium Committee), Marina Gerson (co-Chair Membership Committee), Robert Hansen (Editor, *Herpetological Review*), Travis LaDuc (Board Member, at-large 2014; co-Editor *CAAR*), Lisa Hazard (Board Member, Reg. 2016), Joseph Mendelson, III (Immediate Past-President), Kirsten Nicholson (Past-Treasurer), Ann Paterson (Treasurer; co-Chair, Membership Committee), Gad Perry (co-Editor, *Journal of Herpetology*), Marion Preest (Secretary), Al Savitzky (SSAR Representative to AIBS and BioOne), Greg Watkins-Colwell (Board Member, Reg, 2016; Organizer, SSAR/HL Live Auction), and Dawn Wilson (Chair, Student Participation Committee). Additional society members present included Jim Christensen, Vic Hutchison, Samantha Kahl, Henry Mushinsky, Justin Rheubert, and Tony Wilmes.

Introductions were made and those present were reminded of the open meeting regarding the activities of the Long Range Planning Committee to be held on July 13th. Minutes of the 2012 Board of Directors Meeting (Vancouver, British Columbia, Canada) were approved.

Officers' Reports

President Bob Aldridge reported that he and Past-President Joe Mendelson sent a letter to 492 lapsed SSAR members in Dec 2012 encouraging them to renew their membership. Bob plans to resend a letter in December of this year. He signed a letter written by the members of the Conservation Committee to the Honorable Puerto Rico Planning Board encouraging them to disallow any development activities that could even remotely lead to the loss, or "incidental take" of individuals of the threatened Puerto Rican Crested Toad (*Peltophryne lemur*). Additionally he wrote "An Open Letter to the WikiHerps Community from the Officers and Editors of SSAR," stating that it is a copyright violation to post PDF versions of *Herp. Review*. Bob thanks Kraig Adler for composing the initial draft of the letter and Bob Hansen and Breck Bartholomew for advice. The letter was posted by Joe Mendelson on April 10, 2013.

In the June issue of *Herp. Review*, an open letter from President Aldridge was published in which he introduced himself and stressed the importance of membership in our Society. President Aldridge signed an "Invitation to Membership" letter that was distributed along with an issue of *Herp. Review* to attendees at the 1st North Carolina Congress of Herpetology, held at the North Carolina Zoo, Asheboro, NC. SSAR was a sponsor of this meeting and also donated books for their auction.

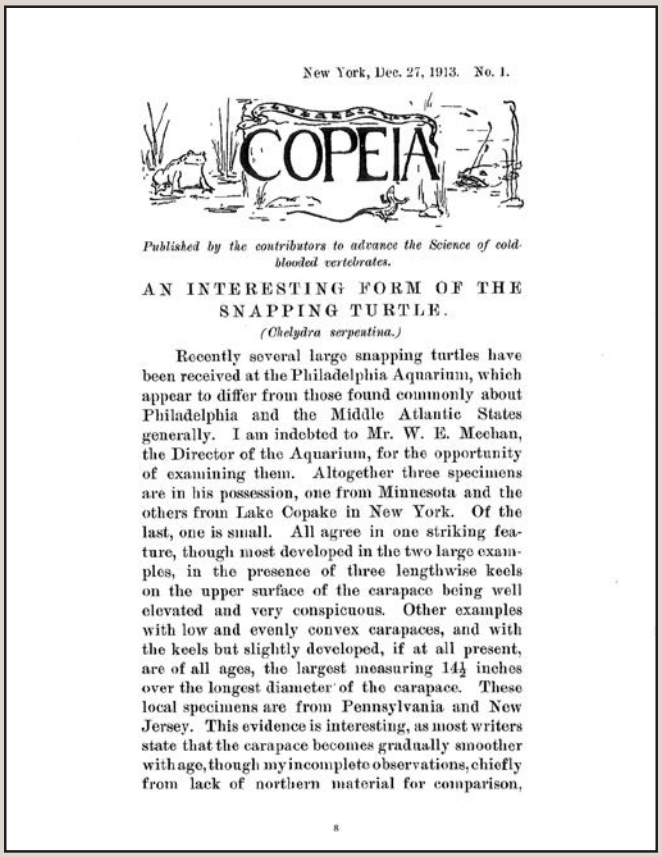
President Aldridge reappointed Kraig Adler Chair of the Long Range Planning Committee and invited Past-President Mendelson to present the 2013 Travelogue at the JMIH. Bob met with the JMIH MMPC in Albuquerque in April to plan the 2013 JMIH. The MMPC arranged times and places for business meetings, symposia, oral presentations, social events, etc.

Immediate Past-President Mendelson reported a quiet final few months in his Presidency. He wrote a final Presidential essay that was published in *Herp. Review* that focused on outreach education. Joe solicited Carol Spencer to lead the SSAR Website



PHOTO BY GREG WATKINS-COLWELL

FIG. 7. Rachel Skinner and Kevin Neal preparing for the live auction.



New York, Dec. 27, 1913. No. 1.

COPEIA

Published by the contributors to advance the Science of cold-blooded vertebrates.

AN INTERESTING FORM OF THE SNAPPING TURTLE.

(Chelydra serpentina.)

Recently several large snapping turtles have been received at the Philadelphia Aquarium, which appear to differ from those found commonly about Philadelphia and the Middle Atlantic States generally. I am indebted to Mr. W. E. Meehan, the Director of the Aquarium, for the opportunity of examining them. Altogether three specimens are in his possession, one from Minnesota and the others from Lake Copake in New York. Of the last, one is small. All agree in one striking feature, though most developed in the two large examples, in the presence of three lengthwise keels on the upper surface of the carapace being well elevated and very conspicuous. Other examples with low and evenly convex carapaces, and with the keels but slightly developed, if at all present, are of all ages, the largest measuring 14½ inches over the longest diameter of the carapace. These local specimens are from Pennsylvania and New Jersey. This evidence is interesting, as most writers state that the carapace becomes gradually smoother with age, though my incomplete observations, chiefly from lack of northern material for comparison,

1

FIG. 8. First page of article by H. W. Fowler (Philadelphia, PA) in Issue 1 of *Copeia* (1913).

Committee and was involved in Travis LaDuc and Chris Bell taking over as co-Editors of *CAAR*. He signed the online publishing agreement with Allen Press that was approved by the Board in 2012 and a contract with EBSCO to expand electronic publishing with them to include *Herp. Review*.

Ann Paterson and Kirsten Nicholson (the Current- and Past-Treasurers respectively) reported that SSAR experienced another sound financial year during 2012 and say that the future is looking bright in the recovering economy. Overall, SSAR underspent the 2012 budget (by $42,516) which is good news given recent changes to journal formats. However, some points of discussion are the transition to stricter policies regarding notification/payment of page charges, and a possible increased push towards more active acquisition of paid advertisements in *Herpetological Review*. Membership numbers are down slightly, but hardly noticeable. Royalty income has remained fairly steady, which is somewhat unexpected, as we had been predicting a steady increase in payments. We also received several generous donations for special projects, in particular from Ronald Javitch and George Zug, and several others in honor of Andy Price. Our investment portfolio enjoyed substantial growth during 2012 (up $85,000 from the previous year), and 2013 is showing continued growth as well.

The Society's investments increased during 2012, in keeping with trends in the global market. The total market value as of December 31st, 2012 was $645,096. By June, 2013 we had increased further to $666,022. Examination of the performance of our funds shows that their percent yields have increased over 2012 and 2013.

The transition to our new Treasurer, Ann Paterson, began early in 2013 and Kirsten has been assisting greatly with this change. Ann is working on changing some investments and is trying to get our taxes finalized earlier in the year.

The approved 2012 budget was balanced. Although some expenses went over budget, most were under budget. *CAAR* was nearly double the expected cost, but was catching up with several accounts. The appearance of the Publications Secretary (Breck Bartholomew) being over budget is erroneous because that office has taken over the handling of memberships from Allen Press, so what was a separate expense paid out to Allen Press is now subsumed within Breck's expenses. The 2011 JMIH meeting was well over budget and SSAR was hit with a very large fee as a consequence. Last year's meeting fees however were paid for by the WCH and we were spared that expense. Both *JHerp* and *Herp. Review* were under budget. There was no return on the Auctions again this year (2012), as we voted to donate the money to the WCH. At the 2013 meetings, Kirsten and Ann hope to discuss details and problems regarding the efficient running of the auctions, as the cost of running them severely cuts into making profits to fund student travel awards.

Joe Mendelson commented on SSAR being under budget and asked whether we needed to spend more money. As a not-for-profit organization, there are IRS regulations in regards to this. Breck Bartholomew noted that many of the funds raised in the past year are due to one-off donations and that SSAR can't count on receiving them in the future.

Secretary Marion Preest summarized the 2012 World Congress of Herpetology for publication in *Herp. Review*. She kept track of changes in personnel and regularly updated SSAR letterhead, informed the Editors of *JHerp.* and *Herp. Review* of these changes, and provided various updates to Webmaster Raul Diaz. She wrote letters to student winners of awards (e.g., Kennedy, GIH, etc) and prepared announcements for publication in *Herp. Review*. The Secretary compiled the 2013 Annual Report and prepared agendas for the Board and Business Meetings for the 2013 JMIH. She was again involved in helping to organize a reception for student members of SSAR and HL to be held at the JMIH. Marion corresponded with the Board regarding various issues that needed a vote, e.g., a proposal regarding remaindering some SSAR publications, symposium proposals, etc. She circulated documents that needed to be signed by members of the Board (e.g., Conflict of Interest), confirmed eligibility for participation in various student activities (e.g., Travel Awards, Poster Awards, Seibert Awards, etc.), and dealt with many emails from SSAR members and the general public.

Breck Bartholomew reported that total income from the Publications Office in 2012 was $124,714.01. He is requesting a budget for 2014 that includes funds to cover rent, utilities, insurance etc. for the office, as Breck is closing down his business *Bibliomania* (which has, for many years, covered these costs for the Society). Breck has contacted book dealers and authors regarding remaindering books to try and deal with excess inventory. Breck suggested that we think of other publication avenues (e.g., iTunes, Ebooks, etc.)

George Pisani reported that he again filed SSAR's annual corporate report with the Office of the Kansas Secretary of State.

Editors' Reports

Co-Editors of the *Catalogue of American Amphibians and Reptiles*, Chris Bell and Travis LaDuc took over the reins of *CAAR* at the beginning of 2013. They wish to thank Bob Powell for completing and publishing the last of the accounts that were submitted to Andy Price. Chris and Travis assumed all of the editorial responsibilities in an effort to maintain the high standards of the series, particularly in the formatting and completeness of the literature citations, personally vetting every citation just as Andy Price and Bob Powell did before them. They have revised the *CAAR* instructions to authors and, as of May 31, 2013, have received six account submissions and corresponded with several potential authors on an additional 10–15 accounts. They established a new "dibs" list for taxa reserved by authors.

During the transition period, there were questions about the suitability and logistics behind revising previously published species accounts. Chris and Travis found precedence for this in the history of the series. Five accounts were revised over the 50-year history of the series, and each revision was published under a new account number, with no specific notations indicating the previous *CAAR* account number and no secondary authorship granted to the author(s) of a previous account. The online system makes it easy to cross-link the new account to the previous one.

Publication of the series is now electronic, and accounts are issued immediately upon acceptance and may be downloaded on demand from the *CAAR* website. The co-Editors hope to bring the number of annually published accounts to a minimum of 15. Because publishing and all correspondence are now electronic, costs for editing the series are extremely low. Chris and Travis wish to thank Breck Bartholomew who was instrumental in scanning and posting all previous accounts to the web, where they are now available to members (http://www.zenscientist.com/index.php/filedrawer/Open-Access-Journals/caar/).

The lack of an ISSN number for the *CAAR* series has now been rectified. Regulations require separate ISSN for the print and online versions. They are ISSN 2325-4882 (print) and ISSN 2325-5021 (online).

Contributions to Herpetology Editor Kraig Adler reported that "*Contributions to the History of Herpetology*," vol. 3, by Kraig Adler, John S. Applegarth, and Ronald Altig was published in 2012. A paper-bound version was presented to all delegates at the WCH. Costs were subsidized with a $5,000 donation plus a further $10,000 for the other congress giveaways. "*A Contribution to the Herpetology of Northern Pakistan*," by Rafaqat Masroor was also published in 2012. "*Contributions to the History of Herpetology*," vol. 1, by Kraig Adler, John S. Applegarth, and Ronald Altig will be reprinted (with annotations and corrections to volumes 1, 2, and 3) in 2014 (making all three volumes available at the same time). "*Herpetology at the University of Kansas*," by William E. Duellman, will be issued in 2015 prior to SSAR's meeting at KU. This is a detailed history of one of the most distinguished herpetological research and graduate education programs, beginning with Edward H. Taylor, the first curator, and concluding with the current era of herpetologists. It will include a description of Henry Fitch's long-term program at the Natural History Reservation, biographies of all herpetological graduates of the KU program, numerous photographs, and summaries of major expeditions, meetings, and other activities. "*A Guide to the Snakes of the Philippines*" by Rafe Brown, Alan Leviton, Maren Gaulke, and Arvin Diesmos, "*Field Guide to Amphibians and Reptiles of the West Indies*" by S. Blair Hedges, and "*Lizards of Southern Africa*" edited by William R. Branch and Aaron Bauer are also planned beyond 2013.

Editor Aaron Bauer (*Facsimile Reprints in Herpetology*) reported that the monumental "Erpétologie Générale ou Histoire Naturelle Complète des Reptiles" (1834–1854) by Duméril, Bibron & Duméril was published in December 2012 with Kraig Adler as guest editor. This work of 7000+ pages, including 240 plates, significant new material by Roger Bour, and a comprehensive index, was produced in a run of 400 sets. The cost of this work was generously supported by Ronald Javitch, and SSAR funding was spread out over a two-year period. Two works nearing completion have been offered to the facsimile series. Both are collected works with substantial new material. "*The Collected Herpetological Works of Giorgio Jan*" has an introduction, annotated bibliography, and extensive systematic comments by Roy McDiarmid and Jay Savage. The collected snake publications of Jan were published in 1857–1882 in French, Italian, and German. The plan is to publish the facsimiles four pages to one page in order to accommodate 500+ pages of new material by McDiarmid and Savage. "*The Collected Herpetological Works of J. V. Barboza du Bocage (1823–1907)*" has an introduction, annotated bibliography, and data on types by Luis Ceríaco. Bocage was the most important Portuguese vertebrate zoologist of the 19th Century and published extensively on all groups, mostly based on collections from the far-flung Portuguese colonies of the day (Angola, Mozambique, Cape Verde, Timor, Guinea, São Tomé, Macau). He also published on Portuguese mainland taxa and other areas, notably New Caledonia. In all, he authored 69 herpetological papers between 1863 and 1905, nearly all in Portuguese or French. Most are relatively short (<20 pages), but his magnum opus: *Herpétologie d'Angola et du Congo* (1895), was 223 pages long, with 19 plates. The total pagination of Bocage's herpetological works is 759 pp. The facsimile will include approximately 100 pages of new material dealing with Bocage's life and works, his complete bibliography, and short accounts for each of the 104 species of amphibians and reptiles he described. Ceríaco anticipates an interest by the Portuguese Academy of Sciences in supporting the work through co-publishing.

John Moriarty (Editor, *Herpetological Circulars*) reported that *Herpetological Circulars* 41 (*A Guide to Tissue Collection, Preservation, and Management for Reptiles and Amphibians*) is in final review and is expected to be published in November 2013.

Editor of *Herpetological Conservation*, Joe Mitchell, reported that no inquiries for publication were received in 2012 and he plans to advertise for submissions soon. His criteria are that the topic be broadly applicable to herp conservation and management, that the geographic coverage not be limited to one country but, preferentially, global in scope or at least regional, and the work makes an important contribution that will be cited extensively. The Board discussed the fact that *Herp. Conservation* volumes don't need to be, and in fact haven't always been, large tomes and encourages Joe to think of smaller projects (in addition to large ones).

Robert Hansen, editor of *Herpetological Review*, reports continued smooth operation. Volume 43 consisted of 632 pages and Volume 44 is projected to run ~700 pages. Personnel changes include the resignations of Brad Lock, Michael Grace, and Emily Taylor and the addition of Robert Hill, Scott Boback, David Blackburn, Stephen Richards, and David Steen. Over two years ago, Denise Wilson Mayer, a volunteer at Zoo Atlanta, undertook the daunting task of indexing all back issues of *Herp. Review*. She made excellent progress before moving on to other pursuits. Meanwhile, Ruthe Smith, associated with the SSAR Publications Office as a part-time employee, has been indexing each new issue. To date, all issues of *Herp. Review* have been indexed, with the master file currently in EndNote format maintained by Breck Bartholomew. The next step is to make this index file publicly available through the SSAR web page. The Board returned to the issue of *Herp. Review* being made available through BioOne (part of the impetus for indexing the journal). Hansen will contact BioOne to see where we stand.

Co-Editors of *Journal of Herpetology*, Erin Muths and Gad Perry, report that former Editor Geoff Smith remains an Associate Editor (AE) for special projects and Paul Andreadis remains the Index Editor. The AE roster at the end of 2012 contained six new names and many continuing ones: Paul Bartelt (US), Phil Bishop (New Zealand), Xavier Bonnet (France), Rafe Brown (US), Tracey Brown (new, US), Russ Burke (US), Steve Corn (US), Tiffany Doan (US), Jennifer Gillette (New Zealand), Evan Grant (new, US), Brian Greene (US), James Harris (Portugal), Tibor Hartel (new, Romania), Toby Hibbitts (US), Hinrich Kaiser (new, US), Nancy Karraker (newly in the US), Edgar Lehr (US), Marc Mazerolle (Canada), Frank Mazzotti (US), Don Miles (US), John Rowe (US), Christopher Salice (new, US), Glenn Shea (new, Australia), Stephen Tilley (US), Tony Tucker (new, Australia), James Watling (US), and Eric Wild (Brazil); both Editors also function as AEs. Ximena Bernal (US), Nancy FitzSimmons (Australia), Walter Meshaka (US), and Phil Smith (US) ended their tenure as AEs in 2012. Expanding the AE base, especially by adding additional colleagues from other countries, remains a challenge. Erin and Gad are especially interested in expanding representation from Brazil and Asia.

Overall, new submissions declined slightly in 2012. Manuscripts from 35 countries were submitted in 2012. As in previous years, the US remains the leading source of manuscripts (~43% of all submissions) and Brazil remains the second highest source (~14% of submissions). Despite availability of the free editing service from SSAR, language remains a concern for many manuscripts from non-English-speaking countries. The larger number of such manuscripts places an added burden on the editorial

process, particularly at the final editing stages. According to the AP "Member Submissions Report," 35% of all submissions in 2012 and 2011 had one or more authors who are SSAR members, compared to 35% in 2010, 38% in 2009, 39% in 2008, and 38% in 2007 and 2006. Submissions so far for 2013 (117 as of June 15th) are lower than the number submitted during the same period in 2012 (172). The amount of time needed to reach initial and final decisions remains similar or is slightly improved compared to the past few years, but the wait between acceptance of a paper and publication remained approximately 12 months in 2012. Gad and Erin have taken several steps to address this, including instructing AEs to reject a greater proportion of submissions and publishing an especially large December issue in 2012 and March issue in 2013. These measures have helped us catch up with the buildup of manuscripts and reduce the wait from acceptance to publication to approximately 9 months.

The Journal now has an official website (http://journalofherpetology.org), maintained by Allen Press. This site offers access to information needed by authors, articles published in the journal (free to SSAR members), pre-publication versions of upcoming papers, and links to SSAR. The site also allows us to post "online only" supporting material such as video, sound files, and raw data.

Another recent change is associated with new technology at AP, allowing us to publish all-color at no extra cost. As currently published articles were accepted before this change, the transition to more color will be ongoing. However, authors are being contacted and offered an opportunity to replace b&w figures with color ones.

The co-Editors have used Editorial Board members this year for several quick turnaround reviews and in addressing an issue of plagiarism. This issue was identified by a reviewer, and reported by the AE to the Editors. They checked the data and used the expertise of the Editorial Board to vet their response to the authors. After ample opportunity to rebut and defend their manuscript, the paper was rejected and all authors were informed that manuscripts by them would not be accepted by the *Journal of Herpetology* for two years. The information was also shared with the editors of other herpetological journals, as part of a multisociety effort to reduce ethical problems within the profession.

The new page charge policy is now in place: If at least one author is an SSAR member in good standing, page charges are not levied. However, if funding allows, members are encouraged to assist in the production of the journal by contributing to page charges. Page charges for non-members are $150 per page. If there are unusual circumstances, a waiver may be requested by contacting Breck Bartholomew.

Obtaining qualified AEs and reviewers remains a huge challenge and Erin and Gad expect this problem to get worse, given the increasing shift of academic institutions to a for-profit managerial style.

The co-Editors raised four issues for the Board to consider:

• *Replacement of Editors.*—Erin and Gad are asking to conclude their tenure as co-Editors for the *Journal of Herpetology* on January 1, 2014, following four years of service. They propose to remain actively involved in the publication of the journal through July 2014 to facilitate transition to a new Editor or co-Editors. They will both serve on the Editorial Board and Erin Muths will remain as an AE.

• *Electronic publishing.*—Establishment of the new journal's website is an important development and Erin and Gad are pleased that the Society is looking at professionalizing its Web presence. They believe that there is a need for careful consideration of the not-far future move to an all-digital journal, and to funding models that would support the Journal and society when that happens.

• *Co-publishing proposal.*—In 2011, the Board rejected the AP co-publishing proposal. Erin and Gad feel that this option should be reconsidered in 2014 after the new editor(s) meet with Allen Press for updated details.

• *Reward for AE service.*—The co-Editors would appreciate the Board reconsidering membership as token recognition to be granted only to those AEs who have served for over a year and completed their reviews in a timely manner.

In their requested budget for 2014 ($128,150), the co-editors have added the cost for maintenance of the Journal website by AP. They expect to publish a similar number of papers in 2014 as in 2013, and anticipate an increase in mailing costs, but expect no change in editorial office costs.

Standing Committee Chair Reports

The Conservation Committee consists of Ross Alford, April Barreca, Jennifer Germano, John Jensen, Nancy Karraker, Karen Lips, Gad Perry, Stephen Richter, and Betsie Rothermel (Chair). Two new graduate student members (Nicole Angeli and Cecilia Langhorne) joined the committee in 2012. In July 2012, the Center for Biological Diversity petitioned U.S. Fish & Wildlife Service (FWS) to list 53 species of reptiles and amphibians under the Endangered Species Act. The consensus of the Conservation Committee was to not take any action at that time, but rather to wait and submit comments on particular species if/when there is a full status review by FWS. In August 2012, SSAR signed on to a letter sent to the U.S. Senate Interior and Environment Appropriations Subcommittee opposing drastic cuts in FY13 funding for the State and Tribal Wildlife Grants Program. In April 2013, they sent a letter to the Southeast region of U.S. Fish & Wildlife Service regarding habitat protection for the Puerto Rican Crested Toad (*Peltophryne lemur*). Specifically, they urged the agency not to add this species to the list of species covered under an incidental take permit for a proposed wind energy facility.

Joe Beatty, Chair of the Dean Metter Award Committee, received 39 proposals this year and **Mitch Tucker**, a Ph.D. student at University of Missouri, was selected as the winner. Mitch's proposal was entitled, "Behavioral consequences of polyploidy in Gray Treefrogs, *Hyla chrysoscelis*." A key component of the proposal hinges upon being able to generate autopolyploid frogs in the lab, which Tucker is able to do with a "cold-shock" treatment developed by him and his supervisor, Carl Gerhardt. The committee thought Tucker's proposal was especially innovative and experimental and takes an approach involving fieldwork as well as laboratory work to provide insight to a particularly interesting biological system.

The 21st annual Seibert Awards competition (Rafe Brown, Chair) was run at the 55th Annual Meeting of SSAR in Vancouver. There were 53 eligible presentations. The Seibert Award winners for 2012 were: Systematics/Evolution: **Sara Ruane** (College of Staten Island), "Speciation in the milksnake (*Lampropeltis triangulum*)." Ecology: **Thomas Luhring** (University of Missouri), "Islands in the sun: nutrient cycling in isolated systems is mediated by canopy cover, predation, and the complex life-histories of their transient tenants." Physiology/Morphology: **Rory Telemeco** (Iowa State University), "Effects of temperature during development on the offspring phenotype of a facultative thermoregulator, the Southern Alligator Lizard (*Elgaria multicarinata*:

Anguidae)." Conservation: **Shawn McCracken** (Texas State University, San Marcos), "Living on the edge: oil road effects on the occupancy and abundance of anurans inhabiting an upper canopy tank bromeliad (*Aechmea zebrina*) in lowland rainforest of the Yasuni Biosphere Reserve, Amazonian Ecuador." All winners received a check for US $200 and a book from University of California Press. Honorable mentions were: Systematics/Evolution: **Hilton Oyamaguchi** (University of California, Los Angeles), "Divergence along a Brazilian rainforest-savanna gradient and the role in generating diversity." Ecology: **Julia Riley** (Laurentian University), "Should I stay or should I go? Influence of environmental factors on *Chrysemys picta* hatchling overwintering strategy." Physiology/Morphology: **Gareth Hopkins** (Utah State University) "Embryonic survival in salt among Rough-skinned Newt (*Taricha granulosa*) families."

No report was received from the Herpetology Education Committee (Hinrich Kaiser, Chair).

The winning paper for the 2012 Kennedy Award (Lynnette Sievert, Committee Chair) is by **Alexa K. Fritzsche** (coauthored with **Stacey L. Weiss**), "Effect of signaler body size on the response of male striped plateau lizards. *Journal of Herpetology* 46:79–84." Alexa will receive a check for $200 or $400 equivalent in SSAR publications.

Kraig Adler, Chair of the Long Range Planning Committee (LRPC), reported that Carol Spencer (newly appointed Chair of the Website Committee) has been added to the LRPC. Following a very active year after being revived in late 2010, the committee as a whole was quiescent for much of 2012 and 2013. Kraig however was busy coordinating SSAR's contributions to the World Congress in Vancouver, e.g., a giveaway poster featuring an original drawing by David Dennis, a giveaway issue of *Herp. Review*, a membership brochure, a giveaway book and two booklets ("*Contributions to the History of Herpetology*, Vol. 3" by K. Adler, J. S. Applegarth, and R. Altig; and two booklets on the scientific and standard vernacular names of amphibians and reptiles in North America north of Mexico, in separate English [B. Crother, editor] and French [D. M. Green, editor] versions), etc. Kraig wishes to particularly thank Breck Bartholomew, Bob Hansen, John Moriarty, and Kirsten Nicholson for their assistance. SSAR was recognized by WCH as the sole Gold-Level Sponsor for our many contributions. Kraig was also involved with Rafe Brown and others in the KU local committee with early planning for the 2015 meeting. He helped them prepare the first ad for the meeting, which appeared in the December 2012 *Herp. Review*, and approached PARC (Partners in Amphibian and Reptile Conservation) to join us at KU as our co-sponsor.

Chair of the Meeting Management and Planning Committee, Rafe Brown, presented information about progress to date in planning for the 2015 meeting at University of Kansas. The local committee consists of Rafe Brown (Chair), Richard Glor, William Duellman, Linda Trueb, and George Pisani. Organizing societies are SSAR, PARC, and Kansas Herpetological Society. Tentative dates are July 29th to Aug 3rd (includes a "zero" day at the beginning for the SSAR Board Meeting). There will likely be two plenary lectures, a number of symposia, a student workshop, a live animal display, and tours of the Museum and the Henry Fitch Natural History Reservation. Social events will include those we have come to expect at JMIH, some new events, and other old favorites that have been revived, e.g., the President's Travelogue, the student reception, a social specifically to recognize senior herpetologists, the revised (now digital) audiovisual shows of David Dennis and Eric Juterbock ("Amphibians of the Appalachians," "Herps of the American West," "Herpetologists Then and Now"), live and silent auctions, a herp art exhibit, the herp quiz, a picnic, etc. Projected prices for registration and accommodation are very reasonable (Registration: $280 regular members, $140 students and retired members, Accommodation: $34–$150/night)

In the past year the Membership Committee (Ann Paterson and Marina Gerson, co-Chairs) was less active than it has been previously while it was waiting to see the results of the 2011 proposals. The Committee has been more closely following membership data to examine patterns and develop procedures for more closely monitoring and analyzing these patterns, developing proposals for possible correspondence with new members and with members who fail to renew, continuing to compile a list of other herpetological societies, and responding to concerns and comments from members and non-members as needed. The detailed proposals for possible correspondence with members are available upon request. Ann Paterson will be discussing them with Bob Aldridge to coordinate with other activities.

Ann and Marina now receive monthly membership data. They remarked on the continued decrease in membership. They noted that more people are taking advantage of the online and senior membership categories, but that there are declines in other categories. The recent dues increase explains the increase in membership income and possibly also the decrease in membership numbers. It is hoped that access to membership data will allow the committee to examine the effect of various activities (e.g., mailings) on membership trends. Breck commented that the membership office sees an increase in renewals and in new memberships around the time Roger Conant GIH proposals, travel award applications, etc., are due.

The Board discussed the idea of making student dues available to individuals for 1–2 years after they are no longer students as a way of encouraging continued membership. This would not require creating another category of membership (of which we already have many) and would need to be advertised. As there is every year, there was discussion of why someone should become a member of SSAR in the first place and why they should renew their membership annually. There is concern over the "revolving door" of members, i.e., individuals (usually students) are members for a few years and then fail to renew, only to be replaced equally temporarily by other young members. The importance of reaching out to undergraduates was emphasized. Someone remarked that there are professional herpetologists who themselves are not members of the society even though they come to the meetings, send their students to the meetings, publish in our journals, etc. The importance of professionals setting examples for their students and encouraging, or even requiring, them to become members and attend meetings was stressed. A comment was made that we need to focus on our core mission and current demographic and make the Society work in whatever form it exists, i.e., we can't force people to become members. Along the same lines, Al Savitzky asked us to think about whether we are currently operating under a model that is not sustainable in the long term.

Kris Kaiser (Chair, Mentorship Committee) reported that, in its first year, the Mentorship Program paired 14 students with mentors. Follow-up surveys showed a general satisfaction with the program, and gave useful feedback for year two of the program. The program this year was advertised in *Herp. Review*, on the SSAR website, and on the JMIH registration page under "Graduate Student Information," and applications were

accepted for both mentors and mentees. The committee is considering working with the MMPC to make this part of the actual meeting registration next year to increase visibility.

The Nominations Committee (Greg Watkins-Colwell, Chair) compiled a list of nominees for the positions of President-Elect, Treasurer, Regular Board Member (three needed), and a non-US Board Member. Marion Preest was willing to run again for the position of Secretary. Voting was carried out electronically with photographs of the candidates being made available. Upon completion of the 2012 election, Greg Watkins-Colwell resigned his post as Nominations Chair, to be replaced by Robert Espinoza. The nominees:

President-Elect.—Aaron Bauer, Geoff Smith
Treasurer.—Ann Paterson
Secretary.—Marion Preest
Board Member (Regular).—Frank Burbrink, Richard Durtsche, Marina Gerson, Lisa Hazard, Greg Watkins-Colwell
Board Member (non-US).—Alison Cree, Carlos Navas, Hidetoshi Ota, Wolfgang Wüster

Rob Denton (Resolutions Chair) presented resolutions at the SSAR Business Meeting in Vancouver in 2012. These have been published in *Herp. Review*.

Josh Kapfer (Chair, Roger Conant Grants-in-Herpetology Committee) received 80 proposals. Most applications were in the "Laboratory Research" category. The winners each received US $500 and they are:

Conservation.—Todd Pierson, University of Georgia
Education.—Tiffany Vanderwerf, Buffalo Zoo
The Andrew H. Price Field Research Grant in Herpetology.—Mark Oliva, California State University-Northridge
Laboratory Research.—Schyler Nunziata, University of Kentucky
Travel.—Justin Lawrence, The University of Mississippi
International.—Jessica Hacking, Flinders University, Australia

Josh reported that, as approved by the Board in 2012, he now requests that a signed waiver of liability (available on the GIH website) be included with all grant applications. Josh continues to have difficulties with reviewers submitting assessments on time. As approved by the Board, the Field Research category has been renamed the Andrew H. Price Field Research Grant in Herpetology. It will continue with this name for as long as funds permit.

Brian Crother, Chair, Standard English and Scientific Names Committee, reported that the 7th edition was released last year at the WCH, and work is yet to start on the next edition. The 7th edition has not yet been posted on the SSAR website, but the CNAH and the Reptile Database sites have the list up. The list is also being used by the iNaturalist site and the names are being used for the development of a Global BioBlitz.

Erin Muths was the lead organizer of a lunchtime student workshop sponsored by SSAR and HL at the WCH in Vancouver. The workshop was titled "How to Turn Your Thesis or Dissertation Chapter into a Publishable Manuscript & Participate in the Peer-Review Process." Editors or Associate Editors from six herpetological journals from the U.S. and Europe participated in the panel presentation. The workshop and panel discussion was designed for graduate students interested in turning their graduate work into publishable manuscripts and learning about the publication process and details on incorporating peer review into their professional career. The goals of the workshop were to provide an understanding of the mechanics of submitting a manuscript and successfully seeing it through the publication process. Topics included transforming the thesis into a manuscript, de-mystifying the review process, interpreting reviews, responding to reviewers, and participating in the peer review process.

Over 80 students attended, the question and answer session was useful, and feedback during the rest of the WCH was positive. Discussion by the editors after the workshop included decisions to post the PowerPoint presentation on the websites of HL and SSAR and the European societies (this is pending) and to consider presenting the workshop every 3–4 years. Dawn Wilson (Chair, Student Participation Committee) indicated that she will ask for ideas about future workshops from students. A suggestion was made that we record and upload the workshops on the new SSAR website.

The second annual SSAR Student Poster Awards (Tiffany Doan, Chair) were presented during the Annual Meeting of the SSAR at the WCH in 2012. There were 40 eligible posters, twice the number of the inaugural year. In recognition of outstanding student poster presentations at the annual meeting, the following awards (a check for US $100 and a book from University of California Press) were made: Evolution, Genetics, & Systematics: **Luke Frishkoff**, Stanford University, "Body size evolution and the colonization dynamics of a radiating Caribbean frog lineage (*Eleutherodactylus*)." Conservation & Management: **Julia Riley**, Laurentian University, To conserve and protect: evaluation of a turtle conservation tool, nest caging, ecology, natural history, distribution, & behavior; **Matthew Lattanzio**, Ohio University, "Habitat use, phenotypic variation, and grazing: The responses of tree lizard populations to altered landscapes." Physiology & Morphology: **Nicole Christie**, Sonoma State University, "Effects of nest temperature variation on viability and sex determination of western pond turtles."

Chuck Crumly worked for a number of years for University of California Press and generously donated UC Press books to the winners of the Seibert Awards, and more recently to winners of the poster awards. Chuck has left UC press and there was discussion of where we might obtain books for paper and poster winners. We could use SSAR books, or the chairs of the Seibert and Poster Awards committees could contact book publishers to see if any are willing to donate books. A point was made that the books needed to be equally attractive to US and non-US members of SSAR, i.e., not necessarily with a strong North American focus.

In 2012, Mike Jorgensen and Vinny Farallo (Co-Chairs, Student Travel Awards Committee) received 41 applicants for the travel award, about equal to the number in previous years. The ten recipients of the US $400 SSAR Student Travel Award took turns to work the silent auction table for 2–3 h over the course of the WCH. Location of the auction was in a low foot-traffic area at the WCH and probably contributed to the difference in total earnings from the previous year in Minneapolis. Since the WCH, it was proposed that the silent and live auctions be coordinated by a single committee in order to streamline the donations to each.

Carol Spencer (Chair), Joe Mendelson, Raul Diaz, Vincent Farallo, Michelle Koo, and Todd Pierson serve on the recently revived Website Subcommittee. In 2011 the Board designated US $10,000 for a one-time complete overhaul of the Society's website, with US $3000 per annum for upkeep and renovations, if needed. This group has met several times in 2013 (both in person and via Skype). Three potential website designers/programmers

have been asked to submit bids for redesigning the SSAR website using content and renovation suggestions from the subcommittee and the LRPC. The subcommittee welcomes feedback and suggestions from any member of SSAR.

Coordinators' Reports

Election Officer, Dan Noble, reported that most ballots were submitted electronically in 2012 and the following individuals were elected:

President-Elect – Aaron Bauer
Treasurer – Ann Paterson
Secretary – Marion Preest
Board Member (Regular) – Frank Burbrink, Lisa Hazard, Greg Watkins- Colwell
Board Member (non-US) – Alison Cree

The Live Auction Committee coordinator is Greg Watkins-Colwell, who reported that the proceeds from the 2012 SSAR/HL Live Auction ($4072) benefited the WCH. Efforts were made to include as many different auctioneers (with different auctioning styles) as possible and to rely upon the help of students who had not assisted with the auction in the past. Following the auction, Kirsten Nicholson, Meredith Mahoney, and Gregory Watkins-Colwell immediately began discussions of how to improve upon the live auction model.

Representative to AIBS and BioOne, Al Savitzky, reported that BioOne, a nonprofit electronic publishing consortium, continues to provide online publishing services for the society and to return both royalties and profit-sharing proceeds to its member publishers. Al has moved away from the mid-Atlantic region, and no longer attends the annual BioOne Publishers and Partners Meeting. He suggested that the society may wish to identify someone closer to Washington, DC, to serve as its representative to BioOne, although, given that most of the presentations at those meetings are archived on the BioOne website, this may not be a major concern to the society.

According to a 2012 year-end summary provided in the April 2013 newsletter, BioOne ended its 11th year online with over 100,000 articles and 900,000 pages in its collection. Those papers have attracted over 18.9 million hits. These represent contributions from 129 publishers, producing 171 titles. Significantly, 42% of BioOne.1 subscribers and 56% of BioOne.2 subscribers are located outside of North America. Furthermore, BioOne makes its content available free to 2500 institutions in developing countries. Revenue sharing in 2012 increased by 6.3% over the previous year. Presentations at the 2013 Publishers and Partners Meeting included a discussion of the changing state of academic libraries in China; a description of BioOne's first self-published title (*Elementa: Science of the Anthropocene*, a fully open-access, online journal due to appear this July); an extensive presentation on citation metrics (especially the h statistic); and a presentation on alternative search strategies for online exploration of the literature (including the beta version of Microsoft Academic Search).

The American Institute of Biological Sciences (AIBS) is an umbrella organization that serves about 160 member societies and organizations (MSOs), most of them in the broad areas of organismal biology and ecology. The most recent AIBS Council meeting, in December 2012, focused on the history and future of scholarly societies in the biological sciences, including a presentation by organizational consultant Mary Byers. As part of its strategic planning process, the AIBS Board of Directors has reviewed two books by Harrison Coerver and Mary Byers, *Race for Relevance: 5 Radical Changes for Associations* and *Road to Relevance: 5 Strategies for the "New Normal."* Coerver and Byers maintain that factors such as a tighter economy, technological advances, and a generational shift in membership have left traditional nonprofit professional associations struggling to survive. Among the threats to their survival are the failure of organizations to focus on their core strengths (as opposed to constantly trying out new services); failure to confront and resolve redundancies among organizations or chapters; and either inertia or pressure from the "old guard" to maintain the status quo or to anticipate failure from changes "so they can advocate a return to the traditions of the past [*Road to Relevance,* p. 143]." Confronting its own decline in individual membership, AIBS has transformed its governance structure and focused its mission over the past few years through intensive strategic planning and introspection. If the threats to organizational survival that Coerver and Byers perceive are true for many scientific organizations, as they appear to be, the three North American herpetological societies should be aware of these trends.

As part of its own strategic planning process, AIBS surveyed representatives of its MSOs concerning trends in their various societies and organizations, and the results have now been made available to the broader community. They received 110 responses from society officers, and the resulting report is available for free viewing and download at http://www.jstor.org/stable/full/10.1525/bio.2012.62.4.3. Similarly, an extensive survey was sent to over 15,000 individual biologists and a detailed report, based on over 4000 responses, is available at http://www.access.aibs.org/page/Index/?. That report includes a wealth of information on attitudes toward professional societies at different stages of individuals' scientific careers, from undergraduates to emeriti. Careful attention to the results of that survey would better inform decisions by the Board of our society concerning the interests and priorities of our members.

AIBS continues to focus much of its service to MSOs in two areas, education and public policy. AIBS has been especially active as an advocate for organismal biology, biological collections, and ecology at the national level. AIBS has also taken a major role in development of an Implementation Plan for a Network Integrated Biocollections Alliance; supporting sound scientific integrity policies at the National Park Service and the National Science Foundation; and opposing the federal budget sequestration due to its impacts on scientific funding. Individual society members are encouraged to register with the AIBS Legislative Action Center (http://capwiz.com/aibs/home/), which provides timely notices of significant policy issues and makes it easy to respond with messages to one's senators and representatives.

This year, SSAR Symposium Coordinator Richard Durtsche received one symposium proposal: "Infrared Imaging: Cellular/Molecular Mechanisms, Behavioral Biology and Ecology of Pit Vipers, Pythons and Boas" (Michael S. Grace, lead organizer). This symposium will bring together a diverse group of biologists from a variety of fields to discuss the current state of knowledge of, and research on, infrared imaging systems and their roles in the lives of snakes. The goals also include an analysis of the next important steps in research of snake thermal biology, the ecological implications of invasions of exotic species possessing novel "weaponry," and a look at the technological advancements that may derive from a thorough understanding of the mechanisms of snake infrared imaging. The symposium proposal was sent out for external review and received comments from two reviewers. The reviews and proposal were submitted to the SSAR

Board for consideration of sponsorship and the Board approved the proposal.

New Business

President Aldridge informed the Board that President Mendelson signed a five-year contract with K-State Conference Services in 2012. Contained in this contract is a provision allowing any of the participating societies to withdraw from a particular meeting by providing a three-year notice.

There was discussion of "WikiHerps" posting full copies of SSAR publications, e.g., copies of *Herp. Review* have appeared on-line within 1–2 days of issuance. The site also provides links to book-length publications. Although the Society wants to encourage access to scholarly publications and is well aware that ease of access varies worldwide, these actions clearly represent a violation of copyright and they have important implications for SSAR. Various officers and editors were involved in recent months in determining an appropriate way of dealing with this issue. On the morning of the Board meeting, President Aldridge uploaded an open letter addressed to the administrators of WikiHerps in which he outlined how the Society operates (i.e., we are a volunteer organization that is primarily member-supported) and the potential effects of the actions of WikiHerps on our membership and our long-term survival as a Society. We were pleased that WikiHerps responded positively to this letter and the Society is in ongoing discussions with WikiHerps.

Greg Watkins-Colwell and Kirsten Nicholson presented various ideas regarding changes to the Live and Silent Auctions. We now have a single committee overseeing both auctions. This will help to ensure that items are funneled towards the appropriate event. Discussion turned to the cost of running the Live Auction (this is significant and cuts into the contribution to the Student Travel Awards budget) and ways of lowering expenses, e.g., implementing a cover charge, finding a local brewery willing to donate beer or a sponsor willing to cover costs, holding the auction at a nearby bar or restaurant, etc. It was emphasized that attendees needed to be reminded that, in addition to being a fun social event that can encourage membership and involvement in SSAR, the main point of the Live Auction is to raise funds to support student members.

A suggestion was received from the Membership Office that, on an annual basis, we acknowledge and publicly thank Life and Sustaining members of the Society by publishing a list of their names in *Herp. Review*. This was last done in 2004. The Secretary will contact Life and Sustaining members to request permission to publish their names and will ensure that this list appears annually.

Dick Durtsche requested that, if, in a given year, SSAR sponsors just one symposium at the Annual Meeting, the Board consider allocating the entire symposium budget (currently $3,000) rather than the normal $1,500. The Board approved this request. Gad Perry suggested that participants in SSAR-sponsored symposia consider contributing a special section to *J. Herp.*

The Board then turned to the 2014 budget. A doubling of funds allocated to the Student Poster Awards and the Roger Conant Grants in Herpetology Awards, a 50% increase in funds for the Student Travel Awards, and a request from the Student Mentorship Committee to support a lunch meeting for mentors and mentees were approved. A balanced budget of $320,000 for 2014 was approved by the Board.

The meeting was adjourned at 1339 h.

LRPC Meeting

An open meeting of the Long Range Planning Committee (LRPC) occurred on July 13th. LRPC Chair Kraig Adler called the meeting to order. In attendance were the following members of SSAR: Kraig Adler, Bob Aldridge, Ann Paterson, Aaron Bauer, Rafe Brown, Raul Diaz, Linda Ford, Bob Hansen, Kris Kaiser, Joe Mendelson, Gad Perry, Marion Preest, Dawn Wilson. Kraig distributed an agenda and introduced members of the LRPC and other officers present. Four main topics were discussed.

SSAR Website.—Joe Mendelson and Raul Diaz (members of the Website Subcommittee) reviewed the status of the website update. The Society needs a revamped website that is easily updatable with lots of imagery and capable of webcasting. We need to avoid redundancy between the ZenScientist and SSAR websites, while still making it easy to bounce from one site to the other. Ideally officers and committee chairs would be able to update their own material (e.g., the Seibert Chair could post information about the award winners). Some training would likely be necessary. Joe and Raul recommended that we provide the webmaster with a list of "trigger dates" on which he/she would contact the appropriate person for a particular update. A suggestion was made that portraits and short bios of "key" people in the Society be posted. There was discussion of posting the budget and IRS tax forms to make the finances of the Society as transparent as possible and also to make it clear that we are a volunteer society (i.e., none of the officers, editors, committee chairs, etc., makes any salary from SSAR) and that more than half of our annual budget relies on member dues. There was also some discussion of making at least part of the website available in a language other than English (e.g., Spanish, Portuguese), and of having a non-graphics version available for those with limited internet access. Kraig requested that the subcommittee keep members of the LRPC updated as proposals for redesigning the website are received and as various decisions are being made.

SSAR Publications Office.—There was discussion of trying to reduce our stock of old journals and books that are no longer selling. The Society has sent some copies to various places, e.g., to individuals teaching herpetology classes accompanied by invitations to join SSAR. It is not clear whether this has resulted in any new members. We now order fewer extra copies of our publications. This reduces our holdings, but we still need to ensure that we have sufficient extra copies to provide a full year's worth of journals as we recruit new members. There was a suggestion that we provide some incentive to try to avoid the necessity of over-printing, e.g., if someone does not join or renew by a certain date, they would only be able to receive electronic versions of our journals.

In light of the closure of his business *Bibliomania*, Breck Bartholomew has offered to step down as Publications Secretary. The Society has received an offer from another vendor to take over. Kraig Adler reviewed the services that Breck has provided SSAR for many years. After some discussion (including mention of Breck's generosity, loyalty, and long-standing service to the Society and the excellent job his office does of handling membership issues), the LRPC voted unanimously to recommend to President Aldridge that we remain with Breck.

New Member-, Publicity-, and Income-Generating Ideas.—Various ideas for increasing membership, publicity, and income were discussed. One idea was to publish anthologies of all of the *Herp. Review* articles about, for example, *Ambystoma*, or larger groups (frogs, salamanders). Bob Hansen pointed out that this would not be an easy task because, even though all issues of *Herp. Review* are now electronic, they are in PDF form, which makes searching them difficult. Bob also did not think these kinds of anthologies would generate much income. A suggestion was made that regional aggregations of articles (e.g., all of the *Herp. Review* articles about species in a particular US region) might be popular.

There was ongoing discussion of having *Herp. Review* picked up by BioOne or JSTOR. "Repackaging" *Herp. Review* (e.g., moving the "news" section to the end or placing it on the website) may make it more attractive to these outlets. Ann, Bob Hansen, and Breck will contact BioOne to ask them about the criteria they use when deciding whether to accept a given publication.

Increasing SSAR's Reach Overseas.—A number of suggestions regarding raising SSAR's profile internationally were discussed. For example, the Society should be keeping track of when non-US herp societies meet and send membership information for distribution. Aaron Bauer suggested that we also send information about articles of relevance to members of these societies (e.g., send a list of articles from *Herp. Review* and *J. Herp* about herps in Africa to the meeting of the Herpetological Association of Africa) to make them aware of the fact that SSAR truly is an international society.

We need to do a better job of making overseas students (both our members and members of other herp societies) more aware of our travel and research awards. A suggestion was made that we use the additional funds just allocated to the Student Travel budget to specifically target overseas members. It would be useful to get feedback on the perceptions towards SSAR of overseas herpetologists who are not members of the society (i.e., are we relevant to them and if we are not perceived in that way, what can we do to change that perception?). We need to promote the new policy of $0 page charges for members, as well as the underutilized pre-submission manuscript review service.

There was a suggestion that we target large Herp Expos, e.g., in Anaheim, Chicago, Arlington, etc. Some of these expos will give the society access to a free, 10 x 10 ft draped booth in which we could stock membership brochures and publications. A local member could be persuaded to give an evening lecture or show one of the updated SSAR Dennis and Juterbock audiovisual shows at one of these expos.

Some SSAR members currently sponsor (or have sponsored in the past) individuals who either cannot afford membership dues or they pay a one-off membership as a way of encouraging individuals to become long-time members. We could think about formalizing a program that matches non-members with potential sponsors. Alternatively, we could have a checkbox on the membership renewal form in which a member indicates if they wish to contribute to support a new member or if they wish to contribute to the meeting registration costs of a current overseas member. Ann agreed to follow up on these suggestions.

SSAR Business Meeting

The Annual SSAR Business Meeting was called to order by President Aldridge (1800 h, July 13th). Seventy-nine members of SSAR were present. Officers, Editors, and Committee Chairs introduced themselves to the other attendees and gave brief summaries of their Annual Reports and relevant information from the Board Meeting. Henri Seibert and Student Poster Awards were presented by Rafe Brown and Tiffany Doan, respectively. The meeting was adjourned at 1906 h.

List of Abbreviations Used
AIBS - American Institute of Biological Sciences
AP - Allen Press
CAAR - *Catalogue of American Amphibians and Reptiles*
EBSCO - Elton Bryson Stephens Company
IRS – U.S. Internal Revenue Service
JMIH - Joint Meeting of Ichthyologists and Herpetologists
LRPC - Long Range Planning Committee
MMPC - Meeting Management and Planning Committee
MSO - Member Societies and Organizations
PARC - Partners in Amphibian and Reptile Conservation
WCH - World Congress of Herpetology

—Respectfully submitted by **MARION PREEST**, *SSAR Secretary*
(with assistance gratefully acknowledged from Aaron Bauer and Greg Watkins-Colwell)

SSAR Life and Sustaining Member Recognition

SSAR wishes to publicly acknowledge the following Life and Sustaining Members. We would also like to thank those members who support the Society at these levels, but wished to remain anonymous. Anyone interested in becoming a Life or Sustaining Member, please contact Breck Bartholomew at the Membership Office (breck@herplit.com).

Life Members.—Kraig Adler, Kevin Arbuckle, Teresa Avila Pires, Mark Bailey, Breck Bartholomew, Thomas Beauvais, Brian Bastarache, Karen Bjorndahl, David Blackburn, I. Brisbin, Edmund Brodie, Rafe Brown, Stephen Busack, Donald Buth, John Cadle, David Canatella, William Carter, Jean-Phillippe Chippaux, Wen-Hao Chou, James Christiansen, Justin Congdon, Merel Cox, Ronald Crombie, Stephen Darbyshire, Kevin de Queiroz, Rafael de Sá, William Degenhardt, David Dennis, Michael Dix, Wei-Guo Du, Arthur Echternacht, Stephen Edwards, Robert Feuer, Clyde Fisher, Lee Fitzgerald, Neil Ford, Michael Forstner, M.J. Fouquette, Ruben Franco, Thomas Fritts, Andrew Gardner, Frederick Gehlback, Alberto Gonzalez-Romero, Eli Greenbaum, Celio Haddad, Stephen Hammack, David Hardy, Larc Hayes, Harold Heatwole, Fred Hendricks, Ronald Heyer, Tsutomu Hikida, Walter Hödl, Rebecca Homan, Kim Howell, Andrew Huck, James Huheey, M. Hunter, Herman in den Bosch, John Iverson, Morris Jackson, Dora Jacobs, Ronald Javitch, Mark Jennings, Eiiti Kasuya, J.P. Kennedy, Douglas Kibbe, Dirk Kreulen, William Lamar, Macreay Landy, Robin Lawson, Adam Leache, Carl Lieb, James List, James MacMahon, Anne Maglia, Eugene Majerowicz, Roy McDiarmid, Wolfgang Michl, Nicholas Millichamp, Joseph Mitchell, Stephen Mullin, Hidetoshi Ota, Margalee Patton, Eric Pianka, George Pisani, Dwight Platt, Harvey Pough, Robert

Powell, Thomson Reuters, Yukio Sakisaka, Frederick Schlauch, Norman Scott, Richard Scott, Diane Secoy, Frank Slavens, Ian Straughan, Douglas Taylor, Robert Thomas, Stephen Tilley, Linda Trueb, Thomas Uzzell, Eddie van Dijk, Frank Velte, Bonnie Walters, Joseph Ward, Gregory Watkins-Colwell, Robert Webb, Yehudah Werner, Chris Williams, Kelly Zamudio, Robert Zappalorti.

Sustaining Members.—Jae Abel, Diane Barber, Catherine Bevier, Peter Bloom, Russell Burke, Oswald Burkhard, Marlin Corn, Maureen Donnelly, Todd Esque, Chris Feldman, Byron Fiegel, Nirvana Filoramo, Thierry Fretey, Jerry Johnson, J. E. Juterbock, Teresa Mayfield, Peter Mayne, Michael McCoid, Robert McKeever, Francis Mondrosch, Eric Munscher, J. Martha Patricia Ramirez Pinilla, David Wales, Kirwin Werner.

SSAR Student Poster Awards

The SSAR Poster Awards will provide recognition for the best student posters presented at the annual meeting of the SSAR. To be eligible, the presented poster must be the result of research conducted by the individual making the presentation. The research must have been conducted while the student was enrolled in either an undergraduate or graduate degree program. Students entering the competition must be members of SSAR. The presentations will be judged by the SSAR student poster prize committee. One SSAR Poster Award of U.S. $200 (plus a book gift from an academic press that supports the award) may be given in each of the following four categories:

- Evolution, Genetics, & Systematics
- Ecology, Natural History, Distribution, & Behavior
- Physiology & Morphology
- Conservation & Management

The SSAR Poster Award will be judged by the following criteria:

- Quality of Research
- Quality of the Visual Display of the Research
- Professionalism and Confidence of the Presenter

Students may win the award only one time. Please indicate the appropriate category for which you are applying on the abstract submission form. Contact Tiffany Doan at tiffperu@yahoo.com or 860-839-2944 for further information.

Recommendations to Students Entering the SSAR Poster Competition

The SSAR Poster Award was presented for the first time at the 2011 Joint Meeting. The SSAR Board of Directors wishes to recognize that poster presentations are an important part of the annual Joint Meeting event and that they are an important component of the graduate and undergraduate experience. The presentation of some research projects is better suited to a poster session, which allows much greater communication between the presenter and the audience. The following recommendations are intended to aid students in improving the quality of their poster presentations. The criteria presented below are applicable to any poster given at a scientific meeting.

Preparing the Presentation

A. The Poster

- More so than an oral presentation, a poster needs to visually draw in the audience. When hundreds of posters are up at the same time, one's poster needs to stand out to be noticed.
- Put the poster up as early as is allowed by the conference center. That way you will have as many viewers as possible.
- Organization is key—a cluttered poster that is hard to read will not keep the attention of the audience.
- Use large fonts: at least 28–36 size font for the smallest words; approximately 90 size for the title.
- Use *sans serif* fonts such as Arial, Helvetica, and Calibri, which are easy to read from a distance.
- Use as many figures as possible, including graphs and photographs, to display your data.
- Use color to your advantage, but do not make it overwhelming. No one wants to look at a black-and-white poster, but too much color can be distracting.
- Do not include paragraphs on your poster (no one wants to stand there and read them). Bullet points or short sentences are much easier to read.

B. Oral Presentation

- Prepare a short explanation to your poster so that viewers do not have to read everything.
- Anticipate questions that the audience might have.
- Be prepared to discuss further research that you may later perform based on the results from the project about which you are presenting.
- Remember that other scientists have stopped at your poster because they are interested in your research. Relax and enjoy the experience of "talking shop" with other scientists who what similar interests.

Describing Your Research

A. Design

- Present your research in a larger context by addressing previous studies (choose 1 or 2 to make your point). Relate your data to the knowledge of your field.
- Clearly state your hypothesis(es) and/or objectives up front.
- Flag techniques that are original to your study (i.e., this study is the first to address this question or to use this technique).

B. Summary of Results

- Present your results clearly. Tables with N and P values are fine (but not necessary) if they are readable. Always indicate your sample sizes.
- Indicate the importance of your results. How do they relate to previous studies? Biology in general?

C. Importance of Study

- An abstract, summary, or conclusions section of your poster is helpful in tying together many results.
- State the importance of your study and how your research has added to knowledge of the subject presented. Are your results generally applicable to larger biological questions?

NEWSNOTES

Kentucky Collections Consolidated

Thomas More College has donated the previously orphaned amphibian and reptile collections from the Baker-Hunt Foundation Museum (Covington, Kentucky aka The Williams Collection), the University of Kentucky (the Roger Barbour collection), and the University of Louisville (the Burt L. Monroe collection) to the Cincinnati Museum Center. Further information on these collections may be obtained from John Ferner (fernerj@thomasmore.edu) and Herman Mays (hmays@cincymuseum.org).

Internship at Smithsonian's National Zoo



An unpaid internship position is available at the Smithsonian's National Zoological Park (NZP) in the herpetology department. NZP exhibits living animal and plant collections and conducts research in conservation biology and reproductive sciences as well as providing educational and recreational environments for the visiting public. The diverse living amphibian and reptile collection is housed in one of the most beautiful reptile buildings in the world, built in 1931. The NZP mission is to celebrate, study, and protect the diversity of animals and their habitats. NZP operates a public zoo of 167 acres in Washington, D.C. and is home to a diverse animal collection, ranging from frogs to elephants. NZP also manages the Smithsonian Conservation Biology Institute (SCBI) with a Smithsonian George Mason University campus on 3150 acres at Front Royal, Virginia. Research programs in animal health, behavior, medicine, and reproduction takes place in NZP, SCBI, and in field locations throughout the world.

For additional information, including qualifications, job description, and application procedures, please contact: Dr. James B. Murphy, Curator at murphyj@si.edu, (tel. 202-633-3251). Information about the Zoo's program can be found by consulting Murphy and Xanten (2007. Seventy five years of herpetology at the Smithsonian's National Zoological Park. Herpetol. Rev. 38:262–273).

Partners in Amphibian and Reptile Conservation Receives Award

At the annual meeting of The Wildlife Society in Milwaukee, Wisconsin, in October 2013, Partners in Amphibian and Reptile Conservation (PARC) received The Wildlife Society's Group Achievement Award, which recognizes an organization's outstanding wildlife achievement. PARC joins other imminent conservation organizations, including the Wildlife Management Institute, the Nature Conservancy, the [International] Association of Fish and Wildlife Agencies, and many other productive and respected wildlife conservation groups as a recipient of this award. Read more about the award and past winners here: http://www.wildlife.org/who-we-are/awards/group-achievement.

Special thanks to Dr. Jessica Homyack, current SE PARC Senior Co-chair and active member of The Wildlife Society, who submitted the nomination with support from several active PARC members, including those who are also members of The Wildlife Society. This award also reflects the tireless efforts of members and product/project development volunteers through the USA who engage through Regional Working Groups and a growing number of State Chapters.

Amphibian & Reptile Conservation Announces New Issue and Website



Amphibian & Reptile Conservation (ISSN: 1083-446X; eISSN: 1525-9153) (*ARC*) is an open-access international journal that publishes original peer-reviewed research, reviews, short communications, new species descriptions, country overviews, and more, that focus on a variety of topics relating to the biology, conservation, natural history, and diversity of amphibians and reptiles. *ARC* is now published semi-annually and each issue typically focuses on one country or subject but not exclusively, with general issues being produced as well. The most recent issue (September 2013) focuses on Mexico and includes seven papers. An upcoming issue on the country of Colombia is being developed for 2014. Potential author(s) are encouraged to submit papers directly to the editor at: arc.publisher@gmail.com and/or for further discussion and consideration.

The NEW journal website is now located at: amphibian-reptile-conservation.org and is the official journal destination for news, updates, current and past papers published in the journal, and more. All current and previously published papers of *ARC* have been added to *ZenScientist.com* and can be downloaded for free there as well as on the official *ARC* website (amphibian-reptile-conservation.org):

http://www.zenscientist.com/index.php/filedrawer/Open-Access-Journals/Amphibian--and--Reptile-Conservation/a

MEETINGS

Sustainable Amphibian Conservation of the Americas Symposium

The first meeting of the Sustainable Amphibian Conservation of the Americas Symposium (SACAS) occurred in Siquirres, Costa Rica on 30 July—5 August 2013. The conference was a first of its kind for bringing together academicians, zoo professionals, amphibian enthusiasts, and conservationists in a forum where they could share expertise from a wide array of backgrounds. The five-day event was an exciting mixture of invited lectures, roundtable discussions, and field trips to nearby natural areas containing high amphibian diversity and endemism, including the Costa Rican Amphibian Research Center (CRARC). Local expeditions yielded exceptional opportunities for the participants to catch glimpses of and photograph gorgeous salamanders and frogs such as the critically endangered Lemur Leaf Frog (*Agalychnis lemur*; Fig. 1). The distinguished speakers included specialists from *ex situ*-focused amphibian conservation projects in Colombia (Tesoros de Colombia), Costa Rica (Costa Rican Amphibian



PHOTO BY BRIAN KUBICKI

FIG. 1. A Critically Endangered Lemur Leaf Frog (*Agalychnis lemur*) from the Costa Rican Amphibian Research Center reserve, one of the many species of amphibians and reptiles seen by participants during the field trip outings in reserves around Siquirres and at La Selva.

PHOTO BY AURA REYES



FIG. 2. Participants of the Sustainable Amphibian Conservation in the Americas Symposium held 30 July—5 August 2013 in Siquirres, Costa Rica. Back row (L to R): Brian Kubicki, Jan Post, Eric Andersen, Erick Berlin, Richard Revis, Federico Bolaños, Justin Yaeger, Erin Kelley, Devin Edmonds, Jason Brown, Colin Clark, Henry Krull, Brent Brock, Chris Sherman, Lucio Sepe, Gabriel Schmied, Jan Dohnal, Steven David Johnson; middle row (L to R): Holly Schroeder, Aura Reyes, Jennifer Pramuk, Matthew Mirabello, Sara Erickson, Ariel Horner, Lola Guarderas, Michael Wallitis, Ivan Lozano Ortega, Christin Schwarz; front row (L to R): Aaron Tuggle, Ed Smith, Lincoln Erickson, Ron Skylstad, Teresa Sepe, Dave Huth, Roberto Ibañez. Not pictured: Tim Herman, Aura Kubicki, Stefan Lötters, Mark Pepper, and Evan Twomey.

Research Center), Ecuador (Wikiri), Peru (Understory Enterprises), and Madagascar (Association Mitsinjo). One of the more interesting themes of this meeting was the concept of "conservation through bio commerce" where revenue generated from surplus captive bred offspring is helping to support in country amphibian conservation efforts. More specifically, several of the speakers highlighted during the conference are maintaining colonies of threatened amphibians and developing partnerships with federal governments. Profits from the sale of certified captive bred offspring to the international commercial trade are returned to the country of origin to support habitat protection, education, research, and other conservation efforts. These captive breeding programs also can help assure the survival of focal amphibian species in areas where emerging threats such as amphibian chytrid fungus (*Bd*) are present or where other threats such as rampant habitat alteration cannot be mitigated in a timely fashion. By flooding the market with certified captive bred stock, these projects also might reduce illegal collection of wild amphibians common in the pet trade. For example, all commercial trade of the endangered Golden Poison Frog (*Phyllobates terribilis*) endemic to Colombia currently is sustained with illegally collected animals. Bio commerce and captive breeding could discourage wildlife smuggling and encourage legal purchase of this charismatic species. Additional speakers from the United States representing Toledo Zoo, Woodland Park Zoo, and Tree Walkers International presented lectures on amphibian-focused *ex situ* recovery projects, reintroduction programs, and education efforts. Lectures by accomplished researchers from Germany, Guatemala, Mexico (including the keynote speaker Federico Bolaños), and United States provided overviews of cutting-edge research being performed on the evolution, taxonomy, and natural history of dendrobatids and other amphibian taxa.

This symposium also was intended as a fundraising event from which proceeds will be disbursed among five *ex situ*-focused amphibian conservation projects. The last evening of the meeting included a live auction of donated items as well as sales of a t-shirt designed for the event. Throughout the week, the well-organized field trips offered tours of local reserves (e.g., Cahuita National Park, La Selva Biological Station), a botanical garden, an indigenous-run chocolate farm, as well as daytime and lively nighttime treks at the CRARC by renowned glass frog expert Brian Kubicki.

In all, more than 40 participants representing a dozen countries, all with an interest in neotropical amphibian conservation and biology, were in attendance. This symposium's success is the result of its thoughtful development and organization by Michael Wallitis and Richard Revis from Black Jungle Terrarium Supply who have had a life-long interest in dendrobatid and other tropical species and their conservation. Additional kudos to go Erik Anderson and Holly Schroeder who organized the symposium's successful fundraising efforts. Arguably, SACAS's most valuable outcome was the sharing of information that occurred throughout the week among its participants representing a wide diversity of expertise (Fig. 2).

—JENNIFER PRAMUK, *Curator, Woodland Park Zoo, 601 N. 59th Street, Seattle, Washington 98103, USA*

Meetings Calendar

Meeting announcement information should be sent directly to the Editor (HerpReview@gmail.com) well in advance of the event.

9–10 January 2014—California / Nevada Amphibian Population Task Force Annual Meeting, Beatty, Nevada, USA. Information: http://www.canvamphibs.com/

21–23 February 2014—39th Annual Desert Tortoise Council Symposium, Ontario, California, USA. Information: http://www.deserttortoise.org/symposium/index.html

18–20 May 2014—6th Conference on the Biology of Plethodontid Salamanders, University of Tulsa, Tulsa, Oklahoma, USA. Information: http://plethodontides2014.weebly.com

4–7 June 2014—Biology of the Pitvipers 2, Tulsa, Oklahoma, USA. Information: http://www.biologyofthepitvipers.com

16–20 July 2014—International Herpetological Symposium, Riverside, California, USA. Information: https://www.facebook.com/InternationalHerpetologicalSymposium

30 July–3 August 2014—Joint Meeting of Ichthyologists and Herpetologists (SSAR, HL, ASIH), Chattanooga, Tennessee, USA. Information: http://www.dce.k-state.edu/conf/jointmeeting/

CURRENT RESEARCH

The purpose of Current Research is to present brief summaries and citations for selected papers from journals other than those published by the American Society of Ichthyologists and Herpetologists, The Herpetologists' League, and the Society for the Study of Amphibians and Reptiles. Limited space prohibits comprehensive coverage of the literature, but an effort will be made to cover a variety of taxa and topics. To ensure that the coverage is as broad and current as possible, authors are invited to send reprints to the Current Research section editors, Beck Wehrle or Ben Lowe; e-mail addresses may be found on the inside front cover.

Two Turtle Genomes Shed Light on the Evolution and Development of Turtle-Specific Morphology

Turtles have a unique body plan compared to other vertebrates, complicating morphology-based attempts to place turtles in the vertebrate phylogeny and shed light on their morphological evolution. To better understand the evolutionary history of turtle armor, modified scapulae, and lack of temporal fenestra and to elucidate the lineage's phylogenetic placement, the authors conducted a phylogenetic analysis with new genomic data. The authors used shotgun sequencing to generate genomic sequence data for a soft-shell turtle (*Pelodiscus sinensis*) and the Green Sea Turtle (*Chelonia mydas*). From these data, a series of sequence contigs were formed through *de novo* assembly averaging in excess of 3.3 megabases in length (N50), and resulting in genomes 2.2 gigabases in size. A concatenated dataset of 1113 homologous genes was generated that included both turtle species, as well as ten other vertebrates including birds, crocodylians, a lizard, mammals, an amphibian, and a fish. Several phylogenetic applications were then employed to infer the phlyogenic relationships and divergence times of these taxa. These phylogenetic analyses placed turtles as the sister taxon to crocodylians and birds, consistent with other recent genomic studies. Furthermore, these analyses revealed the turtle-archosaur split to have occurred sometime between 248 and 268 million years ago, coinciding with the earliest hypothesized stem turtle, *Eunotosaurus*, dated to roughly 260 million years. Interestingly, the olfactory receptor gene family has undergone substantial diversification in turtles, with the majority of the expansion occurring after the divergence of *P. sinensis* and *C. mydas*. Other genes controlling hunger and taste perception appear to have been lost in these turtles. The authors identified suites of genes that showed accelerated evolution, suggesting that these increased rates are tied to morphogenesis. One gene showing a highly accelerated rate of evolution in these turtles is *Mgs3t*, which has been reported in other taxa to reduce oxidative stress, possibly contributing to the decreased senescence and longevity observed in turtles. The authors also collected and sequenced RNA samples from turtle and chicken at different developmental stages. They found that these animals fit the "Hourglass Model" of vertebrate development, where developmental differentiation (and therefore gene expression) between two organisms is greatest early and late in development and reduced at mid-development, when the general vertebrate body plan is developing. Sure enough, despite exhibiting a radically divergent body plan, they found weak but significant support for turtle mid-development gene expression being similar to that of birds relative to early and late development. Furthermore, they found 233 genes with increased expression in turtles after the split from their sister group, many of which are likely involved with ossification and extracellular matrix regulation, including the formation of the turtle-specific carapacial ridge. These findings serve to broaden our understanding of amniote relationships and morphological evolution, as well as evolution within testudines.

Wang, Z., N. Irie, and colleagues. 2013. The draft genomes of soft-shell turtle and Green Sea Turtle yield insights into the development and evolution of the turtle-specific body plan. Nature Genetics 45:701–706.

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New Frog Pheromone Found

Males of most frog species bear nuptial pads, swollen regions on the hand that develop during the mating season. The sexually dimorphic and seasonal nature of these structures strongly supports the hypothesis that they have a reproductive function. It has historically been thought these structures function to aid in gripping females during amplexus, necessary either because females are slippery or other males are intent on dislodging these competitors. The authors of this paper propose a new theory of function of nuptial pad function: pheromone production and delivery. The presence of glandular tissue in anuran nuptial pads has been noted previously, the product of which has been presumed to provide additional grip during amplexus. To investigate these structures further, the authors subjected nuptial pad tissue from breeding *Rana temporaria* to micro-CT scanning and histological staining. Furthermore, to understand their biochemical makeup, RNA transcripts were taken from the nuptial pad of a breeding frog. These transcripts were reverse-transcribed, cloned, and sequenced, as well as subjected to 3' RACE-PCR (a similar method that selectively amplifies the 3' side of transcripts that share a specific motif). Finally, high-performance liquid chromatography (HPLC) and mass spectrometry was performed on samples from nuptial pads from breeding and non-breeding frogs to characterize and quantify the constituent molecules. They found that the nuptial pads possess two distinct dermal gland types, each with pores exiting on the skin surface. The first gland type is a large gland with a thin epithelial layer and large lumen and the second is smaller with a thick epithelial layer and limited lumen. The transcriptome analyses discovered that the most abundant transcript type coded for five variants of a single protein, which the authors christened "amplexin." A search for similar known proteins (BLAST) found it most closely matched the salamander pheromone Plethodon Modulating Factor (PMF), strongly suggesting a pheromone function for amplexin. Furthermore, this finding may indicate a pheromone class that evolved in the branch leading to Lissamphibia (assuming lissamphibian monophyly). The HPLC and mass spectrometry

analyses showed that amplexin concentration spiked during the breeding season, and amplexins were completely absent outside the breeding season. As female frogs frequently exhibit skin abrasions in the pectoral region subsequent to ovipositing, the authors posit that nuptial pad bearing frogs may be delivering pheromones transdermally, as some plethodontid salamanders do. If so, this represents the first evidence of frog pheromones that are passed directly from male to female, rather than through the environment.

Willaert, B., I. Van Bocxlaer, and colleagues. 2013. Frog nuptial pads secrete mating season-specific proteins related to salamander pheromones. Journal of Experimental Biology (*in press*) doi:10.1242/jeb.086363.

Correspondence to: **INES VAN BOCXLAER**, Vrije Universiteit Brussel, Biology Department, Amphibian Evolution Lab, Pleinlaan 2, B-1050 Brussels, Belgium; e-mail: ivbocxla@vub.ac.be

Temperature Affects the Growth of Chytrid Fungus

Many pathogens are affected by environmental conditions such as temperature, precipitation, and humidity. Thus, anthropogenic changes in the environment can spark disease outbreaks. Chytrid fungus (*Batrachochytrium dendrobatidis* or *Bd*) is recognized as one of the leading causes of amphibian declines worldwide, with infections presenting as more intense and more common at cooler times of year and at high elevations. It has been proposed that *Bd* strains can adapt to their local environments. Understanding the properties of *Bd* across the narrow thermal range in which it can grow optimally can help predict effects on amphibian populations as climates change. Three strains of *Bd* from widely different locales in Australia were isolated from a Green-eyed Treefrog (*Litoria serrate*, Queensland), a Booroolong Frog (*L. booroolongensis*, New South Wales), and a Whistling Treefrog (*L. ewingii*, Tasmania) tadpole. The strains were grown *in vitro* at ten different constant temperatures (13–28°C) to examine the effects of temperature on growth and to determine the thermal tolerances of the fungus. The density of each isolate at each temperature was measured every 24 h over 15 days using spectrophotometry, at which point the density reached a plateau. The authors measured reproductive output and growth over 3–4 days by sacrificing a replicate colony and determining the zoospore concentration in 30µl of sample. Temperature most affected *Bd* growth during the logarithmic growth phase. During this phase, the Queensland strain (QLD) grew the fastest from 15°–25°C, the New South Wales strain (NSW) grew fastest from 19°–23°C, and the Tasmania strain (TAS) grew the fastest from 19°–25°C. By growth plateau, NAW and TAS had reached the highest *Bd* density at 13°C. The QLD isolate grew the slowest at 26° and 27°C, whereas the TAS strain showed moderate growth and NSW strain did not grow at these temperatures.

No strains grew at 28°C. Time to zoospore release was not different by strain, but increased at warmer temperatures, while zoospore activity decreased with warmer temperatures. This study better elucidates the stark effects that temperature can have on *Bd* virulence and shows evidence for thermal adaptation in this fungus. This increased understanding of *Bd* ecology can be used to predict effects on amphibian populations with changing environmental conditions.

Stevenson, L. A., R. A. Alford, S. C. Bell, E. A. Roznik, L. Berger, D. Pike. 2013. Variation in thermal performance of a widespread pathogen, the Amphibian Chytrid Fungus *Batrachochytrium dendrobatidis*. PLoS ONE 8:e73830.

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Latitudinal Patterns of Amphibian Diversity Evaluated with Phylogenetics

It has long been noted that across the tree of life, organismal group diversity tends to increase as distance from the equator decreases—and amphibians are no exception to this phenomenon. Several hypotheses have been erected to explain the high species richness in the tropics, including more niches, long-term climate stability, elevated primary productivity, longer regional presence, elevated speciation rates, decreased extinction rates, and elevated and/or greater opportunity for immigration. The authors of this paper made use of a previously published, time-calibrated phylogeny of 2871 amphibians (~40% of extant species) in an effort to test some of these hypotheses. They employed methods that can simultaneously estimate rates of speciation, extinction, and other processes across a phylogeny. These analyses take advantage of the fact that lineages with identical net-diversification rates (speciation minus extinction) but different extinction/speciation ratios will exhibit differently structured phylogenies. Specifically, lineages with higher ratios will appear to have undergone a recent burst of diversification, as extinction has a disproportionate effect on older branches. Methods aiming to estimate these rates solely from information on extant taxa are somewhat controversial, as they assume that rates have remained constant through time, but simulations have shown that model performance improves with sample size and coverage. The authors also compiled geographic range data for 6117 species. From these, the distributional center was calculated and an ecological value was assigned (the first axis of a principal component analysis of 21 climatic and ecological variables, PC1, which was closely correlated with latitude). To investigate inter-region dispersal, they compiled a dataset wherein 6576 species were assigned to one or more of twelve global ecoregions. Suffice it to say there is inadequate space here to describe all that was tested in this paper, however the results of these analyses are fascinating. The hypothesis that high amphibian diversity in the tropics can be explained solely by there being more adjacent land in the tropics and thus more opportunities for immigration was rejected. They did indeed find higher speciation rates and near zero extinction rates in the tropics, and moderate extinction rates in the temperate zone. Despite these dynamics, dispersal rates into the tropics from temperate regions were found to be five times higher than movement in the other direction. Clade richness was positively correlated with area occupied and negatively correlated with latitude and PC1. Also, lineages with low stem- to crown-age ratios are relatively species poor, having suffered disproportionate levels of extinction. Some findings were at odds with recent, family-level studies of amphibian diversity,

such as the amount of time regions have been occupied having no correlation with richness, and increased niche evolution not conferring increased speciation rates. The authors conclude that increased speciation, low extinction, and lopsided dispersal rates explain the high diversity of the tropics, despite longer lineage occupation times in temperate regions. The authors suggest that constrictions of habitable area and drops in temperature experienced during glacial cycles could account for increased extinction rates in temperate regions.

Pyron, R. A., and J. J. Wiens. 2013. Large-scale phylogenetic analyses reveal the causes of high tropical amphibian diversity. Proceedings of the Royal Society B 280:20131622.

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Turtle Embryos Move Within Eggs for Thermoregulation

Behavioral thermoregulation is common in post-hatchling ectotherms and allows them to maintain their preferred body temperatures, increasing fitness through optimized processes from locomotion to digestion to reproductive output. It was thought that only post-hatching developmental stages used this strategy until a recent study on demonstrating that embryos of the Chinese soft-shelled turtle (*Pelodiscus sinensis*) can move to warmer parts of the egg. Yet it was not clear if these movements were due to embryo behavior, or to fluid dynamics within the egg. Additionally, it was not known if the embryos could move to cooler areas within the egg when temperatures rose above their optimal temperatures. The authors incubated 125 eggs from the Chinese Three-keeled Pond Turtle (*Chinemys reevesii*) at temperatures ranging from 26°C to 33°C, as this species is has low hatching success above 32°C. Eggs were assigned to one of five temperature treatments, either being held constant at 26°C, dorsally heated to 29°C, or laterally heated to 29°, 30°, or 33°C. Eggs were candled and the midpoint of the embryo was marked on the egg and re-measured a week later. The authors found that the thermal treatments affected the position of the embryos. Embryos moved towards areas where the egg surface temperature was 29°–30°C, yet moved away from the too hot 33°C areas. To test if this was in fact due to behavior, at ten days, the halfway point of incubation, half the embryos were euthanized by injection and again the embryo position was remeasured a week later. Dead embryos did not move towards the heat source. These results support that embryonic turtles can indeed behaviorally thermoregulate, moving to parts of the egg with preferred temperatures. This may be especially important in turtles and other animals with temperature dependent sex determination as it could be a mechanism under which sex can be influenced by embryonic behavior.

Zhao, B., T. Li, R. Shine, W. Du. 2013. Turtle embryos move to optimal thermal environments within the egg. Biology Letters 9:20130337.

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Frogs Without Middle Ears Use Mouths to Hear

The middle ear is an adaptation that allows land dwelling animals to hear in air, yet some frogs that lack this structure still can hear and produce auditory signals directed at conspecifics. The mechanisms allowing sound to be transferred to the inner ear without a tympanic middle ear are unknown. It has been hypothesized that sound could be transferred via the lungs, the opercular system, and/or through bone conduction in these "earless" frogs. The authors recorded calls from male *Sechellophryne gardineri* (Sooglossidae), a diminutive frog from the Seychelles islands and one of the world's smallest tetrapods. They analyzed call characteristics and performed playback experiments with males in the field to evaluate intensity of responses. Males did not modulate the frequency or amplitude of their calls. For every experimental playback, *S. gardineri* called back, suggesting hearing. Three-dimensional imaging of mass density was generated via holotomography for four earless frogs (all four extant Sooglossidae species including *S. gardineri*), as well as four eared frogs from the Caribbean. Morphology of the skull and distance between the inner ear and air were measured for the frogs and sound resonance frequencies were calculated for these structures. *S. gardineri* were found to have no tympanum, middle ear cavity, or a columella (a middle ear bone present in most living amphibians and reptiles). The authors identified a number of morphological characteristics likely tied to hearing, such as high density, thin tissues around the inner ear, low mineralization of the skull, and overall high ossification. Since the volume of the lungs was smaller than that of the mouth, the pulmonary system is an unlikely route of sound transmission. Additionally, the lungs had a higher resonance frequency than those that made up the calls of the frogs. The resonance frequencies of bone structures was found to weakly match to the frequencies of the calls produced by *S. gardineri*, whereas the resonant frequency of the oral cavity closely matched that of the dominant call frequency. Thus, vibration of the oral cavity appears to be the mechanism to bring sound to the inner ear of these earless frogs.

Boistel, R., T. Aubin, P. Cloetens, F. Peyrin, T. Scotti, P. Herzog, J. Gerlach, N. Pollet, and J.-F. Aubry. 2013. How minute sooglossid frogs hear without a middle ear. Proceedings of the National Academy of Sciences 110:15360-15364.

Correspondence to: **RENAUD BOISTEL**, Centre de Neurosciences Paris-Sud (CNPS), Centre National de la Recherche Scientifique (CNRS) Unité Mixte de Recherche (UMR) 8195, Université Paris XI, 91405 Orsay, France; e-mail: renaud.boistel@univ-poitiers.fr

Stable Isotopes Reveal Tadpole Niche Not Filled by Insect Grazers Following Amphibian Decline

With biodiversity losses, it is important to understand how a whole ecosystem will be affected. Catastrophic amphibian declines in the Neotropics have been hypothesized to have widespread consequences on stream ecosystems. Using stable isotope analyses, the authors identify community responses to tadpole declines in the Río Maria, a headwater stream in central Panama. In 2006, more than 20 species of tadpoles were present in the stream, yet over the subsequent two years, tadpole

biomass dropped 98%. The authors predicted that insect grazers would move in to the tadpoles' dietary niches, specifically that of the dominant tadpole grazer, *Lithobates warszewitschii* (Ranidae). By measuring the biomass and characterizing the diet of *L. warszewitschii* pre-decline and the four most common insect grazers (*Stenonema* sp., *Thraulodes* sp., *Psephenus* sp., and *Petrophila* sp.) both pre- and post-decline, they were able to compare trophic niches. Insects were collected in the dry seasons 2006 and 2008, identified to genus, and sorted into feeding classes. Organic material was collected from stream rocks during the same periods, whereas *L. warszewitschii* tadpoles were only collected in 2006. Each type of sample was dried at 50°C, ground up, and subjected to ^{15}N and ^{13}C analysis. For each sample, N isotope ratio was plotted against C isotope ratio, and the 2-dimentional mean and spread were identified for the tadpoles and each insect species pre- and post-frog decline. The guts were removed from five of each insect grazer per collection year, as were foregut segments from five *L. warszewitschii* tadpoles collected in 2006, and their contents were determined. The authors found that insect biomass in the stream did not change from 2006 to 2008, though the biomass of organic material on rocks more than doubled post-tadpole decline. Despite no change in organic material isotope ratios, three of the four insect taxa shifted their isotopic niche in the direction of *L. warszewitschii* subsequent to the decline. Yet the carbon and nitrogen isotopic niches of the grazing insects did not overlap with that of the tadpoles either pre-or post-decline. *L. warszewitschii* were found to primarily eat non-algal biofilm, and two insect taxa consumed a greater proportion of non-algal biofilm post-decline. The increase in organic material in the stream coupled with the lack of insect biomass increase post-tadpole decline supports the conclusion that despite shifts in diet, the insects did not move into the open tadpole dietary niche. This is one of the first studies to use stable isotopes to quantify effects of biodiversity loss in an ecosystem, showing that tadpole loss does indeed affect the nutrients available in the system.

Barnum, T. R., P. Verburg, S. S. Kilham, M. R. Whiles, K. R. Lips, C. Colón-Gaud, and C. M. Pringle. 2013. Use of stable isotope ratios to characterize potential shifts in the isotopic niches of grazing insects following an amphibian decline in a Neotropical stream. Journal of Tropical Ecology 29:291–299.

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Sea Snake Disappearances from a Biodiversity Hotspot

Biodiversity declines are widespread across vertebrates, often tied to habitat destruction and over-exploitation. Yet in some cases, the causes of population declines are unknown, posing a great challenge to conservation efforts. Many snake declines in the last decade have occurred in protected areas, with evidence for factors leading to reduced population carrying capacity. Sea snakes have historically been found with great species diversity and individual abundances in the Timor Sea off the coast of Australia. The remarkable diversity and abundance of sea snakes at one site in particular, Ashmore Reef, has been known since the early twentieth century, and snake surveys have been conducted there regularly since the early 1970s. However, recent evidence of snake declines at Ashmore Reef have surfaced, though no cause has been identified. To assess the status of sea snake populations in this hotspot, a combination of 11 survey efforts conducted between 1973 and 2010 were compiled from previous studies or conducted by the authors to estimate abundances and species diversity. The authors collected data on habitat complexity of the reef and estimated benthic cover using transects. In 1973 and 1994, more than 40 sea snakes were found per day. By 2002, only 21 snakes were found per day, decreasing to averages of 1–7 snakes found daily in subsequent years, despite increases in researcher sampling efforts. Additionally, there were concomitant decreases in sea snake species found, dropping from 9 species per day found in 1973, to 5 species in 2002, and 1–2 species in subsequent years, with some species disappearing from the site entirely. Habitat areas used by sea snakes also began shrinking after 2002. From their 2010 surveys, the authors found significant differences in coral cover and habitat complexity in different portions of the reef. Since 1983, Ashmore Reef had been a protected area, suggesting that habitat protection alone is not sufficient to curb these sea snake disappearances. Though the causes of these declines are unknown, the authors propose and discuss the following mechanisms of decline: habitat loss, prey loss, poaching and incidental capture, disease, invasive species, pollution, and recruitment failure. However, the authors did not find evidence to support any of these hypotheses, but do identify areas for further study, specifically work on reproductive condition of seas snakes from this area. They conclude that these enigmatic declines are likely due to multiple environmental and biological factors and that more research on other sea snake populations may yield clues to how best to manage these declining populations.

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OBITUARIES

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Robert R. Capranica (1931–2012) and the Science of Anuran Communication

Field herpetologists—and field biologists generally—have been entertained, soothed, and sometimes even seduced by the nocturnal serenades of frogs and toads. A harbinger of spring in the temperate zone and of the rainy season in the tropics, those who have not experienced a frog chorus have missed out on one of Nature's great spectacles.

Aristophanes, the comic playright of ancient Athens, was the first to describe a frog's mating call in written form (in 405 BCE). It wasn't until 1905, however, that Robert M. Yerkes, a psychologist then at Harvard University, showed conclusively that frogs could actually hear the calls! Two Cornell University ornithologists, Arthur A. Allen and Peter Paul Kellogg, made the first sound recordings of frog calls (on the optical sound track of movie film in 1935). The original use of "sonagraphs" (sound spectrograms) to visualize frog calls was by W. Frank Blair of the University of Texas at Austin (1954), and Bernard S. Martof, then at the University of Georgia, was the first to conduct playback experiments with tape-recorded calls (1958). During this same period, Charles M. Bogert, of the American Museum of Natural History, provided a functional classification of frog vocalizations and addressed many issues about the biological significance of frog calls including their role as isolating mechanisms in reproduction.

It could be attested, however, that the subject of anuran communication did not truly become a rigorous experimental science until the research performed by a young electrical engineer–turned-neuroscientist was initiated in the early 1960s. Robert R. Capranica, one of the founders of neuroethology (a branch of biology that seeks to understand the neural basis of natural animal behaviors), began his research career in the Department of Sensory and Perceptual Processes at Bell Telephone Laboratories in Murray Hill, New Jersey, and then, in 1969, moved to the Department of Neurobiology and Behavior at Cornell University in central New York State. It was Capranica who pioneered the use of quantitative behavioral analyses to determine key features in a frog's complex vocal signal and later combined these studies with electrophysiological analyses of the frog's auditory system, thus firmly establishing the connection between brain and behavior. He set the stage for numerous investigations that linked hearing and decoding mechanisms in frogs with both their ecological setting and their evolutionary diversification. Capranica forever changed the standards for bioacoustics research, and he trained and inspired several generations of biologists and engineers to study animal communication from this same broad biological perspective. In doing so he made frog communication one of the best-studied phenomena in biological science.

Robert Rudy Capranica, who died last year a few weeks shy of his 81st birthday, was born in Los Angeles, California, on 29 May 1931, and raised in southern California. His formal education was entirely in electrical engineering (University of California at Berkeley, B.S. 1958; New York University, M.S. 1960; Massachusetts Institute of Technology, Sc.D. 1964). Since 1958 he had been working at the famed Bell labs where they had supported his research on the auditory system of frogs, which formed the basis



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for his doctoral dissertation. What he produced has been referred to as ". . . arguably the most elegant dissertation research ever completed in animal bioacoustics." This was published as a book by MIT Press in 1965—entitled "The Evoked Vocal Response of the Bullfrog [*Lithobates catesbeianus*]. A Study of Communication by Sound"—and is now a classic in the field. In it he pioneered the use of synthetic calls for playback experiments, showed that the mating call of the bullfrog was species-specific, and systematically demonstrated that the two principal components of the bullfrog's mating call (its high- and low-frequency energy bands) must be present simultaneously to evoke a vocal response from an isolated male. It was a first attempt to answer the query, "What does the frog's ear tell the frog's brain?" and he spent the rest of his career attempting to answer this fundamental question.

Although Capranica devoted much of his time studying the function of calls of various species in the field and the lab, his ultimate goal was to understand how acoustic signals are processed. Prior to his work, it was thought that the decoding of sensory information was done solely in the brain and that the ear was simply a passive conduit for information. He demonstrated that much of the signal processing was, in fact, done within the inner ear organs themselves, an example of what is called "peripheral processing." Capranica and his colleagues also followed this message to the brain and determined how information is processed through a series of brain nuclei, culminating in a "mating call detector" in the frog's thalamus.



After arriving at Cornell, Capranica the engineer also became an accomplished field naturalist. His first overseas field trip was to Puerto Rico in 1973, together with his wife (Patricia), a new postdoc from Murray Littlejohn's lab in Australia (Jasper Loftus-Hills), and one of his first graduate students (Peter Narins). He was involved in all aspects of the field work, experimental design, and testing. Narins was searching for an appropriate species to study for his dissertation research and thought that the ubiquitous and abundant Puerto Rican Coqui (*Eleutherodactylus coqui*) would be a likely candidate. He wanted a frog that produced a call with a sequence of simple notes to replicate in the time domain what Capranica had studied with bullfrogs in the frequency domain, in order to determine if the normal note sequence was required for a natural behavior. The coqui frog seemed to be ideal because males produce a two-note call ("co-qui"); each note is spectrally simple and easily synthesized (a Cornell graduate student, Bruce Land, built the first portable "co-qui" synthesizer in 1972); and this species is large enough to permit electrophysiological recordings from its auditory system.

On this first trip to Puerto Rico, a series of acoustic playback experiments with male coquis revealed that the natural (actually, a synthetic version of the natural) two-note call evoked a characteristic one-note ("co" only) response from males in the field nearly half the time it was played. Moreover, both the sequence-reversed call ("qui-co") and the single note ("co") were equally effective at evoking the one-note response, but the "qui" note alone was almost completely ineffective. Capranica's enthusiasm for these field experiments was infectious and inspiring to everyone around him.

Capranica financially supported field studies by his own students and postdocs, and also by those working in other Cornell labs. Loftus-Hills was not directly involved in these Puerto Rican experiments, but on this same trip he discovered a spectacular new species of coqui calling from water-filled bromeliads 10 m above the ground, on the basis of its previously unrecognized call. After his untimely death in 1974, the frog was named for him by George Drewry and Kirkland Jones in *Journal of Herpetology* (1976). This species—the Golden Coqui (*Eleutherodactylus jasperi*)—was the first and is still the only ovoviviparous frog known from the Western Hemisphere. Narins returned to Puerto Rico in 1974 to continue his field studies, accompanied by a fellow graduate student in another lab, Kent Wells, who was thus introduced to Neotropical frogs and their behavioral ecology.

Many in his own field of neuroethology were unaware of Capranica's influence on studies of animal speciation. Species-recognition studies in frogs offered important proof that behavioral isolation could drive speciation. Blair, Littlejohn, and Carl Gerhardt, Capranica's first postdoc, all made seminal contributions to this field by showing how the mating call and its recognition resulted in species-specific mating preferences by females. All of these results were consistent with Capranica's studies of how the auditory system, inner ear, and brain bias the perception of females to find calls of their own species more attractive.

Capranica also teamed up with the noted Israeli biologist, Eviatar Nevo, to extend the concept of species recognition to that of dialect recognition. Combining ecological surveys of the calls of cricket frogs (*Acris*) throughout much of the United States with detailed studies of auditory neurophysiology, Capranica and his colleagues showed how variation in calls and the neural mechanisms that decode them can co-vary from one population to the next even within one species. Although he was trained as an electrical engineer and practiced as a neuroethologist, he knew how

important sexual communication was to evolutionary biology. As such, even the evolutionary biologists who spent time at his bench, such as Michael Ryan, were made to feel welcome.

Capranica's lab at Cornell was home to an interdisciplinary hive of graduate and postdoctoral students drawn from engineering, psychology, neuroscience, and animal behavior. They studied communication and the evolution of sound processing in a diverse array of anuran taxa including *Ascaphus* and *Xenopus* and in representatives of many families of advanced frogs. They also studied the lateral-line sensory organs in *Xenopus*. Among the young scientists he mentored were his own graduate students (including Karen Mudry Avil, Christine Boake, Eliot Brenowitz, Avis Cohen, Martha Constantine-Paton, Frank Dodd [his only student who worked with reptiles—on the vocalizations of geckos], Albert Feng, Peter Narins, John Paton, Gary Rose, David Yager, and Harold Zakon), his postdocs (Deana Bodnar, Carl Gerhardt, Jasper Loftus-Hills, Michael Murray, Andrea Megela Simmons, Walter Wilczynski, and Nigel Woolf), and rotational students from other labs (Stephen Nowicki and Michael Ryan).

In the lab, Capranica worked closely with his long-time technician, Anne Moffat, and together they carried out long electrophysiological experiments in which they would record from single fibers in the auditory systems of frogs. Their studies were usually done on Fridays, a day that was held sacred and thus unavailable for student lab research, but the students would often hang around the lab on those days simply to watch the master at work. The experiments would begin in the morning when the animals were anesthetized, the surgery was done, and the frogs were then placed in the soundproof chamber and the electrode was poised to enter the auditory nerve. The recordings were done in the afternoon but often extended beyond dinner and into the late hours of the evening.

Capranica also served his discipline as a highly dedicated associate editor for section A (sensory, neural, and behavioral physiology) of the *Journal of Comparative Physiology* (1974–1986) and thereby helped to raise its standards to become the leading journal for neuroethology. In attracting manuscripts from around the world, he would often re-write entire papers into proper English in order to help make neuroethology a more international discipline. In the early 1980s, together with a small group of Europeans and Americans, he founded the International Society for Neuroethology, which now awards the Capranica Prize each year for the best paper published in the field of neuroethology. His well-known sense of humor and infectious laughter made him a popular teacher, lecturer, and friend.

Only on one occasion did Capranica attend a herpetological meeting. At the SSAR meeting in 1976, held at Miami University in Ohio, he participated in a symposium, entitled "Reproductive Biology of Amphibians" (published the next year under the editorship of Douglas Taylor and Sheldon Guttman). After listening to a speaker remark how he tested the toxicity of skin secretions of frogs—by requiring his entire class of students to lick them—Capranica exclaimed, "You herpetologists really are crazy." One might infer from this comment that he did not consider himself to be a card-carrying herpetologist, but his research nevertheless is counted among the most important bodies of work ever conducted with amphibians.

Capranica's major research accomplishments include: 1) multiple studies showing that the auditory systems of different species of frogs have different spectral sensitivities; 2) the discovery of acoustic dialects in frogs and the existence of distinct call types in allopatric populations; 3) the introduction of the concept of the "matched filter" to provide an underlying basis for the co-evolution of sender and receiver; and 4) studies on the remarkable temporal sensitivity found in the cells of the anuran central nervous system that are often closely matched to advertisement call features. Together with his Cornell colleague, Watt Webb, an engineering physicist, he applied the then-novel technique of laser Doppler vibrometry to measure the nano-scale vibrations in the eardrums of frogs and other animals. LDV is now a standard technique in the auditory mechanics community.

Robert Capranica died on 11 May 2012 in Tucson, Arizona, where he had retired in 1993. He is survived by his wife, Patricia Alna Capranica (née Mullen).

ARTICLES

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Caretta caretta in Tunisia: Natural History and Report of a New Regular Nesting Area

Five sea turtle species have been recorded in the Mediterranean Basin (Delaugerre 1988; Rivera et al. 2011); however, only three species occur regularly. The Leatherback (*Dermochelys coriacea*) regularly enters the Mediterranean for foraging, with no documentation of nesting activity to date (Casale et al. 2003). The Green Turtle (*Chelonia mydas*) breeds only in the eastern Mediterranean, with the main nesting populations occurring in Turkey, Cyprus, and Syria (Kasparek et al. 2001; Rees et al. 2008). The Loggerhead (*Caretta caretta*) is the most common species, widely distributed in the Mediterranean Sea, with an average of 7200 nests documented annually (Casale and Margaritoulis 2010). However, nesting is almost entirely confined to the eastern Mediterranean Basin, with the main nesting sites being concentrated in Greece, Cyprus, Turkey, and Libya (Casale and Margaritoulis 2010). Minimal to moderate nesting has been recorded in Egypt, the Gaza strip, Lebanon, Israel, Italy, Syria, and Tunisia (Campbell et al. 2001; Margaritoulis et al. 2003; Casale and Margaritoulis 2010). Recently, sporadic nesting has also been recorded in the western Mediterranean, namely in Spain, Corsica, Sicily, and along the Tyrrhenian coast of Italy (Delaugerre and Cesarini 2004; Casale et al. 2012). The Loggerhead is the only species of sea turtle known to nest on Tunisian beaches (Laurent et al. 1990).

Since the initiation of monitoring of sea turtle activity in the Mediterranean (nesting, foraging, bycatch, and live/dead strandings), it was evident that Tunisian beaches represent the westernmost nesting grounds, albeit minor, for Loggerheads in the southern Mediterranean (Laurent et al. 1990), as there are no records of regular Loggerhead nesting activity in Algeria or Morocco (Casale and Margaritoulis 2010). However, the full distribution of nesting activity in Tunisia remains poorly documented. Many potential nesting sites have not been monitored since the first mission of WWF in Tunisia (Laurent et al. 1990) and only one monitoring program has been implemented since 1997, on the Kuriat Islands, which are considered to be the only regular Loggerhead nesting site in Tunisia (Casale and Margaritoulis 2010). Tunisia has many other potentially suitable sites for Loggerhead nesting, with nesting activity being occasionally reported on various beaches by local inhabitants (Laurent et al. 1990).

In this paper we aim to increase available information about Loggerhead nesting activity in Tunisia. At a national scale, we assimilated all available records from the published literature of Loggerhead records and nesting events to determine this species' distribution in Tunisia since the 18th century. At a local scale, we report the nesting activity of Loggerheads at Essir beach in the city of Chebba (Mahdia Governorate). We describe the characteristics of the beach and identify possible threats to nesting activity.

Methods.—Tunisia has approximately 1250 km of coastline, of which 400 km is sandy beaches. A third of the coastline is located in the western basin of the Mediterranean Sea and is mainly characterised by a rocky zone with intermittent small beaches. The remaining coastline extends along the eastern basin of the Mediterranean and is mainly characterized by large sandy beaches.

Our observations took place on the beaches of Chebba, which is located on the eastern coast of Tunisia (35°14N, 11°9E). Chebba is situated 60 km N of the city of Sfax and 30 km S of the city of Mahdia (locality 11 in Fig. 1). The Chebba coast extends 29 km and includes several small islands. Almost all of the Chebba shoreline is rocky, with dead sea grass (*Posidonia oceanica*) deposited on submerged rocks; however, there are two sandy beaches: Sidi Massouad (length 100 m and mean width 25 m) and Essir (length 400 m and mean width 35 m). The Kuriat Islands represent the closest known Loggerhead nesting sites and are located about 65 km N of Chebba (locality 10 in Fig.1).

Our investigations were based on several lines of evidence, including 1) information received from people frequenting the two beaches at night; 2) records of recently hatched turtles being captured in fishing nets close to the beach; and 3) direct observations made by us from 2003–2013. We did not dig to confirm the presence of potential nests. We used only track morphology to infer whether a clutch had been laid or not and made direct observations of hatchling turtles on the beach.

Results.—The first reports of the presence of Loggerheads in the Gulf of Gabes were made in 1889 (Servonet 1889). Subsequently, the presence of Loggerheads was mentioned by Olivier (1896) in the region of Tunis and Bizerte, Mayet (1903) and Seurat

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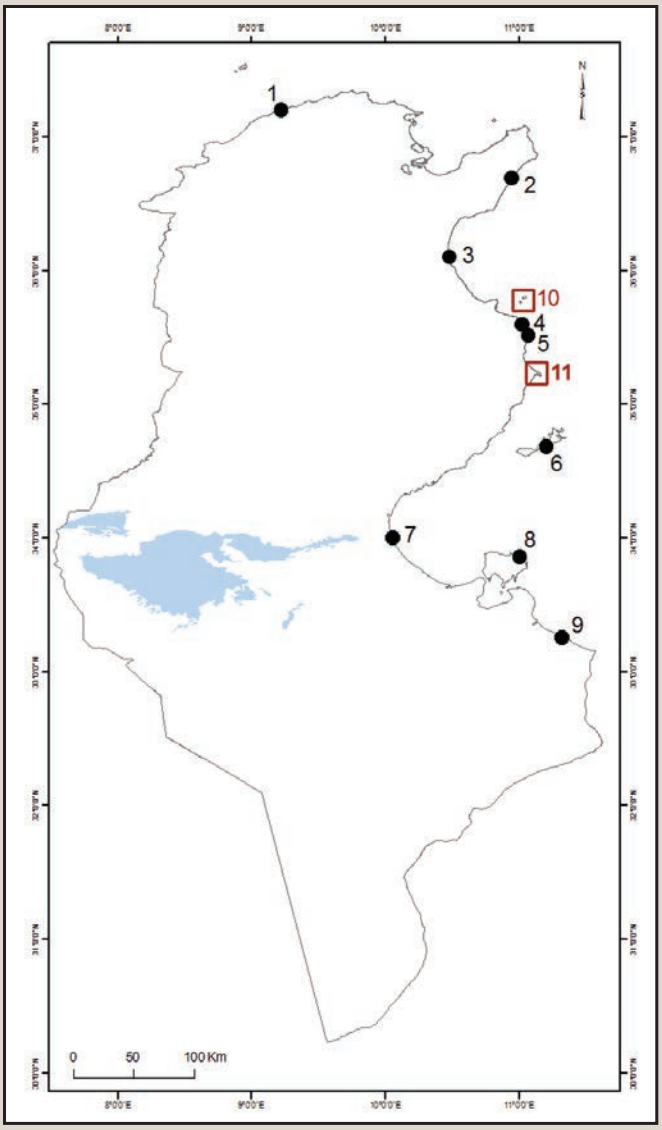


FIG. 1. Distribution of nesting sites of *Caretta caretta* in Tunisia. Black circles: literature sites. Red rectangles: documented nesting sites. 1) Cape Serrat; 2) Nabeul; 3) Hammamet; 4) Ras Dimas; 5) Mahdia; 6) Kerkennah Island; 7) Ghannouche (Gabes); 8) Sidi Mehrez (Jerba Island); 9) El bibane to Libyan borders; 10) Kuriat Island; 11) Chebba.



FIG. 2. Nesting area in Chebba. A) Essir beach; B) Sidi Massouad beach.

(1934) in the Gulf of Gabes, Mosauer (1934) in Sfax, and Blanc (1908, 1935) and Domergue (1959) along the entire coast of Tunisia. According to these authors, Loggerheads were very common throughout Tunisia. Other publications have reported the presence of large numbers of sea turtles, which were probably Loggerheads; according to Bouchon-Brandely and Berthoule (1890) and Charcot (1924), sea turtles were very common in the areas of Sousse and Banc des Esquerquis (northeastern Bizerte), with fishing boats potentially landing five or six turtles a day.

There is a paucity of published information about Loggerhead nesting activity in Tunisia. According to Blanc (1935), Loggerheads lay eggs on the islands, islets, and deserted beaches of Tunisia. Knoepffler (1962) and Parent (1981) mentioned that Loggerheads nest on "petite Syrie" (Gulf of Gabes) and the beach of Bougrara. However, Argano (1979) stated that the eastern coast of Tunisia represented the most important region in North Africa for Loggerhead nesting activity, considering the immense range of uninhabited beaches.

In the past, intense and widespread nesting has been observed along the Tunisian coastline; however, nesting numbers subsequently collapsed because of habitat degradation and intense fishing activity (Bradai et al. 2008). According to Laurent et al. (1990), Schleich et al. (1996), Bradai (2000), Chaeib et al. (2011), and the testimonies of the fishermen and local habitants, there is evidence of past nesting activity on the beaches of Salakta, the beaches between Chebba and Gdhabna, Eddouwira beach, the beaches between Mahdia-Hiboun (locality 5, Fig. 1) and Ras Dimas (locality 4, Fig. 1), the beaches of Ghannouche (Gabes; locality 7, Fig. 1), the beaches between El Bibane, Zarzis, and the Libian border (locality 9, Fig. 1), the beaches of Nabeul (locality 2, Fig.1), the beaches south of Hammamet (locality 3, Fig. 1), and the beaches of Kerkennah Island (locality 6, Fig. 1) and Sidi Mehrez (Jerba Island; locality 8, Fig. 1). Only Groombridge (1990) reported Loggerhead nesting activity in northern Tunisia, at Cape Serrat (locality 1, Fig. 1). The identity of nesting sea turtles in Tunisia as Loggerheads was first confirmed between 1987 and 1988 by Laurent L. and A. Jeudy de Grissac (Laurent et al. 1993; Fig. 1), on a beach situated between Ras Dimas and Mahdia (25 km south off Monastir), the Kuriat Islands (15 km off the coast near Monastir), and at Sidi Massaoud beach in Chebba (Ellouze 1996; Fig. 1).

The southern part of the Gulf of Gabes (Tunisia) is considered to be an important overwintering and foraging region for juvenile and adult Loggerheads in the Mediterranean (Laurent and Lescure 1994; Margaritoulis et al. 2003). However, nesting activity has not been reported on the beaches between Sfax and the border of Libya (RACSPA 2001).

The Kuriat Islands are two small islands (Little Kuriat and Great Kuriat) off the east coast of Tunisia that represent the only known stable and regularly used nesting site for Loggerheads in Tunisia (Casale and Margaritoulis 2010). However, only a small number of nests are deposited each year, with annual numbers ranging from 3–15 (Jribi et al. 2009). Since 1993, nesting activity was not recorded in Hiboun or between Mahdia and Ras Dimas beaches (Ellouze 1996). In addition, nesting has not been reported on Sidi Massaoud beach since 1997 and this nesting area was considered to be used only irregularly (Casale and Margaritoulis 2010).

After the initial record of Loggerhead nesting activity on Sidi Massaoud beach in Chebba (Fig. 2) in 1994 (two nests) and in 1995 (one nest; Ellouze 1996), follow-up surveys during 1996–2000 recorded no further nesting activity. This lack of nesting

was possibly due the physical artificial alteration of this beach (Bradai et al. 2008; pers. observ.). However, during the summer of 2003, vacationers found hatchlings on the road close to Essir beach (probably due to artificial lighting behind the beach disorienting the hatchlings and drawing them inland). Since then and until summer 2013, hatchling turtles have been recorded emerging from the sand of Essir beach every summer (from mid-August to the mid- September) or have been caught in fishing nets close to the coast (Fig. 3). The crawl tracks of nesting females were recorded on Essir beach from late June to July in 2005 and 2008. Recently, female Loggerheads have possibly shifted nesting locations from Sidi Massaoud beach to Essir beach, about 1.24 km further north (Fig. 2). This change in nest-site fidelity is probably a consequence of disturbance affecting Sidi Massouad beach, where a large section of beach area has been destroyed (Fig. 4). Sidi Massouad beach decreased from 150 m in length and 50 m in width at the central point during 1994 (Ellouze 1996) to 100 m in length and 25 m in width at the central point during 2013 (pers. observ.; Fig. 4A). Although Essir beach is also subject to intensive human recreational use during summer, in July 2013, a total of 97 hatchling turtles emerged from two nests at Essir Beach (Fig. 2). Many of them where found lost on the road paralleling the beach by local people. However, in September 2013 hatchling turtles were found for the first time since 1997 at Sidi Massouad beach, possibly in relation to a reduction of human disturbance.



PHOTO BY JIHÈNE BEN HASSINE

FIG. 3. Emergent hatchling turtle on Essir Beach, Chebba (17 August 2013).



PHOTO BY JIHÈNE BEN HASSINE

FIG. 4. Anthropogenic activity in the nesting area of *Caretta caretta* in Chebba. A) Sidi Massouad beach; B) Essir beach.

Discussion.—Our observations, in combination with the literature review of turtle nesting activity, indicate that the number of Loggerhead nesting beaches in Tunisia may be underestimated and that Chebba beaches represents the southernmost regular nesting site for Loggerheads in Tunisia. In summer 2013, a dead adult female was found at Eddouwira beach. This suggests that nesting activity may also exist between this unfrequented beach and Ghabna beaches. Our observations indicated that the nesting period on Chebba beach is limited to the last two weeks of June and the first two weeks of July, which is similar to that recorded at almost all the Mediterranean nesting sites (Margaritoulis et al. 2003). According to Ellouze (1996), the hatching success (percentage of eggs hatched) and hatchling emergence success (percentage of hatchling emerged) on Chebba beach were 81% and 74%, respectively, indicating that this beach is suitable for incubating Loggerhead nests. On the Kuriat Islands, which is currently the only location in Tunisia where Loggerhead nesting beaches have been monitored and protected, the mean hatching success and hatchling emergence success were 73% and 70%, respectively (Jribi et al. 2006).

The sea turtle nesting season in Tunisia coincides with the tourist high season, both occurring during the summer months of June to August. Certain tourism activities may prevent turtles from nesting. The Loggerhead sea turtle is subject to several threats in the area of Chebba beach, both on the beach and in the sea. On Chebba beach, camping and sun-umbrellas risk damaging nests through piercing the eggs and potentially lowering incubation temperatures (Fig. 4B). When incubation temperatures drop below 24°C, embryonic development stops irreversibly (Yntema and Mrosovsky 1982). In addition, the lowering of incubation temperatures might alter hatchling sex ratios, as more males are produced at temperatures below 29°C (Kaska et al. 1998). The artificial lights adjacent to or directly behind the beach (harbor and corniche) have been shown to disorient hatchlings, which are attracted to light, consequently increasing the time that hatchlings spend on the beach, increasing their vulnerability to desiccation or predation by cats and sea birds that frequent Chebba beach (Lorne and Salmon 2007). The mechanical cleaning of Essir beach (to remove rubbish and sea grass) and the use of four-wheel drive cars on the beach obliterate turtle tracks and nests, which confounds monitoring routines and more importantly may destroy nests (through compacting the sand and crushing eggs). The physical alteration of the Essir nesting beach (due to the placement of sun-umbrellas, sunbeds,

boardwalk, two wooden cabins, and beachfront construction) and reduction in nesting habitat through building permanent structures on the beach of Sidi Massouad may prevent female turtles from reaching a suitable nesting location on the beach, leading to a direct impact on hatchling emergence and hatching success. Evidence of this threat was observed in September 2010, when more than 100 hatchlings were found dead, trapped under a boardwalk that is installed every summer in the first week of July. Furthermore, human use of the beach at night risks disturbing female turtles and may prevent them from emerging onto the beach to nest. In Tunisia, in addition to mortality rates caused by fishing methods (Jribi et al. 2007), marine turtles may, on occasion, be intentionally killed by some fishermen in Chebba.

At present, national marine turtle conservation strategies in Tunisia are primarily focused on reducing the at-sea mortality of adult and juvenile Loggerheads (Jribi et al. 2010; Casale et al. 2010) and on protecting the nesting sites on the Kuriat Islands. Beyond the Kuriat Islands, the protection of nests on beaches along the Tunisian coastline would contribute appreciably toward improving Loggerhead numbers and, possibly, genetic diversity. Therefore, large-scale national surveys are required to determine whether other previously described areas with low levels of Loggerhead nesting activity, such as Chebba, might also have undetected nesting activity. To support the conservation of Loggerhead sea turtles, we strongly recommend the introduction of a large-scale conservation approach that reduces at-sea mortality in parallel with protecting known and suspected nesting areas, through a nationwide replicated survey of all potential nesting sites.

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Inferring Sea Turtle Recapture Rates Using Photographic Identification

The ability to consistently identify individuals over time is essential when studying population parameters such as growth rates, age structure, migratory movements, survivorship, residency, and population size (Stevick et al. 2001; Williams et al. 2002; McMahon et al. 2007). Individual recognition often is accomplished by capturing animals and applying a unique marker such as artificial tags or brands that allow for identification upon recapture (McMahon et al. 2007). Such marking techniques are successfully used by many capture-mark-recapture (CMR) studies; however, marked animals may experience adverse physiological or behavioral effects as a result of the capture process and marking procedure and markings may cause pain or infection, reduce survival and reproduction, or increase risks of entanglement (see Walker et al. 2012 for a review). Additionally, the loss of identification markers can compromise estimates of demographic parameters (Arnason and Mills 1981; McDonald et al. 2003).

Identifying individuals by their natural markings serves as an alternative to physically marking animals and is a technique that has been used in long-term studies of a variety of terrestrial and aquatic species (see Morrison et al. 2011 for a review). The process, known as photographic identification (hereafter referred to as photo-ID), involves photographing distinctive characteristics (i.e., spot, pigmentation, or scale patterns, dorsal fin shape and scarring) of an individual to determine if it is a new capture or a recapture (Wursig and Jefferson 1990; Kelly 2001; Frisch and Hobbs 2007; Speed et al. 2007). Photo-ID techniques have been used to examine a wide range of population parameters, some of which include the effect of human interactions on animal behavior (Constantine 2001; Samuels and Bejder 2004), estimates of survival (Langtimm et al. 2004), population size (Karanth and Nichols 1998; McClintock et al. 2013), growth rates (Graham and Roberts 2007), the prevalence of disease (Thompson and Hammond 1992; Bennet et al. 2000), foraging behavior and group dynamics (Hoelzel 1993), and site fidelity and movement patterns (Karlsson et al. 2005; Baird et al. 2008).

Most studies of sea turtle populations use external (e.g., plastic or metal Inconel) and/or internal (e.g., Passive Integrated Transponder [PIT]) tags to identify individuals (Balazs 1999). These tagging methods have greatly improved our understanding of sea turtle movements, reproductive biology, strandings, growth rates, and residency (Balazs 1999); however, errors associated with tag loss have been identified (Balazs 1982; Mrosovsky and Shettleworth 1982; Bjorndal et al. 1996; Bellini et al. 2001; Rivalan et al. 2005; Reisser et al. 2008; Braun McNeill et al. 2013), as have complications with the tagging, handling, and capture processes (Nichols and Seminoff 1998; Broderick and Godley 1999; Wyneken et al. 2010). Photo-ID is becoming an increasingly popular tool for the study of sea turtles because of its nonintrusive nature and the low-cost of digital technology, and it is a technique that has been used to examine a variety of demographic characteristics and conservation issues related to turtle populations (McDonald and Dutton 1996; Bennett et al. 2000; Bounantony 2008; Pauwels et al. 2008; Reisser et al. 2008; Schofield et al. 2008; Jean et al. 2010; Lloyd et al. 2012; Goncalves and Loureiro 2013). For instance, photo-ID has been used to avoid the repeat satellite tagging of individual sea turtles (Schofield et al. 2013a,b), revise remigration estimates (McDonald and Dutton 1996), identify the number of individuals potentially injured by boat strikes (Schofield et al. 2013a), examine the regression of fibropapillomas (Bennett et al. 2000), assess behavioral interactions of conspecifics (Schofield et al. 2007), estimate tag loss (Reisser et al. 2008), and determine operational population sex ratios (Schofield et al. 2009; Hays et al. 2010) and breeding periodicity (Hays et al. 2010).

Beginning in 1989, the National Marine Fisheries Service (NMFS) instituted an in-water CMR project using traditional tagging methods (double Inconel tagging since 1989 and PIT tagging since 1995) to identify individual loggerhead (*Caretta caretta*), green (*Chelonia mydas*), and Kemp's ridley (*Lepidochelys kempii*) sea turtles in the estuarine waters of North Carolina (Epperly et al. 1995). However, beginning in 2008, permitting restrictions prevented the application of tags to turtles captured during a fishery-dependent catch-per-unit-effort (CPUE) study

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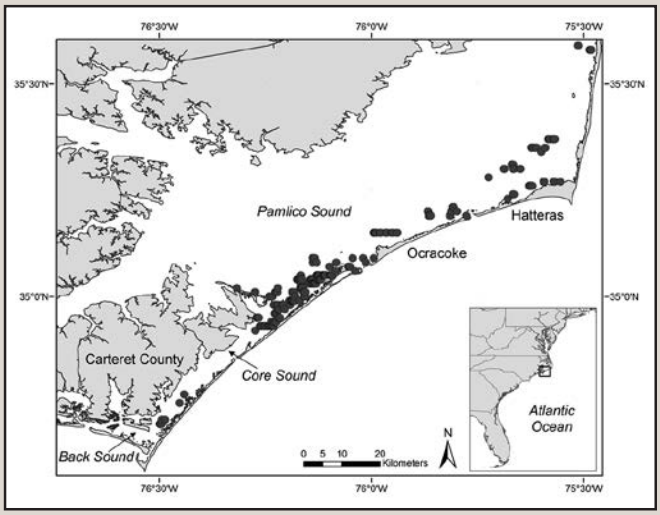


FIG. 1. Study site within the Pamlico-Albemarle Estuarine Complex, North Carolina, USA. Sea turtle capture locations are represented by dark gray circles.

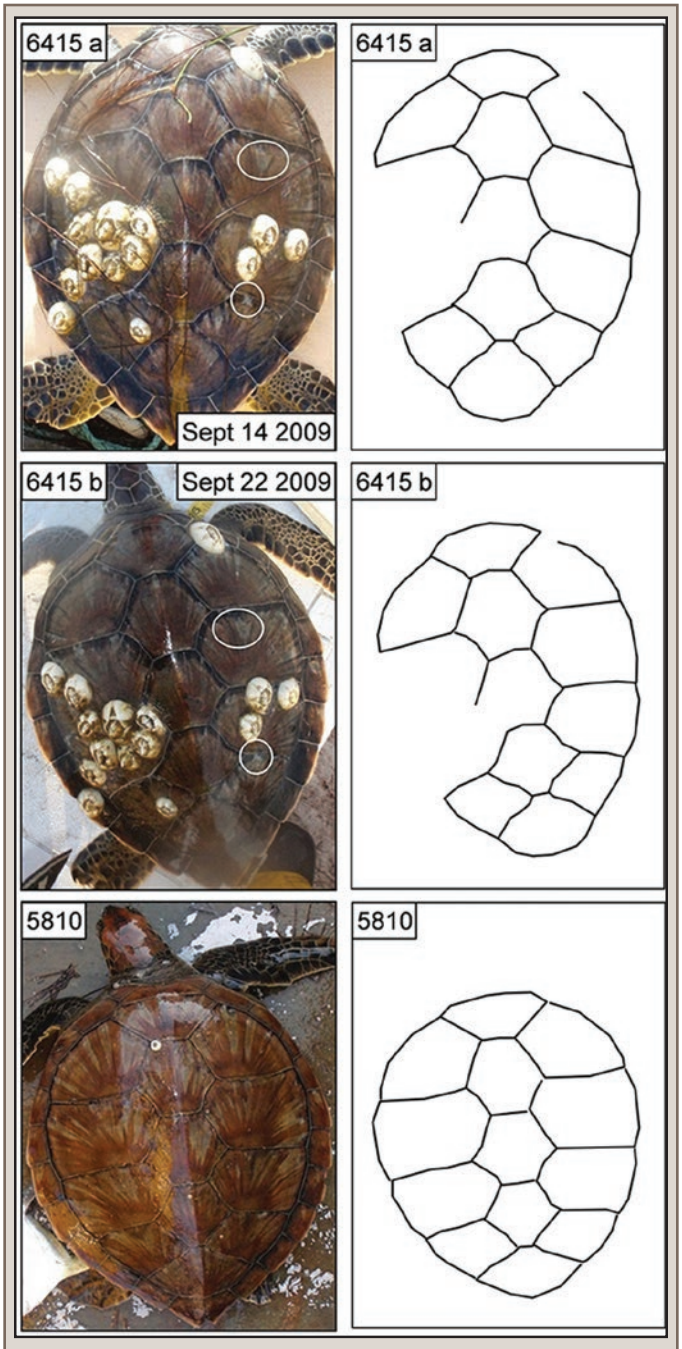


FIG. 2. Photographic view of the carapace that was used to identify recaptured turtles. Images 6415a and 6415b are of the same individual on two different survey days (see capture dates on images). Image 5810 is of a different individual, and is provided to show the difference in scute characteristics. Unique scute colorations that were used to identify 6415 as a recapture are surrounded by white circles. The shape of scute outlines (traced in black and located to the right of each image) varies among individuals and also was used to identify recaptures.

designed to estimate the local abundance of turtles. As a result, we began using photo-ID, thereby allowing us to continue identifying recaptured turtles and thus improve our estimate of unique individuals captured. In this study, we (1) describe the photo-ID technique, (2) compare our 2008 and 2009 estimates of turtle recapture rates using photo-ID with those determined prior to 2008 using Inconel and PIT tags, (3) estimate the number of turtles that may have been misidentified as unique individuals because no photograph was taken or because of poor image quality, and (4) discuss the application of photo-ID as a tool to examine sea turtle abundance. To the best of our knowledge, this is the first study to estimate sea turtle recapture rates during a CPUE study exclusively using photo-ID as a means of identification.

Materials and Methods.—The study site included eastern Pamlico, Core, and Back Sounds, which are part of the Pamlico-Albemarle Estuarine Complex (PAEC; Fig. 1). This system consists of shallow, productive, lagoonal-type ecosystems (Roelofs and Bumpus 1953; Copeland and Gray 1991) that are bounded on the east side by barrier islands, commonly known as the Outer Banks. The PAEC is an important developmental and foraging habitat for juvenile Loggerhead, Green, and Kemp's Ridley turtles from April through December (Epperly et al. 1995; Epperly et al. 2007).

Sea turtles were captured in commercial pound nets from early autumn (mid-September) to early winter (mid-December) in 2008 and 2009 (see Epperly et al. 2007 for a detailed description of the pound net fishery and capture methods). Fishers were chosen at random each week from the State's pound net registration files. Four observers attempted to sample three fishing trips each on a weekly basis. One observer worked with fishers from Hatteras Island, one with fishers from Ocracoke Island, and two with fishers from Carteret County.

Upon capture, turtles were scanned for PIT tags and their flippers were examined for Inconel tags. An Olympus Stylus 850 SW (8.0 megapixel) digital camera was used to photograph the carapace (Fig. 2) as well as the left and right lateral (Fig. 3) and dorsal views (Fig. 4) of the head of each turtle. Photographs of the carapace and dorsal view of the head were taken at a distance of 0.5 to 1 m from the turtle, and the left and right lateral views of the head were photographed 15 to 30 cm from the turtle. Upon returning from the field, turtles were assigned unique identification numbers which were saved with their corresponding images. The best-quality (e.g., in focus, good lighting, no or very low glare, proper angle of the turtle to the camera) image of each photographic view was cropped to isolate the desired view using

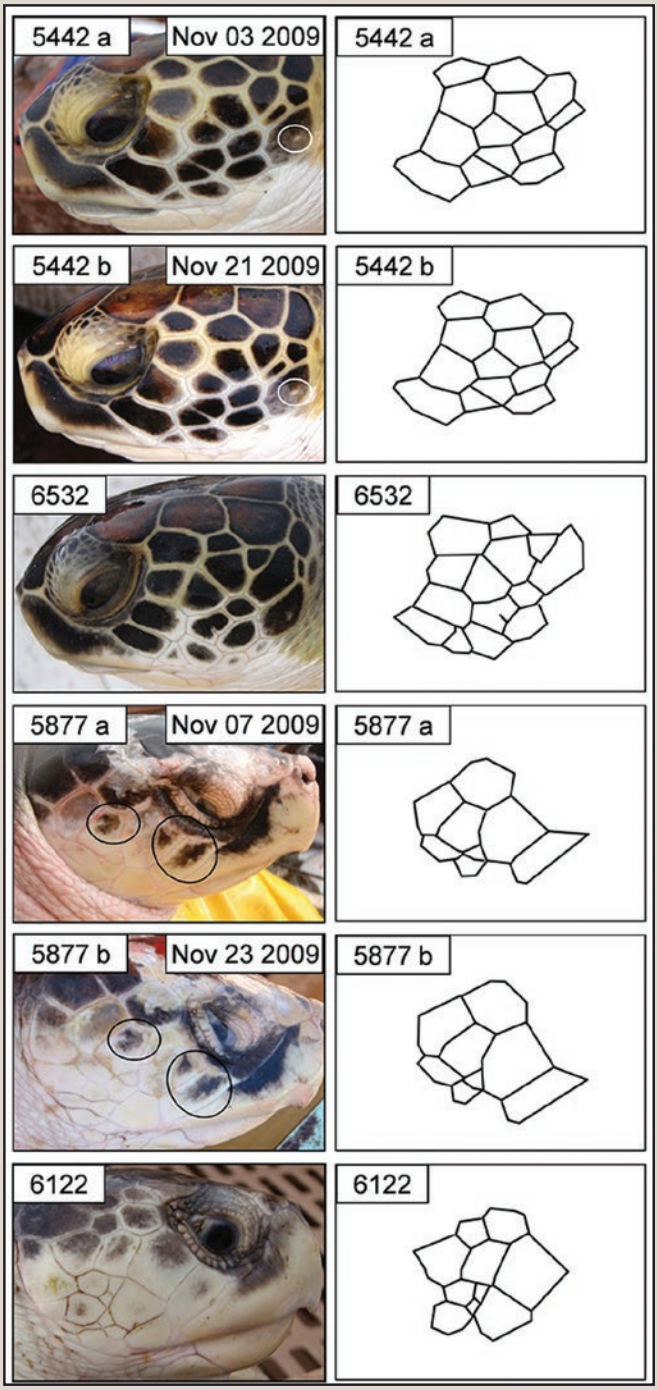


FIG. 3. Photographic view of the left and right lateral sides of the head that was used to identify recaptured turtles. For the left lateral view (top three images), images 5442a and 5442b are of the same individual on two different survey days and image 6532 is of a different individual. For the right lateral view (bottom three images), images 5877a and 5877b are of the same individual and image 6122 is of a different individual. Unique scale colorations are surrounded by white or black circles. The shape of scale outlines were traced in black and are located to the right of each image.

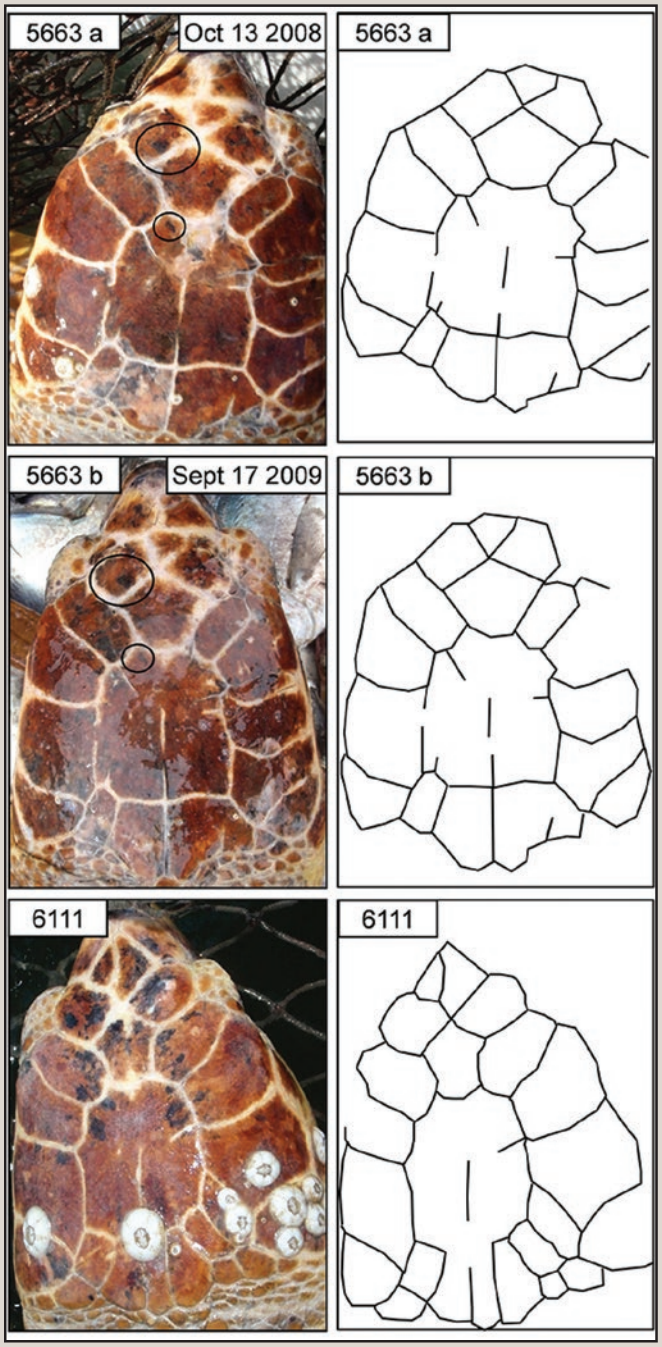


FIG. 4. Photographic view of the dorsal portion of the head that was used to identify recaptured turtles. Images 5663a and 5663b are of the same individual on two different survey days, and image 6111 is of a different individual. Unique scale colorations are surrounded by black circles. The shape of scale outlines were traced in black and are located to the right of each image.

Microsoft Office 2010 Picture Manager. Images were cataloged by capture year, species, and photographic view.

Three observers (O1, O2, and O3) independently compared the coloration and outline of facial scales and carapace scutes among all individuals of the same species to identify recaptured turtles (Figs. 2, 3, and 4). O1, O2, and O3 were the same individuals throughout the study. O3 examined only the 2008 dataset. Turtles were examined within and between study years. Two additional viewers confirmed turtles identified as recaptures by O1, O2, and O3.

Capture-mark-recapture studies that use photographs of natural markings to identify individuals often rate the quality of photographs and the distinctiveness of an individual's marks

because these characteristics influence the probability of identifying a previously photographed individual (Friday et al. 2000). We rated the quality (Q) of photographs (Table 1), but did not assign a distinctiveness rating because the distinct scale and scute patterns of individual sea turtles allow for their identification as long as image quality is good. We modeled our rating system for image quality after Urian et al. (1999) and Friday et al. (2000).

We compared our 2008 and 2009 sea turtle recapture rates to recapture rates of sea turtles sampled in the PAEC during autumn and early winter of 1995–1997 and 2001–2003 (Epperly et al. 2007) and 2007 (NMFS Southeast Fisheries Science Center [SEFSC], Beaufort, North Carolina [NC], unpublished data) to see if our estimates of recapture rates were within the range of these previous studies. All studies were conducted using the same sampling protocols, with the exception that Inconel and PIT tags could be applied to turtles prior to 2008. Therefore, our 2008 and 2009 estimates of sea turtle catch rates were derived from photo-ID, while catch rates prior to 2008 were obtained using Inconel and PIT tags. Similar to Epperly et al. (2007), we estimated the total number of unique individuals captured annually for each species by subtracting the number of within-year recaptured turtles from the total number of turtles captured. Individuals identified as being recaptured twice on one day were not considered to be recaptures.

One assumption of CMR studies is that all previously marked animals are identified as such upon recapture (Stevick et al. 2001). When identifying individuals by their natural markings, errors can occur if an observer incorrectly concludes that two captures of the same individual represent two different individuals (a false negative) or if captures of different individuals are identified as a single individual (a false positive; Stevick et al. 2001). To ensure that false positives were not included in our analysis, all turtles identified as recaptures were confirmed by O1, O2, and O3, as well as by two additional viewers. To address false negatives, we assumed that the unique scale and scute pattern of turtles would allow for individual identification if images were of good (Q2) or excellent (Q3) quality. However, the identification of individuals without images (Q0) would not be possible, and individuals with poor-quality images (Q1) may only be identified some of the time, thus resulting in an inflated estimate of unique individuals. To account for the number of turtles that may have been misidentified as unique individuals, we applied the following equation to the estimated total number of unique individuals for each species in 2008 and 2009:

$$X = (Q0+Q1) - Q1^{*}$$

Where X is the number of turtles possibly misidentified as unique individuals, $Q0$ is the number of individuals without photographs, $Q1$ is the number of individuals with poor-quality

TABLE 1. Image quality (Q) rating system for sea turtles captured by pound net and digitally photographed in the Pamlico-Albemarle Estuarine Complex of North Carolina, USA, during autumn and early winter of 2008 and 2009.

Rating	Criteria
Q0	Image unavailable. Turtle escaped from the net before a photograph was taken.
Q1	Poor-quality image. Image out of focus; strong glare; photographic view is angled or a portion of the desired view is missing; epibiota concealed scute or scale patterns.
Q2	Good-quality image. May be slightly out of focus; some glare; photographic view is slightly angled or a small portion of the desired view is missing; epibiota may be present, but does not significiantly conceal scute or scale patterns.
Q3	Excellent-quality image. Image is clear; no/very low glare; desired photographic view is directly facing the camera; epibiota may be present, but does not conceal scute or scale patterns.

TABLE 2. Comparison of photo-ID derived recapture rates for sea turtles in the Pamlico-Albemarle Estuarine Complex, North Carolina, USA, during 2008 and 2009, with inconel and PIT tag derived turtle recapture rates from previous studies[a,b] conducted in the same region. Photo-ID recapture rates during 2008 and 2009 are highlighted in gray. In the column 'recaptures within year,' the percentage of recaptures within each year for each species is in parenthesis. For each species in 2008 and 2009, the percentage in parenthesis in the column 'turtles possibly misidentified as unique individuals,' refers to the percentage of turtles captured that may have been misidentifed as unique individuals because no image was available to identify them by, or image quality was poor.

Year	Total captured	Recaptures within year	Estimated total unique individuals	Turtles possibly misidentified as unique individuals
Caretta caretta				
1995[a]	111	9 (8%)	102	—
1996[a]	97	5 (5%)	92	—
1997[a]	156	3 (2%)	153	—
2001[a]	258	33 (13%)	225	—
2002[a]	207	16 (8%)	191	—
2003[a]	158	11 (7%)	147	—
2007[b]	81	2 (2%)	79	—
2008	175	18 (10%)	157	13 (7%)
2009	201	25 (12%)	176	12 (6%)
Chelonia mydas				
1995[a]	42	1 (2%)	41	—
1996[a]	33	0 (0%)	33	—
1997[a]	31	1 (3%)	30	—
2001[a]	67	4 (6%)	63	—
2002[a]	44	0 (0%)	44	—
2003[a]	29	0 (0%)	29	—
2007[b]	142	1 (<1%)	141	—
2008	105	8 (8%)	97	8 (8%)
2009	151	4 (3%)	147	3 (2%)
Lepidochelys kempii				
1995[a]	1	0 (0%)	1	—
1996[a]	4	1 (25%)	3	—
1997[a]	10	0 (0%)	10	—
2001[a]	30	1 (3%)	29	—
2002[a]	18	0 (0%)	18	—
2003[a]	7	0 (0%)	7	—
2007[b]	9	0 (0%)	9	—
2008	31	1 (3%)	30	6 (19%)
2009	41	0 (0%)	41	4 (10%)a

[a]Epperly et al. 2007
[b]NMFS Beaufort Lab unpublished data

photographs, and *Q1** is the number of individuals with poor-quality photographs that were identified as recaptures.

Results.—A total of 376 Loggerheads, 256 Greens, and 72 Kemp's Ridleys were captured in 2008 and 2009 (Table 2). Of these, 43 Loggerheads, 12 Greens, and 1 Kemp's Ridley were identified as recaptures using photo-ID. The identification of three of these recaptures was confirmed by Inconel and/or PIT tags applied prior to 2008. When examining recaptures among years, no Green or Kemp's Ridley turtles captured in 2008 were identified as recaptures in 2009, and eight Loggerhead turtles captured in 2008 were identified as recaptures in 2009. Time intervals between initial capture and recapture ranged from 1 to 386 days.

Observer O1 identified a total of 27 recaptures for 2008, 29 recaptures for 2009, and 8 recaptures when comparing 2008 and 2009 captures. All turtles identified as recaptures by O2 and O3 also were identified as recaptures by O1. Observer O2 identified 20 recaptures for 2008, 27 recaptures for 2009, and 8 recaptures when comparing 2008 and 2009 captures. Observer O3 identified 21 recaptures for 2008. No observers identified a capture as a false positive recapture. The two additional viewers concurred that all turtles identified as recaptures by the observers were recaptures.

The percentage of turtles that we identified as recaptures in 2008 and 2009 for each species (Loggerheads ranged from 10–12%, Greens from 3–8%, and Kemp's Ridleys from 0–3%) was comparable to recapture estimates from the 1995–1997, 2001–2003, and 2007 studies (Loggerheads ranged from 2–13%, Greens from 0–6%, and Kemp's Ridleys from 0–25%; Epperly et al. 2007; NMFS SEFSC Beaufort, North Carolina, unpubl. data; Table 2). The percentage of turtles possibly misidentified as unique individuals in 2008 and 2009 ranged from 6–7% for Loggerheads, 2–8% for Greens, and 10–19% for Kemp's Ridleys.

Of the four views photographed in 2008, the dorsal view of the head contained the most Q2 and Q3 images (89%), followed by the carapace (77%), and right (73%) and left (69%) lateral sides of the head. Because the dorsal view of the head was often the best-quality image, and since we found that examining all photographic views was very time consuming (on average, it took 10–15 minutes to compare one image to 200 other images), the dorsal head view was the only photographic view examined in 2009 and when comparing individuals among years; however, the other three views were examined if the dorsal view was of poor quality (<Q2). Image quality of the dorsal head views improved in 2009 (94% of images were ≥Q2; Table 3).

In some cases, recaptured individuals could be identified from poor-quality (Q1) images; 12% of recaptures in 2008 and 8% in 2009 were identified from Q1 images (Table 3). We also found that distinguishing features such as scars, sloughing of the scales or scutes, skin colorations, and barnacle patterns on the carapace and head could aid with the identification of individuals (Figs. 2–5), and that these characteristics were especially helpful when viewing images of poor quality (Fig. 5). However, caution was needed when viewing barnacle patterns because some barnacle formations grew quickly, while others moved in a short (within weeks) amount of time (Fig. 6).

Discussion.—Many studies of sea turtle populations rely solely on the application of identifying markers to recognize individuals; however, the usefulness of photo-ID as a tool to study sea turtle populations is increasingly becoming apparent. Photo-ID served as a valuable resource to our study by providing us with an alternate method for identifying individual turtles when traditional tagging methods could not be used. As a result, we were able to identify recaptured turtles during our study, thereby allowing for an improved estimate of unique individuals captured. The information derived from these data will allow for evaluations of the status of sea turtle populations in this region, which is imperative for the development of conservation policies. These findings also further support the application of photo-ID as a means to monitor sea turtle populations and the lessons we learned can serve to aid others who are considering applying the technique to their research program.

In-water studies using both photo-ID and Inconel/and or PIT tags to monitor sea turtle populations have indicated that individual turtles can be consistently identified upon recapture by the unique variations of their facial scales (Reisser et al. 2008; Schofield et al. 2008). Because it was not possible to confirm the identity of many of the individuals we identified as recaptures using photo-ID (since so few recaptured turtles had been previously tagged), we compared our photo-ID recapture rates with those derived from Inconel and/or PIT tags during previous studies (Epperly et al. 2007, NMFS SEFSC Beaufort, North Carolina, unpubl. data) within the survey region. While we found that our recapture rates were within the range of those established during these studies, the limited timeframe of our study and the differing methods used to identify recaptures limits our ability to make a detailed comparison. Furthermore, comparison of the two identification methods is complicated by the likelihood that photo-ID recapture rates may be greater than those associated

TABLE 3. Number of sea turtles captured and subsequently identified as a recaptures in 2008 and 2009, binned by the quality rating of the photograph of the captured turtle. All photographs were of the dorsal head view. NA= not applicable, and refers to inability of observers to identify recaptured turtles if image quality was 0. The percentage of turtles identified as a recapture within each quality rating bin is in parentheses.

Year	Species	Quality 0		Quality 1		Quality 2		Quality 3	
		Total	Recaptures captured	Total	Recaptures captured	Total	Recaptures captured	Total	Recaptures captured
2008	*Caretta caretta*	2	NA	16	5	28	7	129	21
	Chelonia mydas	0	NA	9	1	17	2	79	13
	Lepidochelys kempii	0	NA	6	0	7	0	18	2
	Total:	2 (1%)	NA	31 (10%)	6 (12%)	52 (17%)	9 (18%)	226 (72%)	36 (70%)
2009	*Caretta caretta*	0	NA	15	3	33	7	153	36
	Chelonia mydas	0	NA	4	1	21	0	126	6
	Lepidochelys kempii	0	NA	4	0	8	0	29	0
	Total:	0 (0%)	NA	23 (6%)	4 (8%)	62 (16%)	7 (13%)	308 (78%)	42 (79%)

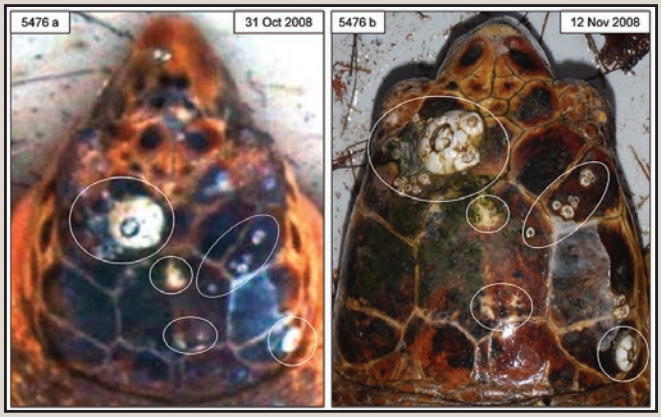


FIG. 5. Poor-quality images (5476a) could occasionally be used to identify recaptured turtles (5476b), especially if unique scale characteristics and/or barnacle patterns (circled) were present on the turtle.

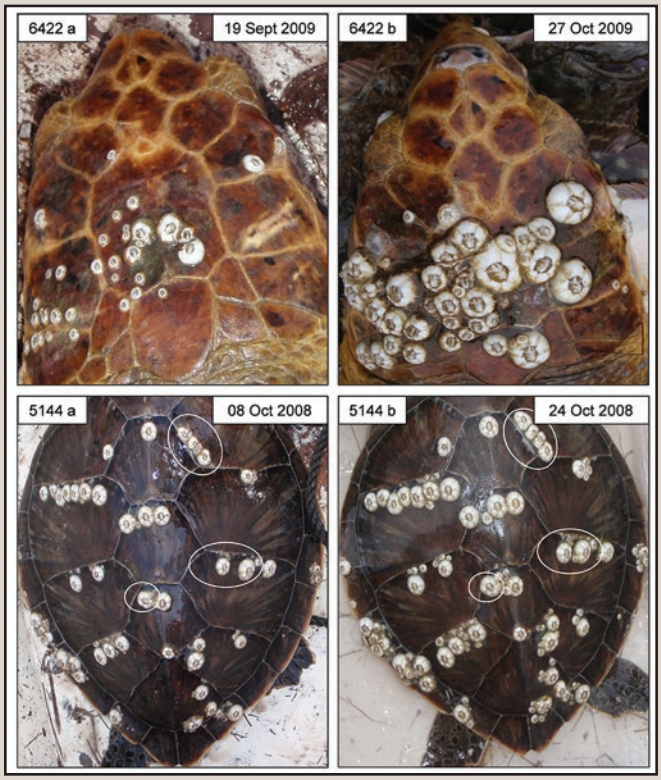


FIG. 6. Rapid growth of barnacles on the head of a loggerhead sea turtle between its initial capture (6422a) and recapture (6422b; 38 days), and movement of barnacles (circled in white) on the carapace of a green turtle between its initial capture (5144a) and recapture (5144b; 16 days).

solely with traditional tagging methods because turtles that have lost external tags or suffered PIT tag malfunctions can still be identified. However, given previous validation of the photo-ID technique for sea turtle identification (Reisser et al. 2008; Schofield et al. 2008), and because the majority of our images were of good or excellent quality (Table 3), we believe our estimate of unique individuals is an accurate representation of the sea turtle population within the estuary at this time of year.

Our estimate of turtles that may have been misidentified as unique individuals because no image was available to identify them, or the image was of poor quality, further improves the accuracy of our estimate of unique individuals captured in 2008 and 2009. It is also probable that this estimate considerably overestimates the number of turtles that may have been misidentified as unique individuals, because it is unlikely that all individuals without images or with poor-quality images were recaptures. Finally, our estimate of the percentage of turtles that may have been misidentified as unique individuals was greatest for Kemp's Ridleys. This is likely because the facial scale outlines of Kemp's Ridleys are often less well defined by color variations between the scales, resulting in a monotonous appearance (e.g., images 5877a,b, and 6122 in Fig. 3). Thus, image quality was especially important for identifying individual Kemp's Ridleys and images that were even only slightly blurry were likely to receive a lower quality rating compared to similar images of another species.

Long-term field studies that monitor changes in demographic characteristics (i.e., survival, abundance, growth, and recruitment) of a population over time are invaluable, especially for long-lived species with complex life histories such as sea turtles (Epperly et al. 2007). However, accurate estimates of population parameters collected in long-term studies require that individuals in a population be consistently identified upon each encounter (Wursig and Jefferson 1990). To date, little is known of the stability of the shape of sea turtle facial scales and carapace scutes throughout their lifespan. Due to the short length of our study, the longest period of time over which we identified a recaptured turtle using photo-ID was a little over a year; however, longer time intervals have been reported. For instance, Reisser et al. (2008), Jean et al. (2010), and Goncalves and Loureiro (2013) identified individual cheloniid turtles by their lateral facial scales over a period just short of three years, four years, and six years, respectively. These studies, along with ours, indicate that photo-ID can serve as an accurate, low-cost, and non-invasive tool for identifying individual sea turtles from year to year; however, future studies are needed to clarify the persistence of scute and scale shapes over longer periods (e.g., decades).

Incorrectly identifying an individual as a recapture, or failing to identify an individual as a recapture, can lead to biases in estimates of population parameters (Stevick et al. 2001). Upon reviewing the turtles identified as recaptures by each observer in 2008, we did not document the occurrence of false positive errors, but O2 and O3 did not identify a number of recaptures. It is likely that some of the recaptured turtles that were not identified by O2 and O3 were overlooked because of poor image quality. Additionally, consistently identifying individuals requires a certain amount of familiarity with the key characteristics that should be examined when viewing images. Consequently, O1 and O2 discussed the characteristics that they focused on when examining images and this discussion, along with an improvement in image quality, resulted in fewer false negative errors in 2009 and when comparing the 2008 and 2009 captures. This improvement highlights the importance of ensuring that all observers are adequately trained, as well as the value of good-quality images.

Estimates of population parameters also may be influenced by tag loss because an individual that has lost all tags is likely to be misidentified as a new individual upon subsequent encounter (Seber 1982; Nichols and Hines 1993; Rivalan et al. 2005; Braun McNeill et al. 2013). Such misidentifications have the potential to negatively impact management decisions that are based on models that evaluate the status of populations. As a result, some CMR studies of sea turtles have attempted to estimate tag loss rates so a correction can be applied to estimates

of population parameters (Van Dam and Diez 1999; Rivalan et al. 2005; Reisser et al. 2008; Braun McNeill et al. 2013). Photo-ID holds great potential as a tool that can be used to estimate tag loss rates of sea turtle populations. This was demonstrated by Reisser et al. (2008), who used photo-ID to estimate Inconel tag loss in juvenile Green and Hawksbill turtles caught at Arvoredo Island, southern Brazil. They found a high rate of tag loss among turtles at their study site, prompting them to suggest that other CMR studies consider integrating photo-ID into their research programs given its potential for increasing the accuracy of data collected.

We found that all four photographic views could be used to identify turtles, but we primarily used the dorsal view because it was typically the easiest to obtain, and therefore, often the best-quality view. This was because turtles were photographed on small vessels with little space to maneuver, making it difficult to position the camera parallel with the side of the turtle's head to obtain a clear, lateral view. To take lateral photos, observers needed to kneel on the deck next to turtles, or hold the camera parallel to the turtle's head and take the image without looking through the view finder, often resulting in blurry images. Additionally, for larger turtles such as Loggerheads, observers frequently had difficulty raising the camera to sufficient height so that the field view encompassed the entire carapace. Furthermore, the carapace of some turtles, particularly Loggerheads, was also often covered in epibionts, thereby obstructing the viewing of scutes. As a result of these difficulties, when designing a photo-ID study, we suggest that researchers consider the conditions in which they will be acquiring images and the size class of the species they will be photographing to determine which photographic view is optimal for their study. For example, lateral views of the head may be easier to acquire when photographing turtles while diving, but overhead images of the head may be preferable when space is limited or turtles are too large to manipulate easily.

Although we could identify some recaptured turtles from poor-quality images, the importance of good-quality images cannot be overstated (Hammond et al. 1990; Whitehead 1990; Friday et al. 2000; Kelly 2001). We found that it was often difficult to distinguish among individuals using poor-quality images because the outlines of their scutes and scales were usually obscured. Additionally, characteristics such as scars, scute and scale colorations, and epibionts often helped with the identification of turtles from poor-quality images; however, these characteristics are likely to change over time. Therefore, while such characteristics may help with identification within a season, identifying turtles from poor-quality images among years is likely to be more challenging.

As the number of photos in an image library increases, it becomes more time consuming to manually compare images to one another (Arzoumanian et al. 2005). One option for decreasing the time it takes to compare turtle images is to divide individuals into subgroups based on scale pattern characteristics (Schofield et al. 2008) so observers only have to match images to a smaller subgroup rather than all previous captures (Bradfield 2004). Jean et al. (2010) also devised a method for cataloging individual turtles based on the location and shape of the scales on the lateral portion of the head, resulting in a unique code that allows for the quick identification of individuals. We chose not to use such identification methods, mainly because determining which group to place individuals in could be complicated by a number of factors (i.e., epibiont coverage, sloughing of scales or poorly defined scale boundaries, unfavorable pose of the turtle, and poor image quality), and we did not want to risk misidentifying an individual because it was grouped incorrectly. In addition, we did not consider using subgroups to aid with identification until after all photographs were taken, and thus, the scale pattern characteristics that may have been chosen to group images were not always well represented. However, subgrouping and cataloging individuals is likely to prove beneficial to many photo-ID studies of sea turtles, and we recommend that the scale pattern characteristics that will be used to group images be well defined prior to the start of a project.

The identification of individual sea turtles by their natural markings served as a valuable means for examining sea turtle recapture rates during our fishery-dependent CPUE study and we suggest that other researchers consider integrating photo-ID into their CPUE and CMR studies. When used in lieu of traditional tagging methods, photo-ID can serve as a reliable, nonintrusive, and low-cost method for identifying individual turtles within a study site. However, identifying individuals using only photo-ID can be time consuming, and a turtle identified solely by photo-ID would not be identified as a recaptured animal when encountered by other researchers. The development of computer-assisted image matching software for cheloniid turtles would not only reduce the time it takes to identify individuals, but also may allow for the creation of a global database that could be used to identify individuals and track their movements (Bounantony 2008; Pauwels et al. 2008). When combined with traditional tagging methods, photo-ID can increase the accuracy of data collected by CMR studies by allowing for an estimate of tag loss (Reisser et al. 2008). Additionally, photo-ID databases collected by research groups can be used to examine a wide range of demographic characteristics (i.e., behavior, remigration estimates, sex ratios, breeding periodicity; McDonald and Dutton 1996; Schofield et al. 2007; Schofield et al. 2009; Hays et al. 2010), health (e.g., the prevalence of disease; Bennett et al. 2000), and conservation and management issues (e.g., incidence of boat strikes; Schofield et al. 2013a).

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Limestone Cave as a Cradle of the Ryukyu Ground Gecko, *Goniurosaurus kuroiwae*

Goniurosaurus kuroiwae is a eublepharid gecko distributed in the central part of the Ryukyu Archipelago, Japan (Ota 1989). Among the members of the genus *Goniurosaurus*, *G. kuroiwae* has been relatively well studied for its reproductive ecology (Tanaka and Nishihira 1987, 1989). According to these authors, gravid females possessing two eggs per clutch appear from late May to late August, and the ratio of gravid females to total females exceeds 80% at the peak. Nevertheless, the oviposition site of this gecko in the wild is unknown. Because *G. kuroiwae* and its close relatives face the risk of extinction and are designated as endangered on the IUCN Red List (Ota 2010), knowledge regarding oviposition and incubation sites in the wild is important for the planning of a habitat preservation program.

In November 2007 and 2012, we found a total of three pairs of unidentified squamate eggshells in a limestone cave in the southern part of Okinawajima Island. There are 24 native and introduced squamates recorded from this island: seven gekkotans, two iguanians, four scincomorphans, and 11 ophidians (Maenosono and Toda 2007). We presumed the eggshells to belong to *G. kuroiwae* because of their small size, parchment-shelled eggs, and local abundance of this gecko around the caves. To confirm this, we attempted to determine sequences of the residual-DNA on the eggshells and compared them with available data for other reptile taxa. We also measured several environmental parameters at and around the oviposition sites.

Materials and Methods

Study site.—All eggshells were found in a limestone cave located in the southern part of Okinawajima Island (26°08N, 127°45E; datum WGS84); further details concerning the location are not provided in order to restrict illegal hunting by pet dealers, which is one of the serious threats to *G. kuroiwae* (Kanari and Xu 2012; Ota 2010). The cave opens southward at the midpoint of a cliff. A passage having a width for the entry of only one person runs northward, curving east at 3–4 m from the entrance, and reaches a round hall (approximately 5 m in width and depth, 3 m in height). There are many small pockets on the walls, and all eggshells were found on the surface of sediments deposited inside these pockets. The hall has another exit at the opposite end of the entrance, but it was not possible to examine the cave any further because it was too narrow (Fig. 1a).

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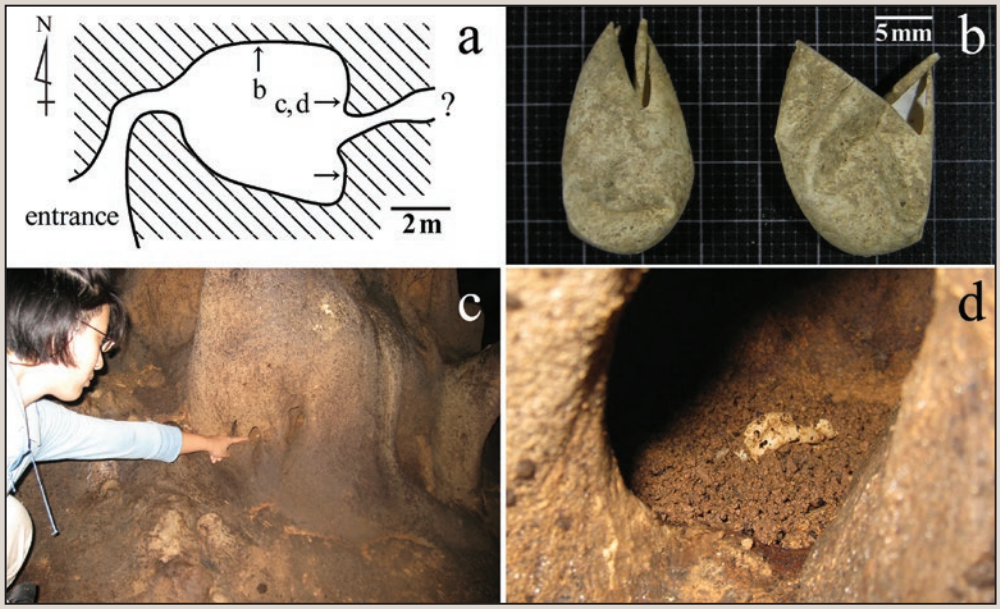


FIG. 1. a) Diagram of the study-site limestone cave in the southern part of Okinawajima Island, Japan; b) photograph of the pair of less damaged eggshells collected from the pocket on the north end wall; c) the pocket on the east end wall, in which a pair of eggshells of *Goniurosaurus kuroiwae* were found; close up view of nest cavity . Arrows in (a) indicate location of oviposition sites and the letters "b–d" correspond to the photographs.

Egg morphometry.—A well preserved pair of eggshells was used for morphological observations and three measurements of the egg were taken to the nearest 0.01 mm using a digital dial caliper: egg length along the long axis, egg breadth along the short axis, and slit length (length of the slit from which neonates emerge from the shell). Each measurement was repeated thrice to obtain a mean.

DNA analyses.—A pair of damaged eggshells was stored at –20°C until DNA extraction. The third pair of shells was heavily damaged and not used for morphological measurements or molecular analyses. A tail tip sample of an adult *G. kuroiwae* collected from the southern part of Okinawajima Island was also used for DNA analyses for comparative purposes.

Total DNA was extracted from the eggshells following the method of Oskam et al. (2010) with some modifications. Eggshells were washed in phosphate buffered saline (1.37 M NaCl, 27 mM KCl, 100 mM $Na_2HPO_412H_2O$, and 18 mM KH_2PO_4) to remove soil from the surface, and then were finely shredded. The shredded shells of the two eggs were combined in the same tube in order to yield a high concentration DNA solution. The eggshells (wet-weight 5 mg) were dissolved in 200 µl digestion buffer (0.47 M ethylenediaminetetraacetic acid pH 8.0, 20 mM Tris/HCl pH 8.0, 0.2% 2-mercaptoethanol, 0.1% sodium dodecyl sulfate, and 100 µg Proteinase K) at 56°C for 24 h. After centrifuging, the supernatant was mixed with five volumes of PB buffer from a QIAquick PCR Purification Kit (Qiagen, California, USA), followed by one tenth volumes of 3 M sodium acetate. DNA was bound to silica membrane columns and washed with 700 µl of AW1 and AW2 wash buffers included in a DNeasy Blood and Tissue Kit (Qiagen). Finally, DNA was eluted in 50 µl of EB buffer (Qiagen). We performed the DNA binding and elution step twice to maximize DNA yield by placing the flow-through back into the silica column and re-centrifugation.

We attempted to amplify short fragments of mitochondrial 12S and 16S ribosomal RNA (rRNA) and cytochrome b (cytb) genes using eight primer pairs shown in Table 1. A 20 µl PCR mixture (0.25 mM each dNTP, 5 pmol each primer, 10x ExTaq Buffer [TaKaRa Corp., Shiga, Japan], 0.8 U ExTaq DNA polymerase [TaKaRa], and 2 µl unknown concentration of total DNA) was incubated under the conditions of an initial denaturation at 94°C for 3 min, followed by 40 cycles of denaturation at 94°C for 30 s, annealing at 50°C for 30 s, and a final extension at 72°C for 30 s. After purification of the PCR products, we conducted a cycle sequencing reaction with a BigDye 3.1 system (Applied Biosystems Inc., California, USA) according to the manufacturer's protocol. The abovementioned primers were used for this reaction. Sequences were determined using an ABI 3730xl DNA Analyzer (Applied Biosystems).

We used negative (without any sample) and positive controls (tail tip of the adult gecko) for the DNA analyses. Sequence data are available in the DDBJ/EMBL/GenBank databases under the accession numbers AB827797–827799. Obtained sequences from the eggshell sample were BLAST-searched against the databases. For the cytb gene sequence, we used our own data obtained from the adult gecko because of lack of comparable data in the databases.

Evaluation of environmental parameters.—We recorded air temperature and relative humidity inside and outside the cave and above the oviposition sites. We collected soil samples from the oviposition sites and from 12 randomly selected points of the hall floor. We measured water-content rate (water/raw soil weight) by the heat-dry method at 105°C for 24 h, and pH after suspension in a volume of distilled water five times the weight of the air-dried soil (Rayment and Lyons 2010).

RESULTS

Identification of the eggs.—All eggs that we collected were parchment-shelled. Two of the measured eggs were elliptical and each had a slit running from one tip to the middle (Fig. 1b). The egg length, breadth, and slit length of one of the eggs were 19.63, 10.91, and 11.72 mm, respectively (Fig. 1b left). Egg ellipticity

TABLE 1. The eight primer pairs designed for amplification of short fragments of mitochondrial DNA. The filled circles indicate successful amplification and sequencing of the target fragments, and the open circles indicate that fragments were amplified but failed to sequence. Size is the expected length of the PCR products.

Primer	Sequence (5' to 3')	Locus	Size
FGss1F	CAACCTAGAGGAGCCTGTCC	12S	152 bp
FGss1R	CACCTTGACCTGACGTTTTT		●
FGss2F	CCCTACTATGCTTAGCCATTAACC	12S	191 bp
FGss2R	TGACGACGGCGGTATATAGG		●
FGls1F	GACGAGAAGACCCTGTGGAG	16S	240 bp
FGls1R	AAGAGGATTGCGCTGTTATC		
FGls2F	GGATAACAGCGCAATCCTCT	16S	118 bp
FGls2R	AATCGTTGAACAAACGAACC		o
FGcb1F	AAAACAACATGAAACACAGGAGT	cytb	120 bp
FGcb1R	AAGGTTTGTGATTACGGTTGC		
FGcb2F	TATCATTCTGAGGCGCAACC	cytb	211 bp
FGcb2R	GGATTGTTTGAGCCTGTTTCA		
FGcb3F	CACACATTTGCCGAGATGTA	cytb	233 bp
FGcb3R	GGTTGCGCCTCAGAATGATA		●
FGcb4F	CCAGAAAACTTCATTCCAGCA	cytb	210 bp
FGcb4R	TTGGGATAAGGGTCGAAATG		

(egg breadth/egg length) was 0.60. The egg length and slit length of the other deformed egg was 19.34 and 12.52 mm, respectively (Fig. 1b right).

DNA fragments of expected lengths were successfully amplified from the eggshell extract by four of the eight primer pairs; of which three were successfully sequenced yielding 211 bp sequences of 12S rRNA (167 and 70 bp with 26 bp overlap) and 193 bp of cytb genes. Some amplification signals were detected in three out of the eight negative controls on agarose gel, but these products were not the target because of their unexpected longer lengths (>500 bp; Table 1).

A BLAST search revealed that the sequence obtained from the 12S rRNA gene matched (100%) with that of *G. kuroiwae* from the southern part of Okinawajima Island (Accession No. AB028750), followed by the congeneric species from the Ryukyus (96–99%) and a Chinese congener (89%). In a BLAST search with our cytb gene sequence as a query, we got hits for homologous genes of some anurans and chiropterans but with very low levels of matching (79–82%). In contrast, the cytb sequence was well-matched with that of *G. kuroiwae* determined in this study (99%), with two synonymous nucleotide substitutions in the third codon positions.

Environmental parameters.—In November 2012, daytime air temperature and relative humidity were 30.1°C and 79% at the entrance of the cave, and 23.6°C and 99% in the hall, respectively. Indirect sunlight scarcely reached the passage, and none reached the hall. There were percolating water drips falling from stalactites in the cave and no other surface water was present. The floor of the cave was extensively covered with flowstones and cohesive brownish soil. In the hall, patchy black sediments originating from bat guano were accumulated. Two of the 12 soil samples were taken from such bat guano-rich sites. Water-content rate and pH of the sediments in the hall ranged between 32.0–69.1% and 3.8–8.5, respectively.

Three pairs of eggshells were found in three different small pockets on the wall of the hall. These pockets were located 0.20–1.45 m above the hall floor. One pocket was at the north end and the other two pockets were at the east end (Fig. 1a). The north pocket and one of the east pockets were horizontally concave (Fig. 1c, d); the other east pocket was vertically concave and covered with a fallen piece of broken stalactite. Air temperature measured in front of the pockets was 21.7–22.3°C and relative humidity was 99%. A layer of small granular soil, approximately 30–100 mm in thickness, was deposited at the bottom of the pockets, but bat guano was absent. Water-content rate and pH of the soil that was used as the egg laying substrate were 33.5–46.5% and 8.1–8.2, respectively. All eggshells were exposed on the surface of the soil. The outer eggshell surfaces were entirely covered with soil particles, but no soil was found on the inner surfaces.

DISCUSSION

The results of the genetic analyses revealed that the eggshells found in the limestone cave were of *G. kuroiwae*. Morphological features of the eggs were also consistent with captive breeding records of closely-related congeners, i.e., parchment shell and size (20 × 12 mm; Henkel and Schmidt 1995). Neonates appeared to have hatched from the eggs, confirming that environmental conditions in the cave were appropriate for incubation. Therefore, we conclude that *G. kuroiwae* uses this limestone cave as an oviposition site.

Why is this limestone cave a suitable oviposition and incubation site for *G. kuroiwae*? One conceivable factor is the stability of hydric conditions; parchment-shelled eggs require a certain amount of ambient air and substrate moisture level to avoid either drying out or becoming moldy (Henkel and Schmidt 1995; Werner 1972). The extreme high humidity recorded in the cave (99%) protects the substrate and eggs from dehydration. In addition, eggs in the cave are also protected from exposure to rains. Thermal conditions during the incubation period critically affect embryonic development and performance of hatchlings in many reptile species (see Du and Shine 2010 and references therein). In this respect, caves are thermally quite stable (Culver and Pipan 2009), and this may be important for this gecko.

Environmental conditions in caves are more uniform than the outside, but are still variable in a fine spatial scale. In fact, our soil samples had highly variable water-content rates and pH, representing extreme water retention and acidification in some samples most probably due to water drips from stalactites and bat excrement (Culver and Pipan 2009; Ferreira et al. 2007). Such excess water could damage eggs (Henkel and Schmidt 1995), and soil acidification can negatively affect embryonic development in some lizards with parchment-shelled eggs (Marco et al. 2005). However, it appears that the pockets on the walls offer some degree of protection from organic substances and water.

Although we lack quantitative data, soil compaction apparently differed between the oviposition sites and the hall floor. The soil particles were granular and loose in the egg laying pockets, but were tight and cohesive on the floor. In captivity, some eublepharid geckos are known to make a pit in humid ground to lay eggs and cover them with soil after oviposition (Henkel and Schmidt 1995). We observed that the outer surfaces of eggshells were entirely coated with soil particles, strongly suggesting that *G. kuroiwae* also deposit their eggs in soil and this necessitates loose soil at oviposition sites.

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Parasitism of Reptiles by the Blacklegged Tick (*Ixodes scapularis*) and Western Blacklegged Tick (*Ixodes pacificus*) with New Records of *I. scapularis* from Arkansas and Oklahoma Lizards: Implications for Lyme Disease Epidemiology

Worldwide, at least 116 species of ticks are known to parasitize reptiles (Barnard and Durden 2000). For some of these tick species, including members of the Holarctic *Ixodes ricinus* complex (including *I. pacificus, I. persulcatus, I. ricinus*, and *I. scapularis*), the immature stages (larvae and nymphs) often feed on reptiles whereas adults mainly feed on larger mammals, including humans (Clark et al. 2013; Keirans et al. 1999). The aforementioned four species in this complex have significant medical and veterinary importance as zoonotic vectors of the causative agents of Lyme disease (= Lyme borreliosis), human babesiosis, human granulocytic anaplasmosis, and/or tick-borne encephalitis in the northern hemisphere (Nicholson et al. 2009).

Lyme disease, caused by infection with *Borrelia burgdorferi* sensu lato spirochete bacteria, is an emerging or persistent zoonosis in much of the Northern Hemisphere (Oliver 1996; Scott et al. 2012). Presently, at least 18 distinct genomospecies are recognized within *B. burgdorferi* sensu lato and three of these, *B. burgdorferi* sensu stricto, *B. afzelii*, and *B. garinii*, are known to cause disease in humans (Nicholson et al. 2009; Scott et al. 2012). Ticks belonging to the *I. ricinus* complex are the principal vectors with different tick species being primary vectors in different regions (Oliver 1996). In North America, the Blacklegged Tick, *I. scapularis* Say, is the main vector in eastern states and provinces whereas the Western Blacklegged Tick, *I. pacificus* Cooley and Kohls, is the principal vector in far western states and a Canadian province (Burgdorfer et al. 1985; Clover and Lane 1995; Eisen et al. 2004a, b; Keirans et al. 1996; Lane and Lavoie 1988; Lane and Loye 1989). Certain species of rodents, and to a lesser extent birds, are enzootic reservoir hosts of *B. burgdorferi* sensu lato (Castro and Wright 2007; Clark et al. 2005; Clover and Lane 1995; Durden and Oliver 1999; Lane and Lavoie 1988; Scott et al. 2012). However, immature stages (larvae and nymphs) of both *I. scapularis* and *I. pacificus* not only feed on mammals and birds, but also on certain species of reptiles, especially lizards (Clark et al. 2005; Durden et al. 2002; Giery and Ostfeld 2007; Lumbad

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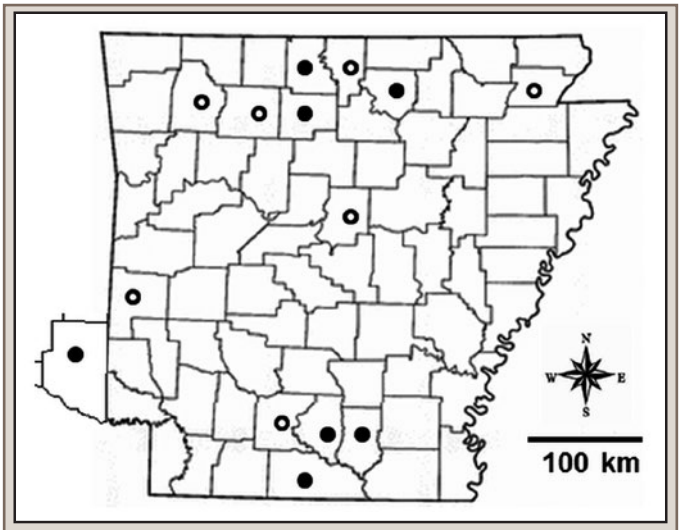


FIG. 1. Thirteen counties in Arkansas and one in southeastern Oklahoma where lizards were collected showing those infested with ticks (solid circle in county) and those without ticks (open circle in county).



FIG. 2. A nymphal *Ixodes scapularis* embedded under scales of dermis in *Plestiodon fasciatus* from McCurtain County, Oklahoma.

et al. 2011; Swanson and Norris 2007; Talleklint-Eisen and Eisen 1999). In fact, in some regions, up to 98% of nymphal *I. pacificus* in a given habitat feed on lizards (Casher et al. 2002). If these lizards are incompetent reservoir hosts of strains of *B. burgdorferi* that cause human disease, feeding of immature *I. scapularis* on lizards would serve to decrease the infection prevalence in tick populations, thereby creating a "dilution effect" (Schmidt and Ostfeld 2001) and an example of biodiversity providing "ecosystem services" to public health (Ogden and Tsao 2009).

Some researchers have reported that certain lizards may be reservoir hosts of *B. burgdorferi* in North America (Clark et al. 2005; Giery and Ostfled 2007; Levin et al. 1996; Swanson and Norris 2007). Similarly, in Eurasia and North Africa, where immature stages of *I. ricinus* frequently parasitize lizards (Bauwens 1983; Dsolui et al. 2006; Keirans et al. 1999; Matchuschka et al. 1991), some of these reptiles have been reported to be reservoir hosts of *B. burgdorferi* sensu lato, notably of the genomospecies *B. lusitaniae* (Amore et al. 2007; Dsouli et al. 2006; Majláthová et al. 2006), which is not a human pathogen. Conversely, other researchers have shown that other species of lizards are refractory to infection by *B. burgdorferi* and have borreliacidal factors in their blood that effectively kill spirochetes (Kuo et al. 2000; Lane and Quistad 1998; Lane et al. 2006; Wright et al. 1998). In this article, we report new lizard hosts of *I. scapularis* in Arkansas and Oklahoma, list the known reptilian hosts of both *I. scapularis* and *I. pacificus* by state/province in North America, record tick stage(s) collected from each host species, and briefly consider the potential role of lizards in Lyme disease epidemiology.

Methods.—Between 2009–2013, 65 lizards (juveniles and adults) were collected by hand from various localities in upland (Ouachita and Ozark plateaus) and Gulf Coastal Plain habitat in 12 Arkansas counties (Baxter, Bradley, Calhoun, Faulkner, Greene, Izard, Madison, Newton, Ouachita, Polk, Searcy, and Union), as follows: 11 Green Anoles (*Anolis carolinensis*), eight Prairie Racerunners, (*Aspidoscelis sexlineata viridis*), four Southern Coal Skinks (*Plestiodon anthracinus pluvialis*), 20 Five-lined Skinks (*Plestiodon fasciatus*), one Broad-headed Skink (*Plestiodon laticeps*), and four Prairie Lizards (*Sceloporus consobrinus*); 12 *P. fasciatus* and five *S. consobrinus* were also collected from

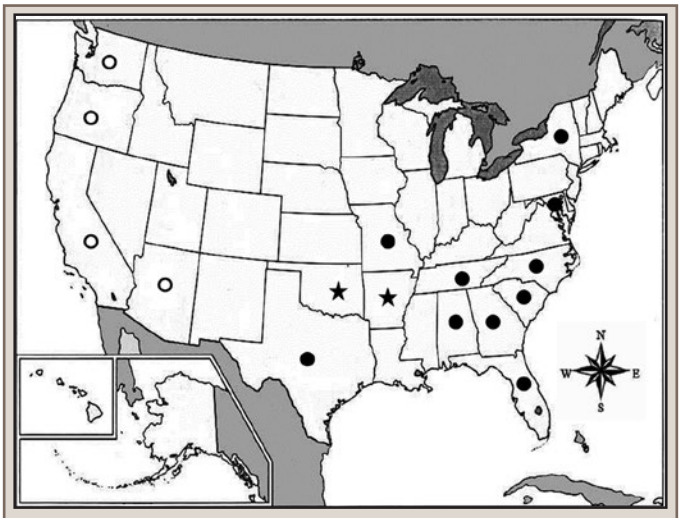


FIG. 3. Sixteen states where larvae and nymphs of *Ixodes scapularis* (solid dots) and *Ixodes pacificus* (open dots) have been reported from various lizard hosts. The latter tick is also reported from lizard hosts in British Columbia, Canada (not shown). Star = new records for *I. scapularis* from lizards.

McCurtain Co., Oklahoma. Following the guidelines for the humane treatment of research animals (HACC 2004) specimens were either examined live and released or euthanized with an intraperitoneal injection of sodium pentobarbital and their bodies examined for arthropod parasites. When ticks were found they were removed with tweezers and placed in vials containing 70% ethanol and shipped to one of us (LAD) for identification. Voucher tick specimens are deposited in the U.S. National Tick Collection, Statesboro, Georgia, under accession numbers RML 124935 (from *P. laticeps*), RML 124936–124937 (from *P. fasciatus*), and RML 124938 (from *S. consobrinus*). Host vouchers are deposited in the Arkansas State University Herpetological Collection (ASUMZ), State University, Arkansas. Previously published records of *I. scapularis* and *I. pacificus* parasitizing reptiles in the U.S. and Canada were compiled through extensive literature searches.

TABLE 1. Recorded reptilian hosts of Blacklegged Ticks (*Ixodes scapularis*) and Western Blacklegged Ticks (*Ixodes pacificus*) in North America.

Host family	Scientific name	Common name	Tick species	Tick stages collected[1]	State/Province records and citations
Anguidae	*Ophisaurus attenuatus*	Slender Glass Lizard	*Ixodes scapularis*	L, N	(NC) Levine et al. (1997) Unspecified (AL, FL, GA and/or SC) Oliver et al. (1993)
	Ophisaurus compressus	Island Glass Lizard		L, N	(GA) Durden & Oliver (1999) Unspecified (AL, FL, GA, and/or SC) Oliver et al. (1993)
	Ophisaurus mimicus	Mimic Glass Lizard		L	Unspecified (AL, FL, GA, and/or SC) Oliver et al. (1993)
	Ophisaurus ventralis	Eastern Glass Lizard		L, N	(FL) Clark et al. (2005) (GA) Durden et al. (2002) (NC) Apperson et al. (1993), Levine et al. (1997) (SC) Clark et al. (2005) (TX) Eads (1949) Unspecified (AL, FL, GA, and/or SC) Oliver et al. (1993)
	Ophisaurus sp.	undetermined species		L, N	Unspecified, Keirans et al. (1996)
Dactyloidae	*Anolis carolinensis*	Green Anole		L	(AR) present report (FL) Rogers (1953) (NC) Levine et al. (1997) (SC) Reeves et al. (2002)
Phrynosomatidae	*Sceloporus consobrinus*	Prairie Lizard		N	(AR) Lancaster (1973), present report (TX) Brennan (1945)
	Sceloporus olivaceus	Texas Spiny Lizard		L, N	(TX) Brennan (1945)
	Sceloporus undulatus	Eastern Fence Lizard		L, N	(FL) Hixson (1941) (MD) Swanson & Norris (2007) (MD/NY) Giery & Ostfeld (2007) (MO) Kollars et al. (1999) Unspecified, Bishopp & Trembley (1945)
Scincidae	*Plestiodon egregius*	Mole Skink		N	Unspecified (AL, FL, GA, or SC) (Oliver et al. 1993)
	Plestiodon fasciatus	Five-Lined Skink		L, N	(AR) present report (MD) Swanson & Norris (2007) (MD/NY) Giery & Ostfeld (2007) (MO) Kollars et al. (1999) (NC) Levine et al. (1997) Unspecified (AL, FL, GA, and/or SC) Oliver et al. (1993)
	Plestiodon inexpectatus	Southeastern Five-Lined Skink		L, N	(FL) Clark et al. (2005) (GA) Durden & Oliver (1999), Durden et al. (2002) (NC) Apperson et al. (1993), Levine et al. (1997) (SC) Clark et al. (2005) Unspecified (AL, FL, GA, and/or SC) Oliver et al. (1993)
	Plestiodon laticeps	Broadhead Skink		L, N	(AR) Lancaster (1973), present report (FL) Hixson (1941), Rogers (1953) Clark et al. (2005) (GA) Keirans et al. (1996), Lavender & Oliver (1996), Durden & Oliver (1999), Durden et al. (2002) (NC) Apperson et al. (1993), Levine et al. (1997) (MD) Swanson & Norris (2007 (MD/NY) Giery & Ostfeld (2007) (SC) Clark et al. (2005) Unspecified (AL, FL, GA, and/or SC) Oliver et al. (1993) Unspecified, Bishopp & Trembley (1945)
	Scincella lateralis	Ground Skink		L, N	(FL) Rogers (1953), Keirans et al. (1996) (GA) Lavender & Oliver (1996) (NC) Apperson et al. (1993), Keirans et al. (1996) (TX) Brennan 1945)

TABLE 1. Continued.

Host family	Scientific name	Common name	Tick species	Tick stages collected[1]	State/Province records and citations
	"Skink"	undetermined species		L, N	Unspecified, Bishopp & Trembley (1945), Keirans et al. (1996)
Teiidae	*Aspidoscelis sexlineata*	Six-Lined Racerunner		L, N	(NC) Levine et al. (1997)
Emydidae	*Terrapene carolina*	Eastern Box Turtle		N	(TN) Reeves et al. (2007)
Anguidae	*Elgaria c. coerulea*	San Francisco Alligator Lizard	*Ixodes pacificus*	L, N	(CA) Jellison (1934), Mohr (1964), Arthur & Snow (1968), Furman & Loomis (1984), Eisen et al. (2004a), Castro & Wright (2007)
	Elgaria coerulea principis	Northwestern Alligator Lizard		L, N	(BC) Gregson (1956), Arthur & Snow (1968), Arnason (1992)
	Elgaria m. multicarinata	California Alligator Lizard		L, N	(CA) Cooley & Kohls (1945), Holdenried et al. (1951), Arthur & Snow (1968), Furman & Loomis (1984), Bennett (1987), Webb et al. (1990), Talleklint-Eisen and Eisen (1999), Wright et al. (2003a, b), Eisen et al. (2004a), Castro & Wright (2007) (OR) Arthur & Snow (1968) (WA) Arthur & Snow (1968)
	Elgaria multicarinata scincicauda	Oregon Alligator Lizard		L, N	(CA) Jellison (1934), Cooley & Kohls (1945), Arthur & Snow (1968), Furman & Loomis (1984), Wright et al. 1998)
	Elgaria sp.	undetermined species		L, N, A	(CA) Mohr et al. (1964), Furman & Loomis (1984), Webb et al. (1990), Castro & Wright (2007)
Phrynosomatidae	*Sceloporus g. graciosus*	Northern Sagebrush Lizard		L, N	(CA) Arthur & Snow (1968), Furman & Loomis (1984), Webb et al. (1990), Goldberg & Bursey (1991), Wright et al. (2003a, b), Castro & Wright (2007)
	Sceloporus occidentalis	Western Fence Lizard		L, N	(CA) Jellison (1934), Cooley & Kohls (1945), Holdenried et al. (1951), Mohr et al. (1964), Arthur & Snow (1968), Furman & Loomis (1984), Manweiler et al. (1990, 1992), Webb et al. (1990), Talleklint-Eisen & Eisen (1999), Eisen et al. (2001, 2004a), Schall et al. (2000), Casher et al. (2002), Wright et al. (2003a, b), Castro & Wright (2007), Lumbad et al. (2011), and others (OR) Arthur & Snow (1968) Unspecified, Bishopp & Trembley (1945)
	Sceloporus undulatus	Eastern Fence Lizard[2]		U	(AZ) Olson et al. (1992)
	Sceloporus sp.	undetermined species		L, N	(CA) Furman & Loomis (1984)
	Uta stansburiana	Side-Blotched Lizard		L, N	(CA) Bennett (1987), Webb et al. (1990), Goldberg & Bursey (1991), Castro & Wright (2007)
Scincidae	*Plestiodon gilberti*	Gilbert's Skink		L, N	(CA) Castro & Wright (2007)
	Plestiodon skiltonianus	Western Skink		L, N	(CA) Bennett (1987), Castro & Wright (2007)
Teiidae	*Aspidoscelis tesselata*	Common Checkered Whiptail[3]		N	(CA) Holdenried et al. (1951)
	Aspidoscelis tigris	Western Whiptail		L, N	(CA) Furman & Loomis (1984), Castro & Wright (2007)
	Aspidoscelis sp.	undetermined species		L, N	(CA) Cooley & Kohls (1945), Arthur & Snow (1968)
Unknown family	"Coast Lizard"	undetermined species		U	(BC) Arthur & Snow (1968)
	"Lizards"	undetermined species		U	(CA) Cooley & Kohls (1945), Arthur & Snow (1968), Furman & Loomis (1984), Webb et al. (1990) (OR) Cooley & Kohls (1945), Arthur & Snow (1968)
Colubridae	*Thamnophis ordinoides*	Northwestern Garter Snake		U	(OR) Arthur & Snow (1968)

[1]L = Larva(e), N = Nymph(s), A = Adult(s), U = Undetermined (not stated in original paper).
[2]This host association was reported for Mohave County, Arizona; however, *S. undulatus* does not occur in Arizona.
[3]This host association was reported for Alameda County, California; however, *A. tesselata* does not occur in California.

Results.—Forty-four ticks were found on 11 of 65 (17%) lizards; a total of 13 larval and 31 nymphal specimens were collected from lizards from six of 13 (46%) counties of Arkansas and a single county in Oklahoma (Fig. 1). All ticks were subsequently identified as *I. scapularis*. A single *P. laticeps* collected on 1 May 2012 from Union Co. harbored seven nymphs and 12 larvae; eight (60%) *P. fasciatus* collected on 18 March 2012 from Marion Co., 26 April 2012, 1 May 2012, 17 July 2012, 10 September 2012, and 19 May 2013 from Union Co., 19 August 2012 from Calhoun Co. and 29 March 2013 from Searcy Co. had one, one, one, six, two, two (plus one larva), one, and three nymphal specimens, respectively; a single (25%) *S. consobrinus* collected on 27 April 2012 in Izard Co. had two nymphs; and one (9%) *A. carolinensis* collected on 24 February 2013 from Union Co. had three nymphs. A single (8%) *P. fasciatus* collected on 25 May 2013 from McCurtain Co., Oklahoma had two nymphs, one of which is shown in Fig. 2.

Table 1 lists the recorded reptilian hosts by state/province of *I. scapularis* and *I. pacificus* and includes references and stages (larvae, nymphs, and/or adults) for each host species. Fig. 3 shows the 16 states from which these two tick species have currently been reported from reptilian hosts.

Discussion.—*Ixodes scapularis* has an extensive Nearctic range and has been reported previously from parts of southeastern Canada, across the eastern USA, and from the Mexican state of Coahuila (Keirans et al. 1996). In the USA, it is known from Florida to Maine in the east to central Texas and north to the Dakotas in the west (Keirans et al. 1996). There are also records of immature stages attached to migrating birds from other regions (Scott et al. 2012). Lancaster (1973) mentions that nymphs of *I. scapularis* have been found on the "common fence lizard" and "blue-tailed skink" in Arkansas but does not give a citation for this statement or list specific lizard species in his table of hosts for this tick. This species is the most common *Ixodes* in Arkansas (Lancaster 1973), where adults parasitize larger mammals (mainly deer and livestock) during the cooler months of the year while immature stages occur on a variety of smaller mammals, birds, and reptiles. However, we document the first definitive lizard host records for *I. scapularis* in Arkansas and Oklahoma, and the first voucher specimens reported from *S. consobrinus* (formerly *S. undulatus hyacinthinus*).

Various lizard species have been reported as hosts of larvae and nymphs of *I. scapularis* in the eastern U.S. including Alabama (Oliver et al. 1993), Florida (Clark et al. 2005; Oliver et al. 1993; Rogers 1953), Georgia (Durden et al. 2002; Keirans et al. 1996; Oliver at al. 1993), Maryland (Giery and Ostfeld 2007; Swanson and Norris 2007), Missouri (Kollars et al. 1999), New York (Giery and Ostfeld 2007), North Carolina (Apperson et al. 1993; Levine et al. 1997), South Carolina (Clark et al. 2005; Oliver et al. 1993), and Texas (Brennan 1945; Eads 1949) (Table 1, Fig. 1). There is also a record of nymphal *I. scapularis* parasitizing an Eastern Box Turtle (*Terrapene carolina carolina*) in Tennessee (Reeves et al. 2007). However, little is known about *I. scapularis* infesting lizards west of the Mississippi River, particularly in Arkansas and Oklahoma.

In the far western United States and parts of far western Canada, larvae and nymphs of *I. pacificus* parasitize various species of lizards (Table 1). Most of these records are from California (Arthur and Snow 1968; Casher et al. 2002; Castro and Wright 2007; Eisen et al. 2001, 2004a, b; Goldberg and Bursey 1991; Lane and Loye 1989; Lumbad et al. 2011; Manweiler et al. 1990, 1992; Schall et al. 2000; Talleklint-Eisen and Eisen 1999; Webb et al. 1990; Wright et al. 1998), but there are additional records from Arizona (Olson et al. 1992), Oregon (Arthur and Snow 1968; Cooley and Kohls 1945; Eads 1949), Washington (Arthur and Snow 1968), and British Columbia, Canada (Arnason 1992; Arthur and Snow 1968; Gregson 1956) (Table 1, Fig. 1). There are also records of adult *I. pacificus* from undetermined alligator lizard species (*Elgaria* spp.) in California (Cooley and Kohls 1945; Mohr et al. 1964) (Table 1). Immature stages of *I. pacificus* presumably also parasitize lizards in other states where this tick is known to occur, namely Idaho, Nevada, and Utah.

Lizards can be relatively important hosts of immature *I. scapularis* and *I. pacificus*. For example, Durden and Oliver (1999) recorded 373 larvae and 21 nymphs of *I. scapularis* on a single *P. laticeps* in coastal Georgia, and Durden et al. (2002) reported a peak monthly average of 96.0 *I. scapularis* immatures/skink (*P. laticeps* and *P. inexpectatus* combined) during May 1994 in the same region. At the same site, Cotton Mice (*Peromyscus gossypinus*) were parasitized by a peak monthly average of 2.9 immature *I. scapularis* (during June 1994) with a maximum of 31 larvae on a single mouse (Durden and Oliver 1999). In one study in California, the Western Fence Lizard (*Sceloporus occidentalis*) accounted for 78% of the larval feedings and 98% of nymphal feedings for the *I. pacificus* population (Casher et al. 2002). These data suggest that in some regions up to 10x the number of immature *I. scapularis* and *I. pacificus* feed on lizards compared to the number that feed on other hosts (mammals and birds) in the same habitat. However, these numbers should be viewed with caution because infestation rates are clearly dependent on variation in host communities and because host body temperatures affect engorgement times of attached ticks. We did not record body temperature of our lizards when captured, but others have found that under laboratory conditions larvae and nymphs of *I. scapularis* remained attached to lizards for about 3x as long on skinks (*Plestiodon* spp.) as on *P. gossypinus* (Durden and Oliver 1999). Similarly, Goldberg and Bursey (1991) reported that, at 24°C, larvae and nymphs of *I. pacificus* attached to Northern Sagebrush Lizards (*Sceloporus graciosus graciosus*) for approximately eight days and to Common Side-blotched Lizards (*Uta stansburiana*) for 16 days.

Galbe and Oliver (1992) successfully fed five separate cohorts of *I. scapularis* larvae on the same individual *Plestiodon laticeps* and noted no reduction in tick engorgement prevalence or weights; additionally, antibodies against *I. scapularis* salivary gland antigens were not present in the blood of these lizards. Because of these phenomena, lizards could represent an important component in the ecology and epidemiology of any pathogens transmitted by these two tick species, in particular *B. burgdorferi*, the causative agent in Lyme disease. Because *I. scapularis* and *I. pacificus* immatures exhibit little host preference when offered laboratory mice, birds (baby chicks), or lizards as hosts (James and Oliver 1990) (larvae of both species showed a slight preference for mice, and nymphs preferred lizards and mice equally over chicks), the larger numbers of these ticks found on lizards in many regions is presumably related to the greater accessibility or availability of lizards. Slowak and Lane (2011) also tested the host preference of immature stages of *I. pacificus* under laboratory conditions but they used more natural hosts in their experiments: Deer Mouse (*Peromyscus maniculatus*), California Kangaroo Rat (*Dipodomys californicus*), California Towhee (*Pipilio crissalis*), and Western Fence Lizard. They demonstrated that both larvae and nymphs of *I. pacificus* preferred Western Fence Lizards as hosts but that rodents were also frequently parasitized and towhees were rarely parasitized.

The exact role lizard hosts play in Lyme disease ecology and epidemiology depends to a large extent on whether lizards are reservoir-competent or reservoir-incompetent hosts for genomospecies of *B. burgdorferi* that can cause human disease and on the proportion of immature ticks that feed on lizards compared to alternative hosts in a given region. Early interpretations, sometimes supported by circumstantial data, suggested that lizards are refractory to infection with *B. burgdorferi* which would mean that any immatures of *I. scapularis* and *I. pacificus* feeding on lizards would not become infected with spirochetes (Durden and Oliver 1999). This would lead to a dilution effect with fewer infected ticks and fewer cases of Lyme disease in areas where most immature ticks feed on lizards rather than on reservoir–competent rodents. This seems to correlate well with the fewer cases of Lyme disease contracted in the southeastern United States where lizards are abundant and appear to feed most of the immature *I. scapularis* in the tick population (Durden and Oliver 1999; Oliver 1996). Conversely, in the northeastern and upper midwestern states, where Lyme disease is hyperendemic, lizard biodiversity and abundance is lower (compared to that in the southeastern USA) and most of the immature *I. scapularis* feed on reservoir-competent rodents (Oliver 1996).

Despite this hypothesis, Levin et al. (1996) reported prolonged (up to 5 wk) laboratory infections of both *P. inexpectatus* and *A. carolinensis* by *B. burgdorferi* sensu stricto. However, as more lizard species have been tested for their ability to maintain infections of *B. burgdorferi*-group spirochetes, the picture has become more complicated. For example, although Clark et al. (2005) used polymerase chain reaction amplification of specific primers to demonstrate the presence of *B. burgdorferi* in the blood of 86 of 160 (54%) lizards from Florida and South Carolina (representing nine species and six genera of lizards), other researchers have found other lizard species to be refractory to infection by *B. burgdorferi* sensu lato. Lane (1990) was unable to experimentally infect Western Fence Lizards with *B. burgdorferi* although one individual lizard apparently maintained a transitory spirochetemia for two days. It was later discovered that *S. occidentalis* has a borreliacidal factor in its blood that kills both *B. burgdorferi* (Lane and Quistad 1998) and the closely related *B. burgdorferi*-group spirochete *Borrelia bissettii* (Lane et al. 2006). Wright et al. (1998) similarly showed that Southern Alligator Lizard (*Elgaria multicarinata*) blood contains a borreliacidal factor. The borreliacidal factors in the blood of both *S. occidentalis* and *E. multicarinata* were shown to be proteins comprising the alternative complement pathway (Kuo et al. 2000).

In southern Maryland, Swanson and Norris (2007) detected *B. burgdorferi* markers in eight of 29 (28%) field-caught lizards (*S. undulatus* and *Plestiodon* spp.). Also, the role of lizards in the ecology of Lyme disease was examined in two endemic zones in the northeastern USA (one in New York and one in Maryland) by Giery and Ostfeld (2007). Based on very low infection prevalences (0–2%) in xenodiagnostic larval *I. scapularis* fed on field-caught *P. fasciatus* or *S. undulatus,* they devised a model to predict the ability of different vertebrate host species to influence the prevalence of *B. burgdorferi* in the tick population, which is an important component of human Lyme disease risk. They considered *P. fasciatus* to be reservoir-incompetent for *B. burgdorferi* and *S. undulatus* to be partially reservoir-competent. Combining these data with population densities of the two lizard species and their average tick burdens, they concluded that *P. fasciatus* is a dilution host for Lyme disease risk in the areas studied, meaning that its presence in the ecosystem reduces the prevalence of *B. burgdorferi*-infected ticks and therefore the risk of *B. burgdorferi* transmission. Similarly, Salkeld and Lane (2010) modeled *B. burgdorferi* transmission and maintenance in hosts and vectors in oak woodlands in northwestern California and demonstrated that Western Fence Lizards are important hosts for feeding immature *I. pacificus* but reduce Lyme disease transmission risk (nymphal infection prevalence). The hypothesis that Western Fence Lizards serve as dilution hosts and reduce Lyme disease risk by diverting immature *I. pacificus* ticks away from *B. burgdorferi*-competent rodents in California was tested experimentally by Swei et al. (2011) who removed lizards from field plots and then tracked tick populations in those plots. Following lizard removal, many larval *I. pacificus* failed to find alternate hosts, resulting in lower nymphal densities the following year. Although lizard removal did not result in increased infection prevalences in *I. pacificus* nymphs, it did result in fewer infected nymphs and, therefore, decreased Lyme disease risk to humans. Nevertheless, Swei et al. (2011) argued that incompetent reservoirs (Western Fence Lizards, in this case) may actually increase disease risk by promoting higher vector density and therefore, a larger overall density of infected vectors.

Based on previous reports, the competence of lizards as reservoir hosts for *B. burgdorferi* sensu lato differs widely depending on the lizard species being studied. Some lizard hosts of Lyme disease tick vectors are reported to be reservoir-competent and appear to perpetuate the transmission of the spirochete whereas others are reservoir-incompetent and evidently serve as dilution hosts by reducing the number of ticks feeding on reservoir-competent rodents, effectively diminishing Lyme disease risk in those regions. Regardless, lizards appear to play a fundamental role in maintaining populations of *I. scapularis* and *I. pacificus* in parts of North America although tick burdens differ in different regions and are dependent on local vertebrate host communities (Apperson et al. 1993; Casher et al. 2002; Durden and Oliver 1999; Eisen et al. 2004a, b). Future studies to assess or re-assess the reservoir competence of different lizard species to strains of *B. burgdorferi* that cause human disease would shed additional light on their role as either dilution or (possibly) amplification hosts for Lyme borreliosis (see Ogden and Tsao 2009). We encourage others to report additional state and county records of lizard infestation by *Ixodes* spp. to more clearly illustrate tick-lizard associations, an important component in understanding the spread of Lyme disease.

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Ontogenetic Shift in Habitat Use in the Western Fence Lizard (*Sceloporus occidentalis*) in Northern California

Ontogenetic shifts in habitat use are obvious for many amphibian species where aquatic larvae shift to terrestrial adults. In lizards, where ontogenetic habitat shifts may not be nearly as dramatic as those that accompany amphibian metamorphosis, there is still evidence for important habitat changes during development. Two general patterns have been observed in lizards. Habitat shifts can occur either 1) horizontally, where ontogeny is associated with different habitat types across a landscape or 2) vertically, where a species remains in the same habitat type but shifts its distribution altitudinally along a substrate (e.g., rocks or trees).

Horizontal shifts have been observed in several lizard species. In *Anolis aeneus*, Stamps (1983) found that juveniles hatch in shady areas, migrate to clearings, and then move back into shady habitat as adults. Hirth (1963) observed that *Basiliscus plumifrons* juveniles are most commonly found on beaches

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whereas adults of the species are found almost exclusively in adjacent hedges. Baharav (1975) found that young *Phrynosoma solare* remained adjacent to ant nests whereas adult horned lizards used habitat along ant trails, farther from ant mounds and closer to large rocks used for basking. Another horizontal-type ontogenetic habitat shift has been observed in the agamid, *Amphibolurus ornatus*, where adults are predominantly found on rock outcroppings whereas juveniles are concentrated at the base of boulders adjacent to these outcroppings (Bradshaw 1971).

Vertical habitat shifts are documented in *Iguana iguana* (Henderson 1974), *Anolis cristatellus* (Kiester et al. 1975), and *Chamaeleo chamaeleon* (Keren-Rotem et al. 2006), where adults are found higher in trees whereas juveniles use the base of trees or remain on the ground. Interestingly, *Varanus komodoensis* exhibit a similar, albeit reversed, pattern where hatchlings are arboreal whereas older animals are terrestrial (Imansyah et al. 2008). In Africa, *Pseudocordylus capensis* exhibits a vertically-stratified distribution where adult males are highest on rocks, adult females are at intermediate heights, and juveniles are found at the base of rocks (Eifler et al. 2007). Simon and Middendorf (1976) found that *Sceloporus jarrovi* shifts from using smaller, lower branches as juveniles to larger, higher branches as adults. Furthermore, although the territories of all *S. jarrovi* age classes spatially overlap, there is a temporal habitat shift where adults use the habitat in the mornings whereas juveniles do so in the afternoon (Simon and Middendorf 1976).

Stamps (1983) outlined six non-mutually exclusive factors that might explain ontogenetic habitat shifts: spatial distribution of food, suitable perches, intraspecific competition with another age class, interspecific competition, thermoregulatory constraints, and predation by conspecifics or other species. Predation pressure best supported the horizontal habitat shift seen in *A. aeneus* (Stamps 1983) and the vertical shift seen in *C. chamaeleon* (Keren-Rotem et al. 2006). There is also support for intraspecific competition (Bradshaw 1971; Schall 1974), food (Baharav 1975; Henderson 1974), and perches (Simon and Middendorf 1976) as explanations for certain ontogenetic habitat shifts in lizards. Although habitat use by different lizard age classes can be potentially complex, understanding habitat use during ontogeny is integral for studying population dynamics and processes (Lecchini and Galzhin 2005).

Our goal in the present study is to determine whether there was a difference in habitat use between two age-classes of Western Fence Lizards (*Sceloporus occidentalis*), young-of-the-year (hereafter juveniles) and adults. We used area- and time-constrained searches to measure adult and juvenile lizard densities in riparian cobble bars as well as upland, grassland habitats in northern California. In our study, riparian cobble bars and grassland habitats are particularly interesting because of their spatial juxtaposition. These cobble bars extend short distances (~2–20 m) from rivers and transition sharply into grassland habitat. The close proximity of these different environs implies that lizards should be able to readily cross between cobble bars and grassland. Given this, we were interested in whether there were differences in habitat use between age classes across relatively short distances. Because of the previously documented riverine subsidies (foreign nutrient inputs from areas of higher productivity into areas of low productivity, Sabo and Power 2002), and thermoregulatory or predatory refuge advantages (Sabo 2003) provided by riparian cobbles, we predicted that juvenile *S. occidentalis* would appear disproportionately more often in riparian cobble bars relative to adult lizards. We further predicted that adult lizards would be more prevalent in upland habitat farther from the stream edge where they could potentially capitalize on different thermoregulatory substrate and prey resources. Although *S. occidentalis* is widespread and is heavily studied, to our knowledge there has been no evaluation of an ontogenetic habitat shift in this species. Here, we provide the first evidence of differential habitat use between juvenile and adult *S. occidentalis*. Because habitat management is key in wildlife conservation, understanding age-specific habitat use is important for management.

Materials and Methods.—Our study took place adjacent to the confluence of the South Fork Eel River and Fox Creek in the Angelo Coast Range Reserve (Mendocino Co., California, USA) during September 2010. We focused on a riparian cobble bar and its adjacent upland, grassland habitat (Fig. 1). For each habitat type (riparian and upland), we selected two habitat patches that were neighboring each other, resulting in four adjacent survey sites.

For surveys, we selected two riparian and two upland sites and conducted a half-hour time-constrained search at each location. We surveyed one pair of riparian and upland sites over two consecutive days and then surveyed the other two sites (one upland and one riparian) on the following two days. We confined our surveys visually using physiognomic delineations between the surveyed habitat and adjacent habitats (i.e., hard transitions from cobble to grassland, dirt paths, trees, etc.). The two upland habitat patches were 2,042.5 m^2 and 409 m^2, while the two riparian sites were 441 m^2 and 387.2 m^2 in size. Because the home range size of *S. occidentalis* is approximately 19–50 m^2 for juveniles and 51–73 m^2 for adults (Davis and Ford 1983), and because all sites were less than 10 m apart, we pooled the two replicate sites for both habitat types for statistical analysis, assuming some movement of lizards among habitat patches. In order to avoid straying into adjacent habitat we surveyed approximately 1 m inside of edges. Each time we spotted a lizard we would pause the search effort and capture the lizard. We captured adult lizards using a noose made from a fly-rod and dental floss and captured juveniles either by noose or a dip net. Although lizards seldom evaded capture, if a lizard escaped, we restarted the search effort. The same two surveyors were responsible for sighting and capturing all lizards. One surveyor was responsible for net captures while the other was responsible for noose captures. On the ventral side of each lizard, we used a felt-tipped pen to write a unique three-digit number and then measured its snout-vent length (SVL). As in Lambert et al. (2012), *S. occidentalis* exhibited a bimodal distribution of SVLs in which juveniles all had an SVL < 4 cm and adults had SVLs > 5 cm, with no individuals between these two size classes. After we processed and released lizards, we continued the search where we had stopped previously. On the following day, we resurveyed the same areas but in reverse order so that each location was surveyed once in the morning and once in the evening. This is important because Simon and Middendorf (1976) found that *S. jarrovi* adults and juveniles temporally segregate in the same habitat, so it is necessary to survey both in the morning and also in the afternoon to adequately assess the number of lizards present. To avoid double-counting individuals, we marked all new individuals captured on the second day of surveys.

We used a Chi-square test to determine whether densities of lizards in the two age classes were distributed non-randomly in the two habitats. We measured the area of each survey site and

calculated lizard densities as lizards/ha. Chi-square tests require integers so we rounded all densities to the nearest integer for analysis.

To characterize the habitats, we randomly oriented two 20-m line-transects that were parallel and spaced 20 m apart in each surveyed area. Every meter, we noted the substrate under the transect line. We defined cobbles as any rock < 0.5 m in length, boulders as any rock > 1 m long, and also identified the dominant substrate such as dry grass or logs.

Results.—Including search time as well as lizard processing time, we spent 73–170 minutes (mean = 109.5 min, SD ± 42.4 min) and 65–148 minutes (mean = 109.75 min, SD ± 35.7 min) surveying riparian and grassland habitats respectively. In total, we caught 9 adults and 18 juveniles in the riparian habitats and 16 adults and 9 juveniles in the upland habitats. The density of adults was 108.7 lizards/ha in riparian areas and 65.3 lizards/ha in upland habitat. The density of juveniles was 217.3 lizards/ha in riparian areas and 36.7 lizards/ha in upland habitat (Fig. 2). A Chi-square test on the density of lizards indicated a significantly non-random distribution of age classes among two habitat types, such that juveniles were more abundant in riparian areas whereas adults were more abundant in upland areas ($p < 0.001$). Because we marked each animal, we were able to confirm that no animals moved between any of the four study sites.

Our transects indicated that riparian habitat was composed of 48% cobble, 18% sand, 16% live grass, 9% bare ground, and < 3% each of boulders, logs, water, bedrock, and dry grass. Upland habitat was composed of 68% dry grass, 13% cobbles, 6% boulders, and 4% thistle, and < 3% each of logs, live grass, bare ground, manzanita (*Arctostaphylos* spp.), and oak (*Quercus* spp.).

Discussion.—Our data provide evidence for an ontogenetic habitat shift in *S. occidentalis*. Similar to Sabo and Power (2002), we found the densities of lizards in general were higher in riparian cobble bars; however, the distributional pattern we observed at least qualitatively shows that the relative proportions of each class was reversed between the two habitat types. Specifically, the number of juveniles was roughly twice that of adults in riparian cobble bars whereas the opposite was true in upland grassland habitat. Although we are unable to explicitly calculate detection probabilities, we are confident that the ability to detect both age classes was relatively equal in both habitat types. On the cobble bars, where juveniles were most prevalent, adults rarely fled under rocks and were readily visible. In the uplands, the grasses were relatively sparse and so juveniles tended to be easy to see. Because of this, we do not believe that our data were dramatically affected by differences in our ability to detect a particular age class in the two habitats.

Interestingly, the total number of lizards caught was similar between habitats, but the total densities of lizards were much lower in the upland habitat relative to the riparian habitat. This is likely because upland habitat was composed mainly of dry grass and was limited in the number of basking and shelter structures like boulders and logs. *S. occidentalis* in the upland habitat were found almost entirely on large basking substrates (logs and boulders), indicating that the species only uses a small fraction of the available habitat. Although the riparian habitats were also limited, and more so, in large basking objects, the main habitat characteristic were cobbles, which can act as refuges, thermoregulatory substrate, and high ground for juvenile lizards. Cobbles are also homogenously distributed in our riparian sites and therefore likely host more lizards for a given unit of area.



FIG. 1. A map showing approximate locations of the riparian (solid line) and upland grassland (dashed line) patches. The study site was along the Eel River at the Angelo Coast Range Reserve, Mendocino, California, USA.

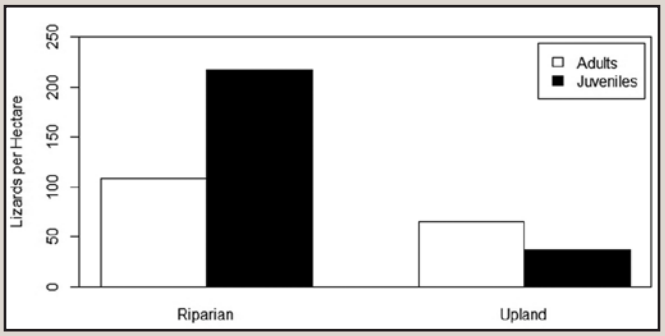


FIG. 2. The densities of adult and juvenile lizards between riparian and upland habitats.

Prior work by Sabo and Power (2002) and Sabo (2003) in the same riparian cobble bar system provides inference as to the mechanisms behind this ontogenetic habitat shift. In relation to the hypotheses proposed by Stamps (1983), there is support for food availability, thermal requirements, predation, and appropriate perches. Sabo and Power (2002) found that riverine subsidies in northern California increase growth rates of subadult *S. occidentalis*, suggesting juvenile *S. occidentalis* may be capitalizing on the abundance of invertebrates along cobble bars to accelerate growth when young. Sabo (2003) found that cobbles, relative to other cover like wood or burrows, remained within a more thermally optimal zone for *S. occidentalis* and that gravid female *S. occidentalis* in cobble bars almost exclusively used cobbles for overnight refuge, whereas males were less selective in cobble bars, and upland females relied more on wood and burrows while gravid. Together with our findings, this indicates that cobble bars may provide more thermally ideal habitat for gravid lizards to lay eggs, and that juvenile lizards remain on cobble bars after hatching rather than dispersing as other species of lizards often do (Schall 1974, Stamps 1983). Sabo (2003) also reported predation by garter snakes (*Thamnophis elegans*) on adult female, but not adult male, *S.*

occidentalis, and that females choose cobbles that are slightly smaller than those most ideal thermally, suggesting that *S. occidentalis* can preferentially select certain cobbles that are less accessible to larger predators. It is thus possible that juvenile lizards may have more refuge from predators in a riparian cobble bar than in upland areas. Furthermore, larger basking surfaces were more prevalent in the upland habitat relative to riparian habitat, so there may have been inappropriate perches for adult lizards to bask upon in the cobble bars, especially given that it is common for adult lizards to bask higher up than juveniles (Bradshaw 1971; Keren-Rotem et al. 2006; Kiester et al. 1975). Alternatively, we suggest that adults may defend perches from younger lizards, thus confining juveniles to riparian areas (*sensu* Schall 1974, Schoener 1975).

Sceloporus occidentalis is widely distributed in the western United States and occurs in an array of habitats that vary significantly from the riparian cobble bar and upland habitats we studied in northern California (Stebbins 2003). Asbury and Adolph (2007) found that *S. occidentalis* from geographically separated and distinct habitats exhibit a high degree of behavioral plasticity and tend to choose similar basking structures when placed in similar environments. We recommend future investigation as to whether *S. occidentalis* exhibits ontogenetic habitat shifts across a wider array of habitat types and, if they do, which factors (e.g., food or thermoregulation) drive this habitat shift. From an evolutionary ecology perspective, this could be particularly interesting in novel, urbanized settings where *S. occidentalis* not only occurs (Asbury and Adolph 2007), but where its physiology and ecology might have changed over time, potentially in favor of greater juvenile growth and survival.

Given how widespread, common, and heavily studied *S. occidentalis* is, it surprises us that an ontogenetic habitat shift has not yet been reported for this species. If these habitat shifts occur commonly in wildlife, as the literature indicates for lizards, then understanding such patterns may be important for managing the appropriate habitat features for species of conservation concern. We believe this study highlights the importance of studying the habitat use of different age classes across species.

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CONSERVATION

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Status and Conservation of a Gondwana Legacy: Bullock's False Toad, *Telmatobufo bullocki* (Amphibia: Anura: Calyptocephalellidae)

Lowland temperate forests often suffer from anthropogenic influences owing to their productive soils and ease of accessibility (Pérez et al. 2009). In fact, extensive alteration of Chile's lowland temperate forests has occurred for over four centuries (Armesto et al. 1994; Donoso and Lara 1996; Pérez et al. 2009). The fragmented forests that remain in Chile are sandwiched between the Andes Mountains to the east, the Pacific Ocean to the west, and the Atacama Desert to the north. A narrow strip of southern Chile and adjacent Argentina house all that remains of the temperate humid forests of the region (Aravena et al. 2002). These forests are biologically unique owing to isolation since the Tertiary Period and they host significant numbers of endemic plants and animals (Aravena et al. 2002; Armesto et al. 1996; Arroyo et al. 1996; Villagrán and Hinojosa 1997). South Chile's *Nothofagus* forests play a key role in creating the microhabitats used by some of the region's largely endemic amphibian fauna (Cuevas and Cifuentes 2009). There are minimally 37 anuran species unique to these forests, constituting no less than 85% of the regional amphibian fauna including three endemic genera (*Calyptocephalella*, *Insuetophrynus*, *Telmatobufo*) and an endemic family, the Calyptocephalellidae (Ortiz and Díaz-Páez 2006; Díaz-Páez et al. 2008; Vidal et al. 2008). The genera *Alsodes*, *Atelognathus*, *Batrachyla*, *Chaltenobatrachus*, *Eupsophus*, *Hylorina*, and *Rhinoderma* are unique to the region, some of which are found in both Chile and adjacent Argentina.

An amphibian found only in these southern forests is Bullock's False Toad, *Telmatobufo bullocki* (Figs. 1–3). It is a relict species restricted to *Nothofagus* forest fragments in south Chile (Correa et al. 2006; Donoso et al. 2010; Núñez and Formas 2000; Sánchez 2010). This frog is infrequently observed as it spends much of its time deep in forest litter. Because much of its habitat has been converted through silviculture and agriculture, and because so few specimens have been seen, the species is now listed by the IUCN as critically endangered (IUCN 2012).

Telmatobufo Taxonomy

Philippi (1899) described *Bufo venustus* from four specimens collected in the Andean foothills of southern Chile. Schmidt, in 1952, erected the genus *Telmatobufo*. Formas and Veloso reassigned *Bufo venustus* to *Telmatobufo venustus* in 1982. The genus contains two (possibly three) other species: *T. australis* (Formas 1972), *T. bullocki* (Schmidt 1952), and, questionably,

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FIG. 1. A female Bullock's False Toad, *Telmatobufo bullocki*, found buried 0.7 m in forest loam beneath a log.



FIG. 2. A female Bullock's False Toad, *Telmatobufo bullocki*; this is a robust species with the ability to withstand strong currents of icy water as well as range into surrounding forest under moderately dry conditions.



FIG. 3. A male Bullock's False Toad, *Telmatobufo bullocki*. Despite its large size and imposing appearance, this remains one of the least-known amphibians in the world.

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T. ignotus (Cuevas 2010). Formas et al. (2001) discussed taxonomic relationships among the then-recognized three species of *Telmatobufo*. Hypothesized phylogenetic relationships between *Telmatobufo* and *Calyptocephalella* (= *Caudiverbera*) have been proposed (e.g., Correa et al. 2006; Formas and Espinoza 1975; Frost et al. 2006; Lynch 1978; Núñez et al. 2000). Correa et al. (2006) indicated that the closest living lineage of frogs to *Telmatobufo* and *Caudiverbera* (now *Calyptocephalella*) (tribe Calyptocephalellini) are Australian myobatrachids and limnodynastids. The Calyptocephalellini may be ancient; Núñez and Formas (2000) indicated that the lineage that led to the Calyptocephalellini diverged around 35 million years ago (mya) and that the lineage of *Telmatobufo* emerged approximately 20–25 mya. San Mauro et al. (2005) and Donoso et al. (2010) suggested that the Calyptocephalellidae may represent a relict lineage of Gondwanian origin.

Telmatobufo is a Reclusive Taxon Now Only found in Forest Fragments

Frogs of the genus *Telmatobufo* are seldom encountered. Cuevas (2010) noted that "Since the description of this genus (Schmidt 1952), specimens of only 20 adults of the three species have been collected. These have been from Cabrerías, Llancahue, Cerro Püschel (*T. australis*); Parque Nacional Nahuelbuta, Rucapehuen (*T. bullocki*); and Altos de Vilches (*T. venustus*)." As another example, adult *T. venustus* was recorded for the first time in 100 years in 1999 (Stuart et al. 2008; Veloso et al. 2004). The larva was not described until 1983 (Díaz et al. 1983), 84 years after the species' description. Veloso (2006) reported that only adult specimens have been observed. Fenolio et al. (2011) reported that the only probable remaining locality for *T. venustus* is Altos de Vilches. During our recent (2011) surveys, we found several specimens of the less frequently encountered *Telmatobufo bullocki* in *Nothofagus* forests of the Butamalal River drainage system and in two more sites in the Nahuelbuta Mountains, which we report here. The tadpole of this species was not described until 1988 (Formas, 1988), 36 years after the description of the species. The numbers of specimens that have been found in this study likely exceed the total of all *Telmatobufo* in museum collections. However, *T. bullocki* remains one of the least-known amphibians in the world, and there are few images of the species available. Exceptions to this can be found at http://ramonreyes-carrasco.blogspot.com/, at http://www.arkive.org/telmatobufo/telmatobufo-bullocki, and in Rabanal and Nuñez (2009) and Diez et al. (2011).



FIG. 4. False Toads of the genus *Telmatobufo* are reclusive for much of their lives. When they are active, either during nocturnal foraging or during reproductive periods, they often inhabit moist drainages and spray zones.

DISTRIBUTION AND HABITAT OF *TELMATOBUFO BULLOCKI*

All known *Telmatobufo* are endemic to southern Chile. Bullock's False Toad, *Telmatobufo bullocki*, is found in coastal range *Nothofagus* forest between 35.9794°S and 38.0000°S and between 10 and 800 m elev. (Donoso et al. 2010; Escobar et al. 2005; Formas et al. 2001). Most localities are just south of the Río Bío Bío but several new sites north of the river have also been reported (Donoso et al. 2010; Escobar et al. 2005). Smith-Ramírez (2004) cited a forest fragment (Los Queules National Reserve) as housing the northernmost population, also reported in Donoso et al. (2010). Formas et al. (2001) recognized nine localities but Veloso et al. (2004) argued that the species is known from fewer than five localities. The distribution of *Telmatobufo bullocki* has been reviewed and/or commented upon by Cei (1962), Péfaur (1971), Smith-Ramírez (2004), Escobar et al. (2005), and Donoso et al. (2010); Donoso et al. (2010) included a range map. The only two protected areas in which the species has been found are Nahuelbuta National Park and Los Queules National Reserve (Donoso et al. 2010; Escobar et al. 2005). A fourth *Telmatobufo* species, *T. ignotus* (Cuevas, 2010), has been described from Los Queules National Reserve. Donoso et al. (2010) claim genetic confirmation of their specimens from the same site as *T. bullocki*, but this has been questioned by Cuevas (2010), who further suggested that the material found by Escobar might also prove to be *T. ignotus*. So, the possibilities are that 1) *T. bullocki* exists in the Cordillera de la Costa where it 2) may or may not be syntopic with *T. ignotus*; or that 3) *T. ignotus* is conspecific with *T. bullocki*. We find the evidence in favor of recognizing *T. ignotus* as a distinct species unconvincing and thus regard the status of *Telmatobufo* in the Cordillera de la Costa as unresolved. Bullock's False Toad is found near coastal range mountain streams (Donoso et al. 2010), yet the frogs can move considerable distances from drainage systems. Donoso et al. (2010) found individuals over 300 m from the nearest stream, and we have found them in excess of this distance. Bullock's False Toads appear to spend much of their nonreproductive time buried beneath forest debris. Favored microhabitats include areas deep below logs and rocks in *Nothofagus* forest (Formas et al. 2001; Rabanal and Nuñez 2009). Escobar et al. (2005) found an individual in a pine plantation, *Pinus radiata*, 90 meters from native forest.

CONSERVATION THREATS

All members of the family Calyptocephalellidae are threatened with extinction (IUCN 2012). Coastal range *Nothofagus* forest is declining in quality and quantity (Wolodarsky-Franke and Díaz Herrera 2011; IUCN 2012). Habitat loss, particularly conversion of *Nothofagus* forests to pine and eucalyptus, is affecting *Telmatobufo* (Cuevas 2010; Fenolio et al. 2011; Rabanal and Núñez 2009; Stuart et al. 2008; Veloso et al. 2004). Remaining habitat has been reduced to isolated forest fragments surrounded by pine plantations and agriculture (Donoso et al. 2010; Echeverría et al. 2006; Sánchez 2010). Survey work is needed to determine the population status of all species (Stuart et al. 2008; Veloso et al. 2004) but we know that Bullock's False Toad now inhabits less than 500 km^2, which is spread across several forest fragments (IUCN 2009). Any use of heavy machinery in native forests, or even in silviculture areas, could disturb terrestrial habitat as these amphibians burrow in forest litter. Cuevas and Cifuentes (2009) argued that the life history of frogs like *Telmatobufo*, having a stream-adapted tadpole with specific habitat requirements, puts them at risk owing to anthropogenic environmental changes in south Chile. Heavy sediments and siltation of breeding streams from human activities in the areas where *Telmatobufo* are found could adversely affect the larval stages of these ancient amphibians (Sánchez 2010). Roads (their construction and use) and timber harvesting have been documented as a source of fine sediments washing into aquatic habitats and degrading them relative to the needs of amphibians living there (Ashton et al. 2006; Trombulak and Frissell 2000; Welsh and Oliver 1998). Hydrologic alterations (such as "run-of-the-river" hydroelectric plants) or impoundments could alter larval habitat. Hydroelectric plants in Nahuelbuta are already in place and new facilities are being constructed (e.g., on the Río Picoiquen and the Río Cayucupil, respectively). Forest fire comprises another significant threat to *T. venustus* (Veloso 2006), particularly in light of the recent conflagrations in south Chile.

There are additional threats to consider. Emergent infectious amphibian disease (amphibian chytrid fungus, *Batrachochytrium dendrobatidis*, or *Bd*) was first reported in Chile from an invasive frog, *Xenopus laevis* (Solís et al. 2010), and subsequently in native amphibian species from south Chile (Bourke et al. 2010, 2011). Emergent infectious disease has been implicated in the rapid decline of amphibian populations around the world (e.g., Berger et al. 1998; Daszak et al. 1999, 2000, 2003; Rachowicz et al. 2006). Epidemics may pose a greater extinction risk to species with reduced distributions.

Introduced and invasive species could serve as an additional threat to *Telmatobufo*. There is no question that invasive species have damaged native Chilean fauna (De Buen 1959; Jaksic 1998; Jaksic and Fuentes 1991; Jaksic et al. 2002; Lobos and Jaksic 2004; Lobos and Measey 2002; Lobos et al. 1999, 2005). The rapid expansion of salmonid fishes, post-introduction, has been

TABLE 1. Results of disease surveillance for amphibian chytrid fungus, *Batrachochytrium dendrobatidis* or *Bd*, in 45 wild Bullock's False Toads, *Telmatobufo bullocki*. Exact locality data / GPS coordinates not provided to ensure the safety of the focal populations. NMR = Nahuelbuta Mountain Range. No *Bd* was detected at NMR site No1, a 24% infection rate of *Bd* was recorded among sampled individuals at NMR site No2, and a 50% infection rate of *Bd* was recorded among sampled individuals at NMR site No3 (the exceptionally small sample size of NMR site No3 needs to be taken into consideration).

Locality	Individual number	Date	Result
NMR, site No1	Individual No.1	December 2011	*Bd* negative
NMR, site No1	Individual No.2	December 2011	*Bd* negative
NMR, site No1	Individual No.3	December 2011	*Bd* negative
NMR, site No1	Individual No.4	December 2011	*Bd* negative
NMR, site No1	Individual No.5	December 2011	*Bd* negative
NMR, site No1	Individual No.6	October 2012	*Bd* negative
NMR, site No1	Individual No.7	October 2012	*Bd* negative
NMR, site No2	Individual No.8	February 2012	*Bd* positive
NMR, site No2	Individual No.9	February 2012	*Bd* positive
NMR, site No2	Individual No.10	February 2012	*Bd* positive
NMR, site No2	Individual No.11	February 2012	*Bd* positive
NMR, site No2	Individual No.12	February 2012	*Bd* negative
NMR, site No2	Individual No.13	February 2012	*Bd* positive
NMR, site No3	Individual No.14	February 2012	*Bd* negative
NMR, site No3	Individual No.15	February 2012	*Bd* positive
NMR, site No2	Individual No.16	October 2012	*Bd* negative
NMR, site No2	Individual No.17	October 2012	*Bd* positive
NMR, site No2	Individual No.18	October 2012	*Bd* negative
NMR, site No2	Individual No.19	October 2012	*Bd* positive
NMR, site No2	Individual No.20	October 2012	*Bd* negative
NMR, site No2	Individual No.21	October 2012	*Bd* negative
NMR, site No2	Individual No.22	October 2012	*Bd* negative
NMR, site No2	Individual No.23	October 2012	*Bd* negative
NMR, site No2	Individual No.24	November 2012	*Bd* negative
NMR, site No2	Individual No.25	November 2012	*Bd* negative
NMR, site No2	Individual No.26	November 2012	*Bd* negative
NMR, site No2	Individual No.27	November 2012	*Bd* positive
NMR, site No2	Individual No.28	November 2012	*Bd* negative
NMR, site No2	Individual No.29	November 2012	*Bd* negative
NMR, site No2	Individual No.30	November 2012	*Bd* negative
NMR, site No2	Individual No.31	November 2012	*Bd* negative
NMR, site No2	Individual No.32	November 2012	*Bd* negative
NMR, site No2	Individual No.33	November 2012	*Bd* negative
NMR, site No2	Individual No.34	November 2012	*Bd* negative
NMR, site No2	Individual No.35	November 2012	*Bd* negative
NMR, site No2	Individual No.36	November 2012	*Bd* negative
NMR, site No2	Individual No.37	November 2012	*Bd* negative
NMR, site No2	Individual No.38	November 2012	*Bd* negative
NMR, site No2	Individual No.39	November 2012	*Bd* negative
NMR, site No2	Individual No.40	November 2012	*Bd* negative
NMR, site No2	Individual No.41	November 2012	*Bd* negative
NMR, site No2	Individual No.42	November 2012	*Bd* negative
NMR, site No2	Individual No.43	November 2012	*Bd* negative
NMR, site No2	Individual No.44	November 2012	*Bd* negative
NMR, site No2	Individual No.45	November 2012	*Bd* negative

well-documented, as has been the ensuing threat to native wildlife (Soto et al. 2006). We surveyed streams for three species of *Telmatobufo* and suggest that there may be a negative correlation between the presence of introduced trout (Brown Trout, *Salmo trutta*, and Rainbow Trout, *Oncorhynchus mykiss*) and *Telmatobufo* tadpoles (Fenolio et al. 2011). Field observations by one of the authors (JJN) indicate that when Brown Trout (*Salmo trutta*) are present, *Telmatobufo* tadpoles are not found; conversely, when *Telmatobufo* tadpoles are present in a given stream, there is an increased biodiversity in invertebrates and freshwater fish (i.e., the ecosystem is intact). Observations reported in Soto-Azat and Valenzuela-Sánchez (2012) support this. During some of our surveys of *Telmatobufo* breeding streams, we found that where trout are absent (one stream for *T. venustus*, one stream for *T. bullocki*, and one stream for *T. australis*), tadpoles existed. Tadpoles were not found in many streams where trout were present (> 12 streams sampled). During surveys in Altos de Lircay National Reserve, we encountered adult *T. venustus* along three streams but found tadpoles in only two of them. Rainbow Trout are common in the stream where we have been unable to locate tadpoles despite intensive searches. A local park ranger and a former landowner indicated that the trout were introduced to the first stream in the mid-1960s. However, one of us (VM) has found trout coexisting with *T. bullocki* tadpoles in many of the streams in Nahuelbuta. Observations of trout with tadpoles do not necessarily demonstrate that a negative interaction is absent and might represent a stage in the process. Trout could prey on or compete with the tadpoles; introduced fish have been implicated in other montane stream amphibian declines (e.g., Adams 1999; Collins and Storfer 2003; Kats and Ferrer 2003).

Our Disease Surveys

Bullock's False Toad was located in a forest fragment along the Río Butamalal in January of 2011 during a frog survey organized by Felipe Rabanal and including Tomas Rivas, Edgardo Flores, Ramon Reyes, and Virginia Moreno-Puig. They found two individuals (Rabanal and Moreno-Puig, *in press*; http://elalmadecayucupil.blogspot.co.nz/2011/01/excursion-nocturna-en-butamalal.html). Subsequently, a group of conservationists found the species there during a field trip after an amphibian conservation symposium. We surveyed the forest fragment several times in December of 2011 and October of 2012. Over 50 person-hours were spent searching the area for *T. bullocki*. Owing to concerns about illegal collecting, the exact location is not included here. We located seven adults, all buried beneath forest debris. More adult specimens were encountered at a second and third site in the Nahuelbuta Mountain Range, during Febuary, October, and November 2012, pursuant to a dissertation project (Moreno-Puig, *in prep.*). Skin swabs from all individuals were sent to the lab of MGL. The results for amphibian chytrid fungus, *Batrachochytrium dendrobatidis* (*Bd*), are reported in Table 1.

Methods for detecting *Bd* were as follows. Frogs were handled using a new set of vinyl gloves per specimen. Frogs were individually swabbed using sterile polyester-tipped applicators (Puritan Medical, Guilford, Maine, USA), which were gently wiped on the gular region, the flanks, the bottoms of the hands and feet, and along the ventral surface for 12 passes per body region. When dry, the tips of the swabs were transferred to individual sterile tubes and stored at 4°C until extracted and assayed. The tip of the polyester applicator was transferred to a 2 mL cryovial; 100 µl of Prepman Ultra (Applied Biosystems, Foster City, California,

USA) was added followed by 50 mg 0.5-mm glass beads for extraction. The tubes were vortexed and homogenized for 1 min in a Mini BeadBeate (Biospec Products), then placed in boiling water for 10 min, cooled for 1 min, centrifuged at 14,000 rpm for 3 min in a Marathon 16KM centrifuge (Fisher Scientific) after which the liquid was transferred using a micropipette to clean 0.6-ml microcentrifuge tubes. The recovered supernatant was then stored at 4°C until assayed using the quantitative real-time PCR protocol of Boyle et al. (2004) using 1 µl of the extract as the DNA template.

Conservation Actions

An unpublished conservation assessment exists for the Bullock's False Toad (Sánchez 2010). Subsequently, Soto-Azat et al. (2012) mirrored many of the recommendations made by Sánchez (2010). Although we do not agree with all of the conclusions made by Sánchez (2010), the assessment is a good starting point. The document calls for several actions: 1) historical sites should be searched for the frog during all times of the year; 2) vegetation type should be recorded across the traditional range of the species to identify specific plant communities that might be important to help identify habitat in unsurveyed areas; 3) study the condition of the water across the range of the species to identify critical hydrology for larvae; 4) evaluate the best uses of public outreach; 5) assess the impact of exotic wood culture in the region; 6) evaluate all other amphibian species across the range of *T. bullocki*; 7) tally area resource extraction; and 8) implement environmental education across the range of the frog. Sánchez (2010) calls for an order of operations that focuses on current threats once vegetation, water, and resource extraction analyses are performed. We respectfully disagree owing to the urgency of the situation with the few remaining populations of this species. Most forest fragments where this species remains are unprotected and could vanish before the proposed analyses are complete. All of the proposed analyses could be performed after critical habitat is secured and without impact on remaining populations. Sánchez and colleagues found no specimens of *T. bullocki*, and their report notes the difficulty of finding specimens and the paucity of basic information regarding biology and ecology. That study does not suggest captive reproduction as a conservation tool (presumably because they could not find frogs) despite support for assurance colonies by Conservation International, Amphibian Ark, and in published documents such as the Amphibian Conservation Action Plan. Despite their stated order of operations, Sánchez (2010) concludes by arguing for protecting remaining forest fragments as the main thrust of a conservation effort; we concur. Finally, the report notes considerable local interest in the conservation of the species during conservation workshops. A recommendation from the report calls for establishing *T. bullocki* as a flagship species for the conservation of the region. Sánchez (2010) includes several valuable conservation suggestions. We base our proposals on our field experiences, from suggestions in the literature, and from recommendations in other conservation assessments. Our recommendations also presume the ability to find live specimens and in doing so, draw from suggestions proposed in the Amphibian Conservation Action Plan (Gascone et al. 2007).

The presence of *Bd* in two of three focal populations of *T. bullocki* is alarming (Table 1); however, no mortality has been recorded. With frogs persisting at the infected sites, and in light of an infection rate of 24% and 50% of surveyed individuals at the two sites where *Bd* has been detected, we suspect that *T. bullocki* might be a carrier of *Bd*. Continued disease surveys are under way. We caution conservation authorities against any early dismissal of the threat of *Bd* to this species based on our findings; the disease has swept through amphibian populations in Guatemala and Panama attesting to the potential speed and lethality of the pathogen (e.g., Mendelson et al. 2004). Our results require several years of verification before we can comment with authority as to the effects of *Bd* on *T. bullocki*. More intensive disease surveys across south Chile should delineate the range of the pathogen, the susceptible species, and the speed at which it is spreading.

Chilean Native Forest Law (Ministerio de Agricultura) protects vegetation surrounding drainage systems, thereby indirectly protecting amphibian species living adjacent to streams. With *T. bullocki* inhabiting sites as far away as 300 m or more from the water during their non-reproductive season, they are susceptible to commercial tree plantation activities, including the use of heavy machinery which compresses forest litter (habitat for adult animals). Silviculture activities that might threaten this species include application of herbicides and fertilizers and mechanical disturbance during harvesting and thinning operations (Donoso et al. 2010). Wider forest buffers around streams are needed to retain gallery forest that is critical to the non-reproductive habitat of Bullock's False Toad (Donoso et al. 2010).

Determining where populations of this species can be found is of critical importance (Sánchez 2010; Rabanal and Moreno-Puig, *in prep.*). Once occupied areas are identified, an intensive effort needs to be made to safeguard these forest fragments. It is not enough to know where remaining populations are; we must elevate the forest fragments to preserves because few populations are contained presently within protected lands.

Once populations are identified, long-term monitoring programs must be implemented so that we can better define the needs of the species and have an understanding of their population ecology. These efforts should be based on standardized field methods, which need to be developed based on the ecological knowledge of the species. The "rarity" of *T. bullocki* is at least partly due to inappropriate field techniques. The detection probability of the species is low, but it is also a function of other variables (observer, weather, time of the year, etc.) and this could be confounded with low abundance (or absence in some cases). Long-term monitoring of wild populations should be systematic and carefully planned. One of the authors (VM) is collecting data for her dissertation which includes habitat use and movement patterns, impact of land-use (plantations) on the species, and conservation genetics (population structure, genetic diversity, and gene flow).

Any proposed reduction or impoundment of the flow of larval streams and rivers needs to be assessed for potential impact on larvae. How are "run-of-the-river" hydroelectric plants affecting larvae? When drainage systems are reduced to the "environmental flow" (defined as 10% of the yearly average flow), how does that impact *T. bullocki*, especially the larvae?

Systematic studies need to be conducted to determine the impact of introduced salmonid fishes on the larvae of *Telmatobufo*. If introduced salmonid fishes are preying on or competing with *Telmatobufo* larvae, the interaction could remove recruitment from many, if not most, of the drainage systems across the range of all known species. If the fish are feeding on the tadpoles, salmonid abatement programs must be implemented to eliminate the predator from critical larval habitats. The resistance of

government and local authorities owing to tourism dollars generated via fishing could be considerable.

Based on the habitat loss and subsequent population fragmentation that all *Telmatobufo* species have suffered, we propose that ex-situ assurance colonies of *Telmatobufo*, including *T. bullocki*, be established immediately. The National Zoo of Chile in Santiago, the San Antonio Zoo, and the Atlanta Botanical Garden have a six-year-old partnership that developed facilities to support a captive assurance colony of Darwin's Frogs, *Rhinoderma darwinii*, at the National Zoo of Chile. That facility is now operational, amphibian keepers have been trained and are in place, and the program has reproducing groups of *R. darwinii*. The National Zoo of Chile in Santiago and the San Antonio Zoo are looking to expand their program to support other threatened amphibians of Chile. Facilities exist and permits have been obtained for the creation of assurance colonies of three species of *Telmatobufo* (*T. venustus*, *T. bullocki*, and *T. australis*). The goal is to establish the assurance colonies before wild populations drop to numbers so low that assurance colonies cannot be created. Another goal includes the development of captive care and reproduction protocols, which will be published to share methodology with all interested stakeholders. Amphibian specialists from the San Antonio Zoo's conservation program, with experience in captive breeding of endangered amphibians, will support the effort at the National Zoo of Chile in the same way that the zoo was supported while the Darwin's Frog facility was created and populated with groups of frogs. Fundraising is a joint venture. Although breeding protocols may be developed outside of Chile, involved stakeholders believe that retaining the assurance colonies within Chile encourages local enthusiasm for the conservation of native and endangered amphibians, resulting in a project that is likely to endure.

Finally, public education and outreach is a critical component of any conservation effort, particularly coming from zoos, aquariums, botanical gardens, and natural history museums (Miller et al. 2004). Our project has developed a bilingual website to promote conservation and contact with the public (www.savedarwinsfrogs.org). We have developed interpretive signage at the National Zoo of Chile around one of the amphibian breeding labs to involve the public in the project. Sánchez (2010) proposed promoting *T. bullocki* as a regional flagship species for conservation in the coastal range of south Chile. The suggestion is valuable based on local public interest in the species and its conservation; further development of the idea within regional conservation circles should be supported.

Ensuring survival of the ancient Calyptocephalellidae requires an expansion of existing partnerships to involve the zoological community, amphibian conservation-oriented programs (such as those at the San Antonio Zoo), the Chilean Forestry industry, and governmental wildlife authorities and respective agencies. Only with support from all pertinent parties can work toward a comprehensive conservation program occur. Such a program could be modeled after a collaborative effort like Partners for Amphibian and Reptile Conservation (PARC; see Gibbons 2005; http://www.parcplace.org/).

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Deconstructing a Southern Portuguese Monster: The Effects of a Children's Story on Children's Perceptions of Geckos

Amphibians and reptiles carry the unfortunate burden of being feared and hated throughout the world. As a result, herpetologists and others dealing directly with herpetofaunal conservation are often faced with widespread public misinformation and, in many areas, folklore-based misconceptions that depict amphibians and reptiles as evil, dangerous, or disease-carrying animals. These situations constitute a serious conservation problem, as they often result in a lack of support for conservation campaigns, a general disregard for these animals in environmental impact assessments, and even episodes of direct persecution and killing of animals (Ceríaco 2012). In the reptile world, snakes are by far the most feared and misunderstood animals globally. This may be explained by cultural interpretations and snake-related folklore in most human societies, but is also due in part to an apparent genetic aversion that primates have towards snakes (Ohman and Mineka 2003; Ohman and Soares 1994). However, snakes are not the only herpetofaunal group hated and feared by humans. Other cases are quite specific to particular regions and historic sociocultural settings, deriving from folklore and cultural-specific interpretations (Bauer and Russell 1987; Ceríaco et al. 2011). These situations are often unknown to the majority of investigators and conservationists, contributing to a poor understanding of this phenomenon at a global level. Additionally, these specific situations are rarely brought to the attention of institutions and international agencies dedicated to the conservation of biodiversity (Mascia et al. 2003). Therefore, the importance of bridging the gap between conservation biology and the study of folklore is far more pressing than might have been imagined some years ago (Mascia et al. 2003).

Folklore can be loosely defined as a series of legends, music, oral history, proverbs, taboos, jokes, popular beliefs, and customs that are the traditions of a given culture, sub-culture, or group that have been passed from person to person or generation to generation by oral transmission or imitation (Medin and Atran 1999). Recently, Ceríaco et al. (2011) investigated folklore regarding geckos in southern Portugal and identified several resulting conservation issues. Both gecko species occurring in mainland Portugal, the Mediterranean House Gecko (*Hemidactylus turcicus*) and the Common House Gecko (*Tarentola mauritanica*), are depicted as venomous, "sticky," and "disgusting" carriers of a dermatological disease, the "*cobro*," which affects humans through direct or indirect contact by this animal (Ceríaco et al. 2011). This idea is quite prevalent throughout southern Portugal, but also extends through Arab or Arab-influenced countries such as Morocco, Egypt, and Pakistan, suggesting a common folkloric origin. However, this concept is nearly absent in other European countries where both species occur but historical Arabic influence has been less substantial (Ceríaco et al. 2011). This widespread folklore directly contributes to the killing

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of many geckos, since both species are often found among human settlements (Cabral et al. 2006; Ceríaco et al. 2011; Mateus and Jacinto 2010). Although only *H. turcicus* is classified as Vulnerable by the Portuguese Red List of Vertebrates (Cabral et al. 2006), continuous persecution could contribute to the reduction or even extinction of local gecko populations (Ceríaco et al. 2011). This maltreatment is also ethically condemnable and forbidden by the national legislation (Cabral et al. 2006). This situation, although long since established, has not been identified or addressed until very recently, and has been virtually absent from environmental education actions that have taken place in Portugal.

In the last decade, several environmental education and awareness operations have been globally implemented in an attempt to alter these misconceptions and negative attitudes that humans have towards reptiles and amphibians. For example, efforts have been made to understand children's relationships with snakes in order to promote a positive and more comprehensive understanding of their ecology and biology (Ballouard 2012; Gangloff 2011; Gomez et al. 2004; Prokop et al. 2009; Tomazic 2011; Wojnowski 2009). Such undertakings are critical not only due to the direct influence they have on public knowledge and attitudes towards these animals, but also because they demonstrate that simple education methodologies are capable of significantly improving public opinion. Since 2010 we have been promoting a volunteer project provocatively called *Salvem as Osgas!* (Save the Geckos!). This project, funded and managed by the University of Évora's Counsel of Biology Students (Conselho de Estudantes de Biologia de Évora; CEBE), is intended to study the bio-ecological aspects of the two aforementioned gecko species occurring in southern Portugal (Ceríaco et al., *in prep.*) in order to document and understand the folklore and traditional ecological knowledge of southern Portuguese people towards these animals (Ceríaco et al. 2011). Additionally, the project promotes several environmental education activities to amiably present these animals to local populations. In this paper we present one specific case study in gecko environmental education implemented through this project involving kindergarten (ages 4–5 years) and elementary school children (ages 5–8 years).

Methods.—From May 2011 to August 2012, we conducted visits to a total of four kindergartens and two primary schools in Évora and one primary school in Beja, southern Portugal, to present a children's story about the friendship between a little boy and a gecko. This story was developed by the authors, fully illustrated with cartoons by a colleague, and published as a children's book (CEBE 2011, Box 1). Specific topics about gecko biology and ecology were addressed in the story, including food habits, diversity, habitat, anatomical characteristics, and ecosystem importance. Simultaneously, folklore-driven ideas, like supposed toxicity and disease-carrying characteristics, were refuted. These topics, both integrated into the story, were selected in order to encompass the greatest number of accurate and informative gecko characteristics, while still catering to the interests of the children.

To present this story, children were gathered into a reading location, where either an author (MM) or undergraduate volunteer read the story while the illustrations were being projected on the wall of the classroom (Fig. 1). After the story, we showed several slides presenting both cartoons and real pictures of the two relevant gecko species to better explain their morphological differences, ecology, and biology. All of this was followed by an informal chat with the children, during which they were invited to present their ideas, doubts, and personal experiences with the animals.



PHOTO BY LUIS CERÍACO

FIG. 1. General aspect of one of the storytelling sessions in Évora, Portugal, June 2011.



PHOTO BY LUIS CERÍACO

FIG. 2. Some drawings made by schoolchildren after one of the sessions, Évora, Portugal.

We established a data collection plan with the educators and teachers in order to quantify children's opinions, ideas, and attitudes both before and after the story session. A total of 114 students participated in this survey, with similar proportions of males and females (61 girls and 53 boys), with a median age of 7 years (minimum age = 5 years, maximum age = 8). Data were collected at two separate times, with the initial session being conducted one week before the presentation of the story, and the latter session being conducted after the presentation, in the same day. For these sessions, children were asked to make a drawing of geckos and provide up to five adjectives that best described these animals in their opinion. Before and after results were then compared using a chi-squared test with a level of significance = 0.05 (Maroco 2007). For this we compared the numbers of adjectives used before and after the session, as well as the presence of the different topics and characteristics in the drawings made before the session and those in the drawing made after it.

Results and discussion.—Throughout these sessions a total of 15 adjectives were used by the children to describe geckos, with

TABLE 1. Number of times that adjectives were used by children to describe geckos in pre- and post-session inquiries. Statistically significant changes ($p < 0.0001$) denoted with an asterisk.

Adjective	# of uses before session	# of uses after session	Change
Bad	56	0	-56*
Venomous	86	0	-86*
Scary	67	2	-65*
Dangerous	90	0	-90*
Sticky	74	5	-69*
Slimy	80	16	-64*
Small	33	24	-9
Ugly	77	20	-57*
Disgusting	88	22	-66*
Friendly	0	90	+90*
Protector	2	96	+94*
Beautiful	4	76	+72*
Cute	1	70	+69*
Quick	10	7	-3
Useful	0	80	+80*

TABLE 2. Statistically significant changes ($p < 0.0001$) denoted with an asterisk.

Characteristics	# of instances before session	# of instances after session	Change
Morphological characters of the animal	33	42	+9
Ecological aspects of the animal	2	40	+38*
Presence of humans in the drawing	0	45	+45*
Presence of "happy" features	5	37	+32*
Presence of "negative" features	40	0	-40*

3 of the adjectives only being used prior to the story reading, and 2 others being only used after the session (Table 1). Statistically significant changes were detected in almost every adjective given by the children. Statistically significant increases ($p < 0.0001$) were found in children's use of the adjectives "friendly," "protector," "beautiful," "cute," and "useful." A statistically significant decrease ($p < 0.0001$) was found in the use of the adjectives "bad," "venomous," "scary," "dangerous," "sticky," "slimy," "ugly," and "disgusting." The adjectives "small" ($p < 0.2893$) and "quick" ($p < 0.6276$) did not have a statistically significant change, although their use decreased after the session (Table 1).

Some of the children did not understand the original instructions for drawing and deviated considerably from the purpose of the investigation. This resulted in the depiction of subjects clearly unrelated to geckos, such as TV shows, cartoons, etc. The possibility that some children didn't know how to draw a gecko, and therefore drew different objects instead, was also considered after discussion with educators and the children. Since we did not have criteria to separate the initial drawings that intentionally deviated from the instructions from those that deviated due to lack of knowledge, we decided to remove both from the analysis. It is important to note that in order to prevent discrimination of any of the children, all participated in both drawing sessions, even if only a part could be used in the analysis. With these samples removed, a total of 45 drawing pairs (one made before the story sessions, the other made after it), were categorized for statistical analysis. We evaluated five different characteristics in both drawings (Fig. 2). Three of those characteristics were direct interpretations of the drawing, which we assumed reflected the most evident characteristics of the drawing, such as, "Morphological characters of the animal" (e.g., presence of distinctive traits such as coloration, skin patterns, claws), "Ecological aspects of the animal" (e.g., presence of the animal near lamps, feeding habits, habitat), and "Presence of humans in the drawing" (existence or not of human representations near the animal representation). Two were indirect interpretations of the drawing, which reflect surrounding details, such as "Presence of 'happy' features" (e.g., the animal or the human was smiling, a smiling sun/moon, flowers), and "Presence of 'negative' features" (e.g., the animal had an aggressive stance, presence of harmful objects, darker colorations).

Statistically significant changes, using a chi-squared test, were detected in most of the drawing characteristics under analysis. Statistically significant increases were found in the characteristics "Ecological aspects of the animal" ($p < 0.0001$), "Presence of humans in the drawing" ($p < 0.0001$), and "Presence of 'happy' features" ($p < 0.0001$), while statistically significant decreases were found in "Presence of 'negative' features" ($p < 0.0001$). The characteristics "Morphological characters of the animal" ($p < 0.3556$) did not have a statistically significant change (Table 2).

These results demonstrate that the use of a children's story, where bio-ecological aspects of geckos were presented, is an effective way to considerably improve children's opinion about these animals. Subsequent assessments could address whether this improvement would become permanent or long-lasting. It is interesting to note that the majority of the children, all of a very young age, already possessed a very strong and misguided opinion about these animals, suggesting that such ideas are orally transmitted between generations (see Ceríaco et al. 2011). The majority of children perceived geckos as "venomous" and "dangerous" and very few recognized any utility or beauty in the animals, reflecting the folklore-driven image of geckos held by the general southern Portuguese population. These ideas, influenced by parents and grandparents and absorbed at quite a young age, undermine the future relations between these children and the animals. Additionally, the drawing results suggest that the children's view of these animals is both incomplete and populated by negative feelings and attitudes. Many of the children possessed a poor understanding of these reptiles, lacking the majority of typical characteristics, but depicted the animal with very aggressive strokes, exaggerated dangerousness (e.g., big and sharp teeth, large claws), or dangerous objects (e.g., poison bottles).

Conservation biology is a multidisciplinary science, integrating ideas, methodologies, knowledge, and techniques from a broad range of biological and ecological fields, in addition to fields traditionally associated with the humanities (e.g., ethnography, cultural anthropology; Primack 2006). Therefore, a multidisciplinary approach is of dual importance, both because of the diversity of approaches necessary to solve such complex



FIG. 3. Illustrations of the children's book, presenting different parts of the story where bio-ecological information or attitudes toward the geckos were implicit.

My Little Gecko Friend! The story behind the experimental children's story

"A Minha Amiga Osguita! A verdadeira história de uma amizade entre um menino e uma osga (My Gecko friend! The true story of a friendship between a boy and a gecko)" was designed to tell a story about the importance of geckos and their harmlessness to small children. The book tells the story of a little boy who meets a gecko, depicted as a *H. turcicus*, in his room. The boy was scared when he saw it, due to the stories and ideas that he had heard about the animal presenting it as poisonous and disease-carrying. After the initial shock and surpassing his fears, both became friends and the gecko promised to keep the boy safe from mosquito bites. The friendship grew and the gecko eventually presented the little boy to his family where the gecko parents were depicted as *H. turcicus* and his "cousins" as *T. mauritanica*, in an attempt to present the diversity of species occurring in Portugal. Things were good until the day the little boy's mother found the gecko in the boy's room while he was in school and tried to kill it. Scared, the gecko ran and told all the other geckos what happened. Due to the incident the geckos decided to go on strike, eating no more mosquitoes to show to the humans how life would be without them around. After some days of the strike, most of the human population in the town was full of bites and a town hall meeting was called to deal with the plague of mosquitoes. There, the little boy presented his gecko friend and pointed to the geckos as being the responsible for his protection against mosquitoes bites. He also explained that these animals are not dangerous. From that day forward all the people started to respect geckos and stopped the persecution. The last pages of the book present a biologically accurate cartoon representing both species, showing the general morphological differences between them, as well as a summary of the project.

problems and because many conservation issues deal with anthropogenic influence as it applies to global biodiversity (Mascia et al. 2003). In the case of human attitudes towards animals, there are many different issues that clearly affect these relations which are currently being studied under the discipline of ethnozoology (Alves 2012). Despite their relevance, ethnozoological studies and data are still quite limited and mostly absent from conservation action plans. Without a fully documented picture about how people understand certain animals, any attempt to conserve or protect them may remain limited and poorly received by local people. Even documentation and knowledge of these relations is singlehandedly insufficient for resolving this persistent problem. Subsequent actions are needed to tackle the issue, with environmental education often understood as a more effective and pedagogic approach than laws and punitive actions (Ardoin and Heimlich 2013). We argue that these environmental education actions, in the form of children's stories, hands-on activities, field trips, etc., will be far more influential if they address specific concerns about discrete species, while still incorporating the cultural and ethnobiological background of the target groups.

As stated above, these school-based sessions were part of a larger project in which other approaches were implemented. Flyers and small descriptive pamphlets were distributed throughout the region, two newspapers articles were published (one in a nationally circulated paper and the other in a regional newspaper), a Facebook page was created, and participation in open-access scientific meetings was conducted. After each of the school-based sessions, a book, sticker, and information pamphlet aimed at parental education were offered to the children. This was in attempt to pass the message on to the parents by the children themselves. These types of indirect, private approaches, in combination with the other forms of public awareness described above, can facilitate the dissemination of the message, and may contribute to a more successful acceptance of these new ideas by the adults (Vaughan et al. 1999). This type of intergenerational transfer of knowledge and ideas has already been demonstrated in other environmental education activities, such as those reported by Vaughan et al. (1999), and has proved successful not only within households, but also throughout the community. Our strategy may have reversed the transfer of misinformation and folkloric concepts of geckos by leading children to deliver real bio-ecological information, such as food habits, diversity, and ecological importance, to their parents and grandparents. Considering the results obtained from these sessions, as well as the spontaneous and authentic reactions of children, we are compelled to conclude that the maintenance of these kinds of activities is an effective way to combat misconceptions, while at the same time alerting children to local biodiversity.

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TECHNIQUES

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New Experimental Method for Semen Extraction in Freshwater Turtles

Tortoises and freshwater turtles are one of the most endangered vertebrate groups, with nearly 50% of species facing the threat of extinction (Ihlow et al. 2012). Globally, they face many threats, including habitat loss and degradation, commercial harvest for food and the pet industry, road mortality, increased predation on all age classes, and the effects of pollution and climate change (Buhlmann et al. 2009). Certain life-history characteristics such as high egg mortality and delayed sexual maturity make populations of many turtle species especially vulnerable to the effects of human encroachment such that any threat can significantly reduce recruitment and survival and thus population viability (Litzgus 2006). In Nova Scotia, Canada, population declines have been observed for all four native species of freshwater turtles and accordingly, three of the four species are protected at the federal or provincial level (COSEWIC 2007, 2008; Herman et al. 1995). Reproductive dynamics of male *Emydoidea blandingii* and *Glyptemys insculpta* have not been investigated (Ernst and Lovich 2009), and previous research has suggested that in Nova Scotia, only a small proportion (5% or less) of the adult male *E. blandingii* are contributing to the gene pool (Beckett 2006). Research into the male contribution to the gene pool of each species will improve our knowledge of turtle reproductive ecology and aid in effective conservation and recovery planning to preserve these small and declining populations, based on sound scientific research.

As part of the study of male turtle reproductive dynamics, sperm samples may need to be collected and evaluated. These samples are key for investigating sperm quality and quantity and give insightful information into the reproductive stability of a turtle population. For example, to investigate the cause of the apparent low male mating success in Blanding's Turtle, sperm samples must be obtained.

To date, there are three recognized methods for sperm collection from turtles. Two of the methods are lethal and the other is highly invasive. Oviduct flushing has been used to collect sperm from inseminated female turtles. After the turtle is euthanized, typically by an intraperitoneal overdose of sodium pentobarbital, the oviduct is removed (Gist et al. 1990). The aliquot can then be observed under a microscope for presence and abundance of sperm. Although this technique has led to significant insights into sperm storage in female turtles, there are several downfalls. Aside from being lethal, this technique does not allow for identification of spermatozoa from individual males and is thus less useful when looking at reproductive deficits from a male perspective. All three species in the present study (*Chrysemys picta*, *Emydoidea blandingii*, and *Glyptemys insculpta*) are known to be promiscuous and/or have sperm storage capacity (Banning Anthonysamy 2012; Jenkins and Babbitt 2003; Kauffman 1992; Pearse et al. 2001), which would not allow us to isolate the actual contributing male.

Removal of the epididymis from a male turtle is another lethal method for collecting spermatozoa. Once the individual is euthanized, the organ can be removed for specific investigation (Gist and Congdon 1998; Gist et al. 2000, 2001). This technique has allowed researchers to investigate the viability and motility of turtle spermatozoa as well as the function this reproductive organ has in sperm storage (Gist et al. 2000); however, this technique is not ideal for use on threatened or endangered species.

Electroejaculation is another technique for sperm collection. Despite being non-lethal, it is highly invasive. Developed by Wood et al. (1982), electroejaculation is commonly used with domestic animals and has been successfully performed on non-anaesthetized turtles as well (Gist et al. 1990). However, according to Gist et al. (1990), it is unreliable while being both invasive and time consuming. Tanasanti et al. (2007) concurred with Wood et al. (1982) that turtles should be sedated before this technique is performed and other less invasive methods should be investigated first.

Because of the listed status of Nova Scotia species, the methods found in the literature were deemed inadequate; two require sacrifice, and electroejaculation is invasive and marginally successful. Therefore, a new technique was needed. The aim of this project was to develop and validate a new experimental method that uses vibration on the plastron and carapace to induce erection and ejaculation in male turtles. This method was tested on the three emydid species found in Nova Scotia to determine its success rate. If proven successful, this new technique for sperm collection could replace the more invasive or lethal techniques that presently exist and thus enable further research in population genetics and conservation of small and declining populations of threatened and endangered species.

Materials and Methods.—Surveys for *G. insculpta* took place at a site known for having the highest local Wood Turtle density

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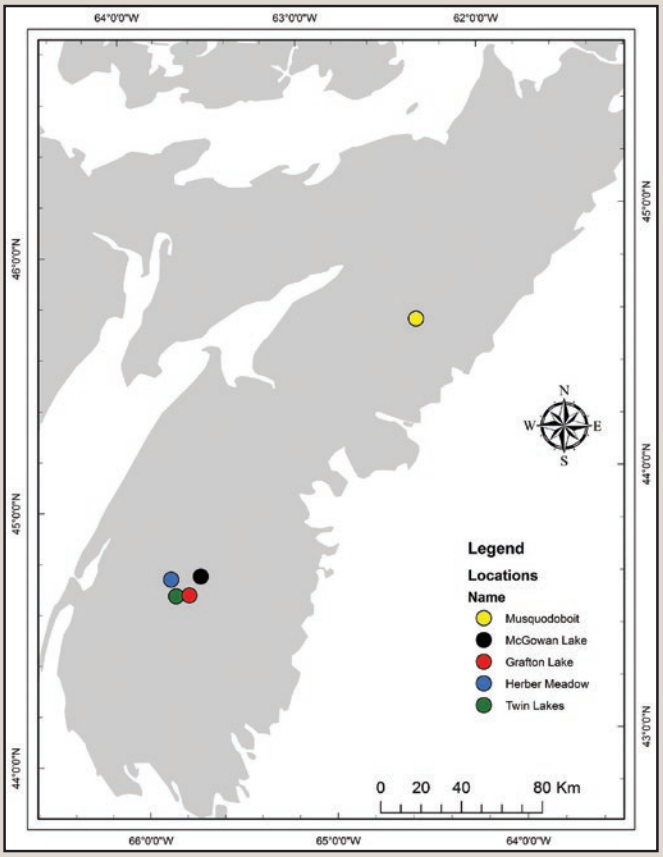


FIG. 1. Locations of spermatozoa sample collection from *Chrysemys picta, Glyptemys insculpta,* and *Emydoidea blandingii* in Nova Scotia, Canada.

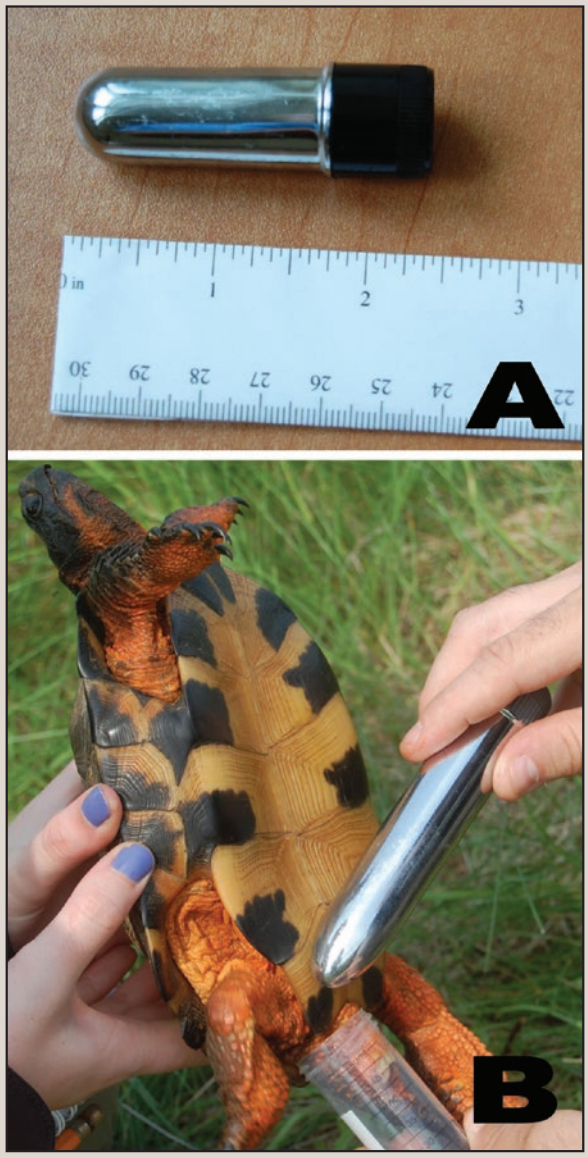


FIG. 2. A) Silver bullet-design vibrator; B) Five-inch (12.7-cm) plastic vibrator. The design was chosen depending on the size of the individual turtle.

in the Mosquodoboit watershed (Holman 2009). The sampling area was an abandoned undulating agricultural field bordering the Little River (44.9979°N, 63.1694°W; Fig. 1). The field consisted of common forbs such as goldenrod (*Solidago* sp.), with dense growth of alder (*Alnus* sp.) adjacent to the river. All *G. insculpta* were found within this site between 9 and 29 June 2011.

Emydoidea blandingii and *C. picta* were sampled from McGowan Lake (West Side Bog, 44.4366°N, 65.0751°W), Kejimkujik National Park (Grafton Lake, 44.3856°N, 65.1895°W and Heber Meadow-cove 2, 44.4084°N, 65.2636°W), and Twin Lakes (Jenny's Pond, 44.4833°N, 65.2449°W; Fig. 1). All sampling sites had extensive cover of *Sphagnum* sp. and had been previously noted to have extensive turtle activity (feeding, breeding, basking, and nesting; McNeil 2002). Sampling for both species took place periodically between 3 June and 17 August 2011.

All *G. insculpta* were collected by hand during visual surveys of the study site. Turtles were inspected for notches in the carapace indicating previous capture. Age and morphological measurements were recorded following standard protocols. Sex was determined by examining secondary sexual characteristics (Ream and Ream 1966).

Emydoidea blandingii and *C. picta* were captured either by hand or by trapping. Hoop traps 1 m in diameter with 3-cm mesh and 30-cm mouths were baited with sardines in soybean oil, set in groups of five, and checked daily for four days (20 trap-nights). Trap locations were recorded in UTM coordinates using a Garmin GPS. All *E. blandingii* captured were examined for carapacial notches indicating previous capture; individual *C. picta* were not marked and measurements were not recorded. Age and morphological measurements were recorded following standard protocols. Sex for both species was determined by examining secondary sexual characteristics (Ream and Ream 1966).

The trial began with placement of the male turtle in an upright vertical position. A vibrator (either the NMC® 5" Multi-speed, Pearlescence, Silky-Smooth plastic vibrator or a generic 2.5" battery-operated silver-bullet-design vibrator; Fig. 2), set to the highest frequency, was then firmly placed against the carapace of the turtle. Generally, the vibrator used was determined by the size of the turtle and whether the vibrator could fit between the carapace and plastron at the anterior end of the turtle.

The vibrator was then moved along the carapace in linear and circular motions (varying). If no erection was produced after covering the whole carapace, the vibrator was then placed against the plastron and the same motions were repeated. If still no erection was induced, the vibrator was first placed firmly on

TABLE 1. The number of males sampled with semen extraction technique from the three emydid species (*Chrysemys picta, Glyptemys insculpta*, and *Emydoidea blandingii*) in Nova Scotia.

Species	Males sampled	Successful trials	Mean attempts (max. 2)
C. picta	30	4	2.0
G. insculpta	17	2	2.0
E. blandingii	12	12	1.3

TABLE 2. Mean duration of all attempts made on each species (*Chrysemys picta, Glyptemys insculpta*, and *Emydoidea blandingii*).

Species	Average time (mins)	Standard deviation (mins)
E. blandingii	13.0	3.83
C. picta	7.7	1.64
G. insculpta	13.4	2.81

TABLE 3. Mean duration of successful attempts and their standard deviations for each species (*Chrysemys picta, Glyptemys insculpta*, and *Emydoidea blandingii*).

Species	Average time (mins)	Standard deviation (mins)
E. blandingii	13.0	3.83
C. picta	7.8	1.71
G. insculpta	16.0	5.65

the head of the turtle and then on the lateral region between the hind leg and tail.

If, at any point, the turtle appeared distressed (e.g., hid in shell and pulled tail or legs up and away from the vibrator), the researcher moved the vibrator to a new location. If an erection was induced, the researcher continued to vibrate that area and placed a Fisherbrand® 50-mL disposable centrifuge tube over the erect phallus to collect ejaculate. All trials were timed in seconds and are reported in minutes.

If no ejaculation was induced after a minimum of four min (maximum of eight min), the trial was terminated. The turtle was then allowed to roam freely in a contained area for up to 15 min before a second trial, with a maximum of 12 min, began. A second attempt was made only if a complete ejaculation did not occur in the first attempt.

For each species, vibration of all areas of the carapace and plastron was attempted on all turtles and some turtles appeared to have particular regions that induced an erection. These induction regions varied over all areas of the carapace and plastron. After running trials on ten *C. picta*, it was found that placing the vibrator directly on their head caused them to expose their phalluses (if only for several seconds). Stimulation of *C. picta* thereafter focused more time on the head of the turtle and less near the posterior end. Furthermore, all *E. blandingii* exposed their phallus (at least a little) upon being placed in the vertical position prior to the use of the vibrator, but no instance of ejaculation occurred with this type of manipulation in any of the three species.

All ejaculate samples collected were refrigerated within 5 h of collection. A trial was deemed successful when the presence of spermatozoa was observed after inspection under a microscope. No previously sampled individual was subjected to the technique for more than two attempts.

To determine if there was a statistically significant difference in the number of successful attempts between each species, four Chi-square tests were performed manually (one three-way comparsion, and three pair-wise comparisons). All other statistical analysis was conducted in R version 2.8.1 (R Development Core Team 2008). Four Fisher's exact tests were performed to confirm the results of the Chi-square tests (reducing concerns of inflation of results due to small sample sizes). Two ANOVAs were performed with time as the dependent variable and species as a covariate. Subsequent pairwise comparisons between each species were completed using the glht function in package multcomp in R to run Tukey's tests with Holm's adjustment, using the family-wise error rate set at $\alpha = 0.05$ (Holm 1977, 1979). Welch two-sample *t*-tests (Welch 1947) were used to compare times between successful and unsuccessful trials in *G. insculpta* and *C. picta*, with $\alpha = 0.05$.

Results.—Fifty-nine male turtles were used for the vibrational sperm extraction technique between 9 June and 17 August 2011. Ejaculate samples were obtained from 18 males in total, with samples being obtained from all three species (Table 1).

The technique was very successful in obtaining semen samples from *E. blandingii* (100%), but success rates were low for the other two species (12% for *G. insculpta* and 13% for *C. picta*). Chi-square comparison revealed a significant difference in the number of successful trials among the three species ($\chi^2 = 122.30$, df = 2, $P < 0.001$), with significant differences between *E. blandingii* and *G. insculpta* ($\chi^2 = 69.66$, df = 1, $P < 0.001$) and *E. blandingii* and *C. picta* ($\chi^2 = 66.27$, df = 1, $P < 0.001$), but not between *G. insculpta* and *C. picta* ($\chi^2 < 0.01$, df = 1, $P > 0.05$). Fisher's exact tests confirmed the Chi-square results, with significant differences in the number of successful trials among the three species ($P < 0.001$) as well as between *E. blandingii* and *G. insculpta* ($P < 0.001$) and between *E. blandingii* and *C. picta* ($P < 0.001$), but not between *G. insculpta* and *C. picta* ($P = 1$).

Comparison of the mean total trial duration for each species revealed that *G. insculpta* had, on average, the longest trial period and *C. picta* had the shortest (Table 2). There was a significant difference in trial duration among the three species (ANOVA; $F = 34.69$, df = 2, $P < 0.001$). Subsequent pairwise comparisons of the duration of all trials showed significant differences in trial duration between *E. blandingii* and *C. picta* (df = 1, $t = -6.07$, $P < 0.001$) and between *G. insculpta* and *C. picta* (df = 1, $t = 7.36$, $P < 0.001$), but not between *E. blandingii* and *G. insculpta* (df = 1, $t = 0.43$, $P = 0.67$). As for all trials, comparison of only successful trials demonstrated that it took on average the longest time to collect a sample from *G. insculpta* and the shortest time to collect a sample from *C. picta* (Table 3). A significant difference existed in the duration of successful trials among the three species (df = 2, $F = 4.28$, $P = 0.034$), with a significant difference existing in successful attempts bewteen *E. blandingii* and *C. picta* (df = 1, $t = -2.47$, $P < 0.001$) and between *G. insculpta* and *C. picta* (df = 1, $t = 2.59$, $P < 0.001$) but not between *G. insculpta* and *E. blandingii* (df = 1, $t = 1.07$, $P = 0.30$). No significant difference was found in the duration of attempts between successful and unsuccessful attempts for *C. picta* ($t = -0.06$, df = 28, $P = 0.95$). Similarly, no significant difference was found between successful and unsuccessful attempts for *G. insculpta* ($t = -0.72$, df = 15, $P = 0.59$)

Discussion.—A new, non-invasive sperm extraction technique was tested on the three emydid species found in Nova

Scotia. The technique was significantly more successful on *E. blandingii* (100% success rate) than on the other two species; however, samples were obtained from all three.

Despite small sample sizes, the results are encouraging, particularly in the case of *E. blandingii*. The majority of the individuals sampled from each species came from single isolated populations. Sampling primarily from these specific populations could have had several effects on the success rates determined in this study (Ream and Ream 1966). First, these populations vary in their human contact. All individual *E. blandingii* sampled had previously been handled and belonged to populations subjected to extensive surveying in the past. While being handled, specifically the notching of the carapace which causes a small vibration, *E. blandingii* males typically exposed their phalluses, thus prompting the idea of using a vibrator to induce ejaculation (J. Lefebvre, unpubl. data). Consequently, these turtles, having past human contact, could have been more relaxed during application of the technique than either *G. insculpta* or *C. picta*, which had not been sampled as extensively. Nonetheless, *E. blandingii* are known for their calm disposition (Lefebvre 2009; S. Mockford, pers. obs. 2011), which may also make them good candidates for this technique.

The majority of the *G. insculpta* sampled also had been previously handled. Although the implications of prior handling for this technique are not known, at least one male sampled earlier in the summer exposed his phallus immediately when captured, a behavior not previously noted in this population (W. Holman, pers. comm. 2011). This anecdote suggests that the technique shows potential with *G. insculpta*.

Reptiles in captivity are known to be sensitive to stress from handling, and sex hormones and overall reproductive activity can be greatly impacted by stress (Mahmoud and Licht 1997). However, the overall effects of stress on turtle arousal remain unclear. Also, stress hormones such as corticosterone have been shown to increase most significantly within the first 30 minutes of handling free-living Red-eared Slider turtles (*Trachemys scripta elegans*; Cash et al. 1997). Snapping Turtles (*Chelydra serpentina*) subjected to captivity and blood sampling have been found to have significant declines in testosterone (Mahmoud and Licht 1997). Higher testosterone levels have been associated with spermatogenesis and mating activity in several species of turtles (Wibbels et al. 1987).

Conversely, some studies have indicated that exposing an erect phallus may actually be a defense mechanism for stressed turtles (McArthur 2008). Therefore, the stressful effects of handling may have decreased the sexual arousal of some of the male turtles sampled, but possibly to a lesser extent for turtles who had previously been handled. Or, the most stressed turtles may have actually been the ones to expose their phallus more quickly. The male *E. blandingii* sampled for this study all exposed their phalluses almost immediately upon being held vertically. This behavior has been noted quite commonly in this population and does not appear to be due to stress or aggression in this species (J. Lefebvre, unpubl. data).

The time of year could explain the differences in successful attempts between species. The sampling all took place within the summer months, the middle of the active season for these emydids. All three species are known to mate within these months; however, copulation is known to peak prior to and following overwintering for *E. blandingii* (Edge et al. 2010; Newton and Herman 2009), and Walde et al. (2003) reported that the majority of mating events of *G. insculpta* were observed in the fall, almost half in October. Previous studies using electroejaculation found significant differences in the success rate of sperm obtained depending on the time of year in *C. picta* (Gist et al. 1990). Males may be more receptive to the technique if it is performed during their natural peak mating season. As Gist et al. (1990) suggested, the ability of the epididymis to transfer sperm to the sperm duct may vary temporally. This might explain the low success rate for this species; spermatogenesis might not have been completed. This might also be the case with *C. picta*, for which spermatogenesis reaches its peak in September (Ernst 1971; Gist et al. 1990; Hugues 2011; Mitchell 1988; Moll 1979).

Another possible explanation for the wide range of success rates found in this study could be physiological and anatomical differences among the species sampled. What little comparative research has been done has found significant variance in the male reproductive structures (Zug 1966). The general male turtle reproductive cycle has been studied in only a few species (Gibbons 1968; Moll 1979). Even less research has focused on comparing reproductive physiological and anatomical differences between species. It is not uncommon to observe domesticated turtles exposing their phalluses in the absence of sexual arousal or stress, although the cause remains largely unknown (McArthur 2008). Consequently, it is possible that anatomical differences may be the key to explaining some of the variation in success rates among species.

Continued testing of this technique may improve the sampling procedures used in this study and reveal variations in the process that increase sampling success for *C. picta* and *G. insculpta*. Turtles should be marked to avoid multiple sampling of individuals and sampling should be done throughout the active season, from several different populations with comparable human contact histories.

Male *C. picta* ejaculated after significantly shorter durations than the other two species. Within species, there was no significant difference in time between successful and unsuccessful trials, thus duration of the trial did not appear to play a critical role in success rates.

These results may be due to the timing methods used in this study. Setting a minimum range of duration instead of a precise time made timing results unspecific. In the future, a more quantitative scale to measure the distress of the turtle should be used. Mating behavior for turtles is a multi-stage, lengthy affair (Baker and Gilligham 1983; Ernst 1971; Kauffman 1992). Likewise, exactly when the trial was considered "complete" was difficult to define. We normally terminated a "successful" attempt when no more ejaculate fluid was being obtained or the phallus would no longer stay erect. However, it is difficult to determine whether the individual turtle had actually completed his ejaculation or simply grew stressed, timid, or uninterested. Kauffman (1992) observed that up to 85% of mating events did not result in sperm transfer. As of yet, no study has been able to determine the exact stimulus for complete ejaculation in any turtle species (Wyneken et al. 2008).

The few previous investigations into turtle ejaculations have described the action as a continuous flow of fluid over various lengths of time (Wyneken et al. 2008). It is difficult to assess the duration of copulation or ejaculation in the species studied, as most reproduction takes place under water (COSEWIC 2007; Ernst and Lovich 2009; Gilhen 1984). Studies to date have found that *E. blandingii* copulate on average for 23 minutes, *G. insculpta* between 22 and 33 minutes, and *C. picta* between 5 and 15 minutes (Ernst and Lovich 2009). Therefore, it is conceivable that

samples collected in this study were not complete ejaculates and sampling should have continued for longer durations despite the turtles' apparent responsive behaviors.

By measuring the amount of seminal fluid collected, we could have improved our confidence in the termination of the trials. Ejaculate amounts in past studies have varied in volume from 1 mL (Olive Ridley Turtles, *Lepidochelys olivacea*; Tanasanti et al. 2007) to 100 mL (Green Turtles, *Chelonia mydas*; Wood et al. 1982). Although these previous studies focus on species much larger than our three emydids, by at least knowing an expected range of semen volume for turtles in general, attempted trials made in this study could have been terminated on a more objective scale. Kimskulvech and Suttiyotin (2012) studied the Black Marsh Turtle (*Siebenrockiella crassicollis*), which is similar to emydids in size, and could not collect sufficient volume to assess quantity and quality. This basic information warrants further study based on the volume of ejaculate fluid obtained.

Conclusions.—With freshwater turtles being on the decline worldwide, it is becoming increasingly difficult to justify killing adult turtles, even for the sake of research. The present study designed and tested a new sperm extraction technique for male turtles that is minimally invasive and non-lethal. Although there was significant variation in success among species, this should not discourage the further application of this technique—other well-documented, non-lethal sperm extraction techniques also have a large range of variation in success.

The simple practicality of this technique also gives it an advantage over other sperm extraction techniques. With minimal equipment needed and the fact that it can be performed *in situ*, thereby reducing stress and handling time, it is hard to argue against its use. Encouraging results, especially for the endangered *E. blandingii*, should make it the primary option for sperm extraction in turtles, particularly when sperm is needed from threatened or endangered species.

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The Use of Photo Identification on Dickerson's Collared Lizard (*Crotaphytus dickersonae*)

Identification of individuals is important for studying the behavior and population demographics of animals. To mark individuals, several techniques can be used (reviewed in Silvy et al. 2005). In studies focusing on lizards the individuals often are marked with a painted number or symbol to allow for identification (e.g., Haenel et al. 2003; Husak et al. 2006; Kwiatkowski and Sullivan 2002). This technique is relatively non-invasive and allows identification from a distance. However, it is not permanent since lizards shed their skin. Permanent marking techniques that can be used in lizards are PIT tags (Godfrey et al. 2006; Rutherford and Gregory 2003), sewing beads in the base of the tail (Fisher and Muth 1989; Halloy and Robles 2002), branding (Hitchmough et al. 2012; Stamps 1977) and, most commonly, toe-clipping (e.g., Allsop et al. 2006; Calsbeek and Cox 2010; Chapple and Keogh 2005; Haenel et al. 2003; Sinervo et al. 2001). In toe-clipping a unique combination of digits is removed from the lizard. The advantages of this technique are that it is permanent, easy and cheap, and lizards can be easily identified and marked in the field (Ferner 1979), although not from a large distance. The main disadvantage of toe-clipping is its invasive nature: toe-clipping may cause inflammation and infection (e.g., Golay and Durrer 1994; Lemckert 1996; Narayan et al. 2011). In addition, negative effects have been reported on mobility, survival and on the probability of recapture of the toe-clipped animal in some species (e.g., Bloch and Irschick 2005; Davis and Ovaska 2001; McCarthy et al. 2009; Schmidt and Schwarzkopf 2010), but not in others (see review in Perry et al. 2011). Natural toe loss is common in some lizard species (e.g., Freeman 1997; Hudson 1996; Kwiatkowski and Sullivan 2002; Morrison et al. 2002). In these species toe-clipping can have fewer negative effects (Hudson 1996), but makes toe-clipping less reliable as an identification technique because in some cases it cannot be determined if the toes were lost naturally or through clipping. More importantly toe-clipping can cause pain and stress according to the definition given by the International Association for the Study of Pain (IASP 1979), and might be considered unethical and should be discouraged (FDA 1989; May 2004).

An alternative to toe-clipping could be the use of photo identification. In many animal species individuals exhibit unique visual morphological characteristics, and photo identification is a non-invasive identification technique that relies on these natural markings. Photo identification is well-documented in studies on marine mammals, which have distinctive features, such as scars or the shape of the dorsal fin, allowing identification of individuals (Würsig and Jefferson 1990). On the first encounter, photos are made of distinctive markings of the animal and these photos are stored in a digital library. When the animal is seen again, subsequent photos

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will be taken to allow cross-matching with the photos in the digital library (Speed et al. 2007).

In herpetology, photo identification has been used in several studies on amphibians, using differences in individual color patterns for identification (e.g., Gamble et al. 2008; Kopp-Hambergher 1998; Kurashina et al. 2003; Streich et al. 1997; Winkler and Heunisch 1997). Surprisingly, the use of photo identification in studies on lizards is low. Differences in ventral scales have successfully been used for identification of *Podarcis muralis* and *Lacerta bilineata* (Sacchi et al. 2010). However, since ventral scales are normally not visible, lizards have to be caught and handled each time. Capture and handling is a potential stressor for lizards (e.g., Moore et al. 1991; Cabanac and Cabanac 2000), so identification by other features would be preferable when handling of the lizard is not needed.

The use of photo identification has not been documented in lizards of the family *Crotaphytidae,* although all species have a pattern of reticulations and/or spots (McGuire 1996). Toe-clipping is the most commonly used permanent marking technique in the lizards of this family (e.g., Baird and Curtis 2010; Husak et al. 2006; Husak et al. 2009; Lappin and Husak 2005; Moehn 1976; Plasman et al. 2007).

In our study on *Crotaphytus dickersonae*, we wanted to investigate whether photo identification can be used as a permanent identification technique and therefore serve as an alternative to toe-clipping. *Crotaphytus dickersonae* is a rock-dwelling species that can be found on the rocky hills of Isla Tiburón in the Sea of Cortez and the adjacent mountainous coastline of western Sonora, Mexico (McGuire 1996). These lizards have a natural pattern of dorsal and lateral white dots (McGuire 1996). We studied whether this pattern is unique and permanent for each lizard. For this purpose, we took photos of each lizard we were able to catch (N = 38: female = 22, male = 16), the first time they were caught (May–July 2011). Capture of the lizards was necessary for another study on this species involving body measurements. The photos were taken with a Panasonic® Lumix DMC-FS6 digital camera of both lateral sides of the lizards. The photos were printed (10 cm x 15 cm) and were carried in the field so individuals could be identified at posterior sightings. In addition, we temporarily marked each lizard with four dots on the dorsal base of the tail in a unique combination of green, red and yellow paint (non-toxic acrylic paint). This served as a way to verify identifications of the lizards based on the photos that were taken, and also allowed identification from a distance.

The 38 photographed lizards all had a unique dorsal and lateral pattern of white dots (Fig. 1). We were successfully able to identify each individual we re-encountered in the field (N = 27) by comparing it with the printed photos in the field. We were able to identify the lizards based on their pattern of white dots from a distance of approximately 3–5 m, which is well outside the range at which these animals allow a human to approach before they flee (Plasman et al. 2007). Photographs of lizards that were recaptured a year after this study (N = 7) showed no change in pattern of white spots (Fig. 2).

The identification of the 38 individuals was done by comparing the pictures visually. A larger sample size however, would require software for pattern recognizing algorithms to match images, such as I3S (Van Tienhoven et al. 2007). Pattern recognition software is available and is used for salamanders (Gamble et al. 2008), frogs (Voros et al. 2007), cheetahs (Kelly 2001), sharks (Arzoumanian et al. 2005; Van Tienhoven et al. 2007), and whales (Hiby and Lovell 2001).



FIG. 1. Photos of the pattern of white dots of four different *Crotaphytus dickersonae* lizards (A + B: females; C + D: males). Differences can be seen in the shape, position, and number of the dots.

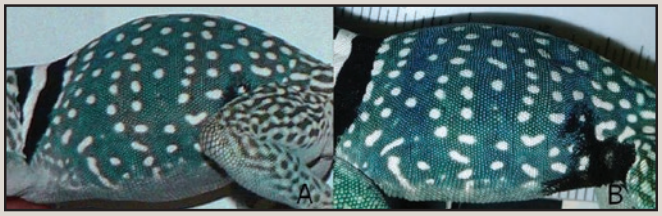


FIG. 2. Photos of a male *Crotaphytus dickersonae,* from May 2011 (A) and May 2012 (B), showing no change in the pattern of white dots.

We conclude that photo identification can be used as an alternative to the commonly used toe-clipping as a permanent identification technique in *C. dickersonae*. This method could be used for other species as well that have natural skin markings. Photo identification is a cheap, easy, and non-invasive identification technique that alleviates some of the potentially negative effects of toe-clipping.

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A Simple and Effective Technique for Demonstrating Post-prandial Metabolic Response of Snakes in the Classroom

The rapid up-regulation of snake metabolic rate following feeding has been well-documented (e.g., McCue 2006; Secor 2009; Wang et al. 2006). Although snakes are not the only animals to exhibit an increased post-prandial metabolic rate (McCue 2006; Secor 2009; Wang et al. 2006), also known as specific dynamic action, they do show an unusually large increase due in part to their low standard metabolic rate (Secor 2009). In fact, the Burmese Python (*Python molurus*), has been proposed as a model organism for studying vertebrate physiological regulation, including specific dynamic action (Secor and Diamond 1998). Because snakes, in general, exhibit dramatic metabolic responses to feeding (Secor and Diamond 2000) and many teaching faculty include the topic of snake metabolic up-regulation in courses on vertebrate biology, vertebrate physiology, and herpetology, snakes make particularly compelling subjects for classroom demonstration and experimentation. Here, a simple and inexpensive method for measuring metabolic rates in snakes to demonstrate metabolic up-regulation in the classroom is proposed.

Research questions related to metabolism typically rely on expensive respirometers wherein relative gas concentrations are measured using electronic gas analyzers (for a comprehensive overview of respirometry techniques, see Lighton 2008). While essential for obtaining research-quality data, this type of analysis is not required for classroom demonstration. Additionally, this type of equipment is not always available outside of research laboratories; consequently, undergraduate access to these instruments is typically quite limited. A simple device for measuring oxygen consumption was developed in the middle of the last century (Huber 1962; Watts and Gourley 1953). Known as a metabolimeter (Huber 1962) or metabolism chamber (Watts and Gourley 1953), this inexpensive device gives remarkably consistent performance in the measurement of oxygen consumption of small animals (Kimbrough and Llewellyn 1973). Originally developed for use with small mammals, the manufacturer of one commercially available version of this device (Phipps & Bird, Richmond, Virginia) recommends its use for a variety of both invertebrate and vertebrate animals. In short, this type of device works as the test animal is securely housed in a sealed system. As oxygen is consumed and carbon dioxide produced, a supply of soda lime is used to remove respired carbon dioxide. Because the system is closed with a fluid bubble, the movement of the bubble within a graduated burette provides a means of measuring oxygen consumption (Fig. 1). While not the only type of system available for measuring metabolic rate in teaching laboratories, this system was chosen for trial because of its ease and intuitiveness of use and because it can be constructed using commonly available materials (Huber 1962; Watts and Gourley 1953) if the purchase price is prohibitive.

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Procedure.—Trials of the Phipps & Bird device were conducted using sub-adult African House Snakes (*Boaedon fulginosus*) (previously included in the genus *Lamprophis*). Animals were tested pre-feeding (approximately 14 days post-feeding) and then again 48 h post-feeding in an attempt to observe the maximum change in metabolic rate (Secor and Diamond 1998). For the post-feeding trials, animals were provided with a meal approximately 6% of average snake body mass. For both pre and post-feeding trials, animals (N = 10) were weighed and then placed individually within the intra-chamber cage of the metabolism chamber (Fig. 1) to restrict movement. The bottom of the chamber was previously covered with approximately 30 g of granulated soda lime (CAS Number 8006-28-8) (color changing soda lime, to indicate CO_2 saturation, may be used if a supply of fresh material is not available for each trial). The rubber stopper and associated burette were fitted to the chamber and the chamber was allowed to equilibrate at room temperature for 15 min. Following equilibration, the inside of the burette was wetted using room temperature water to help prevent loss of bubble integrity. At the start of the trial approximately 1 mL of bubble solution (supplied by the respirometer manufacturer; however, commercial bubble solution sold as a children's toy has also been used successfully) was placed into the end of the burette using a disposable pipette.

The instruction manual for the respirometer (Kimbrough and Llewellyn 2005) suggests measuring the amount of time necessary for the test subject to consume 5 mL of oxygen. Due to the comparatively low metabolic rate of snakes (as compared to mammals), we measured the time necessary to consume 1 mL of oxygen. The measured time was used to calculate mL of oxygen consumed per hour. Because trials were conducted over several days (to allow for pre/post-feeding measurements) results were corrected to account for differences in both temperature and barometric pressure using the following equation:

Corrected volume = observed volume x (barometric pressure [mm Hg]/760) x (273/[temperature (°C) + 273])

This resulted in the observed volume of O_2 consumed being expressed under conditions of standard temperature (0°C) and pressure (760 mm Hg). The average of ten trials (ten snakes) was compared pre- and post-feeding using a paired t-test ($\alpha = 0.05$).

Results.—The average mass of the ten snakes was 50.2 g (SD = 10.6). The average metabolic rate pre-feeding was 3.44 mL O_2/h (SD = 0.66) and the average rate post-feeding was 7.85 mL O_2/

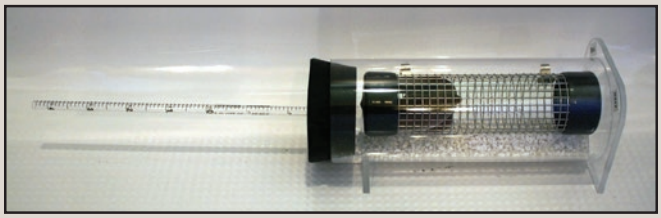


FIG. 1. Phipps & Bird (Richmond, Virginia) metabolism chamber containing a sub-adult African House Snake. Note the presence of the soda lime on the bottom of the chamber and the burette for measuring oxygen consumption.

hr (SD = 3.04). A significant difference in metabolic rate was observed for African house snakes between pre-feeding trials and post-feeding trials ($p = 0.0002$), clearly demonstrating the postprandial up-regulation of metabolic rate.

Discussion.—A published account of African House Snake specific dynamic action (Roe et al. 2004) reported a metabolic rate of 0.68 mL O_2/h for fasted snakes (average mass = 16.7 g) and a 3.2–5.3 times increase 24 h post-feeding. The measured metabolic rate for fasted snakes using the method described in the current report was approximately five times the rate reported by Roe et al. (2004). However, the average mass of their test animals was three times less than those used in the current study.

The classroom demonstration method described herein showed only a 2.3 times increase in metabolic rate as opposed to the 3.2–5.3 times increase reported by Roe et al. (2004). Several factors could have contributed to the observed differences. First, the meal sizes in the Roe et al. (2004) report were 10–30% of the average snake mass. The average meal size in the current study was only 6% of the average snake mass. Second, Roe et al. (2004) indicated the maximum metabolic rate of African house snakes occurs 24 h post-feeding. Our tests were conducted 48 h post-feeding, assuming the peak metabolic rate for house snakes to be similar to Burmese Pythons (Secor and Diamond 1998). Given the difference, the classroom demonstration likely missed the maximum rate window. Third, Roe et al. (2004) maintained their test animals at 25°C, while our tests were conducted at room temperature (approximately 22°C). Fourth, it should also be noted by adopters of this technique, that results would likely be more accurate if in addition to the soda lime for absorption of carbon dioxide, a desiccant such as Drierrite (CAS Number 7778-18-9) would be included in the testing chamber to absorb water vapor, as accumulated water vapor will counteract some of the reduction in chamber volume due to CO_2 absorption. A desiccant was not used in the classroom demonstration reported here.

If the two groups (pre- and post-feeding) were run simultaneously for demonstration purposes, the temperature/pressure correction would not be required. In addition, to accommodate the time limitations associated with a single class/laboratory meeting, two groups of animals could be used; one group could be tested while fasting, while a second group could be tested post-feeding. Metabolic rate could be adjusted to a per-gram basis to allow for ease of comparison; however, there are issues inherent in mass-specific measurements (Beaupre 2005) that should be considered when using this approach.

Conclusion.—Despite the differences from the Roe et al. (2004) study noted above, this simple metabolism chamber method has been shown to be an inexpensive yet effective and reliable method for demonstrating snake metabolic up-regulation in a classroom setting. Although a single species of snake was used in this trial, it is anticipated that other small snake species would work equally well. Additionally, students may readily adapt this method for testing simple hypotheses related to metabolic rate in snakes, as ambient temperature (Zaidan and Beaupre 2003), meal size (Andrade et al. 1997; Zaidan and Beaupre 2003), food type (McCue et al. 2005), snake species (Secor and Diamond 2000) and other factors (McCue 2006; Secor 2009; Wang et al. 2006) may be easily manipulated. Should the commercially available apparatuses not be of suitable size for available snake species, or should instructors desire to construct their own due to cost or other factors, both Watts and Gourley (1953) and Huber (1962) describe home-made versions of the metabolism chamber which may be easily scaled using different sizes of glassware, rubber stoppers, and burettes.

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Captive Reproduction and Husbandry of Adult Ozark Hellbenders, *Cryptobranchus alleganiensis bishopi*

Hellbenders (*Cryptobranchus alleganiensis*) are large, aquatic salamanders inhabiting cool, highly oxygenated, fast-flowing streams in sections of eastern and central North America (Conant and Collins 1998; Nickerson and Mays 1973; Petranka 1998). Currently, there are two described subspecies of Hellbenders (Crother 2012). The Eastern Hellbender (*C. a. alleganiensis*) occurs from New York south to Georgia and west to central Missouri, whereas the Ozark Hellbender (*C. a. bishopi*) is found in the Ozark Highlands of southern Missouri and northern Arkansas. Herein, we focus mainly on the Ozark Hellbender subspecies, but biology and reproductive behavior are similar for both subspecies. Currently, Ozark Hellbender populations are known to occur in the North Fork of the White River, Bryant Creek, Eleven Point River, and Current River, with some individuals possibly still present in the Jacks Fork and Spring River (Briggler et al. 2007b). Historically, Ozark Hellbenders were abundant in these rivers (Nickerson and Mays 1973; Peterson 1988; Trauth et al. 1992; USFWS 2011). Yet subsequent surveys indicate that populations have declined throughout the species' range by at least 70% since the 1970s (Trauth et al. 1992; Wheeler et al. 2003) and revealed a shift in age class structure predominated by increasingly larger individuals and diminished or absent young age classes. Wild populations of Ozark Hellbenders were estimated to be approximately 600 individuals, an extremely low number compared to an estimated carrying capacity of over 11,000 individuals (Briggler et al. 2007b). In addition, Ozark Hellbenders currently exist as small isolated populations, making them vulnerable to individual catastrophic events and reducing the likelihood of re-colonization following localized extirpations.

As a result of drastic population declines, the Ozark Hellbender was designated as critically imperiled and state endangered in Missouri in 2003 (MDC 2003). It has been protected from take or possession in Arkansas since 1990 (K. Irwin, pers. comm.), and was recently listed as federally endangered in 2011 (USFWS 2011). In 2001, the Ozark Hellbender Working Group was formed and is composed of individuals from Federal and State agencies, academia, zoos, non-governmental organizations, and individuals interested in the conservation of the Hellbender. The group has played a significant role in identifying information needs and guiding conservation and recovery efforts for Hellbenders in Missouri and Arkansas, including development of comprehensive conservation strategies (Briggler et al. 2010; Briggler et al. 2012) that addresses captive propagation, augmentation, and reintroduction goals, especially the need to captive-breed the species.

While the primary reason for population declines is unknown, several potential factors have been identified: degraded water quality, habitat alteration and degradation, disease, illegal harvest, human disturbances, and predation by non-native fish (USFWS 2011). The Ozark Hellbender population declines have necessitated the use of captive propagation efforts to ensure the long-term survival and recovery of the subspecies by maintaining/bolstering populations through augmentation and if necessary reintroduction while investigating the causes of the decline.

Herein we report our efforts on the first successful captive reproduction and husbandry of the Ozark Hellbender at the Saint Louis Zoo (STLZ). Although the reproductive biology of wild Hellbenders is well-known (Nickerson and Mays 1973; Nickerson and Tohulka 1986; Peterson 1988), there is limited information in the literature of captive-breeding of *Cryptobranchus* prior to this account. Smith (1907) was successful in artificial breeding of the Eastern Hellbender via mixing sperm and eggs obtained by sacrificing ripe females. Breeding habits of the giant cryptobranchids in Japan (*Andrias japonicus*) and China (*A. davidianus*) is relatively similar to the North American Hellbender (Okada et al. 2008; Zheng 2006). Biologists have been extremely successful in the captive-breeding of *Andrias* for several decades (Kuwabara et al. 1989; Qiang et al. 2012). However, attempts over the past decade or so by many zoos, including Saint Louis Zoo, and other institutions to naturally breed Hellbenders in captivity have been unsuccessful (Wheeler and Trauth 2002; J. Ettling,

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TABLE 1. Brood stock and associated data (mean, SD) for Ozark Hellbenders (*Cryptobranchus alleganiensis bishopi*) collected from the North Fork of the White River (NFWR), Current River (CR), and Eleven Point River (EPR), Missouri.

River	Artificial stream	No. males	No. females	SVL (cm)	TL (cm)	Mass (g)
NFWR	Indoor	5	3	32.1 ± 3.0	47.0 ± 4.9	631.1 ± 194.0
CR	Outdoor	5	4	28.7 ± 5.0	43.6 ± 7.0	449.9 ± 211.8
EPR	Outdoor	5	4	28.2 ± 1.9	42.8 ± 3.4	491.3 ± 125.5



FIG. 1. Indoor artificial stream at the Ron Goellner Center for Hellbender Conservation, Saint Louis Zoo, containing brood stock from the North Fork of the White River.



FIG. 2. Two outdoor artificial streams and associated life-support building at the Ron Goellner Center for Hellbender Conservation, Saint Louis Zoo, containing brood stock from the Current River and Eleven Point River.

pers. comm.). We believe the information provided herein will be useful in future efforts to captive-breed this species range-wide.

Brood stock.—Our goal was to obtain 8–10 wild, adult Ozark Hellbenders from each genetically distinct river drainage to establish breeding groups (Sabatino and Routman 2009; Crowhurst et al. 2011; Tonione et al. 2011). Therefore, breeding stock was collected from the North Fork of White River (NFWR), Eleven Point River (EPR), and Current River (CR). These animals were collected from 2003–2007 for the NFWR, 2009–2011 for EPR, and 2010–2011 for CR. Each animal was implanted with unique identification numbers using a passive integrated transponder (PIT) tag inserted into the tail region. To date STLZ has 8 animals (5 males, 3 females) from NFWR, 9 animals (5 males, 4 females) from EPR, and 9 animals (5 males, 4 females) from CR (Table 1). The sex ratio of breeding stock was slightly skewed towards males to provide increased mate selection for females and increased genetic diversity (Table 1). Different sizes of males were targeted for collection to ensure healthy sperm. If possible, only animals that appeared healthy were collected. However, several of the animals obtained from the various rivers were compromised (e.g., missing appendages, open sores, etc.). The removal of animals was limited to only a few individuals per site to reduce effects on the resident population and to avoid inbreeding depression by collecting from several sites scattered along the river.

Quarantine.—Hellbender brood stock were quarantined and housed separately by river of origin in 151.4-liter aquariums (91.4 x 40.6 x 30.5 cm) that were part of an eight-aquarium rack system with integrated filtration system. Animals remained in quarantine until appropriate disease (e.g., amphibian chytrid fungus [*Batrachochytrium dendrobatidis-Bd*], bacterial, viral, etc.) and health screening (e.g., CBC blood panel, parasites, physical conditions, etc.) tests were conducted by veterinarians and animal management staff. To minimize stress, animals were placed into the stream systems as quickly as possible and in most cases less than 30 days. All animals brought into the STLZ were treated as if they were positive for *Bd* as this fungus is already known to occur in these river systems on Hellbenders (Briggler et al. 2007a, 2008). As part of the health screening, a minimum of two time-sequenced PCR assays were conducted for each individual to determine if the animal should be treated for *Bd* or managed as a *Bd*-positive animal in breeding stock already infected with the fungus. Based on our experiences over past decade, it typically takes approximately six months for an adult Hellbender collected from the wild to adjust to captive conditions. To decrease stress and risk of mortality while the wild animals acclimate to captive conditions, abundant cover was provided for animals (e.g., multiple rocks, artificial shelters, covered tanks, etc.) and lighting was reduced during quarantine.

Artificial streams.—Adult brood stock were maintained and managed in one indoor artificial stream (NFWR brood stock) and two outdoor artificial streams (one for EPR brood stock and one for CR brood stock) once cleared from quarantine. The indoor stream, which is located in the basement of the Herpetarium, is 9.7 m long x 1.7 m wide x 0.6 m high with an average water depth of 0.3 m (Fig. 1). The indoor stream water flow (227 liters/min.) is more circular in nature due to the arrangement of a middle divider running the length of the stream and the filtration system input and output location within the stream. This indoor stream was operational since September 2002, but was not inhabited with brood stock until 2004. The two outdoor streams (11.3 m long x 1.5 m wide x 1.4 m high and 11.7 m long x 1.8 m wide x 1.4 m high) have been in operation since September 2011 (Fig. 2). The water input is located on one end of the stream and outputs are located in the middle and on the opposite end to allow water

flow (454 liters/min) across the length and width of the stream. Water depth in the outdoor streams varies considerably to mimic natural contour of river bottom. Water depths are shallow (0.6 m) on the input and output ends with a gentle sloping towards the middle of the stream, thus reaching a maximum water depth of 1.2 m. The bottom of each stream was covered with 10.2–15.2 cm of natural substrate (gravel). A variety of large flat rocks (moss rock and/or sandstone) and artificial nest boxes (Briggler and Ackerson 2012) were provided for shelter and breeding places (Fig. 3). With the success of nest boxes in the wild (Briggler and Ackerson 2012), we installed 10 nest boxes on 23 August 2011 in each of the outdoor streams prior to breeding season, and later installed six nest boxes in the indoor stream on 14 November 2011. Nest boxes can be easily accessed for observation and egg collection, as well as provide secure locations for males to defend from other Hellbenders. A minimum of two cover rocks and/or nest boxes were provided per individual to allow animals to select.

For the breeding streams and their location (i.e., indoor verses outdoor), we attempted to mimic natural conditions (e.g., photoperiod, precipitation, water temperature, water quality, etc.) of the river of origin of the brood stock to reproductively cycle the animals. Water temperature for both the indoor and outdoor streams was controlled using large multi-temperature chillers. Water temperatures for each stream were adjusted daily for the actual temperature acquired via data loggers from the respective river of origin of the brood stock. The water temperature of NFWR, EPR, and CR generally range between 4.4° and 22.2°C seasonally. Therefore, the outdoor streams also have boiler systems to prevent the streams from dropping below 4.4°C during the winter months. For the indoor stream the precipitation and photoperiod were manipulated to simulate natural cycles experienced in southern Missouri. Photoperiod was adjusted daily using a digital timer and precipitation was mimicked using a manually controlled misting system and adjusting water levels (Fig. 3). For the outdoor raceways photoperiod and precipitation conditions were provided naturally. In addition, animals in the indoor stream are closely monitored with infrared video cameras.

All artificial streams have mechanical, chemical and biological filtration as well as ultraviolet sterilization. Dedicated keeper staff and assignment of separate equipment for each stream reduces potential of disease transmission via cross-contamination. Water quality was intensively monitored to ensure animal health and encourage reproductive cycling. Water quality standards in Table 2 are based on water quality management guidelines established at STLZ staff for all hellbender streams and were recorded every two weeks or more often if warranted. A reverse osmosis filtration system was added in summer 2011 to the indoor stream and in spring 2012 for the outdoor streams to better mimic ionic compositions occurring in the rivers. Total dissolved solids (TDS) were adjusted similar to river conditions as it pertains to provide appropriate electrolyte balance, improving sperm production and defining the role of ionic composition on sperm activation. Chlorine and chloramines were removed from the water using carbon prefilters and/or dechlorinators, such as sodium thio-sulfate and/or reverse osmosis filtration.

Husbandry of brood stock.—In addition to mimicking water, substrate, and weather conditions to encourage natural breeding of the animals in the artificial streams, husbandry and health were important to ensure fitness of the animals to reproduce. A variety of foods were provided to meet the nutritional requirements of the Hellbenders (Dierenfeld et al. 2009). Adults were primarily fed live foods including crayfish (*Orconectes* spp., *Procambarus* spp.), sculpins (*Cottus bairdi, C. carolinae*), darters (*Ethoeostoma* spp.), shiners (*Notropis* spp.), and night crawlers (*Lumbricus terrestris*). The fish species listed above are collected occasionally from the wild and are augmented in the artificial streams to better represent the natural ecosystem from which the brood stock originated. Commercially obtained night crawlers were fed at a rate of two worms/Hellbender/week. Frozen-thawed fish such as Lake Smelt (*Osmerus mordax*), Rainbow Trout (*Oncorhynchus mykiss*), and Atlantic Herring (*Clupea harengus*), with Thiamin E paste supplementation, were offered once per week via tong feeding. Live food items were cleaned, quarantined, and treated prior to feeding to reduce transmission of ectoparasites, bacteria, fungus, and other pathogens.

TABLE 2. Water quality standards maintained in the artificial streams for Ozark Hellbenders (*Cryptobranchus alleganiensis bishopi*).

Parameter	Standard
pH	7.6–8.2
Nitrate (NO3)	< 10 mg/L
Nitrite (NO2)	< 0.2 mg/L
Nitrogen Ammonia (NH3)	< 0.05 mg/L
Phosphates (PO4)	< 0.40 mg/L
% Dissolved Oxygen (DO)	> 90%
Total Dissolved Solids (TDS)	175–300 mg/L

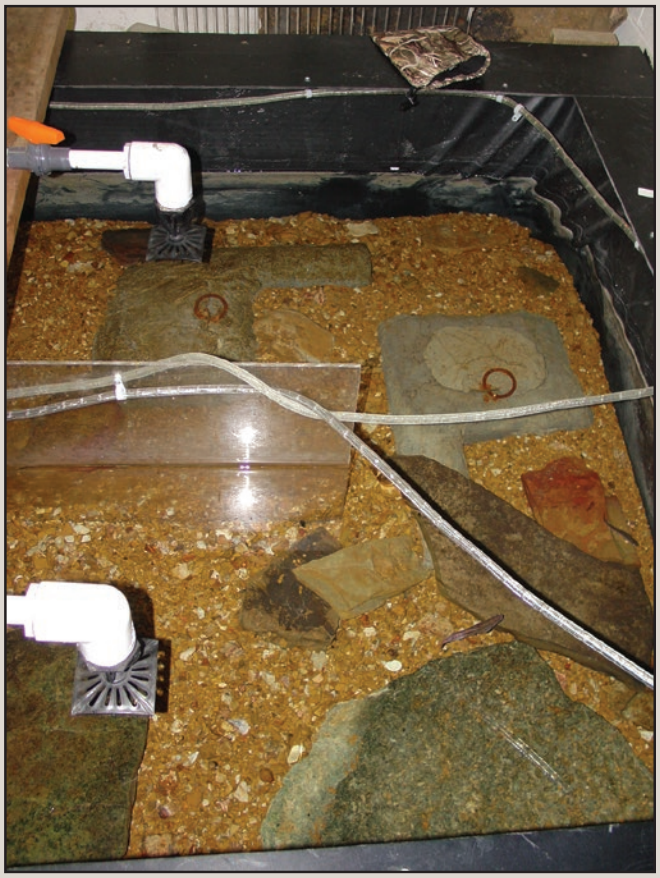


FIG. 3. Habitat (shelter rock and artificial nest boxes) utilized by Ozark Hellbenders (*Cryptobranchus alleganiensis bishopi*) in the artificial streams.

TABLE 3. Egg-laying history and associated estimated dates for female Ozark Hellbenders (*Cryptobranchus alleganiensis bishopi*) collected for brood stock from North Fork of White River, Current River, and Eleven Point River, Missouri. * = did not lay eggs; [1] = two females deposited eggs within one nest box for their respective stream.

PIT Tag No.	2007	2008	2009	2010	2011	2012
North Fork of White River (indoor stream)						
102-806-018	13 Oct	*	14 Oct	04 Oct	07 Oct	22 Sept[1]
066-882-540	*	9 Oct	14 Oct	08 Oct	10 Oct	25 Sept
093-624-774	18 Oct	*	*	*	18 Oct	22 Sept[1]
Current River (outdoor stream)						
051-599-288	–	–	–	–	*	28 Sept[1]
051-584-041	–	–	–	–	*	*
066-292-573	–	–	–	–	*	01 Oct
066-284-079	–	–	–	–	*	01 Oct[1]
Eleven Point River (outdoor stream)						
066-290-098	–	–	–	–	02 Oct[1]	22 Sept
094-070-830	–	–	–	–	*	*
057-810-624	–	–	–	–	10 Oct[1]	*
075-341-564	–	–	–	–	*	01 Oct



FIG. 4. A fertilized clutch of Ozark Hellbender (*Cryptobranchus alleganiensis bishopi*) eggs with attending male in an artificial nest box in an outdoor stream. Nest box lid was removed to view and photograph nest chamber.

Treatment and cleaning included: 1) soaking live crayfish for five minutes in a 50 ppt salt solution (dosed at 50 g/L), then rinsing in a fresh water solution for five minutes (Johnson et al. 2003); 2) rinsing soil from night crawlers; and 3) maintaining/isolating live fish for a three week period in a 5–7 ppt salt solution. Fish were also monitored during the quarantine period for signs of disease and/or parasites. Additional food items were provided April to June and November to January to increase the fitness of the animals prior to and immediately following the breeding season. Records were maintained for each individual Hellbender and included: 1) quarterly physical examinations, mass and length; 2) food intake, with conversion rates and graphs of weight changes over time; 3) medical; and 4) behavior.

Reproduction.—Since 2002 many actions were employed to mimic the seasonal environmental regimes (e.g., photoperiod, water temperature, and precipitation patterns) of the natural river conditions in an effort to trigger breeding activity in the artificial streams, as well as to increase fitness of the animals to produce gametes. Males developed the typical cloacal "donut" swelling and females exhibited abdominal swelling associated with egg production similar to wild animals. Between 2007 and 2011 eggs were laid every year in the indoor stream for a total of 10 clutches (Table 3), which all proved to be infertile. However, on 18 October 2011 two clutches of fertilized eggs with different stages of development were discovered in one of the nest boxes in the outdoor stream housing the EPR Ozark Hellbender population (Fig. 4), eventually yielding 151 larval Hellbenders. As noted earlier, this population is comprised of five males and four females. These animals were removed from the wild from 2009 to 2011 and were augmented into the outdoor stream on 20 September 2011. The two females that deposited eggs were recently collected from the wild (August and September 2011). However, the male that fertilized the eggs and guarded the nest was housed and environmentally cycled indoors since 25 August 2009.

In 2012, natural reproduction occurred in both outdoor streams (EPR and CR brood stock) and finally the indoor stream (NFWR brood stock) resulting in eight fertilized egg clutches and the sequential hatching of over 2500 embryos. All three females deposited eggs in the indoor stream with the NFWR brood stock, two females in the EPR brood stock in one outdoor stream, and three females in the CR brood stock in the other outdoor stream (Table 3). Dates of egg laying in 2012 were earlier than previous years with eggs being laid from 22 September to 01 October (Table 3). All eggs were laid in nest boxes, and in two instances (NFWR and CR) two different females laid eggs within one nest box. In all cases, males guarded the nest site by protecting the nest box entrance tunnel from conspecifics. The male that successfully guarded the first fertilized clutch in the EPR outdoor stream in 2011 was not the guardian of either fertilized clutch in 2012.

While checking nest boxes on 01 October 2012, we witnessed one male and one female in the act of spawning in EPR outdoor stream. The two animals were in a circular position with heads and tails overlapping. There were three visible eggs protruding from her cloaca, and the inside of the nest box chamber was foaming with seminal fluid in a cloudy mass or stringy threads. Immediately the lid of the nest box was put into place to decrease disturbance, and on the following morning the nest chamber was full of fertilized (cleavage furrows visible) eggs.

In the artificial streams it is typical for animals to share cover rocks and nest boxes outside of the breeding season. This changes in late summer however, as males become increasingly aggressive and establish themselves in certain nest boxes or cover rocks as the spawning season approaches in late-September to mid-October. Prior to the 2012 breeding season, aggression among the animals was relatively minor; however, during the major breeding event that occurred in 2012 several animals (males and females) had lost limbs, severe lacerations on the limbs, and bite marks along the lateral folds.

Discussion.— Intensive captive propagation efforts for the Ozark Hellbender have been pursued at the Saint Louis Zoo

since 2002. Seasonal changes in photoperiod, water temperature, and precipitation patterns are thought to trigger breeding activity (Nickerson and Mays 1973). Through seasonal manipulation of the water temperature, photoperiod, precipitation, and feeding regime, Hellbenders housed in the indoor stream consistently cycled at exactly the same time as their wild counterparts (JTB, unpubl. data). For example, when eggs were being laid in the wild on the NFWR, the NFWR brood stock at the STLZ would be laying either on the same day or within a day or two. Even with consistent egg-laying in the indoor stream since 2007, fertilization did not occur until 2012 in the indoor stream. Further investigation revealed that the males comprising our breeding group were producing sperm with deformities and/or low motility. Based on a review of the literature the ionic composition of the water appears to affect sperm development and activation during spawning for fishes (Yeung et al. 2006). With that in mind, the use of reverse osmosis filtration was put into place in August 2011 for the indoor stream and May 2012 for the outdoor streams to adjust the ionic composition (e.g., TDS) of water used in our Hellbender streams in an effort to closely match that of river water. An evaluation of sperm quality on 08 October 2011 for males housed in the indoor raceway indicated motility of 85%, the highest recorded for these animals to date (T. Crabill, pers. comm.). Follow-up sperm assessments in 2012 showed increased sperm quality for animals in all three streams, thus resulting in successful fertilization of all eight clutches deposited by females.

In addition to adjusting the ionic composition of the streams, the nest boxes also played a significant role in the increased level of success occurring in 2011 and 2012. The first fertilized clutch of eggs occurred in a nest box installed in summer 2011 in the outdoor streams. With the success of this fertilized clutch at the STLZ and in the wild (Briggler and Ackerson 2012), nest boxes were later installed in the indoor stream for the upcoming 2012 breeding season, thus resulting in eight fertilized clutches in six nest boxes in both the indoor and outdoor streams. In previous years, it was not uncommon for both male and female Hellbenders in the indoor stream to consume conspecifics eggs under cover rocks provided. Although cannibalism of eggs is known to occur in wild populations (Bishop 1941; Smith 1907), it seemed difficult for males in the streams at the STLZ to protect nests under cover rocks from conspecifics due to many animals that would dig their way into the nest chamber from various sides of the cover rock to consume or remove eggs. Therefore, we believe the nest boxes not only provided ideal conditions for successful spawning, but also provided a long, narrow, single-entrance tunnel from which males could protect nests from conspecifics. Success towards achieving our goal to naturally breed Hellbenders in captivity was steady in the earlier years; however, we believe the addition of nest boxes and mimicking ionic compositions of the river water paved the way to the remarkable breeding successes that occurred in the past two years.

Considerable Hellbender life history data were observed during the process to achieve captive-breeding of the species. It is unclear if female Hellbenders in the wild lay eggs annually. However, Topping and Ingersol (1981) and Peterson et al. (1989) data suggest that not all gravid females lay their eggs during the same season. For the NFWR brood stock, two females consistently laid eggs annually while the third female rarely laid eggs; however, the health of this animal was compromised in 2009 and 2010 (Table 3). We have limited egg-laying history for CR and EPR brood stock, but one female deposited eggs in both 2011 and 2012 (Table 3). Similar to wild Hellbenders, there appears to be variation among captive-held females for their egg laying histories, but it is not uncommon for females to lay eggs annually.

In all cases of successful fertilization of eggs in 2011 and 2012, an individual male protected and remained with his respective clutches by defending the nest box entrance tunnel similar to natural nests found in the wild (Nickerson and Mays 1973; JTB, pers. obs.). However, this does not preclude males foraging on their own eggs as documented via ultrasound by EPR male in 2011. Based on our observation of all streams and video evidences of the indoor stream, it appeared that guardian males were the sole gamete contributors to their respective clutches. However, multiple paternity has been reported within a nest cavity for the related *Andrias* species (Kawamichi and Ueda 1998), and several male Hellbenders have been observed within a nest cavity in the wild in Missouri (JTB, pers. obs.), but only one male attends the nest. To further examine whether multiple paternity has occurred within these artificial streams, we plan to conduct genetic parenting of fertilized clutches. Also, on three occasions multiple maternity was witnessed within a given nest box in each of the streams (Table 3); this is further supported in the literature that males will accept several females into the nest cavity (Bishop 1941; Crowhurst et al. 2009; Smith 1907). Hellbender behavior and reproduction (e.g., multi-parenting, egg laying history, nest box selection, etc.) observed in captivity will likely provide additional insight into the breeding activities of wild populations.

Conclusion.—The first successful captive reproduction of Ozark Hellbenders in 2011, repeated in 2012, at the STLZ was believed to be the result of a combination of six factors: 1) Space—providing ample space allows individual animals the opportunity to establish their own home territory. With this in mind, the streams were designed and constructed to be as large as possible. 2) Cover rocks and nesting sites—a combination of large rocks and nest boxes were provided in both the indoor and outdoor streams. Appropriate nesting sites are ones that can be easily defended by the attending male. 3) Environmental cycling—simulation of seasonal photoperiod, water temperature, and precipitation changes resulted in the Hellbenders becoming reproductive at the same time as their wild counterparts. 4) Water quality—maintenance of high water quality standards, including adjustments to ionic composition, dissolved solids, etc., was vital to overall health including sperm development and activation. 5) Sex ratio—a good ratio of both sexes simulates natural breeding dynamics and provides females with mate selection opportunities. 6) Animal health—increase food availability during late winter and early spring to improve fitness of animals to produce gametes. The factors described above could be applied to other *ex situ* management plans in zoos and conservation organizations in need of propagating the species range-wide. Through the significant achievement of the successful captive-breeding of the Ozark Hellbender in the past two years at the STLZ, many of these offspring will be released into the wild to bolster populations.

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AMPHIBIAN DISEASES

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Detection of *Batrachochytrium dendrobatidis* in River Frogs (Genus *Amietia*) on Mount Kilimanjaro, Tanzania

Within Africa, the amphibian chytrid fungus *Batrachochytrium dendrobatidis* (*Bd*) has been reported from southern, eastern, and central parts of the continent, whereas it is currently undetected in West Africa (Penner et al. 2013 and citations therein). Although *Bd* has been found in some African species without aquatic larval stages (Bell et al. 2011; Conradie et al. 2011a; Gower et al. 2012), the majority of species affected by the fungus are from high altitude and inhabit mostly flowing streams (Murray and Skerratt 2012). River frogs of the genus *Amietia* seem to be particularly susceptible, showing the highest zoospore loads known among African frogs in Kenya (Kielgast et al. 2010), Malawi (Conradie et al. 2011a), South Africa, and Lesotho (Weldon 2005). *Bd* infection also has been detected in Uganda (Viertel et al. 2012), yet records from the Udzungwa Mountains in Tanzania have not detected *Bd* (Moyer and Weldon 2006). Here, we report the occurrence of *Bd* in *Amietia angolensis* and *A. wittei* from Mt. Kilimanjaro, northern Tanzania.

Mount Kilimanjaro is the remnant of a large volcano located on the border with Kenya (3.07583°S, 37.35333°E; Fig. 1). It rises from a hot and dry savanna plain at 700 m to an ice-clad summit of 5895 m, thereby encompassing several different bioclimatic zones. At 1700 m, the borders of the Kilimanjaro National Park delimit the montane forest, whereas the lower part of the slope has been almost entirely converted into a traditional agroforestry system (mainly banana and coffee trees) and monocultures (mainly maize, sunflowers, and beans). *Amietia angolensis* inhabits the lowland (1000–1700 m), whereas *A. wittei* occurs from 1700 m to 3500 m on the Shira Plateau (GZ, unpubl. data).

Samples for *Bd* analysis were collected in 2011 (from March to June–long rains; October and November–short rains) during surveys of *Amietia* tadpoles for other research purposes. Because we observed tadpoles with jaw sheaths and tooth rows completely colorless (Fig. 2d), we gently brushed the mouthparts with common cotton swabs and stored them dry in safe-lock tubes. Diagnostic analysis was performed in October 2012 at the Amphibian Disease Diagnostic Center at Washington State University (Pullman, Washington, USA). Fungal DNA was extracted using DNeasy extraction kits (Qiagen). Detection and quantification of *Bd* was performed using standards (1000, 100, 10, 1, and 0.1) from serial dilutions by means of RT-qPCR according to Boyle et al. (2004).

Although sample size was low (N = 17), we detected *Bd* in at least 40% of the specimens for both species (Table 1). Overall, the *Bd* infection levels appeared low in individual samples (< 5 zoospore equivalents). We believe these results do not reflect realistic levels of pathogen load, but they are very likely due to a combination of technical factors. First, this non-lethal technique for detecting *Bd* on tadpoles is less effective than histological diagnosis (Retallick et al. 2006). In their research, the authors scraped the tadpoles' mouthparts with wooden toothpicks whereas we used swabs which are less invasive (i.e., they are less likely to damage mouthparts and influence the ability of tadpoles to feed). However, swabs may not collect *Bd* DNA as effectively as toothpicks, which regularly break pieces of labial teeth (Retallick et al. 2006). Second, during field work, samples were stored in a freezer to avoid high temperatures, but the power supply at the field station was irregular, resulting in frequent blackouts and consequent thawing of the freezer's contents. High temperatures and long storage periods can result in reduced recovery of *Bd* DNA from swabs (van Sluys et al. 2008). These factors likely induced degradation of DNA in our samples; still, we were able to detect *Bd*, suggesting that the pathogen load may have been high originally.

This is the first record of *Bd*-positive *Amietia* from Tanzania. All specimens presenting depigmentation of keratinized mouthparts were *Bd*-positive; however, the sample size was too low for a statistically significant correlation between oral deformity and *Bd* presence. During the whole field season, we observed larval deformities with similar gross morphology at other sites, but we never encountered dead or moribund adults of *Amietia* or of other species occurring in the area. Similar observations of a general lack of mortality among *Bd*-infected animals have been reported in other studies from Africa, including Kenya (Kielgast et al. 2010), Uganda (Goldberg et al. 2007), and South Africa (Conradie et al. 2011b). The high prevalence of *Bd* and apparent low virulence may suggest that the pathogen is enzootic within those regions, thereby providing support for the "out of Africa" hypothesis (Weldon et al. 2004). However, a lack of connection

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FIG. 1. Mount Kilimanjaro, Tanzania, where *Batrachochytrium dendrobatidis* (*Bd*) was detected. Records of *Bd* infections from the Eastern Arc Mountains are still poor (www.bd-maps.net, accessed 16 April 2013).



FIG. 2. Typical creek within the subalpine zone at ca. 3000 m, Kilimanjaro National Park, Tanzania; a) breeding site of *Amietia wittei* close to the Machame Huts campsite where porters collect water; b) larvae of *Amietia wittei*; c) oral disc with unchanged morphology; d) mouthparts with depigmentation of jaw sheaths and labial teeth.

between *Bd* presence and population decline has been reported elsewhere, for instance in eastern North America (Longcore et al. 2007). The question about the origin of *Bd* remains open.

Kielgast et al. (2010) suggested a taxonomic basis for variation in apparent *Bd* susceptibility among host species, and the genus *Amietia*, in particular, showed the highest pathogen load and prevalence in their study. Other studies have also provided support for aquatic life histories contributing to *Bd* occurrence patterns (e.g., Bancroft et al. 2011; Olson et al. 2013). During our surveys, we regularly observed tadpoles of both species in the water. *Amietia angolensis* adults are semi-aquatic and active throughout the year (Channing and Howell 2006); the tadpoles have a prolonged development and may take up to two years to complete metamorphosis (Channing 2004). Thus, river frogs can act as reservoirs for *Bd* and facilitate disease persistence in the system. Moreover, *Amietia* species cover most of the elevational range of Mt. Kilimanjaro, and this might allow *Bd* to survive during unfavorable conditions within spatially disparate microhabitats (e.g., by persisting at higher elevations during summer and at lower elevations during winter).

Local dispersal of *Bd* may be facilitated by humans. Kilimanjaro National Park is a tourist attraction with over 35,000 climbers a year (Peaty 2012), and each climber has at least three porters to conform with park regulations. The first campsites encountered along the climbing routes are usually allocated at the upper ridge of the forest (ca. 3000 m) and close to ponds or streams which are used by *A. wittei* for breeding (GZ, unpubl. data). We observed porters collecting water (e.g., for cooking and human consumption) at the same water bodies where tadpoles tested *Bd*-positive. Porters are able to walk through the mountain for long distances within a day, and this may translocate zoospores from one site to another. Below the national park borders, the slope is characterized by an extensive network of water canals built by the local human population for irrigation, and by which *Bd* may disperse, or river frogs or other transmission vectors may spread the pathogen (Morgan et al. 2007; Johnson and Speare 2005).

Our results showed the presence of *Bd* infection in river frog populations on Mt. Kilimanjaro. Considering the high susceptibility of *Amietia* species and their potential to serve both as *Bd* reservoirs and vectors to nearby areas (especially the lowland *A. angolensis*), it would be beneficial to intensify surveys for *Bd* detection in the East African highlands and in particular in the Eastern Arc Mountains. The few data available to date are from the southern Udzungwa Mountains, where *Bd* has been detected in 12 species (Moyer and Weldon 2006; www.Bd-maps.net, accessed 16 April 2013), and from the northern East Usambara Mountains with negative records dated 2006 (www.Bd-maps.net). This hotspot of biodiversity harbors an outstanding number of endemic species (Burgess et al. 2007) that may still be naïve to the fungus and thus will suffer population declines if the infection reaches those forests.

TABLE 1. *Batrachochytrium dendrobatidis* infection data for *Amietia angolensis* and *A. wittei* from Mount Kilimanjaro, Tanzania. All samples are from larvae. Because of the extremely low amount of *Bd* DNA, it was not possible to determine *Bd* presence with absolute certainty for some samples. Uncertain results are reported as suspect positive (susp.pos.) or negative (susp.neg.).

Species	Dates	Localities	Coordinates	Elevation (m)	Water bodies and habitat	N Bd-positive samples	N samples	Zoospore equivalents (min–max)	Mouthparts
A. angolensis	18 Oct 2011	Waramu river	3.1959°S 37.2555°E	1532	stream cultivated area	0	1		normal
A. angolensis	18 Oct 2011	Nkuu	3.1808°S 37.2511°E	1692	creek cultivated area	4 (2 susp.neg.)	5	0.001–2.621	depigmented
A. angolensis *A. wittei*	29 Oct 2011	Umbwe route	3.1845°S 37.2789°E	1705	stream disturbed forest	0	1		normal
A. wittei	05 May 2011	Mweka route	3.2038°S 37.3485°E	1992	creek montane forest	0	1		normal
A. wittei	26 Oct 2011	Marangu route	3.2018°S 37.5175°E	2359	stream montane forest	1 (susp.pos.)	1	0.087	depigmented
A. wittei	03 Nov 2011	Machame huts	3.0940°S 37.2657°E	2978	stream moorland	3 (1 susp.pos.)	3	0.014–1.656	depigmented
A. wittei	01 Nov 2011	Machame huts	3.0967°S 37.2667°E	3023	creek moorland	2 (1 susp.neg.)	5	0.004–1.526	depigmented

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Batrachochytrium dendrobatidis in Amphibians of Northern Calhoun County, Illinois, USA

We assessed *Batrachochytrium dendrobatidis* (*Bd*) infection rates among amphibian species occupying aquatic ecosystems (lake, wetland, and creek) within the Great Rivers region, Illinois, USA. Our data provide a baseline for future research to determine how *Bd* is affecting amphibians in this area.

We surveyed for amphibians by nocturnal and diurnal visual encounter surveys throughout all habitats on the McCully Heritage Project from 14 to 19 July 2008. The study area is located in northeastern Calhoun County, Illinois along the Illinois River, approximately 1.6 km south of Kampsville, Illinois (www.mccullyheritage.org). The site consists of approximately 3.8 km^2 of upland and lowland forest, forest edge, and hill prairie habitat, as well as a lake, wetland, and creeks. We swabbed the ventral surface and inside surface of the legs of each amphibian encountered using sterile technique (Livo 2004). We stored swabs individually in 70% EtOH. All swabs were analyzed by either Pisces Molecular LLC (Boulder, CO, USA) within 3 mo of collection or the Amphibian Disease Laboratory, San Diego Zoo Institute for Conservation Research within 3 yr of collection. There were no differences between the methods used in the two different laboratories, hence we pooled all data for statistical analysis.

Table 1. Amphibians tested for *Batrachochytrium dendrobatidis* (*Bd*) at McCully Heritage Project, Calhoun Co., Illinois, USA.

Species	Common name	No. *Bd*-positive/ Total sampled (%)
Acris crepitans	Northern Cricket Frog	25/52 (48.1%)
Hyla crucifer	Spring Peeper	1/1 (100%)
Hyla versicolor	Grey Treefrog	3/13 (23.1%)
Lithobates clamitans	Green Frog	0/1
Lithobates palustris	Pickerel Frog	0/1
Lithobates catesbeianus	American Bullfrog	2/2 (100%)
Lithobates sphenocephalus	Southern Leopard Frog	8/13 (61.5%)
Anaxyrus americanus	American Toad	1/3 (33.3%)
Eurycea longicauda	Long-tailed Salamander	2/19 (10.5%)

We detected *Bd* in 42 of 105 (40%) amphibians, in 7 of 9 (78%) species sampled (Table 1). No animals were observed showing symptoms of the disease chytridiomycosis. Although there was variation in infection level among species (χ^2 test of independence; $\chi^2 = 18.2$, $p = 0.019$), our low sample sizes likely precluded detection if *Bd* prevalence was low (Skerratt et al. 2008). Nevertheless, infection levels were similar to reports of 31% infection level from Sparta Training Center, Randolph County, Illinois (Lannoo et al. 2011). Among species in our sample with relatively greater sample sizes ($N > 10$), *Eurycea longicauda* and *Hyla versicolor* may have had lower infection levels due their terrestrial habitat use (Phillips et al. 1999). *Bd* has been reported to affect amphibians that are dependent on aquatic ecosystems more severely than those species that are more terrestrial (Lips et al. 2003). *Lithobates sphenocephalus* showed the highest level of infection, which is interesting considering anti-microbial skin

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peptides that inhibit *Bd* growth have been shown to occur in ranid frogs (Rollins-Smith et al. 2002). However, *L. sphenocephalus* is highly aquatic and therefore may be more exposed to *Bd*.

Although examination of seasonal patterns of infection is limited by our low sample sizes and haphazard sampling design, of the two species (*A. crepitans* and *L. sphenocephalus*) that were sampled during both spring (May) and summer (July), *L. sphenocephalus* sampled in May (N = 8) were all *Bd*-positive whereas those sampled in July (N = 5) were all *Bd*-negative. Seasonal variation in infection level has been reported previously, and may be due to the more unfavorable conditions (decreased humidity, increased temperature) for *Bd* or the potential for individual amphibians to increase their body temperature to clear themselves of the infection during the summer (Berger et al. 2004; Ribas et al. 2009; Richards-Zawecki 2010).

When all individuals were pooled for analysis by habitat type, there tended to be a difference in infection rate among animals captured in different habitats (lake, wetland, creek: χ^2 test of independence; $\chi^2 = 0.49$, $p = 0.058$). Amphibians captured in wetlands showed the highest infection rate (49.1%). Wetland habitat was used for breeding by all anurans within the community, likely increasing the chance for both *Bd* occurrence and transmission (Kriger and Hero 2007). Although our sample sizes were relatively low, restricting comparisons among habitats within species, the species with the greatest sample in multiple habitats, *A. crepitans*, showed no difference in infection level between habitats (χ^2 test of independence; $\chi^2 = 4.91$, $p = 0.18$).

Our data represent a baseline starting point for understanding *Bd* infection levels in this area. Increased sampling and both seasonal and annual monitoring is needed to better understand patterns of infection.

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Detection of Ranavirus in Ohio, USA

Of the many proximal factors that potentially contribute alone or in combination to the global concern about amphibian population declines (e.g., Stuart et al. 2004), habitat conversion (e.g., Homan et al. 2004) and infectious diseases (e.g., Daszak et al. 2003; Miller et al. 2011) are dominant concerns. To examine the differential patterns of habitat use for adult amphibians, the amphibian community of Taylor-Ochs Pond, Ohio, USA (40.0538°N, 82.3105°W) has been extensively studied since Spring 2005 (Homan et al. 2008, 2010). This 0.1-ha temporary pond supports breeding populations of *Ambystoma maculatum* (Spotted Salamanders), *Lithobates sylvaticus* (Wood Frogs), and *Anaxyrus americanus* (American Toads). As part of our long-term study, we have surveyed the pond by dip-netting weekly each summer since 2005. Prior to the summer of 2012, the only mass mortality of larval amphibians witnessed was clearly associated with early drying of the pond. However, in late May 2012, a time in which the pond had a suitably high water level, routine dip-netting of Taylor-Ochs Pond revealed evidence of mass mortality among larval amphibians. Larval individuals of four species, *A. maculatum*, *L. sylvaticus*, *A. americanus*, and, uncharacteristically, *Lithobates clamitans* (Green Frogs), were present in the pond at that time. Although we did not attempt to formally

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FIG. 1. Ponds sampled for larval amphibians in Granville, Ohio, USA. No larval amphibians were found in either Gurvis Pond or Wood Duck Pond; a recent metamorph was sampled from Wood Duck Pond. Griesse Pond is upstream of Taylor-Ochs Pond, while Gurvis, Olde Minnow, Spring Peeper, and Wood Duck Ponds are downstream.

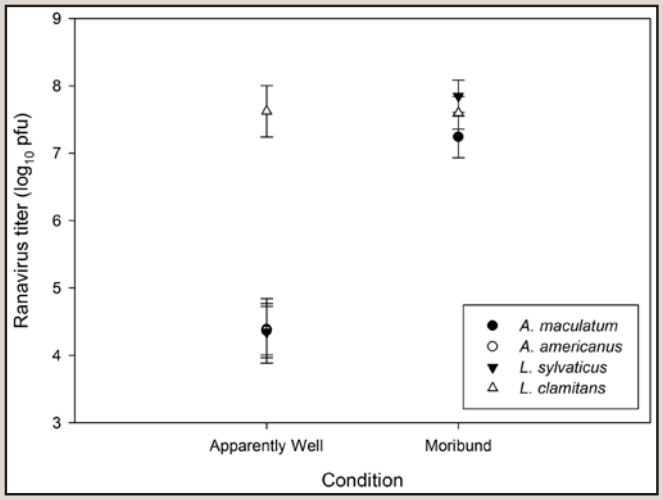


FIG. 2. Log_{10} virus titer (mean ± SE) of apparently well and moribund larval samples collected from Taylor-Ochs Pond, Ohio, USA. For apparently well *Ambystoma maculatum* (N = 2), *Anaxyrus americanus* (N = 5), *Lithobates clamitans* (N = 2), *L. sylvaticus* (N = 2). For moribund *A. maculatum* (N = 3), *A. americanus* (N = 0), *L. clamitans* (N = 5), *L. sylvaticus* (N = 5).

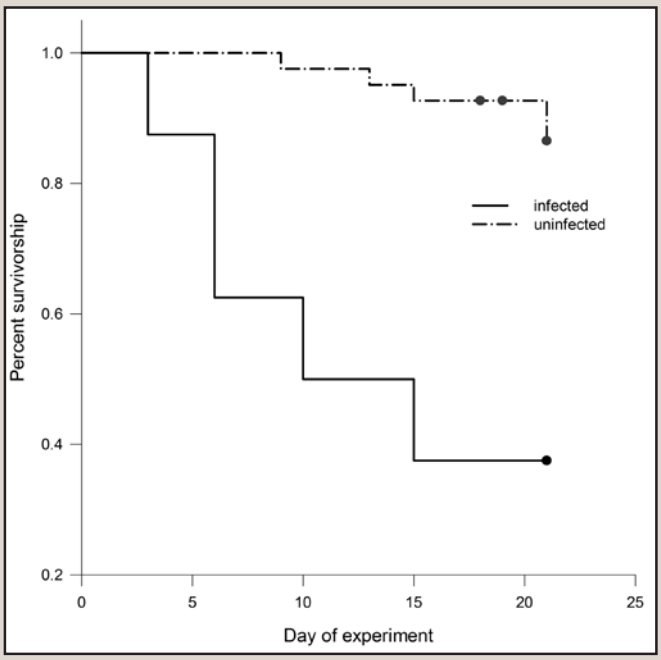


FIG. 3. Kaplan-Meier survival curves for infected (N = 8) and uninfected (N = 41) *Anaxyrus americanus* larvae from Taylor-Ochs Pond, Ohio, USA. Dots represent individuals that were removed during or at the end of the experiment, but were alive at the time of removal.

quantify the magnitude of mortality in the pond, we estimate that hundreds of *A. maculatum*, *L. clamitans*, and *L. sylvaticus* showed signs of illness in the field; only *A. americanus* seemed unaffected.

We suspected ranavirus might have been associated with and contributed to the high mortality based on the signs of individuals, which included hemorrhaging, swelling, erythema, and lethargy (Miller et al. 2011). To determine whether ranavirus was present, on 24 May 2012 we haphazardly collected five each of *A. maculatum* and *A. americanus* larvae, and seven each of *L. clamitans* and *L. sylvaticus* larvae from Taylor-Ochs Pond using dip-nets. Each animal was classified as either moribund (presence of any gross signs consistent with ranavirus infection, as described above) or apparently well (no signs present) at the time of capture. Each animal was bagged individually at the pond, euthanized using MS-222 (2.5g/L buffered to a pH of 7), frozen individually at –80°C, and screened for ranavirus as described below.

Additionally, on 29 and 30 May 2012, we haphazardly collected 49 apparently healthy *A. americanus* larvae from Taylor-Ochs Pond with dip-nets and brought them back to the laboratory. Given their apparent health in the field, we were interested in carefully monitoring individuals over time to document whether they experienced mortality and whether or not that mortality was associated with ranavirus infection. Larvae were housed individually in 500-mL plastic cups with approximately 300 mL of water. Water, either aged tap water or a blend of aged tap and Taylor-Ochs Pond water, was changed every three days. We varied the water source because we originally intended to look for effects of continued exposure to pond water on the mortality and infection status of the larvae; however, the infection rates were the same among the treatments, so we pooled the data to look only at infection and survival. Larvae were fed Tetra fish food every three days *ad libitum*, and were kept in the laboratory at room temperature (21–24°C) in a natural light:dark cycle. Larvae were kept for a period of 21 days. If an animal metamorphosed before the end of that period, it was euthanized and frozen as described above. If a pre-metamorphic animal died before the end of the study, it was bagged individually and frozen at –80°C. All surviving animals at day 21 were euthanized and frozen as above. At the completion of the study, all animals were tested for ranavirus infection, as described below.

In late June, after the confirmation of ranavirus in Taylor-Ochs Pond (see below), we sampled one pond directly upstream of Taylor-Ochs (Griesse Pond) and four ponds downstream of Taylor-Ochs Pond (Gurvis, Olde Minnow, Spring Peeper, and Wood Duck Ponds, Fig. 1). Griesse Pond is a permanent pond that directly feeds Taylor-Ochs Pond via a single stream channel. It has a surface area of ~1.5 ha, and is 200 m upstream of Taylor-Ochs Pond. Gurvis Pond is a permanent pond with an area of ~1.3 ha and is 487 m downstream of Taylor-Ochs Pond; Olde Minnow Pond is a permanent pond with an area of ~0.1 ha and is 684 m downstream of Taylor-Ochs Pond; Spring Peeper Pond is a temporary pond with an area of ~0.1 ha and is 783 m

TABLE 1. Summary of ranavirus infection in *Ambystoma maculatum*, *Lithobates catesbeianus*, *Hyla versicolor*, *L. clamitans*, and *Anaxyrus americanus* in ponds upstream (Griesse) and downstream (Olde Minnow, Spring Peeper and Wood Duck) of Taylor-Ochs Pond, in central Ohio, USA. The 95% confidence interval in the proportion infected is calculated using the method of Wilson (1927) with a correction for continuity (Newcombe 1988).

Site	Date	Coordinates	Species	Infected/Tested	95% CI
Griesse Pond	21 June 2012	40.0546°N, 82.3102°W	*A. maculatum*	0/4	0–0.604
Olde Minnow Pond	21 & 25 June 2012	40.0506°N, 82.3057°W	*L. catesbeianus*	3/3	0.310–1
Spring Peeper Pond	21 & 25 June 2012	40.0501°N, 82.3055°W	*A. maculatum*	1/1	0.055–1
			H. versicolor	0/4	0–0.604
			L. clamitans	1/2	0.027–0.973
Wood Duck Pond	21 June 2012	40.0500°N, 82.3057°W	*A. americanus*	0/1	0.055–1

downstream; Wood Duck Pond is a semi-permanent pond with an area of ~0.2 ha and is 806 m downstream of Taylor-Ochs pond (Fig. 1). Surface areas of ponds and distances between ponds were determined using ImageJ software and satellite photos (Schneider et al. 2012). To avoid potential cross-contamination among ponds, equipment was disinfected with a 10% bleach solution between ponds. In all cases, larvae in these ponds were sampled haphazardly (see Table 1 for sample sizes). We could not find any amphibian larvae in either Gurvis Pond or Wood Duck Pond, but one recent *A. americanus* metamorph was collected from the shore of Wood Duck Pond. All animals were euthanized and frozen as described above and tested for ranavirus. Individuals were kept isolated from one another throughout all procedures.

To screen for ranavirus, we extracted DNA from a combination of tissues from each animal (liver, interrenal glands, and the upper intestine, dissected with sterilized forceps and scissors) using the Qiagen DNeasy Blood and Tissue kit following the manufacturer's instructions (QIAGEN Inc, Valencia, California, USA). We ground up the entirety of very small individuals in 2-mL screw cap tubes filled with a small volume of 1.0-mm diameter silicon-carbide sharp particles (BioSpec Products, Bartlesville, Oklahoma, USA), and then topped up with tissue lysis buffer. These individuals were then homogenized for 45 s using a Mini-BeadBeater-16 (BioSpec Products, Bartlesville, Oklahoma) and DNA was extracted from a 200-µL aliquot of the homogenate. The concentration of extracted DNA was measured using a NanoDrop-2000 (Thermo-Scientific) and, if necessary, diluted to approximately 20ng DNA/µL with elution buffer.

Extracted DNA from each sample was screened for ranavirus in triplicate 20-µL reactions on 96-well plates on a StepOnePlus (Applied Biosystems, Foster City, California, USA) with 5 µL of DNA template (~100ng) using a Taqman realtime polymerase chain reaction (qPCR) with primers and probe that amplify a 70-bp region within the major capsid protein of all known ranaviruses (Brunner and Collins 2009). The unknown samples were quantified by comparing against DNA extracted from a frog virus 3-like ranavirus grown in *Epithilium papilloma cyprinia* cells and serially diluted from 10^2 to 10^7 plaque-forming units (pfu). Each plate also had two no-template controls. Samples with amplification in two or three wells within 35 cycles were scored as positive. Those without amplification in any of the wells were scored as negative. Ambiguous samples were re-run and if at least one well showed amplification the sample was scored as positive. Viral quantities for positive samples are reported as the mean of the $\log_{10}$ (pfu) across all wells of the sample.

In addition, virus isolation was attempted from two moribund, ranavirus-positive animals, one *L. sylvaticus* and one *L. clamitans*. For each animal, the sample was homogenized in 2% fetal bovine serum in minimum essential medium with Hanks salts (HMEM; HyClone, Ottawa, Ontario, Canada) with the Mini-Beadbeater-16 as described above. The homogenates were then filtered through a 0.45-µm filter and 1 mL inoculated onto 90% confluence monolayers of fathead minnow (FHM) cells in 6-well plates for 1 h before being overlayed with 3 mL of 5% FBS-HMEM growth media. Samples were passed two to three times and observed for signs of cytopathic effects using an inverted light microscope. Isolation of ranavirus was verified using conventional PCR with primers 4 & 5 for the major capsid protein (MCP) gene (Mao et al. 1996). The ~500 pb product was sequenced with an ABI 3730 (Applied Biosystems, Foster City, California, USA) and compared with published ranavirus sequences on GenBank using a BLAST search.

We found that all 24 specimens initially collected from Taylor-Ochs Pond were infected with ranavirus (Fig. 2). We successfully isolated a *Ranavirus* from two moribund frogs. The sequence of the MCP gene of these viruses was >99% identical to the type ranavirus frog virus 3 (FV3). To examine the patterns of $\log_{10}$ viral quantities among the four amphibian species in Taylor-Ochs Pond, we ran a two-factor ANOVA to look for effects of species, condition, and any interaction between the two (JMP 10.0, 2012). Excluding *A. americanus*, none of which were moribund, moribund tadpoles had a much higher titer than those that were apparently well ($F_{1,17} = 17.5$, $P < 0.001$). Although sample sizes were small, *L. clamitans* had a significantly higher mean virus titer than *A. maculatum*, *A. americanus*, and *L. sylvaticus* among apparently well individuals ($F_{3,7} = 13.5$, $P = 0.003$; Tukey HSD, $P < 0.05$), whereas there was no significant difference in virus titers among moribund individuals of different species ($F_{2,10} = 1.8$, $P = 0.22$, Fig. 2).

Among the 49 *A. americanus* larvae that were maintained in the laboratory, ranavirus DNA was detected in eight. We generated Kaplan-Meier Survival Curves and used log-rank tests (JMP 10.0, 2012) to look for differences in survivorship between infected and uninfected animals, as well as ANOVA to look for differences in the $\log_{10}$ viral titers among those that died or survived. Infected individuals had significantly lower survivorship than uninfected individuals ($\chi^2_1 = 15.2$, $P < 0.0001$; Fig. 3). Three of the

eight infected larvae survived to the end of the 21-day experiment; two of these survivors metamorphosed during the study. Among the larvae that were infected, there was no difference in virus titer between those that died during the study (mean ± SD = 3.67 ± 3.45 $\log_{10}$ pfu) and those that survived (mean ± SD = 0.90 ± 0.53 $\log_{10}$ pfu; $t_6 = -1.76$, $P = 0.22$), nor was there a difference in virus titer between the surviving metamorphs (mean ± SD = 1.0 ± 0.66 $\log_{10}$ pfu) and the others (mean ± SD = 3.16 ± 3.34 $\log_{10}$ pfu; $t_6 = -0.85$, $P = 0.43$). However, our statistical power was low for both tests (Power = 0.21 and 0.11, respectively).

In our upstream and downstream sampling, we did not detect ranavirus in the four *A. maculatum* larvae found in Griesse Pond, upstream of Taylor-Ochs, but we did find ranavirus downstream, in *L. catesbeianus* from Olde Minnow Pond and in *A. maculatum* and *L. clamitans*, but not *Hyla versicolor*, from Spring Peeper Pond (Table 1). Given our small sample sizes it is not possible to exclude ranavirus occurrence from any site or make meaningful comparisons in prevalence among ponds or species.

In the summer of 2012, Taylor-Ochs Pond in Granville, Ohio experienced a mass die-off event concurrent with the confirmed presence of an FV3-like ranavirus. To our knowledge, this is the first published report of ranavirus in Ohio although ranaviruses have been confirmed in other nearby states, including Illinois and Wisconsin (J. Sekowska, pers. comm.), New York (Brunner et al. 2011), Pennsylvania (Glenney et al. 2010), and Tennessee (Gray et al. 2009; Green et al. 2002). While we cannot be sure that ranavirus caused the observed mortality event, the prevalence of infection among *A. maculatum*, *L. sylvaticus*, and *L. clamitans*, each of which experienced high levels of mortality, as well as the positive relationship between infection and mortality in the laboratory-housed *A. americanus*, suggest that ranavirus likely played a role. In addition to finding ranavirus in our focal pond, we also confirmed its presence in two downstream ponds. Across these three ponds, we identified ranavirus infection among *A. maculatum*, *L. catesbeianus*, *L. clamitans*, *L. sylvaticus*, and *A. americanus*, all of which have had documented ranavirus infections previously (as reviewed by Miller et al. 2011). Whether *H. versicolor* was infected and we simply did not have the sample size to detect it remains unknown, although ranavirus infection in this species has been documented elsewhere (Duffus et al. 2008).

Among the larvae initially sampled from Taylor-Ochs Pond, ranavirus titers were higher in moribund animals than in apparently healthy animals, which is consistent with the finding of Brunner et al. (2005) that higher viral doses are associated with more rapid expression of symptoms. Interestingly, apparently well *L. clamitans*, a species not found in Taylor-Ochs in the preceding seven years, had viral titers that were higher than those of the other species. We hypothesize that a large spring rain event that occurred in 2012 brought the *L. clamitans* larvae to Taylor-Ochs from the upstream Griesse Pond. Although we cannot confirm that *L. clamitans* larvae were the source of the Taylor-Ochs infection, their unusual presence in the community as well as their relatively high viral loads are consistent with this hypothesis. We plan to continue monitoring Taylor-Ochs Pond, as well as the upstream and downstream ponds to document further occurrence and potential impacts of continuing ranavirus presence. Understanding the role of potential co-infection of *Batrachochytrium dendrobatidis*, or another pathogen, in larval health is a secondary objective for future monitoring.

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GEOGRAPHIC DISTRIBUTION

CAUDATA — SALAMANDERS

***AMBYSTOMA MACRODACTYLUM* (Long-toed Salamander).** USA: ALASKA: Ketchikan Gateway Borough: Revillagigedo Island: Ward Lake Area (55.41°N, 131.70°W; WGS84). 19 July 2010. Joshua T. Ream, Verified by J. Andres Lopez. UAM Herpetology 367. Southernmost record of species in Alaska and first record of the species from Revillagigedo Island (Norman and Hassler 1995. Field investigations of the herpetological taxa in southeast Alaska. California Cooperative Fishery Unit, Humboldt State University. Report 29-95). Previous southernmost record in Alaska at Sokolof Island, approximately 130 km N (Norman and Hassler, *op. cit.*). Adult specimen (60 mm SVL; 4.65 g) found under rock on side of trail from Frog Pond to Ward Lake. Collection was made under Alaska Department of Fish and Game Fish Resource Permit # SF2010-0004.

JOSHUA TAYLOR REAM, 7620 Pleasure View Circle, Anchorage, Alaska 99515, USA; e-mail: jtream@alaska.edu.

***HEMIDACTYLIUM SCUTATUM* (Four-toed Salamander).** USA: MICHIGAN: Huron Co.: Albert E. Sleeper State Park (43.973611°N, 83.210611°W; WGS84). 6 May 2013. David A. Mifsud and Sean Zera. Verified by Gregory Schneider. UMMZ image database 973–975. First record for county (Holman 2012. The Amphibians and Reptiles of Michigan. Wayne State University Press, Detroit. xix+291 pp.). Extends the range into "thumb" region of state, approximately 90 km from nearest known record. Two individuals found under logs at water's edge along a forested interdunal swale 0.9 km inland from Lake Huron. One individual also observed 4 May 2011 at same locality.

DAVID A. MIFSUD, P.O. Box 110, Chelsea, Michigan 48118, USA (e-mail: DMifsud@HerpRMan.com); **SEAN ZERA,** 5635 Thomas Road, Ann Arbor, Michigan, USA (e-mail: sean.zera@gmail.com).

***NECTURUS MACULOSUS* (Mudpuppy).** USA: GEORGIA: Fannin Co.: Fightingtown Creek, tributary of the Toccoa River. Accessed from Highway 2, approximately 6 miles NW of Blue Ridge, Georgia (34.893919°N, 84.4157°W; WGS 84). 26 May 2011. Verified J. T. Briggler. Georgia Museum of Natural History (GMNH 50332). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. Univ. of Georgia Press, Athens. 575 pp.). This record fills gap within the predicted range. Egg mass found under large rock in river below a small man-made dam.

SHEM D. UNGER, Savannah River Ecology Laboratory, University of Georgia, Drawer E, Aiken, South Carolina 29802, USA (e-mail: unger@srel.edu); **BART T. KRAUS**, Forestry & Natural Resources, Purdue University, 715 West State Street, West Lafayette, Indiana 47907, USA (e-mail: bkraus@purdue.edu); **THOMAS FLOYD**, Georgia Department of Natural Resources, 116 Rum Creek Drive, Forsyth, Georgia 31029, USA (e-mail: thomas.floyd@dnr.state.ga.us).

***NOTOPHTHALMUS VIRIDESCENS PIAROPICOLA* (Peninsula Newt).** USA: FLORIDA: Lee Co.: Florida Gulf Coast University (FGCU) campus (26.461406°N, 81.777247°W; WGS 84). 18 May 2011. Verified by K. L. Krysko. Florida Museum of Natural History (FLMNH 170244 photo voucher). New county record (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final Report, Project Agreement 08013, Florida Fish and Wildlife Conservation Commission, Tallahassee. 524 pp.). Fills a gap among Charlotte, Collier, Glades, and Hendry counties. Several adult individuals have been captured with minnow and Breder traps in multiple wetlands on the FGCU campus, both before and after university construction began in 1995 (DAC and DWC, unpubl. data).

DEAN A. CROSHAW, Department of Biological Sciences, Florida Gulf Coast University, Fort Myers, Florida 33965, USA (e-mail: dcroshaw@fgcu.edu); **DAVID W. CEILLEY**, Department of Marine and Ecological Sciences, Florida Gulf Coast University, Fort Myers, Florida 33965, USA (e-mail: dceilley@fgcu.edu).

***PLETHODON GLUTINOSUS* (Northern Slimy Salamander).** USA: TENNESSEE: Marshall Co.: Hickory Ridge Trail near River Road at Henry Horton State Park, Chapel Hill, Tennessee, (35.5935397°N, 86.7067119°W; WGS 84). 15 March 2013. Nicole Foster and Colleen Conway. Verified by A. Floyd Scott. Austin Peay State University (APSUMZ 19414). New county record (Scott and Redmond 2008 [latest update: 1 August 2013]. Atlas of Amphibians in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/amatlas/ [accessed 1 August 2013]). Found under a moss-covered rock near a tree.

NICOLE FOSTER, Department of Science Math and Technology (e-mail: nfoster2@Columbiastate.edu); **COLLEEN CONWAY**, Columbia State Community College, Columbia, Tennessee 38401, USA (e-mail: cconway@Columbiastate.edu).

***PSEUDOTRITON RUBER* (Red Salamander).** USA: TENNESSEE: Davidson Co.: Beaman Park Nature Center, Nashville, Tennessee (36.2522°N, 86.8944°W; WGS 84). 23 March 2013. Cynthia Routledge. Verified by A. Floyd Scott. Austin Peay State University (APSU 19407, color photo). First vouchered record for Davidson Co. (Scott and Redmond 2008 [latest update: 30 May 2013. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/). Specimen found under rotting log in deciduous woods, approximately 1 m off the main paved hiking trail. A second specimen was observed under another rotting log in the immediate area. This species was mentioned by Ashton (1966. J. Tennessee Acad. Sci. 41:106–111) as occurring within Davidson Co. but remained unvouchered.

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ANURA — FROGS

ALLOBATES CAERULEODACTYLUS. BRAZIL: AMAZONAS: Manicoré Municipality: 05.47756°S, 61.57783°W (datum WGS 84, 56 m elev.). 18 January 2005. T. M. Sanaiotti. Amphibian and Reptile Collection, Instituto Nacional de Pesquisas da Amazônia - INPA, Manaus, Brazil, (INPA-H 31437, 31438, two males; Permit Number IBAMA 06/2005/NUFAS/RAN/AM). Verified by A. P. Lima. The specimens were found calling during a diurnal survey in the reserve RDS Rio Amapá, only in the leaf litter in mainland forest, with presence of Brazil nuts trees, about 100 m from a periodically flooded forest at left margin of Amapá River. This endemic species was previously known from three localities in Amazonas State, Brazil: the type locality (40 km S of Manaus, at Km12 on the road to Autazes), municipality of Castanho (03.46742°S, 59.81919°W, datum WGS 84, coordinates corrected from the original paper according to information by the author A. P. Lima); municipality of Borba about 102 km to the SE of type locality (04.43417°S, 59.62361°W, datum WGS 84), and Canutama municipality about 665 km SW of type locality (06.9468333°S, 64.2003611°W, datum WGS 84) (Lima and Caldwell 2001. Herpetologica 57[2]:180–189; Simões 2007. Herpetol. Rev. 38[4]:473; Cordeiro et al. 2009. Herpetol. Rev. 40[2]:233). The new record extends the distribution 230 km SW of Castanho and 340 km NE from Canutama and is the first record within a protected area.

TÂNIA M. SANAIOTTI, Instituto Nacional de Pesquisas da Amazônia - INPA, Coordenação de Biodiversidade, Av. André Araújo, nº. 2936, Manaus, Amazonas, Brazil, CEP 69060-001; e-mail: tania.sanaiotti@gmail.com.

ELEUTHERODACTYLUS PLANIROSTRIS **(Greenhouse Frog)**. USA: FLORIDA: Gulf Co.: 1913 Cypress Ave, Port St. Joe (29.799053ºN, 85.293014ºW; WGS 84). 13 December 2011. Matt Greene. Verified by Craig Guyer. Auburn University Museum (AHAP-D 687-688). New county record (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final Report, Project Agreement 08013, Florida Fish and Wildlife Conservation Commission, Tallahassee. 524 pp.), and has been documented in neighboring counties (Bay, Franklin) and five other Panhandle counties. Several adult individuals observed on nearby conservation lands 6 miles to the south (St. Joseph Bay State Buffer Preserve). Individuals also observed on 22 July 2012.

MATT GREENE, National Forests in Alabama, The Nature Conservancy, 2946 Chestnut Street, Montgomery, Alabama 36107, USA; e-mail mgreene@tnc.org.

EXERODONTA JUANITAE **(Juanita's Earless Treefrog)**. MÉXICO: GUERRERO: Iliatenco Municipality: Cruztomahuac (17.043179°N, 98.62038°W; WGS84), 1450 m elev. 12 January 2005. E. Beltrán-Sánchez. MZFC 17903, 17906, 17909. Metlatonoc Municipality: Zitlaltepec, Sierra de Malinaltepec (17.1192°N, 98.4385°W; WGS 84), 1550 m elev. 21 December 2009. E. Pérez-Ramos. MZFC 27023, 27024. All verified by Luis Canseco Márquez. New municipality records fill a ca. 364 km distributional gap between San Vicente de Benitez and San Andrés de la Cruz in the Sierra Madre del Sur, Guerrero, and San Gabriel Mixtepec and Pluma Hidalgo in the Sierra Madre del Sur, Oaxaca (Duellman 2001. Hylid Frogs of Middle America, Vol. 2 [Supplement]. SSAR Contrib. Herpetol. 18: 916, 926–928, 1126). The Zitlaltepec locality is higher than the previously known localities for this species in Guerrero and Oaxaca (1080 and 1530 m, respectively) (Duellman 2001, *op. cit.*). Frogs from both localities were found calling in remnant patches of cloud forest.

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FEJERVARYA PIERREI **(Pierre's Cricket Frog)**. INDIA: HARYANA: Kalesar National Park and Wildlife Sanctuary (01.482030°N, 09.16377°E; 597 m elev.; WGS 84). 22 May 2008. A. Bahuguna. Northern Regional Centre, Zoological Survey of India (ZSI NRC 779). Verified by Karan Bahadur Shah, Natural History Museum, Kathmandu, Nepal. Previously known from central and eastern midlands of Nepal; and in India, from Arunachal Pradesh, Assam, and Nagaland States (Ao et al. 2003. Zoos' Print J. 18[6]:1117–1125; Mathew and Sen 2010. Pictorial Guide to the Amphibians of North East India. Zoological Survey of India, Kolata. 144 pp.). First record for Haryana State.

ARCHANA BAHUGUNA, Northern Regional Centre, Zoological Survey of India, 218 Kaulagarh Road, Dehradun 248 195, Uttarakhand, India; e-mail: archana.bahuguna65@gmail.com.

HYLA CINEREA **(Green Treefrog)**. USA: INDIANA: Spencer Co.: Unnamed bottomland slough on Ohio River floodplain, Ohio Township (37.814056°N, 87.110167°W; WGS 84) 11 June 2013. Michael J. Lodato and Noah M. Gordon. Verified by Chris Phillips. Illinois Natural History Survey (INHS 2013b,photo voucher). New county record (Minton 2001. Amphibians and Reptiles of Indiana, 2nd ed., revised. Indiana Academy of Science. vii + 404 pp.; Lodato et al. 2004. Herpetol.Rev. 35:281). Chorus of singing males audio-recorded and archived with photo voucher. This new locality lies about 23 km SE of the nearest known Indiana population in Warrick Co. and is immediately north of confirmed populations in adjacent Daviess Co., Kentucky (John MacGregor, pers. comm.). Two additional choruses of this treefrog heard on 11 June 2013 in wetlands to the south and southwest of the recorded population.

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HYLA SQUIRELLA **(Squirrel Treefrog)**. USA: ARKANSAS: Union Co.: 4.5 km NE of El Dorado (33.230°N, 92.620°W; WGS 84). 21 May 2013. Tobin Fulmer, Kim Fulmer, and Matthew Connior. Verified by Renn Tumlison. Henderson State University Museum of Zoology (HSU 1645, adult male). Extends the known range 79.5 km NW from nearest known location in Ouachita Parish, Louisiana (Dundee and Rossman 1989. The Amphibians and Reptiles of Louisiana. Louisiana State University Press, Baton Rouge. 316 pp.). New state record. This population was discovered after a small chorus of males was heard in a flooded grassy area following heavy thunderstorms. Several males and two females were observed. This is most likely a naturally occurring population, due to the number of individuals discovered and the contiguous potential habitat between this location and the nearest known population in Louisiana.

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and Natural Sciences, South Arkansas Community College, 300 S. West Ave., El Dorado, Arkansas 71730, USA (e-mail: mconnior@southark.edu).

***HYLA VERSICOLOR* (Gray Treefrog)**. USA: PENNSYLVANIA: Centre Co.: Forest edge 650 m S of PA State Route 45 (40.70995°N, 77.94130°W; WGS 84). 11 May 2012. B. Carlson. Verified by David Laurencio, AUM AHAP-D 678 (digital photograph file). New county record (Hulse et al., 2001. Amphibians and Reptiles of Pennsylvania and the Northeast. Cornell University Press, Ithaca, New York.; Meshaka and Collins 2010. A Pocket Guide to Pennsylvania Frogs & Toads. The Commonwealth of Pennsylvania). Audio recordings taken at the same site on 20 May 2013 confirm the identification as *H. versicolor*. Recording verified by S. Graham, AUM AHAP-C 0020 (digital sound file). This record extends the distribution of *H. versicolor* in central Pennsylvania north from the nearest records approximately 39 km SW in Blair County and 55 km S in Huntingdon County.

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***HYLARANA TYTLERI* (Yellow-striped Frog)**. BANGLADESH: DINAJPUR DISTRICT: Singra National Park (25.882139°N, 88.564028°E, WGS 84; 52 m elev.). 28 June 2013. Md. Abdur Razzaque Sarker and Md Momin Mehedi Selim. Verified by Saibal Sengupta. Museum of Herpetology Laboratory, Ichamati College, Dinajpur, Bangladesh (MHLB-HT02). Adult beside a *Saccharum* plantation field at 1700 h. First record for Dinajpur District, northern Bangladesh; described from Dhaka District (Theobald 1868. J. Asiatic Soc. Bengal 37:i–vi, 7–88, i–iii), and rediscovered at type locality (Mahony et al. 2009. Hamadryad 34:80–94); also recorded from Nilphamari District (Sarker and Howlader 2011. Herpetol. Rev. 43:299), Chittagong District (Asmat et al. 2003. Univ. Rajshahi J. Zool. 22:141–143), and Barisal District (Howlader 2010. Russian J. Herpetol. 17:255–256).

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***INCILIUS NEBULIFER* (Gulf Coast Toad)**. USA: MISSISSIPPI: Lamar Co.: residential neighborhood in West Hattiesburg, ca. 450 ft SSE of intersection of West 4th Street and Pecan Grove Drive (31.33535°N, 89.36198°W; WGS 84). 30 July 2013. Brandon C. Morris and Jennifer Y. Lamb. Verified by Carl P. Qualls. MMNS 19380. New county record (Mendelson III 2005. *In* M. Lannoo [ed.], Amphibian Declines: The Conservation Status of United States Species, pp. 424-427. Univ. California Press, Berkeley; Robert L. Jones, pers. comm.).

A second specimen (MMNS 19381) was collected on 12 August 2013. These are the second and third of this species found at this location. An earlier specimen was captured, photographed, and released on 8 July 2013. Closest known locality is 19 miles W of Wiggins, Mississippi, off Hwy 26 in Pearl River County (MMNS 8560). The differences in age suggest that breeding may be occurring in the area, but calling has not been heard.

These specimens were collected under Mississippi Department of Wildlife Fisheries and Parks Permit #0422131.

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***KALOULA PULCHRA* (Asiatic Painted Frog)**. PHILIPPINES: Mindanao Island, Davao del Norte Province, Panabo City, Barangay San Francisco (07.306389°N, 125.676389°E; WGS 84). Emerson Y. Sy. 16 August 2013. Photographic voucher, Raffles Museum of Biodiversity Research, National University of Singapore (ZRC [IMG] 1.44a–b). Verified by Indraneil Das. Observed in residential area. SVL 39.5 mm. First record from Mindanao Island. An introduced species in the Philippines, previously recorded on Luzon (Aurora, Bulacan, Cagayan, Ilocos Norte, Isabela, Laguna, and National Capital Region) and Palawan (Puerto Princesa) (Brown et al. 2013. ZooKeys 266:1–120; Brown et al. 2012. Check List 8:469–490; Diesmos et al. 2006. J. Env. Sci. Manage. 9:41–53; Fidenci 2009. Herpetol. Rev. 40:446; Siler et al. 2011. Check List 7:182–195). Pathway may be through accidental introduction with agricultural and horticultural products.

EMERSON Y. SY, Philippine Center for Terrestrial and Aquatic Research, 1198 Benavidez St., Unit 1202, Tondo, Manila, Philippines; e-mail: emersonsy@gmail.com.

***LITHOBATES CAPITO* (Gopher Frog)**. USA: FLORIDA: Liberty Co.: Apalachicola National Forest, Little Camel Pond (30.2920°N, 84.9942°W; WGS84). 30 April 2013. Kevin M. Enge. Verified by Kenneth L. Krysko. Florida Museum of Natural History, UF 169926. New county record (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final report, Florida Fish and Wildlife Conservation Commission, Tallahassee. 524 pp.). The only other record from between the Apalachicola and Ochlockonee rivers is ca. 57 km SE near Carrabelle, Franklin Co., in 1948 (UIMH 25907). The nearest records are ca. 26 km SW in Wewahitchka, Gulf Co., in 1946 (FMNH 48210–48229).

Suwannee Co.: 0.25 km SE jct 196th Terrace and 35th Drive, Wellborn (30.0924°N, 82.8153°W; WGS84). 30 May 2013. Kevin M. Enge. Verified by Kenneth L. Krysko. UF 170295 (color photo). First voucher record for the county (Krysko et al. 2011, *op. cit.*). Collected tadpole (108 mm TL) with hind legs while dipnetting a depression marsh in xeric hammock habitat.

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***LITHOBATES MAGNAOCULARIS* (Northwest Mexico Leopard Frog)**. MÉXICO: JALISCO: Municipality of Cañadas de Obregón: Temacapulín, 88 km NE from Guadalajara (21.187605°N, 102.70635°W; WGS84), 1628 m elev. 30 November 2010. Jesús M. Rodríguez-Canseco, Krystal L. González-Estupiñán, and Luand E. López-Rodríguez. Verified by Jacobo Reyes Velasco. UTADC 7614, 7615. First municipality record and a 175 km E range extension from its nearest known locality at Huajimic, Nayarit (Pfeiler and Markow 2008. Mol. Phylogenet. Evol. 49:343–348). The photographed frog and several others were found in a thermal water pool inside the town, and more were observed nearby in Arroyo Colorado and Río Verde, which is lined by gallery forest.

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***LITHOBATES SPECTABILIS* (Showy Leopard Frog)**. MÉXICO: JALISCO: Municipality of Tecolotlán: Sierra de Quila, near Tecolotlán, 100 km SW of Guadalajara (20.24833°N, 104.0566°W; WGS 84), 1326 m elev. 19 February 2011. Jesus Rodriguez-Canseco and Alberto Ayon Escobedo. Verified by Jacobo Reyes-Velasco. UTADC 7616. First municipality record and only second for Jalisco, representing a 100 km E range extension from the only other Jalisco record from Tuxcueca; the next closest locality is from 312 km SE at Morelia, Michoacán (Santos-Barrera and Flores-Villela 2004. *In* IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1; Hillis and Frost 1985. Occas. Pap. Mus. Nat. Hist. Univ. Kansas 117:1–14). The frog was active at night in a permanent stream surrounded by tropical deciduous forest, along with individuals of *L. neovolcanica*, *L. psilonota*, and *L. forreri*.

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***LITHOBATES SPECTABILIS* (Showy Leopard Frog)**. MÉXICO: JALISCO: Municipality of Tuxcueca: near Tuxcueca, 61 km SE of Guadalajara (20.1397777°N, 103.1514444°W; WGS84), 1635 m elev. 12 August 2011. Jesús Rodriguez-Canseco and Rodrigo Quiroz. Verified by Jacobo Reyes-Velasco. UTADC 7617. First record for Jalisco, extending its range 213 km NW from its nearest locality in Morelia, Michoacán (Santos-Barrera and Flores-Villela 2004. *In* IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1; Hillis and Frost 1985. Occas. Pap. Mus. Nat. Hist. Univ. Kansas 117:1–14). The frog was found active during daytime in a streambed with a few small pools surrounded by tropical deciduous forest.

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***LITHOBATES SPHENOCEPHALUS* (Southern Leopard Frog)**. USA: TEXAS: Kleberg Co.: North Padre Island, within the Padre Island National Seashore, 0.48 km W of the intersection of Bird Island Basin Road and Park Road 22 (27.465447°N, 97.295205°W; NAD 83, elev. 1.2 m). 25 May 2005. David Hall. Verified by Travis LaDuc. Texas Natural History Collection (TNHC 65562). New county record (Dixon 2013. Amphibians and Reptiles of Texas, 3rd ed. Texas A&M University Press, College Station. 447 pp.). *L. sphenocephala* occurs sympatrically with *L. berlandieri* at this locality, and some specimens are intermediate in appearance between the two species (TCWC 93885–93887). The two species were audio-recorded calling simultaneously from a pond near this locality.

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***PSEUDACRIS CRUCIFER* (Spring Peeper)**. USA: MISSOURI: Ste. Genevieve Co.: Weingarten. 0.5 km SE of Miller Switch and 1 km N of Jonca Creek at Horton Farm Conservation Area (37.8551°N, 90.2650°W; WGS84). 15 June 2013. Andrew P. Braun. Verified by Dustin S. Siegel. University of Missouri-Columbia (UMC 2381P). Juvenile specimen. Replaces missing county record (Edmond and Daniel 2013 [latest update: 5 April 2013], Missouri Herpetological Atlas Project. Available at http://atlas.moherp.org/; accessed 27 June 2013). Found on bank of fishless artificial pond.

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***RHINOPHRYNUS DORSALIS* (Sapo Borracho)**. HONDURAS: OLANCHO: Juticalpa, Barrio el Portillo (14.673056°N, 86.221389°W, WGS84), 504 m elev. 10 September 2010. Victor Eduardo Henríquez Aguilar. Verified by Larry David Wilson. USNM 579869. This locality fills a wide gap in the known distribution of the species, extending the range ca. 240 km SE from the nearest Honduras locality, 2 km W of Tegucigalpa, Cortés (McCranie 2006. Smithson. Herpetol. Infor. Serv. 137:224–232), and ca. 245 km W from the nearest Nicaraguan locality at Waspam (Köhler 2001. Anfibios y Reptiles de Nicaragua. Herpeton, Verlag Elke Köhler, Offenbach, Germany. 208 pp.). The specimen was caught at the edge of town while active behind a house after a heavy rain, at the base of small mountain supporting secondary xeric forest.

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***SCAPHIOPUS HOLBROOKII* (Eastern Spadefoot)**. USA: TENNESSEE: Hickman Co.: 6132 Parker Road, Lyles (35.838446°N, 87.341899°W; WSG 84). 4 May 2013. Nicole Foster and Mary Christensen. Verified by A. Floyd Scott. Austin Peay State University (APSUMZ 19416). Found in the road. New county record (Scott and Redmond 2008 [latest update: 1 August 2013]. Atlas of Amphibians in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/amatlas/ [accessed 1 August 2013]).

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TESTUDINES — TURTLES

***CHRYSEMYS PICTA* (Painted Turtle)**. USA: GEORGIA: Cherokee Co.: Waleska, Reinhardt University campus, 0.25 km SE of intersection of State Route 108 and Grady Street (34.31884°N, 84.54663°W; WGS 84). 21 April 2013. Z. Felix. UF 170290. Digital photograph. Verified by Kenneth Krysko. New county record (Jensen et al. [eds.], 2008. Amphibians and Reptiles of Georgia, University of Georgia Press, Athens. 575 pp.). One adult female captured in hoop trap in shrubby marsh.

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***CHRYSEMYS PICTA* (Painted Turtle)**. USA: TENNESSEE: Bledsoe Co.: on SR 30, 350 m NW of junction with SR 101 (35.67114°N, 85.24368°W; WGS 84). 18 July 2013. C. Thawley. Verified by David Laurencio. AUM AHAP-D 708 (digital photograph). New county record (Scott and Redmond 2008. Atlas of Reptiles in Tennessee. Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. http://www.apsu.edu/reptatlas [updated 1 August 2013; accessed 2 August 2013]). Adult male found alive on road.

C. picta is presumably distributed statewide in Tennessee, but records in the central portion of the state are lacking. This record fills a distributional gap between the nearest records approximately 35 km ESE in Rhea Co. and 9 km W in Van Buren Co. This specimen showed characteristics of both *C. picta picta* (a carapace with aligned, as opposed to alternate scutes) and *C. picta marginata* (a plastron with characteristic splotching); as such, it was entered into AUM as a *C. picta picta* x *marginata* intergrade.

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***DERMOCHELYS CORIACEA* (Leatherback Sea Turtle).** BRAZIL: AMAPÁ: Municipality of Calçoene: Praia do Goiabal (2.633333°N, 50.816667°W; datum WGS84). 17 April 2012. Verified by C. Bellini. Photographic voucher deposited in the Coleção Científica Fauna do Amapá of Instituto de Pesquisas Científicas e Tecnológicas do Estado do Amapá, Brazil (IEPA 000254). The species is known from Atlantic, Pacific, and Indian oceans, and from the Mediterranean Sea. In the American coasts of the Atlantic ocean, it is known from Canada to Argentina, and the main spawning areas are located in Suriname and French Guiana (Girondo et al. 2007. Chelon. Conserv. Biol. 6[1]:37–46; Fossette et al. 2008. J. Exp. Mar. Biol. Ecol. 356:69–82). In Brazil, the range of the species includes the states of Rio de Janeiro, Santa Catarina, and Rio Grande do Sul, and the only recurrent breeding sites are located along the northern coast of the state of Espírito Santo although spawning has been occasionally recorded in other states (Loebmann et al. 2008. Herpetol. Rev. 39[1]:81–81). New state record, filling a gap of 365 km from French Guiana and 1225 km from Piauí state. The occurrence of *Dermochelys coriacea* in Amapá may be an indication of the resumption of an old migration route or use of new territory due to ideal conditions of food supply or possible new breeding areas.

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***EMYDOIDEA BLANDINGII* (Blanding's Turtle).** USA: MICHIGAN: Benzie Co.: west edge of shrub swamp, Upper Herring Lake Nature Preserve, east of M-22, 5.6 km SE of Elberta, Blaine Twp (T25N R16W) Section 13 SW1/4 (44.565647°N, 86.193547°W; WGS84; elev. 182 m). 21 April 2012. Thomas F. Beauvais. Verified by Chris Phillips. Illinois Natural History (2012g Survey digital color photo voucher). New county record (Casper and Anton 2008. An Amphibian and Reptile Inventory of Sleeping Bear Dunes National Lakeshore. Natural Resource Technical Report NPS/GLKN/NRTR--2008/147. 47 pp.; Holman 2012 . The Amphibians and Reptiles of Michigan. Wayne State Univ. Press, Detroit, Michigan. 291 pp.).

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***GOPHERUS MORAFKAI* (Sonoran Desert Tortoise).** USA: ARIZONA: Santa Cruz Co.: Coronado National Forest, Atascosa and Pajarito Mountains. Forest Road 39 (31.401933°N, 111.144819°W; WGS 84; elev. 1401 m), 22 September 2006. R. D. Babb. UAZ 57470-PSV, photo voucher. Verified by George Bradley. New county record (Brennan and Holycross 2009. Amphibians and Reptiles in Arizona. Arizona Game and Fish Department, Phoenix, Arizona, 150 pp.), an adult female ca. 228 mm straightline carapace. Three other specimens were found (UAZ 57471-PSV) on 11 August 2007, (UAZ 57166-PSV) on 26 July 2008, and (UAZ 57566-PSV) on 24 July 2013.

Current eastern distributional limits of *Gopherus morafkai* in Arizona are delineated as extending southward through central Gila Co., eastern Graham Co., to northeastern Cochise Co. and falling westward through southern Pima County into the Altar Valley to the international boundary on the Buenos Aires National Wildlife Refuge (Brennan and Holycross 2009, *op. cit.*). Closest known record is UAZ 56244 southwest of the town of Arivaca, Pima Co. These records represent an extension of the known range of *G. morafkai* ca. 23 km to the east and a ca. 40 km extension to the south, and places them in another major drainage, Sycamore Creek, which drains into the Río de la Concepcion in Sonora, Mexico.

All tortoises were associated with the more xeric, rocky south and southwest facing slopes of the Atascosa and Pajarito Mountains. Although the habitat could be considered an ecotone between Sonoran desert scrub, Chihuahuan desert scrub, and Madrean evergreen woodland in places (Brown 1994. Biotic Communities: Southwestern United States and Northwestern Mexico. University of Utah Press, Salt Lake City. 342 pp.) it is predominately Madrean evergreen woodland, atypical habitat for this species in Arizona.

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***GRAPTEMYS PSEUDOGEOGRAPHICA* (False Map Turtle).** USA: MISSOURI: Perry Co.: Brazeau Township, near bank of Mississippi River on northwest corner of Cottonwood Island, 0.8 km W of Grand Tower Island and 2.5 km S of Tower Rock (37.6094°N, 89.5128°W; WGS84). 2 July 2013. Andrew P. Braun and John West. Verified by Richard E. Daniel. University of Missouri-Columbia (UMC 2391P). New county record (Edmond and Daniel 2013 [latest update: 5 April 2013]). Missouri Herpetological Atlas Project. Available at http://atlas.moherp.org/; accessed 9 July 2013). Female specimen, captured in fyke net.

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***GRAPTEMYS PSEUDOGEOGRAPHICA PSEUDOGEOGRAPHICA* (False Map Turtle).** USA: TENNESSEE: Lauderdale Co.: Chickasaw National Wildlife Refuge, 30 m S boat ramp on Barr Road

(35.878611°N, 89.70583°W; WGS 84). Michael C. Fulbright and James P. Flaherty. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19408). New county record (Scott and Redmond 2008 [latest update: 01 August 2013]. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/ [accessed 15 July 2013]). Captured by hand while basking on log, both eyes were injured.

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***KINOSTERNON SUBRUBRUM* (Eastern Mud Turtle)**. USA: GEORGIA: Cherokee Co.: Ball Ground, Flatbottom Trail 0.11 km S of intersection with State Route 372 (34.327324°N, 84.366347°W; WGS 84). 7 July 2013. Z. Felix. UGA 50356; digital photograph. Verified by Nikole Castleberry. New county record (Jensen et al. [eds.] 2008. Amphibians and Reptiles of Georgia, University of Georgia Press, Athens. 575 pp.). One adult found dead on road.

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***MACROCHELYS TEMMINCKII* (Alligator Snapping Turtle)**. USA: ALABAMA: Hale Co.: Individual found in a shallow stream 40 m N of Hale County Road 28 and 8.2 km W of Greensboro (32.707624°N, 87.683859°W; WGS84). 26 March 2013. Will Selman and Al Cherry. Verified by Jim Godwin. Florida Museum of Natural History Herpetology Department (UF 170047 photo voucher). New county record (Mount 1975. The Reptiles and Amphibians of Alabama. University of Alabama Press, Tuscaloosa. 270 pp.; Alabama Natural Heritage Program Database, http://www.alnhp.org/). This record fills a large distributional gap between southern Clark and southern Tuscaloosa counties (approximately 215 river miles along the Black Warrior River).

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***STERNOTHERUS ODORATUS* (Eastern Musk Turtle)**. USA: TENNESSEE: Dyer Co.: Tigrett Wildlife Management Area (35.994874°N, 89.263393°W; WGS 84). 3 November 2012. James P. Flaherty. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19418). New county record (Scott and Redmond. 2008 [latest update: 30 May 2013]. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/ [accessed 9 July 2013]). Nearest record ca. 21 km SE in Crockett Co. Desiccated shell found in mostly dry cypress slough.

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***TERRAPENE CAROLINA* (Eastern Box Turtle)**. USA: ALABAMA: Randolph Co.: Found dead on road, along Hwy 22 near the town of Dickert (33.13285°N, 85.47071°W; WGS84/NAD83). 25 July 2013. R. Birkhead, M. Birkhead, and S. Birkhead. AHAP-D-716 (Digital photo). Hale Co.: Found dead on road, on Hwy 69 south of Havana (32.82587°N, 87.6028°W; WGS84/NAD83). 8 August 2013. R. Birkhead. AHAP-D-719 (Digital photos). All specimens verified by David Laurencio. New county records (Mount 1996. The Reptiles and Amphibians of Alabama. University of Alabama Press, Tuscaloosa. xi+347 pp.). *T. carolina* is assumed to occur statewide; however, verified records are lacking for many Alabama counties.

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SQUAMATA — LIZARDS

***ABRONIA LYTHROCHILA* (Red-lipped Arboreal Alligator Lizard)**: GUATEMALA: HUEHUETENANGO: humid Caribbean slope of Sierra de Cuchumatanes, 2862 m elev. 2 October 2010. Monica Torres. Verified by Ted Papenfuss. USAC 3335. First record for Guatemala, extending the range 31 km from the nearest known locality in the Municipality of Comitán de Dominguez, Chiapas, México (MVZ 57170; Global Biodiversity Information Facility, Univ. California, Berkeley. Electronic data accessed 21 August 2011 at http://data.gbif.org/occurrences/201617419/). USAC 3335 and three other adult individuals placed into the breeding collection of Guatemalan NGO Zootropic were found in a remnant pine-oak cloud forest inside a felled pine tree covered with epiphytes. The area also contains the recently rediscovered *A. frosti* (Ariano et al. 2011. Herpetol. Rev. 42:196–198), which represents the first case of sympatry between subgenera *Lissabronia* (*A. frosti*) and *Auriculabronia* (*A. lithrochila*). As in other cases of sympatry between related species, there seems to be niche partitioning within the shared habitat; *A. lythrochila* appears to be restricted to conifer patches within the pine-oak forest, while *A. frosti* seems to be limited to oak patches.

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***ANOLIS ALLISONI* (Allison's Anole)**. HONDURAS: ISLAS DE LA BAHÍA: Utila, Mango Inn (16.083602°N, 86.883486°W; WGS84), 12 m elev. 25 February 2012. Andrea M. Martinez and Steven M. Clayson. Verified by James R. McCranie. MPM P766. First record for Isla de Utila (McCranie et al. 2005. Amphibians & Reptiles of the Bay Islands and Cayos Cochinos, Honduras. Bibliomania, Salt Lake City, Utah. xii + 210 pp.) and likely represents a contemporary introduction from Islas de Roatán, which lies ca. 33.3 km NE of Isla de Utila. The anole was active above a roof gutter at Mango Inn.

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***ANOLIS SAGREI* (Brown Anole)**. USA: FLORIDA: Gulf Co.: St. Joseph Bay State Buffer Preserve office (29.717942°N, 85.304058°W; WGS 84). 1 April 2012. Matt Greene, Verified by Craig Guyer. Auburn University Museum (AHAP-D 689–690). New county record (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final report, Project Agreement 08013, Florida Fish and Wildlife

Conservation Commission, Tallahassee, Florida. 524 pp.). Has been documented in neighboring Bay and Franklin counties and four other Panhandle counties. Several adult and juvenile individuals observed on Preserve's office deck. Dozens of individuals were also observed at the author's residence and in downtown, both in Port St. Joe (6 and 8 miles N of Buffer Preserve, respectively), indicating an established population with widespread distribution in southern Gulf Co. Brown Anoles appeared more numerous in residential areas than in the Buffer Preserve and surrounding natural areas.

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***CALOTES VERSICOLOR* (Common Garden Lizard)**. PHILIPPINES: NATIONAL CAPITAL REGION: Luzon Island, Parañaque City, Barangay Don Bosco (14.485833°N, 121.016389°E; WGS 84). Emerson Y. Sy. 3 August 2013. Photographic voucher, Raffles Museum of Biodiversity Research, National University of Singapore (ZRC [IMG] 2.181a–d). Verified by I. Das. Five juveniles and two adults observed perched on ornamental shrubs and bamboo fences within 500 m^2 in residential area between 1230–1400 h. SVL 49–101 mm. First country record; possible introduction pathway as cargo stowaways due to close proximity to international airport. Native of Iran, Afghanistan, Pakistan, Nepal, Bhutan, Bangladesh, India, Sri Lanka, southern China including Hainan, Cambodia, Peninsular Malaysia, Myanmar, Thailand, and Vietnam (Auffenberg and Rehman 1993. Asiatic Herpetol. Res. 5:14–30; Hallermann 2000. Bonner zool. Beitr. 49:155–163; Radder 2006. Curr. Sci. 91:1354–1363). Introduced on Borneo (Brunei Darussalam), Sumatra (Indonesia), Maldives, Mauritius, Réunion, Seychelles, Singapore, and Florida (USA) (Chou 1994. Herpetol. Rev. 25:75–76; Das et al. 2008. Curr. Herpetol. 27:109–112; Enge and Krysko 2004. Biol. Sci. 67:226–230; Hasen Didi 1993. Hamadryad 18:42; Henkel and Schmidt 2000. Amphibians and Reptiles of Madagascar and the Mascarene, Seychelles, and Comoro Islands. Krieger Publ. Co., Malabar, Florida. 316 pp.).

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***COLOPTYCHON RHOMBIFER* (Isthmian Alligator Lizard)**. COSTA RICA: Puntarenas: Cantón Aguirre, San Andres de Matapalo (09.350025°N, 83.950002°N; WGS84), 515 m elev. 7 October 2012. Juan Andres Lopez. Verified by Jonathan A. Campbell and William W. Lamar. UTADC 7635–7636. Northwestern most record for this species, extending the range by ca. 70 km NW from the closest known locality plotted on the map in Savage (2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna between Two Continents, between Two Seas. Univ. Chicago Press, Chicago, Illinois. xx + 934 pp.). The lizard was found on the ground at the edge of a clearing in tropical humid forest.

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***DAREVSKIA ALPINA* (Alpine Lizard)**. RUSSIA: KABARDINO-BALKARIA: Zolsky District, upper reaches of the Malka River, terrain Dzhily-Su (= Castle Valley) (43.4329771°N, 42.5333118°E), 2400 m elev. 22 July 2013. It is a new extreme northwestern point of species distribution range (Darewskij 1984. *Lacerta caucasica* Méhely, 1909 – Kaukasische Felseidechse // Böhme W. [Hrsg.]. Handbuch der Reptilien und Amphibien Europas. Band 2/I. Echsen II [Lacerta]. Wiesbaden: AULA-Verlag. S. 225–238). The new record extends the range of this species by 20 km to the northwest. This is the first record of *D. alpina* on the northern slopes of Mount Elbrus, the highest mountain in the Caucasus, where it was previously recorded on the southern and western slopes. This suggests that this species is more widespread on Mount Elbrus than previously thought. At the Sultan Waterfall, we observed 10 adult specimens and one juvenile per 300 m of the route (a width of about 2 m). We also observed an adult male and a juvenile specimen at a site more distant from the waterfall at a distance of 60 m, where the humidity was lower; the fewer individuals farther from the waterfall may be due to fewer insect prey on the sparse vegetation distant from the water. These new records are within 15 km of populations of *D. saxicola* and we assume that these species are sympatric in the upper part of the valley of the River Malka.

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***ECHINANTHERA AMOENA* (Corredeira-do-mato)**. BRAZIL: MINAS GERAIS: Alto Caparaó municipality: Parque Nacional do Caparaó: Vale Verde (20.419164°S, 41.846123°W, datum WGS 84; elev. ca. 1330 elev.). 8 November 2008. M. T. Rodrigues. Museu de Zoologia da Universidade de São Paulo, São Paulo, Brazil (MZUSP 17986, adult male; M. T. Rodrigues field number MTR 15853). Verified by F. F. Curcio. Found at 1400 h in an area of dense and preserved forest. *E. amoena* is extremely rare in collections, and known only from a few records. It is known from the Atlantic Rainforest areas in Paraná, São Paulo, Rio de Janeiro, and Minas Gerais states (Di-Bernardo 1992. Comun. Mus. Cienc. PUCRS, sér. Zool. Porto Alegre 5:225–256; Silveira et al. 2010. Herpetol. Rev. 41:108). This new record extends the known distribution ca. 235 km NE of Reserva Ecológica de Guapiaçu, in Rio de Janeiro state (Silveira et al., *op. cit.*), the nearest documented locality, and ca. 250 km NE of Parque Estadual do Ibitipoca, the nearest locality in Minas Gerais state.

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***HEMIDACTYLUS FRENATUS* (Common House Gecko)**. MÉXICO: OAXACA: Municipality of Oaxaca de Juárez: Oaxaca City (17.063326°N, 96.706898°W; WGS84), 1545 m elev. 18 June 2013. Vicente Mata-Silva. Verified by Aurelio Ramírez-Bautista. Photographic voucher, UTEP G 2013.1. First municipality record. The distribution of this species in southern Mexico includes lowland regions on the Pacific and Gulf versants (mapped in Farr 2011. Southwest. Nat. 56:265–273) and in Oaxaca within the floristic-faunistic regions 8 (Planicie Costera del Pacifico) and 9 (Istmo de Tehuantepec), from 0 to 1000 m elev. (Casas-Andreu et al. 1996. Acta Zool. Mex. 69:1–35; Casas-Andreu et al. 2004. *In* Garcia-Mendoza et al. [eds.], Biodiversidad de Oaxaca, pp. 375–390. Inst. Biol. UNAM, Mexico D.F.). The record reported herein is from a higher elevation within floristic-faunistic region 6 (Valles Centrales) (Casas-Andreu et al. 1996, *op. cit.*). The gecko was observed on the outside brick wall of a house; additional individuals were observed by VMS and ARB on walls at other locations

within the city. We assume that successful colonization of Oaxaca City by *H. frenatus* was likely due to passive dispersal by vehicles traveling from coastal regions.

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***HEMIDACTYLUS TURCICUS* (Mediterranean Gecko).** MÉXICO: CHIHUAHUA: Municipality of CHIHUAHUA: Ciudad Chihuahua (28.637965°N, 106.075392 °W; WGS84), 1425 m elev. 28 September 2012. Rubén Alonso Carbajal Márquez and Martín Lara. Verified by Luis Canseco Márquez (UAA-CV 0354). First municipality record, third record for the Chihuahua, extending the known distributional range of the species in the state ca. 153.7 km (airline) NW from the closest known locality, La Perla, Municipality of Camargo, Chihuahua (Lemos-Espinal et al. 2009. Anfibios y Reptiles del Estado de Chihuahua. UNAM, Tlalnepantla, México, México; Univ. Colorado, Boulder; CONABIO, México, D.F. 613 pp.), and ca. 346.6 km (airline) S from Ciudad Juárez (Gatica-Colima et al. 2009. Herpetol. Rev. 40:452). This exotic gecko was found on a downtown street.

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***PHELSUMA GRANDIS* (Madagascar Day Gecko).** USA: FLORIDA: Monroe Co.: Key Largo, near Bass Avenue and Kingfish Street (25.13713°N, 80.39987°W; WGS84; elev. 2 m). 28 May 2013. Elizabeth Frampton and James G. Duquesnel. Verified by Laurence L. Connor. Florida Museum of Natural History (UF-Herpetology 170288). New island record and tenth known island in the Florida Keys to which this species has been introduced (Krysko and Sheehy 2005. Carib. J. Sci. 41:169–172, Krysko and Hooper 2007. Gekko 5:33–38). This specimen was reported by Key Largo resident Elizabeth Frampton via the State's Invasive Species Hotline and collected within an hour by JGD. When found, the gecko was alive and mobile but exhibited a penetrating injury with entry and exit wounds on opposite sides of the body. Several maggots were observed emerging from the wounds, and the gecko died soon after capture. Based on the diameter of the wounds, we suspect that the gecko had been shot with a pellet rifle or similar weapon. Additional *P. grandis* have been observed on Key Largo, one (UF-Herpetology 170996) of which was collected on 22 July 2013 near Oceanview Drive, ca. 0.51 km SW of our first record above. This is from the southern end of the same neighborhood suggesting a more widespread population than currently known. Several residents reported that *P. grandis* had been more abundant locally in the Keys prior to record-setting cold weather of January and February 2010. Our new vouchers are also ca. 22.5 km NE of the closest known verified voucher (UF-Herpetology 135121) from Plantation Key.

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***PLESTIODON FASCIATUS* (Common Five-lined Skink).** USA: TENNESSEE: Van Buren Co.: Fall Creek Falls State Park (35.65663°N, 85.37927°W; WGS 84). 24 June 2013. C. Thawley. Verified by David Laurencio, AUM AHAP-D 685 (digital photograph file). New county record (Scott and Redmond 2008. Atlas of Reptiles in Tennessee. Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. http://www.apsu.edu/reptatlas (updated 30 May 2013; accessed 25 June 2013). *P. fasciatus* is presumably distributed statewide in Tennessee, and this record fills a distributional gap between the nearest records approximately 33 km WSW in Warren Co., 20 km N in White Co., and 12 km E in Bledsoe Co. Funding for this research was provided by IOS-1051367 to T. Langkilde.

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***PLESTIODON LATICEPS* (Broad-headed Skink).** USA: GEORGIA: Cherokee Co.: Ball Ground, Flatbottom Road, 0.56 km S of Northridge Road (34.30526°N, 84.38816°W; WGS 84). 10 May 2013. Z. Felix and K. Bonno. (UF 170289 digital image). Verified by Kenneth Krysko. New county record (Jensen et al. [eds.] 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). One adult male found dead on road near thinned pine stand.

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***SCELOPORUS LUNDELLI* (Lundell's Spiny Lizard).** MÉXICO: QUINTANA ROO: Municipio Benito Juárez: Puerto Morelos, Crococun Zoo (20.88°N, 86.89°W; WGS84), 15 m elev. 16 July 2012. P. Charruau and R. F. Rojo García. Verified by F. R. Méndez de la Cruz and N. Martínez Méndez. CNAR-IBH-RF 40 (a–b). Municipio Solidaridad: Playa del Carmen, Río Secreto, Carretera Federal Libre Chetumal - Puerto Juárez, km 283.5 Col. Ejido Sur (20.62°N, 87.14°W; WGS84), 19 m elev. 2 November 2012, P. Charruau and R. F. Rojo García. Verified by F. R. Méndez de la Cruz and N. Martínez Méndez. CNAR IBH-RF 41 (a–b). New municipality records for the species in Quintana Roo, extending the range ca. 74 km E (Puerto Morelos record) of the nearest locality at Nuevo X-Can, Quintana Roo (Lee 1996. The Amphibians and Reptiles of the Yucatán Peninsula. Cornell Univ. Press, Ithaca, New York. 500 pp.). These records are also located ca. 160 and 120 km NE, respectively, from a supposedly isolated record at Santa Teresa Station, Sian Ka'an Biosphere Reserve, Quintana Roo (Calderón-Mandujano and Mora-Tembre 2004. Herpetol. Rev. 35:295–296). Both localities were composed of medium semi-evergreen forest. Other populations of the species have been recorded from central Belize, northeastern Guatemala, and northcentral portions

of the Yucatan Peninsula in Mexico (Lee 1996, *op. cit.*), Calakmul Biosphere Reserve, Campeche (Calderon et al. 2003. Herpetol. Rev. 34:269–272), near Tenosique, Tabasco (Barragán et al. 2004. Herpetol. Rev. 35:188), and Bahía de Chetumal, Quintana Roo (Cedeño-Vázquez et al. 2003 Herpetol. Rev. 34:393–395). Present records confirm that *S. lundelli* is endemic to the Yucatan Peninsula. However, more field work is needed from the central and southern portions of the Peninsula to determine if its range is continuous or fragmented.

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***TROPIDOPHORUS LAOTUS* (Laotian Water Skink)**. THAILAND: UTTARADIT PROVINCE: Nam Paad District: Nam Paad Wildlife Sanctuary, Huay Sum Ma Kow (17.781340°N, 100.886650°E; ca. 350 m elev.; WGS 84). At night, on small stream bank (water depth 2–3 cm) in mixed deciduous forest and released after photography. Thiti Sonsa. 7 September 2013. Khon Kaen University Vertebrate Collection (KKUD 2013.4a–e). Verified by Sunchai Makchai. First record for Uttaradit Province, ca. 300 km NW of nearest locality (Phu Kradueng National Park, Loei Province; Taylor 1963. Univ. Kansas Sci. Bull. 44:687–1077). Previously known only from northeast Thailand, in Loei and Nong Khai provinces (Chuaynkern and Chuaynkern. 2012. J. Wildl. Thailand 19:75–162).

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TROPIDURUS JAGUARIBANUS. BRAZIL: CEARÁ: Castanhão Ecological Station, municipality of Nova Jaguaribara (5.593701°S, 38.485622°W, datum SAD69; 108 m elev.). 19 March 2004. I. J. Roberto and T. Pinto, Coleção Herpetológica da Universidade de Brasília (UNB), Brasília, Distrito Federal, Brazil (CHUNB 56546); Aiauba Ecological Station, municipality of Aiuaba (6.650833°S, 40.135000°W, datum SAD69; 466 m elev.). 1 September 2007. S. Cardozo Ribeiro. Coleção Herpetológica da Universidade Regional do Cariri (URCA) Crato, Ceará, Brazil (URCA-H 1915). PIAUÍ: APA Chapada do Araripe, Municipality of Caldeirão Grande do Piauí: (7.3449°S, 40.6033°W, datum SAD69; 737 m elev.). 25 June 2013. I. J. Roberto, S. Cardozo Ribeiro and J. A. Araujo Filho. (URCA-H 5935, adult male 7.3 cm SVL). Verified by R. W. Ávila. This species was previously known only for the state of Ceará, at Jaguaribe River Valley, municipalities of São João do Jaguaribe (type locality) and Banabuiú (Passos et al. 2011. Zootaxa 2930:60–68). These new records show a wider occurrence for *T. jaguaribanus*, outside the Jaguaribe River Valley, occurring at elevations of 100–740 m. Also this is the first record for the state of Piauí, extending the known distribution of the species ca. 288 km SW from the municipality of Banabuiú, state of Ceará, Brazil (Passos et al., *op. cit.*).

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***UROSAURUS ORNATUS* (Ornate Tree Lizard)**. USA: CALIFORNIA: Imperial Co.: Property at 2110 W Holt Avenue, El Centro (32.7881°N, 115.5797°W; WGS 84; elev. -10 m) 19 Mar 2008. Tyler J. Grant. Verified by Bradford D. Hollingsworth. San Diego Natural History Museum (SDNHM 72855–72857). First record from the Imperial Valley (Peralta 2009. Historical demography and lineage diversification of the ornate tree lizard *Urosaurus ornatus*. M.S. Thesis, San Diego State University). The specimens were collected in the yard of a house. One specimen was collected on a wood fence; two were collected on the house. Several other specimens were observed. This species was also observed in two other locations in El Centro where they seem to be rather common in the artificial landscapes. The nearest vouchered population is 65 km NNE at Beal Well in the Chocolate Mountains (SDNHM 13545).

It seems possible that *U. ornatus* colonized the Imperial Valley through anthropogenic features such as vegetation along the All-American canal. It seems equally likely it was introduced as a hitchhiker, in a manner similar to a population of *U. ornatus* in San Bernardino, California (Bass and Hakim 2010. Herpetol. Rev. 41:515). To determine the origin of the Imperial Co. population, the collected specimens were included in a phylogeographic analysis (Peralta 2009, *op. cit.)*. The results were inconclusive. The El Centro specimens occurred in clades with southwestern Arizona specimens as might be expected if they were colonizers. However, they were not very differentiated from Maricopa Co., Arizona specimens. If they were naturally occurring in the Imperial Valley, they might be expected to be more differentiated. Therefore it seems likely that they were introduced.

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***VARANUS NUCHALIS* (White-headed Water Monitor Lizard)**. PHILIPPINES: ROMBLON PROVINCE: Tablas Island, Municipality of Ferrol, Barangay Tubigon (12.360833°N, 121.949444°E; WGS 84). Ernest Kurt Tan. 22 August 2013. Photographic voucher, Raffles Museum of Biodiversity Research, National University of Singapore (ZRC[IMG] 2.182 a–c). Verified by Rafe M. Brown. Dead on road. SVL 24.8 cm; TL 63.2 cm. First record from Tablas Island. Species known from Panay, Negros, Cebu, Masbate, Ticao, and Sibuyan (Koch et al. 2007. *In* Horn et al. [eds.], Advances in Monitor Research III, pp. 109–180. Mertensiella 16, Rheinbach; Siler et al. 2012. Check List 8[3]:443–462).

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SQUAMATA — SNAKES

***COLUBER* (=*MASTICOPHIS*) *FLAGELLUM FLAGELLUM* (Eastern Coachwhip)** USA: ALABAMA: Crenshaw Co.: US Route 331, 200 m S of Johnson Rd. intersection (31.78786°N 86.30514°W;

WGS 84). 2 July 2013. M. Herr and S. Graham. Verified by David Laurencio. AUM 40267. New county record (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn Printing Co., Auburn, 347 pp.). Collected DOR.

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***CROTALIS HORRIDUS* (Timber Rattlesnake)**. USA: ALABAMA: Jefferson Co.: Leeds, 2.1 km SE of I20/I459 interchange, 600 m due S of Cahaba River on a ridgetop (33.534548°N, 86.623225°W; WGS 84). 1 May 2013. Kristin A. Bakkegard and Zachery L. Napier. Verified by David Laurencio. AUM AHAP-D 706 (photo voucher). New county record (Mount 1975, Amphibians and Reptiles of Alabama. Auburn University Agricultural Experiment Station, Auburn, Alabama. 347 pp.). Search of 61 museum databases (HerpNET2, http://www.herpNet2.org/ accessed 23 July 2013) and the AUM database show no voucher specimens for Jefferson Co. even though this species is found nearly statewide in Alabama.

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***CROTALUS HORRIDUS* (Timber Rattlesnake)**. USA: ARKANSAS: Lee Co.: 100 m E of County Rd. 222 (34.71366°N 90.72717°W; WGS 84). 13 May 2013. S. Graham, C. Thawley, and G. McCormick. Verified by David Laurencio. AUM AHAP-D 677 (digital photograph file). New county record (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville, Arkansas. 421 pp.). Adult specimen found in ambush posture in slash pile at edge of private agricultural field. This record fills a distributional gap between the nearest records approximately 48 km N in Cross Co. and 11 km SE in Phillips Co..

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***CROTALUS HORRIDUS* (Timber Rattlesnake)**. USA: OKLAHOMA: Choctaw Co.: off St. Hwy. 93 just N of county road E2040 in Messer (34.056280°N, 95.469327°W, WGS 84). 17 August 2013. C. Courtwright. Verified by S. E. Trauth. Arkansas State University Museum of Zoology, Herpetological Collection (photographic voucher, ASUMZ 32768). New county record (Oklahoma Biological Survey, Distribution of Oklahoma Amphibians and Reptiles by Recorded Sightings [DOKARRS Search], http://www/snomnh.ou.edu; Sam Noble Oklahoma Museum of Natural History Reptile Database [SNOMNH Search], http://www.snomnh.ou.edu). Specimen is a large adult (total length = 1880 mm); several *C. horridus* from the state are housed in the SNOMNH from adjacent Bryan and McCurtain counties, and McAllister (2012. Herpetol. Rev. 43:620) recently reported a specimen from nearby Pushmataha Co. Interestingly, Mahaffey (1954. Oklahoma Game Fish News 10:10–11) reported a rattlesnake from Choctaw Co. (near the Red River bottoms) that Webb (1970. Reptiles of Oklahoma. University of Oklahoma Press, Norman. 370 pp.) listed as "probably *horridus*" but there is apparently no voucher specimen. In addition, there are records of *C. horridus* from just south of Choctaw Co. across the Red River in Fannin, Lamar, and Red River counties, Texas (Dixon 2000. Amphibians and Reptiles of Texas. Texas A&M University Press, College Station. 421 pp.).

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***DRYMARCHON COUPERI* (Eastern Indigo Snake)**. USA: GEORGIA: Pierce Co.: Blackshear (31.300588°N, 82.246831°W; WGS 84). 17 May 2013. Alexander D. McKelvy. Verified by Nicole Castleberry (GMNH 5033 photo voucher and tissue). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.) Field series record # ADM559. Male measuring ~1.9 m found DOR in urban area on State Hwy 84/38. Potentially suitable indigo habitat is located ~2.8 km E of this location along the NE bank of the Satilla River.

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***FARANCIA ABACURA* (Red-bellied Mudsnake)**. USA: TENNESSEE: Carroll Co.: U.S. Route 79 ca. 6.5 km SW of McKenzie (36.073982°N, 88.564575°W; NAD 83). 8 August 2013. James Flaherty, Michael Fulbright, Aaron Ross, and Shawn Settle. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19424). New county record (Scott and Redmond. 2008 [latest update: 1 August 2013]. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/ [accessed 14 August 2013]). A second specimen (APSU 19425) was found within 1 km of the first, just two days later. Both specimens were found dead on a heavily trafficked road that bisects a large, vegetated wetland.

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***HETERODON SIMUS* (Southern Hog-nosed Snake)**. USA: FLORIDA: Bay Co: Pine Log State Forest, 0.45 km N jct. State Road 79 and Gumlock Cemetery Road (30.3955°N, 85.8732°W; WGS84). 16 June 2008. Andrea N. Drayer. Verified by Kevin M. Enge. Florida Museum of Natural History, UF 170589 (photo voucher). New county record (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final report, Florida Fish and Wildlife Conservation Commission, Tallahassee. 524 pp.). Gravid female captured in sandhill habitat.

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***IMANTODES GEMMISTRATUS* (Central American Tree Snake).** MÉXICO: QUINTANA ROO: Municipality of Bacalar: Sitio Experimental San Felipe Bacalar, Zona 1 (18.748253°N, 88.327936°W; WGS84), 30 m elev. 19 November 1981. Juan Nava-Solorio. Verified by Luis Canseco-Márquez. Herpetological Collection, Museo de Fauna Silvestre Juan Nava Solorio, Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias, Sitio Experimental San Felipe Bacalar, Quintana Roo (SESFB-H-058). New municipality record, extending known range ca. 70 km S from the closest known locality, 16.9 mi (ca. 27 km) S Felipe Carrillo Puerto (Lee 1996. The Amphibians and Reptiles of the Yucatán Peninsula. Cornell Univ. Press, Ithaca, New York. xii + 500 pp.). Additionally, this record extends the range ca. 103 km E from the closest locality in Campeche (Calderón-Mandujano et al. 2003. Herpetol. Rev. 34:269–272) and closes the gap between the northeastern and southwestern populations on the Yucatán Peninsula. The specimen is a juvenile found in tropical deciduous forest.

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***LAMPROPELTIS NIGRA* (Black Kingsnake).** USA: TENNESSEE: Lawrence Co.: Front yard of 106 Hunter Road, Summertown, Tennessee (35.388345°N, 87.396551°W; WSG 84). 6 April 2013. Kayla Clark and Nicole Foster. Verified by A. Floyd Scott. Austin Peay State University (APSUMZ 19415). New county record (Scott and Redmond 2008 [latest update: 1 August 2013]. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/ [accessed 1 August 2013]).

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***OPHEODRYS AESTIVUS AESTIVUS* (Northern Rough Greensnake)** USA: ALABAMA: Escambia Co.: DOR on Escambia County Rd. 4, 25 m E of Escambia County Rd. 11, Conecuh National Forest (31.06919°N, 86.79368°W; WGS 84). 27 June 2013. S. Graham, M. Herr, J. Williams, and M. Goldy-Brown. Verified by David Laurencio (AUM 40269). New county record (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn Printing Co., Auburn. 347 pp.).

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***OPHEODRYS AESTIVUS AESTIVUS* (Northern Rough Greensnake).** USA: ARKANSAS: Pope Co.: Dover city limits. (35.401471°N, 93.114341°W, WGS 84). 17 May 2013. J. Kremers. Verified by S. E. Trauth. Arkansas State University Museum of Zoology, Herpetological Collection (ASUMZ 32751). New county record; fills gap among previous records in Johnson (Trauth et al. 2004. Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.), Van Buren (Engelbert et al. 2007. Herpetol. Rev. 38:221), and Yell counties (Robison and McAllister 2008. Herpetol. Rev. 39:244–245).

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***PANTHEROPHIS SPILOIDES* (Gray Ratsnake).** USA: TENNESSEE: Carroll Co.: Milan Army Ammunition Plant (35.85388°N, 88.67111°W; WGS 84). 14 May 2013. Michael C. Fulbright and James P. Flaherty. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19428). New county record (Scott and Redmond 2008 [latest update: 01 August 2013]). Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/ [accessed 10 August 2013]).

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***PANTHEROPHIS VULPINUS* (Eastern Foxsnake).** USA: WISCONSIN: Rock Co.: Town of Avon, Avon Bottoms Wildlife Area (42.53693°N, 89.30708°W; WGS 84). 1 July 2013. Karl M. Rutzen and Joshua M. Kapfer. Verified by Erik Wild. University of Wisconsin-Whitewater Collections (UWWHERP 0043 photo voucher). New county record (Casper 1996. Geographic Distributions of the Amphibians and Reptiles of Wisconsin. Milwaukee Public Museum, 87 pp.; Casper 1999. Herpetol. Rev. 30:181–182). Fills the gap in the currently known range of this species in Wisconsin. A juvenile individual was captured under an artificial cover object. Surrounding habitat was primarily open prairie with sandy soils (associated plant species observed include *Tradescantia* sp., *Lupinus* sp.) with adjacent sedge meadow wetland. A second road-killed juvenile was obtained on 8 July 2013. Most land parcels in the immediate vicinity appeared to be active agriculture.

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***PITUOPHIS CATENIFER SAYI* (Bullsnake).** USA: ILLINOIS: Lee Co.: Nachusa Grasslands, 5.9 km NW Franklin Grove (41.88511°N, 89.34151°W; WGS 84). 15 August 2013. T. G. Anton and D. Mauger. Verified by Chris Phillips at the Illinois Natural History Survey

(Unvouch 42959, digital image). New county record (Phillips et al. 1999. Field Guide to Amphibians and Reptiles of Illinois. Illinois Natural History Survey, Urbana, Illinois. 282pp). Adult male, 154 cm S-VL, found alive on the shoulder of Lowden Rd. at 1459 h. Grassland-dominated habitat was present on both sides of the road. The species has been documented from adjacent Ogle County and reported from Nachusa Grasslands without prior documentation with photos or specimens.

The 2013 Herpetofaunal Survey was funded by a grant from The Friends of Nachusa Grasslands with access and support provided by The Nature Conservancy.

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***RENA DULCIS* (Texas Threadsnake)**. USA: COLORADO: Baca Co.: Two Buttes SWA, 0.5 mi S of Prowers Co. line (37.6364778°N, 102.53639167°W; WGS84). 14 May 2012. Verified by J. Hobert. University of Northern Colorado Museum of Natural History (UNC-MNH 4685). The specimen represents a roughly 80 km northward range extension in Colorado (Hammerson 1999. Amphibians and Reptiles in Colorado: A Colorado Field Guide, 2nd ed. University Press of Colorado and Colorado Division of Wildlife, Niwot, Colorado. 484 pp.). Single adult female (2.63 g; 21.9 cm SVL; 1.1 cm TL) encountered alive under rock in sand sage prairie. A species of special concern known from only a few specimens in Colorado.

Specimen was collected under Colorado Division of Wildlife Scientific Collection license (#12HP950) issued to SPM.

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***STORERIA DEKAYI* (Dekay's Brownsnake)**. USA: GEORGIA: Henry Co.: on private residence off of Hearthstone Drive (33.560223°N, 84.16194°W; WSG 84) May 2013. J. Agan. Verified by Nikki Castleberry. UGA 50352. New county record (Jensen et al. [eds.] 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). Adult under leaf debris in Ocmulgee River floodplain.

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***STORERIA OCCIPITOMACULATA* (Red-bellied Snake)**. USA: ALABAMA: Lauderdale Co.: Shoal Creek Preserve Forever Wild Tract (34.916437°N, 87.618602°W; WGS84). 27 July 2010. Ashley S. Peters and Brian D. Holt. Photographic voucher (AUM AHAP-D 645). Verified by Craig Guyer. New county record (Mount 1975. Reptiles and Amphibians of Alabama. Agricultural Experiment Station, Auburn University, Alabama. 347 pp.). Hand captured juvenile on predominantly hardwood slope with sandy soils. An adult (AUM AHAP-D 646 photo voucher) was observed under a cover board on 23 September 2010.

We thank Craig Guyer for verifying these records and Eric Soehren for reviewing this note.

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***STORERIA STORERIOIDES* (Mexican Brownsnake)**. MÉXICO: GUANAJUATO: Municipality Of Cortazar: Cerro El Culiacán, 6 km ENE of Victoria de Cortazar (20.345000°N, 100.976028°W; WGS84), 2646 m elev. 26 July 2009. José Carlos Arenas and Christian Martin García Balderas. Verified by Edmundo Pérez Ramos. MZFC 27073. New municipality record and third locality from Guanajuato, bridging a gap between Sierra de Santa Rosa, Guanajuato populations (Ernst 2008. Cat. Amer. Amphib. Rept. 860:1–4) and Tzitzio, Michoacán populations (Duellman 1961. Univ. Kansas Publ. Mus. Nat. His. 15:1–148). The snake was found under a rock in oak forest.

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***TANTILLA BOCOURTI* (Bocourt's Black-headed Snake)**. MEXICO: OAXACA: Municipality of Oaxaca de Juárez: Agencia San Luis Beltrán (17.095514°N, 96.688878°W; WGS84), 1550 m elev. 30 June 2013. Elí García-Padilla. Verified by Larry D. Wilson. Photographic voucher, UTEP G 2013.2. This individual represents a new municipality record, the second report for Oaxaca, and a range extension of ca. 160 km SSE from the nearest known locality in the vicinity of Santiago Chazumba (Canséco-Márquez and Gutiérrez-Mayén 2010. Anfibios y Reptiles del Valle de Tehuacán-Cuicatlán. Comisión Nacional para el Conocimiento y Uso de la Biodiversidad, Fundación para la Reserva de la Biósfera Cuicatlán A.C., Benemérita Universidad Autónoma de Puebla, México, D.F. xvi + 302 pp.). The snake was found in an empty lot surrounded by an urban housing development.

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***THAMNOPHIS RADIX* (Plains Gartersnake)**. USA: ILLINOIS: Ogle Co.: Nachusa Grasslands, 5.9 km NW Franklin Grove (41.9045°N, 89.3281°W; WGS 84). 2 September 2010. M. King and R. B. King. Verified by Chris Phillips. Illinois Natural History Survey (Unvouch 42967 digital image). New county record (Phillips et al. 1999. Field Guide to Amphibians and Reptiles of Illinois. Illinois Natural History Survey, Urbana, Illinois. 282 pp.). Fills gap among Stephenson, Winnebago, and Lee counties. Juvenile found under cover board in Clear Creek Unit between Lowden and Carthage roads in grassland-dominated habitat. Nine additional individuals have been observed at the Clear Creek and Holland Prairie units in Ogle County managed by Nachusa Grasslands.

The 2013 Herpetofaunal Survey was funded by a grant from The Friends of Nachusa Grasslands with access and support provided by The Nature Conservancy.

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***THAMNOPHIS SIRTALIS PARIETALIS* (Red-sided Gartersnake)**. USA: ARKANSAS: Marion Co.: Yellville (36.226182°N, 92.684888°W; WGS 84). August 2005. Unknown collector. Verified by S. E. Trauth. Arkansas State University Museum of Zoology, Herpetological Collection (ASUMZ 32764, photo voucher of 26 July 2013). First definitive record from the state; previous record for this subspecies from Lawrence Co. (McDaniel and Byrd 1975. Herpetol. Rev. 6:116) is not valid given the variation in "red" specimens from eastern Arkansas (S. E. Trauth, pers. comm.). Specimen is an adult female that gave birth to a litter of 20 live young in 2005 and was subsequently donated to the Arkansas Game and Fish Commission Fred Berry Conservation Education Center (CEC) in Yellville, where it remains for viewing. Trauth et al. (2004. Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.) noted that Conant and Collins (1998. Amphibians and Reptiles of Eastern and Central North America. 3rd ed. expanded, Houghton Mifflin Co., Boston, Massachusetts. 450 pp.) indicated the presence of *T. s. parietalis* in western Benton Co., Arkansas. However, Trauth et al. (*op. cit.*) further mentioned they were unaware of any voucher specimens for this subspecies in the state; thus, we report the first one.

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***THAMNOPHIS SIRTALIS SIRTALIS* (Eastern Gartersnake)**. USA: ALABAMA: Escambia Co.: Escambia County Rd. 4, 10 m E of Escambia County Rd. 11, Conecuh National Forest (31.06922°N 86.79408°W; WGS 84). 25 June 2013. S. Graham and M. Herr. Verified by David Laurencio. AUM AHAP-D 683 (digital photo voucher). New county record (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn Printing Co., Auburn, Alabama. 347 pp.).

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***VIPERA AMMODYTES* (Long-nosed or Nose-horned Viper)**. GREECE: CYCLADES Pref.: Rhinia Island (37.384338°N, 25.246775°E; WGS 84; 39 m elev.). 23 June 2011. Stephanos A. Roussos and Llewellyn D. Densmore III. Verified by M. Dimaki and J. Foufopoulos. University of Michigan Museum of Zoology, Division of Reptiles and Amphibians (Digital Image Collection number 1230, photographic voucher, one individual). New island record (Chondropoulos 1989. Herpetozoa 2:3–36). This record fills a gap in the viper's distribution of the northern islands in the Cyclades among the most proximal islands: Delos, Mykonos, and Tinos. Three individuals were found on the southern part of the island; two females under rocks and one male in a rock wall.

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New Distributional Records for Amphibians and Reptiles from the State of Tamaulipas, México III

This is the third and final contribution to a series of articles reporting new distributional information on the herpetofauna of Tamaulipas, Mexico (Farr et al. 2007, 2009). Twenty-nine species are reported herein, including two new state records. In addition to noting range extensions discovered in the course of conducting fieldwork and examining museum specimens, we include notes on several species previously reported from Tamaulipas in the literature, sometimes from a single specimen or locality, or from a very limited number of localities in outdated sources (e.g., Amaral 1930 (1929); Duellman 1958; Martin 1955, 1958; Oliver 1948; Peters 1951; Smith 1947; Stuart 1941). Although the occurrence of these species in Tamaulipas is widely accepted and reflected in contemporary literature, their exact distributions within the state have never been examined or clearly defined, despite the accumulation of additional museum vouchers over the last half century. We update and clarify the distributions of a number of such species by reporting a single record form each municipality the species is known to occur in (although some are known from several localities in each given municipality), including records that delineate the distributional limits and maximum elevations within the state known to us. Also included are notes on three species that have been inferred to occur in Tamaulipas in previous literature and websites based on records from adjacent areas of neighboring

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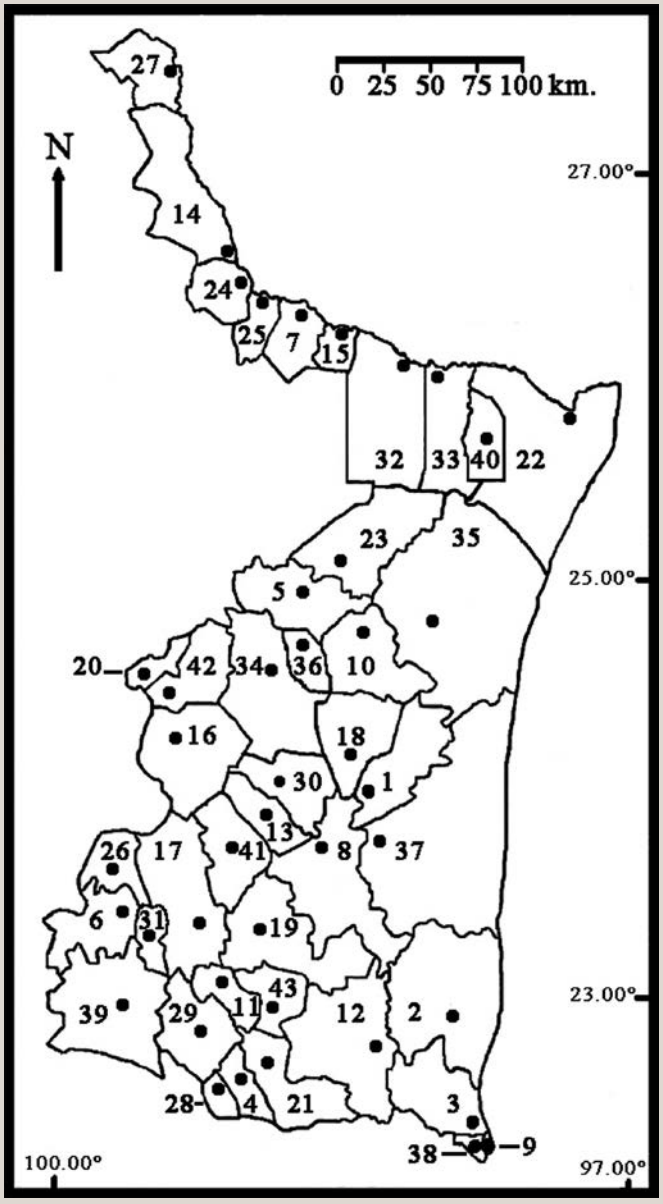


FIG. 1. Map of Tamaulipas, México showing the generalized distribution of its 43 municipalities (equivalent to U.S. counties) and the capital city or town (= •) of each bearing the same name: 1. Abasolo; 2. Aldama; 3. Altamira; 4. Antiguo Morelos; 5. Burgos; 6. Bustamante; 7. Camargo; 8. Casas; 9. Ciudad Madero; 10. Cruillas; 11. Gómez Farías; 12. González; 13. Güémez; 14. Guerrero; 15. Gustavo Díaz Ordaz; 16. Hidalgo; 17. Jaumave; 18. Jiménez; 19. Llera; 20. Mainero; 21. Mante, El; 22. Matamoros; 23. Méndez; 24. Mier; 25. Miguel Alemán; 26. Miquihuana; 27. Nuevo Laredo; 28. Nuevo Morelos; 29. Ocampo; 30. Padilla; 31. Palmillas; 32. Reynosa; 33. Río Bravo; 34. San Carlos; 35. San Fernando; 36. San Nicolás; 37. Soto La Marina; 38. Tampico; 39. Tula; 40. Valle Hermoso; 41. Victoria; 42. Villagrán; 43. Xicoténcatl.

states; even though those species might occur in the state, we are unaware of any confirmed records. Comments on some problematic taxonomic issues involving Tamaulipas species that are in need of status updates are also noted.

The following accounts are based on a review of the literature: 16,133 museum voucher specimens from the subsequent institutions (abbreviations follow Sabaj Pérez 2013), including 11,071 examined by WLF from: AMNH, ANSP, BYU, CAS, CM, FMNH, INHS, KU, LACM, LSUMZ, LSUS, MPM, MVZ, OMNH, OSUS, ROM, SDSNH, SRSU, TCWC, TNHC, TU, UANL, UCM, UF, UIMNH, UMMZ, USNM, UTA, and UTEP, and additional unexamined museum records from: FWM, JFBM, MCZ, MSUM, NMSU, SMBU, UAZ. An additional 2735 field records and photo vouchers were collected during fieldwork by WLF during 2003–2009 (316 field days). DL conducted statewide surveys of the Tamaulipas herpetofauna during 1996–1997 and made additional irregular fieldtrips in the state during 1977–2009 (118 field days). PALM lived in Tamaulipas for 24 years (1978–2002), and conducted statewide surveys while working from 1996 to 2002 at ITCV (Instituto Tecnólogico de Ciudad Victoria), during which time he assembled a collection of ca. 950 specimens from the state that was subsequently transferred to UANL in 2009; the UANL collection currently holds 2377 voucher specimens from Tamaulipas. All museum specimens referenced below were verified by Javier Banda-Leal and UTADC photo vouchers by Jonathan A. Campbell, unless stated otherwise. Distances are expressed in air (not road) km, unless otherwise noted. Locality coordinates and elevations of original field data were determined using a GPS device using map datum WGS84. For older museum and literature locality records that did not include coordinates and elevations we have supplemented these data using topographic maps and Google Earth (map datum WGS84) and present those here in brackets [ ]. The supplemental data in brackets should be regarded as approximate collecting localities. For a few particularly vague localities requiring some speculation, coordinates are preceded by "ca." Martin (1958), which to this day is probably the single most significant publication on the Tamaulipas herpetofauna, referenced Aserradero del Paraíso, Aserradero del Refugio I, and Aserradero del Refugio II, long abandoned lumber camps and sawmills that were active in the region from 1951 to the early 1970s, but have since been reclaimed by the forest; we were unable to identify them with exact coordinates. Also, many of the elevations for localities given by Martin (1958) were imprecise or generalized and do not always agree with elevations provided by current topographic maps, GPS units, and Google Earth. Elevations that differ significantly are also presented in brackets [ ] following the original elevations. Common names follow Liner and Casas-Andreu (2008), with one exception: we follow Keiser (1982), who noted in his review of *Oxybelis aeneus* that it is highly variable in color and pattern and preferred the name Neotropical Vinesnake over Brown Vinesnake. In the following text, when referring to municipalities, they are specified as such (e.g., Municipality of Tula) and the capital community is referred to only by its name (e.g., Tula) (Fig. 1).

CAUDATA — SALAMANDERS

***AMBYSTOMA* (Mole Salamanders).** The following are comments on what is known about the distributions of *Ambystoma mavortium* (Barred Tiger Salamander) and *Ambystoma velasci* (Plateau Tiger Salamander) in Tamaulipas. Despite several records of *A. mavortium* in adjacent counties of Texas (Dixon 2013), and records of *A. velasci* in the vicinity of Doctor Arroyo in neighboring Nuevo León (Irschick and Shaffer 1997; Liner et al. 1976; Reese 1971), and San Luis Potosí (Lemos Espinal and Dixon 2013; Taylor 1952, 1953), as well as implications that both species occur in the state (AmphibiaWeb 2013; Gehlbach 1967; Hammerson et al. 2004; Shaffer et al. 2010), we are unaware of any verifying literature records, museum records, or field records for any *Ambystoma* from Tamaulipas. Although speculative, the southern

distributional limit of *A. mavortium* in Texas— occurring exactly at the USA-Mexican boundary (Irschick and Shaffer 1997; Morafka 1977; Petranka 1998)—could be explained if *Ambystoma* was introduced into the region by Texas fishermen as commercially available bait. We are unaware if *Ambystoma* was ever commercially distributed or customarily used as bait in Tamaulipas.

ANURA — FROGS

***ANAXYRUS SPECIOSUS* (Texas Toad)**. Municipality of Casas: On Hwy 75 (Soto La Marina-Casas), 11 km. NW of Soto La Marina (23.8318°N, 98.3077°W), 42.6 m elev. 10 October 2005. William L. Farr. UANL 6445. Municipality of El Mante: Mante, southern city limits, irrigation canal [ca. 22.7184°N, 98.9805°W, 88 m elev.]. Edmund D. Keiser, Jr., Don E. Ashurst, and Robert A. Thomas. 21 August 1967. LSUMZ 63523. Municipality of González: Magiscatzin [22.800°N, 98.700°W, 51 m elev.]. 6 July 1951. E. R. Burdine. TCWC 6992. Municipality of San Carlos: Hwy 89, 10 km. SE of San Carlos (24.4930°N, 98.8900°W), 362 m elev. 7 August 2005. William L. Farr. UTADC 7576. Municipality of Soto La Marina: Rancho La Rosita, 10 km E of Soto La Marina [23.7978°N, 98.0621°W, 37 m elev.]. 11 March 2000. Angel D. Hernández García. UANL 7408. We have not found any detailed reviews that included specific localities and museum records for this species in Tamaulipas and available maps provide only generalized ranges in the state (Conant and Collins 1998; Morafka 1977; Smith 1947; Stebbins 2003). The above localities define its southern distributional limit on the coastal plain of Tamaulipas and UTADC 7576 is from the highest elevation reported from the state. We have available 351 museum records (326 examined) for this species from 19 municipalities (Burgos, Camargo, Casas, Cruillas, El Mante, González, Güémez, Jiménez, Llera, Matamoros, Méndez, Mier, Miguel Alemán, Padilla, Reynosa, San Carlos, San Fernando, Soto la Marina, Victoria), and our field records include observations from three additional municipalities (Guerrero, Gustavo Díaz Ordaz, Hidalgo). A museum specimen (TCWC 9261) with an imprecise locality, "25 mi N Ciudad Mante" [40.22 road km N on Hwy 85, ca. 23.076°N, 99.1066°W, 113 m elev.], likely originated from the municipality of Xicoténcatl, or possibly Gomez Farías or Llera. *Anaxyrus speciosus* appears to be absent from the Sierra de Tamaulipas, and has not been recorded significantly south of the Río Soto La Marina to the northeast of that mountain range. However, southwest of the Sierra de Tamaulipas it occurs as far as Ciudad Mante and Magiscatzin, but no records are available east of Magiscatzin on the southern coastal plain. Even though the maximum elevation recorded from Tamaulipas was in the foothills of the Sierra San Carlos at 362 m, it reaches higher elevations in Chihuahuan Desert environments in SE New Mexico (900–1300 m, Degenhardt et al. 1996) and a little higher (1314 m) on the Indio Mountains in Trans-Pecos, Texas (Couvillon 2011).

***INCILIUS NEBULIFER* (Gulf Coast Toad)**. Municipality of Tula: Tula [23.0000°N, 99.7104°W, 1183 m elev.]. 20 July 1996. David Lazcano, Alan Kardon, Mike Bishop, David Jacobo Galván. UANL 4117–4118. Carretera Tula-Ocampo en Sierra de Tula [state Hwy 66, 22.9508°N, 99.6062°W, 1461 m elev.]. 7 September 1996. David Lazcano and David Jacobo Galván. UANL 4218. 14 km NE of Tula in the Sierra Mocha (23.0311°N, 99.5841°W), 1740 m elev. 16 September 2009. William L. Farr. UTADC 7593. Near Ejido San Pablo, 15 km SW of Tula (22.8972°N, 99.8236°W), 1064 m elev. 12 October 2007. William L. Farr. UTADC 7592. Respective range extensions of 37 km W, 26.5 km WSW, 24.5 km WNW, and 49.5 km SW from the nearest record "near Aserradero del Refugio No 1, 1050 m elev.," Municipality of Ocampo [ca. 22.9833°N, 99.3499°W, 971 m elev.] (Martin 1958). These are first municipality records, westernmost localities for the state, and first records from the arid interior of the plateau region of Tamaulipas (Mendelson 1998; Mulcahy and Mendelson 2000; Porter 1964). Additional field observations include a few from the Municipality of Miquihuana on the night of 11 August 2003 on the road from La Peña [23.5584°N, 99.6962°W, 1807 m elev.] SE toward Hwy 101 [ca. 23.4936°N, 99.6423°W, 1724 m elev.] in Chihuahua Desert scrub. We have 1140 museum records (921 examined) including verified records from 32 municipalities (Abasolo, Aldama, Altamira, Antiguo Morelos, Camargo, Casas, Cruillas, El Mante, Gómez Farías, González, Güémez, Guerrero, Hidalgo, Jaumave, Jiménez, Llera, Ciudad Madero, Mainero, Matamoros, Méndez, Miguel Alemán, Nuevo Morelos, Ocampo, Padilla, San Carlos, San Fernando, Soto la Marina, Tampico, Tula, Victoria, Villagrán, Xicoténcatl) and our field records include observations from three additional municipalities (Miquihuana, Reynosa, San Nicolás). Among the remaining municipalities of Tamaulipas, it should be anticipated with near certainty in Burgos, Gustavo Díaz Ordaz, Mier, Nuevo Laredo, Río Bravo, and Villa Hermoso; its occurrence in Palmillas is likely, but its presence in Bustamante is questionable. Martin (1958) reported the maximum elevations in Tamaulipas at 1520–1550 m from La Joya de Salas [23.1722°N, 99.3000°W]. In field surveys, *I. nebulifer* was common in the Sierra Madre Oriental between 400–1250 m elevations, significantly less common from 1250–1500 m, and only observed twice between 1500–1800 m. *Incilius nebulifer* is one of the most abundant species of the herpetofauna and nearly ubiquitous in Tamaulipas, being absent only from areas above ca. 1800 m elevation in the Sierra Madre. We have observed it near sea level no more than 45 m from coastal mangrove lagoons, and in thorn scrub, tropical deciduous forest, cloud forest, Chihuahuan Desert flats, and other vegetation zones and ecotones, as well as urban environments and agricultural areas. It is possible that recent changes in land use, such as construction of manmade water tanks and irrigation practices associated with commercial agriculture have facilitated the dispersal and bolstered populations of *I. nebulifer* in the desert flats of Tula Valley. However, those elements would seem less likely to be factors regarding their occurrences in the relatively undisturbed Miquihuana Valley, and the species is known to occur in other eastern regions of the Chihuahua Desert (Flores-Villela 1993; Lemos-Espinal and Smith 2007; Morafka 1977; Schmidt and Owen 1944)

***ELEUTHERODACTYLUS DENNISI* (Dennis's Chirping Frog)**. Municipality of El Mante: Grutas de Quintero, 1.5 mi [2.4 km] SW Quintero [22.6486°N, 99.0416°W, 201 m. elev.]. 13 July 1964. Sherman A. and Madge R. Minton. AMNH 182639. Municipality of Gómez Farías: Río Frío Dulgés, cueva del nacimiento del río [ca. 22.9876°N, 99.1525°W, 205 m. elev.]. 16 February 1970. V. Wade, TNHC 83571. In a cave a near Gómez Farías (23.0411°N, 99.1333°W), 270 m. elev. 9 August 2004. William L. Farr and Tim Burkhardt. UANL 6739. First municipality records for each and range extensions of five, 43.5, and 47 km N, respectively, from the only other known locality for the species at its type locality, Municipality of Antiguo Morelos at "a cave near El Pachón 8 km. N. Antiguo Morelos, Tamaulipas, México, 250 m" (Frost 2013; Lynch 1970). El Pachón is now officially recognized by both state and federal governments as Praxedis Guerrero and depicted by that name on current maps. Reddell and Mitchell (1971) identified

and mapped five caves in the area, and in our field surveys we explored four caves within 2.5 km of Praxedis Guerrero, and locals informed us of more. Presumably the cave referred to by Reddell and Mitchell (1971) as Cueva de el Pachón [22.6070°N, 99.0487°W], which is closest to the town, is the type locality although this was not made explicitly clear by Lynch (1970). We did not observe *E. dennisi* in this cave in our field surveys, but did find them in other caves nearby. Five *E. dennisi* were found beneath rocks on the floor and on walls within nooks and crannies less than 1 m above floor in a cave near Gómez Farías, of which only one was retained as a voucher specimen. The surrounding vegetation there was tropical deciduous forest. *Eleutherodactylus dennisi* occur in caves in the Tamaulipas section of the Sierra Cucharas (= Sierra de El Abra in Reddell and Mitchell 1971) and adjacent areas of the Sierra de Guatemala between 201–270 m elevation. Its occurrence is anticipated in the Sierra Cucharas of San Luis Potosí if its distribution mirrors that of *Lepidophyma micropholis*, a species that shares the type locality and seemingly the same microhabitat (Bezy and Camarillo 2002).

There is a profound need for a review, at the species level, of *Eleutherodactylus* previously assigned to the genus *Syrrhophus* (Lynch 1970) and subgenus *Syrrhophus* (Hedges 1989). We tentatively follow Lynch's (1970) characters of color pattern and small tympanum size in recognizing *E. dennisi* herein, although there are some indications that *E. dennisi* might represent a clinal variant in lower elevational populations of *E. longipes*.

***LEPTODACTYLUS MELANONOTUS* (Sabinal Frog).** Municipality of Aldama: on road to El Sabino 2 mi. E of Aldama [22.915°N, 98.047°W, 80 m elev.]. 8 April 1949. Paul Martin, Richard Robins, and William Heed. UMMZ 101187 A-I. Municipality of Altamira: 8 mi N Tampico [ca. 22.406°N, 97.931°W, 20 m elev.]. 27 June 1953. J. W. Graber. OMNH 26476, 26477, 26478. Municipality of El Mante: Approx. 5 rd. mi. SW. Cd. Mante, El Nacimiento Rd. [22.69344°N, 99.0291°W, 94 m elev.]. 8 July 1965. Douglas A. Rossman, Edmond D. Keiser Jr. and R. Earl Olson. LSUMZ 11087. Municipality of Gómez Farías: Km 610, 7 km. E. Gómez Farías [23.031°N, 99.093°W, 99 m elev.]. 2 July 1961. Ernest A. Liner. UIMNH 64617. Municipality of González: Río Guayalejo near Magiscatzin [22.7972°N, 98.7121°W, 38 m elev.]. 22 December 1939. Archie F. Carr, Jr. UMMZ 88243. Municipality of Ocampo: In the town of Ocampo (22.8522°N, 99.3363°W), 347 m elev. 22 September 2006. William L. Farr, James R. Dixon, and Toby J. Hibbitts. UTADC 7577. Municipality of Soto La Marina: Los Ébanos Rancho; 6.0 km SW, 4.8 km S Tepehuajes [23.477°N, 97.800°W, 19 m elev.]. 8 January 1992. James R. Dixon. TCWC 70394. Municipality of Xicoténcatl: El Encino, 6 mi S of El Encino at Los Kikos [= Los Kikos, 9 km S of El Encino, 23.0830°N, 99.1103°W, 118 m elev.]. 4 July 1966. Ernest A. Liner and Larry D. Wilson. CM 63953 and AMNH 177381–177383. An additional museum record (JFBM 4617) from the Municipality of Tampico, at Tampico [22.240°N, 97.857°W, 5 m elev.] collected 26 July 1957 by J. H. Campbell has not been examined by us. Martin (1958) reported *L. melanonotus* from the Gómez Farías region and correctly speculated that it occurred throughout the coastal plain of southern Tamaulipas south of the Tropic of Cancer, but presented no specific data. Heyer (1970) only included Tamaulipas specimens in his review that were collected by Paul Martin and associates from the Gómez Farías area and considered locality data for a specimen (UIMNH 29817), allegedly from Star County, Texas, to be in error. Some internet accounts underestimate the distribution in Tamaulipas (e.g., AmphibiaWeb 2013; Solís et al. 2010). We have 84 museum vouchers (72 examined) including eight verified municipality records (Aldama, Altamira, El Mante, Gómez Farías, González, Ocampo, Soto La Marina, Xicoténcatl) and one unexamined record from the Municipality of Tampico. *Leptodactylus melanonotus* typically occurs in tropical deciduous forest and in riparian areas on the coastal plain of southern Tamaulipas at elevations below 347 m, including the Chamal Valley west of the Sierra Cucharas and the Ocampo Valley west of the Sierra Tamalave. It appears to be absent from the Sierra de Tamaulipas. In field surveys we found it to be locally abundant in Tamaulipas, but unevenly distributed and apparently absent from many areas supporting appropriate habitat. On the night of 10 September 2007 one of us (WLF), accompanied by Tim Burkhardt, heard a chorus calling from a flooded field near the intersection of Hwy 180 and Hwy 70 (23.7318°N, 98.2205°W), 17 m elev., which represented the northernmost locality for the species, although no voucher specimens or photographs were taken. We are of the opinion that locality data for a specimen (LSUMZ 11060) allegedly collected at Rancho del Cielo [23.1°N, 99.1925°W, 1190 m elev., in cloud forest] is in error and that it was probably found at a lower elevation in tropical deciduous forest a few km to the east.

***PSEUDACRIS CLARKII* (Spotted Chorus Frog).** Municipality of Matamoros: km 10, Camino El Refugio-La Burrita [25.8989°N, 97.3378°W, 6 m elev.]. June 2000. Pablo A. Lavín Murcio. UANL 7333–7334. This is only the second locality recorded for the species in Mexico and a range extension of ca. 22 km E of the other Mexican records (CAS-SUR 315449–450) from 5 km W of Matamoros, Tamaulipas [ca. 25.8693°N, 97.5530°W, 10 m elev.] (Duellman 2001; Lynch 1965), published as 5 mi W of Matamoros by Lynch (1965). The ITCV catalogue had four specimens listed from this locality (ITCV 417, 605–607), however when the collection was transferred and re-catalogued at the UANL only two specimens were found and examined. The locality is in the vicinity of a Resaca in the flood plain of the Río Grande, which supports grassland and thorn scrub vegetation. Additional material (not examined) includes a lot of tadpoles (OMNH 26519) collected by O. Sanders with no date or locality other than Tamaulipas, Mexico.

SQUAMATA — LIZARDS

***COPHOSAURUS TEXANUS* (Greater Earless Lizard).** Municipality of Casas: Cd. Victoria, 33 mi [53 km] E Soto La Marina Rd. [Mexican Hwy 70, 23.6448°N, 98.6460°W, 233 m elev.]. 6 July 1963. Sabath McKinney. TNHC 30326. Municipality of Güémez: 25 km N Ciudad Victoria [ca. 23.9604°N, 99.1145°W, 187 m elev.]. 13 August 1965. A. C. Echternacht. KU 95534. Municipality of Hidalgo: [Santa] La Cruz, 66 km N Ciudad Victoria, 1 km W Hwy 1 [24.1860°N, 99.3650°W, 275 m elev.]. 5 August 1950. Collector unknown. UIMNH 19267. Municipality of Jiménez: 44 mi [70.7 km] S jct. De las Conchas River [= Río San Juan, = Rio San Fernando] on Rt. 101 [24.2815°N, 98.4580°W, 191 m elev.]. 22 February 1971, J. Barry Kirby. LSUMZ 70677. Municipality of Padilla: [Antigua] Padilla, 1 mi [1.6 km] S of [23.993°N, 98.7772°W, 127 m elev.]. 26 August 1963. Sherman A. and Madge B. Minton. UMMZ 125710. Municipality of Victoria: 5 mi [8 km] S Ciudad Victoria [ca. 23.6642°N, 99.1009°W, 326 m elev.]. 23 July 1950. A. W. Jackson. TCWC 7011. New municipality records and range extensions of 114 km SSE, 74 km SSW, 61 km SW, 67 km SE, 66 km SSW, and 107 km S, respectively, from the nearest published locality in the Municipality of San Carlos at Marmolejo [24.6258°N, 99.0031°W,

550 m elev.] (UMMZ 69216–17; Gaige, 1937; Peters, 1951). Each of these six localities represents significant extensions of the species on the Gulf coastal plain of Tamaulipas (Conant and Collins 1998; Morafka 1977; Peters 1951; Stebbins 2003). All localities for the species in Tamaulipas are west of the Bordas Escarpment as illustrated by Johnston (1963). We did not encounter *C. texanus* in any of the municipalities reported above in our field surveys or in any of the localities reported by Martin (1958) in the municipalities of Gómez Farías, Jaumave, and Ocampo in the south of the state, all of which are over 40 years old, which suggests the species is either rare, declining in numbers, or receding in distribution in those areas of the state. In field surveys we found *C. texanus* to be abundant on the plateau in the Municipality of Tula and occasionally observed in the Municipality of Miquihuana at 1038–1900 m. elev.; along the coastal plain and in the Sierra San Carlos we found the species to be abundant in the Municipality of San Carlos and occasionally observed it in the Municipalities of Hidalgo, Mainero, and Villagrán between 344–601 m elev. We observed *C. texanus* in a variety of arid and semiarid vegetation zones including rocky stream beds within oak forest of the Sierra San Carlos and well into the canyons on the eastern versant of the Sierra Madre Oriental draining onto the Gulf coastal plain.

***HOLBROOKIA LACERATA* (Spot-tailed Earless Lizard).** Although the literature implies this species occurs in the far northwestern "pan handle" region of Tamaulipas (Axtell 1956, 1968, 1998; Conant and Collins 1998; Morafka 1977), we are unaware of any museum vouchers or specific literature records from the state. Due to records in adjacent areas of Texas and Coahuila (Axtell 1968; Dixon 2013; Lemos-Espinal and Smith 2007), particularly Falcon Heights, near Falcon Dam, in Star County, Texas [26.565°N, 99.125°W, 98 m elev.] (Axtell 1998), *H. lacerata* most likely occurs in Tamaulipas. On 6 October 2007, in the Municipality of Miguel Aleman, 16 km SSW of Miguel Aleman (26.2556°N, 99.0604°W, 100 m elev.), one of us (WLF) observed a lizard that appeared to be *H. lacerata*, but it eluded capture, so its identification is not unequivocal or verifiable. This species has recently been reported to be in serious decline and extirpated from some areas of its historic range in Texas (Duran and Axtell 2010).

***HEMIDACTYLUS TURCICUS* (Mediterranean House Gecko).** Municipality of Tula: Hotel Jorge in Tula (22.9900°N, 99.7206°W), 1156 m elev. 19 September 2009. William L. Farr. UANL 7094. This is the first record of this exotic species from the plateau region of Tamaulipas west of the Sierra Madre Oriental (Conant and Collins 1998; McCoy 1970), first municipality record, and a range extension of 75 km WNW at El Limón, in the Municipality of El Mante [22.83°N, 99.012°W, 73 m elev.], UMMZ 104077 (Martin 1958).

***SCINCELLA SILVICOLA* (Taylor's Ground Skink).** Municipality of Antiguo Morelos: 10.9 mi [17.5 km] S. Mante on Hwy 85 [22.6086°N, 99.0236°W, 272 m elev.]. 31 March 1972. P. J. Conzelmann. LSUMZ 72299. Municipality of Bustamante: 7.5 mi [12 km] W Palmillas, Hwy 101 [23.2921°N, 99.6638°W, 1726 m elev.]. 26 June 1976. James R. Dixon and Carl S. Lieb. TCWC 52506. Municipality of Jaumave: On the road to Avila y Urbina, 31 km NW of Jaumave (23.6019°N, 99.6025°W, 1703.1 m elev.). 15 October 2006. William L. Farr and Andrew Godambe. UTADC 7578. Municipality of Palmillas (very near Tula boundary): 21 km S of Palmillas on the road through San Vicente (23.1105°N, 99.5497°W), 1425 m elev. 9 July 2005. William L. Farr and José Cortés Larriva. UTADC 7578. Municipality of Tula: On the road to Lagunas Las Hondas, 24 km SE of Tula (22.8125°N, 99.5583°W), 1229 m elev. 24 August 2006. William L. Farr. UANL 6494. Municipality of Victoria: Altas Cumbres Carr. Victoria km 157 [23.6067°N, 99.2055°W, 1270 m elev.]. 24 November 1996. David Lazcano. UANL 4305. We were unable to find a comprehensive or detailed review on the distribution of *S. silvicola* in Tamaulipas. We have 39 museum records (35 examined) available from 20 localities in eight municipalities in the state and an additional 33 field records from 11 localities in five municipalities. Previous records include Martin (1958) who reported a number of records from the Gómez Farías region where several municipality boundaries converge, including: Municipality of Gómez Farías, Rancho del Cielo [23.1°N, 99.1925°W], 1050 [1177] m elev. and 6 km N Gomez Farías [ca. 23.1079°N, 99.1538°W], 120 [135] m elev.; Municipality of Jaumave, La Joya de Salas [23.1666°N, 99.2999°W], 1500 m elev.; Municipality of Ocampo, slopes N of El Tigre [ca. 22.9785°N, 99.3603°W], 1000–1050 m elev.; Municipality of Tula, Sierra de Tula at 1260 elev. [ca. 22.9602°N, 99.6501°W, 1363 m elev.]; Municipality of Xicoténcatl, Mesa Josefeña, 120–300 m elev. [23.1083°N, 99.0851°W, 217 m elev.]. Two additional literature records include SMBU 8594-6 (not examined) from Municipality of Ocampo, 5 mi W Chamal [22.8170°N, 99.2666°W, 462 m elev.] (Auth et al. 2000) and MZFC 8514 (not examined) from Municipality of Gómez Farías, Gómez Farías [23.0472°N, 99.1551°W, 390 m elev.] (García-Vázquez et al. 2010). We have thus verified records of *S. silvicola* from nine municipalities in Tamaulipas (Antiguo Morelos, Bustamante, Gómez Farías, Jaumave, Ocampo, Palmillas, Tula, Victoria, Xicoténcatl), from low to moderate elevations (ca. 135–1726 m) in the Sierra Madre Oriental. Museum records and field surveys suggest it is absent from higher elevations in these mountains, which reach over 3400 m in Tamaulipas, and the arid interior ranges west of the Tula Valley. Canseco-Márquez et al. (2004) previously reported a range of 300–1800 m elev. throughout the Sierra Madre Oriental.

SQUAMATA — SNAKES

***RAMPHOTYPHLOPS BRAMINUS* (Brahminy Blindsnake).** Municipality of El Mante: Hwy 85, ca. 4 km S of Ciudad Mante (22.7108°N, 98.9900°W), 82 m elev. 10 June 2004. 2004 UTA Mexico field Trip. UTA 53054. First record for Tamaulipas. *Ramphotyphlops braminus* is an introduced species and a comprehensive review detailing its distribution in Mexico has not been published. It has been reported from adjacent Texas (Cameron and Hidalgo counties, Merino et al. 2009) and from other states in northeastern Mexico, including: Nuevo León (Nevárez 1999), Veracruz (Mendoza-Quijano et al. 1993), Hidalgo (Hernández-Salinas and Ramírez-Bautista 2010), and Querétaro (Dixon and Hendricks 1979). This snake was found under a cinder block at a gas station and it is unknown if it represents an established population.

***ADELPHICOS NEWMANORUM* (Newman's Earth Snake).** Municipality of Gómez Farías: Gómez Farías, ca. 1 mi [1.6 km] NW of, on Road to Rancho del Cielo [ca. 23.0769°N, 99.1768°W, 791 m elev.]. 26 August 1972. Jeremy F. Jacobs and George J. Jacobs. USNM 244768. First municipality record and a range extension of 23 km NE from the nearest locality, 13 km N of Ocampo [22.9659°N, 99.3654°W, 1000 m elev.] in the Municipality of Ocampo (Martin, 1955, 1958). Martin (1955, 1958) reported the only published records for *A. quadrivirgatus newmanorum* in

Tamaulipas based on a series of 11 specimens collected in a day and a half in April 1953 with help from a 30 man road-building crew. *Adelphicos newmanorum* was not encountered in our state surveys and the lack of additional museum records from the heavily surveyed Gómez Farías region suggests this species is highly secretive or rare in Tamaulipas.

The genus *Adelphicos* is in need of an updated systematic review. A number of authors appear to have missed Martin's records, and the northern distributional limit of the genus on the eastern versant of Mexico has often been reported in the literature as central Veracruz (e.g., Campbell and Ford 1982; Köhler 2003; Lee 1996, 2000; Peters and Orejas-Miranda 1970). Contreras-Arquieta (1989) and Lazcano et al. (2004, 2005) reported records of *A. q. newmanorum* in the neighboring state of Nuevo Leon. Additionally, five variants or combinations of names have been applied to populations from Tamaulipas and adjacent areas of NE Mexico in past and recent years: *A. quadrivirgatus newmanorum* (Martin 1955, 1958; Smith et al. 2001; Lazcano et al. 2004, 2005); *A. quadrivirgatus* (Canseco-Márquez et al. 2004; Dixon and Lemos-Espinal 2010; Lavin-Murcio, et al. 2005a; Murillo et al. 2003); *A. quadrivirgatum* (LaDuc 1995; Lemos-Espinal and Dixon 2013; Ramírez-Bautista et al. 2010); *A. quadrivirgatum newmanorum* (Liner and Casas-Andreu 2008); and *A. newmanorum* (Taylor 1950; LaDuc 1996; Wilson and Johnson 2010; Wilson et al. 2013). Wilson and Johnson (2010) and Wilson et al. (2013) recognized *A. newmanorum* (Taylor 1950) as a full species without comment, although this was based largely on LaDuc (1996; unpubl. thesis) who indicated this population was diagnosable and allopatric (a separate evolutionary lineage) from *A. quadrivirgatum* that ranges from central Veracruz southeastward into Central America. Murillo et al. (2003) and Ramírez-Bautista et al. (2010) reported *A. quadrivirgatum* from NE Hidalgo in areas adjacent to LaDuc's (1996) records for *A. newmanorum* in SE San Luis Potosí and NE Querétaro, and although they did not describe morphological characters, based on distribution we tentatively regard them as *A. newmanorum* here. Future collecting could produce more specimens within the hiatus between the Hidalgo and Veracruz records, but we tentatively follow Taylor (1950), LaDuc (1996), Wilson and Johnson (2010), and Wilson et al. (2013) in recognizing *A. newmanorum* as a distinct species pending new information resolving the issue.

***FICIMIA HARDYI* (Hardy's Hook-nosed Snake).** Municipality of Bustamante: Near La Joya de Herrera, 7 km W of Bustamante (23.4225°N, 99.8211°W), 1947 m elev. 19 September 2007. Tim Burkhardt and William L. Farr. UANL 6480. Municipality of Jaumave: On the road to Avila y Urbina, 33 km NW of Jaumave (23.6017°N, 99.6023°W), 1738 m elev. 5 September 2005. William L. Farr. UANL 6427. First state and municipality records, northernmost localities from throughout the species range, and extensions of 95.5 km and 125 km, respectively, NE from the nearest record at San José de las Flores, Municipality of Guadalcázar, San Luis Potosí (22.7380°N, 100.3900°W), 1850 m elev. (Hernandez-Ibarra et al. 1999; Ramírez-Bautista et al. 1999). The Bustamante specimen was found in high elevation Chihuahuan Desert scrub where adjacent slopes supported stands of juniper trees (*Juniperus angostturana, J. flaccida*). The Jaumave snake was found in moderately open dry pine-oak forest; both were found under rocks. This species was described by Mendoza-Quijano and Smith 1993) and is known form only a few specimens, all found on the semiarid interior western slopes and ranges of the Sierra Madre Oriental in Hidalgo, San Luis Potosí, and Tamaulipas (Hernandez-Ibarra et al. 1999; Mendoza-Quijano and Smith 1993).

***HETERODON KENNERLYI* (Mexican Hog-nosed Snake).** Municipality of Matamoros: Matamoros [ca. 25.8860°N, 97.5010°W, 9 m elev. January–February, 1853 *fide* Conant (1968)]. Lieut. Darius Nash Couch. USNM 1282 [two specimens]. 5 mi [8.04 km] S Matamoros [25.8025°N, 97.5235°W, 9 m elev.]. 11 June 1958. J. Shaffner, D.A. Langebartel, and J. Winkelmann. UIMNH 42848. Municipality of Padilla: 6 mi [9.65 km] W Padilla [24.0739°N, 98.9826°W, 166 m elev.]. 12 June 1950. A. F. Dittman and W. P. Kerr. TCWC 7001–7002. Municipality of Reynosa: On Hwy 97, 7 mi [11.26 km] S jct. Hwys 97 and 2 (40) S of Reynosa [25.9357°N, 98.2697°W, 60 m elev.]. 19 July 1970. R. W. McDiarmid. LACM 114105. Municipality of San Fernando: 41.2 mi [66.29 km] S Matamoros [25.3669°N, 97.8721°W, 10 m elev.]. 30 June 1963. Ernest A. Liner and Richard Whitten. AMNH 158668. An additional specimen is from Rancho Santa Ana, 8 mi [12.87 km] SE of [Antiguo] Padilla [23.9768°N, 98.7246°W, 126 m elev.]. 27 December 1941. Archie F. Carr Jr., MCZ R-46335 (not examined). These eight specimens from four Tamaulipan municipalities include all museum and literature records known to us and we did not encounter *H. kennerlyi* in field surveys. The distribution of *H. kennerlyi* in Tamaulipas has been overestimated in previous literature (Conant and Collins 1998; Platt 1969; Stebbins 2003; Walley and Eckerman 1999; Werler and Dixon 2000). In the state, we have no records of the species occurring within the Sierra Madre Oriental, on the interior plateau, or south of 23.97°N on the Gulf coastal plain. In Tamaulipas, *H. kennerlyi* is known from four records within 12 km of the Río Grande, three isolated records along the Río Purificación in the Municipality of Padilla, and one record from 66 km S of Matamoros. The most recent museum record known to us was collected 42 years ago, although we have viewed photographs of *H. kennerlyi* informally circulated on the internet, purportedly taken during the last five years in the vicinity of Antiguo Padilla [24.0096°N, 98.7762°W, 136 m elev.]. All localities except Reynosa (LACM 114105) were from the general vicinity of riparian habitats on the coastal plain from near sea level to 166 m elev. All those habitats have been severely degraded or entirely altered by urbanization, agriculture, or in one instance submerged after the construction of Presa Vicente Guerrero.

***IMANTODES CENCHOA* (Blunt-headed Tree Snake).** Municipality of Aldama: 9.5 mi [15.28 km] N Aldama [23.0505°N, 98.0322°W, 237 m elev.]. June 1975. L. Landry. LACM 119185. Municipality of Antiguo Morelos: Carretera Nuevo Morelos-Antiguo Morelos [Hwy 80], 20.32 km al E de Nuevo Morelos (22.5518°N, 99.1376°W) [303 m elev.]. 28 March 1997. Ramiro David Jacobo-Galván. UANL 4474. Municipality of Casas: On the "old" highway from Victoria to Soto La Marina (23.5725°N, 98.5227°W), 441.9 m elev. 24 October 2004. William L. Farr. UANL 6383. Municipality of Llera: Hwy 85, 6 km N of El Encino (23.1902°N, 99.0980°W), 238.8 m elev. 9 August 2004. William L. Farr and Tim Burkhardt. UANL 6362. Municipality of Nuevo Morelos: Hwy 80, 1 mi [1.6 km] E Nuevo Morelos [22.5437°N, 99.2026°W, 272 m elev.] 7 August 1975. Jonathan A. Campbell et al. UTA 4672. Municipality of Ocampo: Hwy between Santa María de Guadalupe and Ocampo (22.8707°N, 99.3927°W), 382 m elev. 19 September 2004. William L. Farr. UANL 6366. Municipality of Soto La Marina: Carretera 180 Aldama-Soto La Marina, km 61 [23.4719°N, 98.0102°W, 74 m elev.]. 20 July 1996. David Lazcano Villarreal and "Brown Tracks" (Alan Kardon, Mike Bishop, David Jacobo Galván and

students). UANL 4116. All first municipality records. A complete range-wide review of this species is needed (*fide* McCranie 2011), and although its occurrence in southern Tamaulipas is widely reported in the literature, its distribution within the entire state has never been addressed. Martin (1955, 1958) reported two localities in the municipality of Gómez Farías: source of the Río Frío ca. 5 km [6.2 km] SSE of Gómez Farías [22.9927°N, 99.1444°W, ca. 150 m (95 m) elev.]; Pano Ayuctle (= El Azteca) [23.1130°N, 99.1434°W], 100 m elev. [123 m]. The latter is located on the Río Sabinas, which forms the border of the municipalities of Gómez Farías and Xicoténcatl. We have records of 22 specimens (19 examined) from 21 localities, including verified records from eight municipalities (Aldama, Antiguo Morelos, Casas, Gómez Farías, Llera, Nuevo Morelos, Ocampo, Soto La Marina). *Imantodes cenchoa* most often inhabits tropical deciduous forest associated with the foothills and lower elevations of the Sierra Madre Oriental, Sierra de Tamaulipas, and adjacent areas of the Gulf coastal plain at elevations up to 441 m in southern Tamaulipas. It is less commonly found in tropical thorn forest and occasionally in coastal plain grasslands.

***LAMPROPELTIS SPLENDIDA* (Desert Kingsnake).** Municipality of Guerrero: 10 road mi [16.09 km] S Laredo on Route 85 [27.3211°N, 99.5874°W, 150 m elev.]. 30 August 1968. E. D. Keiser, Jr. and P. A. Keiser. LSUMZ 76222. 21 km S Nuevo Laredo on Mexican Hwy 85 [27.2940°N, 99.6026°W, 143 m elev.]. 30 June 1986. D. G. Barker and J. R. Forester UTA 17793. Municipality of Nuevo Laredo: 8 mi [12.87 km] S Nuevo Laredo [27.3480°N, 99.5734°W, 120 m elev.]. 7 May 1967. James R. McCranie and L. Porras. UCM 50387. This species was not encountered in our field surveys and the three localities listed above include every museum record from Tamaulipas known to us, all of which are from the same stretch (ca. 40 km) on Hwy 85 S of Nuevo Laredo, in the extreme NW panhandle region. Blaney (1977) accurately mapped the distribution of *L. getula splendida* in Tamaulipas, including an additional record unknown to us from the vicinity of Ciudad Camargo or Gustavo Díaz Ordaz. However, subsequent literature has significantly overestimated its range on the Gulf coastal plain of Tamaulipas (Conant and Collins 1998; Morafka 1977; Pyron and Burbrink 2009a, 2009b; Stebbins 2003), including all areas between "dots" in S Texas and extreme NW Tamaulipas as well as records to the south from San Luis Potosí on the Mexican plateau, apparently with little consideration for the lack of any records and the geographic features (Sierra Madre Oriental) separating these localities. We have no evidence suggesting that *L. splendida* occurs in Tamaulipas south of the above records and consider that maps in Blaney (1977), Werler and Dixon (2000) and Dixon and Werler (2005) illustrate its distribution in south Texas and Tamaulipas most accurately.

In their review of *L. getula*, Pyron and Burbrink (2009a,b), who elevated *L. g. splendida* and *L. g. holbrooki* to full species, did not include samples from S Texas or NE Mexico, but predicted *Lampropeltis holbrooki* would occur there based on ecological niche models, even though the precise western extent of the range was unclear and a question mark was included on their map in the vicinity of the Tamaulipas populations referred to herein. Historically the populations occurring in S Texas and Tamaulipas have been considered *L. g. splendida* based on morphological characters, including dorsal scale counts and color patterns (Blaney 1977; Conant and Collins 1998; Dixon 2000; Stebbins 2003; Werler and Dixon 2000). In their species diagnosis, Pyron and Burbrink (2009a) cite Blaney (1977) as having defined *L. holbrooki* with 19–25 midbody scale rows and *L. splendida* typically with 23–25, indicting an overlap in that character between the two taxa. In our reading of Blaney (1977), the definitions indicated *L. g. splendida* with 23 or 25 dorsal scale rows and 21 in *L. g. holbrooki*; individuals in a putative intergrade zone had 23 dorsal scale rows. Based on our examination of morphological characters of the Tamaulipan material (mid-body dorsal scale rows >23, dorsal patterns with head and neck predominantly black followed by a row of distinct and well defined black body blotches from neck to tail, and ventral patterns predominantly black from the posterior neck region to the tail with lighter colors encroaching on the lateral edges, although lighter colors occasionally traverse the ventral surface [on UCM 50387]), these specimens are unambiguously consistent with *L. splendida*.

***LEPTODEIRA MACULATA* (Southwestern Cat-eyed Snake).** Municipality of Llera: 37 rd. mi [59.5 km] S Victoria, 0.6 mi [0.96 km] S jct. with Llera rd. on Rt. 85 [23.3156°N, 98.9888°W, 257 m elev.]. 18 August 1971. Edmund D. Keiser, Pat A. Keiser, and Mark Keiser. LSUMZ 76307. Municipality of Ocampo: On Hwy between Nicolás Bravo and Ocampo (22.8705°N, 99.3919°W), 385.8 m elev. 20 September 2004. William L. Farr. UANL 6367. Municipality of Soto la Marina: Río Soto la Marina, Rancho la Rosita 127 km NE of Ciudad Victoria (23.7738°N, 98.2166°W), 12 m elev. 11 October 2000. Angel D. Hernández García. UANL 7976. The Soto La Marina specimen is the northernmost record from throughout the species distribution, including the Gulf coastal plain, extending the range 174 km N from Tampico [22.240°N, 97.857°W, 5 m elev.] (Duellman 1958). The Llera specimen is the northernmost interior record in the state, extending the range 15.75 km NW from Hacienda La Clementina, near Forlón [23.2642°N, 98.8453°W, 200 m elev.] (Duellman 1958). The Ocampo specimen is the westernmost record in Tamaulipas, extending the range 17 km W over the Sierra de Tamalave into the Ocampo Valley from 4 km NW of Chamal [22.8614°N, 99.2261°W, 174 m elev.] in the Chamal Valley (Duellman 1958). Duellman (1958) is the most recent publication to report any localities from Tamaulipas.

There has been some confusion regarding the status of this taxon in recent literature. Duellman (1958) described *L. annulata cussiliris* and 50 years of subsequent literature referred to the Tamaulipas population by that name. Duellman (1958) also recognized *L. maculata* as a distinct species from the west coast of Mexico. Recent molecular-based studies of phylogenetic relationships within *Leptodeira* have demonstrated that *L. annulata* and *L. septentrionalis* are polyphyletic (Daza et al. 2009; Mulcahy 2007) and elevated the former subspecies *L. a. cussiliris* to full species, *L. cussiliris*. Daza et al. (2009) established that *L. maculata* was nested within *L. a. cussiliris* and concluded that *L. maculata* "should therefore be synonymized" with *L. cussiliris*; then stated that "Species delimitation and description is, however, outside the scope of this study, and taxonomic changes will be treated elsewhere," in opposition to their earlier assessment, leaving the status somewhat unstable. Wilson et al. (2013) and Uetz (2013) pointed out that *L. maculata* (Hallowell, 1861; as *Megalops maculatus*) has priority over *L. cussiliris*, although we note the type locality of *L. maculata* has a convoluted history (Duellman 1958); until future taxonomic analyses counter the patterns supported by Mulcahy (2007) and Daza (2009), the correct name should be *L. maculata*. There is an increasingly common practice of systematic reviews identifying polyphyletic species and other incongruous taxonomy, but concluding without a clear arrangement and updated nomenclature (see *Rhadinaea* below).

Sixty-six museum specimens (60 examined) are known to us from the state, including verified records from ten municipalities (Aldama, Antiguo Morelos, El Mante, Gómez Farías, González, Llera, Ocampo, Soto la Marina, Tampico, Xicoténcatl). *Leptodeira maculata* occurs on the southern Gulf coastal plain of Tamaulipas from near sea level to 510 m elev. including the Chamal Valley and the Ocampo Valley in tropical deciduous forest, thorn scrub, and thorn forest. Martin (1958) stated *Leptodeira maculata* invariably occurred near water; however we have found them on several occasions well over a kilometer from any known source of permanent water.

***LEPTODEIRA SEPTENTRIONALIS* (Northern Cat-eyed Snake).** Municipality of Miquihuana: 14.5 km SE of Miquihuana (23.4975°N, 99.6422°W), 1724 m elev. 14 October 2006. William L. Farr and Andrew Godambe. UANL 6504. Municipality of Palmillas: 15 km south of Palmillas, on the dirt road through San Vicente and on to Tula. (23.1672°N, 99.5538°W), 1506.6 m elev. 11 July 2004. William L. Farr, James R. Dixon, Ricardo Enrique-Nuñez, Mike Forstner, Gilberto Herrera-Patiño, Oscar M. Hinojosa-Falcón, Pablo A. Lavín-Murcio, Armando Martínez. UTADC 7580. Municipality of Tula: 3 km N of El Refugio, 18.5 km NE of Tula (23.0472°N, 99.545°W), 1137.3 [1175] m elev. 16 October 2006. William L. Farr and Andrew Godambe. UTADC 7581. In the forest on the north side of Hwy 66, 15 air km E of Tula (22.9308°N, 99.5861°W), 1376 m elev. 18 September 2009. William L. Farr. UTADC 7582. First municipality records for each, westernmost localities for the species in Tamaulipas, and westward range extensions of 50 km NW, 26 km W, 28 km SW, and 39.5 km SW, respectively, from the nearest locality at La Joya de Salas [23.1722°N, 99.3000°W, 1540 m elev.] (Duellman 1958; Martin 1958). These records effectively extend the distribution westward from the Gulf coastal plain and humid eastern slopes of the Sierra Madre Oriental, into the arid interior western slopes and onto the threshold of the Mexican plateau where the Sierra Madre transitions into the Chihuahuan Desert. We have 125 museum vouchers (106 examined), including verified records from 23 municipalities (Aldama, Altamira, Burgos, Casas, Cruillas, Gómez Farías, González, Güemez, Jaumave, Jiménez, Llera, Matamoros, Miquihuana, Nuevo Morelos, Ocampo, Padilla, Palmillas, San Carlos, San Fernando, Soto La Marina, Tula, Victoria, and Xicotencatl). An additional unexamined specimen (UAZ 27016) from the municipality of Antiguo Morelos, collected 6 August 1967 by Robert Bezy and Charles J. Cole at "El Pachon (cave at), 8 km. (road) NNE of Antiguo Morelos" [22.6070°N, 99.0487°W] is likely valid; however, due to the remarkable resemblance between *L. septentrionalis* and the sympatric *L. maculata* we regard this unexamined record with slight caution. *Leptodeira septentrionalis* occurs in a wide spectrum of vegetation zones in Tamaulipas (Martin 1958) from near sea level up to 1724 m elev. The specimen from Miquihuana was found DOR in Chihuahuan Desert scrub characterized by *Agave lechuguilla*, scattered juniper trees (*Juniperus angosturana, J. flaccida*), and barrel cactus (*Ferocactus* sp.) in the adjacent foothills.

***LEPTOPHIS MEXICANUS* (Mexican Parrot Snake).** Municipality of Aldama: Aldama, NE of Rancho Nuevo, 9 mi [14.48 km.] N of Barra del Tordo [23.1843°N, 97.7790°W, 11 m elev.]. 17 May 1978. Diderot Gicca. USNM 209853. Municipality of Altamira: Altamira [22.4023°N, 97.9330°W, 24 m elev.]. 14 April 1898. Edward A. Goldman USNM 046524. Municipality of Antiguo Morelos: On the dirt road from Adolfo López Mateos (aka Chamal) to Hwy 85 just N of Antiguo Morelos (22.6072°N, 99.0847°W), 170.7 m elev. 24 September 2004. William L. Farr. UANL 6370. Municipality of El Mante: Mexico Route 85, 0.8 mi N El Abra [22.6330°N, 99.0225°W, 119 m elev.]. 4 July 1977. John E. Cadle. MVZ 146962. Municipality of Llera: El Guayabo, Carr. Ciudad Victoria-Mante [23.1980°N, 99.0988°W, 271 m elev.]. 15 October 1989. Pablo A. Lavín-Murcio. UANL 7982. Municipality of Ocampo: Chamal Tamps, 2 mi [3.22 km] N [22.8766°N, 99.1942°W, 151 m elev.]. 18 July 1965. Harrison Gilbert. TNHC 32772. Municipality of Soto La Marina: km 14.5, Carr. La Pesca-Soto la Marina at naval base, rumbo a Soto la Marina (23.8113°N, 97.9380°W), [12 m elev.]. 19 July 1997. David Lazcano and students. UANL 4886. On "new" highway 70, 3 km W of Soto La Marina (23.7644°N, 98.2405°W), 37.2 m elev. 16 May 2007. William L. Farr and Oscar Gallardo. UANL 6525. Km 60, Carr. Casas-Soto la Marina, rumbo a Soto la Marina [ca. 23.6600°N, 98.3416°W, 245 m elev.]. 18 July 1997. David Lazcano and students. UANL 4871. Municipality of Tula: On Hwy 66, 15 air km E of Tula (22.9308°N, 99.5861°W), 1376.4 m elev. 18 September 2009. William L. Farr. UANL 7093. Municipality of Victoria: Cañón de Las Burras [within Cañón del Novillo, ca. 23.7142°N, 99.2769°W, 600–900 m elev.]. 23 March 2001. Teresa Alfaro. UANL 7984. We have found no comprehensive review or map detailing the distribution of *Leptophis mexicanus* in Tamaulipas more recent than Oliver (1948), who stated *L. mexicanus* occurred in extreme southern Tamaulipas and included two dots on his map from the vicinity of Altamira and Tampico. Oliver (1948) also listed two examined specimens, one from Altamira (oddly none from Tampico), and another from central Tamaulipas in the Municipality of Padilla but that was not mapped or discussed, at "La Laguna, Doña [Santa] Ana, Mexico" [23.9768°N, 98.7246°W, 126 m elev.] [submerged by Presa Vicente Guerrero in the late 1970s], collected 22 December 1941 by Archie Carr Jr. MCZ R-46372 (not examined). Martin (1958) reported 21 records, mostly from the Municipality of Gómez Farías, although six records were from Pano Ayuctle [= El Azteca, 23.1130°N, 99.1434°W, 123 m elev.], located on the Xicoténcatl-Gómez Farías border, and four others from the Municipality of Ocampo. Mertens (1973) only included records from Tampico. We have records for 55 museum specimens (48 examined) from Tamaulipas, including verified records from 10 municipalities (Aldama, Altamira, Antiguo Morelos, El Mante, Gómez Farías, Llera, Ocampo, Soto la Marina, Tula, Victoria), and an unexamined literature record from the Municipality of Padilla (northernmost record). Its occurrence in the Municipality of Xicoténcatl should be anticipated with near certainty. Martin (1958) stated the species was limited to tropical deciduous forest and lower sections of the cloud forest. However, it is obvious from museum records and our field observations that the species inhabits more than those two vegetation zones in Tamaulipas. *Leptophis mexicanus* occurs throughout the Gulf coastal plain south of 23.9768°N where it has been found in grasslands, tropical thorn forest, tropical deciduous forest, tropical evergreen forest, lower sections of cloud forest, and pine-oak forests of the Sierra de Tamaulipas and eastern slopes of Sierra Madre Oriental at elevations up to1376 m.

***MASTIGODRYAS MELANOLOMUS* (COMMON LIZARD EATER).** Municipality of Antiguo Morelos: 10 km N Antiguo Morelos [22.6083°N, 99.0241°W, very near El Mante border, 274 m elev.]. 28 May 1966. E. L. Roth. TCWC 76954. 7.4 km W Antigua Morelos on Mex. Hwy 80 [22.5517°N, 99.1463°W, very near Nuevo Morelos municipality border, 382 m elev.]. 22 August 1985. Steve Hammack and others. UTA 16124. Municipality of Gómez Farías: Ej. Alta Cima [23.0588°N, 99.1967°W, 903 m elev.]. 25 May 1995. Oscar

Hinojosa-Falcón. UANL 8000. 1.9 mi [3 km] E Gómez Farías town square by Gómez Farías Rd. [23.0257°N, 99.1396°W, 292 m elev.]. 3 July 1977. John E. Cadle. MVZ 146965. Municipality of Llera: Galeana, 34 mi [54.7 km] N Ciudad Mante on Hwy 85 [23.2066°N, 99.1020°W, 296 m elev.]. 20 July 1970. R. W. McDiarmid. LACM 114115. Municipality of Ocampo: 2 km W Chamal [22.8328°N, 99.2147°W, 158 m elev.]. 30 July 1976. Sherman A. Minton and Madge R. Minton. AMNH 162221. First municipality records for each except Gómez Farías and range extensions of 45.4 km SE for TCWC 76954; 47 km SSE for UTA 16124; 15.2 km S for AMNH 162221, from the nearest record at Aserradero del Paraíso (Martin 1958); and 11.2 km NW for LACM 114115 from the nearest record at Pano Ayuctle (Martin 1958). The Llera record (LACM 114115) is the northernmost record from throughout the species range and the Gómez Farías locality (UANL 8000) is the highest confirmed elevation in Tamaulipas. Although the distribution of *M. melanolomus* is widely reported to include southern Tamaulipas, we are unaware of any detailed review or map of its distribution there. Stuart (1941) included Tamaulipas in the distribution of *M. melanolomus*, but he did not list or map any localities from the state. Previous records include Auth et al. (2000), from 5 mi [8.04 km] E of Gómez Farías [23.0184°N, 99.1187°W, 122 m elev.] (SMBU BCBF 67-1204, not examined) and Martin (1958) from Pano Ayuctle [23.1127°N, 99.1433°W], 100 m elev. (UMMZ 101231–101232); Gómez Farías [23.0471°N, 99.1552°W], 350 m elev. (UMMZ 110832); 3 km WNW of Pano Ayuctle [23.1054°N, 99.1567°W], 300 [148] m elev. (UMMZ 111253); Aserradero del Paraiso [ca. 22.9688°N, 99.2352°W], 450 (765) m elev. (UMMZ 111101); and Rancho del Cielo [23.1°N, 99.1925°W], 1050 [1176] m elev. (UMMZ 112911). All of those records could have originated from the Municipality of Gómez Farías, although Pano Ayuctle [= El Azteca] is located on the Xicoténcatl-Gómez Farías boundary. Also, Aserradero del Paraíso, the site of a sawmill abandoned in the mid-1960s, could have been in either the Municipality of Ocampo or Gómez Farías. Martin (1958) doubted the validity of the locality for UMMZ 112911 from Rancho del Cielo in cloud forest. The Alta Cima record (UANL 8000) reported here, at 903 m elevation, is just below the lower limit of the cloud forest and likely represents the elevation limit in the state. In Costa Rica, Savage (2002) reported it ranging from 4–1760 m elevation, but we are unaware of any records below 122 m elev. in Tamaulipas. All totaled, we have only 13 museum records available from Tamaulipas (12 examined), with confirmed occurrences in four municipalities (Antiguo Morelos, Gómez Farías, Llera, Ocampo), although it is to be anticipated in the Municipalities of El Mante, Nuevo Morelos, and Xicoténcatl. In Tamaulipas, *M. melanolomus* has only been recorded in a remarkably narrow longitudinal zone (99.0241°W–99.2352°W) in the south central region of the state, S of Llera, at elevations between 122–903 m on the eastern slopes of the Sierra Madre Oriental and in the Chamal Valley in tropical deciduous forest and evergreen forest.

***OXYBELIS AENEUS* (Neotropical Vinesnake).** Municipality of Casas: On "old" highway 70, 37 km SE of Casas (23.6044°N, 98.3986°W), 455 m elev. 25 October 2006. William L. Farr. UANL 6517. Municipality of Casas or Soto La Marina: very near their borders on Hwy 70 (the old southern Casas-Soto Marina road), 26 km SW of Soto La Marina (23.6104°N, 98.3911°W), 447 m elev. 5 August 2005. William L. Farr. UANL 6420. Municipality of Ocampo: 21 km NW of Ocampo (22.9919°N, 99.4711°W), 663 m elev. 16 October 2006. William L. Farr and Andrew Godambe. UANL 6505. First municipality records for Casas and Ocampo (and possibly for Soto La Marina). Northernmost records for Tamaulipas and range extensions of 48.9 and 49.1 km N, respectively, for the Casas and Casas/Soto La Marina records from the nearest record (MCZ 55821, not examined) at Las Yucas, Aldama [23.2291°N, 98.1448°W, 332 m elev.] (Keiser 1974). Westernmost record from Tamaulipas and a range extension of 33 km W for the Ocampo record from the nearest locality at Gómez Farías [ca. 23.0471°N, 99.1552°W, 390 m elev.] (Martin 1958). Keiser (1974) reviewed the range-wide distribution of *O. aeneus* and although listing collections utilized, he did not identify specimens examined or specific localities, and included no records north of the Tropic of Cancer on the eastern versant of Mexico. Keiser (1982) included one record from the vicinity of Monterrey, Nuevo León. A specimen listed in the ITCV (601) catalogue from the Municipality of Victoria, Cañón del La Peregrina, Ej. La Libertad [ca. 23.7769°N, 99.2090°W, 390 m elev.] collected on 16 March 2000 by Arnulfo Moreno was not found when that collection was transferred to UANL and is presumed lost. However, that locality seems plausible considering the record from Monterrey, Nuevo León. We have 18 records (16 examined) from Tamaulipas, including 14 verified records from five municipalities (Aldama, Casas, Gómez Farías, Llera, Ocampo), four records from localities very near municipality boundary lines (1 Casas-Soto La Marina, 1 Gómez Farías-Xicoténcatl, 2 El Mante-Antiguo Morelos), and one additional unverifiable record from the Municipality of Victoria. In Tamaulipas, *O. aeneus* occurs mostly in the lower foothills of the Sierra Madre Oriental and the Sierra de Tamaulipas and adjacent areas supporting tropical deciduous forest, and less frequently in thorn forest and riparian areas on the Gulf coastal plain at elevations from near sea level to 663 m.

***PLIOCERCUS BICOLOR* (Northern False Coral Snake).** Municipality of Ocampo: in the forest just E of the road to Emperadores Aztecas (Lagunas Las Hondas), 24 km SE of Tula (22.8036°N, 99.5530°W), 1213 m elev. 6 October 2008. William L. Farr. UTADC 7583. Municipality of Tula: In forest S of Hwy 66, 15 km E of Tula (22.9419°N, 99.5933°W), 1456 m elev. 24 September 2006. James R. Dixon, William L. Farr, and Toby J. Hibbitts. UANL 6621. First municipality records for each and southwestward range extensions of 43.5 and 39.5 km, respectively, from the nearest locality at Rancho Viejo, Municipality of Gomez Farías [23.0571°N, 99.2288°W, 1330 m elev.] [UMMZ 111036] (Martin 1958). These records also fill a gap between previously reported Tamaulipas localities in the cloud forest of the Sierra de Guatemala and records to the S at El Salto Falls, San Luis Potosí [22.5864°N, 99.3823°W, 425 m elev.], which is the type locality of *Pliocercus bicolor hobartsmithi* (Liner 1960). Although both Savage and Crother (1989) and Smith and Chiszar (2001b) provided maps that illustrated the species distribution in Tamaulipas, neither provided a list of specimens examined or data, and both maps include dots that appear to represent the type locality of *Pliocercus elapoides celatus* (Smith 1943), a junior synonym of *P. b. bicolor*, at "Ciudad Victoria." Ciudad Victoria would represent the northernmost record for the genus, although locality data for this record were noted to be in error (Martin 1958; Smith and Chiszar 2001b), a conclusion with which we agree. However, Martin's (1958) speculation that the specimen probably originated from the mountains immediately west of Ciudad Victoria is currently not supported by over half a century of additional museum records and field collections, no *Pliocercus* records have been reported from that far north or from anywhere on the lowland Gulf coastal plain of Tamaulipas. We have 64 museum

records (59 examined) and one additional field voucher. Among those 65 records, 62 are from the Municipality of Gómez Farías, one each from Ocampo and Tula, and one doubtful record from Victoria. Both of the snakes reported here were found inside rotten logs on the floor of humid oak forest.

Curiously, Martin (1958) noted that the distributions of *Micrurus* and its mimic *Pliocercus* did not overlap in the Gómez Farías region and in our statewide analysis of 54 years of additional records, we have no evidence to counter that observation. In Tamaulipas, *P. bicolor* has only been recorded in the Sierra Madre Oriental between 1000–1456 m elev. in cloud forest and humid pine-oak forest (Martin 1958). *Micrurus tener* has recently been recorded at elevations of 1066 and 1120 m in the state (Farr et al. 2009), but only in arid and semiarid environments. *Micrurus tamaulipensis* occurs in humid pine-oak forest in the Sierra de Tamaulipas between 750–1000 m (Lavín-Murcio and Dixon 2004), but no *Pliocercus* have been recorded from that isolated mountain range.

The systematics of the *Pliocercus elapoides* complex is highly contentious and many follow Savage and Crother (1989) in recognizing *Pliocercus elapoides* as monotypic, but which is highly variable in color and pattern. The arrangements of Smith and Chiszar (1996, 2001a,b), recognizing several species and subspecies in the complex, is based solely on color pattern variations correlated with geographic distributions and has been criticized (Wilson and Johnson 2010; Wilson and McCranie, 1997). Our recognition of *P. bicolor* should not be interpreted as support for Smith and Chiszar's arrangement of southern populations of the complex or for recognition of subspecies. However, Smith and Chiszar (2001a,b) demonstrated that *P. bicolor* is uniquely characterized among the complex, in addition to color pattern, by a distinguishing feature of scutellation (posterior infralabial fused with the second labiogenial) and a relatively isolated distribution, if not entirely allopatric in the Sierra Madre Oriental.

***RHADINAEA GAIGEAE* (Gaige's Pine Forest Snake).** Municipality of Tula: 13.5 km ENE of Tula in the Sierra Mocha, on the road to El Refugio (La Union) (23.0216°N, 99.5847°W), 1700 m elev. 16 September 2009. William L. Farr. UANL 7092. Carr. Tula-Ocampo entronque a terraceria km 20 [22.9407°N, 99.5921°W, 1486 m elev.]. 7 September 1996. David Lazcano. UANL 4221. Westward range extensions of ca. 28 and 30 km, respectively, from "Aserradero del Refugio No 2." [Municipality of Ocampo, ca. 23.0137°N, 99.3092°W, 1662 m elev.]. First municipality records (Dixon et al., 2011 referenced UANL 4221, but did not include data) and westernmost locality within the state (Martin 1958). Two additional records from the Municipality of Victoria, which would represent the northernmost records in the state, are problematic. One specimen (UANL 6802) lacks any data other than the locality "Cañón del Novillo" [ca. 23.6991°N, 99.2615°W, 1001 m elev.]. A second unverified specimen (ITCV 687) listed as *R. montana* from La Reja, found on 1 August 2001 by Oscar Manuel Hinojosa Falcón, Gilberto Herrera Patiño, and Ricardo Enrique Nuñez, was not located when the ITCV collection was transferred and re-catalogued at UANL, and is presumed lost. Previously published records include Martin (1958) who reported what he considered *R. crassa* (see below) from a number of localities in the Gómez Farías region near the borders of five municipalities, including indisputable localities in the Municipalities of Gómez Farías (Rancho del Cielo) and Ocampo (see above), and other imprecise localities along trails through the Sierra de Guatemala that likely encompassed the Municipality of Jaumave, "La Joya de Salas, 4 km SE" [ca. 23.1433°N, 99.2746°W, 1683 m elev.], and the Municipality of Llera "ca. 4 km N of Rancho del Cielo, 1380 m" [23.1355°N, 99.2002°W, 1380 m elev.]. Myers (1974) included an additional locality from the Municipality of Antiguo Morelos "cave at El Pachón, 8 rd. km. NNE Antiguo Morelos" (the type locality of *Eleutherodactylus dennisi* (see note in that account above) and Farr et al. (2009) reported a record from the Sierra de Tamaulipas in the Municipality of Casas. We have 109 museum records (102 examined) of *Rhadinaea* from Tamaulipas, including five verified municipality records (Antiguo Morelos, Casas, Gomez Farías, Ocampo, Tula) and additional imprecise localities and unverifiable specimens that likely include three more municipalities (Jaumave, Llera, Victoria). Members of the genus occur in cloud forest and both humid and subhumid pine-oak forests in the Sierra Madre Oriental E and S of the Jaumave Valley, and in the Sierra de Tamaulipas between 1000–1829 m elev. The Antiguo Morelos (UAZ 26582) record is notably unusual, originating from tropical deciduous forest in the Sierra Cucharas at 250 m elev. and the data for this specimen is not explicitly clear if it was found in the general vicinity of the cave, or inside the cave, which would also be notable.

Lavín-Murcio et al. (2005a,b) first included *Rhadinaea montana* among the herpetofauna of Tamaulipas based on an unexamined museum specimen (KU 129234), for which no data were provided. García-Vázquez (2012) incorrectly reported *R. montana* for the first time from Tamaulipas (Municipality of Gómez Farías, rd. from La Gloria-Las Palmas; 23.0710ºN, 99.1420ºW, 1900 m elev.). One of us (WLF) subsequently examined KU 129234 from Agua Linda, Sierra de Guatemala [ca. 23.0888ºN, 99.2611ºW, 2034 m elev., Municipality of Gómez Farías] and the vertebral stripe precisely fits the pattern illustrated by Myers (1974). However, we are reluctant to include *R. montana* among the herpetofauna of Tamaulipas in light of the discussion below. The taxonomic status of populations of *Rhadinaea* in Tamaulipas is problematic. Martin (1958) reported 78 *R. crassa* from the Gómez Farías region and suggested that both *R. montana* and *R. crassa* were conspecific with *R. gaigeae*. Myers' (1974) systematic review of the genus synonymized *R. crassa* with *R. gaigeae*, but he continued to recognize as valid *R. montana* from Nuevo Leon, known from only four individuals. Myers (1974) also recognized as valid *R. quinquelineata*, known from one specimen, and also reported that scutellation of *R. montana* fell within the range of *R. gaigeae*, so the two species were distinguishable only by subtle variations in vertebral and paravertebral stripes. Recently Dixon et al. (2011), in a non-peer reviewed journal, and McCoid and Dixon (1981) reviewed the relationship of *R. quinquelineata*, *R. gaigeae*, and *R. montana* based on morphology using a substantially larger series of 27 specimens from Nuevo Leon (*R. montana* by inference), two *R. quinquelineata*, and additional new *R. gaigeae* from a number of states including Tamaulipas. They demonstrated that the variation in color patterns used to separate *R. montana* from *R. gaigeae* were more variable in both species than was evident to Myers (1974), and noted a generalized cline from south to north of increased numbers of ventrals and subcaudals in all three species, although the counts still largely overlapped. Dixon et al. (2011) were also indecisive in their final arrangement, presenting two possible scenarios for the taxonomic status of the three species: they could be regarded as distinct species or all three could be regarded subspecies of *R. quinquelineata*; they also concluded that "a genetic comparison could prove we were wrong." Despite these shortcomings, Dixon et al. (2011) did find color pattern types used to distinguish the

three species were more variable among the various populations than previously known, and the apparent allopatric distributions among them have left their taxonomic status problematic and somewhat unstable. We concur with the allopatric distribution hypothesis based on our extensive time on the ground in the region, although this might ultimately prove to be wrong with future collecting, especially in light of the one record noted above from 250 m elev. in tropical deciduous forest. We tentatively follow the full species scenario of Myers (1974) and Dixon et al. (2011) in referring to Tamaulipas populations of *R. gaigeae* based on the likelihood of allopatry with Nuevo Leon populations of *R. montana*. However, this only highlights the critical need for further review of *Rhadinaea* from the Sierra Madre Oriental of northeastern Mexico.

***SPILOTES PULLATUS* (Tropical Tree Snake).** Municipality of Aldama: Rancho Nuevo [23.1935°N, 97.7961°W, 34 m elev.]. May 1978. Diderot F. Gicca. UF 49504 and 49506. Municipality of Casas: 54.3 mi [87.3 km] E of Jct. of Hwy 70 and 85 in Victoria on hwy70 [23.5934°N, 98.4173°W, 483 m elev.]. 28 July 1982. H. K. McCrystal. TCWC 61135. 0.45 km N of El Piruli, on "old" Hwy 70, 26 km SE of Casas (23.5766°N, 98.5347°W), 375 m elev. 18 October 2005. William L. Farr and Tiffany Kosch. UANL 6454. Municipality of Llera: El Encino, 2 mi [3.2 km] W of at Río Sabinas [23.1360°N, 99.1488°W, 139 m elev.]. 13 November 1960. James Edward Heath. LACM 20255. First municipality records for each, a range extension of 88.7 km N for the Aldama locality from Altamira [Municipality of Altamira, 22.4030°N, 97.9369°W, 13 m elev.] (Smith and Taylor 1945), and range extensions of 91 km, 80 km, and 2.6 km NE, respectively, from Pano Ayuctle (= El Azteca), Municipality of Gómez Farías [23.1130°N, 99.1434°W, 123 m elev.] (Martin 1958). The records from the Municipality of Casas represent the northernmost verifiable accounts within the entire species range (but see below). *Spilotes pullatus* has not been the subject of a range-wide review since Amaral 1930 (1929), which has since been described as inadequate (McCranie 2011; Stuart 1948), and did not include any Tamaulipas material. Velasco (1892) included *S. pullatus* in his list of Tamaulipas herpetofauna but did not provide any locality information. Martin (1958) reported 10 specimens from three localities in the Municipalities of Gómez Farías, Ocampo, and Xicoténcatl. We have 22 museum records (19 examined) composed of seven verified municipality records (Aldama, Altamira, Casas, Gómez Farías, Llera, Ocampo, Xicoténcatl). Our field accounts include an observation at the maximum elevation of 551 m for the state from W of Gómez Farías (23.0452°N, 99.1693°W), 25 September 2004, although Johnson et al. (2010) listed a maximum of 1500 m elev. in SE Mexico. One of us (PALM) observed an individual at the top of a small tree in the Municipality of Soto La Marina, 19 km W of La Pesca [23.8222°N, 97.9500°W, 57 m elev.], in July 1985, representing the northernmost observation for the species throughout its range. In Tamaulipas, *S. pullatus* occurs most often in tropical deciduous forest and tropical semi-evergreen forest, but also occasionally in thorn scrub and thorn forest.

***STORERIA HIDALGOENSIS* (Mexican Yellow-bellied Brownsnake).** Municipality of Miquihuana: 11 km La Peña-Joya Pelona [23.6027°N, 99.7072°W, 2648 m elev.]. 11 April 1996. Xochitl M. Sampablo Angel. UANL 8077. First verified municipality record and a range extension of ca. 72 km from the nearest known locality in the state, "on the trail from R. El Cielo to Lagua Zarca" [ca. 23.1484°N, 99.2013°W, 1450 m elev.], 23 August 1950, William B. Heed. UMMZ 102986 (Martin 1958). This trail passes through the Municipalities of Gómez Farías and Llera; records from Nuevo Leon might be closer. Martin (1958) reported additional records in the state, all from the Municipality of Gómez Farías, although its occurrence should be anticipated with near certainty in adjacent areas in the Municipalities of Jaumave, Llera, and Ocampo in the Sierra de Guatemala. Martin (1958) had doubts about their occurrence in cloud forest, but a series of 10 specimens from La Gloria (23.04657°N, 99.25188°W, 1631 m elev.), 13 September 1975, R. McCranie and L. Porras, LACM 122912–122921, as well as our field records, confirm its occurrence in that vegetation zone. Ernst (2008) reviewed *S. hidalgoensis*, which included western Tamaulipas (citing Martin 1958) in the description of distribution section, and included photographs of a specimen and habitat from Municipality of Miquihuana, although there are no dots on his map for the state. We confirm the occurrence in Tamaulipas with 38 museum vouchers (37 examined). It has been found in Madrean pine-oak woodlands, humid pine-oak forest, and cloud forest from ca. 900–3203 m elev. in the municipalities of Gómez Farías, Miquihuana, and probably Llera.

***TANTILLA NIGRICEPS* (Plains Black-headed Snake).** Municipality of Camargo: 12 km S of Camargo, on the road to Comales (26.2072°N, 98.8897°W), 53.4 m elev. 8 July 2007. William L. Farr. UANL 6536. Municipality of Guerrero: 16.7 mi [26.87 km] S Nuevo Laredo on Mex. Hwy 85 [27.2517°N, 99.6245°W, 130 m elev.]. 2 June 1979. Darrel R. Frost. UTA 8829. Municipality of Llera: km 196 on Carr. 85 between Ciudad Victoria-Ciudad Mante (23.5036°N, 98.9783°W), [301 m elev.]. 27 March 1997. Terry A. Hammes. UANL 4443. Municipality of Victoria: Cañón del Novillo [ca. 23.6958°N, 99.2049°W, 435 m elev.]. August 1997. Oscar M. Hinojosa-Falcón. UANL 8086. First municipality records for all. The Guerrero record is also a range extension of 102.5 km NW from the nearest Tamaulipas records at Mier, Municipality of Mier [26.4303°N, 99.1482°W, 65 m elev.], USNM 46584–46585 (Smith 1938); literature records from Texas are closer (Werler and Dixon 2000). The Camargo record fills a gap between the preceding Mier locality and 16.3 km SW of Reynosa on Mex. Hwy 40 [26.0173°N, 98.4661°W, 118 m elev.], AMNH 160359 (Liner and Dundee 1977) in the Municipality of Reynosa. The Llera and Victoria records are the southernmost records from throughout the species' entire range, and southward range extensions of 122 km and 103 km, respectively, from 2.6 mi (4.18 km) WNW San Carlos [24.6053°N, 98.9782°W, 1600 ft (488 m) elev.], TCWC 48204 (Cole and Hardy 1981). These eight records all represent verifiable *T. nigriceps* museum vouchers known to us from Tamaulipas, and include seven municipality records (Camargo, Guerrero, Llera, Mier, Reynosa, San Carlos, Victoria). Two additional specimens (TCWC 58114, 58120) from San Carlos could not be located and another (UANL 8087) lacked any data. All records are from areas W of Bordas Escarpment on the Gulf coastal plain and adjacent canyons and foot hills of the Sierra Madre Oriental and the Sierra San Carlos from 53 to 488 m elev. *Tantilla nigriceps* occurs in three seemingly disjunct regions of Tamaulipas, in the far northwest panhandle region, in the Sierra San Carlos, and in the general region around Ciudad Victoria. Nevertheless, the intervening habitats between those areas present no obvious barriers and future fieldwork might fill these gaps.

***AGKISTRODON TAYLORI* (Taylor's Cantil).** Municipality of San Fernando: Near Carboneras, Carr. Estatal No. 340 [24.6294°N, 97.7222°W, 5 m elev.]. 18 January 2000. Fernando Jiménez

Guzmán. UANL 5622. First municipality record, northeastern most record from throughout the species range, and a range extension of 94 km N of the nearest literature record, 8 km west of La Pesca [23.788°N, 97.851°W, 5 m elev.] (Burchfield 1982) and 117 km N from the nearest museum record (UTA 8117) from 12.4 mi [19.95 km] S of Soto la Marina [23.6283°N, 98.12361°W, 40 m elev.] (Burchfield 1982; Campbell and Lamar 2004; Gloyd and Conant 1990). The vegetation in the area is Tamaulipan thorn scrub. Burchfield (1982) reported "problematic localities" from the San Carlos Mountains based solely on information from local inhabitants and Campbell and Lamar (2004) explicitly included the Sierra San Carlos in the distribution of the species. Although its occurrence there seems plausible, the Sierra San Carlos has been well surveyed by us and others (Gaige 1937; Hendricks and Landry 1976), and we are unaware at this time of any confirmed literature, museum, or field records from that mountain range. We have 27 museum specimens (25 examined, including 5 from zoo collections without detailed locality data), with confirmed records from seven municipalities (Aldama, Casas, Llera, Mainero, Ocampo, San Fernando, and Soto La Marina). A specimen from the Municipality of Victoria (ITCV 561) Cañón del Novillo, collected by Aldo A. Guevara Camzales and Gevson Herrera Rivera in October 1999 was not found when the ITCV collection was transferred and re-catalogued in the UANL collection and is presumed lost. There are numerous and significant gaps within the known distribution of the species. Confirmed elevations in Tamaulipas range from near sea level to ca. 500 m. although a maximum elevation of 914 m has been reported from neighboring areas of San Luis Potosí at 18 km W of El Naranjo, [ca. 22.4956°N, 99.4171°W], TAIC 2684 (now AMNH) collected by Allan Chaney 11 August 1971 (Gloyd and Conant 1990).

***CROTALUS MOLOSSUS* (Black-tailed Rattlesnake).** Municipality of Bustamante: On the road to La Tapona, 29 km SW of Bustamante (23.12319°N, 99.99118°W), 1869 m elev. 9 October 2008. William L. Farr. UANL 6612. This specimen is the head from a badly damaged snake found DOR. Additional records include a skin and tail without a head (UANL 4832) and three field records. Municipality of Miquihuana: 5 km. NE of Miquihuana (23.59980°N, 99.71370°W), 2573 m elev. 14 October 2006. William L. Farr and Andrew Godambe. UANL 6499. First record from the Municipality of Bustamante and range extension of 48 km SW from the closest known locality, a literature record at 7 km N of Pamillias at 1280 m [municipality of Pamillias ca. 23.34537°N, 99.58489°W, 1385 m elev.] collected 7 August 1979 (Burchfield et al. 1982). Also, first museum record with published data for Miquihuana and a range extension of 31 km NW, from the above literature record (Burchfield et al. 1982).

Early accounts of *C. molossus* distribution did not include Tamaulipas (Klauber 1972; Price 1980) and more recent ones did not include specific locality data (Anderson and Greenbaum 2012; Campbell and Lamar 2004), but were likely based on a record from Sierra El Macho, rd from La Pena to Valle Hermoso, 3.9 mi N of La Pena-Miquihuana rd jct. (Municipality of Miquihuana: ca. 23.5803°N, 99.7132°W, 2245 m elev.), 31 August 1986,J. F. Copp, D. E. Breedlove, R. R. Riviere, and B. R. Anderson, CAS 165227. Burchfield et al. (1982) reported collecting additional specimens (presumably for zoo display; no museum numbers given) on 8 August 1979, at 2286 m elev. and 9 August 1979 at 2377 m elev., from unspecified localities in the vicinity of Miquihuana. Burchfield et al. (1982), based on personal communications of observations by others, speculated that *C. molossus* occurred in the Sierra de Guatemala in areas where Martin (1958) had previously reported *C. totonacus*. Confusion between the two species is understandable, as Campbell and Lamar (2004) indicated the *C. molossus* (as understood at that time) and *C. totonacus* appeared very similar morphologically and recent molecular research (Anderson and Greenbaum 2012; Wüster et. al. 2005) has shown *C. totonacus* to be the sister taxon of populations located in the northeastern part of the range of the *C. molossus* complex; these were previously considered by Campbell and Lamar (2004) to be subspecies of *C. molossus* (*C. m. molossus* and *C. m. nigrescens*). Wüster et al (2005) were the first to show that northern *C. m. molossus* was paraphyletic, with the eastern (northern Chihuahuan Desert) populations being sister to *C. totonacus*, while the western populations (northern Sonoran Desert) were sister to *C. basiliscus*. Anderson and Greenbaum (2012) resurrected the name *C. ornatus* for the northern Chihuahuan Desert populations. Data presented by both Wüster et al (2005) and Anderson and Greenbaum (2012) indicate that *C. m. nigrescens* is basal to the *C. ornatus*-*C. totonacus* clade, and to the *C. m. molossus*-*C. basiliscus* clade. To date, only *C. m. nigrescens* has be reported from Tamaulipas and a few specimens were used in the two molecular studies noted above. According to Campbell and Lamar (2004), *C. m. nigrescens* is the only *C. molossus* occurring in southern Chihuahuan Desert areas.

All available museum records and our field accounts from Sierra de Guatemala are *C. totonacus*. Based on eight museum records (1 CAS, 7 UANL) and additional literature and field records, *C. molossus* can be confirmed from the municipalities of Bustamante, Miquihuana, and Palmillas between 1385–2573 m elev. in Madrean pine-oak woodlands, Chihuahuan Desert mountains, and juniper-chaparral ecotone zones. During our field surveys we anticipated it occurring in the adjacent municipalities of Jaumave and Tula based on available habitat, but we are unable to confirm its presence there, suggesting the possibility that the two taxa are allopatric in Tamaulipas, although no obvious barriers are apparent in the Tula and the Jaumave Valleys.

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New Distributional Records for Amphibians from Durango, Mexico

Durango, located in the northwestern portion of Mexico, is the fourth largest state in the country (Álvarez 1987), and contains a wide variety of natural habitats and associated biodiversity (González-Elizondo et al. 2007). Knowledge about Durango's herpetofauna has been progressing at a slow rate. The number of amphibian species currently known to occur in Durango is 33 (Valdez-Lares et al. 2013), some of which are based on only one or two specimens, or from records made over 50 years ago. However, a substantial amount of information exists in scientific collections, both within Mexico and in other countries. One example in Mexico is the Herpetological Collection of the Centro Interdisciplinario de Investigación para el Desarrollo Integral Regional, Instituto Politécnico Nacional, Durango, Durango, which is the institution where all voucher specimens reported herein were deposited (CIIDIR-DGO; Sabaj-Pérez 2013) . We report on 18 species of amphibians (two salamanders and 16 anurans), all assembled between 1984 and 2009 by a group of collectors whose names are indicated in the text. Accounts include a new addition to the herpetofauna of Durango (*Hyla wrightorum*), confirmation of a historical record for *Smilisca baudinii* (Günther 1885–1902), and a list of 48 new records from 15 municipalities within the state (Fig. 1). Determination of the new geographic distribution records (e.g., new state and municipality accounts) is based on the lack of substantiating evidence in the literature. We also record new elevational records for two anuran species and discuss systematic relationships between *Hyla eximia* and *H. wrightorum*. Locality coordinates were taken with a GPS device using map datum WGS84 and standard English names follow Liner and Casas-Andreu (2008). In many cases, we collected more individuals from different localities within identified municipalities, but only listed the oldest record in the accounts; data for the others are available through CIIDIR-DGO. Vegetation types in areas surrounding collecting sites were identified, if known. We take all responsibility for accurately verifying the identification of the species. All specimens were collected under SEMARNAT permits issued to Raúl Muñiz-Martínez (FAUT 0003).

CAUDATA — SALAMANDERS

***AMBYSTOMA ROSACEUM* (Tarahumara Salamander).** Municipality of Durango: 48.71 km SE El Salto, Salto de Agua llovida (23.53913°N, 104.95685°W), 2308 m elev. 31 August 2005. Rolando González-Trápaga. CIIDIR-DGO 1230. Municipality of Nuevo Ideal: 4.4 km WSW Pinos Altos (24.93761°N, 105.20472°W), 2690 m elev. 26 August 1999. Rolando González-Trápaga. CIIDIR-DGO 766. Municipality of Tepehuanes: 11.8 km S, 37.2 km W Los Herreras (25.05233°N, 105.86916°W), 2530 m elev. 31 October 1995. Raúl Muñiz-Martínez. CIIDIR-DGO 505. The three localities reflect new municipality records. All salamanders were found in pine forest.

***AMBYSTOMA SUBSALSUM* (Alchichica Salamander).** Municipality of Nuevo Ideal: 4.75 km N, 5.6 km E Guatimape (24.85081°N, 104.86673°W), 2040 m elev. 13 November 1999. Rolando González-Trápaga. CIIDIR-DGO 712. Municipality of Tamazula: 10.8 km N, 11.7 km E El Durazno (25.57116°N, 106.80646°W), 1923 m elev. October 2004. Raúl Muñiz-Martínez. CIIDIR-DGO 1049-1050. Both localities are new municipality records. Even though the taxonomic status of some populations of the *Ambystoma tigrinum* complex in Durango is questionable, we provisionally follow Webb (2004) for assigning these specimens to *A. subsalsum*.

ANURA — FROGS

***ANAXYRUS COGNATUS* (Great Plains Toad).** Municipality of Mezquital: 4.75 km N, 5.6 km E Guatimape (24.85081°N, 104.86673°W), 2040 m elev. 27 August 1999. Rolando González-Trápaga CIIDIR-DGO 761. Municipality of Nuevo Ideal: 0.6 km ENE Miguel Negrete (25.01558°N, 105.15566°W), 1994 m elev. 26 August 2000. Rolando González-Trápaga. CIIDIR-DGO 664. Municipality of Poanas: La Joya (23.8375°N, 103.99916°W), 1890 m elev. 30 October 1984. Raúl Muñiz-Martínez. CIIDIR-DGO 07. All three localities represent new municipality records. The Mezquital toad was found in disturbed oak forest, and the one from Poanas was captured within desert shrubland.

***ANAXYRUS COMPACTILIS* (Plateau Toad).** Municipality of Canatlán: Rancho El Durangueño, 17.29 km SW Canatlán (24.45861°N, 104.93194°W), 2396 m elev. 2 October 2005. Rolando González-Trápaga. CIIDIR-DGO 1238. Municipality of Pánuco de Coronado: 22.31 km N, 9.75 km W Francisco I. Madero, H. Galeana (24.59944°N, 104.42138°W), 1953 m elev. 12 September 2008. Raúl Muñiz-Martínez. CIIDIR-DGO 1365. Both localities represent new municipality records. No information on vegetation type is available.

***ANAXYRUS MEXICANUS* (Mexican Madre Toad).** Municipality of Santiago Papasquiaro: 14.2 km S, 22.8 km W Los Herreras (25.03025°N, 105.72309°W), 2430 m elev. October 1995. Raúl Muñiz-Martínez. CIIDIR-DGO 517–518. New municipality record. An additional toad from San Juan de Camarones, Santiago Papasquiaro (24.92716°N, 106.41147°W; 580 m elev.) (CIIDIR-DGO 538) was caught by Raúl Muñiz-Martínez on 28 June 1997 in subtropical deciduous forest at an elevation 1000 m lower than previously reported for the species (Oliver-López et al. 2009, Wilson and Johnson 2010).

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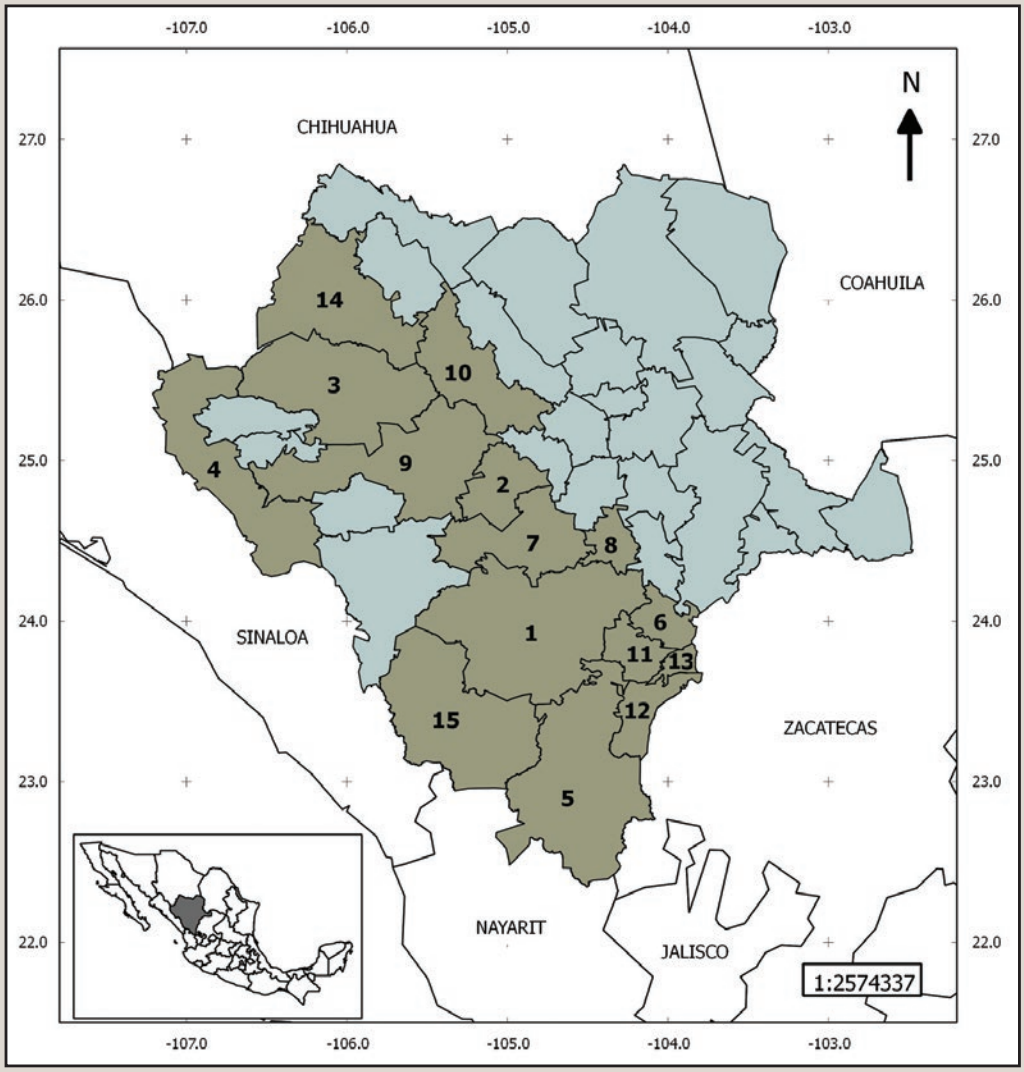


FIG. 1. A map of Durango, Mexico, showing municipalities where new amphibian records were documented. Numbers refer to the following municipalities: 1 = Durango; 2 = Nuevo Ideal; 3 = Tepehuanes; 4 = Tamazula; 5 = El Mesquital; 6 = Poanas; 7. Canatlán; 8 = Pánuco de Coronado; 9 = Santiago Papasquiaro; 10 = El Oro; 11 = Nombre de Dios; 12 = Súchil; 13 = Vicente Guerrero; 14 = Guanaceví; 15 = Pueblo Nuevo.

***ANAXYRUS PUNCTATUS* (Red Spotted Toad).** MUNICIPALITY OF CANATLÁN: Rancho El Durangueño 17.29 km SW Canatlán (24.45861°N, 104.93194°W), 2396 m elev. 14 October 2005. Rolando González-Trápaga. CIIDIR-DGO 1188. MUNICIPALITY OF EL ORO: 1 km S, 18 km E Emiliano Martínez (25.44727°N, 105.0082°W), 1980 m elev. 18 August 2005. Rosaura Valdez-Lares. CIIDIR-DGO 1079–1083. MUNICIPALITY OF NOMBRE DE DIOS: 5 km S, 4.1 km W Nombre de Dios (23.80194°N, 104.28611°W), 1720 m elev. 28 September 1987. Raúl Muñiz-Martínez. MUNICIPALITY OF SÚCHIL: 0.7 km S, 4.6 km W San Miguel de la Michilía (23.58638°N, 104.10805°W), 2020 m elev. 12 July 1985. Raúl Muñiz-Martínez. CIIDIR-DGO 112. MUNICIPALITY OF TEPEHUANES: 11.8 km S, 37.2 km W Los Herreras (25.05233°N, 105.86916°W), 2530 m elev. 1 November 1995. Raúl Muñiz-Martínez. CIIDIR-DGO 508–509. MUNICIPALITY OF VICENTE GUERRERO: 1.8 km N, 9.9 km E Vicente Guerrero (23.74861°N, 103.89027°W), 2070 m elev. 13 September 1983. Raúl Muñiz-Mártinez. CIIDIR-DGO 28–29. All six localities represent new municipality records. The toads were found in pine forest and desert scrubland.

***INCILIUS MAZATLANENSIS* (Sinaloa Toad).** MUNICIPALITY OF MEZQUITAL: 12.1 km S, 2.0 km E Huazamota (22.41222°N, 104.47361°W), 700 m elev. 4 June 1992. Raül Muñiz-Martínez. CIIDIR-DGO 280. MUNICIPALITY OF SANTIAGO PAPASQUIARO: San Juan de Camarones (24.92716°N, 106.41147°W), 580 m elev. 26 June 1997. Raúl Muñiz- Martínez. CIIDIR-DGO 540–542, 544–545. Both localities represent new municipality records and only the second and third known from Durango. The previously listed locality is from Municipality of Pueblo Nuevo, 6 miles (9.6 km) S of Pueblo Nuevo (Webb and Baker 1962). All toads were captured in tropical deciduous forest.

***INCILIUS OCCIDENTALIS* (Pine Toad).** MUNICIPALITY OF VICENTE GUERRERO: 2.0 km S, 1.5 km W Vicente Guerrero (23.71361°N, 104.00055°W), 1920 m elev. 28 July 1989. Raúl Muñiz-Martínez. CIIDIR-DGO 246. New municipality record. The toad was found in an agricultural field.

***RHINELLA MARINA* (Cane Toad).** MUNICIPALITY OF SANTIAGO PAPASQUIARO: San Juan de Camarones (24.92717°N, 106.41147°W), 580

m elev. 27 June 1997. Raúl Muñiz- Martínez. CIIDIR-DGO 539, 546. Municipality of Tepehuanes: 11.8 km S, 37.2 km W Los Herreras (25.05233°N, 105.86917°W), 2530 m elev. Raúl Muñiz-Martínez. CIIDIR-DGO 507. Both localities represent new municipality records. This species was previously known in the state only from the Municipalities of Mezquital (Kellogg 1932) and San Dimas (Günther 1885–1902). The Tepehuanes toad sets a record for highest elevation reported for this wide-ranging species (Oliver-López et al. 2009; Wilson and Johnson 2010).

***CRAUGASTOR VOCALIS* (Pacific Stream Frog)**. Municipality of Santiago Papasquiaro: 0.4 km S, 0.35 km W San Juan de Camarones (24.92277°N, 106.41711°W), 590 m elev. 12 September 2000. Raúl Muñiz-Martínez. CIIDIR-DGO 626. New municipality record, and only the second from the state. The other known locality in Durango is from Municipality of Pueblo Nuevo, 6 mi (9.6 km) S of Pueblo Nuevo (Webb and Baker 1962). The frog was found in tropical deciduous forest.

***HYLA ARENICOLOR* (Canyon Treefrog)**. Municipality of Canatlán: Rancho El Durangueño, 17.29 km SW Canatlán, (24.45861°N, 104.93194°W), 2396 m elev. 14 October 2005. Rolando González-Trápaga. CIIDIR-DGO 1242–1243. Municipality of Nombre de Dios: 10.5 km N, 7.0 km W Nombre de Dios (23.94083°N, 104.300°W), 1800 m elev. 15 June 1984. Raúl Muñiz-Martínez. CIIDIR-DGO 03. Municipality of Nuevo Ideal: 4.4 km SWW Pinos Altos (24.93761°N, 105.20472°W), 2690 m elev. 26 August 1999. Rolando González-Trápaga. CIIDIR-DGO 762, 764–765. Municipality of Poanas: 4 km N, 7.8 km E La Joya (23.87638°N, 103.92111°W), 2017 m elev. March 1995. Raúl Muñiz-Martínez. CIIDIR-DGO 521–523. Municipality of Santiago Papasquiaro: 0.7 km S, 2.95 km E Los Herreras (25.15388°N, 105.47083°W), 1964 m elev. 17 April 1995. Raúl Muñiz-Martínez. CIIDIR-DGO 504. Municipality of Súchil: 0.7 km S, 4.6 km W San Miguel de la Michilía (23.58638°N, 104.10805°W), 2020 m elev. 17-19 July 1985. Raúl Muñiz-Martínez. CIIDIR-DGO 100–106. Municipality of Tamazula: 11.1 km S, 2.9 km W Durazno (25.36672°N, 106.94055°W), 1506 m elev. 27 May 2002. Raúl Muñiz-Martínez. CIIDIR-DGO 638. Municipality of Vicente Guerrero: 2.0 km S, 1.5 km W Vicente Guerrero (23.71361°N, 104.00055°W), 1920 m elev. 28 July 1989. Raúl Muñiz-Martínez. CIIDIR-DGO 247. All eight localities are new municipality records. Frogs were found in a variety of habitats, including desert scrub, oak forest, subtropical deciduous forest, and coniferous forest.

***HYLA EXIMIA* (Mountain Treefrog).** Municipality of Guanaceví: Ciénega de la Vaca (25.92205°N, 106.16444°W), 3000 m elev. 29 September 2001. Karina Grajales-Tam. CIIDIR-DGO 648–649. Municipality of Mezquital: 1.5 km N, 3.8 km E Charcos (23.02222°N, 104.26611°W), 2900 m elev. 25 September 1985. Raúl Muñiz-Martínez. CIIDIR-DGO 107. Municipality of Nombre de Dios: 2.8 km S, 4.0 km W San Isidro de Morillos (23.69611°N, 104.08277°W), 2080 m elev. 16 July 1985. Raúl Muñiz-Martínez. CIIDIR-DGO 99. Municipality of Nuevo Ideal: 4.75 km N, 5.6 km E Guatimapé (24.85081°N, 104.86673°W), 2040 m elev. 20 October 2000. Rolando González-Trápaga. CIIDIR-DGO 710. Municipality of Poanas; San Atenógenes (23.99139°N, 104.01806°W), 1910 m elev. 12 October 1984. Raúl Muñiz-Martínez. CIIDIR-DGO 01–02. Municipality of Santiago Papasquiaro: 14.5 km N, 81.7 km W Santiago Papasquiaro (25.17522°N, 106.23432°W), 2350 m elev. 25 June 1997. Raúl Muñiz-Martínez. CIIDIR-DGO 565. Municipality of Tepehuanes: 11.8 km S, 37.2 km W Los Herreras (25.05233°N, 105.86916°W), 2530 m elev. 01 November 1995. Raúl Muñiz-Martínez. CIIDIR-DGO 514. Municipality of Vicente Guerrero: 3.7 km S, 3.45 km W Vicente Guerrero (23.69877°N, 104.02142°W), 1950 m elev. July 2004. Raúl Muñíz-Martínez. CIIDIR-DGO 1062. All eight municipality records are new for Durango, and the Guanaceví locality is the northernmost record for *Hyla eximia* in Mexico, narrowing the range to 90 km NE of our first reported record of *H. wrightorum* for Durango (see below) and 63 km SE for that species from El Vergel, Chihuahua (Lemos-Espinal and Smith 2007). Frogs were found in a variety of habitats including pine forest, oak forest, grasslands, and desert scrub edges.

It should be noted that our identification of *H. eximia* and *H. wrightorum* were based on morphology, primarily size difference between those two previously synonymized species. *Hyla wrightorum* is considered to be larger than *H. eximia* and is reported to have different mating calls and distinctive molecular qualities (Duellman 2001). Duellman (2001) also considered that the southern distributional limit of *H. wrightorum* was located in the Sierra Madre Occidental of SW Chihuahua, but Frost's (2013) amphibian website, apparently based on personal communication with E. Gergus, indicated that its range continues southeastward along the Sierra Madre Occidental almost to the state of México. That pattern specifies that *H. eximia* and *H. wrightorum* have a substantial zone of overlapping ranges from northern Durango (records reported herein) to the southeast as determined by Duellman's (2001) depiction of the distribution of *H. eximia*. Therefore, additional data on mating calls, molecular features, and other systematic characters from the perceived overlapping zones might well alter the taxonomy and established geographic ranges of the two species.

***HYLA WRIGHTORUM* (Arizona Treefrog)**. Municipality of Tamazula: 1 km N San Juan de Tecuan (25.56972°N, 106.98472°W), 2457 m elev. 22 August 2008. Raúl Muñiz- Mártinez. CIIDIR-DGO 1106–1107. First published record for Durango, extending the known range 99.77 km SW from the nearest known locality, 12.3 km SW of El Vergel, Municipality of Balleza, Chihuahua (Lemos-Espinal and Smith 2007). However, see the *Hyla eximia* account above.

***SMILSICA BAUDINII* (Mexican Treefrog)**. Municipality of Santiago Papasquiaro: San Juan de Camarones (24.92716°N, 106.41147°W), 580 m elev. 26 June 1997, 12 September 2000. Raúl Muñiz-Martínez. CIIDIR-DGO 547–548, 628. First municipality records and first for Durango since Günther (1885–1902) reported that Forrer collected *Hyla baudinii* in the Municipality of San Dimas near Ventanas; Duellman (2001) did not depict this record on his distribution map. The Santiago Papasquiaro records result in a 58.5 km NNE range extension from the closest known locality, 51 km SSE of Culiacán, Municipality of Cosalá, Sinaloa (Duellman 2001), and 133 km NW from the locality mentioned by Günther (1885–1902). CIIDIR-DGO 547–548 (numbers 1969 and 1970 in Muñiz-Martínez 2000) were previously misidentified as *Pachymedusa dacnicolor*. All specimens were found in tropical deciduous forest.

***LITHOBATES BERLANDIERI* (Rio Grande Leopard Frog)**. Municipality of Tamazula: Los Frailes (25.64347°N, 106.90050°W), 2527 m elev. October 2003. Raúl Muñiz-Mártinez. CIIDIR-DGO 1045–1048. First confirmed records from the municipality. Webb and Baker (1984) reported ranid frogs from this and adjacent localities in Chihuahua as belonging to the *Rana pipiens* group.

Lemos-Espinal and Smith (2007) tentatively assigned some frogs from the eastern slopes of central and southern Sierra Madre Occidental, including those from the localities mentioned by Webb and Baker (1984), to *L. berlandieri*, although they also mentioned the possibility that the frogs belonged to a distinct species. *Lithobates berlandieri* had previously been recorded definitely from the eastern portion of the state (Castañeda-Gaytan et al. 2005; Gadsden et al. 2006).

***LITHOBATES CHIRICAHUENSIS* (Chiricahua Leopard Frog).** Municipality of Canatlán: 17.29 km SW Canatlán, Rancho El Durangueño (24.45861°N, 104.93194°W), 2396 m elev. 9 July 2005. Rolando González-Trápaga. CIIDIR-DGO 1234–1235. Municipality of Nuevo Ideal: 7.8 km N, 3.1 km E Guatimapé (24.87623°N, 104.8912°W), 1940 m elev. 25 November 1995. Rolando González-Trápaga. CIIDIR-DGO 727-729. The two localities represent new municipality records for Durango. No vegetation information is available for these records.

***LITHOBATES MAGNAOCULARIS* (Northwest Mexico Leopard Frog).** Municipality of Santiago Papasquiaro: San Juan de Camarones (24.92717°N, 106.41147°W), 580 m elev. 26–27 June 1997, 3 February 2000, 12–13 September 2000. Raúl Muñiz-Martínez. CIIDIR-DGO 555–564, 597–599, 612, 629. New municipality records and only the third locality known from Durango (Webb 1991). The other two records are both from the Municipality of Mezquital: Paso de Sihuacori, ca. 46 km S, 25 km W of Teneraca, 6 km S, 4 km W of Mezquital (Webb 1991). All frogs were found in tropical deciduous forest.

***SPEA MULTIPLICATA* (Mexican Spadefoot).** Municipality of Mezquital: 18.25 km S, 0.9 km W Canoas (22.44972°N, 104.30556°W), 2420 m elev. 6 June 1992. Raúl Muñiz-Martínez. CIIDIR-DGO 284–286. Municipality of Nuevo Ideal: 4.75 km N, 5.6 km E Guatimapé (24.85082°N, 104.86673°W), 2040 m elev. 2 June 2002, 24 August 2000, 20 October 2000 Rolando González-Trápaga. CIIDIR-DGO 703–705, 708–709. Municipality of Pueblo Nuevo: 6.5 km S, 0.2 km W Pueblo Nuevo (23.32389°N, 105.37250°W), 1560 m elev. 18 November 1993. Raúl Muñiz-Martínez CIIDIR-DGO 331–333. Municipality of Tepehuanes: 11.8 km S, 37.2 km W Los Herreras (25.05233°N, 105.86917°W), 2530 m elev. 1 November 1995. Raúl Muñiz-Martínez CIIDIR-DGO 506. Municipality of Vicente Guerrero: 1.0 km N, 1.5 km E Gabriel Hernández (23.82056°N, 104.00833°W), 1900 m elev. 11 August 1984. Raúl Muñiz-Martínez. CIIDIR-DGO 08. Mexican Spadefoots were found in a variety of habitats, including desert shrubland, pine-oak forest, pine forest, and subtropical deciduous forest.

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NATURAL HISTORY NOTES

CAUDATA — SALAMANDERS

***AMBYSTOMA JEFFERSONIANUM* (Jefferson Salamander). PREDATION BY *THAMNOPHIS SIRTALIS*.** *Ambystoma jeffersonianum* is primarily a fossorial species, seldom seen outside of a brief spring breeding season (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Inst. Press, Washington, DC. 587 pp.). Most knowledge of their predators concerns the developing larvae; there is limited documentation of predation upon juveniles and adults (Petranka 1998, *op. cit.*). They are particularly vulnerable when migrating to and from the ponds in which they breed (Petranka 1998, *op. cit.*). The Eastern Gartersnake (*Thamnophis sirtalis sirtalis*) is a generalist predator that would be expected to commonly co-occur with these salamanders, based upon geographic range and habitat preference (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Books, Washington, DC. 668 pp.; Petranka 1998, *op. cit.*). They are known to feed on other ambystomatids, including *A. opacum*, *A. laterale*, and *A. maculatum* (Ernst and Ernst 2003, *op. cit.*). At 2100 h on 10 April 2013 in the State Game Lands No. 176, Centre Co., Pennsylvania, USA (40.77170°N, 77.95856°W; WGS 84) a *T. s. sirtalis* was observed in the process of swallowing an adult *A. jeffersonianum* tail first, which it ultimately completely consumed (Fig. 1). This occurred within 1 m of a vernal pool breeding pond used by *A. jeffersonianum*. To our knowledge, this is the first record of predation by *T. s. sirtalis* on *A. jeffersonianum*.

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***AMBYSTOMA OPACUM* (Marbled Salamander). LARVAL AGGREGATION.** Over several years and at several small-pond breeding sites in Wayne and Jennings counties, Indiana, USA, we observed larval Marbled Salamanders associated with recently laid egg masses of Wood Frogs (*Lithobates sylvaticus*) during March (Fig. 1). Although larval Marbled Salamanders are known to feed on embryos and tadpoles of Wood Frogs in the laboratory and the field (Cortwright and Nelson 1990. Oecologia 83:123–131; Walters 1975. J. Herpetol. 9:267–279), the only published statement intimating aggregation behavior in Marbled Salamander larvae is that by Walters (1975, *op. cit.*) who observed that a "clump of about 30 freshly laid masses [of *sylvaticus*] was surrounded by over 50 larval *A. opacum*."

On the night of 19 March 2013, nine days after the local peak of Wood Frog breeding at an ephemeral pond in old-growth forest (ca. 38.96555°N, 85.62527°W) on the Crosley Wildlife Management Area, Jennings Co., Indiana, USA, we undertook visual surveys around the entire pond margin to test the hypothesis that Marbled Salamander larvae in this pond were concentrated at the site of Wood Frog egg deposition. With only a single LED headlight, we identified two adjacent clusters of Wood Frog egg masses centered about 0.75 m from the shore. We turned on the light for about 15 seconds at the first cluster and quickly counted the number of larvae in a quadrat area of ca. 0.75 m x 0.75 m. In the dark we moved clockwise around the pond, stopping every



FIG. 1. *Thamnophis sirtalis sirtalis* ingesting an adult *Ambystoma jeffersonianum* tail first, Centre Co., Pennsylvania.



FIG. 1. Larval *Ambystoma opacum* (white circles) in association with egg masses of *Lithobates sylvaticus*, Jennings Co., Indiana.

ca. 2 m (about three paces) to repeat the count, centered on the same distance from the shoreline. All sample sites were similar in microhabitat, but varied in depth from ca. 5 to 15 cm. The second count was located over the second Wood Frog egg cluster, but eggs were found at no other site around the pond. Our larval counts were 25, 25, 2, 0, 0, 0, 4, 3, 3, 5, 9, and 7. The mean larval count away from the egg masses (3.3; N = 10) was nearly an order of magnitude fewer than at the egg masses, confirming that Marbled Salamander larvae were strongly associated with Wood Frog eggs. Although we did not sample quantitatively the distribution of Marbled Salamander larvae before Wood Frogs began laying eggs, during our general amphibian surveys at this pond (and others) during November, December, and early March over more than a decade we never found Marbled Salamander larvae concentrated at particular sites along the shoreline prior to Wood Frog breeding. We presume that this larval concentration is facilitated by olfactory cues, and that the association is diet related (references above).

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***CRYPTOBRANCHUS ALLEGANIENSIS ALLEGANIENSIS* (Eastern Hellbender). TERRESTRIAL MOVEMENT.** In the Toccoa River (Ocoee River) drainage, a tributary to Blue Ridge Lake, Fannin Co., Georgia, USA, a larval hellbender (evident external gills present; 7 cm TL) was observed moving terrestrially over fine sand and gravel substrate along the margin of a stream ca. one hour before sunset on 16 July 2012. This individual appeared to be emerging from a cover rock (55 cm x 25 cm) with a small, shallow (barely deep enough for submergence) puddle underneath. The cover rock was located adjacent to a riffle of a 5-m-wide stream and was 50 cm from flowing water and 30 cm from open standing water. Terrestrial movement of adult hellbenders has been observed in captivity and in the wild, but to our knowledge this is the first observation of the terrestrial movement of a larval hellbender. Diurnal terrestrial movements have been observed by captive hellbenders at Riverbanks Zoo and Gardens (Columbia, South Carolina) on several occasions, where hellbenders are maintained in captivity within a 2.5 m x 1.5 m x 3 m exhibit that contains a coldwater-flowing stream as well as planted, dry land areas with a soil and leaf litter substrate. Multiple individual hellbenders have been observed exiting the stream and walking along the rear wall of the exhibit and then reentering the water. All of these observations have been made during daylight hours and the hellbenders could be moving on land at night without being observed. In North Carolina, local fishermen have reported observing hellbenders moving on land some distance from the water. Beck (1965. Field and Stream 69:64–66,109–113.) reported catching hellbenders < 1 m from the water's edge with meat-baited mammal traps on more than one occasion along the Allegany River in Pennsylvania. Terrestrial movement may support biogeographic theory in explaining the distribution of hellbender populations within portions of drainages upstream of apparent barriers to movement (e.g., a hellbender population found upstream of a ca. 35 m waterfall within the Nottely River watershed in Georgia).

Species identification of the larval specimen from this observation was verified from a voucher photograph (K. Krysko and M. Nickerson, University of Florida, Florida Museum of Natural History).

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***CRYPTOBRANCHUS ALLEGANIENSIS ALLEGANIENSIS* (Eastern Hellbender). CANNIBALISM.** Although cannibalism in *Cryptobranchus alleganiensis* has been previously reported (Nickerson and Mays 1973. The Hellbenders: North American Giant Salamanders. Milwaukee Public Mus. Press; 106 pp.; Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, D.C. 587 pp.; Phillips and Humphries 2005. *In* Lannoo [ed.], Amphibian Declines: The Conservation Status of United States Species, pp 648–651. Univ. California Press, Berkeley, California), additional cases are worthy of note, since only a few specific reports of this behavior have been recorded from wild caught hellbenders, and there has been no discussion on the possible causes of this behavior. Cannibalism was first reported in *C. a. alleganiensis* by Reese (1903. Sci. Monthly 62:526–531). In captivity, he observed a larger hellbender consuming a smaller conspecific. He was able to remove the ingested smaller specimen with forceps, and it swam away unharmed when released in its enclosure. Smith (1907. Biol. Bull. 13:5–39) reported a two year-old hellbender in northwestern Pennsylvania, that when placed in quiet water after capture, regurgitated a partly digested 6-cm larval conspecific. The size of the larger specimen was between 12.0 cm and 12.3 cm. The only other reported observation of cannibalism in this species from a wild specimen is that of Humphries et al. (2005. Herpetol. Rev. 36:428) who reported that a larger, wild caught, adult male *C. a. alleganiensis* (37.2 cm TL) regurgitated a smaller individual (18.5 cm TL) in the field. The North Carolina population where this occurred is very dense and comprised of all size classes (J. Humphries, pers. comm. and L. Williams, pers. obs.). Here we report another field case of cannibalism from a North Carolina population.

On 29 June 2010, an adult female (39 cm TL) *Cryptobranchus a. alleganiensis* was collected from a fast riffle, in a section of the French Broad River, Transylvania Co., North Carolina, USA (specific locality is recorded with the North Carolina Wildlife Resources Commission and is withheld to protect the population). After data collection, the specimen was held in a mesh bag and lowered into the water in strong, swift current in preparation for its release. During this process and after being subjected to the strong current, it regurgitated a smaller hellbender (21 cm TL) while still in the mesh bag. The consumed hellbender was decaying, and there was a strong odor of rotten flesh (Fig. 1). From our observations and photographs of the carcass, it appears that the adult hellbender grasped the smaller hellbender laterally on its right side (tooth marks identified on dorso-lateral surface of body confirmed by North Carolina Zoo pathologist, Brigid Trovan). Unfortunately, this regurgitated hellbender was not saved due to its advanced state of decay. The locality where this observation was made contains a robust, reproductively active population of hellbenders of all age classes.

In a similar example, Max A. Nickerson (pers. comm. 2012) informed us of wild-caught Ozark Hellbenders (*C. alleganiensis bishopi*) eating smaller conspecifics from the North Fork of the White River in Missouri when they were placed in coolers under crowded conditions. On 12 March 1972, two Ozark Hellbender gilled larvae (9.5 and 13.0 cm TL) were cannibalized when placed



FIG. 1. Cannibalized juvenile *Cryptobranchus alleganiensis*, Transylvania Co., North Carolina.

and pers. obs.). Hellbenders are opportunistic foragers and scavengers and are attracted to food by visual, chemical, and tactile stimuli (Nickerson and Mays 1973, *op. cit.*). It is possible that cannibalism in this species is a density-dependent behavior, primarily related to population size. Denser populations may provide adults with more opportunity to find younger, smaller hellbenders during foraging activities. All reported cases of hellbender cannibalism have come from dense populations (Smith 1907, *op cit.*; Humphries et al. 2005, *op. cit.*) or in the confines of captivity. Another possible contributing factor to hellbender cannibalism is that in denser populations less food may be available and cannibalism may increase due to fewer or more dispersed food resources. A similar explanation of this behavior has been suggested for other salamanders (Duellman and Trueb 1986. Biology of Amphibians. McGraw Hill, New York. 670 pp.). Our observations and reports from other field biologists working with hellbenders suggest that crayfish are less abundant in denser hellbender populations than in smaller or possibly declining hellbender populations.

We thank Max Nickerson for sharing his observations of cannibalism in hellbenders and for allowing us to publish them. Thanks to Brigid Trovan for examining our photographs. We also thank the many volunteers who worked with us throughout our hellbender surveys for their time and efforts.

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***PLETHODON CINEREUS* (Eastern Red-backed Salamander). MORPHOLOGY.** *Plethodon cinereus* is the most common woodland salamander in the northeastern United States (Conant and Collins 1998. A Field Guide to Reptiles and Amphibians of Eastern and Central North America. Houghton Mifflin Co., Boston, Massachusetts. 616 pp.) This species is polymorphic, and three color variations are commonly recognized and described. The striped or "red-backed" morph is black with a deep red dorsal stripe, the unstriped or "lead-backed" morph is black and lacks a dorsal stripe, and the "erythristic" morph is red with varying degrees of dark mottling. There is also a "leucistic" morph, which is far less common across the range of *P. cinereus*. This morph has general reduction in pigmentation, but retains regular black



FIG. 1. Leucistic individuals of the Eastern Red-backed Salamander, *Plethodon cinereus*, from Geauga Co., Ohio. A) Adult female (33.9 mm SVL) observed 14 Sept 2011. B) Subadult (sex unrecorded; 25.9 mm SVL) observed 14 October 2012.

COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND

eyes and is not considered albino. Across the range of *P. cinereus*, three leucistic individuals have been reported from Maryland (Mitchell and Mazur 1998. Northeast. Nat. 5[4]:367–369), two individuals from Nova Scotia (Moore and Gilhen 2011. Can. Field Nat. 125:58–60) and Massachusetts (Lotter and Scott 1977. Copeia 1977:681–690; Mendyk et al. 2010 Herpetol. Rev. 41[2]:189–190), and one individual each from West Virginia (Pauley 1974. The Restart 42:104), Ontario (Rye 1991. Can. Field Nat. 10:573–574), New York (Mendyk et al. 2010, *op. cit.*), Quebec (Moore and Gilhen 2011, *op. cit.*), and New Brunswick (Jongsma 2012. Herpetol. Rev. 43[3]:460). Two leucistic individuals from Ohio were discovered on 14 Sept 2011 and 14 October 2012 at the West Woods in Russell Township, Geauga Co. The first individual, an adult female, was found under a partially decomposed hardwood log fragment and the second individual, a subadult, was found under an artificial cover object (slate floor tile). Striped and erythristic phenotypes have also been observed at this site.

These are the first two confirmed records of leucistic *P. cinereus* for Ohio and it is notable that both specimens were observed at the same locality. These individuals were not collected; however photo vouchers (Fig. 1) were deposited in the herpetology collection of the Cleveland Museum of Natural History (CMNH 14071, 14072).

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ANURA — FROGS

***CRAUGASTOR LATICEPS*. POSSIBLE OVOVIVIPARITY.** All species of *Craugatsor* (Craugastoridae) are thought to be direct developers (Hedges et al. 2008. Zootaxa 1737:1–182). However, we report an instance in which indirect evidence suggests that *C. laticeps* is ovovivparous. We collected an adult female *C. laticeps* (MVZ 269388) on the ground about 1–2 h after nightfall on 25 April 2011 in the vicinity of San Isidro (15.11666°N, 88.93333°W, datum WGS 84; elev. 1350 m), Copán, Honduras. The frog was placed alone in a plastic collecting bag. The next morning, upon inspection, the female, together with 44 eggs, each of which included a froglet in an advanced stage of development (tails nearly completely resorbed, limbs well developed, etc.), but still within the egg membranes (with the exception of one, which had emerged from its still present membranes), were present in the bag (Fig. 1A).

The female measures 66 mm SVL. The oviducts of the female are highly contracted and only slightly convoluted, rather than dilated and flaccid as we had anticipated (based on the MHW's experience with recently post parturient viviparous caecilians). The ovaries are contracted and compressed dorsally. A large compacted dark gray mass of presumably undigested dirt in the terminal part of the intestine suggests that the female had been feeding; her stomach was compressed dorsally and the large coelomic space is open and evacuated.

The froglet that had emerged from its egg membrane (MVZ 269391; not illustrated owing to positional distortion) is 14.0 mm SVL. A tiny egg tooth is present; it is bifid, each side terminating as a black tip. Its tail is fully resorbed. The SVL of a froglet freed from its membrane (MVZ 269390) is 13.5 mm; that of two slightly smaller ones (included in MVZ 269389; the 42 other eggs/froglets in the clutch), still in their membranes (but with curvature accounted for) are 12.8 mm and 13.8 mm (the latter featured in Fig. 1B). These dimensions appear to approximate the SVL range for the 44 froglets. One of the two smaller froglets in membranes just mentioned has an irregularly shaped, somewhat flattened, approximately 1.8 x 1.2 mm mass of unresorbed yolk in its gut. All of the froglets appear to retain some yolk. External egg diameters range from 9.5 to 12.0 mm. All of the unemerged froglets (MVZ 269389) are in the same position in their membranes; the hind limbs are folded such that the tibio-femoral joint and feet are near the face; the forelimbs are tucked below the jaw so that the froglets are nearly round objects inside the egg membranes. As seen through the membranes at 60x, most of the froglets have resorbed their tails, but a few appeared to have a small fragment remaining and it is attached to the egg membrane. The bifid black-tipped egg tooth appears to be present in all of the froglets. The pigmentation of the froglets is quite uniform in pattern, and strongly resembles that of the adult female. They have a brown dorsum and a cream venter; the hind legs have bars of brown on the cream ground color laterally, and the forearms have laterodorsal brown bars. The head is darker brown and more densely pigmented. All along the upper jaw, the brown pigment is interrupted by short, vertical, cream bars; there are two prominent white bars medially over each premaxilla. The bars are prominent and close together, then followed laterally by a broad brown bar. These color data demonstrate the advanced stage of development in the froglets.

The presence of the advanced, egg-membrane-bound froglets in the collecting bag a few hours after the introduction of a single adult female suggests that the species might be ovoviviparous. Furthermore, JRM has never found a clutch of *C. laticeps* eggs during his years of extensive collecting in Honduras. Given the single adult specimen and the circumstances of the discovery, however, a number of presumptions and questions require additional data to verify and resolve. For example, we assume that fertilization in the species is internal, likely by cloacal apposition as in *Eleutherodactylus coqui* (Eleutherodactylidae), although females of that species very shortly ovulate their fertilized eggs whereupon direct development ensues (Townsend et al. 1980. Science 212:469–471), in order for developing embryos to be retained in the oviducts of the female. We wonder whether

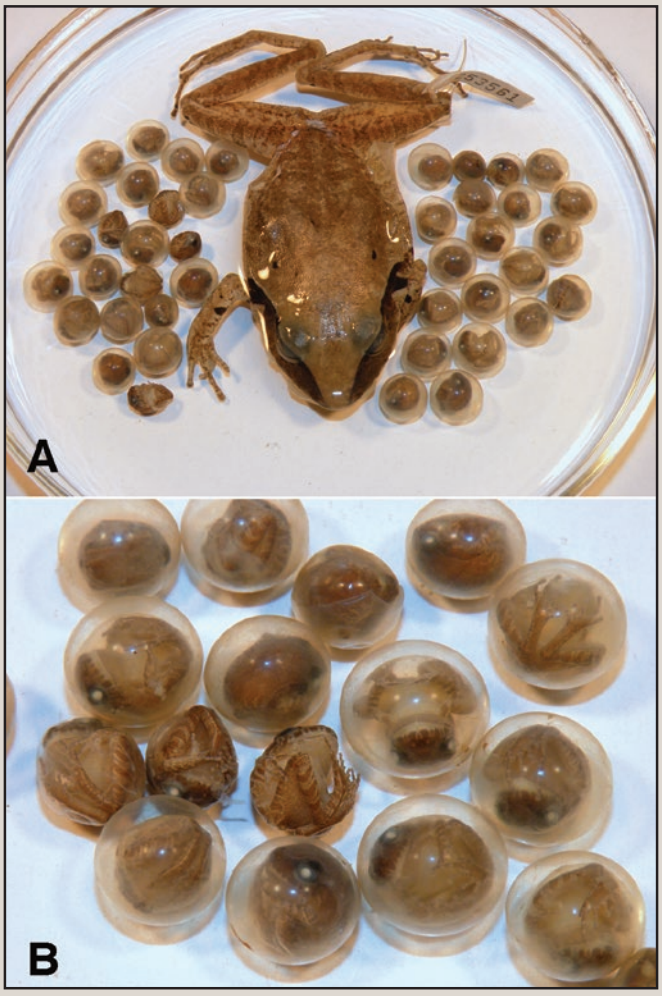


FIG. 1. *Craugastor laticeps* female and egg clutch. A) 66 mm SVL female *Craugastor laticeps* with 42 of her 44 eggs, each of which is a membrane enclosing a fully metamorphosed froglet. B) Close-up of froglets, one (13.8 mm SVL) in center with egg membranes parted. Note its color pattern.

the stress associated with collection precipitated the oviposition of the membrane-bound froglets, such that normally they would hatch in the oviducts just prior to birth, or whether oviposition precedes hatching of the froglets. How she was able to oviposit the large intramembranous froglets without bursting the egg membranes is of biomechanical interest. We have no information on the length of the gestation/developmental period, the endocrine maintenance of the "pregnancy," nor any aspects of seasonality of reproduction. We lack information on egg sizes and numbers in standard clutches for the species; the presence of some yolk remaining in the gut of the advanced froglets supports the idea that the eggs are relatively large, and that the froglets are dependent on that yolk for their development through metamorphosis.

There are other reports of apparent ovoviviparity in related taxa. The now-extinct *Eleutherodactylus jasperi* (Eleutherodactylidae) was definitely ovoviviparous, based on several females that had 1–5 embryos that developed through metamorphosis in her oviducts (Wake 1978. J. Herpetol. 12:121–133). Furthermore, Lynn (1940. Bull. Inst. Jamaica Sci. Ser. 1:1–60) reported that he collected adult *E. orcutti* (Eleutherodactylidae) in Jamaica, placed them in a bottle, and upon return from the night's collecting, found six newly hatched young in the bottle. Lynn suspected ovoviviparity, but his dissections of a number of females gave no support to that idea, and he referred to the finding as "mysterious."

Our observations similarly leave the reproductive biology of *Craugastor laticeps* mysterious. We urge that extensive field research be iniated for this species (considered vulnerable in the IUCN Red List; 2013. http://www.iucnredlist.org). We also strongly recommend that, because specimens are now routinely tissued, collectors should examine gonads and their ducts to sex adults and record any information relevant to the potential reproductive attributes of the animals that they collect—surprises await!

We thank Daniel Portik for photographing the female and her clutch.

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***CRAUGASTOR RANIFORMIS* (Robber Frog). PARENTAL BEHAVIOR.** The genus *Craugastor* contains ca. 113 species distributed in the Americas from the southwestern USA to northwestern South America (AmphibiaWeb 2013. http://amphibiaweb.org/). The representatives of this genus have a terrestrial mode of reproduction with direct development, depositing their eggs in fallen leaves or under rocks or tree trunks, where there is moisture for egg development. Parental care has been reported in *Craugastor angelicus, C. aurilegulus, C. crassidigitus, C. decoratus, C. fitzingeri, C. latrans, C. noblei, C. psephosypharus, C. talamancae* (Jameson 1950. Copeia 1950[1]:44–46; Bogert 1969. Amer. Mus. Novitates 2367:1–9; Hayes 1985. J. Herpetol. 19[1]:168–169; Savage et al. 1988. Bull. S. California Acad. Sci. 87:50–56; Campbell et al. 1994. Herpetologica 50[4]:412–419; Mendoza-Quijano et al. 2002. Herpetol. Rev. 33[2]:125; Whitfield and Pierce 2003. Herpetol. Rev. 34[4]:357–358; Ryan 2005. Herpetol. Rev. 36[4]:234–236; Whitfield et al. 2008. Herpetol. Rev. 39[1]:76). *Craugastor raniformis* occurs from southeast-central Panama to the San Juan de Micay River in Cauca, western Colombia, in the forested lowlands on the west side of the Andes Mountain Chain, and possibly as isolated populations in the Cauca and Magdalena River inter-Andean valleys (Lynch and Myers 1983. Bull. Amer. Mus. Nat. Hist. 175[5]:481–572). Here we report observations on the parental care of *C. raniformis*, as well as data on nesting sites and nest sizes within a premontane wet forest-warm transition, according to Holdridge classification (Instituto Geográfico Agustin Codazzi 1977. 13[11]:238).

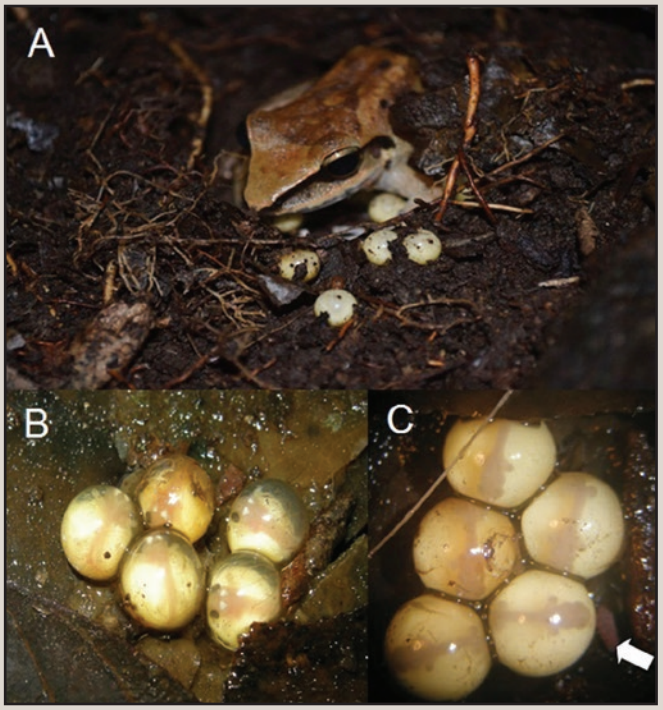


PHOTO BY ANDRES F. JARAMILLO-M

PHOTO BY FERNANDO CASTRO-H

FIG. 1. Parental care in *Craugastor raniformis*. A) Female assisting a nest; eggs in stage 3 of development. B) Egg in stage 5 of development with presence of four limbs; C) Eggs with parasites, the white arrow indicates a parasitic organism.

In September 2011, a *C. raniformis* nest cavity measuring 58.8 x 66.7 mm was found in the "corregimiento" of Piangüita-Bazan, Buenaventura, Valle del Cauca, Colombia (3.845250°N, 77.200001°W, 50 m elev.). The nest was next to a rotting log, in a ca. 60-mm deep hole in the forest floor amid fallen leaves. On 16 Sept at 2100 h, the first observation was made; the nest was found unattended, protected by the trunk and the leaves. Prior to this, an adult female *C. raniformis* (68.7 mm SVL) was seen perched on top of the trunk near the nest, possibly feeding.

The second observation was made on 17 Sept 2011 at 1905 h. An adult female *C. raniformis* was observed tucked into the cavity, on top of an egg clutch, protecting 95% of them with her body and forelimbs (Fig. 1). In addition, when the nest site was disturbed a little, the female performed "push" movements with the front legs in an attempt to not allow us to approach the eggs. Five eggs removed from the nest were completely spherical, with an abundant cream-white colored yolk and a translucent longitudinal band corresponding to the embryo. Five additional eggs were collected for observation of embryonic development. The eggs were in stage 3 (Townsend and Stewart 1985. Copeia 1985[2]:423–436). Five days following collection, the eggs began to develop microorganisms which became pathogenic. On the seventh day, when the embryos had reached stage 5 (four limb development; Townsend and Stewart 1985, *op. cit.*) (Fig. 1B), all

eggs showed a complete invasion of fungi and other organisms' larvae (Fig. 1C), preventing their viability.

Based on this observation, it is likely that attending *C. raniformis* females influence hatching success by protecting the eggs from attack by fungi and other predators. Females have been observed to leave the nest to perform other activities, although they do not venture far from it.

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***EUPARKERELLA TRIDACTYLA* (Sapinho-de-folhiço-de-três-dedos). DEFENSIVE BEHAVIOR.** *Euparkerella* is an Atlantic Forest endemic genus composed of four slow-moving leaf litter species (Ferreira et al. 2010. Herpetol. Notes 3:57–60). *Euparkerella tridactyla* is distributed throughout south and central regions of Espírito Santo state, southeastern Brazil (Frost 2013. Amphibian Species of the World: an Online Reference. Ver. 5.6. Electronic database accessible at http://research.amnh.org/herpetology/amphibia/index.html. American Museum of Natural History, New York; accessed 10 Aug 2013). This is an enigmatic species with few reports on its life history. Here we report for the first time defensive behaviors of *E. tridactyla*.

During fieldwork in 2009, 2012, and 2013, we hand-captured nine individuals of *E. tridactyla* within and around the type locality, Reserva Biológica Augusto Ruschi (19.90694°S, 40.55553°W, datum: UTM; elev. 724–890 m), Santa Teresa municipality. Seven of these individuals were collected (MBML 7565; 7584–7589). In the field, one individual displayed mouth-gaping behavior (Fig. 1A; MBML 7565). In the laboratory during daytime, another eight individuals displayed immobility, fleeing, and active escape in sequence after being disturbed by forceps. Also in the laboratory, one of these individuals displayed a partial body-raising behavior (Fig. 1B; MBML 7586). The only other report of defensive posture for this genus is for *E. cochranae* displaying stiff-legged behavior (Toledo et al. 2011. Ethol. Ecol. Evol. 23:1–25). Mouth-gaping is presumably a threat display, while elevating the body presumably makes the frog appear larger to a predator.

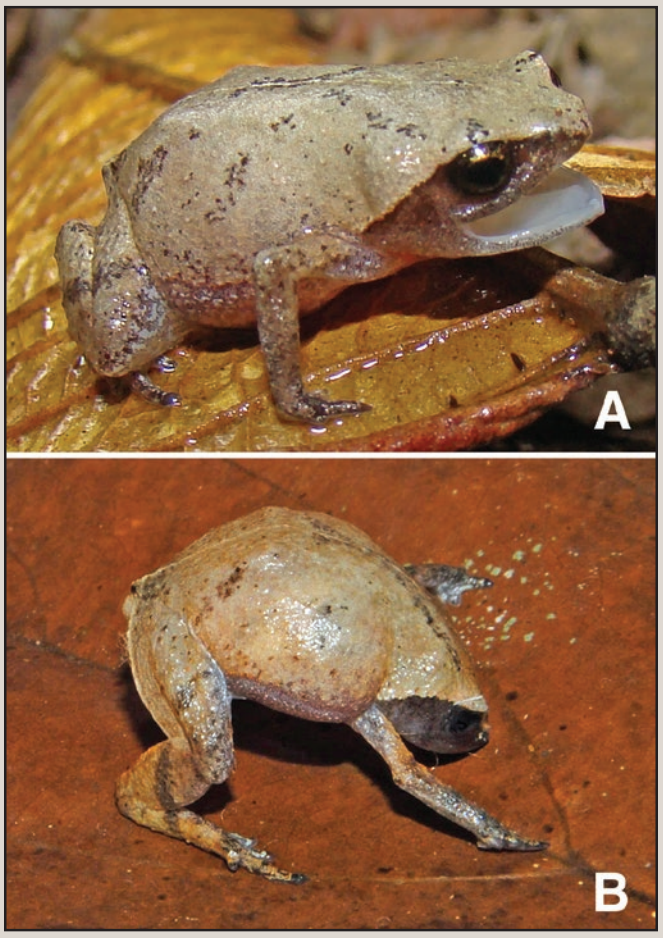


FIG. 1. Defensive behaviors of *Euparkerella tridactyla*: A) mouth-gaping, and B) body-raising display.

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***HYLARANA GUENTHERI* (Günther's Frog). DIET.** *Hylarana guentheri* is widely distributed from central Vietnam throughout southern China, including Hainan and Taiwan. The species is common in lowland and mountainous areas (Fei et al. 2009. Fauna Sinica. Amphibia. Vol. 3. Science Press. 559–1847 pp.). The diet includes insects, earthworms, snails, and small frogs (Fei et al. 2010. Colored Atlas of Chinese Amphibians. Sichuan Publishing Group. 519 pp.). Here we report the first case of predation on a bat by this species.

On 11 Sept 2009, we encountered an adult *H. guentheri* on the ground near a pool eating a bat (Mt. Tianmenshan, Shangqing Town, Yingtan City, Jiangxi province, China). We could not identify the bat as only a part of the wing could be seen (Fig. 1). We took a few photos, and the frog jumped into the pool before we could make any further observations.

To our knowledge, there have been very few cases of predation on bats by frogs in the wild, including *Rana esculenta* (Országhová et al. 2003 Biologia 58:291–293) and *Rana ridibunda* (Kuzmin 1999. The Amphibians of the Former Soviet Union. Pensoft Publishers, Sofia. 538 pp.). It is possible that the bat was injured and picked up by the frog, as it may be unusual that the bat was flying near the ground. This report suggests that *H. guentheri* is an opportunistic predator that preys on non-specific food items depending on the availability.

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***INCILIUS NEBULIFER* (Gulf Coast Toad). NECROPHILIA.** *Incilius nebulifer* (Bufonidae) occurs along the Gulf Coast of the

United States and Mexico (Mulcahy and Mendelson 2000. Mol. Biol. Evol. 17:173–189). At 2255 h on 18 May 2010, in Hidalgo Co., Texas, USA (26.19620°N, 98.12411°W; datum WGS 84), an adult male *Incilius nebulifer* was found amplexed with a deceased female of the same species. The temperature was 25.5°C and approximately 7.2 cm of rainfall occurred that day. The pair was found on a dirt road. The amplexus was photographed and a copy of the image was deposited in the University of Texas– Pan American vertebrate museum (voucher #05109).

Extremely dry habitats impose unique and intense pressures on amphibians. To our knowledge this is the first time this behavior has been observed for this species. This is a noteworthy observation because it may provide insight into the reproductive strategy of these toads in semiarid habitats. There may be an advantage to amplexing dead females if the eggs are still viable and can be extracted and fertilized by the male. This behavior has been described in other anurans and termed "functional necrophile strategy" by Izzo et al. (2012. J. Nat. Hist. 46:47–48).

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***LEPTODACTYLUS FRAGILIS* (Mexican White-lipped Frog). ENDOPARASITES.** *Leptodactylus fragilis* ranges from southern Texas to central Colombia and northern Venezuela (Dodd 2013. Frogs of the United States and Canada, Vol. 1, Johns Hopkins University Press, Baltimore, Maryland. 460 pp.). The purpose of this note is to add to the list of known helminth endoparasites of *L. fragilis*. A sample of eight *L. fragilis* (mean SVL = 32.4 mm ± 3.5 SD, range = 27–39 mm) was examined for helminths. Frogs were collected in Guanacaste Province, Costa Rica during 1963–64 and 1973–74 (LACM 157201, 157211, 157212, 157226, 157230, 157234, 57240, 157250).

Two nematode species were found in the large intestines. They were identified as *Schrankiana formosula* (N = 68; prevalence, number infected frogs/number examined frogs at 100x = 25%, mean intensity, mean number infected individuals = 34.0 ± 14.1 SD, range = 24– 44) and *Cosmocerca podicipinus* (N = 3; prevalence = 38%, mean infection intensity = 1.0). Voucher specimens were deposited in the United States National Parasite Collection (USNPC) as: *Cosmocerca podicipinus* (USNPC 107220) and *Schrankiana formosula* (USNPC 107221). *Schrankiana formosula* is known from *Leptodactylus fuscus* from Brazil and *L. elenae* from Paraguay (Goldberg et al. 2007. Comp. Parasitol. 74:327–342). *Leptodactylus fragilis* is the third anuran species known to harbor *S. formulosa* and represents a new host record for *Schrankiana formosula*; furthermore, Costa Rica is a new locality record for this nematode. *Cosmocerca podicipinus* is widespread in Meso and South American anurans (Goldberg et al., *op. cit.*) and was previously found in *L. fragilis* in Guanacaste Province, Costa Rica (Bursey and Brooks 2010. Comp. Parasitol. 77:221–231).

We thank G. Pauly (LACM) for permission to examine *L. fragilis*.

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***LIMNONECTES GRUNNIENS*. SALINE WATER TOLERANCE.** Individuals of *Limnonectes grunniens* were observed and collected (Museum of Vertebrate Zoology; ALS 297–305, 339) along the banks of saltwater channels in the Aru Islands, Maluku, Indonesia. The Aru Islands are a network of 95 islands in eastern Indonesia, most of which are separated by narrow brackish channels. Located on the Sahul Shelf, the Aru Islands share much of their fauna with New Guinea and formed a land bridge with New Guinea and Australia during glacial maxima. Ten *Limnonectes grunniens* were collected at night on 30 September 2011 along a saltwater channel adjacent to Desa Kongan, Kecamatan Aru Tengah, Kabupaten Kepulauan Aru (6.50277°S, 134.39137°E). All individuals were found along the banks of these saltwater channels, though two specimens collected were found on a small rock (2 m x 5 m) surrounded by water inside the channel. These rocks were located at least 3 m from other land and any access to them would require these frogs voluntarily entering saline water even at low tide. In addition, *L. grunniens* frequently jumped into the saline water as an escape response, often attempting to hide motionless under dead leaves or vegetation to avoid detection. Using a refractometer, we measured the salinity of the water in the channel to be 27 parts per thousand, just below the salinity of seawater which is ca. 31–37 parts per thousand. We conclude that this population of *L. grunniens* is capable of tolerating saline water at least for brief periods and represents another example of salt-water tolerance in dicroglossid frogs as also noted for *Fejervarya cancrivora*.

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***OSTEOPILUS SEPTENTRIONALIS* (Cuban Treefrog). POST-INVASION SPREAD.** *Osteopilus septentrionalis*, a native hylid of Cuba, was first recorded in Florida, USA, in 1931 in Key West, Monroe Co., where it may or may not have been native (Meshaka 2001. The Cuban Treefrog in Florida: Life History of a Successful Colonizing Species. Univ. Florida Press, Gainesville. 191 pp.). The Cuban Treefrog is highly vagile, able to thrive in urban settings and disturbed habitats, and has spread throughout peninsular Florida with a few isolated occurrences in the panhandle (Meshaka 2001, *op. cit.*; Meshaka 2010. A Runaway Train in the Making: The Exotic Amphibians, Reptiles, Turtles, and Crocodilians of Florida. Monograph 1. Herpetol. Cons. Biol. 6:1–101). Cuban Treefrogs have successfully invaded hardwood hammocks and other natural habitats, but further spread is limited by low relative humidity during the dry season in subtropical Florida and cold climate farther north (Meshaka 2001, *op. cit.*).

Cuban Treefrogs were first observed on the Archbold Biological Station (ABS; Highlands Co., Florida; 27.181°N, 81.350°W; elev. 42 m) more than 20 years ago, based on specimens deposited in the ABS Vertebrate Collection. The earliest ABS specimens were collected in 1987 (from a site 15 km N of ABS) and 1993 (found on the main research building at ABS). However, the first published record for Highlands Co. was in the late 1970s (Stevenson 1976. Vertebrates of Florida. Univ. Florida Press, Gainesville. 607 pp.). In July 2009, we saw and heard adult Cuban Treefrogs near a granite-lined drainage ditch that bisects the main grounds of ABS, and individuals were often seen on the exterior of the research building at night.

To determine the extent to which Cuban Treefrogs have invaded adjacent scrub habitats, we installed an array of 50 3.9-cm-diameter PVC pipes extending east and west from the main ditch, with the pipe grid covering an area of ca. 0.1 km^2. Pipes were checked on average every seven days from October 2009 through November 2010. Captured Cuban Treefrogs were euthanized and preserved, and native hylids were relocated well outside the grid to prevent recapture. We also measured snout–urostyle length (SUL) of most individuals to the nearest mm. In total, we captured nine Cuban Treefrogs (two at the ditch, four at 50 m, one at 100 m, and two at 150 m east of the ditch) and 76 native hylids, including 60 *Hyla squirella*, 14 *H. femoralis*, and two *H. cinerea* as far as 200 m away from the ditch. Mean SUL ± SD was 37.3 ± 6.7 mm for *O. septentrionalis* (range 28–45; N = 7), 28.7 ± 5.3 mm for *H. femoralis* (19–37; N = 13), 23.8 ± 4.3 mm for *H. squirella* (18–36; N = 47), and 41.0 mm for *H. cinerea* (N = 1).

Although 32% of the captures of native hylids occurred after 28 January 2010, no Cuban Treefrogs were captured after this date. January 2010 was a particularly cold month at ABS with record-setting minimum temperatures. Daily minimum temperatures at ABS were at or below 0° C for six consecutive days, followed by a low temperature of 2.8°C, and then five more days below 0°C; there were three days in January 2010 when the temperature dropped to -7°C. It is plausible that this extended period of extreme cold reduced the population of Cuban Treefrogs at ABS. Furthermore, Cuban Treefrogs have not colonized undisturbed oak scrub and scrubby flatwoods surrounding the developed part of ABS, despite the presence of many seasonally inundated wetlands. In addition to low humidity during the dry season, the frequent application of prescribed fire at ABS may impose a constraint on this species, either directly or indirectly via effects on vegetation structure and availability of suitable refuges. Refuge availability has previously been shown to be a factor limiting abundance of this species (Meshaka 2001, *op. cit.*).

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***RHINELLA GRANULOSA* (Granulated Toad). PREDATION.** Anurans are preyed upon by several kinds of invertebrates, such as water bugs (Giaretta and Menin 2004. J. Nat. Hist. 38:1711–1722), scorpions (Villanueva-Rivera et al. 2000. Herpetol. Rev. 31:100), spiders (Menin et al. 2005. Phyllomedusa 4:39–47), and all vertebrate groups (Pombal Jr. 2007. Rev. Bras. Zool. 24: 841–843; Toledo et al. 2005 Herpetol. Rev. 36:395–400). The present communication reports predation of *Rhinella granulosa* (Bufonidae) by a banana-spider of the Amazonian genus *Phoneutria* (species unidentified; Ctenidae). At 2118 h on 10 July 2013, the spider was observed predating an adult male of *R. granulosa* (62.3 mm SVL). Our observation occurred at a residence in an urban area in the municipality of Santana, State of Amapá, North Brazil (0.022778°S, 51.164722°W; datum WGS84). The observation lasted at least eight minutes and during this time the spider had already captured the anuran with the aid of its pedipalps, and its chelicerae were inserted in the prey's lateral body.

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***RHINELLA SCHNEIDERI* (Cururu Toad). DIET.** *Rhinella schneideri* is a large bufonid found in open and urban areas, and is widely distributed in South America, inhabiting some regions of Brazil, Paraguay, Bolivia, Argentina, and Uruguay (Pramuk 2006. Zool. J. Linn. Soc. 146:407–452). This species feeds mainly on arthropods (Batista et al. 2011. Herpetol. Notes 4:17–21; Duré et al. 2009. Phyllomedusa 8:27–39; Lajmanovich 1994. Rev. Hydrobiol. Trop. 27:107–112; Moreira and Barreto 1996. Rev. Bras. Zool. 123:313–320), however, like many anurans, it is considered to be a generalist and opportunistic predator.

On 08 February 2013, we collected a female *R. schneideri* (SVL = 905.5 mm; CFBH 35704) from a ranch on the Tietê River, located within the municipality of Barbosa, São Paulo state, southeast Brazil (21.25048°S, 49.92132°W; datum WGS84; elev. 371 m). Stomach contents included ten individuals of newly metamorphosed *Dermatonotus muelleri* (Mueller's Narrow-mouthed Frogs; mean SVL = 16.1 mm). It is known that adults of *R. schneideri*, as well as some congeneric species (Camilotti and Barreto-Lima 2011. Bioscience J. 27:993–994) feed on small vertebrates, such as birds (Vaz-Silva 2003, *op. cit.*) and legless lizards (Oda and Landgraf 2012. Bol. Asoc. Herpetol. Esp. 23:57–59). However, to our knowledge, this is the first record of an adult *R. schneideri* preying upon an anuran. At the time our observation was made, there was a massive emergence of *D. muelleri* in the area, which corroborates the opportunistic feeding behavior of *R. schneideri*. All specimens are housed at Coleção de Anfíbios "Célio F. B. Haddad" at UNESP, Rio Claro, Brazil.

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GYMNOPHIONA — CAECILIANS

***DERMOPHIS GLANDULOSUS*. PREDATION BY *MICRURUS ALLENI*.** Little is known regarding predation on caecilians, due mainly to their fossorial nature and the difficulty to find them. It has been suggested that various semifossorial and fossorial snakes appear to be major predators of these amphibians (Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna between Two Continents, between Two Seas. Univ. Chicago Press, Chicago, Illinois. 934 pp.). Roze (1996. Coral Snakes of the Americas: Biology, Identification, and Venoms. Krieger Publ. Co., Malabar, Florida. 340 pp.) found that the coral snake *Micrurus nigrocinctus* eats caecilians, however he did not identify prey species. Solórzano (2004. Serpientes de Costa Rica: Distribución, taxonomía e historia natural. INBio, Heredia, Costa Rica. 792 pp.) suggested that other species of *Micrurus* also include caecilians in their diet.

On 18 April 2012, a juvenile male *Micrurus alleni* (UCR 21534) was found near Rio Sonador in Volcán of Buenos Aires, Puntarenas, Costa Rica (9.29797°N, 83.47062°W, WGS84; 1120 m elev.).

This region is classified as premontane rainforest (Bolaños et al. 2005. Mapa Ecológico de Costa Rica. Centro Científico Tropical, San José, Costa Rica). A few hours after collection the snake (420 mm TL) regurgitated a caecilian *Dermophis glandulosus* (UCR 21533; 240 mm TL). This specimen showed mechanical damage in the head and nuchal region, suggesting that it was ingested head first.

This is the first record of a predator for *D. glandulosus*, and also the first report of the species in the diet of *M. alleni*, supporting the hypothesis that coral snakes feed on caecilians. Solórzano (2005. Rev. Biol. Trop. 53:227–228) indicated that the diet of *M. alleni* is composed primarily of Marbled Swamps Eels (*Symbranchus marmoratus*); however, this eel is found in Costa Rica from sea level to 650 m elev. (Bussing 1998. Rev. Biol. Trop. 46:1–468), while *M. alleni* is relatively common from sea level to 1500 m elev. (Solórzano 2004, *op. cit.*), suggesting a dietary shift at higher elevations.

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TESTUDINES — TURTLES

***CHRYSEMYS PICTA PICTA* (Eastern Painted Turtle). PREDATION.** On 22 August 2012 at 1030 h we observed a second-year Bald Eagle (*Haliaeetus leucocephalus*) kill and consume an adult *Chrysemys picta picta* along the bank of a farm impoundment at Chesapeake Farms, Kent Co., Maryland, USA (39.1962°N, 76.21707°W). The *C. p. picta* was basking ca. 1.5 m up the gradual, muddy bank of the 6.5-acre impoundment when the eagle landed beside the turtle, used both feet to turn the turtle on edge, and grasped the turtle in its left talon. The bird then flew to a height of ca.15 m and dropped the turtle on the bank, at which point the turtle attempted to right itself. This pattern was repeated several times until the turtle remained motionless upon landing. The *H. leucocephalus* then picked up the *C. p. picta* and flew to a perch ca. 250 m from the capture sight and ca. 10 m above the ground, where it was seen consuming the apparently dead *C. p. picta*.

Ernst and Lovich (2009. Turtles of the United States and Canada. Johns Hopkins University Press, Baltimore, Maryland. 840 pp.) lists *H. leucocephalus* among the many predators of *C. p. picta*, but careful scrutiny of references therein (e.g., Vogt 1981. Natural History of Amphibians and Reptiles of Wisconsin. Milwaukee Public Museum, Milwaukee, Wisconsin. 205 pp.; Ross 1989. Wisconsin Endangered Species Report 59:1–33) and other studies of the diet of *H. leucocephalus* (e.g., Smith 1936. Auk 53:301–305; Imler and Kalmbach 1955. U.S. Fish Wildl. Serv. Circ. 30; Clark 1982. J. Field. Ornithol. 53:49–51) reveals that such assertions are based on observations of *C. p. picta* shells below or in active *H. leucocephalus* nests. It is thus unclear if the turtles noted in these studies were depredated or collected as carrion, as *H. leucocephalus* is a frequent and voracious scavenger (e.g., Buehler 2000. In: The Birds of North America, No. 506: 40; Wilmers et al. 2003. Ecol. Lett. 6:996–1003). Further, if these *C. p. picta* were indeed depredated, the studies fail to document the means by which the turtles were killed by *H. leucocephalus* or if the turtles were consumed by non-nestling *H. leucocephalus*. Thus this observation apparently represents the first reported direct observation of predation of *C. p. picta* by *H. leucocephalus* and provides evidence for the inclusion of *C. p. picta* in the diet of non-nestling *H. leucocephalus*.

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***LEPIDOCHELYS OLIVACEA* (Olive Ridley Sea Turtle). LEUCISTIC HATCHLING.** Along the Odisha coast of eastern India, "*arribadas*" (simultaneous mass nestings) of Olive Ridley Sea Turtles occur at three beaches *viz.*, Gahirmatha, Devi, and Rushikulya. Gahirmatha Beach, within Bhitarkanika National Park, was once regarded as the largest reported *arribada* nesting ground for Olive Ridleys in the world (Bustard 1976. Tigerpaper 3:25). The other two sites, Devi and Rushikulya, are outside the protected area, but are regularly monitored by the Odisha Forest Department during the nesting period.

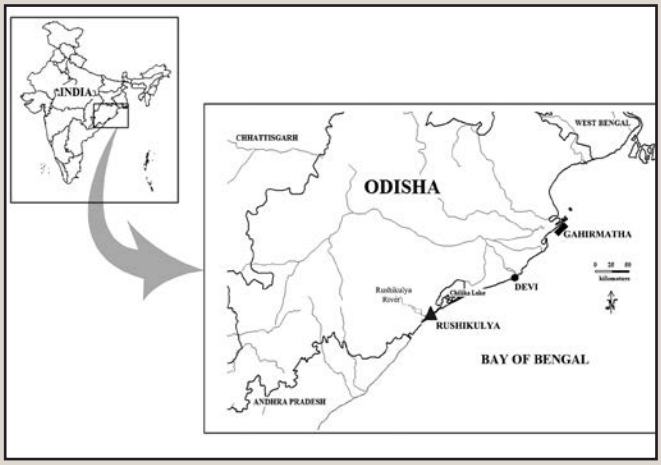


FIG. 1. Map showing the three *arribada* sites in Odisha coast. Solid fill triangle = site of observation at Rushikulya Beach. The coastline between these sites is used by *Lepidochelys olivacea* for sporadic nesting.

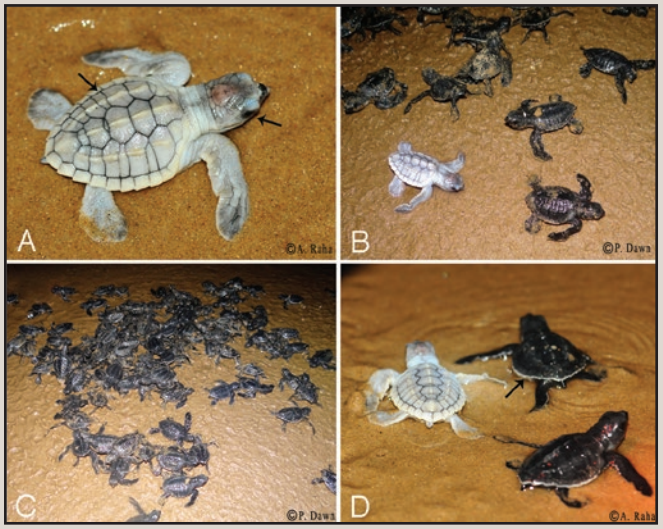


FIG. 2. *Lepidochelys olivacea* hatchlings observed at Rushikulya. A) Leucistic hatchling; arrow marks showing normal eye color and black sutures between plates of the carapace. B) Typical black hatchlings. C) Cluster of normal hatchlings. D) Arrow indicates the narrow white line surrounding the carapace of normal hatchlings.

Rushikulya Beach (19.3945°N, 85.0896°E; WGS 84) is the southernmost nesting site along the Odisha coast (Pandav et al. 1994. A Status Survey of Olive Ridley Sea Turtle [*Lepidochelys olivacea*] and its Nesting Habitats along the Orissa Coast, India. Wildlife Institute of India, Dehradun. 48 pp.). The site falls in the Ganjam district and is north of the Rushikulya River mouth from Purunabandha to Kantiagada village (Fig. 1). In 2012, an *arribada* occurred during the first week of March at Rushikulya Beach and the associated hatching event started after approximately 50 days (mid-April).

On 22 April 2012, while observing the hatching event we came across a rare leucistic hatchling of *L. olivacea*, along with the normal gray/black form (Fig. 2A). The white hatchling looked similar to the black form in size, shape, and structures (Fig. 2B). It was not a true albino because its eyes were of normal black color (typically red in albinos). It had a grayish tinge on the head and edge of the flippers. The sutures between the plates of the carapace and upper part of the beak were blackish. Normal hatchlings are dark gray, but appear black when wet (Fig. 2C), and a narrow white line surrounds the carapace, as well as the trailing edge of the fore and hind flippers (Fig. 2D). The leucistic hatchling was not collected as the species is protected. A literature survey suggests that the leucistic form of *L. olivacea* has not been reported earlier from the Indian coast. Media photographic records are available for leucistic sea turtles from Florida, and some studies have been performed on malformations in hatchlings of *L. olivacea* outside India (Ibarra and Gasca 2009. Vet. Méx. 40:371–380). A thorough monitoring of nesting sites in India during peak season may reveal additional aberrancies or deformities which might provide new insights on the biology and physiology of this species.

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***TERRAPENE CAROLINA* (Eastern Box Turtle). DIET.** *Terrapene carolina* is known to consume carrion and small snakes, including snakes in the genus *Agkistrodon* (Jensen 1999. Herpetol. Rev. 30[2]:95; Ernst and Lovich 2009. Turtles of the United States and Canada. Johns Hopkins Univ. Press, Baltimore, Maryland. 840 pp.). On 5 July 2013, at approximately 1745 h, BD observed a road-killed *A. piscivorus* in Jackson Co., Mississippi, USA (30.528056°N, 88.548889°W, datum WGS84/NAD83). Upon returning 5 minutes later he discovered an adult *T. carolina* feeding on the snake carcass (Fig. 1). Photos were taken and the turtle was left undisturbed. Later that same evening, the turtle could not be located but the snake had been pulled to the margin of the road, possibly by the turtle. Similar behavior was noted by Jensen (*op. cit.*). This is the first diet record of a *T. carolina* consuming *A. piscivorus*. This observation also highlights an additional vulnerability of *T. carolina* to road mortality while scavenging carcasses.



FIG. 1. Eastern Box Turtle (*Terrapene carolina*) scavenging road-killed Cottonmouth (*Agkistrodon piscivorus*), Jackson Co., Mississippi, USA.

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CROCODYLIA — CROCODILIANS

***ALLIGATOR MISSISSIPPIENSIS* (American Alligator). MAXIMUM CLUTCH SIZE.** *Alligator mississippiensis* is an oviparous crocodilian species that is characteristic of the Gulf Coast and lower Atlantic Coastal Plains of the USA (Conant and Collins 1998. A Field Guide to Reptiles and Amphibians of Eastern and Central North America. 3rd ed. Houghton Mifflin Co., Boston, Massachusetts. 616 pp.). The nesting ecology and clutch characteristics of this species have been well documented (Hall 1991. J. Herpetol. 25:133–141; Joanen and McNease 1989. Am. Zool. 29:987–998). The maximum clutch size previously reported for *A. mississippiensis* is 75 eggs (Platt et al. 2004. Florida Field Nat. 32:102–106), collected in 1925 from a nest at Lake Miccosuke, Jefferson Co., Florida, USA.

On 27 June 2012 two of us (LWJ and JJ) collected a clutch from a single nest containing 91 eggs. Further examination of the eggs for banding patterns (i.e., to determine viability) revealed that of the 91 eggs, 82 were fertile and 9 were infertile. The clutch was subsequently taken and hatched in captivity under optimum conditions. The clutch produced 60 hatchling alligators (66% success) on 30 August 2012. The clutch was collected on Eagle Lake in southeastern Colorado Co., Texas, USA (29.55870°N, 96.35287°W, WGS84; 46.6 m elev.)

Detailed examination of the eggs revealed essentially identical size and shape. In oviparous reptiles, data suggest that variability in egg width is restricted by the diameter of the pelvic aperture (Congdon and Gibbons 1985. Herpetologica 41:194–205; Thorbjarnarson 1994. Copeia 1994:907–919; Werner 1989. Israeli J. Zool. 35:199–213). Consequently, because of the egg homogeneity coupled with the uniform hatching date, we hypothesize this clutch was most likely produced by a single gravid female.

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***ALLIGATOR MISSISSIPPIENSIS* (American Alligator). NESTS USED BY OTHER REPTILES IN COASTAL LOUISIANA.** Alligator nests have been documented to serve as commensal nesting

sites for other reptiles in the southeastern USA (see review and references in Enge et al. 2000. J. Herpetol. 34:497–503). Several species of turtle have been identified to nest in alligator nests in these studies, including *Pseudemys nelsoni* (Florida Redbelly), *Apalone ferox* (Florida Softshell), *Kinosternon subrubrum* (Florida Mud Turtle), *K. baurii* (Striped Mud Turtle), and *Sternotherus odoratus* (Common Musk Turtle) (Deitz and Jackson 1979. J. Herpetol. 13:510–512; Enge et al., *op. cit.*; Kushlan and Kushlan 1980. Copeia 1980:930–932). Eggs of *Anolis carolinensis* (Green Anole) have also been found in alligator nests (Deitz and Jackson, *op. cit.*; Kushlan and Kushlan, *op. cit.*), although far less commonly than turtle eggs. Snake eggs are also rarely found in alligator nests, but Deitz and Jackson (*op. cit.*) described *Farancia abacura* (Mud Snake) eggs in one alligator nest in Florida, as well as several specimens of *Seminatrix pygaea* (Swamp Snake) and *Nerodia cyclopion* (Green Water Snake).

In Louisiana, four clutches of *F. abacura reinwardtii* (Western Mud Snake) eggs and one female were found in two alligator nest mounds; one nest had been depredated and the other appeared to be a false nest (Hall and Meier 1993. Copeia 1993:219–222). Additionally, *S. odoratus* eggs were located within two alligator nests in southwestern Louisiana, with two additional nests containing *F. abacura* specimens and eggs (Carbonneau 1987. Unpubl. M.S. thesis. Louisiana State Univ. 54 pp.). We herein report on findings of new reptiles using alligator nests for egg deposition sites in coastal Louisiana, which to our knowledge have not been previously documented.

Alligator eggs were collected from numerous nests on Rockefeller Wildlife Refuge in Cameron and Vermilion parishes for various research projects between 25 June and 2 July 2013. Two clutches of snake eggs were incidentally found within alligator nests. The snake eggs (clutch 1, N = 12; clutch 2, N = 4) were in the nest mound, but not within the egg cavities in which the alligator eggs were deposited. The snake eggs were collected and incubated in a field incubator in the same manner as alligator eggs, as previously described (Joanen and McNease 1977. Proc. World Mariculture Soc. 8:483–489). On 23 July we noted the presence of shed snake skins adhering to the wire mesh container in which the eggs had been placed; regrettably the ventilation holes were large enough to allow escape of the hatched snakes. Examination of the eggshells suggested 8 of 12 eggs from the larger clutch had hatched. The shed skins were collected, and viewed under a dissecting microscope. The presence of one preocular scale and two postocular scales from one shed skin was indicative the hatched snakes were likely *Lampropeltis getula holbrooki* (Speckled Kingsnakes).

One egg of the second clutch of four eggs was then dissected, as we were concerned they were non-viable. A near-term Speckled Kingsnake was noted and the remainder of the clutch was then moved to a more secure container for continued incubation. On the morning of 26 July we found a live Speckled Kingsnake had hatched; it measured 21.0 mm TL, 18.5 SVL, and had a mass of 4.07 g. That afternoon a second snake was beginning to emerge. We attempted to assist it in liberating itself from the egg by gently cutting the eggshell further. The snake did not readily emerge so we replaced the egg mass in the incubator. The following morning that egg had hatched, the snake measured 22.5 mm TL, 20.0 mm SVL, and 4.42 g. Both snakes were released to the wild near the field incubator on the day of hatching. The remaining egg appeared desiccated and non-viable.

On 29 July 2013, we visited six additional alligator nests to collect vegetation and soil samples for an associated research project. Two nests contained presumed skink eggs, but we had not previously attempted to incubate these, although we commonly encounter them in alligator nests. Each clutch contained approximately five eggs; some may have been overlooked due to their small size. One egg in one clutch appeared collapsed and non-viable when collected and incubated in our field incubator. On 5 August two hatchling Ground Skinks (*Scincella lateralis*) were found in the incubator; they each had a mass of 0.14 g. These were released near the field incubator that afternoon. On 8 August six more *S. lateralis* were found hatched. Four had masses of 0.17 g, and one had a mass of 0.11 g and another of 0.15 g. We suspect the two smaller skinks may have hatched with those measured on 5 August but were undetected, having been burrowed in the nesting vegetation at the time.

We incidentally collected twenty clutches of alligator eggs from nests on White Lake Conservation Area in Vermilion Parish, Louisiana on 23 June 2009. One nest contained ten *Pseudemys concinna* (River Cooter) eggs. These were incubated at our field laboratory and seven turtles hatched on 2 August. We occasionally find turtle eggs in coastal marsh nests on Rockefeller Refuge, but far less frequently than in Florida lakes as per Enge et al.'s (2000) multi-year, multi-site study (26.6% of 1586 active alligator nests had *P. nelsoni* eggs).

Kushlan and Kushlan (*op. cit.*) noted that commensal nesting in vertebrates is rare, thus our finding of three previously unreported reptile species using alligator nests is of interest. We regularly see *L. getula holbrooki* locally, and *S. lateralis* was the most commonly encountered reptile in a herpetofaunal study conducted in a nearby chenier habitat (W. Selman, unpubl. data). The River Cooter, however, occurs less commonly in southwestern Louisiana marsh habitats (Dundee and Rossman 1989. The Amphibians and Reptiles of Louisiana. Louisiana State Univ. Press, Baton Rouge, Louisiana. 300 pp.). The advantages and disadvantages of turtles nesting in alligator nests were discussed in detail by Enge et al. (*op. cit.*, and references therein). Hall and Meier (*op. cit.*) also discussed strategic advantages of commensal nesting in alligator nests for nesting turtles and snakes (and their eggs). Similar benefits and adverse effects may play a role in other reptiles using alligator nests, such as the taxa described herein: *L. getula holbrooki*, *S. lateralis*, and *P. concinna*.

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SQUAMATA — LIZARDS

***ANOLIS EQUESTRIS* (Cuban Knight Anole). NOCTURNAL ACTIVITY.** *Anolis equestris* is native to Cuba and has been introduced to Florida, USA (Kraus 2009. Alien Reptiles and Amphibians: A Scientific Compendium and Analysis. Springer, Dordrecht, Netherlands. 563 pp.; Krysko et al. 2003. Florida Sci. 66:74–79). This species consumes a wide variety of animals and plants including vertebrates, invertebrates, and fruit (Camposano et al. 2008. Iguana 15:212–219, Giery et al., unpubl.). Documented activity times for populations in southern Florida indicate that *A. equestris* activity falls between mid-morning and late afternoon, ceasing at sunset (Meshaka et. al. 2004. The Exotic Amphibians

and Reptiles of Florida. Krieger Publ. Co., Malabar, Florida. 166 pp.). Here, we report on nocturnal activity of *A. equestris* in South Florida.

On 18 April 2013 between 2203–2215 h, a single adult *Anolis equestris* was observed at Fairchild Tropical Botanical Gardens, Miami, Florida, USA (25.677°N, 80.276°W, WGS84; <1 m elev.). This individual was observed consuming Lepidoptera attracted to an artificial light source positioned above a doorway. Nocturnal lizards (*Hemidactylus mabouia*) were also present around the light source and could represent another potential prey source for nocturnally foraging *A. equestris*. This is the first documentation of *A. equestris* using artificial light sources to allow for nocturnal activity.

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***ANOLIS EQUESTRIS* (Cuban Knight Anole) and *ANOLIS DISTICHUS* (Hispaniolian Bark Anole). EXOTIC INTRAGUILD PREDATION.** *Anolis equestris* is native to Cuba and *A. distichus* is native to Hispaniola; both have been introduced to Florida, USA (Kraus 2009. Alien Reptiles and Amphibians: A Scientific Compendium and Analysis. Springer, [Dordrecht, Netherlands], 563 pp.; Krysko et al. 2003. Florida Sci. 66:74–79). *Anolis equestris* consumes a wide variety of animals and plants including vertebrates, invertebrates and fruit (Camposano et. al. 2008. Iguana 15:212–219, Giery et. al. 2013. Functional Ecol. 2013:1–6). Documented activity times for populations in southern Florida indicate that *A. equestris* activity falls between midmorning and late afternoon, ceasing at sunset (Meshaka et. al. 2004. The Exotic Amphibians and Reptiles of Florida. Krieger Publ. Co., Malabar, Florida. 166 pp.). Here, we report on an intraguild predation event of *A. equestris* in South Florida (Miami) on an *A. distichus*.

On 28 August 2013 at 1504 h, a single adult female *Anolis equestris* was observed at Florida International University, Modesto A. Maidique Campus, Miami, Florida (25.757°N, 80.376°W, WGS84; ~2 m elev.). This individual was observed consuming a juvenile *A. distichus* on a tree at ~2 m height. Ingestion took <1 minute. Prior to the predation event, the *A. equestris* was a uniform dark brown base color, with faded yellow barring. Upon predation of the smaller anole, the *A. equestris* rapidly returned to a more typical pattern—green base color with a yellow bar above the shoulder of the forelimb. During the predation event an adult male *A. distichus* was observed performing dewlap extension displays at the *A. equestris* from a distance of ~55 cm. Following consumption, the *A. equestris* proceeded to try and catch an adult female *A. distichus* between 1507–1508 h but failed. This is the first recorded observation of *Anolis equestris* predating *Anolis distichus* in Florida.

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***ANOLIS SAGREI* (Brown Anole). SEXUAL CANNIBALISM.** Sexual cannibalism occurs when a reproductive adult kills and consumes a potential mate. This form of sexual conflict is common among invertebrates, especially arachnids (Birkhead et al. 1988. Behaviour 106:112–118; Dick 1995. J. Zool. 236:697–706; Kaston 1970. Trans. San Diego Soc. Nat. Hist. 16:33–82; Polis 1980. Annu. Rev. Ecol. Syst. 12:225–251), and typically involves the consumption of males by females. In contrast to its frequent occurrence among invertebrates, cannibalism of any form among adult vertebrates is typically reported only in isolated instances in captivity or under stressful conditions (Amstrup et al. 2006. Polar Biol. 29:997–1002; Gander 1934. Copeia 187; Martinez-Freiria et al. 2006. Herpetol. Bull. 96:26–28). Here, we describe four separate occurrences of sexual cannibalism involving the consumption of adult female *Anolis sagrei* by conspecific males, two of which occurred under natural conditions in a wild population.

Brown Anoles exhibit pronounced sexual size dimorphism. Males from our study populations on the islands of Eleuthera and Great Exuma in The Bahamas exceed females by 22–32% in mean adult snout–vent length (SVL) and 106–153% in mean adult body mass (Cox and Calsbeek 2010. Evolution 64:798–809). Both sexes typically consume a variety of small invertebrates, but only rarely consume vertebrate prey (Norval et al. 2007. Russ. J. Herpetol.17:131–138). Although males of *A. sagrei* and other *Anolis* species are known to cannibalize conspecific juveniles (Cochran 1989. Herpetol. Rev. 20:70; Gerber 1999. Anolis Newsl. V:28–39; Gerber and Echternacht 2000. Oecologia 124:599–607; Nicholson et al. 2000. Herpetol. Rev. 31:173), we report cannibalism among adult *Anolis* lizards in the wild.

During a mark-recapture study in September 2007 on Eleuthera, The Bahamas (24.83°N, 76.32°W), we captured and temporarily confined ca. 20 *A. sagrei* adults of both sexes together in a 6-gal plastic bucket (containing a large pile of sea grape leaves, *Coccoloba uvifera*, to provide individuals with shelter and spatial structure) for transport to a nearby field station. Upon removal of the animals for measurement ca. 2–4 h after capture, two individual adult males were found with the hind limbs and tails of females protruding from their mouths. Both females had lacerations and bite marks on their heads and necks and were dead or nearly dead when removed from the males. We did not document the sizes of the individual males and females in this incident, which we interpreted as an unfortunate and unnatural response to high density and stressful conditions.

We later observed two separate instances of sexual cannibalism under natural conditions during mark-recapture studies of a second population on Regatta Point, near Georgetown, Great Exuma, The Bahamas (23.5°N, 75.75°W). On 7 September 2010, we captured an adult male that was lethargic and visibly



FIG. 1. Conspecific female removed from the mouth of male *Anolis sagrei*.

encumbered. Upon capture, the male immediately regurgitated a conspecific female that he had swallowed headfirst. The female was dead but nearly intact, with only the anterior tip of her head exhibiting signs of digestion. The female weighed 1.0 g (measured to the nearest 0.1 g with a Pesola spring scale) and the SVL and mass of the male after regurgitation were 63 mm and 6.2 g respectively. Although we did not dissect the female comestible to assess her reproductive condition, she exceeded the minimum size of maturity that we have previously established for this population (Cox and Calsbeek 2010. Evolution 64:1321–1330). In a separate instance on 28 May 2013, we captured an adult male with the hind limb of a conspecific female protruding from his mouth. The female was extracted and found to be partially digested, with digestion most pronounced at the anterior end (Fig. 1). The partially digested female weighed 1.0 g, and the SVL and mass of the male after regurgitation were 63 mm and 4.9 g respectively. Dissection of the female revealed mature ovaries with enlarged, vitellogenic follicles, indicating sexual maturity.

Although we do not know how frequently adult males of *Anolis sagrei* prey upon conspecific adult females, our independent observations under natural conditions suggest that sexual cannibalism in this species is not limited to isolated instances or unnatural conditions. In arthropods, sexual cannibalism of males by females has been interpreted as adaptive for males in cases where males have a low chance of finding another mate, and when being consumed during copulation leads to greater paternity (Andrade 1996. Science 201:70–72). This behavior may also be explained by adaptive mate choice in females if the decision of whether or not to cannibalize the male prior to mating is influenced by indicators of his genetic quality (Pearsons and Utez 2005. Anim. Behav. 69:89–94). By contrast, a non-adaptive explanation for sexual cannibalism includes "aggressive spillover," where aggression during the juvenile stage leads to rapid growth, rapid growth leads to greater fecundity in the adult female, and the genetic correlation between aggression in the two life stages is the ultimate driver of sexual cannibalism (Arnqvist and Henriksson 1997. Evol. Ecol. 11:255–273). Adaptive explanations for sexual cannibalism of males are possible because after sperm transfer, a female can gain further fitness benefits from consuming the male. By contrast, a sexually mature female is a necessity for reproduction and presumably always represents a reproductive opportunity for a male. Thus, the sexual cannibalism of females by males in *A. sagrei* appears to be maladaptive. The framework of the "aggressive spillover" hypothesis or even that of male mate choice could hold potential explanations for this behavior (Sentenská and Pekár 2013. Behav. Ecol. Sociobiol. 67:1131–1139).

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***ANOLIS UNIFORMIS* (Lesser Scaly Anole). SELECTED BODY TEMPERATURE.** Body temperature (T_b) data collected in the field form the basis of most of the thermal biology reports in the herpetological literature (Avery 1982. *In* Gans and Pough [eds.], Biology of the Reptilia, Vol. 12, Physiology C, pp. 93–166. Academic Press, New York). In contrast, selected body temperatures (T_{sel}) in laboratory conditions are rarely reported even though they are essential to understanding behavior, natural history, and effects of global warming on ectotherms (Sinervo et al. 2010. Science 328:894–899). T_{sel} represents the range of core temperature within which an ectothermic animal seeks to maintain itself by behavioral means (IUPS Thermal Commission 2003. J. Therm. Biol. 28:75–106). Hence, here we present data on *Anolis uniformis* body temperatures in both field and laboratory conditions.

Anolis uniformis is a small, widely distributed lizard that is found in tropical wet forest in northern Middle America. The thermal ecology of this species has not been adequately addressed (Birt et al. 2001. J. Herpetol. 35:161–166). Thus, during June 2013, we conducted field work in wet tropical rain forest habitat located in Macuspana, Tabasco, Mexico (17.6239°N, 92.4449°W; 195 m elev.). The data presented here are based on 17 adults (> 36 mm SVL; 9 females and 8 males; Campbell et al. 1989. Biotropica 21:237–243) of *A. uniformis* captured by noose and hand. Snout–vent length (SVL) was measured to the nearest 0.05 mm, and sex was determined for all individuals. T_b was recorded using a digital thermometer (Fluke model 51-II) with the sensor introduced one centimeter into the cloaca. We also recorded substrate temperature (T_s) at the exact point of observation and air temperature (T_a) 1 cm above the substrate where the lizard was captured.

In the laboratory, the lizards were maintained at 25°C in plastic containers. Laboratory experiments were conducted one day after capture using a thermal gradient. The thermal gradient consisted of a polycarbonate box 150 cm long x 100 cm wide x 70 cm high. The box was located in a room with controlled temperature of 20°C and two 150 W lamps were placed at different highs over the box to offer thermal gradient (20–50°C). The T_{sel} of individuals in the thermal gradient was taken manually each hour between 0930 and 1400 hs using the digital thermometer. Following laboratory experiments, all lizards were released at the site of capture.

Mean SVL was 38.2 mm (SD = 1.77, range = 36–41 mm). Mean T_b was 28.4°C (SD = 2.71°C, range = 24.5–32.7°C). Mean T_s was 26.1°C (SD = 1.15°C, range = 23.4–27.6°C) and mean T_a was 26.2°C (SD = 1.22°C, range = 23.4–27.9°C). A positive and significant correlation was found between T_b and the microhabitat temperature (Spearman Rank Correlation: r = 0.70, P < 0.0001, N = 17, based on T_s; r = 0.80, P < 0.0001, N = 17, based on T_a). There was no statistically significant difference between sexes (U = 34, P = 0.885). Mean T_{sel} was 30.1°C (SD = 1.90°C, range = 22–34.4°C). Interquartile of 25% and 75% was 28.9 and 30.9°C, respectively. T_b shows that *A. uniformis* analyzed in this study was thermopassive, a mechanism where individuals do not need to invest time and energy actively selecting microhabitats for thermoregulation in tropical habitats (Huey and Slatkin 1976. Q. Rev. Biol. 51:363–384). T_{sel} suggests that *A. uniformis* can be considered a stenothermic species due to the narrow range of temperatures. Previous thermal ecology studies of anoles have also demonstrated these trends (Birt et al. 2001, *op. cit.*; Hertz 1974. J. Herpetol. 8:323–327; Hertz et al. 1993. Am. Nat. 142:796–818).

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***ASPIDOSCELIS EXSANGUIS* (Chihuahuan Spotted Whiptail). FEEDING BEHAVIOR.** *Aspidoscelis exanguis* is a parthenogenetic species of whiptail lizard that primarily ranges within the Chihuahuan Desert ecoregion of the southwestern United States and northern Mexico (Babb 2009. *In* Jones and Lovich [eds.]. Lizards of the American Southwest: A Photographic Field Guide, pp. 338–341. Rio Nuevo Publ., Tucson, Arizona). The species is an active diurnal forager that feeds mostly on arthropods, with termites, grasshoppers, beetles, and arachnids being important prey items (Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. Univ. New Mexico Press, Albuquerque. 431 pp.; Scudday and Dixon 1973. Southwest. Nat. 18:279–289; Smith 1989. Southwest. Nat. 34:418–429). Most published information on food preference is based on removed stomach contents identified to higher taxonomic categories, so little is known about specific food items taken and on the feeding behavior of the lizard in the wild. Herein, we report on the ambushing, subjugation, and consumption of a tarantula by an adult *A. exanguis* in a Black Gramma (*Bouteloua eriopoda*) dominated Chihuahuan Desert grassland landscape.

On 17 June 2009, at 0920 h, on Fort Bliss, McGregor Range in Otero Co., New Mexico, USA (32.418611°N, 105.852778°W, WGS 84; 1606 m elev.), an *A. exsanguis* was observed ambushing and consuming an adult tarantula (*Aphonopelma* sp.) (Fig. 1). The lizard was observed subjugating the tarantula by grasping the tubercle dorsal portion of the thorax, utilizing vigorous head and body twisting, reminiscent of larger, predatory lizard behavior when overcoming large prey. The time frame it took for subduing the prey lasted *ca.* two minutes until the spider showed no signs of movement and was then consumed. Scudday and Dixon (*op. cit.*), mention that *A. exanguis* exhibit a higher foraging activity and more aggression towards prey (i.e., act of slamming prey on the ground) than other sympatrically occuring *Aspidoscelis* species, from which this observation appears to reflect those behaviors. To our knowledge, this is the first documented sighting of *A. exsanguis* subjugating and comsuming large prey of comparable size (*Aphonopelma* sp.).

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FIG. 1. Adult *Aspidoscelis exanguis* consuming a tarantula (*Aphonopelma* sp.) in Otero County, New Mexico, USA.

***ASPIDOSCELIS EXSANGUIS* (Chihuahuan Spotted Whiptail), *ASPIDOSCELIS NEOMEXICANA* (New Mexico Whiptail), *ASPIDOSCELIS UNIPARENS* (Desert Grassland Whiptail). BIFURCATED TAILS.** We report occurrences of bifurcated tails in three parthenogenetic whiptail species (Jones and Lovich 2009. Lizards of the American Southwest: A Photographic Field Guide. Rio Nuevo Publ. Tucson, Arizona. 567 pp.) captured during a long-term study (Bateman et al. 2008. Restor. Ecol. 16:180–190). Bifurcated tails have also been reported from museum specimens in *A. velox*, another parthenogenetic whiptail (Cordes and Walker 2013. Herpetol. Rev. 44:319–320).

We captured and released lizards from late May to mid-September from 2000 to 2006 from riparian forest habitat along the middle Rio Grande in central New Mexico from Albuquerque (35.008380°N, 106.681805°W) to Bosque del Apache National Wildlife Refuge (33.805122°N, 106.859980°W). We measured lizard snout–vent length (SVL), vent–tail length (VTL), and mass. When we encountered lizards with regenerated tails, we recorded the length from the vent to the start of tail regeneration (original tail length, OTL). For some lizards with bifurcated tails, we measured the length of the regenerated portion of the "second" tail (bifid tail length, BTL). The bifurcation typically began at the regenerated or damaged tail segment, as observed by Cordes and Walker (2013, *op. cit.*). In other cases, the bifurcation stemmed from within a portion of a regenerated tail as observed by Gogliath et al. (2012. Herpetol. Rev. 43:129) in *Ameiva ameiva*.

We captured four individual *A. exsanguis* with bifurcated tails (20 July 2001, SVL = 73 mm, VTL = 92 mm, OTL = 27 mm, mass = 9.5 g; 27 July 2001, SVL = 82 mm, VTL = 141 mm, OTL = 56 mm, mass = 12.0 g; 11 July 2005, SVL = 60 mm, VTL = 116 mm, OTL = 61 mm; and 1 Aug 2005, SVL = 70 mm, VTL = 135 mm, OTL = 99 mm, BTL = 7 mm, mass = 5.5 g). We captured four individual *A. neomexicana* with bifurcated tails (10 June 2002, SVL = 71 mm, VTL = 87 mm, OTL = 15 mm, BTL = 60, mass = 10.5 g; 18 July 2002, SVL = 81 mm, VTL = 170 mm, OTL = 150 mm, BTL = 20, mass = 17.0 g; 27 June 2006, SVL = 77 mm, VTL = 99 mm, OTL = 19 mm, mass = 8.5 g; and 17 Aug 2006, SVL = 82 mm, VTL = 152 mm, OTL = 125 mm, BTL = 27, mass = 12.5 g). We captured three individual *A. uniparens* with bifurcated tails (7 July 2001, SVL = 69 mm, VTL = 117 mm, OTL = 86 mm, mass = 6.5 g; 13 July 2001, SVL = 65 mm, VTL = 121 mm, OTL = 87 mm, mass = 7.5 g; 11 June 2002, SVL = 67 mm, VTL = 123 mm, OTL = 85 mm, mass = 9.0 g). These records are among the first reports of bifurcated tails in *A. exsanguis*, *A. neomexicana*, and *A. uniparens*.

The Middle Rio Grande Conservancy District, Bosque del Apache National Wildlife Refuge, and Albuquerque Open Space permitted access to study sites. The University of New Mexico Animal Care and Use Committee approved field techniques (protocol #20415). The long-term herpetofaunal study was funded by the USDA Forest Service – RMRS Middle Rio Grande Ecosystem Management Unit, Joint Fire Sciences Program, National Fire Plan, US FWS Bosque Improvement Initiative, and USFS S&PF NM Collaborative Forest Restoration Program.

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***ASPIDOSCELIS GULARIS GULARIS* (Texas Spotted Whiptail). ACQUIRED COLOR PATTERN.** We have studied *Aspidoscelis gularis gularis* since 1985 near El Ranchito at a site on the Rio Grande near US Hwy 281 (26.028333°N, 97.645278°W, WGS84; ~16 m elev.), Cameron Co., Texas, USA (Walker 1987. Texas J. Sci. 39:313–334). On 4 August 2008, one of us (JEC) collected an adult male of this taxon (SVL 93 mm, tail length 281 mm, and body mass 22.9 g) with a remarkable dorsal color pattern. The specimen (Fig. 1A–C) was originally cataloged as University of Arkansas Department of Zoology 8474 and recently re-catalogued as Arkansas State University Museum of Zoology (ASUMZ) 32691. It is obvious that the essentially symmetrical rearrangement of alternating pale stripes and dark fields on the anterior part of the dorsum resulted from a major superficial injury that healed to produce the pattern featured in Fig. 1A, C. Surviving such an injury, resulting from a likely predator encounter, was remarkable in itself; however, the uniqueness of the acquired dorsal pattern deserves commemoration in the literature.

Adult males of *A. g. gularis* at El Ranchito have a ventral pattern consisting of an unspotted pink-red chin and throat, blue-purple chest, and the latter color in a checkerboard pattern on the abdomen (Fig. 1B; Walker et al. 1989. J. Herpetol. 23:119–130). The dorsal pattern includes six pale colored primary stripes that are fixed in position (ventral to dorsal; pairs of laterals, dorsolaterals, and paravertebrals) and one or two darker variable secondary stripes between the paravertebrals (the vertebral[s]). In some of the intervening dark areas between the stripes (the fields) are pale rounded spots (e.g., in the upper lateral fields superior to lateral stripes). The dorsal pattern described is apparent in ASUMZ 32691, starting a few mm posterior to the forelimbs (Fig. 1A). In the post-cephalic region there is only a small pointed remnant of a vertebral stripe and the paravertebral stripe remnants are displaced medially to being only narrowly separated as the right stripe fragment extends posterior to the left (Fig. 1A). There is a scarred area just anterior to the forelimbs where no parts of the paravertebral and vertebral stripes remain, and beyond which the dorsolateral striped are noticeably displaced medially. In the latter region, the anterior ends of the interrupted paravertebral stripes are displaced medially to an open point (Fig. 1A). A near view of scars and displaced stripes and fields in the lizard, acquired by unknown means, is captured by Fig. 1C.

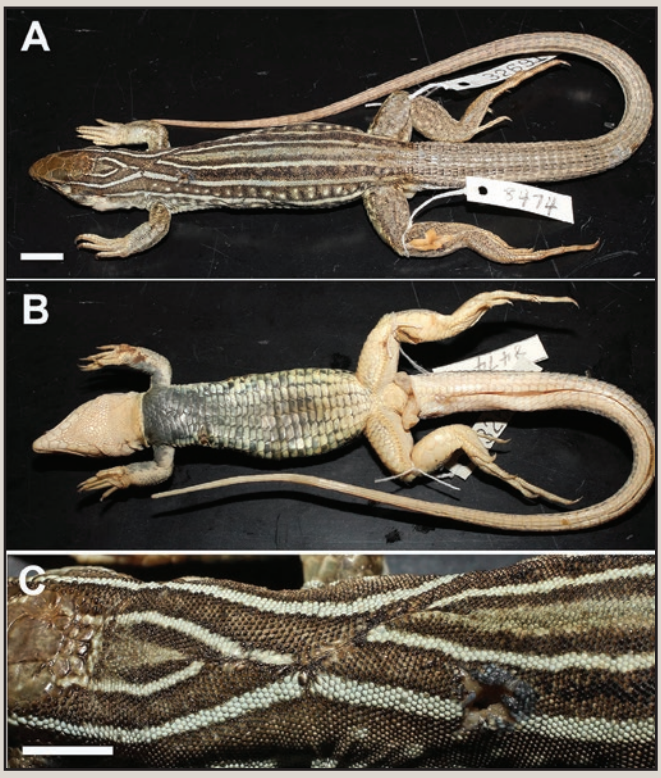


FIG. 1. Color pattern and morphological characteristics of a male of *Aspidoscelis gularis gularis* (SVL 93 mm) from near El Ranchito, Cameron Co., Texas. A) Dorsal coloration and pattern of ASUMZ 32691; line = 10 mm. B) Ventral coloration and pattern of ASUMZ 32691. C) Near view of site of injury and resulting displacement of stripes and fields in ASUMZ 32691; line = 5 mm.

Specimens were collected under authority of Texas Parks and Wildlife Department permit SPR-1090-298 issued to JEC.

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***ASPIDOSCELIS LAREDOENSIS* A (Laredo Striped Whiptail) x *ASPIDOSCELIS GULARIS* (Texas Spotted Whiptail). DIFFERENTIAL RATE OF HYBRIDIZATION.** *Aspidoscelis laredoensis* is a hybrid-derived parthenogenetic species (Bickham et al. 1976. Herpetologica 32:395–399; Dessauer and Cole 1989. *In* Dawley and Bogert [eds.], Evolution and Ecology of Unisexual Vertebrates, pp. 49–71. Bull. 466. New York State Museum, Albany, New York; McKinney et al. 1973. Herpetologica 29:361–366; Parker et al. 1989. *In* Dawley and Bogert [eds.], Evolution and Ecology of Unisexual Vertebrates, pp. 72–86. Bull. 466. New York State Museum, Albany, New York; Wright et al. 1983. Herpetologica 39:410–416) that reproduces asexually by development of unreduced diploid eggs. Sexual reproduction by an individual of this species occurs only when its eggs are fertilized by sperm from a male of a gonochoristic species such as *A. gularis* (Trauth et al. 2013a. Herpetol. Rev. 44:138–140; Trauth et al. 2013b. Herpetol. Rev. 44:314–316; Trauth et al. 2013c. Herpetol. Rev. 44:316–318; Walker et al. 1989a. J. Herpetol. 23:119–130; Walker et al. 1989b. Copeia 1989:1059–1064; Walker et al. 1991. Herpetologica 47:152–164; Walker et al. 2008. Herpetol. Rev. 39:340) resulting in sterile triploid hybrid males and mostly sterile triploid females. However, it is possible that a rare hybrid female from these species could be fertile and become the founder of a new allotriploid parthenogenetic species as has occurred repeatedly through hybridization in the genus *Aspidoscelis* (see Dessauer and Cole, *op. cit.*; Reeder et al. 2002. Amer. Mus. Novitat. 3365:1–61).

There are two morphologically distinct clonal complexes of *A. laredoensis* (Walker 1987. Texas J. Sci. 39:313–334; Walker et al. 1989a, *op. cit.*; Walker et al. 1991, *op. cit.*), each of which originated from a different hybrid of *A. laredoensis* x *A. gularis* based on their histoincompatibility to skin transplants (Abuhteba et al. 2000. Can. J. Zool. 78:895–904; Abuhteba et al. 2001. Copeia 2001:262–266). We used phenotypic attributes to support identification of a hybrid of *A. laredoensis* A x *A. gularis* in order to establish that the rate of hybridization between these species is correlated with clonal complex. Complex B only rarely hybridizes (Walker et al. 1991, *op. cit.*). However, complex A is known to hybridize much more frequently (Walker et al. 1989a, *op. cit.*;

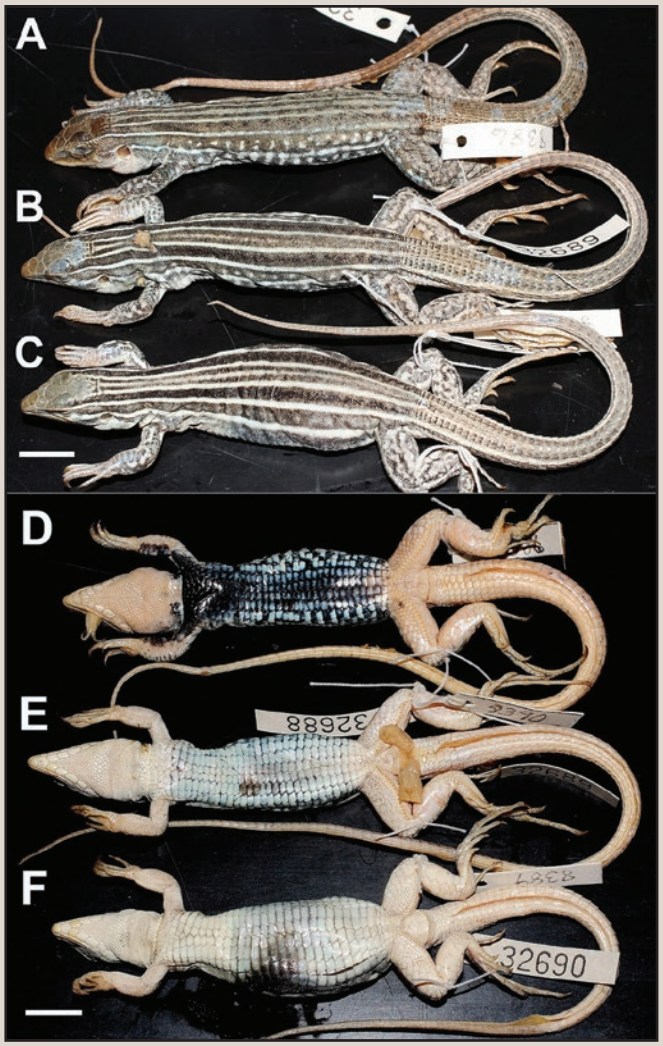


FIG. 1. Color pattern and morphological characteristics of a male of *Aspidoscelis gularis* (SVL 76 mm), hybrid male of *A. laredoensis* A x *A. gularis* (SVL 76 mm), and females of *A. laredoensis* A (SVL 76 mm) from the vicinity of Los Ebanos, Hidalgo County, Texas. A–C. Dorsal coloration and pattern of *A. gularis* (ASUMZ 32688), hybrid (ASUMZ 32689), and *A. laredoensis* A (ASUMZ 32690); line = 1 mm. D–F. Ventral coloration and pattern of *A. gularis* (ASUMZ 32688), hybrid (ASUMZ 32689), and *A. laredoensis* A (ASUMZ 32690); line = 1 mm.

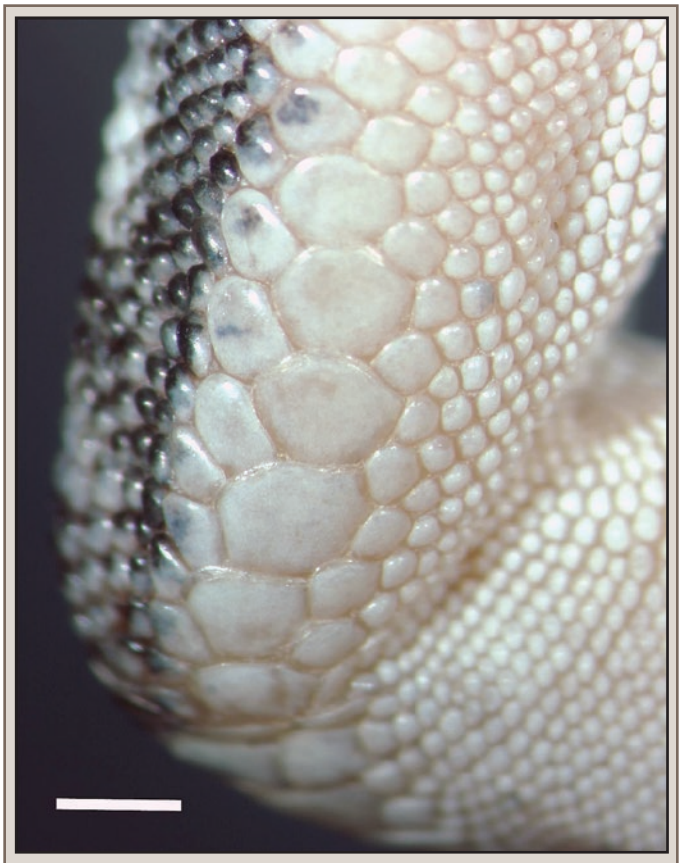


FIG. 2. Enlarged postantebrachial scales of the hybrid (ASUMZ 32689); line = 1 mm.

this study) based on records for 20+ years (1986–2008) in an area near the Rio Grande (26.233889°N, 98.560833°W, WGS84; ~ 40 m elev.) in the vicinity of Los Ebanos, Hidalgo Co., Texas, USA. The male of *A. gularis*, male hybrid, and female of *A. laredoensis* A featured in Fig. 1A–F, originally cataloged as University of Arkansas Department of Zoology 8386, 8390, and 8389, respectively, and re-catalogued as Arkansas State University Museum of Zoology (ASUMZ) 32688, 32689, and 32690, respectively, were collected by one of us (JEC) on 22 June 2008 in the aforementioned area. We have also collected hybrids of *A. laredoensis* A x *A. gularis* from other sites in Dimmit, La Salle, Webb, Star, and Hidalgo counties, Texas, and Tamaulipas State, Mexico (Walker et al. 1989a, *op. cit.*), The distinctive Los Ebanos area, within a prominent oxbow of the Rio Grande, supports a thriving guild of whiptail lizards comprising large numbers of *A. gularis* (gonochoristic) and both clonal complexes A and B of *A. laredoensis* (diploid parthenogens). Here, these congeners are locally dispersed such that opportunities for hybridization of *A. gularis* with each of *A. laredoensis* A and B are essentially present whenever lizards are active.

Prior to preservation, hybrid ASUMZ 32689 had a SVL of 76 mm, tail length of 263 mm, and body mass of 10.6 gm. This male could not be identified to *A. gularis* because of divergent features of both dorsal and ventral color patterns, as well as scutellation (see Conant and Collins 1998. A Field Guide to Reptiles and Amphibians of Eastern and Central North America, 3rd ed. Houghton Mifflin Co., New York, New York. 640 pp.). It lacked the low contrast darkly hued dorsal stripes/spots and fields, and lacked the intense purple-blue ventral suffusion of the mesoptychium, fore limbs, and thoracic/abdominal regions typical of *A. gularis* (Fig. 1A, D). Although the specimen resembles *A. laredoensis* A (Fig. 1C, F) more closely than *A. gularis* (Fig. 1A, D) or *A. laredoensis* B, characters indicating its hybrid origin are these aspects of color pattern: two pairs of pale straight-margined primary stripes (dorsolaterals, and paravertebrals), one pair of pale unevenly margined primary stripes resulting from contact with pale rounded spots and vertical bars, large distinct spots in brown to brown-black fields above (upper laterals) and below (lower laterals) lateral stripes nearest to ventral scales, a single indistinct and discontinuous vertebral stripe past midbody, thoracic and abdominal scales narrowly edged with purple-blue, and pink-red ventral surface of the head (Fig. 1B, E). In comparison, the typically patterned female of *A. laredoensis* depicted in Fig. 1C, F) lacks large spots in the upper and lower lateral dark fields, does not have unevenly margined lateral stripes, and has a cream-white venter absent a pink-red throat and purple-blue edged thoracic and abdominal scales.

Also indicative of a hybrid origin for ASUMZ 32689 (comparison with *A. laredoensis* in paren) are the greatly enlarged mesoptychial scales bordering the gular fold (rather than enlarged); enlarged postantebrachial scales on posterior aspect of forelimbs (Fig. 2, rather than moderately enlarged), and 80 granular scales around midbody (compared with 91.8 ± 0.76 based on Walker et al. 1989b, *op. cit.*).

The specimen collected in 2008 described herein establishes that production of viable, if infertile, hybrids of *A. laredoensis* A x *A. gularis* has been ongoing in the Los Ebanos vicinity for 20+ years. The first of these was collected by combinations of the authors at Los Ebanos a few hundred meters from the Rio Grande in 1986 (Walker et al. 1989a, *op. cit.*) followed by collection of other hybrids over the years up to 2008. Remarkably, there are apparently strong pre-mating/post-mating isolating mechanisms to hybridization between *A. laredoensis* B x *A. gularis*, as only three hybrids representing this combination (Walker et al. 1991, *op. cit.*) have been collected in Texas and Mexico during ~75 expeditions since 1984. Internal examination of reproductive organs in the present hybrid by one of us (SET) revealed the following: the testes were enlarged and appeared to be functional; the epididymis was expanded and appeared to have sperm present.

Specimens were collected under authority of Texas Parks and Wildlife Department permit SPR1090-298 and USDI/LRGVNWR special use permit 21552-09-13-MS. Special thanks are given to Mitch Sternberg of the USFWS at Santa Ana NWR for providing the special use permit.

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***ASPIDOSCELIS LAREDOENSIS* A (Laredo Striped Whiptail) x *ASPIDOSCELIS GULARIS* (Texas Spotted Whiptail). STOMACH CONTENTS.** Diploid parthenogenetic *Aspidoscelis laredoensis* clonal complexes A and B, and gonochoristic parental species *A. gularis*, are syntopic at many sites in Texas and Mexico, mostly in the vicinity of the Rio Grande (Walker 1987. Texas J. Sci. 39:313–334). During the past 20+ years (1986–2008), it has not been unusual to find one or more hybrids of *A. laredoensis* A x *A. gularis* among collections from sites such as the one near the Rio Grande (26.233889°N, 98.560833°W, WGS84, ~40 m elev.) in the vicinity of Los Ebanos, Hidalgo Co., Texas (Walker et al. 1989. J. Herpetol. 23:119–130). Recently, SET examined stomach contents of hybrid male Arkansas State University Museum of Zoology (ASUMZ) 32689 (Trauth et al. 2013. Herpetol. Rev. 44: *in press*) collected by JEC on 22 June 2008 at the aforementioned site. We use this individual of 76 mm SVL as the basis for the first reported observations on the diet of a hybrid whiptail. Upon opening the body cavity of ASUMZ 32689, the stomach was seen to be distended to maximum capacity. The contents consisted almost entirely of termites (order Isoptera). By counting intact termites and detached heads it was found that the hybrid had consumed 181 of these insects. Although it would require several minutes for a lizard to consume such a large number of prey items while relatively stationary at an exposed termite colony (and thus be susceptible to predation), such a bonanza discovery would yield far more calories per unit of time than the more difficult tactic of harvesting grasshoppers which are typically in evidence at Los Ebanos. Paulissen 2001. (J. Herpetol. 35:282–292) and Paulissen et al. 1992 (J. Herpetol. 26:153–158) reported that termites comprised the numerical majority of prey consumed by both of the parental species of the hybrid, *A. laredoensis* A and *A. gularis*, at several sites of syntopy in Texas.

The specimen was collected under authority of Texas Parks and Wildlife Department permit SPR-1090-298 and USDI/LRGVNWR special use permit 21552-09-13-MS. Special thanks are given to Mitch Sternberg of the USFWS at Santa Ana NWR for providing the special use permit.

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***ASPIDOSCELIS NEOMEXICANA* (New Mexico Whiptail) x *ASPIDOSCELIS INORNATA LLANURAS* (Plains Striped Whiptail). PHENOTYPE.** *Aspidoscelis neomexicana*, a hybrid-derived parthenogenetic species (Cole et al. 1988. Amer. Mus. Novitat. 2905:1–38; Parker and Selander 1984. Herpetologica 40:245–252), reproduces asexually by development of unreduced diploid eggs. Sexual reproduction in the species occasionally occurs when its eggs are fertilized by sperm from a male of *A. inornata* (Axtell 1966. Herpetologica 22:241–253; Cuellar and McKinney 1976. J. Exp. Zool. 196:341–350; Taylor and Medica 1966. Univ. Colorado, Ser. Biol. 22:1–9; Taylor and Walker 1996. Copeia 1996:945–954; Wright and Lowe 1967. Amer. Mus. Novitat. 2286:1–36) resulting in sterile triploid hybrid males or females.

Herein, we describe phenotypic attributes of the first hybrid of *A. neomexicana* x *A.inornata llanuras* reported as involving this subspecies and the first one reported from the westernmost part of the distribution of these species in New Mexico (see map in Cole et al., *op. cit.*). This female (originally catalogued as University of Arkansas Department of Zoology 6081 and re-catalogued as Arkansas State University Museum of Zoology 32423) was collected by JEC on 13 July 1998 in Hidalgo Co.: 21.321.6 km NW jct of US Hwy 90 and New Mexico Hwy 70, on 70 in the vicinity of the site at 32.515000°N, 108.876667°W (datum WGS84). Also obtained here during six visits between 1998 and 2001 were 17 (19.3%) *A. inornata llanuras* (gonochoristic), 22 (25.0%) *A. neomexicana* (diploid parthenogen), and 48 (54.5%) *A. uniparens* (triploid parthenogen). Prior to preservation, the hybrid had a SVL of 62 mm, tail length of 217 mm, and body mass of 6.3 gm. It could not be identified to *A. inornata llanuras* because of the presence of spots (i.e., rounded pale areas) in the dark fields between the stripes; this taxon is characterized by the lack of spots throughout ontogeny (Sullivan et al. 2013. Copeia 2013[3]:366–377; Wright and Lowe 1993. J. Arizona-Nevada Acad. Sci. 27:129–157). Although the specimen resembles *A. neomexicana* more closely than *A. inornata llanuras*, obvious phenotypic consequences of the hybrid genome are these intermediate aspects of color pattern (Fig. 1A–B): paired lateral and dorsolateral stripes relatively straight-margined, paired paravertebral stripes slightly unevenly margined,

single vertebral stripe with several interruptions and unevenly margined, strongly contrasting pale stripes and dark fields, incipient rather than distinct spots; and off-white to very pale blue rather than gray-blue venter. Data for four morphological characters are also consistent with the hypothesis for a hybrid origin for ASUMZ 32423 (comparison with *A. neomexicana* in paren): low number of granules around midbody (compared to 75–83, N = 22); moderately enlarged mesoptychial scales (Fig. 1C, rather than small); slightly enlarged postantebrachial scales (Fig. 1D, rather than granular), and incomplete circumorbital scales (Fig. 1E, rather than complete).

That production of viable, if not fertile, hybrids of *A. neomexicana* x *A. inornata llanuras* is a rare event in the guild sampled at the Hidalgo Co. site is indicated by ASUMZ 32423 (0.01%) being among 88 specimens collected (i.e., < 33% of observed whiptail lizards) in six visits from 1998 to 2001. The hybrid is an "immature" female with both oviducts highly regressed, exhibiting minimal enlargement posteriorly. Both gonads appear as minimally-expanded, linear strips of translucent tissue, exhibiting no evidence of developing follicles. Abdominal fat bodies are modestly enlarged. Based on these observations, we infer that the hybrid was sterile.

Specimens in Hidalgo Co. were collected under authority of permit number 1850 issued to JEC by the New Mexico Department of Game and Fish.

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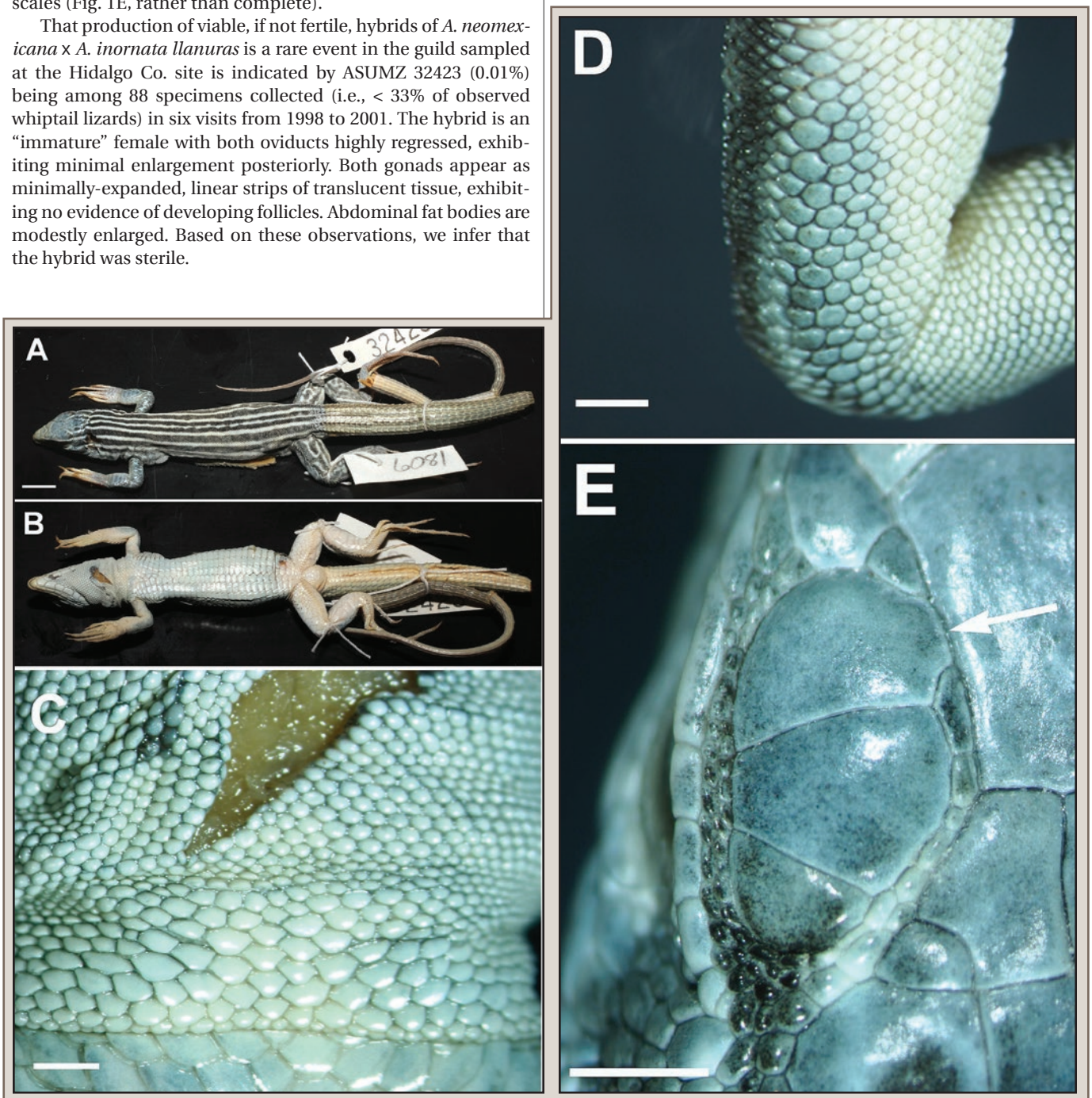


FIG. 1. Color pattern and morphological characteristics of a putative hybrid female specimen of *Aspidoscelis neomexicana* x *A. inornata llanuras*. A) Dorsal coloration and pattern of ASUMZ 32423; line = 10 mm for A and B. B) Ventral coloration of ASUMZ 32423. C) Moderately enlarged mesoptychial scales of ASUMZ 32433; line = 1 mm. D) Slightly enlarged postantebrachial scales of ASUMZ 32423; line = 1 mm. E) Incomplete circumorbital scale series (see arrow) in ASUMZ 32423; line = 1 mm.

***ASPIDOSCELIS SEXLINEATA* (Six-lined Racerunner). ARTIFICIAL HABITAT.** *Aspidoscelis sexlineata* is a "species in greatest conservation need" in Minnesota. It typically lives in sand prairies or bluff prairies, although Oldfield and Moriarty (1994. Amphibians and Reptiles Native to Minnesota. University of Minnesota Press, Minneapolis, Minnesota. 237 pp.) noted that it can inhabit the rock and cinder fill of railroad tracks and dike roads. We examined racerunner use of artificial habitat associated with the Prairie Island dike near Winona, Winona Co., Minnesota, USA. Completed in 1967, the dike is topped by a two-lane blacktop road approximately 7–8 m above normal river level (less during periods of flooding). Sampling was conducted in a 4.7-km stretch extending northwest from Mississippi River Lock-and-Dam 5A toward Minnesota City. The river (northeastern) side of the dike was rip-rapped with boulders and chunks of concrete, whereas the southwestern side, which bordered bottomland marsh and forest, consisted of prairie-like habitat with patches of open sandy substrate. A remnant sand prairie that formerly existed near the southeastern end of the study stretch, where racerunners were observed as recently as the early 2000s, presumably served as the source of racerunners that inhabited the dike, but the site is now occupied by artificial wetlands.

Paired transect surveys, one on each side of the road, were conducted in 2010 on 15 July (5 pairs), 16 July (10), 21 August (10), 22 August (10), and 1 September (10). The 50-m transects were parallel to the road and randomly positioned with respect to distance from the southeastern end of the study stretch (0–4.7 km) and distance from the roadside (0–13 m). Data were collected by two observers using an event recorder to tally the number of racerunners observed within 1 m of each side of the transect. Substrate and shaded air temperature was measured at the start of each transect.

Racerunners were observed over a distance of 3 km on the southwestern side of the road (N = 17) and 1 km on the northeastern side (N = 2). Racerunners occurred from 2 m to 13 m from the edge of the road; mean distance on the southwestern side (7.23 m) and the northeastern side (5.50 m) were not significantly different ($t = 0.674$, $df = 13$, $p = 0.512$). The number of racerunners per transect was significantly greater on the southwestern side of the dike (paired t-test, $t = 3.028$, $df = 44$, $p = 0.004$). This may have been related to the greater substrate temperature on the southwestern side (paired t-test, $t = 3.305$, $df = 44$, $p = 0.002$), but racerunners may have been less detectable among the boulders on the northeastern side.

The substrate temperature for transects when racerunners were observed ranged from 26°C to 46°C, with a mean (32.8°C) slightly less than substrate temperatures selected in oak savannah (34.7°C) and open grassland (39.2°C) in Wisconsin (Kapfer and Pauers 2006. Herpetol. Rev. 37:420–423). Shaded air temperature ranged from 22°C to 34°C. Oldfield and Moriarty (*op. cit.*) reported that racerunners have been observed active in Minnesota at air temperatures as low as 22°C, and Fitch (1958. Univ. Kansas Publ. Mus. Nat. Hist. 11:11–62) reported an optimal air temperature in Kansas of 34°C.

Expanding the estimated densities of racerunners observed on the 50 m × 2 m transects on the southwestern (0. 00378/m^2) and northeastern (0.00044/m^2) sides of the dike to the total area of potential habitat on each side yielded total estimates of 229 and 26 racerunners, respectively. These are likely underestimates because of imperfect detectability (Smolensky and Fitzgerald 2010. J. Herpetol. 44:372–381). Nevertheless, they fall within the range of densities reported by Bellis (1964. Herpetologica 20:9–16) in South Carolina (0. 0245/m^2) and Warner (2000. Trans. Illinois St. Acad. Sci. 93:239–248) in northwestern Illinois.

The southwestern-facing slope of the Prairie Island dike provides extensive artificial habitat similar to the bluff prairies typically inhabited by racerunners in southeastern Minnesota. This sort of artificial habitat may become increasingly important as bluff prairies decline in area due to encroachment by invasive woody plants. Kraszewski (2004. A Survey of Native Flowering Plant Species on Goat Prairies in Winona, Minnesota. Unpubl. B.A. thesis, Saint Mary's University of Minnesota, Winona. 29 pp.) used aerial photographs to estimate the areas of 10 bluff prairie remnants in the Winona area, some of which are inhabited by racerunners. Prairie area varied from 0.25 ha to 3.14 ha (mean = 1.49 ha). When Gerty (2013. Species Richness in Relation to Both Remnant Size and Leafy Spurge [*Euphorbia esula*] Invasion. Unpubl. B.A. thesis, Saint Mary's University of Minnesota, Winona. 19 pp.) remeasured the same areas on the ground, she found them broken into 20 remnants of 0.03–0.56 ha. In comparison, each side of the Prairie Island dike provides 6.07 ha of potential habitat, although racerunners do not necessarily occur along the entire road and available habitat is reduced during years with periods of high water.

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***ASPIDOSCELIS SEXLINEATA VIRIDIS* (Prairie Racerunner). BURROW SITE FIDELITY.** The burrows and burrowing activity of Prairie Racerunner, *Aspidoscelis sexlineata viridis*, have been well documented (Fitch 1958. Univ. Kansas Publ., Mus. Nat. Hist. 11:11–62; Hardy 1962. Univ. Kansas Sci. Bull. 43:3–73; Leuck 1982. Copeia 1982:416–424; Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. Univ. of Arkansas Press, Fayetteville, 421 pp.). Burrow types, excavation sites, space use, and lizard activity were described by Hardy (*op. cit.*) and Leuck (*op. cit.*) from their observations of the lizards in outdoor enclosures, whereas Fitch (*op. cit.*) and Trauth et al. (*op. cit.*) described or illustrated burrows as reported from field studies on this species. In the present study, we report on an unusual incident of burrow site fidelity in *A. s. viridis*.

On 18 June 2013, one of us (SET) observed burrowing activity of a large (78 mm SVL) male Prairie Racerunner on a gradual-sloping, west-facing, red clay, highway embankment from ca. 1800–1840 h. The site is located on the Salem Plateau in the Ozarks Mountains (Randolph County, Arkansas 36.28215°N, 91.253°W). About 2 m^2 of ground surface had been disrupted earlier in the day with a potato rake by SET while searching for lizard egg clutches. The excavated site had previously contained numerous surface burrows prior to unearthing and had been photographed on 7 May 2010 (Fig. 1). What made this particular observation significant was that the lizard moved toward this disrupted excavation site from the surrounding grassy habitat and stopped abruptly at a point directly in front of the observer (within 1 m) before it began digging in the loosened soil. The lizard moved back and forth across the torn ground presumably searching for former burrow shelters. The lizard soon departed the area, but it then returned and repeated the searching and digging behavior in and around the dirt pile. A repetition of this searching/digging behavior in the dirt pile continued several times during a time span of ca. 35 min. Eventually, SET attempted to catch the lizard as it had partially

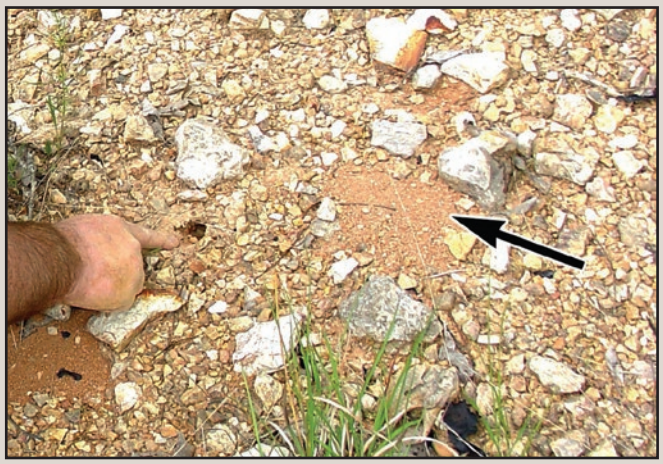


FIG. 1. Finger points to the open mouth of a Prairie Racerunner burrow photographed on 7 May 2010 (see text for site description). Arrow points to fresh soil tailing (an indication of the presence of a lizard) from a recently excavated burrow shelter.

dug a burrow shelter, but the lizard evaded the attempted capture and darted into the adjacent grassy habitat. Soon, the lizard returned and walked directly beside the observer's feet and began digging again into the dirt pile. Finally, the lizard dug into the same loose soil where it had previously evaded capture and soon disappeared far enough within its burrow so as to allow for its capture.

The digging behavior of this racerunner was similar to observations reported by Hardy (*op. cit.*), although not in the context of burrow fidelity. She termed the shelter created as being an "inactivity-tunnel," a nighttime refuge or one for periods of prolonged inactivity. The particular lizard reported here would dig with alternating front legs and by pushing into the soil inward with its snout; then, it would turn around and push the tailings out of the hole with its front legs and chest. This behavior was repeated several times until the lizard's body was well hidden inside the burrow. The loose soil tailings created by this type of burrowing behavior are shown in Fig. 1.

We have collectively studied *A. s. viridis* in many parts of the range in Arkansas and other states, and have often observed fleeing lizards work their way to what appeared to be a targeted burrow. We suggest that burrow fidelity, in addition to conservation of energy by continued use of a burrow, can also serve as a targeted escape route for a lizard.

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***ASPIDOSCELIS SEXLINEATA VIRIDIS* (Prairie Racerunner). SKELETAL REMAINS.** Between 1973 and 1980, Trauth (1983. Amer. Midl. Nat. 109:289–299) studied nesting habitat of *Aspidoscelis sexlineata* (as *Cnemidophorus sexlineatus*) across 10 states, during which 195 clutches of eggs and large numbers of lizards were excavated. The excavations took place mostly from within well-drained red clay exposures facing S to W along secondary highways and rural dirt roads. Most of this work was conducted in the Interior Highlands Region of Arkansas while studying *A. s. viridis* (Prairie Racerunner) where it was noted that, with

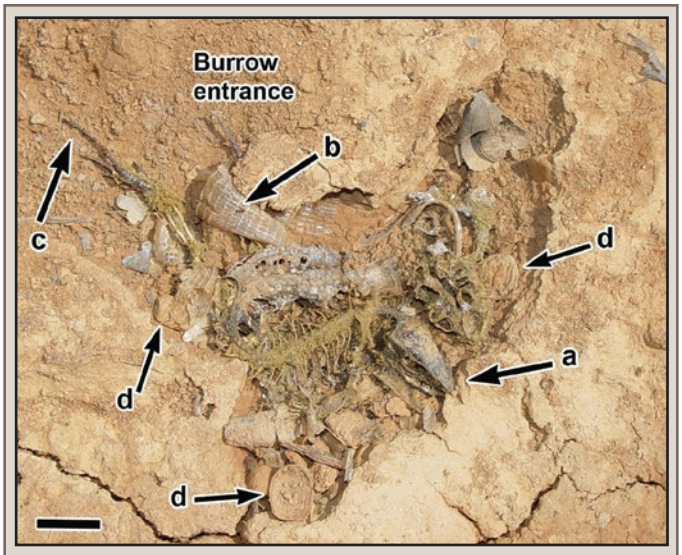


FIG. 1. Skeletal remains of a Prairie Racerunner photographed on 20 September 2003 (see text for site description). Characteristics of this species include a combination of the following structures (designated by labeled arrows): (a) a wedge-shaped head, (b) rectangular belly scutes, and (c) an elongated fourth toe. Eggshells (d) from a previous egg clutch of *A. s. viridis* are also evident. Line = 10 mm.

the hundreds of hours of excavation work, remains of expired lizards were never found. Thus, on 20 September 2003 SET was surprised by the discovery of clearly identifiable skeletal remains which we agree are those of a large Prairie Racerunner (Fig. 1) in a burrow shelter uncovered from beneath a flat rock (ca. 25 cm in diameter) on a gradual-sloping, south-facing, red clay embankment at 1435 h. The site is located within the Arkansas Army National Guard controlled Fort Chaffee Maneuver Training Center in the Arkansas River Valley, Sebastian Co., Arkansas, USA (35.20034°N, 94.15700°W; elev. 241 m). The lizard was occupying a nesting chamber that contained eggshells from a previous egg clutch (Fig. 1). Bacterial action on the lizard's undetached skin and/or the remaining flesh along the spine and hind legs cast a greenish tint to the exposed dorsum. Moreover, and based upon the presence of this greenish coloration, there appeared to be the corpse of another vertebrate beside the lizard, although its identity was not determined at the time of the discovery.

We have collectively studied *A. sexlineata* in many parts of the range in Arkansas and other states, and only SET has observed another instance of a dead racerunner in a burrow shelter. That instance occurred on 29 July 1982 in Pasco Co., Florida, in which the partially decomposed body of an Eastern Six-lined Racerunner, *A. s. sexlineata*, was infested with what appeared to be fire ants. These examples of deceased racerunners located in burrow retreats provide preliminary support for our hypothesis that many of them die by means other than predation. Nevertheless, it seems likely that skeletal remains of racerunners are ephemeral given their rare discovery during the large number of excavations performed by SET.

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FIG. 1. Adult *Leptophis ahaetulla* preying upon an adult *Bogertia lutzae* in Pernambuco, Brazil.

***BOGERTIA LUTZAE*. PREDATION BY *LEPTOPHIS AHAETULLA*.** *Bogertia lutzae* is a small bromelicolous lizard (Avila et al. 2010. J. Helminthol. 84:199–201) endemic to the northeast region of Brazil and is found in different ecosystems, mainly inhabiting sandbanks, Atlantic forest, and Caatinga (Rodrigues 1987. Arq. Zool. 1:105–230). *Leptophis ahaetulla* is a snake with a wide geographical distribution, occurring from southern Mexico to northern Uruguay (Albuquerque et al. 2007. J. Nat. Hist. 41:1237–1243; Carvalho et al. 2007. Biol. Geral Exper. 7:41–59). It is a primarily diurnal and semi-arboreal snake and is reported to occur over a wide range of habitats. The diet of *L. ahaetulla* consists predominantly of hylid frogs; however, there are also records of *Anolis* sp., *Thecadactylus rapicauda, Mastigodryas boddaerti*, and young birds in their diet (Albuquerque et al. 2007, *op. cit.*).

On 8 April 2013 at 1230 h we observed an adult *L. ahaetulla* preying upon an adult *B. lutzae*. This event occurred at Tapacurá Ecological Station, Pernambuco, Brazil (8.036°S, 35.199°W; datum WGS 84). The event was recorded at a forest edge. This is the first record of predation reported for *B. lutzae* by *L. ahaetulla*. The image of predation is available in the collection of images of Herpetology and Paleontology Laboratory of the Federal Rural University of Pernambuco - UFRPE, Recife, Pernambuco, Brazil.

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***CALLOPISTES MACULATUS* (Chilean Iguana). SAUROPHAGY ON *LIOLAEMUS*.** The highly endemic reptile diversity of Chile is characterized by lower numbers of lizard species, of predominantly small body sizes (SVL <180 mm), compared to adjacent countries. Among these species, *Callopistes maculatus*, the largest known lizard (and only teiid) occurring in the country (SVL average: 150.5 ± 10.9 mm, range [adult size estimated from the largest 2/3 of a 38-specimen sample]: 135–173 mm), and the *Liolaemus* evolutionary radiation, one of the richest amniote genera on Earth and the richest vertebrate genus in Chile (Pincheira-Donoso et al. 2008. Zootaxa 1800:1–85), stand out as some of the most prominent elements of the indigenous herpetofauna. All



FIG. 1. Saurophagy of *Callopistes maculatus* on *Liolaemus nitidus* in central Chile.

geographic areas where *C. maculatus* has been recorded are also inhabited by one or more species of *Liolaemus*. In these common areas, both groups of lizards are found in the same microhabitats, and overlap temporally (they are all diurnal). Surprisingly, however, ecological interactions among *Callopistes* and *Liolaemus* have only rarely been documented in the literature (e.g., see Jaksic 1998. Ecología de los Vertebrados Terrestres de Chile. Pont. Univ. Católica Press, Santiago. 262 pp.). Here, we report a predation event between *C. maculatus* and *L. nitidus*, one of the largest known *Liolaemus* species (SVL average: 92.5 mm, range: 85.4–107.5 mm; Pincheira-Donoso et al. 2008. BMC Evol. Biol. 8:68).

The feeding ecology of *Callopistes maculatus* is primarily insectivorous and secondarily carnivorous (including both heterospecific and conspecific small lizards, as well as birds and mammals), while other reports also describe consumption of plant material (Fuentes 1976. Ecology 57:3–17; Mellado 1982. Donana Acta Verteb. 9:372–373; Vidal and Ortiz 2003. Herpetol. Rev. 34:364–365). Within the lizard component of *C. maculatus* diet, only small *Liolaemus* species (*L. lemniscatus*, SVL average = 48.8 mm; *L. tenuis*, SVL average = 56.9 mm) have been observed as prey.

Near the city of Ovalle (30.39861°S, 71.22889°W), Coquimbo Region of Chile, we observed an adult male *Callopistes maculatus* actively preying on an adult *Liolaemus nitidus* (Fig. 1). The observation took place on 10 January 2009, at 1310 h, and the recorded air temperature was 27°C. The feeding behavior of the *C. maculatus* consisted of multiple attacks to the body of the *L. nitidus*, which at the time of our initial observation was lying dead ~50 cm from a shrub (*Fabiana imbricata*). The *C. maculatus* was using this shrub as an intermittent shelter (possibly as a result of our presence) while periodically returning to the prey item to continue its attacks. Every attack to the lifeless *L. nitidus* lasted only a few seconds, and given the adult size of the prey, the predatory lizard showed signs of difficulty in handling it. Within 72 sec. of observation, the *C. maculatus* eventually moved the body of *L. nitidus* out of sight into the vegetation. Although it remains unknown whether the predator managed to eat the captured prey item, our report shows that *C. maculatus* will target other lizard species with only slightly smaller body sizes. In addition, from the ecological perspective of the prey, our observation reveals that the largest species of the genus *Liolaemus* are not only preyed upon by considerably larger vertebrates, such as

mammalian carnivores, birds of prey, or snakes, but also by other lizards. A recent study (Pincheira-Donoso 2012. Anim. Biol. 62:277–287) showed that saurophagy within *Liolaemus* mostly involves adults feeding on heterospecific and conspecific (i.e., cannibalism) newborns and juveniles. Collectively, our report challenges the generality for predators of *Liolaemus* lizards. This note provides a record of the largest known prey consumed by *C. maculatus*, while expanding the diversity of reptiles this large species feeds on.

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***CNEMIDOPHORUS OCELLIFER* (Spix's Whiptail). PREDATION.** Predation events are difficult to record in the natural environment (Shepard 2007. Herpetologica 63:193–202). Such reports are relevant because they present ecological interactions within ecosystem dynamics, thus providing key information concerning diet and natural life history of the species (Morin 1983. Ecol. Monogr. 53:119–138).

In natural environments, lizards serve as potential prey for arthropods (Bocchiglieri and Mendonça 2009. Herpetol. Rev. 40:438–438) and vertebrates such as other lizards (Faria and Araujo 2004. Braz. J. Biol. 64:775–786), snakes (Silva and Araújo 2008. Ecologia dos Lagartos Brasileiros. Technical Books, Rio de Janeiro. 271 pp.), and birds (Gogliath et al. 2010. Herpetol. Bull. 114:36–38). In this note, we describe a predation event of a terrestrial lizard, *Cnemidophorus ocellifer*, by a Great Egret (*Ardea alba*) on a sand dune beach complex in northeastern Brazil.

On 19 September 2012 at 1530 h during fieldwork at Mosqueiro's Beach, Aracaju, Brazil (11.0885°S, 37.1166°W) we observed a predation attack by a Great Egret on a *C. ocellifer*. The egret was observed walking slowly along the dunes, and suddenly changed its stance, beginning to walk faster with the neck stretched toward and facing upright. It then stopped close to some herbaceous vegetation and remained still with the neck held in an S-shape, the typical posture of this species during stalking behavior. A few seconds later the egret attacked and captured the lizard with its bill (Fig. 1).



FIG. 1. Great Egret predation upon *Cnemidophorus ocellifer* at Mosqueiro's Beach, Aracaju, Brazil.

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***COPESGLOSSUM AFF. NIGROPUNCTATUM* (Amazonian Skink). PREDATION.** The Amazonian Pygmy-Owl (*Glaucidium hardyi*) typically feeds on arthropods and is considered insectivorous, although it may less commonly predate on small vertebrates such as birds, mammals, amphibians and reptiles (Sick 1997. Ornitologia Brasileira. Editora Nova Fronteira, Rio de Janeiro. 912 pp.). At 1000 h on 1 November 2012, while I was birdwatching on "ZF-2 Tower," at "Reserva Cuieiras," property of Instituto Nacional de Pesquisas da Amazônia, 80 km from Manaus, Amazonas, Brazil, I saw a *G. hardyi* perched near the tower. I approached quietly and took some photos. After a few minutes, the owl flew to a 30 m-high platform on the tower where it remained for a few seconds, as if in pursuit of prey. Upon returning to its perch, the owl was holding a *Copesglossum aff. nigropunctata* in its talons. The skink tried to escape, but the owl bit the dorsal region of the neck, killing it, and flew away with the prey. This is the first record of predation on a *C. aff. nigropunctata* by an Amazonian Pygmy-owl, and a rare record of vertebrate predation by this species.

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FIG. 1. An Amazonian Pygmy-Owl (*Glaucidium hardyi*) holding an Amazonian Skink (*Copesglossum aff. nigropunctata*).

TABLE 1. Observations of aggregations of Japanese Geckos (*Gekko japonicus*) in Fukuoka, Japan conducted from November 2011 to April 2012. Geocoordinates based on datum WGS84. A = # of *G. japonicus* observed in aggregation.

Site 1	Coordinates: 33.597266°N, 130.3748°E			Natural Ground Elevation: 21 m							
Date	10 Dec	25 Dec	29 Dec	18 Jan	30 Jan	18 Feb	6 Mar	27 Mar	9 Apr	16 Apr	27 Apr
Time	1430 h	1030 h	1030 h	1130 h	1230 h	1330 h	1400 h	1230 h	1230 h	1300 h	1545 h
°C	7.5°	4.5°	7°	9°	8.5°	1°	12°	15°	21.5°	22°	19°
A group 1	4	5	4	7	6	6	6	3	7	2	4
A group 2	5	6	7	7	5	6	6	5	6	3	0

Site 2	Coordinates: 33.589433°N, 130.458316°E			Natural Ground Elevation: 14 m					
Date	28 Nov	15 Dec	24 Dec	4 Jan	12 Deb	4 Mar	8 Apr	15 Apr	22 Apr
Time	1830 h	1900 h	1800 h	1500 h	1830 h	1730 h	1500 h	1700 h	1600 h
°C	17°	9°	6°	3°	6.5°	9°	22°	20°	22°
A group 3	4	7	7	8	6	7	4	1	1
A group 4*	5	10	11	8	6	5	4	2	1

*View partially obscured by a small can placed in hole. # of animals present may be higher.

***GEKKO JAPONICUS* (Japanese Gecko). COLD WEATHER AGGREGATIONS.** There is little in the literature discussing brumating aggregations of *Gekko japonicus* (Hisai 1997. Misc. Rep. Inst. Nat. Stud. 28:1–5 [In Japanese]; Hisai 1998. Misc. Rep. Inst. Nat. Stud. 29:1–3 [In Japanese]) and, to the best of my knowledge, nothing in English. Hisai (1997, 1998, *op. cit.*) continuously observed two brumating aggregations of *G. japonicus* behind sign boards on a building and also noted that this species has been reported to utilize woodpiles, potted plants, retaining walls, loose bark, and crevices of utility poles and buildings. Here I report on observations of four large aggregations of *G. japonicus* in weep holes (Fig. 1) in retaining walls at two sites in the city of Fukuoka, Japan. The aggregations were initially found during a survey of utilization of retaining walls by *G. japonicus*. As time permitted, observations were repeated from November 2011 through April 2012 (Table 1). These aggregations occurred in holes that were 1–1.5 m from the ground. Holes were viewed with a 3-LED flashlight and observation times were limited to 1 minute or less in an attempt to minimize disturbance to the animals. The geckos remained responsive on all but the coldest days (air temp < 3°C).



FIG. 1. Aggregation of six *Gekko japonicus* occupying a weep hole at a park in Fukuoka, Japan (33.597266°N, 130.3748°E) observed at 1400 h, 6 March 2012.

The aggregations were primarily comprised of adults, though juveniles were often present. Consistent with Hisai's observations, the geckos moved to and from holes throughout their brumation period. The aggregations fluctuated in size, peaking in December or January and grew smaller from January to April. The largest aggregation, consisting of at least 11 individuals, was observed on 24 December 2011 among group 4 at Site 2. At each site, the aggregations were in neighboring holes, though many other holes were available. All holes housing the aggregations had also been sites of oviposition as evidenced by the presence of unhatched gecko eggs and eggshells.

Among all groups, the geckos typically clustered near the back of the holes. However, in the latter half of April, after the brumation period had clearly ended, geckos were always observed near the mouths of the holes, retreating to the back upon being approached. During that time, the aggregations largely dispersed, though four geckos were observed occupying one hole at Site 1 during the final observation on 27 April.

Aggregating in lizards mitigates the effects of abiotic environmental factors, such as temperature fluctuations and evaporative water loss; it has been postulated that aggregative behavior evolved among multiple gecko species to take advantage of this (Lancaster et al. 2006. Anim. Behav. 72:199–207; Shah et al. 2003. Behaviour 140:1039–1052). The overall patterns observed in these *G. japonicus* aggregations, which peaked in late December and January, suggests that aggregative behavior during brumation in this species could be an adaptation to exploit the thermal inertia of a group as a means of protection against drops in temperature.

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***GEKKO MONARCHUS* (Spotted House Gecko). REPRODUCTION.** *Gekko monarchus* ranges from the Philippines and southern Thailand through Peninsular Malaysia and Singapore, eastward through the Indo-Australian Archipelago (Grismer 2011. Lizards of Peninsular Malaysia, Singapore and their Adjacent Archipelagos. Chimaira, Frankfurt am Main. 728 pp.). There is anecdotal information on its reproduction in Grismer (*op. cit.*) and

numerous accounts of clutches consisting of two eggs and communal nesting in various field guides on reptiles from Southeast Asia, for example, see Das (2006. A Photographic Guide to Snakes and Other Reptiles of Borneo. Ralph Curtis Books, Sanibel Island, Florida. 144 pp.). In this note we present information on reproduction of *G. monarchus* from West Malaysia from a histological examination of museum specimens. Minimum sizes for reproduction are given for both sexes.

A sample of 129 *G. monarchus* from West Malaysia collected 2002, 2003, 2004 to 2006, 2008, and 2011 and deposited in the herpetology collection of La Sierra University, Riverside, California, USA was examined. The sample consisted of 51 adult males (mean SVL = 78.1 mm ± 6.5 SD, range = 58–90 mm), 30 adult females (mean SVL = 66.0 mm ± 4.5 SD, range = 56–75 mm), 35 juveniles (mean SVL = 43.6 mm ± 6.1 SD, range = 31–54 mm) and 10 neonates (mean SVL = 28.4 mm ± 1.3 SD, range = 27–30 mm). All juveniles contained very small gonads indicating reproductive activity had not commenced. Neonates were within the size range for *G. monarchus* in Malkmus et al. (2002. Amphibians and Reptiles of Mount Kinabalu [North Borneo] Koeltz Scientific Books, Königstein. 424 pp.). *Gekko monarchus* were collected in West (Peninsular) Malaysia (by state): Johor (N = 64), Melaka (N = 3), Pahang (N = 60), Perak (N = 1), Penang (N = 2), Selangor (N = 3), Terengganu (N = 1).

A cut was made in the lower abdominal cavity and the left testis or ovary was removed, embedded in paraffin, cut into 5 µm sections and stained with Harris hematoxylin followed by eosin counterstain. Enlarged follicles (> 4 mm) or oviductal eggs were counted. Histology slides were deposited in LSUHC.

Two stages were present in the testicular cycle: 1) recrudescence, characterized by a proliferation of germ cells in the seminiferous tubules, primary or secondary spermatocytes predominate; 2) spermiogenesis, seminiferous tubules lined by clusters of sperm or metamorphosing spermatids. Spermiogenesis was the predominant phase in the months data was available from: March (N = 9, 100%), June (N = 2, 100%), July (N = 16, 100%), August (N = 8, 63%), September (N = 16, 94%). The smallest reproductively active male (spermiogenesis) measured 58 mm SVL (LSUHC 5257) and was collected in March. The significance of males exhibiting recrudescence in August (N = 3) and September (N = 1) is not known. One of the August males (LSUHC 5766) measured 58 mm SVL and likely had not joined the breeding population.

Four stages were present in the monthly distribution of stages in the ovarian cycle of *G. monarchus* (Table 1); 1) quiescent, no yolk deposition; 2) yolk deposition, basophilic yolk granules in the ooplasm; 3) enlarged follicles > 4 mm; 4) oviductal eggs. The smallest reproductively active female (yolk deposition) measured 56 mm SVL (LSUHC 5710) and was from August.

Table 1. Monthly stages in the ovarian cycle of 30 *Gekko monarchus* from West Malaysia.

Month	N	Quiescent	Yolk depositon	Enlarged follicles > 4 mm	Oviductal eggs
March	5	3	1	0	1
June	1	0	0	0	1
July	8	5	1	0	2
August	4	3	1	0	0
September	12	5	3	1	3

Mean clutch size for 8 females was 1.9 ± 0.35, range = 1–2. *Gekko monarchus* females were reproductively active in all months sampled. No female with oviductal eggs or corpora lutea and concurrent yolk deposition, indicating production of multiple clutches was found. Nevertheless this is likely possible in view of the extended breeding period and likely reflects our small adult female sample size (N = 30).

The presence of reproductively active males and females in all months examined and the observations of gravid females from March through November by Grismer (*op. cit.*) indicates *G. monarchus* exhibits a prolonged reproductive cycle. This was found to occur in other geckos from Southeast Asia including the congener *G. smithi* (Goldberg 2009. Texas J. Sci. 61:225–228, *Dixonius siamensis* (Goldberg 2008. Texas J. Sci. 60:233–238), and *Cyrtodactylus baluensis* (Goldberg 2012. Hamadryad 36:42–44).

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***HEMIDACTYLUS MABOUIA* (Tropical House Gecko). CANNIBALISM.** Intraspecific predation (cannibalism) is a widespread ecological behavior that has been reported in numerous lizards (Blanco et al. 2012. Cuad. Herpetol. 26:91–93; Pincheira-Donoso 2012. Anim. Biol. 62: 277–287; Sales et al. 2011. Herpetol. Notes 4:265–267). *Hemidactylus mabouia* is a prolific colonizer, widely distributed, and frequently associated with urban areas, but also found in natural environments from the Amazonia to the Caatinga (Ávila-Pires 1995. Zool. Verh. Leiden. 299:1–706; Zamprogno and Teixeira 1998. Brazil. J. Biol. 58: 143–150). The diet reported for *H. mabouia* consists mainly of spiders, insect larvae, and termites (Rocha and Anjos 2007. Brazil. J. Biol. 67: 485–491). In this note we report a case of intraspecific predation by *H. mabouia.*



Fig. 1. Gravid female *Hemidactylus mabouia* preying upon a juvenile conspecific.

During the rainy season on 21 May 2013 at ca. 2110 h, we observed an adult female *H. mabouia* (57.5 mm in SVL) with two eggs in its abdomen (viewable through the skin) and a conspecific juvenile gecko (36.5 mm in SVL) inside its mouth (Fig.1). The adult had a firm bite hold on the lateral region of the juvenile's torso. Our observation occurred in a residence in the urban area (0.002694°S, 51.091306°W, datum WGS84; 31 m elev.), municipality of Macapá, State of Amapá, northern Brazil. The observations here lasted 20–35 minutes. Seven minutes subsequent to ingestion, the adult female gecko regurgitated the juvenile. The regurgitation may have been caused by the body size of the juvenile, which represented more than half of SVL female adult. A previous case of cannibalism in this species was reported from southeastern Brazil (Pombal and Pombal, Jr. 2010. Herpetol. Rev. 41: 223–224). Cannibalism in *H. mabouia* might represent opportunistic feeding based on an increase in the juvenile population or as a strategy to minimize the ecological costs during periods of low arthropod availability.

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***HEMIDACTYLUS MABOUIA* (African House Gecko). PREDATION BY *CALLITHRIX PENICILLATA*.** *Hemidactylus mabouia* is an exotic lizard that broadly distributed in Brazil from forests to urban areas (Sousa and Freire 2010. Biotemas 23:231–234) but native to Africa. This is a nocturnal species, sheltering in crevices and under tree bark during the day. Marmosets (*Callithrix* spp.) are endemic Brazilian primates that consume different kinds of food, from plant reproductive parts to animals, such as insects, toads, and lizards (e.g., *Anolis, Mabuya*) (Martins and Setz 2000. Int. J. Primatol. 21:476–476; Passamani and Rylands 2000. Primates 41:27–38; Rylands et al. 2009. *In* Ford et al. [eds.], The Smallest Anthropoids: the Marmoset/Callimico Radiation, pp. 25–61. Springer, New York). In this short note, we describe an autotomy event in *H. mabouia* followed by its predation by *C. penicillata* (É. Geoffroy, 1812).

On 18 June 2013, while monitoring a group of *Callithrix penicillata* (eight individuals), we observed the capture and predation of an individual *Hemidactylus mabouia* by two marmosets (a juvenile and an adult). This event occurred in a Cerrado remnant, located in the urban area of Campo Grande, state of Mato Grosso do Sul, Brazil (20.301418°S, 54.365219°W). At 0929 h (ambient temperature = 28°C), a juvenile marmoset (< 6 months) was foraging on a trunk (ca. 60 cm circumference) at ca. 1.5 m above ground. It tracked and captured a *H. mabouia*. Instantaneously, the lizard released the tail while in the hands of the primate, launched itself to the ground, and remained motionless. The juvenile marmoset started to eat the tail, whereas the adult marmoset (> 2 years) searched the ground intensively. After 1 min (0930 h), the adult marmoset came down to the ground, leaped onto the lizard, captured it and brought it to its mouth. Later, the same individual marmoset climbed a tree at 2 m above ground and started to eat the lizard (Fig. 1). The juvenile marmoset made successive requests for food to the adult, which shared a small part of the lizard. From the tracking to the end of the ingestion approximately 6 min elapsed.

Tail autotomy in lizards is a mechanism that may reduce mortality by predation, since tail movements (postautotomy) may distract or confound the predator (Congdon et al. 1974. Science 184:1379–1380). However, it is possible that this antipredator mechanism is more efficient against solitary predators than against individuals that forage in groups, such as marmosets.



FIG. 1. An adult *Callithrix penicillata* preying on *Hemidactylus mabouia* in Campo Grande, Mato Grosso do Sul, Brazil.

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***HOLASPIS GUENTHERI* (Günther's Gliding Lizard). PREDATION.** On 13 January 2010, at 1117 h, one of us (SI) observed and photographed an adult Senegal Kingfisher (Coraciiformes: Alcedinidae: *Halcyon senegalensis*) holding an adult *Holaspis guentheri* in its beak. The bird was perched on the landing strip barrier of the Joachim Mahothes Magouindi Airport (2.79°S, 10.06°E), Gamba, Ogooué-Maritime Province, southwestern Gabon. Neither the bird nor the lizard was collected, but their respective color patterns readily distinguish them from related taxa recorded in the region (Angehr et al. 2006. *In* Alonso et al. Gamba, Gabon: Biodiversité d'une forêt équatoriale africaine, pp. 327–351. Bull. Biol. Soc. Washington 12; Pauwels and Vande



FIG. 1. A Senegal Kingfisher (*Halcyon senegalensis*) with an adult Günther's Gliding Lizard (*Holaspis guentheri*).

weghe 2008. Reptiles du Gabon. Smithsonian Institution, Washington. 272 pp.). It is the first time that this specific predator-prey relationship is reported.

We thank ornithologists Patrice Christy and Jean Pierre Vande weghe (Libreville) for the confirmation of the identification of the kingfisher and discussions on its ecology.

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***LIOLAEMUS MONTICOLA* (Mountain Lava Lizard). PREDATION ON *LIOLAEMUS LEMNISCATUS*.** *Liolaemus* is a diverse genus of small to medium-sized, omnivorous lizards, distributed in the southern hemisphere of the Neotropical realm. *Liolaemus monticola* is endemic to Chile and is distributed in Andean scrub from Coquimbo to Maule regions, from 500–3000 m elev. (Pincheira-Donoso and Nuñez 2005. Publ. Ocas. Mus. Nac. Hist. Nat. Chile 59:1–486). This species is an active forager on insects with more than 50% of its reported diet as ants (Fuentes and Ipinza 1979. J. Herpetol. 13:123–124; Vidal and Labra 2008. Herpetología de Chile. Science Verlag, Santiago. 593 pp.). Here I report an observation of saurophagy.

On 21 January 2011, at 1100 h, on a sunny day with an ambient temperature of 22°C, an adult *L. monticola* (mean SVL 157 mm and tail length at 94 mm) was observed attacking and then ingesting a juvenile *Liolaemus lemniscatus* (SVL = 45 mm) at Fundo Las Lomas, Colina County, Metropolitan region, Central Chile (33.065546°S, 70.670172°W, WGS84; elev. 810 m). The adult was resting in the soil and then chased the *L. lemniscatus* when it approached, taking ca. five minutes to capture and ingest the small lizard, and then sought refuge under some rocks. The habitat was an open and rocky scrubland dominated by *Baccharis linearis* and *Proustia cuneifolia*, with an additional assemblage of annual forbs. The area is not currently pristine with the original vegetation showing anthropogenic disturbance as a result of wood and charcoal extraction, and livestock use. To my knowledge, this is the first record of saurophagy for *L. monticola* as well as for the entire genus of *Liolaemus* (cf. Vidal and Labra, *op. cit.*).



FIG. 1. *Liolaemus monticola* eating a juvenile *L. lemniscatus*.

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***LIOLAEMUS WIEGMANNII*. PREDATION.** Lizards are typical prey items for birds, however direct observations of predation are relatively rare in the field. The sand lizard *Liolaemus wiegmannii* (SVL = 42–64 mm), is largely restricted to sandy soils of a vast region of Argentina and Uruguay (Cei 1993. Reptiles del Noroeste, Nordeste y Este de la Argentina. Museo Regionale di Scienze Naturali. Torino, Italy. 949 pp.). This species occurs along coastal sand dunes of the Buenos Aires Province in semi-fixed dunes, usually far away from open spaces and beach (Block et al. 2012. J. Herpetol. 46:608–613). This note reports a single observation of predation on *Liolaemus wiegmannii* by a Burrowing Owl (*Athene cunicularia*). The Burrowing Owl is commonly found in grassy plains of Argentina, being the most abundant owl in agroecosystems (Bellocq and Kravetz 1994. Ecol. Austral. 4:29–34). Reptiles, like the sand lizard, are generally less common prey item in the owl's diet (0.3%, Sanchez et al. 2008. Ornitol. Neotrop. 19:71–80).

During a lizard survey through coastal sand dunes in Arenera Galati (37.38658°S, 57.05781°W; datum Campo Inchauspe), Buenos Aires Province, on 31 October 2008 at 1030 h, we observed the carcass of an adult female of *L. wiergmannii* (SVL = 52 mm; total length = 64 mm) lying a few centimeters away from an *A. cunicularia* burrow. The burrow was located on a dune and the owls were present at the moment of the observation. The lizard's body was completely intact suggesting that the lizard had been recently caught. The specimen of *L. wiegmannii* (UNMdP 1778) was deposited in the Herpetological Collection of the Universidad Nacional de Mar del Plata, Buenos Aires, Argentina.

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***MEROLES CUNEIROSTRIS* (Wedge-snouted Sand Lizard). CANNIBALISM.** Cannibalism has been observed in a diverse number of reptile species; numerous studies have shown that it is not only common, but that it may play an integral role in shaping the ecology of a species and community dynamics (Fox 1975. Annu. Rev. Ecol. Syst. 6:87–106; Jenssen et al. 1989. Anim. Behav. 38:1054–1061; Keren-Rotem et al. 2006. Behav. Ecol. Sociobiol. 59:723–731). Studies suggest that cannibalism is common in generalist predators that might prey on conspecifics opportunistically. This pattern has been observed in diverse

taxa, and most reported cases involve larger individuals feeding on younger, smaller conspecifics (e.g., Polis and Myers 1985. J. Herpetol. 19:99–107; Pincheira-Donoso 2012. Anim. Biol. 62:277–287; Siqueira and Rocha 2008. S. Am. J. Herpetol. 3:82–87). Among lacertid lizards, cannibalism has been mainly documented among island species characterized by high population densities and limited food resources (Amat et al. 2008. Amphibia-Reptilia 29:329–336; Pafilis et al. 2009. Naturwissenschaften 96:1107–1113; Perez-Mellado and Corti 1993. Bonn. Zool. Beitr. 44:193–220; Žagar et al. 2012. Acta Herpetol. 7:29–39). This behavior, however, has been poorly documented among continental species.

On 27 December 2011 near the Gobabeb Training and Research Centre, Erongo, Namibia (23.561986°S, 15.041616°E, datum WGS84; 408 m elev.) we observed a juvenile *Meroles cuneirostris* being eaten by a conspecific adult female (SVL = 44 mm; tail length = 72 mm; 2.6 g). At ca. 1100 h, while attempting to capture the juvenile, an adult female dashed from underneath a small bush and began to chase the juvenile. The chase lasted less than 30 sec. before the female captured the juvenile, biting down on its head and then violently shook her own head. The juvenile then briefly escaped but was recaptured in the same manner. The female relocated to a spot underneath the bush where initially observed and continued to grip the head and neck of the juvenile as it struggled to escape, tightening her grip every few moments. After several minutes the juvenile became lifeless, and the female began to swallow the juvenile whole, headfirst. The entire consumption of the juvenile was completed in ca. 3 min., during which time the female appeared to have no trouble swallowing. Afterward the female remained under the bush for nearly 5 min. and then sprinted ca. 30 m away across the open sand.

There have been no prior examples of cannibalism in any *Meroles* species to date. The diet of *M. cuneiorostris* is primarily insectivorous, and relative food availability is thought to remain constantly low throughout the year in this temperate desert climate (Goldberg and Robinson 1979. Herpetologica 35:169–175). At the time of this observation, median juvenile SVL for this population was 33 mm (range = 27–42 mm; N = 53).

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MESALINA OLIVIERI **(Olivier's Sand Lizard). CESTODE ENDOPARASITES.** *Mesalina olivieri* is known from Algeria, Western Sahara, Tunisia, Libya, Egypt, Israel, Jordan, Iraq, and Saudi Arabia (Bar and Haimovitch 2011. A Field Guide to Reptiles and Amphibians of Israel. Herzliya, Israel. 245 pp.). We know of no endoparasite records for this species. The purpose of this note is to establish the initial helminth list for *M. olivieri*.

One female *M. olivieri* (SVL = 48 mm) collected April 1956 in the Central Negev Region, Israel and deposited in the herpetology collection of the Tel Aviv Museum of Natural History (TAUM), Tel Aviv, Israel as TAUM 2201, was examined for endoparasites. A lateral slit was made on the left side and the coelomic cavity was examined for endoparasites using a dissecting microscope. Found were 30 oblong whitish, bodies measuring ca. 1 mm in length. They were regressively stained in hematoxylin, cleared in xylol, mounted in balsam, studied under a compound microscope and identified as tetrathyridia larvae of the cestode, *Mesocestoides* sp. Voucher helminths were deposited in the United States National Parasite Collection, USNPC, Beltsville, Maryland as USNPC 107017. The life cycle of *Mesocestoides* sp. is unknown but is thought to utilize three hosts, a vertebrate definitive host, a vertebrate second intermediate host and an arthropod first intermediate host (Rausch 1994. *In* Khalil et al. [eds.], Keys to the Cestode Parasites of Vertebrates, pp. 309–314. CAM International, Oxon, U.K.). Tetrathyridia are commonly found in the body cavities of amphibians, reptiles, and rodents (Padgett and Boyce 2004. J. Parasitol. 90:108–113). *Mesocestoides* sp. was previously reported in the congener *M. guttulata* from Israel (Goldberg and Bursey 2012. Herpetol. Rev. 43:136). *Mesocestoides* sp. in *Mesalina olivieri* is a new host record.

We thank Shai Meiri (TAUM) for permission to examine *M. olivieri*, Ezra Maza for facilitating the loan, and the National Collections of Natural History at Tel Aviv University for providing *M. olivieri* for this study.

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MESALINA OLIVIERI **(Olivier's Sand Lizard). REPRODUCTION.** *Mesalina olivieri* is known from Algeria, Western Sahara, Tunisia, Libya, Egypt, Israel, Jordan, Iraq, and Saudi Arabia (Bar and Haimovitch 2011. A Field Guide to Reptiles and Amphibians of Israel. Pazbar LTD, Herzliya, Israel. 245 pp.). Schleich et al. (1995. Amphibians and Reptiles of North Africa. Koeltz Scientific Publishers, Koenigstein. 627 pp.) reported *M. olivieri* from Oran, Algeria commenced mating in October after emergence from aestivation, females with fully developed eggs occurred from mid-October to the end of May, and at least two clutches of 2–4 eggs were produced. In Jordan, clutches of 4–8 eggs were produced (Disi et al. 2001. Amphibians and Reptiles of the Hashemite Kingdom of Jordan. Edition Chimaira, Frankfurt am Main. 408 pp.). In this note I present information on the reproductive cycle of *M. olivieri* from Israel.

A sample of 39 *M. olivieri* collected 1941 to 1965 in Israel consisting of 16 adult males (mean SVL = 44.6 mm ± 2.9 SD, range = 40–50 mm), 17 adult females (mean SVL = 44.6 mm ± 3.3 SD, range = 40–51 mm), 2 juvenile males (mean SVL = 37.0 mm ± 2.8 SD, range = 35–39 mm) and 4 juvenile females mean SVL = 38 mm ±1.7 SD, range = 35–39 mm) was examined from the National Collections of Natural History at Tel Aviv University (TAUM), Tel Aviv, Israel by Region Name: A'rava Valley TAUM 1832, 2602, 4113; Central Negev TAUM 1121, 1480, 1481, 1483, 1486, 1490, 1731, 1741, 2201, 2475, 2500, 2501, 3438, 4367, 5964, 5982; Northern Negev TAUM 1116, 1131, 1445, 1479, 1484, 1485, 1492, 1496,

TABLE 1. Monthly stages in the ovarian cycle of 17 *Mesalina olivieri* females from Israel; one April female (*) with oviductal eggs was also undergoing yolk deposition.

Month	N	Quiescent	Early yolk depositon	Follicles > 4 mm	Oviductal eggs
January	1	0	0	1	0
March	6	1	2	1	2
April	9	2	3	1	3*
November	1	1	0	0	0

1967, 3682, 3951, 3991, 3996; Southern Coastal Plain TAUM 1493, 1495, 2064, 2456, 2953, 2954, 5965.

The left testis was removed from males and the left ovary was removed from females for histological examination. Gonads were embedded in paraffin and histological sections were cut at 5 µm and stained with hematoxylin followed by eosin counterstain. Enlarged ovarian follicles (> 4 mm) and oviductal eggs were counted. No histology was performed on them. Histology slides were deposited at TAUM.

Two stages were observed in the testicular cycle: Spermiogenesis, (seminiferous tubules are lined by sperm or clusters of metamorphosing spermatids); Recrudescence (proliferation of germ cells prior to spermiogenesis), was observed in two juvenile males from September, measuring 35 mm and 39 mm SVL, respectively). Males exhibiting spermiogenesis by month were January (N = 1), March (N = 4), April (N = 8), May (N = 1), November (N = 1). The smallest reproductively active male measured 40 mm SVL (TAUM 1121) and was collected in April. The presence of the November male undergoing spermiogenesis suggests *M. olivieri* exhibits a testicular cycle similar to the congener *Mesalina guttulata* from Israel (Goldberg 2012. Zool. Mid. East 56:27–30) which also initiates sperm formation in autumn.

Four stages were noted in the ovarian cycle of *M. olivieri* (Table 1): Quiescent (no yolk deposition; Early yolk deposition (yolk granules in the ooplasm); Enlarged ovarian follicles > 4 mm; Oviductal eggs. The smallest reproductively active *M. olivieri* females measured 40 mm SVL (TAUM 1731) 3 follicles > 4 mm, early yolk deposition (TAUM 2501) both collected in March. Four smaller females with quiescent ovaries, 35 (September), 38 (December), 38 (January), 39 mm (January) SVL, respectively, were considered juveniles. Mean clutch size (N = 8) was 3.4 ± 0.74, range = 2–4. One female from April with oviductal eggs was undergoing concurrent yolk deposition for a subsequent clutch indicating *M. olivieri* can produce multiple clutches in the same reproductive season in Israel.

I thank Shai Meiri (TAUM) for permission to examine *M. olivieri*, Ezra Maza for facilitating the loan and the National Collections of Natural History at Tel Aviv University for providing *M. olivieri* for this study.

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***NOROPS PENTAPRION* (Lichen Anole). DIRECTED AERIAL DESCENT.** Lizards with gliding or directed aerial descent behaviors are well known from the Old World Tropics (e.g., *Draco, Ptychozoon*), and snakes and frogs exhibiting these behaviors are found both in the Old and New World Tropics (Dudley et al. 2007. Annu. Rev. Ecol. Evol. Syst. 38:179–201). However, lizards showing directed aerial descent have not been reported from the New World Tropics. Here we report on directed aerial descent capability and behavior in *Norops pentaprion*, a canopy lizard from eastern Costa Rica, southern Nicaragua, and western Panama (Köhler 2010. Zootaxa 2354:1–18).

The initial discovery of this behavior in *N. pentaprion* was serendipitous in July 2001 when an individual was captured on a walk-up meteorological tower at canopy level (~ 25 m) at La Selva Biological Station in the Atlantic lowlands of Costa Rica. After identification, the animal was returned to the original location on the tower, but upon release to a horizontal tower brace, it executed a controlled aerial descent to a tree in the distance below. Individuals of *N. pentaprion* have been occasionally observed on our meteorological towers subsequent to our first observation of directed aerial descent. The lizards are typically at canopy level but are sometimes found well above the canopy on the highest levels of the towers (up to 42 m). While the typical response of *N. pentaprion* to the presence of personnel on the tower is to race



FIG. 1. Frames from video of a *Norops pentaprion* individual executing an aerial rotation during directed aerial descent. Arrows track the lizard's descent.

down the tower or hide on the opposite side of vertical supports, the animals will occasionally jump from the tower to escape when approached. Since 2001 we have observed directed aerial descent by *N. pentaprion* from canopy towers on several occasions. In at least two instances the lizard landed at lower levels on the tower, but in other occurrences they covered substantial distance to adjacent trees including aerial rotations of near 180º. During more than one observation, animals appeared to glide with near-horizontal trajectories towards termination of the descent.

Similar to some snakes, frogs, lizards, and ants showing directed aerial descent, *N. pentaprion* does not have strongly specialized features associated with gliding behavior such as skin flaps, skin extensions, or webbed feet. *Norops pentaprion* has a relatively flattened head and wide body. During aerial descent this lizard proceeds headfirst, with limbs partially extended and the body strongly flattened, a position that may take advantage of regions of relatively loose skin along the sides of the body (Guyer and Donnelly 2005. Amphibians and Reptiles of La Selva, Costa Rica, and the Caribbean Slope, Univ. California Press, Berkeley, California. 299 pp.).

At La Selva Biological Station this species is uncommon in the understory and is usually found on trees limbs. *Norops pentaprion* is a member of a closely-related group of anoline lizards subjected to a recent analysis of morphology and morphometrics (Köhler, *op. cit.*); these related taxa share similar body size characteristics with *N. pentaprion* and are frequently arboreal. Future observations of some of these species may result in the discovery of similar directed-aerial descent behavior.

Canopy pioneer Donald Perry reported lizards with a rose dewlap parachuting between trees in the canopy in Costa Rican forests (Perry 1986. Life Above the Jungle Floor, Simon and Schuster, Inc. New York, New York. 170 pp.), but the species was not identified. In their description of *Norops pentaprion*, Guyer and Donnelly (*op. cit.*) indicated that parachuting behavior likely occurs in this species on the basis of our initial observations and those of Perry. Our repeated observations verify directed aerial descent in this species and confirm that the lizard observed by Perry was *N. pentaprion*, the only lizard in the region with magenta dewlap coloration.

These observations were made possible by frequent canopy access provided with support from NSF grants BE 0421178 and DEB-0842235.

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***OPLURUS CUVIERI CUVIERI* (Madagascan Spiny-tailed Iguana). PREY.** Several studies have shown that *Oplurus cuvieri cuvieri* (Opluridae) primarily feeds on invertebrates with a high proportion of ants, but also consumes plant matter such as leaves, twigs, flower buds and seeds (Bloxam et al. 1996. Prim. Rep. 46:189–201; Brillet 1982. Rev. Ecol. Terre Vie 36:79–148; Mori and Randriamahazo 2002. Afr. J. Ecol. 40:61–64; Randriamahazo and Mori 2012. Current Herpetol. 31:8–13). Brillet (*op. cit.*) also reported that *O. c. cuvieri* feeds on small mammals, but it is unclear whether this was an observation under natural conditions or in captivity. In addition, *O. c. cuvieri* has been suggested as a potential predator on nestlings of birds based on the observation that adult Rufous Vangas (*Schetba rufa*) intensely attacked an individual iguana that came close to a nest (Eguchi 2005. In Social Organization of the Rufous Vanga, pp. 83–104. Kyoto Univ. Press, Kyoto). Here, I report on a case of predation on a bird by *O. c. cuvieri*.



FIG. 1 *Oplurus cuvieri cuvieri* captured by a fledgling Madagascar Bulbul.

During a field study in Ampijoroa forest in Ankarafantsika National Park, Madagascar, I observed a predation event of an adult *O. c. cuvieri* on a fledgling of the Madagascar Bulbul (*Hypsipetes madagascariensis*). At ca. 1130 h on 28 November 2011, a fledgling *H. madagascariensis* fell to the ground from a nest in a tree approximately 4 m high. Several avian species such as, the Sickle-billed Vanga (*Falculea palliate*) and the Broad-billed Roller (*Eurystomus glaucurus*) repeatedly flew down and pecked at the fledgling, attempting to capture it, but the parent birds of the fledgling mobbed the other birds and protected the fledgling from their attacks. At 1215 h, a male *O. c. cuvieri* rushed to the fledgling from ca. 10 m away while several birds were still attempting to attack the fledgling, but the lizard failed to capture the fledgling due of the parents' mobbing. This iguana and several birds continued their predation attempts on the fledgling, and the parents of the fledgling had gradually let up mobbing over the course of almost 3 hours of protecting their offspring. Then at 1415 h, the iguana successfully bit and captured the fledgling in its forth attack (Fig. 1), 2 h following its first attempted attack. The parents did not mob the iguana after it captured the fledgling. The iguana tore the body and began consumption, banging the bird on the ground and then against the trunk of the tree while climbing many times. This is the first reported evidence for the predation of vertebrates by *O. c. cuvieri* in the wild.

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***PETRACOLA VENTRIMACULATUS* (Spotted Lightbulb Lizard). CANNIBALISM.** *Petracola ventrimaculatus* is a gymnophthalmid

lizard endemic to the northern Peruvian Andes (Kizirian et al. 2008. Zootaxa. 1700:53–62). The natural history of this species is poorly known and there is no published information regarding its diet. However, species of the related genus *Proctoporus* are known to feed on arthropods—mostly beetles, ants, and spiders (Doan 2008. J. Herpetol. 42:16–21).

While clearing and staining three specimens of *P. ventrimaculatus* for a taxonomic review, a hatchling (SVL = 22.93 mm) of *P. ventrimaculatus* was found in the stomach of an adult male conspecific (SVL = 65.2 mm), collected on 18 September 2006 at Puente Hierba Buena (6.981131°S, 78.379764°W), Province of Celendín, Cajamarca Region, Perú. The stomach contents of the other two specimens included one mite, coleopterans (three adults and two larvae), and one amblypygid. This is the first record of cannibalism in the Gymnophthalmidae, as well as the first prey items reported for the diet of *P. ventrimaculatus*.

The male specimen of *Petracola ventrimaculatus* is deposited in the herpetological collection of the Museo de la Universidad San Marcos, Lima, Perú (MUSM 26233). We thank C. Torres for allowing access to the collection of the MUSM.

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***PHYMATURUS EXTRILIDUS*. PREDATION.** On 28 November 2011 at 1710 h, we observed a female Red-backed Hawk (*Buteo polyosoma*) presenting an adult *Phymaturus extrilidus* to a nest of two approximately 1.5-week-old chicks above a canyon known as Aguada de Pinchagua at the Multiple Use Nature Reserve Don Carmelo, Ullum Department, San Juan Province, Argentina (30.977504°S, 69.083017°W, 3122 m elev.). The hawk had removed the head of the lizard prior to arriving at the nest to feed it to the chicks (Fig. 1). Although Red-backed Hawks are known to eat lizards (Jiménez 1995. Hornero 14:1–9), this is the first record of one eating this species and the first record of a confirmed predator for *P. extrilidus* (Lobo et al. 2012. Copeia 2012:12–22). R. E. Espinoza confirmed the identity of the lizard.

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FIG. 1. Female *Buteo polyosoma* feeding an adult *Phymaturus extrilidus* to two nestlings.

***PHYMATURUS SPECTABILIS*. PREDATION.** *Phymaturus spectabilis* is a medium-sized liolaemid lizard endemic to northwestern Patagonia, found in rocky outcrops near Ingeniero Jacobacci, Departamento 25 de Mayo, southwestern Río Negro Province, Argentina. Predation data are absent for this species, but it has been reported to share its habitat with potential reptile predators such as the colubrid snakes *Philodryas patagoniensis* and *P. trilineata*, and the viperid *Rhinocerophis ammodytoides* (Scolaro et al. 2008. Zootaxa 1786:48–70). Here I report an observation of predation of *P. spectabilis* by a Lesser Grison (*Galictis cuja*).

On 7 December 2011 during a field trip to Paraje Yuquiche, Río Negro Province, northwestern Patagonia, Argentina (41.434050°S, 69.751983°W, datum WGS84; elev. 942 m), I observed a Lesser Grison moving below a shrub (*Stillingia patagonica*) at the bottom of a rocky outcrop, where I had earlier observed three individuals of *Liolaemus elongatus* basking. When I approached to get a closer view I realized that the grison was holding a dead *Phymaturus spectabilis* in its mouth. As soon as it saw me, the grison released the dead lizard from its mouth and retreated. The dead lizard was identified as a juvenile female (69.1 mm SVL). The head of the lizard had been completely crushed, indicating that the grison had captured the lizard by this part of its body. It has been reported previously that Lesser Grisons in Patagonia prey secondarily on reptiles (Diuk-Wasser and Cassini 1998. Stud. Neotrop. Fauna Environ. 33:3–6), however, this is the first case of predation on *Phymaturus* lizards.

Erika Kubisch verified the identifications and the *P. spectabilis* (PH229) was deposited in the Herpetological Collection of the Centro Regional Universitario Bariloche (CRUB), San Carlos de Bariloche, Río Negro.

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***PHYSIGNATHUS LESUEURII* (Australian Water Dragon). MUTILATION BY RAVENS.** During spring and summer 2005 I observed two instances of Australian Ravens (*Corvus coronoides*) removing parts of the tail from adult Australian Water Dragons (*Physignathus lesueurii*) at the Australian National Botanic Gardens, Canberra, Australia (35.27894°S, 149.11048°E). In the first instance, a raven approached and landed on a pavement cement path approximately 2 m from an adult male dragon (size of the lizard was nearly 1 m in total length). The dragon showed little response other than obvious visual contact. The raven then clasped the dragon's tail (about 10–15 cm from the tip) with its bill and dragged the dragon by the tail in different directions. This occurred for nearly one minute, the dragon running in place as it was being pulled. The raven then ran in circles around the dragon, still holding the tail, with the lizard spinning in one spot and still running in place. After another 30 seconds of this behavior part of the tail snapped off, and the raven flew away with it. A second similar event involved an adult female dragon and possibly the same raven about two weeks later. The raven was first observed already clasping the tail of the dragon, again about 10–15 cm from the tip, on the same path as the first event. This time the raven shook the tail vigorously, breaking off the tip within 20 sec

of first being observed. The raven flew off with the tail piece. I could not confirm whether the raven(s) consumed the tails.

Tail breakage induced or caused by ravens appeared to be deliberate, rather than a failed attempt at predation. It seems likely that the ravens consumed the tails (or the muscle component). Corvids are known for their problem solving abilities (e.g., Weir et al. 2002. Science 297:981), and ravens may be responsible for previous observations of incomplete tails in Australian Water Dragon populations. Thompson (1993. Wildl. Res. 20:613–619) speculated that the 41–47% rate of tail breakage/regeneration in adult water dragons in another population was due to predators, rather than intraspecific fighting. My observations partially support this idea, but also suggest deliberate "mutilation" by ravens. Further observations of the proportion of tail loss in a population, along with confirmation of ravens consuming the tails (or parts of them), are needed to determine both the cognitive underpinning of tail removal by ravens and its importance to Australian Water Dragon populations.

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***PLESTIODON FASCIATUS* (Five-lined Skink). ARTIFICAL HABITAT USE.** In central Ontario, Canada, from 1 May to 31 August 2012, systematic surveys were conducted to examine the impacts of roads on reptiles. Surveys were conducted along 13 km of Highway 69/400 in Parry Sound District and 6 km of Highway 529 in Magnetawan First Nation. Of the 28 *Plestiodon fasciatus* found on or within 3 m of a road, 3 (11%) were dead, while the remaining 25 (89%) were alive and interacting with the road. Interactions were categorized as either crossing the road (3 individuals; 12%) or hiding under cover alongside the roadside (22 individuals; 88%; Fig. 1). Only 2 individuals (9%) were found under natural cover objects (rock, grass thicket), while 20 individuals (91%) were found under anthropogenic debris (garbage, tires, sections of retread and cardboard). During haphazard surveys of non-road sites, 7 individuals were observed, 2 (29%) of which were under natural cover and 3 (43%) were under artificial cover (habitat was not recorded for 2 skinks).

Interestingly, only 6% of all of the skinks found on Magnetawan First Nation (both road and non-road sites; Fig. 1) were found under natural cover, suggesting that artificial cover may be preferred habitat within this population. If this is the case, the high level of refuse found along the roadside may attract skinks to areas that subject them to an increased likelihood of road mortality. Road mortality is a known threat to *P. fasciatus* populations in Ontario (COSEWIC 2007. COSEWIC assessment and update status report on the Five-lined Skink, *Eumeces fasciatus,* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 50 pp.), and elsewhere across the species' range (Illinois; COSEWIC 2007, *op. cit.*, and Florida; Aresco 2003. J. Wildl. Manage. 69:549–560).

It has been previously documented that *P. fasciatus* only occasionally uses artificial cover objects in some populations (e.g., Hecnar 1994. Can. J. Zool. 72:1510–1516). In central Ontario, *P. fasciatus* is thought to select habitat based on specific microhabitat characteristics; specifically, rocks averaging 55 cm in length that provide thermal conditions that vary by no more than 1.99°C (Quirt et al. 2006. J. Herpetol. 40:335–342) and that provide an optimum cover temperature range of 28°C to 36°C (Fitch 1954. Univ. Kansas Publ. Mus. Nat. Hist. 8:1–156). The specificity of this species' habitat preference is so strong that degradation or alteration of microhabitat has been linked to population declines (COSEWIC 2007, *op. cit.*). In our observations, temperature underneath artificial cover averaged 23.5°C (N = 16), which is 4.5°C cooler than the previously reported selected minimum optimum cover temperature (28°C) for this species. So, why would *P. fasciatus* be selecting these artificial cover objects? One possible explanation may be that factors other than temperature, such as an increase in potential prey, are contributing to the increased skink abundance around roadways.

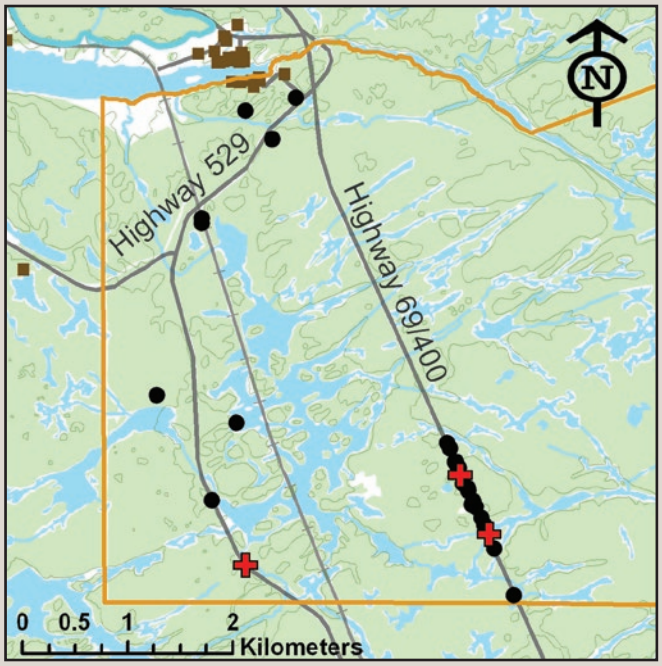


FIG. 1. Distribution of *Plestiodon fasciatus* on Magnetawan First Nation in Central Ontario differentially labeled by living (black circles) or deceased (red crosses) individuals. Most skinks were found in close proximity to human development, including roads and rail lines (grey lines) and buildings (brown squares).

During the course of our road surveys, insects were collected to examine insect road mortality, with an estimated total of 12,900 dead insects collected after colliding with vehicles (Baxter-Gilbert et al., unpubl. data). Insects are known to be a major food source for *P. fasciatus* (COSEWIC 2007, *op. cit.*), and a fecal sample from one of the live Five-lined Skinks on Magnetawan First Nation was comprised mostly of beetle elytra. It might be that the abundance of *P. fasiciatus* around roadways is correlated with the increased availability of immobilized prey items. Our observations demonstrate a need to study the relationship between lizard ecology and roadways to determine if anthropogenically-created resources, such as roadside refuse and road-killed insects, are attracting these reptiles to a known population threat.

We thank Jenn Baxter-Gilbert, Sean Boyle, Damien Buttineau, Ron Maleau, and Chris Neufeld for their field assistance. Financial support for this research was provided by Magnetawan First Nation, Laurentian University, the Ontario Ministry of Natural Resources, and the Ontario Ministry of Transportation. All research was conducted under an approved Laurentian University Animal Care Committee protocol, and authorized by Magnetawan First Nation's Chief and Band Council and the Ontario Ministry of Natural Resources.

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***PLESTIODON GILBERTI* (Gilbert's Skink). PREDATION.** *Plestiodon gilberti* typically occur in open grassy areas where burrows or rocks provide quick cover. They also occupy woodlands, streams, and other wetland areas (Behler and King 1979. The National Audubon Society Field Guide to North American Reptiles and Amphibians. Alfred A. Knopf, New York, New York. 744 pp.; Stebbins and McGinnis 2012. Field Guide to Amphibians and Reptiles of California. Univ. California Press, Berkeley. 538 pp.). Their association with wetland areas increases their risk of predation by wading birds, including Great Egrets (*Ardea alba*), which are opportunistic predators that take a variety of prey, such as crustaceans, insects, frogs, tadpoles, lizards, snakes, and small mammals. Great Egrets have been observed in the Florida Keys searching for *Anolis* lizards (McCrimmon et al. 2011. *In* A. Poole [ed.], The Birds of North America Online. Cornell Lab of Ornithology, Ithaca, New York; doi: 10.2173/bna.570).

On 19 April 2013, while hiking along a trail approximately 675 m E of the San Joaquin River in Fresno Co., California, USA (36.8765°N, 119.7796°W; 90 m elev.), we observed a Great Egret in an upland area struggling with something in its beak. Upon initial observation the item appeared to be a snake but after further examination of photographs taken of the egret, the prey was identified as an adult *P. gilberti*. The skink was whipping its tail back and forth, forcing the bird to attempt a better grip. The bird tossed the lizard into the air and recaptured it with its beak, swallowing the skink whole in less than 30 sec. Although likely a common occurrence based on the similar habitat associations of these two species, this observation, to our knowledge, is the first to be reported.

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FIG. 1. Great Egret (*Ardea alba*) predating a Gilbert's Skink (*Plestiodon gilberti*) in Fresno Co., California

***PSEUDOTRAPELUS SINAITUS* (Sinai Agama). ENDOPARASITES.** *Pseudotrapelus sinaitus* is widely distributed in the Middle East where it inhabits rocky desert habitats (Bar and Haimovitch 2011. A Field Guide to Reptiles and Amphibians of Israel. Pazbar Ltd, Herzliya, Israel. 245 pp.). To our knowledge there are no reports of endoparasites from this species. The purpose of this note is to establish the initial parasite list for *P. sinaitus*.

The body cavity of one female (SVL = 83 mm) *P. sinaitus* collected 23 April 1952 in Israel, Northern Negev Region and deposited in the Tel Aviv University Museum (TAUM), Israel as TAUM 688 was examined for endoparasites. A mid-ventral incision was made and the coelomic contents were examined under a dissecting microscope. Two nematodes were found. The stomach wall was punctured in preservation and some contents had spilled into the body cavity. Thus it is likely the infection site for the nematodes was the stomach. The nematodes were cleared on a glass slide in a drop of lactophenol, cover slipped, examined under a compound microscope, and identified as two immature ascarid nematodes. Voucher nematodes were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland as USNPC 106981.

Ascaridoids commonly utilize vertebrates as intermediate hosts; development to the adult nematode occurs when the intermediate host (in this case a lizard) containing infective larvae is eaten by the definitive host (Anderson 2000. Nematode Parasites of Vertebrates, Their Development and Transmission, CABI Publishing, Oxon, UK. 650 pp.). *Pseudotrapelus sinaitus* represents a new host record for larval ascarid nematodes.

We thank Shai Meiri (TAUM) for permission to examine *P. sinaitus*, Erez Maza for facilitating the loan, and the National Collections of Natural History at Tel Aviv University for providing the *P. sinaitus* for this study.

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***PSEUDOTRAPELUS SINAITUS* (Sinai Agama). REPRODUCTION.** *Pseudotrapelus sinaitus* is widely distributed in the Middle East and is known from Libya, Egypt, Israel, Jordan, Syria, Saudi Arabia, Arabian Peninsula, U.A.E., Oman, Sudan, Ethiopia, and Eritrea where it inhabits rocky desert habitats (Bar and Haimovitch 2011. A Field Guide to Reptiles and Amphibians of Israel. Pazbar Ltd, Herzliya, Israel. 245 pp.). There is anecdotal information on its reproduction found in Bar and Haimovitch (*op. cit.*; Disi et al. 2001. Amphibians and Reptiles of the Hashemite Kingdom of Jordan, An Atlas and Field Guide. Edition Chimaira, Frankfurt am Main, Germany. 408 pp.; Schleich et al. 1996. Amphibians and Reptiles of North Africa. Koeltz Scientific Publications, Koenigstein, Germany. 630 pp.), indicating a spring-summer breeding season with clutches of 5–9 eggs produced. In this note I provide additional information on *P. sinaitus* reproduction from a histological examination of gonads from museum specimens.

A sample of 24 *P. sinaitus* deposited in the Zoological Museum of the Department of Zoology, Tel Aviv University (TAUM), Tel Aviv, Israel, was examined. The sample consisted of 13 males (mean SVL = 78.2 mm ± 4.3 SD, range = 71–83 mm), 10 females (mean SVL = 75.3 mm ± 5.1 SD, range = 68–73 mm), and one juvenile female (SVL = 54 mm) collected 1941–1958 in Israel (32.01587°N, 34.78740°E). Vouchers utilized in this study include:

TABLE 1. Monthly stages in the ovarian cycle of 10 *Pseudotrapelus sinaitus* females from Israel.

Month	N	Quiescent	Yolk deposition	Enlarged follicles > 4 mm	Oviductal eggs
April	6	2	1	2	1
May	2	0	0	1	0
Sept	1	1	0	0	0
Nov	1	1	0	0	0

TAUM 688, 696–698, 701, 705, 709–711, 713–716, 855, 1123, 1279, 1317, 1460, 1839, 2146, 2595, 2985, 3048, 3119.

An incision was made in the lower abdominal cavity and the left testis or ovary was removed, embedded in paraffin, cut at 5 µm sections, and stained with Harris hematoxylin followed by eosin counterstain. Enlarged follicles > 4 mm or oviductal eggs were counted. Histology slides are deposited in TAUM.

Two stages were observed in the testicular cycle: 1) recrudescence. A proliferation of germ cells occurs for the next period of sperm formation; primary and/or secondary spermatocytes predominate; 2) spermiogenesis. Lumina of the seminiferous tubules are lined by sperm or rows of metamorphosing spermatids. Monthly distribution of stages were: March (N = 3, spermiogenesis); April (N = 7, 1 recrudescence, 6 spermiogenesis); May (N =1, spermiogenesis); October (N = 1, recrudescence); November (N = 1, recrudescence). The smallest reproductively active male (spermiogenesis) measured 72 mm SVL (TAUM 2146) and was collected in March.

Four stages were observed in the monthly ovarian cycle (Table 1): 1) quiescent, no yolk deposition; 2) early yolk deposition, basophilic yolk granules in the ooplasm; 3) enlarged ovarian follicles > 4 mm; 4) oviductal eggs. Mean clutch size for five females was 4.4 ± 1.3 SD, range = 3–6. The three smallest reproductively active females each measured 73 mm SVL; (1) TAUM 2595, early yolk deposition, collected in April; (2 and 3) TAUM 696, 2985, 3 follicles > 4 mm, collected in April. Schleich (*op. cit.*) also reported 73 mm SVL as the minimum size for reproductive maturity of *P. sinaitus* females. I arbitrarily considered one slightly smaller reproductively inactive female from April (TAUM 701, SVL = 70 mm) as being an adult. One reproductively inactive smaller female (TAUM 1123, SVL = 54 mm) was clearly a juvenile.

My histological findings confirm *P. sinaitus* exhibits a reproductive cycle typical of numerous temperate zone lizards. Breeding occurs in spring; renewal of germinal epithelium (recrudescence) in males for the forthcoming spring spermiogenesis occurs in autumn. No reproductive activity was exhibited in autumn females. Three is a new minimum clutch size for *P. sinaitus*.

I thank Shai Meiri (TAUM) for permission to examine *P. sinaitus,* Erez Maza for facilitating the loan, and the National Collections of Natural History at Tel Aviv University for providing samples of *P. sinaitus* for this study.

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***SCELOPORUS ANAHUACUS* (Anahuacan Graphic Lizard). SELECTED BODY TEMPERATURE.** Field body temperatures of reptiles have been widely reported (Avery 1982, *In* Gans and Pough [eds.], Biology of the Reptilia, Vol. 12, Physiology C, pp. 93–166. Academic Press, New York), but reports on preferred or selected body temperature is actually quite rare in the literature (Sinervo et al. 2010. Science 328:894–899) because measurement in a laboratory thermal gradient under standard conditions is required (Huey 1982. *In* Gans and Pough [eds.], Biology of the Reptilia, Vol. 12, Physiology C, pp. 25–91. Academic Press, New York). *Sceloporus anahuacus* is a viviparous lizard of the *grammicus* group, which inhabits high elevation pine forest. This species is endemic to central Mexico in Sierra Nevada, Distrito Federal, and Estado de México (Ramírez-Bautista et al. 2009. Herpetofauna del Valle de México, Diversidad y Conservación. CONABIO-UAH. 210 pp.). There have been several reports detailing thermal ecology in *grammicus* group members (Güizado-Rodríguez et al. 2011. Southwest. Nat. 56:120–124; Lemos-Espinal et al. 1995. Can. J. Zool. 73:2184–2191; Woolrich-Piña et al. 2006. Acta Zool. Mex. 22:137–150), and specific to *S. anahuacus* within field conditions (Ávila-Bocanegra et al. 2012. Herpetol. Bull. 121:27–29), but the selected body temperature has not been documented. Here, we provide preliminary selected temperatures of wild-caught individuals of this species under laboratory conditions.

During May 2007, one of us (UOGV) conducted field work in the Ejido Magdalena Petlatalco, Delegación Magdalena Contreras, Sierra del Ajusco, Distrito Federal, México (19.2210°N, 99.2856°W; 3500–3930 m elev.), located in a forested area dominated by pine trees (*Pinus* sp.). The data presented here are based on 10 adults (> 46 mm SVL; 6 females and 4 males) of *S. anahuacus* captured by hand. In the laboratory, the lizards were separated by gender and maintained at 25°C in plastic containers with soil, trunks, and grass, and hydrated with a sprinkler every day. Laboratory experiments were conducted two days after capture using a thermal gradient, which consisted of a wood box (150 cm long x 150 cm wide x 70 cm high) divided into ten tracks of 15 cm each to prevent interaction between lizards. The box was located in a room with a controlled temperature of 20°C and three 150 W lamps were placed at different heights over the box to offer the thermal gradient (20–50°C). Body temperature data were collected manually using a digital thermometer (Fluke model 51-II) with the sensor introduced one centimeter into the cloaca during each hour between 1330 and 1930 hs.

Mean selected body temperature was 32.64°C (SD = 2.73°C, range = 26.0–36.5°C). Interquartile of 25% and 75% was 32.1 and 34.2°C, respectively. These results suggest S. *anahuacus* maintains its thermal requirements similar to others species of the *grammicus* group (Güizado-Rodríguez et al 2011, *op. cit.*; Lara-Resendiz and Díaz de la Vega-Pérez, in press, Herpetol. Rev.; Lemos-Espinal et al. 1995, *op. cit.*; Woolrich-Piña et al. 2006, *op. cit.*). Specifically, the mean selected body temperature is higher than that reported by Ávila-Bocanegra et al. (2012, *op. cit.*) for this species under field conditions. Finally, we propose for future research to assess the thermal biology of the *S. grammicus* group based in tolerance ranges, selected body temperatures in laboratory, body temperatures taken in the field coupled with environmental temperatures, in order to address the patterns of thermoregulation and to determine if the thermal biology in this group of lizards is limited by the environment or if it is evolutionarily conservative.

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***SCELOPORUS GRANDAEVUS* (Cerralvo Island Sator). REPRODUCTION.** *Sceloporus grandaveus* is known only from Isla Cerralvo in the Gulf of California where it is most commonly found in rocky arroyos (Grismer 2002. Amphibians and Reptiles of Baja California, Including its Pacific Islands and the Islands in the Sea of Cortés, University California Press, Berkeley. 399 pp.). Grismer (*op. cit.*) observed gravid females from June through October. The purpose of this note is to present additional information on *S. grandaevus* reproduction from a histological examination of museum specimens.

A sample of 11 *S. grandaevus* was examined consisting of 9 males (mean SVL = 72.1 mm ± 3.8 SD, range = 67–78 mm) and 2 females (mean SVL = 58.5 mm ± 0.71 SD, range = 58–59 mm), collected August 1969 at Isla Cerralvo, (24.250000°N, 109.91666°W) Baja California Sur, Mexico and deposited in the herpetology collection, University of Arizona (UAZ), Tucson, Arizona as UAZ 31487, 31493, 31494, 31539, 31500, 31622, 31742, 31743, 31745–31747.

A cut was made in the lower abdominal cavity and the left testis or ovary was removed, embedded in paraffin, cut at 5µm and stained with Harris hematoxylin followed by eosin counterstain. Enlarged ovarian follicles > 5 mm or oviductal eggs were counted. No histology was performed on them. Histology slides were deposited at UAZ.

Eight of the nine males exhibited spermiogenesis (lumina of the seminiferous tubules were lined by sperm or rows of metamorphosing spermatids), one male had regressed seminiferous tubules which contained spermatogonia and Sertoli cells, however the epididymis contained moderate amounts of sperm. The smallest reproductively active male (spermiogenesis in progress) measured 67 mm SVL (UAZ 31494).

Both females contained clutches of 6 and 7 eggs, respectively (N = 2, mean = 6.5 ± 0.71 SD, range = 6–7 eggs). The smallest reproductively active female (7 oviductal eggs) measured 58 mm SVL (UAZ 31539).

I thank George L. Bradley (UAZ) for permission to examine *S. grandaevus*.

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***SCELOPORUS SCALARIS* (Light-bellied Bunchgrass Lizard). CLUTCH SIZE.** *Sceloporus scalaris* is an oviparous species with the breeding season occurring during the summer (Vázquez-Díaz and Quintero-Díaz. 2005. Anfibios y Reptiles de Aguascalientes. CONABIO y CIEMA. 2nd ed. México, D.F. 318 pp.). Some information has been published on the reproduction of *S. scalaris*, including a clutch of 4–8 eggs reported from México Valley (Ramírez-Bautista et al. 2009. Herpetofauna del Valle de México: Diversidad y Conservación. UAEH, CONABIO, Pachuca. 213 pp.). Additionally, one specimen from a population in extreme western Nuevo León deposited 5 eggs on 11 August (Lemos-Espinal and Dixon 2013. Amphibians and Reptiles of San Luis Potosí. Eagle Mountain Publishing, LC, Eagle Mountain, Utah. 300 pp.). Populations from Aguascalientes have been reported to lay clutches of 9–13 eggs, where it was observed that the females retain the eggs until they are almost fully developed embryos (Vázquez-Díaz and Quintero-Díaz 2005, *op. cit.*). Herein we present the largest clutch size yet reported for *S. scalaris*.



FIG. 1. Clutch of 15 eggs of *Sceloporus scalaris* found at Mesa Montoro, Aguascalientes, Mexico.

On 14 August 2013 at 1700 h, we found a female *S. scalaris* with a clutch of 15 eggs (Fig. 1) beneath a rock in oak savanna at Mesa Montoro, Aguascalientes, México (22.019912°N, 102.562113°W, datum WGS84; elev. 2366 m). Although the female fled after being disturbed, *S. scalaris* is the only species of oviparous lizard in the area.

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***SCELOPORUS SCALARIS* (Light-bellied Bunchgrass Lizard). MATING BEHAVIOR.** Little is known about the reproductive behavior of *Sceloporus scalaris*. In the literature there is only information about the mating or courtship of this widely distributed species from La Michilia, Durango, México (Gutiérrez and Ortega1986. Bull. Maryland Herpetol. Soc. 22:23–25). We provide here an observation of mating behavior of *Sceloporus scalaris* in a population from Aguascalientes, México.

During a field survey on 29 May 2013 at 1040 h, at Mesa Las Preñadas, El Llano, Aguascalientes, México (21.93409°N,



FIG. 1. Male and female *Sceloporus scalaris* displaying mating behavior at Mesa Las Preñadas, Aguascalientes, México.

101.88137°W, datum WGS84; 2432 m elev.), we observed a pair of *S. scalaris* engaged in mating behavior. The male was biting the tail of the female, while she bit the neck of the male, forming a ring with their bodies and exposing their bellies. Both males and females exhibit a white belly in this *Sceloporus* species and in this belly-up position the pair displayed a striking contrast to the surrounding low-growing, green vegetation, presumably making them more vulnerable to predation (Fig. 1). As we approached, the lizards remained in this position for about five minutes, then the male released the female and both tried to escape. The specimens were deposited in the Herpetological Collection, Universidad Autónoma de Aguascalientes (UAA-CV-R 0258–0259). According to our observations, reproductive activity in this population begins in May with the mating events, and gravid females and neonates observed in mid-June.

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***SCELOPORUS SPINOSUS* (Eastern Spiny Lizard). AVIAN PREDATION.** The natural history of *Sceloporus spinosus* is well known, with some reports documenting predators (Leyte-Manrique 2007. Bol. Soc. Herpetol. Mex. 15:23–24; Solano-Zavaleta et al. 2008. Herpetol. Rev. 39:469). This species is a widespread endemic found over much of central México. It ranges between 1500 and 2300 m elev. (Mendoza-Quijano et al. 2007. *In* IUCN 2013. IUCN Red List of Threatened Species, ver. 2013.1 <www.iucnredlist.org>). Herein we provide the first observation of predation on *S. spinosus* by a Solitary Eagle (*Harpyhaliaetus solitarius*), a near threatened bird species (BirdLife International 2012. *In* IUCN 2013. IUCN Red List of Threatened Species, ver. 2013.1 <www.iucnredlist.org>).

On 16 December 2012 at 1552 h, during a survey in Juan Grande Mountain, Aguascalientes, México (21.942281°N, 101.910708°W, datum WGS84; 2276 m elev.), we observed an adult *H. solitarius* predating an adult male *S. spinosus* approx. 100 mm SVL (Fig. 1). Our observation occurred in habitat dominated by *Dodonea viscosa*, *Prosopis laevigata*, and *Quercus potosina*. During our observation the *S. spinosus* was perched on a rock, then a Solitary Eagle suddenly came down from behind and grabbed the lizard in its talons and flew away. This observation is the first photographic evidence of the predation of *Harpyhaliaetus solitarius* on an adult *S. spinosus*.



FIG. 1. Solitary Eagle female (*Harpyhalietus solitarius*) predating an adult male *Sceloporus spinosus*.

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***SPHENOMORPHUS MACULATUS* (Spotted Forest Skink). REPRODUCTION.** *Sphenomorphus maculatus* is known from Myanmar, Thailand, Laos, Cambodia, Vietnam, eastern India, Andaman Islands and southern China inhabiting evergreen forests and more open areas up to 800 m (Das 2010. A Field Guide to the Reptiles of South-East Asia, Myanmar, Thailand, Laos, Cambodia, Vietnam, Peninsular Malaysia, Singapore, Sumatra, Borneo, Java, Bali. New Holland Publishers Ltd. London. 376 pp.). Das (*op. cit.*) reported it as an oviparous species, producing clutches of 4–5 eggs. The purpose of this note is to report information on the reproductive cycle of *S. maculatus* from Thailand.

A sample of 44 *S. maculatus* consisting of 21 adult males (mean SVL = 55.5 mm ± 4.7 SD, range = 48–66 mm), 21 adult females (mean SVL = 57.1 mm ± 5.1 SD, range = 50–56 mm) and 2 juvenile females (mean SVL = 47.5 mm ± 0.71 SD, range = 47–48) collected in 1969 and deposited in the herpetology collection of the Field Museum of Natural History (FMNH), Chicago, Illinois USA was examined from the following localities: Thailand, Nakhon Ratchasima Province, Amphoe Pak Thong Chai (14.7197°N, 102.0214°E) FMNH 182403, 182405, 182407–182410, 182420, 182423–182425, 182427, 182429, 182430, 182432, 182433, 182435–182438, 182440, 182443–182446, 182448, 182450–182453, 182455, 182457, 182458, 182460, 182465, 182466, 182469, 182472, 182474, 182482, 182484, 182486, 182499; Thailand, Nakhon Nayok Province, Sarika falls (14.3213°N, 101.2511°E) FMNH 182414; Thailand, Sara Buri Province, Muak Lek (14.6638°N 101.2027°E) FMNH 182507.

A cut was made in the lower abdominal cavity and the left testis or ovary was removed, embedded in paraffin, cut at 5µm and stained with Harris hematoxylin followed by eosin counterstain. Enlarged ovarian follicles > 5 mm or oviductal eggs were counted. No histology was performed on them. Histology slides were deposited in FMNH.

TABLE 1. Monthly changes in the ovarian cycle of 21 adult *Sphenomorphus maculatus* females from Thailand.

Month	N	Quiescent	Yolk depositon	Enlarged follicles > 5 mm	Oviductal eggs
February	2	2	0	0	0
March	7	7	0	0	0
April	4	2	0	2	0
May	7	1	3	1	2
June	1	0	0	0	1

All males examined from February (N = 2), March (N = 7), April (N = 9), June (N = 1), July (N = 1) were undergoing spermiogenesis (seminiferous tubules are lined by sperm or groups of metamorphosing spermatids). It thus appears the *S. maculatus* males examined exhibited an extended period of sperm production. The only male examined from August contained a regressed testis in which the seminiferous tubules contained spermatogonia and Sertoli cells. Before the significance of this single male with a regressed testis can be ascertained, examination of additional specimens are needed. The smallest reproductively active males both measured 48 mm SVL (FMNH 182450, 182407) and were collected in February and April, respectively.

Monthly stages in the ovarian cycle are in Table 1. Four stages were observed: 1) quiescent, no yolk deposition; 2) early yolk deposition, vitellogenic granules in ooplasm; 3) enlarged follicles > 5 mm; 4) oviductal eggs. Mean clutch size (N = 6) = 3.7 ± 1.6 SD, range = 2–6. Clutches of two and six eggs represent new minimum and maximum clutch sizes for *S. maculatus*. The smallest reproductively active female 51 mm SVL (FMNH 182474) contained two enlarged ovarian follicles (> 5 mm) and was collected in May. Whether the nine *S.maculatus* females from February–March with quiescent ovaries indicates a period of female reproductive inactivity will require further study.

I thank Alan Resetar (FMNH) for permission to examine *S. maculatus*.

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***STROPHURUS CILIARIS* (Northern Spiny-tailed Gecko). COMMUNAL NESTING.** Communal nesting is widespread in reptiles, and is more common than currently appreciated because the eggs and nests of many species are either unknown or rarely recorded in nature (Doody et al. 2009. Quart. Rev. Biol. 84:229–252). One group with secretive nests are the diplodactylid geckos. Unlike the hard-shelled eggs of gekkonid geckos, which are often deposited in relatively conspicuous sites (e.g., under bark, logs, or rocks, on cave walls, in houses), the pliable-shelled eggs of diplodactylid geckos are generally deposited underground where higher humidity or soil moisture is required to promote successful development (Bustard 1968. Copeia 1968:162–164). Details of the eggs and nests of most of the ~125 diplodactylid species are thus, unknown. Accordingly, communal nesting is rarely reported in these species (Doody et al., *op. cit.*). Herein we report on eight communal nests of *Strophurus ciliaris* that were found while excavating the nesting warrens (groups of burrows) of the Yellow-Spotted Monitor (*Varanus panoptes*) in tropical northern Australia.

During May and June 2013 we studied the nesting biology of *V. panoptes* (data reported elsewhere) at El Questro Wilderness Park in the east Kimberley Region of Western Australia (15.895033°S, 128.132456°E). The area consists of savannah woodland situated in the wet-dry tropics, with distinct wet (Nov–March) and dry (April–Oct) seasons. The nesting warrens, each comprising 6–21 burrows within a ca. 10 m^2 area, were in sandy soils of sandhill habitat along creeks and rivers. Warrens were excavated by hand (with the aid of shovels and picks) to a depth of up to 3.6 m (Doody et al. 2014. J. Herpetol. 48: *in press*). During the excavation process we found 15 *S. ciliaris* eggs and 48 eggshells comprising 11 nests in small, back-filled chambers constructed in the floor of burrows of four *V. panoptes* nesting warrens at two locations. One warren contained no *V. panoptes* eggs in that year (but contained eggshells from previous years). Nest depths were < 1 m; depths of three of the nests averaged 45 cm (range = 30–60 cm). We incubated four of these eggs to hatching under ambient temperatures in a makeshift field laboratory; all were confirmed to be *S. ciliaris*. Hatching dates were 10, 16, 22, and 28 June. We assumed that the remaining eggs and eggshells were also *S. ciliaris* based on their similar size and shape, and the absence of other pliable-shelled gecko species in the study area.

There are three interesting implications of our findings. First, like other geckos, *S. ciliaris* lays two eggs. Thus, eight (73%) of the clutches represented communal nests. Second and relatedly, it is interesting (and possibly a novel finding) that *S. ciliaris* mothers added their eggs to other clutches that were completely buried. In at least six of the communal nests the eggs were together within the same back-filled chamber excavated by the first mother. Communal back-filled reptile nests generally involve clusters of nests, rather than egg complements of multiple mothers in one chamber (Doody et al., *op. cit.*). If the alternative is true, that multiple mothers excavated or entered a single nest to lay at the same time, this also represents an interesting and novel finding (although it is considered less likely). Third, our data suggest that *S. ciliaris* is a common burrow associate of *V. panoptes*, at least during nesting. The distributions of the two species overlap in the Kimberley region of Western Australia, the Top End of the Northern Territory, and the gulf country and central desert regions of Queensland (Wilson and Swan. 2008. A Complete Guide to Reptiles of Australia, New Holland, Sydney. 512 pp.). The severe population-level declines incurred by *V. panoptes* due to poisoning by invasive Cane Toads, *Bufo marinus* (Doody et al. 2009. Anim. Conserv. 12:46–53), could thus eventually reduce nesting sites for *S. ciliaris* and other burrow associates (we also found the eggs of *V. gouldii*, and adults of 14 species of reptiles and amphibians in the warrens). The functional role of *V. panoptes* burrows in the savannah woodland ecosystem thus needs more scientific attention, particularly in areas ahead of the Cane Toad front in the west Kimberley region.

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***TRAPELUS SAVIGNII* (Egyptian Sand Agama). REPRODUCTION.** *Trapelus savignii* is known from Egypt and Israel where

it is diurnal and found in sandy habitats (Baha El Din 2006. A Guide to the Reptiles and Amphibians of Egypt. The American University in Cairo Press, Cairo. 359 pp.; Bar and Haimovitch 2011. A Field Guide to Reptiles and Amphibians of Israel. Pazbar LTD 1989, Herzliya, Israel. 245 pp.). There is anecdotal information on its reproduction in Bar and Haimovitch (*op. cit.*). The purpose of this note is to add information on the reproductive biology of *T. savignii* utilizing information from a histological analysis of gonadal material.

A sample of 35 *T. savignii* collected in Israel from 1946 to 2012 and deposited in the herpetology collection of the Natural History Collections of Tel Aviv University (TAUM) was examined, consisting of 9 adult males (mean snout–vent length, SVL = 76.6 mm ± 7.1 SD, range = 68–85 mm) 10 adult females (mean SVL = 87.9 mm ± 5.6 SD, range = 81–98 mm), 7 subadult males (mean SVL = 52.9 mm ± 4.3 SD, range = 48–59 mm), 7 subadult females (mean SVL = 55.0 mm ± 6.2 SD, range = 45–63 mm) and 2 subadults of indeterminate sex (mean SVL = 44.5 mm ± 2.1 SD, range = 43–46 mm).

A cut was made in the lower abdomen and the left testis or ovary was removed, embedded in paraffin, cut into 5 µm sections and stained with Harris' hematoxylin followed by eosin counterstain. Enlarged follicles > 5 mm or oviductal eggs were quantified. Histology slides were deposited in TAUM. *Trapelus savignii* from Israel examined (by region) from TAUM were: Northern Negev Region: TAUM 635–637, 639, 640, 643–645, 1213, 1227, 1917, 2545, 2632, 2633, 5162, 5534, 5535, 5995, 5999, 6005, 6416, 6420, 6421–6426, 6428, 6398, 6399, 6439, 8475, 16128, Southern Coastal Region: TAUM 1233.

Three stages were noted in the testicular cycle (Table 1): 1) regressed, seminiferous tubules reduced in size, containing spermatogonia and interspersed Sertoli cells; 2) recrudescent, proliferation of germ cells for the next period of spermiogenesis (sperm formation); 3) spermiogenesis, seminiferous tubules lined by sperm or clusters of metamorphosing spermatids. The presence of spermiogenic males in March and April indicate *T. savignii* is a spring breeder. The smallest mature males (spermiogenesis in progress) all measured 68 mm SVL and were collected in March TAUM 5999, 6399, 6439. Testes of smaller males (48–59 mm) were either regressed or in recrudescence and were classified as juveniles.

Four stages were noted in the ovarian cycle (Table 2): 1) quiescent (no yolk deposition); 2) yolk deposition (basophilic granules in ooplasm); 3) enlarged pre-ovulatory follicles > 5 mm; 4) oviductal eggs. The period of female reproductive activity encompassed April through August (Table 2). Mean clutch size (N = 3) was 6.3 ± 3.8 SD, range = 2–9. The smallest reproductively active female (TAUM 5535), measured 81 mm SVL, exhibited early yolk deposition and was collected in April. There was no indication (oviductal eggs and concurrent yolk deposition in the same female) to suggest *T. savignii* produces multiple clutches in the same reproductive season. However, the apparent absence of females in the process of preparing a second clutch may be a reflection of small sample size (N = 10). Six smaller females (range 45–63 mm) exhibited quiescent ovaries and were considered as juveniles. One *T. savignii* (TAUM 6421) of indeterminate sex (SVL = 46 mm) was also considered a juvenile.

My finding of one female with oviductal eggs and one with enlarged pre-ovulatory follicles from August (Table 2) confirms the statement in Bar and Haimovitch (*op. cit.*) that *T. savignii* oviposits in August. The presence of reproductive activity in March and April (Tables 1, 2) indicates *T. savignii* commences reproduction early in the spring in Israel. The clutch values reported herein, to my knowledge, represent the first reported for *T. savignii*. In addition, it appears males mature at smaller body sizes than females.

I thank Shai Meiri (TAUM) for permission to examine *T. savignii*, Erez Maza for facilitating the loan and the National Collections of Natural History at Tel Aviv University for providing specimens of *T. savignii* for this study.

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Table 1. Monthly stages in the testicular cycle of 9 adult male *Trapelus savignii* from Israel.

Month	N	Regressed	Recrudescent	Spermiogenesis
March	5	0	0	5
April	2	0	0	2
August	1	1	0	0
September	1	1	0	0

Table 2. Monthly stages in the ovarian cycle of 10 adult female *Trapelus savignii* from Israel.

Month	N	Quiescent	Yolk depositon	Enlarged follicles > 5 mm	Oviductal eggs
April	1	0	1	0	0
May	1	0	1	0	0
June	2	1	0	0	1
August	2	0	0	1	1
September	4	4	0	0	0

***UROSAURUS BICARINATUS* (Tropical Tree Lizard). BIFURCATION.** *Urosaurus bicarinatus* is a small phrynosomatid endemic to Mexico, found from southern Sonora to Chiapas, primarily along the Pacific versant and interior valleys (Feldman et al. 2011. Mol. Phyl. Evol. 61:714–725; Köhler 2008. Reptiles of Central America, 2nd ed., Herpeton Verlag Elke Köhler, Offenbach. 400 pp.; Wiens 1993. Herpetologica 49:399–420; Wilson and Johnson 2010. *In* Wilson et al [eds.], Conservation of Mesoamerican Amphibians and Reptiles, pp. 31–235. Eagle Mountain Publ., LC, Eagle Mountain, Utah), from near sea level to 2500 m elevation (Wilson and Johnson 2010, *op. cit.*). Herein, we report an incidence of tail bifurcation in a *U. bicarinatus* from the coastal lowlands of Oaxaca, Mexico.

On 23 June 2013, at 0940 h, an adult female *U. bicarinatus* was observed resting on a tree trunk on a slope with tropical deciduous forest, ca. 3 km N of La Soledad, Municipality of Tutepec, Oaxaca (18.157883°N, 96.091658°W, WGS 84; elev. 25 m). When the lizard was caught, we noticed that it had a bifurcated tail (Fig. 1). Bifurcation of the tail was represented by the end section of the original tail and the new regenerated tail. This bifurcation was located 41 mm posterior to the cloaca. Length of the original segment after the bifurcation was 15 mm (left side) and the regenerated section was 30 mm (right side). The new regenerated tail section was likely the result of an incomplete autotomization of the original tail (Goin and Goin 1971. Introduction to Herpetology, 2nd ed. W. H. Freeman and Co., San Francisco,



FIG. 1. Female Tropical Tree Lizard (*Urosaurus bicarinatus*) with tail bifurcation found near La Soledad, Oaxaca, México.

California, 353 pp.; Clark 1973. HISS News-J. 1:158). Bifurcated or multiple tail regeneration cases have been published for many species of lizards, including members in the family Phrynosomatidae (see Cordes and Walker 2013. Herpetol. Rev. 44:319; Gogliath et al. 2012. Herpetol. Rev. 43:129; Kumbar and Ghadage 2011. Herpetol. Rev. 42:94; Mata-Silva et al. 2010. Herpetol. Rev. 41:352–353; Mitchell et al. 2012. Herpetol. Rev. 43:650; Tamar et al. 2013. Herptol. Rev. 44:135–136, and citations therein). To the best of our knowledge this is the first report of tail bifurcation in *U. bicarinatus*.

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***VARANUS GLEBOPALMA* (Black-palmed Monitor). NOCTURNAL ACTIVITY AND FORAGING.** Monitor lizards are thought to be diurnal, based on a body of ecological research and on eye structure. Studies of the eye structure of *Varanus exanthematicus* and *V. griseus* have suggested that prey capture in these species is reliant on visual cues, based on the presence of cone cells in the eyes (Bhattacharjee 1992. Exp. Eye Res. 55:243; Röll and Horn 2000. Mertensiella 2:291–306). The morphological similarity of monitor lizards led Röll and Horn (*op. cit.*) to conclude that all *Varanus* species possess the same or similar eye structure and therefore all are diurnal.

However, a number of observations suggest that some monitor lizards occasionally undertake crepuscular and/or nocturnal activity. Of the 53 known species of monitor lizards, field observations of crepuscular or nocturnal activity have been recorded in nine species (*V. spenceri, V. panoptes, V. tristis V. glebopalma, V. rosenbergi, V. melinus, V. glauerti, V. salvator, and V. dumerilli*), and six species in captivity (*V. acanthurus, V. giganteus, V. indicus, V. keithhorni, V. mertensi, and V. varius*) (Bohme and Ziegler 1997. Herpetofauna 19:26–34; Cota et al. 2008. Biawak 2:152–158; Fyfe 1980. Herpetofauna 12:15; Irwin et al. 1996. Herpetofauna 26:50; Irwin et al. 1996. Herpetol. Rev. 27:192–194; Jones 1998. Herpetofauna, 28:50; Rokylle 1989. Herpetofauna 7:4–8; Trembath 2000. Herpetofauna 30:52; Uyeda et al 2013. Biawak 7:25–30; Valentic 1995. Herpetofauna 25:49–50; Yong et al. 2008. Nature in Singapore 1:21–22).

In particular, there are several reports of crepuscular activity in *V. glebopalma*. Christian (1977. Victoria Herpetol. Soc. Newsl. 6:11–13) suggested that *V. glebopalma* does most of its foraging during the first couple of hours after sunset. Wilson and Knowles (1988. Australia's Reptiles: A Photographic Reference to the Terrestrial Reptiles of Australia. Cornstalk, Pymbie. 447 pp.) stated that "although active by day, it is commonly crepuscular and can often be disturbed foraging just after sundown." Two individuals were spotlighted active at night between 1900 and 2100 h by Shea et al (1988. West. Austral. Herpetofauna 18:16), and Valentic (1994. South Austral. Herpetol. Group Newsl. 87:11) observed an individual active in twilight period (1830–1900 h) catching and swallowing prey. It was thus surprising that the only quantitative study on *V. glebopalma* resulted in a lack of nocturnal behavior. In a radio-telemetry study of the spatial ecology of *V. glebopalma*, Sweet (1999. Mertensiella 2:317–366) failed to record any crepuscular or nocturnal activity other than specimens that had been disturbed after dark, despite considerable effort to support previous accounts. Sweet concluded that previous observations of nocturnal/crepuscular activity were a result of the animal being disturbed by the observer. It is only through the continual documentation of observations that we can fully understand the apparent disparity between these findings. This note presents two further observations of nocturnal activity from *V. glebopalma* in tropical northwestern Australia.

At 2300 h on 6 May 2012, an adult male *V. glebopalma* (SVL 253 mm, TL 751 mm) was observed moving across a large flat rock approximately 0.5 m in height and through a clump of spinifex grass. The animal continued to move for another 8 m across another flat section of rock where it was captured. At the time of the observation, there was a full moon and little to no cloud cover. Although the surrounding area was being burned by a small, slow moving fire, the nearest fire front was 300 m from the animal's location. However, it is possible that the animal detected the fire through olfaction from its roost. In a second observation, while spotlighting at approximately 1950 h 28 June 2012, a frog's alarm call drew the attention of observers to a rocky area on the side of a sandstone gorge. Upon closer inspection a *V. glebopalma* was observed for 15 minutes feeding on a frog (unidentified *Litoria* sp.). When observers moved closer to confirm the species of frog, the animal became wary and swallowed the frog prior to retreating into a hole among fallen rocks and boulders. A short search failed to relocate the animal. The temperature at the time of observation was 19.5°C. Sunset that night occurred at 1722 h, and there was a half moon.

Our observations provide further evidence that *V. glebopalma* may forage nocturnally. The lack of crepuscular and nocturnal behavior in Sweet's (*op. cit.*) study may reflect population and/or seasonal variation. Alternatively, observations of nocturnal activity in the species may reflect lizards that were flushed from their roost sites by potential predators (S. Sweet, pers. comm.). However, the growing number of observations suggests that nocturnal behavior occurs in some populations. Interestingly, Sweet (*op. cit.*) noted that *V. glebopalma* adopts a sit and wait, or ambush, foraging strategy that may be unique to monitor lizards. This strategy may allow *V. glebopalma* to forage during low light

conditions. Investigations into the eye structure of *V. glebopalma* should be undertaken to test for any differences between this and other species of monitor lizards.

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SQUAMATA — SNAKES

***CHILOMENISCUS STRAMINEUS* (Variable Sandsnake). ENDOPARASITES.** *Chilomeniscus stramineus* occurs in two disjunct populations. The eastern population ranges from southwestern Arizona, south through western Sonora, Mexico to northern Sinaloa, Mexico; the western population is restricted to Baja California (Grismer 2002. Amphibians and Reptiles of Baja California Including its Pacific Islands and the Islands in the Sea of Cortés. Univ. Calif. Press, Berkeley. 399 pp.). To our knowledge there are no helminths reported from *C. stramineus*. The purpose of this note is to establish the initial helminth list for *C. stramineus* as part of an ongoing survey of the helminths of reptiles from Baja California.

The coelomic cavity of one male *C. stramineus* (SVL = 203 mm) collected at 24 km S Loreto (26.0167°N, 111.3500°W, datum: WGS84), Baja California Sur, Mexico in January 1974 and deposited in the herpetology collection of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California, USA as LACM 138142 was examined. Two oval shaped whitish endoparasites ca. 2 mm in length, found in the body cavity, were studied under a dissecting microscope. Based on body shape, pseudoannulation, and hook root morphology, the parasites were identified as an oligacanthorhynchid acanthocephalan cystacanth. It was deposited in the United States National Parasite Collection, Beltsville, Maryland, USA as USNPC 106939. Acanthocephalans require an arthropod intermediate host in which the cystacanth develops (Kennedy 2006. Ecology of the Acanthocephala. Cambridge Univ. Press, Cambridge, UK. 249 pp.). *Chlomeniscus stramineus* likely become infected with cystacanths when feeding on infected insects (Grismer, *op. cit.*). Because development beyond the cystacanth does not occur, snakes likely serve as paratenic (= transport) hosts. *Chlomeniscus stramineus* represents a new host record for oligacanthorhynchid acanthocephalan cystacanths.

We thank Greg Pauly (LACM) for permission to examine *C. stramineus*.

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***CROTALUS ADAMANTEUS* (Eastern Diamondback Rattlesnake). ANTI-PREDATOR BEHAVIOR.** Snakes exhibit a variety of defensive behaviors when confronted with potential predators. Among rattlesnakes, the most common defensive behaviors include fleeing, coiling, head hiding, body bridging, body flattening, hissing, tongue-flicking, discharging scent gland secretions, vibrating the tail (rattle), and striking (Klauber 1972. Rattlesnakes: Their Habits, Life Histories, and Influence on Mankind. Univ. California Press, Berkeley. 1533 pp.; Weldon and Burghardt 1979. J. Chem. Ecol. 5:141–151). Although primarily terrestrial, rattlesnakes are adept swimmers and will enter water readily in order to pursue food, mates and refuge, and to escape harassment or danger (Klauber, *op. cit.*). While defensive/anti-predator behaviors of most rattlesnakes have been well-described (Klauber, *op. cit.*), few if any reports exist regarding anti-predator behavior of rattlesnakes while in water. Here we describe anti-predator behavior exhibited by *C. adamanteus* while swimming.

On 28 December 2003 at approximately 1200 h, we observed an adult (Total Length [TL] ca. 150 cm) *C. adamanteus* swimming across a small lake (25.40005°N, 80.65630°W, datum: WGS84) on Long Pine Key in Everglades National Park, Florida, USA. The snake was swimming along the shoreline approximately 30 m from land with its head elevated and majority of its body, though not the tip of its tail, visible above the water's surface. As the snake continued swimming, it passed an adult (TL ca. 210 cm) *Alligator mississippiensis* (American Alligator) in shallow water along the shoreline. The alligator turned and rapidly began to pursue the snake from directly behind. When the alligator was within approximately 2.5 m of the snake, the snake suddenly stopped swimming and raised the tip of its tail out of the water. The alligator, at this point approximately 1 m from the snake, abruptly stopped swimming and ceased moving towards the snake. Due to a strong breeze and moderate wave action, we were unable to discern if the snake vibrated its tail (and rattle). After approximately 15 sec, the rattlesnake lowered its tail and resumed swimming towards the shoreline. The alligator allowed the snake to open up a distance of approximately 5 m between them before slowly resuming pursuit. However, within approximately 1 min the snake reached the shore and crawled into the adjacent pine forest.

It is unclear what component of the rattlesnake's behavior deterred the alligator from attacking. Rattlesnakes, like many snakes when threatened, discharge scent gland secretions from the cloaca and multiple reports contend that alligators can distinguish between venomous and non-venomous snakes, presumably by chemical cues (McIlhenny 1935. The Alligator's Life History. Ten Speed Press, Berkeley, California. 117 pp.; Neill 1971. Last of the Ruling Reptiles. Columbia Univ. Press, New York. 486 pp.). However, controlled laboratory studies with captive alligators and snakes failed to corroborate this suggestion (Weldon and McNease 1991. Herpetologica 47:403–406). Whether the raised tail of the rattlesnake resulted in a chemical (scent gland secretion), auditory (vibrating rattle), or visual (tail color) cue remains unknown, but the behavior clearly appeared to be a deliberate and effective warning display.

In addition to the observed defensive behavior by the rattlesnake, to our knowledge this is also the first report of attempted predation by *A. mississippiensis* on *C. adamanteus* in the wild. Given that these two species are often sympatric, encounters between these animals are likely not uncommon.

We thank Allan Woodward and Paul Moler for sharing their knowledge of rattlesnake and alligator interactions in Florida.

The findings and conclusions in this note are those of the authors and do not necessarily represent the views of the U.S. Fish and Wildlife Service.

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***CROTALUS ATROX* × *CROTALUS HORRIDUS* (Western Diamond-backed Rattlesnake × Timber Rattlesnake). NATURAL HYBRID.** Hybridization in rattlesnakes has been unequivocally demonstrated in captivity as a result of intentional or unintentional breeding (Klauber 1972. Rattlesnakes: Their Habits, Life Histories, and Influence on Mankind. Univ. California Press, Berkeley. x + 1533 pp.; Rubio 1998. Rattlesnake: Portrait of a Predator. Smithsonian Press, Washington. 240 pp.). In nature, however, documentation of putative hybrid rattlesnakes is scant and ascertained primarily by way of morphological characters (e.g., Campbell et al. 1989. Herpetologica 45:344–349); molecular methods (allozymes, mtDNA, msats) are rarely used (e.g., Murphy and Crabtree 1988. Herpetologica 44:119–123; Gerard et al. 2011. BMC Evol. Biol. 11:291; see Campbell and Lamar 2004. Venomous Reptiles of the Western Hemisphere. Cornell Univ. Press, Ithaca, New York. 870 pp.). Here, using the mtDNA genes ATPase 8 and ATPase 6 as markers and assessing scalation and color pattern, we report on a subject that we suspect to be a natural hybrid of *Crotalus atrox* × *Crotalus horridus*.

On 2 May 2007 a large (~ 1 m total length) rattlesnake was found coiled on a trail 4.8 km N of the town of Blue, 64 km NE of Austin, Lee Co., Texas, USA. The area is categorized as Post Oak Savannah but the immediate landscape that surrounds this property is disturbed and largely agricultural. Using the methods described in Douglas et al. (2006. Mol. Ecol. 15:3353–3374), we obtained DNA from a sample of shed skin. A comparative analysis of the sequence information (ATPase 8 and 6) obtained from the hybrid to a pre-existing phylogeny of rattlesnakes and other North American pitvipers (M. E. Douglas et al., unpubl. data) revealed that the haplotype was that of *C. horridus*. Thus, owing to matrilineal inheritance of mtDNA, we assigned the hybrid's mother to be *C. horridus*. The overall appearance of the subject appears intermediate to that of the putative parents (Fig. 1A). The paired parietal marking, post-ocular stripe, and mottled venter pattern (not visible) are *C. horridus*-like, whereas the broad dorsal blotches and black and white rings on the tail are *C. atrox*-like.

To our knowledge, this is the second record of natural hybridization between *C. atrox* and *C. horridus*. Meik et al. (2008. Southwest. Nat. 53:196–200), using morphological characters (e.g., scales, color pattern), provided robust evidence for hybridization between *C. atrox* and *C. horridus* in a subadult (SVL = 667) female subject collected 50 km W of Denton, in Wise Co., Texas (University of Texas at Arlington [UTA] R-52942; Fig. 1B). This specimen bears a striking resemblance to the hybrid reported here (Fig. 1A). Our analysis of scalation and color pattern of the present hybrid essentially mirrors the results of Meik et al. (*op. cit.*). However, in our analysis of interoculabials we followed the definition provided by Klauber (*op. cit.*), which includes counting a subocular and a supralabial. Our count for interoculabials was 5-5 (both sides of the head). Using this definition, the hybrid described in Meik et al. (2008, *op. cit.*) is 5-5 rather than 3 (i.e., 3-3) as reported (J. Meik, pers. comm.).



FIG. 1. A) The adult male hybrid (*Crotalus atrox* × *C. horridus*) from Lee Co., Texas. B) The subadult female hybrid (*C. atrox* × *C. horridus*) described by Meik et al. (*op. cit.*) from Wise Co., Texas.

COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND

We thank Hugh Brown for alerting us to the snake we report here. Margie Crisp helped with care and assisted in obtaining photographs of the hybrid. Louis Porras helped to measure scales. Jesse Meik and Carl Franklin discussed hybridization in rattlesnakes, and they allowed us to use their image of the hybrid rattlesnake (*C. atrox* × *C. horridus*) discussed in their 2008 publication. Ryan Sawby kindly prepared the digital image for publication.

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***DROMICODRYAS BERNIERI* (Bernier's Striped Snake). DIET.** Few studies have investigated the ecology of Madagascar's more common diurnal colubrid snake species (Glaw and Vences 2007. A Field Guide to the Amphibians and Reptiles of Madagascar. 3rd ed. Vences & Glaw, Köln. 496 pp.; Kaloloha et al. 2011. Herpetol. Notes 4:397–402). *Dromicodryas bernieri* has only been documented preying upon saurian prey and is assumed to be strictly saurophagous (Cadle 2003. *In* Goodman and Benstead [eds.],



FIG. 1. *Dromicodryas bernieri* consuming an adult *Boophis doulioti* in Mariarano, northwest Madagascar.



PHOTO BY ADRIÁN VILLEGAS NIETO

FIG. 1. *Drymarchon melanurus* attempting to prey on a *Spilotes pullatus* in Tamaulipas, México.

The Natural History of Madagascar, pp. 997–1004. Univ. Chicago Press, Chicago and London); Gehring 2006. Zeitschrift des Kölner Zoo - Heft 49:127–141). Here we report on the predation of an amphibian by a *D. bernieri*.

On 2 August 2011, at 1130 h, at the edge of the main thoroughfare in Mariarano Village, North West Madagascar (15.44878°S, 46.69146°E, datum: WGS84) we encountered a *D. bernieri* with an adult frog, *Boophis doulioti*, that it had seized and partially ingested, head first (Fig. 1). For approximately 3 min we observed the snake attempting to consume the frog; however, our presence seemed to distract the snake and it moved further into the undergrowth with its amphibian prey in its mouth. Considering that *B. doulioti* is locally abundant in this area, even during the long dry season, it is reasonable to assume that this predation event is not unique and that this amphibian forms a regular part of the diet of *D. bernieri* at this location.

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***DRYMARCHON MELANURUS* (Central American Indigo Snake). DIET.** *Drymarchon melanurus* is known to feed on a wide variety of prey, including small mammals, frogs, fish, hatchling turtles, birds, and snakes (Irwin et al. 2003. J. Kansas Herpetol. 7:13–18; Stevenson et al. 2010. Southwest. Nat. 9:1–18). On 5 October 2011, at about 1430 h, AVN found an adult *D. melanurus* near the CIE (Centro Interpretativo Ecológico) inside the Biosphere Reserve of "El Cielo" (23.88555°N, 99.16861°W, datum WGS84; elev. 360 m), municipality of Gómez Farías, state of Tamaulipas, México. The snake was in the process of feeding on an adult *Spilotes pullatus* (Fig. 1). After an hour, the *D. melanurus* had ingested half of the prey and subsequently it crawled under a rock with the prey in its mouth. When checked 2 h later, the prey was found, regurgitated and abandoned by the predator. To our knowledge this represents the first record of *D. melanurus* preying on *S. pullatus*.

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***CHILABOTHRUS* (=*EPICRATES*) *CHRYSOGASTER CHRYSOGASTER* (Turks Island Boa). CLIMBING BEHAVIOR.** *Chilabothrus* (=*Epicrates*) *chrysogaster chrysogaster* is considered to be a rare example of an active terrestrial foraging boid (Reynolds and Gerber 2012. J. Herpetol. 46:578–586). Out of over 350 observations of active boas on Big Ambergris Cay, Turks and Caicos



FIG. 1. *Chilabothrus chrysogaster chrysogaster* demonstrating rarely documented climbing behavior.

Islands, British West Indies, only two individuals were found active off of the ground (Reynolds and Gerber, *op. cit.*). It is thought that juveniles of this species, like others of the genus, might be largely arboreal, though this has not been conclusively demonstrated (Reynolds and Gerber, *op. cit.*). While Big Ambergris Cay is mostly scrub and coppice, some arboreal habitat does exist, though boas have never been found higher than 2 m off the ground (Reynolds and Gerber, *op. cit.*). However, on larger islands in the Turks and Caicos such as North and Middle Caicos, remnant tropical dry forest and pine barrens exist, which provide a great deal of arboreal habitat.

On 12 October 2012, BNM observed a previously unobserved climbing behavior in this species on Pine Cay, Turks and Caicos Islands (Fig. 1). The individual (SVL ca. 1000 mm; likely female) was climbing a telephone pole located along a road in secondary tropical dry forest habitat with a canopy height of ~7 m. The individual was using a stereotyped version of concertina locomotion often associated with other snake species, such as rat snakes (genus *Pantherophis*) and boa constrictors (*Boa constrictor*). The motion consists of lateral undulation against a scaffold (Jayne and Herrmann 2011. J. Exp. Biol. 214:2189–2201). This represents a rare observation of climbing in this species, and suggests that individuals employ a similar strategy to other frequent climbers such as rat snakes and boa constrictors.

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***HEMACHATUS HAEMACHATUS* (Rinkhals). DIET / CANNIBALISM.** Although African elapids are well known to be ophiophagous (FitzSimons 1962. Snakes of Southern Africa. Purnell and Sons Ltd., Johannesburg. 423 pp.) and may consume congeners (Shine et al. 2007. J. Zool. 272:183–193), only one species is known to be cannibalistic (*Naja nivea;* FitzSimons, *op. cit.*). On 10 December 2012 on the farm Ryswick (27.9009°S, 029.2107°E, datum WGS84; elev. 1790 m) in the district of Harrismith of the Free State province, South Africa, I collected an adult male *Hemachatus haemachatus* that had been shot by the landowner. Upon dissection, the snake (SVL = 877 mm; tail length = 200 mm; mass = 661 g) was found to have consumed a smaller female conspecific (SVL = 509 mm, tail length = 118 mm, mass = 105.95 g). The adult male had also recently consumed three toads (*Amietophrynus* sp.; mass = 130.08 g), while a single partially digested toad was found in the digestive tract of the female (*Amietophrynus* sp.; mass = 11.04 g). I thank Graham Alexander for assisting with snake dissection and manuscript preparation.

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***HETERODON PLATIRHINOS* (Eastern Hog-nosed Snake). DIET.** *Heterodon platirhinos* primarily feeds upon amphibians, but it has been reported to eat reptiles, mammals, birds, fishes, and invertebrates (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Books, Washington, D.C. 668 pp.). The only reports of avian consumption were an unidentified bird (Surface 1906. Bull. Pennsylvania State Dept. Agric. Div. Zool. 4:113–208.) and a nestling sparrow (Conant 1938. Am. Midl. Nat. 20:1–200.). Here, we report predation upon an adult Northern Mockingbird (*Mimus polyglottos*) by a female *H. platirhinos* (SVL = 658 mm) from 5.3 km S of Howey-in-the-Hills, Lake Co., Florida, USA. When captured in June 2004, the snake's body was distended by a large prey item. In captivity, the snake died two days after regurgitating the partially digested bird. Both the snake and bird are deposited in the Florida Museum of Natural History (UF 169545).

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***HETERODON PLATIRHINOS* (Eastern Hog-nosed Snake). REPRODUCTION.** There is a lack of consensus regarding the oviposition frequency of *Heterodon platirhinos. Heterodon* spp. have been described as laying eggs every other year or less frequently (Greene 1997. Snakes: The Evolution of Mystery in Nature. Univ. California Press, Berkeley. 365 pp.). In South Carolina, the small proportion of mature female *H. platirhinos* bearing oviducal eggs suggests that annual oviposition is uncommon (Smith 1976. Ecology 57:252–264), whereas body mass data in Kansas has been interpreted to suggest that mature females oviposit annually (Platt 1969. Univ. Kansas Publ., Mus. Nat. Hist. 18[4]:253–420). Moreover, observations of captive *H. platirhinos* producing two clutches in the same breeding season (Wenzel 1990. Bull. Chicago Herpetol. Soc. 25:86) suggest that this trait is plastic and may be influenced by resource availability.

We radiotracked 17 adult *H. platirhinos* (10 females, 7 males) between April 2009 and November 2011 at Cape Cod National Seashore, Barnstable Co., Massachusetts, USA. The study area was located at the northern terminus of the Cape Cod peninsula in an approximately 1800 ha early-successional sand dune landscape. Snakes were relocated approximately once every three days from May–August and less frequently during the early spring and fall. When not observed directly, oviposition was inferred by measuring body mass. Females oviposited from mid-June to mid-July (Table 1). Of the seven females successfully radiotracked during the nesting season, six deposited eggs. Four of these were successfully radiotracked in consecutive years and all

TABLE 1. Summary of *Heterodon platirhinos* oviposition events from Cape Cod National Seashore, Massachusetts, USA, 2009–2011. Asterisk (*) indicates that snake was observed actively depositing eggs.

Snake ID	SVL	Year	Pre-oviposition body mass (g)	RCM (%)	Oviposition date	Hatch date
D	685	2009	370	47.8	08–12 Jul	-
H	610	2009	308	34.4	11–15 Jul	-
F	580	2009	-	-	11 Jul*	-
D	685	2010	415	42.9	22 Jun*	14–16 Aug
H	610	2010	382	37.7	22–24 Jun	-
K	780	2010	541	44.7	22–24 Jun	-
L	585	2010	245	41.6	07 Jul*	01 Sep
N	520	2010	198	52.0	22–27 Jun	-
K	780	2011	-	-	22–23 Jun*	-
N	520	2011	-	-	29–30 Jun*	-
Mean		-	-	43.0	-	-
(SE)		-	-	(2.2)	-	-

four deposited eggs in both years. Moreover, we observed well-developed eggs in the oviducts of an eighth radiotracked female that was predated on 01 July 2009. Thus, during this three-year period there were 12 cases where it was possible to determine if the females we were tracking produced a clutch of eggs and/or oviposited. In 11 of 12 instances (~92%) they did so, indicating that at our study site, a high proportion of mature female *H. platirhinos* oviposit annually. Although it may seem surprising to document annual reproduction near the northern extent of this species' range, moderate coastal temperatures, which appear to extend the activity season relative to other *H. platirhinos* sites at similar latitudes, combined with a locally abundant prey base (*Anaxyrus fowleri* and *Scaphiopus holbrookii*) may explain the high oviposition frequency at our study site. The mean relative clutch mass (RCM) for *H. platirhinos* in our study (mean = 0.430, SE = 0.022, N = 7 events) is similar to that reported by Seigel and Fitch (1984 Oecologia 61:293–301; mean RCM = 0.439).

Work was carried out under scientific collecting permit #017.10SCRA issued by the Massachusetts Division of Fisheries and Wildlife and scientific research and collecting permits #CACO-2011-SCI-0005 and #CACO-2011-SCI-0018 issued by the National Park Service. Work was approved by the Institutional Animal Care and Use Committee of Montclair State University (Ref #2009-01).

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***LACHESIS MUTA* (Surucucu, Atlantic Forest Bushmaster). PARASITISM.** Snakes are parasitized by a wide variety of helminths, mainly nematodes (Silva et al. 2001. Rev. Brasil. Parasitol. Veterinaria 10:91–93). *Lachesis muta* is a tropical rainforest species and the largest viperid of the Americas. Herein we report the nematodes found in a *L. muta* from an Atlantic Forest population in northeastern Brazil.

At 1840 h on 5 August 2012 at the Natural Heritage Reserve (RPPN) Pedra D'Antas, State of Pernambuco (8.69339°S, 35.85824°W, datum SAD 69; elev. 584 m) we found a dead female *L. muta* (total length = 104 cm; Fig. 1A). The snake was underweight with visible vertebral columns. During a necropsy we found one male (30.35 mm) and three female (too damaged to measure) *Hastospiculum onchocercum* in the coelomatic cavity (Fig. 1B). The snake is housed in the Herpetological Collection of the Universidade Regional do Cariri (URCA-H 4184). Nematodes are housed in the Parasitological Collection of the Universidade Regional do Cariri (URCA-P 362). Although *Hastospiculum* has been found in the coelomatic cavity of snakes and lizards throughout Central and South America, this is the first record of *H. onchocercum* parasitizing *L. muta*.



PHOTO BY IGOR. J. ROBERTO

FIG. 1. A) Dead female *Lachesis muta* from Atlantic Forest in the Pernambuco state, northeastern Brazil; B) the coelomatic cavity of the snake.

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***LAMPROPELTIS SPLENDIDA* (Desert Kingsnake). DIET.** *Lampropeltis splendida* consumes other snakes, including those within the genus *Thamnophis* (Werler and Dixon. 2000. Texas Snakes: Identification, Distribution, and Natural History. Univ. Texas Press, Austin. 437 pp.; Ernst and Ernst. 2003. Snakes of the United States and Canada. Smithsonian Institution Press, Washington D. C., 668 pp.; Lemos-Espinal and Smith 2007. Anfibios y Reptiles del Estado de Chihuahua, México. UNAM, Tlalnepantla, México. 613 pp.). *Thamnophis marcianus* is also consumed by snakes within the genus *Lampropeltis* (Ernst and Ernst 2003, *op. cit.*); however, species-specific observations are lacking. We herein present the first confirmed record of *L. splendida* feeding on *T. marcianus*.

On 15 September 2012 at 1419 h a female *L. splendida* (SVL = 660 mm; tail length = 102 mm; 111 g) was found crossing a dirt road in the Municipality of Chihuahua, Chihuahua, Mexico (28.675959°N, 105.964771°W, datum WGS84; elev. 1368 m). Following capture, the snake regurgitated a female *T. marcianus* (SVL = 485 mm, tail length =124 mm, 86 g) that had been swallowed head-first. The *L. splendida* was released but the *T. marcianus* was deposited in the Herpetological Collection, Universidad Autónoma de Aguascalientes (UAA-CV-0353).

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***LEPTODEIRA ANNULATA* (Banded Cat-eyed Snake). DIET.** *Leptodeira annulata* is a nocturnal semi-arboreal colubrid snake that inhabits forested areas in the cerrado, pantanal, caatinga, and rain forest regions of Brazil (Freitas 2003. Serpentes Brasileiras. Malha de Sapo Publicações, Lauro de Freitas-BA. 160 pp). It is usually found near water bodies and feeds primarily on amphibians, with occasional records of small lizards and other snakes in its diet (Cantor and Pizzatto 2008. Herpetol. Rev. 39:462–463). Here we report the first record of a *L. annulata* preying on *Crossodactylus bokermanni*, a frog species endemic

to the Serra do Espinhaço, Minas Gerais, Brazil (Leite et al. 2008. Megadiversidade 4:162).

On 11 February 2012, a *L. annulata* was collected and deposited in Coleção Herpetológica da Universidade Federal de Minas Gerais (UFMG 1022; female; SVL = 290 mm) that had consumed a *C. bokermanni* (UFMG 11303; SVL = 32 mm) in the Municipality of Itacambira, Minas Gerais, Brazil (17.014133°S, 43.3056166°W, WGS 84; elev. 1020 m). *Leptodeira annulata* is known to prey on bufonid, hylid, and leptodactylid frogs (Cantor and Pizzatto, *op. cit.*); however, this is the first predation record on a hylodid species. The observation is also interesting because *L. annulata* is considered nocturnal, while *C. bokermanni* is diurnal (Wachlevski 2007. J. Nat. Hist. 42:1422). This suggests that *L. annulata* may capture *C. bokermanni* while the frogs are in nocturnal refugia.

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***LIASIS OLIVACEUS BARRONI* (Pilbara Olive Python). DIET.** Although the diet of most Australian pythons is relatively well documented, the diet of *Liasis olivaceus barroni* remains poorly known. *Liasis olivaceus* is a highly opportunistic predator that is generally associated with aquatic habitats. Shine and Slip (1990. Herpetologica 46:283–290) characterized the diet of *L. olivaceus* as approximately 26% reptilian, 26% avian, and 48% mammalian prey, but their study did not include individuals of the Pilbara subspecies. The diet of *L. o. barroni* is not well understood apart from few records and observations that include "waterbird species" including "ducks," "pigeons" including *Geophaps plumifera* (Spinifex Pigeon), *Petrogale rothschildi* (Rothschild's Rock-wallaby), small Euros (*Macropus robustus*), captive birds such as *Melopsittacus undulates* (Budgerigar) and finch species (Barker and Barker 1994. Pythons of the World. Vol. 1. Australia. Advanced Vivarium Systems, Lakeside, California 171 pp.; Pearson 2006. Landscope 19:32–39; Pearson 2007. *In* Swan [ed.], Keeping and Breeding Australian Pythons, pp. 174–181. Mike Swan Herp Books, Australia).

During August 2010, a road-killed *L. o. barroni* (total length = 2.8 m; ca. 7 kg) was found next to a large permanent water body near Tom Price, Western Australia. Dissection revealed two previously unknown prey items: a sub-adult *Egretta novaehollandiae* (White-faced Heron; ca. 50 cm in height) and an adult *Chenonetta jubata* (Australian Wood Duck). *Liasis o. barroni* has been has been identified as an opportunistic ambush predator, often observed at water's edge in ambush position awaiting prey items. The association between the species and aquatic habitats within the Pilbara region suggest avian fauna, particularly water birds, are a frequent prey items in addition to mammals attracted to water resources.

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***MASTIGODRYAS MELANOLOMUS* (Salmon-bellied Racer). DEFENSIVE BEHAVIOR.** Defensive behavior of snakes is variable and includes biting, death-feigning, tail detachment, and various postures, including distorting head shape to a form similar to that observed among venomous species (Solórzano 2004. Snakes of Costa Rica. Instituto Nacional de Biodiversidad, Heredia, Costa Rica. 792 pp.). Here we describe a novel defensive behavior in *Mastigodryas melanolomus* not previously observed in snakes.



FIG. 1. *Mastigodryas melanolomus* entangled with *Buteo magnirostris* in San Vito de Coto Brus, Puntarenas Province, Costa Rica.

On 28 May 2012, at 0700 h in a coffee plantation in southern Costa Rica (Coto Brus County, 8.7805°N, 82.9602W, datum WGS84; elev. 1200 m), we observed a subadult *M. melanolomus* entangled with a *Buteo magnirostris* (Roadside Hawk) on the ground (Fig. 1). We did not observe the start of the engagement, but we assume that the hawk attacked the snake (Stiles and Skutch 2007. Guía de Aves de Costa Rica. Instituto Nacional de Biodiversidad, Heredia, Costa Rica. 572 pp.). The hawk attempted to fly but failed, hopping about 50 cm from its original position. The snake was coiled around the wings and legs of the hawk, constraining its movement and precluding flight. The hawk attempted to fly three times but each attempt failed. After the third attempt, the hawk and snake remained still on the ground for several minutes. The hawk was breathing heavily and seemed without energy. We did not observe the conclusion of the interaction.

Based on previous observations, when *M. melanolomus* is handled by humans it typically coils around one's hands but does not bite; we suspect that this strategy might also be employed for defense against predators when fleeing is not possible. By preventing flight and keeping its head out of range of a hawk's beak and talons, *M. melanomus* may remove a raptor's primary killing mechanisms and exhaust it in a protracted struggle.

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***MICRURUS DIASTEMA* (Variable Coralsnake). DEFENSIVE BEHAVIOR.** An adult *Micrurus diastema* (FLMNH 144690) was collected from a campsite (15.49°N, 88.28°W, datum WGS84; elev. 1325 m) approximately 4 km W of La Fortuna, Dept. Santa Bárbara, Honduras, during the early morning of 2 July 2005. While photographing the live snake, we observed it perform a tail-flattening defensive behavior, a form of self-mimicry called the protean effect (Gehlbach 1972. Forma et Functio 5:311–320;



FIG. 1. *Micrurus diastema* performing the first stages of tail-flattening defensive behavior by elongating its posterior to draw attention.

Roze 1996. Coral Snakes of the Americas: Biology, Identification, and Venoms. Krieger Publishing, Malabar, Florida. xii + 328 pp.). The snake flattened its yellow-banded tail and extended the posterior portion of its body, moving the tail in a manner similar to typical anterior/head movement (erecting the tail while flattening it to appear like a head), while simultaneously tucking its actual yellow-banded head under its body (Fig. 1). This type of defensive behavior has been seen from numerous genera within the Elapidae, including *Micrurus surinamensis* (Roze, *op. cit.*) but this is the first documented case from *M. diastema*. The behavior serves several purposes, including predator distraction (Roze, *op. cit.*).

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***MICRURUS NIGROCINCTUS* (Central American Coralsnake). DIET.** *Micrurus nigrocinctus* is a relatively common semi-fossorial snake that ranges from southern Mexico to northern Colombia; its diet is known to include caecilians, lizards, and snakes (Ray et al. 2012. Herpetol. Rev. 43:148). On 30 November 2012 at 0245 h an adult male *M. nigrocinctus* (SVL = 44.7 cm, total length = 52.0 cm; La MICA Biological Station/Team Snake Panama #2012-210) was found on the entrance road to El Copé, Coclé Province, Republic of Panama, between the communities of Las Tibias and El Copé (08.62343°N, 080.57100°W; datum WGS84). The *M. nigrocinctus* was attempting to feed on a dead female *Erythrolamprus bizona* (SVL = 33.7, total length = 39.0 cm; La MICA Biological Station/Team Snake Panama #2012-211), which was flattened and stuck to the road. When approached and poked with a stick the *M. nigrocinctus* continued to try to ingest the *E. bizona* for approximately 1 min, after which the *E. bizona* was released. This is the first record of *M. nigrocinctus* attempting to feed on a snake within the genus *Erythrolamprus* and of *M. nigrocinctus* attempting to feed on carrion. I thank La MICA Biological Station for logistical support, ANAM for permit (SE/A-22-12) and P. Santana for field assistance.

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***MICRURUS TENER* (Texas Coralsnake). ABERRANT PATTERN.** Here we describe unusual dorsal blotches, or a "target" pattern, appearing on *Micrurus tener*, a species that normally bears a pattern of tri-colored rings. Aberrant pattern variations are occasionally reported in snakes; Bechtel (1995. Reptile and Amphibian Variants: Colors, Patterns, and Scales. Krieger Publ. Co., Malabar, Florida. 224 pp.) reviewed many examples. Strecker (1935. Baylor Univ. Bull. 38:1–69) reported exceptional color patterns in *M. tener* and Gloyd (1938. Herpetologica 1:121–124) reported a bite involving a melanistic specimen. On 6 October 2012 one of us (TW) found an aberrantly colored *M. tener* crossing Chandler Road (30.757137°N, 95.660561°W, datum WGS84; elev. 94 m) in Crabbs Prairie, Walker Co., Texas, USA. The snake (Fig. 1; adult female; 47.6 g), which exhibited scutellation patterns consistent with *M. tener*, was donated to Houston Zoo and accessioned into the live collection (HZI 27381).

The typical black, red, and yellow colors characteristic of the species are present, however, the pattern is far from typical. The head and neck are predominantly yellow, with the black restricted to a mask like pattern around the eyes and connecting through the rostral and adjacent scales. The black nuchal band is reduced to a dorsal blotch, barely in contact with the parietals, the center of which has faint flecks of red and yellow. The ground color of the body is red, with many scales being posteriorly tipped with black, but less so on the lateral scale rows. There are 17 black body "bands" appearing as blotches. Each blotch has the appearance of a target, the first (outer) ring being yellow and



FIG. 1. A) Dorsal view of a *Micrurus tener* exhibiting an aberrant pattern; B) Ventral view showing the tail and portions of the body.

COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND

the second black, with sharply defined edges. The inner rings are red with a yellow center but, with indistinct edges bleed into one another. The venter is nearly uniform red with minute black specks, occurring on a few scales, and some yellow from the dorsal blotches entering onto the extreme lateral edges of some ventrals. The subcaudals are predominantly orange, with a "wash" of red appearing at the medium seams of the divided subcaudals. We thank Houston Zoo, Inc. for consent to report on this unusual specimen.

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***NERODIA FLORIDANA* (Florida Green Watersnake). DIET.** *Nerodia floridana*, North America's largest watersnake, occupies most of Florida, small parts of southern Alabama and Georgia, and a portion of southern South Carolina. Fish and adult frogs have been reported to comprise the bulk of its diet; however, it has also been known to consume salamanders, tadpoles, small turtles, and invertebrates (Ashton and Ashton 1981. Handbook of Reptiles and Amphibians of Florida. Part 1. The Snakes. Windward Publ., Miami, Florida. 176 pp.). Here we report several new diet records for *N. floridana*.

In the course of long-term monitoring of aquatic snake populations on the U.S Department of Energy's Savannah River Site (SRS), Aiken and Barnwell counties, South Carolina, USA, we documented the following diet items from individual *N. floridana* captured in plastic minnow traps: 6 June 2006 (33.286533°N, 81.488019°W, datum WGS84), *Erimyzon sucetta* (Lake Chubsucker); 1 July 2006 (33.255185°N, 81.585210°W), *Lepomis gulosus* (Warmouth) and *Lithobates sphenocephalus* (Southern Leopard Frog); 29 March 2007 (33.161047°N, 81.692606°W), two larval *Ambystoma opacum* (Marbled Salamander); 25 June 2008 (33.161047°N, 81.692606°W), two *Acantharchus pomotis* (Mud Sunfish; total length = 48 and 75 mm). On 2 July 2010, a *N. floridana* (SVL = 534 mm) was collected dead in hoop trap set for turtles at Pond 2 on the SRS (33.255185°N, 81.585210°W). Dissection revealed two crayfish (species not determined). No additional prey were found, indicating this was not a case of secondary ingestion. Crayfish are considered a rare diet item for *Nerodia* spp. and have not been documented in *N. floridana* (Gibbons and Dorcas 2004. North American Watersnakes: a Natural History. Univ. Oklahoma Press, Norman. 438 pp.). Finally, at 2025 h on 18 December 2012, an adult *N. floridana* (SVL = ~ 70 cm) was seen consuming a large *Ameiurus* sp. (bullhead catfish; Fig. 1) at the edge of a wetland in Grassy Waters Preserve (26.816926°N, 80.174894°W), Palm Beach Co., Florida, USA.

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***NERODIA SIPEDON* (Northern Watersnake). DIET.** Although Gibbons and Dorcas (2004. North American Watersnakes: a Natural History. Univ. Oklahoma Press, Norman. 438 pp.) listed eight species of ictalurid catfish that have been reported in the diet of *Nerodia sipedon*, their list did not include *Pylodictis olivaris* (Flathead Catfish). On 4 September 2012, we encountered an adult *N. sipedon* (total length = 95 cm) in the process of swallowing a juvenile *P. olivaris* (total length = 26 cm). They were found in shallow water along the shoreline of Pollander Lake, an Upper Mississippi River backwater, immediately upstream from the spillway that extends from Lock and Dam 5A to the Minnesota shoreline, Winona Co., Minnesota, USA (44.080°N, 91.684°W; datum WGS 84). The snake had swallowed most of the head of the catfish, which was still alive when they were observed. Previously, *P. olivaris* has been found in the diet of three other *Nerodia* species (Gibbons and Dorcas, *op. cit.*; Tyson et al. 2008. Herpetol. Rev. 39:472).

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***PELAMIS PLATURA* (Yellow-bellied Seasnake). REPRODUCTION / MATING BEHAVIOR.** The elapid seasnake *Pelamis platura* has the widest distribution range of any snake, including most of tropical and subtropical Pacific and Indian oceans from Central America to Madagascar. Its reproductive cycle is considered to be continuous throughout the year (Ineich 1988. L'Année Biologique, 4ème sér. 27:93–117) but two birthing peaks have been reported in Costa Rica, one in December and January and another in July and August (Solorzano 2004. Serpientes de Costa Rica. Editorial INBio, Santo Domingo Heredia, Costa Rica. 791 pp.). Solorzano and Sasa (2011. Herpetol. Rev. 42:443–444)



FIG. 1. *Nerodia floridana* consuming an *Ameiurus* sp. (bullhead catfish) at Grassy Waters Preserve, Palm Beach Co., Florida, USA.



PHOTO BY M. DUNE/DORIS.FFESSM.FR

FIG. 1. Copulating *Pelamis platura* observed on 22 January 2012 off Puerto Escondido, Oaxaca, Mexico.

reported the first observation of mating behavior for the species. They observed copulating specimens floating at the sea surface in Costa Rica in August 2009. We here report a second copulation observation (Fig. 1) made in natural conditions off Puerto Escondido (Oaxaca, Mexico) ca. 4 km from the coast (15.60°N, 97.13°W, datum WGS84; 22 January 2012). Copulation occurred just below the water's surface, as in the first observation reported above, and lasted over 15 min; the diver (MD) left before its end. Both snakes moved repeatedly from vertical to horizontal position with their tails intertwined and most often maintained a vertical position. Water temperature was ca. 23°C. This is the second observation of mating behavior in the species and is consistent with a continuous or bimodal mating season in Central America.

We wish to thank the DORIS website (http://doris.ffessm.fr/) that enables information exchange among scientists, biologists, divers, and underwater photographers.

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***PHILODRYAS TRILINEATA* (Argentina Mousehole Snake). DIET.** *Philodryas trilineata* is a large (maximum length = 200 cm) species endemic to the Monte biogeographic region in western Argentina (Giraudo and Scrocchi 2002. Smithson. Herpetol. Inform. Serv. 132:1–53). The diet of *P. trilineata* is known to include birds, mammals, lizards, and other snakes; some individuals are known to hunt domestic fowl or rabbits (Cei 1993. Reptiles del Noroeste, Nordeste y Este de la Argentina. Herpetofauna de las Selvas Subtropicales, Puna y Pampas. Mus. Reg. Sci. Nat. Torino. 945 pp.; Laspiur et al. 2012. Herpetol. Rev. 43:151–152). Rodents are frequently reported as prey, but consistent data about diet of this species are lacking. Here we report the first vouchered case of predation by *P. trilineata* on *Microcavia australis*.

On 12 February 2011, at 1015 h, we collected an adult *P. trilineata* (total length = 1635 mm) near Puerto Madryn city, Chubut, Argentina (42.7894°S, 65.0049°W, datum WGS84; elev. 11 m). During transport to the laboratory, the snake regurgitated a partially digested juvenile *M. australis* (Fig. 1). Based on comparison with *Microcavia* specimens from Chubut (N = 33), we estimate a total length of 130 mm for the prey. The snake and its prey were deposited in the Herpetological Collection LJAMM of Centro Nacional Patagónico (LJAMM-CNP 8236). We thank D. Udrizar Sauthier for *Microcavia* identification and revision of comparative material.



FIG. 1. *Philodryas trilineata* and partially digested adult *Microcavia australis* from Chubut Province, Argentina.

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***PITUOPHIS CATENIFER AFFINIS* (Sonoran Gophersnake). PREDATION.** On 9 October 2012, 1400 h, one of us (ECB) found a juvenile *Pituophis catenifer affinis* (SVL ca. 500 mm) entangled with a *Scolopendra heros* (Giant Centipede; total length ca. 178 mm; photo voucher UAZ 57469-PSV) on a path near the western base of Cathedral Rock near Sedona, Yavapai Co., Arizona, USA (34.886467ºN, 111.801529ºW, datum WGS84; elev. 1524 m). When found, the centipede was wrapped around the posterior two thirds of the snake. The anterior one third of the snake was free, outstretched in an attempt to escape. The animals were disentangled and it became apparent that the centipede was indeed preying upon the snake. The latter exhibited a sizable mid-dorsal wound where the centipede had gnawed through the snake's back. When freed the gophersnake moved slowly away while the centipede rapidly departed.



FIG. 1. *Scolopendra heros* predating a young-of-year *Pituophis catenifer*.

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***PITUOPHIS CATENIFER* (Gophersnake). DIET.** *Pituophis catenifer* is primarily a predator of rodents, but also takes birds, bird eggs, and lizards (Rodriguez-Robles 2002. Biol. J. Linn. Soc. 77:165–183). Here we describe the first confirmed predation by *P. catenifer* on *Dipodomys ingens* (Giant Kangaroo Rat), a federally and state listed (endangered) species. *Pituophis catenifer* have been observed within colonies of *D. ingens*, and use their burrow systems as shelter (Williams and Kilburn 1991. Mammalian Species 377:1–7). On 12 December 2012 a *D. ingens* burrow system in the Carrizo Plain, San Luis Obispo Co., California, USA (35.3081°N, 119.8787°W; elev. 655 m) was being excavated for

preservation purposes. A female *P. catenifer* (SVL = 989 mm; tail length = 144) sheltering within the burrow was inadvertently fatally injured during the excavation process. Upon examining the snake a prey bolus was found and extracted. The prey was determined to be an adult male *D. ingens* based on hind foot length (48.8 mm). Predation on *D. ingens* by *P. catenifer* has long been suspected and our observation provides conclusive evidence. This predation event is also notable both due to the relative size of the prey item (88 adult male Giant Kangaroo Rats at this site averaged 123 g; s.d. ± 12.9) and the time of the year. Although winter days in the Carrizo Plain can afford clear skies and moderate daytime temperatures, offering opportunities for heliothermic temperature regulation, nighttime temperatures frequently fall below 0°C, and prolonged periods of precipitation and cloud cover can occur. The anterior portion of this *D. ingens*, including the head, had been digested, suggesting that the snake had been able to maintain body temperatures sufficient to permit digestion despite the season. We thank M. Huising, M. Hemenez, and B. Windecker for their assistance. SunPower Corporation and NRG Energy provided additional support.

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***PLIOCERCUS ELAPOIDES* (Variegated False Coralsnake). REPRODUCTION / CLUTCH SIZE.** Little information has been published on the reproduction of *Pliocercus elapoides*. However, a clutch of 4–8 eggs (August deposition) is known from northern Guatemala (Köhler 2003. Reptiles of Central America. Herpeton, Verlag Elke Köhler, Offenbach. Germany. 367 pp.; Lee 2000. A Field Guide to the Amphibians and Reptiles of the Maya World, The Lowlands of Mexico, Northern Guatemala, and Belize. Cornell Univ. Press. Ithaca, New York. 402 pp.). The natural history of this uncommon species in Mexico is poorly known.

On 22 April 2010 at 1827 h, we found a female *P. elapoides* (UAA-CV 0355, SVL = 350 mm; tail length = 220 mm) in a montane cloud forest in the Sierra Madre Oriental at Alaquines, San Luis Potosí, México (22.122500°N, 99.504890°W, datum WGS84; elev. 1405 m). On 1 May 2010 at 0100 h (after nine days in captivity) she deposited seven eggs in a depression in the substrate below leaf litter. The eggs averaged 15 mm in length (SE = 0.8164).

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***SPILOTES PULLATUS* (Tiger Ratsnake). DIET.** *Spilotes pullatus* is a diurnal generalist that typically feeds on small rodents, birds, and bird eggs (Hartmann et al. 2009. Pap. Avul. Zool. 49:343–360; Mendonça et al. 2011. Herpetol. Notes 4:425–427). On 11 December 2012, at 2145 h, on the property of Chico Mendes Institute for Biodiversity Conservation, ICMBIO (7.38383°S, 39.3544°W; datum WGS 84) in the Araripe National Forest, State of Ceará, Brazil, we observed an attempted predation by *S. pullatus* on the eggs of *Turdus rufiventris* (Rufous-bellied Thrush). Predation was not successful due to "mobbing" behavior of the adult *T. rufiventris* (Yamamoto and Ades 2002. Rev. Etol. 4:75–94), followed by intense vocalization away from their nest. This is the first record of *S. pullatus* attempting predation on *T. rufiventris*.

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***STORERIA DEKAYI* (Dekay's Brownsnake). SEASONAL ACTIVITY.** The annual activity period of *Storeria dekayi* varies with latitude (Ernst and Ernst. 2003. Snakes of the United States and Canada. Smithsonian Univ. Press, Washington, D.C. 668 pp.). Few data are available for northern populations, but Vogt (1981. Natural History of Amphibians and Reptiles of Wisconsin. Milwaukee Public Museum, Milwaukee. 205 pp.) stated that they emerge in late April and are most often seen in May and October as they cross roads while moving to and from hibernacula. Here I present data on activity of *S. dekayi* from a population on the western side of Pheasant Branch Marsh, Dane Co., Wisconsin, USA (43.110°N, 89.493°W; datum WGS 84; Cochran 1988. Bull. Chicago Herpetol. Soc. 23:69–71).

On most days from mid-1981 to mid-1984, I drove Pheasant Branch Road along the slope of a ground moraine adjacent to marsh and observed *S. dekayi* on the road only during spring and fall (Fig. 1). The only three living individuals were recorded on 2 May, 11 May, and 5 October, consistent with the dates for the 25 dead snakes. Mean first sighting date for 1982–1984 was 26 April

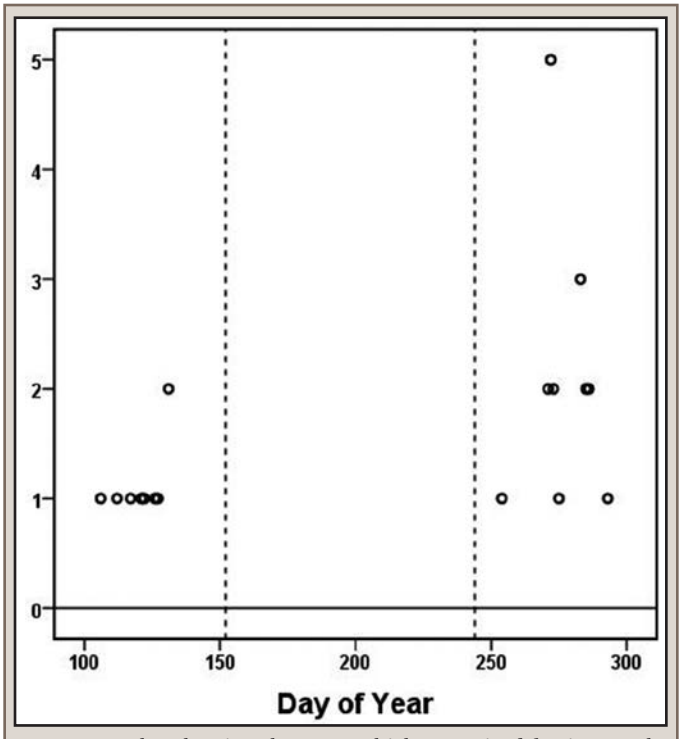


FIG. 1. Dot plot showing dates on which *Storeria dekayi* were observed on Pheasant Branch Road, Dane Co., Wisconsin (N = 25 dead and 3 living snakes). The dashed vertical lines indicate 1 June and 1 September.

(SE = 5.8 d) and mean last date for 1981–1983 was 7 October (SE = 6.6 d). During the same periods, *Thamnophis sirtalis* tended to be found both earlier (mean first date: 18 April; SE = 3.2 d) and later (mean last date: 29 October, SE = 3.3 d), but the difference was significant only for the end of the season (paired-*t* tests: spring – $t = 1.589$, d.f. = 2, $p = 0.253$; fall – $t = 6.803$, d.f. = 2, $p = 0.021$). These observations present a more detailed documentation of general descriptions of activity periods presented in regional field guides (e.g., Vogt, *op. cit.*). Voucher specimens were placed in the University of Wisconsin-Madison Zoology Museum (UWZM 22556, 22594) and the Milwaukee Public Museum (MPM 30266, 33146).

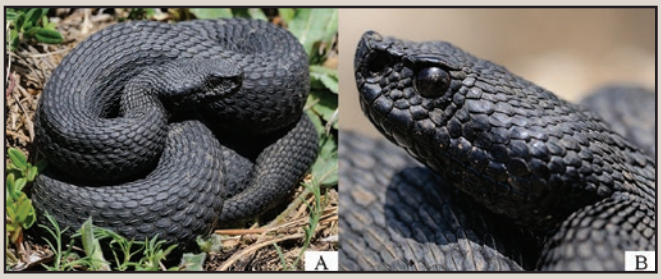
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***THAMNOPHIS SIRTALIS SIRTALIS* (Eastern Gartersnake). HABITAT USE.** Terrestrial snakes typically congregate during colder months in dry, underground refugia; however, some snake species will partially or completely submerge themselves in flooded sites to hibernate (Carpenter 1953. Ecology 34:74–80; Costanzo 1985. Physiol. Zool. 58:682–692). *Thamnophis sirtalis* normally hibernate in terrestrial habitats such as rock piles, debris filled wells, old stumps, rodent burrows, crevices in shale, ant mounds, crayfish and prairie dog burrows (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Books, Washington, DC. 680 pp.). Published accounts of crayfish burrow use by *Thamnophis* spp. indicate either daily refugia use (Dalrymple and Reichenback 1984. Biol. Cons. 30:195–200) or were identified by burrow excavation (Carpenter, *op. cit.*). Few observations have identified either the frequency/seasonality of use or the species of crayfish creating burrows.

During an investigation of *T. s. sirtalis* ecology in Lake Forest, Illinois, USA (42.260°N, 87.883°W; datum WGS84) we observed snakes entering and exiting burrows of an invasive crayfish species, *Cambarus diogenes* (Devil crayfish). On 11 March 2011 three juvenile snakes were observed emerging from a *C. diogenes* burrow and were PIT tagged. The PIT tagged snakes were found again on 6 June and 10 October 2011 at the same site with individuals either partially emerged or basking outside of the burrow. Additional anecdotal evidence of use was presence of silty, clay-like soil on freshly emerged individuals, and high density of individuals surrounding burrows. Our observations are the first confirmation that *T. s. sirtalis* use burrows of *C. diogenes* and indicate that they use these structures throughout the year as refugia.

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***VIPERA ASPIS HUGYI* (Southern Italian Asp). MELANISM.** Melanism, excess of dark pigmentation in the skin, is common in some snakes (Lorioux et al. 2008. Amphibia-Reptilia 29:1–5), resulting from the over-production or dispersion of melanin by melanophores (Sherbrooke et al. 1989. Amer. Mus. Novit. 2943:1–14). In cold environments, dark phenotypes (with low reflectance on the skin) may have a thermoregulatory advantage over lighter phenotypes (Clusella-Trullas et al. 2008. Funct. Ecol. 22:232–238) but are less cryptic and therefore may be more vulnerable to predation (Clusella-Trullas et al. 2007. J. Therm. Biol. 32:235–245).



PHOTOS BY M. R. DI NICOLA

FIG. 1. Melanistic adult female *Vipera aspis hugyi*: whole body (A); close up on the head (B).

Vipera aspis hugyi is endemic to southern Italy and usually treated as subspecies of *Vipera aspis*, although in some studies it has been raised to species rank (Zuffi 2002. Amphibia-Reptilia 23:191–213). Color polymorphism is not accentuated in this subspecies and the pattern usually consists of a broad wavy line, often fragmented in round or oval patches, with a dark outer edge that is often black, and a lighter central area.

On 2 May 2012, around 1020 h, a melanistic adult female *V. aspis hugyi* was encountered basking at the edge of a pine forest at 1300 m elev. in the Sila mountainous plateau, Calabria, Italy. The body was almost completely black except for some small pale dots on the labial scales and a few reddish ventral scales in the terminal part of the tail; the eyes were also very dark, with barely visible reddish pigmentation (Fig. 1). A normally-pigmented adult female *V. aspis hugyi* was found in the same area two days earlier.

Although melanism has been reported for other subspecies of *V. aspis* (Monney et al. 1996. Rev. Suisse Zool. 103:81–100; Naulleau 1973. Bull. Soc. Zool. France 98:595–596) it doesn't seem to have been scientifically recorded for *V. aspis hugyi*, although a photograph of a melanistic specimen was published in Brodmann (1987. Peter Brodmann, Die giftschlanger Europas und die gattung *Vipera* in Africa und Asien, Kummerly+Frey 148 pp.). Thus, this record constitutes only the second published account of melanism in *V. aspis hugyi*. It is unclear whether melanism is rare in *V. aspis hugyi* or if the paucity of records is simply due to insufficient sampling. We thank Johan De Smedt for his advice and Arthur Anker and Marco Colombo for their comments to the manuscript.

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***XENOCHROPHIS MACULATUS* (Spotted Keelback). DIET.** *Xenochrophis maculatus* is a terrestrial and semiaquatic diurnal snake with a distribution restricted to southeastern Asia (Das 2010. A Field Guide to the Reptiles of South-east Asia. New Holland Publishers Ltd., London, U.K. 376 pp.). Along the Lower Pierce Trail in the Central Catchment Nature Reserve, Singapore, at 2217 h on 05 January 2013, we found an adult female *X. maculatus* (SVL = 64.6 cm, tail length = 14.4 cm, 105 g) with an obvious food bolus near its mid-body. The snake was perched 56 cm off the ground on vegetation approximately 3 m from a reservoir edge. The snake died in transport to the laboratory and dissection revealed the prey item as an adult *Limnonectes malesianus* (27.89 g, ~ 36% of the snake's pre-ingestion mass; Fig. 1). Both the *X. maculatus* and *L. malesianus* were deposited in the Raffles Museum of Biodiversity Research (ZRC 2.7000 and ZRC 1.12501, respectively). *Xenochrophis maculatus* is known to prey upon



FIG. 1. *Xenochrophis maculatus* with ingested *Limnonectes malesianus* in Central Catchment Nature Reserve, Singapore.

frogs and fish (David and Vogel 1996. The Snakes of Sumatra: An Annotated Checklist and Key with Natural History Notes. Edition Chimaira, Frankfurt, Germany. 260 pp.); however, we were unable to find any references documenting specific prey or prey size. We thank the National Parks Board of Singapore for issuing us work permit NP/RP11-03-1 and Kelvin K. P. Lim at the Raffles Museum of Biodiversity Research for accessioning specimens.

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***XENOPHOLIS SCALARIS* (Wucherer's Ground Snake). DEFENSIVE BEHAVIOR.** *Xenopholis scalaris* is a dipsadid snake found in leaf litter in humid tropical forests of Bolivia, Brazil, Peru, Ecuador, Colombia, Suriname, and French Guiana (Lehr and Doan 2013. *In* IUCN Red List of Threatened Species, version 2013.1. <www.iucnredlist.org>. Downloaded 5 March 2013). Defensive behavior of this species is relatively unknown. We observed defensive behavior of *X. scalaris* on three occasions in southern Bahia, Brazil. The observations occurred on 1) 17 September 2012 at 2230 h in an area of Atlantic forest at Michelin Ecological Reserve (13.816667°S, 39.133333°W; datum SAD69),



FIG. 1. *Xenopholis scalaris* from southern Bahia, Brazil, exhibiting flattening and head hiding defensive behavior.

Igrapíuna municipality; 2) 3 May 2009 at 1600 h on a trail between a secondary forest and cocoa plantation at RPPN Serra Bonita (15.42387°S; 39.54736°W), Camacan municipality; and 3) 24 February 1992 at the Centro de Pesquisas do Cacau, CEPEC/CEPLAC (14.767492°S; 39.228062°W), Ilhéus municipality. In all observations, the snakes flattened their bodies, hid their heads, and remained motionless for several minutes (Fig. 1). The third observation was of two neonates. Although body flattening behavior has been described for this species (Martins 1996. *In* K. Del Claro [ed.], Anais do XIV Encontro Annual de Etologia, pp. 185–199. Sociedade Brasileira de Etologia, Universidade Federal de Uberlândia, Brazil) this is the first time the head-hiding behavior (Greene 1988. *In* Gans and Huey [eds.], Biology of the Reptilia, pp.1–152. Alan R. Liss, New York) has been noted.

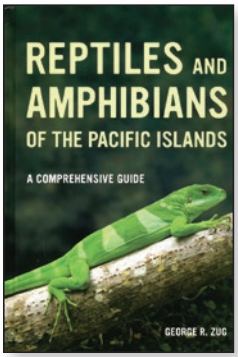
CAIO VINICIUS DE MIRA MENDES, RENAN MANOEL DE OLIVEIRA, DANILO SILVA RUAS, IURI RIBEIRO DIAS, and **ANTÔNIO JORGE SUZART ARGÔLO** (e-mail: ajargolo@gmail.com), Universidade Estadual de Santa Cruz – UESC, Campus Soane Nazaré de Andrade, Rodovia Jorge Amado, Km 16, Bairro Salobrinho, CEP 45662-900, Ilhéus, Bahia, Brazil.

BOOK REVIEWS

Herpetological Review, 2013, 44(4), 700–701.
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Reptiles and Amphibians of the Pacific Islands

George R. Zug. 2013. University of California Press, Berkeley (www.ucpress.edu). x + 306 pp., 35 pls, 5 maps. Hardcover. US $70.00. ISBN 9780520274952 (also available in Softcover and e-Book formats for US $34.95).



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The Pacific Ocean is the world's largest geographic feature, comprising about a third of the globe, but its tropical oceanic islands take up less than 0.05% of the Earth's land surface, a collective area around the size of the U.S. state of West Virginia or the country of Costa Rica. However, these Pacific oceanic islands, most of which are tiny, include well over half the world's island total and are home to a diverse and fascinating herpetofauna.

Organizing the Pacific islands into regions has long vexed geographers. In a highly influential work, de Brosses (1756) coined the term Polynesia, applying it to all the islands of the Pacific. Later, one of the great Pacific explorers, Dumont d'Urville (1832) subdivided the central and south Pacific into three contiguous areas, Polynesia, Micronesia, and Melanesia, based on the physical and cultural attributes of the people. These terms remain in current use but are generally now regarded as somewhat simplistic.

Biogeographers have been less successful in dividing up the Pacific (Kay 1979), and have generally tried to force adjacent islands and island groups into regional assemblages based on faunal or floral relationships. The various proposed schemes remained stubbornly incongruent. In an insightful review, Stoddart (1992) distinguished between different island types, viz., atolls, elevated limestone (*makatea*), and high islands. He produced a scheme, based on the high islands, that remains broadly consistent with the biogeography of various Pacific taxa. He demonstrated for a number of taxa that New Guinea was a major source area for much of the Pacific, with species richness on high islands diminishing with distance from New Guinea (Stoddart 1992). This pattern is very clear in the herpetofauna of the western Pacific (Allison 1993).

George Zug, in his outstanding and highly useful book, takes a very practical but somewhat unusual approach, dividing the Pacific into forty regional areas based on political and geographic criteria. He also includes within his treatment five islands or island groups in the Eastern Pacific, Islas Revillagigedo, Isla del Coco, Isla Malpelo, Clipperton Island, and the Galapagos. While this scheme tends to bring together taxa from very different evolutionary lineages, it helps to put the greater Pacific herpetofauna into a clear regional perspective. Although there are no native species shared between the Eastern and Western Pacific, many of the wide-ranging human commensals, such as the geckos *Hemidactylus frenatus* and *Lepidodactylus lugubris*, now occur in both areas.

Overall, Zug treats a total of 187 taxa. Of these, 151 are native or probably native to some part of the Pacific (i.e., they didn't disperse via human transport), and 35 are introduced. One species of skink, *Carla tutela*, endemic to Halmahera Island west of New Guinea, was once thought to have been introduced to Guam but those populations are genetically similar to *Carla ailanpalai* which is endemic to the Admiralty Archipelago north of New Guinea and may have been introduced to Guam during WWII (Austin et al. 2011).

In his preface Zug makes it clear that his intended readership is "casual to avid naturalists who live on or visit Pacific islands." He also mentions that the book contains much new data and hopes that it will also be useful to professional herpetologists. In both regards he has succeeded admirably.

His introduction, which is barely six pages long, is one of the finest summaries I've ever encountered that puts the Pacific into a historical and regional perspective, starting with the geological history and ending with a discussion of patterns of human settlement.

Although this is a minor point in the context of this book, the introduction mentions Pangaea but not Gondwana. Inasmuch as the geological history of much of the Pacific, particularly the richest areas in the southwest, involved the breakup of Gondwana following its separation from Pangaea, it might have been useful to mention a few general details about that.

I would have also liked to see a bit more about the navigation skills of the Pacific peoples as many of the reptiles that are widespread in the Pacific were transported by humans. It is increasingly clear that the early Polynesians had acquired much more than "elementary navigation skills" and were navigating across vast distances long before European explorers reached the area.

In the next section Zug explains his regionalization scheme for the Pacific, characterizing it as "arbitrary" and includes a checklist of species known to inhabit each of the major islands or island groups. This checklist will assist naturalists in gaining a familiarity with the species known from the various groups. It will also serve as something of a snapshot of current patterns of distribution and diversity. As Zug points out in his preface, molecular studies have shown that a number Pacific species formerly thought to be widespread, are actually complexes of closely related taxa. As more groups are studied this subdivision of species will undoubtedly continue. In addition new species continue to be discovered.

The next section introduces terms used to identify species. I quite liked the fact that Zug explicitly defines what he means

by small, medium, midsize, etc. He gets by with a minimum of jargon. This would certainly not surprise those who know him.

The next 70 pages include 35 color plates, each presented on facing pages, and including virtually all species treated. The quality of the plates varies but generally they are excellent.

Most of the rest of the book, 221 pages, includes detailed accounts of the various species. Each major group, e.g., frogs, is treated in a brief introduction, followed by treatment of each family followed by a detailed, standardized account of each species. Details on the calls of the frogs (all but three of which are introduced) are included under reproduction. The accounts are excellent and include many useful historical and ecological details. Although the book lacks an identification key, I don't think that this is needed given the generally small number of species found in each area and the high quality of the images. In a few cases there are line drawings to facilitate the identification of similar species.

Each species treatment also includes a common name. Zug has generally chosen names that are in widespread use for well-known taxa but has coined many new names for more obscure taxa. These names clearly reflect Zug's overall emphasis on practicality. I was pleased to see that for species of skinks in the genus *Emoia* he dispensed with the use of "emo skink," a name that has somehow crept into the popular literature. Moreover, a quick Google search will quickly confirm that "emo" has many other meanings. Instead Zug focuses on physical features and habitat preferences that are diagnostic and easy for an avid naturalist to remember.

The book concludes with an overall checklist of species, each with a little square "tick" box in front of the scientific name followed by the common name, together with an appendix on the sources of illustrations and indexes to common and scientific names. I think that it would have been useful to also include an index to place names mentioned in the text but this is a minor point.

There do not appear to be any major typographical errors in the book. It is produced to a high standard of quality and is well organized and highly readable. Anyone with an interest in the Pacific, including naturalists, conservation biologists, biogeographers or herpetologists, will find this book indispensable. In my view George Zug has encapsulated a big chunk of his life's work into a masterpiece that should be on everyone's bookshelf.

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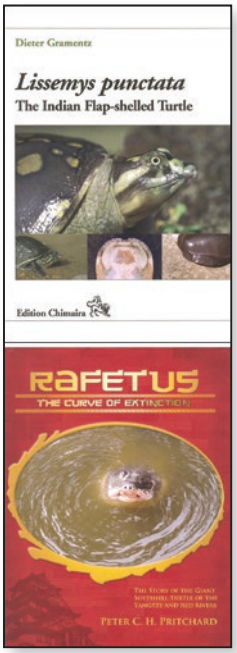
Lissemys punctata, the Indian Flap-shelled Turtle

Dieter Gramentz. 2011. Chimaira Buchhandelsgesellschaft mbH, Frankfurt am Main, Germany (www.chimaira.de). 278 pp. Hardcover. US $79.95 (Zoo Book Sales). ISBN 978-3-89973-496-6.

Rafetus, the Curve of Extinction

Peter C.H. Pritchard. 2012. Living Art Publishing, Ada, Oklahoma (www.livingartpublishing.com). 174 pp. Hardcover. US $69.50. ISBN 978-0-9787556-9-0.

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It is great to see this focused interest in softshelled turtles. The Trionychidae is a family of bizarre reptiles whose members are easily recognized because they are so morphologically distinctive; but otherwise the group may be underappreciated. Each book treats a single species of softshell. These two species are at opposite ends of the softshell turtle spectrum—a small, common, and very terrestrial cyclanorbine and a rare, gigantic, and completely aquatic trionychine. And these volumes are at opposite ends of the spectrum of species treatments. The Gramentz volume strikes me as "Catalogue of American Amphibians and Reptiles account" meets "Biology of the Reptilia." It is a minutely detailed recounting of the extensive literature on a species that was listed on Appendix 1 of CITES in 1975 when it probably should not have been. The Pritchard volume is classic Pritchardian pontification. It has the subtitle, "The Story of the Giant Softshell Turtle of the Yangtze and Red Rivers." A complex story it is; it is a very personal voyage through the author's interactions with *Rafetus swinhoei*, one of those species whose living representatives might just be counted on the fingers of one hand. It was listed by CITES in 2005 (TRAFFIC 2013) when it should have been recognized as endangered at least 50 years ago. Despite the differences between the volumes a great deal of trionychid biology is packed into each one.

The Gramentz volume is a summary and compilation of the surprisingly extensive published literature on what I would argue is the softshell that exhibits the most primitive morphology among living forms. It is astounding that the author identified 346 references that are relevant to understanding the biology of *Lissemys punctata*. It is clear from this work that *Lissemys* is an important model organism for biological research on the Indian subcontinent. In contrast, much of the Pritchard book is a summary of his observations on the very poorly known species, *Rafetus swinhoei*, from the literature, interviews, and observations

made during numerous travels. Pritchard establishes for the first time that it is a truly giant species and he verifies that it is on the brink of extinction. But he goes far afield with chapters on the origin of turtles, a chapter on museums, and a chapter in which he considers candidates for the rarest turtle. Whereas the *Lissemys* volume is tightly organized with an extensive bibliography, the *Rafetus* volume is disorganized, and amazingly, its bibliophile author has not provided a literature cited!

Although I have played a supporting role in understanding the genus *Rafetus* and I have tried to keep up with developments in its conservation, I found the Pritchard volume to be tough to follow at times and then repetitive at others. It would have benefited from a more critical peer review, serious editing, and reorganization. My sense is that it was probably published pretty much as it was first drafted. Furthermore, it is not clear who the target audience is. If it were the scientific and conservation communities, it seems that it would have seen more attention in review and a bibliography would have been added. However, the way it is written it assumes that the reader is familiar with softshell turtle literature, some of which is quite obscure (i.e., Heude 1880).

The *Lissemys* volume will prove valuable to anyone doing comparative biology that involves turtles. As I have said elsewhere (Meylan 1991), it seems unfortunate that the biology of "the turtle" is too frequently based on *Trachemys scripta*. This *Lissemys* volume should prove useful in making more readily accessible the voluminous literature on a very different lineage of cryptodire. The volume also makes it quite clear that *Lissemys* has very interesting biology for a trionychid. It is kinosternid-like in that it is the only living softshell that regularly aestivates on land for a significant portion of the year and it seems to have embryonic diapause so that clutches laid at different times all hatch with the same monsoon rains. The reproductive biology of this species and its control appear to be remarkably well understood.

Although the *Lissemys* volume is better organized and documented, it is the *Rafetus* volume that covers new ground. Pritchard makes the very important work of Heude (1880) available in English for the first time. He lists all of the known specimens of this elusive species including many that he discovered via careful examination of museum collections in China and Vietnam. He establishes its giant size and makes a good argument that the largest turtles, living or extinct, may have been softshells. He identifies the most likely areas where additional living *R. swinhoei* might survive. Also, in covering all aspects of the genus *Rafetus*, he does a reasonable job of summarizing what is known about the smaller species in the genus, *R. euphraticus*, which could also use some serious conservation attention.

In the section in which he argues for *R. swinhoei* being the rarest of all turtles, it becomes clear that collectors of rare turtles are a real problem. It is also clear why this one is so rare, and it fits a pattern that Pritchard buries in his rambling introduction, that big animals are high on the curve of extinction. But you have to be really interested in softshelled turtles to make it through this book. It's not that the author gets off track; it seems that there often is no track. So, I am not sure to whom I could recommend this book beyond turtle aficionados. For biologists and libraries, the *Lissemys* volume is likely to be more useful, if only as a guide back to the original literature which one hopes would be cited in place of this volume in most cases.

It is interesting that *Lissemys* was CITES listed in 1975 but has still served as a model species. It is still harvested in large numbers and undoubtedly has suffered declines throughout its range (what turtle species has not?), but appears to have biological properties that make it resilient. The giant *R. swinhoei*, on the other hand, is dedicated to river channels and oxbows. It may turn up a few more times; but only the most extraordinary measures will prolong the existence of this species. What other large softshells do we need to look at as quickly as possible to determine their true conservation status? The rest of the diversity of the Cyclanorbinae is in Africa and all four taxa are poorly known. The largest of them, *Cyclanorbis elegans*, has apparently become very hard to find. Is it the next *Rafetus*?

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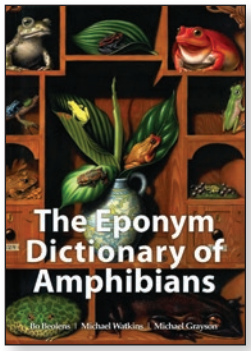
TRAFFIC. 2013. Proposal (A): Inclusion of the following species of the Family Trionychidae in Appendix II: *Aspideretes leithii, Dogania subplana, Nilssonia formosa, Palea steindachneri, Pelodiscus axenaria, P. maackii, P. parviformis, and Rafetus swinhoei* (B): Transfer of the following species from Appendix II to Appendix I*: Chitra chitra* and *Chitra vandijki* www.traffic.org/cites-cop-papers/CoP16_Prop38_Analysis.pdf (accessed 17 August 2013).

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The Eponym Dictionary of Amphibians

Bo Beolens, Michael Watkins, and Michael Grayson. 2013. Pelagic Publishing, Exeter, United Kingdom (www.pelagicpublishing.com). xiii + 244 pp. Hardcover. US $49.99. ISBN 978-1-907807-41-1.

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Scientific names are sources of endless fascination for professionals and amateurs alike: Who was that frog named after? Is that *smithii* named for Malcolm or Hobart? Here are the answers. Beolens et al. here complete the cataloguing of tetrapod eponyms, having previously considered birds (Beolens and Watkins 2003), mammals (Beolens et al. 2009), and reptiles (Beolens et al. 2011).

This is a compact volume of double-columned text. Although it appears sturdy at first glance, the book is not as well produced as the authors' reptile eponym work, although it is also considerably less expensive. The text is not illustrated, but the cover of the book is graced by a striking image entitled *Frog Cabinet* by Madeline von Foerster. It depicts 13 frog species (only five of which have eponymous names) in the cubbies of a cabinet, with two closed drawers meant to represent "all the frog species not yet discovered, and those who might die out before becoming known to us" (p. ii).

As in the reptile volume, a brief introduction explains the "rules" applied in the book. Accounts are provided, in alphabetical order, for those persons who are commemorated by either scientific names or common names (the latter, unfortunately,

based on Frank and Ramus (1995), which coined many arbitrary, incorrectly derived, and inappropriate names). Also included are other nouns that have served as the source of names that might be mistaken as being eponyms. For example, *Hyla andersonii* is named for Anderson, South Carolina and *Psychrophtynella illimani* for Nevado Illimani, a mountain in Bolivia. Not surprisingly, many of the same people have been commemorated in the names of both amphibians and reptiles, thus a good number of biographic entries in this book were also in *The Eponym Dictionary of Reptiles*, some repeated nearly verbatim and others significantly expanded or shortened.

I enjoyed this book and learned a lot from it. However, I found it unsatisfying on two levels. First, the authors' choice of biographic details often seems arbitrary. Authorship of a single publication is often mentioned, but this is as likely to be a minor paper as it is to be the subject's most important and well-known treatise. Examples include Carlo Gené, whose most important herpetological work (Gené 1839), the first treatise of the amphibians and reptiles of Sardinia, is not cited, G. K. Noble, whose influential book *Biology of the Amphibia* (Noble 1931) is not mentioned, J. G. Schneider, none of whose numerous herpetological books are noted, and Ronald Crombie, who is cited as the author of a list of Smithsonian herpetological publications rather than for his original work on the West Indies, the Philippines, or Palau.

One might argue that more comprehensive biographies are warranted for lesser known people, however, it seems a bit unbalanced to allocate only eight lines to Carl Gans, for decades one of the world's leading herpetologists, whereas Philippe Brunneau de Miré and Sir Basil Thomson, both fascinating in their own right, but not herpetological giants, are accorded 36 and 44 lines respectively—among the most extensive entries in the book.

An inherent problem of the style "so-and-so is at such-and-such an institution" is that a retirement or death immediately makes the account seem outdated. Many of those honored by amphibian eponyms have indeed done one or the other since their biographies were written. For example, Hobart Smith, Paolo Vanzolini, Eugenio Izecksohn, and Jorge Jim, all treated as living in the book, have all since passed away, although, to be fair, all but Jim (who died in 2011) were still living when the book went to press. A more difficult to explain and embarrassing mistake is listing Robert Stebbins as having passed away in 2000, 13 years before his actual demise.

A large number (although a small percentage) of the approximately 1600 entries include factual errors of one sort or another. For example, Thomas Bell was not an assistant to J. E. Gray (Adler 1989), Ernst Ahl was never the director of the Berlin Museum (Paepke 2013), Mario Peracca did not visit the Cape Verde Islands (Andreone and Gavetti 2007), and Giacomo Doria was the founder of a museum in Genoa, not Turin (Adler 2012). According to Boelens et al., the Russian scientist Leopold Schrenk "believed that mammoths which he found preserved in the permafrost must have died recently, and thought that they were subterranean animals that ate earth!" (p. 193). In fact, Schrenk (1871), as part of his studies of Siberian mammoths, recorded these as the beliefs of Arctic peoples; they were not his own views.

At least one entry appears to refer to the wrong person. That for Wagner cites Johann Andreas Wagner as the person commemorated in the name *Leptodactylus wagneri* (Peters, 1862); however, Wilhelm Peters, in fact, named this frog for Friedrich Johann Carl Mortiz Wagner (better known as Moritz Wagner), who collected the holotype in Ecuador (Wagner et al. 2012). Boelens et al. (2011) also linked the name of the snake *Diaphorolepis wagneri* Jan, 1863 to Johann Andreas Wagner, but it too was collected by Moritz Wagner. Its description does not indicate the source of the name, but Moritz is again the likely honoree. I caught these errors because I have worked on both the specimens described by Peters and those collected by Moritz Wagner, but I wonder how many other misattributed eponyms I may have missed!

Among contemporary herpetologists, institutions and timelines are sometimes incorrect. For example, Fritz Jürgen Obst was trained in the German Democratic Republic and spent his entire professional career in Dresden (formerly in East Germany), not partly in the west, and Robert C. Drewes has worked at the California Academy of Sciences since 1970, not 1998 as stated by Boelens et al. American university names seem to have been especially confused, as Richard Thomas is stated to have received his doctorate from the University of Louisiana [*sic*, Louisiana State University] and Victor Twitty's undergraduate degree is stated to be from Butler College, Princeton University [it was from Butler University in Indianapolis].

A number of eponyms are noted as having uncertain origin, but at least some are quite easily determined. For example, I was easily able to find the meaning of the specific epithet of *Pseudoeurycea tlilicxitl,* the black-footed salamander, in an online Nauhatl dictionary — not surprisingly it means black foot. Other names of unknown derivation could have perhaps been checked by asking the authors of these names themselves, as was clearly done in the case for some names (e.g., those proposed by Annamarie Ohler that honor members of her family).

Typographical errors are relatively few, e.g., Port Elisabeth [*sic*, Elizabeth] (p. 84) and Alfred Russel Wallace's Brazilian expedition began in 1848 not 1948 (p. 227), but seem to plague accounts of German namesakes: Ein Frauenfahrt urn [*sic*, um] die Welt (p. 101), Ostafrikanischen Insen [*sic*, Inseln], Detley [*sic*, Detlef] Langer (p. 119).

Boelens et al. provide the authors and dates of the Latin names they present. At one level this is helpful, but it would have been more useful if they had followed the convention of placing author and date in parentheses if the specific epithet is not used in conjunction with the generic name with which it was originally paired.

On the positive side, in this book we learn a little about a lot of people, some quite obscure, who have been immortalized in nomenclature. Among some of the more interesting entries are those that reveal that *Allobates algorei* honors former American vice president Al Gore, that *Hyla carnifex* is named after John Lynch (*carnifex* = hangman, to hang unlawfully is to lynch, get it?), and that two African frog names have epithets derived from the name of Charles Lemaire, who may have been the inspiration for the central character of Kurtz in Joseph Conrad's *Heart of Darkness* (although other people have also been proposed as Conrad's model for Kurtz).

On the whole, *The Eponym Dictionary of Amphibians* leaves a lot to be desired. However, it is the only book that does what it does. Relatively detailed biographies of herpetologists may be found in Kraig Adler's *Contributions to the History of Herpetology* series, but no other book provides thumbnail sketches of all those who have had amphibians named after them (including a very large number of non-herpetologists). For those with an interest in the history of herpetology, a curiosity about etymology, or an abiding love of trivia, this book will make an enjoyable read, if not a reliable reference.

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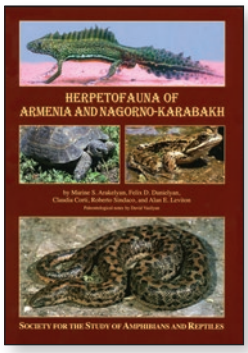
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Herpetofauna of Armenia and Nagorno-Karabakh

Marine S. Arakelyan, Felix D. Danielyan, Claudia Corti, Roberto Sindaco, and Alan E. Leviton. 2011. Society for the Study of Amphibians and Reptiles. Ithaca, New York. iii + 149 pp. Hardcover. US $40.00. ISBN: 978-0-916984-84-7.



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Although the Caucasus Ranges have been designated a biodiversity hotspot, there are no recent reviews of the herpetofauna and literature of Armenia or Nagorno-Karabakh, two of the southernmost republics of that region. Indeed, most people in the West would be hard put to place a finger on them on a map. This slim volume was designed to fill that gap. Nagorno-Karabakh is surrounded by Armenia, apart from its southern border, which abuts Iran. Armenia is also bordered by Iran; it lies between Azerbaijan to the east, Georgia in the north, and Turkey to the west. The history of Nagono-Karabakh is complicated; the current government considers it to be an independent republic, while Armenia and Azerbaijan both claim the territory. It is currently an unsettled dispute. The region has previously been claimed by Persia, the Russian Empire, and the Soviet Union. Internationally, it is considered a province of Azerbaijan, although its ethnic composition is primarily Armenian.

The first four authors accomplished the field work over some two decades; the editing and bibliography reveal the sure hand of Leviton. The book is traditional in its layout, the taxonomic treatment preceded by a discussion of the geography of the region, climate, biodiversity, conservation, and habitats. The authors recognize five zones, based on vegetation types, and five azonal habitats. A table correlates each species with these categories; thus much important information is presented in an economical space. These zones and habitats are described in the text. There are two pages of paleontological notes by David Vasilyan indicating that the modern Armenian herpetofauna dates back at least to the Upper Miocene. For those of us interested in the history of herpetology, there is a section on the history of herpetology of Armenia, similar in structure to those appearing in other SSAR publications.

The heart of the book consists of the taxonomic section, beginning with keys to the herpetofauna, based on easily seen external characters. The major characters are shown in photographs of actual specimens, rather than the more familiar generalized line drawings. Such a presentation has both costs and benefits, but the photographs are clear and show the characters effectively without too much distracting extraneous information. The species accounts each begin with the Latin name and author and an English common name. This is followed by a primary synonymy applying to specimens from Armenia and Nagorno-Karabakh, the type locality, notes on taxonomy, general distribution, distribution in the study area, general information, and a status of conservation statement. Importantly, and rare in taxonomic publications, each species account contains a section listing the references applying to the individual species. Lacking from a taxonomist's point of view, are the museum registry number of the holotype, a citation to the publication of the original description, a diagnosis, and lists of collecting and observation localities. However, these omissions are secondary to the intended purpose of the book, which is an introduction of the fauna and useful to the general reader and to non-herpetology specialists. In any case, the extensive bibliography will lead the interested researcher and collection curator to this and other information.

Following the text, there are 152 figures in 32 excellent color plates showing each species, a distribution map with unnamed and unnumbered spot localities, these followed by ecozone and habitat photographs. The bibliography alone covers 28 pages. It attempts to cover all publications covering the study area, from the earliest literature to that of the year of publication. The format is similar to that used in Leviton and Anderson (2010).

A trivial complaint perhaps, but Table 1 lists six reptile species endemic to Armenia. Endemism has no biological

significance when applied to national boundaries. On the other hand, it may be useful politically in grant proposals for government funds, protecting national fauna, etc.

Those of us who are taxonomists know that taxonomy is a moving target, as generic and species names change all-too-frequently, and common names have never been stabilized as they are for birds. The recognition of family and higher categories also changes, especially frequently today with the advent of phylogenetic and cladistic classifications. This makes the publication of synonymies and bibliographies especially important. This is exemplified by the following quote from the current book:

Bufo variabilis, because it is considered a member of the "*viridis*" complex, was transferred to the new genus *Pseudepidalea* when they established it for the *Bufo viridis* complex (Frost et al. 2006). However, Dubois and Bour (2010.23) argue that this is invalid because, in their view, it creates nomenclatural confusion with respect to the application of the nomen *Bufo*. Thus, they conclude, *Pseudepidalea* must be considered a junior objective synonym of *Bufotes* Rafinesque 1815, a subgenus they include within *Bufo*, and which would include *viridis* and would include all species included in the *Bufo viridis*, complex, or, if treated as a genus, then , e.g. *Bufotes viridis*, *Bufotes variabilis*, et al. (Dubois and Bour 2010:24–25).

Anyone confused yet? In any case, Dubois and Bour (2010) not withstanding, many or most taxonomists have accepted the nomenclature of Frost et al. (2006), if prematurely. This leaves West Asian *Bufo viridis* with an entirely new name, *Pseudipedalea variabilis*, which does not occur in combination in the literature prior to 2006. So much for nomenclatural stability.

This book creates a new template for subsequent similar volumes in local and national taxonomic accounts. It needs a place in all collection libraries and in the hands of field biologists, reserve managers, and others with responsibilities for the fauna of Armenia and/or Nagorno-Karabakh.

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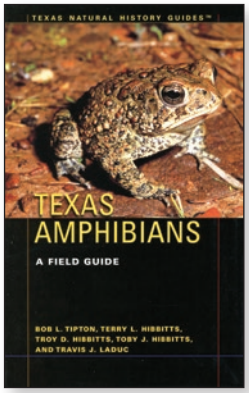
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Texas Amphibians. A Field Guide

Bob L. Tipton, Terry L. Hibbitts, Troy D. Hibbitts, Toby J. Hibbitts, and Travis J. LaDuc. 2012. The University of Texas Press, Austin, Texas (http://utpress.utexas.edu/). xiv + 309 pp. Softcover. US $24.95. ISBN 978-0-292-73735-8.

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For decades, the herpetofauna of Texas captured the attention of both professional and avocational herpetologists. The remarkably diverse herpetological biota of Texas is, at least in part, a reflection of the diversity of biotic provinces that are united geopolitically in that vast state. To judge by the books and monographs that were available historically, especially those readily available to the public, the point of emphasis for Texas herpetology traditionally was centered on the snakes. Among the earliest of the modern volumes on the herpetology of Texas was a pocket field guide to the snakes of Bexar County (Davenport, 1943). It was soon followed by the first of many editions and impressions of the popular booklet on venomous snakes by Werler (e.g., 1950, 1953, 1978), and later by works that addressed medical aspects of venomous snakes in Texas (Huang et al. 1975), focused on the famous rattlesnake 'round-ups' in the state (Kilmon and Shelton 1981; Adams and Thomas 2008), and provided updates to Werler's work (Price 1998, 2009). More expansive volumes that provided coverage of non-venomous as well as venomous species appeared by 1965 (Raun 1965), and were substantial and widely available by the mid 1980s (Tennant 1984, 1985, 2006; Vermersch and Kuntz 1986; Dunlap 1994; Werler and Dixon 2000). The popular appeal of snakes in the state remains undiminished, and is reflected today by the wide availability in garden shops, nurseries, and even coffee shops of a waterproof, quick-reference guide (Pustejovsky 2010). The snakes of Texas have been well served, and served in style, in the literature.

To be sure, amphibians and reptiles were treated collectively in some detail in other volumes, but early summaries were more technical, were intended for specialists, and generally were presented as relatively dry annotated lists without (Brown 1950) or with (Raun and Gehlbach 1972) maps, but devoid of photographs and descriptions (another such list was published by Kutac and Caran in 1994). Dixon's volume on amphibians and reptiles (1987, 2000; see also Dixon et al. 2007) provided a welcome change and included expanded discussion of natural history data, up-to-date taxonomic keys, distribution maps (with ranges documented at the county level), extensive review of the literature, and photos of select species in black-and-white format. The latter were helpful, but still lacked the appeal that so often drew the non-specialist to the natural history section of the (now almost defunct) local book store.

Departure from that traditional state of affairs began with the volume produced by Garrett and Barker (1987) who ushered in a new tradition of publishing non-technical field guides with

descriptions, color photographs, and distribution maps. The volume by Bartlett and Bartlett (1999) was an important update in a similar format. The recently released third edition of *Amphibians and Reptiles of Texas* by Dixon (2013) brings together for all readers a balanced coverage of non-technical text, maps, color photographs, and an extensive review of the literature on the herpetofaunal species of Texas. It certainly will serve to increase awareness of, and interest in, the herpetofauna of the state. But it is not easily carried in the field.

I have heard colleagues decry the field guide as a dying genre of published literature. Some view that demise as collateral damage in the broader and general decline of print media in favor of readily portable digital devices. Others apparently interpret concerns about the decline in outdoor activities among modern children (Louv 2008) as a harbinger of doom for the pocket guide. I admit that my proclivities tend towards an accumulation of books, and I embrace the accusatory labels of 'fuddy-duddy' and 'walking anachronism' that are proffered by students and colleagues who stand with jaws agape in disbelief when they learn that I do not carry a cell phone ("How do you text?") or tablet or other digital devices of our modern age. I also welcome the proximity of those same companions when they gaze over my shoulder as I pull out a field guide to aid in the identification of a darting damselfly, and am happy when they ask to thumb the volume on their own. Field guides clearly continue to serve the many purposes they have served for decades, as handy quick-references, teaching aides, inexpensive navigation guides for the budding naturalist who is grappling for the first time with the complexities of some small component of the world's biodiversity, and succinct guides for the professional or specialist exploring a new geographic area or a new taxonomic group.

Texas Amphibians is the latest release in the Texas Natural History Guides series published by The University of Texas Press, and is the third in that series to embrace a herpetological subject matter. It was preceded, perhaps unsurprisingly, by two volumes addressing snakes; one by Dixon and Werler (2005) and another by Price (2009). The volumes in the series are produced with an emphasis on a portable format that still permits (and, indeed, promotes) quality imagery. The book is sized for easy transport; at 4.5 in x 7.5 in I can slide this field guide into the back pocket of my jeans, drop it in a vest pocket, or carry it effortlessly in a backpack or daypack. The volume sells for $24.95, but a 33% discount is available for purchases made through the website for the press (http://utpress.utexas.edu/index.php/books/tiptep), thus dropping the cost to only $16.72.

The size of the book conforms to the others in the series, and that placed some limits on format, content, and presentation of data. The end product suffers little from those restrictions, and is a handy and helpful compendium that is both informative and easy to use. A four-page table of contents is followed by a brief foreword from James Dixon, who sets the book in the context of both geography and conservation. The 328 numbered pages include introductory sections on the basic biology of amphibians, conservation concerns (with Texas exemplars placed in the broader context of global amphibian declines), notes and tips on how to observe and photograph amphibians, an informative discussion of the laws and regulations that govern the collection of amphibians in Texas, notes on captive maintenance, comments on taxonomic practices adopted by the authors, keys to the salamander and frog species of Texas, a generic key to amphibian larvae, and systematic accounts of 72 species (30 salamanders and 42 anurans) with known records from Texas, to which are appended accounts of an additional six species that possibly occur in the state, but require verification. The bulk of the text (234 pp.) is dedicated to the systematic accounts. A list of state and U.S.-based international herpetological societies is provided in an appendix, along with notes on three museums, and some relevant web sites. The final sections of the book are dedicated to a glossary of terms, a brief bibliography, and indices of common and scientific names. The outer edges of the inside of the front and back covers provide rulers in inches and centimeters, respectively.

A few black-and-white illustrations are provided in the keys to highlight anatomical features, but the book is stunningly adorned with 177 color photographs, all but one of which depict living animals (the sole exception is a photograph depicting the photography set-up used by the authors in the field). The photos are good or excellent throughout, and the majority are sized to fit 1/3 of the height of the page. Most species are depicted in two or more photographs, permitting ready visualization of pattern or color variations, or anatomical details in close-up views. There is at least one photograph for all but two species; the exceptions are an as-yet unnamed species of *Eurycea* from the Pedernales River, and *Eurycea robusta* (known only from the holotype, an image of which was subsequently published by Dixon 2013).

A map depicting geographic distribution is provided for each of the 72 species known to occur within Texas. The maps are of a standard size, county boundaries of the state are depicted, and geographic range is indicated by gray-scale shading. Care appears to have been taken to depict the known (or inferred) range of the species as accurately as possible, given the scale of the maps (i.e., shading, does not conform solely to county boundaries). Geographic ranges of nominal subspecies are not differentiated. Several species of *Eurycea* are documented only from localized springs that would be minuscule if depicted on maps of this scale; for those, standard 1 cm dots are centered on the known locality or localities. The only obvious error in the maps is that the range of the 'Rio Grande' species of *Siren* was copied onto the map for *Siren intermedia* (see discussion by Dixon [2013] for a review of the taxonomic complications surrounding the two taxa, and a map for comparison).

Species accounts are organized taxonomically and according to a standardized format, with text grouped under the sequential headings Size, Description, Similar Species, Distribution, Natural History, Reproduction, Subspecies (when relevant), and Comments and Conservation. Both scientific and common names are provided at the beginning of each account, and with few exceptions follow Crother (2008). Only the common name is provided in the photo captions, but the photos are conveniently placed in close proximity to the text for each species. This format is common to all volumes in The University of Texas Natural History Guides series, and represents a significant stylistic difference from the traditional Peterson Field Guide series, in which taxon illustrations were, until recently, placed in a collection of plates bound near the center of the volume (e.g., Conant and Collins 1991). A style somewhat similar to the Peterson one is followed by the Audubon guides, in which images are clustered at the front of the book, with text and maps in the back (e.g., Behler and King 1988). I confess to a degree of ambivalence about these varying organizational styles; each serves a purpose and a particular category of user, and I have found myself at different times, and with different guides, variably favoring each style over the other, depending often upon the relative degree of my ignorance with the subject matter. Perhaps the harmonious accommodation

of both styles in the newer editions of the Peterson Series (e.g., Conant and Collins 1998) is the way to achieve maximum utility in the service of the broadest possible community.

The third edition of Dixon's *Amphibians & Reptiles of Texas* (2013) was published after the release of *Texas Amphibians* (2012). The two volumes ultimately will serve different (but overlapping) audiences, and some comparative comments are in order. At the time of publication of *Texas Amphibians*, the photos it contained were unique, but 11 of them were reprinted by Dixon (2013). The duplicated images are of *Ambystoma tigrinum*, *Eurycea latitans*, *Eurycea quadridigitata*, *Eurycea tridentifera*, *Notophthalmus viridescens*, *Pseudacris clarkii*, *Pseudacris crucifer*, *Gastrophryne carolinensis*, *Scaphiopus hurteri*, *Lithobates sphenocephala*, and *Eleutherodactylus planirostris*. Interestingly, and somewhat disturbingly, in the case of three shared images, the county-level provenience information provided in the two volumes is different (*Pseudacris clarkii*, either Sterling County or Irion County; *Pseudacris crucifer*, either Jasper County or Houston County; *Gastrophryne carolinensis*, either Houston County or Anderson County). In twelve other instances, the images in the two volumes are clearly of the same individual animals, taken on the same habitat setting, presumably in a single photo-shoot, but the animals have slightly different orientations or positions (*Ambystoma maculatum*, *Eurycea naufragia*, *Eurycea sosorum*, *Desmognathus auriculatus*; *Necturus beyeri*, *Notophthalmus viridescens*, *Anaxyrus debilis*; *Hyla chrysoscelis*, *Hyla cinerea*, *Gastrophryne olivacea*; *Hypopachus variolosus*, and *Lithobates grylio*). The similarity in photos undoubtedly stems from the fact that photos for Dixon's volume were provided by Toby Hibbitts, one of the authors of *Texas Amphibians*. In almost all cases, the images published by Tipton et al. are of a sharper quality and have greater clarity than the images reproduced in Dixon's book. Taxonomic coverage in the two volumes is nearly identical, with equal treatment of the anurans, but the Tipton et al. volume covers two additional and unnamed species of *Eurycea*.

Any book published on amphibians in recent years has addressed a taxonomic group that now is experiencing declining populations across the globe, and challenging threats to persistence. One of the unique features of the Texas amphibian fauna is the taxonomic diversity of *Eurycea* in the state. Many of these salamanders are tied to the karst geology and hydrology of the eastern edge of the Edwards Plateau. The morphologic, genetic, and taxonomic diversity among these salamanders continues to be a topic of intense exploration, and the elucidation of even basic natural history data for many species remains an elusive goal. The extremely localized geographic distribution of many of the species makes them a particularly challenging group, both for basic biological study, and for conservation efforts. Many of these issues are necessarily touched upon in this field guide, and special attention was called to the conservation status of the various species. Since the publication of *Texas Amphibians*, the conservation status of at least four species has changed. *Eurycea tonkawae* is now listed as threatened by the U.S. Fish & Wildlife Service. *Eurycea waterlooensis* now is listed as endangered by the same agency, and the listing status of both *Eurycea chisholmensis* and *Eurycea naufragia* now is 'proposed endangered' (see U.S. Fish & Wildlife Service species profiles at http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=D02T, ...=D033, ...=D02X, and ...=DO2S, respectively). As further testimony to the ever-changing picture on Texas amphibians, I note that the final book manuscript was sent to press a few weeks before the massive Bastrop County fire swept through important habitats for the Houston toad, *Anaxyrus houstonensis* (Travis LaDuc, pers. com. Sept., 2013); the impact on toad populations has not yet been fully assessed. These issues only serve to enhance the importance of this book, especially for the young people of the state of Texas who will utilize this guide to acquaint themselves with what may well be a rapidly changing component of their native biota.

In some respects, this book may considered to be long overdue. The only other book dedicated solely to the amphibians of Texas is a field guide to the anurans of Big Bend National Park (Dayton et al. 2007). The volume by Tipton et al. clearly fills an obvious need for a portable, low-cost guide to the amphibians of Texas. Indeed, with the appearance of this volume, lizards now stand as the most prominent group still in need of greater attention and documentation (lizard lovers in Texas may decorate their shelves only with Frank Blair's 1960 monograph on *Sceloporus olivaceus*, Vermersch's 1992 volume documenting species from the south-central portion of the state, a more expansive regional guide that covers Texas and the southwest [Jones and Lovich 2009], and Axtell's detailed distribution maps issued in 30 parts over approximately 20 years [e.g., Axtell 1987, 2005]).

The quality photographs in *Texas Amphibians* enhance the value of the book for non-specialists, and as the most up-to-date summary of the known amphibian fauna of Texas, it is of direct interest to all professional herpetologists. Beyond its obvious utility as a reference guide in the field, the book also will serve as an excellent introduction to the amphibians of Texas and will be useful as a classroom resource for K-12 teachers who seek useful tools to shape lesson plans and discussions about biodiversity, conservation, and natural resources of Texas. The low cost of this volume should, I think, guarantee a broad circulation, and serves as an additional enticement towards the maintenance of print media. Although internet photos are available for many (not all) of the species discussed in this book, they are sometimes of low quality, may be difficult to compare efficiently, and, if your eyes are as bad as mine, are almost always difficult to appreciate on sunny days when viewed on hand-held screens (and at night those screens destroy your night-vision).

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Amphibians of Eastern Europe. Part 1. Order Caudata

Yevgen Pysanets. 2012. Yevgen Pysanets, Kiev, Ukraine (available through amazon.com). 207 pp. Softcover. US $29.00. ISBN 978-966-02-6514-1.

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This book deals with the salamander fauna of Eastern Europe, defined as the European portions of the former Soviet Union. Ten species in six genera in the families Hynobiidae and Salamandridae are treated in the dual Ukrainian/English text. Ten species may not seem like very many, but the area covered by the book has a continental climate with great temperature extremes and some of the taxa covered barely extend into the region. For example, *Salamandra salamandra*, *Ichthyosaura alpestris*, and *Lissotriton montandoni* all enter Eastern Europe only in the Ukrainian Carpathians.

As this is intended as the first volume in a larger work on the amphibians of the region, it actually includes some more comprehensive features, such as illustrated keys to both the salamanders and frogs of Eastern Europe. The scientific names and authorities of these 30 amphibian species, along with their vernacular names in Ukrainian and English, are provided in a table. Threats to and conservation measures for amphibians are also provided in tabular form, as is a summary of frog and salamander conservation status (including listings by IUCN, the Bern Convention, and national red lists).

Other general information is included in a 17-page section providing biographies of zoologists who have contributed to the study of the Eurasian herpetofauna. These span five centuries from Conrad Gessner to Heinz Wermuth and draw heavily for both text and images from Kraig Adler's biographies in the SSAR *Contributions to the History of Herpetology* series.

The heart of the book is its species accounts. These follow very abbreviated family and genus comments and include subsections dealing with taxonomy, distribution, karyology, sexual dimorphism, morphology and coloration, life history, reproduction, development, behavior, and diet. In the account for *Salamandrella keyserlingii* the English text is about one page in length, whereas the Ukrainian is about six times longer. The discrepancy in other accounts is not as marked but if one wishes to get the fullest picture of a particular species, it may be necessary for non-Ukrainian readers to use Google Translate.

Accounts are each illustrated by a shaded distribution map (within Eastern Europe only), habitat photos, and photos of breeding males and females, as well as larvae, paedomorphs, non-breeding adults, and color or pattern variants, as appropriate. These are all in color and of high quality, although their printed size is quite small (mostly less than 80 mm in maximum dimension).

For the most part, the English portions of the book are not actual translations, but rather extended synopses of the Ukrainian content. This can be seen, for example, on page 26, where pre-, pro- and climax metamorphosis are discussed in Ukrainian, but not in English. In other places the English captions for certain figures do not provide all of the information given in the Ukrainian (p. 27), and some figures are not referenced in the English text at all (e.g., figures 7–9 in the section dealing with reproduction on pages 18–19). Principal components figures on pages 162–163 have English captions, but the relevant information printed on the plots themselves (the localities of sampled *Lissotriton*) are only in Ukrainian (except for two Romanian place names). Page headers are given only in Ukrainian. In most cases Ukrainian section headers are followed by English, and the associated text starts with the English version, then the Ukrainian, but in the section on the basics of amphibian systematics starting on page 51 the text is entirely in Ukrainian except for English figure legends. In the taxonomic accounts, Ukrainian comes first for families and genera, but species accounts start with English.

Translation is an issue in this book and typos are rife in the English text. The map on page 10, for example, incorrectly translates "western" as "eastern." Genera is rendered as "genuses" (p. 79), taxa as "taxons" (p. 86), marked as "market" (p. 86), and endangered as "indangered" (p. 153). Wording is awkward in some places, but understandable. Only on page 69 was I truly unable to decipher the English text. On page 145 the English figure captions are incorrect, having been duplicated from those on page 147. An errata sheet has been glued inside the back cover of the book, but none of the examples noted above are included.

One of the book's most useful features is its extensive (16 pp.) literature cited, with about 325 entries, arranged with references written in languages using the Cyrillic alphabet first, followed by those using the Roman alphabet. Many references, particularly those published in smaller regional journals, are likely to be unfamiliar to readers outside the region. Coverage appears to be quite good, especially for Ukraine, which is both home to the author and the richest region for salamanders within the scope of the book. Unfortunately, there are many typos in this section as well (e.g., Univercity), and Latin names are often not italicized. There is no index to the book in either language.

Salamanders of Eastern Europe have been treated in a number of other books that are available in English, most notably Kuzmin's (1999) *Amphibians of the Former Soviet Union*. Although this is now getting rather out of date, Kuzmin (2013) has just released a new volume with the same title. Kuzmin's work is both broader in scope and much more massive than that of Pysanets, but also considerably more expensive. Detailed species accounts, though again dated, also appear (in German) in the salamander volumes of *Handbuch der Reptilien und Amphibien Europas* (Grossenbacher and Thiesmeier 1999, 2003; Thiesmeier and Grossenbacher 2004). Despite numerous language and editorial issues, Pysanets' book provides a compact, affordable, and up-to-date overview of the caudate fauna from the Carpathians to the Urals and from the Arctic Sea to the Caucasus.

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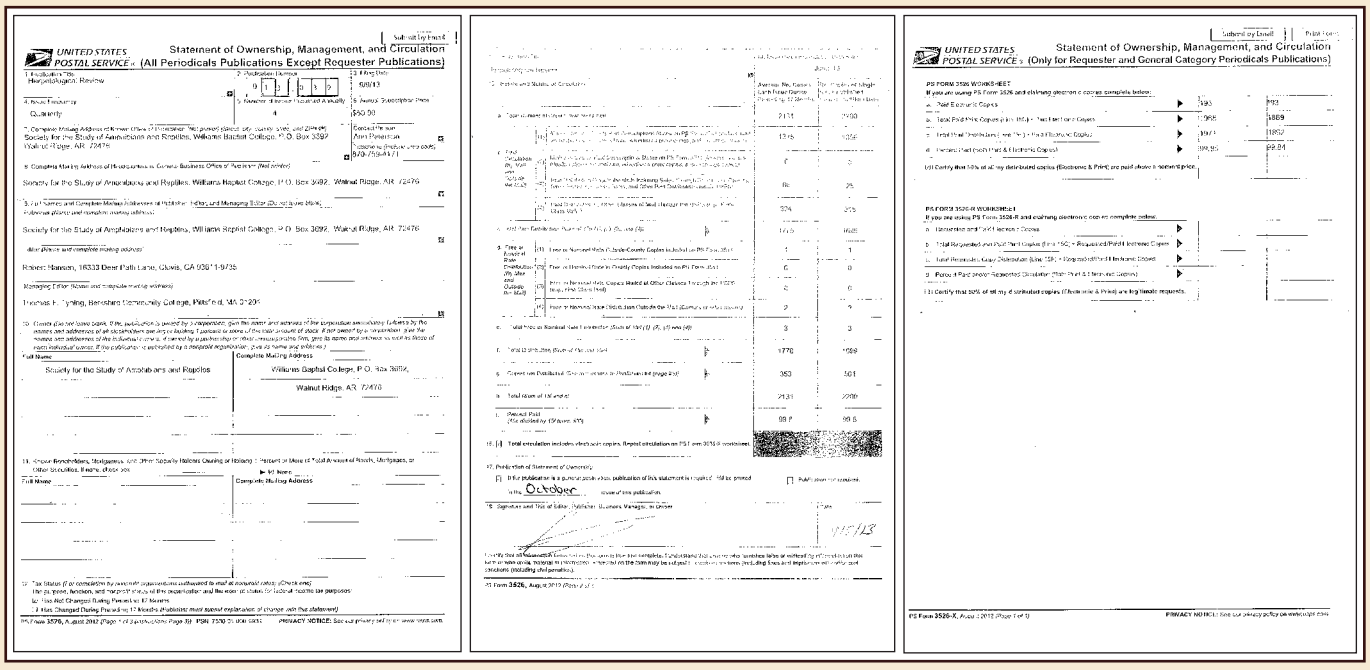
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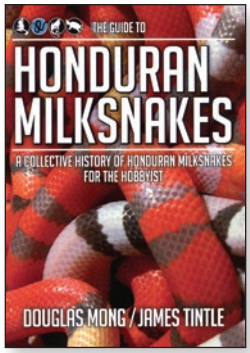
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PUBLICATIONS RECEIVED

Honduran Milksnakes: A Collective History of Honduran Milksnakes for the Hobbyist

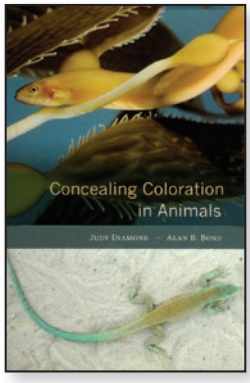
Douglas Mong and James Tintle. 2013. ColdBlooded Publishing, Valrico, Florida (www.facebook.com/ColdBloodedPublishing). 170 pp. Softcover. US $49.95. ISBN 978-0-9897804-0-7.



The Honduran Milksnake (*Lampropeltis triangulum hondurensis*), a large (up to 2.4 m TL) Central American colubrid whose color pattern mimics that of co-occuring venomous coral snakes (*Micrurus* spp.), has become very popular among herpetoculturists. Although there are several naturally occurring regional color pattern variants, captive breeders have taken this founder stock and produced a remarkable array of color and pattern morphs. Individual chapters cover the origins of breeding stock, genetics of color pattern inheritance, captive maintenance and breeding, health and disease, and four chapters are devoted to various morphs. Color photographs occupy most pages, and likely account for the book's high price. Although this book would have benefited from a stronger editorial hand, hobbyist breeders and keepers at all levels will find this a rich and visually stimulating source of information and perhaps inspiration.

Concealing Coloration in Animals

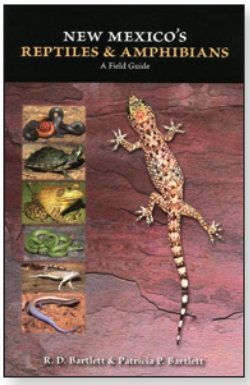
Judy Diamond and Alan B. Bond. 2013. Harvard University Press, Cambridge, Massachusetts (www.hup.harvard.edu). Hardcover. x, [2], 271 pp. US $29.95. ISBN 978-0-674-05235-2.



This is an engaging book for a general audience that deals with a topic of broad biological relevance. Concealing coloration has captured the attention of some of the most well known zoologists of the past two centuries, including Henry Bates (of Batesian mimicry fame), Alfred Russel Wallace, and Ernst Mayr. Even Theodore Roosevelt became embroiled in debates over the topic. This book draws on these historical examples, as well as modern work by Hopi Hoekstra, Michael Nachman, Bree Rosenblum, and others, to investigate topics such as color as signal, perception, the nature of color, and eyes and their sensitivity. Examples are drawn from across the spectrum of animals. The case of industrial melanism in the moth *Biston betularia* is, of course, explored but many cases of herpetological crypsis are also presented. Appropriately, the book is illustrated throughout with color photos of high quality, among which phrynosomatid lizards are especially well represented. Despite its brevity and accessibility, the book includes 30 pages of notes and approximately 600 references, facilitating the reader's access to the rich literature on this topic. This inexpensive volume should be of interest to evolutionary biologists as well as sensory and cognitive scientists and would serve as an excellent accompaniment to an undergraduate seminar class on the biology of color or similar topics.

New Mexico's Reptiles & Amphibians: A Field Guide

R. D. Bartlett and Patricia P. Bartlett. 2013. University of New Mexico Press, Albuquerque (www.unmpress.com). 228 pp. Softcover. US $24.95. ISBN 978-0-8263-5207-1.

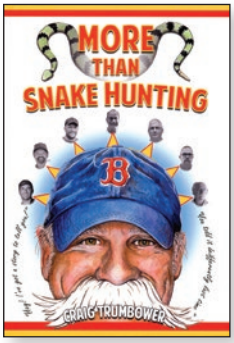


This book should appeal to general readers wanting a quick and handy reference to the herpetofauna of this corner of the American Southwest. Individual species accounts—consisting of brief statements concerning taxonomy, abundance/range, habitat, size, identifying features, voice (for anurans), similar species—are accompanied by small (25 x 25 mm), shaded distribution maps showing range only within New Mexico. The taxonomy used is up to date, but the authors note cases where disagreement remains (e.g., *Rana* vs. *Lithobates*, *Bufo* vs. *Anaxyrus*, *Masticophis* vs. *Coluber*). Each species is illustrated by a color photo, although geographic origin of specimens depicted is not provided, information that would have enhanced their usefulness. Photographs of animals, as well as representative habitats, are aggregated in a section of color plates to keep printing costs low. The photographs should make it possible for users to identify the majority of species, while in other cases readers are directed to consult range maps to determine species ID. Those requiring a more detailed treatment of New Mexico's herpetofauna will want to consult Degenhardt et al.'s *Amphibians and Reptiles of New Mexico*, long the definitive treatment of the subject.

A growing number of titles have appeared in recent years that present stories of hunting for amphibians and reptiles ("herping"), following in the tradition made famous by Carl Kauffeld (*Snakes and Snake Hunting* and *Snakes: The Keeper and the Kept*). However, books in the post-Kauffeld era mostly do not come close to matching those classics. Here, we take brief looks at some recent additions to this genre of herpetological publishing.

More than Snake Hunting

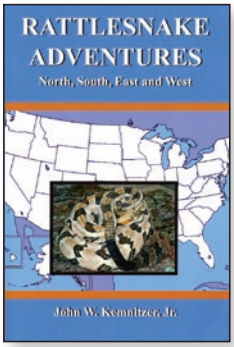
Craig Trumbower. 2012. ECO Herpetological Publishing, Rodeo, New Mexico. 278 pp. Hardcover. US $29.95 ISBN 978-0-9852936-2-8.



Trumbower offers ten chapters of snake hunting adventures set in South Carolina, Florida, Texas, Arizona, and California. These are presented in "storytelling" fashion, and often are as much about the hunters as about the snakes they seek. Specific chapters recall field searches for, among other targets, Blacktail, Eastern Diamondback, and Canebrake (= Timber) rattlesnakes, Eastern Indigo Snakes, and Rosy Boas. A long chapter on *Lampropeltis alterna* (the Gray-banded Kingsnake) includes field-hunting vignettes from a handful of veteran "*alterna* hunters." One chapter captures the essence of reptile "expos"—the sometimes-huge trade shows where live animals are bought and sold. This work has the feel of an "insider" book, written for and about a circle of the author's closest friends and field companions, but those outside the circle will likely find these tales entertaining.

Rattlesnake Adventures: North, South, East and West

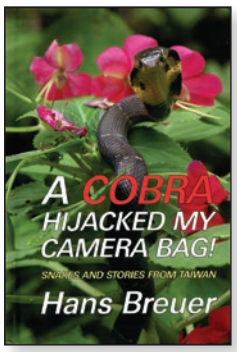
John W. Kemnitzer, Jr. 2011. Serpent's Tale Natural History Book Distributors, Lanesboro, Minnesota (www.zoobooksales.com). 183 pp. Softcover. US $17.95. ISBN 978-1-885209-66-5.



This collection—something of a sequel to Kemnitzer's *Rattlesnake Adventures*: *Hunting with the Old Timers*, published in 2006—consists of 21 individually authored stories and articles. It includes original contributions as well as previously published material, but all focus on the subject of rattlesnakes. The mix of authors includes familiar contemporaries (e.g., Richard Bartlett, David Barker, John Behler, William Brown) and others likely to be encountered for the first time in print. Some names are from long ago—Howard Gloyd, Moody Lentz (an associate of Marlin Perkins), and Isabelle Kauffeld (then-wife of Carl Kauffeld, but later married to Roger Conant and best known for her photographs in Conant's field guides). Subject matter comprises tales of those who hunted rattlesnakes for hides or illegal collection for the pet trade, the search for zoo specimens in remote areas, and includes Gloyd's famous description of the magnificent Prairie Rattlesnake dens of South Dakota. A number of grainy, black-and-white photos are scattered throughout.

A Cobra Hijacked My Camera Bag! Snakes and Stories from Taiwan

Hans Breuer. 2012. Coachwhip Publications, Landisville, Pennsylvania (www.coachwhipbooks.com). 243 pp. Hardcover. US $29.95. ISBN 1-61646-129-2.



Naturalist Hans Breuer, a German national transplanted to Taiwan and later to Borneo, shares stories of discovery of Taiwanese herpetofauna. Breuer enthusiastically recounts his progression from rank amateur, fully ignorant of the local fauna, to one with growing expertise and who has since made several important discoveries. His writing is engaging, entertaining, and scientifically informed. Mixed in with the field stories, readers will encounter interesting facts about the ophidiofauna, herp keeping, wildlife smuggling, Taiwanese culture, and much more. Much of the narrative focuses on field experiences with particular species or groups of snakes (elapids, pitvipers, ratsnakes, etc.), with color photos included for all.

Biology of the Pitvipers 2

BIOLOGY OF THE PITVIPERS 2014

TULSA, OKLAHOMA
JUNE 4-7, 2014
DOUBLETREE HILTON TULSA

Presentation topics will include all aspects of pitviper biology including systematics & phylogenetics, phylogeography & population genetics, morphology & physiology, ecology & conservation, behavior, reproductive biology, venom & snakebites, and husbandry.



Keynote Speaker: Dr. Harry W. Greene

"A Long View of Pitvipers: Past, Present, and Future"



Banquet Speaker: Dr. Todd A. Castoe

"Snake genomes provide insight into the evolutionary origins of extreme phenotypes of vertebrates"



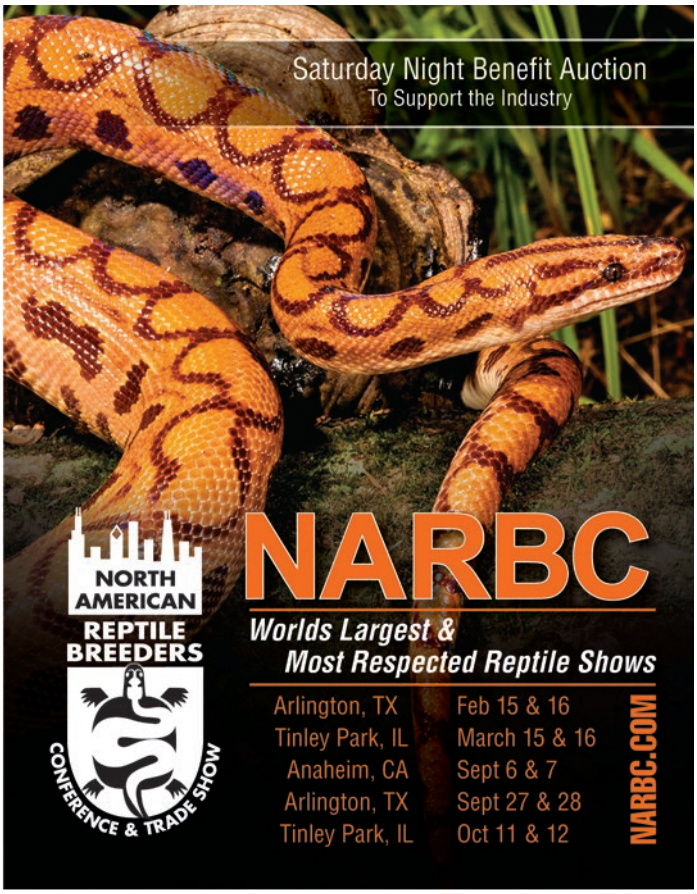
Featured Speaker: Dr. Stephen P. Mackessy

"Evolution of snake venoms and venom research - the last quarter century""

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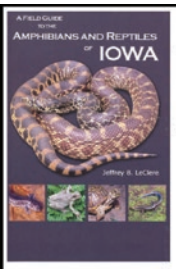
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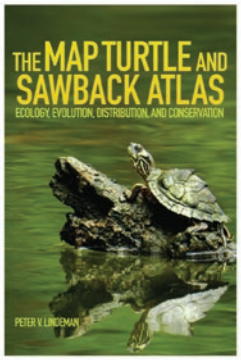
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All members of the SSAR are entitled to vote by mail ballot for Society officers, which allows overseas members to participate in determining the Society's activities; also, many international members attend the annual meetings and serve on editorial boards and committees.

All members and institutions receive the Society's primary technical publication, the *Journal of Herpetology*, and its bulletin, *Herpetological Review*; both are published four times per year. Members also receive pre-publication discounts on other Society publications, which are advertised in *Herpetological Review*.

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Future Annual Meetings
2014 — Chattanooga, Tennessee, 30 July–3 August (JMIH with ASIH, HL, and AES)
2015 — Lawrence, Kansas 30 July–3 August (SSAR with PARC and KHS)

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ABOUT OUR COVER: *Terrapene nelsoni*



A recent phylogenetic study of the North American box turtle genus *Terrapene*, incorporating mitochondrial and nuclear DNA sequence data, suggests recognition of five species: *carolina, coahuila, mexicana, nelsoni*, and *ornata* (Martin et al. 2013. Molecular Phylogenetics and Evolution 68:119–134). The two westernmost species, *nelsoni* and *ornata*, are shown to be sister taxa.

Terrapene nelsoni (Spotted Box Turtle), depicted on our cover, remains the least known of the box turtle species. It occupies the Pacific versant of the Sierra Madre Occidental on Mexico's west coast from Sonora and Chihuahua south to Nayarit and Jalisco. However, the vast majority of records are from the northern part of the range (Sonora) and elsewhere it remains a rarely recorded species (Buskirk and Ponce-Campos 2011. *In* Rhodin et al. [eds.], Conservation Biology of Freshwater Turtles and Tortoises: A Compilation Project of the IUCN/SSC Tortoise and Freshwater Turtle Specialist Group. Chelonian Research Monographs No. 5, pp. 060.1–060.9, doi: 10.3854/crm.5.060.nelsoni.v1.2011, http://www.iucn-tftsg.org/cbftt/).

This is a turtle of thornscrub and pine-oak forest in the Sierra Madre Occidental. Thornscrub, in particular, is a plant community that has a stark appearance for much of the year until the arrival of summer monsoons, when the region is quickly transformed into a luxuriantly green landscape. This is when box turtles become active. The terrain is often rugged, and it seems likely that turtles are capable of traversing steep slopes. Diet is presumed to include insects and fruits. Courtship and oviposition are thought to occur near the start of the rainy season, with females producing clutches of 1–4 eggs (Milstead and Tinkle 1967. Copeia 1967:180–187), although reproductive ecology remains unstudied in the wild.

Our cover depicts an adult Spotted Box Turtle *in situ* near the east bank of the Río Aros, Sonora, Mexico, discovered by **Robert A. Villa**. Here, at the point where the Aros meets the Río Bavispe to form the headwaters of the Río Yaqui, *T. nelsoni* approaches its northern boundary. The habitat is characterized by plants whose northward expansion is thwarted by sensitivity to frost; other neotropical reptiles whose northern range limits are nearby include Central American Indigo Snakes (*Drymarchon melanurus*), Mexican Brown Snakes (*Storeria storerioides*), Mexican Black-bellied Garter Snakes (*Thamnophis melanogaster*), Beaded Lizards (*Heloderma horridum*), and Clouded Anoles (*Anolis nebulosus*) (Enderson et al. 2009. Check List 5[3]:632–672).



PHOTO BY STEVEN YANEZ-ROMO

Villa recorded the image using a Fujifilm FinePix S4500 using fill flash. He is a Tucson, Arizona-based field biologist whose primary interests are in monitoring biodiversity of the Sky Island region. He is a past president of the Tucson Herpetological Society, as well as an accomplished violinist.

SSAR BUSINESS

Dean E. Metter Memorial Award, 2013

The Metter Memorial Award honors the legacy of Dean E. (Doc) Metter, long-time biology faculty member at the University of Missouri-Columbia. The award is designed to encourage students to pursue field research in herpetology.

The 2013 Metter Memorial Award goes to Mitch Tucker, a PhD student in the Division of Biological Sciences at the University of Missouri. His major professor is Carl Gerhardt. Mitch's proposal was entitled "Behavioral Consequences of Polyploidy in Gray Treefrogs, *Hyla chrysoscelis*." A key component of the proposal hinges upon being able to generate autopolyploid frogs in the lab which Tucker is able to do with a "cold-shock" treatment developed by he and Gerhardt. Tucker's proposal was especially innovative and experimental and takes an approach involving field work as well as laboratory work to provide insight to a particularly interesting biological system. Congratulations to Mitch Tucker.

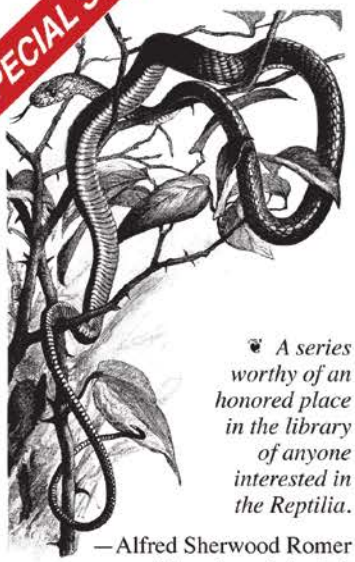
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The third annual SSAR Student Poster Awards were presented at the 56th Annual Meeting of the SSAR in Albuquerque, New Mexico, 10–15 July 2013. This year there were 40 eligible posters. In recognition of outstanding student poster presentations at the annual meeting, a single award was given in each of the following categories: Evolution, Genetics, & Systematics (6 presentations), Ecology, Natural History, Distribution, & Behavior (23 presentations), and Conservation & Management (11 presentations). Because few students entered the Physiology & Morphology category, those students were placed in other categories and no award was given in that category. All awardees received a check for US $100 and a book from University of California Press.

This year's judges were Tiffany Doan (Chair, State College of Florida, Manatee-Sarasota), Marina Gerson (California State

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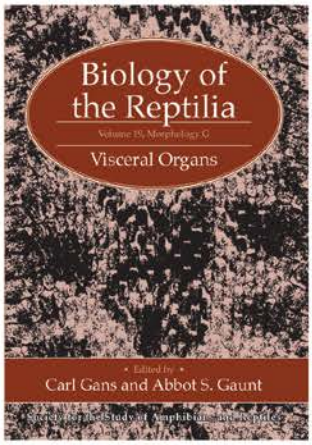
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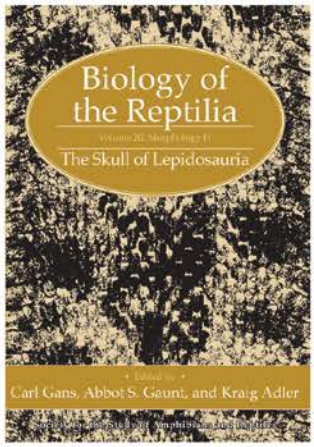
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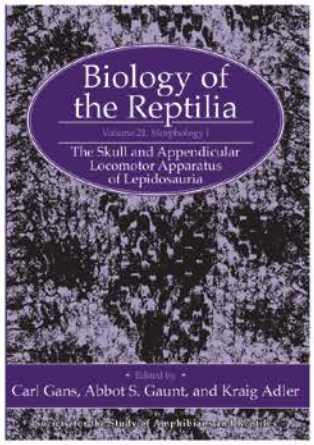
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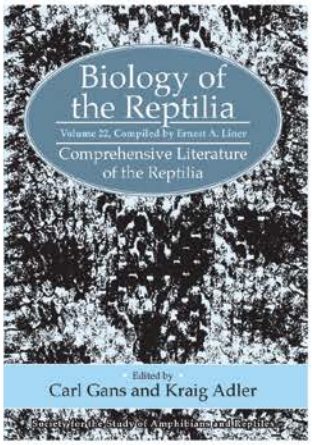
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University, Stanislaus), Ali Reza (Delta State University), Matthew Heinicke (University of Michigan-Dearborn), Sean Rovito (University of California, Berkeley), Steven Kimble (Purdue University), and Kerry Griffis-Kyle (Texas Tech University).

The Winners.—Evolution, Genetics, & Systematics: **Shuangying Yu**, Texas Tech University, "Endosulfan and alpha-cypermethrin inhibit repair of DNA photo adducts and decrease transcription of nucleotide excision repair genes in *Xenopus laevis* embryos." Conservation & Management: **Katherine O'Donnell**, (University of Missouri), "Initial terrestrial salamander responses to prescribed fire and timber harvest in southeast Missouri". Ecology, Natural History, Distribution, & Behavior: **Kristin Winchell**, University of Massachusetts, Boston, "Phenotypic shifts in urban populations of the tropical lizard, *Anolis cristatellus*."

SSAR Roger Conant Grants-In-Herpetology: Award Winners for 2013

An award in the amount of US $500 was made to each of the following individuals:

Conservation.—**Todd Pierson**, University of Georgia, "Monitoring Appalachian Plethodontidae using "environmental DNA." Advisor: Travis Glenn

Education.—**Tiffany Vanderwerf,** Buffalo Zoo, "Save your backyard: a local herpetological conservation education outreach program."

The Andrew H. Price Field Research Grant In Herpetology.—**Mark Oliva**, California State University-Northridge, "Call complexity of an Ecuadorian treefrog, *Dendropsophus carnifex*: mate call recognition and female choice." Advisor: David Gray

Laboratory Research.—**Schyler Nunziata**, University of Kentucky, "Microevolutionary response of two salamander species to climate change in an isolated seasonal wetland." Advisor: David Weisrock

Travel.—**Justin Lawrence**, The University of Mississippi, "The effect of color and pattern on predator generalizations in a polymorphic poison frog." Advisor: Brice Noonan

International.—**Jessica Hacking**, Flinders University, Australia, "Honest signals of fitness? Analysis of immune gene variation, parasite loads, and male colouration in the tawny dragon lizard (*Ctenophorus decresii*)." Advisor: Mike Gardner

SSAR thanks Committee Chair, Joshua M. Kapfer (University of Wisconsin-Whitewater), and the following reviewers: Robert Brodman (St. Joseph's College), Kyle Barrett (Clemson University), Michael Clifford (Virginia Herpetological Society), Gary Fellers (USGS-Western Ecological Research Center), Lee Grismer (La Sierra University), Jeffery Lorch (University of Wisconsin-Madison), Malcolm McCallum (University of Missouri at Kansas City), Melissa Pilgrimm (University of South Carolina Upstate), David Steen (Virginia Tech), Steve Sullivan (Peggy Notebaert Museum, Chicago).

Roger Conant Grants-in-Herpetology Program 2014

Proposals will be accepted for the **2014** SSAR Grants-in Herpetology Program starting on 15 September 2013. This program is intended to provide financial support for deserving individuals or organizations involved in herpetological research, education, or conservation. In keeping with the Society's goal of encouraging participation by the broadest possible community of applicants, preference may be given to individuals who might not have access to other funding sources. Applications must be submitted by individuals only (but see special considerations for education category below).

Grant proposals will be considered in the following categories:

1. CONSERVATION OF AMPHIBIANS AND REPTILES. Proposals should outline a conservation-oriented research project. This project may focus on species endangered or threatened at the state, national, or international level, or address research on potentially threatened habitats or species, or on introduced injurious species.
2. THE ANDREW H. PRICE FIELD RESEARCH GRANT IN HERPETLOGY. Proposals may address needs for field station fees or equipment and materials in field oriented projects, or the field work portions of broader studies. This might include in-situ behavioral studies, ecological, life history, or sexual selection studies. Survey work by individuals or regional societies may be submitted here or in TRAVEL below depending on how the funds are to be used.
3. LABORATORY RESEARCH. Proposals may address needs for equipment or materials in laboratory projects or laboratory portions of broader projects. This might include studies in behavior, biochemistry, molecular biology, biomechanics, or physiology.
4. HERPETOLOGICAL EDUCATION. Proposals may address an educational project or start up support for an educational program in a zoo, museum, park, nature center, regional herpetological society, etc. The project must focus on a herpetological topic. Note: Although proposals for institutional projects are accepted, education proposals must be submitted by an individual (either sole applicant or principle contact person for the project). Applicants need not be students or SSAR member.
5. TRAVEL. Proposals may address support for travel to field study sites near or far, or to utilize distant collections or facilities. If funding is sought to get from one place to another, proposals should be submitted in the TRAVEL category. Proposals normally submitted in the CONSERVATION or FIELD RESEARCH categories should be submitted here if travel funding is being sought.
6. INTERNATIONAL. Proposals may address needs in any of the above five categories. The applicant must be a student, but not necessarily a SSAR member. Preference will be given to students with limited access to research funds and in countries where herpetological research has historically been under-funded. **Note Regarding Eligibility in the International Category**: In late 2011, the current President of SSAR, the Grants-In-Herpetology Chair, and several members of the SSAR Board of Directors decided that proposals in this category would only be accepted if they were submitted from institutions OUTSIDE of the United States. Proposals from students

who are primarily affiliated with United States institutions are *not* eligible for this category.

Submitting your proposal: All proposals must be submitted electronically to Joshua Kapfer (e-mail: kapferj@uww.edu) as a single PDF file named "lastname-category.pdf" no later than 15 December 2013 to be considered (letter of support may be included with the proposal or sent separately). Exceptions to electronic submission and file format may be allowed for special cases with prior approval by SSAR-GIH Chair. Full details about the GIH program and proposal requirements are available on the SSAR website:

http://www.ssarherps.org/pages/GIH.php

Grants In Herpetology Donor Information

Financial contributions by SSAR members, institutions, and other benefactors support this program significantly, and can increase the number and/or size of awards. Your tax-deductible contribution (US citizens) to this program will directly benefit meritorious research and education in herpetology. Contact the SSAR Treasurer (Ann Paterson; distichus@hotmail.com) for additional information about contributing to the Grants-in-Herpetology program. If you are employed by an organization that will match donations made to nonprofit organizations, please notify your employer that you have made a donation to the Grants-in-Herpetology program.

NEWSNOTES

Collections Codes Updated

Standard Symbolic Codes for Institutional Resource Collections in Herpetology and Ichthyology, edited by Mark Sabaj Pérez, has been updated. Version 4.0, dated 28 July 2013, can be downloaded in pdf or Excel format from http://www.asih.org/ (select the Resources tab).

New Version of Reptile Database Released

The Reptile Database (http://www.reptile-database.org/), edited by Peter Uetz as a service to the herpetological community, released a new version in July 2013. The Database now contains 9831 species and 31,756 literature references. For full details of this update, please visit: http://www.reptile-database.org/db-info/news.html.

David J. Morafka Memorial Research Award - 2014

In honor and memory of Prof. David J. Morafka, distinguished herpetologist and authority on North American gopher tortoises, the Desert Tortoise Council, with the aid of several donors, has established a monetary award to help support research that contributes to the understanding, management, and conservation of tortoises of the genus *Gopherus* in the southwestern United States and/or Mexico: *G. agassizii, G. morafkai, G. berlandieri*, and/or *G. flavomarginatus*.

Award Amount: US $2,000 to be awarded at the Desert Tortoise Council's Annual Symposium, depending on the availability of funding and an appropriate recipient.

Eligibility: Applicants must be associated with a recognized institution (e.g., university, museum, government agency, non-governmental organization) and may be graduate students, post-doctoral students, or other researchers. They must agree to present a report on the results of the research in which award funds were used at a future symposium of the Desert Tortoise Council.

Evaluation Criteria: Applications will be evaluated on the basis of the potential of the research to contribute to the biological knowledge of one or more of the above gopher tortoise species, and to their management and conservation. Important considerations are the significance and originality of the research problem, design of sampling and analysis, preliminary data supporting the feasibility of the research, and the likelihood of successful completion and publication.

Application Procedure:

1. Download and open an application form from the Desert Tortoise Council's website www.deserttortoise.org. The form is electronically interactive.

2. Provide all information requested on the application, including a description of the research project in no more than 1,200 words.

3. Submit the completed application to grstewart@csupomona.edu as a pdf attachment.

4. Applications must be supported by three letters of recommendation, one of which must be from the applicant's research advisor, supervisor, or a knowledgeable colleague. Instruct the recommenders to submit their letters to grstewart@csupomona.edu as pdf attachments.

5. Completed applications and letters of recommendation must be received by **December 2, 2013**. They will be evaluated by a committee of gopher tortoise biologists appointed by the Desert Tortoise Council Board of Directors.

The research award recipient will be notified of his/her selection by **January 17, 2014** and the award will be presented at the 2014 Desert Tortoise Council Symposium, February 21–23, 2014.

The Herpetologists' League EE Williams Research Grant

The Herpetologists' League is pleased to announce competitive grants for graduate student research for 2014. These awards

are named in honor of the late Ernest E. Williams, HL's first Distinguished Herpetologist. Cash awards (US $1,000) will be presented to one winner in each category: Behavior, Conservation, Ecology, Physiology, Morphology/Systematics. The application deadline is 15 December 2013. Full details, as well as an application form, may be downloaded from the HL website:

http://www.herpetologistsleague.org/dox/eewilliamsgrant.pdf

Amphibian Ark Surplus Animal Service for Researchers

Amphibian Ark represents a global network of amphibian captive breeding programs as part of the global IUCN *Amphibian Conservation Action Plan* (ACAP). The ACAP emphasizes the primary importance of basic research in fields such as climate-change, ecotoxicology, or disease ecology in order to inform appropriate conservation programs. Much of this research takes place in the realm of academic labs around the globe, and this research often requires the use of living animals (per institutional IACUC guidelines). Some amphibian breeding programs produce surplus progeny that are not needed to ensure the appropriate genetic integrity of a particular survival-assurance breeding program. Amphibian Ark can help potential partners at breeding institutions and research labs to direct surplus animals to the research programs where they can really contribute towards the research needed to inform amphibian conservation. While many *ex situ* partners have disposition policies that cannot support this activity, many do not and surplus animals often are available for qualified IACUC-approved research. Interested institutions should check the "Animals for ACAP" page on the Amphibian Ark website:

http://www.amphibianark.org/mailman/listinfo/animalsforacap_amphibianark.org

IHS Grants Available

The International Herpetological Symposium has established a grant program to provide financial assistance to individuals or organizations conducting herpetological research, conservation, and education. Proposals are accepted January through May of each year and grants are awarded in August. Grants are in the amount of up to US $500 and will be awarded to applicants whose projects represent a significant contribution to herpetoculture in one of the following categories: herpetological natural history, herpetological conservation biology, captive propagation, or herpetological education. For details on the application process, please visit the IHS website at <http://internationalherpetologicalsymposium.com/grant.html>

MEETINGS

Meetings Calendar

Meeting announcement information should be sent directly to the Editor (HerpReview@gmail.com) well in advance of the event.

3–6 October 2013—4th Biology of Vipers Conference, Struga, FYR Macedonia. Information: www.shdmr.org/vipers

2–3 November 2013—52nd Annual Meeting of the Herpetological Society of Japan, Sapporo, Hokkaido, Japan. Information: http://zoo.zool.kyoto-u.ac.jp/herp/meeting/2013/index.html

9–10 January 2014—California / Nevada Amphibian Population Task Force Annual Meeting, Beatty, Nevada, USA. Information: http://www.canvamphibs.com/

4–7 June 2014—Biology of the Pitvipers 2, Tulsa, Oklahoma, USA. Information: http://www.biologyofthepitvipers.com

30 July–3 August 2014—Joint Meeting of Ichthyologists and Herpetologists (SSAR, HL, ASIH), Chattanooga, Tennessee, USA. Information: http://www.dce.k-state.edu/conf/jointmeeting/

CELEBRATING THE 7TH WORLD CONGRESS OF HERPETOLOGY

"Un ouvrage monumental." —Bernard Devaux (*La Tortue*)
". . . a Herculean task. The result is a high-quality facsimile at a bargain basement price." —Glenn Shea (*Herpetological Review*)

ERPÉTOLOGIE GÉNÉRALE
ou Histoire Naturelle Complète des Reptiles


Constant Duméril


Gabriel Bibron


Auguste Duméril



AMONG THE PUBLISHED WORKS IN herpetology over the last five centuries, only two can be said to cover all known species of amphibians and reptiles comprehensively and scientifically. One, in English, was by George A. Boulenger and based on the collections of the British Museum in London (9 volumes, 1882–1896). These books were reprinted in 1961–1966 and, despite their age, remain among the most frequently consulted references in herpetology. The other, in French, was by Constant Duméril, Gabriel Bibron, and the senior author's son, Auguste Duméril, and based on the collections of the Muséum d'Histoire Naturelle in Paris (9 volumes plus an atlas of colored plates, 1834–1854). This latter work, generally known as "D & B," had never been reprinted until now. It remains of continuing value to a broad community of academic zoologists, museum and zoo curators, and conservationists, and especially to herpetologists working in developing countries. D & B is, in fact, more comprehensive than its English counterpart, for in addition to having more detailed descriptions of genera and species, it also covers the internal anatomy, physiology, and the associated literature.



Paris was then the epicenter of world science and its museum boasted the greatest naturalists: Buffon, Geoffroy Saint-Hilaire, Lacepède, Lamarck, and the greatest of them all, Georges Cuvier. Also among them was Constant Duméril, who trained as a physician and became one of Cuvier's closest colleagues. The Paris museum then possessed the largest natural history collections in the world. D & B was the first work in which a natural arrangement of genera was attempted, and many of the genera and species were first described in it.





This full-size facsimile is complete and carefully edited for clarity. The 120 finely executed plates are reprinted in *both uncolored and colored states* because the original coloring sometimes obscures details of scutellation. The nine text volumes, which total nearly 7,000 pages, and the atlas of 240 plates are sturdily bound in library-grade cloth and printed on durable, acid-free paper. The **new introduction by Roger Bour (Paris)** is an in-depth review of the book (including exact publication dates) with new biographies of the three authors. A **comprehensive index to the scientific names**, missing in the original book, has been added. The original book was issued in fewer than 500 sets; a colored set, rarely offered today, costs about US$15,000. Only 400 new sets have been reprinted. (This reprint is being offered at an affordable price because of a generous subsidy from Ronald A. Javitch of Montréal.)

■ *SPECIFICATIONS*: Nine volumes (bound in five) of text, plus an atlas volume of 240 plates (in colored and uncolored states), all 5½ × 8½ inches (14 × 21.5 cm). Library-grade cloth bindings. ISBN 978–0–916984–87–8. ***Published December 2012.***
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CURRENT RESEARCH

The purpose of Current Research is to present brief summaries and citations for selected papers from journals other than those published by the American Society of Ichthyologists and Herpetologists, The Herpetologists' League, and the Society for the Study of Amphibians and Reptiles. Limited space prohibits comprehensive coverage of the literature, but an effort will be made to cover a variety of taxa and topics. To ensure that the coverage is as broad and current as possible, authors are invited to send reprints to the Current Research section editors, Beck Wehrle or Ben Lowe; e-mail addresses may be found on the inside front cover.

Venom Proteins in Non-Venomous Squamates

In recent years, phylogenetic and toxicological studies have greatly increased our understanding of the origins and extent of venom production in Squamata. We now know that several of the toxin-associated proteins found in squamates originated as gene-duplications along the branch leading to Toxicofera, the clade containing Iguania, Anguimorpha, and Serpentes. However, though researchers have made great strides in revealing the variation in the gross morphology of squamate oral glands, it has remained largely unknown how histology and genetic control varies among gland types and taxa. To further our understanding of venom evolution, the authors of this study investigated the oral glands of 23 taxa including representatives of all major squamate lineages using sectioned heads, excised glands, and magnetic resonance imaging of whole heads. Furthermore, they generated transcriptomes for these species by isolating and reverse transcribing RNA from glands and sequencing the resulting cDNA libraries. The recovered sequences identified as toxin genes in BLAST searches were subsequently included in phylogenetic analyses and subjected to tests for selection. These investigations led to some very interesting discoveries. The red-tailed pipe snake *Cylindrophis ruffus* (Uropeltidae) was found to possess large rictal glands, paired and poorly studied organs of snakes occurring in the corner of the mouth posterior to the better-known maxillary and mandibular glands. These rictal glands are strictly composed of serous cells (indicating a digestive or venom function), while the mandibular and maxillary glands of *C. ruffus* are a mix of serous and mucosal cells. Alternatively, the oral glands of the examined boid and pythonid snakes are largely composed of mucosal cells, likely functioning to aid in the ingestion of large prey. Iguanian lizards possess oral glands of mixed cell types, with herbivorous species tending to have predominately mucosal cells while those that regularly consume vertebrate prey have a greater proportion of serous cells. Non-toxicoferan squamates exhibit mucosal mandibular glands (maxillary glands are highly reduced or absent). Interestingly, despite histological variation among the various types of oral glands of a particular species, the glands all possess the same RNA transcripts, indicating they are under the same genetic control. The transcriptome sequences also added to the list of proteins occurring in iguanians, boids, uropeltids, and pythonids that are homologous with venom proteins known from anguimorph and caenophidian squamates. Two iguanian transcripts that were found to be highly expressed and under diversifying selection have been hypothesized to have an antimicrobial function, a possible precursor function of venom proteins. A second group of proteins were found to be shared by the clades Anguimorpha and Serpentes, lending support to the hypothesis that these taxa form a clade (a hypothesis lacking support from traditional molecular phylogenetic analyses). A third burst of protein recruitment occurred along the branch leading to Caenophidia.

Fry, B. G., and colleagues. 2013. Squeezers and leaf-cutters: differential diversification and degeneration of the venom system in toxicoferan reptiles. Molecular and Cellular Proteomics (*in press*) doi:10.1074/mcp.M112.023143.

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Sticky Secretions of Amphibians Strikingly Similar to Those of an Invertebrate

Amphibians of widely disparate families have the capacity to produce a remarkably sticky adhesive. The function of this ability has been studied in some taxa; for instance, some members of the genera *Plethodon* and *Limnodynastes* use their extreme stickiness as a predation deterrent. The sticky secretions of another species, *Notaden bennetti* (Myobatrachidae) of Australia, have been studied in some detail. Interestingly, the characteristics of this substance are remarkably similar to sticky substances produced by velvet worms (Onychophora) for use in prey apprehension. Previous work has indicated that the secretions of *N. bennetti* and the onychophoran *Euperipatoides rowelli* contain large polypeptides lacking protein structure. To further explore the potential similarities of these two substances, the authors collected secretion samples from both *N. bennetti* and *E. rowelli*. To detect and characterize any carbohydrates present, samples from *N. bennetti* were subjected to protein- and carbohydrate-degrading enzymes as well as Schiff staining. Samples from both species were subjected to SDS-polyacrylamide gel electrophoresis (PAGE) to visualize and isolate proteins. The isolated proteins were then analyzed for their amino acid composition and sequenced using in-line tandem mass spectrometry. Some stretched and dried secretion was also investigated for protein structure using wide-angle X-ray scattering (WAXS). When treated with proteinase K (an enzyme that breaks bonds between adjacent amino acids), clumps of *N. bennetti* secretion broke apart and formed a slurry, confirming the substance was largely composed of amino acids. Alternatively, when a protein denaturant was administered, long filaments could be plucked out. Staining for various carbohydrates in the *N. bennetti* secretions revealed the presence of hexose sugars. When these sugars are enzymatically removed, the proteins tended to irreversibly clump (and were resistant to denaturation even when boiled), signifying a potential function of the sugars. The SDS-PAGE experiments demonstrated that the constituent polypeptides of the adhesive were large, as large as 350 Kilodaltons (kDa) in *E. rowelli* and 500 kDa in *N. bennetti*. When these large-molecular-weight polypeptides were analyzed for amino acid composition, they were both found to contain high proportions of the amino acids Glycine, Proline, and Hydroxyproline and a low proportion of Methionine. Both the amino acid sequence

and the WAXS analysis suggest an unstructured polypeptide. The deep phylogenetic divergence between these two taxa prohibits a hypothesis of homology and instead indicates a fascinating case of convergent evolution. However, the authors posit that future research may reveal the secretion of *N. bennetti* is homologous with similar secretions found in other amphibians.

Graham, L. D., V. Glattauer, D. Li, M. J. Tyler, and J. A. M. Ramshaw. 2013. The adhesive skin exudate of *Notaden bennetti* frogs (Anura: Limnodynastinae) has similarities to the prey capture glue of *Euperipatoides* sp. velvet worms (Onychophora: Peripatopsidae). Comparative Biochemistry and Physiology, Part B (*in press*) doi:10.1016/j.cbpb.2013.04.008.

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New Insights into the Morphological Evolution of Turtles

Recently, the discovery and investigation of an ancient member of the turtle lineage, the Triassic *Odontochelys semitestacea*, has greatly expanded our understanding of turtle evolution. The shell of *O. semitestacea* was transitional relative to extant turtles, with a well-developed plastron but a carapace consisting only of expanded ribs, revealing the pathway of turtle shell evolution. However, whether turtle shells are derived exclusively from rib bones or possess contributions from dermal bone remained uncertain. Phylogenetic analyses including *O. semitestacea* also aided in placing the enigmatic Permian fossil reptile *Eunotosaurus africanus* as an even older member of the turtle lineage. The authors of this paper examined undescribed material of *E. africanus* with particular attention paid to whether the specimen supported the dermal-bone-contribution hypothesis. They discovered that *E. africanus* represents an intermediate stage in turtle shell evolution, with a distinct broadening of the ribs but no shell contribution from the neural spines of the vertebrae as seen in *O. semitestacea*. Instead of dermal bone contributing to the broadening of the ribs, their microanatomical investigations revealed that the expansion occurred within the perichondral membrane of the ribs. Furthermore, these investigations demonstrated that the intercostal muscles had already been lost in *E. africanus* and that the respiratory muscles had migrated to the ventral surface of the ribs. Neither *O. semitestacea* nor *E. africanus* exhibited the modern turtle condition of the pectoral girdle being contained within the ribcage, indicating this occurred after the axial skeleton and musculature modifications. The authors suggest that microanatomical investigations of *Milleretta rubidgei*, a Permian taxon proposed by previous researchers to be a successively more ancient relative of turtles, may shed further light on the morphological evolution of turtles.

Lyson, T. R., G. S. Bever, T. M. Scheyer, A. Y. Hsiang, and J. A. Gauthier. 2013. Evolutionary origin of the turtle shell. Current Biology (in press) doi:10.1016/j.cub.2013.05.003.

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Local Adaptation in "Meso-Predators" Has a Buffering Effect on Prey Diversity

Ecologists have sometimes encountered difficulty trying to explain community dynamics through biotic and abiotic factors alone. Though rarely accounted for, local adaptation may be an important component of community dynamics. The author of this paper presents findings from his research into this phenomenon. Larvae of the Marbled Salamander (*Ambystoma opacum*) are both a competitor (for zooplankton prey) and predator of Spotted Salamander larvae (*Ambystoma maculatum*). Interestingly, because they hatch in the fall and require ponds that do not freeze solid over the winter, *A. opacum* abundance varies considerably between breeding sites of *A. maculatum* (a spring breeder). Previous work has demonstrated that *A. opacum* exerts a strong selective pressure on *A. maculatum*. This is evidenced as *A. maculatum* from ponds with high *A. opacum* densities forage more aggressively (and therefore grow large enough to avoid predation faster) than those from ponds with low *A. opacum* density. In this study, three experiments were conducted to determine if this local adaptation works to increase or decrease prey (zooplankton) abundance and diversity. In a laboratory experiment, *A. maculatum* larvae from ponds with different densities of *A. opacum* were placed in a container with an identical prey base (including the four most abundant zooplankton species) and *A. opacum* chemicals cues and after 24 hours, the prey abundance and diversity were determined. This experiment confirmed that *A. maculatum* from *A. opacum*-dense ponds exhibit an increased rate of feeding, though prey preference did not vary. In a subsequent outdoor experiment, *A. maculatum* larvae reared from eggs collected from ponds of varying *A. opacum* density were placed in tubs designed to emulate natural, closed-canopy pond conditions. Identical zooplankton prey allotments were added to all tubs, and to half of these tubs, *A. opacum* larvae were added. Zooplankton density and diversity were then estimated at regular intervals starting prior to adding larval *A. maculatum* and continued through metamorphosis. Over these experiments, *A. maculatum* densities declined by 80% when *A. opacum* were present, with no significant effect of *A. maculatum* source pond. Still, source pond did have the same effect on zooplankton biomass as seen in the previous experiment. Strangely, in treatments with *A. maculatum* from high *A. opacum* density pools, zooplankton diversity increased when *A. opacum* was present and decreased when not. Indeed, a multivariate analysis indicated that *A. maculatum* predation history had a significant effect on zooplankton diversity. This seems to be a result of the two salamanders preferring different zooplankton types. These findings were confirmed in zooplankton diversity and abundance sampling of natural ponds with and without *A. opacum* present. The author concludes that while top predators have a negative effect on prey diversity, local adaptation in "meso-predators" works to counteract this effect.

Urban, M. C. 2013. Evolution mediates the effects of apex predation on aquatic food webs. Proceedings of the Royal Society B 280:20130859.

Correspondence to: **MARK URBAN**, Department of Ecology and Evolutionary Biology, University of Connecticut, 75 North Eagleville Road, Unit 3043, Storrs, Connecticut 06269, USA; e-mail: mark.urban@uconn.edu

Can Tortoises Distinguish Between Real Food and Pictures of Food?

Recent work has revealed some interesting insights into the cognitive abilities of tortoises. For instance, other new research has demonstrated that tortoises can learn from watching other tortoises. The authors of this study set out to determine if tortoises can distinguish between real food and photographic representations of food. In the first part of the study, five Red-footed Tortoises (*Chelonoidis carbonaria*) were first subjected to training trials where they were presented an item of food and a non-food item (objects they had previously been exposed to such a pebble, a piece of paper, or a bottle cap). The tortoises took an average of 12.8 trials to reliably identify the food item. Once they had achieved this, the tortoises were subjected to trials wherein they were presented photographs of a food item and a non-food item. Their performance in these photograph trials did not differ from their performance in the real object trials, implying that the tortoises were able to make a connection between an object and a photograph of that object. In the second part of the study, the tortoises were presented a real food item and a photograph of that food type. The researchers found that the tortoises chose the photograph as frequently as they chose the real food item. As the tortoises were not allowed to eat the food when they chose correctly (and therefore the outcome was the same regardless of their choice), an additional set of trials was performed wherein correct choices were rewarded. In these test trials, the tortoises chose correctly 58% of the time, significantly more than chance. However, a repeated-measures ANOVA revealed that rewards for correct choices did not improve the tortoises' performance relative to the no-reward trials. These experiments provide further evidence that vision is the primary sense employed by turtles, as the olfactory cues of the real food failed to influence the tortoises' decision making.

Wilkinson, A., J. Mueller-Paul, and L. Huber. 2013. Picture-object recognition in the tortoise *Chelonoidis carbonaria*. Animal Cognition 16:99–107.

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New Neotropical Palm-Pitviper from Honduras

The Chortis Highlands region, the mountainous area effectively spanning Honduras, boasts one of the richest and most endemic herpetofaunas of the Neotropics. Indeed, Honduras has 101 described endemic reptiles and amphibians, the vast majority of which occur in the Chortis Highlands. The authors of this paper announce the discovery of Honduras' 102nd endemic herp. While conducting the first herpetological surveys of the wildlife preserve Refugio de Vida Silvestre Texíguat (within the northern "Cordillera Nombre de Dios" region of the Chortis Highlands), they collected a series of palm-pitvipers (*Bothriechis*). These specimens morphologically conform to the species *B. marchi*, which is known from montane regions to the west and south of the Cordillera Nombre de Dios. The authors sequenced four mitochondrial genes for nine Texíguat preserve *Bothriechis* specimens and four other viper specimens from the region, and together with previously published data from eleven other specimens, compiled and analyzed a multi-taxon molecular dataset with the goal of elucidating the phylogenetic relationships of *Bothriechis*. The resulting phylogeny revealed four well-suported clades within *Bothriechis*. A clade consisting of the eyelash vipers (*B. schlegelii* and *B. supraciliaris*) is sister to the rest of the genus. Within this crown clade, the Texíguat preserve snakes form a well-supported clade sister to *B. lateralis*, a species whose closest populations occur over 500km to the south in Costa Rica, while the remaining northern species form a separate, more distantly related clade. Another southern species, *B. nigroviridis*, is molecularly divergent from other *Bothriechis* and its affinities are uncertain. Subsequent morphological analyses uncovered subtle differences between *B. marchi* and the Texíguat preserve *Bothriechis*, and similarities between the latter and *Bothriechis* specimens from Parque Nacional Pico Bonito (farther east in the Cordillera Nombre de Dios and for which no tissue samples exist). Of particular diagnostic importance is the condition of the prelacunal and second supralabial scales (fused or separate). These findings imply that the Texíguat preserve *Bothriechis* may be a relictual species, more closely related to *Bothriechis* from much farther south than to proximal species. This pattern is repeated in other taxa, such as the salamander genus *Nototriton* and the frog genus *Isthmohyla*, indicating the Cordillera Nombre de Dios region may be a paleo-refugium, allowing old lineages to persist that have gone extinct elsewhere. The authors describe the new species as *B. guifarroi* and conclude that populations attributed to *B. marchi* in the region south of Cordillera Nombre de Dios (and for which genetic tissue samples are not currently available) should be included in future analyses.

Townsend, J. H., M. Medina-Flores, L. D. Wilson, R. C. Jadin, and J. D. Austin. 2013. A relict lineage and new species of green palm-pitviper (Squamata, Viperidae, *Bothriechis*) from the Chortís Highlands of Mesoamerica. ZooKeys 298:77–105.

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Herbivorous Lizard King of Eocene Community

Although living herbivorous squamates are significantly smaller than sympatric mammal herbivores, ancient plant-eating squamates may have been closer in size to their contemporary mammal competitors. The authors of this paper describe a new fossil lizard from central Myanmar and with estimates of total size, analyze and discuss its place in its historical ecological community. The lizard, named *Barbaturex morrisoni*, was excavated from a geologic horizon dating back to the late Eocene (about 37 million years ago [mya]) and exhibits characteristics consistent with the family Agamidae. Phylogenetic analyses confirm that *B. morrisoni* is closely related to and possibly a member of Agamidae. This new species possesses several traits characteristic of living agamids and absent in more distant fossil relatives, as well as some features possessed by lizards of the agamid subgenus Uromastycinae, possibly indicative of the fossil's phylogenetic affinity. As the uromastycine fossil record dates back to the early Eocene (54 mya) and molecular clock estimates of the timing of early Agamidae diversification range from 70 to 100

mya, the time when *B. morrisoni* diverged from extant lineages is open to speculation. Though only represented by fragmentary craniofacial material, the authors were able to identify the species as an herbivore. Using measurements from extant agamids, they created a jaw length-body length curve with which to extrapolate the total body length of *B. morrisoni*. This method predicted a snout-vent length of almost one meter and a body mass of 26.7 kg, making *B. morrisoni* twice as large as the largest extant agamid, *Hydrosaurus amboinensis*. When compared with perissodactyl and artiodactyl mammals known from the same fossil deposit, *B. morrisoni* fell out in the middle of the size distribution. In contrast, in three modern communities containing herbivorous iguanians (*Uromastyx aegypticus*, *Hydrosaurus amboinensis*, and *Ctenosaura similis*) the lizards are distinctly smaller than the smallest perissodactyl or artiodactyl. The authors argue that these results signify that competition with mammals did not exclude herbivorous Eocene squamates from attaining large size and that instead Cenozoic climate change may instead have given mammals their present ecological advantage.

Head, J. J., G. F. Gunnell, P. A. Holroyd, J. H. Hutchison, and R. L. Ciochon. 2013. Giant lizards occupied herbivorous mammalian ecospace during the Paleogene greenhouse in Southeast Asia. Proceedings of the Royal Society B 280:20130665.

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Black Velvet Snake Coloration Achieved through Structural Coloration

Some squamates possess microscopic ornamentations on their scales. These structures have been hypothesized to function in aiding with locomotor ability and altering visual appearance in different taxa. For instance, the iridescent color of indigo snakes (*Drymarchon*) and the bright colors of shield-tailed snakes (Uropeltidae) are obtained through epidermal microornamentation. In this study, shed skins of the West African Gaboon viper (*Bitis rhinoceros*) were investigated for scale microornamentation form and function. This species presents a high contrast dorsal patterning consisting of light and remarkably dark, "velvet-like" regions. Scanning electron microscopy (SEM) was employed to reveal the dimensions and morphology of the microornamentation of both light and dark scales. Reflectance measurements were taken for light and dark dorsal scales, ventral scales, and a white reflectance standard with which to compare the scales. To control for the effect of scale transparency and therefore measure the effect of epidermal microornamentation alone, the authors analyzed the reflectance of light and dark scales coated with a gold-palladium alloy. Additionally, the researchers measured transmittance of each scale type. The SEM revealed the light and dark dorsal scales to have radically different microornamentation. The dark scale surfaces are densely packed with thin, wedge-shaped structures roughly 20 µm tall. In turn, the surfaces of these structures are covered with reticulating ridges a fraction of a micrometer in height ("nanoridges"). These ridges are connected by still thinner, shallower ridges and punctuated by small pits and spine-like projections. The microornamentation of the light scales was similar, however the structure at all levels is compressed vertically, resulting in much flatter surfaces. The reflectance values (percentage of white reflectance standard) for all surfaces varied more or less across the visible spectrum, but the dark scales reflected less than the light scales at every wavelength (with the reduction ranging from five to 20%). Remarkably, the gold-palladium had opposite effects on the two scale types: light scales exhibited 20 to 40% increased reflectance over non-coated scales, while coated dark scales reflected less light across the spectrum (zero to 15% of the white reflectance standard). Furthermore, metal coating on light scales reduced transmittance across the spectrum by more than half, however coated dark scales showed no reduction relative to uncoated. The authors state that this microornamentation imparting velvet black color is unique in the animal kingdom, with the most similar phenomenon being the ultra-black seen in some butterflies.

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Genomic Insights into *Bd* Evolution and Biogeography

In recent years, studies have tried to elucidate the genetic diversity and biogeographic history of *Batrachochytrium dendrobatidis* (*Bd*), with particular interest in determining if *Bd* was historically present worldwide or if it is a recent arrival in regions of amphibian declines (the "endemic" and "emergent pathogen" hypotheses, respectively). Previous studies have generally come to the conclusion that *Bd* fits the pattern of an emergent pathogen that has spread around the globe within the last century as evidenced by high genetic diversity in hypothesized regions of origin and little to no diversity elsewhere. The authors of this study aimed to reveal patterns of *Bd* genetic diversity in the New World using genomic data. Samples containing *Bd* were taken from 26 North, Central, and South American amphibians (and from one African, Asian, and Australian amphibian); from these samples, a single strain was isolated and cultured in the laboratory. These cultures were then subjected to next-generation genome sequencing, after which the recovered sequences were compiled and single-nucleotide polymorphisms (SNPs) were identified and extracted. Importantly, they also sequenced a relative of *Bd* to serve as an outgroup. These procedures resulted in 101,931 SNPs, which were then concatenated into a single dataset and subjected to a phylogenetic analysis under the Maximum Parsimony criterion. Additionally, these data were merged with previously published data on an additional 20 isolates, fifteen of which were from the Old World. In this larger dataset, 76,515 SNPs met the criterion for retention, and were analyzed in a similar fashion. As in previous studies, the authors identified a widespread *Bd* clade, the global panzootic lineage (GPL). However, these analyses revealed more genetic diversity within the GPL than previously appreciated, and found the biogeographic scenario to be much more complicated than previously suspected. While in previous studies non-GPL strains were only found in Europe and Africa, this study identified two in Brazil and one

in the USA. The authors state that there is little evidence for any geographic region being the origin of *Bd*. Using a standard rate of evolution, they derived a wide confidence interval for the timing of the origin of the GPL, the lower end of which (500 years ago) is considerably older than previous estimates. If these estimates are reliable, this indicates that either the global spread of *Bd* began earlier than previously thought, or that we cannot trace the global spread of *Bd* to a single strain. Additionally, the inbreeding coefficient was calculated for the GPL, and the low value was indicative of either sexual reproduction or mitotic recombination. To determine which of these two factors is at play, the authors determined how chromosome heterozygosity correlates with chromosome size. They found that larger chromosomes have less heterozygosity than smaller ones, consistent with mitotic recombination. The authors conclude that *Bd* is endemic in some regions and novel in others, and previous attempts to cast *Bd* as either an emergent or endemic pathogen amount to a false dilemma.

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New Pesticides Found to be Accumulating in Frogs of Pristine, Montane Environments

Along with fungal pathogens, invasive species, and habitat destruction, pesticides are recognized as an agent of amphibian declines. The high elevations of western North America's Sierra Nevada seem pristine and beyond the reach of pesticides, but previous research has shown that prevailing winds transport pesticides from California's Central Valley to the tops of the mountains. The authors of this paper sampled high-elevation populations of the Pacific Chorus Frog (Hylidae: *Pseudacris regilla*) to determine if contemporary pesticides are accumulating in Sierra Nevada frogs. Water, sediment, and *P. regilla* samples were collected from seven sites spanning the Sierra Nevada during the breeding seasons of 2009 and 2010. Additional water samples were takes 10–12 weeks later (coinciding with peak pesticide usage). Using gas chromatography, the authors evaluated these samples for the presence of 98 pesticides and pesticide degradates. Pesticide concentrations were analyzed between years and sampling sites, and sites differing in pesticide diversity and prevalence were identified. Twelve pesticides or pesticide degradates were detected in frog tissues across the study area, none of which were detected at all sites. Two fungicides, pyraclostrobin and tebuconazole, were detected from tissues taken at all but one site: the relatively pesticide-free Summit Meadow of Yosemite National Park. Dichlorodiphenyldichloroethylene (DDE; a degradate of the long-banned insecticide DDT) was also detected in frogs at six of the seven sites, which is not surprising given its high environmental persistence. DDE and the insecticide diazinon were the only compounds of the twelve that had ever been recovered from anuran tissue before this study. Overall, the water and sediment samples poorly reflected the compounds seen in the tissue samples. The water and sediment samples turned up fewer pesticide compounds, and the compounds identified in them were quite different from those found in the frog tissues (86% and 43% different, respectively). Giant Sequoia National Monument, the southernmost sampled site, exhibited the highest concentrations of pesticides, while the site with the highest number of pesticides (10) was in the Stanislaus National Forest in the central Sierra Nevada. These findings demonstrate that currently used pesticides applied as much as a 100 km away are finding their way into frogs. This should be an impetus for further studies, as we know little of the effects of these chemicals on amphibians.

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OBITUARIES

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Celebrating Herbert Clay Dessauer 1921–2013

Herb Dessauer (30 December 1921–8 February 2013), clearly one of the nicest and most generous people in herpetology, died with a respiratory illness. He had served as a meteorologist in the Air Force in World War II, being among the first "hurricane hunters" in the Pacific with his lab in the nose-gunner position of a B-24 bomber, then entered medical school at LSU where he realized that the thrill of discovery in biochemistry and nature were his primary interests. His wife, Frances Jane Moffat (1926–2005; they married on 10 December 1949), entertained and enjoyed his graduate students, visitors, and their families as much as Herb did, throughout his long career at the LSU Medical Center, New Orleans. The Dessauers especially loved to expose visitors to the real New Orleans, Herb's home town, and various nature reserves in southern Louisiana. Herb also loved literature of every kind (Fig. 1). However, it is not our intent to do a traditional-style obituary on Herb here. For such personal history see the Historical Perspective (Liner and Cole 2003. Copeia 2003:195–199). Our intent here is to pay tribute to Herb's joy of life; thrill of discovery; love of family, colleagues, and friends; and his accomplishments and productivity in science. Our world would be a lesser place if Herb Dessauer had not been here.



PHOTO BY DAN SHOCHAT, 1974

FIG. 1. The academic Herbert C. Dessauer at his desk, surrounded by literature.

As a graduate student in the 1950s, Herb Dessauer began to wonder whether there was biochemical evidence bearing on the theory of evolution. Consequently, he merged his interests in nature and state-of-the-art research laboratories. After a few discoveries he was thoroughly hooked and went on to influence the following (citing examples from his Bibliography, below): nontraditional animal models (1950–1953); proteins, especially electrophoresis with amphibians and reptiles and attempts to find correlations with phylogeny (1955–1957); use of protein electrophoresis to study genetics of hybrid zones (1961–1962); importance of long-term management of research resources for the broader scientific community (1975, 1984); discovery of multiple paternity in kingsnakes (1983) and alligators (2001); parthenogenetic cloning in unisexual lizards (1986); the hybrid origins of tropical unisexual species and use of molecules to predict the existence of unknown species (1989, 1990); descriptions of new species (1993, 1997); and use of molecular probes to efficiently screen large samples of reptiles from nature (1996). His diverse research subjects included amphibians, reptiles (including birds), and mammals (including humans). Herb was creative and proficient as a laboratory experimentalist, and when the budget was stressed, he made his own potato starch, starting with whole potatoes from the grocery store. Molecular specialists have called Herb "one of the fathers of Molecular Systematics" (Liner and Cole 2003. Copeia:197).

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Comments from Colleagues

The Boy Scout Law states that a scout is "Trustworthy, Loyal, Helpful, Friendly, Courteous, Kind, Obedient, Cheerful, Thrifty, Brave, Clean, Reverent"…a pretty high standard, yet it well describes Herb Dessauer. OK, not Reverent, in fact decidedly irreverent, but 11 for 12 is a great batting average.

In the 1960s I was a graduate student working on anole behavior on Trinidad. I suspected that two species were hybridizing and understood the important implications of the biochemical/genetic work Herb was publishing, often with his friend Wade Fox. When I wrote Herb to ask if I could send some lizards for analysis, he responded by inviting me to work in his lab in the summer of 1964 and learn first-hand. Working with Herb and his associates at the LSU Medical Center in New Orleans, where I was treated as a colleague, kick-started my scientific career. I soon realized that beyond the scout law, Herb was Welcoming, Enthusiastic, Patient, and Supportive. He also completely lacked pretension, and that was one of the most endearing parts of his personality.

An inestimable added bonus to my visit was to be completely embraced by the entire Dessauer clan as a virtual family member. Consequently, I benefitted from many fine meals at their home, generally prepared by Fran. I last saw the Dessauers during a short visit in 2002, when Herb led me and my wife Amy to the Barataria Preserve of the Jean Lafitte National Historical Park, where he enthusiastically pointed out water moccasins and anoles.

George Gorman

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Herb Dessauer was the mentor of my father and a huge figure in my New Orleans childhood, starting at age 4. I practically grew up in his lab. He was a wonderful grandfather figure to me with a mischievous smile and a love for Halloween that made me question whether he was an adult or just a really big kid. My father always discussed him in tones of awe and adoration, which only confirmed that my initial gut feelings were correct and his family welcomed our new immigrant family into their home in a deep and honest way I have tried to emulate since. You never knew what mysteries lay in their labs. Once I had to use the bathroom and pants down at the bowl I looked over at the bathtub and staring back at me was a gaggle of very excited baby alligators. Even for a feral lizard-catching little boy, that was heart attack material. I credit his group of dedicated but fun-loving scientists with inspiring me to study science in turn.

Guy Shochat (son of Dan and Edna)
UCSF Medicine

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Thanks to an introduction through George Gorman, Herb Dessauer invited Dan to join his lab as a graduate student in 1971. We depleted our savings account to purchase trans-Atlantic, one-way air tickets from Israel and arrived in New Orleans with two young children. Herb and Fran were instrumental in softening the culture shock and sense of loneliness associated with the transition from a foreign country for a young and cash-strapped graduate student family. Forty-two years later we look back at Herb and Fran as ones who changed the course of our lives for generations to come. Every Thanksgiving we remember the Dessauers for taking us under their wings, for their love and hospitality, and for important help in settling into our adoptive homeland.

Edna and Dan Shochat,
Agama Inc., Biopharmaceutical Consulting

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The typical day in the Dessauer lab started with the ritual of drinking coffee and chicory. Herb had a white porcelain-looking drip unit that he never washed. Yesterday's grounds were simply dumped out the following morning. Most people drank cafe au lait, a few cafe noir. The most telling aspect of this morning ritual was an inevitable race to the bathroom, however subtle it appeared, as Herb's coffee was one of the great laxatives never sold on the open market.

Another ritual was the weekly trek on Fridays to get a lunch of gumbo at a local restaurant off Canal Street. The gumbo was fantastic, and discussions ranged from hypotheses about why an experiment did or did not work to New Orleans politics (always a fascinating topic) to when the next music festival, Mardi Gras, or other holiday would occur. They do know how to party in New Orleans. One Friday in late 1979 most members of my graduate committee came over with the "regulars" to get gumbo. Herb surprised me by asking if I could name to genus everything in the gumbo. After stammering a bit, I actually named 5 of the genera (*Penaeus*, *Callinectes*, *Crassostrea*, *Sassafras*, *Oryza*). Herb later told me that was the first part of my qualifying exam; those biochemists and molecular biologists were so impressed that I probably passed my orals on the spot (of course they still put me through the wringer two weeks later).

The most important thing that I remember about Herb and daily laboratory life was that he was so willing to come into the lab and help. Here was the man who had published a starch gel electrophoresis study of lizard allozymes a full four years *before* Lewontin and Hubby's classic *Drosophila* allozyme paper appeared in 1966, was a Full Professor and recently the President of the American Society of Ichthyologists and Herpetologists, and he was *still* willing to jump right in to help bleed a snake, run a micro-complement fixation reaction or a gel, or even do the dishes. It was an object lesson that I never forgot.

Some of my most enjoyable times as a graduate student were spent with Herb, Miss Frances and their children Danny, Becky, and Bryan, at their A-frame cabin and extensive wooded property near St. Francisville, LA, the same area where young Audubon lived for a while teaching the children of wealthy plantation owners and painting so many of his famous bird prints. We would sit around drinking beer, eating crawfish, and enjoying each other's company, oh yes and "telling lies." I have modeled my own interactions with our lab's graduate students after Herb and I often think about him when I am at the Rockefeller Wildlife Refuge or some wilderness locality in Texas surrounded by my students and family and enjoying a good meal and a cold beer.

Herb Dessauer was a very special human being who loved his family, loved his students, and loved life and he knew how to get the most out of it. He also loved his science, and his enthusiasm and dedication spread infectiously among those with whom he worked. Herb was a great friend, wonderful mentor, and an outstanding role model for me and many others. We should all be so fortunate to have a life as full as Herbert C. Dessauer had (Fig. 2).

Llewellyn (Lou) Densmore

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F. Harvey Pough, the undergraduate mentor at Cornell who steered me toward Herb Dessauer's lab for graduate school, called Herb "the kindest man you will ever meet." Truer words were never spoken. I was to see Herb prove Pough right time after



PHOTO COURTESY OF SMITHSONIAN PHOTO SERVICES

FIG. 2. The social Herbert C. Dessauer at the Second International Conference on Ancient DNA, 8 October 1993, Washington, DC.

time in his interactions with students, colleagues, family, friends, and even strangers on the streets of New Orleans. Herb absolutely adored children (Fig. 3)—watching them, teasing them, challenging their minds, getting down on the floor and rolling around with them. In many ways his love of science was childlike too—full of wonder, enthusiasm, and awe. Herb and Fran did not yet have grandchildren when I joined the lab in 1977, so they immediately became surrogate grandparents when our daughter Jessica was born. Herb constantly volunteered to babysit, and often asked if I would be taking my wife out on a Friday or Saturday night (so he and Fran could have Jessica). Later he reveled in showing her herps and insects that we encountered on outings. There were few other kids in the lab family at the time, so Jessica often became the center of attention. As her third birthday approached, my wife Kirsten and I asked her who she wanted to invite to her party, expecting her to name classmates from preschool. Her response: "I want Uncle Herb, Aunt Frances, Toby (Bradshaw) and Moira, Lou (Densmore) and Sandy…"—all the adults from Herb's lab group! It worked out well for Jessica, as she got better presents than would have come from a houseful of three-year-olds.

In the lab, Herb was a dyed-in-the-wool experimentalist. Even though he was awed by good literature of every kind, and we worked in a high tech biochemistry department with sophisticated, state-of-the-art-equipment, he had no interest in users' manuals. It was a personal challenge to figure out how something worked by tinkering with it, no matter how complicated. He often said that the first thing he did with a new piece of equipment was to discard the users' manual. We did not know how serious he was until a large and expensive piece of equipment arrived for a new faculty member who was outfitting her lab nearby. It was something like an ultracentrifuge or laminar flow hood, and a small crowd of graduate students and junior faculty gathered to help uncrate and admire the sophisticated equipment. When the users' manual appeared in the packaging, I held it up and said "You know what Herb Dessauer would do with this?" while tossing it into a wastepaper bin with feigned disgust. I retrieved the manual as the laughter subsided, and Herb appeared in the doorway, attracted to the mirth and crowd. "What's this?" he said, "A new toy?" as he admired the shiny machine. Suddenly Herb saw the manual in my hand, grabbed it, and turned to the new owner. "Now, you know what to do with this, don't you?" he said dramatically as he tossed it right back into the same wastepaper bin! Everybody cracked up and Lou Densmore literally fell to the floor doubled over. Herb laughed also, but I do not think he ever knew why his demonstration was so entertaining.

Mike Braun

***

Herb had a helluva run, making his mark big-time as a scientist and remaining a thoroughly decent and life-loving human along the way.

Harry Greene
Cornell University

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In the late 1970s I also received a wonderful invitation for an extended visit to Herb's lab in New Orleans. I asked him when I should arrive to best fit his busy schedule, and he said "I'll have to check the calendar and get back to you." The morning after my arrival we were working feverishly in the lab and had gels running by 1:00 p.m. Then Herb announced "It's time for a parade, let's go!" as he whisked me out the door. In no time, Herb and Fran were down in the gutter scrambling for plastic beads and candies thrown off the parade floats, and Herb was making a mental note on how long it took for this visiting introvert from New York to do the same. Suddenly I realized that checking his calendar to plan the date of my arrival had nothing to do with his lab schedule. It depended on the dates for Mardi Gras parades! The same scheduling happened year after year, and my wife and I enjoyed all the special pleasures of being enveloped in the Dessauer family as have been described above.

Jay Cole

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My first visit to the Dessauers occurred during the year Jay and I were married (1978–1979). When Herb and Fran learned that we had been married at City Hall in New York City they decided we needed a real wedding, which was quickly organized in their back yard. Local wild flowers provided the bouquet and Mike and Kirsten Braun's daughter was the bridesmaid. Lou Densmore, in priestly robes, performed the ceremony, reading from the most recent issue of *Evolution*. A choir of howling dogs in the next yard provided the music. A feast of crayfish followed and immediately became my favorite food.

Our long friendship with the Dessauers greatly enriched our lives. Fran became one of my very best friends. We frequently experienced New Orleans culture, food, and the crazy days of Mardi Gras with them, and they often came north to visit cultural institutions in New York and experience the snow. On one important visit, invited by the Director of the AMNH, Herb appeared in a tuxedo with a portable electrophoresis lab for a Trustee Dinner, where he provided demonstrations that helped the AMNH move into molecular phylogenetics.

Carol Townsend
AMNH

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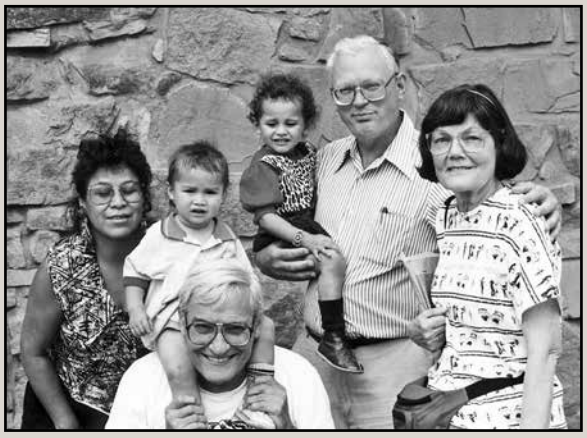


PHOTO BY CAROL TOWNSEND, 1992

FIG. 3. The playful Herbert C. Dessauer and his wife Frances on a visit to the Navajo Reservation with Jay Cole, his daughter-in-law Shirl, and two grandchildren, Clint and Alicia (left to right).

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Paulo Emilio Vanzolini
25 April 1924–30 April 2013

Miriam Heyer and I interviewed Vanzolini at his home in the Cambuci neighborhood of São Paulo in order to compose a historical perspective for the journal *Copeia* (2004:184–189). The following reminiscences about Vanzo slightly duplicate material in the *Copeia* article.



PHOTO BY W. R. HEYER

Vanzo on boat on the Rio Madeira writing his field notes after collecting specimens in the morning.

Vanzo was initially appointed as Director of the museum within the Departmento de Zoologia da Secretaria de Agriculatura do Estado de São Paulo. Shortly thereafter, he successfully transferred the museum to the Museu de Zoologia da Universidade de São Paulo (MZUSP). The scientific staff was small and Vanzo was the only staff member who had a PhD (from Harvard University, Alfred Romer was his Major Professor). Vanzo brought together biology students from the University of São Paulo and provided either "internships" or educational opportunities for them. Naercio Menezes was a USP student at the time Vanzo became Director of MZUSP. Vanzo brokered Naercio to get a PhD (fishes) from Harvard University. Vanzo took it upon himself to be the major professor for other MZUSP zoologists to obtain their PhDs from the University of São Paulo. In the decade 1970–1979, 15 curators obtained their PhDs; from 1980–1989, 7 curators obtained their PhDs, and Vanzo's last PhD student was in 1990. Vanzo's PhD students' dissertations covered the whole field of zoology—6 insects, 1 nematode, 2 gastropods, 5 fish, 3 frogs, 2 lizards, 2 bats, and 1 primate. (I have not included USP Masters degrees or non-biological PhDs). Vanzo's efforts resulted in the MZUSP having the most robust natural history scientists in all of Brazil. This core of high quality scientists established a firm foundation for the Museum during the entire term of Vanzo's directorship (when Vanzo was appointed to be Director of the MZUSP, the term was for life, with mandatory retirement at the age of 70).

The following illustrates, in part, Vanzo's approach to science and scientists. When I was an Assistant Professor of Biology at Pacific Lutheran University (1970–1973, Tacoma, Washington, USA), I obtained a National Science Foundation award to undertake research on *Adenomera* and *Leptodactylus* species in South America. On one of the trips to South America, I collected frogs in northern Argentina and then went to São Paulo to introduce myself to Vanzo and to take some data on the MZUSP *Adenomera* and *Leptodactylus* species. When I arrived at the MZUSP, I was told that Vanzo was on an Amazonian expedition; I was disappointed that I was not able to meet him. In 1973 I obtained a Curator position at the Smithsonian Institution. About a few months after my arrival at the Smithsonian, I received a telephone call from the front desk indicating that a visitor wanted to see me. I walked to the front desk and there was Vanzo! As soon as we reached my office, he asked me about my research. I told him that I had just undertaken research on *Leptodactylus* at Limoncocha, Ecuador, near the Brazilian border, and I was curious about the distribution of *Leptodactylus* in adjacent Brazil. I had a large map of South America in my office and I pointed to the general region in which I would like to pursue fieldwork on Brazilian leptodactylids. Vanzo indicated that he was organizing an expedition to the Rio Purus and if I wished to join him, I could do so. I enthusiastically confirmed my desire to join his expedition from December 1974 to January 1975. Vanzo hired a river boat with a captain and crew. The captain told Vanzo that because of the length of time for the expedition, he would only undertake the trip if he could bring his family along (a wife and three relatively young children) and that the captain's wife would serve as the cook. Vanzo had no other option at the time, so he agreed with the captain's terms. Vanzo invited his nephew, Roberto Brandão, to join the expedition. Beto (as he is known) was finishing college and Vanzo thought that Beto's experiences on the trip might help him determine whether he would go to graduate school in some aspect of zoology. Beto wound up undertaking entomology in graduate school (Universidade de São Paulo), worked on ants, and was hired at MZUSP where he still continues his entomological studies. Vanzo, Beto, and I flew to the town of Rio Branco (on the Rio Acre), where we met the boat and crew. It was after this first trip with Vanzo and my subsequent times at the Museum that I realized that Vanzo managed things differently on the river than at the museum. On the Rio Purus expedition, Vanzo took disasters with a grain of salt. The first potential blow-up occurred when we met the boat and crew and found out there was an additional person who would make the trip. Vanzo had contracted for the three children, wife, captain, engine man, Beto, Vanzo, and myself. The boat was not large. Vanzo asked the captain about the additional person and the captain said he was an old family friend who wanted to go to Manaus before he died. Vanzo suggested that there was no room for the friend and the captain countered by saying he would not undertake the trip without the old family friend. Vanzo calmly deferred. We departed to the city of Boca do Acre which had a naval customs house for inspecting boats going upstream from the town of Boca do Acre. There were three documents that had to be approved by the customs inspector: paperwork for the captain, the engine itself, and the engine man. The captain had appropriate paperwork. Neither the engine man nor the engine had appropriate paperwork. Additionally, there was no toilet on the boat nor were there working lights on the boat. The boat, the engine, and engine man failed the inspection. The only solution

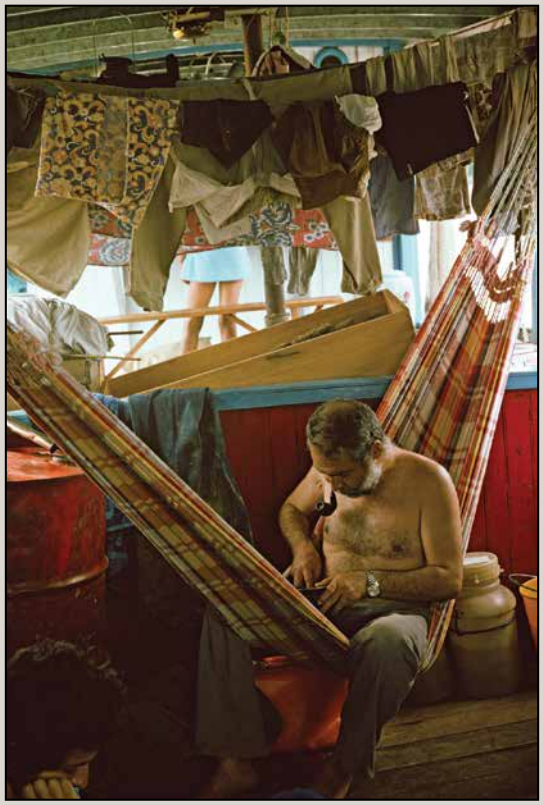
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After the Rio Madeira trip, Smithsonian Under Secretary David Challinor wanted to evaluate the success of the Smithsonian Intstitution's Neotropical Lowland Research Program (I was a participant in the program). Vanzolini gave Challinor a tour of the Manaus region, and Challinor wanted to watch river boats being constructed. (Challinor was a boat fanatic.) After Vanzo's tour with Challinor in Manaus, the three of us flew to São Paulo, with a tour of the Museu de Zoologia and Vanzo took Challinor to see *Araucaria* forests in the mountain range in São Paulo. Challinor also had a fondness for *Araucaria*.

PHOTO BY W. R. HEYER



Vanzo cleaning a turtle skeleton on the Rio Purus boat trip. The wooden box behind Vanzo contained mammal skins. Whenever the sun was out, Vanzo opened the box to fight mold. The two legs behind the clothes belong to the Captain's daughter.

was for the boat and crew to go to the captain's home town of Xapuri. Vanzo was told that the captain's brother had appropriate engine paperwork and that they would install a toilet on the boat at Xapuri. Vanzo accepted the situation very calmly. When the boat and crew returned to Boca do Acre, Vanzo learned that the captain's brother did not have the engine paperwork. The captain and his brother found another engine that did have appropriate paperwork and swapped the engines. Fortunately, the inspector did not ask to have the lights turned on. None of the engine-powered lights worked. Only a kerosene lamp provided light at night. Consequently, there was very little night boat travel. One night when Vanzo, Beto, and I were collecting specimens at Boca do Acre while we were awaiting the return of the boat from Xapuri, Vanzo happened to see a house that had a party going full blast. Vanzo saw the customs inspector exhibiting some sort of inappropriate behavior and the inspector noticed that Vanzo was looking in at the party. When Vanzo went to have the boat inspected, he asked the inspector if there was some way of certifying the engine man. The customs official wrote an official note that the engine man had approval for the trip to Manaus as there were no other licensed engine men in Porto Velho. I don't think the boat would have been approved if Vanzo hadn't seen the customs official partying. The boat and crew returned to Boca do Acre one week later. Again, Vanzo took the information about the changes made on the boat very calmly. This calm personality on Vanzo's river trips was in stark contrast to Vanzo's role as museum director. At MZUSP, Vanzo was THE BOSS! There was no give-and-take regarding how the museum was to be administered. On this trip, Vanzolini told me that he did not drink cachaça or pinga on the river trips, to convince himself that he was not an alcoholic (although he certainly downed quite a bit of cachaça in São Paulo). Vanzo underwent mandatory retirement at 70 years. After Vanzo's retirement, USP initiated four-year terms for MZUSP Directors.

Vanzo often mentioned that he much enjoyed the fellowship of practitioners of "plastic arts." I recently learned that the Brazilian term translates to visual arts, embracing artists, photographers, and film makers. (Vanzo also published a book of his poetry). Vanzo invited me to join an expedition the following year on the Rio Madeira (October–December 1975). Vanzo had received funding from FAPESP (Fundação de Amparo à Pesquisa do Estado de São Paulo) to purchase two boats for his subsequent Amazonian trips. The two boats were lashed side-by-side. The crew slept on the boat with the engine. The other boat lacked an engine and was used by scientists and guests for work, dining, and sleeping. All specimen preparations were performed on the motorless boat so that specimen preservation did not endure vibrations that would otherwise cause distortion of the specimens. Vanzo had the crew catch fish that provided food on the trip as well as several carboys of fish specimens for the MZUSP ichthyologists to study. The Rio Madeira trip included Miriam Heyer, the entomologist Francisca Carolina do Val (Chica, short for Francisca) who focused on drosophilid flies, and the artist José Claudio da Silva to document his impressions of the expedition. José Claudio produced just over 100 oil paintings on the trip, at least one painting per day as well as numerous sketches. José Claudio didn't appreciate the forests in which we collected. He never set foot in the forest except for once to observe our night collecting. Otherwise, he only got off the boat when we stopped at towns to obtain supplies. All of the paintings that José Claudio executed on the Madeira river trip are now in the collection of the State of São Paulo's Governor's Palace in the city of São Paulo. José Claudio also kept a daily log on the expedition, which he subsequently published both as newspaper articles and as a book (Silva 2009). After our return from the Rio Madeira, Vanzo received a message from the director of FAPESP that the Rio Madeira expedition would be the last trip for which Vanzo would receive FAPESP funding. The FAPESP director and Vanzo had some disagreements that resulted in Vanzo being cut off from further

FAPESP funding for use of the boats. Vanzo was livid when he received the telephone call from the FAPESP director and that was a sore spot for several years afterwards. There was some sort of bureaucratic problem involving funding for the boat crew members who were residents in the State of Amazonas and were illegally being paid from São Paulo funds. According to Vanzo, "his boats" sat stagnant at Manaus and finally deteriorated. The irony of this fracas was that Vanzo was part of the committee that established FAPESP. Vanzo was proud of his contribution to the founding committee of FAPESP. In 1959 one of Vanzo's friends was appointed Secretary of Agriculture for the State of São Paulo. For the next four years, Vanzo served as a cabinet advisor to the Secretary of Agriculture. Vanzo was given the assignment of writing the legislation for creating FAPESP. Vanzo was proudest of his role in obtaining an inflation-resistant funding source for FAPESP. The initial 0.5% of state sales tax was later raised to 1%. To this day, FAPESP is able to support the State of São Paulo scientists on the basis of sound research and never have to worry about funding ups and downs. After the FAPESP fracas, Vanzo later found other boats to continue his river collecting trips. As far as I am aware, there were only two additional Amazon river expeditions that he undertook. In addition, one of Vanzo's film director friends made a movie about Vanzo's boat trips describing the nature of the kind of research that Vanzo undertook. The film was completed and shown commercially in Brazil. FAPESP and Editora Beca recently published Vanzo's collection of all of his scientific papers (Vanzolini 2010).

Vanzo lived in an uncompromising positive or negative environment—there was no gray in his life. As an example, Werner Bokermann was a protégé of Vanzo. Werner was raised in Campinas and was a self-taught taxidermist. He went to MZUSP to inquire if there was a taxidermist position available. Vanzo mentored Werner on how to curate and study frogs. Werner's frog articles were well done. Unfortunately, Werner crossed a line. When Vanzo was working on his PhD under Alfred Romer at the Museum of Comparative Zoology at Harvard, Vanzo was personally providing Werner with funds to complete high school so that he could start getting a college education in zoology. Werner decided that going to school was a waste of his time and stopped attending. Werner did not inform Vanzo about his decision, but word got around to Vanzo, who stopped all support for Werner's classes. Vanzo was instrumental in obtaining a position for Werner at the São Paulo zoo, so that Vanzo would no longer have to interact with Werner. Werner was not the only person who crossed Vanzo. When Vanzo was at Harvard getting his PhD, Carl Gans often studied amphisbaenids at Harvard. Upon completion of his PhD at Harvard, Vanzo invited Carl to study amphisbaenids at MZUSP. Carl became friends with a MZUSP staff member. Vanzo did not approve of the situation and a rift developed. Vanzo was not on speaking terms with Carl for the rest of his life. I came dangerously close to crossing the line with Vanzo. The editor of *Papéis Avulsos de Zoologia* sent me a manuscript on amphisbaenids authored by one of Vanzo's colleagues. I reviewed the manuscript and made several minor suggestions for improving it. I received a terse message from Vanzo in the mail telling me that he had fully approved of the manuscript as it was and he was furious at the suggested changes. I thought that I had crossed the Vanzolini line. Miraculously, as far as I was concerned, the manuscript was submitted to another journal. Vanzo subsequently wrote to me that the other journal accepted the manuscript with the same text as initially submitted to *Papéis Avulsos de Zoologia* and that he was not pleased with me and my review!



PHOTO BY W. R. HEYER

Vanzo in the forest on the Rio Purus. Vanzo was particularly looking for *Anolis*, but collected all kinds of vertebrates for the MZUSP collection. At each site that we collected, Vanzo set up lizard markets for children/teenagers. He always paid each youth a fair price and accepted all specimens. He specifically told the collectors that he did not accept snakes as there was always the chance that the collectors would be bitten by venomous snakes.

Through most of Vanzo's tenure as Director of MZUSP, a driver would pick him up at his residence at 7:30 am. He worked in the Director's office in the morning, taking care of museum administration and museum-wide research and collections activities. He spent the rest of the day after lunch in his research offices. He had a drink or two of cachaça or pinga after 6 pm and often invited one or two colleagues to join him. He then went to a restaurant for dinner and visited a night club or two to listen to (and often participate in) Brazilian sambas. Ernest Williams was Vanzo's house guest in Brazil when the two of them worked on joint research projects. When Ernest retired from the MCZ, Vanzo lobbied Ernest to spend the rest of his years in São Paulo so that the two of them could continue their research collaboration. Vanzo was unsuccessful in getting Ernest to live out the rest of his life in São Paulo. By the time I met Vanzo, he was estranged from his wife. His parents had owned a set of five townhouses in the Cambuçi neighborhood that were close to MZUSP. Vanzo moved to one of the Cambuçi houses after first spending some time in a rental apartment. Samba singer Ana Bernardo moved in with him after a few years. During his last decade or so, Vanzo and Ana produced compact discs of Vanzo's music and produced samba "shows." Ana sang with two or more instrumentalists while Vanzo sat on the stage providing commentary on aspects of his sambas. Within Brazil, Vanzo was a famous "pop star" known and appreciated for his sambas. Outside of Brazil, he was an internationally known herpetologist. Vanzo was very frustrated to be more recognized as a musician/composer than as a scientist within Brazil. Reporter Leila Kiyomura (*Jornal da USP*, Ano XXVIII, number 997, p. 16) quoted Vanzo "You cannot want to be the owner of an idea. A scientist has to be generous to divide the investigation with the world. It is necessary to know how to share. This I learned in the United States from the American scientists." Kotomura also pointed out Vanzo's generosity of donating his private library to the University of São Paulo that he bought with the money he made from his songs.

Paulo Emilio Vanzolini was indeed a complicated, intelligent, fascinating, and at times, a frustrating person. I miss him.

There is a substantial amount of Vanzolini correspondence that is now deposited in the Smithsonian Archives and available to the public.

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In Memory of Hobart Muir Smith (1912–2013): From Humble Beginnings to Worldwide Recognition

Unlike most of his peers in academia and in the field of herpetology, Hobart Smith had a problematic childhood characterized by events that both consciously and subconsciously proved to be important elements in his lengthy life. He was not born with a silver spoon in his mouth—in fact, he was not born as Hobart Smith.



PHOTOGRAPHER UNKNOWN

Young Hobart Smith (age 5 or 6) with pet chicken in Oklahoma.

In Stanwood, a small town east of Cedar Rapids, Iowa, on September 26, 1912, a child was born to Harry M. Stouffer and Blanche M. Hawk Stouffer; he was christened Frederick William Stouffer, the fifth child of his parents, who had been married in May 1904 in Chambersburg, Pennsylvania. The family eventually settled in Ohio, where a sixth child was born in 1914. For unknown reasons, Harry Stouffer left his family and enlisted in the army to fight in the Great War. He was killed in combat on July 18, 1918 and was buried in the Aisne-Marne American Cemetery, Belleau Wood, near Paris, France. Meanwhile, the family was destitute, and all six children were farmed out or placed in an orphanage. By early 1915, Frederick was living with three siblings in the Huron County Children's Home in Norwalk, Ohio. So far as known, Blanche Stouffer surrendered all of her children for adoption, never saw her children again, and remarried to become Blanche Hawk Stouffer Burr. Frederick grew up believing that he had been orphaned.

When Frederick was somewhat disobedient at the orphanage, he was punished by being placed in a scary dark basement room. Nevertheless, he survived two years in an orphanage that allegedly had a history of mistreating children. In the summer of 1916, a childless couple, Charles Henry Smith and Frances Muir Smith, who had been vacationing in Michigan, visited the orphanage and later adopted Frederick in Oklahoma on May 10, 1917. Frederick was renamed Hobart Muir Smith. The Smiths resided in the small agricultural town, Shawnee, Oklahoma, where Charles was a postal clerk and Frances had been a schoolteacher. Early in his childhood, the family moved to Okmulgee, Oklahoma, where they lived in a house with gas lights instead of kerosene lanterns that had been their sources of light in Shawnee.

Hobart's parents were strict disciplinarians, who seemed to have had little insight as to how to raise a child; however, his mother is to be credited for having initiated his education prior to his entering school. In fact, on entering grade school, Hobart was placed in the second grade. Although he met the academic challenges, he was small in size and frequently bullied; nonetheless, Hobart was reasonably well muscled and survived by running away. In 1925, the family moved to Bentonville, Arkansas, where they enjoyed electric lights. Hobart skipped the first year of high school, and became active in physical education. Unfortunately, he was stricken with an unknown disease that resulted in tachycardia, which necessitated his slowing his physical pace. While he was in high school his adoptive mother died of tuberculosis.

Hobart held various low-income summer jobs in Bentonville. He greatly enjoyed the woods and streams in the Bentonville area, and developed a fascination with insects. Having no books on insects, Hobart knew nothing of their classification and relationships. One of his high school teachers suggested that if he wished to pursue a career in entomology he should go to Kansas State College. Consequently, in the early fall of 1928 at the age of 15, a socially inexperienced Hobart Smith found himself on the campus of Kansas State University. There he came to know Professor Reginald H. Painter, an insect taxonomist, who proved to be an important influence on Hobart's life.

Shortly after Hobart became established in College at Manhattan, Kansas, his adoptive father came for a brief visit and inopportunely, died there. Again Hobart was an orphan. Once the immediate arrangements were taken care of, Hobart faced a new problem—he was underage and had no parents, although he had inherited funds sufficient to see him through his undergraduate education. Fortunately, Professor Painter agreed to be his guardian. Hobart never lived with the Painter family, but he did accompany them on field trips to collect insects. Painter greatly influenced his orientation toward a career in taxonomy, but taxonomy of what?

Painter introduced Hobart to a young assistant professor in the Department of Zoology, Howard K. Gloyd, who maintained quite a herpetological menagerie. Gloyd "allowed" Hobart to take care of the live amphibians and reptiles, mostly rattlesnakes, and introduced him to scientific names and classification. Hobart

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accompanied Gloyd on three field trips to southeastern Kansas, Utah, and Arizona, and familiarized himself with the habitats and behavior of many species. Initially, Hobart was a mediocre student, but once he developed some basic studying techniques along with an interest in biology, he became an all "A" student.

One day Gloyd introduced Hobart to a visitor from the University of Kansas—Professor Edward H. Taylor. Over the next two years, Hobart joined Taylor on short collecting trips in Kansas. Perhaps because of their different personalities, the domineering Taylor and the comparatively meek Smith worked well together in the field. On one or more of these field trips they must have discussed plans to invade Mexico (herpetologically speaking). On June 4, 1932, 19-year-old Hobart Smith graduated from Kansas State University with three short herpetological publications to his credit,. As he shed his cap and gown, Taylor was waiting for him, and they drove south to Mexico. Thus was born one of the greatest herpetological achievements of all time. [A detailed account of Hobart Smith's childhood and collegiate career can be found in Smith, 2001].



PHOTOGRAPHER UNKNOWN

Charles and Hobart Smith (age about 12) in Arkansas.

In 1932, roads in Mexico were few and still fewer were paved. Smith and Taylor went everywhere they could in Taylor's aging car; the many times they were stuck in deeply rutted roads, they had to be pulled to drier ground by oxen. Flat tires were common; once they even dropped their gas tank. Early in the trip, individual responsibilities were sorted out. Both men spent all available time collecting. Hobart preserved and cataloged specimens, and Taylor drove and prepared meals—mostly rice, sugar, and canned evaporated milk—three times a day! Occasionally this diet was supplemented with bread and rarely by a chicken. Taylor, who personally was financing the trip, sometimes would buy each of them a meal and a beer in town. Taylor had set a goal of 50 specimens per day. Most specimens were caught by hand, but a .22 caliber single-shot rifle with dust-shot cartridges was used for many lizards. At night, they each carried a Coleman lantern for finding frogs and occasional snakes. They exceeded Taylor's goal by collecting 5500 specimens in three months. These specimens formed the EHT-HMS collection maintained by Taylor at the University of Kansas.

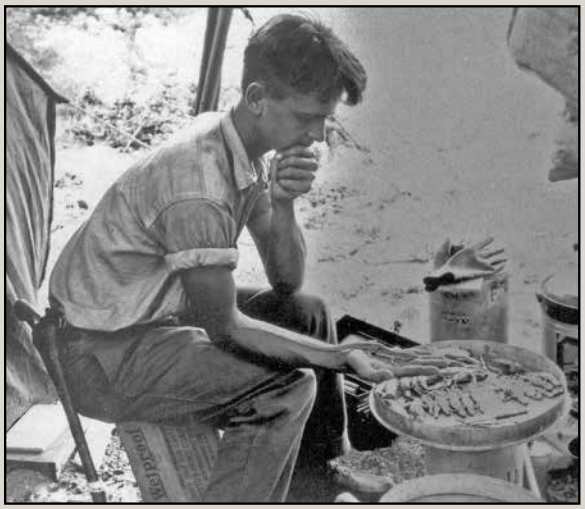
The relationship between Edward H. Taylor and Hobart M. Smith was sometimes tenuous. This is best expressed in a letter to WED from Smith dated April 16, 2011: "Although Taylor made me what I am, quite definitely, what I am is not Ed Taylor. He was forever an enigma to me, and at times I hated him. Certainly some of his actions deserve hate. I can say this and still recognize that he was gifted to an unparalleled or at least remarkable degree in some respects, but was deficient in some humanitarian ways. He seemed to be aware of this (witness his elaborate soirees, erratic displays of generosity) but never really changed."

Upon returning to Kansas in September 1932, Hobart began graduate studies at the University of Kansas. During his first year, he scrounged for funds for support; subsequently, he was the teaching assistant in comparative anatomy, a rather famous course taught by Taylor. Hobart was itching to go back to Mexico, especially to gather more material for his research on lizards of the genus *Sceloporus*. Eventually, a trip was organized with a fellow graduate student, David Dunkle. They scraped together $250 for the trip in the summer of 1934 and traveled in Dunkle's 1923 Model T-Ford coupe. They spent three months in northern Mexico as far south as Zacatecas and collected about 1500 specimens. They were plagued with nearly constant car trouble of one kind or another and the car finally was abandoned in southwestern Kansas. Both men, stricken with malaria, returned to Lawrence by train. In 1936, Taylor financed four months of fieldwork in Mexico. During part of the trip Hobart travelled with Henry D. Thomas, a graduate student working on aquatic insects. Off and on Hobart encountered Taylor in Mexico, who was travelling alone in his car and collecting hundreds of specimens. Part of the summer they were in the Yucatan Peninsula, and Hobart, who was fascinated with a fauna previously unknown to him, spent several weeks in the rainforest at the base of the peninsula.

Once back in Lawrence, Hobart worked feverishly on completing his doctoral dissertation, "The Lizards of the *torquatus* Group of the Genus *Sceloporus* Wiegmann, 1828," and successfully defended it in June 1936. Hobart was extremely fortunate to receive a National Research Council Fellowship, which supported the research for the completion of his monographic study of *Sceloporus* while at the Museum of Zoology at the University of Michigan (1936–1937). Times were tough in the late 1930s, but Hobart persevered by working briefly as a research assistant for Howard K. Gloyd, who was then Director of the Chicago Academy of Sciences, and subsequently as a WPA (Works Progress Administration) employee under Karl P. Schmidt at the Field Museum of Natural History, also in Chicago. He submitted his lengthy manuscript on Mexican and Central American *Sceloporus* to Schmidt for publication by the Field Museum, but Schmidt was reluctant to allocate a large part of the publication budget for this one publication until Taylor presented him with large synoptic collection (about 1500 specimens of 57 species, including 9 holotypes) of Mexican *Sceloporus*. Schmidt had to reallocate a large part of the publication budget to publish the monograph (Smith 1939).

Obviously, Edward H. Taylor played a significant role in Hobart Smith's developing career and continued to do so in the late 1930s. He influenced former Kansas student Alexander Wetmore, then Director of the United States National Museum (USNM), to support Smith for continued fieldwork in Mexico. In the summer of 1938, Smith was awarded a Walter Rathbone Bacon Travelling Fellowship for two years of investigations in Mexico. But Hobart would not be travelling alone. While a graduate student at Kansas, he had dated Rozella Blood, who was a graduate student in the Department of Anatomy in the School of Medicine. In the summer of 1938 he proposed to Rozella, and they were married in Chicago on August 26; Howard K. Gloyd and Karl P. Schmidt witnessed their union.

PHOTO BY H. K. GLOYD



Hobart with specimens of *Cnemidophorus* (now *Aspidoscelis*) in Arizona, 1930. Note long-barreled pistol.

PHOTOGRAPHER UNKNOWN



Hobart in Campeche, Mexico, 1936.

PHOTOGRAPHER UNKNOWN



Hobart and Rozella Smith at the University of Wyoming in 1960.

The newlyweds spent a month in Washington D.C. preparing for their trip to Mexico and in October 1938, their lengthy honeymoon began. They travelled in a 1936 half-ton panel truck and entered Mexico on October 3. Until August 24, 1940, they drove throughout Mexico exclusive of the two peninsulas—Baja California and Yucatan. Sometimes they travelled by train or river steamers to get to places not reachable by roads. Although their "cuisine" seldom included rice and evaporated milk, they survived on a tight budget; Hobart's frugality was continued from earlier expeditions. Taylor joined them for about a month in 1940. As usual, he began to take charge of the operation; Hobart complied as he had in earlier expeditions, but Rozella stood up to Taylor. This was the beginning of a life-long dislike of one another.

The fieldwork in Mexico was extremely productive; they collected slightly more than 20,000 specimens that were to be deposited in the USNM. Wetmore arranged for a third year of support on the fellowship, so that Hobart could study the specimens and properly add them to the USNM collections. By the time that Smith left the USNM in August 1941, he had published 42 papers (961 pages) on Mexican amphibians and reptiles; two papers were coauthored with Edward H. Taylor, one with Bryce C. Brown, and one with David Dunkle. Twenty-seven of these publications dealt with lizards (14 on *Sceloporus*), and 14 pertained to snakes. Amphibians were included in two faunal papers, and one paper contained the description of a new species of frog (*Eleutherodactylus spatulatus*). Most papers focused on descriptions of new taxa from Mexico—1 genus, 20 species, and 12 subspecies of lizards, and 1 genus, 12 species, and 6 subspecies of snakes.

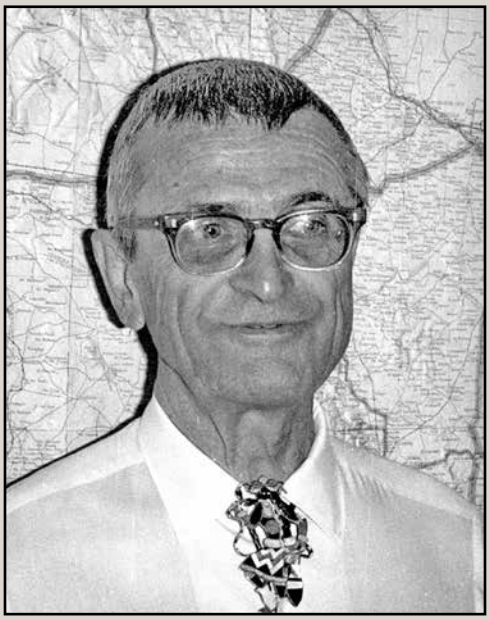
While Hobart was at the USNM, Roger Conant urged him to write a checklist of the amphibians and reptiles of Mexico. Somewhat later, Hobart and Ed Taylor agreed to write the checklist and, more importantly, keys to the Mexican herpetofauna. Smith immediately undertook a volume on the snakes, while Taylor prepared a volume on the amphibians. Taylor's influence with Wetmore again paid off; the USNM would publish the volumes. Smith prepared most of the checklists on the reptiles, whereas Taylor wrote most of the volume on the amphibians. Smith suggested that Taylor should be the first author on the amphibian volume, but Taylor generously argued that they should keep the same authorship throughout the series. The volume on the snakes was written primarily by Hobart when he was at the University of Rochester (Smith and Taylor, 1945). The next volumes were delayed, because Hobart did not want to submit the manuscripts before Taylor could add the finishing touches, and Hobart dared to do so. Taylor was active in Southeast Asia as an officer with the OSS (forerunner of the CIA) from 1944 until January 1946. The volume on amphibians finally appeared after Hobart joined the faculty at the University of Illinois, and a volume on reptiles exclusive of snakes followed two years later (Smith and Taylor, 1948, 1950).

Completion of the fellowship at the USNM was a major turning point in Hobart's life. Before his 29th birthday he had an enviable publication record and became recognized as the authority on the Mexican herpetofauna. This is especially amazing in that he had spent nearly three years in the field, but fieldwork was coming to an end, as pointed out in a letter to WED from Hobart dated August 23, 2010: "The 2 years that Rozella were with me in Mexico were all she wanted of field work. After that it was Best Western [motel] or nothing." In one respect, Hobart was fortunate; most men his age were being drafted for military service, but because of his tachycardia he was not accepted.

Late in the summer of 1941, Doris Cochran recommended Smith for a position at the University of Rochester, where for three and a half years he taught comparative anatomy to navy premed students; his salary for this temporary assistant professor position was $2,200 per year. While at Rochester, Hobart maintained his constant production of scientific publications—58 papers mainly dealing with Mexican reptiles and amphibians. Perhaps it is a coincidence that Sherman C. Bishop, who was a Professor of Vertebrate Zoology at the University of Rochester, published his book on salamanders (Bishop 1943) while Smith was in residence at Rochester, and he must have begun his work on a handbook of lizards in the same series (Smith 1946).

Being kicked out (Smith's own words) of Rochester at the end of the fall semester in December 1944 could have been catastrophic for the family (Bruce D. Smith was born in Rochester on January 22, 1943). Fortunately, at the University of Kansas, E. Raymond Hall, who was awaiting Edward H. Taylor's return from service in Southeast Asia, needed someone to teach comparative anatomy in the spring semester; he hired Smith for one semester. Hall also arranged for Smith to write a book on the amphibians and reptiles of Kansas; Hall would edit the manuscript and

PHOTO BY W. E. DUELLMAN



Hobart at the University of Kansas, 1977. Note elaborate bolo tie.

be a coauthor. Taylor, who had returned to campus in January 1946, was furious that Hall should be a coauthor. Hobart was caught in the middle of this dispute, which resulted in Smith's being the sole author (Smith 1950). This incident apparently was the origin of the nasty, life-long feud between Hall and Taylor. Despite the situation, Hall continued to support Smith and recommended him for a position at Texas A&M College (now Texas A&M University). In the fall of 1946 with a newborn daughter (Sally, August 30, 1946) the Smith family moved to College Station, Texas, where Hobart spent a year teaching various courses in the Department of Wildlife Management.

In the post-war years with thousands of former GIs enrolling in colleges and universities, classes were swelling, and there was a need for more professors. In the spring of 1947 the University of Illinois advertised for an Assistant Professor of Zoology to teach comparative anatomy. Hobart applied and soon was elated when he was offered the position. At last, a tenure-track position in a major state university with a natural history museum was his. It was his dream job. In the summer of 1947, the Smith family happily left the barren Texas plains for the comparatively luxuriant terrain of central Illinois, where towns were surrounded by cornfields. They scraped together sufficient funds to make a down payment on a moderately small frame house in the village of St. Joseph, about 11 miles east of Urbana. The family settled in for the beginning of a secure and more prosperous life.

As soon as the children were in school, Rozella became involved in many activities, none of which was domestically oriented. Rozella installed a huge chest-type freezer on their large enclosed back porch. She made lunches for everyone, mostly the same items stuffed in brown paper sacs properly initialed. She filled the freezer with packed lunches, so she did not have to make another mass production for months. Although both parents were professional workaholics, there was one item of entertainment that obsessed the whole family—the TV series *Gunsmoke* (1955–1975). The family dined in the living room on TV dinners while watching the weekly series.

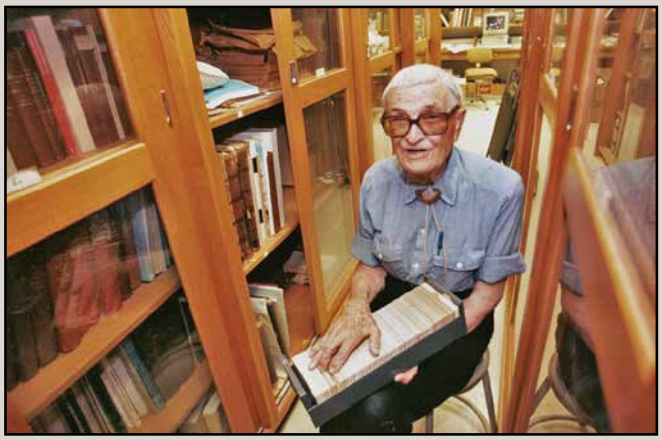
Despite his occupation with research, Hobart took the time to be a good father. Son Bruce considered the best family project to have been the construction of a tree house in a large tree in the yard in St. Joseph; it was a favorite place not only for Bruce and Sally but numerous neighborhood kids. After Rozella obtained a Master's degree in library science in 1963 from the University of Illinois, she became less involved in family activities. From that time on, the Smiths were an academic family. While Hobart continued his herpetological work, Rozella explored new horizons, especially the use of computers in library automation. She applied her skills not only at the University of Illinois, but also at the National Center for Atmospheric Research in Boulder, Colorado, and the University of Kansas Medical Center in Kansas City. Rozella was a renaissance woman—a needle-point perfectionist, science and medical librarian, writer, Shakespearean scholar, and a Sherlock Holmes enthusiast; both she and Hobart were members of the Baker Street Irregulars.

While working in Colorado, Rozella discovered Coors beer, and it became a favorite beverage for both her and Hobart. But in the 1960s, Coors beer was not sold east of Kansas; so periodically, Rozella would show up in Lawrence, driving her huge Chevrolet Impala station wagon. She would take Duellman and Linda Trueb to lunch, but they had to drive, too. Why? Because after lunch they all would go to a liquor store and fill that huge station wagon with cases of beer, even on the floor and the seat beside her. She would take off for Urbana with several months' supply of their favorite beverage. Coors beer was made in Colorado. One might suspect that this was one reason for their move to Boulder in 1968, but by that time, neither one drank beer.

The organizational arrangements between the Department of Zoology and the Museum of Natural History were like those at Kansas. Hobart was an Assistant Professor in the department and the unpaid curator of the herpetological collection in the museum. These units were administered by Donald F. Hoffmeister, a mammalogist and former student of E. Raymond Hall at the University of Kansas. Hoffy, as he was called behind his back, emulated Hall in many ways by being somewhat dictatorial and making sure that mammalogy was first in line for available space, funds, and student help. Smith adapted well to the arrangement. He convinced the administration to provide $10,000 for the purchase of 10,000 specimens (roughly one third of the total) from the EHT-HMS collection. In this way, he had a diverse collection of Mexican amphibians and reptiles for study. These collections were augmented by many expeditions to Mexico by graduate students and funded by the Natural History Museum. Hobart was fortunate to have the continued assistance of Dorothy M. Smith; she catalogued specimens in the collection and maintained Hobart's ever-increasing card file on Mexican herpetology.

Hobart hit his stride at the University of Illinois, where he rapidly rose through the ranks to full professor. He was a popular teacher as evidenced by having as many as 200 students (most premed hopefuls) in his comparative anatomy course. Whether in his office, eating lunch, or walking across campus, he always seemed to have time to converse with his students, undergraduates and graduate students alike. The latter were a mixture of morphologists and herpetologists. Among the morphologists, two became leaders in their fields of specialization—Karel L. Liem in functional morphology at Harvard University and R. Glenn Northcutt as a neuroanatomist at Scripps Institution of Oceanography. Among the many PhD students mainly engrossed in herpetology were Philip W. Smith (1953) at the Illinois Natural History Survey, James C. List (1956) at Ball State University, Ronald A. Brandon (1972) at Southern Illinois University,

PHOTOGRAPHER UNKNOWN



Hobart in his library at the University of Colorado, 1999.

PHOTO BY C. E. BOCK



Hobart collecting in southeastern Arizona, 1989. Note swollen left arm four days after being bitten by a rattlesnake.

and Peters S. Chrapliwy (1964) at University of Texas at El Paso. He also mentored several Master's Degree students and undergraduates who went elsewhere for their PhDs; among these are Kenneth L. Williams and Larry David Wilson who received their PhDs in 1968 and 1970, respectively, under the tutelage of Douglas A. Rossman at Louisiana State University, and John D. Lynch and Thomas H. Fritts who received their PhDs in 1970 and 1972, respectively, under the mentorship of William E. Duellman at the University of Kansas.

Hobart continued his extraordinary rate of publication, usually publishing more than a dozen papers per year (39 in 1963). He published textbooks on comparative anatomy (Smith 1954, 1957, 1964) and various papers on diverse aspects of vertebrate anatomy. However, many publications dealt with Mexican herpetology. From the beginning of their fieldwork in Mexico in 1932 through the time of the publication of their last checklist in 1950 Smith and Taylor wrote 195 papers dealing with the amphibians and reptiles of Mexico; only 10 of these were jointly authored by the two of them. In these papers they proposed 266 new scientific names. These included three genera and 39 species of salamanders and one genus and 67 species of frogs. Among the reptiles, they named six genera of snakes and one of lizards, while proposing names for 88 species and subspecies of snakes and 72 of lizards. It is no wonder that they were considered to be the modern initiators of Mexican herpetology. (Alfredo Dugès is nominally considered to be the father of Mexican herpetology.)

At the University of Illinois, Hobart had his shirt pocket stuffed with a row of pens (in a plastic envelope) and index cards; thusly, he was prepared to scribble notes wherever he might be; later many of these were expanded into publications. While at the University of Illinois, he published 380 papers and books; most of the papers were coauthored, usually with students. Of the 380 publications, a minority of 87 dealt with Mexico, whereas 57 were proposals or opinions published in the *Bulletin of Zoological Nomenclature*. During this period Smith introduced several terms, e.g., herpesian and herpetogeny (Smith 1949), and herpetozoa (Grant and Smith 1960); most of these terms were short lived in the herpetological community. Also, during this period, he published scores of short popular papers in such outlets as *All-Pets Magazine* and *Turtox News* as well as popular books (e.g., Smith and Zim 1953).

Rozella was employed as a librarian at the National Center for Atmospheric Research in Boulder, Colorado, even before they moved to Boulder. Hobart had taught comparative anatomy during summer sessions at the University of Colorado and was offered a full-time professorship there. In the summer of 1968, he bade farewell to the large herpetological collection that he had assembled at the University of Illinois and moved with his extensive library to Boulder. This was the end of the herpetological program at Illinois that had produced so many graduate students and research on amphibians and reptiles..

Hobart's library was amazing. He had accumulated throughout his professional life every publication that he could find that pertained to amphibians and reptiles in Mexico. For originals that he did not own, he had photocopies or microfilms; some even were typewritten. While he was a graduate student he began a card file on names of, and references to, Mexican amphibians and reptiles. This grew to tens of thousands of cards. The checklists that Smith and Taylor wrote in the 1940s were woefully out of date. Hobart was lucky to have Rozella at hand. She had begun getting involved with computers in the early 1960s. As Hobart wrote (Smith, 1988), "…her claim to fame in herpetology and, more importantly, in general scientific endeavor came from her captivation with the intricacies and potentials of computer applications to fixed-field data manipulation and graphics." In a herculean attempt to bring the bibliography of Mexican herpetology up to date, husband and wife set to work in 1968. Rozella worked with programmers with the CDC 6400 mainframe computer at the University of Colorado. Her input device was an Oliveti terminal. Data were on punch cards. Hobart provided the source material and Rozella handled the computerization. They planned to produce nine volumes. The first was the literature on the axolotl; it contained 3311 references (Smith and Smith, 1971).

Hobart's card file contained published erroneous spellings of scientific names and he insisted that these be included, thereby greatly increasing the number of entries. Furthermore, he was a true believer in subspecies—producing still more entries. Sometimes, not all was rosy in Colorado, as emphasized in a long letter from Rozella to Duellman dated January 25, 1979:

"Bill, is it really necessary to include ALL of the 'erroneous subsequent spellings without nomenclatural status' names? OHMYGOD. Only Smitty with his half a century of tight indexing would ever have found them. Some are so obvious. Alvarez del Toro … had a bad type-setter. Well, WHO CARES? Smitty's excuse is 'Mertens and Wermuth did … Stejneger did …'

'I bet that they didn't have as many as you have,' I whine.

'They didn't find them all,' he concedes.

'I'll bet by God they didn't.' I tell him.

"I understand that there are people in the world who would do away with all subspecies. I am one of them. For my own reasons, naturally. Dissolution of subspecies would do away with a hell of a lot of underlining. Underlining is a pain in the ass. It always has been. BUT there is something different any more in the picture than the inconvenience of little underpaid girls who sweat over the typing. The COMPUTER hates to underline. My Olivetti doesn't like to underline and neither do the CDC 6400's. With computers coming more and more into the picture perhaps we can make a break for it. What would happen to the world of systematics if instead of underlining, we put scientific names in CAPS?

"I would appreciate any comment you would care to make. At least if it is necessary to include all of those 'erroneous subsequent spellings…' and if one must underline. I'll feel better if you say I have to."

How Rozella would have loved a modern desktop computer and Microsoft Word®! She worked in the "dark ages" of electronic data management and word processing.

The comments by Rozella were made at the time she was finishing Volume VI (1044 pages on the turtles), published in 1979. In recognition of her collaboration with Hobart and especially for her pioneering work using the computer to compile and edit bibliographies, the University of Colorado awarded Rozella an honorary doctorate in August 1983. Linda Trueb and I visited the Smiths in Boulder in the summer of 1985. After dinner one evening the conversation drifted to the "Synopsis," and I queried them when the next volume would appear. After a few words (almost apologetic) from Hobart, and Rozella shedding a tear, it became obvious that the work would never be finished. Unbeknownst to us, Rozella was ill; she passed away on December 15, 1987. Subsequent to her death, Hobart enlisted various people to input data for Volume VII—1082 pages devoted to bibliographic addenda from 1970–1991. The planned four volumes on squamates and amphibians never saw the light of day.

Despite the trauma of losing Rozella and not finishing the "Synopsis," Hobart maintained an active academic life at Colorado. For 15 years he enthusiastically taught comparative anatomy. He also had several graduate students, many of whom never completed a degree, but some completed dissertations on vertebrate morphology (e.g., Jonathan Oldham, 1975) and reptilian systematics (e.g., Harry L. Taylor, 1983). He also influenced many undergraduates, some of who went elsewhere to graduate school (e.g., Alan H. Savitzky, PhD, University of Kansas, 1979). Hobart was especially proud of Richard L. Holland, one of his undergraduate protégés, who became an outstanding biology teacher in Boulder, Colorado. Hobart was named Chair of the Department of Environmental, Population, and Organismic Biology in 1974 and held that position for three years, plus an additional year as co-chair with Carl Bock. All the while he delegated social duties to others. Hobart was not comfortable in large social gatherings; moreover, his hearing was waning. He continued teaching until his retirement at the age of 70 in 1983. At his last lecture in comparative anatomy his teaching assistants wore tuxedos; they provided him with a golden probe that he faithfully carried in his shirt pocket along with used IBM cards, a fringe benefit from the "Synopsis."

Once Hobart was established at the University of Colorado his production of publications exploded. In the 42-year period of 1969–2010 he had 1119 publications, an average of 26.6 per year. In 1993 he had 68 publications! Nearly all of these were co-authored (67 with Rozella, including seven volumes of the "Synopsis"). Hobart's deep concern for nomenclature is revealed by his 47 proposals and opinions published in the *Bulletin of Zoological Nomenclature*. He became disgusted with the review processes of the leading journals and submitted most of his herpetological papers to non-refereed outlets, his favorites being the *Bulletin of the Maryland Herpetological Society* and the *Bulletin of the Chicago Herpetological Society*. During this time, he published two books on anatomy (Oldham et al. 1970; Smith 1976). Smith, as sole author, had several publications dealing with philosophical issues (e.g., "Evolution by premeditation," Smith, 1970). He and co-authors published several papers dealing with reptiles and amphibians on coins and stamps. Also, many papers were reviews of books; in many of these and in obituaries he waxed eloquently (e.g., Smith 1971).

Many of Smith's publications during this time still dealt with the Mexican herpetofauna—descriptions of new species and subspecies, notable range extensions, noteworthy collections, and nomenclatural problems. Most importantly, he collaborated with several Mexican herpetologists. Although Hobart knew and had contact with Rafael Martin del Campo, they never collaborated together. Miguel Alvarez del Toro was the first Mexican collaborating with Hobart; together they described several taxa in the 1950s–1970s. After the 1970s, many Mexican biologists became interested in amphibians and reptiles. Many of these communicated by letter with Hobart to ask for help, including requests for literature difficult to obtain in Mexico and personal inquires on certain groups of Mexican amphibians and reptiles. Hobart answered all of them and sent advice and photocopies of publications. The list of Mexicans who coauthored papers with Hobart is long, but most notable are Gustavo Casas, Aurelio Ramirez, Oscar Sanchez, Oscar Flores, and Julio Lemos. Many other Mexican students sent copies of their unpublished theses to Hobart, now these are back in Mexico, in his library at UNAM. He was ecstatic about the increasing interest of Mexicans in their herpetofauna. Thus, while in his 80s and 90s, he was subconsciously still collecting in Mexico. And he actually did collect again in Mexico. After 57 years since he had set foot in Mexico, he and David Chiszar spent a week in 1993 collecting in Chihuahua, an experience that was repeated in 1997.

Hobart was seriously concerned about his library on Mexican herpetology. After several diversions and numerous communications with Oscar Flores-Villela, he donated his library to the Museo de Zoología at the Universidad Nacional Autónoma de México (UNAM). Oscar rounded up funds in Mexico to cover the costs of packing and transporting the library from Boulder to Mexico City. In October 2006, he and two helpers spent a hectic week in Boulder (Flores Villela, 2006). They finally got the boxes

of books and cabinets of reprints, files of index cards, and maps to UNAM, where personnel have undertaken the chore of placing the bibliography on a website. The finest library on Mexico herpetology is where it should be—in Mexico, thanks to Hobart Smith's generosity. Its contents are being made available on the web at: http://repositorio.fciencias.unam.mx:8080/xmlui/handle/11154/139840.

Although Hobart obviously spent most of his time on herpetology, he did have one major hobby—lapidary. In 1966 his son, Bruce, gave him some rocks; Hobart got books on the subject and set up a small shop at home. Soon he was producing bolo ties. He must have made hundreds that he gave to his colleagues. Although even in his 80s, he was active outdoors, weather permitting. At home he had an exercise bicycle that he used while reading or watching sports on TV.

Hobart rarely attended national meetings, but he and Rozella had to attend one in 1983. The Society for the Study of Amphibians and Reptiles held its annual meeting in 1983 at the University of Utah in Salt Lake City. The featured symposium, "Biogeography of the herpetofauna of Mexico: perspectives and approaches," was organized by Larry David Wilson in honor of Hobart and Rozella Smith, who were amazed by the presence of Carlos and Miguel Cerón, brothers who had helped them so much at Cuautlapan, Veracruz, more than 40 years previously; also they were enchanted by the roaming mariachis during the outdoor picnic lunches. Furthermore, they were happy to hear presentations by three Mexican herpetologists.

Shortly after joining the faculty at Colorado, Hobart met a young assistant professor in the Department of Psychology, David A. Chiszar, whose research at the time focused on strike behavior of rattlesnakes. Quickly the two became almost inseparable friends and colleagues. After Rozella's death, David took care of Hobart in many ways—foremost was transportation and hearing as Hobart became more and more deaf. Chiszar was an opposite of Hobart; he was robust in size and persona. He was an avid numismatist, fisherman, and weight lifter. Chiszar took Hobart for his first motorcycle ride (at the age of 88); he enjoyed sitting on the back seat, but Chiszar soon made Hobart more comfortable by adding a sidecar. Rozella had ridden on the motorcycle sometime before Hobart rode.

Chiszar and Smith collaborated on a diversity of publications involving snake and turtle behavior, reptile taxonomy, and various other aspects of herpetology. Whenever time permitted and the weather was suitable the two of them traveled throughout Colorado and adjacent Nebraska searching for range extensions or new county records for "herps." Hobart also collected at the Research Ranch, a sanctuary of the National Audubon Society in southeastern Arizona, where he got a scare, as related to me in a letter from Carl Bock dated March 31, 2013: "But on the first occasion he was alone and one evening we were driving to a local restaurant when he spotted a Mojave rattlesnake [*Crotalus scutulatus*] on the road, got out to collect it, and got bitten in the hand. It was a wet bite, though only one fang, from what I am sure you know is a very dangerous beast. You can imagine what raced through my mind as we raced to the nearest hospital (about 40 miles away): that the world's most famous herpetologist was going to die on my watch. They got him into emergency, then tested him for sensitivity to the anti-venom and found he had a positive allergic reaction to the serum. So, they decided not to administer unless he became critical. Fortunately that was not the case. He spent only one additional night in the hospital, and was back collecting again the next day—albeit with one arm swollen to twice the diameter of the other. Hobart was highly embarrassed by the whole thing and swore me to secrecy."

In the period from 1975 to 2010, Smith and Chiszar coauthored 402 publications, of which 102 were one-paragraph notes on geographic distribution in *Herpetological Review.* David Chiszar retired in 2011 and their collaboration terminated, although David was a frequent visitor to Hobart, who then lived in an efficiency apartment at the Villas at the Atrium, a senior living facility in Boulder. Hobart had a computer and communicated with colleagues in Mexico and the USA by e-mail. Hobart's eyesight was declining, so communications were in 24-point type. However, the amazing thing about corresponding with him, even when he was 98 and 99 years old, was his mental acuity. He was sharp as a tack, and his memory was nearly infallible.

Unfortunately, gathering communications between Hobart and other persons must depend on the other persons, because as written to me by Hobart on 16 April 2011: "When Ed [Taylor] was putting together his material for the KU archives, he asked me whether I would like to have our correspondence for my own archives. I told him yes, so he gave it to me. However, it was bulkier than I thought, and since I had thrown out my own correspondence with other colleagues at various times, in the process of successive moves, I decided not to bother with it. I have no archives, here or elsewhere. I never even looked at what he sent to me."

Beginning in 2012, Chiszar's visits to Hobart became erratic because Chiszar was undergoing treatment for cancer. David Chiszar passed away just two months before Hobart's own life ended. However, they did have in a way an important last collaboration. The editors of *Herpetological Conservation & Biology* asked Hobart to reflect on the field of herpetology. Hobart engaged David Chiszar to "interview" him for three things: "(1) to look backward and identify seminal developments in herpetology during my watch, (2) to peer forward and speculate about the future developments in the field, and (3) to provide advice to young people about how to prepare for careers in herpetology." This nostalgic and provocative article (Smith 2012) was published just a few days before his 100th birthday and should be read by all of us. This was Hobart's last publication (number 1635) while he was alive.

In the spring and summer of 2012, I worked with Bob Hansen and Smith's children (Bruce Smith and Sally Nadvornik) on celebration of Hobart's 100th birthday. Bruce was against any party for him at his residence; he said that Hobart would be uncomfortable with a crowd and embarrassed because he could not hear. Thus, I encouraged several former students to send written comments to Hansen, who arranged them and several photos into an article "Hobart Muir Smith turns 100," which was a feature article in the September 2012 issue of *Herpetological Review* published on Hobart's birthday. Meanwhile, Duellman invited scores of colleagues and former students to write congratulatory electronic letters; these were printed in at least 24-point type and together with numerous photographs placed in plastic sheaths in two thick loose-leaf notebooks. The issue of *Herpetological Review* and the notebooks were taken to Hobart by Bruce and Sally, who reported that he was absolutely flabbergasted. However, I felt that there one letter lacking and sent it separately by e-mail:

> September 26, 2012
>
> Smitty, Dammit! I never got that far. Congrats on reaching 100.
>
> —*Edward H. Taylor* (in absentia)

On 15 February 2013, Hobart was admitted to the emergency toom in a hospital in Boulder, where he was treated for bronchitis. He returned to his apartment at Villas at the Atrium in a weakened condition and informed his son, Bruce, that "he did not have the interest in continuing to live and had lost interest in making a come back. He does not want to go to the hospital or an assisted care facility. I have talked with him about this and am comfortable with his decision" (letter from Bruce Smith to WED dated 25 February 2013). Bruce arranged for hospice care, which continued until March 4, when Hobart passed away peacefully at the age of 100 years, 5 months, and 6 days.

What a legacy! The trail from an orphanage in Ohio to Professor Emeritus in Colorado had many stepping stones, some slippery, others encouraging. Serendipitously, these steps led to Mexico, a country and its herpetofauna that became Hobart's lifelong obsession. Hobart wrote prodigiously; it is unlikely that his record of 1637 publications, including 30 books, will ever be surpassed; one paper (Murphy and Smith 2013) and one book (Lemos Espinal et al. 2013) were published posthumously. But his publications are all that most young herpetologists know about "Smitty." They did not have the good fortune to know him personally, as did I for six decades, beginning in 1952. And here I can only repeat what I wrote in *Herpetological Review* last September—viz., that his perspicacity, kindness, and generosity were exceeded only by his modesty.

Further reading.—For a lengthy commentary on the field work in Mexico, see Smith's series of articles published in the *Bulletin of the Chicago Herpetological Society* in 2001. A light-hearted article was published by Ellerbrock (2001). Much of Smith's life is covered in an interview by Chiszar et al. (2004).

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HERPETOLOGICAL NOMENCLATURE

News from the ICZN

Perhaps the most contentious case ever considered by the International Commission on Zoological Nomenclature (ICZN) is Case 3463 relating to the name *Testudo gigantea* Schweigger, 1812 which for many years had been applied to the Giant Tortoise of the Aldabra Atoll. The application in the *Bulletin of Zoological Nomenclature* (BZN, vol. 66, 2009) asked the Commission to conserve Schweigger's name through maintenance of a previous designation of a neotype. The case had broad implications including the standing of the genus-group name *Aldabrachelys*, and the species-group name *Testudo dussumieri* Gray, 1831, applied by some to the Giant Aldabra Tortoise. An all-time record of 83 comments on the case was received by the ICZN from both supporters and those antagonistic to the proposal. In Opinion 2316 (BZN 70[1]:61; 2013) the ICZN ruled under its plenary power that all previous fixations of a type of *Testudo gigantea* be set aside and that National Museum of Natural History turtle (USNM 269962) as designated and described by Frazier (2006) is to be retained as the name-bearing type. In addition, the name *Testudo dussermeiri* Gray, 1831 was suppressed for the purposes of The Principle of Priority but not for the Principle of Homonymy. Further, the generic name *Aldabrachelys* Loveridge and Williams, 1957 of which *Testudo gigantea* is the type species was placed on the Official List of Generic Names in Zoology and *Testudo gigantea* was placed on the Official List of Specific Names in Zoology. Finally, *Testudo dussumeiri* was placed on the Official List of Rejected and Invalid Specific Names in Zoology.

The Aldabra Giant Tortoise is probably best cited as *Geochelone gigantea* (Schweigger, 1812) or *Geochelone* (*Aldabrachelys*) *gigantea* (Schweigger, 1812). I take the opportunity provided by the resolution of this case to briefly review the history of the plenary power of the ICZN and some broader nomenclatural issues.

In the end of the 18th and the early 19th century the Linnean binominal system of nomenclature had been widely accepted. However, there was no consistency in how it was applied to previously published names. Frequently, authors simply proposed new generic or specific names for already named taxa because they thought the old name was not descriptive, not good Latin, or for other reasons. It was also common practice when shifting a previously proposed species name to a new or different genus to claim authorship of the name as new. Such names today are considered new combinations. Gradually, the notion of priority as a way to provide some stability to nomenclature crept into the system (Melville 1995). Strict priority meant that the chronologically first name of two or more names applied to the same taxon had precedence for use. As the numbers of taxa and names increased exponentially by the mid-19th century the ideal of stability and universality of zoological names was seriously undermined. As a consequence, a number of scientific bodies and individuals developed sets of nomenclatural rules to provide a framework for dealing with priority and other issues in the years between 1843 and 1905 (Melville 1995). Two of the most influential were the British Association for the Advancement of Science Code and the American Ornithologists Union Code. The former is often referred to as the Strickland Code as it was the brainchild of H. E. Strickland, a naturalist with broad interests in zoology, or the British Association Code. This set of rules was adopted by the Association in 1843 and revised in 1866. The AOU Code was first published in 1886.

Finally, at the International Congress of Zoology in Berlin (1901) the *Règales Internacioniales de la Nomenclatre Zoologie* was adopted by the Congress and published in 1905. It soon became apparent that several of the rather stringent rules, especially the adoption of absolute priority, were not universally acceptable. The application of the priority rule soon led to major discontent among many systematists because increasingly in-depth studies of the older literature required replacement of long used names by younger ones. Especially upsetting was the replacement of names in the medical and agricultural literature. This concern and other difficulties in the rigid application of the *Règales* resulted in the 9th Congress of Zoology at Monaco (1915) giving the ICZN the plenary power to suspend any part of the Code in any case where the Commission thought that its application would disturb stability or universality or result in confusion. It was through use of that power that the name *Testudo gigantea* was stabilized.

In due course many of the applications to the Commission over the next decades involved the suppression of an older forgotten name in favor of a long used younger one. Consideration of these applications became an increasing burden on the Commission in terms of the volume of applications. During this period use of the plenary power was, in the case of priority, gradually expanded to preserve well-established names of taxa prominent in ecology, physiology, and genetics in addition to those of medical or agricultural importance. However, there was also a gradual increase in applications to preserve younger names over new found senior synonyms where the taxon in question was of interest to only a small number of specialists. After several tries at providing a method whereby these kinds of cases need not go to the Commission, a solution was provided in the 4th edition of the International Code of Zoological Nomenclature (Art. 23.9).

Art. 23.9.1 provides that a name not used as a valid name after 1899 may not be used in preference to a younger synonym or homonym used as the presumed valid name in at least 25 works published by 10 authors in the immediate preceding 50 years and occupying a space of at least ten years. Art. 23.9.2 requires that an author who discovers that the conditions above are met must present evidence and explicitly state that the younger name is valid. From the date of such a published statement the younger name (*nomen protectum*) is to be used and the older becomes a *nomen oblitum*. A number of systematists, myself included, have argued for a less rigorous set of requirements. One suggestion being that citation of material in the *Zoological Record* instead of detailing the required references would expedite the process and place the onus for retention of the older unused name on those who might seek to retain its precedence.

The decision to use the plenary powers to validate the use of *Geochelone gigantea* remains noteworthy. Perhaps more important than the actual details of this case is the Commission's response to comments from conservationists, conservation organizations, and government officials, almost all favoring the

retention of the name *Geochelone gigantea* for the Aldabra species. In the past most comments on cases of this nature have been by dueling systematists. It is refreshing to see in the remarks various Commissioners made with their votes that this time the user community had significant influence.

Recent Rulings on Herpetological Names

BZN = *Bulletin of Zoological Nomenclature*

Opinion 2313 (Case 3510): *Cyclodina aenea* Girard, 1857 (currently *Oligosoma aeneum*; Reptilia, Squamata, Scincidae) and *Tiliqua ornata* Gray, 1843 (currently *Oligosoma ornatum*): specific names conserved and neotype designated. BZN 69(4):308–309. Action was required in this case to preserve current usage of the New Zealand skink species names when it was discovered that the holotype of *Tiliqua ornata* was a specimen of *Oligosoma aeneum*. By action of this opinion a neotype was selected for *Tiliqua ornata* and the name was placed on the Official List of Specific Names in Zoology.

Opinion 2315 (Case 3351): *Chelodina rugosa* Ogilby, 1890 (currently *Macrochelodina rugosa*; Reptilia, Testudines): precedence not granted over *Chelodina oblonga* Gray, 1841. An alternate proposal to set aside all previous designations of the type species for *Chelodina oblonga* and to designate as its neotype the lectotype of *Chelodina colliei* Gray, 1856 also was not granted. BZN 70(1):57–60. The issue in this case is that the name *Chelodina oblonga*, usually applied to a southwestern Australian turtle was recently found to be a subjective senior synonym of *Chelodina rugosa*, a name long used for a northern Australian species. As neither proposal was approved by the Commission the name *Macrochelodina oblonga* must be used for the Northern Long-necked Turtle instead of *Macrochelodina rugosa*. The southwestern Australian turtle remains *Macrchelodina colliei* Gray, 1856.

Opinion 2316 (Case 3463): *Testudo gigantea* Schweigger, 1812 (currently *Geochelone* (*Aldabrachelys*) *gigantea*: Reptilia, Testudines): usage of the specific name conserved by maintenance of a designated neotype, and suppression of *Testudo dussumieri* Gray, 1831 (currently *Dipsochelys dussumieri*). BZN 70(1):61–65.

Opinion 2320 (Case 3536): *Stegosaurus* Marsh, 1877 (Dinosauria, Ornithischia) type species replaced with *Stegosaurus stenops* Marsh, 1887. BZN 70(2):129–130. The generic name *Stegosaurus* was originally based on a specimen described as *Stegosaurus armata* by Marsh in 1877. That specimen has proved to be unidentifiable so to establish the stability of the widely used and recognized generic name a neotype designation was necessary.

Pending Cases of Herpetological Interest

Case 3560: *Plateosaurus engelhartdi* Meyer, 1837 (Dinosauria, Sauropodomorpha): proposed replacement of an unidentifiable name-bearing type by a neotype. BZN 69(3):203–212.

Case 3587: *Podocnemis unifilis* Troschel, 1848 (Reptilia, Testudines): proposed precedence over *Emys cayennensis* Schweigger, 1812). BZN 70(1):33–39.

Case 3599: *Coluber irregularis* Leach in Bowdich, 1819 (currently *Philothalmus irregularis*, Reptilia, Squamta): proposed conservation. BZN 70(2):89–98.

Case 3613: *Nyctimystes cheesmani* Tyler, 1964 (Amphibia, Anura, Hylidae): request for setting aside the name in favor of *Nyctimystes chessmanae* Tyler, 1964. BZN 70(1):30–32.

Case 3618: *Kalophrynus* Tschudi, 1838 (Anura: Microhylidae: Kalophryninae): proposed conservation by designation of a neotype for its type species *Kalophrynus pleurostigma* Tschudi, 1838. BZM 70(2):86–88.

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—Jay M. Savage, Section Editor

ZOO VIEW

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Deadly Encounters By and Upon Crocodilians Depicted in Historical Illustrations and Accounts. Part II. Assaults Upon Crocodilians

To return to reptile "training," the most common variety of this in the Vest is a "Fakir Act" in which the trainer "hypnotises" crocodiles. A remarkable and convincing act it can be, but training it is not. It depends on exactly the same deception as I have explained in the case of the Indian who "charms" the cobras. It depends on timing—in apparently commanding an activity which is, in fact, about to happen in any case.

Here in retrospect is how it looked once to the audience in the old Circus Renz off the Praterstrasse in Vienna. The ringmaster's voice brought a hush of heightened expectation to the audience. "Ladies and gentlemen.... The Great Labero, master of man and beast, will now perform his most sensational and astounding feat. ..." They had already sat spellbound while "The Great Labero" had done most of the tricks and stunts usual in what we call a "Fakir Act." They had watched him "hypnotise" a lioness so that she allowed him to take a hunk of meat away from her jaws. They had seen him "hypnotise" small animals and birds. Now apparently something even more startling was coming.

Labero, a good-looking young man in evening dress, advanced on an oblong black box about fourteen feet long. As he lifted the sliding trap which served as an end to the crate, a deep, loud hissing came from the interior—a sound somehow suggestive of the power behind a steam engine. From the box there emerged a tremendous crocodile. Labero raised his hand and the beast immediately stopped.

The audience shuddered. A few more and the creature sank slowly down on to the sawdust and settled into complete immobility. The audience relaxed slightly. The performer now began a series of short passes with his hands—over the head of the monster across its neck, from the base of the skull between the eyes forward to the nose, then a slight tap at the point of the upper jaw.

Suddenly the monster's jaws gaped hugely and the sinister, spiked teeth shone in the spotlight. Then a gasp of horror from the audience. The man was actually passing his hand and forearm between the jaws of the monster; pausing actually with his hand held rigid between the twin decks of these terrible teeth, turning his hand slowly palm-upward in the creature's mouth... A quick withdrawal, a slap of his hand on the snout, and the jaws crashed shut with a sound that could be heard in the farthest row of seats.

Hans Brick, *The Nature of the Beast*, 1960

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Although habitat alteration and other threats are a serious concern in efforts to preserve crocodilians, this important question must be asked: Why do humans have such a primal fear and hatred toward snakes and crocodilians? There have been studies on ophiophobia (see Burghardt et al. 2009) but the literature on apprehension, trepidation, and panic toward the latter is less complete. At the Dallas Zoo years ago, large American Alligators had to be removed from their outdoor exhibit after one was killed and several others were injured by zoo-goers. At this zoo and others, visitors threw an astounding variety of missiles at them: children's toys, cans of all types and descriptions, coins, batteries, bullets, arrows, bamboo and metal spears, keys, lighted cigarettes and cigars, tree branches, hunting and pocket knives, crayons, pens and pencils, garbage, Frisbees, chunks of concrete, cardboard and Styrofoam boxes, sticks, rocks, sunglasses, baseball caps, plastic and glass bottles, bottle caps, hand tools, soiled baby diapers, and human food. In one case, there was a shoe in the enclosure but unfortunately no foot was inside! In some cases, one would surmise that the patrons planned beforehand to bring the items, such as spears with pointed tips, into the zoo for the expressed purpose of killing the reptiles.

Incredibly, alligators are being used for swimming pool parties with children in Florida. The alligator's mouth is taped shut and the reptile swims, likely in chlorinated water, among the attendees. I suspect that renting an alligator might cost an arm and a leg! As is to be expected, the Florida Fish and Wildlife Conservation Commission has received many complaints about this practice and is now investigating the legality of using alligators in this manner.

"If one visits the famous *Café el-Fishawy* in Cairo, one might notice, among the more conventional objects of interior decoration such as mirrors and chandeliers, a large stuffed crocodile suspended over the doorway. This is not a unique phenomenon: there are other houses in Cairo and many more in Upper Egypt, especially between Aswan and Luxor, that boast crocodiles over their doors, or above the entrance to a *hara*, or neighborhood. In Cairo, the builders of a nineteenth century house even went so far as to carve a limestone crocodile into the lintel over the main entrance. These crocodiles (from *kroke* meaning pebble and *drilos* meaning worm, describing the animal's skin), both real and imitation, are intended to have an apotropaic function: placed above the door they avert the evil eye and safeguard the house's residents." (Ikram 2010, pers. comm.). She found that crocodiles, or parts thereof, were also commonly used in ancient Egyptian medicines, and are still used in some folk-medicines today: leg pains, cramps and stiffness, and balding; dung was used as part of the cure for river blindness caused by the parasitic roundworm (*Onchocerca*) and to test pregnancy in women. Burning

dung was also used to fumigate men, and crocodile blood was used possibly as a remedy for snakebite; the penis was used, in a powdered form, for virility (10 g ground member to 0.5 kg honey).

In 1674, Matthäus Merian published *Neue Archontologia Cosmica* showing four female figures, surrounded by cherubs, on the title page. One woman is pictured, wearing a large hat and looking skyward, sitting on a large crocodile with its mouth open—said to be from Africa. Few crocodilians in my experience would be willing to suffer such indignities and any croc wrangler would be well-served to keep an eye on those open jaws and shiny teeth.

Even famous artists like Jan Frans Portaels, Peter Paul Rubens, Paul Friedrich Meyerheim, Thomas Baines, and François Boucher (Fig. 1) felt compelled to show crocodilians being hunted or subjugated by man in some of the most dramatic renderings imaginable. The weaponry used to kill them runs the gamut; one of the most unusual is a woodcut in *Davy Crockett's Almanack of Wild Sports in the West, Life in the Backwoods, Sket[ch] of Texas, and Rows on the Mississippi,* showing a woman seated on back of a gigantic alligator (with outstretched tongue), which is tied to a tree, and beating it with a pair of tongs.



Fig. 1. Illustration from François Boucher (1703–1770), "*Chasse au crocodile,*" 1739, collection du Musée de Picardie, Amiens. Courtesy of Musée de Picardie / Marc Jeanneteau

Sculptors find battles between crocodilians and other animals irresistible for developing their artwork. There are many statues showing epic struggles with tigers, lions, leopards, sharks, giant snakes, and elephants; the crocodilians almost always appear to be the losers. Two stand out as particularly tense and violent—Antoine-Louis Barye's bronze statues called *Tigre dévorant un gavial* (Tiger Devouring a Gavial) and *Jaguar dévorant un crocodile* (Jaguar Devouring a Crocodile) in the 1830s. Man versus crocodilian is a favorite theme. One of the most striking renditions is "The Crocodile Hunter" by Arthur Bourgeois in front of the Reptile Menagerie at the Jardin des Plantes in Paris. There is even a recent one called "Batman vs Killer Croc DC Classic Confrontations statue" available for purchase; every home should have at least one!

In *The Economist* (May 18, 2010), a portrait of the late crocodilian biologist John Thorbjarnarson provides a hint:

> The rippling fire of the tiger, the cuddliness of the panda, the viridian flash of the green-cheeked parrot, all argue that these most-endangered species should be saved. It's harder to make the case for crocodilians. That bony, hideous head, with its unblinking yellow eye; those huge teeth, smelly with fish-debris, overhanging the long, cruel, curling smile; the slithering slide of the white underside down a muddy slope, into the water where those jaws, the strongest in Nature, will smash round the leg of a man and pull him under, thrashing and screaming.
>
> John Thorbjarnarson knew he could not end men's fear of crocodilians, hard-wired since hominids first ventured down from the trees into swamps that seethed with them. But in his 20-odd years working for the Wildlife Conservation Society he did more than anyone else to try. He commended the grace of their straight, silent swimming, their camouflage mottlings of yellow, grey and olive green, and the jewelled beauty of new, damp hatchlings no bigger than the span of his hand.

Clearly, crocodilian conservationists have a major challenge ahead in trying to protect a group of reptiles with such bad—sensationalized, inaccurate, and misguided—press. Zoo and aquarium biologists, especially in temperate regions where the creatures need to be maintained indoors in cold weather, are faced with a daunting challenge: how to create sustainable captive breeding groups for these animals when so many species are at risk. There are many critical issues. These include the lack of space, especially for many of the larger taxa; the need to have large colonies to ensure genetic diversity; space to allow the separation of sexes for controlling breeding or limiting aggression; the desire by administrators to show the biggest and the more spectacular (for example, Nile and Saltwater Crocodiles) at expense to some of the smaller but more endangered forms; aberrant behavior patterns toward humans; and, generally, the need for suitable enclosures where crocodilians can be handled safely. There were roughly 1500 American Alligators in US zoos and aquariums in 2010, occupying valuable space, space better used for critically endangered forms (*AZA Crocodilian Advisory Group—The Future of Crocodilians in North American Institutions*, Colette Adams, pers. comm.).

In the US, there are relatively few formalized AZA programs for crocodilians—Cuban, Orinoco, Philippine, Siamese, Slender-Snouted crocodiles, and Gharial—and all are faced with the captive challenges listed above. As an example, the number of holdings for Cuban Crocodiles is not adequate so breeding must necessarily be curtailed (Bill McMahan, pers. comm.) To complicate the problem, zoos are generally not directing resources to the construction of expanded facilities or programs. Further, there are limited funds available for supporting *in situ* initiatives that are critical supplements to captive programs. Zoo development officers focus fund-raising efforts on the charismatic mammals at the expense of reptiles, including crocodilians. What is

needed here is a total shift in priorities, elevating crocodilian conservation to the level of support as elephants, giant pandas, tigers, cheetahs, rhinos, and other critically endangered mammals receive.

This leads to one potentially workable solution: concentrate efforts to maintain these reptiles in southern climes where indoor space is not a problem. As there are not enough zoos in these areas to accomplish the goals, private organizations and foundations would need to help with this effort. Further, zoos would be asked to help defray expenses if the private sector is involved, and it goes without saying that most zoos are dealing with serious budget issues; they would likely not have discretionary monies available. If crocodilians at risk go south for the winter and reproduce successfully, will there be suitable wild homes for the young reptiles to be safely reintroduced? A conundrum to be sure!

However, taking a broader view as one looks at the shift of captive elephants to places deemed to have more appropriate space and climate, this move of captive crocodilian programs to the south would just be another way of saying that zoos and aquariums are not fit to have animals. It would be another step in the direction of the elimination of zoos and aquariums.

While all animal managers face the same issues of space and other competition for captive resources, it is unconscionable to give up the fight to protect crocodilians. I am skeptical that protection of any taxon will successfully happen in a sustainable way over the next few decades and so I am preparing myself to watch many of these majestic animals disappear from our planet. But it is too soon to give up the effort and crocodilians deserve to be numbered among the groups that garner attention.

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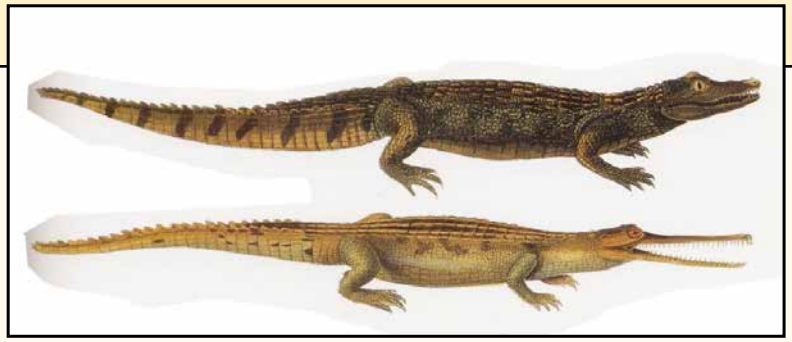
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Baron Georges Cuvier published *Le règne animal…* in 1836–9. Upper: Spectacled Caiman (*Caiman crocodilus*); lower: Indian Gavial (*Gavialis gangeticus*).

These forms may be called, collectively, "crocodilians." In all, there are twenty known living species and many more fossil forms. They are often of great size, ugly and vicious in appearance, and wholly carnivorous. They inhabit fresh water swamps, lakes and rivers in tropical or subtropical countries, though two species, the Nile Crocodile (which is found throughout Africa), and the East Indian Crocodile, are known to swim boldly out to sea. These two species are also notable as the most seriously dangerous to human beings. They are all excellent and powerful swimmers and secure their food either in the water or from the neighboring banks. They are by no means exclusively aquatic, however, the true crocodiles, especially, being capable of active motion on land. All come ashore to sun themselves and to deposit their eggs. In size, the crocodilians are the largest of living reptiles. Some of the existing forms reach an occasional length of thirty feet, while the largest fossil forms are estimated at about fifty feet. The American alligator with a maximum adult size of about sixteen feet is intermediate between these monsters and the smallest forms. One of the South American caimans is not known to reach a length of more than four feet.

Karl P. Schmidt (1922) *The American Alligator*



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COURTESY OF DEN HAAG, MUSEUM MEERMANNO WESTREENIANUM, [SHELF LOCATION] 10 B 25, FOLIO 42R

Medieval bestiaries described the Hydrus, the enemy of the crocodile living in the Nile River, which it kills from the inside. The root of the word refers to water and the description is based on its habit of finding a sleeping crocodile, rolling in the mud, crawling into the reptile's mouth, eating the internal organs, and emerging from the body which causes death is rather vivid, even if fanciful.

Crocodiles were often found in cabinets of curiosities and apothecary shops, usually hanging from the ceiling. Illustration from Ferrante Imperato's. *Dell'historia naturale, / di Ferrante Imperato ... libri XXVIII* in 1599.

A word in regard to shooting saurians. Go prepared to hunt and kill whatever specimens you require, for the chances are you will not get any save what are brought to bag with your own trusty (or rusty) rifle. To kill a crocodile, proceed as follows: Find where he is in the habit of coming out on the bank for his daily sun-bath; then, at precisely the right time,

'Come where my love lies dreaming.'

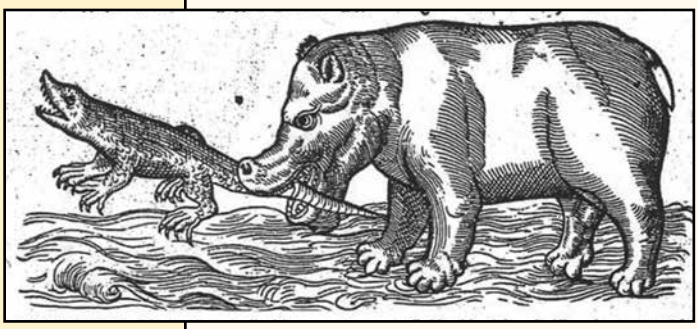
Sneak up as close to him as you can, get a position so that you can attack him broadside on, and post a couple of natives close by, primed beforehand with instructions to rush forward and grab the scaly monster by the tail as soon as you fire. Estimate the distance carefully, wipe the perspiration out of your eyes, aim at the neck-bone, or the vertebral column anywhere in front of the shoulders, and let drive. If the reptile's body lies still and his jaws fly wide open, run for him like a quarter horse, for you have hit his spine, and he is your meat if you only get to him in time to lay hold of his tail. Take your rifle along, for you *might* need it again, particularly if the crocodile is more than ten feet long. If he requires a *coup de grace,* give him another bullet in one of his cervical vertebrae, and the subsequent proceedings will interest him no more.

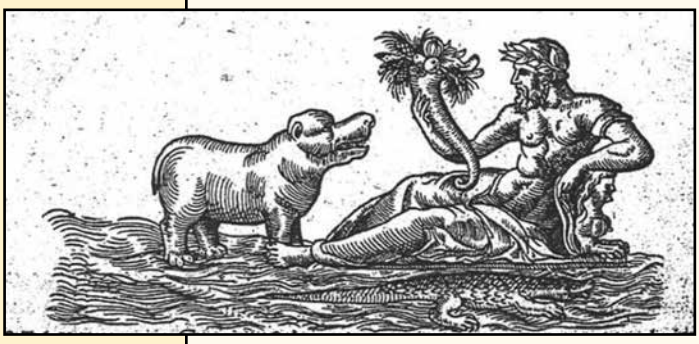
William T. Hornaday, 1905, *Taxidermy and Zoological Collecting. A Complete Handbook for the Amateur Taxidermist, Collector, Osteologist, Museum-Builder, Sportsman, and Traveler.*



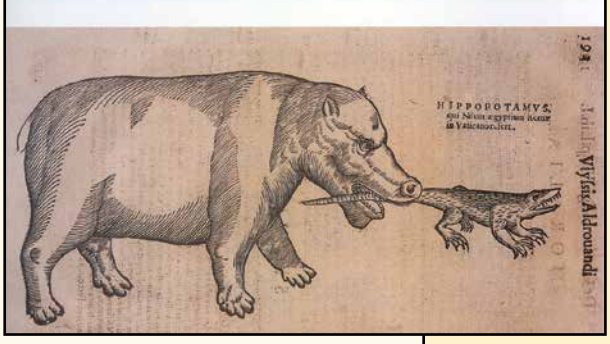
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FROM HAINES, SLITHY TOVES, SSAR 2000



FROM THE COLLECTIONS (ARCHIVES) OF THE ERNST MAYR LIBRARY OF THE MUSEUM COMPARATIVE ZOOLOGY, HARVARD UNIVERSITY

One of the earliest printed images of the hippo/croc battle is in Pierre Belon's works on aquatic animals *Histoire naturelle des estranges poisons marins* (Paris, 1551, a woodcut, hand-colored. There is also a black & white image in his *De aquatilibus* (Paris, 1553). In the French version Belon seems to say that this is an image from an ancient Roman statue or carving on stone, possibly depicted in ancient Egypt. Several Egyptian tomb scenes show a crocodile seizing a baby hippopotamus as it emerged from its mother during birth.

Conrad Gesner used the same image (reversed when it was copied) in his *Nomenclator aquatilium animantium...*" (Tiguri [=Zurich], 1560. The same cut was probably in his slightly earlier *Historia animalium. Liber IIII: De piscium et aquatilium animantium* (Tiguri [=Zurich], 1558).

The same image appears again—the croc is a bit smaller this time—in Ulysse Aldrovandi's *De quadrupedib[us] digitatis viviparis...et...oviparis* (Bononiae [=Bologna], 1637). The subject seems to drop out of the picture after the 1500s.

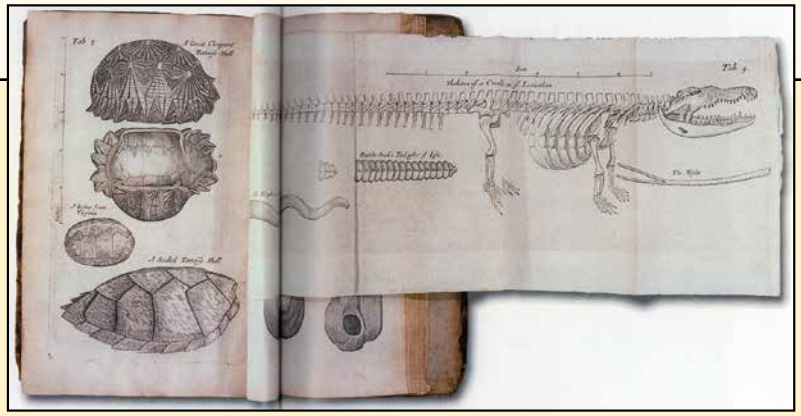
Copying images from earlier works was not considered plagiarism because some authors and artists felt that altering or changing texts or illustrations was inappropriate since the world created by God was already perfect.

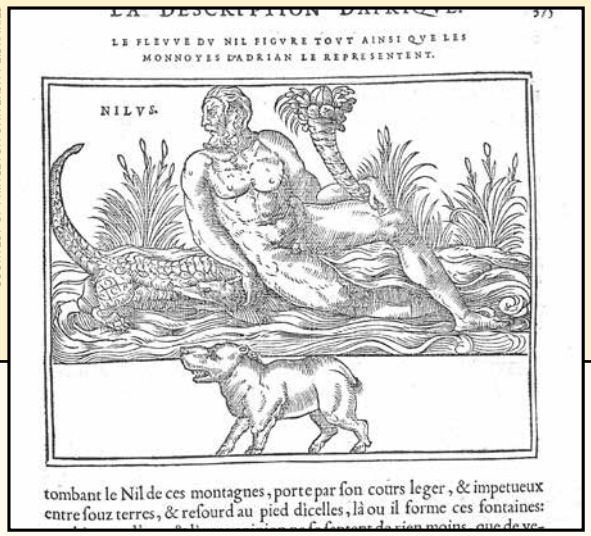
Illustration from Nehemjah Grew's *Musæum regalis societatis*…in 1694. (Haines, Slithy Toves, SSAR 2000).

One of the oldest bits of crocodile natural history is the crocodile's relation with a small bird (Trochilos). In Pliny's version:

When he hath filled his belly with fishes, he lieth to sleep upon the sands in the shore, and for that he is a great and greedy devourer, somewhat of the meat sticketh evermore between his teeth. In regard whereof cometh the wren, and she, for her victuals sake, hoppeth first about his mouth, falls pecking it with her little bill and so forward to the teeth which she cleaneth to make him gap. Then getteth she within his mouth, which openeth wider by reason that he taketh so great delight in this her scraping and scouring of his teeth and jaws.

Sherman A. Minton Jr. and Madge Rutherford Minton
(1973) *Giant Reptiles*





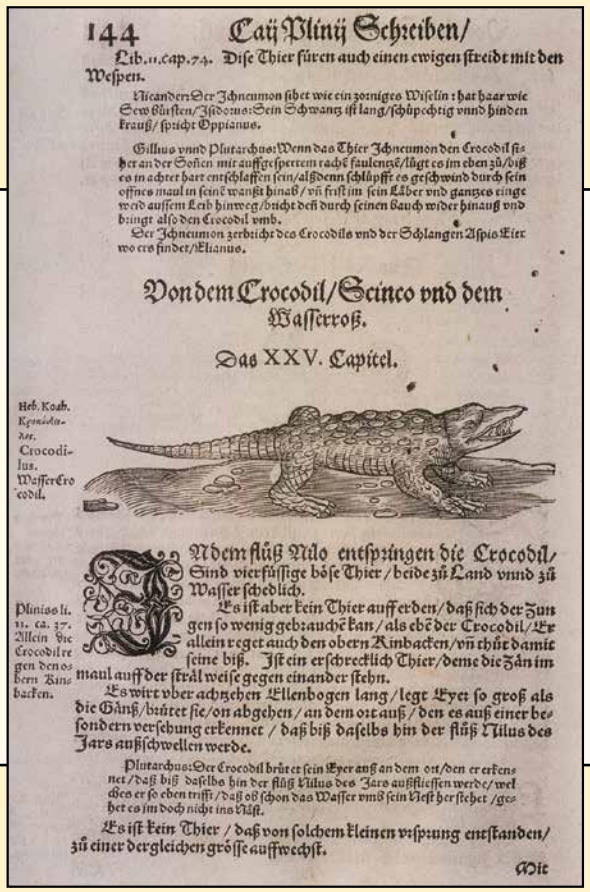


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This illustration (left) shows a human subduing a crocodile from *River God, Crocodile and Hippopotamus* by Jean Temporal, *Historiale Description de l'Afrique* in 16th century. The other one is called *Capturing a Crocodile using a Goat as Bait.* These images were taken from Roman coins.

But such discursions take us away from the real reason for men's curiosity about crocodile diet. Eating is a highly evocative subject to humans, full of sexual and above all cannibalistic symbolism. In the associative processes of our unconscious thinking little distinction is drawn between a man eating a man and an animal eating a man: they both connote cannibalism. Opening up a croc always raises the possibility of finding human remains inside – something bound to excite any human. This lends a juicy, macabre air to poking around inside a croc's gut. And from time to time the inquisitive have indeed found "anklets, wristlets and other lugubrious objects inside crocodiles.

A. D. Graham (1973) *Eyelids of Morning; The Mingled Destinies of Crocodiles and Men*



144 Caij Plinij Schreiben/

Lib. 11. cap. 74. Dise Thier füren auch einen ewigen streidt mit den Wespen.

Vicander Der Ichneumon sihet wie ein zorniges Wiselin: hat haar wie Sew Bürsten/Isidorus: Sein Schwanz ist lang/schüpechtig vnnd hinden krauß/spricht Oppianus.

Gillius vnnd Plutarchus: Wenn das Thier Ichneumon den Crocodil sicher an der Sonnen mit auffgesperrtem rachen faulenzet/flügt es im eben zů/biß es in achtet hart entschlaffen sein/alßdenn schlüpfft es geschwind durch sein offnes maul in seinē wanst hinab/vñ frist im sein Läber vnd gantzes eingeweid aussen Leib hinweg/bricht deß durch seinen Bauch wider hinauß vnd bringt also den Crocodil vmb.

Der Ichneumon zerbricht des Crocodils vnd der Schlangen Aspis Eier wo ers findet/Elianus.

Von dem Crocodil/Scinco vnd dem Wasserroß.

Das XXV. Capitel.

Heb. Koab. Kpenidelan. Crocodilus. Wasser Crocodil.

Plinius li. 11. ca. 37. Allein die Crocodil regen den obern Kinbacken.

Ndem flüß Nilo entspringen die Crocodil/ Sind vierfüssige böse Thier/beide zů Land vnnd zů Wasser schedlich.

Es ist aber kein Thier auff erden/daß sich der Zungen so wenig gebrauchē kan/als ebē der Crocodil/Er allein reget auch den obern Kinbacken/vñ thůt damit seine biß. Ist ein erschrecklich Thier/deme die Zän im maul auff der strāl weise gegen einander stehn.

Es wirt vber achtzehen Ellenbogen lang/legt Eyer so groß als die Gänß/brütet sie/on abgehen/an dem ort auß/den es auß einer besondern versehung erkennet/daß biß daselbs hin der flüß Nilus des Jars außschwellen werde.

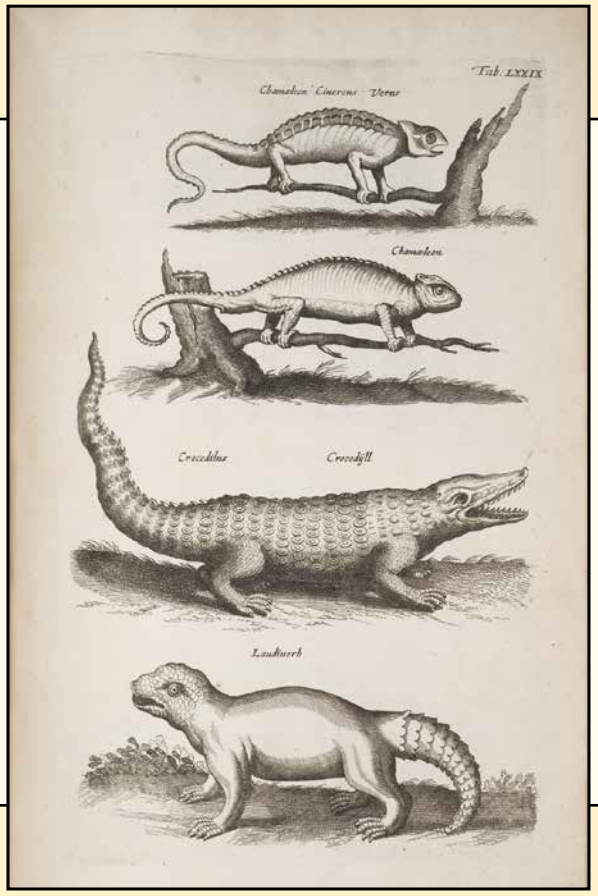
Plutarchus: Der Crocodil brütet sein Eyer auß an dem ort/den er erkennet/daß biß daselbs hin der flüß Nilus des Jars außfliessen werde/welches er so eben trifft/daß oß schon das Wasser vmb sein Nest her stehet/gehet es im doch nicht ins Nest.

Es ist kein Thier/daß von solchem kleinen vrsprung entstanden/zů einer dergleichen grösse auffwechst.

Illustration From *Bücher und Schrifften, von der Natur* in 1565 by Pliny the Elder. (Haines, Slithy Toves, SSAR 2000).

It is a curse on four legs, and equally pernicious on land and in the river. Its teeth are set close together like a comb, it has no tongue, and it bites down with its mobile upper jaw, unlike other land animals. It also has claws, and its hide is impervious to blows. It foreknows to lay its eggs above the point where the river will rise during the next flood. To stay warm, it stays on land during the day and in the water at night. It allows a small bird to enter its mouth to clean its teeth; if it falls asleep with its jaws open while this is happening, the ICHNEUMAN jumps down its throat and gnaws its way out through the belly. Dolphins also attack crocodiles, using the sharp fin on their backs to cut open the crocodile's soft belly.

Natural History, Book 8, 37–38



Tab. LXXIX

Chamaleon Cinereus Verus

Chamaleon.

Crocodilus Crocodill

Landtschrch

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Illustration of crocodile in *Historiae naturalis . . .Cum aeneis figuris. / Joannes Jonstonus ... concinnavit* by Joannes Jonstonus in 1657–1665.

…The ichneumon, or Egyptian mongoose, like other mongooses an important enemy of young crocodiles and a raider of nests, was said by Pliny the Elder to kill the adults as they basked with their mouths open:

Now that he is lulled as it were fast asleep with this pleasure…the rat of India or ichneumon spieth his vantage and seeing him lie thus broad gaping, whippeth into his mouth and shooteth himself down his throat as quick as an arrow, and then gnaweth his bowels, eateth a hole through his side, and so killeth him..

Pliny also said that dolphins attacked crocodiles and killed them by slicing the thin belly skin with their fins. This may have some factual basis in that combats between crocodiles and sharks do sometimes occur. The battle here may go either way, for there is one report of a shark found in a crocodile's stomach.

Sherman A. Minton Jr. and Madge Rutherford Minton (1973) *Giant Reptiles*


THE
HISTORIE
OF
SERPENTS.
OR,
The second Booke of liuing Creatures:

The Boas

LONDON,
Printed by William Jaggard, 1608.

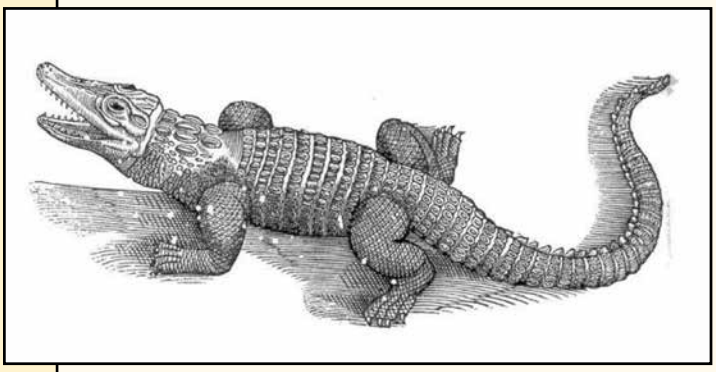


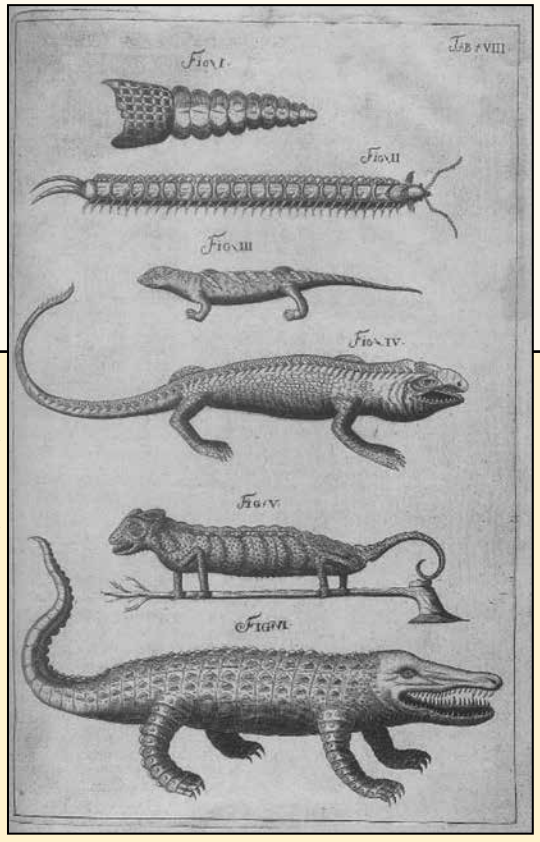
Illustration and quote from Edward Topsell.

There be many who in the hunting and prosecuting of these Crocodiles, doe neither giue themselues to runne away from them, nor once to turne aside out of theyr common path or roade, but in a foolish hardinesse, givue themselues to combat with the beast, when they might very well auoyd the danger, but many times it hapneth that they pay decrely for their rashnes, and repent too late the too much reputation of their owne man-hoode: for whiles with their speares and sharpe weapons they thinke to pierce his fides, they are deceiued, for there is no part of him penetrable except his belly, and that he keepeth safe enough from his enemies, blunting vpon his soales (no leffe hard then plates of yron) all the violence of theyr blowes and sharpneffe of weapons, but clubbes, beetles, and such like weapons, are more irkesome to him, when they be sette on with strengh, battering the scales to his body, and giuing him such knocks as doth dismay and astonish him. Indeede there is no great vse of the taking of this Serpent, nor profit of merchandize commeth thereby, his skinne and flesh yeelding no great respect in the world.

Illustration of crocodilian with interesting mouth from *Muséum regium; seu, Catalogus rerum tam naturalium, quàm artificialium* by Holger Jacobaeus in 1696. Notice the limbs which appear to be covered in armor; crocodile skin was used as armor in the Roman Period.

Landing the crocodile is still a matter of some difficulty. Specimens more than ten feet in length can not be towed with the canoe. One of us, therefore, stripped and waded in the breast-deep water, hauling steadily on the long rope. With a hundred feet of rope, even the largest specimens are rather easily managed in this way. The unfortunate beast makes a few struggles and rushes about at the surface with open jaws, but it is surprising that so powerful an animal make so little effectual resistance. It is important to choose a rocky shore on which to beach the crocodile as he may otherwise become deeply buried in the mud. ..Once hauled out, a large crocodile is a savage customer, snapping viciously at his captors and at the rope.

Karl P. Schimdt (1952) describing the capturing of crocodiles for display in the Chicago Natural History Museum in his book *Crocodile Hunting in Central America*.



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Illustration from Peter Pindar's *Peter's Prophecy… or, An Important Epistle to Sir J. Banks, on the Approaching Election of a President of the Royal Society* in 1788. (Haines, Slithy Toves, SSAR 2000).

Ernest A. Liner (2005) in *The Culinary Herpetologist* has over 375 recipes for alligator, including: Alligator Seviche, Alligator Salad Mold Supreme, Flaming Gator, Alligator Tongue Acadian, Ginger Plum Alligator, Gator Quiche, Szechuan Spicy Alligator, Bean Sprout and Gator Bake, and Gator Etouffé.

The recipe for Bayou Alligator Sauce Piquant calls for 50 lbs cubed alligator meat and serves 100+. It starts off, "Get a big, really big pot."

Preparation—Chances are slim that you will be processing an alligator (or crocodile) from a live specimen so I will give a few pointers, based on my experience, on processing the carcass after it has been skinned for its hide. Be sure to have plenty of free time.



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A multi-course meal shown by Jacques Le Moyne de Morgues in 1588. Illustration from Theodor de Bry's *Dritte Buch Americae, darinn Brasilia / / durch Johann Staden* ... and account from *Narrative of Le Moyne : an artist who accompanied the French expedition to Florida under Laudonnière, 1564 / / translated from the Latin of De Bry ; with heliotypes of the engravings taken from the artist's original drawings* in 1875.

Bringing in wild animals, fish, and other stores.

At a set time every year they gather in all sorts of wild animals, fish and even crocodiles; these are then put in baskets, and loaded upon a sufficient number of the curly-haired hermaphrodites above mentioned, who carry them on their shoulders to the storehouse. This supply, however, they do not resort to unless in case of the last necessity. In such event, in order to preclude any dissension, full notice is given to all interested; for they live in the utmost harmony among themselves. The chief, however, is at liberty to take whatever of this supply he may choose.



Alligators are losing this particular battle as depicted by engraver Theodor de Bry in 1591. Humans are really tiny or alligators are really big! Illustration from Theodor de Bry's *Dritte Buch Americae, darinn Brasilia / / durch Johann Staden* ... and account from *Narrative of Le Moyne : an artist who accompanied the French expedition to Florida under Laudonnière, 1564 / / translated from the Latin of De Bry ; with heliotypes of the engravings taken from the artist's original drawings* in 1875.

Killing crocodiles

Their way of attacking crocodiles is as follows: They put up, near a river, a little hut full of cracks and holes, and in this they station a watchman so that he can see the crocodiles, and hear them, a good way off; for, when driven by hunger, they come out of the rivers, and crawl about on the islands after prey, and if they find none, they make such a frightful noise that it can be heard for half a mile. Then the watchman calls the rest of the watch, who are in readiness; and, taking a portion, ten or twelve feet long, of the stem of a tree, they go out to find the monster, who is crawling along with his mouth wide open, all ready to catch one of them if he can; and with the greatest quickness they push the pole, small end first, as deep as possible down his throat, so that the roughness and irregularity of the bark may hold it from being got out again. Then they turn the crocodile over on his back and, with clubs and arrows pound and pierce his belly, which is softer; for his back, especially if he is an old one, is impenetrable, being protected by hard scales. This is their way of hunting crocodiles; by which they are, nevertheless, so much annoyed that they have to keep up a regular watch against them both day and night, as we should do against the most dangerous enemy.

FROM THE COLLECTIONS (ARCHIVES) OF THE ERNST MAYR LIBRARY OF THE MUSEUM COMPARATIVE ZOOLOGY, HARVARD UNIVERSITY



Illustration of American Alligator and quotation from *The Natural History* by Mark Catesby in 1771.

The flesh is delicately white, but has so perfume[d] a taste and smell that I could never relish it with pleasure.

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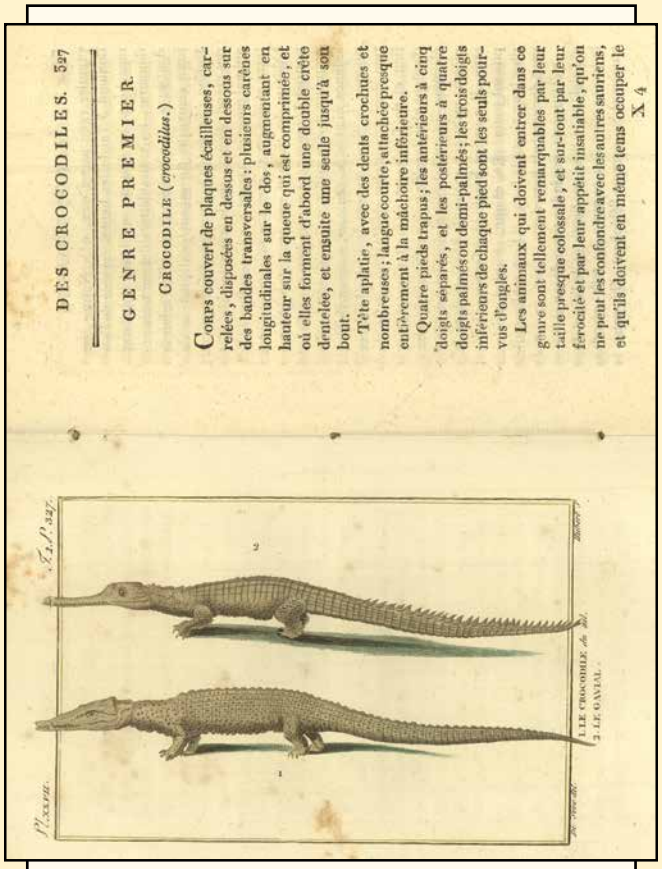


Illustration from *Histoire naturelle, générale et particulière, des reptiles : ouvrage faisant suite à l'Histoire naturelle générale et particulière, composée par Leclerc de Buffon, et rédigée par C.S. Sonnini / / par F.M. Daudin* by François Marie Daudin in 1805.

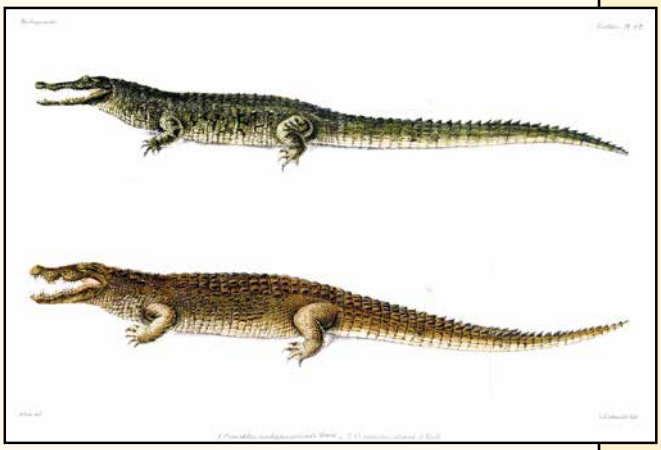
The fights among crocodilians during mating season, which sometimes cause significant mutilations, can lead to the death of an animal…On crocodile farms, where a large number of crocodilians are often kept under cramped conditions, missing limbs, tails, and jaw fractures are not rare.

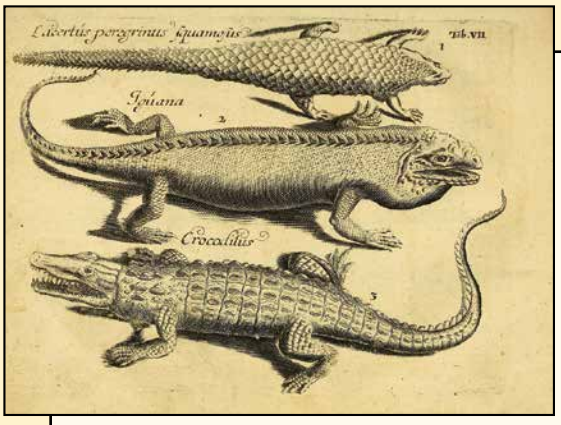
Ludwig Trutnau and Ralf Sommerlad (2006)
Crocodilians ; Their Natural History & Captive Husbandry

In 1885, Léon Vaillant & Guillaume Grandidier published this exquisite color plate of the Nile Crocodile found in Madagascar in *Histoire Naturelle des Reptiles. Premiére Partie: Crocodiles et Tortue. Vol. XVII.* Many of the reptiles pictured in this volume are near extinction, due to poaching and habitat loss.

Descriptions of the Nile crocodile were recorded by the ancient Greeks, and the Romans captured live specimens 50 to 100 years B.C. to exhibit in their menageries in Rome. Nile crocodiles figure prominently in the Bible. Women and children washing clothes in the Nile have been attacked, killed, and eaten by crocodiles dating back thousands of years up to the present day.

Steve Grenard (1991)
Handbook of Alligators and Crocodiles





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Crocodile from *Gottorffiche Kunst-Kammer…* by Adam Olearius in 1674.

…Shooting is most effective if the only motive of the hunter is to kill. If the animal is wanted for its hide or for some other purpose, it may be lost, especially if it is shot in the water. Nevertheless the usual method of professional hunters in Africa is to work at night in a fast motorboat, locate the crocodile by eye-shine, shoot it at point-blank range, and gaff the dying animal before it can sink. Using these tactics, hunters have virtually exterminated crocodiles in many places where they were numerous prior to 1950.

Sherman A. Minton Jr. and Madge Rutherford Minton (1973) *Giant Reptiles*

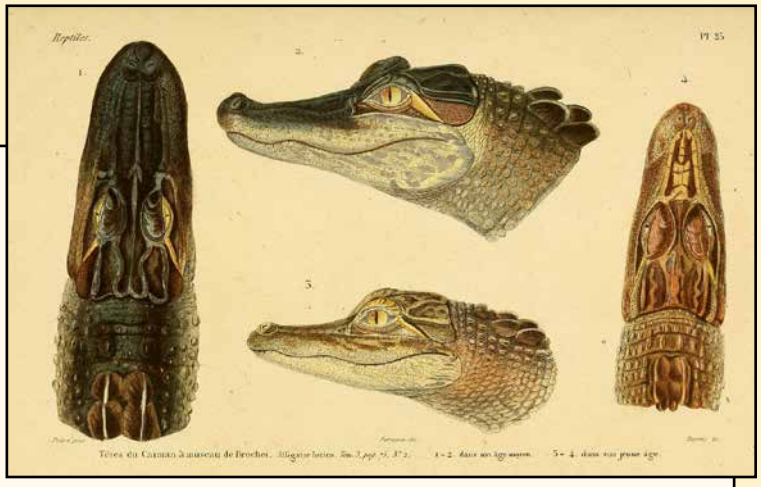
Caimans are heavily hunted for their skins throughout the range. Illustration of Black Caiman (*Melanosuchus niger*) [left] and Dwarf Caiman or Cuvier's Smooth Fronted Caiman (*Paleosuchus palpebrosus*) from Johann Baptist von Spix (1824–[1825]) *Animalia nova, sive, Species novae lacertarum [serpentes, testudinum et ranarum] : quas in itinere per Brasiliam annis MDCCCXVII-MDCCCXX jussu et auspiciis Maximiliani Josephi I. Bavariae regis suscepto / / collegit et descripsit dr. J.B. de Spix.*

Native tribes hunt crocodilians with harpoons hooks, traps, and nets. In the Amazon Basin, many caimans are beaten to death with clubs when the bodies of water dried out. The simple hunting method of the natives did not endanger the overall crocodilian populations…Only when the Europeans with their modern weapons invaded the tropical countries, the number of crocodilians declined drastically.

Ludwig Trutnau and Ralf Sommerlad (2006) *Crocodilians ; Their Natural History & Captive Husbandry*



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Illustration from Constant Duméril, Auguste-Henri-André Duméril, and Gabriel Bibron (1834-1854). *Erpétologie générale, ou, Histoire naturelle complète des reptiles / / par A.M.C. Duméril et par G. Bibron.*

Vaughn Glascow tells us that threats to Alligators were endless even in the early days: Native Americans used skins for tribal instruments, Indian basketry used alligator entrails for baskets, early colonists used tail fat to help produce indigo, and in the middle of the 19th century, alligators' teeth were sold by jewelers for babies' pacifiers.

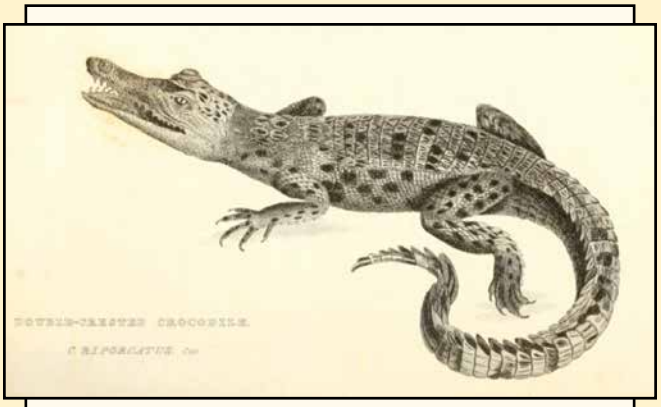
The draining of swamps and marshes, the damming of almost all the major southern rivers, and the clearing and removal of wetland vegetation have all contributed to reducing the alligator's natural habitat. The full impact is often not recognized because of the alligator's ability to adapt to artificial lakes, ponds, and canals, as well as its capacity to persist in areas heavily populated by people. Their obvious presence in such unnatural aquatic systems gives an illusion that alligators are coping with the human alteration of wetland habitat. And they probably are doing so more effectively than most wetland species they normally coexist with.

J. Whitfield Gibbons (1997)



John James Audubon reported on 16 April 1822 that a group of nine Whooping Cranes was killing a band of young alligators. He added the gators in April and painted the background some years later.

Robert Havell Jr was an English engraver hired for Audubon's monumental double-elephant folios of prints [Audubon Plate 8]; Havell number CCXXVI (measured 29.5 × 39.5 inches (untrimmed), drawing traced on copper plates and hand-colored).



COURTESY OF SMITHSONIAN INSTITUTION LIBRARIES, WASHINGTON, DC

Illustration and account from Baron Cuvier in *The class Reptilia* in 1831. The species pictured is the Double-Crested Crocodile (*Crocodylus biporcatus*, now *C. porosus*).

The negroes sometimes kill the crocodile by main force, and in the water, when they surprise him in a spot where he cannot support himself without swimming. They proceed to him, having the left arm guarded by a piece of ox-hide, and a bayonet in the right hand. They keep his mouth open by plunging the left arm into his gullet, and strike him with the bayonet in the throat. This information we also receive from Father Labat.

We cannot terminate the history of the crocodiles, without noticing the threrapeutic qualities, anciently attributed to them. Their blood was supposed to cure opthalmia, and to hinder the development of accidents caused by the bite of serpents. Persons laboring under fever were rubbed with their fat, and the ashes made from their skin when burned, and steeped in the lye of oil, were esteemed to be a powerful narcotic. Assertions such as these could only be opposed by facts, and, unfortunately, there is nothing of the kind to justify them. Another specimen of these absurdities, but of a different kind, was, that the crocodile itself furnished an antidote to its own bite. The reputation of these, and a multitude of other specifics, have been utterly destroyed by the progress of the philosophy of medicine.

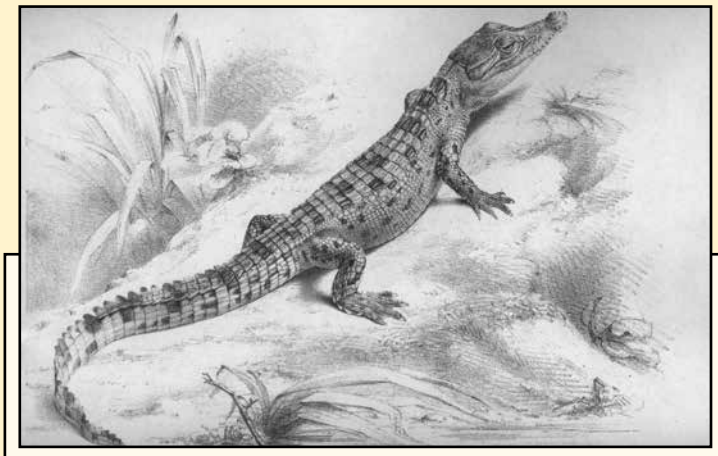


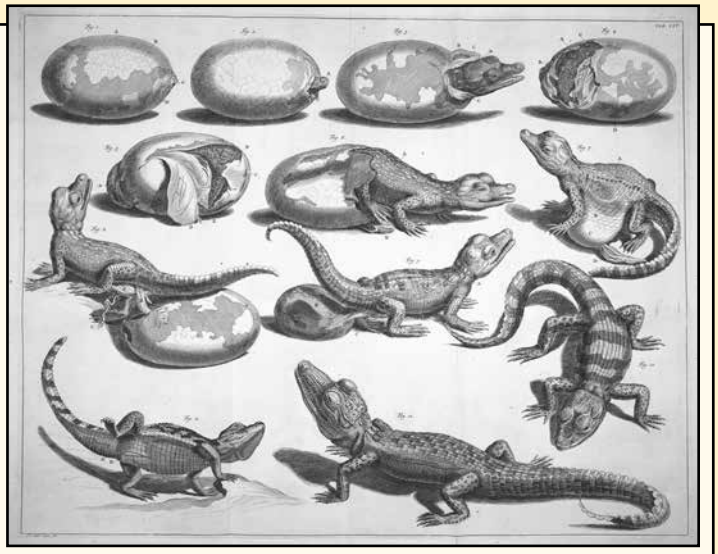
Illustration of Salt Water Crocodile (*Crocodylus pondicerianus,* now *C. porosus*) by Albert C.L.G. Günther (1864) *The Reptiles of British India.*

Account from by Sir J. Emerson Tennent (1861) *Sketches of the Natural History of Ceylon:*

The lagoon of Batticaloa, and indeed all the still waters of this district, are remarkable for the numbers and prodigious size of the crocodiles which infest them. Their teeth are sometimes so large that the natives mount them with silver lids and use them for boxes to carry the powdered chunam, which they chew with the betel leaf. During one of my visits to the lake a crocodile was caught within a few yards of the government agent's residence, a hook having been laid the night before, baited with the entrails of a goat; and made fast, in the native fashion, by a bunch of fine cords, which the creature cannot gnaw asunder as it would a solid rope, since they sink into the spaces between its teeth. The one taken was small; being only about ten or eleven feet in length, whereas they are frequently killed from fifteen to nineteen feet long. As long as it was in the water, it made strong resistance to being hauled on shore, carrying the canoe out into the deep channel, and occasionally raising its head above the surface, and clashing its jaws together menacingly. This action has a horrid sound, as the crocodile has no fleshy lips, and it brings its teeth and the bones of the mouth together with a loud crash, like the clank of two pieces of hard wood. After playing it a little, the boatmen drew it to land, and when once fairly on the shore all courage and energy seemed utterly to desert it. It tried once or twice to regain the water, but at last lay motionless and perfectly helpless on the sand. It was no easy matter to kill it; a rifle ball sent diagonally through its breast had little or no effect, and even when the shot had been repeated more than once, it was as full of life as ever. It feigned death and lay motionless, with its eyes closed; but, on being pricked with a spear, it suddenly regained all its activity. It was at last finished by a harpoon, and then opened. Its maw contained several small tortoises, and a quantity of broken bricks and gravel, taken medicinally, to promote digestion.

Leitch and Catania (2012) asked what the purpose was for the thousands of microscopic pigmented bumps found on crocodiles' bodies and the minute dome organs restricted to the faces of alligators. Using scanning electron microscopy, they discovered that each dome was surrounded by a hinge depression. The authors located sensory receptor structures beneath the domes with sensitive free nerve endings near the dome surface, and laminated corpuscle structures responding to sustained pressure in the lowest skin layer. A delicate network of nerves infiltrated the entire jaw. Remarkably, the domes around the animals' teeth and jaws were more touch sensitive than human finger-tips. The conclusion: this sensitivity allows the crocodilians to distinguish rapidly between inedible debris and prey and aids females during extraction of hatchlings from eggs with their jaws.

Hatchling crocodilians face an array of dangerous predators, including larger crocodilians, during their first few years of life. Drawing from Albertus Seba's *Locupletissimi rerum naturalium thesauri* in 1734–1765.



COURTESY OF SMITHSONIAN INSTITUTION LIBRARIES, WASHINGTON, DC

The absurd story that alligators eat their own young, cannot be believed for a moment. A gentleman informed me, that one of his negroes having caught a young alligator, which whined like a young puppy, the parent came towards the negro with a rapidity he had never witnessed on other occasions—a kind of jumping motion, which caused the boy to run, after dropping his captive. I have been assured, when danger is imminent, that very young alligators run into the parent's mouth for safety. I have this statement from a highly respectable physician.

Bennet Dowler (1846) *Contributions to the natural history of the alligator (Crocodilus mississippiensis) : with a microscopic addendum.*

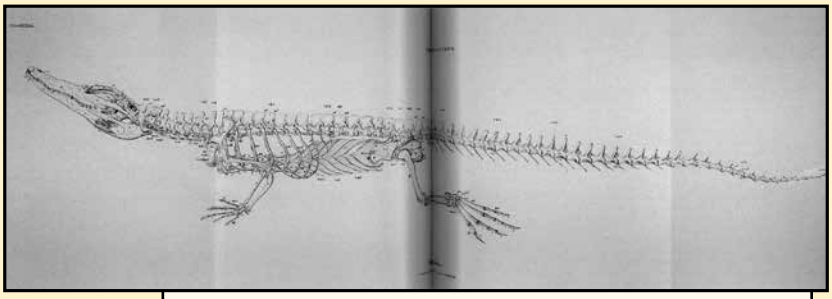


Illustration from K. B. Brühl's *Das Skelet der Krokodilinen* in 1862. (Haines, Slithy Toves, SSAR 2000).

Conservation of crocodilian populations is highly dependent upon management practices that allow people and crocodiles to coexist. Successful programs have focused on incentives to maintain crocodiles and their habitats in a relatively undisturbed state. Sustainable use has become a key element in recent conservation efforts, based on more than two decades of experience with different management schemes in Papua New Guinea, Venezuela, Zimbabwe, the USA, and Australia. In each case, crocodilian populations in the wild have increased or remained stable while supporting economically viable levels of harvest.

Tim Halliday and Kraig Adler (eds.)
Firefly Encyclopedia of Reptiles and Amphibians, 2002.

Illustration of Chinese Alligator (*Alligator sinensis*) from George A. Boulenger, LZS Meeting Proceedings. 1890. Two living specimens were on exhibit at the Society's Menagerie. An interesting photograph of a London keeper holding a tame one was shown in W. S. Berridge, (1926) *Marvels of Reptile Life.*



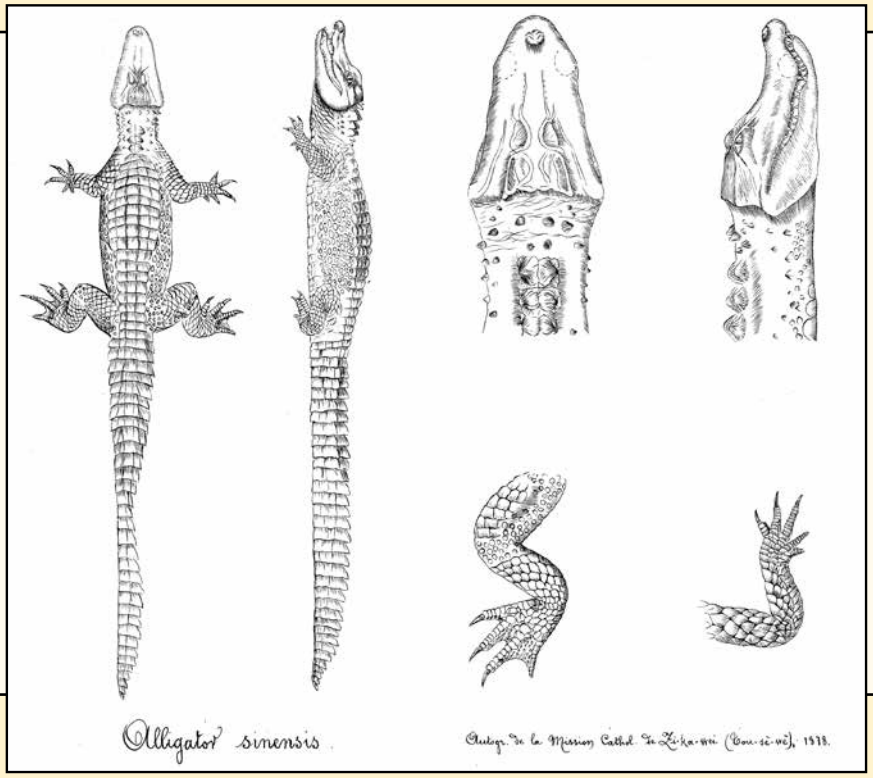


Illustration from A. A. Fauvel describing this species in 1879.

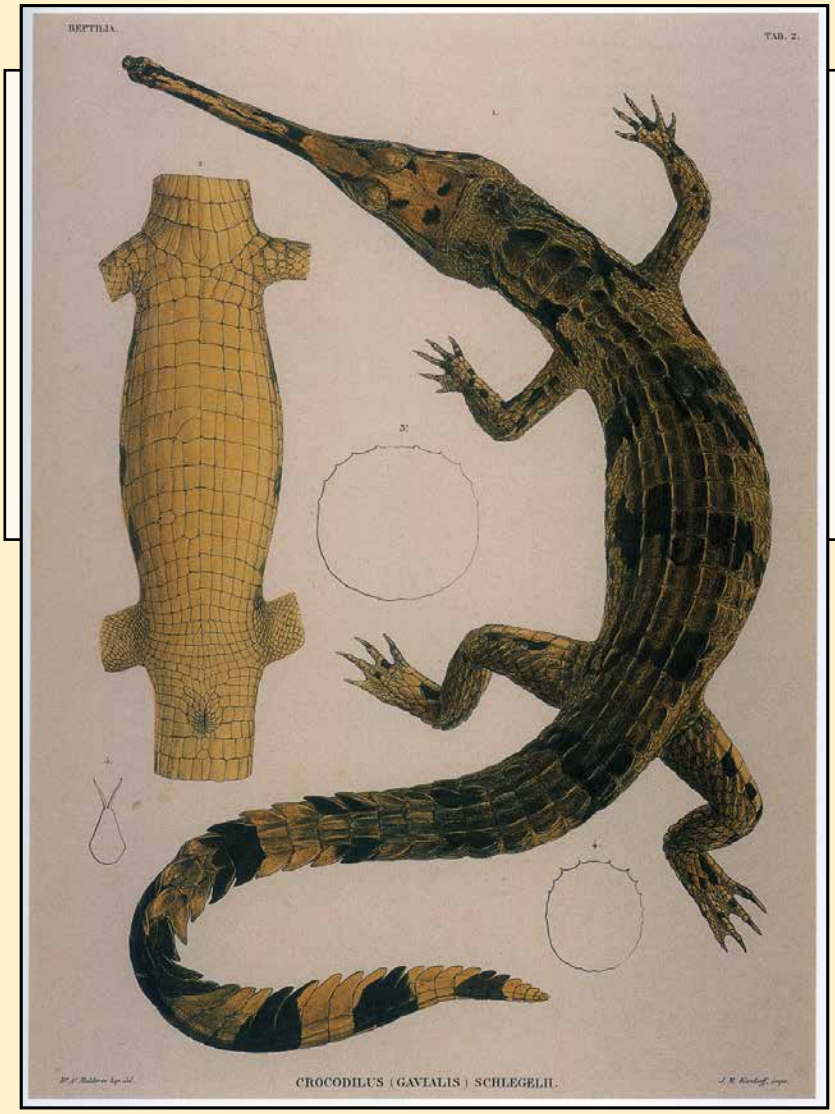
The recovery of the American alligator is a striking conservation success story, and one that demonstrates the resiliency of crocodilian populations to hunting pressures... Despite the large number of hunters after their skins, breeding groups of alligators remained in many areas and became a foundation that allowed a rapid recovery once hunting stopped. The key factor here was the fact that American alligator habitat remained abundant throughout the entire species range . A similar situation is seen for a variety of other species including the black caiman and the Morelet's crocodile. Once widespread commercial hunting was controlled, populations entered a period of recovery. Species like the Chinese alligator, with little or no remaining habitat, represents a very different conservation challenge

John B. Thorbjarnarson and X. Wang (2010)
The Chinese Alligator…

Illustration and quote from Davy Crockett"s Almanack of Wild Sports in the West, Life in the Backwoods, Sket[ch] of Texas, and Rows on the Mississippi (1837, v. 1, no. 3). Crockett's wife and daughters are mentioned: "*The women then slacked the rope a little and made it fast round a hickory stump, when my oldest darter took the tongs and jumped on [the alligator's] back, when she beat up the "devil's tattoo" on it, and gave his hide a real "rub a dub…My wife threw a bucket of scalding suds down his throat, which made him thrash round as though he was sent for. She then cut his throat with a big butcher knife. He measured thirty seven feet in length.*" I am curious as to where he found his ruler. At least she is riding side-saddle as a proper lady should.



COURTESY OF NEW YORK HISTORICAL SOCIETY



Drawing of False Gavial (*Tomistoma schlegeli*) in *Verhandelingen over de natuurlijke geschiedenis der Nederlandsche overzeesche bezittingen…* by Salomon Müller and Hermann Schlegel in 1839-44. This taxon is endangered, due to human activities. This species was assumed to have a predominantly fish diet but recent evidence has shown these reptiles to prey on larger vertebrates including humans, Proboscis monkeys, long-tailed macaques, deer and fruit bats (Rachmawan, D., Brend, S. 2009. *Human-Tomistoma interactions in central Kalimantan, Indonesian Borneo* Crocodile Specialist Group Newsletter January 2009 – March 2009. Volume 28 No. 1: 9–11). (Haines, Slithy Toves, SSAR 2000).

ARTICLES

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Herpetological Surveys of the Serra Jeci and Namuli Massifs, Mozambique, and an Annotated Checklist of the Southern Afromontane Archipelago

The reptiles and amphibians of northern Mozambique are among the least studied in all of Africa. This lack of study stems in part from the combined effects of limited infrastructure and Mozambique's extended civil war (1977–1992), making access notoriously difficult. While much of Mozambique south of the Zambezi River has historically been included as part of the southern African region in field guides and herpetofaunal summaries (Alexander and Marais 2007; Branch 1998; Carruthers 2001; du Preez and Carruthers 2009), the provinces of Cabo Delgado, Nampula, Niassa, and Zambézia are poorly studied in a biological context, with large regions lacking even preliminary surveys (Poynton and Broadley 1991; Schneider et al. 2005). The most significant contribution to the herpetofauna of northern Mozambique was made by Branch et al. (2005a), who recorded 57 species of reptiles occurring in Niassa Game Reserve (NGR). The NGR spans the northern limits of both Niassa and Cabo Delgado Provinces, with the Rovuma (or Ruvuma) River forming the northern border of the Reserve, and border with Tanzania. While much of the Reserve is low elevation woodland or savannah, the Serra Mecula Plateau sits between 800–1000 m elevation, with granite peaks rising to 1442 m elevation (Fig. 1). The Serra Mecula Plateau supports unique habitats, including miombo woodland and evergreen moist forest, the latter containing species commonly associated with Afromontane forests. On the Serra Mecula Plateau, Branch et al. (2005a) discovered a new species of cordylid lizard (Branch et al. 2005b), identified several taxa of equivocal status, and uncovered many faunal elements linked to other Afromontane isolates in Zimbabwe (Eastern Highlands), Malawi (Mt. Mulanje), and Tanzania (Eastern Arc Mountains). Branch et al. (2005a) established the Serra Mecula Plateau and surrounding region as having the highest reptile diversity in all of Mozambique, thereby highlighting the importance of surveying additional inselbergs across Mozambique.

Northern and central Mozambique are dotted with inselbergs, several of which have been explored recently as part of the Royal Botanic Gardens Kew Darwin Initiative to catalogue biodiversity in montane systems (Bayliss et al. 2010; Timberlake et al. 2007; Timberlake et al. 2009). These montane areas are located in Zambézia Province, Mozambique, adjacent to Mt. Mulanje, Malawi, and include Mt. Chiperone, Mt. Inago, Mt. Mabu, and Mt. Namuli (Fig. 1). These four inselbergs each rise to over 1500 m elevation, and support unique habitats not found in surrounding lowlands, including areas of Afromontane vegetation. Formal biodiversity surveys were conducted to catalogue plant, bird, and invertebrate diversity, and although not targeted specifically, reptiles and amphibians were collected opportunistically. The limited herpetological sampling of these inselbergs has already resulted in the discovery of several new species (Branch 2005b; Branch and Bayliss 2009; Branch and Tolley 2010), and these regions await focused herpetological surveys.

Further north are other largely unexplored inselbergs, including the Serra Jeci massif, situated on the Lichinga Plateau in Niassa Province (Fig. 1). The Lichinga Plateau sits between 900–1300 m elevation, with the Serra Jeci massif rising to 1300–1800 m elevation. The vegetation is characterized by grasslands, miombo woodlands, riparian forest patches, and limited evergreen montane forest patches (Ryan and Spottiswoode 2003). The Serra Jeci massif was first identified as supporting a diverse community of forest-dependent birds, including an endemic subspecies, in 1945 (Benson 1945, 1946). However, due to extremely difficult access it has only been visited twice in the last 67 years, once for a two-day avifaunal survey (Ryan and Spottiswoode 2003), and once for a brief scouting expedition by the Royal Botanical Gardens in 2009. Nothing has been reported about the herpetofauna of this area, which represents a critical biogeographic link between the Serra Mecula Plateau and inselbergs further south and west.

During July–August of 2011, we conducted herpetological and avian surveys on and near the Lichinga Plateau and Gurué

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highlands, and our primary survey areas were the Serra Jeci massif (29 July–5 August) and Mt. Namuli (7–11 August). Overall conditions were cool and dry, as these months represent the end of the winter period before seasonal rains begin. In each area, combinations of sites were sampled to maximize the types of habitat surveyed. Sites surveyed in the Namuli region include localities on the massif and in the nearby town of Gurué, and ranged in elevation from 700–1720 m. Sites surveyed at the Lichinga Plateau include the Serra Jeci massif and the nearby town of Lichinga, and ranged in elevation from 1300–1770 m. Specimens were hand-captured during diurnal and nocturnal visual surveys. Time limitations precluded the use of pitfall traps or other systematic techniques. Voucher specimens and tissue samples are deposited in the Museum of Vertebrate Zoology (MVZ) at the University of California, Berkeley, with a subset of voucher specimens deposited at the Natural History Museum of Maputo. Morphological identification of bufonids and hyperoliid frogs were confirmed through DNA barcoding, using the mitochondrial gene *16S* (DMP, unpubl. data).

The following species accounts, including locality and voucher details and relevant natural history information, are given for animals collected during our surveys. We present an annotated checklist (Table 1) of the herpetofauna of the southern Afromontane archipelago based on: 1) this study; 2) the targeted herpetological surveys of Mt. Mulanje, Malawi (Branch and Cunningham 2006) and Niassa Game Reserve, Mozambique (reptiles only, Branch et al. 2005a); 3) the opportunistic collections made by the Royal Botanic Gardens Kew Darwin Initiative across three Mozambican inselbergs (Bayliss et al. 2010; Timberlake et al. 2007; Timberlake et al. 2009); and 4) a brief survey of the Lichinga Plateau that followed our work in the area (Branch 2012).

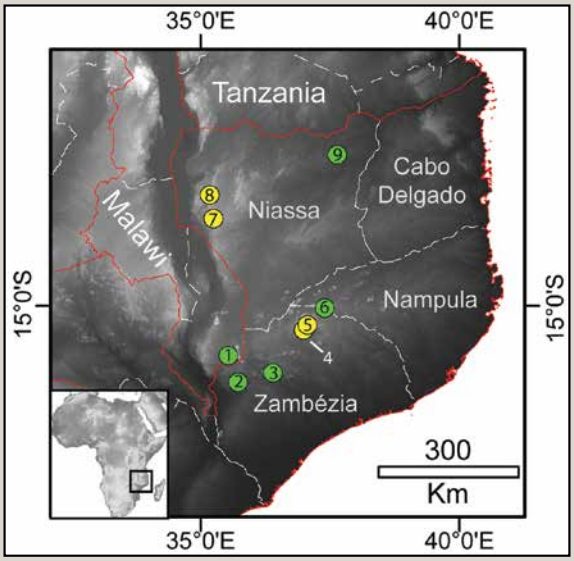


FIG. 1. Map of inselbergs surveyed in northern Mozambique and adjacent Malawi. Yellow circles represent areas surveyed for the present study, whereas green circles represent areas previously surveyed. Localities are as follows: 1) Mt. Mulanje, Malawi; 2) Mt. Chiperone; 3) Mt. Mabu; 4) Gurué; 5) Mt. Namuli; 6) Mt. Inago; 7) Lichinga; 8) Serra Jeci; 9) Serra Mecula Plateau, Niassa Game Reserve. The Lichinga Plateau includes localities 7 and 8. Red outline demarcates country borders, while white dashed lines demarcate province borders.

ANURA

Arthroleptidae

Arthroleptis xenodactyloides (Fig. 2A–C). Niassa Province: Serra Jeci forest drainages, 2–4 August, 12.8512°S, 35.1777°E, MVZ 265868; 12.8492°S, 35.1810°E, MVZ 265869–71; 12.8438°S, 35.17817°E, MVZ 265871–904. This species was found only in moist leaf litter at the edges or in elevated portions of small streams within Afromontane forest, at 1668–1723 m elevation. This species was not found in permanent pools or marshy areas in open grassland below the montane forest (<1450 m).

Brevicipitidae

Breviceps mossambicus (Fig. 2D). Zambézia Province: Gurué, 7 August, 15.4639°S, 36.9778°E, MVZ 266110. Found at night on surface of compacted sandy soil after rain showers, 730 m elevation.

Bufonidae

Amietophrynus gutturalis (Fig. 3A). Niassa Province: Lichinga, 27 July, 13.3010°S, 35.2456°E, MVZ 265843–44; Serra Jeci grassland, end of Malulo-Cal Road, 29 July, 12.8674°S, 35.18503°E, MVZ 265846–53; Zambézia Province: Gurué, 23 July, 15.4687°S, 36.9939°E, MVZ 265840; 7 August, 15.4639°S, 36.9778°E, MVZ 265856–57; Village adjacent to Mt. Namuli, bridge overpass, 9 August, 15.3875°S, 37.0732°E, MVZ 265863, 265865. This was the most common toad species encountered. Adults were found diurnally along banks of irrigation ditches and small streams in open grassland. Males were often heard calling diurnally, and several pairs of males and females were found in amplexus. Egg masses and tadpoles were sometimes found in the same water sources as adults.

Amietophrynus maculatus. Niassa Province: Serra Jeci grassland, end of Malulo-Cal Road, 29 July, 12.8674°S, 35.1850°E, MVZ 265845; Zambézia Province: Gurué, 23 July, 15.4687°S, 36.9939°E, MVZ 265841; Village adjacent to Mt. Namuli, bridge overpass, 9 August, 15.3875°S, 37.0731°E, MVZ 265864. This species was often found in sympatry with *A. guttaralis*, and was active during daytime hours.

Hyperoliidae

Afrixalus brachycnemis (Fig. 2E, F). Niassa Province: Serra Jeci grasslands, 2 August, 12.8673°S, 35.1733°E, MVZ 265820–23; Zambézia Province: Grasslands below Ukalini Forest, Mt. Namuli, 11 August, 15.3842°S, 37.0719°E, MVZ 265824–26. This species was found sheltering diurnally in banana plants, sugarcane leaves, and sedges near flowing water outside of the montane forests, at 1200–1400 m elevation.

Hyperolius marmoratus (Fig. 2G). Zambézia Province: Mt. Namuli grasslands, 11 August, 15.3842°S, 37.0719°E, MVZ 266048, 266051. Two juveniles were captured sheltering in banana plants in an agricultural plot adjacent to a stream in otherwise open grassland habitat.

Hyperolius cf. spinigularis (Fig. 2H). Zambézia Province: Mt. Namuli grasslands, 11 August, 15.3842°S, 37.0719°E, MVZ 266050. A single juvenile was captured sheltering in a banana plant in an agricultural plot adjacent to a stream.

Hyperolius substriatus (Fig. 4A–H). Niassa Province: Serra Jeci Peak Forest, 1 August, 12.8401°S, 35.1845°E, MVZ 265976–86; Grassland agricultural drainage, 2 August, 12.8618°S, 35.1732°E,

COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND



PHOTOGRAPHS BY DANIEL M. PORTIK

FIG 2. Photographs of voucher specimens in life: (A) *Arthroleptis xenodactyloides* (MVZ 265885), Serra Jeci; (B) *Arthroleptis xenodactyloides* (MVZ 265869), Serra Jeci; (C) *Arthroleptis xenodactyloides* (MVZ 265870), Serra Jeci; (D) *Breviceps mossambicus* (MVZ 265910), Gurué; (E) *Afrixalus brachycnemis* (MVZ 265820), Mt. Namuli; (F) *Afrixalus brachycnemis* (MVZ 265826), Serra Jeci; (G) juvenile *Hyperolius marmoratus* (MVZ 266048), Serra Jeci; (H) juvenile *Hyperolius cf. spinigularis* (MVZ 266050), Mt. Namuli.

MVZ 265987–90; Grassland farmbush pond, 2 August, 12.8767°S, 35.1845°E, MVZ 265991–6004; Grassland irrigation ditch, 2 August, 12.8680°S, 35.1841°E, MVZ 266005–14; Serra Jeci Forest Camp, 2 August, 12.8512°S, 35.1818°E, MVZ 266015–18; Serra Jeci Drainage Forest, 4 August, 12.8438°S, 35.1781°E, MVZ 266019–24; Zambézia Province: Mt. Namuli grasslands, 11 August, 15.3842°S, 37.0719°E, MVZ 266026–47, 266049, 266052–107. Specimens at Serra Jeci were found at 1360–1770 m elevation, whereas specimens at Mt. Namuli were found at 1200–1420 m elevation. There is substantially more variation in adult color pattern in the Serra Jeci population as compared to the population at Mt. Namuli, which exhibits a more typical adult form of this species (Fig. 4). This was the most abundant hyperoliid species encountered, and it was found in a variety of habitats including streamside vegetation inside the montane forests (Serra Jeci only), drainages and seeps in open grasslands, grassland ponds and marshes, and in agricultural areas close to moving water.



FIG. 3. Photographs of voucher specimens in life: (A) *Amietophrynus gutturalis* (MVZ 265863), Mt. Namuli; (B) *Amietia* sp. (MVZ 266166), Serra Jeci; (C) *Rhampholeon* sp. (MVZ 266165), Mt. Namuli; (D) *Rhampholeon* sp. (MVZ 266161), Mt. Namuli; (E) *Acanthocercus atricollis* (MVZ 265813), Serra Jeci (F) *Panaspis wahlbergii* (MVZ 266148), Serra Jeci; (G) *Trachylepis margaritifer* (MVZ 266172), Mt. Namuli; (H) *Trachylepis varia*, Lichinga.

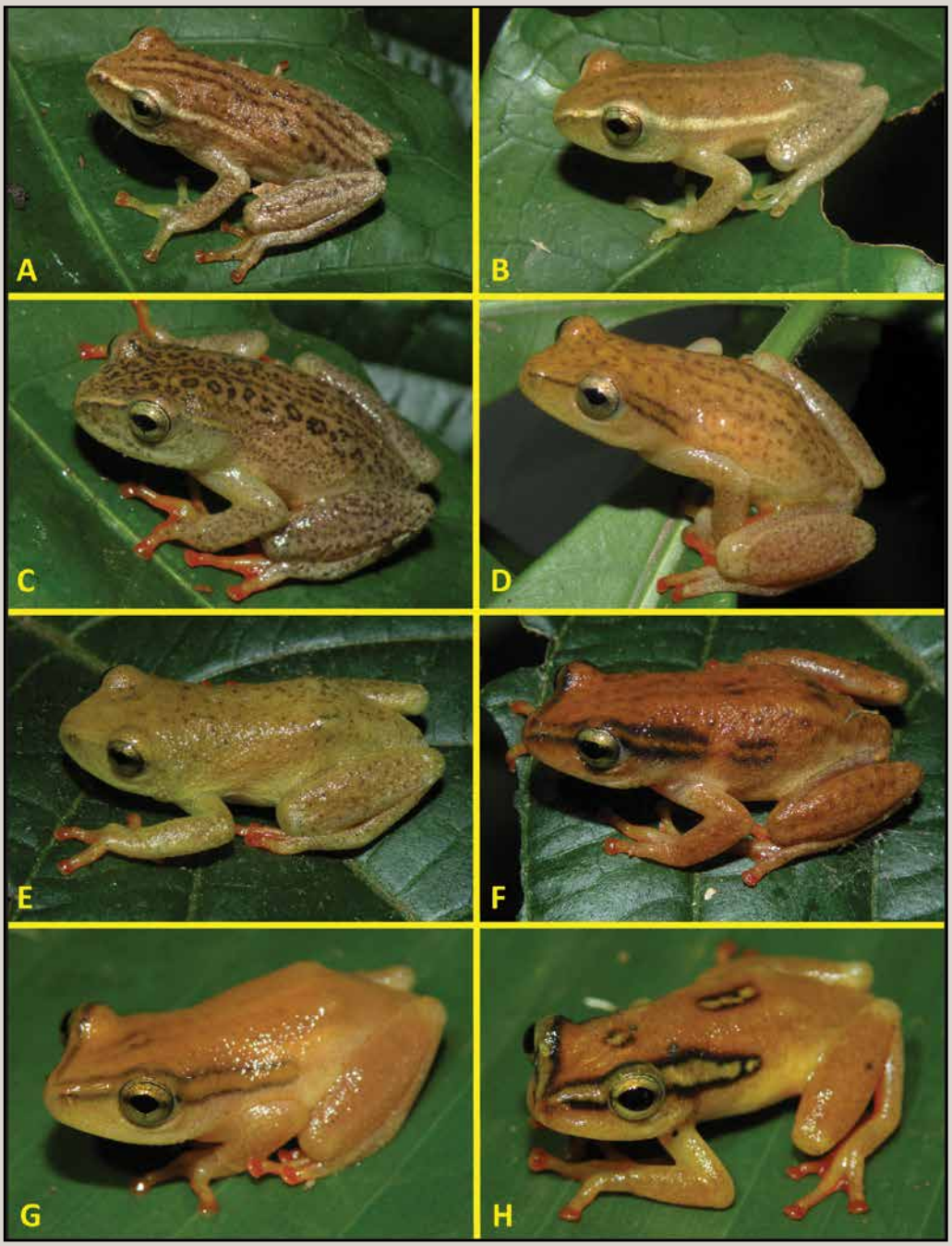
Ptychadenidae

Ptychadena sp. Niassa Province: Serra Jeci grasslands, 2 August, 12.8673°S, 35.1733°E, sight record; Zambézia Province: Mt. Namuli grasslands, 10 August, 15.3745°S, 37.0587°E, MVZ 266150–51.

Pyxicephalidae

Amietia angolensis. Zambézia Province: Ukalini Forest on Mt. Namuli, 9–10 August, 15.3689°S, 37.0615°E, MVZ 265829–30, MVZ 265834; 15.3677°S, 37.0587°E, MVZ 265833; Mt. Namuli riparian patch, 10–11 August, 15.3745°S, 37.0649°E, MVZ 265831–32, MVZ 265835; 15.3875°S, 37.0732°E, MVZ 265836. Found in streams and pools in Ukalini forest and the riparian patch below nocturnally, at 1200–1700 m elevation. Pickersgill (2007) recently elevated three subspecies of *A. angolensis* (*A. lubrica*, *A. tenuoplicata*, and *A. viridireticulata*, distributed across Uganda, Tanzania, and Tanzania and Malawi respectively) to species. The phylogenetic affinities of this newly sampled population are unknown, and additional work will be necessary to clarify its taxonomic status.

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FIG. 4. Photographs of voucher specimens of *Hyperolius substriatus* in life, showing variation encountered in both juveniles and adults: (A) juvenile *H. substriatus* (MVZ 265981), Serra Jeci; (B) juvenile *H. substriatus* (MVZ 266010), Serra Jeci; (C) adult *H. substriatus* (MVZ 265979), Serra Jeci; (D) adult *H. substriatus* (MVZ 265977), Serra Jeci; (E) adult *H. substriatus* (MVZ 266023), Serra Jeci; (F) adult *H. substriatus* (MVZ 266020), Serra Jeci; (G) adult *H. substriatus* (MVZ 265825), Mt. Namuli; (H) adult *H. substriatus* (MVZ 266039), Mt. Namuli.

Amietia sp. (Fig. 3B). Niassa Province: Serra Jeci grasslands, 2 August, 12.8680°S, 35.1841°E, MVZ 266166. A single specimen was collected diurnally next to a shaded irrigation ditch in the grasslands.

TESTUDINES

Testudinidae

Kinixys belliana (Fig. 5A). Niassa Province: Serra Jeci grasslands, 3 August, 12.8694°S, 35.1829°E, MVZ 265908–10. This species was encountered sheltering around rock outcrops after being driven out of the grasslands by a large fire, at 1300–1400 m elevation. A total of seven live animals were observed over the course of three days following the fires, three of which were collected as voucher specimens.

SQUAMATA — LIZARDS

Agamidae

Acanthocercus atricollis (Fig. 3E). Niassa Province: Serra Jeci grasslands, 3–4 August, 12.8674°S, 35.1850°E, MVZ 265813–19. Specimens were collected on large trees in grasslands and were



FIG. 5. Photographs of voucher specimens in life: (A) *Kinixys belliana* (MVZ 266108), Serra Jeci; (B) *Lamprophis capensis* (MVZ 266111), Gurué; (C) *Thelotornis mossambicanus* (MVZ 266167), Serra Jeci; (D) *Naja melanoleuca* (MVZ 266146), Gurué; (E) *Bitis arietans* (MVZ 265905), Serra Jeci; (F) *Bitis arietans* (MVZ 265907), Mt. Namuli.

often found under bark at night. This species is common and widespread, and can be found in eastern South Africa, eastern Botswana, Zimbabwe, Mozambique, Malawi, Zambia, with scattered populations in Tanzania, Uganda, and Kenya. This species has previously been recorded from Niassa Game Reserve, Niassa Province (Branch et al. 2005a), however these records fill in a large distributional gap in northwestern Mozambique.

Agama kirkii. Niassa Province: Serra Jeci grasslands, 3 August, 12.8674°S, 35.1850°E MVZ 265827–28; Zambézia Province: Mt. Namuli grasslands, 11 August, 15.3875°S, 37.0732°E, MVZ 265806–12. Juveniles and adults were found basking on large rock outcrops present in open grassland habitat, 1280–1380 m elevation.

Chamaeleonidae

Chamaeleo dilepis. Niassa Province: Serra Jeci grasslands, 4 August, 12.8674°S, 35.1850°E, MVZ 265912–17; Zambézia Province: Mt. Namuli grasslands, 11 August, 15.3875°S, 37.0732°E, MVZ 265918.

Rhampholeon sp. (Fig. 3C, D). Zambézia Province: Ukalini Forest, Mt. Namuli, 8–9 August, 15.3693°S, 37.0613°E, MVZ 266160–65. Adults and juveniles were found sheltering on branches of small trees or on the fronds of epiphytic ferns within Ukalini Forest at night, at 1590–1715 m elevation.

Gekkonidae

Hemidactylus mabouia. Niassa Province: Lichinga, 26 July, 13.3103°S, 35.2498°E, MVZ 265931–34; Zambézia Province: Gurué, 7 August, 15.4639°S, 36.9778°E, MVZ 265935–42. This common, widespread species was found in disturbed areas on mainly artificial structures at night.

Lygodactylus angularis. Niassa Province: Lichinga, 26 July, 13.3103°S, 35.2498°E, MVZ 266139–45. Specimens found active on shrubs and trees in urban areas during the day, 1320 m elevation.

Lygodactylus capensis. Zambézia Province: Gurué, 23 July, 15.4687°S, 36.9939°E, MVZ 266120; 7 August, 15.4639°S,

36.9778°E, MVZ 266129–34. This widespread species was commonly found diurnally active in low to mid-elevation (<730 m) disturbed habitat.

Lygodactylus sp. Zambézia Province: Mt. Namuli grasslands, 10 August, 15.3745°S, 37.0649°E, MVZ 266137–38. This species was found on wooden debris near a village residence in open grassland habitat on Mt. Namuli, at 1200–1420 m elevation. This species is most similar morphologically to *Lygodactylus rex*, known only from Mt. Mulanje, Malawi.

Scincidae

Panaspis wahlbergii (Fig. 3F). Niassa Province: Serra Jeci grasslands, 29 July, 12.8674°S, 35.1850°E, MVZ 266148. The specimen collected is consistent with the coloration described for *P. wahlbergii*, rather than *P. maculicollis*, both of which have been recorded from central Mozambique (Jacobsen and Broadley 2000). The specimen exhibits a uniform olive-brown dorsal color but lacks longitudinal stripes, which are sometimes present in *P. wahlbergii*. A pale yellowish-brown dorsolateral stripe begins at the nostrils but becomes faint past the shoulder. Below this, beginning at the nostrils, is a broad dark brown band that extends to the base of the tail. A white strip is present below this band (absent in *P. maculicollis*), which begins on the upper labials and terminates past the shoulder. There are no alternating dark markings on the upper and lower labials, a pattern typical of *P. maculicollis*. Schmitz et al. (2005) assigned *Panaspis wahlbergii* to the revived genus *Afroablepharus*, however this assignment seems premature as their study focused mainly on West African species. Branch et al. (2005a) also report *P. wahlbergii* from Niassa Game Reserve.

Trachylepis margaritifer (Fig. 3G). Niassa Province: Serra Jeci grasslands, 4 August, 12.8674°S, 35.1850°E, sight records; Zambézia Province: Gurué, 7 August, 15.4639°S, 36.9778°E, MVZ 266171; Mt. Namuli grasslands, 11 August, 15.3875°S, 37.0732°E, MVZ 266172–79. This species was found on large rock outcrops in open grassland habitat.

Trachylepis striata. Niassa Province: Lichinga, 27 July, 13.3010°S, 35.2456°E, MVZ 266188–89; Serra Jeci grasslands, 3 August, 12.8674°S, 35.1850°E, MVZ 266190; Zambézia Province: Gurué, 7 August, 15.4639°S, 36.9778°E, MVZ 266191–92; Mt. Namuli grasslands, 11 August, 15.3875°S, 37.0732°E, MVZ 266193–200. All specimens exhibit a red-brown dorsal color with a pair of well-defined yellow dorsolateral stripes, consistent with the coloration of typical *T. striata* as described by Broadley (2000). A closely allied form, *T. wahlbergii*, has been recorded from western Mozambique, but exhibits grey-brown to olive-brown dorsal color with poorly defined pale dorsolateral stripes (Broadley 2000). On most specimens the subocular contacts the lip, a condition that varies geographically in *T. striata*, with this particular character state being most common along the coastal plains of Kenya, Tanzania, and northern Mozambique (Broadley 2000).

Trachylepis varia (Fig. 3H). Niassa Province: Lichinga, 27 July, 13.3010°S, 35.2456°E, MVZ 266201–06; Serra Jeci grasslands, 2 August, 12.8672°S, 35.1736°E, MVZ 266207; Zambézia Province: Mt. Namuli grasslands, 11 August, 15.3875°S, 37.0732°E, MVZ 266208–27. Broadley (2000) reports *T. varia* is quite variable throughout its range, which extends from Somalia to South Africa, but that montane populations tend to be smaller in size, more slender, and darker in coloration. Additionally, lowland populations of *T. varia* tend to have 30–34 midbody scale rows, 19–25 lamellae beneath the 4th toe, and fewer supraciliaries (<5), whereas montane populations tend to have higher counts of midbody scale rows (34–38), shorter toes (17–22), and five supraciliaries (Broadley 2000). The specimens collected at the Lichinga Plateau exhibit 34–35 midbody scale rows, 20–25 lamellae beneath the 4th toe, 5–6 supraciliaries, and range from 55–65.5 mm SVL (n = 7). The specimens collected at Mt. Namuli exhibit 31–36 (average 33) midbody scale rows, 18–23 lamellae beneath the 4th toe, 4–5 supraciliaries, and range from 46.5–68.0 mm SVL (n = 20). Given the large geographic range, broad elevational distribution (sea level to 3500 m a.s.l), morphological variation, and bimodal reproductive mode of *T. varia*, this species is an appealing candidate for phylogeographic study.

SQUAMATA — SNAKES

Colubridae

Thelotornis mossambicanus. (Fig. 5C) Niassa Province: Serra Jeci grasslands, 4 and 5 August, 12.8674°S, 35.1850°E, MVZ 266167–70.

Elapidae

Naja melanoleuca (Fig. 5D). Zambézia Province: Gurué, 24 July, 15.4451°S, 36.8975°E, MVZ 266146. Juvenile found basking in large bamboo grove near roadside.

Lamprophiidae

Lamprophis capensis (Fig. 5B). Niassa Province: Serra Jeci grasslands, 5 August, 12.8674°S, 35.1850°E, MVZ 266111; Zambézia Province: Gurué, 7 August, 15.4639°S, 36.9778°E, MVZ 266112. The two specimens collected have two broad pale stripes occurring on the head, one on the upper labials and the other running from the snout, through the upper eye, and extending to a variable distance onto the side of the body. The bodies are light brown with light tan vermiculation on the forebody. This coloration is consistent with that described for *L. capensis*, rather than *L. fuliginosus*, which replaces *L. capensis* in northern Zambia and Tanzania (Broadley et al. 2003). Branch et al. (2005a) report *L. capensis*, rather than *L. fuliginosus*, is also present in Niassa Game Reserve.

Psammophis mossambicus. Niassa Province: Serra Jeci grasslands, 4 August, 12.8674°S, 35.1850°E, MVZ 266149.

Viperidae

Bitis arietans (Fig. 5E, F). Niassa Province: Serra Jeci grasslands, 5 August, 12.8674°S, 35.1850°E, MVZ 265905; Zambézia Province: Mt. Namuli grasslands, 11 August, 15.3875°S, 37.0732°E, MVZ 265906–07. Branch et al. (2005a) noted the puff adders in northern Mozambique display an unusual and complicated color pattern, with the hind body resembling a pattern more typical of *Bitis gabonica*. The puff adders collected at Serra Jeci and Mt. Namuli also display this unusual pattern (Fig. 5E, F). A recent molecular study by Barlow et al. (2013) illustrates the complex relationships of Mozambican puff adders, as a single individual sequenced from the coastline of central Mozambique appears to be highly divergent from all other lineages in central and southern Africa. Branch et al. (2005a) noted the puff adders at this locality (Moebase Region, Zambézia Province) also exhibit the unusual coloration described above, and even suggested

TABLE 1. Initial checklist of species present in the southern Afromontane Archipelago, consisting of surveyed inselbergs and surrounding lowland regions in southern Malawi and northern Mozambique.

	Mt. Mulanje, (Branch and Cunningham 2005)[a]	Mt. Namuli, present study	Mt. Namuli, (Timberlake et al. 2009)[b]	Mt. Chiperone, (Timberlake et al. 2007)[b]	Mt. Inago, (Bayliss et. al. 2010)[b]	Lichinga Plateau, present study	Lichinga Plateau (Branch 2012)[a]	Niassa Game Reserve (Branch et al. 2005)[a, c]
Amphibia								
Anura								
Arthroleptidae								
Arthroleptis francei	X		X					-
Arthroleptis stenodactylus	X							-
Arthroleptis xenadactyloides	X			X		X		-
Leptopelis broadleyi	X							-
Leptopelis flavomaculatus	X							-
Leptopelis parbocagii	X							-
Brevicipitidae								
Breviceps mossambicus	X	X					X	-
Bufonidae								
Amietophrynus gutturalis	X	X	X			X	X	-
Amietophrynus maculatus	X	X			X	X	X	-
Hemisotidae								
Hemisus marmoratus	X							-
Hyperoliidae								
Afrixalus brachynemis	X	X				X		-
Afrixalus crotalus	X							-
Afrixalus fornasinii	X							-
Hyperolius nasutus			X				X	-
Hyperolius marmoratus	X	X	X				X	-
Hyperolius cf. spinigularis	X	X						-
Hyperolius substriatus	X	X	X			X		-
Hyperolius tuberilinguis	X							-
Kassina maculata	X							-
Kassina senegalensis	X							-
Microhylidae								
Phrynomantis bifasciatus	X							-
Pipidae								
Xenopus laevis	X							-
Xenopus muelleri	X						X	-
Ptychadenidae								
Ptychadena anchietae	X						X	-
Ptychadena broadleyi	X							-
Ptychadena oxyrhynchus	X							-
Ptychadena taenioscelis	X							-
Ptychadena uzungwensis	X							-
Ptychadena sp.		X				X		-

TABLE 1. Continued

	Mt. Mulanje, (Branch and Cunningham 2005)[a]	Mt. Namuli, present study	Mt. Namuli, (Timberlake et al. 2009)[b]	Mt. Chiperone, (Timberlake et al. 2007)[b]	Mt. Inago, (Bayliss et. al. 2010)[b]	Lichinga Plateau, present study	Lichinga Plateau (Branch 2012)[a]	Niassa Game Reserve (Branch et al. 2005)[a, c]
Pyxicephalidae								
Amietia angolensis	X	X					X	-
Amietia johnstoni	X							-
Amietia sp.						X		-
Nothophryne broadleyi	X		X					-
Strongylopus fuelleborni	X		X					-
Rhacophoridae								
Chiromantis xerampelina	X							-
Reptilia								
Chelonia								
Testudinidae								
Kinixys belliana						X		L
Squamata (Lizards)								
Agamidae								
Acanthocercus atricollis		X				X	X	L
Agama armata								L
Agama kirkii	X	X				X		L
Agama mossambica	X						X	L
Chamaeleonidae								
Chamaeleo dilepis	X	X				X	X	X
Chamaeleo melleri	X							
Nadzikambia mlanjensis	X							
Rhampholeon platyceps	X							
Rhampholeon sp.		X	X	X	X			
Cordylidae								
Cordylus meculae								X
Platysaurus maculatus					X			L
Platysaurus mitchelli	X							
Gekkonidae								
Chondrodactylus turneri								L
Elasmodactylus tetensis								L
Hemidactylus mabouia	X	X				X	X	X
Hemidactylus platycephalus	X				X			X
Lygodactylus angularis						X		X
Lygodactylus bonsi	X							
Lygodactylus capensis	X	X						X
Lygodactylus chobiensis								L
Lygodactylus grotei								L

TABLE 1. Continued

	Mt. Mulanje, (Branch and Cunningham 2005)[a]	Mt. Namuli, present study	Mt. Namuli, (Timberlake et al. 2009)[b]	Mt. Chiperone, (Timberlake et al. 2007)[b]	Mt. Inago, (Bayliss et. al. 2010)[b]	Lichinga Plateau, present study	Lichinga Plateau (Branch 2012)[a]	Niassa Game Reserve (Branch et al. 2005)[a, c]
Lygodactylus rex	X			X				
Lygodactylus sp.		X	X					
Pachydactylus punctatus								L
Gerrhosauridae								
Gerrhosaurus flavigularis	X							
Gerrhosaurus validus					X		X	X
Lacertidae								
Holaspis laevis	X						X	
Latastia johnstoni								L
Scincidae								
Lygosoma afrum								L
Melanoseps ater	X							
Melanoseps sp.								X
Panaspis wahlbergii	X					X	X	L
Proscelotes mlanjensis	X							
Trachylepis boulengeri	X							X
Trachylepis maculilabris	X							X
Trachylepis margaritifer	X	X				X		X
Trachylepis mlanjensis	X							
Trachylepis striata	X	X				X	X	L
Trachylepis varia	X	X	X			X	X	X
Varanidae								
Varanus albigularis								L
Varanus niloticus	X							L
Squamata (Snakes)								
Colubridae								
Crotaphopeltis hotamboeia	X						X	X
Dispholidus typus	X							L
Meizodon semiornatus								L
Natriciteres sylvatica								X
Philothamnus angolensis	X							
Philothamnus hoplogaster	X							X
Philothamnus semivariegatus	X							L
Telescopus semiannulatus								L
Thelotornis mossambicanus	X			X		X		L
Elapidae								
Dendroaspis angusticeps	X							
Dendroaspis polylepis								L

TABLE 1. Continued

	Mt. Mulanje, (Branch and Cunningham 2005)[a]	Mt. Namuli, present study	Mt. Namuli, (Timberlake et al. 2009)[b]	Mt. Chiperone, (Timberlake et al. 2007)[b]	Mt. Inago, (Bayliss et. al. 2010)[b]	Lichinga Plateau, present study	Lichinga Plateau (Branch 2012)[a]	Niassa Game Reserve (Branch et al. 2005)[a, c]
Naja melanoleuca		X						
Naja mossambica	X							L
Lamprophiidae								
Aparallactus capensis								X
Atractaspis bibronii	X							
Duberria shirana	X							
Hemirhagherris nototaenia								L
Lamprophis capensis	X	X				X		X
Lycodonomorphus mlanjensis				X				
Lycophidion capense	X							L
Psammophis mossambicus						X		L
Psammophis orientalis								L
Psammophylax variabilis	X							
Rhamphiophis rostratus								L
Leptotyphlopidae								
Miriapholis longicauda							X	
Pythonidae								
Python natalensis	X							L
Typhlopidae								
Letheobia obtusus	X			X				
Rhinotyphlops mucrosa								L
Viperidae								
Atheris mabuensis			X					
Bitis arietans		X			X	X		L
Bitis gabonica				X				
Causus defilippii	X							X
Causus rhombeatus								L

Presence of species is indicated by an 'X'. The Niassa Game Reserve column includes species found on the Serra Mecula Plateau, which are indicated by an 'X', and species found in the surrounding lowlands (< 800 m elevation), which are denoted by an 'L'.

[a] Surveys specifically targeting herpetofauna.

[b] General surveys reporting opportunistic encounters or sampling of herpetofauna.

[c] Survey does not include reports on amphibian fauna.

behavioral differences may exist. Given the occurrence of the odd color pattern at Serra Jeci, Mt. Namuli, and Niassa Game Reserve, these populations may form a clade with the Moebase Region, although their phylogenetic affinities remain untested.

Discussion.—We conducted the first targeted herpetological surveys at both the Lichinga Plateau and Mt. Namuli, two poorly studied regions in northern Mozambique. During our work on the Lichinga Plateau, we recorded 7 amphibian and 14 reptile species. Following this, Branch (2012) recorded an additional 10 species, thereby producing a total of 32 species documented for the Lichinga Plateau (13 amphibians, 1 tortoise, 12 lizards, and 6 snakes; Table 1).

Timberlake et al. (2009) initially recorded 11 species occurring at the Namuli massif, based entirely on opportunistic sampling. During our survey we recorded 22 species, 16 of which represent new records for the area. There are now 27 species documented for the Mt. Namuli region (13 amphibians, 10 lizards, and 4 snakes; Table 1).

Several significant discoveries were made during our surveys, including range extensions and taxonomic novelties. Two hyperoliid frog species, *Afrixalus brachycnemis* and *Hyperolius cf. spinigularis,* represent new country records for Mozambique. The former was collected at both Mt. Namuli and the Lichinga Plateau, and was previously only known to occur in Malawi and eastern Zambia, and the latter, previously known from Malawi and Tanzania, was recorded from Mt. Namuli. The species of *Rhampholeon* occurring on Mt. Namuli has been previously reported as an undescribed new lineage (Branch et al., in prep; Branch and Bayliss 2009; Timberlake et al. 2009), and shows affinities to *Rhampholeon platyceps,* which is known from Mt. Mulanje, Malawi. The species of *Lygodactylus* collected on Mt. Namuli is most similar to *Lygodactylus rex,* also known from Mt. Mulanje, but it is morphologically and genetically distinct and represents a new species (Portik et al., *in press*). Other taxa require further investigation to clarify evolutionary and taxonomic relationships, including *Amietia angolensis* from Mt. Namuli, as well as *Lygodactylus angularis* and the species of *Amietia* collected on the Lichinga Plateau.

As survey work in the southern Afromontane archipelago progresses, the biogeographic links between montane isolates in northern Mozambique and other Afromontane regions continue to emerge. We provide a preliminary checklist of the herpetofauna of the southern Afromontane archipelago based on our results and all available literature in Table 1. The ties between Mt. Mulanje and Mt. Namuli are readily apparent, as several species described from Mt. Mulanje have a cryptic sister taxon present at Mt. Namuli, including *Rhampholeon platyceps* (Branch et al., in prep.), *Lygodactylus rex* (Portik et al., *in press*), and *Notophryne broadleyi* (Werner Conradie, pers. comm.). However, only limited herpetofaunal information is available from several nearby inselbergs, such as Mt. Chiperone, Mt. Mabu, and Mt. Inago (Table 1), and additional species closely related to those present at Mt. Mulanje and Mt. Namuli may be uncovered with future work. Beyond geographically proximate inselbergs, more broad-scale patterns can be inferred from the presence of numerous taxa found in northern Mozambique. Several frog species detected in our surveys have distributions following the Afromontane archipelago in Tanzania and Malawi, including the hyperoliid species *Afrixalus brachycnemis, Hyperolius cf. spinigularis,* and *Hyperolius substriatus,* as well as the arthroleptid species *Arthroleptis xenodactyloides.* The discovery of these species at Mt. Namuli or Serra Jeci illustrates the connection of Mozambican Afromontane inselbergs to the larger Afromontane archipelago, and these isolated Mozambican regions likely represent the southern distributional limit for many of these East African forms. The presence of distinct *Rhampholeon* species across the Eastern Arc Mountains of Tanzania, the Eastern Highlands of Zimbabwe, Mt. Mulanje of Malawi, and several Mozambican inselbergs (including Mt. Namuli, Mt. Chiperone, Mt. Mabu, Mt. Inago, and Gorongosa Mountain) supports a biogeographic connection between these areas, with the genus *Rhampholeon* also reaching its southern distributional limit in Mozambique (Gorongosa Mountain). Other forest species which link Mozambican montane isolates with central and East African Afromontane regions include two species of viper: *Bitis gabonica* found at Mt. Chiperone (Timberlake et al. 2007), and the discovery of a new species of *Atheris, A. mabuensis,* at Mt. Namuli and Mt. Mabu (Branch and Bayliss 2009). Together these findings highlight the unique herpetofaunal diversity present in northern Mozambique, which is a complex admixture of Afromontane species, East African lowland forms, and southern African species, and demonstrate the clear need for continued work in this poorly studied region.

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Co-Occurrence of Invasive Cuban Treefrogs and Native Treefrogs in PVC Pipe Refugia

The Cuban Treefrog (*Osteopilus septentrionalis*) was first introduced to Florida at Key West (Barbour 1931). Since this introduction, Cuban Treefrogs have spread first to Miami (Schwartz 1952), and are now established throughout most of peninsular Florida (Meshaka 2001). Cuban Treefrogs can become very abundant in areas they colonize (Meshaka 2001; Townsend et al. 2000). Several factors contribute to their success, including a generalist diet, high fecundity and the ability to reproduce year-round, and use of disturbed or human-modified habitats (Meshaka 1994, 2001).

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Cuban Treefrogs may contribute to the decline of native treefrogs (Allen and Neill 1953; Knight et al. 2008; Meshaka 2001) through both competition and predation. Cuban Treefrogs grow to a larger maximum size than treefrogs native to Florida, have broad dietary niche overlap, and inhabit the same retreat sites, potentially increasing competition between species (Meshaka 1996, 2001). Cuban treefrog larvae can consume larvae of Squirrel Treefrogs (*Hyla squirella*) (Smith 2005b) and adversely affect the development of Green Treefrogs (*Hyla cinerea*) (Smith 2005a). Adult Cuban Treefrogs are known to prey upon several species of native anurans including both Green and Squirrel Treefrogs (Glorioso et al. 2012; Meshaka, 2001).

In recent years, polyvinyl chloride (PVC) pipe refugia have become a popular method for sampling hylid anurans (Bartareau 2004; Boughton et al. 2000; Campbell et al. 2010). This method has been shown to be effective at sampling both native species and introduced Cuban Treefrogs (Bartareau 2004). While some variability may exist in the use of PVC pipe refugia by different species (Zacharow et al. 2003), all species of treefrog occurring in southern Florida will use these pipes. Cuban Treefrogs may pose problems for the use of PVC pipes in monitoring frog populations in two ways. If native treefrogs avoid PVC pipe refugia in use by Cuban Treefrogs, then bias is introduced into

the sample, and populations cannot be estimated accurately. Alternatively, if native treefrogs do not avoid Cuban Treefrogs within PVC pipe refugia, they may be subjected to increased predation risk.

Laboratory and some field evidence indicate that the latter situation may apply (Hoffman 2007; Meshaka 2001; Waddle et al. 2010), suggesting that native treefrogs may be naïve to the threat of Cuban Treefrogs as possible predators. We examined data collected from a project in Everglades National Park in which Cuban Treefrogs as well as native Green Treefrogs and Squirrel Treefrogs were captured. The purpose of this study was to test the hypothesis that native treefrogs will use PVC pipe refugia regardless of whether a Cuban Treefrog is present. We used data from a site where a large number of pipe checks were made to determine if native frogs co-occurred with Cuban Treefrogs more or less often than randomly expected. We also examined body size of individuals to determine if size is a determining factor for whether native treefrogs and Cuban Treefrogs co-occur in pipes.

Methods.—This study was conducted at a site near Main Park Road approximately 2.5 km northeast of the developed area at Flamingo in Everglades National Park, Florida, USA. The site was a stand of mature black mangroves (*Avicennia germinans*) with a thick litter layer on the ground and almost no understory vegetation. Ninety-nine PVC pipe refugia were used at the site; 38 pipes were hung in pairs on trees and 61 were placed singly on trees. Pipes were 1-m long and 5-cm in diameter, with an end cap on the bottom allowing for the retention of water. A hole drilled approximately 10 cm from the bottom of the pipe controlled the water level. Each pipe was hung on a nail in the tree so that the top of the pipe was approximately 2 m from the ground.

The site was sampled about every two weeks from July 2001 through August 2003, unless prevented by weather or equipment failure. During each sample, frogs found within each pipe were identified to species and their snout–vent length (SVL) was measured to the nearest mm. Newly captured frogs were uniquely marked by removing one to four toes (no more than one toe per foot and never the proximal toe on either forelimb) and released back into the pipe where they were found. Recaptured frogs were identified and re-marked if necessary. Beginning in August 2002, Cuban Treefrogs found in the pipes were removed from the site as part of a study to determine the effects of Cuban treefrog removal on native treefrog populations (Rice et al. 2011). These frogs were euthanized, and their stomach contents analyzed to determine the prevalence of native frogs in the Cuban Treefrog diet (Glorioso et al. 2012). The co-occurrence of Cuban Treefrogs with natives within a pipe was noted, and native treefrogs were placed back into the pipes as before.

We examined the co-occurrence of the three species of treefrogs in the PVC pipes by subjecting a contingency table of presence-absence of the three species to a series of log-linear models (Crawley 2007). To account for the potential effect of site on the interaction of the species we used site as a factor in the analysis. Thus the count of pipe checks with each of the possible interactions was aggregated by each of the 99 pipe sites for analysis. We began with a fully saturated model including all possible interactions of the species and the sites (Count ~ Squirrel Treefrog * Green Treefrog * Cuban Treefrog * Site) and the used the step function in Program R (R Development Core Team 2011) to choose the best model based on Akaike's Information Criterion (AIC). The inclusion of interaction terms in the final model was verified through a series of ANOVA tests (Crawley 2007).

Because we began permanently removing Cuban Treefrogs from the PVC pipes at the site about halfway through the study, we conducted the log-linear contingency analysis on the complete dataset, the data collected prior to removal, and the data collected post removal separately. All checks of the PVC pipes were included in the analysis, including those in which no frogs were found. In addition to the three-way contingency analysis, we also conducted a Pearson product moment correlation analysis of our data to for direct comparison to Campbell et al. (2010).

To determine if body size of the native frogs affected their likelihood of co-occurring with Cuban treefrogs, body size measurements of Squirrel and Green Treefrogs caught with and without Cuban treefrogs were tested for equal variances and a two-sample t-test was used to compare the means of each group (Crawley 2007). The mean SVL of Cuban Treefrogs caught with and without a native frog species was also compared to test if body size of the Cuban Treefrogs might be a predictor of co-occurrence with native treefrogs. All statistical tests were performed in the R statistical software environment (R Development Core Team 2011).

Results.—There were 4158 total pipe checks at Flamingo including 1478 instances where at least one frog was found inside a pipe (Table 1). More than one species of frog was observed to be in a pipe in 149 (10.1%) of the pipe checks. Cuban Treefrogs were by far the most common species found within pipes at this site with 1371 captures; more than one conspecific was found in a pipe on 223 (20.9%) of the 1069 pipe checks with Cuban Treefrogs. There were 589 Green Treefrogs captured, and more than one Green Treefrog was found in 79 (15.9%) of the 497 pipe checks with Green Treefrogs. Squirrel Treefrogs were the least frequently encountered species with 76 captures, and more than one conspecific was found in 8 (11.9%) of the 67 pipe checks where Squirrel Treefrogs were captured. Only a small proportion

Table 1. Count of PVC pipe checks (with percentage of total) where Squirrel, Green, and Cuban Treefrogs were present or absent out of N = 4158 checks.

Squirrel Treefrog	Green Treefrog	Cuban Treefrog Absent	Cuban Treefrog Present
Absent	Absent	2680 (64.5%)	942 (22.7%)
	Present	359 (8.6%)	110 (2.7%)
Present	Absent	28 (0.7%)	11 (0.3%)
	Present	22 (0.5%)	6 (0.1%)

Table 2. Results of the log-linear model selection from the contingency analysis of the entire set of visits and those prior to and after the initiation of Cuban Treefrog (CTF) removal. The interactions listed are the species interactions that were saved in the best model. The coefficient with standard error (S.E.) specifies the direction and strength of the interaction, and the test statistic z and associated p value determine if the interaction is statistically significant.

Dataset	Interaction	Coefficient	S.E.	z	p
All Visits	Squirrel and Green Treefrogs	1.713	0.2523	6.783	<0.0001
Pre CTF Removal	Squirrel and Cuban Treefrogs	-15.503	834.29	-0.019	0.9852
	Green and Cuban Treefrogs	0.762	0.3690	2.065	0.0389
Post CTF Removal	Squirrel and Green Treefrogs	1.340	0.2623	5.107	<0.0001

of the encounters of the native treefrog species occurred prior to the onset of the experimental Cuban Treefrog removal (30 pipe checks with Green Treefrogs; 6 pipe checks with Squirrel Treefrogs), while the number of pipe checks with Cuban Treefrogs was similar in the before and after Cuban Treefrog removal datasets (541 and 511, respectively).

The log-linear contingency analysis revealed no evidence of a three-way interaction among either the three treefrog species or any two species and a site (Table 2). In both the complete dataset and the data collected after the start of the Cuban Treefrog removal period only an interaction between Squirrel and Green Treefrogs was present in the best model (Table 2). This interaction was significant and indicated a positive association between the two native treefrog species (i.e., the two were found together more often than would be expected due to chance). The odds ratio calculated from model coefficients indicated that Squirrel Treefrogs were 5.6 (CI, 3.4 to 9.1) and 3.8 (CI, 2.3 to 6.4) times more likely to occur in a pipe with a Green Treefrog in the full dataset and post Cuban treefrog removal dataset, respectively. In the best model using the data from prior to the initiation of Cuban Treefrog removal there was an interaction between Cuban Treefrogs and Squirrel Treefrogs and an interaction between Cuban Treefrogs and Green Treefrogs (Table 2). The interaction of Cuban Treefrogs with Squirrel Treefrogs was negative, but was not statistically significant. While significant, the interaction between Cuban Treefrogs and Green Treefrogs was weakly positive; Green Treefrogs were 2.1 (CI, 1.01 to 4.42) more likely to occur in pipes with Cuban Treefrogs. The Pearson product moment correlation analysis also found no significant correlation between the occurrence of Cuban Treefrogs and either Squirrel Treefrogs (correlation = -0.0004, p= 0.979) or Green Treefrogs (correlation = -0.0007, p = 0.963).

The body size of Squirrel Treefrogs caught with Cuban Treefrogs ($\bar{x}$= 27.3 mm, s = 2.27) was not significantly different from the body size of Squirrel Treefrogs caught without Cuban Treefrogs ($\bar{x}$= 27.0 mm, s = 2.44; t = -0.3113, df = 63, p = 0.7566). Likewise, the body size of Green Treefrogs caught with Cuban Treefrogs ($\bar{x}$= 42.5 mm, s = 5.05) was not significantly different from the body size of Green Treefrogs caught without Cuban Treefrogs ($\bar{x}$= 42.4 mm, s = 4.76; t = -0.1276, df = 475, p = 0.8985). There was, however, a significant difference in the size of Cuban Treefrogs caught with the native treefrog species ($\bar{x}$= 41.2 mm, s = 7.97) compared to Cuban Treefrogs caught in pipes without native treefrogs ($\bar{x}$= 49.5 mm, s = 11.31; t = 10.3511, df = 197.4, p < 0.0001). We also compared the size of Cuban Treefrogs captured with any other frog (i.e. native or Cuban Treefrog) and found that their size ($\bar{x}$= 45.8 mm, s = 8.91) was significantly smaller than that of Cuban Treefrogs captured singly ($\bar{x}$= 49.8, s = 12.01; t = -6.0828, df = 839.0, p < 0.0001).

Discussion.—Our contingency analysis found no conclusive evidence that the occurrence of Cuban Treefrogs in PVC pipes had an influence on the occurrence of either Squirrel or Green Treefrogs in the pipes. The negative interaction between Squirrel and Cuban Treefrogs in the period prior to the removal of Cuban Treefrogs at the site was not statistically significant, and a small positive association between Green Treefrogs and Cuban Treefrogs during the pre-removal period was statistically significant. These results are based on the low number of native treefrog encounters prior to the Cuban Treefrog removal period. We did, however find evidence that the two native species co-occur more often than expected if they were randomly selecting pipes. This may mean that the two species are somehow attracted by the presence of their congener. There were no three-way interactions between two species and a site kept in the most parsimonious models, indicating that location of the pipe did not play a role in the interactions of the species.

The analysis of body sizes did not reveal evidence of size-specific predator avoidance of Cuban Treefrogs by smaller individuals of either Squirrel or Green Treefrogs, as there was no difference in the lengths of the native frog species caught with or without Cuban Treefrogs. We would have expected to find a difference if, for instance, smaller native frogs avoided pipes with Cuban Treefrogs but larger frogs did not. We did find that Cuban Treefrogs found in pipes with the native species were significantly smaller than those captured without native treefrogs. Cuban Treefrogs caught with any other frog, including conspecifics, were also significantly smaller than Cuban Treefrogs caught singly. This may suggest that all the frogs avoided large Cuban Treefrogs, or larger Cuban Treefrogs were choosing to avoid other frogs or prefer different locations within the site. Stomach content analysis found that about 3.5% of removed Cuban Treefrogs had recently consumed a frog, including positively identified Green Treefrogs and other treefrogs only identified as belonging to family Hylidae (Glorioso et al. 2012). Batrachophagous Cuban Treefrogs were distributed evenly among adult size classes, with no evidence that larger individuals were more likely to take frog prey (Glorioso et al. 2012).

There are other lines of evidence that support the conclusion that native treefrogs are naïve to the threat of introduced Cuban Treefrogs. Meshaka (2001) reported that the native treefrogs in Everglades National Park exhibited behavioral interactions that suggested neither species recognized the Cuban Treefrog as a predator. He observed the native treefrogs foraging on lighted buildings alongside Cuban Treefrogs large enough to be a threat. In a laboratory experiment, Hoffman (2007) found that native treefrogs are as equally likely to occupy pipes with Cuban Treefrogs as with conspecifics and that native treefrogs did not avoid pipes that had been previously occupied by Cuban Treefrogs. At a landscape scale, Waddle et al. (2010) found that although the presence of Cuban Treefrogs at a site made it much less likely that native treefrogs would also occur at the site, there was no effect of Cuban Treefrog presence on the detection probability of Green or Squirrel Treefrogs. Thus it seems that even though native treefrogs are vulnerable to predation, they fail to alter their behavior to mitigate the threat.

There are at least two studies which reached the contradictory conclusion that Squirrel Treefrogs are less likely to co-occur with Cuban Treefrogs in PVC pipe refugia (Bartareau 2004; Campbell et al. 2010). The study by Bartareau (2004) used three different diameters of pipes, and demonstrated that Squirrel Treefrogs were more commonly found in the smaller two diameter sizes whereas Cuban Treefrogs were more commonly found in the largest diameter pipes. Therefore it is impossible to determine if Squirrel Treefrogs were avoiding Cuban Treefrogs or simply showing preference for smaller diameter pipes. All of the pipes used in our study were the same diameter, thus eliminating this confounding factor. A study by Campbell et al. (2010) found a negative correlation between Cuban and Squirrel Treefrog observations by using a Pearson product-moment correlation. However, they also found that Cuban Treefrogs were not evenly distributed among the four habitats in their study, which may have confounded their results. Our comparable analysis in this study found no significant correlation between the occurrence of Cuban Treefrogs and either Squirrel or Green Treefrogs. Neither Bartareau (2004) nor

Campbell et al. (2010) found evidence of a negative correlation between Cuban and Green Treefrog occurrence.

The findings of our study have direct monitoring implications. We found that there is no evidence that avoidance of Cuban Treefrogs at retreat sites will bias monitoring efforts of Green and Squirrel Treefrogs. Therefore, when other potential biases are controlled (Boughton et al. 2000) using PVC pipe refugia as a sampling technique may be a good method for estimating treefrog populations.

Wyatt and Forys (2004) suggest that because Cuban Treefrogs are known predators of Green Treefrogs, using PVC pipes to sample treefrogs where the two species co-occur could create an ideal setting for the sit-and-wait predation of Green Treefrogs by Cuban Treefrogs. Evidence from our study and others (Hoffman 2007; Meshaka 2001; Waddle et al. 2010) suggests that Green and Squirrel Treefrogs do not alter their behavior to avoid Cuban Treefrogs. This raises the concern that sampling with PVC pipes may increase the vulnerability of the native species to predation, warranting further research on this subject. Additionally, determining if native treefrogs eventually learn to avoid Cuban Treefrogs and if other species of native anurans avoid Cuban Treefrogs should be further investigated.

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Toad-headed Pitviper *Bothrocophias hyoprora* (Amaral, 1935) (Serpentes, Viperidae): New Records of Geographic Range in Brazil, Hemipenial Morphology, and Chromosomal Characterization

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Toad-headed pitvipers of the genus *Bothrocophias* are distributed throughout Andean South America, in Ecuador, Colombia, Peru, Bolivia, and Brazil (Fenwick et al. 2009). Morphological (Gutberlet and Harvey 2002) and molecular (Castoe and Parkinson 2006; Fenwick et al. 2009) data have supported the monophyly of *Bothrocophias*, and its position as sister to a *Bothrops* + *Bothriopsis* clade (Fenwick et al. 2009).

Six species are currently recognized, all occurring mainly in lowland rainforest, wet-montane forest, and cloud forest areas (Campbell and Lamar 2004; Cisneros-Heredia et al. 2006; Fenwick et al. 2009; Gutberlet and Campbell 2001). *Bothrocophias colombianus* (Rendahl and Vestergren, 1940), *B. myersi* Gutberlet and Campbell (2001) and *B. rhombeatus* (Garcia, 1896) are known only from Colombia. *Bothrocophias campbelli* (Freire-Lascano, 1991) is known from northwest South America in Colombia and Ecuador; *B. microphthalmus* (Cope, 1835) occurs from eastern Colombia to northwestern Bolivia, and *B. hyoprora* (Amaral, 1935) is distributed at low elevations in equatorial forest in the Amazon Basin, in northern-western Brazil, Colombia, eastern Ecuador, Peru, and Bolivia (Campbell and Lamar 2004; Cisneros-Heredia et al. 2006).

Because it is a rarely registered species, the natural history and ecology of *B. hyoprora* are poorly known. Apparently it is a nocturnal pitviper that inhabits very humid tropical rainforest, and is most frequently found on the leaf litter, close to water bodies (Campbell and Lamar 2004). However, our knowledge about the species is based on few specimens, and probably due the lack of sampling, few papers have been published about this species. In fact, the largest collection of *B. hyoprora* available in Brazilian institutions houses only seven specimens, from which we obtained some of the data presented in this study.

Hemipenial morphology has been used to define taxonomic groups in Crotalinae (Campbell and Lamar 2004; Vellard 1946), and although Southern Hemisphere species share general characteristics, such as short and calyculate lobes rounded distally, subtle differences are expected, as in the number and size of spines. Indeed, hemipenial characters are closely associated with species differentiation, and thus are useful in evolutionary studies (Jadin et al. 2010).

The study of chromosomes is potentially useful for species definition and systematics, especially when external morphological characters are not sufficient for the clarification of taxonomic problems (Roze 1996). However, chromosomal data are rarely used for the characterization and differentiation of snake species. The karyotype has been described for few Brazilian snake species, and the paucity of data is especially acute for species from the Amazon Basin. There are no chromosomal data for *B. hyoprora* available in the literature. The chromosomal characterization of *B. hyoprora* will allow comparison with individuals of this species from other localities, with other species of this genus, and with individuals of sister-groups, assisting in the tracing

of patterns of chromosomal evolution in snakes.

Considering the lack of basic data for *B. hyoprora*, we present information about geographic range, hemipenial characteristics, and morphology. Morphological data were obtained from expeditions throughout the Brazilian Amazon plus herpetological collection databases and data available in the literature. In addition, we present for the first time the karyotype of *B. hyoprora*.

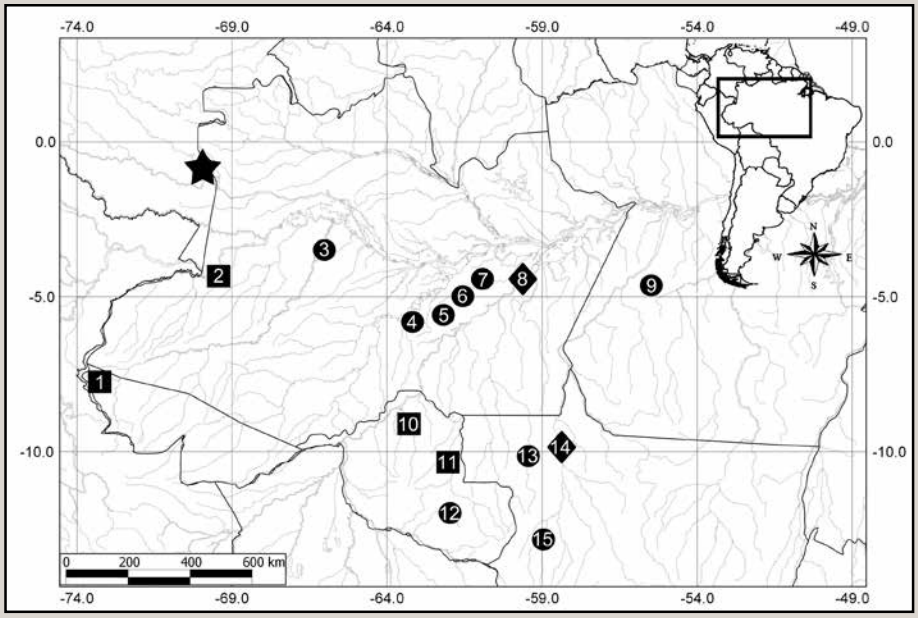


FIG. 1. Geographical distribution of *Bothrocophias hyoprora* in the Amazon Basin. Star = type locality, La Pedrera, Colombia. Squares = literature data. Circles = collected specimens in this suty. Diamonds = uncollected additional specimens. 1) Serra do Divisor National Park, Acre; 2) Tabatinga, Amazonas; 3) Extractive Reserve of Baixo Juruá, Juruá, Amazonas; 4) Forested area near the highway BR-319, km 400, Manicoré, Amazonas; 5) Forested area near the highway BR-319, km 300, Manicoré, Amazonas; 6) Nascentes do Lago Jari National Park, Tapauá, Amazonas; 7) Forested area near the highway BR-319, km 220, Borba, Amazonas; 8) Vicinity of Borba, Amazonas; 9) Floresta Nacional Trairão, Itaituba, Pará; 10) Samuel Hydroeletric Power Station, Porto Velho, Rondônia; 11) Reserva Biológica do Jaru, Vale do Paraíso, Rondônia; 12) Alta Floresta d'Oeste, Rondônia; 13) Aripuanã, Mato Grosso; 14) Fazenda São Nicolau, Cotriguaçu, Mato Grosso; 15) Juruena, Mato Grosso.

MATERIALS AND METHODS

Our data are based on independent sampling expeditions in northern Brazil, in the states of Amazonas, Mato Grosso, and Rondônia (Fig. 1). We found *B. hyoprora* specimens using diurnal and nocturnal visual searches, and in line with the recommendations of Franco and Salomão (2002), we deposited the specimens in the herpetological collection of the Instituto Nacional de Pesquisas da Amazônia, Manaus, Brazil. We used additional data from Herpetological Collections of Instututo Nacional de Pesquisas da Amazônia (INPA-H), Manaus and Museu de Zoologia of the Universidade de São Paulo (MZUSP), plus Coleção Zoológica de Vertebrados da Universidade Federal de Mato Grosso (UFMT-R), Cuiabá (Fig. 1).

Morphometric and meristic data.—We measured snout–vent length (SVL) and tail length (TL) with an accuracy of .01 millimeter. We determined the sex of the specimens by presence or absence of hemipenes, using a small subcaudal incision. We determined scutellation patterns by counting dorsal scale rows (D), ventrals (V), subcaudals (SC), cloacal (C), supralabials (SL), and infralabials (IL).

Hemipenial Morphology.—We prepared the right hemipenis from a preserved specimen, following the methods of Pesantes (1994). A 2% KOH solution was injected through the proximal end, hemipenis was immersed in KOH 2% solution to regain flexibility, and was filled with agar powder dissolved in distilled water. For hemipenial morphological terminology we followed Dowling and Savage (1960), Guo et al. (1999), and Jadin et al. (2010).

Chromosomal Techniques.—Karyotype analysis was conducted on a male *B. hyoprora* from the Parque Nacional Nascentes do Lago Jari (INPA-H 28044, see Fig. 1). Prior to preparation of the cell suspension, the individual was kept at 37°C for 24 h to induce mitosis. Mitotic chromosomes were obtained from intestine, liver, testicle, and spleen using the Ford and Harmerton (1956) "air-drying" method with modifications.

We used 0.2% colchicine at a proportion of 0.2 mL/10 g of body weight. After four hours we euthanized the snake using a veterinary anesthetic. We hypotonized cell material using 0.075 M potassium chloride solution, fixed in Carnoy fixer and stained with Giemsa. To locate the nucleolar organizer region (NOR), we used $AgNO_3$, following Howell and Black (1980). We organized chromosomes in decreasing size order and separated into groups by morphological type.

Chromosome morphology was determined based on the position of the centromere as described by Levan et al. (1964). We considered only macrochromosomes in the determination of the number of arms [fundamental number (FN)].

RESULTS

We examined nine *B. hyoprora* specimens—five males: 171, 209, 270, 352 and 375 mm SVL; and four females: 295, 437, 465 and 515 mm SVL (Table 1; Appendix I). One specimen (UFMT-R 9391) was found in 1990 in the municipality of Alta Floresta d'Oeste, Rondônia (11.97833°S, 61.96166°W; datum WGS 84, as for all subsequent geocoordinates listed; Fig. 1). The second specimen (INPA-H 17135) was found on 17 May 2006, in the Reserva Extrativista do Baixo Juruá, municipality of Juruá, Amazonas (03.47277°S, 66.02638°W). Two specimens (INPA-H 26570, 26571) were found on 29 January 2009, in forested areas at the edges of the Highway BR-319, municipality of Manicoré, Amazonas, with 100 km of distance between them (04.98666°S, 61.56638°W, and 05.58777°S, 62.18472°W). A fifth specimen (INPA-H 28044) was found on 28 March 2011, in Parque Nacional Nascentes do Lago Jari, municipality of Tapauá, Amazonas (05.81527°S, 63.15361°W). The last specimen (INPA-H 28516) we also found along the edges of the Highway BR-319, in the municipality of Borba, Amazonas (04.41472°S, 60.92444°W), on 03 September 2011. One INPA-H specimen (INPA-H 26527) was found on 10 September 2009, in the municipality of Trairão, western

TABLE 1. Morphometric and meristic data of examined specimens of *Bothrocophias hyoprora*. INPA-H = Code for herpetological collection of the Instituto Nacional de Pesquisas da Amazônia; UFMT-R = Universidade Federal de Mato Grosso; MZUSP = Museu de Zoologia Universidade de São Paulo; SVL = snout–vent length; TL = tail length; D = number of dorsal scales; V = number of ventral scales; SC = number of subcaudal scales; C = cloacal scale (simple or divided); S = number of supralabial scales; IL = number of infralabial scales.

Collection	SVL	TL	Sex	D	V	SC	C	S	IL
INPA-H 26571	209	38	M	23/21/19	127	50	S	7 / 7	9 / 8
INPA-H 26570	352	63	M	23/21/19	123	48	S	7 / 7	7 / 8
INPA-H 28044	375	66	M	23/21/19	128	46	S	7 / 7	9 / 9
INPA-H 17135	465	70	F	27/25/19	131	46	S	7 / 7	10 / 9
INPA-H 26527	295	47	F	27/23/19	123	47	S	7 / 7	10 / 9
INPA-H 28516	437	72	F	23/23/19	132	45	S	7 / 7	9 / 10
UFMT-R 9391	515	93	F	25/25/20	129	50	S	7 / 8	9 / 8
MZUSP 11152	270	48	M	24/23/21	127	48	S	7 / 7	9 / 9
MZUSP 11327	171	30	M	23/23/21	127	43	S	8 / 7	9 / 10

TABLE 2. Morphological features of hemipenis of a specimen of *Botrocophias hyoprora* (INPA-H 26570).

Character	Description
Biconic lateral lobe shape	"C" shape
Shape of lobes bifurcation	"U" shape
Spines on each lobe in the sulcate face	18–19
Spines on each lobe in the asulcate face	14–20
Length of spines in the sulcate face (mm)	1.3–3.1
Length of spines in the asulcate face (mm)	1.16–2.71
Maximum width at the middle of lobes (mm)	5.17

Pará (04.63555°S, 55.46444°W), extending the distribution of the species 939 km in straight line to northeast from the nearest record (Mendes-Pinto and Souza 2011). Two MZUSP specimens were from the municipalities of Aripuanã (10.13888°S, 59.42638°W, collected on 11 November 1996) and Juruena (12.86388°S, 58.94944°W, collected on 19 June 1997), state of Mato Grosso. The record from Juruena extended the known distribution of the species 437 km in straight line to the south from the nearest record (Reserva Biológica do Jaru, Rondônia)

We included two additional non-collected specimens on the geographical distribution map, one from the municipality of Borba, Amazonas (04.43416°S, 59.63111°W; INPH-HF 9760, observed by A. P. Lima; Fig. 2A), the other from Fazenda São Nicolau, municipality of Cotriguaçu, Mato Grosso (09.85833°S, 58.41222°W; INPA-HF 9761, observed by J. C. de Noronha; Fig. 2B), extending the distribution of the species by 387 km in straight line East from the nearest record (Reserva Biológica do Jaru, Rondônia).

Hemipenial morphology.—The hemipenis is bilobed (Fig. 3A, B) and when everted extends to the level of the 10th subcaudal scale. The *sulcus spermaticus* bifurcates to 2.72 mm from the bifurcation of the lobes, at the level of 4–5th subcaudals. The lobes are about 1.5 times longer than the hemipenial body. Approximately one third of the lobes are calyculate, and two thirds are covered with spines. The division between calyculate and spinous areas is well demarcated. Spines increase in size towards the outer edges of lobes, with lengths of up to 3.1 mm in the sulcate side, and to 2.71 mm in the asulcate side (Table 2). Three transverse series of spines are present in the medial portion of internal edges of the lobes. The base of the organ is covered by about 20 small, well-spaced spines, both in the sulcate and asulcate sides. There is no clear differentiation between ornaments on the asulcate and sulcates sides of the hemipenis. Lips of the *sulcus spermaticus* are well marked in the calyculate area, inconspicuous on the spinous area, and make it clearly visible at the base of the organ, where it forks.

Chromosomal characterization.—A total of 30 metaphases were analyzed, all from liver cells. The diploid number is 36, comprised of 16 macrochromosomes (14 m–sm, 2 st) and 20 microchromosomes. The pairs 1, 3, 4, and 7 were metacentric; the pairs 2, 5, and 6 submetacentric and FN = 32 (Fig. 4A). It was not possible to determine the pair of sex chromosomes, because the analyzed individual was a male and, in snakes, females are the heterogametic sex. A nucleolar organizer region was found in the terminal region of three microchromosomes (Fig. 4B), suggesting a multiple system.

DISCUSSION

The geographical range of *B. hyoprora* determined by this study extends the distribution 1787 km SE (straight line) from the type locality at La Pedrera, Colombia (Amaral 1935), 939 km NE and 437 km S (straight line) from the Reserva Biológica Jaru, Rondônia (Bernarde et al. 2008), the nearest locality previously documented.

The scale counts were similar to those presented by Gutberlet and Campbell (2001), with little variation in the number of ventrals (123–128 in males, 123–131 in females), subcaudals (46–50 in males and females), and supralabials (7/7 or 7/8) scales (Table 1). The specimen from Alta Floresta d'Oeste, Rondônia (UFMT-R 9391) had a higher number of dorsal scale rows (25-25-20).

The general hemipenial morphology of *B. hyoprora* is consistent with all Crotalinae, strongly bilobed with clearly visible lateral spines, but scant information about the hemipenis of *Bothrocophias* has been published. All information contained herein was obtained from Campbell and Lamar (2004). *Bothrocophias myersi*, a closely related species, has a shorter hemipenis, reaching the second or third subcaudal when fully everted (10th in *B. hyoprora*), with bifurcation at the level of subcaudals 2-3 (4-5). Lateral spines in the *B. myersi* hemipenis are shorter and thicker than in *B. hyoprora*, and are distributed in longer rows, with 18–30 (14–20).

Several studies have been published on Neotropical pitvipers (e.g., Martins and Oliveira 2001; Turci et al. 2010), and many

species are relatively well known. However, among Neotropical pitvipers, *B. hyoprora* is possibly the least known species with regard to natural history, ecological patterns, and geographical range. This is due to the fact that the species is rarely recorded in field studies and poorly represented in herpetological collections. Our study was based on only seven collected specimens and two additional non-collected specimens, and this restricts the discussion of our results.

Some Neotropical pitvipers have been reported as the most frequently encountered species in field work, such as *Bothrops atrox* in the central Brazilian Amazon (Fraga et al. 2011; Martins and Oliveira 1998), and they can be good models for ecology or natural history studies. Even though this is a poorly known and rarely recorded species, we cannot assume that *B. hyoprora* is rare, or even that their population density is low, because there are still large sampling voids within the range of this species, where collecting attempts have not been made, especially in the Brazilian Amazon. The species is not currently on the IUCN Red List (IUCN 2011), but more long term systematic collections of snake populations in the Amazon Basin are needed to determine the population levels and abundances of all species.

Diet of *B. hyoprora* is not well known, but apparently they eat centipedes, amphibians, lizards, and small mammals (Bernarde et al. 2008). In this study we found remains (scales) of a snake in the digestive tract of a juvenile specimen (INPA-H 26571). Due to the advanced state of digestion, we were unable to identify the prey to more specific taxonomic levels.

This is the first time that the karyotype of *B. hyoprora* has been described. The chromosome number in snakes is a conservative character, with 2n varying between 24 and 56 (Oguiura et al. 2010). The karyotype reported here, 2n = 36 (16 macro and 20 microchromosomes), is the most frequently recorded type in those genera with close phylogenetic affiliations with *Bothrocophias*, such as the genus *Bothrops*, and also in basal families (Beçak et al. 2003; Gorman 1981; Oguiura et al. 2010; Pyron 2011). However, the morphology of chromosomes is not always similar among them, which means that chromosomal rearrangements are present. The NOR position is generally restricted to the microchromosomes, although some species show variation in the number of tagged chromosomes and, in some cases show this on macrochromosomes (Trajtengertz et al. 1995). Although *B. hyoprora* had only three chromosomes that stained with silver nitrate, this species probably has a NOR on four chromosomes, but only three were active.

Chromosome number and structure, including the number of macro- and micro-chromosomes, the position and morphology of pairs, their secondary constrictions, and the karyotypic formula are all useful characters for differentiating among species in the genus *Micrurus* (Serafin et al. 2007). Considering 2n = 36 (16 macro, 20 micro) to be the ancestral karyotype for the genus, two general evolutionary patterns were suggested: Central American species had a tendency for a decrease in the number of chromosomes, while those in South America had a tendency to increase this number. Although *B. hyoprora* possesses the putative ancestral pattern (Fenwick et al. 2009), it is not possible to reach a conclusion regarding chromosomal evolution, given that chromosomal information is not yet available for other members of this genus. Further karyotypic work on the genus *Bothrocophias* and also on the Viperidae in general will doubtless reveal evolutionary patterns.

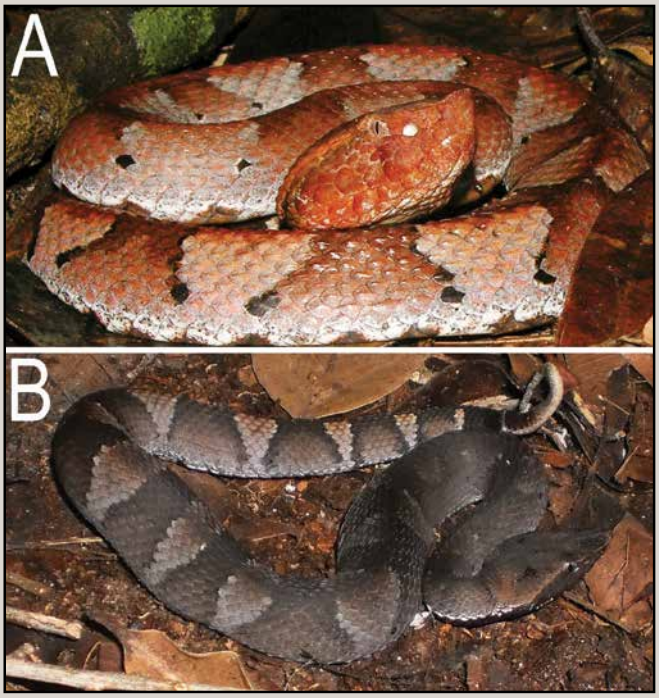


PHOTO BY J. C. NORONHA
COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND

FIG. 2. Live specimens of *Bothrocophias hyoprora*: A) Female from Borba, Amazonas. Photo: A. P. Lima. B) Male from Fazenda São Nicolau, Cotriguaçu, Mato Grosso.

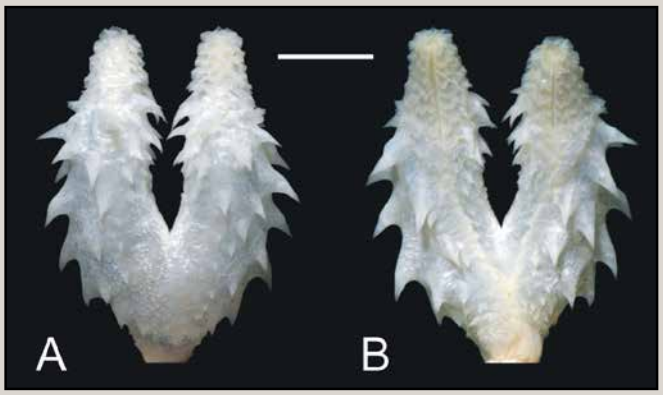


FIG. 3. Hemipenis of *Bothrocophias hyoprora* (INPA-H 26570). (A) Asulcate side view, (B) sulcate side view. Bar = 5 mm.

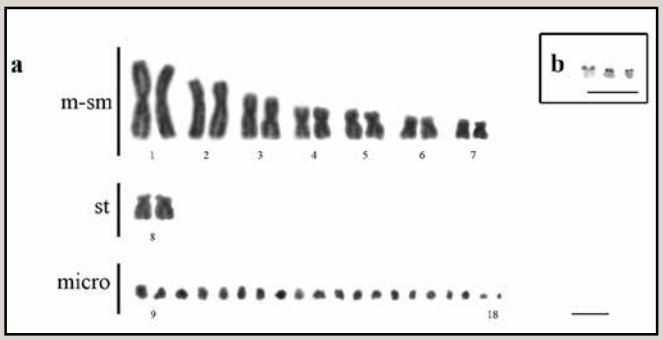


FIG. 4. Karyotype characteristics of *Bothrocophias hyoprora*: A) Conventional staining; B) NOR. Bar = 10µm.

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Appendix 1
Specimens Examined

Bothrocophias hyoprora BRAZIL: Amazonas: Reserva Extrativista do Baixo Juruá, Comunidade Socó, Juruá (INPA-H 17135); Highway BR-319, km 300 and km 400, Manicoré (INPA-H 26570, INPA-H 26571); Highway BR-319, km 220, Borba (INPA-H 28516); Parque Nacional Nascentes do Lago Jari, Tapauá (INPA-H 28044); *Pará*: Floresta Nacional do Trairão, Trairão (INPA-H 26527); Rondônia: Alta Floresta d'Oeste (UFMT-R 9391); Mato Grosso: Aripuanã (MZUSP 11152); Juruena (MZUSP 11327).

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A Galápagos Ectothermic Terrestrial Snake Gambles a Potential Chilly Bath for a Protein-Rich Dish of Fish

The Galápagos Islands are well known for their adaptive radiation of plants and animals (Grant 1986; Itow 1994). It seems logical that organisms should take advantage of new opportunities when they colonize new habitats. On the wild black shores of Fernandina Island, located on the extreme west of the Galápagos Archipelago, the coast is still taking shape under the action of recent eruptions (1995, 2005, and 2009; Smithsonian Institution Global Volcanism Program) from this extremely active shield volcano. This is particularly true of the west coast, which is bathed by cold productive upwellings from the Equatorial Cromwell Under Current. Two locations, Capes Douglas and Hammond, have not been flooded by fresh lava in the recent past and are havens for life, including fur seals, flightless cormorants, and marine iguanas.

Of the four species of xenodontine colubrid snakes reported from the central and southern Galápagos Islands, Fernandina has two species: *Antillophis slevini*, (Fernandina, Isabela, and Pinzon) and *Pseudalsophis biserialis occidentalis* (Fernandina, Isabela, and Tortuga) (Thomas 1997). The latter species is common on the western shorelines, but not exclusive to them. Here we report on a previously unpublished account of *Pseudalsophis biserialis occidentalis* feeding on an unsuspected prey, marine fish.

Setting.—Fernandina is a very young active shield volcano built over the Galápagos hotspot. Its coasts are composed of raw black basaltic lava with the west coast dominated by vertical cliffs often beaten by incoming swells. However, on the northwestern cape (Douglas), a low fractured level ledge of pahoehoe lava extends seaward (Figs. 1a, b). Just to the north of the southwestern cape (Hammond), a sand beach backing a semi-circular tidal pool protected by a boulder ramp is nestled between massive fields of rough a'a lava (Figs. 1a, c). At both of these places exist large populations of Fur Seals (*Arctocephalus galapagoensis*) and Marine Iguanas (*Amblyrhynchus cristatus*), in addition to Flightless Cormorants (*Phalacrocorax harrisi*), Galápagos Lava Lizards (*Microlophus albermarlensis*), and the aforementioned snakes (*Pseudalsophis biserialis* and *Antillophis slevini*), both of the latter being very common. Galápagos Hawks (*Buteo galapagoensis*) have territories in both places.

Fish as prey of Pseudalsophis biserialis occidentalis.—On four separate occasions spread over 14 years from 1995–2009, *P. b. occidentalis*, which mostly feed on lava lizards and recently born marine iguanas, have been observed by one of us (GM) to actively hunt coastal fish. This was also reported to Merlen by filmmaker Richard Wollecombe in 1999. This activity has not been previously described for any of the four species known from Galápagos nor from their mainland and Caribbean ancestors. On Fernandina it is common for snakes to be observed on barren lava shorelines and it has been presumed that they are searching for terrestrial vertebrate prey.

Hunting activities are now described:

1) At Cape Douglas a snake entered a lava contraction crack (approx. 3–10 cm in width) that led to the sea (Fig. 1b). On reaching the vertical shoreline at some 50–100 cm above sea level where the rock is wetted by spray and tidal water, the snake extended 1/4 to 1/3 of its body over the water. This habitat is occupied by the labrisomid endemic Four-eyed Blenny, *Dialommus fuscus*, which spends much of its life out of the water on the wetted surface of the rocks hunting small crustaceans. On one occasion it was possible to view the snake striking at the fish. The captured blenny was taken back into the crack and carried tail first onto the surface of the lava where it was consumed (Fig. 2). This practice has been observed twice: in August 1995 and November 2009.

2) On a post-1998 El Niño survey in the same area, a snake was captured for identification. During this process, the snake regurgitated its prey. Because the prey item was partially digested it was difficult to identify to species, but it was definitely a fish. Merlen sent this specimen to John McCosker, Curator of Fish at the California Academy of Sciences, for identification. It was provisionally placed in the myctophid genus *Bolinichthys*, possibly *B. longipes* (Fig. 2, inset). John Paxton, specialist in lantern fish at the Australian Museum in Sydney also examined an image of this specimen and considered *Bolinichthys* the most likely genus. This is remarkable as this genus forms part of the oceanic deep scattering layer fauna and no terrestrial snake has ever been recorded swimming there. The extreme steepness of the underwater topography off the west coast permits oceanic ecosystems to exist within "a stone's throw" of the shoreline, with myctophid fish and hatchetfish (Sternoptychinae) being killed in abundance by lava entering the coastal waters (McCosker et al. 1997; Merlen, unpubl. data 2009). Possibly the fish was moribund (ill or stunned by a predator such as a fur seal and drifted close in to the shore). Less likely is that the snakes swim at night for this prey, which is uniquely on the surface during darkness.

3) At Cape Hammond the small tidal lagoon and beach is surrounded by recent flows of lava (Fig. 1c). On the low tides much of the sandy rocky floor of the lagoon is uncovered but remains wet (Fig. 3, inset). There are many basaltic boulders and plates of apparently old slabs of volcanic rock permeated by small crevices and holes. In December 2008, 15 snakes were seen patrolling this habitat, investigating holes and the undersides of boulders apparently seeking prey. A snake was observed with 1/3 of its body length in a hole (Fig. 3). When extracted, the snake was ingesting a fish approximately 13 cm in length, apparently *Labrisomus dendriticus*, although the head and the distinctive spot on the gill plates were not visible (Fig. 4).

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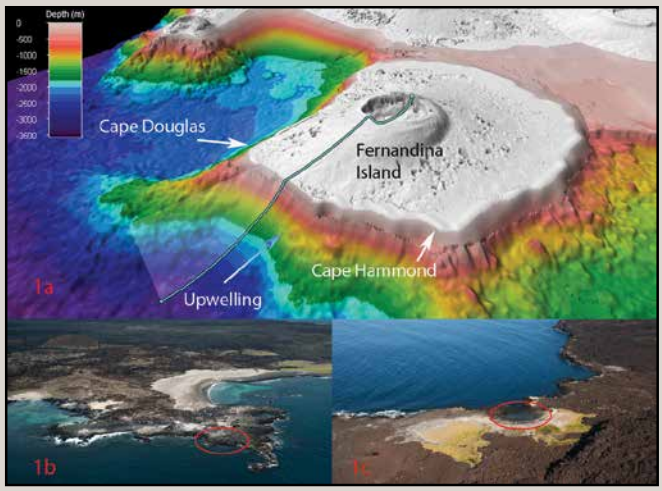


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FIG. 1. A) Bathymetry and topography of Fernandina Island showing Cape Douglas and Cape Hammond and direction of cold productive upwelling waters (Ryan et al. 2009). B) Cape Douglas indicating exposed shelf where fish predation has been observed *(Image: Godfrey Merlen)*. C) Cape Hammond with protected tidal pool where 15 snakes have been observed at low tide seeking prey.



FIG. 2. Observed prey of Galápagos Snake at Cape Douglas. Coastal endemic Four-eyed Blenny, *Dialommus fuscus*. Inset: Alternate prey item: Oceanic Lantern Fish, *Bolinichthys longipes* (used with permission from The Fish Database of Taiwan).



FIG. 3. *Pseudalsophis biserialis occidentalis* exploring hole in bed of tidal pool at Cape Hammond. Inset: Bed of tidal pool at Cape Hammond. Snake can be seen in foreground.



FIG. 4. *Pseudalsophis biserialis occidentalis* consuming fish (probably *Labrisomus dendriticus*, Labrisomidae) after extracting it from a hole in an intertidal rock.

Observations are unknown between these two west coast locations (18.7 km approximately), a little-walked and risky landing stretch of coastal cliff, nor are there recordings from the east coast of Fernandina, which is much more frequently visited. On the present limited data it appears that a piscivorous diet, for at least some snakes, is limited to, and to small areas of, the west coast.

Discussion.—Because there are so few observations available, conclusions beyond the presence of piscivory in *Pseudalsophis biserialis occidentalis* are not possible. Nevertheless it may be interesting and useful to state a few observations concerning snakes and their habits on Fernandina. There are striking differences in habitat possibilities on the east and west coasts of the island. Although all coastal areas are composed of rough open lava rock, the east coast offers a considerable mangrove habitat with numerous small beaches and sea lion colonies. This diverse habitat may offer greater variety and abundance of prey items, especially endemic rats, of which there are two species on this island (*Nesoryzomys narboroughi* and *N. fernandinae*), lava lizards *Microlophus albermarlensis* (which are subdued by constriction) (Merlen, unpubl. data), and the ubiquitous Marine Iguana, *Amblyrhynchus cristatus*. The west coast is a harsh, virtually treeless environment, yet is brushed by some of the most productive waters of the archipelago. Perhaps in the two areas where low-lying land suitable for snakes reaches the sea, Cape Douglas and Cape Hammond, *P. b. occidentalis* have been able to take advantage of this novel environment for a diet of fish.

The observation of 15 snakes at one time around and in the damp basin of the tidal pool at Cape Hammond suggests that fish hunting is not a unique habit of one individual, but one that has spread through, at least, the local population.

A final remark concerns predation. Snakes investigate holes in the bottom on the pool at Cape Hammond (Fig. 3). In order to do so an estimated 1/3 of the body was inserted. This exposes the rest of the body to attack from above because these probing searches are often under open skies. Tjitte de Vries, a specialist on the Galápagos Hawk, has observed on one occasion a snake in the talons of a hawk on Santa Fe Island (de Vries, pers. comm.). Hawks have territories at both Cape Douglas and Cape Hammond. We assume that this predation is not common on Fernandina and is not a deterrent to snakes feeding in exposed holes.

Conclusion.—Predation on marine fish by snakes appears to be a unique habit of *Pseudalsophis biserialis occidentalis* on the west coast of Fernandina, especially at Capes Douglas and

Hammond. We do not know when its ancestor, *Pseudalsophis elegans* (fide Thomas 1997) arrived in the archipelago, but today three subspecies of *P. biserialis* span the central and southern islands. The spread to Fernandina has been recent, less than 70,000 years, (Geist et al., unpubl. ms.) and yet it appears that a new niche for coastal fish predation has been occupied by an adaptable colubrid snake.

Acknowledgments.—We thank the Direction of the Galapagos National Park for authorizing visits to Fernandina island. In particular, GM thanks Wacho Tapia of the Galapagos National Park for his enthusiastic support.

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Conserved Ontogeny of Color Pattern Leads to the Misdiagnosis of Scincid Lizards of the *Plestiodon skiltonianus* Species Complex

Skinks of the *Plestiodon skiltonianus* species complex, which includes the Western Skink (*P. skiltonianus*), the San Lucan Skink (*P. lagunensis*), and Gilbert's Skink (*P. gilberti*), can be very difficult to distinguish unless geographic information accompanies the specimen. This is due to similarity in the ontogeny of color pattern among the different recognized taxa, regional polymorphism in scale and color pattern characters, and a lack of fixed character differences that reliably distinguish each species across the range of the complex (Rodgers and Fitch 1947; Taylor 1935). Some authors have suggested that *P. skiltonianus* and *P. gilberti* be treated as conspecific (e.g., Camp 1916; Cope 1900; Grinnell and Camp 1917; Van Denburgh 1896), and certain statements in the literature (e.g., "…young [*P. g. gilberti*] specimens are marked just like the young and most adults of *skiltonianus*" [Smith 1946, p. 385]) have only added to the confusion. Phylogenetic analyses have also done little to resolve these taxonomic issues, as separate *P. gilberti* lineages have evolved multiple times within a paraphyletic *P. skiltonianus* (Brandley et al. 2012; Richmond and Reeder 2002), and species delimitation varies widely depending on the concept of species (Richmond and Jockusch 2007; Richmond et al. 2011). For the remainder of the paper, we place the name "*gilberti*" in quotation marks to reflect the nonmonophyly of these lineages except where *P. gilberti* is specifically referred to in earlier studies.

The main characters used to distinguish members of the *P. skiltonianus* complex in the field include body size, dorsal color pattern, tail color (pink vs. blue), and to a lesser degree limb length, supralabial count, nuchal scale count, and a few others related to scalation (Grismer 1996; Rodgers 1944; Rodgers and Fitch 1947). Size (SVL) can be effective for differentiating adult individuals in most areas, but is of little use for young specimens. Color pattern is useful to a degree, but dorsal stripes are retained longer into adulthood in certain *"gilberti"* populations than in others, especially in females, and in some areas the stripes are often never completely lost. Aberrantly large *P. skiltonianus* also have very degraded, or in some cases, no stripes at all (JQR, pers. obs.). Juvenile tail color is useful in regions where pink-tailed *"gilberti"* approach or are syntopic with *P. skiltonianus*; however, *"gilberti"* populations in the northern and central Sierra Nevada, as well as in scattered populations in the east Mojave Desert and the Panamint Mountains, are blue-tailed. Allopatry and different juvenile tail colors distinguish juvenile *P. lagunensis* in southern Baja California from *P. skiltonianus* in northern Baja California, but the adult phenotypes of the two species are similar enough that some authors have regarded them as conspecific (Linsdale 1932; Schmidt 1922; Stejneger and Barbour 1933; Tanner 1988).

One of the most widely used characters for distinguishing juveniles of *P. skiltonianus* and "*gilberti*," aside from tail color when the differences are obvious, is the distance that the dark lateral stripes extend onto the tail (Fig. 1). In various field guides and species descriptions, it is commonly stated that this stripe extends much further in *P. skiltonianus* (ca. 1/3 to 1/2 way down the tail) than it does in "*gilberti*"; in the latter, this stripe purportedly ends at the base of the tail just posterior to the hind limbs (Behler and King 1979; Jones and Lovich 2009; Lemm 2006;

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FIG. 1. Example of the lateral tail stripe character in a juvenile *Plestiodon skiltonianus* from Tehama County, California (ca. 520 m elev.).

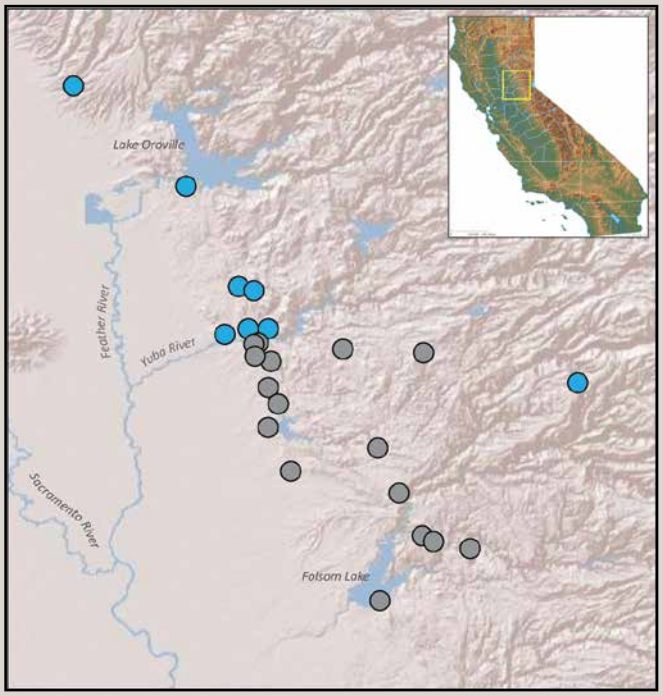


FIG. 2. Map of the Yuba River study region indicating DNA sampling locations for *P. skiltonianus* (blue dots) and *P. "gilberti"* (gray dots). The outlier *P. skiltonianus* locality south of the Yuba River represents a high elevation population at Red Point, Placer Co. (~1430 m), first published in Rodgers and Fitch (1947) and revisited during this study. Several additional high elevation populations from this region referred to as either *P. skiltonianus* or *P. "gilberti"* in museum collections have not yet been sequenced and require taxonomic attention.

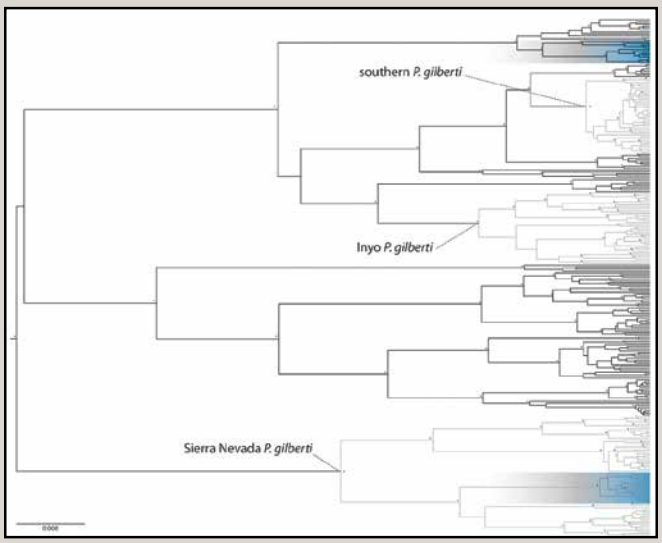


FIG. 3. Maximum clade credibility tree for ND4 mitochondrial haplotypes within the *P. skiltonianus* group; the tree was estimated using a model partitioned Bayesian analysis in BEAST v1.7 (Drummond et al. 2012; 20×10^6 iterations with a 10% burn-in). Gray branches denote separate "*gilberti*" lineages; black branches denote *P. skiltonianus*/*P. lagunensis*. Bullets indicate posterior probabilities ≥ 0.95. Shaded blue-gray boxes highlight haplotypes recovered on the north (*P. skiltonianus*) and south sides (Sierra Nevada "*gilberti*") of the Yuba River, California.

Macey and Papenfuss 1991; Rodgers and Fitch 1947; Smith 1946; Smith and Brodie 1982; Stebbins 2003; Stebbins and McGinnis 2012; Storer et al. 2004; Tanner 1957, 1988). However, like the other characters used to differentiate *P. skiltonianus* and "*gilberti*," we have detected notable variation in the extension of the lateral tail stripe in populations of both species, and below we present data that describe how the character fails to differentiate the two in certain parts of the range.

During recent survey work on *Plestiodon* populations in the western foothills of the northern Sierra Nevada in Yuba County, California, we discovered what appeared to be juvenile *P. skiltonianus* just south of the Yuba River in an area that is reported to be exclusive to "*gilberti*," based on the bright blue tail color and the continuation of the dark lateral stripe well past the hindlimbs (Rodgers and Fitch 1947). A longstanding notion exists that *P. skiltonianus* is essentially restricted to the north side of the river, which runs perpendicular to the Sierra Nevada, and that the range of "*gilberti*" extends north to the Yuba River from the south but does not cross it (Rodgers 1944; Rodgers and Fitch 1947; Stebbins 2003; Fig. 2). Only four isolated *P. skiltonianus* populations have been formally documented from the immediate south side of the Yuba River (Rodgers and Fitch 1947; specimens MVZ 190472,190479; this study), occurring mainly in the conifer zone at approximately 900–1450 m, whereas "*gilberti*" occurs at lower elevation in blue oak woodland and grassland only on the south side of the river. This purported distribution is perplexing, as there are no salient habitat differences on either side of Yuba River, and none of the other major river drainages south of Yuba County have presented barriers that limit the distribution of "*gilberti*" along the western slope of the Sierra Nevada (although they may have intermittently in the past). Thus, we were not surprised to find *P. skiltonianus* south of the Yuba River. Because both species were expected to have blue-tailed juveniles and scale counts were ambiguous, our identification of juvenile specimens relied mainly on the degree to which the dark, lateral stripe extended onto the tail.

To confirm our identifications, we extracted DNA from small tail clips (~ 10.0 mm) preserved in 95% ethanol from 28 individuals and sequenced 16 for their ND4 mitochondrial haplotypes (~1500 bp: Dryad repository: doi:10.5061/dryad.2873b). We then compared these sequences to a large ND4 dataset representing the entire range of the *P. skiltonianus* complex (Fig. 3). *Plestiodon skiltonianus* and "*gilberti*" in Yuba County (the latter regarded as *P. g. placerensis*; de Quieroz and Reeder 2012) have high mitochondrial sequence divergence and are easily distinguishable based on their haplotypes (Richmond and Jockusch 2007; Richmond and Reeder 2002). Surprisingly, we found that all skinks sampled on the south side of the Yuba River below 1430 m had

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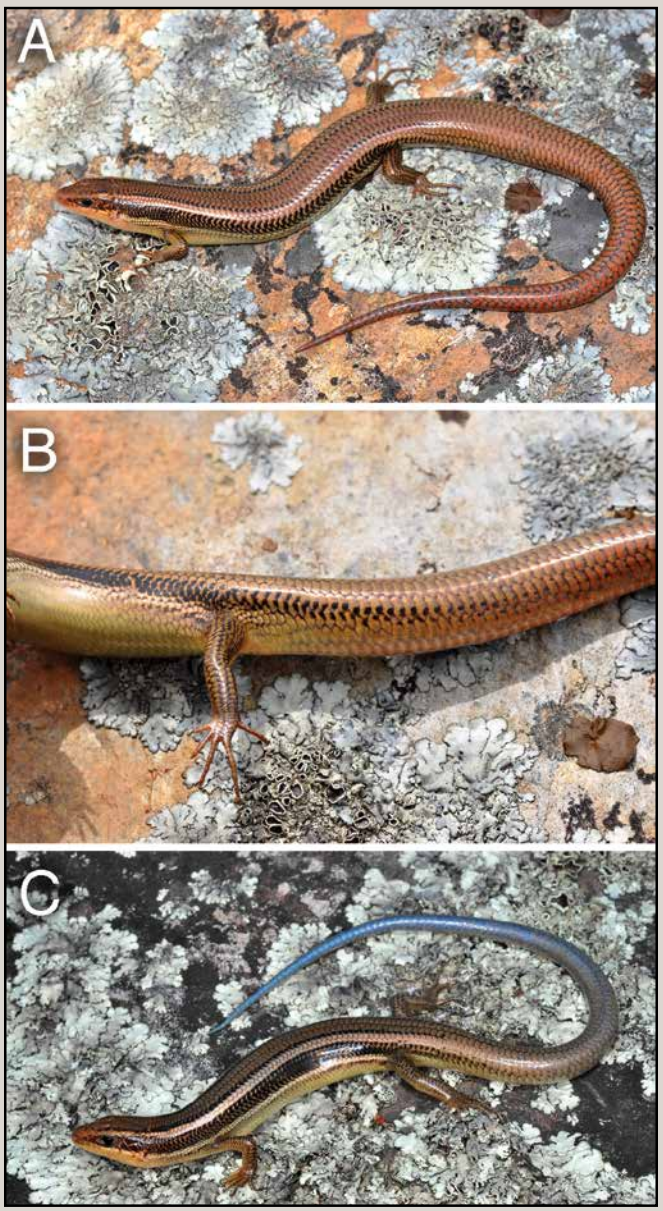


FIG. 4. A) Adult female "*gilberti*" found just south of the Yuba River, California (ca. 100 m elev.). B) Closer, lateral view of the tail (female A), illustrating retention of the lateral stripe and its extension past the hind limb. C) Young adult female "*gilberti*" from this same locality showing the light dorsolateral striping and the dark, lateral tail striping extending well past the hindlimbs, similar to *P. skiltonianus*.

PHOTOS A-B BY J. D. SHEDD; PHOTO C BY R. W. HANSEN



FIG. 5. A) Juvenile *Plestiodon skiltonianus* from just north of the Yuba River, California (ca. 265 m elev.); B) Juvenile "*gilberti*" from just south of Yuba River (ca. 100 m elev.); C) Juvenile "*gilberti*" from Tuolumne County, California (ca. 785 m elev.) showing lateral tail stripe stopping closer to the hind limbs, but still extending notably past them.

COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND

Sierran "*gilberti*" haplotypes, and all those sampled on the north side of the river regardless of elevation had pure *P. skiltonianus* haplotypes, consistent with the supposition of Rodgers (1944) and Rodgers and Fitch (1947). We also noted that while adult male "*gilberti*" in this area completely lose the striped color pattern, as is generally the case for "*gilberti*," adult females retain dark lateral stripes on the flanks and well onto the tail, immediately below the area where the light dorsolateral stripe runs along the body axis in juveniles (Fig. 4; also noted in Rodgers 1944). This same pattern has been noted in other parts of the species' distribution (e.g., creeks along the eastern slopes of California's inner Coast Ranges; JQR, pers. obs.), where lateral stripes extend well beyond the hindlimbs even in some of the largest adult females. Thus, a character that is typically lost early in ontogeny in some parts of the "*gilberti*" range, or is absent altogether, is retained in adult females in other areas, particularly the northern Sierra Nevada.

In his description of *P. g. placerensis*, Rodgers (1944) did not address the lateral tail stripe character, and later accounts identifying this and other *P. gilberti* subspecies provide information about tail color (pink or blue), supralabial count, but little else (e.g., Jones and Lovich 2009; Stebbins 2003). Rodgers and Fitch (1947) provided qualitative descriptions of the ontogeny of *P. skiltonianus* and the different forms of "*gilberti*," illustrating varying degrees in the loss of the dorsolateral stripes and the bright tail color. However, variation in the extension of the dark, lateral tail stripe for "*gilberti*" was not discussed. Consistent with the descriptions of Rodgers and Fitch (1947), we have found that hatchling, juvenile, and younger adult female "*gilberti*" (Fig. 4c)

in Yuba County appear to be *P. skiltonianus* upon initial inspection; in both forms, the tail color is bright blue and the lateral tail stripe extends well beyond the hind limbs (although the stripe may continue further on the tail in *P. skiltonianus* north of the Yuba River than it does in "*gilberti*" south of the Yuba River [Fig. 5a, b]). The similarity in this character between species fades further south in the Sierra Nevada foothills (Fig. 5c), where the dark lateral stripe ends closer to the base of the tail in young "*gilberti*."

Because of the variability of this character across the range of the species complex, we consider it unreliable for distinguishing *P. skiltonianus* and "*gilberti*" over large portions of the range of the *P. skiltonianus* complex. Despite years of field collecting and DNA sequence data from hundreds of individuals (including sequences obtained from museum specimens that were incorrectly identified as *P. skiltonianus*), we have yet to recover a *P. skiltonianus* specimen from locations south of the Yuba River, with the exception of a single site at approximately 1430 m and 14 km SSE of the Yuba River, until Tulare County in the southern Sierra Nevada. We suspect that a number of museum specimens collected from this same region at lower elevation are incorrectly identified as *P. skiltonianus* and instead belong to the Sierran "*gilberti*" lineage as identified in Richmond and Reeder (2002). In fact, bright blue juvenile tail color and the continuation of the dark, lateral stripe past the hindlimbs are the two characters that appear largely responsible for these misidentifications.

Perhaps the most interesting finding of our survey work is that *P. skiltonianus* and "*gilberti*" are most similar in the ontogeny of color pattern where their distributions meet but do not overlap at the Yuba River. Yet in southern California where the two species are syntopic, for example, they are easily distinguished by juvenile and adult color pattern (*P. skiltonianus* juveniles have blue tails and light dorsal stripes throughout adulthood whereas juvenile "*gilberti*" have pink tails and no stripes as adults), and adult body size. In fact, adult body size is more divergent in southern California than anywhere else in the range of the species complex, and is a predominant factor contributing to their reproductive isolation (Richmond and Jockusch 2007; Richmond et al. 2011). This suggests that sympatry in southern California may have influenced phenotypic divergence of the two forms, whereas allopatry in the northern Sierra Nevada may have contributed to retention of the ancestral juvenile color pattern.

Acknowledgments.—We thank Robert W. Hansen for his photo of *P. gilberti* from Tuolumne County, California. Dustin A. Wood and two anonymous reviewers provided helpful comments on the manuscript.

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TECHNIQUES

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A Non-Invasive Method of Measuring Heart Rates in Small Reptiles and Amphibians

Measuring the heart rate of animals is crucial to the work of many biologists, including applications in veterinary, physiological, through to ecological studies. Determining heart rate is valuable because it is an indirect indicator of metabolic rate (Bennett 1972; Bradford 1983; Butler et al. 2004; Greenvald 1971). As such, heart rate measurements can be a substitute for metabolic chamber and doubly-labelled water studies. Aside from the traditional methods of measuring heart rates such as electrocardiography and seismocardiography, recent technical advances have democratized the use of a variety of external or internally implanted data loggers (Altimiras et al. 2000; Woakes et al. 1995). The choice of method depends on the application (long-term field study versus lab work), and the size (technical difficulties arise in animals < 40 g) and type of animals used (i.e., importance of stress as a confounding factor). We suggest a simple and inexpensive method of measuring heart rate in small vertebrates (< 40 g) applicable to both field and laboratory studies.

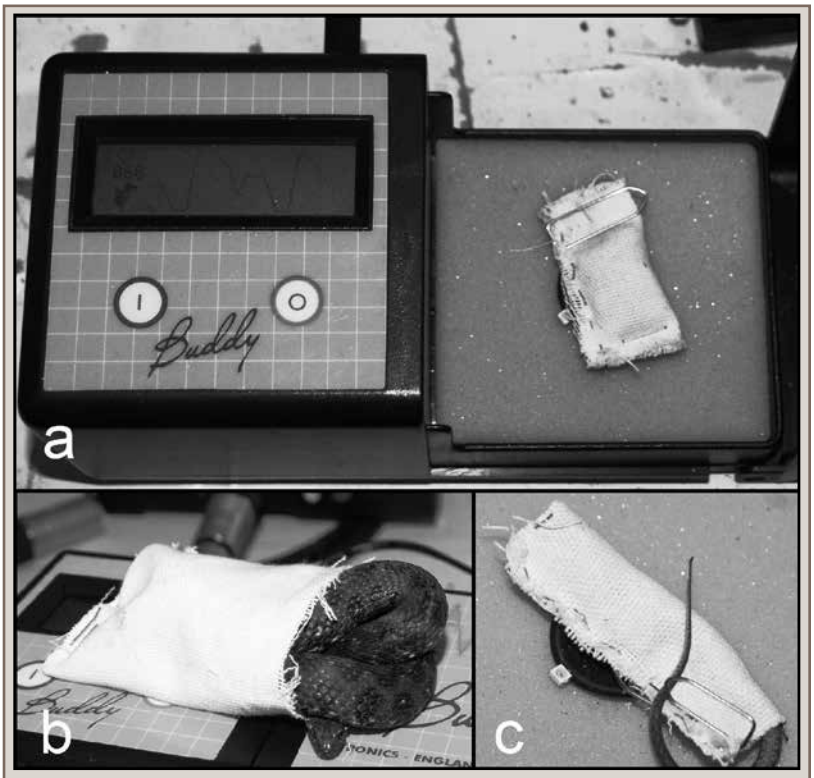


FIG. 1. Animals were placed into cotton material bags and acclimated to the testing temperature. Each bag was then gently lifted onto the sensor pad of the Buddy® monitor (panel A). A young Viperine Water Snake (*Natrix maura*) (panel B) and an adult Wall Lizard (*Podarcis muralis*) (panel C) are shown during testing.

Methods.—The Buddy® digital egg monitor (MK2, Avitronics) was developed for measuring heart rates of avian and nonavian reptile embryos for the poultry industry and research applications (Du et al. 2009; Lierz et al. 2006). The Buddy® system works by shining an infrared beam onto the surface of the egg, detecting minute distortions caused by embryonic heart beats (Du et al. 2009). Muscle impulses other than cardiac ones, as well as external vibrations, generate stronger signals than the study animal's heart beats, which preclude the monitor from measuring concurrent heart beats (Lierz et al. 2006).

Du and colleagues (2010) expanded the use of the monitor when they recorded heart rates in hatchlings of two emydid turtle species, *Chrysemys picta,* and *Graptemys pseudogeographica kohnii*. To do so, young turtles were placed into egg-shaped plastic balls and then onto the Buddy® monitor sensor pad. While this method worked effectively with turtle hatchlings that are roughly round in shape and fit into an egg-shaped plastic ball, we wished to extend this method to other small vertebrates, including elongated animals such as snakes, lizards, and newts.

The major problem faced when trying to record heart rates in small animals (rather than eggs) is immobilizing the animal on the Buddy® system sensor pad to avoid interference with the machine readings. To solve this problem, we made small cotton material bags of various sizes and shapes in order to accommodate

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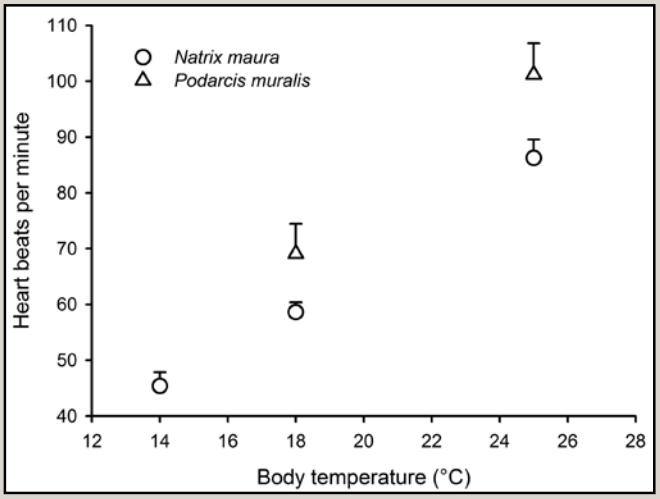


FIG. 2. Heart rates were recorded in eight Viperine Water Snakes (*Natrix maura*) at three body temperatures (14, 18, and 25°C) and 10 Wall Lizards (*Podarcis muralis*) at two body temperatures (18 and 25°C). In both snakes and lizards, heart rates significantly increased with body temperature (see text for details). Means ± standard errors are plotted.

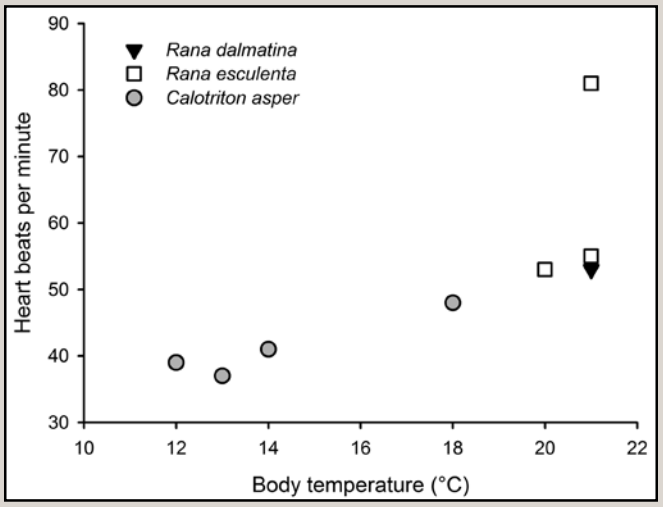


FIG. 3. Heart rate values recorded in three Edible Frogs (*Rana esculenta*), one Agile Frog (*Rana damatina*), and four Pyrenean Brook Salamanders (*Calotriton asper*) are shown. Data are plotted against body temperature.

the different individual snakes, lizards, newts and frogs we wished to test (Fig. 1). We first validated heart rate measurement obtained with the Buddy® egg monitor in young snakes against a proven method (echocardiography). We then recorded heart rates as a function of body temperature in snakes, lizards, newts, and frogs of varying sizes. Body temperatures were recorded with the temperature probe Trotec® BP20.

Because repeated measurements were made on the same individuals, we analysed heart rate measurements using Wilcoxon Matched Pairs Test when comparing two dependent samples, and Friedman ANOVA when comparing multiple dependent samples.

Validation of the method.—We measured heart rates in 12 captive *Natrix maura* (Viperine Water Snakes; born to six different clutches in September 2011; ranging from 4.6 g to 15.1 g in body mass and from 19.9 cm to 27.2 cm in snout–vent length [SVL]) using the Buddy® egg monitor and by echocardiography as a control proven method. Measurements were performed in a controlled temperature room (CTR) maintained at a constant 22°C within a Veterinary Hospital (Dr. Breuil and Feix; Toulouse, France). Light was dimmed inside the CTR to limit potential stress to the snakes. We used a balanced testing order: 6 snakes were first measured using the Buddy® egg monitor, then using an ultrasound device (Esaote® MyLab™30Gold Cardiovascular) and probe (SC3123 Microconvex 10 MHz), and *vice versa* for the remaining six snakes. Snakes were maintained in plastic boxes Exo-Terra® (30.0 × 19.5 × 20.5 cm) and acclimated to ambient temperature for a minimum of 30 minutes prior to testing. Three heart rate readings were taken with each snake and each technique, from which we calculated average heart rates. Each series of measurements was completed in under 5 minutes, and snakes were allowed to rest 5 minutes between the two measurement series (total experimental time for each snake: 15 minutes). There was no significant difference in individual average heart rates between the two techniques: heart rates averaged 104.78 ± 7.16 BPM according to the ultrasound method and 103.17 ± 10.91 BPM using the Buddy® egg monitor (Wilcoxon Matched Pairs Test; N = 12; T = 34.00; Z = 0.39; P = 0.70).

Heart rates as a function of body temperature.—We measured heart rate in eight captive born *Natrix maura* originating from 5 different clutches (three juveniles captive born in August 2011 and five neonates captive born in August 2012). Snakes ranged from 2.1 g to 21.2 g in body mass, and from 12.6 cm to 35 cm in SVL. Each individual was tested at three different body temperatures (14, 18, and 25°C) on three consecutive days applying a balanced order design. Snakes were placed inside their individual testing bags, and into temperature controlled chambers for 30 minutes in order to reach testing temperature and ensure minimum stress levels at the time of testing. As expected, heart rates significantly increased with body temperature (Friedman ANOVA; $\chi^2_2 = 16.00$; P = 0.0004; Fig. 2).

We measured heart rate in 10 field-caught Wall Lizards (*Podarcis muralis*) using the same protocol (see Fig. 1). Lizards ranged from 3.2 g to 7.5 g and from 52.1 mm to 65.6 mm in SVL. Heart rates measured at 25°C were significantly greater than heart rates measured at 18°C (Wilcoxon Matched Pair Test; N = 10; T = 0.01; Z = 2.80; P = 0.0005; Fig. 2). In addition to lizards and snakes, we also used the Buddy® system to measure heart rates in frogs and salamanders. We measured heart rates in three Edible Frogs (*Rana esculenta*) that ranged from 22.7 g to 64.7 g body mass and 61.0 mm to 81.9 mm body length, one Agile Frog (*Rana dalmatina*) (body mass = 35.0 g; SVL = 75.0 mm), and four specimens of the Pyrenean Brook Salamander (*Calotriton asper*) that ranged from 7.5 g to 11.0 g in body mass and from 64.0 mm to 82.0 mm in SVL (Fig. 3).

Applications.—The possible applications of the Buddy® system to record heart rates in small animals are broad, although some fine tuning may be necessary depending on the model system and the conditions of use. For instance, heart rate detection was straightforward in snakes and frogs (heart rates usually stabilized in under 30 sec), but required more repositioning of the bag when measuring a lizard or a newt (perhaps due to their more rigid elongated shape and impossibility to coil into a ball shape). However, differently shaped sensor pads might be developed and work better on differently shaped animals. Notably, it might be possible to fine tune this method to recording heart rates in small mammals (mice, bats etc.) as well as small birds.

In conclusion, the main advantages of using the Buddy® system are that the unit is affordable, accurate, transportable, and can be battery operated; and therefore may be used in remote field locations. Using the system in the laboratory provides researchers with a quick and easy tool to record heart rates (and incidentally metabolic rates) in small animals without relying on high maintenance or expensive (and sometimes fragile) machinery or data loggers.

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Evaluation of Traps to Capture Eastern Hellbenders (*Cryptobranchus alleganiensis alleganiensis*) in Deep Water Habitat

Cryptobranchus alleganiensis (Hellbenders) are large, aquatic salamanders that prefer streams and rivers with moderate to swift-flowing water with large rocks. *Cryptobranchus alleganiensis* individuals are mostly nocturnal, remaining under large rocks and in bedrock crevices during the day and emerging at night to forage primarily on crayfish with fish, insects, worms, snails, frogs, etc., accounting for secondary dietary items (Petranka 1998). Two subspecies are currently recognized, both restricted to the eastern United States: *C. a. alleganiensis* (Eastern Hellbender) and *C. a. bishopi* (Ozark Hellbender; Crother et al. 2012), and both subspecies have experienced population declines throughout much of their range, especially in Missouri (Briggler et al. 2007; USFWS 2011; Wheeler et al. 2003). *Cryptobranchus alleganiensis* population declines in Missouri are mainly linked to habitat degradation and alteration, water quality, commercial exploitation, predation, and disease (Briggler et al. 2010; Briggler et al. 2007; USFWS 2011).

A wide array of capture methods have been used to sample *C. a. alleganiensis* (Foster et al. 2008; Nickerson and Krysko 2003; Williams et al. 1981). A thorough review and critique of the various methods can be found in Nickerson and Krysko (2003) and Browne et al. (2011). Snorkel diving coupled with turning rocks has been and continues to be the most effective method for capturing *C. alleganiensis* (Browne et al. 2011; Foster et al. 2008; Nickerson and Krysko 2003). This technique works well for shallow to moderately deep (< 2 m), clear water streams; but sampling turbid (Secchi depth < 1 m), deeper water habitat is difficult, if not impossible, with this method.

Anglers have reported catching *C. alleganiensis* on hook and line (Beck 1965; Dundee and Dundee 1965; Ferguson 1961; Gates et al. 1985; Wortham 1970) or hoopnets (Trauth et al. 1992) in several states, including Missouri. Several photographic reports from anglers capturing *C. a. alleganiensis* on trotlines during the winter in Missouri, especially the Gasconade River, have been received over the years (J. Briggler, pers. comm.). Based on these reports of *C. alleganiensis* being attracted to baited hooks, it seems plausible that baited traps could be an effective method of capturing *C. alleganiensis* in select Missouri rivers.

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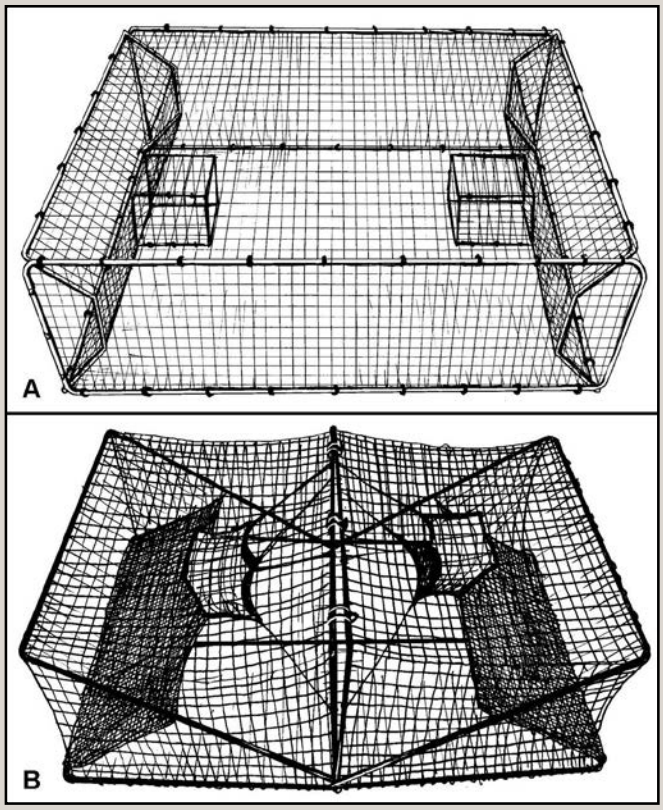


FIG. 1. Collapsible wire-mesh trap (A) and net-mesh trap (B) used to capture *Cryptobranchus a. alleganiensis* (Eastern Hellbender) in the Gasconade River, Missouri.



FIG. 2. Collapsible wire-mesh trap baited with *Dorosoma cepedianum* (Gizzard Shad) that captured two *Cryptobranchus a. alleganiensis* on 16 March 2009 in the Gasconade River, Missouri.

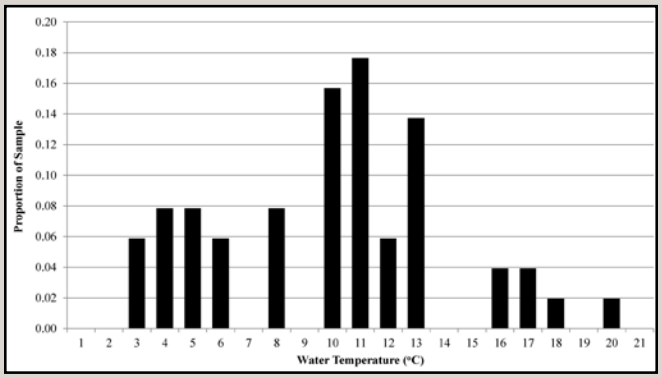


FIG. 3. Proportion of *Cryptobranchus a. alleganiensis* captured (N = 51) for the various water temperature (°C) from November 2007 through May 2009 in the Gasconade River, Missouri.

There have been several investigations that attempted to capture *C. a. alleganiensis* using baited traps with varying success (Foster et al. 2008; Kern 1984; Soule and Lindberg 1994). Soule and Lindberg (1994) baited wire-mesh traps with chicken livers with no success in New York. Kern (1984) used hoop-nets baited with cut sucker fish and captured 29 *C. a. alleganiensis* in Indiana. Foster et al. (2008) captured 22 individuals in New York drainages over 627 trap nights using plastic-coated hardware cloth traps baited with *Catostomus commersonii* (White Sucker). We are unaware of any previous attempts to sample deep, turbid habitat. Based on angler reports, some reported trapping success, and limited knowledge of sampling deeper water habitat, we decided to experiment with trapping design and trapping implementation to sample deep, turbid water habitat that was not conducive for other sampling techniques. The distribution and relative abundance of *C. a. alleganiensis* in these deep-water habitats is relatively unknown and likely to be important to the long-term recovery of the species. The objectives of this study were to 1) determine the distribution and relative abundance of *C. a. alleganiensis* on the lower sections of the Gasconade River, 2) examine the efficacy of baited traps to sample *C. a. alleganiensis* in deep, turbid water conditions, and 3) determine if trapping site characteristics influenced *C. a. alleganiensis* presence.

Materials and methods.—This study was conducted on the lower Gasconade River (7th order) in Gasconade, Maries, Osage, Phelps, and Pulaski counties, in Missouri. Water depths on the lower Gasconade River range from shallow riffles (< 0.5 m) to deep pools (> 8 m). Turbidity in the Gasconade River can be extremely high (Secchi depth < 0.5 m), especially during the summer as a result of algae blooms and sediment in the water. Water clarity does improve during the winter months but snorkeling and diving in cold, deep, flowing water is not recommended. With the aid of topographic maps and prior knowledge of *C. a. alleganiensis* habitat, sampling sites (N = 63) were identified along bluff banks over approximately 192 river km of the lower section of the Gasconade River. The substrates along these bluff banks are typically covered with large rocks suitable for *C. a. alleganiensis* occupancy.

Considerable trapping effort was conducted from February 2006 through August 2007 to evaluate bait types (*Dorosoma cepedianum*, *Hypophthalmichtys* sp., *Orconectes punctimanus*, crayfish magic bait, and chicken liver), distance between trap sets at a particular location, trap type (e.g., wire-mesh trap vs. mesh-net traps), trap design (two throats vs. one throat, collapsible vs. non-collapsible), trap set duration (24 vs. 48 h), and season of trapping (cooler vs. warmer weather months). Based on our experiences in 2006 and 2007, we decided to use custom-made collapsible wire-mesh traps and a few collapsible net-mesh traps. Collapsible traps allowed us to make efficient use of limited space in the boat and set a larger number of traps in a single day. We further decided on a 48-h trap set during the cooler months (November through early May) and to bait the traps with *D. cepedianum* (Gizzard Shad).

Trap design.—We used a wire-mesh and net-mesh trap design for this study. The wire-mesh trap was originally designed by

Foster et al. (2008), and we modified to include two throats and allow it be collapsible as outlined below. Both the wire-mesh trap and net-mesh trap consist of a rectangle design. The wire-mesh trap was made of 1.3 cm mesh green, plastic coated hardware cloth on a steel frame made from 9-gauge galvanized wire. The collapsible wire-mesh trap measured 61 cm long × 46 cm wide × 22 cm high with a funnel entrance on both ends measuring 7.5 cm high × 10 cm wide (Fig. 1a). Plastic zip ties were used to secure the funnel entrances (1 zip tie per entrance) and to hold the trap erect for setting (3–4 zip ties for each end). The collapsible net-mesh trap, also known as collapsible square fish trap, was purchased from Memphis Net and Twine (product code FTA). The net-mesh trap was made of 1.3-cm polyethylene mesh on a steel frame. This trap measured 60 cm long × 42 cm wide × 20 cm high. We modified the horizontal funnel entrance, converting it to a mesh funnel measuring 6 cm high × 10 cm wide on both ends of the trap, and we added 0.3-cm mesh netting to the base of the ramp leading to the funnel entrance to make the footing more firm for *C. a. alleganiensis* (Fig. 1b).

Trap deployment.—Trapping was conducted during the cooler weather months from November 2007 through May 2009 on the Gasconade River over 192 river km. During our first sampling period (November 2007 through May 2008), we aimed to trap monthly on the downstream 97 river km of the Gasconade River. February 2008 trapping was not conducted due to high river levels. Thirty-three unique sites were identified and 50 traps (40 wire-mesh traps and 10 net-mesh traps) were set monthly. Trapping was conducted at six sites in November, six sites in December, five sites in January, seven sites in March, four sites in April, and five sites in May. With the success during the first sampling period, we decided to conduct additional trapping in deep-water habitat further upstream. Our second sampling period occurred in November and December 2008 and March, April, and May 2009 at an additional 30 unique sampling sites scattered over 95 river km on the Gasconade River upstream of the sites sampled in the first sampling period. We decided to not trap during the coldest winter months of January and February, and constructed additional wire-mesh traps to increase sampling effort. Trapping was conducted at three sites in November, five sites in December, 14 sites in March, six sites in April, and two sites in May. We randomly set traps at unique sites in both upstream and downstream reaches for each month sampled during both sampling periods. We wanted to ensure equal chance of capturing animals among months due to limited historical records for *C. a. alleganiensis* from the most distant downstream reaches. No one site was trapped more than once during the course of this study.

Traps were only set along bluff bank sites that appeared suitable for *C. a. alleganiensis* occupancy; the sites contained large cover rocks (e.g., boulder, cobble, and slab rocks) with sufficient water velocity. The number of traps set per site varied on site length (i.e., longer sites had more traps) and ranged from five to 23 traps, and we randomly selected whether a wire-mesh or net-mesh trap was set. Traps were set from a boat due to the deep water conditions and often cold temperatures of the Gasconade River. Traps were secured by two means. First, a rope was secured to a tree or rock on the river bank (bank rope). The bank rope had a small loop (approximately 7.5–10 cm diameter) in the unsecured end. Next, the rope tied to the trap (anchor rope) was passed through the loop in the bank rope and secured to an anchor. The boat was then backed away from shore, and the anchor rope was then tossed upstream. As the boat floated downstream and slack in the anchor rope tightened, the trap was gently dropped in the water. Traps were scattered along the site length. A conscious effort was made to place each trap on a flat area of the river bottom adjacent to a large rock when water and weather conditions allowed. Traps were baited with a medium-size (approximately 14 cm), whole or cut shad (*D. cepedianum*) that was secured in a cloth mesh bag in the center of the trap. Secchi depth (m), water temperature (°C), and water velocity (m/sec) were measured at a representative spot at each unique sampling site, and photographs were taken of each location sampled. In addition, Global Positioning System (GPS) coordinates and water depth were recorded at each individual trap set location. Distance between traps (m) at a unique site was calculated from UTM coordinates. Length of site was distance between the most upstream and downstream trap. Trap setting was completed within eight hours each day, and traps were checked approximately 48 h later.

Each *C. a. alleganiensis* captured was measured for total length (TL), snout-to-vent length (SVL), and mass (g). Each *C. a. alleganiensis* captured was tagged in the dorsolateral musculature of the tail with a passive integrated transponder (PIT) tag. Photographs were taken of each *C. a. alleganiensis* captured. Each animal was released at the specific trap of capture after processing.

Capture efficiency was calculated as the number of *C. a. alleganiensis* captures per unit of effort (captures/trap and captures/trap night). Student's *t*-tests were used 1) to assess if trap parameters (depth of trap set, distance between traps) differed between individual traps with or without *C. a. alleganiensis*, and 2) to assess if site parameters (length of sampling site, water temperature, water flow, and Secchi depth) differed between sites with or without hellbenders. All sites and trap sets were independent because each unique site was only sampled once for the duration of this study. All statistical analyses were performed using JMP statistical software (SAS Institute, 2000).

Results.—Sixty-three river bluffs were trapped from November 2007 through May 2009 with *C. a. alleganiensis* captured at 31 (49.2%) of these sites. All *C. a. alleganiensis* captured were adults (N = 51) with an average (range) TL of 45.8 (40.0–51.0) cm, SVL of 30.4 (26.0–36.5) cm, and mass of 573 (360–981) g.

Monthly trapping during the first sampling period from November 2007 through May 2008 showed the highest captures for *C. a. alleganiensis* in April and November, while the highest captures in the second sampling period was March 2009 (Table 1). We captured a *C. a. alleganiensis* in each month, except for February, when we were unable to sample due to high river levels. During the pilot testing, however, we did capture a *C. a. alleganiensis* in February 2006.

Capture efficiency for *C. a. alleganiensis* was highly variable among sites, ranging from 0.02–0.14 captures/trap and 0.01–0.07 captures/trap night with March and April accounting for the highest capture rates (Table 1). Average capture efficiency for *C. a. alleganiensis* combining wire-mesh trap and net-mesh trap for both sampling periods was 0.073 captures/trap (1 individual/13.7 traps) and 0.036 captures/trap night (Table 1). Wire-mesh traps (0.079 captures/trap night) were almost twice as efficient at capturing *C. a. alleganiensis* as net-mesh traps (0.042 captures/trap night). On average, wire-mesh traps captured 1 *C. a. alleganiensis* per 12.6 traps compared to 1 *C. a. alleganiensis* per 23.6 traps for net-mesh traps. On four separate occasions, 2 *C. a. alleganiensis* were captured in one trap (Fig. 2) and in one trap a *C. a. alleganiensis* and *N. maculosus* were captured together.

TABLE 1. Capture efficiency, measured as number of captures/trap and number of captures/trap night, for *Cryptobranchus a. alleganiensis* (Eastern Hellbender) from November 2007 through May 2009 in the Gasconade River, Missouri. First sampling period was designed for monthly trapping. Second sampling period focused only on the months listed.

Date	No. traps set	No. trap nights	No. sites trapped	No. sites with Hellbenders	No. individuals	Captures/ trap	Captures/ trap night
First Sampling Period							
Nov 2007	50	100	6	2	4	0.08	0.04
Dec 2007	50	100	6	3	3	0.06	0.03
Jan 2008	50	100	5	1	2	0.04	0.02
Feb 2008*	-	-	-	-	-	-	-
Mar 2008	50	100	7	1	2	0.04	0.02
Apr 2008	50	100	4	3	5	0.10	0.05
May 2008	50	100	5	1	1	0.02	0.01
Second Sampling Period							
Nov 2008	48	96	3	2	4	0.08	0.04
Dec 2008	100	200	5	4	5	0.05	0.03
Mar 2009	125	250	14	8	17	0.14	0.07
Apr 2009	100	200	6	4	6	0.06	0.03
May 2009	25	50	2	2	2	0.08	0.04
Total	698	1396	63	31	51		

* Unable to trap in February 2008 due to high river levels.

TABLE 2. Site measurements for individual trap sets and individual trapping sites from November 2007 through May 2009 in the Gasconade River, Missouri.

Variables	N	Mean ± SD	Range	Hellbender presence ± SE	Hellbender absence ± SE
Depth of Trap Set (m)	698	1.8 ± 0.7	0.4-4.5	2.1 ± 0.09*	1.8 ± 0.03
Distance between Traps (m)	635	32.1 ± 18.2	1.4–114.0	30.3 ± 2.8	32.1 ± 0.8
Length of Sampling Sites (m)	63	485 ± 351	60–1,966	524.7 ± 65.4	451.7 ± 60.4
Water Temperature (°C)	63	10.4 ± 5.2	1.5–21.3	10.1 ± 1.0	10.7 ± 0.9
Water Flow (m/sec)	63	0.32 ± 0.22	0.01–0.93	0.27 ± 0.04	0.36 ± 0.04
Secchi Depth (m)	63	1.8 ± 0.8	0.5–3.4	2.1 ± 0.2	1.7 ± 0.1

*Indicates significant difference.

Mean, SD, and range of the site and trap-set parameters can be found in Table 2. Student's *t*-tests results found no significant patterns for distance between traps, length of sampling site, water temperature, water flow, and Secchi depth for the presence or absence of *C. a. alleganiensis* (Table 2). Although average water temperature at sites with and without *C. a. alleganiensis* was similar, 53% of captures occurred within a range of 10–13°C (Fig. 3). Traps with *C. a. alleganiensis* present were on average significantly deeper (t = -2.33, P = 0.02; Table 2).

Discussion.—Considerable information was gained regarding the distribution and relative abundance of *C. a. alleganiensis* in the Gasconade River, Missouri, through trapping in deep-water habitat along river bluffs that were not conducive to traditional snorkel diving methods. *Cryptobranchus a. alleganiensis*, a declining Missouri state endangered species (Briggler et al. 2007; NatureServe 2011), were detected at 31 undocumented sites with 51 individuals captured (Table 1). Wheeler et al. (2003) only captured 33 *C. a. alleganiensis* on the upper sections of the Gasconade River via snorkel diving. The deep water, river bluff sites we sampled may contribute significantly to the long-term persistence of this species in the Gasconade River. However, Wheeler et al. (2003) and our data show a lack of young age classes. We only captured adult *C. a. alleganiensis* estimated to be between 15 and 30 years of age (Taber et al. 1975). This lack of young age classes is likely due to the absence of these individuals in the population compared to historical sampling (Wheeler et al. 2003). Our trap mesh size was definitely narrow enough to capture small *C. a. alleganiensis*, and our traps did capture the smaller *N. maculosus* (TL range 22.5–31.0 cm). Additionally, trapping by Foster et al. (2008) captured mainly adult *C. a. alleganiensis* (> 40 cm TL), but 20% of captures were smaller animals even with the same mesh size as our study.

There have only been a few published accounts of researchers surveying *C. a. alleganiensis* via use of baited traps with varying success (Foster et al. 2008; Kern 1984; Soule and Lindberg 1994). Foster et al. (2008) was the first to report capture efficiency for *C. a. alleganiensis* by using wire traps. Our capture efficiency (ranging from 0.01–0.07 captures/trap night) was similar to Foster et al. (2008; ranging from 0.01–0.10 captures/trap night) and was highly variable among sites and among months (Table 1). The wire-mesh traps used in this study were of the same design and

size as Foster et al. (2008), but we modified the trap by making it collapsible and adding an entrance funnel at each end of the trap. The collapsible wire-mesh traps (1 capture/12.6 traps) were almost twice as efficient at capturing *C. a. alleganiensis* compared to collapsible net-mesh traps (1 capture/23.6 traps). It is unknown why *C. a. alleganiensis* would more likely be captured in the wire-mesh traps. It might be that the individuals can more easily escape the net-mesh trap, that the animals like the increased firm footing of the wire-mesh trap when entering the trap, or that the wire-mesh traps are more stable on the river bottom due to its heavier weight (wire-mesh traps = 2.08 kg compared to 0.91 kg for net-mesh traps). Even though the net-mesh trap can be purchased and modified accordingly with reduced labor cost, the significant increase in capture efficiency for the wire-mesh trap is definitely worth the effort to construct. Plus, the wire-mesh traps are more durable compared to the net-mesh traps; several of the net-mesh traps were damaged or destroyed by river debris.

Based upon reports of local anglers capturing *C. a. alleganiensis* in the winter on hook-and-line in the Gasconade River (JTB, pers. obs.) and our pilot data, we concluded that trapping during the cooler months was likely optimal for success. Trapping success was highest post-breeding of the species in November/December and again in March/April (Table 1). We were unsuccessful in capturing *C. a. alleganiensis* in the warmer months during our pilot testing on the Gasconade River unlike Foster et al.'s (2008) success in New York streams. In addition, we experimented with later spring and early summer trapping at sites known to support higher densities of *C. alleganiensis* on the Big Piney River and North Fork of the White River with no success. In Indiana, Kern (1984) showed seasonal variation in feeding activity with most *C. a. alleganiensis* containing food items in their stomach from January through April and very low percentage during summer and breeding season. This pattern is similar to what Peterson et al. (1989) observed in Missouri, and our ability to capture animals during the colder weather months. Also, high water conditions from January to May made sampling somewhat difficult and also might have influenced capture rates. November to mid-December might be the optimal time to sample due to more stable water levels and increase foraging due to post-breeding. An additional consideration, however, is that November is also a time when male *C. alleganiensis* are guarding nests.

There is no doubt that *C. a. alleganiensis* are attracted to baited traps based upon our success and the success of Foster et al. (2008), as well as the keen olfactory senses that *C. a. alleganiensis* are believed to possess (Gall and Mathis 2010; Nickerson and Mays 1973), but the majority of the diet reported for *C. a. alleganiensis* is primarily crayfish with occasional fish (Kern 1984; Nickerson and Mays 1973; Peterson et al. 1989). During our pilot data collection, we experimented with crayfish baits with no success. The lower Gasconade River appears to have lower numbers of crayfish compared to most other rivers inhabited by *C. a. alleganiensis* in Missouri (JTB, pers. obs.), and therefore, consumption of fish would be strongly related to availability compared to other prey items. *Cryptobranchus a. alleganiensis* captured during this study regurgitated native fish species on several occasions. Although *C. a. alleganiensis* have low metabolism and do not require frequent feeding (Nickerson and Krysko 2003; Nickerson and Mays 1973), limited preferred food resources in these deeper water habitats may contribute to trapping success because these animals are more likely forced to seek prey than to wait for prey to approach them.

Monthly captures may be influenced by food availability and/or reproductive season as discussed above, but water temperature likely plays an important role. The majority of the *C. a. alleganiensis* captures occurred at water temperatures < 14°C (Fig. 3). No *C. a. alleganiensis* were captured below 3°C or above 20°C. We believe that temperature likely affects trapping rates due to concerns such as decreased animal movements during extreme cold water temperatures and increase bait decay during warm water temperatures. Further investigations are needed to determine the role of water temperature, but we would recommend that trapping should not occur at water temperatures below 3°C or above 18°C and ideally between 8–16°C.

Cryptobranchus a. alleganiensis were significantly more likely to be captured in deeper trap sets in this study. Foster et al. (2008) showed that trapping appeared to be most successful at depths between 0.75 and 1.0 m; however, their study site was not as deep as the Gasconade River. Our data show *C. a. alleganiensis* were unlikely to be captured along shallow banks and in the deepest trap sets (> 4 m). These results are more likely an artifact of the preferred habitat of cover rock with the optimal river conditions (i.e., flow, water temperature, etc.) along these bluff banks than the actual depth of the water.

Compared to other sampling methods, trapping causes minimal habitat disturbance especially compared to turning rocks during snorkeling surveys (Browne et al. 2011; Foster et al. 2008). In addition, trapping is likely the most successful technique to use in deep water conditions, especially those affected by turbidity. Advantages to sampling in the colder months are that traps are less likely to be disturbed by river users (i.e., fewer individuals on river) and the by-catch mortality (e.g., turtles and fish) are almost nonexistent in colder water (Barko et al. 2004; Fratto et al. 2008). Trapping may not work for all river conditions throughout the range of the species since trapping success is likely influenced by stream characteristics (e.g., water depth, water temperature, etc.) food availability, *C. a. alleganiensis* density, and time of year (e.g., breeding). However, based upon our successes, trapping should be considered in larger, deeper, turbid rivers to locate additional populations of this declining species rangewide.

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Evaluating a Method for Non-destructively Obtaining Small Volumes of Blood from Gilled Amphibians

In many herpetological research projects, researchers incorporate measures of immunity, stress or other aspects of physiology that necessitate obtaining blood samples from their amphibian subjects. There are a number of proven techniques for sampling blood from amphibians (Baranowski-Smith and Smith 1983; Gentz 2007; Tapley et al. 2011; Thrall 2004), although some may only be useful with large species. For the smaller species (which have limited blood volume), the animals sometimes must be sacrificed. There are certain physiological measures though, that only require minor amounts of blood (less than 10 µl), such as investigations involving blood smear analysis, or molecular assays. For such projects, it would be beneficial to have a method for non-destructively obtaining blood so that the animals could be returned to their natal environment following the study, or so that more than one sample could be obtained from individual amphibians.

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If larval or paedogenic salamanders are the subjects under study, it might be possible to obtain blood samples from their external gills, where blood flows continuously as part of normal respiration. In fact, such methods are already established for small fish (Watson et al. 1989); by making a minor incision in the gill filaments on one side of the animal, small amounts of blood can be siphoned with a microcapillary tube. The goal of the current project was to modify this same procedure for use with gilled amphibians, and evaluate its effectiveness for herpetological research. Here we report the results of an experiment where a collection of gilled salamanders (a paedogenic species) were sampled in the above manner, with and without anesthesia, to determine if the procedure affects survival in the days following the sampling.

Salamander collection and housing.—On 3 March 2011, we captured 34 aquatic, paedogenic Mole Salamanders (*Ambystoma talpoideum*), with dipnets from an impounded pond near the University of Georgia campus (Athens, Georgia, USA). This species is routinely used for studies in our lab (Davis and Maerz 2008a, b; Davis and Maerz 2010) and they are common

in northeast Georgia, especially in permanent water bodies. All salamanders were transported to the laboratory in a cooler of pond water, where they were placed individually into 1.9-L plastic containers filled with dechlorinated tap water and with one to two leaves (also collected from the source pond) for refugia. All containers were placed in an environment chamber that was set to a 12 h day length and at a constant temperature of 15°C. Salamanders were left in the chamber for 24 h before undergoing the blood sampling procedure (below).

Blood sampling.—Salamanders were randomly divided into three groups. Salamanders in Group 1 (N = 13) were first anesthetized via immersion in a solution of Orajel (20% benzocaine) following Cecala et al. (2007). Once immobile, each was blotted dry and weighed with an electronic balance, then lightly wrapped in a paper towel (to aid in handling), leaving the head and gills exposed. Then, using a sterilized pair of scissors, the distal end of one gill frond (Fig. 1) was cut off, and a heparinized microcapillary tube used to siphon the blood that welled from the severed gill. Salamanders in Group 2 (N = 13) underwent the same procedures (weighing, blood sampling), only without anesthesia. For salamanders in groups 1 and 2 we also noted the volume of blood obtained in the microcapillary tubes. The remaining salamanders (N = 8) were weighed and were subjected to the same degree of handling, but were not sampled. These salamanders served as a sham, or control group. All salamanders were returned to their respective containers (and placed in the environment chamber) following the processing and were monitored daily thereafter for four days. After four days, the salamanders were re-weighed, then released into their original pond.

Data analysis.—We first examined whether the volume of blood obtained with this procedure differed between anesthetized and non-anesthetized salamanders, using a Student's t-test. Next, we examined the degree of weight change for salamanders in each group using paired t-tests. Finally, we had intended to test for differences in survival rates across the three treatment groups, although there was no mortality in any group (below). Tests were performed using Statistica 6.1 software package (Statistica 2003).

Effects of the procedure.—No salamanders died in the experimental or the control groups during the four-day monitoring period. We also did not observe any atypical behavior in the salamanders that had been bled, during the post-procedure monitoring. The severed gills of experimental salamanders appeared to have healed by day 4, but we saw no evidence of regeneration. When we examined the change in weight from the day of bleeding to the last day, we found no significant weight change in either the Group 1 ($t = 1.22$, $df = 12$, $p = 0.243$) or Group 2 salamanders ($t = 0.311$, $df = 12$, $p = 0.760$). Collectively, these results all indicate that this blood-sampling procedure has minimal outward effects on salamanders.

Effectiveness of the procedure.—The average volume of blood obtained in both bleeding groups was 3.2 µl (standard deviation = 3.1 µl). Interestingly, we obtained significantly more blood from anesthetized salamanders than from non-anesthetized individuals ($t = -2.14$, $df = 24$, $p = 0.043$); the average for anesthetized salamanders was 4.4 µl while for non-anesthetized salamanders it was 1.9 µl. Part of this difference may stem from our inability to draw blood from one non-anesthetized salamander that thrashed during the procedure and made it difficult to place and hold the capillary tube on the gills. In fact, all non-anesthetized salamanders wiggled somewhat during the procedure, making it challenging (but not impossible) to siphon the blood. On the other hand, we cannot rule out the alternative possibility that more blood flowed from the anesthetized individuals because of some "relaxation" effect of the anesthesia on the animals' blood vessels.

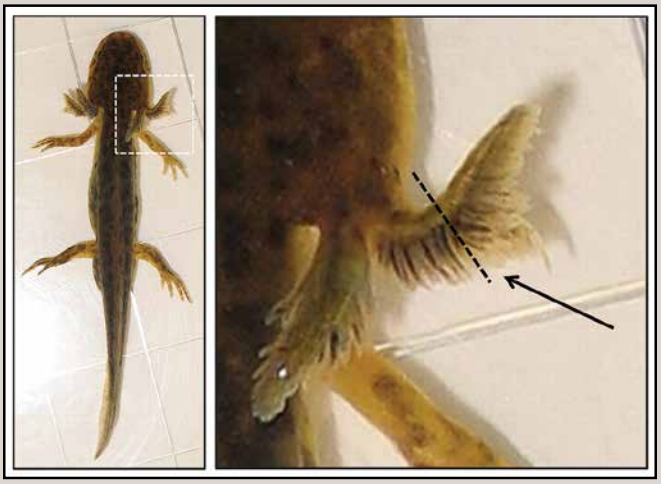


FIG. 1. Paedogenic *Ambystoma talpoideum* with close-up of gill filaments where blood was obtained. The distal tip of one filament (arrow) was severed with sterile scissors. Blood that welled from the cut was siphoned off with a heparinized microcapillary tube.

It is important to point out that the overall volume of blood yielded by this procedure (~5 µl or 0.005 g) would constitute less than 1% of the body weight of *A. talpoideum* (the average weight of *A. talpoideum* in this study was 3.0 g ± 0.6 g SD) and of other similarly-sized salamanders, which is a criterion recommended by Wright and Whitaker (2001). Similarly-sized species (with gills) would include paedogenic newts (family Salamandridae), paedogenic Tiger Salamanders (*A. tigrinum*), and Axolotls (*A. mexicanum*). Late-stage, gilled larvae of other species could also be used if they weighed more than 0.5 g.

The small amount of blood obtained may also limit the suitability of this technique for research purposes (because much larger volumes are needed for many clinical tests). Nevertheless, this volume would indeed be sufficient to conduct certain hematological investigations where only blood smears are needed (e.g., Davis and Maerz 2009; Davis and Maerz 2011; Davis and Milanovich 2010). With practice, it is possible to make (small) blood smears with this amount of blood (AKD, pers. obs.), which can be used to examine blood cells or search for intra- or extra-cellular parasites (e.g., Davis and Cecala 2010; Desser 2001; McAllister et al. 1993). Therefore, although the volume of blood obtained is small, this procedure appears to be useful for non-destructively collecting blood from gilled amphibians, and should serve a variety of purposes to researchers and herpetologists.

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The Use of Photo-Identification as a Means of Identifying Western Painted Turtles (*Chrysemys picta bellii*) in Long-Term Demographic Studies

Critical to any successful long-term demographic study is the ability to accurately identify subjects during recapture events. Previous mark-recapture studies involving freshwater turtles have employed a number of various mutilation techniques such as toe clipping, notching of the shells, or the use of PIT tags. However, the use of mutilation techniques may present a potential risk to the turtles as notching or filing of the shell can cause fracture or lead to potential infections, particularly in hatchling and juvenile turtles (Cagle 1939). Additionally, there are ethical concerns when marking rare or endangered species. While the use of PIT tags can reduce the risk of injury, PIT tags cannot be used on hatchling or small juvenile turtles due to body size limitations (Buhlmann and Tuberville 1998).

The use of photo-identification to identify individuals offers several advantages over other methods in that it is less invasive, eliminates the risk of injury or infection, and can be used to accurately identify hatchlings and juveniles on subsequent recaptures. Further, a photographic data base could have long-term applications that could be shared among researchers. However, in order for photo-identification to be reliable, the meristic character used for identification must be unique to each individual and must remain relatively unchanged over time. For example, plastron pigmentation in Midland Painted Turtles (*Chysemys picta marginata*) has been shown to change in response to environmental variables such as substrate color (Rowe et al. 2006a, b, 2009). Juvenile pigmentation patterns may change as individuals mature, as in the case of plastron markings in juvenile Wood Turtles *Glyptemys insculpta* (Cowin and Cebek 2006). However, photo-identification has been successfully used to identify individuals in populations of Spotted Salamanders (*Ambystoma maculatum*, Loafman 1991), Daruma Pond Frogs (*Rana porosa brevipoda*, Kurashina et al. 2003), Leatherback Turtles (*Dermochelys coriacea*, McDonald et al. 1996), and Loggerhead Sea Turtles (*Caretta caretta*, Schofield et al. 2008). The plastron markings of some species of turtles are unique to individuals and as such may provide an accurate means of identifying individuals during demographic studies. Janzen et al. (2000a; 2000b) used plastron marking to successfully identify hatchling and juvenile Red-eared Sliders (*Trachemys scripta elegans*). More recently, Tichy and Kintrova (2010) demonstrated that plastron morphology could be used to accurately identify individuals in populations of European Tortoises *Testudo graeca ibera*. To date, the use of photo-identification to identify individuals has not been employed in any long-term demographic studies on Painted Turtles (*Chrysemys picta*). The Western Painted Turtle (*C. p. bellii*) possesses expansive and distinct plastron markings that make it an ideal candidate for the evaluation of photo-identification as an individual recognition technique. The goal of the present study was to determine if the use of plastron markings on *C. p. bellii* could provide a non-invasive method for accurately identifying

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individuals during long-term demographic studies. To address this, we used both experienced field observers and untrained volunteers to identify individuals using initial and recapture photographs maintained in a photographic data base.

We captured and photographed 371 Western Painted Turtles from Chapman Lake in Durango, Colorado, USA, between April 1995 and August 2012. Each individual was assigned a unique ID number that was placed on the plastron with an adhesive label or a non-toxic, non-permanent marker that was later removed after photographing the plastron. Plastrons were photographed using a Canon 35mm SLR with a 52mm macro lens. Each plastron was photographed under natural lighting at a distance of 0.2–0.4 m depending on the size of the plastron in order to fill the entire field of view. Photographs were later scanned into digital format where they were cropped and edited for contrast using Adobe Lightroom (v 2.0). Plastron photographs were taken during every capture event and a catalog of 100 × 150 mm color prints was maintained for each individual.

To ensure accurate identification during recapture events and to verify that the plastron marks remained unchanged over time, it was necessary to use additional means to positively identify individuals during recaptures, such as notches filed in the marginal scutes, damaged or deformed shells, and carapace scute anomalies such as supernumerary scutes. Of the 371 turtles that were photographed from our study area, 15 turtles (seven males and eight females) had distinct physical features that allowed verification of identity in addition to the plastron markings.

We assessed the validity of photo-identification using three experienced field observers and 15 untrained volunteers. Experienced observers were trained on how to use photo-identification and had a minimum of 10 hours in the field using this technique. The untrained observers had no prior experience with painted turtles or the use of photo-identification. For each observer, we randomly selected a subset of 10 turtles from the set of all photographs (15 initial photographs and 65 recapture photographs). Age of turtles within each subset varied from 1–19 years (as estimated from growth annuli and original capture dates) and the time between the initial photograph and the subsequent recapture photograph varied from 3–16 years. Midline plastron length (PL) for turtles ranged from 52–214 mm. Photos that showed shell deformities or notches were not included in any of the subsets. Each observer was asked to identify the 10 turtles in the subset by matching a recapture photograph with the initial photograph from a set of 20 photographs, 10 of which contained turtles not included in the recapture subset. A new subset of photographs was used for each volunteer. Observers were not timed, but most were able to complete the task in less than 10 minutes.

The overall success rate for the three experienced field observers in correctly identifying individuals was 100%. The overall success rate for untrained observers was 95.3%. Nine of the untrained observers correctly identified all 10 turtles from recapture photographs. Of the remaining observers, five correctly identified nine out of 10 and one correctly identified eight of 10. Juveniles proved to be more difficult to identify as the pigmentation patterns are not as fully developed as in older individuals. However, our experience with this technique has indicated that distinct plastron markings of juvenile western painted turtles older than one year of age (one growth season) do not change over time and in fact, become more defined with age (Fig. 1). The overall success rate achieved in these trials suggests that photo-identification can be used reliably for this subspecies of painted turtle.

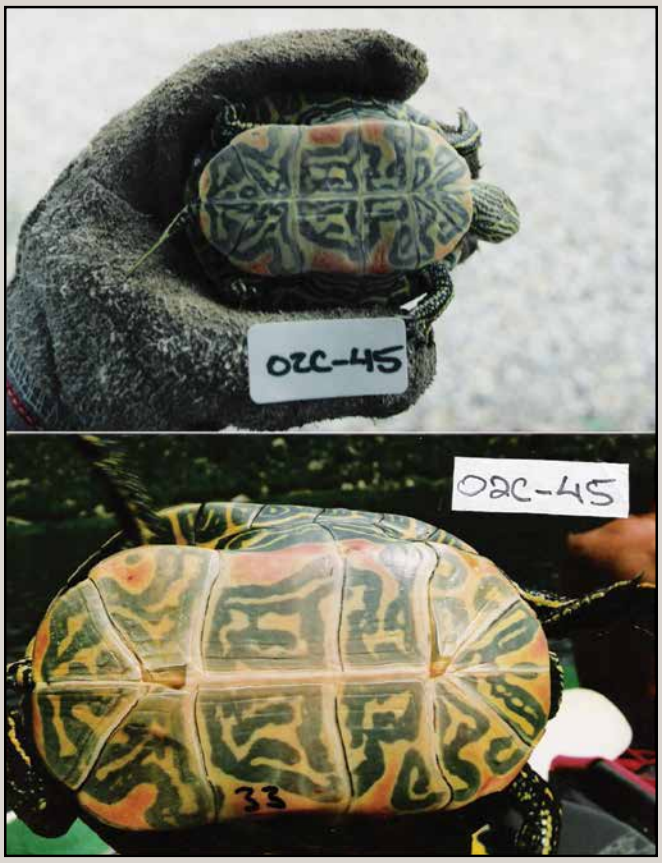


FIG. 1. Two-year old juvenile photographed on 1 August 2002 (top) and at subsequent recapture on 27 July 2007 (bottom).

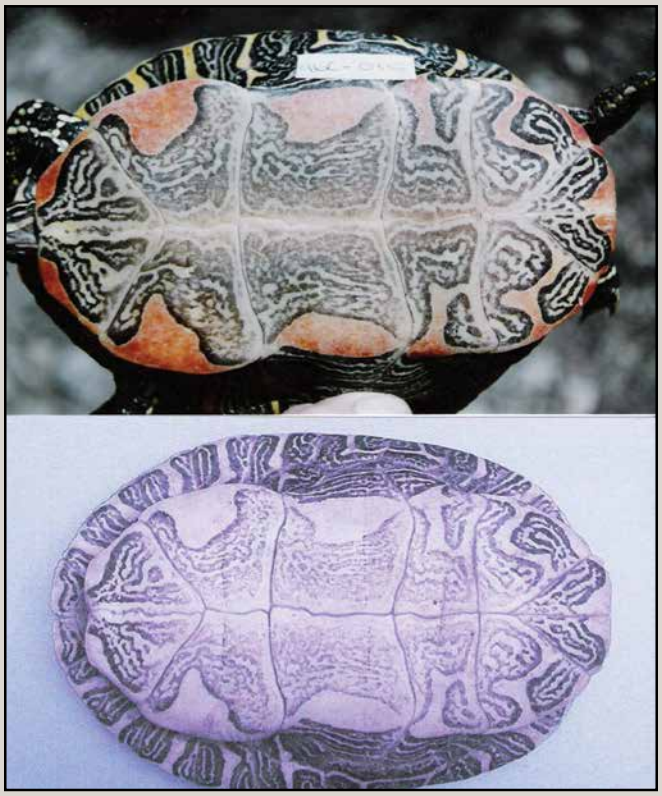


FIG. 2. Adult male photographed on 11 May 1996 (top) and upon found being dead on 26 May 2002 (bottom).

In one case, we were able to compare plastron markings on an individual that was marked in 1996 and had died sometime between 2001 and 2002 by matching the remains of the plastron with an earlier photograph. While the characteristic orange and yellow pigmentation had faded from the plastron, the distinct background markings remained, making identification possible (Fig. 2). We noted one potential problem when using this technique in late summer when the turtles were shedding their scutes: during this time the markings of the plastron became noticeably hazy and minute details of the plastron markings were sometimes obscured. Ideally, sampling events should be avoided during the shed cycle as the quality of photographs may be adversely affected.

Acknowledgments.—We are indebted to the Whitley family for allowing us to collect on their property. We also wish to thank T. Whitley and K. Cooley for their invaluable help in the field. All turtles were caught and released in accordance with the Colorado Department of Wildlife scientific collecting permits and all research protocols were conducted under the Colorado State University and Regis University IACUC guidelines.

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Straight from the Ungulate's Mouth: A Technique for Protecting Data-loggers

The advent of passive acoustic monitoring has vastly improved our ability to collect data on wildlife species that vocalize. Studies that examine a wide variety of taxa have taken advantage of these data collection devices to answer questions of species presence, community diversity, and the effects of sound on wildlife (Goyette et al. 2011; Milne et al. 2004; Shearin et al. 2012). These systems have been used in a wide variety of conditions from arctic wetlands to arid deserts, to forested systems and even in urban settings. Each of these settings comes with its own problems and pitfalls. In this study, we describe some of the problems and solutions for protecting passive recording devices in rangeland systems lacking vertical structure.

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We used passive recording devices in northeastern New Mexico, USA, to monitor amphibian communities in the southern High Plains, a semi-arid grassland dominated by agriculture and rangeland. In this region, ephemeral surface water is located in playa wetlands and stream drainages crossing the grasslands. Earthen cattle tanks and artificial impoundments associated with the river serve as permanent water sources.

Heavy monsoon rains are typical during the spring and summer in the plains, and amphibians residing here have developed an explosive-breeding style to take full advantage of novel breeding habitat. Because of the remoteness of the system and haphazardness of rain events, audio data loggers are useful in allowing us to sample amphibian breeding choruses when we are not available to conduct manual call surveys. These devices are typically attached to trees or other vertical surfaces; however, due to the lack of vertical structure in these grasslands we needed to attach the data loggers to posts. Deploying devices on the ground was not an option due to the risk of water damage from submergence during monsoon rains.

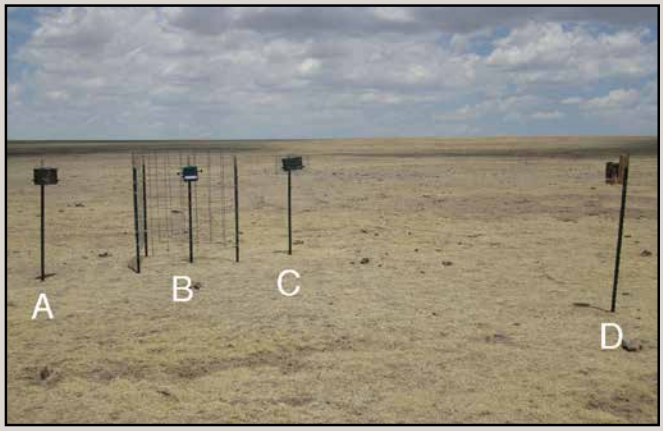


FIG. 1. Experimental design in New Mexico in 2011. A) Control, B) fence, and C) box treatments; D) game camera.

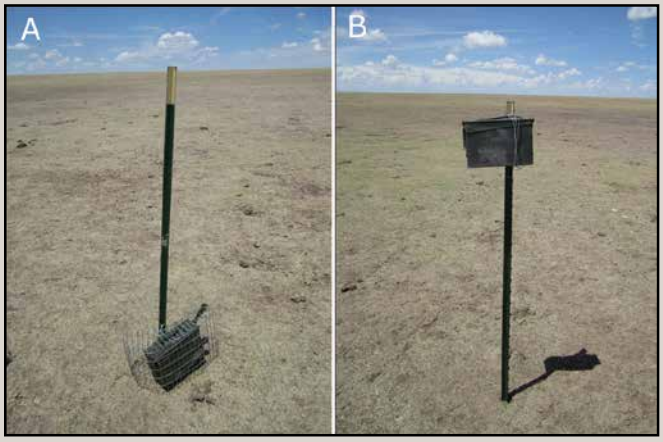


FIG. 2. Treatments after 7 days exposure to ungulates in New Mexico in 2011. A) Box treatment dislodged and the left microphone removed; B) control with both microphones removed.

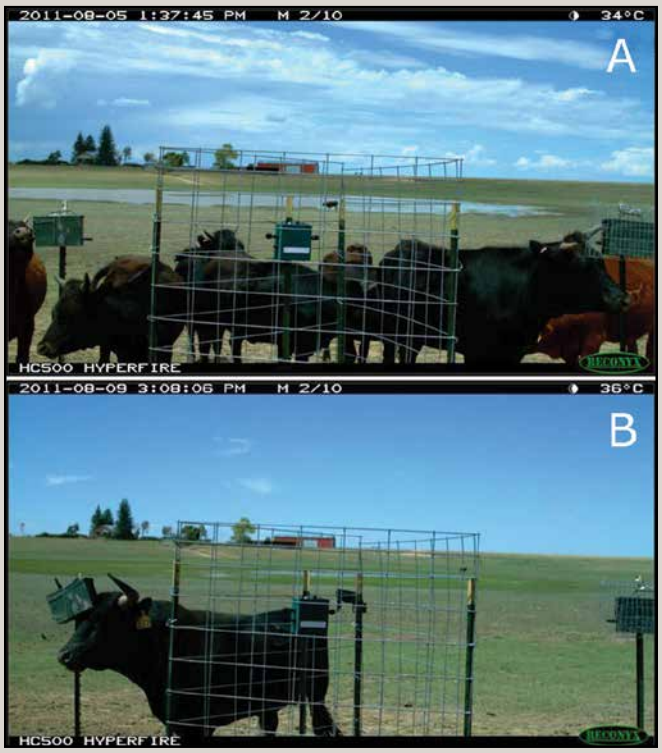


FIG. 3. Pictures from game cameras showing ungulates destroying devices in New Mexico in 2011. A) Cow consuming microphone of control treatment; B) cow rubbing on device and post of control treatment.

Ungulates can interfere with field equipment through several mechanisms. Researchers in various systems worldwide have had problems with these animals ingesting different types of plastic (Provenza 1996; Ramaswamy and Sharma 2010; KLG, unpubl. data, A. Berentsen pers. comm.). Ungulates also tend to rub against objects, and in landscapes such as the southern High Plains that lack vertical structure, they can significantly damage equipment secured to these structures.

During our initial use of the audio data loggers in 2011, we deployed 10 devices. We attached each device with screws to the top of two, 1.5-m wooden posts and placed them at different playa wetlands. After 7 days, 7 of the 10 devices had either had the microphones consumed or had the stand knocked down. This led us to design the following study, evaluating the degree of protection needed to guard the Wildlife Acoustics Song Meter SM2+ Recorder from ungulate depredation. This work will provide other researchers with suggestions for the level of protection needed in a grassland system.

Methods. —This study was conducted on privately owned rangeland in the southern High Plains in northeastern New Mexico during 2011. We evaluated the following treatments: control (no protection), box treatment (protection for the logger only), and fence treatment (protection for the logger and the post). Because the initial goal of the project was to evaluate amphibian breeding choruses, each device was deployed at the edge of a playa wetland. We had seven replicates (each with a different playa wetland and different landowner) with all three treatments represented within each replicate.

Because audio data loggers can be expensive, we created model devices by attaching foam balls with plastic stems (to simulate microphones) to either side of an ammunition box. In all treatments we attached the passive recording device with fencing wire to the top of a 1.8 m t-post. The control treatment (Fig. 1A) had no protection. To create the box treatment (Fig. 1B) we devised a rectangular exclosure (48.3 cm × 27.9 cm × 12.7 cm) out of mesh (5 cm × 2.5 cm) hardware cloth, placed it over the device, and secured the box using fencing wire. We created the fence treatment (Fig. 1C) by constructing a triangular fence, constructed from cattle panels (1.8 m long by 2.1 m tall) and 3 T-posts, around the data-logger. Cattle panels are rectangular sections of rigid welded fencing that do not need to be stretched between fence posts (Fig. 1, 2). These three treatments represent a continuum of physical and financial costs, from fewest to most resources needed.

We spaced the three treatments approximately 1 m apart next to the playa and positioned a motion sensitive game camera (HyperFire Semi Covert IR; Reconyx, Inc.; Holmen, Wisconsin) across from them (Fig. 1D), with all three treatments within its field of view. We left the treatments up for 7 days and upon returning, evaluated the damage by recording levels of destruction of the mock equipment. The protection was considered unsuccessful if either the microphones were destroyed/removed (Figs. 2a, 3a) or the audio data logger was dislodged from the post (Figs. 2b, 3b). We analyzed the data using a contingency table and Kendall's tau-b (Agresti 1990; SPSS 2011).

Results.—We found that the three exclosure types were significantly different from each other ($\tau = 12.6$, $p < 0.0005$) in their ability to protect equipment from ungulate damage. Specifically, we found that the fence exclosure protected the data-loggers in all replicates while 57% in the box treatments and 0% in the control treatments were protected.

Discussion.—Our study documented clear evidence that cattle fence exclosures are the most effective at protecting passive recording devices from ungulates when compared to box exclosures and no exclosures. Fence exclosures kept ungulates from rubbing against the post and protected the microphones from consumption. Others have used exclosures to protect young trees from browsing (e.g., Kota and Bartos 2010), but we have found no published literature on the protection of passive recording devices.

Fences provided the most protection for the passive recording devices for two reasons. First, a large amount of force can be applied to a triangular fence design without it being destroyed. Furthermore, the width and gauge of fencing we used provided strength, but flexibility. Second, the devices were placed within the fence, and were out of reach from ungulates. An added benefit of our fence treatment is its mobility and reusability. Each fence treatment was assembled by one person in 30 minutes, and disassembled in 10 minutes. We recommend this protection technique for studies requiring equipment placement in a conspicuous location where ungulates are present. We recommend the use of fences approximately 0.3 m taller than the shoulder height of tallest damage-prone ungulate in the region. Choosing the appropriate protection method for field equipment is generally constrained by time and funding; however, when using costly equipment such as passive recording devices, it is worth the extra expense to protect them in grassland systems.

Acknowledgments.—We thank New Mexico Game and Fish Share with Wildlife Program and the Department of Natural Resources Management at Texas Tech University for supporting this research. We also thank the volunteers on this project including R. Ramesh, L. Arvidson, J. Quigley, and M. McConnell, as well as the private landowners who graciously gave us permission to use their land and cattle. This is manuscript number T-9-1238, College of Agricultural Sciences and Natural Resources, Texas Tech University, Lubbock, Texas.

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The Use of Gastric Transmitters to Locate Nests and Study Movement Patterns of Breeding Male Ozark Hellbenders (*Cryptobranchus alleganiensis bishopi*)

Hellbenders (*Cryptobranchus alleganiensis*) are large fully aquatic salamanders inhabiting rivers and streams of the eastern United States. Two subspecies occur in the Ozark Highlands of Missouri: the Ozark (*C. a. bishopi*) and Eastern Hellbender (*C. a. alleganiensis*). Throughout most of the year, Hellbenders are solitary animals moving among large rocks or bedrock crevices for foraging and shelter (Peterson and Wilkinson 1996; Smith 1907). However, during the breeding season (September–October), male Hellbenders establish nesting sites under specific rocks and aggressively defend nests from other males (Alexander 1927). Males occupying a nesting site guide females into the cavity in an attempt to secure a mating (Petranka 1998). Females deposit a clutch of 200 to > 400 eggs, and males fertilize the eggs externally (Nickerson and Mays 1973; Phillips and Humphries 2005; Smith 1907). After egg deposition, males chase the females out of the nesting cavity and actively guard the eggs and larvae (Petranka 1998).

Both subspecies of Hellbenders have experienced marked population declines in Missouri (Briggler et al. 2007; Wheeler et al. 2003) and are considered critically-imperiled and state-endangered (MONHP 2012). In November 2011, *C. a. bishopi* was added to the federal endangered species list (USFWS 2011).

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Due to the severe population declines, there is a vital need to collect eggs from the wild for captive propagation efforts and use of young for research projects to address the decline. Although few nests have been found in the wild in Missouri (Dundee and Dundee 1965; Nickerson and Tohulka 1986; Unger and Mathis 2013), the nest-guarding behavior of male Hellbenders provides an ideal opportunity to track their movements as a technique to locate egg clutches.

Radio-telemetry is a technique widely used to monitor animal movements across a variety of taxonomic groups and habitat types. The study of movements and dispersal in small organisms such as salamanders has become more feasible given the technological advances in the size, weight, and battery life of transmitters. External and surgically-implanted internal transmitters have been used to track various species of salamanders including ambystomatids (Faccio 2003; Madison 1997; Madison and Farrand 1998; Rittenhouse and Semlitsch 2006; Steen et al. 2006; Trenham 2001), cryptobranchids (Ball 2001; Blais 1996; Bodinof et al. 2012; Burgmeier et al. 2011; Coatney 1982; Gates et al. 1985; Okada et al. 2006; Stouffer et al. 1983; Wheeler 2007; Zheng 2006), and salamandrids (Jehle and Arntzen 2000). Although data on the utility of gastric implant transmitters are more limited, they appear to be a useful tool for tracking salamander movements on a short-term basis (Blais 1996; Coatney 1982; Schabetsberger et al. 2004).

The purpose of this study was to use gastric implant transmitters to radio-track adult male Ozark Hellbenders (*C. a. bishopi*) during the breeding season to understand their movement patterns, but more importantly, to locate egg clutches in the wild. Gastric implants were selected over external or surgical implants due to the increased risk of impairment these latter attachment methods pose to the animals (i.e., anesthesia overdose, prolonged recovery, skin abrasions or tears, infection, or entanglement) and for ease of implantation at the study site.

Materials and methods.—Movements of adult male Ozark Hellbenders were tracked on the lower North Fork of the White River in southern Missouri from 28 September–8 November 2006 and 21 September–1 November 2007. The study site was a small 0.17-ha area of habitat characterized by shallow, moderately-flowing water, and a substrate comprised of numerous chunk rocks, boulders, and gravel. Animals were collected by turning suitable cover rocks, via snorkeling, and then replaced to their original position. Individual Hellbender locations were temporarily marked with numbered floats, and GPS coordinates, water depth, rock measurements (length, width, height), and substrate composition were recorded. A portable digital scale (Ohaus) and tape measure mounted in 10 cm diameter PVC pipe cut longitudinally in half were used to obtain mass (± 0.1 g), snout–vent length (SVL ± 0.5 cm), and total length (TL ± 0.5 cm) of each male, and PIT tags (Avid) were subcutaneously injected into the dorso-medial surface of the tail. Individual males are hereafter identified using the last three digits of their PIT tag number.

Gastric radio transmitters were purchased from Advanced Telemetry Systems (ATS Model F1010; Isanti, Minnesota) with a marketed battery life of 26 days. Transmitters measured 17 mm × 7 mm (length × diameter) and weighed 1.4 g. Transmitters emitted a pulsed signal with a frequency range of 164–165 MHz (pulse rate: 30 ppm; pulse width: 20 ms) (Table 1). To ensure that transmitters would safely pass through the digestive tract, we selected transmitter size based on the average size of undigested crayfish pinchers that are commonly excreted (pers. obs.). In all cases, transmitters comprised less than 0.6% of body mass (Table 2).

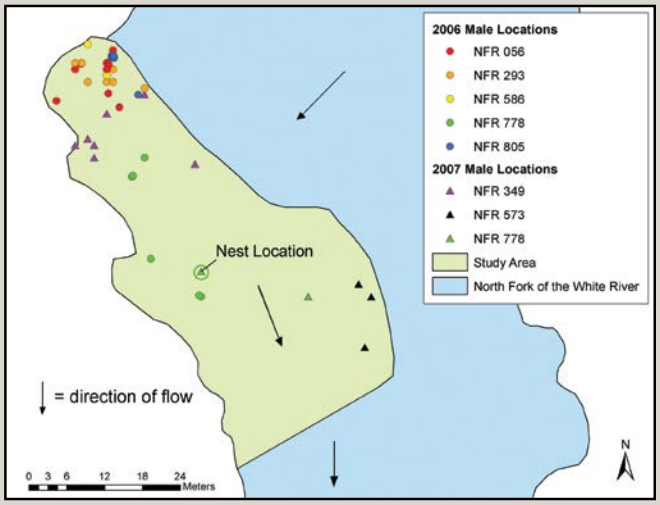


FIG. 1. Weekly locations of individual Ozark Hellbenders (*Cryptobranchus alleganiensis bishopi*) in the North Fork of the White River, 2006 and 2007.

TABLE 1. Transmitter specifications used in tracking male Ozark Hellbenders (*Cryptobranchus alleganiensis bishopi*) in 2006 and 2007 on the North Fork of the White River. Transmitters had a marketed battery life of 26 days, mass of 1.4 g, and frequency between 164.058 to 164.408 MHz. * Indicates individuals that received a second transmitter.

ID Number	Initial signal strength	Actual battery life (days)	Final signal strength
2006			
NFR 056	Strong	41+	V. Weak
NFR 293*	Strong	35–40	None
NFR 293*	Strong	30+	Strong
NFR 586	Moderate	1–6	None
NFR 778	Strong	34+	Moderate
NFR 805	Strong	34+	Moderate
2007			
NFR 349*	Moderate	19–26	None
NFR 349*	Moderate	17+	Weak
NFR 573	Moderate	19–26	None
NFR 778	Moderate	19–26	None

Transmitters were coated with KY Jelly and inserted into a gel-coated disposable oral pill dispenser (11 mm diameter × 115 mm length; Four Paws, No. 01915). The mouth of an animal was gently prodded open using a thin, flat-tipped duckbill clip (Sally Beauty Supply). The pill dispenser was inserted approximately 4 cm into the esophagus and the plunger was depressed to release the transmitter into the esophageal cavity. The entire implantation process from opening the mouth to insertion of the transmitter took less than 10 seconds to complete. Males were then placed into plastic holding containers filled halfway with fresh stream water for a period of one hour to monitor for potential regurgitation of the transmitter, upon which they were returned to their exact capture location.

Seven male Hellbenders were captured on 28 September and 5 October 2006. Five males were selected for gastric implants, and the other two were deemed unsuitable due to small size and

TABLE 2. Morphological measurements of male Ozark Hellbenders (*Cryptobranchus alleganiensis bishopi*) on the North Fork of the White River. *Indicates individuals that received a second transmitter; 1.4 g was subtracted from their mass during the second implant to account for the mass of the first transmitter.

ID number	SVL (cm)	TL (cm)	Initial mass (g)	% Mass (Trans/HB)	No. of days retained	Transmitter status
2006						
NFR 056	24.0	34.5	293.2	0.48	20–27	Discarded
NFR 293*	26.5	40.5	375.6	0.37	15–27	Discarded
NFR 293*	26.5	40.5	348.7	0.40	30+	Retained
NFR 586	28.0	41.0	376.0	0.37	1+	Unknown
NFR 778	26.0	37.5	323.7	0.43	13–20	Discarded
NFR 805	34.0	47.5	668.0	0.20	22–27	Discarded
2007						
NFR 349*	26.0	39.5	324.0	0.43	19+	Unknown
NFR 349*	26.0	39.5	322.0	0.44	22+	Retained
NFR 573	21.5	32.0	258.0	0.54	19+	Unknown
NFR 778	26.5	40.0	407.0	0.34	19+	Unknown

* Discarded = transmitter was no longer in animal but still emitting signal, retained = transmitter still emitting a signal within animal, and unknown = transmitter no longer emitting signal either within animal or on river bottom.

TABLE 3. Movements of male Ozark Hellbenders (*Cryptobranchus alleganiensis bishopi*) between successive weekly relocations on the North Fork of the White River. * Indicates individuals that received a second transmitter.

Male ID	No. of fixes	No. of unique locations	Distance moved (m) Mean	Median	Range
2006					
NFR 056	7	7	6.8	7.0	1.2–10.0
NFR 293*	9	8	4.1	3.8	0.0–11.7
NFR 586	2	2	5.8	5.8	N/A
NFR 778	5	4	6.8	6.8	0.0–10.0
NFR 805	6	2	1.5	0.0	0.0– 7.5
2007					
NFR 349*	8	7	5.7	5.4	0.0–13.6
NFR 573	5	3	2.7	1.4	0.0–8.1
NFR 778	5	2	4.4	0.0	0.0–17.5

poor body condition (i.e., partial limbs with open lesions). The following year, four males were captured on 21 September 2007 of which three received transmitter implants. Because Ozark Hellbenders are critically imperiled, we opted not to increase our sample size until the safety of this technique was verified. Water depth at the study site was typically less than 1 m, but levels fluctuated by 0.5 m during 2006 due to several heavy rain events.

Hellbenders were radio-tracked during the day using either a Lotek (model STR1000) or ATS (model R2000) receiver in conjunction with a two-element folding Yagi antenna or an H-antenna (Telonics). Individuals were relocated one day post-implant to verify that the transmitters were not regurgitated, and then relocated approximately once per week thereafter. Once a transmitter position was located through triangulation, we visually confirmed the presence of the animal with an underwater camera or by carefully lifting the targeted rock. Starting the second week post-implant, each animal was captured to ensure that the transmitter was still retained. The status of the transmitter was recorded, i.e., retained within the animal, discarded (emitting a signal from outside the animal), or unknown (no longer emitting a signal) (Table 2). A GPS reading was also recorded for each location as were measurements of rock size, water depth, and type of substrate.

Locations for each individual were plotted using a Garmin GPS 76 in conjunction with aerial photographs to minimize error; UTM coordinates were adjusted according to known layout of habitat to reduce error to less than 1 m. To quantify movements, we calculated the linear distance between successive relocation points using the measure tool in ArcMap (version 9.1, ESRI Inc., Redlands, California).

Results.—A total of 10 gastric transmitters were implanted in seven individual male Ozark Hellbenders. In the first year, five males were implanted on 28 September and 5 October 2006; one of these males NFR 293 received a second transmitter on 9 October 2006 (Table 1). In the second year, three males were implanted with transmitters on 21 September 2007; one male (NFR 349) received a second transmitter on 10 October 2007 (Table 1). NFR 778 was the only individual implanted with a transmitter during both years of the study.

Mean TL of implanted animals was 39.1 ± 1.6 cm with a mean mass of 378.2 ± 44.8 g (mean ± SE, N = 8) (Table 2). On average, transmitter mass comprised only 0.4% of male body mass. No animals regurgitated the transmitter within the one hour post-implant observation period or discarded the transmitter for at least 13 days post-implant. The possible exception is NFR 586 which lost its transmitter signal within the first week of the study. Five of seven animals maintained the transmitter for a minimum of 19 days with NFR 293 retaining its transmitter over 30 days (Table 2).

During the study period, most of the Hellbenders utilized a small area of the available habitat (Fig. 1). In 2006, there was considerable overlap in habitat use compared to no overlap in 2007 (Fig. 1). Weekly relocations showed that males moved a median distance of 3.8 ± 1.0 m per week (mean ± SE, N = 8), and individual male movements ranged from 0.0–17.5 m per week (Table 3). Although movements were generally small, some males (e.g., NFR 056, 293, 349) moved among locations from week to week whereas other males remained mostly sedentary (e.g., NFR 805, NFR 778 in 2007). NFR 778 tended to move from location

TABLE 4. Mean (± SD) and range (in parentheses) of rocks and water depths used by male Ozark Hellbenders (*Cryptobranchus alleganiensis bishopi*) during the 2006 and 2007 breeding seasons on the North Fork of the White River. * Indicates male was also found in two different bedrock crevices, and no measurements were taken.

Male ID	No. of unique rocks measured	Rock length (cm)	Rock width (cm)	Rock depth (cm)	Water depth (cm)
2006					
NFR 056	6 (40–129)	80.0 ± 29.0 (31–73)	53.5 ± 15.3 (7–38)	18.5 ± 10.9 (52–91)	76.3 ± 14.5
NFR 293	7 (36–78)	56.9 ± 13.1 (23–46)	37.0 ± 8.1 (6–34)	18.7 ± 10.3 (39–101)	74.4 ± 21.5
NFR 586	2 (45–64)	54.5 ± 13.4 (36–38)	37.0 ± 1.4 (8–12)	10.0 ± 2.8 (67–85)	76.0 ± 12.7
NFR 778	2 (73–79)	76.0 ± 4.3 –	56.0 (26–41)	33.5 ± 10.6 –	64.0
NFR 805	2 (51–111)	81.1 ± 42.4 (36–80)	58.0 ± 31.1 (13–35)	24.0 ± 15.6 (39–64)	51.5 ± 17.7
2007					
NFR 349	7 (39–101)	67.4 ± 22.8 (29–63)	44.7 ± 12.8 (9–76)	30.3 ± 22.5 (43–117)	82.6 ± 22.1
NFR 573	1* –	51.0 –	29.0 –	28.0 –	97.0
NFR 778	2 (45–152)	98.5 ± 75.7 (44–104)	74.0 ± 42.4 (13–67)	40.0 ± 38.2 (47–86)	66.5 ± 27.6
Mean	3.6 (36–152)	69.7 ± 27.2 (23–104)	47.3 ± 17.6 (6–76)	24.0 ± 16.7 (39–117)	74.6 ± 19.0

to location in 2006, whereas in 2007 this male only moved once from its initial capture location (Fig. 1; Table 3). The week after implantation, NFR 778 moved to the largest rock (surface area = 15,800 cm^2) used by any Hellbender in the study and stayed under this rock for the next four weeks. This male was found guarding a clutch of eggs on 17 October 2007.

There was considerable variation in rock size (length, width, and depth) used by male Hellbenders, with a mean rock length and width of 69.7 and 47.3 cm respectively (Table 4). However, we found no significant relationship between the size of males and the size of cover rocks (i.e., rock surface area) ($N = 8$, $R^2 = 0.09$, $p = 0.47$). Twenty-nine specific cover rocks and two bedrock crevices were used during the study. Although individual males were observed under the same rocks from week to week (Table 3), there was no overlap observed among males in rock selection during the study period.

Upon the conclusion of this study, three follow-up surveys were conducted between 2008 and 2010 to search for Hellbenders and egg clutches. While no concerted efforts were made to recapture the study animals, these surveys resulted in the recapture of five of the seven animals used in this study. Each animal had gained an average of 140 g. NFR 778 (used in both years of this study) gained 96 g between the 2006 and 2007 breeding season, and was recaptured in 2008 and 2009 where it had gained an additional 142 g.

Discussion.—Radio-telemetry has been used as a valuable tool to obtain information on movement, home range, and behavior in Hellbenders using a variety of different types of transmitter implants including coelomic, subcutaneous, gastric, and external (Ball 2001; Blais 1996; Bodinof et al.et al. 2012; Burgmeier et al. 2011; Coatney 1982; Gates et al. 1985; Wheeler 2007). Gastric implants have been shown to be a suitable method for assessing Hellbender movements on a short-term basis (Blais 1996; Coatney 1982), but the utility of this technique for locating egg clutches has not been previously investigated. Over the course of this study, we tracked seven individual males using gastric implants and determined that these transmitters are a practical, non-invasive method to locate nests and to learn information about male movement patterns during the breeding season.

The size, mass, and battery life of transmitters used in this study were suitable for our short-term tracking needs. Prior studies on Hellbenders indicated retention rates of gastric transmitters between 18-30 days (Coatney 1982) and 16-25 days (Blais 1996). In our study, males retained gastric implants for a minimum of 13 days to over 30 days with the exception of NFR 586 (Table 2). This male had a weak transmitter signal when relocated 24 h after implantation, and no signal could be detected during subsequent relocation attempts. Transmitter failure is a likely explanation for the loss of signal from this male; however, it is also possible the male migrated up- or downstream, was depredated, or was illegally collected from the study area. As of 2012, this animal has not been observed again despite extensive relocation efforts. We determined that a 26-day battery life

expectancy was sufficient for tracking Hellbenders during the active breeding period. While ATS transmitters were used in both years of this study, batteries lasted longer than the marketed 26-day life expectancy in year one, whereas performance was lower and more consistent with life expectancy in year two (Table 1). We also learned that a second gastric implant could be administered to extend tracking time; two animals (NFR 293 and 349) received a second implant with no observable harmful effect.

Transmitter size was selected based upon the size of crayfish pinchers and/or other chitinous parts that would pass through the digestive system of an adult Hellbender. Conversely, Schabetsberger et al. (2004) selected transmitters large enough that they would not pass through the digestive system and were forced to remain in the stomach. It is possible that Hellbenders could regurgitate our transmitters, but we attempted to select a size that was small enough to safely pass through the system without harming the animal (CCAC 2004; HACC 2004) and not so large that the animal would immediately attempt to regurgitate it. Further consideration needs to be taken into account when using gastric transmitters on Eastern Hellbenders which are larger than Ozark Hellbenders (Nickerson and Mays 1973). Blais (1996) implanted 5 g gastric transmitters (20 mm × 10 mm) in two Eastern Hellbenders and had similar retention rates as in our study, with transmitters being excreted after passing through the digestive system. While Blais (1996) did not provide any length data for these two individuals, the mass of his study animals ranged from 545–1318 g. General guidelines recommend that transmitters should be less than 5% of an animal's body mass for studies on amphibians and reptiles (ATS 2012). The Canadian Council on Animal Care and Use has adopted specific guidelines that suggest gastric transmitters not exceed 1% of an animal's body mass because they can alter behavior by mimicking food in the stomach (CCAC 2004). Therefore, mass and size of transmitters should be carefully considered when using gastric implants. Our transmitters were well within the recommended parameters (< 0.6% of body mass).

Only a few telemetry studies provide information on movements in wild Hellbenders (Ball 2001; Blais 1996; Burgmeier et al. 2011; Coatney 1982). Three of these studies either focused on short-term movements outside of the breeding season or on long-term seasonal movement patterns. However, Burgmeier et al. (2011) reported specifically on male movements during the active breeding season. Although our primary objective was not to address diel movements of male Hellbenders, our study does provide insight into movement patterns and habitat utilization during the breeding season. Our data for 2006 demonstrated considerable overlap in habitat used by five males, which is similar to results of other studies (Blais 1996; Coatney 1982; Peterson and Wilkinson 1996). Even though the areal extent of suitable habitat encompassed an area approximately 70 m in length by 25 m in width, four of the five males were clustered in a small 13 m × 14 m area during the entire 2006 study season (Fig. 1). Conversely, in 2007 the three tracked males utilized independent areas of habitat and showed little overlap (Fig. 1); however, we are unsure why this spatial pattern differed from 2006. Considerable variation in movement frequencies was observed among the animals in our study. Some individuals moved between rocks with greater frequency whereas others rarely moved and remained relatively stationary between weekly relocations (Table 3).

Hellbenders are known to use rock and bedrock crevice habitat for shelter and nest sites (Nickerson and Mays 1973; Nickerson and Tohulka 1986; Smith 1907). We found that Ozark Hellbenders utilized large rocks most frequently, and on two occasions, bedrock crevices as shelter sites. Individual males were often found under the same rock from week to week with an average of 3.6 rocks used per male (range: 2–9) during the breeding season. Previous studies reported similar variability in movement patterns and rock use in wild Hellbender populations (Ball 2001; Peterson and Wilkinson 1996). Peterson and Wilkinson (1996) found individual males on average utilized 6.3 cover rocks with a range of 1 to 13 rocks over a five month period from August to January. We would expect overall rock use (i.e., movement) in our study to be reduced since we targeted the breeding season when males are more sedentary. In Hellbenders it is rare to observe more than one individual under the same rock simultaneously (Hillis and Bellis 1971; Nickerson and Mays 1973; Peterson 1988); however, it is not uncommon for the same rock to serve as shelter for multiple animals over time (Peterson and Wilkinson 1996). In our study, male Hellbenders utilized 31 unique locations (i.e., 29 cover rocks and two bedrock crevices), but we never observed the same shelter site being utilized by more than one individual over the entire course of the study.

We conclude that the use of gastric implants is a practical technique for short-term studies of wild Hellbenders as previously demonstrated by Blais (1996) and Coatney (1982). But, more importantly, our study demonstrated the effectiveness of this technique in locating active nests. The importance of locating nests cannot be overstated since this endangered species has experienced marked population declines with larger, mature individuals predominating while small size classes are underrepresented (Briggler et al. 2007; Wheeler et al. 2003). The single egg clutch that we collected as a result of this study was incorporated into the long-term captive propagation efforts of the Ozark Hellbender. Gastric transmitters are quickly and easily implanted on site which reduces the stress and risk associated with surgical implant transmitters (i.e., off-site transportation, anesthesia, surgical procedure, extended recovery time, etc.). To achieve the goal of locating egg clutches, temporary removal (< 1.5 hours) of males from the river to implant gastric transmitters has less impact on their breeding behavior than other external or internal transmitter attachment methods. There has also been recent success using artificial nest boxes to augment nesting habitat, collect wild egg clutches, and propagate Hellbenders in captivity (Briggler and Ackerson 2012). However, the best technique to use in future studies will depend on factors such as stream morphology, water clarity, amount of suitable nesting habitat, and specific research objectives.

The long-term utility of this technique can be measured by the survivability and subsequent condition of the study animals. Coatney (1982) and Blais (1996) did not report adverse effects of gastric transmitters on Hellbenders on a short-term basis; however, they did not monitor animals for a long-term. In this study, five of the seven Hellbenders were recaptured in subsequent years and gained weight (mean =140 g gained). With at least 71% (5 of 7) survivorship and documented weight gains in subsequent years, gastric implant telemetry appears to be a useful, non-lethal tool for short-term studies in Ozark Hellbenders. This method may also have applications in short-term studies learning more about movement patterns and behavior of other imperiled species.

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Visible Implant Alphanumeric Tag Retention in Green Frog (*Lithobates clamitans*) Tadpoles

Marking tadpoles is challenging. Traditional methods include fin-clipping and staining with neutral dye (Donnelly et al. 1994). More recently, researchers have trialed visible implant elastomers (VIE) and coded wire tags (CWT) as techniques to mark tadpoles (Anholt et al. 1998; Grant 2008; Martin 2011). The drawback to fin-clipping and staining is that their use is largely restricted to batch marking (e.g., dates or cohorts), rather than unique identification (Donnelly et al. 1994). Additionally, staining may affect the behavior of marked tadpoles (Carlson and Langkilde 2013), and the effect of fin-clipping on behavior or survival is unknown. VIE may be problematic because marks often migrate away from the marking site, are lost, or are read incorrectly (Bailey 2004; Grant 2008). CWT also has a high rate of tag loss (Martin 2011). Visible implant alphanumeric tags (VIAlpha tags, Northwest Marine Technology Inc., Shaw Island, WA) have the potential to solve these problems. VIAlpha tags are soft, biocompatible, fluorescent tags with a unique alphanumeric code printed on one side. Thus, they represent a promising approach to uniquely identify individuals. They have been used for marking a number of taxa including fish (*Oncorhynchus mykiss*, Isely et al. 2004; *Gadus morhua*, Olsen et al. 2004), crayfish (*Procambarus clarkia*, Isely and Stockett 2001; *Cherax destructor*, Jerry et al. 2001), lobsters (*Jasus edwardsii*, Woods and James 2003), and seahorses (*Hippocampus abdominalis*, Woods 2005). VIAlpha tags have also been used to successfully mark adult anurans (Ackleh et al. 2010; Buchan et al. 2005; Chelgren et al. 2006; Heard et al. 2008), caecilians (Measey et al. 2001; 2003), and salamanders (Osbourn et al. 2011). To date their use in marking tadpoles has not been tested, and this study is the first to report on tag retention in a larval anuran, the Green Frog (*Lithobates clamitans*). Our objective was to assess VIAlpha tag retention in this species.

Materials and methods.—As part of a larger study examining the reproductive success of amphibians inhabiting created wetlands (in which unique identification and mass of individuals were required), in March 2010 we collected 110 green frog tadpoles from a pool connected to a wetland in Grant County, West Virginia (39.2125°N, 79.42361°W). All individuals had hatched the previous summer and overwintered in the pool and were of similar developmental stage (Gosner stage 30–33; Gosner 1960).

We transported tadpoles to the laboratory where they were housed in 33 aquaria (~3 L plastic containers), with five tadpoles per aquarium. We maintained aquaria on a 14 h light: 10 h dark photoperiod at about 22°C. We fed a consistent amount of food (3:1 mixture of rabbit chow and flake fish food, Skelly 1994) to tadpoles once every other day. In an attempt to achieve a balance between disturbance to tadpoles and maintaining conditions as natural as possible, we did not aerate tanks and limited water changes to 1/3 of the water volume once a week with water collected from wetlands. As water was siphoned during water changes, we vacuumed uneaten food, feces, and debris from the bottom of tanks. We randomly assigned aquaria to spaces along a 9 m-long bench and randomly allocated individual tadpoles to aquaria.

Tadpoles were anesthetized in buffered 440 mg/L tricaine methylsulfonate (MS-222), placed on a water-saturated piece of soft foam and tagged using an injector specifically designed to accommodate the 1.2 mm × 2.7 mm VIAlpha tags (Fig. 1). We injected the tags by piercing the first layer of skin at the midpoint of the tail with the pointed injector tip and sliding the injector parallel to the skin towards the base of the tail above the muscle (Anholt et al. 1998). The tip of the injector was rinsed with clean water after each use (although rinsing with ethanol may be more appropriate to prevent disease transmission). We placed all tags on the left side of the tail fin, and care was taken to ensure that tag placement was consistent. Tadpoles recovered (until they resumed normal behavior, 2–5 minutes) in a container of clean distilled water before being placed into aquaria. We monitored tadpoles for tag retention daily until they either died or metamorphosed (mean 14 weeks, range: 1–80 weeks). To minimize disease risk associated with reintroducing amphibians into the wild, all metamorphs were euthanized in a 2% solution of MS-222.

Results.—VIAlpha tag retention was poor, with 25% of the tags lost in the first week (21% were lost in <24 h) and 82% lost within the first two weeks of the experiment. Four tags were not lost: three tadpoles died and one metamorphosed with tags still implanted. The remaining tags were lost by week 11 (day 75) for a total percentage loss of 96% (Fig. 2). No signs of infection, redness or swelling were present at the location of the incision, and marked tadpoles appeared to behave normally.

Discussion.—Contrary to many other taxa that have been marked with this method, VIAlpha tag retention in Green Frog tadpoles was poor. We believe that tag loss is most likely due to the nature of tadpole anatomy. Tags were initially secure in the tail because they were kept against the skin by the support of the tail myotomes. However, tail movement gradually pushed the tags posteriorly toward the skin incision where they exited the body and were lost (this took < 24 h in 23 individuals). Before the initiation of the experiment, additional tadpoles were used to identify alternative tagging locations; attempted locations included the belly, dorsum, and the cheek just beneath the eye. These locations could not be used because substantial subcutaneous musculature is minimal or absent; the tags immediately slid out of place or disappeared under layers of skin. In some instances, particularly on the dorsum, the tags would appear secure but were occluded by dark pigmentation and were not visible even when viewed with the deep violet wavelength light. This occlusion occurred on several experimental tadpoles as well, due to extensive pigmentation on the tail of some individuals.

Tag retention was much poorer in our study compared to two recent studies that used similar techniques. Grant (2008) used

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visual implant elastomer (VIE) to mark larval Wood Frogs (*Lithobates sylvaticus*) and Martin (2011) used coded wire tags (CWT) to mark larval Mexican Spadefoot Toads (*Spea multiplicata*). Implantation of VIE is done with a small hypodermic needle (4 µm), and the liquid elastomer fills the cavity and then cures into a solid, most likely reducing the probability of loss through the small incision created by the needle. In contrast, the injector for the VIAlpha tags is relatively large (19 µm) and shaped identically to the tag, which probably makes loss of the 12-µm tag through the large incision more likely. Grant (2008) injected tadpoles in the same body location as in the present study and, although still too high for most mark-recapture studies, observed a tag loss of only 50% of one of two marks after 20 days, with no tadpole losing both marks. Martin (2011) injected CWT into the ventral tail fin of tadpoles and had a retention rate of 80% after eight days. We did not attempt tagging in the ventral fin, but CWT uses an injector that is small, similar to the VIE needle, and it may be that smaller incisions are less prone to tag loss than the larger incision created with VIAlpha tags, regardless of tagging location. It would be interesting to determine if CWT tag retention remains high over a longer time period.

We have identified two potential solutions that may improve retention in the future and thus render VIAlpha tags effective for individually marking tadpoles. First, closing the incision site with instant glue such as cyanoacrylate has been used in other studies involving aquatic amphibians (Heard et al. 2008; Reh and Constantine-Paton 1984), and it may prevent tag loss in tadpoles; however, this method is not completely effective (Heard et al. 2008) and its efficacy in submerged conditions is unknown. Second, Chelgren et al. (2006) described their procedure for marking adult Northern Red-legged Frogs (*Rana aurora*) with VIAlpha tags in which upon injection into the dorsum of the thigh they pushed the tag to a position on the ventral side of the thigh, away from the site of incision. Pushing the tag from the dorsum of the tail on tadpoles laterally to the side of the tail may significantly increase retention. This solution needs testing to determine its efficacy because the tail is frequently in motion and may expel tags regardless of position. Refining the application of VIAlpha tags with these potential solutions might yield an effective method whenever identification of individual tadpoles is required. We recommend more work to assess tag retention with protocol modifications and to determine the effect of VIAlpha tags on tadpole survival and behavior.

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FIG. 1. Injection of VIAlpha tag into the tail of Green Frog (*Lithobates clamitans*) tadpole.

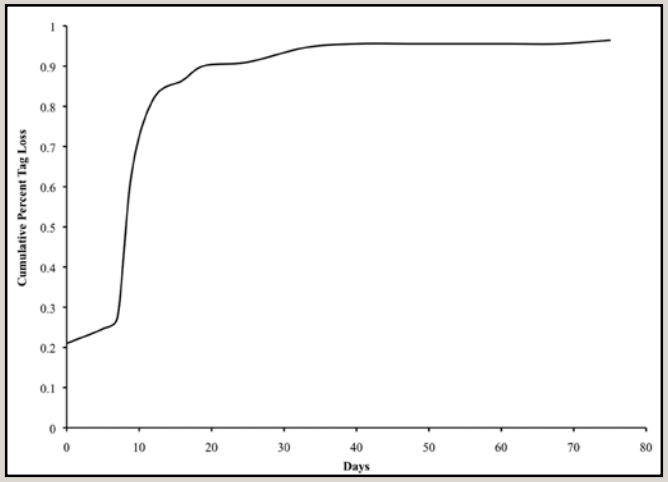


FIG. 2. Cumulative percent tag loss of Green Frog (*Lithobates clamitans*) tadpoles marked with VIAlpha tags.

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Escape Rates of Semi-aquatic Turtles from Basking and Funnel Traps

Traps used to sample animal populations or communities may be biased with respect to the probability of capturing particular subsets of species or individuals (Willson et al. 2008). For example, capture probabilities may differ between the sexes for specific trap types or during different portions of the active season (Noyce et al. 2001; Thomas et al. 1999). Likewise, the efficacy of some traps may vary across different habitats (Lambert et al. 2005; Ryberg and Cathey 2004). Biased sampling methods may produce inaccurate estimates of community or population-level parameters, hampering the development of management and conservation policies. Therefore, it is important to investigate the potential biases associated with methods used to sample animal populations and communities (Willson et al. 2008).

Some turtle traps are more likely to capture certain species, sexes, or sizes (Bluett et al. 2011; Browne and Hecnar 2005; Cagle and Chaney 1950; Fidenci 2005; Ream and Ream 1966; Sterrett et al. 2010). Basking traps take advantage of the basking habit of some turtle species (Boyer 1965) and usually consist of a basking platform (sometimes with treadles) mounted over a net or holding pen (Plummer 1979). Turtles are captured after diving or falling off of the basking platform. Basking traps are used to successfully capture species that commonly exhibit aerial-basking behaviors (e.g., *Trachemys scripta*; Gamble 2006; Thomas et al. 1999), but are unlikely to catch species that do not commonly engage in such behaviors (e.g., *Macrochelys temminckii*; Lagler 1943). In addition, some basking traps are more likely to catch large females than other individuals within a population (Ream and Ream 1966). However, the sexual biases of basking trap captures may vary seasonally (Thomas et al. 1999). The design of some basking traps may allow some turtles to escape from the holding pen (R. B. Thomas, pers. observ.). Gamble (2006) mentioned the possibility that escape rates from basking traps may vary for turtles of different sizes. However, no published studies have compared escape rates of turtles from basking traps.

Baited funnel traps are commonly used to sample freshwater turtle populations and communities (Gibbons and Greene 1990; Plummer 1979; Ream and Ream 1966). Bait (usually food) is used to motivate turtles to enter these traps through an inverted-funnel entrance. The ability of some turtles to escape from funnel traps has been documented (Brown et al. 2011; Frazer et al. 1990; Gamble 2006; Mali et al. 2013). Frazer et al. (1990) found that female *Chrysemys picta* often escaped from funnel traps, with 16 of 20 escaping during a 24-h period. In contrast, Brown et al. (2011) investigated the escape rates of *T. scripta* from funnel traps and found a negligible rate of escape (only 5 out of 139 *T. scripta* escaped within 34 h). Similarly, Mali et al. (2013) reported that only 8 of 107 *Apalone spinifera emoryi* escaped from funnel traps. Possible explanations for the disparity of results among these studies have not been explored. Differential escape rates between sexes or sizes could bias a sample and negatively impact estimates of population-level parameters. We examined the escape frequency of *C. picta* and *T. scripta* from basking traps and funnel traps. Specifically, we compared escape rates among males, females, and juveniles and examined the influence of body size on escape rates for both species.

Methods and Materials. We trapped turtles using funnel traps and basking traps from nine ponds in Lyon County, Kansas, USA, from 8 June to 26 September 2010. Traps were constructed with three rectangular 65 × 90 cm frames covered in 3.8-cm treated nylon mesh (Nichols Net and Twine, Inc., Granite City, Illinois); each trap had a single opening with a mouth height (the maximum vertical height of the inner opening of the funnel entrance; see Brown et al. 2011) that ranged between 10 and 15 cm (mean ± SD = 11.5 ± 1.5). We baited each funnel trap with canned mackerel held in a perforated PVC tube to prevent bait consumption (Nall and Thomas 2009); bait was changed every two days. Basking traps consisted of a 60 × 60 cm wood and Styrofoam frame with a 90-cm deep net basket underneath (Memphis Net and

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Twine Co., Inc., Memphis, Tennessee). The frame supported a board set on a treadle suspended above a net. Long nails (~10 cm) driven through additional pieces of PVC tubing were then snapped onto the sides of the trap at ~20-cm intervals with the sharp end of the nails protruded over the inside of the trap at a 45°-angle from the water surface.

All turtles were uniquely marked for identification (Cagle 1939) and sex, species, and plastron length (PL) were recorded. Both Painted Turtles (*Chrysemys picta*) and Pond Sliders (*Trachemys scripta*) served as test animals in this study. Sex was determined using a combination of PL and the presence or absence of male secondary sexual characteristics. Turtles were considered adult males if they had elongated foreclaws, cloacae positioned posterior to the rear carapace margins, and PL >110 mm for *T. scripta* or >90 mm for *C. picta*; turtles with relatively short foreclaws, cloacae positioned near or anterior to the rear carapace margins, and PL >160 mm for *T. scripta* or >120 mm for *C. picta* were considered adult females (Gibbons and Greene 1990; House et al. 2010). Individuals smaller than these specified sizes that lacked these secondary sex characters were categorized as juveniles.

Captured individuals (both *C. picta* and *T. scripta*) were returned (at random) to either funnel traps or basking traps in their pond of capture. Traps were checked the next day and any of these animals found in the trap ~24 h later were recorded as "non-escapees," while those missing were assumed to have "escaped." Individuals were used as a test animal only once during these trials.

We tested escape frequency from basking traps with 77 turtles: 49 *C. picta* (22 males, 14 females, and 13 juveniles) and 28 *T. scripta* (11 males, 12 females, and 5 juveniles). We tested escape frequency from funnel traps with 88 turtles: 49 *C. picta* (23 males, 16 females, and 10 juveniles) and 39 *T. scripta* (11 males, 18 females, and 10 juveniles).

Male, female, and juvenile escape rates were compared using a Fisher exact test (Zar 2009). The likelihood-of-escape correlation with plastron length was analyzed using a Wilcoxon signed-rank test (Zar 2009). Level of significance was set at 0.05 for all statistical tests.

Results.—Overall, 74% of all turtles escaped from basking traps or funnel traps within 24 h. *Chrysemys picta* escaped from basking traps in 56% of trials (55% of males, 86% of females, and 31% of juveniles; Table 1). We observed significant differences among the escape rates of males, females, and juveniles (χ^2_2 = 9.07; P = 0.011). Juvenile *C. picta* escaped from the basking traps significantly less frequently than adult males or females. Mean PL of escapees and non-escapees were 133.9 mm and 106.0 mm, respectively. We found a significant difference in mean PL between escapees (133.9 mm) and non-escapees (106.0 mm; Z_1 = –3.21; P = 0.0013).

Trachemys scripta escaped from basking traps in 86% of trials (82% of males, 100% of females, and 60% of juveniles; Table 1). We did not observe a statistically significant difference among the escape rates of males, females, and juveniles, although our results approached significance (χ^2_2 = 5.80; P = 0.055); the low numbers in certain cells may have diminished the precision of the test statistic (Zar 2009). However, juvenile *T. scripta* were 40% less likely to escape than adult females. Mean PL of escapees (185.1 mm) and non-escapees (107.0 mm) was significantly different (Z_1 = –2.79; df = 1; P = 0.0052).

TABLE 1. Escape rates of *Chrysemys picta* and *Trachemys scripta* from basking traps over 24-h periods, 8 June to 26 September 2010 in Lyon County, Kansas, USA.

	Chrysemys picta				*Trachemys scripta*			
	Male	Female	Juvenile	Total	Male	Female	Juvenile	Total
Escapees	12	12	4	28	9	12	3	24
Non-escapees	10	2	9	21	2	0	2	4
% Escaped	55	86	31	56	82	100	60	86

TABLE 2. Escape rates of *Chrysemys picta* and *Trachemys scripta* from funnel traps over 24-h periods, 8 June to 26 September 2010 in Lyon County, Kansas, USA.

	Chrysemys picta				*Trachemys scripta*			
	Male	Female	Juvenile	Total	Male	Female	Juvenile	Total
Escapees	16	11	9	36	10	14	8	32
Non-escapees	7	5	1	13	1	4	2	7
% escaped	70	65	90	74	91	72	80	82

Chrysemys picta escaped funnel traps in 74% of trials (70% of males, 65% of females, and 90% of juveniles; Table 2). Differences in escape rates among these groups were not significant (χ^2_2 = 2.05; P = 0.36). The Wilcoxon signed-rank test comparing escapee and non-escapee PL showed no significant difference in escape rates by body size for *C. picta* (Z_1 = 1.44; P = 0.15; means 116.7 mm for escapees and 133.3 mm for non-escapees).

Trachemys scripta escaped funnel traps in 82% of trials (91% of males, 72% of females, and 80% of juveniles; Table 2). Differences in escape rates among these groups were not significant (χ^2_2 = 0.92; P = 0.63). The difference in mean PL of *T. scripta* categorized as escapees (171.2 mm) and non-escapees (159.7 mm) was not significant (Z_1 = –0.49; P = 0.62).

We investigated whether the incidence of escape in turtles was affected by their previous trap experience; for this purpose, we compared escape rates in a subset of first-time captures and experienced turtles (i.e., recaptured turtles). We compared the trap-experience of 69 escapee turtles and 20 non-escapees using Fisher's exact test. Trap experience and escape were independent (χ^2 = 0.66; P = 0.58).

Discussion.—Overall escape rates of turtles were greater than expected. Smaller *C. picta* and *T. scripta* were significantly less likely to escape from basking traps while large females of both species frequently escaped from the basking traps. Therefore, the use of basking traps to sample populations of these two species may result in an underrepresentation of large adults (particularly females).

Escape from funnel traps was relatively frequent; however, relative to basking traps, these traps were less biased with respect to differential rates of escape among males, females, and juveniles. Our results for *C. picta* escape from funnel traps (74%) were very similar to those reported by Frazer et al. (1990; 75%). In contrast, Brown et al. (2011) reported a negligible escape rate (3.6%) of *T. scripta* from funnel traps, versus 82% in our study. It is possible that differences in trapping methods or trap types could be responsible for the disparity among these studies. Our traps were constructed with rectangular 60 × 90 cm frames, while

Brown et al. (2011) used circular 76.2-cm diameter frames. The specific design and dimensions of the traps used by Frazer et al. (1990) were not reported. Perhaps different shapes and sizes of these traps were relevant to the different rates of escape. Specifically, our traps had a mouth height considerably larger (mean = 11.5 cm) than the mouth height of those used by Brown et al. (1.27–2.03 cm); the opening in our traps may have been easier to find and subsequently use for escape. Frazer et al. (1990) also used *C. picta* from a long-term study population of turtles and some of their study animals may have had extensive prior experience in funnel traps. Conversely, Brown et al. (2011) used *T. scripta* that were unmarked and presumably had not been trapped before. Our study used a combination of both "new" turtles and turtles that had been caught and marked previously and we found no difference in escape based on prior trap knowledge. Frazer et al. (1990) reported results similar to ours: 75% escape rate for female *C. picta* in 24 h. These studies also involved two species from three widely spaced study sites (Michigan, Kansas, and Texas) and the potential for geographic variation cannot be dismissed.

Future research should examine possible differences in turtle escape frequency among variations of funnel trap design (one-throated vs. two-throated, round vs. rectangular, etc.). In addition, the possible influence of the frequency of checking traps has not been investigated; Brown et al. (2011) found that all of the turtles who escaped did so in <27 h. Some researchers believe that checking traps more often than once per 48 h disturbs the site and reduces trap yield; others prefer to check their traps every 6–12 h (Cagle and Chaney 1950; Fidenci 2005; Lagler 1943). However, there have been no formal studies conducted to support or negate the efficacy of these practices.

We can conclude that *T. scripta* and *C. picta* have a great potential for escape from some forms of basking and funnel traps and that escape from these basking traps, in some cases, is biased by size. The trap types used for this research were only two of a variety of many different trap designs (Cagle and Chaney 1950; Fratto et al. 2008; Kennett 1992; Lagler 1943; Ream and Ream 1966) that may yield different results with similar testing. Researchers would benefit from an examination of their own trap types and potential escape bias. Of the two traps compared in this study, funnel traps yielded less biased samples of *C. picta* and *T. scripta* in these ponds.

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Color Recognition as a Management Tool with a Female Nile Crocodile (*Crocodylus niloticus*) at the Wildlife Conservation Society's Bronx Zoo

Animal sensory systems are the product of environmental and evolutionary pressures. As such, these systems play important and varying roles for animals that influence behavior. Sensory systems aid in predator detection and avoidance (Dial and Schwenk 1998), prey location and capture (Garamszegi et al. 2002), mate location (Shine et al. 2005), and even habitat orientation (Costanzo 1989; Reinert and Zappalorti 1988). Animals are evolutionarily shaped by all aspects of their environment and species often utilize certain sensory systems more heavily than others. In extreme cases, some species have lost entire sensory systems (e.g., the loss of eyes in blind cave fish, *Astyanax mexicanus* [Jeffery and Martasian 1998]). In zoos and similar institutions, animal caretakers develop species-specific husbandry, breeding, enrichment, and training programs that are largely based around sensory and behavioral ecology.

Training is commonly employed by zoos for various purposes (Ramirez 1999). A well-designed and scientifically validated training and enrichment program can benefit animal husbandry, improve animal and trainer safety, and enrich the lives and increase the well-being of animals maintained in a captive environment. Training also increases activity levels and provides mental stimulation for animals in managed care (Ramirez 1999).

When developing any training program, it is important to consider the sensory and behavioral adaptations of the focal animal. Crocodilians utilize visual signals such as a wide range of postures and head slaps atop the water's surface, which play an important role in crocodilian communication (McMahan 2001). When training crocodilians in captivity, this visual communication channel has been used successfully by implementing visual cues such as targets and stations (Augustine 2009). One of the most fundamental and applicable behaviors used for training is targeting, an animal touching a part of its body to a defined object or "target" (Ramirez 1999). Once targeting is learned the animal can be conditioned to "station," or remain at a specific object or place for a predetermined length of time. These two behaviors allow trainers to safely and easily direct and work with an animal. Operant conditioning to a target and/or station can be utilized as a safe and effective way to obtain desired behaviors in crocodilians. In addition to natural history, the animal's cognitive abilities should also be taken into consideration when developing a training program. The ability of reptiles to learn has been demonstrated in several species (Augustine 2009, 2011; Burghardt et al. 2002; Bustard 1968; Leal and Powell 2011; Manrod et al. 2008).

At the Wildlife Conservation Society's Bronx Zoo, crocodilians are trained to increase safety and improve husbandry. When a training regimen for crocodilians is instituted, a specific color target or station is chosen for each individual animal. For animals that are or will be housed together, we choose two colors on opposite ends of the grey scale. We are not aware of literature that discusses the ability to distinguish between colors or shades in the Nile Crocodile (*Crocodylus niloticus*), a species with which we have had success with training in both group and individual settings.

The Nile Crocodile is a large predator native to Africa that can grow up to 6 m (Trutnau and Sommerlad 2006). It is likely due to this impressive size that *C. niloticus* is relatively common in zoos (39.16.3 [= males, females, unsexed] individuals being kept in 14 institutions in North America; International Species Information System search 25 April 2012). The staff at the Bronx Zoo has had success with conditioning Nile Crocodiles to target and station both as individuals and in pairs. The lack of evidence suggesting crocodilians can behaviorally distinguish between colors led us to question our methodology of assigning different colored plastic discs to individual animals within the collection. Herein, we examine the response of 0.1 *C. niloticus* previously conditioned to a yellow station when presented with a choice between yellow and black stations.

Materials and Methods.—The Bronx Zoo obtained a six-year-old female Nile Crocodile on 25 April 2008 from Crocodile Creek, Kwazulu-Natal, Republic of South Africa. A consistent operant conditioning program began in May 2008, focusing on targeting

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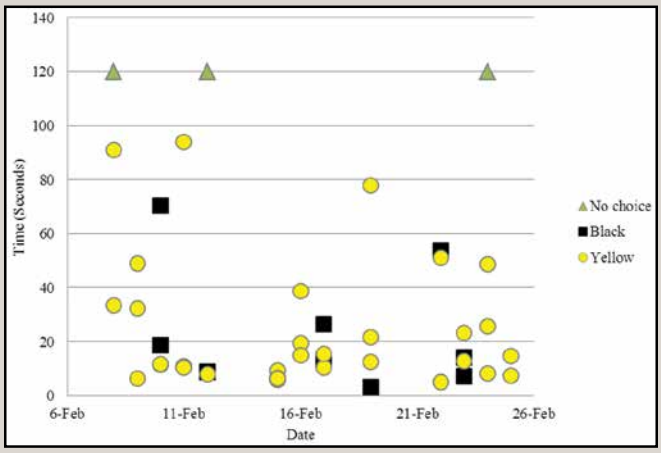


Fig. 1. Time (in seconds) it took for one female *Crocodylus niloticus* to choose a station. Choices were yellow (yellow circles) black (black square) or no choice (green triangle).

and stationing behaviors. The crocodile is housed in a two-part enclosure with a shift door between the two sections. The front portion of the enclosure (exhibit) is approximately 18 m^2 with a pool 2.3 m × 4.7 m and 0.5 m deep. The enclosure has a cement base with two plants, two logs, and a basking spot. The back, off-exhibit section of the enclosure (holding) measures 15.8 m^2 with a pool approximately 2.6 m × 3.5 m and 0.7 m deep. Two sand beaches, each with a tree, encompass one-half of the area and a basking spot is provided on the larger of the two beaches. The land portion of the exhibit connects through a shift door to the larger beach in the holding. This crocodile began shift training between exhibit and holding in 2010. When training for this experiment commenced on 8 February 2011, the female crocodile was conditioned to a yellow target and station (first using a painted pole and then to a yellow plastic disc) and to shift between exhibit and holding on cue.

Ten eyebolts (3 ¾" × 1 ¼" with ¾" opening) were secured along the back wall of the holding and labeled 1 through 10 from left to right. They were positioned one foot apart and at equal heights ca. 3 m above the pool. Two plastic discs, one black and one yellow, were attached to broom handles with a hook-and-eye and metal latch to allow for suspension from the eyebolts positioned along the back wall. This back wall is directly across from the shift door, separating exhibit and holding to ensure that she would see both plastic discs immediately. The crocodile had not been previously exposed to the black disc. Each colored disc was randomly assigned to a specific eyebolt for each trial. Every trial began by targeting the crocodile in her exhibit to a yellow target pole. She was always rewarded with small mice for the completion of this behavior. The shift door was then opened and when the crocodile passed through the shift door she was requested to "station" with a verbal cue. Once all four of her feet were in the water of the holding pool, a timer was started. Final choice was determined when she approached within 1 inch of the station or plastic discs at which point the timer was stopped. If she chose yellow, the color to which she was conditioned, she was rewarded. If she chose black, she was not rewarded and no action was taken. Both discs were removed immediately after the trial and the crocodile was shifted back to the exhibit. This process was repeated at random intervals throughout the day for the duration of this study (17 days). If she failed to choose a disc within a two-minute time frame, she was marked with a zero. We recorded the position of each disc, the color chosen and the time it took for her to complete the behavior. It was also recoded if she chose not to participate by not shifting.

Results.—A total of 48 trials were conducted over 17 days. The animal did not participate during two trials by not shifting into the rear pool; these trials were excluded from analyses. There were 4 trials where she did not choose a color/shade within the two-minute time restriction. The crocodile chose yellow 71.7% of the time and black 19.6% of the time. She was significantly more likely to choose yellow, regardless of position (33 out of 46 times; Chi Square test, $p < 0.001$). However, if she chose black, she only chose it when it was placed on the right side (9 out of 9 times, Chi Square test, $p = 0.003$). There was no relationship between how long it took her to choose and the date in which we performed the trial (Spearman Correlation, $p = 0.268$, $\alpha = 0.05$; Fig. 1).

Discussion.—Crocodilians have fairly good eyesight and their elliptical pupil has great light-gathering ability (McMahan 2001). The crocodilian eye contains single rods (detect presence or lack of light; Kolb 2003) and single and double cones (distinguish between different frequencies of light; Kolb 2003), possibly suggesting an ability to see color (Gans and Parsons 1970; Laurens and Dewiler 1921). Jacobs (1981), however, does not equate the presence of cones to an ability to see color. Certain reptile genera possess rods and four spectral classes of cones, each representing one of the five visual pigment families, which suggests, at least, the potential for tetrachromatic color vision (Bowmaker 1998). Although there is no documentation of crocodiles having color vision or the ability to distinguish different shades along our visible color spectrum, American Alligator (*Alligator mississippiensis*) and caiman (*Paleosuchus* sp.) both have blue- and green-sensitive single cones, and *A. mississippiensis* has a type of cone that absorbs red light (Sillman et al. 1991). The potential for these dangerous predators to utilize color vision could prove to be a useful tool in captive management.

The crocodile examined in this study was previously conditioned to approach the yellow disc but had never been exposed to the black disc. We speculate that if the animal had been preconditioned to the black disc, and never rewarded for approaching it, the percentage of times she went to the black disc during the study (19.6%) would have been significantly lower. We hypothesize that she approached the black station to test or determine the outcome of such an action.

The use of color/shade training can be an important management tool when working with multiple animals in an enclosure, particularly when they pose a threat to one another in times of high excitation such as feeding or breeding introductions. Animals are often separated to decrease or avoid these types of dangerous interactions. Color or shade training has been used with several types of animals in managed collections, including horses (Smith and Goldman 1999), parrots (Pepperberg 1987), primates (Cole 1953), seals (Wartzok and McCormick 1978), and crocodilians (Jepsen, pers. comm.). Although evidence for color vision in crocodiles is scant, we examined whether Nile Crocodiles can distinguish different color stations, at minimum on a gray scale. The results of this experiment demonstrate that the crocodile was able to distinguish between the black and yellow stations, choosing yellow, the previously conditioned station, significantly more often than black (33 out of 46 times), regardless of the position of the station. This would be expected since her entire reinforcement history has been with yellow objects.

This Nile Crocodile was able to discriminate between the two discs when presented with a choice. The crocodile could have

noticed the difference on the grey scale, yellow being much lighter then black, or a difference in brightness or luminance (Jacobs 1981). Further studies are needed to provide a more complete understanding of Nile crocodile vision. While the crocodile in this study was able to distinguish between black and yellow, future studies should address different colors that are similar on the grey scale and in brightness. At minimum, this study has indicated that implementing color/shade training and recognition into operant conditioning can be an important method in managing crocodilians, as our subject preferentially chose to station at her previously conditioned color when given a choice.

Advantages of using learned responses to test color or shade recognition include a greater degree of control for the experimenter, the ability to more closely approximate the behavior, and a smaller possibility that the animal will habituate or lose the behavior during testing (Jacobs 1981). Further studies are needed to provide a more complete understanding of Nile crocodile vision, including close examination of the anatomy of the eye. From an animal management perspective, these types of studies can improve captive husbandry; e.g., while feeding multiple animals in an enclosure simultaneously, or separating animals in times of high excitation. Not only will color or shade recognition be a valuable tool for training crocodilians, but it can also create a more visually stimulating environment.

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Folklore Husbandry and a Philosophical Model for the Design of Captive Management Regimes

Keeping reptiles and amphibians is an activity enjoyed by many hobbyists worldwide and is also undertaken by zoos, museums, research organizations, and other professional animal care facilities. The United Kingdom pet trade alone consists of over 500 species of reptiles and amphibians (Tapely et al. 2011), including the importing of 100,000 individual reptiles (Rayment-Dyble 2004). Imports into the European Union include many CITES-listed species and therefore many species of conservation concern (Auliya 2003). Furthermore this trade has seen a continuous increase in both numbers and species diversity of animals as the private keeping of such animals has notably gained popularity over the last 10–20 years (Auliya 2003; Barten 2006; Mader and Mader-Weidner 2006; Tapely et al. 2011; Varga 2004; Wilson 2005). From the perspectives of animal welfare and conservation it is important to develop appropriate husbandry regimes so that these species thrive in captivity, and ideally these would be based on some form of empirical data (Arbuckle 2009; Hosey et al. 2009; Kaumanns et al. 2000; Swaisgood 2007; Wiese and Hutchins, 1994).

There has been a steady stream of both published and unpublished studies that have provided data relevant to the husbandry of captive animals, though these vary greatly in quality and detail (Fidgett 2005; Hosey et al. 2009). The herpetocultural literature is no exception to this general trend, but the level of research interest tends to be somewhat lower than in certain other groups, particularly mammals (Anderson et al. 2008; Arbuckle 2009; Hosey et al. 2009). Some recent changes including the creation of the Herpetoculture section in *Herpetological Review* are a step in the right direction and should help to fuel studies allowing keepers to develop an evidence-based approach to husbandry.

It should be noted however that such an evidence base is only of benefit if it is consulted and integrated into captive management plans. Unfortunately, it is often the case, both in professional and private contexts, that evidence-based husbandry is not used for a variety of reasons including lack of information, a belief (either explicit or implicit) that experience is a better guide than research, and lack of encouragement or ability (real or perceived) to pursue such an approach (Arbuckle 2010; Clauss et al. 2003).

The aim of this paper is to draw attention to the problem of folklore husbandry for exotic animals, specifically reptiles and amphibians, and to encourage professional and amateur keepers alike to strive towards applying evidence-based methods to their husbandry routines.

What is folklore husbandry and why does it matter?—The term "folklore husbandry" was coined by Arbuckle (2010) to refer to "methods or supposed 'best practices' [which] become established without proper evaluation, often justified simply because 'it has always been done that way' or for otherwise unknown or poorly substantiated reasons." In essence, it refers to the widespread practice in many professional institutions and among many private keepers of doing things by tradition and/or uncritically accepting anecdotal husbandry information.

An important point is whether this actually matters. After all, many species have been kept successfully for many years and often bred using methods that fit the definition of folklore husbandry. Indeed, this may be the primary reason why such methods have been so widely adopted. It is likely that some folklore husbandry methods will prove to be suitable once they have been properly evaluated. Nevertheless there is an inherent issue in that they have not been adequately tested and so should not be blindly accepted as the best nor the only possible solution. Unfortunately that is how folklore husbandry methods are often portrayed, particularly among private keepers (de Vosjoli 2007).

What can result are dogmatic assertions of the "correct" way of doing things that hamper the further development of methods via condemnation of different practices (de Vosjoli 2007). This is an attitude that is to be discouraged on at least two grounds. Firstly, it is problematic to take any current situation and proclaim it to be the best one possible. This is particularly true for the care of reptiles and amphibians, which is still in a stage of frequent development, as it can directly lead to a decrease in motivation to continue to improve husbandry. In fact the basic natural history and ecology of many commonly kept species are poorly known, reducing further our certainty that a given approach is the best one. Secondly, the successful maintenance of a given species is a matter of degree. One method may give good results but another may confer even better results or improved welfare standards. The idea of encouraging a diversity of husbandry practices is not new, and is in fact a key aspect of de Vosjoli's (2007) "multifactorial model of herpetoculture," although he does not explicitly highlight the benefits of such a philosophy to continual methodological improvement.

In addition to the ideological disadvantages noted above, folklore husbandry can also incur time and financial costs that are of more practical concern. As an example of the former is the removal of beaks from avian prey or the chopping of foods for herbivorous species. These are time-consuming methods that are used with some regularity but their benefits have always simply been assumed by those who perpetuate their use. As an aside, recent research by Plowman et al. (2008) has shown that chopping foods provides none of the perceived benefits and is actually contraindicated in some situations. This is a good example of a folklore husbandry claim perceived as beneficial for numerous reasons, but that on investigation turned out to be false. Application of the results of Plowman et al. (2008) should alleviate the time cost of food preparation for keepers, and in a professional setting where "time is money" should also present a financial saving.

Furthermore it is clear that some folklore husbandry claims, if refuted, would also provide a direct financial cost saving. Arbuckle (2009) found that providing a gut-loading diet with the aim of adequately supplementing calcium was not a successful

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approach. However, although supported by a review of previous studies his experimental results did not permit statistical evaluation of this, and therefore require further work to provide concrete evidence. If it does prove to be accurate however, dusting with a relatively cheap supplement may give better results than the use of a specific gut-loading diet, many of which are relatively expensive.

Hopefully, I have now shown that it is important to be aware of folklore husbandry, and to adopt a more evidence-based approach to the care of exotic animals such as reptiles and amphibians. I will now provide some more examples of folklore husbandry that require investigation and also highlight a few studies that have evaluated such claims. I will then offer some guidelines in the form of a framework for establishing a husbandry regime. Finally, I will attempt to encourage dissemination of the basic ideas contained here with the aim of improving husbandry practices in both professional and private collections.

Some examples of folklore husbandry.—Examples of folklore husbandry are ubiquitous and in many cases are so deeply ingrained that they may not be instantly recognized as such. Nevertheless it might be useful to highlight a few of these so that a better idea of what the subject encompasses can be gained. These are somewhat dominated by nutritional examples, and this reflects both my own background and also that captive feeding appears to be a particularly prominent area of research into animal husbandry. Many examples have not been directly examined and the current availability of data to test them is variable. They represent potential for future directed studies and include a wide range of claims.

Do nutritional products such as supplements and "complete" diets that are marketed in a species-specific fashion give better results than equivalent products marketed in a more general way? Given that the nutritional requirements for reptiles and amphibians are for the most part extrapolated from domestic animals (Allen and Oftedal 1994; Baer 1994), the existence of species-specific marketing raises suspicion as to whether any genuine benefit to these products exists. Studies directed at evaluating whether the performance of a given species is better with products marketed for them than others would provide key information to guide which option to use.

Do particular livefood species represent a better staple diet than others? It is a long held belief that locusts are a better staple prey than crickets, and feeder cockroaches have recently become somewhat of a vogue food item that is touted for a high nutritional value. However, despite much published data on nutrient compositions of various invertebrate prey (Finke 2002; Nijboer et al. 2009; Oonincx and Dierenfeld 2011) the relative benefits in practice have rarely been tested. It is an important step to know the composition of a given prey item, particularly compared to another prey item, but in itself this provides no measure of how an animal will perform on that diet. It has previously been highlighted that direct comparison of prey composition to recommended nutrient intake is notable by its absence from most studies (Arbuckle 2009). Furthermore, there are little or no data on nutrient digestibilities for most reptile and amphibian species currently kept, despite the importance of this information for relative assessment of prey species. It is clear that much information is lacking to answer this question with confidence, but many folklore husbandry claims are made apparently without reference to those data that do exist.

Does the substrate influence general activity level or natural behaviors such as burrowing? Despite the almost ubiquitous use of substrates in enclosures, there has been surprisingly little research investigating whether a particular choice is better than any other. There is a plethora of anecdotal evidence available on the issue. For instance I have used a mix of sand, soil, and a few bark chips in an attempt to create a substrate mimicking the reported natural soils of the Plains Hog-nosed Snake (*Heterodon nasicus*). Following the change from newspaper to this substrate I noticed an apparent increase in activity and some burrowing behavior. However, like most such reports this represents a purely untested anecdote. Similarly, based on ecological observations and successful results of the entire husbandry regime used, Bennett and Thakoordyal (2003) strongly recommend the use of deep substrates for burrowing in Savannah Monitor (*Varanus exanthematicus*) enclosures. They particularly advocate soil but mention that others can be used, though the former "is easily the best." While I would personally agree with this last comment, it would be useful to have data from a comparison of various options, providing a direct evidence base to complement the natural history observations.

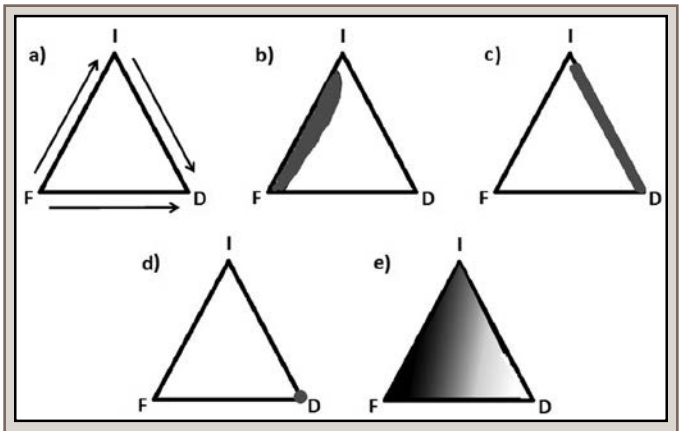


FIG. 1. The FID model of husbandry design. a) Basic model showing arrows representing the directions we should be aiming to move in. b) Shaded area indicates the range of most current designs. c) Shaded area indicates a range of good designs. d) Filled circle represents the ideal design. e) Darker shading indicates higher density of anecdotal evidence. See text for further details. F = folklore husbandry, I = integrated husbandry, D = direct evidence-based husbandry.

Is environmental enrichment necessary for reptiles and amphibians, and if so which form should it take? Enrichment is strongly advocated as a strategy to improve the welfare of captive animals (Swaisgood 2007), but specific considerations for reptiles and amphibians are lacking from most treatments of the subject. The general aim of many enrichment strategies is to increase activity or to encourage natural behaviors (Hosey et al. 2009). The latter aim is probably responsible for the idea that creating naturalistic enclosures promotes good welfare through environmental enrichment (Fàbregas et al. 2011). However, often such benefits are assumed rather than empirically tested. Some notable exceptions exist including Hurme et al.'s (2003) demonstration that an enrichment feeding device for dendrobatid frogs resulted in increased activity, but unfortunately such studies are not the rule. On the basis of natural history observations, Rosier and Langkilde (2011) examined whether the provision of a climbing structure is beneficial to a lizard that regularly climbs off the ground (*Sceloporus undulatus*). In contrast to what might be expected, these authors found no effect on a variety of welfare and behavioral measures. Their study highlighted the non-intuitive nature of providing enrichment, particularly to animals that

are phylogenetically distant from humans. It is a good example of why folklore husbandry claims should be properly tested, not simply accepted because they "make sense."

Can we take information on natural food groups and convert these straight to a captive diet? In other words, if we know that an herbivorous reptile naturally eats 50% leaves, 30% fruit, and 20% other vegetable matter, can we replicate these proportions in captivity? In this example, it is particularly important to note that, although providing some fruit would probably be acceptable, it would be unwise to uncritically make up 30% of the diet with it. One concern is that fruits more than many other plant parts are highly seasonal (Jordano 2000), and so either the absolute amount or the specific fruits eaten or both are likely to vary considerably over the year. This is very different from a constantly high proportion of fruit in the diet. Furthermore, the nutritional content of the food is more important that the "package" in which the nutrients are given to the animal. Schwitzer et al. (2008) highlighted the fact that domesticated fruits, those cultivated for human consumption and taste buds, have a very different nutrient composition to those found in the wild. It seems that wild fruits are actually more similar to cultivated vegetables. Since it is unlikely that most keepers will be able to source the wild fruits that form the natural diet of their animals, it appears as though substituting at least some of the fruit with vegetables in captivity would be preferred. It is likely that further scrutiny of simple "cut and paste" methods will reveal other cases where amendment is needed. This is a case of a partially evidence-based approach but with some aspects remaining under the umbrella of folklore husbandry.

How should we develop husbandry regimes?—With such a spectre hanging over our heads, how should we design our husbandry regimes so as to ensure the best approach we can? Because we must look after our animals now, we don't have the luxury of waiting for a full evaluation of every technique we use and thus we must act with imperfect knowledge. It is certainly true that the reason so many folklore husbandry claims exist is because we simply do not currently have the information to test them—in many cases we have to reserve ourselves to using such methods if we are reasonably confident they will be effective.

The goal should be to implement each part of a given animal's care with the best information available. This can be conveniently divided into three levels of increasing reliability: folklore, integrated, and direct evidence-based husbandry. The former has already been described and so needs no more definition here. Before discussing the other two approaches I should emphasize that although they are discrete categories, any given regime will undoubtedly incorporate all three. Despite the negative light under which I have cast folklore husbandry, as previously mentioned it is prevalent due to the fact that it works (at least to some degree) in many cases. It thus has a place in husbandry regimes when no better information exists as it can represent a conservative approach providing its limitations are borne in mind.

Integrated husbandry is the most common form of evidence-based husbandry and was the view detailed in Kaumanns et al. (2000). It involves integrating the existing ecological and, more generally, biological information on a given species, and assimilating this into a husbandry plan that attempts to mimic nature. This has important benefits in that such information is available for many species, albeit the quantity and quality will vary widely. However, it suffers from two main constraints.

Firstly, as highlighted above care must be taken to ensure that it is the important parts of the information that are replicated. There is no sense in providing a diet with the same set of food groupings as the natural diet if the nutrient composition is vastly different. Similarly, providing light for many species is not as important as providing the appropriate quality of light to enable biosynthesis of vitamin D in the skin.

Secondly, there may be differences between captive animals and their wild counterparts that impact the husbandry methods used or the evaluation of such methods. The captive environment differs from the natural habitat, and different species will not necessarily respond to this in the same way (Mason 2010). Although such differential responses to captive stressors are perhaps unsurprising, other effects of short- and long-term periods in captivity have been noted that are less intuitive. Captive animals have been shown to diverge from their wild counterparts in behavior (Guyon 2009; McPhee 2003), physiology (Studier and Wilson 1979), and even morphology (Moore and Battley 2006; Moss 1972; O'Regan 2001), all of which might have implications for the application of field-collected data to captive management.

Integrated husbandry is an excellent way of introducing an evidence-based approach to captive management, especially since data are far more abundant than for direct evidence-based husbandry. It can also act as an information platform from which hypotheses for direct empirical studies can be based. However, it does have some limitations which should be recognized and we should not accept it as the be-all-and-end-all of husbandry methods.

Direct evidence-based husbandry on the other hand represents the gold standard. It involves empirical examination of methods used and ideally their alternatives. An ongoing example of this is work on the use of ultraviolet B (UVB) lamps to create an appropriate lighting regime in captivity. It is beyond the scope of this paper to offer a thorough discussion of the issue, but comparisons of the light output of different bulbs currently in use (Schmidt et al. 2010) combined with a field study on exposure that is used to provide guidelines in captivity (Ferguson et al. 2010) is a commendable endeavor.

Although forming a discrete category of information, direct evidence-based husbandry often follows folklore and integrated husbandry by using them to generate hypotheses. For instance, a direct study might aim to evaluate a folklore husbandry claim or might be designed to test whether a particular integrated strategy does indeed offer the benefits it proposes in captivity. Once empirically examined, such methods can then be discouraged or elevated to the direct evidence-based category.

The main limitation of this approach is the time and financial resources necessary to investigate each technique, and as a result data from direct studies are lacking for most methods currently in use. With time and effort however, we can increase the proportion of any given husbandry regime that results from a direct evidence-based approach.

The FID model.—I have divided husbandry methods into three discrete categories, but emphasized that these categories will often combine in various proportions to result in the complete husbandry regime. This perspective can be represented by a simple visual model, consisting of a ternary diagram with folklore (F), integrated (I), and direct evidence-based (D) husbandry at separate corners (Fig. 1). In this case each corner represents 100% use of that principle.

The strategy illustrated by the FID model is an attempt to push our husbandry regimes as far as possible in the direction of the arrows (Fig. 1a). In no case should we try to move towards F but the ultimate goal is to use a regime that is as close to D

as possible. If we are close to F then we should look at moving towards either I or D (the side ID represents an evidence-based approach). If we are close to I then the preferred direction would be towards D.

In many cases it is useful to talk about a range of possibilities for the reasons highlighted earlier. Most current designs lie near the side FI (Fig. 1b). This is largely due to the fact that often there are few direct data to rely on, but where this applies we can still attempt to move towards I. Similarly we can denote a range of good approaches which lie along or close to side ID, those which are heavily evidence-based (Fig. 1c).

The ideal scenario would be to have perfect knowledge of the best option (or range of options) to use, and this would lie on corner D (Fig. 1d). Unfortunately this ideal situation is unlikely to be fully realized, certainly for most species and in the near future. However, just because this hypothetical scenario represents 100% direct evidence-based husbandry does not imply that an integrated approach should not apply. As discussed above many direct evidence-based methods are and will be a result of formal tests of integrated methods in captivity. It is not the case that the former will overturn all integrative (or even folklore) husbandry methods, but might often confirm them such that they receive more support and are thus elevated to the status of direct evidence-based.

Finally, it is also worth discussing where anecdotal evidence enters this framework since it has not been explicitly covered here. The reason for this is that anecdotal evidence cannot be allocated to any discrete category and often arises in part from two or even all three categories described here. Nevertheless it is possible to make some comments on its distribution since anecdotes are not expected to occur evenly through the parameter space in the FID model. Anecdotal evidence is expected to be most prevalent near F, showing a decreasing presence through I and declining to zero at the ideal point on D (Fig. 1e).

Note that anecdotes are still expected to be moderately common even in regimes that use a high degree of integrated husbandry; this is a result of the limitations of such an approach highlighted above. Note also that I do not regard them as equivalent to folklore husbandry, despite a strong relationship between them. This is because although they share many similarities, a single piece of anecdotal evidence can be influenced by both folklore and evidence-based methods. In contrast, by definition a folklore husbandry technique is not a result of any evidence-based approach, either direct or integrated.

Finally, and in common with folklore husbandry, although we should aim to move away from anecdotal evidence it is not necessarily a bad thing in all cases. For instance, where better approaches are lacking an anecdotal observation can steer the keeper away from poor practices. Furthermore, anecdotal observations can also provide new hypotheses for further examination and in that sense can contribute to development and improvement of husbandry regimes.

A call to action.—I hope that the ideas presented above can be used to improve professional and private captive management regimes. However, this is only likely to happen if they can stimulate new research and implementation of that research. In this vein, I rely on two (non-mutually exclusive) groups of people for this: researchers and keepers.

Researchers with an interest in animal husbandry and welfare should focus on evaluating folklore husbandry claims and providing a direct evidence base for use by keepers. Aside from such direct studies, reviews of the biology and particularly the ecology of a given species would also be useful, if written from a practical perspective aimed at informing husbandry. Such reviews can provide a good background for integrated husbandry regimes and can give recommendations for further studies. Given the practical nature of such research, I believe that the workers involved have a responsibility to make their studies available to those who can apply their findings, wherever possible. The best study on animal husbandry is useless if keepers cannot read it.

Keepers have a responsibility to share their knowledge and ideas. This should not be a problem since it is the sharing of information that leads to folklore husbandry in the first place. However the important point is that keepers should foster an attitude of awareness of different perspectives on husbandry, particularly folklore husbandry. With an understanding of the different categories of methods and their limitations keepers can evaluate the reliability of any information received.

When disseminating information keepers should make an effort to explain why a particular method is done, not simply pass it on in a manner that promotes parroting of poorly substantiated claims. Finally, it is also the responsibility of keepers to retain an open (but critical) mind to new methods. Trying new methods is the only way we can ultimately improve our husbandry practices, particularly if these represent at least a partially evidence-based approach. This is what we as keepers should continually strive to do, for the benefit of all concerned.

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HERPETOCULTURE NOTES

SQUAMATA — LIZARDS

***AMEIVULA ABAETENSIS*. DRINKING BEHAVIOR.** Many reptiles have morphological adaptations (Sherbrooke et al. 2007. Zoomorphology 126:89–102) and behavioral strategies (Al-Sadoonet al. 1999. Saudi J. Biol. Sci. 6:91–101) for the acquisition of water in the environment, with documented cases of convergent adaptations for species in arid environments (Comanns el al. 2011. Beilstein J. Nanotechnol. 2:204–214). *Ameivula abaetensis* is a diurnal lizard species, endemic to the sand dune habitats ("restinga") along the Brazilian coastline. The geographic distribution of the species extends from the north coastline of Bahia State in Salvador Municipality, to Santo Amaro de Brotas Municipality in Sergipe State (Dias et al. 2002. Copeia 2002:1070–1077). Previous research by Santa-Rosa et al. (2012. Bol. Mus. Biol. Mello Leitão 29:53-63) suggested that the ingestion of *Byrsonima microphyla* fruits by *A. abaetensis* may be an important source of water in restinga habitat during the dry season. This note reports drinking behavior in *A. abaetensis*.

Two independent groups of *A. abaetensis* were kept in captivity during the period of 28 February to 25 April 2009 (N = 8), and 20 to 27 October 2012 (N = 6). The specimens were collected during field activities, in the sand dunes habitat in Restinga do Abaeté, Salvador, Bahia (12.9283°S, 38.3358°W; datum WGS84), and they were kept in captivity for behavioral observations (license nº 31047-1/SISBIO). The climatic and structural conditions of captivity (terrarium with dimensions 100 × 100 × 100 cm) were very similar to those found in the natural microhabitat inhabited by the species (Dias and Rocha 2004. J. Herpetol. 38:586–588; Dias et al. 2005. J. Herpetol. 15:133–137; Dias and Rocha 2007. Braz. J. Biol. 67:41–46), but the specimens were kept sheltered from direct sunlight. For the first group, we provided fruit (*B. microphyla*) and water for sustenance in shallow containers. For the second group, we provided small beetles and water. For

both conditions, during *ad libitum* observations, we recorded the drinking behavior at 1300 h on 20 April 2009 and 1000 h on 25 October 2012 using an SLR camera. In both treatments (with and without the availability of fruit), it was possible to verify the drinking behavior. The behavior consisted of approaching the water source, followed by the animal lowering its head and using its tongue to collect water. Once the water was obtained, the animal raised its head, keeping it perpendicular to the soil surface for up to five seconds. Further, the animals simultaneously kept their front limbs flexed, such that the anterior ventral surface of the body was not in contact with the ground.

Although there are no published data concerning ingestion of water in natural habitat for *A. abaetensis*, these observations suggest that this behavior can be common when water is available in a xeric ecosystem, despite water availability within the diet (e.g., *B. microphyla*). The opportunistic behavior of drinking water has been described in other species of heliophilous lizards (Ribeiro and Freire 2009. Herpetol. Rev. 40:228–229) and it can be considered a convergent behavioral adaptation for lizards occurring in habitat with low water availability.

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***PHRYNOSOMA ASIO* (Giant Horned Lizard). DRINKING BEHAVIOR.** Stereotypical behaviors surrounding water intake in the genus *Phrynosoma* have been well reported (Mayhew and Wright 1971; Peterson 1998; Sherbrooke 1990). Desert lizards like *Phrynosoma* rarely have access to bodies of water and are adapted to take little or no water for long periods of time (Meyer 1966). Herein we report an unknown and unusual water ingestion method in *P. asio*, a horned lizard widely distributed in southwest Mexico (Reeve 1952). On 30 April 2012 we observed a captive female *P. asio* (95 mm SVL) dipping her head, neck, and forelimbs into the water trough of her terrarium while making light and leisurely sucking motions with her throat (Fig. 1). We also recorded the behavioral display time, having a duration of 7 minutes and a repeat of the same behavior the next day with a duration of 5 minutes. The knowledge of this horned lizard's ecological and ethological aspects are relatively little documented (Pianka and Parker 1975). We thank Oscar Avila Morales, Jonathan Vazquez Sanchez, and Jose Antonio Rosas by supporting us in the field and Tania Raya Garcia for support in caring for the specimen in captivity.



FIG. 1 Adult Female *Phrynosoma asio* exhibiting their water intake behavior.

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SQUAMATA — SNAKES

***CROTALUS OREGANUS OREGANUS* (Northern Pacific Rattlesnake). LONGEVITY.** At a local non-profit education center in Mather, California, USA, we believe we have one of the oldest captive rattlesnakes on record. During the spring of 1982, a small juvenile male *Crotalus oreganus oreganus* was collected in Auburn, California, USA, by a student attending Placer High School. It was presented to Placer High biology teacher, Douglas Stryker, who kept the specimen as an educational classroom pet. The snake was kept in the classroom for 31 years. Recently Mr. Stryker retired, and in November 2012 the snake was given to a local non-profit, Sacramento Splash, and now resides in the Splash Education Center.

Crotalus oreganus are typically born in the fall, but do not emerge until the following spring (Diller and Wallace 1984). As this specimen of *C. o. oreganus* was collected as a small juvenile in the spring, it is believed to have been born in the fall of 1981. This makes this *C. o. oreganus* over 31 years old at the time of submission (April 2013). We believe this is the oldest *C. oreganus* on record and among the oldest *Crotalus* that have been recorded.

The average lifespan for *C. oreganus* in the wild is approximately 20 years (Fitch 1949). A captive *C. o. oreganus* that was recorded at 22 years, 7 months is reported by Slavens (http://www.pondturtle.com/lsnaked.html#Crotalus). Still, no records document an individual *C. o. oreganus* older, or even close to the age of the snake reported herein.

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***MASTICOPHIS MENTOVARIUS* (Neotropical Whipsnake). REPRODUCTION.** *Masticophis mentovarius* is a neotropical colubrid that ranges from northern Mexico to northern South America (Lemos-Espinal and Smith 2007. Amphibians and Reptiles of the State of Chihuahua, Mexico. CONABIO-UNAM. 178 pp.). The reproductive mode is oviparous and, at least in a population in Veracruz, Mexico, wild females are gravid from April to May (Pérez-Higareda et al. 2007. Serpientes de la Región de los Tuxtlas, Veracruz, México. UNAM. 189 pp.). Eggs have been reported to be laid inside abandoned burrows or cracks in the ground (Vázquez and Quintero 2005. Anfibios y Reptiles de Aguascalientes. CIEMA-CONABIO. 197 pp.). In populations studied, the eggs are white and are laid in clutches of 17–20, have a granular surface, are not adhesive to one other, and measure 46–64 mm

in length, 26–36 mm in diameter (Lemos-Espinal and Smith, *op. cit.*).

The herpetology laboratory at Facultad de Estudios Superiores Iztacala, Universidad Nacional Autónoma de México, supports a diverse live collection of reptiles and amphibians. The majority of them are Mexican species. The collection includes *Masticophis* spp., including two individuals of *M. mentovarius*. Here we report reproductive information about this species, based on our observations in recent years, including timing of copulation events, clutch production, hatchings, and egg sizes.

Between 1991 and 2000, four copulation events were recorded, two during February and two during March. Four clutches have been laid, two in April and two in July (9, 7 and 2, 5 eggs respectively). Two clutches have hatched during June (4 and 5 hatchlings respectively); on this last clutch, the eggs (N = 5) had a mean mass of 5.14 g, mean length of 42.8 mm, and mean width of 16.4 mm.

During 2008 and 2009 we recorded two additional reproductive events. In April 2008, in an exhibition enclosure (165 × 165 × 65 cm), copulation was observed; temperature was 28–30°C and relative humidity (RH) was 50–70%. The male (1330 mm SVL) came from the state of Morelos and the female (1180 mm SVL) was from the state of Guerrero, Mexico. On 7 July 2008, the female laid a clutch of 11 eggs, of which six were judged to be in good condition. Those eggs were incubated at 28–30°C and a RH of 50–70%. The mean weight of the eggs was 11.30 g. Two hatchlings were found on 13 and 14 August (mean mass 7.73 g, mean SVL 221.1 mm). On 19 August the rest of the eggs were discovered in poor condition and four snakes were found dead inside the eggs (mean mass 5.74 g, mean SVL 194.5 mm).

The second observation was on 13 February 2009. The same pair of *M. mentovarius* produced a clutch of nine eggs (mean mass 13.83 g, mean length 49.9 mm, and mean width 21.4 mm). The eggs were infertile.

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***THAMNOPHIS RADIX* (Plains Gartersnake). REPRODUCTION / LITTER SIZE.** Brood (litter) sizes for *Thamnophis radix* are well documented, and are known to vary by geography, size (and age), and prey availability (Engeman et al. 2002. Herpetol. Rev. 33:59; Fitch 1985. Misc. Publ. Univ. Kansas Mus. Nat. Hist. 76:1–76; Stanford and King 2004. Copeia 2004:465–478). Blackburn and Stewart (2011. *In* Aldridge and Sever [eds.], Reproductive Biology and Phylogeny of Snakes, pp. 119–181. Science Publishers, Enfield, New Hampshire) report the largest known litter size for *T. radix* to be 92.



FIG. 1. All 90 of the seemingly healthy offspring produced by a large *Thamnophis radix* collected in Edmunds Co., South Dakota.

During the fall of 2011, MZ collected a large adult female *T. radix* along a busy highway in Edmunds Co., South Dakota, USA. The female was kept in an enclosure with an adult male *T. radix* and both were hibernated during the winter. The pair was kept in the enclosure until early August 2012 at which time the male was moved into a separate enclosure in anticipation of the female giving birth. Starting on the evening of 9 August 2012, the female gave birth to one unfertilized ovum, six stillborn, one malformed, and 90 seemingly healthy offspring (Fig. 1). Three of the stillborn and the single live malformed offspring displayed bicephaly. The production of 97 offspring represents the largest brood for *T. radix* documented to date.

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AMPHIBIAN DISEASES

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First Report of Ranavirus in Plethodontid Salamanders from the Mount Rogers National Recreation Area, Virginia, USA

Ranaviruses are an emerging pathogen responsible for numerous amphibian die-offs throughout Europe and North America (Miller et al. 2011). In the southeastern United States, local anuran die-offs due to ranavirus have been observed (Green et al. 2002; Hoverman et al. 2012; Todd-Thompson 2010), and suggested to contribute to local species declines (Gray et al. 2009a). The southern Appalachian Mountains have one of the greatest global diversities of plethodontid salamanders (Dodd 2004), and disease emergence could have devastating impacts on community structure and ecosystem function (Whiles et al. 2006). Ranavirus infections have been reported in 14 species of plethodontid salamanders occurring in the southern Appalachian Mountains (Miller et al. 2011). Initial surveys for ranavirus infections have focused on the Great Smoky Mountains National Park (81% prevalence; Gray et al. 2009b), which is known for high species richness of plethodontid salamanders (Dodd 2004). However, much of the remainder of the southern Appalachian Mountains has not been investigated except for a single study in the Ridge and Valley physiographic province of Wise County, Virginia (33% prevalence; Davidson and Chambers 2011). Many other Appalachian peaks have high plethodontid salamander richness and include many species with limited distributions, but the occurrence of ranavirus in these communities is unknown.

We sampled salamanders in the Mount Rogers National Recreation Area (MRNA), Virginia from Whitetop and Beech Mountains (Grayson, Smyth, and Washington counties). Many species reach the extreme northern limit of their range on these mountains with 15 species of plethodontid salamanders found on Whitetop Mountain alone (Organ 1991). Our sampling focused on five species with aquatic larval stages (i.e., complex life cycle), which have shown higher prevalence of ranavirus infection (Gray et al. 2009b), and four terrestrial-breeding species with direct development. Nine species that we targeted for sampling included: Northern Dusky (*Desmognathus fuscus*), Seal (*D. monticola*), Blue Ridge Dusky (*D. orestes*), Northern Pygmy (*D. organi*), Black-bellied (*D. quadramaculatus*), Blue Ridge Two-lined (*Eurycea wilderae*), Northern Gray-cheeked (*Plethodon montanus*), Ravine (*P. richmondi*), and Weller's (*P. welleri*) salamanders. In Virginia, Weller's, Northern Pygmy, Blue Ridge Dusky, and Blue Ridge Two-lined salamanders are listed as species of greatest conservation need (Virginia Department of Game and Inland Fisheries 2005).

Salamanders were captured along transects from June to August 2008 and May to August 2009 from Byars Creek (1158–1311 m elev.; 36.62755°N, 81.58903°W), Whitetop Creek (1158–1615 m elev.; 36.64016°N, 81.60040°W), Dells Branch (945–1585 m elev.; 36.64774°N, 81.60254°W), Beech Mountain (956–1097 m elev.; 36.63362°N, 81.63030°W), and Daves Ridge (1128–1433 m elev.; 36.6475°N, 81.59185°W). Each transect was positioned perpendicular to the elevational gradient centered on either a stream or ridge line. We searched for salamanders on each side of the transect for one person-hour (~150 m) at every 30.5 m of elevation by turning all cover objects. We placed each captured salamander in individual 1.2-liter plastic bags. We used sterile forceps to remove a small tail section along the natural break point and placed each sample in a sterile microcentrifuge tube with 99% reagent grade isopropyl alcohol. We used a different set of sterilized forceps for each individual tail sample. Between sampling events, forceps were autoclaved to destroy remnant DNA.

We extracted genomic DNA from tail samples using a DNeasy Blood and Tissue Kit (Qiagen Inc., Valencia, California), and used a Qubit™ fluorometer to quantify the concentration of genomic nuclear DNA from tail samples. Samples from 2008 (N = 99) were extracted and quantified at the Diagnostic and Investigational Laboratory in the College of Veterinary Medicine at the University of Georgia (UGA). In 2009, we extracted and quantified the 2009 samples (N = 320) in the Center for Wildlife Health at the University Tennessee (UT). Real-time qPCR was performed using the identical primers and protocol of Gray et al. (2012). The qPCR was conducted using a SmartCycler system (Cepheid, Sunnyvale, California) for 2008 samples and an ABI 7900HT PCR system (Live Technologies Corp., Carlsbad, California) was used for 2009 samples. Controls included two positive controls (cultured virus and known positive tadpoles) and two negative controls (water and known negative animal). The qPCR was run in

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TABLE 1. Ranavirus prevalence in salamander communities inhabiting Whitetop Mountain (Grayson, Smyth, Washington counties), Virginia, USA.

Species	No. infected / total no. sampled	Prevalence of infection (95% confidence interval)
Desmognathus fuscus	1 / 11	0.09 (0.02–0.37)
Desmognathus monticola	2 / 22	0.09 (0.03–0.28)
Desmognathus orestes	3 / 145	0.02 (0.01–0.05)
Desmognathus organi	3 / 70	0.04 (0.01–0.12)
Desmognathus quadramaculatus	1 / 32	0.03 (0.01–0.16)
Eurycea wilderae	0 / 5	0 (0–0.44)
Plethodon montanus	3 / 101	0.03 (0.01–0.08)
Plethodon richmondi	0 / 3	0 (0–0.56)
Plethodon welleri	1 / 30	0.03 (0.01–0.17)
Total	14 / 419	0.03 (0.02–0.06)

duplicate and a C_T value ≤ 30 was deemed positive, according to equipment optimization at UGA and UT.

Our results document the first known presence of ranavirus infection in amphibians of the MRNA. Salamanders sampled and all other salamanders observed did not display external signs of ranavirus infection such as swelling or ulcerations (Miller et al. 2011). We detected ranavirus in seven salamander species (Table 1)—four of the species were first-time detections: Weller's, Northern Pygmy, Blue Ridge Dusky, and Northern Gray-cheeked (Miller et al. 2011). Ranavirus prevalence ranged from 3–9% within species, and was 3% among all species that tested positive (Table 1). Infected salamanders were found between elevations of 945–1554 m, and along all transects except Daves Ridge. Species with a more aquatic life history (*D. fuscus* and *D. monticola*) had the highest prevalence of infection (9%), as reported by Gray et al. (2009b). However, there was no association between larval life history (aquatic larvae or terrestrial direct development) and infection status ($\chi^2 = 0.01$, $p = 0.920$), which may be a consequence of low overall prevalence. Additionally, there was no association between sampling years ($\chi^2 = 0.196$, $p = 0.658$).

Our low detection of ranavirus infection could be partly influenced by the type of tissue collected. Gray et al. (2012) demonstrated that tail clips produced false-negative results for 20% of tail samples in American Bullfrog (*Lithobates catebeianus*) tadpoles when compared to liver tissue samples and suggested that false negatives could relate to the sensitivity of the amphibian host. Even with the possibility of a 20% false detection rate, salamanders from the MRNA appear to have lower ranavirus prevalence than salamanders from the Great Smoky Mountains National Park (81%; Gray et al. 2009b) and Wise County, Virginia (33%; Davidson and Chambers 2011). Future research could include histological analyses to reduce the potential of false negatives (Gray et al. 2012) as well as genetic sequencing to identify the strain(s) of ranavirus present in the MRNA.

We documented ranavirus infections occurring in secluded areas (often ≥ 300 m from trails, roads, or other areas of public activities) of the MRNA, indicating that this pathogen is not always associated with human-impacted sites (Gray et al. 2007). We documented infections in four additional species of plethodontid salamanders, including rare species. Weller's Salamanders are an IUCN (2008) Red List species, and our positive results from this species are a concern suggesting that further monitoring may be warranted. These results provide additional evidence that ranavirus could be distributed throughout the Southern Appalachian Mountains. In the MRNA, ranavirus was found to infect both rare and more abundant salamanders as well as those with aquatic or terrestrial embryonic development, suggesting that ranavirus is not selective and any southern Appalachian salamander could be at risk. Additionally, six other species of plethodontid salamanders, Eastern Newts (*Notophthalmus viridescens*), and five anuran species are found in the MRNA, but were not part of this study (Hamed, unpubl. data). Given the tendency for anurans to be more susceptible to ranavirus than salamanders (Hoverman et al. 2011), frogs may be important reservoirs and amplifying hosts for ranavirus (Paull et al. 2012). It would be prudent to include all amphibian species in future monitoring designs to provide a more comprehensive understanding of ranavirus prevalence in the MRNA, and to increase the likelihood of identifying amplifying species and disease hotspots (Paull et al. 2012).

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Batrachochytrium dendrobatidis in South Dakota, USA Amphibians

Although the amphibian chytrid fungus, *Batrachochytrium dendrobatidis* (*Bd*), has been well-studied across the United States, there are still several regions where little is known regarding its presence or prevalence (Oullet et al. 2005; www.Bd-maps.net). Currently, there is no information regarding *Bd* occurrence in South Dakota, yet of the 15 amphibians species known to reside in South Dakota, many have been documented as hosts to *Bd* in other states (Oullet et al. 2005; Woodhams et al. 2008). Additionally, neighboring states have documented the presence of *Bd* in these and other species (Hossack et al. 2010; Rodriguez et al. 2009). To help fill the knowledge gap for South Dakota, we sampled for the occurrence of *Bd* at several locations across the state.

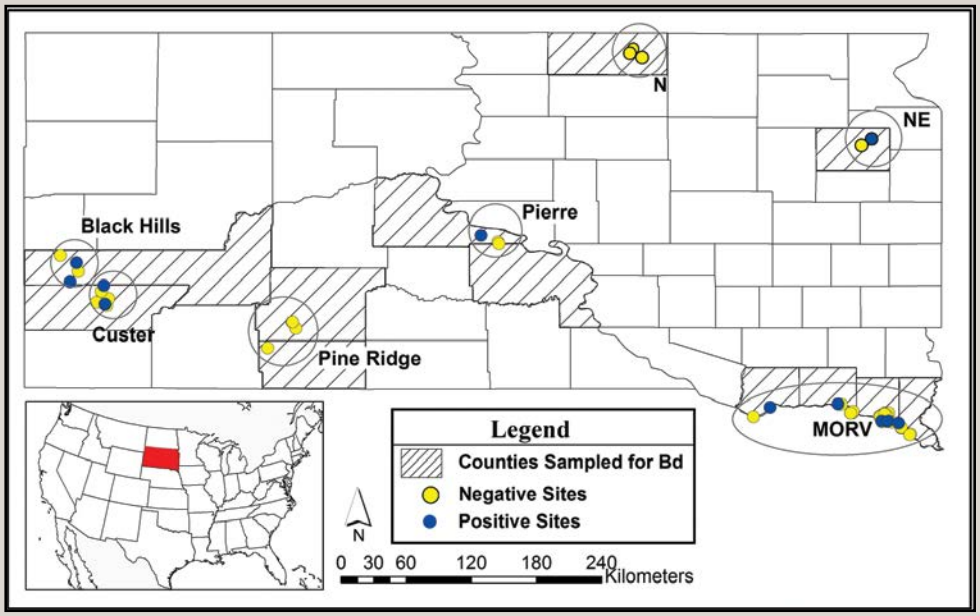


Fig. 1. Locations sampled for *Batrachochytrium dendrobatidis* (*Bd*) within South Dakota, USA. Blue dots represent sites with *Bd* detections.

We opportunistically sampled amphibians for *Bd* in seven regions of South Dakota (Fig. 1) from April 2010–August 2011. Using nylon swabs, amphibians were rubbed along the ventral side of their hands, feet, legs and abdomen five times each for a total of 25 swipes per amphibian. To prevent cross contamination, animals were handled and swabbed separately, and swabs were stored individually in tubes. Samples were kept on ice until brought to a molecular biology facility at the University of South Dakota where they were kept at 0°C until processed.

DNA was extracted from swabs using the included protocol for DNeasy® spin column kits (Qiagen, Inc., Germantown, Maryland). Each sample was run using an Applied Biosystems StepOne Plus quantitative PCR machine (Applied Biosystems, Inc., California) according to the fast qPCR protocol as described by Kerby et al. (2013). Each sample was run in triplicate and was considered positive if at least two of the three replicates were positive. A negative control was placed on each plate and the *Bd* standards utilized were from CSIRO laboratories in Australia. The pathogen load estimates are provided in zoospore genome equivalents per swab.

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TABLE 1. Infection status and pathogen load (# zoospores/positive swab) of species by each region sampled. Fractions represent the number of infected/tested. Average pathogen load estimates for positive values are provided in parentheses. MRV- Missouri River Valley in southeastern part of the state; N- Northern region; NE- Northeastern region; Pierre- Pierre National Grasslands; Black Hills- Black Hills National Forest; Pine Ridge- Pine Ridge Reservation; Custer- Custer State Park.

Species	MRV	N	NE	Pierre	Black Hills	Pine Ridge	Custer	Total	
Lithobates blairi	1/428 (0.48)	0/3	1/28 (0.04)	0/34	2/62 (2.29)	0/9	7/37 (8.15)	11/599 (5.4)	1.80%
Lithobates pipiens	0/55	-	-	-	-	-	-	0/55	0%
Anaxyrus woodhousii	3/343 (2.28)	-	-	-	-	-	0/1	3/344 (2.28)	1%
Acris crepitans	2/102 (110)	-	-	-	-	-	-	2/102 (110)	2%
Pseudacris maculata	68/249 (638)	-	-	1/12 (0.1)	1/30 (0.15)	-	-	70/291	24%
Hyla chrysoscelis/versicolor	0/53	-	-	-	-	-	-	0/53	0%
Spea bombifrons	-	-	-	-	-	0/15	0/1	0/16	0%
Ambystoma tigrinum	0/6	-	-	-	-	0/6	-	0/12	0%
Anaxyrus cognatus	4/100 (0.35)	-	-	-	-	-	-	4/100 (0.35)	4%
Anaxyrus hemiophrys	-	0/2	-	-	-	-	-	0/2	0%
Total by region	7/1287 (535)	0/6	1/28 (0.04)	1/46 (0.11)	3/90 (1.58)	0/30	7/39 (8.15)	90/1525 (470)	5.9%

A total of 1525 amphibians of 10 species were swabbed for *Bd* during the study (Fig. 1). *Bd* was detected on 90 animals (6%) in five different species, and in 5/7 regions sampled (Table 1). One site had particularly high *Bd* occurrence, with 64 of 68 *Pseudacris maculata* being *Bd*-positive near Vermillion, South Dakota. There was no mortality observed at this site, nor were any symptomatic individuals detected.

As expected, *Bd* was present in most of our sampled sites in South Dakota. We found *Bd* in half the species examined, and in all regions with > 30 samples taken. *Bd* was not detected in two sampled regions, but this might be due to lower sampling (< 30) at these sites. Similarly, the three species for which *Bd* was not detected also had low sample sizes, perhaps precluding an accurate assessment if *Bd* occurs at a low level in these species (Skerratt et al. 2008). Therefore the results cannot be examined as a comprehensive determination of host or pathogen distribution, but our findings provide important information regarding infection on specific species and sites.

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Amphibian Chytrid Fungus in Woodhouse's Toads, Plains Leopard Frogs, and American Bullfrogs along the Platte River, Nebraska, USA

We recently documented the first published record of the fungal pathogen *Batrachochytrium dendrobatidis* (chytrid) in Nebraska, USA, where we detected a high prevalence of chytrid in American Bullfrogs (*Lithobates catesbeianus*) in off-channel aquatic habitats on an island of the Platte River (Harner et al. 2011). This pathogen causes the disease chytridiomycosis (Longcore et al. 1999), and widespread amphibian mortality from infection is contributing to declines and regional extirpation of amphibians worldwide (Berger et al. 1998; Collins 2010; Daszak et al. 1999; Lips et al. 2006). We were concerned by the high prevalence of chytrid in American Bullfrogs on this island because American Bullfrogs have been introduced to the region (Fogell 2010), and they may negatively affect native amphibians through both direct (e.g., predation) and indirect (e.g., competition, disease transmission) interactions. Loss of native amphibians is of conservation concern for a number of reasons, notably the loss of biodiversity (e.g., Collins 2010) and alterations to ecosystem structure and function (Whiles et al. 2006). Along the Platte River, amphibian declines also have potentially negative consequences for an endangered migratory bird, the Whooping Crane (*Grus americana*), which relies on the river and surrounding wetlands for critical habitat during spring and autumnal migrations (USFWS 1978) and preys upon frogs during migratory stops (Geluso et al., *in press*).

Objectives of our study were to spatially extend sampling for chytrid to other sites and species along the central Platte River. In our prior survey we also sampled native Plains Leopard Frogs (*Lithobates blairi*) and Woodhouse's Toads (*Anaxyrus woodhousii*) and did not detect chytrid, but our sample sizes were low (N = 20 and 21, respectively) and from a small geographical area, so we may have failed to detect infection (Skerratt et al. 2008). Therefore, in this survey we focused on obtaining sample sizes of greater than 40 individuals for each species and sampled several locations to determine whether chytrid was present in native species and at multiple locations along the central Platte River in Nebraska.

We sampled amphibians along a 100-km reach of the Platte River in central Nebraska (Fig. 1) on Jeffrey Island (40.6901°N, 99.5956°W) and Cottonwood Ranch (40.6868°N, 99.4784°W) in Dawson County; Blue Hole East (40.6836°N, 99.3758°W) in Kearney County; Dippel (40.7036°N, 98.7950°W) in Buffalo County; and Shoemaker Island (40.7920°N, 98.4620°W) in Hall County. Property ownership was as follows: Jeffrey Island (Central Nebraska Public Power and Irrigation District), Cottonwood Ranch and Blue Hole East (Nebraska Public Power District), and Dippel and Shoemaker Island (The Crane Trust). Sampling effort was more extensive on Jeffrey Island to compare this more western portion of the river reach to the previously sampled Shoemaker Island (Harner et al. 2011).

Amphibians were sampled from a variety of habitats including river channels, sloughs (natural and created), ponds, borrow pits, stock tanks, and uplands. Sampling occurred in autumn 2011 (Shoemaker Island) and spring-summer 2012 (all sites).

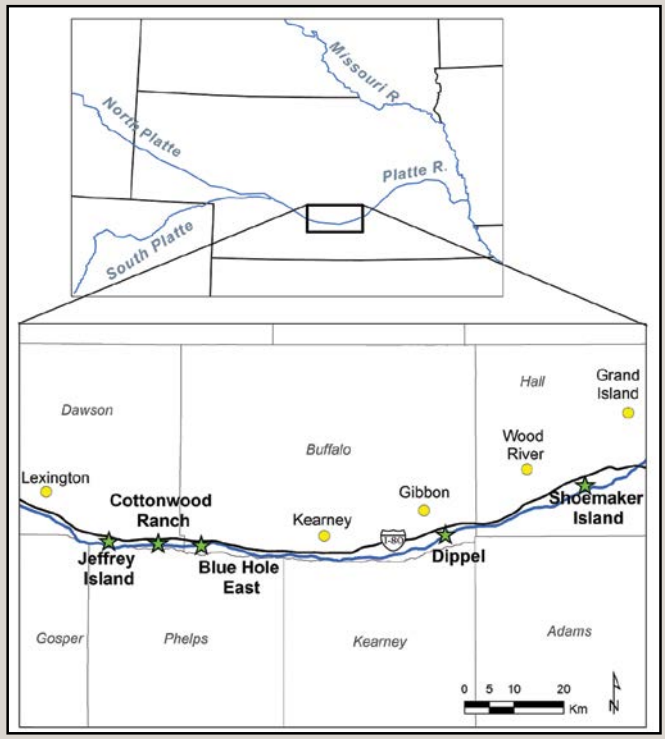


FIG. 1. Location of sites sampled (denoted by green stars and bold text) for amphibian chytrid fungus, *Batrachochytrium dendrobatidis*, along the Platte River in central Nebraska, USA. Detailed image also includes county names (italics), select towns (yellow circles), the Platte River (blue line), and interstate highway (dark black line).

Individuals were captured by hand, and researchers wore disposable gloves to minimize contamination and changed gloves between each capture. After capture we rubbed a sterile swab (Fisherfinest® Dry Transport Swab; Fisher HealthCare, USA) across the abdomen, throat, inner thighs, webbing of toes, and mouthparts. Swabs were air-dried, stored frozen, and shipped frozen to the University of South Dakota for testing.

Samples were analyzed for chytrid with real-time Taqman PCR assay. DNA was extracted from swabs using Qiagen DNEasy Blood and Tissue spin column kits according to manufacturer's protocol. Pathogen load per swab was determined with quantitative PCR on a StepOnePlus machine (Applied Biosystems). Reactions were run based on a standard protocol described in Kerby et al. (2013). Each plate contained a standardized dilution

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series of quantified zoospore numbers to use as a standard curve. A negative control also was included on every plate. Samples were run in triplicate, and positive values were averaged to determine a final estimated pathogen load for each swab.

The study area experienced prolonged drought in 2012 with an onset of abnormally dry conditions by late May that transitioned to extreme drought by the end of August (droughtmonitor.unl.edu; accessed 30 November 2012). As a result, virtually no temporary ponds were present, hindering our ability capture any Plains Spadefoots (*Spea bombifrons*) and restricting our captures of Boreal Chorus Frogs (*Pseudacris maculata*) to only three. Both species rely on temporary ponds and both are known from the region (Ballinger et al. 2010, Fogell 2010).

Table 1. *Batrachochytrium dendrobatidis* (*Bd*) prevalence (no. *Bd*-positive individuals/total no. individuals sampled) at sites along the central Platte River, Nebraska, USA.

Date	Site	Woodhouse's Toad	American Bullfrog	Plains Leopard Frog
Oct 2011	Shoemaker Island	—	—	1 /5
May 2012	Jeffrey Island	0/2	6/18	7/11
	Dippel	—	1/3	10/13
	Shoemaker Island	—	2/8	4/5
Jun 2012	Jeffrey Island	0/5	0 /11	1/8
Jul 2012	Jeffrey Island	10/17	—	0/8
	Cottonwood Ranch	4/14	0/3	3/14
Aug 2012	Jeffrey Island	—	1/12	0/2
	Blue Hole	0/2	—	—
	TOTAL	14/40 (35%)	10/55 (18%)	26/66 (39%)

We sampled a total of 163 individuals of four species for chytrid (Table 1). Five Plains Leopard Frogs were sampled from Shoemaker Island on 25 October 2011 prior to winter, whereas all other individuals were sampled from 9 May to 21 August 2012. Four Plains Leopard Frogs were metamorphs, and all other individuals were adults.

Across sites, prevalence of chytrid was 35% for Woodhouse's Toads, 18% for American Bullfrogs, and 39% for Plains Leopard Frogs (Table 1). None of the Boreal Chorus Frogs tested positive. One Plains Leopard Frog metamorph tested positive. For positive samples, the pathogen load (number of zoospore equivalents per swab) ranged from 0.87-6560 (median = 51) in Woodhouse's Toads; 0.02-84 (median = 2) in American Bullfrogs; and 0.04-8139 (median = 27) in Plains Leopard Frogs.

Our findings add to the geographical extent and list of species infected by chytrid in central Nebraska along the Platte River. Results confirm presence of chytrid in invasive American Bullfrogs as well as in two native species, Woodhouse's Toads and Plains Leopard Frogs, across this 100-km reach of river. Prevalence of chytrid was moderate (30%) across species sampled, but pathogen load did not exceed levels reported as a threshold for mass mortality in other species (~ 10,000 zoospore equivalents per swab; Vredenburg et al. 2010). Prevalence of chytrid was lower in American Bullfrogs from Shoemaker Island in this study (25%) compared to our 2010 survey (41%; Harner et al. 2011). This difference may be linked to climatic differences between years, as 2010 had above-average precipitation (4th wettest over 74-year record), whereas 2012 had below-average precipitation (4th driest over 74-year record) measured at Grand Island, NE (www.ncdc.noaa.gov; accessed 30 November 2012). The influence of drought on chytridiomycosis is currently debated, but some argue that dry conditions may decrease prevalence and severity of chytrid (Kriger 2009). Regardless, presence of chytrid in invasive American Bullfrogs is a concern because they are nonclinical carriers of chytrid (Daszak et al. 2004; Garner et al. 2006; Schloegel et al. 2009).

Seasonality of chytrid infection was not a focus of this study, but trends emerged that warrant further investigation. Prevalence of chytrid in Plains Leopard Frogs from Shoemaker Island went from 1 in 5 to 4 in 5 individuals between autumn and spring, and prevalence of chytrid was higher in May than subsequent months in 2012 across sites. These trends potentially suggest that Plains Leopard Frogs may be at an elevated risk in spring. Other studies have observed peaks in chytrid prevalence and pathogen load in early spring (Gaertner et al. 2012; Kriger and Hero 2007a; Retallick et al. 2004), as well as a negative relationship between temperature and chytrid prevalence (e.g., Kriger and Hero 2007a). From a conservation standpoint, availability and abundance of Plains Leopard Frogs in March and April may be important for foraging Whooping Crane during migratory stopovers in the region (Geluso et al., *in press*).

There is need for ongoing monitoring of chytrid along the central Platte River to capture variation across habitats as well as through time. Along with the seasonal patterns noted above, we saw a trend of varying incidences of infection among different habitats (data not presented due to small sample size), though more systematic sampling is required to draw inferences about prevalence among different habitats. Other studies have detected an effect of local environmental conditions on chytrid, such as greater prevalence in permanent compared to ephemeral water bodies (Kriger and Hero 2007b). A better understanding of the seasonality and influence of habitat on the pathogen may help resource managers target conservation measures to reduce the threat of chytrid to native amphibians along the central Platte River, and thus help maintain the natural structure of the interconnected aquatic and terrestrial food webs along these flood plains.

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Amphibian Populations in Brazos River Basin, Texas, Show No Evidence of *Bd* Infection

Discovered and described only a decade ago (Longcore et al. 1999), amphibian chytrid fungus *Batrachochytrium dendrobatidis* (*Bd*) has rapidly expanded its range, and new geographic distribution reports are being added frequently (http://www.bd-maps.net/). In the United States, *Bd* infection has been documented in amphibian populations in nearly all of the states (Olson et al. 2013). However, except for two studies, the state of Texas remains under-surveyed for this pathogen. Gaertner et al. (2009) reported *Bd* occurrence in individuals of five salamander species along parts of the Colorado and Guadalupe River basins in Central Texas. Saenz et al. (2010) reported incidences of *Bd* infection in five anuran and one plethodontid species *s*pread across forested areas in Eastern Texas. To address the lack of surveys in the Brazos River basin of Texas, we sampled amphibians for *Bd* from two disjunct areas along the watershed (Fig. 1).

In August–September 2011 and April–May 2012 we sampled from urban modified playa wetlands within the city of Lubbock, located in northwest Texas near the upper reaches of the Brazos River basin. Lake Waco wetlands, situated in the central portion of the Brazos River basin in central Texas, were sampled in May–July 2012. Areas of study were under severe drought in the year 2011. However, sampling in 2012 for Lubbock and Lake Waco wetlands (sampled only in 2012) was carried out earlier in the year when temperatures were cooler and rain events facilitated breeding aggregations.

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Post-metamorphic amphibians were swabbed 20–25 times along the ventral side of their abdomen, legs, and between their toes following established field protocol (Brem et al. 2007). Additionally, we also took scrapes from tadpole mouthparts using wooden toothpicks (procedure described by Retallick et al. 2006) while sampling in 2011 as very few post-metamorphic amphibians were being observed in Lubbock during this year. Amphibians were swabbed during call/visual surveys conducted following rain events and tadpole mouthparts were scraped during dipnet surveys conducted during the day in the following two weeks.

Overall, we sampled 76 individuals from Lubbock and 51 individuals from Lake Waco wetlands comprising a total of ten anuran and one caudate species (Table 1). Collected swabs and scrapes were stored in 70% ethanol (Brem et al. 2007) and placed in temperatures at or below –20°C until further analysis. Because swabs were stored in cold temperatures there was no danger of degradation (Hyatt et al. 2007; K. Kriger, pers. comm.). In March 2013, swabs and scrapes from Lubbock, pooled by species, location, and year, were sent to Pisces Molecular LLC in Boulder, Colorado. Total DNA was extracted from all samples using a spin-column DNA purification procedure; these were then assayed for the presence of *Bd* by a modified version of the procedure described by Annis et al. (2004) which increases sensitivity and specificity for *Bd* detection at the laboratory (J. Wood, pers. comm.). Each PCR run included the following controls: positive DNA-DNA prepared from a laboratory culture of *Bd* Strain JEL 270, negative DNA-DNA prepared from an uninfected amphibian, no DNA (control)-water in place of template DNA (information from this paragraph has been directly adapted from test results for the PCR assay from Pisces laboratory).

Samples from Waco were tested for the presence of *Bd* at Texas Tech University in Lubbock using the DNA extraction method and subsequent polymerase chain reaction protocol described by Annis et al. (2004). Samples were pooled in groups of ten, and DNA was extracted using the PrepMan Ultra reagent according to supplier protocol (Life Technologies, Grand Island, New York). We then used the *Bd*-specific primers Bd1a and Bd2a to amplify any *Bd* DNA present from the samples. In addition, we also ran a positive control containing *Bd* genomic DNA and a negative control containing sterile water only. Following PCR analysis, we ran the products on a 1.2% agarose gel and included a 1 kb DNA ladder in order to determine the size of any amplified products. GelStar nucleic acid gel stain (Cambrex Bio Science Rockland, Inc. Rockland, Maine) was used to visualize bands.

Overall, we collected 76 swabs (including tadpole mouthpart scrapes) from Lubbock and 51 swabs from Lake Waco wetlands. All 127 swabs tested negative for the presence of *Bd*. Because our sample size safely exceeds that recommended by Skerratt et al. (2008) for achieving 95% certainty, we can reasonably infer that *Bd* infection has either not spread into, or remains exceedingly rare, in urban wetlands in Lubbock and the Lake Waco wetlands of the Brazos River basin despite reported incidences of *Bd* infection in adjacent river basins to the south and east (Gaertner et al. 2009; Saenz et al. 2010) (Fig. 1).

We acknowledge that the occurrence of false-negatives is a possibility. The year 2011 was a period of intense drought in the region, with Lubbock and Waco setting new records for minimum precipitation and high temperatures. June–August 2011 were the warmest three months ever recorded in the region: the 100-day streak of 32.2+ degree days at Lubbock finally ended on 3 September 2011, while Waco saw a similar streak of 44

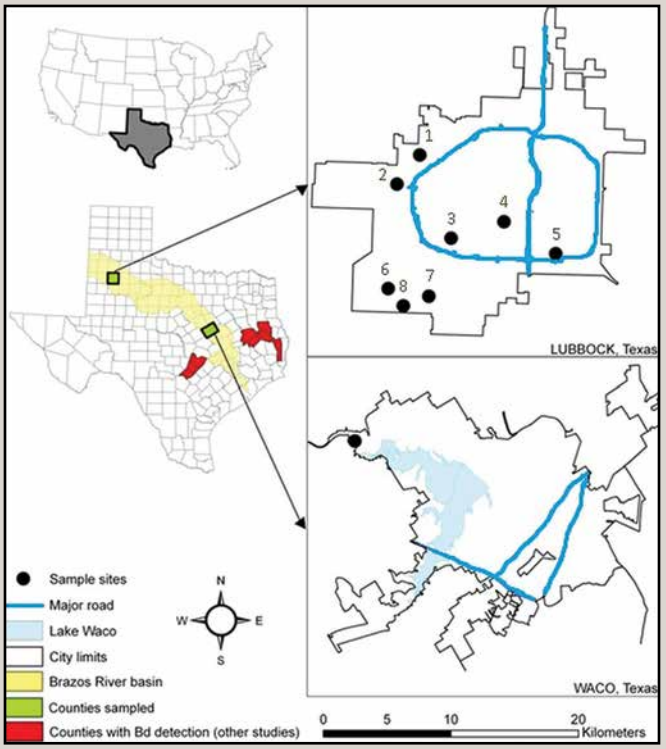


FIG. 1. *Batrachochytrium dendrobatidis* sampling locations at Lubbock and Waco, Texas, USA. Both cities lie in disjunct portions of the Brazos River basin.

days ending on 12 August 2011 (NOAA 2011, 2012). The unprecedented drought and high temperatures, clearly detrimental to amphibian activity and reproduction (Ramesh et al. 2012), may have ironically contributed to keeping *Bd* at bay (Kriger 2009). *Bd* grows best, has a better chance of spread, and is more likely to survive as zoospores in cool, wet conditions and in permanent water bodies (Gaertner et al. 2012; Johnson et al. 2003; Kriger and Hero 2007a). Moreover, *Bd* zoospores are highly prone to desiccation (Johnson et al. 2003), and occur at higher levels in permanent versus ephemeral water bodies (Gaertner et al. 2012; Kriger and Hero 2007b). Lack of standing water for long periods combined with prolonged temperatures well above 30°C during this period could have resulted in the lack of *Bd* occurrence in 2011 and into 2012.

Sampling for this study was conducted over two years in Lubbock and one year in Waco. It would have been ideal to sample under "normal" conditions considering the seasonality associated with chytrid fungus prevalence and persistence. However, such a "normal" year is unlikely in the near future of Texas where climate projections depict increased extreme temperatures, heat waves, and prolonged droughts along with decreased precipitation. Under such circumstances amphibian populations may already be vulnerable, and one cannot discount the additional influence of *Bd* (if present). We suggest that continuous monitoring for *Bd* presence be conducted in the long-term to catch the spread of this deadly pathogen in the state irrespective of climatic conditions.

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TABLE 1. Amphibian species, dates, and locations of *Batrachochytrium dendrobatidis* sampling in Lubbock and Waco, Texas, USA. Post-metamorphic animals were sampled unless noted. Location numbers for Lubbock, Texas are mapped in Fig. 1.

Date	Location	Species	Common name	No. swabs collected
27 August 2011	7, Lubbock	Bufonid tadpole	Unknown	8
1 September 2011	7, Lubbock	Bufonid tadpole	Unknown	3
2 September 2011	4, Lubbock	Bufonid tadpole	Unknown	2
13 August 2011	8, Lubbock	*Pseudacris clarkii*	Spotted Chorus Frog	1
13 August 2011	5, Lubbock	*Gastrophryne olivacea*	Great Plains Narrowmouth Toad	1
15 August 2011	3, Lubbock	*Anaxyrus speciosus*	Texas Toad	8
15 August 2011	4, Lubbock	*Anaxyrus speciosus*	Texas Toad	2
16 September 2011	4, Lubbock	*Lithobates catesbeianus*	American Bullfrog	1
12 April 2012	7, Lubbock	*Pseudacris clarkii*	Spotted Chorus Frog	1
12 April 2012	7, Lubbock	*Spea multiplicata*	New Mexico Spadefoot	1
12 April 2012	7, Lubbock	*Ambystoma tigrinum mavortium*	Barred Tiger Salamander	1
12 April 2012	2, Lubbock	*Anaxyrus speciosus*	Texas Toad	3
30 April 2012	5, Lubbock	*Gastrophryne olivacea*	Great Plains Narrowmouth Toad	1
1 May 2012	1, Lubbock	*Anaxyrus speciosus*	Texas Toad	9
1 May 2012	1, Lubbock	*Anaxyrus cognatus*	Great Plains Toad	1
1 May 2012	7, Lubbock	*Anaxyrus speciosus*	Texas Toad	4
1 May 2012	8, Lubbock	*Spea multiplicata*	New Mexico Spadefoot	13
1 May 2012	8, Lubbock	*Anaxyrus speciosus*	Texas Toad	1
1 May 2012	6, Lubbock	*Anaxyrus speciosus*	Texas Toad	8
2 May 2012	4, Lubbock	*Lithobates catesbeianus*	American Bullfrog	1
11 May 2012	8, Lubbock	*Anaxyrus speciosus* (dead)	Texas Toad	6
15 May to 20 July 2012	Lake Waco wetlands, Waco	*Hyla cinerea*	American Green Tree Frog	40
15 May to 20 July 2012	Lake Waco wetlands, Waco	*Acris crepitans*	Northern Cricket Frog	9
15 May to 20 July 2012	Lake Waco wetlands, Waco	*Incilius valliceps*	Gulf Coast Toad	1
15 May to 20 July 2012	Lake Waco wetlands, Waco	*Lithobates sphenocephalus*	Southern Leopard Frog	1
			Sample size:	127

S. Ramireddy, J. Bradstreet, A. Hicks, E. Marler, B. Garcia, J. Mathews, J. Flores, J. Quigley, D. Marquez, C. St.Clair, S. Krishnamoorthy, C. Crow, N. Stewart, G. Tomer, T. McFarlane, L. Kuhl, J. Proctor, S. Rooney, and G. Richarte. We are grateful to A. Godbee and J. Lippert for their assistance with obtaining landowner permission. We thank N. Schell and T. Conry of the Lake Waco Wetlands and City of Waco. We also thank M. San Francisco for providing us with lab space for molecular work, swabbing supplies, and his invaluable input. This research was carried out in compliance with the Texas Tech University Institutional Animal Care and Use Committee (IACUC permits 12012-04 and 10036-10). This is manuscript number T-9-1244, College of Agricultural Sciences and Natural Resources, Texas Tech University, Lubbock.

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High Prevalence of Ranavirus Infection in Permanent Constructed Wetlands in Eastern Kentucky, USA

Amphibians are declining globally, and both land-use change and infectious diseases are major drivers (Miller et al. 2011; Stuart et al. 2004). Because most wetlands have been destroyed or altered throughout the United States (e.g., Kentucky has lost >81% of its historic wetlands; Dahl 2000), wetlands have been created for mitigation or wildlife management (Brown and Richter 2012; Dahl 2000). Hundreds of closely spaced permanent wetlands have been constructed on ridge tops in eastern Kentucky for wildlife management within the same landscape as natural, ephemeral wetlands (Brown and Richter 2012). Although constructed wetlands provide breeding habitat for amphibians, they might not replace the function of natural wetlands, supporting different amphibian communities than natural ponds (Denton and Richter 2013; Drayer 2011). Moreover, constructed ponds have been associated with ranavirus outbreaks (Harp and Petranka 2006; Petranka et al. 2007). Our objective was to test for the occurrence of ranavirus and amphibian chytrid fungus, *Batrachochytrium dendrobatidis* (*Bd*), in amphibian populations inhabiting natural and constructed ridge-top wetlands of eastern Kentucky, USA.

Field surveys were conducted in five constructed and one natural ridge-top wetland located in the Daniel Boone National Forest (DBNF), Kentucky. All boots, dipnets, and other field supplies were disinfected with a 1% solution of Nolvasan® to prevent spread of pathogens between sampling sites (Bryan et al. 2009). Dipnet sampling was used to capture up to 10 adult Eastern Newts (*Notopthalmus viridescens*) in each constructed wetland and 10 Wood Frog (*Lithobates sylvaticus*) larvae in the natural wetland from 21 to 27 May 2012 (Table 1). No Eastern Newts were detected in natural wetlands, and no Wood Frog larvae were detected in constructed wetlands. These species were chosen because they have been associated with ranaviral disease die-offs in eastern North America (Green et al. 2002; Greer et al. 2005; Harp and Petranka 2006). None of the individuals that were collected had signs of ranaviral disease (Miller et al. 2011). Each Eastern Newt was swabbed using a BBL™ CultureSwab™ (Beckton, Dickinson, and Company, Franklin Lakes, New Jersey, USA) and had a 10-mm portion of its tail clipped. Swabs and tail clips were stored in 70% ethanol. Each *L. sylvaticus* larva was euthanized in 10% ethanol and stored in 95% ethanol (EKU Institutional Animal Care and Use Committee; protocol #04-2012).

Ranavirus and *Bd* testing was performed at the University of Tennessee Center for Wildlife Health following published standardized procedures (Hoverman et al. 2011a; Souza et al. 2012). Genomic DNA (gDNA) was extracted from a homogenate of liver and kidney tissue (Wood Frogs), tail clips (Eastern Newts), and swabs (Eastern Newts) using a commercially available kit (DNeasy Blood and Tissue Kit, Qiagen Inc., Valencia, California, USA) with molecular-grade water as the extraction control. We measured the concentration of gDNA in each sample and standardized the amount of gDNA (0.25 µg) used for PCR among samples. Quantitative real-time PCR (i.e., TaqMan® PCR) was performed following Boyle et al. (2004) for *Bd* assays and following Picco et al. (2007) for ranavirus assays. Positive controls were similar for each assay, and included DNA extracted from culture and a positive animal for each pathogen. Negative controls included molecular-grade water and DNA extracted from an animal that was known to be negative for each pathogen. Each assay was run for 40 cycles on an ABI 7900 Fast Real-Time PCR System (Life Technologies Corporation, Carlsbad, California, USA). Each sample was run in duplicate and considered positive only if the PCR cycle threshold (CT) was < 30 for both samples. The CT value was determined by developing a standard curve for our PCR equipment using serial dilutions of known pathogen quantities. When samples were positive, we used the standard curve to predict virus concentration (i.e., plaque forming units, PFU) using the average CT for the sample.

We did not detect *Bd* in any samples; however, nine samples from two constructed wetlands were positive for ranavirus

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TABLE 1. Prevalence with 95% confidence intervals of *Batrachochytrium dendrobatidis* (*Bd*) and ranavirus infection in Eastern Newts (*Notophthalmus viridescens*; *Nv*) in five constructed wetlands and Wood Frogs (*Lithobates sylvaticus*; *Ls*) from one natural wetland in the Daniel Boone National Forest, Kentucky. For each *Nv*, tail clips were tested for ranavirus, and swabs were tested for *Bd*. For each *Ls*, a homogenate of liver and kidney tissue was tested for ranavirus. Confidence intervals were calculated for small sample size using Wilson Score method with continuity correction (Newcombe 1998).

Study Site	Coordinates	Sample Size	*Bd* Prevalence (95% CI)	Ranavirus Prevalence (95% CI)
Gas Line Natural	38.284583°N 83.368972°W	*Ls*: N = 10	not tested	0 (0–0.345)
Gas line Artificial 2	38.285556°N 83.371778°W	*Nv*: N = 10	0 (0–0.345)	0 (0–0.345)
P5	38.087889°N 83.425278°W	*Nv*: N = 10	0 (0–0.345)	0 (0–0.345)
P5 Algae	38.087911°N 83.423889°W	*Nv*: N = 6	0 (0–0.483)	0.333 (0.060–0.759)
Jones Ridge Artificial	38.092306°N 83.354722°W	*Nv*: N = 10	0 (0–0.345)	0 (0–0.345)
Elk Lick Artificial Large	38.329806°N 83.364472°W	*Nv*: N = 10	0 (0–0.345)	0.700 (0.354–0.919)

infection (prevalence = 70% and 33%; Table 1). Eight of nine positive samples had titers < 100 PFU and the other had a titer of 4114 PFU. The lower titers are consistent with these newts being sublethally infected (Miller and Gray, unpubl. data). From our controlled research (e.g., Hoverman et al. 2011a), individuals with titers > 4000 PFU frequently develop ranaviral disease (Miller and Gray, unpubl. data). Given that adult newts are known to move among wetlands in close proximity (Porej et al. 2004) and use ephemeral and permanent wetlands (Hunsinger and Lannoo 2005), it is possible that this species could transport ranavirus overland among sites similar to Tiger Salamanders (*Ambystoma tigrinum*, Brunner et al. 2004) into amphibian communities composed of highly susceptible species (e.g., Wood Frogs; Hoverman et al. 2011a). The role of Eastern Newts in the epidemiology of ranavirus needs greater attention.

While our sample sizes do not allow for meaningful comparisons of ranavirus prevalence between natural and constructed wetlands, there are several reasons we think that constructed ponds might have important consequences for ranavirus epidemiology. First, the constructed wetlands where ranavirus was detected are permanent compared to the ephemeral hydroperiod (< 200 days) of natural wetlands in the ecosystem. Because ranavirus virions are inactivated faster in dry soil compared to water (Nazir et al. 2012), the long hydroperiods might increase the persistence of ranavirus outside the host. Second, constructed wetlands tend to have deeper littoral zones, which might be important sites for ectotherms to warm body temperatures and inactivate pathogens (Raffel et al. 2010). The absence of *Bd* in the constructed wetlands might be attributed to lack of substrate complexity and shade (Raffel et al. 2010), or it could be because *Bd* has not arrived to the ecosystem or was simply not detected. Lastly, the constructed wetlands were inhabited by amphibian species that require a longer hydroperiod for development and may function as reservoirs for ranavirus, including Eastern Newts, American Bullfrogs (*L. catesbeianus*), and Green Frogs (*L. clamitans*; Daszak et al. 2004; Gahl et al. 2012; Hoverman et al. 2011b).

Ranavirus has been previously documented in two wetlands in Kentucky (J. MacGregor, Kentucky Department of Fish and Wildlife Resources, pers. comm.). We recommend more intensive studies in the future that examine a larger geographic area and larger sample size per wetland type. Additionally, post-metamorphic stages should be tested to determine if terrestrial stages of amphibians are important reservoirs as hypothesized by Brunner et al. (2004).

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Low Prevalence or Apparent Absence of *Batrachochytrium dendrobatidis* Infection in Amphibians from Sites in Vietnam and Cambodia

Batrachochytrium dendrobatidis (*Bd*), the causative agent for the amphibian disease chytridiomycosis, is widespread, but patchily distributed throughout Asia. Within Asia, *Bd* has so far been detected from amphibians in Cambodia, China, India, Indonesia, Japan, Kyrgyzstan, Laos, Malaysia, the Philippines, South Korea, Sri Lanka, and Vietnam (Bai et al. 2010; Goka et al. 2009; Kaiser and Grafe 2012; Kusrini et al. 2008; Mendoza II. et al. 2011; Nair et al. 2011; Savage et al. 2011; Swei et al. 2011; Vörös et al. 2012; Wei et al. 2010; Yang et al. 2009). The pattern of *Bd* prevalence in Asia appears drastically different to that in Australia, Africa, the Americas, and Europe, with isolated cases and low infection prevalence (or apparent absence) at most sites (Swei et al. 2011). To date, there have been no reports of *Bd*-associated morbidity or mortality and no evidence of enigmatic amphibian population declines in Southeast Asia (Rowley et al. 2010).

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Bd was first reported to occur in Vietnam in 2011, with seven samples taken in 2008 from Bidoup-Nui Ba National Park, Lam Dong Province, testing positive for *Bd* (Swei et al. 2011). To date, these are the only positive records published for Vietnam. Here we carried out an additional survey for *Bd* at Bidoup-Nui Ba National Park, and performed surveys at localities in central and southern Vietnam, and in adjacent eastern Cambodia (Fig. 1; Table 1).

Amphibians were sampled for *Bd* as part of broader amphibian surveys in evergreen forest areas between May 2009 and July 2010. During nocturnal surveys, conducted along rocky streams and adjacent evergreen forest, adult amphibians were captured by hand and placed in individual plastic bags. Immediately after capture, or the following morning (<8 h after collection), the ventral surface of each frog was swabbed using

TABLE 1. Locations and taxonomic breadth of amphibians sampled for *Batrachochytrium dendrobatidis* (*Bd*) in Cambodia and Vietnam.

Country	Site	Location	Elevation (m)	No. Families	No. Genera	Approx. No. Species
Cambodia	Seima	12.32°N, 107.10°E	485–585	7	11	16
Vietnam	Bidoup-Nui Ba	12.18°N, 108.68°E	1470–1625	5	10	15
	Ngoc Linh	15.22°N, 107.73°E	1085–2300	5	15	27
		15.06°N, 107.86°E	935–2105	5	12	15
	Nui Ong	11.02°N, 107.72°E	140–1020	5	14	21



FIG. 1. Survey sites in Vietnam and adjacent eastern Cambodia. *Batrachochytrium dendrobatidis* was only detected at Ngoc Linh Nature Reserve (closed circle) in 2009.

TABLE 2. Number of individual amphibians in each family and genus sampled for *Batrachochytrium dendrobatidis* (*Bd*) in Cambodia and Vietnam.

Family	Genus	No. individuals sampled
Bufonidae	*Duttaphrynus*/*Ingerophrynus*	7
Dicroglossidae	*Fejervarya*	1
	Limnonectes	69
	Occidozyga	6
	Quasipaa	4
Icthyophiidae	*Icthyophis*	1
Megophryidae	*Leptobrachium*	71
	Leptolalax	40
	Ophryophryne	56
	Xenophrys	12
Microhylidae	*Kalophrynus*	3
	Microhyla	16
Ranidae	*Amolops*	3
	Hylarana	39
	Odorrana	48
Rhacophoridae	*Gracixalus*	4
	Kurixalus/*Raorchestes*	73
	Polypedates	1
	Rhacophorus	41
	Theloderma	5
Total		500

a sterile cotton swab (Medical Wire & Equipment, Potley, UK). Due to taxonomic uncertainty and the presence of undiagnosed diversity within the amphibians of the area, only the generic identity of the individuals swabbed is given (Table 2).

Samples were stored in the field at ambient temperatures (below that known to reduce the amount of *Bd* detectable; Van Sluys et al. 2008) for 5–14 days, and then at approximately –20°C for 3 weeks to 4 months prior to analysis. Storage conditions are unlikely to have affected our results, as storing swabs for 18 months at 4°C, 23°C, and –20°C does not reduce the amount of *Bd* detected (Hyatt et al. 2007). Due to the cost of PCR and our previous negative results (Swei et al. 2011), our 2009 samples from three sites were analyzed in batches of up to 8 samples via PCR (full volume or half volume pooling; Table 3). Samples from 2010 were analyzed individually via qPCR (Table 3).

All samples were analyzed by Pisces Molecular (Boulder, Colorado, USA). Samples pooled by full volume were transferred into a 50-ml tube of ethanol and vortexed to dislodge any zoospores from the swabs before pooling. Samples pooled by half volume had 1.1 ml of 70% ethanol added to the sample tubes and 500µl was transferred into a 15 ml screw-capped centrifuge tube for each pool. Individually analyzed samples had 1.0 ml of 70% ethanol added before mixing by vortexing, and then the entire volume was transferred into a clean microfuge tube. Total DNA was extracted from all samples using Qiagen DNeasy tissue kits. Samples were evaluated for the presence of *Bd* using diagnostic PCR (Annis et al. 2004), modified for greater specificity and sensitivity at Pisces Molecular. Samples were assayed in triplicate and each PCR run included three controls: a positive control (*Bd* DNA), negative control (sample from an uninfected amphibian), and No DNA control (remains uncapped during addition of sample DNA to detect contaminating DNA in the PCR reagents or carryover of positive DNA during reaction set-up). PCR results were scored as very strong positive (equivalent to the positive control), strong positive, positive, weak positive and negative (no signal/below the limit of detection). Each qPCR run included positive controls of *Bd* DNA in serial ten-fold dilutions from 3×10^6 to 3×100 molecules per reaction (used to generate the standard curve). Each qPCR run also included a No DNA control (as above). The detection sensitivity of these assays is three target sequence molecules (~0.02 zoospore equivalents).

TABLE 3. *Batrachochytrium dendrobatidis* (*Bd*) infecting amphibians in Cambodia and Vietnam. Prevalence and lower and upper 95% binomial confidence limits (CL; singlicate) or bias-corrected maximum likelihood estimates (MLE) for *Bd* infection from samples analyzed using diagnostic PCR.

Country	Site	Date	Analysis	N	Prevalence	95% CL/MLE Lower	95% CL/MLE Upper
Cambodia	Seima	July/August 2009	PCR; Pooled (full volume)	100	0.00	0.00	3.62
Vietnam	Bidoup Nui-Ba	July 2010	qPCR singlicate	124	0.00	0.00	3.39
	Ngoc Linh	July 2009	PCR; Pooled (full volume)	133	3.29	1.08	7.86
		March/April 2010	qPCR; singlicate	43	0.00	0.00	19.51
	Nui Ong	May 2009	PCR; Pooled (half volume)	100	0.00	0.00	3.62

For individually analyzed samples, we calculated the lower and upper 95% binomial confidence limits of infection prevalence. For pooled samples, we calculated infection prevalence and lower and upper confidence intervals using a bias-corrected maximum likelihood estimation for pooled samples of unequal sample size (Hepworth 2005), using PooledInfRate 4.0 (Biggerstaff 2009).

A total of 500 skin swab samples from at least 52 species of amphibian was analyzed for *Bd*. Only samples from the July 2009 survey of Ngoc Linh tested positive for *Bd* using diagnostic PCR (Table 3). Four of the 18 pooled samples collected from the site in 2009 tested strong positive, giving an overall estimate of 3.29% infection prevalence and maximum likelihood estimates of confidence intervals of 1.08–7.86%. Follow-up surveys at Ngoc Linh during 2010 failed to detect *Bd* at the site, with a maximum likelihood estimate of upper confidence interval of 19.51%. Because samples were not pooled by species, the identity of infected species could not be determined. However, positive pools included sampled from the families Megophryidae (*Leptobrachium, Leptolalax, Ophryophryne, Xenophrys*), Microhylidae (*Microhyla*), Ranidae (*Odorrana*) and Rhacophoridae (*Gracixalus, Kurixalus, Rhacophorus*). Samples from the three survey sites at which *Bd* was not detected had upper limits of infection prevalence ranging from 3.39–7.86%. We did not detect *Bd* on samples from Bidoup-Nui Ba, a site at which we previously detected *Bd* at low prevalence and at low intensity of infection in 2008 (6.36% "low" infection prevalence in May 2008 [7/110]), but failed to detect *Bd* again in March 2008 (0/155) (Swei et al. 2011).

Our results are consistent with a previous, large-scale survey of Asia, which found a surprisingly low *Bd* prevalence throughout Asia (2.35%; Swei et al. 2011). Surveys at many sites in the region have failed to detect *Bd*, despite often relatively large sample sizes including Ratanakiri Province, Cambodia (0/178); Lao Cai Province, Vietnam(0/82); Savannahkhet, Laos (0/191), Hong Kong (0/274), and Thailand (0/123) (Rowley et al. 2007; McLeod et al. 2008; Swei et al. 2011). Recent surveys of captive native frogs in the trade markets in Cambodia, Laos, Singapore, and Vietnam also reported low infection prevalence, with <1% (14/2389) of amphibians testing weakly positive for *Bd* (Gilbert et al. 2013).

Although most surveys for *Bd* in Asia have reported low prevalence or apparent absence, *Bd* has been reported at high infection prevalence at some sites (Yang et al. 2009; Swei et al. 2011), including four sites in Cambodia, where *Bd* was reportedly detected on 41% (59/144) of swab samples from southwestern Cambodia (Mendoza et al. 2011), and on 36% (86/238) of swab samples at three lowland sites in Cambodia (Gaertner et al. 2011). These survey results are in contrast to our survey at Seima and our previous surveys in eastern Cambodia, which did not detect the pathogen (Swei et al. 2011). Differences in the habitat and the amphibian species sampled makes comparisons between surveys difficult. However, Mendoza et al. (2011) and Gaertner et al. (2011) surveyed a very different suite of amphibians (most of which were lowland, pond-breeding amphibians).

The global distribution (Olson et al. 2013) and emergence of *Bd* remains far from clarified, and recent evidence suggests that *Bd* may have evolved from or at least have a long history in Asia (Goka et al. 2009; Bai et al. 2012). Additional disease surveys in Asia, molecular analysis of *Bd* from throughout Asia, and infection trials to assess disease susceptibility in Asian amphibians are required in order to assess the threat of *Bd* to amphibians in Asia. We also recommend assessing the identity and distribution of *Bd* haplotypes present throughout Asia. Given that qPCR appears unable to detect all strains of *Bd* present in Asia (Goka et al. 2009), it may also be necessary to identify the *Bd* haplotypes present at a site in order to assess the accuracy of *Bd* infection prevalence estimates obtained using qPCR.

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GEOGRAPHIC DISTRIBUTION

CAUDATA — SALAMANDERS

***AMBYSTOMA MACULATUM* (Spotted Salamander)**. USA: MICHIGAN: Clare Co.: Neithercut Woodland, located near trail marker 139 (43.865263°N, 84.935862°W; WGS84) 26 June 2012. Katherine Belknap, Bradley J. Swanson. Verified by Angela M. Riedel. Museum of Natural History, Central Michigan University (MCNH 2013.004: LS-18a–LS-35a). New county record (Holman 2012. The Amphibians and Reptiles of Michigan: A Quaternary and Recent Faunal Adventure. Wayne State University Press, Detroit, Michigan. 528 pp.). Extends the range of *A. maculatum* 50 km NW from Mecosta Co.

Individuals were identified to species by sequencing 800 bp mtDNA d-loop and cytochrome b loci (18 individuals; Bi and Bogart 2010. BMC Evol. Biol. 10:238). Larvae were caught with nets in a leafy temporary pond in hardwood forest, sampled for DNA, and immediately released.

Field work supported by Central Michigan University and ATCG laboratory. Scientific Collector's Permit Issued 1 May 2012/ Michigan DNR, Central Michigan University IACUC Approval #12-18, 26 June 2012.

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***AMBYSTOMA TALPOIDEUM* (Mole Salamander)**. USA: FLORIDA: Hamilton Co.: Suwannee Ridge Mitigation Park Wildlife and Environmental Area, 4.5 km E jct County Road 249 and County Road 751 (30.4437°N, 83.0479°W; WGS84). 28 March 2013. Kevin M. Enge. Verified by Kenneth L. Krysko. Florida Museum of Natural History (UF 169958, color photo). First county record (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final report, Florida Fish and Wildlife Conservation Commission, Tallahassee. 524 pp.). Larva captured while dipnetting a sinkhole pond in sandhill habitat. A second specimen was photographed (UF 169959) at a second location in Hamilton Co.

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***BOLITOGLOSSA SALVINII* (Salvin's Mushroom-tongued Salamander)**. EL SALVADOR: CUSCATLÁN: Municipality of Cojutepeque: Cerro Las Pavas, Canton El Carrizal (13.709774°N, 88.938550°W; WGS 84), 820 m elev. 31 August 2012. Esmeralda Martinez Umaña. Verified by Eric N. Smith. KUDA 012272–73. New department record (Köhler et al. 2006. The Amphibians and Reptiles of El Salvador. Krieger Publ. Co., Malabar, Florida. ix + 238 pp.), extending the species' range ca. 25 km ENE from the only other known Salvadoran locality at Instituto Tropical de Investigaciones Científicas, San Salvador. The salamander was caught and released after photographs were taken by a farmer in a banana plantation surrounded by coffee groves and remnants of tropical broadleaf submontane semideciduous forest**.** The area is now almost completely deforested and replaced by housing developments and agricultural fields. Because the species was last collected in El Salvador over 50 years ago and since west-central El Salvador lacks natural vegetation, Greenbaum and Komar (2010. *In* Wilson et al. [eds.], Conservation of Mesoamerican Amphibians and Reptiles, pp. 436–459. Eagle Mountain Publ., LC, Eagle Mountain, Utah) speculated that the species was already extirpated from the country, but our record indicates that its ability to survive in banana plantations may sustain the species until proper conservation actions can be initiated.

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***NOTOPHTHALMUS VIRIDESCENS* (Eastern Newt)**. USA: MISSOURI: Madison Co.: Fredericktown. Pond located 50 m E of Piney Creek on private land (37.563564°N, 90.413417°W; WGS84). 14 April 2013. Abbigail E. Nicholson. Verified by Dustin. S. Siegel. University of Missouri-Columbia (UMC 2348P). New county record. Fills the gap among the surrounding Bollinger, Iron, St. Francois, and Wayne counties (Edmond and Daniel 2013 [updated 5 April 2013]. Missouri Herpetological Atlas Project. Available at http://atlas.moherp.org/; accessed 14 April 2012). Found in fishless pond.

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***NOTOPHTHALMUS VIRIDESCENS LOUISIANENSIS* (Central Newt)**. USA: FLORIDA: Hamilton Co.: Suwannee Ridge Mitigation Park Wildlife and Environmental Area, 4.5 km E jct County Road 249 and County Road 751 (30.4437°N, 83.0479°W; WGS84). 28 March 2013. Paul E. Moler. Verified by Kenneth L. Krysko. Florida Museum of Natural History (UF 169988, color photo). First vouchered record for the county (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final report, Florida Fish and Wildlife Conservation Commission, Tallahassee. 524 pp.). Collected sexual pair of paedomorphs while dipnetting a sinkhole pond in sandhill habitat.

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***PSEUDOEURYCEA CAFETALERA* (Coffee Grove Salamander)**. MÉXICO: PUEBLA: Municipality of Chichiquila: El Cantil, Río Tenejapa (19.206889°N, 97.052611°W; WGS84), 1467 m elev. 24 April 2010. Andrés Alberto Mendoza Hernández. Verified by Edmundo Pérez Ramos. MZFC 26528. First record for the state, extending its known range ca. 7 km (airline) WNW of Las Cañadas,

Municipality of Huatusco, Veracruz (Parra-Olea et al. 2010. Zootaxa 2725:57–68). The salamander was found in an ecotone between cloud forest and tropical evergreen forest.

ISRAEL SOLANO ZAVALETA (e-mail: crotalus.viper@gmail.com), **LUIS CANSECO MÁRQUEZ** (e-mail: lcanseco@gmail.com), **ANDRÉS ALBERTO MENDOZA HERNÁNDEZ** (e-mail: andreasmeher@gmail.com), and **LUIS FELIPE VÁZQUEZ VEGA** (e-mail: lepatula@hotmail.com), Museo de Zoología, Facultad de Ciencias, UNAM, A.P. 70-399, México D.F. 04510, México.

***SIREN LACERTINA* (Greater Siren)**. USA: VIRGINIA: York Co.: Yorktown Naval Weapons Station, 4.8 km WSW Yorktown (37.229192°N, 76.565914°W; WGS 84). 10 April 2013. J. C. Mitchell and L. H. Eiser. Verified by Kenneth L. Krysko. Florida Museum of Natural History (FLMNH 169851). New county record (Mitchell and Reay. 1999. Atlas of Amphibians and Reptiles in Virginia. Virginia Dept. of Game and Inland Fisheries, Richmond, Virginia. Spec. Publ. 1. 122 pp.). Fills hiatus between known locations 35 km to the SSE in Isle of Wight Co. and 92 km to the northwest in King and Queen Co. both of which are in the Atlantic Coastal Plain. One individual with 40 costal grooves was caught in a minnow trap and released in an isolated ephemeral pond surrounded by mixed hardwoods and Loblolly Pine (*Pinus taedus*).

Field work was in support of Naval Facilities Engineering Command Contract No. N62470-08-D-1008, Task Order No. WE41. VDGIF Threatened/Endangered Species Permit No. 047472.

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ANURA — FROGS

AMEEREGA HAHNELI. BOLIVIA: BENI DEPARTMENT: Moxos Province: East of Municipality of San Ignacio de Moxos (14.724444°S, 65.0023056°W, WGS84; 153 m elev.). 2 May 2009. Steven Poe and Eric Schaad. Museum of Southwestern Biology at the University of New Mexico (MSB 94808) and Colección Boliviana de Fauna CBF-6661). This species was previously known from the Amazonian lowlands from Colombia, eastern Ecuador, Peru, Guiana, Brazil, and northwestern Bolivia. Within Bolivia this species is known from the Beni, La Paz, and Pando departments, and has been expected to occur in Moxos Province (De la Riva et al. 2000. Rev. Esp. Herpetol. 14:19–164; Kohler 2000. Amphibian Diversity in Bolivia. A Study with Special Reference to Montane Forest Regions. Bonn. Zool. Monogr. 48, 243 pp.). Here we report the first record of this species from the Moxos Province approximately 438 km from the western edge of *A. hahneli*'s previously known range from José Ballivian Province. The fieldwork for this project was funded by NSF DEB-0844624 to Steven Poe.

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CRAUGASTOR LAEVISSIMUS. HONDURAS: OLANCHANO: Muralla National Park (15.09710521°N; 86.73783487°W; WGS84) 1466 m elev. 10 October 2010. Mason Ryan, Steven Poe, Ian M. Latella, and Julian Davis. Verified by Jay M. Savage. MCZ A-140226. First record of this species within Muralla National Park; the closest record is from ca. 50 km west of the park (McCranie and Wilson 2002. The Amphibians of Honduras. SSAR Contrib. Herpetol. 19:i–x, 1–625). The female was discovered in the leaf litter along a small stream in mid-elevation cloud forest. This is also an important find because the species is designated as Endangered by IUCN Red List of Threatened Species, Version 2011.2 (www.iucnredlist.org) and because highland populations above 900 m elevation in Honduras were considered to have disappeared (McCranie and Wilson 2002, *op. cit.*). Fieldwork for this project was funded by NSF DEB-0844624 to S. Poe.

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CROSSODACTYLUS CARAMASCHII. BRAZIL: PARANÁ: Municipality of Guaraqueçaba: Reserva Natural Salto Morato (25.1666°S, 48.2892°W, datum WGS84; 310–535 elev.). 24 February – 1 March 2013. T. M. Iapp. Museu Nacional, Rio de Janeiro (MNRJ 85774–85777, 85780, 85782). 11 April 2013. F. B. Oliveira (MNRJ 85778–85779, 86781). All verified by J. P. Pombal Jr.. All previous records of the species are for the southern portion of the state of São Paulo: Apiaí and Iporanga (Araujo et al. 2010. Biota Neotrop. 10[4]:257–274); Cotia (Dixo and Verdade 2006. Biota Neotrop. 6[2]:1–20); Parque Estadual Carlos Botelho (Forlani et al. 2010. Biota Neotrop. 10[3]:265–309), Iguape (Zina et al. 2012. Biota Neotrop. 12[1]:251–260), and Eldorado (Bastos and Pombal 1995. Copeia 1995[2]:436–439). First state record and the southernmost for the species, extending its distribution 148 km SE from Eldorado (Bastos and Pombal, *op. cit.*), the nearest locality previously cited.

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***DENDROPSOPHUS MICROCEPHALUS* (Small-headed Treefrog; Rana Trepadora Amarilla)**. HONDURAS: LA PAZ: Potrerillos (14.292983°N, 87.7068°W; WGS84), 920 m elev. 8 April 2012. Alexander Gutsche and James R. McCranie. Verified by Steve W. Gotte. USNM 580448. First record for La Paz, with the closest known locality ca. 35 km WNW near Jesus de Otoro, Intibucá (McCranie 2006. Smithson. Herpetol. Info. Serv. 137:1–39). The frog was active at night on a leaf of a small tree at the edge of a small stream in a pasture carved from premontane dry forest (Holdridge 1967. Life Zone Ecology, rev. ed. Trop. Sci. Center, San José, Costa Rica. 206 pp.).

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***DENDROPSOPHUS PHLEBODES* (Veined Tree Frog)**. NICARAGUA: ATLÁNTICO NORTE: Wisconsin (14.51403°N, 84.18591°W; WGS84), 75 m elev. 19 June 2010. Kirsten E. Nicholson, Javier Sunyer, Lenin A. Obando, Jenny Gubler, and John Phillips. Verified by Theodore J. Papenfuss. MVZ 269209. Northernmost record

for the species, first record for Atlántico Norte, and a ca. 260 km range extension N from El Recreo, S side of Río Mico, Department of Atlántico Sur (Köhler 2001. Anfibios y Reptiles de Nicaragua. Herpeton, Verlag Elke Köhler, Offenbach, Germany. 208 pp.). The frog was found on vegetation over a roadside pond surrounded by tropical moist forest.

Specimen was collected under permit No. 011-102010 issued by MARENA. Field work was supported by a NSF grant (DEB 0949359) to Nicholson and laboratory work was partially supported by a COLFUTURO grant to Solano.

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***ELEUTHERODACTYLUS GUTTILATUS* (Spotted Chirping Frog)**. MÉXICO: GUANAJUATO: Municipality Of Jaral Del Progreso: western slope of Cerro El Culiacán, 5.28 km ENE of Victoria de Cortazar (20.342333°N, 100.982333°W; WGS84), 2545 m elev. 29 June 2009. José Carlos Arenas Monroy and Christian Martin García Balderas. Verified by Edmundo Pérez Ramos. MZFC 27074. First record for the municipality, extending the known distribution ca. 80 km (airline) SSE from the type locality, Guanajuato, Guanajuato (Smith and Taylor 1948. Bull. U.S. Natl. Mus. 194:i–iv, 1–118), and also the highest elevational record for the species (Lynch 1970. Univ. Kansas Publ. Mus. Nat. Hist. 20:1–45). The frog was found under a rock in oak forest.

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***ELEUTHERODACTYLUS VERRUCIPES* (Big-eared Chirping Frog)**. MÉXICO: JALISCO: Municipality of Lagos De Moreno: Sierra Cuatralba, 30 km ENE of Lagos de Moreno (21.411523°N, 101.642849°W; WGS84), 2570 m elev. 19 June 2010. José Carlos Arenas Monroy, Rubén Alonso Carbajal Márquez, Christoph Grünwald, and Jason Jones. Verified by John D. Lynch. LSUHCD-PC 6449–6450. First record for Jalisco, extending slightly the known range of the species ca. 13.67 km (airline) NW from the nearest locality at San Felipe, Guanajuato (Arenas-Monroy et al. 2012. Herpetol. Rev. 43:439). The frog was found under a rock on a rocky hillside covered with oak forest.

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***HYLA VERSICOLOR* (Gray Treefrog)**. USA: INDIANA: Howard Co.: Howard Township: 500 Ridge Rd. (40.494187°N, 86.065828°W; WGS 84). 14 March 2012. Michael S. Finkler. Verified by Robert Brodman. Indiana State Museum (INSM 71.7.0522). New county record (Minton 2001. Amphibians & Reptiles of Indiana, 2nd ed. Indiana Academy of Science, Indianapolis. 404 pp.). Fills gap in distribution in north-central Indiana. Known from two of six adjacent counties.

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***LEPTODACTYLUS MELANONOTUS* (Sabinal Frog; Ranita de Charco de Dos Espinas)**. HONDURAS: LA PAZ: Potrerillos (14.292983°N, 87.7068°W; WGS84), 920 m elev. 8 April 2012. Alexander Gutsche and James R. McCranie. Verified by Steve W. Gotte. USNM 580449. First record for La Paz, with the closest known locality ca. 15 km N at Lo de Reina, Comayagua (McCranie 2006. Smithsonian Herpetol. Info. Serv. 137:1–39). The frog was active at night in a grassy area next to a small temporary pond in a pasture carved from premontane dry forest (Holdridge 1967. Life Zone Ecology, rev. ed. Trop. Sci. Center, San José, Costa Rica. 206 pp.).

JAMES R. McCRANIE, 10770 SW 164th Street, Miami, Florida 33157-2933, USA (e-mail: jmccrani@bellsouth.net); **ALEXANDER GUTSCHE**, Museum für Naturkunde, Herpetologie, Leibniz-Institut für Evolutions- und Biodiversitätsforschung, Invalidenstr. 43, D-10115 Berlin, Germany (e-mail: alexander.gutsche@mfn-berlin.de).

***LITHOBATES CATESBEIANUS* (Bullfrog)**. USA: INDIANA: Howard Co.: Howard Township, 600 Ridge Rd. (40.493368°N 86.064738°W; WGS 84). 21 April 2012. Michael S. Finkler. Verified by Robert Brodman. Indiana State Museum (INSM 71.7.0521). New county record (Minton 2001. Amphibians & Reptiles of Indiana, 2nd ed. Indiana Academy of Science, Indianapolis. 404 pp.). Fills gap in distribution in north-central Indiana. Known from two of six adjacent counties.

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***PSEUDACRIS BRACHYPHONA* (Mountain Chorus Frog)**. USA: ALABAMA: St. Clair Co.: Seepage along County Rd 22 (33.72552°N, 86.34179°W; WGS 84). 17 February 2013. S. P. Graham. Verified by David Laurencio. AUM AHAP-C 0019 (digital audio file). New county record (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn Printing Co., Auburn, Alabama. 347 pp.). Small chorus of 3–4 males recorded.

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***RANITOMEYA AMAZONICA*.** BRAZIL: PARÁ: Municipality of Anapú: 3.17407°S, 51.29803°W (datum WGS84)**.** Laboratório de Zoologia de Altamira, Faculdade de Ciências Biológicas, Universidade Federal do Pará, Campus de Altamira, Brazil (LZA 454). 29 Jan 2013. E. A. Oliveira and colleagues. Verified by J. L. Brown. Previously known from northwestern Amazonian Peru (Loreto), extreme southeastern Colombia (Amazonas), and in the adjacent borderlands of Brazil; extreme southern Guyana; eastern French Guiana; region of the mouth of the Amazon in Brazil Frost (2011. Amphibian Species of the World: An Online Reference. Ver. 5.5 [12 Mar 2013]. Electronic database accessible at http://research.amnh.org/vz/herpetology/amphibia/. American Museum of Natural History, New York). This species previously has been recorded from Pará state at Estação Cientifica Ferreira Penna-Flona de Caxiuanã (Ávila-Pires and Hoogmoed 1997. *In* P. L. B.

Lisboa [ed.], Caxiuanã: Populações Tradicionais, Meio Físico e Diversidade Biológica, pp. 389–401. Museu Paraense Emílio Goeldi, Belém, Pará, Brazil). Southeasternmost record of the species, extends known distribution 180 km.

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TESTUDINES — TURTLES

***CHELYDRA SERPENTINA* (Snapping Turtle)**. USA: INDIANA: Howard Co.: Howard Township, 4709 Pavilion Court (40.494148°N, 86.063365°W; WGS 84). 25 May 2012. Michael S. Finkler. Verified by Robert Brodman. Indiana State Museum (INSM 71.7.0524). New county record (Minton 2001. Amphibians & Reptiles of Indiana, 2nd ed. Indiana Academy of Science, Indianapolis. 404 pp.). Eggs collected from nest adjacent to pond and incubated to hatching (voucher specimen hatched 2 August 2012).

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***CHELYDRA SERPENTINA* (Snapping Turtle)**. USA: TENNESSEE: Lauderdale Co.: Chickasaw National Wildlife Refuge (35.874421°N, 89.643653°W; NAD 83). 5 April 2013. James P. Flaherty and Michael Fulbright. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19409 photo voucher). New county record (Scott and Redmond 2008 [updated 15 February 2013]. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/ [accessed 6 May 2013]). Nearest record ca. 38 km E in Crockett Co. Hatchling captured in dipnet near bank of vegetated slough.

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***CHRYSEMYS DORSALIS* (Southern Painted Turtle)**. USA: TENNESSEE: Lauderdale Co.: Chickasaw National Wildlife Refuge (35.874526°N, 89.643346°W; NAD 83). 5 April 2013. James P. Flaherty and Michael Fulbright. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19411 [photo voucher]). New county record (Scott and Redmond 2008 [updated 15 February 2013]. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/ [accessed 6 May 2013]). Nearest confirmed record ca. 59 km SE in Haywood Co. Two individuals observed basking on a floating log in vegetated slough.

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***TERRAPENE NELSONI* (Spotted Box Turtle)**. MEXICO: JALISCO: Municipality of Ameca: Sierra de Quila, near Tecolotlán, 100 km SW of Guadalajara (20.4016°N, 104.122°W; WGS84), 2020 m elev. 6 August 2000. John Pint. Verified by Jacobo Reyes-Velasco. UTADC 7639. First municipality record, extending range 32 km S from its closest reported locality near Guachinango, Jalisco, although the coordinates provided by Buskirk and Ponce-Campos (2011. Chelon. Res. Monogr. [5]:060.1–060.9) for that distance were inaccurate when compared to our measures. The turtle was active during the day in an oak forest disturbed to a certain extent by agricultural fields.

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***TRACHEMYS SCRIPTA ELEGANS* (Red-eared Slider)**. USA: INDIANA: Howard Co.: Kokomo, 101 W. Boulevard (40.462213°N, 86.131553°W; WGS 84). 6 June 2012. David W. Johnson and Michael S. Finkler. Verified by Robert Brodman. Indiana State Museum (INSM 71.7.0525). New county record (Minton 2001. Amphibians & Reptiles of Indiana, 2nd ed. Indiana Academy of Science, Indianapolis. 404 pp.). Eggs collected from nest on stream embankment and incubated to hatching (voucher specimen hatched 8 August 2012).

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SQUAMATA — LIZARDS

***ANOLIS DISSIMILIS*.** BRAZIL: ACRE: Senador Guiomard, Fazenda Experimental Catuaba (10.082222°S, 67.625833°W; datum WGS84), elev. 183 m, in open forest with bamboo (*Guadua weberbaueri*). 16 March 2013. P. R. Melo Sampaio, J. M. L. Maciel, A. da Silva, M. Nogueira, S. Matos, L. Matos, and J. C. da Silva. Verified by M. B. Souza. Herpetological Collection Universidade Federal do Acre, Rio Branco (UFAC-0075). Species previously known only from type locality: Ituahuania, Departamento Madre de Dios, Peru (Williams 1965. Breviora [233]:1–15). First country record, extends the known distribution ca. 490 km N from type locality.

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***ANOLIS NEBULOSUS* (Clouded Anole)**. MEXICO: JALISCO: Municipality of Cañadas de Obregón: Temacapulín, 88 km NE of Guadalajara (21.17772°N, 102.709083°W; WGS84), 1771 m elev. 14 March 2010. Jesús M. Rodríguez-Canseco, Krystal L. González-Estupiñán, and Luand E. López-Rodríguez. Verified by Jacobo Reyes Velasco. UTADC 7609, 7610. First municipality record, and a range extension of 72 km S from localities in southern Aguascalientes (Vázquez Díaz and Quintero Díaz 2005. Anfibios y Reptiles de Aguascalientes. CONABIO, CIEMA A.C., México D.F. 318 pp.) and 102 km E of Atolinga, Zacatecas (Ahumada-Carrillo 2010. Herpetofauna del Municipio de Atolinga, Zacatecas. Thesis, Cent. Univ. Cienc. Biol. Agro., Univ. de Guadalajara. Zapopan,

Jalisco. 82 pp.). One of the lizards was found active on an oak tree (*Quercus laeta*) in one of the remaining patches of oak forest in the area, while the other was found crawling on rocks in direct sunlight within a grove of cedar trees (*Juniperus coahuilensis*).

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***ANOLIS (= NOROPS) SAGREI* (Brown Anole)**. USA: TEXAS: Nacogdoches Co.: 220 N. Stallings Drive (31.391105°N, 94.393109°W; WGS84). 17 September 2012. Daniel Saenz. Verified by Toby J. Hibbitts. Biodiversity Research and Teaching Collection, Texas A&M University, TCWC 96834. New county record (Dixon 2013. Amphibians and Reptiles of Texas, 3rd ed., Texas A&M University Press, College Station. 447 pp.). An adult male *A. sagrei* was first observed displaying in the lawn and garden section of the Lowe's store in Nacogdoches, Texas on 15 September 2012. The voucher specimen was collected two days later at the same store and at least four other adult lizards were observed on the outdoor plant displays; however, *A. sagrei* is not known from any other locations in Nacogdoches. The nearest records for *A. sagrei* are from Brazos Co, over 200 km SW of this locality, and from Harris Co., over 225 km S of Nacogdoches. Many of the tropical plants at the Lowe's store are shipped from Florida. Thus, it is likely that the lizards are new introductions from Florida, via the tropical plant trade, rather than a range expansion in Texas.

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***BACHIA GUIANENSIS* (Guyana Bachia)**. COLOMBIA: GUAVIARE: San José del Guaviare, vereda El Retiro, balneario La Pedrera, Puente de Piedra (2.541467°N, 72.722532°W; datum Bogotá WGS 84). 23 October 2012. G. F. Medina-Rangel. Colección de Reptiles, Instituto de Ciencias Naturales, Universidad Nacional de Colombia, Bogotá (ICN 12275); San José del Guaviare, vereda La Pizarra, Puerta de Orión, forest (2.510672°N, 72.706790°W; datum Bogotá WGS 84). 26 October 2012. M. L. Calderón. (ICN 12270). Both verified by G. Cárdenas-Arévalo. This lizard was only known from Colombia in the department of Vichada, corregimiento de Santa Rosa in the Natural National Park El Tuparro (locality Centro Alto Tuparro) and department of Guainía in municipality of Inírida, and Venezuela in the Territorio Federal of the Amazonas state in Río Guapuchi, tributary of Río Ventuari (Hoogmoed and Dixon 1977. Zool. Med. 51:25–31; Gorzula and Señaris 1999. Contribution to the Herpetofauna of the Venezuelan Guayana I: A Data Base. Scientia Guaianae, Caracas, No. 8, 269 pp.; Ávila-Pires 2005. *In* Hollowell and Reynolds [eds.], Checklist of the Terrestrial Vertebrates of the Guiana Shield. Bull. Biol. Soc. Washington 13:25–42; Uetz 2012. TIGR Reptile Database (version Oct 2007). *In* Bisby et al. [eds.]. Species 2000 and ITIS Catalogue of Life, version 2012. <www.catalogueoflife.org/col/>; Rivaset al. 2012. Zootaxa 3211:1–64). First state record, extending the range ca. 565 km from the nearest known population (type locality: Guri, Bolivar state, Venezuela; Hoogmoed and Dixon, *op. cit.*; Uetz, *op. cit.*; Rivas et al., *op. cit.*).

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***CELESTUS ENNEGRAMMUS* (Huaxteca Lesser Galliwasp)**. MEXICO: CHIAPAS: Municipality of Berriozabal: 2–3 km NNE Tierra y Libertad (16.86033°N, 93.33675°W; WGS84), 1180 m elev. 22 September 2012. Israel Solano Zavaleta. Verified by Edmundo Pérez Ramos. MZFC 27272. First record for the state, extending the known range ca. 137 km (airline) E of the nearest locality at La Gloria, Oaxaca (Campbell and Camarillo 1994. Herpetologica 50:193–209). The lizard was found in tropical evergreen forest.

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***HEMIDACTYLUS TURCICUS* (Mediterranean Gecko)**. USA: CALIFORNIA: Los Angeles Co.: San Fernando Valley, Chatsworth (34.250946°N; 118.608146°W; WGS 84; elev. 286 m). Seven individuals representing adult (N = 4) and juvenile (N = 3) age classes and both sexes were collected in a residential community on stucco or stone walls or stone mailbox posts exposed to direct exterior illumination from 2100–2230 h, 14 and 16 August 2010. R. W. Bernstein, W. L. Bernstein, A. Lopez, and Z. M. Lopez. CSUN 3475 (additional specimens are alive in captivity at CSUN). Verified by R. E. Espinoza. New county records. Originally submitted as photo vouchers to the Natural History Museum of Los Angeles County (LACM) Lost Lizards of Los Angeles citizen science project (http://www.nhm.org/site/activities-programs/citizen-science/lost-lizards-project; LACM photographic vouchers PC 1633–1634). Extends the range ca. 195 km WNW (airline) from the closest vouchered localities at Palm Springs, Riverside Co., California (LACM 147938, 152671, 179871–76). In Southern California, *H. turcicus* has also become established at one or more localities in the counties of Imperial, San Bernardino, and San Diego (Beaman et al. 2005 Herpetol. Rev. 36:79). Although we observed at least 10 additional specimens within a two-block radius of the residential area from which these geckos were collected, surveys outside of this region produced no further sightings suggesting a very limited distribution and relatively recent introduction. Several residents in the area independently suggested that they first noticed the geckos approximately 10 years ago. Repeated visits (2010–13) to the neighborhood by us and herpetologists and staff from California State University, Northridge and LACM indicate the population is thriving, but not expanding.

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***LEIOCEPHALUS CARINATUS* (Northern Curly-tailed Lizard)**. USA: FLORIDA: Polk Co.: Lakeland, near West Pipkin Road and Yates Road (27.97473°N, 82.01237°W; WGS84; coordinate uncertainty: 1250 m; elev. 40 m). 7 March 2013. Cathy Knott. Verified by Kevin M. Enge. Florida Museum of Natural History (UF 169952). New county record (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final Report, Project Agreement 08013, Florida Fish and Wildlife Conservation Commission, Tallahassee. 524 pp.). A single individual was collected in a residential garage south of the Lakeland Linder Regional Airport. Extends the range ca. 63 km SW of the closest known verified voucher (UF 165483) from the Gaylord Palms Resort and Convention Center, 6000 West Osceola Parkway, Kissimmee, Osceola Co.

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***LEPIDOPHYMA GAIGEAE* (Gaige's Tropical Night Lizard)**. MEXICO: SAN LUIS POTOSÍ: Municipality of Aquismón: Cascada de Tamúl (21.802821°N, 99.179946°W; WGS84), 220 m elev. 2 January 2010. Iván T. Ahumada-Carrillo. Verified by Jacobo Reyes Velasco. UTADC 7504–7505. First municipality record and first vouchered state record. Lemos-Espinal and Dixon (2013. Amphibians and Reptiles of San Luis Potosí. Eagle Mountain Publ., Eagle Mountain, Utah. xii + 300 pp.) mapped and listed localities for the species from the municipalities of Huehuetlán, San Vicente Tancuayalab, and Zaragoza, but gave no reference to voucher specimens. Municipality of Aquismón is located directly adjacent to Huehuetlán, and Cascadada de Tamúl represents the lowest reported elevation for the species, as all others were from above 700 m (Bezy and Camarillo R. 2002. Contr. Sci. Nat. Hist. Mus. Los Angeles Co. [493]:1–41). The lizard was found inside a rock crevice in subtropical dry forest, in contrast to pine-oak forest, the normal habitat for this species (Lemos-Espinal and Dixon, *op. cit.*).

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***PLESTIODON LATICEPS* (Broad-headed Skink)**. USA: MISSOURI: Madison Co.: Fredericktown, eastern border of Piney Creek (37.562952°N, 90.412876°W; WGS84). 11 May 2013. Abbigail E. Nicholson. Verified by Dustin S. Siegel. University of Missouri-Columbia (UMC 2350P). New county record. This record fills the gap between the bordering St. Francois and Wayne counties (Edmond and Daniel 2013 [updated 5 April 2013]. Missouri Herpetological Atlas Project. Available at http://atlas.moherp.org/; accessed 11 May 2013).

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***SCELOPORUS ALBIVENTRIS* (Western White-bellied Spiny Lizard)**. MEXICO: SONORA: Municipio de Aconchi: Sierra Aconchi, 9.5 km WSW Aconchi (29.793019°N, 110.315929°W; WGS 84), 1316 m elev. 3 September 2012. Martín F. Villa A. Verified by G. Ferguson. UAZ 57457-PSV. Northernmost locality for this species, extending the range 136 km NW of closest known locality, Arroyo Santa Rosa, Rancho Santa Rosa, 32 km NE Sahuaripa, Sonora 29.28251°N, 109.04432°W (Rorabaugh et al. 2011. Son. Herpetol. 24:126). The specimen was basking in rocky foothills thornscrub near its interface with oak woodland.

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***SCELOPORUS DUGESII* (Dugès' Spiny Lizard)**. MEXICO: GUANAJUATO: Municipality of Cortazar: Cerro La Gavia, 90 km S of La Gavia (20.387139°N, 100.882444°W; WGS84), 2193 m elev. 20 January 2009. Israel Solano Zavaleta, José Carlos Arenas Monroy, and Uri Omar García Vázquez. MZFC 27071. Cerro La Gavia, 1.60 km NE of Mandinga (20.441556°N, 100.922083°W; WGS84), 2030 m elev. 29 November 2009. José Carlos Arenas Monroy. MZFC 27072. Both lizards verified by Edmundo Pérez Ramos. First records for municipality, extending the known distribution ca. 41 km (airline) NE from 2 km E of Moroleón, Guanajuato (Martínez-Méndez and Méndez-de la Cruz 2007. Zootaxa 1609:53–68). Both specimens are adult males and were found under rocks in tropical deciduous forest.

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SQUAMATA — SNAKES

***AGKISTRODON PISCIVORUS CONANTI* (Florida Cottonmouth)**. USA: FLORIDA: Union Co.: County Road 125, 0.3 km E of NE 264 Place (30.11357°N, 82.17824°W; WGS84). 19 April 2013. Kevin M. Enge. Verified by Kenneth L. Krysko. Florida Museum of Natural History (UF 169872, color photo). New county record (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final report, Florida Fish and Wildlife Conservation Commission, Tallahassee. 524 pp.).

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***COLUBER CONSTRICTOR PRIAPUS* (Southern Black Racer)**. USA: ARKANSAS: Calhoun Co.: ca. 8 km N of Ouachita River off US 167 (33.3724°N, 925101°W; WGS 84). 28 April 2013. M. B. Connior. Verified by S. E. Trauth. Arkansas State University Museum of Zoology Herpetology Collection (ASUMZ 32695). New county record filling a distributional hiatus among previous records in Dallas, Bradley, and Ouachita counties in southern Arkansas (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville. 421 pp.).

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***CONIOPHANES PICEIVITTIS* (Cope's Black-striped Snake; Culebra Rayada)**. HONDURAS: LA PAZ: Potrerillos (14.292983°N, 87.7068°W; WGS84), 920 m elev. 9 April 2012. Alexander Gutsche and James R. McCranie. Verified by Steve W. Gotte. USNM 580446. First record for La Paz, with the closest known locality ca. 15 km N at Lo de Reina, Comayagua (McCranie 2011. The Snakes of Honduras. Systematics, Distribution, and Conservation. SSAR Contrib. Herpetol. 26:x + 714 pp.). The snake was in the root mass of a small tree during the day in a pasture carved from premontane dry forest (Holdridge 1967. Life Zone Ecology, rev. ed. Trop. Sci. Center, San José, Costa Rica. 206 pp.).

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***CROTALUS INTERMEDIUS* (Mexican Small-headed Rattlesnake)**. MÉXICO: HIDALGO: Municipality of Mineral de la Reforma: Azoyatla (20.09836°N, 98.69054°W; WGS84), 2505 m elev. 8

July 2006. Elizabeth Cervantes Cornish. Verified by Norma Manríquez Morán. Colección Herpetológica, Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo (CH-CIB 2808). First municipality record and only third specific locality reported for the state. The closest known record is from the Municipality of Tepeji del Río de Ocampo at Presa Requena (Valencia-Hernández et al. 2007. Acta Zool. Mex. 23:29–233), located 80.41 km SW of our record. The snake was found in xerophytic scrub vegetation.

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DRYMARCHON MELANURUS **(Central American Indigo Snake)**. MEXICO: JALISCO: Municipality of Cañadas de Obregón: Temacapulín, 88 km NE from Guadalajara (21.174083°N, 102.713805°W; WGS84), 1726 m elev. 14 March 2010. Jesús M. Rodríguez-Canseco, Krystal L. González-Estupiñán, and Luand E. López-Rodríguez. Verified by Jacobo Reyes Velasco. UTADC 7611, 7612). First records for the municipality, and a range extension of 68 km E from Mezquital del Oro, Zacatecas (Ahumada-Carrillo and Vázquez-Huizar. 2012. Herpetol. Rev. 43:448) and 73 km S of records in southern Aguascalientes (Vázquez Díaz and Quintero Díaz 2005. Anfibios y Reptiles de Aguascalientes. CONABIO, CIEMA, México, D.F. 318 pp.). The snake was found basking in the afternoon sun, on a rock inside a canyon covered by tropical deciduous forest.

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GEOPHIS BICOLOR **(Mexican Plateau Earth Snake)**. MEXICO: JALISCO: Municipality of Tecolotlan: Sierra de Quila, near Tecolotlán, 100 km SW of Guadalajara (20.312353°N, 104.013385°W; WGS84), 2450 m elev. 13 October 2011. Jesús Rodríguez-Canseco and Matías Domínguez-Laso. Verified by Jacobo Reyes-Velasco. UTADC 7613. First municipality record, extending the range 89 km N from its nearest location in the Sierra de Manantlán (Orozco 2006. Herpetofauna de la Estación Científica Las Joyas en la Reserva de la Biosfera Sierra Manantlán, Jalisco, México: Guía Ilustrada y Claves para su Determinación. Univ. de Guadalajara, Cent. Univ. Cienc. Biol. Agro., Zapopan, Jalisco. 90 pp.). The snake was found in pine-oak forest under a rock in the morning after a rainy night.

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GEOPHIS DUGESII **(Duges' Earth Snake)**. MÉXICO: SINALOA: Municipality of Badiraguato: Centro de Estudios "Justo Sierra," Surutato (25.82919°N, 107.56494°W; WGS 84), 1529 m elev. 21 September 2012. Pedro Uriarte-Garzón, Robert A. Villa, and Will Lattea. Verified by Luis Canseco Márquez. MZFC 27267. First municipality record, northernmost record for the state, and bridges roughly a 614-km gap between Yécora, Sonora (Enderson and Bezy 2007. Herpetol. Rev. 38:103) and several montane sites along Mexico Hwy 40 in SE Sinaloa and adjacent SW Durango (Webb 1984. *In* Seigel et al. [eds.], Vertebrate Ecology and Systematics: A Tribute to Henry S. Fitch, pp. 217–241. Univ. Kansas Mus. Nat. Hist. Spec. Publ. 10, Lawrence, Kansas). The snake was found in pine-oak forest.

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HETERODON PLATIRHINOS **(Eastern Hog-nosed Snake)**. USA: TENNESSEE: Van Buren Co.: Found in woods 30 m N of State Rt. 284 (35.62094°N, 85.41251°W; WGS 84). 12 May 2013. S. Graham, C. Thawley, and G. McCormick. Verified by David Laurencio. AUM AHAP-D 676 (digital photograph file). New county record (Scott and Redmond 2008. Atlas of Reptiles in Tennessee. Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. http://www.apsu.edu/reptatlas [updated 30 May 2013; accessed 1 June 2013]). Records of *H. platirhinos* are lacking in several regions of Tennessee, especially the Cumberland Plateau, and this record fills a distributional gap among the nearest records approximately 48 km N in White Co., 48 km SW in Grundy Co., and 72 km SE in Bradley Co.

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LAMPROPELTIS CALLIGASTER OCCIPITOLINEATA **(South Florida Mole Kingsnake)**. USA: FLORIDA: Osceola Co.: Road 10 in Three Lakes Wildlife Management Area (27.824652°N, 81.137155°W; WGS84). 10 April 2013. Florida Museum of Natural History (UF169963, photographic voucher). Verified by Kevin M. Enge. New county record (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final report, Florida Fish and Wildlife Conservation Commission, Tallahassee. 524 pp.), although there is an unverified report (O'Horo and Enge 2008. Herpetol. Rev. 39[2]:241). Extends range 34 km NNW of the nearest record in Okeechobee Co. (UF 137503). Specimen (740 mm SVL) collected at 0915 h on an unpaved road in dry prairie habitat.

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LAMPROPELTIS ELAPSOIDES **(Scarlet Kingsnake)** USA: ALABAMA: Covington Co.: US Route 29, Conecuh National Forest (31.14052°N 86.67253°W; WGS 84). 22 May 2013. S. Graham and M. Herr. Verified by David Laurencio. AUM 40225. New county record (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn Printing Co., Auburn. 347 pp.).

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***LAMPROPELTIS TRIANGULUM* (Milksnake)**. USA: MISSOURI: Madison Co.: Fredericktown (37.562794°N, 90.413135°W; WGS84). 25 May 2013. Abbigail E. Nicholson. Verified by Dustin S. Siegel. University of Missouri-Columbia (UMC 2354P). New county record. This record fills the gap within the surrounding Bollinger, Iron, and Wayne counties (Edmond and Daniel 2013 [updated 5 April 2013]. Missouri Herpetological Atlas Project. Available at http://atlas.moherp.org/; accessed 25 May 2013).

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***LEPTOPHIS MEXICANUS* (Mexican Parrot Snake; Ranera Mexicana)**. HONDURAS: LA PAZ: Potrerillos (14.292983°N, 87.7068°W; WGS84), 920 m elev. 9 April 2012. Alexander Gutsche and James R. McCranie. Verified by Steve W. Gotte. USNM 580445. First record for La Paz, with the closest known locality ca. 15 km N at Lo de Reina, Comayagua (McCranie 2011. The Snakes of Honduras. Systematics, Distribution, and Conservation. SSAR Contrib. Herpetol. 26:x + 714 pp.). The snake was active in a tree during midmorning on a sunny day ca. 2.5 m above a small river in secondary premontane dry forest (Holdridge 1967. Life Zone Ecology, rev. ed. Trop. Sci. Center, San José, Costa Rica. 206 pp.).

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***OPHEODRYS AESTIVUS* (Rough Green Snake)**. USA: TENNESSEE: Van Buren Co.: Gorge Scenic Drive near Millikan's Overlook, Fall Creek Falls State Park (35.67982°N, 85.36717°W; WGS 84). 11 May 2013. S. Graham, C. Thawley, and G. McCormick. Verified by David Laurencio, AUM AHAP-D 675 (digital photograph file). New county record (Scott and Redmond 2008. Atlas of Reptiles in Tennessee. Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. http://www.apsu.edu/reptatlas (updated 30 May 2013; accessed 1 June 2013). Specimen found dead on road. Records of *Opheodry aestivus* are sparse in the Cumberland Plateau, and this record fills a distributional gap between the nearest records approximately 60 km W in Cannon Co., 48 km N in Putnam Co., and 42 km SE in Rhea Co.

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***RAMPHOTYPHLOPS BRAMINUS* (Brahminy Blindsnake)**. USA: ARIZONA: Maricopa Co.: private residence near major crossroads, Greenway and 7th Street, Phoenix (33.62903°N, 112.060439°W; NAD 83). 16 May 2010. Susan Sferra. Verified by Van Wallach. MCZ R-189083. First voucher from an established Arizona population. Nearest records are from Hildalgo County, Texas to the east (Merino et al. 2009. Herpetol. Rev. 40:366), Hermosillo, Sonora, Mexico to the south (Quijada-Mascareñas and Enderson 2007. Herpetol. Rev. 38:490), and San Diego Co., California to the west (Palmer and Fisher 2010. Herpetol. Rev. 41:518). Specimen collected alive under small wooden board in backyard covering a sparsely vegetated area of Bermuda Grass (*Cynodon* spp.) adjacent to bare ground interspersed with Hopbush (*Dodonaea viscosa*), Sweet Acacia *(Acacia farnesiana*), and dried vegetative debris under dry conditions. The residence is 1.6 km from a local nursery. Collector had purchased and planted vegetation from this nursery on several occasions.

Previous specimens were collected at this location on 11 November 2007 and 1 December 2007 by Susan Sferra. These specimens were identified by Michael J. Sredl, Arizona Game and Fish Department, but were not independently verified or accessioned into museum collections. All were observed after heavy rains. A second vouchered specimen (UAZ 57402-PSV) was collected at the same location on 23 December 2010.

Additional *Rhamphotyphlops braminus* specimens have been collected in the region but there is not sufficient evidence that these represent established populations: 33.308629°N, 111.810242°W, 20 October 2008, Cathy Kasevich (unvouchered); 33.410968°N, 111.970299°W, 6 November 2007, Philip C. Rosen. Verified by G. L. Bradley (UAZ 56919).

The parthenogenetic Brahminy Blindsnake is the first nonnative snake to become established in Arizona and is generally considered to be the most widespread, globally distributed, snake species in the world.

We thank Andrew Holycross for his assistance.

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***RHAMPHOTYPHLOPS BRAMINUS* (Brahminy Blindsnake)**. USA: TEXAS: Montgomery Co.: Spring, Deerfern Place, ca. 0.31 km from junction of Cochran's Green (30.20227°N, 95.51304°W; WGS 84) 31 March 2013. Gant D. Austin and Thomas A. Sinclair. Verified by Toby J. Hibbitts. (TCWC 97163, 97164). First record for county. Fills gap in reported range. Nearest known record is Nacogdoches, Texas. (Dixon 2013. Amphibians and Reptiles of Texas, 3rd ed. Texas A&M University Press, College Station. viii + 446 pp.)

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***SIPHLOPHIS WORONTZOWI* (Worontzow's Spotted Night Snake)**. BRAZIL: ACRE: Senador Guiomard, BR-364 highway, km 23, Fazenda Experimental Catuaba (10.0822°S, 67.06258°W, WGS84; elev. 180 m). 11 May 2013. S. M. Arruda and A. M. Sobrinho. Herpetological Collection, Universidade Federal do Acre, Rio Branco, Acre, Brazil (UFAC-0527). The specimen was found dead on ground, under a log, into forest edge dominated by *Guadua* bamboo 1400 h. Verified by M. B. Souza. Species previously known from Curichon, Nacebe, and Palmira, Pando, Bolivia (Moravec et al. 2009. Herpetozoa. 22[2]: 92–94), Tinkanari, Departamento Cuzco, Peru (Vriesendorp et al. [eds.] 2004. Perú: Megantoni. Rapid Biological Inventories Report 15. The Field Museum, Chicago, Illinois. 300 pp.). In Brazil this species is found in following states: Amazonas, Mato Grosso, Pará, and Rondônia

(Prado 1940. Mem. Inst. Butantan 13:1–7; Jorge-da-Silva 1993. Herpetol. Nat. Hist. 1:37–86; Santos-Jr. et al. 2003. Herpetol. Rev. 34:390; Frota et al. 2005. Biociências 13:211–220; Bernarde and Abe 2006. S. Amer. J. Herpetol. 1:102–113; Costa et al. 2010. Herpetol. Notes 3:97–100). First state record for Acre, extends the known distribution ca. 104 km N from Nacebe (Moravec, *op. cit.*), the nearest locality previously known. Voucher collected under permit #SISBIO 27290-3.

SIMONE ARRUDA DE MATOS (e-mail: simonebiologa1@hotmail.com) and **PAULO ROBERTO MELO-SAMPAIO** (e-mail: prmelosampaio@gmail.com), União Educacional do Norte – Uninorte, Alameda Hungria, 200, Jardim Europa II - CEP 69.911-900 Rio Branco, AC - Brazil.

STORERIA DEKAYI **(Dekay's Brownsnake)**. USA: TENNESSEE: Lauderdale Co.: Chickasaw National Wildlife Refuge (35.874526°N, 89.643346°W; NAD 83). 5 April 2013. James P. Flaherty and Michael Fulbright. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19410 [photo voucher]). New county record (Scott and Redmond 2008 [updated 15 February 2013]. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/ [accessed 6 May 2013]). Nearest record ca. 30 km NW in Dyer Co. Found on grassy roadside near vegetated slough.

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STORERIA DEKAYI WRIGHTORUM **(Midland Brownsnake)**. USA: INDIANA: Tipton Co.: Jefferson Township, 3565 E. CR 250 N. (40.321549°N 86.241667°W; WGS 84). 13 June 2012. Lina Rifai, Andrea Gerig, and Michael S. Finkler. Verified by Robert Brodman. Indiana State Museum (INSM 71.7.0523. New county record (Minton 2001. Amphibians & Reptiles of Indiana, 2nd ed. Indiana Academy of Science, Indianapolis. 404 pp.). Fills gap in distribution in north-central Indiana. Known from three of six adjacent counties.

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TANTILLA GRACILIS **(Flat-headed Snake)**. USA: TEXAS: Karnes Co.: near Kenedy, County Road 125, 0.32 km from junction of 239 (28.80436°N, 97.79686°W; WGS 84). 24 October 2009. John T. Williams and Thomas A. Sinclair. Verified by Toby J. Hibbitts. TCWC 97162. First record for county. Fills gap in reported range for five of the seven counties that border Karnes (Dixon 2013. Amphibians and Reptiles of Texas, 3rd ed. Texas A&M University Press, College Station. viii + 446 pp.)

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New Geographic Distribution Records for Reptiles from North Carolina, USA

The geographic distribution of reptiles in North Carolina (USA) was summarized by Palmer and Braswell (1995) and has since been supplemented by others, including Beane (1998), Beane and Palmer (2006), Eskew et al. (2008), and Beane and Corey (2010). Here I report additional new records based upon specimens and photographs verified by William M. Palmer or Bryan L. Stuart and housed at the North Carolina State Museum of Natural Sciences (NCSM). Geocoordinates are based on datum WGS 84.

TESTUDINES — TURTLES

APALONE SPINIFERA ASPERA **(Gulf Coast Spiny Softshell)**. Richmond Co.: 10.3 km W Rockingham, Pee Dee River (34.9433302°N, 79.868541°W). 9 May 2002. Wayne C. Starnes. NCSM 62966. First specimen voucher for county. Palmer and Braswell (1995) reported a photographic record.

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CHELYDRA SERPENTINA **(Snapping Turtle)**. Catawba Co.: 3.1 km E Catawba, along Catawba River (35.7021°N, 81.0434°W). 6 Sept. 2007. David G. Cooper et al. NCSM 77310. New county record.

CHRYSEMYS PICTA PICTA **(Eastern Painted Turtle)**. Davidson Co.: 9.0 km SSE center Lexington (35.74689°N, 80.21111°W). 19 June 2012. Bruin DeWald. NCSM photographic voucher BD 12-2. New county record.

Hertford Co.: 6.8 km ESE Como, Chowan River (36.4861°N, 76.9324°W). 16 July 2010. John T. Finnegan and Michael P. Schafale. NCSM photographic voucher JTF 10-1. New county record.

Onslow Co.: 1.1 km S Petersburg (34.9158°N, 77.520878°W). July 2011. Conrad Wernett. NCSM photographic voucher CW 11-1. New county record. Extends range ca. 46 km ESE and 44 km WSW of nearest records in Duplin and Craven counties, respectively (Palmer and Braswell 1995).

CLEMMYS GUTTATA **(Spotted Turtle)**. Vance Co.: 3.6 km S Gillburg (36.2448°N, 78.3626°NW). 16 June 2006. Phil and Alecia LaKernick. NCSM photographic vouchers ALB-11814. New county record.

KINOSTERNON BAURII **(Striped Mud Turtle)**. Bertie Co.: 12.1 km SSW Windsor (35.8959°N, 77.0098°W). 8 August 2002. Alvin L. Braswell, Michael Canada, J. Edward Corey III, and Jean Richter. NCSM 64202. New county record.

Carteret Co. 1.6 km ENE Ocean (34.720410°N, 76.96967°W). 12 July 2010. Jeffrey C. Beane, Brandon Fulton, Jeffrey G. Hall, Natalia L. Smith, and Bryan L. Stuart. NCSM 77280. New county record.

Tyrrell Co.: ca. 3.1 km S.SW Woodley, Scuppernong River State Park along Scuppernong River (35.867734°N, 76.350560°W). 29 April 2011. J. Edward Corey III. NCSM photo vouchers JEC 11-1. New county record and first record for Albemarle-Pamlico Peninsula.

***PSEUDEMYS CONCINNA* (River Cooter)**. Alamance Co.: 3.9 km SW center Burlington (36.0902°N, 79.4677°W). February–March 2011. Ryan W. Kirk. NCSM 79134. New county record.

Madison Co.: 7.1 km WNW Hot Springs, French Broad River (35.933787°N, 82.886506°W). 24 August 2010. Gabrielle J. Graeter, K. Graeter, and Eric Usher. NCSM 77349. New county record. First specimen voucher for Blue Ridge province in North Carolina, and first record for French Broad River drainage in North Carolina. Extends range ca. 95 km NW of nearest record in Polk Co. (Palmer and Braswell 1995), ca. 112 km W of nearest record in Burke Co. (Herman et al. 2003), and ca. 19 km E of nearest records in Sevier Co., Tennessee (Iverson 1992; Scott and Redmond 2008), filling part of range hiatus shown in Conant and Collins (1998).

Northampton Co.: 5.3 km SSW Rich Square (36.231063°N, 77.317519°W). 28 June 2007. Jeffrey G. Hall. NCSM 78691. New county record.

Pasquotank Co.: 1.0 km WSW Weeksville (36.2047°N, 76.1735°W). 3 June 1964. Joseph R. Bailey and Reeve M. Bailey. NCSM 55516. New county record.

Perquimans Co.: ca. 0.5 km N center Hertford, Perquimans River (36.1943°N, 76.4665°W). 2 July 1975. Jesse P. Perry. NCSM 52958–52959. New county records.

Rutherford Co.: 9.3 km ENE Lake Lure (town), Cove Cr. (35.4558°N, 82.10719°W). 5 May 2010. Stephen J. Fraley, W. T. Russ, and N. A. Bowman. NCSM photographic voucher 100505.1sjf. New county record. Extends range ca. 15 km N of nearest record in Polk Co. (Palmer and Braswell 1995).

Vance Co.: 5.8 km NW Middleburg, Kerr Lake State Park along Kerr Reservoir (36.4403°N, 78.3645°W). 2 August 2003. Bryce Fleming and Lori Fleming. NCSM photographic vouchers LF 97-1. New county record.

Wilkes Co.: ca. 6.6 km WSW Wilkesboro, W. Kerr Scott Reservoir (36.12°N, 81.27°W). March 1997. Joseph H. Mickey. NCSM photographic voucher JHM 97-1. New county record. Extends range ca. 75 km WNW of nearest record in Davie Co. (Palmer and Braswell 1995) and fills part of range hiatus shown in Conant and Collins (1998).

***TRACHEMYS SCRIPTA SCRIPTA* (Yellow-bellied Slider)**. Chowan Co.: 3.7 km SW Valhalla (36.1113°N, 76.6861°W). 11 June 1988. Rufus W. Gaul, Jr. and David Carson. NCSM 71830 (7 eggs removed from road-killed female). First specimen vouchers for county. Palmer and Braswell (1995) reported an unvouchered observational record.

SQUAMATA — LIZARDS

***ASPIDOSCELIS SEXLINEATA SEXLINEATA* (Eastern Six-lined Racerunner)**. Granville Co.: 4.7 km NNW Stem, north slope Bowling Mtn. (36.2337°N, 78.7500°W). 12 Sept. 2010. David G. Cooper and Henry Wood. NCSM photographic vouchers DGC 10-1. New county record.

***HEMIDACTYLUS TURCICUS* (Mediterranean Gecko)**. Columbus Co.: 1.9 km S Whiteville (34.3206°N, 78.7028°W). 12 July 2010. Gail Reynolds. NCSM photo vouchers KL 10-1. New county record. This introduced species was first vouchered from North Carolina in 2003, from an apparently established population in New Hanover Co. (Beane et al. 2010; Beane and Corey 2010). It is unknown whether this Columbus Co. record represents an established colony or an isolated introduction.

Orange Co.: 5.2 km N center Chapel Hill (35.9605°N, 79.0525°W). 7 August 2011. Jacob Judd and Jessica Hampton Judd. NCSM 78421. New county record. Numerous individuals of different age classes were observed at this locality during 2011 and 2012 (pers. obs.; A. Iyoob, J. Judd, and J. H. Judd, pers. comm.), suggesting a well-established population.

Wake Co.: 0.5 km WSW center Raleigh (35.7781°N, 78.6421°W). 17 November 2009. Michael E. Dunn. NCSM 77274. 1.6 km ESE center Cary (35.7800°N, 78.7661°W). 30 November 2010. Gail Powell et al. NCSM 77728. New county records and second and third specimen vouchers for North Carolina (Beane and Corey 2010). There have been additional reports of this species at the two Wake Co. localities, as well as unsubstantiated reports from other localities in Orange and Wake counties, suggesting established populations. The population at the second Wake Co. locality (1.6 km ESE center Cary) reportedly originated from several escaped captives in the early 1980s, and has apparently persisted for over 30 years (Daniel F. Lockwood, pers. comm.). Over 400 individuals were captured at this site in June and July 2012, during a mark-recapture study (Kevin Durso, pers. comm.).

***PLESTIODON FASCIATUS* (Common Five-lined Skink)**. Davidson Co.: 9.5 km ESE Linwood (35.744639°N, 80.210972°W). 16 April 2011. Bruin DeWald. NCSM photo vouchers BD 11-1. New county record.

***SCELOPORUS UNDULATUS* (Eastern Fence Lizard)**. Davidson Co.: 9.3 km ESE Linwood (35.744887°N, 80.21031°W). 13 March 2012. Bruin DeWald. NCSM photo vouchers BD 12-1.

***SCINCELLA LATERALIS* (Little Brown Skink)**. Stokes Co.: 4.0 km WNW Danbury (36.42535°N, 80.24270°W). 29 April 2012. Jeffrey C. Beane. NCSM photo vouchers JCB 12-529. New county record.

SQUAMATA — SNAKES

***AGKISTRODON CONTORTRIX* (Copperhead)**. Iredell Co.: 1.6 km ESE Mount Mourne (35.540801°N, 80.829140°W). 26 June 2007. Steven J. Price. NCSM 78705. First specimen voucher for county. Beane and Corey (2010) reported a photographic record, and Palmer and Braswell (1995) reported an unvouchered observational record.

***CARPHOPHIS AMOENUS AMOENUS* (Eastern Wormsnake)**. Rockingham Co.: ca. 14.0 km SSW Reidsville, Haw River State Park (36.2505°N, 79.7565°W). 17 March 2010. Jeffrey C. Beane et al. NCSM 77223. New county record.

***CEMOPHORA COCCINEA COPEI* (Northern Scarletsnake)**. Alexander Co.: ca. 8.0 km NE Taylorsville, Rocky Face Mountain (35.972°N, 81.109°W). April 2010. Cade Coone and Michael S. Coone. NCSM 77237. First specimen voucher for county. Beane and Corey (2010) reported a photographic record from the same locality.

***COLUBER CONSTRICTOR CONSTRICTOR* (Northern Black Racer)**. Davidson Co.: 9.3 km ESE Linwood (35.744887°N, 80.21031°W). 25 August 2010. Bruin and Lori DeWald. NCSM photographic vouchers BD 10-1. New county record.

***CROTALUS HORRIDUS* (Timber Rattlesnake)**. Warren Co.: 0.2 km W Manson (36.42164°N, 78.28503°W). 23 November 2010. Charlie Forsythe. NCSM 78461. New county record. Fills portion of gap between northern Coastal Plain populations and a north-central Piedmont population thought to be isolated (Palmer and Braswell 1995, Conant and Collins 1998).

***FARANCIA ABACURA ABACURA* (Eastern Mudsnake)**. Greene Co.: 7.7 km NNW Jason, Button Branch (35.4416°N, 77.8175°W). 26 April 2010. Rufus W. Gaul, Jr. NCSM 77236. New county record.

***LAMPROPELTIS ELAPSOIDES* (Scarlet Kingsnake)**. Camden Co.: 6.9 km NNW South Mills, Dismal Swamp State Park (36.50422°N, 76.35715°W). 18 April 2012. Jane C. Wyche, Signa B. Williams, et al. NCSM photographic voucher JCW 12-1. New county record.

Gates Co.: 6.4 km NE Gatesville (36.44214°N, 76.69991°W). 26 May 2011. Jane C. Wyche. NCSM 78289. New county record.

***LAMPROPELTIS GETULA* (Eastern Kingsnake)**. Chowan Co.: 2.6 km WSW Hancock (35.0909°N, 76.6545°W). 8 June 2009. Elizabeth Hanrahan. NCSM 77220. First specimen voucher for county. Beane and Corey (2010) reported a photographic record from the same locality.

Davidson Co.: 9.3 km E.SE Linwood (35.744887°N, 80.21031°W). 8 September 2010. Bruin and Lori DeWald. NCSM photographic vouchers BD 10-2. New county record.

***MICRURUS FULVIUS* (Harlequin Coralsnake)**. Robeson Co.: ca. 2.7 km WNW center Lumberton (34.6351°N, 79.0331°W). Early August 2009. Kenneth Jones. NCSM 77078. New county record.

***NERODIA TAXISPILOTA* (Brown Watersnake)**. Northampton Co.: 2.1 km S Gaston, Roanoke River (36.48181°N, 77.64429°W). 24 April 2012. Jim Cole. NCSM photographic voucher JC 12-1. New county record.

***OPHEODRYS AESTIVUS* (Rough Greensnake)**. Bertie Co.: 8.7 km SSE Grabtown, Roanoke River National Wildlife Refuge (35.8902°N, 77.0197°W). 5 June 2011. Jeffrey C. Beane, Mark Berman, and John Ellis. NCSM photographic vouchers JCB 11-1017. First photographic voucher for county. Palmer and Braswell (1995) reported an unvouchered observational record.

***RAMPHOTYPHLOPS BRAMINUS* (Brahminy Blindsnake)**. Wake Co.: ca. 6.8 km NW center Raleigh (35.825°N, 78.690°W). Ca. 2 December 1994. Lawrence T. Englert. NCSM 78302. New county record and first record for North Carolina. Thus far, this appears to represent an isolated introduction; no established populations of this widely introduced, parthenogenetic species have been reported in North Carolina.

***REGINA SEPTEMVITTATA* (Queensnake)**. Alamance Co.: 6.1 km SE Alamance, Rock Cr., Cedarock Park (35.995672°N, 79.440916°W). 6 July 2012. Corey T. G. Goldman. NCSM 79771. New county record.

***STORERIA DEKAYI DEKAYI* (Northern Brownsnake)**. Davidson Co.: 9.7 km ESE Linwood (35.74475°N, 80.209806°W). 18 April 2011. Bruin DeWald. NCSM photo vouchers BD 11-2. New county record.

Rutherford Co. 1.9 km ESE Thermal City (35.51303°N, 81.95294°W). 8 June 2012. Jeffrey C. Beane, Robert A. Davis, et al. NCSM 79522. New county record.

***THAMNOPHIS SAURITUS SAURITUS* (Common Ribbonsnake)**. Anson Co.: 5.0 km ENE Ansonville, Pee Dee National Wildlife Refuge, along Pee Dee River (35.10546°N, 80.05385°W). 4 October 2007. W. Jeffrey Humphries. NCSM photographic voucher WJH 07-1. New county record.

Moore Co.: 4.8 km WSW Pinebluff, Horse Cr. (35.0684°N, 79.5161°W). 2 May 2010. L. Todd Pusser, Tiffany A. Arnold, and Zachary S. Barfield. NCSM photographic voucher LTP 10-1. New county record.

Washington Co.: 12.7 km SSW Cherry, Pocosin Lakes National Wildlife Refuge (35.7390°N, 76.4720°W). 3 May 2011. L. Todd Pusser. NCSM photographic voucher LTP 11-1. New county record.

***VIRGINIA VALERIAE VALERIAE* (Eastern Smooth Earthsnake)**. Beaufort Co.: 1.4 km WNW Blounts Creek (35.355700°N, 76.973452°W). 17 April and 20 May 2012. Robby Deans. NCSM photographic vouchers RD 12-1 and RD 12-2. New county records.

Halifax Co.: 4.8 km ESE Halifax, along Roanoke River (36.3023°N, 77.5447°W). 24 March 2012. Stephen P. Hall and Merrill Lynch. NCSM 79358. New county record.

Jones Co.: 3.7 km ESE Trenton (35.0508°N, 77.3155°W). 19 June 2012. David H. Allen. NCSM 80200. New county record.

Tyrrell Co.: 4.2 km SSE Newfoundland (35.91033°N, 76.11211°W). 5 August 2009. Daniel J. Smith. NCSM photographic voucher DJS 09-1. New county record and first record for Albemarle-Pamlico Peninsula.

Acknowledgments.—I sincerely thank all those whose fieldwork resulted in new distributional records. William M. Palmer reviewed the manuscript.

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New County Records and an Update for Kansas and Nebraska, USA

Kansas and Nebraska are states found within the midwestern region and the geographical center of the United States. Although both have enjoyed a long history of herpetological exploration, much still needs to be done to verify the existence and distribution of reptiles and amphibians within the region. Here, I report 24 new county records from this region, supported by photo vouchers. Most collections occurred during May 2012. All voucher photographs are deposited in the Herpetology Section of the Natural History Museum of Los Angeles County (LACM). All were verified by Neftali Camacho. These records were determined by examination of the three regional field guides for the area, Collins et al. (2010), Fogell (2010), and Ballinger et al. (2010). The Kansas Herpetofaunal Atlas (Taggart et al. 2013), an online map of county vouchers, was also consulted for updates to the previously cited publications. Most of these records are for turtles, which are underrepresented in museum collections within the region. Geocoordinates were obtained from GoogleEarth/Google Maps WGS84 datum. All observations were made by the author.

KANSAS

TESTUDINES — TURTLES

***CHRYSEMYS PICTA BELLI* (Western Painted Turtle).** Dickinson Co.**:** Abilene, DOR on I-70 (38.942991°N 97.20183°W). 11 May 2011. LACM PC 1575. This is the first vouchered record of this species in Dickinson Co. with complete locality data. Three voucher specimens exist from 1916 (KU 3191, 3192, 157811), with ambiguous locality information. These specimens were verified by Andrew Campbell on 4 June 2012 as from "Dickinson County" with no further information.

Morris Co.: Council Grove Lake (38.705312°N, 96.497518°W). 14 May 2012. LACM PC 1585. New county record.

***GRAPTEMYS PSEUDOGEOGRAPHICA PSEUDOGEOGRAPHICA* (False Map Turtle).** Dickinson Co.: between Soloman and Abilene, Smoky Hill River (38.906017°N, 97.28424°W). 8 May 2012. LACM PC 1577.

Ottawa Co.: Solomon River S of Bennington (39.014585°N, 97.612513°W). 9 May 2012. LACM PC 1580.

Saline Co.: Soloman River, approx. 1 mi. N Salina (38.887556°N, 97.593758°W). 9 May 2012. LACM PC 1579.

***APALONE SPINIFERA* (Spiny Softshell).** McPherson Co.: Marquette, in Smoky Hill River (38.551195°N, 97.833560°W). 11 May 2012. LACM PC 1581.

Saline Co.: Salina, in Smoky Hill River (38.834272°N, 97.585935°W). 9 May 2012. LACM PC 1578.

***TRACHEMYS SCRIPTA ELEGANS* (Red-eared Slider).** Dickinson Co.: Pond at BSA camp S Abilene (38.880057°N, 97.203546°W). 12 May 2012. LACM PC 1584.

Ellsworth Co.: Kanopolis Reservoir, in Smoky Hill River below dam (38.611095°N, 97.952822°W). 12 May 2012. LACM PC 1583.

Morton Co.: Pond in river bottom in Cimarron National Grasslands (37.135831°N, 101.824225°W). 5 May 2012. LACM PC 1576.

Rice Co.: Little River, in Little Arkansas River (38.376818°N, 97.991388°W). 11 May 2012. LACM PC 1582.

NEBRASKA

ANURA — FROGS

***LITHOBATES CATESBEIANUS* (American Bullfrog).** Greeley Co.: Spalding, in city golf course pond (41.680409°N, 98.374483°W). 23 May 2012. LACM PC 1596.

TESTUDINES — TURTLES

***APALONE MUTICA* (Smooth Softshell).** Saline Co.: Solomon River (38.88751°N, 97.593498°W). 8 May 2012. LACM PC 1600.

***CHELYDRA SERPENTINA* (Snapping Turtle).** Boone Co.: SW Petersburg (41.828648°N, 98.091406°W). 23 May 2012. LACM PC 1594.

Fillmore Co.: approx. 2.9 mi. NNE Fairmont (40.676775°N, 97.578675°W). 22 May 2012. LACM PC 1586.

Hamilton Co.: 40.704159°N, 97.997123°W. 22 May 2012. LACM PC 1590.

Nance Co.: 41.342119°N, 97.975041°W. 22 May 2012. LACM PC 1592.

***CHRYSEMYS PICTA BELLI* (Western Painted Turtle).** Boone Co.: SW Petersburg (41.828631°N, 98.091378°W). 23 May 2012. LACM PC 1594.

Clay Co.: Sutton (40.610672°N, 97.866004°W). 22 May 2012. LACM PC 1589.

Fillmore Co.: approx. 2.9 mi. NNE Fairmont (40.676775°N, 97.578675°W). 22 May 2012. LACM PC 1587.

Garfield Co.: Burwell (41.774923°N, 99.095180°W). 23 May 2012. LACM PC 1597.

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Greeley Co.: 41.683766°N, 98.314841°W. 23 May 2012. LACM PC 1595.

Hamilton Co.: 41.073613°N, 97.999864°W. 22 May 2012. LACM PC 1591

***EMYDOIDEA BLANDINGII* (Blanding's Turtle).** Garfield Co.: Burwell (41.774935°N, 99.095105°W). 23 May 2012. LACM PC 1598.

SQUAMATA — SNAKES

***THAMNOPHIS SIRTALIS PARIETALIS* (Red-sided Garter Snake).** McPherson Co.: 41.554029°N, 101.212865°W. 24 May 2012. DOR. LACM PC 1599.

Acknowledgments.—I thank Curtis Schmidt (Sternberg Museum, Fort Hays University, Hays, Kansas), Travis Taggart (Fort Hays University, Hays, Kansas), and Dan Fogell (Southeast Community College, Lincoln, Nebraska) for their confirmation of species identifications, encouragement, and help with the gathering of these new records, and Neftali Camacho (LACM) for verifying all vouchers.

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New and Updated Records of Amphibians and Reptiles from Minnesota, USA

In preparation for the publication of the revised edition of "Amphibians and Reptiles in Minnesota" (Moriarty and Hall, pers. comm.), authors accessioned several new or updated records at the Bell Museum of Natural History (JFBM) based on Oldfield and Moriarty (1994) and Gamble and Moriarty (2006). Previously accessioned vouchers documented during or before 1960 were considered outdated. Vouchered records include physical specimens, digital photographs (accession number preceded by "P") and audio recordings (accession number preceded by "AUD"). Of the 36 records included here, 11 were collected by state employees from the Minnesota Department of Natural Resources - Nongame Wildlife Program, and their acquisition was funded in part by a grant from the State Wildlife Grants Program administered by the U.S. Fish and Wildlife Service. Don Shepard verified records. Geocoordinates are based on datum WGS 84. Fieldwork conducted on federal lands with special-use permit number 32550-11009.

CAUDATA — SALAMANDERS

***AMBYSTOMA LATERALE* (Blue-spotted Salamander).** Chisago Co.: Wild River State Park (45.53672°N, 92.73043°W). 08 June 2009. New county record. E. P. Hoaglund, D. McDermott, and C. E. Smith. JFBM P412.

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Isanti Co.: CR 18, 0.75 km S of CR 9 (45.44523°N, 93.04034°W). September 2011. Updated county record. Steve Pucktel. JFBM P447.

Sherburne Co.: NW Sherburne National Wildlife Refuge (45.50134°N, 93.76233°W). 18 April 2011. New county record. E. P. Hoaglund. JBFM P440.

***AMBYSTOMA TIGRINUM* (Eastern Tiger Salamander).** Watonwan Co.: 8.5 km SW of Madelia (44.02075°N, 94.52454°W). 01 July 2011. Updated county record. C. E. Smith. JFBM P413.

ANURA — FROGS

***ANAXYRUS AMERICANUS* (American Toad).** Anoka Co.: Carlos Avery Wildlife Management Area (45.33048°N, 93.044429°W). 23 July 2011. Updated county record. C. E. Smith. JFBM P414.

Le Sueur Co.: 1.5 km E of St. Peter (44.31990°N, 93.93607°W). 15 July 2011. Updated county record. C. E. Smith. JFBM P415.

Sherburne Co.: Sand Dunes State Forest at border with Uncas Dunes Scientific and Natural Area (45.41940°N, 93.71033°W). 26 May 2011. Updated county record. E. P. Hoaglund and C. E. Smith. JFBM 416.

Watonwan Co.: 4.6 km SW of Madelia at CR 111 and railroad crossing (44.03417°N, 94.48897°W). 01 July 2011. New county record. C. E. Smith. JFBM P417.

***HYLA CHRYSOSCELIS* (Cope's Gray Treefrog).** Renville Co.: 6 km SW of Fairfax (44.47072°N, 94.75504°W). 18 June 2011. New county record. C. E. Smith. JFBM AUD1.

Watonwan Co.: 3.75 km SW of Madelia along County Hwy 13 (44.02918°N, 94.46570°W). 01 July 2011. New county record. C. E. Smith. JFBM AUD6.

***HYLA VERSICOLOR* (Gray Treefrog)**. Saint Louis Co.: Lake Vermilion State Park (47.83234°N, 92.20556°W). 25 June 2011. New county record. E. P. Hoaglund and C. E. Smith. JFBM AUD3.

Sherburne Co.: Sand Dunes State Forest (45.42959°N, 93.70830°W). 25 May 2011. New county record. E. P. Hoaglund and C. E. Smith. JBFM AUD8.

***LITHOBATES CLAMITANS* (Green Frog)**. Sherburne Co.: Larsen Slough, south of St. Francis River (45.41170°N, 93.66292°W). 27 June 2011. Updated county record. E. P. Hoaglund and C. E. Smith. JFBM P418.

***LITHOBATES PIPIENS* (Northern Leopard Frog)**. Brown Co.: Flandrau State Park (44.29492°N, 94.47918°W). 22 August 2009. Updated county record. C. E. Smith. JFBM P419.

Watonwan Co.: 4.6 km SW of Madelia on County Hwy 13 (44.02914°N, 94.47503°W). 01 July 2011. New county record. C. E. Smith. JFBM P420.

***LITHOBATES SEPTENTRIONALIS* (Mink Frog)**. Sherburne Co.: NW Sherburne National Wildlife Refuge (45.50166°N, 93.76021°W). 06 June 2011. New county record. E. P. Hoaglund and C. E. Smith. JFBM P421.

***PSEUDACRIS CRUCIFER* (Spring Peeper)**. Sherburne Co.:. NW Sherburne National Wildlife Refuge (45.49553°N, 93.75853°W). 03 May 2011. New county record. E. P. Hoaglund. JBFM P422.

***PSEUDACRIS MACULATA* (Boreal Chorus Frog)**. Sherburne Co.: SE Sand Dunes State Forest (45.39110°N, 93.64790°W). 25 May 2011. Updated county record. E. P. Hoaglund and C. E. Smith. JBFM AUD9.

TESTUDINES — TURTLES

***CHELYDRA SERPENTINA* (Snapping Turtle)**. Carlton Co.: Nesting along County Hwy 210 in Jay Cooke State Park (46.65612°N, 92.35989°W). 11 June 2010. Updated county record. C. E. Smith. JFBM P378.

Fillmore Co.: Forestville State Park (43.62195°N, 92.22628°W). 14 June 2009. New county record. E. P. Hoaglund and C. E. Smith. JFBM P424.

Nicollet Co.: Hwy 14, 2.1 km W. of Courtland (44.27766°N, 94.37066°W). 18 June 2011. New county record. C. E. Smith. JFBM P425.

Rice Co.: Straight River at River Bend Nature Center (44.27404°N, 93.24207°W). 25 May 2007. Updated county record. C. E. Smith. JFBM P426.

Sibley Co.: County Hwy 8 just E of Hwy 169 (44.46391°N, 93.92682°W). 18 June 2011. New county record. C. E. Smith. JFBM P427.

***CHRYSEMYS PICTA* (Painted Turtle)**. Chisago Co.: Wild River State Park (45.55457°N, 92.83389°W). 09 Aug 2009. Updated county record. E. P. Hoaglund and C. E. Smith. JBFM P428.

Le Sueur Co.: Township Rd. 140, 0.45 km N of 480th St. (44.25812°N, 94.00687°W). 26 August 2011. New county record. E. P. Hoaglund and C. E. Smith. JFBM P430.

Nicollet Co.: Hwy 99 at Oakleaf Lake (44.31195°N, 94.01610°W). 19 June 2011. New county record. C. E. Smith. JFBM P431.

***GRAPTEMYS PSEUDOGEOGRAPHICA* (False Map Turtle)**. Nicollet Co.: Minnesota River, 0.70 km down river from outlet to Seven Mile Creek (44.24033°N, 94.02103°W). 14 July 2008. Updated county record. Jeff LeClere and C. E. Smith. JFBM P357.

SQUAMATA — LIZARDS

***PLESTIODON SEPTENTRIONALIS* (Prairie Skink)**. Isanti Co.: Cedar Creek Ecosystem Science Reserve (45.43318°N, 93.19477°W). 18 June 2009. Updated county record. E. P. Hoaglund and C. E. Smith. JFBM P433.

SQUAMATA — SNAKES

***HETERODON PLATIRHINOS* (Eastern Hog-nosed Snake)**. Anoka Co.: Cedar Creek Ecosystem Science Reserve, west of Cedar Creek (45.40291°N, 93.21002°W). 15 June 2009. Updated county record. E. P. Hoaglund and C. E. Smith. JBFM P434.

Pine Co.: Saint Croix State Park (45.97503°N, 92.54344°W). 07 June 2009. Updated county record. E. P. Hoaglund and C. E. Smith. JFBM P435.

***OPHEODRYS VERNALIS* (Smooth Greensnake)**. Shelburne Co.: Sand Dunes State Forest (45.42958°N, 93.71270°W). 24 September 2009. Updated county record. C. E. Smith and D. Kaufman. JFBM 16864.

***STORERIA DEKAYI* (Dekay's Brownsnake)**. Blue Earth Co.: 570th Ave. W of CR 5 (44.23689°N, 94.00294°W). 05 November 2011. New county record. E. P. Hoaglund and C. E. Smith. JFBM P436.

***STORERIA OCCIPITOMACULATA* (Red-bellied Snake)**. Houston Co.: CR 249, W of Hwy 26 (43.59310°N, 91.29431°W). 30 July 2010. New county record. E. P. Hoaglund, Jeff LeClere, and C. E. Smith. JFBM P359.

***THAMNOPHIS RADIX* (Plains Gartersnake)**. Stearns Co.: CR 44 just W of intersection with 4th Ave. E (45.34742°N, 94.11127°W). 29 August 2011. Updated county record. C. E. Smith. JFBM P437.

***THAMNOPHIS SIRTALIS* (Common Gartersnake)**. Pine Co.: Robinson Park just E of Sandstone (46.13436°N, 92.85908°W). 01 July 2009. Updated county record. E. P. Hoaglund and C. E. Smith. JFBM P438.

Sibley Co.: Scenic Byway Rd 2.5 km S of County Hwy 5 (44.60502°N, 93.88869°W). 05 November 2011. Updated county record. E. P. Hoaglund and C. E. Smith. JFBM P439.

Acknowledgments.—We thank Don Shepard for verifying species identity. We also thank Dav Kaufman, Jeff LeClere, Duane McDermott, and Steve Pucktel for taking the time to document field observations as well as Liz Harper and John Moriarty for reviewing this note.

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Geographic Distribution of Herpetofauna of Middle Tennessee

Geographic distribution of Tennessee herpetofauna has been well documented by Scott and Redmond (2002), and is regularly updated via online atlas. However, some distribution gaps remain in the Middle Tennessee region. The following records fill some of these gaps. All specimens were collected from a eight-county area in Tennessee to include Hardin, Hickman, Lawrence, Macon, Marshall, Maury, Smith, and Williamson counties. Identification and distribution of species followed Conant and Collins (1998). All specimens represent new county records supported by Scott and Redmond (1996, 2008). GPS datum is WGS 84. Photo vouchers were deposited in the Austin Peay State University's Museum of Zoology (APSUMZ). Nomenclature follows Crother (2012). All specimens were independently verified by A. Floyd Scott (APSU).

CAUDATA — SALAMANDERS

***EURYCEA CIRRIGERA* (Southern Two-Lined Salamander)**. Maury Co.: Mount Pleasant, Creek 200 m downstream from the fall at Stillhouse Hollow Falls (35.470526°N, 87.26777°W). 10 October 2012. Nicole Foster and Cameron Hargrove. APSUMZ 19386.

ANURA — FROGS

***ACRIS CREPITANS* (Eastern Cricket Frog)**. Macon Co.: Red Boiling Springs, near 1727 Jennings Creek Road (36.447708°N, 85.832877°W). 15 October 2012. Nicole Foster and Mary Christensen. APSUMZ 19380.

Maury Co.: Columbia, 70 m N of boat ramp at Chickasaw Trace along the sandy bank beside the Duck River (35.663503°N, 87.093869°W). 13 April 2012. Nicole Foster and Colleen Conway. APSUMZ 19230.

***ANAXYRUS AMERICANUS* (American Toad)**. Williamson Co.: Nolensville, 1039 Britain Lane (35.971178°N, 86.684675°W). 23 May 2012. Nicole Foster and Michele Dillashaw. APSUMZ 19240.

***ANAXYRUS FOWLERI* (Fowler's Toad)**. Maury Co.: Columbia, 3781 Talley Moore Road (35.67919°N, 86.822966°W). 18 May 2012. Nicole Foster and Michele Dillashaw. APSUMZ 19232.

***GASTROPHRYNE CAROLINENSIS* (Eastern Narrow-mouthed Toad)**. Maury Co.; Mount Pleasant, 8195 Mount Joy Road (35.518024°N, 87.252876°W). 8 June 2012. Caitlin King. APSUMZ 19323.

***HYLA VERSICOLOR / CHRYSOSCELIS* COMPLEX (Cope's Gray Treefrog / Gray Treefrog)**. Hickman Co.: Lyles, 6158 Parker Road (35.837839°N, 87.340656°W). 22 June 2012. Nicole Foster and Mary Christensen. APSUMZ 19319.

Lawrence Co.: Lawrenceburg, 80 Gang Road (35.300658°N, 87.369821°W). 16 June 2012. Jared Johnston. APSUMZ 19320.

***LITHOBATES CLAMITANS* (Green Frog)**. Maury Co.: In a shallow creek along Chickasaw Trace about mile marker 6.8. (35.6714714°N, 87.0820265°W). 14 March 2012. Colleen Conway and Nicole Foster. APSUMZ 19228.

Wayne Co.: Waynesboro, 645 Pineridge Road (35.292325°N, 87.716045°W). 11 June 2012. Wyatt Kerr. APSUMZ 19324.

***LITHOBATES PALUSTRIS* (Pickerel Frog)**. Giles Co.: Pulaski, 515 Leatherwood Creek Road South (35.170964°N, 86.959585°W). 02 August 2012. Anna Grace Lowry and Nicole Foster. APSUMZ 19325.

***SCAPHIOPUS HOLBROOKII* (Eastern Spadefoot)**. Maury Co.: 1075 Cliff White Road (35.621198°N, 86.945221°W). 17 May 2012. Colleen Conway and Nicole Foster. APSUMZ 19233.

TESTUDINES — TURTLES

***APALONE SPINIFERA* (Spiny Softshell)**. Maury Co.: Duck River approximately 2.3 km NW from Carpenter Bridge (35.631382°N, 86.859623°W). 22 May 2012. Nicole Foster and Colleen Conway. APSUMZ 19239. On a rock surrounded by a rocky escarpment alongside the Duck River.

***CHELYDRA SERPENTINA* (Snapping Turtle)**. Lawrence Co.: Davy Crockett State Park, Crockett Falls (35.286376°N, 87.284816°W). 26 June 2012. Kasin Sanders. APSUMZ 19331.

Lewis Co.: Columbia Highway about 350 m W of Finis Road (35.563814°N, 87.364081°W). 29 May 2012. Nicole Foster and Colleen Conway. APSUMZ 19336.

Maury Co.: Columbia, 1101 Bear Creek Road (35.634838°N, 86.935961°W). 10 May 2012. Nicole Foster and Michele Dillashaw. APSUMZ 19250.

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***GRAPTEMYS GEOGRAPHICA* (Northern Map Turtle).** Hickman Co.: South Lick Creek at County Highway 1839, 100 m E of Hicks Cemetery Road (35.844879°N, 87.245150°W). 17 June 2012. Nicole Foster and Michele Dillashaw. APSUMZ 19325.

Lewis Co.: Buffalo River 200 m W of Metal Ford Road (35.463254°N, 87.480609°W). Nicole Foster and Colleen Conway. APSUMZ 19337. At least 20 young *Graptemys geographica* were observed in the area to the apparent exclusion of any other species of turtle. 29 May 2012.

Williamson Co.: South Harpeth River at 7456 South Harpeth Road (35.931373°N, 87.079919°W). Nicole Foster and Michele Dillashaw. APSUMZ 19348. 02 June 2012.

***PSEUDEMYS CONCINNA* (River Cooter).** Marshall Co.: Along the Duck River east of the Hardison Mill/ Highway 431 bridge. (35.609965°N, 86.820778°W). 21 May 2012. Nicole Foster and Colleen Conway. APSUMZ 19235.

***STERNOTHERUS MINOR PELTIFER* (Striped-Neck Musk Turtle).** Hardin Co.: Clifton, near 4039 Hardin Creek Road (35.332142°N, 88.029338°W). 15 June 2012. Jared Johnston. APSUMZ 19326.

***TERRAPENE CAROLINA* (Eastern Box Turtle).** Hickman Co.: Bon Aqua, 5205 Meadowwood Drive (35.933835°N, 87.266648°W). 31 May 2012. Nicole Foster and Tabitha Manor. APSUMZ 19329.

Giles Co.: Lynnville, near 2176 Mount Olivet Cemetery Road, (35.335304°N, 87.067394°W). 5 July 2012. Nicole Foster. APSUMZ 19330.

Lawrence Co.: Jones Road in Laurel Hills Wildlife Management Area less than 0.7 km from junction with Laurel Hill Road (35.406541°N, 87.509923°W). 15 May 2012. Nicole Foster and Michele Dillashaw. APSUMZ 19248.

Macon Co.: Red Boiling Springs, near 1727 Jennings Creek Road (36.447688°N, 85.832879°W). 14 October 2012. Nicole Foster and Mary Christensen. APSUMZ 19384.

Wayne Co.: Waynesboro, backyard of 645 Pineridge Road (35.29269°N, 87.716601°W). 12 June 2012. Wyatt Kerr. APSUMZ 19343. A second specimen was found at 2019 Waynesboro Highway (35.427970°N, 87.796046°W). 21 June 2012. Agustin Villaneuva. APSUMZ 19344.

Williamson Co.: College Grove, 6836 Pulltight Hill Road (35.7610624°N, 86.7443854°W). 10 July 2012. Nicole Foster. APSUMZ 19349.

***TRACHEMYS SCRIPTA* (Pond Slider).** Hickman Co.: 10628 County Highway 1839, Primm Springs (35.839314°N, 87.225112°W). 17 May 2012. Nicole Foster and Michele Dillashaw. APSUMZ 19234.

Lawrence Co.: Loretto, Clax Branch Golf Course behind 187 Fairway Circle, (35.10545°N, 87.437589°W). 16 April 2011. Neisha Newton. APSUMZ 19332.

Marshall Co.: Along the Duck River east of the Hardison Mill/ Highway 431 bridge (35.610242°N, 86.820835°W). 20 October 2011. Nicole Foster and Colleen Conway. APSUMZ 19236.

Maury Co.: Highway in front of 1221 Highway 7, Columbia (35.6572691°N, 87.0732907°W). 23 April 2012. Nicole Foster and Colleen Conway. APSUMZ 19234.

Williamson Co.: South Harpeth River at Fernvale Road crossing (35.954246°N, 87.078449°W). 02 June 2012. Nicole Foster and Michele Dillashaw. APSUMZ 19346.

SQUAMATA — LIZARDS

***PLESTIODON FASCIATUS* (Common Five-lined Skink).** Marshall Co.: Lewisburg, 1285 Powell Lane (35.5644790°N, 86.7639610°W). 27 April 201. Michael Williams and Nicole Foster. APSUMZ 19225. Found with a *Plestiodon laticeps*.

***PLESTIODON LATICEPS* (Broad-headed Skink).** Marshall Co.: Lewisburg, 925 Collins Road (35.6363402°N, 86.7971062°W). 27 April 2012. Michael Williams and Nicole Foster. APSUMZ 19226.

***SCELOPORUS UNDULATUS* (Eastern Fence Lizard).** Hickman Co.: Lyles, 6158 Parker Road (35.459936°N, 86.781505°W). 29 April 2012. Nicole Foster and Mary Christensen. APSUMZ 19223

Lawrence Co.: Gildridge Road less than 0.4 km from junction with Artemis Road (35.365306°N, 87.515008°W). 15 May 2012. Nicole Foster and Michele Dillashaw. APSUMZ 19249.

Lewis Co.: Mt. Pleasant, 121 High Forest Drive, (35.557303°N, 87.3354°W). 08 June 2012. Nicole Foster and Michele Dillashaw. APSUMZ 19339.

Macon Co.: Red Boiling Springs, Near 1727 Jennings Creek Road (36.4622098°N, 85.8326708°W). 15 October 2012. Nicole Foster and Mary Christensen. APSUMZ 19382.

Marshall Co.: Lewisburg, River Glen Drive (35.610287°N, 86.795474°W). 13 March 2012. Michael Williams and Nicole Foster. APSUMZ 19224.

Smith Co.: Carthage, Dam Road off of Turkey Creek Road (36.2808738°N, 85.9358253°W). 15 October 2012. Nicole Foster and Mary Christensen. APSUMZ 19388.

Williamson Co.: Franklin, 5416 Parker Branch Road (35.919808°N, 86.997044°W). 17 May 2012. Nicole Foster and Michele Dillashaw. APSUMZ 19237.

SQUAMATA — SNAKES

***CARPHOPHIS AMOENUS* (Eastern Wormsnake).** Smith Co.: Carthage, Woodlands near Defeated Creek Campground, Marina Lane (36.3050176°N, 85.9120353°W). 13 October 2012. Nicole Foster and Mary Christensen. APSUMZ 19387.

***COLUBER CONSTRICTOR* (North American Racer).** Maury Co.: Road in front of 1239 Cliff White Drive, Columbia (35.6093123°N, 86.9522292°W). 19 April 2012. Colleen Conway and Nicole Foster. APSUMZ 19227.

***CROTALUS HORRIDUS* (Timber Rattlesnake).** Maury Co.: Santa Fe, 4634 Steam Mill Hollow Road (35.735069°N, 87.128063°W). 23 July 2012. Chantia Gibson, Jessica White, and Nicole Foster. APSUMZ 19340.

***DIADOPHIS PUNCTATUS* (Ring-necked Snake).** Maury Co.: Columbia, Cheek's Bend Trail about 5 m before the bluff while taking the loop (35.5692713°N, 86.896734°W). 07 May 2012. Colleen Conway and Nicole Foster. APSUMZ 19231.

***LAMPROPELTIS GETULA* (Eastern Kingsnake).** Marshall Co.: Wilhoite Mill Trail, Chapel Hill beside the bridge just before descending to the river (35.59299°N, 86.695724°W). 23 May 2012. Nicole Foster and Michele Dillashaw. APSUMZ 19241.

***OPHEODRYS AESTIVUS* (Rough Greensnake).** Hickman Co.: Lyles, 6158 Parker Road (35.837839°N, 87.340656°W). 28

September 2012. Nicole Foster and Mary Christensen. APSUMZ 19378.

***PANTHEROPHIS SPILOIDES* (Gray Ratsnake).** Hickman Co.: Bon Aqua, 6823 State Highway 100 (35.932262°N, 87.242952°W). 8 July 2012. Nicole Foster and Mary Christensen. APSUMZ 19327.

Macon Co.: Red Boiling Springs, near 2141 North Springs Road (36.5188865°N, 85.8181021°W) 14 October 2012. Nicole Foster and Mary Christensen. APSUMZ 19383.

Wayne Co.: Waynesboro, 305 Pea Ridge Road (35.432662°N, 87.691473°W). 20 June 2012. Rachel Melson. APSUMZ 19342. Was crawling around an old rusty truck in a barn.

Williamson Co.: Franklin, 2013 Columbia Avenue (35.895217°N, 86.875784°W). 13 April 2012. Melissa Antignane Blackmore and Nicole Foster. APSUMZ 19347.

***REGINA SEPTEMVITTATA* (Queensnake).** Lewis Co.: Buffalo River about 800 m W of Metal Ford Road (35.467150°N, 87.486526°W). 29 May 2012. Nicole Foster and Colleen Conway. APSUMZ 19338.

***STORERIA DEKAYI* (Dekay's Brownsnake).** Hickman Co.: Lyles, 1144 Blake Road, (35.93418°N, 87.303885°W). 28 September 2012. Hella Weber, Autumn Feustel, and Nicole Foster. APSUMZ 19379.

Maury Co.: Chickasaw Trace trail 150 m NE of the east parking lot (35.669004°N, 87.079078°W). 4 April 2012. Nicole Foster and Colleen Conway. APSUMZ 19341.

***STORERIA OCCIPITOMACULATA* (Red-bellied Snake).** Williamson Co.: 7336 South Harpeth Road (35.922049°N, 87.101904°W). 02 June 2012. Nicole Foster and Michele Dillashaw. APSUMZ 19345.

***TANTILLA CORONATA* (Southeastern Crowned Snake).** Hickman Co.: 1144 Blake Road, Lyles (35.93418°N, 87.303885°W). 24 August 2012. Hella Weber and Nicole Foster. APSUMZ 19328.

***THAMNOPHIS SIRTALIS* (Common Gartersnake).** Lawrence Co.: Lawrenceburg, 57 Mattox Road (35.286376°N, 87.284816°W). 18 June 2012. Jared Johnston. APSUMZ 19333–19335.

Macon Co.: Whitleyville, Wartrace Road between Thomas Hollow Lane and Wartrace Lane (36.4235347°N, 85.8364021°W). 14 October 2012. Nicole Foster and Mary Christensen. APSUMZ 19385.

Smith Co.: Pleasant Shade, near 378 Difficult Road (36.3961396°N, 85.8705617°W). 15 October 2012. Nicole Foster and Mary Christensen. APSUMZ 19389.

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Lizards from Qeshm Island, Iran

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The Persian Gulf is approximately 1000 km long with a depth of approximately 35 m but with depths of more than 100 m in the Strait of Hormoz. The Persian Gulf Islands in Hormoz strait are part of the Zagros formation; of these, Qeshm Island was formed by collision of the Iran and Arabian plates in the Cenozoic (Janakipour 2007; Majnonian et al. 2006; Motamed 1998). The Gulf has been frequently filled and emptied during glacial and interglacial periods in the Quaternary (Mahmoodi 1988). The sandy dunes along the gulf are important habitat for many amphibian and reptile species in this region. To date, there have been no general studies of the lizards of the islands in the Persian Gulf. Here we report on the lizard fauna of one island, Qeshm, based on surveys in the northern and central parts of the island near Deyrestan village.

Materials and Methods.—Qeshm Island is the largest island in the Persian Gulf and is part of Hormozgan Province. The island is located between 27°01' and 26°32'N and 055°16' and 056°27'E (Fig. 1). The island is 135 km long and the widest part, at about 40 km, is located between Laft and Shibderaz, though in most areas it is approximately 11 km wide. The average annual temperature is 25°C, the warmest month of the year is August (with highs of ~46°C), and the coldest month is January (with lows of ~0°C).

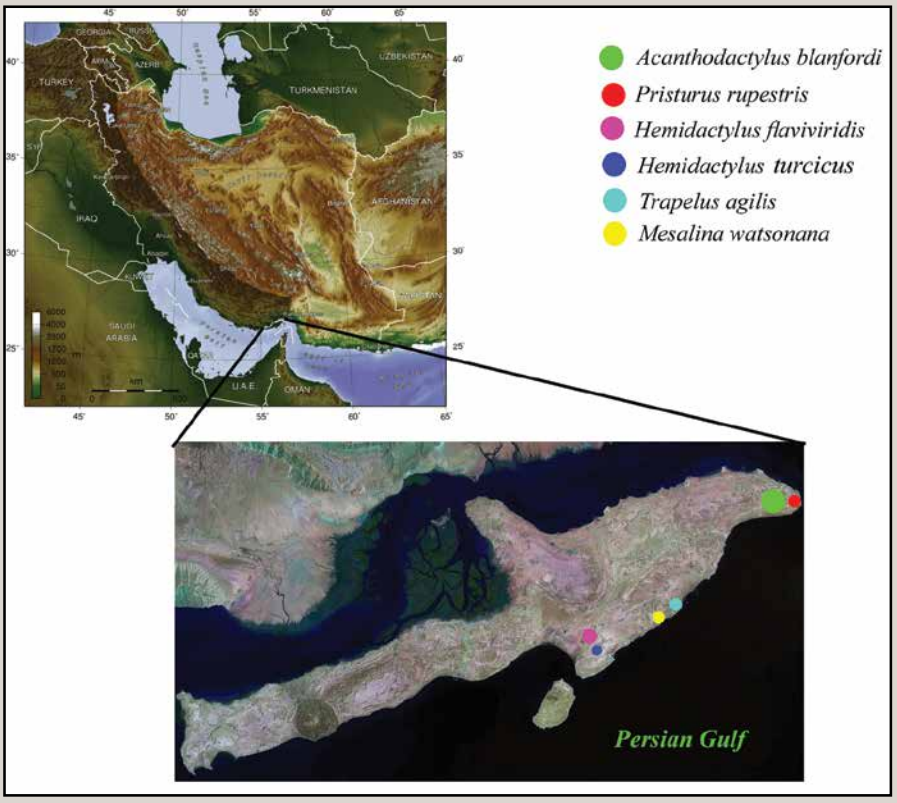


FIG. 1. Map of Iran and the location of Qeshm Island. The location of each species is identified by a different color on the map of the island.

TABLE 1. The species observed and collected from Qeshm Island during our surveys. Specimens are catalogued in the Sabzevar University Herpetological Collection (SUHC).

Museum number	Species	Family
SUHC 844	*Trapelus agilis*	Agamidae
SUHC 855	*Hemidactylus flaviviridis*	Gekkonidae
SUHC 853, 854	*Hemidactylus turcicus*	
SUHC 841, 845, 846, 847	*Pristurus rupestris*	
SUHC 848, 849, 850, 851, 852	*Acanthodactylus blanfordi*	Lacertidae
SUHC 856, 857, 858, 859	*Mesalina watsonana*	

TABLE 2. The complete list of lizards species on Qeshm Island based on supplemental information in the published literature (* = Dakhte et al. 2007).

Species	Family
Trapelus agilis	Agamidae
Hemidactylus flaviviridis	Gekkonidae
Hemidactylus turcicus	
Pristurus rupestris	
*Stenodactylus doriae**	
*Pseudoceramodactylus khobarensis**	
*Tropiocolotes steudneri**	
Acanthodactylus blanfordi	Lacertidae
Mesalina watsonana	
*Scincus mitranus**	Scincidae

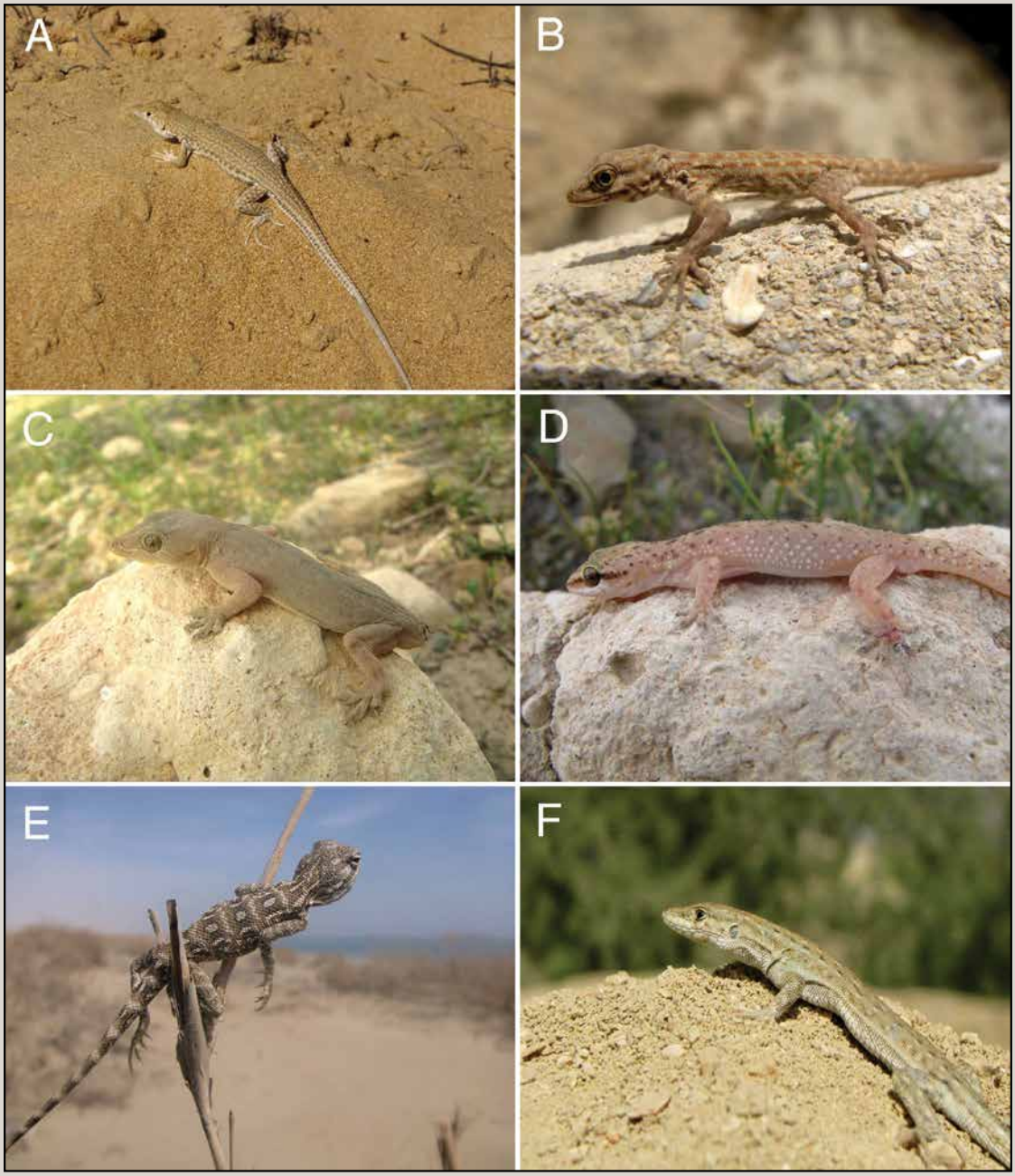
Our investigation was carried out in March 2011 on Qeshm Island for three days. Four people surveyed habitats (sand dune, coastal regions, villages) three times each day—morning, afternoon, and early evening. Sampling was by hand, and after obtaining tissue samples for genetic studies, each specimen was fixed according to standard methods in herpetology (Simmons 2002). Localities were recorded by a handheld GPS unit (eTrex Vista 245000 T-E) and digital photos were recorded for each specimen by Canon camera (G7). Voucher specimens are deposited at the Sabzevar University Herpetological Collection (SUHC) and were identified by the published sources for the Iranian herpetofauna (Anderson 1999; Rastegar Pouyani et al. 2007).

Results.—Our surveys identified six lizard species representing three families and five genera on Qeshm Island (Table 1). Based on comparisons to previously published sources on the Iranian herpetofauna, we have added four other lizard species, thus raising the total to 10 species (Table 2).

Discussion.—As mentioned above, the Persian Gulf has been emptied several times in the Quaternary, and during those times, there were land connections between the island and the mainland. The conditions of the island suggest that the herpetofauna is a southern extension of the Arabian fauna (Anderson 1999). Our investigation of the island's herpetofauna indicates that as many as ten lizard species occur on the island (Table 1; Fig. 2; Anderson 1999; Dakhte et al. 2007). Among these, *Pseudoceramodactylus khobarensis* was not recorded from the nearby mainland and Qeshm Island appears to be the northernmost locality for this species (Dakhte et al. 2007). Another species recorded on Qeshm Island, *Scincus mitranus*, probably dispersed from the Arabian Peninsula to the island during the second glacial period before 11,000 years ago (Dakhte et al. 2007). This species has also been reported from Khuzestan, suggesting that it extends into Iranian territory from the Mesopotamian Plain (Fahimi et al. 2009); we expect that future studies may find this species along the northern coastal plains of the Persian Gulf.

Islands are important to understanding phylogeographical patterns and evolutionary divergences. Because the Persian Gulf was a dispersal corridor for the Iranian and Arabian herpetofaunas approximately 20,000–30,000 years ago (Mahmoodi 1988), we suggest that genetic methods on the localized populations in this region will aid our understanding of the history of the island and the biogeography of this region.

Acknowledgments.—We thank Mohammad Dakhte, Mojtaba Ranaei, and Yaser Gholami for help during field surveys and investigations in this region. Our special thanks go to David Blackburn for editing a previous version of this manuscript.



COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND

FIG. 2. Species collected from Qeshm Island. A) *Acanthodactylus blanfordi* (SUHC 848); B) *Pristurus rupestris* (SUHC 845); C) *Hemidactylus flaviviridis* (SUHC 855); D) *Hemidactylus turcicus* (SUHC 853); E) *Trapelus agilis* (SUHC 844); F) *Mesalina watsonana* (SUHC 856).

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NATURAL HISTORY NOTES

CAUDATA — SALAMANDERS

***AMBYSTOMA MACULATUM* (Spotted Salamander). UNUSUAL EGG ENTRAPMENT.** On 9 March 2012 while surveying ridge-top wetlands in Daniel Boone National Forest (DBNF), Rowan Co., Kentucky, USA, we observed a planorbid snail that had become entrapped in an *Ambystoma maculatum* egg mass (Fig. 1). Planorbid snails are known to feed upon bacteria growing on structures present in water and detritus (Brown and Lydeard 2010. *In* Thorp and Covich [eds.], Ecology and Classification of North American Freshwater Invertebrates, pp. 277–307. Academic Press, London). The individual observed likely became entrapped by either being very close to the jellies as they swelled or attempting to consume bacteria that was present on the egg mass and burrowed in deeply enough to become encased with no mode of escape. To our knowledge, this is the first report of a non-amphibian species becoming entrapped in an egg mass in this portion of DBNF.

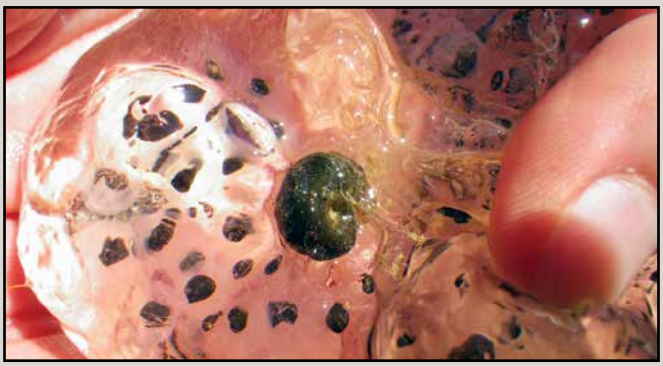


FIG. 1. Planorbid snail entrapped within an *Ambystoma maculatum* egg mass.

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***BOLITOGLOSSA LIGNICOLOR* (Camron Mushroom-tongue Salamander). PREHENSILITY.** On 15 June 2012, six *Bolitoglossa lignicolor* were observed on a trail system adjacent to the ANAM station (Autoridad Nacional del Ambiente) between 2000–2300 h at the Montuoso Forest Reserve (Herrera Province) in the Azuero Peninsula of Panama (7.73251°N, 80.80033°W; 582 m elev.). When approached, one individual located ca. 1 m off the ground on the leaf of a shrub flipped its body to escape and propelled itself off its perch, catching itself by its tail on a branch about 30 cm below its initial position on the same plant. With the tail encircling the branch, the *B. lignicolor* proceeded to right itself on the branch and returned to its initial perch. To our knowledge there have been no published records where any *Bolitoglossa* has used its tail in any such utility to catch itself or grasp an object following a flipping escape, but this behavior has been observed previously in *B. colonnea* (T. Leenders, pers. comm.; D. B. Wake, pers. comm.). As this behavior has yet to be described, we hereby term the behavior of using the tail in a hook-like fashion to prevent falling and aid in climbing as caudate prehensility.

Similar flipping behavior has been reported in other members of *Bolitoglossa* including *B. colonnea* (Leenders and Watkins-Colwell 2003. Phyllomedusa 2:101–104; pers. obs.), *B. schizodactyla* (pers. obs.), *B. englehardti, B. franklini, B. resplendens,* and *B. subpalmata* (Brodie Jr. 1982. Nat. Geog. Soc. Res. Rep. 14:77–88). These species give a broad representation of the *Bolitoglossa* clade (Pyron and Wiens 2011. Mol. Phylog. Evol. 61:543–583), indicating this behavior may be present within the majority of *Bolitoglossa* species as an ancestral behavior. The mechanics of a similar flipping mechanism has been described in *Chiropterotriton* and *Oedipina*, which are similar bolitoglossine genera (Dodd Jr. and Brodie Jr. 1976. Herpetologica 32:269–290), but such motion has not yet been analyzed in *Bolitoglossa*. All observations of flipping in *Bolitoglossa* occurred while the salamanders were on vegetation or in a laboratory setting, not on solid ground in the rain forest. This behavior has not been observed in laboratory tests of *Bolitoglossa* with snake predators (Ducey et al. 1993. Biotropica 25:344–349), so it is possible that flipping is typically employed as a defense mechanism against large predators that can readily attack *Bolitoglossa* above the ground such as large mammals and birds. Predominantly terrestrial *Bolitoglossa* may not gain the same defensive advantages from flipping that may benefit arboreal salamanders. Although a number of snake predators are known for the genus *Bolitoglossa* (six species listed in Brodie Jr. et al. 1991. Biotropica 23:58–62), other predators are largely unknown or unreported as to corroborate this hypothesis. Further field observations are necessary to determine whether these observations were isolated incidents, or if prehensility occurs frequently within *Bolitoglossa* and perhaps other related species.

We thank D. Laurencio and S. Burton for aid in fieldwork, and D. Wake and T. Leenders for correspondence on this note. Special thanks also to R. Bonett for many insightful comments on this manuscript. The fieldwork during which these observations took place was made possible by NSF grant DEB 0949-359. We complied with all applicable Animal Care guidelines (CMU-IACUC # 10-02) and all federal and international permits are on file and available from K.E.N.

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***CRYPTOBRANCHUS ALLEGANIENSIS* (Hellbender). LARVAL DIET.** Little is known about the natural history of *Cryptobranchus alleganiensis* larvae. Only two larval Hellbender diet samples have been published (Smith 1907. Biol. Bull. 13:5–39; Pitt and Nickerson 2006. Herpetol. Rev. 37:69). On 21 Sept 2010, a gilled larva (40 mm SVL, 50 mm TL, 3 g) was collected from beneath a rock during skin diving surveys in Great Smoky Mountains National Park, Tennessee, USA. We flushed the individual's stomach using an Easy Feeder Nipple Tip Syringe (Four Paws Products, Ltd., Hauppauge, New York) filled with river water. The larval *C. alleganiensis* regurgitated an intact *Eurycea* salamander measuring ca. 40 mm TL, which we subsequently preserved in a buffered 10% dilution of concentrated formalin. The Hellbender weighed 2 g following regurgitation.

This is the first report of a first-year *C. alleganiensis* larva consuming vertebrate prey, and also the first indication that *C. alleganiensis* larvae consume other salamander species. Although it has been suspected that larval *C. alleganiensis* feed primarily on aquatic insects (Pitt and Nickerson 2006, *op. cit.*), Smith (1907, *op. cit.*) stated that a second year individual measuring ca. 120 mm TL regurgitated a 60 mm TL conspecific. Hill (2012. Herpetol. Rev. 42:580) indicated that sub-adult *C. alleganiensis* may prey upon salamanders of approximately the same size. The consumption of a large vertebrate prey item relative to body size suggests that young *C. alleganiensis* larvae are able to utilize a wide variety of prey items and may be opportunistic feeders.

This research was conducted under National Park Service Permit (GRSM-2008-SCI-0052) and University of Florida ARC Protocol (#017-08WEC). We thank the National Park Service, The Great Smoky Mountains Institute at Tremont, Philip Colclough, Marcy Souza, and all volunteers for their assistance. Funding was provided by the Cryptobranchid Interest Group Jennifer Elwood Hellbender Conservation Grant, the Reptile and Amphibian Conservation Corps, and the Carlos C. Campbell Memorial Fellowship.

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***EURYCEA CIRRIGERA* (Southern Two-Lined Salamander). PARTIAL ALBINO LARVA.** Larvae of *Eurycea cirrigera* are described as having two rows of small, paired, lightly colored dorsolateral spots, and as sometimes having two darkly pigmented dorsolateral lines (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Inst. Press., Washington, DC. 587 pp.). Although this applies to many larvae of *E. cirrigera* in southern Mississippi, larvae can also vary dramatically in color and pattern from very pale-yellow individuals, to individuals with significant amounts of dark mottling or streaking on their sides (pers. obs.). On 26 July 2012, JYL collected a partial albino larva of *E. cirrigera* (17 mm SVL, 31 mm TL) from a leaf-litter bag deployed at Mill Creek in Forest Co., Mississippi, USA (30.94702°N, 89.24844°W). A total of 48 larvae of *E. cirrigera* were caught in leaf litter traps in Mill Creek during Summer 2012, and 1133 larvae of *E. cirrigera* were caught in traps across the 16 creeks sampled during that summer. This was the only abnormally colored larva collected.

We have identified this individual as a partial albino due to the lack of melanin in the skin, presence of iridophores and xanthophores, and the lack of melanin in the retina (Fig. 1) (Dyrkacz 1981. SSAR Herpetol. Circ. No. 11; Bechtel 1995. Reptile and Amphibian Variants: Colors, Patterns, and Scales. Krieger Publ. Co., Malabar, Florida. 206 pp.). Interestingly, this larva retains the dark, horizontal eye-stripe through the iris that occurs in normally pigmented larvae of this species in this region.



FIG. 1. Partial albino larva of *Eurycea cirrigera* showing retention of dark pigment in the iris of both eyes.

To our knowledge, this is the first record of a partially albino *E. cirrigera* found in Mississippi, if not the first record of albinism in this species elsewhere. However, what makes this *E. cirrigera* intriguing is the retention of dark pigment in the iris, a phenomenon that has been recorded for other species of salamanders. The irises of the albino larvae of *E. bislineata* collected by Bartley (1959. Herpetologica 15[4]:192) retained the eye-stripes typical of that species, and the albino larvae of *Ambystoma opacum* found by Deegan et al. (1998. Herpetol. Rev. 29[4]:229) had regularly pigmented irises. Typically, when albinos are described, the iris lacks melanin and eye-stripes that would have contained melanin in normal individuals appear red (albino *Gyrinophilus porphyriticus*, Hill et al. 2012. Herpetol. Rev. 43[1]:116–117)

We thank G. Thibaudeau, T. Vandeventer, and R. Altig for their insights regarding this larva. Funding was provided by the National Science Foundation Graduate Research Fellowship Program (#0940712), and by U.S. Geological Survey Cooperative Agreement (#G10AC00689). This research was approved by the USM Institute for Animal Care and Use Committee (No. 11061301). After metamorphosis, this specimen will be deposited in the Mississippi Museum of Natural Science in Jackson, Mississippi.

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***HEMIDACTYLUM SCUTATUM* (Four-toed Salamander). REPRODUCTION.** In New Brunswick, Canada, the occurrence of *Hemidactylum scutatum* is based on a small number of specimens observed, but none retained in collections, from sphagnum-shrub (*Kalmia angustifolia*, *Chamaedaphne calyculata*) -rimmed Marven Lake in Fundy National Park (45.571633°N, 65.093460°W). The Fundy National Park (FNP) consists of 206 km^2 of heavily wooded mixed Acadian forest in the Caledonia Highlands along the Bay of Fundy coast (Freedman et al. 2010. *In* McAlpine and Smith [eds.], Assessment of Species Diversity in the Atlantic Maritime Ecozone, pp. 63–70. NRC Press, Ottawa).

The first recorded New Brunswick occurrence of *H. scutatum* is a single presumptive female observed and photographed on 3 May 1983 (Woodley and Rosen 1988. Can. Field-Nat. 102:712; McAlpine 2010. *In* McAlpine and Smith [eds.], *op. cit.*, pp. 613–631). At the time one of us (DFM) confirmed the identification. Marven Lake continues to be the sole location in the province from which the species is known, in spite of extensive searching inside and outside FNP (DFM, unpubl.; M. MacDonald, pers. comm. to DFM). Since 1983, FNP personnel have surveyed Marven Lake on two occasions (1999, 2000) to confirm the persistence of the species. However, beyond presence, no other information regarding the species in New Brunswick has been recorded. In 2012 we obtained a federal Parks Canada permit to collect one whole specimen from FNP and to retain up to three tail-tips for genetic archiving in the New Brunswick Museum (NBM) frozen tissue collection (whole animal: NBM AR 9764; tissue: NBM FTC AR2012.001-002). Here we report on the specimens handled and provide the first reproductive data for the *H. scutatum* in New Brunswick. The province is at the species' northeastern range limit (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington. 587 pp.) and at latitude from which there is limited natural history information for *H. scutatum* (Gilhen 1984. Amphibians and Reptiles of Nova Scotia. Nova Scotia Museum, Halifax. 162 pp.).

We visited Marven Lake on 29 June 2012 and during 105 minutes of searching along ca. 15 m of bog shoreline on the northeastern shore of a lake inlet (45.57284°N, 65.09332°W to 45.57310°N, 65.09397°W) located 3 *H. scutatum* egg clutches, two of which were accompanied by females (420 person minutes [pms] of search time; 1 clutch/140 pms). One clutch of 13 eggs was accompanied by a female (71.2 mm TL), and a female (79.9 mm TL) guarded a clutch of 18 eggs. No female was observed with a clutch of 12 eggs. Embryos in all eggs were fully developed and in the 18-egg clutch one embryo was free of the egg envelopes. Egg clutches were located 23–35 mm below the surface of sloping (40–80°) shoreline of *Sphagnum magellanicum*, 126–228 mm from the open water's edge in areas free of shrubs at ca. 256 m elevation.

New Brunswick data for *H. scutatum* presented here agrees with information from adjacent Quebec and Maine. In Quebec clutches of 10–30 eggs predominate (among clutches ranging from 4–114) and most nests (87.4%) are located in pure sphagnum (Desroches et Pouliot 2007. Le Naturaliste Canadien 129:30–33). Likewise, New Brunswick clutches were situated in circumstances similar to those described for Maine by Chalmers (2004. MSc thesis, Univ. Maine, Orono. 109 pp.). There appears to be no previous information concerning hatch dates for *H. scutatum* in Maritime Canada (Gilhen 1984, *op. cit.*), although Chalmers (2004, *op. cit*) reported hatch dates for central coastal Maine from 16 June to 9 July.

This work was conducted under Parks Canada scientific permit FNP-2012-12934. We thank Dan Mazerolle, FNP, for facilitating the issuing of this permit. Michael MacDonald, Stantec Inc., shared information from a 1999 search for *H. scutatum* in FNP. Bruce Bagnell, New Brunswick Museum, kindly identified the *Sphagnum* sp. for us.

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***NECTURUS BEYERI* (Gulf Coast Waterdog). DETECTION BY LEAF LITTER BAG.** Leaf litter bags made of plastic mesh and stuffed with leaf litter, are passive traps used to sample salamanders (Pauley et al. 1998. Banisteria 12:32–36; Waldron et al. 2003. Appl. Herpetol. 1:23–36). This method has detected at least 28 species of Plethodontidae. Prior to this note, we only know of one species of salamander outside of this family that has been caught in litter bags (*Necturus alabamensis*) (Graeter et al. 2013. Inventory and Monitoring: Recommended Techniques for Reptiles and Amphibians, with application to the US and Canada. PARC Tech. Rept. Aiken, South Carolina). Herein, we report the detection of *Necturus beyeri* using leaf litter bags.

In November and December 2011, JYL deployed leaf litter bags at 10 creeks within the Pascagoula River Drainage in the DeSoto National Forest, in southern Mississippi, USA. *Necturus beyeri* were caught in litter bags at two of these creeks and identified based on range maps (Guyer 2005. *In* Lannoo [ed.], Amphibian Declines: The Conservation Status of United States Species, pp. 867–868. Univ. California Press, California). Two individuals were caught at Deep Creek (30.93009°N, 88.92031°W), the first on 13 Nov 2011 (20 mm SVL, 37 mm TL), and the second on 16 Dec 2011 (35 mm SVL, 58 mm TL). One individual was caught at Beaver Creek (30.97380°N, 88.93868°W) on 30 Nov 2011 (36 mm SVL, 57 mm TL). No *N. beyeri* were caught from May through July 2012 when the same reaches of Deep and Beaver Creeks were resampled with litter bags. A total of 169 salamanders were caught in bags in Fall 2011, and 1235 salamanders were caught using this method in Summer 2012.

Deep and Beaver creeks are medium-sized creeks. At the tributaries we sampled, these creeks had total drainage areas of 11.8 km^2 and 11.0 km^2 (ArcMap 10.1), and average widths of ca. 2.5 m and 3 m. For both creeks, sampled reaches averaged shallower than 0.5 m. Sand was the dominant substrate, and leaf litter packs, coarse wood, and submerged roots were the most abundant types of available cover. Over the course of litter bag sampling during Fall 2011 and Summer 2012, three species of plethodontids were detected at Deep Creek (*Eurycea cirrigera*, *E. quadridigitata*, *Desmognathus conanti*) and two plethodontids were detected at Beaver Creek (*E. cirrigera*, *E. guttolineata*).

Detecting any organism depends on using an appropriate method in the right place and at the right time. C. Guyer (pers. comm..) found that dip-netting for *N. alabamensis* was a more time-efficient method than was using litter bags. Leaf litter bags may not capture large numbers of *Necturus*, but they have been successful at detecting other cryptic or rare species of salamanders (Waldron et al. 2003, *op. cit.*).

Funding was provided by the National Science Foundation Graduate Research Fellowship Program (#0940712), and by U.S. Geological Survey Cooperative Agreement (#G10AC00689). This research was approved by the USM Institutional Animal Care and Use Committee (No. 11061301).

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***SIREN* SP. PREDATION.** On 5 February 2012 at 2027 h, a remote game camera captured a digital image of a Barred Owl (*Strix varia*) perched on stump with a sirenid in its talons (Fig. 1). The game camera was situated along Goodland Creek, a first order stream in the Upper Coastal Plain of Orangeburg Co., South Carolina, USA. Although *Siren intermedia intermedia* (Eastern Lesser Siren) has been captured on the property and is the only



FIG. 1. A Barred Owl (*Strix varia*) landing on a stump with a siren in its talons on 5 Feb 2012 at 2227 h. The species is probably the Lesser Siren (*Siren intermedia*) as several have been captured in the marginal swampy areas of the stream. Wildlife camera set up by Whit Gibbons.

documented sirenid to occur in the creek, *S. lacertina* (Greater Siren) is also found in sluggish intermittent backwaters in the region ("Pen Branch Delta" Luhring and Jennison 2008 J. Fresh. Ecol. 23:445–450) and there are intermittently connected pools on the property. Because the sirenid in the picture appears to be within the size range of a large *S. i. intermedia* or medium *S. lacertina* we are withholding its species-level designation. There are several documented avian predators of "aquatic salamanders" (amphiumids and sirenids) although few cases are specified to the species or even familial level (Luhring 2008. M.S. Thesis, Univ. Georgia, Athens, Georgia). This is the first confirmed observation of a Barred Owl depredating a sirenid.

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***SIREN LACERTINA* (Greater Siren). PREDATION.** Natural predators of *Siren lacertina* are poorly documented (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington. xvi + 587 pp.). Luhring (2008. MS Thesis, Univ. Georgia, Athens, Georgia) reported two *S. lacertina* presumably, but not conclusively, killed by wading birds; Stevenson et al. (2009. Herpetol. Rev. 40:247–249) reported a predation attempt on an adult *S. lacertina* by a Great Blue Heron (*Ardea herodiea*); and Kilham (1984. Colonial Waterbirds 7:143–145) reported Great Egrets (*Ardea alba*) and White Ibis (*Eudocimus albus*) preying on "large, eel-like salamanders" of uncertain identity.

On 2 Feb 2013 at Viera Wetlands, ca. 8.5 km WSW Pineda, Brevard Co., Florida, USA (28.216°N, 80.762°W; WGS84), we observed an adult American Bittern (*Botaurus lentiginosus*) stalk, catch, subdue, and swallow a subadult (ca. 25–30 cm TL) *S. lacertina* (Fig. 1). The bittern was foraging in thickly vegetated, shallow water at the edge of a wetland, and appeared to be feeling for prey with its feet. After watching the water intently for several minutes, it seized the *S. lacertina* in its bill at 1231 h, but immediately dropped it. After focusing intently on the spot for another 4 min, it grabbed presumably the same siren again and manipulated it with its bill for slightly less than 1 min before swallowing it. The American Bittern is a generalist predator of small aquatic, semiaquatic, and terrestrial vertebrates and invertebrates, including various amphibians (Terres 1982. The Audubon Encyclopedia of North American Birds. Alfred A. Knopf, New York. 1109 pp.), and would be expected to include sirens in its diet. To our knowledge, this represents the first published record of *B. lentiginosus* as a predator of *S. lacertina*.



FIG. 1. An American Bittern, *Botaurus lentiginosus,* preying on the Greater Siren, *Siren lacertina*, Brevard Co., Florida, USA.

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ANURA — FROGS

***ANAXYRUS FOWLERI* (Fowler's Toad). INTERSPECIFIC NEST USE.** *Pituophis melanoleucus* (Pinesnake) females in the New Jersey Pine Barrens excavate nests in open canopy, sandy upland areas. Nests, consisting of a tunnel up to 2 m and a hollowed egg chamber, are excavated and not revisited after oviposition (Burger and Zappalorti 1991. J. Herpetol. 25:152–160). The mouth of the tunnel typically collapses within a month of excavation, though the inner tunnel system may stay intact (pers. obs.). Little is known about the biophysical constraints and site selection pressures on *P. melanoleucus* nesting. We study *P. melanoleucus* in the northern extent of its range where it overlaps with several amphibians known to burrow into the sandy soil typical of this region. Specifically, much of the *P. melanoleucus* habitat is shared with the Fowler's Toad (*Anaxyrus fowleri*).

When investigating *P. melanoleucus* nests in the Franklin Parker Preserve, Chatsworth, New Jersey, USA, in July 2011, using a fiber-optic camera, we video captured *A. fowleri* use of an active nest. The toad was located 1 m into the tunnel, not in the egg chamber. At this point, the mouth of the nest was open and there was no sign of additional excavation by the toad. This nest produced four hatchling *P. melanoleucus* that year. Another *A. fowleri* was found in an artificially dug hole near the nest site the same day. The artificial hole was similar in dimensions to

the test holes often dug by female *Pituophis* spp. near true nests, 30 cm deep (Wright 2008. Can. Field Nat. 122:138–141; Burger and Zappalorti 1986. Copeia 1986[1]:116–121). It is unknown if neonate *P. melanoleucus* prey on *A. fowleri*, though the toads are prey to other snakes in the surrounding habitats including Black Racer (*Coluber constrictor*) and Eastern Hognose Snake (*Heterodon platihrinos*). Fowler's Toads have a small annual home range, limited to ca. 75 m diameter (Clark 1974. Am. Midl. Nat. 92:257–274). During *P. melanoleucus* incubation months (July and August), nest tunnels may serve as temperature and humidity refugia for Fowler's Toads. Toad predator avoidance and breeding success are contingent on optimal body temperature and humidity (Preest and Pough 2003. Physiol. Biochem. Zool. 76:229–239). Although the potential effects of toad presence on *P. melanoleucus* egg development are unknown, cooler, humid, and more stable conditions of the subterranean nests may make them important resources for Fowler's Toads (Burger 1989. Behav. Ecol. Sociobiol. 24:201–207).

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***COLOSTETHUS INGUINALIS* (Common Rocket Frog). DIET.** *Colostethus inguinalis* is an endemic Colombian species found in the lowlands of northern Choco and the Valley of Magdalena (Grant 2004. Amer. Mus. Novit. 3444:1–24). This diurnal species occurs in rocky areas along the bank of streams in rainforests and mountainous forests. The species is abundant, but populations are decreasing due to deforestation by agricultural and livestock activities, illegal plantations, human establishments, and contamination by fumigation of illegal plantations (Grant and Lynch 2004. IUCN Red List of Threatened Species. Ver. 2012.1 www.iucnredlist.org, 19 March 2013). The food habits and many aspects of its ecology are unknown. Herein we describe the diet of *C. inguinalis* in the dry tropical forest of Colombia in the Natural Reserve of Civil Society Campoalegre (8.48502°N, 76.19520°W; 120 m elev.), municipality Los Cordobas, Department of Cordoba.

We examined 30 stomachs of *C. inguinalis* collected during 0800–1200 h and 1600–1800 h, Feb–Nov 2007 along the banks of streams inside the forest. These samples were collected during the dry season (January–March), first rains (April–June), and heavy rains (September–December). We identified prey to family and genus when possible, measured the length and width of each complete prey item by using a digital caliper (to 0.1 mm). We estimated the volume using the equation for volume of a prolate spheroid.

All frogs collected (N = 30; 15.5–29.5 mm SVL; mean 21.6 ± 2.7) had prey in their stomachs. The diet consisted mainly of arthropods and mollusks (Table 1). Insects (9 orders, 19 families, and 37 morphotypes) and arachnids (especially spiders) were the most important prey. Orthoptera, Coleoptera, and Araneae were the most important volumetrically, however Orthoptera was represented by a single large prey consumed by a single individual. Numerically, the most important prey were ants, *Pheidole* and larval Carabidae and Diptera (Ceratopogonidae). Ants (*Pheidole* and *Solenopsis*) and Staphilinidae had the greatest frequency of occurrence.

TABLE 1. Composition of prey in the diet of *Colostethus inguinalis* from Reserva Campoalegre, Córdoba, Colombia. Volume in mm^3.

Prey	Number (%)	Volume (%)	Frequency of ocurrence
Diplopoda	1 (47.39)	0.00	1
Crustacea			
Malacostraca	8 (379.15)	12.73 (2.03)	2
Mollusca			
Gastropoda	1 (47.39)	0.60 (0.10)	1
Arachnida			
Acari			
Laelapidae	1 (0.47)	0.69 (0.11)	1
Trombiidae	1 (0.47)	0.43 (0.07)	1
Undet	2 (0.95)	0.64 (0.10)	1
Araneae			
Psauridae	1 (0.47)	1.17 (0.19)	1
Selenopidae	1 (0.47)	82.90 (13.21)	1
Insecta			
Dictyoptera			
Blattidae	1 (0.47)	0.00	1
Coleoptera			
Bostrichidae	2 (0.94)	2.65 (0.42)	2
Cerambycidae	1 (0.47)	3.39 (0.54)	1
Curculionidae	2 (0.94)	33.98 (5.41)	2
Hydrophilidae	1 (0.47)	0.54 (0.09)	1
Pselaphidae	1 (0.47)	0.44 (0.07)	1
Scarabaeidae			
Canthon	1 (0.47)	46.97 (7.48)	1
Scolytidae	1(0.47)	0.62 (0.10)	1
Staphylinidae	6 (2.84)	1.09 (0.18)	6
Undet	2 (0.95)	2.82(0.45)	3
Larva Carabidae	48 (22.75)	23.09 (3.67)	4
Larva Coleoptera	2 (0.94)	1.2 (0.19)	2
Collembolla			
Sminthuridae	1 (0.47)	0.02 (0.00)	1
Diptera			
Anthomizidae	2 (0.95)	0.57 (0.09)	1
Ceratopogonidae	20 (9.47)	2.32 (0.37)	3
Hylaromorphidae	1 (0.47)	0.00	1
Phoridae undet	4 (1.89)	0.33 (0.05)	2
Undet	9 (4.26)	4.18 (0.66)	2
L. Diptera	2 (0.94)	0.24 (0.04)	2
Hemiptera			
Alydidae	2 (0.95)	0.00	2
Hymenoptera			
Formicidae			
Acromyrmex	1 (0.47)	0.74 (0.12)	1
Azteca	2 (0.95)	2.39 (0.38)	2
Camponotus	1 (0.47)	0.15 (0.02)	1
Carebara	3 (1.42)	0.19 (0.03)	1
Crematogaster	5 (2.37)	3.20 (0.51)	3
Neivamyrmex	1 (0.47)	0.41 (0.07)	1
Nesomyrmex	1 (0.47)	0.00	1
Odontomachus	1 (0.47)	10.08 (1.61)	1
Pheidole	44 (20.85)	19.03 (3.03)	11
Pseudomyrmex	2(0.95)	2. 48 (0.40)	1
Solenopsis	12 (5.69)	1.04 (0.17)	6
Strumigenys	4 (1.90)	0.49 (0.08)	3
Wasmannia	1 (0.47)	0.18 (0.03)	1
Hymenoptera undet	1 (0.47)	0.00	1
Isoptera			
Termitidae			
Rhynchotermes	3 (1.42)	6.30 (1.00)	3
Lepidoptera			
Larva Geometridae	3 (1.42)	15.33 (2.44)	2
Orthoptera			
Tettigonidae	1 (0.47)	342 (54.49)	1
Total 211	625.14		

We found *C. inguinalis* consumes a large of ants; however, its diet consists of a large number of different prey, which is consistent with other investigations. Volumetrically, the most important prey are somewhat different than those represented in the diet other closely related species.

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DENDROBATIDAE and *BUFO CONIFERUS*. DEFENSE. Little is known of the taxonomic identity of predators on chemically defended species such as poison frogs of the family Dendrobatidae. Studies of predation on poison frogs have found marks thought to be attributable to ants (Saporito et al. 2007. Copeia 2007:1006–1011; Hegna et al. 2011. Ann. Zool. Fennici 48:29–38), and frogs are occasionally found missing digits, which could also be due to encounters with ants (pers. obs.). Here I describe an interaction of an army ant swarm (*Eciton hamatum*) on three species of poison frogs (*Dendrobates pumilio*, *D. auratus*, and *Phyllobates lugubris*) and on a toad (*Bufo coniferus*) on mainland Panama adjacent to the Bocas del Toro archipelago. Though *E. hamatum* predominantly feed on ants, bees, and wasps (Bartholomew et al. 1988. Physiol. Zool. 61:57–68), differences in their interaction with anuran species provides further evidence for the likelihood of an olfactory signal in the chemical defense of poison frogs.

At 1040 h on 27 Dec 2012 while sampling a polymorphic population of *D. pumilio* from the Aguacate Peninsula an army ant swarm entered the study area. Channels of ants quickly overtook the site and many invertebrates (crickets, katydids, and scorpions) emerged from the leaf litter and escaped. A blue subadult *D. pumilio* became completely surrounded by ants, and remained untouched perched on a leaf. Shortly thereafter three more blue adults and one brown adult were surrounded but also left untouched. Throughout the swarm a small margin (2–3 cm) was maintained between the ants and the frogs. Twenty-four minutes into the ant invasion an adult *D. auratus* perched on a large buttress was similarly approached and avoided as the ants climbed up the tree. Two additional blue and one brown *D. pumilio* were then observed to be surrounded by ants during which one male continued to produce an advertisement call. One hour into the swarm an adult *P. lugubris* and a second *D. auratus* were also surrounded and avoided by ants in a tree buttress, as was a second male *P. lugubris*, which vocalized nearby.

At no point in the column swarm did the ants come into direct contact with any of the three species of poison frogs present in the site; rather the ants maintained about a 2-cm margin from all frogs. In contrast, ants covered a toad (*Bufo coniferous*), which closed its eyes as its body was pressed flat against a tree. Its eyes remained closed until there were gaps in the ant column when its eyes would open, then close again as more ants arrived.

Though this observation unfortunately does not add to our knowledge of specific poison frog predators, it does provide some insight into the possible disparity between results from clay model studies and actual predation. Saporito et al. (2007, *op. cit.*) note that some attack marks on their clay models appeared to be due to the incisors of what they hypothesize could be attributable to *Atta* spp., another group of ants encountered in high densities throughout the tropics. Additionally, the "buffer" distance observed from the frogs could be due to an olfactory component of the alkaloids possessed by these poison frogs which clay models would lack. Poison frog activity during the ant swarm did not appear to be inhibited by the presence of ants. Male vocal advertisements continued for two species during the swarm. At no point did individuals appear threatened by the presence of ants and initiate an escape. These observations further support previous studies mentioning alkaloid olfactory cues in the context of other arthropods, including spiders (*Cupiennius coccineus*; Szelistowski 1985. Biotropica 17[4]:345–346) and other predatory ("bullet") ants (*Paraponera clavata*; Fritz et al. 1981 Biotropica 13:158–159).

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***HYLA ARENICOLOR* (Canyon Treefrog). HABITAT USE.** Several species of treefrogs have been documented using tree cavities and avian nest boxes as refugia or hibernacula, including *Hyla chrysoscelis* (Ritke and Babb 1991. Herpetol. Rev. 22:5–8), *H. cinerea* (Redmer and Brandon 2005. *In* M. Lannoo [ed.], Amphibian Declines: The Conservation Status of United States Species, pp. 452–454. Univ. California Press, Berkeley, California), and *H. squirrella* (McComb and Noble 1981. Wildl. Soc. Bull. 9:261–267). Treefrogs may use these structures to exploit favorable microclimates or diverse invertebrate food sources. Herein, we report two observations of related behavior in *H. arenicolor*, a treefrog that inhabits isolated mountain canyons in the southwestern USA. Unlike most other treefrogs, *H. arenicolor* is typically found on rock surfaces along stream courses and rarely climbs trees. On 18 June 2012 at 1121 h, we observed three adult *H. arenicolor* inside a Black Phoebe (*Sayornis nigricans*) nest in the Rincon Mountains east of Tucson, Arizona (32.26278°N, 110.62744°W, WGS84; elev. 1068 m; Fig. 1). The cup nest was constructed of mud and plant material and cemented to a vertical rock surface



FIG. 1. Three adult *Hyla arenicolor* in a mud nest constructed by Black Phoebes (*Sayornis nigricans*) in southern Arizona, USA.

ca. 1 m above a bedrock-lined pool, typical of Black Phoebe nests in the desert southwest (Wolf 1997. *In* Poole and Gill [eds.], Birds of North America, No. 268. Acad. Nat. Sci., Philadelphia, Pennsylvania). Similarly, on 21 June 2013 at 1100 h, ERZ observed one *H. arenicolor* in a Black Phoebe nest in another canyon in the Rincon Mountains (32.15668°N, 110.60713°W, WGS84, elev. 1077 m). This nest was attached to the angled underside of a large boulder >0.8 m above the surface of a pool. In both cases, the nests appeared to be intact and undamaged, but there was no evidence that birds had used the nests recently.

Although *H. arenicolor* have lower rates of evaporative water loss than many other anurans (Preest et al. 1992. Herpetologica 48:210–219), they are still at considerable risk of desiccation at midday in June. The bird nests provided shade for the treefrogs, which were >30 mm below the nest opening, likely reducing their risk of dehydration. During summer months, canyon treefrogs are often observed on vertical surfaces of boulders above pools of water, a strategy that presumably reduces rates of predation by vertebrate and invertebrate aquatic predators, including *Thamnophis cyrtopsis* and insects in the family Belostomatidae (Jones 1990. Southwest. Nat. 35:115–122; Swann 2005. Sonoran Herpetol. 18:39–42; Wylie 1981. PhD Dissertation, Arizona State Univ., Tempe, Arizona). Nests may have further reduced risk of predation by concealing treefrogs from potential predators when using these vertical rock surfaces.

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***HYLA CHRYSOSCELIS* (Cope's Gray Treefrog). BREEDING ACTIVITY.** Little is known about the biotic and abiotic factors that influence the timing and intensity of reproduction in most anurans. One potentially important but rarely examined factor is lunar phase (Grant et al. 2009. Anim. Behav. 78:349–357). Here, we report observations on the relationship between lunar phase and the intensity of breeding in populations of *Hyla chrysoscelis* in east-central Minnesota, USA.

We observed reproductive activity over six consecutive breeding seasons (28 April to 8 July, 2006–2011) in populations located within 80 km of St. Paul, Minnesota. Teams of 3–4 people used headlamps or handheld lanterns to search for and collect pairs found in amplexus (Fig. 1). Searching occurred between 2200 and 0200 h and was concentrated in areas of ponds with the highest numbers of calling males. Our sampling regime was neither randomized nor systematic in any way; rather, it was guided by the objective of collecting as many pairs as possible each night for use in ongoing behavioral studies of female mate choice; pairs were returned to their collection site within 48 h.

PHOTO COURTESY ROBERT SCHLAUCH

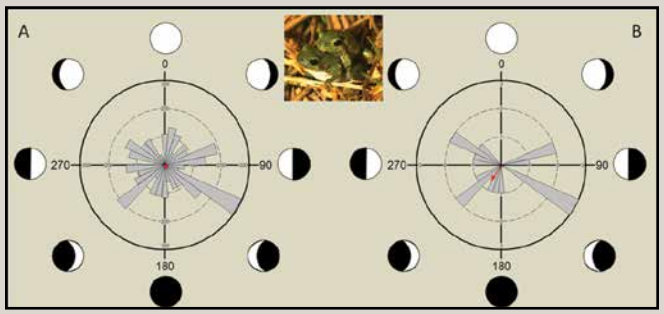


FIG. 1. Lunar cycle and breeding activity in *Hyla chrysoscelis*. Circular histograms showing the distribution, mean vector (μ), and vector strength (r) for A) the number of breeding pairs observed per night over all breeding nights relative to the lunar phase (μ = 141°, r = 0.06); and B) the number of nights on which large breeding events occurred relative to the lunar phase (μ = 213.9°, r = 0.21). Time during the 29.5-day lunar cycle is here expressed as an angle such that 0° and 360° correspond to the full moon and 180° corresponds to the new moon. Inset: Breeding pair of *H. chrysoscelis* in amplexus.

We observed a total of 3293 pairs on a total of 317 "breeding nights" on which at least one pair was observed (range: 1–97 pairs/night; median: 12 pairs/night). The day of the lunar cycle assigned to each breeding night was expressed as an angle and calculated as the days since full moon divided by 29.5 days (0° = 360° = full moon; 180° = new moon). Breeding was statistically more likely to occur closer to the new moon than the full moon when we considered all pairs together (Rao's spacing test: 356.3, p = < 0.01, N = 3293 pairs; Fig. 1A). This trend also held for nights when relatively large breeding events occurred, which we defined as those nights ranking above the 90th percentile within a season in terms of the numbers of pairs collected (median = 70.5 pairs/night, range = 30–97 pairs/night, N = 17 nights). Nights on which these large breeding events occurred were relatively rare around the time of the full moon (Fig. 1B; Rao's spacing test: 168.7, p = < 0.05, N = 17 nights).

These observations suggest lunar phase could be one, albeit weak, factor influencing decisions by some females of *Hyla chrysoscelis* about when to breed. One hypothesis that might explain these data is that breeding, and especially nights when large numbers of females breed, was restricted to darker times during the lunar cycle because of potentially increased risk of predation by visually-oriented predators on nights surrounding a full moon. Other correlates of the lunar cycle (e.g., changes in geomagnetism or gravity), however, might also play some role. Interestingly, our observations contrast with data on several European frogs, for which Grant et al. (2009, *op. cit.*) showed that large breeding events were more likely to occur closer to the full moon. This evidence suggests the lunar cycle might be important in anuran breeding phenology and that there might be patterns of species differences worth investigation.

Research and collecting were conducted with permission from the Minnesota Department of Natural Resources, the Three Rivers Park District, and the University of Minnesota Institutional Animal Care and Use Committee.

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***HYPSIBOAS CINERASCENS*. PREDATION.** *Hypsiboas cinerascens* is a small (31–37 mm SVL), common Amazonian treefrog, predominantly arboreal, nocturnal, and frequents the vegetation in riparian and wetland areas (Lima et al. 2006. Guide to the Frogs of Reserva Adolpho Ducke – Central Amazonia. Attéma Design Editorial, Manaus. 168 pp.). Antbirds, Thamnophilidae, are a family of Neotropical passerines that feed predominantly on arthropods, however a substantial proportion of the diet of some species may also consist of small vertebrates, principally frogs and lizards (Poulin et al. 2001. J Trop. Ecol. 17:21–40). On 12 Feb 2013, ACL and I. Thompson found a pair of nest-building Spot-winged Antshrikes (*Pygyptila stellaris*) at the ecotone of degraded primary forest and *varzea* on the left bank of the lower Rio Guama at the Comunidade Menino Jesus, Marituba, Pará

state, Brazil (1.48666°S, 48.31666°W). The birds were loosely associating with a mixed species flock. While under observation the female of the pair was observed carrying a live *H. cinerascens*. The frog was captured within the same tree that was presumed to hold the nest (the female was observed carrying nesting material a few minutes before), which was about 4 m tall and situated in *varzea* forest with a water depth of ca. 50 cm. The *Pygiptila* appeared to experience some difficulty in securing the large prey item and the frog repeatedly grabbed the vegetation surrounding the bird's perch. To subdue the frog the *Pygiptila* was observed to violently bash the frog against its perch on four occasions over the course of two minutes after which point the frog ceased to move. The bird then moved out of sight and we could not confirm that the prey item was consumed. ACL documented the event with a series of digital photographs, reproduced here (WA882353, http://www.wikiaves.com.br/882353&p=1&t=b). *Pygiptila* exhibits a strong preference for foraging for food items extracted from curled dead leaves (Rosenberg 1997. Ornithol. Monogr. 48:673–700), and it is likely that the treefrog was captured in its diurnal hideout under leaves. Although predation of frogs by Thamnophilidae is probably not uncommon we believe this to be the first well-documented incident of such a predation event.

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***LEPTODACTYLUS SAVAGEI* (South American Bullfrog). LOCOMOTION AND FORAGING.** In the majority of anurans, individuals in the adult stage move by jumping. Consistently, frogs and toads have several morphological adaptations specific for this type of locomotion (Zug 1972. Copeia 1972:613–624; Zug 1978. Smithson. Contrib. Zool. 276:1–31). Other forms of terrestrial locomotion are also common in anurans including hopping, walking, and burrowing (Wells 2007. The Ecology and Behavior of Amphibians. Univ. Chicago Press, Chicago, Illinois. xi + 1148 pp.). While some species primarily use one form of locomotion, other species combine different forms using specific locomotor behaviors in given contexts. Here we report the observations of a previously undescribed locomotor behavior in *Leptodactylus savagei* (formerly *L. pentadactylus*) performed while foraging.

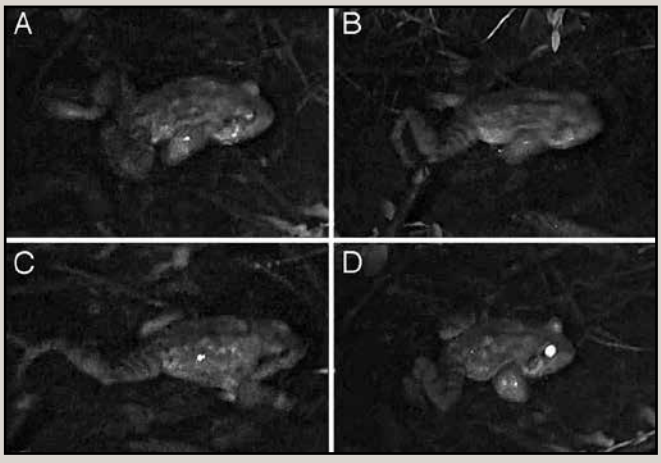


FIG. 1. A) Male *Leptodactylus savagei* with body lowered to the ground prepared to move forward. B) Male lunged forward by force from hind legs. C) The individual *Leptodactylus savagei* stretched with right foreleg in front as the individual crawled forward. D) Male halts crawl and the crouched position is reassumed.

During the evening of 6 August 2012 we observed *L. savagei* actively hunting Túngara Frogs (*Engystomops* [*Physalaemus*] *pustulosus*) at a water channel in Gamboa, Panama (9.11666°N, 79.69833°W). A male *L. savagei* was first observed when it attacked and missed catching a calling male Túngara Frog. After that, the same individual was followed and video recorded while it attacked and consumed three additional Túngara Frogs within 4 m from the first attack. This predator moved by sporadic jumps but once it was closer to a Túngara Frog, within about 100–200 cm, it lowered its body so at least half of it would be submerged under water and began to slowly drag itself towards its prey by staying close to the bottom of the puddle in a movement reminiscent of an army crawl (Fig. 1). When it was within about 30 cm, the *L. savagei* attacked the smaller frog by jumping onto it to catch it by its month. The Túngara Frog was pushed deep into the mouth using the front legs and was rapidly swallowed. After a few seconds of having swallowed the frog, the *L. savagei* scoped for its next victim using the same strategy. We observed this frog-eating predator successfully performing the "jump-army crawl-capture" strategy three consecutive times. In all cases the attacked frogs were calling male Túngara Frogs. Although *L. savagei* is known to be a voracious predator of Túngara Frogs (Ryan et al. 1981. Behav. Ecol. Sociobiol. 8:273–278), hunting strategies have not been described. As in the observations reported here, previous studies have documented *L. savagei* attacking Túngara Frog males aggregated at breeding areas, where the individuals attacked were apparently calling. Eavesdropper predators and parasites that exploit the communication system of Túngara Frogs are known (Tuttle and Ryan 1981. Science 214:677–678; Bernal et al. 2006. Behav. Ecol. 17:709–715), but whether *L. savagei* individuals are also using the mating calls to cue in on this prey needs further investigation.

The army crawl described here is similar to the walking behavior characteristic of some species of frogs (e.g., phyllomedusine hylids). As with walking, crawling involves alternated movement of front and back legs from both sides with little lateral movement of the trunk. It differs, however, in that the body is lowered to the bottom of the puddle and the frog's back legs slide along the ground while the front legs are bent very low. In contrast to jumping, the characteristic locomotor behavior of *L. savagei*, the crawl was performed submerging at least half of the body. The army crawl allows this predator to move closer to its intended prey creating less water displacement by its large body mass and without producing splash sounds associated with jumping. By reaching an appropriate position to seize its prey with minimal disturbance, foraging success is likely improved. Crawling behavior on land has been observed in *Rana esculenta* during feeding (Nauwelaerts and Aerts 2002. J. Zool. 258:183–188), but it is unclear if this sneak attack strategy is deployed by other anurans.

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***LIMNONECTES PALAVANENSIS* (Smooth Guardian Frog). OCULAR ANOMALY.** *Limnonectes palavanensis* is a small anuran (to 40 mm SVL) which dwells in the leaf litter of primary



FIG. 1. Front (upper) and dorsolateral (lower) views of an adult *Limnonectes palavanensis* with ocular anomaly found at the Ulu Kimanis Substation, Crocker Range National Park, Sabah, Malaysia.

forest from near sea level to 1502 m elev. (Kueh et al. 2011. Herpetol. Rev. 42[2]:261). The species occurs on Palawan Island of the Philippines, and throughout Borneo (Sabah and Sarawak of Malaysia, Brunei Darussalam, and Kalimantan of Indonesia) (Das 2007. A Pocket Guide: Amphibians and Reptiles of Brunei. Natural History Publications [Borneo] Sdn. Bhd. Kota Kinabalu. 200 pp.; Inger 2007. Systematics and Zoogeography of Philippine Amphibia. Natural History Publications [Borneo] Sdn. Bhd. Kota Kinabalu. 370 pp.; Inger and Stuebing 2005. A Field Guide to the Frogs of Borneo, 2nd ed. Natural History Publications [Borneo] Sdn. Bhd. Kota Kinabalu. 201 pp.).

On 6 Oct 2012 at 2055 h during the Localized Nature Guide Course organized by Borneo Tourism Institute (BTI), an adult male *L. palavanensis* (29 mm SVL) was collected on the forest floor among dead leaves at Crocker Trail (5.4047°N, 116.1104°E; 1049 m elev.), Ulu Kimanis Substation, Crocker Range National Park, Papar District, West Coast Division, Sabah, Bornean Malaysia. The anuran was void of a right eye, while the left eye was present and normal (Fig. 1). Compared to typical *L. palavanensis*, the anuran displayed lighter body hue, but was agile during an indoor *ex-situ* photography session. The anomaly appeared not to affect the overall field of view and did not restrain its visual response and movement. In Dec 2010, Kueh et al. (2011. Herpetol Rev. 42[3]:410) reported ocular anomaly in the microhylid *Chaperina fusca* from highland West Coast, Sabah. Further studies are warranted to determine if such anomaly occurs in other Bornean anuran families and species either with similar or dissimilar effects, the frequency of occurrence of the anomaly in different families and species, and geographical range of the anomaly, to help understand the nature and pattern of ocular anomaly in anurans.

Ocular anomaly in anurans can be caused by physical injuries and selective predation, infections and diseases (fungal infection by *Batrachochytrium dendrobatidis* [*Bd*]), exposure to chemicals and UV radiation, mutation, and developmental errors (Adams et al. 2008. Herpetol. Rev. 39:460–461; Silva and Toledo 2010. Herpetol. Rev. 41:333–334; Streicher et al. 2010. Herpetol. Rev. 41:208–209; Pirani and Moura 2012. Herpetol. Rev. 43:471). However, examination of the anuran showed no body injuries. The anuran was found on a dry trail without any water bodies in the vicinity to corroborate the causal factors of chemical pollution and *Bd* infection.

The anuran was released after photographs and measurements were taken, in accordance to the requirement of the management of Crocker Range National Park under the Sabah Parks. Photographic vouchers are available from the first author. To our knowledge, this is the first observation of ocular anomaly in *L. palavanensis*.

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***LITHOBATES SYLVATICUS* (Wood Frog). EGG PREDATOR ENTRAPMENT.** On 9 March 2012 while surveying ridge-top wetlands in Daniel Boone National Forest (DBNF), Rowan Co., Kentucky, USA, we observed a *Lithobates clamitans* larva that had become entrapped within an *L. sylvaticus* egg mass. This represents the second observation of an amphibian species entrapped in an egg mass that has occurred in this portion of DBNF (Richter 2012. Herpetol. Rev. 43:459). The *L. clamitans* larva presumably became entrapped while attempting to eat embryos inside the egg mass, as they are known to depredate *L. sylvaticus* eggs (Vasconcelos and Calhoun 2006. Wetlands 26:992–1003). Upon further examination, it was evident that the egg mass had been preyed upon based on the amount of damage observed, however it was undetermined if the entrapped larva or other *Lithobates* larva present in the pond were responsible for the damage.

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***LITHOBATES SYLVATICUS* (Wood Frog). UNUSUAL MORTALITY.** *Lithobates sylvaticus* is a common species throughout the northern United States and Canada. They are explosive breeders that lay communal egg masses in ephemeral ponds during the early spring. *Lithobates sylvaticus* are often the first amphibian breeders to arrive at these ponds (followed by *Ambystoma jeffersonianum* and *A. maculatum*; J. MacGregor, pers. comm.). On warm, rainy nights, frogs can be seen and heard commuting to



FIG. 1. An array of *Lithobates sylvaticus* egg masses in trees above the pond. Heights above water level ranged from 0 to ca. 1.75 m. The hypothesized laying-freezing-thawing event appears to only have affected those eggs laid early during the breeding season.



FIG. 2. *Lithobates sylvaticus* egg mass ca. 1.8 m above the ground and 1.5 m above water level. The jelly envelops surrounding the eggs were highly desiccated and slightly frozen.

breeding ponds. However, atypical weather patterns can act as false cues for the frogs to begin breeding.

On 31 Jan 2013, several *Lithobates sylvaticus* egg masses were observed in trees overhanging an ephemeral pool (37.519472°N, 084.234128°W) on the border of Rockcastle and Metcalfe counties in eastern Kentucky (Figs. 1, 2). I believe the cause of this phenomenon was an atypically warm and wet night followed by several days (and nights) with temperatures below freezing. The *L. sylvaticus* likely received temperature and humidity stimuli that initiated their breeding behavior. Eggs were then laid in an unfrozen, relatively warm pond. During subsequent weeks, Kentucky (and much of the eastern USA) was hit with an ice storm. Ice deposition on trees must have weighed them down to the point where they entered the water among the frog egg masses. Upon thawing, the trees would have then returned to their position above the ponds pulling the egg masses with them. The scenario presented above appears to be the most likely explanation, but other possibilities surely exist.

This observation emphasizes the important role weather and climate cues play in amphibian life histories. Indeed, as anthropogenic climate change continues to alter weather patterns, occurrences such as this may become more common.

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***PSEUDACRIS CRUCIFER* (Spring Peeper). MYIASIS.** Calliphorid flies are known to parasitize North American anurans (Kraus 2007. J. Nat. Hist. 41[29–32]:1863–1874). However, to the best of our knowledge, there have been no published accounts of *Pseudacris crucifer* parasitism by the blowfly *Lucilia sylvarum* (previously *Bufolucilia sylvarum*).

On 24 July 2012, at ca. 0930 h, we observed *P. crucifer* with 32 blowfly eggs of *L. sylvarum* attached to its back. Seventeen eggs were attached just anterior to the sacral hump and lateral of the midline. Another 15 eggs were attached just posterior of the sacral hump, ca. 30 degrees dextral to the anteroposterior axis (Fig. 1).

The specimen was discovered on the ground in southeastern Minnesota, USA, as we collected anurans for a chytridiomycosis survey (44.7245°N, 93.3425°W, 275 m elev.). The frog appeared healthy other than the aforementioned infestation. No lesions, injuries, or signs of disease were noted. Seventeen *P. crucifer*, 4 American Toads (*Anaxyrus americanus*), 22 Gray Treefrogs (*Hyla* sp.), 27 Green Frogs (*Lithobates clamitans*), 2 Northern Leopard Frogs (*Lithobates pipiens*), and 6 Western Chorus Frogs (*Pseudacris triseriata*) were collected



FIG. 1. Spring Peeper (*Pseudacris crucifer*) with blowfly (*Lucilia silvarum*) eggs attached to back.



FIG. 2. Myiasis observed in the Spring Peeper (*Pseudacris crucifer*).

from the same vicinity and inspected for parasites between 24 July and 22 September. No additional instances of blowfly parasitism were observed.

The parasitized *P. crucifer* was held for observation. No efforts to dislodge the eggs were observed and the individual behaved normally until the eggs hatched. After hatching, the maggots quickly penetrated the skin of the host and produced a single lesion just lateral of the dorsal midline and anterior to the sacral hump (Fig. 2). Myiasis and larval development followed the course observed in Wood Frogs (Bolek and Janovy 2004. J. Parasitol. 90[5]:1169–1171) and the specimen was quickly reduced to slurry and bones.

It appears from the number of *L. sylvarum* eggs deposited on the specimen (i.e., 32) that host size and parasitic intensity are uncorrelated variables. Bolek and Janovy (2004, *op. cit.*) observed approximately the same number of *L. sylvarum* eggs on juvenile Wood Frogs in southeastern Wisconsin, USA (i.e., 28–31, N = 2). Although they did not report the mass of the parasitized frogs collected, their photographs and the natural histories of the two species suggest a 2× or greater difference in body mass, with Wood Frogs being substantially larger than *P. crucifer*. American Toads (N = 9) parasitized by *L. sylvarum* in southeastern Wisconsin averaged 8.7 g (Bolek and Coggins 2002. J. Wildl. Dis. 38[3]:598–603), which is ca. twice the mass of a typical *P. crucifer*.

We supplemented the *P. crucifer* carcass with a *L. clamitans* carcass weighing ca. 35 g. The larva reduced both carcasses to bones. Because the eggs of *L. sylvarum* hatch within hours of deposition and the host can be reduced to skeletal remains within 96 h, anuran parasitism by the blowfly *L. sylvarum* is likely to escape notice and may be considerably more common than our observations and published records indicate.

Elevated temperatures resulting from climate change are likely to advance the emergence of anurans and blowflies in the spring, extend their activities in the fall, and increase the cumulative incidence of myiasis in temperate anurans, as anticipated and observed in other species (Goulson et al. 2005. J. Appl. Ecol. 42:795–804). Unfortunately, it may be difficult to document the impacts of climate change on myiasis-induced death rates due to the difficulty of observing myiasis in wild populations and a scarcity of published observations suitable for constructing baseline rates in North American anurans.

We thank University of Minnesota entomologists J. Luhman and P. Tinerella for confirming the identity of the *L. silvarum*.

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***RANA DRAYTONII* (California Red-legged Frog). UNUSUAL DEATH.** *Rana draytonii* has been declining in southern California since the late 1960s and is currently listed as Vulnerable by the IUCN and Threatened by the U.S. Fish and Wildlife Service. It has been extirpated in California from San Diego, Orange, Riverside, and San Bernardino counties and only two populations are known for Los Angeles Co.. While conducting surveys on 26 Feb 2013 at the southernmost extant population in the USA in Ventura Co., an adult male *R. draytonii* was discovered dead, entangled in several native blackberry (*Rubus ursinus*) vines just below the surface of the water. The frog's hind right leg was wrapped with six small vines that were cut to free the body. The frog's leg was broken, indicating it struggled to free itself before its demise. The frog was collected (U.S. Fish and Wildlife Recovery Permit TE-045994) and deposited in the Los Angeles County Natural History Museum (LACM 183590). This is contribution 455 of the USGS Amphibian Research and Monitoring Initiative.



FIG. 1. Dead adult male *Rana draytonii* entangled in vines below water surface, Ventura Co., California.

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***SCINAX* CF. *ARDUOUS* (Bromeliad Frog). PREDATION.** Composed of 13 species, the *Scinax perpusillus* group is distributed along the Atlantic rainforest between the states of Santa Catarina and Espírito Santo, southeastern Brazil (Frost 2013. Amphibian Species of the World: an Online Reference. Ver. 5.6. Electronic database accessible at http://research.amnh.org/herpetology/amphibia/index.html. American Museum of Natural History, New York). This group is thought to be strictly bromeligenous in having the larval stage associated with water stored in Bromeliaceae (Peixoto 2005. Rev. Universidade Rural 17:75–83). The freshwater crab *Trichodactylus fluviatilis* is widely distributed in the states of Bahia and Rio Grande do Sul (IUCN 2012. www.iucnredlist.org) and is present in freshwater environments, lentic and lotic, where it is known to feed on plant material, eggs, crustaceans,



FIG. 1. Predation of *Scinax* cf. *arduous* by the freshwater crab *Trichodactylus fluviatilis.*

mollusks, and tadpoles. On 6 Oct 2012, at Área de Proteção Ambiental do Mestre Álvaro (20.16722°S, 40.18040°W; 246 m elev.), we observed a male *T. fluviatilis* (2.8 × 3.2 cm carapace) feeding on a *Scinax* cf. *arduous* (2.2 cm SVL) (Fig. 1). The anuran was held by the larger chela (3.6 × 1.6 cm) of the crab. The observation took place on the edge of a stream environment in a secondary patch of Atlantic rainforest. When first observed, the crab was feeding on the anuran, which already had the hind limbs missing. Only photographs were taken, no specimens were collected.

The occurrence of this anuran in the stream environment may be linked to the presence of bromeliads in rock outcrops present in the immediate area of our observation. We cannot confirm the act of predation as the anuran was already being consumed at the beginning of our observation. Because they are associated with different environments, we believe that such interaction between the taxa cited is not frequent, which possibly would not affect the structure of the anuran population in the study area.

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***SCINAX RUBER*. PREDATION.** Between 2145 and 2210 h on 30 Dec 2009, we observed a *Trachycephalus typhonius* (94 mm SVL) preying on two *Scinax ruber* in the city of Carolina, Maranhão, northeastern Brazil (7.29277°S, 47.49305°W; 168 m elev.). The *T. typhonius* was observed ca. 4 m above ground on a tree. It captured an adult *S. ruber* and in less than 30 min there was a second attack on another adult. Both attacks occurred in savanna (Cerrado) vegetation. When captured, the *T. typhonius* regurgitated the second *S. ruber*, the first was extracted from the stomach. All specimens are deposited in the Herpetological collection of the Pontifícia Universidade Católica de Goiás, Goiânia (*T. typhonius* CEPB9241). These observations confirm that *T. typhonius* is a predator of *S. ruber*, although it is unknown if *S. ruber* is an important dietary item or if they are only sporadically ingested.

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TESTUDINES — TURTLES

***APALONE FEROX* (Florida Softshell). DIET.** *Apalone ferox* is thought to be omnivorous, with a strong preference for carnivory. Although the majority of reported prey consists of invertebrates, a wide variety of vertebrate prey has been documented, including fish, turtles, snakes, and birds. Ranid frogs are, to date, the only reported anuran prey (Ernst and Lovich 2009. Turtles of the United States and Canada, 2nd ed. Johns Hopkins University Press, Baltimore, Maryland. 827 pp.).



FIG. 1. *Apalone ferox* feeding upon the lower leg of a still living *Rhinella marina*.

On 12 September 2012 at approximately 0900 h, an adult *A. ferox* was observed in a drainage canal in Homestead, Florida, USA (25.471190°N, 80.468122°W). At the time of observation, the *A. ferox* was in the process of partially consuming a still living *Rhinella marina* (Fig. 1). The turtle proceeded to consume much of the toad's lower right leg. It is unknown whether the *A. ferox* consumed the remainder of the *R. marina*, as the observer left the area before the end of the feeding event.

This documents the first known instance of *A. ferox* preying upon *R. marina*. *R. marina* was introduced to south Florida in 1955 as a result of an accidental release at Miami International Airport (Krakauer 1968. Herpetologica, 24:214–221). It has since expanded its range to include much of south and central Florida (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final Report, Project Agreement 08013, Florida Fish and Wildlife Conservation Commission, Tallahassee. 524 pp.). The relationship between *R. marina* and native south Florida predators has received little attention. *R. marina* possess large parotoid glands that produce bufotoxins, which can result in cardiac failure if ingested (Toledo and Jared 1995. Comp. Biochem. Phys. 111A:1–29). Mortality associated with ingestion of *R. marina* has been attributed to the decline of certain predatory species, especially within their introduced range (Letnic et al. 2008. Biol. Conserv. 141:1773–1782). However, consumption of *R. marina* resulting in little to no detrimental effect has been documented in several species of vertebrates (Phillips et al. 2003. Conserv. Biol. 17:1738–1747; Calderón-Patrón et al. 2012. Herpetol. Rev. 43:125; Beaty and Beaty 2012. Herpetol. Rev. 43:471). In the case of this observed predation by *A. ferox*, it is possible that by feeding primarily on the lower leg of the *R. marina*, the turtle avoided the high concentration of bufotoxin produced on and near the parotoid glands.

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***CHELYDRA SERPENTINA* (Snapping Turtle). DIET.** *Chelydra serpentina* is known to have a varied diet of both plants and animals, as well as carrion (Ernst and Lovich, 2009. Turtles of the United States and Canada, 2nd ed., Johns Hopkins University



FIG. 1. Snapping Turtle with dewberry stains and remnants on its jaws.

Press, Baltimore, Maryland. 827 pp.). During a survey of the Louisiana Nature Center (heavily damaged by Hurricane Katrina in late August 2005) by the Gulf Coast Herpetological Society on 15 April 2012, a large male *Chelydra serpentina* (CL = ± 33 cm) was observed on the bank of the Farrar Canal feeding on ripe Southern Dewberries (*Rubus trivialis*). When encountered (by IW and SW) the turtle was holding a berry in the front of its mouth, apparently positioning it for swallowing. The turtle's mouth on each side of the berry was stained red, suggesting that the turtle had eaten other berries (Fig. 1). Amy LeGaux, of the Audubon Nature Institute, encountered a Snapping Turtle of similar size eating dewberries along the same canal on 1 April 2013. We believe this is the first report of dewberries in the diet of this species.

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***CHRYSEMYS PICTA* (Painted Turtle) and *CHELYDRA SERPENTINA* (Snapping Turtle). COMMENSALISM.** Over a period of several years (late-1980s to 1992) from late spring to early fall, I observed apparent commensalism between *Chrysemys picta* and *Chelydra serpentina* in a pond (area = 0.15 ha) in Williamson Township, Wayne Co., New York, USA (43.2131°N, 77.1771°W; WGS 84). This site was visited weekly, and on approximately two-thirds of all visits, I observed a small *Chrysemys picta* (10 cm carapace length [CL]) always in close proximity (approximately 2 m) to a very large *Chelydra serpentina* (ca. 45–50 CL). During the entire duration of all observations (2–3 per visit, and up to 10 minutes each), the *Chrysemys* would promptly move as necessary to maintain its position behind the *Chelydra*, presumably to avoid a predation attempt. When the *Chelydra* was observed feeding upon frogs and fishes, the *Chrysemys* would occasionally snap at and consume small food scraps that floated behind the *Chelydra*. Whenever I came within view of the *Chelydra*, it would immediately dive into the aquatic vegetation at the bottom of the pond and the *Chrysemys*, which was evidently more focused on the *Chelydra* than its other surroundings, would follow the same flight path after about a two-second latency.

On one occasion, while attempting to capture the *Chelydra* by net, the *Chrysemys* was opportunistically captured instead. The *Chrysemys* was sexed (as a male) and measured, and was clearly in healthy condition, as the soft body parts at the base of its anterior and posterior legs were bulging, and the plastron was slightly convex. The *Chrysemys* was released onsite within 5 minutes of capture. A week later, I returned to the site and the two turtles were again in association as observed during previous visits. This symbiotic relationship continued to the time of my last visit in August 1992. I can find no reference to a commensalistic relationship between these species in the literature. *Chrysemys* is a known prey item of *Chelydra* (Ernst and Lovich 2009. Turtles of the United States and Canada. Smithsonian Institute Press, Washington D.C. 827 pp.), and thus such behavior incurs a potential risk to the *Chrysemys* of which it was evidently aware because it focused upon and always remained posterior to the *Chelydra*. However, in doing so, the *Chrysemys* was less wary of and thus more vulnerable to other potential threats, as evidenced by its capture by me. Nonetheless, this was apparently a long-term and beneficial relationship for the *Chrysemys*, as evidenced by its healthy condition. Due to abundant food sources available to the *Chelydra*, it is highly improbable that the scavenging activities by the *Chrysemys* resulted in food deprivation or any other adverse impacts to the *Chelydra*. Therefore, I believe this is a genuine example of commensalism between these turtles.

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***CLEMMYS GUTTATA* (Spotted Turtle). REPRODUCTION.** Little is known regarding the ecology of *Clemmys guttata* on barrier islands (Mitchell and Anderson 1994. Amphibians and Reptiles of Assateague and Chincoteague Islands. Virginia Museum of Natural History, Martinsville. 120 pp.). At 1400 h on 18 March 2004 (air temperature = 9°C) on Assateague Island, Maryland, a pair of Spotted Turtles was observed copulating along the shoreline of a brackish marsh (salinity = 2 ppt; conductivity = 1135 µs/cm; pH = 6.4; water temperature = 15°C) in approximately 15 cm of water. The male (CL = 119.9 mm, PL = 89.5 mm, mass = 150 g) was approximately 3 cm below the surface of the water while the female (CL = 107.7 mm, PL = 97.7 mm, mass = 190 g) was under the male and not immediately visible. The male and female had 13 and nine visible annuli, respectively.

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***MACROCHELYS TEMMINCKII* (Alligator Snapping Turtle). UNUSUAL HABITAT AND TRAP SURVIVABILITY.** *Macrochelys temminckii* is the largest freshwater turtle in North America and typically inhabits deep creeks and rivers in southeastern and midwestern states (Ernst and Lovich 2009. Turtles of the United States and Canada. Smithsonian Institute Press, Washington D.C. 827 pp.). Juveniles occasionally occupy and prefer shallow water environments (Allen and Neill 1950. Spec. Publ. Ross Allens's Rept. Inst. 4:1–15; Moore 2006. M.Sc. Thesis, Southeastern Oklahoma State Univ.), but adults are typically not found in these habitats unless they are associated with other deeper creeks/rivers (e.g., oxbow lakes, cypress swamps. Sloan and Taylor 1987. Proc. Annu. Conf. Southeast. Assoc. Fish Wildl. Agencies 41:343–348). Herein, we report on an unusually small, shallow creek and marsh habitat utilized by an adult *M. temminckii*, as well as survivability following neck capture in a Conibear trap.

In the spring 2013, AC was daily tending a nuisance furbearer (i.e., nutria, beaver, raccoon) trap line of four Conibear 330

traps (size: 25 cm × 25 cm). Traps were set in small creek channels, gaps in beaver dams, and paths made by furbearers both upstream and downstream of a moderate-sized farm pond dam in Hale Co., Alabama, USA (32.760833°N, 87.629722°W). The pond (6.2 ha) is fed by two intermittent streams, with a small, first order stream (~1–2 m wide) that exits from the dam. Below the dam, the stream flows into several, successive shallow pools that are surrounded by freshwater marsh vegetation (primarily *Polygonum* species [Smartweed] and *Salix nigra* [Black Willow]). The pools along the stream were formed likely due to the constriction of water flow by a culvert that passes underneath a county road (0.1 km downstream of dam, Hale County Road 28). This creek eventually flows into the Black Warrior River (following ~22.5 river km), a large tributary of the Mobile River system, which is inhabited by *M. temminckii* (Mount 1975. The Reptiles and Amphibians of Alabama. The University of Alabama Press, Tuscaloosa. 270 pp.).

On 26 March 2013 (1500 h), AC found a moderate-sized *M. temminckii* (~11.3 kg) captured in a Conibear trap that was set on the edge of one of the shallow pools. The turtle was still alive even though the trap captured the individual around the neck. Because of the size of the turtle and likely struggle after the turtle was captured, the trap was pulled up from its original location, but was still anchored at another point. Therefore, we were unable to determine which direction the turtle was traveling before it entered the trap. The turtle was carefully removed from the trap and placed downstream of the trap site. To confirm the species that AC observed, WS returned to the site with AC (1630 h) and indeed found the *M. temminckii* in the stream approximately 15 m downstream of the trap site. Thereafter, the individual was removed from the creek and found to be full of vigor, while showing no visible signs of trauma to the head and neck region. The individual was photographed (Florida Museum of Natural History Herpetology Department photographic archive, UF 170047) and then placed downstream of the last trap. On 27 March 2013, WS and AC returned to the site and did not find the *M. temminckii*.

The habitat at the capture site is unique for this species for multiple reasons. First, the area downstream of the dam and around the capture site is not typical habitat for *M. temminckii*; it was a marshy, ephemeral shallow pond setting and more typical habitat for other pond turtle species such as *C. serpentina* and kinosternid turtles. Second, the stream below the dam, between the shallow pools, and downstream of the county road is relatively narrow (1–2 m wide) and while moving through this creek, the *M. temminckii* individual likely occupied most of the channel width. Third, the creek was relatively shallow (10–61 cm deep) and in some sections, the water likely did not completely cover the adult turtle. It is unknown why this individual was in this type of habitat, but it may have been seeking more shallow environments during the spring for thermoregulatory reasons as suggested by Riedle et al. (2006. Southwest. Nat. 51:35–40). Further, it is unknown if the turtle came from upstream (farm pond side) or downstream (small, first order stream) prior to being captured in the trap. For both of these scenarios, the habitat is not typical for the species and the closest "apparently suitable" creek habitat is >15 river km downstream. However, *M. temminkii* will disperse over long distances (Wickham 1922. Proc. Oklahoma Acad. Sci. 2:20–22), which might explain the presence of this individual in this apparently unsuitable habitat.

The Conibear trap is designed to be "triggered" by a target animal and to snap shut and kill the target animal quickly via fracturing of the spinal column or asphyxiation. Thus, Conibear 330 traps effectively kill large beavers, otters, and nutria. However, many non-target species are captured with these body-gripping traps, including larger turtles. AC captured approximately 20 turtles via Conibear trap at this site over six months of trapping (Snapping Turtle, *Chelydra serpentina*; Red-eared Slider, *Trachemys scripta*), but this was the first and only *M. temminckii* captured. Almost all other turtles captured survived because their shells were strong enough to withstand the force of the trap; however, the lone mortality was a *C. serpentina* that was similarly caught by the neck. Further, smaller turtles are not large enough to trigger the trap mechanism, and thus are likely not killed by larger Conibear traps. It is unknown how long the *M. temminckii* individual had been in the trap, but it was <22 h as the trap was checked at ~1730 h the previous day. The survivability of this individual to a Conibear trap neck capture is probably due to the robustness of the skin and musculature of the neck in this species, which is likely associated with both the thrust-bite feeding and defensive behavior and protection during conspecific aggressive encounters.

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***TERRAPENE CAROLINA* (Eastern Box Turtle). MIDWINTER COMBAT and REPRODUCTIVE BEHAVIOR.** At ca. 1400 h on 13 January 2007, 7.9 km NE of Wewahitchka, Gulf Co., Florida, USA (30.16414°N, 85.14253°W; WGS 84), I observed combat between two adult male *Terrapene carolina*. Conditions were sunny, with a light breeze, and an air temperature of ca. 24°C. When first discovered, the two individuals were ca. 30 cm apart. The smaller (15 cm carapace length [CL]) was inverted on its carapace, and presumably had been overturned by the larger individual (20 cm CL). I placed it right-side-up and stepped back 2 m, whereupon the larger turtle almost immediately charged and overturned the smaller one by placing his head under its carapacial margin and then thrusting his head upwards. I picked up the larger individual and placed it back onto the ground, whereupon it walked into a backwater area of the Apalachicola River and immersed itself in ca. 1 m water. I then picked up and moved the smaller individual ca. 60 cm from its original location and placed it on the ground right-side-up, whereupon it walked to the same area and immersed itself in ca. 1 m water as well.

At ca. 0900 h on 12 January 2013, 5.3 km NE Vernon, Washington Co., Florida, USA (30.65860°N, 85.675661°W; WGS 84), I observed copulation by a pair of *Terrapene carolina*. Conditions were partly sunny, with a moderate breeze, and an air temperature of ca. 18°C. The turtles were located in partial sunlight and adjacent to a large hardwood log. After 5 min of observation from 3 m away (during which time the turtles remained in the same position), I left the area without disturbing the turtles further.

Because a female individual was not seen in the vicinity of the two males during the first observation, it is impossible to determine if the combat behavior was territorial or in defense of a mate or other limited resources. However, with the exception of the Florida Peninsula (Dickson 1953. Everglades Nat. Hist. 1:58–62), reproductive behavior has only been reported in *Terrapene carolina* from spring to fall (Ernst and Lovich 2009. Turtles of the United States and Canada, Smithsonian Institute Press, Washington D.C. 827 pp.). Similarly, of the few reports of potential territorial behavior in *Terrapene carolina* (e.g., Stickel.

1989. J. Herpetol. 23:40–44), none have occurred during the winter. Moreover, in the Florida Peninsula, *Terrapene carolina* is less active during the winter (Pilgrim et al. 1997. Chelon. Conserv. Biol. 2:483–488). Thus, territorial or reproductive behavior by this species during the comparatively cooler winters in the Florida Panhandle (where my observations occurred) would appear to be noteworthy. Additional observations are desirable before conclusions can be made on the causes of these behaviors and their overall frequency of occurrence.

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CROCODYLIA — CROCODILIANS

***ALLIGATOR MISSISSIPPIENSIS* (American Alligator). REPORT OF A LARGE FIBROSARCOMA IN A WILD ALLIGATOR.** Neoplastic diseases have been documented in reptiles, and a recent retrospective study noted neoplasia is most common in snakes, followed by lizards, chelonians, and crocodilians (Garner et al. 2004. Vet. Clinics N. Am. Exotic Animal Practice 7:653–671); indeed crocodilians have few reported neoplasms (Jacobson 1984. *In* Laboratory Animal Medicine, pp. 449–476. Academic Press, Orlando, Florida). A fibrosarcoma of the oral cavity was reported in a captive Siamese Crocodile (*Crocodylus siamensis*, Janert 1998. J. Zoo Wildl. Med. 29:72–77). Two cases of fibrosarcomas were reported in the coelomic cavity of snakes (presumably captive, due to reported known ages of 8 and 15 years old; Hes et al. 2007. Veterinarni Lekar 3:49–55). Two additional cases of fibrosarcomas in known captive snakes were described previously (Frye 1991. Biomedical and Surgical Aspects of Captive Reptile Husbandry. Vol. II. Krieger Publ. Co. Malabar, Florida. 637 pp.). Other neoplasms have been described in captive crocodilians (Huchzermeyer 2003. Crocodiles. Biology, Husbandry and Diseases. CABI Publ., Wallingford, Oxon, United Kingdom. 337 pp.

Wild crocodilians have been examined for abnormalities and injuries; a thorough study of 1345 wild caught Saltwater Crocodiles (*Crocodylus porosus*) showed only three (0.2%) had "growths." The crocodiles were released after examination, and histology was not available (Webb et al. 1977. Aust. Wildl. Res. 4:311–319). A similar survey of 797 wild caught Freshwater Crocodiles (*C. johnstoni*) noted only six "growths," two appeared to be associated with older injuries and three appeared to be sites of infection; the other was described as a "lump" in the ventral pelvic region (Webb et al. 1983. Aust. Wildl. Res. 10:407–420); without histology this may not have been a neoplasm. A smaller disease surveillance study of 144 wild caught Nile Crocodiles (*C. niloticus*) did not reveal any growths or tumors; the only external lesions were an old bite injury and a recent puncture injury (Leslie et al. 2011. J. S. Afr. Vet. Assoc. 82:155–159). Other studies have focused on endohelminth prevalence and infections in *Alligator mississippiensis* (Scott 1995. Proceedings of the Wildlife, Production, Management and Utilization Conference, Texas A&M Univ., College Station, Texas. 12 pp.) and more recently on West Nile Virus prevalence in free-ranging American Alligators (hereafter, alligators) in Florida (Jacobson et al. 2005. J. Wildl. Dis. 41:107–114) and Louisiana (McNew et al. 2007. Southeast. Nat. 6:737–742).

The state of Louisiana has an alligator management program which includes a regulated harvest of wild alligators (Elsey and Kinler 2004. *In* Crocodiles. Proc. 17th Working Meeting Crocodile Specialist Group, pp. 92–101. IUCN–The World Conservation Union, Gland, Switzerland and Cambridge UK.). Recently we recovered a harvested wild *A. mississippiensis* with an unusually large growth on the left rear foot (Fig. 1).

The male specimen was harvested on 14 September 2011, total carcass length 9 ft., 4 in. (112 in. or 284.5 cm). It was taken on private property in Terrebonne Parish in southeastern coastal Louisiana. The mass measured approximately 30 cm wide × 30 cm long and 18 cm high. The circumference around the equator was 106 cm, and around the upper and lower poles was 83.5 cm. The mass was 10.4 kg; however that includes a bit of the remaining bone after the limb was crudely excised. Upon palpation the mass was quite solid (not cystic or fluctuant); histological evaluation revealed it was a fibrosarcoma and radiological examination showed evidence of erosion of bony structures (Fig. 2). The alligator appeared relatively healthy; although not particularly robust it was also not emaciated; we are unclear if the alligator



FIG. 1. Wild harvested *Alligator mississippiensis* with large fibrosarcoma on left foot.

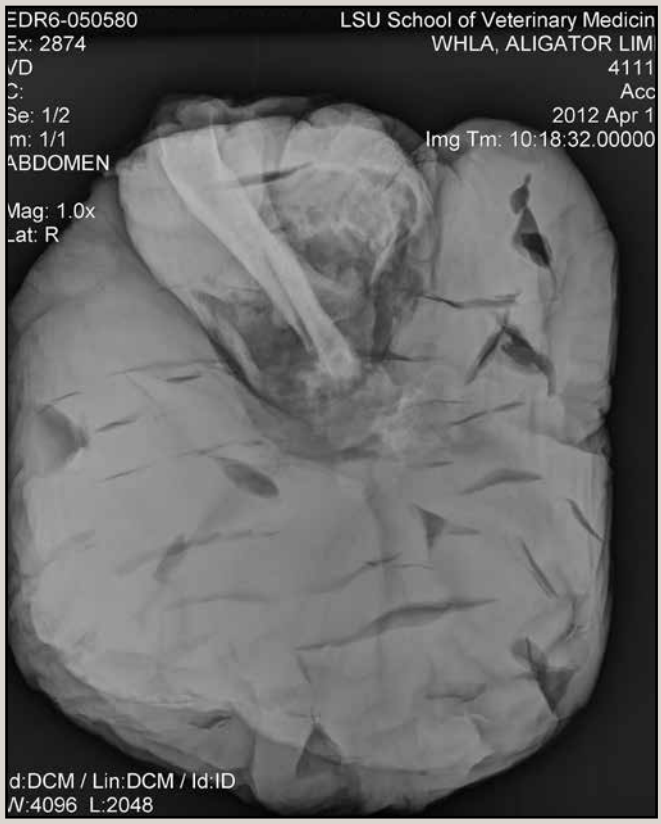


FIG. 2. Radiograph of excised fibrosarcoma from *Alligator mississippiensis*.

could ambulate and it seems likely the volume/bulk of the mass may have interfered with normal streamlined swimming. We surmise the alligator was healthy and feeding, as it was caught on a baited hook as is standard practice in Louisiana. The trapper confirmed he caught all alligators that year by baited hook, and recalls this alligator exhibited normal evasive behavior during the harvest procedure (C. Lovell, Jr., pers. comm.).

To our knowledge this is one of the largest tumors ever reported in a wild crocodilian. It would be of interest to know how long it may have taken for a tumor of this size to develop in a wild alligator. Studies have shown alligators do have a strong capacity to resist infection and their blood has antibacterial (Merchant et al. 2003. Comp. Biochem. Physiol. 136:505–513), amoebacidal (Merchant et al. 2004. J. Parasitol. 90:1480–1483), and antiviral properties (Merchant et al. 2005. Antiviral Res. 66:35–38) but little is known about resistance to neoplasms. A recent study on ocular disease in American Crocodiles (*Crocodylus acutus*) found no association between contaminant accumulation and eye disease, but could not rule out infection or chemical toxicosis as causes of eye lesions (Rainwater et al. 2011. J. Wildl. Dis. 47:415–426). It may be that wild alligators do succumb to malignancies, but after death in the wild carcasses may rapidly deteriorate in ambient heat and humidity, and then are not known to or recovered by researchers. It is possible that environmental stressors such as recent hurricanes in Louisiana followed by drought years may suppress the immune system and predispose some alligators to development of abnormal lesions. Additional research investigating disease mechanisms in valuable crocodilian resources may be warranted.

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SQUAMATA – LIZARDS

***AMEIVA POLOPS* (St. Croix Ground Lizard). BEHAVIOR.** We report on burrowing and aggressive behavior in the endangered teiid lizard *Ameiva polops* herein. This species is a relatively small (32–88 mm SVL), active lizard remaining in remnant populations on four small islands <104 m above sea level off the northern and southern coasts of St. Croix, United States Virgin Islands, USA (17.75°N, 64.75°W). Adult males can often be distinguished from females by bluish coloring on the flanks and tail, as well as a deeper red throat patch and the size of the head (Heatwole and Torres 1976. Herpetogeography of Puerto Rico III: 63–111). In its offshore localities, this diurnal species occupies sandy coastal forest with an abundance of dead leaves (Philibosian and Ruibal 1971. Herpetologica. 27:450–454). Individuals retreat overnight in burrows, and previous studies observed that lizard abundance was highest in habitat with loose soil, land crab burrows (*Gecarcinus ruricola*), and ground cover (Heatwole and Torres 1967, *op. cit.;* Meier et al. 1993. Carib. J. Sci. 29:147–152). No reports of burrow construction or defense have been published to our knowledge.

On 22 March 2013, at the end of a trail survey for the species at Buck Island Reef National Monument, USVI (17.7869°N, 64.6192°W), we observed a male *Ameiva polops* between 70 and 75 mm SVL in leaf litter under a small *Pisonia subcordata* shrub. Starting at 1547 h, the individual began rubbing its hind legs briskly on fewer than ten leaves adjacent to the shrub. After 14 minutes, a smaller male (approximately 60 mm SVL) approached the area from the northeast in leaf litter of a Lignum Vitae (*Guaiacum officinale)*. The larger individual continued rubbing his hind legs and tail vigorously on the leaves until the smaller individual was approximately 1.5 m away. The larger individual approached, and both individuals engaged in biting to the head and tails of one another. A large Mangrove Cuckoo (*Coccyzus minor)* came into view but left after the larger lizard chased the smaller lizard up into more dense shrubbery to the north. The animals were not in view for 3 minutes. When the larger male reappeared alone, he returned to his initial position via a circular route 2–4 m from his starting point. He returned to his starting point and continued to intermittently dig in the coarse dirt/sand soil and rub his hind legs on the ground while creating a ramp into the burrow as a pile of course sand accumulated behind him. Eventually he entered the burrow, which we later examined. The entire observation lasted 32 minutes, ending at 1619 h. External burrow dimensions were measured: the entrance was 1.4 mm wide and 1.0 mm high with a 3.2 mm entry ramp under approximately 4 mm leaf litter. We therefore suggest that male *A. polops* construct and/or maintain, as well as defend, burrows to some degree. Further, we believe that the larger male was marking the burrow with femoral pore secretions.

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***AMEIVULA ABAETENSIS*. DIET.** *Ameivula abaetensis* is a lizard endemic to the "restinga" habitats from northern Bahia State in Salvador Municipality to south of Sergipe State, Brazil. This species was only recently described and knowledge of its biology and ecology are lacking (Dias and Rocha 2004. J. Herpetol. 38:586–588; Dias and Rocha 2007. Braz. J. Biol. 67:41–46; Dias et al. 2002. Copeia 2002:1070–1077; Dias et al. 2005. J. Herpetol. 15:133–137). Here we present a report on the consumption of a squamate egg by *A. abaetensis*.

A female *Ameivula abaetensis* (SVL = 61.89 mm) was observed eating a soft-shelled elliptical egg (volume = 312.61 mm^3; measuring accuracy of 0.01 mm) at 1300 h on 14 March 2012 at Parque Nacional Serra de Itabaiana, Areia Branca municipally, Sergipe, Brazil (10.747500°S, 37.339444°W; datum WGS84; 201 m elev.). The species that produced the egg was not identified. After feeding on the egg, the specimen was captured by hand (collection permit: 31047–1 IBAMA/RAN), euthanized and deposited in the collection of the Laboratório de Biologia e Ecologia de Vertebrados/Universidade Federal de Sergipe. This is the first documented case of egg predation by *A. abaetensis*. The diet of *A. abaetensis* is known to consist of small arthropods with the presence of various plant matter and fruits (Dias and Rocha 2007, *op. cit.*; Rosa et al. 2012. Bol. Mus. Biol. Mello Leitão [N. Ser.]

29:53–63). Further, *A. abaetensis* is known to prey on juveniles of the lizard *Tropdurus hygomi* (Dias and Rocha 2004. Herpetol. Rev. 35:398–399). Our observation reported here indicates that *A. abaetensis* is a source of mortality in the offspring of small squamates that lack nest attendance behavior by parents.

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***AMEIVULA ABAETENSIS*. MATING BEHAVIOR.** *Ameivula abaetensis* is a recently described (Dias et al. 2002. Copeia 2002:928–937) terrestrial and diurnal teiid lizard (Dias and Rocha 2004. J. Herpetol. 38:586–588; Dias and Rocha 2007. Braz. J. Biol. 67:41–46) endemic to coastal sand dune habitats from northern state of Bahia to the southern state of Sergipe, Brazil (Dias et al. 2002. Copeia 4:1070–1077; Tinôco et al. 2010. Herpetol. Bull. 111:19–24). Recent studies on this species include analyses of thermal ecology, activity patterns, habitat use and diet (Couto-Ferreira et al. 2011. J. Threat. Taxa 3:1990–2000; Dias and Rocha 2004. J. Herpetol. 38:586–588; Dias and Rocha 2007. Braz. J. Biol. 67:41–46; Santa-Rosa et al. 2012. Bol. Mus. Biol. Mello Leitão 29:53–63). The only report on the reproductive biology of *A. abaetensis* was provided by Rosário et al. (2011. Herpetol. Rev. 42:428), in which the authors observed the occurrence of oviposition in April. Thus, the aim of this research is present the first report of *in situ* mating behavior of *A. abaetensis*.

On 24 November 2012 at 1137 h, mating behavior of *A. abaetensis* was observed at Restinga de Abaeté, Salvador municipality, State of Bahia (12.914378°S, 38.322402°W; datum WGS84; 31 m elev.). The behavior began with the movement of two individuals within a shrub. After approximately 20 seconds, the subjects moved to the edge of the shrub, the male being guided by the female, where they then mated. At this point, male and female were interconnected by cloacal apposition. The female remained motionless on the sandy soil, while the male was biting her near the pelvic region during the entire copulatory event. Copulation lasted about 30 seconds. At the end of interaction, the two individuals separated and moved to a new shrub, ca. 2 m away. Field observations of behaviors related to reproduction are rarely recorded, even for common species (Mesquita et al. 2012. Herpetol. Bras. 1:41–42). From our observations and those published by Rosário et al. (2011. Herpetol. Rev. 42:428), we believe that *A. abaetensis* begins the reproductive process in intermediate months of the dry season (September to March), with oviposition between the end of this period and the beginning of the rainy season (March to August).

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***ASPIDOSCELIS GULARIS* (Spotted Whiptail). PREDATION.** The predation of vertebrates, including lizards, by spiders has been well documented (Ervin et al. 2007. Herpetol. Rev. 38:468; Filipiak and Lewis 2012. Herpetol. Rev. 43:486). Such predation can occur via active foraging, ambush, or the use of webs (Hamilton 2012. Herpetol. Rev. 42:603; Lanschi and Barbosa 2012. Herpetol. Rev. 43:134; Lazcano et al. 2012. Herpetol. Rev. 43:138). Spiders of the genus *Latrodectus* are known to prey on lizards, ensnaring them with self-constructed webs (Lane 2012. Herpetol. Rev. 43:339; Painter and Kamees 2010. Herpetol. Rev. 41:227). To our knowledge this is the first account of predation on *Aspidoscelis gularis* by a Black Widow (*L. mactans*).

On 1 November 2012, at ca. 1100 h, a juvenile *A. gularis* (approximate SVL = 30 mm) was found dead, trapped in spider web occupied by a *L. mactans,* in a cistern near a house (Fig. 1), at Municipality of Chihuahua, Chihuahua, Mexico (28.668856°N, 105.942033°W, datum WGS84; elev. = 1376 m).



Fig. 1. *Aspidoscelis gularis* (juvenile) trapped in a Black Widow Spider web before consumption, in Chihuahua, Chihuahua, México.

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***ASPIDOSCELIS NEOMEXICANA* (New Mexico Whiptail) × *ASPIDOSCELIS SEXLINEATA VIRIDIS* (Prairie Racerunner). DURATION OF HYBRIDIZATION.** *Aspidoscelis neomexicana* is a hybrid-derived parthenogenetic species (Cole et al. 1988. Am. Mus. Novitat. 2905:1–38; Parker and Selander 1984. Herpetologica 40:245–252) that reproduces asexually through development

of unreduced diploid eggs. Sexual reproduction in the species occurs only when its eggs are fertilized by sperm from a male of a gonochoristic species such as *A. sexlineata* (Manning et al. 2005. Am. Mus. Novitat. 3492:1–56; Walker et al. 1990. Am. Midl. Nat. 123:404–408) resulting in sterile triploid hybrid males and mostly sterile triploid females. However, it is conceivable that a rare fertile female could become the founder of a new allotriploid parthenogenetic species as has occurred repeatedly through hybridization in the genus *Aspidoscelis* (see Reeder et al. 2002. Am. Mus. Novitat. 3365:1–61).

We used phenotypic attributes to confirm the identity of a hybrid of *A. neomexicana* × *A. sexlineata viridis* in order to establish that hybridization between these species has occurred over a period of >30 years in the vicinity of Conchas Lake and the Canadian River, San Miguel Co., New Mexico, USA. This female (originally catalogued as University of Arkansas Department of Zoology 8578 and recently re-catalogued as Arkansas State University Museum of Zoology 32422) was collected by one of us (JEC) at 1145 h on 9 August 2009 at Conchas Lake in the South Recreation Area (35.377222°N, 104.1094444°W, datum

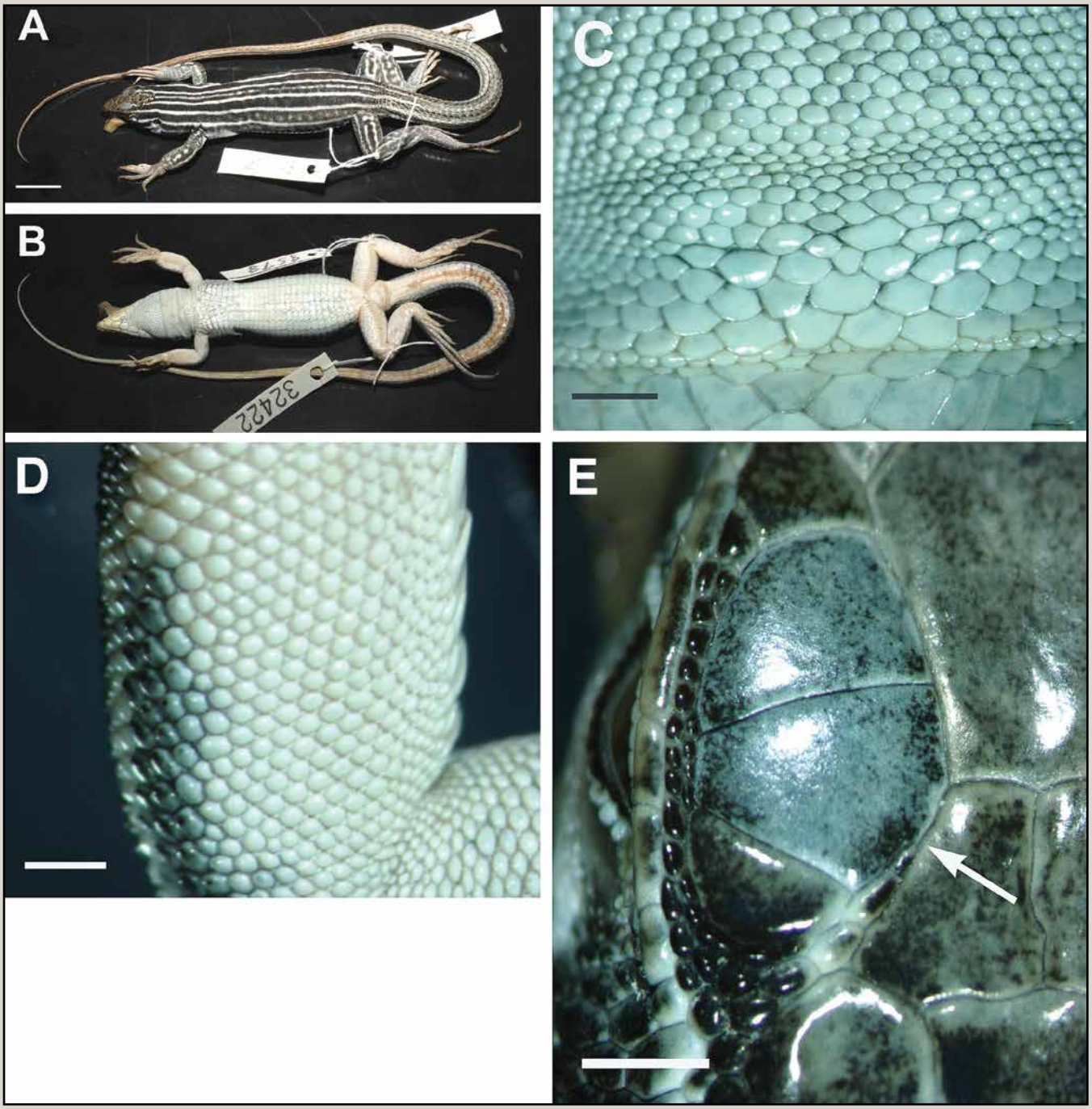


FIG. 1. Color pattern and morphological characteristics of a hybrid female specimen of *Aspidoscelis neomexicana* × *A. sexlineata viridis* from Conchas Lake, San Miguel Co., New Mexico. A) Dorsal coloration and pattern of ASUMZ 32423; line = 10 mm for A and B. B) Ventral coloration of ASUMZ 32422. C) Moderately enlarged mesoptychial scales of ASUMZ 32432; line = 1 mm. D) Slightly enlarged postantebrachial scales of ASUMZ 32422; line = 1 mm. E) Incomplete circumorbital scale series (see arrow) in ASUMZ 32423; line = 1 mm.

WGS84; ~1272 m elev.). In this area, one of three near Conchas Lake where hybrids between these species have been collected (Manning, *op. cit.*), the guild of whiptail lizards includes *A. exsanguis* (triploid parthenogen, rare), *A neomexicana* (diploid parthemogen, abundant), *A. sexlineata viridis* (gonochoristic, moderately abundant), and *A. tesselata* pattern classes C and D (diploid parthenogens, moderately abundant). Prior to preservation, ASUMZ 32422 had a SVL of 71 mm, tail length of 244 mm, and body mass of 9.2 g. It could not be identified to *A. sexlineata viridis* because of the presence of spots (i.e., rounded pale areas) in the dark fields between the stripes, parts of primary stripes with uneven margins, and distinct vertebral stripe with interruptions. *Aspidoscelis sexlineata viridis* is characterized by straight-margined stripes and lack of spots throughout ontogeny (Conant and Collins 1998. A Field Guide to Reptiles and Amphibians of Eastern and Central North America, 3rd ed. Houghton Mifflin Co., New York, New York. 616 pp.; Perez-Ramos et al. 2010. Southwest. Nat. 55:420–426; Trauth 1992. Texas J. Sci. 44:437–443). Although the specimen resembles *A. neomexicana* more closely than *A. sexlineata viridis*, characters indicating its hybrid origin are these intermediate aspects of color pattern (Fig. 1A–B): paired lateral and dorsolateral stripes relatively straight-margined only posterior to level of the forelimbs, paired paravertebral stripes relatively straight-margined anterior to forelimbs and unevenly margined posteriorly, vertebral stripe single and relatively straight-margined anteriorly and with numerous interruptions posterior to forelimbs, strongly contrasting pale stripes and dark fields to produce an ornate effect, large round spots in the fields superior to the lateral stripes, and off-white rather than gray-blue venter. Observations for three characters of scutellation are also consistent with the hypothesis for a hybrid origin for ASUMZ 32422 (comparison with *A. neomexicana* in paren): moderately enlarged mesoptychial scales bordering the gular fold (Fig. 1C, rather than small); very slightly enlarged postantebrachial scales on posterior aspect of forelimbs (Fig. 1D, rather than granular), and incomplete circumorbital scale series between supraocular and median head scales (Fig. 1E, rather than extending anteriorly past the second supraocular sutures or with complete series).

The specimen described herein establishes that production of viable, if infertile, hybrids of *A. neomexicana* × *A. sexlineata viridis* has been ongoing in the vicinity of Conchas Lake for more than 30 years. The first of these was collected by B. E. Leuck and companions on the north side of the Canadian River/Conchas Lake in 1978 (Manning et al., *op. cit.*) followed by collection of other hybrids on the south side of the lake/river between 1988 and 2009 (Manning et al., *op. cit.*; Walker et al., *op. cit.*; this study). The general area from which ASUMZ 32422 was collected on the south side of Conchas Lake has been the source of more than a dozen hybrids to date. An internal examination of the present hybrid by one of us (SET) revealed the following: right oviduct elongated and thin, undeveloped; right gonad translucent, around 3 mm in length, and only slightly larger in width than its associated ligament, no evidence of ova; left oviduct elongated and slightly developed; left gonad translucent and minute (around 2 mm in length), and only slightly larger in width than its associated ligament; no evidence of ova. Both abdominal fat bodies were yellow and greatly enlarged. We infer that the individual was sterile.

Specimens from San Miguel Co. referenced in this study were collected under authority of permit number 1850 issued to JEC by the New Mexico Department of Game and Fish, and in cooperation with the U.S. Army Corps of Engineers.

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***ASPIDOSCELIS TIGRIS* (Tiger Whiptail). DIET.** On 22 April 2007 at 1410 h in Lower Colorado River Valley subdivision Sonoran Desert (Brown 1994. Biotic Communities: Southwestern United States and Northwestern Mexico. Univ. of Utah Press, Salt Lake City, Utah. 342 pp.), just north of the Mexican border south of Yuma, Yuma Co., Arizona, USA (32.420405°N, 111.562379°W; 57 m elev., T_A 26°C), we observed an adult *Aspidoscelis tigris* (98 mm SVL, 209 g) carrying a dead juvenile *Dipsosaurus dorsalis* (Desert Iguana, 56 mm SVL, 4.1 g) in its jaws (photo voucher UAZ 57461-PSV). The head of the desert iguana was badly crushed. The whiptail carried the desert iguana by the head to a Creosote Bush (*Larrea tridentata*) ca. 10 m distant. Once in cover it stopped, repeatedly dropped and picked up the prey, biting down on its head. Within a few minutes the *Aspidoscelis* abandoned its prey, likely disturbed by our presence.

We believe this is the first report of predation of *D. dorsalis* by *A. tigris*. Invertebrates compose the bulk of *A. tigris* prey (Aspland 1964. Herpetologica 20:91–94; Best and Gennaro 1985. Great Basin Nat. 45:527–534; Scudday and Dixon 1973. Southwest. Nat. 18:279–289; Vitt and Ohmart 1977. Herpetologica 33:223–234) and prey varies seasonally (Vitt and Ohmart, *op. cit*). Vitt and Ohmart (*op. cit.*) noted lizard parts in the stomach of one of 82 *A. tigris* examined, and Best and Gennaro (*op. cit.*) found two occurrences of lizard prey in 174 stomachs; species of prey lizards were not reported. It is likely that lizards and perhaps other small vertebrates comprise a small portion of *A. tigris* diet seasonally, perhaps more so in the spring and late summer when young of many lizards are most abundant.

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***COLEONYX VARIEGATUS* (Western Banded Gecko) and *RENA HUMILIS* (Western Threadsnake). ATTEMPTED PREDATION.** On 8 July 2008, 2045 h we encountered a small, ca. 127 mm TL *Rena humilis* surface active on the edge of a wash near Queen Valley, Pinal Co., Arizona, USA (33.301018°N, 111.314240°W; 611 m elev.). While we were watching the snake, a ca. 63 mm SVL *Coleonyx variegatus* attempted to prey on it. When the gecko first encountered the snake, it cocked its head to one side then rushed forward a few centimeters and grabbed the snake, which thrashed wildly. The gecko shook it a couple of times, then released it. We do not know if the gecko decided the snake was too large, or if it was simply disrupted by our presence, but we suspect the latter as the gecko fled after dropping the snake.

This is the first report of *C. variegatus* as a potential predator of *R. humilis*. *Coleonyx variegatus* is primarily a predator of small invertebrates (Parker and Pianka 1974. Copeia 1974:528–531), and vertebrate prey is virtually unknown. Though Parker and Pianka (*op. cit.*) documented the remains of four lizards or lizard skin in the stomachs of 185 *C. variegatus* examined, they

did not elaborate as to whether those were ingested shed skin or actual prey items. Though this predation attempt was unsuccessful, it is not unlikely that small vertebrates such as hatchling lizards (e.g., *Uta, Xantusia*) and small snakes (e.g., *Rena, Tantilla, Sonora*) may occasionally fall prey to large *C. variegatus*.

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***DIPLOGLOSSUS MONOTROPIS* (Costa Rican Rainbow Striped Galliwasp). PREDATION.** *Diploglossus monotropis* occurs in tropical rainforest from Nicaragua to Colombia and Ecuador (Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna between Two Continents, between Two Seas. Univ. Chicago Press, Chicago, Illinois. 994 pp). Information regarding the natural history of this anguid is scarce, including its predators, mainly due to its secretive and nocturnal behavior (Solórzano 2001. Fauna. 2:8–12).

On 26 February 2011 at 1200 h, while conducting herpetofaunal surveys in Veragua Rainforest Adventure Park, Limón Province, Costa Rica (9.926361°N, 83.19095°W, datum WGS 84; 200 m elev.), we observed a Sunbittern (*Eurypyga helias*) standing over a stone at the edge of a river exhibiting feeding behavior. Upon arriving at the site for inspection, a carcass of a *D. monotropis* was found on the same stone where the Sunbittern had been perched. The carcass retained only the back and ribs of the reptile; all the organs were consumed. However, the carcass was relatively fresh (Fig. 1). It is known that this aquatic-foraging bird is capable of feeding on lizards such as *Anolis oxylopus* and *Ameiva festiva* (Lyon and Fogden 1989. Auk 106:503–507). The behavior of the Sunbittern suggests it was original predator of the lizard, or was at least feeding on the carrion, and to our knowledge this would be the first record of predation on a *D. monotropis* (or for the genus *Diploglossus*) by an avian predator. Further, this is the largest lizard species reported for the diet of the Sunbittern to date.



FIG. 1. A) Carcass of *Diploglossus monotropis* (dorsal view). B) Carcass of *D. monotropis* (ventral view).

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***HEMIDACTYLUS FRENATUS* (Common House Gecko). PREDATION.** *Hemidactylus frenatus*, a species native to the Old World tropics (Leenders 2001. A Guide to Amphibians and Reptiles of Costa Rica. Zona Tropical. Miami, Florida. 305 pp.), is reported to have become established in Costa Rica after 1990 (Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna between Two Continents, between Two Seas. Univ. Chicago Press, Chicago, Illinois. 934 pp.). Currently, however, no information is available regarding the interaction of this exotic species with native vertebrate or invertebrate species in Costa Rica. Herein, we document predation on the exotic *H. frenatus* by a native White-fronted Capuchin (*Cebus capucinus*).

On 21 March 2013 at 0730 h an adult capuchin monkey was observed searching for, catching, and eating an adult *H. frenatus* on the patio of the second floor of a residence (09.404678°N, 84.157719°W, datum WGS 84; 140 m elev.) in the town of Manuel Antonio, Costa Rica. Manuel Antonio is located next to Parque Nacional Manuel Antonio, where capuchin monkeys and other animals are frequently seen active on the dense vegetation of the surrounding residences. That morning a group of about 10 capuchin monkeys arrived at the patio of our residence in search of potential food items, an event we had witnessed on four occasions during the previous three days. Two individuals climbed to the ceiling and methodically began to examine every crevice in the ceiling that might potentially harbor prey; in this case, *H.*



PHOTO BY VICENTE MATA-SILVA

FIG. 1. White-fronted Capuchin (*Cebus capucinus*) eating a Common House Gecko (*Hemidactylus frenatus*) in Manuel Antonio, Costa Rica.

frenatus. One monkey succeeded in locating and capturing one gecko from its shelter, and descended to the floor holding its prey with one hand (Fig. 1). First, the monkey ate the tail and a significant portion of the skin covering the trunk and head of the body, and then bit the venter of the gecko and ate some of the internal organs, while the lizard was still alive. After nibbling on the gecko for ca. three minutes, another capuchin approached and took the remains of the gecko and disappeared into the surrounding vegetation. At that point, all four limbs and the head of the gecko remained attached to the body, and most of the muscle tissue was intact. The second capuchin found another gecko, but did not succeed in extracting it from its shelter. The learning behavior required for capuchin monkeys to identify the potential habitat (i.e., houses) and microhabitats where the exotic *H. frenatus* is found, and utilized as a prey, is noteworthy. Additionally, predation on *H. frenatus* by a native bird species (the Great-tailed Grackle, *Quiscalus mexicanus*) has been reported in Mexico (Rojas-Gonzalez and Wakida-Kusunoki 2012. Herpetol. Rev. 43:133). To the best of our knowledge, this observation represents the first report of predation on *H. frenatus* by *C. capucinus*.

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***HEMIDACTYLUS MABOUIA* (Tropical House Gecko). PREDATION.** *Hemidactylus mabouia* is a gekkonid lizard of African origin, although currently it has a wide distribution in the Neotropics (Kluge 1969. Misc. Publ. Mus. Zool. Univ. Michigan 138:1–78). Despite being associated with anthropogenic environments (Vanzolini et al. 1980. Répteis das Caatingas. Acad. Brasil. Ciências. 161 pp.; Anjos 2008. Nature Conserv. 6:96–207), this species also occurs in natural environments such as the Atlantic Forest, Cerrado, Caatinga, Restingas, Amazon rainforest, and occurs on islands of the Brazilian coast (Rocha and Bergallo 2011. Braz. J. Biol. 71:447–450). There are few studies conducted on the natural history and ecological interactions of *H. mabouia* (Howard et al. 2001. Caribb J. Sci. 37: 285–288). Diniz 2011 (Herpetol. Notes 4:357–358) and Lanschi and Ferreira 2012 (Herpetol. Rev. 43:133–134) reported predation events involving *H. mabouia* and the orb-weaver spider *Nephilengys cruentata* (Nephilidae) and a hunting spider (Ctenidae), respectively. Here we report an interaction of predation on *H. mabouia* in the Rppn Fazenda Bulcão (19.3119°S, 41.0504°W; elev. 255 m) at Aimorés municipality, Minas Gerais state, southeastern Brazil.



FIG. 1. Lycosid spider feeding on a *Hemidactylus mabouia*, in Aimorés, Minas Gerais, southeastern Brazil.

On 5 June 2012 at 1746 h one of us (LM) observed a lycosid spider (29 mm, cephalothorax + abdomen length) on leaf litter attached to and feeding on a juvenile of *H. mabouia* (SVL = 50.5 mm). The spider bit the prey and remained attached to it until the lizard's death, this process lasting approximately 30 minutes. The family Lycosidae, typically referred to as wolf spiders, is one of the most diverse groups of spiders, with 2393 currently described species in 120 genera (Platnick 2013. The World Spider Catalog. Version 12.0 www.research.amnh.org, accessed 8 January 2012). It comprises mainly hunting spiders that occur in significant numbers in virtually every terrestrial habitat. This report contributes to the knowledge of predation interactions of the non-native lizard *H. mabouia* by native spiders in Brazil, and also suggesting that spiders of different guilds, such as orb-weavers (*Nephilengys cruentata)* and hunting spiders (Ctenidae, Lycosidae) may represent a potential mortality source for populations of this gekkonid.

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***LEPOSTERNON MICROCEPHALUM*. PREDATION.** *Leposternon* is a very specialized genus of Amphisbaenidae (Gans 1974. Biomechanics: an Approach to Vertebrate Biology. J. B. Lippincott, Philadelphia. x + 261 pp.) with a broad distribution in South America (Gans 2005. Bull. Amer. Mus. Nat. Hist. 289:11–30), including Atlantic Forest areas in Southeastern Brazil. *Leposternon microcephalum* is common prey for some terrestrial snakes, especially *Micrurus* spp. (Marques and Sazima 1997. Herpetol. Nat. Hist. 5:88–93), but it is typically not known to be preyed upon by birds. Here we report on a specimen of *L. microcephalum* being caught and consumed by a White-necked Hawk (*Amadonastur lacernulatus*) (Fig. 1), an endemic and threatened species of the Brazilian Atlantic Forest (and so only photographed, not collected) (Thiollay 1994. *In* del Hoyo et al. [eds.], Handbook of the Birds of the World. Vol. 2, pp. 52–205. Lynx Edicions, Barcelona). The predation event was observed by one of us (HR) at Jardim Botânico do Rio de Janeiro, Brazil (the Botanical Garden at Rio de Janeiro City, Brazil; 43.2290°W, 22.9688°S, WGS84; elev. 50 m) at 0900 h on 3 June 2012. The identification of *L. microcephalum* was possible through the pholidosis observed by a specialist (JDBF) and available data on the known distributions of amphisbaenian

species. The photograph in Fig. 2 shows the hawk detaching the amphisbaenian skin from adjacent musculature to eat only the exposed flesh. To our best knowledge, this is the first record of such a behavior for an amphisbaenian predator. Bird predators of amphisbaenians are considered mainly as opportunistic. Zamprogno and Sazima (1993. Herpetol. Rev. 24:82–83) reported four birds of prey as predators of *L. wuchewreri*: Turkey Vulture (*Cathartes aura*), Crested Caracara (*Caracara plancus*), Yellow-Headed Caracara (*Milvago chimachima*), and an unidentified species of hawk (*Buteo* sp.). Additional reports of birds as predators of amphisbaenians include: Southern Lapwing (*Vanellus chilensis*) (Gans 1971. Amer. Mus. Nov. 2475:1–32) and Maguari Stork (*Ciconia maguari*) (Tozetti et al. 2011. Panamjas 6:65–67), which had specimens of *Mesobaena huebneri* and *Amphisbaena trachura* in their stomachs, respectively; chickens and the Roadside Hawk (*Rupornis magnirostris*) feeding on *Amphisbaena* (*darwini*) *heterozonata* (Gallardo 1967. Ciencia e Investigación 23:406–411); chickens feeding on *Amphisbaena* (=*Bronia*) *bedai* (Vanzolini 1991. Pap. Avul. Zool. 37:347–361). However, the present record suggests some specialization of *A. lacernulatus*, regarded as a "ground searcher" species, for its skill in separating and rejecting the skin of *L. microcephalum* before swallowing the head and body. *Amadonastur lacernulatus* is apparently a broad generalist, its recorded prey items including snakes, mammals, birds and invertebrates (mainly arthropods) (Thiollay, *op. cit.*).



FIG. 1. *Leposternon microcephalum* caught by a White-necked Hawk (*Amadonastur lacernulatus*).



FIG. 2. Hawk's behavior of detaching the skin of *L. microcephalum* from adjacent musculature to eat only the exposed flesh.

This is the first documentation of the consumption of an amphisbenian by *A. lacernulatus*.

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***MABUYA FRENATA, M, MACRORHYNCHA*. TAIL BIFURCATION.** Bifurcation in lizards is the result of abnormal tail regeneration following autotomy. This phenomenon is considered rare, and has been reported in lizard species of different families (e.g., Brindley 1894. J. Bombay Nat. Hist. Soc. 9:30–33; Colwell 1992. Herpetol. Rev. 23:118; Gogliath et al. 2012. Herpetol. Rev. 43:129; Kumbar and Ghadage 2011. Herpetol. Rev. 42:94). However, such reports usually only mention isolated cases, and the frequency of occurrence of this phenomenon within lizard populations is mostly unknown. In skinks, tail bifurcation has been known to occur in few species, including the North American *Plestiodon egregius* (Taylor 1935. Univ. Kansas Sci. Bull. 23:1–643), *P. fasciatus* (Scott 1982. Herpetol. Rev. 13:46; McKelvy and Stark 2012. Herpetol. Rev. 43:138), *P. anthracinus* (Walley 1997. Bull. Maryland Herpetol. Soc. 33:178–180), and *P. inexpectatus* (Mitchell et al. 2012. Herpetol. Rev. 43:650), the Australian *Liopholis* (=*Egernia*) *whitii* (Hickman 1960. Pap. Proc. R. Soc. Tasmania 94:111–118), and the African *Trachylepis punctatissima* (=*Mabuya striata punctatissima*) (see Plate 1 in Broadley 1977. Occ. Pap. Nat. Mus. Monum. Rhodesia B 6:45–79). The present note reports cases of tail bifurcation in the Neotropical skinks *Mabuya frenata* and *M. macrorhyncha*, observed in specimens housed at the reptile collection of the Museu Nacional, Rio de Janeiro (MNRJ).

Three adult specimens of *Mabuya frenata* collected by DV in an area of rock outcrops (22.933333°S, 46.919167°W) in Valinhos, state of São Paulo, Brazil, expressed tail bifurcation. Two of them, a male (MNRJ 6727; SVL = 71.6 mm) and a female (MNRJ 6728; SVL = 84.4 mm), were collected on 19 December 1993; the male had an original (non-regenerated) portion of tail 51.6 mm long, followed by a regenerated portion extending 18 mm before bifurcating into two sub-equal tips about 10 mm long each. The female had 30 mm of original tail followed by a regenerated portion extending to 31.4 mm before bifurcating into a smaller lateral (7 mm) and a larger (14 mm) axial branch. In the third specimen, an adult male (MNRJ 6800; SVL = 66 mm) collected on 21 March 1994, the original portion of the tail extended 8 mm from the cloaca, then a regenerated portion extended to 10 mm and then bifurcated into a left and a right branch (respectively, 47.8 mm and 37.6 mm long) (Fig. 1). On the left branch, 17 mm from the tip, a second tip (1.7 mm long) was present (Fig. 1), suggesting that another bifurcation could result if it kept growing. The right branch showed evidence of having been broken and re-regenerated.

One specimen of *M. macrorhyncha* (MNRJ 15686) collected in the "restinga" of Barra de Maricá (22.960556°S, 42.862222°W), state of Rio de Janeiro, Brazil, on 30 April 1992 also expressed tail



FIG. 1. Adult male of *Mabuya frenata* (MNRJ 6800) with tail bifurcation. The arrow indicates a second tip growing from the left tail branch.



FIG. 2. Adult male of *Mabuya macrorhyncha* (MNRJ 15686) with tail bifurcation.

bifurcation. The specimen, an adult male (SVL = 66.3 mm), had an original tail portion of 41.3 mm long. The regenerated portion extended 38 mm and then bifurcated into left (20.7 mm long) and right (24.7 mm long) branches (Fig. 2).

It is interesting that, in all cases above, bifurcation apparently occurred after a secondary break of an already regenerated tail portion. In one of the cases (MNRJ 6800), the two branches of the bifid tail were considerably long (each being more than half the total length of the tail, which was as long as the lizard's head and body), indicating that this particular animal was not substantially impaired by this anomaly. This same specimen had a third tail tip which, had it kept growing, could have resulted in a trifid tail (which could possibly result in greater impairment for its mobility).

Van Sluys et al. (2002. Stud. Neotrop. Fauna Environ. 37:227–231) examined 216 individuals of *M. frenata* from Valinhos, São Paulo, and found evidence of tail regeneration in 178 of them (including the three specimens mentioned above). Thus, the frequency of tail bifurcation as a consequence of regeneration can be estimated as 1.7% (3/178) in that population. For the population of *M. macrorhyncha* from Maricá, Rio de Janeiro, D. Vrcibradic (*in* Van Sluys et al., *op. cit.*) found that 78.3% (i.e., 83) of the 106 individuals examined had regenerated tails (including MNRJ 15686). This gives an estimated frequency of bifurcation of 1.2% (1/83), which is similar to that of *M. frenata* from Valinhos. These are, to our knowledge, the first published estimates of the frequency of tail bifurcation in any species of Neotropical lizards.

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***NOROPS FUSCOAURATUS* (Slender Anole). PREDATION.** *Norops fuscoauratus* is a small arboreal anole, active in the shade during the day, but early in the day can be seen briefly exposed to the sun. Individuals are often observed sleeping at night on leaves or on the ends of branches (Bannerman et al. 2001. Mamirauá: A Guide to the Natural History of the Amazon Flooded Forest. Instituto de Desenvolvimento Sustentável Mamirauá, Tefé, Brazil. 175 pp.; Duellman 2005. Cusco Amazónico, the Lives of Amphibian and Reptiles in an Amazonian Rainforest. Comstock Books in Herpetology, Ithaca, New York. 433 pp.; Vitt et al. 2003. Can. J. Zool. 81:142–156). I am unaware of any reports of predation on *N. fuscoauratus* by an arachnid. I report here an instance of predation on *N. fuscoauratus* by an actenid spider (*Ctenus* sp.).

During a herpetofaunal survey conducted for SINCHI Institute on 15 September 2010 in Colombian Amazonian region (location troche tres Salados, Resguardo Indigena Uitora, municipality of Solano, Caquetá state, southeast Colombia; 0.172°N, 74.651°W; WGS84 datum Bogota), I observed an actenid spider *Ctenus* sp. feeding on a juvenile individual of *Norops fuscoauratus* (SLV 28 mm). The predation event occurred at 2253 h in a trail in the secondary Amazonian rainforest (Fig. 1), the attack on the anole was not observed. The spider may have encountered the anole at night while it was asleep. I found the spider and anole on the leaf of a shrub at 120 cm above the forest floor.

Records of *Ctenus* spiders preying upon vertebrate taxa available in the literature are mainly on anurans in the Amazonian region (Menin et al. 2005. Phyllomedusa 4:39–47) and in the Atlantic Forest of southeast Brazil (Barbo et al. 2009. Herpetol. Notes 2:99–100; Centeno 2009. Diversidade e Uso de Ambiente Pelos Anfíbios e Répteis de São Sebastião, Ilhabela, SP. Unpubl. Master's thesis. Universidade de São Paulo, Brazil). Barbo et al. (*op. cit.*) suggested that these spiders could be important predators of the abundant arboreal and leaf litter-dwelling species, but detailed studies are needed in order to support this hypothesis.

The record presented here increases our knowledge of the relationship between spiders and reptiles and the existence of



FIG. 1. Predation of juvenile individual of the anole *Norops fuscoauratus* by the ctenid spider *Ctenus* sp.

important trophic connections between these groups. This field work was supported by Amazon Institute of Scientific Research SINCHI.

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***PHOENICOLACERTA LAEVIS* (Lebanon Lizard). REPRODUCTION.** *Phoenicolacerta laevis* is known from parts of Turkey, Syria, Lebanon, Israel, and Jordan (Uetz 2013. The Reptile Data base, http://www.reptile-database.org., accessed 15 January 2013). There are anecdotal reports on *P. laevis* reproduction consisting of clutch sizes of 2–6 eggs in Turkey (Baran and Atatür 1998. Turkish Herpetofauna [Amphibians and Reptiles]. Publ. Bd. Minis. Environ, Ankara. 214 pp.) and 5–8 eggs in Jordan (Disi et al. 2001. Amphibians and Reptiles of the Hashemite Kingdom of Jordan. Edition Chimaira, Frankfurt am Main. 408 pp.). In Israel, there are two reports of 2–7 eggs (mean = 4 .5) (Frankenberg and Werner 1992. Herpetol. J. 2:7–18) and 2–5 eggs deposited March through May (Bar and Haimovitch 2011. A Field Guide to Reptiles and Amphibians of Israel. Pazbar Ltd., Herzliya, Israel. 245 pp.). The purpose of this note is to provide additional information on reproduction of *P. laevis* from a histological examination of gonadal material from Israel.

A sample of 24 *P. laevis* was examined, consisting of 9 males (mean SVL = 62.2 mm ± 3.9 SD; range = 58–68 mm), 12 females (mean SVL = 62.6 mm ± 5.9 SD, range = 53–72 mm), 2 subadult females (mean SVL = 46.5 mm ± 2.1 SD; range = 45–48 mm) and 1 unsexed juvenile (SVL = 36 mm) collected 1949 to 1998 in Israel and deposited in the Zoological Museum of Tel Aviv University (TAUM), Tel Aviv, Israel by district: Haifa District: 4417, 12237, 13105, 13795; Northern District TAUM 1063, 1065, 1066, 1182–1184, 5374, 6176, 8622, 11458, 11459, 14375, 15484, 15761, 15764; Tel Aviv District: 1059, 2174, 4748, 5541,16437.

TABLE 1. Monthly stages in the testicular cycle of 9 adult *Phoenicolacerta laevis* from Israel.

Month	N	Regressed	Spermiogenesis
March	2	0	2
April	2	0	2
May	2	0	2
August	1	1	0
November	2	0	2

TABLE 2. Monthly stages in the ovarian cycle of 12 adult *Phoenicolacerta laevis* from Israel.

Month	N	Quiescent	Early yolk deposition	Enlarged follicles > 4 mm	Oviductal eggs
March	2	0	1	0	1
April	1	1	0	0	0
May	1	0	0	1	0
June	1	0	0	0	1
July	3	0	1	1	1
September	2	1	0	0	1
November	1	1	0	0	0
December	1	1	0	0	0

A small slit was made in the left side of the abdomen and the left testis was removed from males and the left ovary was removed from females for histological examination. Enlarged ovarian follicles (> 4 mm) or oviductal eggs were counted *in situ*. No histology was performed on them. Removed gonads were embedded in paraffin. Sections were cut at 5 µm and stained by Harris' hematoxylin followed by eosin counterstain. Histology slides are deposited at TAUM.

Two stages were noted in the testicular cycle: 1) regressed = post breeding (seminiferous tubules contain spermatogonia and Sertoli cells); 2) spermiogenesis (seminiferous tubules lined by clusters of sperm or metamorphosing spermatids). Monthly stages in the testicular cycle are in Table 1. The smallest reproductively active male (spermiogenesis) measured 58 mm SVL (TAUM 2174) and was collected in April.

Four stages were noted in the ovarian cycle (Table 2); (1) quiescent, (no yolk deposition); (2) early yolk deposition (vitellogenic granules in the cytoplasm); (3) enlarged follicles (> 4 mm); (4) oviductal eggs. The smallest reproductively active female measured 53 mm (3 oviductal eggs) (TAUM 5374) and was collected in September. Two reproductively inactive females from November (SVL = 45 mm, TAUM 15764) and SVL = 48 mm, TAUM 15484) were considered as subadults. Another subadult of undetermined sex (SVL = 36 mm, TAUM 16437) was collected in September and may have been born earlier the same year. Mean clutch size for 5 females was 3.6 ± 1.1 SD, range = 2–5. There was no evidence (oviductal eggs and concomitant yolk deposition in the same female) to suggest *P. laevis* females produced multiple clutches in the same reproductive season. However, there is sufficient time for production of multiple clutches as reproductively active females were collected from March to September, excluding April (N = 1) and males produce sperm starting in November. Multiple egg clutches are produced by *P. laevis* in Jordan (Disi et al. *op. cit.*). Males of the congener *A. schmidti* in Saudi Arabia also exhibited spermiogenesis in November (Al-Johany and Spellerberg 1988. J. Arid. Environ.15:197–207).

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***PLESTIODON LAGUNENSIS* (San Lucan Skink). REPRODUCTION.** The biology of *Plestiodon lagunensis* is summarized in Beaman et al. (2004. Cat. Am. Amphib. Rept. 792:1–3). Here we report additional information on the timing of reproduction in *P. lagunensis*.

Specimens were examined from the San Diego Natural History Museum (SDNHM 66870, 68703–704, 68706) and the University of Arizona (UAZ 22977–986, 23386). Eight males (mean SVL = 49.8 mm ± 4.7 SD, range = 40–56 mm), 6 females (mean SVL = 50.0 mm ± 5.8 SD, range = 43–59 mm), and 1 neonate (SVL = 26 mm SVL) were examined. One gonad was removed for histological examination. Histological sections were removed and embedded in paraffin, cut at 5µm, mounted on glass slides and stained by Harris' hematoxylin followed by eosin counterstain.

The only stage noted in the ovaries of *P. lagunensis* was quiescence in which no yolk deposition occurred in the follicles. The female samples were from June (N = 1), July (N = 5), and October (N = 1). Three stages of the testicular cycle were observed: 1) regressed (i.e., seminiferous tubules contain spermatogonia

and sertoli cells), 2) early recrudescence (i.e., slightly increased cellularity due to dividing spermatogonia and the appearance of some primary spermatocytes), and 3) recrudescence (i.e., marked increased cellularity with abundant primary spermatocytes). The male samples were from June (N = 3: regressed), July (N = 2: early recrudescence), and October (N = 1: regressed, N = 2: recrudescence).

Our data suggest, along with the collection of a neonate in July, and the observation of hatchlings in mid-July and juveniles from August to November by Grismer (2002. Amphibians and Reptiles of Baja California, Including its Pacific Islands and the Islands in the Sea of Cortes. Univ. California Press, Berkeley. 399 pp.) that *P. lagunensis* appears to breed in spring and early summer. The males of *P. lagunensis* from October, which exhibited recrudescence, would have likely undergone spermiogenesis the following spring. These observations suggest that fall recrudescence in *P. lagunensis* is similar to other North American lizards in the genus *Plestiodon* (*P. gilberti*: Goldberg 2009. Bull. Maryland Herpetol. Soc. 45:28–32; and *P. skiltonianus*: Goldberg 2005. Texas J. Sci. 57:295–301). Other North American lizards that breed in the spring also exhibit fall recrudescence (Goldberg. 1974. Copeia 1974:176–182; Goldberg1975. Am. Midl. Nat. 93:175–185; Goldberg 1977. J. Herpetol. 11:31–35).

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***SCELOPORUS AENEUS* (Bunchgrass Spiny Lizard). DIET.** Many species of *Sceloporus* lizards are considered insectivorous (Lemos-Espinal and Smith 2007. Amphibians and Reptiles of Chihuahua. Universidad Nacional Autónoma de México y Comisión Nacional para el Uso de la Biodiversidad, 613 pp.; Smith 1939. Zool. Ser. Field Mus. Nat. Hist. 26:1–397), with a few documented cases of herbivory (Méndez de la Cruz et al. 1992. Southwest. Nat. 37:349–355) and cannibalism (Leyte-Manriquez et al., 2005. Herpetol. Rev. 36: 454; Vega-López and Alvarez 1992. Acta Zool. Mex. 51:1–128).

On 21 May 2010 at the La Malinche volcano in Tlaxcala, Mexico (19.227122°N, 97.2124083°W, WGS84, 2700 m elev.), we found a female *Sceloporus aeneus* (SVL = 57.31 mm; weight = 4.4 g) perched on a rock in direct sunlight at 1230 h. During capture we discovered lizard toes protruding from outside of its mouth; we extracted the prey item with tongs. Upon extraction we found a partially digested juvenile of *Sceloporus grammicus* (SVL = 33.74 mm; weight = 1 g). The SVL of the prey corresponded to 58% total length and to 22% total weight of the female *S. aeneus*. *Sceloporus aeneus* is generally considered an insectivorous opportunistic species (Urbano-Lozano 2008. Unpubl. Bachelor's Thesis, Universidad Nacional Autónoma de México, FES-Iztacala). Thus, we document the first record of *S. aeneus* feeding on a lizard and show that this species has the capability to feed on proportionally-sized prey. This could be an uncommon event induced by malnutrition subsequent to oviposition, when females lose a large portion of body mass.

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***SCELOPORUS LINEATULUS* (Isla Santa Catalina Spiny Lizard). DIET AND ACCIDENTAL MORTALITY.** *Sceloporus linealtulus* is endemic to Isla Santa Catalina, Baja California Sur, Mexico. Virtually nothing is known of the natural history of *S. lineatulus* (Grismer 2002. Amphibians and Reptiles of Baja California, Including its Pacific Islands and the Islands of the Sea of Cortéz. Univ. California Press, Berkeley. 339 pp.). On 26 May 2011 several specimens of *S. lineatulus* were observed at the base of a large *Pachycereus pringlei* (Cardón Cactus) feeding on the seeds of the cactus's fallen fruit. Closer observation revealed a deceased individual whose head had become stuck in the seed pod while feeding, and presumably succumbed to the midday heat. To our knowledge this is the first record of the natural diet of *S. lineatulus* and subsequent mortality by seed pod.

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FIG. 1. Desiccated carcass of *Sceloporus linneatulus*, mortality by seed pod, Isla Santa Catalina, Baja California Sur.

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***SCELOPORUS UNDULATUS* (Eastern Fence Lizard). FEEDING BEHAVIOR.** Eastern Fence Lizards obtain a substantial portion of their diet from ants, particularly as juveniles (Parker 1994. Copeia 1994:136–152). *Solenopsis invicta* (Red-imported Fire Ant; hereafter fire ant) was introduced through the port of Mobile, Alabama in the 1930s and has now invaded much of the southeastern United States (Wojcik et al. 2001. Amer. Entomol. 47:16–23). It is likely that Eastern Fence Lizards consume fire ants while foraging and fire ants are considered a novel, toxic prey as they can sting fence lizards when eaten and ultimately cause death in smaller individuals (Langkilde and Friedenfelds 2010. Wildl. Res. 37:566–573). To date, all observations of fence lizards consuming

fire ants of which I am aware occurred when individuals were under attack, or possibly opportunistically (e.g., Boronow and Langkilde 2010. J. Exp. Zool. 331A:17–23; Robbins and Langkilde 2012. J. Evol. Biol. 25:1937–1946). Moreover, Robbins and Langkilde (*op. cit.*) indicate uncertainty regarding whether fence lizards consume fire ants during regular foraging activity.

I observed a juvenile Eastern Fence Lizard (SVL = 22 mm) on top of an active fire ant mound on 10 October 2012 between 1730 h and 1759 h at the Joseph Jones Ecological Research Center in Newton, Georgia, USA. I observed and recorded the lizard actively moving on the mound to forage for 30 minutes and watched it consume three fire ants. Prior to this observation, on 12 September and 13 September 2012 at 1823 h and 1938 h, respectively, I observed an additional juvenile lizard on top of an active fire ant mound and, after monitoring the individual for 10 minutes, I observed the lizard consume one fire ant at 1833 h. A third juvenile lizard (SVL = 39 mm) was seen basking on an active fire ant mound by S. Greenspan on 8 October 2012 at 1118 h and I observed two more fence lizards basking on active fire ant mounds on 8 November 2012 at 1110 and 1445 h, but we did not stop to monitor their behavior. My observations indicate that Eastern Fence Lizards consume fire ants during regular foraging, rather than just opportunistically, and will use fire ant mounds as foraging sites. If fire ant consumption can lead to juvenile mortality, as found by Langkilde and Friedenfelds (*op. cit.*), this behavior could have a considerable influence on fence lizard population dynamics.

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***SCELOPORUS UNIFORMIS* (Yellow-backed Spiny Lizard). DIET.** *Sceloporus uniformis*, recently elevated to species from within the *S. magister* complex (Crother [ed.] 2012. SSAR Herpetol. Circ. 39:1–92; Leaché and Mulcahy 2007. Mol. Ecol. 16:5216–5233), is a robust spiny lizard of the Mojave and Great Basin deserts. As with most *Sceloporus*, the species appears to be a generalist insectivore, feeding on ants, beetles, caterpillars, and other locally abundant arthropods as well as the occasional lizard (Knowlton and Nye 1946. Utah J. Econ. Entomol. 39:546; Parker and Pianka 1973. Herpetologica 29:143–152; Vitt and Ohmart 1974. Herpetologica 30:410–417). Here we document a novel insect prey of *S. uniformis*, ladybird beetles (Coleoptera: Coccinellidae). This observation is noteworthy because ladybird beetles are chemically defended (King and Meinwald 1996. Chem. Rev. 96:1105–1122), and despite being conspicuous and often abundant, they are noticeably absent from the diet of nearly all North American lizards.

On 5 May 2011, along the eastern point of Anaho Island National Wildlife Refuge in Pyramid Lake, Washoe Co., Nevada, USA (39.94937°N, 119.49952°W, NAD83; 980 m elev.), we noosed several *S. uniformis*. While handling these lizards, two adult males (SCUN AI.005, SVL 85 mm; SCUN AI.008, SVL 95 mm) regurgitated their stomach contents, which were largely Seven-spotted Ladybird Beetles (*Coccinella septempunctata*). One lizard (SCUN AI.005) regurgitated ~17 ladybird beetles, the other (SCUN AI.008) ~12 ladybirds. The lizards were measured, marked and released, and the stomach contents retained for verification.

The absence of coccinellids in the diet of most lizards is striking, given the ubiquity, abundance, and visibility of these insects. Coccinellids possess formidable chemical defenses that may deter most arthropod and vertebrate predators (Happ and Eisner 1961. Science 134:329–331; Marples 1993. Chemoecology 4:33–38), including pyrazines that give an unpleasant odor (Moore et al. 1990. Chemoecology 1:43–51) and various toxic or distasteful alkaloids that ladybirds can exude from their haemolymph when threatened (King and Meinwald 1996, *op. cit.*). These chemicals are particularly effective against some birds, even inhibiting growth (Marples 1993, *op. cit.*). However, other vertebrates appear less affected; many amphibians seem tolerant of coccinellid toxins, and some bufonids and ranids consume significant quantities of ladybirds (Sloggett 2012. Insects 3:653–667). Among North American lizards, coccinellids have only been found as apparently accidental food items in the anguid *Elgaria multicarinata* (Cunningham 1956. Herpetologica 12:225–230) and xantusiid *Xantusia vigilis* (Brattstrom 1952. Copeia 1952:168–172), as well as the phrynosomatids *Uta stansburiana* (Knowlton and Thomas 1936. Copeia 1936:64–66) and *S. occidentalis* (Johnson 1965. Herpetologica 21:114–117). Only two phrynosomatids, *S. undulatus* and *S. graciosus*, appear to include ladybirds as a meaningful component of their diets, taking coccinellids with the same frequency as other similar-sized beetles (Johnson 1966. Am. Midl. Nat. 76:504–509; Knowlton 1948. Herpetologica 4:151; Knowlton and Thomas 1936, *op. cit.*; Knowlton et al. 1946. Utah J. Econ. Entomol. 39:382–383; Toliver and Jennings 1975. Southwest. Nat. 20:1–11). We suspect that our case of ladybird predation is purely incidental because earlier diet analyses of lizards in the *S. magister* complex have failed to turn up coccinellids as prey (e.g., Knowlton and Nye 1946, *op. cit.*; Parker and Pianka 1973, *op. cit.*; Vitt and Ohmart 1974, *op. cit.*), and in our examination of several *S. uniformis* stomachs from Anaho Island we have never observed coccinellids. Nevertheless, it remains unclear whether the toxins in ladybirds are effective deterrents to lizard predation in general, and whether some lizard groups (e.g., *Sceloporus*) have evolved tolerance or other means of resistance to these defenses.

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***TROPIDURUS HYGOMI* (Reinhardt's Lava Lizard). COURTSHIP BEHAVIOR.** *Tropidurus hygomi* is a heliothermic, generalist lizard, endemic to northeastern Brazil in restinga ecosystems of the north coast of Bahia from Salvador to the state of Sergipe (Rodrigues 1987. Arq. Zool., S. Paulo 31[3]:105–230). There are no records concerning the courtship behavior of the species.

On 13 March of 2013, around 0900 h, we recorded courtship behavior, followed by an attempted mating, between two *T. hygomi* within restinga of Reserva Imbassaí (12.481616°S, 37.957193°W; datum WGS 84) using a Samsung WB100 digital camera. We kept a distance of 3 m from the lizards during filming. Air and substrate temperature were 36.6°C and 28°C, respectively. The adult female was foraging among leaf litter. When the female noticed the presence of the male, she elevated her tail (Fig. 1). Such behavior in some lizard species is performed during courtship or as a defensive action towards predators (Dial 1986. Amer. Nat. 127:103–111). The female then waved the tail



FIG. 1. Tail display by a female *Tropidurus hygomi* directed towards a male of the same species.



FIG. 1. Use of aphid gall by *Takydromus smaragdinus* on Okinawajima Island, Japan.

laterally for approximately one second and also raised her pelvis. The male, larger than the female, was at approximately 3 m away and approached her, directing his head to her cloaca region. The female refused copulation, moving away from the male, who then bit her right hind limb. The male stayed in the same place with his body stretched forward, watching her.

After the first attempt, there was a second attempt after three minutes. The female was on a dead bromeliad and raised the tail again and waved it laterally. Then, the female climbed into a bush, followed by the male, at which time we were no longer able to continue observation.

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***TAKYDROMUS SMARAGDINUS* (Green Grass Lizard). OVERWINTER SHELTER.** *Takydromus smaragdinus* is a diurnal grass lizard occurring in subtropical forests and is endemic to the Central Ryukyu Islands, Japan (Ota et al. 2002. Biol. J. Linn. Soc. 76:493–509). Because the lizards are exposed to great predation pressures by a variety of species, including avian, mammalian, and snake predators, they exhibit several defensive behaviors, including sleeping and resting site selection. For example, during the active season (early spring to early winter), this lizard utilizes leaves located at the tips of thin branches as a nighttime sleeping site (unpubl. data), and such sleeping site selection by small lizards is believed to aid in nocturnal predation avoidance (see references in Ikeuchi et al. 2012. Current Herpetol. 31:107–116). Herein, we report that this lizard exploits insect galls as shelters during the inactive season. In winter, *T. smaragdinus* enters a temporary state of torpor, therefore, it has seldom been observed active during this time of year in the bushes, which are its natural habitats both day and night during the active season. During daylight hours, we collected seven galls, which had previously been abandoned by parasitic aphids, *Sinonipponaphis monzeni*, from five individual host plants (*Distylium racemosum*) in January 2013. The trees were located at the edge of the forests on Okinawajima Island (26.755°N, 128.297°E). In three out of the seven galls, we found two male lizards (SVL = 42.0 mm; head width = 5.0 mm; SVL = 32.9 mm; head width = 4.5 mm) and one female (SVL = 63.5 mm; head width = 5.7 mm). The largest diameters of three galls were 63.6, 56.4, and 55.3 mm, and the diameters of holes on these galls were 12.9, 12.1, and 11.8 mm, respectively. Galls were located at the heights of 4.5, 5.5, and 4.5 meters from the ground. Compared to the inhabited galls, there were bigger holes on the four galls that were not utilized by the grass lizards (diameters from 13.5 mm to 37.8 mm), but there appeared to be no differences in gall size and distance from the ground. Nocturnal mammals and snakes, which are common arboreal lizard feeders in the study area, would not have access to the lizards within these galls due to the small entrances. This shelter also protects the lizards against diurnal predators, such as birds, while lizards on the leaves at the tip of branches would present easy targets for them. In *T. smaragdinus*, insect galls potentially serve as optimum shelters against predators during both daytime and nighttime, although the number of galls might not be enough compared to the number of lizards in the area and they can only be utilized after autumn when the aphids leave. This is a unique example of a secondary usage of shelter previously utilized by another animal.

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***TROPIDURUS HISPIDUS* (Peters' Lava Lizard). SAUROPHAGY.** *Tropidurus hispidus* is a widely distributed Neotropical lizard, occurring from eastern Maranhao and eastern Para, and from enclaves of open vegetation north of the Amazon river, in Roraima, Brazil, to southern French Guiana, Suriname, Guyana, and Venezuela (Ávila-Pires 1995. Zool. Verh. Leiden. 299:1–706). The diet of *T. hispidus* is composed mainly of arthropods, including ants, beetles, insect larvae, and termites, as well as plant material, including leaves, flowers, and fruits (Kolodiuk et al 2010. South Am. J. Herpetol. 5:35–44; Ribeiro and Freire 2009. Herpetol. Rev. 40:228–228). The ingestion of small vertebrates, such as frogs (Ribeiro and Freire 2009, *op. cit.*) and other lizards (Van Sluys 2004. J. Herpetol. 38: 606–611; Vitt et al. 1996. J. Trop. Ecol. 12:81–101) may occur occasionally. We report here on the

ingestion of a lizard previously unrecorded as prey for *T. hispidus* in the Forest Fragment of the University of Amapá, in the municipality of Macapá, Brazil.

During an ecological study of a community of lizards in the Forest Fragment (0.006283°S; 51.08265°W; datum WGS84), a total of 25 stomachs were analyzed. A dactyloid lizard, *Norops auratus* (SVL = 46.0 mm; total length = 63.0 mm; volume = 18.5 mm^3) was found in the stomach contents of an adult female *T. hispidus* (SVL = 81.3 mm) captured on 26 September 2011, in addition to Hymenoptera, Coleoptera, Orthoptera, and plant matter (fruits and leaves). The voucher specimen of *T. hispidus* was deposited in the Collection of Laboratory of Zoology of the Universidade Federal do Amapá, Brazil (CDLABZOO 111). We thank the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) for financial support (Process 126528/2011-0). ICMBio provided a permit (Proc. Number 31814-2).

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***TROPIDURUS HYGOMI*. PREDATION.** *Tropidurus hygomi* is one of the few species of reptiles endemic to restinga habitat of coastal Brazil, occurring in discontinuous populations along the coast of Salvador, Bahia state, to Santo Amaro das Brotas, Sergipe (Vanzolini and Gomes 1979. Pap. Avul. Zool. 32:243–259). Data regarding the autecology of this species are lacking (Martins et al. 2010. Biotemas 23:71–75) and interspecific relationships with other species are not well understood, with the exception of a report on juvenile predation by *Ameivula abaetensis* (Dias and Rocha 2004. Herpetol. Rev. 35:398–399). The present note reports a predation event on an individual *T. hygomi* (SVL = 71.49 mm) by a juvenile *Boa constrictor* (total length = 49.00 cm; head length = 30.49 mm; head height = 9.75 mm; head width = 14.09 mm) during a field survey at 1140 h on 12 March 2012 at Costa Azul, Jandaira municipality, Bahia, Brazil (11.6621°S, 37.4818°W; datum WGS84). The predatory behavior occurred under a shrub (*Byrsonima* sp.; height = 320 cm). The specimens were captured by hand, euthanized, and deposited in the collection of the Laboratório de Biologia e Ecologia de Vertebrados, at Universidade Federal de Sergipe (collection permission: 31047-1 - IBAMA/RAN).

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***UROSTROPHUS VAUTIERI* (Brazilian Steppe Iguana). DIET.** *Urostrophus vautieri* is native to Brazil, occurring in all states of the south and southeast regions (Condez et al. 2009. Biot. Neotrop. 9:157–185; Levandeira-Gonçalves et al. 2007. *In* C. C. de Faria and E. B. V. de Castro [eds.], Ciência e Conservação na Serra dos Órgãos, pp. 137–153. Brasília, Brasil; Souza-Filho 2011. Check List 7:876–877). There are few records of prey items for this species. Prior to this report, arthropods of the orders Orthoptera and Coleoptera have been reported as food items of *U. vautieri* by Sazima and Haddad (1992. *In* L. P. C. Morellato [ed.], História Natural da Serra do Japi: Ecologia e Preservação de uma Área Florestal no Sudeste do Brasil, pp. 212–235. UNICAMP, Campinas), and by Condez et al. (2009, *op. cit.*).

In the current study we analyzed the stomach contents of five specimens of *U. vautieri* (two females: CRLZ 000065, 000256, and three males: CRLZ 000077, 000126, 000152) deposited in the Coleção de Répteis do do Laboratório de Zoologia, Centro Universitário de Lavras (CRLZ) - UNILAVRAS. All specimens are from the Reserva Biológica Unilavras Boqueirão (RBUB) (21.346°S, 44.990°W, datum WGS84; 1250 m elev.) in riparian forest associated with phytophysiognomies of Cerrado, in the municipality of Ingaí, Minas Gerais state, Brazil. We recorded body parts of specimens of arthropods of the orders Coleoptera (thorax, elytra, and abdomen), Hymenoptera (heads of wasps and ants, and wings), Blattodea (legs and abdomen), and Diptera (heads); and remains of shed skin of these specimens of *U. vautieri*. Hymenoptera, Blattodea and Diptera are novel arthropod taxa reported in the diet of this lizard. Ingestion of shed skin by *U. vautieri* has been previously observed by Ribeiro and Sousa (2006. Herpetol. Rev. 37:348–348).

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***VARANUS PANOPTES* (Yellow-spotted Monitor). CANNIBALISM.** Intraspecific predation, or cannibalism, is common and widespread in animals, and is important in the ecology and evolution of many species (Polis 1981. Annu. Rev. Ecol. Syst 12:225–251). However, there is limited understanding of the implications of cannibalism for the behavior, ecology, and population dynamics of many species (Hämäläinen 2012. Amer. J. Primatol. 74:783–787).

In reptiles, cannibalism is known from at least 191 species (Mitchell 1986. SSAR Herpetol. Circ. 15; Polis and Myers 1985. J. Herpetol. 19:99–107, and other report since). For the carnivorous monitor lizards, field observations of cannibalism exist for eight of the 53 species (*Varanus bengalensis, V. giganteus, V. gouldii, V. griseus, V. komodoensis, V. rosenbergi, V. salvator,* and *V. storri*), with a further three species engaging in cannibalism in captivity (*V. exanthematicus, V. glebopalma, V. timorensis*) (Auffenberg 1994. The Bengal Monitor, Univ. Press Florida; Bennett 2000. Bull. Chicago Herpetol. Soc. 35:177–180; GéCzy 2009. Biawak 2:61–63; Horn and Schurer, 1978. Salamandra 14: 105–116; King and Green 1979. Copeia 1979: 64–70; reviewed in Mitchell 1986, *op. cit.*; King et al. 1989. Austral. Wildl. Res. 16:41–47; Shine et al. 1996. Biol. Conserv. 77:125–134). The generalized diet of many monitor lizards combined with the ability to swallow large prey items suggests that cannibalism may be more widespread than currently appreciated. Here we present two observations of cannibalism in *Varanus panoptes,* a species in which cannibalism has not been previously recorded.

On 6 May 2012 at approximately 1600 h, a medium-sized male *V. panoptes* (SVL = 40.6 cm; TL = 101.4 cm) was radio-tracked to an

area of open woodland along a permanent wetland at El Questro Wilderness Park in the east Kimberley region of Western Australia (15.980556°S, 127.458889°E). Upon approaching the animal, we noticed a juvenile *V. panoptes* (SVL: 192 mm, TL: 479 mm) in the mouth of the male. The male dropped the juvenile before fleeing a distance of approximately 30 m. The juvenile *V. panoptes* was dead upon discovery and exhibited wounds consistent with being mouthed by another monitor lizard.

On 8 June 2001, we observed a large *V. panoptes* on the bank of the Daly River near Oolloo Crossing, Northern Territory, Australia (14.004391°S, 131.240014°E). The lizard was a male, judging by its size (ca. 60 cm), and was in the act of swallowing a sub-adult *V. panoptes* that was about one-third the size of the cannibal. The head and front legs were inside the larger lizard. The smaller lizard was still struggling, raking at the head of the larger lizard with its hind legs. The larger lizard appeared to be struggling to swallow its prey, and would shake it from side-to-side occasionally. Once the prey stopped struggling, the larger monitor slowly swallowed it until just a portion of tail (ca. 15 cm) was left hanging out of its mouth. At this stage the larger lizard appeared to have difficulty walking, and we did not observe the last portion of the tail being swallowed. During the latter part of the swallowing, a third *V. panoptes* walked past that was a similar size to the one that was eaten.

Although our 2001 observation may reflect scavenging, the prey in our 2012 observation was definitely alive. Moreover, there are observations of *V. panoptes* capturing and eating other monitor species (Christian 1995. Herpetol. Rev. 26:146; Rhind and Doody 2011. Herpetofauna 41:64–65). Benefits of cannibalism not involving offspring or eggs include nutrition, reduction of competition for resources, or reproductive competition (Polis 1981, *op. cit.*). In tropical ecosystems in Northern Australia, *V. panoptes* plays an important role as a key predator and is responsible for the regulation of a number of prey species (Blamires 2004. Copeia, 2004:370–377; Doody et al. 2006. Wildl. Res. 33:349–354; Doody et al. 2009. Anim. Conserv. 12:46–53; Doody et al. 2012a. Herpetol. Rev. 43:339–340; Doody et al. 2012b. Herpetol. Rev. 43:491–492; Doody et al. 2013. Biol. Invas. 15:559–568; Webb and Manolis 2010. Freshwater Crocodile, *Crocodylus johnstoni*, Status Survey and Action Plan. Crocodile Specialist Group, Darwin). Large male *V. panoptes* may likewise consume conspecifics frequently, but our observations are not sufficient to determine the frequency of cannibalism or its costs-benefits in this top predator.

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***ZOOTOCA VIVIPARA* (Common Lizard). RECORD WEIGHT.** On 25 June 2011 a very heavy adult female specimen of *Zootoca vivipara* was found on the island of Hiddensee near Vitte (54.563816°N, 13.112562°E) at the German coastline of the Baltic Sea underneath a dry-docked sailing boat. The female *Z. vivipara* reported here weighed 10.0 g (live weight), which makes it the heaviest gravid female specimen of the Common Lizard ever recorded (Fig. 1). The examined *Z. vivipara* measured 157 mm in total length (SVL = 72 mm; tail length = 85 mm). Most adult specimens of *Z. vivipara* express a total length of 110–140 mm with a maximum length of approximately 180 mm (Günther and Völkl 1996. *In* R. Günther [ed.], Die Amphibien und Reptilien Deutschlands, pp. 588–600. Fischer, Jena). Female individuals typically have a SVL measuring between 45 and 70 mm, seldom more than 75 mm (Günther and Völkl, 1996, *op. cit.*). Few reports regarding body weight data have been published for *Z. vivipara.*



FIG. 1 Gravid adult female *Zootoca vivipara* with a record weight of 10.0 g (found on the island of Hiddensee, Germany).

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SQUAMATA — SNAKES

***AGKISTRODON CONTORTRIX* (Copperhead). DIET.** *Agkistrodon contortrix* is a widely-distributed viperid species that occurs in the eastern and central United States and northern Mexico. The species' diet is known to include many species of small mammals, birds, snakes, lizards, frogs, salamanders, and invertebrates (Campbell and Lamar 2004. The Venomous Reptiles of the Western Hemisphere, Volume I. Cornell University Press, Ithaca, New York. 475 pp.). On 19 April 2012, at 2040 h, a male *A. contortrix* (SVL ca. 63.4 cm; Auburn University Museum [AUM] 39901) was collected injured on State Road 503 near CR 20 in Jasper Co., Mississippi, USA (32.13914°N, 89.06058°W; datum WGS84). The snake died overnight. While curating the specimen, the remains of an adult *Plestiodon inexpectatus* (Southeastern Five-lined Skink; AUM 39902) were found in the stomach. The lizard had been ingested headfirst. To our knowledge, this is the first record of *A. contortrix* consuming *P. inexpectatus* (Campbell and Lamar, *op. cit.*).

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***BOGERTOPHIS SUBOCULARIS* (Trans-Pecos Ratsnake). OVERWINTERING BEHAVIOR.** Colubrid snakes in North America, especially those inhabiting higher latitudes, typically hibernate during the cold winter months (Ernst and Ernst 2003. Snakes of

the United States and Canada. Smithsonian Inst. Press. Washington, D.C. 680 pp.). However, there is no information reported on the winter behaviors and ecology of *Bogertophis subocularis*. Herein, we report on a radio-tracked female *B. subocularis* (total length = 1070 mm; 215.4 g) over a nine-month period on Indio Mountains Research Station (IMRS) (centered on 30.75°N, 105.00°W; datum WGS84), Hudspeth Co., Texas, USA. The landscape in the study area is represented by typical Chihuahuan Desert scrub. On 27 November 2010, at 1030 h, the female was observed basking outside its overwintering microhabitat site after ingress. The hibernaculum (elev. 1358 m) was located on a northeastern slope of part of the rimrock of Flat Top Mountain (Worthington et al. 2004. Biotic Resources of Indio Mountains Research Station, Southern Hudspeth County, Texas. University of Texas, El Paso. 85 pp.), which was composed of mostly trachyte rocks with sparse vegetation (*Bouteloua* grasses). The snake was visible until 1120 h, after which it went deeper in the hibernaculum. The body temperature of the snake was 13.5°C, and the ambient, substrate, and microhabitat temperatures were 12.5°C, 13.8°C, and 14°C, respectively. The Chihuahuan Desert has broad periods in which temperatures can reach freezing during the winter months, limiting the surface activity of most snakes, such as *B. subocularis*. This is the first documented sighting of *B. subocularis* basking during the the winter months.

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***BOTHROCOPHIAS CAMPBELLI* (Campbell's Toad-headed Pitviper, Víbora Boca de Sapo de Campbell). DIET/OPHIOPHAGY.** The only documented prey item of *Bothrocophias campbelli* is a partly digested rat-sized rodent reported from Ecuador (Freire and Kuch 2000. Herpetol. Rev. 31:45). On 19 July 2012, ARR and KC collected a juvenile female *B. campbelli* (PSO-CZ 436; total length = 505 mm; SVL = 440 mm) on a tourist trail at Reserva Natural Río Ñambí (RNRÑ), municipality of Barbacoas, department of Nariño, Colombia (01.28592°N, 78.07433°W, datum WGS84; elev. 1431 m) that contained an adult male *Urotheca lateristriga* (Stained Lips Snake; PSO-CZ 437; total length = 430 mm; SVL = 300 mm; Fig. 1) in its stomach. The prey had been ingested tail first. The specimens are housed on Colección Zoológica Universidad de Nariño (PSO-CZ), Pasto, Nariño, Colombia.



Fig. 1. Juvenile *Bothrocophias campbelli* with stomach contents, an adult *Urotheca lateristriga*.

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***COLUBER* (=*MASTICOPHIS*) *BILINEATUS* (Sonoran Whipsnake). DIET.** The diet of the diurnally active, swift-moving *Coluber bilineatus* includes lizards, birds, and occasionally small mammals, frogs, and snakes (Stebbins 1985. A Field Guide to Western Reptiles and Amphibians. Houghton Mifflin Co., Boston Massachusetts. 336 pp.). On 25 July 2012 at 1320 h, while driving along the County Road south of Richards Road in southwestern New Mexico (31.6696°N, 108.8409°W; datum WGS 84) we encountered a DOR male *C. bilineatus* (total length = 1858 mm) that had recently ingested a *C. flagellum* (total length = 991 mm; Fig. 1). The *C. flagellum* had been ingested headfirst and completely consumed. This record is the first documentation of *C. flagellum* in the diet of *C. bilineatus*. The specimens (LACM 183338, 183339) and photo vouchers (LACM PC 1616, 1617) have been accessioned at the Natural History Museum of Los Angeles County, California.

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Fig. 1. *Coluber bilineatus* found dead with a completely ingested *C. flagellum* protruding from its body, Hidalgo Co., New Mexico, USA.

***COLUBER* (=*MASTICOPHIS*) *BILINEATUS* (Sonoran Whipsnake). MAXIMUM LENGTH.** The maximum total length (TL) reported for *Coluber bilineatus* is ~1700 mm (Boundy 1995. Bull. Chicago Herpetol. Soc. 30:109–122). We captured and released a male *C. bilineatus* at ca. 1900 m elevation in the Peloncillo Mountains, Hidalgo Co., New Mexico, USA, that exceeds this length. Captured on 22 April 1995, at 1432 h, this snake measured precisely 1800 mm TL (SVL = 1265 mm) and weighed 460 g. We captured 15 *C. bilineatus* in the Peloncillo Mountains between 1995 and 2001. Males averaged 982 ± 70 (SE) mm SVL (N = 8, range 645–1265 mm). Females averaged 867 ± 48 mm SVL (N = 7, range 685–1076 mm).

A specimen collected from Portal, Cochise Co., Arizona, USA, and deposited in the American Museum of Natural History (AMNH 91620) measured 1331 mm SVL and 1486 mm TL but had an incomplete tail (measurements provided by D. Frost). Based on our small Peloncillo Mountains sample, where both males and females had mean tail/body length ratios of approximately 43% ($t = 2.23$, $df = 10$, $p = 0.43$), we calculate that AMNH 91620 would measure 1903 mm TL if the tail were complete.

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***COLUBER* (=*MASTICOPHIS*) *BILINEATUS* (Sonoran Whipsnake). MORTALITY.** *Spermophilus variegatus* (Rock Squirrel) are known to aggressively attack snakes, often in defense of young (Haywood and Harris 1971. Texas J. Sci. 22:427; Knickerbocker 1988. Arizona Highways 64:12–15). Recently, Christman and Holycross (2001. Herpetol. Rev. 32:48) described an apparent attempt at predation by *S. variegatus* on *Lampropeltis pyromelana*.

On 23 June 1999, at 0826 h, one of us (LK) saw a *S. variegatus* at a rocky tinaja in the streambed of a densely wooded canyon in the Animas Mountains, Hidalgo Co., New Mexico, USA. Immediately after the squirrel was frightened off, a *Coluber bilineatus* (SVL ca. 1200 mm) was found writhing approximately 8 m from the point where the squirrel was first observed. The snake had sustained numerous puncture wounds to the head and anterior 1/3 of the body consistent with those that would be made by rodent incisors. The tail was missing from approximately 60 mm posterior of the vent. When approached, the snake struck haphazardly. Despite the injuries, the snake appeared to be in good condition.

Spermophilus variegatus occasionally take live vertebrate prey (Hoffmeister 1986. The Mammals of Arizona. Univ. Arizona Press, Tucson. 602 pp.) and may have been preying on the *C. bilineatus*. However, in our area most *S. variegatus* give birth in June (Ortega 1990. J. Mamm. 71:448–457), so the squirrel may have been defending itself or its young against a predatory attack by the snake.

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***CROTALUS ATROX* (Western Diamondback Rattlesnake). DIET AND FEEDING BEHAVIOR.** *Crotalus atrox* are generalist predators that prefer a diet of small mammals, but are also known to consume birds, lizards and in some cases, insects (Klauber 1956. Rattlesnakes: Their Life, Habits, History and Influence on Mankind. Vol. 1. Univ. California Press, Berkeley. 708 pp.). Though the natural history and feeding ecology of *C. atrox* has been well documented in captivity, relatively few observations have been made in their natural environment. The feeding behavior of *Crotalus* spp. is generally characterized by a strike, envenomation, and release of the prey item. The snake later tracks the dead prey item for consumption. However, certain stimuli, such as small prey size and prey type, may influence the snake to hold prey after the strike (Kardong 1986. J. Comp. Psychol. 100:304–314). Here, I describe an in-situ observation of prey capture and consumption by a *C. atrox* in Taylor Co., Texas, USA. The observation documents a novel prey species for *C. atrox*, *Cophosaurus texanus texanus* (Texas Greater Earless Lizard), and is unusual in that the prey was not released after the strike.



FIG. 1. *Crotalus atrox* feeding on a *Cophosaurus texanus texanus* in Taylor Co., Texas, USA.

On 20 May 2010, at 1005 h, a *C. texanus* was observed running off the side of a dirt road at the Horse Hollow Wind Energy Center (32.25834°N, 100.02678°W; datum WGS84). While the lizard was running, it was struck and held by a *C. atrox* that was basking on a rock, initially undetected by both the prey and observer. The *C. texanus* was struck head-first, with the initial strike reaching just past the front legs of the lizard (Fig. 1). Consumption of the lizard began approximately 50 sec later and was completed in approximately 7 min.

I thank Caleb Gordon, Normandeau Associates, NextEra Energy, Inc., and Turner Biological Consulting for the opportunity to observe this event.

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***CROTALUS HORRIDUS* (Timber Rattlesnake). FUNGAL PATHOGENS.** Wildlife epidemiology has received a great deal of attention in recent years due in part to an increased awareness of disease prevalence and impacts on wildlife populations. Most notably, fungal species have been implicated in the decline, and even extinction, of anuran (Skerratt et al. 2007. EcoHealth 4:125–134) and bat (Blehert et al. 2009. Science 323:227) populations. More recently, fungal skin infections (and presumed fungal skin infections) have been implicated in the death of individual snakes (Allender et al. 2011. Emer. Infect. Dis. 17:2383–2284; Clark et al. 2010. Biol. Cons. 144:886–891), but little is known about the prevalence or virulence of these fungal pathogens in nature.

On 3 June 2012, two *C. horridus* (herein, "Snake A" and "Snake B") were collected from adjacent bluff prairies located on private property in Houston Co., Minnesota, USA, because of suspicious



FIG. 1. One of two *Crotalus horridus* collected during surveys in Houston County, Minnesota, USA, that tested positive for *Chrysosporium* sp.; note facial dermatitis circled in red.

looking facial dermatitis (Fig. 1). Both individuals were pre-ecdysis when found and were held for approximately five weeks before biopsy samples were sent for analysis; during this time they completed ecdysis. Small biopsies from the head of Snake A and body of Snake B, as well as shed skins from both animals, were sent to the US Geological Survey – National Wildlife Heath Center in Madison, Wisconsin for testing.

Tissue from the biopsies and affected areas of skin from the sheds were subjected to fungal culture at an incubation temperature of 24°C. Fungal isolates were examined microscopically for tentative identification. Most isolates were common environmental fungi that likely represented normal skin flora (e.g., *Aspergillus* and *Penicillium* spp.). However, two isolates (one from the biopsy of Snake A and one from the shed skin of Snake B) could not be identified by microscopic examination. A portion of the internal transcribed spacer region of the ribosomal RNA gene for both isolates was amplified and sequenced using universal primers. The sequences were identical to one another and >99.6% nucleotide match with *Chrysosporium ophiodiicola* (GenBank accession EU715819), a species isolated from a facial mass of a *Pantherophis alleghaniensis* (Eastern Ratsnake; Rajeev et al. 2009. J. Clin. Microbiol. 47:1264–1268). However, further analyses are necessary to determine whether the isolates from the *C. horridus* represent the same species as that from the *P. alleghaniensis*. Histopathology was performed on a small portion of the skin from one of the biopsies using special stains for fungi. No fungal elements were observed, but the sample was taken from the edge of the biopsy and likely did not contain the actual lesion; histopathology could not be performed on the remaining biopsy as that sample was used for culture analysis.

This is the first documented occurrence of a *Chrysosporium* sp. on free-ranging wild snakes in Minnesota; while mortality has been associated with *Chrysosporium* fungi elsewhere (Allender et al. 2011, *op. cit.*; Rajeev et al. 2009, *op. cit.*), it is not known whether this *Chrysosporium* sp. is impacting snake survival in Minnesota. Rajeev et al. (2009) reported that the infected *P. alleghaniensis* died in captivity two months after surgically removing the lesions; similarly, Allender et al. (2011) noted that all three of the *Sistrurus catenatus catenatus* (Eastern (Massasauga Rattlesnakes) with *Chrysosporium* infections from Illinois died in captivity within three weeks after discovery. However, both of the Minnesota animals have improved over the course of 10 weeks in captivity without a specific course of treatment; Snake B now appears asymptomatic.

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***CROTALUS HORRIDUS* (Timber Rattlesnake). REPRODUCTION.** *Crotalus horridus* is a widely distributed species native to the eastern United States; however, most research has focused on northern populations. In Georgia, *C. horridus* typically mates from August to October and gives birth from mid-August to mid-September. However, there have been reports of snakes at higher elevations delaying birth until early October (Jensen et al. 2008. The Amphibians and Reptiles of Georgia. Univ. Georgia Press, Athens. 575 pp.). On 19 October 2011, we collected a road killed female C. *horridus* with a distended lower body in Baker Co., Georgia, USA. No body size measurements were taken on the specimen due to its advanced state of decomposition. Upon dissection, we observed between 8–12 fetuses (SVL range = 291–330 mm) in the latter stages of development. This observation is evidence of late season pregnancy in *C. horridus* in the southeastern Coastal Plain.

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***CROTALUS VIRIDIS* (Prairie Rattlesnake). DIET.** *Crotalus viridis* feeds on small mammals (mice, ground squirrels, rats, small rabbits); it will also consume lizards, amphibians, and other snakes. On 3 July 2012, an adult *C. viridis* was photographed attempting



FIG. 1. Adult *Crotalus viridis* attempting to consume an adult male *Falco sparverius*.

to consume a still quivering adult male *Falco sparverius* (American Kestrel) at the Chihuahuan Desert Rangeland Research Center, Summerford Mountain (32.532536°N, 106.790825°W; datum WGS84), New Mexico, USA (Fig. 1). On 06 July 2012, the site was revisited and the kestrel was found, apparently regurgitated, after being swallowed down to the top of the wings. To our knowledge, this represents the first case of attempted predation on *F. sparverius* by *C. viridis*.

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***CROTALUS VIRIDIS* (Prairie Rattlesnake). REPRODUCTION/COMBAT.** Male-male combat behavior is a component of the reproductive cycle of pitvipers (Aldridge and Duvall 2002. Herpetol. Monogr. 16:1–25). The occurrence of male-male combat behavior is reported in North America during spring (Gloyd 1947. Nat. Hist. Misc. 12:1–4) and summer (Klauber 1972. Rattlesnakes: Their Habits, Life History, and Influence on Mankind, 2nd ed. Univ. California Press, Berkeley; Holycross 1995. Herpetol. Rev. 26:37–38). Here we report field observations of two combat episodes between *C. viridis* in early autumn and spring in northern Chihuahua, Mexico.

At 1130 h on 23 September 2008, 1 km W of the gap that leads to "El Vergel," at km 304 of the Ciudad Juarez–Chihuahua Federal Highway 45, municipality of Juárez, Chihuahua, Mexico (31.20223889°N, 106.51834444°W, datum WGS84; elev. 1285 m) one of us (EMR) encountered two male *C. viridis* (ca.1100 mm SVL) engaged in combat (Fig. 1). The observation occurred in dune habitat with vegetation composed primarily of *Prosopis glandulosa* and *Gutierrezia sarothrae*, about 20 m away from the location of a female *C. viridis* and her newborn offspring. Combat continued for ca. 10 min, after which the defeated male withdrew. A film and photos of the combat are deposited in the scientific collection of vertebrates of the Autonomous University of Juárez UACJ (CHI-VER-189-08-06). The second combat event took place on 15 April 2003, at 1100 h, on the campus of the Autonomous University of Juárez (UACJ) (31.49132095°N, 106.41687207°W; datum WGS84). These observations are unusual in that they occurred outside of the typical summer breeding season of the species.

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***DIPSAS ALTERNANS* (Jan's Snail-Eater, Dormideira). DEFENSIVE BEHAVIOR.** The genus *Dipsas* comprises small and nonvenomous Neotropical snakes that show several defensive strategies, some of which are thought to mimic venomous snakes of the genus *Bothrops* (Sazima 1992. *In* Campbell and Brodie Jr. [eds.], Biology of Pitvipers, pp. 199–216. Selva, Tyler, Texas). Recently, Maia-Carneiro et al. (2012. Biotemas 25:207–210) described three defensive behaviors in *Dipsas alternans*: immobility, spherical body coiling, and hiding the head among the body coils. In our long-term studies of snakes in the Atlantic forest region of the state of Paraná, southern Brazil, we have collected seven *D. alternans*. Five of these demonstrated the same defensive behaviors described by Maia-Carneiro et al. (*op. cit.*), but two exhibited a unique defensive behavior: spiral coiling. The two snakes were found moving within the leaf-litter on the ground of the forest. Both stayed immobile, but after manipulation, rolled their body into a perfect plain spiral, with their heads completely visible in the center (Fig. 1), displaying three spots on the dorsum of the head, as described by Maia-Carneiro et al. (*op. cit.*). In captivity, the specimens never showed any other defensive behaviors, but always forming the spiral when stimulated. Although the exact function of this behavior remains unknown, the spiral shape might confuse a potential predator or mimic the spiral-shaped dead leaves of common tree fern in the area, *Dicksonia sellowiana* (Cyatheaceae). The specimens are deposited in the herpetological collection of the Museu de História Natural Capão da Imbuia (MHNCI.691, Camarinhos, municipality of Campo Largo, Paraná; 25.43°S, 49.63°W, datum WGS 84; MHNCI.3005, Rio do Meio, municipality of Antonina, Paraná; 25.33°S, 48.75°W, datum WGS 84).

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FIG. 1. Male-male combat between two *Crotalus viridis* observed in September in northern Chihuahua, Mexico.



PHOTO BY ZIG KOCH

FIG. 1. *Dipsas alternans* (MHNCI.691) from Paraná, Brazil, showing spiral defensive behavior.

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***EPICTIA TENELLUS* (Guyana Blind Snake). PREDATION.** The vast majority of anurans, especially mid-sized and small species, feed on arthropods and other invertebrates (Duellman and 1994. Biology of Amphibians, 2nd ed. Johns Hopkins Univ. Press, Baltimore. 670 pp.). However, there are a few field observations of snake predation by frogs. *Leptodactylus labyrinthicus* (Pepper Frog) have been recorded to prey on several snake species: *Sibynomorphus neuwiedi, Trilepida koppesi,* and *Typhlops brongersmianus* (Fonseca et al. 2012. Herpetol. Notes 5:167–168; Vaz-Silva et al. 2003. Herpetol. Rev. 34:359). During necropsy of 74 *L. labyrinthicus,* deposited in Zoological Collection of the Universidade Federal do Mato Grosso, we found an adult *Epictia tenellus* (SVL = 156 mm; total length = 172 mm) in the large intestine of a male frog (SVL = 151 mm) from Mato Grosso State, Brazil. The fact that only one snake was recorded suggests that this frog is an opportunist feeder that infrequently feeds on uncommon snakes such as *E. tenellus*.

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***FICIMIA STRECKERI* (Tamaulipan Hook-nosed Snake). REPRODUCTION.** *Ficimia streckeri* is distributed in extreme southern Texas, USA, and Mexico from Nuevo León, Tamaulipas, and San Luis Potosi to the central Mexican Plateau, Hidalgo and north of Veracruz (Wright and Wright. 1957. Handbook of Snakes of United States and Canada. Vol. 1. Cornell Univ. Press, Ithaca, New York. 564 pp.). It inhabits thorn forest, tropical deciduous forest, and cloud forest (Hardy 1976. Cat. Amer. Amphib. Rept. 181.1–181.2). It is seldom seen and little is known about its natural history, including reproduction (Werler and Dixon 2000. Texas Snakes: Identification, Distribution, and Natural History. Univ. Texas Press, Austin. 430 pp.). On 1 April 2012, at 1848 h, in tropical forest of the Plan de Zapotal, municipality of Pisaflores (21.1800.820°N, 98.5746.858°W, datum WGS 84; elev. 495 m), Hidalgo, Mexico, we found an adult female *F. streckeri* (CIB-4290; SVL = 323 mm; tail length = 51 mm). The female was gravid, with three eggs (mean volume ± SE = 537.4 ± 27.6 mm^3; mass = 0.962 ± 0.032 g), and also contained eight non-vitellogenic follicles, which might be indicative of laying multiple clutches annually. These data represent a useful contribution to our limited knowledge of the natural history of this species. We thank the projects CONABIO FB1580/JM001/12, and FOMIX 2012/191908.

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FIG. 1. Prey items (*Ocypode* sp. and *Cerithidea* sp.) regurgitated by *Fordonia leucobalia* from Sonadia Island, Bangladesh.

***FORDONIA LEUCOBALIA* (Crab-eating Snake). DIET.** *Fordonia leucobalia* is a medium-sized, rear fanged, aquatic snake found in the tidal rivers and mangrove habitats from Southeast Asia to northern Australia (Das 2010. Reptiles of Southeast Asia. New Holland Publishers Ltd. UK. 376 pp.). *Fordonia leucobalia* is known as a crustacean eater, primarily feeding on hard-shelled crabs of the families Grapsidae and Ocypodidae, and on mud lobster (*Thalassina anomala*; Voris and Murphy 2002. J. Nat. Hist. 36:1621–1632; Karns et al. 2002. Raffles Bull. Zool. 50:487–498). Herein, we report the first observation of *F. leucobalia* feeding on a gastropod.

We conducted a field survey of homalopsid snakes in the intertidal zone of Sonadia Island, Bangladesh, from 9 to 17 July 2012. Sonadia Island is a roughly 4900-ha barrier island located in the far southeastern corner of Bangladesh, northwest of Cox's Bazaar town. The island supports some of the last remaining patches of natural mangrove forest found in southeastern Bangladesh. On 15 July 2012, we found eight *F. leucobalia* in the early succession mangrove forest, in the landward side of the intertidal zone. Upon capture, one *F. leucobalia* (adult male; SVL = 52.8 cm, tail length = 7.8 cm, 92 g) defecated a *Cerithidea* sp. (Fig. 1; total length = 1.5 cm; 3 g). *Cerithidea* sp. is small, hard-shelled gastropod, abundant in the mudflats and mangrove forest in this region (Siddiqui et al. 2007. Encyclopedia of Flora and Fauna of Bangladesh: Volume 17: Molluscs. Asiatic Society of Bangladesh, Dhaka, Bangladesh. 415 pp.). Feeding on gastropods has not been previously recorded for any homalopsid snakes. Silva et al. (2011. Herpetol. Notes 4:373–375) recently reported an observation of a sea snake (*Lapemis curtus*) feeding on a gastropod in Sri Lanka, indicating that feeding on gastropods by aquatic snakes (homalopsid snakes and sea snakes) might be more common in this region than anticipated.

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***HELICOPS ANGULATUS* (Watersnake). DIET.** *Helicops angulatus* occurs in northern South America, with records from Atlantic forest or Amazonian environments in Colombia, Venezuela, Trinidad, Guiana, Suriname, French Guiana, Ecuador, Peru, Bolivia, and northern and northeastern regions of Brazil (França et al. 2006. Occ. Pap. Sam Noble Oklahoma Mus. Nat. Hist. 17:1–3; Infante-Rivero et al. 2008. Herpetotropicos 4:39–39). They are

aquatic, nocturnal, and feed on fish, tadpoles, and occasionally adult anurans (Ford et al. 2002. Carib. J. Sci. 38:129–132; Scartozzoni 2009. Unpubl. DS thesis. Universidade de São Paulo, São Paulo).

A mature female *H. angulatus* (SVL = 297 mm) was captured on 9 November 2010, at 2200 h, on the edge of a stream in Atlantic Forest of Cruz do Espírito Santo municipality, Paraíba State, northeastern Brazil. Dissection revealed remains of an adult *Leptodactylus natalensis* (SVL = 49.4 mm) in the snake's stomach. This is the first record of consumption of *L. natalensis* by *H. angulatus*. Because both species are sympatric and their habitats are similar, this type of interaction may be expected. The habit of making nests and vocalizing at the edge of slow-flowing streams (Amorim et al. 2009. Pap. Avul. Zool. 49:1–7) may make *L. natalensis* more vulnerable to predators such as *H. angulatus* during the breeding season. The snake and frog are housed in the Coleção Herpetológica da Universidade Federal da Paraíba, João Pessoa (CHUFPB 00005).

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***LAMPROPELTIS CALLIGASTER CALLIGASTER* (Prairie Kingsnake). ANTHROPOGENIC MORTALITY.** As a component of a *Geomys breviceps* (Baird's Pocket Gopher) study 6 km E Spearsville, Union Parish, Louisiana, USA, metal kill traps (Trapline Products, Menlo Park, California, USA), which constrict the abdomen and humanely euthanize the gopher, were set in open pocket gopher burrows in evenings and left overnight. On 30 April 2011, I found an adult female (SVL = 980 mm) *Lampropeltis calligaster calligaster* that had entered an open pocket gopher burrow and been killed in the trap. It appeared that the snake had entered the burrow at the site of excavation. The specimen was subsequently deposited in the Henderson State University Collection of Herpetology (HSU 1641). To my knowledge, this is the first report of a snake dying as a result of a pocket gopher kill trap. Active pocket gopher burrows are typically closed off to the surface except for short durations of burrow maintenance. When open, however, these burrows may provide *L. calligaster calligaster* with refugia and/or pocket gophers, which are known prey of the snake (Connior et al. 2009. Herpetol. Rev. 40:98; Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Books, Washington, D.C. 668 pp.).

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***LAMPROPELTIS NIGRA* (Black Kingsnake). DIET.** The diet of *Lampropeltis nigra* (taxonomy follows Pyron and Burbrink 2009. Zootaxa 2241:22–32) is diverse and includes a variety of lizard eggs, turtle eggs, snakes and their eggs, mammals, and birds (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Books, Washington, D.C. 680 pp.; Green and Cobb 2011. Herpetol. Rev. 42:615). On 15 June 2010, we captured a male *L. nigra* (SVL = 104.2 cm; total length = 118.4 cm; 380 g) in a trap array located on the Camp Shelby Joint Force Training Center, De Soto National Forest, Perry County, Mississippi, USA. During transportation, the *L. nigra* regurgitated a juvenile *Cemophora coccinea* (Scarletsnake), an *Agkistrodon* sp., and *Crotalus adamanteus* (Eastern Diamond-backed Rattlesnake) rattle segments. Rattle segments were identified as *C. adamanteus* due to the absence of *C. horridus* from the study area (Lee 2009. Southeast. Nat. 8:639–652) and the segments were too large to be those of *S. miliarius*. To the best of our knowledge this is the first documented occurrence of *C. coccinea* in the diet of *L. nigra*, and represents a novel food item for the genus *Lampropeltis* (Ernst and Ernst 2003, *op. cit.*).

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***LAMPROPELTIS SPLENDIDA* (Desert Kingsnake). DIET.** *Lampropeltis splendida* is a common Chihuahuan Desert species reported to feed on a variety of prey, including bird eggs and hatchlings (Degenhardt et al. 1996. The Amphibians and Reptiles of New Mexico. Univ. New Mexico Press, Albuquerque, New Mexico. 431 pp.). Avian nest predation by snakes has been reported infrequently, but may account for as much as 90% of all nest predation (Weatherhead and Blouin-Demers 2004. J. Avian Biol. 35:185–190). On 20 July 2012, at 0140 h, we recorded a *L. splendida* predating an *Empidonax traillii extimus* (Southwestern Willow Flycatcher) nest with three nestlings (Fig. 1). The nest was located 1.5 m above the ground in a live 4.5-m tall *Salix exigua* (Coyote Willow). The locality was near San Marcial, Socorro Co., New Mexico, USA. A photo series from a trail camera with infrared capabilities documented four minutes of activity, although it is likely the predation event lasted much longer. To our knowledge, this is the first report of a Southwestern Willow Flycatcher



FIG. 1. *Lampropeltis splendida* predating an *Empidonax trailii extimus* nest including three nestlings in a *Salix exigua* dominated riparian area near San Marcian, Socorro Co., New Mexico, USA.

nest predation by *L. splendida*, although there are several records of Willow Flycatcher nest predation by *L. californiae* (Smith et al. 2002. Nongame and Endangered Wildlife Program Technical Report 191. Arizona Game and Fish Dept., Phoenix, Arizona).

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***LEPTODEIRA ANNULATA* (Banded cat-eyed Snake). DIET.** *Leptodeira annulata* has a wide distribution in Mexico, Central, and South America (Peters and Orejas-Miranda 1986. Catalogue of the Neotropical Squamata: Part I, Snakes. Revised ed. Smithsonian Institution, Washington D.C. 347 pp.). This snake has arboreal habits, but can also be found on the ground and in water (Martins and Oliveira 1998. Herpetol. Nat. Hist. 6:78–150; Ávila and Morais 2007. Herpetol. Rev. 38:278–280). Its diet is composed mainly of small frogs (Vitt 1996. Herpetol. Nat. Hist. 4:69–76). Here we report a field observation of attempted predation upon a large-bodied anuran by an adult *L. annulata* in the Brazilian Caatinga.

At 1810 h on 25 October 2009 in the Fazenda Tanques, municipality of Santa Maria, state of Rio Grande do Norte, Brazil (05.87°S, 35.70°W, datum WGS84; elev. 137 m), we found an adult female *L. annulata* (SVL = 602 mm) in herbaceous vegetation on the border of a pond, biting the right hind limb of an adult *Leptodactylus* cf. *macrosternum*. The anuran continuously emitted open-mouthed distress calls (Fig. 1), and tried to escape from the snake. The *L. annulata* held the frog for approximately 15 min while anchoring its body by wrapping its caudal region around vegetation, but eventually the frog was able to escape.

Although we recognize that our presence may have disturbed the snake, the failed predation attempt may have occurred due to the large size and great vitality of the frog. Despite the batrachophagic habits of *L. annulata*, ingestion of large anurans does not seem to be common in this species. In an analysis of 66 specimens of *L. annulata* from the Brazilian Amazon, Vitt (*op. cit.*) reported only small frogs, with mean prey length (29.9 ± 3.9 mm) and width (11.0 ± 1.4 mm) much smaller than the *L.* cf. *macrosternum* we observed (estimated body length = 80 mm; body width = 39 mm).

The *L. annulata* (CHBEZ 2631) was vouchered in the herpetological collection of the Universidade Federal do Rio Grande do Norte, Natal, Brazil. This study was supported by research grants from the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) to JSJ (process 107757/2010-9) and EMXF (process 309424/2011-9), and from the Coordernação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) to RFDS.



FIG. 1. Attempted predation by *Leptodeira annulata* on *Leptodactylus cf. macrosternum* in the Brazilian Caatinga.

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***MONTATHERIS HINDII* (Kenya Montane Viper). DIET.** *Montatheris hindii* is a small Kenyan viperid endemic to high altitude moorlands of the Aberdare Mountains and Mt. Kenya. Little is known about the natural history of this species although its diet consists of lizards and frogs, while small rodents have been suggested as prey (Spawls et al. 2004. A Field Guide to the Reptiles of East Africa. A & C Publishers Ltd., London. 543 pp.).

On 4 October 2011, during a small mammal survey in the Eastern Province of Kenya, Meru South District, Mt. Kenya National Reserve (00.16392°N, 37.44714°E, datum WGS 84; elev. 2980 m) an adult male *M. hindii* (total length = 299 mm; 16 g) was captured in a pitfall trap line. The pitfall line was situated in a transitional region between the upper montane forest zone and the Ericaceous zone along the eastern slope of Mt. Kenya. Vegetation in the immediate vicinity of the pitfall included tussock-forming grasses and herbaceous plants 0.5–1 m in height and this alpine grassland was bordered by a grove of *Hagenia abyssinica* trees ca. 100 m distant. While in the bucket trap, the snake had killed and half-consumed a *Sylvisorex granti mundus* (5.0 g; Fig. 1). The *M. hindii* was deposited at the National Museum of Kenya, Mammalogy Section (TCD 3374) and the *S. granti mundus* is a voucher at the Field Museum of Natural History - Chicago (FMNH 216941). This is the first record of *S. granti mundus* in the diet of *M. hindii*. However, because the event occurred in a pitfall trap, the importance of this species as prey for *M. hindii* remains unknown.

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FIG. 1. A *Montatheris hindii* consuming a *Sylvisorex granti mundus* in a pitfall trap in Mt. Kenya National Reserve, Kenya.

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***NERODIA FLORIDANA* (Florida Green Watersnake). DIET.** Although no diet studies have been completed (Gibbons and Dorcas 2004. North American Watersnakes: A Natural History. Univ. Oklahoma Press, Norman. 496 pp.), *Nerodia floridana* eat a wide variety of aquatic prey (Holbrook 2012. A Field Guide to the Snakes of Southern Florida. ECO Publ., Rodeo, New Mexico. 225 pp.). Though invasive species have the potential to cause harm to some species, there are cases where invasive fish have outcompeted native fish, increasing prey availability and ultimately benefiting watersnakes (*Nerodia* spp.) (King et al. 2006. Can. J. Zool. 84:108–115). During aquatic trapping efforts by the Center for Snake Conservation on 19 March 2012 in a tributary of Fisheating Creek, Glades Co., Florida, USA (26.909461°N, 81.329154°W; datum WGS84), a *N. floridana* (SVL = 595 mm) was accidentally drowned in an aquatic minnow trap. The snake contained a recently ingested *Hoplosternum littorale* (Brown Hoplo Catfish; total length = 110 mm). This is the first record of the native *N. floridana* feeding on this common nonnative species; however, it should be noted that several large *N. floridana* were encountered in the area, which supports dense populations of *H. littorale* (Center for Snake Conservation, unpubl. data). Both snake and fish were deposited together (FLMNH 166557) in the Florida Museum of Natural History Reptile and Amphibian (Herpetology) Collection.

PHOTO BY J.D. HOLBROOK



FIG. 1. *Nerodia floridana* with recently ingested non-native catfish, *Hoplosternum littorale*, from Glade Co., Florida, USA.

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***PANTHEROPHIS OBSOLETUS* (Texas Ratsnake). DIET AND FEEDING BEHAVIOR.** *Pantherophis* spp. are a frequently documented predator of bird nests (Weatherhead and Blouin-Demers 2004. J. Avian Biol. 35:185–190) and are known to frequently use arboreal habitats (Mullin et al. 2000 Herpetol. Rev. 31:20–22). During a study of nest predation in Mississippi Kites (*Ictinia mississippiensis*) in White River National Wildlife Refuge, Arkansas, USA, we documented, using time-lapse video, the simultaneous visit of an active kite nest, 24.8 m high, by two *P. obsoletus*. At 1610 h (CST) on 13 June 2009, a single *P. obsoletus* entered the nest, struck the brooding adult, which flew from the nest, and immediately began consuming one of the two nestlings. While the snake tried to swallow the nestling, it was pulled out of the nest by an adult kite. Later that night (2107 h), a single *P. obsoletus* entered the same nest, again flushing the brooding adult, and immediately bit and coiled around the remaining nestling, which it swallowed within minutes. Following the consumption of the chick, this snake continued searching the nest for additional prey. At this point (2129 h), a second *P. obsoletus* entered the nest and began searching the nest in a similar manner. Both snakes continued searching the nest until 2206 h, when both departed. We do not know if either snake in the nest at 2129 was the same individual pulled out of the nest earlier in the day.

Since 2005, studies in Arkansas have documented *P. obsoletus* consuming both eggs and nestlings of Mississippi Kites (Bader and Bednarz 2009. Wetlands 29:598–606), which represented a previously unrecorded prey item. Additionally, whereas simultaneous visits by *P. alleghaniensis* and *P. obsoletus* have been observed at nests close to ground level (Carter et al. 2007. J. Field Ornithol. 78:390–394; Kukal and Cox 2010. Herpetol. Rev. 41:371–372), to our knowledge our observation is the first to document such an event in the forest canopy. The context of this event generates questions related to the mechanisms used by *Pantherophis* to locate nests as well as the frequency and significance of such social interactions during foraging. As the use of video systems to study nest predation in birds increases (Cox et al. 2012. Stud. Avian Biol. 43:185–210), researchers may discover that social interactions during foraging are more common among snakes than previously known.

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***PANTHEROPHIS VULPINUS* (Western Fox Snake). PREDATION.** American Badgers (*Taxidea taxus*) are opportunistic feeders, and their diets include a number of small mammal species, a variety of reptiles, amphibians, birds, insects, and even fish (Hoodicoff 2003. Ecology of the Badger (*Taxidea taxus jeffersonii*) in the Thompson Region of British Columbia: Implications for Conservation. Univ. of Victoria, British Columbia. 126 pp.). On 7 July 2011, a *T. taxus* was observed depredating a nest of reptile eggs on Squaw Creek National Wildlife Refuge, Missouri, USA. The nest was located on the bank of a drainage ditch (40.1099°N, 95.2434°W; datum NAD83). Upon close inspection of the area after the badger retreated, several other excavated nest holes were located in the immediate vicinity. In total there were 220 exposed snake eggs and nine turtle eggs. Over 97% of the eggs had been depredated or were in poor (severely dented or smashed) condition. Six eggs were in moderate to good condition and were kept for incubation. All six eggs hatched and were identified as *Pantherophis vulpinus*. This represents the first known record of predation on *P. vulpinus* eggs by *T. taxus*.

We thank Mark Mills, Missouri Western State University, for assistance identifying the snakes. The findings and conclusions in this article are those of the author(s) and do not necessarily represent the views of the U.S. Fish and Wildlife Service.

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***PHILODRYAS NATTERERI* (Paraguay Green Racer). DIET.** *Philodryas nattereri* is a diurnal snake belonging to the family Dipsadidae and is widely distributed in the semiarid regions of Brazil. The diet of this species consists mainly of lizards, amphibians, birds, and small mammals (Vitt 1980. Pap. Avul. Zool. 34:87–98). Here we report the first documented predation of *Leptodactylus vastus* (Northeastern Pepper Frog) by *P. nattereri* and the encounter of a theraphosid spider in the snake's stomach contents.

An adult male *P. nattereri* (SVL = 845 mm) was collected alive in the Mocambinho community, City of Nossa Senhora de Nazaré, Piauí, Brazil (04.632667°S, 42.244694°W, datum SAD 69; elev. 117 m), on 04 July 2012 at 1630 h. During transport, the animal regurgitated its stomach contents, including a *L. vastus* and part of a theraphosid spider. We could not identify the species of spider because of its advanced digestion. We believe that the spider was preyed upon by the frog and some parts of the exoskeleton were released into the snake's stomach. The snake and stomach contents were deposited in the Coleção Zoológica Delta do Parnaíba (CZDP 0550) of Universidade Federal do Piauí-UFPI.

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***PITUOPHIS CATENIFER* (Gophersnake). DIET.** Of 2600 *Pituophis catenifer* specimens examined by Rodriguez-Robles (2002. Biol. J. Linn. Soc. 2002:165–183), 213 contained birds or their eggs. We herein provide the first verified report of *P. catenifer* preying on *Lanius ludovicianus* (Loggerhead Shrike) nestlings and eggs.

During a 2012 *L. ludovicianus* study we used remote-triggered wildlife cameras to monitor nests in southeastern New Mexico (Chaves, Eddy, and Lea counties). On 29 April 2012 a ca. 1.4 m (total length) *P. catenifer* was photographed at a nest located 1.7 m off the ground and initially containing six nestlings that were within a week of fledging (Fig. 1). The *P. catenifer* preyed on a nestling at ~2150 h and another at 2203 h. On 30 April 2012, a ca. 0.9 m (total length) *P. catenifer* was photographed eating *L. ludovicianus* eggs at 1345 h while being mobbed by both adult shrikes. The nest was located in a *Prosopis glandulosa* (mesquite tree) 1.1 m off the ground. The *P. catenifer* left after eating at least one egg; the female shrike continued incubation of the nest for the remainder of that day, according to subsequent images. The nest was empty the following day, suggesting that the *P. catenifer* may have returned during the night of 30 April 2012 (the camera on this nest was not capable of infrared nighttime photography).



FIG. 1. A *Pituophis catenifer* preying on a nestling *Lanius ludovicianus* in New Mexico.

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***SISTRURUS CATENATUS CATENATUS* (Eastern Massasauga). DIET.** On 23 July 2012, at 2233 h, an adult female *Sistrurus catenatus catenatus* (SVL = 61 cm) was found on a road in the Magnetawan First Nation, Ontario, Canada, after being struck and killed by a vehicle. The snake had several feathers protruding anterior to the cloaca and a necropsy revealed two outer remiges (primary flight feathers) and several down feathers in the posterior portion of the gastrointestinal tract. In light of the time of year, location and surrounding habitat, coloration and vane width of the feathers, the bird was identified as a female Red-winged Blackbird (*Agelaius phoeniceus*). Based on the lengths of the two outer remiges (64.3 and 65.8 mm), we concluded that the bird was an adult female (average remige length for adult female *A. phoeniceus* is 67.0 mm, whereas average remige length for fledglings is 44.5 mm; Holcomb and Twiest 1968. Ohio J. Sci. 68:277–284).

Overall, *S. c. catenatus* is thought to be an ambush predator that preys upon small animals found within its wet habitat (swamps, marshes, bogs, fens, floodplains, and woods). The diet of adults predominately consists of small mammals (shrews, voles, and mice), but they are also known to consume crayfish, centipedes, insects, fish, amphibians, lizards, snakes, birds, and carrion (Ditmars 1908. The Reptile Book. Doubleday, Page and Company, New York. 472 pp; Ernst and Ernst 2011. Venomous Reptiles of the United States, Canada and Northern Mexico. John Hopkins Univ. Press, Baltimore, Maryland. 352 pp.; Rubio 2010. Rattlesnakes of the United States and Canada. ECO Herpetological Publishing & Distribution, Rodeo, New Mexico. 307 pp.). *Agelaius phoeniceus* are common in wet, marshy areas but may rarely be encountered by an ambush predator like *S. c. catenatus*. Keenlyne and Beer (1973. J. Herpetol. 7:383–384) found that a *S. c. catenatus* in Wisconsin fed upon a fledgling *A. phoeniceus*; however, the fledgling blackbird was only one of 91 food items found. Our observation represents the first record of *S. c. catenatus* feeding on an adult *A. phoeniceus*.

We thank Chris Blomme and the Laurentian University Vertebrate Museum for their consultation and insight. Jenn Baxter-Gilbert, Sean Boyle, Ron Maleau, and Chris Neufeld assisted in the field. Financial support was provided by Magnetawan First Nation, Laurentian University, the Ontario Ministry of Natural

Resources, and the Ontario Ministry of Transportation. All research was conducted under an approved Laurentian University Animal Care Committee protocol, and authorized by Magnetawan First Nation's Chief and Band Council and the Ontario Ministry of Natural Resources.

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***STORERIA DEKAYI* (Dekay's Brownsnake). DIET.** *Storeria dekayi* is a small natricine snake of the eastern United States that feeds primarily on slugs and earthworms. Slug species reported to have been consumed by *S. dekayi* include *Arion hortensis*, *Deroceras laeve*, and *D. reticulatum* (Judd 1954. Copeia 1954:62–64; Fitch 1999. A Kansas Snake Community: Composition and Changes over 50 Years. Krieger Publ. Co., Malabar, Florida. 165 pp.); earthworms have not been identified to either genus or species. In addition to its preferred prey, *S. dekayi* has also been reported to consume snails, insects, isopods, mites, spiders, small fish, and amphibians (Judd, *op. cit.*; Wright and Wright 1957. Handbook of Snakes of the United States and Canada, Vol. 2. Cornell Univ. Press, Ithaca, New York. 441 pp; Langlois 1964. Ohio J. Sci. 64:11–25). Herein I report observations regarding the diet of *S. dekayi* from western Pennsylvania, USA, including the inaugural documentation of millipedes as a food item, as well as the first account specifically identifying *Lumbricus rubellus* (Red Marshworms) as having been consumed by *S. dekayi*.

While studying a population of *S. dekayi* at a site along the Hwy 832 bridge in Erie Co., Pennsylvania, USA (42.09375°N, 80.14180°W; datum WGS84), several observations were made regarding the species' diet. At 1950 h on 24 August 2012 a juvenile female *S. dekayi* (SVL = 145 mm; 2.5 g) was discovered under a panel of particle board on a slope dominated by herbaceous vegetation. While being measured, the snake disgorged the following slugs: *Arion hortensis* complex (N = 1), *Arion* sp. (N = 1), *Deroceras* sp. (N = 2), and one unidentified slug. Also disgorged were two millipedes of the order Julida. The combined mass of the prey items was 0.12 g.

Between 31 May 2012 and 19 September 2012, dietary data were gathered from an additional eight *S. dekayi* (SVL = 114–225 mm; 1.5-7.5 g). Two *S. dekayi* had each consumed a single *L. rubellus*, while another disgorged an unidentified earthworm. The remaining five *S. dekayi* had consumed slugs, three each disgorged a single slug: *Arion* sp., *Deroceras* sp., and *D. reticulatum*, respectively. The remaining two *S. dekayi* regurgitated multiple slugs: one disgorged three *D. reticulatum*, the other disgorged two *Arion* sp., one *Deroceras* sp., and an unidentified slug.

Of the nine *S. dekayi* that disgorged prey, seven were found between 1838–2000 h. Three of these snakes disgorged prey that were still alive; two slugs and a *L. rubellus*. Ernst and Ernst (2003. Snakes of the United States and Canada. Smithsonian Books, Washington, DC. 668 pp.) noted that *S. dekayi* forage most often in the early evening or at night. The fact that live prey was disgorged in the evening suggests that this may be the case at the Erie Co. site as well. The remaining two *S. dekayi* were found in the morning between 0921–1124 h and only contained dead prey.

To my knowledge, this is the first report of millipedes in the diet of *S. dekayi*. The millipedes consumed by the *S. dekayi* captured on 24 August might have been consumed incidentally. Mucus secreted by *Arion* slugs during routine handling was especially sticky (pers. obs.). Millipedes were plentiful under cover objects with slugs and snakes, and it is foreseeable that nearby invertebrates could adhere to a slug being manipulated during predation. It is possible that the remains of insects and mites observed by Judd (*op. cit.*) might have also been ingested accidentally. Although earthworms have previously been reported in the diet of *S. dekayi*, this is the first report specifically identifying *L. rubellus* as a prey item. *Lumbricus rubellus* is a European exotic earthworm usually found in surface litter or under debris (Reynolds 1977. The Earthworms [Lumbricidae and Sparganophilidae] of Ontario. Life Sci. Misc. Publ., Royal Ontario Museum, Toronto, Canada. 141 pp.). Like *L. rubellus*, the slugs (*Arion* sp. and *D. reticulatum*) consumed by *S. dekayi* at the Erie Co. site were European exotics. Although it was not possible to identify most of the disgorged *Arion* slugs to species, *A. subfuscus* was the most prevalent species found at the site. Likewise, *D. laeve* was found at the site in very small numbers, while *D. reticulatum* was much more abundant. Snakes were released at the site of capture; prey items were preserved and will be deposited in the invertebrate collection of the Natural History Museum at the Tom Ridge Environmental Center, Erie, Pennsylvania, USA.

I wish to offer my gratitude to both Jeff Beane and George Pisani for suggestions and comments that improved the manuscript.

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***ZAMENIS SITULA* (Leopard Snake). DIET AND FEEDING BEHAVIOR.** On 22 August 2012, at 0053 h, one of us (PC) observed an adult female *Z. situla* (SVL = 590 mm; tail length = 140 mm; 52 g) preying on a subadult *Mus musculus* (House Mouse). The observation took place on a roadside separated from an olive grove by a blackberry bush, ca. 1 km SW of the town of Cavallino, Lecce Province, southeastern Italy (40.30°N, 18.18°E, datum WGS 84; elev. 41 m). The snake was not preserved, but its morphological examination leaves no doubt as to its specific identity (2 pre-ventrals + 231 ventrals, anal scale divided; 75 subcaudals, divided except for the first six; pupil round; dorsals smooth, vertebral row not enlarged; 25 dorsal scale rows at midbody; 8 supralabials on each side, 4^{th} + 5^{th} contacting the eye; 9 infralabials, 1 loreal, 1 preocular and 2 postoculars on each side; spotted dorsal pattern). The snake was released at the place of capture and the mouse was deposited in the collections of the Museo di Storia naturale del Salento. Rare and poorly known, *Z. situla* is reputed to be diurnal or occasionally crepuscular (Fattizz 1996. Anfibi e Rettili della Penisola Salentina. Physis Ed., Latiano. 125 pp.; Rugiero et al. 1998. J. Herpetol. 32:626–630). Our observation seems to represent the first reported case of nocturnal feeding by this snake in the wild.

We thank Antonio Durante (Cavallino) for his hospitality during our field work.

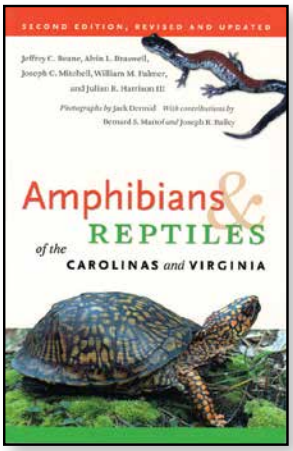
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BOOK REVIEWS

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Amphibians and Reptiles of the Carolinas and Virginia, 2nd edition

Jeffrey C. Beane, Alvin L. Braswell, Joseph C. Mitchell, William M. Palmer, and Julian R. Harrison III, with photographs by Jack Dermid. 2010. The University of North Carolina Press, Chapel Hill (www.uncpress.unc.edu). 274 pp. US $26.00. Softcover. ISBN 978-0-8078-7112-6/ Hardcover. US $56.00. ISBN 978-0-8078-3374-2.



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The sight of an amphibian or reptile manifests a curiosity that is usually expressed through two questions: "what is it" and "what does it do?" For the person who knows what "it" is and does, the sighting raises other questions about whether or not the observation is normal regarding its appearance, location, seasonal activity, reproduction and other aspects the animal's natural history. Rarely is an informed individual present to answer those questions. Instead, guides that summarize the fauna of geographic regions and provide summary natural history data serve as vicarious experts to a state's citizenry, and to that purpose *Amphibians and Reptiles of the Carolinas and Virginia* is exemplary.

The book's format is standard for a regional summary. The introduction is only eight text pages long, without subheadings, but manages, in that short space, to inform the reader about the scope of the book. It outlines the herpetofaunal diversity of the covered area in a passionless two-page summary of taxonomy and nomenclature and continues with discussions of introduced species and conservation (with an unfortunate emphasis on "listings"). There is an admonition to be careful and conservation-minded when searching for and collecting animals, laws regulating take are mentioned (although no specific rules are detailed), and there is a reserved discussion of pet-keeping. The format and arrangement of species accounts are presented, clues useful in identifying animals are provided, and there is a solicitation of new records. Finally, there is a caution about snake bites (but no suggestions about what to do when bit).

The physical characteristics of the Carolinas and Virginia are described (eight pages of text, a map, and seven photographs of habitat) through discussion of physiographic provinces, characteristic vegetative associations, and climate. Another eight pages discuss the history of herpetology in the region. This section has the liveliest prose in the book. It begins with 16th century reports of the fauna, the serendipitous advent of 18 th and 19 th century resident naturalists, followed by the arrival in each state of one or more individuals whose observational skills and prolific writing form the foundation for continued research in the Carolinas and Virginia.

A list of the native and non-native species of amphibians and reptiles separates the introductory material from the species accounts. Classic generic assignments are retained, with current generic names listed in parentheses (e.g., *Eumeces* (*Plestiodon*) *fasciatus*). Each class, order, and suborder receives about one page of descriptive material that characterizes each from a global perspective. Each species account is likewise brief. The amount of text for each account, with few exceptions, appears to be governed by the amount of space available on a single page that also must accommodate a color photograph and range map. Where additional space is required for text, the size of the photographs suffer (e.g., *Bufo americanus*). The species text includes a description, comparison with similar species, description of geographic range and habitat, food (for some species), reproductive data, and conservation status. Description of calls are provided for anurans. All of the information is provided in a little over 200 words per species. Few species are illustrated by more than one photograph, and there is rare mention of subspecies. Species accounts are followed by a thorough glossary, 52 literature references, and a dozen websites for private organizations, museums and universities.

A notable inconsistency in the book is the difference in which species distributions are displayed on the maps. Those for North Carolina are the most precise, portraying a minimal known range, but those of South Carolina and Virginia often appear over generalized and stop abruptly at the North Carolina borders (e.g., *Plethodon cinereus, Lampropeltis triangulum*). I was curious about the discontinuity in ranges of some species (e.g., *Hyla gratiosa, Pantherophis guttatus*) in northern North Carolina, but found no explanation. The color photographs are excellent. Characteristic markings and morphological features for most species are evident, highlighted for example by photographer Dermid's clever means of showing the color pattern of the inner thigh on *Hyla femoralis*, and his positioning of *Rana catesbeiana* and *R. grylio* to compare extent of the hind-foot webbing between the two species. For a few, however, diagnostic markings are not portrayed, such as the long neck, broad forearm bands and striped "pants" of *Deirochelys*.

For those familiar with the first edition of *Amphibians and Reptiles of the Carolinas and Virginia* (Martof et al. 1980), I provide the following comparisons. The number of species has increased from 159 to 189, nearly all through the discovery of cryptic salamander species. Except for three plethodontid species complexes, the second edition provides equal coverage for the new species that have been added during the span of 30 years, and the new species are illustrated by high quality, diagnostic photographs. The range maps show greater detail of distribution, primarily by reducing the broad-brush display of the first edition. The text size is smaller in the second edition, and is presented as two columns, allowing more text to be packed in per page. Some wording is changed (e.g., hellbenders are described as "ugly, slimy and large" in the first edition, vs. "impressive" in the second). The

second edition introduces the term "biodiversity" and has eliminated the first edition's statement that amphibians and reptiles "do well in captivity and make amusing pets." Standard photograph size is 10.5 × 7 cm in the first, vs. 10 × 6 cm in the second edition. Most of Dermid's photographs are retained in the second edition, including some new ones. However, several dozen have been replaced, I suppose to better portray diagnostic features. The new *Rana palustris* photo shows the bright yellow undersurface of the tibia, but the paired, square dorsal blotches are better featured in the first edition. The new *Rana sphenocephala* photo is more typical in coloration of the species, though the characteristic white tympanic spot is obscure.

Except for the history chapter, the book is devoid of personality despite (or perhaps because of) being authored by seven individuals. The text has been masterfully crafted to eliminate all excess wording, and is concisely informative about each topic the authors have elected to cover. It presents a lesson in being succinct—descriptive biology in the form of "one-liners." The citizens of the Carolinas and Virginia can now arm themselves with an updated, highly portable means of identifying and learning about that which creeps or slithers into their comfort zone.

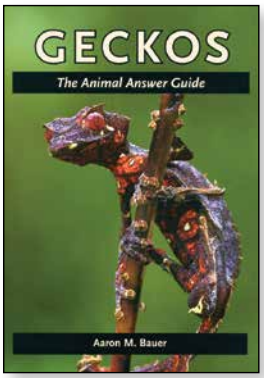
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Geckos: The Animal Answer Guide

Aaron M. Bauer. 2013. Johns Hopkins University Press, Baltimore, Maryland. Softcover. xiv + 159 pages. US $26.95. ISBN 978-1-4214-0852-1.



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This is a fantastic book. Anyone who has had the pleasure of hearing author Aaron Bauer give a lecture will find here that he can write in the same manner—eloquent, clear, easy to understand, yet packed with information. I could hear Aaron's voice in my head while I read this book. As the introductory pages make clear, this book is not a husbandry guide for pet enthusiasts because there are plenty of those available. Nonetheless, there are frequent mentions of topics central to the interests of pet enthusiasts and this book will be well valued by the burgeoning ranks of people keeping geckos as pets, as well as any general naturalist, and all persons interested in herpetology at any level. Honestly, I don't personally know a whole lot about geckos and I learned quite a bit from this book. For example, I have worked a bit with *Thecadactylus rapicauda* in the field for about 20 years, and learned from this book that they parachute between branches, using their extensively webbed feet. Bauer has a gifted approach here that is fully readable by enthusiasts of almost any age and background, yet he includes depth in his text that will inform the practicing comparative biologist. That is not an easy balance to achieve in writing, and Bauer got it impressively right in this book.

The question-and-answer format of the Johns Hopkins Press *Animal Answer Guide* series veers this book refreshingly away from a standard textbook format, yet the organization and well prepared index make information easy to find. The book has handy internal references, to guide readers to related topics appearing in other sections of the book. The style of the book does not allow for traditional academic in-line literature, but a suitably complete bibliography appears at the end. An unusual chapter entitled "Geckology" reviews the history of scholarly study of geckos. This is a very nice nod to the tradition of science that could well encourage a young herpetologist to explore the academic literature. Similarly, an appendix includes the names of virtually all relevant professional societies and journals. I would have greatly benefitted from a list like this when I was first trying to navigate the academic world while in high school. Another scholarly nod is the index including the current taxonomy of geckos, nicely including their IUCN Red List rankings. The chapter on geckos in human culture has far more depth than the after-thought feel that similar chapters in other books often have. Similarly, I greatly appreciated the double perspective approach used to treat the topics of "influences of geckos on humans" and "influences of humans on geckos" as I found it refreshingly original and perfectly balanced. These sorts of attentions are testament to Bauer's evident attempts to positively encourage gecko enthusiasts toward the basic academic efforts that inform this very book. Bauer is being inclusive here, and clearly wants everybody to feel like they can join and contribute to the fascinating world of discovering the mysteries of geckos. This is a gracious approach that really allows this book to bring very technical information across to every interested reader. A particular jargon-packed sentence here or there may serve to make the reader want to learn more, rather than dissuade anyone. As a singular example, I will point to the concise and perfectly accurate summary of the different types of squamate chromatophores and pigments presented on page 42. I've never seen this admittedly complex topic better simplified and summarized, with no loss of basic information; very impressive. I nominate Aaron Bauer to write an *Animal Answer Guide* for every major clade of reptiles and amphibians, and then we will collectively have the ultimate useful textbook for our herpetology courses, and one that the students will actually read.

The production values are generally excellent. I found no spelling typos, and only a handful of awkward spacing/justification issues. Assumedly to keep prices affordable, most images appear in black-and-white, with two sets of well-chosen color plates to highlight certain appropriate taxa. Images are credited to many photographers, but those by Tony Gamble and Lee Grismer really stand out as especially well composed. A few of the black-and-white images are a bit dark and the image discussing the camouflage value of green coloration in *Nautilinus grayi* does not work well in black and white imagery. The image of the inverted hemipenis is well lit, but its close-in perspective makes it a bit disorienting; a related image of the cloacal spur in males of some species (described well in the text) would have been a useful addition. But overall, the black and white images are perfectly suitable to their task. The only information gap I found was in the excellent section describing vision and structure of the eye. I fully thought we were leading into a description of the functional difference between circular and elliptical pupils, but I didn't see it. But I did see a great summary of the function of rod

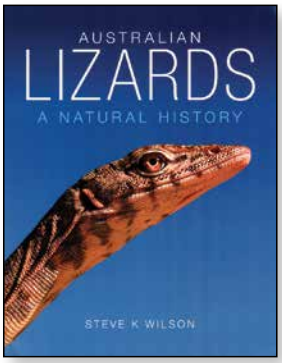
and cone cells in squamates, and I learned for the first time that geckos see in color at night!

What really permeates this book is Bauer's life-long passion and experience with the geckos of the world. No one else could have written this book with both the top-tier academic authority and also the in-hand love of geckos that Aaron Bauer has. His first-hand experiences, his knowledge, and his admiration for the incredible animals make this book ultimately readable for the broadest range of audiences. This is a fine piece of work and I am really glad I read it in its entirety. While Bauer works on the companion volumes for the remaining clades, I strongly recommend this book for everyone, at any level of interest. No matter which taxa you claim to study, go read this book.

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Australian Lizards—A Natural History

Steve K. Wilson. 2012. CSIRO Publishing, Collingwood, Victoria, Australia (in USA and Canada distributed by Stylus Publishing; www.styluspub.com). x + 196 pp. Softcover. AUS $49.95 (approx. US $46.00). ISBN 9780643106406.



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"Lizards are juicy and nutritious" begins Chapter 6 of this new book on Australian lizards. Not since Edgar Waite's (1929) description of geckos as "soft and flabby to handle" have I appreciated a herpetological turn of phrase this much!

This may look like a picture book, but it is so much more. Steve Wilson is known for his excellent photographs of reptiles and amphibians (e.g., Wilson and Knowles 1988; Wilson 2005; Wilson and Swan 2010) and this book does not disappoint. More than 400 color photos strikingly capture the diversity of the Australian lizard fauna. In addition to standard portraits, there are many "action shots" of lizards eating arthropds, arthropods eating lizards, lizards hatching and being born, threatening, thermoregulating, and mating. Throughout the photos are of good to excellent quality. There are great photos of *Pygopus* feeding on a spider (p. 116), various lizards copulating (p. 143–145), a Central Military Dragon (*Ctenophorus isolepis*) caught in the act of defecation (p. 133), and a Garden Skink (*Lampropholis delicata*) with an unimaginable mite load (p. 100).

A photo of fighting male *Nebulifera robusta* (p. 142) dramatically shows off the gekkotan ability to withdraw the eye deep into the socket and examples of geckos (*Diplodactylus conspicillatus*, *D. tessellatus*) using their tails in defensive postures (p. 107) are striking. Of special note are a series of photos illustrating camouflage in geckos and agamids (pp. 94–96); that of *Phyllurus platurus* shows one of the best color matches to substrate I have ever seen (p. 94). I am especially impressed by the photos of limbless and reduced-limbed taxa. These can look like so many pieces of spaghetti, but Wilson has brought out their character, and the diversity of these forms, especially *Lerista*, can really be appreciated.

Come for the photos, stay for the text; it is well-written, detailed without being off-putting to non-specialists, and it serves as a crash course in Australian lizards, their diversity and biology. Although the title of the book is rather similar to Greer's (1989) *The Biology and Evolution of Australian Lizards*, Wilson's book has much more in common with Greene's *Snakes, The Evolution of Mystery in Nature* (1997) or Pianka and Vitt's *Lizards, Windows to the Evolution of Diversity* (2003). Greer's book is a treasure trove of information for herpetologists, a concise summary of data on Australian lizards, but this book is aimed at a more general audience. It is a "gateway" book—the kind that can really spark the interest of budding herpetologists, or even convert the non-herpetologically inclined. I defy anyone with even the slightest interest in the natural world not to be interested in Australian lizards by the time they finish the book.

The book is organized topically rather than taxonomically. After "Meet the Lizards," an introduction to diversity, the book is arranged into chapters such as "Senses: sight, scent and sound," "How lizards manage their water," and "The fate of Australian lizards." The last of these discusses the effects of cane toads and fire ants on lizards, as well as the more familiar and universal issues of changing land use and habitat loss. A series of somewhat more detailed sidelights are presented as "boxes." One deals with the rediscovery of the Pygmy Blue-tongue skink, *Tiliqua adelaidensis*, in 1992 and another with the Pedra Branca Skink, *Niveoscincus palfreymani*, Australia's southernmost totally terrestrial vertebrate, which lives on a tiny rock in the Southern Ocean. Yet another is devoted to the origin of the names "wood adder" and "stone adder" for certain species of *Diplodactylus* geckos. I will leave it to readers to discover the source.

Although the emphasis is definitely Australian, there are a few non-Australian taxa shown or discussed (e.g., *Phrynosoma* and *Furcifer* to illustrate lingual feeding). Taxonomy is as up to date as can be for the local taxa—several new Australian genera that were proposed in 2011 and 2012 (*Uvidicolus*, *Nebulifera*, etc.) are used. However it is less current for some extralimital taxa. For example, *Cnemidophorus uniparens* is used instead of *Aspidoscelis* (p. 147). Typos and misstatements are few and far between in this book. I noted only a few instances each: *Sceloporus poinsettia* is misspelled *poincettii* (p. 64), Mertens' Water Monitor is rendered as Merten's (p. 167), the number of Australian varanid species, given as 27, is said to be "about half of the world's total" (p. 8), but the current tally for varanids is actually 73, *Rhacodactylus* (now *Correlophis*) *ciliatus* can regenerate their tails (contra p. 98), although they often do not, and, in the glossary, the term "pleurodont" is incorrectly defined as an attachment type in which teeth are "set in sockets."

Unfortunately for those whose interests are piqued by particular topics, there are no citations in the text itself, making it difficult to track sources for specific information. However, the references section contains about 215 entries representing a diversity of sources up through 2011, so there is an access point into the literature. Interestingly, although some more general works are included among the technical papers listed, the ultimate classic of Australian herpetology, Cogger's *Reptiles and Amphibians of Australia* (2000) is not. The book concludes with a single index combining common names, scientific names and major subjects.

This book is an ideal gift for any novice herpetologist—in Australia or not. It is also appropriate for any Australian or visitor to Australia who wants to better understand the natural world. Even seasoned herpetologists, familiar with all of the topics discussed, will find new appreciation for Australian lizards through the stunning images.

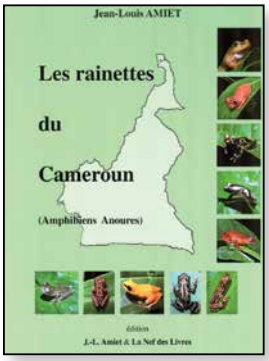
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Les Rainettes du Cameroun (Amphibiens Anoures)

Jean-Louis Amiet. 2012. Edition J.-L. Amiet, Nyons & La Nef des Livres, Saint-Nazaire, France (www.librairielanefdeslivres.fr). 591 pp. Hardcover. 98,00 Euros (approximately US $126.00). ISBN 978-2-7466-4413-7.



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Students working on amphibians of western Equatorial Africa have been spoiled in recent years. Right after the publication of an identification key to the amphibians of Gabon and Equatorial Guinea (Frétey et al. 2011), here is a remarkable book on the treefrogs of Cameroon. It is authored by the French biologist Jean-Louis Amiet, who vies with the Swiss Jean-Luc Perret the title of the best and most productive specialist on Cameroon amphibians. Jean-Louis Amiet is not only an amphibian specialist, he is a living encyclopedia with an extensive knowledge and active research activities on the flora and fauna of tropical Africa. This new, voluminous, solidly bound book, entirely in French, is divided into four main parts: general remarks (pp. 9–50, including a key to genera, an introduction to the physical geography of Cameroon with 26 beautiful landscape photographs, and a methodology section), hyperoliid treefrogs (pp. 51–431), the genus *Leptopelis* (pp. 433–562), and finally a chapter on poorly known species and under-prospected geographical areas (563–569). The literature section (pp. 571–576) includes 150 references, 31 of them authored or co-authored by Amiet, the most recent dating from 2009. Taxa covered belong to the Arthroleptidae (*Leptopelis* Günther, 1859) and Hyperoliidae (*Acanthixalus* Laurent, 1944, *Afrixalus* Laurent, 1944, *Alexteroon* Perret, 1988, *Arlequinus* Perret, 1988, *Cryptothylax* Laurent & Combaz, 1950, *Hyperolius* Rapp, 1842, *Kassina* Girard, 1853, *Opisthothylax* Perret, 1966, and *Phlyctimantis* Laurent & Combaz, 1950). The rhacophorid treefrogs *Chiromantis* (represented in Cameroon by *C. rufescens* (Günther, 1868)) were not included "in order to preserve the taxonomic homogeneity of the opus." In total, 62 species are covered, among them 24 *Hyperolius* spp. and 16 *Leptopelis* spp., i.e., a bit less than a third of the ca. 200 amphibian species currently known from Cameroon.

Species accounts systematically include references to the original description and sections on adult morphology, pattern and color, sexual dimorphism, eco-ethology, and distribution. Depending on the species, some accounts also include sections on tadpole morphology, parasitism, taxonomic issues, or phylogenetic relationships. Each species account is illustrated by one or two plates of color photographs taken by Amiet (with the exception of the photograph of *Afrixalus schneideri* [Boettger, 1889], in black and white and taken by Perret—this is the only species that is not illustrated alive in color in the book), one or two plates showing superb drawings made by Amiet (dorsal patterns, webbing, tadpole, vocal sacs, etc., depending on the species), activity cycle graphs, and a point locality distribution map. In all there are 667 photographs of live individuals, with up to ten individuals per photograph. The distribution maps, limited to Cameroon, also show the major vegetation zones and the areas above 600 m asl. Illustrated identification keys to *Hyperolius* and *Leptopelis* species are provided, as is comparative table for *Alexteroon* spp. that can be used as a key.

Attention should be drawn to some taxonomic points presented in the opus, especially because some some of them might be overlooked by non-French speaking readers. Amiet describes a new subgenus of *Afrixalus*, *Laurentixalus* Amiet, 2012 with *Afrixalus laevis* (Ahl, 1930) as type-species. It is said to include, besides the type-species, *A. lacteus* Perret, 1976, *A. dorsimaculatus* (Ahl, 1930) and *A. uluguruensis* (Barbour & Loveridge, 1928). Amiet makes a detailed comparison between *Leptopelis aubryi* (Duméril, 1856) and *L. spiritusnoctis* Rödel, 2007, concluding that they are synonymous. He regards *Hyperolius dintelmanni* Lötters & Schmitz, 2004 as a subspecies of *H. tuberculatus* (Mocquard, 1897). He retains *Hyperolius pallidus* Mertens, 1940 as a subspecies of *H. nitidulus* Peters, 1875, and maintains *Chlorolius* Perret, 1988 as a subgenus of *Hyperolius*. He treats *Phlyctimantis boulengeri* Perret, 1986 as a subspecies of *P. leonardi* (Boulenger, 1906) and regards *Leptopelis occidentalis* Schiøtz, 1967 as a subspecies of *L. boulengeri* (Werner, 1898). In the species account of *Leptopelis brevirostris* (Werner, 1898), Amiet merely suggests that the tympanum-less *Leptopelis crystallinoron* Lötters, Rödel & Burger, 2005, which he says is known from a single female, might be just an aberrant specimen of the former species, while later in the book (p. 515) he unambiguously treats them as synonyms. The synonymy had already been noted by Frétey et al. (2011) who mentioned their resemblance and referred to a personal communication by Amiet who had informed them that he had seen a *L. brevirostris* that was missing a tympanum on one side of its head. Both Frétey et al. (2011) and Amiet (2012) seem to have been unaware of the additional morphological differences

explained in the original description and the rediscovery of that species by Bell et al. (2010; see Pauwels and Chirio 2012). Amiet regards *Leptopelis macrotis* Schiøtz, 1967 as a subspecies of *L. millsoni* (Boulenger, 1895). The book additionally makes corrections to mistakes made in the literature, by Amiet himself or by others, especially with respect to species identifications.

The text of this new book is fluid, pleasant to read, and there are few typographical errors. It has two exceptional qualities. First, it is abundantly illustrated with drawings (about 900!), graphs, and color plates. The drawings are exceptionally accurate. They represent a huge effort; for example, drawings of foot webbing each required about six hours of work (Amiet, pers. comm., May 2013). All photos are outstanding, and they were all taken in Cameroon (their localities and dates are provided in an appendix). Morphological and pattern variations are well represented. Unusually-patterned specimens are shown as well, but they are always clearly indicated as such in the figure captions (the exceptional nature of these specimens could be overlooked by non French speaking readers).

Second, the book suggests numerous directions for future research. Several populations potentially representing new species or subspecies are discussed in detail, with photographs of representatives of these (Manki *Hyperolius riggenbachi* (Nieden, 1910), Mount Cameroon *Kassina* cf. *maculosa* (Sternfeld, 1917), *Leptopelis* cf. *bocagii* (Günther, 1864), *L.* cf. *christyi* (Boulenger, 1912), Mwandong *L.* cf. *modestus* (Werner, 1898), Lena *L.* cf. *notatus* (Buchholz & Peters, 1875), and many others), and all the available information that could help to locate the additional specimens that will eventually allow their taxonomic status to be resolved. Under-prospected areas that might reveal interesting records are listed. Amiet has literally spoon-fed future batrachologists and professors in need of subjects for their students the descriptions of numerous frog taxa. Hopefully this will be capitalized upon. Jean-Louis Amiet is currently working on botanical publications and will then work on butterfly publications before working again on amphibians (Amiet, pers. comm., May 2013); one will thus have to curb one's impatience to see the next publications of Amiet on Cameroonian amphibians. In the meantime, we encourage scientific libraries, batrachologists, and students to acquire and exploit this remarkable and beautiful book.

Acknowledgments.—We are grateful to Jean-Louis Amiet (Nyons) and Thierry Frétey (Médréac) for providing useful information and literature, respectively, and to Yves-Marie Allain of La Nef des Livres for sending a review copy of the book.

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ERRATUM—The geographic distribution note by Martins et al. concerning *Hydromedusa tectifera* in Brazil (2011. Herpetol. Rev. 42:389) contained inaccurate geocoordinates. The correct coordinates, based on Google Earth data, are: 20.25°S, 46.54°W; elev. 1400 m.



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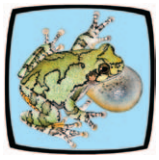
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All members of the SSAR are entitled to vote by mail ballot for Society officers, which allows overseas members to participate in determining the Society's activities; also, many international members attend the annual meetings and serve on editorial boards and committees.

All members and institutions receive the Society's primary technical publication, the *Journal of Herpetology*, and its bulletin, *Herpetological Review*, both are published four times per year. Members also receive pre-publication discounts on other Society publications, which are advertised in *Herpetological Review*.

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2013 — Albuquerque, New Mexico, 10–15 July (JMIH with ASIH, HL, and AES)
2014 — Chattanooga, Tennessee, 30 July–3 August (JMIH with ASIH, HL, and AES)
2015 — Lawrence, Kansas 30 July–3 August (SSAR with PARC and KHS)

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WELCOME LETTER FROM THE NEW SSAR PRESIDENT
ROBERT D. ALDRIDGE


PHOTO BY LINDA ALDRIDGE

It is a recent tradition for new presidents of SSAR to introduce themselves to the membership and to give some sage advice to its younger members. I was born at home in south St. Louis, Missouri, the fourth child of five. I attended St. Anthony's grade school and St. Mary's high school. As a child, I was fascinated with amphibians and reptiles, especially snakes. In the city of St. Louis there were populations of Dekay's brownsnake (*Storeria dekayi*) and the lined snake *(Tropidoclonion lineatum*). I joined the Boy Scouts of America at a young age, primarily for the camping trips and other opportunities to get out of the city. I remained active in the scouts for years and achieved the rank of Eagle Scout.

Following graduation from high school, I enrolled at the University of Missouri, Columbia. After telling my advisors of my interests, they recommended that I enter the Forestry school because snakes are found in the woods. I eventually enrolled in the wildlife program.

The highlights of my undergraduate education were summer jobs with the United States Fish and Wildlife Service. In the summer of 1965, I worked at the Mark Twain National Wildlife Refuge in Grafton, Illinois and the following year at the Upper Souris NWF in North Dakota. In both jobs I worked primarily on banding and censusing wildfowl, but I did manage to make lists of the amphibians and reptiles present. I then enrolled in the Master's of Arts Biology program at the University of Missouri. I was Dr. Dean (Doc) Metter's first graduate student. For my thesis, I worked on the reproductive biology of the Western Wormsnake (*Carphophis vermis).* I completed my MA in 1969 and enrolled in the Ph.D. program at the University of New Mexico. I was one of six graduate students who worked in the Museum of Southwestern Biology under the mentorship of Dr. William Degenhardt. My dissertation research at UMN was on the reproductive cycles of the Prairie Rattlesnake (*Crotalus viridis*) and the Glossy Snake (*Arizona elegans*).

Following graduation, I was hired by Saint Louis University in 1973 and I begin my 41st year there this summer. Throughout my years at SLU, I have been fortunate enough to pursue my childhood passion and study the biology of amphibians and reptiles. Although much of my data comes from museum collections, I have had the opportunity to do extensive fieldwork in the various parts of the US, Mexico, and Guam. I have published over 50 articles on reproductive biology and morphology of amphibians and reptiles and recently co-edited, with David M. Sever, the *Reproductive Biology and Phylogeny of Snakes* (Science Publishers, Inc., Enfield, NH).

In July, SSAR will have its 56th annual meeting at UNM in Albuquerque. I look forward to reuniting with Bill Degenhardt and many of the graduate students with whom I shared so much at UNM.

My Service to SSAR

My first position in SSAR was Translations Coordinator (1978–1990). I was responsible for making available to the membership translations of important scientific papers and arranging for the translation of scientific papers. From 1988 to 2001, I served as Publications Secretary and from 1997 to 2001 I also served as Treasurer. I was elected President-elect in 2012 and now serve as President (2013–2114). I feel that my service to SSAR is really a privilege for me. I get to work with many dedicated individuals who also appreciate the importance of professional societies and share an appreciation for amphibians and reptiles. To paraphrase a colleague on the importance of meetings: I have several friends, very close friends, that I met because we share a common interest and passion for amazing fishes, amphibians, and reptiles. At meetings, I always learn new things, I meet young students who are our "lifeblood." We will only persist as a society if we bring young people into our organizations. The price of membership is unimportant compared to the value of my friendship with other professionals because those friendships are priceless.

Threats to Professional Societies

I believe the greatest threat to science today is the demise of national/international professional societies. This is not unique to herpetological societies. Professional societies rely on membership to publish journals, host meetings, etc. All of the officers and editors are volunteers. These people are dedicated to this effort because they believe in the importance of a peer-reviewed journal. Members belong to societies primarily to get these publications.

The advent of electronic journals has its value, but also some negative aspects. Some groups feel it is important to make all herpetological material available for free. In an ideal world SSAR would like this also. But in reality, there are expenses associated with publishing a professional journal, sponsoring meetings, providing student research and travel support, publishing books, etc. Individual memberships in societies account for the majority (>50%) of the income. If the content of journals is posted for free, there is little incentive for people to become members of societies. A sudden drop in membership would quickly result in the demise of the very journals that some feel should be free for all. **No one wins if this occurs.** Keep in mind that journals, even electronic journals, have a difficult time surviving without the support of society membership (e.g., *Herpetological Natural History*, 1993–2003; *Contemporary Herpetology* 1998–2009). What may occur is that so-called "vanity presses," which say they are peer-reviewed but are mostly pay to publish on-line operations, will be the future of herpetology.

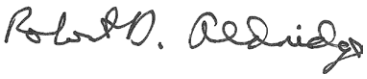
The Importance of Participating in Professional Societies

I strongly urge young members to attend the national/international meetings. The meetings are a great place to meet others with similar interests, whether they are established researchers or novices. At our meetings, there are numerous papers and posters that represent the wide diversity of research on herps. Meetings are expensive, but SSAR, and other societies, make efforts to reduce

those costs for students. SSAR has travel grants that students can apply for and also have hotel rooms that can be shared. There are numerous student competitions that offer monetary awards. To further encourage student participation, SSAR will have its 2015 meeting at the University of Kansas (30 July 30 to 3 August 2015). To keep expenses low, we will have arranged for dorm rooms and a dining plan to be available. There will be a social specifically designed for new members to meet senior herpetologists. We also have planned a tour of the Fitch Natural History Reserve, a live herp display, a Herp Quiz, and a graduate student social.

What You Can Do

If you have an interest helping SSAR, or another society, attend a board meeting. These meetings are generally scheduled for the first day of the Joint Meeting of Ichthyologists and Herpetologists. All of the societies have important committees or positions that require relatively little time, yet are essential to the organization. If you unable to make the board meeting, attend the SSAR/HR Student Social. You need to register for this on the JMIH web page. I thank you for your support of SSAR and hope to see you at our annual meeting. If you have any questions please feel free to contact me at: aldridge@slu.edu.



Robert D. Aldridge
President

ABOUT OUR COVER: *Duellmanohyla soralia*



The genus *Duellmanohyla* includes eight species of small Central American hylid frogs that collectively range from southeastern Mexico to northwestern Panama. These arboreal frogs are typically found near small cascading mountain streams and are generally characterized by the adults' red eyes and the tadpoles' large pendant funnel-shaped oral discs (Köhler 2008. Reptiles of Central America, 2nd ed., revised. Herpeton Verlag Elke Kohler). The Honduran Brook Frog (*Duellmanohyla soralia*) is a species frequently encountered in the cloud forests of northwestern Honduras and eastern Guatemala. Unfortunately, this charismatic species was previously common but now in decline across its range, likely due to a combination of habitat degradation and amphibian chytridiomycosis (Cruz et al. 2010. *Duellmanohyla soralia*. *In* IUCN 2012. IUCN Red List of Threatened Species. Version 2012.2. <www.iucnredlist.org>. Downloaded on 19 April 2013). Currently it is listed as Critically Endangered in the IUCN Red List of Threatened Species and exists only in a patchwork of isolated populations. Cusuco National Park, Honduras, represents the largest "protected" area of critical habitat for the species, but a recent intensification of illegal deforestation within the park's most protected core zone habitat is now threatening this stronghold.

The adult frogs are quite attractive with bright red eyes and cryptic dorsal patterns of greens and browns, often resembling lichen. Although amphibian tadpoles are rarely considered attractive, larvae of this species are quite magnificent, both in appearance and behavior. Flecks of metallic emerald-green pepper their olive to nearly black bodies, with eyes that become increasingly red with age. Despite possessing large pendant oral discs commonly used to cling to rocks near cascade currents, *D. soralia* tadpoles are instead often found swimming upside-down in large schools behind boulders that break the currents and create calm whirlpools. In this inverted fashion, the tadpoles feed by skimming particles from the film at the water's surface.

Although the adult population in Cusuco National Park appears to be more stable than other sympatric hylids, moderate levels of infection with amphibian chytrid fungus have been detected in the species (40%), primarily in tadpoles and recent metamorphs, and subadult animals are becoming increasingly uncommon (Kolby et al. 2010. Diseases of Aquatic Organisms 92[2]:245–251). Plans to begin an *ex situ* management program incorporating both head-start/reintroduction and captive assurance population establishment are now being developed in Honduras and will be located at the Honduran Amphibian Rescue and Conservation Center. These activities will help buffer against future populations declines caused by disease and/or habitat degradation and work to ensure long-term survival.

The cover image depicts four larval *Duellmanohyla soralia* schooling behind a rock and feeding upside-down at the water's surface. The tadpoles were encountered at night in a cloud forest stream of Cusuco National Park, Honduras, during the first targeted field survey for amphibian chytrid fungus in the country. The image was taken in 2007 with a Nikon D200 DSLR, Sigma 180mm macro lens (f/16, ISO200, 1/250 sec.), handheld, and illuminated by a single Nikon SB800 flash.

The photographer, **Jonathan Kolby**, is a PhD Candidate at James Cook University investigating global dispersal mechanisms of amphibian chytrid fungus and ranavirus. He previously worked as a CITES Policy Specialist with the US Fish & Wildlife Service and has a particular interest in the international wildlife trade and biosecurity. Since 2007, Jonathan has been monitoring amphibian chytrid fungus in the endangered amphibians of Cusuco National Park, Honduras, to document the long-term dynamics of disease in the wild. In response to worrisome observations, Jonathan is now working to build in-country capacity and establish the Honduran Amphibian Rescue and Conservation Center, to prevent the extinction of three critically endangered species (*Duellmanohyla soralia*, *Plectrohyla dasypus*, and *P. exquisita*).



PHOTO BY DANIEL CHASE

NEWSNOTES

PARC 2013 Alison Haskell Award Winner



The Alison Haskell Award for Excellence in Herpetofaunal Conservation is presented by Partners in Amphibian and Reptile Conservation (PARC), in memory of Alison Haskell (1956–2006). This award is intended to recognize an individual from North America who exemplifies extraordinary commitment to herpetofaunal conservation, has been overlooked by other means of acclaim, has displayed exemplary commitment to building or strengthening partnerships, and has displayed distinguished career-long contributions to partnerships and herpetofaunal conservation.

We are proud to announce that the 2013 recipient of the Alison Haskell Award is Charles Painter. Charlie is currently the Endangered Species Herpetologist for the New Mexico Department of Game and Fish. Charlie's career-long contributions to herpetofauna conservation, leadership roles, and ability to build effective partnerships make him a very deserving winner of this award.

Painter will receive his award at the Southwest PARC meeting held in conjunction with the JMIH in Alburquerque, New Mexico in July.

Reptile Database Update

A new version of the Reptile Database was released in March 2013. This brings the total number of species to 9,789 (up from 9,741, i.e. plus 48, including resurrections etc.) and the total of literature citations to 31,315 (+674), including 89 published in 2013. The synonymies of 1960 entries have been updated since last time (mostly by adding chresonyms), added references to 1270 species, updated the distribution of 252 species, and edited the comments of 380 species. Overall, almost 4000 species have been edited since the last update.

Selected Taxonomic News and Changes

Anolis. After serious contemplation (and consultation with several experts) we changed the names of anoles back to *Anolis*. For some reasons see Poe et al. (2013) Zootaxa 3626:295–299.

Teiidae. The names of many teiids have changed following the suggestions of Harvey et al. (2012) Zootaxa 3459:1–156. However, we are already getting complaints that this may not be tenable.

Hydrophiinae. This was done already in December 2012, but do note that the names of many sea snakes have been changed too, following Sanders et al. (2013) Molecular Phylogenetics and Evolution 66(3):575–591.

Laudakia. We changed the names of many *Laudakia* species, following Baig et al. (2012) Vertebrate Zoology 62(2):213–260.

Australia. We went through all Australian names and updated them, if necessary, based on Wilson & Swan (2010) and a few more recent taxon-specific papers. The last wholesale review of Australia was based on Cogger (2000) so this needed some verification.

Plestiodon. Now up to date based on Brandley (2012) Zoological Journal of the Linnean Society 165(1):163–189.

Hoser names. We follow Kaiser et al. (2013) synonymizing most of the names that Raymond Hoser has proposed over the past years, but most recently in a series of papers published in 2012. See Kaiser et al. (2013) Herpetological Review 44(1):8–23, for details or simply search the database for reference = Hoser.

Palearctic naked-toed geckos (*Cyrtopodion* etc.). Revised based on Bauer et al. (2013) Zootaxa 3599(4):301–324.

Hobart Smith (1912–2013) passed away in early March. Until recently he was probably the most productive reptile alpha taxonomist alive with more than 100 new reptiles described (Uetz 2010. Zootaxa 2334:59–68) and reportedly more than 1500 papers published. Aaron Bauer now holds this crown with about 125 new species, even though he has to catch up in terms of papers.

Volunteers needed: With a backlog of about 700 papers we have trouble keeping up! If you want to help out, let us know your area of interest, so we can send you a few papers to curate. Most importantly, we need your help to extract taxonomically important information, which you then should send in a format that we can easily add to the database (e.g., new/changed names, references, distribution data, etc.). We are working on a partly automated system to ask authors for help, but it may take a little while until this is in place.

Internships: We have openings for 1 or 2 paid internships, at least for a couple of months. However, you will be required to show up in Richmond, Virginia, at least once. Contact Peter Uetz (phu878@gmail.com) if you are interested.

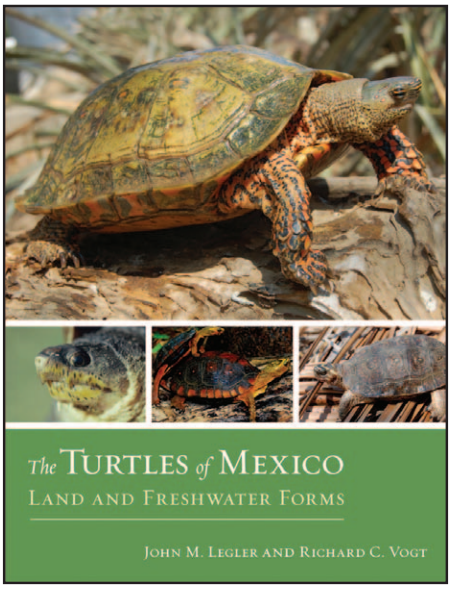
Global checklist: With this release, we have posted a global checklist of all reptiles with their higher taxa online. It's available as an Excel spreadsheet here: http://www.reptile-database.org/data/reptile_checklist_2013_03.xls.zip.

Literature database: As indicated, we have now more than 31,000 references in the reptile database. More than 15,000 are available via weblinks (although often via commercial publishers). Send us URLs of your web pages if you make your own papers available online or send us links to BHL when they are missing in our database.

More details on changed names, etc. are listed on our news page: http://www.reptile-database.org/db-info/news.html.

MEETINGS

Mexican Turtles Symposium



Dick Vogt is organizing a session on Mexican turtles in celebration of the publication of *The Turtles of Mexico, Land and Freshwater Forms*, by John M. Legler and Richard C. Vogt, University of California Press. This session will be held at the annual Symposium for the Conservation and Biology of Tortoises and Freshwater Turtles, hosted by the Turtle Survival Alliance (TSA) in St. Louis, Missouri, USA, 7–10 August 2013. Meeting attendants will be able to purchase the book from UC Press for a 20% discount. The book has 260 color photos most of them never published before, line drawings, maps, and 430 pages of text. Much new material never published anywhere before, compiled by the combined field work in Mexico of over 50 years by Legler and Vogt. Dr. Legler will also be the keynote speaker at the TSA meeting. Visit http://www.turtlesurvival.org/ for meeting information and registration, space is limited.

If you would like to participate as a speaker in the symposium on Mexican species of turtles, please contact Dick Vogt. Posters are also welcome. We already have a dozen speakers committed including: Jim Berry, Taylor Edwards, John Iverson, Pat Minx, Suzanne McGraugh, Oscar Flores Villela, Marco Antonio Lopez-Luna, Miguel Angel de la Torre Loranca, Martha Harfush, Gracia Porter Gonzalez, Michael Pappas, and Jim Berry.

Travel Grants are limited, however a few have been reserved for those in the Mexican session. In order to apply for travel support you must first register and submit your abstract and then fill out the travel grant application at http://www.turtlesurvival.org/. For questions or additional information, please contact Dick Vogt (e-mail: vogt@inpa.gov.br or dickturtlevogt@gmail.com).

Meetings Calendar

Meeting announcement information should be sent directly to the Editor (HerpReview@gmail.com) well in advance of the event.

8–10 July 2013—Southwest PARC (Partners in Amphibian and Reptile Conservation), Albuquerque, New Mexico, USA. Information: http://www.swparc.org/

10–15 July 2013—Joint Meeting of Ichthyologists and Herpetologists (SSAR, HL, ASIH), Albuquerque, New Mexico, USA. Information: http://www.dce.k-state.edu/conf/jointmeeting/

21–25 July 2013—26th International Congress for Conservation Biology, Baltimore, Maryland, USA. Information: http://www.conbio.org/mini-sites/iccb-2013

22–26 July 2013—VI Congresso Brasileiro de Herpetologia, Salvador, Bahia, Brazil. Information: http://www.cbh13.com.br/

31 July–3 August 2013—36th International Herpetological Symposium, New Orleans, Louisiana, USA. Information: http://internationalherpetologicalsymposium.com/index.html

22–27 August 2013—SHE 17th European Congress of Herpetology, Veszprém, Hungary. Information: http://seh2013.org/

13–15 September 2013—6th Symposium on the Ecology, Status, and Conservation of Diamondback Terrapins, Seabrook Island, South Carolina, USA. Information: http://www.bio.davidson.edu/terrapin2013/Welcome.html

17–20 September 2013— XIV Congreso Argentino de Herpetologia, Centro Nacional Patagonico (CENPAT-CONICET) and Universidad Nacional de la Patagonia San Juan Bosco, Puerto Madryn, Chubut, Argentina.
Information: xivcongresoherpetologia@gmail.com or avila@cenpat.edu.ar/morando@cenpat.edu.ar

25–29 September 2013—Annual Meeting of the German Society for Herpetology and Herpetoculture (DGHT), Bonn, Germany. Information: www.dght.de

3–6 October 2013—4th Biology of Vipers Conference, Struga, FYR Macedonia. Information: www.shdmr.org/vipers

CURRENT RESEARCH

The purpose of Current Research is to present brief summaries and citations for selected papers from journals other than those published by the American Society of Ichthyologists and Herpetologists, The Herpetologists' League, and the Society for the Study of Amphibians and Reptiles. Limited space prohibits comprehensive coverage of the literature, but an effort will be made to cover a variety of taxa and topics. To ensure that the coverage is as broad and current as possible, authors are invited to send reprints to the Current Research section editors, Beck Wehrle or Ben Lowe; e-mail addresses may be found on the inside front cover.

Thermal Tolerances of the World's Southernmost Gecko

Most animals have a narrow range of temperatures at which they can function. Knowing the thermal tolerances of ectothermic species across their geographic range is essential for understanding their distributions and how they will be affected by changing climates. *Homonota darwinii*, the world's southernmost gecko, faces great thermal challenges as a nocturnal lizard with a wide South American range. As different *H. darwinii* populations experience a broad range of temperatures, the authors of this recent study expected this species to exhibit increased thermal tolerance with increasing latitude. Geckos were collected from four sites in southern Argentina spanning the latitudinal range of *H. darwinii*. For a year, data loggers collected hourly temperatures in gecko retreats at each site to determine the actual temperatures the geckos experience. The authors determined critical thermal minimums in the lab by lowering the temperature 0.2–1°C per minute until geckos flipped onto their backs could no longer right themselves. Because critical thermal maximum is very close to the lethal maximum temperature in *H. darwinii*, the authors measured panting threshold, raising the temperature 0.5°C per minute until the geckos panted for at least three seconds. They found that the annual minimum and maximum temperatures experienced by the geckos varied considerably by population with the northernmost population experiencing the greatest temperature variation and the southernmost experiencing the least. Geckos from the northernmost populations had the lowest critical thermal minimums, a pattern unexpected based on the lower latitudes of the sites, but expected due to the high elevations. Additionally, these thermal minima were lower than those seen in other gecko species, even reaching sub-freezing temperatures. Broader thermal tolerances occurred with higher environmental temperature variation. The panting thresholds did not vary across populations, a pattern seen in other ectotherms. This may be because of behavioral thermoregulation at extreme high temperatures, including inactivity during the time of day when it is hot. The authors suggest that some populations of *H. darwinii* may not be greatly affected by climate warming because these high temperatures occur while the geckos are at rest in retreats, yet those in thermally heterogeneous habitats with narrower tolerances may be affected by climate change.

Weeks, D. M., and R. E. Espinoza. 2013. Lizards on ice: Comparative thermal tolerances of the world's southernmost gecko. Journal of Thermal Biology 38:225–232.

Correspondence to: **ROBERT ESPINOZA**, Department of Biology, California State University, Northridge, Northridge, California 91330, USA; e-mail: robert.e.espinoza@csun.edu

Lack of Shelter has Cascading Consequences for Snakes

Shelter use can serve essential roles for animals and has been well studied as a way to buffer extreme temperature conditions. Yet, shelters are also used for a number of other ecologically significant functions, such as sleeping, reproduction, and digestion. Considering the importance of shelters, depriving an animal of this resource is expected to increase physiological stress and possibly disrupt a myriad of other functions. The authors of this study measured thermoregulation, digestion, and plasma corticoid levels (an indicator of stress) in Aspic Vipers (*Vipera aspis*) over multiple temperature/shelter configurations and feeding states. In a four-treatment choice experiment, fed and unfed snakes were given access to a hot and a cold compartment, each with either a shelter or no shelter. Snakes more often chose the compartment with a shelter, regardless of temperature. When no shelters were available, snakes chose the hot compartment. When both compartments had shelters, slightly more snakes chose the hot compartment. These patterns were found in both fed and unfed snakes. In a second experiment, fed snakes were placed in either a hot or cold compartment with or without a shelter and had their feces collected for digestive analysis, including transit time measurement and an estimate of assimilation. About two-thirds of these vipers were subjected to daily simulated predator attacks with a leather glove. Another group of unfed snakes had their plasma corticoid levels measured 10 days after being placed in one of the hot/cold, shelter/no shelter compartments. Vipers in hot compartments have shorter digestive transit times than those in cold compartments, but shelter did not affect transit time. "Predator attacks" reduced transit time in all groups, though more so in hot habitats. Regurgitation was common in cold compartments, twice as frequent when the snake lacked a shelter, and even more increased in "attacked" snakes (though this was not affected by shelter availability). All regurgitating snakes assimilated less of their prey than snakes that were able to digest normally. Plasma corticoid levels were much higher in snakes lacking both heat and a shelter than in each of these states alone, indicating high snake stress due to this interaction. Though in some of their experiments, snakes provided with heat appeared to be less stressed even if lacking a shelter; this forced the vipers to increase their temperature and thus energy expenditure, possibly to compensate for increased predation risk. Availability of shelter can greatly affect the temperature, energy expenditure, digestion, and stress in snakes. Shelters play an important role in habitat selection and the authors suggest shelter availability and quality should be incorporated into conservation and captivity concerns.

Bonnet, X., A. Fizesan, and C. L. Michel. 2013. Shelter availability, stress level and digestive performance in the aspic viper. The Journal of Experimental Biology 216:815–822.

Correspondence to: **XAVIER BONNET**, Chizé Centre for Biological Studies, CEBC-CNRS, 79360 Villers en Bois, France; e-mail: bonnet@cebc.cnrs.fr

Salamander Contact Zones Show Climate Variation and Suggest Interspecific Competition

Geographic ranges of species pairs that abut each other and are stable over time provide interesting opportunities for studying the determinants of species range limits. In habitats with environmental gradients, abiotic factors are thought to govern range limits; in homogeneous areas, competition or other biotic factors may direct these borders. Combinations of these factors have also been previously experimentally supported. The ranges of the widely distributed *Salamandra salamandra* (Fire Salamander) and the pre-montane/montane *S. atra* (Alpine Salamander) meet in the European Alps. The authors of this study gleaned distributional information for these species from museum records, with random background points from within the species' distributions added to represent available habitats. Climatic conditions of salamander habitats from 1961–1990 were characterized using GIS-layers with a 100 m x 100 m resolution. From this, five non-correlated climate variables were identified for further analysis of each species' climatic niches in the contact zone. Using species distribution modeling (SDM) and a multivariate analysis, the authors developed null-distributions and null-models of niche overlaps. They compared the actual species distributions and niches to find that *S. atra* were found in a wider range of climate conditions than *S. salamandra*. This was unexpected as *S. atra* had a narrower geographic range. *S. salamandra* were found in drier areas with less solar radiation. The climatic variables differed among the three contact zones, and the western zone was narrowest when compared with the central and eastern contact zones. The main predictors of the *S. atra* SDM were mean annual precipitation and slope of habitat, and in the western contact zone, mean temperature in January. *S. salamandra* SDM predictors also varied by contact zone: for the central and eastern zones it was January temperature, while in the west it was radiation in July and slope. Yet at all contact zones, the two species were found to have a moderate niche overlap, though lower than predicted by the null-model, supporting the sharp climatic gradient as an important factor in maintaining the hybrid zones. However, when range-wide thermal tolerance breadth and variation was taken into account, the absence of *S. atra* from apparently suitable habitats suggests that its distribution is most likely limited by competition. *S. salamandra*, on the other hand, is likely most limited by abrupt climatic changes as they have a narrower abiotic niche. This study provides support for the role of abiotic factors determining species boundaries and identifies biotic interactions as a likely influence as well. The authors suggest mechanistic species distribution models may add to the understanding of the salamanders' climatic niches and physiological tolerances.

Werner, P., S. Lötters, B. R. Schmidt, J. O. Engler, and D. Rödder. 2013. The role of climate for the range limits of parapatric European land salamanders. Ecography (*in press*) doi: 10.1111/j.1600-0587.2013.00242.x

Correspondence to: **PHILINE WERNER**, Department of Biogeography, Trier University, Universitästring 15, DE-54286 Trier, Germany; e-mail: werner.philine@gmail.com

Hot Frogs Less Susceptible to *Bd*

Chytridiomycosis, caused by the fungus *Batrachochytrium dendrobatidis* (*Bd*), is responsible for massive amphibian declines around the world. Yet in numerous cases, amphibians that have been infected with chytrid in some populations coexist with *Bd* in others. Some infected individuals may not show symptoms in the field, others uninfected in the field may become highly sensitive to *Bd* in the lab. In one study, chytrid-positive frogs had increased body temperatures, possibly to produce "behavioral fevers" for escape of *Bd*'s optimal growth temperatures of 17–25°C. In this study, three *Litoria* species (Hylidae: *L. lesueuri*, *L. serrate*, and *L. nannotis*) that have suffered different degrees of *Bd*-related declines were swabbed for *Bd* and tracked at four sites in excess of two weeks during the wet season in Australia. The dorsal temperatures of re-sighted frogs were recorded at each observation (on average 17 times per individual). Infection prevalence was the same among sites, but different among species. On average, individuals with body temperatures greater than 25°C had decreased incidence of *Bd* infection. Infection was particularly rare if greater than 75% of an individual's body temperatures exceeded 25°C. Males of the two most vulnerable species, *L. serrate* and *L. nannotis*, had the highest infection rates, with females of those species exhibiting moderate infection prevalence. This is the first study to show that thermal behavior in the field affects *Bd* infection probability. These findings do not support frogs elevating body temperature as a response to infection, but rather that elevated temperatures prevent infection or do so coincidentally while serving other physiological functions. This study underscores the importance of body temperature on host-pathogen interactions. Variation in individual thermal preferences may allow for evolution of higher thermal tolerances, possibly increasing amphibian survival against the threat of chytridomycosis.

Rowley, J. J. L., and R. A. Alford. 2013. Hot bodies protect amphibians against chytrid infection in nature. Scientific Reports 3:1515. doi:10.1038/srep01515.

Correspondence to: **JODI ROWLEY,** School of Marine and Tropical Biology and Amphibian Disease Ecology Group, James Cook University, Townsville, QLD 4811, Australia; e-mail: jodi.rowley@austmus.gov.au

Painted Turtle Genome Offers Insights into Chelonian Phylogeny, Evolution, and Physiology

The unique morphologies, physiologies, and life histories of turtles such as extreme environmental tolerances, tooth loss, temperature dependent sex determination, and longevity have long made them a curiosity to researchers. Additionally, as the placement of turtles in the tree of life has long been an enigma, genome-wide analyses offer important information for understanding the evolution of this unusual clade. The authors of this study sequenced the nuclear genome of a female Western Painted Turtle, *Chrysemys picta bellii*. Using a combination of next-generation shotgun sequencing and Sanger sequencing of paired-end BACs, the authors constructed a scaffold with an N50 size of 5.2 megabases and over 93% coverage of the genome. They then compared 1955 homologous genes across eight vertebrate

taxa to build a phylogenetic tree. Their results strongly support turtles as the sister clade to Archosauria and show the turtle genome has been evolving very slowly. The Western Painted Turtle has a one of the highest tolerances of oxygen deprivation of any vertebrate, even relative to other turtles. RNA transcripts collected from hearts and brains of Western Painted Turtles exposed to anoxic and normal-oxygen conditions showed considerable upregulation in 19 heart genes and 23 brain genes. These results reveal regulatory changes in conserved vertebrate genes as mechanisms for the evolution of anoxia tolerance. Comparing the genes of *C. picta bellii* to those of a less freeze-tolerant turtle (*Apalone spinifera*) and humans identified a novel microRNA associated with freeze tolerance. Five previously identified tooth-specific genes had premature stop codons or were greatly degraded, similar to patterns found in birds, though turtles accumulated these mutations at half the rate. Aging related genes from other taxa were looked for in *C. picta bellii* and other turtle genomes. Two genes were found to be absent across all sampled turtles, suggesting further investigations should be made into their role in senescence. Through phylogenetic reconstruction, temperature dependent sex determination was identified as the ancestral condition in turtles, with genetic sex determination likely evolving multiple times. Comparisons with the genomes of eight other vertebrates identified gene families likely responsible for the unique characteristics of turtles as a whole. These findings open further investigation into the genes and regulation of turtle genomes, as well as the implications for advance the understanding of turtles' extraordinary traits.

Shaffer, H. B., and Colleagues. 2013. The western painted turtle genome, a model for the evolution if extreme physiological adaptations in a slowly evolving lineage. Genome Biology (*in press*) doi:10.1186/gb-2013-14-3-r28.

Correspondence to: **BRAD SHAFFER**, Department of Ecology and Evolutionary Biology, University of California, Los Angeles, Los Angeles, California 90095, USA; e-mail: brad.shaffer@ucla.edu

Salamanders Provide Evidence for an Early Isthmus of Panama

The Isthmus of Panama has long been recognized for its dual role as a barrier and conduit for dispersal. Though most researchers have operated under the premise that the Isthmus opened for overland travel less than four million years ago, geological and phylogenetic studies finding evidence in support of an earlier connection between North and South America have been accumulating. In this paper, the authors present results from a phylogenetic study of South American representatives of the plethodontid genus *Bolitoglossa*, and in doing so add to the growing debate over New World biogeography. This group of salamanders undoubtedly originated in Central America and southern Mexico, where the vast majority of its species diversity still resides. Nevertheless, 28 *Bolitoglossa* species occur in South America, most of which are endemic to the continent. The researchers collected genetic sequence data on for two genes (one mtDNA, one nuclear DNA) for 60 exemplar specimens including 15 South American *Bolitoglossa*. Using these sequences and a Plethodontidae crown group age of 75 million years as a calibration point, they constructed a time-calibrated "species-tree" phylogeny. The resulting phylogeny presented a monophyletic South American *Bolitoglossa*, with two instances of South American species expanding their distributions north into Central America. They found evidence for considerable cryptic diversity, as three of their South American samples did not closely align with currently recognized species. The crown age of the South American *Bolitoglossa* clade was found to be 23.6 million years. It is theoretically conceivable that diversification began prior to the formation of the land bridge, and independent lineages simultaneously dispersed south subsequent to land bridge formation while also simultaneously going extinct north of the bridge. However, the great differential between diversification timing and land bridge formation coupled with the number of lineages that would need to have accomplished this feat makes this hypothesis unlikely. And while the estimated timing of bolitoglossine diversification relative to the plethodontid crown age is much older than recovered in other analyses that employed greater gene and lineage sampling, this discrepancy is not sufficient to realistically fit the recovered genetic diversity of this clade into four million years. And while overwater dispersal to South America remains a possibility, even for taxa that are unlikely candidates for this dispersal scenario, each example such as this shifts the weight of evidence slightly further to a continental scale phenomenon such as an early Panamanian land bridge. Additionally, this study finds evidence for considerable cryptic diversity among South American *Bolitoglossa*.

Elmer, K. R., R. M. Bonett, D. B. Wake, and S. C. Lougheed. 2013. Early Miocene origin and cryptic diversification of South American salamanders. BMC Evolutionary Biology 13:59.

Correspondence to: **KATHRYN ELMER**, Institute of Biodiversity, Animal Health & Comparative Medicine, College of Medical, Veterinary & Life Sciences, University of Glasgow, Glasgow, UK; e-mail: kathryn.elmer@glasgow.ac.uk

Cane Toads Modulate Muscle Length When Landing

Jumping requires the coordination of two mechanical phases: positive acceleration during take off and negative acceleration during landing. For hopping animals such as anurans, landing in a controlled manner is important for decreasing the risk of muscle damage. The anconeus, or forelimb muscle, in Cane Toads (*Rhinella marina*) is important to dissipating the mechanical energy experienced during landing. Muscles, however, are more likely to sustain damage if actively stretched. In a previous study, it was found that in preparation for landing, Cane Toads fine-tune their muscle activity to in response to jump height. The authors of this study tested the hypothesis that such modulation functions to shorten the frogs' anconeus muscles, decreasing the likelihood of muscle damage. Electromyography (EMG) transducers were implanted into the anconeus muscles of five Cane Toads. Muscle activity and fascicle length were recorded during hopping trials, after which the muscles were dissected out and mounted to a servomotor. Isolated muscles were stimulated at varying lengths to characterize force-length properties. The authors found that shortening of the anconeus muscle before landing occurred was inversely correlated with hop distance. They infer that this is to dissipate energy as the muscle is stretched during landing and thus protecting the muscles from damage caused by going beyond optimal length. Indeed, the anconeus

muscle is engaged well in advance of landing, extending the toad's elbow and altering the length of the muscle at impact. Thus, the anconeus muscle does not get stretched beyond its optimal length and the maximum length at the end of landing does not vary with jump distance. Yet this restriction is likely a trade-off with muscle force capacity. This study reveals that frogs are able to modulate both their muscle recruitment and the length of their muscle when landing to incur the least damage when landing.

Azizi, E., and E. M. Abbott. 2012. Anticipatory motor patterns limit muscle stretch during landing in toads. Biology Letters 9:20121045.

Correspondence to: **EMANUEL AZIZI**, Department of Ecology and Evolutionary Biology, University of California, 321 Steinhaus Hall, Irvine, California 92617, USA; e-mail: eazizi@uci.edu

Survey of *Bd* in Cameroon Finds First Record in Caecilians

Amphibian declines caused by chytrid fungus *Batrachochytrium dendrobatidis* (*Bd*) have been well documented in frogs and salamanders. *Bd* is hypothesized to have originated in Africa, yet a recent survey of northeastern Cameroon showed no incidence of the pathogen. Considering that a 70-year old museum specimen from Cameroon tested positive for *Bd*, as did amphibian populations from surrounding countries, the authors of this study conducted follow up surveys of Cameroon's diverse amphibian fauna to investigate these conflicting results. Across 12 sites, 108 amphibian species (including four caecilian species) were screened for *Bd* through skin swabs or toe clips, for a total of 1137 individuals sampled. Samples were analyzed for *Bd* using a quantitative PCR protocol. Overall, 10.9% of samples tested positive for *Bd*, with an average of 32.0% prevalence per site. Three sites had no detected *Bd* and one site, Rumpi Hills, had only one infected individual. Infection intensity was low for all positive specimens. Across all sites, 6.7% of frogs and 64.2% of caecilians were positive for *Bd*. This is the first record of *Bd* in caecilians. Of note, this may be the largest sampling of caecilians tested for chytrid. There are conflicting results as to whether there are differences in infection intensity between frogs and caecilians. The Mt. Oku site showed considerable between-year variation in *Bd* prevalence, perhaps accounting for the negative results of the previous survey. Since amphibians from some sites were not shown to have Bd whereas other ecologically similar populations were positive, Cameroon may be a model locale to track amphibian-*Bd* interactions to better understand how to manage this pathogen in other parts of the world, though more work is necessary to understand how native Cameroonian amphibians are affected by *Bd*. Additionally, Cameroon may serve as a source for *Bd* spread and thus is important to monitor for amphibian conservation considerations.

Doherty-Bone, T. M., and colleagues. 2013. *Batrachochytrium dendrobatidis* in amphibians of Cameroon, including first records for caecilians. Diseases of Aquatic Organisms 102:187–194.

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No Within-Clade Trade-offs in Chameleon Foot Performance

Chameleons have highly specialized morphology including ballistic tongues, independently movable eyes, and prehensile tails and feet. The grasping ability of these lizards' feet and tails is thought to be an adaptation to their arboreal niches. Previous studies have shown faster running species from divergent chameleon clades to be poorer at gripping with their feet, probably due to differences in the mechanical requirements for these activities. To test if this pattern is generally present or the result of clade-specific adaptations, the authors examined the morphology and locomotor performance of closely related pairs of terrestrial (*Chamaeleo namaquensis* and *Bradypodion occidentale*) and arboreal (*C. dilepis* and *B. damaranum*) chameleon species. They collected lizards from the wild and measured snout–vent length, femur, tibia and lateral hindfoot length, and humerus, radius and lateral forefoot length. Using microtomography (an x-ray technique that generates images similar to CT-scans), they produced three-dimensional images of each species. Chameleons were recorded gripping a dowel attached to a force platform for 60 seconds. During the trial, individuals were pulled away from the dowel and allowed to reattach repeatedly. This method was also repeated for forefoot-only measurements. Additionally, chameleons were chased down a 2-m track to measure sprint speed. Both arboreal species had longer phalangeal elements and fused carpals, absent in both terrestrial chameleons. Generally, though, morphological and performance differences by habitat type were dependent on clade. Arboreal species had higher grasping strength and speed, as well as larger hands and feet. Hand size was the best predictor of grip strength. Larger hands and feet may be beneficial for stability on larger perch diameters. In the terrestrial chameleons, unfused carpals may allow for increased flattening of the feet to better grip a flat surface. The two *Chamaeleo* species had no differences in sprint speed, yet the arboreal *Bradypodion* sprinted faster than the terrestrial *Bradypodion*. Thus, trade-offs in gripping and running are more an effect of phylogeny than functional habitat use alone.

Herrel, A., K. A. Tolley, G. J. Measey, J. M. da Silva, D. F. Potgieter, E. Boller, R. Boistel, and B. Vanhooydonck. 2013. Slow but tenacious: an analysis of running and gripping performance in chameleons. Journal of Experimental Biology 216:1025–1030.

Correspondence to: **ANTHONY HERREL**, Département d'Ecologie et de Gestion de la Biodiversité, 57 rue Cuvier, Case postale 55, 75231, Paris Cedex 5, France; e-mail: Anthony.herrel@mnhn.fr

INSTITUTIONAL PROFILES

Herpetological Review, 2013, 44(2), 185–187.
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Developing an Undergraduate Herpetology Club at Cornell University

In its 20 years of existence, the Cornell Herpetological Society (CHS)—an undergraduate herpetology club at Cornell University in Ithaca, New York—has reached several hundred students. It has shaped their college experience and in many cases their careers. Undergraduate herp clubs like the CHS provide opportunities that students could not gain through coursework alone, such as peer mentorship, field experiences, teaching opportunities, interactions with established scientists, and the opportunity to take on a leadership role. These groups create a community of students with similar interests who can amplify each other's curiosity outside of a strictly academic setting, often leading to lasting friendships beyond graduation. Because the CHS has positively influenced the lives and careers of its many undergraduate members, it could serve as an example to inspire the creation of similar groups at more universities. Ultimately, connections among several university herp clubs could provide additional opportunities and ideas.

PHOTOS BY JESSICA TINGLE



FIG. 1. CHS members examine and photograph a salamander during a local field survey.



FIG. 2. By conducting systematic surveys each fall and spring of properties owned by a local land conservation organization called the Finger Lakes Land Trust, the CHS contributes to the Land Trust's and other herpetological databases.

Three Cornell undergraduates who were devoted to the scientific study of amphibians and reptiles founded the CHS in 1992. Since then, it has operated continuously on a model based on leadership from a group of undergraduate officers, with advice and guidance from its faculty advisor Kraig Adler. Although the CHS is organized and run by undergraduate students, it welcomes participation from the broader Cornell and Ithaca communities. The CHS is a registered student-run organization that must apply for funding each semester along with over 800 other student organizations at Cornell University. The CHS organizes three main activities: 1) monthly meetings in which local or visiting speakers present their work; 2) field trips that include short excursions into the field and longer, multi-day visits to universities, museums, and zoos for behind the scenes tours with staff; and 3) educational programs that provide outreach to the community. Each of these activities has served to enrich the lives of herp club undergrads and other community members.

Monthly Meetings

True to its mission as a club run by students primarily for students, the CHS now reserves its first meeting every year for a series of talks by more senior club members based on their summer research or other biological activities. New students benefit from other undergraduates discussing their research, recently including topics as diverse as lizard mating systems in the American Southwest, toad colonization of Alaska, or Brazilian frog phylogeography. More senior students show new students how to seek out funding for their own research projects, demonstrating that one can, in fact, become a budding scientist while still an undergraduate. Other meetings during the academic year feature scientists, conservationists, wildlife photographers, veterinarians, and more, allowing students to learn about different types of careers. Speakers have included Aaron Bauer, Carl Gans, Chris Jenkins, Joseph Mendelson, Robert Murphy, and Margaret Stewart, among many other accomplished herpetologists. After each meeting, a casual dinner at a local restaurant allows students to have closer interactions with the guest speakers.

Off-Campus Activities

Field trips, both local day trips and multi-day excursions farther afield, give an inside look into different applications of herpetology. The club makes the most of the herp diversity in

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PHOTO BY BRIAN SHERMAN



Fig. 3. The club sponsors a trip every August to observe hellbenders in the wild. To achieve success requires a small army of rock turners and dip-net holders, and someone to grope for the animal. The giant salamanders are then PIT tagged, measured, weighed, and returned to the same GPS-referenced rocks, in cooperation with a New York State Department of Environmental Conservation officer.

PHOTO BY JESSICA TINGLE



Fig. 4. Behind the scenes at the Philadelphia Zoo, CHS undergrads get up close and personal with a tortoise named Bubba and many other herps, some of which are never exhibited.

the region by focusing the majority of outings locally. Many of those trips are with a conservation organization called the Finger Lakes Land Trust, which has the CHS conduct herp surveys on their various properties each semester (Figs. 1, 2). The club has frequently sent those data to the New York Herp Atlas project. The CHS also takes advantage of the annual spring salamander migrations to witness explosive breeding events. Last year the CHS began collaborating with Cornell's natural areas and arboretum staff to form a plan for protecting salamanders as they cross roads and for educating the increasing number of people who go to see the migration each spring. Additionally, an annual trip to southwestern New York with a staff member from the New York State Department of Environmental Conservation lets students spend a day finding hellbenders, collecting data about them, working on habitat restoration projects, and releasing juveniles head-started by the Buffalo Zoo (Fig. 3).

Members of CHS take at least one annual trip to locations farther away, including Boston, New York City, Philadelphia, Toronto, Ann Arbor, Washington and other cities around the eastern United States. The club uses these trips as a way to visit museums, zoos, or university labs, often meeting curators, veterinarians, and researches at multiple institutions over the course of a weekend (Figs. 4, 5). Students choose the location at the beginning of the year, and then the faculty advisor arranges the trip.

Educational Outreach and Community Benefits

The club benefits the larger university and local communities through educational outreach. Every year members of the CHS take reptiles and amphibians to university residence halls, Cornell's annual veterinary college open house, local schools, the Ithaca Science Center, and community centers to educate people about these oft-misunderstood creatures (Fig. 6). Most of the people who attend these programs leave feeling less afraid of herps than when they arrived, while some even leave with a newfound love of herps and other creatures. Occasionally, parents from the community bring their children to join the herp club on local field trips and at its meetings, thus fueling the next generation of herpetologists.

Club members who participate in outreach programs develop strong public speaking skills that often help them in their subsequent careers. They learn how to effectively engage an audience, an ability that serves them in a variety of situations, whether they go into research, conservation, environmental law, or another career.

Other Activities

Members of the CHS have taken advantage of several opportunities outside the club's regular activities. Some arose in the form of summer research projects, grants, or internships that the students heard of from other club members or from the club advisor. Others received research funding from an anonymous donor who provides funds to the CHS. For example, three undergrad club members used this source and other funding to do a survey of herpetofauna in Papua, New Guinea, during which they discovered a new frog species that presently holds the world record for smallest known vertebrate (see their article in PLOS One, at http://www.plosone.org/article/info:doi/10.1371/journal.pone.0029797). A few years prior to that, CHS undergraduates participated in a faculty search for a herpetologist in Cornell's Department of Ecology and Evolutionary Biology. The CHS members interviewed each candidate, and then wrote a report on each. The search committee took their recommendations

quite seriously because the CHS members took the process so seriously, and ultimately chose the candidate whom the herp club had recommended. Such experiences played a formative role in the subsequent academic and career pursuits of the students who participated in them.

Finally, the CHS fosters friendships by bringing students together. Outside of formal club activities, students get together for fun events like herp-related movie nights, holding potluck dinners, and watching such outlandish films as *Life in Cold Blood, Anaconda*, or *Snakes on a Plane*. They also go on hikes or camping trips together to take a break from school. These informal activities help relieve student stress while creating a more tightly-knit club.

Post-Herp Club Careers

Many club alumni remember their CHS days fondly as a formative influence. One of the club's founders now directs a worldwide conservation organization called Amphibian Ark, and returns to Cornell from time to time to give talks, help, and advice to current undergrads. Other members have become university professors or museum curators. Some of them did not previously recognize the possibility of building a career in research until they joined the CHS. Other alumni have pursued careers as zoo or private veterinarians, or medical doctors. Many who chose fields outside of biology or conservation for their careers remain interested in herpetology, including a couple of environmental lawyers and one computer programmer who spends his free time describing new species of turtles. In dozens of cases, the presence of an undergraduate herpetology club has fueled people's enthusiasm during college, providing a jumping off point for a lifelong interest in reptiles and amphibians.

Throughout the history of the Cornell Herpetological Society, a few dedicated students have sustained the meetings, field trips, and community outreach that left a lasting impact on so many. Similar undergraduate-driven herpetology clubs can thrive anywhere provided they have certain critical components. First and foremost, enthusiastic and focused students must manage to find each other, and then they must sustain a high enough level of involvement in the club to organize events. Nearly as important is guidance and mentorship from an advisor who truly cares about the club and its members. Such an advisor provides continuity and has the expertise to help students plan the best meetings and field trips possible. A third important component is funding, which many universities provide to student clubs through student activity fees. However, funding plays a less crucial role than do the students and faculty advisor. Even without money, clubs may hold local excursions, herp-themed movie nights, meetings, and much else. Different regions in the world have different resources to offer, so as long as students (with an advisor's help) can recognize those resources, then they can create a very successful organization.

Members of the CHS sincerely hope that students will find a way to use whatever resources they have—human, ecological, or institutional—to engage their peers outside of classrooms and labs, leaving a lasting contribution on their campus as they explore their passion.



PHOTO BY KRAIG ADLER

Fig. 5. At the Pittsburgh Zoo, the club members observe an Alligator Snapping Turtle held by the curator of reptiles. *Left to right:* Herb Ellerbrock (reptile curator), Rich Glor, Mehdi Joseph-Ouni, Mike Benard, Howard Evans (Cornell professor), Jeremy Sabatini.



PHOTO BY CARLY HODES

Fig. 6. The CHS operates a large display of live herps, skeletons, and other learning materials as part of its extensive outreach program to the local community. Among its largest events is an open house sponsored by Cornell's College of Veterinary Medicine, where students and Ithacans of all ages overcome fears to learn about the animals.

Acknowledgments.—I thank the advisor of the CHS, Kraig Adler, and several officers and former officers—Mike Benard, Joseph Chase, Rich Glor, Matthew Meyer, Eric Rittmeyer, Bryan Stuart, Mike Treglia, Tristan Weinkle, Brian Worthington, and Kevin Zippel—for providing information, help, and photos. For more information on the Cornell Herpetological Society, consult our website and blog:

http://rso.cornell.edu/cuherps/flash/flash.html
http://cuherps.blogspot.com/

OBITUARIES

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In Memoriam: David Alfred Chiszar (1944–2013), with Reflections from Colleagues and Friends

The herpetological community lost one of the shining lights in the field of ethology and comparative psychology when David A. Chiszar, known for his pioneering work on social and predatory behavior in lower vertebrates, died after a long struggle with T-cell lymphoma on 3 January 2013. He was born in Sioux City, Iowa on 21 October 1944 and grew up in Perth Amboy, New Jersey. David is survived by his wife, Terri Macey, his former wife, Joan Wilson, and their two children, Adam Chiszar and Laine Chiszar, as well as his stepchildren, Kris Mayer and Daniel Mayer. He is also survived by his mother, Florence Chiszar, his sister Natalie Chiszar, and his brothers, Dan Chiszar, Al Chiszar, and Emery Chiszar.



PHOTO BY TERRI MACEY

David Chiszar at Arches National Park, Utah before he started cancer treatments.

He attended Rutgers University-The State University of New Jersey in Newark where he earned a B.A. (Psychology) in 1966, M.S. (Experimental Psychology) in 1969, and his Ph.D. in Experimental Psychology the next year. Chiszar was a NASA Predoctoral Fellow (1966–1967), NIMH Predoctoral Fellow (1967–1970) and was a Lecturer in Introductory Psychology at Rutgers.

He began and finished his distinguished professional career at the University of Colorado (CU) in Boulder where he quickly rose through the ranks: Visiting Assistant Professor of Psychology (1970–1971), Assistant Professor of Psychology (1971–1974), Associate Professor of Psychology (1974–1980), Professor of Psychology (1980–2013), Director, Undergraduate Education in Psychology (1977–1980), Chairman (1980–1983), Associate Dean, College of Arts and Sciences (1984–1985). During 1983–1984, Chiszar served as National Science Foundation (NSF) Program Officer in Washington, DC. He was recognized as an effective teacher because he received the University of Colorado Award for Excellence in Teaching (Statistics and Animal Behavior). He retired in 2011.

Chiszar was always committed to professional service. He reviewed manuscripts for *Animal Behaviour, Behavior Genetics, Behavioral and Neural Biology, Behavioral Processes, Herpetologica, Journal of Comparative and Physiological Psychology, Learning and Motivation, Psychological Bulletin, Journal of Herpetology, Psychological Record, Zeitschrift für Tierpsychologie,* and *Zoo Biology.* In addition, he was listed as a member of the Editorial Board for *Behavioral and Neural Biology, The Psychological Record, Zoo Biology, Journal of Comparative Psychology,* and *Journal of Herpetology.*

He reviewed grant proposals for the NSF and National Geographic Society. David was Vice President and Program Officer, Colorado-Wyoming Academy of Science (1975–1976) and Member of the Executive Committee of CWAS (1977–1980), Vice President and Program Officer for CU Chapter of Sigma Xi (1978–1979), and President of CU Chapter of Sigma Xi (1979–1980). He was a strong supporter of zoos and aquariums and much of his research was done at these institutions; he served as a Member of the Scientific Advisory Board at the Denver Zoological Gardens for many years.

Chiszar received about a dozen grants, three of which were from the US Department of the Interior to learn about the predatory and locomotory behavior of the Brown Tree Snake (*Boiga irregularis*) on the Island of Guam. This invasive snake has been a major contributor to the near extinction of a number of indigenous mammals and birds. Between 1987 and 2000, he explored methods of using chemical attractants to control this widespread pest. He co-edited an important volume in 1999 with Gordon H. Rodda: *Problem Snake Management: The Habu and the Brown Treesnake.*

In the early days of his career in 1968, he focused mainly on studies of learning and other behaviors in rats and fishes. Seven years later, his interests began to broaden to include reptiles and amphibians with the first papers on the behavior of aquatic and terrestrial turtles, as well as garter snakes. Papers appeared on the behavior of zoo animals, a topic of interest throughout his entire career. These included subjects such as animal communication, maternal behavior, "child" development and socialization in the zoo, courtship and copulation, and curiosity, learning, and occupational therapy (now called animal enrichment) in the zoo. In 1977, his studies included rattlesnakes, pine snakes, and garter snakes on topics like investigatory, predatory, and courtship behaviors. From that point onward, many papers were published that examined snake predatory behavior, often with two of his longtime collaborators—Charles W. Radcliffe and Hobart M. Smith.

Chiszar was remarkable in many ways. He was a physical fitness advocate, weightlifter, and motorcycle rider, taking a number of cross-country trips on his bike. Unlike some herpetologists who are misanthropes, David loved interacting with others, especially when exciting ideas surfaced. When this happened, he was radiant with excitement. Conversations were always Socratic dialectics and he never tried to dominate people intellectually, although he was certainly smart enough to do so. Early on, he

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understood the value of collaboration, so often his papers included a number of co-investigators. He used zoo and aquarium collections brilliantly. Since he designed simple, elegant experiments that could be done in these settings without major disruption, zoo workers regularly invited him to work together. When he worked at these places, his easy-going style, sensitivity, and brilliance captivated all in attendance—he was a joy to be with at all times. He was always willing to review projects and drafts from zoo biologists and students, and his comments would invariably improve the final product. His wide-ranging intellect encompassed many topics—human social behaviors, politics, psychology, philosophy, theology, history of science, ophiophobia and other phobias, history of herpetoculture, art and scientific illustration among many. He was enthralled with the peculiar habits of some herpetologists and loved to talk about them with amusement; there was never condescension toward them but rather fascination with them. He was the consummate raconteur.



PHOTO COURTESY OF CHARLES C. CARPENTER

David Chiszar and friends at the "snake den" in Sinclair, Wyoming, 14 September 1984. Pictured from left to right: Chiszar, David Duvall, Harry Greene, Mike King, Geoff Carpenter, Brent Graves.

Recollections of David Chiszar

When I attended the joint annual meeting of the Society for the Study of Amphibians and Reptiles and The Herpetologists' League in Raleigh, North Carolina in 1982, I heard a wonderful presentation by David Chiszar on the predatory behavior of the Red Spitting Cobra (*Naja mossambica pallida*). I was entranced and invited him to join me for lunch. We talked for hours about all things herpetological and he told me that he wanted to do a comparative study on the behaviors of rattlesnakes and other pitvipers. Because we had a large collection of these reptiles at the Dallas Zoo where I was employed, mostly collected by Jonathan Campbell and Barry Armstrong, I invited him to visit and study these lovely snakes. Thus began a wonderful association with him as collaborator and later as close friend.

Imagine my surprise years later when an envelope arrived at the Zoo from the president of CU informing me by letter that Chiszar and Hobart Smith had contacted dozens of my friends and colleagues to provide letters of support for an honorary doctorate and the university was pleased to give me this extraordinary honor at the next graduation ceremony. I was thunderstruck and so grateful for this act of kindness; I will never forget their efforts on my behalf. When I traveled to Boulder for the ceremony, my parents accompanied me and expressed surprise to the university president at a luncheon that their son had somehow amounted to something by actually making a modest living as a herpetologist and was recognized as such. Later, I told Dave that issuing this degree to me would likely spell the death of Western education.

When I learned that Dave was dealing with cancer several years ago, I called on a regular basis to see how he was faring. There was no self-pity. Every time, he briefly updated me on the severe after-effects of the treatments but quickly changed the subject to herpetology. In fact about six weeks before his death, although his voice was weak and he was tired, he wanted to talk about movement patterns in Prairie Rattlesnakes so we spent nearly an hour on this topic. As he told me at the end of our conversation, "Murphy, I've lived a good life and have no regrets." That about says it all!

James B. Murphy
Smithsonian National Zoological Park

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David was trained as a graduate student in Experimental Psychology at Rutgers, and his doctoral research focused on the comparative ethology of marine arthropods, such as crabs, lobsters, and the like. With that background he was employed at the University of Colorado, fresh from his Ph.D. Indeed, his first research setup in the psychology department there was designed to continue his doctoral line of research. At that time, consequently, he had never had anything to do with herpetology. Therefore his transformation in a relatively short time, becoming a leading, innovative experimental herpetologist, is very astonishing, almost unbelievable. Only his outstanding scholarship made it possible.

As I was the only herpetologist at CU at that time, we became fast friends. We helped each other as best we could, but our approaches were quite different, his experimental, mine descriptive. His choice of research in the change to herpetology at CU was his own, initially the feeding behavior of rattlesnakes. That especially appealed to him, not only because it had never been understood in detail, but also because his macho approach to life made it appealing.

Ultimately we shared many publications, analyzing to various degrees each other's thoughts on them as they took form. Above all, we thoroughly enjoyed field work in various western states and in northern Mexico. On such trips we had ample time for discussion of almost anything conceivable, where David's background knowledge was always an inspiration and a model for me.

David was very careful in handling snakes, including rattlesnakes, and was bitten only once, after several decades, by a Lower California Rattlesnake (*Crotalus enyo*) that he was helping to shed. He almost immediately became unconscious, barely having time to make a call for help. His survival was a very close call. Ultimately it was concluded that he had developed an allergy to venom over his many years of exposure to it. Upon his recovery he soon disposed of all of his venomous snakes. However, he had a big backlog of accumulated experimental data on the snakes that he continued to analyze and publish.

Hobart M. Smith
University of Colorado

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David was a fine, enthusiastic, and innovative scientist, generous in so many ways to all who knew him, and a true friend to me as we traversed the early terrain of studying reptile, especially snake, behavior. We both began with an interest in chemoreception in feeding behavior and prey recognition in snakes. We both

got started about the same time and we were those two weird guys studying snake perception in psychology departments. This association with comparative psychology as well as zoology and ethology, helped cement our friendship and mutual support over many years. I focused on natricines, primarily gartersnakes, while Dave was always most interested in the far more challenging pitvipers, especially rattlesnakes. He also did important behavioral work on gartersnakes as well as numerous other vertebrates. In fact, he was a pioneer in fostering academic – zoological park collaborations in behavioral research. In addition to his own extensive research studies on reptile behavior, Dave served in administrative capacities at NSF as well as being Chair of his department at the University of Colorado. Although Dave collaborated with dozens of scientists and students, his most sustained collaboration was with Hobart Smith, which moved him into herpetological taxonomy, bibliography, herpetological stamps and coins, and other areas quite removed from his psychological and behavioral work. He was personally generous in recognizing my own research and he and Hobart did me the honor of naming a subspecies of false coral snake for me (*Pliocercus euryzonus burghardti*).

Dave's research on snake behavior was particularly neat in that he devised clear experiments, often with innovative testing situations, but always with objective behavioral measures and straightforward and rigorous statistics. In fact, during my stints as journal editor, I often relied on Dave for statistical input and evaluation. Dave was a speculative thinker and would test his ideas. One we talked about at length was the retention of prey recognition in copperheads from presumptive ancestral species. He was a fine psychologist. For example, he applied psychophysical signal detection theory to snake behavior at a time when it had rarely been used with any animal species outside the usual suspects (rats, pigeons). Besides coming up with tests of behavioral aspects of welfare for reptiles (such as the problematic role of cleaning snake cages too often), he also came up with a novel functional aspect of play that I have frequently cited—play used by parents as a measure of behavioral competence.

Those who may not have worked with Dave will not, however, forget his talks if they attended herpetological and behavioral conferences. His were inimitable—with humor and phrasing that made them memorable. His talk on testing hot sauces on snakes (not WITH snakes) is one I always remember with smiles and fondness. Even if the scientific issue was not one of seeming great import, he presented the work with such enthusiasm, delight, and thought-provoking asides, that they were events to look forward to at meetings.

The field has lost a true scholar with much yet to contribute, and will be sorely missed.

Gordon M. Burghardt
University of Tennessee

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My first contact with David Chiszar was in 1975 in response to a request for reprints involving lateral displays in lizards. In the ensuing years this led to correspondence concerning the use of zoo herp collections in behavioral research and the collaboration between academic institutions (zoology and psychology departments, and their graduate programs) and zoological parks. This approach has been fruitful in involving exotic species and in producing numerous publications.

Dave was a great University of Colorado footfall enthusiast, so much so, that when the Colorado Buffalos defeated the Oklahoma Sooners in 1990, he sent me a copy of the Boulder newspaper sports page announcing this defeat which was signed by every member (30+) of his class in Animal Behavior.

Charles C. Carpenter
University of Oklahoma

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Science is like most human endeavors—people work in it and hear about other folks who share their interests and then, over the years, images grow about people you never actually meet. I never really knew Dave—I met him a few times at meetings and because we both worked on aspects of snake feeding, we had read some of each other's work. Dave was already a well-established researcher with a wide reputation when I first met him. I knew about Dave's work on strike-induced chemosensory searching (SICS) and I'd been asked by almost everyone I met in the zoo world whether I knew Dave. It was only mildly embarrassing to have to confess that I didn't know him personally, but also a little puzzling to me why most people seemed to think I should know him well.

Dave and I had attacked the biology of feeding in snakes from entirely different perspectives. Dave's approach was an experimentally-based search for the sensory foundations of the behavior that grew from his Ph.D. work. He developed marvelous experiments that provided excellent tests of hypotheses about what senses snakes were using to recognize and find prey, approaches that he and many others have exploited to flesh out the sensory world of snakes. Dave had worked with a lot of other people that I also worked with but somehow we never overlapped. It was clear from everything I heard, though, that Dave was highly regarded for reasons that go beyond his science.

The images that grew about Dave Chiszar in my mind were of a person devoted to exploring his curiosity and finding out the answers to questions he thought were good questions. He did science for the sake of fleshing out our understanding, basically, for his love of simply doing science. But there was more to Dave than just this. He brought lots of other folks into his quests—and he joined others in their quests. I think that Dave's enthusiasm for his questions sucked others into his projects and he was always able to make it seem really worthwhile. This is my image of Dave—built not on close association or years of collaboration, but from what I've heard from everyone I've talked to who knew him. I'm looking forward to learning a lot more from those who knew him well. Herpetology and sensory biology have lost a friend who gave us a new appreciation for some of the extraordinary sensory adaptations of snakes.

David Cundall
Lehigh University

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One of the most enjoyable experiences of having a career in academia is the opportunity to continue to learn from one's peers and colleagues. It was most rewarding, then, that I was able to do so during my many interactions with Dave Chiszar. Our mutual interests in chemosensory adaptations of rattlesnakes specifically and snakes in general brought us together a number of times, through the mail and in person. I always felt that I gained a great deal from this communication as Dave was so generous and liberal with his knowledge. I firmly believe this was largely due to his background in psychology, which also greatly contributed to his innovative and elegant experimental designs. These subsequently led to greater insight into rattlesnake

predatory behavior including the concept of the Strike Induced Chemosensory Searching that they exhibit. His work was landmark and most significant in that regard.

In addition to so generously sharing his expertise with others, Dave Chiszar was also generous in other ways. On a number of occasions he was a most gracious host to me at his home in Boulder. During one of these visits Dave took me to meet his good friend and colleague, a man whom I admire greatly, Hobart Smith. I owe Dave a debt of gratitude for an unforgettable afternoon at the Smith home. On a lighter note, I was also fortunate to experience Dave's culinary proficiency. His "Godfather Dinner," complete with the movie theme music and good conversation, will long remain in my memories as a most delightful evening. I will miss you Dave!

James C. Gillingham
Central Michigan University

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Shortly after finishing my Ph.D., I was pleased to run across Dave's overview of lateral displays in lower vertebrates (Chiszar 1978. Lateral displays in lower vertebrates: forms, functions, and origins. *In* E. S. Reese and F. J. Lighter [eds.], Contrasts in Behavior: Adaptations in the Aquatic and Terrestrial Environments, pp. 105–135. John Wiley and Sons, New York). Reptile ethology was still in its long infancy, and here was someone other than Gordon Burghardt, my major professor, also generalizing beyond observations of individuals and species. Dave's careful, thoughtful experimental studies of captive vipers began appearing about the same time, a series that continued throughout his productive and influential career. More than anything else his publications have impressed me with an unusual flair for posing questions in a lab setting that bore on the lives of snakes in nature.

I didn't know Dave well personally, although we corresponded and met occasionally at scientific conferences, but our one sustained interaction remains vivid in memory. In 1984, David Duvall invited me to speak at the University of Wyoming, and Chiszar drove up from Boulder so that we could all visit Duvall's nearby Prairie Rattler study site. Rumor had it Chiszar was agitated by Duvall grad student Brent Graves' ear ring, so we found a gold clip-on for my left ear and when Chiszar came over for dinner, sat him on my left as we got acquainted—resulting in several tense minutes of Dave staring and me grinning, then finally a good laugh all around. The next day was long and glorious, the landscape stunning for its wide-open austerity. We'd arrived the morning after fall's first cold snap, and thus watched the rattlers migrating to a den from their summer foraging grounds. Most dramatically, we entered a small side canyon so populated by females with clusters of babies that Chiszar's dog was tied up to avoid an accident. Duvall's research was ground-breaking, directly relevant to questions Chiszar was asking in his lab, but I doubt any of us, as we marveled over the scene, imagined just how complex rattlesnake behavior eventually would prove to be (e.g., Clark et al. 2012. Cryptic sociality in rattlesnakes (*Crotalus horridus*) detected by kinship analysis. Biology Letters 8:523–525; Saviola et al. 2013. Molecular basis for prey location in viperid snakes. BMC Biology 11:20, doi:10.186/1741-7007-11-20). And what most strikes me in recalling Dave that day is how intellectually fascinated he was by it all, what joy he seemed to find in the animals themselves and the unanswered questions.

Harry W. Greene
Cornell University

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Although I was one of Chiszar's colleagues at Boulder for 16 years (1983–1999), I saw him only occasionally; we were not research collaborators, nor did we ever teach together. I can say, however, that all it took was one visit to his laboratory to leave an indelible impression; I remember my first—and only—visit as if it were yesterday. As you probably know, he had a large lab, the main room of which was chock full of big plastic trashcans. None of the cans had a lid, but each had at least one large rattlesnake, each one seemingly meaner than the one before it. As you walked through the lab next to the cans, the snakes would begin to rattle until soon it was one loud and continuous hiss. Absolutely horrifying, or so it seemed to someone who studied tiny salamanders.

To clean home cages or keep snakes available for experiments, the reptiles were routinely removed from the enclosures with a snake hook and placed in trashcans. I guess that this was what was happening when I visited.

James Hanken
Harvard University

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There can be a lot of hand-waving that replaces careful science when discussing reptile behavior. The special approach and talent David Chiszar brought to the study of reptile behavior was to craft well-designed scientific experiments relating olfactory/vomerolfaction to squamate predatory behavior. With the confidence built on these discrete results he was able to build up a larger framework of predatory behavior, discovering in the process a fundamental behavioral feature he termed SICS, Strike Induced Chemosensory Searching. In turn, this invited further tests and logical enlargement to many species of reptiles. Not only his experimental results but also his solid scientific style provided the example that would become the standard of such research.

On a personal basis, he was always generous in recognizing the experimental results of colleagues and volunteered his support to the rest of us in a collegial way that represented the best of scientific collaboration. Many fond memories rush back for me of David at meetings and in the field, which I am sure most of those who knew and worked with him also recall. I am glad for this chance to record my thanks and appreciation for his work and for the person.

Kenneth V. Kardong
Washington State University

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I first met Dave in the early 1970s when I went to the University of Colorado to consult Hobart Smith about some forgotten herpetological issue, probably about rattlesnakes. After helping me graciously, Hobart said there was a new professor in the psychology department that I should meet and directed me down to Dave's office. Dave was studying feeding behavior in Bluegills at that time, but he had a large cage containing several rattlesnakes in a corner of his lab. I believe he was holding these for a friend or as part of a confiscation, but his infectious enthusiasm for anything animate was apparent immediately. When I mentioned that I had a collection of several species of live rattlesnakes his interest heightened and it seemed that both of us immediately realized that our futures would be bound together. I arranged for Dave and his wife to come to dinner and see the snakes and he was like a boy in a candy shop. I wanted to show him some of things they did when they ate, and he immediately saw that we

could study this behavior using statistical methods of timing and counting tongue flicks.

By the time Dave left he had already mapped out several experiments we would do with my collection, he followed up and drove to Denver repeatedly where we would be closeted in my snake rooms for hours observing and quantifying feeding behaviors in a variety of species of rattlesnakes. Dave became increasingly interested and involved in rattlesnakes, and soon he switched his entire laboratory over to snake behavioral research. (He wisely waited until he achieved tenure before taking this step). After Dave switched over his lab, most of the rattlesnake research was moved to that location and Dave pursued it with unflagging enthusiasm and a relentless work ethic that was typical of his every endeavor.

Over the next 20+ years we collaborated on many different projects, and for one three-year period, I stepped aside from my zoo work and became Dave's research associate, teaching animal behavior and running the snake lab so that he could head up the National Science Foundation for two years. This was a wonderful opportunity for me because the last year of the work, Dave and I were both there working together every day. However, this opportunity came with a price. Dave insisted that I take his statistics course to appreciate the power of statistics. I was looking forward to this with all the enthusiasm of having toenails extracted without anesthesia, but he was such an excellent and entertaining teacher that the experience was stimulating and useful, with little pain; and, as he promised, it was of great value, and changed the way I viewed experimental studies of behavior.

Because of his broad intellectual curiosity, working around Dave was always interesting. Early in our work on trailing behavior, Dave wondered if the snakes could distinguish between a trail made by an envenomated mouse and an non-envenomated one. Experiments done in the lab by several of us showed that they preferentially followed the envenomated mouse and preferentially investigated them when given a choice. Even though I had made some of the observations and the statistics confirmed the effect, Dave knew I was always a little skeptical. The last time I saw Dave, about 10 days before his death, he was very excited; one of his former students, now working in another lab, had identified a component in the rattlesnake venom responsible for causing the envenomation effect on trailing behavior and thus vindicating his earlier findings.

Dave was so much more than a valued colleague. He was friend, co-worker, and mentor; and he had an infectious enthusiasm for anything to do with herpetology or animal behavior. Once, when we needed some Rock Rattlesnakes (*Crotalus lepidus*) to study the differences in feeding behavior in a species that fed on lizards and one that fed on rodents, I talked Dave into getting out of the lab and going on a collecting trip. Since he had very little field experience at that time, I explained that we would walk up these talus slopes and carefully tap on rocks with snake hooks, whereupon the snakes would reveal themselves by rattling. He was excited by the prospect of seeing a new species in the field and actually doing some collecting. After a long walk to the site we headed up opposite sides of the talus slide. I soon became aware of a constant clatter of rocks falling and banging together, and wondered if perhaps a bear was trying to dig out a snake. I slowly worked around the hill to discover it was only Dave attacking the slope, clambering up as fast as possible, making small rockslides as he went. Nothing in his experiences growing up in New Jersey or in years of lab work had prepared him for slow quiet movement in uneven terrain. Despite this inauspicious beginning, his enthusiasm never flagged, and when we finally succeeded in finding the snakes we needed, the seed of field work was planted. Years later Dave spent a number of summers doing field work with Hobart Smith (then in his 80's) all over Colorado and in Mexico. They added dozens of locality records in Colorado, fleshing out the distribution of many poorly known species.

Charles W. Radcliffe
Denver Zoo

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Dave was my undergraduate mentor, then a colleague through his landmark studies in reptile behavior, then a collaborator on Brown Treesnake trap development and a co-editor of a seminal volume on applied snake ecology, and finally a field partner when I occasionally caught up with Dave and Hobart in their Colorado ramblings. His greatest early influence on me was as a statistician. He taught the stats course required of all psychology majors, one dash of mathematical rigor in an otherwise squishy subject area. His course and he in particular was widely viewed therefore as a gatekeeper in what was otherwise viewed as a "gut" major. However, this was back in the days before four-function calculators were affordable. At the time, Dave himself did his calculations (including square roots, which could only be done by successive approximation!) on a mechanical adding machine. You may recall that adding machines had a button for each digit in each decimal place, and a huge lever on the side which one pulled to effect the specified multiplication or addition (the process was inverted for subtraction or division). To be fair to students who could not afford an electronic calculator, calculators of any sort were not allowed in exams, and tests in Dave's stats course included, as an appendix, pages of equations (written out by Dave in longhand) with their numerical results. The challenge, of course, was that both correct and incorrect formulations were calculated out, and one had to sift through four or five pages of possibilities to find the correct result among the many that were not. This process had the effect, whether intended or not, of whittling down the number of undergraduates in search of an effortless major (student deferments being in great demand during the Vietnam War).

Later, while working in his lab I began to really understand his scientific greatness, in his unique ability to parse each behavioral question into experiments, for Dave was a great believer in the value of the decisive, exquisitely controlled experiment. For me, his series of experiments on the role of individual envenomation as the key to strike-induced chemosensory searching in *Crotalus* stands out as a paragon of the value of a well-conducted experiment. Finding the decisive experiment may be the holy grail of science, and Dave was its master practitioner. Decades later we collaborated on a series of field and laboratory experiments on Brown Treesnake behavior that were not so salubrious (Chiszar 1990. The behavior of the brown tree snake, *Boiga irregularis*: a study in applied comparative psychology. *In* D. A. Dewsbury [ed.], Contemporary Issues in Comparative Psychology, pp. 101–123. Sinauer Assoc., Sunderland, Massachusetts), and it is greatly to his credit that he accepted the results for what they were, and acknowledged the limitations of the laboratory environment to which he was so committed.

During the period in which Dave was active in Brown Treesnake research he periodically attended our scientific conferences. Despite his somewhat peripheral involvement in the field, his talks were always the eagerly awaited highlight of the annual conferences. It is easy to see why. As in everything he did, Dave

approached the scientific challenges of the Brown Treesnake as a child approaches the gifts under the Christmas tree. As he unwrapped each scientific puzzle, he utterly charmed the audience with his sense of wonder and delight in each insight. The world was a mystery awaiting discovery, and no one enjoyed the detective work with more evident enthusiasm than Dave. He passed that zeal onto many of us, a gift that has lasted a lifetime.

Gordon Rodda
United States Geological Survey

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As an undergraduate in the department of Ecology and Evolutionary Biology at the University of Colorado, I had hopes of one day pursing a graduate career in herpetology. Having grades well below the required cutoff seemed to hinder the possibility of being accepted into a graduate program, and I wanted to try to do something extracurricular, specifically research. I felt that my poor grades would keep me from gaining research experience, but one person, Dr. David Chiszar, took a chance and offered me the opportunity to work in his lab. Work with Dave during my undergraduate career quickly progressed into learning the basics of predatory behavior research with snakes, foundations of statistical analyses (by completing stats by hand—the best way to learn, Dave would always tell me) and importantly, how to avoid being bitten by a venomous snake. "Never rush," he would always say "that's when accidents happen." Projects started early, at 7 AM, to count tongue flicks of Western Diamondback Rattlesnakes toward scent cues, followed by explanations of the behaviors of pit vipers, vomeronasal chemoreception, trail following and many other topics in herpetology and predatory behaviors of rattlesnakes. Of course, there was always a quick lesson on statistics—Dave loved statistics. My fascination grew, and as simple questions quickly progressed into 100s, I soon entertained the idea of pursuing a graduate degree working under Dave's guidance.

Shortly after I was accepted into the Master's program working with Dave to examine chemoreception in snakes, he was diagnosed with cancer. In response to strict orders by his doctors to avoid reptiles, especially venomous snakes, and countless visits to oncologist and chemotherapy sessions, resulted in him spending the vast majority of his time away from his lab. "Don't worry," he would always tell me "everything will work out just fine." Frequent emails and monthly visits to his house to discuss new research ideas, analyze data, work on statistics, and to write manuscripts together slowly progressed into weekly visits just to talk, to have lunch or dinner with him and his family, to discuss the struggles of graduate school and my future goals and plans. Visits were no longer solely for professional discussions; they were also to spend time with a guy that was becoming one of my closest friends. Dave would share stories of spending late nights in the lab— "I would take naps on a cot I had in my office, and then wake up and count tongue flicks throughout the night. Amazing what you can do with all that free time." And concerning the one and only time he was envenomated, by a Lower California Rattlesnake (*Crotalus enyo*), he simply said: "I was rushing." Publications over his 35-year career almost always had a unique twist or funny story attached, such as sticking a mouse carcass into a condom to examine strike-induced chemosensory searching behaviors when the snake's palate doesn't come in contact with the prey's integument. I could only imagine the look on my face as he explained to me his reasoning for shoving a dead mouse into a condom. Through all of these visits, I got to know Dave as someone beyond my academic advisor. He had become one of my best friends, and with every story or problem I shared with him, or request for guidance that I needed, he always listened, always offered a solution, and always extended the most sincere advice.

As I met more herpetologists, psychologists, and biologists who knew Dave, the one thing I heard repeatedly is how he so selflessly, during critical times, helped with aspects of their project(s) or even with their career. One of the first herpetology talks I heard years ago ended with the typical slide of acknowledgments to everyone that had assisted with the project. However, on the next slide was a large picture of Dave cautiously looking at a Brown Tree Snake in his lab, as Dr. Steve Mackessy said, "Dave has so generously helped me with my career, I really just want to say thank you to him." I recently spoke with Dr. Thomas Dunn, also at the University of Northern Colorado, and we both agreed that there must be at least 100 more of us out there that Dave had so generously helped. Dave was one of the most modest people I have ever met, always willing to help, and although his lab has provided some of the most significant contributions to rattlesnake biology and behavior to date, he never talked about himself. In spite of his modesty, his work with rattlesnake behavior was novel and inspirational, helping to transform public opinion of these maligned and magnificent animals. As I now pursue my PhD, I always think of the talk I heard years ago, and how now, for myself, Dave provided the foundation for the career I always dreamed of. He believed in me when so many would have just looked at my poor grades and GRE scores and would have turned away. He listened and provided insights to every crazy research project I came up with. He continued helping me with my research, writing, and statistics, and even during the continuous chemotherapy treatments, visits to the oncologist and weekly stays in the hospital, he never once hesitated to be there for me during a time of need, right up to the end. Dave lost his long fight with cancer just after the New Year—herpetology and behavioral sciences have lost an honest, compassionate scientist, and I lost an academic mentor, and more importantly, a true friend and colleague.

Anthony Saviola
University of Northern Colorado

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Although it took me a considerable time to realize it, Dave Chiszar's interests were closely aligned with my own, and our paths brought us surprisingly close to one another, either geographically or professionally. Those paths were never closer in space than at the University of Colorado, where I was halfway through my undergraduate degree when Dave arrived in 1970. Unfortunately, as a student obsessed with the systematics and morphology of snakes, ophidian behavior was an afterthought for me, and I was unaware of Dave's arrival at CU. His appointment in the Department of Psychology, rather than one of the several biology departments, only served to deepen the chasm between the new Assistant Professor and the undergraduate biology student.

By the time Dave published his first paper on ophidian behavior, in 1975, I was in graduate school at the University of Kansas, still working on systematics and morphology. That same year Dave began to publish with Hobart Smith, who had been my undergraduate mentor, and it was largely through Hobart's publications that I began to follow Dave's growing herpetological output. Dave was beginning to work at a number of major zoos, a move that would soon broaden his taxonomic range and propel him into a period of accelerating studies on predatory behavior and

the role of the vomeronasal sense in snakes. In 1980 Dave published his first paper on strike-induced chemosensory searching (SICS) in rattlesnakes, demonstrating the critical role that the strike plays in releasing prey-searching behavior in pitvipers.

I was following Dave's work on SICS as I began to work on the embryonic development of the pit organs, a project that involved bringing numbers of gravid female pitvipers into the lab for collection of embryos. As my live collection grew during the 1980s, Dave's observations on the role of the strike in initiating the feeding sequence revealed its practical side, as I learned that recalcitrant captive pitvipers could be induced to feed by harassing them into a defensive strike at their prey. Another of Dave's discoveries—that too-frequent cage-cleaning can induce repeated defecation and loss of nutrients in captive snakes—proved invaluable in convincing my Institutional Animal Care and Use Committee that snakes were healthier when cages were not cleaned obsessively.

Our paths crossed only a few times at conferences, but when they did Dave was always a jovial presence and a delightful companion at dinners and socials. I can never remember a time when he didn't have a broad smile on his face, and his presentations were filled with the joy he brought to his science and to life in general. I'll remember Dave most for the delight he took in his interactions with colleagues and for the critical role that he played in revealing fundamental elements of the feeding and foraging behaviors of snakes.

Alan H. Savitzky
Utah State University

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† *Editor's note.*—During preparation of this manuscript, Hobart M. Smith passed away on 4 March 2013.

SSAR TO MEET IN 2015 AT UNIVERSITY OF KANSAS

On the campus of one of the world's major herpetological research centers

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The SSAR held highly successful meetings at KU in 1977 and 1996, and anticipates another memorable event in 2015. The intimate campus setting will facilitate personal interaction, while moderating fees for registration and lodging. The meeting will be co-sponsored by PARC (Partners in Amphibian and Reptile Conservation) and the Kansas Herpetological Society.

Featured events will include:

- Oral presentations and poster sessions
- Featured symposia (to be announced)
- Selected plenary speakers (to be announced)
- Recognition of senior herpetologists
- Commercial and non-commercial display booths
- Tours of the Henry Fitch Natural History Reserve
- Tours of newly renovated research laboratories
- New audio/visual shows
- Live Kansas herps for photography
- Silent and live auctions

Hosted by: The University of Kansas Biodiversity Institute and Museum of Natural History.

Local committee: Rafe Brown, William Duellman, Rich Glor, Linda Trueb, Andrew Campbell, and George Pisani.

ZOO VIEW

Herpetological Review, 2013, 44(2), 196–207.
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Deadly Encounters by and upon Crocodilians Depicted in Historical Illustrations and Accounts. Part I. Assaults by Crocodilians

> The old adage "eternal vigilance is the price of safety" was never more true than for those living near the haunts of the estuarine crocodile. One does not have to enter the water to provide a meal for these great reptiles as they lie concealed in the muddy waters of lagoon or river. Often the first intimation of their presence received by some unwary stroller at the water's edge is when, his legs swept suddenly from beneath him by a deftly wielded tail, he is seized in a vise-like grip of great jaws to disappear in swirling water whose surface quickly resumes its normal placid appearance regardless of the human tragedy it conceals.—Arthur Loveridge (1945)

> A number of the bigger crocodilians are perversely unable to see the special nature of the human animal, and absentmindedly eat him from time to time.—Archie Carr (1970)

> Such is the average crocodile—an active, vicious and, above all, treacherous brute. When the keepers of the reptile house in the New York Zoological Park clean out the big pool for crocodilians, they actually walk over the backs of some of the big 'gators, so tame are these. They never become unduly familiar with the crocodiles, finding it necessary to pen the latter behind heavy barred gates—and in the process the men are often chased from the enclosure.—Raymond L. Ditmars (1933)

The ongoing struggle that crocodilians face, both as predators and prey, is beautifully documented in historical images and written accounts. In this paper, I show how humans have dealt with these reptiles, mostly catastrophically for the latter, over many centuries. First, humans are at risk because crocodilians can eat them and so the literature is filled with arresting images and graphic descriptions of attacks upon man. Second, crocodilians are efficient predators so humans are intrigued and often unnerved by their ability to subdue a plethora of prey, ranging in size from small invertebrates to large mammals. Watching a large crocodilian feed on sizable prey is an unforgettable experience—zoo patrons flock to an exhibit whenever dead rabbits are offered as food and stand slack-jawed and mesmerized during the entire banquet. Third, many predators find a small crocodile or alligator to be a tasty meal and cannibalism is not an unusual occurrence. Fourth, the crocodilian skin is highly prized in the fashion industry so many taxa are currently at risk in the wild. Others are being threatened by habitat alteration: especially Philippine Crocodiles (less than 100), Chinese Alligators (estimated at 300), and Siamese Crocodiles (virtually extinct) as well as Gharials, and Mugger, Cuban, Morelet's, and Orinoco Crocodiles to name a few. As a result, an alarming number of crocodilians are listed as threatened and endangered. To supply the insatiable demand for leather, crocodile farming has become a big business and illegal trading still exists in spite of nominal protection (Brazaitis and Watkins-Colwell 2011). The sum total of these pressures: Crocodilians are generally in trouble where they are found and the situation is not likely to markedly improve.

If given half a chance, crocodilians are adept at survival. A Saltwater Crocodile between 6–7 feet escaped into the zoo lake in the Menagerie at the Botanic Gardens in Singapore in the early 1900s and began eating waterfowl and stalking laborers. Many attempts to kill it failed: it was shot twice, arsenic and strychnine were put into chickens, dynamite was tried. The lake was virtually drained— with shots and spears aimed at the crocodile— but it buried into the mud and escaped that night (Ridley 1906).

Major Stanley Smyth Flower (1925) observed the following: "Crocodilians may perhaps live to a great age: probably longer in the sheltered conditions of captivity than when exposed to the active, combatant, competitive career that is theirs in nature." He listed longevities as follows: American Alligator–40 years and perhaps longer than 73 but record cannot be verified with certainty; Mugger Crocodile–31 years and still alive; Nile Crocodile–17 years and still alive; African Dwarf and Slender-snouted Crocodiles–15 years; Cuban Crocodile–13 years; and American Crocodile–10 years. Snider and Bowler (1992) listed the following records in North American collections: American Alligator >73 years; Chinese Alligator >46 years; six caiman taxa between 15–30 years; 14 crocodile taxa between 3–50 years, and Gharial >27 years.

Peter Brazaitis (pers. comm.) describes the predatory behavior and intelligence of crocodilians:

> "The first is that there is considerable difference between the way an alligator (or possibly expanded to "alligatorids"), zeroes in on potential prey or invader. Alligators seem to be attracted to something and then often swim toward it, mostly on the surface, perhaps pausing from time to time along the way, perhaps to evaluate the purpose of the target, eventually getting close enough to lunge in an attack. There is no hard set of rules. Crocodiles, on the other hand, often detect prey or an invader, slip into the water without so much as creating a ripple, and travel in the direction of the invader or prey underwater, coming to the surface from time to time to relocate and get their bearings. Eventually they are within lunging distance, perhaps surfacing at the end of the stalk with the head at the surface, well camouflaged by floating debris. At this time the prey/

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person still has had no idea that a crocodile is about to get them. Escape is virtually not possible. Dr. Richard Root, who was taken by a Nile croc out of his canoe in Botswana a couple of years ago, was taken and disappeared beneath the water in an instant, never to be seen again, before the people and his wife in a following canoe even knew there was a crocodile present. His colleagues here called me in disbelief and asked if such a thing could happen? Undoubtedly the croc had been successful in easily plucking people out of shallow draft canoes before. Crocs learn people behaviors and modify their own behaviors accordingly.

At AZA Croc school this year we had a student, 'Peter,' from the wildlife service in Uganda. He told me one night that Nile crocs were probably taking upwards of 500 people throughout the country a year. He said that in his district the local lake had been depleted of fish by overfishing. The crocodiles had learned that when they hear the people come down to the lake with nets and baskets and start fishing, they will have fish. The crocodiles then come from wherever they are and take the fish. Absent the fish they take the people.

I recall how I used to exit the crocodile pool at the Reptile house [Wildlife Conservation Society, Bronx Zoo] when we had a pair of young 6–7 foot long Nile crocs in the pool with several mixed species. The two worked cooperatively every time I entered the exhibit and began to leave. There was a bit of a shallow inlet, about 3-feet wide, immediately in front of the exit gate. I had to hop over it to get to the gate. The pair would split. One croc would swim underwater to one end of the pool and come around the backside of a support column that rose out of the pool to one side, and sit waiting underwater along my path for me to arrive. The other croc would swim underwater and lay at the bottom of the inlet and wait for me to arrive and start to hop over the inlet. My shadow on the water above the croc was the trigger. Then both would lunge, bursting from beneath the water at the last moment. Once I learned the plan, and as I always carried a stiff, brown-fiber broom with me in the pool, I could prematurely trigger the attack by reaching ahead and touching the surface of the water with the broom above the nearest lurking croc. Triggering one was usually sufficient to trigger the second. Once the "attack" was fruitlessly expended, the crocs would forget the whole thing and give up the sham."

Operant conditioning is modifying behavior through positive or negative reinforcement. Large captive crocodilians can be dangerous to zoo workers performing basic husbandry or medical procedures. For greater safety, especially while feeding or shifting these reptiles, operant conditioning is being used routinely in a number of zoos. Initially, a whistle is used as a bridge to reinforce a desired behavior, conditioning the animal to associate the sound with food. Next, the crocodilian must target a colored disk attached to a pole, touching its snout to it without moving or biting; when this stationing behavior is performed properly, it is fed. There are several excellent articles on training crocodilians using this method: Augustine (2009, 2010), Augustine and Baumer (2012), and Hellmuth et al. (2012).

The earliest record reflecting crocodiles in captivity is from the pictographs and hieroglyphs of 2500 BC, found at the Saqqara cemetery near Memphis in Egypt. Two Romans, Aemilius Scaurus, built a tank filled with water for his five crocodiles in 58 BC and the 3rd century Roman emperor Heliogabalus (= Elagabalus) kept one of these reptiles in his palace; it was said to be tractable. "The Emperor Augustus had the Flavinian circus filled with water, and exhibited there to the people thirty-six crocodiles, which were killed by an equal number of men, who were habituated to fight with these animals" (Cuvier 1831).

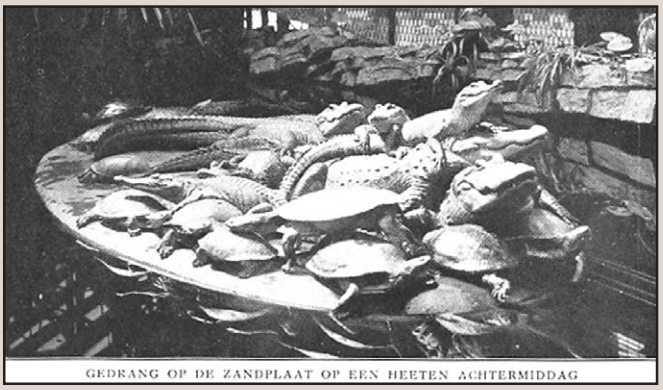
Crocodilians were kept in temple precincts in ancient Oriental societies. Guggisberg (1972) noted that Egyptian priests in the 3rd millennium held "sacred crocodile feedings." Alligators were religious symbols in China, and the Arabs and Turks maintained crocodiles. Gavials were held in the menageries of Buddhist convents in Burma and Siam. In 1882, the Trivandrum Zoo in India had four Mugger Crocodiles on exhibit. A Mugger Crocodile was living at the Adelaide Zoological Gardens in Australia in 1886.

In Europe during the Renaissance, crocodiles were kept in menageries by Italian princes and held at the Royal Menagerie of Louis IV at Versailles, France as early as 1664; the arrival of a crocodile at the Vineuil Menagerie in 1783 caused much public interest. At the Jardin des Plantes in Paris in 1852, six American Alligators were on display where they lived for many years (Duméril 1854–1855, 1858–1861).

In the Tower Menagerie in London, the American Alligator (*Crocodilus Lucius*, now *Alligator mississippiensis*) was described by E. T. Bennett (1829) in *The Tower Menagerie*. There is also a picture in Robert Huish's *The Wonders of the Animal Kingdom Exhibiting Delineations of the Most Distinguished Wild Animals in the Various Menageries of the Country* in 1830 (see Murphy 2006). In 1872 at the London Zoo, the collection included the Nile, Cuban, Slender-snouted, Mugger, and American crocodiles, as well as the Yacare Caiman and American Alligator (Sclater 1872). C. J. Cornish (1894) described African Slender-snouted, American, Nile, Estuarine, Cuban, and West African Dwarf crocodiles, as well as the Dwarf, Spectacled, and Broad-nosed caiman living in the reptile building. The collection also included American and Chinese Alligators.

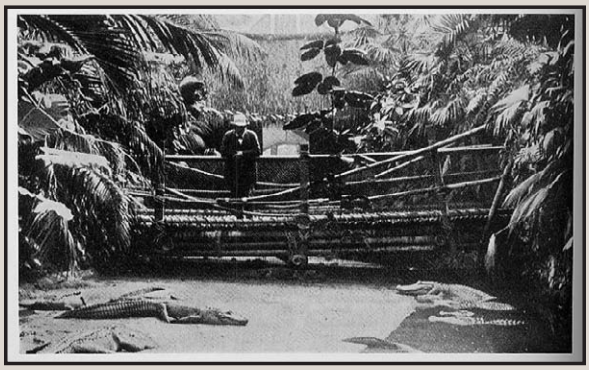
In 1821, the Menagerie in the Imperial Hofburg [Castle] Garden in Vienna, exhibited an American Crocodile. Crocodilians were displayed in the Promenade at the zoological gardens (Jardin Zoologique d'Anvers) in Antwerp, Belgium (Gens 1861). At the Reptile House in the Royal Zoological Gardens in Amsterdam in 1907, an African Slender-snouted Crocodile and alligators were on exhibit. At the Rotterdam Zoo, known now also as Diergaarde Blijdorp, a list of taxa included the False Gavial, Nile Crocodile, and several American Alligators in 1858 (Visser 2003). A new reptile building was built in May 1906. During World War II bombing raids, survivors included a pair of American Alligators and African Slender-Snouted Crocodiles. The Berlin Zoo had eight species between 1860–1875; Oskar Heinroth designed the first walk-through "Crocodile Hall" in 1913 in the new Aquarium. The onlooker seems to be awfully close to the reptiles. I certainly would not get that near an adult Cuban or Philippine crocodile, two of the most agile and aggressive species.

The first book on herpetoculture in English was the Reverend Gregory Climenson Bateman's *The Vivarium*, published in 1897.



COURTESY OF GERARD VISSER, ROTTERDAM ZOO

Mixed exhibit of turtles and crocodilians at Rotterdam Zoo in 1925.



BERLIN AQUARIUM, COURTESY OF JÜRGEN LANGE AND CHRISTINA UNGER

Berlin Aquarium Crocodile Hall in 1914.

There were many advertisements for animals, plants, and supplies in his book. According to Bateman, a broad range of live reptiles and amphibians were obtainable in London in 1897. In addition to the common European species, a number of rare, exotic types were offered for sale, including young American Alligators and crocodiles. Bateman continues, "My Alligator unfortunately, lost his temper when a friend and I one day were trying to photograph him, and, as I was holding him, he whipped my legs with his tail in such a way that I suffered pain from the blows for some little time afterwards, and thought there was some truth in the saying, 'If you want to offend your friend, photograph him.'"

Thousands of caimans and small American Alligators and crocodiles were imported into the U.S. and Europe for the pet trade during the twentieth century and most were kept in deplorable conditions. There was a publication connected to Ross Allen by Dick Bothwell called *The Great Outdoors Book of Alligators* in 1962. It has a chapter entitled "Crocodilian As a Pet" in which it was said that G. L. Thompson of Lane Wilson Company in Monroe, Louisiana shipped 500 caimans a week to pet shops and variety stores in the US. An aspiring pet keeper could order one through the mail and the poor dehydrated creature would arrive in a small cardboard box, similar to those used to ship baby turtles. Books encouraging the keeping of them in captivity were available (Roberts 1958; Schneider, n.d.)

Frank Buckland in *Notes and Jottings from Animal Life* in 1882 published this weird observation: "Several of the ladies in Southport have purchased pets among them, and it may be that no Southport lady will consider her establishment perfect without a baby alligator to bask on the hearth rug, and go out on a walk on the promenade with her. When the pet defuncts, he can be stuffed, gilt, and put in the hat for an ornament, don't you know?" As those few that survived captivity grew to predictable adult size, zoo workers were inundated with telephone calls from desperate owners pleading to take an aggressive crocodilian off their hands.

In the 16th century, crocodilians were drawn from antique statues, medals, and coins. Sometimes sketched by travelers, crocodilians were often shown with tails curling around and upwards behind the rest of the body, perhaps due to a need to fit the long shape on a round coin. An interesting example is "Cocodrillus," from the *Hortus sanitatis* in 1497.

Many of the early depictions of crocodilians from the New World looked like lizards as there was confusion as to what constituted an "iguana" or a "crocodile;" some writers considered iguanas to be the same animal as the Nile Crocodile. For example, Francisco Fernandez de Oviedo "...begins by criticizing Martyr's assertion that the iguanas are identical to the crocodilians of the Nile on the grounds of the obvious size different size of the animals, a fact evident to all those who have seen them. Oviedo then quotes Isidore of Seville's Etymologies on the crocodile and concludes that the iguana could never be a crocodile because, as Isidore says, these are large animals and usually of a yellow colour...while the iguanas measure about four feet and are green or brownish. Besides, Isidore holds that the crocodile is the only animal which elevates the upper maxillary, something the iguanas are unable to do." (quote from Miguel de Asúa and Roger French, 2005. *A New World of Animals. Early Modern Europeans on the Creatures of Iberian America*). The idea that the crocodile's "upper jaw" was hinged also shows up in a lot of illustrations.

During the late 1500s–1700, some authors were compilers rather than scientists, and illustrations were sometimes copied from earlier publications. Mistakes contained in the original illustrations were perpetuated in later reproductions, as shown in the publication by Simmons and Snider (2012). Examples are shown here, arranged mostly chronologically, of scientific endeavor and artistic expression by using changing techniques and methods: woodcuts, etchings and copper engravings, and lithographs. Peter Brazaitis (pers. comm.), who published a key to living crocodilians in 1973, noticed the following: "As an aside, in looking at the illustrations, I found that in a number of cases the artist's eye had captured specific relatively obscure characteristics that discriminated specific species. Like the pre-orbital ridges on the snout of *Crocodylus porosus*; the missing scales in the dorsal scalation and the pre-orbital hump of *C. acutus*; the diagonal dark bar across the anterior flank of *C. niloticus*; the diagonal bony elevations on the snout and the tan dorsal neck of *Melanosuchus niger*, etc. Wonderful!"

Caricatures of crocodilians even appear in cartoons as evil creatures placing humans at risk. In an issue of *Harper's Weekly* (1871) by political cartoonist Thomas Nast, Catholic bishops in the shape of alligators are emerging from the water to threaten the American family (and the American public school), standing horrified at the water's edge. The bishops are wearing miters, tall pointed hats with peaks in front and back, festooned with teeth inside to look like crocodilian jaws. This cartoon is called "The American River Ganges." St. Peter's Catholic Cathedral is in the background.

With most of the legends in my articles, appropriate literature quotations are included to put the images in context. Part II, showing assaults upon crocodilians plus literature citations for both installments, will appear in the next issue.

This 16th century German etching vividly sums up the challenges in the crocodilian world as both predators and prey.





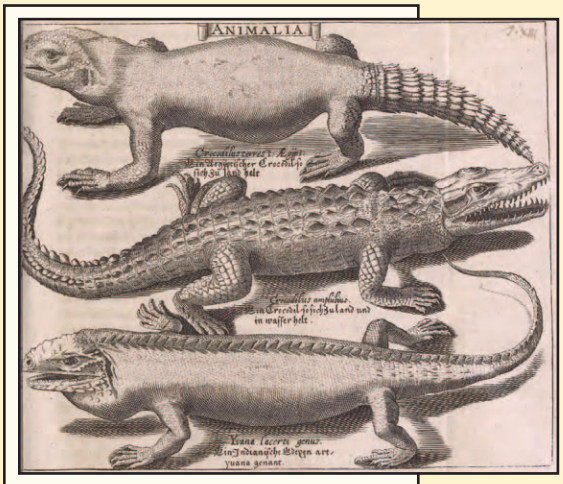
COURTESY OF DEN HAAG, MUSEUM MEERMANNO WESTREENIANUM, [SHELF LOCATION] 10 B 25, 12R

An array of deadly encounters may be found in Medieval Bestiaries between crocodilians and men with the former clearly having the upper hand. Notice that humans are swallowed whole. After dinner is finished, it is said that the crocodile will weep for the rest of its life in repentance! The expression "Crocodile Tears" appeared in bestiaries and are a false or insincere display of emotion such as a hypocrite crying fake tears of grief. It stemmed from the belief that crocodiles weep in order to lure their prey, or that they cry for the victims they are eating. Although "tears" will be visible after a crocodile is out of the water for long periods and the eyes begin to dry out, they do not actually cry. Crocodiles possess lacrymal glands that secrete a proteinaceous fluid behind the nictitating membrane to prevent dessication, so ancients believed that "tears" were generated as in humans. It is striking that this expression is still in use.



COURTESY OF SMITHSONIAN INSTITUTION LIBRARIES, WASHINGTON, DC

Artists during this era likely did not have access to living or preserved crocodilians so the renditions were highly stylized. In early drawings, these carnivorous reptiles are shown with impressive dentition. Illustration of Cocodrillus from the *Hortus sanitatis* in 1497.



COURTESY OF SMITHSONIAN INSTITUTION LIBRARIES, WASHINGTON, DC.

Naturalistic drawing from *Rariora musei Besleriana* by Basilius Besler in 1500s. Bartholomaeus (or Bartholomeus) Anglicus, or Bartholomew the Englishman, was a Franciscan monk of the thirteenth century who had a vivid imagination while describing the crocodile. He wrote his encyclopedia, *De proprietatibus rerum* Book 18 (On the nature of things, or On the properties of things), some time before 1260: "If the crocodile findeth a man by the brim of the water, or by the cliff, he slayeth him if he may, and then he weepeth upon him, and swalloweth him at the last."

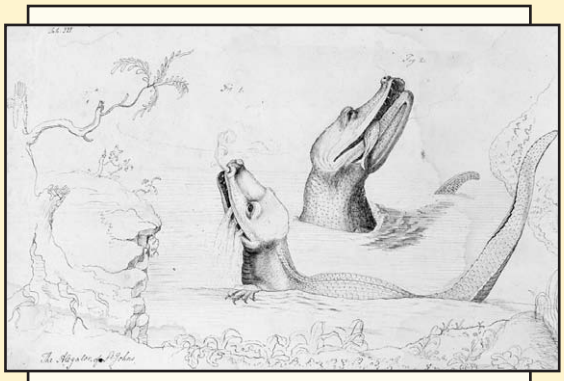

In Lib. secundum Dioscoridis. 365

CROCODILVS.

CHAMAELEON.

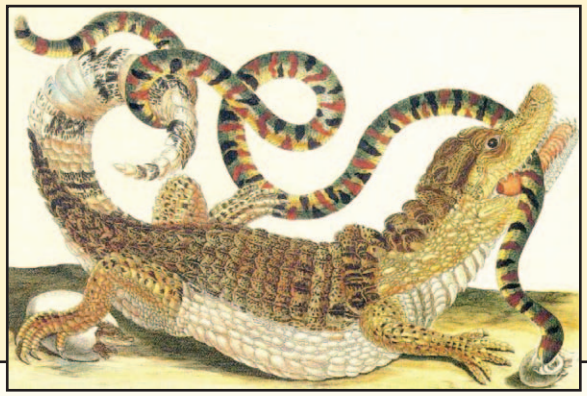
COURTESY OF SMITHSONIAN INSTITUTION LIBRARIES, WASHINGTON, DC

Illustration of crocodile in *Senensis medici, Commentarii in sex libros Pedacii Dioscoridis Anazarbei De medica materia. . .* by Petri Andreæ Matthioli in 1565. "As it lives chiefly in the river, it has the inside of its mouth constantly covered with leeches; hence it happens that, while all the other birds and beasts avoid it, with the trochilus it lives at peace, since it owes much to that bird: for the crocodile, when he leaves the water and comes out upon the land, is in the habit of lying with his mouth wide open, facing the western breeze: at such times the trochilus goes into his mouth and devours the leeches. This benefits the crocodile, who is pleased, and takes care not to hurt the trochilus."—Herodotus (*History*, book 2)



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This image is often improperly cited across the internet. The alligator image is actually a famous drawing (not a published print) from a manuscript collection by William Bartram called the "Fothergill Album," so named after John Fothergill, an 18th century British physician who was Bartram's expedition patron. After Fothergill's death, the collection was sold. Sir Joseph Banks purchased many of the specimens and their related materials including the album, which eventually became the property of the British Natural History Museum. The Fothergill album was reproduced in 1968 in the Memoirs of the American Philosophical Society (v. 74) by the title *William Bartram: Botanical and Zoological Drawings, 1756-1788*. It is from this publication that likely most of the published images come. Bartram (1794) wrote in *Travels*… regarding "The Alegator of St John [River, East Florida]," "…represents the action of this terrible monster when they bellow in the Spring Season. They force the water out of their throat which falls from their mouth like a Cataract & a stream or vapour from their Nostrils like smoke."



Coral Cylinder Snake (*Anilius scytale*) with Caiman from Maria Sibylla Merian in 1717. Hand-colored etching from *Dissertation sur la generation et les transformations des insectes de Surinam.*

COURTESY OF SMITHSONIAN INSTITUTION LIBRARIES, WASHINGTON, DC

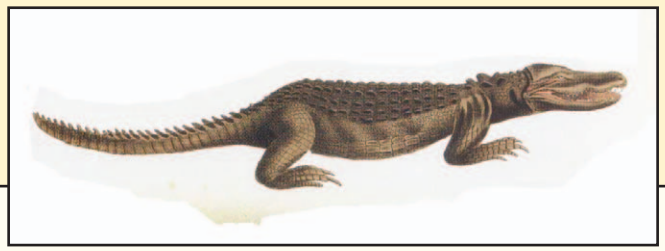
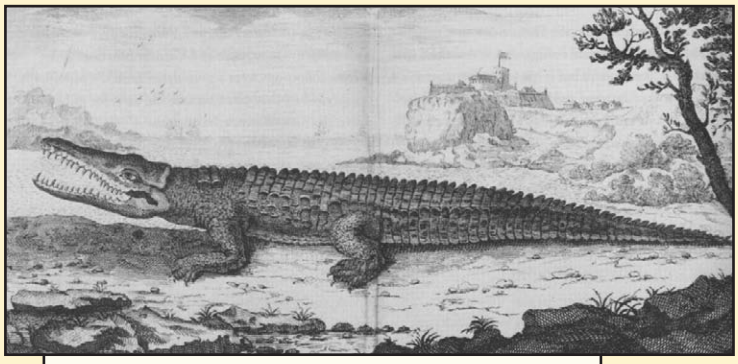


Illustration from *The Zoological Miscellany: Being Descriptions of New, or Interesting Animals / / by William Elford Leach* (1814)… "Human beings have a great dread of this voracious reptile. Many instances are known where men have been surprised near the water's edge or captured when they have fallen into the river. There is, it is said, only one way of escape from the jaws of the Crocodile, and that is to turn boldly upon the scaly foe and press the thumbs into his eyes, so as to force him to relax his hold or relinquish the pursuit."—J. G. Wood (1885), *Popular Natural History*

COURTESY OF SMITHSONIAN INSTITUTION LIBRARIES, WASHINGTON, DC



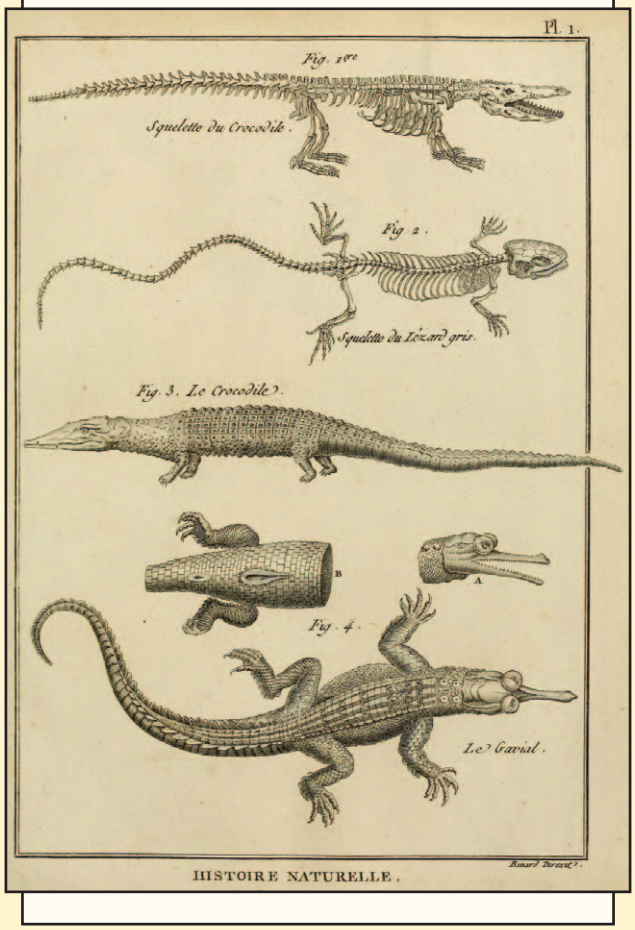
Species of Crocodile Called "Alligator" in *Histoire Générale des Voyages* in 1739. "When an alligator catches a large animal that is too large to be killed by crushing it in its jaws, it immediately starts rolling. The roll is accomplished by throwing its tail up and sidewise and turning its body at the same time and in the same direction that it twists its tail, holding its feet folded backwards against its sides; this twisting and rolling is done with great power, and the animal grasped in its jaws is violently thrashed about until it is quite dead. If an alligator catches an animal that is too large to be swallowed whole, it crushes the leg bones close to the body in its powerful jaws, and then by twisting, rolling and shaking, tears the member loose from the body when it can by easily swallowed. It is generally supposed alligators will not swallow food under the water; this is a mistake, however, as I have often seen alligators catch birds, fish and small animals and sink with them, swallowing the food while under the water. My observations are that an alligator can and will swallow while under water, food small enough to be swallowed without opening its mouth. If the food must be chewed, which necessitates opening its jaws, the head is always raised above the water. I have, on numerous occasions, when fishing on the bottom for large saltwater fish, using large baits, either fish or crab, had alligators swallow bait and hook, and for a few minutes they put up a hard fight when hooked on a fish line. That alligators sometimes hunt their food on the bottom of streams and ponds has been proven to me by seeing alligators that had not before been in view, rise to the surface with large water snakes, turtles or crabs in their mouths, which were killed and swallowed above the water's surface."— Edward Avery McIlhenny (1935), *The Alligator's Life History…*

COURTESY OF SMITHSONIAN INSTITUTION LIBRARIES, WASHINGTON, DC



Illustration of crocodile with a bunch of slender teeth of the same size and strange eyes in *Locupletissimi rerum naturalium thesauri* by Albertus Seba in 1734–1765. Crocodilians have four digits on the hind foot. "Even the smallest children seem to recognize very early in life that crocodiles are animals that bite. Not long after that, they learn that crocodiles will not only bite—like the neighbourhood dogs with which they are familiar—but they can also eat you. It must surely both confuse and excite children within a world so heavily shaped by 'safety.' How can there be any large predators left that attack and eat people? Why haven't parents got rid of such troublesome 'things.' The image of crocodiles is akin to that of a very clever and exciting criminal, that is too smart, cunning, sly or deceptive to be 'got rid of.' The aura of romanticism that surrounds some not-so-pleasant people (Robin Hood, Billy the Kid, Ned Kelly, Bonnie and Clyde) is similar to that placed on large predatory animals by children."—Grahame Webb & Charlie Manolis (1998), *Australian Crocodiles.*

Illustration in Pierre Joseph Bonnaterre, abbé (1789) *Tableau encyclopédique et méthodique des trois règnes de la nature…* "Its usual method is to float along upon the surface, and seize whatever animals come within its reach; but when this method fails, it then goes closer to the bank. Disappointed of its fishy prey, it there waits, covered up among the sedges, in patient expectation of some land animal that may come to drink; the dog, the bull, the tiger, or man himself. Nothing is to be seen of the insidious destroyer as the animal approaches; nor is its retreat discovered till it be too late for safety. It seizes the victim with a spring, and goes at a bound much faster than so unwieldy an animal could be thought capable of; then, having secured the creature with both teeth and claws, it drags it into the water, instantly sinks with it to the bottom, and in this manner quickly drowns it."—*A System of Natural History*, 1834



COURTESY OF SMITHSONIAN INSTITUTION LIBRARIES, WASHINGTON, DC



Illustration of American Alligator from Antoine Simon Le Page du Pratz (1758) *Histoire de la Louisiane…* Michael G. Frick showed photographs to me where alligators were regularly traveling to marine environments where they preyed upon sea turtles, sharks, stingrays, and other organisms. Courtesy of Smithsonian Institution Libraries, Washington, DC "The Common Alligator inhabits Northern America, and is plentifully found in the Mississippi, the lakes and rivers of Louisiana and Carolina, and similar localities. It is a fierce and dangerous reptile, in many of its habits bearing a close resemblance to the crocodiles and the other members of the family. Unlike the crocodile, however, it avoids the salt water, and is but seldom seen even near the mouths of rivers, where the tide gives a brackish taste to their waters. It is mostly a fish-eater, haunting those portions of the rivers where its prey most abounds, and catching them by diving under a passing shoal, snapping up one or two victims as it passes through them, tossing them in the air for the purpose of ejecting the water which has necessarily filled its mouth, catching them adroitly as they fall, and then swallowing them."—J. G. Wood (1885), *Popular Natural History*

Crocodile eyeing a potential meal. Feet have four talons like a bird of prey but the digits are reversed. Illustration from André Thevet (1556) *Cosmographie de Levant…* "This croc, which measured 12 feet from tip of tail to tip of snout, must have had a catholic taste in its form of diet. On opening up the stomach we found a strange assortment of articles—sticks, about a dozen round and smooth pebbles, an African woman's foot, an African man's hand, some coloured beads, wire bangles and anklets, a waterbuck's hoof, the claws of a cheetah, a shinbone of a reedbuck, the shell plates of a large river turtle, the horns of a goat, the hoof of a calf, and a variety of other strange objects. I felt delighted at having been its executioner."—A. D. Graham (1973), *Eyelids of Morning; The Mingled Destinies of Crocodiles and Men*

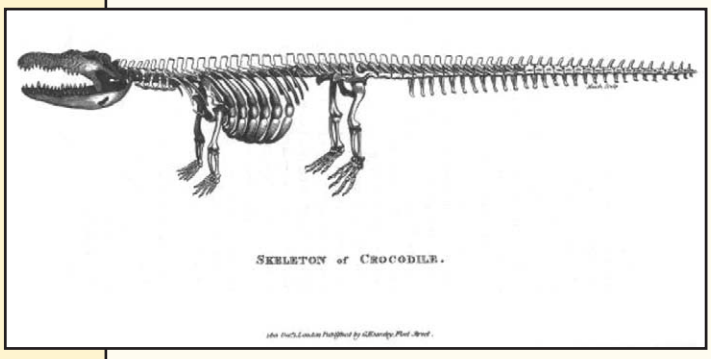

140 COSMOGRAPHIE

eſt pure, & de couleur entiere : ſi l'hypoſtaſe eſt bonne, & ſi elle eſt legere : car la grauité d'icelle denote terre, qui eſt meſlee enſemble. Outre faut cõſiderer ſi elle prend tot froi d & chaleur. Mais à propos dedens le Nil ſe trouuent Crocodiles, ainſi apelez, pourautant qu'ils haiſſent & creingnent

grandement le Safran, & combien qu'ils ſoient animaus terreſtres, marchans à quatre piez, toutefois ne laiſſent d'eſtre aquatiques: car la nuit ils ſe retirent dedens la riuiere, pource que l'eaue eſt plus chaude que le ſerein, ne que la roſee. Ioint auſsi que ſans eaue ils ne peuuẽt viure, combien qu'ils ſe tiennent la plus part du tems en terre. Ils ont la peau tant dure, qu'à grand' peine la peut on percer d'un dard, & certes n'y ha

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"The Crocodile, so remarkable for its size and powers of destruction, has in all ages been regarded as one of the most formidable animals of the warmer regions. It is a native of Asia and Africa, but seems to be most common in the latter; inhabiting large rivers, as the Nile, the Niger, &c. and preying principally on fish, but occasionally seizing on almost every animal which happens to be exposed to its rapacity. …In the full grown animal it is so strong and thick as easily to repel a musket-ball …The Crocodile, in a young state, is by no means to be dreaded, its small size and weakness preventing it from being able to injure any of the larger animals: it, therefore, contents itself with fish and other small prey... but in the glowing regions of Africa, where it arrives at its full strength and power, it is justly regarded as the most formidable in habitant of the rivers. It lies in wait near the banks, and snatches dogs and other animals, swallowing them instantly, and then plunging into the flood, and seeking some retired part, where it may lie concealed till hunger again invites it to its prey."—George Shaw (1982), *General Zoology…*

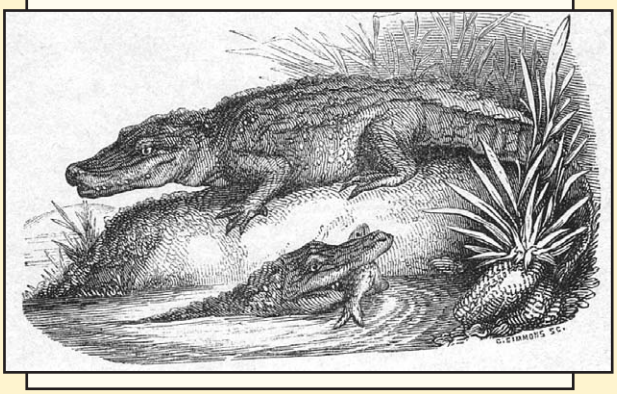




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Illustration from Constant Duméril et al. (1834–1854), *Erpétologie générale, ou, Histoire naturelle complète des reptiles / / par A.M.C. Duméril et par G. Bibron.* "[Raymond L.] Ditmars thus describes the fate of a dog that approached too near a very large alligator: 'As a dog, weighing about fifty pounds, unwarily approached the edge of this creature's tank, it was suddenly grasped and before completing its first yelp of terror was dragged beneath the surface. A few minutes later the twelve-foot saurian appeared at the top, holding the dead canine in its jaws. The dog was shifted about, amid the sound of breaking bones, and swallowed head first, and entire, after a few gulps."—Albert Moore Reese (1915), *The Alligator and its Allies*

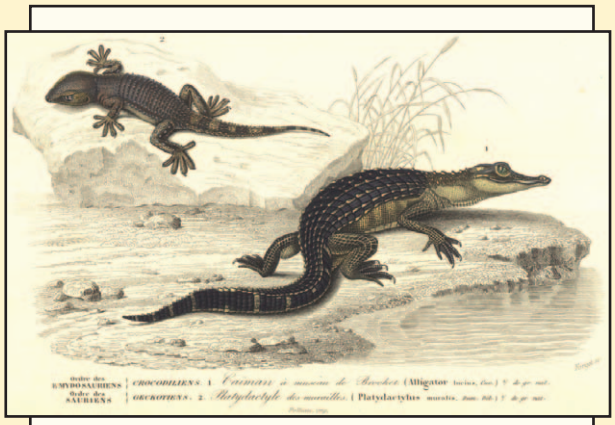
Plate of "Caiman a Tète de Brochet," translated as "Caiman with the snout of a pike" from *Promenade au jardin zoologique d'Anvers par Eugéne Gens,* by Eugéne Gens in 1861.



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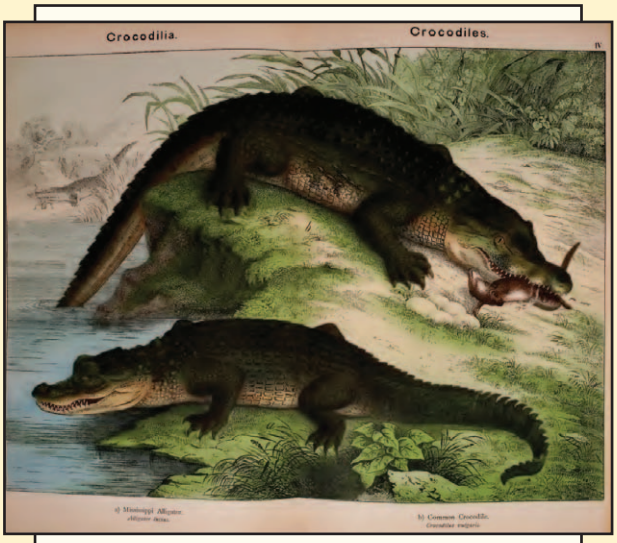
Nile Crocodile (*Crocodylus niloticus*) from *Histoire naturelle de Lacepéde* in 1788. This species has been extirpated from the Comoro Islands in the beginning of the 19th century and recently has disappeared from Israel.





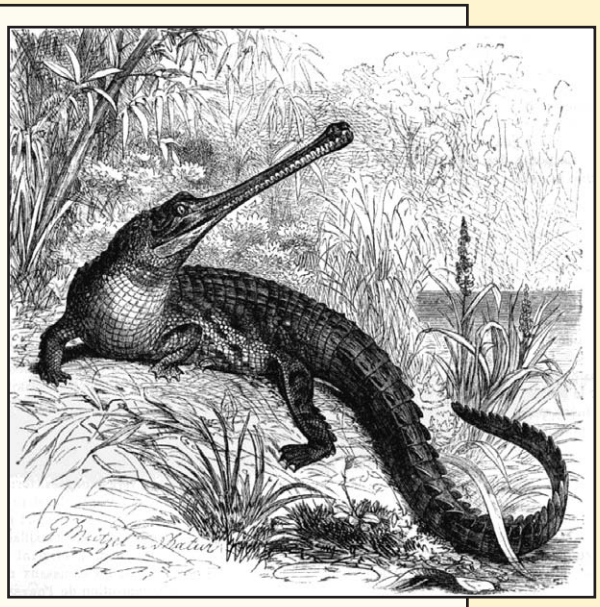
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Illustration from *Dictionnaire universel d'histoire naturelle, zoologie, atlas. Reptiles, Poissons et Insectes, tome deuxiéme,* by M. Charles D'Orbigny in 1849. "All crocodilians are predators that overpower their prey within seconds. The attack can happen in the water, underwater, from the water onto the land or land into water, and also by jumping into the air."—Ludwig Trutnau and Ralf Sommerlad (2006), *Crocodilians: Their Natural History & Captive Husbandry*



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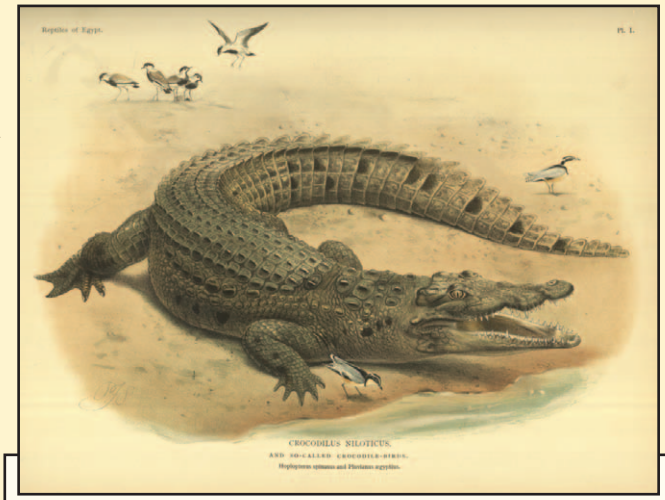
Illustration in W. F. Kirby's English adaptation of Gotthilf Heinrich von Schubert's *Naturgeschichte des Thierreichs…,* published in 1869. The author says that the Nile Crocodile (top) reaches a length of 20–30 feet, lives to be at least 100 years old, has eggs as big as goose eggs, and young hatch in one month and are two feet long. Bullets bounce off its back. It is very fierce and feeds on sheep, antelope and humans. The mongoose is the predator of its eggs and young. The Mississippi Alligator below is common and is dangerous, attacking boats on rivers. In this illustration, although somewhat unclear, it appears as though one of these crocodilians may be transporting young in the mouth, next to a group of eggs. Notice the predation event in the upper left-hand corner.



There are beautiful plates in Alfred E. Brehm's *Les Merveilles de la Nature. Les Reptiles et les Batraciens* (Librairie J.-B. Baillière et Fils, Paris, 1883). Brehm was Director of the Hamburg Zoo in Germany from 1863 onward and founder of the Aquarium Unter den Linden (Berlin's main street) in 1869. This drawing is of a Gharial (*Gavialis gengeticus*). "Although possessing the reputation of being more or less harmless, the stomach of a recently dissected specimen was found to contain human remains, a fact proving beyond all possible doubt that large specimens, at least, will not hesitate to attack man when hungry. Two seven-foot-long specimens that have come under my charge at the Zoological Gardens were extremely savage. On arrival both these specimens refused all food, and it was not until they had been over three months in captivity that they took their first meal. The fish are caught by the tip of the snout, by means of a rapid sideway snap, and are passed down to the mouth, head first, in a series of jerks."—Edward G. Boulenger (1914), *Reptiles and Batrachians*



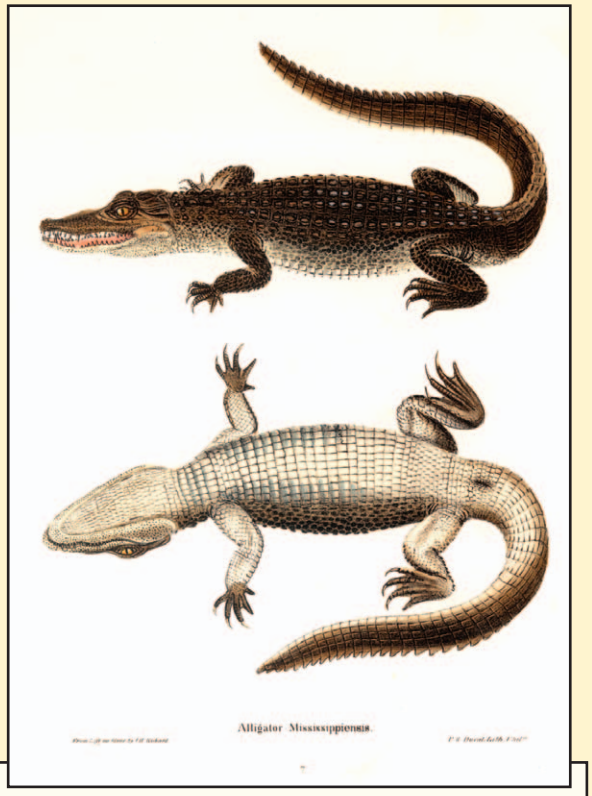
Illustration from George Shaw's *The naturalists' miscellany…*in 1789–1813 (reproduced in Haines, *Slithy Toves,* SSAR 2000).



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This beautiful image may be one of the best crocodilian portraits ever rendered. Notice the Crocodile Birds. "The Nile crocodile has always and justly been credited with great ferocity, but the degree to which it manifests this seems to depend largely on the abundance of its food-supply, as pointed out by Maçoudi and by Schweinfurth. Fish is its principal diet, but birds, the domestic animals found along the banks of the Nile, baboons, and man himself, all fall to it as prey. It either seizes its prey directly with its jaws or, by means of its powerful tail, whisks its prey within reach of them, dragging it under the water."—John Anderson (1898), *Zoology of Egypt*

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John Edwards Holbrook published *North American Herpetology*, beginning in 1836, covering all herps found east of the Mississippi River at that time. "The Alligator in his native state is exceedingly voracious, and feeds on any animal substance that may fall in his way; though he seems most attracted by fish, and by other animals in motion, as minks, musk-rats, dogs, &c., so as to render it almost impossible for them to cross even small streams without danger, at certain seasons of the year. These the Alligator seizes, drags under water, suffocates, and conveys to his lair, to be devoured at leisure."—Holbrook (1836)

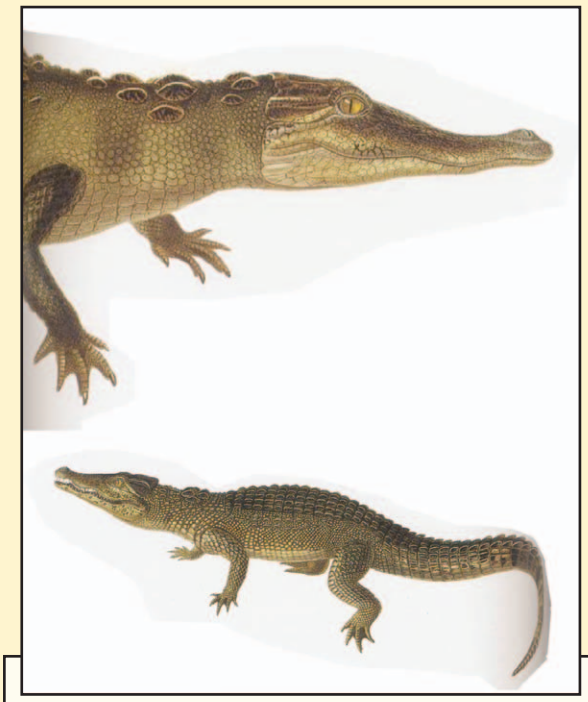
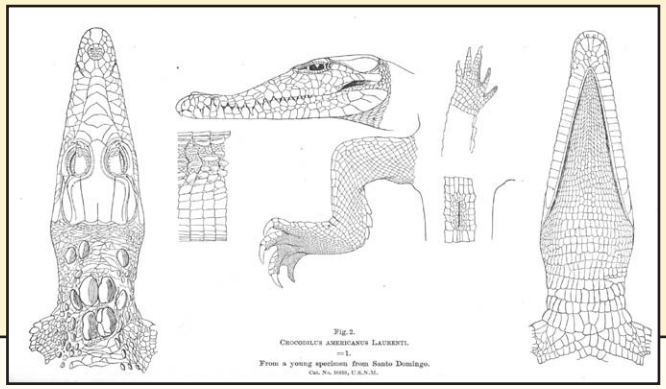
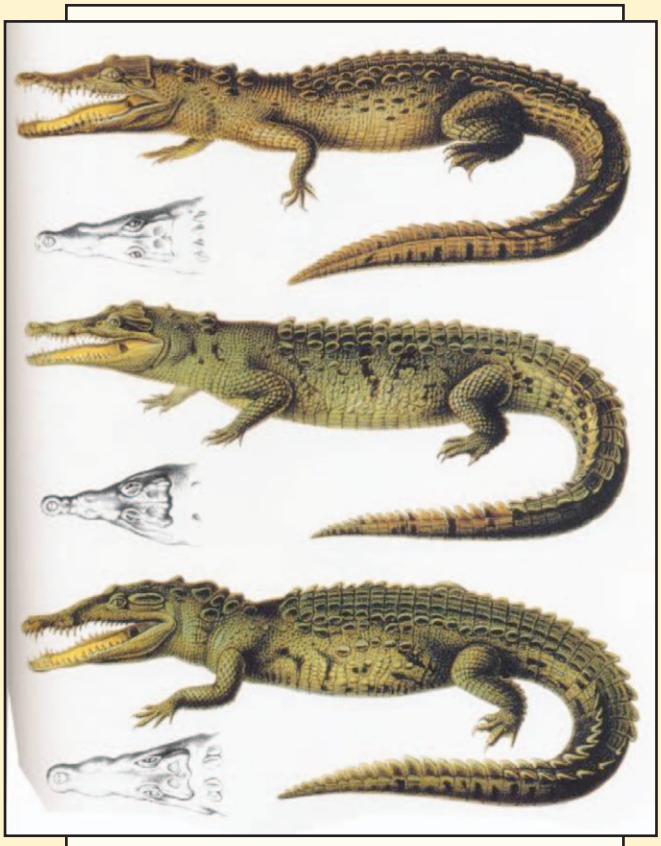


Illustration of American Crocodile (*Crocodylus acutus*) [top] and Cuban Crocodile (*C. rhombifer*) from *Historia fisica, politica y natural de la isla de Cuba*, by Ramón de la Sagra in 1839–1856. Hybridization between these two species is a serious threat to the Cuban Crocodile. "It has been known that they have killed human beings. I shall recite an episode told me by Don Helvecio Lanier. Once while this gentleman was on the Isla de Piños at Nueva Gerona, one of the numerous prisoners of war interned there insisted upon bathing in a river which was known to be inhabited by a large Caiman. No sooner had he jumped in than he was seized by the beast and pulled under; his companions being infuriated laid traps and caught the animal, which they would have torn to pieces had not Sr. Lanier intervened asking them to allow him to remove the hide, after which they tore the body into bits. Nine foot Cocodrilos or Caimans are not to be feared, I myself have gone into lagoons up to my chest where they abound, and instead of attacking they have always run away."—Thomas Barbour and Charles T. Ramsden (1919), *The Herpetology of Cuba*

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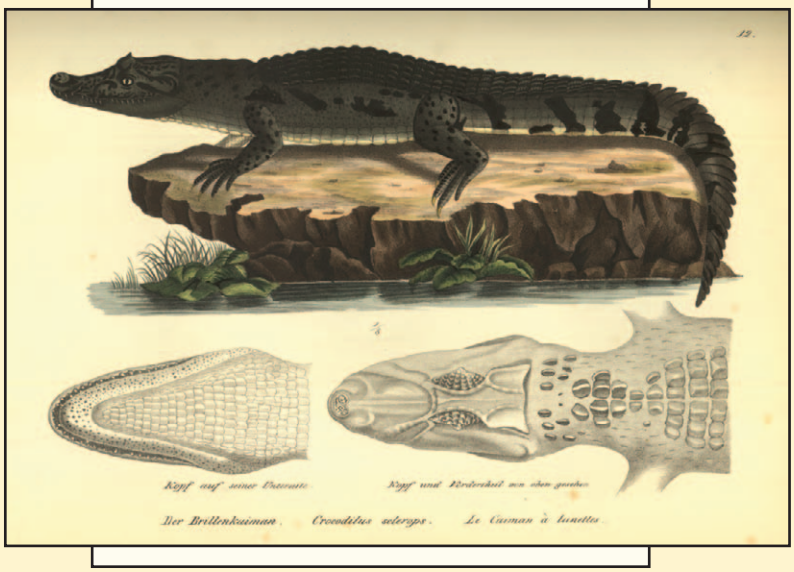


American Crocodile from *The Crocodilians, Lizards, and Snakes of North America*, by Edward Drinker Cope (1900). "Although seldom perturbed to any great degree by his own internecine activities, man is much aroused on those rare occasions when he himself falls prey to some lower animal. The importance of such occasions could easily be overemphasized. In discussing alligator attacks on man, I should like to note at the outset that this reptile is far less dangerous to man than is, say, the domestic dog. Rabid dogs, and even nonrabid ones, attack people far more often than do alligators; and the same can be said of domestic cattle and hogs. Alligator predation on man would not in fact merit lengthy discussion were not the literature so confused and contradictory in its treatment of the subject."—Wilfred T. Neill (1971), *The Last of the Ruling Reptiles; Alligators, Crocodiles, and their Kin*



This drawing of American Crocodile (*Crocodylus acutus*) is from *Études sur les reptiles*, by Auguste Henri André Duméril, Marie-Firmin Bocourt, and François Mocquard in 1870. "By far the most interesting thing about the feeding habits of crocodilians is the way they overcome large prey and reduce it to pieces that can be swallowed easily. This method is also used by crocodilians struggling over the same object. Once the jaws get a firm hold on the animal, the body of the crocodilian turns over and over, revolving rapidly on its long axis, so that one of two things happens: either the victim is turned over and over until it is rendered completely helpless, or it is simply twisted into two pieces. I have seen the photograph of a man who was given this treatment and had his arm torn from the socket. Oddly enough, he lived and was able to be photographed the day after the accident. The twisting action kept him from bleeding to death by closing the ends of the blood vessels instead of allowing them to remain open, as would have been the case if the arm had been cut off by a sharp knife. After the prey has been overpowered and reduced to pieces small enough to be swallowed, it is literally gulped down. If a piece includes big bones, these may be crushed by the jaws. Mouthfuls beyond a certain length may be tossed about until they will start end-first down the throat. The head is held high and tilted backward during this preliminary process, and is lifted above the surface if the crocodilian is submerged. Although large objects are always wolfed out of water, very small ones may be swallowed when the head of the crocodilian is under it and the jaws are tightly shut."—Clifford H. Pope (1957), *Reptiles Round the World*

Illustration from Heinrich Rudolf Schinz (1861), *Naturgeschichte und Abbildungen der Reptilien*. "Humans and crocodilians have been interacting since the dawn of civilization. The arena for this early interaction was probably Africa and Asia. It can be presumed that crocodilians preyed upon humans for food, but as man became a hunter, he stalked the crocodilians and was much more successful…Wherever and whenever humans meet crocodilians, there is bound to be fear, revulsion, and on occasion injury or death for either the person or the animal. Strangely, there is rarely any "hatred"... Crocodilians, however, have recently been the losers in this inter-species battle. While surviving for tens of millions of years, it has just been within the last hundred years that the few species remaining on earth have been severely threatened with extinction. The discovery that their hides make prized leather has been the chief cause of this demise. Secondary causes include hunting of the animal for sport and for food (including eggs) and loss of habitat due to human encroachment."—Steve Grenard (1991), *Handbook of Alligators and Crocodiles*



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ARTICLES

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Terrestrial Movements of the Red-bellied Mudsnake (*Farancia abacura*) and Rainbow Snake (*F. erytrogramma*)

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Red-bellied Mudsnakes (*Farancia abacura*; Fig. 1A) and Rainbow Snakes (*Farancia erytrogramma*; Fig. 1B) are relatively large species with geographic distributions restricted to the southeastern United States. Both species are highly associated with aquatic habitats, to the extent that at least one, the Red-bellied Mudsnake, has been described as "fully aquatic" (Lutterschmidt et al. 2006). Adults of both species have highly specialized diets: Red-bellied Mudsnakes feed primarily on aquatic, elongate, eel-like salamanders (Sirens [*Siren* spp., *Pseudobranchus* spp.] and Amphiumas [*Amphiuma* spp.]), while adult Rainbow Snakes feed almost exclusively on a stream-dwelling, catadromous fish, the American Eel (*Anguilla rostrata*; Neill 1964).

Because *Farancia* are difficult to observe or study, we know little about their ecology and natural history; however, both species are known to undertake terrestrial movements. Our knowledge regarding terrestrial activity of these snakes is based largely on captures from drift fences surrounding Carolina bays (e.g., Semlitsch et al. 1988); although data derived from these captures have expanded our understanding of the species, the spatial extent of terrestrial movements has not been reported. This information, however, is of relevance to the conservation of wetland-associated organisms (Semlitsch and Bodie 2003).

Farancia may undertake terrestrial movements for several reasons. Both species are generally thought to hibernate below ground or under woody debris adjacent to their aquatic habitats (Ernst and Ernst 2003; Gibbons et al. 1977; Neill 1948; Young and Gibbons 2008). Richmond (1945) suggested Rainbow Snakes were the most abundant snake in the sandy fields of New Kent County, Virginia, based on his observations that specimens were frequently discovered by plowing fields. In this region, snakes were observed more often on land than in the neighboring wetlands.

Farancia may emigrate from wetlands during drought (Seigel et al. 1995; Willson et al. 2006) but sample sizes from past studies have generally been small. In the only published radio-telemetry study of the genus, Martin (1998) noted that Red-bellied Mudsnakes (N = 3) had small home ranges and were highly aquatic, making only small movements overland to neighboring wetlands during drying conditions. Red-bellied Mudsnakes may move overland in response to significant rainfall events, based on a mass movement of juveniles across a two-lane highway through a freshwater marsh in Florida (Hellman and Telford 1956).

Both species nest on land and their nests are generally thought to be located close to wetlands (e.g., Neill 1964; Hall and Meier 1993). However, Red-bellied Mudsnake nests have been found 15 m and 46 m from lakes in Alachua Co., Florida (Auth

1992; Riemer 1957) and 91 m from a lake in Aiken Co., South Carolina (Neil 1964). Neil (1964) also noted a Rainbow Snake approximately 64 m from a lake in Richmond Co., Georgia, but the impetus for this movement is not known.

Methods.—Herein, we review our previously unpublished data on Red-bellied Mudsnakes and Rainbow Snakes found in terrestrial habitats >25 m from the nearest body of water. For Rainbow Snake captures, we also report the distance to the nearest body of water known to be inhabited by American Eels (when available). Distances were estimated through use of Geographic Information Systems, topographical maps, or Google Earth. Because water levels may fluctuate, the distances we report should be considered approximations, but they correspond to our impressions in the field.

To determine whether our observations of *Farancia* away from water were unusual events, we reviewed location data compiled by the Carolina Herp Atlas (CHA), an online database maintained by Davidson College and generated by voluntary submissions of amphibian and reptile observations in North and South Carolina (Price and Dorcas 2011). We first removed data from Aiken or Barnwell Counties, South Carolina, because many of the observations from these counties were not generated from incidental observations, but rather resulted from controlled trapping efforts for semi-aquatic snakes on the Savannah River Site (e.g., Durso et al. 2011). We also removed any remaining observations generated from trapping elsewhere, as indicated in the "Remarks" section of the data input form. Finally, we removed observations collected prior to 2000 to ensure currently available wetland boundaries were relevant to snake observations. Then, we used ESRI ArcMap 9.3.1 to measure the distance between each *Farancia* location and the nearest wetland boundary, as delineated by the National Wetland Inventory (U.S. Fish and Wildlife Service 2011). A value of zero was recorded if the observation was within a wetland boundary.

Results.—We compiled 60 and 18 observations of Red-bellied Mudsnakes and Rainbow Snakes, respectively, from our unpublished field notes and trap capture data (Table 1). Individuals of both species were observed considerable distances from the nearest body of water (up to 1288 and approximately 2000 m for Red-bellied Mudsnakes and Rainbow Snakes, respectively). We included 17 Red-bellied Mudsnake and six Rainbow Snake observations from the CHA (Fig. 2). On average, Red-bellied Mudsnakes submitted to the CHA were observed 62 m from the nearest wetland boundary (SD = 72.07 m, range 0–264 m) and Rainbow Snakes were observed 44 m from the nearest wetland boundary (SD= 44.91 m, range 0–117 m).

Discussion.—We demonstrate that both Red-bellied Mudsnakes and Rainbow Snakes undertake considerable terrestrial movements and these movements may not be unusual events. This information supplements similar and recent information on terrestrial movements of other snakes considered highly aquatic (Steen et al. 2011), and further emphasizes the important role of the terrestrial landscape to species that spend the majority of their time in wetlands. We are unable to determine why the snakes we observed were traveling overland. However, many of the small individuals captured in the spring were likely immature (Gibbons et al. 1977; Lutterschmidt et al. 2006) and dispersing to wetlands after overwintering and emerging from their nests (Gibbons et al. 1977). For example, our spring observations of four hatchling-sized Rainbow Snakes (captured in a large area of xeric sandhill habitat adjacent to the Canoochee River on Fort Stewart, Georgia [Table 1]) suggest that the coarse sandy soils of xeric sand ridges adjacent to perennial blackwater streams may be important nesting habitat, when available.



COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND PHOTOS BY D. STEVENSON

FIG. 1. A) Western Mudsnake (*Farancia abacura reinwardtii*), Cache River bottomlands, Johnson Co., Illinois, USA. B) Rainbow Snake (*Farancia e. erytrogramma*), Canoochee River, Liberty Co., Georgia, USA.

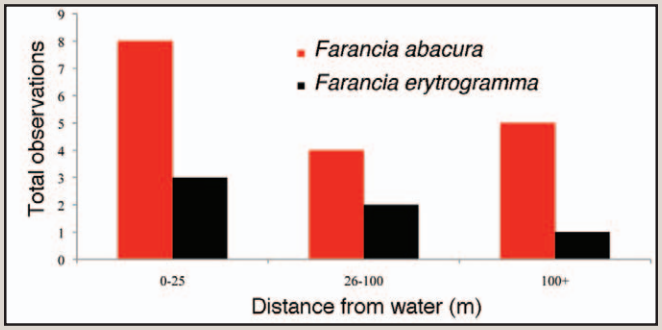


FIG 2. Distance to nearest body of water for Red-bellied Mudsnake (*Farancia abacura*) and Rainbow Snake, (*F. erytrogramma*) observations submitted to the Carolina Herp Atlas since 2000.

Sexually mature individuals were likely undertaking a nesting migration, dispersing to wetlands, or moving to a terrestrial overwintering site. Observations from Baker Co., Georgia (Table 1) suggest these animals may also travel overland in response to flooding events, as suggested by Hellman and Telford (1956). Only two captures from this site were recorded in seven years of trapping in a Longleaf Pine forest and both were in months of unusually high

TABLE 1. Information related to observations of Red-bellied Mudsnake (*Farancia abacura*) or Rainbow Snake (*F. erytrogramma*) located far (>25 m) from the nearest body of water. When the sex of a snake is known, it is indicated by M (male) or F (female). If no size data were available, but it is known whether the individual was an adult or juvenile, this is indicated by an A, or J, respectively. DOR = Dead on Road, AOR = Alive on Road.

Date	Location	Sex	SVL[a](mm)	TL[b]	Mass (g)	Distance[c] (m)	Wetland Type	Distance Eel[d]	Observation
Farancia abacura									
5/16/1987	Scotland Co., NC	J				423	Stream		Incidental, AOR
6/14/1987	Scotland Co., NC					341	Stream		Incidental, DOR
7/19/1987	Scotland Co., NC					570	Lake		Incidental, DOR
8/9/1987	Montgomery Co., NC					720	Pond		Incidental, DOR
6/18/1989	Scotland Co., NC					360	Headwater stream		Incidental, DOR
4/12/1992	Scotland Co., NC	F	205	233		120	Headwater stream		Incidental, DOR
9/5/1992	Bladen Co., NC					270	Carolina bay lake		Incidental, DOR
5/9/1993	Scotland Co., NC					710	Headwater stream		Incidental, DOR
9/5/1994	Bulloch Co., GA		~225	~250		90	Forested swamp		Incidental, AOR
5/15/1997	Scotland Co., NC	F	202	230		625	Stream		Incidental, DOR
10/8/1997	Bryan Co., GA		225	251		26	Cypress-gum pond,		Trap
4/8/1999	Bryan Co., GA	F	235			130	Cypress-gum swamp		Trap
9/5/2000	Bryan Co., GA		225	253	6	65	Cypress-gum swamp		Trap
7/20/2001	Barnwell Co., SC	M				183	Pond		Incidental, DOR
5/13/2002	Aiken Co., SC					~200	Stream		Incidental, DOR
7/6/2002	Aiken Co., SC			471		38	Pond		Incidental, DOR
8/16/2002	Barnwell Co., SC					290	Forested wetland		Incidental, DOR
9/11/2002	Orangeburg Co., SC					~170	Forested wetland		Incidental, DOR
5/5/2003	Aiken Co., SC	M		~980		~100	Stream		Incidental, DOR
5/11/2003	Aiken Co., SC			~850		~750	Beaver pond/stream		Incidental, DOR
5/20/2003	Aiken Co., SC	M		1021	208	390	Beaver pond/stream		Incidental, AOR
5/24/2003	Aiken Co., SC	F		1072	242	1086	Barrow pit		Incidental, AOR
6/12/2003	Aiken Co., SC			~1000		317	Carolina bay		Incidental, DOR
6/17/2003	Barnwell Co., SC	J		260	5.2	461	Stream		Incidental, DOR
6/21/2003	Bulloch Co, GA					138	Stream		Incidental, DOR
6/21/2003	Bulloch Co., GA					~600	Pond		Incidental, DOR
6/23/2003	Effingham Co., GA	F				79	Stream		Incidental, DOR
10/13/2003	Walton Co, GA					557	Farm pond		Incidental, DOR
4/25/2004	Covington Co., AL	J				150	Cattle pond		Trap
5/13/2004	Covington Co., AL		235	266	5.5	115	Creek		Trap
5/18/2004	Aiken Co., SC					77	Carolina bay		Incidental, DOR
5/27/2004	Covington Co., AL		218	260	6.5	62	Beaver pond		Trap
6/22/2004	Vernon Parish, LA			1000		160	Stream		Trap
6/29/2004	Aiken Co., SC	F	774	859	176	363	Carolina bay		Incidental, AOR

Table 1. Continued.

Date	Location	Sex	SVL[a](mm)	TL[b]	Mass (g)	Distance[c] (m)	Wetland Type	Distance Eel[d]	Observation
7/12/2004	Covington Co., AL		231	278	7	72	Beaver pond		Trap
8/31/2004	Aiken Co., SC	J	192	226	5.33	91	Carolina bay wetland		Coverboard
4/11/2005	Baker Co., GA	F	709	856	227	457	Creek		Trap
5/14/2005	Moore Co., NC	F	222	249		446	Beaver swamp		Incidental, DOR
5/21/2005	Aiken Co., SC	F	930	1046		520	Stream		Incidental, DOR
6/11/2005	Jasper Co., Texas			720		180	Stream		Trap
6/13/2005	Perry Co., MS	F	323	384	18	181	Gum swamp		Trap
9/3/2005	Liberty Co., GA	A		914		265	Canal		Incidental
7/2/2006	Barnwell Co., SC	F	~680	~780	117	125	Pond		Incidental, DOR
7/3/2006	Barnwell Co., SC	M	~645	~745		730	Beaver pond/stream		Incidental, DOR
7/14/2006	Montgomery Co., NC	F				80	Stream		Incidental, AOR
8/2/2006	Scotland Co., NC	F	816	913		325	Stream		Incidental, DOR
5/23/2007	Moore Co., NC	M	714	853		415	Stream		Incidental, AOR
5/28/2007	Moore Co., NC	F	696	778		1288	Stream		Incidental, DOR
June, 2007	Liberty Co., GA	A		1270		150	Cypress swamp		Incidental, DOR
6/18/2007	Sabine Co., TX			880		140	Stream		Trap
6/20/2007	Moore Co., NC	F	745	833		1100	Stream		Incidental, DOR
6/20/2007	Richmond Co., NC	M	584	690		534	Stream		Incidental, DOR
6/22/2007	Walton Co., FL	A				54			Incidental, DOR
7/12/2007	Beinville Parish, LA					200	Stream		Trap
5/14/2008	Macon Co., AL	F	580	712	175	35	Oxbow lake		Incidental
7/22/2009	Walton Co., FL	F		1905		32			Incidental, DOR
6/20/2010	Walton Co., FL	F				75			Incidental, DOR
8/17/2010	Walton Co., FL	A				30			Incidental, DOR
7/8/2011	Scotland Co., NC	F				788	Lake		Incidental, AOR
7/17/2011	Elmore Co., AL	F	1425	1580	1440	148	Stream		Incidental
Farancia erytrogramma									
5/9/1993	Bulloch Co., GA			~864		210	Forested Swamp	460	Incidental, AOR
1/6/1994	Washington Parish, LA				120	River	Same		Incidental, plowed
1/6/1994	Washington Parish, LA	A				120	River	Same	Incidental, plowed
5/19/1996	Bladen Co., NC	M				480	Stream	Same	Incidental, AOR
4/2/1999	Bryan Co., GA	M	~200	~220		65	Cypress-gum swamp	470	Trap
4/7/1999	Bryan Co., GA	F	200	220		210	Cypress-gum swamp	590	Trap
4/16/1999	Bryan Co., GA	M	229	279		210	Cypress-gum swamp	590	Trap
5/5/2000	Bryan Co., GA	F	216	248	6	185	Cypress-gum swamp	575	Trap
5/7/2003	Liberty Co., GA	F		1070		150	Cypress-gum swamp	365	Incidental, DOR

TABLE 1. Continued.

Date	Location	Sex	SVL[a](mm)	TL[b]	Mass (g)	Distance[c] (m)	Wetland Type	Distance Eel[d]	Observation
6/8/2003	Bladen Co., NC	J				625	Pond	1329	Incidental, DOR
6/23/2003	Candler Co., GA					~200	Stream/river	same	Incidental, DOR
6/27/2003	Aiken Co., SC	F - gravid				230	Stream	same	Incidental, DOR
7/20/2003	Liberty Co., GA	F		356		45	Cypress-gum swamp	2590	Incidental, DOR
2004	Pulaski Co., GA	F		<1700		140	River	255	Incidental, plowed
5/21/2005	Aiken Co., SC	M	670	814		~2000	Stream	same	Incidental, DOR
7/18/2005	Baker Co., GA	F	820	949	326	457	Creek	457	Trap
6/1/2007	Liberty Co., GA			345		26	Cypress-gum swamp	505	Incidental, DOR
3/29/2008	Emanuel Co., GA			~200		70	Stream		Incidental, under log

[a] Snout–vent length
[b] Total length
[c] Distance from the snake to the nearest body of water
[d] Distance from the snake to the nearest body of water known to contain a population of American Eels, *Anguilla rostrata*

flow rates for Ichawaynochaway Creek, the nearest body of water at this site (U.S.G.S. Water-Data Report GA-2005).

Results presented herein demonstrate that both Red-bellied Mudsnakes and Rainbow Snakes undertake long movements overland. We are unable to determine the cause or extent of these movements, or the frequency with which these snakes move onto or across the terrestrial landscape. Radio-telemetry studies of other aquatic snakes (e.g., *Nerodia* spp.) have demonstrated that they undertake regular terrestrial movements and terrestrial landscapes were identified as an important component of their life history (e.g., Camper 2009; Roe et al. 2003). The distances we report are well beyond the mean distances traveled overland by these other species (Camper 2009; Roe et al. 2003). Given the biology of *Farancia*, generating robust sample sizes for comparable radio-telemetry studies might be difficult; however, studies of this type are warranted, as they will likely generate novel natural history information related to aquatic home range size or the degree to which terrestrial habitats are used. An intact landscape to accommodate terrestrial movements is likely an important component to the life history of these wetland-associated snakes.

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Northern Mexican Gartersnakes, *Thamnophis eques megalops*, feeding on *Spea multiplicata* in an Ephemeral Pond

The Northern Mexican Gartersnake, *Thamnophis eques megalops*, is the only subspecies of the Mexican Gartersnake occurring in the United States. Historically, it ranged from central Arizona and southwestern New Mexico southward through the Mexican states of Sonora, Chihauhua, Durango, Guanajuato, Hidalgo, and San Luis Potosí (Brennan and Holycross 2006; Rosen and Schwalbe 1988; Rosen et al. 2002), but is now thought to be at extremely low population densities or extirpated in New Mexico (Holycross et al. 2006). In Arizona, population declines have been recorded in approximately 83% (15/18) of the Mexican Gartersnake populations originally surveyed in the early to mid-1980s and re-surveyed in 1995–2000 (Rosen et al. 2002). Survey data from the Gila River watershed in Arizona and New Mexico during 2004–2005 suggest continued severe population declines and local extirpations (Holycross et al. 2006). These declines were considered significant enough that the Center for Biological Diversity petitioned (CBD) to list the Northern Mexican Gartersnake as Threatened or Endangered under the U.S. Endangered Species Act (CBD 2003). Although the petition was initially unsuccessful (USFWS 2006), the U.S. Fish and Wildlife Service (USFWS) later concluded that the Northern Mexican Gartersnake is threatened with extirpation, or may already be extirpated from 85–95% of its historical distribution in the United States and that listing was warranted (USFWS 2008). The USFWS expects to publish updated information in the Federal Register on the status of Northern Mexican Gartersnakes (J. M. Servoss, pers. comm.)

Northern Mexican Gartersnakes are associated with permanent water and cienega habitats containing aquatic vegetation and a wide range of terrestrial vegetation (Rosen and Schwalbe 1988; Rossman et al. 1996). Their prey consists primarily of fish, frogs and tadpoles, although invertebrates, lizards (T. R. Jones, pers. comm.), and mammals are also eaten (Garcia and Drummond 1988; Rosen and Schwalbe 1988; Van Devender and Lowe 1977).

Observations.—On 15 July 2012 at 2130 h following one of the first heavy monsoon rains in the area, a male Mexican Gartersnake was observed feeding on a Mexican Spadefoot (*Spea multiplicata*) in a seasonal pond at the Appleton-Whittell Research Ranch (AWRR) of the National Audubon Society, near Elgin, Arizona, USA. The pond, which had been dry since the summer of 2010 (R. Cogan, L. Kennedy, pers. comm.), filled earlier that day to approximately 150 × 30 × .5 m (L×W×D) from overflow of an adjacent dry wash which had also been dry since the previous summer (Fig. 1). A breeding aggregation (>50) of *S. multiplicata*, that had not been present on previous nights, was active in the tank. The 520 mm SVL snake was captured by hand, photographed, and released on site. The following morning during 0745–0950 h, five other Mexican Gartersnakes were observed basking at the bases of Sacaton grass (*Sporobolus wrightii*) surrounding the pond. Four were captured by hand, but the fifth eluded capture. The captured snakes included two males (505 mm, 520 mm SVL) and two females (675 mm, 737 mm SVL). The snakes were released at their site of capture following data collection. All five snakes captured were at or near sexual maturity. Male Mexican Gartersnakes from nearby Finley Tank, also at AWRR, are thought to reach sexual maturity when

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FIG. 1. Ephemeral pond at the National Audubon Society Appleton-Whittell Research Ranch, Santa Cruz County, Arizona. Northern Mexican Gartersnakes, *Thamnophis eques megalops*, were observed basking at the bases of Sacaton grass, *Sporobolus wrightii*, in the left foreground and left rear shore of the pond.



FIG. 2. A Northern Mexican Gartersnake engorged on Mexican Spadefoots, *Spea multiplicata*, at the National Audubon Society Appleton-Whittell Research Ranch, Santa Cruz County, Arizona.



FIG. 3. Seven Mexican Spadefoots, *Spea multiplicata*, regurgitated by a female Northern Mexican Gartersnake, *Thamnophis eques megalops*, upon her capture at the National Audubon Society Appleton-Whittell Research Ranch, Santa Cruz County, Arizona. Toads were re-ingested by the snake prior to her release at the site of capture.

they are 410–580 mm SVL; females at SVL's between 550–700 mm (Rosen and Schwalbe 1988).

The four snakes captured on the morning of 16 July were engorged with anurans (Fig. 2). One female regurgitated seven *S. multiplicata* upon capture and palpation revealed two more. The seven regurgitated spadefoots, one female and six males, had a combined mass of 60 g (Fig. 3). The approximate mass of all nine spadefoots ingested by the snake was 77 g, representing approximately 39% of the total mass of the 200 g snake, recorded after she had re-ingested all seven of the regurgitated prey. No feeding or aquatic activity was observed during the morning of 16 July, indicating that the snakes had fed during the previous night or in the early morning hours prior to the initial sighting of two snakes basking at 0745 h.

Discussion.—To our knowledge, this is the first documentation of Mexican Gartersnakes feeding on any species of spadefoot and the first report of nocturnal foraging in this species. In contrast to reports stating that Mexican Gartersnakes are restricted to riparian habitats with permanent sources of water (Brennan and Holycross 2006; Rosen and Schwalbe 1988; Rossman et al. 1996), our observations raise the possibility that this species can occur, at least temporarily, in riparian areas where standing water is only seasonally available. In a study of Mexican Gartersnakes at Finley Tank in 2007, two neonates were found at the tank in July, the beginning of the monsoons, which had been dry since the previous winter, suggesting at least one adult female had successfully reproduced without access to a nearby permanent water source containing frogs or fish (d'Orgeix 2011).

The species is either extirpated or occurs at extremely low densities at the Babacomari River, which is the nearest large permanent water source 4.2 km N and downstream from the pond, and none has been seen since 2007 in a small rock pool in Post Canyon 1.5 km SW of the pond (d'Orgeix 2011). The nearest known population of Mexican Gartersnakes is 1.2 km distant at Finley Tank where individuals have been seen as recently as 2009 (d'Orgeix 2011). Although Finley Tank was once a permanent water source, it has contained water only intermittently since 2006 (d'Orgeix 2011). Following the July–August monsoons in 2011, Finley Tank went dry and did not fill again until the night we observed snakes in the pond. If the snakes we observed had emigrated from Finley Tank between the time of the pond filling and our observations, they would have had to have left Finley Tank as it was filling with rainwater and moved 1.2 km overland through open semi-desert grassland in 6–17 h. Even less plausibly, snakes could have followed the single connecting riparian corridor from Finley Tank to the pond (~2.3 km long) that would have required upstream travel against rapidly moving floodwaters carrying substantial debris. Last, none of the five snakes we captured at the pond were marked individuals from the Finley Tank population where all individuals encountered (N = 29) had been given unique identification marks and PIT tags from 2007 to 2009 although recapture rates were low (d'Orgeix 2011). These considerations collectively suggest that the snakes we observed were already present in the near vicinity of the pond before it filled.

Our observations raise the possibility that, under drought conditions, spadefoots are an important food source for Mexican Gartersnakes, and are taken during the brief time these anurans are breeding in ephemeral ponds. Snakes may then be aestivating when the pond is dry. Aestivation in snakes has rarely been documented, but the small aquatic snake *Seminatrix pygaea* aestivates in seasonally dry wetland and has been predicted to

survive multiyear droughts in this manner (Winne et al. 2006). However, we cannot exclude the possibility that the snakes are also feeding on other terrestrial organisms (e.g., lizards, rodents) when ephemeral sites are dry, or emigrating to other sites with permanent water.

To confirm whether our findings are more widely applicable to the ecology of Mexican Gartersnakes, additional surveys for snakes are needed at ephemeral sites in riparian habitat when spadefoots are breeding. Subsequent results may determine whether use of this previously unrecognized habitat and food source is more prevalent than previously thought and contribute meaningfully to recovery strategies.

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Behavior of *Plethodon metcalfi* Following Anesthetization with Tricaine Methanesulfonate (MS-222)

Tricaine methanesulfonate (also called Ethyl 3-aminobenzoate methanesulfonic acid or MS-222) is commonly used as an anesthetic in fish and amphibian research. Because MS-222 generally appears to be safe and effective for a range of amphibian species, it is commonly used in the process of surgery or marking of animals (e.g., Chelgren et al. 2006; Osbourn et al. 2011; Peterman et al. 2008). Amphibian responses to anesthesia may be species-specific (Fellers et al. 1994), and a number of studies have performed multi-species evaluations of induction and recovery times (Cecala et al. 2007; Lowe 2004; Peterman and Semlitsch 2006). Recovery times of individuals following anesthesia have previously been reported as the time until first response to a stimulus (Cecala et al. 2007; Peterman and Semlitsch 2006), recovery of a righting reflex (Crook and Whiteman 2006), or recovery of normal motor function with no indication of sluggishness or disorientation (Cecala et al. 2007; Crook and Whiteman 2006). In many cases, researchers will face a trade-off between the desire to minimize the time that animals are in captivity and the need to ensure that animals have adequate time to recover from anesthesia before release.

As a practical consideration for field research, allowing amphibians adequate time to recover from anesthesia may be critical for ensuring that our research activities do not cause predation or desiccation-related mortality. Behavioral studies are also conducted on the assumption that released individuals are behaving normally between subsequent observations. Furthermore, many mark-recapture models for estimating population parameters are based on the assumption that all individuals in

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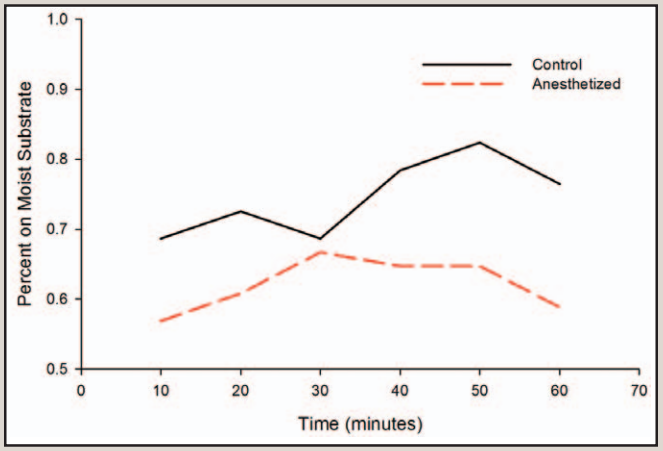


FIG. 1. Proportion of salamanders found on the moist substrate (N = 102).

a population (marked and unmarked) have an equal probability of survival and subsequent capture (Bailey et al. 2004). This assumption would be violated if the marking process resulted in elevated mortality or affected individual behavior in a way that altered the probability of future recapture. As a result, it is critical that we understand the extent to which the behavior of amphibians is impacted by the process of anesthetization and handling.

Many amphibians have narrow temperature and moisture requirements (Spotila 1972) and microhabitat selection behavior can be highly important for the regulation of water loss and desiccation risk (Heatwole 1960). As a result, we designed a laboratory experiment in which both un-anesthetized and previously anesthetized salamanders were presented with a choice between moist and dry substrate. We compared the substrate choice and movement behavior of control individuals with the behavior of individuals which had recently recovered full motor function following anesthesia. Ultimately, we sought to determine whether previously anesthetized individuals continued to demonstrate behaviors indicative of compromised function following their apparent recovery.

MATERIALS AND METHODS

Salamanders for this study were captured on the grounds of the Highlands Biological Station, Macon Co., North Carolina, USA (35.0546°N, 83.1902°W). A total of 102 *Plethodon metcalfi* (Southern Gray-cheeked Salamander) were hand-captured during nocturnal surveys in July of 2011. Each captured salamander was housed in an environmental chamber set to 16°C with a 14 h light/10 h dark photoperiod which corresponded to the natural photoperiod at the time. Salamanders were kept for a maximum of one week following initial capture, during which time they were housed individually in sterile plastic containers and were only exposed to other animals collected from the same area (within 400 m) during our experiment. Following completion of experimental trials, all salamanders were released at their site of capture.

To examine the effects of anesthetization with MS-222 on salamander behavior, we conducted a laboratory experiment in which we presented salamanders with a choice between moist and dry substrate. In this experiment, six choice test chambers were constructed out of rectangular plastic storage containers (61 × 42.7 × 16.8 cm) following procedures outlined by Crawford (2007). A piece of corrugated plastic was attached with silicone across the width of the containers in order to divide the chambers into equal halves. Four large panels were cut out of the lids of the containers and sealed with window screening. Both sides of the chamber were filled with commercial topsoil (about 20 cm^3) to the level of the plastic divider. Next, a moist and a dry side were randomly assigned within each container and a small spray bottle was used to add six ounces of water to the surface of the moist side of the chamber.

To begin this experiment, our MS-222 solution was prepared at a concentration of 500 mg/L and was buffered with 0.4 g of sodium bicarbonate (Peterman and Semlitsch 2006). Each salamander was being housed individually in a uniquely numbered plastic container and was selected for a trial and treatment group using a random number table. Six salamanders were randomly selected for each of 17 trials which were conducted from 16–29 July 2011. Three of these six salamanders were randomly selected to be anesthetized and were simultaneously placed in the MS-222 solution. Salamanders were considered fully anesthetized when they no longer responded to a light limb pinching (typically 5–10 min), at which point they were placed in fresh water to recover. Salamanders were considered fully recovered when they regained consciousness and seemed to have recovered full motor function, which we defined as the point at which salamanders appeared able to walk or swim normally with no sign of sluggishness or disorientation (Cecala et al. 2007). Specifically, only salamanders which showed a rate of body or tail undulations comparable to the rate of an unanesthetized salamander and which showed a rapid righting response while swimming were determined to be fully recovered. After each of the three salamanders for a trial had fully recovered from anesthesia (<15 min), salamanders were randomly assigned to one of the choice test chambers, which were positioned in an environmental chamber. All trials were conducted during the night photoperiod of the chamber and at a temperature of 20°C, which falls within the preferred temperature range of several *Plethodon* species (Spotila 1972). Prior to beginning the experiment, each salamander was gently placed under a Styrofoam cup on the barrier of the dry and moist side of the chamber and allowed to acclimate for five minutes. To begin each trial, the cups were removed and the lids placed back on the containers. Using a black light, we quickly inspected each of the six chambers at 10-min intervals for a total of 60 min. On a few occasions, a dim flashlight was needed to locate a salamander (<5% of checks). At each inspection, we recorded whether a salamander was on the moist or dry side of the chamber. If the salamander was on the center divider, then the snout position was used to assign the individual to either the moist or dry side of the chamber. In the last nine trials (54 salamanders), we also used fluorescent powder tracking (e.g. Rittenhouse et al. 2006) to obtain the movement paths of salamanders within the choice test chambers. In these trials, all salamanders had the posterior half of their body covered with fluorescent powder immediately prior to introduction to the choice test chambers. At the end of each 60-min trial in which we conducted powder tracking, we determined the distance travelled by each salamander by tracing their movement path with a piece of string which we measured on a meter stick. Following completion of each trial, we collected 100 ml of soil from the surface of each side of the chamber which was dried in an oven for 48 h in order to calculate the percent soil moisture of both the dry and moist sides. A t-test of independence was used to ensure that a significant difference in soil moisture existed between our moist and dry substrates. We then discarded the rest of the soil

and thoroughly washed each container. Fresh soil was used in each subsequent trial. Salamander test subjects were not re-used and were released at their site of capture following completion of their trial.

Data Analysis.—We examined the effects of anesthetization with MS-222 on three different measures of salamander behavior in this substrate choice test including: distance travelled, overall substrate preference, and final substrate choice. We used an analysis of covariance (ANCOVA) to assess the effect of anesthetization on distance travelled, independent of body size (snout-to-vent length). For this analysis, our measure of distance travelled represented the total powder trail length of the 54 salamanders for which this was measured. Additionally, we used a Fisher's Exact Test to determine whether salamanders which did not move during the course of our experimental trials were non-randomly distributed among our two treatments. To assess overall substrate preference, we classified salamanders according to whether they were observed on the moist side of the chamber greater than 50% of the time (at least four of six observations). Salamanders spending more time on the dry side or an equal amount of time on each side were classified as showing no preference for the moist side. We performed a G-test to assess the null hypothesis that salamanders spending a majority of their time on the moist side would be independently distributed between the anesthetized and control treatments. Finally, we considered final substrate choice to be the position of the salamander (moist or dry side of the chamber) on the final observation made during the experiment (at 60 minutes). We then employed a G-test to determine whether the final substrate choice of each salamander appeared to be independent of treatment. All statistical analyses were performed in the program R (R Development Core Team 2010).

Results

Powder tracking revealed that 51.9% of recently anesthetized salamanders did not move at all during the course of the experiment, while all control animals moved a minimum of 37 cm. Salamanders that failed to move at all during our experimental trial were clearly non-randomly distributed between treatments (Fisher's Exact Test: P<0.01). Overall, control animals moved significantly greater distances than recently anesthetized individuals (ANCOVA: $F_{1,51} = 56.62$, $P < 0.01$), and travelled an average of 125.6 ± 54.9 cm (mean ± 1 SD), while recently anesthetized animals travelled just 30.3 ± 40.4 cm (mean ± 1 SD). The mean masses of the control and treatment individuals were 2.70 ± 1.33 g (mean ± 1 SD) and 2.68 ± 1.23 g (mean ± 1 SD), respectively, and there was not a strong influence of body size on the distance travelled by each salamander (ANCOVA: $F_{1,51} = 0.86$, $P = 0.36$).

In our study, average soil moisture differed significantly between the moist and dry side of the choice test chamber ($t = 28.46$, $df = 101$, $P < 0.01$) and salamanders from both the anesthetized and control group spent the majority of their time on the moist side of the chamber (Fig. 1). Although salamanders in the control group were more often located on the moist side of the chamber than recently anesthetized salamanders (74.5% vs. 62.1% of observations), when salamanders were classified according to whether they showed a preference for the moist side of the chamber (4+ observations on the moist substrate), there was not a significant association between treatment and substrate choice (G-test: P = 0.126). Although not statistically significant, we found a trend indicating a stronger association between treatment and the final substrate choice of a salamander. At the end of the choice test experiment, 76.5% of control animals were located on the moist side of the chamber compared to 58.8% of recently anesthetized animals (G-test: P = 0.058).

Discussion

In this study, recently anesthetized salamanders were presented with a choice between moist and dry substrate. We found that salamanders that appeared to exhibit no sluggishness or disorientation after anesthesia were still likely to differ from control animals in aspects of their behavior. Overall, a large proportion of previously anesthetized salamanders did not move from their release location during our 60-minute experiment. Indeed, 51.9% of recently anesthetized animals did not move at all, while control individuals moved a minimum of 37 cm. The mean distance traveled by control salamanders was over four times greater than that of treatment individuals.

Salamanders in our two treatment groups differed greatly in movement distances, yet we did not observe a significant difference in the number of individuals selecting moist over dry substrates. Although a greater proportion of control individuals were observed on the moist substrate throughout our study, salamanders often switched between substrate types. In addition, our ability to make statistical inference based on substrate choice may be confounded by the large number of treatment individuals being classified as preferring the moist substrate based on their initial snout position even though they did not move at all during the study. An alternative definition for substrate choice, requiring that the salamander's entire body cross the center line may have been more appropriate.

In several previous studies, MS-222 appeared to have minimal effect on the health and survival of many amphibian species (Cecala et al. 2007; Peterman and Semlitsch 2006). A variety of measures have been used to assess amphibian recovery times after anesthesia, with one of the most conservative being the time to full recovery of motor function with animals showing no indication of sluggishness or disorientation (Cecala et al. 2007; Crook and Whiteman 2006). In this study, we investigated the behavior of salamanders that had recovered full motor function after anesthesia and found that these animals still appeared to behave differently from control individuals. Although we cannot distinguish the effects of anesthesia itself from the potential effects of stress or exhaustion due to partial submersion in the anesthetic solution, it is apparent that animals showing no visible signs of compromised function may still be incapable of behaving normally upon release in the field.

Researchers may be required to anesthetize amphibians for a number of purposes, such as surgery, marking, or photography (e.g., Chelgren et al. 2006; Kaiser and Green 2001; Osbourn et al. 2011; Peterman et al. 2008). This may lead to a trade-off between minimizing the time that animals are in captivity and ensuring that animals have adequate time to recover from anesthesia prior to release. Our study clearly indicates that researchers anesthetizing amphibians should account for the fact that some animals may not be capable of normal behavior even after they appear to be physically recovered from anesthesia. Due to the reduced level of movement and reduced ability of recently anesthetized salamanders to respond to substrate moisture, this study suggests that animals may face a temporarily heightened risk of predation and water loss if released too shortly after anesthesia. An important goal of future studies should be to more

precisely determine the amount of time required for released amphibians to be capable of resuming normal behavioral function following anesthesia. Due to the species-specific nature of physical recovery times (e.g., Cecala et al. 2007; Peterman and Semlitsch 2006), researchers should seek to identify the timeframe for behavioral recovery in their own study species. Additional research should also investigate the relative influence of handling stress versus anesthetization on behavior (e.g., Kinkead et al. 2006). This could potentially demonstrate an advantage of using anesthetics that require less handling time and/or do not require immersion in an anesthetic solution (e.g., cutaneous application of Orajel; Chen and Combs 1999).

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Within-Pond Selection of Water Depth for Oviposition in *Ambystoma maculatum*

Animals tend to select habitats in an optimal fashion, thereby maximizing evolutionary fitness (Huey 1991; Morris et al. 2008). For pond-breeding salamanders selection of oviposition sites within breeding ponds can have important consequences for successful hatching and larval success (Petranka 1998). Many aspects of reproduction in Spotted Salamanders (*Ambystoma maculatum*) have been investigated (see review in Petranka 1998) but few details regarding oviposition microhabitat selection are published. Females usually attach eggs to submerged twigs, tree branches, or aquatic plant stems (Egan and Paton 2004; Petranka 1998) and occasionally deposit eggs on pond bottoms (Sexton et al. 1986). However, little is known regarding depth of egg mass attachment. Oviposition studies comparing the total water depth at which egg masses occur relative to random locations in ponds indicate that most egg masses are deposited in shallower areas of ponds where warmer water accelerates development (Dougherty et al. 2005; Egan and Paton 2004). However, little attention has focused on the actual distribution of egg masses with respect to depth from the water surface.

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Depth is hypothesized to be important for successful embryonic development for several reasons. Sufficiently submerged egg masses would remain protected from desiccation when water levels fluctuate or decrease over time (Marco and Blaustein 1998). Pond-breeding salamanders in the temperate zone typically oviposit just after the spring thaw when water levels are highest. The outer gelatinous envelope of the egg mass is hydrophilic and affords protection from desiccation and predators (Petranka 1998; Ward and Sexton 1981). However, when egg masses are deposited or attached too deep development may be negatively affected because temperature, light penetration, and dissolved oxygen concentration decrease with increasing water depth (Wetzel 2001). We examined the depth of *Ambystoma maculatum* oviposition sites in a single breeding season within a small permanent forest pond to determine if there was any evidence of depth selection. Because the tradeoffs to hatching success vary with depth, we expected that the egg mass distribution would be modal and reflect an optimal depth for embryonic development.

Methods.—The study location was a small (288 m^2) permanent pond in an upland portion of an eastern deciduous forested reserve near the Ausable River in Bosanquet Township, of southwestern Ontario (43.11958°N, 81.79574°W). The pond was constructed in 1973 to provide water for fire protection for an adjacent pine plantation. Forest canopy covered about 11% of the pond surface and the perimeter (54 m) vegetation was comprised of tree (30%), shrub (21%), and grass/forbs (49%). The pond averaged a 31-degree slope towards the deepest part of the basin (3.3 m). Emergent vegetation covered 5% of the pond. The sloping edges of the pond contained an ample accumulation of dead deciduous and coniferous twigs and branches that were used by spotted salamanders for egg attachment in each of the past 21 breeding seasons (pers. obs.). The pond lacked fish, but was inhabited by other potential predators including Green Frogs (*Lithobates clamitans*), Wood Frogs (*L. sylvaticus*), Eastern Newts (*Notopthalmus viridescens*), Snapping Turtles (*Chelydra serpentina*), Leeches (*Macrobdella* spp.), and Caddisflies (Order: Tricoptera) (pers. obs.).

We measured water depth from the surface to the top of each egg mass (to nearest 0.5 cm) using a wooden measuring stick within approximately one month after oviposition. Only modest rainfall occurred since the thaw (Environment Canada 2011) and it likely countered evaporation as the pond water level appeared relatively unchanged (pers. obs.). It is unlikely that we missed any egg masses due to the high water clarity when measurements were taken. All egg masses also appeared intact, suggesting that no major hatching or predation had occurred since oviposition. We assigned egg masses to one of twenty, 5-cm depth classes ranging from 0 to 100 cm. All egg masses in the pond were < 100 cm deep. We examined the pattern of oviposition using a *G*-test with William's correction applied (Sokal and Rohlf 1995). To determine if depth selection occurred we compared the observed frequency of egg masses to an expected frequency based on available surface area in each depth class. The expected frequency was determined by multiplying the total number of egg masses observed by the proportion of total area in each depth class (to 100 cm deep). To calculate the proportionate areas for each depth class we first determined the surface area of the pond as length × width × a shape factor of 0.92 (to account for the pond's rounded corners). We then divided the maximum depth of the first depth class by the tangent of the mean slope angle (31 degrees) to determine class horizontal width. We next calculated the pond area beyond that depth class by subtracting twice the class width from the original pond dimensions and multiplying the remaining length × width × 0.92. Subtracting this remaining area from the area that included the depth zone of interest gave the area of that zone; we repeated

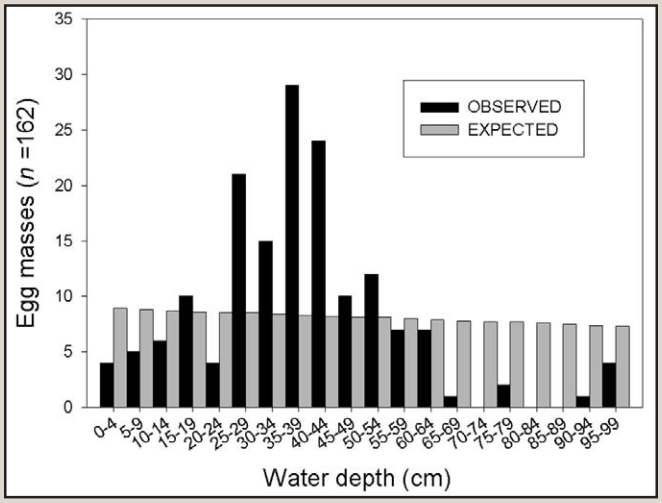


FIG. 1. Frequency distribution of *Ambystoma maculatum* egg masses with water depth from the surface shortly after oviposition in a 3.3-m deep pond in southwestern Ontario, Canada.

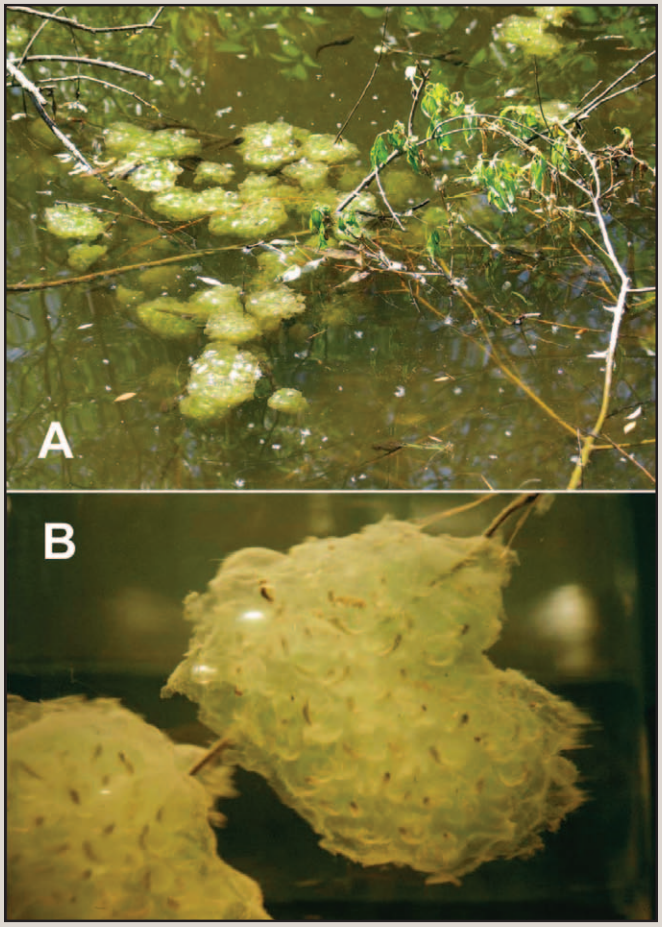


FIG. 2. Cluster of *Ambystoma maculatum* egg masses in the study pond (A). Most masses were attached to stems and twigs (B). Green color imparted to egg jellies by symbiotic algae (*Oophila amblystomatis*).

this process for each successive depth class. Calculating class area in this way accounted for basin shape with decreasing available area of depth classes in sequential bands from shore towards the pond center. Available area (0–100 cm deep = 103.6 m^2 total) decreased from 5.7 (proportion = 0.055) to 4.7 m^2 (proportion = 0.045) from the shallowest to deepest class yielding expected egg masses from 8.9 to 7.3 per class. We consider our available area estimates to be accurate as we carefully mapped pond perimeter and shape using a range finder and compass and determined average slope from multiple random measures along the pond perimeter.

We determined basic statistics and examined shape of the distribution using Lillefor's test and central moment statistics (Systat 12). We subsequently visited the pond five times through the season to observe the egg masses and their condition. Although we measured depth from the water surface to egg masses in just one season, we observed general oviposition patterns during 3–7 visits each year for 21 breeding seasons as part of a longer amphibian monitoring program (unpublished data).

Results.—Mean oviposition depth was 37.9 ± 1.41 cm SEM (median 38.0 cm); range 3.0–95.0 cm, N = 162 (Fig. 1). Egg masses were not distributed as expected with depth class (G = 148.5, df = 19, P < 0.001). Greater use than expected occurred in the 25–29 to 50–54 cm depth classes (Fig. 1). The distribution pattern was bell shaped (Fig.1), but differed significantly from an expected normal curve (Lillefor's test D = 0.0996, P<0.001) with a right-skew ($g1$ = 0.7492) and leptokurtosis ($g2$ = 1.6029). All masses were attached to twigs and stems within 2.0 m from the pond edge and most egg mass envelopes were clear and impregnated with symbiotic algae (*Oophila amblystomatis*) (Fig. 2). The small amount of emergent vegetation (*Typha latifolia*) was not used for egg attachment sites.

Discussion.—Oviposition sites in the pond were non-random. Distribution of available debris for attachment was not measured but it was abundant, appeared relatively even dispersed, and it extended from the water's surface further and deeper into the pond beyond the furthest occurring egg masses. Attachment sites thus appeared not to be limited. Our observations indicated that all egg masses occurred in shallower sections of the pond (< 2.0 m from edge, < 1.0 m deep) similar to the findings of others who examined pond depth where *A. maculatum* egg masses occurred. Egan and Paton (2004) found that egg masses were deposited in shallower water (mean 51.2 cm, range 0–220 cm) compared to mean maximum pond depth (107 cm) in 79 ponds in Rhode Island. Similarly, Dougherty et al. (2005) found that egg masses occurred in water averaging 37 cm relative to depths at randomly selected locations averaging 46 cm in a single pond in Ohio.

We also found a strongly leptokurtic unimodal distribution pattern of egg mass depth suggesting that females preferentially oviposited at ca. 38 cm below the water surface (Fig. 1). We are aware of only two other studies that examined *A. maculatum* oviposition sites with respect to water depth from the surface. Brodman (1995) found that females laid egg masses non-randomly in large clusters on submerged logs and emergent vegetation ca. 10–25 cm deep in an Ohio pond with 1.0 m maximum depth. He concluded that the success of hatching at this depth was attributable to warmer temperatures and presence of symbiotic algae relative to deeper waters. In North Carolina, 26% of 513 *A. maculatum* egg masses were <10 cm from the water surface and the remainder were at greater depth (Petranka, unpubl. data, reported in Starnes et al. 2000).

Six possibly adaptive reasons for the oviposition depth pattern we observed are oxygen levels, spring freezing events, water level fluctuations, sufficient light for symbiotic algae, protection from the harmful effects of UV-B, and predation by invertebrate and vertebrate predators (other amphibians and reptiles). Attachment of egg masses in midwater likely functions to prevent eggs from slipping to pond bottoms where oxygen levels are low (Duellman and Trueb 1986). We found DO_2 was 8.4 ppm in both spring and summer at 10 cm depth but did not measure concentrations across the complete depth profile. Eggs that are deposited in shallow depths may also be subjected to occasional mortality from freezing (Ireland 1989; Wells 2007). Return of ice with cold weather after initial thawing occurs occasionally in this region. During one year we observed several dead adults apparently frozen while exiting the pond. Water level tends to drop by mid-summer in this pond each year by 0–75cm (average fluctuation 25.3 ± 4.7 cm, N = 21 y). Considering that *A. maculatum* eggs hatch within 20–60 d (Harding 1997, June–July in this pond, pers. obs.) the mean depth we observed of 38 cm would leave most egg masses submerged and protected from desiccation during the low water levels of most summers (79.6% of masses > 25.3 cm deep). Virtually all egg jellies we observed were transparent (a few were white) and impregnated with symbiotic unicellular algae (*Oophila amblystomatis*). The oviposition depths we observed also place egg masses at a level where temperature would be warm and optimal light levels occur for development, algal growth, and protection from UV-B. Ultraviolet light can harm salamanders but most UV-B attenuates within 10–20 cm from the surface in natural waterbodies (see references in Crump et al. 1999). However, *A. maculatum* embryos are not particularly sensitive to elevated levels of UV-B and are thought to be at low risk in natural situations (Crump et al. 1999; Starnes et al. 2000).

The thick, firm egg jellies of *A. maculatum* are considered to provide protection from predators (Ward and Sexton 1981) and desiccation (Petranka 1998). We observed adult Red-spotted Newts (*Notopthalmus v. viridescens*), large overwintered Green Frog tadpoles (*Lithobates clamitans melanota*), and leeches (*Macrobdella* spp.) preying upon egg masses, but losses appeared minimal. High densities of newts may be capable of eliminating virtually all *Ambystomata* eggs in small ponds (Wells 2007) and *L. sylvaticus* tadpoles are capable of inflicting high levels of mortality on *Ambystoma* eggs (Petranka 1998). Our observations suggested that *N. viridescens* and *L. syvaticus* densities were moderate and low, respectively, in this pond in most years (3–7 visits/y, N = 21 y). Large Caddisfly larvae can feed on *A. maculatum* eggs (Rowe et al. 1994; Stout et al. 1992) and occur in the pond, but have not been observed feeding on eggs (pers. obs.). Another potential predator is the Snapping Turtle (*Chelydra serpentina*) which has been noted to feed on frog eggs (Steyermark et al. 2008) and *A. maculatum* (life stages other than eggs) (Ernst and Lovich 2009). A large Snapping Turtle resides in the pond but we have not observed it feeding on salamander eggs. Although our detailed study of oviposition depth selection involved only one pond and one season, our results and observations monitoring this pond for 21 years suggest that female *A. maculatum* choose oviposition sites that would provide optimal conditions for embryonic development in most years. Our observations of the distribution of egg masses supports the anoxia, desiccation, freezing, symbiotic algal, and predation hypotheses. Further research examining the processes and mechanisms of factors affecting developmental success is warranted.

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Estimates of Tag Loss for Loggerhead Sea Turtles (*Caretta caretta*) in the Western North Atlantic

Capture-mark-recapture (CMR) research can provide valuable information on the survival rates, movements, population sizes and trends, growth rates, demographics, and other life-history parameters of wildlife populations (Williams et al. 2002). However, in order for CMR research to be accurate in the estimation of these parameters, a reliable method needs to be used to mark animals. Nevertheless, tag or mark loss occurs since no marking system is infallible. This loss, if not accounted for, can bias estimation of population parameters and abundance (Arnason and Mills 1981; Cowen and Schwarz 2006; Frazer 1983; McDonald et al. 2003).

The inability to recognize a mark (hereafter referred to as tag loss) generally has been measured using simple models that evaluate tag retention by monitoring groups of double-tagged animals and quantifying those that were recovered with one and two tags (Seber 1982). However, the assumption that the two tags have an independent rate of loss was not found to be true for sea otters (Siniff and Ralls 1991), black bears (Diefenbach and Alt 1998), fur seals (Bradshaw et al. 2000), leatherback sea turtles (Rivalan et al. 2005), or elephant seals (McMahon and White 2009). Furthermore, Seber's (1982) model only calculates discrete rates of tag loss that might not be accurately extrapolated to the end of the

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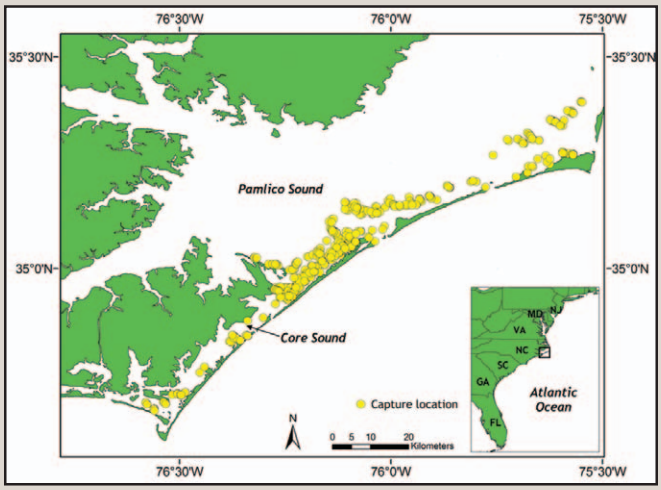


FIG. 1. Loggerhead Sea Turtles (*Caretta caretta*) were captured in fishing gear set in Core and Pamlico Sounds, North Carolina, United States. Inset shows position of main figure within the east coast of the USA.

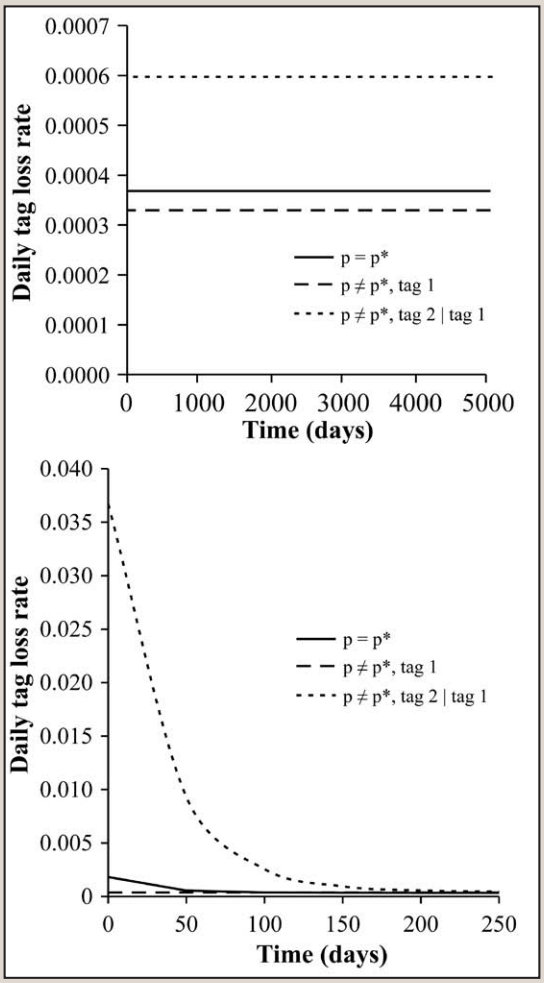


FIG. 2. Daily tag loss rate estimated for Data Set 1 (all individuals that received a PIT tag) using model A, the best fit model, which had a constant tag loss rate over time (upper panel). Daily tag loss rate estimated for Data Set 2 (only those individuals that received a PIT tag during initial capture; lower panel). The best fit model for DS2 was Model D with $p \neq p^*$, which resulted in model A for Inconel tag one and model D for Inconel tag two.

CMR study. Therefore, new methods were developed to address some of these limitations (Diefenbach and Alt 1998; Pistorius et al. 2000; Rivalan et al 2005; Schwartz et al. 2012). One of the models, described in Rivalan et al. (2005), takes an integrative approach that provides an estimate of tag loss rate while allowing for several tag shedding possibilities.

Loggerhead Sea Turtles (*Caretta caretta*) are long-lived, slow-growing animals that spend portions of each life stage in various oceanic and coastal environments (Meylan and Ehrenfeld 2000). In addition, they are vulnerable to many sources of mortality, most notably incidental capture in commercial fisheries (Lewison et al. 2004). Consequently, there is an urgent need to assess and protect their populations from extirpation (National Research Council 2010). Many turtles have been tagged in long-term, in-water studies so that aspects of their cryptic life history can be revealed (see Chaloupka and Musick 1996 for a review). Identification of individual sea turtles is generally accomplished through the use of metal or plastic flipper tags and Passive Integrated Transponder (PIT) tags (Balazs 1999). Efforts to develop photo identification techniques for turtle identification are also becoming more common (Lloyd et al. 2012; McDonald and Dutton 1996; Reisser et al. 2008; Schofield et al. 2008) Previous studies have attributed tag loss in sea turtles to a variety of reasons including turtle species, size of turtle, position of tag, tag material, poor application of the tag, or environment of the turtle (Alvarado 1993; Balazs 1982; Bjorndal et al. 1996; Henwood 1986; Limpus 1992; Parmenter 1993; Reisser et al. 2008; van Dam and Diez 1999).

The first objective of our study was to determine the tag loss rate of Loggerhead Sea Turtles in Pamlico and Core Sounds, North Carolina, USA. We have been double-tagging sea turtles with Inconel metal tags since 1989 and additionally tagging with PIT tags since 1995. We estimated tag loss using the maximum likelihood method in Rivalan et al. (2005), which makes two assumptions: 1) PIT tag loss is negligible and 2) the probability of a turtle not being observed again is the same for individuals tagged initially with or without a PIT tag. The second objective of our study was to determine the ramifications of the two assumptions and to explore if they were valid assumptions for our data set.

Materials and Methods.—We handled Loggerhead Sea Turtles incidentally captured in pound nets, long haul seines, and trawlers in Core and Pamlico Sounds, North Carolina, from June through December, 1989 to 2010 (Fig. 1). Core and Pamlico Sounds are a part of the Pamlico-Albemarle estuarine complex, the largest estuarine system (6630 km^2) in the southeastern United States. This system, which is bounded on the east side by the Outer Banks barrier islands, consists of lagoonal-type ecosystems that are shallow (the mean depth of Pamlico Sound is 4.5 m; Core Sound is 1.2 m), and productive (Copeland and Gray 1991; Roelofs and Bumpus 1953).

We recorded standard straight-line carapace length (SCL, notch to tip) to the nearest 0.1 cm. We applied Inconel metal alloy size 681 self-piercing tags (National Brand and Tag Company, Newport, Kentucky, USA) with approximately half the length of the tag to the trailing edge of both rear flippers, just anterior to the first large scale (Balazs 1999). We chose the rear instead of front flippers as we found some turtles were becoming entangled in the mesh of pound nets when the tag was on either front flipper (NMFS, unpubl. data). Beginning in 1995, we additionally injected unencrypted PIT tags (Destron-Fearing Corp., South St. Paul, Minnesota, USA, 125 kHz) subcutaneously approximately 1 cm anterior to the second most proximal scale of the trailing

margin of the left or right front flipper, or in the triceps superficialis muscle of the left front flipper; thus, all turtles were triple tagged beginning in 1995. We initially scanned all turtles to determine if they already had a PIT tag; if none was found, we scanned each PIT tag both before and after insertion to ensure it was functioning. After tagging, we released turtles in the vicinity of their capture locations. When a turtle was recaptured, we recorded all tags still detectable on the turtle. Only three of the recaptured turtles were recovered by researchers outside of our group who did not scan for a PIT tag, thus having a negligible effect on our results.

To determine daily tag loss rate, we used the integrative model of tag loss developed by Rivalan et al. (2005). We converted turtle capture histories so that the data provided time intervals (in days) for the following tag loss categories: N_{22} is the number of days that the recaptured turtle had retained both Inconel tags; N_{21} is the number of days during which the recaptured turtle had lost one of its Inconel tags; N_{20} the number of days during which the recaptured turtle had lost both Inconel tags (and only the PIT tag remained for identification); N_{11} is the number of days during which the recaptured turtle that had lost one of its Inconel tags was released with one tag and was recaptured still retaining that one Inconel; and N_{10} is the number of days during which the recaptured turtle that had lost one of its Inconel tags was released with one tag and was recaptured without any Inconel tags (and only the PIT tag remained for identification). For example, if a turtle was recaptured three times (first event with two tags, second event with one tag, and third event with one tag), then one would calculate the time intervals for N_{22}, N_{21}, and N_{11}.

The maximum likelihood method described by Rivalan et al. (2005) makes two assumptions: 1) that PIT tag loss is negligible and 2) that those individuals tagged initially without a PIT tag have the same probability of not being observed again as those individuals who initially received a PIT tag. We addressed the first assumption by calculating the percentage of recaptured turtles whose PIT tags were no longer detectable. We addressed the second assumption two different ways. First, we separated turtles into two different groups: turtles that were triple-tagged (2 Inconels and 1 PIT) and turtles that were double-tagged (2 Inconels). We compared the percent of triple-tagged turtles that were never recaptured to that of double-tagged turtles that were never recaptured to test the assumption that tag loss rate was the same for individuals in both groups. Confidence intervals for each of the proportions were calculated using Wilson's (1927) confidence interval and the confidence intervals were compared to see if they overlapped. Second, we created two data sets to see if the shape and magnitude of tag loss over time was the same when analyzing the data using the methods of Rivalan et al. (2005). The first data set (DS1) included all tagged individuals in the study who received a PIT tag at some point (N = 2811). The second data set (DS2) included only those individuals that received a PIT tag on their first capture event (N = 2606); thus, DS2 is a subset of DS1. By analyzing both data sets separately, we were able to determine if tag loss rate was affected by including those individuals that were not PIT-tagged during their initial capture event.

Each data set was then used to find daily tag loss rate, using maximum log-likelihood to find parameter values for:

$$p(t) = \frac{1-\min_t}{1+e^{(a_0(a_1-t))}} + \min_t \quad \text{where} \quad \min_t = \frac{a_4}{1+e^{(a_2(a_3-t))}}$$

where p is the probability of tag loss; t is time; and a_0, a_1, a_2, a_3, and a_4 were model parameters with standard errors being estimated with the delta method (Rivalan et al. 2005). We used the software application TAG LOSS, Version 3.2.3 (Girondot 2011).

We modeled six different tag loss patterns, which can be found in Fig. 1 of Rivalan et al. (2005):

Model A, a constant daily tag loss rate;

Model B, a linearly decreasing tag loss rate;

Model C, a high tag loss rate that decreased over time to asymptote near zero;

Model D, a high tag loss rate that decreased over time to an asymptote above zero;

Model E, a high tag loss rate that gradually decreased over time, although not as a smooth function; and

Model F, an initially decreasing tag loss rate, which began increasing after a certain period of time.

Each model was fit for each data set assuming 1) probability of tag loss was equal for both tags ($p = p^*$) and 2) probability of tag loss was different for both tags ($p \neq p^*$). Tag loss rates were estimated for Inconel tags, not PIT tags, and the probability of tag loss for the second tag was a conditional probability. We selected the best model based on the lowest Akaike's Information Criteria (AIC; Akaike 1974) values.

Results.—From 1990 to 2010, we tagged 2811 loggerheads and recaptured 585 identifiable turtles, ranging from 44.1 to 102.5 cm SCL (mean ± SE, 64.7 ± 0.3) at initial capture. Recapture intervals ranged from 1 to 4725 days (mean ± SE, 507.1 ± 29.5). We triple-tagged (2 Inconel and 1 PIT tag) 2606 loggerhead turtles, of which 2021 or 78% (95% CI: 0.76–0.79) never were recaptured. We double-tagged (2 Inconel tags) 205 loggerheads which were PIT-tagged during subsequent recaptures, and of those turtles, 172 or 84% (95% CI: 0.78–0.88) were never recaptured. Based on our data, we were not able to detect the PIT tag for 44 of the 557 recaptures that were scanned for a PIT tag, resulting in a 0.079 failed detection rate over the duration of the 15 years that we were tagging with PIT tags.

For DS1, daily tag loss rate for $p = p^*$ was estimated at 0.00037 using model A (Table 1; Fig. 2; AIC = 788.29). Daily tag loss rate for $p \neq p^*$ was estimated at 0.00033 for tag one and 0.00060 for tag two using model A (Table 1; Fig. 2; AIC = 391.15). Daily tag loss rate for $p = p^*$ using model C was a decreasing function through time starting at a high of 0.00050 on day one and decreasing as time continued (Table 1; Fig. 2b; AIC = 788.81). Daily tag loss rate for $p \neq p^*$ using model C was a decreasing function through time starting at a high of 0.00044 for tag one and 0.00143 for tag two on day one and decreasing as time continued (Table 1; Fig. 2; AIC = 777.15). When fitting models B, D, E, and F, the parameter estimates all reduced to model A as the best fit to the data.

For DS2, daily tag loss rate for $p = p^*$ was estimated at 0.00040 using model A (Table 1; Fig. 3; AIC = 770.67). Daily tag loss rate for $p \neq p^*$ was estimated at 0.00037 for tag one and 0.00058 for tag two using model A (Table 1; Fig. 3; AIC = 767.40). Daily tag loss rate for $p = p^*$ using model C was a decreasing function through time starting at a high of 0.00058 on day one and decreasing as time continued (Table 1; Fig. 3; AIC = 774.03). Daily tag loss rate for $p \neq p^*$ using model C was a decreasing function through time starting at a high of 0.00052 for tag one and 0.00122 for tag two on day one and decreasing as time continued (Table 1; Fig. 3; AIC = 767.90). Model D did not reduce to model A as in the other data set. Daily tag loss rate for $p = p^*$ started at a high of 0.0018 on day one and decreased to an asymptote of 0.00034 using model D (Table 1; Fig. 4; AIC = 757.57). Daily tag loss rate for $p \neq p^*$ reduced to a constant loss rate (model A) for tag one and remained a decreasing function with an asymptote for tag two (model D).

TABLE 1. Model parameter estimates (standard error) for the models that converged for each data set and the associated AIC values. Data sets are DS1, which includes all turtles marked during this study, and DS2, which includes only turtles that received a PIT tag during the initial capture event. If $p \neq p^*$, then the parameter estimates (standard errors) are listed as the parameter estimates for the first tag followed by the parameter estimates for the second tag. Parameters with dashes below them were not estimated for that specific formulation of the model.

Data set	Model	AIC	a_0	a_1	a_4
DS1	A; $p \neq p^*$	391.15	—	—	6.59×10^{-4} (5.7×10^{-5}) 1.19×10^{-3} (2.1×10^{-4})
DS1	C; $p \neq p^*$	777.15	-6.1×10^{-4} (6.57×10^{-6}) −12531.3 (138.12)	-1.1×10^{-3} (2.6×10^{-5}) −5943.0 (156.70)	—
DS1	A; $p = p^*$	788.29	—	—	7.36×10^{-4} (5.6×10^{-5})
DS1	C; $p = p^*$	788.81	-6.08×10^{-4} (5.76×10^{-6})	−12479.9 (122.68)	—
DS2	D; $p \neq p^*$	755.26	— -2.87×10^{-2} (2.9×10^{-3})	— −114.1 (16.46)	7.5×10^{-4} (6.3×10^{-5}) 8.7×10^{-4} (1.8×10^{-4})
DS2	D; $p = p^*$	757.57	-3.89×10^{-2} (1.5×10^{-3})	−167.7 (7.39)	6.8×10^{-4} (5.8×10^{-5})
DS2	A; $p \neq p^*$	767.40	— —	— —	7.4×10^{-4} (6.3×10^{-5}) 1.17×10^{-3} (1.9×10^{-4})
DS2	C; $p \neq p^*$	767.90	-7.3×10^{-4} (7.1×10^{-6}) -9.8×10^{-4} (2.2×10^{-5})	−10284.8 (113.5) −6845.6 (170.6)	—
DS2	A; $p = p^*$	770.67	—	—	8.08×10^{-4} (6.0×10^{-5})
DS2	C; $p = p^*$	774.03	-6.96×10^{-4} (6.5×10^{-6})	−10720.14 (104.82)	—

For tag one, the tag loss rate was a constant 0.00037, while for tag two, the tag loss rate started at a high of 0.0367 and declined to an asymptote of 0.00044. Model D with $p \neq p^*$ (which resulted in model A for tag one and model D for tag two) had an AIC value of 755.26. Finally, when fitting models B, E, and F, the parameter estimates all reduced to model A as the best fit to the data.

Discussion.—Careful consideration of assumptions should always be used when analyzing data. For Loggerhead Sea Turtles in North Carolina, Inconel tag loss rate estimates were different when including all individuals that were PIT-tagged in the study (DS1) than when restricting the analysis to only those that received a PIT tag during their initial capture event (DS2). Although daily tag loss rates were similar for both data sets, the first year for DS2 showed the greatest tag loss rate for the second tag, which could have an effect on tag retention rates over time. The estimation of tag loss using DS2 demonstrated that the probability of not being observed again was not the same for turtles that initially received a PIT tag as compared to those that were PIT-tagged later; therefore, the second assumption made in Rivalan et al. (2005) should be considered for other datasets that have not PIT-tagged individuals during the entire duration of their study. Additionally, a portion of turtles from DS1 could have shed their Inconel tags prior to being PIT-tagged, and thus their tag loss would not be noted, as they would not have been recognized as recaptures. We also found that the first assumption of the method was not met as PIT tag detection failure during the 15 years we used these tags was 7.9%, which was not negligible. How PIT tag loss affects the model outcomes is unknown at this point, but could be addressed by constructing a model with three different tags that can be lost at different rates. Based on these findings, we suggest that those marking turtles for mark-recapture use more than one type of tag. Furthermore, our decision to only include turtles that received a PIT tag during their initial capture event did lead to different tag loss rates over time. Thus, careful consideration of input data into the model should be used.

A constant tag loss rate, such as that found for Inconel tag one in DS2, could be an indication of well-applied tags, the effect of tag location, or the interval of recapture. We calculated a tag loss rate of 13% after one year for the first tag using model A with $p \neq p^*$ for individuals tagged in the rear flipper. In contrast, Gorham et al. (1997) calculated a tag loss rate of >50% after 440 days for loggerhead turtles tagged in the front flippers. Thus, tagging rear flippers might result in an increase in tag retention compared to tagging front flippers. However, a constant tag loss rate also could be a reflection of the long recapture intervals (2–4 years) that we recorded with some individuals. Because of a lack of data on recaptures during the time immediately following marking of these individuals, the model has little information to determine the shape of the tag loss rate function during the time interval immediately following marking. Thus, the model falls back to the simplest explanation, which is a constant tag loss rate over the entire time interval.

In our study, the daily loss rate for tag two given that tag one had been lost was a decreasing function that went to an asymptote of 0.00044. Rivalan et al. (2005) also found tag loss rate for Leatherback Sea Turtles, *Dermochelys coriacea*, in French Guiana, to be very high initially, followed by a rapidly decreasing probability of tag loss soon after application. However, they found this initial high tag loss rate for tag one while we found it to be true for tag two. They tagged the rear flippers with Monel tags and attributed tag loss over a short time scale to tagging failure caused either by human or mechanical error. Likewise, the loss of the second tag in our study could have been a result

of incorrect application of the tag or failure of the tag to lock properly. Over the course of our 21-year study, several different trained technicians applied tags, which may be responsible for some tagging failure.

Similar to Rivalan et al. (2005), we also found that the rate of losing the second tag was significantly higher given the loss of the first tag. Tissue necrosis could have increased tag loss dependency since individuals susceptible to tissue necrosis are likely to lose both tags (Rivalan et al. 2005). However, tissue necrosis may be more of a problem with leatherback turtles than with loggerhead turtles, as we did not encounter any loggerheads with tissue necrosis on our study site. Rather, a possible explanation for the tag loss dependency in North Carolina loggerhead turtles may be attributed to tagging failure as a result of human error, i.e., improper application of the tag. In other words, if the first tag was not applied correctly (either through improper technique or mechanical failure of either the tag or tag applicator), there was an increased chance that the second tag also would not be applied correctly, resulting in the second tag being lost as well.

Tag loss in sea turtles varies, depending upon turtle species, size of turtle, position of tag, tag material, environment of the turtle, and the experience of taggers (see Balazs 1982 for a summary). For example, van Dam and Diez (1999) reported an Inconel tag loss rate of 18% after 3 years for front-flipper-tagged Hawksbill Sea Turtles (*Eretmochelys imbricata*), much less than our calculated rate of 39% after 3 years, indicating that hawksbill turtles might have an overall higher tag retention rate for Inconel tags in their front flippers than loggerhead turtles tagged in their rear flippers. However, their large sub-adults and adults (>60 cm) were tagged with just external tags (no PIT tags), so the possible inability to identify recaptures due to the loss of external tags might have influenced their overall estimation of tag retention rates.

Although PIT tags have been described as being "permanent"(Gibbons and Andrews 2004), several sea turtle tagging studies, including this one, have reported a failure to detect these tags. Failure to detect PIT tags can be attributed to a variety of factors: tags can be expelled from the body or migrate internally, the PIT tag scanner or reader can fail to detect a tag that is present, or the tag itself can fail (Wyneken et al. 2010). Parmenter (1993) found an 8% failure rate of PIT tags in Flatback Turtles (*Natator depressus*) after two years, while van Dam and Diez (1999) saw up to 15% failure in their ability to detect PIT tags in hawksbill turtles after a five-year period. We failed to detect approximately 8% of the PIT tags in loggerheads over the course of the 15 years we used PIT tags. Despite this failure rate, there are many advantages to using PIT tags to mark sea turtles. Because the tags are internal, tag loss through abrasion is low to non-existent. In addition, they have very little negative impact on the turtle, including entanglement in fishing gear, provided the animal is of a sufficient size to receive the tag. Finally, although our failure rate to detect PIT tags was not negligible, it was substantially less than the tag loss rate of Inconel tags, which was about 13% each year.

To increase our tag retention rates, we followed the advice of previous researchers by applying more than one tag to each turtle, using two Inconel tags and a "permanent" PIT tag. Triple-tagging turtles in this way allowed for greater identification of recaptures and enabled us to take advantage of the benefits of using both methods of tagging. For example, metal, external tags such as Inconel tags do not require a special reader to view the tag. Additionally, the cost (US $70 for 100 tags) is substantially less than that of PIT tags (US $6–8 per tag). On the other hand, despite their higher costs and need for a reader, PIT tags are essentially permanent marks as they can potentially last for the lifetime of the animal. Therefore, we likewise recommend using PIT tags in conjunction with one or more external tags (such as Inconel) to maximize the probability of identifying a recaptured turtle.

Loggerhead Sea Turtles are a slow-growing, late-maturing species that conduct wide-ranging migrations, life-history traits that make them especially susceptible to overexploitation (National Research Council 2010). Successful management of these vulnerable populations requires an accurate accounting of their absolute abundance to properly evaluate potential impacts of management decisions (National Research Council 2010). Estimation of tag loss rates will help to correct for potential biases in models used to estimate population abundance and survival over time. This allows for increased accuracy of abundance and survival estimates used in population modeling and for management of sea turtle populations.

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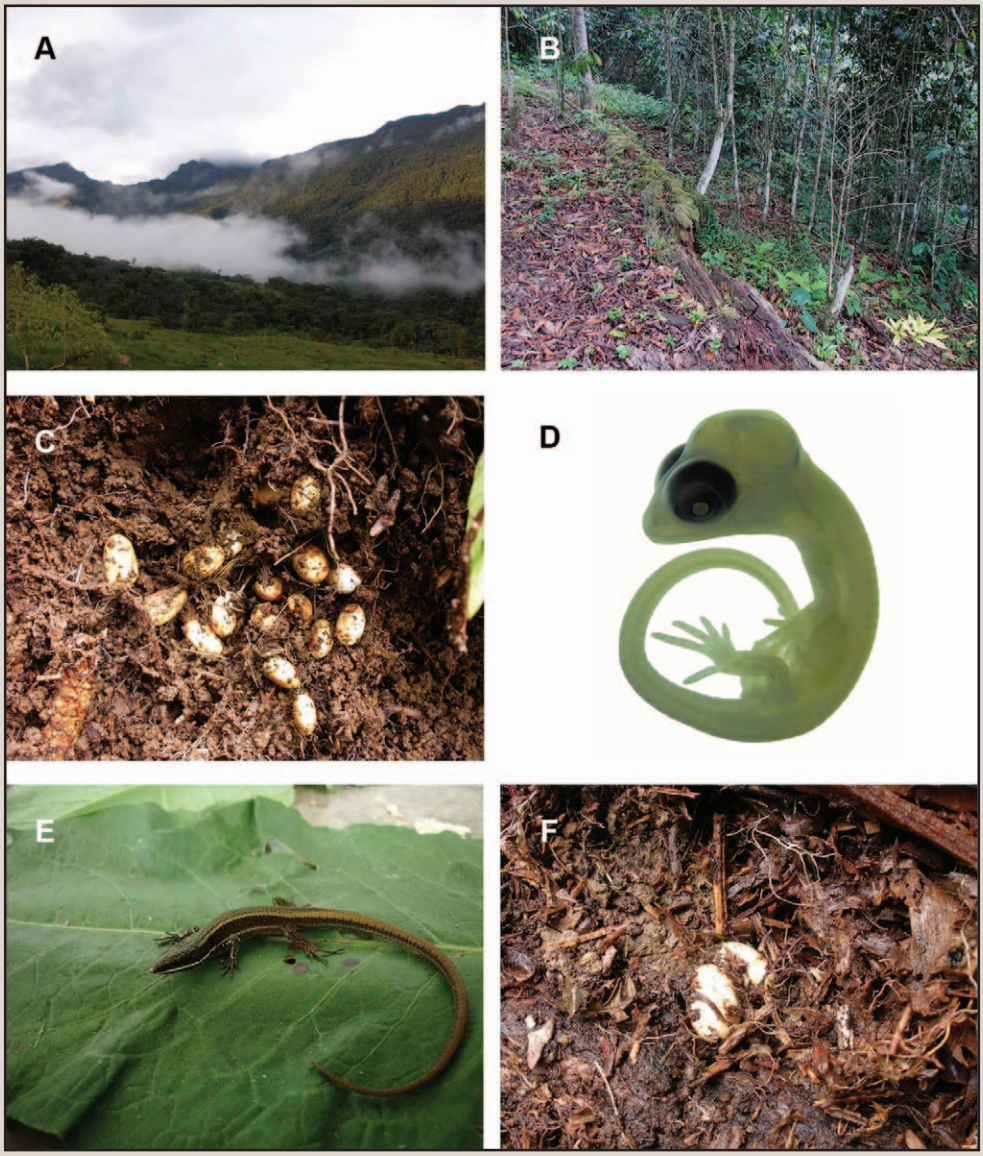
A Case of Communal Egg Laying in a Population of *Cercosaura ampuedai* (Squamata: Gymnophthalmidae) in the Colombian Andes

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Neotropical squamates display a diversity of reproductive strategies, which plays a key role in the evolution of their life histories (Shine 2005). Communal nesting is a widespread reproductive behavior among reptiles (Doody et al. 2009; Graves and Duvall 1995). An important aspect of this behavior is the selection of nesting sites with optimal environmental conditions by females to guarantee reproductive success (Blouin-Demers et al. 2004; Brown and Shine 2005; Iraeta et al. 2007; Montgomery et al. 2011). Female nest-site choice is considered an important form of parental care in most squamates, which leave their eggs unprotected soon after oviposition (Blouin-Demers et al. 2004). Thus, elucidating the factors directing this behavior in any reptile species is fundamental to understanding its reproductive biology (Iraeta et al. 2007).

Reptile egg aggregation occurs when "animals deposit their eggs or young along with those of conspecifics" (Doody et al. 2009). Traditionally, this reproductive behavior has been related to limited availability of optimal incubation nest-sites and/or adaptive responses, such as increased fitness by egg aggregation (Braz et al. 2008; Montgomery et al. 2011; Radder and Shine 2007). However, testing these non-exclusive (constraints and adaptationist) hypotheses represents a major challenge for evolutionary biologists (Radder and Shine 2007). Among squamates, available information about communal nesting behavior is biased toward best-studied and conspicuous species (e.g., gekkonids, scincids, polychrotids, iguanids), whereas information about fossorial and semi-fossorial lizards (e.g., gymnophthalmids) is very scarce



COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND

FIG. 1. Communal nest of *Cercosaura ampuedai* found at the Vereda Santa Isabel, municipality of Toledo, Norte de Santander Department, Colombia. A) Study area showing the transition between forest and pasture area. B) Decomposing tree trunk in the coffee plantation. C) The photograph shows an aggregate of eggs; the arrangement of eggs in pairs is not clear due to the removal of soil. D) Embryo (36-D&H stage) of *C. ampuedai*. E) Adult of *C. ampuedai* found inside the egg-laying site. F) Eggs of *C. ampuedai* arranged in pairs.

because their eggs are difficult to find in the wild (Doody et al. 2009).

The family Gymnophthalmidae contains 213 species of relatively small to medium-sized lizards, with a great ecological and morphological diversity (Donnelly et al. 2006; Pellegrino et al. 2001). Nevertheless, little is known about reproductive characteristics of most species in this family, including social reproductive behaviors such as communal nesting. The genus *Cercosaura* contains 15 species, of which six are distributed in the Colombian Andes, Magdalena River Valley, and Amazonian lowlands (Hernández-Ruz 2005; Hernández-Ruz and Bernal-González 2011; Uetz et al. 2011). *Cercosaura ampuedai* inhabits the uplands at the eastern slope of the Cordillera Oriental of the Andes mountains, in the Departments of Boyacá, Cundinamarca, and Norte de Santander in Colombia, and in the state of Táchira in Venezuela (Hernández-Ruz 2005; La Marca and García-Pérez 1990; Sánchez et al. 1995). To date, the reproductive behavior and other natural history traits of this species remain poorly known (Hernández-Ruz 2005).

Herein, we describe four communal nests and a communal nestsite used by females of *C. ampuedai* and some ecological and reproductive features of this population. Additionally, we compare our observations with those reported for other lizards and discuss the possible causes of this behavior.

Materials and Methods.—A communal egg-laying site of *Cercosaura ampuedai* was found on July 2011 in a farm located at Vereda Santa Isabel, municipality of Toledo, Norte de Santander Department, Colombia (7.28341°N, 72.36866°W, 2580 m elev.), at the eastern flank of the Cordillera Oriental of the Colombian Andes. The farm has nearly 200 ha dedicated almost exclusively to livestock activities, but around 1 ha is planted with approximately 2000 rustic coffee trees shaded with *Musa* sp. trees. Historically, this zone has an extended rainy season (April to November), with a mean annual precipitation of 1255 mm.

We removed 26 eggs from the egg-laying site and put them into plastic dishes with soil from the collection site. We transported the eggs to the Laboratorio de Biología Reproductiva de Vertebrados at the Universidad Industrial de Santander (Bucaramanga, Colombia). We dissected ten randomly selected eggs, and raised the remaining (16) eggs in plastic dishes covered with 1 to 2 cm of moistened soil and incubated them at 18°C during ten days. At this time, we dissected ten other randomly selected eggs and incubated the surviving (6) eggs until hatching.

We measured egg mass with a precision (± 0.001 g) electronic balance (Precisa, Switzerland) the longest and shortest diameters with Vernier calipers (± 0.02 mm; Anyi Instruments Co., China), and estimated egg volume with the water displacement method (Magnusson et al. 2003). We fixed all embryos in 10% buffered formalin, preserved in 70% ethanol and staged according to the table of Dufaure and Hubert (1961) for *Zootoca* (*Lacerta*) *vivipara* (D-H stages). We deposited embryos and neonates in the Herpetological Collection of the Natural History Museum of the biology school at Universidad Industrial de Santander and coded as UIS-R (2551 to 73).

Results.—We found the eggs on a dry day in the rainy season by visual encounter surveys, during a field trip through the organic coffee shade plantation. The communal nesting site was a small area (~2 m^2) close to a decomposing tree trunk on the edge of the coffee plantation near a pasture, which is adjacent to a fragment of an Andean cloud forest (Fig. 1A, B). The egg-laying site was characterized by shaded humified soil, rich in decaying organic matter and vegetal detritus, such as leaf-litter from coffee, shade trees, and rotten wood.

Eggs were distributed in four communal nests (two inactive and two active), next to each other. The two inactive nests contained 32 and 37 eggshells that apparently successfully hatched based on the observation of a slit that occurs during the eclosion of neonates (Fig. 1C). The presence of newly empty shells suggests the nests were recently active. The two active nests contained 31 and 33 eggs at several stages of development from 33 to 44 D&H stage, and neonates (Fig. 1D). Six eggs hatched during the time of the discovery of the nests. In all cases, eggs were grouped in pairs between 10–20 cm deep, together with one adult, two juveniles, and four neonates (Fig. 1E). The arrangement of eggs in pairs indicates a fixed clutch size of two eggs per female; the embryos within each pair of eggs were always at the same development stage (Fig. 1F). The eggs had a mean length of 14.34 mm (± SD 1.42, N = 26), mean width of 9.67 mm (± SD 0.98, N = 26) and a mean volume of 723.45 mm^3 (± SD 147.48, N = 26). We also found a positive and significant relationship between egg volume and development stage ($R = 0.86$, $p < 0.001$, d.f. = 20). Neonates had a SVL of 22.5 mm (± SD 0.43, N = 8) and a mean weight of 0.26 g (± SD 0.02, N = 8). The only evidence of predation inside the communal nesting site was the presence of a coral snake, *Micrurus mipartitus*, a potential predator of adults and juveniles.

Discussion.—A communal nest may be the result of oviposition by several females in a selected site, the oviposition of multiple clutches by a single female, or a combination of both (Bock 1996; Montgomery et al. 2011). The presence of juveniles and neonates near the site of oviposition and the presence of several clutches with embryos in the same stage of development suggest that the communal egg laying of *C. ampuedai* reported here is the product of oviposition by multiple females in a selected site, without excluding the possibility that females may return several times to lay eggs. Additionally, the presence of eggshells, plus eggs and individuals in several development stages indicates this egg-laying site may have been used for an extended period of time.

We found eggs in pairs, at the same stage of embryonic development, indicating that clutch size in this species consists of two eggs. Hernández-Ruz (2005) found two clutches, each with two eggs, and recorded the presence of two oviductal eggs (one per oviduct) in this species. Thus, *C. ampuedai* apparently has an invariant clutch size, which is characteristic of the family and has been considered to be genetically determined (Fitch 1970; Sherbrooke 1975; Vitt 1982).

Communal egg laying has been reported in about 14 gymnophthalmid species belonging to different genera (see Doody et al. 2009 supplementary material; Doan and Castoe 2003; *Leposoma rugiceps*, Hernández-Jaimes, pers. comm.; *Cercosaura vertebralis*, Meza-Joya, pers. comm.). However, this number may underestimate the incidence of this behavior within the family, given that eggs are difficult to find because of the semi-fossorial lifestyle of most species. Hernández-Ruz (2005) suggested the presence of communal egg laying in a population of *C. ampuedai*, which is confirmed by our observations.

Several benefits, including an increased rate of hatchling survival, metabolic heating, and saturation of nesting sites to reduce predation, may be associated with communal nesting in lizards (Ewert and Nelson 2003; Graves and Duvall 1995; Montgomery et al. 2011). Communal nests may occur where suitable sites for egg deposition are scarce, and thus females are attracted to places where the hydric, thermal, and soil characteristics are more appropriate (Graves and Duvall 1995; Espinoza and Lobo 1996). Also, females may select sites used by conspecifics based on the presence of empty eggshells, even in the presence of potential predators (Brown and Shine 2005; Espinoza and Lobo 1996; Plummer 1981), similar to our observations.

Despite the benefits of communal oviposition, the repeated use of the same egg-laying site by one or more females during a long period of time may increase the probability that predators discover the eggs (Doody et al. 2009; Montgomery et al. 2011). Interestingly, we found a coral snake next to the nesting site, a potential predator of *C. ampuedai*. *Micrurus* snakes generally feed on fossorial species, including other snakes, caecilians, amphisbaenians, and gymnophthalmids (Maffei et al. 2009; Marques and Sazima 1997; Souza et al. 2011).

The communal oviposition behavior of *C. ampuedai* could result from environmental constraints, due to local scarcity of potential egg laying sites restricted to the coffee plantation. However, given that we found several communal nests in the same site, this could result in a benefit to the offspring from communal oviposition, which can be explained by the "adaptation" hypothesis. An alternative explanation is that the metabolic heat generated by embryos plays a key role in the development rate, producing larger and faster hatchlings (Ewert and Nelson 2003; Shine et al. 1995; Zbinden et al. 2006). However, Radder and Shine (2007) found that the presence of multiple eggs in contact does not have a significant effect on the increase of metabolic heat; in contrast, particular hydric conditions that occur inside communal nests could lead to a direct benefit in the fitness of the communal oviposition (Clutton-Brock 2009; Nowak 2006; Sachs et al. 2004).

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TECHNIQUES

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The Use of Visible Implant Alpha Tags for Anuran Tadpoles

Amphibians are one of the most threatened groups of vertebrates in the world and are currently facing major declines due to habitat loss, emerging infectious diseases, and climate change, leading many species to extinction (Stuart et al. 2004). To face this amphibian extinction crisis, there is an urgent need to gather data on the demography and ecological characteristics of amphibian species (Wake 2007). In most of these studies, it is necessary to be able to identify individuals across time to study density, growth trajectories, or habitat use. Date-specific cohort marks can be used for density estimates but when intending to quantify growth, movement or survival, marks have to allow identifying individuals. Such marks have to possess a set of characteristics. First, it should allow each individual to be identified accurately. Second, it should have a minimal impact on the individual and should not affect behavior, survivorship and catchability.

A variety of techniques are available for individual recognition in amphibians. For adult anurans, toe clipping was the method most commonly used since the 1950s (Martof 1953). It has been shown to be well-adapted and to have little impact for some amphibian species (Grafe et al. 2011), and studies focusing on physiological indicators of distress show no increased stress resulting from toe-clipping (Perry et al. 2011). One of the drawbacks of toe-clipping is that it may have an effect on recapture and survival for some species (McCarthy and Parris 2004). More recently, Passive Integrated Transponder (PIT tag) have been proposed for amphibians (Brown 1997) and proved to be particularly well-suited. Nonetheless, PIT tags are still limited in their use by their size and can only be inserted in adult amphibians of larger size (4 cm SVL). The use of color patterns via picture identification (Kenyon 2009) has also been proposed as an alternative technique for the identification of adult amphibians but requires a specific color pattern for each individual, as e.g. found in tropical amphibian species. Finally, Visual Implant Elastomers (VIE) may mainly be used for date-specific cohort marking. To allow individual recognition, VIE marks have to be placed in distinct body parts or to be coupled with toe clipping (Hoffmann et al. 2008). Several marking procedures have been employed in studies of larval amphibians including tail-clipping (Turner 1960), staining of the entire tadpole (Travis 1981), coded wire tags (Martin 2011) and picture identification (Ribeiro and Rebelo 2011). Nonetheless, few of these techniques are suitable for monitoring the entire lifespan of anurans from the tadpole to the adult stage.

One alternative technique to mark amphibians both at the adult and larval stage is VI Alpha tagging (© Northwest Marine Technology Incorporation). VI Alpha tags are small rectangles of an inert elastomer inscribed with an alphanumeric code. Tags are available in four colors providing 2600 unique alphanumeric codes. VI Alpha tags were initially developed for fishes (Karvonen et al. 2004), but they have been successfully used with others organisms such as shrimp (Arce et al. 2003) or seahorses (Woods 2005). In the last five years, VI Alpha tags have been tested successfully for use on caecilians (Gower et al. 2006; Measey et al. 2001), urodeles (Osbourn et al. 2011), and anurans (Chelgren et al. 2006; Heard et al. 2008; Pittman et al. 2008). None of these studies were able to assess whether VI Alpha tags can allow following an individual through metamorphosis.

In this study, we evaluated the use of VI Alpha tags to mark tadpoles of the anuran species *Alytes obstetricans* and tested whether the mark remains after metamorphosis. More specifically, we aimed to assess whether these tags can be used for ecological studies using individual recognition in *A. obstetricans* by determining: 1) the rate of tag loss, 2) the readability of the tag across tadpole development until metamorphosis, and 3) the effect of such tags on survival rate.

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Materials and Methods

Study species.—Alytes obstetricans, the Common Midwife Toad, is a European species ranging from northern Portugal and Spain in the south to southern Belgium and Central Germany to the northeast. It is present throughout France, except in the high Alps. It ranges from the sea line up to altitudes of 2400 m in the Pyrenees. This species is known for its male parental care behavior. The male carries a string of eggs wound on its hind legs until they are ready to hatch. After three to six weeks, the male releases the hatching larvae into suitable water habitat. Tadpoles measure about 15mm just after hatching, but can reach up to 10 cm in total length before metamorphosis with a mean body size of 2.3 (Standard Deviation = 0.4 cm; Courtois et al., unpubl. data).

VI Alpha tags.—VI Alpha tags (© Northwest Marine Technology Incorporation) are 1.2 × 2.7 mm tags (Fig. 1) that are

subcutaneously inserted with a specific injector needle. Each tag is coded with black letters and numbers on a fluorescent colored background. In this study, we used tags with a yellow background. After tagging, the unique code remains visible to the naked eye under daylight and readability can be enhanced with UV light (delivered by © Northwest Marine Technology Incorporation; Fig. 1).

We collected 90 tadpoles at Gosner Stage 25 (Gosner 1960) from a large population in a trough in Balagué (Ariège, France, 42.963889°N, 1.025278°E) measuring 5.3 ± 0.7 cm in total length (including tail) and weighing 1.5 ± 0.5 g. We tagged 30 tadpoles on the ventral side and 30 dorsally, resulting in 60 tadpoles marked in total. In half of the cases (15 tadpoles in each group), we used a surgical glue to help healing and potentially prevent tag loss.

Tadpoles were first immobilized by immersion in ice-cold water (around 4°C) and were restrained by gently squeezing the body between the thumb and index finger. A 3-µm-wide needle was used to make a small first incision in the epidermis, and the tag was inserted under the skin using the supplied needle injector. Whilst this instrument is designed for direct injection of VI Alpha tags, prior creation of a skin incision expedited the injection process considerably (Heard et al. 2008). Tadpoles were handled with powder-free latex gloves during the tagging manipulation, but no gloves were used in subsequent manipulation. We did not experience any tadpole mortality related to the usage of Latex gloves as found in other studies (Cashins et al. 2008), either in the experiment described here or in field research done on the same species (Schmeller et al., unpubl. data).

VIE tags.—We marked 30 tadpoles with VIE (© Northwest Marine Technology Incorporation) tags (orange) in the back in order to compare mark loss and survival rate between these two tag types. VIE are biologically compatible polymers which are composed of a colorant and a curing agent. They are mixed in equal quantity just before use, resulting in a liquid. The liquid is then sucked into a syringe and injected dorsally under the skin of the tadpole, where it solidifies to a permanent mark. The mark remains visible with the naked eye, but visibility can be further increased using UV light.

Tadpole rearing.—The 90 tadpoles were kept together in an aquarium with constantly filtered and aerated water at 18°C, pH 6.9, and a photoperiod of 10 hours of daylight. The aquarium was cleaned and water was replaced once a week. The tadpoles were fed after water replacement with fish food tablets (Tetra TabiMin). They were kept for six weeks in order to monitor both tadpole survival, tag loss until metamorphosis, and readability after metamorphosis. Once a week we recorded whether the VI Alpha tag or the VIE tag was still present or not for each individual. We defined tag retention as the percentage of tags in each group that were still present at the end of the experiment (i.e., 42 days after marking). For the VI Alpha tag, when the tag was present, we noted its degree of readability (index 0: not readable, index 2: readable only with UV-light, and index 3: readable under daylight), and the Gosner stage of the tadpole (Gosner 1960). The Gosner stage varied from 25 (no limb bud) to 46 (complete metamorphosis). When the tag was lost, the tadpole was released back into the wild. When the tag was retained, the tadpole was released after completion of metamorphosis, usually after five to six weeks.

Statistical analysis.—Binomial generalized linear models (GLM) were run to explain tag retention at the end of the experiment as a function of place of injection (ventral or dorsal) and use of glue, using the software package R (http://cran.r-project.org/). The variable "presence" was binary, as either the tag was still present (1) or lost (0). Similarly, the same type of model was used to determine the effect of the factors "place of insertion" (dorsal or ventral) and "surgical glue" (use or not) on the readability of the VI Alpha tags. Readability was then defined as 0 when not readable (index 0) and 1 when readable either with day light (index 3 defined previously) or UV light (index 2 defined previously).

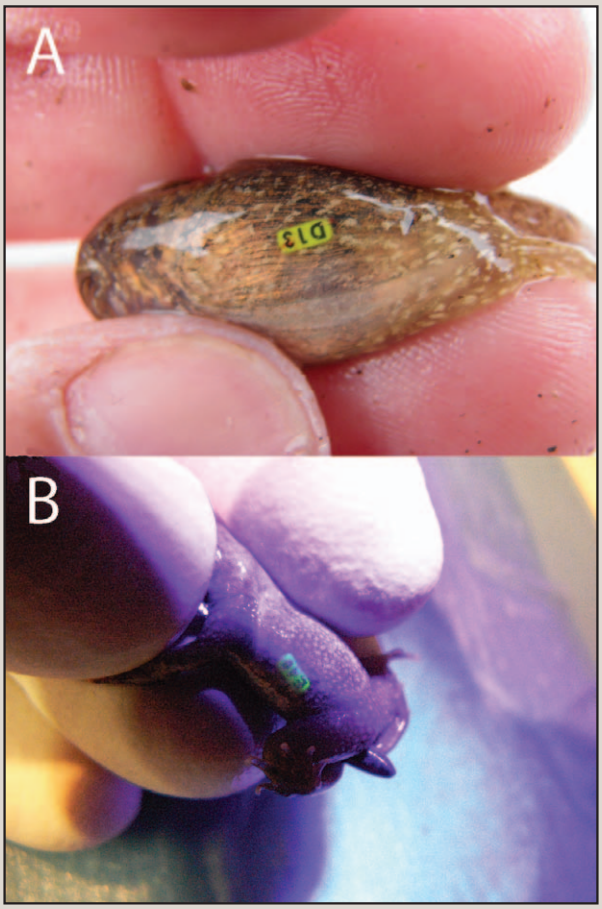


FIG. 1. VI Alpha tag inserted on the ventral side of *Alytes obstetricians* for a (A) tadpole and (B) recently metamorphosed frog when enhanced with UV-light.

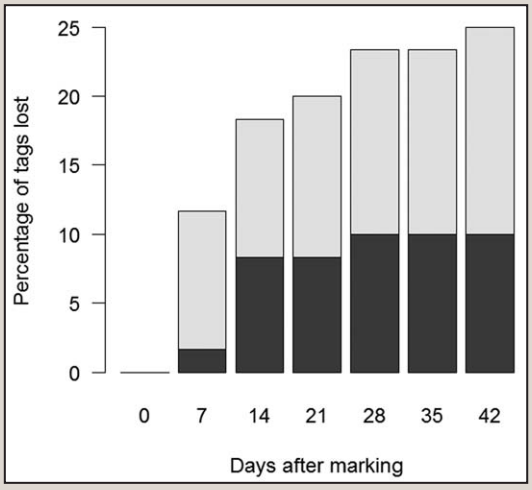


FIG. 2. Cumulative percentage of tags lost out of 60 as a function of the number of days after the injection when injected ventrally (in light grey) or dorsally (in dark grey).

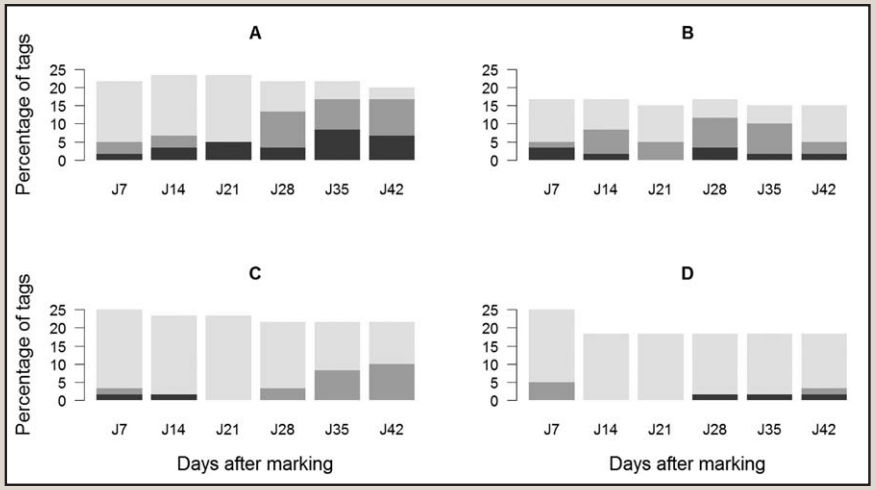


FIG. 3. Percentage of tags out of 60 that were not readable (black), readable only with UV light (dark grey) and readable under daylight (light grey) for (A) tadpoles marked dorsally without glue, (B) tadpoles marked dorsally with glue, (C) tadpoles marked ventrally without glue and (D) tadpoles marked ventrally with glue.

TABLE 1. Readability (% of readable tags—i.e., with readability index 2 or 3—at the end of the experiment) and tag retention (% of remaining tags at the end of the experiment) 42 days after marking.

	Readability (%)	Final tag retention (%)
Group A (dorsal, without glue)	67	80
Group B (dorsal, with glue)	89	60
Group C (ventral, without glue)	100	87
Group D (ventral, with glue)	91	73

RESULTS

In total, 15 tadpoles (25%) of the 60 individuals tagged with VI Alpha tags lost their tag before metamorphosis, of which 6 were marked ventrally and 9 dorsally. Tag retention tended therefore to be higher on the ventral than on the dorsal side (Table 1) but this difference was not significant (GLM, Deviance = 0.15, P = 0.38). Of the 15 tags that were lost, 10 were sealed with surgical glue and 5 were not, but the difference between groups was not significant (GLM, Deviance = 0.41, P = 0.14). Tag loss was most important in the dorsal group during the first 7 days (6 out of 9 tags lost), while tag loss in the ventral group was later with a maximum during the second week (5 out of 6 tags lost; Fig. 2). The retention rate of VIE-marked individuals was 100%.

Overall, 100% of VI Alpha tags were readable immediately after injection and an average of 87% were readable at the end of the experiment (Table 1). However, in 15 out of 45 cases UV light was needed to identify the VI Alpha tag code (readability index 2, Fig. 3). Our results show a higher readability on the ventral side than on the dorsal one (Table 2, GLM, Deviance = 0.43, P = 0.046). The better readability of the ventral tags compared to the dorsal tags was stable over tadpole development (Fig. 2). The use of surgical glue did not affect the readability of the tags (GLM, Deviance = 0.03, P = 0.58).

No tadpoles died during the experiment; the survival rate under controlled condition was therefore 100% for both the VIE tag group and the VI Alpha tag group.

DISCUSSION

Here, we tested the usage of VI Alpha tags for the marking of tadpoles of the species *A. obstetricans* under laboratory conditions. We found that tag retention was globally low (75%), rendering this technique unsuitable for Capture-mark-recapture studies on this species by introducing tag-loss bias. A previous study on the use of VI Alpha tags on amphibians demonstrated a level of 92.31% of tag retention for *Litoria raniformis* (Heard et al. 2008), which is comparable to the tag retention in the group in which we inserted VI Alpha tags ventrally and used no surgical glue to close the insertion (87%). Indeed, contrary to our expectations, the use of surgical glue did not increase the retention rate and seems to be more painful for tadpoles even under cold anesthetic (Calvez and Lelong, pers. obs.) and we therefore advise against its use. To counterbalance tag loss, Heard et al. (2008) proposed to couple the use of small VIE dot marks with VI Alpha tags in order to be able to identify an individual as marked even if the VI Alpha tag was lost, a suggestion also valid for *A. obstetricans* tadpoles as the VIE retention was 100% in our study.

The retention rate of the VI Alpha tags tended to be higher on the ventral than on the dorsal side, and additionally, the readability of the tags was significantly higher on the ventral side. Hence, ventral insertion of the VI Alpha tags should be preferred in future studies, especially as VI Alpha tags were readable after metamorphosis. Future studies should assess whether VI Alpha tags are readable in adult frogs that were marked as tadpoles. If so, VI Alpha tags may be useful in studies on breeding site fidelity, home range size, dispersal distances, infection load and habitat selection of amphibians (Pittman et al. 2008). Nonetheless, it should be noted that *A. obstetricans* tadpoles are especially large and tadpole marking in other species may not always be possible with this technique.

One advantage of VI Alpha tag compared to VIE is that only one injection is needed, as compared to multiple injections necessary for individual recognition using VIE-markers. Hence, the marking effort is strongly reduced per marking and recapturing sessions, allowing for an increased number of marked individuals and limiting the risk of mistaken identity. Readability of tags remains high (87%) even at the end of the experiment. Decrease of readability during the development of the tadpole and after the metamorphosis can be explained by the fact that tadpole skin becomes less transparent in tadpoles of high Gosner stage and even less in post-metamorphic tadpoles. VI Alpha tags are also a good alternative to more expensive marking techniques such as PIT tags. It opens up the possibility to work with smaller-sized amphibian species and larval stages as the minimum size for VI Alpha tags is 2 cm for SVL compared to 4 cm for PIT tags. Moreover, Alpha tags are flatter than PIT tags. Further, survival rate was 100% and we therefore agree with the assessment of Heard et al. (2008) that VI Alpha tags are a promising alternative to PIT tags for marking larval amphibians.

Future studies should be conducted to determine whether the results observed in this study are the same under field conditions. Moreover, marking could change the subsequent behavior

of tadpoles and make them more susceptible to disease or predation in the field (i.e. reduce their survivorship under field conditions). A field study may therefore be able to conclude on the use of VI Alpha tag for *A. obstetricans* tadpoles marking.

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Using a Handheld PIT Scanner and Antenna System to Successfully Locate Terrestrially Overwintering Hatchling Turtles

The benefits of Passive Integrated Transponders (PIT) for identification of individual wildlife have been well documented. Originally used to determine movement of salmonids (Prentice and Park 1983), PIT technology has been used with a variety of reptiles and amphibians for spatial ecology studies. For example, mark-recapture techniques were used in conjunction with PITs to measure habitat use and movement of Brown Water Snakes (*Nerodia taxispilota*; Mills et al. 1995) and the activity patterns of arboreal geckos (*Gehyra variegata*; Gruber 2004). PITs do not transmit a signal and cannot be located unless an antenna is within close proximity.

While earliest studies with PITs in turtles involved sea turtles, PIT injection into the body cavity of smaller freshwater adult turtles was not considered until Buhlmann and Tuberville (1998) injected young *Trachemys scripta elegans* with 12 × 2 mm PITs in

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the inguinal region. Of six turtles recovered over two years, none showed adverse effects due to PITs. The authors recommend against the use of PIT with hatchling turtles, presumably due to the size of hatchlings relative to the tags used in their study. Subsequently, PITs (12 × 1 mm) were injected into the intraperitoneal region of hatchling *Chrysemys picta* with no adverse effects or mortality observed in the lab after one year (Rowe and Kelly 2005). A more recent study embedded PIT tags into *Podocnemis sextuberculata* and *P. unifilis* adults and hatchlings in the Amazon Basin (Guilhon et al. 2011). The authors reported results for mark-recapture, movement, abundance, survival, and recruitment.

I suggest a new application for using PIT tags with a scanner and a portable antenna to track and precisely locate terrestrial overwintering hatchling turtles. I field-tested this technique with hatchling Diamondback Terrapins (*Malaclemys terrapin*) overwintering beneath ground cover and soil. Diamondback Terrapin hatchlings overwinter on land near their nests but specific locations have not previously been determined (Muldoon and Burke 2012).

Methods.—In September and October 2009 I inserted 9 × 2.12 mm (0.067 g) PIT tags (Biomark, TX148511B) into 60 individual hatchling diamondback terrapins newly emerged from protected nests in Jamaica Bay Wildlife Refuge, New York. Thirty-six hatchlings were tagged in August, September, and October of 2010. An additional 251 hatchlings were tagged in August and September of 2011, all from protected nests at the same locale. Tag insertion generally followed the procedures of Rowe and Kelly (2005) with the exception that tags were not inserted via needle injection. Prior to tag insertion the skin in the left inguinal region was cleaned with 99% ethyl alcohol. A 2-3 mm incision was made into the body wall with a recurved scalpel blade to avoid excessive cutting of musculature and internal organs. A single sterilized PIT was inserted via the incision into the intraperitoneal region with sterilized tweezers. Once the PIT was no longer visible, the wound was again sterilized and covered with a quick-drying liquid bandage (CVS, liquid bandage). Hatchlings were observed a minimum of 20 min and up to 24 h post-insertion. Release sites were within 1 m of capture sites.

After release, area searches were conducted with a Biomark FS2001 Reader and portable antenna to determine each animal's location throughout the year. The reader was worn in a chest harness and the attached antenna was mounted on a handle and waved a few centimeters over or in direct contact with the ground much like a metal detector. Searches were generally concentrated on potential cover such as wrack lines, under dense vegetation and areas of leafy and woody debris. Failure to locate an individual was followed by a more methodical radius search from the release point.

According to the manufacturer, the antenna can scan through wood, soil, and water, although the signal is influenced by metals and other electronics and the read range of the antenna at highest power is optimal when a tag has a perpendicular orientation. The effective read range of the portable antenna with an 8-ft. (2.4 m) cable is 3.7 in. (9.4 cm) with the tag at a parallel orientation and 10.5 in. (26.7 cm) when the tag is oriented perpendicularly (Anonymous 2011).

Hibernacula were excavated to recover tags or possible hatchling remains after 1 June when presumably all active hatchlings had emerged. Excavation was done by hand. One millimeter of soil was removed from the site and scanned away from the nest to detect the presence or absence of tags. Each soil sample was carefully searched for any remains apart from the PIT tag.

Results.—One hundred forty-three (41%) of the tagged hatchlings were relocated at least once, 57 (16%) within 24 h. Of the individual hatchlings located, 127 (89%) stayed within 10 m of the nest while 13 (9%) moved 10–20 m, 1 (0.7%) moved 20-30 m, and 2 (1.3%) moved 40+ m, before settling in winter hibernacula. Thirteen individuals changed location at least one time before choosing hibernacula while one individual moved twice and three changed location three times.

I was able to monitor 81 (23%) hatchlings throughout the winter. By early summer they had either left their hibernacula or were killed by predators. Thirteen PIT tags were found when hibernacula were excavated, three with dead hatchlings and the other ten at varying depths in the soil without any visible hatchling remains.

Discussion.—I demonstrated the ability of the Biomark TX148511B scanner and handheld antenna to locate PIT-tagged hatchlings within their shallow hibernacula in a terrestrial environment under a variety of soil types and moisture conditions and the ability of hatchlings to retain the PITs for up to 295 days. Previous studies imbedded larger 12 × 2 mm PIT tags (Buhlmann and Tuberville 1998) or 10 × 2.1 mm tags (Camper and Dixon 1988) into turtles. The smaller 9 × 2.2 mm tag allowed me to embed tags into hatchling turtles, apparently without negative effects, although I cannot identify the cause of deaths for some tracked turtles.

The finding that 59% of tagged individuals were never relocated and 77% were lost before spring emergence may be attributed to five possibilities. Hatchlings may have moved beyond my search area, either on land or into the ocean. Thick vegetation hampered effective searching, either by making some areas impassable to me or by deflecting the antenna from effectively scanning some areas. Hatchlings may have dug deeper than the effective read range of the antenna. Also, marked hatchlings may have been killed by predators and carried away. Tags found with no visible hatchling remains were possibly shed from live individuals.

Compared to a radio-telemetry system, the PIT tag system is less expensive per animal (ca. US $6.25/ tag vs. ca. US $200/ transmitter) but more expensive for receivers and antennas (ca. US $4500 vs. ca. US $1200). Marking a large number of hatchlings, especially given normally high predation rates, is prohibitively expensive with radio transmitters, but may be possible with PIT tags. PIT tags are smaller and lighter than radio transmitters (0.067 g vs. 0.23 g) which may be important if attachment weight may alter the behavior of tagged animals. Adhesives for transmitters may affect normal shell growth in young turtles and the recommended transmitter weight is not more than 10% of the host animal (Beaupre et al. 2004). The average weight of terrapin hatchlings in Jamaica Bay is 6.7 g (N = 74). Small radio transmitters typically having lifespans of days to weeks are a viable option for short-term tracking studies. However, PIT tags weighing 1% of the host hatchling have indefinite lifespans, perhaps making it possible to track hatchlings into maturity. Unlike radio transmitters, PIT tags can only be detected from a small range. A distinct disadvantage of the handheld antenna is the potential need for a researcher to search large areas that may be covered by thick vegetation. It is also possible to confirm predation on PIT-tagged animals via the presence of tags in predator scats because PIT tags should survive predation events. Known latrine sites as well as individual scats can be scanned for tags, which would indicate predation events.

There is little information regarding behavior for the young of many reptiles. This is especially true with *Malaclemys* and *Terrapene* hatchlings, both of which have been reported to overwinter on land (Capitano 2005; Draud et al. 2004). Therefore, identification of critical habitat for both terrestrial and aquatic turtles that may overwinter on land is necessary for direct effective management.

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Sex Identification in the Common Snapping Turtle (*Chelydra serpentina*): A New Technique and Evaluation of Previous Methods

The Common Snapping Turtle has been regarded as a species of conservation concern and is very susceptible to declines (Brooks et al. 1991; Congdon et al. 1994; Tucker and Lamer 2004), primarily due to life-history constraints and documented imbalances in sex ratio (Congdon et al. 1994; Steen et al. 2006; Steyermark et al. 2008). Populations have been negatively affected by a variety of mortality sources, including female road mortality (Steen et al. 2006), overharvest (Congdon et al. 1994; Garber and Burger 1995; Mitchell 1994; Steen and Gibbs 2004; Tucker and Lamer 2004), and global warming (Tucker et al. 2008), all of which may impact sex ratios.

Although studies of snapping turtle demography are important for their conservation and management, gender assignment methods vary in their reliability. Morphological ratios have been developed (M. Dorcas, unpubl. data; Ernst et al. 1994; J. Tucker, pers. comm.) but differ substantially from one another and are not always accurate (pers. obs.). Sexual size dimorphism has also been used to differentiate between sexes, as male snapping turtles typically grow larger than females (Gibbons and Lovich 1990; Mitchell 1994; Palmer and Braswell 1995), but this attribute cannot be used on turtles that are not full-grown adults. Several sources (Ernst et al. 1994; Johnson 2000; Mitchell 1994; Palmer and Braswell 1995; Phillips et al. 1999) also note that males have a longer precloacal tail length than females but this measure is relative to the turtle as the precloacal lengths of younger turtles change throughout development (Gibbons and Lovich 1990).

Penis extrusion has been reported in males in response to handling and suggested as a potential aid when attempting to determine sex of male snapping turtles (de Solla et al. 2001). The present study details a simple and accurate sexing method for Common Snapping Turtles that relies on extrusion of either the penis by males or the cloacal wall by females. Using this technique, I tested the accuracy of previous methods used in sex determination. Besides providing an accurate analysis of sex ratios in this species, this method will also allow researchers to accurately sex snapping turtles in future studies and provide a mechanism to reevaluate previous studies involving sex determination.

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Methods.—Turtles were sampled during the summers of 2008 and 2009. In 2008, turtles were sampled at Carlyle Lake in Illinois (USA), approximately 150 km upstream of the confluence of the Mississippi and Ohio Rivers. The lake was constructed by the United States Army Corps of Engineers (USACE) in the 1960s for the purpose of flood control, human recreation, and as a water supply (X. Potts, pers. comm.). Study sites were located at North Carlyle in Fayette Co. (38.8333°N, 89.1833°W), managed by the Illinois Department of Natural Resources; South Shore (38.6166°N, 89.2833°W), located in Clinton Co., managed by the USACE; and Coles Creek (38.6500°N, 89.2666°'W), also located in Clinton Co. and managed by the USACE.

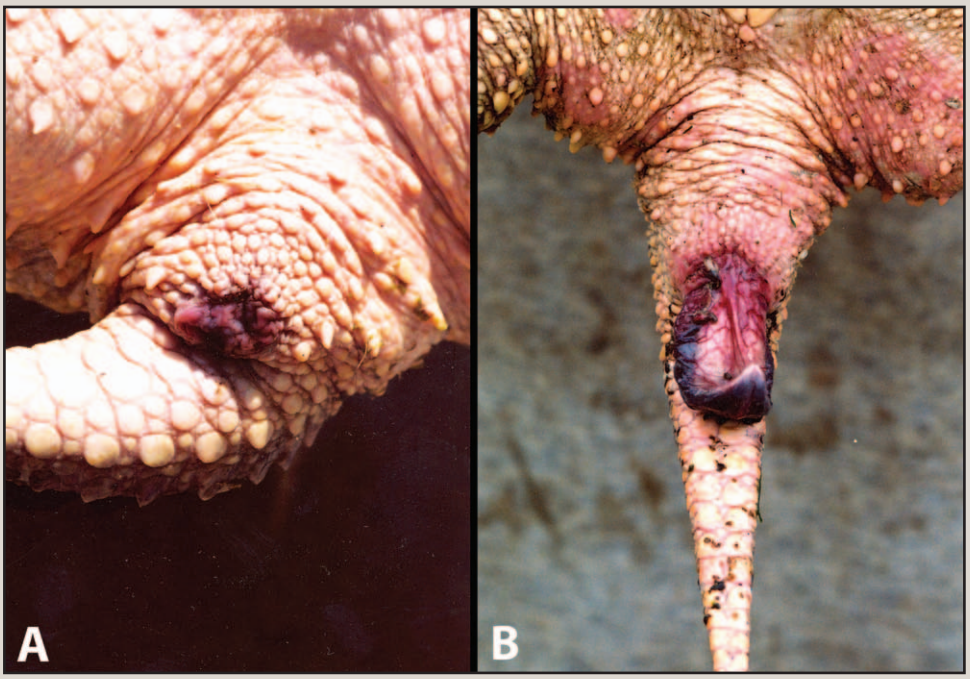


FIG. 1. Photo representation of snapping turtle genitalia (A, female cloacal wall; B, male penis) when using the eversion technique.

In the summer of 2009, my study continued at and near the Clear Creek Wildlife Management Area (CCWMA) in Hopkins Co., Kentucky. Sites in Kentucky were the Cabin site (37.3500°N, 87.7166°W), owned by a private landowner and outside of the CCWMA; Downstream (37.3333°N, 87.6833°W), managed by the Kentucky Division of Fish and Wildlife Resources (KDFWR); and Upstream (37.3166°N, 87.6666°W), also managed by the KDFWR as part of the CCWMA.

Turtles were collected using hoop nets (Legler 1960) that were 1.5 m in length and 76 cm in diameter and were made with 2.5-cm nylon mesh. During the trapping period, nets were baited daily with fresh fish carcasses and once weekly with canned sardines in soy oil (Vogt 1980). At the Illinois site, eight hoop traps were checked daily for a total of 240 trap days. At the Kentucky study site, six hoop traps were checked daily for a total of 270 trap days.

Measurements taken on all captured turtles with Haglöf calipers to the nearest 1 mm consisted of carapace length, carapace width, carapace height, plastron length, posterior lobe length, and precloacal length. Posterior lobe was measured from the middle of the plastron to the posterior end of the plastron. Precloacal length was measured from the posterior end of the plastron to the center of the cloaca (Ernst et al. 1994). Each turtle was weighed on a spring platform scale to the nearest 10 g and given a unique mark along the marginal scutes (Cagle 1939).

Collected snapping turtles were evaluated with several methods of sex determination. The new method presented here, the eversion technique, involves holding the turtle by the lower marginal scutes beneath the rear legs with the plastron facing away, approximately 30 centimeters from the holder's body in a vertical position. Once properly positioned, the holder then motions the turtle gently up and down, tilting slightly until the penis or the cloacal wall is everted (Fig. 1). In addition to this sexing technique, the ratio of the posterior lobe length to precloacal length, referred to as PPR (Fig. 2), was also utilized to sex snapping turtles. The ratio does not apply to turtles <200 mm in carapace length (CL), however, which are considered sexually immature (Ernst et al. 1994). As a result, I also evaluated the ability of the eversion technique to assess sex in turtles ranging from 100 to 200 mm CL.

According to Ernst et al. (1994), a turtle is considered male if the ratio between the precloacal length and posterior lobe (precloacal length divided by posterior lobe) is greater than 1.20 and is considered female if this ratio is less than 1.10. Conversely, Dorcas (unpubl. data) suggested that if the ratio between precloacal length and posterior lobe is greater than 0.86 the turtle is considered male and less than 0.86 the turtle is considered female. Furthermore, Tucker (pers. comm.) considered a turtle a male when the ratio is greater than 1 and female when the ratio is equal to or less than 1. These morphological ratios were tested for accuracy with turtles of known sex, which was determined by using the eversion technique.

Analyses were performed using the statistical program R (R Foundation for Statistical Computing, Vienna, Austria). A contingency table was created to determine how many times sex was correctly or incorrectly assigned. In order to establish whether previous methods for sexing were significantly different from one another, a Pearson's Chi-square test was performed (α = 0.05).

Results.—A total of 215 Common Snapping Turtles were collected during this study. Nearly all specimens (98%, N = 210/215) everted a cloacal wall or penis. Everted male genitalia varied in color from light gray to shades of pink and purple and typically had a smooth texture. Everted cloacal walls of females also varied in these colors and were also smooth in texture (Fig. 1). When the eversion technique was applied to turtles classified as juvenile (< 200 mm CL), 13 of the 16 turtles everted their genitalia.

Ernst et al.'s (1994) morphological ratio (PPR > 1.20 = male and PPR < 1.10 = female) was 67% accurate when tested against turtles of known sex with 72 known males misidentified. Tucker's method (PPR > 1.0 = male and PPR < 1.0 = female) was 88% accurate with 23 known males and 4 known females being misidentified

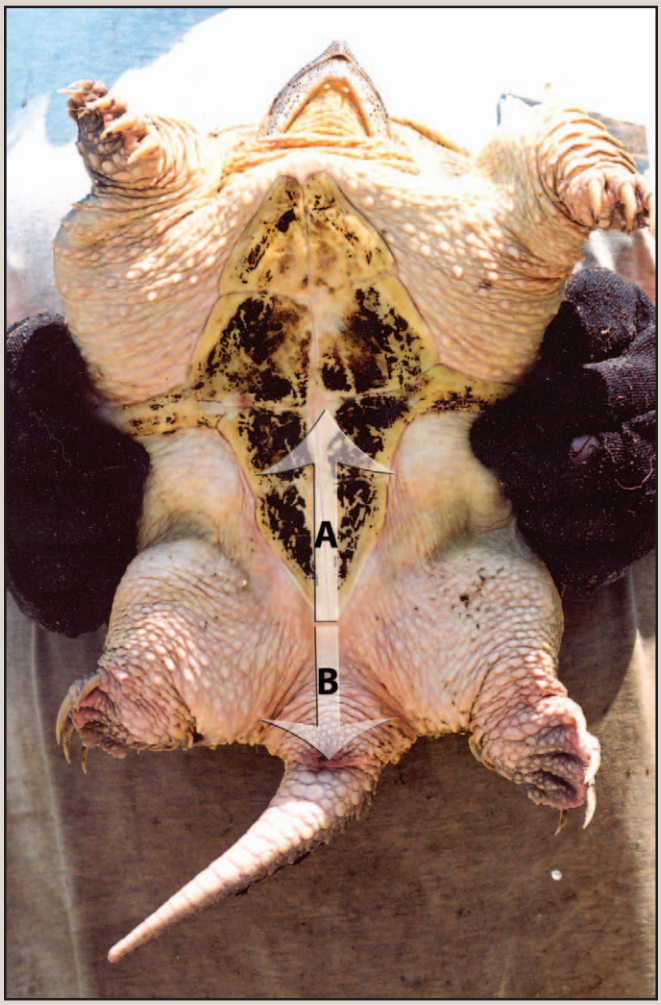


FIG. 2. Photo representation of measurements used in calculation of PPR as B divided by A (A, posterior lobe; B, precloacal length).

by this ratio. Dorcas's method (PPR > 0.86 = male and PPR < 0.86 = female) was 92% accurate with 4 known males and 14 known females misidentified. As verified by the eversion technique, the latter two ratio methods were both significantly more accurate (Dorcas: $\chi^2 = 20.5$, df = 1, $P < 0.0001$, N = 215; Tucker: $\chi^2 = 14.71$, df =1, P = 0.0001, N = 215) than the Ernst et al. ratio (N = 202). The Tucker and Dorcas methods did not differ significantly in accuracy ($\chi^2 = 0.56$, df = 1, p = 0.46). The PPR ranges were broadly overlapping for males (0.66–1.91; mean 1.16) and females (0.31–1.10; mean 0.73), with 73 males (51% of the total sample of males) having higher ratios than any of the females, i.e., almost half of the males overlapped with females in PPR ratio.

Discussion.—I present a simple, safe, and unambiguous method for sexing snapping turtles. Only 5 of 215 specimens could not be unambiguously sexed using this technique, one of which was clearly in poor health (it was lethargic, had numerous tumor-like growths, and was found dead the next day) and three that were very small juveniles. Previous methods that rely upon morphological ratios had low accuracy rates when tested against the results of the eversion technique, as the most accurate unpublished method of the three still misidentified gender 8% of the time. Furthermore, despite the varying accuracy of these three developed morphological ratios, the PPR ranges were 0.66–1.91 mm for males and 0.31–1.10 mm for females, thus illustrating that there actually is no ideal morphological ratio for determining snapping turtle gender. Future studies would thus benefit from utilizing the eversion method described here rather than any of the current morphological ratios.

There are several other problems with using morphological ratios. For the most commonly used method (Ernst et al. 1994), there is a gap in the ratio in which turtle sex is unknown. Turtles with a PPR greater than 1.20 are assumed to be male and turtles with a PPR less than 1.10 are assumed to be female but for any turtle with a PPR falling between 1.11 and 1.19, sex is unknown (Ernst et al. 1994). In addition, it is likely that these ratios will not be equally accurate across the entire geographic range of snapping turtles. Several other turtle species have been known to exhibit differences in morphology, color, shell shape, and body size depending on geographic location (Iverson 1985; Lovich et al. 1998; Tinkle 1961), perhaps as a result of physiological or environmental differences (Gibbons and Lovich 1990). Further, it has been noted that precloacal length increases throughout development in most, if not all, turtle species (Gibbons and Lovich 1990). In addition, chemical contaminants can affect the morphological development of sexual characteristics, particularly reducing the rate of increase in precloacal length. For instance, in areas with organochloride contamination, the PPR's of male snapping turtles were significantly smaller than those from non-contaminated sites (de Solla et al. 1998). To this end, assigning sex based on morphological ratios can potentially lead to skewed demographic data. Furthermore, past studies that have utilized these morphological ratios excluded turtles < 200 mm CL (Ernst et al. 1994 and J. Tucker, pers. comm.). In contrast, 13 of 16 turtles smaller than this size were successfully sexed using the eversion technique. Thus, the eversion technique can be successfully used for some juvenile common snapping turtles with a CL between 100 and 200 mm (see also de Solla et al. 2001), whereas the ratio techniques cannot.

With this new sexing method, assigning sex to Common Snapping Turtles is unambiguous and 100% accurate if the turtle everts its genitalia; only 1% of adults failed to do so. In the past, the only definite way to determine sex of the Common Snapping Turtle was through dissection, which involved killing the specimen. The nonlethal eversion technique is thus especially beneficial to snapping turtle populations where they are a species of conservation concern.

The ability of biologists to accurately record sex is important for the management of many populations, but particularly turtles in which much of the female-biased mortality is a direct result of anthropogenic impacts via road mortality (Haxton 2000; Marchand and Litvaitis 2004; Steen et al. 2006). The development of the eversion sexing technique is important for the conservation of snapping turtles and may allow more accurate management decisions to be made in the future. Further development of this and other techniques, particularly in other species of turtles with more pressing conservation needs, will only aid in the management of such populations.

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DNA Extraction from the Fecal Sac of Common Chameleons, *Chamaeleo chameleon*

Genetic tagging facilitates studies of species identification, analysis of population size and structure and the tracking of individuals. Because the sampling of natural populations of vertebrates for molecular ecology studies often involves the injuring or the sacrificing of individuals, this inevitably interferes with their natural behavior. Non-invasive, DNA-based techniques have become routine in assessing population abundance and genetic structure (Banks et al. 2003; Paetkau 2003; Palomares et al. 2002). Such techniques include buccal swabbing (Beebee 2008; Poschadel and Möller 2004), external eggshell swabs (Schmaltz et al. 2006) and fecal DNA extraction (Wasser et al. 1997). DNA from feces provides an ideal, non-invasive, source of information. This is especially so because feces are readily available and abundant and because even minute amounts of feces contain large quantities of the animal's DNA (Wasser et al. 1997). Consequently, fecal remains of free ranging animals have been used extensively in mammalian (Adams et al. 2007; Broquet and Petit 2004; Ernest et al. 2000; Frantzen et al. 1998) and avian (Idaghdour et al. 2003; Regnaut et al. 2006) research. However, feces were only infrequently used in reptilian research and only fresh samples, immediately cooled, have yielded PCR products (Jones et al. 2008). We here examined, for the first time, the use of

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fresh and of old fecal mucous sacs of the Common Chameleon, *Chamaeleo chameleon* (Reptilia, Lacertilia) as sources for DNA sampling that is non-invasive and has no adverse effects.

Common Chameleons are arboreal lizards that forage for insect prey and dispose of their feces wrapped in a mucous sac. The sac is formed in the intestine and contains the chameleon's epithelial cells. We addressed the following questions: 1) Does DNA from the fecal sac reliably represent the endogenous DNA of the chameleon? 2) Can DNA extracted from the fecal sac be used for PCR reactions? 3) Does the quality and/or quantity of the DNA, extracted from dry samples of different age, change over time?

Chameleons were collected in northern Israel and kept in captivity (details in Lustig et al. 2012). The following samples were obtained: a) liver tissue (N = 3); b) tail tip tissue (N = 5); c) buccal swabbing (N = 13); d) fresh feces (N = 23) (Fig. 1B); and e) dry feces of different ages (up to 43 days; N = 69) (Fig. 1A). Liver and tail tip tissues were collected from dead individuals and kept frozen at -20°C. To obtain buccal swabs, a pipette tip was gently moved over the chameleons' gums and the samples then washed off the tip using ATL lysis buffer (QIAGEN). Fresh feces were collected on the day of excretion and kept in distilled water at 4°C for a few days until extraction, to prevent the mucous sac from drying. Dry feces were collected over a period of 43 days and were kept in open, dry Petri dishes, in an open outdoor container placed in a shed. The container was covered with gauze so that the samples were protected from insects yet exposed to ambient Mediterranean summer conditions (temperatures of ca. 28–32°C and humidity of ca. 80–90%). Prior to DNA extraction, a fecal sac was removed from the fresh or the dry sample using tweezers, and washed with distilled water. Extractions were performed using DNeasy Blood & Tissue Kit (QIAGEN) following the manufacturer's instructions. The DNA quantity of each sample was assessed by Nano-Drop and its integrity was checked by agarose gel electrophoresis.

To validate the extraction of chameleons' high molecular weight DNA from the fecal sacs, we amplified and sequenced fragments of the mitochondrial Cytochrome C Oxidase I (COI) gene (NCBI GenBank Accession #ABM89788). The following primer pairs were used for the amplification: COI.F1 (5'- AGGCGGAGATCCCGTACTAT-3') and COI.R1 (5'- GAAATAGGCTCGGGTGTCAA -3') fragment size 244 bp; COI.F2 (5'- TCTATTGATTTCCACTAATTTCAGG -3') and COI.R2 (5'- GAATATCGTCGTGGTATTCC -3') fragment size 181 bp.

DNA amplification was performed at 94°C for 4 min and subsequent 35 cycles of 94°C for 1 min, 57°C for 1 min, 72°C for 2 min, with a final extension of 72°C for 4 min. Each PCR reaction contained: 9µl Taq Polymerase (Lamda Biotech©), 0.7µl $MgCl_2$, 4.3µl H_20, 1µl primer F (10 mM), 1µl primer R (10 mM) and 2µl DNA. The single PCR products were purified (QIAGEN, QIAquick PCR Purification Kit) and sent to ex-campus sequencing. Sequence chromatographs were checked manually, and compared with the *C. chameleon* COI sequences in the GeneBank.

A high quantity of DNA was obtained from the liver and the tail tip samples, a lower quantity was obtained from the fresh and the dry mucous fecal sac, and a significantly lower amount from the buccal swabbing samples (Fig. 2A).

The sequence results from all the tested tissues confirmed that the DNA extracted and amplified was the endogenous DNA of the chameleons. The quality of the sequences from both the fresh and the dry fecal sacs at different ages was similar (Fig. 3). Our samples showed a complete (100%) identity with the COI sequence of the mitochondrial genome published for the common chameleon (NCBI GenBank Accession #EF222198). A sequence comparison of a fragment of 240 bp from the COI gene of nine individuals showed no variation.

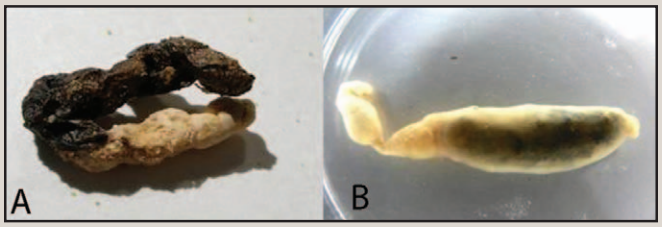


FIG. 1. Feces of the common chameleon, *Chamaeleo chameleon*, in their mucous sac (A - dry, B - fresh feces).

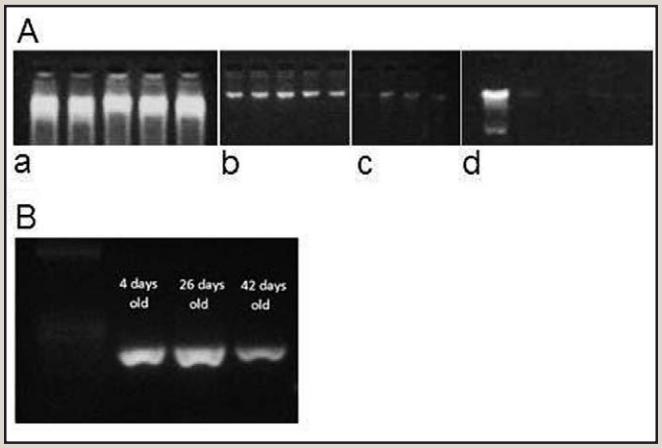


FIG. 2. A) High molecular weight genomic DNA isolated from: a) tail tip; b) fresh fecal sac; c) dry sac; d) buccal swabbing. B) COI PCR products from dry feces samples after 4, 26, and 42 days in natural climatic conditions.

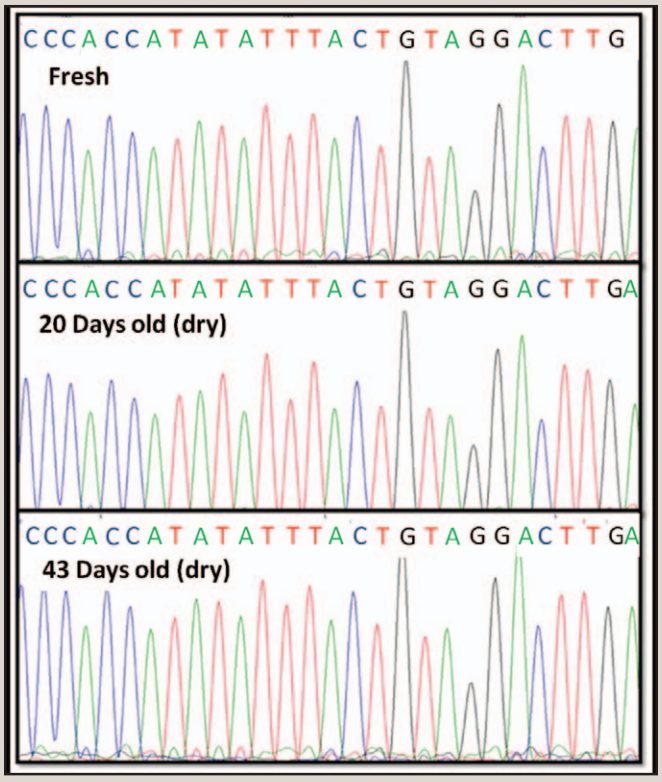


FIG. 3. COI gene sequence extracted from mucous sacs at different ages.

Techniques using DNA to distinguish between species, populations, and individuals are of extremely high value in molecular ecology. However, the reliability of these measurements depends not only on the genetic material but also on having a large sample size to characterize any population variation. The difficulty of acquiring adequate sample sizes using invasive techniques, such as tissue or blood sampling, restrict the application of molecular technology in the field (Wasser et al. 1997). Non-invasive samples such as sampling of hair, urine, saliva, feathers, scent marks, eggshells, sloughed skin, and feces have been found to be effective in acquiring DNA from free-moving animals (Beja-Pereira et al. 2009). However, non-invasive sampling methods for reptiles have been largely overlooked, probably because of the difficulty in identifying the remains. Most non-invasive samples from reptiles depend on sloughed skin, aborted eggs, road-kill, and museum samples. Such samples may well be biased and may not necessarily represent the actual population structure. Feces, however, are commonly used as a DNA source for avian and mammalian species because they provide more information (e.g., on diet, stress or reproductive hormone status) and thus should be useful in herpetological studies as well (Beja-Pereira et al. 2009; Jones et al. 2008).

For reptiles and amphibians that produce a fecal sac, we present here a non-invasive technique of high potential for species-specific sampling. Our results clearly demonstrate that sufficient amounts of high molecular weight DNA may be obtained from the fecal mucous sac (Fig. 2A). Moreover, fecal sacs remained a good source for DNA extraction and PCR amplification for over a month following their secretion, under natural environmental conditions (Fig. 2B).

The sampling of mucous sacs requires no animal handling and thus imposes no disturbance, and may have wide applications for population genetics in the field. The ability to isolate DNA of high molecular weight from old and dry fecal sacs makes this method especially appealing.

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Positioning Minnow Traps in Wetlands to Avoid Accidental Deaths of Frogs

Funnel trapping has become a widely used technique for monitoring amphibians and can be especially useful for sampling species that congregate at breeding wetlands for short periods of time (Willson and Gibbons 2010). While this technique can provide invaluable information on the biology of the species of interest, inherent risks associated can sometime lead to the injury or even death of the organism being sampled.

While surveying wetlands for breeding Crawfish Frogs (*Lithobates areolatus*) using collapsible mesh minnow traps, we found one adult female nearly drowned because her leg was caught at the knee in the metal support structure of the trap. The minnow traps we used were manufactured by American Maple Inc. (Gardena, California) and sold by Lee Lures (Valrico, Florida; product # TR-503). Traps were 61 cm x 30 cm, covered with black polyethylene mesh (mesh size 1.5 x 1.0 cm; Fig. 1a). The mesh is supported by a steel framework of a single piece of 0.4 cm (diameter) stock twisted to form two end loops (30 cm diameter) and a coil frame (61 cm) with 3½ spirals between trap ends supporting the mesh. Where the coil portion of the frame attaches to the end loop the distance between the metal stock gets progressively smaller (Fig. 1b). The trap mesh has two zippered openings, one, 25 cm long, allowing access to the trap, and a second, 11 cm long, at the opposite side accessing a bait pouch. The large opening is situated at the opposite side of the trap from where the coil of the metal frame attaches to each end loop, therefore, when the opening is positioned up and out of the water, these frame attachments are submerged.

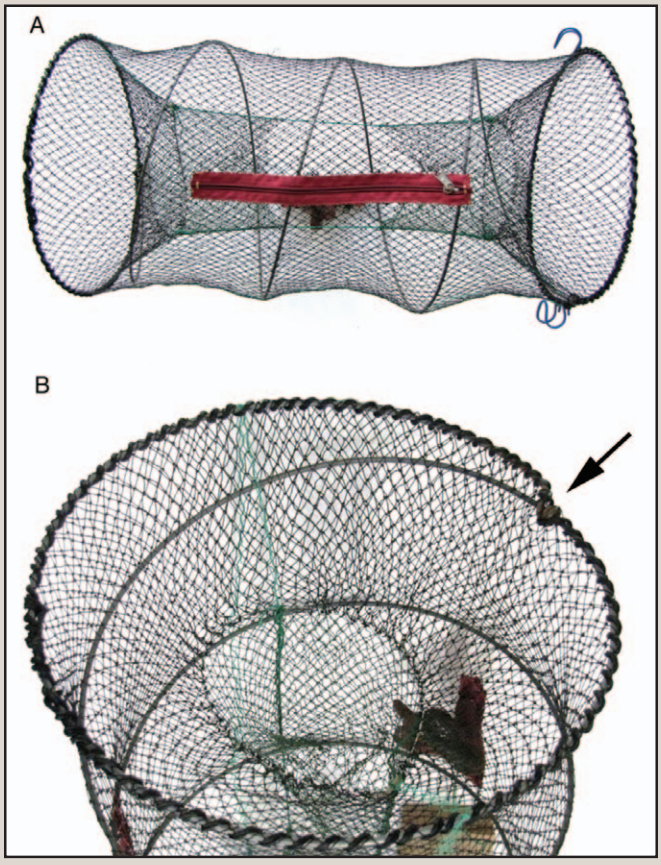


FIG. 1. Collapsible mesh minnow trap used to census Crawfish Frogs. A) Top-down view of the trap with access zipper positioned on top. B) View of the trap opening showing the steel coil and end loop junction where a frog's leg can be caught.

On 15 March 2012, we discovered a female Crawfish Frog (8.8 cm SVL, 86 g) in one of our traps. The left leg of the frog was caught immediately above the knee in the trap frame between the spiral and the end loop. There was no visible trauma to the leg, but the frog appeared to have been submerged for some time (the trap was last checked the previous day) and was unconscious; it was not breathing and had no detectable heartbeat. Crawfish Frogs are atypical ranids in that they do not tolerate submergence for long (~ 1 h) periods of time (Heemeyer and Lannoo 2010, 2011). Soon after chest massage we noticed a heartbeat, and after approximately 20 minutes, the frog began breathing on its own and was brought into our lab for recovery and observation. Though initially lethargic and unresponsive, later in the day the frog appeared healthier (sitting upright, conscious) and three days later, on 18 March, we released her near where she was captured. On 20 March she was found dead in shallow water at the release site, mostly intact, but with lacerations on her throat and abdomen. Because the frog was found in the open, close to the point of release, we suspect that it may have suffered neurological damage while it was submerged in the trap, and that its ability to quickly escape predation was compromised. It is also possible that the frog succumbed to its injuries and was attacked but not consumed after it had already died.

Accidental trap injury and mortality have been reported for other herpetofauna including Greater Sirens (*Siren lacertina*; Johnson and Barichivich 2004), Two-toed Amphiumas (*Amphiuma means*; Darby et al. 2001), Florida Green Watersnakes (*Nerodia floridana*; Johnson and Barichivich 2004; Darby et al. 2001), Diamond-backed Terrapins (*Malaclemys terrapin*; Dorcas et al. 2007; Grosse et al. 2009), False Map Turtles (*Graptemys pseudogeographica*), Pond Sliders (*Trachemys scripta*), Smooth Softshells (*Apalone mutica*), Spiny Softshells (*Apalone spinifera*), and Snapping Turtles (*Chelydra serpentina*; Barko et al. 2004). In an effort to prevent injury and accidental drowning, researchers have augmented trap designs by attaching floatation devices (Casazza et al. 2000), using plastic coated mesh (Johnson and

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Barichivich 2004), and extending trap cages above the water surface (Roosenburg et al. 1997).

Trap mortality is not often reported in field studies (Enge 2001), and most available funnel trap mortality data for amphibians are from studies using terrestrial funnel trapping techniques. Enge (1998) reported an anuran trap mortality rate of 7.8% when using a combination of aquatic and terrestrial funnel traps, and studies using exclusively terrestrial funnel traps have reported anuran mortality rates ranging from 0.9–37.1% (Enge 2001; Jenkins et al. 2003). In our study we have repeatedly sampled three different wetlands during four different breeding seasons, and in this time have observed relatively low trap-related mortality (1.0%; 2/194 adults captured) in breeding Crawfish Frogs. The only other Crawfish Frog death occurred when an adult male was skinned and eviscerated by a predator (likely either a mink or raccoon; Heemeyer et al. 2010) within a trap. What is particularly unfortunate about the incident we report here is that Crawfish Frogs are listed as Near Threatened on the IUCN Red List (IUCN 2012) and are a state endangered species in Indiana where our study was located (Engbrecht and Lannoo 2010). Because the female was gravid, we estimate, based on size, that she would have produced approximately 4,200 eggs (C.I. ± 410; Kinney 2011; Redmer 2000). While we have not observed this type of trap entanglement in any other species during our study, the inherent risk seems present.

When sampling for Crawfish Frogs at our study site, we always place funnel traps in shallow water with the top portion of the trap above the water's surface, which allows frogs and other terrestrial animals to surface for air. Because of the current construction of the American Maple Inc. collapsible mesh minnow traps, we recommend that care be taken to place the spiral attachments of the frame to the end loops out of the water to prevent casualty. This means that the access zipper is submerged and—depending on water level—that the bait pouch is out of the water. This would not be a problem for unbaited traps, but would be an issue if using submerged bait. We have notified the manufacturer of this issue, and suggested during construction that they rotate the mesh on the frame, so that the attachments of the spiral to the end loops is aligned with the access zipper instead of the bait pouch.

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Attachment and Deployment of Remote Video/Audio Recording Devices (Crittercams) on wild American Alligators (*Alligator mississippiensis*)

Historically, researchers have used direct observation, often with the assistance of specialized equipment (e.g., binoculars, telescopes, remote video/audio recorders), to document animal behavior and ecology (Altmann 1974). However, these observer-based techniques typically cause disturbance to animals via presence of observers or equipment, are limited in the data that can be collected (e.g., field of view, magnification), and often occur over short temporal scales, all of which restrict the inferences that can be gleaned from the data (Marsh and Hanlon 2004; Samuel et al. 1987). Documenting the behavior of aquatic species, such as crocodilians, presents additional complications because the majority of their interactions occur below the water's surface where direct observation can be even more challenging (Dickens et al. 2011). To overcome these limitations and increase the quality and quantity of observational data, researchers have utilized technological advances to develop devices that can be attached to animals and are capable of collecting video and audio data from the animal's point-of-view. Collectively known as "animal-borne imagery," this field has flourished in the past 20 years, in-part due to the success of the National Geographic Remote Imaging (NGRI) Crittercam program (Marshall 1998). To date, their animal-borne imaging systems have been used to study the behavior of over 60 species spanning a wide range including aquatic vertebrates and invertebrates, such as large sharks, sea turtles, and Humboldt squid, as well as terrestrial species such as lions, bears, and various species of birds (Marshall, unpubl. data). Crittercam, in addition to other animal-borne imaging systems, has revolutionized the field of animal behavior and ecology by permitting the observation of novel natural history characteristics, such as cryptic foraging behaviors or subtle species interactions, and by expanding the range of response variables available for ecological studies, such as diving, foraging, and prey capture success rates (Moll et al. 2007).

To facilitate use of animal-borne imaging to study crocodilians, initial experiments were conducted with Crittercam units on crocodilians in 1988 and later in 2004. Variations on a neoprene-and-nylon webbing style harness were used to attach a video recorder to captive *Alligator mississippiensis* (American Alligator) and in 2001 test fittings were done with *Gavialis gangeticus* (Indian Gharial), although planned wild deployments were not carried out. Attempting to design an attachment apparatus that could securely hold the Crittercam during deployment but also incorporated a reliable, automatically-activated releasing mechanism led to development of fairly complex harnesses that were difficult to make and deploy. Here we present a much simpler method for attaching and detaching Crittercam units on crocodilians that has proven successful and we summarize the results from our first deployments on wild adult *A. mississippiensis* in two Florida estuaries.

Methods and Materials— From 22 April to 6 May 2010 and 27 April to 8 May 2011, adult (> 2 m total length, TL) *A. mississippiensis* were captured using standard crocodilian capture techniques (e.g., snatch hooks and rope snares) as part of ongoing research and monitoring programs. Once secured, individuals were subject to standard morphometric measurements (head length, head width, snout-to-vent length, total length, and tail girth), blood sampling, scute tissue biopsies, and urine collection. Individual alligators were held for 20–30 minutes during sampling and Crittercam unit attachment and then immediately released at their sites of capture. The location of individual alligators outfitted with a Crittercam unit was monitored via an onboard VHF radio transmitter throughout the duration of each deployment.

Crittercam units were loaned by NGRI for two weeks during each sampling period. Each cylindrical Crittercam unit (5.7 cm height × 27 cm length, 770 g) was secured using two worm gear hose clamps (10 cm max. diameter) to a composite base (32 × 10 cm, 350 g), hereafter known as the cradle, constructed out of a thin (3 mm thickness) carbon-fiber base-plate and buoyant polyurethane foam body, formed to accommodate the Crittercam unit (Fig. 1A). Once mounted to the cradle, the Crittercam footprint measured 32 × 10 × 7.5 cm and weighed 1 kg (Fig. 1B). Additionally, to reduce vibration, adjust the field of view, and add stability, we fixed a single piece of 5-cm-thick heavy-duty urethane foam cut to dimensions of the cradle (0.78 g/cm^2, Airtex Industries Inc., Houston, Texas) to the bottom of the cradle using hot glue.

Crittercam units were attached to alligators using a harness constructed from a single (1–2 m) length (size varied depending on girth of individual) of 2.52 cm wide 100% cotton webbing (National Webbing Products Co., Plainview, New York; Fig. 2). To allow for full mobility of the head and neck we positioned the Crittercam unit foam side down on the dorsum of the alligator so that the anterior edge of the cradle rested above the anterior edge of the shoulder girdle. The middle of the length of cotton webbing was laid through a channel at the anterior edge of the cradle base-plate, between the raised polyurethane form and two protruding bolts (1 cm in height) at the leading edge. The two free ends of the cotton webbing under the ventral surface of

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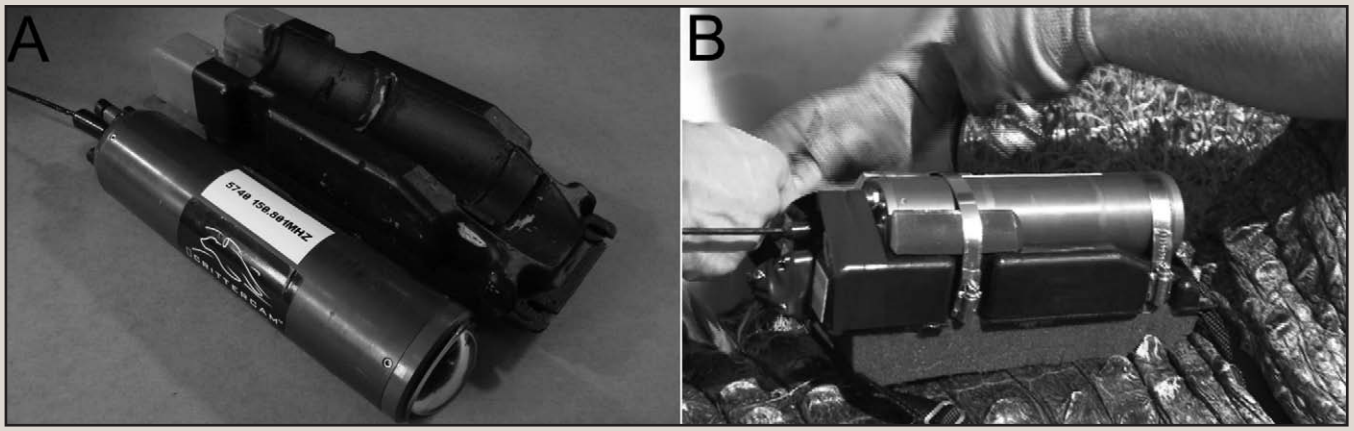


FIG. 1. A) Photo of Crittercam unit (left) and polyurethane cradle (right). B) Photo of fully assembled Crittercam unit within cradle mounted on adult alligator.

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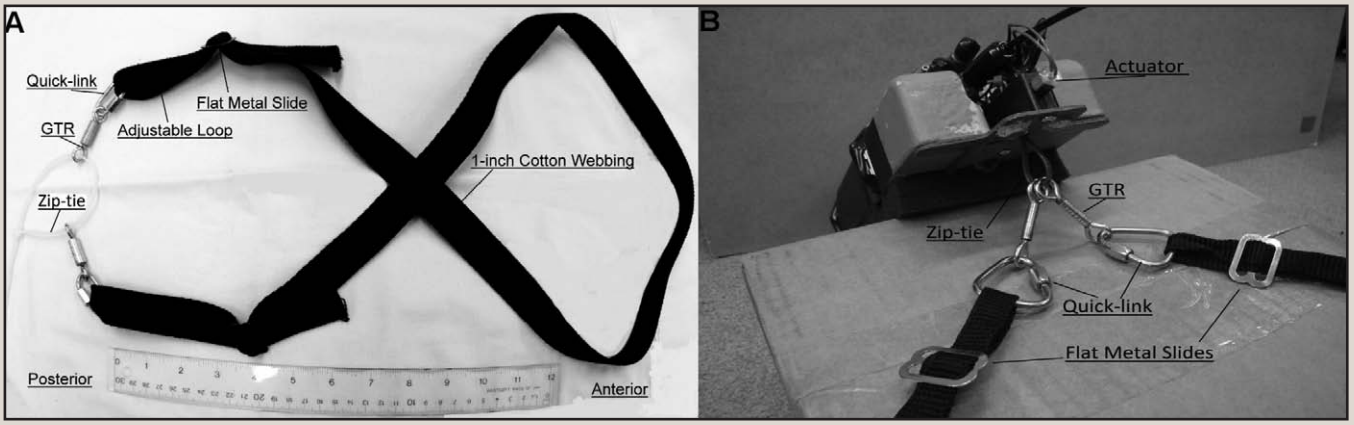


FIG. 2. A) Photo of single strand harness system, with components of harness and fail-safe detachment system labeled. B) Photo of detachment system, with components labeled.

the alligator at the shoulder girdle and opposing ends secured to a single plastic zip-tie (22.6 kg test) via two 2.5-cm steel quick-links at the posterior of the base-plate of the cradle (Fig. 2). We adjusted each harness to accommodate body size variation by looping the terminal end of the cotton webbing through a 2.5-cm flat metal slide. This loop also served to secure the quick-links in place (Fig. 2 A). To allow for programmed detachment, the plastic zip-tie holding the terminal ends of the harness was fed through a portal (0.5 cm diameter) in the base-plate of the cradle then through a circular tube drilled into a rectangular polyoxymethylene (Delrin; DuPont, Washington D.C.) housing (5.4 × 1.9 × 1.2 cm) attached to the base-plate (Fig. 2B). Prior to attachment, within the plastic housing a flattened brass bolt was screwed in a perpendicular tube so the flattened end was flush with the anterior edge of the tube containing the plastic zip-tie to act as a backstop. Following the placement of the zip-tie, a 1-cm-long steel blade (flat on one side and roughly sharpened on the other) was inserted into a portal at the posterior end of the perpendicular tube, held in place by a rubber padded screw, and followed by a small pyrotechnic piston actuator (Chemring Energetic Devices, Downers Grove, Illinois) screwed into a threaded portion of the same portal (Fig. 2B). The actuator was then connected to a power port on the Crittercam unit and grounded to the rear faceplate of the unit using a small bolt. At the programmed time of detachment, an electrical impulse sent to the actuator via the power cord ignited a small amount of gunpowder housed in the actuator. The force from the ignited gunpowder then ejected a small piston from the anterior end of the actuator propelling the small cutting blade into the zip-tie, breaking the zip-tie as it contacted the brass backstop. Once the harness was detached, the Crittercam unit was free to float to the surface or fall on the ground depending on the habitat.

As a fail-safe, a Galvanic Timed Releases (GTR; Neptune Marine Products Inc. Port Townsend, Washington) was inserted between each quick-link and the zip-tie loop of the harness system (Fig. 2). Comprised of two dissimilar metals, GTRs corrode and separate at predictable rates dependent on their size and the salinity and temperature of the water in which they are used. We used two types of GTRs with predicted decay rates of either 24 or 48 h depending on the desired duration of each deployment. All portions of the harness system left in the environment (i.e., cotton webbing, quick links, metal strap slides, and GTRs) were biodegradable and in most cases, the harness was recovered with the Crittercam unit.

Crittercam units, depending on the camera type (standard or high-definition video), had the potential to record 6–8 h of audio and video data, constrained either by the capacity of the onboard batteries or the video data storage, depending on the sampling protocols used. The Crittercams can be programmed to sample the video according to a variety of time and environmental conditions, determined by the user. To maximize the coverage of the 24-h timeframe, we used a combination of 30- and 60-minute

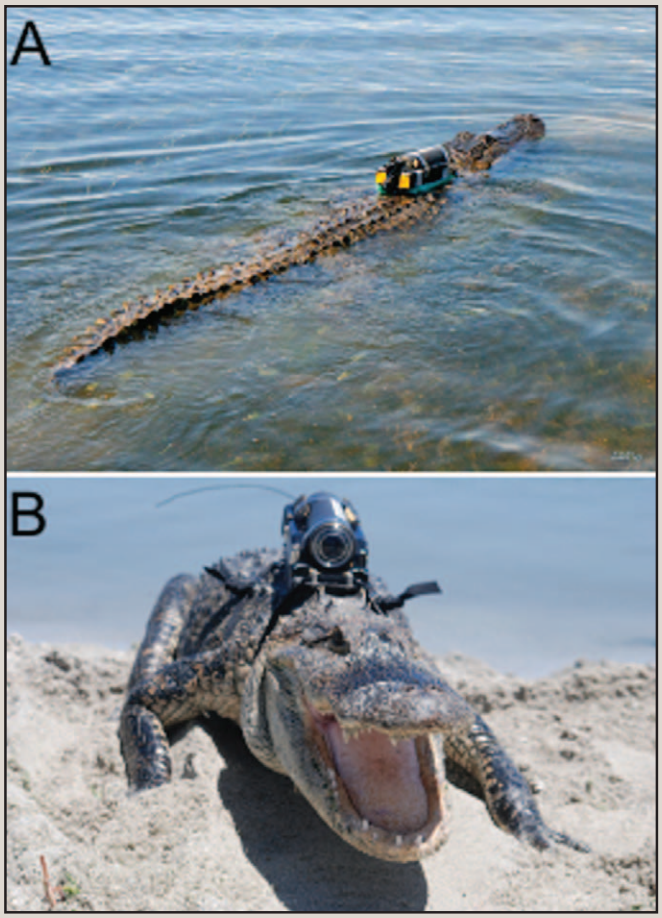


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PHOTO BY J. NIFONG

FIG. 3. A) Photo of *Alligator mississippiensis* with Crittercam attached in natural habitat, view from rear. B) Photo of *A. mississippiensis* with attached Crittercam, view from front.

TABLE 1. Comparison of observable individual-based behavioral variables that can be recorded/documented using animal-borne imagery compared to traditional direct observation techniques.

Observable variables	Animal-borne imagery	Direct observation
Night-time Images	Yes	Yes*
Acoustic data	Yes	Yes*
Body position	Yes	Yes*
Ambient temperature	Yes	Yes*
Individual identification	Yes	Yes*
Above-surface interactions	Yes	Yes
Below-surface interactions	Yes	Yes*
Point-of-view images	Yes	No
Depth	Yes	No
Acceleration	Yes	No

*Observations are limited.

recording intervals over 4- to 8-h recording windows set at different times of the day. This enabled us to record over multiple days on the same individual and to collect data during all hours of the day. Crittercam units were deployed for one to two days under a variety of recording schedules including day and nighttime recording windows. To collect video at night, Crittercam units are outfitted with onboard red LED lights. Lights were programmed to turn on during nighttime recording intervals. In addition to audio and video recorders, Crittercam units also came outfitted with a variety of environmental data collection sensors, including temperature, depth, and acceleration. These data parameters were collected every second during deployments and data collection terminated at the scheduled time of detachment.

Results.—We outfitted 15 adult alligators (4 females and 11 males, TL range 221–307 cm, mean ± SD: 262 ± 25 cm) with Crittercam units (N = 9, at Merritt Island National Wildlife Reserve, 28.529543°N, 80.606585°W, in 2010 and N = 6, at Guana Tolomato Matanzas National Estuarine Research Reserve, 30.024833°N, 81.329628°W, in 2011; Fig. 3). Crittercam units were on average 1.9% of the total mass of an individual alligator (mean = 52 kg). A total of 102 hours of audio and video data was recorded during deployments, 79.5 h (~78%) of which was usable footage for behavioral analyses (i.e., clear view of surrounding habitat and the alligator's snout; Fig. 4). Four deployments ended early due either to units detaching prior to scheduled detachment (e.g., snagging on vegetation) or camera lenses becoming obstructed by vegetation and/or substrate. Only one individual displayed signs of discomfort or stress during deployments. That individual, a large male (224 cm TL), was missing a large portion (~40 cm) of its tail from a previous injury and seemed to be disoriented for a portion of the Crittercam deployment. We hypothesize this was due to the added weight and movement of the Crittercam unit in heavy wave conditions in deep water, combined with the loss of stabilization from the missing portion of the tail. In two instances alligators were located using VHF radio signals and the Crittercam unit was manually removed due to the detachment apparatus malfunctioning. Because in our study systems salinities were moderate to high (14–34 ppt) and ambient water temperatures were high (21–25°C), in addition to the fact that units were not fully submerged throughout deployments, GTRs corroded more slowly than anticipated: in 48 and 96 h for predicted 24- and 48-h models, respectively.

The 79.5 h of unobstructed video and audio data collected during deployments generated clear point-of-view footage in most environmental conditions encountered (Fig. 4). Given the properties of the camera (horizontal field of view: 114 degree for Gen 5.7 SD model and 170 degree for Gen 6.0 HD Crittercam) and its position on the alligator, the field of view encompassed the upper portion of the head, snout, and nostrils as well as the surrounding environment. In three instances the Crittercam and harness was displaced producing a side-angle image of the head and snout. Image clarity and field of view were negatively affected by water turbidity and aquatic vegetation density. In all conditions the movement of the head could be observed. We observed a variety of behaviors and species interactions and were able to record video footage during all times of the day and night, although the depth of view was reduced at night. Behaviors and interactions observed included inter- and intraspecific interactions, prey capture and pursuit, diving behavior, body position, basking patterns, and habitat use (Table 1).

Discussion.—Documenting and studying the behavioral interactions of living organisms, in particular aquatic species, can be difficult due to the constraints of technology, limitations of environmental conditions, and behavioral modifications brought on by the presence of human observers or equipment. To reduce bias and limitations in the study of animal behavior using observational techniques, researchers and technicians have developed animal-borne imagery as an effective means to

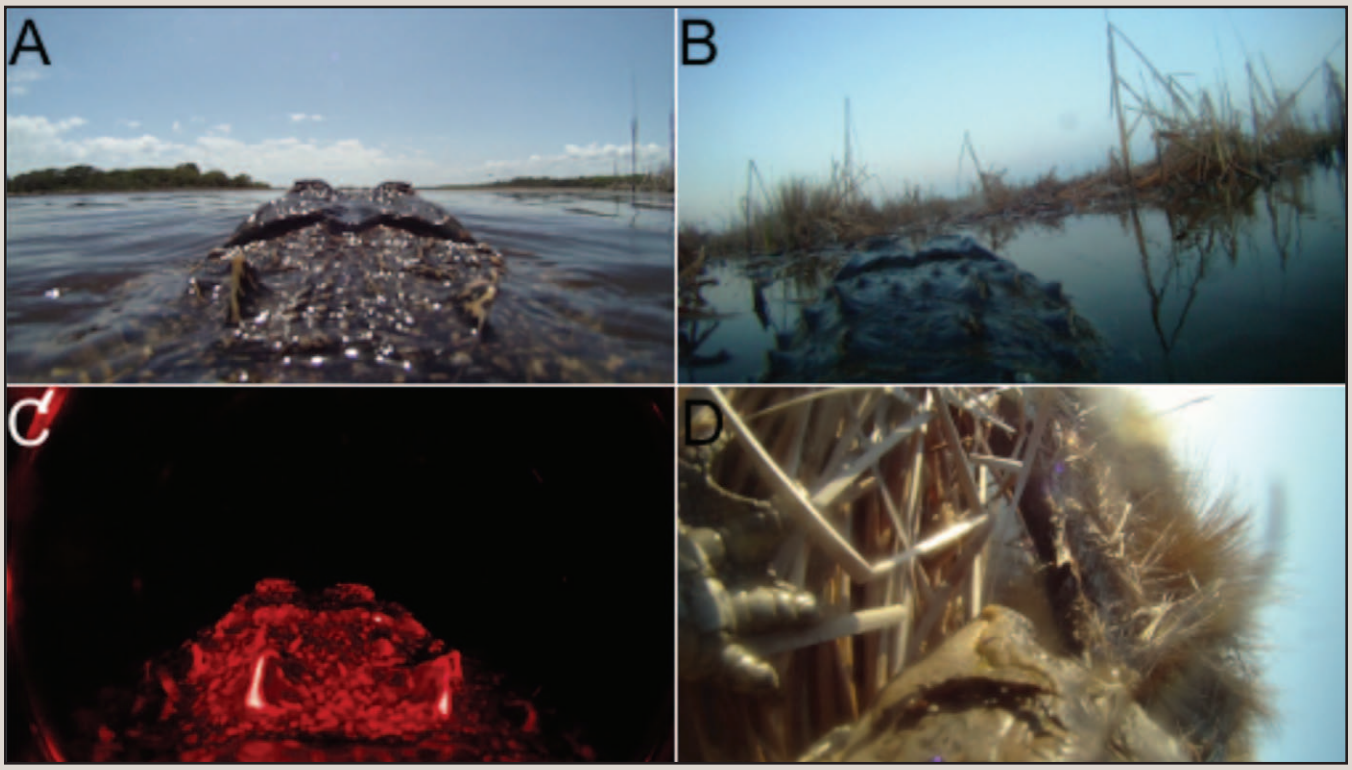


FIG. 4. Snapshots of video footage recorded during Crittercam deployments: A) Color video during day-time. B) Color video during sunrise. C) Color video during night-time. D) Side-angle view following shift in Crittercam position.

collect video and audio data from the perspective of the animal. Here, we demonstrate that animal-borne imagery devices can successfully be used to study the habits of crocodilians with little to no adverse effects on natural behavior. In comparison to direct observation, animal-borne imagery markedly increases both the quality and quantity of certain observational data which can be collected from crocodilians (Table 1). However, animal-borne imagery also has its own limitations in crocodilian studies. While the POV video produced by Crittercam offers an up-close view of animal behavior and interactions, it is restricted by the field of view and position of the camera unit. Additionally, the short duration (~8 h) of video data produced by these units may limit the amount of data available to researchers. Furthermore, when attaching equipment to wild animals there is always the potential to lose or damage the equipment.

From the outcome of deployments performed thus far, we recommend special consideration be given to the size and condition of individual crocodilians receiving Crittercams or similar types of devices. First, individuals smaller than 2 m in total length may be too small to support the added weight and drag of the Crittercam or similar data collection systems. Second, individuals in poor condition (e.g., emaciated, appearing ill or with large injuries) or physically handicapped may not be ideal candidates for camera deployments. With these limitations in mind, animal-borne imagery devices can be useful tools for recording point-of-view video and audio data of crocodilian behavior, ecological interactions, daily activity patterns, and position in the habitat. In addition, when coupled with other data collection devices such as temperature and depth sensors, this data provides an avenue to perform in-depth analyses of the effects environmental conditions have on behavioral and ecological interactions. Although we used a pre-manufactured audio/video recording device (Crittercam), we believe this method of attachment and fail-safe system could be used to deploy a variety of other devices (e.g., small cameras, depth sensors, accelerometers) on any crocodilian species at relatively little cost to researchers.

We suggest the following questions could potentially be addressed using Crittercams or similar equipment while studying crocodilians: What is the diel activity cycle (e.g., basking times, movement rates, den use, and social activities)? What are the rates of submergence? How often do crocodilians attempt to capture prey? What is the rate of success when attempting to capture prey? What foraging techniques are employed while capturing prey? Are certain foraging techniques more successful than others? How do crocodilian species differ in ecological and biological interactions?

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A Method for Surveying Diurnal Terrestrial Reptiles with Passive Infrared Automatically Triggered Cameras

The use of automatically triggered cameras (hereafter-termed cameras) as ecological research tools has expanded considerably in recent decades (Cutler and Swann 1999; Rowcliffe and Carbone 2008). Cameras were once film-based and triggered by mechanical devices such as trip-wires, but now most systems utilize digital technology triggered by active-infrared (AIR) or passive-infrared (PIR) sensors (Swann et al. 2011). Where research questions do not require the physical capture of animals, cameras provide substantial ethical benefits over many traditional survey methods (Putman 1995) and have been shown to be superior to techniques such as live-trapping or hair-tunnels for mammals (De Bondi et al. 2010; Paull et al. 2012). Yet, while the use of cameras for understanding the distribution and ecology of mammals is well advanced, their utility for surveying other vertebrate fauna is mostly unknown. Due to trigger limitations, the use of cameras for reptile research has been restricted to a few species-specific studies. As such, this paper documents a method for use of PIR-triggered cameras to detect multiple species of diurnal terrestrial reptile.

Trigger sensitivity is a key limitation for some cameras. For reliable use, trigger mechanisms need to be sensitive enough to detect the target species, but not so sensitive that excessive false-trigger events (triggering of the camera when an animal is absent) become a hindrance (Swann et al. 2011). Guyer et al. (1997) developed a pressure-plate trigger that was successfully used to study Gopher Tortoises (*Gopherus polyphemus*) (Boglioli et al. 2003; Johnson et al. 2007), and Maier et al. (2002) developed a subterranean seismic trigger that was successfully used to study turtle nest predation (Marchand et al. 2002). However, as reptile communities include small species (< 100 g), these two types of trigger are not practical. Pressure-plates are limited by the mass of the target animal, and so a pressure-plate sensitive enough to detect small reptiles could easily become permanently depressed by displaced vegetation or substrate. Similarly, a seismic trigger sensitive enough to detect small reptiles would be prone to a high level of false-triggers as any vibration in the environment, such as weather events, would trigger the camera.

Active-infrared triggers are analogous to mechanical trip-wires; an infrared beam is transmitted to a receiver and, when broken, signals the camera to capture an image. Trigger sensitivity is generally not a problem with AIR systems but they are limited to where they can be positioned in the landscape (Rice et al. 1995). For example, animals will pass under the beam if it is placed too high, but placing it too low results in high levels of false-triggers from weather events or vegetation disrupting the beam (Rice et al. 1995; Sadighi et al. 1995; Swann et al. 2004). Consequently, AIR triggers would not be suitable for small reptiles. Still, Timber Rattlesnakes (*Crotalus horridus*), Pig-nosed Turtles (*Carettochelys insculpta*), and Gopher Tortoises have all been monitored with cameras triggered by AIR sensors (Sadighi et al. 1995; Doody and Georges 2000; Alexy et al. 2003).

Cameras triggered by PIR sensors are currently the dominant type used in ecological research (Swann et al. 2011). Passive-infrared triggers work by measuring the surface temperature, in the form of infrared radiation, emitted by objects in a detection area and trigger the camera when a rapid change in the temperature occurs; for example, when an animal with a higher or lower surface temperature than the background enters the foreground (Swann et al. 2011). Triggering based on temperature in this manner is problematic for reptiles for two reasons. Firstly, while McGrath et al. (2012) successfully detected two Grassland Earless Dragons (*Tympanocryptis pinguicolla*) with PIR triggered cameras, as reptiles can be similar in temperature to the substrate in the detection zone, they can easily avoid detection (Rovero et al. 2010). Thorbjarnarnson et al. (2000) used PIR triggered cameras to study crocodile nesting behavior and found that a crocodile managed to open the nest while only triggering the camera once.

Secondly, because surface temperatures of objects in the environment vary, temperatures within the detection zones are not uniform (Fig. 1a). Given that the camera is triggered by a thermal change in at least one zone of the detection bands, the PIR sensor requires a larger change in temperature to trigger the camera to overcome the thermal variation (Reconyx 2010). Alternatively, consider the reverse; if the temperature in the environment was homogenous, any difference in temperature becomes more pronounced and therefore more easily detected by the PIR sensor (Fig. 1b). These problems can be overcome by implementing the Camera Overhead Augmented Temperature (COAT) protocol described here. By introducing a material to augment the temperature in the detection area, in this case a cork floor tile, thermal variation is removed. Further, as the tile gets considerably

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warmer than the surrounding substrate (DW, unpubl. data), reptiles will be relatively cooler, resulting in a temperature difference that triggers the camera.

Methods.—Ten Reconyx™ HC600 PIR cameras were deployed for 30 days between March 18 and April 23, 2012, to five transects (~100 m × ~2 m) on Beecroft Peninsula, Jervis Bay, Australia. The site is dominated by coastal heath; thus, each transect had previously been cleared to understory level and two camera stations established 30 m apart from a central position. Each station consisted of a Reconyx™ HC600 camera set to the highest sensitivity; a 30 × 30 cm cork floor tile; a PVC bait holder containing oats and peanut butter; two 3 m drift fences; and a camera mounting pole and block. Each station was set with the camera oriented to take overhead images from 70 cm above the ground with the cork floor tile pegged directly beneath the camera, and the bait holder pegged on the edge of the cork floor tile at the base of the mounting pole (Fig. 2). Tiles of different materials were tested prior to deployment to assess thermal absorbance. Dark-colored roof tiles would also be suitable, as they too become warmer than the surrounding substrate, but cork was selected here as it weighs less and is less fragile. White ceramic tiles were also tested; however, while cooler than the substrate the difference was not significant (DW, unpubl. data).

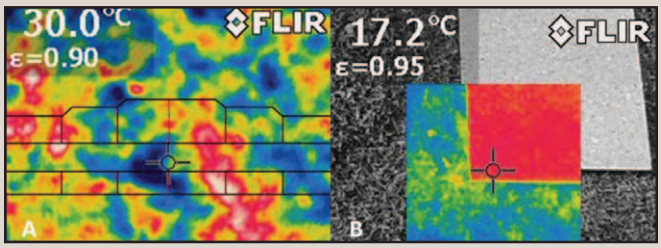


FIG. 1. Picture A) depicts the thermal variation of a 1 m² patch of grass with the Reconyx™ PIR detection bands overlaid for reference. There are six detection zones split vertically between the bands. Picture B) shows the cork tile creating a higher and uniform thermal environment.

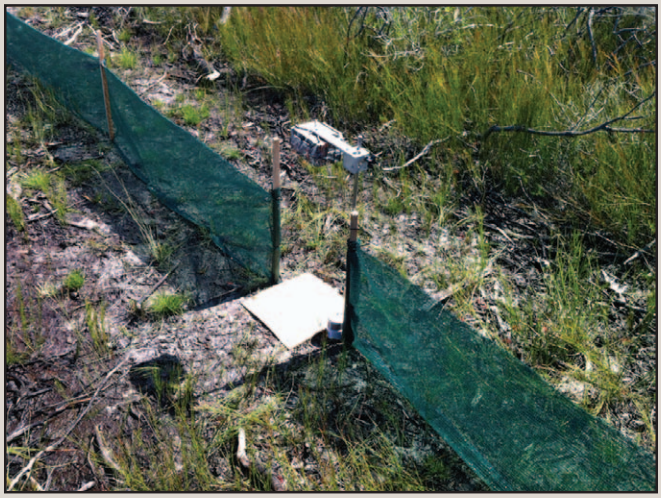


FIG. 2. The Camera Overhead Augmented Temperature protocol is set-up analogous to a pit-fall trap. Camera is oriented for detection zone bands perpendicular to the drift fence.

The PIR sensors of the Reconyx™ HC600 cameras have two parallel detection zone bands oriented left to right in the field of view (Reconyx 2010). To test whether the orientation of the detection zone was significant, each site had one camera oriented with its detection bands parallel to the direction of the drift-fence (Fig. 3b), and the other camera oriented with its detection bands perpendicular to the direction of the drift-fence (Fig. 3a). A Chi-square test was used to assess if trigger frequency varied between the detection band orientations for different groups of target species. For this analysis, species were grouped as reptiles; small mammals (< 500 g) consisting of the genera *Antechinus*, *Cercartetus*, *Mus*, and *Rattus*; and medium and large mammals (> 500 g) consisting of the genera *Macropus*, *Perameles*, and *Wallabia* (Van Dyck and Strahan 2008). One site was removed in the mammal analysis as the infrared flash of one camera failed, resulting in unidentifiable night images.

Results and Discussion.—During the deployment, 3148 trigger events occurred over the 300 trap days. Mammals accounted for ~92.3% (N = 2900) of triggers, reptiles ~3.8% (N = 118), birds ~1.8% (N = 57), and false trigger events ~2.3% (N = 73). Given the majority of trigger events occur through the night, programming the camera to be active during daylight hours or subsetting the images pre-identification can reduce the image processing time. For example, total trigger events for this deployment,



FIG. 3. Shown here is the position of the detection zone bands in Reconyx™ cameras. Picture A) has the drift fence oriented from top to bottom in the image, with detection bands oriented perpendicular to the fence. Picture B) has the drift fence oriented from left to right in the image, with detection bands oriented parallel to the fence.

between 0700 h and 1900 h, were 616. In the subsetted data, reptiles account for ~19.2% (N = 118), mammals ~63.5% (N = 391), birds ~9.3% (N = 57), and false triggers ~8.1% (N = 50).

Eight species of mammal and potentially seven species of reptile were detected (Table 1). The three smallest skink species (snout–vent length ~5 cm) on the study site were grouped together since, due to camera resolution, identification to species level was problematic (Fig. 4). This issue may be overcome by reducing the height of the camera above the ground. However, it will certainly be improved as new camera lens technology is incorporated into new models of automatically triggered camera. Despite this, this is an encouraging result for two reasons. Firstly, though future research will compare the use of this method against alternative reptile sampling methods, the COAT protocol is capable of detecting the smallest reptile species on the study area (Wilson and Swan 2010). Secondly, recent reptile surveys from 40 sites on the study area, which employed active searches and artificial refuges, have only detected 11 species of reptile after concerted effort (C. MacGregor, pers. comm., 06 Jun 2012). It is reasonable to assume therefore, that the lack of detection of other reptile species is due to the non-ubiquitous distribution of those reptiles across the site (C. MacGregor, pers. comm.).

Table 1. Reptile species detected on Beecroft Peninsula, Jervis Bay, Australia, using Reconyx™ HC600 PIR cameras.

Species Groups	Family	Scientific Name	Size (SVL mm)[A]	Detections[B]
Jacky Dragon	Agamidae	*Amphibolurus muricatus*	120	44
Mainland She-oak Skink	Scincidae	*Cyclodomorphus michaeli*	174	1
Small Skinks	Scincidae	*Lampropholis* spp.[C]	48–51	24
	Scincidae	*Saproscincus mustelinus*	55	
Eastern Blue-tongue Skink	Scincidae	*Tiliqua scincoides*	300–320	1
Red-bellied Black Snake	Elapidae	*Pseudechis porphyriacus*	1500–2000	12

[A] Snout–vent length according to Wilson and Swan 2010.
[B] Detection events occur when more than 2 minutes have elapsed since prior trigger of the same species; thus repeat triggers are considered the same event.
[C] Consists of *Lampropholis delicata* and *Lampropholis guichenoti*.

Table 2. Trigger frequency and Chi-square analysis for each target group based on orientation of the detection zone bands of Reconyx™ HC 600 PIR cameras.

Group	Parallel	Perpendicular	Chi-square (d.f. = 1)
Reptile	29	89	30.51, P < 0.0001
Small mammal	698	965	42.87, P < 0.0001
Large mammal	104	111	0.23, P = 0.69

Orientation of the detection zone bands was found to be a significant factor of trigger frequency for reptiles with the perpendicular orientation accounting for ~75% of reptile trigger events (Table 2). Orientation was also a significant factor of trigger frequency for small mammals, but did not appear to be significant for large mammals (Table 2). Orientation was initially tested because of speculation that the drift fence may bias the direction of reptile movement into the detection zone, and therefore bias detection events. Instead, the mounting-pole, bait holder, and drift fence all appeared to obscure part of the detection zone in the parallel orientation, and thereby reduced the effective detection zone. Smaller detection zones are inherently less effective at detecting animals than larger detection zones (Damm et al. 2010) and, as shown here, this effect is compounded as the size of the target species reduces. Further work regarding the efficacy of the drift fence for this method will be carried out in future studies. Despite the fact that Reconyx™ cameras were used in this study, this is still relevant if implementing this protocol with a different brand of camera due to variations in detection zone position and shape between brands (Swann et al. 2004).



Fig. 4. Small skinks can be detected, though identification can be problematic if sympatric species look similar.

Using cameras to survey reptiles provides a way to conduct capture-mark-recapture surveys without capturing the animal. Many ecological questions require animals to be identified to the individual level, and in the case of reptiles this often requires invasive marking techniques often in the form of toe-clipping, scale-clipping, or inserting subcutaneous tags (Sacchi et al. 2010). Once an animal has been captured and marked, it must then be recaptured at some point in the future, further stressing the animal and requiring additional field time for researchers. Of the 44 Jacky Dragon (*Amphibolurus muricatus*) detections, at least 15 individuals were identified from ornamental scale patterns. By eliminating the need for invasively marking individuals, ethical concerns and questions of increased mortality or diminished individual fitness are removed (Sacchi et al. 2010). Alternatively, where individual marking is required due to a lack of or changing ornamental pattern, after the initial capture and marking of individuals the COAT protocol may provide future detections without the need to recapture the individual.

One potential limitation of the COAT protocol is the need for the cork tile to reach a sufficient temperature before detections can occur. If a reptile moves into the detection zone too early (or late) in the day, the tile will not have had enough time to heat (or

will have cooled too much) and therefore reduce detection reliability. In this study however, although the mean detection time of reptiles was 1213 h (± 131 minutes), the earliest detection was at 0846 h of a small skink with the latest detection occurring at 1718 h of a Red-bellied Black Snake (*Pseudechis porphyriacus*). In a comparison of active searches and artificial refuges, Michael et al. (2012) stated "surveys were conducted on clear sunny days between 0900 hours and 1400 hours;" therefore, the times of detection recorded for this study appear no more limiting than alternative reptile survey methods.

In order to be an effective survey tool, cameras need to be capable of reliable detection of the target species while maintaining field deployability. Even though PIR triggers are limited due to the fundamental workings of the sensor, the COAT protocol shown here is a simple way to make use of PIR triggered cameras to detect reptiles. While there is still further work to do to develop this method further, this is the first successful account of employing PIR triggered cameras to deliberately target multiple species of diurnal terrestrial reptile, which others may find useful.

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The Effect of Temperature on Weight Gain in Hatchling Mexican Kingsnakes, *Lampropeltis mexicana*

Temperature is an important component of microhabitat selection (Burger 1991) as well as influencing both behavioral and physiological changes in reptiles (Brattstrom 1965; Fitch 1968). Individuals within a species may seek various substrate temperatures based on sex, life stage, or reproductive status (Aldridge 1975; Blazquez 1995). Growth of neonates often is associated with increased energy demands (Bronikowski 2000; Bronikowski and Arnold 1999; Bronikowski and Vleck 2010; Case 1978). Consequently, neonates are thought to seek temperatures in the warmer extents of their range to facilitate more rapid growth (Dorcas 2004). However, evidence suggests both genetics and locality can both impact growth rate (Bronikowski 2000).

Thermal variation in high-elevation environments makes montane snake species an interesting group on which to conduct thermal studies. Such montane species can be found within the *Lampropeltis mexicana* complex, a popular animal in reptile husbandry where most successful breeders recommend a substantial thermal gradient (Lassiter 2012). Widely distributed, but comprised of locally isolated groups, the *Lampropeltis mexicana* complex is currently in a taxonomic state of flux with various species and subspecies designations often in contradiction with one another (Bryson et al. 2005; Bryson et al. 2007; Gartska 1982). In general, Mexicana populations are found in high-elevation environments where great fluctuations in temperature are commonplace (Bryson et al. 2007; Gartska 1982).

Given the thermal characteristics of their habitats and their prevalence in reptile husbandry, we exposed hatchling Variable Kingsnakes, *L. m. thayeri*, to two temperature regimes to investigate the impact of temperature on feeding rates, growth rates, weight gain, and efficiency of biomass accumulation.

Materials and Methods.—Each snake was placed into a container (33 L × 20 W × 12.7 cm H) containing an identical setup: a water dish, hide box containing approximately 2.5 cm of sphagnum moss (ZooMed Laboratories), and aspen cage bedding (ZooMed Laboratories) approximately 2.5–5 cm in depth. The cages had four ventilation holes drilled through each side and three on the lid. Each cage was placed into a larger cage set up (Boaphile Plastics) that contained under-cage heating tape. Temperatures were maintained within 0.6°C using two thermostats set for treatment specific temperatures (Ranco Model #ETC-111000). Data loggers (HOBO TEMP Loggers; ± 0.5°C) were used to ensure consistency within treatment groups and to quantify any variation from the programmed temperature.

Samples sizes totaled 11 hatchling snakes with 9 individuals from the same clutch and 2 from other captive clutches. Individual snakes were assigned to one of two groups (N_{group1}= 5, N_{group2}= 6) to minimize potential impacts of any differences associated with initial weights (± 0.04 g starting difference between treatments). Based upon recommended thermal gradients for the species in captivity (Lassiter 2012), we chose two treatment temperatures (23.3°C and 28.9°C). Once placed in the treatments the snakes were fed commercially obtained, frozen and thawed mice (Big Cheese Rodent Factory; 4.5 ± 3 g) twice a week, with a 3 or 4-day period between feedings. Prior to the first feeding each week, the snakes were weighed (O'Haus Adventurer balance: ± 0.002 g). Mice were left in the cages overnight and removed the next day if uneaten. Measurements were taken on the snakes from 1 Dec 2010 to 28 Mar 2011 (27 total feeding opportunities and 14 weight measurements). The process was repeated from 28 Mar 2011 to 18 Jul 2011 (27 total feeding opportunities and 15 weight measurements) with the animals switched between treatments (ex. 23.3°C is now 28.9°C, and vice versa) to minimize potential bias associated with inherent differences among individual snakes.

Throughout the experiment, cages were spot cleaned and provided with fresh water as needed. Monthly bedding changes occurred with the cleaning of all cage materials (Chlorohexidine solution).

Using repeated measures ANOVA, we evaluated the impact of both time series and temperature on weight gain. Using simple linear regression, we generated growth equations for each period and treatment and compared the slopes. Finally, we compared amount of prey refusals between treatments using a G-test while we compared the ratio of weight consumed to weight added between treatments.

Results.—Data were collected on 11 hatchling kingsnakes from 01 Dec 2010 to 18 Jul 2011, resulting in a total of 927 weight measurements taken and 14 and 15 weighings per snake per treatment (Table 1). Initial and final hatchling weights did not differ for either period (Table 2). There is an risk associated with live prey capture that would impact wild populations. Similar growth rates with the observed fewer feedings in colder temperature may better suggest optima. Growth rates for our study

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are greater than those reported by Gartska (1982) over a 2.5-year period for *L. alterna* females, suggesting a difference in growth rate over time, species differences, or different feeding regimes. Furthermore, possible costs associated with increased growth rates have been documented in many ectotherms (Gotthard 2001; Sibly and Atkinson 1994).

Our results may also have implications for husbandry. No detectable differences between temperatures suggest reptile keepers of the Mexicana kingsnakes may be able to conserve financial and logistic resources without negatively impacting growth rates of hatchlings. However, hatchling refusal of prey has been reported with this species and decreased temperature increased this propensity in our study. Furthermore, it is unknown whether the increase in efficiency of weight gain in period 2 was a consequence of the physiology of the animals or a component of increased mass of the prey items.

The sample size of our study, as well as switching snakes between temperatures, merit caution when interpreting our results. We suggest future studies maintain snakes in the same temperature for the duration of the experiment. Although the majority of our snakes were from the same clutch, our study suggests individual variation was minimal among snakes despite the presence of an outlier. We feel a study or numerous studies could be conducted on captive populations to examine the impact of faster growth rates on other aspects of individual fitness and call for increased collaborative, large-scale experiments involving both scientists and those involved in reptile husbandry.

TABLE 1. Summary weight gain data on 11 hatchling Mexican Kingsnakes during a captive study. Temperature, Initial Weight (g), Final Weight (g), Growth Rate (g/day), Ratio (grams of intake/1 g growth) for individual snakes in each time.

	Period 1					Period 2				
Snake ID	Temp (°F)	Initial Weight	Final Weight	Growth Rate	Ratio	Temp (°F)	Initial Weight	Final Weight	Growth Rate	Ratio
1	84	13.16	39.05	0.24	2.82	74	39.05	70.97	0.23	2.28
2	74	17.74	35.48	0.14	3.01	84	35.48	88.90	0.48	2.46
3	84	19.91	41.26	0.20	3.47	74	41.26	93.28	0.45	2.27
4	84	19.65	46.15	0.23	2.82	74	46.15	102.80	0.45	2.21
5	74	17.22	42.87	0.22	2.67	84	42.87	97.55	0.51	2.53
6	74	20.50	45.66	0.21	2.69	84	45.66	106.06	0.57	2.21
7	84	15.22	36.66	0.19	3.41	74	36.66	70.76	0.27	3.04
8	84	18.25	45.43	0.23	2.95	74	45.43	105.28	0.57	2.43
9	84	14.95	40.77	0.22	2.87	74	40.77	83.11	0.37	2.85
10	74	14.38	43.64	0.26	2.86	84	43.64	88.65	0.42	2.97
11	74	14.67	20.07	0.05	6.03	84	20.07	63.13	0.43	2.54

TABLE 2. Summary weight data (mean ± std. dev.) at the beginning and end of treatments in a study of hatchling growth rates at different temperatures for a six-month period.

	Period 1		Period 2	
Temperature	Begin	End	Begin	End
28.9°C	16.86 ± 2.79 g	41.55 ± 3.66 g	39.58 ± 12.13 g	87.70 ± 15.21 g
23.3°C	16.90 ± 1.12 g	37.54 ± 10.50 g	43.71 ± 4.09 g	88.86 ± 16.07 g

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IN THE LARDER.

The inclusion of the Diamondback Terrapin (*Malaclemys terrapin*), or saltwater terrapin, as a New World dietary staple dates back to the arrival of European colonists in the United States in Maryland and Virginia in the late 1500s. In the United States' early years, Diamondback Terrapins were so abundant and inexpensive they were purportedly fed to pigs and, in the Chesapeake Bay region, to servants and slaves to such excess that this practice led to a slave rebellion in the 1700s. But by the 1800s, the Diamondback Terrapin became a staple in the well-to-do's larder, attaining a gourmet status in such dishes as Terrapin Maryland and Terrapin Philadelphia. The culinary status of the diamondback was brought to life in an illustrated plate prepared for the article "Canvas-Back and Terrapin," featured in an 1877 issue of *Scribner's Monthly*. The illustration in question, *In the Larder*, depicts two terrapins—one balanced atop the foot of a wine glass, the other upside-down—surrounded by the finer things in life: oysters, canvas-back ducks, a box of Flor Fina cigars, a case of Bordeaux wine from the Château Pontet-Canet. To meet this demand for terrapins, diamondbacks were collected all along the Eastern Seaboard and the Gulf Coast. Those collected from northern waters were allegedly more flavorful and considered superior to their southern cousins. "Chesapeakes" (or "Delawares") from the Delaware and Chesapeake bays commanded a higher price than did "Southerns" from North and South Carolina southward. That didn't prevent shippers and their middle-men, however, from "relocating" southern Diamondback Terrapins to more northerly latitudes, mixing them with their Chesapeake stock, and then selling the ensemble as "Chesapeakes."

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AMPHIBIAN DISEASES

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Amphibian Chytrid Fungus Confirmed in Endemic Frogs and Caecilians on the Island of São Tomé, Africa

Although the presence of the pathogenic fungus *Batrachochytrium dendrobatidis* (*Bd*) is confirmed on six continents, its origin is still undetermined (Kriger and Hero 2009). One of the oldest records of *Bd* in Africa is from a museum specimen collected in Cameroon in 1933 (Soto-Azat et al. 2010), and although this region is a proposed source for *Bd* (Weldon et al. 2004), the presence of the pathogen and its potential role in amphibian declines in West and Central Africa (a region that ranges from Mauritania to Democratic Republic of the Congo) are not well documented. In central Africa, the presence of *Bd* is confirmed in Gabon (Bell et al. 2011), Cameroon (Soto-Azat et al. 2010), Nigeria (Imasuen et al. 2011; Reeder et al. 2011), and Democratic Republic of the Congo (Greenbaum et al. 2008); to date there are no records of *Bd* from West Africa despite considerable sampling (Penner et al. 2013). In addition, recent surveys of Madagascar indicate that the chytrid fungus may not be present there (Vredenburg et al. 2012), raising questions about the distribution of *Bd* on oceanic islands. Collecting baseline data on the geographic and taxonomic extent of the pathogen in this region will help elucidate the extent of its distribution in Africa, and the degree of threat to local and/or endemic species.

We conducted this study on the island of São Tomé (Central Africa), a volcanic island in the Gulf of Guinea located approximately 250 km off the coast of Gabon. This island has no historic connection to the mainland and hosts five endemic amphibian species—one caecilian (*Schistometopum thomense*) and four frogs (*Hyperolius molleri, H. thomensis*, *Phrynobatrachus leveleve*, and *Ptychadena newtoni*). Two of these species—*P. newtoni* and *H. thomensis*—are listed as endangered on the IUCN Red List (www.iucnredlist.org). Because of the high level of endemism of this island amphibian community, determining whether the species are naïve to this pathogen is essential for evaluating disease risk and whether preventative measures for the island are necessary (Crottini et al. 2011).

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Amphibian surveys were opportunistic and conducted at night from 9–17 April 2012 on the island of São Tomé (during the wet season). Surveyed habitats include pristine forest, disturbed forest, and agricultural fields, ranging in elevation from 65 to 1424 m (Fig. 1). We captured amphibians by hand (without gloves) and placed them in individual plastic bags until processing. We collected swab samples from 62 adults (Appendix 1) using sterile fine-tip swabs (MW113; Medical Wire & Equipment Co., Wiltshire, England). Swabs were stored in 95% ethanol and stored at 4°C until processing. All swabbed amphibians were euthanized and prepared as voucher specimens, now accessioned in the collections of the California Academy of Sciences, San Francisco, California, USA (Appendix 1).

We followed established methods for sampling *Bd* in the field, and for DNA extraction and quantitative *Bd* detection in the laboratory (Boyle et al. 2004). We analyzed 1:10 dilutions of the DNA extract in 96-well plates on a real-time PCR machine (ViiA 7; Applied Biosystems, Carlsbad, California, USA). Samples that showed signs of inhibition were further diluted to 1:100 and re-analyzed and all samples were evaluated in duplicate plates. Standard curves were generated from templates of known zoospore concentrations ranging from 0.1 to 1000 zoospores (Boyle et al. 2004). To evaluate fluorescence levels of the samples and standards we used ViiA 7 software (Applied Biosystems). Due to the overall low infection intensities in our samples, we deemed samples positive when significant sigmoidal amplification (GE ≥ 1) occurred in one or both qPCR reactions. We calculated Clopper-Pearson confidence intervals ($\alpha = 0.05$) to estimate *Bd* prevalence for *H. molleri* (the sample sizes for the remaining species were too small to produce meaningful estimates of *Bd* prevalence).

We detected *Bd* infections on four of the five species sampled (Table 1) and our survey documents the first records of *Bd* infections in these species on São Tomé. We detected *Bd* in all surveyed habitats and at all elevations, indicating that *Bd* is widely distributed on the island. The infection load for all positive individuals was low, with a maximum infection intensity of 18.3 zoospores detected on one individual of *H. molleri*. We did not observe any dead individuals or symptoms of chytridiomycosis in the field.

Our study raises questions about both the mechanisms and temporal scale of the spread of *Bd* to São Tomé and other

TABLE 1. Distribution of *Batrachochytrium dendrobatidis* (*Bd*) across species sampled on São Tomé, Africa. NI = number of infected individuals; N = total number of individuals sampled; Clopper-Pearson confidence intervals for species level prevalence ($\alpha = 0.05$); GE = genomic equivalents inferred from qPCR.

Species	NI/N	95% CI	*Bd* intensity (GE)
Phrynobatrachus leveleve	0/2	—	N/A
Hyperolius molleri	12/50	0.13–0.38	3.52 (0.67–18.26)
Hyperolius thomensis	1/3	—	9.0
Ptychadena newtoni	1/2	—	4.3
Schistometopum thomense	1/5	—	3.5

volcanic islands. Although *Bd* appears to be widespread among species throughout the island, individual infection loads ranged from 0.7 to 18.3 zoospores, which is much lower than the 10,000 zoospores known to cause severe chytridiomycosis in susceptible species (Vredenburg et al. 2010). We did not observe signs of chytridiomycosis in the field; however, our sampling is limited for four of the five species and does not address potential seasonal variation in infection intensity (Longo et al. 2010). Further studies should focus on increasing sample sizes for *H. thomensis*, *P. newtoni*, *P. leveleve*, and *S. thomense* to obtain more precise estimates of *Bd* prevalence in these species and establish baseline conditions for future monitoring efforts.

We detected *Bd* on one individual of *S. thomense*, which is one of the first records of *Bd* in a wild caecilian (Doherty-Bone et al. 2013). Though we found *Bd* in only one individual—with an estimated infection load of 3.5 zoospores—our study demonstrates that caecilians should be surveyed along with other amphibians when conducting field studies for *Bd* on São Tomé, and elsewhere. *Bd* is generally found on more aquatic anuran species (Kriger and Hero 2007), and though its presence on a more terrestrial amphibian is not unprecedented, it poses unique challenges because *Bd* infection intensities tend to vary seasonally on terrestrial species, which can make diagnosis difficult (Longo et al. 2010; Weinstein 2009). Thus, to increase the probability of detecting *Bd* in these terrestrial amphibians, surveys should include both wet and dry months (our surveys occurred during wet months).

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FIG. 1. Distribution of sampling localities (black circles) on São Tomé Island, Africa. Large star indicates the capital city and small stars indicate other major cities on the island. Sample site abbreviations: Caixueira, Ca; Monte Café, MC; Campo Grande, CG; Bom Sucesso, BS; Bom Sucesso Radio Tower, BSRT; Bem Posta, BP; Lagoa Amelia, LA; Terra Batata, TB; Contador Valley, CV.

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Appendix I. Sampling localities, voucher information, and *Bd* infection intensities for specimens examined in this study.

Catalog No.	Genus	Species	Locality	Elevation(m)	Northing	Easting	Average GE
CAS251574	*Schistometopum*	*thomense*	Contador Valley	616	00.28638	006.57027	3.52
CAS251575	*Schistometopum*	*thomense*	Contador Valley	616	00.28638	006.57027	(-)
CAS251576	*Schistometopum*	*thomense*	Contador Valley	616	00.28638	006.57027	(-)
CAS251577	*Schistometopum*	*thomense*	Contador Valley	616	00.28638	006.57027	(-)
CAS251578	*Schistometopum*	*thomense*	Contador Valley	522	00.29245	006.56730	(-)
CAS251579	*Hyperolius*	*molleri*	Campo Grande	879	00.30585	006.61875	0.82
CAS251580	*Hyperolius*	*molleri*	Campo Grande	879	00.30585	006.61875	0.84
CAS251581	*Hyperolius*	*molleri*	Campo Grande	879	00.30585	006.61875	18.26
CAS251582	*Hyperolius*	*molleri*	Campo Grande	879	00.30585	006.61875	(-)
CAS251583	*Hyperolius*	*molleri*	Bemposta	848	00.30818	006.61673	5.70
CAS251584	*Hyperolius*	*molleri*	Bemposta	848	00.30818	006.61673	(-)
CAS251585	*Hyperolius*	*molleri*	Bemposta	848	00.30818	006.61673	(-)
CAS251586	*Hyperolius*	*molleri*	Bemposta	848	00.30818	006.61673	(-)
CAS251587	*Hyperolius*	*molleri*	Bemposta	848	00.30818	006.61673	(-)
CAS251588	*Hyperolius*	*molleri*	Bemposta	848	00.30818	006.61673	0.67
CAS251589	*Hyperolius*	*molleri*	Bemposta	848	00.30818	006.61673	(-)
CAS251590	*Hyperolius*	*molleri*	Bemposta	848	00.30818	006.61673	(-)
CAS251591	*Phrynobatrachus*	*leveleve*	Bemposta	840	00.30913	006.61753	(-)
CAS251592	*Phrynobatrachus*	*leveleve*	Bemposta	840	00.30913	006.61753	(-)
CAS251593	*Hyperolius*	*molleri*	Bom Sucesso	1156	00.28821	006.61307	(-)
CAS251594	*Hyperolius*	*molleri*	Bom Sucesso	1156	00.28821	006.61307	(-)
CAS251595	*Hyperolius*	*molleri*	Bom Sucesso	1156	00.28821	006.61307	0.90
CAS251596	*Hyperolius*	*molleri*	Bom Sucesso	1156	00.28821	006.61307	(-)
CAS251597	*Hyperolius*	*molleri*	Bom Sucesso	1159	00.28978	006.61162	(-)
CAS251598	*Hyperolius*	*molleri*	Bom Sucesso	1159	00.28978	006.61162	(-)
CAS251599	*Hyperolius*	*molleri*	Bom Sucesso	1159	00.28978	006.61162	(-)
CAS251600	*Hyperolius*	*molleri*	Terra Batata	1020	00.28848	006.62404	(-)
CAS251601	*Hyperolius*	*molleri*	Terra Batata	1020	00.28848	006.62404	(-)
CAS251602	*Hyperolius*	*molleri*	Terra Batata	1020	00.28848	006.62404	0.97
CAS251603	*Hyperolius*	*molleri*	Terra Batata	1020	00.28848	006.62404	(-)
CAS251604	*Hyperolius*	*molleri*	Terra Batata	1020	00.28848	006.62404	(-)
CAS251605	*Hyperolius*	*molleri*	Terra Batata	1020	00.28848	006.62404	(-)
CAS251606	*Hyperolius*	*molleri*	Monte Café Water Tank	758	00.29613	006.63805	2.99
CAS251607	*Hyperolius*	*molleri*	Monte Café Water Tank	758	00.29613	006.63805	(-)
CAS251608	*Hyperolius*	*molleri*	Monte Café Water Tank	758	00.29613	006.63805	(-)
CAS251609	*Hyperolius*	*molleri*	Monte Café Water Tank	758	00.29613	006.63805	(-)
CAS251610	*Hyperolius*	*molleri*	Monte Café Water Tank	758	00.29613	006.63805	(-)
CAS251613	*Hyperolius*	*molleri*	Lagoa Amelia	1424	00.28145	006.59080	1.65
CAS251614	*Hyperolius*	*molleri*	Lagoa Amelia	1424	00.28145	006.59080	(-)
CAS251615	*Hyperolius*	*molleri*	Lagoa Amelia	1424	00.28145	006.59080	(-)
CAS251616	*Hyperolius*	*molleri*	Lagoa Amelia	1424	00.28145	006.59080	(-)
CAS251618	*Hyperolius*	*molleri*	Lagoa Amelia	1424	00.28145	006.59080	(-)
CAS251619	*Hyperolius*	*molleri*	Lagoa Amelia	1424	00.28145	006.59080	2.77
CAS251620	*Ptychadena*	*newtoni*	Caxueira	65	00.30234	006.73228	(-)
CAS251621	*Ptychadena*	*newtoni*	Caxueira	65	00.30234	006.73228	4.26

Appendix I. Continued.

Catalog No.	Genus	Species	Locality	Elevation(m)	Northing	Easting	Average GE
CAS251622	*Hyperolius*	*molleri*	Caxueira	65	00.30234	006.73228	(-)
CAS251623	*Hyperolius*	*molleri*	Caxueira	65	00.30234	006.73228	(-)
CAS251624	*Hyperolius*	*molleri*	Caxueira	65	00.30234	006.73228	(-)
CAS251625	*Hyperolius*	*molleri*	Caxueira	65	00.30234	006.73228	(-)
CAS251626	*Hyperolius*	*molleri*	Caxueira	65	00.30234	006.73228	(-)
CAS251627	*Hyperolius*	*molleri*	Caxueira	65	00.30234	006.73228	2.64
CAS251628	*Hyperolius*	*molleri*	Caxueira	65	00.30234	006.73228	(-)
CAS251629	*Hyperolius*	*molleri*	Caxueira	65	00.30234	006.73228	(-)
CAS251630	*Hyperolius*	*molleri*	Caxueira	65	00.30234	006.73228	(-)
CAS251631	*Hyperolius*	*molleri*	Caxueira	65	00.30234	006.73228	4.00
CAS251632	*Hyperolius*	*molleri*	Caxueira	65	00.30234	006.73228	(-)
CAS251633	*Hyperolius*	*molleri*	Caxueira	65	00.30234	006.73228	(-)
CAS251634	*Hyperolius*	*molleri*	Caxueira	65	00.30234	006.73228	(-)
CAS251635	*Hyperolius*	*thomensis*	Bom Sucesso Radio Tower	1326	00.27568	006.60412	(-)
CAS251636	*Hyperolius*	*thomensis*	Bom Sucesso Radio Tower	1326	00.27568	006.60412	9.02
CAS251637	*Hyperolius*	*thomensis*	Bom Sucesso Radio Tower	1326	00.27568	006.60412	(-)

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Occurrence of *Batrachochytrium dendrobatidis* in *Notophthalmus viridescens* in Northwestern Virginia, USA

Batrachochytrium dendrobatidis (*Bd*) (Longcore et al. 1999), the causative agent of the amphibian disease chytridiomycosis, has caused global amphibian population declines and extinctions (Berger et al. 1998; Fisher et al. 2009; Lips et al. 2005). Little is known about the occurrence of *Bd* in northwestern Virginia, USA, and continued efforts to sample for *Bd* are needed to provide a more complete understanding of its distribution and which species are infected (Gratwicke et al. 2011). Information on the presence, prevalence, and abundance of *Bd* on host amphibian populations in this region will provide baseline data for *Bd* in local populations in order to form a basis for continued monitoring of the pathogen. In addition, if amphibians are surviving in this region despite *Bd* infection, it may suggest they possess adequate defenses, such as microbial defenses, that could be investigated to help conserve susceptible amphibians (Harris et al. 2006; Vredenburg et al. 2011).

Notophthalmus viridescens, the Red-spotted Newt, is found throughout the northeastern USA and is abundant in the George Washington National Forest (GWNF) in northwestern Virginia. Declines in newt populations have not been reported in any areas of its range, and given that this species is not cryptic and is present in ponds for several months each year, it is likely that major declines would have been detected (Hunsinger and Lannoo 2005). Therefore, this species is either not infected by *Bd* because *Bd* is not found locally, individuals are able to persist despite infection because they have adequate defensive mechanisms, such as innate immunity or microbial defenses (Harris et al. 2006; Rollins-Smith 2009) or limited surveys assessing population trends of this species have been conducted to accurately document population dynamics. Few studies have investigated *Bd* infection in *N. viridescens*, but they suggest that newts can be infected. One study in Alabama found two dead newts that were confirmed positive for *Bd*, and it was suggested that these individuals might have died as a result of chytridiomycosis (Bakkegard and Pessier 2010). In western Pennsylvania, a survey detected *Bd* infection in newts at six locations with varying prevalence (Groner and Relyea 2010), and in central Pennsylvania, infected individuals were found at 12 of 16 ponds (Raffel et al. 2010). Rothermel et al. (2008) surveyed locations throughout the southeastern USA and found newts infected with *Bd* in eastern North Carolina, northern Mississippi, and southeastern Virginia. Only two newts were sampled in Virginia, and both were positive for *Bd*, but showed no signs of disease. An additional study conducted in central Virginia sampled seven newts, all of which were negative for *Bd* (Pullen et al. 2010). Two additional studies in Virginia, one in the central Appalachians in Maryland and Virginia (Hossack et al. 2010) and one in Warren Co., Virginia (Gratwicke et al. 2011), surveyed different amphibian hosts, and found low infection prevalence across the sampled populations. Few studies have surveyed amphibian populations in Virginia and no studies to our knowledge have been completed in the GWNF in northwestern Virginia. We surveyed *Bd* infection status in *N. viridescens* populations in northwestern Virginia to determine if *Bd* was present and to assay the prevalence of infection.

Three populations of *N. viridescens* in the GWNF, including populations at Todd Lake, White Oak Flat Pond, and Mud Pond (Fig. 1), were surveyed between 27 February and 1 May 2012. Todd Lake, a medium-sized lake located at an elevation of 579 m, was surveyed on 27 Feb 2012. White Oak Flat Pond, a pond located on top of Shenandoah Mountain at an elevation of 1034 m, was surveyed on 5 March 2012 and 1 May 2012. Mud Pond, a

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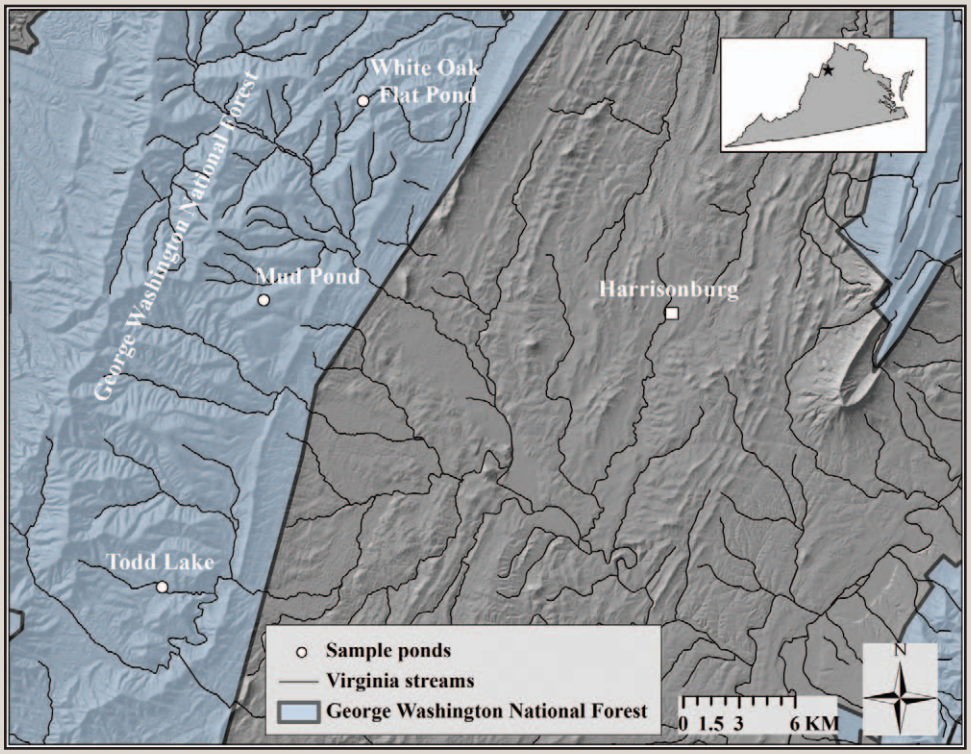


FIG. 1. Topographic map of sampling locations for *Batrachochytrium dendrobatidis* on *Notophthalmus viridescens* in the George Washington National Forest in northwestern Virginia, USA.

TABLE 1. Prevalence of *Batrachochytrium dendrobatidis* (*Bd*) infection at three sampled locations in the George Washington National Forest, Virginia, USA.

Location (date)	Number sampled (*Bd*-positive)	Prevalence
White Oak Flat Pond (5 March 2012)	10 (1)	10%
White Oak Flat Pond (1 May 2012)	39 (33)	84%
Todd Lake (27 Feb 2012)	22 (20)	90%
Mud Pond (27 March 2012)	10 (3)	30%

natural pond located at an elevation of 864 m, was surveyed on 27 March 2012. Other amphibian species, including *Lithobates sylvaticus, Pseudacris crucifer*, and *Ambystoma maculatum* were seen at the sampled locations.

During each survey, adult newts were captured using a dip net, and the presence of *Bd* was assessed using established methods that involve swabbing the skin and conducting traditional PCR (Annis et al. 2004; Hyatt et al. 2007). Unique gloves were worn for capture and swabbing of each animal to ensure that *Bd* was not transferred between individuals. Nets were not cleaned between individual captures but were cleaned in 10% bleach solution in between sample locations. Boots were also cleaned between sampling locations. Each newt was rinsed two times in 20 ml of sterile Provasoli medium (Wyngaard and Chinnappa 1982) before swabbing and then swabbed 10 times (1 swab = up and back) on the ventral body surface and one time on each foot using a Fine Tip MW 100 swab (Medical Wire and Equipment, Corsham, UK). Swabs were stored on ice until transfer to a -80°C freezer. Captured newts were visually assessed for signs of chytridiomycosis, such as lethargy, hemorrhagic lesions, reddening of the ventral region, and skin sloughing (Berger et al. 2005). Newts from Mud Pond were returned to the pond immediately following swabbing. Newts from the remaining surveys were collected for laboratory experiments (data not shown).

DNA was extracted from the swabs using Qiagen QiaAMP DNA micro kit (Qiagen, Valencia, California) following the manufacturer's protocol for DNA extraction from swabs with minor modifications. The volume of buffers ATL and AL were reduced to 200 µl. Conventional PCR was performed to detect infection. Twenty-five µl PCR reactions were completed containing the following: 2 µl of DNA extract, 2.5 µl 10X Buffer A (Fisher Scientific, Pittsburgh, Pennsylvania), 0.7 µl of 25 mM MgCl, 0.5 µl dNTPs (10 µM), 2.5 µl of each primer (10 µM), 0.2 µl Taq DNA polymerase (Fisher Scientific), and 14.1 µl of PCR-grade water. Primers *Bd*1a (5'-CAG TGT GCC ATA TGT CAC G-3') and *Bd*2a (5'-CAT GGT TCA TAT CTG TCC AG-3'), as described by Annis et al. (2004), were used. Thermocycler parameters were as follows: 94°C for 4 min, followed by 29 cycles of 94°C for 30 sec, 58°C for 1 min, and 72°C for 2 min, and a final step of 72°C for 10 min. Positive and negative controls were completed during DNA extraction and PCR. All negative controls were negative for *Bd*, and all positive controls were positive for *Bd*.

Newts were infected with *Bd*, but infection prevalence varied based on location and time of survey. In the first survey at White Oak Flat Pond, 1 of 10 sampled newts was *Bd*-positive, whereas in the second survey, 33 of 39 newts were *Bd*-positive, showing an increased infection prevalence (Fisher's Exact Test, $p = 0.037$) (Table 1). Twenty of 22 individuals sampled at Todd Lake were *Bd*-positive (Table 1). At Mud Pond, 3 of 10 sampled newts were *Bd*-positive (Table 1). The February Todd Lake sample and the May White Oak Flat Pond sample revealed variation in band intensity, suggesting variable levels of infection. It was not possible to estimate variation for the March White Oak Flat Pond and March Mud Pond samples because of the low number of positive individuals. No newts showed prominent signs of chytridiomycosis.

Bd detection in these ponds expands the known distribution of *Bd* to northwestern Virginia. Differences in *Bd* prevalence between sampling times and locations suggest that *Bd* may be responding to differences in environmental conditions, such as temperature or habitat composition, changes in transmission frequency or variation in host susceptibility. Increases in the number of amphibians entering ponds, or the frequency of contact between individuals in ponds may increase *Bd* transmission (Lips et al. 2006). For example, *Bd* prevalence increased during the time when *P. triseriata* congregated to breed in ponds in Arizona (Hyman and Collins 2012). Furthermore, newts have

an elaborate courtship ritual involving periods of sustained amplexus; therefore, the onset of courtship is an additional explanation for increased *Bd* prevalence at White Oak Flat that bears further consideration. Continued and repeated monitoring of these sites in northwest Virginia is an avenue of future research that can further investigate the possibility of temporal variation in *Bd* prevalence within these newt populations. This study, in tandem with other studies, documents *Bd* infection across the geographical range of *N. viridescens* with no signs of chytridiomycosis or striking population declines. This result suggests that newts may have a defensive mechanism, such as antimicrobial peptides or cutaneous antifungal symbionts (Harris et al. 2006; Rollins-Smith 2009). The potential defenses of newts against *Bd* warrant further investigation.

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Investigations into the Life History Stages of the Common Frog (*Rana temporaria*) Affected by an Amphibian Ranavirus in the United Kingdom

Ranaviruses are emerging infectious disease agents that affect a wide range of ectothermic and poikilothermic vertebrates: fish, reptiles (including turtles and tortoises) and amphibians (Ahne et al. 1997; Chinchar et al. 2009; Miller et al. 2011). In the United Kingdom (UK), amphibian ranaviruses began to emerge in the late 1980s and early 1990s in southeast England (Cunningham et al. 1996) and manifested as adult mass morbidity and mortality events (Cunningham et al. 1993; Cunningham et al. 1996; Drury et al. 1995).

Evidence for local ranavirus outbreaks in the UK have, to date, relied exclusively upon reports of moribund or dead adult common frogs (e.g. Cunningham et al. 1993; Cunningham et al. 1996; Drury et al. 1995; Teacher 2009; Teacher et al. 2009; Teacher et al. 2010). In the majority of the cases, few frogs were collected from each site and these were usually in poor condition and thus uninformative for post mortem examinations. The sole focus on adults leaves open the question of whether earlier life history stages are susceptible to and involved in ranavirus outbreaks in the UK, as they are in North America. For example, an outbreak of the Regina Ranavirus (RRV) affected both larval and adult Tiger Salamanders (*Ambystoma tigrinum*) in Saskatchewan, Canada (Bollinger et al. 1999). Susceptibility to ranavirus infection also changes throughout development (e.g., Haislip et al. 2011; Warne et al. 2011). Therefore, it is not appropriate to assume that all life history stages are equivalent.

In Common Frogs (*Rana temporaria*), it is unknown if ranavirus infections occur naturally in eggs or tadpoles, even in locations where there is a known history of outbreaks in adults. We attempted to establish if ranavirus infections are present in the eggs and tadpoles of Common Frogs and to confirm the presence of ranavirus infections in adult Common Frogs using molecular methods.

From April to June 2007, Common Frog tadpoles were collected from 15 ponds (N = 20/pond) distributed over a 40 km^2 area around central London, UK. Eight of the ponds were known to have a history of repeated ranavirus infections in adult Common Frogs and six of the ponds were historically free of ranavirus (see Teacher 2009, Teacher et al. 2009, and Teacher et al. 2010 for pond selection). One additional site had an unknown ranavirus infection history. No die-offs were apparent in any of these ponds during our collections. All of the sites are on privately owned land, so in order to maintain confidentiality we are unable to provide more detailed location information than is provided in Tables 1 and 2.

Live tadpoles were transported in a common container in pond water to the Institute of Zoology, Zoological Society of London, London, UK. Upon arrival, tadpoles were euthanized using an overdose of MS-222 (1g/L tricaine methanesulphonate, Thompson & Joseph Ltd., Norwich, UK) buffered to pH 7.0 with sodium bicarbonate. Tissue samples were then dissected out and frozen at -80°C for ranavirus screening. In the case of larger tadpoles, tissues included the right anterior quarter of the body, and in smaller individuals, the central half was used. This sampling method ensured that commonly used tissues (e.g., liver and kidneys) for ranavirus screening were contained in the sample. Instruments were disinfected with a Virkon solution (40%; Antec International Ltd, Suffolk, UK) then rinsed thoroughly in fresh water to avoid cross contamination.

In February and March 2008, portions of four freshly laid broods of eggs were collected from each of six locations (three historically ranavirus infected sites, including Ealing and Deal, and three historically ranavirus infection free sites, including Eltham 1 and Farham 1, as per Teacher 2009, Teacher et al. 2009, and Teacher et al. 2010). A sample of ≈ 120 eggs per clutch was taken and immediately preserved in 100% ethanol. From this, a subsample of 30 eggs per clutch was taken for screening for the presence of the major capsid protein (MCP) gene of frog virus 3. Egg jelly was removed from each egg prior to DNA extraction to remove potential surface contamination as per Duffus et al (2008).

Beginning in 2006 adult frogs from suspected ranavirus mortality events were collected with the cooperation of pond owners, FrogLife (Registered Charity No. 1093372 in England and Wales), and the South Essex Wildlife Hospital. All animals received by A.L.J.D. underwent complete post mortem examinations, with hepatic tissue taken for molecular testing for the presence of the major capsid protein (MCP) of frog virus 3. The carcasses are archived at the Institute of Zoology.

DNA from eggs, tadpole tissues and adult hepatic tissue were extracted using the Wizard SV96 Genomic DNA Purification System (Promega, Southampton, UK) then screened for the presence of *Ranavirus* DNA using the polymerase chain reaction (PCR) primers and procedure of Pearman et al. (2004) and reagents from Multiplex PCR kits (QIAGEN, Crawley, UK). All samples were screened twice to ensure the repeatability and accuracy of the results. Any ambiguous results were re-screened. Positive PCR and negative extraction controls were used throughout. Originally, positive controls consisted of DNA extracts from known positive animals (Teacher 2009), but later were DNA from pure ranavirus cultures from UK frogs (Duffus 2010). The PCR products were visualized on a 1% agarose gel stained with ethidium bromide and the presence of a 500bp band was considered diagnostic for the presence of ranaviral DNA. Confidence intervals on the prevalence of infection were calculated using the calculator at http://vassarstats.net.

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TABLE 1. Prevalence and infection rates of the ranavirus in Common Frog (*Rana temporaria*) tadpoles in the spring of 2007 in various locations in the south east of the United Kingdom.

Location	Gosner stages	Site ranavirus history	Number ranavirus positive	Number tested	Prevalence	CI
London, NW10	25–26	Negative	0	19	0	0–0.209
Fareham 1	30–32	Negative	0	20	0	0–0.201
Fareham 2	32	Positive	0	20	0	0–0.201
Fareham 3	33–36	Negative	0	20	0	0–0.201
Camden	27–34	Unknown	0	20	0	0–0.201
Eltham 1	26–27	Negative	0	20	0	0–0.201
Eltham 2	30–40	Positive	0	20	0	0–0.201
London, N12	27–40	Negative	0	20	0	0–0.201
Worthing	36–38	Positive	0	20	0	0–0.201
Dagenham	36–40	Positive	0	20	0	0–0.201
Deal	28–33	Positive	1	20	0.05	0.003–0.269
Ealing	35–39	Positive	0	20	0	0–0.201
Ladywell	30–40	Positive	0	20	0	0–0.201
Isleworth*	38–40	Positive	0	8	0	0–0.402
Tooting	37–41	Negative	0	20	0	0–0.201

CI = Confidence Interval. * Only 8 tadpoles were found at this site.

TABLE 2. Number of infections in adult *Rana temporaria* screened for the presence of the ranavirus from various location in the United Kingdom from 2006 to 2008.

Year	Location	Site ranavirus history	Number ranavirus positive	Number tested	Prevalence	CI
2006	Unknown Site A	Unknown	5	9	56%	0.227–0.847
	Unknown Origin	Unknown	0	5	0%	0–0.537
2007	Uxbridge	Unknown	0	20	0%	0–0.201
	Camden	Unknown	0	11	0%	0–0.321
	Cowden	Unknown	1	2	50%	0.027–0.973
	Barnet	Unknown	0	1	0%	0–0.945
	Arylesy	Unknown	0	13	0%	0–0.283
	Brighton	Unknown	2	4	50%	0.092–0.908
	Charton	Unknown	0	1	0%	0–0.945
	Unknown Origin	Unknown	0	2	0%	0–0.802
	Ealing	Positive	0	1	0%	0–0.945
	Bexhill-on-Sea	Negative	0	2	0%	0–0.802
	Dagenham	Positive	0	4	0%	0–0.604
	Eltham 2	Positive	0	2	0%	0–0.802
	Teddington	Positive	0	2	0%	0–0.802
2008	Bristol	Unknown	0	2	0%	0–0.802
	Lewes	Unknown	0	1	0%	0–0.945
	Peterborough	Unknown	0	1	0%	0–0.945
	Bournemouth	Unknown	0	1	0%	0–0.945
	Plymouth*	Unknown	2	2	100%	0.198–1
	Wokingham*	Unknown	2	2	100%	0.198–1
	Carshalton	Unknown	1	2	50%	0.027–0.973
	Preston†	Unknown	7	11	64%	0.261–0.796
	Whitstable†	Unknown	8	15	53%	0.274–0.777
	Unknown Origin	Unknown	3	3	100%	0.310–1
	Southampton	Unknown	1	1	100%	0.055–1

* Denotes that the positive result was done through isolation methods and confirmed with PCR.
† Denotes that the animals come from an unusual or mass mortality event.
CI = Confidence Interval.

Only one of the 288 tadpoles collected and screened for the presence of the MCP of FV3 was positive (Table 1). This tadpole was collected from Deal, a historically positive site where the owners intensively manage the amphibian population (i.e. actively bring in eggs and/or animals from other populations). This infection was confirmed using virus culture techniques (Duffus 2010). Unfortunately, no adult frogs were obtained from this site so we cannot ascertain whether adult frogs were concurrently or subsequently infected. No eggs screened positively for the MCP of FV3 (even those from historically positive sites such as Deal and Ealing) (N = 30 eggs/brood, 4 broods/site, 6 sites; 3 negative and 3 positive). In contrast, adult ranavirus infections were documented during all years of this study: 5 of 14 (36%) in 2006, 3 of 65 (5%) in 2007, and 24 of 41 (59%) in 2008 (Table 2). None of the frogs obtained from historically ranavirus positive sites were positive for FV3, presumably because of small sample sizes ($N \leq 4$), and hence low power to detect infections (Table 2). Animals of all three life history stages that were tested from the site in Ealing were negative for the virus, even though this site has a long history of ranavirus infection (Teacher 2009), although just a single adult animal was screened.

The extremely low prevalence of the ranavirus in Common Frog tadpoles was unexpected, as North American ranid populations seem to have persistent infections after a long history of ranavirus outbreaks (e.g., Duffus et al. 2008). Ranid tadpoles appear to be especially susceptible to infection with a variety of ranaviruses (e.g., several North American isolates; Hoverman et al. 2011; FV3 in Europe, Pearman et al. 2004; Pearman and Garner 2005). Since the susceptibility of ranid tadpoles to infection changes throughout development (e.g., Warne et al. 2011), it is possible that the sampling strategy of our study missed affected tadpoles. The tadpoles that were collected were Gosner stage 30–40 and individuals affected by the virus may have already succumbed to ranaviral disease. Future studies would benefit from sampling across developmental stages. Alternatively, there may have been very few infected tadpoles because of minimal opportunities for viral transmission from adults to tadpoles or between tadpoles. The concentration of ranavirus particles in water may not be sufficient to result in infection under natural conditions. The infection rate for some amphibian species under experimental conditions are known to be dose dependent (Brunner et al. 2005; Pearman et al. 2004).

The absence of infections in eggs is not wholly unexpected because the prevalence of ranaviral infection in ranid eggs is thought to be very low (see Duffus et al. 2008). Therefore, it is plausible that vertical or pseudovertical (where the offspring are infected by the parents but not directly through infected gametes) transmission occurs infrequently, if at all in Common Frogs.

Adult Common Frogs did test positive for infection in all years of this study. The apparent large increase in the number of infections in 2008 can be explained by an increase in sampling effort attributed to a joint campaign between the Zoological Society of London and FrogLife. The samples obtained were from frogs that had died and that pond owners themselves had submitted to the study. It is important to note that the number of ranavirus infected adults in this study does not necessarily represent the prevalence in the population where they had originated or of the true distribution of ranavirus infections in common frog populations in the UK. Although our samples of adults were small and unevenly distributed across the UK (primarily in the Southeast), it is clear that ranavirus infections are relatively common. Moreover, in many cases they were associated with unusual or large scale mortality events (e.g., Preston in the Northwest and Whitstable in the Southeast; unpubl. data).

The majority of the Common Frogs examined in this study were from historically ranavirus positive sites or from unusual mortality events that were thought to be associated with a ranavirus outbreak. However, the true extent of the distribution of ranavirus(es) in the UK needs to be determined with a structured and non-biased sampling regime that looks at multiple species and uses more sensitive molecular methods (e.g., quantitative real time PCR) to ensure that no infections are missed.

Our study is the first to address the possibility of ranavirus infections in Common Frogs affecting life history stages other than adults. While further investigations into the transmission, maintenance, and alternative hosts are required to fully understand viral dynamics, our results are consistent with the conclusion that ranavirus infections in Common Frogs in the UK predominantly affect adults. This ranavirus continues to cause mass mortality events more than 20 years since it began to emerge. A detailed understanding of the ecology and dynamics of this pathogen are essential if any conservation or management plans are to be successful.

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A *Ranavirus*-related Mortality Event and the First Report of *Ranavirus* in New Jersey

Members of the genus *Ranavirus* in the family Iridoviridae have been documented on all continents with native amphibians except for Africa, though not always in amphibians (Gray et al. 2009). These viral pathogens can infect amphibians, fish, and reptiles. Infected animals typically exhibit skin lesions, organ and tissue swelling, and eventually die of organ failure (Gray et al. 2009 and references within). Ranavirus typically kills amphibians within a few days to a week of infection (Harp and Patrenka 2006), and can be transmitted via the environment, direct contact with an infected individual, or consumption of an infected individual (Pearman et al., 2004).

Although ranavirus has been detected throughout North America, including New York State (Johnson et al. 2008; Brunner et al. 2011) and the Delaware Water Gap of Pennsylvania (Glenney et al. 2010), there are currently no reports of ranavirus in New Jersey. Here we document the occurrence of ranavirus in New Jersey.

In May 2011 we were alerted to a *Lithobates clamitans* tadpole die off in Ocean County, NJ (Robert Zappalorti, pers. comm.). At the site we observed tadpoles that displayed signs consistent with ranaviral disease including lethargy, swelling, and red skin lesions. Additionally, we observed *Anaxyrus fowleri* tadpoles in the same area consuming the carcasses of dead *L. clamitans* tadpoles. Approximately one week after the initial *L. clamitans* die off, there was mass *A. fowleri* tadpole mortality. To assess whether ranavirus was the cause of this tadpole die off, we screened living and dead *L. clamitans* and *A. fowleri* tadpoles as well as other opportunistically sampled animals for the presence of *Ranavirus* DNA using Polymerase Chain Reaction (PCR) and quantitative PCR (q-PCR) at this and several nearby ponds (Table 1, Fig. 1).

Animals were sampled from five ponds located in Ocean County, New Jersey (USA), within an area that is being managed for the benefit of Pine Snake (*Pituophis melanoleucus*) populations (Fig. 1). The first site, Mitigation Pond (MP), is a retention pond immediately adjacent to a capped landfill. One side of the basin is lined and retains water year-round. The remainder of the basin is unlined, and the water level rises and falls with the water table seasonally. The second and third sites (MF Ponds) are located in close proximity to one another at the edge of a field that was artificially cleared for pine snake management (Management Field 2). Management Field 2 Breeding Pond (MF2BP2) is a small artificially constructed, unlined pond. MF2 Vernal Pool (MF2VP) is a small temporary pool covering a section of an unused unpaved road. The fourth site, Hay Pond (HP), is a large, heavily vegetated natural permanent pond. The final site, Costco Pond (CP), is a lined irrigation pond at the edge of the property near the roadside, across the road from a major shopping center. Sampling occurred on 17 May, 26 May, and 16 June 2011. Two other large permanent ponds (Beach Pond (BP) and Spotted Pond (STP)) were only sampled on 26 May.

We retrieved dead and dying *L. clamitans* tadpoles and symptomatic *A. fowleri* tadpoles by net, stored them on ice for approximately three hours, and then froze them at -20° C for 24

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TABLE 1. Sample collection information and ranavirus detection results. Data presented as number testing positive (+) out of number tested (N) by traditional PCR (first column of numbers) and q-PCR (second column). Samples negative by traditional PCR and positive with q-PCR are bold.

Site	Species	Life Stage	First Sample(5/17/11)			Second Sample (5/26/11)			Third Sample (6/16/11)		
			Symptomatic?	+/N	+/N	Symptomatic?	+/N	+/N	Symptomatic?	+/N	+/N
BP (Beach Pond)	*L. clamitans*	Adult	—	—		No	0/2	0/2	—	—	
HP (Hay Pond)	*Hyla* species	Tadpole	—	—		—	—		No	0/1	0/1
	L. clamitans	Tadpole	No	0/2	0/2	—	—		—	—	
	L. clamitans	Adult	No	0/2	0/2	No	0/4	0/4	No	0/7	0/7
	L. sphenocephala	Adult	No	0/2	0/2	No	0/1	0/1	—	—	
CP (Costco Pond)	*A. fowleri*	Tadpole	No	0/4*	2/4*	No	0/5	0/5	No	0/4	0/4
MF2BP2 (Management Field 2 Breeding Pond)	*A. fowleri*	Tadpole	No	0/3*	1/3*	No	0/6	0/6	—	—	
	A. fowleri	Metamorph	—	—		—	—		No	0/5	0/5
	L. clamitans	Tadpole	Yes	3/3	3/3	—	—		—	—	
MF2VP (Management Field 2 Vernal Pool)	*A. fowleri*	Tadpole	No	0/2*	0/2*	No	0/7	0/7	No	0/1	0/1
	L. clamitans	Adult	No	0/1	0/1	—	—		—	—	
Mitigation Pond (MP)	*A. fowleri*	Tadpole	No	0/5*	5/5*	Yes	3/6	3/6	—	—	
	A. fowleri	Metamorph	—	—		—	—		No	0/6	0/6
	Hyla species	Tadpole	—	—		—	—		Dead	0/10	0/10
	L. clamitans	Tadpole	Yes	16/18	16/18	Yes	1/2	1/2	—	—	
	L. sphenocephala	Adult	—	—		Dead	1/1	1/1	—	—	
STP (Spotted Pond)	*L. clamitans*	Tadpole	—	—		No	0/1	0/1	—	—	
	L. clamitans	Adult	—	—		No	0/1	0/1	—	—	

* Water in which the tadpole was held was screened for ranavirus, not a tissue sample.

h before DNA extraction. DNA has been shown to be present in the environment even when an organism is no longer present (Ficetola et al. 2008) so we attempted to determine if water containing asymptomatic *A. fowleri* tadpoles could test positive for *Ranavirus* DNA. We placed all apparently healthy (asymptomatic) *A. fowleri* tadpoles in 1.5 ml eppendorf tubes and allowed them to "swim" in the tube for approximately 30 seconds. Healthy tadpoles were released back to the pond and the water in the eppendorf tubes they had been in (approx. 100 ml) was frozen until DNA extraction.

We caught adult animals by net or hand and removed one toe for DNA extraction using scissors sterilized in 95% EtOH. Toes were stored at room temperature in 1.5 mL eppendorf tubes filled with Drierite desiccant to preserve DNA (Chase and Hills 1991). All adult frogs, with the exception of one dead *L. sphenocephala* (Table 1), appeared to be healthy and were released at the point of capture immediately after tissue removal. Additionally, we removed a small piece of tail tissue that included skin and muscle but no bone from a dead common Snapping Turtle (*Chelydra serpentina*) and collected a shed skin from a northern water snake (*Nerodia sipedon*) found at STP during the second sampling session.

We extracted DNA from tissue and the water that had held asymptomatic *A. fowleri* tadpoles using the Qiagen QIAamp DNA Mini Kit following the manufacturer's instructions. We digested the entire body of *A. fowleri* tadpoles and equivalent amounts of tail tissue from the *L. clamitans* tadpoles. (Since the dead tadpoles displayed varying degrees of decay, harvesting of internal organs was not possible.) Tail tissue was removed using scissors sterilized with 10% bleach. We extracted DNA from a rear leg of the *A. fowleri* metamorphs, and a toe for adult frogs. Additionally, we extracted DNA from the dead *C. serpentina* tail tissue and the shed skin from *N. sipedon* (Table 1).

We used *Ranavirus*-specific primers MCP4 and MCP5 designed by Mao et al. (1997) to amplify an approximately 530 bp fragment of the *Ranavirus* major capsid protein gene using both traditional and q-PCR. For traditional PCR we used 2 µl of DNA in 25 µl reactions that included the following components: 0.4 µM forward and reverse primers, 1.5 mM $MgCl_2$, 0.2 mM dNTPs, and 0.1 U/µl taq polymerase. We ran PCR reactions under the following conditions: 1 cycle of 95°C for 5 min followed by 30 cycles of 95°C for 30 sec, 60°C for 30 sec, and 72°C for 30 sec, followed by a final 7-min extension at 72°C. All reactions were run in a GeneAmp 9700 Thermocycler (Applied Biosystems). Appropriate negative controls using water in place of DNA were included with each PCR run. PCR products were checked for the presence of the *Ranavirus*-specific fragment on 2% 1XTAE gels by SYBR Safe (Invitrogen) staining and UV illumination. Samples were considered positive if there was a DNA fragment present at approximately 530 bp.

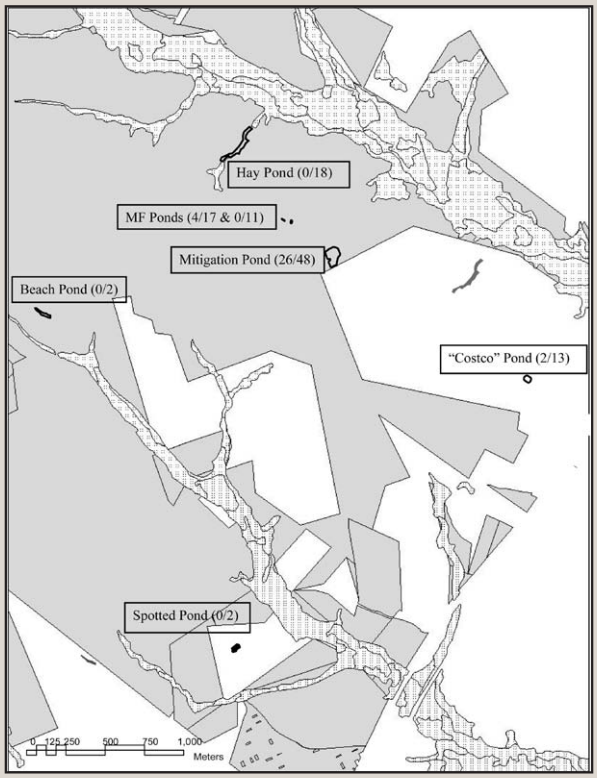


FIG. 1. Map of sampling locations in Ocean County, New Jersey. Numbers in parentheses represent number of samples testing positive for *Ranavirus* DNA / number tested.

PCR product for six putative positive samples was sequenced on an ABI 3130 Genetic Analyzer and compared to known ranavirus major capsid protein DNA sequence to confirm the presence of ranavirus DNA. All six samples were identical to each other and shared 99% similarity to an isolate of Frog Virus 3, confirming their identity as a ranavirus.

We used q-PCR to re-screen all samples. We used 4.6 µl of DNA in 10-µl q-PCR reactions that included the following components: 0.4 µM forward and reverse primers, 5 µl of Brilliant II SYBR Green q-PCR Master Mix (Agilent Technologies), and H_2O to a final volume of 10 µl. We ran positive control reactions using 2 µl of *L. clamitans* tadpole DNA that tested positive for ranavirus using traditional PCR and negative control reactions using water in place of DNA under the same conditions. PCR reactions were subjected to 1 cycle of 95°C for 10 min followed by 40 cycles of 95°C for 45 sec, 50°C for 30 sec, and 72°C for 30 sec. All q-PCR reactions were run on a StepOne Plus Real Time PCR System (Life Technologies). A sample was considered positive if the fluorescence was at least as high as the positive control.

Of the 114 animals sampled, 24 tested positive for the presence of *Ranavirus* DNA with traditional PCR and an additional eight (total of 32) tested positive with q-PCR (Table 1). The water from all 14 of the asymptomatic *A. fowleri* tadpoles from the first sampling session tested negative for ranavirus using traditional PCR, but eight tested positive with q-PCR suggesting q-PCR may be more appropriate for sampling when pathogen concentration is low. Ranaviral DNA was detected in three of the seven ponds tested, although low sample sizes prevent us from excluding its presence from the others (Fig. 1). No ranavirus was detected in the dead snapping turtle or skin shed of the water snake.

To our knowledge, this is the first published account of the presence of *Ranavirus* in the state of New Jersey. Our research demonstrates the need to sample during multiple time periods when a ranavirus outbreak is suspected of occurring. Our initial screening of *A. fowleri* tadpoles during the first sampling session, combined with their healthy physical form, gave the appearance they were not infected with *Ranavirus*. We only detected the presence of *Ranavirus* in multiple tadpoles of this species with traditional PCR after 10 days of exposure to known infected *L. clamitans* individuals in the same pond. Although we detected *Ranavirus* DNA using a non-lethal technique in asymptomatic *A. fowleri* tadpoles, further comparative tests between our non-lethal sampling (tadpole water) and tissue sampling will be necessary before we can determine if this non-lethal method is sensitive enough to consistently detect the presence of ranavirus. Future work at this site should focus on continued monitoring and screening for ranavirus over multiple seasons, and on increasing sampling effort, since for some sites where we had no positive results we did not have sufficient sample size to conclusively say those areas are actually disease free.

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Presence of *Ranavirus* in Green Frogs and Eastern Tiger Salamanders on Long Island, New York

Disease has been implicated as a factor in amphibian population die-offs and declines worldwide (Berger et al. 1998; Blaustein et al. 1994; Brunner et al. 2011; Daszak et al. 2000; Gray et al. 2009a; Green et al. 2010; Kiesecker et al. 2001; Laurance et al. 1996; Muths et al. 2006; Muths and Hero 2010; Russell et al. 2011; Skerratt et al. 2007). One hypothesis for the emergence of diseases in amphibian populations is reduced amphibian immunity associated with increased incidence of natural and anthropogenic stressors. Natural stressors include drying ponds, weather variations, and the presence of predators (Gray et al. 2009a), while the anthropogenic stressors include habitat loss and degradation, invasive species, pollution, agricultural land use, global climate change, and acid rain (Blaustein et al. 1994; Carey et al. 2003; Fellers et al. 2001; Forson and Storfer 2006; Gahl and Calhoun 2010; Gray et al. 2009a; Jaconovich et al. 2005; Kiesecker at al. 2001; Knapp and Matthews 2000 ; Pechmann et al. 1991).

While amphibians are susceptible to many pathogens, viruses belonging to the genus *Ranavirus* appear to be responsible for most amphibian die-offs in North America (Brunner et al. 2011; Collins et al. 2004; Gray et al. 2009a; Jaconovich et al. 2005; Muths et al. 2006; Phillott et al. 2010; Russell et al. 2011). The first catastrophic die-offs from *Ranavirus* in the United States were reported in the mid-1990s and have occurred in all regions of the United States (Brunner et al. 2011; Converse and Green 2005; Green et al. 2002; Jaconovich et al. 1997; Jaconovich et al. 2005; Russell et al. 2011). Furthermore, the number of reported mortality events in the United States from *Ranavirus* is 3 to 4 times greater than that for the amphibian chytrid fungus, *Batrachochytrium dendrobatidis* (Muths et al. 2006). A variety of North American species have been affected in these mortality events, including several ranid species (*Lithobates* spp.), ambystomatid species (*Ambystoma* spp.), and plethodontid species (Bollinger et al. 1999; Brunner et al. 2011; Gray et al. 2009a; Gray et al. 2009b; Green et al. 2002; Greer et al. 2005; Jancovich et al. 1997; Jancovich et al. 2005). Undoubtedly, additional die-offs have likely occurred but have gone unnoticed.

In New York State, declines in populations of several amphibian species have been documented in recent years. The tiger salamander, *Ambystoma tigrinum*, once abundant in many wetlands throughout Long Island (Bishop 1941), is now listed as a New York State Endangered Species. Other species, such as the green frog, *Lithobates clamitans*, remain common, and their populations appear to be stable. While declines in green frog populations have not been reported, monitoring mortalities in a common species can be an indicator of potential threats to less common species. The purpose of this paper is to document observed *Ranavirus* presence in mortalities of green frogs and tiger salamanders in a single wetland population at Brookhaven National Laboratory, Long Island, New York in 2007 and 2008 (Due to the endangered status of the eastern tiger salamander in New York, we cannot report the exact locality on the BNL property).

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In 2007, we collected 10 dead pre-metamorphic tiger salamanders at the study location. In 2008, an additional 5 dead juvenile green frogs between Gosner stages 39 and 45 (Gosner 1960) and 4 dead pre-metamorphic tiger salamanders were collected. The mortality event occurred between 6 July – 12 July in 2007, and between 24 June – 3 July in 2008, both periods being very warm and dry (above 82°F during the hottest part of the day for over a week) and occurring just prior to the animals' metamorphosis. Animals that were collected were very bloated, and their ventral surfaces were reddened. Additional carcasses were observed, but were not analyzed because of severe decomposition. We could not estimate the size of the population at this wetland, therefore we cannot provide an estimate of the percentage of the population affected.

We extracted DNA from liver tissue using the DNeasy kit (Qiagen, Valencia, CA, USA). The *Ranavirus* major capsid protein was amplified using the sense primer (5'-GACTTGGCCACTTATCAC -3') and anti-sense primer (5'-GTCTCTGGAGAAGAAGAA-3'), as previously described (Green et al. 2000; Johnson et al. 2008). Using a Taq PCR Kit (New England Biolabs), we amplified mixtures containing the extracted DNA, primers, distilled water, 10x buffer, dNTP, Mg, and Taq in a thermal cycler (PTC-100, MJ Research) with an initial denaturation at 94°C for 2 min., followed by 94°C for 20 sec., 55°C for 30 sec., and 68°C for 2 min. Then after 34 cycles of denaturation at 50°C, the mixture was annealed at 68°C for 7 min. and finally extended at 4°C. PCR products were resolved in 2.0% agarose gels, and bands were examined.

The liver samples confirmed the presence of *Ranavirus* in all nineteen collected specimens from 2007 and 2008. While we cannot conclude that *Ranavirus* caused the mortalities, it is likely that the other carcasses that were not analyzed suffered a similar fate because of the similar appearance, but more advanced decomposition, of those specimens.

The pH of the water at the time of the die-offs in both years was around 10–11, whereas the pH of Pine Barrens ponds on Long Island are generally under 6. Our pond receives storm water runoff from surrounding buildings constructed with Recycled Concrete Aggregate (RCA), which could have elevated the pH observed. It is possible that other runoff from surrounding areas (roadsides, athletic fields, buildings) might have also accumulated in this wetland. These areas are often treated for tick prevention, and salts are used in the winter on icy roads and sidewalks. While we cannot attribute the mortalities to *Ranavirus* specifically, both pesticides and road salt chemicals appear to increase susceptibility to *Ranavirus* in amphibians (Forson and Storfer 2006; Gahl and Calhoun 2010; Gray et al. 2007).

Ranavirus was previously confirmed in eastern box turtles in late 2005 at a pond 2000 m northwest of this location (Johnson et al. 2008), and box turtles were observed consuming carcasses of

larvae that were not able to transform prior to this pond drying (pers. obs.). Larval amphibians were not tested for *Ranavirus* in the nearby ponds because we were not aware of the presence of this disease prior to the observations reported here. Due to the proximity of confirmed *Ranavirus* outbreaks in box turtles, it is possible that the virus was present at our site for some time prior to these events, but was not detected.

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GEOGRAPHIC DISTRIBUTION

Herpetological Review publishes brief notices of new geographic distribution records in order to make them available to the herpetological community in published form. Geographic distribution records are important to biologists in that they allow for a more precise determination of a species' range, and thereby permit a more significant interpretation of its biology.

These geographic distribution records will be accepted in a **standard format** only, and all authors *must* adhere to that format, as follows: SCIENTIFIC NAME, STANDARD ENGLISH NAME if available (for the United States and Canada as it appears in Crother [ed.] 2012. *Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, with Comments Regarding Confidence in Our Understanding*. 7th ed. Herpetol. Circ. 39:1–92 [available from ssarbooks.com], for Mexico as it appears in Liner and Casas-Andreu 2008. *Standard Spanish, English and Scientific Names of the Amphibians and Reptiles of Mexico*. Herpetol. Circ. 38:1–162), LOCALITY (use metric for distances and give precise locality data, including lat/long coordinates in **decimal degrees** and cite the map datum used), DATE (day-month-year), COLLECTOR, VERIFIED BY (*cannot* be verified by an author; curator at an institutional collection is preferred), PLACE OF DEPOSITION (where applicable, use standardized collection designations as they appear in Sabaj Pérez [ed.]. 2010, *Standard Symbolic Codes for Institutional Resource Collections in Herpetology and Ichthyology: an Online Reference*, ver. 2.0, available at http://www.asih.org/) and CATALOG NUMBER (required), COMMENTS (brief), CITATIONS (brief and must adhere to format used in this section; these should provide a geographic context for the new record). Close with author name(s) in bold, capital letters (give name and address in full—spell out state or province names—no abbreviations, e-mail address after each author name/address for those wishing to provide it—e-mail required for corresponding author). Please include distance from nearest previously known record (provide a citation or refer to existing vouchered material to substantiate your report). If publishing specific locality information for a rare or endangered species has the potential to jeopardize that population, please consult with the Section Editor at time of record submission. If field work and/or specimen collection occurred where permits were required, please include permit number(s) and authorizing agency in the text of the note.

Some further comments. The role of the "Standard Names" lists (noted above) is to standardize English names and comment on the current scientific names. Scientific names are hypotheses (or at least represent them) and as such their usage should not be dictated by a list, society, or journal.

Additionally, this geographic distribution section does not publish "observation" records. Records submitted should be based on preserved specimens that have been placed in a university or museum collection (private collection depository records are discouraged; institutional collection records will receive precedence in case of conflict). A good quality photograph (print, slide, or digital file) may substitute for a preserved specimen *only* when the live specimen could not be collected for the following reasons: it was a protected species, it was found in a protected area, the observer lacked the necessary permit for collection, or the logistics of preservation were prohibitive (such as large turtles or crocodilians). Photographic vouchers *must* be deposited in a university or museum collection along with complete locality data, and the photographic catalog number(s) must be included in the same manner as a preserved record. Before you submit a manuscript to us, check Censky (1988, *Index to Geographic Distribution Records in Herpetological Review: 1967–1986*; available from the SSAR Publications Secretary), subsequent issues of *Herpetological Review*, and other sources to make sure you are not duplicating a previously published record. The responsibility for checking literature for previously documented range extensions lies with authors. **Do not submit range extensions unless a thorough literature review has been completed.**

For reports concerning introduced species, it is important to note whether a population has become established or if the report represents an isolated occurrence, such as a released captive. Additionally, it will be helpful to include any information that establishes a timeline for the introduction, such as date of first observation.

Please submit any geographic distribution records in the **standard format only** to one of the Section Co-editors: **David C. Blackburn** (Africa and Europe), **Indraneil Das** (Asia), **Stephen Richards** (Australasia, South Pacific) **Jerry D. Johnson** (Mexico and Central America, including the Caribbean Basin), **Alan M. Richmond** (USA & Canada), or **Gustavo J. Scrocchi** (South America). Short manuscripts are discouraged, and are only acceptable when data cannot be presented adequately in the standard format. **Electronic submission of manuscripts is required** (as Microsoft Word or Rich Text format [rtf] files, as e-mail attachments). Refer to inside front cover for e-mail addresses of section editors.

Recommended citation for new distribution records appearing in this section is: Cabral, H., and A. Caballero. 2012. Geographic distribution: Paraguay, Departamento Central: *Pseudoeryx plicatilis*. Herpetol. Rev. 43:622.

CAUDATA — SALAMANDERS

***DESMOGNATHUS AENEUS* (Seepage Salamander)**. USA: ALABAMA: Coosa Co.: First order seepage tributary of Hatchet Creek, 50 m NW of U.S. Hwy 280 (33.03820°N, 86.86.12861°W; WGS 84). 17 February 2013. S. Graham. Verified by David Laurencio. AUM 40149. New county record (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn Printing Co., Auburn, 347 pp.). This record fills a distribution gap for this species between Chilton County to the southwest and Clay County to the northeast.

This location is about 10 km SW of the nearest known collection site in Clay County (Mount 1975, *op. cit.*).

This specimen was collected under a special permit issued by the Alabama Department of Conservation and Natural Resources.

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***EURYCEA GUTTOLINEATA* (Three-lined Salamander)**. USA: GEORGIA: Cherokee Co.: Reinhardt University Campus, 0.5 km NNW of intersection of SR 140 and SR 108 (34.320915°N, 84.554160°W; WGS 84). 22 October 2010. Z. Felix. UF 169265 (Digital photograph). Verified by Kenneth Krysko.. New county record (Jensen et al. [eds], 2008. Amphibians and Reptiles of Geórgia. University of Georgia Press, Athens. 575 pp.). One adult found under cover near mucky creek

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***HEMIDACTYLIUM SCUTATUM* (Four-toed Salamander)**. USA: TENNESSEE: Rhea Co.: wetland north of Liberty Hill Road, 3.5 miles E from intersection with Summer City Road (35.58824°N, 85.01275°W; WGS 84). 11 March 2013. Brian Folt. Verified by Craig Guyer. Auburn University Museum of Natural History (AUM 40178). Individual collected from under moss along periphery of wetland. New county record (Niemiller and Reynolds 2011. The Amphibians of Tennessee. University of Tennessee Press, Knoxville, Tennessee. 369 pp.).

BRIAN FOLT, Auburn University, Department of Biological Sciences, 331 Funchess Hall, Auburn, Alabama 36849,USA; e-mail: brian.folt@gmail.com.

***HEMIDACTYLIUM SCUTATUM* (Four-toed Salamander)**. USA: WISCONSIN: Rusk Co.: Rusk County Forest: ~0.5 mi SE of Skinner Creek Rd. at ~1.25 mi NE of jct Skinner Creek Rd., Hervas Rd., and Hackett Rd. (45.603390°N, 90.777320°W; WGS 84). 17 May 2012. Erik R. Wild (UWSP 4300). Verified by Joshua M. Kapfer. New county record that completes a gap in the species' documented range (Casper 1996. Geographic Distributions of the Amphibians and Reptiles of Wisconsin. Milwaukee Publ. Mus., Milwaukee, Wisconsin. 87 pp.; *Herpetological Review* 1996–present).
Specimen collected under Wisconsin Department of Natural Resources Permit SCP-131-WCR-C-11.

ERIK R. WILD, Department of Biology & UWSP Museum of Natural History, University of Wisconsin-Stevens Point, Stevens Point, Wisconsin 54481, USA, e-mail:ewild@uwsp.edu.

***NECTURUS MACULOSUS* (Mudpuppy)**. USA: TENNESSEE: Franklin Co.: Beans Creek (35.127056°N, 86.309058°W; NAD83). 29 May 2012. Joshua A. Miller. Verified by A. F. Scott. Austin Peay State University (APSU 19368 photographic voucher). First record for county and for Elk River watershed in Tennessee (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Internet version [http://apbrwww5.apsu.edu/amatlas] accessed 18 January 2013; latest update 10 January 2013). Larva found underneath a small rock in the center of stream.

JOSHUA A. MILLER, NOAH FLANIGAN, and **BRIAN T. MILLER**, Department of Biology, Middle Tennessee State University, Murfreesboro, Tennessee 37132, USA (e-mail: Brian.Miller@mtsu.edu).

***NECTURUS MACULOSUS* (Mudpuppy)**. USA: TENNESSEE: Hickman Co.: Big Swan Creek (35.681819°N, 87.428678°W; NAD 83). 5 June 2012. D. Dodge, J. A. Miller, and T. Walls. Verified by A. F. Scott. Austin Peay State University (APSU 19370 photographic voucher). First record for county and extends known distribution of species into Big Swan Creek of the Duck River watershed (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Internet version [http://apbrwww5.apsu.edu/amatlas] accessed 18 January 2013; latest update 10 January 2013.). An adult female found with a clutch eggs underneath a large rock at edge of stream.

DEREC DODGE, NOAH FLANIGAN, JOSHUA A. MILLER, TAYLOR WALLS, RAYMOND WRIGHT, and **BRIAN T. MILLER,** Department of Biology, Middle Tennessee State University, Murfreesboro, Tennessee 37132, USA (e-mail: Brian.Miller@mtsu.edu).

***NOTOPHTHALMUS VIRIDESCENS VIRIDESCENS* (Eastern Newt)**. USA: GEORGIA: Cherokee Co.: Ball Ground, Flatbottom Road 0.15 km S of intersection with Northridge Road (34.316960°N, 84.387238°W; WGS 84). 3 October 2012. Z. Felix. UF 169264. Digital photograph. Verified by Kenneth Krysko. One eft found on road on rainy night. New county record (Jensen et al. [eds] 2008. Amphibians and Reptiles of Geórgia. University of Georgia Press, Athens. 575 pp.).

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***NOTOPHTHALMUS VIRIDESCENS* (Eastern Newt)**. USA: INDIANA: Morgan Co.: Morgan-Monroe State Forest (39.34251°N, 86.42096°W; NAD 83). 21 February 2012. Sarabeth Klueh and Jason Mirtl. Illinois Natural History Survey (INHS 2012p). Orange Co.: Hoosier National Forest (38.65423°N, 86.67107°W; NAD 83). 21 February 2012. Sarabeth Klueh and Jason Mirtl. INHS 2012e. Both are new county records (Minton 2001. Amphibians and Reptiles of Indiana, 2nd ed., revised. Indiana Academy of Science. vii–404 pp.). Verified by Chris Phillips.

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***NOTOPHTHALMUS VIRIDESCENS* (Eastern Newt)**. USA: WISCONSIN: Sawyer Co.: Chequamegon-Nicolet National Forest: ~0.25 mi N Tower Rd. (=Forest Rd. 311) at ~0.25 mi W of jct with Forest Rd. 162. (45.95298°N, 90.76274°W; WGS 84). 20 April 2012. Erik R. Wild. UWSP 4282. Verified by Joshua M. Kapfer. New county record begins to document the expected species occurrence in north-central Wisconsin (Casper 1996. Geographic Distributions of the Amphibians and Reptiles of Wisconsin. Milwaukee Publ. Mus., Milwaukee, Wisconsin. 87 pp.; *Herpetological Review* 1996–present). The male individual was found swimming in shallows of forest pond. Three other individuals observed in same pond. Additional observations made at another pond ~0.15 mi to the SW (45.94999°N, 90.76351°W; WGS 84).
Specimen collected under Wisconsin Department of Natural Resources Permit SCP-131-WCR-C-11.

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***PLETHODON CINEREUS* (Eastern Red-backed Salamander)**. USA: MICHIGAN: Charlevoix Co.: S end of Hog Island, Eastern

Lake Michigan (Beaver) Archipelago (45.772911°N, 85.388231°W; WGS 84). 12 July 2011. Nancy E. Seefelt. Verified by Fred Janzen. Iowa State University Research Collection (ISUA201201; digital images. New record for Hog Island (Bowen and Gillingham 2004. Michigan Acad. 35:213–223). Salamander was found under a log in a coastal forest dominated by Northern White-cedar (*Thuja occidentalis*); other individuals of the same species were also observed.

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***PLETHODON GLUTINOSIS* (Northern Slimy Salamander)**. USA: INDIANA: Sullivan Co.: Greene-Sullivan State Forest (39.00161°N, 87.25044°W; NAD 83). 25 April 2012. Sarabeth Klueh and Jason Mirtl. Verified by Chris Phillips, Illinois Natural History Survey (INHS 2012q). New county record (Minton 2001. Amphibians and Reptiles of Indiana, 2nd ed., revised. Indiana Academy of Science. vii–404 pp.).

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ANURA — FROGS

***ANAXYRUS WOODHOUSII WOODHOUSII* (Rocky Mountain Toad)**. USA: CALIFORNIA: Inyo Co.: Amargosa River (35.815919°N, 116.214778°W, 360 m elev.; WGS84). 18 April 2012. Lacey Greene and Tammy Branston. Verified by S. Sweet. Natural History Museum of Los Angeles County (LACM PC 1602, 1603; photographic vouchers). New county record (Sullivan 2005. *In* M. Lannoo [ed.], Amphibian Declines: The Conservation Status of United States Species, pp. 438–440. Univ. California Press, Berkeley). Loud and abundant calls emanated from this section of the Amargosa River at dusk.

Historically, Rocky Mountain Toads were recorded in the Vegas Valley (Stejneger 1893. N. Amer. Fauna [7]:159–228) but more recently Rocky Mountain Toads have been observed near Las Vegas, approximately 35 km to the east (D. Bradford in Sullivan 2005, *op. cit.*). The nearest location in California is approximately 160 km to the southeast (Stebbins and McGinnis 2011. Field Guide to Amphibians and Reptiles of California, 2nd ed., revised. University of California Press, Berkeley. 538 pp.). Our record places *A. woodhousii* 130 km S and within the same river drainage as the Amargosa Toad (*A. nelsoni*). The Amargosa Toad is restricted to a ten-mile stretch of the Amargosa River in Oasis Valley, Nevada. Most of the intermittent Amargosa River channel is generally dry but water flows above ground after rainstorms (Tanko and Glancy 2001. Fact Sheet 036-01: Flooding in the Amargosa River Drainage Basin, February 23–24, 1998, Southern Nevada and Eastern California, including the Nevada Test Site).

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***DENDROPSOPHUS MIYATAI* (Hosteria La Selva Treefrog)**. COLOMBIA: CAQUETÁ: Municipio de Solano: Resguardo Indígena El Quince (0.803194°N, 75.199528°S; WGS84), ca. 204 m. elev. 6 September 2007. C. Malambo L., J. P. Nuñez, and L. Luna. Museo de Historia Natural Universidad de la Amazonia, Florencia-Caquetá, Colombia (UAM 792–796). Verified by J. D. Lynch. First department record and the westernmost for the species. Extends known range 798 km N from the previous record. Previously, this species was known only from the department of Amazonas in Colombia (Lynch 2005. Rev Acad. Colomb. Cienc. 29[113]:581–588); Ruiz-Carranza et al.1996. Rev. Acad. Colomb. Cienc. 20[77]:365–415) with the northernmost record in the Municipio de Leticia (ca. 4.116°S, 69.95°W).

CÉSAR MALAMBO L. (e-mail: malambidae@gmail.com), **MARIO A. MADRID-ORDÓÑEZ** (e-mail: mamadrido@unal.edu.co), **ALEXANDER VELÁSQUEZ-VALENCIA**, **JULIETH A. ZAPATA-ORTIZ,** and **DIANA C. ARISTIZÁBAL-VALBUENA,** Museo de Historia Natural de la Universidad de la Amazonía, Carrera 11 N° 6-69 Barrio Juan XXIII, Florencia, Caquetá, Colombia.

HYPSIBOAS CAINGUA. BRAZIL: PARANÁ: Municipality of Cianorte: 23.889626°S, 52.814711°W (SAD 69). 4 September 2012. V. G. Batista, I. P. Affonso, and F. H. Oda. Coleção Zoológica da Universidade Federal de Goiás, Goiânia, Goiás, Brazil (ZUFG 7335–7337). Verified by R. P. Bastos. The distribution of *Hypsiboas caingua* encompasses Misiones (type locality), and Corrientes provinces in northeastern Argentina (Carrizo 1990. Cuad. Herpetol. 5:32–39) and adjacent southeastern Paraguay (Brusquetti and Lavilla 2006. Cuad. Herpetol. 20:3–79) as well as isolated populations in São Paulo (Brassaloti et al. 2010. Biota Neotrop. 10[1]:275–292; Condez et al. 2009. Biota Neotrop. 9[1]:157–185; Melo et al. 2007. Biota Neotrop. 7[2]:93–102; Araujo and Almeida-Santos 2011. Biota Neotrop. 11[3]:47–62), Mato Grosso do Sul (Souza Filho and Lima 2012. Check List 8[4]:800–801; Aoki et al. 2010. Herpetol. Rev. 41[4]:507), and Rio Grande do Sul states, Brazil (Garcia and Vinciprova 1998. Herpetol. Rev. 29[2]:117–118; Kwet 2001. Frösche im Brasilianischen Araukarienwald. Anurengemeinschaft des Araukarienwaldes von Rio Grande do Sul: Diversität, Reproduktion und Ressourcenaufteilung. Münster. Natur und Tier-Verlag. 192 pp.). First state record, extends known distribution ca. 160 km NW from the closest known locality (Naviraí municipality, state of Mato Grosso do Sul; Aoki et al. 2010, *op. cit.*), and fills distributional gap.

VINICIUS GUERRA BATISTA (e-mail: vinicius.guerra_@hotmail.com), **IGOR DE PAIVA AFFONSO,** and **FABRÍCIO HIROIUKI ODA**, Programa de Pós-Graduação em Ecologia de Ambientes Aquáticos Continentais, Universidade Estadual de Maringá, Nupélia - Núcleo de Pesquisas em Limnologia, Ictiologia e Aqüicultura – Bloco G-90, Av. Colombo, 5790, CEP 87020-900, Maringá, PR, Brazil.

***LITHOBATES AREOLATUS* (Crawfish Frog)**. USA: OKLAHOMA: Seminole Co.: ca. 2.3 air km NW of jct State Hwy 56 and Interstate 40; (35.40682°N, 96.46704°W; WGS84). 15 Mar 2013. Richard D. Butler. Verified by Jessa L. Watters. Sam Noble Oklahoma Museum of Natural History (OMNH 43713). New county record and a range extension of 2.8 km from Okfuskee Co. to the east (Sievert and Sievert 2011. A Field Guide to Oklahoma's Amphibians and Reptiles. Oklahoma Dept. Wildlife Conserv, 3rd ed. vi + 211 pp.). Calling males were abundant in a shallow vernal pool, air temperature was 17.2°C.

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***PSEUDACRIS CRUCIFER* (Spring Peeper)**. USA: INDIANA: Gibson Co.: Patoka River National Wildlife Refuge (38.362506°N, 87.379450°W; NAD 83). 22 March 2012. Sarabeth Klueh and Jason

Mirtl. Verified by Chris Phillips. Illinois Natural History Survey (INHS 2013a photo voucher). New county record (Minton 2001. Amphibians and Reptiles of Indiana, 2nd ed., revised. Indiana Academy of Science. vii–404 pp.). Calling male captured in vegetation approx. 2 m from a semi-permanent pond.

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***PSEUDOPALUDICOLA CANGA*.** BRAZIL: PARÁ: Municipality of Brasil Novo: 3.376°S, 52.576°W (datum WGS 84). 10 February 2012. E. A. Oliveira, J. C. Carvalho, and E. J. Hernández-Ruz. Museu Paraense Emilio Goeldi, Belém, Pará, Brazil (MPEG 34545–34553, MPEG 34584). Verified by M. S. Hoogmoed. Previously known only from the type locality: Serra dos Carajás, municipality of Marabá, State of Pará, Brazil (Giaretta and Kokubum 2003. Zootaxa 383:1–8). Northwesternmost record for the species, extends known distribution 260 km NW from Serra dos Carajás, the closest locality previously mentioned.

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***RHACOPHORUS SUFFRY* (Suffry Red-Webbed Treefrog).** INDIA: ARUNACHAL PRADESH: Papumpare District: Nirjuli, NERIST Block-G hostel campus, 27.131547°N, 93.750133°E (WGS 84), 127 m elev. 15 August 2012. NERIST Block-P hostel campus., 27.131319°N, 93.740599°E (WGS84), 139 m asl., 20 August 2012; NERIST Block-P hostel campus, 27.131568°N, 93.749794°E (WGS 84), 140 m asl., 25 August 2012; P. C. Ray and B. Singha (ZSI/APFS/A-084). Verified by Saibal Sengupta. All three adult individuals sighted between 1900 h and 0300 h, were mostly resting on plants such as *Duranta* sp., *Begonia* sp., and *Chrysocephalum* sp. Associated anuran species include *Bufo stuarti*, *Polypedates megacephalus*, and *Duttaphrynus himalayanus*. New state record for Arunachal Pradesh, extending range ca. 125 km SE of type locality at Suffry Tea Estate, Assam, India (Bordoloi et al. 2007. Zootaxa 1653:1–20).

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***THELODERMA HORRIDUM* (Thorny Bush Frog).** MALAYSIA: SARAWAK: Miri (Fourth) Division: Lambir Hills National Park, vicinity of Borneo Tropical Rainforest Resort (04.176551°N, 113.993948°E; WGS84). 16 February 2013. Photographic voucher, Raffles Museum of Biodiversity Research, National University of Singapore, ZRC [IMG] 1.42a–c. C. Lee. Inoue Trail, near Park Headquarters (ca. 4.300000°N, 113.66667°E). 24 September 2012. Photographic voucher, ZRC [IMG] 1.43a–b. Y. Emang and H. R. Kiprawi. Verified by Kelvin K. P. Lim. In both cases, found on trunks of live trees. Specimen on 16 February encountered ca. 2100 h, ca. 2 m on tree trunk. No vocalization heard. First locality record for Sarawak State, and second for Borneo, only known population on Borneo reported from Danum Valley (5.016667°N, 118.05°E), Lahad Datu District, Sabah (Inger et al. 1995. Raffles Bull. Zool. 43:115–131), ca. 492 km to the northeast (linear distance calculated using Movable Type Scripts, http://www.movable-type.co.uk/scripts/latlong.html). Known distribution outside Borneo includes southern Peninsular Thailand, Peninsular Malaysia, Pulau Tioman, Singapore, and the Mentawai Archipelago (Dring 1979. Bull. Brit. Mus. Nat. Hist. Zool. 34:181–241; Figueroa and Selveindran 2011. Nat. Singapore 4:259–262).

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***VITREORANA OYAMPIENSIS* (Zidok Cochran Frog).** BRAZIL: RONDÔNIA: Porto Velho (District of Vista Alegre do Abunã) BR-364 highway, km 265, Fazenda Presidente Prudente I e II (9.57656°S, 65.57098°W; datum WGS84). 03 November 2012. P. R. Melo-Sampaio, C. M. B. Oliveira, and K. R. Silva. Herpetological Collection, Universidade Federal do Acre, Rio Branco, Acre, Brazil (UFAC 5751, male found calling on the branches and leaves, above small stream into forest 2200 h). Verified by J. M. Guayasamin. Species previously known from the Guianas (Guayasamin et al. 2008. Zootaxa 1815:25–34), Peru (Torres-Gastello et al. 2007. J. Natl. Mus. Prague, Nat. Hist. Ser. 176:11), Colombia (Flores 1987. J. Herpetol. 21:185–190; Lynch 2005. Rev. Acad. Colomb. Cienc. Exact. Fis. Nat. 29:581–588), Ecuador (Guayasamin et al. 2006. Check List 2[1]:70–75), Bolivia (Muñoz and Aguayo 2009. Cuad. Herpetol. 23[2]:97–99; Moravec et al. 2011. Bonn. Zool. Beit. 23[3]:47–56), and Amazonas state in Brazil (Lima et al. 2006. Guide to the Frogs of Reserva Adolpho Ducke, Central Amazonia. Instituto Nacional de Pesquisas da Amazonia-INPA, Manaus. 168 pp.). First state record extends the known distribution ca. 275 km NE of San Antonio, Bolivia (Moravec et al., *op. cit.*) and 930 km S from Reserva Ducke, Amazonas state, Brazil (Lima et al., *op. cit.*).

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***ZAKERANA TERAIENSIS* (Terai Cricket Frog).** BANGLADESH: DINAJPUR DISTRICT: Birgonj, Singra National Park (25.890786°N, 88.566706°E; WGS84; 79.08 m elev.). 16 March 2013. Md. Abdur Razzaque Sarker. Adult male (MHLB-FT-03) at 1900 h, on bank of Norto River. Museum of Herpetology Laboratory, Ichamati College, Dinajpur, Bangladesh, and Kazi Zaker Hossain Zoological Museum, Department of Zoology, University of Dhaka, Bangladesh. Verified by Mohammad Sajid Ali Howlader. First record from Dinajpur District. Previously recorded from Dhaka (Sarker 2012. Herpetol. Rev. 43:440); Moulvibazar (Sreemangol) (Rahman 2011. Herpetol. Rev. 42:562); Chittagong (Hathazari); Cox's Bazaar (Himchari); Noakhali (Hatia Island); and Barisal (Sundargaon), southeast Bangladesh (Rasel et al. 2007. Bannoprani- Bangladesh Wildl. Bull. 4:1–2).

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TESTUDINES — TURTLES

***CHRYSEMYS PICTA MARGINATA* (Midland Painted Turtle)** USA: MICHIGAN: Charlevoix Co.: Southwest end of Hog Island, Eastern Lake Michigan (Beaver) Archipelago (45.775096°N, 85.394518°W; WGS 84). 12 July 2011. Nancy E. Seefelt. Verified by Fred Janzen. Iowa State University Research Collection (ISUA201202; digital images). New record for Hog Island (Bowen and Gillingham 2004. Michigan Acad. 35:213–223). Turtle shell was found in a coastal wetland on the island; other turtles were observed in the area.

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***PELODISCUS SINENSIS* (Chinese Softshell Turtle)**. BRAZIL: BELÉM: Belém City (1.366°S, 48.392°W; datum WGS 84). February 2010. D. Félix-Silva, J. Pezzuti. MPEG 1214. Verified by Marinus Hoogmoed. Pelodiscus sinensis is a South Asian species that has been introduced in several localities outside its natural range, and was recently reported in Amazonia (Félix-Silva et al. 2012 Herpetol. Rev. 43:616). Due to heavy exploitation for food and traditional medicine, natural populations are seriously depleted and *P. sinensis* is now considered vulnerable in its native range (Asian Turtle Trade Working Group 2000. *In* IUCN 2012. IUCN Red List of Threatened Species. Version 2012.2. <www.iucnredlist.org>. Accessed 3 November 2012). Here we report additional Brazilian specimens.

The specimens reported here were found and captured in small bodies of water near densely inhabited neighborhoods in Belém City, Brazil (1.366°S, 48.392°W; datum WGS 84). Two hatchlings (about 20 mm carapace length) were found by children in a sandy place next to an artificial lake in February 2010 (MPEG 1214). One year later, three similarly-sized young animals were caught at the same locality. An adult male was caught in a hole near the same lake in November 2010 (MPEG 1215). In April 2011 an adult female was found nearly 1 km downstream from the first locality (MPEG 1216). This individual laid five small spherical eggs in the water 9 May 2011 and three more eggs on 31 May 2011. After 60 days of incubation, none of the eggs showed any sign of embryonic development. It seems probable that there is a feral population of unknown size established in the streams and lakes of Belém City, and studies on the distribution and impacts of *P. sinensis* on local aquatic habitats and aquatic biodiversity are recommended.

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***PSEUDEMYS CONCINNA* (River Cooter)**. USA: GEORGIA: Cherokee Co.: Ball Ground, intersection of state highways 369 and 372 (34.277379°N, 84.298898°W; WGS 84). 9 July 2011. Z. Felix. UF 166972 (Digital photograph). Verified by Kenneth Krysko. One adult female found alive on road mid-afternoon. New county record (Jensen et al. [eds;] 2008. Amphibians and Reptiles of Geórgia. University of Georgia Press, Athens. 575 pp.).

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***TRACHEMYS SCRIPTA* (Pond Slider)**. USA: NEVADA: Washoe Co.: Reno, Rancho San Rafael Regional Park, Peavine Pond (39.54606°N, 119.83107°W; NAD83). 3 June 2006. Photographed by Fredric F. Petersen. Verified by Jens Vindum. CAS-HPV 74 photo voucher. First record for Nevada. *Trachemys scripta* has been introduced widely in the western USA through the pet trade (Rhodin et al. 2010. Chelon. Res. Monogr. No. 5: 000.85-000.164). The species is known from many sites in the Central Valley of California (Thomson et al. 2010 Chelon. Conserv. Biol. 9:297–302, and references therein), with the closest previous record (Thomson et al., *op. cit.*) being approximately 166 km WSW of this first Nevada record.

Pond Sliders appear to be common in urban ponds and lakes in Reno and Sparks, Nevada (additional localities are documented by CAS-HPV 72, 73, and 75. An individual photographed on 19 June 2011 (CAS-HPV 72) with mud covering the hind limbs, tail, and rear edge of the carapace, suggesting it had been digging a nest provides circumstantial evidence of breeding in the area. Reports of this species (without vouchers) also exist for Clark County in southern Nevada (FFP, pers. obs.).

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***TRACHEMYS SCRIPTA ELEGANS* (Red-eared Slider)**. USA: INDIANA: Lawrence Co.: approx. 7 mi SW of Bedford on Hwy 50 (38.77892°N, 86.55451°W; NAD 83). 14 March 2012. Sarabeth Klueh and Jason Mirtl. Verified by Chris Phillips. Illinois Natural History Survey (INHS 2012r). This capture provides a new county record for Indiana (Minton 2001. Amphibians and Reptiles of Indiana, 2nd ed., revised. Indiana Academy of Science. vii–404 pp.).

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SQUAMATA — LIZARDS

***ACANTHODACTYLUS MICROPHOLIS* (Persian Fringe-toed Lizard)**. IRAN: BUSHEHR PROVINCE: 20 km SE of Khoormouj, near Naseri village (28.489644°N, 51.473191°E), 10 m elev. Kamran Kamali, Behzad Zadhoosh, and Shahrzad Malekzadeh. 22 February 2013. Iranian Herpetological Institute (IHI0014: one adult female; IHI0015: one adult male). Verified by Steven C. Anderson. This is the first record of this species from Bushehr Province. Individuals were found among low hills on sandy riverbeds with scattered bushes and in narrow canyons on stream beds covered with small bushes and grass. The specimens fit the diagnosis and color pattern in Anderson (1999. The Lizards of Iran. SSAR Contrib. Herpetol., Ithaca, New York. 442 pp.). The nearest reported locality is 480 km E of the record noted here (27.016667°N, 55.716667°E), 109 km W

of Bandar-e-Abbas to Kerman road along road to Bandare-e-Lengeh, 0–50 m elev (MMTT [Muze-ye Melli-ye Tarikh-e Tabii, Tehran] 813; Anderson 1999:205–206). This is the first record from Bushehr Province and for the southwestern part of Iran. **KAMRAN KAMALI**, Iranian Herpetological Institute, Apt. #2, No. 19, 7th alley, Nima youshij St., Shahran Blvd., Tehran, Iran, 14788-54818; e-mail: canis58@yahoo.com.

***ALEXANDRESAURUS CAMACAN* (Alexandre's Lizard, Calanguinho do Alexandre)**. BRAZIL: BAHIA: Municipality of Amargosa: Timbó Farm (13.11058°S, 39.6673°W; WGS 84), 800 m elev.; Municipality of Jaguaripe: 13.19238°S, 39.00191°W. 21 November 2011. M. Matos. Museu de Zoologia, Universidade Federal da Bahia (UFBA 3019, 3033, 3034; adults collected in pitfall in pristine tropical forests). Verified by M. Rodrigues. Previously known from five localities in Bahia (Freitas et al. 2007. Herpetol. Rev. 38:481; Rodrigues et al. 2007. Amer. Mus. Novit. 3565:1–27). The new records fill a distributional gap in the range of the species. The Amargosa record extends the distribution 190 km SW from Municipality of São Sebastião do Passé and 177 km NW from Uruçuca, and represents the interiormost record known.

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***ASPIDOSCELIS SEXLINEATA* (Six-lined Racerunner)**. USA: GEORGIA: Cherokee Co.: Ball Ground, 1.30 km SE of intersection of Lower Dowda Mill Rd. and Soap Creek Rd. (34.365784°N, 84.427675°W; WGS 84). 24 June 2012. Z. Felix. UF 169262. Digital photograph. Verified by Kenneth Krysko. One adult gravid female captured in funnel trap in middle of field. New county record (Jensen et al. [eds.] 2008. Amphibians and Reptiles of Geórgia. University of Georgia Press, Athens. 575 pp.).

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***CROTAPHYTUS BICINCTORES* (Great Basin Collared Lizard)**. USA: NEVADA: Washoe Co.: Hays Canyon Range (41.415183°N, 119.978771°W; WGS84; elev. 1392 m). 7 July 2012. Verified by Jimmy A. McGuire. MVZ 20444–20457 (photo vouchers). First record from this mountain range (McGuire 1996. Bull. Carnegie Mus. Nat. Hist. 32:1–143; St. John 2002. Reptiles of the Northwest. Lone Pine Publ., Renton, Washington. 272 pp.; Stebbins 2003. A Field Guide to Western Reptiles and Amphibians. 3rd ed. Houghton Mifflin Co., Boston, Massachusetts. 533 pp.). Specimen was an adult male. An adult female (MVZ 35933–35935 photo vouchers) was also recorded.

In Nevada this extends the distribution for this species in Washoe Co. ca. 89 km N from "Smoke Creek, 0.25 and 1 mi from Nevada state line" (MVZ 20444–20457) and 68 km W from Soldier Meadow, Humboldt Co. (MVZ 35933–35935). In Oregon the nearest reported locality is from the Pueblo Mountains, Harney Co. at "14 mi N Denio" (OSUMNH 8817–8823), ca. 140 km to the NE.

Both specimens were observed basking on boulders along Co. Rd 37 in Surprise Valley at base of W slope of the Hays Canyon Range, 1.75 km E of California border.

We thank Steve Arnold for providing catalogue data for vouchers of this species in the OSUMNH collection.

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***CTENOSAURA PECTINATA* (Western Spiny-tailed Iguana)**. MÉXICO: AGUASCALIENTES: Municipality of Calvillo: Jaltiche de Abajo (21.77976°N, 102.81016°W; WGS84), 1545 m elev. 4 August 2011. Efraín López-Martínez. Verified by Víctor Hugo Reynoso-Rosales. UAA-CV-0330. First record for Aguascalientes (McCranie and Wilson 2001. Cour. Forsch.-Inst. Senckenberg 230:1–57), extending known range ca. 60.9 km NE from the closest known locality in SW Zacatecas (Baker et al. 1967. Amer. Midl. Nat. 77:223–226). Several lizards were found at this site in tropical deciduous forest.

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***HEMIDACTYLUS MABOUIA* (Wood Slave)**. USA: FLORIDA: Brevard Co.: Eddy Creek (28.67568°N, 80.64768°W;WGS 84). 7 June 2012. Nathan Byer, Kaite Anderson, and Richard Seigel. Verified by Walter Meshaka, Jr. Fort Hays State University's Sternberg Museum of Natural History (FHSM 16500 photo voucher). First reported record from Canaveral National Seashore and a range extension of 24.22 km NE of neartest reported location: I-95 between SR 406 and 405 in Titusville (Criscione et al. 1998. Herpetol. Rev. 29[4]:248.

Found inside of storage shed at Eddy Creek Parking Area, Playalinda Beach, Canaveral National Seashore. In January 2013, two additional lizards were seen at this locality. One specimen was photographed, captured, preserved, and stored with the National Park Service.

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***HEMIDACTYLUS TURCICUS* (Mediterranean Gecko)**. USA: TEXAS: Chambers Co.: Anahuac National Wildlife Refuge (29.61377°N, 94.53398°W, WGS 84; elev. 2 m), on an exterior bathroom wall near the entrance to the refuge. 27 July 2012. William L. and Limei T. Farr. Verified by Carl J. Franklin. UTADC 7639. First county record (Dixon 2013. Amphibians and Reptiles of Texas. Texas A&M University Press, College Station. 447 pp.). This record fills a gap in county records from east Texas for this invasive species. *Hemidactylus turcicus* was also observed in abundance (ca. 10–20 individuals on each date) and photographed in situ at this same locality, and on other small adjacent buildings including the visitor's center and a kiosk on the evenings of 13 July 2012, 24 Aug 2012, and 28 Sept 2012. This appears to be a well-established population.

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LEPOSOMA PUK. BRAZIL: BAHIA: Municipality of Amargosa: Timbó Farm (13.11058°S, 39.6673°W; datum WGS 84), 800 m elev.

21 November 2011. M. Matos. Verified by M. Rodrigues. Museu de Zoologia, Universidade Federal da Bahia, Salvador, Bahia, Brazil (UFBA 3018 adult, collected in a pitfall in a pristine tropical forest). Previously known from three localities in southern Bahia State, Brazil: municipalities of Jussari, São Jose da Vitória, and Una (Rodrigues et al. 2002. Pap. Avulsos Zool. 42[14]:335–350). The new record extends the known distribution about 180 km N of the nearest previous record (Municipality of São José da Vitória; Rodrigues et al., *op. cit.*).

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***MESALINA BREVIROSTRIS* (Blanford's Short-nosed Desert Lizard)**. IRAN: HORMOZGAN PROVINCE: 5 km NW of Parsian, near Milaki village (27.234114°N, 52.990888°E), 18 m elev. Kamran Kamali, Behzad Zadhoosh, and Shahrzad Malekzadeh. 25 February 2013. Iranian Herpetological Institute (IHI0022: adult female). Verified by Omid Mozaffari. This species has been recorded from Khoozestan, Bushehr Provinces and Tonb-e-Bozorg and Qeshm Islands in Persian Gulf (Rastegar-Pouyani et al. 2008. Field Guide to Reptiles of Iran, Volume 1: Lizards. Razi University Press). This is the first record of this species from mainland Hormozgan Province. Individual was found on a plain with alkaline soil covered with scattered small bushes and shrubs. The specimen fits the diagnosis and the color pattern in Anderson (1999. The Lizards of Iran. SSAR Contrib. Herpetol., Ithaca, New York. 442 pp.). The nearest reported localities are Tonb-e-bozorg Island (WB [William T. Blanford] 74, 76) and Qesm Island (CAS 96153) (Anderson 1999:249–251), 250 and 300 km SE of the reported locality, respectively. Another nearby locality is Ahram in Bushehr Province (FMNH 141492; Anderson 1999:249–251), 250 km NW of the locality reported here.

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***STENODACTYLUS AFFINIS* (Iranian Short-fingered Gecko)**. IRAN: HORMOZGAN PROVINCE: 5 km NW of Parsian, near Milaki village (27.234114°N, 52.990888°E), 18 m elev. Kamran Kamali, Behzad Zadhoosh, and Shahrzad Malekzadeh. 25 February 2013. Iranian Herpetological Institute (IHI0023: adult male). Verified by Omid Mozaffari. This is the first record of this species from Hormozgan Province. It was found on a plain with alkaline soil covered with scattered small bushes and shrubs. The specimen fits the diagnosis and the color pattern in Anderson (1999. The Lizards of Iran. SSAR Contrib. Herpetol., Ithaca, New York. 442 pp.). The nearest reported locality is 2–3 km SSE Bushehr (KS [Karl P. Schmidt] 55) 300 km from the reported locality Anderson (1999:182–183).

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***TROPIOCOLOTES LATIFI* (Latifi's Dwarf Gecko)**. IRAN: QOM PROVINCE: 2 km S of city of Qom (34.571972°N, 50.870742°E), 1069 m elev. 17 November 2012. Seyyed Mehdi Mirghazanfari. Iranian Herpetological Studies Institute (IHSI0011: adult male; IHSI0012: juvenile). Verified by Kamran Kamali. First record for Qom Province. A suitable habitat for this species was found and one adult male and one juvenile were collected at 1600 h on a plain covered with gravel and small to medium-sized rocks near a mountain with scattered bushes. The specimens were inactive beneath a rock. The nearest reported locality is center of Isfahan Province, 27 km S of Kashan (Zoological Museum of Razi University; GT.20.2, GT.20.3), 130 km from the locality reported here (Rastegar-Pouyani et al. 2009. Zoology in the Middle East 47:105–1070.

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TUPINAMBIS QUADRILINEATUS. BRAZIL: MARANHÃO: Municipality of Riachão: BR 230 (07.2526°S, 46.4012°W; SAD 69), 335 m elev. 18 February 2003. M. Freitas. Coleção Herpetológica da Universidade Federal Rural de Pernambuco, Recife, Brazil (CHP – UFRPE 2620, killed on the road, in cerrado). Verified by M. Rodrigues. Previously known only from cerrado biome of Tocantins, Minas Gerais, Goiás, Mato Grosso, Pará, and western Bahia states (Silveira 2009. Check List 5[3]:442–445; Ferreira et al. 2009. Bol. Mus. Emílio Goeldi Cienc. Nat., Belém 4[3]:355–361; Freitas et al. 2011. Herpetol. Rev. 42[3]:392). First state record, extends distribution ca. 350 km N from Mateiros municipality, Tocantins state (Silveira 2009, *op. cit.*).

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SQUAMATA — SNAKES

***AGKISTRODON PISCIVORUS LEUCOSTOMA* (Western Cottonmouth)**. USA: TENNESSEE: Wayne Co.: Green River (35.42736°N, 87.76688°W; NAD 83). 30 May 2012. Derec Dodge. Verified by A. F. Scott. Austin Peay State University (APSU 19367 photographic voucher). Adult found sunning on woody debris along bank of river, substantiates previous questionable county records (Scott and Redmond 2008 (latest update: *14 November 2012*). Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/ (latest update 14 November 2012, accessed 18 January 2013).

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***CARPHOPHIS AMOENUS HELENAE* (Midwestern Wormsnake)**. USA: INDIANA: Sullivan Co.: Greene-Sullivan State Forest (38.99930°N, 87.25631°W; NAD 83). 4 April 2012. Sarabeth Klueh and Jason Mirtl. Verified by Chris Phillips. Illinois Natural History Survey (INHS 2012s). New county record (Minton 2001. Amphibians and Reptiles of Indiana, 2nd ed., revised. Indiana Academy of Science. vii–404 pp.).

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***COLUBER FLAGELLUM TESTACEUS* (Western Coachwhip)**. USA: TEXAS: Lavaca Co.: 29.491879°N, 96.74353°W (WGS84). 5

May 2011. Eric C. Munscher. UTADC 7640, 7643 photo vouchers). Verified by Carl J. Franklin. New county record (Dixon 2013. Amphibians and Reptiles of Texas. Texas A&M University Press, College Station. 447 pp.).

One adult snake was hand captured at 1030 h as it tried to climb a live oak tree (*Quercus virginia*). This species is documented in the surrounding counties, of Fayette, Gonzales, Dewitt, Victoria, Jackson, Wharton, and Colorado (Dixon, *op. cit.*).

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***GONYOSOMA OXYCEPHALUM* (Red-tailed Green Ratsnake).** PHILIPPINES: ROMBLON PROVINCE: Sibuyan Island, Municipality of San Fernando, Barangay Taclobo, Sitio Cabitangahan (12.610278°N, 122.925000°E; WGS84; 50 m elev.). Ernest Kurt Tan. 5 January 2013. Photographic voucher, Raffles Museum of Biodiversity Research, National University of Singapore (ZRC [IMG] 2.180a–b). Verified by Rafe M. Brown. Dead on bank of Cabitangahan River. Total length 170 cm. First record from Sibuyan Island. Widespread species in mainland and Southeast Asia (Das 2002. A Photographic Guide to Snakes and other Reptiles in India. New Holland Publishers [UK], Ltd., London. 144 pp.), and within the Philippines, from the islands of Luzon, Lubang, Balabac, Palawan, Negros, Panay, Bohol, and Sulu Archipelago (Ferner et al. 2000. Asiatic Herpetol. Res. 9:1–37; Leviton 1963. Proc. California Acad. Sci. 31[15]:369–416; Taylor 1922. The Snakes of the Philippine islands. Bureau of Science, Manila. 312 pp. + 37 pls.).

EMERSON Y. SY, Philippine Center for Terrestrial and Aquatic Research, 1198 Benavidez St., Unit 1202, Tondo, Manila, Philippines (e-mail: emersonsy@gmail.com); **ERNEST KURT TAN,** Philippine Native Plants Conservation Society Incorporated, 11 Ipo Street, Salvacion, Quezon City, Philippines (e-mail: tablasisland@gmail.com).

***HETERODON PLATIRHINOS* (Eastern Hognose Snake).** USA: GEORGIA: Cherokee Co.: Ball Ground, north of Creighton Rd., 0.45 km E of intersection with SR 372 (34.294587°N, 84.307530°W; WGS 84). 10 October 2012. Z. Felix. UF 169263. Digital photograph. Verified by Kenneth Krysko. New county record (Jensen et al. [eds.] 2008. Amphibians and Reptiles of Geórgia. University of Georgia Press, Athens. 575 pp.). One juvenile captured in wooded lawn.

ZACH I. FELIX, Biology Department, Reinhardt University, Waleska, Geórgia 30183, USA; e-mail: zif@reinhardt.edu.

***LAMPROPELTIS CALLIGASTER* (Yellow-bellied Kingsnake).** USA: TEXAS: Caldwell Co.: TX Hwy 80, 0.97 rd. km N jct. TX Hwy 130 (29.79221°N, 97.79167°W; WGS 84). 19 June 2012. Drew R. Davis. Verified by Travis J. LaDuc. Texas Natural History Collections, TNHC 85239. New county record (Dixon 2000. Amphibians and Reptiles of Texas. Texas A&M University Press, College Station. 421 pp.). A second individual (TNHC 85240) was also found the same night. Specimens were collected under a Texas Parks and Wildlife Scientific Collecting Permit (SPR-0511-126) to Drew R. Davis.

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***LAMPROPELTIS ZONATA* (California Mountain Kingsnake)** USA: CALIFORNIA: San Benito Co.: San Juan Bautista, 2.11 km ENE Fremont Peak on San Juan Canyon Road at intersection with undesignated road (36.7655°N, 121.4827°W; WGS 84), elev. 825 m. 6 June 2009 at 1450 h. Snake found DOR. Nick Dana Waters. Verified by Carol Spencer. MVZ 269317. This is the first report within San Benito Co. and the Gabilan Range. Nearest localities are within the Santa Lucia Range 46 km SW near Carmel-By-The-Sea, Monterey Co. (MVZ 97822), and within the Santa Cruz Mountains 45 km NW at Uvas Canyon, Santa Clara Co. (CAS 190482). This specimen most closely resembles the Santa Clara color morph (Mitch Mulks, pers. comm.). Dominant structural flora include *Quercus chrysolepis, Q. agrifolia, Pinus sabiniana,* and *Arctostaphylos* sp. in adjacent chaparral.

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***LICHANURA TRIVIRGATA TRIVIRGATA* (Mexican Rosy Boa).** USA: ARIZONA: Pima Co.: West Silver Bell Mountains (32.438219°N, 111.573397°W; WGS 84), elev. 686 m. 01 May 2010. Paul Lynum and Jason Pike. University of Arizona (UAZ PSV 57458). Verified by A. T. Holycross. The nearest vouchered localities are from ca. 75 km to the WNW in the Sand Tank Mountains and ca. 90 km to the NW in the North Maricopa Mountains (Holycross and Brennan 2006. A Field Guide to Amphibians and Reptiles in Arizona. Arizona Game and Fish Department, Phoenix. 150 pp.). Subadult female collected at 1610 h in a dry wash surrounded by Sonoran Desertscrub (Arizona Upland Subdivision).

Two additional specimens (UAZ PSV 57459 and 57460) were photographed in the same location on 21 March 2012.

PAUL LYNUM, 2820 North Mohawk Trail, Chino Valley, Arizona 86323, USA (e-mail: paullynum@earthlink.net); **JASON PIKE**, 641 Juanita Street, La Habra, California 90631, USA.

***OPHEODRYS AESTIVUS* (Rough Green Snake).** USA: TENNESSEE: Weakley Co.: Found dead on shoulder of TN Hwy. 43 approximately 30 m S of intersection with University Street in Martin, Tennessee (36.3472°N, 88.8731°W; WGS 84). 05 May 2012. Tom Blanchard. Verified by A. Floyd Scott. Austin Peay State University (APSUMZ 19252). New county record (Scott and Redmond 2008. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/, latest update 04 December 2012, accessed 18 January 2013).

TOM BLANCHARD, Department of Biological Sciences, University of Tennessee at Martin, Martin, Tennessee 38238, USA; e-mail: tblanch@utm.edu.

***RHADINAEA FLAVILATA* (Pine Woods Littersnake).** USA: FLORIDA: Hardee Co.: 2.6 km N Gardner, Charles Creek at U.S. Hwy 17 (27.37616°N, 81.79642°W; NAD 83). 20 October 1985. R. A. Moulis, R. S. Redmond, and M. P. Wallace. Verified by Lance D. McBrayer. GSU 3195. New county record (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Florida Fish and Wildlife Conservation Commission, Tallahassee. 524 pp.)

DIRK J. STEVENSON, The Orianne Society, Indigo Snake Initiative, 414 Club Drive, Hinesville, Georgia 31313, USA (e-mail: dstevenson@orianne society.org); **KEVIN M. ENGE**, Florida Fish and Wildlife Conservation Commission, 1105 S.W. Williston Road, Gainesville, Florida 32601, USA (e-mail: kevin.enge@myfwc.com).

***STORERIA DEKAYII* (Dekay's Brownsnake)** USA: MICHIGAN: Charlevoix Co.: Southwest end of Hog Island (Grape Spit), Eastern Lake Michigan (Beaver) Archipelago (45.777581°N, 85.407715°W;

WGS 84). 12 July 2011. Nancy E. Seefelt. Verified by Fred Janzen. Iowa State University Research Collection (ISUA202203; digital images). New record for Hog Island and the Beaver Archipelago (Bowen and Gillingham 2004. Michigan Acad. 35:213–223). Snake was found under a deflated rubber trampoline with other snakes, including Northern Water Snakes (*Nerodia sipedon*) and Eastern Garter Snakes (*Thamnophis sirtalis*). The voucher, a gravid female, was photographed and released at the site.

NANCY E. SEEFELT (e-mail seefe1ne@cmich.edu), **JAMES C. GILLINGHAM**, **PATRICK D. FARRELL**, **LORRIN A. ORTMANN,** and **DESIREE R. RASMER**, Department of Biology, Central Michigan University, Mt. Pleasant, Michigan 48859, USA; **KENNETH D. BOWEN**, National Park Service, Great Lakes Inventory and Monitoring Network, 2800 Lakeshore Drive East, Suite D, Ashland, Wisconsin 54806, USA.

***THAMNOPHIS BUTLERI* (Butler's Gartersnake)**. USA: WISCONSIN: Jefferson Co.: Town of Whitewater (42.84699°N, 088.74271°W; WGS 84). 13 June 2012. Joshua M. Kapfer and Kerry Katovich. Verified by Erik Wild (University of Wisconsin-Stevens Point). University of Wisconsin-Stevens Point Collections (UWSP 0162–0165 photo vouchers; tissue sample catalogued UWSP 4534). New county record (Casper 1996. Geographic Distributions of the Amphibians and Reptiles of Wisconsin. Milwaukee Public Museum, 87 pp.). Extends the currently known range of this species in Wisconsin.

The identification of these specimens as *T. butleri* was supported by genetic analyses with techniques previously developed by Sloss (2011. Genetic identity of Wisconsin gartersnakes [*Thamnophis* spp.] using microsatellite genetic markers. Wisconsin Department of Natural Resources Research Report 192: PUB-SS-592-2011; http://dnr.wi.gov/topic/EndangeredResources/documents/SlossReport.pdf; accessed 15 February 2013). The accessioned tissue sample represents an individual whose genetic profile was consistent with a pure Butler's Gartersnake (BGS) (mean STRUCTURE q-value of 0.8018% with a threshold of 80% for identifying pure BGS per Sloss 2011; BLS, unpubl. data).

Several adult individuals were captured under artificial cover objects (photographed with tissue samples collected) on 13 June 2012. Juveniles were also captured in the same manner during September 2012 surveys, indicating a reproductive population. Associated habitat consisted of an open grassland/prairie. Adjacent habitats were primarily a mix of immature deciduous woodland and a shallow wetland dominated by Reed Canary Grass (*Phalaris arundinacea*) and Cattail (*Typha* sp.). This observation supplements specimens collected by R. Van Koningsveld in 1971 from nearby locations in the town of Whitewater (Walworth Co.; HerpNet catalogue numbers MPM 18291, 18292, 18294, and 18302; http://www.herpnet.org; accessed 6 February 2013). Although Casper (*op. cit.*) mentioned that Walworth Co. populations may be comprised of *T. butleri* x *T. radix* hybrids and questioned the likelihood that they contained true BGS, our analyses suggest that the genetic composition of these populations should be re-assessed. Given the short distance between the site where our specimens originated and Van Koningsveld's nearby Walworth Co. site (~ 1 km), future genetic research may lead to the inclusion of Walworth Co. in the known distribution for this species in Wisconsin. *Thamnophis butleri* is currently listed as "Threatened" by the state of Wisconsin and information that better refines its distribution in the state is particularly valuable for managing this species.

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***THAMNOPHIS SIRTALIS SIRTALIS* (Eastern Gartersnake)**. USA: TENNESSEE: Weakley Co.: approx. 450 m E of TN Hwy 43 along the Brian Brown Memorial Greenway in Martin, Tennessee (36.3492°N, 88.8672°W; WGS 84). 21 April 2012. Tom Blanchard. Verified by A. Floyd Scott. Austin Peay State University (APSU 19253). New county record (Scott and Redmond 2008. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/, latest update 04 December 2012, accessed 18 January 2013).

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***TROPIDOCLONION LINEATUM* (Lined Snake)**. USA: NEW MEXICO: Eddy Co.: 14.5 km SW of Queen, 3.4 km E of Martine Ridge, 9.3 km N of Texas State Line, and 0.1 km SSW of El Paso Gap on New Mexico State Highway 137 in southwestern Eddy Co. (32.0843°N, 104.8359°W; WGS84), elev. 1677 m. 20 September 2012. Christopher Newsom. Verified by J. Tomasz Giermakowski. University of New Mexico Museum of Southwestern Biology (MSB 94444). New county record (Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. Univ. New Mexico Press, Albuquerque, New Mexico xix + 431 pp.).

Extends the known range by approximately 87 km SSE from the nearest known specimen from Chaves Co., New Mexico (AUM 22798) and approximately 109 km SE of a recently verified locality near Mayhill, Otero Co., New Mexico (MSB 72651, Murray et al. 2010. Herpetol. Rev. 41:519–520.). The specimen was observed at night.

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Further Range Extensions for Reptiles and Amphibians from Papua New Guinea

The Papuan region—consisting of New Guinea, Bismarck Archipelago, the Solomon Islands, and associated islands—has one of the most speciose herpetofaunas on Earth, but much work remains to better understand the composition and distributions of its members. The region's complex geological history, involving multiple waves of accretionary as well as vicariant events (Davies 2012; Pigram and Davies 1987), has resulted in many species being confined to local landforms such as offshore islands or peripheral mountain ranges. This has led to high levels of narrow endemism in the area. Furthermore, the region's steep terrain and difficulty of access have significantly retarded the pace of survey work. These factors have hindered detailed understanding of the geographic distributions of the local megadiverse herpetofauna. As one indication of the poverty of our knowledge, a large percentage of these species remain known only from their type localities. This is especially true among the frogs, for which this applies to approximately 25% of the species (cf., IUCN 2012). However, given the high proportion of narrow-range endemics that inhabit the Papuan region, it is uncertain which of these species are truly narrowly endemic vs. merely poorly surveyed. Intensive survey work conducted in the past 15 years or so has resulted in improved understanding of the geographic distributions of scores of Papuan species (Günther 2003; Kraus 2010; Kraus and Allison 2004, 2006; Kraus and Shea 2005). Herein I report additional significant range records for species collected by me in the past few years. In some of these cases it is obvious that the species in question ranges quite widely, and in several instances I present records indicating a species to range beyond the limits of the distinctive geological landforms (usually isolated mountain ranges) from which it was first described. However, in a few other instances I present evidence of a general distribution across the original massif from which the species was first described, but evidence for wider distribution outside that massif remains lacking.

Politically, the records presented below include one new country record and 18 new provincial records. Biogeographically, they include five new island records and 16 records that are first reports for particular isolated mountain ranges. Four new records for higher-elevation species are important in that they show each species' range to span the low-elevation habitat of the Musa Valley in the southern Owen Stanley Range, an expanse of terrain that is presumably unsuitable for these species at present. Finally, four additional records are to new areas within the high-elevation habitats of the Suckling–Dayman Massif (south of the Musa Valley) for species that are likely to prove endemic to that massif and the adjacent high-elevation Mt. Simpson.

All specimen records are for Bernice P. Bishop Museum (BPBM) and use the WGS 84 datum. One photo voucher is at University of Michigan Museum of Zoology (UMMZ).

ANURA — FROGS

AUSTROCHAPERINA BASIPALMATA. PAPUA NEW GUINEA: East Sepik Prov.: Prince Alexander Mts., Mindangua Stream, 3.6056°S, 143.4921°E, 410 m asl. 17–21 September 2009. F. Kraus and native villagers. BPBM 35476–85; 16.25 km W of Wewak, 3.5788°S, 143.5003°E, 227 m. asl. F. Kraus and local villagers. BPBM 35486–87. New provincial record and range extension of approximately 150 km to E from nearest locality in Torricelli Mts. (Zweifel 2000).

BARYGENYS ATRA. PAPUA NEW GUINEA: Northern Prov.: S slope Mt. Victory, along Ajoa River, 9.2388°S, 149.1356°E, 400 m asl. 29 September–4 October 2010. F. Kraus, J. Anamiato, and local villagers. BPBM 37100–12, 37118–21; SW slope Mt. Trafalgar, 9.2238°S, 149.1561°E, 187 m asl. 2–6 November 2011. F. Kraus, J. Anamiato, and local villagers. BPBM 39973–78. First record for Cape Nelson Range and range extension of 100 km to SE of Popondetta (Zweifel 1981).

BARYGENYS MACULATA. PAPUA NEW GUINEA: Milne Bay Prov.: W slope Mt. Dayman, vicinity Binigun, 9.7071°S, 149.2498°E, 900 m asl. 17–19 March 2012. F. Kraus, E. Gagomin, B. Iova, and local villagers. BPBM 38914–15. Second known locality and range extension approximately 25 km to NNW of type locality on the other side of Mt. Dayman (Menzies and Tyler 1977).

CALLULOPS DORIAE. PAPUA NEW GUINEA: Milne Bay Prov.: Normanby Island, E end Sewa Bay, 10.0072°S, 150.9872°E, 52 m asl. 13 April 2011. F. Francisco. BPBM 38830–32. First record for any of the D'Entrecasteaux Islands (Zweifel 1972).

COPHIXALUS BALBUS. PAPUA NEW GUINEA: East Sepik Prov.: Prince Alexander Mts., Mindangua Stream, 3.6056°S, 143.4921°E, 410 m asl. 16–19 September 2009. F. Kraus and local villagers. BPBM 35458–59, 35461–62, 35469. New record for mountain range and range extensions of approximately 125 km to NE and 150 km to E from nearest localities in Hunstein Mts. and Torricelli Mts., respectively (Kraus and Allison 2006).

COPHIXALUS CRYPTOTYMPANUM. PAPUA NEW GUINEA: Milne Bay Prov.: N slope Mt. Simpson, Etakaba Creek, 10.0290°S, 149.5947°E, 1540 m asl. 1 March 2003. B. Uruwa. BPBM 17959–74. Range extension of 40 km to SE from type locality (Zweifel 1956) and only second certain locality for this species. Based on call information, other populations to the north (Menzies 2006; Zweifel 1962) are mis-assigned to this species.

COPHIXALUS DESTICANS. PAPUA NEW GUINEA: Northern Prov.: S slope Mt. Victory, along Ajoa River, 9.2248°S, 149.1062°E, 530 m asl. 20–22 September 2010. F. Kraus, J. Anamiato, and local villagers. BPBM 37153–70; S slope Mt. Victory, 9.2388°S, 149.1356°E, 400 m asl. 27–29 September 2010. F. Kraus, J. Anamiato, and local villagers. BPBM 37171–72; SW slope Mt. Trafalgar, 9.2238°S, 149.1561°E, 187 m asl. 2–9 November 2011. F. Kraus, J. Anamiato, and local villagers. BPBM 40020–21, 40024, 40028,

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40030–36; SW slope Mt. Trafalgar, 9.2002°S, 149.1596°E, 700 m asl. 5 November 2010. F. Kraus, J. Anamiato, and local villagers. BPBM 40026–27. New provincial records and range extension of 160 km to NW of nearest reported localities in southern Milne Bay Province (Kraus and Allison 2009a).

COPHIXALUS PIPILANS. PAPUA NEW GUINEA: East Sepik Prov.: Prince Alexander Mts., Mindangua Stream, 3.6056°S, 143.4921°E, 410 m asl. 17–21 September 2009. F. Kraus and local villagers. BPBM 35842–43, 35845–56. New provincial record and range extension of 250 km to W of nearest reported locality in the Adelbert Mts. (Zweifel 1980).

COPIULA FISTULANS. PAPUA NEW GUINEA: Madang Prov.: Adelbert Mts., Keki Lodge, 4.7048°S, 145.4042°E, 854 m asl. 30 September–6 October 2009. F. Kraus and I. Haguna. BPBM 35961–67, 35973–78, 35985; Northern Province: S slope Mt. Victory, 9.2388°S, 149.1356°E, 400 m asl. 4–5 October 2010. F. Kraus, J. Anamiato, and local villagers. BPBM 37223–31. The first locality is a new provincial record and range extension of approximately 270 km to NW of nearest locality south of the Saruwaged Range; the second is the first report for Cape Nelson and a range extension of 100 km SE of nearest locality at Popondetta (Menzies and Tyler 1977).

HYLARANA MILNEANA. PAPUA NEW GUINEA: Milne Bay Prov.: NW slope Mt. Dayman, Yamsiai, 9.6724°S, 149.2734°E, 120 m asl. 7 April 2011. F. Kraus, E. Gagomin, B. Iova, and local villagers. BPBM 39304–05; Northern Prov.: S slope Mt. Victory, along Ajoa River, 9.2248°S, 149.1062°E, 530 m asl. 21–24 September 2010. F. Kraus, J. Anamiato, and local villagers. BPBM 37007–09; S slope Mt. Victory, 9.2388°S, 149.1356°E, 400 m asl. 27 September 2010. F. Kraus, J. Anamiato, and local villagers. BPBM 37010–24. Range extensions of approximately 100 and 160 km to NW of nearest localities near Alotau and 140 km from nearest locality on western side of intervening Owen Stanley Range; the localities on Cape Nelson are new provincial records (Kraus and Allison 2007).

HYLARANA VOLKERJANE. PAPUA NEW GUINEA: East Sepik Prov.: Prince Alexander Mts., Mindangua Stream, 3.6056°S, 143.4921°E, 410 m asl. 15–21 September 2009. F. Kraus and local villagers. BPBM 34755, 35536–37, 35542–43; Madang Prov. Adelbert Mts., Keki Lodge, 4.7048°S, 145.4042°E, 854 m asl. 6 October 2009. F. Kraus and I. Haguna. BPBM 35549. New provincial records and range extensions of 150 km and 320 km to E from nearest locality in Torricelli Mts. (Kraus and Allison 2006).

HYLARANA WALIESA. PAPUA NEW GUINEA: Northern Prov.: S slope Mt. Victory, 9.2388°S, 149.1356°E, 400 m asl. 28–29 September 2010. F. Kraus, J. Anamiato, and local villagers. BPBM 37038–41; SW slope Mt. Trafalgar, 9.2238°S, 149.1561°E, 187 m asl. 31 October – 5 November 2011. F. Kraus, J. Anamiato, and local villagers. BPBM 39920–27. First records for province and range extension of 160 km to NW of nearest known localities in mainland Milne Bay Province and 100 km from populations on Goodenough Island (Kraus and Allison 2007).

LIOPHRYNE DENTATA. PAPUA NEW GUINEA: Milne Bay Prov.: Normanby Island, N slope Mt. Hobia, 10.0777°S, 150.9896°E, 555 m asl. F. Kraus. 27 March–2 April 2012. BPBM 41916–23. First record for any offshore island in Milne Bay Province, and third reported locality (Zweifel 2000).

LIOPHRYNE MAGNITYMPANUM. PAPUA NEW GUINEA: Milne Bay Prov.: E slope Mt. Suckling, 9.7580°S, 149.1822°E, 1860 m asl. 23–28 March 2011. F. Kraus, E. Gagomin, B. Iova, and local villagers. BPBM 39307–24. First provincial record and range extension of 130 km to east of type locality (Kraus and Allison 2009b).

LITORIA ARFAKIANA. PAPUA NEW GUINEA: Northern Prov.: S slope Mt. Trafalgar, 9.1951°S, 149.1616°E, 833 m asl. 7 November 2011. F. Kraus. BPBM 40124–26. First provincial record and first record for Cape Nelson Range (Menzies 2006).

LITORIA GASCONI. PAPUA NEW GUINEA: East Sepik Prov.: Prince Alexander Mts., Mindangua Stream, 3.6056°S, 143.4921°E, 410 m asl. 18–21 September 2009. F. Kraus and local villagers. BPBM 35422–31. First record for country, and range extension of approximately 570 km to the east of previous records in the Foja Mts. (Richards et al. 2009).

LITORIA HUNTORUM. PAPUA NEW GUINEA: West Sepik Prov.: Torricelli Mts.: Parkop, 6.5 km S Mt. Sapau summit, 3.4246ºS, 142.5187ºE, 416 m asl. 14 May 2005. Local villager. BPBM 23243. New mountain range and range extension of approximately 100 km to E of type locality (Richards et al. 2006).

LITORIA MICROMEMBRANA. PAPUA NEW GUINEA: Milne Bay Prov.: E slope Mt. Suckling, 9.7580°S, 149.1822°E, 1860 m asl. 23 March 2011. F. Kraus, E. Gagomin, B. Iova, and local villagers. BPBM 39425–26; Biniguni Bunua, 9.7650°S, 149.2176°E, 1730 m asl. 21 March 2011. F. Kraus, E. Gagomin, B. Iova, and local villagers. BPBM 39418–24. New provincial record and extends range 130 km to E of nearest known locality (Kraus and Allison 2006).

LITORIA OLLAURO. PAPUA NEW GUINEA: Milne Bay Prov.: Milne Bay Prov.: W slope Mt. Dayman, 9.7071°S, 149.2498°E, 900 m asl. 17 March 2011. F. Kraus and B. Iova. BPBM 39620–26. Second known locality and range extension approximately 25 km to NNW of type locality on the other side of Mt. Dayman (Menzies 1993).

NYCTIMYSTES PERSIMILIS. PAPUA NEW GUINEA: Milne Bay Prov.: E slope Mt. Suckling, Biniguni Bunua, 9.7650°S, 149.2176°E, 1730 m asl. 21 March 2011. F. Kraus, E. Gagomin, B. Iova, and local villagers. BPBM 39429–53; Sota, 9.7580°S, 149.1822°E, 1860 m asl. 23 March 2011. F. Kraus. BPBM 39454. Range extensions of approximately 15 km and 55 km to W of type locality on Mt. Dayman (Zweifel 1958) and prior record on Mt. Simpson (Kraus and Allison 2004), respectively.

OREOPHRYNE GEISLERORUM. PAPUA NEW GUINEA: Northern Prov.: S slope Mt. Victory, along Ajoa River, 9.2248°S, 149.1062°E, 530 m asl. 20–24 September 2010. F. Kraus, J. Anamiato, and local villagers. BPBM 37291–303; S slope Mt. Victory, 9.2388°S, 149.1356° E, 400 m asl. 30 September 2010. F. Kraus, J. Anamiato, and local villagers. BPBM 37304–08; SW slope Mt. Trafalgar, 9.2238°S, 149.1561°E, 187 m asl. 1 November 2011. F. Kraus, J. Anamiato, and local villagers. BPBM 40148. First records from Cape Nelson Range and range extension of 100 km to SE of Popondetta (Zweifel et al. 2003).

SQUAMATA — LIZARDS

CYRTODACTYLUS LORIAE. PAPUA NEW GUINEA: Northern Prov.: S slope Mt. Trafalgar, 9.1951°S, 149.1616°E, 833 m asl. 11–13

November 2011. F. Kraus and local villagers. BPBM 39792–95. First provincial record (Bauer and Henle 1994) and range extension of 130 km E of Mt. Obree, Central Province (FK, unpubl. data).

HYPSILURUS DILOPHUS. PAPUA NEW GUINEA: Milne Bay Prov.: Normanby Island, E end Sewa Bay, 10.0072°S, 150.9872°E, 52 m asl. 3 March 2011. F. Francisco. BPBM 39725. New island record (de Rooij 1915; Manthey and Denzer 2006).

HYPSILURUS MAGNUS. PAPUA NEW GUINEA: East Sepik Prov.: Prince Alexander Mts., Huriak, 3.5846°S, 143.5007°E, 68 m asl. 23 September 2009. Local villager. BPBM 34769. New provincial record and fills gap of approximately 530 km between nearest northern-versant localities in Madang and West Sepik provinces (Kraus 2010).

PRASINOHAEMA PREHENSICAUDA. PAPUA NEW GUINEA: Milne Bay Prov.: E slope Mt. Suckling, Sota, 9.7580°S, 149.1822°E, 1860 m asl. 29 March 2011. Local villager. BPBM 39096. New provincial record and range extension of approximately 380 km SE of Mt. Kaindi (Gressitt and Nadkarni 1978) for this poorly known arboreal lizard, indicating that it likely inhabits the entire length of the Owen Stanley Range at appropriate elevations.

VARANUS JOBIENSIS. PAPUA NEW GUINEA: Northern Prov.: S slope Mt. Victory, 9.2424°S, 149.1350°E, 320 m asl. 30 September 2010. Local villager. BPBM 37714. New provincial record and range extension of approximately 160 km E of Port Moresby (Böhme et al. 1994).

SQUAMATA — SNAKES

ASPIDOMORPHUS SCHLEGELI. PAPUA NEW GUINEA: East Sepik Prov.: Prince Alexander Mts., 17.2 km W and 1 km S Wewak, 3.5922°S, 143.4937°E, 270 m asl. 18 September 2009. Local villager. BPBM 35954. New provincial record and range extension 140 km E of nearest record at Aitape (McDowell 1967).

CANDOIA CARINATA. PAPUA NEW GUINEA: Northern Prov.: S slope Mt. Trafalgar, 9.2340°S, 149.1541°E, 223 m asl. 2 November 2011. Local villager. BPBM 39803. New provincial record, first record for Papuan Peninsula, and range extension of 360 km SE of nearest locality at Lae (Smith et al. 2001).

LEIOPYTHON ALBERTISII. PAPUA NEW GUINEA: Milne Bay Prov.: S end Sewa Bay, 10.03858°S, 150.97345°E, 54 m asl. 4 March 2011. Local villager. BPBM 39682; Northern Prov.: SW slope Mt. Trafalgar, 9.2238°S, 149.1561°E, 187 m asl. 9 November 2011. Local villager. BPBM 39805. Former is first verified record for D'Entrecasteaux Islands; latter is first record for Cape Nelson Range (Schleip 2008).

MORELIA BOELENI. PAPUA NEW GUINEA: Milne Bay Prov.: Gayari, W slope Mt. Dayman, ca. 1700 m asl. 3 April 2011. Local villager. Photographic voucher UMMZ Division of Reptiles and Amphibians digital image #972. First verified record for province and range extension of approximately 110 km to E of Mt. Brown (McDowell 1975), across the intervening low-elevation (maximum ca. 1000 m asl) Musa Valley. The source for a reported record from nearby Goodenough Island (O'Shea 1996) is uncertain (M. O'Shea, pers. comm.) and requires confirmation.

RAMPHOTYPHLOPS BRAMINUS. PAPUA NEW GUINEA: Milne Bay Prov.: Woodlark Island, Upper Muniai Creek, 9.1216°S, 152.7486°E, 67 m asl. 17 October 2011. Local villager. BPBM 39807. New island record and second record for province (Kraus and Allison 2004).

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Noteworthy Distributional Records of Amphibians and Reptiles from Costa Rica

Costa Rica is known to support a diverse herpetofauna (Savage 2002). According to the most recent checklist (Bolaños et al. 2011), 196 species of amphibians and 239 species of reptiles are known to occur in that country. During several visits to Costa Rica during 2010 and 2011, GK and JV have collected several specimens that constitute extensions of their known distributions in either geographic or elevational range. Herein we report upon these noteworthy specimens. Locality and elevation data were recorded using a Garmin 60 CSx GPS receiver with integrated barometric altimeter; map datum WGS84. Abbreviations for museum collections follow those of Sabaj Pérez (2010). Species determination was done using the keys in Köhler (2008, 2011) and Savage (2002), and all vouchers were verified by Sebastian Lotzkat and Andreas Hertz.

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ANURA — FROGS

ECNOMIOHYLA SUKIA. ALAJUELA: SAN CARLOS, CERRO CHATO (10.2632°N, 84.4052°W), 922 m elev. 16 May 2012. Joseph Vargas. SMF 94578 (Fig. 1). First record for Alajuela Province, extending the species' known geographic distribution 147 km NE of Guayacan, Limón Province (Savage and Kubicki 2010).

ISTHMOHYLA PSEUDOPUMA. ALAJUELA: Volcán Tenorio (10.7048°N, 85.0305°W), 1143 m elev. 5 March 2011. Gunther Köhler and Joseph Vargas. SMF 91989–92. GUANACASTE: Volcán Miravalles (10.7060°N, 85.1107°W), 1225 m elev. 22 October 2011. Gunther Köhler and Joseph Vargas. SMF 94596. Volcán Rincón de la Vieja (10.8362°N, 85.3284°W), 1340 m elev. 27 October 2011. Gunther Köhler and Joseph Vargas. SMF 94597. First records for Volcán Tenorio and for Guanacaste Province, and also northernmost records for this species, extending its geographic range about 50 km NNW (Volcán Tenorio), 59 km NNW (Volcán Miravalles), and 82 km NW (Volcán Rincón de la Vieja), respectively, of Monteverde, Puntarenas (Duellman 2001; Savage 2002).

PHYLLOBATES VITTATUS. PUNTARENAS: Punta Burica, Río Coco (8.1807°N, 83.0149 °W), 390 m elev. 19 February 2011. Joseph Vargas. SMF 93576. Southeasternmost record for the species, extending its geographic range about 18 km S of previous southernmost record at Conte, 6 km E Puerto Pilon (UCR 9311) (Savage 2002; Savage, pers. comm., April 2013).

COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND

PHOTO BY JOSEPH VARGAS



FIG. 1. *Ecnomiohyla sukia* (SMF 94578).

PHOTO BY GUNTHER KÖHLER



FIG. 2. *Pristimantis altae* (SMF 94594).

PHOTO BY GUNTHER KÖHLER



FIG. 3. *Anolis woodi* (Photo voucher F-SMF 238).

PHOTO BY GUNTHER KÖHLER



FIG. 4. *Ptychoglossus plicatus* (SMF 94592).

PHOTO BY GUNTHER KÖHLER



FIG. 5. *Dendrophidion paucicarinatum* (SMF 94576).

PHOTO BY GUNTHER KÖHLER



FIG. 6. *Geophis zeledoni* (SMF 92524).

PHOTO BY GUNTHER KÖHLER



FIG. 7. *Sibon longifrenis* (SMF 94598).

PHOTO BY GUNTHER KÖHLER



FIG. 8. *Tripanurgos compressus* (SMF 93056).

PRISTIMANTIS ALTAE. GUANACASTE: Volcán Miravalles (10.7084°N, 85.1180°W), 1400 m elev. 23 October 2011. Gunther Köhler and Joseph Vargas. SMF 94593–94 (Fig. 2). First record for Volcán Miravalles, filling the gap between Monteverde (ca. 59 km SSE), and Cerro Cacao (ca. 42 km WNW) (Savage 2002; Köhler 2011). Also, this record increases the previously known elevation for the species 140 m (Sasa et al. 2010).

SQUAMATA — LIZARDS

DIPLOGLOSSUS BILOBATUS. GUANACASTE: Volcán Miravalles (10.7044°N, 85.1136°W), 1215 m elev. 21–23 October 2011. Gunther Köhler and Joseph Vargas. SMF 94583–85. First records for Volcán Miravalles, filling the gap between Monteverde (ca. 59 km SSE), and Cerro Cacao (ca. 42 km WNW) (Savage 2002).

ANOLIS KEMPTONI. PUNTARENAS: N of Buenos Aires (9.2525°N, 83.2283°W), 1834 m elev. 6 February 2010. Gunther Köhler. SMF 92547. This record extends the species' geographic range about 65 km WNW from Las Tablas, Puntarenas (Savage 2002; Ponce and Köhler 2008).

ANOLIS INTERMEDIUS. SAN JOSÉ: Río Blanco (9.6469°N, 83.8876°W), 2110 m elev. 18 February 2010. Gunther Köhler. SMF 92597. This record increases the documented elevation of the species, which was previously known from as high as 1950 m (Sasa et al. 2010).

ANOLIS WOODI. ALAJUELA: Volcán Tenorio (10.7056°N, 85.0308°W), 1164 m elev. 6 March 2011. Gunther Köhler and Joseph Vargas. Photo voucher F-SMF 238 (Fig. 3). GUANACASTE: Volcán Miravalles (10.7101°N, 85.1205°W), 1460 m elev. 25 October 2011. Gunther Köhler. SMF 94586. First record for Guanacaste and northernmost records for this species, extending its geographic range about 50 km NNW (Volcán Tenorio) and 59 km NNW (Volcán Miravalles), respectively, of Monteverde, Puntarenas (Savage 2002).

ANOLIS TROPIDOLEPIS. CARTAGO: Hotel Tapanti (9.6787°N, 83.8927°W), 2520 m elev. 12 February 2010. Gunther Köhler. SMF 93627; HEREDIA: Cerro Chompipe (10.0978°N, 84.0729°W), 2613 m elev. 23 March 2010. Gunther Köhler. SMF 93668-69; SAN JOSÉ: Road between Copey and Providencia (9.6101°N, 83.9087°W), 2540 m elev. 21 February 2010. Gunther Köhler. SMF 93642. These records increase the documented elevation of the species, which was previously known from as high as 2506 m (Sasa et al. 2010).

PTYCHOGLOSSUS PLICATUS. ALAJUELA: Volcán Miravalles (10.7459°N, 85.1116°W), 1200 m elev. 25 October 2011. Gunther Köhler and Joseph Vargas. SMF 94592 (Fig. 4). This record extends the species' geographic range about 70 km NW of its closest known locality in the Cordillera de Tilarán, Alajuela (Savage 2002).

SPHENOMORPHUS CHERRIEI. ALAJUELA: Volcán Miravalles (10.7064°N, 85.1170°W), 1330 m elev. 21 October 2011. Gunther Köhler. SMF 94587. PUNTARENAS: Santa Elena, Sunset Hotel (10.3270°N, 84.8236°W), 1420 m elev. 28 October 2011. Gunther Köhler. SMF 94590. These records increase the documented elevation of the species in Costa Rica, which was previously known from as high as 1200 m (Sasa et al. 2010).

SQUAMATA — SNAKES

DENDROPHIDION PAUCICARINATUM. GUANACASTE: Volcán Miravalles (10.7060°N, 85.1168°W), 1220 m elev. 24 October 2011. Gunther Köhler. SMF 94576 (Fig. 5). First record for Volcán Miravalles, filling the gap between Monteverde (ca. 59 km SSE), and Cerro Cacao (ca. 42 km WNW) (Savage 2002).

GEOPHIS BRACHYCEPHALUS. HEREDIA: Volcan Barva, Las Tres Marias (10.1031°N, 84.1060°W), 2230 m elev. 28 February 2010. Gunther Köhler. SMF 94577. This record increases the documented known elevation of the species, which was previously known from as high as 2115 m (Wilson and Johnson 2010).

GEOPHIS ZELEDONI. HEREDIA: Volcan Barva, Las Tres Marias (10.1029°N, 84.1034°W), 2230 m elev. 28 February 2010. Gunther Köhler. SMF 92528. Volcan Barva, Los Angeles de Paso Llano (10.1077°N, 84.1033°W), 2260 m elev. 24 February 2010. Gunther Köhler. SMF 92524–27 (Fig. 6). These records increase the documented elevation of the species, which was previously known from as high as 2100 m (Wilson and Johnson 2010).

RHADINAEA DECORATA. PUNTARENAS: Punta Leona, Sendero Gigante (9.702660°N, 84.649400°W), 70 m elev. 4 March 2010. Gunther Köhler. SMF 92535. This record extends the species' geographic range along the Pacific versant about 159 km WNW from Boruca, Puntarenas (Myers 1974; Savage 2002).

PSEUSTES POECILONOTUS. PUNTARENAS: Las Tablas (8.926750°N, 82.785400°W), 1610 m elev. 18 March 2010. Gunther Köhler and Joseph Vargas. SMF 92538. This record increases the documented elevation of the species which was previously known from as high as 1330 m (Wilson and Johnson 2010).

SIBON LONGIFRENIS. ALAJUELA: Volcán Miravalles (10.7478°N, 85.1095°W), 1030 m elev. 25 October 2011. Gunther Köhler. SMF 94598 (Fig. 7). First record for Volcán Miravalles, filling the gap between Monteverde (ca. 59 km SSE), and Cerro Cacao (ca. 42 km WNW) (Savage 2002), respectively, and highest documented elevation for the species, which was previously known from as high as 750 m (Wilson and Johnson 2010).

TRIPANURGOS COMPRESSUS. PUNTARENAS: Punta Banco, Cerro Incendio (8.3613°N, 83.1224°W), 300 m elev. 22 February 2011. Joseph Vargas. SMF 93056 (Fig. 8). Southeasternmost record of this species in Costa Rica extending its geographical range about 30 km of the previous southernmost record at Quebrada Corosol near Golfito (UCR 11645) (Savage 2002; Savage, pers. comm., April 2013).

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Amphibians and Reptiles of Jasper County, Mississippi, with Comments on the Potentially Extinct Bay Springs Salamander (*Plethodon ainsworthi*)

The Bay Springs Salamander (*Plethodon ainsworthi*) is a plethodontid salamander known from only two museum specimens collected in 1964 from a single locality in Jasper County, Mississippi, USA (Lazell 1998). Throughout the 1990s, numerous collection efforts were undertaken at the type locality and other nearby sites, utilizing diurnal searches, cover boards, and, on one occasion, a nocturnal search. To date, however, no searches have occurred during rainy nights or used drift fence arrays, the presumed optimal detection methods (Lazell 2005). Because no further individuals were found, the species is presumed to be extinct (Hammerson 2004).

Despite receiving considerable attention for *P. ainsworthi*, the amphibians and reptiles of Jasper County, Mississippi remain undersampled. Because no comprehensive county-by-county distributional lists or maps currently exist for Mississippi (Cliburn 1976; Lohoefener and Altig 1983), we compiled data from museum records and the published literature to address the historic occurrence of species in the county. We identified only 37 species historically documented from Jasper County: 34 by museum specimens and three solely by literature records (Table 1).

We conducted a bioblitz of amphibians and reptiles of Jasper County. Bioblitz competitions are survey events in which biologists compete to document the most species of defined taxa in a particular area (e.g., Graham et al. 2007; Graham et al. 2010a, 2010b). The objectives of the bioblitz were to: 1) search for the potentially extinct *P. ainsworthi* and 2) document new records to supplement the list of known species for the county. Because only a single effort has been conducted for *P. ainsworthi* at night to date, we aimed to utilize nocturnal searches to detect this species (Lazell 2005).

From 19–22 April 2012, eight individuals in two teams searched suitable habitat in public and private lands (with landowners' permission) throughout Jasper County. In particular, the Tallahala Wildlife Management Area provided a large area of diverse habitats. Situated in the transitional zone from upper to lower coastal plain (specifically, areas of the Pine Hills and Jackson Prairies physiographic provinces [Lowe 1921; Lohoefener and Altig 1983]), characteristic vegetation in Jasper County includes mixed agricultural areas, pine, and hardwood forests. Extensive diurnal and nocturnal searches were undertaken at the Ainsworth spring, the type locality of *P. ainsworthi*. Amphibian and reptile species were detected by visual encounter surveys, searching cover objects, road driving, and call surveys.

Extensive diurnal and nocturnal searches to locate *P. ainsworthi* were unsuccessful at the type locality and other nearby springs. During these searches, three salamander species were observed active at the surface of leaf-litter: *Eurycea cirrigera* (Southern Two-lined Salamander), *Eurycea guttolineata* (Three-lined Salamander), and *Desmognathus conanti* (Spotted Dusky Salamander). *Plethodon mississippi* (Mississippi Slimy Salamander) and *Pseudotriton ruber* (Red Salamander) were found under cover. No precipitation occurred during our searches (the most recent rain was three days prior), and the region was experiencing a cold front. Daytime high temperatures reached only approximately 17°C and nighttime lows were around 9°C. This effort represents only the second documented attempt to locate *P. ainsworthi* by searching at night. Perhaps future nocturnal efforts in conjunction with wet weather conditions could rediscover this presumably extinct species (Lazell 2005).

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TABLE 1. Amphibian and reptile species historically documented from Jasper County, Mississippi, USA, as identified by a comprehensive search of museum and literature records. OMNH = Oklahoma Museum of Natural History, MMNS = Mississippi Museum of Natural Sciences, USNM = Smithsonian National Museum of Natural History, CM = Carnegie Museumof Natural History, FMNH = Field Museum of Natural History, MCZ = Museum of Comparative Zoology.

Species	Common name	Museum records	Literature records
Amphibians			
Anura			
Acris crepitans	Eastern Cricket Frog	OMNH 39216	—
Acris gryllus	Southern Cricket Frog	MMNS 12968	—
Anaxyrus terrestris	Southern Toad	MMNS 7402	—
Gastrophryne carolinensis	Eastern Narrow-mouthed Toad	MMNS 14900	—
Hyla cinerea	Green Treefrog	MMNS 12063	—
Lithobates clamitans	Green Frog	MMNS 8261	—
Lithobates palustris	Pickerel Frog	MMNS 15113	—
Pseudacris feriarum	Upland Chorus Frog	MMNS 14701	—
Caudata			
Ambystoma maculatum	Spotted Salamander	MMNS 3179	—
Ambystoma opacum	Marbled Salamander	MMNS 8873	—
Desmognathus auriculatus	Southern Dusky Salamander	MMNS 11199	Lazell (2005)
Desmognathus conanti	Spotted Dusky Salamander	MMNS 3173	—
Eurycea cirrigera	Southern Two-lined Salamander	CM 134653	—
Eurycea guttolineata	Three-lined Salamander	MMNS 6472	—
Eurycea cf. chamberlaini	Chamberlain's Dwarf Salamander	—	Boyd & Vickers (1963)
Necturus beyeri	Gulf Coast Waterdog	MMNS 1686	—
Plethodon ainsworthi	Bay Springs Salamander	MCZ A-125869, 126696	—
Plethodon mississippi	Mississippi Slimy Salamander	MMNS 12621	—
Pseudotriton ruber	Red Salamander	MMNS 149741	—
Reptiles			
Testudines			
Graptemys gibbonsi	Pascogoula Map Turtle	—	Selman & Qualls (2009)
Kinosternon subrubrum	Eastern Mud Turtle	MMNS 9348	
Terrapene carolina	Eastern Box Turtle	MMNS 2920	—
Lacertilia			
Anolis carolinensis	Green Anole	MMNS 16976	Cliburn (1959)
Aspidoscelis sexlineatus	Six-lined Racerunner	FMNH 247134-5	—
Plestiodon inexpectatus	Southeastern Five-lined Skink	FMNH 194412	—
Sceloporus undulatus	Eastern Fence Lizard	FMNH 15316	Cliburn (1959)
Scincella lateralis	Ground Skink	—	Cliburn (1959)
Serpentes			
Diadophis punctatus	Ring-necked Snake	MCZ R-176876	—
Farancia abacura	Red-bellied Mudsnake	MMNS 3428	—
Heterodon platirhinos	Eastern Hog-nosed Snake	MMNS 2563	—
Lampropeltis nigra	Black Kingsnake	MMNS 12059	—
Pantherophis guttatus	Red Cornsnake	MMNS 3129	—
Pantherophis spiloides	Central Ratsnake	MMNS 3232	—
Regina rigida	Glossy Crayfish Snake	MMNS 3029	—
Thamnophis sauritus	Ribbon Snake	CM 2562	—
Virginia striatula	Rough Earth Snake	MCZ 192989	—
Sistrurus miliarius	Western Pygmy Rattlesnake	FMNH 3074	—

* Refer to literature records.

The Ainsworth spring appears to be in poor condition. The stream channel is heavily incised, likely as a result of ridge top deforestation and subsequent topsoil deposition, and Chinese Privet (*Ligustrum sinense*) is abundant. We recommend future searches in areas other than the type locality, since, despite the persistence of other plethodontid salamanders there, it seems degraded.

However, during our survey we detected 19 species of amphibians and 26 species of reptiles in Jasper County. Of these 45 species, 20 have not been collected from the county and represent new records. Two additional species were previously only represented by literature records, and we obtained the first museum specimens. Our bioblitz increases the list of amphibian and reptiles species known from Jasper County, Mississippi from

37 to 57. Records were vouchered as specimens or digital photographs, and deposited in the Herpetological Collections of the Auburn University Museum (AUM/AHAP). All records were verified by Craig Guyer. The datum for all GPS coordinates is WGS 84.

CAUDATA — SALAMANDERS

***EURYCEA cf. CHAMBERLAINI* (Chamberlain's Dwarf Salamander)**. Spring south of County Road (CR hereafter) 215 (31.89891°N, 89.20602°W). 21 April 2012. S. Graham and B. Folt. AUM 39665. A literature record for *Eurycea quadridigitata* (Dwarf Salamander) exists from "near Laurel" in Jasper County (Boyd and Vickers 1963). We found an individual from this species complex which was morphologically consistent with the description of *Eurycea chamberlaini* (e.g., the animal has a completely yellow ventral surface). However, a recent molecular analysis of the *E. quadridigitata* complex found support for an undescribed central lineage in Alabama and Georgia (Lamb and Beamer 2012), and this specimen likely belongs to that lineage. Tail tissue from this specimen was sent to D. Beamer, and future studies with more complete sampling are needed to resolve the taxonomy of the dwarf salamander complex.

***NOTOPHTHALMUS VIRIDESCENS* (Eastern Newt)**. Bienville National Forest, Tallahala Wildlife Management Area, floodplain east of W. Tallahala Creek and west of unnamed Forest Service road (32.17347°N, 89.31175°W). 20 April 2012. D. Laurencio and B. Folt. AUM 39844. Eft found surface active.

ANURA — FROGS

***HYLA AVIVOCA* (Bird-voiced Treefrog)**. Pond off CR 16 near W. Tallahala Creek (32.09298°N, 89.28417°W). 20 April 2012. B. Folt and D. Laurencio. AUM 39863. Male collected calling along edge of swamp.

***HYLA CHRYSOSCELIS* (Cope's Gray Treefrog)**. Pond off CR 16 near W. Tallahala Creek (32.09298°N, 89.28417°W). 20 April 2012. D. Laurencio and B. Folt. AHAP-C 0012. Calling male.

***LITHOBATES CATESBEIANUS* (American Bullfrog)**. Bienville National Forest, Tallahala Wildlife Management Area, CR 24, eastmost bridge near Quarterliah Creek (32.20348°N, 89.25446°W). 19 April 2012. B. Folt and D. Laurencio. AHAP-D 00507.

***LITHOBATES SPHENOCEPHALUS* (Southern Leopard Frog)**. Swamp off CR 16 near W. Tallahala Creek (32.09298°N, 89.28417°W). 19 April 2012. B. Folt and D. Laurencio. AUM 39868.

TESTUDINES — TURTLES

***CHELYDRA SERPENTINA* (Snapping Turtle)**. Junction of SR 18 & CR 1822 (32.12635°N, 89.02720°W). 21 April 2012. S. Graham. AHAP-D 00508. Dead on road.

***CHRYSEMYS DORSALIS* (Southern Painted Turtle)**. Bienville National Forest, Tallahala Wildlife Management Area, Quarterliah Creek at CR 24 (32.20343°N, 89.25914°W). 22 April 2012. B. Folt and S. Graham. AHAP-D 00511. Adult basking on log.

***PSEUDEMYS CONCINNA* (River Cooter)**. Bienville National Forest, Tallahala Wildlife Management Area, Quarterliah Creek at CR 24 (32.20343°N, 89.25914°W). 19 April 2012. B. Folt and D. Laurencio. AHAP-D 00512. Adult photographed basking on log in creek.

***STERNOTHERUS MINOR PELTIFER* (Stripe-necked Musk Turtle)**. Juncture of Tallahoma Creek and CR 8/SR537 (31.83338°N, 89.15817°W). 22 April 2012. S. Graham. AHAP-D 00509.

***TRACHEMYS SCRIPTA* (Pond Slider)**. Cedar Creek at CR 24 (32.20047°N, 89.30022°W). 20 April 2012. B. Folt. AHAP-D 00510. Juvenile hand captured in creek.

SQUAMATA — LIZARDS

***PLESTIODON FASCIATUS* (Common Five-lined Skink)**. Bienville National Forest, Tallahala Wildlife Management Area, forest south of CR 24 (32.20267°N, 89.27019°W). 21 April 2012. S. Goetz and J. Goessling. AUM 39840.

***SCINCELLA LATERALIS* (Little Brown Skink)**. Culvert off CR 2414 (32.16584°N, 89.07288°W). 19 April 2012. B. Folt and D. Laurencio. AUM 39869. Adult collected at night. A literature record exists for this species in the county (Cliburn 1959), but our collection provides the first verifiable museum specimen.

SQUAMATA — SNAKES

***AGKISTRODON CONTORTRIX* (Copperhead)**. SR 503 near junction with CR 20 (32.13914°N, 89.06058°W). 19 April 2012. B. Folt and D. Laurencio. AUM 39901. Collected injured on road.

***AGKISTRODON PISCIVOROUS* (Cottonmouth)**. Bienville National Forest, Tallahala Wildlife Management Area, CR 24 at Quarterliah Creek (32.20348°N, 89.25446°W). 19 April 2012. B. Folt and D. Laurencio. AHAP-D 00518.

***COLUBER CONSTRICTOR* (North American Racer)**. Bienville National Forest, Tallahala Wildlife Management Area, CR 24 at Quarterliah Creek (32.20348°N, 89.07288°W). 19 April 2012. D. Laurencio and B. Folt. AHAP-D 00515.

***COLUBER FLAGELLUM* (Coachwhip)**. Rocky Mount Cemetery near CR 52814 (32.00931°N, 89.08140°W). 22 April 2012. S. Graham. AUM-S 0001.

***NERODIA ERYTHROGASTER* (Plain-bellied Watersnake)**. Bienville National Forest, Tallahala Wildlife Management Area, CR 24 at Quarterliah Creek (32.20348°N, 89.25446°W). 19 April 2012. B. Folt and D. Laurencio. AUM 39867.

***NERODIA RHOMBIFER* (Diamond-backed Watersnake)**. CR 24 at Cedar Creek (32.19994°N, 89.31655°W). 22 April 2012. S. Graham and B. Folt. AHAP-D 00516.

***STORERIA DEKAYI* (DeKay's Brownsnake)**. Bienville National Forest, Tallahala Wildlife Management Area, forest south of CR 24 (32.20325°N, 89.26417°W). 21 April 2012. J. Goessling, S. Goetz, and B. Folt. AUM 39852.

***STORERIA OCCIPITOMACULATA* (Red-bellied Snake)**. Bienville National Forest, Tallahala Wildlife Management Area, forest off CR 23 (32.17161°N, 89.26458°W). 21 April 2012. J. Goessling and S. Goetz. AUM 39861.

***VIRGINIA VALERIAE* (Smooth Earthsnake)**. Bienville National Forest, Tallahala Wildlife Management Area, forest off CR 23 (32.17161°N, 89.26458°W). 21 April 2012. J. Goessling, S. Goetz. AUM 39862.

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New County Records of Reptiles and Amphibians from State Managed Properties in East-Central Illinois, USA

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As part of an ongoing study examining the ecological integrity of seasonal wetlands in the state of Illinois, we sampled 117 wetlands for the presence of amphibians and reptiles on state managed properties in east-central Illinois. Since the publication of Phillips et al. (1999), multiple articles documenting new county records from our study region have appeared in *Herpetological Review* (Foster and Mullin 2007; Petzing et al. 1998, 2000, 2002, 2007, 2008). These publications presented a large number of new county records for this once poorly sampled region. With the extensive sampling required by this new study, we were able to document some less commonly encountered species in the region. Herein we report 17 specimens that represent new county records in the state of Illinois. All vouchered specimens are housed at the Illinois Natural History Survey (INHS) amphibian and reptile collection while unvouchered specimens are represented by a digital image in the Non-INHS Unvouchered Illinois Herps Database (Unvouch). County records were confirmed using the Illinois Herpetological Database at the INHS, which contains records of Illinois amphibians and reptiles from 30 museums collections as well as a collection of digital images of unvouchered specimens and observations from herpetologists and state biologists, and by examining volumes of *Herpetological Review* published since Phillips et al. (1999). Coordinates are presented in decimal degrees using map datum WGS84. Scientific and common names follow Crother (2012).

CAUDATA — SALAMANDERS

***AMBYSTOMA LATERALE/JEFFERSONIANUM* (unisexual allotriploid [JJL] combining genomes of *A. jeffersonianum* and *A. laterale*)**. Crawford Co.: Crawford County Conservation Area; 3.4 km NW of Trimble (39.08635°N, 87.71039°W). 16 March 2010. A. R. Kuhns, T. L. Esker, W. J. B. Anthonysamy, J. Gillespie. Verified

by W. E. Peterman (University of Missouri-Columbia) by gel electrophoresis using AjeD94, AjeD346, and AjeD212 microsatellite primers (Julian et al. 2003). INHS 21629. This specimen was one of six individuals captured in minnow traps from ponds created at the site in 2005.

Salamanders of the *Ambystoma laterale/jeffersonianum* complex are considered endangered and therefore are afforded protection by the Illinois Endangered Species Protection Board (Nyboer et al. 2006). Unisexual allotriploids were previously known from only a small handful of ponds in the Middle Fork Vermilion River drainage, northeast of Oakwood, Vermilion Co., Illinois. This new record is 120 km from the other known location of known allotriploids in Illinois. Although extensive sampling for ambystomatid salamanders has occurred in the region (Peterman et al. 2013), no allotriploids have been documented between these two locations in Illinois.

***AMBYSTOMA MACULATUM* (Spotted Salamander).** Lawrence Co.: Red Hills State Park; 6.2 km WNW of Bridgeport (38.7181°N, 87.83023°W). 7 March 2012. J. A. Crawford, E. J. Kessler, A. R. Kuhns, and C. A. Phillips. Verified by D. B. Wylie. INHS 22727. Adult captured in drift fence beside a recently created ephemeral pond.

***AMBYSTOMA TEXANUM* (Small-mouthed Salamander).** Shelby Co.: Eagle Creek State Park; 3.5 km ESE of Findlay (39.50555°N, 88.71979°W). 1 May 2012. J. A. Crawford, E. J. Kessler, A. R. Kuhns, and C. A. Phillips. Verified by D. B. Wylie. INHS 22809. Adult caught in pitfall trap.

***AMBYSTOMA TIGRINUM* (Tiger Salamander).** Crawford Co.: Crawford County Conservation Area; 3.4 km NW of Trimble (39.08635 -87.71039). 16 March 2010. A. R. Kuhns, T. L. Esker, W. J. B. Anthonysamy, and J. Gillespie. Verified by D. B. Wylie. INHS 21628. This specimen was one of four individuals captured in minnow traps from an ephemeral pond created in 2005.

***PLETHODON GLUTINOSUS* (Northern Slimy Salamander).** Jasper Co.: Prairie Ridge State Natural Area; 3.6 km NNW of Bogota (38.94819°N, 88.25375°W). 9 May 2012. E. J. Kessler and J. A. Crawford. Verified by D. B. Wylie. INHS 22834. Adult found under log in woodland.

***SIREN INTERMEDIA* (Lesser Siren).** Jasper Co.: Simpson Property; 2.1 km WNW of Yale (39.13012°N, 88.04545°W). 12 April 2012. J. A. Crawford and E. J. Kessler. Verified by D. B. Wylie. INHS 22777. Adult captured in minnow trap in ephemeral pond created in 2010.

Wayne Co.: Sam Dale Lake State Conservation Area; 10.9 km SSE of Xenia (38.54289°N, 88.59354°W). 9 May 2012. C. A. Phillips, E. M. Wright, and L. L. Jacques. Verified by D. B. Wylie. INHS 22835. Adult caught in minnow trap in ephemeral pond.

ANURA — FROGS

***LITHOBATES SYLVATICUS* (Wood Frog).** Fayette Co.: Ramsey Lake State Park; 1.9 km NW of Ramsey (39.15422°N, 89.12731°W). 7 June 2012. R.S. Saffer and E.M. Wright. Verified by D. B. Wylie. INHS 22928. Juvenile captured in pitfall trap near ephemeral pond.

Lawrence Co.: Red Hills State Park; 6.4 km WNW of Bridgeport (38.71948°N, 87.83178°W). 7 March 2012. J. A. Crawford, E. J. Kessler, A. R. Kuhns, and C. A. Phillips. Verified by D. B. Wylie. INHS 22728. Adult caught in a pitfall trap near an ephemeral pond.

TESTUDINES — TURTLES

***STERNOTHERUS ODORATUS* (Eastern Musk Turtle).** Wayne Co.: Sam Dale Lake State Conservation Area; 10.6 km SSE of Xenia (38.54539°N, 88.59484°W). 16 February 2012. J. A. Crawford, B. Daugherty, and A. R. Kuhns. Verified by D. B. Wylie. INHS 22638. Shell found by small pond. Gravid adult female was also found DOR near pond at entrance to park on 13 June 2012.

Clark Co.: Lincoln Trail State Park 6.1 km SSW of Marshall. (39.33798°N, 87.71184°W). 28 June 2011. E. M. Wright. Verified by D. B. Wylie. Unvouch 42631. Adult female found in campground on the edge of the state park presumably searching for nesting habitat.

***TRACHEMYS SCRIPTA ELEGANS* (Red-eared Slider).** Moultrie Co.: Whitley Creek Recreation Area; 7.3 km SSW of Sullivan (39.53607°N, 88.62716°W). 3 May 2012. E. J. Kessler, A. R. Kuhns, and C. A. Phillips. Verified by D. B. Wylie. INHS 22817. Juvenile found crossing park access road.

SQUAMATA — LIZARDS

***PLESTIODON FASCIATUS* (Common Five-lined Skink).** Shelby Co.: Eagle Creek State Park; 5.8 km SSE of Grandview (39.49142°N, 88.70842°W). 3 May 2012. E. J. Kessler and A. R. Kuhns. Verified by D. B. Wylie. INHS 22818. Found under log in woodlands between ephemeral pond and golf course.

***PLESTIODON LATICEPS* (Broad-headed Skink).** Lawrence Co.: Red Hills State Park; 6.1 km WNW of Bridgeport (38.72425°N, 87.82633°W). 17 May 2012. J. A. Crawford, A. R. Kuhns, and C. A. Phillips. Verified by D. B. Wylie. INHS 22925. Adult captured in drift fence beside ephemeral pond.

***SCINCELLA LATERALIS* (Little Brown Skink).** Marion Co.: Stephen A. Forbes State Recreation Area, 10.3 km SE of Kinmundy (38.71153°N, 88.75856°W). 12 June 2012. E. J. Kessler and L. L. Jacques. Verified by D. B. Wylie. INHS 22923. Adult found under piece of silt fencing while removing drift fence.

SQUAMATA — SNAKES

***HETERODON PLATIRHINOS* (Eastern Hog-nosed Snake).** Moultrie Co.: Whitley Creek Recreation Area, NW of Co. Hwy. 19 and Co. Rd. 900N (39.53608°N, 88.62781°W). 3 May 2012. E. J. Kessler, A. R. Kuhns, and C. A. Phillips. Verified by D. B. Wylie. INHS 22819. Juvenile captured in funnel trap placed along a drift fence.

***STORERIA DEKAYI* (Dekay's Brownsnake).** Jasper Co.: Sam Parr State Park; 5.8 km NE of Newton (39.02860°N, 88.11581°W). 22 June 2012. A. R. Kuhns, R. S. Saffer, and E. M. Wright. Verified by D. B. Wylie. INHS 22912. Adult captured in drift fence beside ephemeral pond.

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New Departmental Records for Amphibians and Reptiles in Honduras

From 30 June to 12 July 2011, we conducted a preliminary survey of the amphibians and reptiles on the islands in the Gulf of Fonseca, Department of Valle, in southern Honduras. McCranie (2007, 2011) had previously demonstrated that Valle was one of several departments that had been understudied regarding its amphibian and snake faunas, respectively. Two of us (JRM and LVO) also spent a week during April 2011 collecting in the Departments of Copán and Santa Bárbara in northwestern Honduras. McCranie (2007, 2011) had shown that Santa Bárbara was also under-studied in regards to its amphibian and snake faunas. During those surveys we documented one species of snake new to Honduras (*Tantilla vermiformis*) and new department records for one frog, two lizards, six other snakes, and one turtle. Identifications of USNM specimens were verified by Steve W. Gotte, those deposited in MVZ were verified by Sean M. Rovito, and UNAH vouchers were verified by Gustavo A. Cruz. Coordinates and elevations were taken with a GPS device using map datum WGS84.

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ANURA — FROGS

***TRACHYCEPHALUS TYPHONIUS* (Veined Treefrog; Rana Trepadora Lechosa).** VALLE: Isla Garrobo (13.3169°N, 87.700126°W), 25 m elev. 7 July 2011. USNM 579695. Closest known locality for this species is ca. 30 km SE at Cedeño, Choluteca (McCranie 2006). The frog was active at night in a tree ca. 3 m above the ground in second growth dry forest.

SQUAMATA — LIZARDS

***HOLCOSUS UNDULATUS* (Rainbow Ameiva; Lagartija Metálica).** VALLE: Isla del Tigre, near communications tower (13.26678°N, 87.633412°W), 783 m elev. 30 June 2011. USNM 579690. Closest known locality for this species is ca. 65 km ENE on Cerro Guanacaure, Choluteca (SDSNH 72693, 72696, USNM 579539). The lizard was active on the ground at midday in an area denuded of its dry forest.

***IGUANA IGUANA* (Green Iguana; Iguana de Ribera).** VALLE: Isla de La Vaca (13.300024°N, 87.583562°W), 5 m elev. 9 July 2011. UNAH 5653. First published record from Valle, although Lovich et al. (2006) in an unpublished report, acknowledged a

photograph of this species from nearby Isla del Tigre. Nearest mainland records are from ca. 25 km SE at Cedeño, Choluteca (BYU 18289–300). The lizard was ca. 2 m above ground in a tree growing on a small cliff overlooking the Gulf of Fonseca.

SQUAMATA — SNAKES

***CONIOPHANES FISSIDENS* (Yellow-bellied Snake; Panza Amarilla)**. SANTA BÁRBARA: Quebrada Las Cuevas, Montaña El Joconal (15.053444°N, 88.517056°W), 1150 m elev. 19 April 2011. MVZ 267178. Closest known localities are from ca. 50 km SW at Dolores, Copán, and ca. 35 km ESE in the vicinity of El Jaral, Cortés (McCranie 2011). The snake was killed by a local resident on a coffee farm.

***ENULIUS FLAVITORQUES* (Pacific Long-tailed Snake; Coluda del Pacifico)**. VALLE: Isla Exposición (13.300212°N, 87.66690°W), 20 m elev. 8 July 2011. USNM 579683. Isla Inglesera (13.300248°N, 87.700033°W), near sea level to 15 m elev. 4, 5, and 12 July 2011. USNM 579684–86. Closest known locality to both islands is ca. 30 km SE at Cedeño, Choluteca (McCranie 2011). All snakes were active at night on the ground or in rock walls in denuded dry forest.

***IMANTODES CENCHOA* (Blunthead Tree Snake; Cordelilla Manchada)**. SANTA BÁRBARA: Quebrada Las Cuevas, Montaña El Joconal (15.053444°N, 88.517056°W), 1150 m elev. 19 April 2011. MVZ 267184. Closest known localities are from ca. 60 km SW at Santa Rosa de Copán, Copán, and ca. 40 km ESE at Agua Azul, Cortés (McCranie 2011). The snake was active at night on low vegetation in an area of moderately disturbed broadleaf forest.

LEPTODRYMUS PULCHERRIMUS. VALLE: Isla Comandante (13.283569°N, 87.616893°W), 2 m elev. 9 July 2011. USNM 579687. Closest known locality is ca. 80 km E at El Banquito, Choluteca (McCranie 2011). The snake was active at midday on the grounds of a resort previously covered by dry forest.

***OXYRHOPUS PETOLARIUS* (Calico False Coral Snake; Falsa Coral de Calico)**. COPÁN: San Isidro (15.116667°N, 88.933333°W), 1100 m elev. 26 April 2011. MVZ 267202. Closest known Honduran locality is ca. 115 km ESE in the vicinity of Lago de Yojoa, Cortés (McCranie 2011). The snake was under surface debris during the day in an area of highly disturbed broadleaf forest.

TANTILLA IMPENSA. SANTA BÁRBARA: El Cedral (14.916677°N, 88.066884°W), 1700 m elev. 29 April 2011. MVZ 267219. Closest reported localities are ca. 100 km WNW at Quebrada Grande, Copán, and ca. 15 km E at Lago de Yojoa, Cortés (McCranie 2011). The snake was inside a large rotten log on a coffee farm.

TANTILLA VERMIFORMIS. VALLE: Isla Exposición (13.300212°N, 87.666901°W), 20 m elev. 8 July 2011. (USNM 579681). First record for Honduras and first record for any island. The locality bridges the gap between Lago de Ilopango, San Salvador, El Salvador, ca. 160 km to the WNW (Köhler et al. 2005) and Chinandega, Nicaragua, ca. 95 km to the SE (Köhler 2001). McCranie (2011) had predicted that this species would eventually be found in Honduras as it was known from west and south of the country. The juvenile female (Fig. 1) was under a rock on a steep hillside surrounded by dry forest.



PHOTO BY A. GUTSCHE

FIG. 1. Juvenile female *Tantilla vermiformis* (total length 73 mm) from Isla Exposición, Valle, Honduras (USNM 579681).

TESTUDINES — TURTLES

***LEPIDOCHELYS OLIVACEA* (Olive Ridley Sea Turtle; Tortuga Golfina)**. VALLE: Isla Garrobo, small sandy beach on SW side of island (13.3169°N, 87.700126°W). 9 July 2011. UNAH 5654. Closest recorded locality is ca. 20 km E at Punta Ratón, Choluteca (UF 34483–517, 69895–905). In this case, an egg shell was found exposed on the beach, and according to locals, the site is infrequently used for nesting by this species.

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NATURAL HISTORY NOTES

GYMNOPHIONA — CAECILIANS

***SCHISTOMETOPUM THOMENSE* (São Tomé Caecilian). PREDATION.** The caecilian *Schistometopum thomense* is endemic to the island of São Tomé, Central Africa. Its unusual bright yellow coloration makes it a familiar animal, locally known as 'cobra-bobo'(Measey and Van Dongen 2006. Evol. Ecol. Res. 8:1049–1059). This species has a wide distribution including anthropogenic habitats but little has been reported on the natural history of S. *thomense* in its natural environment (Nussbaum and Pfrender 1998. Misc. Publ. Mus. Zool., Univ. Michigan 187). Herein we report a direct observation of an adult domestic Muscovy Duck (*Cairina moschata*) predating on an adult S. *thomense*, the first predation record for this species. At 0630, 31 Oct 2012, we observed a domestic Muscovy Duck attempting to swallow a bright yellow *S. thomense* at the entrance of the main group of houses of the locality of Água Sampaio (00.3513°N, 06.6049°W), district of Lobata, São Tomé Island. The duck had already approximately half of the body length of the caecilian in its beak and unsuccessfully attempted to swallow it for about 30 seconds. The duck then carried the amphibian to a puddle of water where, with the help of this liquid, it finally managed to swallow the caecilian. We occasionally observed the duck during the next few hours in which it seemed to be unaffected and behaving normally. This report casts doubt on the hypothesis that the unusually bright coloration of *S. thomense* is aposematic and thus that the skin of *S. thomense* is toxic (Hofer 1998. Herpetozoa 11:37–46).

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CAUDATA — SALAMANDERS

***AMBYSTOMA BISHOPI* (Reticulated Flatwoods Salamander). EGG SURVIVAL AFTER FIRE.** Reticulated Flatwoods Salamanders are endemic to the fire-maintained Longleaf Pine (*Pinus palustris*)/Wiregrass (*Aristida stricta*) ecosystem of the Southeastern Coastal Plain of the United States. Adults migrate to ephemeral wetlands during fall and early winter (Palis 1997. J. Herpetol. 31:71–78), and females lay eggs on the ground before the wetland basin fills with water. Larvae develop within terrestrially deposited eggs, often for several weeks or months, and hatch upon inundation from winter rains (Anderson and Williamson 1976. Herpetologica 32:4–22; Pierson Hill, Florida State Univ., pers. com.; Kelly Jones, pers. obs.; Sylvia Powell, pers. obs.).

We observed live *Ambystoma bishopi* eggs in wetlands with dry basins from late December 2011 to late-February 2012 on Eglin Air Force Base, Okaloosa Co., Florida, USA. The fall-winter season was characterized by low rainfall, and the majority of the eggs we monitored were not inundated and did not hatch successfully. Most, but not all, of the monitored eggs were dead by late-February.

On 3 January 2012, B. Rincon found a group of at least six live eggs on the ground sheltered above by herbaceous plants (including the dead basal leaves of *Eriocaulon compressum* and a rosette of *Dichanthelium* sp.). Embryos visible within the eggs exhibited tails with bright skin coloration (Harrison stage between 35 and 45; Harrison 1969. Organization and Development of the Embryo. Yale Univ. Press, New Haven, Connecticut). Additional eggs might have been obscured behind others, because the egg deposition site was a recess of soil and vegetation (< 5cm deep), and we tried not to disturb the eggs.



FIG. 1. View of the area where *Ambystoma bishopi* eggs were laid as seen the day after a fire passed over the area. Living eggs were located here after the prescribed burn of the wetland, which occurred on 22 February 2012 in Okaloosa Co., Florida, USA.

On 19 February 2012, SDP again noted at least six eggs present at the location, including a moving embryo with eyes, tail, and gills (stage 37–46) in a partially open egg sac. The wetland had some scattered small puddles of water at the time. On 20 February, an embryo with forelimbs (stage 40–46) was moving within an intact egg; the soil was saturated with water but no standing water was present. Anticipating a prescribed fire at the location, a fire resistant marker (large bolt with washer) was placed ca. 10 cm from the eggs on the evening of 21 February. On the morning of 22 February, at least four live eggs were observed. Later that day, the wetland was burned by a prescribed fire that burned through the entire wetland, but did not consume all of the herbaceous plant material in areas with moist soil.

On the morning after the burn, two apparently healthy embryos were visible and one moved, but some embryos were clearly dead. Charred vegetation was present immediately above the eggs, indicating that fire passed directly over the eggs (Fig. 1). The dead embryos were closer to the charred vegetation at the surface, and their skins were grayish rather than brightly colored. The dead embryos had fully formed mouths (stage 43–46); one was measurable and was ca. 11.3 mm total length. Live eggs were present at the site as late as 25 February, when two embryos moved in partially open egg sacs and an intact egg with an apparently healthy embryo inside was nearby. All of the eggs were dead by 28 February.

Prescribed fires in pine flatwoods are usually implemented during the winter months when wetlands typically retain water (Bishop and Haas 2005. Nat. Areas J. 25:290–294). However, this prescribed fire was in an uncharacteristically dry wetland, so the fire successfully carried through the wetland. Based on our observations it appears that in some cases eggs laid terrestrially can survive fire. Additional observations of eggs before and after fires would be necessary to determine how fire may affect egg survival rates or influence populations.

SDP's fieldwork on Eglin Air Force Base was funded by a grant ("Experimental Restoration of Pine Flatwoods") from the Department of Defense Legacy Resource Management Program to Thomas Gorman and Carola Haas. We thank the field technicians and volunteers who assisted with locating and monitoring eggs, Robert Powell who made editorial comments, and the natural resource staff of Jackson Guard, Eglin Air Force Base for their support.

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***AMBYSTOMA MAVORTIUM* (Barred Tiger Salamander). BEHAVIOR UNDERNEATH THE ICE.** Larval *Ambystoma mavortium* in North Dakota spend the winter months (late October–early April) restricted underneath a thick (0.5–1.3 m) ice sheet. During February and March 2012, we observed larval *A. mavortium* in Swalls Lake, Ward Co., North Dakota, USA (48.1044°N, 101.1644°W). We drilled holes in the ice using an ice auger equipped with 20.3 cm blade. We established three ice-hole grids. Each grid had nine holes in a 3 × 3 arrangement on a 20 × 20 m square (i.e., four holes were the corners of the square). Thus, we established 27 observation holes over three locations on the lake. We could drill and observe nine holes during a four-hour observation period. We completed four, four-hour observation periods before the ice became unsafe.

To make observations, we used an Aqua-Vu underwater 760 color camera equipped with video recorder. When salamanders were viewed among vegetation, we used an average cattail stem diameter of 11.8 mm for calibration using ImageJ to estimate salamander size. Water temperatures ranged from 2.2 to 3.0°C. Observation depths ranged from 0.2 to 2 m.

Because each hole is 10 m from the nearest hole, we assumed that the number of individual salamanders observed more than once during a visit was minimal. Visibility was estimated as 0.7 m in any direction, thus a full rotation of the camera covered a circular area with a radius of 0.7 m and a circular viewing area of 1.54 m^2. Given this viewing area at each hole, we observed 13.86 m^2 during each trip to the pond (i.e., nine holes, each 1.54 m^2). We viewed a total of 224 salamanders during our four observation periods (i.e., an average of 56 salamanders observed in an area of 13.85 m^2, or 4.04 salamanders/m^2). Using a total lake area of 45,285 m^2 provides a coarse winter population estimate of approximately 183,102 salamanders in Swalls Lake. This estimate falls within our previous catch-per-unit effort and PIT-tag mark-recapture estimates (Poitra et al. 2007. Proc. NDAS 61:15). Salamanders measured (N = 11) averaged 128.1 mm SVL (standard deviation 17.2). All observed salamanders were large (range 99.1–151.2 mm SVL).

The Amphibian Growth Project (AGP) has been monitoring Swalls Lake as part of a long term population monitoring program since 2005. Metamorphosis of *A. mavortium* at Swalls Lake occurs during August and September at ca. 98 mm SVL. Swalls Lake is a semipermanent wetland that last dried completely in the late 1980s. This wetland is irregular in shape and is surrounded by farm fields maintained by the North Central Research Extension Office of North Dakota State University. When full of water, the maximal depth in this wetland is 2.8 m. In summer months, the *Ambystoma* population at Swalls Lake consists of a mixed population of immature larvae, sexually mature larvae (i.e., paedomorphs), immature transformed salamanders, and sexually mature transformed salamanders (Poitra et al. 2007. *op. cit.*). We did not observe any transformed salamanders and it is likely that these salamanders that we viewed consist of both immature and mature larvae. Both salamanders with and without swollen cloacae were observed.

Most of the salamanders observed were active. No aggression among salamanders was observed. In several cases, the salamanders are crowded such that they are nearly always in contact with another salamander. Movement up and down in the water column was very common. We often observed salamanders slowly ascending to the top of the water column (i.e., to the bottom of the ice cover) and then swimming rapidly downwards. This is a behavior seen when salamanders gulp air from the surface during ice-free months. Lung deflation in amphibians occurs during long term restriction from surface area and can be a cause of significant mortality (Ultsch et al. 2004. Comp. Biochem. Phys. Part A 139:111–115). However, the salamanders were able to maintain position in the water with no effort, i.e., were buoyant. Therefore we suggest that these salamanders are able to maintain inflated lungs during the winter. We are unable to determine at this time if the salamanders are gulping from pockets of air under the ice.

Amphibians often overwinter under the ice. For example, adult Northern Leopard Frogs (*Lithobates pipiens*) can spend winter months dormant in shallow pits on the pond bottom (Emery et al. 1972. Copeia 1972:123–126), and adult Red-spotted Newts (*Notophthalmus viridescens*) spend their lives in ponds that can freeze over (Berner and Puckett 2010. J. Exp. Zool.

313A:231–239). In these reports, overwintering amphibians are slow or dormant. Our observations indicate high activity levels on larval *A. mavortium* under the ice. This high activity is seen in the other organisms in Swalls Lake. Aquatic arthropods were also seen at high density and high activity. In addition, bubbles were constantly forming and releasing from the surface of cattail stems that were covered with biofilms (presumably algae and cyanobacteria).

Our video recordings are archived at amphibiangrowthproject.org and at youtube.com/user/Kidbeachy. The AGP has been supported by grants from the National Center for Research Resources (5P20RR016471-12) and the National Institute of General Medical Sciences (8 P20 GM103442-12) from the National Institutes of Health to CKB and D. Sens. Long term access to Swalls Lake is kindly provided by the North Central Research Extension Center of North Dakota State University and its director, J. Fisher.

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***CRYPTOBRANCHUS ALLEGANIENSIS ALLEGANIENSIS* (Eastern Hellbender). AGGREGATE BEHAVIOR.** *Cryptobranchus alleganiensis* is a large, fully-aquatic salamander that resides beneath boulders and in bedrock crevices in cool, swift flowing streams throughout much of the eastern USA (Nickerson and Mays 1973. The Hellbenders: North American "Giant Salamanders." Milwaukee Public Museum, Milwaukee, Wisconsin. 106 pp.; Smith 1907. Biol. Bull. 13:5–39). Hellbenders are typically described as a solitary and territorial species (Humphries and Pauley 2005. Amer. Midl. Nat. 154[1]:135–142; Nickerson and Mays 1973, *op. cit.*; Smith 1907, *op. cit.*). However, during the breeding season (late summer and fall) sexually mature adults are known to congregate briefly at rock nesting cavities and may aggressively defend rock shelters from conspecifics (Smith 1907, *op. cit.*). Rarely, more than one hellbender has been located beneath a single rock for reasons other than breeding (Hillis and Bellis 1971. J. Herpetol. 5[3-4]:121–126; Nickerson and Mays 1973, *op. cit.*). Nickerson and Mays (1973, *op. cit.*) located three Ozark Hellbenders (*C. a. bishopi*) from beneath a single rock on two occasions, and two individuals from beneath a single rock on 14 occasions in North Fork of the White River, Missouri, USA. Hillis and Bellis (1971, *op. cit.*) found more than one Eastern Hellbender (*C. a. alleganiensis*) under a single rock once during a study in French Creek, Pennsylvania, USA. Because reports of hellbender cohabitation by Nickerson and Mays (1973, *op. cit.*) and Hillis and Bellis (1971, *op. cit.*) resulted from rock-lifting surveys, it remains unclear whether cohabitants beneath a single rock may have been compartmentalized from each other and whether cohabitation may have been a short-term artifact of disturbance caused by survey methods. For example, Hillis and Bellis (1971, *op. cit.*) report that hellbenders being pursued would often crawl beneath a nearby rock sometimes occupied by another hellbender.

On 16 September and 27 October 2012, we observed an aggregation of nine and four hellbenders, using a single bedrock cavity in a stream within the South Fork Holston River drainage (HUC 06010102), Washington Co., Virginia, USA. Due to the current status of *C. alleganiensis* (Fed. Register 2011a. 76[194]:61956–61978; Fed. Register 2011b. 76[194]:61978–61985) and threats of illegal collection we do not report the specific locality of our observations. The site consisted of an approximately 10-m long pool just below a large riffle. Though numerous large rocks occurred upstream of the adjacent riffle and downstream of the pool, suitable shelter for hellbenders within the immediate vicinity largely consisted of bedrock crevices. We used snorkeling gear and dive lights (Underwater Kinetics, Poway, California, USA) to peer into crevices and locate animals. On 16 September 2012 we observed eight hellbenders in a single cavity (85 cm long × 5.4 cm high) at ca. 1700 h (water temperature 17°C; air temperature 19.2°C). The cavity was located along a submerged bedrock face, and was oriented horizontal to but ca. 30 cm below the water surface and 66 cm above a rock ledge that was elevated 109 cm above the stream bed. While photographing the aggregation of hellbenders, we observed a ninth individual approach from upstream apparently intending to enter the cavity. We captured the ninth individual by hand and noted a lack of morphological characteristics indicating sexual maturity (lack of a swollen cloaca or gravid appearance; Makowsky et al. 2010. Herpetol. Conserv. Biol. 5[1]:44–48). Upon release at the location of capture the ninth individual readily entered the cavity without obvious protest from the crevice dwellers. All of the hellbenders we observed were facing the cavity opening and were in physical contact with at least one other individual (http://youtu.be/xl-ErtfB1ug). To rule out the possibility that our observation represented an isolated aberration from normal behavior, we revisited the site on 27 October 2012 at ca. 1300 h (water temperature 14.4°C; air temperature 17.2°C) and observed four individuals using the same cavity (Fig. 1).



FIG. 1. Aggregation of four Eastern Hellbenders (*Cryptobranchus alleganiensis alleganiensis*) on 27 October 2012 in a Virginia, USA, stream.

Though our observations occurred during the breeding season for hellbenders in Virginia (late August–October), we consider it unlikely that the aggregation was an attempt to breed based on the lack of evidence of a nest within the cavity (i.e., no eggs were observed), entrance of an apparently immature individual into the cavity, lack of obvious aggression noted between conspecifics, and observation of the behavior outside a single occasion. Our observations indicate hellbenders may aggregate for reasons other than breeding, though the reason and commonality of such behavior across the range of *C. alleganiensis* is unclear.

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***SIREN INTERMEDIA* (Lesser Siren). PREDATION.** Confirmed predators of Lesser Sirens include snakes (*Agkistrodon piscivorus, Farancia abacura, Nerodia cyclopion, N. erythrogaster, N. fasciata*), wading birds (*Ardea herodias, Casmerodius albus*), Red-shouldered Hawk (*Buteo lineatus*), Largemouth Bass (*Micropterus salmoides*), and American Mink (*Mustela vison*); Anderson et al. 2006. Herpetol. Rev. 37:233–234; Dobbs and Dobbs 2003. Herpetol. Rev. 34:47; Frese and Britzke 2001. Herpetol. Rev. 32:99; Leja 2005. *In* M. J. Lannoo [ed.], Amphibian Declines: The

Conservation Status of United States Species, pp. 910–912. Univ. California Press, Berkeley). Herein I provide evidence of Lesser Siren predation by a Coyote (*Canis latrans*).

On 2 March 2012, I found a dead adult male Lesser Siren (277 mm SVL, 394 mm total length) in a shallow (<30 cm), seasonally-inundated pond on Horseshoe Lake State Fish and Wildlife Area HLSFWA), Alexander Co., Illinois, USA. Bite marks and scratches on the siren's head, body, and tail indicate it was killed by a mammal. I compared a complete set of canine-teeth punctures on the siren's body with skulls of carnivorous mammals that occur in southern Illinois. Upper and lower canines of Coyote skulls matched the puncture wounds in the siren.

Although Coyotes feed principally on terrestrial animals (Bekoff 1977. Mammalian Species 79:1–9), they have been observed in water capturing aquatic prey (Grimm 1940. J. Mammal. 21:458–459; Minckley 1965. J. Mammal. 47:137). Coyotes are common on HLSFWA (pers. obs.) and may be attracted to wetlands in late-winter and early spring by chorusing frogs. The Coyote did not eat the Siren. Copious mucous produced by Lesser Sirens (Reno et al. 1972. Copeia 1972:625–631) may be distasteful to Coyotes or may have facilitated the Siren's escape after receiving mortal injuries.

I thank Robert Bluett for funding that made this observation possible, Erin Palmer for the loan of Coyote skulls, and Paul Frese for alerting me to a reference.

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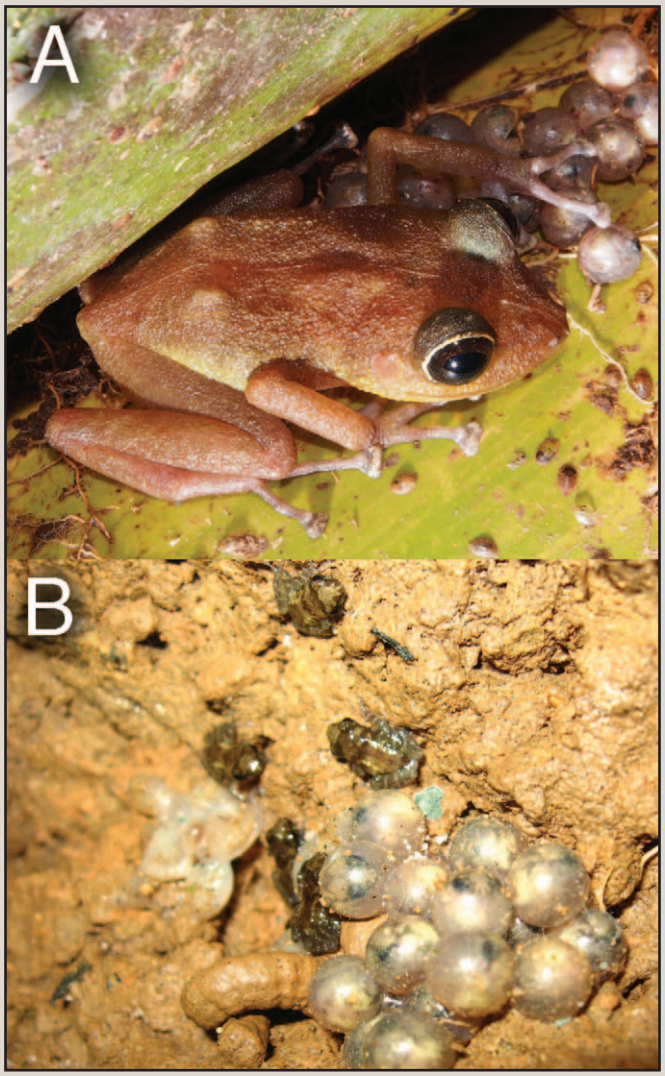
ANURA — FROGS

***ELEUTHERODACTYLUS COOKI* (Coquí Guajón). NESTING SITE.** *Eleutherodactylus cooki* is a threatened direct-developing frog endemic to southeastern Puerto Rico. *Eleutherodactylus cooki* is considered a habitat specialist that uses caves formed by large granodiorite boulders, crevices, and grottos in rocky streams for reproduction (Joglar 1998. Los Coquíes de Puerto Rico: Su Historia Natural y Conservación. Editorial de la Universidad de Puerto Rico, San Juan. 232 pp.). Males can attend up to four clutches with an average size of 17 eggs per clutch, which are laid on vertical surfaces or in crevices of these plutonic rocks (Burrowes 2000. Herpetologica 56:375–386). Herein we report two new *E. cooki* nesting sites that are not on the typical granodiorite substrate.

On 16 Nov 2012, we found an adult male (40.4 mm SVL; 4.93 g) guarding one egg clutch laid on the surface of a green bamboo trunk (Fig. 1A). The bamboo (*Bambusa vulgaris*) was ca. 2 m away from large granodiorite formations in a small stream in Patillas, Puerto Rico (18.050°N, 65.990°W). The egg clutch contained 16 gray embryos corresponding to developmental stage VI: legs are visible and the white yolk is greatly reduced (Burrowes 2000, *op. cit.*).

On 19 Nov 2012, we found an adult male guarding a double-clutched nest in a muddy substrate located below a large boulder (Fig. 1B). The nesting site was located ca. 1 m away from the stream bank, which is part of a designated U.S. Fish and Wildlife Service critical habitat (Unit 2: Montones in Las Piedras, Puerto Rico; 18.148°N, 65.917°W). We observed five recently hatched juveniles from one of the clutches, and 14 embryos in developmental stage V: pink coloration, frequent rapid movements (Burrowes 2000, *op. cit.*).

Both of these localities were characterized by a high abundance of calling *E. cooki* males. Thus, our observations suggest that when nesting sites on granodiorite surfaces are limited, *E. cooki* can select other substrates to lay and attend egg clutches.



PHOTOS BY (A) ALBERTO L. LÓPEZ-TORRES, AND (B) CARLOS A. RODRÍGUEZ-GÓMEZ

FIG. 1. Photographs taken in the field of A) male *Eleutherodactylus cooki* guarding an egg clutch in a bamboo trunk; and B) double-clutched nest with recently hatched juveniles on the left and 14 well-developed embryos on the right.

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***LEPTODACTYLUS BUFONIUS* (Oven Frog). PREDATION.** Ants have been documented as predators of juvenile anuran (Clerke and Williamson 1992. Austr. Zool. 28:64–67), and eggs (Dayton and Jung 1999. Herpetol. Rev. 30:164; Schalk 2012. Herpetol. Rev. 43[4]:635). The following observation documents the predation of tadpoles of *L. bufonius* by ants.

On 19 March 2012 at 2100 h, we came upon a pond that had recently dried (< 24 h) in the Yande Yari guard post (18.69181°S, 62.30192°W; WGS 84), Kaa-Iya National Park, Cordillera Province, Santa Cruz Department, Bolivia. On the still-moist mud we observed a total of 28 *Leptodactylus bufonius* tadpoles that were

being attacked by black ants (ca. 10 mm in length; Formicidae). The tadpoles were still alive; as they were attacked they would flick their tails from side to side in an attempt to free themselves from the jaws of the ants. We observed the ants for ca. 20 minutes, during which time two tadpoles were carried off by several ants.

The presence of breeding ponds across the Chacoan landscape is extremely dynamic; ponds can dry down and refill completely multiple times within a rainy season (pers. obs.). Many anurans of the Gran Chaco possess physiological or behavioral adaptations to cope with the xeric conditions of region (Schalk 2012. Herpetol. Rev. 123–124, and references therein). With this observation, it appears that tadpoles of *L. bufonius* can persist outside of the water, at least for short periods of time, but it also exposes them to terrestrial predators they would not otherwise encounter.

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***LEPTODACTYLUS MELANONOTUS* (Sabinal Frog). ENDOPARASITISM.** *Leptodactylus melanonotus* is a small frog ranging from NW Mexico to Central America and Ecuador, in arid and wet mountain woodlands. The species is nocturnal, semiaquatic, insectivorous, oviparous, and can persist in anthropogenically disrupted areas; it is indeed an indicator of impacted areas (Ramírez-Bautista and García 2002. *In* Noguera et al. [eds.], Historia Natural de Chamela, pp. 251–264. Universidad Nacional Autónoma de México). According to IUCN – the World Conservation Union, *Leptodactylus melanonotus* is listed in the category of Least Concern with populations considered as "stable" (Solís et al. 2010. *In* IUCN Red List of Threatened Species. Version 2012.1, www.iucnredlist.org, accessed 28 June 2012).

During recent survey work on metazoan parasites of *L. melanonotus* in the Chamela-Cuixmala Biosphere Reserve in Jalisco, west-central Mexico, 20 specimens of *L. melanonotus* were examined for parasitic mites. One frog (prevalence 5%) was parasitized with 10 chiggers *Hannemania hylae* (Leeuwenhoekiidae) from Chamela Creek (19.52738°N, 105.06994°W). Chiggers were found on the ventral skin, into the subdermal layer of the trunk and thighs of the host. Frogs were collected under permit FAUT-0250 issued to Gerardo Suzán and will be deposited at Colección Herpetológica, Estación de Biología Chamela. Voucher chigger specimens are housed at the Colección Nacional de Ácaros, Universidad Nacional Autónoma de México, Instituto de Biología, México, D.F., with accession numbers CNAC 007098–007102.

This is the first record of *Hannemania hylae* on *Leptodactylus melanonotus*. This chigger ranges from the southwestern USA to Argentina. It has previously been reported to parasitize *Hyla arenicolor, Pseudacris cadaverina,* and *Eleutherodactylus guttilatus* from several localities in the USA (Jung et al. 2001. Herpetol. Rev. 32:33–34; Loomis and Welbourn 1969. Bull. South. California Acad. Sci. 68:160–168). Also, it has been reported from *Pseudacris cadaverina, Lithobates berlandieri, Eleutherodactylus* sp., *Eleutherodactylus longipes, Lithobates* sp., *Scaphiopus couchii,* and *Incilius mazatlanensis* from Mexico (Espino del Castillo et al. 2011. Int. J. Acarol. 37:427–440; Goldberg et al. 2002. Herpetol. Rev. 33:301–302; Hoffmann 1969. Rev. Latinoam. Microbiol. Parasitol. 11:209–216; Hoffmann and López-Campos 2000. Biodiversidad de los Ácaros en México. CONABIO, UNAM, México. 230 pp.; Loomis and Welbourn 1969, *op. cit.*); and also known to infest *Hypsiboas curupi* from Argentina (Alzuet and Mauri 1985 [1987]. Rev. Soc. Entomol. Argentina 44:111–116).

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***LEPTODACTYLUS SAVAGEI* (Savage's Thin-toed Frog). PREY.** *Leptodactylus savagei* is a large species distributed in primary and secondary forests, forest edges, and deforested areas from Honduras, Nicaragua, Costa Rica, Panama, and scattered localities in both the Caribbean and Magdalena Valley regions of Colombia, from sea level to 1385 m (Heyer 2005. Arq. Zool. 37:269–348; Heyer et al. 2010. Cat. Amer. Amphib. Reptiles 867:1–19). This species is known to feed on diverse prey types from arthropods to small vertebrates (Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna between Two Continents, between Two Seas. Univ. Chicago Press, Chicago, Illinois. xx + 934 pp). Among vertebrate prey items, *L. savagei* is known to feed on adults of both *Hypsiboas rosenbergi* and *Engystomops pustulosus* (Kluge 1981. Misc. Publ. Mus. Zool., Univ. Michigan 160:1–170; Ryan et al. 1981. Behav. Ecol. Sociobiol. 8:273–278). In Colombia, *L. savagei* and *E. pustulosus* occur sympatrically in the Middle Valley of the Madgalena River. Based on a stomach content analysis, herein we report the predation of *L. savagei* on *E. pustulosus* at an open area in the Reserva Rio Manso (5.666°N, 74.7745°W, WGS84; ca. 220 m elev.), municipality of Norcasia, department of Caldas.

On 12 May 2010 at 1924 h, GGD collected an adult male *L. savagei* (SVL 58.7 cm; MHN-UC 460) on the border of a small pond about 1 m diameter, with a chorus of *E. pustulosus*. The stomach of the *L. savagei* contained two *E. pustulosus*, a mature female (26.8 mm SVL; MHN-UC 461) and other individual (24.7 mm SVL; not sexed due its state of decomposition). To our knowledge, this is the first record in Colombia of *L. savagei* feeding on *E. pustulosus* and the second report through its distribution range. The specimens are housed on Museo de Historia Natural of the Universidad de Caldas (MHN-UC), Manizales, Colombia.

We suggest that predation of *E. pustulosus* by *L. savagei* could be an opportunistic event or by convenience, because anurans that predate other anurans are not predators specialized on anurans, but feed on them with regularity (Toledo et al. 2007. J. Zool. 271:170–177). Because *L. savagei* often breeds near sites of activity of *E. pustulosus* (Ryan et al. 1981, *op. cit.*), the syntopic occurrence of these two species during reproductive aggregations can promote the predation of the latter species by an opportunistic predator like *L. savagei*.

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***LITHOBATES BERLANDIERI* (Rio Grande Leopard Frog). LEARNED FEEDING BEHAVIOR AND DIET.** Primarily nocturnal, seeking shelter in thick vegetation and under rocks during the day, *Lithobates berlandieri* is generally found in clear flowing streams or permanent pools that originate from springs (Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. Univ. New Mexico Press, Albuquerque. 431 pp.). The species is a generalist, opportunistic predator whose diet is most strongly influenced by prey availability (Parker and Goldstein 2004. J. Herpetol. 38:127–130) and includes a variety of insects and invertebrates (Degenhardt et al. 1996, *op. cit.*). Herein we document a learned feeding behavior of *L. berlandieri* for a temporally specific prey, the honeybee.

On the night of 27–28 June 2005, we were netting bats over the pool at La Cienaga, a natural spring in the western quarter of the Chinati Mountains State Natural Area (CMSNA), Presidio Co., Texas, USA. Situated in typical Chihuahuan Desert, La Cienaga is a natural seep spring with a marshy drainage of dense grasses dominated by Saltgrass (*Distichlis spicata*) and Alkalai Sacaton (*Sporobolus airoides*), the interior of the cienaga is covered by cattail (*Typha latifolia*) and bulrush (*Scirpus* sp.) (Jones et al. 2011. Occas. Pap. Mus. Texas Tech Univ. No. 300, 29 pp.). Before CMSNA was founded, ranch owners built a circular stone and concrete pool for human bathing with the cold water flowing into the pool under spring pressure. The ca. 1.27 m high pool has six steps, each ca. 21 cm high, rising to a ca. 1 m wide concrete rim. Between first light and sunrise on 28 June, we observed two large *L. berlandieri* jump each of the six concrete steps and into the pool water, the first did so while SK was sitting on the steps, determined to reach the water. We did not disturb their progress. Just after sunrise, hundreds of honeybees, *Apis mellifera* (Hymenoptera: Apidae), swarmed over the water and began to dip and short-rest on the water's surface. Desert honeybees must collect water for thinning of honey to feed larva and evaporative cooling of the hive (Nicolson 2009. J. Exp. Biol. 212:429–434). The two *L. berlandieri* swam underwater towards the resting honeybees and each took one honeybee, swam down into the dark detritus material at the bottom of the pool, and then intermittently returned to the surface. These leopard frogs continued to take honeybees using this method until the swarm of honeybees nearly dissipated. We estimated that 6–8 honeybees were taken by the two *L. berlandieri* during ca. 4–5 min of observations. Although not directly observed, the *L. berlandieri* were either consuming each bee while near the bottom or were inserting the captured bees into the detritus layer. If the latter is correct, this feeding behavior could be a strategy for food hoarding and time management of a temporally restricted resource, and a practice to neutralize a dangerous prey.

In a comparison study of five populations of *L. berlandieri* from Texas, the population from Big Bend National Park in Brewster Co., Texas (the nearest locality to CMSNA), had the least diverse spring diet, almost evenly distributed among Lepidoptera (33%), Coleoptera (27%), and Hymenoptera (33%), however only one prey item was identified to the family Apidae from 27 spring frogs sampled across three localities, including Big Bend (Parker and Goldstein 2004, *op. cit.*). Hymenoptera were listed in the diet of two species of eastern Texas leopard frogs, *L. clamitans* (10.7%) and *L. sphenocephala* (7.1%), although no discrimination was made to bee, ant, or wasp (Forester et al. 1998. Herpetol. Rev. 29:208–211). Examination of 31 *Rana aurora* indicated that each of three frogs had a single honeybee in their diet (Hayes and Tennant 1985. Southwest. Nat. 30:601–605). The limited number of prey items identified to Apidae in these studies infers that bees are not a regular component in the diet of *Lithobates* or *Rana*.

Generally, leopard frogs appear to recognize potential prey by continuous movement that elicits a predatory response (Hayes and Tennant 1985, *op. cit.*), choosing prey from any moving object that is of an appropriate size (Forester et al. 1998, *op. cit.*). Although some frogs may develop preferences, dietary studies of ranid frogs as a group tend to reflect habitat and prey availability (Forester et al. 1998, *op. cit.*). We found that these two *L. berlandieri* developed a prey preference defined on a temporal component. It appears that these honeybees came to water around sunrise on a regular basis with the leopard frogs seemingly needing to make a time appointment for prey, as evidenced by being undeterred by our direct presence. The water may be too cold to spend extended periods in the pool at night, and these two *L. berlandieri* learned a strategy to take a regular prey based on a sunrise schedule. Two subsequent visits to net bats at the site on 21 June 2007 and 9 July 2008 indicated the presence of *L. berlandieri* in the grasses at La Cienaga, however no leopard frogs or honeybees were observed in the pool around sunrise, possibly due to an extirpated prey source.

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***LITHOBATES CLAMITANS MELANOTUS* (Green Frog). UNUSUAL FOOD ITEM.** Much is known about the food habits and feeding behavior of *Lithobates clamitans* (Pauley and Lannoo 2005. *In* M. Lannoo [ed.], Amphibian Declines: The Conservation Status of United States Species, pp. 549–552. Univ. California Press, Berkeley, California). This frog is an opportunistic "sit-and-wait" predator that will feed on various invertebrates and vertebrates during both day and night (Hamilton 1948. Copeia 1948:203–207; Minton 2001. Amphibians and Reptiles of Indiana, 2nd ed. Indiana Academy of Science, Indianapolis, Indiana. 404 pp.). A summary of food items of *L. clamitans* was provided by Hamilton (1948, *op. cit.*), Whitaker (1961. Herpetologica 17:173–179), Stewart and Sandison (1972. J. Herpetol. 6:241–244), and Forstner et al. (1998. Herpetol. Rev. 29:208–211). Herein, we report an unusual food item of *L. clamitans melanotus* from the Ouachita Mountains of Arkansas.

On 25 July 2012, five juvenile Green Frogs (mean ± 1SD SVL 39.8 ± 3.3, range 37–45 mm) were collected from 5.0 km N Mena, off St. Hwy. 88 at Blue Haze Vista Pond, Polk Co., Arkansas, USA (34.62605°N, 94.24444°W; WGS84). Specimens were placed in individual plastic bags on ice and transported to the laboratory within 48 h for necropsy. Frogs were anesthesized with a concentrated chloretone solution and an incision was made to expose the stomach contents. Contents were placed in a Petri dish, rinsed with 0.6% saline, and identified under a stereomicroscope



FIG. 1. Walkingsticks removed from stomachs of Green Frogs, *Lithobates clamitans melanotus* from Arkansas.

using Triplehorn and Johnson (2005. Borrer and Delong's Introduction to the Study of Insects, 7th ed. Thomson/Brooks Cole, Belmont, California. 864 pp.). Voucher specimens of *L. c. melanotus* are deposited in the Arkansas State University Museum of Zoology Herpetological Collection (ASUMZ) as ASUMZ 32392–32396.

Two *L. c. melanotus* (41 and 45 mm SVL) were each found to contain a single adult walkingstick (Phasmatodea: Heteronemiidae) belonging to the genus *Diapheromera* in its stomach (Fig. 1). These insects appear to be unusual food items of *L. clamitans*. Other insects reported as prey of *L. clamitans* includes coleopterans, dipterans, ephermeropterans, hemipterans, lepidopterans, odonates, orthopterans, and trichopterans (Pauley and Lannoo 2005, *op. cit.*). Walkingsticks are slow-moving and the best time to observe them is midsummer to late fall (Triplehorn and Johnson 2005, *op. cit.*). This is the first time, to our knowledge, that walkingsticks have been reported as prey items of *L. clamitans*.

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***LITHOBATES PIPIENS* (Northern Leopard Frog). MALFORMATION.** On 13 September 2011, AR collected a single metamorphosed *Lithobates pipiens*, 37.8 mm SVL, from a farm field in Minot, Ward Co., North Dakota, USA (48.1044°N, 101.1643°W). This frog contained two supernumerary arms that emerged from the throat (Fig. 1A). Upon collection, AR kept the frog in a plastic container and successfully fed several crickets to the frog. These arms were fully formed, and responded to stimuli (i.e., they would move when pinched with forceps). This frog was capable of full locomotion (i.e., walking, hopping, and jumping). The frog was brought to the Amphibian Growth Project (AGP) and euthanized by prolonged immersion in a 10% solution of MS-222, preserved in 10% formalin, and stored in 70% ethanol. The

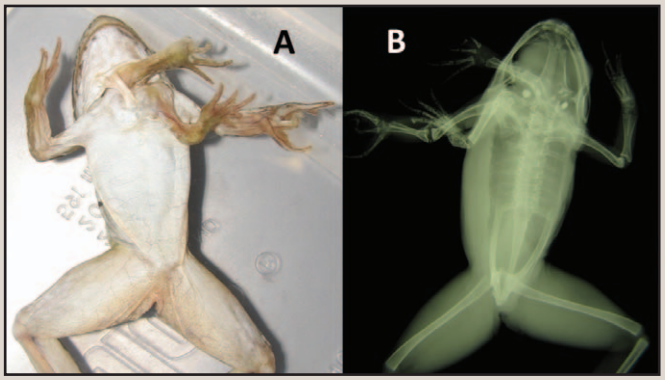


FIG. 1. A) Ventral view of preserved *Lithobates pipiens* collected in Ward Co., North Dakota with two supernumerary arms. B) Radiograph of same individual.

frog was shipped to ML who prepared radiograph images that revealed that these supernumerary limbs contained usual skeletal elements distal to the pectoral girdle (i.e., humerus, radius, ulna, metacarpals, carpels, phalanges). These arms were not articulated to any other part of the skeleton (Fig. 1B).

The AGP maintains a database of life history data for local amphibians that includes over 1250 capture records of *L. pipiens* from 2005–2012 from several sites in northwestern and north central North Dakota. This is the first report of a malformed frog that we are aware of in this region. Metamorphosis in this region occurs during July at ca. 25 mm SVL. Given the timing of collection, the size of the frog, and the observation that this frog could capture and consume prey successfully, we are comfortable with suggesting that this frog was at least 16 months old.

The most likely wetland that produced this frog is ca. 500 m away from the collection site. This wetland is surrounded by farm fields maintained by the North Central Research Extension Office of North Dakota State University. The wetland is generally oval in shape and is approximately 200 x 100 m. It has held water continuously since 2007, but would dry periodically prior to this. When full of water, the maximal depth in this wetland is 1.75 m.

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***LITHOBATES SYLVATICUS* (Wood Frog). DAVIAN BEHAVIOR.** A breeding population of Spotted Salamanders (*Ambystoma maculatum*) has been monitored annually at Bat Lake, Algonquin Provincial Park, Ontario, Canada (45.5857°N, 78.5185°W) as part of an ongoing mark-recapture study. Minnow traps are deployed around the lake perimeter following spring thaw to capture adult *A. maculatum* during the breeding period. Traps are deployed at night and checked the following morning. On 2 May 2009 while checking traps we observed a male *Lithobates sylvaticus* in pectoral amplexus with a gravid female *A. maculatum* (86.0 mm



FIG. 1. Wood Frog (*Lithobates sylvaticus*) in amplexus with a gravid female Spotted Salamander (*Ambystoma maculatum*), Bat Lake, Algonquin Provincial Park, Ontario, Canada.

SVL, 20.5 g mass) (Fig. 1). Both individuals were found inside a submerged minnow trap ca. 1 m below the surface. The frog was tightly clasped around the pectoral girdle of the salamander, immediately posterior to the forelimbs. After photographing, the pair was separated. The *L. sylvaticus* was released without measurement and the *A. maculatum* was measured, weighed, and marked prior to release.

Interspecific amplexus is functionally equivalent to other well characterized Davian behaviors which include misdirected mating with conspecifics, necrogamy, or amplexus with inanimate objects. Observations of interspecific amplexus between anurans are recorded with some regularity (Meshaka 1996. Florida Scient. 59[2]:74–75; Eaton et al. 1999. Can. Field Nat. 113:512–513; Pearl et al. 2005. Am. Mid. Nat. 154:126–134; D'Amore et al. 2009. Herpetol. Cons. Biol. 4:325–330). By contrast, reports of interspecific pairings of salamanders are rare and restricted to specific species or well-characterized hybridization events (Verrell 1990. J. Zool. Lond. 221:441–451; Verrell 1994. Evolution 48:921–925). An exhaustive search of the formal literature revealed few observations of amplexus between an anuran and caudate, including *Bufo bufo* and *Salamandra salamandra* (Marco and Lizana 2002. Ethol. Ecol. Evol. 14:1–8), although this phenomenon is likely underreported.

It has been proposed that Davian behaviors may result from the highly competitive nature of anuran reproduction characterized by seasonal (time sensitive) and explosive reproductive aggregations (Meshaka 1996, *op. cit.*; Reading 1984. J. Zool. Lond. 203:95–101). Given the shared breeding habitat and synchronized breeding periods of *L. sylvaticus* and *A. maculatum*, mate misidentification seems a likely cause. While close confinement may have facilitated the Davian behavior reported here, previous observations of interspecific amplexus in other species affirm that this behavior is naturally occurring. The fact that the frog exhibited a pectoral girdle clasp further suggests that it was attempting to engage in normal amplexus rather than an accidental or temporary effort.

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***LITORIA RANIFORMIS* (Growling Grass Frog). LEUCISM.** *Litoria raniformis* is a large, semi-aquatic frog that occurs naturally across south-eastern Australia, including parts of New South Wales, Victoria, Tasmania, and South Australia (Pyke 2002. Austr. Zool. 32:32–48). Introduced populations also occur in New Zealand (Voros et al. 2008 Austral. Ecol. 33:623–629). *Litoria raniformis* is listed as endangered by the IUCN. On 24 January 2012, we caught a leucistic *L. raniformis* in a wetland in Bundoora, Melbourne, Victoria, Australia (37.7°S, 145.033°E). It was found in good physical condition, floating among emergent vegetation near the water's edge. Two adult female *L. raniformis*, of typical green and brown coloration were also caught in the same water body. The leucistic individual was an adult male (64 mm SVL) in breeding condition (Fig. 1). It was entirely yellow with a pink tinge, except for darkly pigmented eyes, and raised brown nuptial pads on its thumbs. The dorsal skin was translucent. We observed the leucistic *L. raniformis* on 22 February 2012 in the same wetland, ca. 30 m from the original point of capture. No attempt was made to recapture this individual. It has been suggested that incidences of leucism and albinism may occur with more frequency in nocturnal or cryptozoic animals, due to selection against these traits in diurnal species with visually orientated predators (Sazima and Di-Bernado 1991. Mem. Inst. Butantan 53:167–173). Interestingly, *L. raniformis* is partly diurnal, with individuals often observed basking in either direct or filtered sunlight (Heard et al. 2006. Wildl. Res. 33:557–564). To our knowledge, this is the first documented case of leucism in *L. raniformis*. A section of toe-web was deposited in the tissue collection of Museum Victoria, Australia (NMVZ 17602).

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FIG. 1. Adult male leucistic *Litoria raniformis* from Melbourne, Victoria, Australia.

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***OOPHAGA PUMILIO* (Strawberry Poison Frog). PREDATION.** Bright coloration in dendrobatid frogs is presumed to function as an aposematic signal to natural predators with color vision (Saporito et al. 2007. Copeia 2007:1006–1011), thereby warning predators such as birds of the frog's alkaloid-based chemical defenses. The known natural predators of dendrobatid frogs are based largely on anecdotal reports, and include an amphibian, ant, fish, spiders, and snakes (Santos and Cannatella 2011. Proc. Nat. Acad. Sci. 108:6175–6180). *Dendrobates auratus* was reportedly preyed upon by an adult *Baryphthengus martii* (Rufous Motmot) at the La Suerte Biological Station in northeastern Costa Rica (Limon Province), representing the only known bird predator of dendrobatid frogs (Master 1998. Herpetol. Rev. 29:164–165). Herein, we report an additional observation of predation by a Rufous Motmot on *Oophaga pumilio*.

Oophaga pumilio ranges from southern Nicaragua to western Panama (Guyer and Donnelly 2005. Amphibians and Reptiles of La Selva, Costa Rica, and the Caribbean Slope. Univ. California Press, Berkeley. 299 pp.), and falls well within the geographic range of *B. martii* (Garrigues and Dean 2007. *In* The Birds of Costa Rica, p. 146). On 15 May 2011, at the OTS La Selva Biological Station in northeastern Costa Rica (Heredia Province), between 1000–1100 h, we observed two independent events in which one individual of a pair of adult *B. martii* landed on a branch carrying an adult *O. pumilio* in their beak (Sendero Tres Rios trail between 100–150 m; Fig. 1). The pair of Rufous Motmots was observed carrying the captured *O. pumilio* to their nest of chicks only a few meters away, presumably feeding the frogs to their young. Motmots typically nest in deep cavities, and therefore we were not able to observe the chicks feed on the frogs; however, the pair of Rufous Motmots was also observed bringing to its nest spiders and fruits of *Virola koschnyi* (Myristicaceae). Rufous Motmots are reported to feed on the fruits of palms and members of the plant genus *Heliconia*, as well as insects, spiders, small frogs, lizards, fishes, and crabs (Stiles and Skutch 1989. *In* A Guide to the Birds of Costa Rica, p. 242). To the best of our knowledge, this represents only the second report of a Rufous Motmot feeding upon a dendrobatid, and the first report of these birds feeding their young a dendrobatid poison frog. Further research is needed to determine the extent to which *O. pumilio* is preyed upon by *B. martii*, the importance of *O. pumilio* as a dietary source for developing chicks, and how *B. martii* are presumably immune to the alkaloid defenses of *O. pumilio*.



FIG. 1. An adult *Oophaga pumilio* (Strawberry Poison Frog) being preyed upon by an adult *Baryphthengus martii* (Rufous Motmot) at La Selva Biological Station, Costa Rica during May 2011.

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***PELOPHRYNE MISERA* (Kinabalu Dwarf Toad). NOVEL MICROHABITAT AND MAXIMUM SIZE.** *Pelophryne misera* is a minute anuran (to 21 mm SVL in males, and 23 mm SVL in females) (Inger and Stuebing 2005. A Field Guide to the Frogs of Borneo. 2nd ed. Natural History Publications [Borneo] Sdn. Bhd. Kota Kinabalu. viii + 201 pp.) which is endemic to Borneo (Mount Kinabalu in Sabah and Mount Murud in Sarawak of Malaysia, and Upper Sulon in East Kalimantan of Indonesia) (Malkmus et al. 2002. Amphibians and Reptiles of Mount Kinabalu [North Borneo]. A.R.G. Gantner Verlag K.G. Ruggell. 424 pp.; Veith et al. 2004. Tropical Zool. 17:1–13; Inger and Stuebing 2005, *op. cit.*). The species inhabits primary and old secondary mossy forests on the forest floor (breeding site) and sometimes in low vegetation 10–50 cm from the ground at 1450–3140 m elev. (Malkmus et al. 2002, *op. cit.*). The species is listed as Vulnerable in 2011 IUCN Red List of Threatened Species primarily due to restricted distribution, but is deemed locally abundant (Inger et al. 2004. *In* IUCN 2011. IUCN Red List of Threatened Species. Version 2011.2. <www.iucnredlist.org>. Accessed on 15 June 2012). There is still inadequacy in the natural history understanding on *P. misera* attributed to the scarcity of its record of occurrence, and thus, herein we report a novel microhabitat at an extended vertical dimension, and maximum size for *P. misera*.

On 11 December 2008, between 1900 and 2200 h, three *P. misera* were discovered via opportunistic examination at Geludu Trail (6°N, 116.5375°E; 1478 m elev.) on Geludu Hill, Bundu Tuhan, Ranau District, West Coast Division, Sabah, Bornean Malaysia. Air temperature was 17.3°C, and relative humidity was 86%. The individuals were located among mosses covering a part of an old iron water pipe at 150 cm above the ground. Approximately 25 m of the 30-cm-diameter pipe was exposed from the ground caused by erosion that happened quite some time ago as indicated by surrounding thick leaf litter and compacted soil, while the rest of the pipe was still buried underground. The three *P. misera* were found close to one another about 5 m from a buried edge of the pipe. The pipe is utilized to supply clean water to nearby villages.

Intensive search did not find potential predators in proximity. The finding of three individuals, coupled with the absence of predators omit the causal factors of randomness and predator avoidance for the occurrence of *P. misera* at the novel microhabitat. Moisture might have played a role in motivating *P. misera* to occupy the long patch of live mosses on the exposed water pipe as moisture is an imperative factor determining the selection of non-breeding microhabitats for anurans for foraging, thermoregulation, and dispersal (Blomquist and Hunter 2009. Herpetol. Conserv. Biol. 4[2]:142–160). Documentation and understanding of non-breeding microhabitats are equally as crucial as of breeding sites and tadpole habitats in the conservation of anurans (Gillespie et al. 2004. J. Trop. Ecol. 20:439–448; Regosin et al. 2005. J. Wildl. Mgmt. 69[4]:1481–1493), particularly of non-stream breeding species such as *P. misera*.

The three adult *P. misera* were determined to be two females (27 mm SVL, mass 0.4 g and 27 mm SVL, mass 0.3 g) and one male (16 mm SVL, mass 0.3 g) based on the presence of a row of yellowish brown mandibular spines on the male (Malkmus et al. 2002, *op. cit.*), and adult SVL ranges (Inger and Stuebing 2005, *op.*

cit.). SVL and weight were measured with a standard metric tape and an electronic balance. The individuals were photographed *ex-situ* indoors, and euthanized under the permission granted by the pertinent authority. The voucher specimens (Female 1: HEP00916; Female 2: HEP00917; Male 1: HEP00915) were deposited in BORNEENSIS, the Bornean reference collection of the Institute for Tropical Biology and Conservation, Universiti Malaysia Sabah. The two females represent the new maximum SVL for *P. misera*.

We are grateful to Indraneil Das (Institute of Biodiversity and Environmental Conservation, Universiti Malaysia Sarawak) for verification of the species. We thank Agnes James Lintanga for field assistance, Paulus Abas for field transportation, and Haleluyah Retreat Centre for lodgings support. Sampling was conducted under the permission granted by the Jawatankuasa Pemegang Amanah Hutan Simpanan dan Tanah Perumahan Bumiputera Kg. Bundu Tuhan, Ranau, to KBH. We also thank the Institute for Tropical Biology and Conservation, Universiti Malaysia Sabah for support.

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***PHYSALAEMUS GRACILIS* (Graceful Dwarf Frog). DEFENSIVE BEHAVIOR.** Many animal lineages independently developed different defensive behaviors in response to the presence of visually oriented predators (Bertoluci et al. 2007. Alytes. 25:38–44). Among anurans, defensive behaviors are divided into 30 categories (Toledo et al. 2011. Ethol. Ecol. Evol. 23:1–25), among them, the stiff-legged behavior (Sazima 1978. Biotropica 10:158). In this type of behavior the animal is motionless, with body flattened and legs stretched out (Costa et al. 2009. Herpetol. Notes 2:227–229). This behavior has been little reported anurans, comprising less than 5% of observations (Toledo et al. 2011, *op. cit.*). However, the behavior has been reported in Bufonidae (*Dendrophryniscus leucomystax, D. brevipollicatus, D. berthalutzae*), Brachycephalidae (*Euparkerella cochranae),* Cycloramphidae (*Proceratophrys boiei, P. appendiculata, P. melanopogon, Zachaenus parvulus*), Leptodactylidae (*Paratelmatobius poecilogaster, Scythrophrys sawayae*) and Microhylidae (*Arcovomer passarellii, Ctenophryne geayi, Stereocyclops parkeri, S. incrassatus*) (Toledo et al. 2011, *op. cit.*; Tonini et al. 2011. Herpetol. Notes 4:435–444). *Physalaemus gracilis* is possibly a complex of more than one species (IUCN 2012. IUCN Red List of Threatened Species. http://www.iucnredlist.org/amazing-species). It dwells in forest borders and Cerrado grasslands in Brazil, Paraguay, Uruguay, and Argentina, and is strongly adapted to disturbed and polluted environments (Frost 2011. http://research.amnh.org/vz/herpetology/amphibia/; IUCN 2012. IUCN Red List of Threatened Species. http://www.iucnredlist.org/amazing-species). On 11 Jan 2010 at 2000 h., we observed defensive behavior by a *P. gracilis* upon capture. After being manually captured and released moments after on the ground, the frog remained still with its legs stretched during more than 3 minutes (Fig. 1). The observation occurred in a temporary pool in an urban street in the town of Xangri-lá, north coast of the state of Rio Grande do Sul, Brazil (29.4712°S, 50.0143°W). Although other kinds of defensive behaviors have been observed in the Leiuperidae (Toledo et al. 2010. J. Nat. Hist. 44:1979–1988), our report is the first case of the stiff-legged defensive behavior for this family.



FIG. 1. *Physalemus gracilis* from Rio Grande do Sul, Brazil displaying the stiff-legged defensive behavior.

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***RHINELLA SCHNEIDERI* (Rococo Toad). BREEDING SITE.** *Rhinella schneideri* is a giant toad (210 mm maximum SVL) occurring in the xeric regions of Bolivia, Argentina, Paraguay, and Brazil (Cei 1980. Zool. Ital. Monogr. 2:1–609). Relatively little information is available on its breeding site associations. In soybean farmlands in Argentina, *R. schneideri* was found to occur around larger ponds that contained high diversity of vegetation along the pond's shore (Peltzer et al. 2006. Biodiv. Cons. 15:3499–3513). The association with vegetative structure is likely the result of its reproductive mode; it deposits its eggs in long gelatinous strings that are attached to aquatic plants (Cei 1980, *op. cit.;* Perotti 1997. Rev. Chil. His. Nat. 70:277–288). Observations on the reproductive biology of this species in other parts of its range are lacking. Here we describe a breeding site of *R. schneideri* in the Bolivian Gran Chaco.

While crossing the Parapetí River on 29 January 2011, we heard a chorus of three *R. schneideri* calling from a temporary pond located within the riverbed outside the community of Rancho Viejo, Cordillera Province, Santa Cruz Department, Bolivia (19.44055°S, 62.53694°W; WGS 84). This pond had most likely been formed by the floodwaters of the river, which had receded when we had crossed it. The next day we returned to the pond which was ca. 200 m from the nearest forest cover, and observed hundreds of *R. schneideri* tadpoles swimming within the pond. We did not observe any recently oviposited egg strands. The pond, which lacked both vegetative and woody debris structure, was ca. 13 m long, and 5 m wide with a substrate comprised entirely of sand. We also observed larval odonates (Corduliidae) within the pond.

The breeding site used is not consistent with previous reports documenting *R. schneideri*'s high affinity for breeding ponds with high aquatic and shoreline vegetation, as any sort of habitat structure was absent in this pond. While habitat structure was lacking, the pond's isolation may provide an amenable environment for the tadpoles of *R. schneideri*; the predator abundance and diversity was reduced as compared to other temporary ponds in the

region (Schalk, unpubl. data) and there were no other species of tadpoles co-occurring in the pond. Body size is generally positively correlated with vagility in amphibians (Duellman and Trueb 1986. Biology of Amphibians. McGraw Hill, New York. 610 pp.), thus the larger bodied *R. schneideri* may be able to make the long forays to these riverbed pools allowing them to exploit these ponds.

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***SCINAX FUSCOVARIUS* (Snouted Treefrog). PREDATION.** Vertebrates, invertebrates, and carnivorous plants are commonly documented as predators of anuran eggs, tadpoles, and post-metamorphic individuals (Toledo 2005. Herpetol. Rev. 36[4]:395–400). Most predation records by invertebrates upon anurans are credited to representatives of four classes of Arthropoda: Arachnida, Insecta, Crustacea, and Chilopoda (McCormick and Polis 1982. Biol. Rev. 57[1]:29–58). In the Neotropical region, spider predation upon frogs is mainly attributed to five spider families (Ctenidae, Pisauridae, Lycosidae, Sparassidae, and Theraphosidae; Menin at al. 2005. Phyllomedusa 4[1]:39–47), with the genera Ctenus, Cupiennius, and Oligoctenus (all ctenids) the three most typically documented (reviews in Menin et al. 2005, op. cit.; Toledo 2005, op. cit.). By the year 2009, the genus Phoneutria, including the medically important Brazilian ctenid Phoneutria nigriventer (Eickstedt 1994. In B. Barravieira [ed.], Venenos Animais: uma Visão Integrada, pp.151–172. EPUC, Rio de Janeiro), had not yet been recorded in the literature as an invertebrate predator of frogs (Santana et al. 2009. Bol. Mus. Biol. Mello Leitão 26:5965).

Herein, I report the spider *P. nigriventer* preying upon *Scinax fuscovarius*. During a herpetofaunal survey conducted on 30 May 2010 in a riparian forest near the Mogi-Mirim River (municipality of Conchal, state of São Paulo, southeast Brazil), I observed an adult *P. nigriventer* (31.2 mm cephalothorax + abdomen length) capturing an adult *S. fuscovarius* (26.1 mm SVL) on a road (disturbed sandy soil, with some holes and roots mixed with the ground, for maintenance of a small dirt road), following the edge of the riparian forest 10–15 m distant from the river margin. I observed the scenario just when the spider inserted its chelicerae into the frog's body along the side. The frog attempted to escape but became paralyzed a few minutes later. The predation (Fig. 1) was observed at night (2005 h), during peak activity of both species, in secondary Atlantic Forest (22.273822°S, 47.1866472°W; 579 m elev.). The weather was windy and cloudy; air temperature was 19.2°C; humidity 85.8%. I also observed ca. 30 *S. fuscovarius*, randomly distributed around and near the predation site, although none were heard calling. Approximately 15 *P. nigriventer* were also observed. I observed this event until the moment the spider started to handle the freshly dead frog and to walk in direction to a nearly hole/crevice in the soil, probably its shelter. To ensure vouchers, I then captured both individuals: *S. fuscovarius* was deposited at Coleção de Anfíbios "Célio F. B. Haddad" at UNESP, Rio Claro, Brazil - CFBH 32635, and the spider had been deposited at Butantan Institute, Brazil, but was unfortunately lost in an accidental fire in July 2010. Although this is the first predation record by *P. nigriventer* upon *S. fuscovarius*, considering the nocturnal habits and relatively high local densities for both species, the encounter and predation between these species is likely frequent.

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PHOTO BY RAFAEL P. BOVO



FIG. 1. *Scinax fuscovarius* being preyed upon by the spider *Phoneutria nigriventer* (Aranae: Ctenidae).

***SCINAX SQUALIROSTRIS* (Striped Snouted Treefrog). PREDATION.** Predation is an important cause of amphibian mortality, and many cases of predation by spiders are found in the literature (Menin et al. 2005. Phyllomedusa 4[1]:39–47). The neotropical hylid frog *Scinax squalirostris* occurs from central and southeastern Brazil to northeastern Argentina, including Uruguay and southeastern Paraguay. Herein, we report the predation on this species by a spider. On 22 June 2006, at 2130 h, in the Municipality of Vacaria, State of Rio Grande do Sul, Brazil, a *Phoneutria nigriventer* (Ctenidae) was observed preying on an adult male *Scinax squalirostris* (24 mm SVL) on a 40-cm leaf of *Paspalum exaltatum* (Poaceae) at a permanent pond. The spider (cephalotorax 11.2 mm x 8.3 mm) held the hylid with the chelicerae penetrated into its head, but released it when disturbed. The *P. nigriventer* is deposited in the spider collection of Museu de Ciências Naturais, Fundação Zoobotânica do Rio Grande do Sul (MCN 42600), and the *S. squalirostris* is deposited in the herpetological collection of Departamento de Zoologia, Universidade Federal do Rio Grande do Sul (UFRGS 5676).

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***SCINAX SQUALIROSTRIS* (Striped Snouted Treefrog), *SCINAX AROMOTHYELLA*. MORBID EMBRACE.** The neotropical hylid *Scinax squalirostris* occurs from central and southeastern Brazil

to northeastern Argentina, including Uruguay and southeastern Paraguay. *Scinax aromothyella* occurs in northeast Argentina, Uruguay, and southern Brazil. Herein, we report the occurrence of a morbid embrace at a permanent pond in the Municipality of Vacaria, State of Rio Grande do Sul, Brazil, on 22 June 2006, at 2140 h. An adult male *S. squalirostris* was found being preyed upon by a spider. When disturbed, the spider released the dead treefrog that fell to the ground. However, a few moments later another male *S. squalirostris* vocalizing in the area immediately amplected the corpse. On the same night, in the same pond, other cases of morbid embrace were observed among *S. aromothyella* individuals. Five males were found embracing other recently-dead conspecifics (possibly accidentally killed by researchers trampling). At least two of all corpses found were males. The collected individuals were deposited in the herpetological collection of Departamento de Zoologia, Universidade Federal do Rio Grande do Sul (UFRGS 5675, 5678). These observations occurred on the first rainy night after a long dry spell in that area. We suspect that the animals were under intense reproductive pressure and, due to the desperate attempt at mating, they invested in dead partners and/or those of the same gender.

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***SCUTIGER BOULENGERI* (Xizang Alpine Toad). NESTING.** While the development of *S. boulengeri* larvae has been previously reported (Song and Huang 1990. Acta Zootaxonomica Sinica 187–193), their nesting behavior is not yet described. From 9–30 June 2012, we observed more than 30 nests across the Qinghai Province of China. Gelatinous eggs were attached as a circular or globular mass to the bottoms of stones in small streams, along the edges of larger streams, and in ephemeral pools (Figs. 1, 2). One average-sized nest was counted and found to contain 323 eggs; some rocks contained multiple nests. Almost all nests were guarded by males, and of the few without male attendance, most appeared to be in various states of decay. Only one female was found underneath a stone with a nest, but a male was also present with the recently laid eggs. In areas where nests occurred, observed males—both with and without nests—outnumbered females more than twenty to one. These observations are consistent with the nest site selection, clutch size, and paternal guarding of nests described for another member of Megophryidae, *Leptobrachium boringii* (Zheng et al. 2011. Asian Herpetol. Res. 2[4]:199–215).



FIG. 1. Overturned *Scutiger boulengeri* nest, guarded by a male, in Qinghai, China.

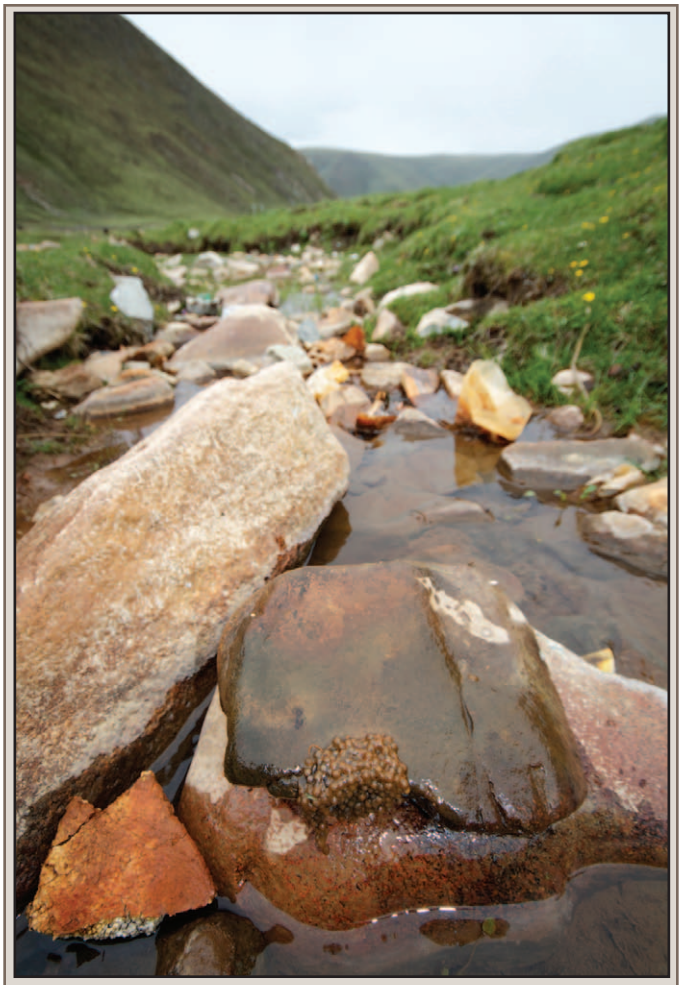


FIG. 2. Overturned *Scutiger boulengeri* nest (lower middle) in Qinghai, China.

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***XENOPHRYS BRACHYKOLOS* (Short-legged Toad). DIET.** *Xenophrys brachykolos* is endemic to Hong Kong with a SVL to 6 cm (Karsen et al. 1998. Hong Kong Amphibians and Reptiles. Provisional Urban Council, Hong Kong. 186 pp.). Although the natural diet of this species is unknown, it has been reported to feed on earthworms, crickets, and termites in captivity (Karsen et al. 1998, *op. cit.*). At 2000 h on 15 October 2011, in Pokfulam Country Park (22.268°N, 114.141°E, WGS84; elev. 250 m), Hong Kong, we observed an adult, gravid female *X. brachykolos* (5 cm SVL) sitting on a rock in a stream with a partly ingested earthworm (total length = 26 cm) in its mouth (Fig. 1). The earthworm was still alive and slowly wriggled out of the frog's stomach and eventually escaped. The earthworm appeared to be at least double the body size of the frog by volume and it seemed impractical for the frog to accommodate the whole worm in the stomach

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FIG. 1. Adult female *Xenophrys brachykolos* feeding on an earthworm much larger than its size in Hong Kong. The earthworm was still alive and slowly wriggled out of the frog's stomach and eventually escaped.

even if the earthworm was dead. To our knowledge, this is the first record of such unusual feeding behavior of this species.

Foraging of frogs is stimulated entirely by prey movement (Lettvin et al. 1959. Proc. IRE 47[11]:1940–1955), and frogs will attempt to ingest any prey that fits within its gape width limit. Without the ability to masticate, frogs are sometimes prone to mistakenly tackle prey larger than they can handle. The theory of optimal feeding strategy suggests that prey size selection is governed by the balance between the cost of handling and the benefit of eating the prey (Schoener 1966. Annu. Rev. Ecol. Syst. 2:369–404); therefore predators should not attempt to consume large prey if handling proves too costly, even if they can physically ingest it. Frogs are possibly one of the few taxa that defy this theory. Feeding behavior of this sort, although rarely reported, may occur more often than expected.

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TESTUDINES — TURTLES

***CHELONOIDIS CHILENSIS* (Argentine Tortoise). ECTOPARASITE.** *Chelonoidis chilensis* ranges from southwestern Bolivia and western Paraguay south to northwestern Argentina (Bonin et al. 2006. Turtles of the World. Johns Hopkins Univ. Press, Baltimore, Maryland. 416 pp.). It is listed as a vulnerable species on the IUCN Red List of Threatened Species (http://www.iucnredlist.org. Accessed 10 December 2012). Herein, we report a new host record for a tick found on *C. chilensis*.

A hatchling *C. chilensis* (voucher retained by the Museo de Historia Natural, Asunción, Paraguay) was collected by PSF in February 1996, 15.6 km S of Filadelfia and 37.7 km NW on the Ruta Transchaco (Dr. Carlos Antonio López) Highway, Boquerón District, Paraguay (22.3475°S, 60.2545°W; datum WGS84). It was infested with a single tick, which was placed in a vial containing 70% ethanol and sent to CTM. It was later forwarded to LAD for processing and identified as a female *Ambylomma dissimile* Koch, 1844. The specimen is deposited in the U.S. National Tick Collection, Statesboro, Georgia, under accession number RML 122343.

Although *A. dissimile* has been reported previously from amphibians and reptiles in Paraguay (Nava et al. 2007. Ann. Trop. Med. Parasitol. 101:255–270) this is the first time, to our knowledge, that it has been reported from *C. chilensis*. This tick is a common ectoparasite of various Neotropical reptiles and/or amphibians in Central America, the Caribbean, and South America (Guglielmone et al. 2003. Ticks [Acari: Ixodida] of the Neotropical Zoogeographic Region. International Consortium on Ticks and Tick-borne Diseases, Atalanta, Houten, Netherlands. 173 pp.; Voltzit 2007. Acarina 15:3–134). It also occurs in Florida (Keirans and Durden 1998. J. Med. Entomol. 35:489–495).

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***CHRYSEMYS PICTA MARGINATA* (Midland Painted Turtle). AVIAN PREDATION.** While conducting road-cruising surveys and systematic transect surveys to estimate reptile abundance from 1 May 2012 to 31 August 2012 on the Magnetawan First Nation, Ontario, Canada, we observed a high number of reptile road mortality events and predation on *Chrysemys picta marginata* by birds (Common Ravens (*Corvus corax*) and American Crows (*Corvus brachyrhynchos*)). The road mortality data are being used for another study; here we report the details of the avian predation events.

A total of 10 successful avian predation events on Painted Turtles (6 females, 2 males, 2 sex unknown) occurred between 27 May 2012 and 11 June 2012. These dates correspond with Painted Turtle nesting season at our site, and the time when males are moving among marshes in search of mates (pers. obs.; Ernst and Lovich 2009. Turtles of the United States and Canada, 2nd ed., John Hopkins Univ. Press, Baltimore, Maryland. 827 pp). An unsuccessful predation event occurred on 5 June 2012, when researchers chased a murder of American Crows off an adult female Painted Turtle who was flipped onto her carapace on the roadside. As they approached, the researchers noted a bird pecking at the legs of the turtle. The turtle was not injured, thus, it is presumed that the researchers interrupted the predation event.

All of the 10 bodies collected from the successful predation events indicated a consistent method used by the *Corvus* spp. to predate the turtles. Typically, the turtle would be found flipped onto its carapace, and had an open wound in the inguinal space of the hind limbs (Fig. 1). This opening would allow the birds' access to both entrails and eggs within gravid females. We found that the predation event did not immediately kill the turtle, but rather the turtle remained alive for 2–6 h post-predation (timing estimated based on durations between surveys). We found that over half of the individuals with internal organs missing still retained muscular function in their jaws and eyelids; it has been reported that brain function in freshwater turtles can persist for upwards of three hours after blood flow stops (Milton 2008. *In* Proceedings of the Turtle Stewardship and Management Workshop. Toronto Zoo, Toronto, Ontario. 17 pp). Turtles that were found predated but alive were euthanized to prevent further suffering.

As a result of the high intelligence and socialized problem-solving behaviors of *Corvus* spp. (Seed et al. 2008. Proc. Royal Soc. B, 275:1421–1429), and the uncommon occurrence of this method of predation, we suspect that this is a learned behavior

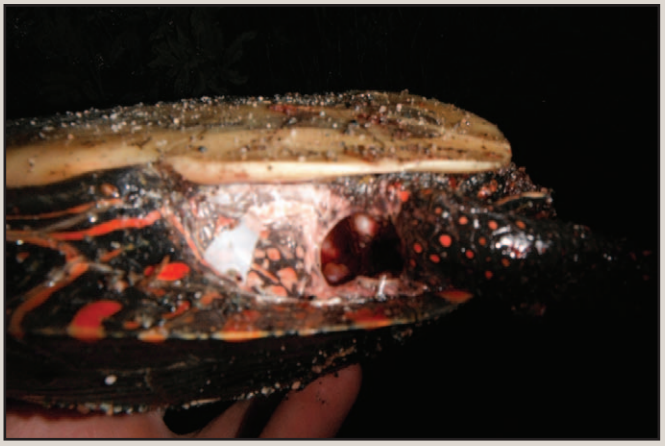


FIG. 1. Predation of *Chrysemys picta marginata* by Common Ravens (*Corvus corax*) and American Crows (*Corvus brachyrhynchos*). The avian predator would create an opening in the inguinal spaces of the hind limbs and then access the entrails and eggs of the turtle through that opening.

seen in the Magnetawan First Nation population (and perhaps other populations) of *Corvus* spp. rather than a genus-wide trait. Corvids have previously been documented to predate freshwater turtle eggs and hatchings (Rollinson and Brooks 2007. J. Herpetol. 41:174–176; Ernst and Lovich 2009, *op. cit.*), and to predate juvenile Desert Tortoises (*Gopherus agassizii*; Boarman and Kristan 2006. Evaluation of Evidence Supporting the Effectiveness of Desert Tortoise Recovery Actions. USGS Scientific Investigations Report 2006–5143, 27 pp.), but we found no published records of corvid predation on adult freshwater turtles. Birds of prey have been documented as avian predators of adult *C. picta* (Ernst and Lovich 2009, *op. cit.*). All of the corvid predation events we recorded occurred during spring, when the turtles are moving terrestrially in search of nest sites (females) or potential mates (males), so presumably the birds are targeting turtles when they out of the aquatic environment and most accessible.

Across North America, turtle populations are in decline (Gibbons et al. 2000. BioScience 50:653–666). Turtle populations rely on high adult survivorship to offset low juvenile recruitment and delayed sexual maturity (Gibbs and Shriver 2002. Conserv. Biol. 16:1647–1652), and any new source of adult mortality observed deserves further investigation, whether the source is anthropogenic (road mortality or habitat destruction) or ecological (invasive or adapting species).

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***CHRYSEMYS PICTA MARGINATA* (Midland Painted Turtle), *EMYDOIDEA BLANDINGII* (Blanding's Turtle). HATCHLING MORTALITY.** From 1 May to 31 August 2012, road-cruising and systematic transect surveys were conducted to quantify reptile road mortality. Surveys were conducted in three areas along highways in Ontario, Canada ([i] 13 km of Highway 69/400 in Sudbury District; [ii] 13 km of Highway 69/400 in Parry Sound District; and [iii] 6 km of Highway 529 in Magnetawan First Nation). A total of 173 *Chrysemys picta marginata* and 36 *Emydoidea blandingii* were found on the roads, and of this total, 31 of the *C. picta* (18%) and 1 of the *E. blandingii* (3%) were hatchlings. Of these hatchlings, all but one (97%) were found dead on the road (DOR); the only live hatchling was a *C. picta* found on Highway 529 (the lower traffic road) on 8 June 2012. The DOR hatchlings were found between 3 and 30 May 2012, the time period coinciding with spring nest emergence of *C. picta* in Central Ontario after overwintering within the nest chamber (Riley 2012. M.Sc. Thesis, Laurentian University, Canada), and the movement period of *E. blandingii* hatchlings from upland, terrestrial overwintering sites to wetlands (Paterson et al. 2012. Wildl. Res. 39:408–418). Female turtles are attracted to road-side gravel for nesting (Gibbs and Steen 2005. Cons. Biol. 19:552–556; Gibbs and Shriver 2002. Cons. Biol. 16:1647–1652). This behavior may not only increase the mortality risk to nesting females, but also increases mortality risk to the hatchlings through increased depredation and vehicle impact on roadways (Steen and Smith 2006. Herpetol. Cons. Biol. 1:9–15).

Collisions with vehicles are a known source of mortality for adult turtles, and this mortality can have population-wide effects. For instance, road morality skews sex ratios within populations (Gibbs and Steen, *op. cit.*) and decreases population sizes (Gibbs and Shriver, *op. cit.*). There has been extensive research examining the negative effects of road mortality on turtle populations, particularly pertaining to mortality of breeding females during nesting (Steen et al. 2006. Anim. Cons. 9:269–273; Gibbs and Steen, *op. cit.*; Marchand and Litvaitis 2004. Cons. Biol. 18:758–767). However, little research has documented the threats traffic and roads pose to the hatchling life-stage of turtles. Research on sea turtles has demonstrated that vehicular traffic on nesting beaches can negatively affect hatchlings by compacting substrate and preventing emergence from the nest, by disorienting hatchlings during migration from nest chamber to sea, and even killing hatchlings during collisions (Buckley 2004. Environmental Impacts of Ecotourism. CABI Publishing, New York. 389 pp.; Mann 1977. M.Sc. Thesis, Florida Atlantic University). For freshwater turtles, roads negatively affect eggs and hatchlings by increasing nest depredation (Steen and Smith, *op. cit.*); however, we are not aware of any documented cases of hatchling road mortality from vehicle impact.

The presence and mortality rate of hatchling turtles found on roads in our study was likely an underestimation for two reasons. First, scavengers patrol roadways and quickly remove dead individuals, reducing the likelihood of their discovery (Hubbard and Chalfoun 2012. Herpetol. Cons. Biol. 7:150–156). Second, our methodology did not include road surveys during the fall nest emergence period. Although high hatchling mortality is likely common for turtles (Heppell et al. 1996. Ecol. Appl. 6:556–565), unnaturally high levels of hatchling mortality can exacerbate population declines (Crouse et al. 1987. Ecology 68:1412–1423; Crowder et al. 1994. Ecol. Appl. 4:437–445; Seburn 2007. Recovery Strategy for Species at Risk Turtles in Ontario. Ontario Multi-Species Turtles at Risk Recovery Team, Canada). Roads are known to threaten turtle populations, and our observations demonstrate that these threats are present throughout all life stages of turtles.

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***CHRYSEMYS PICTA PICTA* (Eastern Painted Turtle). MORPHOLOGY.** Bicephaly, or having two heads, was known for *Chrysemys picta* from at least as far back as the late 1800s (Barbour 1889. St. Nicholas 16:525–527). Here we report the first observation of this morphological anomaly for Maine.

On 26 April 2012, an immature *C. p. picta* was observed moving across the lawn of a residence in Alfred, York Co., Maine, USA. Due to the time of year and the turtle's age (<1 yr old), it likely overwintered in the nest and had recently emerged (Fig. 1). The turtle was brought to a local wildlife rehabilitation center, and although it initially appeared healthy and fed normally with both heads, it died on 20 June 2012. Aside from possessing two heads the only other morphological anomaly observed is the presence of an extra marginal scute on each side of the carapace. The specimen has been deposited at the Yale Peabody Museum (YPM 18600).



FIG. 1. Bicephalic *Chrysemys p. picta* from Alfred, York Co., Maine, photographed on 19 May 2012.

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***EMYDOIDEA BLANDINGII* (Blanding's Turtle). FORAGING AND DIET.** *Emydoidea blandingii* is thought to be primarily carnivorous. Although the majority of reported prey consists of invertebrates, a wide variety of vertebrate prey has been documented, including fish, anurans, turtles, and birds. Fish most likely comprise the bulk of vertebrate prey (Ernst and Lovich 2009. Turtles of the United States and Canada, 2nd ed. Johns Hopkins Univ. Press, Baltimore, Maryland. 827 pp.).

On 6 May 2010 an adult *E. blandingii* was observed swimming in a roadside ditch adjacent to a mixed shrub-scrub and cattail (*Typha* sp.) wetland (44.666455°N, 75.229485°W; WGS 84) in St. Lawrence Co., New York, USA. The turtle proceeded to dive below a floating mat of European Frogbit (*Hydrocharis morsus-ranae*) and resurfaced grasping a still moving Central Mudminnow (*Umbra limi*) in its mouth. The turtle then dove below the vegetation mat a second time, where it presumably consumed the *U. limi*. This is the first documented instance of *E. blandingii* preying upon *U. limi*. This observation is significant due to the fact that both species occupy eutrophic, shallow water wetlands and are focally distributed around the Great Lakes region (Ernst and Lovich 2009, *op. cit.*; Hubbs et al. 2004. Fishes of the Great Lakes region, rev. ed. University of Michigan Press, Ann Arbor, Michigan. 276 pp.). Because of this, *U. limi* may be a food source for *E. blandingii* throughout a substantial portion of its range. It is also significant that this predation event occurred in and around the exotic *H. morsus-ranae*, a fairly recent invader of the wetlands of north-central St. Lawrence Co. (Catling and Dore 1982. Rhodora 84[840]:523–545). The presence of *H. morsus-ranae* has been shown to functionally alter invaded wetlands (Catling et al. 1988. Nat. Can. 115[2]:131–137), and may also have unknown effects on the ecology of *E. blandingii*.

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***HOMOPUS FEMORALIS* (Greater Padloper). REPRODUCTION.** *The reproduction of Homopus femoralis* has not been systematically studied, but field guides report that the species produces clutches containing up to three eggs in spring (November) and summer, at egg lengths (EL) of 29–36 mm, and egg widths (EW) of 25–27 mm (Boycott and Bourquin 2000. The Southern African Tortoise Book. Privately printed, Hilton, South Africa. 228 pp.; Branch 2008. Tortoises, Terrapins and Turtles of Africa. Struik Publishers, Cape Town. 128 pp.). I radiographed wild females (SCL > 114 mm based on females reproducing in captivity, pers. obs.) from Beaufort West Municipality, South Africa, in December 2008, February 2010 (summer), and October 2011 (spring), and recorded SCL and shell volume (SV, Loehr et al. 2004. Herpetologica 60:444–454) for each individual. I measured pelvic widths (PW), EL, and EW on radiographs to the nearest 0.5 mm, and corrected measurements to actual dimensions (Graham and Petokas 1989. Herpetol. Rev. 20:46) using a focus to film distance of 1000 mm, an egg radius of 13.54 mm, and an estimated distance between film and egg of 5 mm. Egg lengths of some eggs

TABLE 1. Means, standard deviations, and ranges of pelvic widths (mm), clutch and egg dimensions (mm) and volumes (cm^3), in three wild *Homopus femoralis* females.

	Mean	SD	Range	N
Clutch size	3.0	1.73	1–4	3
Clutch volume	36.5	23.01	9.92–50.35	3
Egg length	31.3	2.93	28.0–33.6	3
Egg width	26.6	0.51	26.02–27.0	3
Egg volume	11.6	1.46	9.9–12.6	3
Pelvic width	31.7	1.24	30.4–32.9	3

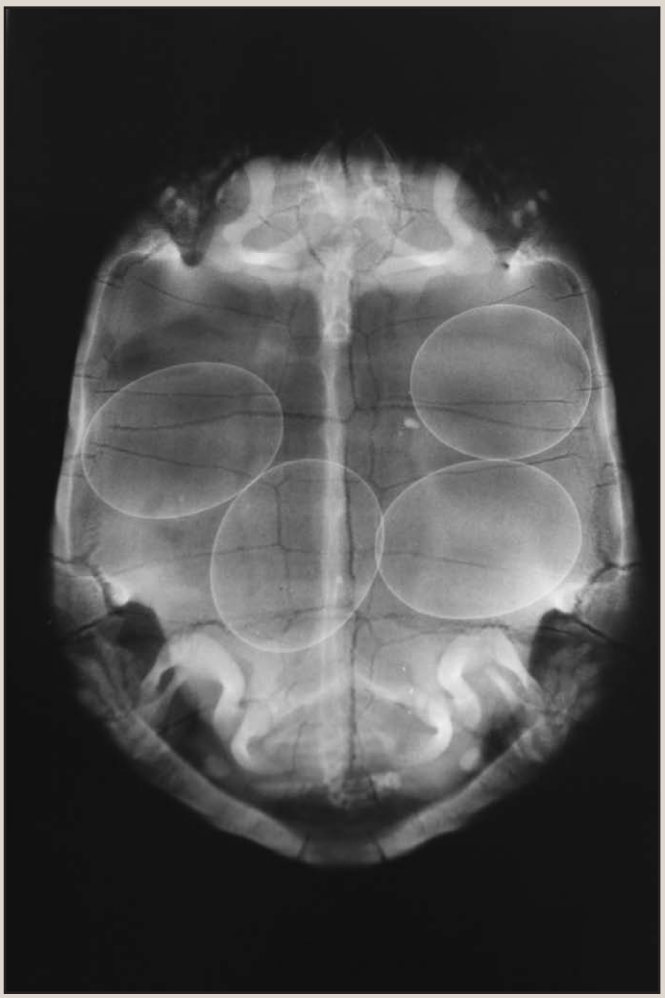


FIG. 1. Radiograph of a female *Homopus femoralis* containing four eggs.

may have been underestimated when long axes of eggs were not parallel to the film plane. The corrected EL and EW was used to estimate egg volume (EV, Loehr et al. 2004, *op. cit.*). To avoid pseudoreplication, mean dimensions for all eggs in a clutch (i.e., eggs with the same level of calcification) were treated as single samples.

Six females (SCL 116.64–137.29 mm; SV 269.15–447.86 cm^3) radiographed in summer did not contain calcified eggs. In spring all three individuals that were radiographed contained calcified eggs: one female (SCL 130.54 mm; SV 392.38 cm^3) contained one egg, and two others (SCL 127.36 and 133.46 mm; SV 389.18 and 393.16 cm^3) each contained a clutch of four eggs (Fig. 1; Table 1). Clutch volume was 2.5–12.8% of SV.

Egg dimensions tended to fall within the range published previously, and their production did not appear to require pelvic kinesis. The recorded clutch size represents a new maximum for the species. Clutch volume relative to SV exceeded the ratio found for congener *Homopus signatus* that produces relatively large eggs (Loehr et al. 2011. Copeia 2011:278–284). The lack of females with calcified eggs in summer may indicate that the species' low activity level (Loehr 2012. Afr. Zool. 47:294–300) enables it to produce only a single clutch annually.

Thanks are extended to Beaufort West Hospital (Marcel van Wyk in particular) for radiographing the tortoises.

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***KINOSTERNON FLAVESCENS FLAVESCENS* (Yellow Mud Turtle). ROAD-CARRION FEEDING.** *Kinosternon flavescens flavescens* is found in almost any quiet water within its range but readily moves over land, occasionally migrating between bodies of water (Ernst et al. 1994. Turtles of the United States and Canada. Smithsonian Institution Press, Washington, D.C. 578 pp.). Studies from Oklahoma revealed that the diet of adult *K. flavescens* comprises, by volume, Insecta (27.8%), Crustacea (27.7%), Mollusca (23.5%), Amphibia (9.2%), aquatic vegetation (8.5%), and carrion (3.2%) (Mahmoud 1968. Herpetologica 24:300–305). Given that carrion is such a limited part of the diet of *K. flavescens* and no records of road scavenging were found for any species in the genus *Kinosternon*, herein I describe *K. f. flavescens* scavenging on a dead-on-road (DOR) Striped Skunk (*Mephitis mephitis*).

While driving on 3 July 2010, I noticed a small turtle near the carcass of a Striped Skunk on the shoulder of U.S. Hwy. 82, ca. 1.5 km W of Crosbyton, Crosby Co., Texas, USA. Closer examination revealed that a male *K. f. flavescens* (carapace = 135 mm; plastron = 104 mm) was feeding on the extruded organs of the recently struck Striped Skunk. The turtle and skunk were subsequently moved to the grassy bar-ditch where the turtle began to re-feed on the entrails. Heavy rains occurred in the area during the previous two weeks and probably initiated the *K. f. flavescens* to move between local playa lakes found on either side of the highway. Rainfall is known to stimulate movement in *K. flavescens* (Ernst et al. 1994, *op. cit.*), a behavior also observed in *K. subrubrum* where a mass movement and mass road mortality followed a local "deluge of rain" (Crawford and Doyle 2010. Herpetol. Rev. 41:71). The discovery of the skunk by the *K. f. flavescens* was probably incidental to a post rainfall migration.

Many fully aquatic turtles are known to utilize carrion (Ernst et al. 1994, *op. cit.*) but most are spatially limited to DOR scavenging, whereas tortoises and terrestrial turtles have a more direct access to scavenge DOR carrion. Examples include Gopher Tortoises (*Gopherus polyphemus*) scavenging a dry, flattened Great-horned Owl (*Bubo virginianus*) and an armadillo (*Dasypus novemcinctus*) (Jackson and Ostertag 1999. Herpetol. Rev. 30:40); an Eastern Box Turtle (*Terrapene carolina*) feeding on the entrails of a DOR *Agkistrodon contortrix* (Jensen 1999. Herpetol. Rev. 30:95); an Ornate Box Turtle (*T. ornata*) eating the entrails of a DOR *Bufo cognatus* (Hill and Wilcoxen 2005. Herpetol. Rev. 36:443); and a Desert Box Turtle (*T. ornata luteola*) found on a road with a DOR *Phrynosoma modestum* in its mouth (Germano 2009. Herpetol. Rev. 40:80). Opportunistic scavenging of DOR vertebrates by wandering turtles and tortoises is potentially a significant dietary resource. However, it also encourages turtles to loiter along roadways and is a potential source of mortality in these situations.

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***KINOSTERNON INTEGRUM* (Mexican Mud Turtle). ECTOPARASITES.** Leeches (Hirudinea) are common ectoparasites of aquatic reptiles, especially of turtles and crocodilians, and can cause anemia, bacterial, and protozoal infections in their hosts (Lane and Mader 1996. *In* D. R. Mader [ed.], Reptile Medicine and Surgery, pp. 185–203. W. B. Saunders Co., Philadelphia, Pennsylvania). In Mexico only 27 species of leeches are known, of which three belong to the genus *Placobdella* (Oceguera-Figueroa et al.

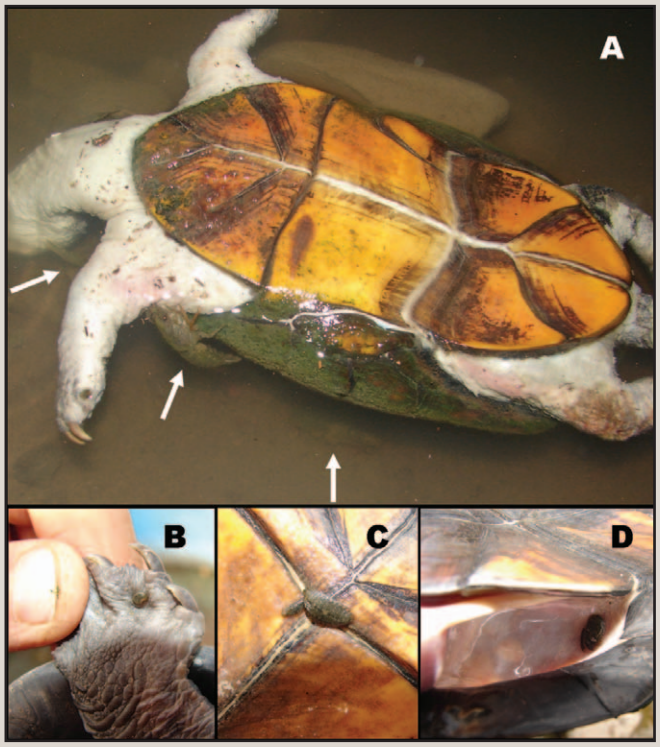


FIG. 1. A) Individuals of *Cambarellus montezumae* tearing tissue from the *Kinosternon integrum* carcass. B) A leech individual on the hind right web foot. C) Two leeches on the plastron surface. D) Leech mass individuals inside of the left hind limb cavity.

2010. Sanguijuelas. CONABIO. Biodiversitas 90:1–5). This genus is well represented in North America, with members that feed almost exclusively on freshwater turtles (Sawyer 1972. Illinois Biol. Monogr. 46:18–23).

Here we report a new host record and mean intensity data for *Placobdella mexicana,* which was previously recorded on *Kinosternon hirtipes* (Lamothe Argumedo et al. 1996. Catálogo de la Colección Nacional de Helmintos. Universidad Nacional Autónoma de México, México), and we document the first record of freshwater crayfish (*Cambarellus montezumae*) feeding on a *K. integrum* carcass.

On 18 August 2012, during fieldwork around a pond's edge in the Municipality of Chapala, Jalisco, México (20.323612°N, 103.218758°W, datum WGS 84; elev. 1790 m), we found one dead adult specimen of *K. integrum* (JLB-R022: carapace length [CL] = 138.80 mm) at 2105 h. The specimen showed a perforation between the fourth and fifth vertebral scute of the carapace, suggesting that death was caused by a gunshot. Upon examination of the carcass we observed adult individuals of crayfish feeding actively on the carcass (Fig. 1A); crayfish specimens were collected and identified as *Cambarellus montezumae* (Saussure, 1857) (Crustacea: Decapoda: Cambaridae). This feeding behavior can be related to their general and opportunistic habits, including cannibalism, previously reported (Gherardi 2002. *In* D. M. Holdich [ed.], Biology of Freshwater Crayfish, pp. 258–290. Blackwell Science, Oxford, UK). Moreover, we found two parasitic leeches on the *K. integrum* carcass, both in soft tissue on the neck; these were collected and identified as *Placobdella mexicana* Moore, 1898 (Hirudinea: Rhynchobdellida: Glossiphoniidae). Additionally, we have five records of living specimens of *K. integrum* parasitized by leeches (*P. mexicana*) found at Chapala's lakeshore on 27 March 2012 (2 specimens) and 18 November 2012 (3 specimens) (20.314078°N, 103.135139°W, datum WGS 84; elev. 1530 m). In these five specimens the mean intensity of infection (mean number of leeches per infected turtle ± SD) was 11.2 ± 16.54 SD, range = 1–44. The affected body parts were the ventral surface of the plastron, and soft tissues of the neck, limbs (specially front and hind limb cavities), and tail (Fig. 1B, C, D).

All samples (crayfish and leeches) were deposited at the Entomological Collection, Centro de Estudios en Zoología, CUCBA, Universidad de Guadalajara (CZUG), and the Colección Nacional de Helmintos, Instituto de Biología, Universidad Nacional Autónoma de México (UNAM). JLB-R was supported by a Scholarship from CONACYT for his Master degree.

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***MALACLEMYS TERRAPIN* (Diamond-backed Terrapin). COASTAL EROSION AND NEST MORTALITY.** *Malaclemys terrapin* inhabits coastal salt and brackish marshes from Texas to Massachusetts along the Gulf and Atlantic coasts of the United States (Ernst and Lovich 2009. Turtles of the United States and Canada, 2nd ed. John Hopkins Univ. Press, Baltimore, Maryland. 827 pp.). Terrapins usually nest in sandy or porous substrates along coastal beaches, sand dunes, sand spits, or shell islands. In these habitats, nesting usually occurs above mean high tide levels and in areas with little erosion (Burger 1977. Am. Midl. Nat. 97:444–464). However, Roosenburg (1992, Ph.D. dissertation, Univ. of Pennsylvania) and Butler et al. (2004. Am. Midl. Nat. 152:145–155) noted that terrapin nests were sometimes "washed out" by high tides or buried by shifting sand, but nest loss due to large-scale, coastline erosion has not been reported. Herein we report on a terrapin nest that was destroyed by barrier island erosion in coastal Louisiana, with discussion on potential



PHOTO BY ME2 MARK CAMACHO, UNITED STATES COAST GUARD

FIG. 1. Evidence of coastal erosion that has encroached into the nest cavity of a Diamondback Terrapin (*Malaclemys terrapin*) nest on the island of East Grand Terre (Plaquemines Parish, Louisiana).

PHOTO BY A. WHITE



FIG. 2. An example of a rapidly eroding shoreline near the locality of the terrapin nest on East Grand Terre Island (Plaquemines Parish, Louisiana). Note the installed sand fencing—a dune formation and coastal erosion control measure—that is also being lost to coastal erosion.

population-level consequences that coastal erosion may have on Louisiana terrapin populations.

On 15 May 2012, one of us (MC, U.S. Coast Guard) was on the island of East Grand Terre (Plaquemines Parish, Louisiana) and noted an exposed terrapin nest along the edge of an eroding shoreline (29.306541°N, 89.874788°W). MC took a photograph of the nest (Fig. 1) and sent it to the additional authors (BS, AW, JW, and WS), all biologists with the Louisiana Department of Wildlife and Fisheries (LDWF). This was almost certainly a terrapin nest as there is no other nesting turtle species recorded for the island (A. White, unpubl. data). Unfortunately, LDWF biologists could not arrange a boat trip to revisit the site for a month and therefore could not confirm the fate of the nest (i.e., nest failure directly or indirectly linked [nest desiccation] to shoreline erosion). BS searched the location on 13 June 2012 and found no exposed nest, but only an undercut beach shoreline in the nest location. This shoreline is known to be frequently subjected to high rates of erosion during times of unusually high tides and storms (Fig. 2). This nest can be presumed lost, thus this observation represents the first reported terrapin nest destroyed, whether directly or indirectly, by landscape-level coastal erosion.

Unfortunately, the State of Louisiana is losing coastal marshes and barrier islands at alarming rates due to coastal erosion and coastal conversion of land to water. The greatest land losses in coastal Louisiana occur in the Mississippi Deltaic Plain (Barras et al. 2008. USGS Sci. Inv. Map 3019), which also holds the most confirmed terrapin localities in the state (Dundee and Rossman 1989. The Amphibians and Reptiles of Louisiana. Louisiana State Univ. Press, Baton Rouge. 316 pp.). Land losses have also impacted many barrier island complexes which have been lost or highly degraded over the last few decades (e.g., Chandeleur Islands, Isle Dernieres).

With terrapins using "fringe" brackish and saline marshes that are being lost annually, as well as utilizing rapidly eroding barrier islands for nesting habitat, these factors could detrimentally impact the long-term viability of Louisiana terrapin populations. These factors, along with a paucity of knowledge about terrapins in the state, have led to an increased interest in terrapin research in Louisiana (see Selman and Baccigalopi 2012. Herpetol. Rev. 43:583–588). Current and future research will focus on documenting the distribution and abundance of the species in the state (Selman et al., unpubl. data), as well as documenting nesting beaches and nesting ecology of terrapins in coastal Louisiana (White et al., unpubl. data).

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***MALACLEMYS TERRAPIN* (Diamond-backed Terrapin). DREDGING FORAGING BEHAVIOR.** Diamond-backed Terrapins are the only species of turtle specialized to inhabit the brackish coastal ecosystems along the Atlantic and Gulf coasts of North America. They show unique physiological and behavioral adaptations that enable them to live within these saline environments (Cowan 1971. Can. J. Zool. 49:691–697; Cowan 1990. Can. J. Zool. 68:1520–1524; Davenport and Macedo 1990. J. Zool. Lond. 220:487–496; Gilles-Baillien 1973. J. Exp. Biol. 59:39–43; Hart and Lee 2006. Stud. Avian Biol. 32:206–213). Diamond-backed Terrapins also inhabit Bermuda, a group of small islands (32.30889°N, 64.74599°W; WGS 84) situated 965 km ESE of Cape Hatteras, North Carolina, USA. This population, the only one outside the USA, is considered native (Parham et al. 2008. Biol. Lett. 4[2]:216–219) and is found only in four brackish water ponds located at the eastern end of the archipelago. All four bodies of water are situated within a single square kilometer of area on a private golf course and are separated from each other by <380 m of land (MO, unpubl. data).

Diamond-backed Terrapins are carnivorous and feed primarily upon a variety of marine molluscs and crustaceans (namely periwinkles, crabs, mussels, and clams) throughout their North American range (Tucker et al. 1995. Herpetologica 51:167–181; Spivey 1998. M.Sc. thesis, Univ. North Carolina. 80 pp.; Roosenburg et al. 1999. Chel. Cons. Biol. 3:425–429; Petrochic 2009. M.Sc. thesis, Long Island Univ. 66 pp; Butler et al. 2012. Chel. Cons. Biol. 11[1]:124–128; Erazmus 2012. M.Sc. thesis, Hofstra Univ. 46 pp). These studies indicate that there are geographic differences in the diet of terrapins that may reflect variations in prey availability and accessibility. This turtle appears to be a predator that normally uses visual cues while foraging, showing selectivity in the prey that it eats (Davenport et al. 1992. J. Mar. Biol. Assoc. U.K. 72:835–848; Tucker et al. 1995. Herpetologica 51:167–181; Tucker et al. 1997. Amer. Midl. Nat. 138:224–229).

A study investigating the biology, including diet and feeding ecology, of Bermuda's Diamond-backed Terrapins was performed between 2008 and 2012. One of the brackish ponds where the Bermuda population resides (South Pond) is small (0.44 ha), non-tidal, very shallow (mean depth 35 cm), and contains a 0.27 ha grass-dominated marsh in its center. The annual salinity (measured with an optical refractometer) averaged 10.8 practical salinity units during this period, and the water clarity was often very good, which presented excellent opportunities for observing the terrapins. South Pond has also been incorporated as a water hazard feature on the golf course for the past eight decades. The terrapins that reside in this pond have become habituated to the frequent presence of people and readily forage in

the presence of observers. During the five-year study period, terrapins were commonly observed moving slowly along the bottom of the pond taking successive mouthfuls of sediment during both diurnal and nocturnal surveys. The head was often buried within the sediment during this behavior. The benthic sediment in South Pond is gelatinous and sapropelic, consisting of highly organic mud and detritus. It also contains the deposit-feeding thiarid gastropod *Melanoides tuberculata*, a non-native burrowing species that is known to reach densities <23,000 m^{-2} (Roessler et al. 1977. Florida Sci. 40[1]:87–94). *Melanoides tuberculata* is parthenogenetic and viviparous; breeding females (5+ mm shell length) release large numbers of juveniles (1–2 mm shell length) (Appleton et al. 2009. Zool. Meded. 83:525–536).

Such dredging-style foraging behavior has not been reported in the scientific literature before, possibly because the inconspicuous nature of Diamond-backed Terrapins, together with the turbid waters of the brackish coastal environments in North America where they feed, have precluded effective foraging observations in the wild. It is evidently a behavioral adaptation that has allowed terrapins in Bermuda to take advantage of the small benthic gastropods inhabiting the gelatinous pond sediment. Given the small size and burrowing habit of these gastropods, we propose that Bermuda's terrapins are haphazardly consuming the sediment ("deposit-feeding") in a manner that increases the chances of incidentally ingesting the small gastropods found within it. In support of this hypothesis, we have conducted fecal analyses that confirm that Bermuda's terrapins are consuming high numbers of small *M. tuberculata*, together with large quantities of sediment (MO, unpubl. data). This foraging behavior is inevitably exposing them to harmful contaminants (particularly heavy metals, gasoline-range and diesel-range petroleum hydrocarbons, and polycyclic aromatic hydrocarbons) that have been found within this medium (Fort et al. 2006. Appl. Herpetol. 3:143–172; J. Bacon, pers. comm.).

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***PHRYNOPS GEOFFROANUS* (Geoffroy's Side-necked Turtle). ENDOPARASITE.** *Phrynops geoffroanus* is a freshwater chelid turtle that occurs in South America from Colombian Amazonia to the Brazilian state of Rio Grande do Sul, and from Uruguay to northern Argentina (Lema and Ferreira 1990. Acta Biol. Leopoldensia 12:125–164; McCord et al. 2001. Rev. Biol. Trop. 49:715–764). It inhabits the shallow areas of both lakes and rivers (Pritchard and Trebbau 1984. The Turtles of Venezuela. Society for the Study of Amphibians and Reptiles, Oxford, Ohio. 403 pp.; Ernst and Barbour 1989. Turtles of the World. Smithsonian Institution Press, Washington. 313 pp.). In Brazil, this species can be common in rivers in urban areas (Souza and Abe 2001. Stud. Neotrop. Fauna Environ. Ecol. Syst. 36:57–62.; Lisboa et al. 2004. Arq. Inst. Biol. 71:392–393). The trematode parasites of Brazilian *P. geoffroanus* are apparently poorly known. Between 2006 and 2007, six specimens of *P. geoffroanus* that were already deposited in the Coleção Herpetológica of the Departamento de Zoologia, Universidade Federal de Juiz de Fora (UFJF) (CHLZ - UFJF 564–568, 570) were necropsied. All specimens are from the municipality of Juiz de Fora, Minas Gerais state, Brazil (21.68888°S, 43.34444°W). Trematodes were collected from the small intestine of two male adult host specimens (prevalence: 33.5%, mean intensity: 4 parasites per infected host). After collection, the parasites were fixed in AFA (70% ethanol, 93 parts; 37% formalin, 5 parts; glacial acetic acid, 2 parts) for 48 h, and preserved in 70% ethanol. For identification, the parasites were stained in Delafield's hematoxylin or Mayer's carmalum and mounted in Canada balsam for examination as whole mounts. Voucher specimens (CHIOC 37838) were deposited in the Instituto Oswaldo Cruz Helminthological Collection (CHIOC), Rio de Janeiro, Brazil. All parasites were identified as *Cheloniodiplostum* sp. (Digenea, Proterodiplostomidae) according to Gibson et al. (2002. Keys to the Trematoda, Volume 1. CABI Publishing, London. 544 pp.). In Brazil, previous publications have reported the trematode *Cheloniodiplostomum testudinis* (Dubois, 1936) in unidentified host turtles (Dubois 1936. Rev. Suisse Zool. 43:507–515; Travassos et al. 1969. Mem. Inst. Oswaldo Cruz 67:1–886). *Cheloniodiplostum brevis* (MacCallum, 1921) is the only species of this genus that has been recorded in *P. geoffroanus*, from Colombia (Dubois 1978. Rev. Suisse Zool. 85:607–615). Therefore, this report represents the first Brazilian record for parasitism by *Cheloniodiplostomum* sp. specifically in *P. geoffroanus*.

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***PHRYNOPS TUBEROSUS* (Cotinga River Toad-headed Turtle). BIFID TAIL.** Axial bifurcation is the result of a mutation or developmental error in the embryonic development of organisms that may lead to the emergence of bizarre morphology such as two-headed animals (Buffetaut et al. 2007. Biol. Lett. 3:80–81; Wallach 2007. Bull. Maryland Herpetol. Soc. 43[2]:57–62). This phenomenon can also lead to bifid tails in chelonians (Kuchling 2005. Chelon. Cons. Biol. 4[4]:935–937). These animals do not demonstrate true tail autotomy, but a case of regeneration of this body part and subsequent formation of a bifurcated tail is found in the literature (Kuchling 2005, *op. cit.*). Rahman (2011. Herpetol. Rev. 42[2]:265) also noted the occurrence of bifid tail in *Chelydra serpentina*, but the cause of the split was not determined. Here we report the occurrence of bifid tails in individuals of *Phrynops tuberosus* captured in field expeditions conducted in April, June, and July 2012. This is apparently the first record of bifid tails in South American chelids.

We captured four adult *P. tuberosus* (three males and one female) with bifid tails in the Banabuiu River, in the village of Laranjeiras, Ceará, Brazil. The animals had straight-line carapace lengths of 21.05 cm, 24.06 cm, 23.8 cm, and 17.4 cm, respectively. The bifid tails found in this study were of normal length and width, but their tips were duplicated in the horizontal plane. This pattern is very similar to that reported for *C. serpentina* by Rahman (2011, *op. cit.*).

The lack of difference in size between the bifid tails and normal ones suggests that the cause of this phenomenon may be axial bifurcation. However, the repetition of the event (in four

animals) may raise doubt about this explanation, because the probability of such mutations is presumably low. The occurrence of cartilaginous regeneration of an injured tail can also lead tail bifurcation tails in chelonians (Kuchling 2005, *op. cit.*). However, we were unable to do X-ray examination of these turtles, preventing a more precise diagnosis. The regeneration pattern reported by Kuchling (2005, *op. cit.*) is similar to that found in lizards, wherein the missing part is replaced by fibrous or cartilaginous or calcified tissue (Zug et al. 2001. Herpetology: An Introductory Biology of Amphibians and Reptiles. Academic Press, New York. 630 pp.). If the cases reported here were confirmed to be based on regeneration, it would be the second record of this ability in a chelid turtle. Studies on tail bifurcation in turtles could someday reflect on questions of the phylogenetic history of tail autotomy and regeneration in amniotes.

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***STAUROTYPUS TRIPORCATUS* (Giant Musk Turtle; Guao de Tres Filas). PREDATION.** *Staurotypus triporcatus* is a large freshwater turtle that occurs on the Atlantic versant from central Veracruz, Mexico, to northwestern Honduras. Adults can reach 400 mm carapace length (Iverson 1983. Cat. Amer. Amphib. Rept. 328.1–328.2), and apparently have few documented natural predators. Pritchard (1979. Encyclopedia of Turtles. T.F.H. Publishing, Neptune, New Jersey. 895 pp.) wrote that the "massively constructed" shell of this species "lessens the likelihood of the turtle being cracked and eaten by the crocodiles with which it shares much of its habitat." However, it is well known that humans use the meat of this turtle as a food source (Moll and Moll 2004. The Ecology, Exploitation, and Conservation of River Turtles. Oxford University Press, New York. 393 pp.). Here we provide evidence of natural predation on an adult *S. triporcatus* by a Jaguar (*Panthera onca*) in northwestern Honduras.

At 1431 h on 15 October 2011, a camera trap (Moultrie Game Spy I-65s) set by Panthera staff at "Cerro Agua Caliente," Jeannette Kawas National Park, Atlántida (15.8622°N, 87.6838°W; 30 m elev.) captured an image of an adult female *Panthera onca* carrying an adult *Staurotypus triporcatus* in its mouth (Fig. 1) in a seasonally flooded swamp forest. Jaguars can be individually identified by the shape and pattern of their marks (Silver 2004. Assessing Jaguar Abundance Using Remotely Triggered Cameras. Wildlife Conservation Society, Bronx, New York. 25 pp.). This female was first photographed during August 2010 and has been monitored in the park since then. During October 2011 she was again photographed several times in the "Cerro Agua Caliente" area in company with a cub of about 3 months age. It has been estimated that a jaguar can eat between 1.2 and 1.5 kg of meat per day (Sunquist and Sunquist 2002. Wild Cats of the World. University of Chicago Press, Chicago, Illinois. 452 pp.); a Giant Musk Turtle can weigh up to 10 kg, including the plastron and carapace (Vogt 1997. *In* González Soriano et al. [eds.], Historia Natural de Los Tuxtlas, pp. 494–495. Universidad Nacional Autónoma de México, Ciudad de México), thus having the potential to be an important food item for Jaguars. Moreover, large prey species such as tapirs (*Tapirus bairdii*) and peccaries (*Pecari tajacu, Tayassu pecari*) have been extirpated from Jeannette Kawas National Park, and White-tailed Deer (*Odocoileus virginianus*) are severely declining; all due to human hunting pressure and deforestation. Jaguars are known to prey on turtles, with sea turtles, freshwater turtles, and terrestrial turtles having been documented as part of the Jaguar's diet (Emmons 1989. J. Herpetol. 23:311–314; Wainwright 2002. The Mammals of Costa Rica, A Natural History and Field Guide. Cornell University Press, Ithaca, New York. 454 pp.). However, to the best of our knowledge, this is the first report of Jaguar predation on *S. triporcatus*. The presence of *S. triporcatus* in the Jeannette Kawas National Park has also been confirmed from two specimens collected there. The only other large freshwater turtle in the area is the snapping turtle, *Chelydra rossignonii*; we identified the turtle in the picture as *S. triporcatus* due to the lack of a long tail and the presence of strong carapacial keels.



FIG. 1. A camera trap image of a female *Panthera onca* carrying an adult *Staurotypus triporcatus*, Jeannette Kawas National Park, northwestern Honduras.

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CROCODYLIA — CROCODILES

***ALLIGATOR MISSISSIPPIENSIS* (American Alligator). LONG TERM SURVIVAL OF FARM-RELEASED JUVENILE.** The state of Louisiana has an alligator management program that includes a regulated harvest of wild alligators, a nuisance alligator removal program, and a commercial alligator farming program (Elsey and Kinler 2004. *In* Crocodiles. Proc. 17th Working Meeting Crocodile Specialist Group, pp. 92–101. IUCN—The World Conservation Union, Gland, Switzerland and Cambridge UK). An integral facet of the commercial alligator farming program allows for the collection of eggs from the wild, with mandatory release of a portion of juvenile alligators hatched from collected eggs, as a "head-start" program to ensure recruitment of the species (Elsey and Kinler 2011. *In* P. S. Soorae [ed.], Global Re-introduction Perspectives: 2011. More Case Studies from Around the Globe, pp. 125–129. Gland, Switzerland: IUCN/SSC Re-introduction Specialist Group and Abu Dhabi, UAE: Environment Agency-Abu Dhabi). Each of the juvenile alligators released from alligator farms are measured, the sex is determined and recorded, and the alligators are marked with monel tags placed between the toes

of the hind legs and also marked by tail notching (Elsey and Kinler 2011, *op. cit.*). The juvenile alligators (allowable size range of 91.4–152.4 cm total length [TL] at release) are then released back to the wetlands from which the eggs were collected one or two years earlier.

Over time, we have observed that many of the released juveniles grow to adult size and are subsequently caught by alligator trappers in the annual regulated harvest. On 7 September 2012, a tagged alligator was reported to our agency. The web tag was from a male alligator that was marked and released on 1 May 1992 (then 124 cm TL) and harvested over twenty years, four months later (7434 days, now 244 cm TL). To our knowledge this is the longest time interval for a recovery of a farm-released alligator from Louisiana's egg ranching program, indicating long-term survival after release to the wild.

The interval growth was somewhat below average for this species (Elsey et al. 1992. Comp. Biochem. Physiol. 103A:667–672). However, coastal southeast Louisiana has been adversely affected by four major hurricanes in recent years (Hurricanes Katrina and Rita in 2005, and Hurricanes Gustav and Ike in 2009); thus high salinity conditions post-hurricanes could have stressed some alligators and slowed normal feeding and growth (Lance et al. 2010. J. Exp. Zool. 313A:106–113; Lauren 1985. Comp. Biochem. Physiol. 81A:217–223). Confirmation was obtained from the person reporting the harvest of the alligator that the alligator's total length was accurate, and no portion of the tail was missing.

We have recovered farm-released alligators that have grown longer than the case herein; the largest recovery we have obtained that held the web tag over time was 381.0 cm when harvested on 10 September 2006 (Elsey 2006. Croc. Spec. Grp. Newsltr. 25:16–17). This male alligator had been tagged and released 4761 days earlier on 28 August 1993, at which point the TL was 111.8 cm. Many alligators lose the monel tags placed in the webbing of the rear feet as they grow, thus precluding knowledge of exact time intervals between release and recovery. Use of year-specific tail notches have been used in our program since 1994 to assist in providing some time interval data when marked alligators lose their foot/web tags.

The properties on which the alligator was released (Poverty Flats) in Terrebonne Parish, Louisiana and on which it was recovered (Rebecca) are in close proximity to each other, and are both irregularly shaped, thus the distance moved between release and recovery can only be estimated. Precise GPS locations are not available at either release or recovery sites, but the minimum distance between the two properties is approximately 0.4 km, while the maximum distance is approximately 12.1 km. Although instances of long-distance dispersal have been documented in alligators, in many cases alligators do not move long distances over time (Lance et al. 2011. Southeast. Nat. 10:389–398), and some females show evidence of strong nest site fidelity (Elsey et al. 2008. Southeast Nat. 7:737–743).

The egg ranching program in Louisiana, which allows for the collection of alligator eggs from privately owned wetlands began in 1986, with the first juvenile alligators being released to the wild in 1988 (Elsey et al. 1992, *op. cit.*). Thus it is possible that many alligators from that first cohort may still be surviving, and not yet recovered, as only a small portion of the population is harvested each year in the annual harvest. The recovery of a farm-released alligator having survived over twenty years (and presumably having fathered numerous clutches of eggs over that time interval, adding to population recruitment) lends support to the philosophy of sustained use management of this valuable resource.

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***ALLIGATOR MISSISSIPPIENSIS* (American Alligator). INTERSTATE MOVEMENT OF ALLIGATORS.** The state of Louisiana has an alligator management program administered by the Louisiana Department of Wildlife and Fisheries (LDWF) that includes a regulated harvest of wild alligators, a nuisance alligator removal program, and a commercial alligator farming program (Elsey and Kinler 2004. *In* Crocodiles. Proceeding of the 17th Working Meeting Crocodile Specialist Group, pp. 92–101. IUCN—The World Conservation Union, Gland, Switzerland and Cambridge, UK). Many other southeastern states also have significant alligator populations, and most states conduct regulated harvests and nuisance control programs; some also allow commercial alligator farming. An integral facet of the commercial alligator farming program in Louisiana allows for the collection of eggs from the wild, with mandatory release of a portion of juvenile alligators hatched from collected eggs, as a "head-start" program to ensure recruitment of the species (Elsey and Kinler 2011. *In* P. S. Soorae [ed.], Global Re-introduction Perspectives: 2011. More Case Studies from Around the Globe, pp. 125–129. IUCN/SSC Re-introduction Specialist Group Gland, Switzerland, and Environment Agency-Abu Dhabi, UAE). Each of the juvenile alligators released from alligator farms in Louisiana are measured, the sex is determined and recorded, and marked with monel tags placed between the toes of the hind legs and also marked by tail notching (Elsey and Kinler 2011, *op. cit.*). The juvenile alligators (allowable size range at release of 91.4–152.4 cm total length) are then released back to the wetlands from which the eggs were collected one or two years earlier.

Over time, we have observed that many of the released juveniles grow to adult size and are subsequently caught by alligator trappers in the annual regulated harvest in Louisiana (Elsey et al. 2001. *In* Grigg et al. [eds.], Crocodilian Biology and Evolution, pp. 426–441. Surrey Beatty & Sons, Chipping Norton, NSW). Additionally, other farm-released alligators are captured occasionally as "nuisance" or problem alligators (Elsey 2007. Herpetol. Bull. 102:11–14) causing human safety concerns.

We herein report on five cases of alligators with interstate movement between Louisiana (LA) and Mississippi (MS), USA. The initial case involved a nuisance trapper in Mississippi harvesting an alligator released from a farm in Louisiana. On 17 July 2008, a Warren Co., MS conservation officer trapped a 348.0 cm male alligator (Fig. 1) in Halpino Lake (just south of Eagle Lake, MS); capture site coordinates were 32.46070°N, 91.00877°W. The foot/web tag (LDWF 222285) was from a juvenile alligator released from a Louisiana alligator farm almost 12 years earlier on 22 July 1996 at which time the total length was 116.8 cm; it was released at Lake St. Joseph in Tensas Parish, 48 km away.

On 11 April 2012, a tagged alligator caught by a licensed Louisiana nuisance alligator trapper was reported to LDWF. The web tag reported (07301) did not match any records of farm-released alligators in Louisiana; nor did the tag match any records of native wild alligators caught and marked/tagged for

PHOTO COURTESY OF COREY HUNT



FIG. 1. Adult male American Alligator (348 cm TL) captured in Mississippi almost 12 years after release to the wild from a farm in Louisiana. Tail notches are clearly evident.



FIG. 2. Map showing release location of an American Alligator marked for research in Mississippi (M), and recovered by a nuisance trapper in Louisiana (L) over three years later. Eagle Lake, MS and Lake Providence, LA locations indicated for reference.

research purposes. The trapper reported the alligator had a numbered cattle tag in the tail as well as another tag with a series of numbers determined as possibly a telephone number; the first three digits were recognized as a Mississippi area code. LDWF staff (RME) then called the alligator program leader in Mississippi (RF), who confirmed the alligator had been initially captured, marked, and released at Pervis Lake in Warren Co., MS (32.48384°N, 91.06619°W) as part of their research program. The male alligator's initial total length was 232.4 cm when marked on 18 March 2009; it was 279.4 cm when captured in Louisiana near Lake Providence in East Carroll Parish in northeast Louisiana, bordering Mississippi. The alligator thus moved at least 49 km between Mississippi and Louisiana, and likely had traveled nearly 71 km by water between sites (Fig. 2).

In September 2012, we documented three additional cases of alligators with interstate movement from harvest information provided by licensed recreational alligator hunters in Mississippi. On 7 September, a 308 cm male alligator was harvested on the Big Black River near Grand Gulf/Port Gibson, MS with LDWF web tag 597115 in the foot. This alligator had been tagged at an alligator farm and released on Sunflower Plantation in Tensas Parish, LA on 17 August 2004 at which point the total length was 132.1 cm. The distance moved over the eight- year interval was approximately 23 km.

On 7 September 2012, two Louisiana farm-released alligators were caught in Mississippi, north of Port Gibson (north of where the Big Black River enters the Mississippi River); both had been released by a Louisiana alligator farmer in nearby Tensas Parish. The alligators were harvested by a trapping team in the same location. The first alligator caught that evening was a 304.8 cm male that had been released on Somerset Plantation at 172.7 cm TL on 29 May 2003 (LDWF tag 529134). The alligator caught later that night was a female that measured 188.0 cm TL, and which had been released on Sunflower Plantation on 13 April 2010 at 129.5 cm TL (LDWF tag 853250). The male was caught approximately 6–7 km from the release site in Louisiana, while the female was recovered some 5 km from the release location.

We are not aware of other cases documenting natural interstate movement of alligators; although in September 2008, Hurricane Ike displaced an alligator released from a farm in southwest Louisiana 489 km to Padre Island National Seashore in lower Texas (Elsey and Aldrich 2009. Southeast. Nat. 8:746–749). It may be that many alligator tag and release studies conducted by state or federal government employees are conducted within the confines of their state property; possibly within a given National Wildlife Refuge or Wildlife Management Area, and thus the opportunities to live capture alligators that have moved off the study site are limited. It was fortunate that we were aware of alligator tagging programs in the adjacent state and could advise accordingly when an alligator from the other state was recovered.

Unusually high snowfall in the United States in 2010–2011 and very high water levels in the Mississippi River during spring 2011 may have allowed for increased movement of alligators over floodplains between Louisiana and Mississippi that year. Also, gradual expansion of Mississippi's wild alligator harvest program from 30 alligators harvested in 2005 to 617 alligators harvested in 2012 has allowed additional opportunity for harvest and recovery of alligators that have dispersed from adjacent Louisiana.

Prior studies have documented alligator movement patterns that can vary widely. Although instances of long-distance dispersal have been documented, in many cases adult alligators do not move long distances over time (Chabreck 1965. Proc. Southeast. Assoc. Fish Wildl. Agencies 19:102–110; Lance et al. 2011. Southeast. Nat. 10:389–398), and some females show evidence of strong nest site fidelity (Elsey et al. 2008. Southeast. Nat. 7:737–743). Indeed, in this report two alligators moved over 40 km; one moved approximately 23 km, while two others moved only 5–6 km.

Due to the magnitude of the farm-release program in Louisiana (often 40,000 or more alligators released each year), precise GPS locations are not available for each alligator at release sites. Also, oftentimes the properties on which the alligators are released are irregularly shaped, thus the distance moved between release and recovery can only be estimated, thus distances discussed herein are minimum estimated dispersal distances.

The relatively long time interval for several of the recoveries of farm-released alligators from Louisiana's egg ranching program described above (8, 9, and 12 years) indicates good survival after release to the wild. We recently described a case with an alligator recovered over 20 years after release to the wild from a farm

setting (Elsey 2012. Herpetol. Rev. 44:309–310). Additionally, the growth to the very large size classes of the male alligators in the cases described (279–348 cm TL) suggests they adapted well to the wild environment after release, and presumably added to population recruitment by having fathered numerous clutches of eggs over that time interval, lending support to the philosophy of sustained use management of this valuable resource.

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***CROCODYLUS NILOTICUS* (Nile Crocodile). DIET.** The diet of Crocodylus niloticus has been relatively well documented throughout its range on the mainland of continental Africa (Corbett 1959. Proc. R. Entomol. Soc. 34:17–22; Cott 1961. Trans. Zool. Soc. London. 29:211–356; Games 1990. Unpubl. D. Phil. manuscript. University of Zimbabwe; Hutton 1987. J. Anim. Ecol. 56:25–38; Poole 1989. Ospreys: A Natural and Unnatural History. Cambridge University Press, New York; Shine et al. 2001. Oryx 35:260–262; Wallace and Leslie 2008. J. Herpetol. 42:361–368; Whitfield and Blaber 1979. Copeia 1979:266–269). However, in stark contrast with the abundance of literature from the mainland, this apex predator has been poorly studied in Madagascar and specific information on diet remains scarce from this region.

At ca. 1730 h on 23 July 2011 at a lake adjoining our field camp in the Matsedroy Forest (15.48772°S, 46.64752°E, WGS 84; elev. 19.4 m), a 1.5–2 m *Crocodylus niloticus* was observed predating a Malagasy Jacana (*Actophilornis albinucha*). The crocodile attacked from below in a relatively shallow (<3 m) part of the lake that was densely covered by water hyacinth (*Eichornia* sp.). It took approximately five minutes for the crocodile to seize, drown, and consume the Jacana.

While it stands to reason that Malagasy Jacanas and other species of wading birds present at these lakes should comprise part of the diet of the crocodiles that inhabit them, as far as we are aware this is the first record of *C. niloticus* predation on a Malagasy Jacana. Interestingly, this is also the first positive identification of a predator of *Actophilornis albinucha*. *A. albinucha* is a member of Madagascar's endemic avifauna and therefore this observation also contributes to the known literature of predator-prey interactions of endemic fauna in this highly threatened landscape.

We thank the Transitional Government of Madagascar, the Ministère de l'Environnement et des Forêts for allowing us to undertake this work (permit 54710/MEF/SG/DGE/DREF.BOE), Operation Wallacea for funding, Development and Biodiversity Conservation Action for Madagascar (DBCAM) for logistics, and our local guides and team at Mahamavo.

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***CROCODYLUS POROSUS* (Saltwater Crocodile). FISHING BEHAVIOR.** A form of fishing behavior not previously described for *Crocodylus porosus* was observed repeatedly on separate occasions at Cahill's Crossing on the East Alligator River in Kakadu National Park, Northern Territory of Australia (12.4844°S, 131.7240°E) from August to October 2012. The behavior was witnessed most frequently around high springs tides, when incoming and then outgoing tidal flow crossed an artificial road barrage that fords the river. A number of fish species, primarily Diamond-scale Mullet (*Liza vaigiensis*) take the opportunity to cross this barrier in relatively high densities, and crocodiles mass both upstream and downstream of the barrage to feed upon them. During our observations, many crocodiles adopted a distinctive body posture while floating at the surface: the back legs extended outwards in a loose R-shape on the same plane as the body; the front legs held out perpendicular to the body, with palms facing outwards and toes projecting upwards out of the water (Fig. 1); the jaws held partially open, with the upper jaw resting on the surface and the lower jaw hanging below the water. This posture could be clearly seen with sufficient water clarity, which is the case immediately prior to the incoming tide flooding over the barrage. The primary mechanism of the posture appeared to be improved detection and capture of fish within striking range that were detected by sensitive mechanoreceptors (integumentary sense organs; ISOs). Fish that swam close to the crocodile's head and touched the front legs or feet were immediately seized by a sideswipe of the head towards the touch. The small, tightly packed scales on the feet provide a high density of ISOs (Leitch and Catania 2012. J. Exp. Biol. 215:4217–4230), which perhaps explains the outward extension of the feet and toes to maximize detection of fish passing within range or breaking the surface. This behavior has only previously been described in the Paraguayan Caiman (*Caiman yacare*) (Olmos and Sazima 1990. Copeia 1990:875–877) and is a fishing strategy that is particularly effective with higher densities of fish.

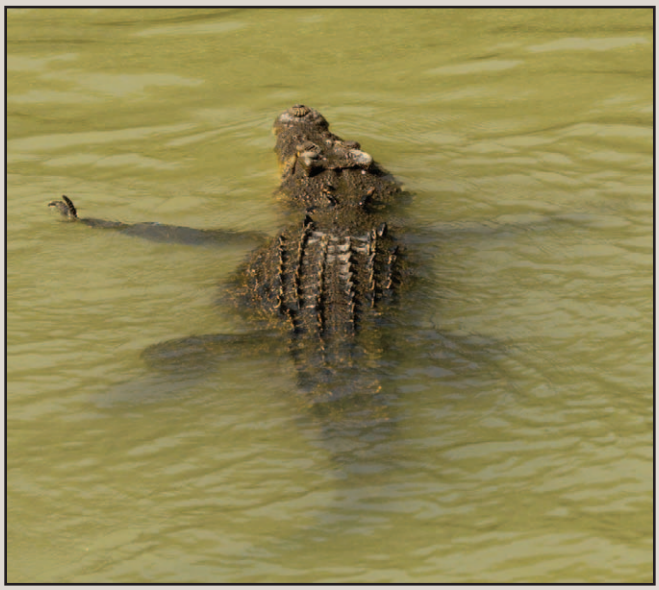


FIG. 1. Adult Saltwater Crocodile (*Crocodylus porosus*) in floating fishing posture.

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SQUAMATA — LIZARDS

***ANADIA BOGOTENSIS* (Bogota Anadia Lizard). NESTING.** *Anadia bogotensis* is a common lizard endemic to Colombia and is distributed in areas of highland Andean scrubland and paramo throughout Cundinamarca, Boyacá, and Santander in Colombia, between 2500–3900 m altitude. Despite being common, little is

known of the natural history of this species (Clavijo and Fajardo 1981. Contribución al conocimiento de la biología de *Anadia bogotensis* [Peters] [Sauria, Teiidae]. Tesis de pregrado. Universidad Nacional de Colombia, Bogotá D.C.; Moreno-Arias 2009. Final report project: Conservation status of highland lizards from Sabana de Bogotá, The Rufford Small Grants Foundation, London, UK. 6 pp.; Sánchez et al. 1995. *In* J. O. Rangel [ed.], Colombia Diversidad Biótica I, pp. 277–325. Universidad Nacional de Colombia, Instituto de Ciencias Naturales, Bogotá D.C.). Here I report communal egg-laying in *A. bogotensis* (Fig. 1) under rocks, low necromass and between clumps of grass in two areas within Andean scrubland paramo transition zone and rocks, the first area in the Vereda Las Moyas, municipality of La Calera, Department of Cundimanarca, Colombia (4.66267°N, 74.01615°W; datum WGS 84), and second area in the Vereda Santa Bárbara, Usme locality, rural area southeast of the city of Bogotá D.C., Department of Cundimanarca, Colombia (4.40639°N, 74.14472°W; datum WGS 84).

At the first site, studied between 30 July and 5 November 2006, I found 21 nests averaging 12 viable eggs (range = 2–54 eggs) at different stages of development and I have found evidence of continuous use of these nests, as older eggs were found among 26–578 eggs already hatched at different times (55 older eggs on average). Old eggs were qualified as dead eggs at different stages of decomposition (e.g., discolored, empty, crushed, or beneath new eggs). At the second site, studied between 2 March and 5 May 2009, I found 15 nests more spatially separated averaging six viable eggs (range = 1–18 eggs) at different stages of development. I also found evidence of continuous use of the nests at this site, as older eggs were found among 6–27 eggs that had already hatched at different times (nine older eggs on average). In lizards, communal nests have been observed in various families, but few studies report data for female individuals representing different ages depositing eggs in the same nest cavity simultaneously in highlands (Doody 2009. Q. Rev. Biol. 84:229–252; Magnusson and Lima 1984. J. Herpetol.18:73–75; Radder and Shine 2007. J. Anim. Ecol.76: 881–887). Communal oviposition in reptiles might result from scarcity of nest-sites offering suitable incubation conditions (direct fitness benefits accruing from the proximity of other eggs) (Doody, *op. cit*; Radder and Shine, *op. cit.*). The reproductive ecology of highland Colombian lizards is poorly known and information on nests, laying, hatching, and hatchlings is not available; thus, this report provides the first data concerning highland lizard communal nesting in Colombia.



FIG. 1. Eggs at different stages of development and one newly hatched young of *Anadia bogotensis* observed at a communal oviposition site under rocks in Colombia.

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***ANOLIS CAROLINENSIS* (Green Anole). FEEDING BEHAVIOR.** *Anolis carolinensis* is an animal that feeds largely on small insects, spiders, and other arthropods (Losos 2009. Lizards in an Evolutionary Tree. Univ. California Press, Berkley, California. 507 pp.). At ca. 1215 h on 5 Sept 2006 I observed a Green Anole exhibiting a novel feeding behavior in an area of the Tuskegee National Forest in Macon Co., Alabama, USA. On first observation the animal appeared to be trapped in a spider's web, but upon further investigation, it was discovered that the animal had intentionally moved out onto the web in order to feed upon the resident spider. The anole remained on the web while it consumed its prey, then moved off the web, onto the adjacent branch, and out of sight. To my knowledge there have been no previously reported instances of a Green Anole demonstrating this type of feeding behavior, which seems to imply that this could be a hunting strategy for this species that is rarely observed.



FIG. 1. *Anolis carolinensis* feeding on a spider by having moved out onto its web.

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***ANOLIS OXYLOPHUS* (Stream Anole). PECCARY WALLOWS AS NOVEL HABITAT.** Over the course of two months (June–July 2012), we surveyed six water-filled Collared Peccary (*Pecari tajacu*) wallows (places where peccaries roll that later fill with water) at La Selva Biological Station, Heredia, Costa Rica. All wallows were used by peccaries during the time of our surveys, as evidenced by fresh tracks and hair imprints in the mud. At two of the wallows, we noted the presence of *Anolis oxylophus*, which we identified using Savage (2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna between Two Continents, between Two Seas. Univ. Chicago Press, Chicago, Illinois. 934 pp.). At wallow #1, one *A. oxylophus* was positioned on a piece of submerged debris directly in the water. At wallow #2, one *A. oxylophus* was located on leaf litter under a small branch, approximately 0.5 m away from the wallow itself. Both *A. oxylophus* were stationary and were observed at midday. Wallow #1 has an

area of approximately 1.5 m^2 (assuming an elliptical shape) and is around 150 m from the nearest stream, while wallow #2 has an approximate area of 3.4 m^2 and is about 50 m away from the nearest stream. In September 2012 we revisited both wallows and found a subadult female *A. oxylophus* (SVL: 56.1 mm) in standing water at wallow #2. Wallow #1 no longer contained water.

Historically, *A. oxylophus* has been observed living in and very close to streams, and has not been observed beyond the riparian zone (Savage 2002, *op. cit.*; Vitt et al 1995. Can. J. Zool. 73:1918–1927). To our knowledge, our observations are the first of *A. oxylophus* using peccary wallows. Our observations suggest that these tropical anoles are able to utilize a wider range of habitats than has previously been reported, which may have important implications for conservation efforts. In the Amazon, White-lipped Peccaries (*Tayassu pecari*) have been recognized as ecosystem engineers because of their habit of maintaining wallows, which amphibians use as reproductive habitat (Beck et al. 2010. J. Trop. Ecol. 26:407–414; Zimmerman and Bierregaard 1986. J. Biogeog. 13:133–143). Some Central American amphibian species have recently been observed using Collared Peccary wallows for breeding (Reider and Ream, ms. in review). The presence of *A. oxylophus* in and around Collared Peccary wallows indicates that wallows might be important, albeit temporary, habitat for aquatic reptiles in addition to amphibians. Our observations might imply that wallows serve as important stops for *A. oxylophus* moving between streams and warrant additional research to investigate the dispersal patterns of this species. Additionally, future studies of the biology of *A. oxylophus* should consider that some individuals might be spending a portion of their time away from streams.

We thank the staff at La Selva Biological Station for logistical support. These observations were made possible by funds from the Organization for Tropical Studies and the National Science Foundation Research Experience for Undergraduates program.

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***ANOLIS SAGREI* (Brown Anole). NEST-SITE CHOICE.** *Anolis sagrei* is native to Cuba and the Bahamas, and has been introduced throughout many tropical and subtropical regions of the world (Kolbe et al. 2004. Nature 431:177–181). Although *A. sagrei* has served as a model for many ecological and behavioral studies (Losos 2009. Lizards in an Evolutionary Tree: Ecology and Adaptive Radiation of Anoles. Univ. of California Press. 528 pp.), relatively little is known about its oviposition behavior. Like all anoles, female *A. sagrei* produce a single egg clutch, for the duration of a breeding season lasting from April to October (Lee et al. 1989. Copeia 1989:930–937). Despite their frequent egg production, the lack of published information about their oviposition sites is largely attributable to difficulty in finding nests.

During field work from 29 September to 9 October 2012, we documented five *Anolis* eggs on two spoil islands in the intracoastal waterway near Marineland, Florida, USA (29.640042°N, 81.214419°W; WGS 84). All eggs were found in soil beneath wooden cover objects. On two occasions, two eggs were found under the same cover object (four eggs total). The fifth egg was found under a board that also contained hundreds of individuals of an unknown ant species. Two of the eggs (found under the same object) were empty shells that hatched earlier, desiccated, or were depredated; the other three eggs were intact and turgid (including the egg in the presence of ants). However, one of the intact eggs had disappeared less than one hour after discovery, possibly depredated upon by a fiddler crab at the study site (*Uca* sp.). Given the high densities of *A. sagrei*, it is unlikely that these eggs belonged to another lizard species (e.g., *Anolis carolinensis*, the only other lizard on these islands, which occurs at relatively low densities).

To assess microhabitat characteristics of the oviposition sites, we took soil samples to measure moisture content and hemisperhical photos to measure canopy openness (methodology of Doody et al. 2006. Herpetol. Rev. 37:49–52) at each oviposition site. The three intact eggs were in soil that had an average moisture content of 15.8% (range 15.0–16.5%), whereas the soil moisture content around the non-intact eggs was 63.0%. The intact eggs were found at relatively open sites (mean canopy openness = 46.7%, range: 43.7–51.2%) compared to the site with the non-intact eggs (14.8% canopy openness). Canopy openness from these five nests (mean = 33.8%) did not differ from canopy openness measured at 40 randomly selected locations on the islands (mean=34.9%), suggesting that female *A. sagrei* choose oviposition sites randomly with respect to canopy cover.

Although nest-site information has been reported for other *Anolis* species (Andrews 1988. Oecologia 76:376–382; Rand 1967. Herpetologica 23:227–230), we are not aware of previously published information for *A. sagrei* in the field. Laboratory-based studies have shown that females select relatively moist conditions that enhance egg hatching success and offspring survival (Reedy et al. 2013. Behav. Ecol. 24:39–46). Although we do not know what moisture conditions were present at the time of ovipostion for the eggs reported here, we nonetheless provide some baseline data on moisture levels that eggs experience in the field. Our small sample suggests that female nest-site choice is not based on canopy cover—a finding that contrasts with other studies of reptiles (e.g., Angilletta et al. 2009. Ecology 90:2933–2939; Warner and Shine 2008. Anim. Behav. 75:861–870), and hence warrants focused studies on nest-site choice and egg ecology in *Anolis sagrei*.

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***ASPIDOSCELIS LAREDOENSIS* × *ASPIDOSCELIS GULARIS* (Laredo Striped Whiptail × Texas Spotted Whiptail). HYBRID GYNANDROMORPH.** We evaluate the identity and reproductive status of a whiptail lizard from a site of syntopy involving diploid hybrid-derived parthenogenetic *Aspidoscelis laredoensis* and its maternal progenitor *A. gularis* (Bickham et al. 1976. Herpetologica 32:395–399; McKinney et al. 1973. Herpetologica 29:361–366; Wright et al. 1983. Herpetologica 39:410–416) situated in Texas (Walker 1987. Texas J. Sci. 39:313–334). The specimen is unlike any other in color pattern among a combined total of >1000 specimens of these species examined by us between 1984–2009 from México and Texas. Consequently, it was hypothesized to be

a putative hybrid (i.e., via fertilization of an unreduced diploid egg [2n = 46] of *A. laredoensis* clonal complex A by a reduced sperm [1n = 23] of *A. gularis*) by Walker et al. (1989a. J. Herpetol. 23:119–130). We have subsequently examined several live/freshly killed male and female putative hybrids of *A. laredoensis* × *A. gularis* from Texas and Mexico that were subjected to confirmational studies of their genealogies based on triploidy as verified by karyotypes (Walker et al. 1989a, *op. cit.*; Walker et al. 1989b. Copeia 1989:1059–1064) and skin histocompatibility experiments (Abuhteba et al. 2000. Can. J. Zool. 78:895–904; Abuhteba et al. 2001. Copeia 2001:262–266). Not surprisingly, morphological studies of these hybrids have also revealed the presence of dorsal and ventral color pattern, scutellation, and meristic variables that differ from the parental species. Herein, we use morphological characters and a detailed description of color pattern in support of our identification of a female hybrid deposited in the Arkansas State University Museum of Zoology (ASUMZ). The genealogical status of the animal is also correlated with an aberrant histological condition of reproductive organs that we describe.

We made seven visits to the rural community of Artesia Wells (28.281274°N, 99.285796°W) in La Salle Co., Texas, USA, to collect and observe *A. laredoensis* and *A. gularis* in mesquite-invaded, overgrazed, and degraded sandy habitat along unpaved roads, and in adjacent pastures and fields near jct Texas 133-135 located west of Interstate 35 and railroad tracks. This is one of only three known sites for *A. laredoensis* well-removed from the Rio Grande in La Salle and Dimmit counties, whereas *A. gularis* is

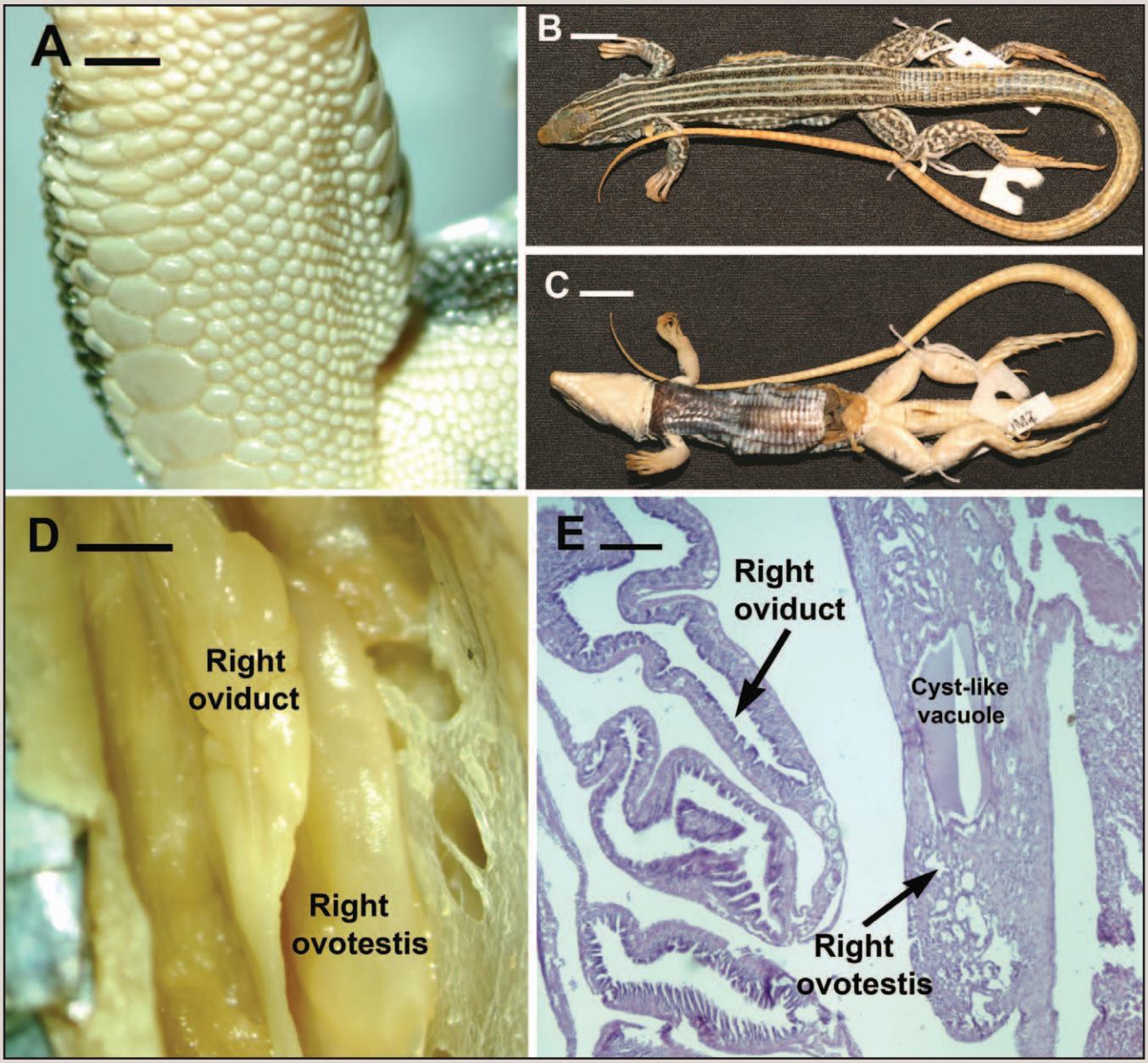


FIG. 1. Morphological characteristics of a hybrid gynandromorph of *Aspidoscelis laredoensis* × *Aspidoscelis gularis* (ASUMZ 6250) collected from Artesia Wells, La Salle Co., Texas, USA. A) Postantebrachial scales of right antebrachium; line = 1 mm. B) Dorsal coloration and pattern; line = 10 mm for B and C. C) Ventral coloration. D) Right gonadal structures; line = 1 mm. E) Longitudinal histosection of right oviduct and ovotestis; line = 100 µm.

widely distributed in both of them (Walker et al. (2004. Texas J. Sci. 56:237–252). We collected 21 (51.2%) parthenogenetic *A. laredoensis* [26 April 1986 (UADZ 1438–1440, N = 3); 16 July 1986 (UADZ 19511–1953, N = 3); 7 September 1996 (UADZ 5764–5769, N = 6); 8 September 1996 (UADZ 5771, 5772, 5774–5776, N = 5); 31 August 1997 (UADZ 5982–5985; N = 4)], 18 (43.9%) gonochoristic *A. gularis* [26 April 1986 (UADZ 1630–1634, N = 5); 2 May 1986 (UADZ 1626–1629, N = 4); 16 July 1986 (UADZ 1998, 1999, N = 2); 19 May 1989 (UADZ 3548, 3549, N = 2); 7 September 1996 (UADZ 5761–5763, N = 3); 8 September 1996 (N = UADZ 5770, 5773; N = 2)], and two (4.8%) hybrids of *A. laredoensis* × *A. gularis* [25 April 1986 (UADZ 1626, N = 1 male); 16 July 1986 (UADZ 2017, N = 1 putative female).

The large distinctively patterned hybrid, UADZ 2017, became ASUMZ 6250 in preparation for this study. It has a SVL of 88 mm, head length of 26.5 mm, head width of 13.0 mm, and body mass obtained before preservation of 14.0 g. It is 9% and 21.5% larger in SVL and body mass, respectively, than the largest parthenogen from Artesia Wells (e.g., mean 69.3 ± 2.75; range 61–80 mm SVL, N = 12) collected on various dates. The large size of ASUMZ 6250 apparently stemmed from hybrid vigor in what externally appeared to be a female of *A. laredoensis* × *A. gularis*. Its postantebrachial scales (Fig. 1A) are intermediate between the moderately enlarged scales of *A. laredoensis* and the enlarged and plate-like scales of *A. gularis*, though being more like the latter. Similarly, the score for one meristic character in ASUMZ 6250 (first number presented in the following list) is below (1), one is above (5), and three (2, 3, 4) are within the ranges of variation for the other specimens of *A. laredoensis* from Artesia Wells (mean, range, N): 1): granular scales around midbody, 83 (91.6 ± 0.54, 88–97, N = 17); 2) granular scales from occiput to base of tail, 226 (227.8 ± 1.00, 221–239, N = 17), 3) granular scales between the paravertebral stripes, 9 (11.1 ± 0.28, 9–14, N =17); 4) right and left femoral pores summed, 36 (32.6 ± 0.33, 30–36, N = 17); and 5) right and left circumorbital scale series summed, 15 (10.3 ± 0.31, 8–12, N = 16).

In life, ASUMZ 6250 possessed a distinctive combination of ornate color pattern attributes that we have never observed in another female from either a site of allopatry or syntopy involving *A. laredoensis* and/or *A. gularis*. This individual of *A. laredoensis* × *A. gularis* (notes made prior to preservation) has a dorsal pattern more similar to *A. laredoensis* and a ventral pattern more similar to *A. gularis*. The dorsal pattern consisted of three pairs of moderately (lateral) to well-defined (dorsolateral and paravertebral) primary stripes and a single vertebral (traits of *A. laredoensis*; Fig. 1B). In life, the green-gray-white lateral and green-yellow dorsolateral and paravertebral stripes were positioned between green-brown-black fields; the stripes ended near the tail. Using the left side of the body for analysis, we noted nine gray-white vertical bars in the lower lateral field, and 19 distinct rounded gray-white spots in the upper lateral field. Some of the spots and bars of the upper and lower lateral fields, respectively, were fused to or superimposed upon the lateral stripes (Fig. 1B). The tail was olive-tan. The upper parts of forelimbs were brown with cream-white streaks. The hindlimbs were brown with gray to yellow spots/reticulations (Fig. 1B). Also included was a pink-red throat and mesoptychium (the latter with a pale purple suffusion), purple-black thoracic region, purple-blue abdominal region (scales with darker edges), cream-white thighs and femora, and cream-white-pink tail (Fig. 1C).

We used standard histological techniques to prepare reproductive tissues for light microscopy. Gonadal tissues were dehydrated in a graded series of ethanol, cleared in xylene, embedded in paraffin, sectioned with a rotary microtome into 10 µm serial sections, stained with Harris hematoxylin and counterstained with eosin.

The genital anatomy of ASUMZ 6250 differed markedly from that found in a gynandromorph *A. laredoensis* (ASUMZ 4654) collected in Reynosa, Tamaulipas, Mexico (Trauth et al. 2013. Herpetol. Rev. 44:138–140). However, as in ASUMZ 4654, a pair of small regressed oviducts was observed lying laterally to equally small, oblong gonadal masses (Fig. 1D). The gonadal morphologies were unrecognizable macroscopically as ovaries; these gonads appeared slightly orange in coloration upon gross inspection. The right gonadal mass and oviduct were examined histologically revealing a multipart anatomy including adrenal tissue, mesonephric duct and tubules, and rudimentary ovotestis along side of convoluted, regressed oviducts. The mesonephric tubules and duct were associated with the adrenal tissue. The ovotestis mass exhibited numerous regressed seminiferous tubules along its entire length. These tubules averaged 41.8 µm (range 30.0–55.0 µm; N = 10) in diameter. No recognizable primordial follicles were observed within the ovotestis. A large translucent, oblong, cyst-like vacuole (follicle?) dominated most of the distal ovotestis, a small segment of which is shown in Fig. 1E. This structure exhibited no distinguishing features characteristic of secondary or tertiary follicles, but appeared to retain a poorly-developed granulosa cell layer and some scattered ooplasm. The glandular middle region of the oviduct averaged 73.5 µm (range 54.8–90.3 µm; N = 10) in height and exhibited regressed tubuloalveolar uterine glands (Fig. 1E) that averaged 27.5 µm (range 22.6–36.1 µm; N = 10) at their greatest diameter. The surface mucosa of the glandular region was strongly basophilic.

This is only the third publication known to us in which gynandromorphism has been described in specimens of whiptail lizard. Mitchell and Fouquette (1978. Copeia 1978:156–159) discovered an adult individual of *Cnemidophorus inornatus arizonae* (= *Aspidoscelis inornata arizonae* sensu Reeder et al. 2002. 3365:1–61) from 7 km SE of Willcox, Cochise Co., Arizona, with male reproductive organs in the left side of the body cavity and female organs in the right side of the cavity. These authors, based on morphology, rejected the possibility that the specimen in question was a hybrid involving triploid *A. uniparens*, which was also present at the Arizona site. Cole et al. (2010. Am. Mus. Novitat. 3698:1–43) used the terminology "apparently female (but intersex) laboratory hybrid" to describe a genetically confirmed individual of *A. inornata arizonae* (♀) × *A. tigris marmorata* (♂). Lastly, we reported a gynandromorph of *A. laredoensis* in this journal (Trauth et al. 2013, *op. cit.*).

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***ASPIDOSCELIS LAREDOENSIS* × *ASPIDOSCELIS GULARIS* (Laredo Striped Whiptail × Texas Spotted Whiptail). SPERMATOGENESIS.** Hybridization between each of the diploid hybrid-derived parthenogenetic species of *Aspidoscelis* in the United States and one or more syntopic gonochoristic species has been shown to occur often enough to be considered a frequent occurrence under appropriate ecological conditions. We

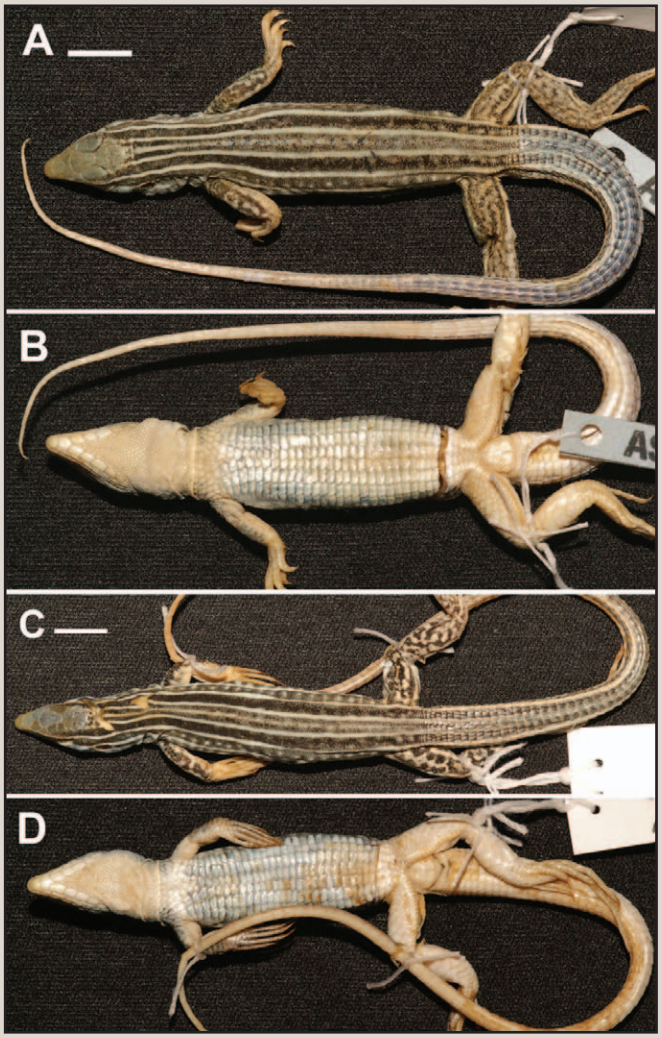


FIG. 1. Morphological characteristics of two hybrid male specimens of *Aspidoscelis laredoensis* × *A. gularis*. A. Dorsal coloration and pattern of ASUMZ 31263; line = 10 mm for B and C. B. Ventral coloration of ASUMZ 31263. C. Dorsal coloration and pattern of ASUMZ 31264; line = 10 mm for C and D. D. Ventral coloration of ASUMZ 31264.

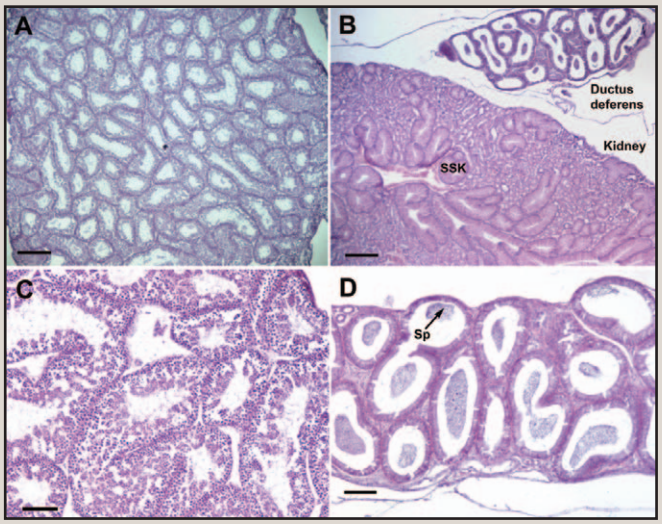


FIG. 2. Photomicrographs of the testicular and kidney histology of two hybrid male specimens of *Aspidoscelis laredoensis* × *A. gularis*. A. Right testis of ASUMZ 31263 exhibiting seminiferous tubules actively producing sperm; line = 200 µm. B. Right ductus deferens and adjacent kidney of ASUMZ 31263 exhibiting sperm and enlarged sexual segments (SSK), respectively; line = 200 µm. C. Seminiferous tubules of right testis of ASUMZ 31264; line = 100 µm. D. Right ductus deferens of ASUMZ 31264 containing masses of sperm (Sp); line = 100 µm.

base this statement on reports of multiple hybrids from New Mexico of *A. tesselata* × *A. tigris* (Taylor et al. 2001. Am. Mus. Novitat. 3345:1–64), *A. neomexicana* × *A. inornata* (Taylor and Walker 1996. Copeia 1996:945–954), and *A. neomexicana* × *A. sexlineata* (Manning et al. 2005. Am. Mus. Novitat. 3492:1–56), and hybrids from Texas of *A. laredoensis* × *A. gularis* (Walker et al. 1989a. J. Herpetol. 23:119–130). We evaluate the identity and reproductive status of two male whiptail lizards in the Arkansas State University Museum of Zoology from two sites of syntopy in Texas (Walker 1987. Texas J. Sci. 39:313–334) between *A. laredoensis* and its maternal progenitor *A. gularis* (McKinney et al. 1973. Herpetologica 29:361–366; Bickham et al. 1976. Herpetologica 32:395–399; Wright et al. 1983. Herpetologica 39:410–416). Included are ASUMZ 31263 collected 17 July 1983 from 1.6 km S of Laredo and E of U.S. Hwy 83, Webb Co., and ASUMZ 31264 collected 2 May 1986 from Artesia Wells, La Salle Co. In both specimens, details of dorsal and ventral color pattern are in agreement with characters of confirmed hybrids of *A. laredoensis* × *A. gularis* based on a triploid karyotype (Walker et al. 1989b. Copeia 1989:1059–1064) and histocompatibility reactions (Abuteba et al. 2000. Can. J. Zool. 78:895–904; Abuhteba et al. 2001. Copeia 2001:262–266). We also correlate the genealogical status of each animal with the first detailed histological analyses of spermatogenesis and associated reproductive structures in *A. laredoensis* × *A. gularis*, which extends the preliminary treatment of Walker et al. (2008. Herpetol. Rev. 39:340).

Neither ASUMZ 31263 (67 mm SVL, Fig. 1A–B) nor 31264 (69 mm SVL; Fig. 1C–D) could be field identified as adult males of *A. gularis*, as both possessed dorsal patterns and colors similar to *A. laredoensis*. Moreover, each of them lacked the distinctive peach-pink-red throat, intense purple/almost black thorax, and checkered abdomen which characterize adult males of *A. gularis*. In addition, we deemed the size of the postantebrachial scales to be intermediate between the parental species and indicative of hybridity.

We used standard histological methods to prepare reproductive tissues for light microscopy. Gonadal tissues were dehydrated in a graded series of ethanol, cleared in xylene, embedded in paraffin, sectioned with a rotary microtome into 10 µm serial sections, stained with Harris hematoxylin and counterstained with eosin.

ASUMZ 31263 and 31264 possessed well-developed testes, predisposing them as males (Fig. 2A and C). No female genital structures were observed. Histological examination of the right testis, attached epididymis and ductus deferens, and the sexual segment of the right kidney (SSK) indicated that these lizards were at or near the peak of spermatogenic activity. The seminiferous tubules of the testes of both specimens were characterized by a tall seminiferous epithelium 7–9 cell layers in thickness, and they contained what appeared to be functional sperm within expanded lumina. The testis of ASUMZ 31263 measured 4.2 × 2.5 mm, whereas the testis of ASUMZ 31264 measured 6.1 × 3.0 mm. The average diameter of the seminiferous tubules of ASUMZ 31263 and ASUMZ 31264 was 132.3 µm (range 120.7–146.7 µm; N = 10) and 170.8 µm (range 141.3–196.8 µm; N = 10), respectively.

Sperm and cellular debris were observed within the epididymal ducts of both males. The average diameter of the ductus deferens of ASUMZ 31263 and ASUMZ 31264 (Fig. 2B and D) in ductal segments adjacent to their respective kidneys was 140.2 µm (range 124.0–168.0 µm; N = 10) and 145.0 µm (range 120.6–193.5 µm; N = 10). The SSK of the kidneys (Fig. 2B) were great hypertrophied and acidophilic in these individuals. These tubules averaged 109.9 µm (range 96.0–128.0 µm; N = 10) in ASUMZ 31263 and 102.6 µm (range 88.0–126.4 µm; N = 10) in ASUMZ 31264.

Hybrid males of *A. laredoensis* × *A. gularis* are known to be triploid 3n = ~69 (Walker et al. 1989b, *op. cit.*), with XXY sex chromosomes (sensu Cole et al. 1969. Am. Mus. Novitat. 2395:1–14) based on two genomes from *A. gularis* and one from *A. sexlineata* via two hybridizations (Walker et al. 1989b, *op. cit.*). This would seem to preclude meiotic development of genetically capable haploid sperm, a condition also inferred from histological sections from 12 males of *A. tesselata* × *A. tigris* (Taylor et al. 2001. Am. Mus. Novitat. 3345:1–64). However, assuming that adult hybrid males engage in mating behaviors, and even inseminations of females of *A. laredoensis* and *A. gularis*, there is no evidence that the existence of such rogue individuals is destabilizing to the reproductive success in either species.

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***ASPIDOSCELIS NEOMEXICANA* (New Mexico Whiptail). HABITAT.** The main distribution area of diploid parthenogenetic *Aspidoscelis neomexicana* (= *Cnemidophorus neomexicanus*) encompasses areas essentially contiguous with the Rio Grande entrenchment from northern New Mexico to El Paso, Texas (Axtell 1966. Herpetologica 22:241–253). Although New Mexico Whiptail is abundant in parts of the city of El Paso (Cordes et al.1989. Texas J. Sci. 41:425–428), it has not been reported from south of the river in Ciudad Juárez, Chihuahua, or elsewhere in México (Cordes and Walker 2009. Southwest. Nat. 54:226–230). Subsequent to Axtell's (1966, *op. cit.*) analysis of the geographic distribution of *A. neomexicana*, arrays of the species widely disjunct from the main distribution area have been reported as follows from New Mexico: Hidalgo Co. at sites northwest of Lordsburg (Cole et al 1988. Amer. Mus. Novitat. 2905:1–38); San Miguel Co. at Conchas Lake (Leuck et al. 1981. Southwest. Nat. 26:72–74; Manning et al. 2005. Amer. Mus. Novitat. 3492:1–56; Walker et al. 1992. Southwest. Nat. 37:82–86); De Baca Co. at Fort Sumner (Manning et al., *op. cit.*; Manning and Walker 2006. Amer. Midl. Nat. 155:411–416; Taylor 2002. Herpetol. Rev. 33:223–224); Lincoln Co. southwest of Carrizozo (Burkett et al. 2004. Herpetol. Rev. 35:408), and Roosevelt Co. in the extreme western part (Cordes and Walker 2011. Herpetol. Rev. 42:568). The species also has been reported from Arizona in Apache Co. in Petrified Forest National Park (Persons and Wright 1999. Herpetol. Rev. 30:207–209). It has been reported from Utah in Salt Lake Co. in Salt Lake City and Sandy City and from Utah Co. in Lehi (Oliver and Wright 2007. Western North Amer. Nat. 67:461–467). Finally, it has been reported from Texas in El Paso and Hudspeth counties in the vicinity of Hueco Tanks and Horizon Lake (Cordes et al., *op. cit.*) and in Presidio Co. south of Candelaria (Cordes et al., *op. cit.*; Cordes and Walker, *op. cit.*). We agree that the Utah and Arizona records for *A. neomexicana* are most likely based on the descendants of lizards introduced by humans (Oliver and Wright, *op. cit.*; Persons and Wright, *op. cit.*). We do not concur with these authors that the apparently disjunct groups of *A. neomexicana* in New Mexico and Texas have resulted from human introductions (for reviews see Taylor, *op. cit.*; Manning et al., *op. cit.*; Cordes and Walker, *op. cit.*).

In Texas, locality records for *A. neomexicana* are clustered in the El Paso metropolitan area, ca. 70 km NE of the city in the vicinities of Hueco Tanks State Park and Horizon Lake, El Paso and Hudspeth counties, and 200 km SE of the city at south of Candelaria, Presidio Co. Two of us have recently detailed aspects of the distributional ecology for the species and its congeners south of Candelaria (Cordes and Walker, *op. cit.*). We present observations on the habitats utilized by *A. neomexicana* in the Hueco Tanks-Horizon Lake area of El Paso and Hudspeth counties, the only records for the species well removed from the Rio Grande in Texas. The presence of *A. neomexicana* in this bi-county area is vouchered by these specimens examined from the Sul Ross State University (SRSU) and University of Texas at El Paso (UTEP) herpetology collections, and pitfall trap records: El Paso Co.: Hueco Mountains of Fort Bliss (pitfall trapped/released by DWB), 31.913952°N, 106.152937°W, WGS84; Hueco Tanks State Park (UTEP 609, 10793, 10794, N = 3); Hueco Tanks on south side of first enclave or rocks east of entrance (UTEP 1695, 1696, N = 2); Horizon Lake on west bank (SRSU 4162, 4195, N = 2); Hueco Mountains between Horizon Lake and El Paso National Compressor Station (SRSU 4156, 4161, N = 2); Hudspeth Co.: between Horizon Lake and El Paso National Compressor Station (SRSU 4185, 4186, N = 2).

The non-riverine occurrence of *A. neomexicana* in El Paso Co. is in the Hueco Bolson (i.e., a flat valley that drains to a central evaporation pan or playa) of the Chihuahuan Desert near Horizon Lake. This bolson is characterized by a substratum of sandy to gravelly soil that has accumulated since Miocene time. During the Pleistocene the bolson was flooded by Lake Cabeza de Vaca, a huge body of water that extended southeasterly deep into Chihuahua, México, northward into central New Mexico, and westward to the Sierra Madre Occidental in Sonora, México (Axtell 1977. *In* R. H. Wauer and D. H. Riskind [eds.], Transactions of the Symposium on the Biological Resources of the Chihuahuan Desert Region, United States and Mexico, pp. 493–512. U.S. Department of the Interior, National Park Service Transactions and Proceedings Series no. 3). Today, the edges of the Hueco Bolson contain gravel grading into alluvium and larger rock-debris from the Franklin Mountains to the west and the Hueco Mountains to the east as aggradations of the mountains and filling of the bolson continues.

Horizon Lake, now known as Shadow Mountain Lake, is a man-made impoundment created by the Horizon Corporation as a part of their development plan for the area. The soil in the area where the lake was created is aeolian sands overlaying the slope of an eroded karst which projects slightly above the bolson floor only a short distance to the west of the lake. Vegetation in the immediate vicinity consists of Sand Sagebrush (*Artemisia filifolia*), Spike Dropseed (*Sporobolus contractus*), and Broom Snakeweed (*Xanthocephalum sarothrae*); these are interspersed with Soaptree Yucca (*Yucca elata*) and Honey Mesquite (*Prosopis glandulosa*). The aeolian sands tend to accumulate at the bases of the mesquite and yucca clusters creating hummocks with blow-out open spaces nearby. Numerous small burrows were evident at the bases of the hummocks, and to a lesser extent, within

the open spaces. Species of lizards in addition to *A. neomexicana* at this locality were *Aspidoscelis marmorata* (= *C. tigris marmoratus*; Marbled Whiptail) and *Uta stansburiana* (Common Side-blotched Lizard).

The habitat for *A. neomexicana* at Horizon Lake was similar to the habitat for the species near Hueco Tanks State Park where the species was abundant. However, specimens of *A. neomexicana* collected from Hudspeth Co. only a few miles to the east of Horizon Lake were on bajada slopes of the Hueco Mountains with a gravelly to rocky substrate. Dominant plants here were Creosote Bush (*Larrea tridentata*), Fluff Grass (*Erioneuron pulchellum*), Viscid Acacia (*Acacia neovernicosa*), Prickly Pear (*Opuntia* sp.), Lechuguilla (*Agave lechuguilla*), and some Torrey Yucca (*Yucca torreyi*). Associated lizards at this locality in addition to *A. neomexicana* were *Aspidoscelis exsanguis* (Chihuahuan Spotted Whiptail), *Aspidoscelis inornata* (Little Striped Whiptail), *Cophosaurus texanus* (Greater Earless Lizard), and *Phynosoma modestum* (Round-tailed Horned Lizard). For collections via pitfall/drift fence trapping along the Hueco Mountain foot slopes and drainages, *Coleonyx brevis* (Texas Banded Gecko) was one of the most prominent lizard species present.

The occupation of both playa and outwash habitats by *A. neomexicana* in the areas of El Paso and Hudspeth counties well removed from the Rio Grande fits in perfectly with Axtell's (1966, *op. cit.*) description of the fidelity to playa habitats of the species in the southern portion of its range. The syntopy of *A. neomexicana* with other congeners at these sites also corroborates Axtell's discussion.

We thank Texas Parks and Wildlife Department for permission granted to JEC and DAB to collect specimens of *A. neomexicana* in Texas. Much of the descriptions of habitats for *A. neomexicana* presented herein were contributed by JFS.

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***ASPIDOSCELIS VELOX* (Plateau Striped Whiptail). BIFURCATION.** *Aspidoscelis velox*, a triploid hybrid-derived parthenogenetic species (Moritz et al. 1989. Evolution 43:958–968), has a natural range extending from the four corners area into contiguous parts of Colorado, New Mexico, Arizona, and Utah, and it has been introduced in Oregon (Stebbins 2003. A Field Guide to Western Reptiles and Amphibians, 3rd ed. Houghton Mifflin Co., New York, New York. 533 pp.). In a sample of *A. velox* (= *Cnemidophorus innotatus*, sensu Wright 1993. *In* J. W. Wright and L. J. Vitt [eds.], Biology of Whiptail Lizards, pp. 27–81. Oklahoma Museum of Natural History, Norman, Oklahoma) from 11.5 km N of Kanab and west of US Hwy 89 in the vicinity (37.14726°N, 112.57979°W; 1693 ± 2 m elev.) of Coral Pink Sands State Park, Kane Co., southern central Utah, are two preserved lizards (University of Arkansas Department of Zoology, UADZ 9168 of 87 mm SVL from 26 July 2012 and 9176 of 58 mm SVL from 27 July 2012), each with a with a caudal bifurcation. Unlike the very small representation of one branch of this anomaly in a specimen of *Ameiva ameiva* reported by Gogliath et al. (2012. Herpetol. Rev. 43:128–129), both individuals of *A. velox* have conspicuously developed bifurcations. In the large third or fourth year adult



FIG. 1. Noteworthy specimens of *Aspidoscelis velox* (= *Cnemidophorus innotatus* [sensu Wright *op. cit.*]) from Kane Co., Utah: UADZ 9168 (adult of 87 mm SVL) with short distorted original and supernumerary branches distal to bifurcation of the tail; UADZ 9176 (subadult of 58 mm SVL) with elongated original (63 mm) and supernumerary (57 mm) branches distal to bifurcation of the tail. During collection, the tail of each lizard was inadvertently broken, following which a small section was removed from each for DNA extraction.

(UADZ 9168), the supernumerary branch is ~ 29 mm in length; however, the original tail retains evidence of the initiating injury, being ~ 11 mm from bifurcation to a rigid angle indicating damaged/healed vertebrae, ~ 15 mm to a semi-rigid angle, and ~ 6 mm to the tip. The second year juvenile lizard (UADZ 9176) presents an amazing example of "twin" tails (Fig. 1). The original tail, as indicated by position and scalation, is 63 mm in length from the bifurcation; the supernumerary branch is 57 mm in length. We surmise that the bifid tail in the adult would have been inconsequential to its biology, whereas the amount of energy diverted into the growth and maintenance of the structure in the juvenile could have affected its reproductive potential. These are the only specimens of *A. velox* with bifid tails among >200 specimen of the species that we have examined from Arizona, New Mexico, and Utah.

We are grateful to the Utah Division of Wildlife Resources for issuing a license to JEC for collection of *A. velox* in Kane Co., Utah. The 2012 expedition to Utah and New Mexico was partially funded by an Endowed Professorship awarded to JEC by Louisiana State University Eunice and Opelousas General Hospital.

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***BRONCHOCELA CRISTATELLA* (Crested Green Lizard). ATTEMPTED PREY.** *Bronchocela cristatella* is a familiar agamid lizard in Southeast Asia, frequenting a variety of disturbed and pristine habitats, and especially common in open areas, such as parks and gardens, its diet is reported to be comprised mayflies, beetles, flies, and ants, in addition to skinks (Das 2010. A Field Guide to the Reptiles of South-east Asia. New Holland Publishers [UK], Ltd., London. 376 pp.; Diong and Lim 1998. Raffles Bull. Zool. 46:345–359).

On 21 October 2012, at 1128 h, an adult (ca. 110 mm SVL) male *Bronchocela cristatella* was observed at a patch of beach forest, adjacent to a mangrove creek at Teluk Penyuk (1.755833°N, 110.320278°E, ca. 56 m elev.), at the foothills of Gunung Santubong, Sarawak, East Malaysia (Borneo). It had gripped the



FIG. 1. *Bronchocela cristatella* with the posterior end of a *Lonchodes jejunus* (Phasmatida, Heteronemiidae, Lonchodinae).

posterior 5 mm of the abdomen of a ca. 130 mm long phasmid (or stick insect), *Lonchodes jejunus* (Phasmatida, Heteronemiidae, Lonchodinae) in its mouth (Fig. 1). For ca. eight minutes, the lizard struggled to subdue the stick insect, and finally released its hold, and moved back to the shrub vegetation at the edge of the beach, leaving the now nearly immobile insect. Still and video images were taken with a Sony HDR-XR 350E camera; these and additional still and video images have been registered with the Raffles Museum of Biodiversity Research, National University of Singapore (ZRC [IMG] 2.176a–c).

The phasmid genus *Lonchodes* includes long-bodied and slender species of uniform thickness; females may have anteriorly swollen mesonotum. Bragg (2001. Phasmids of Borneo. Natural History Publications [Borneo] Sdn Bhd., Kota Kinabalu. xi + 772 pp.) listed at least five species within the genus from Santubong and adjacent regions of western Sarawak, of the 19 species known from Borneo (excluding two additional species erroneously recorded from the island). Phasmids have earlier been reported in saurian diets, although chiefly of the much larger varanids (e.g., Pianka 1970. West. Aust. Natural. 11:141–144; Greene 1986. Fieldiana Zool., n.s. [31]:i–iii; 1–12), and no Asian agamids have been reported to consume or attempt to predate on these large-growing insects.

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***CERCOSAURA SCHREIBERSII* (Long-tailed Little Lizard). DEFENSIVE BEHAVIOR.** Little is known about the natural history of *Cercosaura schreibersii*, a small gymnophthalmid lizard (Tedesco and Céspedez 2005. Bol. Asoc. Esp. Herpetol. 16:30–32). The few available data are related to taxonomic features (Cei 1993. Mus. Reg. Sci. Nat., Torino, Monogr. 14, 949 pp.; Doan 2003. Zool. J. Linn. Soc. 137:101–115; Tedesco and Cei 1999. Boll. Mus. Reg. Sci. Nat. 16:309–320) or reproductive mechanisms (Balestrini et al. 2010. Biota Neotrop. 10:131–139). Here we provide the first report on death-feigning behavior combined with caudal autotomy in this species.

On 15 July 2012 we collected two *Cercosaura schreibersii* specimens, an adult and a juvenile, under a log in putrefaction in a xeric grassland at the Paraje Zapallo (27.845028°S, 57.866842°W), San Luis del Palmar Department, Corrientes province, Argentina. The adult specimen (total length = 80.58 mm) responded aggressively by biting the collectors' fingers upon initial attempt to lift it for examination. The lizard was put down and at which time it leaned backwards and began to rotate in a circular motion over its own body, causing autotomy of its tail. After this it placed its forelimbs stretched over the abdomen and arched its body and head back. It remained motionless for a couple of minutes, feigning death.

Caudal autotomy is a common method of antidepredatory behavior, reported in squamates, salamanders, and rodents (Arnold 1988. *In* Gans and Huey [eds.], Biology of the Reptilia Vol. 16. Defense and Life History, pp. 235–273. Alan R. Liss, New York; Brito et al. 2001. Herpetol. Rev. 32:43–44). But reports on caudal autotomy in conjunction with death feigning are scarce (Torres-Cervantes et al. 2004. Herpetol. Rev. 35:384). In this case, the animal did not lose its tail via traditional autotomy, rather it twisted its own body in order to detach it.

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***CHALCIDES OCELLATUS* (Ocellated Skink). SPIDER PREDATION.** The spider genus *Latrodectus* has a worldwide distribution, with many species recorded as having a broad diet and as being occasional predators of lizards and mice (Garb et al. 2004. Mol. Phylog. Evol. 31:1127–1142; e.g., *Latrodectus hasselti* in Knoflach and Van Harten 2001. Fauna of Arabia 19:321–361; *L. pallidus* and *L. revivensis* in Blondheim and Werner 1989. Brit. Herpetol. Soc. Bull. 30:26–27); this is likely the reason for the presence of a vertebrate-specific toxin (-latrotoxin) found in their venom (Garb et al., *op. cit.*). In Europe, the diet of *Latrodectus lilianae* has been found to include the lizards: *Acanthodactylus erythrurus*, *Psammodromus algirus*, *Psammodromus*



PHOTO BY M. COLOMBO

FIG. 1. Female *Latrodectus tredecimguttatus* spider with a dead juvenile *Chalcides ocellatus* in its web; the spider's egg sacks visible in upper left corner.

hispanicus, Tarentola mauritanica (Hòdar and Sànchez-Piñero 2002. J. Zool. Lond. 257:101–109). The only Italian species of *Latrodectus, L. tredecimguttatus,* is reported as occasionally preying on small lizards in Romania (Duma 2006. Travaux du Muséum d'Histoire Naturelle 49:75–81). Schwammer and Baurecht (1988. Herpetozoa 1:73–76) reported predation upon *Podarcis melisellensis* in Croatia.

On 1 August 2011, near Maristella (Sassari province, Sardinia, Italy) while inspecting some black widow spider webs under stones and bushes in a Mediterranean maquis for photographic purposes, a female *L. tredecimguttatus* was observed with a juvenile *Chalcides ocellatus tiligugu* entangled in its web, already dead. The skink clearly bore the bite of the spider on its right side (Fig. 1), showing necrosis of tissues around it. The prey was located under the hunting platform as also observed for *L. lilianae* (Hòdar and Sànchez-Piñero, *op. cit.*) and not in the nest, where at least two egg sacks were present. It is possible that the reptile was either caught while moving under the web, or by falling in it from above, as the web was constructed in a corner of a rocky outcrop covered by *sterpaglie* (extensive growths of Graminaceae). The following day another inspection of the web confirmed that the spider had finished consuming its prey, leaving it on the ground under the web. It is possible, as proposed by Hòdar and Sànchez-Piñero (2002, *op. cit.*) for lizards, that the overlapping of daily activity of both skinks (diurnal) and spiders (nocturnal) in the first hours of the day and at sunset permits this kind of interaction, even more with juvenile skinks that have smaller bodies and better thermoregulation (considering that during summer months this skink's activity is bimodal; Corti et al. 2011. Fauna d'Italia. XLV. Reptilia. Edizioni Calderini, Milan. 270 pp.). In the same area, *L. tredecimguttatus* has been observed preying upon several arthropods but never on vertebrates before (M. Colombo and B. Manunza, pers. obs.); however, predation on reptiles could be more frequent than has been reported, as also stated by Hòdar and Sànchez-Piñero (2002, *op. cit.*). This record represents the first documented case of predation of a spider on a skink in Europe (a not-so-common kind of prey also in other parts of the world; McCormick and Polis 1982. Biol. Rev. Camb. Philos. 57:29–58), and one of the few cases of predation by a spider on a reptile in Italy. This observation adds to the limited knowledge of trophic interactions between reptiles and spiders (an often overlooked phenomenon in food webs; McCormick and Polis, *op. cit.*) in Mediterranean environments, as *C. ocellatus* was already known to feed on arthropods including spiders (Corti et al. 2011, *op. cit.*).

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COPEOGLOSSUM NIGROPUNCTATUM. **ENDOPARASITES.** *Copeoglossum nigropunctatum* occurs in parts of Brazil, French Guiana, Guyana, Venezuela, Isla Margarita, Trinidad, Tobago, Suriname, Bolivia, Peru, and Ecuador (Uetz [ed.] 2012. The Reptile Database. http:www.reptile-database.org. Accessed 1 November 2012). It is the most common skink in Amazonia (Avila-Pires 1995. Zoolog. Verh. Leiden 299:1–706). There are previous reports of nematodes in *C. nigropunctatum* (previously *Mabuya nigropunctata*) from Brazil, *Oochoristica travassosi, Oswaldocruzia* sp., *Physaloptera lutzi, Physaloptera retusa* (Avila and da Silva, 2011. Comp. Parasitol. 78:129–139), *Oochoristica* sp. (Avila et al. 2011. Comp. Parasitol. 78:120–128), *Physalopteroidea venancioi* (de Albuquerque et al. 2012. Comp. Parasitol. 79:64–67) and Peru, *Oswaldocruzia brasiliensis, Parapharyngodon sceleratus, Piratuboides zeae* (McAllister et al. 2010. J. Parasitol. 96:444–447). The purpose of this note is to add to the helminth list of *C. nigropunctatum.*

A sample of 15 *C. nigropunctatum* (mean SVL = 83.3 mm ± 7.9 SD, range = 62–93 mm) collected in Pará State, Brazil in 1995 and 2004, and deposited in the herpetology collection of the Sam Noble Museum (OMNH), Norman Oklahoma, USA as (OMNH 36828–36842, 41807–41811) was examined. Lizards were fixed in 10% formalin and stored in 70% ethanol. The stomachs had previously been removed and were not available for examination. The intestines were removed, opened, and the contents examined under a dissecting microscope. Nematodes were found in the small intestines, prevalence, number infected/number examined × 100 = 73%, mean intensity, mean number helminths = 3.8 ± 2.1 SD, range = 1–7. They were cleared in a drop of lactophenol on a microscope slide, cover slipped, studied under a compound microscope and identified as *Oswaldocruzia vitti.* Voucher nematodes were deposited in the United States National Parasite Collection (USNPC), Beltsville Maryland as USNPC 106130.

We have assigned our specimens to *Oswaldocruzia vitti* because the spicule blade terminates in three bifurcated processes; the spicule blade of *O. brasileinsis* is spatulate. *Oswaldocruzia vitti* was originally described from *Cercosaura eigenmanni* (Brazil) and *C. oshaughnessyi* (Brazil, Ecuador) (Bursey et al. 2004. J. Parasitol. 90:140–145). It was also found in *Alopoglossus angulatus* (Brazil, Ecuador) and *A. atriventris* (Brazil) (Goldberg et al. 2007. Herpetol. J. 17:269–272), *Anolis punctatus* (Brazil, Ecuador) (Goldberg et al. 2006. Amphibia-Reptilia 27:575-579), *Anolis fuscoauratus* (Brazil, Ecuador) (Goldberg et al. 2006. Phyllomedusa 5:83-86), *Arthrosaura reticulata* (Ecuador) (Goldberg et al. 2010. Herpetol. Rev. 41:349-350), *Cercosaura eigenmanni* (Peru) (Bursey et al. 2005. Comp. Parasitol. 72:50-68), *Plica plica* and *P. umbra* (Brazil) (Goldberg et al. 2009. Herpetol. J.19:49-52). *Copeoglossum nigropunctatum* represents a new host record for *Oswaldocruzia vitti.*

We thank Jessa L. Watters (OMNH) for facilitating the loan.

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CTENOSAURA HEMILOPHA **(Baja California Spiny-tailed Iguana). DISPERSAL PHENOMENON.** *Ctenosaura hemilopha* is endemic to Baja California Sur, Mexico, including Cerralvo Island located in the Sea of Cortez east of La Paz (Grismer 2002. Amphibians and Reptiles of Baja California including its Pacific Islands and the Islands in the Sea of Cortés. University of California Press, Berkeley. 409 pp.; Stebbins 2003. A Field Guide to Western Reptiles and Amphibians, 3rd ed. Houghton Mifflin Co., New York. 560 pp.). This large lizard occurs in arid, sub-tropical scrub habitats where



FIG. 1. *Ctenosaura hemilopha* drifting on log in the Sea of Cortez, Mexico.

most rainfall occurs during late-summer tropical storms. The isolated occurrence of this iguana on the Baja California peninsula presumably results from dispersal over land originating from the Mexican mainland (Smith 1972. Great Basin Nat. 32:104–111) or from human introductions (Stebbins 2003, *op. cit.*). Here we describe a rare observation of a long distance dispersal phenomenon and natural mechanism for dispersal over water.

On 28 September 2012 tropical storm Norman moved northerly over the Sea of Cortez with reports of heavy rain and flooding in La Paz and other coastal towns. While boating on 2 October in the Sea of Cortez between La Paz and Cerralvo Island we observed extensive debris carried by coastal floodwaters and wind. Tree trunks, large branches, and smaller woody debris were observed. The debris field appeared to be moving from the La Paz area toward Cerralvo Island and the open waters of the Sea of Cortez. On the same day an adult *Ctenosaura hemilopha* was found floating on driftwood between La Paz and the northern tip of Cerralvo Island (Fig. 1). The lizard was approximately 7 km W of the island and 40 km E of La Paz (24 km E of the nearest shore). The driftwood log was approximately 90 cm in length and the size of the iguana was estimated at 22 cm SVL. The iguana was captured and appeared to be in good health. It was later released in the village of La Ventana, south of La Paz, Baja California Sur.

Evidently the stranded iguana, caught in flood waters, floated on debris for 24–40 km or more from the La Paz area and for a period of up to four days (i.e., from the time the storm began to the time observed in open water). It is plausible that this lizard could have continued to drift at a rate of 5–10 km/day and reached Cerralvo Island within 1–2 days. Our observation documents a natural dispersal event rarely seen, and indicates that peninsular individuals of this species may still be colonizing the island today.

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***CTENOSAURA SIMILIS* (Gray's Spiny-tailed Iguana). NON-NATIVE DIET.** *Ctenosaura similis* is native to Central America, occurring from Mexico through to Panama (Traveset 1990. Am. Midl. Nat. 123:402–404), and has been introduced to several Caribbean islands, and Florida, USA (Kraus 2009. Alien Reptiles and Amphibians: A Scientific Compendium and Analysis. Springer, [Dordrecht, Netherlands], 563 pp.; Krysko et al. 2003. Florida Sci. 66:74-79). This species exhibits an ontogenetic diet shift, where juveniles are primarily carnivorous and adults are primarily herbivorous (Hirth 1963. Ecology 44:613–615; Krysko et al. 2009. Florida Sci. 72:48–58; Rand et al. 1990. J. Herpetol. 24:211–214). Diet has been documented for some introduced populations in southern Florida, particularly those on Gasparilla Island, Charlotte and Lee counties, and Key Biscayne, Miami-Dade Co. (Krysko et al. 2009, *op. cit.*, Krysko et al. 2010. Herpetol. Cons. Biol. 5:132–142). Herein, we augment previously documented diet of *C. similis* on Key Biscayne.



FIG. 1. *Ctenosaura similis* eating *Canavalia rosea* flowers at Crandon Park beach.

On 14 September 2012 between 1205–1220 h, a single adult female *Ctenosaura similis* was observed in beach coastal habitat feeding on flowers of the native Baybean, *Canavalia rosea* (Fabaceae), at Crandon Park, Key Biscayne (25.706°N, 80.153°W, WGS84; elev. <1 m). The iguana periodically foraged through a large area (ca. 20 m x 20 m) of Baybean and ate 21 individual flowers; no other parts of the plant were eaten. This is the first documentation of *C. similis* consuming *Canavalia rosea* (Krysko et al. 2009, *op. cit.*; Krysko et al. 2010, *op. cit.*). Florida currently has the largest number of non-native herpetofaunal species in the world, and the impact of native/non-native interactions on ecosystem functioning remain poorly understood (Krysko et al. 2011. Zootaxa 3028:1–64). The potential impacts of this feeding behavior on local plant survivability are not known and should be considered important in future monitoring. No sympatric reptile species were observed throughout the duration of the feeding behavior.

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***DIPSOSAURUS DORSALIS* (Desert Iguana). REPRODUCTION BAJA CALIFORNIA SUR.** *Dipsosaurus dorsalis* ranges from southern Nevada to the tip of Baja California (Stebbins 2003. A Field Guide to Western Reptiles and Amphibians. Houghton Mifflin Co., Boston, Massachusetts. 533 pp.). Detailed information on *D. dorsalis* reproduction in southern California was reported by Mayhew (1971. Herpetologica 27:57–77). Previous information on reproduction of *D. dorsalis* in Baja California Sur was reported by Asplund (1967. Amer. Midl. Nat. 77:462–475) and Grismer (2002. Amphibians and Reptiles of Baja California Including its Pacific Islands and the Islands in the Sea of Cortés. Univ. Calif. Press, Berkeley. 399 pp.). The purpose of this note is

TABLE 1. Monthly stages in the testicular cycle of 27 *Dipsosaurus dorsalis* from Baja California Sur, Mexico.

Month	N	Regressed	Recrudescence	Spermiogenesis	Late Spermiogenesis
May	9	0	0	9	0
June	1	1	0	0	0
July	9	2	4	1	2
August	8	1	7	0	0

TABLE 2. Monthly stages in the ovarian cycle of 14 *Dipsosaurus dorsalis* from Baja California Sur, Mexico.

Month	N	Quiescent	Early yolk deposition	Oviductal eggs
May	3	0	3	0
July	5	4	0	1
August	6	6	0	0

to report additional information on reproduction of *D. dorsalis* from Baja California Sur.

A sample of 51 *D. dorsalis* collected from 1949 to 1978 at the southern tip of Baja California Sur, Mexico (between 24.1666°N, 110.3000°W and 22.8800°N, 109.9000°W), consisting of 27 adult males (mean SVL = 119.1 mm ± 8.3 SD, range = 105–134 mm), 14 adult females (mean SVL = 107.0 mm ± 10.8 SD, range = 93–127 mm), 8 subadult males (mean SVL = 93.1 mm ± 6.3 SD, range = 80–98 mm), 2 subadult females (mean SVL = 89.0 mm ± 0.71 SD, range = 88–89 mm) was examined from the herpetology collection of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California, USA; LACM 17133–17136, 17138, 17154–17156, 17159, 17161, 17163–17167, 17173–17175, 17180–17191, 17193–17196, 17199–17201, 17204, 17205, 17207, 127939, 127940, 127943, 127946–127950, 127952, 127955, 127956.

A small incision was made in the lower part of the abdomen and the left gonad was removed for histological examination. Gonads were embedded in paraffin, sections were cut at 5µm, and stained with Harris hematoxylin followed by eosin counterstain. Oviductal eggs were counted. Histology slides were deposited in LACM.

Four stages were noted in the testicular cycle (Table1): 1) regressed, seminiferous tubules contain mainly spermatogonia and Sertoli cells; 2) recrudescence, proliferation of germ cells for the next period of spermiogenesis is in progress, primary spermatocytes predominate; 3) spermiogenesis, lumina of seminiferous tubules lined by clusters of sperm or metamorphosing spermatids; 4) late spermiogenesis, only a few rows of germinal cells remain, fewer sperm present in comparison to stage 3. Spermiogenesis occurred in May and concluded in July. Recrudescence was underway in July and August. The smallest reproductively active male (LACM 127940) (undergoing spermiogenesis), measured 106 mm SVL and was collected in May 1978. This is smaller than the minimum size (115 mm SVL) reported by Mayhew (1971, *op. cit.*) for reproductively active *D. dorsalis* males in California.

Three stages were noted in the ovarian cycle (Table 2): 1) quiescent, no yolk deposition; 2) early yolk deposition, basophilic vitellogenic granules are present; 3) oviductal eggs are present. Early yolk deposition occurs in May. Ovarian activity concludes by August. One July female (LACM 17201) contained six oviductal eggs. The smallest reproductively female (LACM 127946) exhibited early yolk deposition, measured 93 mm SVL and was collected in May 1978. This is smaller than the minimum size (110 mm SVL) reported by Mayhew (1971, *op. cit.*) for reproductively active *D. dorsalis* females in California.

My findings support Asplund (1967, *op. cit.*) who reported reproduction in *D. dorsalis* had ceased in August in the Cape Region of Baja California Sur. It appears the reproductive cycles of *D. dorsalis* are in synchrony in both California (Mayhew 1971, *op. cit.*) and Baja California Sur.

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***GEKKO JAPONICUS* (Japanese Gecko). SAP FEEDING.** *Gekko japonicus* is a small gecko (up to 73 mm SVL) occurring in Japan (Ota and Tanaka 1996. The Encyclopaedia of Animals in Japan 5, Amphibians, Reptiles, Chondrichthyes. Heibonsha, Tokyo, Japan. 69 pp.). On the basis of anecdotal information, this species is believed to inhabit urban areas almost entirely (Ota and Tanaka 1996, *op. cit.*). *Gekko japonicus* gathers around artificial lights on buildings and other anthropogenic structures at night to forage on insects that are attracted by the lights, such as moths, leaf beetles, and mayflies (Ota and Tanaka 1996, *op. cit.*; Werner et al. 1997. Asiatic Herpetol. Res. 7:153–165). Ota and Tanaka (1996, *op. cit.*) suggested coastal rocky areas and forests as the original habitats of *G. japonicus*. No ecological studies have shown the foraging behavior of *G. japonicus* in its natural habitat. Here, we report sap-feeding behavior by *G. japonicus* in a dark forest.

Our field survey was conducted in the coppice areas at the Kitashirakawa Experimental Station of the Field Science Education and Research Center, Kyoto University (35.0325°N, 135.7855°E, datum WGS84; 67 m elev.) and Yoshidayama Mountain (35.0227°N, 135.7838°E to 35.0286°N, 135.7886°E; 74–110 m elev.), Kyoto, Japan. We observed geckos licking the sap of the Japanese Willowleaf Oak (*Quercus salicina*) in the Kitashirakawa Experimental Station on 10 days in July and August 2010. On Yoshidayama Mountain, similar behaviors were observed by the geckos on Sawtooth Oak (*Quercus acutissima*) on 9 July 2010, 15 and 29 June 2012. During these surveys, we observed 14 *G. japonicus* individuals licking sap from trees. They usually did not move on the tree trunk or branches for several minutes and licked a small patch of tree sap. During the 2-min detailed observation on 29 June 2012, the gecko consumed sap for 19 sec by licking it 14 times. On one occasion (9 July 2010), we observed a *G. japonicus* consume a moth that was attracted by the sap from the Sawtooth Oak on Yoshidayama Mountain. After 1 min of tree-sap feeding by the gecko, a moth (Catocalinae) flew to the sap site of the tree trunk near the gecko. The gecko stopped licking the sap and captured the moth. Because we observed many moths and beetles attracted by the tree sap at night, we assumed that geckos might use the patch of tree sap as a sit-and-wait location to forage for insects attracted to the tree sap. However, further observations are required to evaluate the relative importance of sap feeding of *G. japonicus* in forest habitats.

To our knowledge, this is the first study to show a *Gekko* species using tree sap as a resource for direct ingestion of the sap and foraging for insect prey. However, in several species of lizards, it is considered that tree sap could be a valuable food resource

because of the high concentration of sugars and nutrients (Greer 1989. The Biology and Evolution of Australian Lizards. Surrey Beatty and Sons, Chipping Norton, Sydney, Australia. 264 pp.). Therefore, tree sap consumption by *Gekko* species may be more widespread than was previously considered, especially in several congeners that inhabit forest areas (e.g., Aowphol et al. 2006. Amphibia-Reptilia 27:491–503).

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***HELODERMA HORRIDUM CHARLESBOGERTI* (Guatemalan Beaded Lizard). WILD REPRODUCTIVE ECOLOGY.** *Heloderma horridum charlesbogerti* is an endangered venomous lizard endemic to the seasonally dry tropical forests of Motagua Valley in eastern Guatemala (Campbell and Vannini 1988. J. Herpetol. 22:457–468).

We conducted a four-year radio-tracking study from July 2004 to September 2008 to determine the ecology and behavior of this species. Lizards were fitted with a radio transmitter (CHP-5P by Telonics, Mesa, Arizona, USA) and tracked using an ATS FieldMaster FM100 Receptor. The transmitters were attached within the second and third tail ring of each lizard (approximately 20 mm posterior to the vent), and to improve the security of the transmitters, they were fixed using duct tape (Truper, USA), with care taken not to obstruct the cloaca. Each individual was also marked with PIT-tags (AVID microchips, Los Angeles, California, USA) inserted at the level of the right forelimb.

One of the radiotracked females (No. 094.519.273) was gravid at the beginning of November 2006. This was verified by detecting egg masses in her belly by direct ventral palpation. During the second week of November 2006 this female entered a burrow probably made by an armadillo (*Dasypus novemcinctus*), in which she remained for 12 days at a depth of 2.5 m. After this time, the female emerged notably thinner (late November 2006) and a tactile exam revealed that eggs has been laid inside this burrow. Five months later (early April 2007) marks on the entrance of the burrow indicated that juveniles had left this underground retreat. Internal inspection of the burrow revealed four hatched egg shell remains.

The nest described above was monitored with data loggers. Simultaneous data of relative humidity (%), temperature (°C), and dew point (°C) were recorded at a depth of 1 m in the underground shelter of female No. 094.519.273 nest. This was made using EL-USB-2 preprogrammed Lascar® data loggers. The data storage time was settled to record every 5 min. Means are given ± 1 SD.

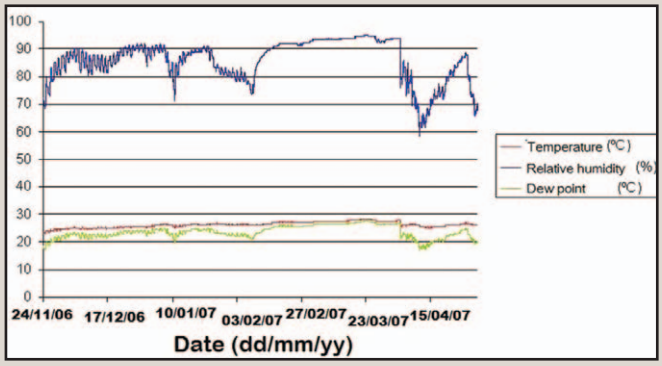


FIG. 1. Microclimatic parameters of the incubation period of a nest of *Heloderma horridum charlesbogerti* in the wild monitored from 24 November 2006 to 21 April 2007.

The incubation period of this nest was 149 days. The average incubation temperature was 26.36 ± 1.09°C, average relative humidity was 82.16 ± 9.76%, and average dew point temperature was 22.97 ± 2.38°C. These data were taken from 24 November 2006 to 21 April 2007.

The temperature range inside the nest was between 23–29°C. The relative humidity ranged from 58.5% to 95%, with the lowest percentages occurring near the end of the incubation period. The dew point temperature varied from 16.8 to 27.6°C. There were no differences between the nest temperature and the dew point temperature inside the shelter during the first four months of incubation. This implies that for successful incubation the eggs of this species require a humidified or nearly saturated environment, but with no direct contact with water.

The incubation time of a monitored nest (149 days) agrees with previous reports on captive incubations of eggs of *H. h. charlesbogerti* at San Diego Zoo, which varied between 145 to 164 days (Owens 2006. Iguana 13:212–215). These incubation periods are much less than those reported in captivity for other subspecies of *H. horridum* which vary from 201 to 215 days (Beck 2005. Biology of Gila Monsters and Beaded Lizards. Univ. California Press, Los Angeles. 211 pp.). The microclimate data of the nest monitored and presented in this note are the first observation and microclimate data gathering of a wild nest of any *Heloderma* species in nature (Beck 1990. J. Herpetol. 24:54–68; Beck 2005, *op. cit.*; Beck and Jennings 2003. Herpetol. Monogr. 17:111–129; Beck and Lowe 1991. J. Herpetol. 25:395–406; Campbell and Vannini, *op. cit.*; Jones 1983. Herpetologica 39:247–253). The data reported here will be of great relevance for further captive breeding programs on this endangered species, as captive incubation in *H. h. charlesbogerti* has been reported to be problematic (Owens, *op. cit.*).

Fieldwork was conducted under CONAP scientific research permits. Funding was provided by grants from Zoo Atlanta, IRCF, Eli Lilly Co., Disney Worldwide Conservation Fund, San Diego Zoo, Oklahoma City Zoo, Idea Wild, and The Nature Conservancy. This work was part of a Master's thesis of D. Ariano-Sánchez at Universidad de Costa Rica. Field assistance was provided by Erick Lopez, Cristian Beza, and Pablo Salazar.

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***LEPOSOMA PARIETALE*. ENDOPARASITES.** *Leposoma parietale* is known from the Amazonian slopes of the Andes in southeastern Colombia, eastern Ecuador and northeastern Peru where it inhabits leaflitter (Avila-Pires. 1995. Lizards of Brazilian Amazonia [Reptilia: Squamata]. Zoologische Verhandelingen 299:1–706). We know of no reports of helminths for *L. parietale*. The purpose of this note is to establish the initial helminth list for this gymnophthalmid lizard.

Eleven *L. parietale* (mean SVL = 32.3 mm ± 3.1 SD, range = 27–35 mm) from the herpetology collection of the Sam Noble Museum (OMNH, The University of Oklahoma, Norman, USA) were examined for helminths, all from Ecuador, including specimens from Napo Province, Jatun Sacha (OMNH 36379; 0.98333°S, 77.81667°W, WGS 84; elev. 400 m) collected in April 1989, and

from Sucumbios Province, Reserva Faunistica Cuyabeno, Estación Biología da Universidad Católica (Quito) (OMNH 36456–36467; 0°S, 76.11667°W, WGS 84; elev. 260 m), collected in February, March, and April 1994. The stomachs had been previously removed and were not available for examination. The small and large intestines were removed, opened, and examined under a dissecting microscope. Cestodes were regressively stained in hematoxylin, mounted in balsam on a microscope slide, cover slipped, and studied under a compound microscope as a whole-emount. Nematodes were removed, placed separately on microscope slides, cleared in a drop of lactophenol, cover slipped, and studied under a compound microscope. One species of Cestoda, *Tejidotaenia appendiculata* (N = 3) was found in the small intestine of OMNH 36379. Two species of Nematoda were found, including *Cosmocerca vrcibradici* in the large intestine of OMNH 36464 (N = 2) and OMNH 36467 (N = 1) and *Oswaldocruzia vitti* (1 each) in the large intestine of OMNH 36459 and 36460. Prevalence, number infected/number examined × 100 = 9.0% for *T. appendiculata,* 18.1% for both *C. vrcibradici* and *O.* vitti. Mean infection intensity (mean number infected individuals) was 1.50 ± 0.71, range: 1–2 for *C. vrcibradici.* Helminths were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland, USA as *Tejidotaenia appendiculata* (USNPC 106354), *Cosmocerca vrcibradici* (USNPC 106355), and *Oswaldocruzia vitti* (USNPC 106356).

Tejidotaenia appendiculata (originally *Proteocephalus appendiculatus* from *Tupinambis nigropunctatus* [currently *T. teguixin*] collected in Surinam) was redescribed from the same host collected in Brazil (Rego and de Chambrier 2000. Mem. Inst. Oswaldo Cruz 95:161–165). *Leposoma parietale* represents the second reported host for *T. appendicualta*; Ecuador is a new locality record. *Cosmocerca vrcibradici* was described from the gymnopthalmid *Prionodactylus eigenmanni* (currently *Cercosaura eigenmanni*) from Rondônia State, Brazil (Bursey and Goldberg 2004. J. Parasitol. 90:140–145). Other hosts are in Goldberg et al. (2010. Herpetol. Rev. 41:495–496). *Oswaldocruzia vitti* was described from *P. eigenmanni* from Amazonas State, Brazil by Bursey and Goldberg (*op. cit.*); a host list is in Goldberg et al. (2013. Herpetol. Rev. 44, *in press*). *Tejidotaenia appendiculata, Cosmocerca vrcibradici* and *Oswaldocruzia vitti* comprise the initial parasite list for *L. parietale.*

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***LEPOSOMA PERCARINATUM* (Muller's Tegu). ENDOPARASITES.** *Leposoma percarinatum* is known from northern South America east of the Andes where it inhabits leaflitter, frequently close to water (Avila-Pires. 1995. Lizards of Brazilian Amazonia (Reptilia: Squamata). Zoologische Verhandelingen 299:1–706). We know of no reports of helminths for *L. percarinatum.* The purpose of this note is to establish the initial helminth list for *L. percarinatum.*

Twelve *L. percarinatum* females (mean SVL = 29.2 mm ± 5.1 SD, range = 23–37 mm) were examined for helminths from the herpetology collection of the Sam Noble Museum (OMNH, The University of Oklahoma, Norman, USA) collected July 1993 (OMNH 36344–36355) in Roraima State, Brazil, 7.0 km E Rio Ajarani (1.55000°S, 61.26666°W, WGS 84; elev. 66 m). The stomachs had been previously removed and were not available for examination. The small and large intestine were removed, opened and examined under a dissecting microscope. The only nematode found was from the small intestine of OMNH 36355. It was placed on a microscope slide, cleared in a drop of lactophenol, cover slipped and studied under a compound microscope. It was identified as an adult female *Oswaldocruzia vitti.* Prevalence (number infected/number examined × 100 = 8.3%). The helminth was deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland, USA as *Oswaldocruzia vitti* (USNPC 106357).

Oswaldocruzia vitti was described from *Prionodactylus eigenmanni* (currently *Cercosaura eigenmanni*) from Amazonas Province, Brazil by Bursey and Goldberg (2004. J. Parasitol. 90:140–145). A host list is in Goldberg et al. (2013. Herpetol. Rev. 44 *in press*). *Leposoma percarinatum* represents a new host record for *O. vitti.*

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***LEPOSTERNON* SP. PREDATION.** During the analysis of stomach contents of a young female Crab-eating Fox (*Cerdocyon thous*) in the Laboratório de Ecologia of the Universidade Veiga de Almeida, Rio de Janeiro, Brazil, we collected body parts of an unidentified species of *Leposternon* sp. The specimen of *C. thous* was a road kill, collected on 2 December 2009, on the BR-040 highway, at km number 97 (22.583°S, 43.260°W; datum SAD 69), in the locality of Xerém, Duque de Caxias, Rio de Janeiro state, Brazil. The Crab-eating Fox is a medium-sized canid that is widely distributed in Brazil (Reis et al. 2011. Mamíferos do Brasil. 2ª edição. Londrina. 442 pp.), which has an omnivorous diet, including plants (fruits), small mammals, arthropods, fishes, anurans, birds, carrion, and reptiles (turtle eggs, lizards, and snakes) having been reported in the literature (Bueno and Motta-Júnior 2004. Rev. Chil. Hist. Nat. 77:5–14; Gatti et al. 2006. Jour. Trop. Ecol. 22:227–230; Gomes et al. 2012. Herpetol. Notes 5:463–466; Juarez and Marinho-Filho 2002. J. Mammal. 83:925–933; Reis et al. 2011, *op. cit*; Rocha et al. 2004. Rev. Bras. Zool. 21:871–876; Uchoa et al. 2004. Cad. Biodiv. 4:67–74; Pedó et al. 2006. Rev. Bras. Zool. 23:637–641; Vieira and Port 2007. J. Zool. 272:57–63). Prior to the report presented here, reptiles reported in the diet of this wild canid are the lizards *Brasiliscincus agilis, Ameivula littoralis, Ameiva ameiva, Vanzosaura rubricauda, Tropidurus* sp., *Anolis* sp., *Mabuya* sp., and *Ameiva* sp.; and the snakes *Typhlops brongersmianus* and *Bothropoides jararaca* (Gatti et al., *op. cit.*; Gomes et al. 2012, *op. cit.* Juarez and Marinho-Filho, *op. cit.*; Raíces and Bergallo, 2010. Neotrop. Biol. Conserv. 5:24–30; Rocha et al., *op. cit.*; Rocha et al. 2008. Rev. Bras. Zool. 25:594–600).

The head of *Leposternon* species are characterized by the presence of the rostral and nasals fused into a single shield, and by having nostrils with the openings on the ventral surface of the

snout (Perez and Ribeiro 2008. Check List 4:291–294; Peters and Orejas-Miranda 1970. Catalogue of Neotropical Squamata Part I. Snakes. U.S. Nat. Mus. Bull. 347 pp.), which was observed in the head of the specimen of the current study. *Leposternon* species are differentiated from each other by the size and position of the azygous, by the size of the pectoral shields, and the number of rows of postpectoral shields (Barros Filho and Valverde 1996. Sitientibus 14:57–68; Perez and Ribeiro, *op. cit.*; Peters and Orejas-Miranda, *op. cit.*). According to Perez and Ribeiro (*op. cit.*) and Rocha et al. (2004. Publ. Avul. Mus. Nac. 104:3–23), *Leposternon* is represented by four species in the Rio de Janeiro state: *L. infraorbitale*, *L. microcephalum*, *L. scutigerum*, and *L. wuchereri*. In the current study, it was not possible to identify the *Leposternon* species because of missing body parts. Therefore, the present study is the first report of a *Leposternon* sp. as a food item in the diet of Crab-eating Fox from Brazil.

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***PHRYNOSOMA CORNUTUM* (Texas Horned Lizard). PREDATION.** Despite the Texas Horned Lizard's large protective horns and spiny scales, some species of snakes are able to successfully consume them. Common snake predators of *Phrynosoma cornutum* include Coachwhips and Sonoran Whipsnakes (*Masticophis flagellum* and *M. bilineatus*) and Western Diamondback Rattlesnakes (*Crotalus atrox*) (Sherbrooke 2003. Introduction to Horned Lizards of North America. Univ. California Press. Berkeley, California. 177 pp.; Sherbrooke et al. 2012. Herpetol. Rev. 40:386–391). Here I report on another successful serpent predator on *P. cornutum*, the Broad-banded Copperhead (*Agkistrodon contortrix laticinctus*).

A female *P. cornutum* was recently discovered in the stomach of an *A. c. laticinctus* during a radio telemetry study. The captive-hatched, three-year-old *P. cornutum* was released on a private site in Parker Co., Texas, USA, on 08 September 2011 as part of a reintroduction project and had been tracked using radio telemetry for eight months. She was outfitted with a radio transmitter glued to her back and was last sighted near the edge of an oak motte on 2 May 2012. Six days later on 8 May 2012, a weak radio signal led to an *A. c. laticinctus* coiled under a tangle of bramble within the oak motte. The snake was captured and radiographed (Fig. 1). The radiograph confirmed suspicions that the horned lizard had been consumed. The transmitter was later passed safely through the snake's digestive system on 30 May 2012. The *P. cornutum* weighed approximately 46 g prior to being consumed and the *A. c. laticinctus* measured 69.2 cm total length and weighed 136.1 g after the horned lizard was digested and the transmitter was expelled.

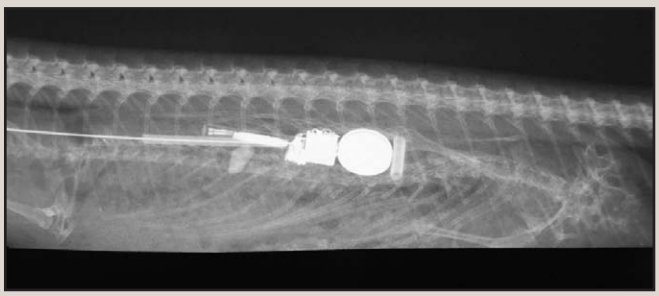


PHOTO COURTESY OF FORT WORTH ZOO

FIG. 1. Radiograph of an *Agkistrodon contortrix laticinctus* showing ingested *Phrynosoma cornutum* with radio transmitter.

These observations were made while conducting research with permission of the Texas Parks and Wildlife Department and the private landowners. Assistance with the radiograph was provided by the Fort Worth Zoo veterinary staff and financial support for the radio telemetry work was granted through the Fort Worth and Phoenix Zoos. I thank all, including the FWZ herpetology staff, for their continued support of this project.

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***PHRYNOSOMA CORNUTUM* (Texas Horned Lizard). NOCTURNAL ACTIVITY.** On 20 May 2009, two of us (RALR and HG) observed copulation in *Phrynosoma cornutum* (SVL 93 mm, male; 73 mm, female) at 2130 h during a full moon in desert thornscrub habitat in the Bolsón of Mapimí, Chihuahua, Mexico (26.843360°N, 103.860004°W, 1115 m elev.). This behavior was observed at a distance of 4 m from the lizards. After the copulation ended, we collected data on body temperature for both individuals using a digital thermometer (29.1°C, male; 31.2°C, female). We also recorded substrate temperature (29.1°C) at the exact point of observation and air temperature (23.6°C) at 1 cm above the substrate where the lizards were found. That day, sunset had occurred at 1937 h and the temperatures recorded at the nearest weather station (25.53°N, 103.45°W; 1124 m elev.) were on average 24.4°C, maximum 33.5°C, and minimum 19°C.

According to Huey (1982. *In* Gans and Pough [eds.], Biology of the Reptilia, Vol. 12, Physiology C, pp. 25–91. Academic Press, New York) some diurnal reptiles voluntarily select relatively low T_b after sunset (e.g., *Gopherus agassizii*, *Gambelia wislizenii;* see also Martínez-Méndez et al. 2013. Herpetol. Rev. 44:148 for *Sceloporus clarkii*), which may prolong potential foraging time by reducing the animals' dependence on solar radiation for activity. Furthermore, previous studies (Dunham 1993. *In* Kareiva et al. [eds.], Biotic Interactions and Global Change, pp. 95–119. Sinauer Associates, Sunderland, Massachusetts; Huey et al. 2010. Science 328:832–833; Sinervo et al. 2010. Science. 328:894–899) have suggested that if diurnal lizards are exposed to environmental temperatures greater than their thermal preferences, thus shortening activity time and forcing retreat, then the net energy gain becomes insufficient. In the case reported here, horned lizards were observed to be reproductively active almost two hours after sunset while remaining within their preferred body temperature range and above minimum voluntary temperatures (Prieto and Whitford 1971. Copeia 1971:498–504). This observation suggests the possibility that *P. cornutum* had fewer opportunities to complete their daily activities during daylight, due to high diurnal temperatures. Therefore, copulations after sunset may increase their chances of reproducing, which may be an adaptive response for individuals that fail to perform their activities during the day (i.e., feeding, breeding, nesting, etc.).

In addition, we suggest that the full moonlight helps to prolong activity time at night, as long as the degree of voluntary hypothermia does not fall below the level of the minimum voluntary temperature. Finally, more data are necessary to determine whether this behavior is common in *Phrynosoma*, and other diurnal desert lizards as well, to evaluate the thermal efficiency of *P. cornutum* and the thermal quality of its habitat.

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***PHRYNOSOMA HERNANDESI* (Greater Short-horned Lizard). PREDATION.** Greater Short-horned Lizards are known to be preyed upon by a variety of predators, including black widow spiders (*Latrodectus mactans*) (Painter and Kamees 2010. Herpetol. Rev. 41:227), Striped Whipsnakes (*Coluber taeniatus*), Burrowing Owls (*Athene cunicularia*) (Hammerson 1999. Amphibians and Reptiles in Colorado. Univ. Press Colorado and Colorado Division of Wildlife, Denver. 484 pp.), and Ferruginous Hawks (*Buteo regalis*) (Cartron et al. 2004. Southwest. Nat. 49:270–276). Here we report the first documentation to our knowledge of Chihuahuan Ravens (*Corvus cryptoleucus*) preying on *P. hernandesi*.

Previous work establishes that Chihuahuan Ravens are omnivorous birds that are known to include lizards, including *Phrynosoma* sp. in their diet (Aldous 1942. The White-necked Raven in Relation to Agriculture. Res. Rep. 5. U.S. Fish Wildl. Serv.; Bednarz and Raitt 2002. *In* A. Poole [ed.], The Birds of North America Online. Cornell Lab of Ornithology, Ithaca, New York). However, most of the available dietary information on this bird species was provided by Aldous (1942, *op. cit.*), who examined the stomach contents of 827 ravens, the majority of them originating from agricultural regions in Texas. Though species-level information is not included for the horned lizards that were documented in raven diets for that study, the likely species would be *Phrynosoma cornutum* based on the origins of the birds dissected.

On 21 July 2007, we observed the predated carcasses of 23 adult *P. hernandesi* under a Chihuahuan Raven nest situated on a power-line pole in desert grassland ca. 700 m W of NM State Rd. 47 and 4.1 km N of US Route 60, Socorro Co., New Mexico, USA (34.468736°N, 106.570816°W, WGS84; 1616 m elev.). We examined several freshly killed (carcasses still supple with no degradation) horned lizards (deposited into the Museum of Southwestern Biology, Univ. of New Mexico as MSB 75695 and 75699) and noted that ravens had extracted the viscera through a single large cut on the ventral side, discarding the rest of the carcass (Fig. 1). Chihuahuan Ravens may have the potential to be locally important predators on Greater Short-horned Lizards.

PHOTO BY IAN W. MURRAY



FIG. 1. Two of 23 predated Greater Short-horned Lizards found below a Chihuahuan Raven nest in central New Mexico.

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***PHYLLODACTYLUS TUBERCULOSUS* (Yellow-Bellied Gecko). BODY TEMPERATURE.** Monitoring thermal requirements and thermoregulatory behavior of reptiles is crucial for understanding effects of global warming on species (Sinervo et al. 2010. Science 328:894–899; Paranjpe et al. 2012. Proc. Meas. Behav. 460–462). Data on body temperature for Mexican nocturnal lizards is actually quite rare in the literature (Huey 1982, *In* C. Gans and F. H. Pough [eds.], Biology of the Reptilia, Volume 12, Physiology C, pp. 25–91. Academic Press, New York; Supporting Online Material for Sinervo et al. 2010, *op. cit.*). *Phyllodactylus tuberculosus* is a nocturnal lizard that inhabits arid to semiarid regions of the Neotropics and occurs from southern Sonora, Mexico to southern Costa Rica, at elevations of 0 to 1230 m (Dixon 1964. New Mexico State Univ. Sci. Bull. 64:1–139; Blair et al. 2012. Cons. Genet. Resour. 4:807–810). The thermal biology of this species has received little attention. Hence, here we present data on *P. tuberculosus* thermal ecology.

During October 2012, we conducted field work in tropical dry forest habitat located in Alamos, Sonora, Mexico (27.0596°N, 108.9465°W; elev. 439 m). The data presented are based on 21 adults (> 40 mm; Dixon 1964, *op. cit.*) of *P. tuberculosus* captured by noose and hand, with SVL measured to 0.05 mm. Body temperature (T_b) was recorded using a digital thermometer. We also recorded substrate temperature (T_s) at the exact point of observation and air temperature (T_a) 1 cm above the substrate where the gecko was found. Sex was not determined in the field because obvious sexual dimorphism was lacking.

Mean SVL was 59.8 mm (SD = 12.07, range = 40–78 mm). Mean field T_b was 27.2°C (SD = 2.35°C, range = 24.2–31.1°C). Mean substrate temperature was 24.1°C (SD = 1.79°C, range = 22–29.2°C) and mean T_a was 23.3°C (SD = 2.28°C, range = 21.3–32°C). Body size was unrelated to T_b (Spearman Rank Correlation: r = -0.36, P = 0.10, N = 21). A positive and significant correlation was found between T_b and the temperature of the microhabitat (Spearman Rank Correlation: r = 0.74, P < 0.0001, N = 21, based on substrate; r = 0.71, P = 0.0002, N = 21, based on air). Geckos were found active from 1830 to 2200 h.

These results show that *P. tuberculosus* analyzed in this study were thermopassive, a mechanism where individuals do not need to invest time and energy actively selecting microhabitats for thermoregulation during night activity (Huey and Slatkin 1976. Q. Rev. Biol. 51:363–384). Brattstrom (1965. Am. Midl. Nat. 73:376–422) reported a mean T_b of 22.7°C (range = 16.5–30°C) for this species, but measurements were taken only during the morning (1000–1100 h). Previous thermal ecology studies of nocturnal geckos have demonstrated that T_b can vary between day (photophase) and night (scotophase) (e.g., Angilletta et al. 1999. Herpetologica 55:212–222; Dial 1978. Herpetologica 32:194–201;

Sievert and Hutchison 1988. Herpetologica 44:266–273). Therefore, we propose that future studies evaluate the thermal efficiency of this gecko and the microhabitat thermal profile available in both phases.

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***POGONA BARBATA* (Eastern Bearded Dragon). DIET.** *Pogona barbata* is a large agamid widespread on the coast and ranges of eastern Australia, with reported diet ranging from vegetation such as soft fleshy leaves, flowers, and fruit, terrestrial and flying arthropods, to small vertebrates. However there are few records of predation by any wild Australian lizard where arthropod prey items are identified to species level; for example, several authors of general references on Australian herpetology mention cicadas as one of the insect groups included in lizard diets but do not provide species identification or details of predator-prey interactions. This note reports observations of an instance of predation by *P. barbata* on the endemic Australian cicada *Henicopsaltria eydouxii* (Hemiptera: Homoptera: Cicadidae), a medium- to large-sized insect species (~50 mm total length).

On 17 February 2007, ~0915 h, at Mount Kuring-gai (a northern suburb of metropolitan Sydney), New South Wales, Australia (33.636639°S, 151.129778°E, WGS84; 213 m elev.), during the course of the field component of statutory ecological requirements of environmental assessment in connection with a proposed residential development, TJH observed a small (probable subadult) *P. barbata* (27 cm total length) resting in diffuse sunlight in a canopy-foliage-shaded area on yellow sand adjacent to a small *Dillwynia retorta* (Fabaceae) shrub ~0.8 m height on a sunny day (1/8 cloud cover). The *P. barbata* held in its jaws a freshly dead *H. eydouxii*; the lizard was motionless upon initial detection, despite the high temperature (30–32°C) and humidity (70–80%). The cicada also did not display movement. Approached closer, the lizard remained motionless even when touched lightly by the observer along the back; it did not move the body or attempt escape or threat display, although movement and orientation of the eyes indicated that the lizard was aware of the observer's presence; neither animal was collected. Habitat in the area comprised a Hawkesbury Sandstone ridge with semi-cleared remnant Dry Sclerophyll Woodland dominated by *Eucalyptus punctata, E. eximia, E. sclerophylla* (Myrtaceae), *Banksia ericifolia, B. serrata* (Proteaceae), and *Allocasuarina littoralis* (Casuarinaceae), and a heath understory of species of many plant taxa, principally Fabaceae, Epacridaceae, and Proteaceae. Initiation of the interaction was not observed, however it is possible that the lizard had either captured the cicada on the trunk of a tree or on the ground, or scavenged a recently deceased individual (cicada adults are very short-lived); whichever the case, *H. eydouxii* is undoubtedly a dietary inclusion of *P. barbata*, a large single item that in the above case would have provided substantial nutrient resources for the lizard.

H. eydouxii is a widespread cicada in coastal areas from southeastern Queensland to southern New South Wales; adults are usually found resting on the trunks and main branches of large *Eucalyptus* spp. (Myrtaceae) but are also known to oviposit on the branches of dead *Casuarina* (*sensu lato*; probably includes *Allocasuarina* spp.) trees (Moulds 1990. Australian Cicadas. New South Wales University Press, Kensington. 216 pp.); although this author noted generally that lizards prey on cicadas, specific examples of lizard predation on any cicada and the identity of predators and prey were not provided. There appear to be no other relevant references, and the present record is therefore of interest, particularly the relatively large size of this single prey item.

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***SCELOPORUS GRAMMICUS* (Mesquite Lizard). SELECTED BODY TEMPERATURE.** Data on preferred body temperature is actually quite rare (Sinervo et al. 2010. Science 328:894–899) because measurement in a laboratory thermal gradient under standard conditions is required (Huey 1982. *In* Gans and Pough [eds.], Biology of the Reptilia, Vol. 12, Physiology C, pp. 25–91. Academic Press, New York). *Sceloporus grammicus* is a geographically widespread viviparous lizard that exhibits considerable variation in habitats occupied (Köhler and Heimes 2002. Stachelleguane. Herpeton. 174 pp.). There have been several reports detailing thermal ecology in *S. grammicus* in different environments (Andrews et al. 1997. Copeia 1997:108–115; Lemos-Espinal and Ballinger 1995. Can. J. Zool. 73:2184–2191; Woolrich-Piña et al. 2006. Acta Zool. Mex. 22:137–150), but the selected body temperature has not been documented. Here, we describe thermal preferences in *S. grammicus* under laboratory conditions.

During May 2012, we conducted field work in La Malinche Volcano, Tlaxcala (19.2379°N, 97.9770°W; 3030 m elev.) located in a forested area dominated by pine. The data presented are based on 15 adults (> 49 mm SVL; 9 females and 6 males) of *S. grammicus* captured by noose.

In the laboratory, the lizards were separated by gender and maintained at 25°C in plastic containers with soil, branches, and grass, and hydrated with a sprinkler. Laboratory experiments were conducted two days after capture using a thermal gradient, which consisted of a polycarbonate box (150 cm long x 150 cm wide x 70 cm high) divided into ten tracks of 15 cm each to prevent interaction between lizards. The box was located in a room with a controlled temperature of 20°C and three 150 W lamps were placed at different heights over the box to offer the thermal gradient (20–50°C). Body temperature data was collected manually using a digital thermometer in the thermal gradient each hour between 1330 and 1930 h. We applied a nonparametric Kruskal-Wallis one-way test to analyze differences between all measurements of body temperature in the laboratory and we used a Mann-Whitney Rank test to analyze the differences between gender.

There were no statistically significant difference between measurements of temperature ($H_6 = 9.173$, $p = 0.164$) or between gender ($U = 1112.5$, $p = 0.169$). Mean preferred body temperature was 32.9°C (SD = 2.64°C, range = 25.3–37.6°C). Interquartile of 25% and 75% was 30.8°C and 35.0°C, respectively. These results suggest S. *grammicus* can be considered a eurythermic species due to the wide range of preferred temperatures in this species. Therefore, we propose to evaluate the thermal efficiency by monitoring mean thermal requirements and microhabitat temperatures across its distribution for understanding effects of global warming on this geographically widespread lizard.

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***SCELOPORUS OCCIDENTALIS LONGIPES* (Great Basin Fence Lizard). DIET.** On 2 July 2012, an adult *Sceloporus occidentalis longipes* was observed and photographed ingesting a hatchling conspecific on a cement walkway outside of a residence in Poway, California. Although cannibalism has been documented in *S. occidentalis* through the analysis of stomach contents (Johnson 1965. Herpetologica 21:114–117), to my knowledge there do not appear to be any photographs documenting cannibalism within this species in the wild.



FIG. 1. Adult *Sceloporus occidentalis longipes* cannibalizing a hatchling conspecific.

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***TUPINAMBIS MERIANAE* (Argentine Giant Tegu); *PANTHEROPHIS GUTTATUS* (Red Cornsnake). NON-PREDATORY KILLING.** *Tupinambis merianae* is an established invasive lizard in Florida, USA, where a population was discovered initially in Balm Boyette Scrub Preserve, Hillsborough Co. (Enge et al. 2006. *In* Proceedings 28th Annual Gopher Tortoise Council Meeting. Valdosta, Georgia; Engeman et al. 2011. Curr. Zool. 57:599–612). The threats posed by this species to native species are undetermined, although it has been observed using Gopher Tortoise (*Gopherus polyphemus*) burrows, where it potentially could have similar burrow usurpation and juvenile predation impacts as does another large invasive lizard in southern Florida, Gray's Spiny-tailed Iguana (*Ctenosaura similis*) (Avery et al. 2009. Herpetol. Rev. 40:435; Engeman et al. 2009. Herpetol. Rev. 40:84). We have been testing a variety of methods to detect and index populations of *T. merianae* and to investigate their tortoise burrow usage in Balm Boyette Scrub Preserve (Kaiser et al. 2011. *In* Proceedings 33rd Annual Gopher Tortoise Council Meeting. Orlando, Florida). We report here evidence from these investigations that *T. merianae* may pose a threat to snakes.

We used wildlife cameras to obtain still photographs and video recordings at 16 *G. polyphemus* burrow entrances (Kaiser et al., *op. cit.*). On 14 June 2011 at 0828 h EST, we obtained a video recording of a *T. merianae* (ca. 120 cm TL) attacking a Red Cornsnake (*Pantherophis guttatus*) (ca. 132 cm TL). The lizard was observed carrying and shaking the snake violently as it entered a tortoise burrow being monitored by one of our video cameras. Within 4 sec, the lizard emerged (the tail of the snake remained visible the entire time) still carrying and shaking the less active snake. Within another 4 sec, the lizard disappeared from view carrying the snake.

Adult *T. merianae* in Brazil occasionally feed on snakes (Mercolli and Yanosky 1994. Herpetol. J. 4:15–190), but this snake appeared too large for the lizard to consume. We cannot explain the lizard's behavior towards the snake, but a defense mechanism seems plausible, particularly since *C. similis* has been observed exhibiting this behavior in Florida (Engeman et al. 2009. Herpetol. Rev. 40:84–85). Janzen and Brodie (1995. J. Herpetol. 29:132–136) studied *C. similis* responses to color cues by using different color patterns on snake replicas and found that brightly colored replicas (red, yellow, black) elicited the most attacks. Engeman et al. (2009, *op. cit.*) observed a *C. similis* attack a Southern Black Racer (*Coluber constrictor priapus*) with a drab, monotone color and no pattern. The *P. guttatus* attacked by the *T. merianae* was a bright rust-red color, but we do not know whether its coloration was a contributing factor in the attack. The *T. merianae* was obviously willing to attack a snake, and more importantly, this agonistic behavior may have implications regarding its potential to impact snakes, including small individuals of the Eastern Indigo Snake (*Drymarchon couperi*), a federally threatened species. An introduced population of the Gold Tegu (*Tupinambis teguixin*) on the island of San Andrés, Colombia, was suspected of adversely impacting an endemic snake species (Fitzgerald et al. 2005. *In* Joint Annual Meeting of Ichthyologists and Herpetologists, Tampa, Florida). High-density populations of *T. merianae*, such as is apparently found in Balm Boyette Scrub Preserve, could negatively affect snake recruitment and numbers through such behavior.

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***CROTALUS CATALINENSIS* (Santa Catalina Island Rattlesnake). DIET.** *Crotalus catalinensis* is a poorly understood rattlesnake endemic to Isla Santa Catalina, BCS, Mexico. Potential prey items of *C. catalinensis* include approximately 44 species of reptiles, birds, and mammals that occur or visit Isla Santa Catalina (Case et al. 2002. A New Island Biogeography of the Sea of Cortés. Oxford Univ. Press, New York. 669 pp.). However, only five species have been documented as prey items of *C. catalinensis* thus far: *Amphispiza bilineata* (Black-Throated Sparrow), *Sceloporus lineatulus* (Santa Catalina Island Spiny Lizard), *Peromyscus slevini* (Santa Catalina Island Deer Mouse), *Dipsosaurus catalinensis* (Santa Catalina Island Desert Iguana), and *Uta squamata* (Santa Catalina Side-Blotched Lizard; Grismer 2002. Amphibians and Reptiles of Baja California, Including its Pacific Islands and the Islands in the Sea of Cortés. Univ. California Press, Berkeley. 409 pp.; Avila-Villegas et al. 2007. Copeia 2007:80–84; Avila-Villegas et al. 2004. Herpetol. Rev. 35:60). Grismer (*op. cit.*) speculated that juvenile *C. catalinensis* probably also consumes other small lizards, especially *Phyllodactylus bugastrolepis* (Santa Catalina Island Leaf-Toed Gecko).

While measuring specimens for another study, we recovered the regenerated tail of an *Aspidoscelis catalinensis* (Santa Catalina Island Whiptail lizard) from the stomach of an adult male *C. catalinensis* (TTU 3540; SVL = 770 mm). Additional dissection of the rattlesnake did not produce additional pieces of the lizard. Through direct comparison to specimens of other lizard species from Isla Santa Catalina, we are confident of this identification based on both scalation and size. Our observation adds to the growing list of prey items for *C. catalinensis* and may indicate a more generalist diet. However, it does not support the hypothesis that rattle loss in *C. catalinensis* is for stealth when hunting avian prey in trees, as has been suggested by some authors (Greene 1997. Snakes: The Evolution of Mystery in Nature. Univ. California Press, Berkeley. 351 pp.; Grismer, *op. cit.*).

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***HELICOPS ANGULATUS* (Brown-Banded Watersnake). DIET / SCAVENGING.** Although snakes feed on a wide variety of prey, from small insects to large mammals, scavenging by snakes is poorly documented (DeVault and Krochmal 2002. Herpetologica 58:429–436.; Sazima and Strüsmann 1990. Rev. Brasil. Biol. 50:463–468). Sazima and Strüsmann (*op. cit.*) hypothesized that scavenging by snakes is commonly practiced by opportunistic species, and that low number of observations is probably due to sampling biases. Among the species of snakes known to scavenge dead prey are several aquatic and piscivorous species, but scavenging is not considered a common foraging behavior among neotropical snakes. Neotropical aquatic snakes in the genus *Helicops* are nocturnal and feed mostly on fish, tadpoles and adult frogs (Ávila et al. 2006. J. Herpetol. 40:274–279; Martins and Oliveira 1998. Herpetol. Nat. Hist. 6:78–150), but scavenging has only been documented for *H. modestus* in southern Brazil (Sazima and Strüsmann, *op. cit.*). Herein, we describe an *H. angulatus* scavenging on a rotting *Electrophorus electricus* (Electric Eel) in Ajuruxi basin, Extractive Reserve of Rio Cajari, lower Amazon river, state of Amapá, Brazil.

At 1035 h on 19 December 2011, in aquatic vegetation on the bank of Pelaes stream (0.56218145°S, 51.89035590°W; datum WGS84), we observed an *H. angulatus* attempting to scavenge an *E. electricus* that had recently been killed by a local fisherman. The snake tried to swallow the fish headfirst (Fig. 1), but was unsuccessful, possibly due to the larger size of eel. With our approach, the snake moved into vegetation, leaving the eel on the creek bank. The observation of attempted scavenging by *H. angulatus* is consistent with the hypothesis that scavenging by aquatic and piscivorous species is often overlooked by researchers and may be more common than previously thought (DeVault and Krochmal, *op. cit.*; Sazima and Strüsmann, *op. cit.*).



FIG. 1. *Helicops angulatus* attempting to swallow a rotting *Electrophorus electricus* (Electric Eel) in the Pelaes Stream, Amapá State, Brazillian Amazon.

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***LAMPROPELTIS CALLIGASTER* (Prairie Kingsnake). DIET.** *Lampropeltis calligaster* preys upon a variety of small burrowing and surface dwelling mammals but also includes birds and their eggs, reptiles, amphibians, and insects in its diet (Werler and Dixon 2000. Texas Snakes. Univ. Texas Press, Austin. 437 pp.). The few snake species reported as prey items have included *Carphophis amoenus*, *Coluber constrictor*, *Lampropeltis triangulum*, and *Crotalus horridus* (Fitch 1978. Trans. Kansas Acad. Sci. 81:354–362). Here I report an attempted predation event, representing a new diet item for *L. calligaster*.

On the afternoon of 14 May 2012, I observed an adult *L. calligaster* (SVL = 98 cm; total length = 117 cm) attempting to subdue a much larger *Pantherophis obsoletus* (SVL = 138 cm; total length = 166 cm) on the edge of a grassland trail in Van Zandt Co., Texas, USA (Fig. 1). On closer examination, the *L. calligaster*



FIG. 1. *Lampropeltis calligaster* (coiled) attempting to subdue a much larger *Pantherophis obsoletus* in Van Zandt Co., Texas, USA.

appeared to be in the process of swallowing the lower jaw of the open-mouthed *P. obsoletus*, but was having difficulty proceeding past the junction of the upper and lower jaw. After 20 min of observation, both snakes were separated and measured. To my knowledge, this predation attempt not only represents the first report of a *P. obsoletus* in the diet of a *L. calligaster*, but is also notable due to the size of the prey.

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***LAMPROPELTIS GETULA CALIFORNIAE* (California Kingsnake). ELEVATION.** On 5 and 6 May 2012, we observed two *Lampropeltis getula californiae* at elevations of 1852.3 m and 1850.4 m, respectively, in Southern California. The first, a juvenile female, was found under a rock in pine woodland near Mount Laguna, San Diego Co., California, USA (32.839°N, 116.420°W, datum WGS84). The second, a young male, was found under a rock in grassland sparsely populated by oak trees on Tejon Ranch in the Tehachapi Mountains, Kern Co., California, USA (34.958°N, 118.568°W; datum WGS84). Both snakes were cataloged with photo vouchers at the San Diego Natural History Museum (female, SDSNH_HerpPC_05214; male, SDSNH_HerpPC_05215). Although *L. g. californiae* have been found as high as 2164 m in the eastern Sierra Nevada, they have not been documented above 1676 m in the California mountain ranges south of the Sierra Nevada (Hubbs 2009. Common Kingsnakes: A Natural History of *Lampropeltis getula*. Tricolor Books, Tempe, Arizona. 412 pp.). To our knowledge, our observations represent the highest maximum elevations reported for *L. g. californiae* in Southern California.

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***LATICAUDA* SPP. (Sea Krait). AVIAN PREDATION.** Sea snakes are conspicuous and locally abundant in many Indo-Pacific coral reefs. The combination of their potent venom, aposematic coloration, and unpalatable taste presumably deters predation (Heatwole 1999. Sea Snakes. Univ. of New South Wales, Sydney. 148 pp.). However, sea snakes (including amphibious sea kraits, *Laticauda* spp.) are susceptible to predation by some large fish species such as Tiger Sharks (Simpfendorfer et al. 2001. Environ. Biol. Fishes 61:37–46; Wirsing and Heithaus 2009. Mar. Ecol. Prog. Ser. 387:287–293). Some marine birds are considered predators of sea snakes (Heatwole 1975. *In* Dunson [ed.], The Biology of Sea Snakes, pp. 233–249. Univ. Park Press, Baltimore, Maryland; Aubret 2006. Herpetol. Rev. 37:93). Because of their reliance on terrestrial activity, *Laticauda* spp. are also considered to be common prey for Sea Eagles, Ospreys, and Reef Herons (Ineich and Laboute 2002. Sea Snakes of New Caledonia. IRD & Mus. Nat. Hist. Nat. Editions. Collection Faune et flore tropicales, Paris. 303 pp.). However, this assumption is based on very few observations in the wild (Leach 1928. Emu 28:20–42; Bauer and Devaney 1987. *In* Van Gelder et al. [eds.], Proceedings of the 4th Ordinary General Meeting of the Societas Europaea Herpetologica, pp. 43–48. Radboud Universiteit Nijmegen, Mijmegen).

In the Maldives during August 2010, one of us (SP) observed a Grey Heron (*Ardea cinerea*) feeding on what appeared to be a *L. colubrina* (Yellow-lipped Sea Krait; Fig. 1). The bird was manipulating the "snake" by the tail, apparently carefully avoiding the head (Fig. 1B). Overall, manipulation (including vigorous shaking) of the prey lasted for a few minutes before the "snake" was swallowed tail first.

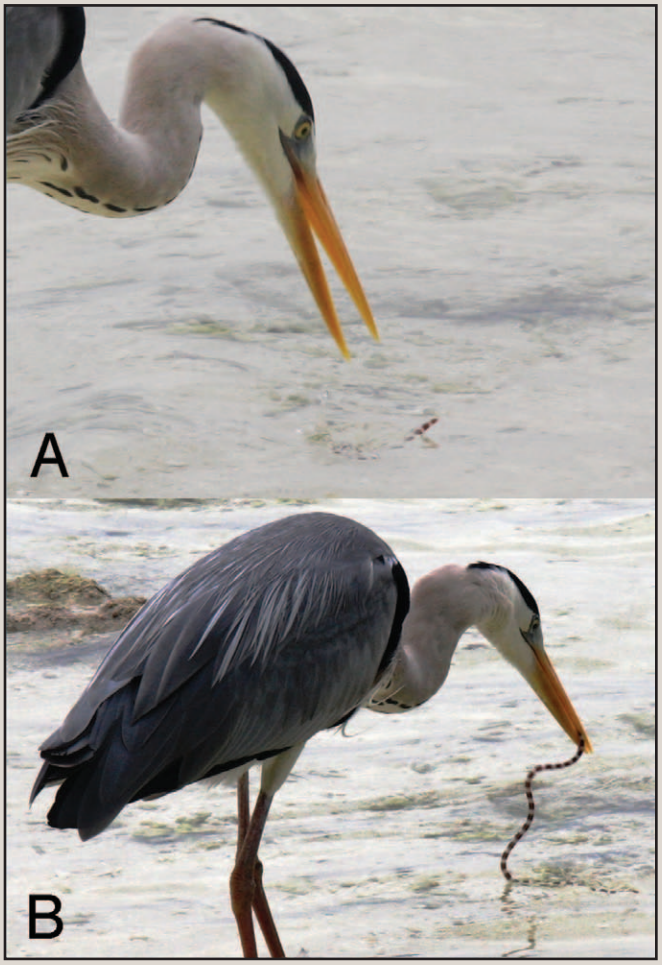


FIG. 1. A) A Grey Heron (*Ardea cinerea*) readies to strike a *Myrichthys colubrinus* (Harlequin snake-eel), which is mimetic with amphibious sea kraits (*Laticauda* spp.). B) The heron manipulates the snake-eel before swallowing.

However, sea kraits are absent from the Maldives. Careful examination of the photographs revealed that the prey eaten by the heron was actually a *Myrichthys colubrinus* (Harlequin Snake-eel) which is mimetic with sea kraits (Randall 2005. Zool. Stud. 44:299–328). Indeed, the similarity between moving (swimming) snake-eels and sea kraits has already misled sea krait specialists (FB and XB, pers. obs.). Although correct identification of *M. colubrinus* is straightforward in still pictures (Fig. 1; see also Randall, *op. cit.)*, differentiation between the mimetic fish and the sea krait is undoubtedly equivocal when the observation is done in the field from a distance. This is especially true if the prey is vigorously struggling to evade predation (Fig. 1B).

Long-term monitoring (2002–2011) of sea krait populations in New Caledonia suggests the absence of avian predation despite the presence of numerous Reef Herons, Ospreys, and large colonies of sea birds (Brischoux and Bonnet 2009. Mém. Mus. Nat. Hist. Nat. 198:133–147). We have never collected any direct or indirect evidence of predation on sea kraits during intensive field work at more than 38 different sites, whereas the birds were

regularly observed preying on fish. Consequently, our observations suggest reappraising avian predation records on sea kraits without a reliable identification of the "snake" prey.

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***LEPTOPHIS AHAETULLA* (Giant Parrotsnake). REPRODUCTION.** *Leptophis ahaetulla* is widely distributed from Mexico to Ecuador and northern Argentina, from 0 to 2750 m elevation (Pérez-Santos and Moreno 1988. Ofidios de Colombia. Monografía VI. Museo Regionale di Scienze Naturali Torino. Torino, Italy. 498 pp.). In Costa Rica, *L. ahaetulla* is relatively common in all but the driest habitats and is often observed in bushes and trees in wetlands in tropical and subtropical forests (Solórzano 2002. Serpientes de Costa Rica, Distribución, Taxonomía e Historia Natural. Instituto Nacional de Biodiversidad. Heredia, Costa Rica. 792 pp.). *Leptophis ahaetulla* is known to be oviparous, laying clutches of one to five eggs that hatch during the wet season (May–Nov) after an incubation of approximately 89 days (Solórzano 2002, *op. cit.*; Savage 2002. The Amphibians and Reptiles of Costa Rica: a Herpetofauna Between Two Continents, Between Two Seas. Univ. Chicago Press. Illinois. 934 pp.). However, little is known about courtship and mating behavior in this species.

On 22 January 2006, at 1535 h, we observed a *L. ahaetulla* on the ground in an open area of a private garden in a semi-urban area of Matapalo, Osa Peninsula, Costa Rica (8.39823°N, 83.28219°W, datum WGS84; elev. 240 m). A second individual (male) slowly approached from approximately 3 m away, aligned its body with the first individual (female), and began rolling over the female's body with caudocephalic waves and moving forward across the garden. After 12 min of this behavior, both snakes ascended into a bush (*Croton variegatum*) located approximately 3 m from the first encounter. Over the next 6 mins, the snakes climbed to a height of approximately 1.6 m, at which point they stopped in a position coiled around one another. Intromission occurred for nearly 6 min; afterwards both snakes made coordinated tail-whipping movements with pausing lapses (three times), both in a single movement and always maintaining the same position allowing coitus. This process lasted nearly 8 min, after which a short pause occurred (3 min) and then both individuals dropped to the ground and departed in different directions. No coital neck biting was observed (Gillingham 1987. *In* Seigel et al. [eds.], Snakes: Ecology and Evolutionary Biology, pp. 184–209. Blackburn Press, New Jersey). The entire process, from the first encounter to the drop-down to the ground, lasted nearly 35 min. To our knowledge, this is the first detailed description of courtship behavior in *L. ahaetulla*. Also, our observation suggests that the mating season for this species occurs at the start of the driest season in the region.

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***MASTIGODRYAS BODDAERTI* (Boddaert's Tropical Racer). REPRODUCTION.** *Mastigodrya boddaerti* is a mid-sized snake (average length = 1.5 m) that occurs from Venezuela to Brazil and is common in the eastern region of Pará, Brazil (Cunha and Nascimento 1993. Ofídios da Amazônia. As cobras da região leste do Pará. Bol. Mus. Para. E. Goeldi 9:1–191). On 3 December 2011, we actively searched for herpetofauna around and in the mouth of the Planaltina cave, Pará, Brazil (3.376°S, 52.576°W; datum WGS 84). The area near the cave is secondary forest with a small stream and is surrounded by pastures. Inside the cave we found a nest of five *M. boddaerti* eggs (average length 33.6 mm; range 30.0–39.6 mm) in a wall cavity at 1.5 m above the ground. We visited this nest a month later and four eggs had hatched. We removed and dissected the unhatched egg, revealing a dead neonate (SVL = 214 mm; tail length = 76 mm). This is the first record of *M. boddaerti* nesting inside a cave and provides some of the first reproductive data for the species.

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***MICRURUS FULVIUS* (Harlequin Coralsnake). DIET.** *Micrurus fulvius* is known to take a variety of prey items, including lizards: *Plestiodon fasciatus, P. inexpectatus, Neoseps reynoldsi, Ophisaurus ventralis,* and *Scincella lateralis* (Ernst and Ernst 2011. Venomous Reptiles of the United States, Canada, and Northern Mexico, Volume 1, Johns Hopkins Univ. Press, Baltimore, Maryland. 352 pp.). Herein we report a novel prey item for *M. fulvius.*

On 30 March 2005 at 1530 h, JRL and TGJ captured a juvenile female *M. fulvius* (SVL = 470 mm; tail length = 76 mm; 25 g) in a box trap on the Camp Shelby Joint Forces Training Center, Perry Co., Mississippi, USA. The snake appeared to have recently fed due to a large bolus in its stomach and upon palpating, the snake regurgitated an adult male *Anolis carolinensis.* It is possible the *A. carolinensis* was consumed in the trap, and therefore it is unknown how frequently *M. fulvius* will take this species as prey under natural circumstances.

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***NERODIA SIPEDON SIPEDON* (Northern Watersnake). FEEDING BEHAVIOR.** *Nerodia sipedon* is a widely distributed, semi-aquatic snake species that inhabits a variety of lotic and lentic habitats. The diet of *N. sipedon* has been evaluated elsewhere (e.g., Cundall and Pattishall 2011. J. Herpetol. 45:174–177; King 1993. J. Herpetol. 20:90–94), and is known to include a variety of fish and amphibian species (Gibbons and Dorcas 2004. North American Watersnakes: A Natural History. Univ. Oklahoma Press, Norman. 437 pp.). Herein we describe a foraging event of *N. s. sipedon* on the Hiawassee River, Polk Co., near Reliance, Tennessee, USA. At approximately 1100 h on 13 August 2011 we observed an adult *N. sipedon* (ca. 1 m total length) retreating from the water with a large (ca. 15 cm total length) River Chub (*Nocomis micropogon*) grasped laterally in its jaws. After exiting the stream, the snake traveled nearly 10 m and retreated tail-first under a small streambank burrow until its entire body was hidden from view. The snake maintained a grasp on the fish, which was folded partially into the burrow.

Although *N. sipedon* has been documented previously as feeding on *N. micropogon* (Gibbons and Dorcas, *op. cit.*), detailed descriptions of prey acquisition have been lacking. Our observation suggests semi-aquatic snakes such as *N. sipedon* use the adjacent streambank as a means to subdue aquatic prey. If a prey item were to escape initial predation attempts within the aquatic environment, it would likely decrease the snake's foraging success. Therefore, it may be advantageous for snakes to move to the terrestrial environment after seizing aquatic prey. Alternatively, retreating to the streambank may serve as an antipredator strategy by which the snake is able to maintain possession of a food item while simultaneously protecting itself from potential predators during the vulnerable period of prey acquisition and processing.

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***NERODIA TAXISPILOTA* (Brown Watersnake). DIET.** *Nerodia taxispilota* are known to eat a wide variety of aquatic prey (Holbrook 2012. A Field Guide to the Snakes of Southern Florida. ECO Publ., Rodeo, New Mexico. 225 pp.). Though invasive species have the potential to cause harm to some species, King et al. (2006. Can. J. Zool. 84:108–115) documented a case in which proliferation of an invasive fish was beneficial for Lake Erie Watersnakes (*Nerodia sipeon insularum*). Here we document a novel invasive fish species in the diet of *N. taxispilota*.



FIG. 1. *Nerodia taxispilota* consuming a *Hoplosternum littorale* in Palm Beach Co., Florida, USA.

On 16 May 2012, at Grassy Waters Preserve, Palm Beach Co., Florida, USA (26.80244°N, 80.19479°W; datum WGS84), a small (approx. 25 cm total length) *N. taxispilota* was observed foraging in shallow (~15 cm) marsh habitat. The *N. taxispilota* proceeded to capture and began to consume a *Hoplosternum littorale* (Brown Hoplo Catfish), an exotic species that is well-established in southern Florida (Fig. 1). The *N. taxispilota* consumed the *H. littorale* half way, and then released the meal; likely because it was unintentionally disturbed by the author, not because the food was unpalatable.

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***PYTHON MOLURUS BIVITTATUS* (Burmese Python). HABITAT USE / OCCURRENCE WITHIN *GOPHERUS POLYPHEMUS* BURROWS.** Many native snake species use *Gopherus polyphemus* burrows as a refuge against cold weather conditions, to prevent desiccation, and to assist with shedding (Bogert and Cowles 1947. Am. Mus. Novit. 1358:1–55; Dodd and Barichivich 2007. Florida Sci. 70:83–94; Stevenson et al. 2009. Herpetol. Conserv. Biol. 4:30–42). It has been speculated that the non-native *Python molurus bivittatus* might also use *G. polyphemus* burrows for the same reasons. The discovery of a live *P. molurus* and a shed skin in *G. polyphemus* burrows within Rookery Bay National Estuarine Research Reserve (NERR), Collier Co., Florida, USA, confirms use of this unique habitat by the invasive snake.

On 20 May 2010, I observed a *P. molurus* shed protruding from the mouth of a *G. polyphemus* burrow and extracted approximately 1 m of the shed from outside the burrow and 0.8 m from inside the burrow before it broke off. On 23 Jan 2012, Rookery Bay NERR volunteer Paul Allen tracked and then extracted a live *P. molurus* (total length = 429 cm; 44.4 kg) from a *G. polyphemus* burrow (Fig. 1) approximately 250 m from the previously found shed. The snake was facing towards the burrow entrance and was located approximately 2 m inside the burrow. Tracks indicated that prior to capture, the snake had investigated several other burrows, which it did not enter, before it selected the burrow in which it was captured. The snake appeared to be ready to shed and its selection of this particular burrow, which was smaller than the other burrows, may have been based on size to assist with shedding (Stevenson et al., *op. cit.*). Both the shed and



PHOTO BY RICHARD NADEAU

FIG. 1. Capture of *Python molurus bivittatus* in a *Gopherus polyphemus* burrow at Rookery Bay National Estuarine Research Reserve (NERR), Florida, USA.

the snake were located in palmetto scrub habitat near pine flatwoods and several fresh to brackish water ponds.

The confirmation of burrow use by *P. molurus* raises several important questions. Do *P. molurus* habitually use *G. polyphemus* burrows to prevent desiccation or while shedding (Dodd and Barichivich, *op. cit.*; Stevenson et al., *op. cit.*)? Do *P. molurus* seek underground refugia during cold weather conditions and might this influence their range expansion (Dorcas et al. 2011. Biol. Invas. 13:793–802; Mazzotti et al. 2010. Biol. Invas. 13:143–151)? What effect does burrow use by *P. molurus* have on *G. polyphemus* and burrow commensals?

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***PYTHON MOLURUS BIVITTATUS* (Burmese Python). REPRODUCTION / NESTING.** *Python molurus bivittatus* are reported to nest in mammal burrows, under logs and rocks, and in crevices and vegetation; however, little data exist on their nest structure and characteristics (Snow et al. 2007. Herpetol Rev. 38:93). Here, I report an observation of an abandoned nest of *P. m. bivittatus* from a tea plantation in northeastern Bangladesh.

On 13 May 2011, I found an abandoned nest of *P. m. bivittatus* inside a mammal burrow near Lawachara National Park, Bangladesh (24.330963°N, 091.801120°E; datum WGS 84). Based on information provided by locals, the burrow likely belonged to a porcupine (*Hystrix* sp.). The burrow was located on an east facing slope of a hill (elev. 77 m) in a 12.9-ha cultivated reed (*Imperata* spp., *Phragmites* spp.) grassland, surrounded by tea plantation and tropical mixed-evergreen forests. There were ca. 30 egg shells clustered together in the center. The eggs were unhatched and may have been destroyed by locals. The width and height of the burrow entrance were 44 cm and 30 cm, respectively. The burrow was ca. 268 cm deep on the horizontal plane and the mean width and height were ca. 34 cm and ca. 18 cm, respectively. Notably, on 27 January 2011, two adult *P. m. bivittatus* (female, total length = 414 cm; male, total length = 228 cm) were captured from mammal burrows within 200 m of the abandoned nest. Therefore, it seems that *P. m. bivittatus* in Bangladesh associates with porcupine burrows for breeding and overwintering, similar to *P. m. molurus* in arid regions of western India (Bhupaty and Vijayan 1989. J. Bombay Nat. Hist. Soc. 86:381–387). Despite their tremendous popularity in the pet industry, little is known about the natural history of *P. m. bivittatus* in its native range. Our observation expands our knowledge of python reproduction in Asia.

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***RHINOCHEILUS LECONTEI TESSELLATUS* (Texas Long-nosed Snake). DEFENSIVE BEHAVIOR AND ATTEMPTED PREDATION.** *Rhinocheilus lecontei tessellatus* is a nocturnal constrictor of the dry prairies and deserts (Conant and Collins 1991. A Field Guide to Reptiles and Amphibians: Eastern and Central North America, 3rd ed. Houghton Mifflin, Boston, Massachusetts. 450 pp.). Defensive behaviors of *R. lecontei* include a shifting of coils, twisting of the body, concealment of the head beneath a body coil, and cloacal smearing of blood, feces, and musk gland secretions (Conant and Collins, *op. cit.*; McCoy and Gehlbach 1967. Texas J. Sci. 19:349–352). Here, I report an observation of attempted predation on *R. lecontei* by *Coluber* (=*Masticophis*) *flagellum*. The observation documents a novel predator species and the unusual defensive behavior of knotting for *R. lecontei*.

On 6 May 2001 at ca. 1045 h, I observed a *C. f. testaceus* (total length ca. 125 cm) attempting to prey on a female *R. l. tessellatus* (SVL = 74.7 cm; total length = 84.4 cm) at Lake Alan Henry Wildlife Mitigation Area, ca. 6.5 km N and 14.5 km E of Justiceburg, Garza Co., Texas, USA. The *C. flagellum* had the posterior third of its body wrapped around the base of a prickly pear cactus (*Opuntia* sp.) and was biting the *R. lecontei* near the juncture of the head and neck. The *R. lecontei* was tightly constricted (knotted) around a 26 cm tall clump of dry Broomweed (*Amphiachyris dracunculoides*) adjacent to the prickly pear. The entire *C. flagellum*, except the wrapped tail, and all of the *R. lecontei* were suspended above the ground. This bridged tug-of-war continued without perceived movement for ca. 10 min until I approached and the *C. flagellum* released the *R. lecontei* and retreated. The *R. lecontei* exhibited bite damage dorsally and ventrally, but recovered and was released one week later.

The defensive behavior of knotting is described as a snake wrapping itself around an object or by forming a knot in its body (Yeatman 1983. Herpetol. Rev. 14:22). By knotting around vegetation, the *R. lecontei* established a stalemate and prolonged the predator-prey interaction, potentially increasing the possibility that the predation event would be interrupted and the *R. lecontei* allowed to escape. Knotting may be a widespread defensive behavior in snakes (Hammerson 1988. Herpetol. Rev. 19:85) but has been reported in relatively few species: *Virginia valeriae* (Yeatman, *op. cit.*), *Regina alleni* (O'Brien 1998. Herpetol. Rev. 29:46–47), *Opheodrys aestivus* (Hammerson, *op. cit.*), *Thamnophis crytosis* (Stitt and Swann 2007. Herpetol. Rev. 38:94), and *Boa constrictor* (Guyer and Laska 1996. Herpetol. Rev. 27:203). It is likely that the *R. lecontei* would have been consumed by the *C. flagellum* if the stalemate was not disturbed.

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***SALVADORA HEXALEPIS* (Western Patch-Nosed Snake). FORAGING BEHAVIOR.** Members of the genus *Salvadora* have an enlarged rostral scale; the function of this "patch" has not been well described, though it may be used to excavate buried lizard eggs (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Institution Press, Washington, DC. 668 pp.). On 08 May 1999, I observed a *S. hexalepis* at Fort Irwin, California, USA (35.1267°N, 116.4962°W, datum WGS84; elev. 650 m). The snake was seen moving slowly and tongue-flicking around the base of a *Larrea tridentata* (Creosote) bush. It stopped near the base of the bush, lifted its head above the ground and forcefully rammed its head into the dirt several times. This movement opened a small hole in the ground. The snake went down into the hole, which apparently led into a subterranean tunnel, and disappeared from sight. As it did so, a small rodent, likely *Perognathus* or *Chaetodipus* sp., emerged from a different hole on the far side of the bush and ran away. The snake eventually emerged from the hole where the rodent appeared. In this apparent foraging attempt, the snake used its snout to directly ram into the soil to expose a likely rodent burrow. Having a larger, thicker rostral scale might be beneficial for this activity.

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***STORERIA OCCIPITOMACULATA* (Red-bellied Snake). DIET.** Although it is known that *Storeria occipitomaculata* feeds primarily on slugs (Trapido 1944. Am. Midl. Nat. 31:1–84), there remains a paucity of information regarding the identification of the particular species of slugs involved. Gilhen (1984. Amphibians and Reptiles of Nova Scotia. Nova Scotia Museum, Halifax. 162 pp.) noted that *S. occipitomaculata* in Nova Scotia had preyed upon native *Philomycus carolinianus* (Carolina Mantleslug), as well as non-native slugs in the genera *Arion* and *Deroceras*. Herein, we identify a non-native species of slug in the diet of a *S. occipitomaculata* from northwestern Pennsylvania, USA.

At 0830 h on 11 June 2012, at a site along Hwy 89, 6.2 km SE of Wattsburg, Erie Co., Pennsylvania (41.96156ºN, 79.76165ºW, datum WGS84; elev. 434.3 m), we found a female *S. occipitomaculata* (SVL = 231 mm; total length = 293 mm; 9.5 g) beneath a wooden panel in old field habitat. Upon being handled, the snake disgorged a live *Arion circumscriptus* (Brown-banded Arion), a non-native slug of European origin (Chichester and Lowell 1973. Sterkiana 51:11–42). The slug was 22 mm long, and had a mass of 0.5 g, representing a mass ratio (prey mass to snake mass) of 0.053. *Arion circumscriptus* was present underneath several pieces of debris at the Wattsburg site, and is likely an abundant food source for *S. occipitomaculata* there. Also observed at the site were non-native *Deroceras reticulatum* (Grey Field Slug). The *S. occipitomaculata* was released at the point of capture, while the *A. circumscriptus* was preserved and deposited in the invertebrate collection of the Natural History Museum at the Tom Ridge Environmental Center, Erie, Pennsylvania.

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***THAMNOPHIS PROXIMUS* (Western Ribbonsnake). NECROPHILIA.** Mating or attempted mating with a dead conspecific has been reported in several species of squamates including *Ameiva ameiva* (Costa et al. 2010. Ecologia 3:79–83), *Gambelia wislizenii* (Fallahpour 2005. Herpetol. Rev. 36:177–178), *Holbrookia maculata* (Brinker and Bucklin 2006. Herpetol. Rev. 37:466), *Tiliqua rugosa* (How and Bull 1998. Herpetol. Rev. 29:240), and *Tachymensis brasiliensis* (Amaral 1932. Mem. Int. Butantan 7:91–94). Here, I provide a report of necrophilia in a North American snake species.

At ca. 0230 h on 14 June 2012, I observed what appeared to be a carcass of a dead snake on Navarro Co., Texas, road FM 1129. Upon closer examination, the entwined mass of two courting *T. proximus* became apparent. The smaller snake's head was positioned immediately behind the larger snake's head and appeared to be pressing on the larger snake's dorsum at a downward angle. Caudocephalic waves as described by Gillingham (1987. *In* Seigel et al. [eds.], Snakes: Ecology and Evolutionary Biology, pp. 184–209. McGraw-Hill, New Jersey) were observed being performed by the smaller snake, however, it was difficult to ascertain if there was actual cloacal alignment on the closely positioned bodies. As I attempted to move the two individuals off of the roadway, they separated, revealing a live male (total length ca. = 48 cm) and a dead female (total length ca. = 56 cm). The road killed female appeared freshly dead, yet no overt signs of trauma were evident.

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***THAMNOPHIS SIRTALIS* (Common Gartersnake). OPEN SEAWATER SWIMMING.** *Thamnophis sirtalis* is common in a myriad of habitats throughout its extensive range in North America (Wright and Wright 1957. Handbook of Snakes of the Unites States and Canada, Vol. II. Comstock Publ., Ithaca. 1055 pp.). Eastern subspecies of *T. sirtalis* are thought to be less aquatic than western subspecies, but all are known to use habitats near or in standing and flowing fresh water (Rossman et. al. 1996. The Garter Snakes: Evolution and Ecology. Univ. Oklahoma Press, Norman. 332 pp.). Here we report the occurrence of *T. sirtalis* in cold open coastal seawater in Maine, USA.

At 2000 h on 18 August 2009, one of us (EEM), while returning to port aboard a nature cruise vessel, discovered a *T. sirtalis* actively swimming at the surface in Frenchman Bay, Maine. The snake was approximately 3.5 km from Bar Harbor, Hancock County, Maine USA and 150 m from the northern tip of Burnt Porcupine Island (44.24521°N, 068.10717°W; datum WGS 84), Hancock Co., Maine USA. Water depth and temperature were approximately 17 m and 13°C, respectively. Upon capture with a dip net, we noted that the snake (unsexed, total length = 479 mm) was alert, exhibited coordinated body movement, and was free of injuries.

Thamnophis sirtalis are found on a number of offshore islands in Frenchman Bay (Mittelhauser et. al. 1996. Technical report NPS/NESO-RNR/NRTR/96-01, National Park Service, New England System Support Office, Boston. 118 pp.), suggesting that this individual may have dispersed from Burnt Porcupine Island. Whether this snake entered the water of its own volition or was forced in is unknown, but Lillywhite et. al. (2008. BioScience 58:947–955) reported that pit vipers living on Gulf Coast islands occasionally enter seawater, venturing as much as 100 m offshore. Western subspecies of *T. sirtalis* are known to frequent intertidal areas in search of fish prey (Batts 1961. Copeia 1961:350–351), but to the best of our knowledge, this is the first report of *T. sirtalis* swimming in open seawater. Our sighting is also noteworthy from the perspective of snake thermal biology. Nelson and Gregory (2000. J. Herpetol. 34:32–40) found that *T. sirtalis* forage in freshwater as cold as 12.5° C when air temperatures were between 27.0°C and 34.0°C. Although air temperature was not measured in our case, the combination of water temperature, time of day (20 min past sunset), and distance from shore indicate a potentially more challenging thermal environment for snakes to sustain swimming in than that previously reported.

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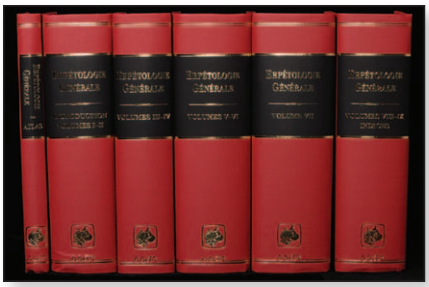
BOOK REVIEWS

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Erpétologie Générale ou Histoire Naturelle Complète des Reptiles

by André Marie Constant Duméril, Gabriel Bibron and Auguste H. A. Duméril, facsimile reprint with a new introduction by Roger Bour, edited by Kraig K. Adler. 2012. Society for the Study of Amphibians and Reptiles, Ithaca, New York (www.ssarbooks.com). 10 volumes in 6. ~7000 pp., 120 pls. (each in colored and uncolored states). Hardcover. US $275.00. ISBN 978-0-916984-87-8.

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In the first half of the 19th century, with the European discovery of the last of the continents and their colonization of most, natural history museum collections grew rapidly with material obtained from voyages of exploration and new settlements. With the competing colonial aspirations of England and France, the natural history museums in London and Paris in particular rapidly expanded during this period. The herpetological collections in both museums were actively curated and studied, by John Edward Gray in the former case, and André Marie Constant Duméril and his assistant, Gabriel Bibron, in Paris. Both groups commenced herpetological work at about the same time (Gray was first formally employed by the British Museum in December 1824 to prepare a catalogue of the reptiles; Duméril replaced Lacepède as Professor on the latter's death in October 1825, although he had been informally working in that role since 1803, and Bibron was officially employed as Duméril's assistant in 1832, although he had been a student in the laboratory since 1818), and published extensively on their herpetological collections among other activities, but in very different ways. Gray published many of his more extended species descriptions in appendices accompanying the narratives of various exploring expeditions, and restricted his encyclopaedic works, the various Catalogues of the Collection of the British Museum (turtles, crocodiles and amphisbaenians in 1844, lizards in 1845, snakes, in part, in 1849), and an 1831 classification of reptiles accompanying Griffith and Pidgeon's English translation of Cuvier's *Animal Kingdom*, to a more abridged style. Duméril and Bibron, however, largely left the reporting of the natural history collections of the French exploratory expeditions to the naturalists accompanying those expeditions and instead, following a long tradition of French encyclopaedic works on natural history (Buffon's *Histoire Naturelle, Générale et Particulière*, 7 vols, 1785–1791; Cuvier's *Dictionnaire des Sciences Naturelles*, 60 vols, 1816–1830 and *Le Règne Animal Distribué d'après son Organisation*, 4 vols, 1817; the *Nouveau Dictionnaire d'Histoire Naturelle*, 36 vols, 1816–1819; Bory de Saint-Vincent's *Dictionnaire Classique d'Histoire Naturelle*, 16 vols, 1822–1830; Guérin Méneville's *Dictionnaire Pittoresque d'Histoire Naturelle*, 9 vols, 1833–1840; and more specifically herpetologically, Sonnini and Latreille's *Histoire Naturelle des Reptiles*, 4 vols, 1801 and Daudin's *Histoire Naturelle, Générale et Particulière, des Reptiles*, 8 vols, 1801–1803), produced a nine-volume work, the *Erpétologie Générale ou Histoire Naturelle Complète des Reptiles*, aiming to cover the entire knowledge of herpetology. The result was much more thorough than Gray's work (and ultimately more extensive: despite the title mentioning only reptiles, amphibians were included in the *Erpétologie Générale*, whereas Gray left the British Museum amphibians and colubroid snakes to his successor). While Gray covered, for example, the scincid lizards in 64 pages of his Catalogue of the Lizards, recognizing 130 species across 57 genera and 6 families, Duméril and Bibron took over five times that space in 1839, covering the skinks in 326 pages, recognising 96 species in 32 genera, with only one genus in a different family. Not only were Duméril and Bibron's descriptions much more detailed than those of Gray, but their accounts of each order and family were prefaced by extensive biological accounts and thorough bibliographies of the previous literature on the topic, given alphabetically by author and, in the case of systematic studies, chronologically. It is this historical and bibliographic perspective that makes this work so valuable to modern herpetology. However, the *Erpétologie Générale* is not just of value as a review of the older literature. With a large amount of the material being sent to Paris coming from the tropics, both in the Old and New Worlds, many new names were first proposed in these tomes, and as a compilation of knowledge, it formed the major baseline for the next half-century of herpetological systematic studies. Hence, the *Erpétologie Générale* is also an essential and frequently consulted reference for any laboratory working in herpetological systematics.

The amount of work involved in producing the 6,600 pages and 120 plates of the *Erpétologie Générale* was enormous, even taking into account the lower known herpetological biodiversity of the era, and Bibron was unable to see the completion of the project, dying of tuberculosis in 1848. With his death, his place as Duméril's assistant was taken by Duméril's son, Auguste Henri André Duméril, and volumes 7 and 9 of the *Erpétologie générale* (the last two volumes published) carry all three names.

The production of this much-awaited facsimile reprint of the *Erpétologie Générale* has similarly been a Herculean task. The largest single facsimile project ever produced by the SSAR, the nine original tomes and atlas are here bound into six handsomely bound volumes (two tomes in most facsimile volumes, with the two parts of Tome 7 constituting a single volume). The first volume begins with an extraordinarily thorough biographical chapter (102 pages) by Roger Bour that provides much new material on the authors and their place in French society of the time, the history of publication of the work and its reception by others, and corrects a number of errors that have been perpetuated in earlier literature on the topic (including, surprisingly, Bibron's date of birth). With Duméril senior in particular also having significant activities in botany, entomology, ichthyology, and medicine (he retained a private medical practice until he was 74, and taught generations of medical students anatomy and pathology), this material will be of broad interest to historians outside of herpetology.

This has clearly been a labor of love for Bour, with the liberal scattering of quotations from contemporary sources, including Duméril's personal letters, and color reproductions of documents and illustrations, combining to give a very personal perspective on the authors' lives. I was particularly struck by the suggestion that Duméril may have inadvertently passed on the smallpox that claimed Lacepède's life through a handshake made after examining patients with the disease—possibly the only case in herpetology of career advancement through killing one's superior.

At the other end of the reprint, Mélanie Pérez, supervised by Bour, and with additional assistance from Kraig Adler, undertook the equally valuable task of creating an extensive index to scientific names that concludes the last text volume, making the information much more accessible (the original largely lacked indices, concluding each tome with a contents listing; the only alphabetic listing, at the end of Tome 9, mixing vernacular and Latin names and only covering genera and higher groups).

The reproduction of the facsimile is of excellent quality. The original text had occasional printing imperfections, varying between copies. These and the inevitable foxing and print-throughs in old books have been fastidiously corrected in the facsimile, making the text as readable as possible, although the scanning is of slightly lower resolution than the original print. The many fold-out synoptic tables in the original are here slightly reduced to fit on facing pages, and inserted (unpaginated, as in the original) in the text. The plates, reprinted here as a single Atlas (the original plates were issued separately in ten parts to accompany the original volumes, in both colored and uncolored versions) are reproduced in both formats on facing pages. This is to allow full details of the plates to be viewed, as the original coloring obscured some of the line details. Although there are some differences in the coloring, in shade, tint and detail, between the facsimile and online scans of two copies of the Atlas on the Biodiversity Heritage Library site (from the Harvard and Smithsonian libraries), these seem to largely reflect individual variation created by the hand coloring of the originals. The vibrant hues of the original plates remain in the facsimile.

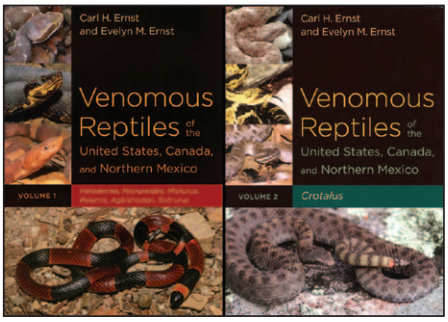
The production of a facsimile on this scale is a costly exercise. Luckily, this facsimile was subsidized by a large donation to SSAR by Ronald Javitch, who must be profusely thanked for his generosity. The result is a high-quality facsimile at a bargain basement price for the size of the work. Given the high price of the original at recent sales (two uncolored sets currently available online are priced between US $8000–9000, and even cheap paperback print-on-demand copies cost about US $30 per volume), the limited print run (400 copies) will undoubtedly result in a rapid appreciation of the value of these facsimile sets, so get them while you can.

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Venomous Reptiles of the United States, Canada, and Northern Mexico (volumes 1 & 2)

by Carl H. Ernst and Evelyn M. Ernst. 2012. Johns Hopkins University Press, Baltimore (www.press.jhu.edu/). xviii + 352, xiv + 391 pp. Hardcover. US $75.00 each volume. ISBN 978-0-8018-9875-4 and 978-0-8018-9876-1.

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There seems to be a long-standing tradition in North American herpetology, especially when it comes to writing books about snakes, for husband and wife co-authorships or publishing collaborations. Examples include Albert and Anna Wright (1957a, b, 1962), Sherman and Madge Minton (1971, 1973), and Roger and Isabelle Conant (1958, 1975). Carl and Evelyn Ernst continued this trend with *Snakes of the United States and Canada* (2003), and they now present their two-volume *Venomous Reptiles of the United States, Canada and Northern Mexico.*

This most recent twin-tome publication is effectively an expansion and update on Carl Ernst's earlier, single-authored, *Venomous Reptiles of North America* (1992), the geographical scope now enlarged to include all "venomous reptiles from the northernmost distribution in southern Canada, through the United States, to 25°N in continental Mexico, the Baja California Peninsula, and those islands in the Gulf of California and off the Pacific Coast of Baja California where they occur" (p. xii). Defining the Baja Peninsula, the islands of the Sea of Cortez and the Mexican islands in the Pacific Ocean, is simple as they exhibit clearly defined natural boundaries, their coastlines, but more difficult must have been the decision how far south to extend the geographical scope of the books in continental Mexico, and how to delineate the southern-most boundaries when no natural feature, like the Rio Grande or a convenient national border, presents itself. The authors ended up using 25°N latitude, which brings all of Sonora, most of Chihuahua and Coahuila, and the northern parts of Sinaloa, Durango, Nuevo Leon, and Tamaulipas under the umbrella of their volumes. But this decision is not without its problems since this is an invisible line with no bearing on the actual distribution of species. Fully 50% of the 34 species included in these volumes have ranges that extend south of

the Latitude 25°N and two of these species (*Agkistrodon taylori* and *Crotalus totonacus*) occur almost entirely south of this line.

Despite their latitudinal cut-off, the authors provide detailed range maps, with the Mexican state borders clearly indicated, illustrating each taxon's entire distribution, into southern Mexico and even Central American countries where necessary. Also included in the species accounts are all the subspecies of these 34 'North American' species whether those subspecies occur within the stated geographical area of the volumes or not. The result is that 13 subspecies with ranges entirely south of 25° N, are included because their conspecifics occur to the north of that line: *Heloderma horridum horridum, H. h. alvarezi, H. h. charlesbogerti, Micruroides euryxanthus neglectus, Micrurus distans michoacaensis, M. d. oliversi, M. d. zweifeli, M. tener fitzingeri, M. t. maculatus, M. t. microgalbineus, Crotalus molossus oaxacus, C. pricei miquihuanus,* and *C. scutulatus salvini*. This is refreshing given that many guides fall back on a phrase such as "four subspecies but only the nominate form is represented within the geographical area of this volume." To their credit, Ernst and Ernst have gone to considerable lengths to include, where possible, as much detail for these extralimital subspecies as those occurring north of 25°N, and in so doing they have increased the value of these two volumes.

The systematic scope of *Venomous Reptiles* is greatly expanded by both its increased geographic area and by taxonomic revisions that have taken place in the twenty years since 1992. The geographical expansion allows the inclusion of northern Mexican species such as *Heloderma horridum, Micrurus distans, Crotalus basiliscus, C. catalinensis, C. enyo,* and *C. tortugensis*, and numerous northern Mexican subspecies of US taxa, such as *Crotalus lepidus, C. ruber,* and *C. willardi*. The taxonomic revisions include the splitting of *Crotalus viridis* into three species (*C. viridis, C. oreganus*, and *C. cerberus*), and the elevation of four former subspecies (*Agkistrodon bilineatus taylori, Micrurus fulvius tener, Crotalus mitchelli stephensi*, and *C. durissus totonacus*) to species. The only taxonomic "loss" might be the synonymy of *Crotalus horridus atricaudatus* within *Crotalus horridus*, as no subspecies are now recognized (Allsteadt et al. 2006). Therefore, this two-volume set includes the same seven genera (*Heloderma, Micruroides, Micrurus, Pelamis, Agkistrodon, Crotalus*, and *Sistrurus*) as the previous volume (Ernst 1992), but with 34 species and 86 subspecies, compared to 21 species and 49 subspecies in the earlier volume.

Of course, taxonomy is an evolving process and field guides and volumes such as these quickly become out of date, albeit by small degrees. New species are described, others placed in synonymy, old names are resurrected, and revisions split long-established taxa. The first to affect the current volumes occurred in the same year as they were published, the resurrection of *Crotalus ornatus* for the Texan populations of *C. molossus* (Anderson and Greenbaum 2012). There is nothing authors can do about this, other changes will undoubtedly follow, but provided the reader keeps up to speed with such advances they do little to detract from the value of the volumes concerned and it will be a further twenty years before a new edition is required to update any changes.

The authors specifically omit the "Rear-fanged (opisthoglyphous) snakes of the Family Colubridae" because North American rear-fanged species have caused only mild envenomings (*Thamnophis, Diadophis* and *Heterodon*), unlike species found in Africa (*Thelotornis* and *Dispholidus*) and Asia (*Rhabdophis*), which have caused fatalities. The authors' decision to omit rear-fanged venomous snakes is completely understandable, it would create another invisible line in the sand, lacking a natural boundary, and to include all rear-fanged North American snakes would greatly expand the size of the volumes and dilute their original purpose.

The content of these two volumes is detailed and comprehensive, as one would expect for two volumes on probably the most studied venomous snake fauna in the world. Volume One begins perfectly logically, not with a section on snake natural history, classification or distribution—a prior knowledge of which is presumably a given, but with sections (they are not numbered chapters) that go straight to the heart of the volumes. The first three sections are titled: Venom, Envenomation by North American Reptiles, and Treatment of Envenomation by Reptiles, so the reader is confronted immediately with the consequences of close encounters with the subjects of the two volumes. The next section concerns itself with the other side of the fence, Conservation of Venomous North American Reptiles, a concept many non-reptile oriented members of the public find hard to comprehend.

There follows a Key to the Families of North American Venomous Reptiles, which might be considered superfluous, as anyone with the slightest knowledge of reptiles can immediately distinguish between the three families represented in these volumes. Surely, more helpful would have been the tools to enable an amateur to separate a milk snake from a coral snake, or a water snake from a cottonmouth. True, as already stated, these volumes are only concerned with front-fanged venomous snakes and venomous lizards, but surely that remit extends to determining whether the snake in the yard is actually a venomous species. The inclusion of a short section explaining the importance of the loreal scale in elapid recognition, and heat-sensitive pits in the pitvipers, and the inclusion of the innocuous colubroid snake families in the key, might have enhanced this section and made it more useful to non-herpetologist readers. In this respect I commend Campbell and Lamar (2004), whose second volume contains an entire chapter on venomous snake mimicry and 237 color plates illustrating venomous snake mimics.

From there the two volumes follow the usual arrangement, with Volume One containing Helodermatidae, Elapidae and the genera *Agkistrodon* and *Sisturus* from the Viperidae, and Volume Two containing the genus *Crotalus*.

The species accounts are excellent, highly detailed and comprehensive, with sections devoted to Recognition, Geographic variation, Confusing species, Karyotype, Fossil Record, Distribution, Habitat, Behavior and Ecology, Reproduction, Growth and Longevity, Diet and Feeding Behavior, Venom Delivery System, Venom and Bites, Predators and Defense, Parasites and Pathogens, Populations, and Remarks. These species accounts are intensively researched and I believe Ernst and Ernst will be the first port of call for anybody wishing to check an unusual prey species, behavioral trait or longevity record for any of the 34 species included in these volumes. For information on North American venomous reptiles it is a one-stop shop, so expect it to be cited on a regular basis in the Natural History Notes section of *Herpetological Review*.

Each species account is also illustrated with grayscale photographs of the species and subspecies concerned, most of them of extremely high quality, as one would expect considering the names in the credits. It is a shame these photographs could not be reproduced in color but the cost of including color images on many if not most pages may have been prohibitive, although the same authors do accomplish this in their earlier volume on the entire snake fauna of the United States and Canada (Ernst and Ernst 2003). Sometimes, however, a grayscale image is more

useful than a color photograph in that detail becomes more apparent, so the fact these images are so reproduced does not detract from the volumes. In fact, if I were to criticize the photography it would be in reference to some of the color plates.

Each volume contains a center section comprising 16 pages of color plates, with two to three plates per page. Some of these plates are excellent but others are of inferior quality, with specimens poorly positioned, too dark with detail obscured, too soft (out of focus) with shallow depth of field, or badly illuminated with stark shadows or color hazes. Many of these images do not do justice to the rest of the books; they look dated and, when one checks back to the earlier volume, it is easy to see why. The 1992 volume contained 32 pages of color plates, equal to the combined total for the 2012 volumes, with 55 individual plates, compared to a total of 76 in the current volumes. Fourteen of these are reused from the earlier volume, in some cases to lesser effect as if the image had been reproduced from a reproduction, rather than the original, with a subsequent loss of quality. This is a shame since some of the color photographs included are excellent, high in detail, well lit, with good depth of field, and with vibrant colors, but the inclusion of a few poor, tired photographs can go a long way to spoil the effect of such high quality images. Given that the North American herpetofauna is probably the most photographed in the world, surely it would have been possible to provide a complete series of new images to enhance these otherwise excellent volumes.

Nit-picking about photography apart, these two volumes are a must-have for anyone interested in the North American herpetofauna, or venomous reptiles and their venoms, and they are likely to grace the shelves of many private and public herpetological libraries. The back cover includes as quote from SciTech Book News: "Likely to remain the standard reference for the next 20 years" and given the impressive content of these two volumes that prediction will probably be proven true.

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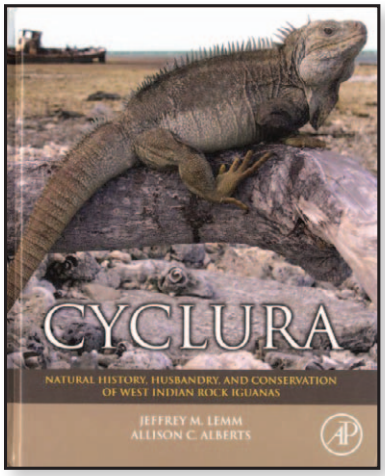
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Cyclura—Natural History, Husbandry, and Conservation of West Indian Rock Iguanas

by Jeffery M. Lemm and Allison C. Alberts. 2011. Academic Press, London (www.elsevier.com). xviii + 221 pp. Hardcover. US $89.95. ISBN 978-1-43-773516-1 (also available in e-book edition for US $70.00).

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Rock iguanas (*Cyclura*) are among the most threatened groups of lizards (Alberts 2000)—a fact much publicized in conservation media outlets. Despite this, a comprehensive, authoritative book on the genus, to which interested persons could be directed, has so far been lacking. *Cyclura—Natural History, Husbandry, and Conservation of West Indian Rock Iguanas* is the refreshing and much-needed response to this void, a book for the educated public noting the natural history and husbandry of the 16+ species in the genus *Cyclura*. As the greatest threats to rock iguanas are anthropogenic in nature—habitat loss, hunting, mammal predation, etc.—the authors point out in the introduction that this book is intended "…to educate the public on the plight of rock iguanas and the unfortunate demise their populations have suffered at the hands of people and their feral animals." For those interested in a more academic treatment, *Iguanas: Biology and Conservation* (Alberts et al. 2004), stemming from the 1997 "Iguanas: Biology and Conservation" symposium and for which Alberts and Lemm were also key editor/contributors, treats diversity in many more iguanas, including sections dedicated to ecology and conservation.

Cyclura is the kind of book that people can spend hours poring over line by line because it is great fun. I imagine that public libraries, schools, veterinary offices, and eco-lodges will derive great satisfaction from including this scholarly, yet accessible book in their collections.

This book has seven chapters, three of which are contributed (Chapter 1: "Evolution and Biogeography" by Catherine Stephen; Chapter 5: "Nutrition" by Ann Ward and Janet Dempsey; Chapter 6: "Health and Medical Management" by Nancy Lung). The progression that the book makes is mostly natural—wild

rock iguanas and their evolution (Chapters 1–3) is followed by information about husbandry (Chapters 4–6), with a final word on conservation (Chapter 7). Accompanying photographs of species, morphology, and habitat are distracting in the most pleasant way.

Readers are treated in the first chapter, Evolution and Biogeography, to a clear account of the complex island geology and biology of the Caribbean, which follows insular formation from the proto-Antillean landmass (~80–70 MYA) to the present. More than a quarter of the book is dedicated to the second chapter, "Species Accounts," comprising 59 pages devoted to individual accounts for 15 living and one confirmed extinct species, as well as three possible species noted from the fossil record. Each species account includes information on nomenclature, morphology, behavior, and IUCN/CITES/USFWS conservation status. In the species accounts, 'Natural History Notes' synthesize the more important contributions to the scholarly literature. To note, the authors thoughtfully included three labeled diagrams of *Cyclura* scalation and body plan, and a well-planned glossary to guide lay readers through the technical terms in species descriptions.

In the third chapter, "Natural History," the authors supplement current literature with their own observations, providing a comprehensive overview of rock iguanas. For example, 'Diet and Foraging' contains a fascinating description of how rock iguanas use colic nematodes to digest food. The section 'Predators and Defense' builds on the mammalian predation motif from the first two chapters, and includes eye-opening photographs of predators.

The next three chapters (Chapter 4: "Husbandry"; Chapter 5: "Nutrition"; Chapter 6: "Health and Medical Management") could be a great resource for those who keep iguanas or even for those who manage head start programs to share with their volunteers and staff. Importantly, these chapters highlight the paucity of species-specific information. For example, the contributors writing the fifth chapter explicitly state that the lack of diet information on wild rock iguanas is the reason they included fairly general sample diets and supplements appropriate for any *Cyclura* spp. (see Tables 5.3 and 5.4). These chapters also dispel husbandry myths that are not supported in the peer-reviewed literature, such as the belief that gout is induced by high protein diets.

I have just a few complaints with this attractive book. The first is actually a compliment to the authors—the seventh chapter, "Conservation," is a fantastic resource with syntheses of threats, current conservation work, tables of population estimates, and relevant photographs. I believe that it should have been placed much earlier in the book because it shines. It also more appropriately transitions between the wild rock iguana accounts and husbandry content.

Second, wild rock iguana accounts are accessible and informative, but this section desperately needs a distribution map. Flipping back and forth between diagrammatic boxes (see figure 1.3) representing the emergence of Caribbean islands is the only place to contextualize the distribution of *Cyclura* spp. I found myself scanning the whole book several times to see where a map was placed—only to be disappointed. A simple diagram will supplement and vastly improve the species accounts in future editions.

Last, I love glossaries. Everything about a glossary speaks of order and thoughtful preparation of a text. Accordingly, the glossary of ~ 90 terms (pp. 213–215) is well chosen with clear definitions. However, the terms don't include page numbers or warrant space in the index. I recognize that this may be a decision that the publishers made. However, I would argue that it is unlikely a reader is going to make flashcards or study the glossary before using the book. Indexing each term will increase accessibility in a book aimed at a general audience.

Ultimately, the conservation of one of our most lovely iguanid genera depends on exciting the younger generation of herpetological enthusiasts and educating Caribbean tourists. This sort of book, so far outside of traditional books on single topics—either husbandry, or biogeography, or a checklist of species—exhibits the sort of synergy that captivates the public. Non-academics interested in, but unable to find, a soup to nuts account of these charismatic animals are going to be well served by *Cyclura*.

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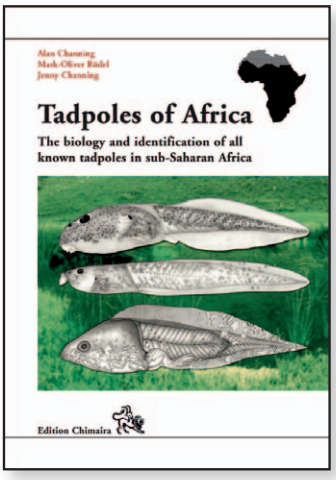
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Tadpoles of Africa. The Biology and Identification of All Known Tadpoles in Sub-Saharan Africa

by Alan Channing, Mark-Oliver Rödel, and Jenny Channing. 2012. Chimaira Buchhandelsgesellschaft, Frankfurt am Main, Germany (www.chimaira.de). 402 pp. Hardcover. EUR 49.80 (approx. US$ 68.00) ISBN 978-3-89973-448-5.

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Another book. A different book. A must for all people interested in African anurans! There have been a couple of books published in recent years dedicated to Afrotropical amphibians. While, on the one hand, there is a considerable need for new knowledge or summaries of existing information in this field, several of these new books contribute little towards a better understanding of anurans from the African continent. This is certainly not the case with the book by Channing et al. in which the authors have both comprehensively reviewed and organized current knowledge on tadpoles of sub-Saharan African frogs and toads and filled in existing knowledge gaps. As such, the book will become a standard work which will be used for many years. To be

honest, I was initially skeptical about the feasibility of the book and was more than positively surprised how well it succeeds in reaching its goals.

This book justifiably places Africa in a 'pole position' with regard to our understanding of anuran amphibians at the global scale. Certainly, African amphibian diversity in general remains poorly understood and understudied. However, books describing *all* tadpoles in the same manner are still lacking for South America or Asia, regions similarly species-rich and, generally speaking, perhaps better studied.

I very much appreciate the book's structure and how data are presented. Before the species accounts start on page 88, in which tadpoles (as far as this stage exists) of all African anuran genera are described, the authors comprehensively describe the environment in which larval habitats occur, summarize what is known about oviposition and development, and present the reader with an exhaustive chapter on the tadpole bauplan. This is followed by a very informative chapter on (African) tadpole ecology, including information on larval growth to metamorphosis and interactions (both abiotic and biotic) with the environment. The latter topic also encompasses conservation problems like climate change. In an additional chapter, for completeness, Channing et al. also discuss direct development. All chapters are accompanied by high-quality photographs, most of them in color.

In the species account section, about 300 pages long, 365 tadpole descriptions are arranged by family and genus. For each genus, Channing et al. start with a brief introduction and a list of species for which larval stages are unknown. This is perhaps unusual but highlights remaining gaps very well. They then list and describe the known tadpoles, based on either literature information (which is mentioned) or new data. Detailed descriptions are made in a standardized way and follow the following scheme: general information (if applicable), distribution and habitat, morphological description of body as well as of mouthparts. It must be mentioned that the majority of species entries are accompanied by excellent drawings which increase the significance this book even more. Moreover, the authors provide photographs of many tadpoles and their corresponding adults. At the end of the book, the authors attempt to provide keys to aquatic tadpole stages of sub-Saharan African frogs and toads.
I found very few errors or unjustified statements, such as the claim that *Leptopelis mackayi* occurs in the Ruwenzoris of Uganda—there are no published and perhaps not even unpublished records of this species from Uganda. Also, even though literature information is provided in a species entry, it is most useful if the original material examined were also consistently listed (e.g., *Werneria tandyi*). Finally, allocation of larval stages to species is a difficult issue; perhaps the value of the book would have been even higher if the authors had mentioned in each case how tadpoles were assigned to species. These issues, however, are minor and do not detract appreciably from this really impressive volume, which is destined to be a most useful tool for anyone working with African anurans.

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Western Pond Turtle: Biology, Sampling Techniques, Inventory and Monitoring, Conservation, and Management

by R. Bruce Bury, Hartwell H. Welsh, Jr., David J. Germano, and Donald T. Ashton (editors). 2012. Northwest Fauna No. 7, Society for Northwestern Vertebrate Biology (www.thesnvb.org). vii + 128 pp., 11 pls. Paperback. US $12.00.

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After several years in the making, this winter saw the publication of The Society for Northwestern Vertebrate Biology's Northwest Fauna monograph, *Western Pond Turtle: Biology, Sampling Techniques, Inventory and Monitoring, Conservation, and Management* (known informally from its inception as "the western pond turtle handbook"). This handbook marks the culmination of more than 160 years of western pond turtle research since the species was first described (Baird and Girard 1852). It summarizes the state of the species to date, reviewing surveying and sampling protocols, and providing recommendations on species conservation, habitat restoration, and future research needs. Considering that the list of editors (Bury, Welsh, Germano, Ashton) and contributing authors is a veritable who's who in the western pond turtle community, this handbook stands to become a "user's manual" for the species.

The first two chapters are devoted to a brief history and natural history of the species, beginning with a review of nomenclature and taxonomy, a species description, and documentation of the range and distribution between British Columbia and Baja California, followed by a comprehensive summary of western pond turtle biology. The distribution of the western pond turtle throughout its Pacific Coast range illustrated in Figure 1 is a great synthesis of regional distribution databases, including the California Natural Diversity Database, Nevada Department of Wildlife, Oregon Biodiversity Information Center, and Washington Department of Fish and Wildlife.

The bulk of the handbook, chapters 3 through 7 and the associated appendices, are devoted to a review of surveying and sampling protocols. First the authors begin by walking a would-be-researcher through sampling design considerations to help identify the possible constraints and opportunities of a study. Then, the authors tap into standard survey methodologies loaded with a dose of their personal experience garnered collectively through untold years of experience to demonstrate how the techniques can be tailored to studying the western pond turtle. These include everything from visual encounter surveys (western pond turtles are particularly wary) to trapping and snorkeling (the best baits)

to nest searching and detecting hatchlings and young turtles (needles in a haystack). Turtle in hand, the authors next review standard field procedures on how to handle turtles and their data: equipment needs, sanitation, veterinary care, measurements (weight, size, age, sex), marking systems, and radiotelemetry.

In closing, the authors dedicate two chapters to the western pond turtle's future. Under the banner of conservation and restoration, the authors describe the need for habitat preservation and restoration, the unknowns surrounding turtle relocation and head-starting, and the multitudes of threats that continue to put the species at risk: wetland and upland habitat loss, urban development and roads, contaminant spills and pollution, and introduction of predators (bullfrogs and largemouth bass) and competitors (red-eared sliders). Recognizing the need for further studies, the authors conclude with a caution against gray literature and a call for additional peer-reviewed, published research. Answering the questions that remain unanswered—species abundance, population trends, geographic variation, habitat requirements, life-history traits, daily and seasonal activity patterns, diet—may be critical to conserving the species in the years to come.

A single misstatement is noteworthy. In describing the nomenclature and taxonomy of the species in Chapter 1, the authors mistakenly state (page 2): "The name 'Western Pond Turtle' appears to have been first used in the *Field Guide to Western Reptiles and Amphibians* (Stebbins 1966)." In reviewing the early literature it would appear that Cooper (1859:292)—not Stebbins—was the first, not only to use the name "western pond turtle" by more than a century, but also to designate any common name for the species. Earlier scientific literature referred to the species by various binomial names only: *Emys marmorata* (Baird and Girard 1852), *Emys nigra* (Hallowell 1854; Gray 1855; Hallowell 1859), or *Actinemys marmorata* (Agassiz 1857; Baird 1858). Over the next century, several other authors referred to the species as the western pond turtle in advance of Stebbins, among them Lord (1866), Gray (1872), Ditmars (1907), Grinnell and Camp (1917), and Storer and Usinger (1963). Although trivial, this nomenclatural precedence establishes the priority for "western pond turtle" (instead of "Pacific pond turtle") as the oldest available name applied, thereby reinforcing its use consistent with recent convention.

This aside, the handbook is nothing short of thorough, concise, and timely as interest in and threats to the species continue to grow, and the need for a coordinated study and census of the species becomes necessary. A 1992 petition to list the western pond turtle as federally Threatened or Endangered was rejected the following year, although today the species remains listed Endangered in Washington, Sensitive-Critical in Oregon, and a Species of Special Concern in California. Proactive research and conservation, as summarized and advocated in this handbook, are critical to prevent or mitigate the possible need to up-list the species in the future.

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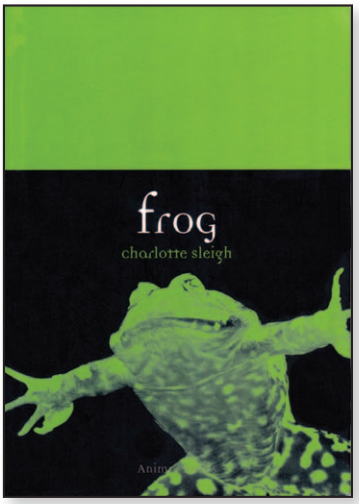
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Frog

by Charlotte Sleigh. 2012. Reaktion Books, London (www.reaktionbooks.co.uk), distributed by The University of Chicago Press (www.press.uchicago.edu). Softcover. 208 pp. US $19.95. ISBN 978-1-861-89920-0.

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This small volume is the latest herpetological entry in the "Animal Series" from Reaktion Books, which includes the earlier titles *Snake* and *Tortoise*, as well as 48 other, similarly-named books on assorted mammals, birds, fish, mollusks, and arthropods. All books in the series are similar in size, format, and organization. A suitable subtitle for this book might be "a social history of frogs" or "frogs and the human experience."

The Introduction provides a thumbnail sketch of what frogs are and how they live, touching

on feeding, locomotion, skin secretions, larval life, and other topics. It also chronicles the etymology of "frog" and other words used for anurans and notes the difficulty that humans have traditionally had in categorizing frogs among other vertebrates. Seven chapters follow, each examining a particular theme in the frog-human relationship.

"Just a Kiss" considers the story of the Frog King and similar tales. "Warts and All" looks at the negative connotations of frogs, for example their image as "unclean" animals, plagues of frogs, and their role in witchcraft. "Them, Us, and Frogs" relates frogs and frog-eating to various concepts of national identity. Most English speakers will be familiar with the term "frog" as a derogatory term for the French, but readers may be surprised to learn that in England it was previously used as a slur against the Dutch—until William III, Prince of Orange, invaded England and took the throne, at which time it became politically expedient to apply the epithet elsewhere. This chapter also considers the cane toad and its successful invasion of Australia in light of both that country's national psyche and biosecurity.

"Under the Knife" extolls the role of frogs in medical and other research from Boyle and Swammerdam to the present. "Evolution on Fast-forward" discusses frogs in evolutionary biology and related fields, touching on Ernst Haeckel's biogenetic law, Wilhelm Roux's embryology, the role of *Xenopus* in pregnancy tests, and the well-known "Case of the Midwife Toad" that ended Paul Kammerer's career (and life). The sex life of frogs, and the association of frogs with fertility, rain, luck, and wealth in cultures from ancient Egypt to modern China is the subject of "Of Frogs and Fruitfulness." Lastly "Jumped Up" celebrates frogs as humorous or hapless characters in literature (e.g., *The Celebrated Jumping Frog of Calaveras County*, *The Wind in the Willows*) and popular culture (Michigan J. Frog, Kermit the Frog, the Budweiser frogs) and contrasts this with the current plight of frogs and other amphibians due to a variety of causes, most notably chytridiomycosis.

The book is rounded out by a Timeline of the Frog (with 23 highlights from the origin of frogs to the making of the animated movie *The Princess and the Frog* in 2009), a listing of more than 100 References and a separate Select Bibliography, a list of Associations and Websites, Acknowledgements, and a four page Index to scientific names, people, and subjects. Oddly the "References" are numbered sequentially within chapters but these numbers do not correspond to specific locators in the text (they do in *Snake* and *Tortoise*).

Entertaining though the text is, what really makes this book appealing are its 100+ illustrations, most in color. These include images taken from illuminated manuscripts to classic printed works such as Roessel von Rosenhof's *Historia Naturalis Ranarum Nostratium* with a smattering of magazine covers, political cartoons, television and movie stills, and photos of frog statues, textiles, and jewelry, as well as numerous portraits of photogenic frogs.

There are some oversimplifications regarding anuran systematics and biology and a few minor errors that may be forgiven, since the author is a historian of science, not a herpetologist. Some names are inconsistently used (e.g., *Rana* instead of *Lithobates* for the American Bullfrog, but *Pelophylax* not *Rana* for the European pool and marsh frogs). The claim that frogs were included among reptiles until the mid- to late 19th century is exaggerated. Although some herpetologists used the vernacular term "reptiles" (and others used "amphibians") for both groups of organisms until late in the century, Henri de Blainville formally separated the classes from one another in 1816. On p. 29 an "unidentified blue and yellow frog" is in reality *Phyllomedusa bicolor* and the work it is from is *De Rana Bicolore* by Peter Boddaert (1772). An image on p. 35 is stated to be from the 20th century, but it is from the early 19th century (the date 1825 is even visible on the plate itself). Images of dendrobatids on pages 23 and 24 are transposed relative to their captions and a photo of a ranid on p. 137 is misidentified as *Xenopus laevis*. Finally, at least in my review copy, the text on p. 201 is a duplication of that on the lower two-thirds of p. 200.

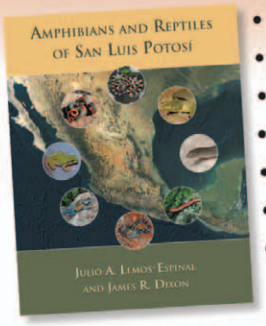
The handful of minor complaints aside, this is an inexpensive and attractive little book that can be enjoyed by anyone with a soft spot for frogs, an interest in history, or a love of literature, art, or popular culture. Although herpetologists are unlikely to learn much about their study organisms, they will surely find something new and interesting in this book.

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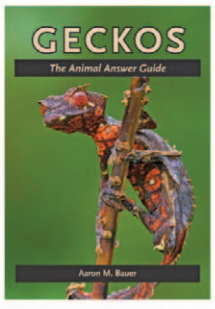
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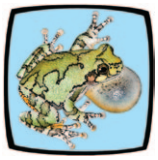
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ABOUT OUR COVER: *Lithobates areolatus*



The Crayfish Frog (*Lithobates areolatus*) is a large ranid native to the central United States. Along with the related gopher frogs (*L. sevosus* and *L. capito*), it is among the most fossorial of all North American ranids. This species is of conservation concern throughout most of its range. However, until recently very little was known about its biology other than its breeding season, some aspects of its life history, and that throughout most of its range it primarily uses burrows constructed by large crayfish as refugia outside of the breeding season. Recent studies have shed considerable light on additional aspects of its biology. Perhaps most innovative were studies of Crayfish Frog spatial ecology, as well as the use of passive "trail cameras." These studies documented that individual Crayfish Frogs return to specific burrows or home areas after traveling long distances to and from their breeding ponds, and then once there, they remain nearly sedentary for the remainder of their active seasons (Hoffman et al. 2010. BioScience 60:829–834; Heemeyer et al. 2012. Journal of Wildlife Management 76:1081–1091; Heemeyer and Lannoo 2012. Copeia 2012:440–450).

Our cover depicts a Crayfish Frog from Williamson County, Illinois, in a typical posture outside of a crayfish burrow. The image was taken in 2002 with a Canon EOS A2E film camera, Canon 20–35mm lens, mounted on a Bogen Tripod. Exposure was f/16 at 15 seconds, recorded on Fujichrome Provia 100F slide film. A hand-held Canon 540-EZ flash (using the front-curtain synchcronization function) was used to correctly expose the frog at the beginning of the exposure, while the long total exposure accurately captured the colors of the late dusk sky).

The photographer, **Michael Redmer**, is a biologist with the US Fish & Wildlife Service's Chicago Illinois Field Office. Before joining the Fish & Wildlife Service, Mike worked on demography and reproductive ecology of several species of anurans in Illinois, including *L. areolatus*. This resulted in several publications on those species, including the species account for *L. areolatus* (co-authored with Matthew Parris) in the 2005 book "Amphibian Declines: The Conservation of United States Species," edited by M. J. Lannoo (University of California Press). Experience working with a species associated with crayfish burrows has followed Redmer, who has since 2005 been the USFWS lead biologist for the Eastern Massasauga Rattlesnake (*Sistrurus catenatus*). Mike still dabbles in freelance natural history photography, specializing in portraiture of amphibians, reptiles, invertebrates, and plants.



PHOTO BY ED HAMMER

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A brief and simple set of instructions to authors as well as a list of topic headings and associate editors can be viewed on the JNAH web page (JNAH.CNAH.org). Questions can be addressed to JNAH.editor@cnah.org. We look forward to your submissions.

—Walter Meshaka Jr. and Dan Fogell

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Species Monitoring and Conservation: Reptiles

Reptiles is an introduction for graduate students and professionals in wildlife management and conservation to the essential aspects of reptile conservation (both in-situ and ex-situ). It is sponsored by the Smithsonian-Mason School of Conservation, and is to be held at the Smithsonian Conservation Biology Institute, Front Royal, Virginia, USA. The course focuses on the use of field, laboratory, computational, and captive techniques to measure, monitor, and conserve reptile populations. Participants will gain first-hand experience by working with professionals in a variety of settings designed to address current and developing issues in the conservation of reptile diversity.

During the 12-day intensive residential session, participants will learn the principles of study design, develop and carry out field assessments, and use the latest techniques to analyze their data. Practical training in hands-on field techniques, including distance sampling, modern surveillance, trapping, handling and marking methods, sample collection for disease monitoring, and radio-telemetry will be provided by scientists who use these methods as part of their research programs. Participants will also be introduced to use of relevant analytic software, such as DISTANCE, PRESENCE, and MARK, for the application of field-monitoring data to population management and decision making.

Course instructors include experts from the Smithsonian's National Zoological Park (Curator Jim Murphy and Biologist Matt Evans) and National Museum of Natural History, the Virginia Department of Game and Inland Fisheries, the University of Massachusetts, and national and international NGO's. While most instruction takes place on the 3200-acre campus in Front Royal at the newly opened facilities of the Smithsonian-Mason School of Conservation, the course also includes trips to field sites around the region and visits to the National Zoo's Reptile Discovery Center and the National Museum of Natural History's Division of Amphibians and Reptiles, which houses the world's largest curated reptile collection.

The total course fee, which includes instruction and course materials, food, shared lodging, and transport to/from Washington-Dulles International Airport (IAD) is US $3,478. All other travel costs and incidental expenses are the participant's responsibility. Partial scholarships are available on a competitive basis. Participants earn Continuing Education Units; graduate course credit (3) is available for qualified applicants through George Mason University at an additional fee. Participants should have previously completed a college-level basic ecology/evolution course. For first consideration, apply before March 4, 2013. Courses such as this have been full during previous offerings, so you are encouraged to apply early.

Visit http://SMconservation.gmu.edu or contact SCBItraining@si.edu for more information.

MEETINGS

Meetings Calendar

Meeting announcement information should be sent directly to the Editor (HerpReview@gmail.com) well in advance of the event.

20–23 May 2013—World Crocodile Conference, 22nd Working Meeting of the Crocodile Specialist Group IUCN-SSC, Colombo, Sri Lanka. Information: www.csgsrilanka.com

10–15 July 2013—Joint Meeting of Ichthyologists and Herpetologists (SSAR, HL, ASIH), Albuquerque, New Mexico, USA. Information: http://www.dce.k-state.edu/conf/jointmeeting/

21–25 July 2013—26th International Congress for Conservation Biology, Baltimore, Maryland, USA. Information: http://www.conbio.org/mini-sites/iccb-2013

31 July–3 August 2013—36th International Herpetological Symposium, New Orleans, Louisiana, USA. Information: http://internationalherpetologicalsymposium.com/index.html

22–27 August 2013—SEH 17th European Congress of Herpetology, Veszprém, Hungary. Information: http://seh2013.org/

13–15 September 2013—6th Symposium on the Ecology, Status, and Conservation of Diamondback Terrapins, Seabrook Island, South Carolina, USA. Information: http://www.bio.davidson.edu/terrapin2013/Welcome.html

25–29 September 2013—Annual Meeting of the German Society for Herpetology and Herpetoculture (DGHT), Bonn, Germany. Information: www.dght.de

3–6 October 2013—4th Biology of Vipers Conference, Struga, FYR Macedonia. Information: www.shdmr.org/vipers

CURRENT RESEARCH

The purpose of Current Research is to present brief summaries and citations for selected papers from journals other than those published by the American Society of Ichthyologists and Herpetologists, The Herpetologists' League, and the Society for the Study of Amphibians and Reptiles. Limited space prohibits comprehensive coverage of the literature, but an effort will be made to cover a variety of taxa and topics. To ensure that the coverage is as broad and current as possible, authors are invited to send reprints to the Current Research section editors, Beck Wehrle or Ben Lowe; e-mail addresses may be found on the inside front cover.

A listing of current contents of various herpetological journals and other publications is available online. Go to: http://www.herplit.com and click on "Current Herpetological Contents."

Insights into the Integumentary Sensory Organs of Crocodylians

Herpetologists have long recognized that crocodilians possess integumentary sensory organs (ISOs), rounded dermal protrusions on their scales. While there is general agreement that they have a sensory function, the exact function of ISOs has been a topic of debate. The distribution of ISOs differs between the two major lineages of crocodylians: in Alligatoridae (alligators and caiman) they are restricted to the head and are densest on the anterior labial regions, while in Crocodylidae (crocodiles and gharials) they are distributed uniformly across the body. The authors of this paper examined the anatomy and physiology of crocodylian ISOs and the feeding behavior of crocodylians with the hopes of illuminating the specific function of these structures. Cross sections through ISOs of both *Alligator mississippiensis* and *Crocodylus niloticus* revealed that they were densely packed with receptors and axons, including receptors within the epidermis, Merkel cell columns directly beneath the epidermis of the ISOs (and absent elsewhere), and lamellated corpuscles (akin to mammalian Pacinian corpuscles) deeper within the dermis. Numerous melanocytes were found immediately beneath the Merkel cells, giving the ISOs their distinctive dark hue. The stratum corneum of the ISOs was 60% thinner than was observed in adjacent skin, which would allow for efficient transdermal perception. In many ways, crocodylian ISOs structurally resembled receptor organs found on the snouts of ducks, monotremes, and moles. For rostral and mandibular ISOs, the afferent neurons lead to the trigeminal nerve. While monitoring extracellular activity near the trigeminal ganglion, the authors stimulated facial ISOs to determine sensitivity and identify "receptive fields" (total area of skin from which a given region of the ganglion receives afferents). This revealed numerous, sometimes overlapping receptive fields, which were smaller anteriorly. Indeed, some of the anterior-most receptive fields comprised a single ISO. The measured threshold of ISO sensitivity ranged from 14 to 0.078 millinewtons (the smallest force that could be experimentally applied). Electrical fields and hypersaline solutions applied to these receptive fields failed to elicit ganglion activity. The authors investigated the ability of these species to locate food without auditory or visual cues, videotaping both species reacting to food dropped into their aquaria under infrared light and white noise. With their ISO-dense labial regions beneath the water, the animals oriented toward water disturbances, but then failed to locate the food until it made physical contact. Upon apprehension, the crocodylians were able to discriminate between edible and non-edible items. Prey-generated water movement did not reliably elicit a response under these conditions. Altogether, these experiments strongly suggest a highly effective mechanoreceptive function for crocodylian ISOs.

Leitch, D. B., and K. C. Catania. 2012. Structure, innervation and response properties of integumentary sensory organs in crocodilians. Journal of Experimental Biology 215:4217–4230.

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Interesting Patterns of Anuran Life History Evolution

Frogs exhibit a wide range of early developmental strategies. Many begin as larvae hatched from unattended, underwater eggs and procure their own food (exotrophy). At the opposite end of the parental investment spectrum, some species hatch into miniature versions of adults (direct development) in nutrient-provisioned terrestrial eggs tended by parents. And a great many species display intermediate strategies. The authors of this study aimed to reveal evolutionary patterns of development and parental investment among frogs, and specifically whether certain intermediate strategies are precursors to direct development. They collected life history, climate, and DNA sequence data for 720 anuran species, including representatives from 48 of the 53 families. For indirect developing species, they determined whether the eggs are laid terrestrially or aquatically, if the eggs and/or larvae occur in protected microhabitats (e.g., underside of leaf, bromeliad, isolated pool of water), have parental protection, and whether the larvae are exotrophic or are sustained by maternally supplied nutrients such as a yolk sack (endotrophy). For a subset of these taxa (470), adult female size, egg size, and clutch size were also recorded and tested for correlations with life history characteristics. Using the concatenated molecular dataset, a time-calibrated phylogeny replete with estimates of clade support was constructed using likelihood methods. Upon this tree, ancestral character states for the life history characters were estimated under a likelihood framework and tests were performed to determine if terrestrial ovopositioning, endotrophy, and/or larval development in a protected microhabitat are evolutionary precursors to direct development. This research revealed that terrestrial egg-laying evolved 48 times, with those lineages subsequently evolving direct development eleven times. Interestingly, direct development evolved in aquatic egg lineages almost as many times (eight). There was also evidence for reversals back to aquatic egg laying from terrestrial laying. Neither developing young located in protected places nor endotrophic larvae were supported as precursors to direct development. Generally, egg size was negatively correlated with clutch size, larger females laid larger clutches, and species exhibiting terrestrial ovopositioning or direct development disproportionately practiced parental care. Relative to terrestrially ovopositioning species, aquatic-laying species were found to have significantly larger females, smaller eggs, and larger clutch sizes, and live in cooler, drier places. This last finding is

interesting, suggesting that while terrestrial egg laying frees species from large bodies of water, as this is a wet-climate phenomenon, it is unlikely to lead to arid-adapted species.

Gomez-Mestre, I., R. A. Pyron, and J. J. Wiens. 2012. Phylogenetic analyses reveal unexpected patterns in the evolution of reproductive modes in frogs. Evolution 66:3687–3700.

Correspondence to: **IVAN GOMEZ-MESTRE**, Estación Biológica de Doñana, Consejo Superior de Investigaciones Científicas, Avda. Americo Vespucio s/n, Sevilla 41092, Spain; e-mail: igmestre@ebd.csic.es.

Española Island Giant Tortoise Recovery Program a Success

The Galápagos tortoises native to the island of Española (*Chelonoidis hoodensis*) have been in decline since European contact, initially due to human persecution and later to competition with feral goats. By the 1960s the wild population had diminished to two males and twelve females, which were captured for a breeding program at the Charles Darwin Research Station (along with a third male from the San Diego Zoo). Despite a lack of recruitment on the island, these tortoises successfully reproduced in captivity. In unison with goat eradication efforts, regular offspring repatriation efforts were initiated on the Isla Española during the 1970s. A previous microsatellite study of repatriated tortoises failed to find evidence of successful island breeding and found the allelic frequencies to be very different from those of the breeder population. The authors of this paper aimed to determine whether repatriated tortoises have reproduced on the island, the relative parental contributions of the breeder tortoises in the program, and whether there has been differential post-release survivorship based on genotype. They collected tissue samples from the breeding animals, offspring prior to release (2003, 2007), and tortoises encountered on the island (1994, 2003, 2007). These samples were then genotyped for fifteen microsatellite loci. Using these data, the authors assigned parentage to the offspring and calculated indices of genetic diversity. Failure to identify one or both parents was interpreted as island reproduction if all microsatellite alleles occurred within the breeder population (and breeding pool contamination if not). Island tortoise carapace lengths were also measured. While no reproduction between repatriated tortoises was detected in the 1994 sample, the 2003 and 2007 samples contained nine and 50 island-born tortoises, respectively. Indeed, a quarter of the tortoises sampled in 2007 were born on the island. No significant differences between the genotype frequencies of the pre-release and island samples were recovered, indicating that there has not been strong selection against particular genetic backgrounds and that uneven parentage among the breeder tortoises explains the previously reported skewed genetic makeup of island tortoises. Using available release data, a 5% annual mortality rate, a 20 cm. release size, and a 4 cm. annual growth rate, the authors modeled an expected size frequency of island turtles and found it to be highly correlated with the observed size distribution. This lends support to their hypothesis that the observed heterogeneity in size of island turtles is a solely consequence of variable release effort over the years. This study demonstrates that reintroduction efforts can be successful even with a minimal breeding population; the authors suggest the repatriated animals being a single generation removed from wild ancestors was a reason for this success.

Milinkovitch, M. C., R. Kanitz, R. Tiedemann, W. Tapia, F. Llerena, A. Caccone, J. P. Gibbs, and J. R. Powell. 2012. Recovery of a nearly extinct Galápagos tortoise despite minimal genetic variation. Evolutionary Applications (*in press*) doi:10.1111/eva.12014.

Correspondence to: **MICHEL MILINKOVITCH**, Laboratory of Artificial & Natural Evolution (LANE), Department of Genetics & Evolution, University of Geneva, Sciences III, 30, Quai Ernest-Ansermet, 1211 Genève 4, Switzerland; e-mail: Michel.Milinkovitch@unige.ch

Physiological Dynamics of Wood Frog Freeze Tolerance

Among vertebrates, the ability to survive being frozen solid has been most extensively studied in the Wood Frog (*Rana sylvatica* or *Lithobates sylvaticus*) of North America. This species uses glucose to protect cells from freeze damage and while frozen, blood circulation and respiration cease, and metabolism is reduced to modest anaerobic fermentation. Furthermore, it has been shown that frozen frogs catabolize carbohydrates through the winter while sympatric frogs that overwinter underwater primarily burn lipids. The authors of this paper use respirometry methods to determine the metabolic activity of Wood Frogs over a freeze-thaw cycle and in conjunction with field-collected temperature data, model the cost of winter freezing for this species. To calculate metabolic activity, individual frogs were placed in a small, flow-through chamber fitted with a thermometer and the CO_2 content of the air was determined as it exited. CO_2 was monitored while the frogs were slowly cooled from 4°C to -2.4°C, held there for twelve hours, and slowly returned to 4°C. Freeze-thaw cycle parameters and temperature data from data loggers placed in *R. sylvatica* overwintering microhabitats near Ottawa, Canada were used to generate a model to predict nutrient consumption, the freeze-thaw cycle number, and cumulative time frozen experienced by wild frogs. The change in metabolic activity between 3.5 and 1.8°C was calculated, and as this temperature-metabolic rate relationship ("Q_{10}") was high relative to other vertebrate estimates, the authors used a second, lower Q_{10} above a threshold of 4°C. They also conducted analyses to determine how sensitive their model was to particular parameters; these included allowing a third rate of metabolic change once the frog is frozen, and using a single Q_{10}, different rate change thresholds, and different freezing and thawing temperatures. A general relationship of temperature-metabolism was determined and three consistent metabolic rate spikes were observed: during cooling but prior to freezing, immediately after freezing, and during thawing. These periods coincide with increased O_2 consumption but not increased physical activity, indicating that these increases were due to metabolic activity. The authors estimated that Ottawa Wood Frogs undergo roughly 20 freeze-thaw cycles over winter and spend about 7% of the winter frozen; the insulating properties of the leaf litter and snow lead to dramatic departures from ambient temperatures. The sensitivity analyses demonstrated that neither increasing the amount of time frozen nor the number of freeze-thaw cycles had much effect on lipid consumption while the latter greatly increased carbohydrate consumption. The authors conclude that any lipid savings accrued while frozen are offset by the nutrient costs of freezing and thawing, indicating there must be other selective pressures that led Wood Frogs to freeze tolerance. Furthermore, changes in winter snow cover are predicted to drastically alter the overwintering conditions in this species.

Sinclair, B. J, J. R. Stinziano, C. M. Williams, H. A. MacMillan, K. E. Marshall, and K. B. Storey. 2013. Real-time measurement of metabolic rate during freezing and thawing of the wood frog, *Rana sylvatica*: implications for overwinter energy use. Journal of Experimental Biology 216:292–302.

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Amphibian Species Found to have Ability to Shrink

Though it seems strange, some vertebrate species have the ability to decrease their length when times are tough. This phenomenon has been demonstrated in a few phylogenetically disparate species, including some fish, a couple tortoises, Marine Iguanas, and a shrew. The authors of this paper find evidence for the first shrinking amphibian, the Jollyville Plateau Salamander (Plethodontidae: *Eurycea tonkawae*). This neotenic species inhabits limestone caves and their associated springs and spring runs in a tiny section of the Edwards Plateau of central Texas, where human demands for water and space are leaving little left for its unique fauna. The authors were conducting a mark-recapture study of this species when a severe drought occurred. During this episode the springs ceased flowing for ten months and the salamanders were forced into subterranean retreats, where food availability was more limited. During multiple sampling efforts before, during, and after the drought, measurements of body length and tail-base width (a proxy for condition) were taken. Within-effort recaptures were used to estimate measurement error. The between-capture growth rate data revealed that almost all individuals shrank in both measurements (tail-base width and body length) during the drought and grew after the drought, even when measurement error is taken into account. These data were then subjected to a series of statistical analyses. Analyses of growth rate covariances with period (drought vs. post-drought) and initial size as explanatory variables revealed significant covariance between all comparisons as well as a significant interaction between period and initial size with regard to body length (but not tail-base width). T-tests revealed that the negative growth rates were statistically significant during the drought. Finally, during the drought, the two growth rates were significantly correlated with each other, while neither were correlated with size at first capture. Attempting to narrow down the possible mechanisms responsible for body shrinkage, the authors examined several cleared and stained specimens, revealing that in these salamanders the vertebrae abut one another, leaving little opportunity for cartilage constriction and pointing to bone loss as the source of shrinkage. The authors emphasize that this strange phenomenon is not necessarily adaptive and may simply be a result of energetic stress.

Bendik, N. F., and A. G. Gluesenkamp. 2013. Body length shrinkage in an endangered amphibian is associated with drought. Journal of Zoology (*in press*). doi:10.1111/jzo.12009.

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New Insights into Venom Function in a Neotropical Pitviper

The Terciopelo (Viperidae: *Bothrops asper*) of the Neotropics is responsible for a plurality of the venomous snakebites across its distribution. Like that of other venomous snakes, *B. asper* venom is complex. Recent *in vitro* experiments investigating the myotoxic (muscle-damaging) component of the venom revealed that rather than destroying muscle cells outright, *B. asper* myotoxins alters the permeability of the cells, allowing Ca^{2+} to enter while K^{+} and ATP flow out. In this paper, the authors extended this investigation with *in vivo* experiments. Two previously identified myotoxins were isolated from *B. asper* venom. Anesthetized lab mice were then injected with one of the myotoxins and a solution that releases florescent light as it reacts with ATP and subsequently, emitted light was monitored and quantified. As expected, a large signature of ATP presence was detected in the experimental treatments relative to controls. But strangely, delivery of whole *B. asper* venom indicated a much weaker ATP presence. The authors then assayed the venom for enzymes capable of breaking down ATP, as these have previously been identified in other members of the Terciopelo's subfamily (Crotalinae). Indeed, they found nucleotidases capable of rendering ATP into adenosine, a molecule important in homeostasis, signal transduction, and other vital functions when regulated, but capable of inducing hypotension, paralysis, and anticoagulation when not. This discovery is interesting, as adenosine or a similar molecule is present in most snake venoms but not usually those of the subfamily Crotalinae. The obvious benefits of adenosine in the venom cocktail have been noted by previous researchers, and the authors argue that rather than lacking adenosine in their arsenal, *B. asper* utilizes a by-product of the myotoxin's attack on muscle cells (ATP) as the adenosine source. These discoveries could have great benefits for public health and biomedical research.

Caccin, P., P. Pellegatti, J. Fernandez, M. Vono, M. Cintra-Francischinelli, B. Lomonte, J. María Gutiérrez, F. Di Virgilio, and C. Montecucco. 2012. Why myotoxin-containing snake venoms possess powerful nucleotidases? Biochemical and Biophysical Research Communications (*in press*) doi:10.1016/j.bbrc.2012.11.129.

Correspondence to: **CESARE MONTECUCCO**, Dipartimento di Scienze Biomediche, Università di Padova, viale G. Colombo 3, Padova 35121, Italy; e-mail: cesare.montecucco@unipd.it.

Population Genetics of an Imperiled Salamander at its Distributional Limit

Salamandra infraimmaculata is a large fire salamander of the Middle East, reaching its southern distributional limit in northern Israel. It is considered threatened throughout its range, with habitat destruction and invasive species thought to be driving forces of imperilment. To elucidate patterns of genetic diversity and connectivity in *S. infraimmaculata* of northern Israel, the authors of this paper collected 475 genetic samples from 20 populations. These populations were divided between two biogeographic provinces: the Galilee region (11), comprising salamander populations considered contiguous with populations to the north of Israel, and Mt. Carmel (9), where salamander populations are presumed to be isolated from those of the Galilee region to the north (separated by naturally or anthropogenically inhospitable

lowlands) and are the species' southernmost populations. They genotyped the samples for ten microsatellite loci and with those data, generated summary statistics, identified genetic structure using the software package STRUCTURE and analysis of molecular variance (AMOVA), and assessed isolation by distance via mantel tests of F_{ST} statistics. They found the Galilee region to be much more genetically diverse, possessing 40 alleles not found in the Mt. Carmel region. Despite the Mt. Carmel populations lacking any unique alleles (indicating recent divergence from the Galilee populations), the STRUCTURE analysis found strong support for two genetic clusters corresponding to the two regions. This is likely due to strong differences in allele frequencies and indicates the regions are separated by a formidable barrier to gene flow. Furthermore, the AMOVA found that in addition to strong regional differentiation, there is also significant genetic structuring between populations within regions and across the sampled distribution (irrespective of regional membership). They also found a significant signal of isolation by distance within the two regions as well as across the sampled distribution, indicating that gene flow is limited at all levels, which is not surprising given the well-documented limited dispersal ability and breeding site fidelity of this species. The authors argue that because of their genetic distinctiveness, the Mt. Carmel populations need to be managed separately from the Galilee populations.

BLANK, L., I. SINAI, S. BAR-DAVID, N. PELEG, O. SEGEV, A. SADEH, N. M. KOPELMAN, A. R. TEMPLETON, J. MERILÄ, AND L. BLAUSTEIN. 2012. Genetic population structure of the endangered fire salamander (*Salamandra infraimmaculata*) at the southernmost extreme of its distribution. Animal Conservation (*in press*) doi:10.1111/acv.12009.

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Two Native New Zealand Frogs Evaluated for Susceptibility to *Bd*

New Zealand's native frogs, the four species of *Leiopelma*, together encompass a large swath of anuran phylogenetic diversity, as they likely split from the nearest relatives during the breakup of Pangaea. They are also threatened with extinction due to a number of factors, with all four species occupying a small fraction of their historical distribution and two of the species restricted to near-shore islands and heavily managed sanctuaries. Furthermore, this threat may be understated, as there is evidence that there may be cryptic diversity within this group. Fortunately, recent work demonstrated that one species, *Leiopelma archeri*, seems to be resistant to *Bd*. The authors of this paper set out to determine whether two additional *Leiopelma* species, *Le. pakeka* and *Le. hochstetteri*, also show a resistance to Bd. Importantly, they used a strain of *Bd* cultured from New Zealand frogs, the virulence of which has not previously been evaluated. Individuals of both species were either inoculated using a solution containing a known concentration *Bd* zoospores or not (control), as were several *Litoria ewingii* (Hylidae), an Australian species introduced to New Zealand and known to be susceptible to *Bd* infection. Frogs were inspected daily for pathological symptoms and evaluated weekly for their weight, ability to right themselves, and infection status (determined through standardized swabbing and qPCR). Weight and infection status were also determined prior to inoculation and at termination. Finally, the effects of species membership, initial weight, and mean Bd load on number of weeks *Bd* -positive were investigated using generalized linear model (GLM) methods. While all *Li. ewingii* in the experimental treatment succumbed to *Bd*, none of the inoculated *Leiopelma* did. Average *Bd* load and species membership were the greatest predictors of weeks *Bd* -positive. Though all *Leiopelma* were *Bd* -free by the end of the experiment, all *Le. hochstetteri* were cleared of *Bd* by week eight while the *Le. pakeka* experimental group took until week 13 to do so. Neither species exhibited symptoms specific chytridiomycosis, though the *Le. pakeka* experimental group did lose a significant amount of weight over the experiment relative to controls and sustained that weight loss long after the terminus of the experiment. The authors stress that while these experiments are important and informative, their findings may not translate to natural systems.

OHMER, M. E., S. M. HERBERT, R. SPEARE, AND P. J. BISHOP. 2012. Experimental exposure indicates the amphibian chytrid pathogen poses low risk to New Zealand's threatened endemic frogs. Animal Conservation (*in press*) doi:10.1111/acv.12010.

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Snout Ornamentation Evolution in a Sri Lankan Lizard Genus

The lizard genus *Ceratophora* (Agamidae) is endemic to Sri Lanka and consists of five species. Three of these species possess distinct projections on their snout which the other two species lack. A published molecular phylogeny suggests that rostral appendages have been lost or gained three times in this group. This is surprising, as the acquisition of these structures has been infrequent across Squamata. Three equally parsimonious hypotheses of *Ceratophora* rostral appendage evolution have been identified, however DNA sequence data alone is insufficient for evaluating the relative merits of these scenarios. The authors of this paper collected and analyzed morphological data with the goal of shedding light on *Ceratophora* rostral evolution. Available specimens were assigned to a demographic group (male, female, juvenile) and measured for several characters including snout-vent length, jaw length, and rostral appendage length. Some characters might scale differently with total size. Identifying to what degree and within which age classes this allometric growth is occurring allows comparisons between species, where similar patterns of growth would be evidence for homology. Reduced major axis regression (RMA) was performed to identify and quantify allometric growth in these characters. The standardized allometric coefficients generated by the RMA were then included in an analysis of covariance (ANCOVA) with *post hoc* tests to test for differences in allometry between the demographic groups. These analyses revealed that the patterns of rostral appendage growth vary among the three species. Adult males of one species (*C. tennentii*) exhibit positively allometric rostral growth, but unique to this species, the fleshy, fan-shaped rostrum is also present in juveniles. Taken together with the slow movements of this species, crypsis is a more likely explanation for the rostrum

than sexual selection. Males of the earliest-diverging species (*C. aspera*) have a rough, lanceolate appendage longer than that of the females (despite having a smaller body size), suggesting that sexual selection may be at play. Males of the third species (*C. stoddartii*) showed positively allometric jaw length growth while the females exhibited the opposite; this might indicate opposing selection between the sexes. An increased jaw length increases the length of the lip, which is white and visually extends the white lanceolate rostral appendage (automimicry). This would benefit males if there is intrasexual competition but would be a disadvantage for females, as it would make them more conspicuous. Supporting this hypothesis, individual *C. stoddartii* have been observed twitching their appendages while performing an open-mouth display. The authors conclude, based on the differences in rostral appendage development, form, and function that they likely evolved independently in these three species.

Johnston, G. R., M. S. Y. Lee, and T. D. Surasinghe. 2013. Morphology and allometry suggest multiple origins of rostral appendages in Sri Lankan agamid lizards. Journal of Zoology 289:1–9.

Correspondence to: **GREG JOHNSTON**, Vertebrates Section, South Australian Museum, North Terrace, Adelaide, SA 5000, Australia; e-mail: pelecanus85@gmail.com.

Auditory Communication in a South American Turtle

Although turtles have historically been regarded as silent animals, one familiar instance of chelonian vocalization is that of mating tortoises. Other cryptodiran turtles have also been documented vocalizing, including adolescent big-headed turtles (*Platysternon*) and ovopositioning Leatherback Sea Turtles. Recently, an extensive study of the vocal behaviors of an Australian snake-necked turtle (*Chelodina*) identified 17 distinct vocalization types, indicating that pleurodirans are also capable of vocalizing. As part of a larger project exploring the ecology of the species, the authors of this paper investigated the vocal behavior of the Giant Amazon River Turtle (Pleurodira: *Podocnemis expansa*) both in nature and in captivity. Initially, they made audio recordings of groups of turtles (hatchlings, adults, or both) in water-filled aquaria. Then, they performed similar assays in nature, expanding them to include recordings of eggs prior to hatching, and of adult females released on land. Some of these turtles were fitted with radio transmitters prior to release. The authors then used software to measure various acoustic properties of the vocalizations, allowing for them to be categorized. *P. expansa* of all age classes were recorded making low amplitude vocalizations. They were able to identify eleven different vocalization categories, some effectively age-class specific, and some relatively complex. The embryos begin vocalizing hours before hatching, possibly serving to coordinate hatching, allowing for efficient nest escape and predation dilution. In experiments where groups of hatchling and adult *P. expansa* were released near each other, both vocalized (evidenced by the presence of both juvenile- and adult-specific sounds), and the adults approached the hatchlings. Three separate times, transmitter-fitted hatchlings and adults were found swimming together, once almost four kilometers from the release site. The authors suggest these observations are the first evidence for parental care of hatchlings in turtles. Given the low amplitude of the calls, they suggest that for some species, noise pollution should be added to the list of turtle conservation concerns.

Ferrara, C. R., R. C. Vogt, and R. S. Sousa-Lima. 2013. Turtle vocalizations as the first evidence of posthatching parental care in chelonians. Journal of Comparative Psychology (*in press*). doi: 10.1037/a0029656.

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New Insights into the Salamander Transcriptome

The ability of salamanders to readily regenerate anatomical structures has been of great interest to researchers investigating the phenomenon of regeneration generally. Particularly, the molecular processes associated with salamander regeneration have garnered much attention. The authors of this study assembled a transcriptome of various tissues undergoing regeneration in Eastern Newts (*Notophthalmus viridescens*). "Transcriptomes" are the RNA molecules collectively occurring at a particular time and place within an organism, and reflect the particular type of activity that is occurring. As genomic resources are lacking for salamanders (their gigantic genomes are mostly to blame), this transcriptome was assembled without a scaffold ("*de novo*"). To accomplish this, the researchers employed cutting-edge methods of nucleic acid characterization (454 and Illumina paired-end sequencing) as well as Sanger sequencing (after reverse transcription, cloning, and PCR amplification). After combining the results from their various methods, the authors identified 120,922 unique transcripts, of which 38,384 were found to be sufficiently similar to known transcripts of other organisms to be considered homologous. Some of these homologs of previously known transcripts were only recovered in tissues undergoing regeneration. Furthermore, roughly 15,000 transcripts were identified as likely coding for proteins, of which 826 did not match known proteins and therefore have the potential to be unique to Caudata. Many of these contain previously unknown protein motifs, indicating they represent undescribed protein families. As they included transcripts isolated from various regions undergoing regeneration, the authors suggest that it is likely some of these novel proteins are involved with the regeneration process. The discovery of these heretofore unknown proteins will undoubtedly motivate further research into their function. Furthermore, the assembly of the transcriptome of *N. viridescens* lays the groundwork for investigating transcript diversity among salamanders.

Looso, M., and Colleagues. 2013. A *de novo* assembly of the newt transcriptome combined with proteomic validation identifies new protein families expressed during tissue regeneration. Genome Biology 14:R16.

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Best Practices: In the 21st Century, Taxonomic Decisions in Herpetology are Acceptable Only When Supported by a Body of Evidence and Published via Peer-Review

Taxonomy, the scientific process by which natural groups are identified, described, named, and classified is an exciting research pursuit, not only because it makes an indispensable contribution to biodiversity science but, at a more basic level, because it satisfies the human enjoyment of discovery. However, taxonomy has been an area of biological science in which errors, ethical transgressions, and clashes of egos have been particularly vicious and public, harkening back to the earliest days of the binomial system of nomenclature when Linnaeus (1737) named what he considered an insignificant weed (genus *Siegesbeckia*) after Johann Georg Siegesbeck, a contemporary and very vocal critic.

Taxonomy's Impact.—Taxonomy is a fundamental component of biology because it includes the subdiscipline of biology in which organismal groups are defined and named so that they may fittingly be included in the scientific discourse. Only with precise taxonomy can biologists, and those who apply biological principles, communicate effectively (Cotterill 1997). As a consequence, dubious taxonomy undermines the underpinnings of science as a whole, with potentially serious consequences in basic and applied research. As scientists, we are fully accountable for all elements of our research, especially when our findings have broad contemporary applications. This accountability extends to the taxonomies we create or use. We also believe this responsibility includes monitoring the evidence presented as justification for taxonomic decisions. Normally, this is a key function of peer review (McPeek et al. 2009; Perry et al. 2012; Thompson 2010), but when peer review is circumvented, biologists are forced to find other means to protect the integrity of their science.

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Taxonomy in Practice.—The problem with taxonomy arises when the data used to create taxonomic decisions are shoddily presented, derive from spurious research, or lack evidence. While it is true that taxonomic decisions invariably require detailed descriptive components, when these descriptions are built into a scientific framework, they strictly conform to the scientific method; the hypothesis tested is the existing taxonomy, and this hypothesis can be falsified and reformulated (Crother 2009). To perform the tasks that should define 21st Century taxonomic science, three main steps are key: (1) Generate hypotheses of group membership (e.g., a species, a clade) or evolutionary relationship (e.g., sister taxa) based on available primary sources (e.g., existing or new collections of specimens including whole animals, tissues, and DNA sequences) and the available literature; (2) test these hypotheses via appropriate, rigorous, and honest analysis of the relevant data; and (3) submit proposed taxonomic decisions (e.g., taxonomic rearrangements, descriptions of new species, elevation of subspecies to species rank) to peer-reviewed journals in the form of manuscripts that present the data and provide a rational justification for the proposed decisions. These three responsible steps constitute the information processing system that helps to ensure that taxon names, taxon concepts, and taxonomic arrangements are properly grounded in evidence.

21st Century Developments.—In the post-2000 explosion of electronic information, the rapid publication and quick dissemination of scientific information have been prominent and generally positive trends across all research fields, including taxonomy. In keeping with these developments, the International Commission on Zoological Nomenclature (ICZN) recently amended several articles of the *International Code of Zoological Nomenclature* (hereafter referred to as the *Code*) to allow publication of nomenclatural acts solely via electronic media (ICZN 2012). However, in addition to diverse online publishing channels, universally available desktop-publishing technology has also made production of high-quality booklets, pamphlets, and even journals easy for anyone. For taxonomists, this trend is both a curse and a blessing. Even as the path to publication has been simplified and the time to publication shortened by the emergence of

reputable, rigorously scientific, peer-reviewed, and well-edited electronic or rapid-print journals (e.g., *ZooKeys*, *Zootaxa*), publishing is no longer a controlled environment and there are outlets where nonscientific and misguided taxonomy is presented as fact. Differentiating between science and non-science in taxonomy is a challenge. The *Official Register of Zoological Nomenclature* (online as ZooBank) is the authoritative ICZN register for nomenclature and can legitimize registered, electronic-only publications (ICZN 2012).

The authors of this paper understand that the right to freely interpret scientific data as it relates to taxonomic decisions must remain inviolate. Furthermore, we acknowledge that as scientists, we identify provisional truths, which are the best approximations of ultimate truths that we are able to produce at the time, and which remain subject to revision and discussion. However, we see a cautionary tale in the manner by which information is disseminated in the fast-paced world of modern science. We have learned that better placed or marketed falsehoods may supplant truths in public perception. Thus, a taxonomic fact can become obscured by nonscientific information, misleading those who are unable to discern whether the information was appropriately generated. To resist such occurrences, the practice of science in general (and taxonomy in particular) first requires adherence to certain standards for generating, analyzing, and disseminating data. Scientists also need to improve information flow regarding matters of taxonomy and nomenclature, and online registration of names (ICZN 2012) may be a suitable first step. While we accept that "bad" taxonomy remains a possible outcome even when researchers follow proper procedure, we feel that it has become necessary to defend taxonomy against misguided, unscientific practices, and to develop a set of principles to guide taxonomic herpetologists in their research, with the intent to promote (to the extent possible) reliable research that contributes to scientific progress.

Does Unscientific Taxonomy Matter?

In herpetology, unscientific taxonomy, under the guise of science, has been presented with increasing frequency in nonprofessional outlets since the year 2000 (Table 1). The many taxon names proposed in these outlets can have serious negative ramifications: they destabilize taxonomy, and in so doing they confound conservation and legislative efforts, medical herpetology, academic processes, grant administration, and the public perception of herpetology as a whole. As a result, the negative practical impact of needlessly destabilizing taxonomy is likely to be more profound than any other type of fraud or error in herpetology.

Information Storage and Retrieval.—The proliferation of superfluous or dubious names can lead to a breakdown in the information storage and retrieval functions of the taxonomy. A change in the name of a genus, for instance, may lead to the establishment of parallel listings for all the species in that genus.

Professional Communication.—Fear of taxonomic piracy, where one author deliberately expropriates the naming intentions of another, creates an atmosphere of mistrust, stifles collegiality, and promotes insular research. In particular, it discourages communication about unnamed taxa, thus delaying research progress and even conservation action (Oliver and Lee 2010).

Bona fide Taxonomic Research.—Unscientific taxonomic acts have several impacts on genuine taxonomic research. For example, scientists are forced to trace unwarranted or bogus taxonomic accounts in potentially hard-to-locate publications during literature inquiries on synonyms, and they must examine type material in potentially difficult-to-access collections. This not only wastes time and resources, it dilutes legitimate taxonomy with unscientific materials. Taxonomists are relegated to "redescribing" valid taxa that were named prematurely in acts of mass naming or in deliberate acts of intellectual kleptoparasitism (e.g., Aplin and Donnellan 1999; Rawlings et al. 2008). Furthermore, graduate students may have to reformulate thesis proposals or thesis conclusions, and their subsequent publications may be redundant. Nomenclature in grant applications may conflict with unscientific taxonomic publications, resulting in needless delays to ascertain the veracity of the information. In addition, institutional managers not well versed in the details of herpetological research may be unable to follow the mix of validly and unscientifically proposed names or classifications.

Applications of Herpetological Taxonomy.—Confusion about names may cause genuine harm in endeavors relying upon accurate taxonomy of organisms. At the broadest scale, taxonomic confusion will increase the taxonomic impediment to characterizing and managing Earth's biodiversity (Wilson 1985, 2004), including the assessment and protection of threatened taxa and the direction of conservation efforts (Georges and Thomson 2010; Georges et al. 2011; Parham et al. 2006; Pillon and Chase 2007). For example, in the case of species protected by CITES or listed in the IUCN Red List of Threatened Species, dubious taxonomic changes may produce loopholes, where species remain protected according to the rules of these lists, but are not recognized by enforcement agencies. Other areas of particular concern include clinical toxinology, especially the production and use of antivenoms as treatment for the bites of venomous snakes (Fry et al. 2003; Williams et al. 2011; Wüster and McCarthy 1996). In the case of clinical toxinology this may literally be a matter of life and death, when name changes spread via media outlets by attention-seeking authors may cause uncertainty among medical personnel as to which antivenom is appropriate in cases where the name of the source snake species has changed (Sutherland 1999). Wholesale nomenclatural changes at the genus level, especially among medically important snakes, must be carefully considered (even when taxonomically justified) because of the confusion that can arise when the names of relevant species become inconsistent with the names quoted on antivenom products.

Science and the Public.—The public perception of and trust in science is eroded when decisions lacking evidence are presented as fact and permeate what is assumed to be a scientific discourse. The often-strident tone of exchanges surrounding unethical and unscientific taxonomic acts (Borrell 2007) further diminishes the entire scientific discipline in the eyes of the public. In cases where unethical behavior involves illegal activities, international relations, or other similarly sensitive dynamics, the resulting backlash can make it more difficult to conduct *bona fide* research even when good science is demonstrably needed for initiatives such as biodiversity management and conservation.

Unscientific Taxonomy, Embodied

We here present two cases to illustrate unscientific practice. These stand out in the herpetological discipline by the sheer number of taxonomic proposals presented, and the manner in which the authors use the *Code* in contravention of the spirit, if not the letter, of the rules. We use these examples as the departure point for a more general discussion of the scientific

TABLE 1. List of herpetofaunal taxa published on or after 1 January 2000 that can be objectively classed as unscientific, non-peer reviewed, misguided in intent or presentation, fraudulent, or lacking evidence. These names *should not be used* in herpetological nomenclature, pending suitable action by the ICZN. Instead, we urge that these names be treated as listed in the column titled Recommendations by reverting to the older name of record, or by another suitable name as indicated. To avoid confusion, in the Recommendation column we list subgenera in parentheses along with the genus name according to standard nomenclatural usage. All other capitalized, italicized names are genera. Where these recommendations are based on previously published taxonomic decisions or errors, citations and explanations are referenced as superscripts and listed at the end of the table. These recommendations are not formal nomenclatural proposals according to articles of the *Code*, but temporary treatments until the ICZN has developed a suitable response to actions of taxonomic vandals.

Taxon	Taxon Level	Citation	Recommendation
Abilenea	gen. nov.	Wells 2007c	*Aprasia*
Acanthophiina	subtrib. nov.	Hoser 2012e	Elapidae, Hydrophiinae
Acanthophis antarcticus cliffrosswellingtoni	ssp. nov.	Hoser 2002b	*Acanthophis antarcticus*
Acanthophis groenveldi	sp. nov.	Hoser 2002b	*Acanthophis laevis*
Acanthophis macgregori	sp. nov.	Hoser 2002b	*Acanthophis laevis*
Acanthophis wellsei donnellani	ssp. nov.	Hoser 2002b	*Acanthophis wellsi*
Acanthophis yuwoni	sp. nov.	Hoser 2002b	*Acanthophis laevis*
Acetyphlops	subgen. nov.	Hoser 2012as	*Typhlops*
Adelynhoserea	gen. nov.	Hoser 2012o	*Trimeresurus*
Adelynhoserserpenae	gen. nov.	Hoser 2012c	*Atropoides*
Adelynhoserserpenina	subtrib. nov.	Hoser 2012d	Viperidae, Crotalinae
Adelynhoserserpinini	trib. nov.	Hoser 2012d	Viperidae, Crotalinae
Adelynkimberleyea	gen. nov.	Hoser 2012ao	*Laudakia*
Adrasteia	gen. nov.	Wells 2002f	*Lampropholis*
Adrasteiascincus[1]	nom. nov.	Wells 2010	*Lampropholis*
Agamatajikistanensis	subgen. nov.	Hoser 2012ao	*Laudakia*
Agkistrodonini	trib. nov.	Hoser 2012d	Viperidae, Crotalinae
Agressiserpens	gen. nov.	Wells 2002d	*Acanthophis*
Aipysurini	trib. nov.	Hoser 2012e	Elapidae, Hydrophiinae
Aiselfakharius	gen. nov.	Hoser 2012am	*Salvadora*
Alanbrygelus	subgen. nov.	Hoser 2012ah	*Tropidonophis*
Alcisius	gen. nov.	Wells 2012	*Lerista*
Alexteesus	gen. nov.	Hoser 2012ai	*Rhadinaea*
Allengreerus	gen. nov.	Hoser 2009b	*Lampropholis*
Allengreerus delicata jackyhoserae	ssp. nov.	Hoser 2012ab	*Lampropholis delicata*
Allengreerus ronhoseri	sp. nov.	Hoser 2009b	*Lampropholis delicata*
Altmantyphlops	gen. nov.	Hoser 2012as	*Typhlops*
Altmantyphlops (*Goldsteintyphlops*) *kirnerae*	sp. nov.	Hoser 2012as	*Typhlops brongersmianus*
Altmantyphlops (*Goldsteintyphlops*) *kirnerae wellingtoni*	ssp. nov.	Hoser 2012as	*Typhlops brongersmianus*
Altmantyphlops reticulatus wellsi	ssp. nov.	Hoser 2012as	*Typhlops reticulatus*
Anelytropsinae	subfam. nov.	Hoser 2012ar	Dibamidae
Anomalepididoidea	superfam. nov.	Hoser 2012as	Anomalepididae
Anomalepiini	trib. nov.	Hoser 2012as	Anomalepididae
Antaresia maculosus brentonoloughlini	ssp. nov.	Hoser 2004	*Antaresia maculosa*[2]
Antaresia saxacola campbelli	ssp. nov.	Hoser 2000a	*Antaresia stimsoni*
Antaresiina	subtrib. nov.	Hoser 2012b	*Antaresia*
Aphroditia	gen. nov.	Wells 2012	*Lerista*
Argyophiini	trib. nov.	Hoser 2012as	*Argyophis*
Arnoldtyphlops	gen. nov.	Hoser 2012as	*Typhlops*
Asianatrix	gen. nov.	Hoser 2012ah	*Amphiesma*
Aspidites melanocephalus adelynensis	ssp. nov.	Hoser 2000a	*Aspidites melanocephalus*[2]
Aspidites melanocephalus davieii	ssp. nov.	Hoser 2000a	*Aspidites melanocephalus*[2]
Aspidites melanocephalus rickjonesii	ssp. nov.	Hoser 2009a	*Aspidites melanocephalus*[2]
Aspidites ramsayi neildavieii	ssp. nov.	Hoser 2009a	*Aspidites ramsayi*[2]
Aspidites ramsayi panoptes	ssp. nov.	Hoser 2000a	*Aspidites ramsayi*[2]
Aspidites ramsayi richardjonesi	ssp. nov.	Hoser 2000a	*Aspidites ramsayi*[2]
Aspiditesina	subtrib. nov.	Hoser 2012b	*Aspidites*
Aspidomorphina	subtrib. nov.	Hoser 2012e	Elapidae, Hydrophiinae
Atractaspini	trib. nov.	Hoser 2012l	*Atractaspis*
Australiasis funki	sp. nov.	Hoser 2012b	*Morelia amethistina*
Barrygoldsmithus	gen. nov.	Hoser 2012ai	*Rhadinaea*
Billmacordus	gen. nov.	Hoser 2012as	*Gerrhopilus*
Binghamus	subgen. nov.	Hoser 2012f	*Micrurus*

TABLE 1. Continued

Taxon	Taxon Level	Citation	Recommendation
Bitisini	trib. nov.	Hoser 2012d	Viperidae, Viperinae
Bobbottomus	gen. nov.	Hoser 2012as	*Leptotyphlops parkeri*
Bothriechisina	subtrib. nov.	Hoser 2012d	Viperidae, Crotalinae
Bothrocophiina	subtrib. nov.	Hoser 2012d	Viperidae, Crotalinae
Bothropina	subtrib. nov.	Hoser 2012d	Viperidae, Crotalinae
Bothropoidina	subtrib. nov.	Hoser 2012d	Viperidae, Crotalinae
Broghammerini	trib. nov.	Hoser 2012b	Pythonidae
Broghammerus	gen. nov.	Hoser 2004	*Python*
Broghammerus reticulatus dalegibbonsi	ssp. nov.	Hoser 2004	*Python reticulatus reticulatus*[2]
Broghammerus reticulatus euanedwardsi	ssp. nov.	Hoser 2004	*Python reticulatus reticulatus*[2]
Broghammerus reticulatus haydenmacphiei	ssp. nov.	Hoser 2004	*Python reticulatus reticulatus*[2]
Broghammerus reticulatus neilsonnemani	ssp. nov.	Hoser 2004	*Python reticulatus reticulatus*[2]
Broghammerus reticulatus patrickcouperi	ssp. nov.	Hoser 2004	*Python reticulatus reticulatus*[2]
Broghammerus reticulatus stuartbigmorei	ssp. nov.	Hoser 2004	*Python reticulatus reticulatus*[2]
Brucerogersus	gen. nov.	Hoser 2012y	*Thamnophis*
Calloselasma	trib. nov.	Hoser 2012d	Viperidae, Crotalinae
Cannia australis aplini	ssp. nov.	Hoser 2001	*Pseudechis australis*
Cannia australis burgessi	ssp. nov.	Hoser 2001	*Pseudechis australis*
Cannia australis newmani	ssp. nov.	Hoser 2001	*Pseudechis australis*
Carettochelys insculpta canni	ssp. nov.	Wells 2002a	*Carettochelys insculpta*
Carrytyphlopea	gen. nov.	Hoser 2012as	*Ramphotyphlops*
Cerastini	trib. nov.	Hoser 2012d	Viperidae, Viperinae
Cerrophidionina	subtrib. nov.	Hoser 2012d	Viperidae, Crotalinae
Charlespiersonserpens	gen. nov.	Hoser 2012ac	*Dendrelaphis*
Charlespiersonserpens (*Downieea*) *papuensis lizelliottae*	ssp. nov.	Hoser 2012ac	*Dendrelaphis papuensis*
Charlespiersonserpens (*Macmillanus*) *jackyhoserae*	sp. nov.	Hoser 2012ac	*Dendrelaphis lorentzi*
Charlespiersonserpens gastrostictus tyeipperae	ssp. nov.	Hoser 2012ac	*Dendrelaphis gastrostictus*
Chlamydosaurus kingii mickpughi	ssp. nov.	Hoser 2012ap	*Chlamydosaurus kingii*
Chlamydosaurus kingii pughae	ssp. nov.	Hoser 2012ap	*Chlamydosaurus kingii*
Chondropython viridis adelynhoserae	ssp. nov.	Hoser 2009a	*Morelia viridis*[2]
Chondropython viridis shireenae	ssp. nov.	Hoser 2004	*Morelia viridis*[2]
Coniophanes	subgen. nov.	Hoser 2012aj	*Coniophanes*[7]
Copelandtyphlops	subgen. nov.	Hoser 2012as	*Typhlops*
Costinisauria couperi	sp. nov.	Wells 2009b	*Lampropholis couperi*
Cottonkukri	gen. nov.	Hoser 2012ag	*Oligodon*
Cottonserpens	subgen. nov.	Hoser 2012aj	*Coniophanes*
Cottontyphlopini	trib. nov.	Hoser 2012as	*Letheobia*
Cottontyphlops	gen. nov.	Hoser 2012as	*Letheobia*
Cottonus	subgen. nov.	Hoser 2009d	*Crotalus*[3,4]
Crishagenus	gen. nov.	Hoser 2012as	*Epictia*
Crocodylini	trib. nov.	Hoser 2012an	Crocodylidae
Crossmanus	subgen. nov.	Hoser 2012x	*Leptodeira*
Crotalina	subtrib. nov.	Hoser 2012d	Viperidae, Crotalinae
Crottykukrius	subgen. nov.	Hoser 2012ag	*Oligodon*
Crottyreedus	gen. nov.	Hoser 2012ak	*Calamaria*
Crottytyphlopini	trib. nov.	Hoser 2012as	Typhlopidae
Crottytyphlops	gen. nov.	Hoser 2012as	*Typhlops*
Crutchfieldus	subgen. nov.	Hoser 2009d	*Crotalus*[3,4]
Cryptophis edwardsi	sp. nov.	Hoser 2012ad	*Cryptophis nigrescens*
Cummingea	gen. nov.	Hoser 2009d	*Crotalus*[3,4]
Cybelia	gen. nov.	Wells 2012	*Lerista*
Cyclotyphlopini	trib. nov.	Hoser 2012as	*Cyclotyphlops*
Cyrilhoserini	trib. nov.	Hoser 2012as	*Gerrhopilus*
Cyrilhoserus	gen. nov.	Hoser 2012as	*Gerrhopilus*
Cyrtodactylus abrae	sp. nov.	Wells 2002c	*Cyrtodactylus tuberculatus*
Dalegibbonsus	gen. nov.	Hoser 2012ar	*Dibamus*
Dannyelfakharikukri	gen. nov.	Hoser 2012ag	*Oligodon*
Dannyleeus	subgen. nov.	Hoser 2012q	*Pareas*
Dannytyphlops	subgen. nov.	Hoser 2012as	*Typhlops*
Daraninserpens	subgen. nov.	Hoser 2012aj	*Coniophanes*

TABLE 1. Continued

Taxon	Taxon Level	Citation	Recommendation
Daraninus	subgen. nov.	Hoser 2012g	*Bothrops*
Daviekukri	gen. nov.	Hoser 2012ag	*Oligodon*
Demansiini	trib. nov.	Hoser 2012e	Elapidae, Hydrophiinae
Dendroaspini	trib. nov.	Hoser 2012e	Elapidae, Elapinae
Denisonini	trib. nov.	Hoser 2012e	Elapidae, Hydrophiinae
Desburkeus	subgen. nov.	Hoser 2012ah	*Tropidonophis*
Desmondburkeus	subgen. nov.	Hoser 2012ai	*Rhadinaea*
Dibaminae	subfam. nov.	Hoser 2012ar	Dibamidae
Dorisious	gen. nov.	Hoser 2012ac	*Boiga*
Downieea	subgen. nov.	Hoser 2012ac	*Dendrelaphis*
Dudleyserpens	subgen. nov.	Hoser 2012ai	*Rhadinaea*
Dugitophis	gen. nov.	Wells 2002e	*Pseudonaja*
Echiini	trib. nov.	Hoser 2012d	Viperidae, Crotalinae
Echiopsis curta martinekae	ssp. nov.	Hoser 2012ad	*Echiopsis curta*
Edwardstyphlops	gen. nov.	Hoser 2012as	*Typhlops*
Edwardsus	subgen. nov.	Hoser 2009d	*Crotalus*[3,4]
Eippertyphlopea	gen. nov.	Hoser 2012as	*Typhlops*
Eipperus	gen. nov.	Hoser 2012u	*Psammophis*
Eksteinus	gen. nov.	Hoser 2012z	*Lampropeltis*
Elapsoidini	trib. nov.	Hoser 2012e	Elapidae, Elapinae
Elfakhariscincus	gen. nov.	Hoser 2012aq	*Chalcides*
Elliottnatrix	gen. nov.	Hoser 2012ah	*Amphiesma*
Elliotttyphlopea	gen. nov.	Hoser 2012as	*Typhlops*
Elliottus	subgen. nov.	Hoser 2012u	*Psammophis*
Elseya dorriani	sp. nov.	Wells 2002b	*Myuchelys bellii*
Elseya jukesi	sp. nov.	Wells 2002b	*Elseya dentata*
Ephalophina	subtrib. nov.	Hoser 2012e	Elapidae, Hydrophiinae
Eristicophina	subtrib. nov.	Hoser 2012d	Viperidae, Viperinae
Euanedwardsserpens	gen. nov.	Hoser 2012p	*Coelognathus*
Evanwhittonus	gen. nov.	Hoser 2012as	*Rena*
Freudreedus	subgen. nov.	Hoser 2012ak	*Calamaria*
Freudtyphlops	gen. nov.	Hoser 2012as	*Typhlops*
Funkelapidus	gen. nov.	Hoser 2012n	*Sinomicrurus*
Funkikukri	gen. nov.	Hoser 2012ag	*Oligodon*
Funkityphlops	gen. nov.	Hoser 2012as	*Ramphotyphlops*
Funkus	gen. nov.	Hoser 2012h	*Nerodia*
Furinini	trib. nov.	Hoser 2012e	Elapidae, Hydrophiinae
Gaia	gen. nov.	Wells 2012	*Lerista*
Gavialini	trib. nov.	Hoser 2012an	Crocodylidae
Geddykukrius	subgen. nov.	Hoser 2012ag	*Oligodon*
Gerrhopilidini	trib. nov.	Hoser 2012as	Gerrhopilidae
Gerrhopilus carolinehoserae	sp. nov.	Hoser 2012as	*Gerrhopilus hedraeus*
Ginafabaserpenae	gen. nov.	Hoser 2012x	*Leptodeira*
Gleesontyphlops	gen. nov.	Hoser 2012as	*Letheobia*
Goldneyia	gen. nov.	Wells 2012	*Lerista*
Goldsteintyphlops	subgen. nov.	Hoser 2012as	*Typhlops*
Greernatrix	gen. nov.	Hoser 2012ah	*Amphiesma*
Gregshwedoshus	gen. nov.	Hoser 2012y	*Thamnophis*
Gryptotyphlopidini	trib. nov.	Hoser 2012as	*Letheobia*
Guystebbinsus	gen. nov.	Hoser 2012aa	*Natrix*
Harrigankukriae	subgen. nov.	Hoser 2012ag	*Oligodon*
Hawkeswoodus	subgen. nov.	Hoser 2012as	*Liotyphlops*
Helioscincus	gen. nov.	Wells 2002f	*Lampropholis*
Helminthophiini	trib. nov.	Hoser 2012as	Anomalepidae
Hemachatusina	subtrib. nov.	Hoser 2012e	Elapidae, Elapinae
Hemiaspini	trib. nov.	Hoser 2012e	Elapidae, Hydrophiinae
Homoroselapidae	fam. nov.	Hoser 2012e	*Homoroselaps*
Homoroselapiini	trib. nov.	Hoser 2012e	*Homoroselaps*
Hoplocephalina	subtrib. nov.	Hoser 2012e	Elapidae, Hydrophiinae

TABLE 1. Continued

Taxon	Taxon Level	Citation	Recommendation
Hoseraspea	gen. nov.	Hoser 2012l	*Atractaspis*
Hoseraspini	subtrib. nov.	Hoser 2012l	*Atractaspis*
Hoserea	gen. nov.	Hoser 2009d	*Crotalus*[3,4]
Hoserelapidea	gen. nov.	Hoser 2012f	*Micrurus*
Hoserelapidea	subgen. nov.	Hoser2012f	*Micrurus*
Hoserkukriae	gen. nov.	Hoser 2012ag	*Oligodon*
Hugheskukri	gen. nov.	Hoser 2012ag	*Oligodon*
Hulimkai	gen. nov.	Hoser 2012i	*Suta*
Hulimkini	trib. nov.	Hoser 2012e	Elapidae, Hydrophiinae
Hydrelapini	trib. nov.	Hoser 2012e	Elapidae, Hydrophiinae
Hydrophiina	subtrib. nov.	Hoser 2012e	Elapidae, Hydrophiinae
Jackyhoserea	gen. nov.	Hoser2012g	*Bothrops*
Jackyhoserina	subtrib. nov.	Hoser 2012d	Viperidae, Crotalinae
Jackyhoserini	trib. nov.	Hoser 2012d	Viperidae, Crotalinae
Jackyhosernatrix	gen. nov.	Hoser 2012aa	*Natrix*
Jackyindigoea	gen. nov.	Hoser 2012ao	*Laudakia*
Jackypython	subgen. nov.	Hoser 2009a	*Morelia*[2]
Jacobclarkus	subgen. nov.	Hoser 2012af	*Lycophidion*
Jockpaullus	subgen. nov.	Hoser 2012ai	*Rhadinaea*
Johnwilsontyphlops	gen. nov.	Hoser 2012as	*Ramphotyphlops*
Judywhybrowea	subgen. nov.	Hoser 2012as	*Typhlops*
Karimdaouesus	gen. nov.	Hoser 2012as	*Leptotyphlops*
Karma	gen. nov.	Wells 2009b	*Eulamprus*
Katrinahoserea	gen. nov.	Hoser 2012r	*Rhadinophis*
Katrinahoserserpenea	gen. nov.	Hoser 2012q	*Pareas*
Katrinahosertyphlopini	trib. nov.	Hoser 2012as	Typhlopidae
Katrinhosertyphlops	gen. nov.	Hoser 2012as	*Typhlops*
Katrinina	subtrib. nov.	Hoser 2012b	Pythonidae, Moreliini
Katrinus	gen. nov.	Hoser 2000a	*Liasis*[2]
Katrinus fuscus jackyae	ssp. nov.	Hoser 2004	*Liasis fuscus*[2]
Kirnerea	subgen. nov.	Hoser 2012ah	*Tropidonophis*
Kraussus	subgen. nov.	Hoser 2012as	*Liotyphlops*
Krishna	gen. nov.	Wells 2012	*Lerista*
Laidlawserpens	subgen. nov.	Hoser 2012aj	*Coniophanes*
Laidlawtyphlops	gen. nov.	Hoser 2012as	*Letheobia*
Laidlawus	subgen. nov.	Hoser 2012k	*Macrovipera*
Leiopython albertisi barkeri	ssp. nov.	Hoser 2000a	*Leiopython albertisii*[2,5]
Leiopython albertisi barkerorum	ssp. nov.	Hoser 2009a	*Leiopython albertisii*[2]
Leiopython albertisi bennetti	ssp. nov.	Hoser 2000a	*Leiopython benettorum*[2,5]
Leiopython hoserae	sp. nov.	Hoser 2000a	*Leiopython hoserae*[2,5]
Lenhosertyphlopini	trib. nov.	Hoser 2012as	*Typhlops*
Lenhosertyphlops	gen. nov.	Hoser 2012as	*Typhlops*
Lenhoserus	gen. nov.	Hoser 2000a	*Morelia*[2]
Leptotyphlopoidea	superfam. nov.	Hoser 2012as	Leptotyphlopidae
Leswilliamsus	gen. nov.	Hoser 2012ar	*Dibamus*
Libertadictiini	trib. nov.	Hoser 2012as	Typhlopidae
Lokisaurus	gen. nov.	Wells 2012	*Lerista*
Longinidis	subgen. nov.	Hoser 2012as	*Myriopholis*
Loveridgelapina	subtrib. nov.	Hoser 2012e	Elapidae, Hydrophiinae
Lukefabaserpens	gen. nov.	Hoser 2012x	*Leptodeira*
Maclachlanus	gen. nov.	Hoser 2012x	*Imantodes*
Macmillanus	subgen. nov.	Hoser 2012ac	*Dendrelaphis*
Maconchieus	gen. nov.	Hoser 2012x	*Imantodes*
Macphieus	subgen. nov.	Hoser 2012as	*Anomalepis*
Magmellia	gen. nov.	Wells 2009b	*Eulamprus*
Mariolisus	gen. nov.	Hoser 2012h	*Regina*
Marrunisauria	gen. nov.	Wells 2012	*Lerista*
Martinekea	gen. nov.	Hoser 2012m	*Orthriophis*
Martinwellstyphlopini	trib. nov.	Hoser 2012as	*Acutotyphlops*
Martinwellstyphlops	gen. nov.	Hoser 2012as	*Acutotyphlops*

TABLE 1. Continued

Taxon	Taxon Level	Citation	Recommendation
Maticorini	trib. nov.	Hoser 2012e	Elapidae, Elapinae
Matteoea	gen. nov.	Hoser 2009d	*Crotalus*[3,4]
Maxhoserboa	subgen. nov.	Hoser 2012w	*Eunectes*
Maxhoserini	trib. nov.	Hoser 2012as	*Ramphotyphlops*
Maxhoserus	gen. nov.	Hoser 2012as	*Ramphotyphlops*
Maxhoservipera	gen. nov.	Hoser 2012k	*Daboia*
Maxhoserviperina	subtrib. nov.	Hoser 2012d	Viperidae, Viperinae
Mecistopsini	trib. nov.	Hoser 2012an	Crocodylidae
Michaelnicholsus	subgen. nov.	Hoser 2012t	*Leioheterodon*
Micropechiina	subtrib. nov.	Hoser 2012e	Elapidae, Hydrophiinae
Micropechiini	trib. nov.	Hoser 2012e	Elapidae, Hydrophiinae
Morelia harrisoni	sp. nov.	Hoser 2000a	*Morelia spilota harrisoni*[2]
Morelia macburniei	sp. nov.	Hoser 2004	*Morelia spilota imbricata*[2]
Morelia mippughae	sp. nov.	Hoser 2004	*Morelia spilota*[2]
Morelia wellsi	sp. nov.	Hoser 2012b	*Morelia spilota*
Moreliina	subtrib. nov.	Hoser 2012b	Pythonidae, Moreliini
Moseselfakharikukri	gen. nov.	Hoser 2012ag	*Oligodon*
Mosestyphlops	subgen. nov.	Hoser 2012as	*Typhlops*
Mullinsus	subgen. nov.	Hoser 2009d	*Crotalus*[3,4]
Mulvanyus	gen. nov.	Hoser 2012ac	*Boiga*
Najina	subtrib. nov.	Hoser 2012e	Elapidae, Elapinae, Najini[6]
Ndurascincus	gen. nov.	Wells 2002f	*Lampropholis*
Neilsimpsonus	subgen. nov.	Hoser 2012x	*Imantodes*
Neilsonnemanus	subgen. nov.	Hoser 2012y	*Thamnophis*
Nindibamus	subgen. nov.	Hoser 2012ar	*Dibamus*
Ninkukri	gen. nov.	Hoser 2012ag	*Oligodon*
Nintyphlops	gen. nov.	Hoser 2012as	*Typhlops*
Notechiina	subtrib. nov.	Hoser 2012e	Elapidae, Hydrophiinae
Notopseudonaja	gen. nov.	Wells 2002e	*Pseudonaja*
Notopseudonajini	trib. nov.	Hoser 2012e	Elapidae, Hydrophiinae
Oceanius	gen. nov.	Wells 2007d	*Aipysurus*
Oopholis (*Philas*) *adelynhoserae*	sp. nov.	Hoser 2012an	*Crocodylus novaeguineae*
Oopholis (*Philas*) jackyhoserae	sp. nov.	Hoser 2012an	*Crocodylus johnsoni*
Ophiophagini	trib. nov.	Hoser 2012e	Elapidae, Elapinae
Ottobreus	subgen. nov.	Hoser 2012as	*Leptotyphlops*
Oxycrocodylus	gen. nov.	Hoser 2012an	*Crocodylus*
Oxykukrius	gen. nov.	Hoser 2012ag	*Oligodon*
Oxynatrix	gen. nov.	Hoser 2012ah	*Tropidonophis*
Oxynatrix	subgen. nov.	Hoser 2012ah	*Tropidonophis*
Oxyreedus	subgen. nov.	Hoser 2012ak	*Calamaria*
Oxytyphlops	gen. nov.	Hoser 2012as	*Ramphotyphlops*
Oxyuranini	trib. nov.	Hoser 2012e	Elapidae, Hydrophiinae
Oxyuranus scutellatus adelynhoserae	ssp. nov.	Hoser 2009c	*Oxyuranus scutellatus canni*
Oxyuranus scutellatus andrewwilsoni	ssp. nov.	Hoser 2009c	*Oxyuranus scutellatus scutellatus*
Oxyuranus scutellatus barringeri	ssp. nov.	Hoser 2002a	*Oxyuranus scutellatus scutellatus*
Oxyus	gen. nov.	Hoser 2012j	*Trimeresurus*
Pailsus rossignolii	sp. nov.	Hoser 2000b	*Pseudechis rossignolii*
Panacedechis papuanus trevorhawkeswoodi	ssp. nov.	Hoser 2009c	*Pseudechis papuanus*
Parahydrophina	subtrib. nov.	Hoser 2012e	Elapidae, Hydrophiinae
Parapistocalamini	trib. nov.	Hoser 2012e	Elapidae, Hydrophiinae
Paulwoolfinae	subfam. nov.	Hoser 2012ar	Dibamidae
Paulwoolfus	gen. nov.	Hoser 2012ar	*Dibamus*
Pelamiidae	fam. nov.	Wells 2007d	Elapidae, Hydrophiinae
Pelamiina	subtrib. nov.	Hoser 2012e	Elapidae, Hydrophiinae
Piersonina	subtrib. nov.	Hoser 2012d	Viperidae, Crotalinae
Piersontyphlops	gen. nov.	Hoser 2012as	*Ramphotyphlops*
Piersonus	gen. nov.	Hoser 2009d	*Crotalus*[3,4]
Pillotttyphlops	gen. nov.	Hoser 2012as	*Typhlops*
Pillotus	subgen. nov.	Hoser 2009d	*Crotalus*[3,4]
Placidaserpens	gen. nov.	Wells 2002e	*Pseudonaja*

TABLE 1. Continued

Taxon	Taxon Level	Citation	Recommendation
Plumridgeus	gen. nov.	Hoser 2012af	*Aparallactus*
Porthidiumina	subtrib. nov.	Hoser 2012d	Viperidae, Crotalinae
Proatherini	trib. nov.	Hoser 2012d	Viperidae, Viperinae
Pseudechini	trib. nov.	Hoser 2012e	Elapidae, Hydrophiinae
Pseudechis porphyriacus eipperi	ssp. nov.	Hoser 2003d	*Pseudechis porphyriacus*
Pseudechis porphyriacus rentoni	ssp. nov.	Hoser 2003d	*Pseudechis porphyriacus*
Pseudocerastina	subtrib. nov.	Hoser 2012d	Viperidae, Viperinae
Pseudocerastini	trib. nov.	Hoser 2012d	Viperidae, Viperinae
Pseudonaja affinis charlespiersoni	ssp. nov.	Hoser 2009c	*Pseudonaja affinis*
Pseudonaja elliotti	sp. nov.	Hoser 2003c	*Pseudonaja textilis*
Pseudonaja gowi	sp. nov.	Wells 2002e	*Pseudonaja aspidorhyncha*
Pseudonaja guttata whybrowi	ssp. nov.	Hoser 2009c	*Pseudonaja guttata*
Pseudonaja textilis cliveevatti	ssp. nov.	Hoser 2009c	*Pseudonaja textilis*
Pseudonaja textilis jackyhoserae	ssp. nov.	Hoser 2009c	*Pseudonaja textilis*
Pseudonaja textilis leswilliamsi	ssp. nov.	Hoser 2009c	*Pseudonaja textilis*
Pseudonaja textilis pughi	ssp. nov.	Hoser 2003a	*Pseudonaja textilis*
Pseudonaja textilis rollinsoni	ssp. nov.	Hoser 2009c	*Pseudonaja textilis*
Pseudonajini	trib. nov.	Hoser 2012e	Elapidae, Hydrophiinae
Pughus	subgen. nov.	Hoser 2012y	*Thamnophis*
Ramphotyplopini [sic]	trib. nov.	Hoser 2012as	*Ramphotyphlops*
Rattlewellsus	gen. nov.	Hoser 2012f	*Crotalus*
Rawlingspython	subgen. nov.	Hoser 2009a	*Antaresia*
Rayhammondus	subgen. nov.	Hoser 2012u	*Psammophis*
Rentontyphlops	gen. nov.	Hoser 2012as	*Typhlops*
Rentonus	gen. nov.	Hoser 2012ac	*Crotalus*
Rhiannodon	gen. nov.	Wells 2009b	*Glaphyromorphus*
Rhinocerophiina	subtrib. nov.	Hoser 2012d	Viperidae, Crotalinae
Richardwellsus	gen. nov.	Hoser 2012m	*Zamenis*
Robvalenticus	gen. nov.	Hoser 2012ai	*Rhadinaea*
Rolyburrellus	subgen. nov.	Hoser 2012as	*Typhlops*
Ronhoserini	trib. nov.	Hoser 2012as	Typhlopidae
Ronhoserus	gen. nov.	Hoser 2012as	*Typhlops*
Sammykukriae	subgen. nov.	Hoser 2012ag	*Oligodon*
Sayersus	subgen. nov.	Hoser 2009d	*Crotalus*[3,4]
Scanlonus	gen. nov.	Hoser 2012as	*Myriopholis*
Sharonhoserea	gen. nov.	Hoser 2012aa	*Coronella*
Shireenhoserus	gen. nov.	Hoser 2004	*Python*[2]
Simoselapini	trib. nov.	Hoser 2012e	Elapidae, Hydrophiinae
Sinoelaphe	gen. nov.	Hoser 2012ae	*Euprepiohis*
Slatteryus	subgen. nov.	Hoser 2012u	*Psammophis*
Smythkukri	gen. nov.	Hoser 2012ag	*Oligodon*
Smythserpens	subgen. nov.	Hoser 2012aj	*Coniophanes*
Smythtyphlopini	trib. nov.	Hoser 2012as	Typhlopidae
Smythtyphlops	gen. nov.	Hoser 2012as	*Letheobia*
Smythus	subgen. nov.	Hoser 2009d	*Crotalus*[3,4]
Spectrascincus	gen. nov.	Wells 2012	*Lerista*
Spracklandus	gen. nov.	Hoser 2009e	*Naja* (*Afronaja*)[3]
Stegonotus adelynhoserae	sp. nov.	Hoser 2012s	*Stegonotus diehli*
Stegonotus lenhoseri	sp. nov.	Hoser 2012s	*Stegonotus modestus*
Stegonotus sammacdowelli	sp. nov.	Hoser 2012s	*Stegonotus parvus*
Strophurus intermedius burrelli	ssp. nov.	Hoser 2005	*Strophurus intermedius*
Sundanatrix	subgen. nov.	Hoser 2012ah	*Amphiesma*
Sutini	trib. nov.	Hoser 2012e	Elapidae, Hydrophiinae
Swileserpens	gen. nov.	Hoser 2012t	*Buhoma*
Swileytyphlops	gen. nov.	Hoser 2012as	*Afrotyphlops*
Teesleptotyphlops	subgen. nov.	Hoser 2012as	*Leptotyphlops*
Toxicocalamina	subtrib. nov.	Hoser 2012e	Elapidae, Hydrophiinae
Trimeresurusini	trib. nov.	Hoser 2012d	Viperidae, Crotalinae
Trioanotyphlops	gen. nov.	Hoser 2012as	*Letheobia*
Troianous	subgen. nov.	Hoser 2012f	*Micrurus*

TABLE 1. Continued

Taxon	Taxon Level	Citation	Recommendation
Tropidechis sadlieri	sp. nov.	Hoser 2003b	*Tropidechis carinatus*
Tropidolaemusini	trib. nov.	Hoser 2012d	Viperidae, Crotalinae
Tropidonophis (*Alanbrygelus*) *alanbrygeli*	sp. nov.	Hoser 2012ah	*Tropidonophis elongatus*
Tropidonophis (*Alanbrygelus*) *alanbrygeli sammywatsonae*	ssp. nov.	Hoser 2012ah	*Tropidonophis elongatus*
Tropidonophis (*Alanbrygelus*) *smythi*	sp. nov.	Hoser 2012ah	*Tropidonophis elongatus*
Tropidonophis (*Desburkeus*) *dikkoriae desburkei*	ssp. nov.	Hoser 2012ah	*Tropidonophis doriae*
Tropidonophis multiscutellatus cottoni	ssp. nov.	Hoser 2012ah	*Tropidonophis multiscutellatus*
Tropidonophis novaeguineae trioani	ssp. nov.	Hoser 2012ah	*Tropidonophis novaeguineae*
Tropidonophis picturatus pillotti	ssp. nov.	Hoser 2012ah	*Tropidonophis picturatus*
Tychismia	gen. nov.	Wells 2012	*Lerista*
Typhlophisini	trib. nov.	Hoser 2012as	*Typhlophis*
Typhlopini	trib. nov.	Hoser 2012as	*Typhlops*
Unechis boschmai crutchfieldi	ssp. nov.	Hoser 2012ad	*Unechis boschmai*
Unechis durhami	sp. nov.	Hoser 2012ad	*Unechis nigrostriatus*
Vermicellini	trib. nov.	Hoser 2012e	Elapidae, Hydrophiinae
Wallisserpens	gen. nov.	Hoser 2012ai	*Rhadinaea*
Wellingtonnatrix	gen. nov.	Hoser 2012ah	*Amphiesma*
Wellsnatrix	gen. nov.	Hoser 2012ah	*Amphiesma*
Wellsus	gen. nov.	Hoser 2009e	*Naja* (*Uraeus*)[3]
Whittonserpens	gen. nov.	Hoser 2012aj	*Conophis*
Whybrowtyphlops	gen. nov.	Hoser 2012as	*Letheobia*
Whybrowtyplops [sic]	subgen. nov.	Hoser 2012as	*Letheobia*
Whybrowus	subgen. nov.	Hoser 2012y	*Thamnophis*
Wilsontyphlops	gen. nov.	Hoser 2012as	*Namibiana*
Wollumbinia	gen. nov.	Wells 2007a	*Myuchelys*
Wollumbinia dorsii	sp. nov.	Wells 2009a	*Myuchelys latisternum*
Wondjinia	gen. nov.	Wells 2012	*Lerista*
Woolftyphlops	gen. nov.	Hoser 2012as	*Typhlops*
Woolfvipera	subgen. nov.	Hoser 2012v	*Atheris*
Xenotyphlopidini	trib. nov.	Hoser 2012as	*Xenotyphlops*
Yeomansus	gen. nov.	Hoser 2012al	*Hierophis*
Zeusius	gen. nov.	Wells 2007b	*Cyclodomorphus*
Zeusius melanops gillami	ssp. nov.	Wells 2007b	*Cyclodomorphus m. melanops*
Zeusius melanops swani	ssp. nov.	Wells 2007b	*Cyclodomorphus m. elongatus*
Zeusius sternfeldi	sp. nov.	Wells 2007b	*Cyclodomorphus casuarinae*

[1] replacement for *Adrasteia* Wells 2002f
[2] Schleip and O'Shea (2010)
[3] Wallach et al. (2009)
[4] Wüster and Bérnils (2011)
[5] Schleip (2008)
[6] unjustified emendation of Najini Boulenger 1884
[7] preoccupied by *Coniophanes* Hallowell 1861

standards that we think should be met for acceptable taxonomic studies (and their taxonomic conclusions).

Raymond Hoser's Private Taxonomy.—Between January 2000 and September 2012, Raymond Hoser named two superfamilies, one family, three subfamilies, 89 tribes and subtribes, 113 genera, 64 subgenera, 25 species, and 53 subspecies of reptiles, including Old and New World snakes, geckos, skinks, and crocodiles (Table 1). These names constitute 76% of genera and subgenera and 16% of species and subspecies newly proposed for snakes over that time period (Uetz 2012). Hoser's invariably single-authored papers are characterized by a lack of scientific rigor and plagued by a variety of other problems, including: (1) naming of putatively allopatric populations without primary evidence, but listing the current distribution as the sole or primary distinguishing character (e.g., the diagnosis of *Oxyuranus scutellatus barringeri*—Hoser 2002a:47); (2) invention of evidence (e.g., body color of *Oxyuranus scutellatus adelynhoserae* Hoser 2009c, based on a holotype that is actually an isolated head: BMNH 1992.542); (3) repeated description of the same taxon as new (*Leiopython albertisi barkeri* Hoser 2000a = *L. a. barkerorum* Hoser 2009a = *L. a. barkerorum* Hoser 2012b; *Oxyuranus scutellatus barringeri* Hoser 2002a = *O. s. andrewwilsoni* Hoser 2009c); (4) descriptions of new species and subspecies based on morphological aberrations and vague differences in color pattern (e.g., *Acanthophis barnetti* Hoser 1998:24—diagnosed by the absence of raised supraoculars, which is merely an artifact of preservation [WW, pers. obs.], and "heavier dark pigmentation;" *Pseudonaja textilis cliveevatti* Hoser 2012i:38—diagnosed by stating that "each dorsal scale is darker brown tipped"); and (5) harvesting of clades from published phylogenetic studies for description as new genera or subgenera. For example, the division of *Natrix* into three monotypic genera (*Natrix*, *Jackyhosernatrix*, and *Guystebbinsus*) by Hoser (2012aa[1]) stems from the

[1] Due to the large number of works produced by Raymond Hoser in 2012 (N = 45), we continued the enumeration of citations by beginning the alphabet anew. Thus, in addition to Hoser (2012a–z), 19 additional references exist (Hoser 2012aa–as).

recognition of an unsupported branch in Pyron et al. (2011). Even though the use of patronyms in the naming of taxa is not a contravention of the *Code*, Hoser does not coin and assign names for the purpose of scientific need, taxonomic clarity, or improved characterization of biodiversity, but rather for personal reasons, as explained by the author in most of his etymology sections, as well as in several Internet blogs and social media environments. Hoser's genus and species names are all patronyms, and many include the author's surname (N = 43; Table 1) or the names of his relatives, employees, and even pets.

Without exception, Hoser's taxonomic decisions have been published in outlets with evaluation processes that, if they exist, are not designed to safeguard scientific rigor. Most recently, Hoser (2009a–e, 2012a–ac) has published in the *Australasian Journal of Herpetology* (*AJH*), a vehicle produced and mailed by Hoser himself, and primarily geared towards taxonomic articles of which he is the exclusive author and editor. Although the *AJH* masquerades as a scientific journal, it is perhaps better described as a printed "blog" because it lacks many of the hallmarks of formal scientific communication, and includes much irrelevant information (Ross et al. 2012). Examples of the latter include private email messages in their entirety, as well as polemics against taxonomic herpetologists (e.g., Hoser 2001:48–56; Hoser 2009a:3–21, 30; Hoser 2012a:1–34), taxonomic journals (*Zootaxa*; Hoser 2012a:15ff), wildlife officials (e.g., Hoser 2012f:12), and even judges in courts of law (e.g., Hoser 2012i:45). We maintain that *AJH* should not be considered a "public and permanent *scientific* record" and therefore fails a requirement of the *Code* (Art. 8.1.1; emphasis added) in both style and substance. The *AJH* is not a journal in the scientific sense. It is instead personally distributed by Hoser for unscientific purposes, and should therefore perhaps be best classified as advertising.

The Unscientific Taxonomic Contributions of Richard Wells.—The second case of taxonomic malpractice involves Richard Wells, who has a long history of producing scientifically controversial names, beginning with a near-wholesale alteration of the taxonomy of Australian amphibians and reptiles (Wells and Wellington 1983, 1985). Since 1 January 2000, Wells has described one family, 25 genera, seven species, and three subspecies of reptiles in a publication called *Australian Biodiversity Record*, which he alone edits and produces. Whereas some of the observations in these accounts relating to the natural history of particular taxa may qualify as scientific, the taxonomic decisions proposed by Wells (e.g., Wells 2000a–d) are without scientific merit. Like those published by Raymond Hoser, works by Wells follow the basic requirements of the *Code*, yet lack standard taxonomic data: new taxon names are supported by a diagnosis, but no justification is given for the necessity or authenticity of these names beyond the personal opinion of the author, which is often irreconcilable with published evidence (e.g., Wells 2007d). A failure to specify the material examined and a lack of comparisons with related specimens mean that the taxonomic decisions published by Wells are generally unsupported by well-established sources of evidence. This has resulted in the erection of genera based on characters with unsuitably high degrees of variation, as well as the naming of clinal variants as distinct species. In addition, type designations are often vague, precluding identification of the specimens upon which the names are based (e.g., "an adult specimen in the Australian Museum" in the case of both *Elseya jukesi* and *E. dorriani*; Wells 2002a:8). Furthermore, Wells is very active on blogs, where he has repeatedly threatened "taxonomic terrorism" should his proposals not be accepted by practicing taxonomists. In summary, while Hoser and Wells are undoubtedly knowledgeable about reptiles and could potentially make meaningful scientific contributions, both are instead producing unscientific herpetological taxonomy for apparently private purposes, based on vague descriptions, insufficient evidence, misrepresentations, and other forms of malpractice, which are defended aggressively by personal accusations and invective.

A Matter of Process.—Whereas taxonomy is considered to be a scientific endeavor, nomenclature is essentially a tool for taxonomists to stabilize the use of names corresponding to particular taxonomic findings and entities (*sensu* Mayr 1969; Simpson 1961). Nomenclature could be viewed as the language that scientists use to communicate about biological diversity, and effective communication requires the linguistic terms (in this case, taxon names) to be explicit, universal, and as stable as possible (de Queiroz and Gauthier 1994). The *Code* and the rulings of the ICZN safeguard and uphold the rules of nomenclature, but unfortunately these safeguards do not extend to the taxonomic processes by which names are established in the first place. There is currently no system in place by which the ICZN can prevent the establishment of nomenclature, and concomitant classification schemes, based on taxonomy produced by unscientific practices, including instances of "taxonomic vandalism" (Jäch 2007a,b). As ICZN commissioner Douglas Yanega expressed (Yanega 2009:423), "I think the present system by which we name species is not policed effectively and has loopholes and ambiguities. For example, scientific names can be published in journals without peer review. Although that freedom is fine, the reality effectively permits taxonomic vandals to plagiarize others or publish without scientific merit." This is an apt summary of the problems in taxonomic herpetology (and other disciplines) that are the primary focus of this article: instances where the *Code* protects names produced unscientifically, including those without sufficient evidence, justification, or privately published to bypass the peer-review process.

Best Scientific Practices for Publishing Taxonomic Decisions in Herpetology

The following guidelines, loosely modeled after those presented by the Turtle Taxonomy Working Group (2007), are a set of recommendations against which authors of taxonomic decisions in herpetology, editors of journals publishing such decisions, and anyone consulting such publications upon their release, may judge the merits of these taxonomic decisions and the methods by which they were reached. They are not intended to serve as the single binding set of rules for how taxonomic decisions should be reached, presented, and published in herpetology. However, from our point of view, taxonomic decisions that do not adhere to these best practices should be considered inadmissible to the body of scientific knowledge (and its applications).

Governance.—For any taxonomic decision that proposes a new taxon name or a change to an established one, the ultimate authority regarding nomenclature lies with the ICZN and its *Code*. To be acceptable, nomenclatural changes should be proposed not only in accordance with the requirements presented in the articles of the *Code*; they should also adhere to its spirit (as detailed in the *Introduction* to the *Code*) and its ethics (as detailed in the *Code of Ethics* of the *Code*). However, unless the ICZN formally votes on the conservation or suppression of taxon names, academic freedom governs their use and it is a judgment

call of authors, editors, and readers whether a proposed name should be applied. Thus, we uphold the long-standing tradition by which taxonomy will stabilize over time by use and acceptance or invalidation and rejection in the scientific literature.

Stability.—Whereas new species will be named and taxonomic changes will periodically be necessary to reflect improved information on inferred relationships between taxa, it is ideal if taxonomists maintain concordance with existing nomenclature, and thereby retain existing classifications, to the extent possible to preserve the stability of the established system. Preservation of nomenclatural stability is one of the primary objectives of the *Code*, and even though the *Code*'s articles currently do not set stringent constraints on the naming of taxa, the lack of such constraints must not be misconstrued as license to produce taxonomies according to the letter of the *Code* yet in violation of its spirit, as demonstrated by the examples of Hoser and Wells. Taxonomists should favor nomenclatural continuity unless new, strongly supported analyses make changes unavoidable.

Species.—The biological basis for classification lies with elucidating relationships of evolutionary lineages. Thus, underpinning the presentation of taxonomic decisions are data sets that credibly and reliably assert that the group to be named is on an independent evolutionary trajectory. Names of species should not be coined merely to recognize unusual patterns of distribution or even morphology, but to identify biologically cohesive populations with recent common ancestry, no matter their distribution. The burden of evidence is high in such cases.

Higher Taxa.—Taxonomic decisions regarding taxa above the species level require particular care and demand an even higher burden of evidence, because changes in the names of higher taxa can be especially confusing and destabilizing for users of taxon names and classifications. Names of higher taxa should ordinarily only be coined when data sets reliably identify a monophyletic group containing multiple terminal taxa, although not all such clades necessarily require formal recognition. In this regard, the naming of monotypic higher taxa should be avoided as far as possible, because minimal phylogenetic knowledge is conveyed by such arrangements. However, under some circumstances the establishment of monotypic higher taxa may be justified. For example, this may be the case when an existing generic definition cannot be applied to a sister species with highly divergent morphology, which would otherwise be included in the existing genus. In general, naming of monotypic higher taxa should be avoided and names must be based on the currently available evidence irrespective of hypotheses that the taxon could be expanded in the future.

Evidence.—Information gathering in science is a careful and deliberate process, and it requires the best effort possible to produce a transparent chain of evidence based on reproducible methods. Three lines of evidence are generally accepted for the proposal and testing of taxonomic hypotheses. First, novel evidence is obtained through field and laboratory work, involving samples (e.g., whole specimens, animal parts, tissue samples) from known phenotypes collected in nature, with precisely known provenance, and associated with the obligatory documentation. These samples are deposited in institutions where their long-term curation makes them accessible to other researchers for subsequent hypothesis testing (see Cotterill 1997 on the value of biological collections).

Second, evidence should be sourced from existing samples in museum collections or from published information (e.g., GenBank), both of which are ultimately obtained as described above. In the case of museum specimens (or specimens linked to published information) whose provenance is not precisely known, or whose phenotypic characteristics were not detailed well in life, scientists know to exercise due caution to judge the merits of the material they choose to incorporate into a study.

One or (typically) both of these lines of evidence should be required for taxonomic investigations. They act as a base for further research, so that later work does not have to begin the evidence-collection process *de novo*. For example, storage of sequence data in GenBank makes these data readily available online. If no records from publicly accessible genetic databases, backed by suitable voucher specimens, are listed in support of a taxonomic decision alleged to have been derived from DNA sequence data, then the decision should be rejected. In the case of morphological studies, a standard requirement is a list of specimens of a proposed taxon and a list of the comparative material examined, with their unique identifiers (i.e., source collections and catalog numbers); therefore, if these are not cited (Cifelli and Kielan-Jaworowska 2005:651) the proposed taxonomic arrangement should be rejected. In each case, the mandated citation of the evidence ensures reproducibility, which is one of the hallmarks of science (e.g., Popper 1972).

The third line of evidence is the existing scientific literature—the body of knowledge produced prior to a new research effort. Investigation of the literature on the taxonomic group of interest can provide direction and perhaps impose constraints on proposed taxonomic changes.

Taxonomic decisions proposed in the absence of compelling supporting evidence should be inadmissible in science and in applications of scientific knowledge. Likewise, equivocal or weakly supported nodes in phylogenetic trees should not be named. Furthermore, taxonomic decisions are ideally based on consilience of multiple data sets (e.g., morphological, morphometric, bioacoustic, behavioral, molecular). In the case of cryptic species that cannot be discriminated morphologically or behaviorally, support from molecular data (e.g., mtDNA, nucDNA, cytogenetics) is usually required. The burden of evidence rests on the author(s) of taxonomic decisions, and in each paper that contains such a decision the rationale must be explicit.

This discussion of evidence would be incomplete if we omitted the next logical next step scientists should ideally take once compelling evidence about taxonomic relationships becomes available. Unresolved taxonomic inconsistencies can cause confusion and uncertainty in the literature, which is undesirable for scientists in other disciplines who rely on taxonomists for clear guidance on issues of nomenclature and taxon definition. We therefore strongly recommend that authors who present data sets with clear taxonomic implications (e.g., well-resolved and well-supported molecular phylogenies, evidence for undescribed species) follow their evidence to its taxonomic conclusion and add suitable, formal taxonomic proposals to their discussion. Additionally, an 'orphaned' data set may invite such mischief as discussed above.

Publication.—We think that proposals of taxonomic decisions invariably require a quality control assessment (i.e., peer review) by a group of qualified taxonomic herpetologists (i.e., the editors and reviewers of a particular manuscript). Proposals should take the form of carefully prepared manuscripts that outline the evidence leading to a justified conclusion. Their assessment would typically constitute the editorial process of peer-reviewed journals, during which competent scientists prepare reviews of the work. Authors and print or Internet outlets

avoiding this process can readily be identified as working outside the acceptable rules of science and taxonomy.

It is our recommendation that taxonomic decisions and their concomitant nomenclatural changes are only acceptable when published in peer-reviewed scientific journals and after meeting the following criteria: (1) The investigation must follow an appropriate scientific methodology, which has to be presented in a section devoted to methods. (2) The investigation must provide a list of publically accessible specimens examined, including collection catalog numbers. (3) Publication occurs in a regularly published outlet for scientific research (i.e., not a popular science or trade magazine), available via subscription or accessible online. (4) The outlet must be supported by an editorial team (e.g., editor, associate editors) and supervised by an expert scientific panel (i.e., an editorial board), whose identities and professional affiliations are printed in each issue. (5) Ideally, the manuscript is reviewed by at least two individuals and an editor who, by their research and publication record, can objectively be considered experts in the field. (6) The publication is indexed in the *Zoological Record*, the *Science Citation Index*, or future equivalent databases. (7) If published electronically after 2011, the work must follow the parameters defined by the ICZN (2012). We further propose that the herpetological community, perhaps through the well-curated and easily accessible *Reptile Database* or *Amphibian Species of the World* and with oversight from the ICZN, electronically publish an annual list of outlets known to meet the standards above, through which acceptable taxonomic decisions can be published. New journals, or those not included in the initial listing, may follow the proposed criteria to establish a record of publishing scientifically rigorous taxonomic decisions and will be added to the list as warranted.

The Tricky Business of Working with the *Code*

Taxonomy is a unique area of science because it not only requires research (identification, description, and classification) but also bookkeeping (nomenclature). While the investigative activities are governed by the Scientific Method, bookkeeping is governed, to some extent, by the *Code*. This creates the potential for disharmony in an otherwise logical process; this disharmony is what taxonomic vandals exploit.

"*Coded*" *Challenges.*—The *Code* assists taxonomic scientists once their research is completed by providing rules for the proper administration of a name. It is here that the *Code*, grown from a scientific need, fails to adhere to the science it supports. For example, according to Article 13.1.1 of the *Code*, to become available a name must be "accompanied by a description or definition that states in words characters that are *purported to* differentiate the taxon" (ICZN 1999; emphasis added), regardless of the diagnostic utility of these characters or even their existence. Therefore, the inclusion of taxonomic characters in support of a taxonomic decision may, in practice, be viewed as only *pro forma*. Even as taxonomists endeavor to follow the evidence carefully (e.g., by listing the minutiae of species characteristics in descriptions; Mąkol and Gabryś 2005), such evidence is not required by the *Code*! Even though the gatekeepers of taxonomic science (i.e., the editors, reviewers, and users of taxonomy) may require evidence, the omission in the *Code* provides loopholes for the entrenchment of taxonomic vandals. Furthermore, the *Code*'s *Principle of Priority* (Article 23; ICZN 1999) is the dictum that governs the validity of taxon names, whether derived by proper scientific procedures or not. Consequently, taxonomy becomes prone to abuse by authors like Hoser and Wells.

The ICZN is well aware of the problem of taxonomic vandalism and the resulting destabilization of nomenclature, as exemplified above. Commissioners raise the topic regularly, and the Commission is considering how it can help promote nomenclatural stability in the face of such issues in a way that works within the limits of the *Code* and does not curtail academic freedom (E. Michel, ICZN Executive Secretary, in litt.). It is important to recognize that the purpose of the *Code* is to provide for both continuity and stability of scientific names. The *Code* "has one fundamental aim, which is to provide the maximum universality and continuity in the scientific names of animals compatible with the freedom of scientists to classify animals according to taxonomic judgments" (ICZN 1999: Introduction, line 2). Acceptance of unscientific publications, such as those discussed above, extends the freedom to name animals to people not acting as scientists, which violates the spirit of this "one fundamental aim." Although the ICZN has staunchly advocated and defended the *Principle of Priority* regarding taxonomy, exceptions exist for extraordinary circumstances: "The *Code* recognizes that the rigid application of the *Principle of Priority* may, in certain cases, upset a long-accepted name in its accustomed meaning through the validation of a little-known, or even long-forgotten, name. Therefore the rules must enable the *Principle of Priority* to be set aside on occasions when its application would be destructive of stability or universality, or would cause confusion." (Introduction, Principle 4; ICZN 1999). In the case of unscientific taxonomy, the *Principle of Priority* may be set aside due to lack of usage of a taxon name *in scientific publications*. Thus, boycotting the use of unscientific names proposed since 1 January 2000 and adhering to the recommendations we present (Table 1) will eventually permit the ICZN to rule against them, the *Principle of Priority* notwithstanding.

Items for Action

The Line in the Sand.—To defend herpetological taxonomy against unscientific incursions, we propose that the herpetological community, including authors, reviewers, editors, users of taxon names in applications, and other interested parties, set aside and *strictly avoid the use of the taxon names listed in Table 1*. These taxon names (proposed since 1 January 2000) can be objectively categorized as unscientific by the criteria we have presented. Users may follow the recommendations we present in Table 1 until the ICZN concludes its deliberations about countering the effects of taxonomic vandalism.

In practice, we suggest a two-tiered implementation of this proposal. Firstly, texts in which unscientific taxon names originate should only be cited in the scientific literature when a new taxon is being proposed to overwrite the unscientific name. Secondly, in circumstances where it is necessary to cite a text in which an unscientific name originated, authors should not use the unscientific name itself but should include a suitable explanatory statement, such as: "We follow the recommendations of Kaiser et al. (2013) and consider the name proposed by [author, year] for the taxon under investigation unscientific and unavailable."

The rationale for strict adherence to this recommendation is found in the *Code* itself. According to the *Code* (Article 23.9.1–3; ICZN 1999) it is desirable to avoid the use of names that threaten stability even when this reverses the *Principle of Priority*. This is one area of the existing *Code* where ICZN actions can favor the

establishment of names generated within a genuine scientific framework. The *Code* adopts a strict stand against names (including those that could be classed as unscientific) that have not been used in "at least 25 [scientific] works, published by at least 10 authors in the immediately preceding 50 years and encompassing a span of not less than 10 years" (Article 23.9.1.2; ICZN 1999); thus, authors following best practices could legitimately create names that, under strict application of the *Code*, would amount to junior synonyms of taxa named in an unscientific manner. Unscientific names should be boycotted and scientifically sound names should be used in their place; applications requesting the suppression of unscientific names could then be filed with the ICZN after 10 years have elapsed, and the Commission would then be able to enforce the *Code*. Whilst the date of 1 January 2000 as a "line in the sand" is arbitrary, we consider it a suitably clear juncture at which to begin the rigorous defense of taxonomic integrity in herpetology.

Best Practices.—We further propose that the best practices presented above be used as a basis for framing a practical standard for the taxonomic process in herpetology that can be amended and adopted by herpetological societies and the editorial boards of scientific journals.

ICZN Action Against Taxonomic Vandalism.—We applaud the discussions held by the ICZN on how best to curb taxonomic vandalism, and we encourage the Commission to proceed with all due speed in their deliberations. Time is of the essence, especially given the recent emergence of instances (described above) where individuals have flagrantly violated the spirit of the *Code* and have used taxonomic publications as a vehicle to defame and inflict professional harm on those working within ICZN guidelines.

Censure of Taxonomic Vandals.—We further espouse the idea that emerged at the Seventh World Congress of Herpetology, that herpetological societies pass motions of censure against Raymond T. Hoser and Richard W. Wells (and any other agents of similar grievous taxonomic malpractice that may emerge) for their unwarranted and deliberate destabilization of herpetological nomenclature in the absence of evidence and peer review. We apply the term censure in the sense of *Demeter's Manual of Parliamentary Procedure* (Demeter 1969), meaning that these societies express strong disapproval while allowing the opportunity for those censured to subsequently reform. As of this writing, the British Herpetological Society (BHS) and the Deutsche Gesellschaft für Herpetologie und Terrarienkunde (DGHT) have adopted resolutions to censure Hoser and Wells.

The ideas we present have received broad support from herpetological taxonomists and others with an interest in herpetology (see *Acknowledgments*), and the authors have received formal support from the American Society of Ichthyologists and Herpetologists (per email vote taken by the society's Executive Committee), the Australian Society of Herpetologists (per unanimous Annual General Meeting vote), the BHS (per unanimous Council Meeting vote), the Chinese Herpetological Society (per decision by the society's Standing Council), the DGHT (per Peter Buchert, President; Axel Kwet, Vice President; Jörn Köhler, Chief Editor of *Salamandra*), The Herpetologists' League (per Board of Trustees vote), the Societas Europaea Herpetologica (per decision by the society's Council: Claudia Corti, President; Uwe Fritz, Vice President; Anna Rita Di Cerbo, General Secretary; Wolfgang Böhme, Ordinary Member), the Society for Research on Amphibians and Reptiles in New Zealand (per unanimous Annual General Meeting vote), and the World Congress of Herpetology (per Executive Committee vote) to endorse the Point of View presented here. In addition, the Committee of the Herpetological Association of Africa has expressed its opposition to taxonomic vandalism and has endorsed ethically conducted, scientifically sound taxonomic practices similar to those presented in our Best Practices section. The Crocodile Specialist Group also supports our Point of View, specifically the call to avoid the use of taxon names produced by the type of "vanity publishing" perpetrated by Hoser and Wells (Ross et al. 2012).

Last, it is our hope that the model we present here to safeguard herpetological taxonomy (combining best taxonomic practices, ICZN support, self-policing by authors, reviewers, and editors, and society action) may emerge as a workable solution for other zoological disciplines facing similar challenges.

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Anecdote vs. Substantiated Fact: The Problem of Unverified Reports in the Toxinological and Herpetological Literature Describing Non-front-fanged Colubroid ("Colubrid") Snakebites

Non-front-fanged colubroid snakes (NFFC) comprise a diverse group of approximately 2,350 species. Some of these snakes were previously and inappropriately placed together in the family Colubridae. During the last 50 years, increasing attention has been given to the systematics of snakes in this artificial assemblage, and recent investigations have re-assigned a significant number of former colubrid taxa to other families or sub-families (e.g., Lawson et al. 2005; Pyron et al. 2011; Vidal et al. 2007, 2010; Wiens et al. 2008; Zaher et al. 2009). These snakes were previously termed "rear-fanged," "opisthoglyphous," or "aglyphous" "colubrids" in reference to their posterior or mid-maxillary dentition that may or may not have external grooves, but lacks an internal lumen or canal (McKinstry 1983; Weinstein and Kardong 1994; Weinstein et al. 2011).

Envenoming by five species of NFFC (three species of dispholidines and two natricine taxa; see ahead) have proved

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to be life threatening and/or fatal in humans, a clear warning that all NFFCs should be handled carefully, some if at all, and that bites should be avoided as much as possible. Among other NFFCs, there is no clear correlation between lethal potencies of venoms/Duvernoy's secretions and risk to humans. The venoms of the aforementioned five species have i.v. murine LD_{50} ranging between 0.05–0.50 mg/kg, while those of the relatively small number of other species studied to date range widely between 2.5–80 mg/kg (see Weinstein and Kardong 1994 and Weinstein et al. 2011, for tabular comparisons of representative NFFC venom/secretion LD_{50}). While these general observations suggest that many common smaller species of NFFC present little medical risk, such assessment must be cautious because of the limited available comprehensive data; some of these can produce significant local morbidity but the vast majority of NFFC have not been studied at all. The composition of NFFC venoms/Duvernoy's secretions is similar to that of venoms of viperids, elapids and *Atractaspis* spp. (Ching et al. 2006; Fry et al. 2003, 2008; Hill and Mackessy 2000; Mackessy 2002; Minton and Weinstein 1987; Peichoto et al. 2012 Weinstein and Smith 1993; Weinstein and Kardong 1994; Weldon and Mackessy 2010), and recent proteomic, genomic and transcriptomic investigations have further characterized or identified a rich array of biologically active constituents including multiple enzymes and isozymes (e.g., metalloproteases, phospholipases A_2, fibrinogenases, Factor X and prothrombin-activators, and others), cysteine-rich secretory proteins (CRISPs), myotoxins, and post-synaptic neurotoxins (Ching et al. 2006, 2012; Estrella et al. 2010; Fry et al. 2003, 2008; Peichoto et al. 2012; Weldon and Mackessy 2010). Although it is likely that some of these contribute to the effects (especially local pathology) observed after some medically significant NFFC bites, to date, the few well-characterized neurotoxins have not had any clear medical relevance as these have shown greater specificity for the motor-end plates of their natural saurian and/or avian prey species (e.g., Pawlak et al. 2006, 2009). Only a single NFFC species (the Montpellier Snake, *Malpolon monspessulanus*) has inflicted a well-documented neurotoxic envenoming. Although a relative handful of toxins present in the oral secretions/venoms and glands of NFFC have been well-characterized, the majority of NFFC produce oral products that have unknown properties and/or functions (Weinstein et al. 2011, 2012). A large number of NFFC species produce oral products that have been termed by some investigators, "Duvernoy's secretions," in reference to the low-pressure gland found in these snakes, although a number of authors call these glands "venom glands," on the basis of established phylogenetic relationships and/or the presence in their glands/oral secretions or tissues of toxins, or their transcripts/genes that are shared among front-fanged snakes, e.g., viperids, elapids, and atractaspidine lamprophiids. This definition notably departs from the traditional consensus that defined venoms by biological function (e.g., active use in acquisition of prey and/or self defense) in addition to toxinological and morphological criteria (Kardong 1996; Mebs 2002; Minton 1974; Russell 1980). Due to unknown or unverified functions of many of these, a relatively small number of these snakes meet the traditional biological criteria defining them as "venomous."

The controversies associated with these terms and the debate over the definition of the terms "venom" and "venomous," have been detailed elsewhere (Fry et al. 2012; Kardong 2012; Weinstein et al. 2011, 2012).

Snake Venoms and Toxic Oral Secretions: Medical Significance ≠ Biological Significance

The biological basis of the traditional perception of venom is commonly confused with medical significance in the popular, and occasionally, in the medical and even scientific literature. From this perspective, the medical effects of snake venoms are a circumstantial result of the interaction of humans with snakes that produce venoms, which coincidentally have a medically significant effect on a human victim. Venomous snakes evolved long before humans and thus their venoms are directed at increasing their likelihood of survival, their fitness, within their hostile and challenging environment, and not for the explicit purpose of being used against humans. Therefore, the medical effects of snake venoms and other ophidian oral products are evolutionarily irrelevant and should not be used as criteria to define snakes that are "venomous" and those that are not.

"Venom" or "Toxic Saliva"?

Although there has been strong interest in the toxic nature of "colubrid" (=NFFC) oral products since the early 19th century, detection or isolation of proteins/toxins commonly found in front-fanged snake venoms from some NFFC oral products ("Duvernoy's secretions," or "venoms") have been reported only since the late 1970s. Throughout the 20th century, there has been confusion regarding how and when to apply the term "venom," or "venomous," to various NFFC. As a specific example also discussed by McKinstry (1983), Cowles (1941) reported the effects of bites inflicted by the Spotted or Coast Nightsnake (*Hypsiglena ochrorhynchus*) on a variety of lizards, and noted that the effects ranged from slight discoloration to death. Goodman (1953) reported delayed (about 2 h) death of a Sagebrush Lizard (*Sceloporus graciosus*) after being "chewed on" by a *Hypsiglena* sp. However, Dundee (1950) reported that a Texas Nightsnake (*H. torquata texana* [*H. ochrorhynchus texana* sensu Mulcahy 2008]) briefly seized a "worm" (blind) snake (*Leptotyphlops* [*Rena* Baird and Girard 1853] sp.) without any observed effect. Therefore, some authors subsequently described *Hypsiglena* spp. variously as "venomous," "non-venomous," "mildly venomous," or, with "saliva" of a "toxic" or "venomous nature." There are similarly inconsistent descriptions in the literature of a significant number of common NFFC. Some trained observers have reported unambiguous use of NFFC oral products that clearly is consistent with the traditional consensus definition of "venom" in that these were actively used in order to subdue prey. Some of these include: the Boomslang (*Dispholidus typus*), African twig, bird or vine snakes (*Thelotornis* spp.), the Tiger Keelback (*Rhabdophis tigrinus*) and Red-necked Keelback (*R. subminiatus*), Green Vine Snake (*Oxybelis fulgidus*), the Ringneck Snake (*Diadophis punctatus*), the Puerto Rican Racer (*Alsophis portoricensis* [*Borikenophis portoricensis* sensu Hedges et al. 2009]) and the Mangrove Snake (*Boiga dendrophila*) (see Weinstein et al. 2011, for a review of these reports). However, there are other species for which to date there is no well-documented evidence of the active, consistent use of oral products in prey capture and/or self-defense, regardless of their experimental toxicity and demonstrated content of toxins common in snake venoms. Some of these species include garter and ribbon snakes (*Thamnophis* spp.), hognose snakes (*Heterodon* spp.), and False Water Cobras (*Hydrodynastes gigas*). As noted previously, there are a very large number of NFFC taxa (in fact, the majority of the approximately

2,350 species) that have oral products with unknown properties and function.

The Problems with Published NFFC Bite Cases and Accurate Risk Assessment

Several NFFC have repeatedly inflicted serious, life-threatening and/or fatal envenomings on humans (e.g., the natricines *R. tigrinus*, *R. subminiatus*, and the dispholidines *D. typus*, *Thelotornis kirtlandii*, *T. capensis*). However, the medical significance of the majority of NFFC taxa is unknown, and a recent comprehensive analysis of this question emphasized the paucity of well-documented medically significant bites, or "envenomings," inflicted by NFFC in the literature (Weinstein et al. 2011). Most of the published bite cases ascribed to NFFC lack sufficient documentation, rely on anecdotal information, and/or are authored/analyzed by non-medically qualified contributors. In many cases, auto-reporting by the victim him/herself introduces confusion because of the inclusion of purely subjective symptoms that are related to anxiety rather than envenoming. Certainly, there are also a number of common NFFC (e.g., Western Hognose Snake, *Heterodon nasicus*) that have inflicted bites that cause mild-moderate local effects, while the bites of other NFFC species (e.g., Lichtenstein's Racer, *Philodryas olfersii* and *M. monspessulanus*) rarely may cause systemic effects. Some previous authors have speculated about the possible medical importance of NFFC taxa that are popular in the commercial snake trade. As a result of these uncertainties, a number of taxa have acquired an unwarranted or premature reputation for inflicting dangerous bites. Many NFFC are popular in private collections, and since many species may have oral products/venoms worthy of biomedical investigation, it is important to establish standards for formally documenting any clinical case report describing their bites. These standards should be as rigorous as for any medical case study, whether it is for example complications of Dressler's syndrome or necrotizing epidermolysis associated with a new drug. These details should include formal identification of the specimen that inflicted the bite and clinical information, including results of thorough, repeated physical examination including formal testing for crucial signs and laboratory investigations. Unusual clinical signs should be documented photographically, a task facilitated by the widespread availability of mobile phone cameras. Anecdotal and circumstantial information must be identified as such and cannot be used to reach any conclusion about true medical risks, or the lack thereof, associated with the species of interest.

Speculation about the possible medical hazards posed by some NFFC has intermittently appeared in field guides, or regional herpetological accounts. Some of these include personal observations of mixed quality, while others include unverified descriptions of local effects of bites, as well as objectively unsupported reports of more serious systemic sequelae. For instance, Kudryavtsev and Mamet (1998) anecdotally described the mild local effects (mild pain, edema, lymphadenitis) of *Psammophis* spp. (sand snakes or racers) bites, and their description was concordant with other similar accounts (Weinstein et al. 2011). However, they also reported "extremely rare" progressive edema, nausea, "difficulties in breathing and moving," as well as ptosis (Kudryavtsev and Mamet 1998). Many casual readers often focus on the unverified and unqualified serious symptoms and signs and thus may uncritically perceive the species of interest as far more medically hazardous than the preponderance of evidence suggests. This also emphasizes the need for careful review of sufficient evidence regarding the hazard associated with any NFFC species prior to the assignment of relative medical risk. Also, medical hazard of any NFFC species cannot be accurately assessed solely on the presence of toxins in their oral secretions/venoms. However, this should not be interpreted to imply that bites from all NFFC without documented, clearly medically significant effects are without any possible medical concern, or that these snakes are necessarily "harmless." Aside from the species that are clearly capable of inflicting fatal bites, the bites of some taxa can cause systemic effects and/or significant local pathology that in some cases may resemble mild-moderate crotaline envenoming (Weinstein and Keyler 2009; Weinstein et al. 2011).

Several taxa of NFFC whose reputation for being particularly dangerous is based purely on anecdotal information (sometimes second- or third-hand) are outlined in Table 1. Bites by some of these species are alleged to have proved fatal to humans. We argue that this is not only inaccurate and misleading, but also poses possibly serious repercussions. Confused identification between some NFFC and medically important species of front-fanged snakes may occur due to their shared local vernacular names (e.g., cobra cipó [vine snake] or cobra verde [green snake] used in Brazil for several species of crotaline viperids, as well as for *P. olfersii*; see Fig. 1), as well as similar appearance of pattern (e.g., between *Xenodon severus* and *Bothrops brazili* and between several species of false coral snakes [e.g., *Erythrolamprus* spp., *Pliocercus* spp., and others] and coral snakes [*Micrurus* spp.]; see Fig. 1). Attention should also be given to common English names used for multiple species that may present confusion between NFFC species popular in the commercial trade and some species with significant medical hazard. For example, several species commonly called "vine snakes" include taxa that on occasion have inflicted bites with mild, and rarely, moderate local effects (e.g., *Oxybelis* spp.; *Ahaetulla* spp. [also known as whip snakes]), and others that have caused fatal envenoming (*Thelotornis* spp., also known as twig or bird snakes).

Several concerns emerge from these considerations:

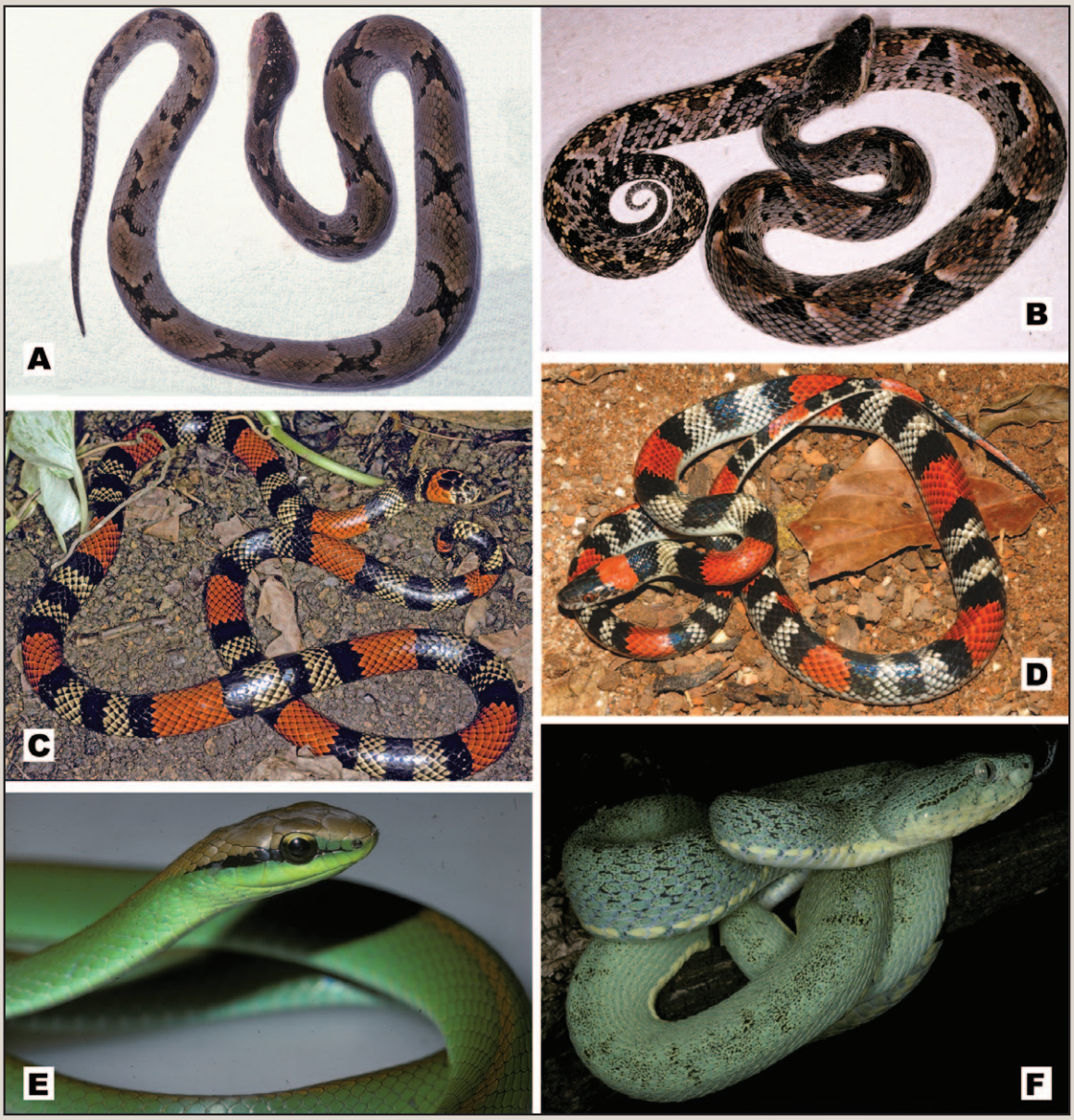
- Some medical facilities located in regions where snake bite is a serious public health problem do not carefully distinguish the implications of local effects from bites by venomous vs. non-venomous snakes, and this can lead to inappropriate and dangerous unnecessary treatments (see Weinstein et al. 2011, for a review of some of these cases). For instance, patients presenting to some medical facilities in Brazil and South East Asia may be given antivenom for NFFC bites for which no specific antivenom exists and for which there is no clinical need. Thus, the patient is subjected to substantial risk (the possible adverse side effects of antivenom, including anaphylaxis which can be lethal, and serum sickness that can cause long-term disability) without any clinical basis or benefit. Thus, the accurate identification of hazard, whether termed "venom", or "toxic secretion" is of paramount importance to the bitten victim, and is not simply an academic exercise. The only effective antivenoms against venoms of NFFC are prepared against *D. typus* venom (South African Institute of Medical Research [SAIMR; now, South African Vaccine Producers, SAVP] boomslang antivenom, Johannesburg, South Africa) and that of *R. tigrinus* (anti-Yamakagashi antivenom, Japan Snake Institute, Gunma Prefecture, Japan) because these taxa have inflicted a number of well-documented fatal and life-threatening envenomings. Also, anti-*R. tigrinus* antivenom probably provides paraspecific

Table 1. Representative anecdotal cases of non-front-fanged colubroid snake (NFFC) bites suggesting fatal outcomes without supporting evidence.

Species, Family, Sub-family [1] [common names]	Features of cases	Nature of documentation	Remarks	Relevant references
Oligodon arnensis, Colubridae, Colubrinae [common, banded or russet kukri snake]	Third-hand account of sudden death of a young man attributed to a kukri snake sighted near the victim.	No established linkage between the presence of the snake and the death of the victim. There is no biomedical or clinical evidence that supports any hazard *Oligodon* spp.	An anecdotal case reported in a classical herpetological contribution. The medically qualified herpetologist author recorded his doubts about any linkage between the *Oligodon* and the reportedly fatal outcome.	Wall 1921; Weinstein et al. 2011
Philodryas olfersii, Colubridae, Dipsadinae[Lichtenstein's green racer; South American green racer; cobra cipó; cobra verde]	A purported "fatal" pediatric case often repeated in the literature.	Reported 4 years after alleged bite. Purely anecdotal, without any clinical documentation or supporting information.	Commonly cited as an excerpt, this rare "newsletter"-style publication of a little-known institution contains no supporting information about the alleged incident and is almost wholly a general public health warning of the dangers of snakebites in pediatric patients.	Centro de Informações Toxicológicas do Rio Grande do Sul 1996; Weinstein et al. 2011
Tachymenis peruviana, Colubridae, Dipsadinae [Peruvian slender snake]	There is no human bite recorded in the cited literature. The publication soley describes effects in experimental animals.	Contains no clinical information as the cited reference only involves effects of oral secretions on experimental animals.	Report contains no information about human bites.	Vellard 1955; Weinstein et al. 2011
Xenodon severus, Colubridae, Dipsadinae [mock viper; false fer-de-lance; yana yuta]	Third-hand anecdotal inference of fatal pediatric case.	There is no verified identity of the alleged snake involved in an unverified fatal case. The alleged snake is identified only by local jargon: "yana yuta."	Purely anecdotal report lacking any specific information or clinical detail. Identity of the snake is unknown and most parsimoniously is a misidentification of a crotaline viperid (see text Fig. 1).	Orcés 1948

[1]The taxonomy of NFFC is fluid and under active revision by several investigating teams. The taxonomy here follows that of Pyron et al. 2011.

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FIG. 1. Some representative examples of confused identification between non-front-fanged colubroid (NFFC) and front-fanged snakes. Panels A and B demonstrate the similar appearance between a NFFC species, *Xenodon severus* (Panel A; mock viper or false fer-de-lance; yana yuta), and a pit viper, *Bothrops brazili* (Panel B; Brazil's Lancehead). Note the closely similar general dorsal patterns. Panels C and D also compare the appearance of a medically important elapid species, *Micrurus frontalis* (Panel C; Southern or Short-tailed Coralsnake; boipinima; coral venenosa), and that of a NFFC coral snake mimic, *Oxyrhopus trigeminus* (Panel D; False Coral Snake; boicora). The color and arrangement of bands are commonly confused. Panels E and F illustrate two medically important Brazilian snakes, Lichtenstein's Green Racer (*Philodryas olfersii*) and the green jararaca or Two-lined Tree Viper (*Bothriopsis* [*Bothrops bilineatus smaragdinus* sensu Monzel and Wüster 2008] *bilineata smaragdina*, Whithworth and Beirne 2011). The NFFC, *P. olfersii*, has recently been identified as a medically important species in Brazil. However, the vast majority of cases feature mild to moderate local effects, and only one well-documented systemic case involving widespread ecchymoses has been described. To date, there are no verified fatalities associated with bites from this species. However, envenoming by *B. bilineata* has resulted in occasional fatalities. These species can be called by the same vernacular names, e.g., cobra cipó, or cobra verde (and many others). Therefore, some species of NFFC and crotaline viperids may be confused in anecdotal accounts without voucher specimens because they are interchangeably named with the identical vernacular term. It is probable that some popularized anecdotal reports of fatalities attributed to some NFFC were based on bites inflicted by highly venomous viperids or elapids that were identified by using a regional name for the envenoming species that was shared among several non-venomous and venomous snakes.

PANEL A. *Xenodon severus*, DOR (dead on road), Porto Velho, Brazil.

PANEL B. *Bothrops brazili*, Tenampa de Pastaza, Ecuador.

PANEL C. *Micrurus frontalis*, Museu do Instituto Butantan, São Paulo, Brazil.

PANEL D. *Oxyrhopus trigeminus*, North-eastern Brazil.

PANEL E. *Philodryas olfersii*, Brazil.

PANEL F. *Bothriopsis bilineata smaragdina*, Fundación Herpetológica Gustavo Orcés, Napo, Ecuador.

protection against envenoming by *R. subminiatus*, although, to date, the handful of serious envenomings from this species have been managed without antivenom.
- Propagation in the literature of incorrect information about the medical risks of some NFFC requires correction. This is a difficult task as incorrect published material that is repeatedly cited can be hard to undo, particularly in the Internet age with its concomitantly wide distribution of/access to such information.
- Incorrectly associating fatalities (especially of children) with a given species of snake may lead to threats to natural populations of the species and excessive statutory regulation of the taxon.

There is a need for timely recognition of this problem as incorrect information regarding some of these snakes continues to be propagated in the toxinological and herpetological literature, as well as in Internet fora. As a current example, a recent paper incorrectly ascribed coagulopathy and "internal bleeding" to bites from *Philodryas olfersii* (Collaço et al. 2012). Analysis of the well-documented literature reveals only one verified case of systemic envenoming by *P. olfersii*, and that case featured only extensive ecchymoses distant from the bite site (Warrell 2004; Weinstein et al. 2011). There have been no well-documented cases of *P. olfersii* bites that have shown verified coagulopathy or "internal bleeding," although some authors (e.g., Collaço et al. 2012) may have misinterpreted ecchymoses as the clinical equivalent to "internal bleeding," a term that implies visceral hemorrhage. The extent of medical hazards associated with clinically significant *P. olfersii* bites remains unclear, and careful qualified contribution and analysis of additional cases may eventually illuminate this, but objectively unsupported anecdote should not be propagated in the literature. Also, Collaço et al. (2012) state that "...most cases of systemic envenoming have been treated with bothropic antivenom that neutralizes the toxic effects but has little effect on the local tissue damage." This is incorrect as the only information regarding "neutralization of toxic effects" of *P. olfersii* venom/Duvernoy's secretion by anti-bothropic antivenom/antibodies is primarily derived from *in vitro* studies (e.g., Assakura et al. 1992). Medically significant bites from *P. olfersii* and *P. patagoniensis* are among the few by NFFC that have received some formal study either through prospective, retrospective, or epidemiological review and critical analysis (de Madeiros et al. 2010; Ribeiro et al. 1999). None of these studies has supported the use of anti-bothropic antivenom for treatment of *P. olfersii* bites, the vast majority of which are limited to mild-moderate local effects, and the rare more serious sequelae require greater documentation in order to characterize the possible clinical outcomes from the more significant bites by this species. As stated previously, the notably unfavorable risk: benefit profile of using antivenom of unproven efficacy for any bites inflicted by this species cannot be clinically justified.

Conclusions

In conclusion, whenever possible, several essential features must be part of formal reports describing medically significant bites by NFFC:
- A physician must have reviewed anyone receiving a medically significant bite from a NFFC, and the salient results of the physical examination, investigations, etc., included in the report.
- Whenever possible, the NFFC responsible for the bite should be formally identified by an academic herpetologist or qualified clinical toxinologist, and, ideally, the specimen should be photographed and provided to a museum collection with an assigned accession number.
- Investigators must be wary of regionally used common names applied to unavailable specimens involved in any medically significant snake bite, as these may be used for snakes of similar appearance, whether they be NFFC, or medically important crotaline viperids or elapids.
- A clinically detailed case report should be carefully prepared and submitted to an appropriately refereed journal. The referees should primarily be physicians, ideally with herpetological and/or toxinological training. The victim should not be the senior author, even if he/she is medically qualified. Even though cases describing minimal medical effects are likely to be difficult to publish, as editors of clinical journals may not comprehend their importance, an effort to formally document them should be made. Such cases are important as they help establish/build an accurate risk profile for otherwise undocumented/unverified NFFC. Thus, the documented absence of medically significant effects can be as important as the recording of their presence.
- Anecdote and/or unverifiable information should be avoided, and must not be included in the case report without clear qualification.
- Obscure literature describing an unusual or particularly serious effect of a bite from any NFFC must be checked first-hand, and never cited without careful review (and qualified translation if necessary) of the original publication.
- Field guides describing and illustrating NFFC species that either have an established medically significant risk profile or lack well-documented clinical information describing/analysing their bites, should recommend caution and strongly discourage careless handling of these snakes. It must be emphasized that unverified or unestablished medical risk does not imply a lack of hazard (unverified ≠ harmless!). A physician should promptly review those receiving a NFFC bite that produces significant local effects or distressing signs/symptoms.

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Population Genetic Structure and Revised Geographic Range for the Tridactyl Skink (*Brachymeles muntingkamay*) from Luzon Island, Philippines

The genus *Brachymeles* represents a unique radiation of semi-fossorial (burrowing) lizards, all but two of which are endemic to the Philippines in Southeast Asia (Siler et al. 2011a, 2012b). Although all species can be described as slender, brown, and small- to medium-sized, this radiation represents one of the best systems for studying the evolution of limb reduction and loss; body forms within the genus range from pentadactyl to externally limbless (Siler and Brown 2011). Over the last decade, a renewed effort at understanding evolutionary patterns within *Brachymeles* has resulted in the discovery of 21 new species previously unknown to science or masquerading within the range of a previously recognized, widespread, and morphologically diverse species (Siler 2010; Siler and Brown 2010, 2011; Siler et al. 2009, 2010a,b, 2011a,b,c,d, 2012a,b). Although the dense survey efforts leading to these discoveries have filled in many gaps in our understanding of this radiation, there still remain species with unique body plans that are poorly represented in collections and are far less understood (Siler 2010; Siler et al. 2011c,d, 2012a).

Many of the species representing unique digit classes within the genus are micro-endemics, with recognized ranges currently limited to single sites. Among these taxa, several low-elevation species have persisted despite nearly complete deforestation across their limited ranges on Mindanao and Cebu islands (*B. cebuensis*, *B. pathfinderi*); until rediscovered in 2009, *B. pathfinderi* had not been observed for more than 80 years (Siler et al. 2011c). Other taxa include several mid-to-high elevation species (*B. elerae*, *B. muntingkamay*, *B. wrighti*), with *B. elerae* and *B. wrighti* long represented in museum collections by only a few specimens (Siler et al. 2011d). All three of these species occur in the mountainous terrain of northern Luzon Island in the Philippines. Interestingly, all micro-endemic taxa are non-pentadactyl, with finger counts ranging from 3–5 and toe counts ranging from 2–4.

Brachymeles muntingkamay Siler, Rico, Duya, and Brown, 2009 is one of 36 recognized lizard species of *Brachymeles*, and is one of only four species known to possess three digits on the fore- and hind limbs. This unique species was discovered only recently in mid- to high-elevation forest on Mt. Palali in the northern portions of Luzon Island, and has since been presumed to be endemic to this single, isolated mountain peak in the Caraballo Mountain Range of central Luzon. During a recent survey around the caldera of Mt. Cagua in the extreme northeastern portion of Luzon Island, a second montane population of this species was discovered.

From 7–23 July 2011, seven adults and one juvenile of *Brachymeles muntingkamay* were collected during herpetological field surveys in mid- to high-elevation forest on Mt. Cagua, in extreme northeast Luzon Island, Philippines (Fig. 1). Here we report on this newly discovered population of *B. muntingkamay* from Mt. Cagua, located in the northern extreme of the Sierra Madre Mountain Range. The new population is not only geographically disjunct from the type locality of *B. muntingkamay*, but is located in a completely disparate mountain range on the island. With this new discovery, we present data on the genetic identity and structure between the two geographically disjunct populations, provide new photographic and morphological data for the species, revise the known geographic range of *B. muntingkamay*, and discuss the implications of this discovery for future research involving other unique (and possibly rare) mid- to high-elevation vertebrate species in the Philippines.

Materials and Methods.—Field survey protocols follow Brown et al. (1996, 2000), Diesmos et al. (2005), Siler et al. (2011e), and McLeod et al. (2011). Vouchered specimens collected in the field were deposited in the University of Kansas Natural History Museum (KU) herpetological collections and the National Museum of the Philippines (PNM). We examined fluid-preserved specimens for variation in qualitative and mensural characters. Sex was determined by gonadal inspection, and measurements were taken to the nearest 0.1 mm with digital calipers by CDS. X-rays were taken with a company cabinet X-ray on Kodak MIN-R 2000 film exposed at 5 milliamperes and 30 volts for 1 minute 15 seconds. Meristic and mensural characters were chosen based on Siler et al. (2009): snout–vent length, total length, tail length, paravertebral scale-row count, supralabial count, infralabial count, supraciliary count, and supraocular count. Additionally, we counted the number of presacral vertebrae from x-ray images of specimens. A summary of representative diagnostic characters highlighting the minor variation observed between mountain populations is provided in Table 1.

Genetic samples of *B. muntingkamay* from the recently surveyed site in the Municipality of Gonzaga were used to investigate the northeastern population's identity, as well as its genetic similarity with the type populations of topotypic *B. muntingkamay* from Mt. Palali, central Luzon (Fig. 1). The dataset included newly collected sequences of the mitochondrial gene NADH dehydrogenase subunit 2 (*ND2*), supplemented by published *ND2* sequence data from *B. elerae* and *B. boulengeri* for use as outgroup samples (Siler et al. 2011a). We follow the methods described in Siler et al. (2012c) for calculating haplotype networks. All Mt. Cagua specimens were initially identified on the basis of body and head scalation patterns (Siler et al. 2009).

The newly collected *B. muntingkamay* specimens include: KU 330086, 330087, 330089–93, seven adult females; KU 330088,

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juvenile. All specimens were collected on Mt. Cagua, Barangay Magrafil, Municipality of Gonzaga, Cagayan Province, Luzon Island, Philippines (18.22538°N, 122.11445°E; 694 m elev.; WGS 84; Fig. 1). Voucher information corresponding to data from novel sequences deposited in GenBank, and haplotype labels corresponding to those shown in Figure 1, are included in Table 2.

Results and Discussion.—The haplotype network reveals some degree of haplotype diversity within and between the two sampled populations of *Brachymeles muntingkamay* (Fig. 1). Both populations are recovered as genetically distinct, albeit with low genetic divergence observed between the two allopatric populations (uncorrected pairwise sequence divergence 1.2–1.4%; Fig. 1). Intraspecific genetic structure within both sampled populations appears similar based on the few individuals sampled for this study.

Meristic and mensural characters of the newly discovered population are consistent with the recognized diagnostic characters for *Brachymeles muntingkamay* (Table 1). Character variation observed between the Mt. Palali and Mt. Cagua populations includes (Table 1): 1) presacral vertebrae 42 at Mt. Cagua (versus 42 or 44 at Mt. Palali); 2) supraciliaries 6 at Mt. Cagua (versus 6 or 7 at Mt. Palali); 3) supraoculars 5 at Mt. Cagua (versus 5 or 6 at Mt. Palali); and 4) prefrontals separated at Mt. Cagua (versus in medial contact at Mt. Palali). All other diagnostic characters for *B. muntingkamay* (Siler et al. 2009) were observed to be consistent (CDS, pers. obs.).

TABLE 1. Summary of representative meristic and mensural characters among adult specimens from the two disjunct populations of *Brachymeles muntingkamay*. Sample size, body length, and tail length are included for reference (snout–vent length, total length given as range over mean ± standard deviation).

	Mt. Palali	Mt. Cagua
Sample size	12 female	7 female
Number of digits (fore/hind)	3/3	3/3
Snout–vent length	61.8–81.3	61.8–81.3
	(73.6 ± 5.9)	(73.6 ± 5.9)
Total length	107.4–136.0	109.7–116.4
	(124.0 ± 8.6)	(113.3 ± 2.9)
Tail length/snout–vent length	50–79	53–85
	(65 ± 10)	(64 ± 14)
Presacral vertebrae number	42, 44	42
Paravertebral scale-row count	85–90	87–88
Supralabial count	6 (12)	6 (7)
Infralabial count	6 (12)	6 (7)
Supraciliary count	6 (10)	6 (7)
	7 (2)	
Supraocular count	5 (11)	5 (7)
	6 (1)	
Prefrontal contact	Present	Absent

TABLE 2. Summary of specimens corresponding to genetic samples included in the study. Haplotype identification numbers (ID) correspond to those shown in Figure 1. KU = University of Kansas Natural History Museum.

Voucher	Locality	Haplotype ID	Genbank Accession Numbers (ND2)
KU 330086	Mt. Cagua, Barangay Magrafil, Municipality of Gonzaga, Cagayan Province, Luzon Island, Philippines	5	JX966377
KU 330087	Mt. Cagua, Barangay Magrafil, Municipality of Gonzaga, Cagayan Province, Luzon Island, Philippines	4	JX966378
KU 330088	Mt. Cagua, Barangay Magrafil, Municipality of Gonzaga, Cagayan Province, Luzon Island, Philippines	5	JX966375
KU 330089	Mt. Cagua, Barangay Magrafil, Municipality of Gonzaga, Cagayan Province, Luzon Island, Philippines	5	JX966376
KU 330090	Mt. Cagua, Barangay Magrafil, Municipality of Gonzaga, Cagayan Province, Luzon Island, Philippines	5	JX966373
KU 330092	Mt. Cagua, Barangay Magrafil, Municipality of Gonzaga, Cagayan Province, Luzon Island, Philippines	5	JX966374
KU 308813	Mt. Palali, Barangay Maddiangat, Municipality of Quezon, Nueva Vizcaya Province, Luzon Island, Philippines	3	HQ907478
KU 308865	Mt. Palali, Barangay Maddiangat, Municipality of Quezon, Nueva Vizcaya Province, Luzon Island, Philippines	2	JX966372
KU 308866	Mt. Palali, Barangay Maddiangat, Municipality of Quezon, Nueva Vizcaya Province, Luzon Island, Philippines	3	HQ907476
KU 308922	Mt. Palali, Barangay Maddiangat, Municipality of Quezon, Nueva Vizcaya Province, Luzon Island, Philippines	2	JX966371
KU 308923	Mt. Palali, Barangay Maddiangat, Municipality of Quezon, Nueva Vizcaya Province, Luzon Island, Philippines	2	HQ907477
KU 308953	Mt. Palali, Barangay Maddiangat, Municipality of Quezon, Nueva Vizcaya Province, Luzon Island, Philippines	1	JX966370

Brachymeles muntingkamay is now recognized to occur in separate and distinct geological units of Luzon Island: the Caraballo and the Sierra Madres mountain ranges (Fig. 1). The species occurs in primary- and secondary-growth forest at mid-elevations (Siler et al. 2009). All newly collected individuals from Mt. Cagua were observed within small, rotting logs. Interestingly, all individuals of *B. muntingkamay* observed at both localities are females. Given what is known now about species in the genus, we suspect that the absence of male specimens is simply a result of sampling effort, and future surveys conducted in these regions of Luzon Island will likely result in the observation of male individuals. Whether males of this species possess a unique behavior relative to females that has led to gender bias in collections remains unknown, and in-depth studies are needed on the natural history of this unique mid-elevation species. *Brachymeles muntingkamay* remains one of only three limbed, non-pentadactyl species that occur at higher elevations (incl. *B. elerae* and *B. wrighti*; Siler 2010; Siler et al. 2011d). The discovery of a high elevation, isolated population of *Brachymeles muntingkamay* more than 200 km from the type locality brings to light questions regarding the full distribution of this species.

While a few biotic surveys have been conducted within the intervening landscape (Brown et al. 2000, 2012, 2013; Siler et al. 2011e), the presence of this species in intervening areas between Mt. Cagua and Mt. Palali has yet to be documented. Due to the limited access to suitable, mid- to high-elevation habitat, it is likely that additional populations may be present along central and southern portions of the Sierra Madre Mountain Range. However, this can only be validated with continued survey efforts, targeting higher elevation habitat in intervening areas (e.g., Cagayan and Isabela Provinces). Until such time, the distribution of this species is known only from two disjunct, mid-elevation localities. With this new data, we have re-evaluated this species against the IUCN criteria for classification, and find that it does not qualify for Critically Endangered, Endangered, Vulnerable, or Near Threatened status. *Brachymeles muntingkamay* is quite abundant on both Mt. Palali and Mt. Cagua, and we predict the species has a broad geographic distribution throughout the Sierra Madres Mountain Range at mid- to high elevations. We therefore classify this species as Least Concern LC (IUCN, 2011).

This discovery has major implications for conservation biology of reptiles in the mountains of the northern Philippines, with the possibility of underestimated ranges for mid- and high-elevation micro-endemic species, especially on topographically complex islands like Luzon and Mindanao. Just considering ground skinks, the newly discovered montane population of *B.*

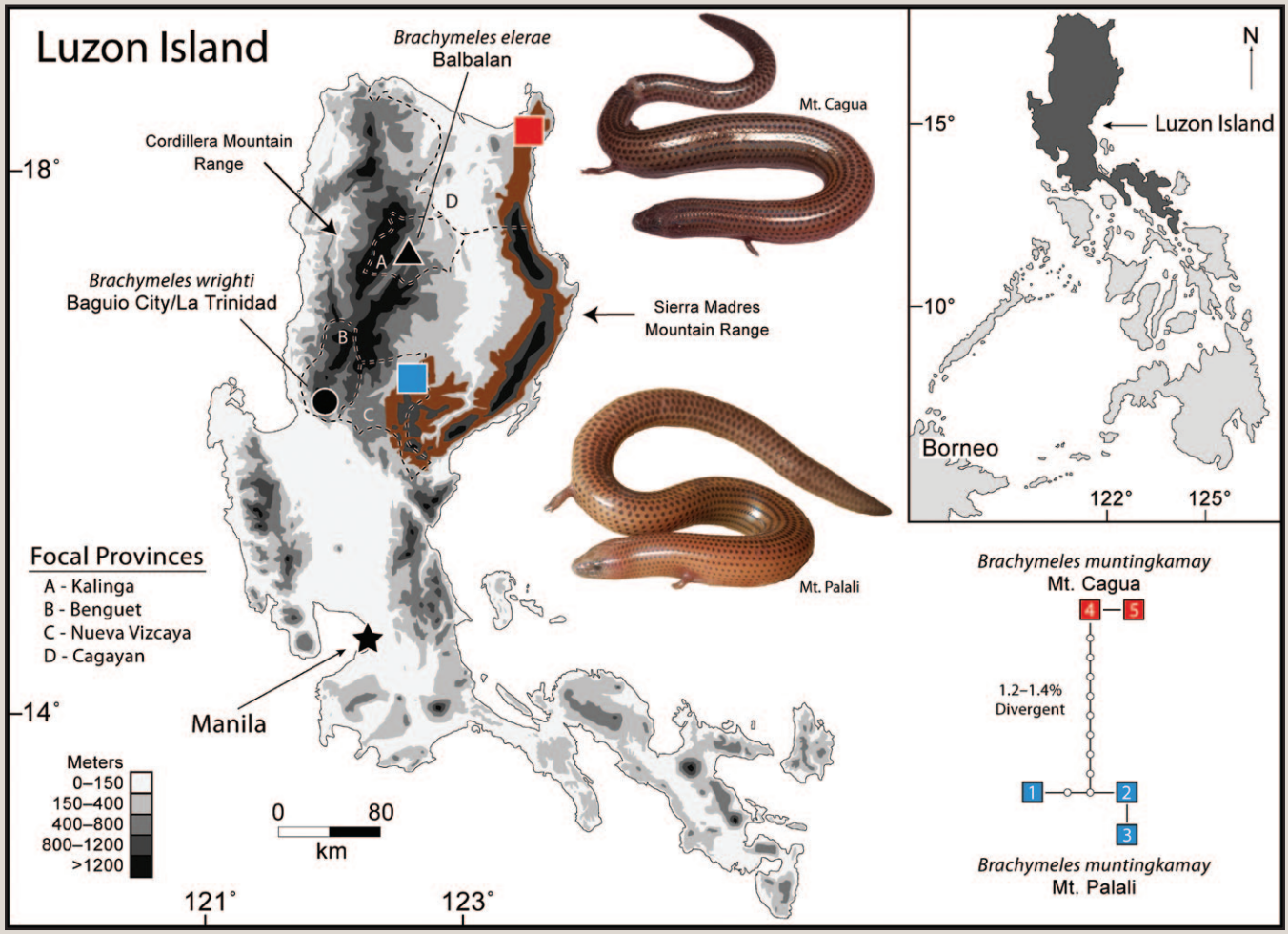


FIG. 1. Known localities of *Brachymeles muntingkamay*, with provincial boundaries for known populations of the three mid- to high-elevation species of *Brachymeles* on Luzon Island, Philippines. Hypothesized distribution of *B. muntingkamay* highlighted in brown. The minimum spanning, 95% connection probability, statistical parsimony haplotype network is shown depicting population-level genetic structure between and within the two sampled populations. Haplotype numeric labels and colors correspond to sampled individuals and localities (refer to Table 2). Photographs in life of *B. muntingkamay* from Mt. Cagua and Mt. Palali shown for comparison.

muntingkamay provides hope for future discoveries of the only two tetradactyl species in the genus *Brachymeles* (*B. elerae* and *B. wrighti*), as well as the poorly known Cordillera endemic species of *Eutropis* (*E. bontocensis*). At present there remain only two known specimens of *B. wrighti*, five specimens of *B. elerae*, and three specimens of *E. bontocensis* in museum collections. Unfortunately, both *B. wrighti* and *E. bontocensis* have not been observed in over 80 years, and our three focused surveys of the type localities for *B. wrighti* have resulted in no new records. Although such sparse data on the distribution of these species prevents a complete assessment of their geographic distribution, renewed survey efforts throughout the Cordillera Mountain Range may result in the discovery of additional populations of these vulnerable species. Fortunately, recent studies have indicated that many species of *Brachymeles* appear to be resilient to habitat degradation (Siler 2010; Siler and Brown 2010; Siler et al. 2011b,c,d, 2012a,b), and we remain optimistic that future surveys will result in similar discoveries of montane poopulations.

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Note added in proof.—During the period of review and publication of this note, we have identified a third population of *B. muntingkamay* at an intervening locality at Nassiping, Isabela Province (Brown et al. 2013; pers. comm. with ACD) but no genetic material is available and its genetic relations remain unknown.

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The Dog-faced Water Snake (*Cerberus rynchops*) and Gerard's Mud Snake (*Gerarda prevostiana*) at the Western Edge of Their Distribution

The homalopsid snake genus *Cerberus* has been recently revised (Murphy et al. 2012), and now contains five species that range from India's northwest coast (at 22°N) to Australia's Gulf of Carpentaria (at 18°S), a straight-line distance of over 8000 km (~ 20% of the Earth's circumference). *Cerberus* has a coastal distribution, and is mostly restricted to the intertidal zone characterized by mud flats, tidal creeks, mangrove forests, and Nipa Palm (*Nypa fruticans*). Thus, its geographic distribution has a strong linear component; when the distance is measured following the major coastlines of India, Bangladesh, Myanmar, the Malay Peninsula, the Sunda Shelf, the Lesser Sunda Islands and the Sahul Shelf, its linear range exceeds 11,000 km (Murphy et al. 2012). The monotypic *Gerarda prevostiana* has a coastal distribution somewhat similar to the genus *Cerberus*, one that extends from India's west coast to the Philippines (Murphy 2007). *Gerarda*, however, is not as well known as *Cerberus*. Its smaller size and secretive behavior within the intertidal burrow system has resulted in few museum specimens and fewer observations on its natural history, although it was first reported from western India by Wall (1921).

Cerberus rynchops has a South Asian distribution. On the eastern edge of its range, it extends to the Mouth of the Irrawaddy, Myanmar and perhaps into the Mergui Archipelago, where it is replaced by *Cerberus schneiderii* along the Andaman Sea coast of Thailand and coastal Southeast Asia (Murphy et al. 2012). The western edge of the distribution of *C. rynchops* was reported to be in the vicinity of Mumbai, India (Murphy 2007; Murphy et al. 2012; Smith 1943; Whitaker 1969), but Vyas (1996) and Gadhvi and Vyas (2002) had noted its presence about 170 km north of Mumbai, in the rivers and estuaries of Gujarat, India. Here, we provide specific localities, document the identity of the snake with photographs, and discuss the habitat and abundance of *Cerberus* and *Gerarda* at the western edge of their respective ranges.

Cerberus and *Gerarda* (Fig. 1) were found at eight localities in the Gulf of Khambaht in Gujarat where notes on habitat and relative abundance were taken (Table 1). The surveys of 5–7 h were conducted by 2–3 observers during daytime hours and at low tide. The Tapti River estuary near Hazira town and the Auranga River estuary adjacent to the Valsad coastal area were surveyed 3–5 times while the other locations were surveyed only once. The habitat observations support the association of *C. rynchops* with mangroves and tidal flats of mud and sand (Table 1 and Fig. 2 A–E) and of *Gerarda prevostiana* with mangroves. Abundance estimates for *Cerberus* at these locations fall into two broad categories. Snakes were considered rare when only a single specimen was observed on a survey and in good numbers when several individuals were observed on each visit.

On the south side of the Gulf of Kutch (Fig. 2), numerous coastal areas were surveyed from Dwarka and Okha at the mouth of the Gulf of Kutch to Jamnagar inside the gulf. In addition, coastal areas near Mandvi and Mundra on the north side of the Gulf of Kutch were surveyed at least once. The coastal areas in the Gulf of Kutch include tidal flats of mud and sand, numerous tidal creeks, and mangroves in varying densities. No *Cerberus* or *Gerarda* were observed at any of the Gulf of Kutch survey sites.

The survey data suggest the 53,200 ha intertidal wetlands of the Gulf of Khambhat (Sevlan 2003) is the western edge of distribution for both *Cerberus* and *Gerarda*. Neither is known from the Gulf of Kutch, a 58,200 ha wetland (Selvan 2003), about 270 km to the northwest of the Gulf of Khambhat. Both of these Gujarat wetlands are somewhat unique in that most of their freshwater supply does not come from a major river, but from rainfall and smaller streams. While the Gulf of Khambhat receives about 900 mm of precipitation annually, the Gulf of Kutch receives only 470 mm of precipitation annually, and both are classified as drowned

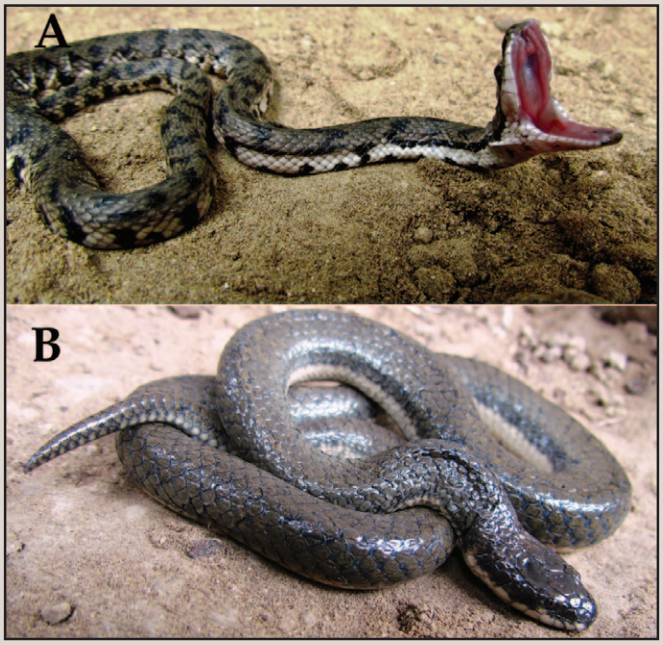


PHOTO BY D. PARMARA AND RAJU VYAS

FIG. 1. A) *Cerberus rynchops* from Tapti River estuary near Hazira town, 31 July 2012. Photo by Rajendra V. Vyas B) *Gerarda prevostiana* from Tapti River estuary near Hazira town, July 2012.

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PHOTO A, B, AND D BY RAJU VYAS; C BY VIRAL PRAJAPATI; E BY DIPAK CHHETA

FIG. 2. A map providing survey locations (details in Table 1) in Gujarat, India. A–E show *Cerberus rynchops* and *Gerarda prevostiana* habitats in the Gulf of Khambaht. A) Low tide near Ghogha village, 10 Feb. 2005; B) Fishing net near Ghogha village during low tide, 10 Feb. 2005; C) Low tide near the mouth of the Tapti River at Hazira town, 19 Feb. 2008; D) Mouth of tidal creek at low tide in the Narmada River estuary, 30 Dec. 2010; E) Shentrunji River, near Sartanpar village.

TABLE 1. The localities surveyed in the Gulf of Khambaht, Gujarat, India. Summary information on the coordinates, intertidal habitat, and snake abundance are provided.

Locality	Coordinates	Intertidal Habitat	Abundance
Jafrabad sea coast, Amreli District	20°51'23.54"N; 71°22'21.47"E	Mixed sand and mud shoreline with sparse mangroves	*Cerberus* reported by local snake rescuer (Dinesh Goswami); *Gerarda* not observed.
Sartanpar village, nr. Town of, Talaja, Bhavanagar District	21°17'12.69"N; 72°6'0.51"E	Packed mud with sparse mangroves on south bank of Shentrunji River	*Cerberus* and *Gerarda* are rare in the Shentrunji River estuary.
Kuda village, Bhavanagar District	21°36'41.08"N; 72°17'30.74"E	Firm sand shoreline with no mangroves	*Cerberus* and *Gerarda* are rare along the sea shore.
Ghogha village, Bhavanagar District	21°40'5.61"N; 72°16'44.00"E	Soft mud with dense mangroves; see Fig. 2A, B	*Cerberus* and *Gerarda* rare along shoreline.
Mahi River mouth, Anand, Bharuch, and Valdodara Districts	22°15'58.00"N; 72°52'21.00"E	Soft mud with sparse mangroves	Both *Cerberus* and *Gerarda* are rare in the area.
Narmada River estuary, Bharuch District	21°39'18.00"N; 72°49'34.00"E	Soft mud with mangroves	Intermediate numbers of *Cerberus* and *Gerarda*, fewer than Tapti River estuary.
Hazira town, Surat District	21°5'57.49"N; 72°41'48.18"E	Tidal creeks with soft mud and good numbers of mangroves; see Fig. 2C	Good numbers of *Cerberus* found in the Tapti River estuary, *Gerarda* present but not common.
Valsad coastal area, nr.Valsad town, Valsad District	20°36'31.65"N; 72°53'30.32"E	Muddy shoreline with sparse mangroves	Good numbers of *Cerberus* and *Gerarda* were found in the Auranga River estuary.

valley type mangroves. The Gulf of Khambhat has a dry season lasting eight months; the Gulf of Kutch has a dry season nine months or slightly longer. The climate for both gulfs is hot with a rather cold winter, maximum - minimum temperatures 40°C (May–June) and 10°C (January–February) and combined with the extended dry season the mangroves in this region are considered to be arid zone communities. Additionally, the low volume of freshwater entering both of these estuaries results in high salinity at both locations (Rashid 1985; Selvan 2003).

Murray (1884, 1886) reported *Cerberus rynchops* from Karachi and the Sindh Coast (the Indus River Delta) of Pakistan, about 600 km northwest of the Gulf of Khambhat, but Minton (1966) and Khan (2002) could not document its presence in this region. The environmental conditions in the Indus Delta may prevent *Cerberus* from permanently colonizing the area. Barkati and Rahman (2005) describe the habitat as the most arid land mangroves in the world, with the area receiving only 221 mm of precipitation per annum. In addition, they report water temperatures ranging from 20 to 33°C, and averaging 26.1, 27.3, and 25.2°C at three different locations in the Indus Delta. These average temperatures are below the 30°C body temperatures reported for other homalopsid snakes (Murphy et al. 1999). Yet, it should be noted that there is a homalopsid endemic to the Indus delta, *Enhydris pakistanica*, a poorly known, highly aquatic species that represents the most western population of the family Homalopsidae.

Sea surface temperatures are warm enough for *Cerberus* from Khambaht to the Indus most of the year. However, January (and maybe February) temperatures may be too low and therefore thermally stressful for both species north of the Gulf of Khambaht. Seasonally low levels of surface freshwater (rain and runoff) and high salinities may also be an important factor throughout the region but particularly north of the Gulf of Khambaht. Mangrove habitats and mud flats do not seem to be limiting in this region and are present from the Gulf of Khambaht to the Indus. Pockets of *Cerberus* and/or *Gerarda* may have occurred in the past or may now occur northwest of the Gulf of Khambaht but physical factors may cause frequent local extinctions, similar to the salinity crisis observed in Lake Songkhla, Thailand in 1999 (Murphy 2007).

Early in the 18th century, one of the Indus canals and the Indian Banas and Saraswati rivers carried substantial freshwater flows in Rann of Katch. This might have reduced the salinity and created optimum habitat for the species. A high magnitude (7.9 Richter scale) earthquake on 16 June 1819 uplifted an area 80 km long, 6 km wide, and 6 m high, known as Allah bund in the Greater Rann of Kutch. This event altered the course of Narra River (eastern branch of Indus). By the mid-19th century, all these rivers had reduced flow due to construction of dams for irrigation purposes (Mukhtar and Hannan 2012; Thakkar et al. 2012). The Indus mangroves are now extremely degraded as the result of the scarcity of freshwater, siltation, industrial pollution, deforestation for fire wood, and rapid urbanization and Mukhtar and Hannan (2012) predict the disappearance of the forest in the next two decades.

Although Murray's (1884) record of *Cerberus* may have been a misidentified *Xenochrophis* (Minton 1966), it is also possible that *Cerberus rynchops* had an established population in the Indus delta in the 19th century and a combination of anthropogenic habitat modification, seismic alterations, and marginal thermal conditions combined to produce a sub-optimal habitat resulting in the extirpation of the population.

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Morphological and Molecular Variation in the Endemic and Poorly Known Honduran Jumping Pitviper *Atropoides indomitus* (Serpentes: Viperidae), with Notes on Distribution

Smith and Ferrari-Castro (2008) described *Atropoides indomitus* based on one adult male (UTA R-52952) and one adult female (USNM 337487) from two localities in southwestern Colón and northwestern Olancho, Honduras (Fig. 1). Castoe et al. (2005) had previously identified the distinctness of this species based on mitochondrial DNA sequence data that placed it as sister to the Guatemalan *A. occiduus* (Hoge). McCranie (2011) presented morphological data from two additional females (USNM 578404–05) of this taxon from north-central Olancho in the vicinity of the species' type locality. Furthermore, a juvenile *Atropoides* sp. (UNAH 4425) was subsequently examined from a locality in south-central El Paraíso, Honduras, that appeared morphologically similar to *A. indomitus* (McCranie 2011). However, due to the large distance from any known *Atropoides* localities, McCranie (2011) remarked that additional specimens, including tissue samples, were needed from the El Paraíso locality before that population could be assigned to a described species.

Subsequently, four additional specimens (MVZ 267165–67, UNAH 5651) from the El Paraíso locality have become available, including two tissue samples. Thus, the goals of this study are threefold. First, we identify the *Atropoides* specimens from the El Paraíso locality using mitochondrial sequence data. Second, we describe the morphological variation of these four additional specimens. And third, we compare the four additional specimens to *A. indomitus* from the type and paratype localities and to its sister species *A. occiduus* using morphological and molecular data.

Methods

Molecular data.—Muscle tissue was obtained from two of the four *Atropoides indomitus* (MVZ 267165 and UNAH 5651) specimens collected from near Mapachín, El Paraíso, Honduras, and stored in 95% ethanol. Genomic DNA was isolated from tissues using a Qiagen DNeasy kit (Qiagen, Valencia, California, USA). For these samples, we amplified a 661 base pair region of the mitochondrial NADH dehydrogenase subunit 4 (ND4) without using tRNAs with the primer set (Arévalo et al., 1994) of forward primer ND4 (5'-CACCTATGACTACCAAAAGCTCATGTAGAAGC-3') and reverse primer LEU (5'-CATTACTTTTACTTGGATTTGCACCA-3'). All amplification reactions used GoTaq® Green Master Mix, 2X (Promega Corporation, Madison, Wisconsin, USA). Thermal cycling was performed on a GeneAmp® PCR System 9700 machine (Applied BioSciences, Foster City, California, USA). The ND4 fragment was amplified using an initial 5 min denaturation cycle at 95°C, followed by 30s denaturing at 94°C, 45s annealing at 52°C and 1 min extension at 72°C for 38 cycles, and a final 5 min extension at 72°C. PCR product was quantified by visualization on 1% agarose gel stained with ethidium bromide. Successfully amplified PCR products were prepared for sequencing by using the ExoSAP-IT kit (United States Biochemical). A BigDye Terminator Cycle Sequencing Kit (Applied Biosystems Inc.) was used for sequencing following the manufacturer's protocol and using PCR primers. The sequenced products were precipitated using an ethanol/sodium acetate method and rehydrated in HPLC purified formamide (HIDI). The sample was then analyzed on an ABI PRISM 3100xl Genetic Analyzer in the Genomics Core Facility at the University of Texas at Arlington, USA.

Alignments were constructed and edited by eye using the program Sequencher 4.8 (GeneCodes, Ann Arbor, Michigan, USA) and genetic distances (uncorrected "p") were generated in PAUP* (Swofford 2002). Resulting DNA sequences from this analysis were submitted to GenBank (accession numbers: KC354700 and KC354701).

Morphological data.—Specimens were initially fixed in 10% formalin and transferred to 70% ethanol two to four months later. Length data were taken to the nearest 1.0 mm using a ruler. We used the same terminology for scales and method of counting ventral scales as described by Smith and Ferrari-Castro (2008). The color codes and names follow those of Smithe (1975–1981).

Results

Molecular variation.—The two *Atropoides* specimens from El Paraíso (MVZ 267165 and UNAH 5651) shared identical ND4 haplotypes (i.e., 100% DNA sequence similarity). These two specimens had an ND4 haplotype only slightly divergent (0.30%) from the Honduran *A. indomitus* (as *A. occiduus*; UTA R-52952) specimen identified by Castoe et al. (2005). However, the three Guatemalan *A. occiduus* specimens identified as sister taxa to *A. indomitus* (UTA R-24763, 29680, 46719; Castoe et al., 2005) each had ND4 sequences about 6.0% (6.4, 5.9, and 5.8%) divergent from MVZ 267165, UNAH 5651, and UTA R-52952. Divergence among the three Guatemalan *A. occiduus* sequences was less than 1.0% (0.45, 0.46, and 0.91%). Given the sequence similarity between MVZ 267165, UNAH 5651, and UTA R-52952, we identify MVZ 267165 and UNAH 5651 as *A. indomitus*.

Morphological variation.—Smith and Ferrari-Castro (2008) distinguished *Atropoides indomitus* from *A. mexicanus* (Duméril, Bibron, and Duméril), the only other species of *Atropoides* known to occur in Honduras, based on number of ventrals (140 in both the single male and single female *A. indomitus* versus maximum of 130 in male and 135 in female *A. mexicanus*),

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TABLE 1. Size (in mm) and scale data for all known specimens of *Atropoides indomitus*. SVL = snout–vent length, TOL = total length, and TAL = tail length; Supral = supralabial.

	SVL	TOL	TAL/TOL	Ventrals	Subcaudals	Prelacunal-2nd Supral	Rostral Apex Reaching	Nasorostrals
El Paraíso Males								
MVZ 267165	399	466	0.144	138	39	1 Scale	Canthal Ridge	1–1
UNAH 5651	546	639	0.146	138	36	1 Scale	Canthal Ridge	0–0
UNAH 4425	278	325	0.145	133	37	1 Scale	Canthal Ridge	0–0
El Paraíso Females								
MVZ 267167	594	658	0.097	141	29	1 Scale	Canthal Ridge	0–0
MVZ 267166	263	298	0.117	142	31	1 Scale	Canthal Ridge	0–0
Colón Male								
UTA R-52952	494	573	0.137	140	37	1 Scale	Canthal Ridge	1–1
Olancho Females								
USNM 578404	465	520	0.106	133	30	1 Scale	Canthal Ridge	0–0
USNM 578405	222	252	0.119	138	30	1 Scale	Canthal Ridge	0–0
USNM 337487	495	550	0.100	140	28	1 Scale	Canthal Ridge	0–0
Total-Males	278–546 (429.3 ± 102.0)	325–639 (500.8 ± 118.8)	0.137–0.146	133–140 (137.3 ± 3.0)	36–39 (37.3 ± 1.3)	1 Scale (1)	Canthal Ridge (All)	0–1 (0.5 ± 0.5)
Total-Females	222–594 (407.8 ± 158.9)	252–658 (455.6 ± 173.4)	0.097–0.119	133–142 (138.8 ± 3.6)	28–31 (29.6 ± 1.1)	1 Scale (1)	Canthal Ridge (All)	0–0 (0)

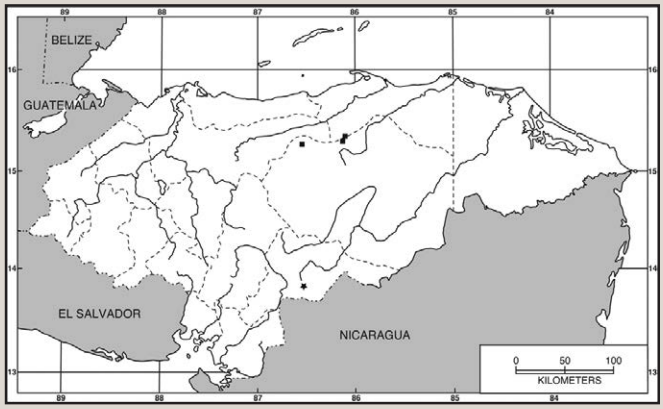


FIG. 1. Map of Honduras showing the previously known localities (squares) and the new locality reported herein (star) for *Atropoides indomitus*.



FIG. 2. Adult male of *Atropoides indomitus* (UNAH 5651) from near Mapachín, El Paraíso, Honduras.

COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND

number of scales between the prelacunal and second supralabial (1 in *A. indomitus* versus 2–3 in *A. mexicanus*), number of nasorostrals (0–1 in *A. indomitus* versus 2–4 in *mexicanus*), rostral apex condition (reaching canthal ridge in *A. indomitus* versus not reaching canthal ridge in *A. mexicanus*), postorbital stripe condition (including temporal rows 2 and 3 at midlength in *A. indomitus* versus rows 3 and 4 in *A. mexicanus*), and in subocular spot condition (large and distinct in *A. indomitus* versus usually absent, small when present, in *A. mexicanus*). In addition, *A. indomitus* was thought to be a smaller species than *A. mexicanus* (maximum known total length [TOL] 573 mm in *A. indomitus* versus 938 mm in *mexicanus*). Morphological data from two *A. indomitus* subsequently collected from the vicinity of the type locality (McCranie 2011) supported the diagnostic characters given for the species by Smith and Ferrari-Castro (2008).

Smith and Ferrari-Castro (2008) distinguished *Atropoides indomitus* from *A. occiduus* in part based on number of ventrals (140 in both the single male and single female *A. indomitus* versus maximum of 135 in male and 137 in female *A. occiduus*), subocular spot condition (not contacting orbit in *A. indomitus* versus contacting orbit in *A. occiduus*), condition of dark spot below pit (small and only encompassing prelacunal and adjacent edges of postlacunal and foveals in *A. indomitus* versus large and encompassing prelacunal and most of postlacunal and foveals in *A. occiduus*), and ventral pattern (nearly immaculate in *A. indomitus* versus dark ventrolateral blotches or heavy mottling in *A. occiduus*). Morphological variation in all five El Paraíso

specimens (MVZ 267165–67, UNAH 4425, 5651) agree with that of the Colón and Olancho *A. indomitus* specimens as described by Smith and Ferrari-Castro (2008) and McCranie (2011; see Table 1).

Color in life of an adult female (MVZ 267165) from the El Paraíso population was recorded as follows: dorsal ground color Russet (34) with Vandyke Brown (121) dorsal and lateral blotches; top of head Russet with Vandyke Brown postocular stripe; side of head below postocular stripe yellowish brown with Russet subocular spot; ventral surface of head cream medially, yellowish brown laterally; venter of body yellowish brown with slight dark brown flecking anteriorly, grading to heavily flecked and mottled with dark brown posteriorly; subcaudal surface Vandyke Brown with yellowish brown mottling on anterior two-thirds, pale brown on posterior third. The pale ventral surfaces in life of MVZ 267165, along with the pale ventral surfaces, the distinct subocular spot not reaching the orbit, the postorbital stripe involving temporal rows 2 and 3 at midlength, and the tiny spot below the pit in all El Paraíso specimens in alcohol agree with *A. indomitus* and not *A. mexicanus* or *A. occiduus*. Figure 2 shows a specimen of *A. indomitus* from El Paraíso in life.

The hemipenis from an El Paraíso specimen (UTA R-59770; extracted from UNAH 5651) agrees in most aspects with the *Atropoides indomitus* hemipenis described and illustrated by Smith and Ferrari-Castro (2008) and Jadin et al. (2010), except the small spines between the levels of bilobation of the organ and bifurcation of the sulcus spermaticus are slightly larger in the El Paraíso specimen than in the *A. indomitus* holotype.

Discussion

The results of this study are consistent with those of previous studies that suggest *Atropoides indomitus* to be a distinct species and sister to *A. occiduus* (Castoe et al. 2005, 2009; Daza et al. 2010; Smith and Ferrari-Castro 2008). Studies estimating divergence times among *Atropoides* species suggest that *A. indomitus* split from *A. occiduus* during the Pliocene (Castoe et al. 2009 [as *Atropoides* sp.]; Daza et al. 2010).

The diagnostic scale and size data for the five *Atropoides indomitus* specimens from El Paraíso are listed in Table 1. These diagnostic data, the color patterns, and the hemipenial morphology all agree with those of the *Atropoides indomitus* from Colón and Olancho as given by Smith and Ferrari-Castro (2008) and McCranie (2011) and along with the new molecular data reported herein, further support recognition of the El Paraíso population as *A. indomitus*. Table 1 also summarizes the currently known variation in these characters in *A. indomitus*.

We also take this opportunity to correct some errors in the diagnosis of *A. indomitus* by Smith and Ferrari-Castro (2008). Those authors gave the subcaudal range as 37–41 (on p. 59) and 37–40 (on p. 60) and they gave the number of dorsal scale rows at midbody as 24–25 for the two *A. indomitus* they examined. Those numbers should have been 28–37 (subcaudals) and 23–25 (dorsal scale rows at midbody, respectively) as correctly noted by Smith and Ferrari-Castro (2008) in the remainder of the description. Also, Smith and Ferrari-Castro (2008:60) stated "*Atropoides indomitus* has fewer ventral scales than most of its congeners, 140 (vs. 138–155)." Actually, *A. indomitus* has more ventral scales than most of its congeners (as correctly stated by Smith and Ferrari-Castro in their abstract and resumen).

The new *Atropoides indomitus* locality in El Paraíso is in a low mountain range (Cerro Quiebra Cajón) northeast of Mapachín and about 15 km SE of Danlí (13.9830°N, 86.4910°W). This new locality lies about 170 km SSW of the species' type locality and about 135 km S of the paratype locality (Fig. 1). The snakes were collected between 850 and 1150 m elevation during May and September (elevation and date of collection of UNAH 4425 not known). MVZ 267165–67 and UNAH 5651 were all collected on the ground during the day in second growth grassy areas being cleared by local workers. The area originally was covered by a mixture of pine-oak forest and broadleaf rainforest (Premontane Wet Forest of Holdridge, 1967).

The new locality in El Paraíso, Cerro Quiebra Cajón, is an isolated and very small mountain range that is completely surrounded by elevations below 800 m that contain subhumid forest conditions seemingly unsuited for *Atropoides* populations. Other isolated and relatively low elevation mountain ranges occur between Cerro Quiebra Cajón and the other known localities for *A. indomitus*. However, most of those mountains contain the subhumid pine forests that cover most interior mountain ranges in central Honduras. These pine forests contain a depauperate reptile fauna consisting primarily of species that also occur at lower elevation subhumid conditions in the interior of Honduras. The low levels of mitochondrial variation between the El Paraíso population and those from the vicinity of its type locality suggests that there was probably some recent gene flow across this portion of Honduras, thus the populations are likely to have only recently separated. Several isolated mountain ranges with pockets of humid vegetation that conceivably could contain remnant populations of *A. indomitus* do occur between the El Paraíso locality and that of the paratype in northwestern Olancho. Thus, suitable localities in Montaña El Chile (El Paraíso and Francisco Morazán), Sierra de Misoco (Francisco Morazán and Olancho), Montaña El Armado (Olancho), Montañas del Flor (Francisco Morazán), and Montañas de Yoro (Francisco Morazán and Yoro) could be explored for other populations of *A. indomitus*. In addition, the proximity of the El Paraíso locality to Nicaragua suggests the possibility that *A. indomitus* might eventually be discovered in that country.

MVZ 267165 consumed a field mouse (*Peromyscus* sp.) that was placed alive in the small plastic bucket in which the snake was temporarily housed. Nothing else is known about diet or reproduction in this species.

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Applied Anatomy of the Eyelash Viper (*Bothriechis schlegelii*)

Eyelash Vipers (*Bothriechis schlegelii*), in the family Viperidae, subfamily Crotalinae (Leysner 2002), are found throughout southern Mexico through Ecuador and Venezuela (Boldy 1983) living at elevations from sea level to 1500 m (Kuch and Freire 1995). Their small size, distinctive facial appearance, colorful polychromatic variable patterns, less aggressive demeanor, and compared to other species of Crotalinae, less potent venom, make them popular display specimens (Blake 1990; Kuch et al. 1996; Leysner 2002). A modified supraocular scale gives the taxon the "eyelash" appearance that is the basis for the common name (Leysner 2002; Seifert 1983). Eyelash vipers typically attain lengths of 60–72 cm (Blake 1990; Leysner 2002; Seifert 1983; Werman 1984). Their relatively small size and availability contribute to their suitability as a representative model for studies of South American neotropical arboreal pit vipers.

Knowledge of species-specific major organ topology informs studies of taxonomy, phylogeny, life history, ecology, growth and development, adaptive physiology, and provide landmarks in surgical procedures (Blackburn 1998; Gentilli et al. 2009; Pizzato et al. 2007; McCracken 1999; Travaglia-Cardoso et al. 2010; Vincent et al. 2004). General organ topology has been described in various taxa of snakes, including *Heterodon platyrhinus*, *Boa constrictor*, *Pantherophis guttatus*, and *Morelia spilota spilota*, demonstrating taxonomic variations in organs (Funk 2005; Kellicott 1898; McCracken 1999). This study describes the topology and dimensions of the major organs of *B. schlegelii*.

Methods and Materials.—Twenty-seven frozen specimens of *B. schlegelii* (15 females, 12 males) used in this study were animals that died over several years in a private breeding colony and were donated to North Carolina State University's College of Veterinary Medicine. Background source data and medical histories on individual snakes were unavailable. The total length of the vipers examined ranged from 49 to 81.4 cm. Prior to study, each frozen carcass was individually defrosted in a cool room (7.7°C) for 24 h. An external examination recorded color phase (red, yellow, or green), and any signs of trauma or external abnormalities were noted. The cloaca was probed using a 20-gauge 6.3 cm blunted needle (Covidien, 15 Hampshire Street Mansfield, Massachusetts 02048, USA) inserted caudally to establish the full depth of the posterior cloacal pocket. Results were recorded as the number of ventral scales the probe extended past, starting from the insertion point at the vent opening and tallying to the nearest ventral scale the probe could be advanced as detected by palpation. Probing was performed as a secondary assessment technique in evaluating whether or not differences in tail length could be used for determining the sex of animals in a field setting. Each snake was then placed in ventral recumbency on a flat level dissection table and straightened to minimize positional deviations, but without applying tension. The head was secured to the dissection table with surgical tape (Covidien) to prevent any minor movement. A plastic flexible measuring tape was anchored in a straight line on the dissection table, adjacent and parallel to the snake, with the 0-cm mark positioned at the most rostral point of the head. All measurements were taken to the closest millimeter. External measurements recorded for each snake included the total body length, ([TBL] measured from the tip of the rostrum to the distal tip of the tail), the body length, ([BL] measured from the tip of the rostrum to the anterior margin of the cloaca), and the greatest width of the dorsal skull ([SW] measured across the quadrate bones). Based on an obvious break in the data distribution, the snakes were arbitrarily categorized as large (over 50 cm BL [N = 17]) or small (snakes under 50 cm BL [N = 10]).

Measured specimens were repositioned into dorsal recumbency and an incision made along the entire length of the animal's ventral midline. Internal measurements were taken using the anchored measuring tape adjacent to the specimen. The distance between the tip of the rostrum and the anterior and posterior poles of the heart, lung, liver, stomach, right and left kidney, and gonads were recorded to the nearest millimeter. Ovary and oviduct were considered as a single organ cluster for the purposes of this study, and measured from the anterior pole of the ovary to the posterior pole of the oviduct or last follicle, if follicles were present**.** The number of follicles in right and left oviducts were counted for each female and compared between sides. There was difficulty discerning the junction of lung tissue and the air sac. The posterior pole of the lung was defined by and

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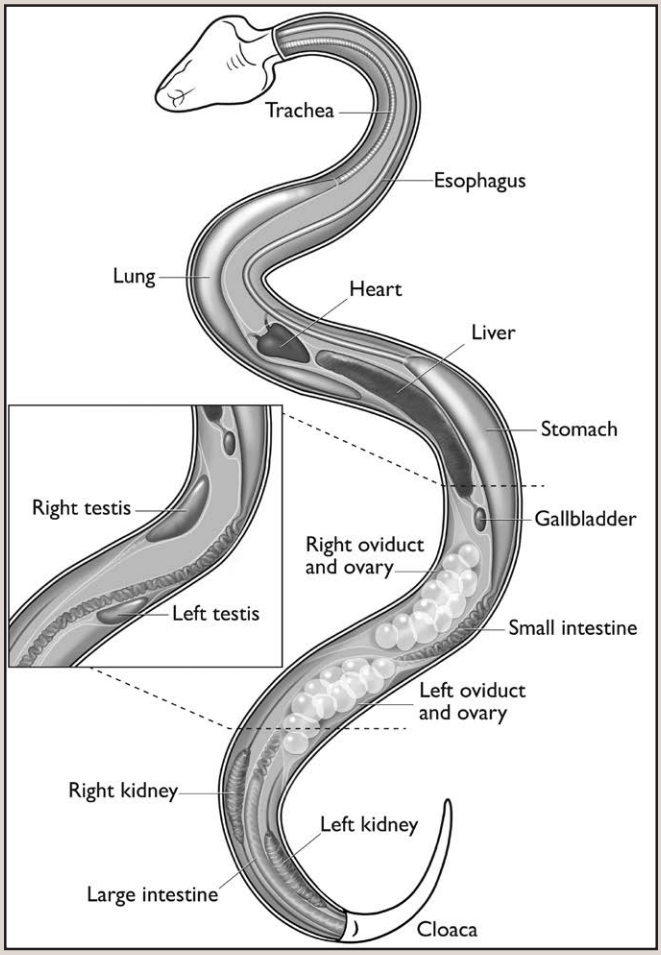


FIG. 1. Illustration of internal anatomy of *Bothriechis schlegelii.*

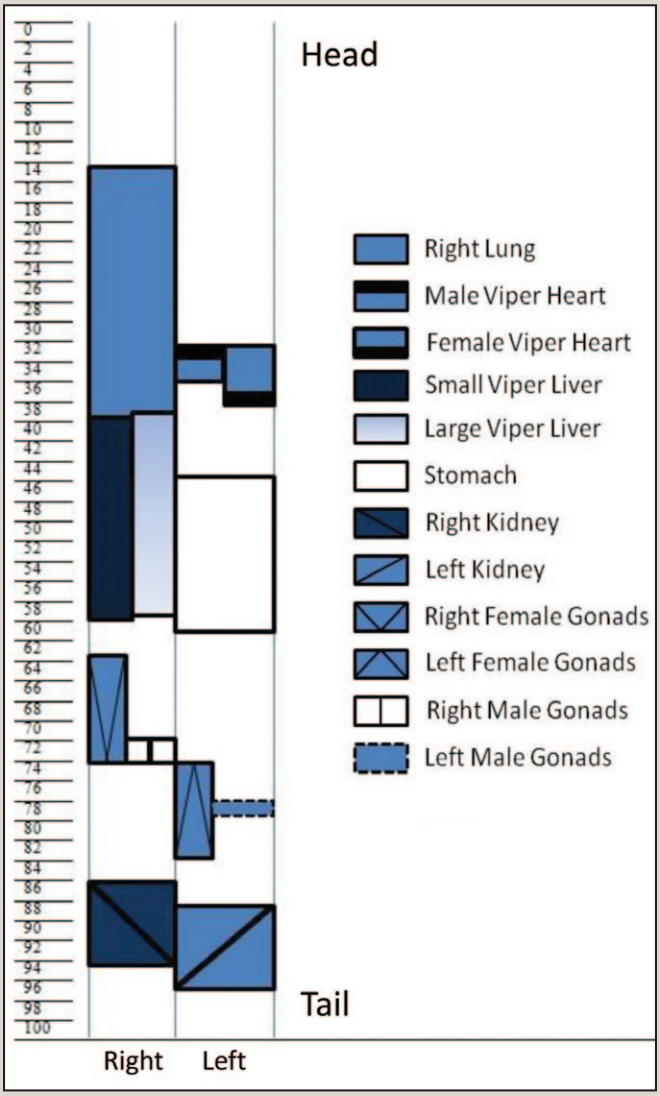


FIG. 2. Organ topography of *Bothriechis schlegelii* expressed as a percentage of Body Length (BL) (Y axis).

measured to the loss of gross vascularization in the pulmonary tissue.

The internal organ measurements were converted to a percentage of the body length (BL) for each individual snake (X = measurement / BL) × 100), and rounded to the nearest tenth of a percentage point (McCracken 1999). The lengths of individual organs were calculated by subtracting the measured position of the anterior pole of each organ from the measurement of the location of the posterior limit of that organ. The tail length [TL] was also a calculated rather than measured value, achieved by subtracting the BL from the TBL for each snake.

The measured and calculated data medians and ranges of all organ positions as a percentage of body length were plotted on an axis to better appreciate their distributions. The nonparametric Wilcoxon rank sums test using JMP software (SAS Institute Inc. 100 SAS Campus Drive Cary, North Carolina, 27513-2414, USA) considering a $P < 0.05$ as statistically significant was used to evaluate the measured and derived relative position data for all snakes analyzing for differences by sex, color phase, and size group.

Results.—The arbitrary size groups were comprised of essentially equal numbers of snakes of each sex, with the sex ratio in the small snake group being 5.5 and in the large snake group 7.10. Statistically significant differences were observed between sexes for gonad size and location, posterior cloacal sac depth, heart length, and skull width. The only statistically significant differences in calculated organ positions identified between size groups was liver length and no differences were noted between color morphs. The depth of the cloacal pocket measured as the number of subcaudal scales was consistently deeper (7 subcaudal scales with a range of 3–14) for males than for females (2 subcaudal scales with a range of 1–5 [$P < 0.0001$]). This was expected as males commonly probe to a deeper depth than females (Cover 1984; Denardo 2006; Laszlo 1975).

Fig. 1 illustrates the internal organ anatomy of a prototypical Eyelash Viper. Fig. 2 presents the organ positions expressed as a percentage of BL. The anterior extent of the single right lung is consistently near the base of the skull with a median (range) percentage of BL of 14.5 (9.8–19.1) %. The lung extends posteriorly to a median of 39.5 (33.9–44.0) % of the BL. The trachea extends and is incorporated into nearly the entire length of the lung. The heart is situated near the caudal aspect of the lungs with the anterior aspect of the heart at a 32.6 (29.6–35.9) % of the BL and extends caudally to 36.1 (33.0–8.5) % of the BL. There was a statistically significant difference in heart lengths between sexes, with female vipers having longer hearts 1.9 (1.1–3.1) cm versus males 1.4 (1.1–2.6 [Wilcoxon Ranked Sum $P = 0.0328$]) cm. The anterior aspect of liver is located at 39.7 (35.0–42.1) % of the

BL just caudal to the posterior aspect of right lung and ends at 59.8 (55.6–64.2) % of the BL. There was a statistically significant difference in liver lengths between small and large vipers, with small vipers having shorter livers 9.9 (7.6–17.1) cm compared to large vipers 11.8 (9.5–14.6 [Wilcoxon Ranked Sum $P = 0.0096$]) cm. The anterior extreme and most of the stomach overlaps the liver at 46.0 (39.2–53.6) % of the BL, with only the posterior aspect of the empty stomach extending beyond the liver. The anterior aspect of the right kidney is positioned at 86.8 (83.5–89.6) % of the BL and ends at 95 (92.9–97.3) %. The left kidney is positioned just caudal to the posterior aspect of the right kidney at 88.2 (85.4–90.4) % and ending caudal to the right kidney at 96 (93.7–98.7) % of the BL. There was a statistically significant difference in skull widths between sexes, with female vipers having wider skulls (mean 2.9 cm; range 2.0–4.1) than males (mean 2.0 cm; range 1.5–4.5 [Wilcoxon Ranked Sum $P = 0.0059$]) cm.

The right ovary and oviduct are located at the posterior aspect of the liver at 64.2 (56.3–71.9) % and end at 75.5 (69.6–79.5) % of the BL. The left ovary and oviduct overlap the right ovary and oviduct, starting at 74.5 % of BL (68.5–95.5) and ending at 84.3 (80.3–98.7) % of the BL. These data did not have a normal distribution (Wilkes Shapiro, $P = 0.005$ for starting point and $P = 0.0038$ for end). There was no statistically significant difference between the lengths of the left and right ovary and oviduct (Wilcoxon Ranked Sums, $P = 0.4552$). The mean number of follicles was the same for both the left and right ovaries and oviducts, 3–4 on each side.

The right testes also overlapped the liver, starting at 72% BL (66–75.5 %) and ending at 74.5 (67.8–76.9) % of the BL. The left testes are located caudal to the right testes, starting at 78.3 (67.9–80.7) % of the BL and ending at 80.4 (69.6–83.6) % of the BL. These data did not have a normal distribution curve (Wilkes Shapiro, $P = 0.004$ for starting point and $P = 0.02$ for end). There was a statistically significant difference in length between the right and left testis (Wilcoxon Signed Ranked test $P = 0.0204$) with the right being larger than the left.

Discussion.—The organ topology in *B. schlegelii* is similar to the anatomical descriptions of other snakes (Ackerman 1997; Chiodini et al. 1982; Evans 1986; Funk 2005; Girling and Raiti, 2004; Kellicott 1898; McCracken 1999; Rhan 1942). The absence of the left lung in *B. schlegelii* is typical of Viperidae and other families having vestigial or no left lung (Colubridae, Xenopeltidae, Loxocemidae, Pythonidae, and Boidae) (Gans and Gaunt 1998; Kellicott 1898; Wallach 1998). No differences were observed in length or position of the right lung, stomach, and kidneys with respect to sex, color scheme, or size of the viper. Species belonging to the genera *Thamnophis* and *Diadophis* have been described as possessing a longer right kidney than the left (Bishop 1959; Gans and Parsons 1977; Myers 1965), however. right and left kidney lengths did not differ in *B. schlegelii*. We did not observe nor expect any differences in anatomic locations of organs among different color morphs of *B. schlegelii*. Offspring are generally polychromatic throughout the litter.

Determining certain organ borders might be a source of variability in some measurements collected for our study. The right lung of the snake has been described as having no distinct end point, only being divided into the vascular portion and avascular portion (Gans and Gaunt 1998). The stomach presents similar challenges because there is no distinct grossly appreciable anatomical separation between stomach and esophagus (Gans and Gans 1978). In our study organ limits were determined by a single observer (EOC) for all specimens, thus avoiding inter-observer error. Variations in observer assessment of organ borders might result in minor differences in absolute organ locations in relation to body length.

The livers of vipers categorized as large in our study had longer livers relative to body length compared to vipers we categorized as small. Though it is tempting to assign this difference to age differences, the two size categories we used for our study were determined by a natural break in the data set and do not necessarily reflect differences among adult, juvenile, or neonatal animals. Based on published literature, establishing the average adult size of wild *B. schlegelii* as 50 cm TBL (Seifert 1983) and considering the smallest viper in our study was 49 cm TBL, it is likely that all of the vipers we studied were adult animals. Similarly, the sex ratios in the two arbitrary size groups were similar suggesting the difference in liver size is unlikely to be a gender characteristic. If not age or gender, the seasonality at time of death might have influenced the size of the liver in our dataset. Seasonal changes in liver size with specimens examined in periods of increased feeding (summer) having larger livers are described for *Thamnophis sirtalis parietalis* (Aleksiuk and Stewart 1971; Gans and Gaunt 1998). Consumption of food can affect internal viscera size (Andersen et al. 2005; Grossmann and Starck 2006; Starck and Beese 2001; Starck and Beese 2002). Imaging studies have documented rapid postprandial enlargement of the liver, up to 1.5 times baseline with return to fasting size 7–10 days after feeding in *Python molurus bivittatus, Thamnophis sirtalis parietalis*, and *Dasypeltis scabra* (Grossmann and Starck 2006; Starck and Beese 2001; Starck and Beese 2002). If similar changes occur in *B. schlegelii*, which has a similar "sit and wait" foraging strategy to the species studied, this could explain the variation in liver size seen in our study (Starck and Beese 2002). Feeding records were not available for the specimens we studied.

Female viper hearts were statistically longer than those of males in our study. We did not examine the size of individual atria, the ventricle or the weight of the hearts in our specimens. There is at least one report of increased food consumption being related to increased heart mass in *Python molurus bivittatus* (Andersen et al. 2005). We have no data to suggest that females in our study were fed more frequently or greater amounts than males.

Asymmetry of snake gonads has been well documented in the literature, establishing the right testis, ovary and oviduct positioned anterior to the left testis, ovary and oviduct in many species (Blackburn 1998; Funk 2005; Kellicott 1898; Girling and Raiti 2004; McCracken 1999; Pizzato et al. 2007; Rhan 1942; Werner and Drook 1967) This asymmetry is thought to be further exaggerated in arboreal species compared to terrestrial species based on studies of Indo-Australian pythons and boids (Lillywhite and Henderson 1993; Pizzato et al. 2007). Linear displacement of the gonads in arboreal snakes has been postulated to support larger embryos with minimal distension of the coelomic cavity, thereby reducing impacts of gravidity on locomotion (Blackburn 1998; Nunes et al. 2010; Pizzatto et al. 2007; Travaglia-Cardoso et al. 2010), and improving support of the body on thin tree branches (Blackburn 1998; Lillywhite and Henderson 1993; Pizzatto et al. 2007). Our data would be consistent with an arboreal survival strategy for female *B. schlegelii*. Though follicle number and size are reported to be greater for the right ovary and oviduct in several snakes, including *Thamnophis radix, Xenochrophis vittata, Natrix sipedon, Natrix rhombifera*, and *Ptyas mucosus* (Bergman 1950; Betz 1963; Bragdon 1953; Cieslak 1945; Das 1960), this was not the case for *B. schlegelii*. We observed no statistically

significant difference in the length or the number of follicles of the left and right ovaries in the females we dissected. We did, however, observe a statistically significant longer length of the right testis compared to the left in male *B. schlegelii*. This has been previously reported in *Leptotyphlops phillipsi* and *Vipera berus* (Gans and Parsons 1977; Werner and Drook 1967).

Sexually dimorphic characteristics observed in *B. schlegelii* included expected differences in cloacal pocket depth between males and females, with the probe inserting further into the distal tail of males than females. This is commonly observed in most snake species (Cover 1984; Denardo 2006; Laszlo 1975).

Another sexually dimorphic characteristic observed in *B. schlegelii* in our study was skull width. The skulls were found to be wider in females than in males. This trait has been documented in other species including, *Thamnophis* spp. *Acrochordus arafurae*, and *Laticauda colubrina* (Houston and Shine 1993; Shine and Crews 1988; Shetty and Shine 2002). Though our data showed a statistically significant difference between male and female snakes for this trait, there was a great deal of overlap of the male and female measurements, suggesting that it will not be practical to use this measurement for differentiating sex in *B. schlegelii*.

Tail length has also been reported to be a secondary sex characteristic in some species of snakes, with male *Bothrops insularis*, *Vipera aspis*, and *Elaphe longissima* reported to have longer, thicker tails than females (Bonnet et al. 1998; Cardoso et al. 2010; Denardo 2006; Laszlo 1975; Travaglia-Cardoso et al. 2010). Our study found no statistically significant difference in tail length between sexes in *B. schlegelii* and tail length would not be a reliable method for determining sex in this species.

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Hoop Net Escapes and Influence of Traps Containing Turtles on Texas Spiny Softshell (*Apalone spinifera emoryi*) Captures

Hoop nets are probably the most commonly used device for sampling aquatic turtles because they 1) are lightweight, easily portable in large numbers, and comparatively easy to hide; 2) provide easily quantifiable results; and 3) do not require intensive labor to operate (Conant and Collins 1998; Lagler 1943; Thomas et al. 2008). Several authors have reported escapes from hoop nets (Brown et al. 2011a; Frazer et al. 1990; Gamble 2006; Koper and Brooks 1997). Escape rates may be species-specific (Frazer et al. 1990) and turtles may not only be attracted by bait placed in the trap, but also influenced, either positively or negatively, by other turtles present in the trap (Cagle and Chaney 1950; Frazer et al. 1990; Ream and Ream 1966). Of particular interest is the suggestion that hoop nets are a male-biased sampling method because males are attracted to females caught in traps (Cagle and Chaney 1950; Vogt 1979). Frazer et al. (1990) tested this hypothesis and caught more Painted Turtles (*Chrysemys picta*) in traps containing females than in traps without turtles. However, Vogt (1979) found no differences in number of male Painted Turtle captures between female-baited and male-baited traps. Because few studies have been conducted on this topic and these studies have obtained conflicting results, it is currently unclear whether turtles present in traps bias future captures.

Differential escapes from and attraction to hoop nets could also be an influential source of bias when estimating population size and structure of freshwater turtles. We are aware of only one study that directly assessed differential escapes from hoop nets. Brown et al. (2011a) found that significantly more female than male Red-eared Sliders (*Trachemys scripta elegans*) escaped hoop nets in lentic water bodies. Thus, differential escapes rather than differential attraction could explain why hoop nets are perceived to be male-biased. However, the applicability of these results to other taxa and aquatic environments is currently unknown. The purposes of our experiment were to determine if sex or body size influenced Texas Spiny Softshell (*Apalone spinifera emoryi*) escapes and to determine if "seeded" traps (i.e., traps with turtles placed in them) attracted more turtles than unseeded traps.

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Materials and methods.—In the summer months of 2010 through 2012 we trapped and seeded turtles at three sites along the Rio Grande in Texas. In 2010, the study site was Big Bend National Park (29.18304°N, 102.9907°W), Brewster Co. In 2011, the study site was Black Gap Wildlife Management Area (BGWMA; 29.56139°N, 102.77798°W), Brewster Co. In 2012, the study sites were BGWMA and Southmost Preserve (25.84070°N, 97.38863°W), Cameron Co. The stretch of Rio Grande in Brewster Co. contains abundant Texas Spiny Softshells and Big Bend Sliders (*Trachemys gaigeae*), with a potentially growing population of non-native Red-eared Sliders (Jackson 2010), while the stretch of Rio Grande in Cameron Co. contains abundant Texas Spiny Softshells and Red-eared Sliders (Brown et al. 2011b). In addition to trapping the Rio Grande to obtain individuals for this experiment, we also trapped adjacent lentic water bodies to increase the sample size.

We used the same 76.2-cm diameter single-throated, single-opening, widemouth hoop nets with 2.54-cm mesh used by Brown et al. (2011a). Distance between the traps ranged from 5–100 m depending on availability of vegetation to secure the traps. All traps were set with entrances facing downstream (Lagler 1943) and baited with canned sardines placed in non-consumable containers containing holes for scent dispersal (Brown et al 2011a; Gamble 2006). We replaced bait every two days. In 2010, we completed 160 trap-days from 4-8 June. In 2011, we

completed 449 trap-days from 14–19 June. In 2012, we completed 132 trap-days at BGWMA, from 8–10 May and 65 trap-days at Southmost Preserve from 27 May–8 June. We excluded all trap-days prior to seeding turtles (Table 1).

For all captured turtles we recorded carapace length and width, plastron length and width, and body depth to the nearest 1.0 mm using tree calipers (Haglof, Madison, Mississippi) and determined mass to the nearest 10 g using spring scales (Pesola, Baar, Switzerland). Sex was determined using secondary characteristics; for Texas Spiny Softshells, the pre-cloacal portion of the tail lies beyond the edge of the carapace in males and before or at the edge of the carapace in females (Berry and Shine 1980). We marked softshells by engraving individual numbers on the posterior end of the carapace and marked sliders by notching marginal scutes on the carapace using a rotary tool (Dremel, Racine, Wisconsin). After softshells were processed, we placed them in the hoop nets at random, with one turtle used per trap and each turtle used only one time for the experiment. We seeded between one and 26 traps per day. Therefore, not all traps were seeded at all times, which gave us the opportunity to test if seeded traps attracted more turtles than unseeded traps. Every 24 h we recorded escapes from seeded traps as well as new captures in both seeded and unseeded traps and we released the original turtles used to seed the traps. We conducted this experiment using a total of 107 seeded trap-days and 481 unseeded trap-days. Of the 107 turtles, 88 were originally captured in the river, while the remaining turtles were originally captured in adjacent lentic water bodies.

We used logistic regression to determine whether escapes were sex- or size-biased (Lindsay 1995). We combined the data from all years and tested two models. The first model included body depth as the predictor and hoop net escape as the binary response variable and the second model included both body depth and sex as predictors (i.e., juveniles were removed from this analysis). Likelihood-ratio tests were used to determine if the predictors significantly increased the fit of the data relative to the intercept-only model (i.e., deviance greater than chance alone). We used a randomization test to determine if seeded traps attracted more turtles than unseeded traps (Sokal and Rohlf 1995). All statistical analyses were performed in R 2.8.1 (The R Foundation for Statistical Computing, Vienna, Austria).

Results.—Eight of the 107 softshell turtles escaped (7%), including 6 males (8% of males), one female (3% of females), and one juvenile. Body depth was a significant predictor in the model that included only body depth as a predictor, with smaller turtles being more likely to escape (Deviance $\chi^2_{1,105} = 52.35$, $P = 0.03$; AIC = 56.35; Fig. 1). However, body depth was not a significant predictor when sex ratio was added to the model (Deviance $\chi^2_{1,103} = 48.81$, $P = 0.10$; AIC = 58.14). Sex was not a significant predictor (Deviance $\chi^2_{1,102} = 48.59$, $P = 0.64$). In addition to the 107 softshells, we captured 39 sliders during this study. Seeding traps did not affect Texas spiny softshell captures ($P = 0.52$) or overall turtle captures ($P = 0.87$).

Discussion.—We found a much lower escape percentage for Texas Spiny Softshells in a river system (7%) than Frazer et al. (1990) reported for Painted Turtles and Snapping Turtles in a lentic system (80% and 25%, respectively) and a higher percentage than Brown et al. (2011a) found for Red-eared Sliders in a lentic system (3.6%). In addition, Brown et al. (2011a) reported escapes were sex-biased, with females escaping more than males, but not size-biased, whereas we obtained the opposite results. The conflicting results among studies indicate there are interspecific differences in escape probability and potentially habitat-influenced differences. Different types of water bodies could potentially change the behavior of turtles within traps and, as a consequence, escape probabilities.

Our study does not support the hypothesis that turtle captures in hoop nets are influenced by the presence or absence of other turtles in the trap. This is contrary to Frazer et al. (1990), who found more *C. picta* in traps that already contained turtles. Thus, interspecific differences may exist for turtle attraction as well as escapes. Unfortunately, due to a low sample size for females, we were unable to determine whether or not sex of the captured turtle matters in terms of potential to attract other turtles. Based on results from the small number of studies that have investigated the efficacy of sampling freshwater turtles using hoop nets, it is clear that there is still much knowledge to be gained.

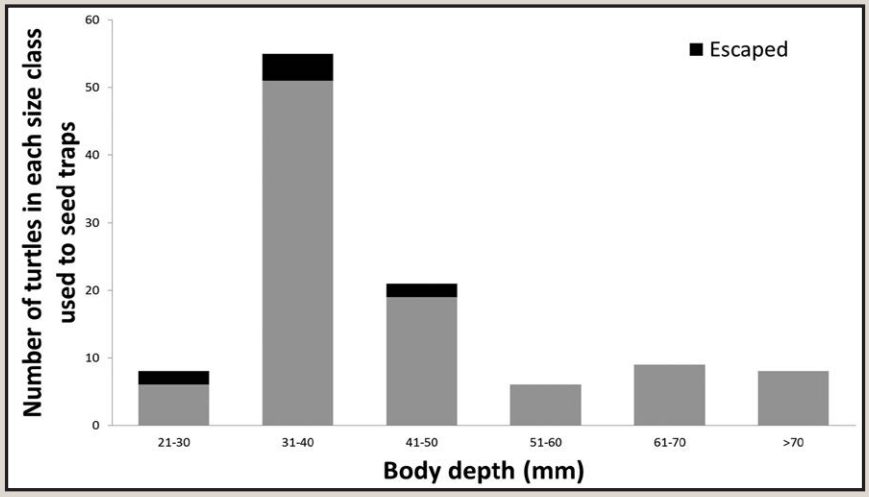


FIG. 1. Total number of Texas Spiny Softshells (*Apalone spinifera emoryi*) used to seed hoop nets along the Rio Grande with numbers that escaped by body depth. Body depth was a significant predictor in the model that included only body depth as a predictor, with smaller turtles being more likely to escape (Deviance $\chi^2_{1,105} = 52.35$, $P = 0.03$).

TABLE 1. Study locations, number of trap days (excluding initial trap days prior to seeding traps), and number of turtles used to seed traps each year at sites used to investigate hoop net escapes and attraction for Texas Spiny Softshells (*Apalone spinifera emoryi*) in the Rio Grande river in Texas.

Year	Study site	Number of trap days	Number of seeded turtles
2010	Big Bend National Park	120	41
2011	Black Gap Wildlife Management Area	369	29
2012	Black Gap Wildlife Management Area	72	26
2012	Southmost Preserve	36	11
Total		597	107

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Relationships of Body Size and Male Melanism to Biting Propensity in Red-eared Sliders (*Trachemys scripta*)

Biting is a primitive and versatile behavior of turtles that likely evolved for feeding but is also used for defense and during social interactions (Davis and Jackson 1973). Biting during social interactions has been documented in numerous turtle species (Bury and Wolfheim 1973; Bury et al. 1979; Carpenter 1966; Ernst and Barbour 1992; Lardie 1983; Mafli et al. 2011; Schofield et al. 2007). The standard English names of snapping turtles, *Chelydra serpentina* and *Macrochelys temminckii,* reflect their tendency for defensive biting directed at human handlers. Bite force is generally correlated with body size (Herrel et al. 2002). Therefore, it is not surprising that adults sometimes use defensive biting in situations where juveniles do not (Pritchard 1989) or that larger turtles often prevail in social interactions that involve biting (Carpenter 1966; Lindeman 1999).

The Red-eared Slider (*Trachemys scripta*) is a widely distributed freshwater turtle that occurs in many aquatic habitats (Ernst et al. 1994). Lindeman (1999) observed that aggressive interactions among basking *T. scripta* resulted in larger turtles successfully displacing smaller turtles twice as often as smaller turtles displaced larger turtles. Turtles utilized several aggressive behaviors including biting, clawing and pushing when competing for basking sites (Lindeman 1999). These data support the hypothesis that aggression increases with increasing body size.

Another hypothesis regarding aggression that is specific to male *T. scripta* is that aggression increases as males become melanistic (Cagle 1950; Cahn 1937; Carr 1952; Lardie 1983; Parker 1990; Tucker et al. 1995). This hypothesis is attractive because in diverse taxa, including other turtles (Mafli et al. 2001), there is a correlation between aggressiveness and degree of melanism (Ducrest et al. 2008). Male *T. scripta* exhibit ontogenetic melanism (Lovich et al. 1990). As males approach the body size of sexually mature females in the local population, the green and yellow pigmentation on the integument and shell is replaced with melanin (Cagle 1950; Lovich et al. 1990; McCoy 1966). Although the function of melanism in *T. scripta* is not understood, several hypotheses have been presented including thermoregulation (but see Boyer 1965; Gronke et al. 2006), sexual selection, intra- or interspecific communication, and non-adaptive by-product of hormonal changes (Lovich et al. 1990). Of these, the hypothesis with the most support is the sexual selection hypothesis. In laboratory experiments examining courtship behavior, alternative mating tactics were observed. Nonmelanistic males initiated titillation, a precopulatory behavior consisting of rapid

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vibration of the foreclaws against the head of a female turtle (Cagle 1950; Jackson and Davis 1972) while melanistic males used chasing and biting as courtship behaviors (Thomas 2002). Anecdotally, melanistic male *T. scripta* have been described as aggressive and socially dominant (Cagle 1950; Cahn 1937; Carr 1952; Lardie 1983; Parker 1990; Tucker et al. 1995).

In the course of our research we handled hundreds of *T. scripta* across the complete range of body size for this species. This provided an opportunity to test two hypotheses: 1) the propensity to bite increases with body size, and 2) the propensity to bite increases with melanin deposition. During 2007–2008 we recorded biting attempts by *T. scripta* during handling. With these data we report the frequency of biting attempts, explore ontogenetic, intersexual and intrasexual differences in biting attempts, and test whether biting attempts during handling can be predicted from body size or melanism.

Materials and Methods

Study Area.—Our study area consisted of three ponds in Canadian County, Oklahoma, USA. The largest pond (35.6643°N, 97.6896°W; WSG84) was 2.1 ha. Two smaller ponds of 0.9 ha each were located adjacent to one another and within 1.07 km of the larger pond (see Stone et al. 2005 and Beshara 2009 for a detailed description of the study area).

Field Methods.—We trapped turtles during March–July 2007 and April–October 2008. We used double-throated hoop nets of varying sizes, with mesh sizes of 2.5 or 3.8 cm, baited with sardines. Traps were set overnight around the perimeter of ponds an average of four days per month, for a total of 377 trap days. Turtles were processed and released the following day.

Captured turtles were held in buckets and processed individually. The number of turtles captured in a net ranged from 0–25. All turtles in a given net were held in the same bucket until processing. Depending on the number of turtles captured, holding time varied from 10–90 min. We did not test the effect of length of holding time on biting propensity. Individuals were released immediately after processing.

Each turtle was removed from the bucket, dried with a towel, and tapped on the nose to provoke a response. If the turtle opened its mouth or attempted to bite, we recorded the response as a biting attempt. After testing for biting, we measured a series of traits for each turtle. Midline plastron length (MPL) was measured with dial calipers to the nearest 0.1 mm and used as an estimate of body size. We used body size and the presence or absence of secondary sexual characteristics (Cagle 1950) to determine the sex of each turtle. We classified turtles having elongated foreclaws and an enlarged postanal tail as males. Turtles that did not have male secondary sexual characteristics were classified as juvenile if MPL was <100 mm, juvenile female if MPL was 101–165 mm, and adult female if MPL was ≥166 mm. Size thresholds for these categories were obtained from our unpublished data but are consistent with values published elsewhere (Cagle 1950; Dunham and Gibbons 1990).

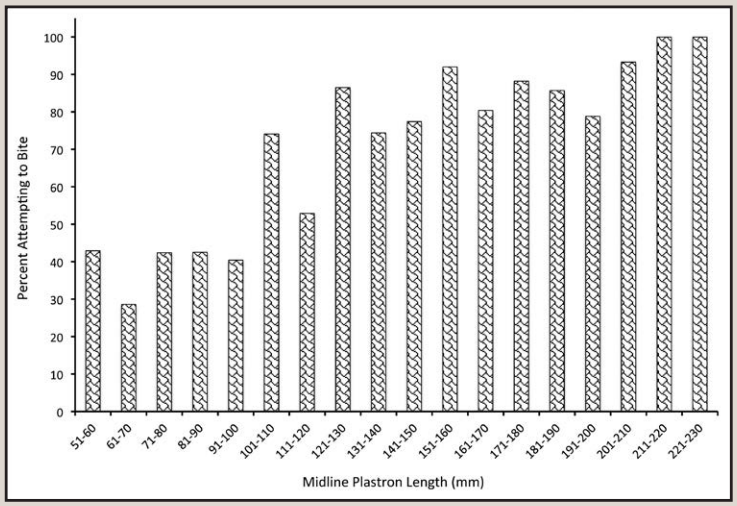


Fig. 1. Biting frequency as a function of midline plastron length in *Trachemys scripta*.

Table 1. Biting attempts by *Trachemys scripta* of different age and sex classes.

Class	N	Number attempting to bite	Percent attempting to bite	Mean ± SE MPL (mm)
Melanistic males	69	62	89.9	172.2 ± 1.52
Partially melanistic males	66	59	89.4	155.3 ± 1.27
Non-melanistic males	158	118	74.7	126.9 ± 1.35
Females	119	100	84.0	192.0 ± 1.36
Juvenile females	49	30	61.2	136.6 ± 2.70
Unsexed juveniles	132	54	40.9	82.4 ± 1.00

Table 2. Logistic regression analysis of the effect of plastron length on biting propensity in *Trachemys scripta*.

Group	P	Odds ratio	95% Wald C.L.	% Concordance	C (area under ROC curve)
All Turtles	<0.0001	1.023	1.018–1.029	73.8	0.740
Adult males	<0.001	1.028	1.015–1.042	67.5	0.678
Melanistic males	0.5089	1.021	0.960–1.087	59.0	0.600
Partially melanistic males	0.3927	1.035	0.956–1.112	60.5	0.615
Non-melanistic males	0.0086	1.032	1.008–1.057	63.0	0.633
All females	<0.0001	1.026	1.013–1.039	70.3	0.705
Adult females	0.0614	1.037	0.998–1.078	62.1	0.624
All juveniles	0.0026	1.017	1.006–1.029	60.4	0.608
Juvenile females	0.0231	1.040	1.005–1.077	70.2	0.706
Unsexed juveniles	0.6249	1.008	0.977–1.039	51.0	0.525

Male melanism was determined by the degree of melanin deposited on the shell and the degree that the line pattern on the skin was obscured. Adult males were scored as nonmelanistic (NM), partially melanistic (PM), or fully melanistic (MM). Nonmelanistic turtles had bright, defined line patterns on the integument with no melanin deposited on the plastron. Partially melanistic turtles had line patterns that were still visible, but noticeable melanin deposited on both the integument and the plastron. In fully melanistic turtles, the line patterns were completely obscured by melanin, and the plastron was completely melanized. These three stages are similar to the categories of progressive melanism described by Tucker et al. (1995).

Statistical Analyses.—We used logistic regression to determine whether biting attempts were predictable from plastron length or degree of melanism in adult males. Logistic regression was used to model the relationship between plastron length and biting attempts for all turtles, all adult males, nonmelanistic males, partially melanistic males, fully melanistic males, all females, adult females, juvenile females, and unsexed juveniles. We also conducted a Chi-square contingency analysis to determine whether frequencies of biting attempts were the same for nonmelanistic, partially melanistic, and fully melanistic males. We used an ANOVA to determine whether plastron length differed among the three groups of adult males. All data analyses were generated using SAS software (Version 9.1). For all statistical tests we used an alpha level of 0.05.

Results

We captured 593 *T. scripta* over the course of the study, of which 423 (71.3%) exhibited a biting response (Table 1). The stepwise logistic regression removed melanism as a significant predictor of biting response in adult males and indicated that plastron length predicted propensity to bite. However, melanistic individuals were significantly larger than nonmelanistic individuals ($F = 259.8$, $P < 0.001$). Therefore, we ran a logistic regression using plastron length alone for adult males and plastron length was a significant predictor of biting response ($P < 0.001$, Odds Ratio = 1.028). Although Chi-square contingency analysis indicated that melanistic and partially melanistic males are more likely to bite than nonmelanistic males ($\chi^2 = 9.85$, df = 1, $P = 0.0017$), the logistic regression suggests that their higher propensity to bite is related to body-size differences. Logistic regression also indicated that plastron length was a significant predictor of biting response for all turtles combined, nonmelanistic males, all females, all juveniles, and juvenile females (Table 2). Fig. 1 shows the increase in biting attempts as plastron length increased for all turtles combined. In addition to *P*-values, Table 2 includes three other methods for determining the goodness-of-fit for a logistic regression model. In determining goodness-of-fit, a good model will show that the Odds Ratio Confidence Interval should not include the value of 1 and should have a narrow range, % concordance should be large (the closer to 100% the better), and area under the Receiver Operating Characteristic (ROC) curve should be large (the closer to 1 the better). The *P*-values corresponded with values for these other methods. For example, the most significant *P*-value of <0.0001, for all turtles combined, corresponded to the highest % concordance and area under the ROC curve.

Discussion

We tested two hypotheses about biting in Red-eared Sliders: 1) body size is a significant predictor of propensity to bite; 2) degree of melanism in males is a significant predictor of propensity to bite. These hypotheses were not mutually exclusive because degree of melanism was correlated with body size as reported by Lovich et al. (1990). Therefore, the effect of body size on propensity to bite had to be accounted for before the effect of melanism could be properly evaluated.

Our results supported the body-size hypothesis. Using logistic regression, we demonstrated a strong relationship between body size and biting. In the Red-eared Slider, biting propensity increases with an increase in body size in juveniles, females, and nonmelanistic males, groups in which melanism is not a factor. This seems to indicate that regardless of other factors, such as sex and melanism, body size is the predictor of biting. Bite force increases with increasing body size in many species of turtles (Herrel et al. 2002). Therefore, biting should be a more effective defensive strategy in larger turtles. Conversely, smaller turtles might be better off keeping their head retracted, even in species that lack plastral hinges, such as red-eared sliders.

Our results did not support the melanism hypothesis. Using logistic regression, the effects of melanism on bite propensity were not significant. The evolution of melanism in Red-eared Sliders has been widely discussed (Lovich et al. 1990; McCoy 1966; Thomas 2002; Tucker et al. 1995). In general, interest has preceded data (see Thomas 2002), producing a surplus of hypotheses that have remained mostly untested (Lovich et al. 1990). In particular, the hypothesis that melanism evolved via sexual selection has a number of untested or anecdotal components, including the assertion that melanistic males are more aggressive than non-melanistic males (Cagle 1950; Cahn 1937; Carr 1952; Lardie 1983; Parker 1990; Tucker et al. 1995). Our data suggest that any differences in aggressive behavior between melanistic and non-melanistic males are the result of differences in body size.

We recorded biting attempts toward a human observer instead of attempting to observe intrasexual aggression. Many reports of increased aggression in melanistic males are based on observations involving turtles and human observers (Cagle 1950; Cahn 1937; Carr 1952; Mafli et al. 2011; Tucker et al. 1995;). While this may validate our experimental design, it seems clear that making observations of interactions between conspecifics of different sizes and degrees of melanism in a natural setting would be preferred. Most progress in sexual selection theory has been made using animal models that are easy to observe in nature such as fish, lizards, and birds (reviewed in Andersson 1994). Less is known about behavior and social systems of freshwater turtles because they often live in turbid water, making direct observations difficult. Instead, speculation often prevails, such as we have addressed herein. The behavior of freshwater turtles is likely to be interesting, but advancing our knowledge in this area will likely require carefully designed experiments rather than anecdotal observations coupled with speculation.

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Body Size and Sex Ratio in a Population of Spotted Turtles (*Clemmys guttata*) in Southwestern Michigan

Body size within populations of reptiles can vary as a function of age, genetics, sex, and random variation in resource acquisition among individuals (Andrews 1982; Gibbons and Lovich 1990). Within freshwater turtle populations, body size distributions show a preponderance of large adults due to either low recruitment (Browne and Hecnar 2007) or sampling methods that favor the collection of adults relative to juveniles (Ream and Ream 1966; Reeves and Litzgus 2008). Among populations, differences in mean, minimum, and maximum body sizes may be influenced by variation in environmental factors such as diet, primary productivity, and climatic factors that affect environmental temperature and growing season length (Iverson 1992; Iverson and Smith 1993). Among populations of some species of freshwater turtles for example, mean population body size (carapace length or mass) and some measures of reproductive output (e.g., clutch size) are positively correlated with longitude, latitude, or both (*Chelydra serpentina*, Iverson 1992; Iverson et. al. 1997; *Chrysemys picta*, Iverson and Smith 1993). Relatively large body size at more northern latitudes (Bergmann's Rule) may be related to heat retention (Ashton and Feldman 2003; Mayr 1963) or to enhanced energy acquisition and storage for

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TABLE. 1. Demographic (J = juveniles, including hatchlings, F = females, M = males), sex ratio, and body-size statistics across the distributions of *Clemmys guttata*.

Population number	Location of population	N (J : M : F)	Sex ratio M : F	CL (mm) Mean Min–Max	PL (mm) Mean Min–Max	Mass (g) Mean Min–Max	Study
1	Lancaster Co.,	–	1 : 1.5	–	F: 89.8 – M: 86.3 –	–	Ernst 1976 (as reported in Litzgus and Brooks 1998a)
2	Cedar Bog, Ohio	–	–	F: 92.4 – 86.1 –	80.7 –	– –	Lovich 1985 (as reported in Litzgus and Brooks 1998a)
3	Lockport Prairie, Illinois	–	–	F: 106.4 – M: 104.8 –	F: 94.9 – M: 87.9 –	–	Mauger 1990 (as reported in Litzgus and Brooks 1998a)
4	Cedar Swamp, Massachusetts	7 : 12 : 21	1 : 1.8	F: 110.2 79–126 M: 113.3 105–123	F: 101.5 72–116 M: 96.4 89–105	–	Graham 1995
5	Georgian Bay (inland), Ontario	11 : 49 : 58	1 : 1.2	F: 115.0 – M: 116.3 –	F: 101.1 – M: 94.9 –	–	Litzgus and Brooks 1998a
6	Perry Nuclear Site, Ohio	–	–	F: 98.0 – M: 104.8 –	F: 87.3 – M: 87.6 –	–	Collins (as reported in Litzgus and Brooks 1998a)
7	Mer Bleue Bog, Ontario	5 : 6 : 21	1 : 3.5	F: 106.4 – M: 108.5 –	F: 192 – M: 187 –	–	Seburn 2003
8.	Francis Beidler Forest, South Carolina	6 : 17 : 21	1 : 1.2	F: 103.8 – M: 105.2 –	F: 91.2 – M: 86.8 –	F: 190 – M: 168 –	Litzgus and Mousseau 2004
9	Georgian Bay (island), Ontario	11 : 6 : 23	1 : 3.8	F: 108.9 – M: 117.9 –	F: 96.8 – M: 97.0 –	F: 212.2 – M: 219.8 –	Reeves and Litzgus 2008
10	Southwestern Michigan	10 : 28 : 47	1 : 1.7	F: 88.2 66–114 M: 87.5 65–105	F: 80.3 53–105 M: 75.7 48–90	F: 105.9 45–200 M: 102.3 54–150	Present study

growth or reproduction in a seasonal environment (Iverson and Smith 1993; Iverson et al. 1993; Olalla-Tárraga et al. 2006; Rollinson and Brooks 2007).

Sex ratios skewed toward either sex can result from intersexual differences in natality, mortality, or maturation schedules in freshwater turtles (Gibbons 1990; Lovich and Gibbons 1990; Lovich et al. 1990). Skewed operational sex ratios could impact reproductive output and thus population growth rate because members of the more abundant sex may have limited access to mating opportunities (Fisher 1930). Variation in primary sex ratio (sex ratio at hatching) can be related to a bias in nest thermal conditions that favor the development of one sex or through temperature-dependent sex determination (Gibbons 1990; Lovich and Gibbons 1990). Intersexual differences in seasonal movement patterns (nesting forays by females and overland travel by males for mating purposes) can lead to skewed secondary sex ratios if individuals experience differential mortality rates while terrestrial (Aresco 2005; Gibbons 1990; Gibbs and Steen 2005; Lovich and Gibbons 1990). Age at maturity can impact secondary sex ratio if members of one sex mature before those of the other sex (Georges et al. 2006; Gibbons 1990). For instance, because males do not carry eggs, maturation at the

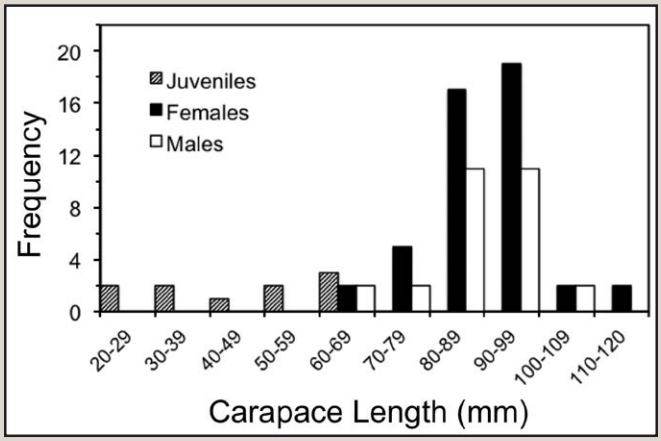


FIG. 1. Body size frequency distributions of juveniles (N = 10), adult female (N = 47), and adult male (N = 28) *Clemmys guttata* from southwestern Michigan, 2004–2007.

smallest size possible for successful reproduction can lead to male-biased secondary sex ratios (Dunham and Gibbons 1990; Lovich and Gibbons 1990).

The Spotted Turtle (*Clemmys guttata*) is widely, but discontinuously, distributed over a range of latitudes that span eastern North America as far south as Florida, USA, and as far north as southeastern Ontario, Canada (Ernst and Lovich 2009). *Clemmys guttata* occupies a range of habitats including various shallow wetlands and uplands (Litzgus and Brooks 2000) and coupled with its broad distribution, local and latitudinal body-size variation among populations would be expected. Mean population body size is positively, but weakly, correlated with latitude and may actually be intermediate at more intermediate latitudes (Litzgus et al. 2004), which could reflect a trade-off between growth and body size and clutch frequency (Litzgus and Mousseau 2006). In order to clearly understand broad-scale geographic variation in body size of *C. guttata* given the substantial variation in mean population body size within a region (Litzgus and Brooks 1998a; Litzgus et al. 2004), a comprehensive documentation of body-size variation throughout the distribution will be critical. Sex ratios are either equal or female-biased in *C. guttata* (Reeves and Litzgus 2008; Seburn 2003) and potential causes of skewed sex ratios include nest-site selection biases that cause differential production of females through temperature-dependent sex determination (Schwanz et al. 2010) or differential mortality and longevity of the sexes (Litzgus 2006; Martins and Souza 2009).

We studied body-size variation and sex ratio in a *C. guttata* population in southwestern Michigan. A paucity of life-history information has been reported for *C. guttata* from Michigan and few data have been reported from the northwestern part of the species' range. If body size is correlated with latitude (Litzgus and Brooks 1998a), then we expected that mean body size (carapace length and body mass) should be relatively large given the northern location of our population. We expected a 1:1 secondary sex ratio because there is no indication that nest-site selection is related to the determination of sex through temperature-dependent sex determination in *C. guttata* (Lovich and Gibbons 1990). Although female longevity may exceed that of males in some *C. guttata* populations (Litzgus 2006; Seburn 2003), the turtles of our study population reside in a single wetland year-round (Rowe et al., *in press*) and elevated mortality that occurs during long-distance treks for nesting or mate seeking should be minimal and result in a secondary sex ratio of parity.

Materials and methods.—Our study site is a 14-ha wetland in southwestern Michigan, USA (42°N, 85°W; elev. 228 m) that is dominated by grasses (chiefly *Spartina pectinata* and *Eriophorum virginicum*), sedges (*Carex* spp.), Leather Leaf (*Chamaedaphne calyculata*), various ferns (chiefly *Matteuccia struthiopteris* and *Pteridium aquilinum*), and *Sphagnum* sp. mounds and bordered on all sides by Tamarack (*Larix laricina*) and White Cedar (*Thuja occidentalis*) swamp (see Rowe et al. *in press* for a more detailed site description). Between May and August of 2004–2007 and 2009, we searched the study site and located turtles as they were aquatically active in deer trails or in depressions, or when they were terrestrial on vegetation. We measured maximum straight-line carapace length (CL) to the nearest 1 mm using calipers (50 cm, Haglöf aluminum tree caliper, Långsele, Sweden) and body mass (BM, g) using spring scales (100 g, Pesola, Kapuskasing, Ontario, Canada). Because male and female *C. guttata* mature at similar ages and sizes (Litzgus and Brooks 1998a), we considered individuals that lacked male secondary sex characteristics (concave plastron and relatively long pre-cloacal tail length) and that had CL values that were equal to, or exceeded, that of the smallest identifiable male (65 mm) to be adult females (Ernst and Lovich 2009). We included morphometric measurements only from the initial capture of an individual to maintain statistical independence. We uniquely marked individuals by shell notching (Cagle 1939) and released them at their capture sites within several hours.

Results and discussion.—A majority of individuals in the population were adults, with females being more numerous than males. We captured 85 turtles of which 10 were juveniles (12%), 47 (55%) were females, and 28 (33%) were males (Fig. 1). Similarly, throughout the range of *C. guttata*, juveniles and adults averaged 16% (9–28%) and 82% (73–91%) of the total population, respectively (N = 5, populations 4–5 and 6–9 in Table 1). While a small percentage of juveniles might suggest low recruitment (Ernst 1976), hatchlings and relatively small juvenile turtles may be difficult to find (Reeves and Litzgus 2008) or occupy microhabitats that are different from those of adults (Congdon et al. 1992). However, we found both juveniles and hatchlings within the boundaries of our study site. It therefore seems probable that if more than 50% of female *C. guttata* reproduce nearly annually (Litzgus and Mousseau 2006), hatchlings and larger juveniles would have been more frequently collected if juvenile survivorship were high.

In contrast to our prediction, we did not find that average body size was relatively large in our population of *C. guttata* that is in the northern part of its distribution (Litzgus and Brooks 1998a) and at a relatively high latitude (Iverson 1992; Iverson and Smith 1993). In fact, mean CL values for female (88.2 mm) and male (87.5 mm) *Clemmys guttata* of our northern population were near the lower range of values reported for populations throughout the species' range (female: mean = 105.1 ± 2.4 mm, 92–115 mm; male: mean = 107.1 ± 3.3 mm, 86–116 mm; N = 8 populations 2–9 in Table 1). Similarly, Litzgus et al. (2004) found mean population CL values of near 100 mm throughout most of the range of *C. guttata* except at approximately 39°N where it declined to between 90 and 100 mm.

When we incorporated our data with previously studied populations of *C. guttata* (N = 9, populations 2–10 in Table 1), Spearman-rank correlations indicated that neither CL nor BM was correlated with latitude within either sex or for both sexes combined ($P > 0.05$). Similarly, Litzgus et al. (2004) found a weak correlation between body size and latitude only when a very

northern and large-bodied population was included in their data set. Positive correlations between latitude and mean population body size are well established among populations within freshwater turtle species (*Chrysemys picta*, Iverson and Smith 1993; *Chelydra serpentina*, Iverson et al. 1997; *Clemmys muhlenbergii*, Lovich et al. 1998; *Emys orbicularis*, Zuffi et al. 1999) and among freshwater turtle species (Iverson 1992; Iverson et al. 1993). Rapid seasonal growth in northern populations relative to southern populations seems likely to be related to delayed sexual maturation or compensatory rapid individual growth rate in an environment with low annual primary production and short growing seasons (Iverson 1992; Iverson and Smith 1993). While it is possible that latitude positively affects growth rate and body size in *C. guttata*, its relatively small body size coupled with local variations in environmental conditions (see below) that affect growth might have obscured statistically significant correlations.

Variation in habitat quality is likely to influence both turtle density (Reeves and Litzgus 2008) and individual growth rate, ultimately causing variation in mean body size among populations of *C. guttata*. Litzgus and Brooks (1998a) reported that age and size (PL) at maturity vary among *C. guttata* populations (female mean = 78.8 mm, 72–88 mm; male mean = 78.8 mm, 70–80 mm; N = 4 populations). Within populations, age and size at maturity can vary among individuals within the sexes (Ernst and Lovich 2009) but age and size at maturity appear to be similar between the sexes in *C. guttata* (Litzgus and Brooks 1998a). Interestingly, Litzgus and Brooks (1998a) found that age and size at maturity and mean and maximum body size in an Ontario population exceeded values reported from more southern populations. Delayed sexual maturation and large mean body size may increase clutch size and mass when the growing season is relatively short, such that multiple annual clutches, or even annual clutch production, are constrained (Litzgus and Brooks 1998b; Litzgus and Mousseau 2006). Minimum adult body size in our relatively northern population, at least for males for whom sexual maturity was readily discernible (CL = 65 mm, PL = 48 mm), seems well below values reported for other populations (Litzgus and Brooks 1998a). Assuming approximately similar age and size at maturity between the sexes in our population (Litzgus and Brooks 1998a), it seems likely that small mean body size was at least in part related to relatively small body size at maturity (Dunham and Gibbons 1990). At 40°N in Pennsylvania, Ernst (1970) reported minimum sizes at maturity of 81 and 83 mm for females and males, respectively, and mean PL values of 90 and 86 mm, respectively (from Ernst 1976 as estimated by Litzgus and Brooks 1998a). At our slightly more northern latitude (42°N), our comparatively small mean, minimum, and maximum PL values (Table 1) further support our conclusion that local conditions probably affect growth rates regardless of latitude and that maturation at a small body size affects mean population body size.

We suggest that individual growth and body size in our population could be seasonally limited moreso than in some other previously studied populations of *C. guttata*. A radiotelemetric study of *C. guttata* at our site indicated that turtles estivated between late June and early August and did not move to distant, more favorable habitats to continue feeding during drought (Rowe et al., *in press*); this annual period of aphagia may have resulted in overall smaller body sizes. Across the distribution of *C. guttata*, mean population clutch size and egg size are positively correlated with maternal body size and therefore with latitude (Litzgus and Mousseau 2006). Relatively small turtles at intermediate latitudes (ca. 39°N; Litzgus et al. 2004) could reflect a transition zone between turtles in southern populations that show relatively rapid pre-maturation growth with the production of one or more annual clutches and turtles in more northern populations that invest in rapid pre-maturation growth at a cost of producing one or fewer annual clutches (Litzgus and Mousseau 2006; Litzgus et al. 2004). Our small mean population body sizes indicate that local variation in life-history traits is not yet completely understood in *C. guttata*. It would be interesting to know if annual clutch frequency in our small-bodied *C. guttata* population is similar to that of turtles in populations within the "transition zone" as proposed by (Litzgus et al. 2004).

In our population, sex ratio was significantly skewed in favor of females (1 M : 1.7 F; $\chi^2_1 = 4.8$, $P < 0.05$). Similarly, female-biased sex ratios have been reported from other *C. guttata* populations (Table 1) and, with our data included, average 1 M : 2.1 F.

Differential adult mortality is the likely cause of our biased sex ratio, as alternative explanations seem inapplicable to our population. Because *C. guttata* have temperature-dependent sex determination, a female hatchling bias might be the result of warm temperatures during incubation (Ewert and Nelson 1991; Gibbons 1990). Female-biased sex ratios that result from latitudinal variation in environmental temperatures seem unlikely because female-biased sex ratios occur at northern latitudes where incubation temperatures are cooler and equal sex ratios occur at southern latitudes where incubation temperatures are warmer (Litzgus and Mousseau 2004). Reeves and Litzgus (2008) discounted differences in incubation conditions as a source of sex ratio bias between two local *C. guttata* populations because nesting conditions appeared to be identical at both of the Ontario sites. Differences in activity, movement, and habitat use patterns between the sexes (Litzgus and Brooks 2000) could lead to collecting biases or intersexual differences in mortality rates (Gibbons and Lovich 1990; Reeves and Litzgus 2008). However, because radio-tagged *C. guttata* in our population remained within a single wetland year-round and members of both sexes estivated in synchrony (Rowe et al. in press), sampling biases that are related to differential activity (Ernst and Zug 1994; Gibbons and Lovich 1990) or road mortality (Gibbs and Steen 2005) should have been minimal.

Litzgus (2006) found that females may live 1.7 times longer than males in an Ontario population, perhaps because males expend relatively large amounts of energy or experience elevated exposure to predators as they search for widely-dispersed females during the mating season (Morreale et al. 1984). Differential mortality between the sexes following sexual maturation seems the likely cause of the sex ratio bias in our population because the frequencies of each sex are fairly similar in the smallest age class but diverge through the midrange size classes (Fig. 1). However, the necessary assumptions that *C. guttata* age and size are correlated (Ernst 1975; Litzgus and Brooks 1998a) and that age-specific mortality rates of each sex are constant over the lifetimes of the individuals, both of which may change over time (Browne and Hecnar 2007), remain to be tested in our population.

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Reproductive Behavior of *Anotheca spinosa* (Anura: Hylidae) Under Natural Conditions in Costa Rica

Anotheca spinosa (Steindachner 1864) is a medium-sized casqued-headed frog inhabiting mainly undisturbed areas in premontane rainforests from Mexico to Panama (Savage 2002). Despite being described almost 150 years ago, the breeding behavior of this species in nature is poorly known. Tadpoles have been reported from inside bromeliads (Taylor 1954), water-filled tree holes (Duellman 2001; Robinson 1961), and bamboo (Jungfer 1996). Most information on the breeding biology of *A. spinosa* is derived from individuals found in nature and then raised in captivity (Jungfer 1996; Savage 2002), and all the information available on the breeding behavior of the species to date comes from a single report (Jungfer 1996).

Herein, we present new information on the breeding behavior of *A. spinosa* in nature, providing data on the size of egg masses, tadpole feeding habits and growth, and the male advertisement call. To our knowledge, this is the first report of the reproduction of *A. spinosa* under natural conditions.

Materials and Methods

Observations were made from May to August 2006 in a 7-ha organic coffee farm surrounded by cattle pastures and coffee plantations in Cartago, Costa Rica (9.8423°N, 83.8503°W; elev. 1300 m). The nearest town was 1 km away. Along the edges of streams at the site are small patches of secondary-growth forest. The section of the coffee plantation where the observations were made is ca. 1300 m^2, next to a dirt road and surrounded by a living fence composed of native and some introduced plant species (e.g., conifers). The number of days between visits varied so we refer to each visit by the number of days after the first visit.

We made observations of egg masses, tadpoles, and adults. Eggs and tadpoles were observed in bromeliads from 0 to 1.5 m above the ground. We counted the number of visible eggs attached to the bromeliad leaf and floating in the water in the leaf axils. If tadpoles were present, we counted them and staged all or one of them according to Gosner (1960) using a 20x magnifying glass. We determined whether tadpoles had been eating eggs by looking for eggs in their guts since we could see through their skin. We measured the snout–vent length (SVL) of adults, except for individuals found in amplexus. For individual identification we used overall phenotypic patterns. When we found a male calling, we recorded the call with a portable cassette recorder (Marantz PMD222) and a Telinga Parabola with a Sennheiser ME66 microphone. Advertisement call analyses were performed in RAVEN 1.2 (Charif et al. 2004), using a fast Fourier transformation length of 512 samples, Hann window, and 90% overlap.

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Results and Discussion

Breeding behavior.—On 21 May 2006 at around 1930 h, a pair of *A. spinosa* was found in amplexus, laying eggs on a bromeliad 70 cm above the ground. Both individuals were immersed in the water tank of the leaf axil with their heads facing upwards (Fig. 1). The behavior of the pair in amplexus, submerged in the water, is partially consistent with observations described for individuals in captivity (Jungfer 1996) except that the pair we found had their heads out of water rather than underwater. The male left the bromeliad two hours later, and the female remained immersed in the water for another three hours. We could not tell if the eggs were laid that day or days before, but based on our later observations it is very probable that they were laid that night. Eggs were floating on the water and attached to the leaf. At the same time there were other two males calling simultaneously, providing evidence of at least three males and one female in the area.

Advertisement call.—We recorded the call of the three males, but we only located one (SVL 70 mm, 21.5 g), which was found twice during subsequent visits within an area of ca. 90 m^2. This male was calling early at night (1900 h) from a bromeliad leaf axil full of water (water temperature 18°C), 45 cm above the ground. Our observations of males calling from water-filled bromeliad axils coincide with the information reported by Savage (2002). The male's call consisted of a singly pulsed note repeated at a regular interval (Fig. 2). The lengths of calling bouts varied among bouts within individual males and among males. Males usually began calling with short bouts, increasing the duration over the night. Pulse duration ranged from 0.102 to 0.161 sec with an inter-pulse interval between 0.46 and 0.25 sec. The fastest-paced call had 1.88 pulses/sec. Each calling bout was separated by a pause lasting from three to five min. The calling bouts of two males ranged from 107 to 480 pulses (2–168 pulses), and lasted between 54 and 234 sec. Pulse peak frequency varied along the duration of the call, with lower peak frequencies at the beginning of the call, ca. 375 Hz up to 560 Hz. When harmonics were present, the dominant frequency was found in the first harmonic. The calls usually began at a very low intensity, barely audible to the human ear, and continued rising in intensity until they could easily be heard from more than 100 m away. The calling activity of the other two males lasted for 45 min and two hours each.

Tadpole development and survival.—We located only four bromeliads occupied by tadpoles, adults, or both. The maximum number of eggs observed in a leaf axil was 166; the minimum number of tadpoles found in a leaf axil was three. For those axils where less than five tadpoles were found, we were not able to locate them in subsequent visits.



FIG. 1. *Anotheca spinosa* pair in amplexus and eggs.

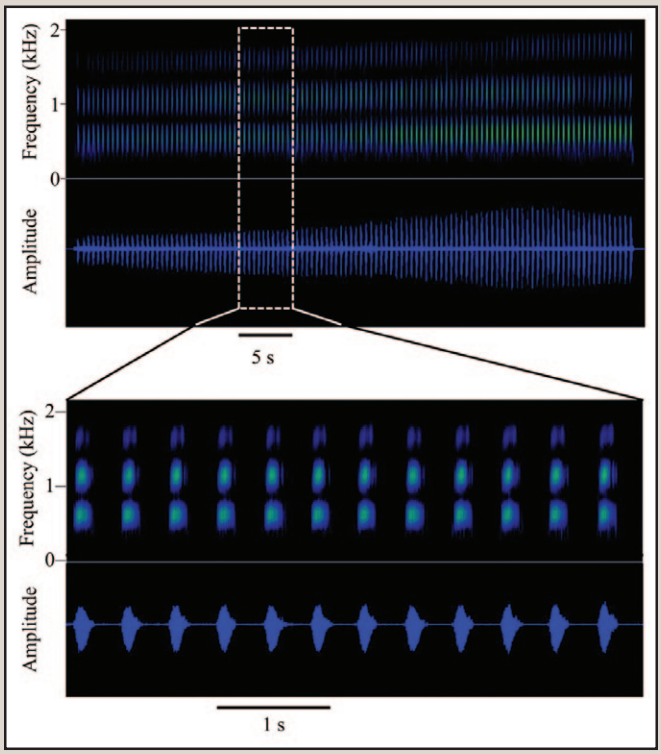


FIG. 2. Spectrogram and oscillogram of the call of a male of *Anotheca spinosa* recorded at 18°C.

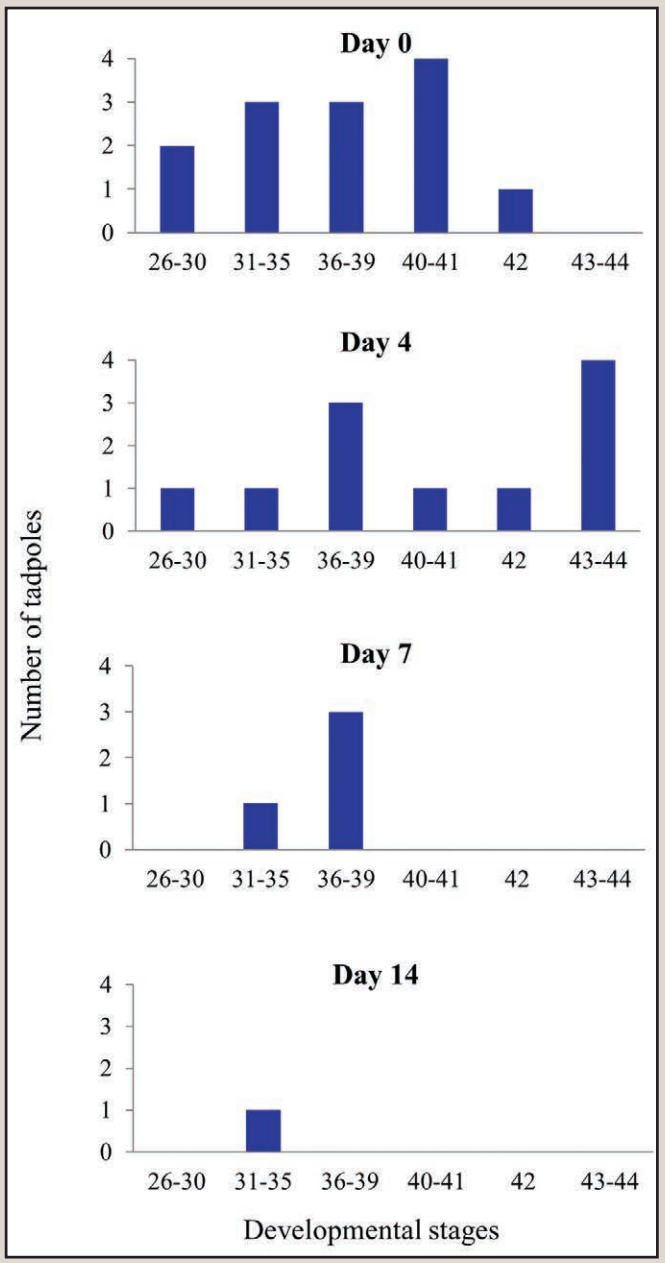


FIG. 3. Number of tadpoles by Gosner (1960) developmental stages found in a single leaf axil over time.

One week after we observed the pair in amplexus there were 35 tadpoles in the same axil; two and three weeks after oviposition only two tadpoles remained in the leaf axil. To avoid the possibility that disturbance may compromise their development, we did not measure these tadpoles, but we could observe they had not reached the stage when hind legs are noticeable (stage 36). In another bromeliad, we observed 13 tadpoles between stage 26 and 42 (Gosner 1960). Fourteen days after the first visit only one tadpole at stage 31–35 remained in this bromeliad (Fig. 3)

CONCLUSIONS

Jungfer (1996) described *A. spinosa* amplexing late at night and laying eggs during the day, while we found a pair of *A. spinosa* in amplexus early in the night, with the female already having laid eggs. As we did not record the starting time of the amplexus, it is possible that this pair may have been in amplexus since the previous night. At our study site, the number of eggs and tadpoles varied greatly among bromeliads; Jungfer (1996) reported similar information from different regions. Our study found the largest number of *A. spinosa* tadpoles in a single axil (N = 35) reported in nature to date. This number is also higher than the maximum number of tadpoles hatched in captivity so far.

Anotheca spinosa is classified as Near Threatened (NT) on the IUCN Red List due primarily to habitat loss over much of its range (Santos-Barrera et al. 2004). During the last revision of this list in 2004, the species was reclassified to Least Concern (LC) largely due to anecdotal reports of this species in disturbed areas. The fact that we found this species in a highly disturbed area near a busy dirt road, and reproducing in a bromeliad in

front of a house supports that this species is able to breed in disturbed areas. More data on recruitment success and long-term population trends are necessary.

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Spectral Analysis Reveals Limited Potential for Enhanced-Wavelength Detection of Invasive Snakes

Effective control of invasive species often requires novel and multifaceted approaches. A comprehensive approach to the control of invasive Brown Treesnakes (*Boiga irregularis*) on Guam includes trapping (Rodda et al. 1999; Tyrrell et al. 2009), application of toxicants (Savarie et al. 2001), olfactory detection by dogs (Savidge et al. 2011), and visual detection by human searchers (Christy et al. 2010; Rodda and Fritts 1992). While visual searching far surpasses trapping in successfully targeting all size classes of snakes (Rodda et al. 2007), it is not cost effective to implement in large-scale control efforts due to high labor demands and inherently low detectability of these cryptic snakes (Christy et al. 2010). Technologies that significantly and cost-effectively increase the detectability of snakes by human searchers may be welcome additions to a comprehensive toolbox for invasive species research and management.

Though the coloration of invasive snakes to the unaided human eye may be cryptic and not easily distinguished from the surrounding habitat, it has been hypothesized that detection could be facilitated by selectively filtering or amplifying portions of the visible light spectrum or converting invisible infrared or ultraviolet wavelengths in to high-contrast visible proxy images (as is done by night vision goggles). Such novel applications of advanced technologies have inherent appeal, but should be thoroughly vetted before significant investment of scarce resources. Thorough vetting of proposed control technologies reduces the likelihood of investment in projects with limited potential for success, and may redirect the allocation of resources toward lines of research that are more likely to bear fruit and be cost-effective.

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Spectroscopy is the study of light as a function of wavelength. Objects reflect light differently at varying wavelengths. Variation in reflectance within the visible range of the electromagnetic spectrum is how we perceive color; however, objects also vary in how they reflect light at wavelengths beyond those we can perceive with the human eye, such as in the ultraviolet and infra-red wavelengths (see Fig. 1). An object's reflectance of electromagnetic radiation as a function of wavelength is known as a "spectral profile." In comparing objects, marked differences between their spectral profiles provide the contrast that can be used to differentiate between them.

Our objective was to determine whether the spectrum profiles of Brown Treesnakes exhibit any absorptions in reflectance which may be exploited to increase our ability to distinguish them from surrounding vegetation. If such spectral features exist within the visible range of the spectrum, we might increase an observer's chance of sighting a snake by preferentially filtering or supplementing light at key wavelengths through filtered lenses or light sources. Should such features be found in the non-visible ultraviolet or infrared domains, potential may exist for developing technologies which use sensors responsive to the targeted wavelength and translate the signal to a high-contrast visible image.

Materials and Methods.—To assess whether Brown Treesnakes have any spectral reflectance features that might be exploited in order to increase our ability to detect snakes in surrounding vegetation, we used an ultraviolet-near infrared (UV-NIR) field spectrometer to characterize the spectral profiles of dorsal, lateral and ventral surfaces of six captive Brown Treesnakes collected from Guam. Laboratory reflectance measurements were made with an ASD Inc. Fieldspec® Full Range Spectrometer over the wavelength range from 0.35–2.5 microns using a halogen lamp

for illumination and Spectralon® panel for reference. These spectra were converted to absolute reflectance using a NIST traceable spectralon reflectance spectrum. The ASD spectrometer has 5-nm spectral resolution from 0.35–1.0 microns and 11-nm spectral resolution from 1.0–2.5 microns. Snakes were measured while they were held within the beam of the tungsten lamp about 1 m distant from the light source. The ASD fiber optic probe was held perpendicular to the skin surface and 10 six-second spectra were collected at each location on the snake's body. These ten spectra were co-averaged and converted to absolute reflectance for comparison of skin absorption features. Snake spectra were plotted against reference spectra for woody and leafy vegetation and examined for wavelengths of marked contrast (Fig. 2).

Ideally, we hoped to identify one or more wavelengths at which Brown Treesnakes exhibit a peak of reflectance with respect to other objects in their environment (primarily woody and leafy vegetation). Spectra were also recorded from a Common House Gecko (*Hemidactylus frenatus*) and a Mangrove Monitor (*Varanus indicus*) as these species may also be encountered during Brown Treesnake surveys. Additionally, we took this opportunity to determine whether diagnostic absorption features existed for a Brown Treesnake (*Boiga irregularis*) from Indonesia, a closely-related Mangrove Snake (*Boiga dendrophila*), a Western Hognose Snake (*Heterodon nasicus*), and a Massasauga (*Sistrurus catenatus*). This methodology provides a high-resolution spectrum profile for the entire range of wavelengths investigated. It is not proposed as a field application for snake detection, but rather to identify a small subset of wavelengths which could be selectively filtered or amplified with equipment designed for field detection.

Results and Discussion.—Sample spectra from the ventral, lateral, and dorsal surfaces of a single Brown Treesnake specimen are plotted against reference spectra from woody and leafy vegetation in Fig. 2, while the range of all spectra from three surfaces of six Brown Treesnakes are depicted in Fig. 3. The only range within which Brown Treesnake reflectance exceeds the reflectance of vegetation is the ventral surface of the snake across the visible range of the spectrum. High reflectance across the visible spectrum is seen as white. This will be no surprise to experienced Brown Treesnake surveyors whose search image is typically triggered by the white to whitish-yellow underbelly of snakes perched in arboreal activity. The low reflectance of blues, moderate reflectance of greens and higher reflectance of reds in all body surfaces are perceived as the olive-brown color characteristic of Brown Treesnakes, increasing in darkness from ventral to lateral to dorsal surfaces. The lateral and ventral surfaces of Brown Treesnakes are

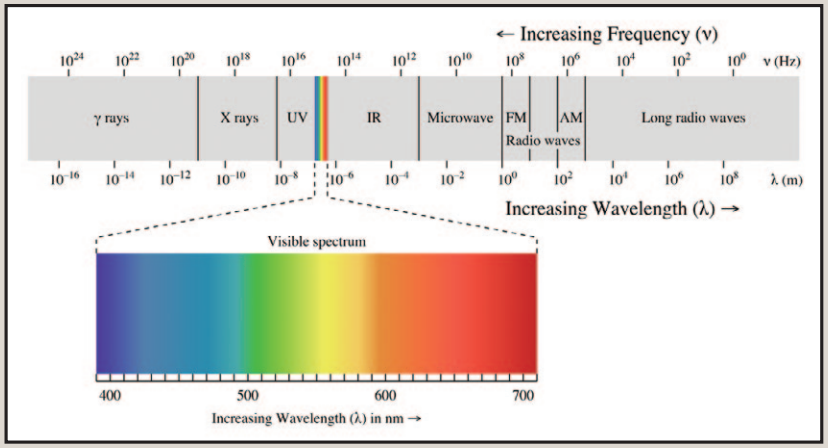


FIG. 1. Electromagnetic spectrum (© Wikimedia Commons, reproduced under the GNU Free Documentation License). The visible portion of the spectrum is from approximately 400–700 nm, or 0.4–0.7 microns.

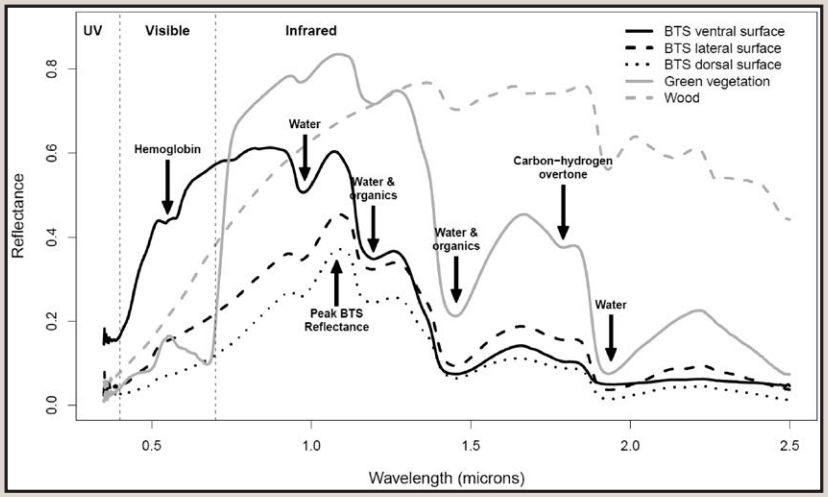


FIG. 2. Plot of spectral reflectance profiles of dorsal, lateral, and ventral surfaces of one Brown Treesnake (BTS) specimen against reference spectra from woody and leafy vegetation. Arrows highlight notable spectral features.

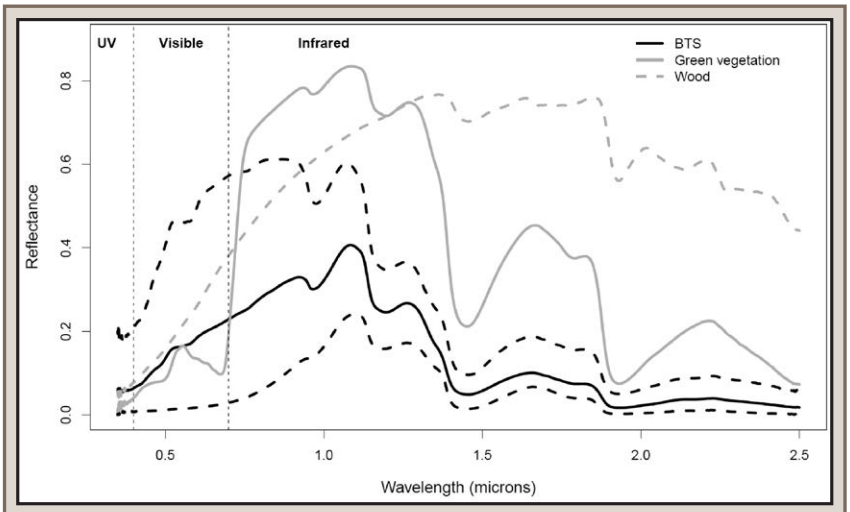


FIG. 3. Spectral reflectance profiles showing the mean (solid black), maximum and minimum reflectance (dashed black lines) from all surfaces (dorsal, lateral, ventral) of six Brown Treesnakes (BTS) against vegetation reference spectra.

as or less reflective than vegetation, requiring observers to rely upon the snake shape aspects of their search image.

While there is a large contrast between lateral and ventral surfaces of Brown Treesnakes and green vegetation in the red range (~0.7 microns), this is also true of woody vegetation. Selective filtering of non-reds or amplification of reds may help to decrease the brightness of green vegetation, but do little to distinguish snakes from the branches and vines which they also resemble in shape.

Within the span of UV wavelengths, the ventral surface of the Brown Treesnake is brighter than dorsal and lateral surfaces of the snake and the vegetation spectra; however, the magnitude of the difference is not much greater than the difference throughout the visible portion of the spectrum and overall UV reflectance is low, indicating that selective enhancement of UV wavelengths is not likely to be worth the additional technological effort required to do so.

Within the infrared domain, all three Brown Treesnake surfaces show a reflectance peak at 1.1 microns (Fig. 2); however, the chlorophyll in leafy vegetation is known to have remarkably high reflectance within the near-infrared, which overwhelms the peaks of Brown Treesnake reflectance and negates any visibility advantages these peaks might have conferred. Nowhere throughout the Brown Treesnake spectra are the hoped-for diagnostic absorptions that would have indicated promising features for selective amplification leading to the desired high-contrast search image and increased detection probability. Using a computerized algorithm exploiting the "shoulderness" of the snake's spectrum as it slopes downward from 1.1 to 1.6 microns, combined with the green peak and chlorophyll absorptions of green vegetation, one could effectively differentiate snakes from dry vegetation (which has "small shoulderness"—flat or shallow slope—from 1.1 to 1.6 microns) and green vegetation (with "large shoulderness," or steep slope) compared to intermediate shoulderness or slope of the snakes' spectra. This assumes that the spatial resolution of the image is fine enough that single pixels would land entirely on the snake. The presence of a chlorophyll band would eliminate the green vegetation while a low shoulderness would eliminate dry vegetation (branches, etc.). Collecting such spectral data at night would pose a challenge, considering the amount of light needed to get a workable signal-to-noise ratio on the detectors. While this may technically be possible, the prospects for cost-effectively implementing such sophisticated technology in a manner practical for use by a field worker are not promising.

The reference vegetation spectra were obtained in North America rather than Guam; however, given the lack of distinctive spectral features in the snake spectrum profiles, there is little reason to believe that Guam's vegetation would be different in any meaningful manner. The results of our lab experiment have indicated that a more expensive effort in Guam is not likely to be worth the investment of resources.

In comparison to the sympatric gecko and monitor species, as well as the four additional snake species tested, all spectra were similar in the UV and IR ranges of the spectrum. Given the taxonomic breadth of species examined here, it is not promising that such features may be observed in other reptile species of invasion concern, such as the Burmese Python (*Python molurus bivittatus*) and other large-bodied boids devastating the native fauna of the Florida Everglades (Dorcas et al. 2012; Dove et al. 2011). All living organisms—including vegetation—exhibit the negative spectral features, or light absorption bands, indicated at ~0.97, 1.20, 1.45, and 1.95 microns which result from absorption by water and/or the carbon-hydrogen and nitrogen-hydrogen bonds of organic compounds (Fig. 2). The ubiquity of these features in biotic organisms negates their utility as characters to discern them from other life forms. All noteworthy differences between Brown Treesnake and other reptile spectra assessed here lie within the visible portion of the spectrum, manifesting in differences in color that are obvious to the unaided eye.

As predators that rely on stealthy foraging or ambush to obtain prey, it is not surprising that the coloration of the Brown Treesnake is difficult to visually distinguish from its surroundings. The results of spectroscopy reflect little potential for simple filtering or single-feature amplification techniques. While there may be some potential for multi-wavelength computer algorithms to enhance snake features while "backing out" characteristic features of vegetation, such technologies are not likely to be cost-effective or practical for field applications in the short term. The apparent lack of significant results reported here is extremely important, in that this small-scale validation of a novel concept has forestalled a hasty investment of scarce resources in a more comprehensive research and development program, and provides important information for others considering similar approaches.

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TECHNIQUES

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Use of an Infrared Thermographic Camera to Measure Field Body Temperatures of Small Lacertid Lizards

Measuring body temperature is crucial in the study of reptiles, as most of their behaviors and physiological processes depend critically on temperature (Angilletta et al. 2002). Different devices have been used to measure deep body temperature in lizards, including mercury thermometers, thermistors, and thermocouples. However, these devices require the use of invasive and considerably stressful techniques for lizards (Avery 1982; Hare et al. 2007; Langkilde and Shine 2006; Moore et al. 1991). Consequently, remote sensing equipments, such as infrared (IR) thermometers, are increasingly used as a non-invasive alternative to measure body temperature of reptiles in the field (Alberts and Grant 1997; Bucklin et al. 2010; Hare et al. 2007). This equipment is inexpensive, lightweight, and easy to use. However, IR thermometers are problematic when used to measure the surface temperature of small-sized animals. This is because the size of the sensing field often exceeds the surface area of the target body, so temperature readings reflect a composite measure of the target animal and the surrounding substrate (Bucklin et al. 2010; Hare et al. 2007). Thermographic cameras offer a potential alternative that may alleviate this problem.

Thermographic cameras are available to measure surface temperature (T°s) and provide several advantages over other non-invasive methodologies: 1) readings can be taken at distances ranging from a few centimeters to several meters; 2) IR images provide data on the temperature of the animal distinct from its immediate surroundings; 3) depending on the measuring distance and the resolution of the camera, it may be possible to obtain simultaneous readings from several points on the body surface of the focal lizard; 4) moving animals can be easily tracked; and 5) it is generally possible to make adjustments (e.g., correcting for emissivity) after the image is collected. Furthermore, modern IR cameras are portable, relatively cheap, and have higher image resolution than the cumbersome first-generation cameras used until recently in herpetological studies (Jones and Avery 1989; Tosini and Avery 1993, 1996).

One potential drawback of thermographic cameras and other remote-sensing equipment is that they provide a measure of surface temperature, while many behavioral and physiological processes arguably depend on deep body temperature (Angilletta et al. 2002). In small ectothermic animals, deep body temperatures should not differ markedly from body surface temperatures (Bell 1980; Jones and Avery 1989; Tosini and Avery 1993), but it is still important to understand and acknowledge the error committed. In this paper, we evaluate the use of an IR camera to estimate deep body temperatures in small lacertid lizards (adult body weight <10 g).

Materials and methods.—We collected thermographic data from five species of small lacertids: *Podarcis liolepis, Po. muralis, Psammodromus algirus, Ps. Hispanicus*, and *Acanthodactylus erythrurus*. Lizards were captured in Valencia (Spain), except for *P. muralis*, which were captured in the eastern Pyrenees (Angoustrine, France). In the laboratory, lizards were housed individually in holding terraria measuring 40 × 20 × 15 cm. Water was provided *ad libitum* while food (mealworm larvae) was provided every two days. Immediately before each test, lizards were weighed and measured (snout–vent length, SVL). During the experiment, each lizard was placed in a small experimental terrarium (20 × 15 × 15 cm) with a thermocouple probe inserted in its cloaca, and restrained under a 125W infrared spotlight (Exoterra IR lamp) that was initially turned off. The thermocouple probe was connected to a quick-reading thermometer (Omega HH96/T, ± 0.1°C) and provided an estimate of deep (core) body temperature (T°b). Ambient temperature in the test area was constantly monitored with a mercury thermometer placed next to the experimental terrarium while lizard body surface temperatures were recorded with a still IR camera (Fluke Ti25). According to manufacturer specifications, this camera has a thermal sensitivity of ≤ 0.09–30°C (90 mK) and a spatial resolution of the thermal image of 320 × 240 pixels. When room and lizard surface temperatures were similar (± 0.5°C) the lamp was turned on and the lizard was allowed to warm until the temperature of its dorsal surface reached 39–40°C, after which time the lamp was turned off and the lizard was left to cool down in the terrarium. To determine the relationship between T°s and T°b, we measured both temperatures simultaneously at one-minute intervals. Finally, we measured operative temperature (i.e., the predicted equilibrium temperature of a nonregulating ectotherm) inside the experimental terrarium with a thermocouple probe inserted into a hollow copper model measuring 64 mm length x 16 mm Ø (Hertz et al. 1993).

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TABLE 1. Body mass, snout–vent length (SVL), and mean and standard deviation of the difference between dorsal surface temperature (T°s) and deep body (i.e., cloacal) temperature (T°b) when lizards were warming and cooling for the five species used in this study.

Species	N	Body mass (g) mean [range]	SVL (mm) mean[range]	Warming T°s-T°b ± SD	Cooling T°s-T°b ± SD
Psammodromus algirus	10	6.86 [5.9–9.8]	64.54 [65–74]	1.78 ± 0.48	0.38 ± 0.29
Psammodromus hispanicus	8	1.91 [1.4–1.7]	44.50 [37–46]	1.44 ± 0.46	0.76 ± 0.29
Podarcis muralis	6	6.20 [6.5–9.4]	61.83 [61–71]	1.00 ± 0.40	0.52 ± 0.30
Podarcis liolepis	10	3.28 [2.0–5.7]	52.90 [47–64]	1.34 ± 0.37	1.15 ± 0.45
Acanthodactylus erythrurus	10	8.71 [6.1–11.0]	68.30 [61–71]	1.76 ± 0.92	0.52 ± 0.30

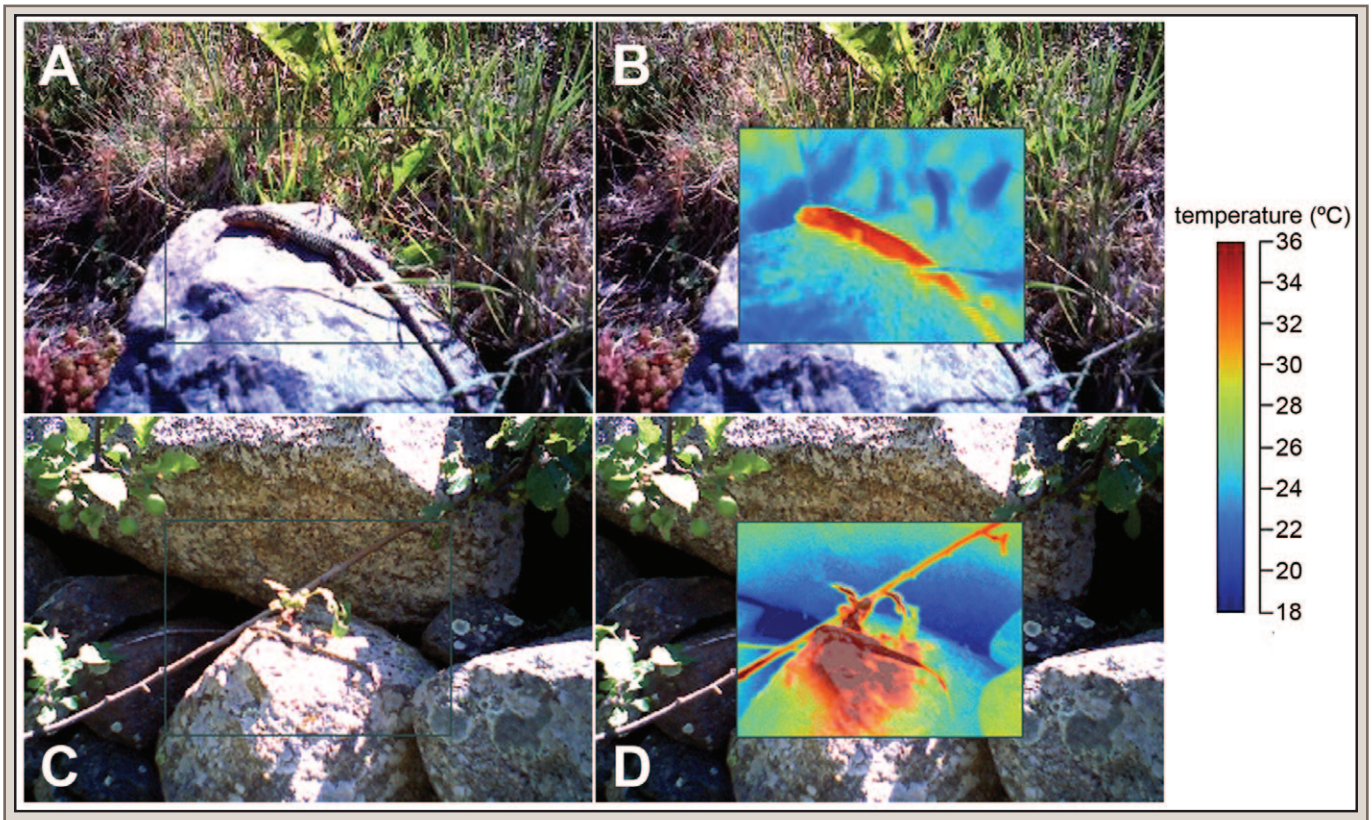


FIG. 1. A standard color digital photograph (A) and the corresponding infrared image (B) of an adult male of *Podarcis muralis* basking in the field. Digital photograph (C) and the infrared image (D) of another adult male in thermal equilibrium. In both cases, digital and infrared images were taken simultaneously with the IR camera. Note the difference in temperature between different lizard body regions (e.g. head, legs, tail). The color scale on the right indicates the surface temperature of the lizard and its immediate surroundings.

It is generally accepted that, regardless of their color, reptiles radiate almost as black bodies with an emissivity of approximately 0.95–1.00 (Carroll et al. 2005). Therefore, for acquisition of thermographic images we set the IR camera emissivity at 0.97. During preliminary trials, we determined that temperature readings varied in the range of ± 0.5°C when emissivity was varied from 0.95 to 1.00. Thermographic images were analyzed using the software provided with the camera (SmartView 2.1, Fluke), which allowed average and maximum-minimum temperature measurements to be determined from a rectangular area approximately equidistant from the insertion of the fore and hind limbs.

We plotted graphs showing variation of T°s and T°b with time when lizards were warming and cooling. To assess the relationship between T°s and T°b we also calculated determination coefficients of the two temperatures using standardized major axis regression (SMA) with (S)MATR software (v.2 Falster et al. 2006).

Results.—Fig. 1 shows two examples of the types of images produced by the IR camera. Fig. 2 presents results for each species showing variation of temperature with time**.** When the lizards were warming, the average error committed estimating T°b from IR images was 1.46 ± 0.53°C (mean ± SD) while the error committed when lizards were cooling was 0.67 ± 0.33°C (see Table 1 for further details). Determination coefficients of the relationship between T°s and T°b ranged from 0.95 to 0.99. This suggests that, in all cases, over 95% percent of the variation in surface temperature can be explained by the correlation between cloacal and surface temperatures.

Discussion.—The present study demonstrates that IR cameras can provide accurate estimates of deep body temperatures of small lizards without the need to capture or chase them. The error committed when estimating T°s and T°b should not be large in small animals due to rapid heat conduction from surface to the body core (Dzialowoski and O'Conner 2001; Seebacher and Shine

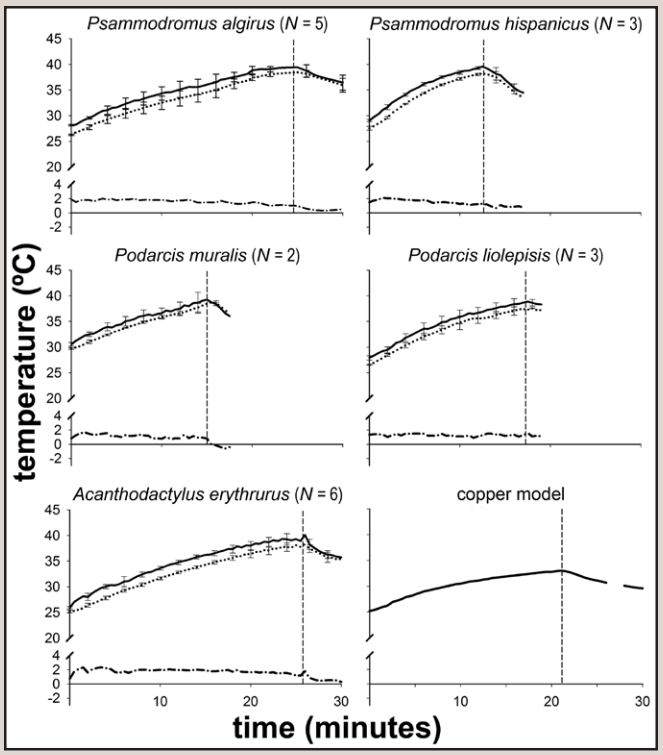


FIG. 2. Graphs showing temperature variation in five lacertid species and a hollow copper model equipped with a thermocouple probe and subject to the same treatment as the experimental lizards. Solid lines represent surface body temperature as determined from IR camera measurements. Dotted lines represent cloacal temperatures obtained by means of a thermocouple attached to a quick-reading thermometer. Differences between surface and deep body temperature are shown by dash-dot lines. The time when the spotlight was turned off is indicated by vertical dashed lines. Note that the sample sizes given differ from those in Table 1 because we have excluded from the graphs some lizards that changed location underneath the spotlight during the experiment causing oscillations in the recorded temperatures. Error bars = ± 1 SD.

2004), as shown in Fig. 2, where the lines representing T°s and T°b variation are roughly parallel and with nearly the same differential across temperatures and lizard species. The large determination coefficients between T°s and T°b ($R^2 > 0.95$) for all the species in our sample corroborate this conclusion. However, we caution that the error committed when estimating deep body temperatures of larger animals with slower rates of heating and cooling will likely be larger and should be determined empirically.

The average difference between T°b and T°s measured from an IR image when animals are basking is 1.46 ± 0.53°C, which is larger than that reported in previous studies (Jones and Avery 1989; Tosini and Avery 1993). However, this error is likely much smaller than the error committed when measuring cloacal temperatures in the field using standard procedures (Avery 1982; Hare et al. 2007). Moreover, when lizards are cooling the average error committed is 0.67 ± 0.33°C, which is similar to the error committed with other non-invasive techniques such as IR thermometers (Alberts and Grant 1997; Bucklin et al. 2010; but see Carretero 2012).

The discrepancies between T°s and T°b are possible because the dorsal skin of basking animals warms faster and may reach higher temperatures than the body core when animals are warming, and because the body core has a higher thermal inertia than the body surface when the animals are cooling (Remmert 1985; Tosini and Avery 1993). The lag between surface and core body temperature, especially during the warming phase of the experiment, reflects a lack of thermal equilibrium which may produce inaccuracies in T°b estimation (Dzialowoski and O'Conner 2001; Seebacher and Shine 2004). Although the error committed in estimating T°b from T°s is bound to be negligible in small animals with low thermal inertia, care should be taken when recording temperatures of lizards that have just started basking or that have recently moved into a new thermal environment and therefore may have not yet reached a steady state.

In conclusion, thermographic cameras are a useful alternative to traditional techniques for measuring body temperature in small reptiles in the laboratory and in the field. Our results demonstrate that, at least for small lizards, thermographic cameras can provide precise and highly accurate estimates of deep body temperature. Although thermographic cameras have several advantages over other non-invasive techniques, perhaps the most important are the ability to simultaneously record thermal data from different parts of the lizard and its surroundings (Fig. 1), and the possibility of acquiring readings from animals at distances large enough to ensure that observer effects are minimal.

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Modification of Camera Traps for the Study of Ectothermic Vertebrates

Camera traps have been used extensively to study animal behavior and ecology (Rowcliffe and Carbone 2008). Recent studies have instituted motion-sensitive camera traps as a method for noninvasive observation of crocodilian behavior (Chenna et al. 2010). However, because these devices are designed to capture images of mammals, the motion sensors on virtually all commercially available cameras are based on infrared energy detection. This presents a problem for the use of these devices for the study of ectothermic vertebrates. Recent data (not shown) collected in our outdoor alligator handling facilities have shown that, while capturing some photos of alligators, these digital camera traps are unreliable due to the fact that temperature differentials between the animal and the environment are often too small to trigger the camera's IR sensor. To resolve this problem, we designed a small electronic circuit that drives an infrared light-emitting diode (IR LED). The circuit, which is powered by tandem 9V batteries, activates the LED for two sec every five min. The IR LED is nestled against the IR detector of the camera and, when stimulated by the circuit, triggers the camera to take a photograph. Therefore, the cameras are stimulated to capture an image approximately every five min, or when triggered by another IR source (endotherm, etc.). We have used this method to monitor nests and to determine the frequency, length of time, and time of day of visits by alligators and by potential predators to nests of alligators.

Materials and Methods

Materials.—Four IR2 game cameras (Wildgame Innovations, Grand Prairie, Texas, USA) were purchased at a local sporting goods store. Plastic dry boxes, 555 timers, capacitors, resistors, and infrared LEDs were purchased from Radio Shack. Nickel-metal hydride rechargeable batteries (C and 9V), and battery charges were purchased from Tenergy Corp. (Fremont, California, USA).

Electronic Circuits.—The camera was triggered by an infrared LED which was controlled by a 555 timer circuit (Figs. 1A, B). It is one of the typical applications of the 555 timer chip. This circuit

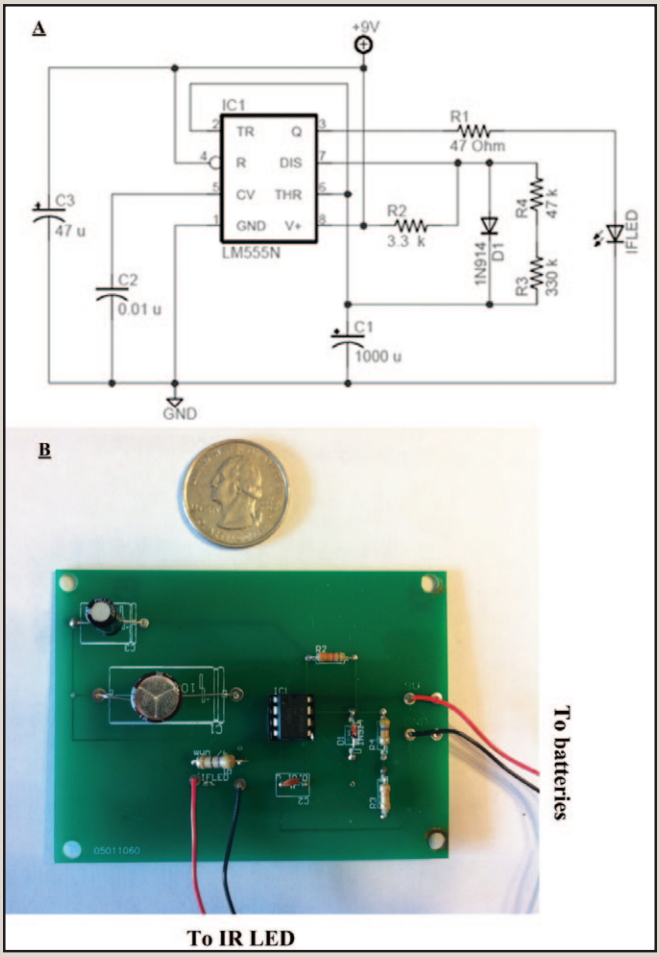


Fig. 1. A) Diagram of the electrical circuit that controlled the camera traps placed at alligator nests. B) Photograph of a finished electrical circuit.

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utilizes the "astable" mode of the 555 timer, so that it continuously generates pulses whose duty cycle (percentage of time on during a periodic cycle) is controlled by a combination of resistors and capacitors. A diode was added between pins 6 and 7 of the timer such that the duty cycle was less than 50%. The 555 timer should be TTL type, as a TTL 555 chip is able to output 200 mA current which is high enough to power the IR LED. A CMOS type 555 timer should be avoided due to its limited current output

One of the resistors (R3, 330 kΩ) was used to control the length of the time interval between the periods when the IR LED was powered on (Fig. 1A). The resistance can be changed to stimulate the camera to capture images at different time intervals. The other resistor (R2, 3.3 kΩ) was used to control the amount of time which the LED was on (Fig. 1A). This value was chosen to ensure that the LED was on long enough to stimulate the camera to capture an image. Because power consumption of the circuit was a major concern, we used a 555 timer, which requires a 5 to 15 V power supply. We used three 9V Energizer batteries in parallel, which was sufficient to power the camera system for approximately 10–11 days.

The circuit was placed inside of an electrical project box to prevent corrosion from moisture in the field. A hole was drilled in the box so that the LED, in contact with the camera, could be wired into the circuit (Fig. 2A). Prior to placement in the field, the seam at the box/lid interface was sealed with electrical tape to act as a further moisture barrier. The circuit was conjugated to an electrical jack and mounted in the box such that batteries driving the circuit could be changed easily in the field without opening the electrical box.

Placement of Cameras.—Cameras were set at alligator nests in the Lost Lake area of the Salt Bayou Unit of JD Murphree Wildlife Management Area in Port Arthur, Texas, USA. For each, a metal stake was driven in the ground approximately 1.5–2.0 m from the nest, and the camera attached to the stake, approximately 0.3–0.4 m above ground level using bungee cords (Fig. 2B). The dry box containing the electrical circuit board was attached above the camera using electrical tape. The LED leads were taped to the camera such that IR light source was touching and pointed directly into the IR detector of the camera. Due to limited battery life, and storage capacity of the 2-gigabyte memory cards, batteries and memory cards were changed weekly.

Results

We employed four cameras in the field at alligator nests in June 2010. These modified cameras proved to be a reliable method for the capture of time-lapse images of both endothermic and ectothermic vertebrates. Cameras were placed such that the entire nest area was within the field of view of the camera (Fig. 2B, Fig. 3). Analysis of time stamps revealed that cameras captured images on a regular basis (every 4.5 min) throughout the week. In addition to the regular capture of images stimulated by the IR LED, the presence of endothermic animals in the area of the nests, such as mammals and birds, also triggered the camera independent of the added circuit.

Fig. 3 shows an alligator attending a nest. This series of photographs was captured during an 18-min period. From the times on the photographs, we deduced that this female alligator was at the nest site between 18 and 27 min. For instance, the minimum time (18 min) would be the possibility if the alligator arrived at the nest just as the camera was triggered, and left just after the fifth photo, thus spending the minimum time possible during the time frame. The other extreme (27 min) would be possible if the alligator arrived approximately 4–4.5 min prior to the first photo, and the left approximately 4.5 min after the fifth photo, just prior to another timed photo.

Discussion

In recent years, the qualities of commercially available camera traps have improved immensely, and costs have declined, making this technology a popular tool for the non-invasive study of animal behavior. Digital camera traps are now available from a

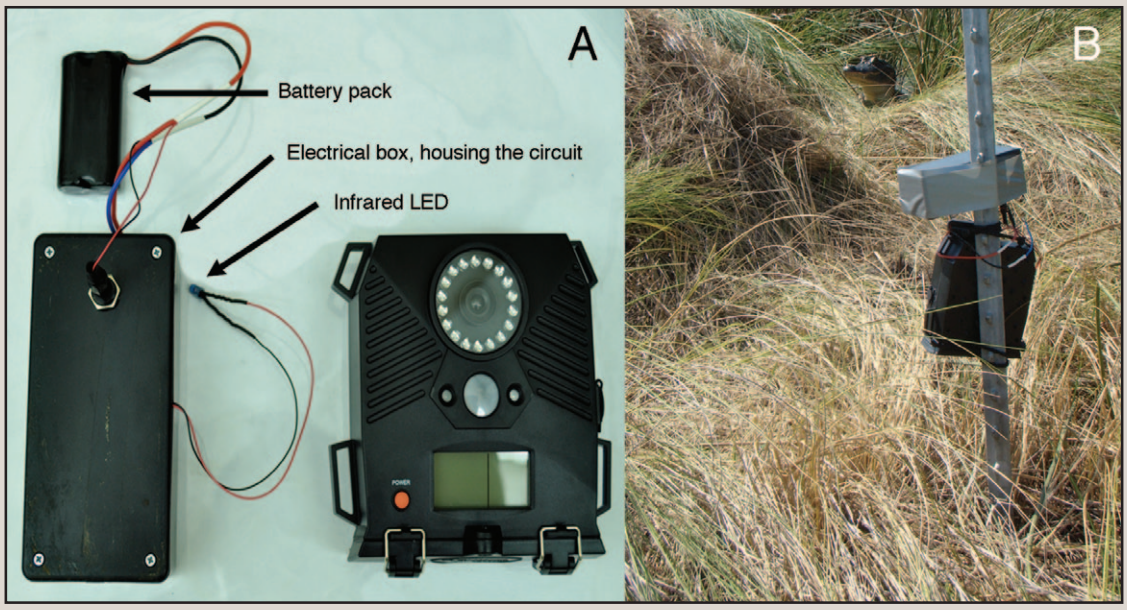


Fig. 2. A) Equipment used to capture alligator nest visitation. The IR LED light source is placed in contact with, and pointing directly into, the IR detector on the camera. The electrical circuit board is secured in the dry box to protect it from corrosion in the field. B) Placement of the camera at an alligator nest. When possible, the camera was placed to capture trails leading from the water to the nest as well.



FIG. 3. Images of an alligator captured by camera traps at an alligator nest. Since the length of time between photos is known, an approximate length of the visit to the nest can be estimated.

infrared or visible light flash, color or gray-scale photos, a variety of resolutions, and video or still-photo modes.

Camera traps are typically used to capture images of nocturnal animals, where they are commonly placed along heavily-used trails or in areas where the animals of interest are known to inhabit. Because all currently available camera traps sense motion based on infrared input, most of the studies in which these tools are used are focused on mammals. These devices have been used extensively to study of populations of feline species including tigers (Karanth 1995; Kuranth et al. 2006; Wegg et al. 2004), jaguars (Soisalo and Cavalcanti 2006), and ocelots (Maffei et al. 2005; Trolle and Kery 2000). Some studies have focused on the accuracy of using camera traps, comparing the data collected from these devices to other classical population determination techniques, such as line transect census and track surveys (Ross et al. 2003; Royle et al. 2009; Silveira et al. 2003). All of these studies and reviews have validated the use of this method for population determinations (Swann et al. 2011).

The results from the work reported here illustrate a simple modification of commercially available field cameras for the capture of images of ectothermic vertebrates. This modification is inexpensive, relatively easy, non-invasive, and provides reliable data concerning crocodilian nesting behavior. The circuits are composed of common, inexpensive electrical components; the total cost of each circuit/box was approximately US $12. Each camera was purchased for US $70, the rechargeable batteries (two sets each) for both the camera (four C) and the circuit (three 9V) were approximately US $28, and the battery recharger was US $15. Therefore, each complete camera system cost approximately US $125.

The use of these modified camera traps can provide data such as time of nest visits, frequency of visits, length of stays, and other behavioral data including egg deposition and nest opening. In addition, the time-lapse nature of the system provides a temporal aspect to the behavioral data collected. One potential disadvantage of this method is the large number of photos generated (approximately 2300 images per week), many of which may contain no useful information. However, we found that it was easy to quickly scan the images and save photographs with images of alligators at the nest. Another disadvantage is the fact that the large number of photographs means that the batteries, for both the camera and the circuit board, must be changed regularly. The batteries used for these studies provided power for approximately 10 days.

These modified camera traps will be a useful tool for monitoring the nest defense strategies of alligators and other crocodilians, and they provide a new means to study the behaviors of other poikilotherms as well. The 377 kΩ resistor used here can be replaced with another resistor of lesser or greater resistance to trigger the camera less or more frequently, respectively. The 3.3 kΩ resistor can be altered to provide a shorter or longer IR pulse, depending on the sensitivity of the camera used. Additional batteries and SD cards with larger data storage capacities can be used so that fewer trips to the field are required to replace batteries and collect photographs from the cards. Thus, with slight adjustments, this method can be adapted to meet the needs of a variety of specific research projects.

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A Method for Telemetry-based Logging of Animal Activity

Using direct visual observations to collect data on the circadian rhythm of animals is tedious at best, and may be impossible if the subject moves through a habitat that prevents a clear line of sight without the observer approaching so close that data are compromised. Radio transmitters for animal telemetry can be built to incorporate a mercury switch that causes the signal to change from a fast pulse rate to a slow pulse rate depending on how the transmitter is oriented (Burger 1988). Commercially available data loggers can sit in the field and record when the transmitter changes orientation, indicating that the animal moved or changed its posture. But the lack of signal change is not evidence that the animal did not move, because not all movements cause the switch to tip (Dorcas and Peterson 2012). Whether the switch tips depends not only on the animal's body position but also on a combination of how the switch is oriented in the transmitter and the transmitter's orientation in (or on) the animal. Here we describe a method for increasing the reliability of information on animal activity and movements that can be gained from telemetry signals. We used a digital recorder to record the received signal, and then analyzed the sound files for changes in not only pulse rate (a.k.a. inter-pulse interval) but also the amplitude of the signal received at an antenna-receiver-recorder station. We exploited the fact that the transmitter's antenna orientation relative to the receiving antenna affects the strength of the signal received. The structure and density of vegetation between the transmittered animal and the receiver also cause variation in received signal amplitude as an animal travels through a heterogeneous habitat.

Methods.—We studied activity and movements in juvenile Brown Treesnakes (*Boiga irregularis*), which are almost exclusively nocturnal and to a large extent arboreal. We quietly approached snakes as they foraged in trees at night and offered them, from forceps on a 1-m stick, dead geckos containing a 1.0-g tip-switch transmitter featuring a coiled helical antenna (BD-2NHXP; Holohil Systems Ltd., Carp, Ontario, Canada). If a snake consumed the gecko, we slowly backed off. This hands-off approach left us with a snake whose movements and activity would presumably closely resemble that of an un-manipulated snake. Snakes typically passed the transmitter 5–7 days later. The smallest snakes were often wary of accepting the offered baits, so as a complementary approach we captured and hand-fed some small snakes. To minimize the risk that a snake's behavior would be affected by a feeling of satiation caused by a bulky transmitter sitting in its stomach, we had the transmitters built so that the mercury switch added to the transmitter length (31 mm including switch and antenna spool) rather than its width (6 × 4 mm where widest). The switch was incorporated so that the unstable tipping point occurred when the transmitter was positioned horizontally (i.e., lying down), as this was deemed the orientation that would result in the most tipping events.

After a snake ingested a transmitter, and every afternoon thereafter, we rigged a small, directional antenna (RA-14; Telonics Inc., Mesa, Arizona) in a tree typically 20–40 m from the snake and connected it to a receiver (R-1000; Communications Specialists Inc., Orange, California) to which was connected a

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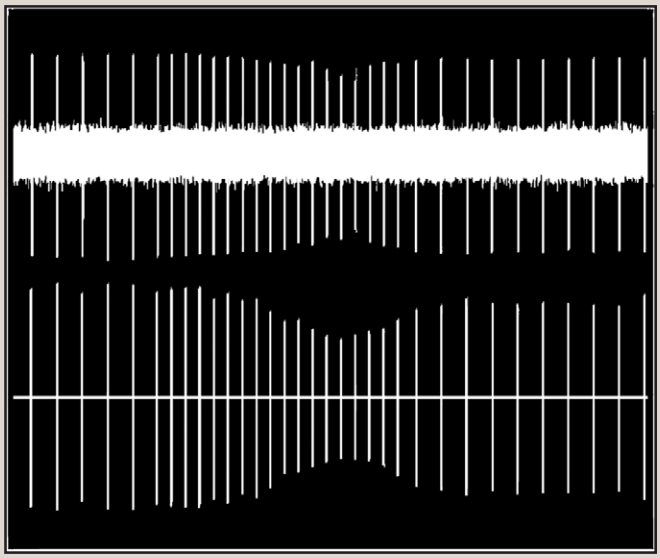


FIG. 1. Oscillograms showing a segment of an unprocessed wave file (top) and the same segment after processing for noise reduction. Vertical bars are transmitter pulses; their spacing on the time (x) axis shows the two discrete classes of pulse periods (i.e., inter-pulse interval arising from activation/deactivation of the tip-switch) whereas the differences in the bar heights show the amplitude variation.

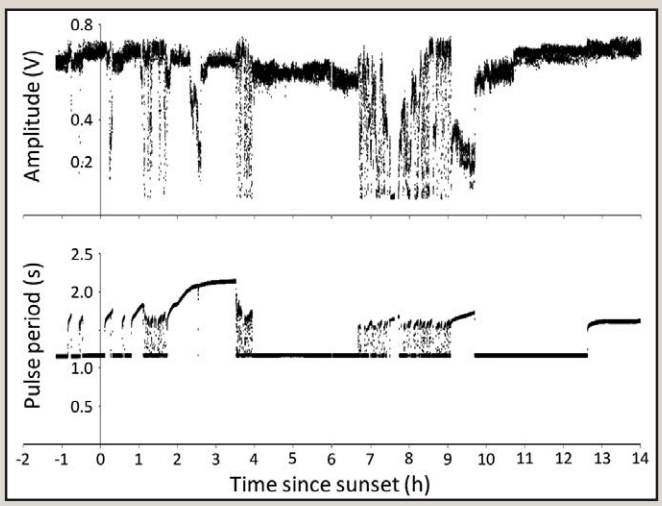


FIG. 2. Transmitter signal amplitude and pulse period variation for a fixed-station recording of a telemetered Brown Treesnake (*Boiga irregularis*) starting ca one hour before sunset and continued until ca two hours after sunrise. The transmittered snake did not move far and the antenna-receiver-recorder station was not adjusted during the recording. Notice the scatter in amplitude around 2.5 h after sunset and the lack of simultaneous scatter in pulse period (but just what appears to be a single tipping event). Such amplitude variation is often seen during rain showers. In our experience, the short-term variation in rain-caused amplitude fluctuation is normally lower than that caused by animal movements, resulting in a wavy band rather than a wide scatter.

digital recorder (Tascam DR-05; TEAC Corp., Tokyo, Japan). Because radio frequency interference was evident when the recorder was placed close to the receiver (a property of three different digital recorders we tested), we placed the receiver and recorder in different water-proof boxes that were connected by a 1-m cable. We fitted an external battery pack to the receiver as well as to the digital recorder. Recording 16-bit 44.1-kHz mono uncompressed .wav files to an 8-GB micro-SD card potentially allows for un-supervised 24-h sessions. When combined with our computer hardware, the software we used for signal analysis could not handle certain tasks if the file to be processed was too long. Instead of splitting long files, we set the recorder to limit file size to 256 MB (corresponding to a duration of ca 51 minutes), after which it started a new file.

Using low-power transmitters in a densely vegetated habitat meant that some snakes travelled sufficiently far from the station during the course of a night to cause signal loss. Snakes travelling perpendicular to the directional antenna sometimes strayed outside the detection range. Moving the station further away alleviated the latter issue but reduced the signal-to-noise ratio and increased the risk of complete signal loss due to distance. We therefore chose to visit the field site two or three times per night to see if the station had to be moved or the antenna re-directed to avoid signal loss and maintain a reasonably good signal-to-noise ratio.

A transmitter that has an average pulse rate of 0.75 s^{-1} will render 32,400 pulses during a 12-h recording session. This amount of data calls for an automated sound file analysis. We used a feature called "pulse train analysis" in the program Avisoft SAS Lab Pro (Avisoft Bioacoustics, Berlin, Germany). This feature identifies sound pulses, given user-specified detection threshold criteria, and for each pulse reports its time since the start of the analyzed time segment, the interval between the previous pulse detected and the focal pulse, the pulse amplitude (V), and its frequency (Hz). While sound pressure thresholds for detection of pulses can be adjusted in the pulse train analysis, we found that the radio frequency noise in our recordings, caused by a moderately high gain setting on the receiver, often led to a high number of false (non-transmitter) pulses detected when the signal-to-noise ratio was low. Avisoft SAS Lab Pro features a noise reduction function that removes all signals below a user-defined sound pressure threshold while retaining peaks exceeding the threshold. Using sound files from which noise has been filtered (Fig. 1) for the consecutive pulse train analysis will help generate clean data, and may under some circumstances be a good option. But when the noise reduction (or actually, the signal retention) is set to a sufficiently high precision, the file processing takes a long time even with a fast computer. (Provided that all files from a recording session have the same noise floor properties, batch processing can be used for the sake of efficacy.) When the signal-to-noise ratio is very low, relying on the noise reduction function to discard false pulses will cause transmitter pulses that are barely audible to the ear (signals with peaks that do not rise above the white noise floor) to be discarded.

We preferred to omit the processor-intensive and time-demanding noise reduction altogether. Instead, we first applied a frequency bandpass filter to help push down the noise floor relative to the transmitter signals. We then adjusted the pulse train analysis settings so that very weak and barely audible pulses were also detected. Because the transmitter pulses we recorded fluctuated in frequency with ambient temperature through a day-night-day recording session (caused by temperature dependencies in both the transmitters and the receivers, or possibly their batteries), we applied a bandpass filter that was sufficiently wide to encompass all pulses during the focal time frame. We batch-processed all files from one day-night-day session with one fixed bandpass filter, often 300 Hz wide. Depending on the circumstances, the pulse train analysis settings may be the same for all files (and files batch-processed), adjusted for each file, or

adjusted after splitting the original files into shorter files with more uniform signal-to-noise properties throughout. When the signal-to-noise ratio is low, this procedure can lead to inclusion of numerous false pulses (unless the settings are such that transmitter pulses are at risk of being discarded), and further signal discrimination is necessary.

We used IF-functions in a spreadsheet program to further discriminate signals, accepting or rejecting pulses based on their frequencies and pulse periods. The temperature-dependence of pulse frequency meant that it was not possible to use a fixed frequency range for signal discrimination. We instead created a function for a floating modal pulse frequency around the focal pulse, and then discarded pulses outside a 60 Hz frequency band centered on the current mode. In some recordings signal frequency varied considerably over short periods of time; we then used a 100 Hz pulse acceptance range. We visually inspected plots of floating modal pulses to detect outliers, often appearing when the signal was more or less lost and mostly noise was detected, and then manually inserted suitable frequency acceptance ranges for those segments. Temporal discrimination was based on the distribution of pulse periods from each recording session (as pulse period varied noticeably, not only across transmitters but also within transmitters, across nights), omitting the two tails of the bimodal distribution. Having created a spreadsheet template, we used these spreadsheet-based signal discrimination algorithms for files that had been subjected to noise reduction since they, too, included the occasional false pulse.

Our spreadsheet processing also included creation of suitable time stamps for the consecutive sound files from each recording session, as each sound file subjected to a pulse train analysis had a time stamp starting with zero. For each recording session we calculated these time stamps so that zero was the time of sunset on the focal date (Nouvellet et al. 2012), and we then plotted the pulse periods and pulse amplitudes on a timeline.

Results.—When seen in conjunction, pulse period and pulse amplitude allow a more reliable evaluation of the animal's activity patterns than does pulse period alone (Fig. 2). These activity data have high temporal resolution and can be compared with data from an on-site weather station for fine-scale evaluation of relationships between activity and environmental variables.

Discussion.—Just as non-changing pulse periods do not mean the animal cannot have moved, signal amplitude changes that suggest movement must be viewed with caution. A passing rain shower can cause noticeable fluctuations in amplitude, and this effect can linger as vegetation between the transmitter and the receiver dries out. High winds that set the intervening vegetation in motion may also cause amplitude to vary (Burger 1988), but wind should result in briefer and more back-and-forth amplitude fluctuations than do directional animal movements. With practice judging the temporal patterns of the amplitude change, such changes should be possible to tell from movements.

In our case, studying an arboreal snake that moves up and down in the vegetation, the signal amplitude changes and changes in pulse period normally agreed well (Fig. 2), suggesting that the tipping function alone would have provided sufficient data to interpret snake activity. Having access to two independent metrics nevertheless made us more confident in our interpretation of the data, especially as they were coupled with fine-grained data on precipitation and leaf wetness. We suspect that adding amplitude information may be of more benefit for those studying terrestrial animals that move over level ground or the submergence behavior of aquatic animals (Rodda 1984). Also, for those studying small animals that require lightweight transmitters, using *only* amplitude to measure activity will allow the use of regular (non-tipping) transmitters. Excluding the mercury switch will reduce transmitter weight by ca. 0.4–0.5 g and allow activity to be measured with transmitters weighing as little as 0.35 g (e.g., Holohil BD-2N).

We see both advantages and disadvantages of our method compared to the use of commercially available telemetry signal loggers, some of which register all measures we obtained from the pulse train analysis. While we have not tested such systems, we suspect that our method has the ability to render more data under poor reception conditions because we have full control over the physical signal parameters, and we can tweak noise reduction and/or pulse detection settings *after* the recording event. When several animals are transmittered simultaneously and they are located too far from each other to be monitored by one logging station, our method is also less expensive than the commercial solutions. The software we used costs ca. US $1,860 (educational price) or ca. US $2,730 (retail), and each receiving station (receiver, recorder, antenna) costs approximately US $1,000; commercially available logging stations may cost from US $4,100 (our inquiry; not including power source or antenna) to US $14,000 (Dorcas and Peterson 2012). Thus, those using the software with multiple relatively inexpensive receiving stations will achieve the best cost savings compared to purchase of multiple commercial logging stations. The major drawback with our method is that file management and analysis is very labor intensive; it can take one person a full day to complete file management, noise filtering, pulse train analyses, time stamp creation, quality control efforts, and graph plotting in a spreadsheet program for a 14-h recording session. Commercially available logging stations that provide files with pulse periods and amplitude for a full session can reduce the labor effort significantly. Since we have not tested such systems we cannot tell if that benefit outweighs the risk of more data loss when the signal-to-noise ratio is low and there is no opportunity for post-processing to optimize noise reduction and/or pulse discrimination settings to the particular signal recording.

Our method requires some practice to obtain sound files that are optimal for extraction of information. It is important to avoid use of auto level functions on the recorder, as that will eliminate any signal amplitude information. Using a limiter function is good as it prevents the recorded sound from clipping, should the animal closely approach the station, but the recording level should still be set low enough to maintain sufficient headroom to avoid amplitude information loss when the limiter kicks in. Adjusting the receiver gain, volume, and the recording level are done in conjunction; the optimal settings will depend on the hardware used, the animal's movements, and the habitat.

Bear in mind that we used small transmitters with a helical antenna spool, which had a weak signal output, and we studied mobile animals in a densely vegetated habitat. This represents a worst-case scenario, and investigators facing fewer obstacles may experience less labor-intensive field work and a simplified signal post-processing workflow. Under less challenging scenarios, simultaneous monitoring of multiple animals with recording stations similar to ours can potentially be done with even greater cost-efficacy.

Acknowledgments.—This study was conducted under Colorado State University IACUC #11-2845A. Any use of trade, product, or firm names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

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Working with a Full Deck: the Use of Picture Cards in Herpetological Surveys of Timor-Leste

Timor is the 44th largest island in the world and the seventh largest between Asia and Australia (area 29,402 km^2). It occupies an extremely interesting geographical position within the biogeographical sub-region known as Wallacea, at the southeastern edge of the Lesser Sunda Archipelago and separated from Australia by the Timor Sea (ca. 450 km). This gap was considerably lessened during the final 250,000 years of the Pleistocene Epoch (2.588-0.012 MYA), when glaciation lowered sea levels by up to 120 m below present-day shorelines (Voris 2000). The Sahul Shelf of Western Australia extended to within 300 km of the Timorese coast, with stepping-stones present in the vicinity of the Ashmore and Hibernia Reefs, during at least 50% of this time and, as calculated from Voris (2000), was as close as 100–150 km for a much shorter combined period of 15,000 years.

Through the capricious nature of colonialism, Timor is politically divided into two almost equal parts. The western part (14,395 km^2: Monk et al. 1997), formerly part of the Dutch East Indies, now belongs to Indonesia's East Nusa Tenggara Province (in Bahasa: Nusa Tenggara Timur), whereas the formerly Portuguese eastern half, inclusive of the Oecusse District, an exclave surrounded by Indonesian West Timor on the northern coast of the island, and the neighboring islands of Ataúro and Jaco, comprise the 15,007 km^2 Democratic Republic of Timor-Leste (area taken from the website of the Government of Timor-Leste). The eastern part in particular has had a tumultuous and often-violent history, which has resulted in it being one of the least biologically explored islands in the region.

History of Herpetology on Timor

In terms of herpetological surveys, the port of Kupang in the western part of Timor was an important Dutch East Indian reprovisioning stop for some of the great expeditions of the early 19th century (reviewed in Kaiser et al. 2011), and a few specimens from this time exist in European museum collections (most significantly, the Muséum National d'Histoire Naturelle in Paris, France; Naturalis, formerly the Rijksmuseum van Natuurlijke Historie, in Leiden, The Netherlands; and the Zoologisch Museum Amsterdam, now also housed in Leiden). Additional short surveys were conducted there during the early 20th century (e.g., Smith 1927; collections in the Natural History Museum, London, United Kingdom) and in the 1990s (e.g., How et al. 1996a,b; collections in the Western Australian Museum, Perth, Australia). In contrast, the Portuguese eastern half of the island was not a popular shipping destination and, through the centuries, received little attention from biological, let alone herpetological, collectors. Small collections were made by Francisco Newton and co-workers (reported in Bethencourt Ferreira 1897, 1898) and during explorations for the availability of natural resources (Manaças 1956, 1972; Themido 1941). Unfortunately, all but the two specimens housed at the University of Coimbra listed by Themido (1941) were lost in the fire at the Museu Bocage, Lisbon in 1978 (Brandao 1997). Even though some collecting has occurred in Timor-Leste during the early years of independence, by batrachologist Stephen J. Richards (James Cook University, Townsville, Queensland, Australia) and ornithologist Colin J. Trainor (Charles Darwin University, Darwin, Northern Territory, Australia), no further herpetofaunal reports were available until this project was initiated in 2009.

A New Start

As a consequence of the lack of available survey data, published reports, or extant museum collections, we embarked on the first comprehensive herpetofaunal survey of Timor-Leste in 2009 working from an almost blank canvas. In our initial report (Kaiser et al. 2011), we documented the results of our first survey phase (June–July 2009), together with results from Richards and Trainor. Since then we have conducted a further six phases, at a rate of two per year, adding further species and data to our knowledge of the herpetofauna of 'mainland' Timor-Leste (O'Shea et al. 2012 and in prep.), the exclave of Oecusse (Sanchez et al. 2012), and of Ataúro Island (Kaiser et al., *in press*). The known herpetofauna currently stands at almost sixty taxa, approximately one third of them new to science.

The Need for a Tool

Part of the remit of our surveys has been to involve Timorese students from the national university (Universidade Nasional Timór Lorosa'e) in the country's capital, Dili, in the study of

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their own herpetofauna. This process also allows these students to engage and interact with local administrators and Timorese citizens in general. The work includes promoting conservation of the Reticulated Python (*Python*[1] *reticulatus*), learning about the cultural links to the Saltwater Crocodile (*Crocodylus porosus*), and investigating the provenance of Chinese Pond Turtles (*Mauremys reevesii*) sold by the roadside in Dili (see Kaiser et al., in prep). While these types of story-telling opportunities frequently emerge when discussing nature with local residents, and while discussions of local species based on an overall '*bauplan* knowledge' of animals is quite straightforward, we wanted to ensure that we could collect local knowledge that was as detailed as possible. In this regard, researchers elsewhere noticed that the rural peoples in the Highlands language group Kalam (also known as Karam) in northeastern Papua New Guinea were able to differentiate between morphologically similar species of frogs, lizards, and snakes, and could provide separate names and even an ethnobiological classification system (Bulmer and Tyler 1968; Bulmer et al. 1975). Although a number of the frogs served as food species, several of the snakes were of 'medical importance' (see Gopalakrishnakone and Chou 1990; Jena and Sarangi 1993), and some taxa had totemic or other cultural value to local residents, many of the smaller species had no apparent bearing on the lives of the local inhabitants, yet were afforded names in the Kalam language. This level of cognitive awareness of the herpetofauna contrasts with the fact that, in many regions, harmless, inedible species are known only by a 'catch-all' common name. Bulmer and colleagues also noted that people of language groups neighboring the Kalam-speakers were less discerning and did group small reptiles together under umbrella names. The degree of local cognitive awareness relating to natural history cannot, therefore, be either simply assumed or discounted.

In an effort to maximize the exchange of information where different languages are in play, visual aids are a boon because photographs reach across the language barrier. As a consequence, we have long given thought to ways in which best to create visual aids for use during fieldwork. Although there now exist a small number of books on the herpetofauna of the Lesser Sunda Islands containing color photographs (Auliya 2007; de Lang 2011; Iskandar 1998; McKay 2006), these are not ideal as visual aids when interviewing individuals or groups of villagers, as they only permit a single open spread at any one time and often prevent the comparative examination of more than one image. The use of several books is also clumsy from a logistical viewpoint, since having to carry several guidebooks to a remote village can add considerable weight to already full packs. Some titles are also not easily or inexpensively obtained and could become spoiled by their excessive handling during fieldwork in a tropical climate. The titles listed above are also deficient in their coverage: whereas they list frogs, turtles, and snakes, they exclude lizards, which, as a group, account for approximately 66% of the reptile fauna of Timor-Leste (O'Shea et al., unpubl. data). The need for a simple, portable, visual tool, ensuring ease of use and dependability even under field conditions, was the driving force behind the idea for Species Identification Cards (SICs), which one of us (MOS) came up with in late 2011.

[1] We accept the reasoning of Zug (2011) and Kaiser et al. (2013) in retaining the Reticulated Python (*reticulatus*) and the Lesser Sunda Python (*timoriensis*) in the genus *Python*. While the data presented by Rawlings et al. (2008) indicate a split in the genus *Python*, the resulting new genus has not yet been scientifically named.

Species Identification Cards—Design

Images.—Each card displays a high resolution photograph of a reptile or amphibian, showing as much morphological detail as possible. When warranted, such as with the red flanks in sexually mature male four-fingered skinks (*Carlia* spp.) or the orange tail-tips of juvenile bent-toed geckos (*Cyrtodactylus* spp.), we included sexual or ontogenetic dichromatic variation on the same cards. With especially variable species, such as rice-paddy frogs (*Fejervarya* spp.) or Emerald Tree Skinks (*Lamprolepis* cf. *smaragdina*), the latter of which occurs as both a green-and-bronze phase or as a completely bronze phase, more than one card was produced. This approach was also taken with the Lesser Sunda Island Pitviper (*Trimeresurus insularis*); although all the specimens we have seen in Timor-Leste so far have been vivid green, one of our Timorese field colleagues assured us that the bright yellow phase, commonly seen in specimens from Wetar, an island in Indonesia's Maluku Province to the northeast, is also present in eastern Timor-Leste. For this reason a card was produced for each of the known color phases—green, yellow, and cyan—the last being the color of some Komodo Island populations. We also included species rare for Timor, those not recorded since the now lost 19th century collections of Newton were made (e.g., the Little Filesnake, *Acrochordus granulatus*, and Cantor's Watersnake, *Cantoria violacea*), as well as species reported from West Timor by earlier fieldworkers (e.g., the Crab-eating Mangrove Snake, *Fordonia leucobalia*).



How to use the Species Identification Cards
and contribute to the survey

The card set contains images of all the frogs, lizards, snakes, turtles and crocodiles currently known to live in Timor-Leste, plus extra snakes found on nearby islands, such as Flores or Sumbawa, and seasnakes & sea turtles that could occur in Timorese coastal waters. The harmless species are indicated with a green border while the dangerous species (venomous snakes and the crocodile) receive a red border and skull & crossbones icon.

Please examine all the cards and place them into three piles:
A) species you have seen near your village;
B) species you have seen in Timor but not near your village;
C) species you have never seen in Timor.

then list the card numbers on the recording sheet.

Please return the cards and the sheet to the researchers.

Thankyou.

Fig. 1. Title card (top) and instruction card (bottom) of the Species Identification Card deck used in Timor-Leste.



FIG. 2. Four sample cards from the deck of Species Identification Cards developed for Timor-Leste. Images of harmless species (top row) are framed in green, whereas images of dangerous species (bottom row) are framed in red and feature a red skull-and-crossbones symbol.

The SICs were further expanded to include all sea snakes and sea turtles likely to occur within Timorese coastal waters, and also a number of significantly important snake species from elsewhere in the neighboring Indonesian province of East Nusa Tenggara. Some of these species may yet be encountered in Timor-Leste. The reasoning behind these inclusions was that although frogs and lizards are often fairly abundant and an intensive survey will generally locate most of them, snakes are much more solitary and secretive and therefore more easily overlooked, even by experienced field herpetologists visiting an area many times over a prolonged period of time. It was primarily the desire to learn more about the snakes that initiated the SIC idea. Living and working an entire life in a localized area, the rural Timorese hunter, farmer, or fisherman is much more likely to have encountered most species inhabiting the home location than a visiting scientist. Providing a set of snake SICs is not dissimilar to showing a series of 'mug shots' or an identification line-up to a potential witness of crime. The species from outside Timor that were added to the SICs included the Lesser Sunda Catsnake (*Boiga hoeseli*) and the Common Mock Viper (*Psammodynastes pulverulentus*), both found on Flores, Alor, and Sumbawa, as well as the Indonesian Spitting Cobra (*Naja sputatrix*), found on Flores and Alor, and the Eastern Russell's Viper (*Daboia siamensis*), found on Komodo, Lembata and Flores. Also included was the Lesser Sunda Python (*Python timoriensis*), although it is now fairly certain that the type locality of Kupang, West Timor, is in error and this species does not occur on the island of Timor (see Barker and Barker 1996).

Production.—In total, a set of 99 SICs, corresponding to 51 genera and approximately 86 species (and populations that might represent undescribed taxa), was produced to standard playing card size (3.5" × 2.5" or 89 mm × 63 mm). The set of photo cards was accompanied by a title card (Fig. 1 top) and an instruction card (Fig. 1 bottom). Each SIC carries the scientific name of the species concerned (these cards also serve as teaching aids for our students) and their common names in English and, where available, in the languages Bahasa Indonesia and/or Tetun. Common names in Tetun were drawn from names that already existed in the language or, where no such names existed, from those coined by Kaiser et al. (2011), O'Shea et al. (2012), and Sanchez et al. (2012), in collaboration with Timorese colleagues. All amphibians and harmless reptiles received a green border around the photograph (Fig. 2 top), while medically important species (front-fanged venomous snakes and the crocodile) received a red border and a skull-and-crossbones icon in the bottom left corner (Fig. 2 bottom). The top left corner bears the Timor-Leste flag, the top right the project logo, and the bottom right the SIC's number. SICs were numbered sequentially by alphabetical scientific genus and species names from *Acalyptophis* to *Varanus*. This proved to be a valuable addition as it not only sped up the sorting of a used suite of SICs, it also allowed for the species to be easily listed in three columns (see below) rather than merely placed in piles. The cards were printed with the project logo reproduced on the reverse, in the style of genuine playing cards.

Six sets of cards packed in a double compartment plastic case were printed by Ad Magic, Inc. (Netcong, New Jersey, USA; www.



FIG. 3. Zito Afranio Soares (in white shirt at center left) conducting the interview in Anartutu Village on Ataúro Island.

admagic.com). One set was donated to Timor-Leste's Directorate of National Parks, while the remaining sets were distributed to the team, especially to the Timorese students.

Text.—The text of the English instruction card (Fig. 1 bottom) invites the participant by explaining "*How to use the Species Identification Cards and contribute to the survey.*" It further explains the setup of the card: "*The card set contains images of all the frogs, lizards, snakes, turtles and crocodiles currently known to live in Timor-Leste, plus extra snakes found on nearby islands, such as Flores or Sumbawa, and sea snakes & sea turtles that could occur in Timorese coastal waters. The harmless species are indicated with a green border while the dangerous species (venomous snakes and the crocodile) receive a red border and skull & crossbones icon.*" This brief summary sets the stage for the following set of instructions: "*Please examine all the cards and place them into three piles: (A) species you have seen near your village; (B) species you have seen in Timor but not near your village; (C) species you have never seen in Timor. Then list the card numbers on the recording sheet. Please return the cards and the sheet to the researchers. Thank you.*" It is our intention to reproduce additional versions of the introduction card in Bahasa Indonesia and Tetun, the *lingua franca* of Timor-Leste.

Use of the cards.—The basic premise of using SICs is straightforward: give the set to one or more individuals, who can then independently, in their leisure time, sort the cards in the manner requested. It was therefore our initial plan to leave sets of SICs in villages to which we would be returning later in a survey, asking elders and/or interested individuals to examine the cards and place them into three piles. However, our Timorese colleagues advised that it would be more productive if they conducted interviews so that they could firm up identifications with more detailed explanation if the need arose, observe the body language of those being interviewed and listen to their inflections when speaking, thereby extracting a maximum of information about the way in which the species were encountered, and also to ensure that the cards were returned afterwards. Thus, one of our Timorese team members (Zito Afranio Soares) conducted the first SIC survey amongst a group of Timorese villagers in Anartutu village (elevation 560 m), Macadade Suco, Ataúro Subdistrict, Dili District, Timor-Leste, on 29 January 2012 (Fig. 3). This was followed with an interview conducted among his workers by Barry Hinton, proprietor of the lodge Barry's Place in Beloi village (4 m elev.), Beloi Suco, Ataúro Subdistrict, Dili District, Timor-Leste, on 3 February 2012. We further used the cards opportunistically for species identification during discussions (e.g., with expatriates and Australian Army personnel we met on Ataúro Island), and we tested them informally to obtain ideas that might allow us to optimize our methodology. Although we have subsequently conducted a similar survey in a village near Balibo, Bobonaro District, on the mainland, the focus of this paper will be the two specific interviews listed above.

Results and Comments: The Numbers in the Cards

In an accounting simplified by eliminating different color variants, we report on the placement of 57 species into categories (Table 1). In nearly half of the cases (24 of 57, 42%), selections by both sets of villagers agreed with our current understanding of the Ataúro herpetofauna. Furthermore, our own collecting data supported an additional 28% of choices made in Anartutu only and 9% of choices made in Beloi only, for a total of 79% of observations with some level of agreement via the use of SICs. Whereas it is encouraging to learn that there is considerable agreement between scientists and villagers in their respective assessments, there are also signs that great care must be taken in the analysis. For example, is the reason that there is substantially higher agreement between our team and the Anartutu villagers than with the Beloi villagers (70% vs. 51%, respectively) that the people in Anartutu know their fauna better, or is the underlying reason our choice of interviewer (Timorese scientist vs. non-Timorese employer, respectively)? As with any scientific enterprise, beginnings can sometimes be perplexing, but as we gain more experience with this model of involving local residents, we anticipate being able to improve our evaluation methodology.

Results and Comments: The Anartutu Cardgame

Amphibians.—The complete absence of amphibians indicated by our interviewees was not surprising since after three surveys on Ataúro we have yet to record any amphibian species (Table 1; Kaiser et al., *in press*). However, we would have expected at least one of the villagers to have seen rice-paddy frogs (*Fejervarya* sp.) or the Common Asian Toad (*Duttaphrynus melanostictus*) on visits to Timor.

Turtles and the crocodile.—The three Timor freshwater turtles (the introduced *Mauremys reevesii* and *Pelodiscus sinensis,* and the endangered endemic *Chelodina mccordi timorensis*) were unknown to our interviewees, as were all sea turtles with the exception of *Caretta caretta* (Table 1). Curiously, *Crocodylus porosus* was also not recognized as present, even though crocodile attacks are relatively commonplace on Timor and the crocodile is part of the creation myth for mainland Timorese.

Geckos.—Whereas the house geckos *Hemidactylus frenatus, Hemidactylus* cf. *tenkatei,* and *Gehyra mutilata,* all rather similar in appearance, were considered present, the obviously flat-tailed *H. platyurus* was not (Table 1). This reflected our own experience of having collected *H. frenatus* and *G. mutilata* on Ataúro but not *H. platyurus* (Kaiser et al., *in press.*). *Gekko gecko* was listed present, as were *Cyrtodactylus* spp.

Skinks.—Almost all the cards featuring skinks (*Carlia, Eremiascincus, Sphenomorphus* spp.) were placed into Category A (Table 1). As expected, the interviewees included *Eutropis multifasciata* and both color phases of *Lamprolepis* cf. *smaragdina.* We have collected only a single specimen of the Lowland Snake-eyed Skink *Cryptoblepharus leschenault* on Ataúro, and this was the only snake-eyed skink, out of three possible species, the interviewees considered present.

TABLE 1. Results from two interviews conducted using Species Identification Cards on Ataúro Island, Timor-Leste. Responses were tallied using presence/absence categories. Cards with species known from near the interviewees' village were assigned to Category A, species known from elsewhere in Timor but not near the village to B, and species considered absent from Timor to C. In the village of Anartutu, a member of our survey team conducted the interview and all three categories (A–C) were used as intended, whereas in Beloi the interviewer lumped two categories identifying "known" species to save time. A plus sign (+) in the village columns indicates that the species was considered present, with superscripts in the Anartutu column indicating the A or B category. In the Survey Results column, a plus sign indicates that we have confirmed this species on Ataúro Island (Kaiser et al., *in press*). A minus sign (–) indicates absence. The comment section clarifies the choices made, where appropriate.

	Anartutu	Beloi	Survey Results	Comments
Amphibians				no amphibians recorded from Ataúro to date
Duttaphrynus melanostictus	–	+	–	
Fejervarya sp.	–	+	–	
Kaloula cf. *baleata*	–	–	–	
Limnonectes timorensis	–	–	–	
Litoria everetti	–	–	–	
Polypedates cf. *leucomystax*	–	+	–	
Crocodile				
Crocodylus porosus	–	–	–	Ataúro's coastal habitat unsuitable
Turtles				
Caretta caretta	+[B]	–	–	recorded from Timor
Chelodina mccordi timorensis	–	–	–	Timor endemic
Chelonia mydas	–	+	–	recorded from Timor
Dermochelys coriacea	–	+	–	recorded from Timor
Eretmochelys imbricata	--- omitted ---	+	–	recorded from Timor
Mauremys reevesi	–	–	–	introduced on Timor
Pelodiscus sinensis	–	–	–	introduced on Timor
Lizards				
Carlia spp.	+[A]	+	–	expected, not yet recorded
Cryptoblepharus leschenault	+[B]	+	+	a single voucher specimen recorded
Cryptoblepharus spp.	--- omitted ---	+	–	two Timor endemics
Cyrtodactylus spp.	+[A]	+	+	two species recorded
Draco timoriensis	–	–	–	
Eremiascincus spp.	+[A]	+	+	one species recorded
Eutropis cf. *multifasciatus*	+[A]	+	+	
Gehyra cf.*mutilata*	+[A]	+	+	
Gekko gecko	+[A]	+	+	
Hemidactylus cf. *tenkatei*	+[A]	+	–	
Hemidactylus frenatus	+[A]	+	+	
Hemidactylus platyurus	–	+	–	expected, not yet recorded
Lamprolepis cf. *smaragdina*	+[A]	+	+	
Sphenomorphus spp.	+[A]	+	–	expected, not yet recorded
Varanus cf. *salvator*	+[A]	+	+	possibly an undescribed endemic
Varanus timorensis	–	+	–	recorded from Timor
Snakes				
Acalyptophis peronii	+[B]	+	–	open water or coral reef species
Acrochordus granulatus	+[B]	+	–	possible in coastal waters
Astrotia stokesii	+[B]	+	–	open water species
Boiga hoeseli	+[A]	+	–	recorded from Alor
Brachyorrhus albus	+[A]	+	–	restricted to islands in NE Maluku[1]
Cantoria violacea	+[B]	–	–	poorly known on Timor
Cerberus cf. *rynchops*	–	+	–	locally common on Timor in rice-paddies
Coelognathus subradiatus	+[A]	+	+	
Cylindrophis boulengeri	+[A]	–	–	only known from one Timor locality

TABLE 1. Continued.

	Anartutu	Beloi	Survey Results	Comments
Snakes				
Daboia siamensis	+[B]	–	–	believed absent for lack of bites; present on neighboring islands, not Timor
Dendrelaphis inornatus	+A	+	+	observed, escaped
Enhydrina schistosa	+[B]	+	–	turbid estuary habitat not available
Fordonia leucobalia	+[B]	+	–	likely in coastal mangroves
Hydrophis elegans	–	+	–	open water or estuarine
Lapemis hardwickei	–	+	–	open water or estuarine
Laticauda colubrina	–	+	–	coral reef and rocky islets, likely
Laticauda laticaudata	–	+	–	coral reef and rocky islets, possible
Liasis mackloti	+[A]	–	–	expected, not yet recorded
Lycodon capucinus	+[A]	+	+	
Lycodon subcinctus	–	–	–	uncommon on mainland
Naja sputatrix	–	+	–	on neighboring islands, not Timor
Pelamis platura	–	+	–	open water
Psammodyastes pulverulentus	–	–	–	on neighboring islands, not Timor
Python reticulatus	–	–	–	expected, not yet recorded
Python timoriensis	–	+	–	records from Timor in error[2]
Ramphotyphlops spp.	+[A]	+	+	possibly an undescribed endemic
Stegonotus sp.	+[A]	+	–	Timor south coast endemic
Trimeresurus insularis	+[A]	+	+	

[1] Murphy et al. (2012)
[2] Barker and Barker (1996)

Agamas and Monitors.—We have failed to find any *Draco* on Ataúro and have been told previously that they do not exist there, despite the relative abundance of *D. timoriensis* on Timor. Our interviewees confirmed this by listing *Draco* as absent (Table 1). They considered the Common Tree Monitor from the mainland (*Varanus timorensis*) absent, but clearly recognized the much larger *V. salvator* complex monitor from Ataúro's coastal swamps (Table 1). While we doubt that these large lizards inhabit the area surrounding the montane village, they may on occasion be temporarily taken to the villages at higher elevation to function as a totem in conflict resolution (see Kaiser et al., in prep).

Marine snakes.—Sea snakes and sea kraits were included among the SICs with the expectation that they would primarily be identified by residents of coastal villages. However, our mountain village interviewees identified *Acalyptophis, Enhydrina,* and *Astrotia* as seen nearby (Table 1). All other taxa, *Hydrophis, Lapemis, Laticauda,* and *Pelamis,* were unrecognized. Since *Enhydrina* inhabit turbid estuarine environments and *Astrotia* is a rarely encountered, open-water species, these are likely to be errors that stem from a relative unfamiliarity with the species.

Terrestrial snakes.—The interviewees recognized the same species we have recorded from Ataúro (*Coelognathus subradiatus, Lycodon capucinus, Ramphotyphlops* sp.; Table 1). They also included the green and cyan color phases of *Trimeresurus insularis* but not the yellow phase found on neighboring Wetar. One python species, *Liasis mackloti*, was recognized, but neither *Python reticulatus* nor *P. timoriensis* were considered present.

Among the other recognized species were *Cylindrophis boulengeri* and *Brachyorrhus albus*. Whereas the former is known from eight specimens collected on Timor (Forcart 1953), records for the latter from Timor appear to have been in error (Murphy et al. 2012). The bronzeback *Dendrelaphis inornatus timorensis*, which we sighted but failed to capture, the catsnake *Boiga hoeseli*, a species not known from Timor but recorded from Alor, Ataúro's western neighbor, and *Stegonotus*, a genus not recorded from Timor until 2011, were also considered to be present (Table 1).

As seen in Timor but not near the village (Category B), our interviewees selected *Acrochordus granulatus, Cantoria violacea,* and *Fordonia leucobalia*, all mangrove swamp species (Table 1). Aside from a few very small mangrove lagoons along its northeastern shore, Ataúro has no suitable mangrove swamps for these species, but such habitats exist near Dili on the mainland. A fourth and seemingly more common taxon from the same habitat type and also rice-paddy, *Cerberus rynchops*, was not selected.

A worrying inclusion in the "seen but not nearby" category was the highly venomous *Daboia siamensis*, probably the most dangerous snake in the Lesser Sunda Archipelago, which is not known to occur as far east as Timor. However, the occurrence of *Daboia* has been verified from Lembata, an Inner Banda Arc neighbor of Ataúro, three islands removed. Therefore, it is possible that the interviewees did not remember that our question restricted their observations to Timor and that their familiarity extends to a species from a nearby island. Were this species present on Timor, we would have expected to reveal a medical history of serious snakebites, including fatalities.

Apart from the species mentioned above, the rarer wolfsnake *Lycodon subcinctus*, the mock viper *Psammodynastes pulverulentus*, known from Alor and other islands to the east but not Timor, and the spitting cobra, *Naja sputatrix* were also not selected (Table 1). Non-recognition of *N. sputatrix* by people from the higher elevations on Ataúro does not contradict anecdotal evidence we have collected regarding its presence on the island, because spitting cobras are lowland habitat generalists.

Conclusions of the Anartutu interview.—Our interviewees' observations coincided very closely with our own field experience, especially with regards to amphibians, turtles, the crocodile, and lizards, with the possible exception of the inclusion of *Carlia* as present on Ataúro. The exclusion of *Draco timoriensis* and *Varanus timorensis*, but the inclusion of the large *Varanus* was especially in agreement with our own findings. Even among the more elusive and generally feared snakes there was a great deal of agreement between the interviewees and our data, with all the species we had recorded being recognized (Table 1). The inclusion of several seasnakes and *Daboia* were unexpected, as was the exclusion of *Naja* and *Python reticulatus,* whereas the inclusion of *Cylindrophis*, *Brachyorrhus, Boiga,* and *Stegonotus* suggests more fieldwork is required on this rugged island.

Results and Comments: The Beloi Cardgame

The Anartutu village survey can be compared with a similar survey conducted with workers at Barry's Place, an eco-resort on the coast just north of Beloi village, who are more likely to be widely travelled and familiar with species from the mainland. In this survey the interviewer (the employer Barry, a Tetun-speaking Australian) simplified the trial on his own initiative during the interview by combining both categories indicating familiarity (Categories A and B), presumably to encompass Ataúro in a single category.

Amphibians.—The eco-resort workers recognized *Duttaphrynus, Fejervarya,* and *Polypedates* but excluded the three localized mainland amphibians (*Kaloula* cf. *baleata, Limnonectes timorensis, Litoria everetti*; Table 1).

Turtles and the crocodile.—Again *Crocodylus* and the three freshwater turtles were unfamiliar, but sea turtles were sorted in an exact contrast to the previous interview: *Dermochelys, Chelonia,* and *Eretmochelys* were included, *Caretta* was excluded (Table 1).

Geckos.—As in the previous interview, *Cyrtodactylus, Hemidactylus, Gehyra,* and *Gekko* were familiar (Table 1), although a striped *H. frenatus* was omitted. However, the workers also recognized *H. platyurus*, a species we do not yet know from Ataúro.

Skinks.—Every single skink was recognized (*Carlia, Cryptoblepharus, Eremiascincus, Eutropis, Lamprolepis, Sphenomorphus*). The inclusion of the endemic mainland *Cryptoblepharus* spp. was obviously an error but the inclusion, once again, of the unverified *Carlia* was interesting.

Agamas and monitors.—*Draco* was again unrecognized, but *Varanus timorensis* was included, possibly being mistaken for juveniles of the familiar, larger Ataúro swamp monitor (Table 1).

Marine snakes.—Curiously, all the species pictured were listed as present (Table 1) but it is possible the workers included some former net fishermen used to removing seasnakes from their nets and seeing a flattened tail assumed they were all the same.

Terrestrial snakes.—The workers agreed with both ourselves and the previous interviewees by including *Coelognathus subradiatus, Trimeresurus insularis* (with all three color phases), *Lycodon capucinus,* and *Ramphotyphlops* spp., while excluding *Lycodon subcinctus* (Table 1). They agreed with the first interviewees and our suspicions by including *Dendrelaphis inornatus* and *Boiga hoeseli,* but they erred in including *Brachyorrhus* and *Stegonotus.*

Unlike the Anartutu interviewees, the workers included *Acrochordus, Cerberus, Fordonia,* and *Naja* as present but excluded *Cylindrophis, Cantoria, Liasis,* and *Daboia.* They also included *Python timoriensis* but excluded *P. reticulatus.* If *P. timoriensis* is to be found anywhere in Timor-Leste, then Ataúro, being close to its easternmost record of Alor, is the most likely location.

Conclusions of the Beloi interview.—Among the obvious differences in how this interview was conducted is that the person doing the interview was not a native Timorese and that two categories were lumped together. While it may be easy for an employer inspired by a herpetological survey to gather employees for this type of exercise, we are not certain how effectively someone largely unfamiliar with the featured species can conduct the interview. It also occurred to us that employees might try to please their employer by answering in the positive more frequently than warranted. Overall, we again found considerable overlap with our own collections, even though there were some discrepancies such as the inclusion of mainland species as present on Ataúro. It is interesting that our survey has not revealed a single species on Ataúro not already known, and therefore selected, by at least one of the interviewees.

Discussion

Based on our specific test interviews, we find that the use of SICs alongside traditional survey methods shows great promise. Having used SICs in situations where we had some prior knowledge of the existing fauna allowed a reasonably good assessment of how to optimize use of SICs. Furthermore, we were also in a position to determine whether the results could add useful information to our survey efforts. Having completed these initial trials, we recognize the benefits of SICs, but we freely admit that there is room for improvement.

Interview optimization.—Based on the two interviews presented here in detail, as well as on several others conducted in mainland Timor-Leste, there are several ways by which use of SICs and the associated interviews can be improved. Firstly, our Timorese colleagues suggested that it would work best if we, as *malaes* (Tetun: foreigners) kept our distance, because they believed that during an interview villagers open up more to a fellow Timorese when foreigners are absent. The Anartutu interview was conducted in this way, whereas the eco-resort interview was conducted by the workers' Australian employer, a resident but nonetheless a *malae*. This may have led to differences in the interpretation of what was required of both the interviewers and the interviewees, and an increased desire to please by answering in the affirmative. In general, the interview ought to garner the best results if it is conducted by a team member indigenous to the survey area and not by actual or perceived outsiders.

Secondly, for the interview process it is essential that the interviewer have intimate knowledge of the animals surveyed as well as their habits and habitats. This is essential for the interviewee(s) if questions about the card arise, and it is important for the interviewer to ascertain whether positive identifications reflect the reality of a habitat and the probability of the encounter actually having taken place; refining questions can then be asked by the interviewer to eliminate doubts.

Thirdly, while it is certainly possible that interviews of multiple interviewees provide more results (i.e., animals recorded) more quickly, this may create a distracting group dynamic. For example, if one individual in a group is found not to be able to answer the interviewer's request for clarification, this may cause embarrassment and subsequent reluctance on the part of the interviewee to answer further questions (or to speak up at all), and on the part of the interviewer to ask that particular interviewee for further clarification questions in order to avoid further

embarrassment. We would consider individual interviews optimal, although we realize that in the village dynamic this may have to be an area for compromise since the deliberate exclusion of villagers wanting to participate may lead to resentment and future difficulties with fieldwork in the area.

Card optimization.—From a visual perspective, we found the design of the cards to be appropriate and effective overall. In order to provide size information, we had added a scale in the shape of a snake with expected ranges in length to the images of *Ramphotyphlops braminus* and *R. polygrammicus*, since these snakes are fairly uniform in body shape and coloration and difficult to differentiate for non-experts in the absence of size. This may be a useful addition to these cards in general. We also determined that some refinements were needed in the text. For example, the parameters of what constitutes a category need to be more finitely determined. Using Category B on Ataúro in its current incarnation, it could be seen as applying to "elsewhere on Ataúro" or even as "elsewhere on neighboring islands," when it was intended to indicate "elsewhere in Timor-Leste." Furthermore, the addition of cards in Bahasa Indonesia, Tetun, and possibly other local languages might be important so that both the indigenous interviewer and the interviewee(s) are able to refer to it frequently as decisions about card placement are made.

A final thought.—A possible follow-on worth considering for SICs, once a survey is complete and most, if not all, amphibians and reptiles have been documented, is to produce suits of cards as genuine playing cards, allowing both adults and children to use them as a popular form of wildlife and conservation education through entertainment.

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A Comparison of Two Methods to Assess Territorial Aggression in the Lizard *Uta stansburiana*

Techniques to assess social behavior, and especially territorial aggression, are as diverse as the behaviors they measure. Aggression has been measured in response to many types of stimuli: conspecific tethered intruders, mirror images, video-playbacks, and even robotic models. These stimuli may be interpreted differently by males and females, individuals with differing social status or condition,different aged individuals, etc., and these groups of individuals may respond in disparate ways. Also, it is important to note that the methods commonly used in the laboratory may not yield comparable results in the field. We used two methods to assess territorial aggression in the lizard *Uta stansburiana*. Due to strong sexual differences in morphology and behavior and the known costs of tail autotomy on social status in *U. stansburiana*, we felt it would make an excellent organism to compare and contrast two field methods, and at the same time evaluate how autotomy impacts territorial aggression. Lizards, especially small territorial ones like *U. stansburiana*, are excellent models to study social behavior (Fox 1983; Fox et al. 2003). They are often abundant, easily captured, individually identifiable, and exhibit stereotypical complex behavior—all traits that make them ideal subjects for studies of social behavior. Lizard territoriality especially has been thoroughly studied (Fox 1983; Fox et al. 2003; Stamps 1977). In lizards, field studies often rely on two methodsto quantify territorial behavior of residents: unmanipulated, time-constrained, focal observations (Baird et al. 1996; Baird et al. 2001) and experimental placement of tethered intruders into a resident's territory (Fox and Baird 1992; Husak et al. 2006; Moore 1987; Stamps 1977, 1978). Studies of dominance and territoriality in the laboratory use a different set of techniques, including dyadic contests in neutral arenas (Fox 1983; Fox et al. 1990; Husak et al. 2006; Karsten et al. 2009), mirror stimuli (Brandt 2003; Brandt and Allen 2004; Hurd 2004; Korzan et al. 2000; Watt et al. 2007), and video playbacks (Clark et al. 1997; Macedonia 1994; Ord et al. 2002). Mirrors work in laboratory settings to induce aggressive responses in lizards as well as in fish, birds, and primates (Bisazza and de Santi 2003; Gallup Jr. 1968; 1970; Gouchie et al 2008; Hirschenhauser et al. 2008; Moretz et al. 2007). The intensity and duration of lizard responses in the laboratory to a mirror have been used to measure endurance and aggression in lizards (Brandt 2003; Brandt and Allen 2004; Watt et al. 2007). However, the use of a mirror to induce an aggressive response from territorial lizards in nature has not previously been attempted. We took the mirror technique and transported it to the field to quantify territorial aggression. The tethered intruder method is a standard way to assess territoriality in the field. We compared the field-based standard of tethered intruder method to the typically laboratory-used mirror image intruder method, but here employed in the field.

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We used the lizard *Uta stansburiana* for these tests because it is an abundant, territorial lizard with clear sexual differences in morphology and behavior and is easily observed with minimal disturbance. *Uta stansburiana* at our study site experiences frequent tail autotomy (Fox and McCoy 2000; Tinkle 1967),and in this population the tail is used by subadults as a social signal (Fox and Rostker 1982; Fox et al. 1990). The benefit of tail autotomy is escape from predation; however, numerous costs are incurred post-autotomy, including decreases in performance, loss of caudal resources, and altered social and territorial behavior (reviewed in Arnold 1984 and Bateman and Fleming 2010). Therefore we also examined the impact of autotomy on territorial behavior.

The objectives of this study were to 1) compare the intensity and types of aggressive displays in the field against a mirror-reflected intruder versus a real, tethered intruder, and 2) evaluate differences in aggressive response due to sex and tail condition.

Materials and Methods

The study was conducted at a site in Winkler Co., Texas, USA, located on a large cattle ranch and oil/natural gas field, from early March to late May 2009, the breeding season of *U. stansburiana* in western Texas. This site has been used for numerous studies examining the demography, life history, and behavioral ecology of *U. stansburiana* over the last 50 years (Anderson et al. 2012; Fox 1978; Fox and McCoy 2000; Tinkle 1962, 1967).

Method 1: Tethered Intruder.—This method requires a size- and sex-matched intruder to be introduced into the territory of a resident lizard (Stamps 1977, 1978). Some residents had fully intact tails while others had autotomized tails in various stages of regeneration. For intruders, we used lizards collected from an offsite area of similar habitat. All intruders had fully intact tails. The intruders were kept in the laboratory in individual plastic cages and taken to the field only on the day of their trials. Intruders were provided with mealworms (*Tenebrio* sp.) *ad libitum* and their cage walls were misted with water each day. Intruders exhibited no signs of deterioration in condition due to captivity or manipulation, and were replaced with a new offsite lizard after several trials. Each intruder was paint marked with a single

dorsal stripe (blue or red). Intruders were sorted into three categories: small, medium, and large (males: 42–45, 46–49, and 50–52 mm SVL, respectively; and females: 39–42, 43–46, and 47–50 mm SVL, respectively). Intruders were the same sex as the resident and matched in size as closely as possible. Each intruder was used at most twice a day, with the two trials separated by at least 4 hours. The intruder was secured (tethered) to a 3-m telescopic pole via a 10-cm segment of monofilament fishing line around its waist. Intruders were placed approximately 1 m from a targeted resident. The intruder's presence and/or behavior usually elicited a response from the resident;however, since the intruder was tethered, it could not chase the resident and never attacked it.

All trials were conducted by one investigator (LAW) and all behavior performed during a 10-minute trial was recorded. *Uta stansburiana* has very stereotypical territorial behavior, consisting mainly of headbobs, pushups, lateral displays, and circling, which have been observed and catalogued with relation to aggression in previous studies (see Table 1 modified from Fox 1983). Sometimes, aggression can escalate into a fight, with chasing and biting occurring. At this site, *U. stansburiana* seems largely unaffected by the presence of humans, often foraging or interacting with conspecifics within just a few feet of the observer. Trials were carried out during the morning (0900–1300 h) and then again in the late afternoon (1600–1930 h), corresponding with peak activity of *U. stansburiana*at the study site (Irwin 1965; Tinkle 1967; Anderson, pers. obs.). Weather conditions were similar for all trials and an effort was made to avoid excessively hot or windy conditions.

Table 1. Behavior patterns recorded and point values used to score total (raw) and weighted aggression.

Behavior Score	Type (aggressive or submissive)	Score	Weighted
Attack	Aggressive—resident runs toward and tussles with intruder	+1	3
Bite	Aggressive—resident bites intruder	+1	3
Superimposition	Aggressive—resident sets limb or body over intruder	+1	3
Lateral Display	Aggressive—resident extends limbs to raise the trunk of the body above the ground, while dorsoventrally compressing the torso and inflating the dewlap	+1	2
Pushup	Aggressive—resident performs rapid up and down movement in which the trunk of the body is raised off of the ground	+1	2
Lick	Aggressive—resident licks intruder	+1	2
Circling	Aggressive—resident moves in a semi-circle or circle around intruder, often while performing other aggressive acts	+1	2
Headbob	Aggressive—resident performs up and down head movement without raising the trunk	+1	1
Approach	Aggressive—resident moves toward intruder	+1	1
Flee	Submissive—resident quickly and deliberately retreats from intruder	-1	-1
Flatten	Submissive—resident presses trunk of body and limbs flat against the ground	-1	-1

Table 2. Size (SVL) comparison between resident lizards challenged with a real, tethered intruder or the mirror-image intruder (t-tests).

Sex	Intruder Type	Sample Size	SVL (mm) ± 1 SD	t-statistic	df	P-value
Male	Mirror	12	50.83 ± 3.5	0.568	30	0.574
	Tethered	20	50.20 ± 2.29			
Female	Mirror	22	46.50 ± 1.82	1.184	48	0.242
	Tethered	28	44.21 ± 8.89			

Method 2: Mirror-Image Intruder.—We custom designed a mirror for field use. The device consisted of a flat mirror (61 × 30.5 cm) mounted to a plywood board of similar dimensions. This board was connected to a 2–4 m collapsible pole. The pole was made of aluminum and lightweight, but rigid enough to support the weight of the mirror and board. This device was carried into the field and deployed once a resident lizard was located (Fig. 1). A different subset of resident lizards was used from those in Method 1.The mirror image was always size-, sex-, and condition- matched (including tail status) to the resident. The behavior of the intruder was also identical to the resident. So if the resident escalated its aggression, so did the intruder, and this cycle continued throughout the trial.

To deploy the mirror, the collapsible pole was extended to an appropriate length and the mirror was placed on the ground directly in the resident's line of sight. Due to the loose, sandy soil at the study site and the weight of the mirror/board, the mirror was easily placed at ground (lizard eye) level. If during this process the lizard fled from the experimenter, the trial was aborted and tried again later (> 5 h).

Once the mirror was in place the trial began. All trials were observed by one investigator (LAW), and all behavior performed during the trial was recorded. Mirror trials were carried out during the morning (0900–1300 h) and late afternoon (1600–1930 h). Weather was similar for all trials, and again an effort was made to avoid excessively hot or windy conditions. Duration of the trials was dependent on the resident lizard. We tried to conduct 15-min trials, but in many cases had to cut the trial short because the intruder lost sight of the mirror image and left the area.

To account for the varying and different durations of the two methods, all frequencies of behavior patterns were converted to a common 10-min basis. Three dependent variables were calculated for each trial: total (raw) aggression, weighted aggression, and trial aggression. Total (raw) aggression is the sum of all agonistic behavior patterns observed during a trial; behavior patterns were categorically assigned a +1 if aggressive, and a -1 if submissive. The weighted aggression score is the sum of all agonistic behavior patterns observed during a trial, but each behavior pattern is given a weight from +3 to -1, based on the intensity of the behavior. See Table 1 for a detailed description, categorization of aggressive or submissive, and weights for each behavior pattern. Trial aggression was a single value based on the sequence of aggression observed during the trial; each trial was scored from zero to 5 (0 = immediately flee, 1 = no response, 2 = display then flee, 3 = display with no subsequent fight or flee, 4 = display then fight, and 5 = fight then display). Total Aggression and Weighted Aggression werelog transformed to ensure normality,and in all cases in which parametric statistical tests were used, distributions of transformed data were normal (Kolmogorov-Smirnov tests, all $P > 0.05$). Non-parametric tests were used in the case of Trial Aggression since this was an ordinal, and not continuous, variable. All statistical comparisons were made using the statistical package SPSS (IBM Corp. Ver. 19.0).

Results

During the spring of 2009, 48 tethered intruder and 33 mirror intruder trials were completed. Tethered intruders were introduced into the known territories of 20 male and 28 female lizards. The mirror was tested in the territories of 11 males and 22 females. Fewer males were tested because this population of *U. stansburiana* is female-biased, potentially due to differential predation pressure on the males. Males are more conspicuously colored, larger bodied, and defend larger territories, all of which may contribute to higher death rates due to predation(Constantini et al. 2007; Husak et al. 2006; Magnhagen 1991; Stuart-Fox et al. 2003). Size of the resident can affect aggressive response, but there was no significant difference in size of either male or female residents tested with the tethered intruder versus the mirror image (all $p > 0.05$; see Table 2 for details of morphological comparisons).

We first determined that *U. stansburiana* would act aggressively toward a mirror-image intruder in a natural setting. We observed an aggressive response from residents in 22 of 33 trials (67%). Of the 11 trials without aggression, in onethe resident fled from the mirror and in 10 the resident showed no response. Comparing this to the introduction of real, tethered intruders, 29 intruders in 48 trials (60%) elicited aggression. We conclude that the mirror image of an individual *U. stansburiana* can elicit aggressive behavior from free-living, territorial resident lizards.

Within method analysis: Tethered Intruders.—Using a full-factorial two-way ANOVA, the interaction between the effects of sex and tail status on Total Aggressive response to a tethered intruder was non-significant ($F_{1,47} = 0.0010$, $P = 0.971$). Considering main effects, males were significantly more aggressive toward a tethered intruder than females ($F_{1,47} = 6.833$, $P = 0.013$; Fig. 2a), but there was no significant difference between tail status groups ($F_{1,47} = 0.970$, $P = 0.758$).When examining Weighted Aggression toward a tethered intruder, we found no significant interaction between sex and tail status ($F_{1,37} = 0.001$, $P = 0.992$). Considering main effects, males were significantly more aggressive toward a tethered intruder than females ($F_{1,37} = 7.102$, $P = 0.012$; Fig. 2b) and there was no significant difference between tail status groups ($F_{1,37} = 0.058$, $P = 0.812$). Trial Aggression was assessed using the Mann-Whitney U Test. Males responded more aggressively against a tethered intruder than females (Mann-Whitney $U = 109.0$, $n_1 = 20$ $n_2 = 27$, $P < 0.0001$ two tailed; Fig. 2c). Tail status did not affect Trial Aggression for males (Mann–Whitney $U = 46$, $n_1 = n_2 = 10$, $P = 0.745$ two-tailed), or for females (Mann–Whitney $U = 60.0$, $n_1 = 11$ $n_2 = 16$, $P = 0.144$ two-tailed).



Fig. 1. The custom-designed mirror on a pole used to elicit territorial aggression. The pole is telescopic (2–4 m) and made of lightweight aluminum.

Within method analysis: Mirror Image Intruders.—No significant interaction between the effects of sex and tail status on Total Aggression toward a mirror image intruder was detected ($F_{1,22} = 0.008$, $P = 0.929$). Analysis of simple main effects showed that males were not more aggressive toward a mirror image intruder than females ($F_{1,22} = 1.074$, $P = 0.142$) and there was no significant difference between responses with respect to tail status ($F_{1,22} = 0.159$, $P = 0.564$). No significant interaction effect was detected between the effects of sex and tail status on Weighted Aggressive response to a mirror image intruder ($F_{1,26} = 0.032$, $P = 0.860$). Males tended to be more aggressive than females; however, this difference was not statistically significant ($F_{1,26} = 2.738$, $P = 0.111$). There was no significant difference with respect to tail status ($F_{1,24} = 0.301$, $P = 0.589$).Trial Aggression within mirror image intruder trials was assessed using the Mann-Whitney U Test. Trial Aggression was the same between male and female residents (Mann-Whitney $U = 97.0$, $n_1 = 11$ $n_2 = 22$, $P = 0.300$). Tail status did not affect Trial Aggression for males (Mann-Whitney $U = 14.5$, $n_1 = 6$ $n_2 = 5$, $P = 0.892$ two-tailed), nor females (Mann-Whitney $U = 46.0$, $n_1 = 12$ $n_2 = 10$, $P = 0.319$ two-tailed).

Between methods analysis.—To compare the two methods, we separated the sexes due to the sexual differences detected in the within method analysis. However, tail status was removed from the analysis; lizards with recent tail autotomy and those with intact tails were pooled.

Males responded to the two methods with significantly different amounts of Total Aggression ($F_{1,31} = 4.169$, $P = 0.050$; Fig. 3a). They responded with almost 1.5 times the mean aggressive behavior per 10-minute trial toward the tethered intruder than the mirror image intruder. Weighted Aggression from males toward the two types of intruders showed a similar tendency, but it was not statistically significant ($F_{1,31} = 3.681$, $P = 0.065$; Fig. 3b). Females did not show a difference in response to the two

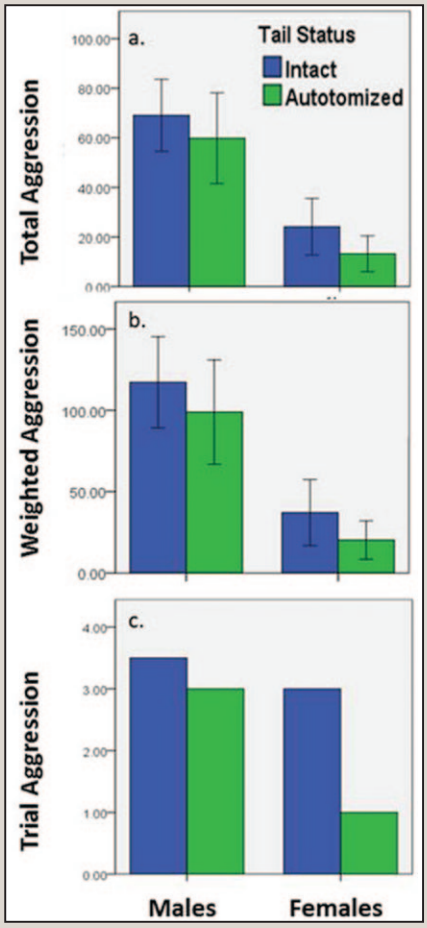


FIG. 2. a) Total Aggression directed at a tethered intruder was significantly different for the sexes ($F_{1,47}$= 6.833, P = 0.013), but both sexes responded similarly regardless of tail status ($F_{1,47}$ = 0.0010, P =0.971). Error bars represent ±1 SE. b) Weighted Aggression directed at a tethered intruder was significantly different for the sexes ($F_{1,37}$ = 7.102, P =0.012), but both sexes responded similarly regardless of tail status ($F_{1,37}$ = 0.001, P =0.992). Error bars represent ±1 SE. c) Males responded with greater Trial Aggression than females when confronted with a tethered intruder (U =109.0, P <0.001), butboth sexes responded similarly regardless of tail status.

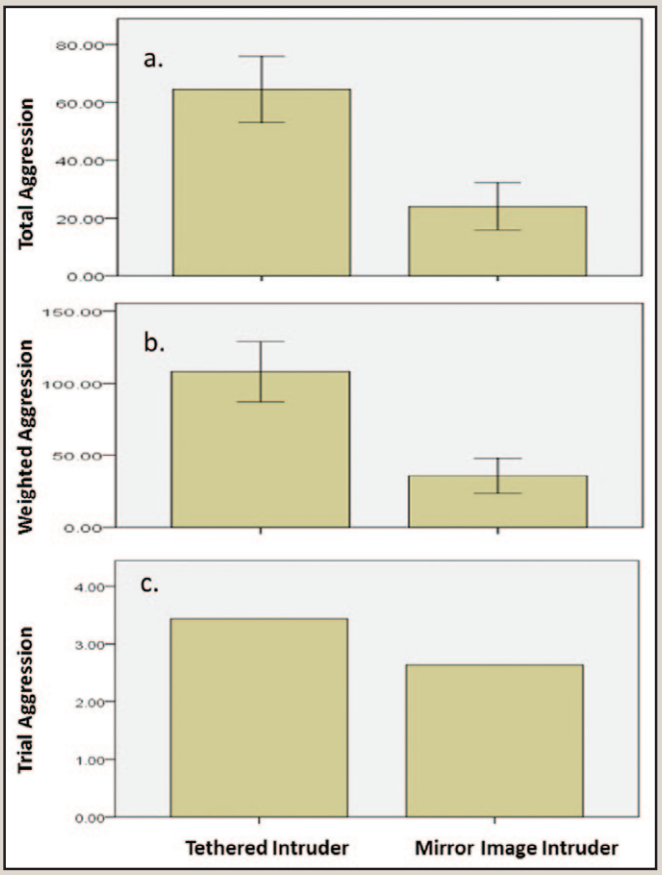


FIG. 3. a) Total Aggression displayed by males in response to the two methods (tail status of males pooled). Males responded to the tethered intruder with significantly more Total Aggression than they did towards a mirror image intruder ($F_{1,31}$ = 4.169, P =0.050).Error bars represent ±1 SE. b) Weighted Aggression displayed by males in response to the two methods (tail status of males pooled). Males responded to the tethered intruder with marginally more Weighted Aggression than they did towards a mirror image intruder ($F_{1,31}$ = 3.681, P =0.065). Error bars represent ±1 SE. c) Trial Aggression displayed by males in response to the two methods (tail status of males pooled). Male responses to the tethered intruder weregreater than their responses to a mirror image intruder (U = 60.5, P = 0.022).

responded with equal Total Aggression regardless of intruder type ($F_{1,32}$= 1.070, P = 0.309). Because variances of weighted aggression between the two methods were significantly non-homogenous for females, we used the nonparametric Mann-Whitney U-test to detect differences in Weighted Aggression to tethered intruders and mirror image intruders. The response of females was not significantly different (Mann-Whitney U = 270.0, n_1 = 27, n_{22} = 22, P = 0.580). Trial Aggression between tethered intruder and mirror image intruders was assessed by the Mann-Whitney U Test (tail status groups pooled). Trial Aggression of males against tethered and mirror intruders was significantly different (Mann-Whitney U = 60.5, n_1 = 20 n_2 = 11, P = 0.022 two-tailed; Fig. 3c). Trial Aggression of females was not different (Mann-Whitney U = 236.5, n_1 = 27 n_2 = 22, P = 0.198 two-tailed).

Additionally, we observed that residents (males more than females) presented with a real, tethered intruder not only scored higher quantitatively on indices of aggression, but they also behaved differently in a qualitative sense. Real intruders were attacked and ultimately bitten more. In 380 minutes of tethered intruder trials, 39 attacks and 27 bites were recorded, compared to only 5 attacks and no bites in 412 minutes of mirror trials. A major component of the stereotypical territorial encounter in *U. stansburiana* is a phase of circling the intruder. In doing so, the resident dorsoventrally compresses its body, inflates its dewlap, and struts around the intruder in a tight circle. This behavior is a sign of escalating aggression and typically leads into a rough-and-tumble fight. During the 380 minutes of tethered intrusions, 31 instances of circling were recorded, as opposed to only 2 instances in 412 minutes of mirror intrusions.

DISCUSSION

The mirror successfully elicited territorial aggression in 67% of the trials. This was similar to the rate (60%) of eliciting territorial aggression toward a real, tethered intruder (χ^2 = 0.328, df = 1, P = 0.567). However, the intensity and duration of the aggression against a tethered individual was noticeably different, especially in males. Residents attacked, and ultimately bit, real, tethered intruders more often than they tried to attack the mirror. The residents also used their full repertoire of territorial

behavior against tethered intruders, including circling and lateral compression displays. These behavior patterns were much less frequently used against a mirror intruder. With the mirror technique, a resident cannot really circle the intruder, nor bite the plane of the mirror. In general, males responded significantly more aggressively than females toward a real, tethered intruder, but this sexual difference was not observed against a mirror image intruder.

Previous laboratory studies have shown decreases in social status for juvenile *U. stansburiana* during neutral arena dyadic encounters following tail autotomy (Fox and Rostker 1982; Fox et al. 1990). We did not detect lower aggression from resident lizards with recent tail loss for any of the measures used in this field study. However, our methods differed significantly from those in the earlier studies, and the sudden appearance of an intruder (whether tethered or mirrored) into the territory of a resident may be impossible for tailless individuals to ignore. Our methods did not assess whether the resident would have won the encounter with the intruder, just its overall response. Perhaps the cost of territorial incursions by intruders is so high that residents must respond, regardless of tail status. Repeating laboratory dyadic encounters with adult lizards with and without tail loss is worth further investigation.

The use and limitations of tethered intruders to assess territoriality in the field have been discussed elsewhere (Civantos 2000; Fox and Baird 1992; Husak 2004; Husak and Fox 2003), so we focus instead on our novel use of the mirror intruder method deployed to assess territorial aggression in the field. Even though the mirror method did not elicit as high a level of aggression nor all the aggressive behavior patterns as the real, tethered intruder, this method does have some obvious benefits. The mirror projects an image of the intruder that is exactly matched to the resident with respect to size, sex, and condition. This is a major advantage because with the use of real, tethered intruders, care must be taken to ensure an appropriate match between resident and intruder, which is never perfect. Additionally, small subsets of intruders are used often, which can sometimes lead to deterioration in condition or motivation of the intruder and ultimately decreased aggression from the resident. The mirror image always "responds" in kind to the resident's behavior. This is not the case with a tethered intruder, who may or may not respond to the resident. This mirror response might show display endurance (Brandt 2003; Brandt and Allen 2004) and willingness or ability to escalate aggression (Cox et al. 2009) more reliably than a real intruder since the mirror image always responds aggressively to an aggressive resident.

In some studies the use of tethered intruders might not be practical or ethical. In cases where lizards are especially large (e.g., large iguanids or varanids) the tethering of an intruder seems impractical at best and might be dangerous to both investigator and the lizard. For threatened, uncommon, or endangered species, there may be legal or ethical concerns with tethering an intruder into the territory of a resident. Tethering, if done correctly, is a standard and safe method and does not cause long-term harm to the intruder. However, it might cause temporary stress to the tethered intruder because the intruder cannot flee and avoid the aggression of the resident, but it is unknown if this temporary stress is more than an unmanipulated, natural intruder experiences. In these cases, use of the mirror technique in the field might be a more suitable alternative.

The use of the mirror in a field setting does present some limitations. The most obvious limitation is the logistic demand of carrying a large, cumbersome mirror-on-a-pole into the field. The entire device weighed almost 4.5 kg, even with the modifications we made. For the pole, we used a lightweight aluminum pole used in swimming pool maintenance, and we constructed the backing board out of thin plywood. The placement of the mirror at our desert study site was made relatively easy due to the sparse vegetation and the sandy soil. Our method might not work in densely vegetated habitats or in rocky soils.

Another major limitation is lack of control of the stimulus of the mirror intruder. Basically, the resident loses focus on the intruder when the intruder passes out of sight. Unlike the tethered intruder technique (where the intruder is anchored to one small area), the mirror image may disappear during the trial when the resident moves too much to the side of the mirror. We observed this phenomenon, and we also sometimes witnessed the resident reach the edge of the mirror, lose the intruder, turn and walk back in front of the mirror. At this point the intruder "returns," and the resident begins its aggressive behavior again. To minimize this shortcoming, the size of the mirror must be appropriate for the size of the lizards. At our study site, adult *U. stansburiana* are approximately 48 mm in SVL, and the mirror was 610 mm in length, almost twelve times the lizard's body length. This size of the mirror allowed the resident ample opportunity to move while displaying, and never lose sight of the mirror image. For larger-bodied lizards, a larger mirror would be needed, but makes the device even heavier and more cumbersome.

The last limitation of the field mirror technique is that the deployment of the mirror can spook the resident lizard and cause it to flee. This occurred in a number of early trials, but, as with all techniques, with practice the investigator (LAW) became much more proficient at placing the mirror without disturbing the resident. The life history and general behavior of *U. stansburiana* made this issue less troublesome than it might be with other species. *Uta stansburiana* are not nervous, or flighty, lizards. Residents occupy small territories and patrol often so as to prevent incursions from neighbors, and to switch ambush locations. So if residents are disturbed during the setup of the mirror, they often will return to this location within a short time and respond to their image, or allow the setup near their new location.

In sum, the mirror technique used in the field elicited aggression from residents but has limitations, as do all methods of eliciting aggression in a field study. The mirror results in aggression only if and when the resident is viewing its mirror image, and demonstrates only a certain level of aggression and not all aggressive behavior patterns. Real, tethered intruders clearly force the resident to engage in intense combative behavior, yet may give a false estimate of their social status since they cannot chase away the intruder. Both methods can be used to peek into the lives of lizards, and we recommend the use of both to elucidate different aspects of lizard territorial behavior.

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Applicability of "Tablet" Computers for Use by Field Biologists

Aside from traveling to and from their study sites and answering emails, three of the most time-consuming things that field biologists do are to (1) write field notes, (2) enter information onto field data sheets, and (3) transcribe those data sheets into Excel, Access, or another database program. Given that the concept of "spare time" is an unknown term to most biologists, any means of saving time in recording data in the field would seem to be highly desirable. In addition, any mechanisms that can make it easier to either retrieve information from field notes efficiently or that minimize errors in data entry are also quite valuable.

Although electronic aids such as micro tape recorders and PDA's have been used in the past for recording field data, the recent explosion of availability of small, highly portable "tablet" computers (i.e., hand-held devices running the Android, Microsoft Windows 8, or Apple iOS operating systems) has made many more solutions available to field biologists. Here, I provide an evaluation of a variety of tablet computers in terms of their applicability for field biologists to record field notes and data under real-life conditions. Although funding constraints make this less than a fully-comprehensive review, I was able to test a wide enough spectrum of devices to provide at least a preliminary guide to determine whether these tablets can be used to make recording data in the field more efficient and less time-consuming than traditional paper notebooks or datasheets.

Methods

I tested seven devices ranging in price from US$199 to $449 (Table 1). Four of these are classified as tablet computers as noted above (Apple iPad 2, Asus Eee Pad Transformer 101, Samsung Galaxy Tab 7.0 Plus, and Samsung Galaxy Tab 8.9), one is a cell phone with multi-purpose capabilities (iPhone 4s), and two are media players that can double as multi-purpose devices (iPod Touch and Samsung Player 5). Each device was used by myself and several of my students in a variety of field situations in Arizona, Florida, Maryland, and Missouri for both general note-taking and day and night-time data entry. I timed how long it took to enter a set of field notes via a traditional field notebook and entered the same information under field conditions with each electronic device. This exercise was repeated by myself and two students to provide some indication of variation due to operator skill level.

Because these devices can serve purposes other than data entry, I also evaluated their ability to assist investigators in three areas; photography, reading the literature, and replacement of traditional field guides with electronic substitutes. Specifications for photographic capabilities are listed in Table 1. To determine the ability of these devices to replace or compliment standalone digital cameras, I took two photographs with each device, a close-up of a plastic model of a frog from approximately 30 cm away, and a landscape photograph of a marsh. I then asked a series of volunteers to rate these photographs as "good" (comparable to a standard digital camera), "acceptable" (not rated as highly as "good", but usable for PowerPoint presentations), and "unacceptable" (meaning the photographs were not usable in a professional setting). One additional photograph from a Canon Sx 230 digital camera with 12 megapixel resolution was included for comparison. All evaluations were from single-blind trials, where I knew the identity of the device responsible for each photograph, but the evaluators did not.

Evaluating the usefulness of these devices for reading the literature or as an electronic field guide was more subjective; for each device, I downloaded both Microsoft Word and Adobe Acrobat versions of manuscripts and reprints, respectively, and determined whether I could adequately read the material using that device. Devices were rated as "good", "acceptable", or "unacceptable", similar to the way that photographs were evaluated. Ratings of electronic field guides for reptiles and amphibians were based on use by myself or students under field conditions in Maryland and Florida, but detailed ratings were not attempted.

Results

Portability.—The tablets I tested ranged in size from easily transportable in a pants pocket or belt pouch (iPhone, iPod Touch, Samsung Player), to those that were large enough to require a small hip or backpack (Samsung 7 and Samsung 8.9), to those that required at least a small daypack (iPad 2 and Asus Transformer). I found that having a tablet in a pants pocket made me much more likely to use the device compared with having to carry the units in a hip pack or, especially, in a daypack. However, several of my students that used the iPad 2 in the field felt that this was not a serious inconvenience and that they would be more concerned about the accidental loss of a small tablet carried in a pants pocket. In any event, neither I nor my students felt that the weight of any of these tablets was overly burdensome under most field conditions, including inclement weather.

Screen Size and Visibility.—There was an obvious trade-off between screen size and portability. The units with the largest screens (iPad 2, Asus Transformer, Samsung 8.9) were the easiest screens to read and, to some degree, the easiest for data entry (but see below), but these tablets could only be carried in a daypack or hip pack. To a large degree, the need for the larger screens depends on the visual abilities of the user and the way the tablet was used in the field. For examples, even with my poor 20/40 vision (after correction), I had few problems inputting and reading field notes with the three smallest tablets (iPod Touch, iPhone, Samsung Player), but found these screens to be less than useful for entering data onto electronic data sheets, for looking up data on Excel-compatible files, or for reading Adobe Acrobat or Microsoft Word files.

An important consideration for the use of tablet computers in the field is their degree of visibility when exposed to bright sunlight. With few exceptions, current tablet computers have highly reflective screens that, while producing high quality images indoors, reflect so much ambient light that legibility is greatly reduced when used outdoors under sunny conditions

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(http://www.displaymate.com/IPS_Tablet_ShootOut_1.htm). Screens with higher levels of adjustable brightness can, to some extent, reduce this problem, but I found that all of the tablets tested had high enough screen reflectivity to make sunlight a significant issue during field tests. Qualitatively, the iPhone, iPod Touch, and Samsung 8.9 had the best screens under bright conditions and the Samsung Player and Asus Transformer had the worst, with their screens almost unreadable in bright daylight. Use of an aftermarket anti-reflective screen can reduce glare and may make tablet screens more useful during daylight conditions, but may not always be effective. Thus, users should be aware of this issue and try and test the tablet they intend to purchase under real-world conditions and not simply in an indoor store environment. In addition, some newly-released tablets (e.g., Asus Transformer Infinity, Kindle Fire HD) have either extraordinarily bright screens (Asus) or less reflective screens (Kindle Fire) that are designed for better visibility under daylight use. However, using a higher brightness level can also decrease battery life.

Virtual Keyboard and Data Entry.—All of these tablets offer an on-screen (virtual) keyboard which, while not well-adapted for typing lengthy material, can easily be used for entering field notes or for typing information into datasheets. Table 2 illustrates the time it took myself and two students to enter a text passage of 40 words and 168 characters into each of the tablets compared with the time to enter the same text into a standard sized field notebook with a pencil. Time differentials (positive if typing on the tablets took longer than writing by hand, negative if typing was faster) ranged from +18 to 77 seconds for myself, from +6 to 46 seconds for a graduate student, and from -13 to +44 seconds for an undergraduate student who was more accustomed to typing with a small virtual keyboard (i.e., this student was faster with two of the tablets than writing by hand).

The Samsung 7 had the fastest input times compared with a traditional field notebook, followed by the iPad 2 and Samsung 8.9. The Samsung 5 (which had the screen least visible under sunny conditions and the slowest processor) had the worst input times (Table 2). Both my students and I felt that the ability to customize the keyboard types (easily done on the Samsung and Asus tablets) was a significant advantage, allowing the user to find the keyboard type that he or she was most comfortable with. I found that a keyboard that had a separate row of numeric keys greatly facilitated data entry, compared with a keyboard that lacked this option.

Quality of Photographs.—I found taking photographs using these tablets to be fairly easy, especially once I had practiced a few times and became familiar with the controls, which are obviously very different from those of a standard digital camera. The

TABLE 1. Specifications and information on the tablets evaluated. All prices (US $) are as of July 2012 at common discount web sites. Specifications come from the manufacturer's web site. Camera resolution in megapixels. See text for discussion of camera ratings.

Device	Price	Diagonal screen size	Mass (g)	Camera resolution	Camera rating (G = Good, A = Acceptable, U = Unacceptable)
Apple iPad 2	$399	246 mm	613	0.92	Close up (N = 9): G(0%), A(100%), U(0%) Landscape (N = 6): G(0%), A(100%), U(0%)
Apple iPhone 4s	$299	89 mm	140	8.0	Close up (N = 9): G(56%), A(44%), U(0%) Landscape (N = 6): G(50%), A(50%), U(0%)
Apple iPod Touch (8 gb)	$199	89 mm	101	0.69	Close up (N = 9): G(0%), A(0%), U(100%) Landscape (N = 6): G(0%), A(33%), U(67%)
Asus Eee Pad Transformer 101	$399	257 mm	680	5.0	Close up (N = 9): G(20%), A(80%), U(0%) Landscape (N = 6): G(67%), A(33%), U(0%)
Samsung Galaxy Player 5	$220	127 mm	182	3.2	Close up (N = 9): G(0%), A(11%), U(89%) Landscape (N = 6): G(50%), A(50%), U(0%)
Samsung Galaxy Tab 7 Plus	$399	178 mm	345	3.0	Close up (N = 9): G(100%), A(0%), U(0%) Landscape (N = 6): G(67%), A(33%), U(0%)
Samsung Galaxy Tab 8.9	$449	226 mm	448	3.0	Close up (N = 9): G(100%), A(0%), U(0%) Landscape (N = 6): G(83%), A(17%), U(0%)

TABLE 2. Comparative times to enter a set of 40 words and 168 characters into either a standard field notebook using a pencil (scored as 0) versus the additional time (positive numbers) or reduced time (negative numbers) to enter the same text into a selected tablet. Thus it took 18 seconds more for RAS to enter the text into the iPad 2 than it did to write the text into a field notebook using a pencil. Sum is the total of both reduced and increased times, so smaller numbers for Sum indicates faster entry times compared with other tablets.

Tester	Hand	iPad 2	iPod Touch	Samsung 8.9	Samsung 7	Samsung 5	Asus Transformer
RAS	0	+18	+60	+23	+26	+77	+38
Grad Student	0	+45	+46	+8	+6	+31	+27
Undergrad	0	-13	-1	+24	-1	+32	+44
Sum	0	+50	+105	+55	+31	+140	+109

only substantive problem was encountered when taking photographs in bright sunlight, when the screen (viewfinder) was hard to see, especially for the Asus Transformer and Samsung 5 units. My students rated the Samsung 7 and 8.9 as having the best photographs of the plastic frog (equivalent to a macro photograph of a live animal), with all students rating the photograph as "good" for both devices, even rating these two tablets above the Canon digital camera used as a comparison (Table 1). The iPhone and Asus Transformer were rated from "acceptable" to "good", but the iPod Touch and Samsung 5 were both judged to be largely or entirely unacceptable based on this test (Table 1). The Samsung 8.9, the Samsung 7, and the Asus Transformer had the best performance on the landscape photograph, followed closely by the iPhone, iPad, and Samsung 5 (Table 1). Both photographs taken by the iPod Touch were rated as the worst of these devices, which is unsurprising, as it has the lowest camera resolution of any of the tablets tested.

Availability of Critical "Apps".—Regardless of price, size, and screen quality, it is the availability of "apps" (software programs for tablets) that largely determines the utility of these devices. Because the iPad and iPhone have such large market shares, the availability of apps tends to be more comprehensive for these devices. However, the popularity of new Android-based tablets such as the Amazon Kindle Fire and Nexus 7 has resulted in many new apps being introduced for this platform as well. All apps noted below are available for Apple devices via the iTunes Store (www.apple.com/iTunes) and for Android devices via Google Play (https://play.google.com/store).

I divided the apps available for both platforms into two general categories; productivity software and field-specific software. Below, are brief overviews of both categories. However, the reader should keep in mind that new apps are introduced almost daily and older packages are updated frequently, so this should be used as an introduction rather than a comprehensive review.

Productivity Apps: Word Processing and Spreadsheets.—Field biologists wanting to use tablets for recording field data will certainly need apps that fill the roles taken by such standards as Microsoft Word and Excel. I tested several such apps for both the Apple and Android platforms. For the Apple (iOS) platform, the most comprehensive packages are Pages (Microsoft Word compatible) and Numbers (an Excel compatible spreadsheet). Both integrate extremely well with the iPad and iPhone, are not overly expensive ($9.99 each), and, after some experience using a touch screen instead of a mouse, are quite easy to use. Other Word and Excel replacements for the Apple products include Documents to Go ($16.99 for both word processing and spreadsheet apps), Office 2 HD ($7.99 for the package), and Quick Office ($19.99). I found Pages and Numbers to have a very good combination of features and ease of use, but two of my students using an iPad 2 for field data entry preferred Documents to Go or QuickOffice. Thus, this will be a matter of individual preference.

Word and Excel compatible apps are quite common on the Android platform as well. I tested four such programs for this review; Documents to Go ($14.99), OfficeSuite Pro ($14.99), Kingsoft Office (free), and QuickOffice ($19.99). I found that Kingsoft Office worked as well as the other packages and was free. Both the Apple and Android word processing and spreadsheet apps worked well for entering data and, when combined with a physical keyboard (see below) are useful for composition of manuscripts. However, they still lack certain features (most notably "Track Changes") that will allow tablets to replace a traditional laptop. This will likely change as these apps become more capable; the most recent release of Apple's Pages app (1.7.1, late fall 2012) does allow a form of Track Changes to be implemented, and other apps may well do the same. In addition, full versions of Microsoft Office are now available on the new Windows RT and Windows 8 tablets that are just entering the market in late 2012.

An important consideration for use of all of these apps is how to transfer data files to your main computer and how to guard against potential loss of data, and the ease of this does vary widely among devices and packages. Several of the Android devices (the Samsung Galaxy Player 5, the Galaxy 7 Plus, and the Asus Transformer) have micro-SD card slots where data can easily be stored and then copied directly to a laptop or desktop. I found this to be the simplest solution to backing up my data on the tablets. For devices that lack such a capability (or if you prefer a different method), data can be transferred via email (all devices), via iCloud (Apple devices only), or via a cloud-based service such as Dropbox (https://www.dropbox.com/) or Google Drive (https://www.google.com/intl/en_US/drive/start/index.html). Indeed, one reason for my preference for Kingsoft Office was the ease with which this app integrated with Dropbox. I experienced no loss of data under actual field conditions using either of the Apple products or using Kingsoft Office for the Samsung devices, but did find that some of the other Android apps made saving files less than transparent. Thus, being thoroughly comfortable with how the selected apps save data files is something that should be done before recording data in the field.

Field Apps.—Although applications designed specifically for field herpetologists remain relatively small in number, there are several useful apps available. For North America, the Audubon Nature series (US $4.99 each) is available for the Apple devices (at least for reptiles and amphibians) and has been used extensively by some of my students. A more international app, Turtles of the World (US $9.99, also for the Apple devices) contains color photographs, range maps, and ecological information on all known species of turtles (500+ species and subspecies), with the text based on Ernst and Barbour (1989). Although I found fewer herpetological apps available for the Android platform, development of additional field apps are ongoing, so more choices should be available as the use of tablets expands.

Beyond herpetological-specific apps, there are a number of useful programs available for both the Apple and Android devices. For North America, these include iBird Plus/Pro (Apple via iTunes and Android via Google Play) and Mammals of North America (Android). Such apps can be valuable not only for personal use, but for use in field classes as well.

For GPS-enabled devices (e.g., the iPhone, Samsung Player, Samsung 8.9, and Asus Transformer), there are a number of GPS apps that have considerable advantages for field workers. I tested the iPad app Motion-X GPS HD (US$1.99 on the iTunes store) and the Android app GPS Essentials (free on the Google Play site). Each app did an excellent job of taking advantage of the larger screens available on the iPad, Samsung 8.9, and Samsung Player to make tracking of routes, recording waypoints, and displaying compass headings very simple and easy to do. While not perhaps replacing stand-alone GPS units, having one less device to buy and carry was quite convenient.

Apps for reading the literature.—Given that most reprints today are distributed as Adobe Acrobat files (.pdf files), having an app that allows downloading and reading your reprint files greatly enhances the utility of tablet computers. Fortunately, there are a number of relatively inexpensive and easy-to-use apps that do just this for both the Apple and Android platforms.

Examples include Adobe Reader (both platforms), GoodReader (Apple), and most of the word-processing apps noted above. The Kindle reader app from Amazon is also a very capable reader of Acrobat files. In addition, the widely used reference management program Mendeley has a version available for the Apple iPad and iPhone/iPod Touch that can synch with your desktop files, giving you access to your entire reprint library.

With the exception of the Galaxy Player 5, I found all of these devices displayed reprints and text files quite well. The larger screens of the Asus Transformer, the iPad 2, and the Galaxy Tab 8.9 were the best for reading reprints and text documents (all rated as "good"), whereas the small screen and low resolution of the Player 5 made reading problematic and this device was rated as "unacceptable" for this purpose.

Accessories.—There are a number of accessories for tablets that, while not strictly required, are important in making tablets more useful and extending their life in a field environment. The most obvious of these is a good case, clearly important in protecting tablets when used in the field. Cases, available for all tablets in a very wide variety of levels of costs (ca. $20–100), protection (including waterproof cases), and features are widely available from both web sources (Amazon) and from retail sellers (Best Buy, Office Depot, etc).

Another valuable accessory is a physical keyboard. Although the on-screen (virtual) keyboard has the advantages of being always available and requiring no additional purchase, a physical keyboard can transform a tablet computer from a device that is used primarily for "consumption" (reading, looking at field apps, etc) to one that enhances productivity as well. Indeed, most of this paper was written on such keyboards while I was in the field. External keyboards come in two basic kinds; a docking keyboard that links to the tablet through a dedicated port (Android platform) or a Bluetooth keyboard which connects to the tablet wirelessly (Apple and Android devices). Both have pros and cons. Docking keyboards ($50–140) eliminate the need to make a Bluetooth connection (which can reduce battery life and sometimes be problematic in my experience), and often have additional ports for connecting memory cards or speakers. However, external Bluetooth keyboards are cheaper ($30–70), lighter, and can be used with multiple devices. In addition, there are a number of keyboard "folios" that, while not physically connecting to tablets through a port, contain both a case and a keyboard and make a combination that is very similar to a laptop.

Battery Life.—I did not formally test battery life for these devices, but used all of these in the field over about a 12 month period. Battery life only became a concern if I was making heavy use of 3G, WiFi and/or Bluetooth technologies or if I forgot to charge the tablet when battery life fell to < 20%. Qualitatively speaking, I found the Apple devices to have the best battery life and the Android devices to be somewhat less capable, but rarely found myself restricted in this regard. In general, if the WiFi and the Bluetooth connections were kept off except when needed for internet or keyboard connectivity, I could use the tablets 2-3 hours per day and only have to recharge the batteries every second or third day. Battery life could be further extended by powering down the tablet (as opposed to putting it to sleep) at night or during long periods of inactivity. In addition, purchasing a mobile power adapter for use in a vehicle makes charging while on the road quite simple and portable power supplies to allow recharging while in remote areas are also available (e.g., http://www.richardsolo.com/iPad_Accessories.html).

Conclusions

As an admitted "technophile", my interest in adopting tablet computers for field use was quite high. However, after extensive testing by both myself and my students, we have found that these devices are, to a large degree, the modern electronic equivalent to the Swiss Army Knife. The ability to record field notes and data, take and display reasonable-quality photographs, use electronic field guides, record GPS locations, write papers, and read electronic reprints has made a tablet computer an essential piece of field gear for myself and several of my students.

This is not to say that tablet computers do not have limitations, sometimes important ones. The most critical of these are (a) cost, (b) screen readability, and (c) weight. Of these, the first two are probably most important, as the total mass of a digital camera (220 g for my Canon SX 230), field notebook (113 g for a Rite in the Rain notebook), and metal clipboard (700 g) for recording data sheets is very close to or even greater than some of the tablet computers tested here (Table 1). Other constraints to keep in mind are the habitat conditions where field work takes place (e.g., working in monsoon conditions in wetlands may make using these devices impractical) and whether tablets can be recharged at least every few days.

Whether the multi-functional nature and convenience of a tablet computer is worth the $199–450 cost is a personal decision that depends on available funding and the conditions under which the tablet will be used. However, the wide range of costs, sizes, and screen readability suggests that there are many cases when the "match" between cost and need will be a good one. That being said, I strongly advise those looking at a tablet for field use to be sure to either test the unit under field conditions before buying or to purchase a tablet from a vendor that has a reasonable return policy. That would help insure that the purchase is one that will fit the exact needs of the individual.

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HERPETOCULTURE

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Observations on the Endangered Iranian Zanjan Viper, *Montivipera albicornuta* (Squamata: Viperidae), in Captivity and in the Wild

The Zanjan Viper, also known as the Iranian Mountain Viper, or Zig-Zag Mountain Viper (*Montivipera albicornuta* [Nilson and Andrén, 1985]) is a small viper endemic to the Zanjan Valley and surrounding mountains in northwestern Iran (Latifi 1991; Rastegar-pouyan et al. 2008). The type locality is Abhar in the Zanjan Valley (36°8'N, 49°13'E) between Tabriz and Teheran (McDiarmid et al 1999; Fig. 1). This species is generally associated with rocky habitats, including rock walls, scree, and cliff edges within the Valley. It is not present in the steppe-like habitat or agricultural areas of the valley floor. Nilson (2008) outlined the major threats to this species: over-collecting by commercial snake hunters for its use in serum production, resulting in a corresponding decline in populations, and livestock grazing. He stressed that the habitat appears to be in suitable condition, but since the snake is currently marginally protected throughout its range, there is an urgent need to restrict or, better yet, prevent collection. Nilson further said that this viper is not considered to be a great threat to people because it lives in a remote area at elevations of around 2500 m. The population is listed as vulnerable in the Red List of IUCN and is decreasing (Nilson 2009). Its conservation status in Iran—according to the Environmental Protection Council No. 168 about hunting and fishing of wild animals—is protected, but enforcement is difficult. Two areas have

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FIG. 1. Type locality of Zanjan Viper (*Montivipera albicornuta*) in Zanjan Valley, Zanjan province. This viper is at risk due to collection by snake hunters. The Razi Institute continues to produce antivenin to counteract potential snakebites.

PHOTO BY MEHRAN HARIRI





FIGS. 2, 3. Habitat of Zanjan Viper (*Montivipera albicornuta*) north of Sorkhabad in protected area in Zanjan Province.



FIG. 4. Dorsal aspect of Zanjan Viper (*Montivipera albicornuta*) from the type locality. Map in upper right shows range in NW Iran with Zanjan Valley in red.

PHOTOS BY ALIREZA SHAHRDARI

COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND





FIGS. 5, 6. Captive Zanjan Vipers (*Montivipera albicornuta*).

viper populations: Anguran Wildlife Refuge and Sorkhabad Protected Area in Zanjan Province (Kalantary and Parchiyanlu 2009) (Figs. 2, 3).

McDiarmid et al. (1999) and Roy McDiarmid (pers. comm.) stated that the taxonomic allocation for this taxon is confusing. Nilson and Andrén (1985) placed it in the *Vipera raddei* group. Schätti et al. (1991) suggested that *Vipera albicornuta, V. latifi*, and *V. raddei* (including *kurdistanica*) might represent allopatric populations of one species. Golay et al. (1993) treated

albicornuta and *latifii* as subspecies of *Vipera raddei*. Because there has been some controversy about several of these taxa, McDiarmid recommends following the most recent paper (Rajabizadeh et al. 2011), which recognizes *albicornuta* as distinct and shows its range as separate from the other Iranian species in the *Montivipera raddei* group, so we use this name here.

In older Iranian literature on venoms and snakebites, many *Vipera* species, including this taxon, were considered *Vipera xanthina* or *V. xanthina* ssp. (Mallow et al. 2003). Nilson et al. (1999) erected a new subgenus *Montivipera* within the genus *Vipera;* nine taxa are represented including *M. albicornuta*. We consulted Andrén and Nilson (1979), Latifi (1985), Nilson and Andrén (1986), Mallow et al. (2003), and Phelps (2010) for descriptions of *M. albicornuta,* especially color and pattern morphs. We examined diagnostic characters of three of our snakes that died shortly after arrival and these fit the description published by Mallow et al. (2003). Total length of one of our snakes (male) was 81.2 cm and tail length was 5.6 cm; Mallow et al. (2003) recorded 66 cm as maximum size in a male.

The coloration and pattern in some of our specimens correspond to the snake pictured in Latifi (1985; plate 4, # 8, *Vipera xanthina*). He includes the snake in his list as the Zanjani Viper in Zanjan Province (19). Fig. 4 shows a specimen collected at the type locality.

Today this species is vulnerable and has essentially vanished from parts of its range due to both the destruction of its natural habitat and the over-collecting of snakes for the production of antivenin. In 1958, the Razi Institute started to produce antivenin and the first serum was issued for therapeutic use two years later (Latifi 1978). In 1984, Latifi described venom extraction and antivenin production. Studies before taxonomic changes were published on Iranian vipers (*Vipera albicornuta, V. latifii, V. raddei*) were based on the taxon *Vipera xanthina* (Mallow et al. 2003). Latifi and Farzanpay (1973) said that between 1969 and 1973, about 1680 snakes were collected for Razi. Up to 1978, 4400 vipers were used (Latifi 1978). Mallow et al. (2003) describe the production of antivenin in detail. Today, Razi produces a polyvalent antivenin to cover Iranian vipers. Abolfazl Akbari (pers. comm.) stated that over 2000 venomous snakes are brought to Razi Institute annually for venom extraction. Kian (pers. observ.), who worked at Razi, saw the following species used for antivenin production: Central Asian Cobras (*Naja oxiana*), Levantine Vipers (*Macrovipera lebetina*) (200–250 individuals), and the rest mostly comprised Latifi's Viper (*Montivipera latifii*), Caucasian Pit Viper (*Agkistrodon halys*), Transcaucasian Meadow Viper (*Vipera ursinii*), Persian Horned Viper (*Pseudocerastes persicus*), Saw-scaled Viper (*Echis carinatus*), and Zanjan Mountain Viper. Gasperetti's Viper (*Cerastes g. gasperettii*) was not used for venom extraction.

There are three main reasons for setting up a colony of *M. albicornuta* and other species at Razi Institute: to eliminate the need to purchase snakes from local collectors for antivenin production, to increase numbers by improved captive management and expanded captive breeding, and to decrease mortality rates.

Captive Management

In 2009 and 2010, respectively, four specimens (two adult pairs) and 10 adult individuals (three females and seven males) were collected from Zanjan Valley to begin a captive colony to study reproductive biology and behavior (Figs. 5, 6). The first group was kept at the Razi Institute and the next at University of Tehran. Husbandry and captive protocols follow those outlined for Latifi's Viper (*Montivipera latifii*) described earlier by Kian et al (2011). During August 2009, two adult pairs were housed in a vivarium with aluminum gauze on top for ventilation (120 cm length × 60 cm width × 50 cm height). In 2010, two adult pairs were housed together in these enclosures, three males and one female in another, and two males in the third. The substrate was peat moss and hiding places were provided. The temperature within the vivaria ranged from 30 to 32°C under the heat lamp, set to mimic daylight cycles during the day, and allowed to cool at night without supplemental heat to 26–28°C. The humidity was between 40–50% and every week the enclosures were sprayed with warm water. Sexes were tentatively assigned based initially on tail ratio and later validated by observation of male copulatory organs. Nail polish was used to mark the animals.

Feeding.—The diet for this species in the wild consists of insects, grasshoppers, lizards, and mice (Mallow et al. 2003). Newborn and adult mice (*Mus musculus albinus*), newborn rats (*Rattus norvegicus berkennhout*), and lizards (*Mesalina watsonana, Eumeces schneiderii*) were offered once a week. Laboratory mice were the most common food items for this species. They were selected to decrease the risk of endoparasitic infection. In 2010, the food items were supplied with Rep-Cal Herptivite Multivitamin (Rep-Cal Research Lab, Los Gatos, California). There was competition during feeding. In some cases, snakes struck each other during predatory episodes.

Ecdysis.—Shedding depends largely on environmental temperature and amount of food intake; our snakes generally shed between one to two weeks, although there were occasions where ecdysis occurred at intervals of several months. Adequate moisture was provided by spraying water into vivaria every other day. Sometimes snakes had incomplete sheds so they were soaked for 20 minutes to facilitate complete removal of the skin.

Temperatures and Light Cycle.—Temperature records from the site of collection are as follows: frost may begin in October and last until early April. The coldest months are January and February with average temperatures of 0°C. In January, temperatures were as low as -5°C. The average temperature in July and August is 24°C but may rise to 31.7°C during the latter month.

We believe that hibernation is necessary for this species to reproduce, so males and females were separated and placed in hibernation. Prior to hibernation, the range of weight for seven males was 86–159 g (mean 107 g), and three females was 96–160 g (mean 122 g); the snakes were not weighed after emergence to reduce potential stress. On 15 November 2009, feeding was discontinued. After seven weeks, the temperature of the vivaria was lowered to 10°C and the supplemental lamps were removed. The cooling period was three months and temperature hovered between 8–10°C throughout this span. Food was not offered but water was provided. Three months later, the lighting cycle was increased to three hours and thus we began increasing day length until 12 hours of light per week were reached. Natural sunlight was allowed to penetrate into the room after snakes emerged from hibernation. Thirty-five days later, after emerging from hibernation, males and females were placed together to elicit courtship and copulation. During May 2010, courtship behavior by the male was seen but mating was not observed. Male combat was not seen. Importantly, the survival ratio of all the hibernated snakes in two years was 100%.

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Larval Growth and the Potential for Head-starting of Eastern and Ozark Hellbenders (*Cryptobranchus alleganiensis alleganiensis* and *C. a. bishopi*)

Eastern Hellbenders (*Cryptobranchus alleganiensis alleganiensis*) are large, paedomorphic salamanders found across the midwestern USA east to the Appalachian states of Pennsylvania and New York and south to northern Georgia (Petranka 1998), with western populations of the Ozark Hellbender subspecies (*C. a. bishopi*) confined to Missouri and Arkansas. Hellbender populations across this geographic range are experiencing significant declines largely characterized by an overall lack of recruitment, with populations composed almost entirely of older age classes (Wheeler et al. 2003). The Ozark Hellbender (*C. a. bishopi*) recently has been listed as federally endangered.

Detailed descriptions of early developmental stages (eggs and larvae) are essential for understanding life history traits for species of conservation concern. Although growth rates for adults (older age classes) have previously been reported (Horchler 2010; Peterson et al. 1988), information on growth rates at the vital gilled larval stages is surprisingly lacking in the scientific literature for this cryptic species. Hellbender larvae are rarely encountered during surveys, possibly due to high mortality rates, observer bias, or their occurrence in small interstitial spaces in gravel beds (Nickerson and Mays 1973; Williams et al. 1981). Although a select few sites within their range do harbor this early life stage in moderate numbers (Hecht-Kardasz et al. 2012), attempts at measuring growth based on recaptured larvae have proved unsuccessful. Recently, the importance of secure larval habitat has been proposed as a major factor for maintaining large adult populations (Nickerson et al. 2003). Successful captive management strategies for this species should incorporate information concerning life-history traits to maximize head-starting recovery programs.

The primary purpose of this study was to quantify growth rates of Eastern (*Cryptobranchus alleganiensis alleganiensis*) and Ozark Hellbenders (*C. a. bishopi*) at an early life stage, six

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months post-hatching, to determine the potential for rearing larvae under laboratory conditions. A secondary goal was to compare the growth rates among clutches from several populations and two subspecies to examine potential intrinsic differences in development of gilled larvae. This information should be useful for captive management decisions. For example, if clutches differ substantially in growth, further studies should examine whether different dietary regimes might be required for salamanders from different populations.

Laboratory Rearing/Analyses.—Larvae were hatched out of egg masses collected from the field on 10, 13, and 30 September and 18 November 2002, with one clutch each from the following sites: Davidson River, North Carolina; Coopers Creek, Georgia; Gasconade River, Missouri (eastern subspecies); and the North Fork of the White River, Missouri (Ozark subspecies), respectively. Following hatching, individuals were measured (TL mm) with calipers weekly on the same day for 24 weeks (~6 months) from 5 October 2002 to 3 April 2003. Larvae were kept at 19–21°C and were housed individually in aerated plastic containers (34.5 × 21.6 × 10.6 cm; 5.4 liters) for the majority of the study with de-chlorinated tap water, which was changed three times per week. Because egg masses were collected at different stages of development, we standardized stages based on morphological features defining each stage (Smith 1912) at hatching, which occurred on the following dates: 5 and 14 October and 4 and 25 November 2002 for Eastern Hellbenders from the Davidson River, Coopers Creek, and Gasconade River, and Ozark Hellbenders from the North Fork of the White River, respectively. Hatching success was highly variable (5–95%), with mortality associated with presence of a fungus that attacked the egg mass, identified as *Saprolegnia*. Consequently, sample size for each clutch was also highly variable: Davidson River N = 111, Coopers Creek N = 9, Gasconade River N = 66, and North Fork of the White River N = 145. Growth rates among clutches (rivers) were compared using a Kruskal-Wallis test (MINITAB).

Larval diets were adjusted as the larvae changed in size. Larvae were initially fed a variety of live food items including blackworms (*Lumbriculus variegates*), mayfly nymphs (*Stenonema* sp.), cladocerans (*Ceriodaphnia* sp., *Simocephalus* sp.), and chopped earthworms (*Lumbricus terrestris*). Once larvae obtained a TL of 60–80 mm, they readily consumed small crayfish (*Orconectes* sp.) (3.5–5.1 cm). At 80–100 mm they were successfully fed small darters (*Etheostoma* sp.) (approximately 3.8 cm TL); however, blackworms made up the majority of their diet at this size.

Growth Rates.—Intra-clutch size variation during weekly measurements was so small that even slight differences among populations were statistically significant. For example, there was a statistically significant difference in average size of larvae among clutches at week 3 (Fig. 1) even though the actual difference was only about 1 mm (Kruskal-Wallis test: H = 12.3, d.f. = 3, $P = 0.006$). By week 13, the larvae of the Eastern Hellbenders from Missouri and Georgia were noticeably smaller than larvae from North Carolina and Ozark Hellbenders (H = 29.1, d.f. = 3, $P < 0.001$). However, this difference disappeared over the next two months and growth rates were strikingly similar among populations and subspecies (Fig. 1).

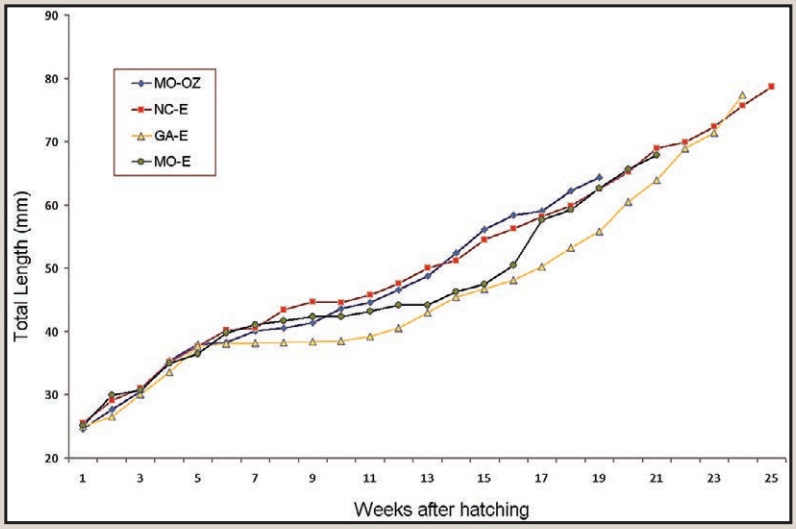


FIG. 1. Comparison of populations for weekly growth following hatching. SEs are omitted for the sake of clarity. E = eastern subspecies (*Cryptobranchus a. alleganiensis*), OZ = Ozark subspecies (*C. a. bishopi*). MO-Ozark (N = 145–119); NC-Eastern (N = 111–47); GA-Eastern (N = 9–4); MO-Eastern (N = 66–29). Preceding numbers (in parentheses) represent the range in sample size per group measured weekly over the course of the study.



PHOTO BY ADAM CRANE

FIG. 2. Typical *Cryptobranchus* larva showing recent absorption of yolk, gill structure, and complete limb development.

We observed an overall difference in post-hatching mortality among clutches, with the Missouri Ozark clutch having the lowest post-hatching mortality (North Carolina eastern = 58%; Georgia eastern = 56%; Missouri eastern = 44%; Missouri Ozark = 18%). A critical period of development in which unusual mortality occurred is the period of change in nutrition (yolk-based to active feeding) (Smith 1912). We noted minimal mortality during the period in which the yolk is exhausted. Directly following this period, a few individuals had trouble eating and eventually starved. However, the majority of larvae did not have difficulty switching to live food and developed fully (Fig. 2).

Developmental abnormalities were seen only in larvae from the clutch of Eastern Hellbenders from Missouri. These included severely malformed (curved) spines (N = 2), tails (N = 4), and bloating (N = 15). Samples of malformed larvae were examined at the Veterinary Medical Diagnostic Laboratory in Columbia, Missouri. They reported that the larvae were infected by common bacteria (*Staphlococcus* sp. and *Aeromonas* sp.), but found no evidence of potentially harmful fungi or other parasites. The larvae were also diagnosed with hepatic lipidosis (fatty liver disease). Malformed larvae appeared to have great difficulty swimming and this disease presumably was contracted as a result of not being able to feed.

Successful Head-starting.—The similarity in larval growth rates suggests that there are no major intrinsic differences among the populations of Eastern and Ozark Hellbenders at this critical early stage. Laboratory-reared larvae had greater ranges in size in this study than those reported by Grenell (1939) and Smith (1912), who studied a combination of laboratory-reared and field-caught larvae (3–9 months old: Grenell = 35–60 mm, 6.5 months post hatching; Smith = 57 mm; this study = ~45–80 mm). However, growth rates for amphibians often are higher in the laboratory than in nature, and laboratory growth rates should be interpreted as measures of growth potential (physiological capabilities) (Jorgensen 1992). For example, laboratory-reared *Bolitoglossa subpalmata* individuals had twice the monthly growth rate as seen in nature (Houck 1982; Vial 1968). Laboratory-reared hellbender larvae begin to lose their gills at an earlier time than those in nature based on our observations. Faster growth under laboratory conditions could be the result of higher temperatures than those found in nature or could result from laboratory-reared larvae receiving more food and experiencing lower activity levels than would be required for actively foraging for food in the field.

This study demonstrates the efficacy of rearing hellbender larvae and monitoring development under relatively simple laboratory conditions. These results are encouraging since gills are typically not lost until 1.5–2 years after hatching or at ~100–130 mm TL (Grenell 1939; Smith 1912), indicating larvae reared in a laboratory setting can readily obtain this transformation size at an earlier age than observed in nature. Conservation efforts for this species can apply these accelerated growth rates and developmental ontogeny into their management programs.

Acknowledgments.—We thank Chris Barnhart for the use of his AHAB system for initial egg rearing of these individuals. Individuals were collected as part of another study with the permission of the Missouri Department of Conservation (#11505), North Carolina Wildlife Resources Commission (#2002-ES286), and Georgia Department of Natural Resources (#14781). Individuals were maintained in the laboratory following Animal Care guidelines. Funding was provided by the U.S. Fish and Wildlife Service, Missouri State University Department of Biology and Graduate College.

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HERPETOCULTURE NOTES

TESTUDINES — TURTLES

***MAUREMYS ANNAMENSIS* (Vietnamese Pond Turtle). LOCALITY AND LONGEVITY.** *Mauremys annamensis* is a rare geoemydid turtle native to central Vietnam (Nguyen et al. 2009. Herpetofauna of Vietnam. Edition Chimaira, Frankfurt am Main, Germany. 768 pp.). The development of wetlands and intensive collection for the wildlife trade have resulted in the near total extirpation of *M. annamensis* from the wild (TCC [Turtle Conservation Coalition] 2011. Turtles in trouble: the world's 25+ most endangered tortoises and freshwater turtles – 2011. IUCN/SSC Tortoise and Freshwater Turtle Specialist Group, Turtle Conservation Fund, Turtle Survival Alliance, Turtle Conservancy, Chelonian Research Foundation, Conservation International, Wildlife Conservation Society, and San Diego Zoo Global, Lunenburg, Massachusetts. 54 pp.). Although large numbers of specimens within the wildlife trade have been documented, since 1939 only two individuals outside of captivity have been recorded in the literature. A hatchling was recovered in 1993 from the artificial well of a village in Gia Lai Province (Parham et al. 2006. Herpetol. Rev. 37:239). The second, a subadult, was captured in a wetland in Quang Nam Province in 2006 (TCC 2011, *op. cit.*).

As a consequence of its scarcity, little is known about the life history of *M. annamensis*. Most aspects of the species' biology, such as life span, have only been inferred through observations of captive individuals. Snider and Bowler (1992. Longevity of Reptiles and Amphibians in North American Collections, 2nd ed. SSAR Herpetol. Circ. 21:1–40) listed an age of 23 years and 11 months for the oldest known individual, a wild-captured female residing at the Columbus (Ohio, USA) Zoo in 1990. This record has continued to be reported by subsequent authors (e.g., Slavens and Slavens 2000. Reptiles and Amphibians in Captivity: Breeding—Longevity and Inventory [current January 1, 1999]. Slaveware, Seattle. 400 pp.). Herein, we provide the first published details regarding the acquisition and history of this turtle, update the longevity record, and discuss the significance of this specimen.

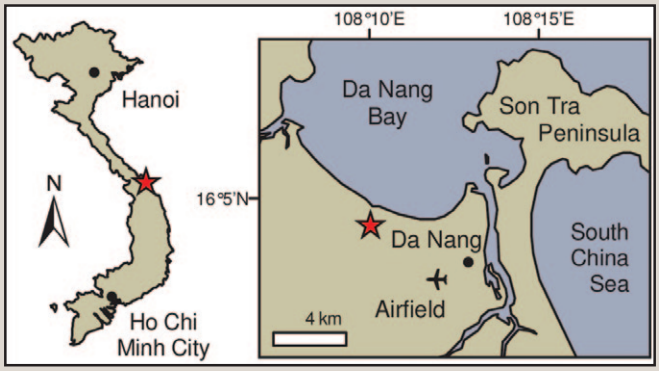


FIG. 1. Maps of Vietnam and the Da Nang area. The star indicates the approximate location where the specimen of *Mauremys annamensis* was captured. Based on a map drawn by James Lowery.

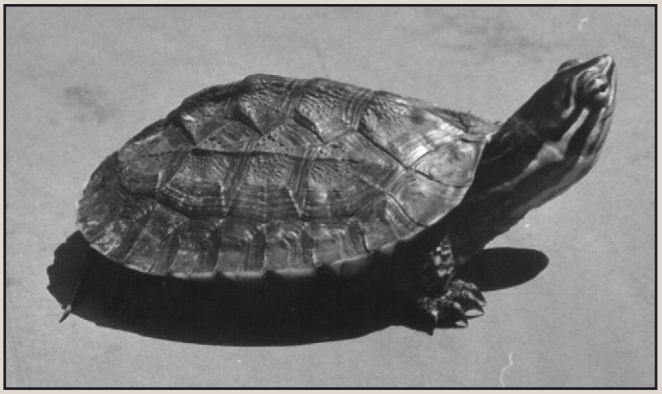


FIG. 2. An undated photograph, presumably from the late 1960s, showing the juvenile *Mauremys annamensis*. Photo from the image archives of the Columbus Zoo and Aquarium Reptile Department.

PHOTO BY JEFFREY E. DAWSON



FIG. 3. The female *Mauremys annamensis*, the oldest known individual of this species, at the Columbus Zoo and Aquarium in September 2012.

U.S. Navy corpsman James "Jim" Lowery was stationed in the Republic of Vietnam (South Vietnam) from 12 September 1965 to 11 September 1966. Assigned to a preventive medicine unit, Lowery's primary duty was mosquito surveillance, but he and the other personnel also conducted surveys of local wildlife, collecting potential disease vectors and other specimens, including representatives of herpetofauna. These collections resulted in papers on the natural history (Johnson and Lowery 1968. Herpetologica 24:336–338) and distribution (Johnson 1970. Herpetologica 26:527–532) of herpetofauna in Quang Nam Province. Prior to his military service, Lowery had worked at the Columbus Zoo. While in South Vietnam, he maintained contact with Louis Pistoia, then Curator of Reptiles and Amphibians at the zoo. Through his communications with Pistoia and military officers, Lowery (pers. comm.) arranged for some of the animals that he caught to be sent live to the zoo.

During a mosquito-collecting mission in late January or early February 1966, Lowery (pers. comm.) captured a juvenile *M. annamensis* in a ca. 0.6 m wide, slow-flowing, low-turbidity stream surrounded by a meadow. The stream was located ca. 8 km NW of the city of Da Nang, in Quang Nam Province (Fig. 1), an area which includes several low-lying sloughs and tributaries of the Phu Loc River (Danang URENCO [Danang Urban Environment Company] 2003. Vietnam Three Cities Sanitation Project: Danang Sub-project, Vol. 10: Environmental Impact Assessment. Report to the World Bank. http://www-wds.worldbank.org/servlet/WDSContentServer/WDSP/IB/2003/10/10/000094946_0309300404042/Rendered/PDF/multi0page.pdf). The turtle was discovered during daylight hours floating among vegetation along the edge of the channel.

In 1997, Da Nang was separated from the rest of Quang Nam Province to become an independent, centrally-controlled municipality. Today, Da Nang is the third largest city in Vietnam. The approximate collection locality of the turtle is now incorporated into the city and encompasses parts of An Khe, Hoa Minh, and Thanh Khe wards. Since the collection of the turtle, the area has been heavily developed and the watercourses have been impacted by the filling of low-lying areas, channelization, and pollution (Danang URENCO 2003, *op. cit.*). Due to the current unsuitability of habitat, it is unlikely that *M. annamensis* continues to inhabit the area where the turtle was collected.

The specimen of *M. annamensis* was accessioned into the Columbus Zoo's collection on 2 June 1966 (Fig. 2). Unfortunately, little specific information is available regarding the early husbandry of the turtle (however, for an overview of the diet and housing developed for freshwater turtles at the zoo during the late 1970s and 1980s, see Goode 1991. *In* Beaman et al. [eds.], Proceedings of the First International Symposium on Turtles and Tortoises: Conservation and Captive Husbandry, pp. 66–76. Chapman University, August 9–12, 1990). In the 1990s, the turtle was loaned to the late Michael Ewert; data resulting from his work on reproduction in this species were later included in Ewert et al. (2004. *In* Valenzuela and Lance [eds.], Temperature-dependent Sex Determination in Vertebrates, pp. 21–32. Smithsonian Books, Washington, D.C.). Ewert returned the turtle to the zoo on 11 June 2002.

To our knowledge, this turtle was the only living representative of *M. annamensis* in the United States for several decades after 1966. Additional specimens of the species did not appear in the U.S. through reptile importers until the late 1980s and early 1990s (pers. obs.). The Columbus Zoo acquired five additional individuals in 1990 and received another three individuals on breeding loan later that year. More turtles were obtained over the next few years. Propagation of the species at the zoo first occurred in 1991, with successful reproduction also occurring in subsequent years (Columbus Zoo, unpubl. data). At the time of writing this manuscript (October 2012), the turtle is still living at the Columbus Zoo and Aquarium (Fig. 3). In 1990, the turtle was already recognized as the oldest known *M. annamensis* in

captivity (Snider and Bowler 1992, *op. cit.*). Now, at approximately 46 years old, the age of this specimen is nearly double the previously reported maximum longevity.

In addition to being the oldest documented captive individual of *M. annamensis*, this turtle, to our knowledge, is only the third specimen of the species since 1939 with reliable collection data and fills a 54-year gap in the documented presence of the species in the wild. Details on the origin of this individual have been unreported until now, leading to this specimen being overlooked in previous works. Johnson (1970, *op. cit.*), for example, documented the occurrence of 23 species of herpetofauna in Quang Nam Province based on 159 specimens collected during military operations. However, *M. annamensis* was not one of the species listed. This omission apparently occurred because Johnson left Vietnam in January 1966 (Johnson 1970, *op. cit.*), just prior to when Lowery caught the turtle.

Information on collection locality and date is generally lost when animals are obtained from the live animal trade or through confiscations from illegal poachers or traders (Fong et al. 2007. Anim. Conserv. 10:452–460). The rarity of locality-specific specimens of *M. annamensis* has hindered previous phylogenetic analysis of the species (Fong et al. 2007, *op. cit.*). As a result of her detailed provenance, this turtle potentially represents a unique opportunity in the study and recovery of this imperiled species. Genetic samples from this specimen have already been included in an ongoing project aimed at better elucidating the relationship of *M. annamensis* to other taxa and investigating any genetic structure among *M. annamensis* populations. As reintroduction efforts are currently being planned for this species (TCC 2011, *op. cit.*; McCormack, pers. comm.), such research may guide conservationists in the proper placement of individuals into the wild.

We are indebted to Jim Lowery, who kindly shared his recollections with us and permitted publishing of this information. Additional information was provided by Peter Pritchard, Jim Parham, and Bryan Stuart. Thanks to Tim McCormack and Brian Horne for their comments on an early draft of the manuscript. Special thanks to the staff and management of the Columbus Zoo and Aquarium, in particular Becky Ellsworth and Doug Warmolts, for their assistance, support, and encouragement. This paper is dedicated to the memories of the late Louis Pistoia, Mike Goode, and Mike Ewert.

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SQUAMATA — LIZARDS

***OPHISAURUS ATTENUATUS ATTENUATUS* (Western Slender Glass Lizard). DEATH FEIGNING.** Death feigning (i.e., thanatosis) is a category of stationary behaviors that involves a reduction of responsiveness to external stimuli that resembles a dead or dying individual that, presumably, is used to reduce the likelihood of predation (Carpenter and Ferguson 1977. Biology of the Reptilia 7:335–554). It has been reported in a number of lizard and snake species representing many different families (e.g., Greene 1988. Biology of the Reptilia, Vol. 16:1–152). Though most observations of death feigning in lizards and snakes occur during terrestrial encounters, there have been few observations of the behavior being displayed in or on the surface of water. Within the genus *Ophisaurus*, death feigning behaviors have been reported during the handling of both *O. gracilis* (Tikader 1967. J. Bombay Nat. Hist. Soc. 65:233–234) and *O. attenuatus longicaudus* (Smith 1994. Bull. Maryland Herpetol. Soc. 30:107). Here we provide the first report of *Ophisaurus attenuatus attenuatus* death feigning in water.

On 24 June 2010, 10 individual *O. attenuatus* were captured while crossing roads in Ellis and Russell counties, Kansas, USA. These individuals were taken back to the laboratory and kept in captivity for use in an unrelated study on locomotor performance. Once in the lab, lizards were kept individually in plastic containers with commercial terrarium bedding consisting of red cypress mulch and a water dish. Lizards were fed crickets weekly and were minimally handled. On 10 August 2010, lizards were individually placed in a 2.5 m-long trough containing water (23° C) to assess their swimming abilities for the locomotor study. Though seven of the ten individuals began swimming as expected once placed in the trough, three individuals exhibited a death feigning-like behavior on the surface of the water. These three lizards weighed 18.9, 10.4, and 19.6 g and measured 31.2, 37.1, and 41.6 cm in total body length, respectively. All three lizards immediately flipped upside-down and floated motionless with their heads submerged; it was apparent that the lizards were not breathing throughout the duration of the death feign (Fig. 1). The investigator stood motionless ca. 1 m from the lizards throughout the death feign so that they could be captured at the conclusion of the behavior. All three lizards voluntarily righted themselves after an average of 246 sec (134, 342, and 262 sec) and began to quickly swim away from the investigator until they were recaptured. After several successive death feigning displays for each lizard (3-5 displays), each lizard elected to swim down the aquatic raceway rather than feign death.

Death feigning on water has been previously described in snakes of the genera *Storeria* (Gerald 2008. Anim. Behav. 75:647–654) and *Heterodon* (Gehlbach 1970. Herpetologica 26:24–34). To our knowledge, this is the first report of a lizard death feigning while floating on the water's surface. The fact that this behavior occurred with *O. attenuatus* on water is unique because slender glass lizards are considered terrestrial lizards that prefer grassland habitats (Fitch 1989. Occ. Papers Mus. Nat. Hist. Univ. Kansas 125:1–50). There are no reports, to our knowledge, of this species using or crossing any body of water. Placement of these lizards in water was likely a very stressful event that resulted in a rarely seen behavior. The lizards did surface swim very quickly (similar to that observed in snakes) when the feigning behavior ceased. As a result, their presumed lack of experience in this medium may have resulted in lizards displaying the behavior sooner than they normally would as opposed to attempting to flee first. The behaviors were not due strictly to handling prior to placement in water because the lizards did not feign death after handling or upon subsequent placement on a terrestrial surface both before and after the observed behaviors.

Many lizards have been reported to feign death prior to or as a result of handling when they feel cornered by a predator. Several studies have suggested that death feigning is advantageous as a last line of defense when the likelihood of active escape from a predator is greatly reduced (e.g., Burghardt and Greene 1988. Anim. Behav. 36:1842–1844; Gerald 2008. Anim. Behav. 75:647–654). The observation that *O. attenuatus* initially feign death in water is consistent with this hypothesis if lizards lack experience and are unsure of their locomotor abilities in water. Though this

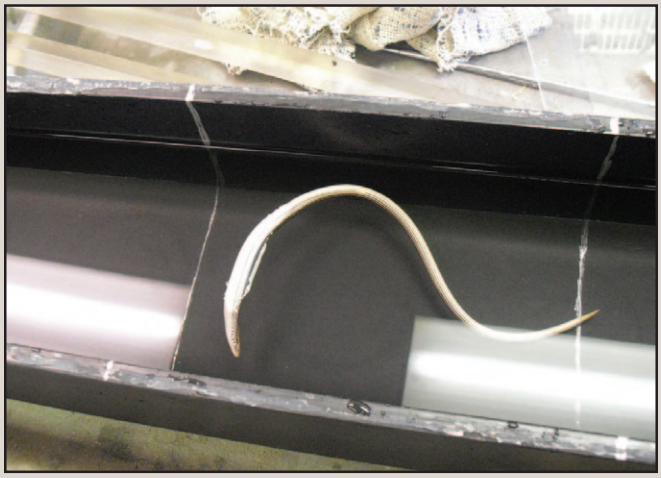


FIG. 1. Western Slender Glass Lizard (*Ophisaurus attenuatus attenuatus*) death feigning while floating on the water's surface.

may be a rare behavior in *Ophisaurus* (as well as in many other lizard species), it may be a beneficial behavior when lizards are captured or cornered by predators, or when they find themselves in unusual microhabitats or other situations as a result of actions by a potential predator.

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***PHRYNOSOMA GOODEI* (Goode's Horned Lizard). AGGRESSIVE BEHAVIOR.** Behavioral reports of horned lizards are scattered (Sherbrook 2003. Introduction to Horned Lizards of North America. University of California Press, Berkeley, California. 178 pp.). There have been several reports detailing defensive behavior in *Phrynosoma* using blood-squirting (Sherbrooke and Middendorf 2001. Copeia. 2001:1114–1122), social behavior, and display patterns (Lynn 1965. Southwest. Nat. 10:25–30; Tollestrup 1981. Herpetologica 37:130–141 and references therein), but only a few references report aggressive behavior. Here, I describe aggressive behavior in *P. goodei* under laboratory conditions.

In July and August 2010, I collected 35 adult *P. goodei* in the El Pinacate and Gran Desierto de Altar Biosphere Reserve, Sonora (31.5839°N, 113.4951°W; 80 m elev.) to conduct a thermal preference study. In the laboratory, the horned lizards were separated by gender and maintained at 25°C in plastic containers with sand, trunks, and grass, fed ants, and hydrated daily with a sprinkler. Laboratory experiments were conducted two or three days after capture using a thermal gradient. The thermal gradient consisted of a wooden box 150 cm long × 100 cm wide × 70 cm high, divided into ten tracks of 10 cm each to prevent interaction between lizards. The box was located in a room with controlled temperature of 20°C and three 150-W lamps were placed at different heights over the box to offer a thermal gradient (20–50°C). I took body temperature manually using a digital thermometer in the thermal gradient each hour between 0930 and 1900 h. During the thermal experiment, three specimens (two males and a female 70, 69 and 69 mm SVL, 40, 39 and 43 mm tail length, 14.2, 14 and 14 g, respectively) exhibited aggressive behavior when I attempted to take their body temperature. After laboratory experiments, all lizards were released at the site of capture.

The aggressive display consisted of a jump forward with the lizard reaching two or three centimeters from the ground. The jump was accompanied with a hissing sound and an open mouth. In the initial position, the lizards raised the posterior portion of their body and lowered the front part of the body (i.e., placing forelimbs flexed and hindlimbs fully extended). From this posture, the lizards hopped when I tried to lift them up. The lizards displayed this behavior up to eight times in a row when I tried to approach them with my hand or another object. The hissing sound was produced only during exhalation. Before each jump the lizards swayed from side to side. These defensive behaviors likely maximize the chances of escape against certain would-be predators.

Previously, similar displays were reported in *P. douglasii*, *P. hernandesi*, *P. cornutum* (Milne and Milne 1950. Am. Midl. Nat. 44:720–741), and *P. platyrhinos* (Lowe and Woodin 1954. Herpetologica 10:48). This is the first report on such displays for *P. goodei*.

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AMPHIBIAN DISEASES

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Batrachochytrium dendrobatidis in Amphibians of the Piedmont and Blue Ridge Provinces in Northern Georgia, USA

The amphibian chytrid fungus, *Batrachochytrium dendrobatidis* (*Bd*), has been found in the state of Georgia, USA but the full extent of its distribution in that region is not well understood (Gonynor et al. 2011; Hossack et al. 2010; Timpe et al. 2008). Although previous studies in Georgia have found a low prevalence of *Bd*, more in-depth studies are needed to establish locations of *Bd* infections, provide a better assessment of infection rates, and assess the vulnerability of different species to symptoms of the disease chytridiomycosis because such species may be vulnerable to population declines in the future. Georgia is rich in amphibian biodiversity, with 87 species known to occur within the state (CNAH 2012). Conserving amphibians is important because they account for the majority of the vertebrate biomass in the area and are centrally nested in food webs, supplying higher-level predators with energy (Wright et al. 2001).

Our aim was to determine the extent of *Bd* infection in stream and stream-bank amphibians in two different physiographic provinces in Georgia, the Blue Ridge Mountains of the Southern Appalachian Mountains and the lowland Piedmont Province around the Atlanta region. This is the only multiple-site *Bd* survey of the Atlanta area. We hypothesized that *Bd* would have higher prevalence in the montane Blue Ridge province sites since previous studies have detected *Bd* in amphibians in high elevation areas possibly due to lower preferred developmental temperatures (Daszak et al. 1999; Longcore et al. 1999). Streams were chosen for sampling because species restricted to these areas may be the most prone to infection (Kriger and Hero 2007). We attempted to examine the factors that affected the occurence of *Bd* and quantify the levels between the Georgia amphibian communities within the Piedmont and Mountain provinces.

Ten sites were selected for *Bd* sampling. Five sites were located in the Blue Ridge province around Cooper Creek (Union Co., Georgia) in a Wildlife Management Area located within the Chattahoochee National Forest, and five sites were in the Piedmont Province near the city of Atlanta (Arabia Mountain Natural Heritage Area, Fernbank Forest, Lullwater Preserve, Panola Mountain State Conservation Park, Stone Mountain Park) (Fig. 1, Table 1). A site was defined as a permanent first-order stream reach (~50 m of stream length) and the near-bank area, within two meters of the stream.

Sampling was conducted from September 2010 to early December 2010 with each site being sampled approximately once a month. The same location was sampled each time. Sites were hand-sampled by flipping over rocks and down wood as well as dip netting in the water. Larvae were not sampled due to difficulty of determining species, especially among the salamanders. Each individual was swabbed for *Bd* (Brem et al. 2007) using polyester swabs. Swabs were subsequently stored in a freezer at -20°C. Once a site was sampled, all nets and shoes were disinfected with a 10% solution of bleach to prevent the spread of *Bd* from site to site. New non-powdered gloves were used when handling individuals, and each individual was kept in a new zip-loc bag to minimize the potential for cross-infection among captures.

Swab DNA extractions were conducted at Emory University. The DNA from each swab was extracted using a DNeasy Blood and Tissue kit (Qiagen). To assess *Bd* presence, we used real-time PCR (polymerase chain reaction) assays using SYBR green and an Applied Biosystems StepOnePlus Real-Time PCR System. The primers were chosen based upon those designed by Boyle et al. (2004). Reactions (10 µL) containing 5 µL of SYBR green master mix (Applied Biosystems) primers at a concentration of 5 pmol/mL and 1 µL of DNA were prepared in duplicate and used for the PCR assays. Each plate was run with pure water as a negative control and known *Bd* DNA at a concentration of 10 ng/µL as a positive control. Melting curve analysis after amplification was used to confirm that positive test samples had the same melting temperature as the positive control. Samples were run in triplicate, and if at least two of three samples matched the positive control, the sample was deemed positive for *Bd*. To quantify the amount of *Bd* in positive samples relative to a control of known *Bd* DNA concentration, each positive sample was run again, in triplicate, alongside a diluted standard series. The *Bd* DNA concentration of each positive sample was then estimated relative to these standards.

We used logistic regression to examine associations between *Bd* occurrence in individuals, province, and species. Generalized linear models using a binomial logit distribution were used for the occurrence (*Bd* present or not found) dataset, which allowed for simultaneous comparisons of multiple variables. To examine

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the association of province with *Bd* occurrence, a subset of the data was analyzed which included those species found in both province types. To examine associations between *Bd* concentration levels within individuals and factors such as province and species, only samples that tested *Bd*-positive were analyzed. We used analysis of variance (ANOVA) to account for the continuous data (*Bd* concentrations) rather than the binomial distribution used for the categorical data used in the occurrence analyses. Since the data were not normal according to a Kolmogorov-Smirnov test, all values were log-transformed for all analyses. All statistical tests were run using JMP (SAS Institute Inc., 2010, ver. 9.0.0).

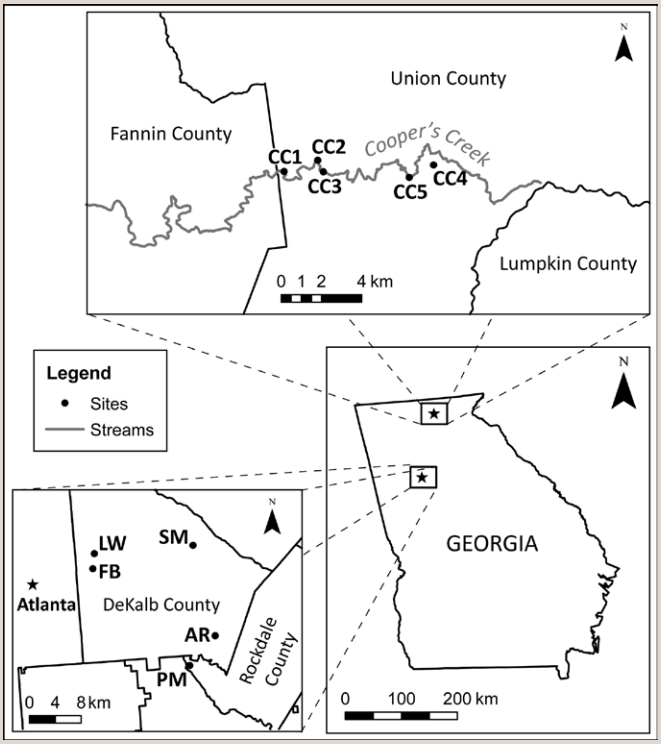


FIG. 1. Locations where amphibians were sampled for *Batrachochytrium dendrobatidis* in Georgia, USA. Ten study sites in two provinces are shown: CC 1–5 are upland sites around Cooper Creek in the Blue Ridge Mountain province of the Southern Appalachian Mountains; sites in the Piedmont Province include AR (Arabia Mountain Natural Heritage Area), FB (Fernbank Forest), LW (Lullwater Preserve), PM (Panola Mountain State Conservation Park), and SM (Stone Mountain Park).

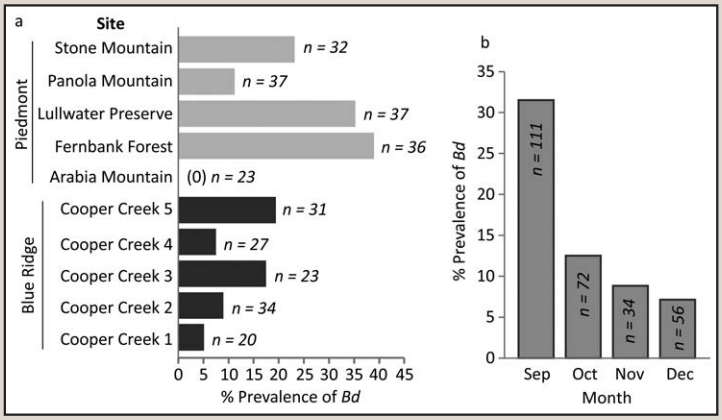


FIG. 2. A) Occurrence of *Batrachochytrium dendrobatidis* (*Bd*) infections among individual amphibians sampled at ten sites from two different provinces in northern Georgia, USA. B) *Bd* infections occurred during all months of sampling (September to December 2010) but were most prevalent during September.

A total of 273 individuals of 14 species were tested for the presence of *Bd*, of which 51 (18.7%) individuals tested positive (Table 2). The most common amphibian in our study was the Black-bellied Salamander (*Desmognathus quadramaculatus*; 57 captures in the Blue Ridge province) and the most common anuran was the Northern Cricket Frog (*Acris crepitans;* 23 captures in the Piedmont province). Four species were caught in both provinces: North American Bullfrogs (*Lithobates catesbeianus*), Seal Salamanders (*Desmognathus monticola*), Red Salamanders (*Pseudotriton ruber*), and Spring Salamanders (*Gyrinophilus porphyriticus*). The species with the highest *Bd*-occurrence rate (80%) was the North American Bullfrog, but our sample size was small for this species (N = 5). Our sample size for several other taxa also was low, reducing our confidence in the accuracy of *Bd* occurrences. Skerratt et al. (2008) recommended a sample > 59 in order to effectively detect *Bd* occurrence in populations with a low infection rate. The second-most infected species in our sample was the Southern Two-lined Salamander (*Eurycea cirrigera*; 57.4%; N = 47 individuals sampled). However, the individual that was host to the greatest quantity of *Bd* was a Seepage Salamander (*Desmognathus aeneus*; 99.1 ng/µL). Most individuals had less than 1 ng/µL of *Bd*. The sites with the highest occurrence of *Bd* infection were Fernbank Forest (38.9%, N = 36) and Lullwater Preserve (35.1%, N = 37), both of which were in the Piedmont Province. The only site that had no occurrence of *Bd* was Arabia Mountain, also within the Piedmont and no symptoms of *Bd* were seen at this location throughout the study.

Within our study there appears to be an effect of province on *Bd* occurrence when considering all species together, with more infected individuals found in the lowland Piedmont area (Fig. 2A). However, to adequately address this statistically, to separate province and species effects, we analyzed a subset of the data to include only those species caught in both provinces. This analysis revealed no statistical effect of province or species on the occurrence of *Bd*; therefore, province was excluded from all subsequent analyses of occurrence. However, for the entire data set, species was a significant factor associated with *Bd* occurrence ($\chi^2 = 71.8166$, df = 14, $p < 0.0001$). Additionally, there appeared to be a seasonal decline in *Bd* occurrence in the fall, with more infections occurring in September (Fig. 2B), but this trend was only significant for some species (e.g., *D. ocoee* and *E. cirrigera*, $\chi^2 = 14.00$, df = 1, N = 30, $p = 0.0002$, $\chi^2 = 12.53$, df = 1, N = 47, $p = 0.0004$).

Neither province nor time of year influenced the severity of infection within individuals (province, one-way ANOVA, $F(1,49) = 2.63$, $p = 0.11$, month, one-way ANOVA, $F(3, 47) = 1.08$, $p = 0.37$). Species, on the other hand, significantly affected the amount of *Bd* on an individual (one-way ANOVA, $F(6, 44) = 3.17$, $p = 0.011$) (Table 2). However, this significance is due to an outlier of a single *D. aeneus* (99.09 ng/µL) that had over seven times as much *Bd* as the next highest individual, which was *L. catesbeianus* (12.84 ng/µL). Upon removal of this *D. aeneus* individual, species was no longer significant (one-way ANOVA, $F(6, 43) = 2.10$, $p = 0.073$).

Our data do not support our hypothesis that there would be a higher occurrence of *Bd* in the cooler mountains.

Although we found *Bd* infections in both the mountains and lowland areas, there was a greater prevalence of infection in both the warmer lowlands as well as the warmer months within the timeframe examined. The U.S. National Weather Service data show that the mountain sites in Union County, Georgia are cooler than the Piedmont sites. The average high temperature is 2°C less, the average low is 5°C less and the mountain sites receive on average 159 mm more precipitation (The Weather Channel 2011). These findings were initially surprising since previous studies showed lower prevalence of *Bd* infections in lowland areas (Berger et al. 1998). However, predictions based upon earlier research in the tropical habitats of Central America and northern Australia may be inappropriate for the more temperate climate of Georgia, USA. In particular, our lowland fall season surveys were conducted during temperature regimes suitable for *Bd*. The average temperature for the Piedmont Province area at the start of the survey in September is 23°C (The Weather Channel 2011), very close to the ideal temperature for the development of *Bd*. This would explain why the highest prevalence of *Bd* infection was found during this month. After September, as the months became colder (average temperatures of 17.5°C, 12.5°C, and 7.5°C for October, November, and December, respectively) (The Weather Channel 2011) the number of infections decreased (Fig. 2B), potentially due to lower temperatures being less suitable for *Bd* growth.

In our study, the specific reason for why one species might be more likely to be infected is unclear. It is possible that there is a life history strategy difference or some other behavioral cause for differences in likelihood of infection between species (Bancroft et al. 2011; Searle et al. 2011). For example, many amphibians are known to perform behaviors such as grouping to overwinter or aggregate for breeding, both of which could increase the likelihood of transmitting *Bd* (Myers and Zamudio 2004; Ultsch et al. 2000). Continued monitoring of these species is warranted in order to establish if any species may be at risk for development of chytridiomycosis and potentially suffer mortality rates that may lead to a population decline. Lastly, the increase of *Bd* infections since the previous survey in Georgia in 2008, which found a 1.88% prevalence (Timpe et al. 2008), is of interest. However, the spatial and temporal scopes of sampling and species sampled differed among our two studies making them difficult to compare. Nevertheless, this possible trend toward greater infection rates in Georgia is another reason to establish a monitoring program of both *Bd* and amphibian populations in this region.

Acknowledgments.—We thank R. Hill from the Atlanta Botanical Gardens and ZooAtlanta for helping design the sampling protocol as well as supplying many materials. In addition, without the invaluable help of E. Huang, G. Manser, L. Neilson, D. Wilson, as well as T. Madden and C. Showalter from Fernbank Science Center, the sample size would be considerably smaller. We also thank M. Yabsley and his staff in Southeastern Cooperative Wildlife Disease Study at University of Georgia Athens for assistance with *Bd* sampling and analysis, and J. Kovacs for statistical assistance. Lastly, the project could not have happened without the help of N. Gerardo and D. Sok in providing a space to run DNA extractions and real-time PCR. Research was

TABLE 1. Coordinates of sites surveyed for *Batrachochytrium dendrobatidis* in Georgia, USA. See Fig. 1 for site names.

Site	°N	°W
CC1	34.761235	84.088873
CC2	34.764253	84.068908
CC3	34.75883	84.066558
CC4	34.755324	84.003423
CC5	34.751284	84.018197
AR	33.670065	84.128295
FB	33.776981	84.320676
LW	33.797607	84.316261
PM	33.632195	84.174416
SM	33.797377	84.152102

TABLE 2. Total number of individuals per species sampled for *Batrachochytrium dendrobatidis* (*Bd*) in two different province types, Blue Ridge Mountains and Piedmont Province, in northern Georgia, USA, from September to December 2010. Number of *Bd*-positive individuals is in parentheses, per province. *Bd* quantity is shown in ng/µL. * Denotes that all *Bd*-positives were found in only one province type regardless of the species' presence in both province types.

Species	Blue Ridge	Piedmont	% *Bd* Occurrence	*Bd* Quantity (SD)
Acris crepitans	0	23 (0)	0	0
Desmognathus aeneus	6 (2)	0	20	16.705 (40.36)
Desmognathus conanti	0	50 (4)	8	0.0021 (0.009)
Desmognathus monticola	31 (4)	7 (0)	10.53*	0.0061 (0.032)*
Desmognathus ocoee	30 (5)	0	16.67	0.0144 (0.053)
Desmognathus quadramaculatus	57 (5)	0	8.77	0.0018 (0.007)
Eurycea cirrigera	0	47 (27)	57.45	0.8255 (1.927)
Eurycea wilderae	4 (0)	0	0	0
Gyrinophilus porphyriticus	3 (0)	1 (0)	0	0
Lithobates catesbeianus	1 (0)	4 (4)	80*	2.6828 (5.683)*
Lithobates clamitans	0	1 (0)	0	0
Plethodon serratus	0	1 (0)	0	0
Plethodon glutinosus complex	2 (0)	0	0	0
Pseudacris crucifer	0	1 (0)	0	0
Pseudotitron ruber	1 (0)	3 (0)	0	0
Total	135 (16)	138 (35)	18.68	0.5334 (5.925)

carried out under the GA DNR permit (29-WBH-10-30) and Georgia State Parks permit (282010).

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Batrachochytrium dendrobatidis Not Detected in Anurans in the Northern Kimberley Region of Western Australia

Chytridiomycosis, caused by the fungal pathogen *Batrachochytrium dendrobatidis* (*Bd*), is recognized as a significant threat to amphibian populations worldwide (Skerratt et al. 2007). The distribution and virulence of *Bd* appears to be dependent on various host and environmental parameters including host species, habitat, precipitation and temperature (Murray et al. 2011a; Puschendorf et al. 2011). The likelihood of *Bd* occurring in the range of bioregions across Australia is predicted in the model proposed by Murray et al. (2011b). The model predicts that chytridiomycosis is unlikely to occur in arid and hot regions such as in northwestern Australia. However, sampling in these regions has been scant (Murray et al. 2010, 2011b). Most opportunistic reports and systematic surveys of *Bd* in Australia have been limited to the eastern, south-eastern and south-western coastal regions where overt population effects have been reported (Murray et al. 2010, 2011b). Therefore, we examine the predictions of Murray et al. (2011b) by opportunistically screening frogs for *Bd* as part of a biodiversity survey of vertebrate fauna in the north Kimberley region of north Western Australia.

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We sampled 14 locations across Doongan and Theda Stations from 3–27 May 2011 (Table 1, Fig. 1). In this area of the arid Kimberley region, mean maximum air temperatures are lowest from May to July, ranging from 29.0°C to 31.1°C (Australian Government Bureau of Meteorology 2012); hence, this is the most favorable time of year for the detection of *Bd* (Berger et al. 2004). Each location included 7–8 survey sites (62 sites, total), representing a range of different habitat types (and proximity to water) within the sampled landscape. The landscape sampled was dominated by savannah woodland or open woodland (*Eucalyptus tetradonta*, *E. tectifica*), and included grassland (hummock and tussock), shrubland, forest, rainforest, and paperbark swamps. At each site, four pitfall traps and eight terrestrial funnel traps

were checked each morning for four consecutive nights. Additionally, 60 minutes diurnal and 20 minutes nocturnal searching was conducted at each site, during which time frogs were hand caught opportunistically.

All amphibians captured were adult frogs, and were handled using clean plastic bags. The skin of each frog was thoroughly swabbed (Medical Wire & Equipment Co [UK] MW 100-100 sourced from Biomerieux Australia), with emphasis given to the ventral abdomen, thighs, and feet. Frogs were released at the capture site on the same day. Frogs were not marked for identification; it is unknown if individuals were caught and sampled on more than one occasion. Swabs were refrigerated at 4–8°C until processing. Swabs were tested in taxonomically-based batches of three for *Bd* DNA using the real time quantitative PCR test described by Boyle et al. (2004) with modifications proposed by Hyatt et al. (2007) and Garland et al. (2010). This modified PCR test has been validated for wild amphibians (Skerratt et al. 2011).

Swabs were collected from 287 anurans representing seven genera and 16 species (Table 2). All samples tested negative for *Bd* DNA. All live frogs sampled appeared healthy. Nine *Uperoleia* sp. and one *Litoria inermis* were found dead in funnel traps, predominantly clustered over two consecutive nights; these deaths were attributed to dehydration due to inappropriate microclimate in the traps, and were not investigated further.

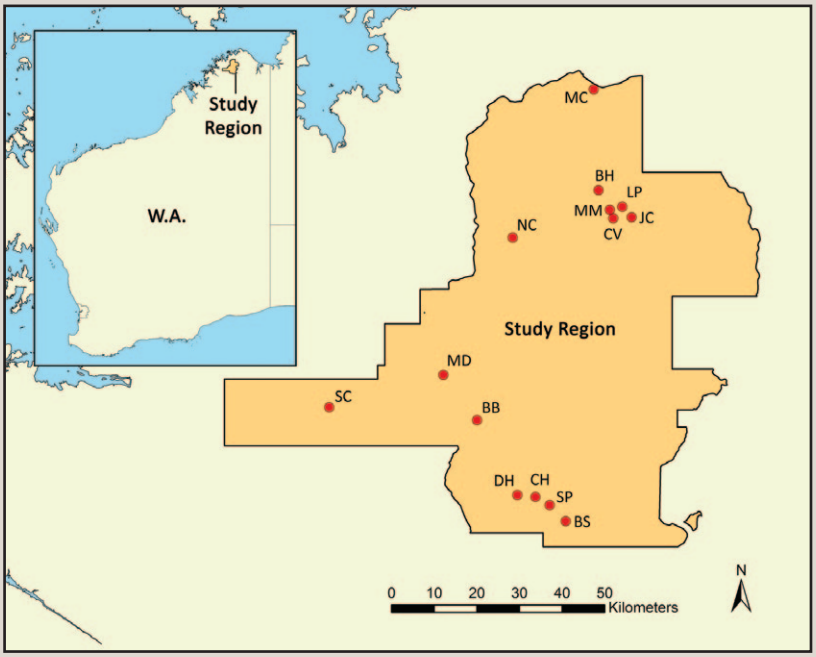


FIG. 1. Sampling locations for *Batrachochytrium dendrobatidis* within the study region in the north Kimberley, Western Australia (site codes correspond to Table 1).



FIG. 2. *Limnodynastes convexiusculus*, north Kimberley, Western Australia.

Our inability to detect *Bd* in this population is consistent with the model proposed by Murray et al. (2011b). The climate and ecology of the surveyed region is likely inappropriate to support *Bd*. Mean monthly maximum air temperatures are consistently >29°C, which are likely correlated to water temperatures. Temperatures >27°C are known to be unfavorable for chytridiomycosis (Berger et al. 2004). However, it is conceivable that *Bd* could occur in pockets of favorable aquatic microclimates within the Kimberley region. Rainfall is markedly seasonal; monthly averages range from 0.4 mm in June to >300 mm in January. Higher rainfall favors *Bd* (Skerratt et al. 2008). The low winter rainfall in the northern Kimberley would likely limit *Bd* to permanent water bodies; high summer rainfall coincides with mean monthly maximum air temperatures >32°C which may raise water temperatures above the tolerance threshold for *Bd*.

Skerratt et al. (2008) suggested a sample size of 60 to give at least 95% confidence of detecting at least one positive individual, assuming a minimum apparent prevalence of 5%. This sampling protocol has been shown to detect *Bd* where it is known to occur in Queensland (Skerratt et al. 2010). However, if *Bd* occurs in the Kimberley region at lower levels than elsewhere in Australia, then inadequate sampling may explain our inability to detect *Bd*. At the species level, we achieved a sample size >60 only for *Limnodynastes convexiusculus* (Fig. 2) and *Uperoleia* spp. (the extent of local species diversity in the latter genus is yet to be resolved), the predominant species captured. It is likely that these species are relatively abundant in this bioregion, or at least that capture methods biased the diversity of species sampled. Murray and Skerratt (2012) predicted the probability of infection in *L. convexiusculus* as unlikely at 0.3, and slightly higher in a number of untested *Uperoleia* spp. at 0.5–0.6. This is because they largely occur in regions climatically less favorable for *Bd* and are ephemeral breeders. However, other species belonging to both these genera and ecological groups have tested positive in areas favorable for chytridiomycosis (Murray et al. 2010).

The presence of *Bd* cannot be ruled out altogether if it is overdispersed in amphibian species (i.e., it occurs in few species), or in areas within this region such as in favorable microclimates, as may occur in Arizona, USA (Bradley et al. 2002). However, this has generally not been found to occur in other regions of northern Australia (Skerratt et al. 2010). It is also possible that *Bd* has not had an opportunity to disperse to this area; it has managed to achieve long distance dispersal across ecological barriers within Australia, such as across Bass Strait to Tasmania, and across the arid Nullarbor Plain to southern Western Australia, possibly through movement of infected amphibians (Murray et al. 2010).

Acknowledgments.—We acknowledge David Taggart, Wendy Foster, staff at Conservation Ark / Zoos South Australia, the ecologists

TABLE 1. Sampling locations for *Batrachochytrium dendrobatidis* in north Kimberley, Western Australia (see Fig. 1).

Map Code	Location	Lat/Long
BB	Billabong	15.22°S, 126.21°E
BH	Basalt Hills	14.74°S, 126.46°E
BS	Black Soil	15.43°S, 126.40°E
CH	Cuckoo Hill	15.38°S, 126.33°E
CV	Cypress Valley	14.80°S, 126.50°E
DH	Doongan Homestead	15.38°S, 126.29°E
JC	Josh's Crossing Track	14.79°S, 126.53°E
LP	Lilypond	14.77°S, 126.51°E
MC	Mongonai Creek	14.52°S, 126.46°E
MD	Mitchell River Road	15.13°S, 126.14°E
MM	Munia Marsh	14.78°S, 126.49°E
NC	Ngoollalah Creek	14.84°S, 126.28°E
SC	Spring Creek	15.19°S, 125.90°E
SP	Stony Plains	15.40°S, 126.36°E

TABLE 2. Numbers of anurans sampled for *Batrachochytrium dendrobatidis* (*Bd*) at Doongan and Theda Stations, north Kimberley, Western Australia, May 2011. No samples were *Bd*-positive.

Species	Sample Size		
	Doongan	Theda	Total
Crinia bilingua	16	0	16
Crinia remota	0	0	0
Cyclorana australis	1	0	1
Limnodynastes convexiusculus	109	11	120
Limnodynastes lignarius	1	1	2
Litoria bicolor	0	0	0
Litoria caerulea	1	0	1
Litoria cavernicola	0	0	0
Litoria coplandi	1	0	1
Litoria inermis	21	4	25
Litoria nasuta	16	6	22
Litoria microbelos	0	0	0
Litoria pallida	1	0	1
Litoria rothii	1	0	1
Litoria rubella	0	0	0
Litoria splendida	0	0	0
Litoria staccato	0	0	0
Litoria tornieri	3	0	3
Litoria wotjulemensis	2	2	4
Notaden melanoscaphus	4	0	4
Notaden weigeli	1	0	1
Platyplectrum ornatum	10	1	11
Uperoleia sp.	60	14	74
Total	248	39	287

and volunteers who assisted with field operations, Sara Bell and Rebecca Webb who conducted PCR tests, and the residents of Doongan and Theda Stations. We thank the Myers family for their support. This project was supported by funding from the Australian Government under Round 2 of the Jobs Fund - Local Jobs scheme, and approved under Wildlife Permit SF007650 (Department of Environment and Conservation, Western Australia) and ethics approval 13/2011 (Department of Environment and Natural Resources, South Australia).

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GEOGRAPHIC DISTRIBUTION

Herpetological Review publishes brief notices of new geographic distribution records in order to make them available to the herpetological community in published form. Geographic distribution records are important to biologists in that they allow for a more precise determination of a species' range, and thereby permit a more significant interpretation of its biology.

These geographic distribution records will be accepted in a **standard format** only, and all authors *must* adhere to that format, as follows: SCIENTIFIC NAME, STANDARD ENGLISH NAME if available (for the United States and Canada as it appears in Crother [ed.] 2012. *Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, with Comments Regarding Confidence in Our Understanding*. 7th ed. Herpetol. Circ. 39:1–92 [available from ssarbooks.com], for Mexico as it appears in Liner and Casas-Andreu 2008. *Standard Spanish, English and Scientific Names of the Amphibians and Reptiles of Mexico*. Herpetol. Circ. 38:1–162), LOCALITY (use metric for distances and give precise locality data, including lat/long coordinates in **decimal degrees** and cite the map datum used), DATE (day-month-year), COLLECTOR, VERIFIED BY (*cannot* be verified by an author; curator at an institutional collection is preferred), PLACE OF DEPOSITION (where applicable, use standardized collection designations as they appear in Sabaj Pérez [ed.]. 2010, *Standard Symbolic Codes for Institutional Resource Collections in Herpetology and Ichthyology: an Online Reference*, ver. 2.0, available at http://www.asih.org/) and CATALOG NUMBER (required), COMMENTS (brief), CITATIONS (brief and must adhere to format used in this section; these should provide a geographic context for the new record). Close with author name(s) in bold, capital letters (give name and address in full—spell out state or province names—no abbreviations, e-mail address after each author name/address for those wishing to provide it—e-mail required for corresponding author). Please include distance from nearest previously known record (provide a citation or refer to existing vouchered material to substantiate your report). If publishing specific locality information for a rare or endangered species has the potential to jeopardize that population, please consult with the Section Editor at time of record submission. If field work and/or specimen collection occurred where permits were required, please include permit number(s) and authorizing agency in the text of the note.

Some further comments. The role of the "Standard Names" lists (noted above) is to standardize English names and comment on the current scientific names. Scientific names are hypotheses (or at least represent them) and as such their usage should not be dictated by a list, society, or journal.

Additionally, this geographic distribution section does not publish "observation" records. Records submitted should be based on preserved specimens that have been placed in a university or museum collection (private collection depository records are discouraged; institutional collection records will receive precedence in case of conflict). A good quality photograph (print, slide, or digital file) may substitute for a preserved specimen *only* when the live specimen could not be collected for the following reasons: it was a protected species, it was found in a protected area, the observer lacked the necessary permit for collection, or the logistics of preservation were prohibitive (such as large turtles or crocodilians). Photographic vouchers *must* be deposited in a university or museum collection along with complete locality data, and the photographic catalog number(s) must be included in the same manner as a preserved record. Before you submit a manuscript to us, check Censky (1988, *Index to Geographic Distribution Records in Herpetological Review: 1967–1986*; available from the SSAR Publications Secretary), subsequent issues of *Herpetological Review*, and other sources to make sure you are not duplicating a previously published record. The responsibility for checking literature for previously documented range extensions lies with authors. **Do not submit range extensions unless a thorough literature review has been completed.**

Please submit any geographic distribution records in the **standard format only** to one of the Section Co-editors: **David C. Blackburn** (Africa and Europe), **Indraneil Das** (Asia, Australasia), **Jerry D. Johnson** (Mexico and Central America, including the Caribbean Basin), **Alan M. Richmond** (USA & Canada), or **Gustavo J. Scrocchi** (South America). Short manuscripts are discouraged, and are only acceptable when data cannot be presented adequately in the standard format. **Electronic submission of manuscripts is required** (as Microsoft Word or Rich Text format [rtf] files, as e-mail attachments)**.** Refer to inside front cover for e-mail addresses of section editors.

Recommended citation for new distribution records appearing in this section is: Cabral, H., and A. Caballero. 2012. Geographic distribution: Paraguay, Departamento Central: *Pseudoeryx plicatilis*. Herpetol. Rev. 43:622.

CAUDATA — SALAMANDERS

***AMBYSTOMA OPACUM* (Marbled Salamander)**. USA: MISSOURI: Madison Co.: Fredericktown. Found in wooded area near fishless pond located 50 m E of Piney Creek (37.5625°N, 90.413056°W; WGS84). 1 September 2012. Abbigail E. Nicholson. Verified by Dustin S. Siegel. University of Missouri-Columbia (UMC 2197P). New county record. This record fills the gap among surrounding Bollinger, Iron, St. Francois, and Wayne counties (Edmond and Daniel 2012 [latest update 13 April 2012]. Missouri Herpetological Atlas Project. Available at http://atlas.moherp.org/; accessed 17 October 2012).

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***AMBYSTOMA TALPOIDEUM* (Mole Salamander)**. USA: ARKANSAS: Hot Spring Co.: Poplar Road, 0.3 mi. E of Sycamore Road (34.252543°N, 93.092608°W; WGS 84). 16 May 2012. Tobin Fulmer. Verified by Renn Tumlison. Henderson State University Museum of Zoology, Arkadelphia, Arkansas (HSU 1640). New county record. Fills a distribution gap between Garland and Clark counties (Caldwell and Tumlison 2005. Herpetol. Rev. 36:88; Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.). One larval specimen was collected with a dip net from a vernal pool.

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***AMBYSTOMA TALPOIDEUM* (Mole Salamander)**. USA: NORTH CAROLINA: Orange Co.: off of McDade Store Rd. (36.1897861°N, 79.1734500°W; WGS 84). 26 May 2011. Katherine A. Walston and Ron Grunwald. Verified by Jeffrey C. Beane. North Carolina State Museum of Natural Sciences (NCSM 78797). New county record (J. C. Beane, pers. comm.). Sexually immature; 95 mm TL, 53 mm SVL. Extends the range ca. 24 km WSW of the nearest record in Person Co. (NCSM 59607, 59617), ca. 32 km W of the Granville Co. (NCSM 70383), and ca. 56 km E of the nearest records in Guilford Co. (NCSM 30446, 31333, 31335, 49855, 49856).

KATHERINE A. WALSTON (e-mail: kawalsto@uncg.edu) Biology Department, and **CATHERINE E. MATTHEWS**, Teacher Education & Higher Education Department, University of North Carolina at Greensboro, Greensboro, North Carolina 27402, USA.

***DESMOGNATHUS FUSCUS* (Northern Dusky Salamander)**. USA: TENNESSEE: Macon Co.: Unnamed tributary to Grisham Hollow Creek, just south of Heady Ridge Rd (36.555278°N, 85.876111°W; WGS 84). 1 October 2011. Michael C. Fulbright and Matthew D. Wagner. Austin Peay State University Museum of Zoology, APSU 19191 (color photo). Verified by A. Floyd Scott. New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. [Hard copy and Internet versions, the latter of which includes links to information on Tennessee amphibians having appeared since 1996, http://www.apsu.edu/amatlas/, accessed 15 October 2011]). Adult found under a moss-covered rock in a dry creek bed.

MICHAEL C. FULBRIGHT, Center of Excellence for Field Biology, Austin Peay State University, Clarksville, Tennessee 37044, USA (e-mail: mfulbright@my.apsu.edu); **MATTHEW D. WAGNER**, Department of Natural Resource Management, South Dakota State University, Brookings, South Dakota 57007, USA (e-mail: matthew.wagner@sdstate.edu).

***EURYCEA CIRRIGERA.* (Southern Two-lined Salamander)**. USA: TENNESSEE: Macon Co.: Salt Lick Creek, at Spring Hill Rd. Bridge (36.518611°N, 85.844167°W; WGS 84). 1 October 2011. Michael C. Fulbright and Matthew D. Wagner. Austin Peay State University Museum of Zoology, APSU 19188 (color photo). Verified by A. Floyd Scott. New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. [Hard copy and Internet versions, the latter of which includes links to information on Tennessee amphibians having appeared since 1996, http://www.apsu.edu/amatlas/, accessed 15 October 2011]). One adult under rock at edge of stream.

MICHAEL C. FULBRIGHT, Center of Excellence for Field Biology, Austin Peay State University, Clarksville, Tennessee 37044, USA (e-mail: mfulbright@my.apsu.edu); **MATTHEW D. WAGNER**, Department of Natural Resource Management, South Dakota State University, Brookings, South Dakota 57007, USA (e-mail: matthew.wagner@sdstate.edu).

***OEDIPINA FORTUNENSIS* (Fortuna Worm Salamander)**. PANAMÁ: CHIRIQUÍ: Reserva Forestal Fortuna, 100 m S of Lost and Found Ecohostel (8.674917°N, 82.214417°W; WGS84), 1249 m elev. 12 December 2010. John Himes. Verified by David B.Wake. MVZObs Herp 8. Only the third known individual of this species (Kohler et al. 2007. Senckenbergiana Biol. 87:213–217; Hertz et al. 2011. Herpetol. Rev. 42:245–250), first report from the Pacific side of the Continental Divide, and first recorded juvenile (SVL 25 mm, TL 53 mm). The salamander was located at ca. 1800 h under a small hardwood log in partially cleared primary rain forest.

JOHN G. HIMES, Florida Fish and Wildlife Conservation Commission, 3911 Highway 2321, Panama City, Florida 32409-1658, USA (e-mail: John.Himes@MyFWC.com); **KEVIN M. ENGE**, Florida Fish and Wildlife Conservation Commission, 1105 SW Williston Road, Gainesville, Florida 32601-9044, USA (e-mail: Kevin.Enge@MyFWC.com).

***PLETHODON GLUTINOSUS* (Northern Slimy Salamander)**. USA: TENNESSEE: Macon Co.: Abandoned house on the north side of Kelly Ridge Ln (36.453056°N, 85.904167°W; WGS 84). 1 October 2011. Michael C. Fulbright and Matthew D. Wagner. Austin Peay State University Museum of Zoology, APSU 19190 (color photo). Verified by A. Floyd Scott. New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. [Hard copy and Internet versions, the latter of which includes links to information on Tennessee amphibians having appeared since 1996, http://www.apsu.edu/amatlas/, accessed 15 October 2011]). One adult found under board.

MICHAEL C. FULBRIGHT, Center of Excellence for Field Biology, Austin Peay State University, Clarksville, Tennessee 37044, USA (e-mail: mfulbright@my.apsu.edu); **MATTHEW D. WAGNER**, Department of Natural Resource Management, South Dakota State University, Brookings, South Dakota 57007, USA (e-mail: matthew.wagner@sdstate.edu).

ANURA — FROGS

***DENDROPSOPHUS MIYATAI* (Hosteria La Selva Treefrog)**. COLOMBIA: CAQUETÁ: Municipio de Solano: Resguardo Indígena El Quince (0.803194°N, 75.199528°S; datum WGS84), ca. 204 m elev. 6 September 2007. C. Malambo L., J. P. Nuñez, and L. Luna. Museo de Historia Natural Universidad de la Amazonia, Florencia-Caquetá, Colombia (UAM 792–796). Verified by J. D. Lynch. This species in known only from the department of Amazonas in Colombia (Ruiz-Carranza et al.1996. Rev. Acad. Colomb. Cienc. 20[77]:365–415; Lynch 2005. Rev. Acad. Colomb. Cienc. 29[113]:581–588) with the northernmost record in the Municipio de Leticia (ca. 04°7´S, 69°57´W). First department record and the westernmost for the species, extends known range 798 km N from the northernmost record previously known.

CÉSAR MALAMBO L. (e-mail: malambidae@gmail.com), **MARIO A. MADRID-ORDÓÑEZ** (e-mail: mamadrido@unal.edu.co), **ALEXANDER VELÁSQUEZ-VALENCIA**, **JULIETH A. ZAPATA-ORTIZ,** and **DIANA C. ARISTIZÁBAL-VALBUENA**, Museo de Historia Natural de la Universidad de la Amazonía, Carrera 11 N° 6-69 Barrio Juan XXIII, Florencia, Caquetá, Colombia.

***ECNOMIOHYLA MIOTYMPANUM* (Small-eared Treefrog).** MEXICO: COAHUILA: Municipality of Arteaga: Sierra de Arteaga, 20 km E of San Antonio de las Alazanas (25.263889°N, 100.29555°W; WGS84), 1590 m elev. 10 April 2010. Daniel Garza-Tobón and Julio Lemos-Espinal. Verified by Hobart M. Smith. Laboratorio de Ecología–Unidad de Biotecnología y Prototipos, FES-Iztacala, UNAM, Tlalnepantla, México (LEUBIPRO-Photo Voucher 1). First record for Coahuila (Lemos-Espinal and Smith. 2007. Amphibians and Reptiles of the State of Coahuila, Mexico. UNAM, CONABIO, México D.F. i–xiv + 550 pp.), extending its known range from the closest reported locality 15.15 km (airline) NW of Potrero Redondo, Municipality of Santiago, Nuevo León (Lazcano-Villarreal 1997. Anfibios y Reptiles del Estado de Nuevo León. Univ. Autón. Nuevo León, Facultad de Ciencias, Bases de Datos SNIB2010-CONABIO, Proyecto No. B099, México, D.F.). The frog was found in a small temporary pond surrounded by pine forest.

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***ELEUTHERODACTYLUS PLANIROSTRIS* (Greenhouse Frog).** USA: GEORGIA: Tift Co.: Tifton (31.480529°N, 83.507719°W; WGS 84). 27 October 2012. Todd Pierson and Malavika Rajeev. Verified by Kenneth Krysko. Florida Museum of Natural History (UF 169095 photo voucher). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). This non-native frog has been recorded in scattered counties throughout southern Georgia. We uncovered seven adults across a suburban backyard.

TODD PIERSON (e-mail: twpierso@uga.edu) and **MALAVIKA RAJEEV** (e-mail: mrajeev@uga.edu), Odum School of Ecology, University of Georgia, Athens, Georgia 30609, USA.

***HYLA CINEREA* (Green Treefrog).** USA: INDIANA: Warrick Co.: Old Channel Cut-off, Cypress Creek, Anderson Township (37.936805°N, 87.347805°W; WGS 84) 20 June 2012. Michael J. Lodato. Verified by Chris Phillips. Illinois Natural History Survey (INHS 2012k). New county record (Lodato et al. 2004. Herpetol. Rev. 35[3]:281; Minton 2001. Amphibians and Reptiles of Indiana, 2nd ed., revised. Indiana Academy of Science. vii + 404 pp.). Specimen collected from vegetation at margin of wetland. Chorusing males first noted at this site in May 2005 and a breeding colony has been established there since that time. This collection represents the third known county record for *H. cinerea* in Indiana, a species new to the state since 2003.

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***INCILIUS CAMPBELLI* (Campbell's Forest Toad).** MÉXICO: CHIAPAS: Municipality of Marquez De Comillas: Playón de la Gloria (16.142787 °N, 90.891155 °W; WGS84), 224 m elev. 12 July 2012. M. Bénard-Valle. Playón de la Gloria (16.142405 °N, 90.891833 °W; WGS84), elev. 197 m. 30 September 2012. R. Percino-Daniel and Y. García. Both verified by Antonio Muñoz-Alonso. Colección Herpetológica, El Colegio de la Frontera Sur (ECO-SCH 2549 and 2550, respectively). First accurate records for Mexico, expanding the species range ca. 32 km N of the nearest known locality in Guatemala (Mendelson 1994. Occ. Pap. Mus. Nat. Hist. Univ. Kansas 166:1–21). The two toads, along with others of both sexes from each locality, were found on leaf litter in tropical rain forest between 1200 and 1400 h. Mendelson (1997. Herpetologica 53:14–30), without comment or description, referred several specimens from NW Chiapas (TCWC 21483–85) and adjacent Veracruz (KU 27466) to *I. campbelli*. Recent re-examination of those specimens by JRM verified that they in fact represented *I. macrocristatus*.

We thank Adrian Sarabia Rangel for assistance. Fieldwork was funded by Yaxal-Na.

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***KALOULA PULCHRA* (Painted Bullfrog).** BANGLADESH: COX'S BAZAR DISTRICT: Saint Martin Island (20.629158°N, 92.325372°E, WGS 84; 8.23 m elev.). 26 August 2012. Md. Abdur Razzaque Sarker and Shahriar Caesar Rahman. Adult at 2030 h on brick pile, in human settlement. Photographic voucher, Raffles Museum of Biodiversity Research, National University of Singapore (ZRC [IMG] 1.41a–d). Verified by I. Das. First record for St. Martin Island, situated 20 km S of southernmost end of Cox's Bazar District. Previous records from mixed-evergreen forest of NE and SE Bangladesh; nearest populations recorded from Teknaf Game Reserve, ca. 30 km N (Reza 2010. Ph.D. Dissertation, Texas Tech University, Lubbock, Texas. 115 pp.).

MD. ABDUR RAZZAQUE SARKER, Herpetology Laboratory Bangladesh; House no: 28/5, Shonatangar, Jigatola, Dhanmondi, Dhaka 1209, Bangladesh; and Department of Zoology, University of Dhaka, Bangladesh (e-mail: razzaqsciencebd@gmail.com); **SHAHRIAR CAESAR RAHMAN**, Department of Environmental Science, Independent University, Bangladesh (e-mail: caesar_rahman2004@yahoo.com); **A. H. M. ALI REZA**, Division of Biological and Physical Sciences, Delta State University, Cleveland, Mississippi 38733, USA (e-mail: areza@deltastate.edu).

***LITHOBATES AREOLATUS* (Crawfish Frog).** USA: INDIANA: Spencer Co.: Hammond Township, on State Route 70, 2.5 km E intersection US Route 231 (38.002117°N, 86.996633°W; WGS 84) 26 March 2008. Michael J. Lodato. Verified by Chris Phillips. Illinois Natural History Survey (INHS 2011n). First voucher from county (Minton 2001. Amphibians and Reptiles of Indiana, 2nd ed., revised. Indiana Academy of Science. vii + 404 pp.). Specimen found alive on road during night rain.

A colony of *L. areolatus* has been known from Spencer Co. since 1998, from a site about 4 km NNE Newtonville (38.0303°N, 86.920117°W; WGS 84) and about 6 km ENE of the location cited above. This population, discovered by DSD, has been monitored each year during the breeding season but landowner restrictions have prohibited collection of vouchers from the site.

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***LITHOBATES CATESBEIANUS* (American Bullfrog).** USA: NEBRASKA: Franklin Co.: 40.002974°N, 98.902216°W (WGS 84), elev. 633 m. 24 September 2012. Brian Hubbs. Verified by Neftali

Camacho. Natural History Museum of Los Angeles County, LACM PC 1612. New county record (Ballinger et al. 2010. Amphibians and Reptiles of Nebraska. Rusty Lizard Press, Oro Valley, Arizona. 400 pp.; Fogell 2010. A Field Guide to the Amphibians and Reptiles of Nebraska. Institute of Agriculture and Natural Resources, University of Nebraska-Lincoln. 158 pp.).

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***LITHOBATES CATESBEIANUS* (American Bullfrog)**. MÉXICO: COAHUILA: Municipality of Guerrero: Rancho La Burra, km 92 on Nuevo Laredo–Piedras Negras Hwy (28.0605000°N, 100.16016°W; WGS84), 200 m elev. 25 April 2010. Daniel Garza-Tobón and Julio A. Lemos-Epinal. Verified by Hobart M. Smith. Laboratorio de Ecología – Unidad de Biotechnología y Prototipos, FES-Iztacala UNAM, Tlalnepantla, México (LEUBIPRO photo voucher 2). First record for Coahuila in over 175 years (Smith et al. 2003. Newsl. Bull. Int. Soc. Hist. Bibl. Herpetol. 4:19–30; Lemos-Espinal and Smith 2007. Amphibians and Reptiles of the State of Coahuila. UNAM, CONABIO, México D.F., México. i–xiv + 550 pp). This record is about 11 km S from the Mexican border with Texas, USA. Even though the species is known from adjacent areas within the state of Texas, whether those populations are native is questionable because of rampant introduction of this species as a food resource (Dixon 2000. Amphibians and Reptiles of Texas. Texas A&M Univ. Press, College Station, Texas. i–vii + 421 pp.). However, because it was supposedly collected by Berlandier sometime between 1827 and 1834 near Saltillo, Coahuila (Lemos-Espinal and Smith 2007, *op. cit.*), there is the possibility that Rancho La Burra frogs occur within a historically naturally occurring population. The frog was found in a small (ca. 20 x 80 m) man-made reservoir.

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***PHRYNOBATRACHUS RUTHBEATAE* (Ruth-Beate's Puddle Frog)**. GABON: HAUT OGOOÉ PROVINCE: Batéké Plateau National Park, Osséré (2.0807°S, 14.0637°E; 414 m elev.) and Camp Ntsa (1.9816°S, 14.0011°E; 395 m elev.). 30 May–2 June 2011. B. M. Zimkus, J. G. Larson. Museum of Comparative Zoology (MCZ A-147865–67, 14770–73, 147882–86, 147888–91). Verified by José Rosado. This recently described species was previously known only from the type locality near Dja Biosphere Reserve in southern Cameroon where it was collected in primary swampy evergreen rainforest at 659 m elev. (Rödel et al. 2012. Zootaxa 43[1]:99). This represents the first confirmed country record in Gabon, extending the range approximately 600 km SE from the holotype locality. This species is believed to be more widespread within lowland forests of Cameroon and Gabon, including the Moukalaba-Dougoua Faunal Reserve in southwestern Gabon (*Phrynobatrachus* sp. 2; Burger et al. 2004. *In* B. L. Fisher [ed.], Monts Doudou, Gabon: a Floral and Faunal Inventory with Reference to Elevational Variation, pp. 145–186. California Academy of Sciences Memoir 28. 295 pp.). The presence of *P. ruthbeateae* within gallery forests of the Batéké Plateau National Park in southwestern Gabon makes it highly likely that this species is also distributed across the border within the Republic of Congo.

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***PSEUDOPALUDICOLA CANGA*.** BRAZIL: PARÁ: Municipality of Brasil Novo: 3.376°S, 52.576°W (datum WGS 84). 10 February 2012. E. A. Oliveira, J. C. Carvalho, and E. J. Hernández-Ruz. Museu Paraense Emilio Goeldi, Belém, Pará, Brazil (MPEG 34545–34553, MPEG 34584). Verified by M. S. Hoogmoed. Previously known only from the type locality: Serra dos Carajás, municipality of Marabá, State of Pará, Brazil (Giaretta and Kokubum 2003. Zootaxa 383:1–8). Northwesternmost record for the species extends known distribution 260 km NW from Serra dos Carajás, the closest locality previously mentioned.

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***TERATOHYLA MIDAS* (Santa Cecília Cochran Frog)**. BRAZIL: RONDÔNIA: Porto Velho (District of Vista Alegre do Abunã) BR-364 highway, km 265, Fazenda Presidente Prudente I e II (9.57656°S, 65.57098°W; WGS84). 03 November 2012. P. R. Melo-Sampaio, C. M. B. Oliveira, and K. R. Silva. Herpetological Collection, Universidade Federal do Acre, Rio Branco, Acre, Brazil (UFAC 5749–5750, amplectant pair found moving on the branches and leaves, above small stream into forest at 2200 h). Verified by J. M.Guayasamin. Species previously known from Amazon Basin in northeastern Ecuador, northeastern Peru (Cisneros-Heredia and McDiarmid 2005. Check List 1[1]:18–22; Lynch and Duellman 1973. Occ. Pap. Nat. Hist. Mus. Univ. Kansas 16:1–66) and Boca do Acre, state Amazonas in Brazil (França and Venâncio 2010. Biotemas 23[3]:71–84). First state record extends the known distribution to Rondônia state ca. 190 km SE of Boca do Acre (França and Venâncio, *op. cit.*).

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TESTUDINES — TURTLES

***APALONE SPINIFERA* (Spiny Softshell)**. MÉXICO: SONORA: Municipio de Cananea : on a dirt road crossing of the Río San Rafael, a major tributary to the Río San Pedro, 24.8 km NNE Cananea (31.17187°N, 110.26603°W; WGS84), 1415 m elev. 6 July 2009. James C. Rorabaugh and Abigail D. King. UAZ 57185-PSV. Verified by G. Bradley. First record for Cananea, which represents the third verified record from Sonora, extending its range 449 km ESE of the nearest locality at the inflow of the Wellton Canal to the Ciénega de Santa Clara, ca. 46 km SSW San Luis Río Colorado (Rorabaugh et al. 2008. Herpetol. Rev. 39:365). The nearest record to the San Rafael locality, is ca. 21 km NNE at the San Pedro River, Arizona, USA (Corman 1988. Abundance, Distribution, and Habitat Management of the Reptiles and Amphibians of the San Pedro Riparian National Conservation Area. U.S. Bureau of Land Management, Fairbank, Arizona). This introduced species likely colonized the Río San Rafael from the Río San Pedro. The turtle was found AOR during the day in an area surrounded by plains grassland.

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***APALONE SPINIFERA* (Spiny Softshell)**. USA: KANSAS: Coffey Co.: John Redmond Reservoir spillway (38.241370°N, 95.755066°W; WGS 84). 29 June 2012. Andrew W. Coleman and Greg Sievert. Verified by Curtis J. Schmidt. Sternberg Museum of Natural History, Fort Hays State University (FHSM 16451). New county record (Collins 2010. Amphibians, Reptiles, and Turtles in Kansas. Sternberg Museum of Natural History, Fort Hays State University, Hays, Kansas. 312 pp.). Fills a gap in the known range of this species within the Neosho River basin in eastern Kansas. A single adult turtle was found, decapitated and desiccated, on the exposed rocks within the river channel immediately below the dam on John Redmond Reservoir. The area is commonly used by anglers, one of whom presumably caught this individual accidentally.

This specimen was collected under a Kansas Wildlife Collecting Permit (SC-094-2012).

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***APALONE SPINIFERA* (Spiny Softshell)**. USA: TENNESSEE: Lawrence Co.: Shoal Creek, 50 m downstream from US Highway 227 bridge (35.023681°N, 87.579013°W; WGS 84). 15 September 2012. Michael C. Fulbright, Kristen M. Pilcher, James P. Flaherty, and Chris Gienger. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19359 [color photo]). New county record (Scott and Redmond 2008 [latest update 7 August 2012]. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/, accessed 17 September 2012). Juvenile hand captured in backwater.

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***APALONE SPINIFERA EMORYI* (Texas Spiny Softshell)**. USA: CALIFORNIA: Orange Co.: Yorba Linda (33.85704°N, 117.79071°W, WGS84; elev. 87 m). 16 September 2012. Daniel Jablonski. Verified by Gregory B. Pauly and Neftali Camacho. LACM PC 1608–1611. New county record (Lemm 2006. Field Guide to Amphibians and Reptiles of the San Diego Region. University of California Press, Berkeley. 326 pp.; Somma 2012. USGS Nonindigenous Aquatic Species Database. Available online at <http://nas.er.usgs.gov/queries/FactSheet.aspx?speciesID=1275>; Stebbins and McGinnis 2012. Field Guide to Amphibians and Reptiles of California. University of California Press, Berkeley. 538 pp.). One subadult specimen (~180 mm SCL) was discovered in the bank areas of the Santa Ana River (water depth approx. 200 mm) in urban area of Yorba Linda (southern outskirt of the city). The closest record to the Yorba Linda specimen was found in El Dorado Park, Long Beach, Los Angeles Co. (Somma, *op. cit.)*.

This introduced species has been previously observed in California in Contra Costa, Los Angeles, Kern, San Diego, and Santa Clara counties and in the Sacramento River system (Stebbins and McGinnis, *op. cit.*; Somma, *op. cit.*).

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***APALONE SPINIFERA GUADELUPENSIS* (Guadalupe Spiny Softshell)**. USA: TEXAS: Liveoak Co.: northeast of the town of Three Rivers (28.502675°N, 98.077247°W; WGS84). 11 May 2009. Eric C. Munscher and Mick Cook. Verified by Carl J. Franklin (UTADC 7626–7629 photo voucher). New county record (Dixon 2000. Amphibians and Reptiles of Texas. Texas A&M University Press, College Station. 421 pp.). Two adult (one female and one male) turtles were captured in double-throated hoop nets. This species is documented in the surrounding counties of McMullen, Duval, San Patricio, Karnes, and Atascosa (Dixon 2000, *op. cit.*).

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***CHELYDRA SERPENTINA* (Snapping Turtle)**. USA: FLORIDA: Suwannee Co.: E Peacock Springs (30.12218°N, 83.13221°W; WGS84). 3 November 2012 . Eric C. Munscher, David H. Rogers, Stephen G. Ross, and Charles Huang. Verified by Kenneth Krysko. Florida Museum of Natural History (UF 168690 photo voucher). New county record (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final report, Florida Fish and Wildlife Conservation Commission, Tallahassee. 524 pp.).

An adult male (carapace length 389 mm, midline plastron length 273 mm, 12.5 kg) was captured by hand as we snorkeled on 3 November 2012 as a part of a long-term turtle population study at Peacock Springs State Park. This species has been documented in the surrounding counties of Columbia, Gilchrist, Layfette, Madison, and Hamilton. Peacock Springs State Park is located just north of the Suwannee River and at times of high water is hydrologically connected to the river. It is possible that this species is abundant within the county but has been overlooked.

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***CHELYDRA SERPENTINA* (Snapping Turtle)**. USA: TENNESSEE: Decatur Co.: Wade Hampton Lane in Decaturville (36.5280°N, 88.2083°W; NAD 83). 20 June 2012. Rob Colvin, Jeremy Dennison, and Chad Harden. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19360 photo voucher). First county record (Scott and Redmond 2008. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. http://www.apsu.edu/reptatlas [updated 14 November 2012; accessed 4 December 2012]).

Photo voucher collected under the authority of the Tennessee Wildlife Resources Agency; field work supported by State Wildlife Grant (SWG) funding under the authority of the U.S. Fish and Wildlife Service.

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***CHELYDRA SERPENTINA* (Snapping Turtle)**. USA: TENNESSEE: Trousdale Co.: Old Hickory Lake Lock 5 Refuge, east of TN Highway 10 on the north side of Cumberland Rd (36.302222°N, 86.261667°W; WGS 84). 30 September 2011. Matthew D. Wagner and Michael C. Fulbright. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19187 [color photo]). New county record (Scott and Redmond 2008 [latest update: 7 August 2012]. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/, accessed 15 October 2011). Yearling captured in dip net.

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***CHELYDRA SERPENTINA* (Snapping Turtle)**. USA: TEXAS: Comal Co.: New Braunfels, Landa Park (29.713446°N, 98.135651°W; WGS84). 14 April 2012. Eric C. Munscher and Stephen G. Ross. Verified by Carl J. Franklin (UTADC 7618, 7622, photo vouchers) New county record (Dixon 2000. Amphibians and Reptiles of Texas. Texas A&M University Press, College Station. 421 pp.). This species has been documented in the surrounding counties of Kendall, Blanco, Hays, and Caldwell. Two adult turtles (male, female) were captured in a double-throated hoop net. Four additional turtles (three females, one male) have also been caught (UTADC 7623–7629).

Studies conducted under permit # SPR-0212-019.

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***CHRYSEMYS PICTA BELLI* (Western Painted Turtle)**. USA: NEBRASKA: Franklin Co.: 40.098211°N, 98.780119°W (WGS 84); elev. 554 m. 24 September 2012. Natural History Museum of Los Angeles County (LACM PC 1613). Gosper Co.: 40.669192°N, 99.859899°W (WGS 84), elev. 770 m. 17 September 2012. Hall Co.: Grand Island (40.887326°N, 98.353157°W, WGS 84; elev. 568 m). 22 September 2012.

All specimens were observed by Brian Hubbs and are new county records (Ballinger et al. 2010. Amphibians and Reptiles of Nebraska. Rusty Lizard Press, Oro Valley, Arizona. 400 pp.; Fogell 2010. A Field Guide to the Amphibians and Reptiles of Nebraska. Institute of Agriculture and Natural Resources, University of Nebraska-Lincoln. 158 pp.). All specimens were verified by Neftali Camacho.

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***DEIROCHELYS RETICULARIA* (Chicken Turtle)**. USA: ALABAMA: Covington Co.: County Rd. 24 (31.10239°N 86.43944°W; WGS 84). 17 July 2012. J. Newman, G. Brooks, and C. Thawley. Verified by David Laurencio. AUM AHAP-D 597 (digital photograph file). New county record (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn Printing Co., Auburn, Alabama. 270 pp.). This record fills a distributional gap along the southern edge of the state of Alabama between Escambia and Geneva counties. The closest record in Escambia Co. is approximately 20 miles west of this record, and the closest record in Geneva Co. is approximately 20 miles to the east.

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***DERMATEMYS MAWII* (Central American River Turtle)**. MÉXICO: QUINTANA ROO: Municipality of Bacalar: Instituto Nacional de Investigaciones Forestales Agrícolas y Pecuarias, Sitio Experimental San Felipe Bacalar (SESFB), Zona 4, San Felipe Lagoon (18.801256°N, 88.485086°W; WGS 84), 18 m elev. 17 March 1981. Gilberto Chávez-León. Verified by J. Rogelio Cedeño-Vázquez. Herpetological collection, Museum of Wildlife "Juan Nava Solorio" of SESFB, Quintana Roo (SESFB-H-100). First municipality record, northernmost locality on the Yucatán Peninsula, and a 103 km range extension N from the only other verified state record, 6 km NE of La Union, Municipality of Othón Pompeyo Blanco (Bahena-Basave 1995. Herpetol. Rev. 26:43).

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***GRAPTEMYS PSEUDOGEOGRAPHICA PSEUDOGEOGRAPHICA* (False Map Turtle)**. USA: FLORIDA: Volusia Co.: Blue Springs State Park, 200 m E of the mouth of St. Johns River inside of the Blue Spring Run (28.94337°N, 81.341264°W, WGS84; elev. 6 m). 27 May 2011. Eric C. Munscher. Verified by Gerald R. Johnson and Kenneth L. Krysko. Florida Museum of Natural History (UF 168572). New county record (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final report, Florida Fish and Wildlife Conservation Commission, Tallahassee, USA. 524 pp.). Female (carapace length = 233 mm, straight midline plastron length = 178 mm, 927 g) captured by hand at 1000 h as we snorkeled along the center of the lower Blue Spring Run toward the St. Johns River. The abundance of algae on the carapace (60% of surface area) suggests this is not a recently released captive. This is the first reported occurrence of *G. p. pseudogeographica* in the St. Johns River Basin. This non-indigenous turtle may be in the early phase of an introduction that may require monitoring. In Florida, *G. p. pseudogeographica* is commonly sold in pet stores and may replace the Red-eared Slider (*Trachemys scripta elegans*) as the most frequently released non-indigenous pet turtle. Given its omnivorous diet and the proximity to habitat types similar to its native habitat in the Missouri and Mississippi River drainages, *G. p. pseudogeographica* could potentially thrive in the St. Johns River Basin.

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***TRACHEMYS SCRIPTA ELEGANS* (Red-eared Slider)**. USA: FLORIDA: Levy Co.: Manatee Springs State Park, 0.43 km from the Manatee Springs boil (29.48859°N, 82.98005°W, WGS84; elev. 6 m). 16 August 2011. Eric C. Munscher, David Rogers, Eleanor Havens. Verified by Kenneth L. Krysko, Florida Museum of Natural History (UF 168695). New county record (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final report, Florida Fish and Wildlife Conservation Commission, Tallahassee. 524 pp.). Female (carapace length 229 mm, midline plastron length 157 mm, 546 g) captured by hand at 930 h as we snorkeled along the eastern side of the Suwannee River / Manatee Springs Spring Run outflow. The lack of algal growth on this turtle's shell might indicate a recent release; however, this area is rather remote. In Florida, *T. s. elegans* has been commonly sold in pet stores for many years and as a result has become one of the most prolifically released exotic species of turtle in Florida.

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***TRACHEMYS SCRIPTA ELEGANS* (Red-eared Slider)**. USA: FLORIDA: Seminole Co.: Wekiwa Springs State Park, 0.17 km from the Wekiwa Springs boil (28.71361°N, 81.45859°W, WGS84; elev. 6 m). 26 March 2011. Eric C. Munscher, J. Brian Hauge, Joseph McDonald, and David Rogers. Verified by Kenneth L. Krysko, Florida Museum of Natural History (UF 168593). New county record (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final report, Florida Fish and Wildlife Conservation Commission, Tallahassee. 524 pp.). Female (carapace length = 242 mm, midline plastron length = 183 mm, 1023 g) captured by hand at 1030 h as we snorkeled along the eastern end of the Wekiwa Springs Lagoon. The lack of algal growth on this turtle's shell might indicate a recent release.

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SQUAMATA — LIZARDS

***ANOLIS SAGREI* (Brown Anole)**. USA: FLORIDA: Escambia Co.: Pensacola: Agriculture Interdiction Station I-10, Station 19: I-10 eastbound (30.54519°N, 87.35201°W, WGS84). 15 November 2012. Katrina Simmons and Randal St. Louis. Verified by Kenneth L. Krysko, Florida Museum of Natural History, University of Florida (UF 169126). First county interdiction and westernmost vouchered specimen for the Florida Panhandle (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final report, Project Agreement 08013, Florida Fish and Wildlife Conservation Commission, Tallahassee. 524 pp.). Currently, *A. sagrei* is not known to be established in Escambia Co., but is present in adjacent Santa Rosa Co. and at least 54 other Florida counties (Krysko et al. 2011, *op. cit.*).

One adult male was confiscated from a truck delivering horticultural plants from Alvin, Brazoria Co., Texas, where non-indigenous *A. sagrei* is previously established (McCoid 2006. Herpetol. Rev. 37:361). The specimen was originally turned in to Division of Plant Industry, Florida Department of Agriculture and Consumer Services, Gainesville, Florida; Entomology Log No. E2012-8695.

The vehicle's destination was Boynton Beach, Palm Beach Co., Florida, where an established population of this Caribbean anole already exists (Krysko et al. 2011, *op. cit.*), and potentially could have contributed to the known genetic admixture among various invasive populations (Kolbe et al. 2004. Nature 431:177–181; Kolbe et al. 2008. Biol. Lett. 4:434–437).

I thank Dyrana Russell for details regarding confiscation locality.

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***HEMIDACTYLUS TURCICUS* (Mediterranean Gecko)**. USA: ILLINOIS: Jackson Co.: Carbondale (37.72031°N, 89.21746°W; WGS84). 15 July 2011. M. Rowland, B. Sadie, and Matt R. Whiles. Verified by Ronald A. Brandon. Southern Illinois University Fluid Vertebrate Collection (SIUC R-3424). New county record, extending range ca. 37 km from Williamson Co. record (McDowell et al. 2006. Herpetol. Rev. 37:481).

McDowell et al. (2006, *op. cit.*) documented the first state occurrence of this gecko in adjacent Williamson Co. Juvenile and adult *H. turcicus* were again found at the Williamson Co. site in 2011 and 2012. The presence of a second population (Jackson Co.) indicates that *H. turcicus* is firmly established and expanding its range in southern Illinois. Four adults were found after dark on a building in downtown Carbondale. Five adults and two juveniles were found at the same locality on 28 July 2012.

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***HEMIDACTYLUS TURCICUS* (Mediterranean Gecko)**. USA: KENTUCKY: Kenton Co.: Taylor Mill (39.016460°N, 84.507355°W; WGS 84). 4 June 2012. Paul J. Krusling and Heather Boor Mitchell. Verified by Jeffrey G. Davis. Cincinnati Museum Center Herpetology Collection (CMC 12339–12341). The first documented records for the Commonwealth of Kentucky (Kraus. 2009. Alien Reptiles and Amphibians: A Scientific Compendium and Analysis. Invading Nature: Springer Series in Invasion Ecology No. 4. Springer, New York. 563 pp.).

In addition to the three vouchers, at least 15 individuals, including large, apparently gravid females, and juveniles were seen on, or near, a strip shopping center in Taylor Mill, Kentucky between 2200 and 2300 h. The source of this population is unknown, but may be the result of escapes from a local pet shop or accidental introduction from a grocery store located at the site. This population has persisted for at least seven years (HBM, pers. obs.).

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(e-mail: pkrusling@gmail.com); **HEATHER BOOR MITCHELL**, Scott High School, 5400 Old Taylor Mill Road, Taylor Mill, Kentucky 41015, USA (e-mail: Htmz6911@yahoo.com).

***PODARCIS MURALIS* (Common Wall Lizard)**. USA: OHIO: Butler Co.: Hanover Twp., near intersection of Ross Hanover and Black Roads (39.39158°N, 84.63873°W; WGS 84). 11 November 2012. J. G. Davis and J. W. Ferner. Verified by Paul Krusling. CMC 12360–12361 (with tissues). New county record (Wynn and Moody 2006. Ohio Turtle, Lizard and Snake Atlas. Ohio Biol. Surv. Misc. Contrib. No. 10). This is an established breeding population that occupies a south-facing, stacked-rock wall approximately 0.75 m high and 7 m long.

Wall lizards were introduced in eastern Cincinnati (Hamilton Co.), Ohio from northern Italy in the early 1950s (Deichsel and Gist 2001. Herpetol. Rev. 32[4]:230–232). It is likely these were also released at this additional site as no known dispersion corridors such as railroad beds (Hedeen and Hedeen 1999. Herpetol. Rev. 30[1]:57–58) and river drainages are nearby. This metapopulation now includes Hamilton Co., Ohio to the south and Boone, Campbell, and Kenton counties across the Ohio River in northern Kentucky (Kraus. 2009. Alien Reptiles and Amphibians: A Scientific Compendium and Analysis. Invading Nature: Springer Series in Invasion Ecology No. 4. Springer, New York. 563 pp.).

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SQUAMATA — SNAKES

***AGKISTRODON CONTORTRIX* (Copperhead)**. USA: TENNESSEE: Weakley Co.: Shades Bridge Rd, 4 km E of Hwy 45E (36.13395°N, 88.78111°W; NAD 83). 10 August 2011. Jeremy Dennison. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19194). First county record (Scott and Redmond 2008. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. http://www.apsu.edu/reptatlas [updated 7 August 2012; accessed 4 December 2012]).

Voucher specimen collected under the authority of the Tennessee Wildlife Resources Agency; field work supported by State Wildlife Grant (SWG) funding under the authority of the U.S. Fish and Wildlife Service.

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***CLONOPHIS KIRTLANDII* (Kirtland's Snake)**. USA: INDIANA: Fayette Co.: Connorsville Township (39.6566°N, 85.2386°W; NAD 83). 20 August 2012. John Cannarella. Field Museum of Natural History (FMNH 282154). Jackson Co.: Grassy Fork Township (38.76201°N, 85.92413°W; NAD 83). 26 April 2012. Sarabeth Klueh and Jason Mirtl. FMNH 282784.

These are new county records (Minton 2001. Amphibians and Reptiles of Indiana. 2nd ed., revised. Indiana Academy of Science. vii + 404 pp.). Both specimens were verified by Alan Resetar.

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***CROTALUS HORRIDUS* (Timber Rattlesnake)**. USA: ARKANSAS: Nevada Co.: Vicinity of Pleasant Plains, approximately 9.6 km N of Prescott (33.880825°N, 93.440531°W; WGS 84, elev. ~ 106 m) on St. Hwy 19, September 2008. Jessica F. Crump. Verified by Malcolm L. McCallum. Two adult males (Arkansas State University Museum of Zoology Herpetological Collection—ASUMZ 31289, 31290) collected DOR within a week of each other at nearly the same spot. First county records (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.), approximately 27 air km from nearest known record in Pike Co.

Live Timber Rattlesnakes have been seen crossing St. Hwy 19 at this particular point on several other occasions. Predominate surrounding habitat is low rolling hills of Loblolly Pine (*Pinus taeda*) plantations interspersed with bottomland hardwood riparian areas located in the northernmost region of the West Gulf Coastal Plain ecological system

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***CROTALUS HORRIDUS* (Timber Rattlesnake)**. USA: TENNESSEE: McNairy Co.: Found DOR on Hwy 45 S near the Mississippi state line. (35.003722°N, 88.52094°W, NAD 83). 2 March 2012. Sam Bedwell. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19363 photo voucher). First county record (Scott and Redmond 2008. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. http://www.apsu.edu/reptatlas [updated 14 November 2012; accessed 4 December 2012]).

Photo voucher collected under the authority of the Tennessee Wildlife Resources Agency; field work supported by State Wildlife Grant (SWG) funding under the authority of the U.S. Fish and Wildlife Service.

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***CROTALUS MOLOSSUS* (Black-tailed Rattlesnake)**. MÉXICO: CHIHUAHUA: Municipio Ascensión: Sierra El Capulín (30.85841667°N, 107.7508611°W; WGS84; 2037 m elev.), 30 August 2010. Eduardo Macías-Rodríguez and Jesús M. Martínez-Calderas. Verified by H. Gadsden-Esparza. Sección Herpetológica, Colección Científica de Vertebrados, Universidad Autónoma de Ciudad Juárez (CCV-UACJ 823). First record for municipality and a ca. 38 km N (straight line) range extension from the nearest record in Chihuahua at Sierra La Escondida, Nuevo Casas Grandes (Gatica et al. 2011. Herpetol. Rev. 42:393). The male snake was found at ca. 1500 h, at the base of an *Opuntia violacea* in Chihuahuan Desert Scrub. Collecting permit (# 04134) was kindly issued by Dirección General de Vida Silvestre, SEMARNAT.

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***DIADOPHIS PUNCTATUS* (Ring-necked Snake)**. USA: TENNESSEE: Henderson Co.: Natchez Trace State Park on Lodge Rd. (35.77967°N, 88.25751°W, NAD 83). 27 March 2012. Jeremy Dennison. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19364 photo voucher). First county record (Scott and Redmond 2008. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. http://www.apsu.edu/reptatlas [updated 14 November 2012; accessed 4 December 2012]).

Photo voucher collected under the authority of the Tennessee Wildlife Resources Agency; field work supported by State Wildlife Grant (SWG) funding under the authority of the U.S. Fish and Wildlife Service.

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***DRYMARCHON COUPERI* (Eastern Indigo Snake)**. USA: FLORIDA: Hamilton Co.: 11.3 km NE Lee (30.486800°N, 83.21300°W; WGS 84). 23 October 2012. D. Stevenson. Verified by Kenneth L. Krysko (UF 168815). New county record (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Florida Fish and Wildlife Conservation Commission, Tallahassee. 524 pp.)

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***DRYMARCHON COUPERI* (Eastern Indigo Snake)**. USA: GEORGIA: Brantley Co.: State Route 139, 2.5 km NNE of Hortense (31.343650°N, 81.941728°W; WGS84). 11 October 2012. C. Rentz. Verified by Nikki Castleberry. Georgia Museum of Natural History (GMNH 50219); a second specimen (GMNH 50220) was also found. First records for county (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens, Georgia. 575 pp.).

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***FARANCIA ERYTROGRAMMA ERYTROGRAMMA* (Common Rainbow Snake)**. USA: SOUTH CAROLINA: Darlington Co.: Lauthers Lake, 13.3 km ENE Darlington (34.32889°N, 79.72456°W; WGS 84). 23 March 2012. Jeffrey D. Camper and Christopher Johnson. Verified by Stanlee Miller. Clemson University Vertebrate Collections (CUSC 2850, voucher photograph). New county record (Camper 2010. Herpetol. Rev. 41:385–386). This juvenile specimen (~0.5 m SVL) was discovered under a log in a seepage area approximately 1 m from a small stream at 1430 h. This species has been previously observed in adjacent Florence Co. at Lynches River County Park, 11 km S Florence (Camper 2010, *op. cit.*).

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***HETERODON PLATIRHINOS* (Eastern Hog-nosed Snake)**. USA: TENNESSEE: Henderson Co.: 2410 Hwy 104 S near Lexington (35.5879°N, 88.3559°W; NAD 83). 5 June 2011. Shannon Gigliotti and Rob Colvin. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19361,19362 photo vouchers). First county record (Scott and Redmond 2008. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. http://www.apsu.edu/reptatlas [updated 7 August 2012; accessed 4 December 2012]). Two individuals photographed on the Gigliotti Farm.

Photo voucher collected under the authority of the Tennessee Wildlife Resources Agency; field work supported by State Wildlife Grant (SWG) funding under the authority of the U.S. Fish and Wildlife Service.

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***HYDROPHIS CYANOCINCTUS* (Annulated Sea Snake)**. BANGLADESH: COX'S BAZAR DISTRICT: Sonadia Island (21.493541°N, 91.853424°E; WGS 84). 15 August 2012. Photographic voucher, Raffles Museum of Biodiversity Research, National University of Singapore (ZRC [IMG] 2.175 a-b). Specimen collected by local fishermen ~1.5 km offshore. SVL 135 cm, tail length 14.4 cm. Verified by Aaron Savio Lobo. First record for Sonadia Island, a ca. 4900-ha barrier island in SE Bangladesh, NW of Cox's Bazaar town. Island supports some of the last remaining patches of natural mangrove forest in SE Bangladesh. Khan (2008. Protected Areas of Bangladesh—A Guide to Wildlife. Nishorgo Program, Bangladesh Forest Department, Dhaka, Bangladesh. 293 pp.) mentioned its occurrence in Bangladesh, but with no locality information or voucher specimen.

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***LAMPROPELTIS GETULA* (Eastern Kingsnake)**. USA: TENNESSEE: Lauderdale Co.: Hwy 19 at Ripley Elementary School (35.74099°N, 89.53758°W; NAD 83). 29 August 2011. Wade Hendren. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19195). First county record (Scott and Redmond 2008. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. http://www.apsu.edu/reptatlas [updated 7 August 2012; accessed 4 December 2012]).

Voucher specimen collected under the authority of the Tennessee Wildlife Resources Agency; field work supported by State Wildlife Grant (SWG) funding under the authority of the U.S. Fish and Wildlife Service.

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***MICRURUS BERNADI* (Saddled Coralsnake)**. MÉXICO: HIDALGO: Municipality of Huazalingo: near San Juan (20.98861°N, 98.5044°W; WGS84), 1249 m elev. 20 March 2007. Raúl Valencia and Jorge Valencia-Herverth. Verified by Irene Goyenechea. Colección Herpetológica Fotográfica, Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo (CHCIB 03). First record for municipality, extending range 16.16 km E from nearest record in the Municipality of Tlanchinol, Hidalgo (Ramírez-Bautista et al. 2010. Lista Anotada de los Anfibios y Reptiles del Estado de Hidalgo, México. Universidad Autónoma del Estado de Hidalgo, CONABIO. x + 104 pp.). The snake was found on the ground in tropical deciduous forest.

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***MICRURUS DISTANS* (West Mexican Coralsnake)**. MEXICO: SONORA: Municipio de Sahuaripa: Sierra Los Chinos, 17.5 km NNE Sahuaripa (29.20624°N, 109.19078°W; WGS84), 875 m elev. 13 April 2010. James C. Rorabaugh, Abigail D. King, Carmina Gutiérrez González, and Miguel A. Gómez Ramírez. Verified by G. Bradley. UAZ 57239-PSV. New municipality record, northernmost locality for this species, and extends the range in Sonora 100 km NNW from the previous northern range limit near Río Maycoba reported by Van Devender and Enderson (2007. Herpetol. Rev. 38:488). The specimen was found while crossing a dirt road at about 1000 h on a steep rocky slope in foothills thornscrub; air temperature was 27°C.

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***NERODIA SIPEDON* (Northern Watersnake)**. USA: TENNESSEE: Macon Co.: Salt Lick Creek at Spring Hill Rd bridge (36.518611°N, 85.844167°W; WGS 84). 1 October 2012. Michael C. Fulbright and Matthew D. Wagner. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19189 [color photo]). New county record (Scott and Redmond 2008 [latest update: 7 August 2012]. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/, accessed 15 October 2011). Small adult found under rock at stream edge.

Trousdale Co.: Goose Creek, under TN Highway 25 bridge (36.3850°N, 86.1292°W; WGS 84). 30 September 2011. Michael C. Fulbright and Matthew D. Wagner. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19186 [color photo]). New county record (Scott and Redmond 2008, *op. cit.*). Juvenile found under rock at stream edge.

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***OLIGODON BITORQUATUS* (Boie's Kukri Snake)**. INDONESIA: BALI: Gyanyar District: Sukawati, Tegenungan (08.345786°S, 115.171970°E, WGS 84; 68 m elev.). 25 January 2012. Ron Lilley. Photographic voucher, Raffles Museum of Biodiversity Research, National University of Singapore (ZRC [IMG] 2.174). Verified by I. Das. Live individual crawling on garden path, presumably flushed out of soil during heavy rain, at 1000 h. SVL 137 mm; TL 20 mm. Defensive display consisted of raising posterior body and tail tightly curled spirally. Head and anterior part of body occasionally raised in S-shape. First record for Bali (Das 2010. A Field Guide to the Reptiles of South-east Asia. New Holland Publishers [UK] Ltd., London. 376 pp.; McKay 2006. A Field Guide to the Reptiles and Amphibians of Bali. Krieger Publishing, Malabar, Florida. 146 pp.). Nearest populations recorded from Java and Sumbawa, and there are unconfirmed reports from Borneo and Sumatra (de Lang 2011. The Snakes of the Lesser Sunda Islands [Nusa Tenggara], Indonesia. Chimaira Editions, Frankfurt am Main. 349 pp.).

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***OPHEODRYS AESTIVUS AESTIVUS* (Northern Rough Greensnake)**. USA: TENNESSEE: Trousdale Co.: Parking area on east side of Oldham Rd (36.386111°N, 86.211944°W; WGS 84). 30 September 2011. Michael C. Fulbright and Matthew D. Wagner. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19164). New county record (Scott and Redmond 2008 [latest update: 7 August 2012]. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/, accessed 15 October 2011). Found dead on the road.

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***OPHIOPHAGUS HANNAH* (King Cobra)**. PHILIPPINES: ROMBLON PROVINCE: Romblon Poblacion (12.96667°N, 122.4333°E). Mark Wallbank. 9 November 2012. Photographic voucher, Raffles Museum of Biodiversity Research, National University of Singapore (ZRC [IMG] 1.177). Verified by I. Das. Total length 280 cm. First record for Romblon Island, species known from throughout South and Southeast Asia (Das 2010. A Field Guide to the Reptiles of South-east Asia. New Holland Publishers [UK], Ltd., London. 376 pp.), and within the Philippines, from the islands of Luzon, Mindanao, Mindoro, Negros, Palawan, Dinagat, Jolo, Balabac, Catanduanes, Polillo, Bohol, and Cebu (Alcala 1986. Guide to Philippines Flora and Fauna. Volume X. Amphibians and Reptiles. Natural Resources Management Center, Ministry of Natural Resources and University of the Philippines, Manila. xiv + 195 pp.; Leviton 1964. Philippine J. Sci. 93:531–550). Romblon Province is situated in central Philippines, and is composed of three major islands (Tablas, Sibuyan, and Romblon) and 17 smaller islands. No terrestrial elapid snake has been recorded on any island of Romblon Province (Siler et al. 2012. Check List 8:443–462).

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***RAMPHOTYPHLOPS BRAMINUS* (Brahminy Blind Snake)**. MÉXICO: BAJA CALIFORNIA SUR: Municipality of La Paz: La Paz (24.164045°N, 110.310326°W; WGS84), 19 m elev. 15 August 2010. Tonatiuh Chavez Sánchez. Verified by Lee Grismer. CIBNOR Herpetological Collection (CIB 1479). New municipality record, extending the distributional range ca. 434 km (air) SE of closest known locality at San Ignacio, Baja California Sur (Murphy and Ottley 1979. Herpetol. Rev. 10:119). The snake was found in a flower pot at 1500 h in downtown La Paz.

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***RENA HUMILIS* (Southwestern Threadsnake)**. USA: CALIFORNIA: Inyo Co.: Ninemile Canyon Road, 3.9 mi. by road W of Hwy 395 (35.849°N, 117.940°W; WGS 84), 4018 ft. 12 June 2004. H. Adams, M. Cady. Natural History Museum of Los Angeles County, LACM PC 1567. Kern Co.: Jawbone Canyon Road, ca. 1 mi. WNW of Hwy 14 (35.308°N, 118.014°W; WGS 84), 2260 ft elev. 12 May 2011. R. Guerra. LACM PC 1568. Kern Co.: Jawbone Canyon, 4.77 rd mi WNW of jct Hwy 14 (35.317°N, 118.077°W; WGS 84), 2578 ft elev. 20 June 2011. M. Waters. LACM PC 1635. All verified by N. Camacho. These are the first records for the Sierra Nevada/Tehachapi Mountains region, and the latter two records are the first vouchers for Kern Co. Spoecker (1967. Amer. Midl. Nat. 77:484–494) noted the occurrence of *R. humilis* in the El Paso Mountains of eastern Kern Co., but none of his material was ever vouchered.

I thank Herb Adams, Michael Cady, Ricardo Guerra, and Mike Waters for field collections.

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***STORERIA DEKAYI* (Dekay's Brownsnake)**. USA: TENNESSEE: Lewis Co.: Hidden Valley Road ca. 0.6 km NW of SR 99 (35.444848°N, 87.638874°W; WGS84). 15 September 2012. James P. Flaherty. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19352). New county record. (Scott and Redmond. 2008 (latest update: 7 August 2012). Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/ [accessed 2 October 2012]). Nearest confirmed record ca. 30 km NW in Perry Co. Found dead on road.

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***STORERIA DEKAYI WRIGHTORUM* (Midland Brownsnake)**. USA: ARKANSAS: Faulkner Co.: 152 Donna Kay Drive, Greenbrier (35.222689°N, 92.395939°W; NAD83). 29 September 2012. J. P. Crank. Verified by S. E. Trauth. Arkansas State University Herpetological Museum (ASUMZ 32351, photographic voucher). New county record filling a distributional hiatus between Conway and Pulaski counties of the Arkansas River Valley (Trauth et al. 2004. Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.).

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***STORERIA OCCIPITOMACULATA OCCIPITOMACULATA* (Northern Red-bellied Snake)**. USA: TENNESSEE: Jackson Co.: Cummins Falls State Park (36.2547°N, 85.5675°W; WGS 84). 3 October 2012. Kim Bailey. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19366 Color Photo). New county record (Scott and Redmond. 2008 [latest update: 7 August 2012]. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/).

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***TANTILLA HOBARTSMITHI* (Smith's Black-headed Snake)**. USA: TEXAS: Ward Co.: 1200 E. Sealy Ave., 1.25 km E of St. Hwy 18 (31.58778°N, 102.890556°W; NAD83). 13 May 2012. Matthew Anderson. Verified by Stanley Fox. Oklahoma State University (OSUS R6160). New county record. The closest known localities are immediately west in Reeves Co. (Dixon and Werler 2005. Texas Snakes: A Field Guide. University of Texas Press, Austin. 364 pp.). The snake was found under debris, in the parking lot of an abandoned hotel. The hotel has been empty for several years, with sand and grass beginning to cover the former parking areas.

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***THAMNOPHIS EQUES* (Mexican Gartersnake)**. USA: ARIZONA: Mohave Co. / La Paz Co. border: Bill Williams River, approximately 22.5 km E from the Highway 95 crossing of the Bill Williams River (34.25279°N, 113.85513°W; NAD 83). June 2012. Taylor B. Cotten and Jonathan D. Miller. Verified by G. L. Bradley (UAZ 57451). Range extension (Brennan and Holycross 2006. A Field Guide to Amphibians and Reptiles in Arizona. Arizona Game and Fish Department, Phoenix, Arizona. 150 pp.). The closest known extant population occurs approximately 178 km to the northeast in Yavapai Co. and does not share a drainage system with the Bill Williams River until the Gila River-Colorado River confluence approximately 180 km SW of this specimen. Closer populations formerly occurred on the Colorado River based on specimens collected east of Fort Mohave in 1904 and Yuma in 1890—approximately 110 km NW in Mohave Co. and 184 km SW in Yuma Co., respectively. More recently (1981), a verified population was located on the Agua Fria River 156 km E in Maricopa and Yavapai counties. However, these populations have been extirpated.

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***TRIMORPHODON TAU* (Mexican Lyresnake)**. MEXICO: SONORA: Municipality of Sahuaripa: Northern Jaguar Reserve, Rancho La Ventana, 32 km NNE Sahuaripa (29.32245°N, 109.10180°W; NAD 27 CONUS), ca. 1000 m elev. 6 June 2008. James C. Rorabaugh. Verified by T. J. Devitt and T. J. LaDuc. UAZ 57047-PSV. New municipality record, extending range 143 km N of closest known locality in eastern Sonora (UAZ 42839), 8.0 km S Nuri on road to Tesopaco (= Rosario) (Rorabaugh 2008. J. Arizona-Nevada Acad. Sci. 40:20–65). Specimen was in a mesquite-lined arroyo in thornscrub.

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NATURAL HISTORY NOTES

The Natural History Notes section is analogous to Geographic Distribution. Preferred notes should 1) focus on observations in the field, with little human intrusion; 2) represent more than the isolated documentation of developmental aberrations; and 3) possess a natural history perspective. Individual notes should, with few exceptions, concern only one species, and authors are requested to choose a keyword or short phrase which best describes the nature of their note (e.g., Reproduction, Morphology, Habitat, etc.). Use of figures to illustrate any data is encouraged, but should replace words rather than embellish them. The section's intent is to convey information rather than demonstrate prose. Articles submitted to this section will be reviewed and edited prior to acceptance.

Electronic submission of manuscripts is requested (as Microsoft Word or Rich Text format [rtf] files, as e-mail attachments). Figures can be submitted electronically as JPG files, although higher resolution TIFF or PDF files will be requested for publication. Please DO NOT send graphic files as imbedded figures within a text file. Additional information concerning preparation and submission of graphics files is available on the SSAR web site at: http://www.ssarherps.org/HRinfo.html. Manuscripts should be sent to the appropriate section editor: **Charles W. Painter** (amphibians; charles.painter@state.nm.us); **James Harding** (turtles; hardingj@msu.edu); **Jackson D. Shedd** (crocodilians, lizards, and *Sphenodon*; Jackson.Shedd@gmail.com); and **John D. Willson** or **David A. Steen** (snakes; hr.snake.nhn@gmail.com).

Standard format for this section is as follows: **SCIENTIFIC NAME** in bold, capital letters; standard English name in parentheses with only first letter of each word capitalized (if available, for the United States and Canada as it appears in Crother [ed.] 2012. *Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, with Comments Regarding Confidence in Our Understanding, 7th ed.* Herpetol. Circ. 39:1–92, available from SSAR Publications Secretary, ssar@herplit.com; for Mexico as it appears in Liner and Casas-Andreu 2008. *Standard Spanish, English and Scientific Names of the Amphibians and Reptiles of Mexico.* Herpetol. Circ. 38:1–162); **KEY WORD(S)** referring to the content of the note in bold, capital letters; content reporting observations and data on the animal; place of deposition or intended deposition of specimen(s), and catalog number(s) if relevant. Then skip a line and close with author name(s) in bold, capital letters (give names and addresses in full—spell out state names—no abbreviations, e-mail address after each author name/address for those wishing to provide it—e-mail required for corresponding author). References may be briefly cited in text (refer to this issue for citation format and follow format closely). One additional note about the names list (Crother 2012) developed and adopted by ASIH-HL-SSAR: the role of the list is to standardize English names and comment on the current scientific names. Scientific names are hypotheses (or at least represent them) and as such their usage should not be dictated by a list, society, or journal.

Recommended citation for notes appearing in this section is: Goldberg, S. R., and C. R. Mahrdt. 2012. *Bogertophis rosaliae*: reproduction. Herpetol. Rev. 43:655.

CAUDATA — SALAMANDERS

***AMBYSTOMA CINGULATUM* (Frosted Flatwoods Salamander). COURTSHIP and OVIPOSITION.** Following the passage of a frontal rain system on the evening of 3 Nov 2010, I observed two loose congregations of adult *Ambystoma cingulatum* within a dry pond basin in the Apalachicola National Forest, Liberty Co., Florida, USA. The two congregations each consisted of 5–8 males and 1–2 females and were about 20 m apart within the wetland basin. The pond was a shallow depression with a sparse overstory of Pond Cypress (*Taxodium ascendens*) and tupelo (*Nyssa* sp.) and a midstory dominated by Apalachicola St. John's Wort (*Hypericum chapmanni*). Salamanders were associated with comparatively open areas carpeted with dense patches of herbs, primarily Fleabane (*Erigeron vernus*), and pipeworts (*Eriocaulon compresum* and *E. decangulare*), but with scattered occurrences of various bunch grasses and pitcher plants (*Sarracenia* spp.). Male salamanders prowled actively among the herb layer and crawled in a haphazard manner, frequently doubling back or crawling through areas they had visited previously. The few gravid females were observed to be nearly motionless within the herb layer, one disappearing into a nearby crayfish burrow after a few minutes of observation. No interactions were noted between male and female salamanders, even though crawling males passed within a few centimeters of females. Salamander movement waned after 2300 h and few salamanders were seen above ground as the rain had long since stopped and the sky finally cleared at 2400 h.

Following the passage of a cold front on the evening of 16 Nov 2010, I returned to the same location and immediately observed a pair of salamanders engaged in courtship at 2005 h. The male salamander crawled alongside, just behind, and to the side of a large gravid female for 5–7 seconds, with its head at the level of her rear legs, until the female came to a stop. The male then crawled forward of the female, positioned its rear legs at the level of her head, and made several short jerking motions with its body before undulating or "wagging" its tail slowly back and forth over the anterior half of the female's body. The female would resume crawling for several centimeters before it would again stop and the male would then reposition itself for a repeated bout of tail wagging. Three cycles of this behavior were observed over the duration of 4 min before both salamanders were obscured from view by a thick clump of sedges. I assume it was at this time that spermatophore exchange occurred as the female salamander emerged from the sedges alone ca. 30 min later and crawled slowly but directly to her oviposition site about

1 m away beneath a large pipewort at the base of a cypress knee where she then remained for ca. 1.5 h. After crawling away and disappearing down a crayfish burrow, a cluster of four freshly deposited eggs was visible beneath the decumbent leaves of the pipewort. Although the clay substrate was nearly saturated, the nearest standing water was a small puddle about 2 m away which contained only a few centimeters of water.

Also during this time, another 8 males and 2 gravid females were observed. Males were crawling quickly within the herb layer while females were crawling slowly, pausing often, or remaining motionless but no other incidences of courtship were observed. All salamander movement stopped shortly after 2300 h. Approximately 15 other egg deposition sites were observed nearby in various stages of early development, all of which were above water and beneath the leaves of rosette-forming herbs. I was able to photograph courtship, egg deposition, and the freshly laid eggs and the photos can be made available upon request.

The four focal eggs' development was followed in the field and I observed and photographed them at 14, 24, 30, and 46 days. The eggs had developed to Harrison Developmental Stage 37 by day 14, were at stage 38 on day 24, stage 39 on day 30. The eggs were finally inundated by rising water levels on day 46 (31 Dec), when larvae hatched at stage 45 from two of the four eggs.

These observations of *A. cingulatum* courtship are the first documented for the federally threatened species and they confirm that it occurs terrestrially, as suspected by previous researchers. Additionally, these observations confirm terrestrial egg deposition as reported by Anderson and Williamson (1976. Herpetologica 32[2]:214–221), whose conclusions were disputed by Ashton and Ashton (2005. *In* Meshaka, and Babbitt [eds.], Amphibians and Reptiles: Status and Conservation in Florida, pp. 62–73. Krieger Publ., Malabar, Florida).

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***AMBYSTOMA MACULATUM* (Spotted Salamander). TERRESTRIAL OVIPOSITION.** *Ambystoma maculatum* frequents permanent or ephemeral water bodies in the spring for breeding where females oviposit ca. 50 eggs on submerged vegetation or aquatic substratum (Petranka 2010. Salamanders of the United States and Canada. Smithsonian Inst. Press, Washington DC. 587 pp.). On 26 and 27 April 2012, walking surveys were conducted around the perimeter of Lost Ray Lake (45.591130°N, 78.537941°W), Algonquin Provincial Park, Ontario, Canada, as part of an ongoing study to assess breeding activity of *A. maculatum*. On two separate surveys, terrestrial oviposition was noted for *A. maculatum*. We propose multiple explanations for our observations as well as draw comparisons with the terrestrial nesting habits of other *Ambystoma*.

The first egg mass was found 26 April under a log (Log A) ca. 4.8 m from the north shoreline of Lost Ray Lake. Upon flipping Log A an adult female *A. maculatum*, which appeared to have recently oviposited, was found in a shallow depression beside a small white globular mass containing four fertilized eggs (Fig. 1). Log A was overgrown with *Sphagnum* sp. moss and partially submerged in water-saturated mud. Ground surface temperature underneath the log was 3.3°C, nearest water temperature was 4.0°C and ambient air temperature was -1.3°C. The second egg mass (Log B) also contained four opaque eggs and was found 27 April ca. 27.9 m from the east shore of Lost Ray Lake. No adult *A. maculatum* were found in the immediate vicinity of the second log, however several *A. maculatum*, *A. laterale*, and *Pseudacris cruicifer* were found in the surrounding area. Log B was situated loosely on top of a bed of long flattened grass in the lake floodplain. Although moist, the mud below Log B was much dryer compared to Log A. Crustose lichen was present on Log B, but no mosses were present. Ground surface temperature beneath Log B was 1.2°C, nearest water temperature was 4.3°C and ambient air temperature was 0°C.



PHOTO BY SEAN BOYLE

FIG. 1. Terrestrial oviposition of female *Ambystoma maculatum* (Log A) with a four-embryo egg mass (upper right). An isolated gelatinous capsule lacking an embryo is pictured center.

While terrestrial egg-laying is relatively commonplace in North American salamanders, most notably within Plethodontinae, only two ambystomatids exhibit terrestrial oviposition: *A. cingulatum* and *A. opacum* (Petranka 2010, *op. cit.*). To our knowledge this is the first report of terrestrial oviposition for *A. maculatum*. It seems unfavorable for female *A. maculatum* to lay eggs terrestrially. This claim is supported by the fact that in both instances the egg masses numbered only four eggs each, far below the species typical clutch size of 50 eggs (Petranka 2010, *op. cit.*). Furthermore, eggs laid terrestrially risk desiccation and freezing. The eggs of *A. maculatum* are well noted as sharing a symbiotic relationship with green algae, conferring several benefits including gaseous exchange (Kerney 2011. Symbiosis 54:107–117). Presumably eggs laid in dark terrestrial environments would not experience benefits provided by an algal symbiont.

One possible explanation for the terrestrial oviposition is that laying occurred secondarily (i.e., each female already oviposited their main egg mass[es] in the nearby water body). In a final attempt to reduce the energetic cost associated with retaining the eggs that remained in the oviduct, each female may have laid them shortly after migration away from Lost Ray Lake. The eggs also could have been laid due to stressful conditions (e.g., predation risk, environmental stressors). In 2012, Algonquin Provincial Park experienced the earliest lake ice out and forest thaw dates on record, nearly a month in advance of the mean thaw date (Fraser and Tozer 2012. Ice-out dates for Lake Opeongo. Unpublished report, Algonquin Park Visitor Centre Library #6097). Early lake and forest thaw followed by a period of

low precipitation and a cold snap altered the spring 2012 migration and breeding phenology of pond-breeding salamanders in Algonquin (SPB and PDM, pers. obs.). We speculate that unusual environmental conditions may have prompted stress-induced oviposition or else mixed physiological messages spurring abnormal reproduction.

The nest site features reported here share similarities with those documented for other terrestrial laying mole salamanders. *Ambystoma cingulatum* and *A. opacum* have been reported to oviposit beneath logs, grasses, and moist vegetation (Anderson and Williamson 1976. Herpetologica 32:214–221; Bishop 1941. New York State Mus. Bull. 324:1–365; Jackson et al. 1989. Can. J. Zool. 67: 2277–2281). Lastly, both *A. cingulatum* and *A. opacum* depend on rising floodwaters to trigger hatching and allow development of gilled larvae. Perhaps the floodplain was deemed a suitable nesting site and actively chosen by *A. maculatum* females because of impending potential for flooding.

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AMBYSTOMA OPACUM **(Marbled Salamander). COLORATION.** *Ambystoma opacum* is a medium-sized, stout-bodied salamander that has a ground color of black with conspicuous white or gray crossbars across the dorsum (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Inst. Press, Washington, D.C. 587 pp.). They are common throughout the southeastern United States, yet are rarely seen due to their reclusive habits (Petranka 1998, *op. cit.*; Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.). Herein, we report an unusual color morph of an adult *A. opacum*.

On 29 Sept 2012, we captured a total of 14 *A. opacum* at ca. 2100 h crossing a paved two-lane road (2.5 km N Wesson, Union Co., Arkansas, USA; 33.143440°N, 92.771521°W) migrating to breeding sites during a rainstorm. Thirteen of these had the typical color pattern; however, a single adult had a unique dorsal color pattern. This adult male (50 mm SVL) did not express the typical crossbars across the dorsum (Fig. 1). We deposited this individual within the Arkansas State University Museum of Zoology Herpetology Collection (ASUMZ 32341). Some individuals lack the crossbands and instead exhibit a morph variation consisting of longitudinal stripes (Dundee and Rossman 1989. The Amphibians and Reptiles of Louisiana. Louisiana State Univ. Press, Baton Rouge. 300 pp.; Trauth and Richards 1988. Bull. Chicago Herpetol. Soc. 23:87). However, this is the first report of the color morph that we illustrate herein.



FIG. 1. Two morphs of *Ambystoma opacum* showing typical morph (above) and unusual morph (below) collected on 29 September 2012 in Union Co., Arkansas, USA.

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ANEIDES AENEUS **(Green Salamander). COLOR VARIATION.** Anomalous colors and color variants in amphibians are well known and widely reported for several genera such as *Ambystoma*, *Plethodon*, *Pseudotriton*, and *Rana* (Bechtel 1995. Reptile and Amphibian Variants: Colors, Patterns, and Scales. Krieger Publ., Malabar, Florida. 224 pp.; McDonald et al. 2011. Herpetol. Rev. 42:405–406; Mendyk et al. 2010. Herpetol. Rev. 41:189–190; Mitchell and Mazur 1998. Northeast. Nat. 5:367–369; Larson and Muller 2011. Herpetol. Rev. 42:406; Simpson and Wilson 2010. Herpetol. Rev. 41:185–186). However, only a few similar reports exist in the published literature for *Aneides* spp., and they pertain to albino *A. flavipunctatus* (Hensley 1959. Publ. Mus. Michigan State Univ. 1[4]:135–159; Seeliger 1945. Copeia 1945:122) and *A. ferreus* (= *vagrans*) (Dyrkacz 1981. Herpetol. Circ. 11:1–31; Houck 1969. Herpetologica 25:54).

Unlike most of its West Coast congeners, *A. aeneus* coloration typically includes bright green, "lichenlike" color patches on a dark gray to black dorsum; the color pattern extends onto the tail and legs (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, D.C. 587 pp.). Here, we describe what we believe to be the first examples of extreme color variation in *A. aeneus* with two observations for two individuals in North Carolina whose conditions may be described as "xanthic" (i.e., yellow pigmentation exhibited), "hypomelanistic" (i.e., reduced pigmentation exhibited) (Simpson and Wilson 2010, *op. cit.*) and/or "amelanistic" (i.e., no pigmentation exhibited). These conditions may be attributed to nonfunctioning or defective chromatophores, or pigment cells, in the skin (Bechtel 1995, *op. cit.*).

A xanthic and/or hypomelanistic adult female (4.5 cm SVL, 10.8 cm TL) was found 4.3 airline km NE Cedar Mountain, Transylvania Co., North Carolina, USA, in a rock outcrop in a large rock field across a mountain ridge top in mixed oak, hardwood, and pine forest on 7 April 2011 (Fig. 1A). The individual had normal-shaped patterns on the dorsum, legs, and tail, but they were faint yellow in color. The body exhibited reduced coloration and appeared translucent pink overall, with a wash of blue color evident on the ventral surface. Two normal-colored conspecifics were also found in this same rock outcrop (Fig. 1B). Out of four subsequent site visits from April–July 2011, this female was seen three more times, with normal colored conspecifics on each occasion.

An amelanistic, gravid adult female (12.7 cm TL, 6.3 cm SVL, # eggs visually estimated $\geq$20) was found 7.3 airline km NE Cedar

COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND PHOTO BY ALAN D. CAMERON

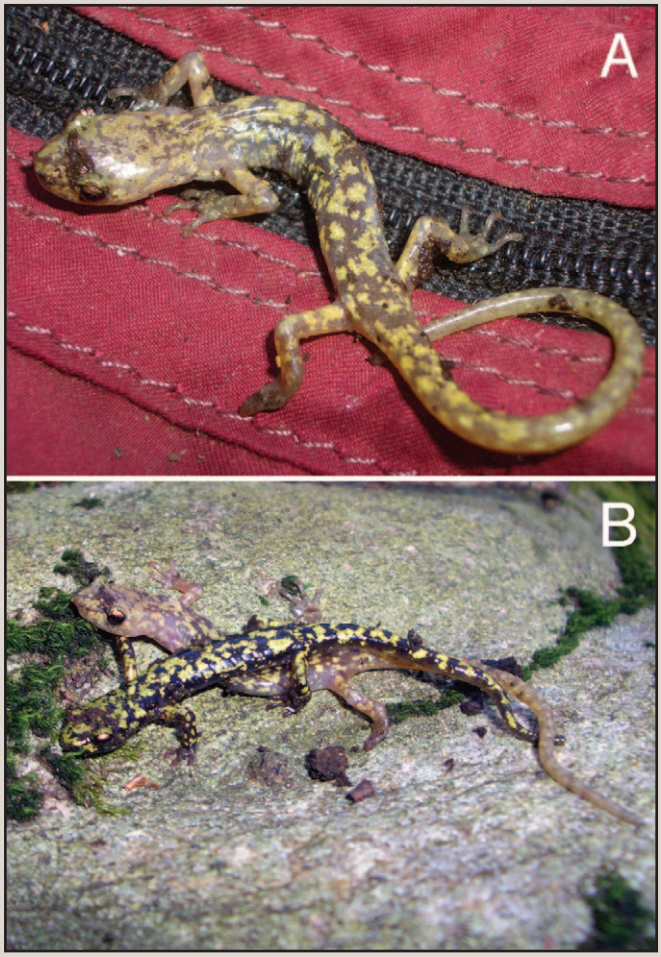


FIG. 1. A) Xanthic and/or hypomelanistic adult female *Aneides aeneus*, Transylvania Co., North Carolina, USA; B) Same individual photographed with a normally colored conspecific from the same site.

PHOTO BY ALAN D. CAMERON



FIG. 2. Photograph of an amelanistic, gravid adult female *Aneides aeneus* (Green Salamander) on boulder surface, Henderson Co., North Carolina.

Mountain, Henderson Co., North Carolina, in a large boulder in open, pine-dominated forest with scattered boulders and rock outcrops on 9 June 2011 (Fig. 2). This individual lacked all normal pattern and color and was a translucent pink overall with very faint darker splotches on its body. Four normal-colored conspecifics were also found in this boulder, including a hatchling from the previous year. Despite nine subsequent searches of this site from June–November 2011, we never found a nest belonging to this female, nor did we see her again. This second site is separated from the first by two heavily used trails and three steep, forested ravines with creeks and waterfalls. It appears that the two anomalous salamanders belonged to separate populations.

Specific coordinates for each locality are on file with the North Carolina Wildlife Resources Commission and are withheld here to protect sites.

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***EURYCEA CIRRIGERA* (Southern Two-lined Salamander). INGESTED AIR BUBBLES.** Many species of amphibian larvae with developing or developed lungs are capable of breathing air, a behavior that is influenced by a variety of factors (Wells 2007. The Ecology and Behavior of Amphibians. Univ. Chicago Press, Chicago, Illinois. 1148 pp.). Air-filled lungs can alter the buoyancy of larvae, and lunged larvae can expel excess air through the mouth or gill slits (Chadwick 1950. Amer. Midl. Nat. 43:392–398; Wells 2007, *op. cit.*). During feeding, ambystomatid larvae can sometimes ingest air, which causes them to float and prevents them from swimming normally (Johnson et al. 2003. Can. J. Zool. 81:1726–1735). To our knowledge, gulping and the ingestion of air has not been recorded in larval plethodontids. In the summer of 2012, JYL observed multiple larvae of *Eurycea cirrigera* that developed gas bubbles in their intestines after they were removed from leaf-litter traps.

On 21 April 2012, JYL collected three larvae from a leaf-litter trap (Waldron et al. 2003. Appl. Herpetol. 1:23–36) and transported them via sealable plastic bags from field sites in south Mississippi to a laboratory at the University of Southern Mississippi (USM). After a ca. 30 minute hike back to the vehicle, two of the larvae were floating at the surface of the water, with both larvae containing prominent bubbles in their intestines (Fig. 1). The intestine of the third larva contained a smaller bubble, but the larva never floated. By the next afternoon, all three had lost these bubbles and were swimming normally. JYL has observed gas bubbles in the intestines inhibiting the normal swimming behavior of four other individuals captured using this method. Two of these four, collected on 28 June 2012, contained gas bubbles large enough that the anterior region of their abdomens were noticeably expanded. These are the most extreme examples observed to date; both of these larvae lost their bubbles by the next day. JYL has also observed larvae with expanded gular regions on multiple occasions *in situ*; these larvae returned to normal after a few minutes and were released. While in the field, every effort was made to collect measurements from larvae as quickly as possible and to keep all containers with larvae out of direct sunlight. Mortality did not occur in the lab with any of the larvae that exhibited these symptoms.

The most likely explanation for these observations is that the larvae ingested air bubbles, presumably due to the stress of being captured, held, and occasionally jostled over time. When in sealable plastic bags, larvae often exhibit short periods of frantic, rapid swimming near the surface of the water, with their heads frequently breaking the surface. Because some observations *in situ* occurred within only a few minutes of placing the



FIG. 1. Larva of *Eurycea cirrigera* that ingested air during handling and transport.

larvae in the plastic bags, it is not likely that gulping was induced by hypoxic water conditions, which triggers air gulping in lunged larvae (Wells 2007, *op. cit.*). It is possible that small bubbles were already present in individuals prior to their removal from litter traps, and that the process of shaking the litter trap to check the trap caused the larvae to ingest more air. It does not seem likely that bubbles were produced from within by bacteria in the gut, as the bubbles appeared rapidly. Multiple observations of extended gular regions, without the presence of bubbles in the gut, suggest that air entered through the mouth.

We do not know whether the stress experienced by the larvae was brought on by being captured, confined, jostled, exposed to light, changes in temperature, or a combination of these factors. However, during the cooler months (November–December 2011), none of 160 *E. cirrigera* larvae that were caught in litter traps, and handled and transported in a similar fashion, exhibited any symptoms of gas bubble ingestion. This suggests that temperature stress might induce air gulping. However, JYL did not observe any floating individuals during cooler months, therefore she did not check larvae for ingested bubbles. JYL caught a total of 1133 larvae of *E. cirrigera* in litter traps between April and July 2012. Of these, very few individuals exhibited expanded gular regions (i.e., likely < 2–3%), and even fewer had ingested enough air to alter their swimming abilities.

Funding for this project was provided by the National Science Foundation (Grant No. 04344) and the U.S. Geological Survey (Grant No. 04150). This project was approved by the USM Institute for Animal Care and Use Committee (No. 11061301). Specimens maintained in the lab will be deposited in the Mississippi Museum of Natural Science in Jackson, Mississippi. We thank W. Selman and J. R. Ennen for reviewing this manuscript.

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***EURYCEA RATHBUNI* (Texas Blind Salamander). HABITAT.** The paedomorphic *Eurycea* clade of south central Texas is composed of 12 known species that are endemic to the Edwards Plateau (Chippindale and Hillis 2000. Herpetol. Monogr. 14:1–80). These salamanders inhabit the aqueous environments supported by the underlying Edwards Aquifer and have various morphological characteristics seemingly associated with aquatic-subterranean living (Chippindale 2000. *In* Bruce et al. [ed.], The Biology of Plethodontid Salamanders. pp. 149–150. Kluwer Academic/Plenum Publishers, New York). Adaptations to cave living are exemplified by the endangered *Eurycea rathbuni*, which has a broad head, long slender appendages, and reduced eyes and pigment



FIG. 1. Seasonal spring found at the intersection of W. Sessom Drive and State Street, San Marcos, Texas. The spring's location can be described as an urban setting, on the edge of Texas State University campus.

(Chippindale 2000, *op. cit.*). *Eurycea rathbuni* inhabits the subterranean aquifer system and the associated karst habitat of Hays Co., Texas (Chippindale and Hillis 2000, *op. cit.*). There are few accessible water sources that converge with the aquifer and sustain *E. rathbuni*. Those that do (e.g., Rattlesnake Cave) constitute the only naturally occurring habitat in which to observe the species. Most specimens are retrieved from man-made wells and pipes (e.g., artesian wells and Spring Lake). Occasionally, specimens are retrieved from seasonal and yearly springs when water pressure in the aquifer ejects them through fractures in the limestone of the Artesian Zone of the Edwards Plateau. These fractures result in sporadic springs scattered along the Edwards Plateau (Longley 1981. Inter. J. Speleol. 11:123–128). Moreover, sightings are uncommon given the species' lack of eyesight and pigment, which may make them highly susceptible to predation above ground (Chippindale and Hillis 2000, *op. cit.*).

Importantly, *E. rathbuni* inhabits inaccessible regions of the Edwards Aquifer. Specimens found as a result of high aquifer pressures provide the majority of known habitat and distribution data for the species. The paucity of specimens documented from natural water sources (caves, sinkholes, and springs) renders much of the species' natural history enigmatic. Herein we present, to the best of our knowledge, the first documented specimens salvaged from a seasonal spring in San Marcos, Texas.

On 23 March 2012 at 1332 h, a juvenile *E. rathbuni* (41.6 mm SVL, 71.1 mm total length, 13.3 mm head length, 8.3 mm head

width) was found dead in a seasonal spring at the intersection of W. Sessom Drive and State Street, located in the city of San Marcos, Hays Co., Texas, USA (29.89050°N, 097.93684°W, WGS84; elev. 177 m). The cause of death was not apparent; we speculate poor water quality or internal trauma sustained while emerging from the spring may have been responsible. Ambient water temperature of the spring was 20°C. Water depth at the entrance of the spring was ca. 24.13–25.4 cm. The specimen was found in the water ca. 1.5 m from the mouth of the spring. The specimen was salvaged via hand-held net under TPWD scientific permit number SPR-0707-1387 to RUT. A tissue sample was taken from the tail and was preserved in 90% ethanol. The remainder of the specimen was preserved in 70% ethanol. Specimen identification was verified by Paul T. Chippindale from the University of Texas at Arlington, where the specimen and tissue sample have been deposited at the Amphibian and Reptile Diversity Research Center (UTA-A 61913; Field ID, RUT 01).

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ANURA — FROGS

***ACRIS BLANCHARDI* (Blanchard's Cricket Frog). FEIGNING DEATH.** On 21 May 2012 at Boehler Seeps and Sandhills Preserve (Atoka County, Oklahoma USA; 34.16563°N, 95.88901°W) an *Acris blanchardi* was captured in a funnel trap that had been placed along a drift fence. When the frog was first observed, it was actively jumping inside of the trap; however, when it was picked up to remove it from the trap, it immediately opened its mouth, closed its eyes, and slowly began stretching its rear legs into a fully extended position (Fig. 1). It twitched its rear legs as it extended them and continued to twitch them after they were fully extended, but otherwise it remained completely motionless until one of the authors (DTM) gently touched one of its rear feet. When touched, it quickly retracted its legs and closed its mouth (its eyes remained closed). It then sat motionless with its rear legs tucked tightly against its body, its front legs held tightly against its head, and its head pressed down against DTM's hand (the frog was in DTM's hand during this entire process). The frog remained in this position even when it was touched and rolled onto its back.

The frog was then placed upside-down into a container. It did not move for approximately ten minutes, at which point, it righted itself and began moving around in the container. When the container was opened, it jumped out and attempted to flee.

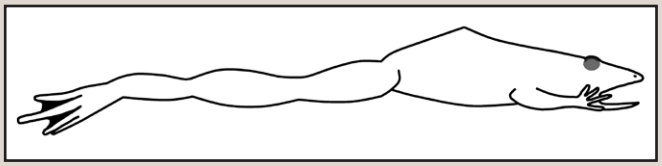


FIG. 1. A drawing of the Blanchard's Cricket Frog (*Acris blanchardi*) feigning death with its rear legs fully extended.

When it was grabbed, however, it immediately resumed its previous position with its head down, eyes closed, and limbs tucked in. When placed back on the ground, it abandoned this position and began actively fleeing. This cycle was repeated several times, however, it only opened its mouth and twitched its legs the first time that it was grabbed.

Death feigning has been previously reported in the Northern Cricket Frog (*A. crepitans*), but in that instance, the frogs remained motionless with their legs held against their body in a position that was similar to what we observed in *A. blanchardi* after touching the frog's foot, but they never extended their rear legs, twitched, or opened their mouths (McCallum 1999. Herptol. Rev. 30:90). It is possible that the differences between our observation and the observations of *A. crepitans* are a result of interspecific differences in behavior. It should be noted, however, that 161 *A. blanchardi* were captured at this site during 2012, and very few of them remained motionless with their limbs tucked in, and, other than this individual, none of them extended their rear legs, twitched, or opened their mouths. This may, therefore, be an isolated occurrence.

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***ACRIS CREPITANS* (Northern Cricket Frog). AXANTHISM.** Variability in phenotype and expression of pigments has been well documented in some amphibians (Berns and Narayan 1970. J. Morphol. 132:169–172; Frost et al. 1986. J. Embryol. Exp. Morphol. 95:117–130; Grether et al. 2004. Biol. Rev. 79:583–610; Hoffman and Blouin 2000. Biol. J. Linn. Soc. 70:633–665; Nevo 1973. Evolution 27:353–367). On 7 Sept 2011 a juvenile *Acris crepitans* was found at Harrison Lake National Fish Hatchery in Charles City Co., Virginia, USA. Blue pigmentation was apparent on the dorsum. It was a mottled phenotype of tan/grey, green, and blue. The frog appeared to be an axanthic mosaic animal in that it was not entirely lacking xanthophores (evident in its green coloration). Many other *A. crepitans* have been seen at the hatchery across many years, by many observers, and none have been noticed to exhibit this phenotypic coloration. It is unclear as to whether the coloration was a result of diet, disease, environment, genetic variation, or hormones as all are possible causes (Berns and Narayan 1970, *op. cit.*; Chatzifotis et al. 2011. Aquaculture Nutrition 17:90–100; Frost et al. 1986, *op. cit.*; Grether et al. 2004, *op. cit.*; Hoffman and Blouin 2000, *op. cit.*; Mizusawa et al. 2011. Gen. Comp. Endocrinol. 171:75–81; Nevo 1973, *op. cit.*). It is possible that this animal may be more susceptible to disease, desiccation, or predation (Nevo 1973, *op. cit.*). A review of the literature produced no articles mentioning *A. crepitans* exhibiting the axanthic phenotype. To my knowledge, this is the first reported case of an axanthic mosaic *A. crepitans*.

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***AGALYCHNIS CALLIDRYAS* (Red-eyed Treefrog). PREDATION.** *Agalychnis callidryas* is a charismatic representative for neotropical forest conservation and tropical tourism. Predation has been observed in both the egg and larval stages, and close examination of the these life stages has increased our understanding of the ontogenetic differences in predation risk and

the mechanisms behind reducing predation risks in subadults (Warkentin 2000. Anim. Behav. 60:503–510; Warkentin 1999. Behav. Ecol. 10:251–262). Surprisingly, little has been reported on predators of the adult life stage of this species. Careful investigation for this report has resulted in general statements to identify predators of adult *A. callidryas*, with assumptions based on the feeding preferences of potential predators (Savage 2002. The Amphibians and Reptiles of Costa Rica: a Herpetofauna between Two Continents, between Two Seas. Univ. Chicago Press, Chicago, Illinois. 934 pp.).

Adult *A. callidryas* are nearly exclusively arboreal, although reproductive females seek out standing water on the ground from which to absorb moisture (presumably into their bladders), which is used to hydrate internally maturing ova (Pyburn 1970. Copeia 1970[2]:209–218). Although males occasionally are found on the margins of small pools, calling for females, our observations suggest that the majority of vocalizations come from arboreal perches. Adults typically rest during the day within the forest canopy in a shallow state of torpor, often on the underside of leaves. During evenings and rain events, adults are typically found grasping (or alight on) leaves, branches, and vegetative stalks.

The event described here represents a rarely reported observation of the predation of *A. callidryas* in the adult life stage. During the evening of 04 June 2012, in the Fincas Naturales Wildlife Refuge, Quepos, Costa Rica, Central America (9.40444°N, 84.15516°W; elev. 136 m), we detected numerous *A. callidryas* within the herbaceous vegetation throughout the refuge. The vast majority of observed individuals were above ground (approximately 0.5 to 3.0 m), and typically within vegetation of a similar color to the frog. Males vocalized frequently while engaged in saltatory movements.

While slowly walking along a transect, we observed an adult *A. callidryas* leap from the vegetation to the ground. Nearly instantaneously, a nearby adult *Leptodactylus pentadactylus* (South American Bullfrog) moved quickly through leaf litter and grasped the *A. callidryas* by the head and shoulder. The *L. pentadactylus* used its front limbs to maneuver the *A. callidryas* to grasp it by the pelvic area, with the prey's torso and head deep within the predating bullfrog's buccal cavity. When one of us attempted to photodocument the event, the *L. pentadactylus* retreated quickly with its prey into leaf litter, where it presumably consumed the *A. callidryas*.

This observation was doubly rare in that it documented terrestrial predation on adult *A. callidryas*; this and other treefrog species are presumed to be at greatly reduced risk from terrestrial predators because of their arboreal lifestyle. It can be assumed that predation on adult *A. callidryas* occurs more typically by arboreal predators, such as the *Bothriechis schlegelii* (Eyelash Viper) and juvenile *Bothrops asper* (Terciopelo) (Savage 2002, *op. cit.*), both of which were observed within the wildlife refuge during our survey effort.

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AGALYCHNIS CALLIDRYAS (Red-eyed Treefrog), ***CRUZIOHYLA CALCARIFER*** (Gray-eyed Treefrog), ***HYPSIBOAS RUFITELUS*** (Scarlet-webbed Treefrog), and ***LEPTODACTYLUS MELANONOTUS*** (Fringe-toed Foamfrog). **PECCARY WALLOWS AS BREEDING HABITAT.** We surveyed six temporary water-filled depressions used as wallows by Collared Peccaries (*Pecari tajacu*) at La Selva Biological Station, Heredia, Costa Rica in June–July 2012. Fresh tracks confirmed that all wallows were actively used by peccaries during the study period. Four wallows contained tadpoles of one to three amphibian species. We identified tadpoles following Savage (2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna between Two Continents, between Two Seas. Univ. Chicago Press, Chicago, Illinois. 934 pp.) and Hoffmann (2005. Rev. Biol. Trop. 53:561–568). Wallow #1 contained *Agalychnis callidryas* eggs, tadpoles, and metamorphs, and *Leptodactylus melanonotus* tadpoles and an adult. Wallows #2 and #3 contained *A. callidryas* tadpoles. Wallow #4 contained *A. callidryas* tadpoles, *Hypsiboas rufitelus* tadpoles, and *Cruziohyla calcarifer* eggs, tadpoles, and an adult male. In wallows #1 and #4, we encountered *A. callidryas* and *C. calcarifer* tadpoles at various developmental stages, indicating that multiple clutches were laid at different times. We returned to wallow #1 three times over the two-month survey period, and on our final visit we noted several *A. callidryas* tadpoles at Gosner stage 41 and metamorphs at Gosner stage 42 (Gosner 1960. Herpetologica 16:183–190). We expect these tadpoles would have successfully completed metamorphosis.

To our knowledge, this is the first record of any of these species using peccary wallows as breeding habitat. We were not surprised to find *L. melanonotus* and *H. rufitelus* breeding in peccary wallows because both species seem to be habitat generalists (Savage 2002, *op. cit.*), and will use disturbed habitats such as forest fragments and cattle pastures (pers. obs.). Although *A. callidryas* also utilizes disturbed habitats, we were surprised that *A. callidryas* was the most common species encountered in wallows because this species typically breeds in temporary ponds at least an order of magnitude larger in surface area than our wallows (Donnelly and Guyer 1994. Oecologia 98:291–302). Recent observations of *A. callidryas* adults piggybacking on peccaries (Kuhn et al. 2012. Herpetol. Rev. 43:629) suggest that adult frogs may disperse among wallows by riding on the peccaries. We were even more surprised to observe multiple egg masses and tadpoles of *C. calcarifer* in wallow #4. *Cruziohyla calcarifer* is described by Savage (2002, *op. cit.*) as "…not found near either permanent or temporary ponds." *Cruziohyla calcarifer* has previously been reported using water-filled cavities in the trunks or buttresses of fallen trees (Donnelly 1987. Copeia 1987[1]:247–250). There were no treefalls visible within 30 m of wallow #4. Peccary wallows constitute a previously undescribed breeding habitat for *C. calcarifer*.

Peccaries have long been recognized as ecosystem engineers of breeding habitat for Amazonian amphibians (Gascon 1991. Ecology 72:1731–1746; Zimmerman and Bierregaard 1986. J. Biogeog. 13:133–143; Zimmerman and Simberloff 1996. J. Biogeog. 23:27–46). White-lipped Peccaries in the Amazon create wallows that hold water longer into the dry season than natural depressions. For amphibians, these wallows create novel aquatic habitats that support reproductive activities and increase the anuran biodiversity of forests with peccaries (Beck et al. 2010. J. Trop. Ecol. 26:407–414). Zimmerman and Bierregaard (1986, *op. cit.*) went so far as to recommend that the minimum size of preserves for pond-breeding amphibians in the Amazon should be determined on the basis of the size of reserve required to sustain White-lipped Peccary populations. Schlueter (2005. Herpetol. Rev. 36:160) emphasized the negative effects of peccary loss on Amazonian amphibian populations and diversity.

To our knowledge, these are the first observations of wallow-breeding by Central American amphibians. We returned to our four tadpole-containing wallows in September 2012 and noted that each wallow still contained water, new egg masses, and tadpoles, whereas two large ponds at La Selva were dry. We suggest that peccary wallows may also be important breeding habitat for many amphibian species throughout Middle America.

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***ALLOBATES BRUNNEUS* (Chapada Rocket Frog). PREDATION.** Some species of spiders are specialized for feeding on frogs (Lima et al. 2006. Guia de Sapos da Reserva Ducke – Amazônia Central / Guide to the Frogs of Reserva Adolpho Ducke – Central Amazonia. Áttema Design Editorial, Manaus, Brazil. 168 pp.). Herein we report predation of an adult *Allobates brunneus* by a spider in the family Ctenidae. *Allobates brunneus* is a medium-sized anuran (males 15.9–16.5 mm, females 15.4–20.0 mm) (Morales 2000. Publ. Asoc. Amigos Doñana 13:1–59), that occurs in the Amazon of Brazil from its mouth to southern Amazonas and Mato Grosso, and into extreme northern Bolivia (Frost 2011. Amphibian Species of the World: an Online Reference. Ver. 5.5 [accessed 17 October 2012]. http://research.amnh.org/vz/herpetology/amphibia/. Amer. Mus. Nat. History, New York). It inhabits the margins of lakes and pools of stagnant water in tropical rainforest; in Bolivia it is found in seasonally flooded forests. Its breeding habits are unknown, but the larvae likely develop in water (Silvano et al. 2004. *In* IUCN 2012. IUCN Red List of Threatened Species. Ver. 2012.2. <www.iucnredlist.org>. Accessed 17 Oct 2012).

On 11 Aug 2012 at 1600 h, we found an adult *A. brunneus* being preyed upon by an adult ctenid spider in leaf litter along a stream near Cave Planaltina, Brasil Novo – Pará, Brazil (3.3761°S, 52.5761°W). At the moment of observation, the *A. brunneus* was being held by the dorsolateral region by the spider. Anurans that live in the leaf litter of the forest floor have a great chance of being consumed by spiders, especially the family Ctenidae (Santana et al. 2009. Bol. Mus. Biol. Mello Leitão [N.S.] 26:59–65).

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***AMEEREGA FLAVOPICTA* (Yellow-painted Poison-arrow Frog). DEATH FEIGNING.** Anurans are known to feign death as a way to avoid or minimize the risk of predation (Toledo et al. 2010. J. Nat. Hist. 44[31–32]:1979–1988). This behavior is mostly displayed by non-toxic species (Toledo et al. 2010, *op. cit.*). However, this behavior has not been previously documented in *Ameerega flavopicta*, a dart-poison frog. Herein we report death-feigning behavior in *A. flavopicta*.

On 2 Feb 2006, during an anuran survey in a montane meadow (*campo rupestre*, 14.2056°S, 48.3811°W, WGS 84; elev. 353 m) near a palm swamp at Serra da Mesa, municipality of Niquelândia, Goiás state, central Brazil, we captured an adult male *A. flavopicta*. When handled to take photographs, it turned its belly up, with the arms upward and the legs close to the body, exhibiting aposematic colors on the ventral region (Fig. 1). It remained in this position for about 3 minutes, afterwards slowly returning to normal position.



FIG. 1. Adult male *Ameerega flavopicta* exhibiting death-feigning behavior.

Deimatic behavior associated with parental care is known for this species (Toledo et al. 2004. Phyllomedusa 3[2]:145–147). However, this is the first reported case of death feigning in *A. flavopicta*. A voucher specimen is deposited at the Coleção Zoológica da Universidade Federal de Goiás (ZUFG 3031).

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***BOMBINA VARIEGATA PACHYPUS* (Apennine Yellow-bellied Toad). CANNIBALISTIC OOPHAGY.** *Bombina variegata pachypus* occurs throughout peninsular Italy (IUCN Red List 2010: Endangered). It is considered by some as a distinct species (*B. pachypus*; Canestrelli et al. 2006. Mol. Ecol. 15:3741–3754), although recent evidence suggests it is nested in the *B. variegata* clade (Hofman et al. 2007. Mol. Ecol. 16:2301–2316). As *B. pachypus*, it is listed as Endangered in the IUCN Red List (www.iucnredlist.org, assessed 2009). It has an extended breeding season (May–September), during which discrete spawning events alternate with non-breeding phases (Guarino et al. 1998. Ital. J. Zool. 65:335–342). Tadpoles are macrophagous and known to be at least partly carnivorous, although they feed mainly on algal

film (Bonacci et al. 2008. Zool. Anz. 247:47–54). Larval development mostly occurs in small, ephemeral water bodies. As in other *B. variegata* subspecies, the lower trophic availability and higher desiccation risks of shallower ponds represents a trade-off against the higher predatory pressure and slower tadpole development rates of colder, more permanent water bodies (Barandun and Reyer 1997. Amphibia-Reptilia 18:143–154).

On 31 July 2012, during surveys of a population of *B. v. pachypus* in Val Fontanabuona, Liguria, Italy (44.41666°N, 9.25°E, elev. 410 m), twelve tadpoles (Gosner stage 26–30) were observed to feed on a single mass of approx. 20 eggs. Tadpoles and eggs were located in a small (40 x 40 cm) rock pool near a mountain stream in argillite-shale substrate. Both were identified as *B. v. pachypus*, and no other amphibian species has ever been observed at the site during extensive surveys since 2009. In total, the pond hosted ca. 40 tadpoles in Gosner stage 26–30 and ca. 15 undergoing metamorphosis (Gosner stage 39–46). On previous occasions, we had recorded two separate spawning events in the pond in late May and mid-June, with a maximum number of ca. 60 tadpoles of various stages.

Cannibalistic oophagy has been reported for adults of *B. variegata*, but never for larval stages (Polis and Myers 1985. J. Herpetol. 19:99–107). Since 2009, we have monitored several populations of *B. v. pachypus* in the area, recording larval density and activity. However, this was the first instance of cannibalistic oophagy we observed. The small size of the water body and the high density of tadpoles, together with the co-occurrence of different cohorts from different spawning events, suggest late-stage tadpoles might accelerate their development by feeding on recently laid eggs with high protein contents. This might also represents a density-regulating factor for subsequent tadpole cohorts, diminishing the intra-cohort competition when water levels decrease later in the season.

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***CHIROMANTIS DORIAE* (Doria's Asian Treefrog). PREDATION.** *Chiromantis doriae* occurs in Cambodia, China, India, Laos, Myanmar, Thailand, and Vietnam. It can be found in paddy fields, abandoned farmland and ponds in shrublands, and forests (Fei et al. 2010. Colored Atlas of Chinese Amphibians. Sichuan Publishing House of Science and Technology, China. 519 pp.). Here we present the first report of predation on *C. doriae* by a spider belonging to genus *Dolomedes* that is the first documented record of this frog species predated by invertebrates.

During a field survey in an abandoned fishpond near Yinggeling Nature Reserve (19.02407°N, 109.40511°E, WGS 84; elev. 320 m), Hainan Island, China, on 29 August 2012, at 2130 h, we observed that a male *C. doriae* (SVL ca. 2.5 cm) was held by a *Dolomedes* sp. with its mouthpart on a grass stalk 80 cm above the water. The frog was immobilized and not breathing. There was a wound on the back of the frog, part of the tissue was probably digested by the spider and the spinal cord was exposed (Fig. 1).

In other regions, frogs are common prey of spiders (Menin et al. 2005. Phyllomedusa 4:39–47). In this same pond, we also detected *Kurixalus bissaculus*, *Liuixalus hainanus*, *Microhyla butleri*, *Microhyla heymonsi*, and *Occidozyga martensii*; all are of similar size as *Chiromantis doriae*. Frogs may be an important prey item for *Dolomedes* sp., at least in the wet season.



COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND

FIG. 1. An adult *Chiromantis doriae* predated by a *Dolomedes* sp. in the Yinggeling Nature Reserve, Hainan, China.

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***DENDROPSOPHUS NORANDINUS* (North Andean Treefrog). DIET.** *Dendropsophus norandinus* is an endemic Colombian treefrog occurring in the northeastern part of the Cordillera Central in the municipalities of Amalfi and Anorí (Department of Antioquia), between 1420 and 1950 m elev. (Rivera-Correa and Gutiérrez-Cárdenas 2012. Zootaxa 3486:50–62). Published information on the natural history of this species is limited to the description of habitat use and predation by the snake *Leptodeira septentrionalis* (Rivera-Correa and Gutiérrez-Cárdenas 2010, *op. cit.*); no information exists on its food habits. Herein we provide data on the stomach contents of 15 individuals (museum vouchers Museo de Herpetologia Universidad de Antioquia, Medellín, Colombia, MHUA-A 3824–3838) collected by PDAGC on 27–29 September 2003 between 2300 and 0100 h and on 12–13 November 2003 between 1400–1800 h, in the "Bosque La Forzosa" (6.980555°N, 75.135277°W, ca. 1700 m elev.), municipality of Anorí, Department of Antioquia.

Only 53% of the individuals had identifiable stomach contents (three males, two females, and three juveniles; MHUA-A 3824–3826, 3829, 3831, 3833–3835). Males ranged from 25.3–26.4 mm SVL (mean 25.93 ± 1.41), females from 33.1–35.1 mm SVL (mean 34.10 ± 0.57), and juveniles from 11.8–14.3 mm SVL (mean 13.33 ± 1.34). We identified each prey item to order or family as possible, and measured the length and width to nearest 0.1 mm

TABLE 1. Types of prey in the diet of *Dendropsophus norandinus* from the "Bosque La Forzosa," Anorí, Antioquia, Colombia. Volume in mm^3.

Prey	Number (%)	Volume (%)	Frequency of occurrence
Arachnida			
Acari	1 (8.3)	4.19 (3.49)	1
Undet.	1 (8.3)	10.47 (8.73)	1
Insecta			
Coleoptera			
Chrysomelidae	2 (16.7)	12.57 (10.48)	1
Hemiptera			
Cercopidae	2 (16.7)	65.97 (54.99)	1
Cicadellidae	1 (8.3)	1.57 (1.31)	1
Hymenoptera			
Formicidae	3 (25.0)	2.42 (2.02)	2
Lepidoptera			
Noctuidae	1 (8.3)	7.07 (5.89)	1
Orthoptera			
Gryllidae	1 (8.3)	15.71 (13.09)	1
TOTAL	12	119.97	

of each item using a manual caliper. We estimated prey volume using the formula for a prolate spheroid. The diet was comprised only of arthropods (six orders and six families; Table 1), without a marked numeric dominance of a single prey item. Volumetrically, froghoppers (Cercopidae) were the most important prey item, followed by the crickets (Gryllidae) and leaf beetles (Chrysomelidae). The adults ate all prey items, except the leaf beetles and all were represented by a single prey item (except Cercopidae). Chrysomelid beetles, were consumed only by the juveniles. These results may be explained by the tendency of larger individuals to incorporate larger prey into their diets (Hirai and Matsui 2002. J. Herpetol. 36:719–723; Valderrama-Vernaza et al. 2009. J. Herpetol. 43:114–123), and that each frog consumes fewer prey as the SVL increases (González-Duran et al. 2011. Herpetol. Rev. 42:583–584).

Reports on the diet of other *Dendropsophus* species (*D. ebraccatus*, *D. microcephalus*, *D. nanus*, *D. phlebodes*, *D. sanborni*) suggest that these frogs are generalists, eating various arthropods, principally insects (Jiménez and Bolaños 2012. Phyllomedusa 11:51–62; Macale et al. 2008. Herpetol. J. 18:49–58; Menin et al. 2005. Rev. Bras. Zool. 22:61–72; Muñoz-Guerrero et al. 2007. Caldasia 29:413–425; Peltzer and Lajmanovich 2000. Bol. Asoc. Herpetol. Esp. 11:71–73). The three most important prey found in *D. norandinus* were also found in *D. nanus* and *D. phlebodes*, but in these species dipterans, spiders, larval butterflies, cicadellids, and checkered beetles (Cleridae) accounted for the largest volume of prey items (Jiménez and Bolaños 2012, *op. cit.*; Macale et al. 2008, *op. cit.*; Menin et al. 2005, *op. cit.*).

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***EUPEMPHIX NATTERERI* (Four-eyed Frog). PREDATION.** Snakes are well known to prey upon anurans (Michaud and Dixon 1989. Herpetol. Rev. 20:39–41). Toledo et al. (2007. J. Zool. 271:170–177) reported that approximately 45% of cases of predation of anurans were conducted by snakes. *Erythrolamprus poecilogyrus* is a widely distributed colubrid snake from South America (Dixon and Markezich 1992. Texas J. Sci. 44:131–166). Despite its terrestrial habits this species is often found in flooded areas and close to water bodies (Pinto and Fernandes 2004. Phyllomedusa 3[1]:9–14). Its diet consists of insects, fishes, amphibians, lizards, and rodents (Achaval and Olmos 2003. Anfíbios y Reptiles del Uruguay, 2nd ed. Impresora Graphis, Montevideo, Uruguay. 136 pp.). *Eupemphix nattereri* is a terrestrial, nocturnal anuran found in open areas after heavy rains (Uetanabaro et al. 2008. Field Guide to the Anurans of the South Pantanal and Surrounding Cerrados. Edit UFMS Campo Grande, MS).

On 24 Oct 2007 at 2205 h, along the margin of a tempory pond in the municipality of Miranda, Mato Grosso do Sul State, Brazil (20.083931°S, 56.613210°W; WGS84), we observed an attempted predation by an adult *E. poecilogyrus* on *E. nattereri*. During 20 minutes, we observed an *E. poecilogyrus* trying to swallow an *E. nattreri* headfirst, which filled its lungs with air, thus hindering ingestion. After some time the *E. nattereri* escaped, possibly due to the poisoning of the snake through contact with secretions from glands scattered on the frog's body. Species of the genus *Eupemphix* and *Physalaemus* are known to have physalaemins in the skin, peptides that act as a hypotensive and stimulates smooth muscles in vertebrates (Erspamer et al. 1964. Experientia XX/9:489–490). Sazima and Caramaschi (1986. Rev. Biol. 13:91–101) reported that under a perch of a Barn Owl (*Tyto alba*), four dead but intact specimens of *E. nattereri* were found together with regurgitated pellets, indicating a possible toxic effect of the skin secretions on the bird. In an experiment, the same authors, offered an *E. nattereri* to a *Nasua nasua*, which placed the frog in its mouth but then immediately rejected it. Rodrigues and Filho (2004. Herpetol. Rev. 35:160–161) also described the unsuccessful predation attempt by *Leptodactylus latrans*, which regurgitated the prey. The specimens reported in this note were identified in the field and soon after released.

We believe that this failed predation was due to the action of toxins from the skin of *E. nattereri*, showing how the chemical mechanism plays an important role in the species defense against potential predators.

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***HYLA GRATIOSA* (Barking Tree Frog). ALGAL HARVEST.** Although most tadpoles are not herbivores in the strict sense, they do harvest large amounts of periphyton to gain access to other nutritional material. Experiments involving the feeding behaviors of tadpoles usually focus on the tadpole's response, and the efficiency of the algal harvest is not shown.

We submerged a number of plastic coverslips about 10 cm below the surface of a permanent pond for two weeks to allow the growth of a layer of periphyton. We allowed tadpoles of *Hyla gratiosa* (ca. 58 mm TL and Gosner stage 33) to feed from these periphyton mats before the coverslips were frozen in liquid nitrogen, lyophilized, and sputter-coated for scanning microscopy.

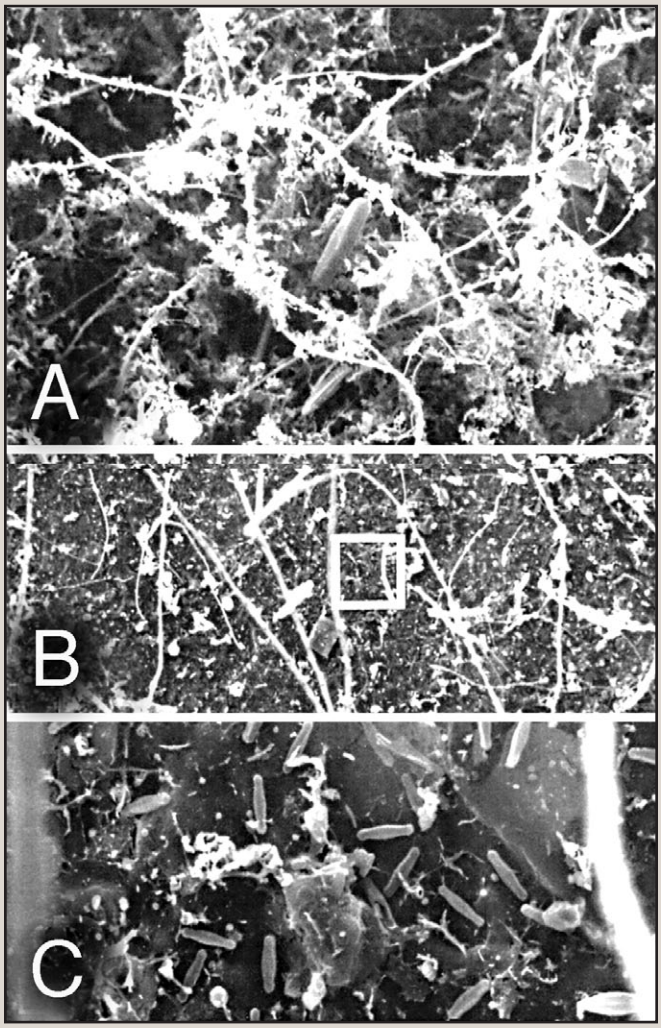


FIG. 1. **A)** A scanning microscopy image of an intact periphyton mat grown on glass in a native pond; **B)** part of the same area after being fed upon by a tadpole of *Hyla gratiosa*; and **C)** an electronic enlargement of part of the area within the white rectangle in frame B.

The coverslips initially had a dense canopy of filamentous algae, fungi, diatoms, and other algae (0.4 mm tall after lyophilization Fig. 1A). The feeding tadpoles removed the overstory (Fig. 1B) but left adnate diatoms and other small algae near the substrate (Fig. 1C, part of area of white square in Fig. 1B). After the tadpoles fed it appeared that most of the material had been removed, but about 41% (0.85 vs. 0.50 mg/cm²) of the chl *a* remained; that is, much of the material removed was not chlorophyllic and much of the chlorophyll was contained in small organisms that were closely attached at the base of the periphyton layer.

Occasional isolated bites taken from the surface of the periphyton mat did not penetrate the total algal canopy; algal filaments were cut and not merely pulled from the mass. Usually the tadpole attacked at an edge and systematically harvested the entire mat. In one case, the 4.7 cm² surface was grazed during three feeding bouts within 39 min. Single feeding bouts ranged from 3.0–57.0 (30.1 ± 4.0) sec, and resting bouts ranged from 4.0–653.0 (134.4 ± 47.1) sec. In one case, five short feeding bouts that totaled about 1.5 min were followed by a rest period of 7 min. Filamentous material could be seen being manipulated in the buccopharynx of this relatively translucent tadpole during resting bouts. Apparently when a critical amount was harvested relative to an unknown limitation of the buccopharyngeal apparatus, the tadpole rested quietly. These observations suggest that the amount of material harvested differed in some way among bouts, all of the material was not removed from the buccopharynx during a given rest, feeding on bulky material interfered with respiratory currents, or the tadpole fatigued. In any case, the feeding mechanics of the tadpole did not form a slurry of small particles.

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***ISCHNOCNEMA BILINEATA* (Two-lined Robber Frog). REPRODUCTION.** *Ischnocnema bilineata* is a small frog classified as "little concern" by IUCN due to its relatively wide distribution in the Atlantic Forest of the eastern State of Bahia, its tolerance to habitat disturbance, and its large population size (Junca and Pimenta 2004. *In* IUCN 2012. IUCN Red List of Threatened Species. Ver. 2012.1 http://www.iucnredlist.org. Accessed 07 August 2012). However, information regarding this species is limited. We collected a gravid female (UFBA 011447, 30.4 mm SVL) in a pitfall trap in Estação Ecológica Serra do Timbó (13.108083°S, 39.670583°W), municipality of Amargosa, State of Bahia, Brazil. We dissected the female and found 10 unfertilized eggs which averaged 3.07 ± 0.13 mm (mean ± SD) with a volume of 6.42 ± 0.27 mm³. The relatively large size of the eggs and their small number is compatible with that observed for species with direct development (Salthe and Duellman 1973. *In* J. L.Vial [ed.], Evolutionary Biology of the Anurans: Contemporary Research on Major Problems, pp. 229–249. Univ. Missouri Press, Columbia).

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***LEPTODACTYLUS FUSCUS* (Rufous Frog) and *ELACHISTOCLEIS OVALIS* (Oval Frog). REPRODUCTIVE BEHAVIOR.** *Leptodactylus fuscus* and *Elachistocleis ovalis* are tropical, terrestrial frog species that inhabit rainforests and forest edge, as well as grasslands and shrublands. These species are known from the Pacific lowlands of central Panama, throughout South America east of the Andes, to southern Brazil, Bolivia, and northern Argentina. In Colombia they are found in the Caribbean region, inter-Andean valleys, and the Orinoquia region. *Leptodactylus fuscus* is a relatively small species (43–70 mm SVL) that is closely associated with open savannah, streams, and creeks where it breeds in permanent or temporary ponds. *Elachistocleis ovalis* is a considerably smaller species (39–40 mm SVL), and is linked to open flooded areas and agricultural land where it seeks refuge underground and breeds (Medina-Rangel et al. 2011. Anfibios y Reptiles de los Alrededores del Complejo Cenagoso de Zapatosa, Departamento del Cesar, Colombia. Instituto de Ciencias Naturales, Universidad Nacional de Colombia-CORPOCESAR, Bogotá D.C. 105 pp.; Cochran and Goin 1970. Frogs of Colombia. U.S. Natl. Mus. [288]:1–655).

Reports of interspecific amplexus among frogs are relatively common at different locations and latitudes (Pearl et al. 2004. Am. Midl. Nat. 154:126–134; Streicher et al. 2010. Herpetol. Rev. 41:208; Grogan and Grogan 2011. Herpetol. Rev. 42:89–90; Manzano and Corzas 2011. Herpetol. Rev. 42:84; Turner 2012. Herpetol. Rev. 43:123). However, amplexus in species that are morphologically very different is not often reported. Mollov et al. (2010. Biharean Biol. 4[2]:121–125) suggest that amplexus is abnormal if the amplexus is between a live frog and a dead or morphologically very different species. Herein I report one such example of amplexus between *E. ovalis* and *L. fuscus*, despite the large differences in size and morphology.

At 2000 h on 3 June 2010, I observed a male *E. ovalis* in amplexus with an adult *L. fuscus* of undetermined sex. Weather conditions were cloudy with light rain during the afternoon. The pair was encountered immobile within the tree-lined savanna at the edge of a temporary pool at the edge of a village (176 m elev.) near Vereda La Poyata, township of Mani, department Casanare, Colombia (72.149114°E, 4.44453°N; Bogotá WGS 84). The male *E. ovalis* had a firm grasp around the armpits of the *L. fuscus* (axillary amplexus). The frogs were observed at close range for a period of ca. 10 min. during which time there was no movement. Although the pair was briefly manipulated, they remained in amplexus as they were photographed (Fig. 1). One possible explanation for this amplexus, may be due to the confusion of chemical signals as stated by Mollov et al. (2010, *op. cit.*). The timing of this observation coincided with the start of the breeding season of both species in the local area.



FIG. 1. Male *Elachistocleis ovalis* in amplexus with an adult *Leptodactylus fuscus* of undetermined sex.

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***LEPTODACTYLUS GRACILIS* (Dumeril's Striped Frog). ALBINO TADPOLE.** In recent years the number of reports on albinism in anurans has notably increased. However, the observation of this anomaly in nature remains a rare event (Toledo et al. 2011. Herpetol. Notes 4:145–146). In Uruguay, there is only one report of albinism in amphibians, that being in the larvae of *Melanophryniscus montevidensis* (Maneyro and Achaval 2004. Herpetol. Rev. 35:261).

Although there is a report of albinism in Leptodactylidae (Rodriguez and De Oliveira Filho 2004. Herpetol. Rev. 35:373), this is the first report of an albino *Leptodactylus gracilis* tadpole. The specimen was found on 24 April 2012 in the "Barra de Laguna de Rocha," Rocha county, Uruguay (34.667027°S, 54.233694°W) in a temporary pond (0.60 m max depth, ca. 300 m^2). This geographical region belongs to a Protected Area (Paisaje Protegido Laguna de Rocha). The albino tadpole was caught at 2110 h together with 20 *Odontophrynus* sp. larvae. Air temperature was 14.0°C, water temperature 14.2°C, and pH 6.58. The habitat surrounding the water body was mainly composed of grasses and *Eryngium pandanifolium*. When collected the tadpole was at Gosner stage 40 (Fig. 1a) (Gosner 1960. Herpetologica 16:183–190). The specimen was maintained in captivity for two weeks, although it died as a juvenile after completing metamorphosis (Fig. 1b). The individual was accessioned into the Vertebrate Collection of the Faculty of Sciences (ZVCB 22737).

The rarity of albino specimens may be due to the low frequency of occurrence, low breeding success, or differential mortality (Childs 1953. Evolution 7:228–233). This mortality could be due to increased predation because of the ease of detection in nature (Childs 1953, *op. cit.*), or some intrinsic physiological factors (Toledo et al. 2011, *op. cit.*). To obtain more information about the mortality of albino individuals more records and experimental work is necessary.

Our fieldwork was partially supported by the Agencia Nacional de Investigación e Inovación (Proyecto ANII FCE 2009-1-2514).

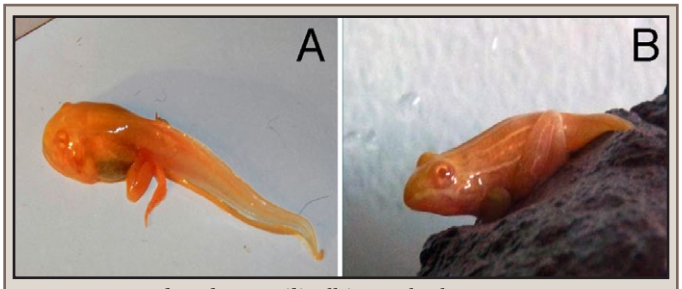


FIG. 1. A) *Leptodactylus gracilis* albino tadpole (Gosner stage 40); B) same specimen as a transformed froglet.

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***LEPTODACTYLUS MELANONOTUS* (Sabinal Frog). ENDOPARASITISM.** *Leptodactylus melanonotus* is a small frog ranging from northwestern Mexico to Central America and Ecuador, in arid and wet mountain woodlands. The species is nocturnal, semiaquatic, insectivorous, oviparous, and can persist in anthropogenic disrupted areas; it is indeed an indicator of impacted areas (Ramírez-Bautista and García 2002. *In* Noguera et al. [eds.], Historia Natural de Chamela, pp. 251–264. Universidad Nacional Autónoma de México). *Leptodactylus melanonotus* is listed in the category of Least Concern with populations considered "stable" (Solís et al. 2010. *In* IUCN Red List of Threatened Species. Ver. 2012.1, <www.iucnredlist.org>. Accessed 28 June 2012).

During recent work on the metazoan parasites of *L. melanonotus* in the Chamela-Cuixmala Biosphere Reserve in Jalisco, west-central Mexico, 20 specimens were examined. One frog (prevalence 5%) from Chamela Creek (19.52738°N, 105.06994°W) was parasitized with 10 chiggers *Hannemania hylae* (Leeuwenhoekiidae). Chiggers were found on the ventral skin, into the subdermal layer of trunk and hind legs (thighs) of the host. The term "chiggers" refers to larvae of parasitic mites of the families Trombiculidae and Leeuwenhoekiidae, associated with vertebrates. Chiggers in the genus *Hannemania* are subdermal parasites restricted to amphibians. Voucher specimens are housed at the Colección Nacional de Ácaros, Universidad Nacional Autónoma de México, Instituto de Biología, México, D.F., with accession numbers CNAC007098–007102.

This is the first record of *H. hylae* on *L. melanonotus*. *Hannemania hylae* ranges from the southwestern USA to Argentina, and was previously reported parasitizing *Hyla arenicolor*, *Pseudacris cadaverina,* and *Eleutherodactylus guttilatus* from several localities in the USA (Jung et al. 2001. Herpetol. Rev. 32:33–34; Loomis and Welbourn 1969. Bull. So. California Acad. Sci. 68:160–168). The species has been reported from *P. cadaverina*, *Lithobates berlandieri, Eleutherodactylus* sp., *E. longipes*, *Lithobates* sp., *Scaphiopus couchii*, and *Incilius mazatlanensis* in Mexico (Espino del Castillo et al. 2011. Int. J. Acarol. 37:427–440; Goldberg et al. 2002. Herpetol. Rev. 33:301–302; Hoffmann 1969. Rev. Latinoam. Microbiol. Parasitol. 11:209–216; Hoffmann and López-Campos 2000. Biodiversidad de los Ácaros en México. CONABIO, UNAM, México 230 pp.; Loomis and Welbourn 1969, *op. cit.*), and is also known to infest *Hypsiboas curupi* from Argentina (Alzuet and Mauri 1985 [1987]. Rev. Soc. Entomol. Argentina 44:111–116).

Frogs were collected under permit FAUT-0250 issued to Gerardo Suzán and will be deposited at Colección Herpetológica, Estación de Biología Chamela.

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***OSTEOPILUS SEPTENTRIONALIS* (Cuban Treefrog). PREDATION.** The introduced Cuban Treefrog occurs throughout most of peninsula Florida and has established populations as far north as Nassau Co. at the Florida-Georgia state line (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final report, Florida Fish and Wildl. Cons. Comm., Tallahassee. 524 pp.). Known predators of this frog in North America include several species of snakes and birds, as well as conspecifics (Meshaka 2001. The Cuban Treefrog in Florida, Univ. Press of Florida, Gainesville. 191 pp.). No invertebrate predators have been reported. On 25 September 2010, we observed predation of a young adult *O. septentrionalis* by a giant water bug, *Lethocerus americanus* (Belostomatidae), at the edge of a small, vegetated pond on the Santa Fe College campus, Gainesville, Alachua Co., Florida (29.704167°N, 82.44333°W; WGS 84). The bug held the frog with its right front leg inserted into the frog's left axilla and the left front leg placed around the front of its snout (Fig. 1). Its beak was inserted behind the left eye. The frog was dead by the time it was observed. Giant water bugs in the genus *Lethocerus* are well-known predators of adult and larval anurans (Graham et al. 2011. Herpetol. Rev. 42:84; Hinshaw and Sullivan 1990. J. Herpetol. 24:196–197; Toledo 2005. Herpetol. Rev. 36:395–400). This bug obviously found the frog palatable because it was not deterred by the sticky and noxious skin secretions that cause nasal irritation in humans (Meshaka 2001, *op. cit.*; JCM, pers. obs.). This is the first report of giant water bug predation on adults of the introduced Cuban Treefrog.

Matt Kail aided in the field observation.



PHOTO BY MATT KAIL

FIG. 1. Giant water bug (*Lethocerus americanus*) predation on *Osteopilus septentrionalis*.

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***PELTOPHRYNE LEMUR* (Puerto Rican Crested Toad). REFUGIA and DEFENSIVE BEHAVIOR.** Very few natural history observations have been documented for *Peltophryne lemur* due to its rarity and semi-fossorial nature. *Peltophryne lemur* habitat in Puerto Rico is comprised primarily of arid to semi-arid areas containing an abundance of Karst limestone and well-drained soils at low elevations (< 200 m above sea level) (Lee 1992. USDI Fish Wildl. Serv., Caribbean Field Office, Boquerón, Puerto Rico). However, the species is also known to inhabit river beds, grassy fields, and moist forests (Garcia-Diaz 1967. Stahlia [10]:1–6; Moreno 1985. Unpubl. report, Puerto Rican Dept. Natural Resources, San Juan). Outside of breeding events, *P. lemur* has been observed on, under, or in holes and crevices within limestone rock, where it appears to seek protection from predators and refuge from the heat (Schmidt 1928. New York Acad. Sci.



FIG. 1. Newly metamorphosed *Peltophryne lemur* scale steep limestone in search of holes and crevices for shelter.



FIG. 2. Male *Peltophryne lemur* utilizing an abandoned bird nest in vertical dirt bank.



FIG. 3. An empty tarantula burrow under a mango tree serves as refuge for a male *Peltophryne lemur*.

[10]:1–160; Johnson 1999. Endangered Spec. Bull. 24[3]:8–9; Matos-Torres 2006. M.S. Thesis. Univ. Puerto Rico, Mayagüez; pers. obs.). When disturbed, this toad often remains still and relies on cryptic camouflage to avoid detection (Schmidt 1928, *op. cit.*; pers. obs.). It is typical for biologists monitoring *P. lemur* to find them in limestone rock crevices, yet little has been documented regarding specific use of these microhabitats. During a radio telemetry study in the Guánica State Forest in 1990, it was noted that toads used rock holes and crevasses for refuge during the day and would climb vertical rock faces to reach shelter in the limestone at least 45 cm above the ground (Lentini 2002. PRCT SSP Husbandry Manual. Toronto Zoo). Also in Guánica, a habitat characterization study concluded that 53% of observed toads utilized rocky areas with cacti (limestone scrub) the majority of the time compared to other habitat types (scrubland, semi-evergreen forest, and evergreen forest). It was surmised during this study that the use of limestone areas linked to subterranean water and cave systems is an important adaptive factor for this species since the toads have been previously found in underground caves (Matos-Torres 2006, *op. cit.*).

Herein we document additional refugia sites, verify the suspected used of the head for defense (Rivero et al. 1980. Carib. J. Sci. 15:33–40), and relay further behavioral observations of *P. lemur* in Puerto Rico. On 2 Nov 2005, we observed newly metamorphosed toads at 0928 h climbing steep limestone rock 1.2 m above ground in search of refugia holes in Guánica (Fig. 1). At 2130 h on 12 May 2010 at a reintroduction site near Arecibo, we found a male *P. lemur* protruding out of a hole on a steep vertical dirt bank ca. 2.13 m above the ground (Fig. 2). The hole was most likely excavated and abandoned by a *Todus mexicanus,* an endemic species of bird that utilizes hillsides in the area to create nesting sites. At 2102 h on 16 May 2012, an adult male toad was observed in a presumed tarantula (*Cyrtopholis portoricae*) burrow (Fig. 3) in a mango plantation near Punta Ventana. Also in Ventana, near an ephemeral pond, between 1845 h and 2030 h on 16 June 2012, 16 juvenile and adult toads (4.0–6.9 cm SVL) were found in limestone holes and crevices. During this event, two juvenile toads were sitting 4.0 cm apart within a single horizontal crack measuring 3 cm tall x 15 cm wide x 7 cm deep. The entrances of the other holes utilized by toads ranged from 1.5 to 4.5 cm wide and 2.0 to 4.5 cm tall. All of the toads inside of the holes were sitting with their heads facing outward from the side of large boulders. Depths of the holes from the rock surface to the head of each toad varied from 3.5 to 9.0 cm. Upon our approach, toads pulled backward, deeper into their holes, and tucked their lower jaw to the chest so that the bony top of the head formed a shield blocking the rest of the body. Several toads were also observed pulling their closed eyes deep into their sockets for additional protection. The vertical distance from the holes to the ground at Ventana ranged from 30.48 cm to 1.52 m. We have also observed individual crested toads utilizing the same holes as permanent refuge. On 13 June 2012 during the evening, two adult males were found in separate holes on the same vertical dirt bank as previously reported in May 2010. Passive Integrated

Transponder (PIT) tags were inserted into the toads, which were found in their respective holes five days later at 1220 h. Later that day at 2120 h, the toads were found foraging just outside of their holes under the cover of darkness. The hole openings were 2.5 cm wide × 2.0 cm tall and 3.4 cm wide × 3.0 cm tall and were 1.82 m and 1.52 m above the ground, respectively.

These observations were made while conducting research with permission of the USFWS, PRDNER, and private landowners. We thank them for their continued support.

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***PHYLLOMEDUSA CAMBA*. DEFENSIVE BEHAVIOR.** *Phyllomedusa camba* is a species in the *P. tarsius* group distributed in Bolivia, Peru, and Brazil in the states of Amazonas, Acre, Mato Grosso, and Rondonia (Frost 2011. Amph. Species of the World; Rodrigues et al. 2011. Checklist [2]:397–399). On 03 November 2011, we observed the defensive behavior of an adult male *P. camba* at the Terra Indígena do Zoró, Mato Grosso, Brazil (10.31780°S, 60.51561°W, SAD69; elev. 179 m). When disturbed, the individual began secreating a milky venom from the doral glands (Fig. 1A), raised the body (Fig. 1B), and began making lateral movements as if to attack the intruder (Fig. 1C).

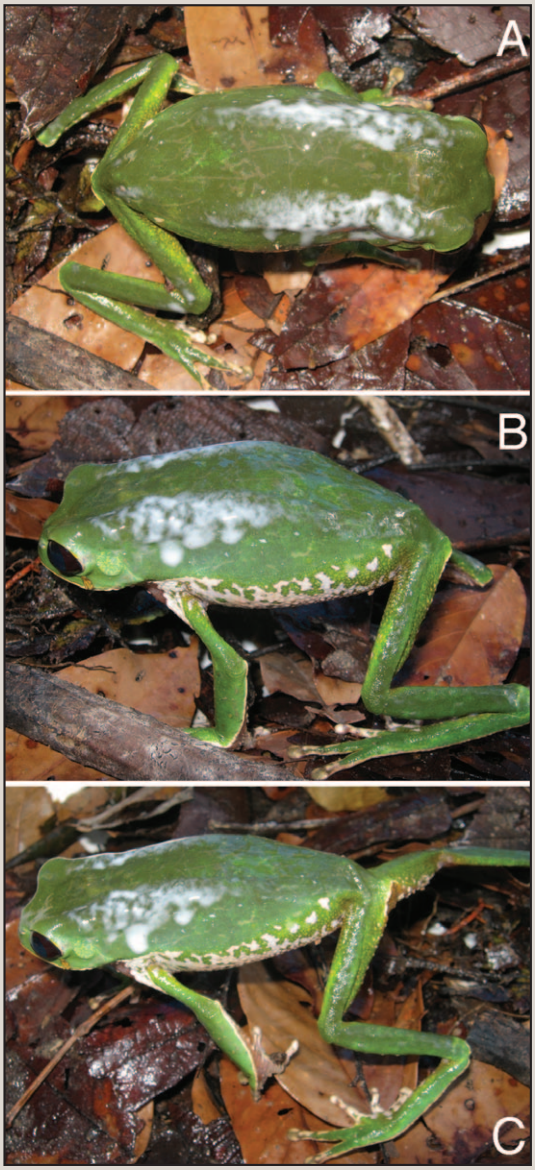


FIG. 1. *Phyllomedusa camba* from Terra Indígena do Zoró, Mato Grosso, Brazil showing defensive behavior. A) Secreting milky toxins from the dorsal glands; B) raising the body; C) defensive movements towards the attacker.

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***RANA DRAYTONII* (California Red-legged Frog). CANNIBALISM.** *Rana draytonii* has been the subject of numerous research reports and notes documenting predation. Specifically, several predators have been reported for *R. draytonii*, including Great Blue Heron (*Ardea herodias*) (Fellers and Wood 2004. Herpetol. Rev 35:163), Loggerhead Shrike (*Lanius ludovicianus*) (Alvarez 2005. Ecol. Restor. 23:66–67), American Bullfrog (*Liothobates catesbeianus*) (Jennings and Cook 2001. Herpetol. Rev. 33:182–183), and several others (US Fish and Wildlife Service 2002. Recovery Plan for the California red-legged frog [*Rana aurora draytonii*]. Portland, Oregon). Herein I report on mortality from the cannibalistic behavior of two life stages of this federally threatened species.

While monitoring a stock pond in eastern Contra Costa Co., California, USA (37.81708°N, 121.78768°W; elev. 601 m), I observed a larval *R. draytonii* appearing to feed on an object floating at the surface. Larvae of *R. draytonii* are typically observed feeding within vegetation, likely filter-feeding on algae, protozoans, and phytoplankton from the surfaces and substrate within the pond (Stebbins and Cohen 1995. A Natural History of Amphibians. Princeton Univ. Press, Princeton, New Jersey. 316 pp.). In this instance, upon close inspection with binoculars, I was able to determine that the larva engaged in feeding was *R. draytonii* and that the object on which it fed was a second *R. draytonii* larva. It appeared that the larva being consumed was still alive, although it moved very little. I observed that the predating larva appeared to feed by scraping the surface of its *R. draytonii* prey. This behavior continued for 12 minutes during my observations.

During the same day, and at the same site, I observed approximately 245 post-metamorphic *R. draytonii*. While conducting individual counts I noted two distinct size cohorts. This is a typical observation at stock ponds in this general area, and likely reflects the metamorphosis of current-year larvae and larger *R. draytonii* metamorphosing after overwintering as larvae (Fellers et al. 2001. Herpetol. Rev. 32:156–157). On 26 occasions I observed the larger-size cohort (approx. 50.8 mm), attempting to feed upon the smaller size cohort (approx. 25.4 mm) (Fig. 2). Feeding attempts typically started with the larger animal orienting toward the smaller. The larger frog remained motionless until the small frog moved, at which time the larger frog leapt directly at and onto the smaller with mouth agape. In 25 of the 26 observations of this activity, the smaller frog escaped. On one attempt, the larger frog was able to grasp and ultimately consume the smaller.

These observations suggest that *R. draytonii* of two life stages number among the seasonally abundant resources utilized by



FIG. 1. A larval *Rana draytonii* cannibalizing a conspecific at the surface of a stock pond.



FIG. 2. Two size cohorts (frog on right is approx. 25 mm; frog on left is approx. 50 mm) of *Rana draytonii*, with the larger cannibalizing the smaller shortly after the photo was taken.

both pre- and post-metamorphic *R. draytonii* and are taken by cannibalistic feeding. This cannibalism likely is opportunistic and provides a seasonally abundant source of protein for larvae and post-metamorphic frogs.

These observations contribute to the greater understanding of the natural history and population dynamics within occupied breeding habitat for *R. draytonii*. Cannibalism witnessed in this species is likely common among many anurans, but may confound attempts to increase populations of this rare species.

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***RANA DRAYTONII* (California Red-legged Frog). ASSOCIATION WITH BEAVER.** A number of new observations are being reported on microhabitat use by California Red-legged Frogs. Among these, Cook (1997. MS thesis, Sonoma State Univ., Rohnert Park, California. 23 pp.) reported on the use of microhabitat in a freshwater marsh by this species; Alvarez (2004. Herpetol. Rev. 35:85–86) documented the use of desiccation cracks in the bottoms of dry ponds by *R. draytonii* seeking shelter from extreme climatic conditions, and Alvarez et al. (*in press*. Amphibian Conservation and Biology) detailed the microhabitat use by ovipositing *R. draytonii* at several aquatic breeding habitats. Nonetheless, many natural history details related to this species remain unknown or unreported, and land managers continue to use scant information to make management decisions in habitat occupied by *R. draytonii*. This potentially creates conditions under which this federally listed species may be harmed or killed during land management activities. Here we report the use of dams and burrows (bank-lodges) constructed by beaver (*Castor canadensis*) as refugia for the *R. draytonii*.

In Spring 2000, it was discovered that beaver naturally colonized the upper portion of Kellogg Creek, downstream from Los Vaqueros Reservoir in Contra Costa Co., California, USA. This colonization was considered potentially damaging to mitigation developed for the construction of the reservoir, and catalyzed the design and implementation of a program to indirectly control the beavers through the removal of at least 24 beaver dams.

Two monitoring biologists were posted on-site during each dam removal to document any "take" of *R. draytonii*. Dams were removed with the aid of a backhoe equipped with a thumb. Twigs, branches, logs, and mud were grasped and pulled from the creek bed, and material was placed on the upper bank. Biologists maintained positions downstream of the dam and collected *R. draytonii* that were in harm's way from debris or inundation (Fig. 1). Collected frogs were released unharmed within the creek channel after each dam was removed.

During removal of the 24 beaver dams, 60 adult and subadult *R. draytonii* were collected and subsequently returned to the creek. Four *R. draytonii* larvae were also detected when a large portion of one beaver dam was removed and stranded the tadpoles in the previously inundated areas.

Over subsequent months, post-removal surveys were conducted along Kellogg Creek at various times to determine if beavers had restored their dams and if *R. draytonii* and other species were present. On one occasion, *R. draytonii* were observed utilizing a previously inundated burrow of a bank-lodge dug into the bank of Kellogg Creek. This burrow afforded refuge not only to the beavers and the *R. draytonii*, but also to Western Pond Tturtles (*Actinemys marmorata*), as observed during previous management actions (Alvarez 2006. Herpetol. Rev. 37:339).

It is clear that the infrastructure—both dams and burrows associated with bank-lodges—resulting from beaver activity provides refuge microhabitat for *R. draytonii*. Beaver-dammed water bodies also provide breeding habitat for *R. draytonii* adults and rearing habitat for tadpoles. These sites should be treated as critical to the survival of local populations of this species;



FIG. 1. Two adult *Rana draytonii* well-hidden within a beaver dam that was being removed along Kellogg Creek, Contra Costa Co., California.

removal of beavers or their dams within the range of *R. draytonii*, although potentially beneficial under certain circumstances, is likely to temporarily or permanently affect habitat suitability for this federally threatened species. Such removals should be avoided to the greatest extent possible.

Considering that beavers are native to the Central Valley of California and some streamcourses in surrounding foothills (Grinnell et al. 1937. Fur-bearing Mammals of California: Their Natural History, Systematics, and Relations to Man. Univ. of California Press, Berkeley. 777 pp.), beavers and *R. draytonii* likely co-evolved over much of the range of both species. Careful consideration should be made before controlling beavers within the range of this rare anuran species.

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***RANA LUTEIVENTRIS* (Columbia Spotted Frog). MAXIMUM SIZE.** Similar to other species in the *Rana boylii* group (Hillis and Wilcox 2005. Mol. Phylogenet. Evol. 34:299–314), *Rana luteiventris* is size-dimorphic in favor of females (Davis and Verrell 2005. Can. J. Zool. 83:702–711; Reaser 2000. Can. J. Zool. 1158–1167; Turner 1960. Ecol. Monogr. 30:251–278), so females reach the body-size maximum. Bull (2005. Ecology of the Columbia Spotted Frog in Northeastern Oregon. USDA, Forest Service, PNW-GTR-640. 45 pp.) reported the maximum body size for *R. luteiventris*, a 100 mm SVL female. Here, we augment that maximum.

While examining western North American ranid frogs for misidentifications at the Charles R. Conner Museum (CRCM), Washington State University (WSU), Pullman, Washington, we noted an unusually large female *R. luteiventris* (CRCM 42-34; Fig. 1). Conveniently preserved flat, this female measured 127 mm SVL. The specimen's tags and the CRCM catalog give the collection locality as simply Pullman, Whitman County, Washington (~46°73'N, 117°17'W, WGS 84; elev. ~750 m). However, the catalog also reveals that Roy D. Shenefelt, curator of the entomology collection at WSU (then Washington State College) around that time, collected this animal on 26 March 1942. No further details are available for this specimen, but the catalog provides locality modifiers for the two other vertebrates collected by Shenefelt, so the Pullman locality likely means Pullman proper rather than somewhere in the vicinity.



FIG. 1. Large female *Rana luteiventris* (CRCM 42-34) collected at Pullman, Washington, USA on 26 March 1942.

Three aspects of this observation merit comment. Recent phylogenetic work on *R. luteiventris* has revealed deep genetic subdivisions that may warrant taxonomic recognition (Funk et al. 2008. Mol. Phylogenet. Evol. 49:198–210). Based on locality, our large *R. luteiventris* falls within the area of what Funk et al. (2008, *op. cit.*) label as the Northern clade, which extends from southeastern Oregon to the Yukon Territory, Canada. Maximum sizes reported for *R. luteiventris* attributable to the remaining two clades of Funk et al. (2008, *op. cit.*) differ substantially (79 mm SVL for the Utah clade: Morris and Tanner 1969. Great Basin Nat. 29:45–81; and 90 mm SVL for the Great Basin clade: Reaser 2000, *op. cit.*), but whether variation among clades reflects any phylogenetic signal is unclear. Second, among native ranid frogs in western North America, the size of this female is exceeded only by *R. draytonii*, for which the maximum is 138 mm SVL (Hayes and Miyamoto 1984. Copeia 1984:1018–1022). Lastly, given that shrinkage is a typical artifact of long-term preservation (Deichmann et al. 2009. Phyllomedusa 8:51–58), our measurement of this 70-year-old specimen likely underestimates its size in life.

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***RANA SYLVATICA* (Wood Frog). LEUCISM.** On 2 June 2012 a single leucistic *Rana sylvatica* was captured by Campbell Schneider in a pond in Vanderhoof, British Columbia, Canada (54.026022°N, 124.049758°W). Luce and Moriarty (1999. Herpetol. Rev. 30:94)



FIG. 1. Leucistic *Rana sylvatica*, British Columbia, Canada.

reported the first record of an albino, however, to the best of our knowledge this is the first record of leucism reported for this species. The leucistic individual was transported to the University of Northern British Columbia for photographs and measurement (2.8 mm SVL, 1.55 g). After analysis, the frog was returned to its pond of origin. The specimen was ivory yellow to orange and pinkish on the limbs, but the eyes retained their color and some dark flecks could be seen on the face (Fig. 1). Pigmentation present in the eyes is a key diagnostic that distinguishes leucism from albinism. However, the frog's viscera were also darkly pigmented and could be seen through the dermis.

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RHACOPHORUS FEAE **(Thao Whipping Frog). HABITAT.** *Rhacophorus feae* is a poorly known, large-bodied rhacophorid from Asia. During amphibian and reptile surveys at high-elevations in Pu Hoat Proposed Nature Reserve, Que Phong District, Nghe An Province, Vietnam (19.66°N, 104.79°E, ca. 1300 m elev.), we uncovered an adult female *R. feae* in a terrestrial shelter site. The individual was discovered at 1550 h on 14 April 2011 while surveyors were raking leaf litter 15 m from a pond, and was covered by a 3-cm-thick layer of litter. The temperature and relative humidity at the time were 18.6°C and 100%, respectively. When uncovered, the frog displayed the defense posture previously documented for the species (Le and Rowley 2010. Herpetol. Rev. 41:342). Our discovery of *R. feae* in a terrestrial shelter site was unexpected for a tree frog that was thought to be arboreal. However, terrestrial retreat sites have been recorded previously in *Rhacophorus* (for the more terrestrial species *R. schlegelii*; Ihara 1999. Japan. J. Herpetol. 18:39–44) and in arboreal treefrogs in the family Hylidae (Rowley and Alford 2007. Dis. Aquat. Org. 77:1–9).



FIG. 1. *Rhacophorus feae* uncovered in diurnal shelter site under leaf litter, Nghe An Province, Vietnam.

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RHACOPHORUS VIRIDIS VIRIDIS **(Okinawa Green Tree Frog). PREDATION.** Anuran amphibians are vulnerable to various predators at all stages of their life history (Wells 2007. The Ecology and Behavior of Amphibians. Univ. Chicago Press, Chicago, Illinois. 1148 pp.). Spiders seem to be the most important invertebrate predators of anurans (Toledo 2005. Herpetol. Rev. 36:395–400), although few reports have been published on Asian species (Hamidy et al. Herpetol. Rev. 41:66–67; Riehl et al. 2008. Herpetol. Rev. 39:77–78).

Rhacophorus v. viridis is a common species distributed in the Okinawa Islands, Ryukyu Archipelago, occurring in forests from lowlands to montane regions. On 9 May 2011 at 1955 h, I detected the spider *Heteropoda* cf. *simplex* (Sparassidae) grasping the abdominal region of a recently metamorphosed *R. v. viridis* at a garden pond of Nakagami-gun, Okinawa Prefecture, Japan (Fig. 1). The air temperature was 25.2°C and relative humidity was 88%. The spider with its prey was first found on the underside of an *Asplenium setoi* leaf, located ca. 1.5 m above water surface and 18 cm above the ground. The frog was immobile, probably due to paralysis caused by the spider venom. Unfortunately, the spider was disturbed by photography and escaped into vegetation.

Metamorphosing *R. v. viridis* descend to the terrestrial habitat with an unabsorbed long tail. When darkness approaches, metamorphosing frogs move away from the pond to climb surrounding vegetation. Mean snout–vent length of newly metamorphosed *R. v. viridis* is 20.6 ± 0.86 mm SD (range 18.0–22.5 mm, N = 74). It takes about two days to absorb the tail. As the prey frog in this case had a relatively long tail, it was likely captured by the spider shortly after leaving the water. The spider (cephalothorax + abdomen) was estimated at ca. 2 cm in length.



FIG. 1. The spider *Heteropoda* cf. *simplex* grasping a metamorphosed *Rhacophorus v. viridis*.

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RHAEBO HAEMATITICUS **(Litter Toad) and** ***CRAUGASTOR FITZINGERI*** **(Fitzinger's Rain Frog). REPRODUCTIVE BEHAVIOR.** *Rhaebo haematiticus* and *Craugastor fitzingeri* are common tropical leaf litter frogs that can be found sympatrically from Honduras to Colombia in lowland and premontane wet and moist forests. *Rhaebo haematiticus* is a moderate-sized toad (males 42–62 mm SVL, females 50–80 mm) that reproduces



FIG. 1. Male *Craugastor fitzingeri*, a terrestrial breeder, in amplexus with female *Rhaebo haematiticus*, an aquatic breeder, in the leaf litter at La Selva Biological Station, Costa Rica.

by depositing strings of eggs in rocky pools along streams. *Craugastor fitzingeri* is also moderately sized but is generally smaller (males 24–35 mm SVL, females to 52 mm) and likely reproduces by depositing terrestrial, direct-developing eggs (Guyer and Donnelly 2004. Amphibians and Reptiles of La Selva, Costa Rica and the Caribbean Slope: A Comprehensive Guide. Univ. California Press, Berkeley).

Interspecific amplexus has been reported numerous times for anurans, both among closely related species that in some cases can create hybrid offspring (Lamb et al. 1990. J. Evol. Biol. 3:295–309; Christman et al. 2000. Herpetol. Rev. 31:99–100; Lind et al. 2003. Herpetol. Rev. 34:234–235; Ritchie et al. 2008. Herpetol. Rev. 39:80; Turner 2012. Herpetol. Rev. 43:123) and among more distantly related and dissimilar species (Grogan and Grogan 2011. Herpetol. Rev. 42:89–90; Manzano and Corzas 2011. Herpetol. Rev. 42:84; Streicher et al. 2010. Herpetol. Rev 41:208). Misdirected amplexus has also been reported with inanimate objects (Streicher 2008. Herpetol. Rev. 39:75). Instances of breeding interference due to interspecific amplexus may negatively affect species demographics of sympatric species (Pearl et al. 2005. Am. Midl. Nat. 154:126–134). Here, we report amplexus between two individuals of markedly different sizes from unrelated taxa with different reproductive modes.

At 1442 h on 22 Aug 2012, a male *C. fitzingeri* was observed in amplexus with a large female *R. haematiticus* in the Arboretum at the La Selva Biological Station in Sarapiquí, Costa Rica (10.430055°N, 84.011102°W). They were sighted when the observers were 50 cm in approach distance from the pair, and the female *R. haematiticus* jumped. Jumping did not appear to interfere with amplexus. The frogs maintained their position until at least 1510 h when the observers returned to take more photos. The frogs were found in an area that is maintained with regular mowing, under the shade and leaf litter of mature *Casearia corymbosa* and *Hieronyma alchorneoides* trees.

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***RHINELLA MARINA* (Cane Toad). DIET.** The diet of *Rhinella marina* has been reported by several authors (Zug and Zug 1979. Smithson. Contrib. Zool. 284; Murray and Lampo 1996. J. Herpetol. 30[1]:73–76). Its diet is mostly composed of insects and



FIG. 1. *Rhinella marina* preying on a juvenile Southwestern Cat-eyed Snake (*Leptodeira maculata*), at Playa Linda Ixtapa–Zihuatanejo, Guerrero, Mexico.

different species of invertebrates. There are also reports on the predation of *R. marina* on several species of vertebrates (Lever 2001. The Cane Toad. Westbury, Otley; Beckmann and Pizzato 2011. Herpetol. Rev. 42[4]:592). Snakes (*Typhlops*) have been reported as food in a study of its natural distribution in the Philippine Islands (Rabor 1952. Copeia 1952:281–282).

On 10 April 2011 on the Pacific Coast in Playa Linda Ixtapa–Zihuatanejo (17.681986°N, 101.644333°W), Guerrero, Mexico, we found a *R. marina* preying on the semiaquatic colubrid snake, *Leptodeira maculata*. Both animals were observed at 2130 h in a tropical deciduous forest, at about sea level. The toad and snake were photographed and left without disturbance. This is the first report of predation on a snake by *R. marina* in its natural distribution.

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***RHINELLA SCHNEIDERI* (Cururu Toad). PREDATION.** Anurans are often a food source of passerines and other bird species in neotropical forests (Poulin et al. 2001. J. Trop. Ecol. 17:21–40). Some species of birds are dietary generalists and opportunistically prey on anurans (Toledo et al. 2007. J. Zool. 271:170–177).

Rhinella schneideri is a large toad included in the *Rhinella marina* group (Pramuk et al. 2007. Global Ecol. Biogeogr. 16:1–12), and is widely distributed in South America (Pramuk 2006. Zool. J. Linn. Soc. 146:407–452). This species is commonly found in open, urban areas and has a wide distribution in South America, from the Atlantic coast (Ceará to Rio Grande do Sul, Brazil), eastern Amazon in Paraguay, Bolivia, Argentina, and Uruguay (Frost 2011. Amphibian Species of the World: an Online Reference. Ver. 5.5. http://research.amnh.org/vz/herpetology/amphibia/; American Museum of Natural History, New York), occurring also in Brazilian savannah (Colli et al. 2002. *In* Oliveira and Marquis [eds.], The Cerrados of Brazil: Ecology and Natural History of a Neotropical Savanna, pp. 223–241. Columbia Univ. Press, New York).

The Guira Cuckoo, *Guira guira*, is a species of the subfamily Crotophaginae and is widely distributed through South America

(Sick 1997. Ornitologia Brasileira. Editora Nova Fronteira, Rio de Janeiro. 912 pp.). This species is common in areas affected by human activities, including deforested areas, urban areas, and crop fields (Mesquita 2009. Ararajuba 17:84–85). Here we report the attempted predation of a juvenile *R. schneideri* by the Guira Cuckoo.

On 7 Jan 2012 around 0915 h, in a semi-deciduous forest fragment near a swampy area in the Baguaçú Ecological Park (21.22000°S, 50.42833°W; 353 m elev.), in an urban area of Araçatuba, state of São Paulo, Brazil, we heard the vocalization of a group of Guira Cuckoos on the aquatic macrophyte, *Pistia stratiotes*, in a swampy area. After a few minutes, the birds were photographed during flight, with one of the individuals holding a juvenile *R. schneideri*. The bird grasped the toad by its hind leg, thereby avoiding the parotoid macroglands (Fig. 1). The *R. schneideri* was identified by the presence of the parotoid macroglands from digital photographs taken with a Canon EOS 7D with a Canon 100–400 mm f/4.5-5.6L lens.

Species of the genus *Rhinella* produce toxic secretions from the skin and parotoid macroglands, protecting them from predators (Cardoso and Sazima 1977. Cienc. Cult. 29:1130–1132). However, our observations do not allow us to say if the poison is effective against the Guira Cuckoo.

Our record suggests that anurans that produce toxic secretions for defense are subject to opportunistic predation by generalist species of birds such as the Guira Cuckoo. Predation of other anurans by the Guira Cuckoo is rare and limited to few reports: *Physalaemus* cf. *fuscomaculatus* (Kokubum and Zacca 2003. Herpetol. Rev. 34:232–233), *Leptodactylus ocellatus* (Repenning et al. 2009. Zoologia 26:443–453), *Rhinella granulosa* (Mesquita 2009, *op. cit.*), *Rhinella* cf. *henselli* (Gomes 2009. Atual. Ornitol. 151:8–9), and *Pseudis platensis* (Landgref-Filho et al. 2011. Herpetol. Rev. 42[1]:90). We believe that our record probably represents an attempted predation, rather than predation *per se*, because the toad was alive when observed.

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FIG. 1. An adult Guira Cuckoo, *Guira guira*, holding a *Rhinella schneideri* by its hind leg during flight in a swampy area at the Parque Ecológico do Baguaçú, Araçatuba municipality, state of São Paulo, Brazil.

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***SCAPHIOPUS HURTERII* (Hurter's Spadefoot). LEUCISM.** Leucism (or partial albinism) is a condition in which an animal lacks most or all of the melanin in its skin but retains most of the pigment in its eyes (in true albinism the eye pigment is lacking as well; Warham 2005. Elsevier's Dictionary of Herpetological and Related Terminology. Bournemouth, England. 227 pp.). Both leucism and albinism have been reported in a number of anurans including the American Bullfrog (*Lithobates catesbeianus*; Mitchell and McGranaghan 2005. Banisteria 25:51), Foothill Yellow-legged Frog (*Rana boylii*; Norman and Moller 2002. Bull. Chicago Herpetol. Soc. 37:2–3), and Burrowing Toad (*Rhinella fernandezae*; Lopez and Ghirardi 2011. Belg. J. Zool. 141:59–61). In this note, we report the first documented occurrence of leucism in *Scaphiopus hurterii*.

On 5 May 2012 at Boehler Seeps and Sandhills Preserve, located in Atoka Co., Oklahoma, USA (34.17091°N, 95.88964°W) we encountered a recently metamorphosed (SVL 16 mm), leucistic *S. hurterii*. Its skin was a light pink color except for its dermal tubercles, which were red with a black spot in the middle (Fig. 1). Its eyes were largely black, but they retained some of their normal gold coloration. The eyes appeared blue when viewed through the skin. Its ventral surface was transparent, and internal organs could be seen through the skin.

During the summer of 2012, 433 recently metamorphosed *S. hurterii* were captured in traps, and many others were randomly encountered, but this was the only one that was leucistic. Both leucism and albinism have been reported in tadpoles of the Eastern Spadefoot (*S. holbrookii*), but to our knowledge this is the first report of leucism in *S. hurterii* (Feinberg and Hoffmann 2004. Herptol. Rev. 35:377; Johnston and Johnston 2006. Herptol. Rev. 37:211–212).



FIG. 1. Leucistic *Scaphiopus hurterii* alongside a normally pigmented conspecific.

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ZACHAENUS CARVALHOI **(Carvalho's Bug-eyed Frog). REPRODUCTION.** *Zachaenus carvalhoi* is a little-known species that occurs in the leaf litter of the Atlantic Rainforest in few localities of southeastern Brazil (Sales and Maciel 2010. Check List 6:458–459). *Zachaenus carvalhoi* and *Z. parvulus* are the only members of the genus. *Zachaenus carvalhoi* is categorized as Data Deficient in the IUCN Redlist, due to the lack of information on its occurrence and biology. On 18 Oct 2010, an adult female *Z. carvalhoi* (34.8 mm SVL) was captured in a pitfall trap inside a forested area in the Serra Brigadeiro State Park (20.7219°S, 42.4786°W, SAD 1969; 1380 m elev.), in the municipality of Araponga, Minas Gerais state, Brazil. The specimen was sacrificed using 5% xylocain cream, and preserved in 10% formalin. After dissection, 37 eggs were found; average egg diameter was 3.5 ± 0.16 mm (3.14–3.78 mm). The voucher was deposited in the herpetological collection of the Museu de Zoologia João Moojen, Universidade Federal de Viçosa, Minas Gerais, Brazil (MZUFV 10642).

Both body size (34.8 mm SVL) and clutch size (37 eggs) reported herein are greater than those for *Z. parvulus*, where the mean body size was 21.1 ± 5.7 mm (12.7–10.9; N = 29) and clutch size was 12.6 ± 2.6 eggs (10–16; N = 9) (Van Sluys et al. 2001. J. Herpetol. 35:322–325). However, the eggs size of *Z carvalhoi* (mean diameter 3.47 mm) is within the range (1.5–4.2 mm) reported for *Z. parvulus* (Van Sluys et al. 2001, *op. cit.*). There was no relationship between female body size (FBS) and number of eggs reported for *Z. parvulus*, although the authors suggested the small sample size influenced the analysis. Additional studies are necessary to clarify the relation between FBS and clutch size in *Z. carvalhoi*.

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TESTUDINES — TURTLES

CHELYDRA SERPENTINA **(Snapping Turtle). NEST INUNDATION.** As part of a study of Wood Turtle (*Glyptemys insculpta*) nesting ecology in Nova Scotia, Canada, nests were recorded and covered with predator exclusion screens. During this study a *Chelydra serpentina* was observed nesting in the area on 21 June 2008; although the nest was not covered, its location was noted. On 2 August 2008, heavy rains caused the water to rise in the river and flood the nest beach containing this *C. serpentina* nest as well as six Wood Turtle nests. The beach remained inundated for five days.

When the water receded one egg from each of three Wood Turtle nests was excavated, removed, and dissected; all three embryos were dead. Subsequently, all Wood Turtle eggs and the eggs from the known *C. serpentina* nest were excavated and removed for dissection. All 22 fertile Wood Turtle eggs contained dead embryos, ranging from 40–58 days of development. However, of the first three *C. serpentina* eggs dissected, two contained live embryos. The remaining 12 eggs were allowed to complete incubation. Eight eggs hatched following a total incubation time of 78–81 days. Of the remaining four eggs, three had no visible development and one contained a fully developed embryo that failed to emerge.

Of the eight *C. serpentina* hatchlings, three had some form of visible deformity. Two had a minor deformity in the form of a slightly crooked, or bent, tail. The third was more severe, with the tail curving 360 degrees, a misshapen carapace, and an apparent inability of the hatchling to open its mouth to feed. In comparison, of 38 *C. serpentina* hatchlings from two clutches that were not inundated, no deformities were observed.

As the excavated *C. serpentina* eggs were originally assumed to be dead, they were not handled gently and spent some time in a moving vehicle without appropriate substrate. Consequently, it is unknown if the deformities of these hatchlings resulted from egg handling or temperature extremes during early development, the inundation, or genetic anomalies.

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CHRYSEMYS PICTA **(Painted Turtle). SIAMESE TWINS.** At ca. 0900 h on 13 April 2002, while searching a residential area around a pond in Wayne Co., Indiana, USA (39.7975°N, 84.96388°W) for spring-emerging hatchling Painted Turtles, I noticed an open Painted Turtle nest cavity (not uncommon in April in this area). Upon closer inspection, it was clear that the cavity had been breached by emerging hatchlings, but that two hatchlings remained in the nest because they were not capable of crawling out. Although fully developed, of near equal size, and very active (Fig. 1), they had been unable to leave the nest cavity because they were conjoined along the plastral midline. Twinning in turtles is not uncommon (e.g., Tucker and Janzen 1997. Copeia 1997:166–173; and references therein); however, this is the first record for the widespread and common Painted Turtle. In



FIG. 1. Conjoined twins of *Chrysemys picta* found in nest cavity in Indiana.

addition, my observation demonstrates that conjoined twins are capable of overwintering successfully in the nest, but also suggests that in nature they probably are unable to leave the nest due to locomotor difficulties.

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***LEPIDOCHELYS OLIVACEA* (Olive Ridley Seaturtle). ASSOCIATION WITH *PLANES MARINUS* (Columbus Crab).** *Lepidochelys olivacea* has a wide-ranging distribution in tropical and subtropical oceans, and is perhaps the most abundant species of the Cheloniidae (Plotkin 2007. Biology and Conservation of Ridley Sea Turtles. John Hopkins University Press, Baltimore, Maryland. 356 pp.). *Planes* is a genus of small oceanic crabs also widespread in the tropical and subtropical areas of the world, all known as Columbus crabs. Three species are currently recognized; *Planes marinus* is recorded in Brazil from the states of São Paulo throughout Santa Catarina (Melo 1996. Manual de Identificação dos Brachyura [Caranguejos e Siris] do Litoral Brasileiro. Plêiade/Fapesp, São Paulo. 603 pp.). An association between Columbus crabs and cheloniid turtles is well-known, however the nature of this relationship has been controversial. An older view suggested that the crabs feed on turtles feces, but recent authors suggest a mutualistic relationship, where the crabs feed on turtles' parasites during the day and use the turtles as floating devices to feed on neuston at night (Davenport 1994. J. Mar. Biol. Assoc. U.K. 74:735–737; Frick et al. 2004. J. Crustacean Biol. 24[2]:350–355). According to Frick et al. (*op. cit.*), the crabs benefit the turtles by eating the encrusting parasites, thus improving their hydrodynamics, while the carapaces of the turtles provide shelter, food, and dispersion capability for the crabs. Despite these possible advantages, *P. marinus* was the only species of the genus that had never been reported as an sea turtle epibiont (Frick et al. 2006. Mar. Turt. Newsl. 111[4]:12–14). The first report of this association was from the Hawaiian Islands to the eastern tropical Pacific Ocean (Frick et al. 2011. Mar. Biol. 158:1699–1708). Here, we present the first known occurrence of *P. marinus* in association with sea turtles in the Atlantic Ocean. Also, the known area of occurrence of the crab is expanded to the northeastern coast of Brazil. We found three specimens of *P. marinus* on two *Lepidochelys olivacea* collected in the Economic Exclusive Zone of Northeastern Brazil (ZEE-NE). The turtles were collected accidently by the longline fishery vessel Ghandi. The turtles were inspected, photographed, and released. The crabs were collected between the tail and the carapace of the turtles (Fig. 1), fixed in 70% ethanol, and deposited in the carcinological collection of the Museum of Zoology of the University of São Paulo (MZUSP 27695). The two ovigerous females and one adult male were collected between 24 and 29 August 2004. The geographic coordinates are 1.55°S, 30.13°W and 1.23°S, 30.33°W for the females and male, respectively.



FIG. 1. Ecological association between *Lepidochelys olivacea* and the crab *Planes marinus*.

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***STERNOTHERUS MINOR* (Loggerhead Musk Turtle). DIET.** *Sternotherus minor* is primarily a riverine species and is known as an opportunistic dietary generalist. Its diet consists of a variety of aquatic food items, especially insects and mollusks. As body size increases, head morphology characteristics, including hypertrophied head muscles and broadened alveolar plates, also change allowing for feeding heavily on mollusks (Ernst and Lovich 2009. Turtles of the United States and Canada. Johns Hopkins University Press, Baltimore, Maryland. 827 pp.). Most reports on the diet of *S. minor* are from Florida spring habitats (Berry 1975. Copeia 1975:692–701). Here, we report on a snake-skin shed from a diet sample of *S. minor*.

At 1230 h on 4 August 2012, we captured an individual female *S. minor* (maximum straight-line carapace length = 112.26 mm) in a fish-baited hoop trap near the confluence of Ichawaynochaway and Chickasawhatchee Creeks in Baker Co., Georgia, USA. Following the capture, the individual was cleaned by scrubbing the carapace and plastron to remove any mud and algae. The axillary and inguinal regions of the turtle were scrubbed and rinsed and leeches were removed from all parts of the body. The individual was kept in a plastic bin with two liters of stream water. The bin was covered by window screening secured by binder clips to not allow the turtle to escape. At the end of six hours, fecal material was found in the bottom of the tank and several pieces of snake shed were discovered, including both ventral and dorsal snake scales. The snake shed had long, highly keeled scales. As far as we know, snake-skin shed, of any species, has not been reported in the diet of *S. minor*. Although identification of the snake shed to species level was not possible, we suspect the shed belonged to the genus *Nerodia*. The Brown Watersnake (*Nerodia taxispilota*) is a common species found along the margins of streams in Georgia, and was observed multiple times while trapping this reach of Ichawaynochaway Creek.

Shed snake skin has also been found in the diet of Eastern Mud Turtle (*Kinosternon subrubrum*) from riverine habitat (Steen et al. 2012. Herpetol. Rev. 43:639). Dermatophagy (shed-skin eating) has been described for several groups of amphibians and reptiles, but often occurs by individuals eating their own skin or that of conspecifics (Weldon et al. 1993. J. Herpetol. 27:219–228). *Sternotherus minor* has been reported to eat carrion and non-nutritional foods like rock and detritus that are assumed to have been accidentally swallowed (Folkerts 1968. J. Herpetol. 2:171–173). They are also known to feed among algal mats and other substrates and it is possible that this is how the snake shed was ingested.

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***TERRAPENE CAROLINA TRIUNGUIS* (Three-toed Box Turtle). DIET.** *Terrapene carolina* is considered omnivorous, eating a wide variety of plant and animal foods. Mammals documented as food items, typically as carrion, include mice (*Mus musculus*, *Peromyscus leucopus*, *P. maniculatus*), voles (*Microtus pennsylvanicus*), shrews (*Blarina* sp., *Cryptotis parva*, *Sorex* sp.), and a bovine (*Bos taurus*) (Ernst and Lovich 2009. Turtles of the United States and Canada. 2nd ed. Johns Hopkins University Press, Baltimore, Maryland. 827 pp). On 19 August 2012, on the Camp Shelby Joint Forces Training Center, Forrest Co., Mississippi, USA, a female *Sigmodon hispidus* (Hispid Cotton Rat) was found dead (of unknown causes) in a box trap and was discarded ~5 m away from the trap. The next day we observed an adult male *T. c. triunguis* eating the carcass and entrails of the *S. hispidus*. As we approached, the turtle took a bite of the entrails and then started to slowly walk away from us, at which time the turtle was captured and processed (i.e., sexed, measured, and marked).

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***TERRAPENE CAROLINA TRIUNGUIS* (Three-toed Box Turtle). DIET.** *Terrapene carolina triunguis* is the western-most subspecies of *T. carolina* and has a range that stretches from southeast Kansas and central Missouri south to the Gulf Coast (Conant and Collins 1998. A Field Guide to Reptiles and Amphibians of Eastern and Central North America. 3rd ed. Houghton Mifflin Co., Boston, Massachusetts. 616 pp.). Three-toed Box Turtles are omnivorous and consume a wide variety of food items (Ernst et al. 1994. Turtles of the United States and Canada. Smithsonian Institution, Washington D.C. 578 pp.). It has been suggested that *Terrapene carolina triunguis* may be a seed disperser for some plants (Braun and Brooks 1987. Amer. Midl. Nat. 117:31–318).

On 6 April 2012, we observed a *T. carolina triunguis* eating a berry of an exotic invasive *Nandina domestica* (Berberidaceae; Nandina, Sacred Bamboo) plant (Fig. 1) in the yard of a residence in Nacogdoches Co., Texas, USA (94.668382°N, 31.592993°W; WGS84). Nandina naturally ranges from central China to India and has been cultivated in Japan for many centuries (Chongxi and Foster 1985. Herbal emissaries. Healing Arts Press, Rochester, Vermont. 356 pp.). Nandina was introduced into the United States in 1804 for use as an ornamental plant (Wyman 1969. Shrubs and Vines for American gardens. Revised ed., Collier-Macmillian, Toronto, Ontario. 613 pp.). It is naturalized in North Carolina (Radford et al. 1964. Guide to the Vascular Flora of the Carolinas. University of North Carolina Press, Chapel Hill. 383 pp.) and is suspected to have invaded nine states throughout the southeastern United States, including Texas (Miller 2003. Nonnative Invasive Plants of Southern Forests: a Field Guide for Identification and Control. USDA Forest Service Gen. Tech. Rep. SRS–62. USDA Forest Service Southern Research Station, Asheville, North Carolina). It has been suggested that Nandina is dispersed by birds and mammals (Ludlow 1995. Florida Department of Environmental Protection, Resource Management Notes 6:4–5). In this note we document a previously unknown food item for *T. carolina triunguis* as well as an additional possible species for seed dispersal of invasive *Nandina domestica*.



FIG. 1. *Terrapene carolina triunguis* eating a berry of an exotic invasive *Nandina domestica* plant.

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***TERRAPENE ORNATA LUTEOLA* (Desert Box Turtle). NESTING/ HATCHLING OVERWINTERING/ HATCHLING DIET.** Hatchling *Terrapene ornata ornata* are known to either emerge from the nest cavity during the fall of the year they hatched, or to spend the winter beneath the nest cavity after hatching (Doroff and Keith 1990. Copeia 1990:387–399; Costanzo et al. 1995. Ecology 76:1772–1785; Converse et al. 2002. Am. Midl. Nat. 148:416–422). However, no published information exists on the emergence behavior of hatchling *T. o. luteola*, the westernmost subspecies of *T. ornata*. The following observations were made ca. 2 km E of US Hwy 54, ca. 20 km S of Alamogordo, New Mexico, USA (32.69611°N, 105.98053°W, WGS84; 1225 m elev.).

On the evening of 14 July 2002, a gravid female *T. o. luteola* was observed in the early stages of digging a nest. Earlier in the day, the region had received its first monsoonal rain of the year, and puddles of water were evident. Approximately 2 h before sunset this turtle was observed in the open, digging with its forelimbs into a small depression. My presence disturbed the animal, which retreated to a nearby mesquite bush. The animal was left, but checked on again immediately before dark. It had returned to the same depression, and was in the process of burying itself, which typically precedes construction of the actual nest cavity.

The site was re-visited on the morning of 15 July, and an empty hole was observed. The recent rainfall had only moistened the soil to a depth of several cm, beyond this depth a clear demarcation was visible between the wet surface, and the powder-dry subsurface, and it was assumed that moisture was insufficient to complete the nest. The site was re-visited on 19 July, after more rain had fallen. At 1045 h during overcast and humid conditions, I observed the same female about 50 m from her original nesting attempt on a slightly raised patch of bare ground next to a small depression with a scraped over appearance. It was clear that she had just finished covering a nest. The nest was excavated to ascertain the presence of eggs. At least one egg was noted at a depth of 25 cm, and the nest was immediately reburied. The nest was securely protected with a cage made of hardware cloth and rebar, and camouflaged with woody debris. On 4 October,

PHOTO BY IAN MURRAY



FIG. 1. Hatchling *Terrapene ornata luteola* feeding on Thread-leaf Groundsel (*Senecio flaccidus* var. *douglasii*) petals on 6 October 2008.

PHOTO BY RAQUEL BETANCOURT



FIG. 1. Aftermath of predation attempt by *Paleosuchus trigonatus* on the porcupine *Coendou bicolor*.

the nest was again excavated, revealing two hatchlings buried in the bottom of the nest cavity. The nest was carefully re-buried and covered. On 27 June 2003, the area received its first summer rainfall, and the nest was visited, but no emergence noted. On 29 June the site was visited once again, and 2 hatchlings (SCL = 38.1, 36.3 mm) were noted on the surface, under the cage (MSB 78220, 78221). The cavity was exhumed, revealing that out of a clutch of three eggs, two had been viable. These young remained within the nest cavity for at least 266 days. To my knowledge, this is the first documented case of hatchling *T. o. luteola* overwintering in the nest. Additionally, hatchling emergence may vary based on geography or local rainfall patterns.

Observations on captive 'backyard' turtles in Albuquerque, New Mexico (35.08482°N, 106.61151°W, WGS84; 1578 m elev.) also indicate that hatchlings overwinter within the nest cavity and emerge the following summer. However, on 6 October 2008, I observed a hatchling *T. o. luteola* (SCL = 38.4 mm, 12.9 g) active on the surface and feeding on Thread-leaf Groundsel petals (*Senecio flaccidus var. douglasii*) in a central New Mexico population on the Sevilleta National Wildlife Refuge (34.401643°N, 106.662123°W, WGS84; 1567 m elev.). Not only do these observations suggest plasticity for hatchling *T. o. luteola* emergence, but this feeding record adds to the paucity of information available describing hatchling *T. ornata* feeding ecology (Fig. 1).

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CROCODYLIA – CROCODILIANS

***PALEOSUCHUS TRIGONATUS* (Schneider's Smooth-fronted Caiman). PREY.** Despite being a widespread species, the natural history of the Schneider's Smooth-fronted Caiman (*Paleosuchus trigonatus*) is little known due to its habitat preferences and cryptic behavior (Magnusson and Lima 1991. J. Herpetol. 25:41–48). Its main habitat comprises the closed-canopy streams and rivers of forested regions through the Amazon and Orinoco drainage basins and the fluvial coastal systems of the Guyanas (Magnusson and Campos 2010. *Paleosuchus trigonatus*. Crocs. CSG:43–45). Like all crocodilians, *P. trigonatus* is a generalist predator consuming a wide variety of prey, however, its diet includes a higher proportion of terrestrial vertebrates than other Amazonian alligatorids (Magnusson et al. 1987. J. Herpetol. 21:85–95).

On 5 February 2011 at 1030 h, we witnessed a unusual predation attempt by a *Paleosuchus trigonatus* (ca. 150 cm total length) on a porcupine (*Coendou bicolor*) at Playas de Cuyabeno (0.31428°S, 75.96146°W, 213 m elev.), Reserva de Producción Faunística Cuyabeno, Sucumbíos Province, Ecuador. The locality lies within tropical rainforest and the observation was made during the dry season, which extends from December to March in this region. We could not determine if the predation attempt was successful, but it was evident that the caiman attacked the porcupine, as its head and jaws were covered with quills (Fig. 1). When captured, the caiman appeared stressed, as the porcupine's quills (up to 5 cm long) had penetrated 0.5 cm into the flesh of caiman. The caiman was covered by leaf litter under a large, overhanging horizontal root, at a small salt lick with footprints of several mammals evident, suggesting that the caiman attacked the porcupine nearby. Magnusson et al. (1987, *op. cit.*) reported that adult *P. trigonatus* consumed mammals such as rats (*Oryzomys* sp. and *Proechimys* sp.), agouti (*Dasyprocta* sp.), monkey (undetermined), a marsupial (*Metachirus nudicaudatus*), armadillo (*Dasypus novemcinctus*), and porcupine (*Coendou* sp.) in Central Amazonia, Brazil. Therefore, our observation supports predation on porcupines, and suggests that adult *P. trigonatus* forage near salt licks.

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LIZARDS — SQUAMATA

***ACANTHODACTYLUS BOSKIANUS* (Bosk's Fringe-fingered Lizard). BIFURCATION.** *Acanthodactylus boskianus* is a diurnal, ground dwelling, medium to large-sized lacertid lizard. It is one of the most widespread species of the genus ranging from West Sahara, through all of North Africa (including the Sahel) to the Arabian Peninsula and east to SW Iran northwards to Southern Turkey (Sindaco and Jeremcenko 2008. The Reptiles of the Western



FIG. 1. Adult *Acanthodactylus boskianus asper* with bifurcated tail.

Palearctic. Edizioni Belvedere, Latina, Italy. 579 pp.). *Acanthodactylus boskianus* usually occurs in arid and desert ecosystems and is an ecologically plastic species which occurs on variety of habitats, typically inhabits coarse substrates with moderate vegetation. This species is often the most conspicuous and abundant lizard in arid and desert regions in its distribution range.

On 12 May 2011 we captured three adult individuals of the subspecies *A. b. asper* in an open area with thorny bushes in Wadi Paran, southern Israel (30.337°N, 34.946°E). Lacertids are known to readily autotomize their tails (Fitch 2003. J. Herpetol. 37:395–399; Pafilis et al. 2009. Evolution 63:1262–1278). In order to collect tissue samples from these specimens we cut the tips of their tails, and kept the animals alive for breeding at the I. Meier Segals Garden for Zoological Research at Tel-Aviv University (collection was done under INPA permit # 38074). The specimens were kept in plastic terraria, and their tails regenerated. In one female (Fig. 1; 66 mm SVL; 6.6 g), the regenerated tail had bifurcated 4 cm posterior from the cloaca, with both tail tips at even lengths of 50 mm. This individual is the only *Acanthodactylus* specimen (out of 46 individuals we kept, belonging to six species) that did not flee in the presence of humans. We did not observe bifurcated tails in *Acanthodactylus* specimens in the field, nor did we among the >1000 specimens (in 9 species, including 391 *A. boskianus* specimens) kept at the Tel-Aviv University Zoological Museum.

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***AMPHISBAENA ALBA* (Giant Worm Lizard). PREDATION.** *Amphisbaena alba* is a species widely distributed in South America (Gans 2005. Bull. Am. Mus. Nat. Hist. 289:1–130). In Brazil is found in different ecosystems, where it is primarily fossorial (Moura et al. 2011. *In* Herpetologia do Estado de Pernambuco. 440 pp.; Vitt et al. 2008. *In* Guia de Lagartos da Reserva Adolpho Ducke - Amazônia Central. 175 pp.). This species can be an important prey item for some bird species, being reported in the diet of the hawk *Rupornis magnirostris* in an area of Atlantic Forest in southern region of Brazil (Santos and Rosado 2009. Revista em Agronegócios e Meio Ambiente 2:421–430). The White-naped Jay (*Cyanocorax cyanopogon*) is a bird endemic to Brazil, belonging to the family Corvidae. It is a generalist and has the habit of forming conspecific aggregations (Sick 1997. Ornitologia Brasileira. Editora Nova Fronteira, Rio de Janeiro, Brazil. 912 pp.).



PHOTO BY LEONARDO BARBOSA DA SILVA

FIG. 1. Predation of *Amphisbaena alba* by *Cyanocorax cyanopogon* in the Floresta Nacional do Araripe, Ceará, Brazil. Record: CHP-UFRPE N°2800.

On 20 August 2012 at 0740 h, at the edge of a forested area located in Floresta Nacional do Araripe (7.3838°S, 39.3544°W; WGS 84), Ceará, Brazil, we observed a group of five individuals of *C. cyanopogon* preying on an individual of *A. alba* (Fig. 1). The prey was on the ground when five jays approached, emitting intense vocalizations. Two individuals of the group attacked the amphisbaenian, pecking it in the head and tail with their beaks. A third individual then joined them and also began to peck the prey. When the *A. alba* ceased resistance, it was taken into the forest, where other individuals of the group approached and began to feed on the prey. This is the first record of predation reported for *A. alba* by *C. cyanopogon* in the northeastern region of Brazil. The images of predation were filed in the Collection of Herpetological and Paleoherpetological of Federal Rural University of Pernambuco - UFRPE, Recife, Pernambuco, Brazil.

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***ANOLIS CAROLINENSIS* (Green Anole). PREDATION.** A wide variety of predators have been documented for Green Anoles, including birds (e.g., Arndt 1975. Florida Sci. 58:249–251; Palmer and Braswell 1995. Reptiles of North Carolina. Univ. of North Carolina Press, Chapel Hill. 412 pp.), frogs (Hoffman and Johnson 2008. Herpetol. Rev. 39:339), snakes (Wharton 1969. Bull. Florida St. Mus. 14:227–272), other lizards, including conspecifics (Campbell and Gerber 1996. Herpetol. Rev. 27:106; Gerber and Echternacht 2000. Oecologia 124:599–607; Netting 1940. Copeia 1940:266), and wolf spiders (Corey 1988. J. Aranachol. 16:392–393). Orb web spiders usually catch and consume invertebrates, and are known to occasionally eat small vertebrates such as small snakes (Burt 1949. Herpetologica 5:127; Groves 1978. Bull. Maryland Herpetol. Soc. 14:44–46) and the lizards *Anolis porcatus* and *A. sagrei* in the Caribbean (Armas 2001. Revista Ibérica de Aracnologia 3:87–88; Armas and Alayón 1987. Poeyana 344:1–18). Here we describe the first successful predation of an *A. carolinensis* by an orb weaving spider.



FIG. 1. An *Anolis carolinensis* captured by the orb weaver *Neoscona domiciliorum*.

On 11 October 2008 on Jekyll Island, Glynn Co., Georgia (31.058333°N, 81.419444°W; WGS84), an adult *A. carolinensis* was observed wrapped in the web of a female orb weaver (*Neoscona domiciliorum*) (Fig. 1). Females of this spider are common in moist woodland habitats dominated by the live oak *Quercus virginiana* (Edwards 2003. Florida Coop. Ext. Service, DPI Entomology Circular 266, Gainesville, Florida. 4 pp.) where *A. carolinensis* may also be abundant (Jensen et al. 2008. Amphibians and Reptiles of Georgia. Univ. Georgia Press, Athens, Georgia. 575 pp). Adult female *N. domiciliorum* tending eggs will leave their webs up during the day when Green Anoles are active (Edwards, *op. cit.*; Jensen et al., *op. cit.*), which apparently facilitated the lizard's capture in our observation. This is the first report of predation on *A. carolinensis* by *N. domiciliorum* and the first known lizard prey for the spider (G. B. Edwards, pers. comm.).

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***ANOLIS NEBULOSUS* (Clouded Anole). PREDATION.** There are 20 lizard species occurring in seasonally tropical dry forest in the vicinity of Chamela, Jalisco, Mexico. Here we report the first predation record of *Anolis nebulosus* by *Sceloporus melanorhinus* at the Chamela Field Station, Universidad Nacional Autónoma de México, Jalisco (19.497867°N, 105.043047°W). This event was recorded at 1500 h on 7 February, 2010 while using video-cameras (SONY Handy Cam DCR-SX43) to identify potential predators of *A. nebulosus* as part of ongoing research. At our study site, individuals of *A. nebulosus* were attached to a tree with a 50 cm string at a perch height of 25 cm from 900 h to 1500 h for three days, every two months. The video (available upon request) shows one adult *S. melanorhinus* approaching, attacking and consuming an adult *A. nebulosus*. This recorded event lasted 28 seconds and revealed that *S. melanorhinus* is not a strict insectivorous lizard and will feed opportunistically on other smaller lizards. *Anolis nebulosus* is approximately half of the body size of *S. melanorhinus* (43mm SVL vs. 96 mm, respectively) and both species are arboreal, diurnal and insectivorous (Garcia and Ceballos 1994. Guía de Campo de los Reptiles y Anfibios de a Costa de Jalisco, México. [Edición en Inglés y Español]. Fundación Ecológica de Cuixmala, A. C. e Instituto de Biología [UNAM], México. 184 pp.). At Chamela, predation of *A. nebulosus* by *Aspidoscelis lineatissima* also has been recorded occasionally (A. Garcia and B. Lister, pers. obs.). Lizard predation and cannibalism is common in insular *Anolis* species (Gerber 1999. *In* Losos and Leal [eds.], *Anolis* Newsletter V, pp. 28–39. Washington University, Saint Louis, Missouri) but previous records of predation by *Sceloporus melanorhinus* have not been reported before.

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***ANOLIS SAGREI* (Cuban Brown Anole). AGGRESSIVE BEHAVIOR.** Males of *Anolis sagrei* have a repertoire of aggressive behaviors that they typically use to defend territories, sometimes inflicting considerable injury on an opponent (Henderson and Powell 2009. Natural History of West Indian Reptiles and Amphibians. Univ. Press of Florida, Gainesville. 271 pp.).

From between 1900 and 2000 h on 03 June 2012, I observed three male *A. sagrei* on the road outside of The Island School and Cape Eleuthera Institute on the island of Eleuthera, The Bahamas. One individual (***A***) appeared to be healthy. A second individual (***B***) was dead, but the body was intact showing no obvious physical damage like that which could be caused by vehicular traffic or predatory activity. A third individual (***C***) was alive but relatively immobile and had a severed tail. ***C*** exhibited a dark coloration, which is characteristic of a resident *A. sagrei* in a territorial conflict (Evans 1938. J. Comp. Psychol. 25:97–123). Individual ***A*** was initially positioned next to individual ***B***, but moved several centimeters upon my approach. Once I retreated, ***A*** returned to his position next to ***B***. ***A*** then attacked ***B***, biting and flipping the lifeless body while showing other signs of aggression including tail lashing, a display modifier used during high states of aggressive arousal (Scott 1984. Breviora 479:1–22). When I moved closer to observe the interaction in greater detail, ***A*** moved a short distance toward individual ***C***. When I once again retreated, ***A*** returned and resumed his attack on ***B***. I left and returned ~15 min later, at which time I found ***C*** dead, presumably a result of an attack by ***A***. At this time, ***A*** was once again attacking the body of ***B***. I left the site and returned ~30 min later finding only the lifeless males and a previously unseen female that was walking slowly around the body of ***B***.

Robert Powell and John S. Parmerlee, Jr. reviewed the manuscript and helped edit the images. Sandra D. Buckner and Stacy Lubin-Gray facilitated our fieldwork in the Bahamas and the staff

of the Cape Eleuthera Institute and the Island School was quite tolerant of our antics. The permit to conduct research in the Commonwealth of the Bahamas was issued by Philip S. Weech, Director, The BEST Commission. Protocols were approved by the Avila University Animal Care and Use Committee (IACUC 2007-01). Fieldwork was funded by a grant from the National Science Foundation (USA) to Robert Powell (DBI-0851610).

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***ASPIDOSCELIS GULARIS* (Common Spotted Whiptail). CLUTCH SIZE.** *Aspidoscelis gularis* has a wide distribution from southern Oklahoma to Jalisco and Querétaro, Mexico with several recognized subspecies throughout its distribution (Hammerson et al. 2007. *In* IUCN 2012. IUCN Red List of Threatened Species. Version 2012.1. <www.iucnredlist.org>. Accessed on 19 September 2012). Little information is known regarding the reproduction and litter size of this species in the state of Jalisco. In the state of Querétaro, clutch size has been reported as 1–4 eggs, depending on female body size (Dixon and Lemos Espinal. 2010. Anfibios y Reptiles del Estado de Querétaro, México/Amphibians and Reptiles of the State of Queretaro, Mexico. UNAM, ATM and CONABIO. 428 pp.). In Durango, the reported clutch size is 1–5 eggs (Estrada-Rodríguez et al. 2004. Cañón de Fernández: Anfibios y Reptiles. Instituto de Ecología, A.C. Goméz Palacios, Durango, México. 60 pp.). In Zacatecas, a clutch size of 1–7 eggs has been reported, although based on oviductal eggs rather than actual clutches (Walker 1981. Copeia 1981:850–868).

On 26 October 2009, a litter of 8 hatchlings of *Aspidoscelis gularis* was found on Cerro La Mesa, in the town of Temacapulin, in the municipality of Cañadas de Obregon, Jalisco, Mexico (21.199797°N, 102.708274°W, datum WGS84; elev. 1745 m). The recently hatched lizards were healthy, inactive, and all together under a rock in xerophilic scrub, under direct sunlight, on the side of a dirt road. When the rock was lifted, three of them attempted to escape, but were captured to be photographed. We counted 8 hatchlings and found the 8 corresponding fresh egg shells. We did not find any unhatched eggs or extra shells. The hatchlings were returned under the rock where they were found after some photos were taken. This is the first report of litter size for this species in Jalisco and augments data for the subspecies *A. g. semptemvittata*.



FIG. 1. Eight hatchling *Aspidoscelis gularis* from a single litter found in Jalisco, Mexico.

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***ASPIDOSCELIS LAREDOENSIS* (Laredo Striped Whiptail). GYNANDROMORPH.** We evaluate the identity and reproductive status of a whiptail lizard specimen collected from a site of syntopy between diploid hybrid-derived *Aspidoscelis laredoensis* and this species' maternal progenitor, *A. gularis* (McKinney et al. 1973. Herpetologica 29:361–366; Bickham et al. 1976. Herpetologica 32:395–399; Wright et al. 1983. Herpetologica 39:410–416) situated in México (Walker 1987. Texas J. Sci. 39:313–334). The lizard stands apart in size and color pattern among the >1000 specimens of these species examined by us between 1984–2009 from México and Texas. It was tentatively identified as a hybrid between these species by Walker et al. (1989a. J. Herpetol. 23:119–130). However, genealogical causation (i.e., fertilization of an unreduced diploid egg of *A. laredoensis* clonal complex A by a reduced sperm of *A. gularis*) was selected without appropriate assessment of the other possible bases (i.e., gynandromorphism, senescence, or a variational outlier involving one of these species) for the observed condition of the reproductive organs and external morphology. Fortunately, we have subsequently examined several live/freshly killed male and female putative hybrids of *A. laredoensis* x *A. gularis* that were subjected to confirmational studies of their genealogies based on triploidy as verified by karyotypes (Walker et al. 1989a, *op. cit.*; Walker et al. 1989b. Copeia 1989:1059–1064) and skin histocompatibility experiments (Abuhteba et al. 2000. Can. J. Zool. 78:895–904; Abuhteba et al. 2001. Copeia 2001:262–266). Morphological studies of these hybrids have also revealed the presence of well-defined character states of dorsal and ventral color pattern, scutellation, and meristic variables that differ from the parental species. In this study we use morphological and histological evidence in support of our identification of a gynandromorph of *A. laredoensis* from México deposited in the Arkansas State University Museum of Zoology (ASUMZ).

On 27 May 1985, we collected 11 specimens of *A. laredoensis* just south of the Rio Grande in the Mexican state of Tamaulipas; University of Arkansas Department of Zoology (UADZ 1101) from the vicinity of the northwest suburbs of Reynosa on Mexican Hwy 102 near a hydroelectric complex, and UADZ 1102–1111 (and one *A. gularis*, UADZ 1260) from La Playita situated 8 km NW of Reynosa. Subsequently, UADZ 1111 became ASUMZ 4654 in preparation for this study. It has a SVL of 86.5 mm, head length of 26 mm, head width of 13.5 mm, and body mass (obtained before preservation) of 13.5 g. It is much larger than any of the other adults of *A. laredoensis* (mean SVL 69.9 ± 0.89, range 66–76 mm, N = 10) collected on the same date at the two sites in Tamaulipas. The SVL and mass of ASUMZ 4654 are 13.2% and 33.3% larger, respectively, than observed in any other individual of *A. laredoensis* from the sites. Based on the size of the lizard, we initially hypothesized that it was an *A. laredoensis* x *A. gularis* hybrid; however, we now know that such lizards have discrete morphological markers not present in ASUMZ 4654. The slightly to moderately enlarged postantebrachial scales (Fig. 1A) of the specimen places it within the range of variation for this character present in the 10 contemporary *A. laredoensis* (slightly to moderately enlarged) rather than that of *A. gularis* (enlarged and plate-like), or a character state intermediate between the two

species. In addition, scores for meristic characters in ASUMZ 4654 (first number) are also within the ranges of variation for the other specimens of *A. laredoensis* from the sites (mean, range, N): granular scales around midbody, 91 (90.4 ± 0.67, 89–94, N = 9); granular scales from occiput to base of tail, 227 (225.2 ± 0.22, 222–229, N = 9), granular scales between the paravertebral stripes, 14 (11.1 ± 0.48, 9–14, N = 9); right and left femoral pores summed, 33 (34.1 ± 0.31, 31–35, N = 10); and right and left circumorbital scale series summed, 12 (10.3 ± 0.33, 9–12, N = 10).

Based on SET field notes made shortly after collection, and prior to preservation, ASUMZ 4654 possessed color attributes that we subsequently learned should have precluded identification of it to either *A. gularis* or *A. laredoensis* x *A. gularis*, the overall resemblance being that of an unusually old individual of *A. laredoensis* that had progressed to an extreme color pattern ensemble. Included was a blue face, blue-green dorsal surface of head, and light blue throat and mesoptychium, with no evidence of pink or red hues typical of either *A. gularis* or all known adult hybrids between the two species. The dorsal pattern in ASUMZ 4654 consisted of three pairs of moderately (lateral) to well-defined (dorsolateral and paravertebral) primary stripes and a single vertebral (traits of *A. laredoensis*; Fig. 1B). In life, the green-hued stripes were positioned between brown-black fields suffused with green flecks; the stripes ended near the tail. Using the left side of the body for analysis, we noted sixteen partial to complete gray-green-tan vertical bars in the lower lateral field, 22 rounded spots of the same blend of colors in the upper lateral field, and a series of three similarly colored spots in the

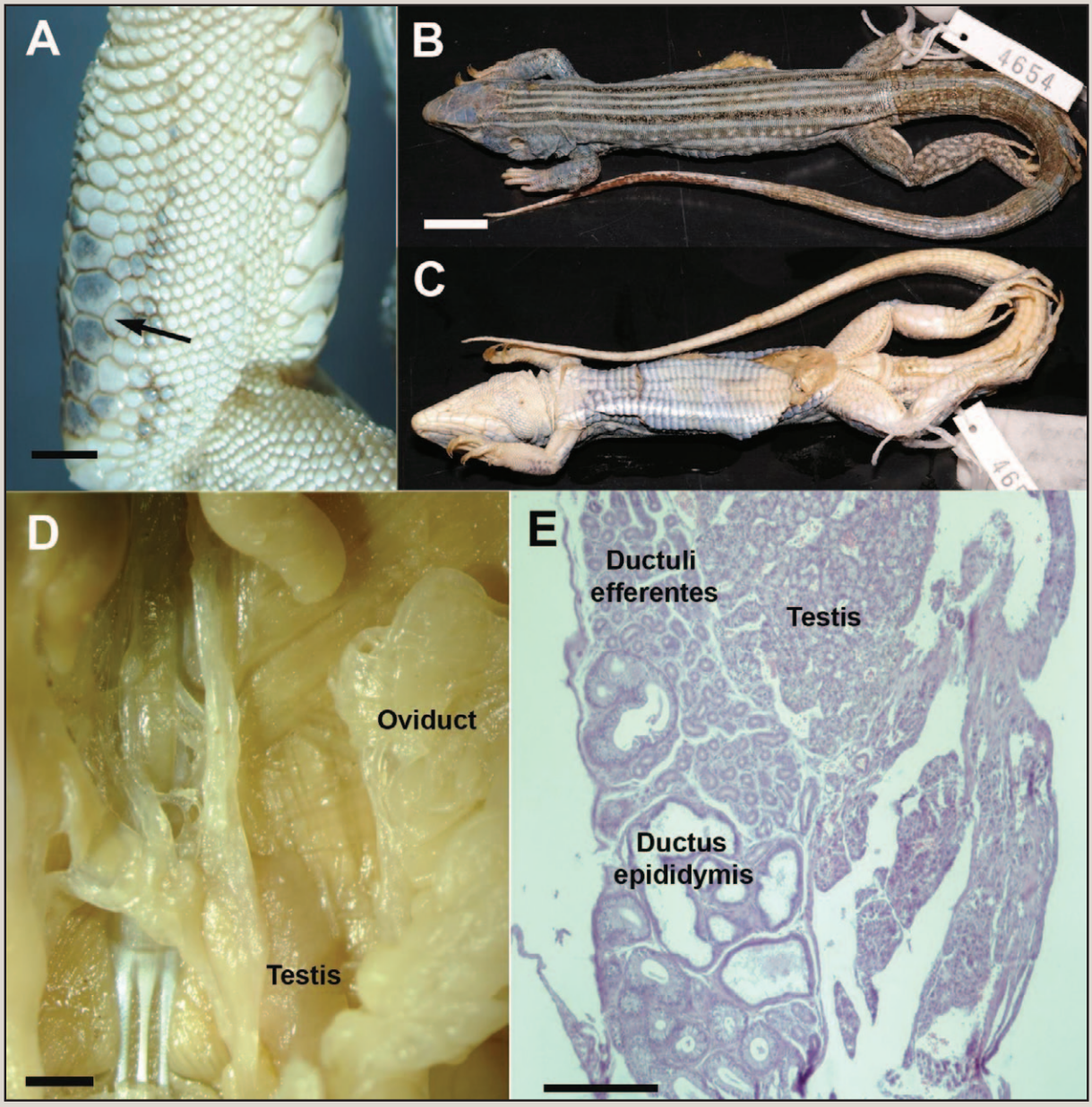


FIG. 1. Morphological characteristics of a gynandromorph of *Aspidoscelis laredoensis* (ASUMZ 4654) collected from La Playita, Tamaulipas, México. A) Postantebrachial scales (arrow) of right antebrachium; line = 1 mm. B) Dorsal coloration and pattern; line = 10 mm for B and C. C) Ventral coloration. D) Left gonadal structures; line = 1 mm. E) Longitudinal histosection of left testis and ductus epididymis; line = 200 µm.

dorsolateral field near the tail. Some of the spots and bars of the upper and lower lateral fields, respectively, were fused to or superimposed upon the lateral stripes (Fig. 1B). The tail was blue laterally and olive dorsally. The upper parts of forelimbs were hues of green and the forearms were shades of blue, both areas with indistinct gray-white marking. The hindlimbs were olive dorsally, and shades of blue elsewhere, with gray-white markings. The thoracic and abdominal scales were sky blue, some with darker edges. The ventral surfaces of the limbs and tail were a mixture of blue and cream-white (Fig. 1C).

We used a standard histological protocol to prepare reproductive tissues for light microscopy. Gonadal tissues were dehydrated in a graded series of ethanol, cleared in xylene, embedded in paraffin, sectioned with a rotary microtome into 10 µm sections, stained with Harris hematoxylin and counterstained with eosin. We designated this lizard to be a gynandromorph due to the presence of an abnormal sexual anatomy characteristic of both sexes. No ovaries were observed; however, paired Müllerian ducts (oviducts) of moderate development were positioned lateral to small (< 5 mm in length), paired rudimentary gonads (Fig. 1D). These gonadal structures appeared slightly orange in coloration upon gross inspection. Histological examination of the left gonadal mass (Fig.1E) revealed a differentiated ovoid testicular mass immediately adjacent to numerous mesonephric derivatives including efferent ductules of the ductuli efferentes and a ductus epididymis with ductules of variable size and epithelial height. Adrenal tissue was aggregated along the cauda of the epididymis (Fig. 1E). The testicular mass, enveloped by a thin connective tissue tunic, was organized into tightly packed medullary cords (Fig. 1E) that appeared to be precursors to seminiferous tubules. These cords averaged 35.3 µm in diameter (range, 31.6–43.3 µm; N = 10). The germ cells of the cords did not appear to be mitotic. The cytoplasm of the germ cells of the cords was slightly basophilic throughout the testicular mass. Numerous blood vessels were interspersed among these presumptive seminiferous tubules, and the tubules generally lacked lumina. Numerous spherical efferent ductules were dispersed along the entire medial margin of the testicular mass. Those ductules adjacent to the caudal region of the testicular mass (Fig. 1E) averaged 40.2 µm in diameter (range, 33.3–48.3 µm; N = 10). The low simple columnar epithelia of these ductules exhibited stereocilia, and the apical cytoplasms of these cells were slightly acidophilic.

The cauda portion of the epididymis was more developed than either the caput or the corpus, which were poorly organized. The anteriormost mesonephric ductules of the cauda exhibited simple columnar epithelia that averaged 27.3 µm in height (range 20.0–36.0 µm; N = 10). The epididymal duct within the cauda exhibited irregular, greatly-expanded segments (Fig. 1E). These hypertrophied ductal tubules exhibited a low simple columnar epithelium (Fig. 1E) with the epithelial cell layer averaging 11.5 µm in height (range 9.8–14.6 µm; N = 10) in height. The epithelial cells also exhibited conspicuous stereocilia averaging 12.6 µm in height (range 10.3–14.6 µm; N = 10). Finally, acidophilic cellular debris was observed in epididymal ductules leading to the ductus deferens.

This is only the second publication known to us in which terminology specifically in reference to gynandromorphism has been employed to describe the reproductive organs in a specimen of a whiptail lizard species. Mitchell and Fouquette (1978. Copeia 1978:156–159) described an adult (Arizona State University 15323; 67 mm SVL) of *Cnemidophorus inornatus arizonae* (= *Aspidoscelis inornata arizonae* sensu Reeder et al. 2002. Am. Mus. Novit. 3365:1–61) collected 10 July 1975 from 7 km SE of Willcox, Cochise Co., Arizona, with male reproductive organs in the left side of the body cavity and female organs in the right side of the cavity. These authors, albeit based on morphology, explicitly rejected the hypothesis that the specimen in question was a tetraploid hybrid involving triploid *A. uniparens* which was also present at the Arizona site. More recently, Cole et al. (2010. Am. Mus. Novit. 3698:1–43) chose to use the terminology "apparently female (but intersex) laboratory hybrid" to describe a genetically confirmed allodiploid individual (American Museum of Natural History 153158; 81 mm SVL) of *A. inornata arizonae* () x *A. tigris marmorata* ().

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***BRACHYLOPHUS BULABULA* (Fiji Banded Iguana). PREDATION.** Documented predation of any South Pacific iguana is rare, as all three species remain very uncommon and restricted in range. Two previous studies have reported food habits of wild Pacific Boas (*Candoia bibroni*), and neither found evidence of these boas preying on *Brachylophus* (McDowell 1979. J. Herpetol. 13:1–92; Harlow and Shine 1992. J. Herpetol. 26:60–66). One



COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND

FIG. 1. *Candoia bibroni* preying on *Brachylophus bulabula* on Wakaya Island, Fiji.

second-hand account (Gibbons and Watkins 1982. *In* Burghardt and Rand [eds.], Iguanas of the World, pp. 418–441. Noyes Publ., Park Ridge, New Jersey) reported that a *B. fasciatus* was observed being eaten by a *C. bibroni* on Vanuabalavu Island in Fiji. We report here a verified observation of predation on *B. bulabula* by a *C. bibroni* (Fig. 1.) on Wakaya Island in Fiji (17.60°S, 179.00°E) from 17 October 2008. The predation event involved an adult *B. bulabula*, being consumed by an adult *C. bibroni*. Adult *B. bulabula* weigh approximately 125 g (RNF, unpubl. data), making this iguana a significantly larger prey item than skinks and geckos, which are reported to constitute most of the diet for *C. bibroni* (McDowell, *op. cit.*; Harlow and Shine, *op. cit.*).

Candoia and *Brachylophus* are known to co-occur on many islands in Fiji (Fisher and Harlow, unpubl. data), although the island with the highest known density of *Brachylophus* iguanas apparently lacks *Candoia* (Harlow and Biciloa 2001. Biol. Conserv. 98:223–231). It is possible there is a previously undocumented top down effect of these snakes on iguanas when they co-occur on small islands.

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***CROTAPHYTUS COLLARIS COLLARIS* (Eastern Collared Lizard). FRUGIVORY.** Lizards of the genus *Crotaphytus* are commonly viewed as being strictly carnivorous, feeding mainly on insects and occasionally on small vertebrates (McGuire 1996. Bull. Carnegie Mus. Nat. Hist. 32:1–143). However, in May 2011, one of us (JJC) observed an individual *Crotaphytus collaris* ingesting *Morus* sp. fruit. The observation was made during a two-year study of the behavioral ecology of *C. collaris collaris* in the Smoky Hills region of central Kansas, USA. The individual was an adult male, perched within a ~1 m *Morus* sp. tree. Our observation constitutes the first documentation of frugivory in *C. collaris* in the northeastern portion of its range, as well as the first documentation of any crotaphytid ingesting *Morus* sp. fruit. Literature discussing the diet of crotaphytid lizards reference occasional herbivory (Best and Pfaffenberger 1987. Southwest. Nat. 32:415–426; Blair and Blair 1941. Am. Midl. Nat. 26:230–232; Ellis and Henderson 1913. Univ. Colorado Stud. 10:39–129; Fitch 1956. Univ. Kansas Publ. Mus. Nat. Hist. 8:213–272), and frugivory is noted specifically in three reports (Banta 1960. Wasmann J. Biol. 18:309–311; Montanucci 1971. Herpetologica 18:183–197; Turner et al. 1969. Herpetologica 25:247–257). These reports note ingestion of *Lycium* sp. fruit by *C. bicinctores* (as *C. collaris baileyi*) in southern Nevada (Banta 1960, *op. cit.*), *C. reticulatus* in southern Texas and northern Mexico (Montanucci 1971, *op. cit.*) and *Gambelia wislizenii* (as *C. wislizenii*) in southern Nevada (Turner 1969, *op. cit.*). Collectively, these observations suggest fruit might be a standard dietary component of crotaphytid lizards throughout their geographic range, despite the traditional view of crotaphytids as strictly carnivorous.

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***DRACO QUINQUEFASCIATUS* (Five-banded Gliding Lizard). REPRODUCTION.** *Draco quinquefasciatus* inhabits lowland rainforest particularly in peat swamp forest. It forages on tree trunks looking for ants, termites and small insects. This gliding lizard is widely distributed from Trang in southern Thailand to Peninsular Malaysia, Sumatra and Borneo (Cox et al. 1998. A Photographic Guide to Snakes and other Reptiles of Peninsular Malaysia, Singapore and Thailand. New Holland Publishers, UK. 144 pp.). The total length of this species is up to 27 cm and the female can lay up four eggs per clutch (Cox et al. 1998, *op. cit.*). A clutch of two eggs (measuring 16.8 and 17.2 mm) were reported as obtained from the buttress leaf litter within a dipterocarp forest (Das 2007. A Pocket Guide of Amphibians and Reptiles of Brunei. Natural History Publications [Borneo], Kota Kinabalu, Sabah. 200 pp.). Here I report on a maximum clutch size for *D. quinquefasciatus*.

On 11 February 2011, between 2100 and 2200 h, an adult female *D. quinquefasciatus* was caught at Sungai Sedim (5.250574°N, 100.465147°E; elev. < 200 m), Kedah, Malaysia. This specimen was captured while perching on a tree trunk (ca. 3–4 m above ground). For further inspection, the lizard was euthanized and dissected and four whitish eggs in the uterus were found. The oval-shaped eggs were measured and the mean ± SD (range, N) length, diameter and weight of the eggs were 14.5 ± 0.58 mm (14–15, 4), 7.5 ± 0.58 mm (7–8, 4) and 601 ± 13.6 mg (587–615, 4), respectively. Later the specimen (11USM-SDM-DQ01) was fixed with 10% formalin, stored in 70% ethanol and deposited at School of Pharmacy, Universiti Sains Malaysia for reference.

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***ENYALIUS BRASILIENSIS*. DEATH-FEIGNING.** *Enyalius brasiliensis* is an Atlantic forest species of Brazil, inhabiting areas with humid vegetation and closed canopies (Jackson 1978. Arq. Zoo. 30:1–79). Almost nothing is known about the ecology of the genus *Enyalius* and information available is restricted to accounts of feeding habits and microhabitat use (Jackson, *op. cit.*; Sousa et al. 2008. Iheringia Sér. Zool. 98:260265; Van Sluys et al. 2004. Braz. J. Biol. 64:353–356; Vanzolini 1972. Pap. Avulsos Zool.



FIG. 1. Death-feigning posture in a female *Enyalius brasiliensis*.

26:83–115; Vitt et al. 1996. Herpetol. Nat. Hist. 4:77–82; Zamprogno et al. 2001. Rev. Bras. Biol. 61:91–94). Little information is published on behavioral aspects of this species.

Death-feigning, also known as tonic immobility or thanatosis, is an innate, anti-predator behavior. In squamates, death-feigning is a widespread defensive tactic that is described from several different families, such as Anelytropsidae (Torres-Cervantes et al. 2004. Herpetol. Rev. 35:384), Crotaphytidae (Gluesing 1983. Copeia 1983:835–837), Scincidae (Langkilde et al. 2003. Herpetol. J. 13:141–148), and Tropiduridae (Bertoluci et al. 2006. Herpetol. Rev. 37:472–473; Machado et al. 2007. S. Am. J. Herpetol. 2:136–140). Herein we provide observations on death-feigning in *Enyalius brasiliensis* with a brief description of the behavior in this lizard.

We collected two *E. brasiliensis* specimens during the inspection of a drift fence with pitfall and funnel traps used for a reptile survey conducting inventory of the area sampled. Both lizards exhibited death-feigning when removed from the traps and when manipulated in the laboratory to perform marking procedures and/or morphometric analysis. On 29 September 2008 we collected a male *Enyalius brasiliensis* (SVL: 74.7 mm), and on 31 October 2009 we collected a female of *E. brasiliensis* (SVL: 102.3 mm) in fragmented forest of Atlantic Rainforest in the Floresta Farm (21.742667°S, 43.29225°W, WGS 84; ca. 709 m elev.), in the municipality of Juiz de Fora, State of Minas Gerais, Brazil. The lizards became immobile, lying belly-up, crossing the limbs over the stomach and typically closing the eyelids. The death-feigning posture persisted even after the animal was gently placed upside down on the ground (Fig. 1). An individual would recover after 15–30 min and then attempt to flee. Both specimens were deposited in the Coleção Herpetológica da Universidade Federal de Juiz de Fora (CHUFJF 586, 591). We believe these observations to be the first records of death-feigning in this lizard species..

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***HELODERMA SUSPECTUM* (Gila Monster). FEMALE REPRODUCTIVE ANATOMY.** Variation in gross uterine morphology is well defined in mammals (i.e., Kobayashi and Behringer 2003. Nature Rev. Genet. 4:969–980), and has been included in comparative anatomy textbooks for decades. In placental mammals the uterus has been described as duplex, bicornuate, bipartite, or simplex (Koayashi and Behringer 2003 *op. cit.*). However, until recently (e.g., Siegel et al. 2011a. J. Anat. 218:342–348; Siegel et al. 2011b. Acta Zool. 93:400–408), little attention has been paid to the variation in female reproductive anatomy of reptiles, and even this recent literature failed to describe multiple "types" of uteri similar to those described in mammals. From Gadow (1887. Phil. Trans. R. Soc. Lond. B. 178:5–37) and Gabe and Saint-Girons (1965. Mem. Mus. Nat. Hist. XXXIII:149–332), all lepidosaurs, testudines, and crocodylians possess paired uteri that empty into the cloaca separately. Thus, it would appear that all non-mammalian amniotes possess uterine morphology that is most similar to the "duplex" condition described for some mammals; although Gadow (1887, *op. cit.*) does mention the possible fusion of uteri in a lizard of the genus *Lophura* (no species provided), which we can only assume is a synonym for *Hydrosaurus* (sailfin lizards).

In a broad survey of squamate urogenital tracts, in-depth literature review, and histological preparation of cloacal/oviducal junctions from hundreds of squamate individuals (Siegel et al. 2011a, *op. cit.*; Siegel et al. 2011b, *op. cit.*), we found the dogma of non-mammalian amniotes possessing only duplex-like uteri to be correct in all but one species: *Heloderma suspectum* (Gila Monster). Tissues from the cloacal/oviducal junction of two preserved *H. suspectum* specimens were obtained from the Sam Noble Oklahoma Museum of Natural History (#020151 and #32499). Tissues were dehydrated with ascending concentrations of ethanol, cleared in toluene, embedded in paraplast, serially sectioned at 10 µm, affixed to albumenized slides, and stained with hematoxylin and eosin for general histological examination.

At the cranial aspect of the cloaca, paired uteri can be observed traveling dorsal to the urodaeal chamber (Fig. 1A). As the

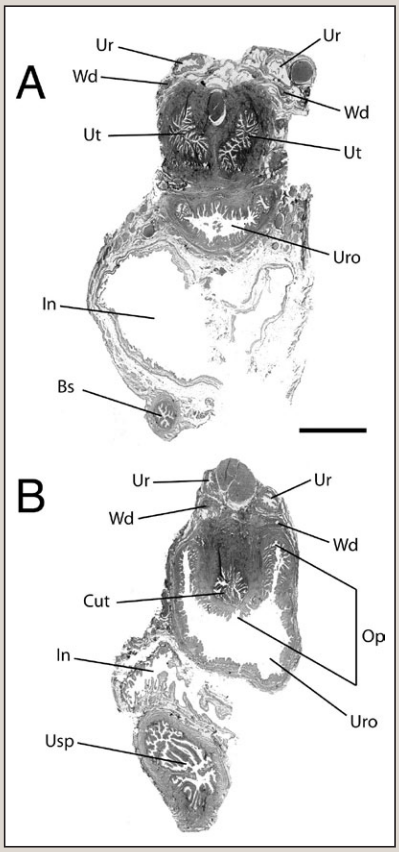


FIG. 1. Cross sections from the cloacal/oviducal junction of female *Heloderma suspectum* (hematoxyline and eosin; scale bar = 2,800 µm). Please see Siegel et al. (2011c. Reproductive Biology and Phylogeny of Snakes. CRC Press, Boca Raton. 759 pp.) for a review of cloacal anatomy and terminology in squamates. **A.** Paired uteri residing dorsal to the cranial aspect of the urodaeum. **B.** A common uterus resulting from the union of the paired uteri. Bs, bladder stalk; Cut, common uterus; In, intestine; Op, oviducal papilla; Ur, ureter; Uro, urodaeum; Usp, urodaeal sphincter; Ut, uterus; Wd, Wolffian duct.

uteri persist caudally, the urodaeal chamber enlarges (Fig. 1B). Paired uteri then invade the enlarged urodaeal chamber and unite forming a single large oviducal papilla (Fig. 1B). At this level the lamina propria of each uterus merges with that of the urodaeum. Immediately caudal to the uterine-cloaca junction, the epithelia of each uterus join and create a common uterine opening into the urodaeum at the most caudal aspect of the uterus (Fig. 1B). The union of the uteri occurs at the posterior, non-glandular portion of the uterus (region 2, see Siegel et al. 2011c. Reproductive Biology and Phylogeny of Snakes. CRC Press, Boca Raton. 759 pp.). Thus, female *Heloderma suspectum* possess a bipartite-like uterus.

The basal lineage of Lepidosauria (i.e., *Sphenodon*; Meyer and Zardoya 2003. Annu. Rev. Ecol. Evol. Syst. 34:311–388) possesses a duplex-like uterus (Gabe and Saint-Girons 1965, *op. cit.*). Because no mammalian amniote possesses a cloacal/oviducal junction (i.e., these taxa have a vaginal/oviducal junction instead) besides the basal Monotremata (Meyer and Zardoya 2003, *op. cit.*), and monotrematan taxa do not possess bipartite uteri (Kobayashi and Behringer 2003, *op. cit.*), the bipartite-like uterus in a non-basal lineage of Lepidosauria is secondarily derived. We make no hypothesis of similar function between the bipartite-like uterus of *Heloderma suspectum* and the bipartite uterus of mammals, but suggest that the bipartite-like uterus is a convergent characteristic. Female specimens of *Hydrosaurus* (see Gadow 1887, *op. cit.*) should be examined to elucidate the possibility of a similar bi-partite uterus in another lineage of lizards (e.g., Agamidae).

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***HEMIDACTYLUS BRASILIANUS* (Amaral's Brazilian Gecko). DIET.** *Hemidactylus brasilianus* is nocturnal with terrestrial/arboreal habits (Rodrigues 2003. *In* Ecologia e Conservação da Caatinga, pp. 181–236. Editora Universitária da UFPE, Recife, Pernambuco; Vanzolini et al. 1980. Répteis das Caatingas. Acad. Bras. de Ciênc., Rio de Janeiro, Brazil. 161 pp.). Few studies have been conducted on the diet of *H. brasilianus* (Rocha and Rodrigues 2005. Pap. Avul. Zool. 45:261–284). Thus, the aim of the present study was to assess the food composition of *H. brasilianus* in a caatinga region of the San Francisco Valley, northeastern Brazil.

Collections were conducted from 19 September to 5 November, 2011 during a herpetology course in an area of bushy caatinga (9.3280°S, 40.5497°W; elev. 385 m) on the Agrarian Sciences Campus of the Universidade Federal do Vale do São Francisco – UNIVASF, Petrolina, Pernambuco, Brazil. Lizards were captured in pitfalls (7-liter buckets). In the lab, individuals were euthanized with an injection of xylocaine diluted in water. Stomach contents were analyzed under stereomicroscope to identify the food items ingested, most taxa to order level. Larval stages of the orders Lepidoptera and Coleoptera were assigned to the same prey category (insect larvae) because they represent a single morphotype.

Diet was analyzed from numerical (occurrence and numerical frequencies of ingested items) and volumetric data. The volume (V) of food items was estimated using the modified version of the spheroid formula: $V = 4/3\varpi\ (width/2)^2 \times (length/2)$, following Vitt et al. (1996. J. Trop. Ecol. 12:81–101). To calculate food niche breadth from numerical proportions and remove the effect of the number of prey categories consumed, we used standardized values of Simpson's Diversity Index in the equation of Levin's Standardized Index, as follows: $B_a = B - 1/n - 1$, where B is Simpson's niche breadth index, and n the number of prey categories used. Values in this case range from 0 (exclusive use of a single prey category) to 1 (equal use of all prey categories) (Kenney and Krebs 2000. Programs for Ecological Methodology. Version 5.2. Vancouver, Canada. University of British Columbia). Moreover, the importance value index (IVI) was calculated to determine the proportion of each diet item, adding occurrence, numerical and volumetric percentages, and dividing by three (*IVI=F%+N%+V%/3*) (Mesquita et al. 2006. Copeia 2006:460–471). Grouped stomach contents, and separating males and females, were considered in this analysis. The Mann-Whitney U test was applied to determine possible differences in snout-vent length between males and females.

A total of 11 individuals were collected, seven males, three females and one whose sex was not identified. The SVL of males (35.1 ± 6.5 mm) did not differ significantly from that of females (42.4 ± 6.3 mm) (Mann-Whitney U test, Z = -1. 481, P = 0. 138). With respect to diet, five categories of consumed prey were recorded for *H. brasilianus* (Table 1). The highest occurrence frequencies were registered for insect larvae (45.5%) and Blattaria (36.4%), but numerically, termites (Isoptera) were the most important items (52.6%). Despite the considerable consumption of Isoptera, in terms of volume, Blattaria was the most important food item consumed (34.4%) (Table 1).

The largest importance index value was recorded for insect larvae (33.4), followed by Isoptera. Considering sex, we found an absence of Isoptera in the diet of *H. brasilianus* males and a high importance index for insect larvae (48.3). For females, the highest importance index values were for Isoptera (66.2) and insect larvae (19.6); however, it is important to underscore that only one female consumed a large amount of termites, skewing the importance value for this category.

Prey categories consumed show that *H. brasilianus* predominantly captures nocturnal prey (cockroaches and crickets), with little mobility (insect larvae) and unpredictable, aggregate distribution (termites). Insect larvae, represented by the highest IVIs (total, for males, and second for females), were also important items in the diet of *H. brasilianus* in a dune field belonging to the Caatinga of Bahia state (Rocha and Rodrigues, *op. cit.*). We believe that this marked consumption of insect larvae is associated with their wider availability in the study area. However,

TABLE 1. Diet composition of *Hemidactylus brasilianus* at Campus Ciências Agrárias, Petrolina municipality, Pernambuco, Brazil, from September to November 2011. F = frequency of occurrence, N = number, V = volume (mm^3), IVI = importance value index (t = total sample, m = males, f = females).

Prey category	F (%)	N (%)	V (%)	IVIt	IVIm	IVIf
Blattaria	4 (36.4)	4 (10.5)	360.8 (34.4)	27.1	36.9	14.2
Coleoptera	1 (9.1)	1 (12.6)	67.0 (6.4)	6.0	10.2	–
Isoptera	1 (9.1)	20 (52.6)	209.3 (20.0)	27.2	–	66.2
Insect larvae	5 (45.5)	10 (26.3)	296.7 (28.4)	33.4	48.3	19.6
Orthoptera	3 (27.3)	3 (8.0)	112.5 (10.8)	15.4	18.9	–
TOTAL		38	1,046.3			

the food niche breadth of *H. brasilianus* (0.437) reveals moderate diet specialization, and despite the small number of prey types, food resource exploitation is relatively equitable. In addition, these findings are correlated with behavioral characteristics of *H. brasilianus,* such as its nocturnal habits and arboreal lifestyle, with only sporadic activity at ground level.

The *H. brasilianus* specimens (CCA 007, 013, 018, 022, 025, 028, 029, 033, 055, 057 and 058) were deposited in the Herpetological Collection of the Caatinga Fauna Museum at CEMAFAUNA-CAATINGA (Centro de Conservação e Manejo de Fauna da Caatinga). We thank the CEMAFAUNA-CAATINGA for logistical support and the Chico Mendes Institute for Biodiversity Conservation (ICMBio) for issuing the collection license (n° 29558-1).

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***LEPIDODACTYLUS LUGUBRIS* (Mourning Gecko). REPRODUCTION.** *Lepidodactylus lugubris* occurs in most parts of Oceania and has been introduced into parts of Asia and North, Central and South America (Kraus 2009. Alien Reptiles and Amphibians A Scientific Compendium and Analysis. Springer Science. 563 pp.). It is an all-female parthenogenetic species that originated due to hybridization (Yamashiro et al. 2000. Zool. Sci. 17:1013–1020). However, males, which are generally considered to be the consequences of crosses between *L. lugubris* females and males of congeneric bisexual species, are occasionally found (Röll et al. 2008. Zoology 111:385–400) and have been reported from Hawaii and the Ryukyu Archipelago (Brown and Murphy-Walker 1996. Herpetol. J. 6:69–73; Yamashiro and Ota 1998. Jpn. J. Herpetol. 17:152–155). The purpose of this note is to report a second phenotypic male *L. lugubris* from Hawaii, USA.

One male *L. lugubris* (SVL = 48 mm), collected 12–15 August 1998, at Hilo, district of South Hilo, Hawaii, Hawaii USA, and deposited in the herpetology collection of the Natural History Museum of Los Angeles County, Los Angeles, California, USA as LACM 145408, was examined. The testes were removed, embedded in paraffin, sections were cut at 5µm and mounted on glass slides, and stained with hematoxylin followed by eosin counterstain.

The testes of our male *L. lugubris* contained seminiferous tubules of normal morphology (Fig. 1), and contained mainly Sertoli cells, spermatogonia, primary spermatocytes, spermatids and clusters of abnormal sperm, which lacked tails (Fig. 2). Because the spermatozoa lacked tails, we conclude this male was infertile. The histology was similar to that of a phenotypic male *L. lugubris* reported by Röll et al., *op.cit.* The prevalence of male phenotypes in our *L. lugubris* sample from Hilo, Hawaii was 1/20 (5%). This is the second record of a phenotypic male *L. lugubris* from Hilo, Hawaii. In another examination, one of seven (14%) *L. lugubris* collected in May 1986 was also a phenotypic male (Brown and Murphy-Walker op. cit.). Currently, no other *Lepidodactylus* species is known to occur in Hawaii, so these findings tend to suggest that sterile males do occur at very low prevalences in wild populations of *L. lugubris* from Hawaii. Histology slides were deposited in LACM.

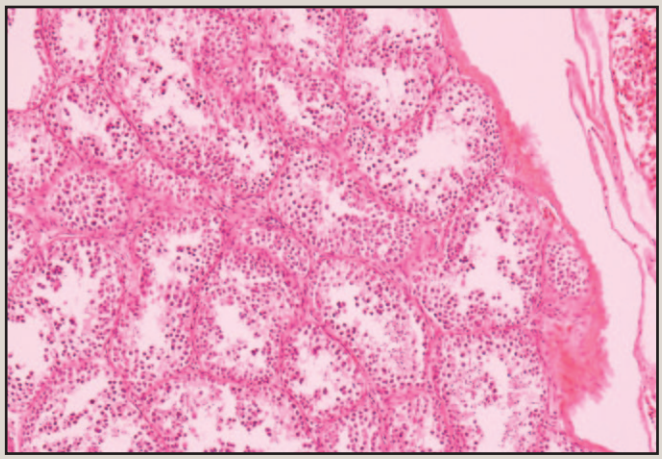


FIG. 1. Seminiferous tubules of the male *Lepidodactylus lugubris* (LACM 145408) described herein. 100x.

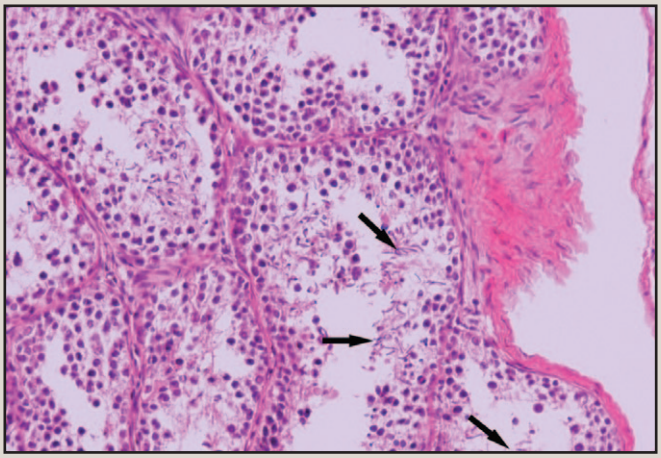


FIG. 2. Seminiferous tubules of the male *Lepidodactylus lugubris* (LACM 145408) described herein. Note the clusters of sperm (arrows) 200x.

We thank G. Pauly (LACM) for permission to examine *L. lugubris*.

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***LIOLAEMUS KOSLOWSKYI*. SCOLIOSIS AND KYPHOSIS.** Scoliosis and kyphosis have been recorded in captive lizards (Otero Llende and Bengoa Rodríguez 2001. Res. VII Cong. Anual Soc. Española Med. Veterinaria 1:24–30), but infrequently reported in wild populations of lizards (Chavez-Cisneros and Lazcano 2012. Herpetol. Rev. 42:140; Frutos et al. 2006. Herpetol. Rev. 37:468–469; Mitchell and Georgel 2005. Herpetol. Rev. 36:183–184; Norval et al. 2010, Herpetol. Rev. 41:224–225). Here we provide the first report of scoliosis and kyphosis in *Liolaemus koslowskyi*, a small liolaemid lizard of western Argentina.

On 10 February 2012, we caught an adult female *Liolaemus koslowskyi* (42 mm SVL) on the roadside of Ruta Nacional 40, Cuesta de Miranda, 3.5 km W Bordo Atravesado, near Los



FIG. 1. Adult female *Liolaemus koslowskyi* showing multiple kyphosis and scoliosis.



FIG. 2. X-ray images of adult female *Liolaemus koslowskyi*, lateral (left) and dorsal (right) views.

Tambillos, 2 km NE El Siciliano, Departamento Felipe Varela, La Rioja Province (34.41500°S, 68.80727°W, WGS84; 1664 m elev.). She exhibited two vertical curvatures on the spine (kyphosis), one behind the head in the pectoral girdle and one over the pelvic girdle. In addition, the tail had nine alternating lateral curves (scoliosis) (Figs. 1, 2). This lizard appeared to experience no obvious limitations in mobility. Apparently, these malformations do not appear to decrease the probability of survival of the lizard (Frutos et al., *op. cit.*). To our knowledge, this is the first reported occurrence of these conditions in *Liolaemus koslowskyi* in natural conditions. Voucher specimen (LJAMM 14800) was deposited in the herpetological collection LJAMM-CNP of the Centro Nacional Patagónico (CENPAT-CONICET), Puerto Madryn, Argentina.

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***OPHIODES STRIATUS* (Glass-lizard). MINIMUM BODY MASS FOR NEONATES.** *Ophiodes striatus* is an anguid lizard with a cylindrical and elongate body, lacking front limbs, but expressing vestigial hind limbs and is viviparous (Cunha 1961. Bol. Mus. Para. Emilio. Goeldi. Cienc. Nat. 39:1–189). This species is widely distributed, occurring from the montane areas of southeastern and central Brazil, the Cerrado biome and altitude camps in the Atlantic Forest and Araucaria Forest (Barbosa et al. 1991. Rev. Bras. Biol 51:285–287).

On 3 December 2011 an adult female *O. striatus* (CRLZ 000329; body mass = 15.50 g; snout–vent length [SVL] = 18.35 cm; total length [TL] = 29.98 cm) was collected from the Reserva Biológica Unilavras Boqueirão (RBUB) (21.34638°S, 44.99083°W, 1250 m elev.; datum WGS84) in riparian forest associated with phytophysiognomies of Cerrado. The specimen was placed in a terrarium with sandy soil, water, rocks, and natural vegetation obtained at the collection site. Two days later on 5 December 2011, this female gave birth to four young, for which body mass, SVL, and TL were measured. They were then euthanized and fixed in 10% formalin and preserved in 70% alcohol, labeled and deposited in CRLZ. Mean body size of offspring was obtained (body mass = 0.64 ± 0.05 g; SVL = 5.43 cm ± 0.09; TL = 12.80 cm ± 0.20). Prior to this report, morphometric data and body mass of *O. striatus* neonates have not been described. Only data regarding young still within the uterus of females necropsied have been provided until now (Barbosa et al., *op. cit.*; Barros e Teixeira 2007. Bol. Mus. Mello Leitão 22:11–23; Leitão 1973. Iheringia 42:34–39). This study is the first report of minimum body mass for neonates of *Ophiodes striatus*.

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***OPHIODES STRIATUS* (Striped Worm Lizard). BIFURCATED TAIL.** Many morphological malformations have been reported on duplication (i.e., bifurcation; trifurcation) of the regenerated portion of the tail in lizards capable of caudal autotomy (see Chan et al. 1984. Hawaii Volcanoes National Park: Proceedings of the Fifth Conference of National Science, pp. 41–50; Chandra and Mukherjee 1980. J. Bombay Nat. Hist. Soc. 77:343; Gogliath et al. 2012. Herpetol. Rev. 43:129; Kumbar and Ghadage 2011. Herpetol. Rev. 42:94; Mata-Silva et al. 2010. Herpetol. Rev. 41:352–353). Generally this duplication is caused by regeneration failure of the tail rather than congenital malformations (Lynn 1950. Herpetologica. 6:81–84).



FIG. 1. Photograph showing a female *Ophiodes striatus* and bifurcated tail. Note the different design pattern of the regenerated tails in relation to the body.

On 9 June 2011, an adult female *Ophiodes striatus* was found on the campus of Juiz de Fora Federal University, in the municipality of Juiz de Fora, Minas Gerais, Brazil (21.773698°S, 43.368405°W, WGS84; 857 m elev.) with an unusual double tail (Fig. 1). It weighed 24.7 g and measured 111.50 mm (SVL). The main tail measured 90.41 mm and the bifurcated portion measured 48.94 mm. Most lizard species can regenerate broken tails, but the regenerated part usually differs in shape and color from the original tail; this specimen expressed a uniformly colored tail, lacking the striped pattern of the body. The presence of double tails does not seem to have affected the lizard's welfare.
The specimen was deposited in the herpetology collection the of Juiz de For a Federal University (CHUFJF 922). We thank the Brazilian environmental agency, IBAMA, for issuing the collection permit (16895-1).

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***OPHISAURUS COMPRESSUS* (Island Glass Lizard). SWIMMING.** *Ophisaurus compressus* is a legless anguid native to the southeastern United States (Holman 1971. Cat. Amer. Amph. Rept. 113:1–2). The habitat of this species is described as pinelands (Duellman and Schwartz 1958. Bull. Florida State Mus. 3:181–324) and rosemary-palmetto scrub (Telford 1959. Copeia 1959:100–119), although Neill (1948. Herpetologica 4:153–158) found them under tidal wrack on sandy beaches. As its common name suggests, *O. compressus* is often found on offshore barrier islands, but over-water dispersal by any species of *Ophisaurus* is undocumented.

At 1253 h on 29 March 2012 while kayaking, we encountered an adult *O. compressus* in the Intracoastal Waterway in Flagler Co., Florida, USA (29.621958°N, 81.210497°W, datum WGS 84). This section of the Intracoastal Waterway is within the Guana Tolomato Matanzas National Estuarine Research Reserve (GTMNERR), and contains numerous spoil islands that extend parallel to the waterway for approximately 1.75 km. Upon capture, this *O. compressus* (SVL = 176 mm, tail length = 417 mm) was swimming west towards the nearest spoil island (~ 87 m away) and was approximately 125 m from the mainland.
To our knowledge, this observation provides the first direct evidence for over-water dispersal in *O. compressus*. The frequency of movements among island and mainland habitat at this site is unknown, but this dispersal behavior is likely an important component of the ecology of *O. compressus* despite several potential risks. For example, the saline environment of the estuary (ranges between 11 and 38 ppt depending on the phase of the tide cycle [GTMNERR Water Quality Metadata]) likely poses a physiological challenge to this predominately terrestrial species. In addition, the estuary contains several potential aquatic predators, including Bottlenose Dolphins (*Tursiops truncatus*), American Alligators (*Alligator mississippiensis*), and several predatory fish.

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***OPHISOPS ELEGANS* (Snake-Eyed Lizard). BIFURCATION.** *Ophisops elegans* is a diurnal, ground dwelling, medium-sized lacertid lizard. It is widespread in the eastern Mediterranean region from southeastern Europe (northeastern Greece, Bulgaria, including Cyprus) to northeast Sinai and coastal Egypt, eastward to Iraq and Iran. It was also reported from Algeria (Sindaco and Jeremcenko 2008. The Reptiles of the Western Palearctic. Edizioni Belvedere, Latina, Italy. 579 pp.).

On 4 June 2012 at 0905 h, we tried to capture an *O. elegans* male first seen on an oak tree (*Quercus* sp.) in a scrubland area near the field school on Mt. Meron in northern Israel (33.011°N, 35.394°E; 897 m elev.). While trying to capture the individual, its tail was amputated as lacertids are known to readily autotomize their tails (Fitch 2003. J. Herpetol. 37:395–399; Pafilis et al. 2009. Evolution 63:1262–1278). The lizard (TAU 16297) was subsequently captured (50.3 mm SVL; 3.3 g) and its tail collected. The tail, autotomized at the base, was bifurcated approximately 2 cm posterior to the position where it was amputated. One tail tip is 0.5 cm longer than the other. We did not observe other *Ophisops* specimens with bifurcated tails in the field, and few individuals have regenerated tails (less than 1% of all specimens; authors' unpubl. data). We know of no other cases of tail bifurcation in this species (including 360 other Israeli specimens kept at the Tel Aviv University Zoological Museum).

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***PHRYNOSOMA CORNUTUM* (Texas Horned Lizard). NECROPHILIA.** Necrophilia has been documented in only five lizard species to our knowledge. These are the Giant Ameiva (*Ameiva ameiva*) by Vitt 2003 (*In* Pianka and Vitt [eds.], Lizards: Windows to the Evolution of Diversity, p. 103. Univ. of California Press, Berkeley) and Costa et al. 2010 (Herpetol. Notes 3:79–83), the Long-nosed Leopard Lizard (*Gambelia wislizenii*) in Fallahpour 2005 (Herpetol. Rev. 36:177–178), the Lesser Earless Lizard (*Holbrookia maculata*) in Brinker and Bucklin 2006 (Herpetol. Rev. 37:466), the Western Fence Lizard (*Sceloporus occidentalis*) in Shedd and Eisenburg 2012 (Herpetol. Rev. 43:338), and the Sleepy Lizard (*Tiliqua rugosa*) in Sharrad et al. 1995 (W. Austr. Nat. 20:33–35) and How and Bull 1998 (Herpetol. Rev. 29:240). Here we report this behavior observed in a sixth lizard species, *Phrynosoma cornutum*. We believe this to be the first recorded observation of necrophilia in this species.

While driving Owen Prather Highway (also known as New Mexico Highway 506) in Otero Co., New Mexico, USA, on 25 May 2012, we encountered two dead *Phrynosoma cornutum* killed by the vehicle in front of us (32.520211°N, 105.980033°W). We stopped to examine the scene and found that one of the lizards was male and the other was female. Based on their slightly overlapping positioning, we presume the lizards were attempting to mate at the time of death. While examining the dead lizards, a living conspecific approached the area, head-bobbing. Although not captured, the enlarged basal region of its tail suggests it was a male. Fearing this lizard would also be killed by vehicle traffic, we attempted scaring it away from the road by walking towards it.



FIG. 1. A living *Phrynosoma cornutum* male positioning itself on top of a freshly run-over female conspecific, next to a simultaneously run-over male conspecific.



PHOTO BY MARCELO AROCA

FIG. 1. Predation of *Podarcis hispanicus* by *Steatoda nobilis* in Villaviciosa de Odón, Spain.

The lizard would flee a short distance (approximately 1 m) when approached, but would return closer to the area of the dead lizards when we would back away a few steps. Having noticed this, we then allowed the male to approach the dead lizards without interfering. The male continued head-bobbing as it approached, placed one of its front limbs on the female's back, and positioned himself on top of the dead female (Fig. 1). It then would position its pelvis to either side of the female's body and would try to slide the lower half of its body under her, attempting to mate. The dead lizards were then moved to prevent the living male, other horned lizards, and scavenging wildlife species from being potentially attracted to the road. The male temporarily left the scene during this activity, but returned to where the dead lizards had been as soon as we moved approximately 1 m away. In an attempt to remove any remaining attractants, a shovel load of soil was then placed over the area where the dead lizards had been, and the male left the area altogether.

Because of the lack of behavioral interactions with the dead conspecifics, we believe this male was operating primarily on olfactory senses. Olfactory cues have been noted in this genus as being important in mating, interactions with conspecifics and other species, and in the marking of sites (Tollestrup 1981. Herpetologica 37:130–141). We believe this observation supports those claims, as the male lizard returned to the site even after the dead lizards were removed from the location of initial interaction. We also believe this observation suggests an intense drive for males of this species to reproduce when in the presence of a reproductively active, receptive female (based on the presumed mating positioning of the dead lizards), even if the potential mate is recently deceased and in the presence of observers who would be recognized as a physical threat and avoided under other circumstances. This observation occurred in a remote area where habituation of the lizard to humans is unlikely.

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***PODARCIS HISPANICUS* (Iberian Wall Lizard). PREDATION.** *Podarcis hispanicus* is a small lizard that inhabits most of the Iberian Peninsula, southern France, and North Africa. Its ability to adapt to varied environments has facilitated its dispersal to areas occupied by humans. This trend is shared by other organisms such as certain arthropods. In many situations the latter may prey on these lizards, while in others, the opposite may occur. It has been previously reported that large roaming spiders are able to sporadically catch reptiles (e.g., Hamilton 2010. Herpetol. Rev. 42:603; Raven 1990. Mem. Queensland Mus. 29:448), nevertheless, the evidence related to small spiders acting as predators is somewhat scarce.

On 10 March 2011 at 1415 h, a *Podarcis hispanicus* was found trapped in a garden at a residence outside Madrid, Spain (40.35699972°N, 3.90099983°W). It was entangled in a web made by a False Widow Spider (*Steatoda nobilis*) (Fig. 1), which repeatedly bit and wrapped the lizard, leaving it motionless. After a few minutes, the lizard was still alive but unable to move, while the spider came out of hiding several times in order to reinforce the structure and bite the prey again.

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***SCELOPORUS CLARKII* (Clark's Spiny Lizard). ENDOPARASITES.** *Sceloporus clarkii* occurs from central Arizona and southwestern New Mexico, USA, to northern Jalisco, Mexico (Stebbins 2003. A Field Guide to Western Reptiles and Amphibians, 3rd ed. Houghton Mifflin Co., New York. 533 pp.). To date, the only report of helminths from *S. clarkii* are the cestodes *Mesocestoides* sp. and *Oochoristica scelopori* and the nematodes *Cyrtosomum penneri, Physaloptera retusa, Piratuba prolifica, Skrjabinoptera phrynosoma,* and *Spauligodon giganteus* (Goldberg et al. 1994. J. Helminthol. Soc. Washington 61:73–83). The purpose of this paper is to add to the helminth list of *S. clarkii.*

Two male *S. clarkii* (mean SVL = 83.0 ± 4.2 SD, range = 80–86 mm) collected at Mazatlan (23.2167°N, 106.4167°W), Sinaloa, Mexico and deposited in the herpetology collection of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California, USA as LACM 95628 (collected July 1960) and LACM 95637 (collected August 1963) were examined. The digestive tract was removed through a mid-ventral incision and the esophagus, small and large intestines were examined for helminths using a dissecting microscope. One species of Nematoda

was found which was cleared in a drop of lactophenol, coverslipped on a microscope slide, studied under a compound microscope, and identified as *Strongyluris similis* from the large intestines of LACM 95628 (1 female) and LACM 95637 (3 females). Voucher helminths were deposited in the United States National Parasite Collection, Beltsville, Maryland, USA as *Strongyluris similis* (USNPC 105895). *Strongyluris similis* is a common parasite of sceloporine lizards (Goldberg et al. 1995. J. Helminthol. Soc. Washington 62:188–196; Goldberg et al. 1996. Am. Midl. Nat. 135:299–309; Goldberg et al. 2003. Southwest. Nat. 48:208–217). *Sceloporus clarkii* represents a new host record for *Strongyluris similis*; Sinaloa, Mexico is a new locality record.

We thank Gregory Pauly (LACM) for permission to examine *S. clarkii*.

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***SCELOPORUS CLARKII* (Clark's Spiny Lizard). NOCTURNAL FORAGING ACTIVITY.** On 1 June 2007, an adult male *Sceloporus clarkii* was observed to be active at night during a full moon in tropical dry forest habitat near Alamos, Sonora, Mexico (27.0167°N, 108.9333°W; elev. 396 m). We found *S. clarkii* foraging for insects with poor success at 2230 h; only one attempt to feed on moths was successful. This behavior was observed at a distance of 4 m from the lizard for a period of two hours. Following our observations, the lizard slowly took shelter within a rock crevice located 1.5 m from the foraging locality. Unfortunately, we could not take its body temperature (T_b), but temperatures recorded at the nearest meteorological station were 35.5°C at 2230 h and 33°C at 0030 h (T_{ave} = 31.2°C, T_{max} = 43°C, T_{min} = 19.8°C).

Diurnal reptiles are characterized by maintaining a high T_b to perform daily activities (Avery 1982. *In* C. Gans and F. H. Pough [eds], Biology of the Reptilia, Vol. 12, Physiology C, pp. 93–166. New York). Nocturnal activity in diurnal lizard species has only been reported in laboratory conditions (Dial 1978. Science 155:1551–1553). However, the finding of diurnal species on roads at night has been documented previously (Trombulak and Frissell 1999. Conserv. Biol. 14:18–30). Many authorities suggest that diurnal reptiles are attracted to roads at night to elevate their body temperatures during cooler periods, thus turning the roads into "heat islands" (Dodd et al. 1989. J. Herpetol. 23:197–200.). Nevertheless, more data are necessary to qualify these observations as true activity, because species are not thermally passive during inactivity and select stable thermal microenvironments (Ruben 1976. Herpetologica 32:323–325) and a high nocturnal body temperature may promote digestion (Harlow et al. 1976. J. Comp. Physiol. 111:1–6).

More often, suboptimal ambient temperatures at night preclude the activity of many species of reptiles. It is at this time when T_b falls near or below the level of the minimum voluntary temperature, which is the lower limit for activity. It is well-known that many reptiles take shelter before the natural environment becomes thermally unfavorable. However, in the case of *S. clarkii,* high diurnal temperatures (up to 43°C) resulting in elevated temperatures of the air, tree trunks and rocks, was enough to maintain T_b in the activity range until midnight.

It can be difficult to establish the limits between activity and inactivity, as some species are known to opportunistically engage prey under suboptimal environmental conditions. Thus, the environment may maintain T_b adequate for low levels of activity. According to Huey (1982. *In* C. Gans and F. H. Pough [eds], *op. cit.*, pp. 25–91) some reptile species voluntarily spend the night outside of their burrows to prolong potential foraging time and actively select relatively low body temperatures (i.e., voluntary hypothermia). Furthermore, voluntary nocturnal hypothermia produces a lower T_b that reduces metabolic loss throughout the night. This may be an adaptive response for individuals that fail to obtain food during the day, even if voluntary hypothermia becomes unfavorable and makes the lizard more vulnerable to nocturnal predators. In the case of *S. clarkii*, this hypothesis may explain the fact that we found the lizard outside its burrow. We also suggest that the full moon light helps to prolong foraging time at night, as long as the degree of voluntary hypothermia does not fall below the level of the minimum voluntary temperature.

The physiological and ecological advantages of voluntary hypothermia may be important for species affected by global warming, as the behavior could serve as a mechanistic response to minimize the risk of overheating stress during diurnal foraging. For example, the lizard *Sceloporus serrifer* in the Yucatan Peninsula has been observed to have fewer opportunities for foraging during the day because the species limits its period of activity due to the extremely high diurnal temperatures recorded throughout the year (Sinervo et al. 2010. Science 328:894–899). Additional nocturnal surveys are needed in order to document nighttime active foraging behavior or voluntary hypothermia, particularly in populations and species where the probabilities of extinction are high due to climate change (Sinervo et al. 2010, *op. cit.*). This would help to determine the frequency of this phenomenon and whether it is more common in species more sensitive to global changes in climatic conditions.

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***SCELOPORUS MAGISTER* (Desert Spiny Lizard). ENDOPARASITES.** *Sceloporus magister* occurs in the Sonoran Desert of Arizona, southern California, Sonora, northern Baja California, and the Colorado Plateau in southeastern Utah, adjacent Arizona, and Colorado and northwestern New Mexico (Jones and Schwalbe 2009. *In* Jones and Lovich [eds.], Lizards of the American Southwest: A Photographic Field Guide, pp. 226–229. Rio Nuevo Publishers, Tucson, Arizona). The previous reports of helminths from *S. magister* (*sensu stricto*) are listed in Goldberg et al. (1994. J. Helminthol. Soc. Washington 61:73–83). The purpose of this note is to add to the helminth list of *S. magister*.

Two female *S. magister* (mean SVL = 96.5 mm ± 5.0 SD, range, 93–100 mm) collected June 1966 at Guaymas (27.316667°N, 109.916667°W) Sonora, Mexico, and deposited in the herpetology collection of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California, USA as LACM 25098, 25099 were examined. The digestive tract was removed through a mid-ventral incision and the esophagus, stomach, and small and large intestines were examined for helminths under a dissecting microscope. Individuals of one species of Nematoda were found in the large intestines; these were cleared in a drop of

lactophenol, cover-slipped on a microscope slide, studied under a compound microscope, and identified as 480 *Cyrtosomum scelopori* in LACM 25098 and 649 in LACM 25099. Voucher helminths were deposited in the United States National Parasite Collection, Beltsville, Maryland, USA as *Cyrtosomum scelopori* (USNPC 105897). Other hosts for *C. scelopori* are listed in Baker (1987. Mem. Univ. Newfoundland, Occas. Pap. Biol. 11:1–325), Moravec et al. (1997. J. Helminthol. Soc. Washington 64:240–247), and Mayén-Peña and Salgado-Maldonado (1998. J. Helminthol. Soc. Washington 65:108–111).

Cyrtosomum scelopori is an oxyurid nematode that does not utilize an intermediate host (Anderson 2000. Nematode Parasites of Vertebrates: Their Development and Transmission. CABI Publishing, Oxon, U.K. 650 pp.). Infection likely occurs by *S. magister* licking soil containing *C. scelopori* eggs. *Sceloporus magister* is a new record for *Cyrtosomum scelopori*. Sonora, Mexico is a new locality record.

We thank Gregory Pauly (LACM) for permission to examine *S. magister*.

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***SCELOPORUS ORCUTTI* (Granite Spiny Lizard). ENDOPARASITES.** *Sceloporus orcutti* occurs from lower slopes of the Peninsular Ranges of southern California, southward to just north of the Cape Region of Baja California and is largely restricted to granite boulders (Stebbins 2003. A Field Guide to Western Reptiles and Amphibians, 3rd ed. Houghton Mifflin Co., New York. 533 pp.). To date, the only report of helminths from *S. orcutti* is that of the cestode *Oochoristica scelopori* and the nematode *Spauligodon giganticus* (Goldberg and Bursey 1991. J. Wildl. Dis. 27:355–357). The purpose of this paper is to add to the helminth list of *S. orcutti*.

Two male *S. orcutti* (mean SVL = 87.0 ± 5.7 SD, range = 83–91 mm) were collected in April 1978 from Cataviña (29.73194°N, 114.72083°W), Baja California, Mexico, and deposited in the herpetology collection of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California, USA, as LACM 128066, 128067. The digestive tract was removed through a midventral incision and the esophagus, stomach, and small and large intestines were examined for helminths under a dissecting microscope. Individuals of three species of Nematoda were found; these were cleared in a drop of lactophenol, cover-slipped on a microscope slide, studied under a compound microscope, and identified as *Parapharyngodon californiensis* (2 females) and *Strongyluris similis* (7: 3 males, 4 females) from the large intestine of LACM 128066 and *Thubuanea iguanae* (1 male) from the small intestine of LACM 128067. Voucher helminths were deposited in the United States National Parasite Collection, Beltsville, Maryland, USA as *Parapharyngodon californiensis* (USNPC 105898), *Strongyluris similus* (USNPC 105899), and *Thubunaea iguanae* (USNPC 105900).

Parapharyngodon californiensis has been previously known only from the xantusiid lizards *Xantusia bolsonae, X. henshawi*, and *X. vigilis* (Goldberg et al. 1993. J. Helminthol. Soc. Washington 60:165–169). *Sceloporus orcutti* is the fourth lizard species and first member of the Phrynosomatidae reported to harbor *P. californiensis*. *Parapharyngodon californiensis* is an oxyurid nematode that does not utilize an intermediate host (Anderson 2000. Nematode Parasites of Vertebrates: Their Development and Transmission. CABI Publishing, Oxon, U.K. 650 pp.). Infection likely occurs by *S. orcutti* licking substrate containing *P. californiensis* eggs. *Strongyluris similis* is a common parasite of sceloporine lizards (Goldberg et al. 1995. J. Helminthol. Soc. Washington 62:188–196; Goldberg et al. 1996. Am. Midl. Nat. 135:299–309; Goldberg et al. 2003. Southwest. Nat. 48:208–217). *Thubunaea iguanae* is known from a large number of lizards from the southwestern United States (McAllister et al. 2008. Comp. Parasitol. 75:241–254). Both *S. similis* and *T. iquanae* utilize insect intermediate hosts. *Parapharyngodon californiensis, Strongyluris similes,* and *Thubunaea iguanae* represent new host records for *S. orcutti*. Baja California, Mexico is a new locality record for *P. californiensis*.

We thank Gregory Pauly (LACM) for permission to examine *S. orcutti*.

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***TRAPELUS MUTABILIS* (Desert Agama). REPRODUCTION.** *Trapelus mutabilis* is known from Egypt, Sinai, Syria, and Israel (Uetz [ed.], The Reptile Database, http://www. reptile-database. org. accessed 15 October 2012). It is diurnal, living at the base of dunes with dense vegetation (Schleich et al. 1996. Amphibians and Reptiles of North Africa, Koenigstein, Germany. 630 pp.). Information on *T. mutabilis* reproduction is limited and consists of one clutch of 5–7 eggs deposited in June, sperm production in spring with mating in April–May (Schleich et al., *op. cit.*). The purpose of this note is to provide additional information on *T. mutabilis* reproduction from a histological examination of gonads from museum specimens.

A sample of *T. mutabilis* deposited in the Zoological Museum of the Department of Zoology, Tel-Aviv University (TAUM), Tel Aviv, Israel was examined. The sample consisted of 18 males (mean SVL = 62.0 mm ± 4.5 SD, range = 56–73 mm), 9 females (mean SVL = 65.8 mm ± 6.9 SD, range = 56–77 mm) and one juvenile female (SVL = 50 mm) collected 1944–1986 in Israel (31.5°N, 34.75°E). Vouchers used in this study include: TAUM: 674, 1095, 1319, 1459, 1761, 1765, 2540, 3004, 3067, 3305, 3355, 3356, 3673, 4068, 4867, 5376, 5777, 6002, 6419, 6683, 7108, 7119, 7120, 8480, 13184, 13185, 13563, 13945.

A cut was made in the lower abdominal cavity and the left testis or ovary was removed, embedded in paraffin, cut at 5 µm sections and stained with Harris hematoxylin followed by eosin counterstain. Oviductal eggs were counted. Histology slides are deposited in TAUM.

Two stages were noted in the ovarian cycle: 1) quiescent, no yolk deposition; 2) early yolk deposition, basophilic vitellogenic granules in ooplasm. All females from the following months exhibited quiescent ovaries, sample size in parentheses: March (N = 1); April (N = 2); May (N = 1); August (N = 1); September (N = 1); October (N = 1); November (N = 1). A second female collected in May (TAUM 1095, SVL = 64 mm) contained 5 oviductal eggs and concurrent early yolk deposition for a subsequent clutch. This is the first evidence that *T. mutabilis* may produce multiple

TABLE 1. Monthly stages in the testicular cycle of 18 *Trapelus mutabilis* from Israel.

Month	N	Regression	Spermiogenesis
March	4	0	4
April	7	0	7
May	2	0	2
June	2	1	1
August	2	2	0
October	1	1	0

clutches in the same reproductive season. One female (SVL = 50 mm) with quiescent ovaries was considered a sub-adult.

Two stages were observed in the testicular cycle: 1) Regression, the germinal epithelium in the seminiferous tubules is reduced to 1-3 layers of predominantly spermatogonia and Sertoli cells; 2) spermiogenesis, lumina of the seminiferous tubules are lined by sperm or rows of metamorphosing spermatids. The presence (Table 1) of males with regressed testes from June and August, marking the end of spermiogenesis, and a female with oviductal eggs in May indicates that *T. mutabilis* follows a seasonal reproductive cycle with breeding and ovulation in spring, typical of temperate zone lizards (Fitch 1970. Univ. Kansas Mus. Nat. Hist. Misc. Publ. 52:1–247).

I thank Shai Meiri (TAUM) for permission to examine *T. mutabilis*, Ezra Maza for facilitating the loan and the National Collections of Natural History at Tel Aviv University for providing samples of *T. mutabilis* for this study.

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VARANUS MERTENSI **(Mertens' Water Monitor). PREDATION.** Identifying trophic links is necessary to construct food webs, which in turn are critical for understanding multiple areas of the ecology of a given species, including community interactions, predator-prey dynamics, and the impacts of invasive species. Trophic links are often poorly understood in the tropics, including the Australian wet-dry tropics.

Varanus mertensi is a large aquatic lizard (up to about 1 m in total length) inhabiting freshwater systems in tropical Australia (Cogger 2000. Reptiles and Amphibians of Australia. Reed New Holland, Sydney. 808 pp.). Although few predators are large enough to prey upon adult *V. mertensi*, eagles are an exception. We report a case of *V. mertensi* predation by a White-bellied Sea Eagle (*Haliaeetus leucogaster*) in tropical Australia, based on remains under a feeding perch near an eagle nest. We discuss the importance of monitor lizards as prey for eagles, and implications for population declines in monitors with the arrival of invasive Cane Toads (*Rhinella marina*) in northern areas of Western Australia.

On 16 May 2012 the desiccated tail of a *V. mertensi* was found under a *Eucalyptus* tree, approximately 90 m from an active sea eagle nest at the junction of the Chamberlain and Pentecost rivers at El Questro Wilderness Park in the Kimberley Region (15.968847°S, 127.928739°E). The tail was on the ground next to multiple bones of two individual catfish, and several feathers of a Sulphur-crested White Cockatoo (*Cacatua galerita*). The tree was one of several feeding perches of a pair of sea eagles. An earlier climb into the eagle nest on 9 May 2012 confirmed two incubating eggs. The nest was ca. 30 m high in a *Eucalyptus* tree. The sex of the dead lizard could not be determined, but based on size was a medium-sized adult. Although it is possible that the eagle found the lizard as carrion, the prey item was well within the prey-size range of the raptor.

Sea eagles are previously unreported predators of *V. mertensi*, but this probably reflects the dearth of dietary studies of tropical Australian eagles, rather than an infrequent trophic interaction. Sea eagles are limited to coastal areas and large inland rivers. In the latter areas, where *V. mertensi* is widespread, the monitor is possibly an important food item for the eagles. *Varanus mertensi* is one of three species of Australian monitor lizards that suffer severe population-level declines, via lethal toxic ingestion, with the invasion of *Rhinella marina* (e.g., 87–93%, Doody et al. 2009. Anim. Conserv. 12:46–53). Cane Toads began to invade the site in 2012 (S. Doody, unpubl. data). Thus, invading Cane Toads may be essentially removing an important prey item for the eagles, potentially influencing the energetics and reproductive success of these apex predators. Regardless, we predict a shift in the diet in sea eagles as a result of toad invasion and declines in *V. mertensi* (and of *V. panoptes*; Doody and Cherriman 2012. Herpetol. Rev. 43:653–654). Dietary surveys of eagle nest remains before and after toad invasion in the Kimberley Region would test this prediction.

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SQUAMATA — SNAKES

AGKISTRODON CONTORTRIX **(Copperhead). DIET AND ACCIDENTAL MORTALITY.** At ca. 1115 h on 08 June 2012, an adult male *Agkistrodon contortrix* (total length = 824 mm, SVL = 705 mm) was found near death in a rural yard, ca. 9.8 km WSW Brogdon, Sumter Co., South Carolina, USA (33.77818°N, 80.35468°W, datum: WGS84). Both mandibles of a bird's bill were protruding outward from separate exit wounds on the left side of the snake's body, ca. 90 mm posterior to the tip of its snout (Fig. 1), and a small point of broken mandibular bone was protruding outward on the right side. The snake was found dead a few hours later. The partial skull of a *Corvus ossifragus* (Fish Crow) was later removed from the snake's throat. No additional remains were in the digestive tract and the entire bird would have been far too large for the snake to swallow. The angle of the bill protrusion indicated that the head was most likely swallowed backward. This, along with the fragmented condition of the skull, suggests that the snake had encountered only the detached partial head of the bird and attempted to scavenge it.

Numerous reports exist of injury and mortality in snakes during feeding attempts. These include accounts of indigestible foreign objects that may contain the scent of prey (Palmer and Braswell 1995. Reptiles of North Carolina. Univ. North Carolina Press, Chapel Hill. xiii + 412 pp.), as well as trauma from natural prey items with sharp spines or otherwise injurious body parts (Carr 1940. A Contribution to the Herpetology of Florida. University of Florida, Gainesville. 118 pp.). As a generalist feeder and known scavenger, *A. contortrix* may fall victim to such accidental mortality relatively frequently. To our knowledge, this represents the first record of *A. contortrix* feeding on *C. ossifragus*, or attempting to feed on any portion of such a large bird.

The snake and partial crow skull are deposited in the collections of the North Carolina State Museum of Natural Sciences



FIG. 1. *Agkistrodon contortrix* with attempted meal (head of a *Corvus ossifragus*, Fish Crow) that proved fatal.

(NCSM 79738). Brian J. O'Shea helped confirm identification of the skull.

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***AMPHIESMA STOLATUM* (Striped Keelback). PREDATION.** *Amphiesma stolatum* is a small (to 80 cm total length) diurnal snake found throughout South and Southeast Asia. It is one of the most common snakes in this region, found in villages, paddy fields, thick grass, bushes, and gardens (Whitaker and Captain 2004. The Snakes of India. Draco Books, India. 481 pp.). Herein, we report predation by a free ranging chicken on an adult *A. stolatum* from a village adjacent to Lawachara National Park, Bangladesh (25.8907694°N, 088.8502083°E; datum WGS 84). On 15 April 2012, at ca. 1100 h, while conducting a visual herpetological survey in the village, we observed an adult domestic chicken in a backyard garden preying upon an adult *A. stolaum* (Fig. 1). It is likely that many other birds prey upon *A. stolatum* as well.



FIG. 1. Predation by a free ranging chicken on an adult *Amphiesma stolatum*.

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***ATRACTUS GUENTHERI* (Günther's Ground Snake). REPRODUCTION.** *Atractus guentheri* has a very restricted distribution in the coastal Atlantic Rainforest in the southeast of the state of Bahia, Brazil (Fernandes and Argôlo 1995. Bol. Mus. Nacional, Nova Série, Zoologia 397:1–5; Passos et al. 2010. Zootaxa 2364:1–63). Many aspects of its natural history are poorly known with nothing reported about reproduction (Fernandes and Puorto 1993. Mem. Inst. Butantan, 55:7–14). Here we provide the first data on clutch size, egg morphometry, and timing of oviposition for *A. guentheri*.

At 1830 h on 07 December 2011, during the rainy season in the Atlantic rainforest of Brazil, an adult female *A. guentheri* (SVL = 427 mm, tail length = 43 mm) was captured by local farmers crossing a dirt road 15 m from a large river (Rio de Contas) near the city of Itabuna, Bahia, Brazil (14.7976°S, 39.2334°W, datum WGS84; elev. 38 m). The road passed through vegetation locally known as Cabruca, a Cacao plantation system that retains the largest trees. Two days post capture, the female deposited six white elliptical eggs. Mean egg measurements were: length = 30.2 mm (range = 27.8–32.7 mm); width = 11.3 mm (range = 10.8–11.8 mm); mass = 2.67 g (range = 2.4–2.9 g). Unfortunately, all eggs were lost during incubation and their fertility could not be assessed. The *A. guentheri* was deposited at the Reptile Collection of Museu de Zoologia da Universidade Federal da Bahia (MZUFBA–2382).

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***BOA CONSTRICTOR* (Boa Constrictor). REPRODUCTION / FACULTATIVE PARTHENOGENESIS.** Facultative parthenogenesis is the alternation between sexual and asexual reproduction (Booth et al. 2011. J. Hered. 102:759–763). In vertebrates, facultative parthenogenesis has mostly been recorded in captive animals, but recently documented in wild populations (e.g., snakes; Booth et al. 2012. Biol. Lett. *in press*). This mode of parthenogenesis is rare in reptiles (Lampert 2008. Sex Dev. 2:290–301). In lizards, it has only been reported in *Phymaturus patagonicus* (Chiszar et al. 1999. Herpetol. Rev. 30:98), monitor lizards (Lenk et al. 2005. Amphibia-Reptilia 26:507–514), and Komodo Dragons (Watts et al. 2006. Nature 444:1021–1022). In snakes, facultative parthenogenesis has been reported pitvipers, *Agkistrodon contortrix* and *A. piscivorus* (Schuett et al. 1998. Herpetol. Nat. Hist. 5:1–10; Booth and Schuett 2011. Biol. J. Linn. Soc. 934–942; Booth et al. 2012, *op. cit.*), and in the boid *Epicrates maurus* (Booth et al. 2011. J. Hered. 102:759–763). Recently, Booth et al. (2011, *op.*

cit.) recorded the first evidence of facultative parthenogenesis in *Boa constrictor*. Here we report the second record of facultative parthenogenesis in captivity for *B. constrictor*.

A female *B. constrictor*, born in captivity (July 2003), was maintained in complete isolation in a glass enclosure with lighting and constant temperature between 28 and 32°C and was fed weekly. On 27 May 2012, RALR and BCLB recorded that the snake (SVL = 1700 mm, 3340 g) gave birth to 20 dead all male hatchlings and ten infertile ova. The average measurements of the offspring were: SVL = 259 ± 1.13 mm (range = 208–312 mm); tail length = 39 ± 0.15 mm (range = 32–45 mm); 18.5 ± 1 g (range = 14.3–23.9 g). No malformations were present. We cannot distinguish the reason for the death of hatchlings, but one month before parturition metronidazole medication was administered as an antibiotic. The dead hatchlings and the ova are deposited in the Colección Nacional de Anfibios y Reptiles, Instituto de Biología, Universidad Nacional Autónoma de México.

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***CONOPHIS VITTATUS* (Striped Road Guarder). DEFENSIVE BEHAVIOR / DEATH FEIGNING.** Thanatosis or death feigning behavior has been reported in several species of snakes (Gehlbach 1970. Herpetologica 26:24–34; Zeeshan et. al. 2011. Herpetol. Notes 4:295–267). On 14 February 2012, at 1930 h, I found an adult *C. vittatus* (SVL = 330 mm) under a log in the ecotone between tropical deciduous forest and oak forest in the Municipality of Villa Purificación, Jalisco, Mexico (19.782505°N, 104.719172°W, datum WGS84; elev. 585 m). Immediately upon capture the snake displayed typical defensive behavior: agitation, coiled posture, fast movements, musk production, and biting attempts. The snake was placed in a bag for further photography. When released, it rotated the anterior third of its body onto its back with its mouth wide open and tongue sticking out (Fig. 1) and did not demonstrate any reaction to manipulation. After approximately 1 min, the snake rotated the full length of its body and remained immobile on its back. I was able to handle the specimen for about 11 min. before the snake began to react and attempt to escape. Photographs of the snake were deposited at University of Texas Arlington Digital Collection (UTADC 7499, 7500, 7574).



FIG. 1. Death-feigning behavior in *Conophis vittatus* from Jalisco, Mexico.

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***CONTIA TENUIS* (Common Sharp-tailed Snake). ALBINISM.** Despite high population densities throughout the northern California portion of its range, little is known about *Contia tenuis* (Hoyer et al. 2006. Northwest. Nat. 87:195–202) and aberrant phenotypes in this species are rarely observed (R. Hoyer, pers. comm.). Here I report on albinism in *C. tenuis*.

At 1350 h on 11 February 2012, I found an aberrant *Contia tenuis* in Bidwell Park, Chico, Butte Co., California, USA (39.7458°N, 121.8086°W; datum: WGS84). The specimen was a juvenile, approximately 118 mm (total length), lacking normal pigmentation in the skin and eyes, suggesting albinism (Fig. 1A). The snake was found thermoregulating under a piece of plywood lying beneath a large Valley Oak (*Quercus lobata*). According to Bechtel (1995. Reptile and Amphibian Variants: Colors, Patterns, and Scales. Krieger Publ. Co., Melbourne, Florida. 206 pp.), "true albinism in snakes is a congenital decrease or absence of melanin in the skin, mucosa, and eyes." This description seems appropriate, considering the pink eyes and pale, pinkish orange dorsum of this specimen. Further, the venter was light colored, rather than the typical alternating, dark-light pattern of the belly scutes in normal individuals of this species (Fig. 1B).



FIG. 1. A) Albino *Contia tenuis* from Butte Co., California. B) Venter showing lack of melanin in belly scutes.

COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND

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***CROTALUS ATROX* (Western Diamond-backed Rattlesnake). HABITAT USE.** *Crotalus atrox* is usually found in dry washes, rocky slopes, and open desert (Brennan and Holycross 2006. A Field Guide to Amphibians and Reptiles in Arizona. Arizona Game and Fish Dept., Phoenix, Arizona. 150 pp.; Stebbins 2003. A Field Guide to Western Reptiles and Amphibians. Houghton Mifflin Co., Boston, Massachusetts. 533 pp.). Here, I report encounters with *C. atrox* in an unusual habitat: the leaf litter of Mesquite trees (*Prosopis* sp.). Mesquite usually occurs in a grassland/savannah-like habitat where the trees are not touching, hence tree cover may be 20–50%. In Arizona, near water courses, mesquite forms impenetrable thickets where branches of the trees interlace. On 16 April 2011, between 0930 and 1000 h (air temp = 24°C) on the Tarr Ranch, at the junction of Burro Creek and the Big Sandy River (34.53°N, 113.56°E, datum WGS84; elev. 500 m) in southern Mohave Co., Arizona, USA, I was searching for metal objects under a big thicket of mesquite trees. Lifting up a metal object that was buried 25 cm deep at the base of a mesquite tree, I encountered a large *C. atrox* that was buried so deep that I could not see it until I removed the metal object. About 15 min later, at the edge of another thicket, I was removing some metal wire and surprised two large *C. atrox* that were buried under the wire and leaf litter, which was about 30 cm deep. One was coiled, the other stretched out but touching the other. Mesquite thickets harbor a variety of nesting songbirds, several species of rodents, and lizards, all common prey items of *C. atrox* (Stebbins 2003, *op. cit.*). Thus these thickets may provide a source of food for these reptiles and in the winter and summer heat, the deep leaf litter may provide thermal insulation for inactive snakes.

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***EIRENIS ROTHII* (Roth's Dwarf Racer). REPRODUCTION.** *Eirenis rothii* is known from Turkey, Syria, Lebanon, and Israel (Baran and Atatür 1998. Turkish Herpetofauna [Amphibians and Reptiles]. Ministry of Environment, Republic of Turkey, Ankara. 214 pp.). The purpose of this note is to provide the first information on the timing of the *E. rothii* testicular cycle.

A sample of 14 *E. rothii* males (mean SVL = 190.3 mm ± 32.0 SD, range = 125–163 mm) collected 1960–1980 in Israel and deposited in the Zoological Museum of the Department of Zoology, Tel-Aviv University (TAUM), Tel Aviv, Israel was examined: TAUM 4009, 5589, 6019, 6020, 7681, 7865, 7870, 7871, 8331, 8491, 10313, 10314, 11146, 12239. A cut was made in the lower abdominal cavity and the left testis and part of the vas deferens was removed, embedded in paraffin, cut into 5 µm sections and stained with Harris hematoxylin followed by eosin counterstain. Histology slides are deposited in TAUM. Three stages in the testicular cycle were noted: 1) Residual spermiogenesis, a few sperm are present in the lumina of the seminiferous tubules from a previous spermiogenesis, germinal epithelium reduced to a few layers of spermatogonia with interspersed Sertoli cells; 2) Regressed, germinal epithelium in seminiferous tubules reduced to a few layers of spermatogonia with interspersed Sertoli cells; 3) Early recrudescence, proliferation of germ cells for the next period of sperm formation (spermiogenesis) has commenced. A few primary spermatocytes are present. Monthly distribution of stages in the testicular cycle with sample size in parenthesis were: January (1) one recrudescence; February (1) one recrudescence; April (7) six regressed, one vas deferens only; May (5) one residual spermiogenesis, one regressed, three recrudescence. Eight of nine examined vasa deferentia (89%) contained sperm. The smallest reproductively active male, sperm in vas deferens (TAUM 8491) measured 175 mm SVL.

The absence of full spermiogenesis or late recrudescence characterized by the presence of secondary spermatocytes and spermatids, and vasa deferentia with sperm in spring, suggests *E. rothii* may follow an aestival spermatogenesis (*sensu* Saint Girons 1982. Herpetologica 328:5–16) in which spermiogenesis is completed in autumn and matings and ovulation occurring in spring. Other congeners of *Eirenis* deposit eggs in summer (Arakelyan et al. 2011. Herpetofauna of Armenia and Nagorno-Karabakh. Society for the Study of Amphibians and Reptiles, Ithaca, New York. 149 pp.), also suggesting they may follow an aestival spermatogenesis.

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***EPICRATES ANGULIFER* (Cuban Boa). DIET.** *Epicrates angulifer* is a medium-sized snake endemic to Cuba, where it is widespread (Schwartz and Henderson 1991. Amphibians and Reptiles of the West Indies. Descriptions, Distributions, and Natural History. Univ. Florida Press, Gainesville. 720 pp.). It inhabits a wide range of habitats, from xerophytic scrub to broadleaf forests, where it is often found in trees up to 10 m in height (Henderson and Powell 2009. Natural History of West Indian Reptiles and Amphibians. Univ. Press Florida, Gainesville. 496 pp.). This species preys on small vertebrates, principally birds and mammals, although frogs, lizards, and other snakes are also taken (Schwartz and Henderson, *op. cit.*; Henderson and Powell, *op. cit.*). Wild individuals are known to hunt domestic fowl (Barbour and Ramsden 1919. Mem. Mus. Comp. Zool. 47:71–213), while captive specimens take a variety of bird species (Morell et al. 1998. Flora y Fauna 2:40–42).

On 24 May 2010, at 0535 h, we found an adult *E. angulifer* (ca. 2000 mm total length) preying on a nestling *Tyrannus dominicensis* (Gray Kingbird) in the gardens surrounding the facilities of the Siboney Biological Station, Siboney-Juticí Ecological Reserve, eastern Cuba (19.9608°N, 75.7155°W; datum NAD 27). The kingbird nest was 7.8 m above ground in a Yarúa Tree (*Caesalpinia violacea*). The snake's tail was coiled around a branch just below the nest and the rest of its body was hanging down, with the anterior portion of the nestling bird's body in the snake's mouth (Fig. 1). The adult kingbird pair defended its nest by flying around the snake, bill-snapping and emitting high-pitched calls, but the snake appeared to be unaffected. At 0605 h the boa finished swallowing its prey and moved to the nest, coiling itself above it. Another young kingbird was found some minutes later, alive on the ground near the nest; we assume it was a sibling of the depredated bird and escaped by dropping from the tree.



FIG. 1. Adult *Epicrates angulifer* swallowing a nestling *Tyrannus dominicensis* (Gray Kingbird) in the Siboney Biological Station, Cuba (the arrow indicates the snake's eye). The nest, wrapped in *Tillandsia* sp. leaves, is situated in the upper area of the photo.

Our observation is the first record of *E. angulifer* preying on *T. dominicensis*. Several authors have mentioned birds in the diet of *E. angulifer* (Henderson and Powell, *op. cit.*) and Vogel (1965. Aquarien Terrarien 12:340–343) reported that the species regularly depredates bird nests, but our observation represents the first documentation of this behavior.

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***ERYTHROLAMPRUS AESCULAPII* (False Coral). DIET.** *Erythrolamprus aesculapii* is a diurnal terrestrial snake that is widely distributed in Brazil (Marques 1996. Rev. Brasil. Biol. 13:747–753). It is strongly ophiophagous, but juveniles also prey on lizards and amphibians. (França et al 2008. Copeia 2008:23–28; Marques and Puorto 1991. Mem. Inst. Butantan. 53:127–134). On 13 April 2012, we dissected an adult female *E. aesclapii* (CRLZ 000290; SVL = 69.21 cm, total length = 76.37cm; 102 g) collected at the Unilavras Biological Reserve – Boqueirão, Brazil (21.34638°S, 44.99083°W, datum WGS84; elev. 1250 m). In the stomach we found a young *Atractus pantostictus* (CRLZ 000345; SVL = 7.63 cm, total length = 9.29 cm; 1.47 g). Although *A. pantostictus* is common in the cerrado (savannah) region of Brazil it has not been previously recorded in the diet of *E. aesculapii*.

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***LEPTOPHIS AHAETULLA* (Swordsnake). DIET.** *Leptophis ahaetulla* is a terrestrial and arboreal snake that feeds primarily on amphibians and secondarily on lizards, small birds, and small mammals (Albuquerque et al. 2007. J. Nat. Hist. 41:1237–1243; Vanzolini et al. 1980. Répteis das Caatingas. Academia Brasileira De Ciencias, Rio De Janeiro. 161 pp.). On 2 October 2011, at 1100 h, in the Estação Ecológica do Tapacurá (8.049°S, 35.221°W, datum: WGS 84; elev. 102 m), São Lourenço da Mata city, Pernambuco, Brazil, we observed a male *L. ahaetulla* (SVL = 93.6 cm) feeding on a male lizard, *Polychrus marmoratus* (Fig. 1; SVL = 13.7 cm). This is the first record of *P. marmoratus* in the diet of *L. ahaetulla*. Photographs of the predation event are deposited Paleoherpetological Laboratory of Universidade Federal Rural de Pernambuco, Recife, Pernambuco, Brazil (CHP UFRPE I001).

We thank the coordinator of the Estação Ecológica do Tapacurá for authorizing the research.



FIG. 1. *Leptophis ahetulla* ingesting a freshly killed *Polychrus marmoratus* in Atlantic forest of northeastern Brazil.

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***LIOPHIS POECILOGYRUS* (Yellow-bellied Liophis). REPRODUCTION.** The colubrid snake *Liophis poecilogyrus* is broadly distributed in South America. Despite recent studies of its reproductive biology (Pinto and Fernandes 2004. Phyllomedusa 3:9–14; Vitt 1983. Herpetologica 39:52–66), no detailed data are available on hatchling size. Herein, we expand the knowledge on the reproductive biology of *L. poecilogyrus* through the record of hatchling morphometry.

At 1140 h on 12 May 2010, a clutch of 7 *L. poecilogyrus* eggs was collected in an urban area of Caucaia Municipality, state of Ceará, northeastern Brazil. The eggs were placed in a terrarium with a humid substrate of sand and leaf-litter, and maintained at room temperature in the laboratory of herpetology of the Núcleo Regional de Ofiologia da Universidade Federal do Ceará. The eggs averaged 2.83 ± 0.14 cm (range = 2.70–3.07 cm) in length and 1.60 ± 0.29 cm (range = 1.07–1.94 cm) in diameter, and all hatched within 24 h of collection. The newborn neonates measured 15.74 ± 0.44 cm (range = 15.10–16.30 cm) SVL; 2.71 ± 0.12 cm (range = 2.59–2.91 cm) tail length; and 2.82 ± 0.09 g (range = 2.64–2.91 g) mass. Hatchling voucher specimens were deposited in the scientific collection Coleção Herpetológica da Universidade Federal do Ceará (CHUFC 3550–3552).

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***MICRURUS OBSCURUS* (Black-necked Amazonian Coralsnake). MAXIMUM SIZE.** The maximum size reported for *Micrurus* species based on an examination of the literature is 1602 mm (*M. spixii princeps*) and 1520 mm (*M. spixii martius*; Roze 1996. Coral Snakes of the Americas: Biology, Identification, and Venoms. Krieger Publ. Co., Malabar, Florida. 340 pp.). However, after examining specimens, Harvey (2003. Ann. Carnegie Mus. 72:1–52) concluded that these records were incorrect. Thus, the correct maximum total length for *Micrurus* is currently 1486 mm, based on a *Micrurus ancoralis ancoralis* from the Andes (Harvey, *op. cit.*). On 10 January 2012, at 1830 h, we found a freshly-killed female *M. obscurus* (SVL = 1480 mm; total length = 1555 mm) in Chácara de Jesus, Rio Branco, Acre, Brazil (9.911880°S, 67.767382°W, datum: WGS84; elev. 173 m). The habitat where the specimen was caught was secondary forest (capoeira) surrounded by pastures, agricultural land, and ponds. Our record exceeds the maximum recorded total length for the species by 210 mm (15%), and 69 mm (5%) for the genus. The specimen (UFAC 0380) was deposited in the herpetological collection at Universidade Federal do Acre. Fieldwork was funded by UNINORTE - Programa de Iniciação Científica and conducted under SISBIO permit n. 27290-1/2011.

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***MICRURUS SERRANUS* (Coral Verdadera). DIET.** *Micrurus serranus* is a small coralsnake endemic to the inter-Andean dry valleys of Bolivia (Harvey et al. 2003. Ann. Carnegie Mus. 72:1–52). While most species of Bolivian coral snakes are distributed in lowland habitats, *M. serranus* generally occurs at higher altitudes, being found at elevations as high ~2750 m (Muñoz-Saravia et al. 2009. Checklist 5:510–512). Data on the diet of this species are lacking. Known prey of *M. serranus* are primarily snakes and amphisbaenians and include *Leptotyphlops striatulus*, *Amphisbaena cegei* (Harvey et al., *op. cit.*), *Lystrophis semicinctus*, and *Oxyrhopus* sp. (A. Langer, pers. comm.). Here we report a new snake species in the diet of *M. serranus*.

We dissected an adult female *M. serranus* (SVL = 545 mm, tail length = 35 mm) that was found dead on a dirt road (18.03°S, 64.15°W, datum WGS 84; elev. 1320 m) on 5 February 2011 in Florida Province, Santa Cruz Department, Bolivia. Inside the *M. serranus* we found an adult male *Apostolepis multicincta* (Dipsadidae; SVL = 290 mm; tail length = 40 mm) that had been ingested head-first (Fig. 1). This report confirms an additional snake species in the diet of *M. serranus*, providing further evidence for its ophiophagous feeding habits.



FIG. 1. Adult female *Micrurus serranus* from Florida Province, Santa Cruz, Bolivia. Protruding from the sides of the body of the *M. serranus* are the head and tail of an adult male *Apostolepis multicincta* that it had consumed.

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***NAJA HAJE* (Egyptian Cobra). DIET / OPHIOPHAGY.** *Naja haje* is a large cobra (to 2.5 m total length) that is distributed across much of North Africa south to the Congo basin and east to Kenya and Tanzania (Trape et al. 2009. Zootaxa 2236:1–25). The diet of *N. haje* is based primarily on anecdotal data, suggesting the consumption of a variety of vertebrates (anurans, small mammals, small tortoises, lizards, small birds and their eggs, and occasionally snakes, including conspecifics; Schleich et al. 1996. Amphibians and Reptiles of North Africa. Koeltz Scientific Publishers, Koenigstein. 630 pp.; Trape and Mané 2006. Guide des serpentes d'Afrique occidentale. Editions, Paris. 226 pp.). Here we report two original observations of ophiophagy by *N. haje* in Dghoumes National Park, in southern Tunisia. The protected area consists of a halophytic zone merging with the Chott El Jerid, an intermediate plain of sub-desert continental steppe, marked by ephemeral watercourses (*wadis*), and a mountain chain to the north.

The first observation occurred at 0830 h on 20 September 2011. EF and an eco-guard discovered an adult *N. haje* (ca. 2

m total length) entwined with an adult female *Cerastes cerastes* (Horned Viper; SVL = 64.0 cm; tail length = 4.8 cm). Their arrival disturbed the snakes and the *N. haje* immediately released the *C. cerastes* and slipped into a bush. The partially paralyzed *C. cerastes* soon died and was preserved. The second observation occurred on 3 October 2011. Two eco-guards observed a recently killed *C. cerastes* surrounded by many snake tracks on the sand. Based on size and length, these tracks were likely from a cobra which we assume had been disturbed while preying on the viper. *Cerastes cerastes* is a specialized semi-fossorial snake that ambushes rodents and lizards while partially buried in soft sand (Young and Morain 2001. J. Exp. Biol. 205:661–665). Because this species is quite common in Dghoumes National Park, it may be a usual prey for an active predator like *N. haje*.

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***NAJA KAOUTHIA* (Monocellate Cobra). REPRODUCTION / EGG SIZE.** *Naja kaouthia* is a non-spitting cobra that inhabits plains and mountains up to 700 m elevation throughout Thailand, Peninsular Malaysia, India, China, Myanmar, Laos, Cambodia, and Vietnam (Cox et al. 1998. A Photographic Guide to Snakes and other Reptiles of Peninsular Malaysia, Singapore and Thailand. New Holland Publishers, United Kingdom. 144 pp.). It also can be found in secondary forests and near human habitation (Ibrahim et al. 2008. The Common Amphibians and Reptiles of Penang Island. The State Forestry Department, Penang, Malaysia, 116 pp.). The total length of this species is up to 200 cm and the females can lay up to 45 eggs in a clutch (Cox et al., *op. cit.*).

On 4 December 2011, an adult female *N. kaouthia* (total length = 130 cm; 1700 g) was found dead (probably killed by villagers) near a paddy field at Kampung Anak Kurau, Taiping, Perak, Malaysia (4.562989°N, 100.470401°E, datum: WGS84; elev. <150 m). Dissection revealed 17 oval eggs that measured (mean ± SD) 5.72 ± 0.35 cm (range = 5.0–6.2) in length, 2.76 ± 0.14 cm (range = 2.5–3.0) in diameter, and weighted 27.94 ± 1.20 g (range = 26–30). The specimen (11USM-BK-NK01) was preserved and deposited at School of Pharmacy, Universiti Sains Malaysia.

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***NERODIA CLARKII CLARKII* (Gulf Saltmarsh Watersnake). PREDATION.** *Nerodia clarkii* inhabits saltmarshes and coastal brackish waters along the Gulf Coast from Florida to Texas and on the northern coast of Cuba (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Institution Press, Washington D.C. 668 pp.). Predators of *N. clarkii* likely include large carnivorous fish, large wading birds, *Agkistrodon piscivorus*, *Alligator mississippiensis*, and *Crocodylus acutus* (Ernst and Ernst, *op. cit.*), as well as large invertebrates such as crabs (Gibbons and Dorcas 2004. North American Watersnakes. Univ. Oklahoma Press, Norman. 438 pp.). To our knowledge, *Callinectes sapidus* (Blue Crab) represents the only previously published observation of a predation attempt on *N. clarkii* (Mohrman et al. 2008. Herpetol. Rev. 39:355–356).



PHOTO BY STEVE REISINGER

FIG. 1. Adult *Grus americana* (Whooping Crane) consuming a *Nerodia clarkii clarkii* at Aransas National Wildlife Refuge, Texas, in February 2012.

On 4 February 2012, an adult *Grus americana* (Whooping Crane) was observed and photographed (Fig. 1) consuming a *N. clarkii* at the Aransas National Wildlife Refuge, Aransas Co., Texas, USA (28.15294°N, 96.89620°W; datum WGS84). The crane consumed the snake headfirst after manipulating it for a short time. This observation represents the first documented vertebrate predator of *N. clarkii*. Diets of Whooping Cranes on wintering grounds in Texas mainly consist of Blue Crabs and clams, with other commonly reported prey items consisting of fish, snails, acorns, fruit of Carolina Wolfberry (*Lycium carolinianum*), and crayfish (Allen 1952. The Whooping Crane. Research Report 3, National Audubon Society, New York. 246 pp.; Hunt and Slack 1989. J. Wildl. Manage. 3:1150–1154). An *A. piscivorus* and unknown watersnake (possibly *N. clarkii*) were reported as prey items of Whooping Cranes in Texas (Allen, *op. cit.*). Understanding the diet of Whooping Cranes, especially when crabs and other common prey items are unavailable, such as during

droughts, will assist conservation efforts to protect habitats and associated prey items on wintering grounds and during migration.

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***RHINOCEROPHIS AMMODYTOIDES* (Yararanata). DIET.** *Rhinocerophis ammodytoides* is a medium-sized pitviper endemic to southern Argentina (Carrasco et al. 2010. Amphibia-Reptilia 31:323–338). The diet of this species is known to include small vertebrates such as lizards and rodents (Cei 1993. Reptiles del Noroeste, Nordeste y Este de la Argentina. Herpetofauna de las Selvas Subtropicales, Puna y Pampas. Mus. Reg. Sci. Nat. Torino. 945 pp.; Martins et al. 2002. *In* Schuett et al. [eds.], The Biology of Pitvipers, pp. 307–328. Eagle Mountain Publ., Eagle Mountain, Utah). Here we report two novel lizard prey species for *R. ammodytoides*: *Pristidactylus scapulatus* (Leiosauridae) and *Liolaemus cf. ruibali* (Liolaemidae).

At 1500 h on 2 April 2012, we captured a subadult female *R. ammodytoides* (total length = 422 mm) in Quebrada Vallecito, Andes Mountains, Calingasta Department, San Juan Province, corresponding to pre-Andean limit of the occidental Monte Phytogeographic Region, Argentina (31.20°S, 69.28°W, datum WGS84; elev. 2860 m). The snake contained an obvious food item and dissection revealed a recently ingested *L. cf. ruibali* (SVL = 60 mm) and the posterior portion of a *P. scapulatus* (SVL ca. 70 mm) in the stomach (Fig. 1). Together, the prey totaled 15% of the snake's mass. The snake and prey were deposited in the Colección Herpetológica de la Universidad Nacional de San Juan (UNSJ).

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FIG. 1. *Rhinocerophis ammodytoides* from San Juan Province, Argentina, with two novel lizard prey, *Pristidactylus scapulatus* and *Liolaemus cf. ruibali.*

***SENTICOLIS TRIASPIS* (Green Ratsnake). DIET.** *Senticolis triaspis* is known to feed on small rodents, lizards, and birds (Reyna-Bustos et al. 2007. Anfibios y Reptiles del Bosque La Primavera. CUCBA, Gobierno de Jalisco. 125 pp.; Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna between Two Continents, between Two Seas. University of Chicago Press, Illinois. 934 pp.; Vázquez and Quintero 2005. Anfibios y Reptiles de Aguascalientes. CONABIO, CIEMA. 318 pp.). As with ratsnakes (*Pantherophis* spp.) and other semi-arboreal species, *S. triaspis* may inhabit caves where they presumably feed on bats (Schulz 1996. A Monograph of the Colubrid Snakes of the Genus *Elaphe* Fitzinger. Koeltz Scientific Books, Czech Republic. 439 pp.). Herein we report the first account of *S. triaspis* consuming a bat, *Eptesicus fuscus*.

On 12 August 2011, a juvenile *S. triaspis* was found in the municipality of Tuxcueca, Jalisco, Mexico (20.1397777°N, 103.1514444°W, datum WGS84; elev. 1635 m). The snake was crawling out of a hole in a wall full of bat refuges, about 2 m above the ground. When we captured the snake we detected the presence of a large prey item in its stomach and the snake subsequently regurgitated when placed in a bag. The recently ingested prey was identified as a bat, *Eptesicus fuscus* (Fig. 1). The wall bordered an ephemeral stream in tropical deciduous forest and was shared by other species of bats (*Artibeus hirsutus, A. jamaisencis, Tadarida brasilensis*, and another unidentified species).



FIG. 1. Prey item (*Eptesicus fuscus*) regurgitated by a *Senticolis triaspis* from Jalisco, Mexico.

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***STEGONOTUS CUCULLATUS* (Slaty-grey Snake). DIET.** *Stegonotus cucullatus* is a colubrid snake native to the tropics of Papua New Guinea and Australia (Greer 1997. The Biology and Evolution of Australian Snakes. Surrey Beatty & Sons Pty Ltd., Chipping Norton. 358 pp.). The diet of *S. cucullatus* is varied, comprised largely of reptile eggs, but also includes insects, frogs, lizards, fish, and mammals (Brown et al. 2005. J. Trop. Ecol. 21:605–612; Greer, *op. cit.*; Trembath et al. 2009. Aust. J. Zool. 57:119–124).

A road-killed male *S. cucullatus* (SVL = 104 cm; total length = 124 cm) was collected at 1945 h on 19 May 2011 on the Arnhem Highway, in the tropics of the Northern Territory, Australia (12.65°S, 131.32°E; datum WGS84). On dissection its digestive

tract was found to contain a large (SVL = 11.81 cm) primarily undigested agamid lizard (*Amphibolurus temporalis*). Within its distribution, *A. temporalis* is similar in appearance to *Amphibolurus gilberti*, from which it was distinguished on the basis of dorsal scale keel orientation (Wilson and Swan 2003. A Complete Guide to Reptiles of Australia. Reed New Holland, Sydney. 480 pp.). The only species of agamid previously recorded as a prey item for *S. cucullatus* is *Diporiphora* sp. (Shine 1991. Copeia 1991:120–131). Because *S. cucullatus* is primarily nocturnal and a capable arboreal predator (Brown et al., *op. cit.*), and *A. temporalis* is diurnal and generally sleeps in trees, it is likely that *S. cucullatus* preys on these large agamids during their sleep.

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***THAMNOPHIS EQUES* (Mexican Gartersnake). MORTALITY.** Abandoned, lost, or otherwise discarded fishing gear (ALDFG) represents a growing risk to aquatic environments. The ability of ALDFG to continue to fish (often referred to as "ghost fishing") has detrimental impacts on fish and other aquatic organisms (Macfadyen et al. 2009. Abandoned, Lost or Otherwise Discarded Fishing Gear. UNEP Regional Seas Reports and Studies, No. 185; FAO Fisheries and Aquaculture Technical Paper, No. 523. Rome, UNEP/FAO. 115 pp.). Here we report the death of two *Thamnophis eques* in abandoned fishing nets (ALDFG).

On 11 March 2012, during a visit to the shore of Lake Chapala near the pumping station in the Municipality of Chapala, Jalisco, México (20.311377°N, 103.142034°W, datum WGS 84; elev. 1530 m), we found two dead adult *T. eques* trapped in ALDFG (Fig. 1). Both individuals were located on the edge of a canal leading to the pumping station, a site commonly visited by local fishermen who usually fish with nets. On previous visits to the site we observed other organisms killed in abandoned fishing nets, mainly fishes but also several *Thamnophis melanogaster*. Further research is needed to determine the impact of the ALDFG in the local fauna of Lake Chapala.



FIG. 1. Two dead adult *Thamnophis eques* trapped in abandoned fishing nets at Lake Chapala, Jalisco.

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***THAMNOPHIS EQUES MEGALOPS* (Northern Mexican Gartersnake). PREDATION.** Documented instances of fish preying on snakes are generally rare and the extent to which these events affect local populations is unknown. Recent records including a brown trout preying on *Pituophis catenifer* in Utah, USA (Wamback and Engemen 2011. Herpetol. Rev. 42:618–619), a Rainbow Trout with a *Notechis scutatus* in its stomach in Australia (Clear 2011. Herpetol. Rev. 42:442–443), and a Longnose Gar attacking *Pantherophis spiloides* in Illinois, USA (McCallum et al. 2011. Herpetol. Rev. 42:443), demonstrate that a variety of fish species likely prey on snakes when provided the opportunity. Predators such as nonnative fishes, in combination with other threats, have undoubtedly contributed to the decline of *Thamnophis eques megalops* populations throughout all or portions of its range (U.S. Fish and Wildlife Service 2008. Fed. Reg. 73:71778–71826). One nonnative predator, *Micropterus salmoides* (Largemouth Bass), will apparently prey on "any moving thing small enough to swallow" (Minckley 1973. Fishes of Arizona. Arizona Game and Fish Dept., Phoenix, Arizona. 293 pp.), however, we are aware of few instances of bass preying specifically on gartersnakes (Hodgson and Hansen 2005. J. Freshwater Ecol. 20:793–794),



PHOTO BY DON ALTRINGER

FIG. 1. Largemouth Bass (*Micropterus salmoides*), attacking an adult *Thamnophis eques megalops* at Bubbling Ponds Hatchery, Arizona, USA. The bass in the foreground is indicated with a black arrow, and has swallowed much of the posterior half of the snake, while another bass can be seen behind the snake.

despite the apparent assumption that it occurs relatively commonly (U.S. Fish and Wildlife Service, *op. cit.*). Here we describe two instances of predation by Largemouth Bass on *T. eques* that we documented during a study of the gartersnakes at Bubbling Ponds Fish Hatchery, Yavapai Co., Arizona, USA (34.765°N, 111.895°W; datum NAD83).

Largemouth Bass maintained in a single, earthen pond at the hatchery average 1.3–1.8 kg (400–500 mm standard length), with some larger individuals reaching over 2 kg. At 1030 h on 16 July 2010, we witnessed a neonate *T. eques* enter the pond, startled off the bank by our approach. Immediately, a Largemouth Bass engulfed the snake. After momentarily releasing the snake, the bass bit it again and appeared to swallow the snake. At 1000 h on 22 June 2011, a visitor to the hatchery observed a Largemouth Bass attacking the tail of an adult (ca. 600 mm total length) *T. eques* (Fig. 1). The snake struggled to continue swimming for ca.15 min. Eventually it was dragged under water, after which several other bass attacked it as well, and the snake was not seen again. Although the frequency with which bass prey on snakes appears to be low (J. R. Hodgson, pers. comm.), the implications of these observations for conservation of *T. eques* are clear; conversion of aquatic habitats to impoundments stocked with bass has the potential to seriously affect small local gartersnake populations.

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***THAMNOPHIS GIGAS* (Giant Gartersnake). MOVEMENT.** *Thamnophis gigas* historically inhabited marshes in the Central Valley of California, but currently inhabits rice fields and their supporting infrastructure of canals in the Sacramento Valley (northern portion of the Central Valley). Because of extensive habitat loss, *T. gigas* is listed as Threatened by the State of California and the U.S. Fish and Wildlife Service. Existing populations of *T. gigas* are often fragmented by inhospitable habitats (uplands, forests, most agriculture) and roadways. We report the movement of an individual *T. gigas* across a busy highway, and suggest that movement occurred through a culvert.

On 8 July 2010, one of us (ECH) captured, marked, and released a small (SVL = 362 mm; mass = 30 g) female *T. gigas* 349 m east of California Highway (CA Hwy) 99 in Sacramento Co., California, USA. On 5 July 2011, the same individual was recaptured 928 m to the west of the original capture location (579 m west of CA Hwy 99; Fig. 1). The individual had grown 263 mm and gained 104 g in the intervening year. She was subsequently captured on 6 July 2011, 99 m east of her location on 5 July 2011, and again on 7 July 2011, 133 m east of her location on 6 July 2011 (Fig. 1). She might represent a young female dispersing to establish a stable home range.

The snake's movement across CA Hwy 99 is significant because of the volume of traffic on and characteristics of CA Hwy 99 and characteristics of the box culvert through which the individual likely passed. CA Hwy 99 consists of four lanes of traffic (each direction is paved for a width of 13 m) separated by an 11 m median consisting of herbaceous vegetation. To the east, the road is bordered by 28 m of herbaceous vegetation, then a 9-m wide canal oriented north-south, with about 10 m between the east bank of this canal and the end of the east-west canal in which the individual was initially captured. A small (approx. 0.6 m diameter) cylindrical culvert connects the east-west canal to the north-south canal. To the west, CA Hwy 99 is bordered by 23 m of herbaceous vegetation, then a 5 m wide canal oriented north-south, with about 18 m between the west bank of this canal and the end of the east-west canal in which the individual



FIG. 1. Observations (yellow dots, with dates), locations of culvert openings (black stars), and potential movement paths (red lines; solid = culvert passage, dashed = direct overland route) of *Thamnophis gigas* #1461. Note that 2010 and 2011 observations are bisected by California Highway 99.



FIG. 2. The 1.8 m x 1.8 m box culvert 89 m long through which *Thamnophis gigas* #1461 likely passed. The culvert is located 1.2 km south of the east-west canal in which the individual was captured.

was subsequently captured. *Thamnophis gigas* are highly aquatic and rarely move more than a few meters from aquatic habitats (USGS, unpubl. data), so the total overland distance of 130 m (including the 14 m of north-south canals) itself represents a substantial barrier to movement.

In addition to the distance over which upland movements would have to occur, CA Hwy 99 has very high traffic volumes. In 2002, average annual daily traffic volume was 41,000 vehicles (CA DOT; www.dot.ca.gov). This volume of traffic is nearly four times that reported for US Hwy 441 in Florida, where culverts and barrier walls were constructed to reduce mortality of small vertebrates (Dodd et al. 2004. Biol. Conserv. 118:619–631). It is likely that residential and commercial development in the Natomas Basin have substantially increased traffic volumes since 2002. The high volume of traffic and great width of CA Hwy 99 make it highly unlikely that the individual crossed the road's surface.

If the individual did not cross over the road's surface, it could have crossed under CA Hwy 99 through culverts located 1.2 km south or 1.6 km north of the canal in which the individual was captured. The culvert to the south was a single box culvert approximately 1.8 m wide x 1.8 m tall x 89 m long, with an approximate water depth of 0.2 m and air clearance of 1.6 m (Fig. 2). Use of this culvert would imply a net movement of 3.3 km over 362 days. The culvert to the north was a double box culvert, with both passages measuring 2.1 m wide x 2.1 m tall x 102 m long. In contrast to the south culvert, these culverts are located near a pumping station, and were nearly filled with water (20 cm air space on 1 May 2012). Use of these culverts would imply a net movement of approximately 4.1 km. Because of the shallower depth and slower movement of water, greater light penetration, greater air space, and closer proximity to the canal in which the individual was captured, we suggest that the individual more likely passed through southern culvert than the northern culverts.

The characteristics of ideal culverts for wildlife crossings (wide, short length, allowing the penetration of light, and with fences to direct movement away from the road and into the culvert; Yanes et al. 1995. Biol. Conserv. 71:217–222.; Woltz et al. 2008. Biol. Conserv. 141:2745–2750) are in marked contrast to the long, narrow box culvert through which the individual likely passed. If individual *T. gigas* pass through culverts of this type and length, it is likely that bridges and culverts of shorter length or greater width would allow, at a minimum, genetic connectivity among populations separated by roadways. Examining the probability of use of culverts of different characteristics and enhancing culverts to improve passage rates of *T. gigas* will promote gene flow and could maintain demographic connectivity among otherwise fragmented populations.

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***THAMNOPHIS VALIDUS CELAENO* (Baja California Gartersnake). ARBOREALITY.** Terrestrial and arboreal habitats differ in the type and amount of prey they offer, vulnerability to predation, and in physical factors such as temperature and humidity. Many snake species are highly specialized for either terrestrial or arboreal life and rarely exploit alternative habitats (Shine et al. 2005. J. Therm. Biol. 30:179–185). However, some taxa display ontogenetic shifts in habitat use or use a broader range of habitats on occasion (Shine et al. 2002. Ethology 108:897–910). Species in the genus *Thamnophis* are primarily terrestrial, although some species occasionally climb in vegetation. For example, *T. sirtalis parietalis* (Red-sided Gartersnakes) use arboreal habitats to access higher temperatures than those available on the ground (Shine et al. 2005, *op. cit.*). *Thamnophis validus* is a semi-aquatic species with a fragmented distribution in the water systems of the Cape Region, Baja California Sur, México (Grismer 2002. Amphibians and Reptiles of Baja California, including its Pacific Islands and the Islands in the Sea of Cortes. Univ. California Press, Berkeley. 399 pp.). *Thamnophis validus* is primarily nocturnal, which distinguishes it from many other gartersnakes (Rossman et al. 1996. The Garter Snakes: Evolution and Ecology. Univ. Oklahoma Press, Norman. 336 pp.), and is strongly tied to aquatic habitats (De Queiroz et al. 2001. Copeia 2001:1034–1042). Herein we report the first account of arboreal habitat use for *T. validus celaeno*.



FIG. 1. *Thamnophis validus celaeno* in El Chorro, Agua Caliente, Baja California Sur, México, *in situ*, exhibiting arboreal behavior.

On 30 August 2011, at 2045 h (air temp. = 28.7°C), we observed a juvenile female *T. validus celaeno* (SVL = 213 mm; total length = 286 mm; 7.5 g; cloacal temp. = 32.9°C) 40 cm above the ground in *Ambrosia monogyra* vegetation (Fig. 1) along the margin of a pond in El Chorro, Arroyo Agua Caliente, Baja California Sur, México (23.43996°N, 109.80757°W, datum: WGS84; elev. 182 m). This species has also been seen climbing on *Typha dominguensis* at this same locality and on *Baccharis salicifolia* in Cañon de la Zorra (A. Cota pers. comm.), both localities on the eastern slope of the Sierra de la Laguna, Baja California Sur. Because *T. validus* feed primarily on aquatic prey, we suggest that this may be a thermoregulatory behavior.

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BOOK REVIEWS

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Contributions to the History of Herpetology. Volume 3

edited by Kraig Adler. 2012. Contributions to Herpetology, Volume 29. Society for the Study of Amphibians and Reptiles, Vancouver, British Columbia, Canada (www.ssarherps.org). 564 pp. Clothbound. US $75.00. ISBN 978-0916984-82-3.

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At the First World Congress of Herpetology (1989) all delegates were presented with an amazing book relating to the history of herpetology containing sections by Kraig Adler (Herpetologists of the Past), John S. Applegarth (Index of Authors in Taxonomic Herpetology), and Ronald Altig (Academic Lineages of Doctoral Degrees in Herpetology). It was the talk of the meetings and provided hours of consultation during the following years. In 2007, on the occasion of the celebration of the golden anniversary of the founding of the Society for the Study of Amphibians and Reptiles, the same authors produced a follow-up of 389 pages. It was again an exciting and scholarly insight into the history of herpetology with many new biographies added by Adler and updates and expansion of their sections by Applegarth and Altig. The present volume is the third iteration in the series by Adler, Applegarth, and Altig, issued at the Seventh World Congress of Herpetology held at the University of British Columbia in August, 2012. We all must be grateful to these authors for providing the herpetological community with these in-depth treatments of the people who made herpetology what it is today. There is no other sub-discipline of zoology that can boast of a similar wide-ranging, detailed, and original coverage of the majority of figures that have contributed to our field, from Nicander of Colophon (ca. 197–130 B C.) to John T. Thorbjarnarson (1957–2010 A.D.).

The Herpetologists of the Past is the longest section and, as in the previous two volumes, is worldwide in coverage providing a biography, portrait, and signature of each treated subject (N.B.: In a very few cases signatures or portraits were unavailable). In addition, there are short sketches of individuals mentioned in the main biographies but without the accompanying portrait or signatures, usually in the endnote following a biography. Biographies are clustered around the time period when the covered individual was active in herpetology. For the period 1820 to 1960, the clusters are for half decade timeframes (e.g., 1820–1825) but by decade thereafter. Many other herpetologists are mentioned in the context of their relationship to the individual covered by the main biography. The biographies in this section bring to 786 the individuals covered in the main biographies in the series. As in earlier volumes no living herpetologists are included. I note that as the series progressed the average biography became longer with an increasing depth of coverage of the subject's contributions.

While the two earlier volumes, because of the trajectory of the development of the field, included mostly European and American scientists, Volume 3 has extensive biographic essays on Russian, Japanese, Chinese, Indian, and Brazilian herpetologists, among others. It also provides a significant coverage of pre-Linnaean contributors to our field. The fuzzy limits of who is a herpetologist have also been expanded between 1989 and 2012. Of course the early workers, at least in the post-Linnaean period, were frequently medical doctors and usually would have considered themselves to be both physicians and naturalists. The notion of a separate sub-discipline of herpetology was a 20th century construct. I think that a number of folks portrayed from later periods, especially in the late 19th and 20th centuries would have called themselves an embryologist, physiologist, geneticist, etc., rather than a herpetologist. However, their inclusion provides a significant historical context to the entire section. The Herpetologists of the Past concludes with a comprehensive index to all names of herpetologists in the biographies and the mini-biographies, and names of all herpetologists mentioned in the body of the main accounts. Adler notes his sections provide a basis for a comprehensive history of herpetology, one that I could imagine being like the classic *Ornithology from Aristotle to the Present* by Erwin Stresemann (1975). Kraig, maybe it's about time you started on it.

When I first started in herpetology there were probably less than 250 herpetologists worldwide. Almost everyone was exchanging publications and corresponding with one another, often by handwritten correspondence. Almost every one of these colleagues is included in one of the three Adler volumes. In those days annual meetings of the American Society of Ichthyologists and Herpetologists would have a couple hundred attendees. Now there are so many in the field that we have become extremely specialized with few having a broad knowledge across geographic and many taxonomic boundaries. Perhaps the last herpetologist with worldwide knowledge akin to that of the Dumérils and Bibron, Boulenger, and Cope was Robert Mertens, who personally collected and published on amphibians and reptiles from every continent except South America. However, it

is clear with the many intellectual and technological advancements of recent years (e.g., cladistic analysis, computers, GPS, PCR, genomics, tomography, etc.) that the present century is a golden age for our field of study. Adler's Herpetologists of the Past provides a reminder of the notable achievements of our predecessors who made extraordinary contributions to the framework of herpetology and provided the foundation for all future research.

The second section, The Index of Authors in Taxonomic Herpetology, has been extensively revised and expanded from the two earlier iterations. It now contains 5,290 names, double the number listed in Volume 2. The list consists of the full name of the individual, dates, country of residence, and the order or orders of amphibians and reptiles for which the individual has published a new genus-group or species-group name. Also listed are the same data for all herpetologists who have had one or more taxa within the living orders of amphibians and reptiles named for them and have published at least one herpetological paper. This list happily includes many extant herpetologists. As acknowledged by the author, this is a list in progress because it was not always possible to ascertain details of all relevant entries about an individual from existing sources. He encourages all readers who have additional information to contact him as he plans a continuous update. Hopefully this may be set up as a website.

The third section on Academic Lineages is completely updated and expanded and contains 57% more entries than the 2007 version. It includes the names of each herpetologist who was the professor/mentor to one or more doctoral students. The information is arranged by series within a particular country so that succeeding derived generations can be followed both forward and backward. The section contains 5,562 names. The most populated lineage in the list is from Louis Agassiz through his students and their students to form 273 separate doctoral lineages consisting of 1,461 descendents. Agassiz was a student of Lorenz Oken but also identified himself with Alexander von Humboldt with whom, one might say, he did a post-doc at the Paris Museum. The association of the two is made clear by the placement of life-sized statutes of these two giants of biology on the second-story facade of Jordan Hall, the original biology department building at Stanford University, by the university's first president David Starr Jordan. Jordan is listed as a student of Agassiz in Altig's treatment. Because of Agassiz' preeminence as the founder of this lineage the majority of herpetologists active in the United States today are academic cousins. This section concludes with an index to all names for ready reference.

There is, of course, a serious problem with this great work. Once one opens it to read a biography, check on a taxonomic herpetologist, or follow an academic lineage, one can't put it down because the next page and the one after that are so inviting! That having been said, everyone reading this review should have a copy of the *Contributions* in their library, preferably near their desk as an essential reference and a reminder of the history that underpins our own ongoing contributions to herpetology.

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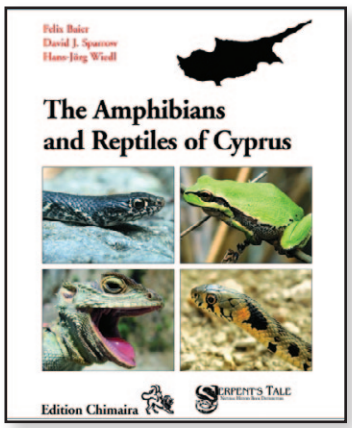
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The Amphibians and Reptiles of Cyprus

by Felix Baier, David J. Sparrow, and Hans-Jörg Wiedl. 2009. Edition Chimaira, Frankfurt, Germany (www.chimaira.de). 364 pp. Hardcover. EUR 49.80. US $79.95. ISBN 978-3-89973-476-8.

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The Frankfurt Contributions to Natural History ("Frankfurter Beiträge zur Naturkunde") series has been equipping amateur as well professional herpetologists with fine field guides for nearly two decades. Depending on their particular scope, these mostly handy books allow for the identification of all known members of discrete taxa (single families, frogs, lizards, reptiles, etc.) or the entire herpetofauna of the treated territory. Books in this series feature a black silhouette map of the region under consideration on a white cover. Volume 45 of "the white series" is dedicated to the easternmost of the Mediterranean Sea's large islands, Cyprus. The team of authors is nicely heterogeneous in every aspect. Whereas the German senior author was an undergraduate student of biology and philosophy in his early twenties at the time of publication, his co-authors are more than 40 years older—a British photographer with a PhD in chemistry and an expatriate Austrian residing and running a reptile park on Cyprus. However, all three share a passion for amphibians and reptiles and have a long familiarity with the island.

As the Minister of Agriculture, Natural Resources and Environment of the Republic of Cyprus points out in his foreword, the book "fills a long-standing need." In their following preface, the authors specify that this need is two-fold, as addressed by the scope of their work. The first aim is to summarize existing knowledge of the Cypriot herpetofauna which, according to them, has received little scientific attention in the past. The book's second purpose is to provide a solid source of information as well as an identification guide for the non-expert and especially the island's residents.

The Materials and Methods section concisely outlines the scope of the different sections of the species accounts and elucidates the sources and processing of the data presented. Before listing the abbreviations used in the text, the authors briefly but thoroughly justify the exclusion of certain doubtful species records from Cyprus (e.g., *Zootoca vivipara*) mentioned by previous workers.

The two-fold approach pursued by the authors manifests itself in the subsequent introduction, the first part of which is dedicated to Cyprus itself. The reader is familiarized with the island's geography, geology, and tectonic history, aided by physical and political maps as well as photographs of major geological units. Likewise, the section on climate and vegetation is

complemented by representative pictures of its four major vegetation types, for which typical plant species are listed, and by a brief summary of the island's botanical diversity and endemism. Clearly directed at the non-herpetologist, the introductory chapter's second half provides a short course on herpetology, spanning the history of herpetology and systematics, the principles of classification and taxonomy, the evolution of amphibians and reptiles as well as aspects of their ontogeny, anatomy, physiology, sensory perception, behavior, vocalization, and reproductive and feeding strategies. Here the authors have successfully managed to condense a great an amount of meaningful information into just twelve pages while both maintaining a coherent flow of ideas and keeping the highly concise text perfectly intelligible to the layman.

Species accounts for three anurans and 27 reptile species occupy more than two thirds of the book. Preceding their respective specific accounts, the alphabetically arranged orders and families are each briefly characterized. With the exception of shorter accounts for five species whose records from Cyprus require substantiation (*Eirenis levantinus, Natrix tessellata, Platyceps najadum*) or which have been introduced by man (*Trachemys scripta* and *Testudo* spp.), all species accounts are adequately detailed and consistently organized. For widespread taxa, the information presented explicitly refers to the Cypriot populations when available.

The scientific name, author, year of publication, and English common name(s) comprise the headline for each account and are followed by common names in Greek and Turkish. Starting with the first historical mention of the species from the island, the paragraph on taxonomy details the taxonomic history of its populations on Cyprus, thereby discussing nomenclatural changes and their applicability to the Cypriot populations in detail, usually down to the subspecies level. A short diagnosis defines the population, endemic subspecies, or endemic species found on Cyprus; i.e., this paragraph is not intended for distinguishing a Cypriot specimen of a certain species from specimens of other species found on Cyprus, but rather from non-Cypriot specimens of the same, or a closely related, species.

An additional detailed description of external morphology and coloration will allow for a reliable identification of any amphibian or reptile encountered on the island. However, in most cases where the animal in question is alive and complete, the reader will not have to consult it in full, given the brilliant photographs illustrating different color variants, morphological details and, where relevant, developmental stages, of every species. On the other hand, the professional reader will be delighted by the detailed characters of scalation and even more by the fine head drawings provided for seven lizard and seven snake species.

The altitudinal distribution on Cyprus of each species is delineated along with its entire geographic range. A clear point distribution map combines locality records from a handful of key publications listed in the Materials and Methods chapter with those from the large dataset generated by the authors during their own field studies. A minor drawback of these maps is that the contours indicated (determined by me to be at 300, 700, and 1300 m asl) are not mentioned anywhere. A "Biogeographic classification" section assigns each species to a zoogeographical subregion of the Palaearctic.

A paragraph on ecology details the habitat(s) occupied by the species on Cyprus and varied aspects of its life history, such as seasonal activity patterns, reproduction, prey, predators, abundance, and population ecology. Syntopic occurrences with other herpetofaunal species are listed along with present threats and conservation status. The concluding section on behavior merges mostly rather general behavioral traits reported from the literature with numerous specific observations made by the authors.

The species accounts as a whole, and especially their sections on distribution, ecology, and behavior, benefit greatly from the combined long-term experience of the three authors with the island and its herpetofauna. Luckily, cameras must have been at hand throughout their field trips, as photographs of mostly superior quality illustrate many ecologically and behaviourally salient points, in addition to the more standard portrait and habitat shots. Typical examples include defensive postures and actions, utilization of different substrates, and a variety of predation events.

The fourth chapter presents a brief zoogeographical analysis that reveals that a large fraction of the species belong to the Eastern Mediterranean and/or Irano-Turanian regions as defined by the authors. Furthermore, three species and eight subspecies are currently regarded as endemic to Cyprus. Apart from a short discussion of possible cases of island dwarfism and gigantism among the Cypriot herpetofauna, the authors summarize published information on divergence time estimates and compare these to the island's geological history. Discussing different immigration times and scenarios, they reach the conclusion that both overland (during the Messinian Salinity Crisis) and oversea dispersals have contributed to the current herpetofaunal assemblage. Pointing out the few dating approaches that have been undertaken to present, as well as several indications of faunal divergences between the island's two separate mountain systems, they pinpoint open questions and delineate possible directions for future research.

Subsequently, a short chapter provides examples how the herpetofauna—mostly reptiles—have influenced human culture on Cyprus. In turn, the book's last chapter is concerned with the opposite relationship; after identifying the principal threats that Cypriot amphibians and reptiles currently face, all of which are linked to anthropogenic activity, the authors summarize existing conservation legislation and programs as well as the state of environmental education, inevitably concluding that much remains to be done for the conservation of the island's terrestrial herpetofauna, especially the three taxa which they regard as most seriously threatened: *Mauremys rivulata, Hierophis cypriensis,* and *Natrix natrix cypriaca.*

A twelve-page glossary assures that not a single non-herpetologist will be left wondering about the meaning of any technical term, twenty-two pages of references provide the interested reader with every opportunity for further reading, and a systematic index helps to locate mentions of organism as well as place names. Last but not least, the book is completed with two fine appendices: Appendix I provides a polytomous identification key in full-phrase question style that focuses on easily detectable features of external morphology and usually offers several characteristics per question. As the key is explicitly directed at the non-specialist, the trade-off of the greater precision and efficiency of a "professional" key for increased intelligibility can be seen as a successful strategy. Appendix II deals with snakebite on Cyprus, and does so excellently. Its first part very clearly contrasts the bites of Cypriot colubrids with those of the native viper and separates misbelief from reality and the second part gives reasonable step-by-step advice for first aid after a viper bite, including Cypriot emergency and hospital phone numbers.

In conclusion, *The Amphibians and Reptiles of Cyprus* is more than a field guide to 30 species inhabiting an island. It is also

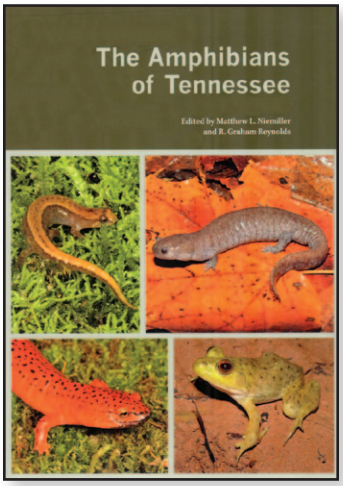
more than a summary of scattered publications on these species. Much more, it is the best possible result of a profitable alliance of three passionate connoisseurs of a micro-continent somewhere between southwestern Asia and southeastern Europe and its herpetofauna. From another perspective, it is a prime example of how a sophisticated treatment of a geographically restricted herpetofauna may be realized. The book seems to contain virtually every bit of knowledge generated so far on any aspect of the amphibians and reptiles of Cyprus and should be an equally valuable source of information for the herpetologist (amateur or professional), the conservationist, the local resident, and the visitor with an interest in wildlife. Simultaneously, its portability and durable binding certainly qualify it for real-life use outside of hotel rooms or libraries. If Cyprus is on your travel agenda, this hybrid between reference work and field guide should be on top of your packing checklist. No wonder a second edition is in preparation for 2013.

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The Amphibians of Tennessee

edited by Matthew L. Niemiller and R. Graham Reynolds. 2011. University of Tennessee Press, Knoxville, Tennessee (www.utpress.org). Hardcover. 369 pp. US $39.95. ISBN 978-157233-762-6.

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In the United States, Tennessee has one of the highest levels of amphibian species richness and diversity, including many endemics. Furthermore, Tennessee has a wide range of ecoregions, from the Mississippi Alluvial Plain on the western border, with a high average annual temperature and an overall low elevation, to the Blue Ridge Mountains at the eastern edge, with low average annual temperatures and overall high elevation. This gradient of ecoregions across the state allows for the great diversity of amphibian species. Until this book was published, the primary guide to amphibians of Tennessee was the *Atlas of Amphibians in Tennessee* (Redmond and Scott 1996), which—as an atlas—provided primarily distributional data and gave only short descriptions without photos or keys. Although this book is available online (www.apsu.edu/amatlas/), changes to taxonomy and increased research on amphibians of Tennessee certainly warranted an updated and more extensive publication on the topic. Other quality guides are available for amphibians in Tennessee such as *The Amphibians of Great Smoky Mountains National Park* (Dodd 2004), but no up to date field guide covers the entirety of the state and the diversity of habitat types it encompasses.

The book appears to be well constructed, with flex binding that keeps the book light but still durable. As of this writing, I have been abusing it for two months, including taking it on a field trip to the Cherokee National Forest and the Great Smoky Mountains National Park, and it has yet to show any real damage. A casual flip through the book reveals many gorgeous photographs. All species accounts contain multiple photos, including a larval representative when appropriate. Similarly, the aesthetically pleasing design of the book highlights important information while also making it easy to navigate for amateur and professional herpetologists alike.

The Amphibians of Tennessee is similar to many other guide books in that it is broken into several parts. The first part contains information about habitat, conservation issues, and general amphibian knowledge. Niemiller and Reynolds do a great job detailing amphibian biology, including large easy to interpret photographs of important morphological characters and diagrams of the typical measurements taken on specimens. Much of the general information on amphibians will be too basic for a seasoned herpetologist to benefit from, but it is by no means trivial and will certainly benefit the people new to the study of amphibians or those simply wanting to know more about local wildlife. The editors also present an informative section of the physiography, climate, and habitats of Tennessee, with many useful maps and photographs. As with any field guide there is also a section on finding amphibians in Tennessee. This will be especially useful for people just beginning in herpetology, especially as it makes people aware of the existence of local, state, and federal laws that govern collecting activities. Furthermore, this section also strongly highlights the importance of returning cover objects to their original position, certainly a good habit for all young field herpers to develop and one that even some of the most experienced need to be reminded of from time to time. The second and third parts of the book comprise species accounts of salamanders and frogs, respectively. Each account section begins with a map displaying the number of species per county and a taxonomic key for that particular group. The key is immediately followed by the species accounts, ordered alphabetically first by family, then by genus and species. Each account contains seven (salamanders) or eight (frogs) subsections, a map of the species' range in Tennessee, and several photographs. The subsections are standard for field guides and are presented in the following order: 1) a basic description of the species, 2) the etymology of the scientific name, 3) similar species, focusing on species one might see in Tennessee, 4) distribution, again with focus on their range in Tennessee, 5) habitat in which the species is found, 6) natural history, including reproduction, diet, potential predators, etc., 7) vocalization (anurans only), and finally, 8) conservation status. At the end of the book, following the species accounts, there is also a section covering species which have been reported to occur in Tennessee but remain unverified. This information can be especially useful when an animal is found but does not match the description of any of the native species. The editors also included a checklist of the amphibians of Tennessee and a list of additional readings on select topics. Finally, the book also contains a comprehensive glossary.

An additional feature, spread throughout the text, and my favorite component of this publication, is the field notes sections. These are 1–2 page narratives of interesting experiences the editors have had while searching for amphibians in Tennessee. These stories are great for generating interest in amphibians and instilling a lifelong passion for wildlife. I will always remember the first time I witnessed a spring migration of amphibians to breeding ponds in northern Ohio; it was an experience that

helped solidify my interest in herpetology. Reading the field note accounts in *The Amphibians of Tennessee* elicits a similar response and makes me want to get out in the field to look for amphibians.

I only have a few small criticisms of the book. The size of the book is both a pro and con. At approximately 7 inches wide and 10 inches tall, the editors were able to include a large amount of information while still maintaining a very clean and uncluttered design. They were also able to include large photographs to illustrate morphological characters. Larger photos were also ideal because they highlight the quality of the photographs used in the book as even stunning photographs can seem mundane when shrunk down. However, the books dimensions make it less ideal for field situations. I already know this book will be a fixture in my vehicle, but I am probably less likely to want to carry it out into the field with me. Furthermore, the range maps for the species accounts were used to display both the species range and specific counties in which verified specimens have been documented. However, I found that the colors utilized made it difficult to readily distinguish between the two. I would have liked to see a range map accompanied by specific points that species have been found. Additionally, as a herpetologist who works in multiple states, I would have liked to see a small inset map of the species entire range, similar to the ones found in *Salamanders of the Southeast* (Mitchell and Gibbons 2010). Finally, as this book is aimed at amateur through professional herpetologists, the taxonomic keys may be difficult to follow for some people. The figures accompanying the taxonomic keys were very helpful, but additional photos and figures would have made the keys even more useful. Additional photos of larval salamanders and tadpoles might also have been helpful, especially close ups of tadpole mouths in the species accounts. However, most of these criticisms reflect personal preference and do not detract from the quality of the book.

Overall, this is a great field guide both in terms of the content and aesthetics. The information presented in this book will be useful to people of all experience levels. The editors do a good job of instilling interest in the reader and highlighting the diversity of amphibians found in the state through both their narrative and the use of superb photographs. I certainly recommend this book to anyone who plans on searching for, or simply learning more, about the amphibians of Tennessee.

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Lézards, Crocodiles et Tortues d'Afrique Occidentale et du Sahara

by Jean-François Trape, Sébastien Trape and Laurent Chirio. 2012. IRD Éditions, Marseille, France (www.ird.fr/editions). 503 pp. Softcover. EUR 64.00 (approximately US$ 80.50). ISBN 978-2-7099-1726-1.

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Although a number of papers and a few books deal with the non-ophidian reptile fauna of West Africa, they all focus on a limited region or taxonomic group, and the taxonomic and ecological information on numerous genera is outdated in many of these works. This new book by Trape et al. not only is the first book providing an extensive overview of all non-ophidian West African reptiles, but it does it in an exceptional way, at a level of documentation rarely achieved in any African reptiles book. It covers all lizard, turtle and crocodile species in the 15 West African countries, as well as Chad, the Saharan areas of Morocco ("Sahara occidental"), Algeria and Tunisia south of 32°N, and Lybia except its littoral area.

The genesis of the present book, only briefly mentioned in the book itself, is worth explaining here. Borreliosis was a nearly totally unknown disease in West Africa and Sahara when Sébastien, Jean-François Trape's son and second author of the opus, contracted it during a field trip in 1989. It took three months for Jean-François to diagnose Sébastien's disease, while the latter had already gone through seven high fever episodes. Jean-François eventually published a medical record of his son's borreliosis case and later of more and more other cases he diagnosed in other patients. This poorly known disease actually turned out to be the second most common cause for fevers in Senegal, after malaria (Trape et al. 1991). From 2002 J.-F. Trape conducted intensive field researches on this disease in western, central and northern Africa. J.-F. Trape was not at all a specialist of lizards until he began that research program in 2002 (J.-F. Trape, pers. comm., Sept. 2012). But he took this unique opportunity of visiting between 2002 and 2011 a large number of localities, often extremely remote, in 16 African countries, to observe, photograph and collect lizards and other reptiles, as a by-product of his medical research. About 6,500 specimens were collected during these surveys. Sébastien, whose Ph.D. dissertation was on the Mugilidae of West African coasts, specialized in fish and reptiles and in molecular biology, the latter specialty having proven very useful for the numerous taxonomic changes, resurrections, synonymies and new species descriptions included in the book.

The binding and paper of the book are of excellent quality. The front cover of the book is illustrated by a photograph of a *Chamaeleo gracilis* (without locality; it was actually taken near Kpalimé, Togo; J.-F. Trape, pers. comm., Aug. 2012). Main parts of the book include a geographical introduction (pp. 11–21), an introduction to the herpetofauna treated (pp. 23–59), identification keys to families, genera and species (pp. 61–121), lizard species accounts (pp. 123–417), crocodile species accounts (pp. 419–425), turtle species accounts (pp. 426–471), literature cited (pp. 473–493), an appendix giving for each species treated in the book the list of West African countries where it occurs (pp. 495–499), and an index to currently used scientific names (pp. 501–503).

The geographical introduction offers useful maps and 41 excellent photos of various biotopes found throughout the region covered, all with precise locality data. The biotope photo for Guinea-Bissau (page 17) shows in its foreground an intriguing roundish object, which actually is a *Chelonia mydas* (Linnaeus, 1758), and the locality is more precisely Poilao Island (J.-F. Trape, pers. comm., Aug. 2012).

The introduction to the herpetofauna treated provides excellent drawings to illustrate scale nomenclature. On the lizard head scale drawing (p. 27), the number corresponding to the subocular scale is missing. This chapter also presents recent taxonomic changes and brings important new ones, that we should briefly mention here since they might be overlooked by non-French speaking readers. These include the revival from synonymy of *Agama africana* (Hallowell, 1844), *A. boensis* Monard, 1940 and *A. insularis* Chabanaud, 1918 (the latter already revalidated by Trape 2011) (Agamidae), of *Mochlus mocquardi* (Chabanaud, 1917), *Trachylepis aureogularis* (Müller, 1885) and *T. keroanensis* (Chabanaud, 1921) (the latter actually already revalidated by Böhme et al. 2011) (Scincidae), the elevation to species rank of *Trachylepis paucisquamis* (Hoogmoed, 1978) (Scincidae) and of *Tarentola hoggarensis* Werner, 1937 and *T. senegambiae* Joger, 1984 (Gekkonidae), the synonymization of *Agama sylvanus* Macdonald, 1981 with *A. africana* (Agamidae), of *Philochortus lhotei* Angel, 1936 with *P. zolii* Scortecci, 1934 (Lacertidae), of *Mabuia guineensis* Monard, 1940 with *Trachylepis perroteti* (Duméril & Bibron, 1839), and of *Panaspis nimbensis* (Angel, 1944) with *P. tristaoi* (Monard, 1940) (Scincidae). Most importantly, nine new lizard taxa are described within this chapter (with different authors as indicated): *Uromastyx dispar hodhensis* J.-F. Trape & S. Trape *in* J.-F. Trape, S. Trape & Chirio, 2012 (Agamidae), *Hemidactylus albituberculatus* J.-F. Trape *in* J.-F. Trape, S. Trape & Chirio, 2012, *H. albivertebralis* J.-F. Trape & Böhme *in* J.-F. Trape, S. Trape & Chirio, 2012, *H. kundaensis* Chirio & J.-F. Trape *in* J.-F. Trape, S. Trape & Chirio, 2012, *Tarentola pastoria* J.-F. Trape, Baldé & Ineich *in* J.-F. Trape, S. Trape & Chirio, 2012 (Gekkonidae), *Acanthodactylus boskianus nigeriensis* J.-F Trape, Chirio & Geniez *in* J.-F. Trape, S. Trape & Chirio, 2012 and *A. b. khattensis* J.-F. Trape & S. Trape *in* J.-F. Trape, S. Trape & Chirio, 2012 (Lacertidae), *Cophoscincopus senegalensis* S. Trape, Mediannikov & J.-F. Trape *in* J.-F. Trape, S. Trape & Chirio, 2012, and *Leptosiaphos dungeri* J.-F Trape *in* J.-F. Trape, S. Trape & Chirio, 2012 (Scincidae). There is no mention of the sex of the holotype and the paratype of *Uromastyx dispar hodhensis*, of the holotype of *Hemidactylus albituberculatus, H. albivertebralis* and *H. kundaensis*, of the holotype and paratypes of *Tarentola pastoria, Leptosiaphos dungeri, Cophoscincus senegalensis, Acanthodactylus boskianus nigeriensis* and *A. b. khattensis*. This is very unfortunate, but is a deliberate choice made by J.-F. Trape who did not want to dissect and damage the types to verify their sex (J.-F. Trape, pers. comm., Oct. 2012). The descriptions of *Uromastyx dispar hodhensis, Cophoscincopus senegalensis* and of both new subspecies of *Acanthodactylus* are accompanied by phylogenetic trees, but there are no details on methodology and no museum numbers indicated for the comparative specimens used. *Hemidactylus albituberculatus* is said to differ from *H. angulatus* only by a slightly larger size, more colorful and contrasted dorsal tubercles and by genetics, but no data on genetics are provided; obviously a better characterization of this species will be needed, including the actual results of the genetic analysis. The diagnosis of *Acanthodactylus boskianus nigeriensis* (relatively small size, females and juvenile without bright colors on tail) is insufficient to help identify specimens of this population.

At most five days before the present book appeared, two agamid species were co-described by two of its co-authors: *Agama parafricana* J.-F. Trape, Mediannikov & S. Trape *in* Mediannikov, S. Trape & J.-F. Trape, 2012 and *A. wagneri* J.-F. Trape, Mediannikov & S. Trape *in* Mediannikov, S. Trape & J.-F. Trape, 2012 (Mediannikov et al. 2012). The latter paper was published in a volume that appeared on June 25th, 2012 according to the website of the Russian Journal of Herpetology, while the date shown on the book is June 2012, which has to be interpretated as June 30 at the latest.

The list of species provided at the end of this chapter shows that, among the 179 species and subspecies treated in the book (156 lizards, 3 crocodiles and 20 turtles), 23, i.e., 13%, were described in the 21st Century. Among them, relatively large and colorful geckos such as *Hemidactylus beninensis* Bauer, Tchibozo, Pauwels & Lenglet, 2006, a terrapin *Pelusios cupulatta* Bour & Maran, 2003, and the gecko *Pristurus adrarensis* Geniez & Arnold, 2006 which represent a 4,700 km range extension for the genus (Geniez and Arnold 2006); all this indicates that much remains to be discovered in this part of the world.

Identification keys are abundantly illustrated. Some of them unfortunately include mistakes. In the key to Agamidae, page 69, there is no link to couplet 22; actually the second alternative from couplet 19 should be 22, not 23 (J.-F. Trape, pers. comm., Oct. 2012). In couplet 21, re. *Agama sankaranica* Chabanaud, 1918, the variation given for the number of scales on the vertebral line is different from the variation given in the species account (31–46 versus 31–39). In couplet 28, re. *Agama parafricana*, the variation given for the number of scales on the vertebral line is different from the variation given in the species account (29–34 versus 29–37), and the same is true for the midbody scale rows (54–72 versus 54–63). In the Gekkonidae key, the caption of the photo of *Hemidactylus richardsoni* on p. 81 wrongly indicates that it was taken in "Ivindo, Gabon" – for having taken the photo ourselves (OSGP), we know that it was actually taken in Gamba, southwestern Gabon (idem with both photos of the same individual p. 243). In couplet 22, it is indicated that *Hemidactylus albivertebralis* has a "paravertebral" whitish stripe – it is actually a vertebral stripe. In couplet 30, re. the *Tarentola mauritanica* complex, the variation given for the number of lamellae under the 5th toe (16–20) differs from the one given in the species account (16–21), giving the impression that there is no overlap with the key's alternative species *T. deserti* Boulenger, 1891 (21–25). In couplet 34 (p. 89), re. *Tarentola senegambiae* Joger, 1984, the variation given for the number of granular scales between the eyes (14–18) differs from that provided in the species account (13–17). In the Lacertidae key, page 95, there is no link to couplet 20; actually the second alternative from couplet 12 should be 20, not 21 (J.-F. Trape, pers. comm., Oct. 2012). In couplet 20 (p. 98), 10 to 14 ventral scale rows leads to couplet 21, which, however, itself leads, among others, to *Acanthodactylus dumerilii* (Milne-Edwards, 1829) whose range for this

character is said to be 12 to 16 in its species account. In the same couplet 20, one reads that *A. longipes* Boulenger, 1921 shows 60–77 dorsal scale rows at midbody, whereas the corresponding species account says the species has 55–88. In the key to Scincidae, page 105, there is no link to couplet 23; the second alternative from couplet 19 should in fact be 23, not 22 (J.-F. Trape, pers. comm., Oct. 2012). In couplet 21, re. *Cophoscincus greeri* Böhme, Schmitz & Ziegler, 2000, the key indicates 48–57 paravertebral scales *contra* 45–57 in the species account. In couplet 25 p. 107, the variation in the number of keels on the paravertebral row in *Mochlus brevicaudis* (Greer, Grandison & Barbault, 1985) is indicated as 8–15 *contra* 7–15 in its species account, which means an overlap with the variation for the alternative species in the key. We found other discrepancies between variation given in some keys and variation given in associated species accounts, but contrary to the ones cited above, they do not impact the use of these keys.

Species accounts include clear and well-written sections on rapid diagnosis, size, geographic distribution and habitat, description and natural history, and are each illustrated by a distribution map (with squares of 1 × 1 degrees, in red when the species has been recorded within the square) and two photos. It is a pity that there is no distinction in geographical distribution between literature data and new data added by the authors, as the new data certainly represent a large part of the known distribution for many species.

The iconography of the book is absolutely exceptional. The photos, all in colour, are of outstanding quality. Among the *ca.* 650 reptile photos shown (besides the numerous scale drawings and biotope photos), 567 (thus about 87%) were taken by the authors. Only a single species, *Trapelus schmitzi* Wagner & Böhme, 2007 (Agamidae) could not be illustrated alive. All photos are accompanied by precise locality data, which adds much informative value to the book, and the vast majority of the photos were taken within the geographical area covered by the book. Taking some of the photos was a real challenge; for example taking those of *Acanthodactylus boskianus* (Daudin, 1802) in Galtat Zemmour (p. 295) or trying —unsuccessfully—to take some of *Uromastyx occidentalis* Mateo, Geniez, López-Jurado & Bons, 1998 at its type locality required crossing mine fields (J.-F. Trape, pers. comm., Oct. 2012). On page 303, in the species account for *Acanthodactylus busacki* Salvador, 1982, both photos illustrate the same individual, although two distinct localities are indicated; the actual locality for both photos is "surroundings of Tan-Tan, Marocco" (J.-F. Trape, pers. comm., Oct. 2012).

When we (OSGP) asked the first author why *Hemidactylus ansorgii* Boulenger, 1901 was indicated as occurring from Guinea to Gabon (p. 224), while the species is unknown in the latter country (Pauwels and Vande weghe 2008), he indicated to us that Gabon was actually a *lapsus calami* for Cameroon (J.-F. Trape, pers. comm., Oct. 2012). Regarding that species, let us mention that its common name "Ansorg's Half-toed Gecko" as mentioned by Trape et al. is erroneous, the species having been dedicated to the explorer William John Ansorge (1850–1913, see Beolens et al. 2011).

The literature cited includes 502 references. There are remarkably few typographical errors in the book. We warmly recommend the purchase of this excellent opus which represents a nice addition to any natural history library because of its beautiful photos, showing many species that have rarely or never been illustrated alive before. But, above all, this book deals with a fauna that was never synoptically treated before, and represents a major milestone in the progress of African herpetology.

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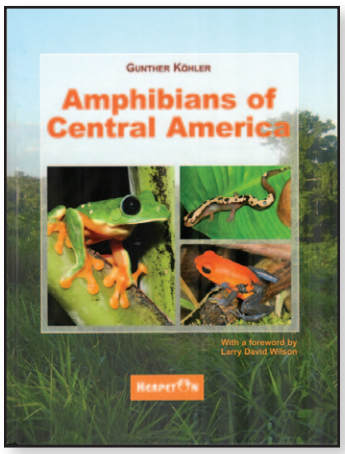
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Amphibians of Central America

by Gunther Köhler. 2011. Herpeton, Verlag Elke Köhler, Offenbach, Germany (www.herpeton-verlag.de). 379 pp. Hardcover. EUR 78.00 (US $125.00). ISBN 3-936180-33-4.

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The increasingly rapid pace of discovery and description of new taxa, along with the taxonomic revision of long-known groups, has made an accurate accounting of regional herpetofaunal diversity difficult for even the most dedicated specialists to track. Recent years have seen a remarkable proliferation of quality reference books dealing with the rich Mesoamerican herpetofauna, that is, those amphibians and reptiles occurring east of the Isthmus of Tehuantepec and southward through Panama. Given the large number of species known from this region, most works are necessarily limited to a single country or protected area, with few books attempting to deal large segments of the entire regional herpetofauna (Wilson

et al. 2010). One notable exception has been Gunther Köhler's *Reptiles of Central America* (2003, 2008), which managed to combine comprehensive taxonomic coverage with extensive illustrations and identification keys to provide the best approximation of a regional field guide ever published. That invaluable reference has now been joined by an equally well-produced companion volume, Köhler's *Amphibians of Central America*.

Like its companion, *Amphibians of Central America* is small enough (17 × 23.5 cm) to be carried into the field, at least as well as other available "field guides" that claims coverage beyond a single protected area. The book boasts 930 color photographs that include nearly 90% of the 498 species covered within, along with 177 maps and 92 other illustrations, all contained in 379 pages that feel relatively svelte in the hand. Following a four page foreword by Larry David Wilson, the book begins with an Introduction chapter that immediately alludes to both the "breathtaking" diversity of Mesoamerican amphibians, as well as the dramatic declines in wild populations of many taxa witnessed by the author as well as the majority of other researchers that have worked in Central America over the past 25 years. It is within this dual context that the import of this reference comes into focus.

The Introduction includes a section entitled "Comments on the Usage of this Book," which includes details of the conventions for using the dichotomous keys and the structure of each taxonomic section. Species-rich groups such as *Bolitoglossa* and Terrarana each have two identification keys, one for northern and for southern geographic regions divided at the Nicaraguan Depression. The Introduction is followed by a two-page illustrated "Classification of the Amphibians of Central America," which shows the genera and number of constituent species from each of the 16 regional families.

A chapter entitled "The Environment" provides general descriptions of major habitat types found in Central America, along with representative photographs from five of the eight countries covered in the book. These habitats are grouped into "Rainforest," "Cloud forest," "Dry forest," and "Marshes, swamps, and seasonal flooded forest," which somewhat undersells the region's rather remarkable ecophysiographic diversity, but adequately details the habitats for the purposes of the book. This chapter also includes two full page, full color maps; one illustrating topography and the other showing vegetation zones. Finally, the chapter includes the section "Climate in Central America," with climate diagrams showing mean daily and nightly temperature and monthly precipitation throughout the year for nine localities in eight countries. These nine localities represent a spectrum of elevational ranges on both Caribbean and Pacific versants, and one Caribbean island (Utila, Honduras).

After these introductory sections, the bulk of the book consists of the taxonomic accounts covering the breadth of the Central American amphibian fauna, beginning with a one page summary of the Class Amphibia and a key to the three orders of amphibians. This is followed by the nine page section on caecilians, which also introduces the format for subsequent sections. The section starts with a rather detailed two page introduction to the Order Gymnophiona, including aspects of the group's biology, ecology, and distribution from a global perspective. A photograph and two illustrations depict the critical morphological characteristics used in the identification keys, which are relatively few, given the simplified body plan of caecilians. Only a single family is represented in Central America, the Caeciliidae, and, as is the case with all family-level accounts, a key to the constituent genera and a list of additional references is provided. The rest of the section is divided into accounts for each of the four genera present in Central America: *Caecilia*, *Dermophis*, *Gymnopis*, and *Oscaecilia*.

These generic accounts, along with the rest of those in the book, follow the now familiar format seen in both editions of *Reptiles of Central America*, making usage of the new companion volume almost second nature for those accustomed to using the *Reptiles* book. Each account contains one or more paragraphs that provide a general introduction to the genus, which includes details if its taxonomic content, distribution, natural history, and recent research, with content varying based on the information available for each genus. Each generic account then contains a list of the Central American species, with information on their original description (author, citation, and type locality) and a summary of their known distribution. Information about species are set apart in pale yellow text boxes, making visual identification simple. Each generic account is rounded out with one or more maps showing the known distributions of species, a key to the species of the genus, and a list of further references specific to the group.

The generic accounts for the caecilians are well illustrated, considering the relatively poorly-known nature of many species compared with their salamander and anuran relatives. Three of four species of *Caecilia*, three of six *Dermophis*, both species of *Gymnopis* and the three species of *Oscaecilia* are represented by color photographs of live animals, with four species represented by two photographs each.

The 57-page section dealing with the salamanders covers eight genera (not seven, as stated on p. 36) and 151 species within the single family Plethodontidae. The key to the eight genera of Central American plethodontids is accompanied by illustrations showing the external diagnostic characteristics and roof of the mouth of a generalized plethodontid, as well as photographs of the dorsal and ventral aspects of the foot of *Bolitoglossa heiroreias*, a species possessing distinct toes and subdigital pads. With the majority of plethodontid diversity contained within the genera *Bolitoglossa* and *Pseudoeurycea*, it is not surprising that the generic account for the primarily Central American *Bolitoglossa* encompasses some 30 pages (only six species of *Pseudoeurycea* occur east of the Isthmus of Tehuantepec, with most of its diversity found to the west and north in Mexico).

Nearly one-third of the pages in the *Bolitoglossa* account are taken up by color photographs, generally of live animals and of good quality. Only a single species is represented by a photograph of a preserved specimen (*B. pygmaea*), and I detected one case of a misidentified photograph (Fig. 59: labeled as *B. dunni*; this photo is representative of a male *B. diaphora* from the same locality). The identification key for *Bolitoglossa* is necessarily (and thankfully!) divided into two parts: one for southern Mexico to Nicaragua, and a second for Nicaragua to Panama. The author has taken the welcome step of providing photographs of the dorsal surfaces of the feet of 48 species of *Bolitoglossa* to accompany the keys, a useful and stylish touch. This attention to detail becomes a welcome thematic element in all the identification keys presented in *Amphibians of Central America*. The taxonomic content of this section was also apparently kept updated right up until publication; for example, a number of recently described Guatemalan species (Campbell et al. 2010) are represented not only in the keys and generic accounts but also by color photographs.

With many fewer species to deal with, the accounts for other plethodontid genera are much shorter, but nonetheless maintain

the author's commitment to providing color photographs of as many species as possible, including uncommonly illustrated taxa from genera such as *Dendrotriton* and *Nototriton*. The identification keys for *Cryptotriton*, *Dendrotriton*, and *Nototriton* all contain close-up photographs of the lateral aspects of the heads of most constituent species, which should further aid in identification of these small and difficult to distinguish salamanders. The generic account for the more diverse *Oedipina* (29 species) is equally well-illustrated, and the keys are supplemented with dorsal head photographs of five species and dorsal views of the hind feet of four species.

Naturally, the taxonomic accounts for the Class Anura make up the bulk of *Amphibians of Central America*, with 205 pages covering 14 families and 332 species, accompanied by another 16 pages dealing specifically with tadpole identification. Without exception, each family and genus receives the same excellent treatment as was apparent in the preceding sections. The key to the anuran families of Central America is accompanied by six illustrations and five color photographs meant to show specific characteristics used in the keys, with more detailed illustrative figures reserved for family and generic accounts, an approach that does a good job of balancing the informative and utilitarian aspects of the book. Perusing the expansive anuran section of the book, with extensive photographic coverage of the majority of species, gives the reader an opportunity to visually appreciate the remarkable amphibian diversity of Central America like few other references afford.

Taxonomically, families such as Bufonidae, Centrolenidae, Dendrobatidae, and Ranidae follow recent revisionary generic arrangements, rather using than traditional mega-genera such as *Bufo* and *Rana*. Within the Bufonidae, for example, the genera *Atelophryniscus*, *Atelopus*, *Chaunus*, *Crepidophryne*, *Incilius*, *Rhaebo*, and *Rhinella* are recognized. In cases where the recognition of particular taxa may be a matter of some controversy in the literature (such as the genus *Atelophryniscus* and species *Incilius ibarrai* and *I. porteri* within Bufonidae), the author clearly states his justification for usage on a case by case basis, usually within the descriptive narrative that makes up the initial portion of a given generic account.

While the extensive use of color photographs are a major strong point of *Amphibians of Central America*, it is, in this reviewer's opinion, the illustrated keys that stand out as exceptional. As anyone who has attempted to construct dichotomous keys for large numbers of taxa will attest, undertaking the development of keys that are both accurate and easy to use can be an enormous challenge. Doing so for speciose groups as notoriously difficult to identify as *Craugastor*, *Diasporus*, or *Pristimantis* could be considered an almost herculean task, yet Köhler manages to combine these, along with the remaining genera of Central America Terrarana (New World direct-developing frogs), into two workable, geographically-delimited keys. The two identification keys for Terrarana encompass some 18 pages, and, like all other keys in the book, are extensively illustrated with photographs and drawings that clearly demonstrate key diagnostic characteristics. Only extensive application of these keys in field and laboratory settings will reveal any hidden flaws, but admittedly my attempts to challenge the accuracy of the keys in identifying relatively challenging specimens of *Craugastor* from my own Honduran collections were unsuccessful; that is, the keys worked in each test case.

The illustrations and keys in the account for Hylidae may be the most visually impressive in the book, owing both to the natural beauty of many species in this family as well as to the extensive selection of diagnostic drawings and photographs used in the keys, at the family level as well as in the generic accounts. Few opportunities to show comparative photographs or illustration of hands are foregone when showing differences in the condition of the prepollex or nuptial pads are referenced in an associated key. Likewise, few instances of species not represented by a color photograph in life are apparent; in fact, I found myself actively searching for such cases just to see how many I could uncover, and came to the conclusion that the effort was not worthwhile given that it amounts to such a relatively minor shortcoming in such an otherwise comprehensive treatment.

The last part of the Anura section deals specifically with the identification of anuran larvae. This section begins with an overview of tadpole morphology an ecology, and details of terminology used in tadpole identification. The written descriptions of the morphological terminology are augmented by two diagnostic illustrations showing key characteristics of tadpole body plans and the oral disk and mouthparts. A table listing 41 species of Central American anurans whose larvae lack published descriptions is provided. An identification key to tadpoles for over 150 species follows, taking some 14 pages to present what may be one of the better illustrated key of its kind ever produced. The same attention to detail shown in the other keys presented in the book is evident in the tadpole key, with macro photographs of mouthparts and dorsal and lateral aspects of bodies throughout.

Any work focused on Mesoamerican amphibians would be remiss if the subject of regional amphibian declines was not discussed, and the author presents an 11 page chapter dealing with this subject as an epilogue to the taxonomic guide. This section presents a concise summary of factors leading to declines, including those familiar culprits such as habitat degradation and chytridiomycosis. Also discussed are the potential impacts of global climate change, ultraviolet-B exposure, and parasite infestations. A summary of recent "rediscoveries" of Central American anurans previously feared extinct is presented, followed by a discussion on potential approaches to mitigating the loss of amphibian diversity in the region and beyond. A final page discusses the use of amphibians as biological indicators, with the author concluding that "there is no evidence to indicate amphibians are better bioindicators than other animals," and that amphibian declines or extirpations do not in themselves indicate the potential loss of other biodiversity elements.

As a herpetologist working in Central America, this book becomes an instant "must-have" resource, and for the foreseeable future will have place on the nearest bookshelf to my desk as well as secured within a plastic bag in my *mochila* on fieldtrips to Mesoamerica. While the list price for this book is regrettably high (a seemingly unavoidable circumstance in the modern climate of scientific book publishing), there are few references available that provide such a comprehensive treatment of a regional fauna in such a manageably-sized package. The author's attention to detail and commitment to Neotropical herpetology are admirable, and *Amphibians of Central America* stands not only as an irreplaceable resource for regional biologists, but as a broadly accessible catalog of a declining endemic fauna of global conservation priority. Perhaps the most commendable aspect of this book is the skill with which Köhler has been able to construct a guide which is both valuable to specialists and visually striking and accessible to non-specialists, and my hope is that this book will provide further impetus for uniting the former and the latter in the name of protecting the remarkable amphibian fauna of Central America.

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Die Amphibien und Reptilien Bulgariens

by Andrei Stojanov, Nikolay Tzankov, and Borislav Naumov. 2011. Edition Chimaira, Frankfurt am Main (www.chimaira.de). 592 pp. Hardcover. EUR 59.80 (approximately US $73.00). ISBN 978-3-89973-464-5.

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The latest contribution devoted to the study of the Balkan Peninsula in the Edition Chimaira series is volume 35 of the Frankfurt Contributions to Natural History: *Die Amphibien und Reptilien Bulgariens*, authored by Andrei Stojanov, Nikolay Tzankov, and Borislav Naumov. The book is a synthesis of accumulated research spanning well over a century, interpreted within a modern scientific framework that covers diverse branches of biology such as systematics, taxonomy, ecology, ethology, paleobiology, and biogeography.

By European standards, this mid-sized country harbors an impressive diversity comprising 58 widely accepted species. This variety is largely due to Bulgaria being on the crossroads between the Orient and continental Europe and exhibiting diverse climate and topography, resulting in a melting pot containing European, Pannonian, Balkan, Mediterranean, and Oriental faunal elements and integrades thereof.

Interest in the Bulgarian herpetofauna has long been overshadowed internationally by that of its neighboring countries of Greece and former Yugoslavia, largely due to historic political reasons. Regrettably, dedicated research on the herpetofauna of Bulgaria has been a source of neglect domestically as well. This was caused partially by lack of support from the government for the development of herpetological institutions and the resulting limited employment opportunities, producing few local professionals. Additionally, much of the collected information has been published in journals in Bulgarian, severely restricting the accessibility of the results to foreign researchers and thus hindering successful international collaborations.

As a result, comprehensive scientific catalogues and guides on the Bulgarian herpetofauna have been few and far between. Some, such as the seminal works from mid-20th century by Ivan Buresch and Jordan Zonkow, became obsolete or were aimed specifically at professionals (Beškov and Beron 1964) or at the general public (Beshkov and Nanev 2002). As a result, the accumulation of knowledge on the distribution, biology, and ecology of the Bulgarian herpetofauna has been inadequate, although such information is currently needed as never before in the face of the global declines of amphibians and reptiles.

Fortunately, herpetological research in Bulgaria has been revived with a recently emerged generation of highly competent herpetologists who have established a productive collaboration. The three authors of the book under review form an essential part of this trend. They have well over 50 years of field experience combined, and are based at the National Museum of Natural History-Sofia and the Institute of Biodiversity and Ecosystem Research. Their collective effort is manifested in the production of this present work; over five years have been dedicated specifically to the production of its 592 pages (A. Stojanov, pers. comm.), a volume which exceeds by over two and a half times the latest similar work by Biserkov (2007).

Our first impressions of the book are the sheer amount of information, presented on high quality paper, enveloped by a sturdy cover. The layout of the pages is highly professional and the typography is easy on the eyes and allows for a smooth, comfortable reading experience. For example, separator lines at the header and figures smoothly align across the pages with very few exceptions (e.g., pp. 136–137).

The volume is extensively illustrated and includes 614 high quality maps, photos, and sketches. Most of the photos have been contributed by the authors themselves and were chosen to be included in the book after an extensive comparison, to provide the best available photographic material: spectacular scenery, depiction of amphibian species of different stages in their life cycles, behaviors such as mating, dorsal and ventral aspects of lizards, etc. Most of the pictures have been taken specifically for this book, usually by means of a high-end analog camera utilizing slides (A. Stojanov, pers. comm.). Sadly, a few images suffer from minor chromatic aberrations likely to have arisen during the scanning processes, doing the original material little justice.

Overall, the book content is divided into three major sections: an introduction, detailed species accounts, and an extensive bibliography. Following a preamble by the publisher and the acknowledgements is a short user guide presenting the way the species accounts are constructed and interpreting the maps and associated data. A list of well-chosen, intuitive and easy to use abbreviations is also included.

To make the book useful for a general readership, the authors provide general remarks on the geopolitical and biogeographical features of the territory of the Bulgarian Republic by supplementing maps of major landmarks, geographical,

climatic and biogeographical features. In addition, this section of the book includes a succinct, but well-illustrated description of the major habitats with dominant and typical vegetation and animal species, putting the herpetofauna into a broader biological context. A table defining the chorotypes of the species is also provided (pp. 37–38). These features of the book are especially useful for readers who are unfamiliar with the geography and fauna of the country and are eager to rapidly obtain general information.

A brief history of herpetological research in Bulgaria is presented. This information is later followed by detailed systematic and taxonomic remarks. Of great value is the table on p. 72 summarizing the information on taxonomic changes in the Bulgarian herpetofauna from the early 20th century until the present-day.

The last segment of the section is devoted to the past and current conservation of Bulgarian amphibians and reptiles. It contains a full description of the current conservation status of each species in the most important international and local lists such as the IUCN Red list, CITES, and Bulgarian legislation. Brief information is presented on current administration and legislation in the country relating to nature conservation, as well as contact information for some of the major entities devoted to the study and protection of the herpetofauna.

The species account section stands out as the greatest asset of the book. For each family, a synopsis of about one page presents general information for the taxon. After that brief introduction, highly detailed and accurate information for each species is presented on 2–4 pages with description and remarks on its biology, ecology, behavior, reproductive biology, geographic range, chorotype and conservation status; the species accounts are elegantly woven into a succinct format, with data compiled from a vast swathe of seminal works, obscure printed sources, and personal observations. To facilitate accurate determination, specific characteristics differentiating each species are presented along with identification keys in tables. The description of the species follows a rigorous and well-chosen format, which allows information to be found quickly and conveniently. For every species the authors include Latin, German, English, and Bulgarian names (the last in Cyrillic with a transcription). A useful feature that provides a realistic perception of the species' approximate size is the use of graphic outlines in different colors for the average- and maximum size of adult individuals, juxtaposed to a human hand or legs in a stride; in addition, a centimeter ruler is given alongside. For each species, multiple photos are provided (up to 17 per species), carefully selected to deliver a well-rounded depiction of the species, demonstrating intraspecific variability, life stages, colorations, dimorphism traits, specific behaviors and key identification features.

Furthermore, the geographic range of each species is illustrated on separate maps. The inclusion of thousands of the authors' personal records from locations rarely if ever visited previously by herpetologists (N. Tzankov, pers. comm.), combined with all available literature records and multiple data contributed by colleagues, is among the strengths of the book. The distribution of subspecies and contact zones is displayed using legends of contrasting colors (for example the map for the Common Wall Lizard *Podarcis muralis*, p. 383). Potential locations where the species is likely to be found in the future are also noted with a "?". In contrast to previous works, the range is superimposed onto a detailed map including relief and major rivers, thereby defining each location precisely and allowing the reader to study the distribution in greater detail.

An innovative and useful feature is the inclusion of simple graphical representations beside each map of the local optimal and suboptimal altitudinal distribution of the species, and temporal information on its seasonal and reproductive activity, including mating, egg deposition (if any), and metamorphosis or hatching.

The venomous snakes (Adder *Vipera berus*, Nose-horned Viper *V. ammodytes*, Eastern Montpellier Snake *Malpolon insignitus*, and Cat Snake *Telescopus fallax*), are given special consideration in a separate section due to the multiple misconceptions and misunderstandings surrounding these animals. In addition to a clear and objective overview that addresses the topic, general advice is provided for responding in cases of envenomation. The applicability of the instructions has proven its worth in two unintentional field misfortunes involving vipers, to which one of the authors of this review (YVK) was a witness. Although stressful and unpleasant for all participants, these situations did not result in long term harm to anybody, but demonstrated the highly undeserved notoriety of vipers.

The book also provides updated information on unresolved and controversial issues such as the historic records of Asp Viper *Vipera aspis*, Meadow Viper *V. ursinii*, and the few observations of vagrant individuals of Green Turtle *Chelonia mydas* and Loggerhead turtle *Caretta caretta*.

In a separate section, the authors describe in comparable detail six extraterritorial species that are either probably present at the moment but have not yet been unambiguously detected, or that have high chances of extending their range into Bulgaria. These include three water frogs, two lizards, and a viperid snake. The last species account section is committed to describing the single introduced species in Bulgaria—the Red-eared Slider, *Trachemys scripta elegans*, which is currently believed to be reproducing in the wild and poses significant conservation challenges. Altogether, the total number of species described in the book is 64.

The species accounts are followed by the bibliographical section—an exhaustive compilation totaling 489 references, including some old, rare, obscure, and elusive sources. The added advantage is the duplex citation format of Romanized and Cyrillic script ensuring facilitated literature search, since no unilaterally standardized transliteration format for Cyrillic exists. This ease of use greatly extends the value of the bibliography and allows readers to easily look for additional sources if interested. Regrettably, this section suffers from minor typesetting and typographical errors, but that does not detract from the usefulness of the accumulated information.

The reference list is followed by a glossary, which covers the most essential terminology. This is followed by the inclusion of a transliteration/pronunciation guide, a strength of the book to aid non-native speakers; we have tried it with foreign friends and colleagues and obtained positive results.

Overall, the high quality of this book is unequalled in its field and marks a milestone in the history of Bulgarian herpetology. The authors have faced a gargantuan task in compiling years of personal field experience along with that of their colleagues and tracking down a vast array of literature, resulting in an unprecedented richness of data brilliantly condensed into this volume. For any researcher involved in the study of the herpetofauna of the Balkan Peninsula or for the interested naturalist *Die Amphibien und Reptilien Bulgariens* should constitute an essential part of their library and is bound to become a standard reference for many years to come.

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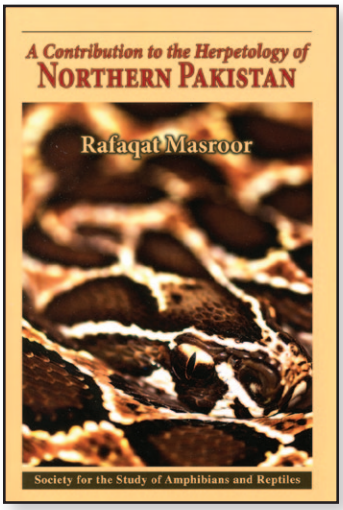
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A Contribution to the Herpetology of Northern Pakistan: The Amphibians and Reptiles of Margalla Hills National Park and Surrounding Regions

by Rafaqat Masroor. 2012. Society for the Study of Amphibians and Reptiles, Ithaca, New York (www.ssarherps.org). 217 pp. Hardcover. US $45.00. ISBN 978-0-916984-83-0.

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This book is a mixture of two main themes: an update on the herpetology of Pakistan in general, and a detailed account of the results of a seven year survey by the author of the herpetofauna of a single national park near Islamabad, the Margalla Hills National Park. The book, which is organized in a field-guide format, starts with a brief introduction to the geography and biogeography of Pakistan, and the ways and degrees to which some regions are being designated for conservation. This is followed by a list of national parks, and maps depicting the topography and hydrography of Pakistan, as well as major districts (but not, strangely, the boundaries of the national parks). The area at the focus of the book, namely the Margalla Hills National Park, is then described in some detail. The introduction finishes by moving back to all of Pakistan, providing a list of herpetological works carried out there and, importantly, mentioning poorly studied regions. A short "Methodology" section provides a general description of the methods the author used in his survey of the Margalla Hills National Park.

The main section of the book begins with a checklist (Chapter 1) and key (Chapter 2) to the 42 species of reptiles and amphibians of the Margalla Hills National Park. Chapters 3–6 occupy the majority of the book, providing information on the amphibians, turtles, lizards and snakes of the park. Species descriptions comprise the following sections: Diagnostic Features, Description, Habits and Habitat, (global) Distribution, and (for some species only) Remarks, which can include information on conservation, behavior, geographic variation, or other topics.

The species descriptions are usually good but brief, and to an extent, inconsistent. For example, the usually very detailed morphological description is followed by no body size estimate for some species (e.g., *Calotes versicolor*). Furthermore, size estimates are probably too low for adult *Cyrtopodion scabrum*, and minimum size is probably reported as maximum size for *Asymmblepharus himalayanus*. Likewise, data on sexual size dimorphism are only reported for some species (including some that other works show are dimorphic). There is usually a fairly detailed description of behavior and phenology – but only sometimes of reproductive biology, life history, diet, temperature, etc. (e.g., no breeding data are provided for a well-known species such as *Varanus bengalensis*). The pictures of the species are good, if a little small. The maps depict the distribution throughout Pakistan (based on Minton 1966, Khan 2006, and specimens from the Pakistan Museum of Natural History) and are clear and precise. However, perhaps rather than political maps, physical maps, or maps of biogeographic regions/ecoregions would have been more helpful.

The book ends with a table (Chapter 7) of distribution of the species by habitat, and a discussion of conservation threats (Chapter 8), followed by a glossary, a bibliography, and a checklist of all the 210 species of reptiles and amphibians inhabiting Pakistan. In a recent review of this book Vyas (2012) commented on what he perceived as doubtful distribution data for Pakistan (e.g., species that are found on border regions in India, but are missing from the adjacent part of Pakistan according to Masroor). Vyas (2012) further pointed to a few taxonomic issues, and corrected some of the distribution data Masroor listed for India in his book. He further listed seven species that were included in the Pakistani species list by Minton (1966) and Khan (2006), but are omitted from the list in the current work.

Khan's (2006) book, dealing with all the amphibians and reptiles of Pakistan, is worth mentioning here, because one might wonder, as I have, whether there is a place for a book on Pakistani reptiles and amphibians, six years after the publication of that work. Masroor's (2012) book certainly has some advantages. It is more up to date in its data and taxonomy, has better maps (more precise and providing more data, although the Indus and its tributaries are marked in Khan's book, but not in Masroor's) and more detailed data. It is certainly smaller and lighter than the large format book of Khan (2006), and would thus make a much better field companion. This brevity, however, may also be its main problem, as it may have little appeal to a wide audience, focusing on just one 174 km^2 national park. While the data in the book are valuable, its narrow scope may deter potential users, who may be more interested in the Pakistani fauna as a whole.

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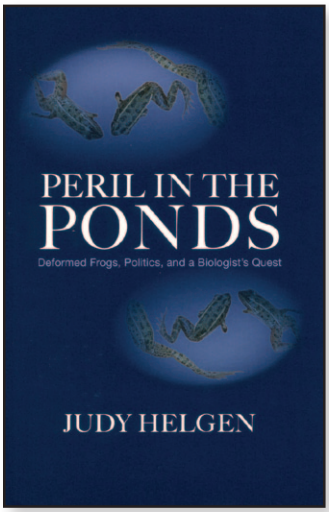
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Peril in the Ponds: Deformed Frogs, Politics, and a Biologist's Quest

by Judy Helgen. 2012. University of Massachusetts Press (www.umass.edu/umpress). 243 pp. Softcover. US $24.95. ISBN 978-1-55849-946-1.

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Combat veterans, reflecting back on their lives decades later, often realize that they never felt more alive than when they were in action, surrounded by death. You get the same sense of this from Judy Helgen as she describes in *Peril in the Ponds* what it was like to be at ground zero when, in the mid-1990s, a local malformed frog problem got big fast, and exploded into the global malformed frog phenomenon. By this time, Helgen, in her 50s, had already raised a family and was a successful soft-money employee with the Minnesota Pollution Control Agency (MPCA), a state government unit that, based on its battles with 3M, had a reputation for being scrappy and persistent.

In the interest of full disclosure, I was a part of this story. I first met Judy Helgen and her MPCA colleague Mark Gernes before there were malformed frogs to discuss—in 1993, in Jamestown, North Dakota, at a Wetlands Symposium hosted by biologists at the USGS's Northern Prairie Science Center. We had dinner and talked about amphibians as aquatic bioindicators. A couple years later, when the malformed frog phenomenon began, Helgen and I talked more frequently. As the investigation proceeded, I was mostly in the background (Dave Hoppe and Bob McKinnell, in the University of Minnesota system, were in the field; biologists at the National Wildlife Health Center in Madison were doing necropsies and making diagnoses). Mid-investigation, I recommended that Helgen bring on the classically trained parasitologist, Dan Sutherland, who was then on the faculty in the University of Wisconsin system. I also radiographed MPCA-collected frogs. In 2001, Sutherland, his student Josh Kapfer, and I re-sampled the hottest of the Minnesota hotspots. Having been a part of Helgen's story, I can assure readers that she tells the truth. She does not play herself up, and when she calls out folks it's for things they actually did; no straw men populate Helgen's stories.

Helgen discovered in the late 1990s what many others have so painfully learned—that you will not find instructions anywhere on how to proceed when day-to-day reality blows up and metastasizes into uncertainty and malevolence. Dogged by cameras and microphones, politicians, bosses, and scientists, Helgen and Gernes sought to discover what was causing the apparent epidemic of malformed frogs across much of Minnesota, and—true to the MPCA mission—determine whether or not humans, especially the school kids who first found those funny looking frogs, were in harm's way. Helgen describes how National Institutes of Environmental Health Science (NIEHS) scientists came onboard and immediately found themselves in competition for answers with Environmental Protection Agency (EPA) scientists. Her MPCA bosses were bipolar—sometimes supportive, more often distanced—she rarely knew where she stood within her agency, a big concern for a soft-money employee. Willard Munger, the legendary progressive politician, was consistently supportive; so was Bob McKinnell, the biologist who pioneered the idea (from studying leopard frogs) that viruses can cause cancer. Dave Hoppe was a steady, stabilizing presence in the field, as was Dan Sutherland, who helped separate parasite fact from fiction.

Helgen faced many problems, including: the need for immediate answers to unanswerable questions (should the State deliver bottled water to families deemed in harm's way?); the pressure of the press; the need to build a team of scientists; the need to simultaneously collect data and discuss results at state and national forums; competition among federal government agencies; smokescreens set by distant scientists with a deep need to be the center of attention; and the simple biological fact, as we now know, that there was more than one cause for the malformations that were being observed.

Perhaps the most fundamental problem Helgen faced was that the MPCA had no contingency plans for what might happen should an environmental concern blow up into an emergency (or public relations nightmare). The U.S. Forest Service, for example, having lost several smokejumpers by placing them in the wrong place at the wrong time, developed an Incident Command Structure (ICS). This model provides a mechanism for populating a disaster response team that includes adding administrative overhead appropriate to the task. (Imagine an organization as a pyramid, with bosses on top. An ICS model adds personnel to one side, including more experienced people, recognizing that a fire boss capable of handling a 10-acre fire may not be capable of handling the same fire after it blows up to 10,000-acres). Because MPCA (despite the implications of the name "pollution control") never adopted anything like an ICS contingency plan, once Helgen initially took charge of the malformed frog investigation, she became, de facto, always in charge of the malformed frog investigation. When she needed assistance, MPCA added a layer to the base of the organizational pyramid (i.e., technicians—less experienced people). Under such a system, no one in her position could have possibly succeeded; the fact Helgen did so well is a credit to her and her primary team.

While the political difficulties Helgen describes with her agency—being a state entity in a region dominated by agriculture—are predictable, the political difficulties created by a handful of then-respected scientists are deeply disturbing. As Helgen notes, there is nothing quite like a catastrophe to bring out the best and the worst in people. And, whether we acknowledge it or not, among our fellow scientists there are a lot of ambulance chasers looking for ways to fund their labs or get their names in the papers. Helgen treats most of these folks with kindness, or not at all (many were transient; my favorite was a USDA biologist who claimed to have found a new life form at the CWB site). However, Helgen does not hold back when it comes to her feelings for proponents of the parasite theory—the idea that amphibian malformations are caused by tissue disruption during

development by metacercarial cysts of the trematode *Ribeiroia ondatrae* (Rib). It's not that the parasite theory was wrong; the problem was that it could not—despite the deepest wishes of its loudest proponents—be generalized to all hotspots. People were confusing "a" cause for malformed frogs with "the" cause for malformed frogs. The parasite theory for frog malformations was always the best story, but as Helgen points out, in Minnesota it was never the best science.

A short elaboration from someone who was there. As a field biologist, imagine that you have a set of observations where you see a clear pattern "X," but that someone half a continent away who has never seen your study sites or your animals is telling both you and the press that it is pattern "Y." That's the way the parasite hypothesis played out in Minnesota. First the facts: using data assembled by Dan Sutherland, we found every possible combination of Rib/malformation hotspot interaction (Rib/hotspot; Rib/no hotspot; no Rib/hotspot; no Rib/no hotspot). We then concluded that the distribution of Rib and the distribution of hotspots were independent. Where Rib and hotspots co-occurred, Rib was the likely cause of malformations. However, one big and simple factor worked against Rib as a general explanation for frog malformations: in hotspots where Rib did not occur, Rib could not have been the cause (Lannoo et al. 2002).

But the parasite hypothesis is beautiful, and paraphrasing Thomas Henry Huxley, none of us really enjoys destroying beautiful hypotheses with nasty, ugly little facts. Helgen describes how the parasite hypothesis was transformed from idea—something that grows and expands a discipline—to ideology—something that constrains and dictates. With contrary data in hand, we reminded ourselves of Aldo Leopold's observation that the fundamental weakness of conservation biology is that many of its proponents, although unaware of it, come to value personal prestige over real conservation (Meine 1988). We were also reminded of the marine biologist W. K. Fisher, who, as Ed Ricketts described, had too much integrity to fit for convenience what wouldn't fit in fact (Rodger 2006). One clear pattern that did emerge from our field observations, something Helgen notes, was that most malformed frog hotspots were either wetlands recently constructed or highly altered (usually through runoff which could contain nutrients and/or contaminants). These oddball wetlands disproportionately produced Minnesota's oddball frogs.

Helgen's book completes a trilogy of volumes on the Minnesota's malformed frog phenomenon. The first was Bill Souder's *A Plague of Frogs* (Souder 2000), which covered the investigation from a reporter's perspective—from all angles while looking for answers. The second was my own *Malformed Frogs* (Lannoo 2008), which laid out the science of amphibian malformations and put global and historical perspectives on the Minnesota issue. Helgen's new book is by far the most personal, but they all tell the same story—that had we spent the same amount of money differently and considered each site independently, we would have likely solved the malformed frog phenomenon. And that much of the trouble was that the special needs or wants of people and agencies got in the way and added complexities that were expensive to consider and impossible to overcome. *Peril in the Ponds* will make a major contribution to the field of investigative science if, during the next environmental train wreck, some smart, mid-level professional who finds themself in the middle of either a scientific or public relations meltdown, says: "This will not be another punching Judy show; what happened to Helgen in Minnesota will not happen to us. Let's set up an organization with clear lines of responsibility and accountability, then assemble the resources to get the job done." It's a strategy that may not (given human foibles) always work, but as combat veterans also know, the way through a minefield is often laid out by those who went before and didn't make it.

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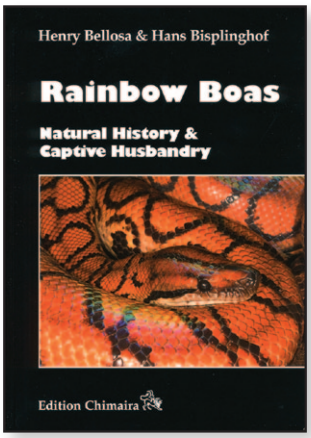
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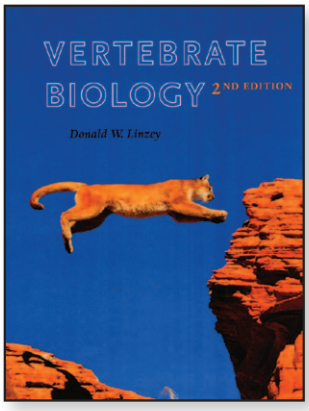
Rainbow Boas—Natural History & Captive Husbandry



by Henry Bellosa and Hans Bisplinghof. 2012. Edition Chimaira, Frankfurt am Main, Germany (www.chimaira.de). 223 pp. Hardcover. € 39.80 (approx. US $51.50. ISBN 978-3-89973-494-2.

This is an English translation of the German-language title *Regenbogenboas Das Kompendium*, also issued in 2012, devoted to *Epicrates cenchria* and *E. maurus*, beautifully iridescent snakes of Central and South America that are also very popular subjects for herpetoculturists. The book is organized into chapters concerning systematics, distribution and habitat, subspecies, captive breeding, husbandry requirements, diseases and parasites (authored by Frank Mutschmann), and color and pattern morphs (authored by John R. Berry). A glossary and list of references are included, but there is no index. Although "natural history" is part of the book's title, the focus is unmistakably on life in the terrarium. Aside from habitat photos from various parts of the range, new information concerning ecology and natural history is lacking. Three subspecies of the more northerly occurring *E. maurus* are recognized, while the widely distributed *E. cenchria* is described as having eight poorly defined subspecies, though clearly with extensive phenotypic diversity. The book is lavishly illustrated, with excellent photographs of snakes and their habitats, maps, illustrations, and diagrams—nearly all in color.

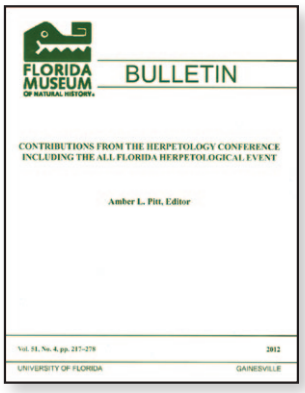
Vertebrate Biology, 2nd edition



by Donald W. Linzey. 2012. The Johns Hopkins University Press (www.press.jhu.edu). Hardcover. xi, [4], 583 pp. US $110.00. ISBN 978-1-4214-0040-2.

This is a vertebrate biology textbook covering the evolution, form, function, and ecology of all of the major chordate lineages. In addition, zoogeography, extinction, and conservation are also dealt with. Evolution, morphology, reproduction, growth and development are treated group by group (e.g., gnathostome fishes, amphibians, reptiles including birds, etc.), whereas other topics (population dynamics, movements, intraspecific and interspecific ecology and behavior, extinction and extirpation, and conservation and management) are dealt with in chapters that discuss all vertebrate groups. An atypical, but useful chapter for such a book is "Techniques for Ecological and Behavioral Studies." Each of the book's 16 chapters concludes with review questions and topics, supplemental reading, and a list of relevant internet sites. The last of these is critical for any modern class in vertebrate biology, but must be diligently revised over time to remain current. Together the amphibian and reptile chapters occupy 137 pages of text (closer to 100 if avian reptiles are excluded). Appendices provide a classification of vertebrates (to order for fishes and family for tetrapods) and a list of endangered vertebrates in the United States, and there is an extensive glossary, a bibliography of more than 1600 references, and a subject index. The volume is illustrated throughout by black and white photos, diagrams, maps, and graphs. The formal classification is largely up-to-date with respect to recent higher order taxonomic changes and most herpetological information is current, but there are a few errors (e.g., the turtle hyoplastron is labeled as the hypoplastron, p. 204; the name *Alligator lucius*, a very old synonym of *A. mississippiensis*, is used in a figure, p. 224; an egg-eating *Dasypeltis* is identified as *Elaphe obsoleta quadrivittata*, p. 213) and some topics, such as turtle phylogeny, are out of date. At $110.00 the book is priced about the same as competing texts and at 482 pages of actual text it presents a concise overview of vertebrate biology, appropriate for a single semester course on the topic.

Contributions from the Herpetology Conference Including the All Florida Herpetological Event

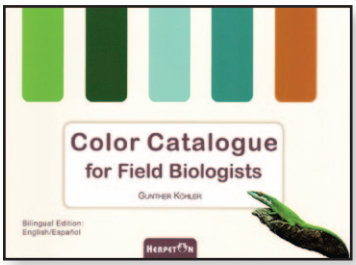


edited by Amber L. Pitt. 2012. Bulletin of the Florida State Museum of Natural History Vol. 51, No. 4, pp. 217–278.

This is a special volume of the *Bulletin of the Florida State Museum of Natural History* containing five separate papers from the Herpetology Conference including the All Florida Herpetological Event, a meeting that has been hosted in Gainesville for several decades. The first such volume of its kind, its included contributions are diverse, but four are directly relevant to the southeastern quadrant of the United States. These include Hecht-Kardasz et al. on "Population structure of the hellbender (*Cryptobranchus alleganiensis*) in a Great Smoky Mountains stream," Johnston et al. on "Population ecology of the snapping turtle (*Chelydra serpentina osceola*) in a northern Florida river," Nickerson et al. on "Historical turtle population decline and community changes in an Ozark River," and Mohr on "Movements of

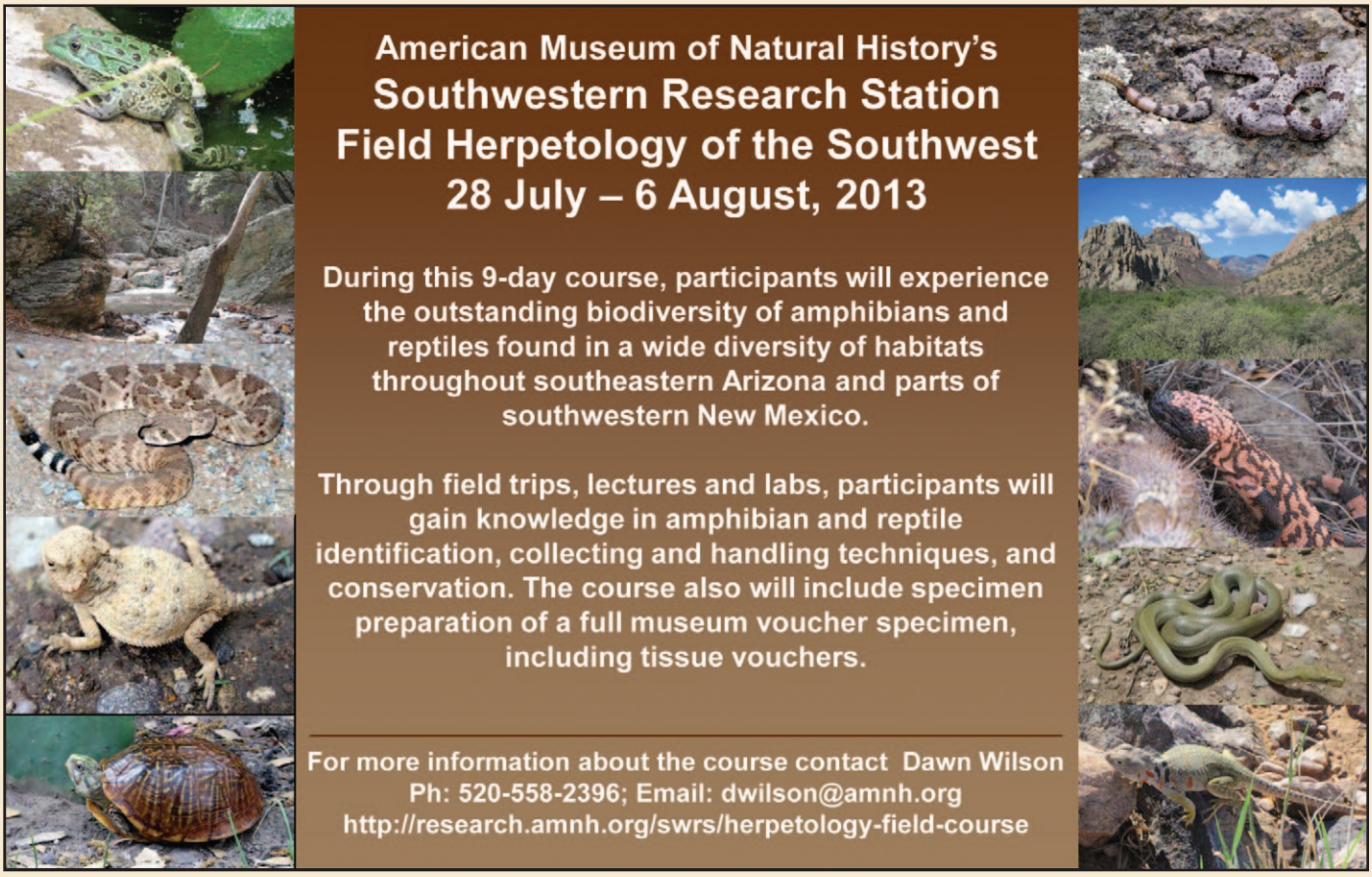
the timber rattlesnake (*Crotalus horridus*) in the South Carolina mountains." The fifth contribution is by Byram and Nickerson on "Effects of nitrogen ammonia and MS-222 on *Xenopus laevis* development, growth, and foraging behavior." Appropriately, the volume is dedicated to Max Nickerson, long the driving force behind the conference, who is also an author on three of the included papers. The publication has the standard format of the *Bulletin* and the papers are illustrated in black and white with numerous graphs and maps. The *Bulletin* has a long history of herpetological publications, both neontological and paleontological, which are available for hard copy purchase or free download (see www.flmnh.ufl.edu/bulletin/bulletin_vols.htm and http://ufdcweb1.uflib.ufl.edu/ufdc/?a=ufirg&m=hitflmnh).

Color Catalogue for Field Biologists



by Gunther Köhler. 2012. Herpeton Verlag Elke Köhler, Offenbach, Germany (www.herpeton-verlag.de). Softcover. 49 pp. Euro 24,80 (approximately US$ 32.70). ISBN 9783936180404.

This dual language (English/Spanish) book serves the important function of providing field biologists with the tools to accurately describe the coloration of animals, particularly in life. Although many authors invest little effort in their descriptions of color, some biologists have strived to use a standard terminology to make their color descriptions as useful as possible. For many years the standard reference work in this field was the *Naturalist's Color Guide* by Frank B. Smithe, which provided 182 color swatches to which organismal colors could be matched. This volume replaces the now out-of-print Smithe and adds additional colors for a total of 300. The bulk of the oblong, spiral-bound book is made up of 30 pages of color swatches (10 per page), including approximations of the familiar colors from Smithe with names adopted accordingly. The book also gives definitions for terms used in color description, such as suffusion, splotches, chevrons, and bands. A series of 24 color photos of mostly Neotropical amphibians and reptiles (four to a page) illustrate the use of these terms and three detailed examples of color descriptions are also provided. Although herpetological examples are used, any biologist who needs to accurately describe color could make good use of the *Color Catalogue*. Reference to this book (or to another color guide, such as that of Smithe) should be considered as a "best practice" for species descriptions and other publications for which color documentation is important.



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SOCIETY FOR THE STUDY OF AMPHIBIANS AND REPTILES

www.ssarherps.org



The Society for the Study of Amphibians and Reptiles, the largest international herpetological society, is a not-for-profit organization established to advance research, conservation, and education concerning amphibians and reptiles. Founded in 1958, SSAR is widely recognized today as having the most diverse society-sponsored program of services and publications for herpetologists. Membership is open to anyone with an interest in herpetology—professionals and serious amateurs alike—who wish to join with us to advance the goals of the Society.

All members of the SSAR are entitled to vote by mail ballot for Society officers, which allows overseas members to participate in determining the Society's activities; also, many international members attend the annual meetings and serve on editorial boards and committees.

All members and institutions receive the Society's primary technical publication, the *Journal of Herpetology*, and its bulletin, *Herpetological Review*; both are published four times per year. Members also receive pre-publication discounts on other Society publications, which are advertised in *Herpetological Review*.

To join SSAR or to renew your membership, please visit the secure online ZenScientist website via this link:
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2013 — Albuquerque, New Mexico, 10–15 July (JMIH with ASIH, HL, and AES)
2014 — Chattanooga, Tennessee, 30 July–3 August (JMIH with ASIH, HL, and AES)
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PHOTO BY R. A. ODUM/TOLEDO ZOO

THE IMPORTANCE OF EARNEST OUTREACH: SSAR AND BEYOND

"Public understanding of science not only affects people's ability to appreciate and make full use of the products of science, it also contributes to the extent of support for scientific research. Yet far too many scientists are reluctant to engage with people outside their own community."
Alan I. Leshner, CEO American Association for the Advancement of Science (2012 Science 337:777)

It is hard to believe that my two-year term as President of SSAR is coming to an end this month. While being president of a major society was never a specific goal of mine, contributing to herpetology on behalf of the animals we study has been a lifelong goal. I will use this piece to continue with the theme I visited in my last essay: the importance of broadening all aspects of SSAR in order to better serve the different stakeholders within the herpetological community and, moreover, to best serve the needs of the animals upon which we base our hobbies and careers. In the past few years, I have given many lectures in a range of venues, from universities to zoos to herp clubs to nature centers to cub scouts. I have noticed that many of our colleagues and members are doing some really amazing work in the realm of what people generally refer to as public education or outreach. I would like to highlight some of their efforts here.

The current widespread popularity of reptiles and amphibians as pets, and the omnipresence of these animals in documentaries and television wildlife programs, is inconceivable to many of us because they were summarily ignored—or worse—by most of society and public media until relatively recently. In the USA, where I was raised, Raymond Ditmars was arguably the first important public proponent in the early 20th Century for the wonder of reptiles and amphibians. Mid-century saw zoo collections improve their standards of care (Petzold 2008. *The Lives of Captive Reptiles*. Contributions to Herpetology 22. SSAR, Ithaca, New York. 275 pp.) and the development of programs and educational materials for the public by people like Bill Haast, Robert Stebbins, Doris Cochran, Carl Kauffeld, Roger Conant, Archie Carr, and Ross Allen. More recently, colleagues like Marty Crump, Rafael Joglar, Joe Collins, Kate Jackson, Harry Greene, Mike Lannoo, and Luis Coloma, among others, have produced academically sound books and programs aimed toward the general public. While great nature programming on television existed, produced by people like Marlin Perkins or Jacques Cousteau, it very rarely included any non-menacing or non-sensational coverage of herps except perhaps for the occasional chelonian.

The pet trade was limited, entirely based on wild-caught animals, and was so specialized and out of the view of the public that it rather resembled the illegal black market trade of today. So it is very heartening today to see a pet trade that includes so many captive-bred animals, even if over-collection and other unacceptable problems related to commercial trade persist. Regional societies, such as the Chicago Herpetological Society, host enormously popular annual reptile and amphibian shows where the animals are showcased, not sold. It is encouraging to see zoos, aquariums, nature centers, and botanical gardens stepping up to be leaders in reptile and amphibian research and conservation, over and above their more traditional roles as educators and public attractions.

Similarly, while natural history museums have traditionally been leaders in research, conservation is becoming more important in their programs as well; AmphibiaWeb, based out of the Museum of Vertebrate Zoology at University of California Berkeley is as much about conservation as it is about biodiversity. Herpetological eco-tour program are now available, through organizations such as Green Tracks (www.greentracks.com) or the Costa Rican Amphibian Research Center (www.crarc.com); eco-tours traditionally have focused mainly on birds or marine mammals.

There even has been progress in the horrific realm of rattlesnake roundups, as only three U.S. states (shamefully!) still permit them. In 2012, the event in Claxton, Georgia, voluntarily transformed itself from a "roundup" into a "festival" of rattlesnakes. No snakes were killed there, nor likely ever will be again, and the local community attracted a record-breaking attendance.

In recent years, many regional herpetological societies have focused on pets and husbandry, but more and more, groups in places like Chicago, Dallas-Fort Worth, and Kansas are stacking their speaker rosters with research- or conservation-oriented herpetologists. Most states or regions now have detailed field guides available, such as the exemplary *"Field Guide to Amphibians and Reptiles of the San Diego Region"* by Jeff Lemm (University of California Press, Berkeley, 344 pp.). Reptiles and amphibians also are featured nearly exclusively on a number of well-produced educational programs hosted by colleagues like Brady Barr or Jeff Corwin, even if a few unfortunately exploitative or overly sensational programs still seem all too prevalent. Importantly, I often see my colleagues having their research or conservation programs featured on wildlife programs and nightly news broadcasts. How delightful it is to see media coverage on a great piece of herpetological work and to think "Hey, I know that person!" Indeed academics are getting better at attracting and engaging the media. Related to this point, I highly recommend the book *Escape from the Ivory Tower: A Guide to Making Your Science Matter* (Nancy Baron, 2010. Island Press) to educate oneself on the realities of dealing with media communications as a scientist.

In a recent essay (2012. *Herpetological Review* 43[2]:165–166) I emphasized the importance and value of citizen science to inform academic herpetology. Now it is time to make sure academics are giving something back to a public that is primed and eager to learn about these animals and their conservation challenges. The SSAR membership includes a wonderfully engaging group of people ranging from hobbyists to undergraduates to emeritus academic faculty or curators who have much to offer to the public and, therefore, much

to offer to the animals we study. Outreach education is how public perceptions are changed; the near demise of rattlesnake roundups is evidence of this. Some of our members contribute a lot already, but I challenge all of us to consider reaching out to a nature center, community group, K–12 school, library, or similar venue to give a fun talk about herpetology or your research. Perhaps lead your own eco-tour to a local wetland. Invite non-traditional people to assist at your study site; Gad Perry does this all the time (Gerbert 2012. IRCF Reptiles & Amphibians 18:110–115). Honestly, some of the most interesting insights I have had to my own research have germinated from naïve (not "dumb" mind you!) questions from a public audience. SSAR does a good amount of outreach already. In 2010 SSAR set up a booth at the first annual National Science Fair on the National Mall in Washington, DC (2010. *Herpetological Review* 41[4]:409–410). The event was attended by over a million members of the public and I was proud to see virtually all of the "big-name" herpetologists in the DC area tirelessly working the booth all day long. I am also proud to point out that the SSAR Roger Conant Grants-in-Herpetology program that Josh Kapfer leads has always had a funding category specifically dedicated for herpetological education. Finally, I will highlight a few exceptional outreach education programs, among others too numerous to mention here, that I have encountered in the last couple of years.

Education and celebration of wildlife has long been central missions of zoos and natural history museums, but while reptiles and amphibians have always been exhibited, they were never a focus in any positive sense. I encourage everyone to go back and read about the extraordinary program "Toad Trackers" that Rachel Rommel (2012. *Herpetological Review* 43[2]:417–421) created at the Houston Zoo; this program turns every participating kid into a contributing citizen herpetologist! Who says that herps can't party? Jennifer Stabile, while she was at Central Florida Zoo, created a massively popular *Festival del Coqui,* wherein proud Puerto Ricans and their international friends converge for a few days of frenzied frog-focused partying and learning about the "other" coqui species native to their island (proyectocoqui.org; centralfloridazoo.org). Zoo associations across the world recently have developed successful programs to raise awareness and, importantly, conservation funds with campaigns such "Year of the Frog" and "Shellshock" for amphibians and chelonians, respectively, in recent years.

In the realm of the Ivory Tower, we were all proud in recent years to watch Whit Gibbons, Bob Powell, and Mike Dorcas receive the Meritorious Teaching Award in Herpetology co-sponsored by SSAR, ASIH, and HL. I believe a large part of the reason these three people earned the award is because each of them stepped up and implemented educational programs that go far outside their typical academic job descriptions. Whit is a tireless proponent of public lectures; I think he has given as many such lectures in the Atlanta area as I have in the last eight years, and he does not even live in this city. Bob, with his energetic and innovative approach to field courses, has single-handedly turned many dozens of undergraduates into peer-reviewed published herpetologists and produced more than a few career academics. Mike's lab also churns out high quality undergraduate publications, but he further empowers his undergraduates to lead a very busy schedule of public outreach events and maintain a website (http://www.bio.davidson.edu/people/midorcas/outreach/Outreach.htm) that is more informative for North Carolina citizens than is typical of most state or national parks. Similarly, John Maerz (University of Georgia; http://ugaherpsociety.uga.edu/Home.html) and Kraig Adler (Cornell University; http://www.rso.cornell.edu/cuherps/) among others, selflessly volunteer as faculty advisors for campus herpetology clubs that inspire undergraduates as well as connect with thousands of members of the public. I am pretty sure that these extra-curricular efforts do not figure strongly in their annual evaluation for promotion and tenure.

There are many more great campus and zoo programs, public proponents and educators, and popular media outlets for herpetology than I can include here. As I mentioned, I am simply pointing out a subset with whom I have had the pleasure of visiting lately and with a clear bias toward programs in my native country. My main point is that every SSAR member owes it to society and our favorite animals to devote some time and energy toward outreach education in any sense or framework that fits your position and expertise.

As I end my term as President of SSAR, I am so very proud to have represented a hard-working membership and team of chairpersons, officers, board members, and editors who have made a difference in modern herpetology—and the public perception of the discipline and the animals involved. SSAR has put a lot of energy in recent years to ensure that it remains relevant to the ever-changing roles of research, conservation, and education in our corner of the biological sciences. We have done so much in terms of new and revamped programs to try to make SSAR more inclusive and accessible and relevant for the broadest membership possible. We have decreased membership rates for certain groups of stakeholders. We have expanded our concept of "student" to truly mean *all students* of any age. We have increased and expanded our awards and grants programs for students. We have a new mentorship program to make sure first-timers at annual meetings feel oriented and welcomed. We have revamped *Journal of Herpetology* and *Herpetological Review* to accomplish what seemed impossible: make them more colorful, more attractive to new readers, retained top-quality content, yet are less expensive to publish and ship. As user expectations have evolved, we have made two of our signature publications series (*Herpetological Review* and *Catalogue of the American Amphibians and Reptiles*) now available as downloads and searchable electronically for the first time ever. We have waived all page-charges for members to publish in our journals. We remain committed to publishing works that are of primary importance for understudied areas of the world (Masroor 2012. *Contribution to the Herpetology of Northern Pakistan*. SSAR Contributions to Herpetology. 217 pp.), newly emerging fields of study (Mitchell et al. [eds.] 2008. *Urban Herpetology*. Herpetological Conservation 3. SSAR, Salt Lake City, Utah. 586 pp.), truly affordable facsimile reprints of classical volumes of incalculable importance (*Erpétologie Génerale, by* Duméil and Bibron, published by SSAR November 2012; see *Herpetological Review* 43[3]:362), and that cross-inform stakeholders in agencies, the public, and academia (Crother 2012. Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, with Comments Regarding Confidence in our Understanding. SSAR Herpetol. Circ. 39. 92 pp.). We allocated funds to make our website a most vital herpetological portal; we are working on this now.

But how do we measure success as a taxon-based society? *Journal of Herpetology* was recently ranked among "Top 100 Journals in Biology and Medicine in the Past 100 years" by the Special Libraries Association. I would point to the fact that both *Journal of Herpetology* and *Herpetological Review* have represented more nations than ever before, both in terms of study sites and—more importantly—nationalities of authors. I would also point to the amazing fact that SSAR appears to be one of the only taxon-based professional societies in biology that is not suffering a precipitous decline in membership. Declines in taxon-based societies are a regrettable modern reality, and certainly not an opportunity to gloat. However, self-reflection is appropriate at this time. What I have tried to describe in my series of informal "Presidential Essays" is the reality of being a taxon-based

biologist in a modern age. Harry Greene famously defended the importance of natural history (1993. *Herpetological Natural History* 1:3). Natural history is the study of all aspects of nature by all interested persons. I believe that SSAR can attribute its survivorship and relative success to its breadth of publications, its non-arrogant open-door policy for contributors, and a membership that invites, and appreciates, well beyond the Ivory Tower. Speaking personally, I have spent my entire life hoping to contribute to herpetology. My CV might suggest that I have done so, but my term as President of this vital society has convinced me that I have done so. Thank you, to the entire SSAR membership for all that we do.

Acknowlegments.—Rachel Rommel, Jen Stabile, Jessica Tingle, Nitya Rao, John Archer, Danny Beckwith, Cyndi Carter, Carl Franklin, and Bob Hansen provided essential information and conversations for this essay. Harry Greene, Jenny Pramuk, Karen Lips, George Rabb, Jim Murphy, Beth Timpe, Mike Dorcas, Bob Johnson, Mike Lannoo, Andy Odum, Ron Gagliardo, Danny Benboe, Kristine Kaiser, Sean Graham, Brad Lock, Robert Hill, Luke Wyrwich, Stacy Graison, David Brothers, Jason Brock, Bob Hansen, and many others have joined-shared many relevant discussions with me over the years.



Joseph R. Mendelson III
President

ABOUT OUR COVER: *Strophurus taenicauda*



The family Diplodactylidae contains about 120 species of geckos endemic to the Australian region. They occur throughout the continent with outliers in New Zealand and New Caledonia. The 17 species of *Strophurus* are among the more unusual members of this diverse family.

Strophurus occur in dry to arid areas of Australia. They have broad padded digits and tend to climb among slender objects, grasping twigs, thin branches, and grasses. The species fall broadly into arboreal and tussock-inhabiting groups. The jewelled and striped geckos (*S. elderi*, *S. jeanae*, and their allies) dwell exclusively in grasses and sedges. Most inhabit the interlocking matrix of tough spines that form hummocks of *Triodia*, a genus of drought-resistant grasses dominating the arid landscape. Tussock-inhabiting *Strophurus* have dotted or simple linear patterns. Arboreal species, including spiny-tailed geckos (*S. ciliaris* and its relatives) shelter under the bark of dead saplings, in narrow hollows and among foliage. Some of these species are distinctively ornamented with rows of spines along the tail and sometimes over their eyes.

Strophurus share an extraordinary defensive strategy. The ability to expel sticky repellent fluid from glands set deep within the tail appears unique to *Strophurus* and the New Caledonian genus *Eurydactylodes*. The substance can be dribbled and smeared, or a fine jet may be forcibly ejected up to half a meter. The fluid initially has a treacle-like consistency, drying quickly to cobweb-like filaments. It is not known to be toxic (Richardson and Hinchliffe 1983. Copeia 1983[1]:161–169) but when experimentally applied to mealworms they were distasteful to chickens (Rosenberg and Russell 1980. Can J. Zool. 58:865–881). It can certainly cause eye irritation in humans, resulting in redness and discomfort that may persist for several hours.

The substance may be metabolically expensive to produce, as the geckos seem reluctant to expel it except under extreme circumstances. They rarely squirt fluid when captured by hand but will do so if handled roughly or grasped by a predator. There can be little doubt that a face-full of sticky irritant fluid would give a small predator cause to reconsider its options.

Unlike other Australian geckos, *Strophurus* exhibit some diurnal tendencies. While not actively foraging by day, the lizards can often be encountered basking in direct or dappled sunlight. *Strophurus williamsii* has been recorded clinging fully exposed to a wire fence in temperatures exceeding 40°C. The lizard had adopted pale, heat-reflecting hues and did not appear remotely stressed by the temperature.

The strikingly marked Golden-tailed Gecko (*Strophurus taenicauda*) is an arboreal species, restricted to the Brigalow Belt bioregion of the southeastern interior of Queensland. It inhabits dry forests, favoring associations of eucalypt, native pine (*Callitris*), and various species of acacia, particularly Brigalow (*Acacia harpophylla*). There are three described subspecies, differing in scalation details but also readily identifiable by coloration (Brown et al. 2012. Zootaxa 3243:1–28). The lizard pictured is the nominate subspecies, *S. taenicauda taenicauda*, which has ruby red eyes, dense black speckling, and a wavy-edged tail stripe. Other races have grey to amber eyes, straight-edged stripes, and finer black spotting.

Golden-tailed Geckos are of conservation concern and are listed under Queensland Government legislature as "Near threatened." Though very common in their habitat, native vegetation throughout the bioregion is declining and fragmenting through clearing for agriculture and grazing, inappropriate fire regimes, weed and feral animal invasions and, more recently, a rapid expansion in the exploitation of coal and natural gas.

This lizard was photographed by Australian herpetologist **Steve Wilson** at Lake Broadwater in southeastern Queensland. Steve mounted a Canon 30D and a Canon 100mm lens on a tripod to capture the image at a shutter speed of 0.6 second with natural daylight at ISO 100 and an aperture of f16. Steve has written field guides to reptiles of Australia and his home state of Queensland, a guide to reptiles of the southern Brigalow Belt, and a reptile book for children. His most recent book (*Australian Lizards: A Natural History*. CSIRO Publishers, Collingwood, Victoria. 208 pp.), published in 2012, is a popular guide to Australia's remarkable lizard fauna.



PHOTO BY MARILYN PARKER



CELEBRATING THE 7TH WORLD CONGRESS OF HERPETOLOGY

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ERPÉTOLOGIE GÉNÉRALE

ou Histoire Naturelle Complète des Reptiles



Constant Duméril



Gabriel Bibron



Auguste Duméril



AMONG THE PUBLISHED WORKS IN herpetology over the last five centuries, only two can be said to cover all known species of amphibians and reptiles comprehensively and scientifically. One, in English, was by George A. Boulenger and based on the collections of the British Museum in London (9 volumes, 1882–1896). These books were reprinted in 1961–1966 and, despite their age, remain among the most frequently consulted references in herpetology. The other, in French, was by Constant Duméril, Gabriel Bibron, and the senior author's son, Auguste Duméril, and based on the collections of the Muséum d'Histoire Naturelle in Paris (9 volumes plus an atlas of colored plates, 1834–1854). This latter work, generally known as "D & B," has never been reprinted, yet it remains of continuing value to a broad community of academic zoologists, museum and zoo curators, and conservationists, and especially to herpetologists working in developing countries. D & B is, in fact, more comprehensive than its English counterpart, for in addition to having more detailed descriptions of genera and species, it also covers the internal anatomy, physiology, and the associated literature.





Karl Patterson Schmidt, a leading American herpetologist, wrote: **"The *Erpétologie Générale* was the crowning work of a century of herpetological studies, during which the leadership in the field had lain with the French."** At that time, Paris was the epicenter of world science and its museum boasted the greatest naturalists: Buffon, Geoffroy Saint-Hilaire, Lacepède, Lamarck, and the greatest of them all, Georges Cuvier. Also among them was Constant Duméril, who trained as a physician and became one of Cuvier's closest colleagues. The Paris museum then possessed the largest natural history collections in the world. D & B was the first work in which a natural arrangement of genera was attempted, and many of the genera and species were first described there.





This full-size facsimile is complete and carefully edited for clarity. The 120 finely executed plates are reprinted in *both uncolored and colored states* because the original coloring sometimes obscures details of scutellation. The nine text volumes, which total nearly 7,000 pages, and the atlas of 240 plates are sturdily bound in library-grade cloth and printed on durable, acid-free paper. The **new introduction by Roger Bour (Paris)** is an in-depth review of the book (including exact publication dates) with new biographies of the three authors. A **comprehensive index to the scientific names**, missing in the original book, has been added. The original book was issued in fewer than 500 sets; a colored set, rarely offered today, costs about US$15,000. Only 400 new sets are being reprinted. (This reprint is being offered at an affordable price because of a generous subsidy from Ronald A. Javitch of Montréal.) Herpetological centers in developing countries are invited to contact the editor (*Kraig Adler*: kka4@cornell.edu) about special arrangements for obtaining copies.

■ SPECIFICATIONS: Nine volumes (bound in five) of text, plus an atlas volume of 240 plates (in colored and uncolored states), all 5½ × 8½ inches (14 by 21.5 cm). Library-grade cloth bindings. ISBN 978–0–916984–87–8. ***Issued December 2012***.

■ PRICES: • **Regular Price:** $275. • **Special Price to SSAR members** (if order is received before 31 January 2013): $225. • **Shipping**: USA address, add $15; non-USA shipping at cost. • **Orders to:** SSAR Publications Secretary, P.O. Box 58517, Salt Lake City, Utah 84158–0517, USA (*telephone and fax*: 801–562–2660; *e-mail*: ssar@herplit.com). • **Payment:** Make checks payable to "SSAR." Non-USA orders must be paid in USA funds using a check drawn on an American bank or by International Money Order. Books may be charged to American Express, Discover, MasterCard or Visa (please give account number and expiration date). • SSAR Membership and Other Publications: Membership information and a list of society publications can be obtained from the Publications Secretary at the address given above or at www.ssarherps.org.

SSAR BUSINESS

SSAR Election Results

Results of the 2012 SSAR election are as follows:

President-Elect: Aaron Bauer
Treasurer: Ann Paterson
Secretary: Marion Preest
Board Members (Regular): Frank Burbrink, Lisa Hazard, Greg Watkins-Colwell
Board Member (non-US): Alison Cree

Thank you to all of the nominees who agreed to stand for positions and to Dan Noble (Elector).

Seibert Award Winners for 2012 Announced

The 21st annual Seibert Awards were presented at the 55th Annual Meeting of the SSAR (held in conjunction with the 7th World Congress of Herpetology) in Vancouver, Canada, 8–14 Aug 2012. These awards are named in honor of Henri C. Seibert, an early and tireless supporter of SSAR (having served as an officer for over 20 years). In recognition of outstanding student presentations at the annual meeting, a single award was given in each of the following categories: Evolution/Systematics (12 presentations), Ecology (22 presentations), Physiology/Morphology (8 presentations) and Conservation (11 presentations). All awardees will receive a check for US $200 and a book from Chuck Crumly at University of California Press.

The Winners.—Systematics/Evolution: **Sara Ruane** (College of Staten Island), "Speciation in the Milksnake (*Lampropeltis triangulum*)." Ecology: **Thomas Luhring** (University of Missouri), "Islands in the Sun: Nutrient Cycling is Isolated Systems is Mediated by Canopy Cover, Predation, and the Complex Life-Histories of their Transient Tenants." Conservation: **Shawn McCracken** (Texas State University, San Marcos), "Living on the Edge: Oil Road Effects on the Occupancy and Abundance of Anurans Inhabiting an Upper Canopy Tank Bromeliad (*Aechmea zebrina*) in Lowland Rainforest of the Yasuni Biosphere Reserve, Amazonian Ecuador." Physiology/Morphology: **Rory Telemeco** (Iowa State University), "Effects of Temperature During Development on the Offspring Phenotype of a Facultative Thermoregulator, the Southern Alligator Lizard (*Elgaria multicarinata*: Anguidae)." Honorable Mentions were given to **Gareth Hopkins**, **Julia Riley**, and **Hilton Oyamaguchi**.

The judges were Chris Parkinson, Andrew Crawford, Traci Rittenhouse, Doug Eifler, Eric Juterbock, Caren Goldberg, Edgar Lehr, Pete Zani, and Rafe Brown (chair).

SSAR Student Poster Awards

The SSAR Poster Awards will provide recognition for the best student posters presented at the annual meeting of the SSAR. To be eligible, the presented poster must be the result of research conducted by the individual making the presentation. The research must have been conducted while the student was enrolled in either an undergraduate or graduate degree program. Students entering the competition must be members of SSAR. The presentations will be judged by the SSAR student prize committee. One SSAR Poster Award of U.S. $100 may be given in each of the following four categories:

- Evolution, Genetics, & Systematics
- Ecology, Natural History, Distribution, & Behavior
- Physiology & Morphology
- Conservation & Management

The SSAR Poster Award will be judged by the following criteria:

- Quality of Research
- Quality of the Visual Display of the Research
- Professionalism and Confidence of the Presenter

Students may win the award only one time. Please indicate the appropriate category for which you are applying on the abstract submission form. Contact Tiffany Doan at tiffperu@yahoo.com or 860-839-2944 for further information.

Recommendations to Students Entering the SSAR Poster Competition

The SSAR Poster Award was presented for the first time at the 2011 Joint Meeting. The SSAR Board of Directors wishes to recognize that poster presentations are an important part of the annual Joint Meeting event and that they are an important component of the graduate and undergraduate experience. The presentation of some research projects is better suited to a poster session, which allows much greater communication between the presenter and the audience. The following recommendations are intended to aid students in improving the quality of their poster presentations. The criteria presented below are applicable to any poster given at a scientific meeting.

Preparing the Presentation

A. The Poster Itself

- More so than an oral presentation, a poster needs to visually draw in the audience. When hundreds of posters are up at the same time, one's poster needs to stand out to be noticed.
- Organization is key—a cluttered poster that is hard to read will not keep the attention of the audience.
- Use large fonts: at least 28–36 size font for the smallest words; approximately 90 size for the title.
- Use *sans serif* fonts such as Arial, Helvetica, and Calibri, which are easy to read from a distance.
- Use as many figures as possible, including graphs and photographs, to display your data.
- Use color to your advantage, but do not make it overwhelming. No one wants to look at a black-and-white poster, but too much color can be distracting.
- Do not include paragraphs on your poster (no one wants to stand there and read them). Bullet points or short sentences are much easier to read.

B. Oral Presentation

- Prepare a short explanation to your poster so that viewers do not have to read everything.
- Anticipate questions that the audience might have.
- Be prepared to discuss further research that you may later perform based on the results from the project about which you are presenting.

- Remember that other scientists have stopped at your poster because they are interested in your research. Relax and enjoy the experience of "talking shop" with other scientists who share similar interests.

Describing your Research

A. Design

- Present your research in a larger context by addressing previous studies (choose 1 or 2 to make your point). Relate your data to the knowledge of your field.
- Clearly state your hypothesis(es) and/or objectives up front.
- Flag techniques that are original to your study (i.e., this study is the first to address this question or to use this technique).

B. Summary of Results

- Present your results clearly. Tables with N and P values are fine (but not necessary) if they are readable. Always indicate your sample sizes.
- Indicate the importance of your results. How do they relate to previous studies? Biology in general?

C. Importance of Study

- An abstract, summary, or conclusions section of your poster is helpful in tying together many results.
- State the importance of your study and how your research has added to knowledge of the subject presented. Are your results generally applicable to larger biological questions?

2012 Annual Meeting, Vancouver, British Columbia, Canada

The 55th Annual Meeting of SSAR took place from 8–14 August 2012 on the campus of the University of British Columbia in Vancouver, British Columbia, Canada. This meeting was held in conjunction with the 7th World Congress of Herpetology (Aaron Bauer, Secretary General). WCH has previously met in the United Kingdom, Australia, the Czech Republic, Sri Lanka, South Africa, and most recently, in Brazil. This was the first WCH to be held in North America and the first to include ichthyological colleagues from ASIH and AES. Organizing societies this year were the World Congress of Herpetology, Society for the Study of Amphibians and Reptiles (along with the International Society for the History and Bibliography of Herpetology), American Elasmobranch Society (celebrating its 28th annual meeting), American Society of Ichthyologists and Herpetologists (celebrating its 92nd annual meeting) and The Herpetologists' League (celebrating its 70th annual meeting). Pat Gregory was the hard-working chair of the Local Organizing Committee and David Green was chair of the Scientific Program Committee. They were ably assisted by other members of both committees and a host of local volunteers. Special thanks to Sheri Donavan (of "Conferences and Accommodation at UBC") and others in her team.

The meeting included 133 sessions, with 25 symposia on topics as diverse as "Habitat Fragmentation," "Caecilian Biology," "Reintroductions and Translocations," "Insights from the Fossil Record," and "Biogeochemical Methods in Ecology." SSAR sponsored two symposia: "Technology and Innovations in Collections" and "Invasive Species and Global Change" (Fig. 1). Around 1040 oral presentations and 430 poster presentations were made. Each day began with a plenary session, followed by multiple oral presentation sessions, and then a poster session beginning at 5 pm (Fig. 2).

SSAR was the sole Gold Level Sponsor of the WCH, as well as a contributing society. Other sponsors and contributors included LGL Limited- Environmental Research Associates, University of Victoria, Wildlife Acoustics, UBC Faculty of Forestry, Beaty Biodiversity Museum, Canadian Association of Herpetologists, Canadian Amphibian and Reptile Conservation Network, The Herpetologists' League, ASIH, and AES.

David Dennis produced a striking poster that was distributed *gratis* to all delegates. The image is of a frog with tadpoles and eagle heads and is based on Pacific Northwest aboriginal designs from the Haida cultural group. Thanks to Jim and Sarah Christiansen who sponsored the poster. A version of the poster in multiple languages was used to welcome delegates from around the world to WCH (Fig. 3). This was one of many elements of SSAR's contribution to the Congress, emphasizing our commitment to WCH from its very beginnings, and to demonstrate our status as a truly international society. Also included in the delegate bags were copies of *Herpetological Circulars* 39 and 40 (7th edition of the *Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico* and *Noms Français Standardisés des Amphibiens et des Reptiles D'Amérique du Nord*

PHOTO BY RICHARD DURTSCHE



FIG. 1. Participants in the SSAR-sponsored symposium on Invasive Species. L to R: Ray Huey, Mike Dorcas, Gad Perry, Karen Lips, Barry Sinervo, Mike Angilletta, Che Weldon, Mike Lannoo, Lee Berger, Bradley Shaffer, Mo Donnelly, Jim Collins, Joe Mendelson, Tracy Langkilde, David Towns, Robert Reed, Susan Jewell, Christina Ramagosa. Not shown: John Maerz, Luis Coloma.

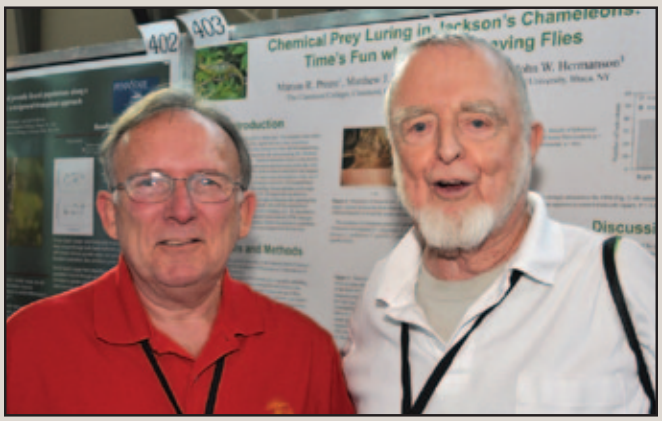


PHOTO BY ROBERT HANSEN

FIG. 2. Joe Mitchell and Bayard Brattstrom at one of the busy poster sessions.

WCH 7 Posters Available

The official SSAR poster that welcomed delegates to the 7th World Congress of Herpetology in Vancouver in August 2012 is available in limited quantities. Each poster measures 11 x 17 inches and can be purchased from the SSAR Publications Office for $4.00 each postpaid or $3.00 in quantities of 10. Posters cannot be shipped outside the USA because of their size.

Orders or inquiries to:
Breck Bartholomew, SSAR Publications Secretary
Post Office Box 58517, Salt Lake City, Utah 84158-0517, USA
Telephone and Fax: (801)562-2660, e-mail: ssar@herplit.com



FIG. 3. A version of the poster designed by David Dennis and given to delegates at WCH.

Au Nord du Mexique / Standard French Names of Amphibians and Reptiles of North America North of Mexico), the special June 2012 "Congress" issue of *Herpetological Review*, "Contributions to the History of Herpetology, vol. 3," and a recently produced membership brochure. Thanks to the many individuals (e.g., Kraig Adler, Breck Bartholomew, Bob Hansen, John Moriarty) who made all of this possible.

After a busy day of Board and Executive Committee meetings, the 2012 WCH began officially with a Plenary Session on the morning of Aug 9th. Pat Gregory and David Green, local organizing chairs, gave us a warm welcome to Canada (Fig. 4). Pat mentioned that the idea for a WCH in Canada began back in 2002 at the JMIH meeting in Kansas City, Missouri. Pat reported that nearly 1,700 herpetologists and ichthyologists from at least 48 different countries were in attendance. This makes it the largest WCH yet! Approximately 44% of the attendees were students. Pat couldn't resist informing us that Canada was "punching above its weight" relative to the United States, i.e., the US has 10 times the population, but only 5 times the number of herpetologists at WCH! He also pointed out Canada's Summer Olympics bronze medal win in women's soccer that same day. Pat acknowledged the hard work of Sheri Donavan and her colleagues.

WCH Secretary General, Aaron Bauer, then welcomed SSAR, ASIH, HL, and AES to the WCH. He reserved a particular welcome to those who had traveled long distances. Aaron went over details of WCH business meetings occurring over the next few days. Angela Redish (Vice Provost and Associate Vice President of Enrollment and Academic Facilities) welcomed WCH to the UBC campus. She provided some information about the University and highly recommended that we visit the Beaty Biodiversity Museum and the Museum of Anthropology.

The first plenary presentation for the morning was by Tyrone Hayes (University of California, Berkeley)—"THE Cause of Amphibian Decline" (Fig. 5). Tyrone introduced himself as the "little boy who likes frogs" and spent the next 45 minutes explaining his self-acknowledged "obnoxious" title. He spoke extensively about his experimental laboratory work with atrazine and studies on atrazine in the field. He also spoke about how he regarded being referred to as an environmentalist, not as a slur, as sometimes intended, but rather as something to aspire to. Tyrone finished with a quote from Einstein: "Those who have the privilege to know have the duty to act."

SSAR, ASIH, and HL then announced Michael Dorcas as the third recipient of the Meritorious Teaching Award in Herpetology. Mike received a plaque and a cash award. ASIH representatives



PHOTOS BY ROBERT HANSEN

(Left) Fig. 4. Pat Gregory, Chair, Local Organizing Committee, welcoming delegates to the 7th WCH at the first Plenary session.
(Right) Fig. 5. Tyrone Hayes, first plenary speaker of the meeting.

PHOTO BY ROBERT HANSEN



FIG. 6. David Dennis, designer of the SSAR meeting poster, and Jonathan Campbell, winner of the ASIH Fitch Award enjoying the opening reception.

PHOTO BY M. PREEST

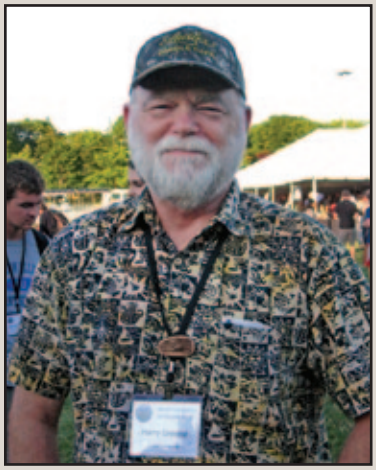


PHOTO BY ROBERT HANSEN



(Left) Fig. 7. Harry Greene, 2012 SSAR President's Travelogue speaker. (Right) Fig. 8. Jonathan Losos about to wield a croquet mallet at the opening reception.



FIG. 9. From left to right, David Wake, Miguel Vences, and Jay Savage enjoy the relaxed atmosphere at the opening reception, held outdoors in beautiful weather.



FIG. 10. The opening reception presented the opportunity to reconnect with friends and colleagues. From left to right: Rafe Brown, Bryan Stuart, Mary White, Kraig Adler, and Bob Mason.

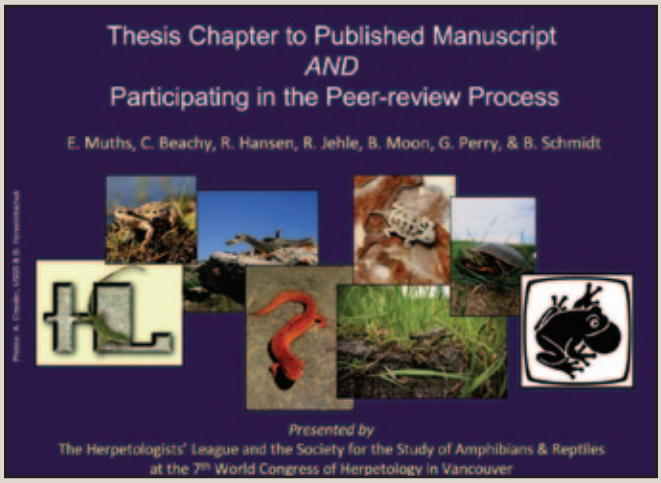


FIG. 11. Title slide for student workshop organized by Erin Muths.

PHOTO BY WULF SCHLEIP



FIG. 12. Organizers and presenters of the very successful and well-attended SSAR/HL student workshop on writing and review process. L to R: Benedikt Schmidt (*Amphibia-Reptilia*), Gad Perry (*Journal of Herpetology*), Brad Moon (*Herpetologica*), Erin Muths (*Journal of Herpetology*), Robert Hansen (*Herpetological Review*), Chris Beachy (*Copeia*), and Robert Jehle (*Herpetological Journal*).

PHOTO BY ROBERT HANSEN



FIG. 13. Attendees at the student workshop—standing room only!

presented a number of awards (the Robert Gibbs Award to Lance Grande, the Fitch Award to Jonathan Campbell [Fig. 6], and the Johnson Award to Brooks Burr).

Michael Douglas, ASIH Past-President, made time for a slide-show tribute and eulogy to Joe Nelson by his wife Claudine and then gave a short presentation on "Riverside Genetics as a Conservation Tool in Southwestern North America."

The Canadian Association of Herpetologists presented the Rankin Distinguished Herpetologist Award to Richard Wassersug, and the Canadian Amphibian and Reptile Conservation Network presented its Blue Racer Award to Jim Bogart. The second plenary speaker for the first morning, Karen Warkentin, was introduced by Pat Gregory. Karen spoke about "Environmentally-Cued Hatching: Integrative and Evolutionary Biology." She began by reminding us that most organisms begin life as eggs, that selection on embryos and hatchlings varies, and that eggs provide benefits, but also impose constraints. She made the point that embryos should hatch when the benefits of being outside an egg exceed the costs. Karen then began speaking about the two decades she has spent working with Red-eyed Treefrogs after discovering that embryos can hatch as much as 30% prematurely in response to predation cues. She spoke about other sources of mortality that can induce early hatching, the consequences of this early emergence, and the role of various kinds of vibrations on hatching. Pat Gregory wrapped up the first plenary session shortly before noon with concluding remarks and more announcements.

Shorter plenary sessions were held each morning with great talks each time. On 10 August, Lara Ferry, the AES invited speaker, talked about "Elasmobranchs in Biological Research" and Susan Evans gave a talk entitled "On the Evolution and Early History of Lepidosaurian Reptiles." The next day, the speaker was Laurie Vitt ("Walking the Natural History Trail"), and on 12 August, Mark-Oliver Rödel spoke about "West African Amphibians: Diversity, Threats, and Future." Kelly Zamudio was the final plenary speaker of the 7th WCH and she spoke about "Diversification and Conservation of Reptiles and Amphibians: Genomes, Populations, and Landscape."

Social and Professional Events

Harry Greene was this year's much-anticipated SSAR President's Travelogue speaker (Fig. 7). To say that there was standing room only for his presentation ("Natural History, Aesthetics, and Conservation") would be an understatement. After an introduction from President Mendelson and some technical difficulties (which he handled with a good-humored quip "just be glad it's happening to me and not you"), Harry got underway. He spoke about how science inspires values, the distinction between beauty and sublime, how we can all be teachers, and of the significance of his "three favorite things—a rolling pin, a book, and a rifle." He then focused on frog diversity and the "froginess" of these organisms as jumping machines. Next he spoke about the relationship between snakes and primates ("snakes eat primates, primates eat snakes"), the approximately 75 million years of "conflict" between these groups, and some of his work with Black-tailed and Timber Rattlesnakes. Harry finished up with a story of a discussion about *Crotalus atrox* that he had years ago with a cowboy in a Texas bar.

The SSAR/HL Student Reception was held late afternoon on 9 August. The room was packed with students and invited professional herpetologists. President Mendelson gave a warm welcome to our student members and encouraged them to enjoy finger food, drinks, and meeting senior herpetologists. Thanks to those who donated door prizes and congratulations to the lucky winners. A special thanks to Ronn Altig who provided handmade wooden coasters/medalions imprinted with the SSAR congress frog, as gifts to the students. The student reception was followed by the WCH Welcome Reception on a field near the halls of residence where most attendees stayed. In addition to good food, there were games of minigolf, volleyball, fooseball, boci ball, and croquet (Figs. 8–10).

Erin Muths was the lead organizer of a lunch-time student workshop on "Thesis Chapter to Published Manuscript AND Participating in the Peer-Review Process" (Fig. 11). Other participants were Chris Beachy, Robert Hansen, Robert Jehle, Brad Moon, Gad Perry, and Benedikt Schmidt (Fig. 12). Pizza and sodas were provided (as promised, we didn't run out this year! Barely….. one piece of pizza and four sodas were left) and students were lined up outside the room before the workshop began (Fig. 13). The organizers had produced a detailed and polished 85-slide Powerpoint presentation. They spoke, and answered questions, about such issues as the importance of publication, preparing manuscripts, understanding the review process, interpreting reviews, revisions, and becoming a peer-reviewer. At least 83 students attended. Discussion by the editors after the workshop included decisions to post the Powerpoint presentation from the workshop on the websites of HL and SSAR and the European societies and to consider presenting the workshop every 3–4 years.

The SSAR/HL live auction was held on 12 August. Although it was never going to live up to last year's Ernie Liner Auction, it was still well attended and good fun and we raised $5,800. All proceeds will be donated to the WCH. Auctioneers Steve Mullin, Frank Burbrink, Robert Fisher, and Jose Lefebvre were ably assisted by Greg Watkins-Colwell and a number of hard-working students (Heather M. Heinz, Matthew H. Shirley, Max Lambert, Madeline Miguel, Nassima Bouzid, James Titus-McQuillan, and Johana Goyes Vallejos; Figs. 14 and15).

Mike Jorgensen and Vinny Farallo once again organized the Silent Auction. The silent auction items were set up in the lobby of the main halls of residence for the meeting (Fig 16). A particular thank you is due to Shifra Laskier Levene, Dave Bickford, David and Marvalee Wake, and Sinauer Press for their donations. A big-screen TV with 24-hour Olympics coverage was nearby, so the silent auction desks enjoyed plenty of traffic. Once again, the ten recipients of the $400 SSAR Student Travel Award (Fig. 13) took turns to work the silent auction table for 2–3 h throughout the course of the meetings.

The WCH Plenary Business Meeting was held on the evening

PHOTO BY M. PREEST



FIG. 14. Madeline Miguel (L) and Sima Bouzid (R) handing out bidding numbers at the Live Auction.

PHOTO BY M. PREEST



FIG. 15. Beck Wehrle, Matt Ward, and Kris Kaiser with their loot from the Live Auction. Yes, Matt did manage to take the turtle on the plane with him the next day!

PHOTO BY ROBERT HANSEN



FIG. 16. One of the many great items on display for the Silent Auction. There was also a matching triad of turtles (see Fig. 15).

of 12 August. The main topic of discussion was the location of the next WCH. Proposals had been received for four venues - Kusadasi (Turkey), Hangzhou (China), Florence (Italy), and Cairns (Australia, a joint bid from Australian and New Zealand delegates). Representatives for each of these bids made their case, and discussion of the merits of each followed. There was a non-binding vote and then in a closed session the Executive Committee made the final decision.

The meeting ended with a picnic on the grounds of the Museum of Anthropology on the UBC campus (Fig. 17). Gone was the formality of recent JMIH banquets. Attendees had the pleasure of viewing the amazing indoor and outdoor exhibits at the museum before and after dinner (Fig. 18). The food (a buffet) was excellent and the live music much enjoyed. It was announced that China has been selected as the venue for the next WCH. The China Herpetological Society and the Asian Herpetological Society invite the world's herpetologists to attend the 8th WCH in Hangzhou, China, 2016.

Board and Business Meeting Summaries

SSAR Board Meeting

Society President Joseph Mendelson called the Board Meeting to order at 0808 h on 8 August 2012 in the Student Union Building on the UBC campus. In attendance were the following members of the Board of Directors, Editors, and Committee Chairs: Kraig Adler (Editor, *Contributions to Herpetology*; Chair, Long Range Planning Committee), Bob Aldridge (President-Elect), Breck Bartholomew (Publications Secretary), Aaron Bauer (Editor, *Facsimile Reprints in Herpetology*), Rafe Brown (Chair, Seibert Award Committee), Brian Crother (Past-President), David Cundall (Board Member, Reg. 2012), Kevin de Queiroz (Board Member, Reg. 2012), Tiffany Doan (Board Member, Reg. 2014), Richard Durtsche (Coordinator, Symposium Committee), Vincent Farallo (Chair, Silent Auction Committee), Pat Gregory (Board Member, non-US 2012), Robert Hansen (Editor, *Herpetological Review*), Josh Kapfer (Chair, Roger Conant Grants-in-Herpetology Committee), Travis LaDuc (Board Member, At Large, 2014), Joseph Mendelson, III (President), Joe Mitchell (Editor, *Herpetological Conservation*), Erin Muths (co-Editor, *Journal of Herpetology*), Kirsten Nicholson (Treasurer), Dan Noble (Elector), Gad Perry (co-Editor, *Journal of Herpetology*), Jennifer Pramuk (Board Member, Conservation, 2014), Marion Preest (Secretary), Al Savitzky (SSAR Representative to AIBS and BioOne), Carol Spencer (Board Member, Reg. 2014), Greg Watkins-Colwell (Chair, Nominations Committee; Organizer, SSAR/HL Live Auction). Additional society members present included Jim Christiansen, Marina Gerson, Steve Godley, Hinrich Kaiser, Roy McDiarmid, Henry Mushinsky, Wulf Schleip, and Jackson Shedd. Introductions were made and minutes of the 2011 Board of Directors Meeting (Minneapolis, MN) were approved.

Annual reports for 2011/2012 were submitted by most Officers, Editors, and Committee Chairs.

Officers' Reports.—President Joe Mendelson reported that SSAR recognized the following individuals with Special Recognition awards: Andrew Price, Marion Preest, Chuck Crumly, Ronald Javitch, Breck Bartholomew, and David Chiszar. Condolence letters were sent to the families of Andrew Price and Joseph T. Collins. Acknowledgment letters were sent to Jim Christiansen and Wendy Hodges and award letters were sent to the recipients of the Roger Conant Grants-in-Herpetology Awards and

the Andrew Price Field Research fund. The President wrote two "state of the union" type essays about SSAR-related matters that were published in *Herpetological Review*. Minor JMIH-related business was attended to this year, in relation to the planning of meetings for 2013 and 2014. Working closely with David Dennis, Kraig Adler, Ronn Altig, Breck Bartholomew, and Pat Gregory, significant efforts were put toward preparation of various *gratis* and promotional materials related to the 2012 World Congress of Herpetology. Harry Greene accepted an invitation to be the 2012 President's Travelogue presenter. The President acted as the voice of SSAR for numerous requests for information related to herpetology and/or SSAR, and also acknowledged an overwhelming number of compliments from members and colleagues regarding the reformatted appearance of *Journal of Herpetology* and *Herpetological Review*. Completion of the electronic index for *Herpetological Review* was anticipated for January 2012, but is not quite complete as of the time of this report. The President worked with Kris Kaiser, Andrew Durso, and Marion Preest to conceptualize and launch the new Mentorship program for the annual meetings. The President also engaged in ongoing discussions with relevant editors and officers related to matters of Conservation Committee letters, page charges for journals, the website, and the future of the CAAR publication series.

Treasurer Kirsten Nicholson reported that, overall, the finances of SSAR continue to be sound despite ongoing global economic issues combined with recent changes to our dues structures and journal formats. Overall we underspent our budget this year (by just over $110,000). Several changes were made to our journal formats, but all costs were covered within expected limits. Our investment portfolio went down over the course of 2011, but has come back well over 2012 and we are hovering at the value of our investments' totals from 6 years ago. Kirsten reported that the market value of our investments at the end of 2011 was $560,053, but as of June 2012 has increased to $605,478. Membership numbers are down slightly, but not significantly, and thus our numbers seem to be holding steady in the light of the economy combined with a dues increase. This will allow us to continue to provide high quality publications and serve our membership by supporting their research and presentation endeavors. SSAR accepted extremely generous donations during 2011 and 2012 for various projects that are underway currently or have been recently completed, and these have added to our financial security.

Kirsten reported that Breck Bartholomew's membership management for the society has been a fantastic and welcome change and has cost us very little. Breck takes a 10% commission on membership income as payment for his services to us which is well due and likely much less than he should be paid, particularly given the work that is going into processing and selling all of the estates that have recently been bequeathed to SSAR.

Secretary Marion Preest provided Officers, Editors, and Committee Chairs with minutes of the 2011 Board Meeting and summarized the 2011 Annual Meeting for publication in *Herp. Review*. She keeps track of changes in personnel and regularly updates SSAR letterhead, informs the Editors of *Journal of Herpetology* and *Herp. Review* of these changes, and provides various updates to Raul Diaz. She routinely writes letters to student winners of awards (e.g., Kennedy, GIH, etc) and prepares announcements for publication in *Herp. Review*. Marion compiled the 2012 Annual Report and prepared agendas for the Board and Business Meetings for the 2012 Annual Meeting. She again organized a reception for student members of SSAR and HL to be held at the WCH. Marion corresponded with the Board regarding various issues that needed a vote, e.g., naming the Grants-in-Herpetology Awards after Roger Conant, funding of proposals for upcoming symposia, a resolution from the Amphibian Survival Alliance, support for the Global Reptile BioBlitz, changes in dues structure, changes in page charges for *Journal of Herpetology*, proposals from the LRPC, etc. As an *ex officio* member of the Nominations Committee Marion helped to identify and contact potential candidates for the six positions we need to fill in 2012. She also served on the new Mentorship Committee (chaired by Kris Kaiser).

Publications Secretary Breck Bartholomew reported that total income from the Publications Office in 2011 was $40,644.43. Income generated as of 30 June 2012 was $60,482.67. He is requesting a budget for 2013 of $43,660. This includes funds to pay an employee to list items from the Ernie Liner Collection. All expenses associated with the collection will be covered by the sale of the collection before it is distributed to HL and ASIH. Breck indicated that the library of Roger Conant is selling well. There was discussion by the Board of E-reader versions of herpetology books and some interest was expressed. Thanks to Jeff Miller, scanned pdf versions of back issues of *Herp. Review* are now

PHOTOS BY M. PREEST



FIG. 17. Grounds of the Museum of Anthropology where tents were erected for the end of meeting picnic.



FIG. 18. Museum of Anthropology.

available to members. There was some discussion of whether these files should be made open access.

George Pisani (Trustee) reported that he again filed SSAR's annual corporate report with the Office of the Kansas Secretary of State.

Editors' Reports.—Kraig Adler, *Contributions to Herpetology* Editor, reported that "*Snakes of Honduras*," by James R. McCranie and "*Herpetology of Armenia and Nagorno-Karabakh*," by Marine Arakelyan, Felix Danielyan, Claudia Corti, Roberto Sindaco, and Alan Leviton were published in 2011. "*A Contribution to the Herpetology of Northern Pakistan*" by Rafaqat Masroor was published in early 2012 and "*Contributions to the History of Herpetology,*" the third and final volume, by Kraig Adler, John S. Applegarth, and Ronald Altig was published in August of this year (this was included in the bags of all delegates at WCH). Both of the 2012 publications were supported by generous donations. "*A Guide to the Snakes of the Philippines*" by Rafe Brown, Alan Leviton, Maren Gaulke, and Arvin Diesmos is expected in 2013 and "*Field Guide to Amphibians and Reptiles of the West Indies*" by S. Blair Hedges, and "*Lizards of Southern Africa*" edited by William R. Branch and Aaron Bauer are planned beyond 2012.

Editor Aaron Bauer (*Facsimile Reprints in Herpetology*) reported that a major publication is planned for Dec. 2012 (Duméril and Bibron's "*Erpétologie Générale ou Histoire Naturelle Complète des Reptiles*" [1834–1854] [to be guest edited by Kraig Adler]). This is one of the most important of all herpetological works and a truly comprehensive summary of all amphibian and reptile species known at the time. It is global in scope and contains descriptions of many species. Only relatively poor pdfs are available on the web, despite the fact that this is a critical reference for systematists. The work totals nearly 7000 pages with a separate Atlas of 120 plates. As the result of a generous donation from Ronald Javitch, Aaron expects to be able to sell this *Facsimile* at US $275 (US $225 before 31 January 2013 to current members of SSAR) plus postage. The majority of projects planned beyond 2012 (e.g., The Herpetological Contributions of John Edward Gray, The Collected Herpetological Works of Giorgio Jan) are in various stages of completion and only one publication is planned per year for the foreseeable future.

John Moriarty (Editor, *Herpetological Circulars*) reported that HC-39 (Seventh Edition of the *Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico*) will be given away at the World Congress in Vancouver. HC-40 (*Noms Français Standardisés des Amphibiens et des Reptiles D'Amérique du Nord Au Nord du Mexique / Standard French Names of Amphibians and Reptiles of North America North of Mexico*) will also be given away at the WCH as a companion to the 7th edition. HC-41 A *Guide to Tissue Collection, Preservation, and Management for Reptiles and Amphibians* is in prep, but has been postponed because of the publication of the names lists and the author's schedule.

Editor of *Herpetological Conservation*, Joe Mitchell reported that little progress has been made in the past year on a possible project for the next publication and acknowledges that it is time we make this series more visible.

Robert Hansen, Editor of *Herpetological Review*, reported that Volume 42 consisted of 632 pages (a 27% increase since 2009) and Volume 43 is projected to run over 700 pages. Personnel changes include Associate Editor Kerry Griffis-Kyle stepping down at the end of 2012 and Daniel Saenz joining the staff. Jay Savage proposed the addition of a new section ("Herpetological Nomenclature"), for which he agreed to serve as Section Editor; this debuted in the June 2012 issue. Beginning in 2011, *Herp. Review* initiated two new sections: "Conservation"—to better reflect the importance of conservation-related issues in herpetology, and "Herpetoculture Notes"—to accommodate interesting and often important observations that are not always a good fit for our Natural History Notes section. Bob reports resurrecting a long-dormant feature—"Institutional Profiles"—with the first contribution appearing in the June 2011 issue. Another section—"National and Regional Organizations"—also saw its first installment in 2011.

The "Amphibian Diseases" section in *Herp. Review* was conceived in 2007 as a means to facilitate the rapid communication of chytrid-related findings in amphibian populations. The number of manuscripts by year is as follows: 2007 (9), 2008 (23), 2009 (18, including the first *Ranavirus* paper), 2010 (27), 2011 (25). Although nearly all of the early papers focused exclusively on *Bd*, about 40% of current submissions are reporting on *Rv*. This herculean effort has been made possible by the assistance of 224 reviewers. Submissions are broadly international in scope, including manuscripts from Australia, Finland, Denmark, India, Cambodia, Malawi, Ghana, Nigeria, Morocco, Gabon, Jamaica, Honduras, Costa Rica, Panama, Bolivia, Uruguay, Peru, Colombia, Canada, Ecuador, Brazil, Venezuela, Taiwan, Italy, Congo, Czech Republic, and Mexico, in addition to 29 U.S. states or territories. Many international collaborations are represented by this body of work. These papers are being referenced in many other disease papers in other journals, so we are having a big impact. *Bd* survey sites are mapped by the Global *Bd* Mapping Project (www.Bd-maps.net) managed by personnel at Imperial College, London. *Rv* sites will be mapped with the *Rv* Reporting System, under development now, in cooperation with *Rv* Consortium and Imperial College, London.

The June 2012 *Herp. Review* was a special issue to commemorate the 7th WCH. The centerpiece of this effort was a WCH history, from its earliest beginnings through the 6th WCH. Kraig Adler was instrumental in helping pull this together, and Breck Bartholomew and Ken Dodd also contributed. The end result is an 18-page retrospective—the only history of the WCH published to date. In addition to the WCH history, in light of our Canadian venue for the meeting, Pat Gregory and David Green (current and former Presidents, Canadian Association of Herpetologists) were invited to prepare a current overview of the status of herpetological organizations in Canada. The June issue—at 196 pages—is our largest ever, and was distributed *gratis* to all delegates at Vancouver.

Co-editors of *Journal of Herpetology*, Erin Muths and Gad Perry, report that former Editor Geoff Smith remains as Associate Editor (AE) for special projects, but no longer serves as "Interim Editor." The AE roster at the end of 2011 contained four new names and many continuing ones. Despite considerable efforts and public appeals made at the 2011 JMIH meeting, expanding the AE base, especially by adding colleagues from other countries, remains a challenge. The editors report that two of their personnel were explicitly told that their editorial involvement was damaging to their professional careers, and one has chosen to reduce their contribution. Several potential AEs contacted expressed similar concerns when declining the position. Erin and Gad fear that this reflects an institutional change in Academe as a whole, whereby service is discouraged in favor of revenue-enhancing activities.

Overall submissions to *JHerp* declined slightly in 2011, compared to the record level set in 2010. Submissions so far for 2012 (178 as of the end of June) are slightly higher than the number

submitted during the same period in 2011. The amount of time needed to reach initial and final decisions remains similar to the past few years. The biggest challenge to reducing handling times is obtaining timely reviews. Unfortunately, the wait between acceptance of a paper and publication rose in 2011 from approximately 9 to 12 months. This is primarily a function of the record submission level in 2010. As part of their desire to increase the international flavor of the journal, Erin and Gad report that they were more lenient towards foreign manuscripts in early 2011, and the slightly lower rejection rate also contributed to the problem of handling time. They have taken steps to address this, including instructing AEs to reject a greater proportion of submissions, more aggressively forcing authors to address linguistic and formatting issues prior to review, and planning an especially large December issue.

The US remains the leading source of manuscripts (~ 40% of all submissions), and Brazil remains the second highest source (> 12% of submissions). Australia, with ~ 7% of submissions in 2011, is also a consistent source of manuscripts. Of countries with sufficient submissions to assess, the US and Australia have relatively high acceptance rates and Brazil is not far behind. Erin and Gad added a Brazil-based AE in 2011 and are currently seeking one from Australia. President Mendelson expressed appreciation for the increased internationality of the journal. Erin and Gad regard the Editorial Board as still under-utilized, although they have been using them to a slightly greater extent. They are currently assessing the group and will determine if additions or other changes are necessary. Letters have been sent to current members to ascertain interest in remaining on the Board.

According to the Allen Press "Member Submissions Report," 35% of submissions in 2011 had one or more authors who are SSAR members, compared to an average of 38% in the previous five years. Journal quality, as reflected by the ISI Impact Factor and total citations reported, remains good in comparison to other journals in the field, with *JHerp* consistently remaining the most cited herp-only journal.

Comments received by Erin and Gad regarding recent changes have been positive. Changes include a larger paper format, implementation of an optional second-language abstract, inclusion of invited long-term perspective papers, inclusion of special "focus" features, uniting related papers in a single section for easier location and visibility, abandonment of a format distinction (use of different font size) between Notes and Full Papers, and inclusion on the back cover a world map to indicate countries of origin for papers appearing in that issue.

Starting in 2010, the co-Editors attempted to provide a complete accounting of *JHerp* income and expenses, rather than just their approved budget. Some of the decisions the co-Editors are asking the Board to make require a better understanding of where journal-related costs and income originate. As of this year, *JHerp* invoices are copied to Erin and Gad as they are sent to the Treasurer.

Committee Chair Reports.—Chair of the Conservation Committee, Betsie Rothermel, reported that in November 2011, the Committee sent comments to the U.S. Fish and Wildlife Service regarding proposed critical habitat for the endangered Mississippi Gopher Frog. As in earlier comments on this issue, the Committee supported the move to designate critical habitat, including areas outside the current range of the species to enable future reintroductions, and they argued for increasing the area of the buffer around existing breeding sites. In January 2012, the Committee sent a letter to organizers of the Claxton Rattlesnake and Wildlife Festival in Georgia praising them for their decision to change the focus of the festival and suspend the collection of wild snakes for the March 2012 event, initiating a break with the 44-year-old tradition of annual rattlesnake roundups. In May 2012, the Committee submitted comments to the U.S. Environmental Protection Agency regarding the effects of atrazine on amphibians. They urged the EPA to re-evaluate its earlier findings in light of recent research results regarding effects of atrazine on larval development, survival, interactions with parasites, and immunosuppression. They also recommended that the EPA support additional research in advance of the registration review, avoid relying on industry-funded studies, and consider lowering the currently allowed maximum contaminant concentration, or phasing out atrazine altogether.

The Conservation Committee also reviewed and endorsed (on behalf of SSAR) a pre-publication copy of the second edition of *Habitat Management Guidelines for Amphibians and Reptiles of the Midwestern United States*, a technical publication produced by Midwest Partners in Amphibian and Reptile Conservation (PARC). Finally, during federal congressional committee meetings regarding deficit reduction in Fall of 2011, SSAR signed on to a "Teaming with Wildlife Coalition" letter urging preservation of funding for critical conservation, recreation, and historic preservation programs in 2012. Betsie thanks Priya Nanjappa, Carol Rizkalla, Chris Jenkins, Jason Rohr, Christine Bishop, and Rick Relyea for bringing issues to the attention of the committee and/or providing information to help them respond to various issues over the past year.

Joe Beatty (Chair, Dean Metter Award Committee) received 20 proposals this year and two winners were chosen. They are: Nicole Karres, an M.S. student in the Biology Department at Sonoma State University (whose thesis research deals with the diet and feeding ecology of the Western Pond Turtle, *Emys marmorata* in two urban habitats) and Dustin Owen, an undergraduate biology major at Ball State University, whose proposal was entitled, "Physiological impacts of roads on copperheads (*Agkistrodon contortrix*)." The Committee thought that both projects exemplified the kind of work that Dean Metter would have appreciated and enjoyed very much. In later discussions, the Board decided that, unless other funds become available, the budget line for the Metter Award should be capped at $1,000.

The 20th annual Seibert Awards Competition (Rafe Brown, Chair) was run at the 54th Annual Meeting of SSAR in Minneapolis, Minnesota. There were 38 eligible presentations. The Seibert Award winners for 2011 were (names of winners in bold): Systematics/Evolution: **Daniel Scantlebury**, University of Rochester, "Patterns of Adaptive Radiation in West Indian Dwarf Geckos (Sphaerodactylidae: *Sphaerodactylus*)." Ecology: **James Paterson**, Brad Steinberg, and Jacqueline Litzgus, Laurentian University, "Generally Specialized or Especially General? Habitat selection by Snapping Turtles (*Chelydra serpentina*)." Physiology/Morphology: **Angela Rivera**, Clemson University, "Evolution of Flapping in Turtles: A Comparative Examination of Forelimb Kinematics and Muscle Function across Three Lineages (Trionychidae, Carettochelyidae, Cheloniidae)." Conservation: **Jeanine Refsnider**, Fredric Janzen, Iowa State University, "Nest-site Choice in Response to Climate Change and Effects on Offspring Performance in a Turtle with Temperature-dependent Sex Determination." Awardees received a $200 check and a book from Chuck Crumly at University of California Press.

Honorable Mentions in the Seibert competition were: Systematics/Evolution: **Charles Linkem**, University of Kansas,

"Species Tree Despite Gene-Tree Incongruence in Large Datasets: The Phylogeny of the *Sphenomorphus* Group (Squamata: Scincidae)." Ecology: **Andrew M. Durso**, Stephen J. Mullin, Eastern Illinois University, "Interactions of Sex, Age and Behavior in Death-feigning Snakes (*Heterodon*)." Conservation: **Steven Price**, Robert Browne, Michael Dorcas, Davidson College, "Modeling the Effects of Urbanization on Salamander Abundances using a Before-After Control-Impact Design." **Yik-Hei Sung**, Nancy Karraker, Billy Hau, The University of Hong Kong, "Impacts of Illegal Trapping on Endangered Big-headed Turtles (*Platysternon megacephalum*) in Hong Kong."

The largest project of the Herpetology Education Committee (HEC) continues to be the Meritorious Teaching Award in Herpetology (MTAH), sponsored by The Herpetologists' League, the Society for the Study of Amphibians and Reptiles, and the American Society of Ichthyologists and Herpetologists.

In 2013, all remaining candidates for the MTAH plus any new nominations received during the year will be eligible for consideration for next year's MTAH, but in 2014, some of the earlier candidates will not be eligible according to the current guidelines. The HEC chair recommended that this stipulation of ineligibility be reconsidered so that clearly outstanding candidates continue to be eligible for consideration. The Board voted to support this recommendation.

The HEC received a letter of application from Shelby Miller as part of the SSAR Mentorship Program. All three herpetology societies had formerly agreed to collectively underwrite the registration fees for one pre-baccalaureate student and accompanying person per year. The HEC unanimously approved the application from Shelby Miller to the SSAR Mentorship Program to receive the funds for the K-12 student award to attend the Vancouver meeting.

Whit Gibbons is stepping down as chair of the HEC at the WCH and he thanked the several dedicated members of the HEC for their many contributions to herpetological education. Hinrich Kaiser volunteered to serve as chair of the HEC.

Kennedy Award Chair, Lynnette Sievert, announced that the winning paper for 2011 is by **Mizuki Takahashi** (coauthored with Yukiko Takahashi and Matthew Parris) "Rapid change in lifecycle polyphenism across a subspecies boundary of the eastern newt, *Notophthalmus viridescens*. *Journal of Herpetology* 45:379–384." Mizuki will receive a check for $200 or $400 worth of SSAR publications.

Kraig Adler, Chair of the Long Range Planning Committee (LRPC), reported that after its formation in Fall 2010, the LRPC submitted a series of recommendations to the SSAR Board regarding changes to *Herp. Review*. These recommendations were approved and rapidly implemented by editor Bob Hansen. At the JMIH in 2011, the Board approved the recommendation from the LRPC for an increase in membership dues and institutional subscriptions and the formation of a "senior member category." Despite some decrease in numbers of members and institutions, Kraig reports that our income from dues is currently up. Thus, the Board's decision to increase dues and subscriptions has been successful in increasing income, in order to cover the changes in *Herp. Review* and to help other society programs. Kraig warns however that we must not be complacent about the loss of some members and suggested that President Mendelson send a letter to all lapsed members and institutions to point out the many features recently added to a membership in SSAR and to tell them that we very much want them back in the society. Kraig reiterated his call for a vigorous membership drive with a sound plan, a solid budget, and a means of assessing success. The new membership brochure that Breck produced for distribution at WCH is a good start.

The LRPC found a proposal from Allen Press to co-publish *JHerp* unacceptable on philosophical and material grounds and voted 9 to 2 to decline the proposal as written. There were some features of the proposal that were interesting and the Board encouraged the *JHerp* co-editors to consider the costs of implementing some of them. The LRPC discussed a proposal to assume management of the existing on-line journal *Contemporary Herpetology*. Although the LRPC was sympathetic to the need for an online-only journal, they felt that seven existing publication series stretched the SSAR's budget and editorial capabilities to such an extent that it was not feasible to accept it. The LRPC unanimously recommended that SSAR decline the proposal and the Board agreed. (Subsequently, the Center for North American Herpetology has announced that it is assuming responsibility for *CH*.)

During the Fall of 2011, the LRPC considered three topics: SSAR Website, Future Meeting Sites, and the Society's International Status. Each of these topics was discussed by the committee via email, at an Open Meeting of the LRPC that was held at the Minneapolis meeting, and further by email during the Fall months. Eventually, the LRPC made two recommendations to the Board, both of which were approved. These are:

1. SSAR website.—There is a strong desire to make our website more user-friendly, to make it easier for officers and editors to post relevant information, and to maximize its use to promote the society and herpetology in general, both to our membership and to the general public. A subcommittee (Bob Hansen, chair; Breck Bartholomew, Raul Diaz) developed a plan, which was submitted to the full LRPC for discussion and vote (11 yes, 0 no, 1 abstained). This plan recommended a first-year budget of $10,000 with annual allocations of $3,000. The Board accepted the LRPC's recommendation. President Mendelson will now appoint a committee and a person to implement this initiative.

2. Future meeting sites.—SSAR has had a long tradition of annual meetings from its founding in 1958. We have used a variety of formats: SSAR (or OHS)-only, SSAR-HL, SSAR-HL-ASIH, and JMIH. Our last SSAR-only meeting was in 1996 and the last SSAR-HL meeting in 2001. Kansas State Conference Management Services began handling the JMIH in 2002. Because of size, these have been held in conference centers or in large hotels with conference facilities. This arrangement is (usually) convenient, but it comes at the cost of high hotel room rates, high fees for exhibitors (thus, few now attend), and the need to meet in busy downtown areas.

Historically, SSAR has met on university campuses (35 times), museums (6), and biological stations (twice), venues that are familiar to academics and where costs are more moderate (especially room rates, as at UBC this year). Many herpetologists have suggested to us that SSAR consider meeting on university campuses occasionally, even as a SSAR-alone event. Our current contract with JMIH states that we may opt out of any year's meeting on three years' notice.

The LRPC considered the general question of occasional herpers-only meetings. To make this a realistic discussion, with President Mendelson's permission Kraig Adler approached the University of Kansas (Rafe Brown, Linda Trueb, Bill Duellman) to see if they might be interested in hosting a meeting in 2014 or 2015. Their response was positive.

The LRPC voted in favor of occasional SSAR-only, on-campus meetings (i.e., once every 3–5 years, that is, once in the "lifetime"

of a graduate student). The committee did not vote specifically for KU, but this real possibility was known to them. The SSAR Board, however, took two votes: 1) to pursue SSAR-only meetings every 3–5 years [approved 10 yes, 3 no]; and 2) to pursue KU for a meeting in 2015 [9 yes, 3 no, 1 abstained].

Accordingly, Kraig has been working with Rafe, Linda, and Bill to put together a formal proposal. The meeting (30 July 30–3 August 2015) would be headquartered at the Kansas Union, where SSAR met in 1977 and 1996, and located immediately adjacent to the Museum of Natural History. The KU local committee consists of Rafe Brown (chair), Linda Trueb, Bill Duellman, Rich Glor, and some others. Rafe will formally invite PARC to co-sponsor this meeting, as a way to make conservation a main theme at that meeting and to develop new connections between SSAR and PARC (subsequently PARC accepted SSAR's invitation).

Rafe is planning for up to 500 participants. The Local Committee is planning a special program of events including some traditional and popular ones from SSAR meetings of yesteryear. Their main effort is to make this meeting enjoyable, both scientifically and personally, especially for our student members, and to bring back senior members who have not attended in a long time.

In his capacity as President, Joe Mendelson serves as SSAR representative on The Meeting Management and Planning Committee (MMPC). The Committee did not meet this past year (because WCH was responsible for planning the 2012 meeting), but did plan to meet during WCH. President Mendelson, and President-Elect Bob Aldridge will attend a planning meeting in Albuquerque in March 2013. Marty Crump will replace long-serving chair of the MMPC, Mo Donnelly. Upcoming JMIH meetings are:

2013 — Albuquerque, New Mexico

2014 — Chattanooga, Tennessee

2015 — Reno, Nevada

Ann Paterson (chair) reported that during 2011-2012, the Membership Committee voted to become less active while waiting to see the results of the many proposals that were presented at the 2011 board meeting. The Committee felt that it would be more helpful to see how other committees decided to respond to those than to continue to present more, especially as those proposals were based on considerable contemplation combined with the results of a substantial membership survey. A separate Mentorship Committee was formed to pursue mentorship activities specifically. The Membership Committee did accomplish the following: 1) designed a bookmark featuring mantellas by Tim Halliday and listing SSAR member benefits that was distributed with renewal notices in 2011; 2) continued to work on compiling a list of other herpetological societies (both in the U.S. and internationally); and 3) responded to concerns and comments from members and non-members as needed.

The number of members decreased slightly in 2012, which obviously concerns the Membership Committee. There are already 49 individuals taking advantage of the new Senior category. However, there are fewer individual memberships and fewer institutional memberships. The only membership categories showing increases were Associate memberships and Life memberships. While it is not unexpected to see a decrease in members following a dues increase, the Committee feels that it should work diligently to attempt to counteract this decrease over the next year. Marina Gerson will take over as chair of the Membership Committee and agreed to write a proposal for a Membership Drive that will be sent to the Board. Gad Perry reminded the Board of the large number of manuscripts he receives for publication in *JHerp* that are from overseas, and emphasized the need for the drive to be international in focus.

The Mentorship Committee was formed by President Mendelson as an *ad hoc* committee to create a program to help students new to the annual meeting navigate social and academic events, and to meet other students and faculty relevant to their interests. President Mendelson appointed Kristine Kaiser as chair of this committee, and Marion Preest and Andrew Durso to serve on the committee. A survey of the student membership suggested that graduate student mentors would be preferred to faculty mentors. The committee advertised the program on the society's website and Facebook page, the WCH meeting registration page, and in *Herp. Review*. Fifteen students, from high school age to advanced graduate student, applied to the program this year and all were accepted. The committee matched mentors to the mentees for the WCH based on research interests. Although the mentoring part of the program is intentionally not highly structured, the committee planned a meet-and-greet on the first night of the WCH for all mentors and mentees to meet face-to-face, and invited all mentees to the SSAR/HL Student Reception.

The Nominations Committee (Greg Watkins-Colwell, Chair) compiled a list of nominees (see below) for the positions of President-Elect, Treasurer, Secretary, Regular Board Member, and non-US Board Member. Kirsten Nicholson is stepping down as Treasurer and the Board gratefully thanked Kirsten for her service. President-Elect: Aaron Bauer, Geoff Smith; Treasurer: Ann Paterson; Secretary: Marion Preest; Board Member (Regular): Frank Burbrink, Richard Durtsche, Marina Gerson, Liza Hazard, Greg Watkins-Colwell; Board Member (non-US): Alison Cree, Carlos Navas, Hidetoshi Ota, Wolfgang Wüster.

Resolutions Chair, Robert Denton, reported that resolutions were presented at the SSAR Business Meeting in Minneapolis in 2011. These have been published in *Herp. Review*.

Chair of the Roger Conant Grants-in-Herpetology Committee, Josh Kapfer, received 87 proposals this past year. This is the largest number since at least 2001. Most applications were in the "Travel" and "Laboratory Research" categories. The winners each receive $500 and they are: Conservation: **Tyler D. Hoskins**, Miami University of Ohio; Education: **Jacob Ngwava Mueti** and **Beryl A. Bwong**, National Museums of Kenya; The Andrew H. Price Field Research Grant in Herpetology: **Jesse Delia**, Boston University; Laboratory Research: **Robert Literman**, Iowa State University; Travel: **Rebecca Tarvin**, The University of Texas at Austin; International: **Stefano Canessa**, University of Melbourne, Australia.

Josh reports that the deadline for proposal submission remains December 15th, and he attempts to have reviewers secured by mid-January of the following year. Two reviewers were secured per grant category this year, but several were late in returning comments and rankings. This resulted in the decisions reaching all applicants later than normal. For this year, it was suggested that, based on monetary donations, the Field Category be renamed "*The Andrew H. Price Field Research Grant In Herpetology*." The change was adopted for 2012. In grateful recognition of Andy's long service and commitment to the Society, the Board indicated its willingness to continue with this name as long as funds are available (currently for the next two years).

Brian Crother, Chair of the Standard English and Scientific Names Committee, indicated that the 7th edition of the Standard English and Scientific Names List will be included in meeting bags at WCH. The introduction was expanded to provide a brief history of names lists for North American amphibians and

reptiles as well as provide rules for English name formation. The list of sanctioning societies for the 7th edition was expanded to include the SSAR, HL, ASIH, the Canadian Association of Herpetology, the Canadian Amphibian and Reptile Conservation Network, and PARC. A special French names list was produced for the WCH. David Green chaired the committee that produced the list. The online edition of the names list will continue and may be expanded. With the CNAH dropping its involvement in names, they have offered to be an additional outlet for the SSAR, HL, ASIH list.

No report was received from the Student Participation Committee. A suggestion was made to hold a workshop at the 2013 JMIH focusing on how to move student theses from dissertation to publication.

The first annual SSAR Student Poster Awards were presented at the 54th Annual Meeting of the SSAR in Minneapolis, Minnesota. Twenty eligible students participated in the competition. All awardees received a check for US $100 and a book award from Chuck Crumly at University of California Press. The winners were: Evolution, Genetics, & Systematics: **Anthony Geneva**, University of Rochester, "A Multi-locus Molecular Phylogeny of Distichoid Anoles;" Ecology, Natural History, Distribution, & Behavior: **Beth Pettitt**, University of Minnesota, "Oviposition and Tadpole-rearing Site Selection of a Phytotelm-breeding Frog, *Anomaloglossus beebei*;" Physiology & Morphology: **Mingna Zhuang**, University of California, Berkeley, "Comparative Gliding Performance of *Anolis carolinensis* and *Anolis sagrei*."

Vinny Farallo and Mike Jorgensen continue as co-chairs of the Student Travel Awards Committee. They reported that $1,763 was raised by the Silent Auction at the 2011 JMIH. There were 51 applications for the student travel award in 2012 and 10 winners were selected randomly. In an attempt to increase donations, a notice requesting donations for the silent auction was published in the March issue of *Herp. Review* and on the WCH website. A major goal this year (and in future years) was to increase auction donations. Vinny Farallo contacted 10 herpetologists and five publishers in May to solicit donations for the silent auction. Vinny is also keeping a detailed list of all people/publishers contacted to help avoid repeat solicitations in future years. They indicated some success from advertising on the WCH website and *Herp. Review*.

Webmaster Raul Diaz reported that activity on the website involved upkeep with common names and edits to pages. According to Election Officer Dan Noble, no election was held in 2011.

Coordinator of the Live Auction Committee, Greg Watkins-Colwell reported that, in 2011 the ASIH joined SSAR and HL for the Live Auction which featured items from the Ernie Liner collection. Proceeds from this auction, after all expenses are paid, are to be used for establishing a fund in each of the three societies for "up and coming herpetologists" as per Ernie's will. Auctioneers for 2011 were Brad Moon, John Moriarty, Steve Mullin and Aaron Bauer. Students assisting the live auction were Heather Heinz, Jolene Rearick, Alicia Kennedy, Brittany Barker, and Jenny Gubler. Efforts were made to include as many different auctioneers (with different auctioning styles) as possible and to rely upon students who had not helped with the auction in the past. The latter was facilitated by announcing at the student social the need for student volunteers. The auction had a Mardi Gras theme with each registered bidder getting a string of beads and a drink ticket that could be used for soft drink, beer, wine, or a hurricane. Through the evening a Powerpoint presentation ran on the screens between auction lots and featured photos from throughout Ernie Liner's life (thanks to Joe Mendelson). Each winning bid received another set of beads and sometimes coins. This served as a game whereby the person at the end of the night who had the most beads (and coins) would win a one-year membership to each of the three societies. The winner was Shelby Miller. The live auction made $4,766 which approximately equaled the costs. In addition to the live auction items, donations were actively sought during the auction via the "sale" of Mardi Gras beads. At a side table during the auction we sold refrigerator magnets and toys. These two activities brought in an additional $557 to be split three ways. Although the income from the auction was low due to the overhead cost of the Mardi Gras theme and splitting profits three ways, the notion of a theme-based auction was a success. Participation from the membership was high and the event was fun. The Live Auction Committee is exploring other ways to inject fun into the auction. Ideas include games and live music. The Committee is exploring the option of a "cover charge."

Representative to AIBS and BioOne, Al Savitzky, reported that AIBS continues to re-examine its role as an umbrella organization, representing about 160 member societies and organizations (MSOs), as well as its several thousand individual members. AIBS has been involved for about two years in an intensive strategic planning process, and the results of that process are expected to be announced later this year. The basic goal of the strategic planning process is to determine what the most effective role can be for such an umbrella organization, and how the Institute can best serve its member organizations and the discipline of biology in general. Toward that end, AIBS extensively revised both its Constitution and Bylaws during the past year, to ensure that it has the flexibility to respond more quickly to the rapidly changing landscape of professional organizations. The AIBS leadership continues to include a large number of biologists with research interests in ectothermal vertebrates, including Vice President James Collins and Board members James Hanken, Joseph Travis, and Al Savitzky.

Several important changes have already taken place in the organization, including the discontinuation of the formal annual meeting of the society. The AIBS Council, which previously met in association with the annual meeting, met this year in association with the Institute's spring meeting of its Board of Directors. Some representatives participated via teleconferencing. The trend toward remote participation is likely to increase in the future.

AIBS continues to concentrate a great deal of effort and staff time in two areas, public policy and education. These two realms of AIBS activity, together with the historic commitment of the Institute to organismal biology and ecology and the representation it provides in Washington, continue to offer substantial benefits to its member organizations. Members of MSOs, such as this society, are encouraged to consider joining the AIBS Legislative Action Center (http://capwiz.com/aibs/home/), which provides a simple way to stay informed on important congressional action regarding biodiversity and support for scientific and funding agencies, as well as affording a direct means to contact members' national legislators.

The nonprofit electronic publishing consortium BioOne continues to serve many society publishers of journals in organismal biology, ecology, and other fields. Increasingly these have included journals published overseas, either through direct electronic publication by BioOne (e.g., *South American Journal of Herpetology*) or through partnership with UniBio in Japan (e.g., *Current Herpetology*). For the first time, Al Savitzky was unable to attend the annual Publishers and Partners Meeting of BioOne, held in

May 2012 (http://www.bioone.org/page/about/meetings/past). In addition to the annual update on the status of BioOne, this year's presentations included discussions of rapidly evolving fair use policy in digital publications, open-access publishing, an evaluation of BioOne's new mobile app, and TEEAL (a program from Cornell University for delivering agricultural journal content offline to developing countries).

BioOne Executive Director Susan Skomal reported that, in the 11 years since the launch of the original BioOne collection (BioOne.1, with 89 titles), the collection has returned $19.96 million to its member publishers. BioOne's annual royalties to publishers continue to increase, and its price per page (to subscribing libraries) has dropped. Five years ago BioOne launched a second collection of journals, BioOne.2 (with 66 titles), designed to serve additional nonprofit publishers while not eroding the financial benefits to original consortium members. That second collection has shown even greater growth in recent years and has continued BioOne's record of success. Together with BioOne's 12 open access titles, the three BioOne collections now include 167 titles from 126 publishers. In 2011 BioOne published more than 97,000 articles totaling over 800,000 pages, and generated more than 27.6 million hits, an increase of 10.7% over 2010.

The issue of open access (OA) publishing was discussed by Alan Kahan of the Entomological Society of America, which publishes several journals with a variety of OA options. One journal is entirely OA, whereas others allow all authors to post their articles online at no charge after an embargo of two years (or immediately, if an OA fee is paid). Kahan referred to a study of articles published through Highwire Press that found that, although OA articles received more downloads and a wider audience in the first year after publication, the number of citations was no different from non-OA articles after three years. It is not yet clear whether OA substantially affects article use by other scientists, but it does make the material more readily available to a broad public audience. A recent development is the appearance of "predatory OA journals," which charge authors to publish articles online but have low scholarly standards and, in some cases, no peer review whatever.

Kevin Meinershagen of Allen Press discussed the new BioOne mobile app, which launched in November 2011. Mobile internet usage is projected to exceed desktop internet usage by 2014, and the number of individuals with a web-capable phone increased by 39% last year, so the mobile market for bibliographic information may be quite large. Although organized differently than the full BioOne site, the mobile app is very effective on such devices, and members are encouraged to consider using the free mobile app from BioOne.

SSAR Symposium Coordinator, Richard Durtsche, received two proposals in 2011. The first proposal entitled "Impact of Energy Development on Amphibians and Reptiles in North America" was submitted by Terry Riley as lead organizer, with Deanna H. Olson, Alvin R. Breisch, and Priya Nanjappa as a co-chairs. The purpose of this symposium is to examine the potential effects of traditional and renewable energy developments on amphibians and reptiles in North America and to identify appropriate research needs and management recommendations. While there have been several recent studies on the impacts of energy developments on wildlife (bats, Greater Sage-grouse, Lesser Prairie-chicken, Mule Deer, Pronghorn, and songbirds), few studies have focused on the impacts these developments are having on amphibians, reptiles, or their habitats. Reliable baseline data are needed on amphibian and reptile population densities and distributions over large portions of North America before the effects of energy development can be examined.

The second proposal, "A Global Partnership for the Ecology and Conservation of New World Vipers," was submitted by Christopher L. Jenkins as lead organizer, with Heidi Hall and Douglas L. Hotle as a co-organizers. In light of the threatened or endangered status of many viper species and their generally misunderstood and underappreciated value as animals, the Orianne Society has partnered with the IUCN to form the Viper Specialist Group (VSG). This symposium will kick off the opening meeting of the VSG with presentations by the world's experts in viper ecology and conservation. Thus, the symposium will provide a platform for the world's leaders in viper biology to present the most up-to-date science on vipers and provide the opportunity for the broader herpetological community to become involved with the VSG. In addition to building relationships among several societies, the symposium will reinforce the collaborative relationship among nonprofit organizations, academics, and zoos, and lead to stronger conservation initiatives.

Both symposium proposals were sent out for external review with two reviewers each. The reviews and proposals were submitted to the SSAR Board for consideration of sponsorship.

New Business.—A proposal was received from University of Kansas to host the annual meeting in 2015 (30 July–3 August). The Local Committee would consist of Rafe Brown (Chair), William Duellman, Linda Trueb, and Rich Glor, who would work closely with KU's Center for Professional Development (Gina Cregg, director). KU has hosted two successful SSAR meetings previously (1977 and 1996) and regularly hosts professional meetings. The proposal was discussed, voted on, and accepted by the Board.

Several issues were raised by the *JHerp* co-Editors (Erin Muths and Gad Perry).

1) *Page charges.*— The Board previously asked Erin and Gad to develop a page charge policy for its consideration. Discussions of their proposal at the 2011 JMIH stalled, and ongoing email-based deliberations since then have mostly been unfruitful (the one exception is the agreement that the Publications Secretary will take on the job of handling page charges and copyright releases). Erin and Gad continually receive inquiries about page charges. At the request of President Mendelson, they provided a detailed proposal in which they suggested a graduated payment structure, where regular members are asked to pay $50/page, student members and retired persons are asked to pay $25/page, and non-members are charged $150/page. An average non-member would pay about $1000/paper, but would only pay about $450 (membership included) if they chose membership. As the current policy does not require payment or even an explicit waiver, Erin and Gad suspect that most students currently provide no page charges. Given a 20% compliance rate, which seems quite feasible now that Breck's office will be handling page charges, they expect the greater payment coming in from non-members to help offset any income lost from giving members a price break. They suggested that the Publications Secretary be authorized to provide to members waivers in common situations (students, developing countries), be instructed to be less lenient with non-members (while recommending membership), and consult with the Editors on special cases such as invited papers. Hopefully, Breck's office can provide the co-Editors with a breakdown of income in 2013 which will allow them to reevaluate these numbers and update the Board.

The Board discussed the obvious need for a clear, consistent policy that encourages membership in SSAR and submissions to

our journals. Concerns were expressed that authors may choose to publish in journals without page charges if we adopt a policy that includes charges. After considerable discussion, it was recommended that no page charges be assessed as long as the author (or at least one of the authors if more than one) is a member in good standing of SSAR. However, if funding allows, members are encouraged to assist by contributing to page charges. If the author (or none of the coauthors) of the manuscript is not a member, he/she will be given the option to become a member. If they choose to not join the Society, they will be asked to pay the current page charge rate. They will also have the option of requesting a waiver of charges from the Publications Secretary. This information will be published on the website in *Instructions to Authors*. The Board voted to adopt this policy.

2) *Electronic publishing*.—Journals are increasingly going wholly or optionally digital. According to the LRPC, about 10% of our membership has chosen the digital-only option, and this is likely to grow. Erin and Gad see this as a positive move, but feel that greater electronic presence is needed. For example, they are increasingly being asked about digital features such as posting of accepted papers on a journal web site prior to publication. They acknowledge and appreciate the efforts of the current (volunteer) webmaster. However, the Journal web site and the available capabilities are likely to often be the first (and perhaps only) contact that nonmembers have with the Society. They therefore feel that we are jeopardizing the standing of both the Journal and the Society by not utilizing a full time, professional service. If services such as online early publication are not available, or if details such as *Instructions to Authors* are out of date or poorly formatted for some screens, then potential members are likely to go elsewhere.

In 2011, the Board rejected the Allen Press (AP) co-publishing proposal, but authorized Erin and Gad to further investigate the costs of implementing especially attractive features of the proposal and bring them back to the Board for further discussion. Having a professional web-presence is the highest priority item. Although the Board has approved $10,000 for revamping the SSAR web page and $3,000/yr for maintenance after that, this is not going to address the need for seamless integration and full-time technical support. The current proposal for this from AP would utilize the AP Pinnacle platform, require a one-time $3,000 setup fee, and entail an annual cost of $14,120 which would cover all preparation and hosting expenses.

The Board considered this issue. There was discussion of on-line pre-publication of papers on taxonomy (this would not happen) and concerns regarding too many links (because of a need for regular updates) and a potential loss of "branding." The Board voted to accept the proposal from AP.

2) *Difficulties in obtaining qualified AEs and reviewers*.—Erin and Gad regard this as currently the biggest challenge to a more rapid manuscript handling process. Given the increasing shift of academic institutions to a for-profit managerial style, they expect this problem to get worse and negatively impact the quality and timeliness of reviews. Recruiting capable new AEs, who spend considerably more time than reviewers in the service of the journal, remains extremely difficult. Many leading journals provide AEs (and some also to reviewers) token recognition for their services. The past suggestion to provide AEs with free membership was an attempt to partially address this, but was rejected by the Board in both 2010 and 2011. At the instigation of Erin and Gad, names of Editors and AEs for the *Journal of Herpetology* (and other herpetological journals) are printed in the WCH program (at no cost to SSAR), but they do not feel that this small step is sufficient. They would appreciate the Board reconsidering token recognition, which they envision to be granted only to those AEs who have served for over a year and completed their reviews in a timely manner.

A wide-ranging discussion followed. It was suggested that AEs who serve a multi-year term be granted the honorific "fellow," that donations be solicited to provide small grants to AEs, that officers of the society serve as reviewers or AEs after their term as an officer is over, that the Editorial Board be utilized more, that presidents from a number of societies (including SSAR) consider writing a policy piece for publication in a major journal (e.g., Science) addressing the vital importance of editorial and reviewing service to our field.

In 2011, the LRPC, SSAR Board, and President Mendelson informally initiated a new series of "Lifetime Achievement Awards" for select colleagues who have contributed significantly to the Society and/or the field of herpetology during their careers. Kraig Adler and his production assistant Tim Perry produced attractive formal documents and they were signed by available board members and senior officers/editors. Several more worthy recipients were informally proposed in 2012 and similar awards were produced and presented. The achievement awards evidently have become a popular and requested commodity, yet SSAR has no guidelines to govern if, when, or how they are to be awarded. In order to maintain their professional and personal value, they should be administered according to agreed standards and perhaps limited in number each year, so as not to "flood the market" and thereby diminish their perceived value. President Mendelson submitted a proposal that these awards shall be renamed as the "SSAR Presidential Award for Lifetime Achievement in Herpetology" and shall normally be limited to three awards per calendar year. There will be no committee, but rather nominations may be made by any active Board member, officer, or primary editor directly to the President. The President/Secretary will call for an electronic vote from the Board. If approved by majority vote, the President (alone) will sign the award and deliver it to the recipient, and make the announcement at the annual Business Meeting. The Board voted to approve this proposal.

In the 1980s, David Dennis, Eric Juterbock, and Kraig Adler produced four different audio-visual shows for use at SSAR, SSAR/HL, World Congress, and other meetings in US, Canada, and the UK. SSAR commissioned them. They seemed to be popular because the auditorium was always full and many people came back year after year to see them again. These have not been shown in several years because the technology is out of date (six slide projectors coordinated by an ancient computer) and not of high digital quality. Kraig suggested to the Board that SSAR may wish to commission a new, updated generation of these shows in digital format that would be much easier to show and even to export overseas to herp meetings to advertise SSAR. All photographs would have to be made digitally (the existing photos are faded), which will require a great deal of fieldwork, scanning originals, etc. If SSAR meets in Lawrence in 2015, these shows would be a magnet to draw an audience. They were especially popular among students. The Board voted unanimously to provide funding to partially cover the costs to re-do the shows.

Josh Kapfer (Chair, Grants-in-Herpetology) was contacted by an officer from another society with a question regarding liability insurance for our student research grants. The Board discussed this issue and decided that we should request that students sign a liability waiver when they submit proposals to our various

funding Committees. After the WCH, Josh produced a waiver form and this is now available on the website.

The future of the CAAR series was discussed. In 2011, *CAAR* Editor Andy Price reported that the series was languishing primarily as a result of lack of submitted manuscripts. This, coupled with lengthy review and editorial returns, resulted in an intermittent publication schedule. More generally, the hard-print non-updateable format became outdated and was not engendering much excitement, nor perhaps even much current use. President Mendelson appointed an informal committee to begin discussions for the future of the series. The members of this committee generally agree that the series is valuable in its original concept and propose that SSAR continue the series, but in a more affordable (pdf/online) format and also one that permits updates, and allows SSAR to exercise quality control over the product bearing our name. For taxa not yet covered in CAAR series, volunteer authors will produce CAAR accounts, which will be edited/reviewed per our usual model. For CAAR accounts that are now outdated, we will solicit updated versions which would include in a single pdf both the original (outdated) account, plus formatted addendum sheet(s) that include all literature and dot localities appearing since the original account was produced. This way both the original author and the update author would get credit. The citation could be something like "Conant and Siler 1970/2012."

CAAR accounts will become electronic pdf publications distributed online only. They will be available *gratis* on Zen Scientist to the entire membership. E-mail announcements to the membership should accompany the appearance of each new account, and once per year, *Herp. Review* should publish a list of the accounts appearing in the last calendar year. All parties should be working to remind our colleagues that these accounts are time-consuming to author, are of exceptional value to our field, and do constitute a peer-reviewed publication. Graduate students should be explicitly encouraged to author accounts or updates of their focal taxa, as they more than anybody will know the most recent relevant literature. Travis LaDuc and Chris Bell agreed to take over as co-Editors of CAAR and offered to develop a plan for the future.

SSAR received a request from Henry Mushinsky (member JMIH LRPC) that we initiate a discussion regarding what we want the future of our societies to look like. Henry asked us to consider the following questions: 1) Is there interest in uniting our societies under an umbrella society? 2) If so, what model do we want to use? Many are familiar with SICB, their divisions include animal behavior, ecology and evolution, comparative biomechanics, comparative morphology, phylogenetics and comparative biology and so forth. At our JMIH we use many of the same divisions used by SICB when we are preparing the academic program, i.e., fish ecology, herp systematics, shark behavior, and so forth.

Specifically, Henry was asking for some guidance on whether SSAR though the JMIH LRPC should continue to think along these lines. The Board discussed the issue of an umbrella society for SSAR, ASIH, HL, etc., and what such a society would look like and be responsible for. A shared treasurer and shared editors have been suggested. Benefits could include cost-savings and streamlining. Concern was expressed regarding a potential loss of identity and institutional history and a sense that the various societies might be heading in different directions. There was a consensus among the Board that, although not willing to commit to anything definite, discussions regarding an umbrella society should continue and we would be interested in seeing what ideas were developed.



PHOTO BY M. PREEST

FIG. 19. Winners of Travel and Seibert Awards along with chairs of the committees. L to R: James Baxter-Gilbert (Travel Award), Vinny Farallo (co-Chair, Student Travel/Silent Auction Committee), Sean Harrington (Travel Award), Rafe Brown (Chair, Seibert Student Award Committee), and Shawn McCracken (Seibert Winner, Conservation Category). The title of Shawn's presentation was "Living on the edge: Oil road effects on the occupancy and abundance of anurans inhabiting an upper canopy tank bromeliad (*Aechmea zebrina*) in lowland rainforest of the Yasuni Bioshpere Reserve, Amazonian Ecuador."



PHOTO BY M. PREEST

FIG. 20. Tiffany Doan (Chair, Student Poster Award Committee) with Matthew Lattanzio and Julia Riley—two of the four poster award winners this year. Luke Frishkoff and Nicole Christie were the other two winners.



PHOTO BY M. PREEST

FIG. 21. Joe Mendelson, nearing the end of his two-year term as SSAR President, passing the gavel to President-Elect Bob Aldridge.

The Editors of *Herp. Review* and *JHerp* received a proposal from Allen Press that would increase the flexibility for using color in *JHerp* without heavy financial impact and at the same time bringing down the overall costs for both journals. All Editors were in favor of signing a contract with AP and the Board supported this.

President Mendelson received a request from an author of a manuscript submitted to *Herp. Review* that the Society endorse a resolution regarding taxonomic practice. Because this manuscript is still being reviewed, President Mendelson thought that a vote regarding the resolution was premature and unnecessary. The Board agreed.

A balanced budget for 2012 of $304,440 was approved by the Board and the meeting was adjourned at 1551 h.

SSAR Business Meeting

The annual SSAR Business Meeting was called to order by President Mendelson (1806 h on 11 August 2012). Twenty-two members of SSAR were present. Joe then introduced Judit Vörös who made an announcement about the European Congress of Herpetology to be held in Veszprém, Hungary, during 22–27 August 2013. Officers, Editors, and Committee Chairs who were at the Business Meeting introduced themselves to the other attendees and gave brief summaries of their Annual Reports and relevant information from the Board Meeting. There was some discussion of the Board's acceptance of the invitation from KU to host the 2015 SSAR Annual Meeting.

SSAR "Presidential Awards for Lifetime Achievement in Herpetology" were presented to Chuck Crumly, Ronald Javitch, and Marion Preest. Winners of the 2012 Travel, Seibert, and Student Poster awards were announced (Figs. 19, 20). As is traditional, outgoing President Mendelson passed the SSAR gavel to President-elect Bob Aldridge (Fig. 21). The meeting was adjourned at 1930 h.

—Respectfully submitted by Marion Preest, SSAR Secretary

NEWSNOTES

IHS Grants Available

The International Herpetological Symposium has established a grant program to provide financial assistance to individuals or organizations conducting herpetological research, conservation, and education. Proposals are accepted January through May of each year and grants are awarded in August. Grants are in the amount of up to US $500 and will be awarded to applicants whose projects represent a significant contribution to herpetoculture in one of the following categories: herpetological natural history, herpetological conservation biology, captive propagation, or herpetological education. For details on the application process, please visit the IHS website at <http://internationalherpetologicalsymposium.com/grant.html>

Amphibian Academy: Serving Amphibians
Developing Amphibian Conservation Expertise



We are pleased to announce a new capacity building program with a novel and holistic approach to amphibian conservation training for both *in-situ* and *ex-situ* program development. This new program is called *Amphibian Academy*: a broad perspective training opportunity that will benefit people from diverse backgrounds who desire to help save amphibians. A key difference between this effort and earlier endeavors is that the emphasis is on the individual student so that graduates will be poised to address the needs of threatened amphibians. Our mission is simple: train amphibian conservation biologists so that they can best *Serve Amphibians*.

The *Amphibian Academy* has been developed under the umbrella of the Amphibian Ark and the Toledo Zoological Society. It will be a week-long course with robust conservation emphases. The school is scheduled for 20–28 April 2013 at the Toledo Zoo, Toledo, Ohio, USA. The amphibian conservation and breeding programs at the Toledo Zoo are internationally known and the collection is extremely diverse—an ideal environment for training amphibian conservationists. Local field opportunities will be utilized for teaching purposes. Centrally located, Toledo is a friendly city with reasonably priced accommodations and food. Costs to attend will not be excessive.

The course includes lectures, hands-on practical exercises, and fieldwork. Most of all there will be ample opportunities for students to be personally mentored by globally recognized and successful amphibian conservationists to help them address their specific program's focus and needs. The students can rely on the faculty members to remain as their mentors and professional contacts throughout their careers. The hands-on activities are designed for students to "learn by doing" in small groups with an instructor, thus providing an optimal learning opportunity. The faculty for the course includes leaders in the fields of amphibian husbandry, medicine, research, reintroduction, and conservation. As amphibian decline knows no borders and is a significant global concern, we invite a diverse group of students from all countries. The vision for this training course is to *Serve Amphibians*. If this motto is in alignment with your conservation interests, this course will provide you with a unique opportunity to develop the appropriate skills for making a difference. Some scholarship opportunities will be available for deserving individuals with limited resources. There will also be a few short-term internships available to qualified students after the course. Registration will be open in October 2012. Tuition costs US $750 and the process for obtaining financial support and internship opportunities will be announced shortly.

For registration information and process, contact AArk Education Officer, Rachel Rommel (Rachel@AmphibianArk.org), or

Ron Gagliardo (Ron@AmphibianArk.org) and Andy Odum (RAOdum@aol.com).

Sabin Award for Amphibian Conservation



Since 2007 Conservation International and the IUCN Amphibian Specialist Group have been offering the Sabin Award for Amphibian Conservation. Recipients have included Luis Coloma (Ecuador), Franco Andreone (Italy), Jonh Jairo Mueses Cisneros (Colombia), SD Biju (India), Herilala Randriamahazo (Madagascar), Alonso Quevedo (Colombia), and the 2012 recipient Karen Lips (USA). The award recognizes true leaders in local and global research and conservation efforts toward addressing the ongoing demise of the world's amphibians. The award is sponsored by Andrew Sabin, a conservationist and philanthropist whose efforts and generosity are direct contributions toward global conservation efforts, including significant contributions toward amphibians. SSAR greatly appreciates Andrew Sabin's vision and efforts and extends congratulations to the winners of this award.

New Brazilian Journal



The Sociedade Brasileira de Herpetologia (Brazilian Herpetological Society) has launched a new open access electronic-only journal, *Herpetologia Brasileira*. The journal is published in Portuguese and is under the general editorship of Taran Grant and Marcio Martins. The journal may be accessed at: http://www.sbherpetologia.org.br/herpbras/index.html.

MEETINGS

Meetings Calendar

Meeting announcement information should be sent directly to the Editor (HerpReview@gmail.com) well in advance of the event.

10–11 January 2013—California/Nevada Amphibian Populations Task Force 2013 Meeting, Humboldt State University, Arcata, California, USA. Information: Dr. David Bradford (dbradfo@herpconbio.org)

21–23 January 2013—3rd International Symposium on Agamid Lizards (DeAgamis 3), Melbourne Museum, Melbourne, Australia. Information: Dr. Jane Melville (jmelv@museum.vic.gov.au)

29 January–1 February 2013—37th Meeting of the Australian Society of Herpetologists, Point Wolstoncroft, New South Wales, Australia. Information: http://www.australiansocietyofherpetologists.org/

2–8 February 2013—33rd Annual Symposium on Sea Turtle Biology and Conservation; together with Terrapin, Tortoise & Freshwater Turtle Meeting, Baltimore, Maryland, USA. Information: http://iconferences.seaturtle.org/

22–23 March 2013—4th Box Turtle Conservation Workshop, North Carolina Zoological Park, Asheboro, North Carolina, USA. Information: www.boxturtleconservation.org

20–23 May 2013—World Crocodile Conference, 22nd Working Meeting of the Crocodile Specialist Group IUCN-SSC, Colombo, Sri Lanka. Information: www.csgsrilanka.com

10–15 July 2013—Joint Meeting of Ichthyologists and Herpetologists (SSAR, HL, ASIH), Albuquerque, New Mexico, USA. Information: http://www.dce.k-state.edu/conf/jointmeeting/

21–25 July 2013—26th International Congress for Conservation Biology, Baltimore, Maryland, USA. Information: http://www.conbio.org/mini-sites/iccb-2013

31 July–3 August 2013—36th International Herpetological Symposium, New Orleans, Louisiana, USA. Information: http://internationalherpetologicalsymposium.com/index.html

22–27 August 2013—SHE 17th European Congress of Herpetology, Veszprém, Hungary. Information: http://seh2013.org/

3–6 October 2013—4th Biology of Vipers Conference, Struga, FYR Macedonia. Information: www.shdmr.org/vipers

CURRENT RESEARCH

The purpose of Current Research is to present brief summaries and citations for selected papers from journals other than those published by the American Society of Ichthyologists and Herpetologists, The Herpetologists' League, and the Society for the Study of Amphibians and Reptiles. Limited space prohibits comprehensive coverage of the literature, but an effort will be made to cover a variety of taxa and topics. To ensure that the coverage is as broad and current as possible, authors are invited to send reprints to the Current Research section editors, Beck Wehrle or Ben Lowe; e-mail addresses may be found on the inside front cover.

A listing of current contents of various herpetological journals and other publications is available online. Go to: http://www.herplit.com and click on "Current Herpetological Contents."

Night Lizards Aggregate to Stay Warm, But Climate Change May Affect Behavior

There is little known about why or how sociality originates, though various studies of taxa from across Animalia suggest that delayed juvenile dispersal is a common path to sociality. Social living is thought to confer fitness benefits, but this is difficult to measure in complex social systems. The authors of this study were able to collect genotypic and physical fitness data on aggregating and solitary individuals of the Desert Night Lizard (*Xantusia vigilis*) through marking and recapturing 2,332 lizards in 441 social groups. In winter, approximately two-thirds of these lizards aggregate in groups of 2–20, usually with kin. Using microsatellite data to infer parentage, the authors compared fitness across solitary and grouping lizards, finding that males who were solitary in the winter did not produce offspring the next summer. Conversely, some grouping males produced offspring with multiple females. Aggregated female lizards had an increased survival rate and aggregated females and juveniles were significantly fatter than their solitary counterparts. The frequency of aggregation was found to be strongly inversely correlated with temperature. Additionally, the authors found that groups of lizards lost heat more slowly than solitary lizards, including experimentally isolated individuals. As huddling changes the surface area to volume ratio, this is not surprising, and, indeed, the effect scaled with mass and therefore affected small juveniles the most. The average difference in time to temperature equilibrium between solitary and grouping lizards was 6.5 hours, greatly minimizing the amount of time aggregations experienced the coldest temperatures relative to solitary individuals. Since this social behavior has thermal consequences, the authors considered four climate change models to determine how aggregations might be affected in the future. They modeled monthly aggregation levels from 1950 to 2099, finding a decrease in number of groups and duration of grouping through time. By 2099, the aggregation rate is expected to decrease by at least 20% and up to 50% of the modeled grouping rate from 1950. Social aggregation provides fitness benefits to adults and juveniles in the form of thermal buffering and decreasing metabolic costs, but may also allow for reproductive benefits to males such as through mate guarding. This study is important in testing the benefits of social behavior, as well as acknowledging the effect of environmental conditions.

Davis Rabosky, A., A. Corl, H. E. M. Liwanag, and Y. Surget-Gorba. 2012. Direct fitness correlates and thermal consequences of facultative aggregation in a desert lizard. PLoS ONE 7:e40866.

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Review of Poison Sequestering Amphibians and Reptiles Suggests Under-documentation

Toxin sequestering is rarely documented in tetrapods. Though it is not uncommon for compounds to accumulate in organism's tissues, the authors of this review paper note that this is not by itself sequestering for chemical defense. Defining sequestration as the novel evolution of poison retention that results in a selective advantage, they review the known cases in amphibians and reptiles. Based on morphological and physiological correlations, the authors suspect that the true diversity is much higher than currently known. In their examples, the authors identified the following prey classes that if included in diet, may indicate a tetrapod species is sequestering toxins for chemical defense: toxic arthropods, toxic mollusks, and toxic amphibians. Poison sequestering has been identified in five frog taxa: Dendrobatidae, Mantellidae, *Melanophryniscus*, *Pseudophryne*, and *Eleutherodactylus*. In these taxa, defensive toxins are obtained from eating poisonous arthropods. These frogs are also small, brightly colored, and generally at risk for predation from visual predators. Of interest is whether Dendrobatidae and *Melanophryniscus* independently evolved this trait or if it was retained from a common ancestor and lost in other descendents (e.g., the remainder of Bufonidae; determination awaits clarification of evolutionary relationships among the major hyloid clades). Other anurans, some plethodontids, and three species of caecilians are identified as candidates for sequestering chemical defenses. Among reptiles, scolecophidians and a lineage of arthropod-eating geckos, *Liolaemus monticola*, are potential poison sequesterers. Some snakes that specialize on eating mollusks also exhibit static defensive behavior (e.g., death feigning) or mimicry of known noxious prey (e.g., toxic millipedes), encouraging further investigation of their toxicity. Three species of garter snake (*Thamnophis*) sequester tetrodotoxin in their livers from consuming newts in the genus *Taricha*. The toxicity of *Taricha* and the tolerance of the snakes to tetrodotoxin covary geographically; populations of snakes that consume large quantities of newts have also been found to have aposematic coloration and a decreased flee response. The tetrodotoxin in *Thamnophis* livers can be lethal to avian or mammalian predators and garter snakes have been found to survive with a partial organ. The natricine snake *Rhabdophis tigrinus* stores bufadienolides in its nuchal glands, even passing along these compounds intergenerationally to neonates. With this sequestration, *R. tigrinus* has also developed behavior to direct their glands at oncoming predators. Other *Rhabodophis* and Xenodontini snakes are likely also using sequestered chemical defense. This review urges greater investigation of this field of research and suggests toxin sequestration in herpetofauna as a more common phenomenon than previously thought.

Savitzky, A. H., A. Mori, D. A. Hutchinson, R. A. Saporito, G. M. Burghardt, H. B. Lillywhite, and J. Meinwald. 2012. Sequestered defensive toxins in tetrapod vertebrates: principles, patterns, and prospects for future studies. Chemoecology 22:159–168.

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Facultative Parthenogenesis Found in a Garter Snake and Two Wild Pitvipers

Facultative parthenogenesis is rare in vertebrates, but has recently started being documented in sharks, birds, varanids, and snakes. The following two studies use microsatellite analyses to identify instances of parthenogenesis in otherwise sexually reproducing snake species and add support to the claim that facultative parthenogenesis might serve as an alternative reproductive strategy. Reynolds and colleagues[1] observed parthenogenesis in a wild-caught Checkered Garter Snake (*Thamnophis marcianus*) reared in captivity. The female was very young at isolation from other snakes. During her lifetime, she produced five litters that included three viable offspring, 11 stillborns, and numerous yolked ova. Blood, liver, muscle tissue, and shed skin were collected from the female and nine of her progeny to use for genetic analyses. Thirty microsatellite loci were identified and developed for comparison. Of these, 18 microsatellites produced clear results, and five were maternally heterozygous. In the young, differential homozygosity was observed at four microsatellite loci, and at one locus four offspring had identical genotypes to their mother. There was no evidence of any paternal genes, supporting this as an example of parthenogenesis and not sperm storage. Additionally, this is in line with the assumptions about the female's reproductive history. All three of the sexed offspring were male, as is expected with parthenogenesis in ZW organisms (where females are the heterogametic sex). These offspring developed normal looking hemipenes, suggesting that they were reproductively viable, though histological analyses of the testes were inconclusive to the presence of spermatozoa. Similar instances of facultative parthenogenesis have been confirmed in other *Thamnophis* species, but instances of successive virgin births confirmed via molecular data are few.

While facultative parthenogenesis has been documented in captive vertebrates, Booth and colleagues[2] report on the first known cases in the wild. The authors collected litters from 22 wild Copperhead snakes (*Agkistrodon contortrix*) and 37 wild Cottonmouths (*A. piscivorous*). Pregnant snakes gave birth in captivity and two litters were identified as being possibly parthenogenesis due to (a) production of single male offspring, and (b) multiple yolked ova (characteristics seen in previously confirmed parthenogenic squamate litters). These two litters were analyzed at seven (*A. contortrix*) or eight (*A. piscivorous*) microsatellite loci. Homozygosity for one of the maternal alleles was observed for all offspring. These genotypes were not found outside the mothers and their progeny. Inbreeding in the wild population was small and the calculated probability of a male providing an identical allele was incredibly small. The young were healthy at release. This study shows that facultative parthenogenesis is not just a captive phenomenon. Together these two studies suggest that facultative parthenogenesis may not just be a reproductive abnormality and could be a valid mechanism for an isolated female to jumpstart a new population.

[1]Reynolds, R. G., W. Booth, G. W. Schuett, B. M. Fitzpatrick, and G. M. Burghardt. 2012. Successive virgin births of viable male progeny in the checkered gartersnake, *Thamnophis marcianus*. Biological Journal of the Linnean Society (*in press*) doi: 10.1111/j.1095-8312.2012.01954.x

[2]Booth, W., C. F. Smith, P. H. Eskridge, S. K. Hoss, J. R. Mendelson III, and G. W. Schuett. 2012. Facultative parthenogenesis discovered in wild vertebrates. Biology Letters (*in press*) doi: 10.1098/rsbl.2012.0666

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Insights into Snake Evolution Stemming from the Discovery of the Earliest Ophidian

Much debate has centered on the ancestral ecology of snakes, with the leading hypotheses being that leglessness evolved as an adaptation to either a fossorial or aquatic lifestyle. Unfortunately, fossil material of early-diverging snakes remains scant. One snake, *Coniophis*, was described based on vertebral material collected from eastern Wyoming by O.C. Marsh in 1892. Subsequently, this fossil bed has been dated to the vicinity of the Cretaceous-Paleogene extinction event and cranial material attributable to *Coniophis* has been discovered but has remained undescribed. The authors of this paper officially described this material attributable to the snake *Coniophis* and evaluated it under an evolutionary framework. This cranial material exhibits a mix of ancestral ("lizard") and derived (ophidian) features. For instance, the teeth are long, cylindrical, and hooked like a snake, yet the maxilla maintains strong sutural connections with the other cranial elements much like non-ophidian lizards. The authors conducted phylogenetic analyses of living and fossil snakes using both cranial and vertebral material combined, as well as cranial and vertebral material separately. All three analyses found *Coniophis* to be the earliest diverging known snake. When specific characteristics associated with cranial kinesis were plotted onto the trees, only those associated with an intramandibular joint predated the split between *Coniophis* and other snakes, with most of the remainder immediately predating the split between Scolecophidia and Alethinophidia. The authors posit that with low neural spines, a kinetic mandible, and recurved teeth, *Coniophis* represents a fossorial predator on small vertebrates. Furthermore, as the majority of features associated with a kinetic skull immediately predate the most recent common ancestor of the diverse clade Serpentes and are absent in *Coniophis* and the similarly early-diverging *Najash*, these analyses lend credence to the idea that cranial kinesis may have served as a key innovation, permitting the incredible ophidian diversity we see today.

Longrich, N. R., B.-A. S. Bhullar, and J. A. Gauthier. 2012. A transitional snake from the Late Cretaceous period of North America. Nature 488:205–208.

Correspondence to: **NICHOLAS LONGRICH**, Department of Geology and Geophysics, Yale University, PO Box 208109, New Haven, Connecticut 06520-8109, USA; e-mail: nicholas.longrich@yale.edu

Photos Solicited for the New Show

HERPETOLOGISTS PAST AND PRESENT



Yes, you are correct. This is the current, about-to-be-former SSAR President in one of his more serious moments.

PHOTOGRAPH BY ALISON KELLY

To Be Revised for University of Kansas Meeting in 2015

In 1982, SSAR commissioned an audiovisual slide show to celebrate its 25th Anniversary Meeting in Raleigh (North Carolina). This 30-minute program was later enlarged and became a popular staple at SSAR meetings for nearly two decades. However, the technology used then (6 computer-controlled slide projectors) is now obsolete and must be completely revised using modern digital techniques.

SSAR has commissioned a new program, to debut at its 2015 meeting at the University of Kansas (July 30th through August 3rd). Color slides of herpetologists at work or play are hereby solicited. These may be color slides (which will be returned after scanning) or digital files (at 300 dpi/ppi or higher, preferably in TIFF but JPEGs are OK; best to burn files to CDs or DVDs). *All sources will remain confidential!*

Please send all of your images to David M. Dennis, 2708 Bigelow Drive, Sarasota, Florida 34239, USA or send them by e-mail to daviddennis@verizon.net. Be sure to include relevant data for each image (names of persons, dates, places, etc.).

Proposal to Alter Anole Taxonomy and Ecological Nomenclature

Phylogenetic work on squamates over the last decade has made great strides in clarifying relationships and diversification patterns. One recent study[1] used multilocus molecular phylogenetic approaches to examine evolutionary relationships within Iguania. Therein, the authors provided strong evidence for the paraphyletic condition of Polychrotidae sensu lato. To repair this violation of taxonomic rules, the authors proposed to resurrect the family Dactyloidae to encompass *Anolis* (anoles), which was found to be more closely related to Corytophanidae (basilisks) than to the nominative genus of Polychrotidae, *Polychrus* (bush anoles). Though there have been propositions to break up *Anolis* into several genera, these changes have not been widely accepted, resulting in a monogeneric Dactyloidae. A more recent study[2] used morphological and mtDNA sequence data for 189 taxa to generate a time-calibrated phylogeny of anoles. These analyses revealed eight mostly well-supported *Anolis* clades. The authors argue that leaving these species within a massive *Anolis* (387 species) obscures patterns of diversity and hinders research and scientific communication. To this end, they resurrect eight generic names for these clades and assign unsampled taxa to these clades presumably using previously published hypotheses. Furthermore, citing the fact that mainland anoles often are not morphologically convergent with their Caribbean "ecomorphological" counterparts, the authors propose to instead use the term "ecomode" to describe anole microhabitat specialist types. In addition to the five generally accepted types, they propose four additional ecomodes: ground, saxicolous, semiaquatic, and ground-bush. Using the recovered phylogenies, the authors performed analyses of ancestral reconstruction with regards to ecomode and geography of anoles. These analyses revealed the ancestral anole was probably a large, tree-dwelling South American lizard. Anoles diversified into the eight clades between 125 and 65 million years ago in the vicinity of Central America at a time when the region was an island archipelago that included the precursors to both modern day Central America and Greater Antilles. As these proposed changes affect taxonomy within a widely studied model system and are nonessential in that they are not an attempt to rectify paraphyly, they have generated considerable discussion, particularly on an internet forum frequented by anole researchers (Anole Annals: http://www.anoleannals.org/). Discussion has included the efficacy of using taxonomy to impart phylogenetic information, how recognizing several anole genera could increase appreciation of anole evolutionary and ecological diversity, the importance of taxonomic stability, and the feasibility of assigning unranked clade names in lieu of changing generic taxonomy.

[1]Townsend, T. M., D. G. Mulcahy, B. P. Noonan , J. W. Sites Jr., C. A. Kuczynski, J. J. Wiens, and T. W. Reeder. 2011. Phylogeny of iguanian lizards inferred from 29 nuclear loci, and a comparison of concatenated and species-tree approaches for an ancient, rapid radiation. Molecular Phylogenetics and Evolution 61:363–380.

[2]Nicholson, K. E., B. I. Crother, C. Guyer, and J. M. Savage. 2012. It is time for a new classification of anoles (Squamata: Dactyloidae). Zootaxa 3477:1–108.

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Arbovirus Found in Two Pivipers

The Eastern Equine Encephalomyelitis Virus (EEEV) is a pathogenic virus found in the eastern United States. Known for affecting mammals, EEEV is spread by mosquito hosts with bird infections serving as a viral reservoir. Two mosquito species known to transmit EEEV feed on amphibians and reptiles. Ectothermic terrestrial vertebrates have been suggested as overwintering viral reservoir hosts for EEEV, supported by laboratory studies. In previous studies, experimentally infected snakes maintained infectious levels of virus longer than birds did, including during brumation. In this study, eight snake species in the Tuskegee National Forest of Alabama were tested for virus positivity. Cottonmouths (*Agkistrodon piscivorous*) were the most common snake sampled, accounting for over 40% of the site's potential EEEV host biomass, though Copperheads (*A. contortrix*) were also commonly encountered. The authors collected plasma from each snake, using a luminex assay to test for EEEV antibodies, indicative of exposure. To test for presence of the actual virus (rather than mere exposure), they extracted RNA samples from the plasma which were analyzed using qRT-PCR. Those that tested positive for EEEV RNA were subjected to virus isolation. Samples that tested positive and negative for the virus via the luminex assay were compared were compared with respect to viral RNA presence from the qRT-PCR. Significantly more EEEV-positive Cottonmouths were found via the luminex assay (54; 45%) than via the qRT-PCR assay (13; 10.8%). Nonetheless, one antibody-negative Cottonmouth did have EEEV RNA. Snakes most frequently tested positive for EEEV in the spring, with those numbers decreasing until August. One Copperhead also tested positive for the virus antibodies and RNA, but sampled Plain-bellied Watersnakes (*Nerodia erythrogaster*) and Racers (*Coluber constrictor*) indicated antibodies but no RNA. No differences in EEEV antibody presence were detected due to snake size, but larger snakes were slightly more often EEEV RNA positive. This study is the first to find EEEV (and not just antibodies) present in the serum of wild ectothermic vertebrates. Though lab studies showed that this was possible, this field study provides support for snakes as a vector for this virus and documents some of the patterns of this relationship.

Bingham, A. M., S. P. Graham, N. D. Burkett-Cadena, G. S. White, and T. R. Unnasch. 2012. Detection of Eastern Equine Encephalomyelitis Virus RNA in North American snakes. The American Journal of Tropical Medicine and Hygene (*in press*). doi:10.4269/ajtmh.2012.12-0257.

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Diversity of Color Sexual Dimorphism in Frogs

Differences in color among sexes (sexual dichromatism) is common in animals and has been investigated extensively in birds, fishes, and butterflies. In frogs, >90% of species exhibit size differences by sex, making this the most common sexually dimorphic trait. Sexual dichromatism has previously been documented in 25 frog species. The authors of this review paper identify 115 additional cases of color sexual dimorphism in anurans and analyze the ecological and evolutionary distributions of this phenomenon. Sexually dichromatic frogs may permanently change color or pattern at sexual maturity (ontogenetic dichromatism) or male frogs can undergo temporary color changes just for the breeding season (dynamic dichromatism). These color changes can vary from slight differences in shade to stark color and pattern changes. Ontogenetic sexual dichromatism was found to be more taxonomically widespread (18 families) than dynamic dichromatism (nine families), which is only found in crown frog lineages (Neobatrachia). Using a robust phylogeny to quantify phylogenetic signal, the authors found that both types of sexual dichromatism are independent of evolutionary history. Broad ecological factors, on the other hand, correlate with patterns of distribution in sexual dichromatism. Sexual selection is the most likely pressure driving dynamic color differences as these changes are only seen in the breeding season and in males. This temporary change may be limited by physiology—in most cases, males become more yellow or darker or lighter than their non-breeding coloration. Sexual niche partitioning is an alternative explanation for selection on ontogenetic dichromatism, supported by the presence of nocturnal, conspicuously colored sexually dichromatic frogs. This hypothesis of sexual niche partitioning may be well suited for study in frogs due to multiple independent origins of dichromatism. In brightly colored male ontogenetic changers (mostly Hylinae and Bufonidae), it is suggested that these changes are subject to similar selection pressures as those of dynamic color changers, but the effects are present year-round. In ontogenetic sexually dichromatic species where sexes both are brightly colored (common in African hyperoliid treefrogs), sexual selection in the form of female mate choice or within-sex competition are possibilities, but sexual differences in habitat use are also proposed. Future work on the genetics of color change pathways is needed to determine its adaptive value, as is further investigation into the ecological correlates of this phenomenon.

Bell, R. C., and K. R. Zamudio. 2012. Sexual dichromatism in frogs: natural selection, sexual selection, and unexpected diversity. Proceedings of the Royal Society B (*in press*). doi: 10.1098/rspb.2012.1609.

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OBITUARIES

Herpetological Review, 2012, 43(4), 534.
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Paul M. Daniel (1924–2012): A Key Early Officer in the Society



Paul Mason Daniel, who was an early officer in The Ohio Herpetological Society (OHS), forerunner of the Society for the Study of Amphibians and Reptiles, died on 3 June 2012 in a retirement community in Adamstown (Maryland). He was 87. Paul was born in Philadelphia on 12 July 1924. After finishing high school in 1942, he enlisted in the U.S. Army's 34th Infantry Division and saw combat duty in North Africa and Italy; he won both a Purple Heart and a Silver Star. After discharge from the army, he matriculated at Miami University in Oxford (Ohio) to study zoology because of his boyhood interest in animals. After his marriage in 1948, he transferred to the University of Cincinnati (B.A. 1950). Paul and his wife then moved to Liberia in West Africa as missionaries. There he taught biology and math at Cuttington College (now University), founded by the Episcopalian Church of the United States; several of his students went on to become leaders in the Liberian government.

While in Liberia, Paul completed an extensive study of the life history of the Red-headed Agama (*Agama agama*), which was turned into his master's thesis (M.S., Miami University, 1954). He then became a faculty member at Miami—first in Physiology and then in Zoology—and later completed his doctorate (Ph.D., Ohio State University, 1964). At Miami, he taught various courses in field zoology, served as curator of the department's Hefner Zoology Museum, and helped to found Miami's Institute of Environmental Sciences. He mentored many students, several of whom had herpetological interests. One of them was Ray Ashton who went on to a career at the North Carolina State Museum (he chaired SSAR's silver anniversary meeting in Raleigh in 1982) and then to Florida where he championed conservation of the Gopher Tortoise. Paul also served as President of the Ohio Academy of Science. Beginning when he was still an undergraduate, he was very active in local Boy Scout programs (his 40 years of service later earned him a high award from Boy Scouts of America) and other community activities (he was named Oxford's Citizen of the Year). After retirement, he and his wife moved to the Philadelphia area.

In the Spring of 1958, Paul joined OHS and attended its first meeting in Toledo in June of that year. He quickly threw in his lot with the society's officers, who at that time were all teenagers. This was a risky decision for a college professor, but it was a huge morale boost for the society's officers. He gave the society some academic credibility at a time when it had none. In 1959, Paul became Vice-Chairman for Membership and thus was intimately involved in the society's rapid growth. He attended all of the early meetings and field trips (in those early years, the society also sponsored separate outings in the southern part of the state).

Paul's other contribution to the society's early history was to offer part of his master's thesis on agamid life history for publication. He had presented this research at the society's meeting in Cleveland, in 1960. His paper was issued in 1961 and created a small furor. Publication of a major paper on an African lizard in a state herp journal run by amateurs drew attention from leaders of the existing herp societies. I was Paul's editor. I received several quite critical letters that pointed out the inappropriateness of publishing this paper in such a place. I did seek the best advice, however, and had the manuscript reviewed by Arthur Loveridge, the leading expert on African herpetology who was then at Harvard, and by Robert Stebbins, the well-known specialist on lizard biology at Berkeley. They were listed on the publication as the reviewers. One letter-writer even asked me, incredulously, whether Loveridge or Stebbins had ever seen the manuscript at all! Well, as I replied, yes they did. I still have their reviews in my files today. Paul's paper was another milestone for OHS and helped to stake out the society's intention to be a scientific society, although at that time still a very small one. Paul published the other half of his master's thesis in *Copeia* (1960). He had a special interest in the herpetofauna of Adams County (Ohio), located in the southern part of the state along the Ohio River. He and his students had surveyed this county for many years because of its unusual physiographic features. They showed that it has the most diverse herpetofauna of any region in the state (31 species of amphibians and 23 of reptiles; published 1984).

In 1967, when the society changed its name to SSAR, Paul, like many others in Ohio, were quite unhappy because it meant that the society's focus was no longer going to be on Ohio, but its transition to a broader scope of interest had already been underway for several years. A decade later, when SSAR returned to meet in Ohio during America's Bicentennial Year, the conference was held at Miami University. Paul was on the Organizing Committee and it gave him much personal pleasure to welcome the society back home. By this time, Miami had two other herpetologists on its zoology staff, Douglas H. Taylor (who became SSAR's Publications Secretary and, later, its Treasurer) and Sheldon I. Guttman, who co-chaired that meeting, SSAR's 19th. Paul retained his membership in SSAR and watched the society's further growth with pride. His early involvement with the society, when its very existence was sometimes in question, remains his greatest contribution to the society's history.

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ZOO VIEW

> It is still so near pioneer times that people over forty remember wilderness to spare. But talk big to your boy nowadays about your own boyhood in the woods and you suddenly realize that you're stirring him up with urges less likely to profit him than knowing how to shrink heads or to build himself a sound harem.
>
> In Florida these days, you can still hear, under the mindless, glad din over industry coming in, the voices of the old ones—or of the young ones who have listened to the old ones—grieving over the passing of the wilderness. They are no longer watching landscapes wasting away. That happened long ago. What is going on now is just a lot of little cleanup operations, little scratchings-out of small tag-ends and patches of the past overlooked in the first waves of ruin.
>
> Archie Carr (1993) *Ulendo*

In a recent issue of *Connect*, the newsletter of the American Zoo and Aquarium Association (AZA), it was said that zoos and aquariums supported conservation initiatives to the tune of over US $130 million in 2011, an impressive sum indeed. These included both *in situ* and *ex situ* programs. Between 2007–2011, AZA's Conservation Endowment Fund awarded $419,694 to 22 reptile and amphibian conservation projects. This was out of 71 projects funded overall during that time period. The herp projects were conducted at the institution or in the field.

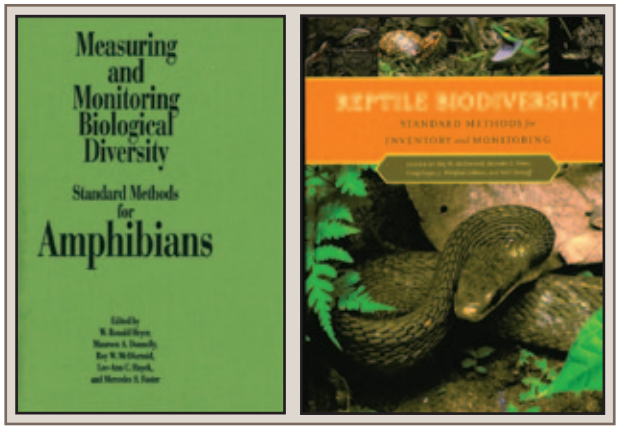
In 1983, since-retired curator Richard A. Sajdak from the Milwaukee County Zoo published an important article called "Herpetological research in zoos: A literature survey, 1977–1981" in the journal *Zoo Biology*. Of 1084 herp papers published in three major journals between 1977 and 1981, zoos were involved in 53. A total of 16 zoos contributed and nearly three fourths of these papers involved behavioral research.

Fifteen years later, Winston Card and David Roberts from Dallas Zoo and R. Andrew Odum from Toledo Zoo published a disturbing critique of zoo involvement in research (Card et al. 1998). They tried to survey 52 herp departments in the US to assess involvement with AZA-sponsored programs and formalized research programs during the past decade. Problem #1: less than half responded; Problem #2: nearly 80% of the 164 technical papers published were contributed by three institutions; Problem #3: over 40% of the non-technical articles were published by one institution; Problem #4: only four of the 20+ departments having what they described as "in-house research projects" had clearly defined objectives.

If one takes this analysis further, it is clear that some zoo herpetologists devote many hours to AZA-related activities, e.g., preparing studbooks and Taxon Management Accounts (TMAs), administering Taxon Advisory Groups (TAGs), and so on, and believing that these activities constitute research. That is really not true.

For some time, the U.S. Fish and Wildlife Service (USFWS) has prompted incorporation or support of field initiatives. In order to comply with some regulations protecting endangered species, we must demonstrate that our programs will enhance survivability in the wild by some direct involvement with wild populations. Sometimes, we are inexperienced or unprepared to conduct projects in the field, especially in developing countries. Extensive habitat destruction, hopeless bureaucracies, and nightmares obtaining permits and indifference by issuing officials were identified by Jonathan Campbell and Darrel Frost nearly twenty years ago: "If the effect of our statements is to make others press for legal restrictions in the taking of these animals, without serious protection of their habitats, then we can only lament that these people have failed what is, in effect, a conservation biology IQ test. They will have put a new roof on a burning house" (Campbell and Frost 1993). Can anyone argue that the situation has improved since that time of writing?

Because zoo keepers and biologists too often feel overwhelmed embarking on a project involving wild populations, I offer this solution to curators for initiating a study in the field: 1) arrange to work with a biologist who already has a field project in place; 2) use the keeper staff as field assistants and rotate them; 3) minimally, keepers must prepare for the field beforehand by reading the two books mentioned below; 4) zoo staffers benefit by learning a new skill set. Although zoo herpetologists may have spent time in the field collecting herps, they rarely have formalized training in conducting a field research project. I say this with certitude because during my career I have reviewed hundreds of résumés, from keeper to curatorial jobs, and this deficit is striking.



The task is easier now because these two books, one old and the other new, provide a comprehensive guide to conducting an *in situ* study on amphibians and reptiles. The first is *Measuring and Monitoring Biological Diversity. Standard Methods for Amphibians* (Heyer et al. 1994 and a Spanish-language edition issued in 2001). The new companion volume covers reptiles: *Reptile Biodiversity. Standard Methods for Inventory and Monitoring* (McDiarmid et al. 2012). There are four parts in the reptile volume: Introduction, Planning a Diversity Study, Sampling Reptile Diversity, and Conclusions. I hope that a Spanish version will be available in the future. In the foreword, Rick Shine sums up the challenge in studying biodiversity: "This is the book that I desperately needed at the beginning of my scientific career. Like most other young herpetologists, I had a pretty simple set of ideas about how to gather data—I'd just go out there, look for snakes, find some, catch them. and then write down anything that seemed useful (such as their sex or body size). And somehow or another, once I'd been doing that for long enough, I'd have a data set that could then tell all kinds of interesting stories about the biology of the creatures in question…And after talking with those more experienced herpetologists, it dawned on me that I actually needed to think about what I was going to do, and how I might ultimately use the data, *before* I started my fieldwork."

Before any field study is planned, both books should be thoroughly read to ensure that proper methodology is incorporated; no herpetologist's bookshelf should be without them.

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McDiarmid, R. W., M. S. Foster, C. Guyer, J. W. Gibbons, and N. Chernoff (eds.) 2012. Reptile Biodiversity. Standard Methods for Inventory and Monitoring. University of California Press, Berkeley. 412 pp.

Sajdak, R. A. 1983. Herpetological research in zoos: A literature survey, 1977–1981. ZΔoo Biol. 2:149–152.

NEW PAPERS OF IMPORTANCE TO ZOO BIOLOGISTS

Redefining the Role of Ex Situ Conservation

"We believe, however, that ex situ conservation has a more important role to play, especially in the face of the evidence of increasing extinction rates, exacerbated by climate change. We wish to stimulate discussions about the need to revise the contributions that ex situ approaches can make to conservation. Integrated conservation management approaches hold much potential but we must recognize the significance of institutional factors, not just the science that have hitherto constrained the development of direct conservation contributions from ex situ and integrated techniques. We question the continued validity of the in situ / ex situ distinction."

Pritchard, D. J., J. E. Fa, S. Oldfield, and S. R. Harrop. 2012. Bring the captive closer to the wild: redefining the role of ex situ conservation. Fauna & Flora International, Oryx 46(10):18–23.

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Breeding Farms Used to Launder Smuggled Wildlife

"Wildlife breeding farms have been promoted to aid biodiversity conservation by alleviating the pressure of harvest on wild populations. There is, however, growing concern that many breeding farms are being used to launder illegally caught wildlife. Surveys of wildlife traders in the Indonesian provinces of Maluku, West Papua and Papua were conducted between August 2009 and April 2011 to assess the trade of the green python (*Morelia viridis*), the species currently exported in the largest numbers from Indonesia declared as captive-bred. In total, 4227 illegally collected wild green pythons were recorded during surveys and high levels of harvest were found to have depleted and skewed the demographics of some island populations."

Lyons, J. A., and D. J. D. Natusch. 2011. Wildlife laundering through breeding farms: Illegal harvest, population declines and a means of regulating the trade of green pythons (*Morelia viridis*) from Indonesia. Biological Conservation 144:3073–3081.

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Role of Founder Effects and Natural Selection in Island Populations

Of interest to zoo biologists engaged in *ex situ* or *in situ* conservation efforts is the relative importance of founder events ("founder effects") and natural selection in maintaining genetic diversity, especially as population numbers decline to small levels. In an experimental study, Kolbe et al. introduced Brown Anoles (*Anolis sagrei*) to small islands in the Bahamas that had recently been cleared of lizards by a hurricane. They monitored both genetic and phenotypic responses among the descendents of these founder lizards on various islands, concluding that founder effects and natural selection jointly determine trait values in these populations.

Kolbe, J. J., M. Leal, T. W. Schoener, D. A. Spiller, and J. B. Losos. 2012. Founder effects persist despite adaptive differentiation: a field experiment with lizards. Science 335:1086–1089.

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Amphibian Extinction Crisis is Here

In this review of current threats and recent research findings, Wake offers a broad perspective that addresses the truly dire future facing many amphibian species. Although chytridiomycosis receives considerable attention as the leading cause of population declines in Australia and Central America, other agents of extinction such as climate change and land-use changes may be more consequential over time. In a faintly hopeful note, he points out that amphibians have persisted through end-Cretaceous extinctions and Pleistocene climate changes, although present conditions of habitat loss make it less likely that populations will be able to respond geographically or elevationally in the face of warming temperatures.

Wake, D. B. 2012. Facing extinction in real time. Science 335:1052–1053.

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—James B. Murphy, Section Editor

HERPETOLOGICAL NOMENCLATURE

Extra! Extra! Extra! Read All About It! International Comm Approves Electronic Publishing of New Zoological Names!!!!

In one of the most momentous actions in the history of the International Commission on Zoological Nomenclature, the Commission has amended the International Code to provide recognition and regulation of names first published in electronic journals and books. Amendments to Articles 8 and 9 (what does and does not constitute publication); Article 21 (determination of date of publication); Article 78 (powers of the Commission), are designed to expand and refine methods of publication to include electronic ones. Full details of these changes, which are retroactively effective as of January 1, 2012, are available online (http://www.pensoft.net/journals/zookeys/article/3944/). Here I summarize the principal features of the changes:

Article 8.5. Works issued and distributed electronically must be published after 2011, state the date of publication, and be registered in the *Official Register of Zoological Nomenclature* (Zoobank) with evidence provided in the work itself that it has been registered prior to publication.

Article 9. What does not constitute publication adds three new prohibited categories to those enumerated in the 4th edition of the Code as follows: 1) after 1985 works produced by hectographing or mimeographing; 2) before 1986 and after 2012 works issued on optical discs; 3) preliminary versions of works accessible electronically in advance of publication.

Article 21. New wording clarifies the situation where a date is not specified in the original publication (21.7) and to prohibit the date of publication being derived from an online preliminary version of a publication. A new article (section 21.9) is added to establish the date of publication where a publication appears in both print and electronic form on different dates (whichever came first).

Article 78. This article as amended provides the authorization for the creation and eminence of the *Official Register of Zoological Nomenclature* (Zoobank).

The International Commission is to be congratulated for developing a carefully nuanced solution to the problem of electronic publication following their original commitment to it in principal in 2008. It should be noted that some of the concerns about Zoobank are met in the present set of amendments by requiring nomenclatural works, not individual names, to be registered.

New Cases of Herpetological Interest

Case 3561: *Anchisaurus* Marsh, 1885 (Dinosuaria, Sauropodomorpha): proposed conservation of usage by designation of a syntype for the type species *Megadactylus polyzelas* Hitchcock, 1865. BZN 69(1):44–50.

Case 2566: *Tropidolaemus* Wagler, 1830 and *Cophias wagleri* F. Boie, 1827 (currently *Tropidolaemus wagleri*) (Reptilia, Squamata, Viperidae): proposed conservation. BZN 69(2):116–121.

—Jay M. Savage, Section Editor

Herpetological Review, 2012, 43(4), 537–538.
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On the Type Species of the Snake Generic Name *Anilios* Gray, 1845 (Serpentes: Typhlopidae)

During most of the 20th century, worm snakes of the family Typhlopidae were referred to a single genus, *Typhlops* Oppel, 1811. Robb (1966b), on the basis of her discovery (1960, 1966a) of the presence of solid, coiled hemipenes and retrocloacal sacs in some male typhlopids, recognized those species with these features as the separate genus *Ramphotyphlops* Fitzinger, 1843. McDowell (1974) thought that the preoccupied name *Typhlina* Wagler, 1830 had priority over *Ramphotyphlops*, but Wagler's name was suppressed for purposes of priority by the International Commission on Zoological Nomenclature in Opinion 1207 (1982). Consequently, *Ramphotyphlops* was used until 2006 for Asian, Indo-Malayan, and Australian snakes having unique features of male anatomy.

Wallach (2006) proposed that *Ramphotyphlops* be divided on the basis of his unpublished, 1998, phylogenetic analysis into an Asian, Indo-Malayan, and Papuan genus (*Ramphotyphlops*) and a southern New Guinea-Australian genus which he named *Austrotyphlops*. Unfortunately, Wallach's name is a *nomen nudum* as the only characters that he mentions as diagnostic of the genus are those shared with all species of *Ramphotyphlops* for which those characters have been studied. Under Article 13.1 of the International Code of Zoological Nomenclature, in order to be available, a name published after 1930 must be "accompanied by a description or definition that states in words characters that are purported to differentiate the taxon." In addition, there are three available generic names that are senior subjective synonyms of *Austrotyphlops*.

The earliest name for the southern New Guinea-Australian clade is *Anilios* Gray, 1845, a masculine noun (an + helios = without sun), type species *Anilios australis* Gray, 1845 by subsequent

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designation of Stejneger, 1904: 683. Wallach overlooked the fact that Stejneger had designated a type-species for this genus, although Williams and Wallach (1989: 9) accepted Stejneger's (1907: 260) reiterated designation. Wallach (2006) followed Loveridge (1957: 240) who made an invalid subsequent designation of *Anilios leachii* Gray, 1845 (= *Anguis jamaciensis* Shaw fide Hahn (1980: 60), or = *Anguis lumbricalis* Linnaeus, 1758 fide Roux-Estève (1974: 26), as the type species. Wallach further rejected the names *Libertadictus* Wells and Wellington, "1983", 1984 (type species by original designation and monotypy: *Onychocephalus bituberculatus* Peters, 1863) and *Sivadictus* Wells and Wellington, 1985 (type species by original designation: *Anilios nigrescens* Gray, 1845). Wallach attempted to dismiss these names as *nomina dubia* because their diagnoses are "inadequate and composite." However, the original descriptions of both nominal taxa are characterized by features that purport to differentiate them from other nominal genera. Consequently, these two names are available junior subjective synonyms of *Anilios* as their descriptions meet the requirements of Article 13 of the International Code.

The genus name *Anilios* is one of several names proposed for snakes currently included within *Ramphotyphlops* by most workers. Should the morphology-based generic arrangement of typhlopids proposed by Wells and Wellington (1985:40–41) gain recognition, *Anilios* probably will have priority over their name *Libertadictus* as it is likely that the included species (all Australian) have the distinctive hemipenial structure of that genus. Similarly, *Sivadictus* via their inclusion of *A. australis* as a species therein, as well as their generic diagnosis, places that name as a synonym of *Anilios*. The most recent (molecular) phylogenetic analysis of the Typhlopidae (Vidal et al. 2010) based on DNA sequence data confirms Wallach's finding that *Ramphotyphlops* is paraphyletic. However, their analysis did not include the type species of *Ramphotyphlops* (*Typhlops multilineatus* Schlegel, 1837) whose Indonesian distribution strongly suggests that it does not belong to the southern New Guinea-Australia clade as a putative *Anilios*. Consequently, the eventual usage of *Anilios* as a recognized genus, and the species it may contain awaits study within the perspective of the Vidal et al. (2010) analysis.



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ARTICLES

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Tropical Fiord Habitat as a Year-round Resting, Breeding, and Feeding Ground for East Pacific Green Sea Turtles (*Chelonia mydas*) off Costa Rica

Golfo Dulce, located along the South Pacific coast of Costa Rica, is a fiord-like structure with an inner basin of more than 200 m depth, sheltered against the open ocean by a shallow sill of 60 m (Svendsen et al. 2006). These conditions make Golfo Dulce the only tropical fiord on the Pacific side of the Americas (Hebbeln et al. 1996) and one of only four tropical fiords in the world (Toft 2009). Current calculations list 4745 marine species in Costa Rica's Pacific waters, more than double the number reported from the Caribbean side of the country (Wehrtmann et al. 2009), and emerging data show Golfo Dulce to be a very diverse ecosystem, supporting at least 1028 species, from small invertebrates to large marine mammals (Morales-Ramírez 2011).

East Pacific Green Sea Turtles, *Chelonia mydas*, are known to utilize the waters around the Osa Peninsula, as are three other species: Olive Ridley, *Lepidochelys olivacea*; Hawksbill, *Eretmochelys imbricata*; and Leatherback, *Dermochelys coriacea* (Quesada-Alpízar et al. 2006). However, to date, limited data have been published regarding abundance and spatial and temporal distribution of *C. mydas* in the region. Sea turtle nesting activity near Golfo Dulce was first registered by Richard and Hughes (1972), who described the southwestern beaches of the Osa Peninsula as having one of the highest sea turtle track densities in the South Pacific region of Costa Rica. The Olive Ridley is the most common species on the nesting beaches just outside Golfo Dulce and while the Hawksbill is the least frequent species (Drake 1996), most of the Hawksbill nesting observations reported for Costa Rica during 2007–2009 took place in Corcovado National Park on the Osa Peninsula (Gaos et al. 2010). Here, we report the use of Golfo Dulce as a year-round resting, breeding, and feeding ground for East Pacific Green Sea Turtles.

Two onboard marine sighting surveys were conducted in Golfo Dulce from a 15-50 hp boat during the dry season months of January–February 2010 and the rainy season months of July–August 2011.The basic methodology has previously been described, including systematic interviews with 82 local fishermen and tour boat guides (Bessesen 2012), who were asked with what frequency they see sea turtles inside Golfo Dulce: always (N = 36), frequently (N = 33), occasionally (N = 10), rarely (N = 3), and never (N = 0). Combined onboard survey effort totaled 55 days (dry season, N = 30; rainy season, N = 25) and 424 observation hours. A blank on the field data sheet was used to indicate species ID reliability as definite (D), probable (P), maybe (M) or unconfirmed (U), but the two sea turtles marked M during the surveys were shifted to U for this reporting. Group size and behavior were also recorded.

A total of 177 sea turtle sightings were logged between 2010 and 2011. Forty-six of those sightings were marked U, while the remainder represented three species: *C. mydas* (N = 101), *L. olivacea* (N = 20), and *E. imbricata* (N = 10). GPS data showed each species using a different part of Golfo Dulce: Olive Ridleys were encountered in the lower half of Gulf, and Hawksbills were distributed coastally around the embayment, but 86.5% of East Pacific Green Sea Turtle sightings occurred in the upper half of the inlet. Based on areas of use by confirmed species and the locations of the U sightings, which were also concentrated in the upper half of the inlet, even more Green Sea Turtles may have been utilizing the northerly reaches of Golfo Dulce during the study period (Fig. 1). Use of the Gulf by *C. mydas* was comparable between the dry season (N = 53) and the rainy season (N = 48). In fact, *L. olivacea* was the only sea turtle species to show a distinct seasonal shift in numbers, increasing to coincide with its known nesting season on the Osa Peninsula during the rainy season (N = 19, vs. N = 3 in the dry season).

Chelonia mydas was the prevalent turtle species in Golfo Dulce, accounting for 57% of all turtle sightings. Digital images played an important role in species confirmation and photos or video were collected for 80% of our *C. mydas* sightings. Because a sighting could comprise one or more individuals of the same species in the same area at the same time, a single sighting might represent multiple individuals, as was the case for Green Sea Turtles when many were spotted simultaneously and could not be logged separately. Thus, the actual number of *C. mydas* counted during the study exceeded 288 individuals. Based on size, most appeared to be adults.

Green Sea Turtles were typically found floating motionless or quietly paddling at the surface in what appeared to be a resting

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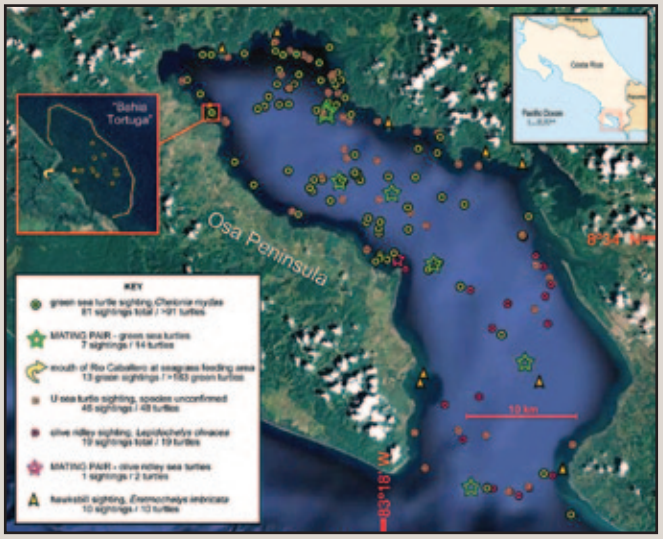


FIG. 1. Keyed GPS points for all of our 2010–2011 sea turtle sightings in Golfo Dulce. Insets: (upper right) location of Golfo Dulce in Costa Rica; (upper left) close-up view of sighting points in "*Bahia Tortuga.*"



FIG. 2. Surface behaviors of East Pacific Green Sea Turtles in Golfo Dulce. (A) Basking behavior – note the dry shell. (B) Copulating pair.

state, with liberal exposure of the carapace indicating some degree of thermoregulation (Fig. 2A). Head position was variable, from upright to hanging at or slightly below the water surface and turtles in this basking position (N = 70) often remained at the surface for several minutes. Mating pairs of *C. mydas* (N = 7) were also documented during our surveys (Fig. 2B). Although Green Sea Turtles showed positive selection for the upper half of the inlet, breeding was recorded in all four quadrants of Golfo Dulce and the behavior did not appear to be seasonally driven (dry season, N = 4; rainy season, N = 3). It should be noted that while there are a few locally known nesting sites for Green Sea Turtles along the banks of Golfo Dulce, including Playa Preciosa, nesting did not seem to be a major activity inside the inlet.

In many neritic habitats, the diet of adult *C. mydas* is predominantly herbivorous (Bjorndal 1980; Devaux and DeWetter 2000; Seminoff et al. 2002) and a coastal tracking study by Senko et al. (2010) showed Green Sea Turtles off the Pacific coast of Baja California Sur, Mexico, spent 69% of their time over areas of seagrass and 59% in depths < 5 m. In Golfo Dulce, a considerable number of Green Sea Turtle sightings occurred in a > 400 m^2 area where shallow subsurface topography supported an abundance of seagrass. The bed was situated around 40.058°N, 26.598°W, near the mouth of Rio Caballero. Underwater photographs revealed two species of seagrass. Only two species have been reported on the Pacific side of Costa Rica, *Ruppia maritima* and *Halophila baillonis* (Cortés 2001; Cortés and Salas 2009). While one of our specimens was clearly *H. baillonis,* the other, filamentous species was challenging to confirm via photos. It may have been *R. maritima* but was more likely *Halodule beaudettei* (J. Cortés, pers. comm.; J. Samper-Villarreal, pers. comm.), a grass found in Panamá, which Cortés (2001) believes might also grow in Costa Rica.

We came to call the seagrass bed "*Bahia Tortuga*" ("Turtle Bay") because it supported extensive cheloniid activity and appears to be a critical feeding habitat. At least 183 individual *C. mydas* were observed in the area with total estimated numbers exceeding 500 turtles. All photographs taken in Bahia Tortuga confirmed the sightings to be *C. mydas* with the exception of one obvious Hawksbill seen near the mangrove roots (described as emerging habitat for that species; Gaos et al. 2012). In Bahia Tortuga, Green Sea Turtles spent their time submerged and were never observed floating at the surface as described in other parts of the Gulf. Green Sea Turtles were sometimes visualized from the boat as they swam subsurface in the shallowest water (<3 m) and skin diving allowed one observer (BLB) to view several turtles near the seagrass floor, although actual feeding behavior was not observed. The majority of sightings in Bahia Tortuga occurred from the research vessel, floating quietly with the motor off. During these periods of silent observation, turtle heads popped up as various individuals surfaced to breathe. Carapaces were not visible and cranial exposure was fleeting, never lasting more than 1–2 sec, a behavior possibly common in foraging habitats (Hazel et al. 2009). Loud exhales indicated extended breath-holding. Since passing boats were unlikely to see any turtles, the area was generally unrecognized as a turtle hotspot and was at the time undisturbed by human activity.

Globally, Green Sea Turtle populations have fallen into collapse from anthropogenic impacts (Devaux and DeWetter 2000; Mancini and Koch 2009; Marquez et al. 1982; Seminoff et al. 2002). Numbers are said to be dropping precipitously in Golfo Dulce as well. Several interviewed fishermen with up to four decades experience in the Gulf stated that recent years have brought a decline in sea turtles of at least 30%. Understanding habitat use is fundamental to the conservation of these large marine vertebrates. In the East Pacific, the Green Sea Turtle is a highly migratory species and corridors between the Galápagos Islands and the Baja California peninsula have been identified; these serve as routes of travel between feeding grounds and nesting sites (Amorocho and Reina 2007; Amorocho et al. 2012). Tag recovery data have shown nesting females traveling from México to Colombia and from the Galápagos Islands to Costa Rica (Alvarado-Diaz and Figueroa 1990), including Golfo Dulce (Chacón et al. 2011). Our data now indicate that East Pacific Green Sea Turtles are using Golfo Dulce as a resting, breeding, and foraging area throughout the year, suggesting this tropical fiord may be an important site within the Green Sea Turtle migratory corridor in the East Pacific.

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Here be a Dragon: Exceptional Size in a Saltwater Crocodile (*Crocodylus porosus*) from the Philippines

Crocodiles (Reptilia: Crocodylia) are generally regarded as the largest living reptiles by mass (Britton 2003). Exceptionally large individuals regularly attract mainstream attention, often enhanced by unrealistic and exaggerated accounts of their size and behavior. Actual evidence on the upper size limit of crocodiles is lacking and romantic accounts and misleading photographs are often the only remains. Skulls found in museums and private collections provide a tantalizing glimpse into the size of their former owners, yet total lengths are usually not available, the techniques used to obtain them are not known, and the veracity of such measurements is questionable (Greer 1974; Whitaker

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and Whitaker 2008). Limited verification is possible using existing formulae for predicting total length (TL) from skull measurements such as dorsal cranial length (DCL; e.g., Verdade 1999; Webb and Messel 1978; Wu et al. 2006). However, such formulae are typically derived from a subset of possible size ranges, and become increasingly inaccurate if applied outside those ranges to the largest examples of a species. Not only do crocodilian body parts show allometric change with increasing size (Gans 1980), the rate and direction of change is not constant (Hall 1985; Hall and Portier 1994) and there is increasing variability particularly near the maximum upper size limit (Whitaker and Whitaker 2008). As there is a dearth of data available from thorough and systematic measurements of very large crocodiles, our ability to predict TL from other variables including DCL is compromised near the upper limit. Such information is useful across a number of disciplines including paleontology, conservation and population management (Brochu 2001; Schmidt-Nielsen 1984).

We present accurate measurements for an exceptionally large Saltwater Crocodile (*Crocodylus porosus* Schneider 1801) that was captured alive from Mindanao in the Philippines. We compare these measurements with those of other exceptionally large crocodiles and discuss factors responsible for exceptional size.

Background.—The capture of an exceptionally large male *C. porosus* from a small creek not far from Bunawan in the Agusan del Sur province of Mindanao in the Philippines made international headlines on 3 September 2011. This crocodile was captured after a two-year effort to remove the animal thought responsible for the death of 12-year-old Rowena Romano in Lake Mihaba in Agusan Marsh on 7 March 2009 (Sistante 2009) and later in mid-2011 the unreported disappearance of a fisherman close to Bunawan village (R. Sumiller, pers. comm.). An experienced member of the Palawan Wildlife Rescue and Conservation Center (PWRCC), Ernesto "Lolong" Cañete, died of a heart attack in late August 2011 shortly before the crocodile's eventual capture. The crocodile was named "Lolong" in his memory (R. Sumiller, pers. comm.).

Lolong's capture was coordinated by wildlife specialist Ronnie Sumiller and other PWRCC members. Steel nooses baited with Carabao (*Bubalus bubalis carabanesis*) meat were deployed hanging from trees along the creek. The first four nooses were destroyed by the crocodile's struggling before a fifth, thicker-cabled noose was successful. The remains of the other nooses were found fastened around the crocodile's upper jaw. Dozens of people were reportedly required to haul the crocodile onto the bank where his jaws and legs were bound using ropes (E. Elorde, pers. comm.). Key PWRCC staff who were not present on the capture night provided additional guidance by mobile phone. Over 100 people were required to haul the crocodile by cart along the river bank to the nearby village and a floating pontoon had to be constructed to float the crocodile across the creek to access the only available road. The crocodile was then transferred to nearby holding facilities and now resides at Bunawan Eco-Park and Research Center.

There was considerable international interest in the total length of Lolong. The crocodile which killed Rowena Romano was estimated by a witness to be "30 ft" (9.1 m) in length, whereas the crocodile seen hunting carabao near the village shortly before capture was suspected to be closer to "16 ft" (4.9 m) long (E. Elorde, pers. comm.). His true size only became apparent during capture. Media reports of his length were inconsistent, ranging from 6.1 to 6.4 m (20–21 ft). It was not known at the time how accurately the crocodile had been measured, what method had been used, or whether the figure had been reported correctly. However, photographic and video evidence showed his size to be exceptional. This was sufficient to attract serious interest in verifying the measurement and Natural History New Zealand dispatched one of the authors (AB) to visit Bunawan and independently measure the crocodile where it would be witnessed and documented. Funding was provided by National Geographic.

Table 1. Measurements of Lolong. See Materials and Methods for the difference between Method A and Method B. Method A is considered the principal measurement. All measurements are illustrated in Fig. 2. All length measurements are taken from tip of premaxilla (snout). All width measurements are taken at the widest point.

Measurement (mm)	Method A	Method B
Dorsal cranial length (DCL)	700	694
Snout–eye length (SEL)	496	495
Maximum head width (MHW)	450	450
Maximum cranial width (MCW)	228	228
Inter-orbital width (IOW)	84	84
Cranial height (CH)	363	363
Snout–pelvis length (SPL)	2851	2844
Snout–scute junction (SSJ)	4982	4949
Total length (TL)	6170	6095

Materials and Methods

Capture and restraint.—One of the authors (AB) measured Lolong in his enclosure at the Bunawan Eco-Park on 9 November 2011 at 1400 h local time. Measurement conditions were considered ideal. Lolong was lying relatively straight on the level concrete floor of a recently-drained pool. A combination of chemical and physical restraint was employed to facilitate accurate measurement, to improve safety for personnel, and to ensure the crocodile's welfare. Chemical restraint was achieved using pancuronium bromide, the dose (2 x 2 mg, 40 minutes apart) intended to provide temporary partial immobilization (after Bates et al. 2004), plus diazepam (10 mg, single dose) to provide temporary mild sedation. Both drugs were injected IM into opposite sides of the tail. As Lolong was outside the size range of crocodiles for which either drug had previously been tested, we used highly conservative dose rates—the minimum required dosage to permit safe handling without compromising handler welfare. Ventilation rate and eye blink response were monitored throughout the procedure.

Induction took two hours, at which point the crocodile was capable only of lethargic movements of the head, limbs, and tail tip. At this point standard physical restraint was employed: the head was secured with a controlling rope noose on the upper jaw, a second noose around both jaws to close them remotely through tightening, and thick damp towels over the eyes to reduce visual reactions. At this point a five-person team engaged the crocodile from behind, applying downward pressure to the top of the head, the pectoral and pelvic regions, and the body and tail, while lifting each limb from the ground to limit traction (Fig. 1). The jaws were secured shut using duct tape, with the nostrils free to permit normal breathing. At this point, handling and close-quarters measurements were considered safe. Measurement activities lasted approximately one hour, after



PHOTO BY ROB TAYLOR, NATIONAL GEOGRAPHIC

FIG. 1. Lateral view of Lolong under restraint during measurement procedure.

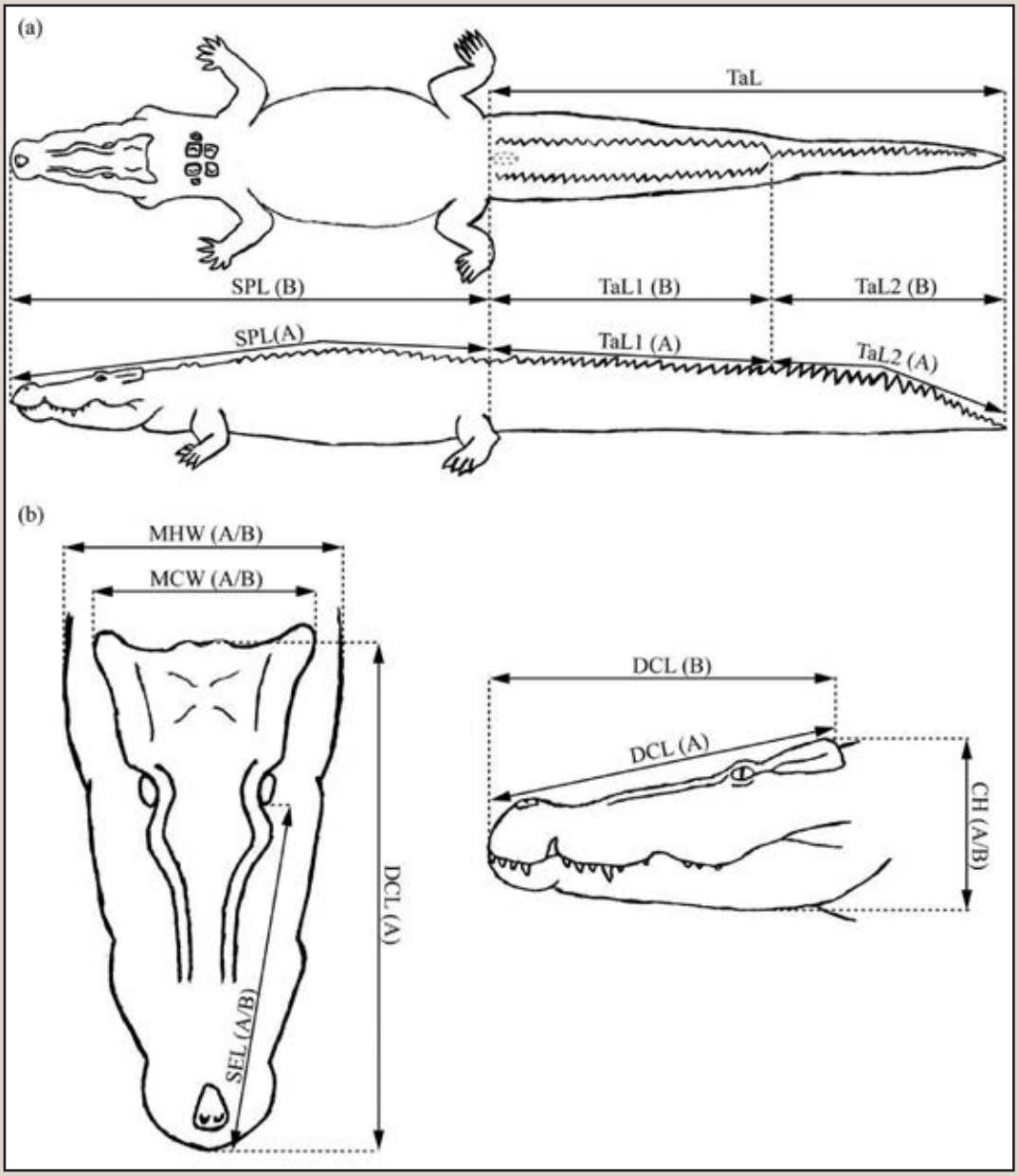


FIG. 2. Top-down and profile diagrams of entire crocodile (a) and head (b) illustrating measurements taken using Method A (A) and Method B (B). DCL = dorsal cranial length; SEL = snout–eye length; MHW = maximum head width; MCW = maximum cranial width; IOW = inter-orbital width; CH = cranial height; SPL = snout–pelvis length; TaL = tail length; TaL1 = anterior tail length; TaL2 = posterior tail length; SPL+TaL1 = snout–scute junction (SSJ); SPL+TaL1+TaL2 = total length (TL).

which all physical restraint was carefully removed using established safety protocols. A reversal agent for pancuronium bromide (e.g., neostigmine methylsulphate) was not used and the drugs were allowed to metabolize naturally while the crocodile was under observation. Lolong was exhibiting normal behavior six hours post-injection, moving around his enclosure with ease.

Measurement.—Lolong's head and tail were straightened carefully before any measurement took place. He maintained this posture throughout the procedure. Measurements concentrated on head dimensions and body length variables that were unlikely to be influenced by body condition in any way (Figs. 2a, 2b), unlike for example belly width. All measurements were taken using a flexible but non-stretchable steel tape with a millimeter scale. Conversion into other units (e.g., feet) was done after the fact. The tape was held taut for each measurement and where necessary straight wooden rods held perpendicular to the ground were used as boundary markers for specific measures (e.g., maximum head width; Fig. 1).

There is no clear agreement on a "standard" method for measuring crocodilian dimensions. We generally followed methods previously published for *C. porosus* (Webb and Messel 1978) slightly modified based on our experience on practical techniques with wild crocodiles. We used DCL specifically for "head length" to avoid any confusion with skull measurements that have occasionally confused mandible length with head length (Whitaker and Whitaker 2008). Skull widths and heights were taken at the maximum points. Snout–pelvis length (SPL, Fig. 2a), to the posterior margin of the hind legs joining the pelvis, was used as a substitute for snout–vent length (SVL) because it was highly impractical to roll such a large crocodile onto its back and there were concerns about the welfare implications of doing so with such a heavy crocodile on concrete. Previous comparisons (A. Britton, pers. obs.) suggest that SPL and SVL differ by less than 1%.

To address possible disagreement over the most suitable method for body length measurements, two methods were used for comparative purposes (Table 1, Fig. 2a). Method A used a steel tape along the dorsal midline from snout tip to tail tip following the slope of the skull and latter part of the tail. Method B used the horizontal distance from snout tip to tail tip exactly parallel to the ground. In practice Method B gave fractionally shorter lengths than Method A (by around 1% in large individuals) and yet Method A is more frequently used (A. Britton and R. Whitaker, pers. obs.), simply because it is more practical especially with large individuals that are difficult to move. Measurements using Method A are therefore more relevant because they allow more meaningful comparison with measurements of other large crocodiles. It should be noted that Lolong's tail tip did not appear to be damaged.

Lolong's mass was recorded at a nearby truck weigh-bridge during transport to his captive holding facilities on 3 September 2011. As it was logistically impractical to verify his mass during our visit, his reported mass on that date is provided here. There is no reason to believe that rigor in this simple measurement was lacking and we considered it valid.

Results

Using Method A, Lolong's total length (TL) was 6.17 m (20.24 ft; Table 1), with a dorsal cranial length (DCL) of 700 mm (27.6 in). Ratio of DCL to TL was 1:8.8. Snout–pelvis length (SPL) was 2.85 m (9.35 ft). Therefore tail length (TaL) was 3.32 m (10.89 ft), with TaL to TL ratio of 1:1.9. Snout–scute junction (SSJ) was 4.98 m (16.34 ft), therefore we calculated anterior tail length (TaL1) as 2.13 m (6.99 ft) and posterior tail length (TaL2) as 1.19 m (3.90 ft). The ratio TaL2 to TaL is 1:2.8. Measurements using Method B are provided for comparison (Table 1). All measurements differed by less than 1% between Methods A and B except TL, which differed by 1.2%. Lolong's net mass (accounting for the trailer weight) was 1075 kg (2370 lbs).

General body condition was good, with normal muscle tone and fat deposits typical of a large wild crocodile. Age cannot be determined by physical examination, but there were no obvious signs of senescence. Age was estimated subjectively at approximately 50 to 60 years based on indicators such as level of skull rugosity, health of teeth alveoli, height of dorsal scute keels, and overall appearance, which can be compared with prior observations. Very little historical scarring was found on the skin, and no limbs, toes, or parts of the tail were missing, which was considered unusual for such a large wild crocodile. The ventral surface was not examined. Recent superficial injuries evident in a handful of locations (pads of feet, flanks, dorsal osteoderms, snout) appeared to have been caused by rope abrasion incurred while struggling during capture and transport. All recent injuries appeared to be healing normally; almost all scab tissue had fallen off, revealing fresh, non-pigmented or partially-pigmented skin tissue.

Discussion

Lolong's TL, at 6.17 m (20.24 ft), makes him the largest wild crocodile ever captured alive. The TL measurement taken by Edwin Elorde shortly after capture (6.4 m, 21 ft) was slightly higher than the one obtained here. Although measurement inaccuracy may be a factor, it is also likely a result of the crocodile's posture when it was strapped to a cart with the tail hanging onto the ground. The weight of the tail muscle would be sufficient to pull vertebrae apart, enough to account for most of the additional 20 cm (7.9 in) length, underlining the need for measurements to be taken with a crocodile lying on flat, level ground.

There are a number of reports of wild-caught crocodiles with greater TL, but these are either difficult to verify or are from incomplete specimens (e.g., dried skins; Whitaker and Whitaker 2008). While it is improbable that Lolong is the largest *C. porosus* ever found, it is disappointing that the evidence for larger specimens is so incomplete. This evidence comes almost entirely from skulls residing in museums and personal collections around the world. Data from their original owners are often lacking, with TL either not recorded or impossible to verify, and even the country of origin is doubtful in some cases. However, it is possible to use known relationships between each DCL and TL to estimate the total length of the crocodile from which each skull was derived. Unfortunately, the only thorough analysis to date for *C. porosus* uses data from relatively small hatchlings up to sub-adults and the formulae were obviously never intended to be extrapolated for much larger animals (Webb and Messel 1978). It is apparent from the limited data available that skull shape is subject to greater variation with increasing TL, DCL becoming a smaller proportion of TL with increasing size. The DCL:TL ratio for smaller crocodiles has long been thought to be around 1:7 (Bellairs 1970; Greer 1974; Wermuth 1964) but this would under-estimate Lolong's length by over a meter (3.3 ft). The DCL:TL ratio for large *C. porosus* is closer to 1:9 (Whitaker and Whitaker 2008). Therefore, caution must be used when estimating TL based on DCL of existing museum skull specimens.

The largest known *C. porosus* skull is housed at the Paris Museum (MNHN PMP specimen #A11803 = old museum collection #7738) originally from Cambodia. It has a DCL of 760 mm (29.9 in), making it 8.6% longer than Lolong's skull. If we apply a DCL:TL ratio of 1:9 for this skull, TL is estimated at 6.84 m (22.4 ft) which is 11.3% longer than Lolong's TL. Although the actual TL was never preserved, these figures strongly suggest a nearly 7 m (almost 23 ft) crocodile. We can compare this with another slightly smaller skull (currently in the private collection of Shivendra Narayan Bhanja Deo, the Yuvaraj of Kanika in Bhubaneshwar, Orissa) of DCL 730 mm (28.7 in), originally from the Indian Bhitarkanika province, reported to have come from a 7 m (23 ft) *C. porosus*. If those figures are true then DCL:TL ratio would be 1:9.5, sufficiently high for minor skepticism but still feasible. Applying the 1:9 ratio to the Bhitarkanika skull gives an estimated TL of 6.6 m (21.7 ft). The truth is unlikely to be far from these figures and there is a strong sense that 7 m (23 ft) is likely the maximum possible length for *C. porosus*.

After Lolong, the best documented evidence of a record-sized crocodile comes from Obo village on the Fly River in Papua New Guinea (Montague 1983). This crocodile drowned in a fishing net set for barramundi fish and after 50 men hauled the crocodile onto the bank they found an entire Rusa Deer (*Cervus timorensis*) carcass in the stomach. The crocodile's skin had already been removed and salted when Jerome Montague and one of the authors (RW) visited the village, but the skin plus decapitated head measured 6.2 m (20.3 ft). The authors considered this likely an underestimate considering possible shrinkage of the skin plus an incomplete tail tip, suggesting a TL closer to 6.3 m. The DCL of this crocodile was 720 mm (28.3 in), which at 6.2 m TL would indicate a DCL:TL ratio of 1:8.6, or 1:8.8 considering the likely 6.3 m TL. While not a complete or living specimen, this is still considered the largest *C. porosus* ever measured and documented.

There are several unverified reports of even larger wild crocodiles, the most popular being a 7 m plus (over 23 ft) *C. porosus* sighted within the Bhirtarkanika Wildlife Sanctuary in Orissa, India, in 2006 (Whitaker and Whitaker 2008). However, this was not a measurement but a size estimate taken from a boat and regardless of the skill of the observers it cannot be compared to a verified tape measurement, especially considering the uncertainty inherent in visual size estimation in the wild (Bayliss 1987). Another famous giant crocodile shot on the Norman River in Australia in 1957 was reported by the shooters to be over 8 m (approx. 26 ft). While it seems likely that an exceptionally large crocodile was shot, no actual evidence was ever taken. For a crocodile whose length exceeds that of any other record by a large margin, a high degree of skepticism is understandable when bearing in mind the track record of inaccurate or exaggerated size records (Greer 1974; Whitaker and Whitaker 2008).

In 2011 Guinness World Records announced that a 5.48 m (18 ft) *C. porosus* called "Cassius" at Marineland Melanesia on Green Island, Queensland, was the largest crocodile in captivity (Guinness World Records 2011). Cassius was captured alive from the Finniss River in the Northern Territory, Australia, in 1984, and was reportedly missing a small amount of his tail tip. Lolong is 69 cm (2.2 ft) longer than Cassius. The only other captive crocodile that rivals Lolong for length is "Yai" at Samutprakarn Crocodile Farm, Thailand, who was measured in 2000 at 6.0 m (19.7 ft) with a mass of 1114 kg (2455 lbs). While Yai will have grown slightly in the last decade, it seems unlikely that he currently exceeds Lolong. Yai is also the result of artificial captive hybridization between *C. porosus* and *C. siamensis* (Siamese Crocodile), his size potentially the result of heterosis (or "hybrid vigor"; Shull 1948). In June 2012 Guinness World Records pronounced Lolong to be the largest crocodile in captivity (Guinness World Records 2012).

To address the question of why extremely large crocodiles are so rare, it is instructive to look at factors responsible for growth and size. An early analysis suggested that males cease growth from 3.9 to 6.0 m (12.8 to 19.7 ft; Webb et al. 1978), yet it is widely known that environmental and social factors that influence access to required resources (e.g., desired temperatures, access to water, access to basking sites, food availability and quality, and social stress) can have a significant impact on health and growth rates (Coulson and Hernandez 1983; Dalrymple 1996; Lang 1987; Webb 1985). Crocodilians in captive situations are highly sensitive to stress and the availability of resources, which have a marked effect on growth rate (e.g., Choudhury and Bustard 1983; Lance 1994; Smith and Marais 1994). We also know that genetic factors play a significant role in post-hatching growth and behavior, as does the incubation environment (Allsteadt and Lang 1995; Isberg et al. 2004).

Growth rate in crocodiles is based on a von Bertalanffy growth curve, being fastest in juveniles and progressively slower in adults. The greatest proportion of growth occurs in the first 15–25 years, to around three-quarters of maximum size, although faster-growing individuals appear to sustain rapid growth for longer (Webb et al. 1978). Slow-growing juveniles become smaller adults, growth rates falling too low to ever achieve very large sizes. In such individuals growth essentially stops in older animals (Webb et al. 1978; Woodward et al. 1995). Conversely it is the fast-growing juveniles that reach the largest adult sizes and grow for longer. It is incorrect to assume that extremely large crocodiles are necessarily the oldest crocodiles. For example, the hybrid Yai reached 6 m (19.8 ft) in less than 30 years and a purebred *C. porosus* ("Jaws") at Madras Crocodile Bank reached 5.13 m (16.8 ft) in 38 years. Most wild *C. porosus* take at least 15 years to reach 3.5 m (Webb and Manolis 1989).

In order to achieve maximum growth rates and size in the wild, crocodiles require greater access to optimal environmental conditions particularly when young, access to all necessary resources when desired, and minimal growth-inhibiting stress. Given the role that stress plays in inhibiting growth, it is likely that exceptional size can only be achieved when crocodiles do not encounter humans on a regular basis. Lolong, for example, appears to have spent his entire life in and around Agusan Marsh, an area that sees very low human traffic due to difficulty of access and where overall crocodile densities appear to be well below carrying capacity (Pontillas 2000). The lack of scarring and body injuries also suggests limited competition. Under such favorable conditions for a crocodile, individuals that may also have been genetically predisposed for faster growth would have excellent opportunities to thrive and reach exceptional sizes. How important genetic factors are in influencing growth rates and maximum size in wild *C. porosus* remains unclear, although it is possible that extensive and widespread hunting of populations until the 1970s may have eliminated genetic traits that had selected for exceptionally large crocodiles preferred by trophy hunters, traits that may exist today only extremely rarely.

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Farm-raised "*Salmonella*-free" Turtle Hatchlings Do Not Excrete *Salmonella* in Home Aquariums

A rise in reptile-associated cases of salmonellosis in children under ten years of age led the United States Food and Drug Administration in 1975 to create regulations that prohibited the inter- and intrastate sale of turtles with a carapace length less than four inches (ca. 10 cm) while educational sales and overseas sales continued unchanged (Cohen et al. 1980). The rationale for this ban was that turtles carry *Salmonella* as part of their normal assortment of bacteria. *Salmonella* may be shed intermittently (Kaufmann et al. 1967) and complete eradication of *Salmonella* in turtles through treatment would be complicated. By prohibiting the sale of small turtles, the legislature limited the possible exposure to *Salmonella* assuming that larger turtles would make less desirable pets for young children.

To insure that pet turtle farmers upgrade their facilities to assist the industry in its effort to lift the FDA ban, the Louisiana Department of Agriculture & Forestry requires turtle farmers to be licensed and regulates the industry through Act 770 Regulation of Pet Turtles, Regular Session 1990. In particular, turtle hatchlings produced on Louisiana farms are required to be laboratory tested and shown to be free of any trace of *Salmonella* bacteria before they can be sold. Currently, most Louisiana turtle farmers now produce "*Salmonella*-free" turtles by washing the turtle eggs with chemical disinfectants rather than treatment with antibiotics like gentamicin (Mitchell et al. 2007).

The purpose of the present study was to investigate whether it is possible to maintain the *Salmonella*-free status of turtle hatchlings in aquariums similar to those found in homes. To test our hypothesis, *Salmonella*-free turtle hatchlings were maintained in such aquariums and monitored for a year for any evidence of *Salmonella* bacteria.

Methods

Turtles and their facilities.—The aquatic Red-eared Slider (*Trachemys scripta elegans*) is the mainstay of the Louisiana turtle producers and the primary turtle hatchling species sold (Iazdjoo et al. 1987). In late August 2008, we obtained 80 one-week-old *T. scripta elegans* hatchlings from a Louisiana turtle farm. Fifty hatchlings came from a group of eggs that were sanitized with 500 ppm sodium hypochlorite and 30 came from rinsed but unsanitized eggs. Each turtle was individually kept in 50 ml of sterile water for 30 days. After 30 days, the water containing feces was assayed for *Salmonella* as described below (Michael-Marler et al. 1983). The hatchlings that came from sanitized eggs tested negative for *Salmonella*, while the hatchlings that came from unsanitized eggs tested positive for *Salmonella*. The turtles were then transferred into three aquarium tanks each with approximately 30 L of water for an additional 30 days and the aquarium water was again assayed for *Salmonella*. The *Salmonella*-free turtles were split into two tanks with 25 turtles in each tank, while the *Salmonella*-containing turtles were housed in their own tank. This additional incubation was to ensure that the hatchlings were healthy enough to be used in a year-long study and that they would eat commercial pet turtle food (Tetra turtle food). If *Salmonella* were resident within these turtle hatchlings, the fecal mater from eaten food would likely have *Salmonella*.

Forty *Salmonella*-free turtle hatchlings were divided into four groups of ten turtles. Each group of ten was housed in a commercially-sold 20-gallon (75.7 L) glass tank that included a floating island, a Tetra Whisper EX20 water circulation pump (110 gph) with a carbon containing bio-bag and bio-scrubber (bristle design), and a fluorescent light fixture. The lights were attached to a timer to provide 12 hours lights and 12 hours dark. Tanks contained 2.5 cm of sterile aquarium stones and 24 L of tap water. A control tank with 20 turtles that were found to be excreting *Salmonella* was set up in an adjacent room. The aquarium was a 40-gallon (151.4 L) glass tank that included a Tetra Whisper EX45 water circulation pump (240 gph).

Water from each aquarium was sampled for *Salmonella* once a month for 12 months (Jan 2009–Jan 2010) following the methods detailed below. After taking water samples, all the water from the aquarium tanks was siphoned out and replaced with fresh tap water. With each water change, the carbon bio-bag within the water pump was also replaced.

Salmonella *assays.*—*Salmonella* has been detected from various types of samples after incubation in an enrichment broth and the use of a polymerase chain reaction (PCR) method (Aabo et al. 1995; Bennet et al. 1998; Chiu and Ou 1996; Lin and Tsen 1999; Soumet et al. 1999; Stone et al. 1994). To ensure *Salmonella* detection, we inoculated our samples in two enrichment broths, tetrationate broth (TTB) and selenite cysteine broth (SCB). Samples of 1 ml of water from each aquarium were inoculated into two tubes containing 7 ml TTB and two tubes containing 7 ml SCB. Inoculated SCB tubes were incubated for 24 hours and inoculated TTB tubes were incubated for 48 hours, both at 37°C. Cells from 1 ml of each enrichment broth culture were concentrated by centrifugation (14000 × g) for 5 minutes in a sterile 1.5 ml microcentrifuge tube. The cell pellets were suspended in 100 µl of 5% (w/v) Chelex 100 (Bio-Rad Laboratories) and bacterial chromosomal DNA was released by thermal lysis by incubation at 95° C for 5 minutes followed by 5 minutes on ice. This heat treatment was repeated and then the cell debris was removed by centrifugation (14000 × g) for 2 minutes. The *Salmonella* DNA was detected by PCR amplification with two *Salmonella*-specific primers that amplify unique DNA fragments of defined size (see below). We confirmed that the DNA preparation contained amplifiable bacterial DNA by including a PCR primer pair to a highly conserved region of the 16S ribosomal RNA genes of bacteria. PCR DNA fragments were revealed by agarose gel electrophoresis (see below). Hereafter, we will call this assay the *Salmonella* PCR method.

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Primers and PCR conditions.—*Salmonella*-specific primers 139 and 141 were described by Rahn et al. (1992) and have the following nucleotide sequences based on the *invA* gene of *Salmonella*: 5' GTGAAATTATCGCCACGTTCGGGCAA-3' and 5' TCATCGCACCGTCAAAGGAACC-3', respectively. They allow amplification of a 285 bp PCR product from *Salmonella* DNA.

Salmonella-specific primers STM3098F1 and STM3098R2 were described by Kim et al. (2006) and have the following nucleotide sequences: 5' TTTGGCGGCGCAGGCGATTC-3' and 5' GCCTCCGCCTCATCAATCCG-3', respectively. It was demonstrated that this primer pair from a putative transcription regulator was *Salmonella*-specific and gives a 423-bp PCR amplified band in all subspecies of *Salmonella enterica* (I, II, IIIa, IIIb, IV, V, and VI). Most infections in endothermic animals are caused by subsp. I. In the wild ectotherms such as turtles contain primarily *S. enteric*a subspecies IIIa (*S. enterica* subsp. *arizonae*) and IIIb (*S. enterica* subsp. *diarizonae*; Diaz et al. 2006; Hopkins et al. 2009; Schroter et al. 2004).

For confirmation that DNA template preparations contained amplifiable bacterial DNA, primers to a conserved region of the 16S ribosomal RNA genes of all bacteria, rrs1 (5' TAACACATGCAAGTCGAACG-3') and rrs2 (5' CCCATTGTGCAATATTCCCC-3'), were used (Vliegenthart et al. 1990). These primers give a PCR amplified band of approximately 330 bp.

All primers were prepared as 20 µM solutions. The 25-µl PCR reaction mixture contained 2.5-µl template, 12.5 µl Go Taq Green Master Mix (Promega), 0.5 µl of each of the *invA* primers and STM3098 primers, 0.25 µl of each of the 16S rRNA gene primers, and deionized sterile water. PCR incubation was performed using Perkin-Elmer GeneAmp PCR system 2400. The cycle conditions were as follows: an initial incubation at 94°C for 5 minutes followed by 25 cycles of denaturation at 94°C for 1 minute, primer annealing at 53°C for 2 minutes, and primer extension at 72°C for 3 minutes. Following the last cycle they were incubated at 4°C.

After PCR amplification, 10 µl of each reaction was separated by electrophoresis on a 1.9% agarose (3:1 agarose from AMRESCO) with 0.5 µg/ml ethidium bromide (ETBr). The assay products were run for 45 minutes at 12.5 volts/cm^2 in TBE buffer (89 mM Tris, 89 mM borate, 2 mM EDTA, pH 8.0) also containing 0.5 µg/ml ETBr. The DNA bands were visualized under UV light and digitally imaged with a Strategene's Eagle Eye II.

Necropsies.— Necropsies were performed to demonstrate a 1:1 correlation between non-excretors and non-carriers. Eight "*Salmonella*-free" turtles (two turtles from each aquarium) and two turtles from the positive control tank were necropsied. The turtles were euthanized with an intracardia injection of Beuthanasia using 0.05 ml/turtle. Five turtles were necropsied on 1 July 2010, two from Tank A, two from Tank B, and one from Tank C. Five turtles were necropsied on 9 July 2010, one from Tank C, two from Tank D, and two from the positive control tank. Tissue samples from blood, an upper intestine sample containing throat, stomach and small intestine, and a lower intestine sample containing large intestine and rectum were analyzed for *Salmonella*. These tissue samples were put into 10 ml preenrichment broth, Difco lactose broth (Iazdjoo et al.1987). Lactose broth was used to enable us to dispense equal amounts of material into the enrichment broths. After 24 hrs at 37°C, 1 ml was used to inoculate each tube of enrichment broth (two tubes SCB and two tubes TTB) and tested for *Salmonella* as described above.

Results

During the 12 months of the study no *Salmonella* was detected from the water of the *Salmonella*-free turtle tanks (Table 1). A representative agarose gel from month seven analysis is shown in Fig. 1. Water from the control tank with the *Salmonella*-excreting turtles was positive (agarose gel exhibited the 3 expected PCR fragments) until the last two sample months (Table 1). The *Salmonella*-free turtle tanks exhibited only the approximate 330-bp ribosomal RNA product (rrs), which indicated the presence of bacterial DNA but not *Salmonella* DNA.

Salmonella was not detected by PCR assay from any necropsied tissue in 120 different enrichment cultures (ten turtles, three tissue samples from each turtle, two tubes TTB and two tubes SCB for each tissue sample). Two additional turtles of approximately the same age that were excreting *Salmonella* as part of another study were necropsied because the turtles from the positive control group were negative. *Salmonella* was cultured from the lower intestine-large intestine sample of these turtles. These additional necropsies validated our dissection techniques for the detection of *Salmonella*.

Discussion

In this study we demonstrated that 40 *Salmonella*-free turtles remained *Salmonella*-free for over a year. The turtle hatchlings were divided into four aquarium tanks and the water was tested for *Salmonella* once a month before each water change. We used duplicate cultures from two different enrichment broths to prepare DNA templates for the PCR analysis and used two sets of *Salmonella*-specific primers. This PCR analysis should have detected *Salmonella* even if just one of the 40 turtles began to excrete *Salmonella*. Our results demonstrated that these turtles will not eventually begin to actively shed *Salmonella*. First, 12 months should be long enough to expect that if the turtles carried *Salmonella*, it would be found (Kaufmann et al. 1967). Second, two turtles from each aquarium tank were necropsied and again *Salmonella* could not be detected by PCR in blood and upper and lower intestinal samples. If these turtles had established bacterial flora with *Salmonella*, then we should have detected *Salmonella* in their intestines. Only two turtles from the *Salmonella*-positive tank were necropsied because we expected to find *Salmonella* in their intestines. Since the *Salmonella*-free turtles already have an established bacterial flora in their intestines, we expected they would not easily become carriers of *Salmonella*. In support are the investigations by Pasmans et al. (2002), who showed that *Salmonella enterica* subsp. *Muenchen* only colonized the mucosal lining of the intestine of orally-infected *T. scripta scripta*. *Salmonella* invasion of the intestinal wall and the colonization of internal organs were not observed. In their study, *Salmonella* was isolatable from the large intestine for only eight days.

Our results suggest that if a *Salmonella*-free turtle is acquired from a Louisiana turtle farm and the appropriate environment is provided, it is likely to remain *Salmonella*-free. We feel that an appropriate environment should include an aquarium tank with a water recirculator and the turtles being fed only commercial pet food. The possibility of acquiring *Salmonella* is more likely in free-ranging turtles found in pond and lake environments where the turtles are in constant contact with *Salmonella*-contaminated water, rather than a controlled environment. However, many studies have reported a low prevalence of *Salmonella* in free-ranging chelonians (Harwood et al. 1999, 5%; Lockhart

et al. 2008, 5%; Readel et al. 2008, 0%; Richards et al. 2004, 0%; Saelinger et al. 2006, 0%). In a recent paper by Readel et al. (2010), in which the possibility that the turtles may harbor but not actively shed *Salmonella* was investigated by performing intestinal mucosal scrapings of adult free-ranging red-eared sliders in ponds in Illinois, *Salmonella* was detected in only 8 of 73 (11%) adult turtles analyzed. However, other studies have found environments where the percentage of turtles harboring *Salmonella* have been higher. For example, Gaertner et al. (2008b) found 8 out of 21 Red-eared Sliders (38%) had *Salmonella* and another study performed by the same group found that 51% of free-ranging turtles were carriers of *Salmonella* (Gaertner et al. 2008a). The importance of our study is that *Salmonella*-free turtles within a proper environment with limited or no exposure to *Salmonella* remained *Salmonella*-free.

The inability to detect *Salmonella* after ten months in our positive control was not expected. Transient shedding of *Salmonella* was documented in turtles by Kaufmann et al. (1967). They found ten groups of turtles were excreting *Salmonella* nine months after hatching, but only six groups excreted *Salmonella* a full year after hatching. Kaufmann kept turtles separated in shallow pans. Otis and Behler (1973) investigated turtles in the New York Zoological Park (Bronx Zoo) for *Salmonella*. They observed that turtles in tanks with water recirculators were found to not harbor *Salmonella* whereas community tanks often harbored *Salmonella*. They believed that placing infected turtles in tanks with water recirculators may clear the turtles of *Salmonella*. In our study, the positive control turtles were in an aquarium equipped with a water recirculator that may have facilitated the loss of *Salmonella*. In a related study, Mitchell et al. (2005), evaluating the efficiency of Baquacil to suppress *Salmonella* in aquatic turtles, could not detect *Salmonella* in 20% of their initial excreting controls after one month by both water sampling and turtle necropsy. A possibility proposed by Mitchell et al. (2005) is that the turtles could have "self-cleared or not remained colonized" with *Salmonella*.

Poor environmental conditions and other causes of physiological stress likely contribute to whether turtles remain carriers of *Salmonella*. In this study, turtles were housed in a large aquarium environment, with plenty of space and enough water to swim and to be active. Water was filtered and changed regularly and the turtles were fed a healthful diet. Future studies are needed to determine if these environmental conditions allow for the suppression or elimination of *Salmonella* in *Salmonella*-excreting turtles.

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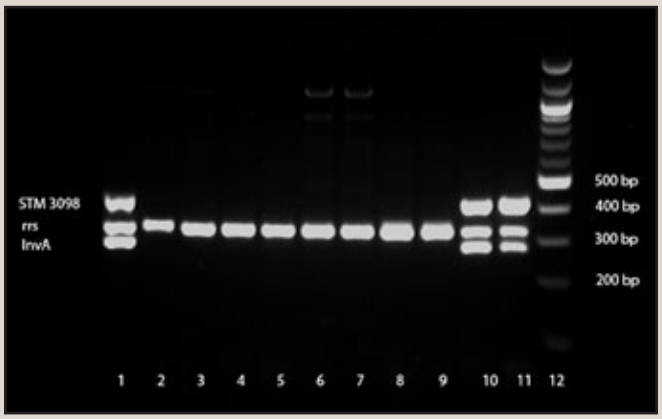


FIG. 1. Representative agarose gel electrophoresis of PCR products of the samples from month seven. On this gel all samples were from independent TTB enrichments of tank water. Positive lanes have three PCR products, the 423-bp STM3098 product, approximate 330-bp product for ribosomal RNA (rrs) genes, and the 285-bp *Salmonella inv*A product. Negative lanes only have the rrs fragment. Lane 1, Control *Salmonella* DNA. Lanes 2 and 3 are from tank A. Lanes 4 and 5 are from tank B. Lanes 6 and 7 are from tank C. Lanes 8 and 9 are from tank D. Lanes 10 and 11 are from *Salmonella*-positive control turtle tank. Lane 12 is a 100-bp ladder (New England Biolabs); the thick bands are 500 and 1000 bp.

TABLE 1. Presence of *Salmonella* in the water of turtles' tanks. Every sample involved two SCB and TTB enrichments before being tested for *Salmonella* by the PCR assay. Water samples from which *Salmonella* was detected in any of the enrichment cultures are scored positive. "Negative" indicates that both *Salmonella* primer products (invA and STM3098) were not detected but ribosomal rrs primer product was detected in the enrichment samples.

Date	Tank A	Tank B	Tank C	Tank D	Control Tank
21 Jan 2009	negative	negative	negative	negative	*positive*
20 Feb 2009	negative	negative	negative	negative	*positive*
20 March 2009	negative	negative	negative	negative	*positive*
23 April 2009	negative	negative	negative	negative	*positive*
20 May 2009	negative	negative	negative	negative	*positive*
22 June 2009	negative	negative	negative	negative	*positive*
20 July 2009	negative	negative	negative	negative	*positive*
21 Aug 2009	negative	negative	negative	negative	*positive*
22 Sept 2009	negative	negative	negative	negative	*positive*
22 Oct 2009	negative	negative	negative	negative	*positive*
23 Nov 2009	negative	negative	negative	negative	*positive*
21 Dec 2009	negative	negative	negative	negative	negative
25 Jan 2010	negative	negative	negative	negative	negative

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An Old World Skink, *Chalcides ocellatus*, with a Long History of Anthropogenically Assisted Dispersal, Now Established in Mesa, Arizona, USA

The Ocellated Skink, *Chalcides ocellatus*, is native to northern Africa, the Middle East and the Mediterranean (Pasteur 1981; Schleich et al. 1996). It occurs in a diverse array of habitats including: "…sand and gravel deserts, agricultural lands, gardens, and piles of refuse along the Mediterranean coast…" (Attum et al 2007). Using genetic analyses, Kornilios et al. (2010) argued that this lizard has colonized islands throughout the central and eastern Mediterranean in part due to anthropogenic assistance over the past three thousand years. Caputo et al. (1997) suggested that populations of *C. ocellatus* in southern Italy and nearby islands (Sicily, Sardinia), as well as its discontinuous range across Greece and various islands of the Aegean Sea, are best explained by a long history of colonization via anthropogenic facilitation. More recently, Kraus (2009) documented that *C. ocellatus* has been introduced to France and Great Britain, and established in Italy. With respect to the New World, Krysko et al. (2011) documented its presence in Broward and Pasco counties, Florida, USA. They found that a local reptile dealer in Mirimar, Florida, purchased *C. ocellatus* collected from local areas for resale in the pet trade (Krysko et al. 2011). It appears that *C. ocellatus,* like a number of squamates (e.g., gekkonids, lacertids, and iguanids), has expanded its range due in part to its ability to thrive in close proximity to humans and their habitations in relatively warm regions on several continents. Here we report on an established, actively reproducing population of *C. ocellatus* in a suburban area located in the arid Sonoran Desert Biome, near Phoenix, Arizona, USA.

Kornilios et al. (2010) argued that, as a relatively generalized omnivore with ovoviviparous reproduction, *C. ocellatus* is a good candidate for colonization following transportation in soil with plants, or via other means associated with human activities. Attum et al. (2007) suggested that with respect to morphology, *C. ocellatus* is a generalized skink in comparison to relatives specialized for sandy habitats, and unlike its sand-dwelling relatives, typically escapes to vegetation in response to the approach of predators. Though a number of the recently established populations of *C. ocellatus* have been documented in relatively mesic environments, with ample vegetation associated with anthropogenically altered habitats (e.g., Caputo et al. 1997; Krysko et al. 2011), they have not been documented in arid regions of the New World. Given its occurrence in relatively arid habitats in the Old World, and propensity to colonize anthropogenically impacted landscapes, the success of *C. ocellatus* in the southwestern USA is potentially of great interest.

One of us (JG) first observed *C. ocellatus* in a relatively high density housing area of Mesa, Maricopa Co., Arizona, USA (111.852°W, 33.361°N; NAD 1927), in 2007; in 2011, another of the authors (RB), independently discovered individuals (Fig. 1) in the same neighborhood, and began to canvass the area to determine the extent of the distribution. The results we present here are of two kinds: data on individual skinks collected by one of the authors during 2011 and early 2012, and reports on skinks by residents in the neighborhood in response to either door to door interviews or "information wanted flyers" distributed in the fall of 2011. Person to person interview validity during door to door surveys and in follow-up interviews with residents that responded to flyers was established by only recording those observations in which the occupant was familiar with lizards in general, and had lived in the residence for a minimum of one year, or recognized *C. ocellatus* from a photograph. During interviews, several residents volunteered "oh, those skinks" before they were even provided the photograph of the lizard (no other skinks occur within ~ 50 km of Mesa; Brennan and Holycross 2006).

Canvassing of the neighborhood revealed that two different residents were confident they first observed *C. ocellatus* during 2001 (both within 0.5 km of the 2007 observation of JG). Residents reported *C. ocellatus* from potted plants, block walls, larger planters, and shrubbery, but also from comparatively barren micro-sites, such as the interiors of garages and storerooms. In sum, 18 different residents spread across an area of ~ 30 ha reported the presence of one or more individuals of one or more size classes over the past decade (Fig. 2). During 2011–2012, we collected a total of 20 individuals within roughly 15 ha of the same general area, which ranged in size from 68 to 118 mm SVL (mean ± SE: 91.0 ± 3.21 mm), with an apparent bimodal size class distribution (most individuals were ~ 85 or 115 mm SVL; total length ~160–230 mm). This mean SVL is at the upper end of that documented for a number of Old World populations of *C. ocellatus* (mean = 79–94 mm for six samples; see review in Greenbaum et al. 2006). It is important to note that these individuals were collected during a particularly dry fall and winter, prior to the onset of warm temperatures and presumably higher levels of activity.

The cumulative distribution of sightings and collected individuals yields an area of occupation of ~ 30 ha. Because two size classes have been observed over more than ten years, including many sub-adults (not represented in the size data above; lizards ~ 50 SVL were often observed, but escaped capture), it is clear that reproduction is occurring locally, and thus a "stage 3" level introduction (Emerton and Howard 2008) has been attained for this species in Arizona: a naturalized population is established, and capable of spreading in the immediate area without

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FIG. 1. Ocellated skink (*Chalcides ocellatus*) from Mesa, Arizona; SVL = 125 and 95 mm.

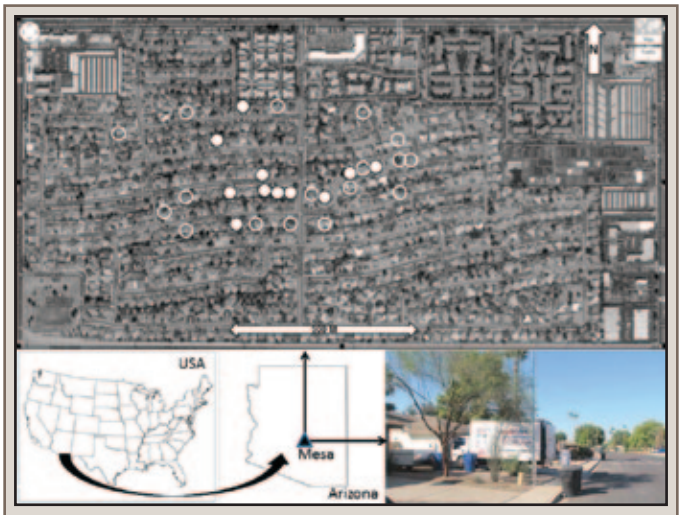


FIG. 2. Upper panel shows aerial view of the approximate distribution for *Chalcides ocellatus* in a residential area of Mesa, Arizona; W Pecos Drive is roughly the center of 30 ha occupied by skinks. Solid circles-specimens collected; open circles-flier/interview responses only (used by permission GoogleEarth©). The lower panels show outlines of the USA and Mesa, Arizona, and a ground level view of W Pecos Drive, from left to right.

assistance. Although assessment of size estimates by residents is potentially problematic, at least two residents reported having seen much larger individuals (~ 250 mm TL, the upper end of the size distribution of *C. ocellatus*; Mateo et al. 1995).

Given their popularity in the pet trade, perhaps the simplest explanation for this colonization by *C. ocellatus* is the result of herpetocultural exchange including accidental or intentional release. If *C. ocellatus* arrived, as they reportedly did in Naples (Caputo 1997) via ornamental vegetation nursery stock, they may be arriving intermittently, or transported elsewhere via landscape management practices including debris removal from resident yards in the area of establishment. In addition to the landscape management assisted transport scenario described above, as area residents move, *C. ocellatus* will also have the opportunity to relocate via ornamental vegetation nursery stock, storage boxes, and other items. *Chalcides ocellatus* is the third saurian to become established in Arizona (*Ctenosaura macrolopha* and *Hemidactylus turcicus*; Brennan and Holycross 2006). Our observations highlight the establishment of *C. ocellatus* in a relatively mesic island of urban habitat surrounded by the xeric Sonoran Desert in Arizona. It is noteworthy that the only widespread lizards inhabiting urban areas of the Sonoran Desert are arboreal or scansorial (*Urosaurus ornatus* and *Hemidactylus turcicus*), which may be less susceptible to predation by house cats; *C. ocellatus* represents the only relatively large, ground-dwelling saurian in this urbanized environment.

The notion that biological communities can be negatively impacted by the successful colonization of exotic species is a widely held tenet of conservation biology, though the costs and the benefits of removing exotics is open to debate (see reviews in Davis et al. 2011 and Simberloff 2011). While any introduced species warrants monitoring, understanding the means by which exotic organisms become introduced and established in novel communities, including the timeline during the early stages of establishment, should be afforded careful consideration.

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Northwestern Salamanders (*Ambystoma gracile*) in Mountain Lakes: Record Oviposition Depths Among Salamanders

Oviposition timing, behaviors, and microhabitats of ambystomatid salamanders vary considerably (Egan and Paton 2004; Figiel and Semlitsch 1995; Howard and Wallace 1985; MacCracken 2007). Regardless of species, however, females typically oviposit using sites conducive to embryo development and survival. For example, the results of an experiment by Figiel and Semlitsch (1995) on *Ambystoma opacum* (Marbled Salamander) oviposition indicated that females actively selected sites that were under grass clumps in wet versus dry treatments, and surmised that environmental conditions such as humidity, moisture, and temperature contributed to their results. Other factors associated with ambystomatid oviposition and embryo survival include water temperature (Anderson 1972; Brown 1976), dissolved oxygen concentration (Petranka et al. 1982; Sacerdote and King 2009), oviposition depth (Dougherty et al. 2005; Egan and Paton 2004), and oviposition attachment structures such as woody vegetation (McCracken 2007; Nussbaum et al. 1983). Resetarits (1996), in creating a model of oviposition site selection for anuran amphibians, hypothesized that oviparous organisms were also capable of modifying oviposition behavior and site selection to accommodate varying habitat conditions and to minimize potential negative effects of environmental stressors. Kats and Sih (1992), investigating the oviposition of *Ambystoma barbouri* (Streamside Salamander) in pools of a Kentucky stream, found that females preferred pools without predatory *Lepomis cyanellus* (Green Sunfish), and that the number of egg masses present in a pool historically containing fish increased significantly the year after fish had been extirpated from the pool. Palen et al. (2005) determined that *Ambystoma gracile* (Northwestern Salamander) and *Ambystoma macrodactylum* (Long-toed Salamander) eggs were deposited either at increased depth or in full shaded habitats, respectively, as water transperancy to UV-B radiation increased.

Ambystoma gracile is a Pacific Northwest (USA and Canada) species that breeds in permanent ponds and lakes from sea level to about 2000 m elevation (Corkran and Thoms 1996; Leonard et al. 1993; Richter 2005). Egg masses are usually affixed to stems of emergent–submergent vegetation or the branches of submerged woody debris. Reported depths for *A. gracile* egg mass oviposition range from just below the water surface to 2 m deep (Table 1). Here we describe *A. gracile* oviposition in a montane lake in Mount Rainier National Park (MORA), Washington, USA, which is substantially deeper than previous reports.

Methods.—On 23–24 July 2003 and 12 July 2005, we surveyed 4 lakes at MORA for *A. gracile* egg masses (Table 1). A total of 276 egg masses were observed in the 4 lakes, all attached to branches of submerged fir and hemlock trees (Fig. 1). In 2003, Dick, Harry, and Sunrise Lakes were surveyed during daytime snorkel surveys, and depths from the lake surface to the top of each observed egg mass were measured using a meter tape. In 2005, Upper Palisades Lake (Fig. 2) was surveyed by two SCUBA divers, and egg mass depths were measured using a Suunto Favor Air Lux Dive Computer with depth gauge. During the period 1996–2004, 12 daytime and 2 nighttime shallow littoral snorkel surveys for locating *A. gracile* egg masses and larvae were also conducted in Upper Palisades Lake. Larvae were observed during these surveys but egg masses were not.

Dick, Harry, and Sunrise Lakes have extensive and relatively shallow littoral zones which slope gradually to a flat bottom (maximum depths = 2.5, 4.2, and 7 m, respectively). The littoral zones contain abundant sunken logs and large woody debris, and some emergent–submergent vegetation. In 2003, the 3 lakes were fishless, although Harry and Sunrise Lakes were historically stocked with non-native salmonids (Harry = 3 times between 1926 to 1951; Sunrise = 21 times between 1926 to 1971; MORA, unpubl. stocking records). All fish were removed from Harry Lake using gill nets during the summers of 1996 through 1998, and the absence of fish from Sunrise Lake was determined during the same period by angling, using gill nets, and observation during snorkel surveys. Although Dick Lake was never stocked, gill nets were set in the lake in 1996 to determine the absence of fish and subsequent snorkel surveys were used to further document fish absence.

Upper Palisades Lake has minimal littoral habitat primarily on a relatively shallow shelf (variable maximum depth = ~1–3 m) just beyond the mouth of a stream flowing into the lake, and the lake slopes steeply on all sides beyond the shelf to a maximum depth of 15.3 m (Fig. 2). There is no emergent–submergent vegetation in the littoral zone, and accumulations of large woody debris are present predominantly at depths >3m, due, in part, to the steeply sloping perimeter and bowl-shaped bathymetry of the lake (Fig. 2). Gill nets were used to remove Eastern Brook Trout (*Salvelinus fontinalis*) from Upper Palisades Lake in 1996. Subsequent gill netting efforts and snorkel surveys documented the continued absence of fish from the lake, which was fishless in 2005. The lake had previously been stocked 7 times between 1961 and 1971 (MORA, unpubl. stocking records). The *A. gracile* adults in Upper Palisades Lake are predominantly neotenes or gilled-adults. Frequency of this life-history stage increases with

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FIG. 1. *Ambystoma gracile* egg masses attached to the branches of a submerged hemlock tree in Upper Palisades Lake, Mount Rainier National Park, 12 July 2005.



FIG. 2. Mid- to late August view of the shallow inlet shelf, deep water area, and steep-sided perimeter of Upper Palisades Lake.

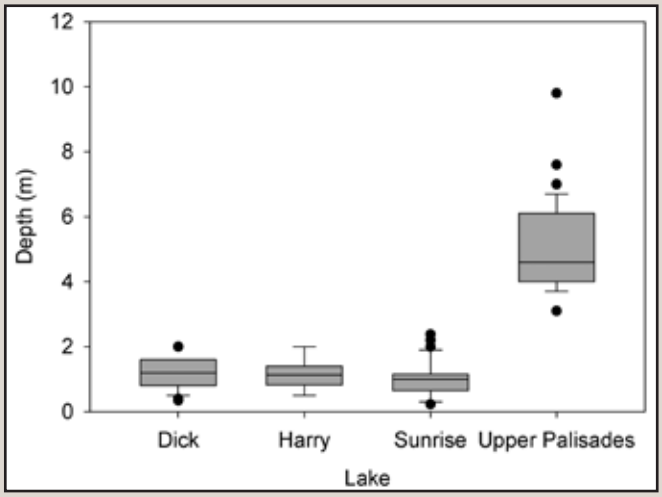


FIG. 3. Box plots of the range of oviposition depths in the 4 MORA lakes. Lines within the boxes represent medians, and the dark circles represent outliers.

elevation, and it is uncommon for individuals to transform to the terrestrial life stage in Pacific Northwest mountain lakes (Eagleson 1976; Efford and Mathias 1969; Snyder 1956; Taylor 1983). In the decade (1996–2005) that we have conducted research at MORA, we have rarely observed transformed *A. gracile* adults while snorkeling or hiking in the park. The *A. gracile* adults in Dick, Harry, and Sunrise Lakes are also predominantly neotenic.

We compared oviposition depths among the 4 MORA lakes using one-way ANOVA with a Bonferroni Multiple Comparison Test. Significance was set at $P = 0.0125$. For further comparison, we also summarized data on *A. gracile* oviposition from 6 additional sources (Table 1).

Results and Discussion.—The Upper Palisades Lake mean oviposition depth (4.9 m) was significantly deeper (F-ratio = 434.7, $df = 3$, $P < 0.0001$) than the mean oviposition depths in the other 3 MORA lakes (range = 1.0–1.2 m) (Table 1). The range of Upper Palisades Lake oviposition depths (3.1–9.8 m) was also considerably deeper than in Dick, Harry, and Sunrise Lakes (0.23–2.4 m), and the range of depths reported by the 6 additional sources (0–1.5 m) (Table 1). In contrast, the oviposition depth ranges for Dick, Harry, and Sunrise Lakes were comparable to the range of depths reported by the other sources (Table 1), although the mean maximum oviposition depth (2.13 m) for the 3 MORA lakes was just over 1 m deeper than the mean maximum oviposition depth (0.96 m) we calculated for the other sources. The deepest egg mass in Upper Palisades Lake was observed at 9.8 m, which extends the reported record oviposition depth for *A. gracile* by just over 7 m (i.e., 2.4 m in Sunrise Lake).

Ambystoma gracile egg masses are known to contain a symbiotic green algae whose presence within egg capsules becomes more apparent as the masses age (Nussbaum et al. 1983; Petranka 1998; Richter 2005). It has been documented that the presence of this algae in *Ambystoma* spp. egg capsules serves to enhance the development of embryos and contributes to hatching at earlier stages of development or over a shorter period of time (Gilbert 1944; Tattersall and Spiegelaar 2008). However, eggs in masses in which the algae is reduced in presence or absent are not necessarily negatively affected. The results of a recent study by Kerney et al. (2011) also produced evidence that the presence of green algae in *Ambystoma maculatum* (Spotted Salamander) egg masses is endosymbiotic, indicating that the algae is carried and transmitted by ovipositing adults. This finding, however, has not been documented for other species of *Ambystoma*. The egg masses that we have observed in the 4 MORA lakes are generally deficient in the presence of green algae, although some egg capsules within a mass contain algae as the mass ages. We speculate that this reduced presence of algae may be due, in part, to: 1) the depths at which egg masses are deposited in the MORA lakes (for example, Tattersall and Spiegelaar (2008) found that the algal content of *A. maculatum* egg masses was negatively correlated with oviposition depth); 2) the use of attachment sites that shade and restrict the amount of available light reaching an egg mass for promoting algal growth; or 3) the possibility that the presence of algae in *A. gracile* egg masses is not or is only minimally endosymbiotic. More research will be required to definitively determine why the presence of green algae is reduced in the *A. gracile* egg masses of the 4 MORA lakes.

During the 12 July 2005 SCUBA survey, we observed numerous *A. gracile* larvae at depths of 6 and 14 m on the bottom substrate of Upper Palisades Lake; and on 1 September 2005 we observed 93 larvae (ca. 10 to >90 mm total length) in four 25-m transects during a daytime snorkel survey of the Upper Palisades

TABLE 1. Comparison of *Ambystoma gracile* egg mass depths in the Pacific Northwest, USA and Canada (MORA = Mount Rainier National Park; nr = not reported; standard errors are in parentheses).

Location	Elevation (m)	Surface area (ha)	Number egg masses measured	Depth range (m)	Mean (m)	Source
Upper Palisades Lake, MORA	1785	0.8	69	3.1–9.8	4.9 (0.16)	This study
Dick Lake, MORA	1726	0.4	104	0.35–2.0	1.2 (0.04)	This study
Harry Lake, MORA	1732	0.5	44	0.5–2.0	1.1 (0.07)	This study
Sunrise Lake, MORA	1750	1.5	59	0.23–2.4	1.0 (0.06)	This study
SW Washington, Cascade Range	915–940	26[a]	762	0.0–1.0	0.24 (0.005)	MacCracken 2007
Olympic National Park, Washington	1077–1472	0.002–0.082[b]	43	0.1–1.0	0.37 (0.03)	Palen et al. 2005
N. Vancouver, British Columbia	nr [ca. ≥ 2]	nr	2	0.5 and 1.0	nr	Licht 2003
WL Finley NWR, Oregon	nr [ca. 82–88]	nr[c]	1	0.6	nr	Pearl 2003
Marion Lake, British Columbia	ca. 300	13	nr	0.61–1.52	nr	Lindsey 1966
South Tacoma, Washington	nr [ca. 116]	nr[d]	nr	0.15–0.61	nr	Slater 1936

[a] total area for wetland complex with multiple shallow water, fen, and bog habitats
[b] range of smaller, fishless, permanent ponds with amphibian breeding in the Sol Duc drainage
[c] described as a semi-permanent pond
[d] described as a small pond

Lake littoral zone. The presence of these larvae indicates that embryos from at least some of the deeply placed egg masses survive to hatching, and eventually develop into reproductively mature adults. Two water quality parameters, dissolved oxygen concentration [DO] and temperature, which are critical to amphibian embryonic development and hatching, are not outside of critical limits for *A. gracile* in Upper Palisades Lake. Although we did not measure [DO] in the lake in 2005, measurements in July 1993–1994 (MORA, unpubl. data) and August 2008–2009 (Anne Weekes, USGS, unpubl. data) indicate that [DO] is high and not limiting at the range of oviposition depths in the lake (1993–1994 ranges: 3 m = 9.1–10.0 mg/L, 5 m = 9.9–10.8 mg/L, 10 m = 10.0–11.5 mg/L; 2008–2009: 3 m = 8.4–9.1 mg/L, 5 m = 8.5–9.1 mg/L, 10 m = 9.4–11.5 mg/L). Similarly, near bottom [DO] in Dick (1.5–2 m mean = 6.4 mg/L; 1994, 1996), Harry (3 m mean = 7.2 mg/L; 1989, 1994), and Sunrise (5.5–6.5 m mean = 7.9 mg/L; 1988, 1994, 2004–2005) Lakes are at concentrations suitable for *A. gracile*. Water temperature also was not limiting. Anderson (1972) and Brown (1976), in separate laboratory studies, determined that development of *A. gracile* embryos proceeds normally at water temperatures of 6–20°C, with time-to-hatching inversely related to temperature (89 to 53 d at 7 to 8°C, respectively; Brown 1976). The water temperature on 12 July 2005 in Upper Palisades Lake, at depths of 4.6 (just above the mean depth of oviposition) to 14 m, was 7.8°C. We speculate that at this temperature it can take up to 90 d or more for embryos to develop and hatch in the lake. Near bottom water temperatures in Dick (1.5–2.5 m mean = 15.6°C; 1989, 1994, 1996), Harry (3 m mean = 15°C; 1989, 1994), and Sunrise (5.5–6.5 m mean = 15.8°C; 1988, 1994, 2004–2005) Lakes were comparatively warmer than in Upper Palisades Lake, and embryos would most likely develop and hatch within a minimum of 17 to as many as 46 d in the 3 lakes (Brown 1976).

The *A. gracile* egg masses we found in Upper Palisades Lake were at much greater depths than is considered typical for this species. These were the deepest depths that we could find documented in the literature for any *Ambystoma* species or other pond-breeding salamander group. We suspect that this pattern of oviposition in Upper Palisades Lake is primarily a reflection of the lack of available attachment structures in the shallower areas of the lake, and the relatively deep occurrence of preferred oviposition braces and environmental conditions at those depths conducive to successful embryo development and survival. Additional deep mountain lakes inhabited by *A. gracile* should be surveyed to determine if oviposition at these deeper depths is more common than is presently thought.

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Notes on Activity, Body Size Variation, and Diet in Insular Speckled Rattlesnakes from the Western Sea of Cortés, Mexico

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Rattlesnakes of the *Crotalus mitchellii* (Speckled Rattlesnake) complex have been reported from 12 islands in the western Sea of Cortés, Mexico (Grismer 2002; Murphy and Aguirre-Léon 2002). Mean body size varies considerably across these island populations, and *C. mitchellii* is unusual among viperids in exhibiting both insular gigantism and dwarfism (Boback 2003). Dwarfism is common in insular populations, while gigantism is known only from Ángel de la Guarda Island. Body size shifts relative to mainland populations may be partly influenced by resource availability, as body size in *C. mitchellii* is strongly correlated with island area (Meik et al. 2010). Shifts in diet composition are also often implicated in body size divergence between mainland and island snakes (Boback 2003; Case 1978); however, there are few data comparing diets between insular and mainland populations (but see Forsman 1991; Madsen and Shine 1993). Klauber (1949) reported that dwarfed Speckled Rattlesnakes from El Muerto Island had eaten both side-blotched lizards (*Uta lowei*) and Banded Rock Lizards (*Petrosaurus mearnsi*). Case (2002) and Grismer (2002) speculated that giant Speckled Rattlesnakes from Ángel de La Guarda Island eat mostly Desert Woodrats (*Neotoma lepida*) and Spiny Chuckwallas (*Sauromalus hispidus*), herbivorous lizards that attain weights of over a kilogram. On a drizzly day in April 1981, Case (2002) encountered two Speckled Rattlesnakes on Ángel de la Guarda Island that were each in

the process of swallowing Spiny Chuckwallas. Other than these anecdotal accounts, data on the diets of insular Speckled Rattlesnake populations are unavailable.

Here we report new data on activity, body size variation, and diet in insular Speckled Rattlesnakes from five islands in the northwestern Sea of Cortés: El Muerto, Smith, Piojo, Cabeza de Caballo, and Ángel de la Guarda. Of these, Smith, Piojo, and Cabeza de Caballo are nearshore islands in Los Angeles Bay, while Ángel de la Guarda is located to the east of Los Angeles Bay, and El Muerto is situated approximately 100 km to the northwest of Ángel de la Guarda (Fig. 1). Although two recent checklists of the insular herpetofauna of Baja California report *C. mitchellii* from Cabeza de Caballo Island (Grismer 2002; Murphy and Aguirre-Léon 2002), until now no voucher specimens or photographs have been deposited in collections in the United States or Mexico.

Materials and methods.—We collected voucher specimens of Speckled Rattlesnakes from El Muerto Island on 23 May 2006, Ángel de la Guarda Island on 25 May 2006, and from Cabeza de Caballo, Piojo, and Smith islands between 17–20 March 2010. Snakes were euthanized within 12 h of capture by chloretone injection to the heart, preserved in 10% formalin, and later transferred to 70% ethanol for long-term storage. We measured snout–vent length (SVL) and tail length with a metric ruler, and head length with a digital caliper. We used rattle segment count as a crude indicator of snake ontogeny because rattle segments of equal width indicate asymptotic growth has been reached (Klauber 1940); only adult snakes were included in estimates of mean SVL. Data on prey items were obtained from feces or by direct examination of gastrointestinal tracts of preserved specimens. We deposited all material at the collections of the Museo de Zoología, Facultad de Ciencias (MZFC), Universidad Autónoma de México, and The Amphibian and Reptile Diversity Research Center at the University of Texas at Arlington (UTA) under the following accession numbers: MZFC 24988–24989 (Ángel de la Guarda); MZFC 26407–409, UTA R-59763–765 (Cabeza de Caballo); MZFC 24984–86 (El Muerto); MZFC 26410–412, UTA R-59766–767 (Piojo); MZFC 26413, UTA R-59768–769 (Smith).

Meik et al. (2010) presented a correlation analysis of mean SVL of island populations as a function of island area; however, their analysis did not include rattlesnakes from Cabeza de Caballo Island. We updated this analysis by adding data on snakes from this island population, as well as additional data for populations from Smith and Piojo islands.

Results and discussion.—Our observations of Speckled Rattlesnakes on both El Muerto (30.087°N 114.541°W) and Ángel de la Guarda (29.170°N 113.332°W) islands are consistent with previous reports (Armstrong and Murphy 1979; Klauber 1949). We visited these islands on 23 and 25 May 2006, respectively, and daytime high temperatures were approximately 34°C. On El Muerto Island, we found three adult snakes within two hours of dusk (two males and a female between 2100 and 2200 h). We encountered one male at about 20 m above sea level on the rocky slope of a steep canyon; the other two snakes were found moving in the upper intertidal zone. Similar to reports provided by Klauber (1949) and Armstrong and Murphy (1979), rattlesnakes from El Muerto were nervous and rattled vigorously at our approach. When collected, these snakes thrashed and struck repeatedly at snake tongs. Similar behavior prompted C. H. Lowe to speculate (in Klauber 1949) that snakes of this population likely have important avian predators, possibly Ospreys (*Pandion haliaetus*) or Peregrine Falcons (*Falco peregrinus*), which are known from the island. We collected two adult male rattlesnakes on Ángel de la Guarda Island, one at dusk, and one approximately an hour and a half later (2130 h). The first individual was found coiled beneath a large agave on the gentle slope of a broad valley approximately 1 km from the sea. The second snake was crossing a sandy wash about 150 m from the shoreline. In contrast to the behavior of snakes from El Muerto, snakes from Ángel de la Guarda were docile. These snakes did not adopt defensive postures or strike, and rattled only briefly in one or two-second bouts.

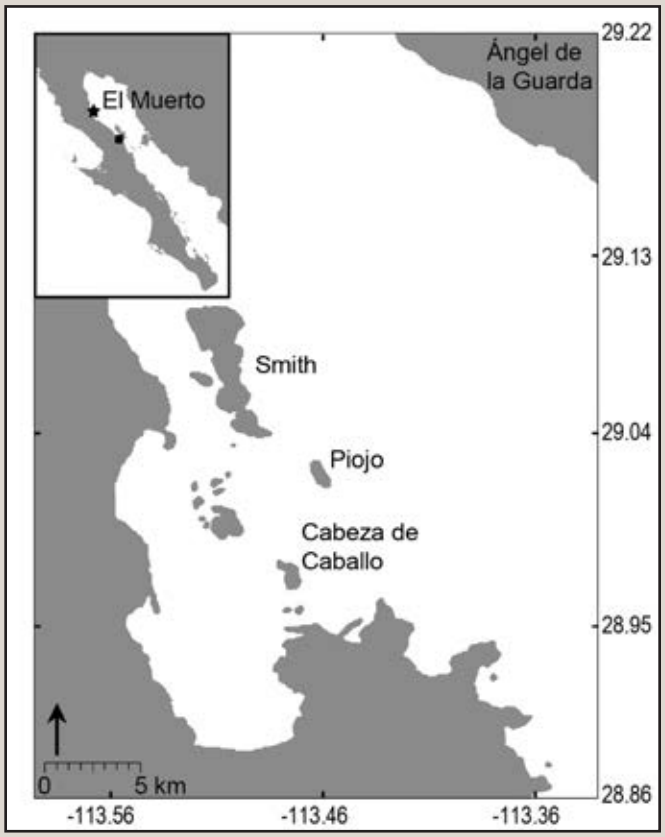


FIG. 1. Map of Los Angeles Bay, and northern Sea of Cortés (inset), showing locations of islands visited during this study (El Muerto, Ángel de la Guarda, Smith, Piojo, and Cabeza de Caballo). The square in the inset indicates the location of Los Angeles Bay within the Baja California Peninsula.



FIG. 2. Photograph of a Speckled Rattlesnake (*Crotalus mitchellii*; MZFC 26409), *in situ*, coiled between boulders on Cabeza de Caballo Island.

COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND

Situated at the southern end of the mouth of Los Angeles Bay, Cabeza de Caballo (28.973°N 113.479°W) is a small (0.77 km^2), steep island with extensive basaltic rock outcroppings. We visited the island between 17–18 March 2010 when overall conditions were cool and windy. All rattlesnakes were encountered during mid-morning and early afternoon hours (1000–1300 h) on 18 March except for an adult male that was active near the highest peak of the island at 2130 h on the night of 17 March (N = 6 total). Of the five snakes collected during the day, the first four were found coiled and exposed on the ground, abutted against boulders (Fig. 2). When disturbed, snakes rattled vigorously and retreated toward rock crevices over two meters from where they had been coiled. The position and posture of these rattlesnakes indicated they were likely both thermoregulating and waiting in ambush for passing prey.

On 18–19 March 2010, we visited Piojo Island (29.016°N, 113.464°W), the outermost island in Los Angeles Bay. Piojo consists of a rugged, plateau-like escarpment, and is sparsely vegetated compared with other major islands in the bay. The island serves as a rookery for Brown Pelicans (*Pelecanus occidentalis*), and most available woody debris has been incorporated into large nests concentrated on the floors of canyons and ravines that are less exposed to the high winds that pummel the island.

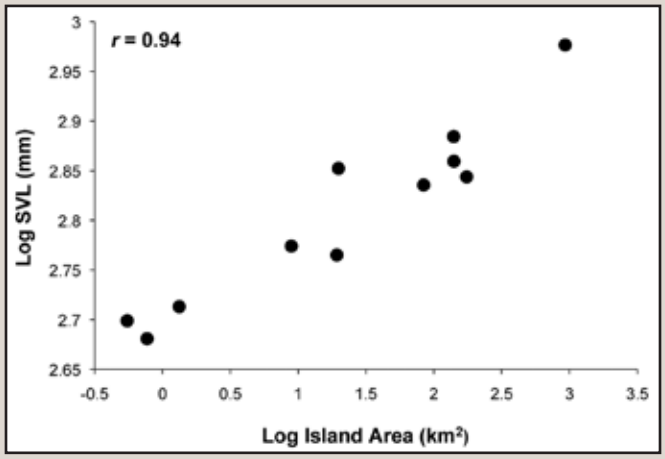


FIG. 3. Relationship between mean log snout–vent length (SVL) and log island area for populations of Speckled Rattlesnakes (*Crotalus mitchellii*) from the western Sea of Cortés, Mexico.

Seib (1978) first reported *C. mitchellii* from Piojo, and Grismer (2002) indicated that on the island *C. mitchellii* could be found beneath pelican nests. The night of 18 March was cool (ground temperature ca. 16°C) and windy; nonetheless, we encountered four rattlesnakes (two juveniles and two adults) active on the elevated flat plateau of the island (between 2030–2200 h). The following afternoon (ca. 1230 h), we found an adult female *C. mitchellii* basking in the intertidal zone of a large basalt finger that protruded into the sea from the northern beach. On the night of 19 March, we searched for Speckled Rattlesnakes on Smith Island (29.051°N 113.509°W), the largest and most topographically diverse island in Los Angeles Bay. We collected three individuals from rocky canyons of the island interior; each of these snakes revealed its presence by rattling.

Mean SVL of six rattlesnakes from Cabeza de Caballo was 479.5 ± 65 mm, the lowest mean SVL yet reported from an insular population of *C. mitchellii* (other populations range from 500 to 947.3 mm in mean SVL; Meik et al. 2010). Although our sample sizes for insular rattlesnake populations from Los Angeles Bay are relatively small (N = 8 for Smith, N = 10 for Piojo, N = 6 for Cabeza de Caballo), most specimens had long, broken rattle chains consisting of 8–11 segments of nearly equal width; therefore, we surmise that these snakes were mature adults. Furthermore, Meik et al. (2010) reported a female specimen of 360 mm SVL from Piojo Island that had enlarged follicles, indicating that reproductive maturity is attained at small sizes in these insular populations (Goldberg [2000] reported the smallest reproductive female in a sample of mainland *C. mitchellii* to be 552 mm SVL). The relationship between log island area and log mean SVL was significant ($r = 0.94$, $P < 0.0001$; Fig. 3), and the additional data improved the strength of the correlation coefficient by about 0.1 from that of a similar analysis presented by Meik et al. (2010).

Studies of insular snake populations have demonstrated that body size shifts may be influenced by adaptive evolution and phenotypic plasticity (Aubret and Shine 2009; Bronikowski 2000; Tanaka 2011)—presumably responses to island environmental regimes that include different resource availability and population densities, as well as differences in prey size distributions. Divergence in body size distributions between insular and mainland snakes may also result from simple differences in survivorship between populations (Hasegawa and Mori 2008; King 1989), which could be important for insular populations because they typically experience different predation regimes than do

TABLE 1. Prey items identified from digestive tracts and feces of insular Speckled Rattlesnakes (*Crotalus mitchellii*). Snout–vent length (SVL) is reported for each rattlesnake.

			Prey Items Recovered		
Specimen	Island	SVL (mm)	Lizards	Birds	Mammals
MZFC 24984	El Muerto	521		*Dendroica* sp.	
MZFC 26408	Cabeza de Caballo	440	*Sauromalus hispidus*		
UTA R-59763	Cabeza de Caballo	476	*Uta stansburiana*		
UTA R-59764	Cabeza de Caballo	498	*Sauromalus hispidus*		
UTA R-59765	Cabeza de Caballo	570	*Sauromalus hispidus*		
UTA R-59766	Piojo	490			*Peromyscus maniculatus*
MZFC 26410	Piojo	341	*Phyllodactylus xanti*		
MZFC 26411	Piojo	255	*Uta stansburiana*		
MZFC 26412	Piojo	255	*Uta stansburiana* [2]		
UTA R-59769	Smith	524	*Sauromalus hispidus*		

populations from the mainland. High predation rates could have shifted body size distributions toward smaller size in populations of dwarfed rattlesnakes; however, terrestrial mammalian predators present on the mainland are absent on islands with dwarfed rattlesnakes. It is possible that certain avian predators may specialize on small insular rattlesnakes, which could select for the pugnacious behavior observed in these populations. The long rattle chains observed on small insular rattlesnakes from islands in Los Angeles Bay provides evidence that these snakes may be long-lived adults; thus, although predation may remain important for insular dwarfs, it seems that predation alone is not sufficient to have shifted the distribution of body sizes downward. Long-term mark-recapture studies that would provide estimates of survivorship are needed to partly test this hypothesis.

We recovered a total of 11 identifiable prey remains from the digestive tracts or feces of Speckled Rattlesnakes collected from islands in the Sea of Cortés (Table 1). A female specimen collected from El Muerto contained a wood warbler (*Dendroica* sp.) in its stomach, and an adult male from Piojo had consumed a large Deer Mouse (*Peromyscus maniculatus*); all other diet items were lizards. On islands in Los Angeles Bay, most larger snakes with prey remains had eaten juvenile Spiny Chuckwallas (*Sauromalus hispidus*); most smaller snakes had eaten Common Side-blotched Lizards (*Uta stansburiana*), and in one instance, a Peninsular Leaf-toed Gecko (*Phyllodactylus xanti*). Both juveniles collected from Piojo had eaten side-blotched lizards, and one of these snakes contained two lizards in its stomach. We found compacted vegetation (including twigs, seeds, and leaves) in the digestive tracts of each rattlesnake that had eaten a chuckwalla, and one such bolus of vegetation also contained several small lepidopteran larvae. We assume that these items were consumed by chuckwallas that were then eaten by the snakes.

Interestingly, juvenile Spiny Chuckwallas seem to make up a large proportion of the diet of dwarfed Speckled Rattlesnakes on islands in Los Angeles Bay (Table 1). Three of six *C. mitchellii* specimens collected from Cabeza de Caballo Island contained chuckwalla remains, as did one of three specimens collected from Smith Island. Case (1978, 2002) suggested that Speckled Rattlesnakes from Ángel de la Guarda Island attained large size in response to their chuckwalla prey, and Meik et al. (2010) found some evidence to support that hypothesis. If so, then why have rattlesnakes on smaller islands in Los Angeles Bay, which also eat *S. hispidus*, decreased in body size? One possibility is that selection for small body size on small islands may counter and supersede selection for exploiting the largest available prey, and hence increased body size, on these islands (see Palkovacs 2003). Alternatively, populations of dwarfed rattlesnakes on islands in Los Angeles Bay might have only recently been exposed to colonizing populations of Spiny Chuckwallas, and insufficient time might have elapsed for these rattlesnakes to exhibit phenotypic response to the availability of large chuckwalla prey. Molecular evidence indicates that *S. hispidus* evolved *in situ* on the ancient island of Ángel de la Guarda (1.5–2 million years old; Carreño and Helenes 2002), and may have only recently colonized land-bridge islands of Los Angeles Bay (Petren and Case 1997). In contrast, populations of Speckled Rattlesnakes on islands of Los Angeles Bay were likely isolated from mainland populations as sea levels rose in the early Holocene (< 10 thousand years ago; Carreño and Helenes 2002).

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Distributional Data for *Bolitoglossa* (Amphibia, Caudata, Plethodontidae) from Nicaragua and Costa Rica

The genus *Bolitoglossa* is the largest and most widely distributed group of neotropical lungless salamanders (Parra-Olea et al. 2004). There are 121 species (AmphibiaWeb 2012) of small to large, relatively robust salamanders distributed from northeastern Mexico to southern Amazonian Brazil (Savage 2002; Wake and Lynch 1976). Although most species in the genus occur in Middle America, there are only four species in Nicaragua (the largest and most centrally located country in Central America; Sunyer and Köhler 2010): *B. indio*, *B. insularis*, *B. mombachoensis*, and *B. striatula*. *Bolitoglossa indio* is a species known only from the holotype, collected at 25 m elevation in Dos Bocas de Río Indio, Dept. Río San Juan (Sunyer et al. 2008). The remaining three species, *B. insularis*, *B. mombachoensis*, and *B. striatula*, are presumed closely related (S. M. Rovito, pers. comm.) and allopatric. *Bolitoglossa striatula* is a relatively widespread species with a distributional range from northeastern Honduras to southeastern Costa Rica, primarily on the Atlantic versant, from near sea level to 1052 m elevation (Savage 2002). *Bolitoglossa mombachoensis* and *B. insularis* are species endemic to higher elevations of cloud forest habitat on two forested and isolated volcanoes of the Pacific versant of Nicaragua. *Bolitoglossa mombachoensis* is a locally abundant species (Jansen and Köhler 2001) restricted to higher altitudes (950–1345 m elevation) of Reserva Natural Volcán Mombacho, Dept. Granada (Köhler and McCranie 1999; Köhler 2011); and *B. insularis* is known only from the holotype, collected at 800 m elevation in Reserva Natural Volcán Maderas on Isla de Ometepe in Lago de Nicaragua, Dept. Rivas (Sunyer et al. 2008).

During fieldwork conducted in October and November 2009 in Nicaragua we collected several specimens that extend the known vertical distribution of *Bolitoglossa insularis*, *B. mombachoensis*, and *B. striatula*. All referred specimens were verified by Theodore J. Papenfuss and Sean M. Rovito and are deposited in the Museum of Vertebrate Zoology (MVZ), University of California, USA, and in the Museo Herpetológico de la UNAN-León (MHUL), Universidad Nacional Autónoma de Nicaragua-León, León, Nicaragua. We also report information on a Costa Rican specimen of *B. indio* in the British Museum of Natural History (BMNH), London, UK. Figure 1 depicts collection localities discussed below. Geocoordinates are based on datum WGS84.

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Bolitoglossa indio: COSTA RICA: ALAJUELA: Cantón de San Carlos: Boca de Arenal, 68 m elev. First country record. On 20 September 2011, D. B. Wake examined specimen number BMNH 96.10.8.77 (Fig. 2a) collected by C. F. Underwood in 1890. This specimen has had a long history. It was first mentioned (but not illustrated) by Günther (1885–1902) as *Spelerpes variegatus* (a composite of species in which he included specimens now assigned to *Bolitoglossa alberchi*, *B. mexicana*, *B. mulleri*, *B. platydactyla*, and *B. salvinii*) and reported it to have been obtained from "San Carlos, Costa Rica." Dunn (1926) discussed the specimen briefly in an addendum to his monograph on the Plethodontidae. At the time Dunn worked, only 30 species of tropical salamanders were known (today there are 121 species of *Bolitoglossa* alone, AmphibiaWeb 2012); many of them were composites of sometimes unrelated species. Under the heading "*Oedipus platydactylus*" Dunn (1926:440–441) listed six specimens in the British Museum of Natural History that he had examined, one from British Honduras, two from Guatemala, the specimen in question from Costa Rica, and two specimens from Colombia. While Dunn noted that this Costa Rican specimen might represent an undescribed form, he stated forcefully that of then-recognized species it fit only into *O. platydactylus*. None of these six specimens is today considered a member of *Bolitoglossa platydactyla*, and as early as 1952 Taylor questioned the identification of the San Carlos specimen. However, in the absence of additional specimens, Taylor took no formal action. When Taylor (1954) described *B. alvaradoi* and *B. arborescandens* (the latter synonymized with *B. alvaradoi* by Savage 2002), he made no mention of the specimen in question. Wake and Brame (1962) assigned the specimen to *B. alvaradoi*, and Savage (2002) accepted this decision. However, Savage added more exact geographic information "Alajuela: San Carlos: Boca de Arenal." Savage (in litt. to DBW, 22 February 2012) explained his reasoning. Underwood was a well-known ornithologist and general naturalist, and he is known to have traveled with the ornithologist M. A. Carikker, Jr. (Carriker 1910). The locality "San Carlos" may seem vague, because the name in its most general sense refers to the Cantón de San Carlos in the Provincia de Alajuela. The Canton is the largest of the 81 cantons in Costa Rica, and includes territory between the Cordillera Central and the Nicaraguan border, with the San Carlos River a central feature. Savage (1974) considers Underwood's "San Carlos" to refer to the village known today as Boca de Arenal, following Carriker's (1910) statement that the

name as used by collectors refers to the head of navigation up the Río San Carlos (above the Río San Juan) and the beginning of the old land route to the Meseta Central. The site, then known as the Comandancia de San Carlos, is today's Boca de Arenal (see Fig. 1). If we accept this reasoning, the assignment of this specimen to *B. indio* extends the known geographical range of the species approximately 87 km to the southwest from the type locality (see Fig. 1), along the San Carlos River south of the San Juan River. Therefore, this species is no longer considered a Nicaraguan endemic.

BMNH 96.10.8.77 is an adult male that has the following dimensions (in mm): Standard length (SL, snout to posterior end of vent) 46.8, tail approximately 42, head width 7.3, forelimb length 10.7, hind limb length 12.9, width of pes 4.9. There are 3 premaxillary teeth and 68 maxillary teeth. The vomerine teeth were not countable, but were in a long, strongly curved row. The foot is especially broad and the fifth digit of the pes is large and stout. Although rather desiccated, color preservation is good. The moderately dark ground color of the dorsal surfaces is covered with extensive light patches that appear to lie superficially above the ground color. These patches are sharply demarcated from the ground color. Light pigmentation is marked on the back of the head and over the shoulders. Small, isolated spots of pigment are found in the mid-dorsal region, where they form two vaguely defined rows that coalesce over the pelvic region. Only 5–6 spots are clearly isolated, with the others partly joined. Spotting is extensive on the tail, with the spots usually slightly to extensively connected. Assignment to *B. indio* is based on close similarity in morphology (see below) and in color pattern (see Fig. 2a), therefore BMNH 96.10.8.77 constitutes the second published record of this species (Sunyer et al. 2008). Because of the rarity of the species, we present here detailed comparisons of the specimens. They are both exactly the same size (46.8 SL), but the holotype is female. The holotype has a slightly broader head and a substantially shorter tail (34.8), but the posterior 40% of the tail of the holotype appears to be regenerated, accounting at least in part for its shorter length. The pes is about the same width (5.1 in holotype) and the hind limbs about the same length (10.9). There are substantially more maxillary teeth in the Costa Rican specimen than in the holotype (68 vs. 48). On the whole the two specimens are similar and measurement differences may relate at least in part to preservation artifacts.

Some further comments on *Bolitoglossa indio* are in order. It is possible that a population of salamanders at Rara Avis (see Fig. 2b), adjacent to and upslope from the La Selva Biological Station, Costa Rica, is attributable to *B. indio* (compare Fig. 2b with Fig. 1b in Sunyer et al. 2008). If this is the case, there are several implications. First, the elevational record for this species would extend upwards to 710 m elev. Second, the species is misassigned to the subgenus *Bolitoglossa* and instead is a member of the subgenus *Pachymandra*, based on the fact that a specimen from Rara Avis was used by Parra-Olea et al. (2004) as their representative of *B. alvaradoi*. An x-ray of the holotype of *B. indio* indicates that the transverse processes of the first caudal vertebrae are not branched, as are those of other members of *Pachymandra* (*B. alvaradoi* and *B. dofleini*). These processes arise at the very anterior end of the vertebra, are very long, and overlap the processes on the last caudosacral vertebra. This qualifies as a "complex" tail base, characteristic of *Bolitoglossa* beta of Wake and Lynch (1976), which characterizes the subgenera *Magnadigita*, *Nanotriton*, *Mayamandra*, *Oaxakia*, and *Pachymandra*. We have x-rayed BMNH 96.10.8.77 and it too, has a complex tail base, although differing from the holotype of *B. indio* in having a bifurcated transverse process of the first caudal vertebra. While this is the usual beta pattern, absence of the bifurcation is also found occasionally in specimens of other species belonging to the above subgenera, and what is most important is the crossing of the transverse processes of the adjacent last caudosacral and first caudal vertebrae. We do not know the condition of the vertebrae in the Rara Avis population, but specimens assigned to *B. alvaradoi* have invariably had the complex tail base, with bifurcated transverse processes on the first caudal vertebra. In addition, some specimens of *B. alvaradoi* from Rara Avis showed a striking change in coloration between day and night time (Twan Leenders, pers. comm.). In contrast, the holotype of *B. indio* was kept living for several days and showed no significant change in coloration. Resolving the question of relationships between *B. indio* and what we now consider its likely closest relative *B. alvaradoi* will require additional specimens and research.

Bolitoglossa insularis: NICARAGUA: RIVAS: Reserva Natural Volcán Maderas (11.45643°N, 85.50845°W), Isla de Ometepe, 1050 m elev. (see Fig. 1). 13 November 2009. J. Sunyer and L. A. Obando. Adult female (MVZ 264228; Fig. 3). The specimen was found active on a fern's leaf 1.5 m above the ground at night time (2030 h) near a rather windy ridge along the trail from Finca Magdalena to the top of the volcano in pristine Premontane Moist Forest formation (Holdridge 1967). At the time it was found, the coloration of MVZ 264228 was homogeneously immaculate yellowish to brownish dorsally and immaculate white ventrally



FIG. 1. Map of Nicaragua and Costa Rica showing the localities mentioned in text. Water surfaces are colored blue. Areas below 600 m green. Areas above 600 m brown. Areas above 1200 m dark brown.

PHOTO BY T. LEENDERS

COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND

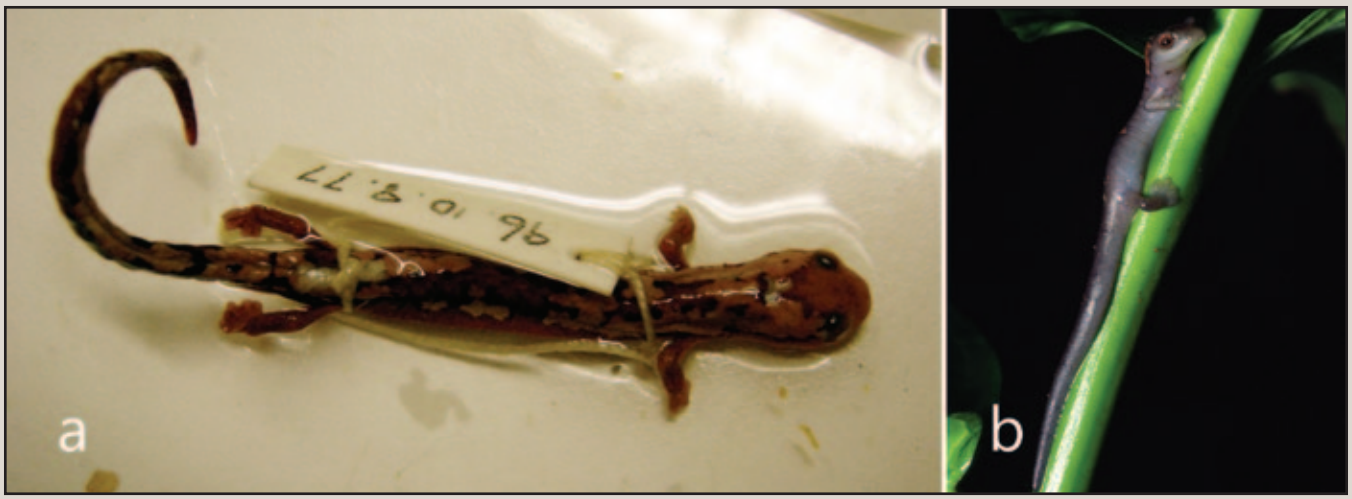


FIG. 2. (a) Preserved adult male *Bolitoglossa indio* (BMNH 96.10.8.77) from Boca de Arenal, Cantón de San Carlos, Provincia de Alajuela, Costa Rica, 68 m elevation (see text), and (b) adult specimen of *B. alvaradoi* from Rara Avis, Provincia de Heredia, Costa Rica, 710 m elevation.



FIG. 3. Adult female *Bolitoglossa insularis* (MVZ 264228) from Reserva Natural Volcán Maderas, Dept. Rivas, Nicaragua, 1050 m elevation. Compare color change between (a) the moment it was found, and (b) after manipulation.

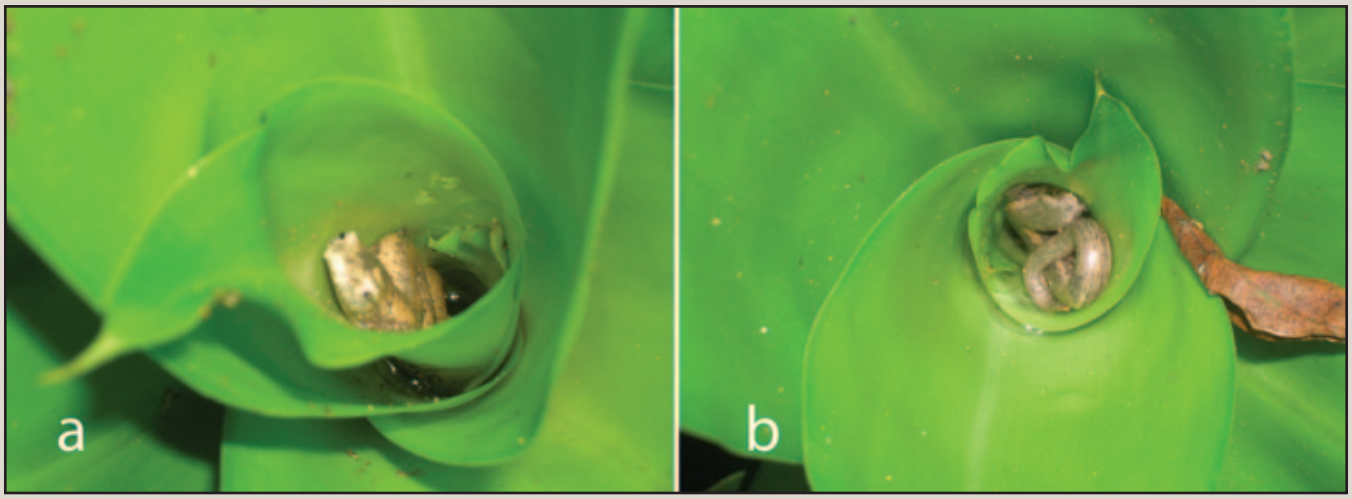


FIG. 4. (a, b) Non-collected adult specimens of *Bolitoglossa mombachoensis* from Reserva Natural Volcán Mombacho, Dept. Granada, Nicaragua, 875–900 m elevation. These and few other specimens were found at day time around the small pond created by rains in the apex of the water-filled tank of the bromeliad-like leaves of *Dracaena fragans*, a plant locally used to delimit coffee plantation parcels.



FIG. 5. Adult female *Bolitoglossa striatula* (MVZ 264227) from Finca Monimbó, Dept. Matagalpa, Nicaragua, 1380 m elevation.

(Fig. 3a). Immediately after manipulation, the specimen quickly developed two pairs (one lateral and one dorsolateral) of non-delimited and weakly defined dark brown shadings (Fig. 3b). Dorsal surfaces of the head and limbs also turned slightly darker, coming to resemble the coloration of the holotype, which differs from MVZ 264228 by having a considerably greater number of small, dark brown spots, giving a mottled appearance to the entire dorsal and ventral surfaces of the head, body, and tail (see Fig. 2 in Sunyer et al. 2008). This color change was not observed in the holotype, which was collected by day; accordingly, we suspect the species presents alternative coloration by night (Fig. 3a) and day, being slightly darker by day as well as under stressful conditions (Fig. 3b). We additionally observed MVZ 264228 using its prehensile tail proficiently as a fifth limb. MVZ 264228 constitutes the second published specimen of *Bolitoglossa insularis* and extends the known altitudinal range of the species by 250 m (Köhler 2011; Sunyer and Köhler 2010; Sunyer et al. 2008), thus with a total elevational range of 800–1050 m. Unconfirmed sight records of local rangers and tourist guides indicate the presence of this species at even higher altitudes, and the species likely occurs all over the upper portions of this 1394 m elevation, humid and forested volcano.

Bolitoglossa mombachoensis: NICARAGUA: GRANADA: Reserva Natural Volcán Mombacho (11.83831°N, 85.99277°W), 875 m elev. (see Fig. 1). 18 November 2009. J. Sunyer and L. A. Obando. Adult female (MHUL 007). The specimen was found during the day in the central-most portion of *Dracaena fragans* (a plant locally used to delimit coffee plantation parcels), 1.5 m above the ground. It was collected along the road from Hacienda El Progreso to the top of the volcano, at exactly the transitional area between the coffee plantation and the reserve's forest, in Premontane Moist Forest formation (Holdridge 1967). While manipulating MHUL 007 we observed it could proficiently use its prehensile tail as a fifth limb. Although the species is, at this premontane elevation, not as abundant as at higher altitudes, several other specimens were observed during the day in the same general area (875–900 m elevation) hidden in the apex of these plants (Fig. 4). This record extends the known altitudinal range of *Bolitoglossa mombachoensis* by 75 m (Köhler 2011), so that the species is currently known to occur from 875–1345 m elevation, roughly the total extent of the core of the protected area on Volcán Mombacho.

Bolitoglossa striatula: NICARAGUA: MATAGALPA: Finca Monimbó (13.03173°N, 85.88682°W), 1380 m elev. (see Fig. 1). 18 October 2009. J. Sunyer and L. A. Obando. Adult female (MVZ 264227; Fig. 5). The specimen was found active at night along a trail inside the coffee plantation property in Lower Montane Moist Forest formation (Holdridge 1967). It was found 0.5 m above the ground on a leaf of a red ornamental introduced plant locally used to delimit coffee plantation parcels, which dominate the area. This record extends the known altitudinal range of *Bolitoglossa striatula* in Nicaragua by 610 m (Sunyer and Köhler 2010; Villa 1972) and in its whole distributional range by 328 m (Köhler 2011; Savage 2002); the species is currently known to occur from about sea level to 1380 m elevation.

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Morphometric Analyses and Ontogenetic Variation in a Neotropical Toad (Amphibia, Anura, Cycloramphidae)

The genus *Proceratophrys*, in the family Cycloramphidae (Frost et al. 2006), was first described by Miranda-Ribeiro (1920) and comprises a group of generally similar anuran species (small toads known locally as "horned frogs" or "bullfrogs") that are often confused with species of the genus *Ceratophrys* and *Odontophrynus* (Amaro et al. 2009; Hoogmoed 1990; Izecksohn et al. 1979; Izecksohn and Peixoto 1981). *Proceratophrys* currently comprises 24 species distributed throughout various morphoclimatic regions in South America (Frost 2011; Martins and Giaretta 2011; Napoli et al. 2011) and the species *P. cristiceps* (Fig. 1) studied here is found in the large Brazilian domain of semi-arid intermontane and interplain depressions known as the "Caatinga" (Ab'Saber 1977; Vieira et al. 2008).

Very little information about *Proceratophrys cristiceps* is currently available beyond its original description, although works by Lynch (1971) and Vieira et al. (2007, 2008) focused on the osteology of this species and provided descriptions of its tadpole phase and its morphometric variations.

Ontogenetic studies examining allometric variability in anuran amphibians are not very common, and are practically non-existent for the genus *Proceratophrys*, with publications concerning this taxon being largely restricted to descriptions of their morphology (Giaretta and Sazima 1993; Izecksohn and Peixoto 1980; Martins and Giaretta 2011; Mercadal de Barrio and Barrio 1993; Napoli et al. 2011; Prado and Pombal 2008) or, more rarely, their ecology and natural history (Boquimpani-Freitas et al. 2002; Giaretta et al. 1998; Izecksohn and Peixoto 1996; Sazima 1978).

Allometric studies of different body parts and organs have been used in mathematical models, which have been adapted or modified over time (Bartoletti et al. 1999; Jolicoeur 1963) and have greatly contributed to phylogenetic studies, by facilitating descriptions of these structures and in identifying corresponding body parts and organs that might otherwise have been considered structurally independent and not homologous (Houck 1990; Wiley 1981). Morphological studies generally focus on factors or structures that appear to have a significant importance in the evolution of the structural or functional characteristics of animal, and ontogenetic studies often focus on allometric relationships and their ecological implications (Di Cerbo and Biancardi 2010; Strauss and Altig 1992; Tejedo et al. 2010; Withers and Hillman 2001)—thus extending the scope of descriptive morphology.

As such, the current work contributes to our knowledge of the species *Proceratophrys cristiceps* by analyzing proportionality in this species, describing the differences between the principal ontogenetic categories during the terrestrial phase of this anuran, and discussing the probable ecomorphological significance of the variations encountered. This information should be useful in further studies of the systematics and ecology of this genus, as well as other taxa of Neotropical toads.

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PHOTO BY WASHINGTON VIEIRA

Fig. 1. Adult individual of *Proceratophrys cristiceps*.

Methods.—A total of 79 individuals of *Proceratophrys cristiceps* were collected in the Pedra da Boca State Park (6.7716°S, 35.6555°W), in the Municipality of Araruna, in the Curimataú Oriental Valley (Borborema geographical meso-region) in northern Paraíba State, Brazil. Both passive and active techniques were used to capture specimens of *P. cristiceps*. The passive techniques used drift fences with pitfall traps, while active collecting employed standard procedures of searching the leaf litter and manual capturing, following the techniques suggested by Heyer et al. (1994) for amphibians.

The captured specimens were euthanized according to internationally recommended techniques for amphibians and reptiles (HACC 2004); the species were subsequently fixed in 4% formalin, preserved in 65% alcohol, and deposited in the Herpetological Collection of the Department of Systematics and Ecology, Centro de Ciências Exatas e da Natureza at the Universidade Federal da Paraíba (UFPB 08423–8502).

Of the 79 individuals of *Proceratophrys cristiceps* collected, 38% were adults, 34% were subadults, and 28% were young individuals, thus forming an adequate growth series for allometric analyses (Abdala and Giannini 2002). The ontogenetic classification of *P. cristiceps* followed the suggestions of Izecksohn and Peixoto (1980, 1981) and Barrio and Barrio (1993), in which animals with snout–vent lengths (SVL) less than 26 mm were considered young individuals; those having SVL of 26–35 mm were considered subadults; while animals with SVL greater than 35 mm were considered adults.

Traditional allometric analyses of the 79 specimens of *Proceratophrys cristiceps* were performed using nine basic measurements (Fig. 2), expressed in millimeters (mm). Measurements were made using a vernier caliper with a precision of 0.05 mm, according to the methodologies described for morphometric studies by Giaretta and Sazima (1993) and modified by Hayek et al. (2001). The measurements included: snout–vent length (SVL), head width (HW), internarial distance (IND), eye-nostril distance (END), eye length (EL), tibia length (TL), foot length (FL), length of internal metatarsal tubercle (IMT), and the distance from the nostril to the most anterior extremity of the rostrum (DNR). These measurements were chosen for their ecological relevance in ontogenetic studies of anuran amphibians (Blouin and Loeb 1991; Emerson 1978) and are considered by taxonomists to be the most informative measurements for the group (Eterovick and Sazima 1998; Giaretta et al. 2000).

Discriminant analyses using logarithmic values were used (Wiley 1981) to determine if the age classes chosen represented well–defined operational ontogenetic units. Allometric growth models can only be used in this type of analysis if the samples represent elements within consistent progressions and differ only in terms of their absolute size (Houck et al. 1990).

All metric variables were expressed as log10 values, using the allometric function $y = 10^b x^a$ (Hammer et al. 2011). The coefficients were estimated based on the reduced major axis (RMA), thereby minimizing *x* and *y* errors. The standard error was calculated according to Miller and Kahn (1962). Snout–vent length (SVL) was considered to be the standard length (SL) in the present study, where x = SL. This criterion is common in morphometric studies involving allometry (Zelditch et al. 2004).

Allometric coefficients were compared between the ontogenetic categories in the same manner as the total sample – with the latter analysis indicating that the body proportions of *Proceratophrys cristiceps* varied throughout its terrestrial life cycle. A values equal to 1 indicated that the proportions were observed to be constant because of their isometric behavior; values greater than 1 described allometrically positive effects (increases in relation to the standard length); while values less than 1 indicated allometrically negative effects.

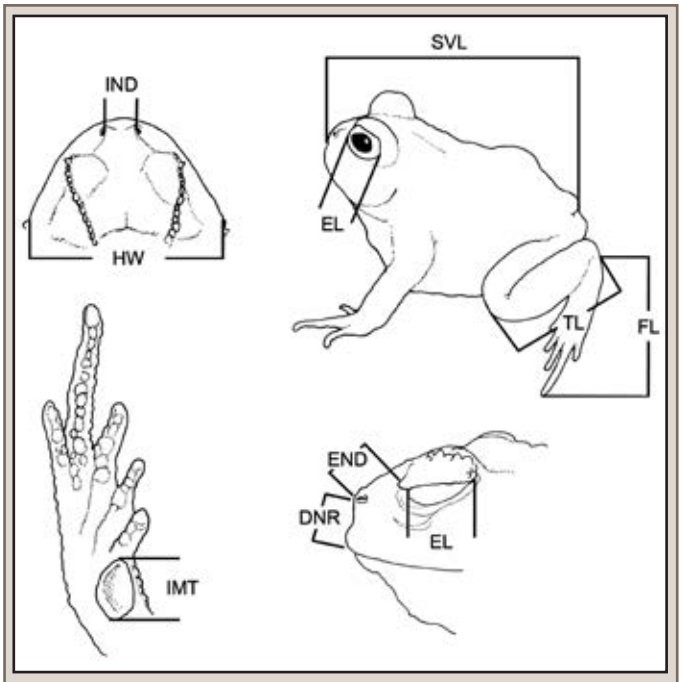


ILLUSTRATION BY KLEBER VIEIRA

FIG. 2. Measures used in studying ontogenetic variation in specimens of *Proceratophrys cristiceps*. Snout-vent length (SVL); head width (HW); internarial distance (IND); eye-nostril distance (END); eye length (EL); tibia length (TL); foot length (FL); length of internal metatarsal tubercle (IMT); and distance from the nostril to the most anterior extremity of the rostra (DNR).

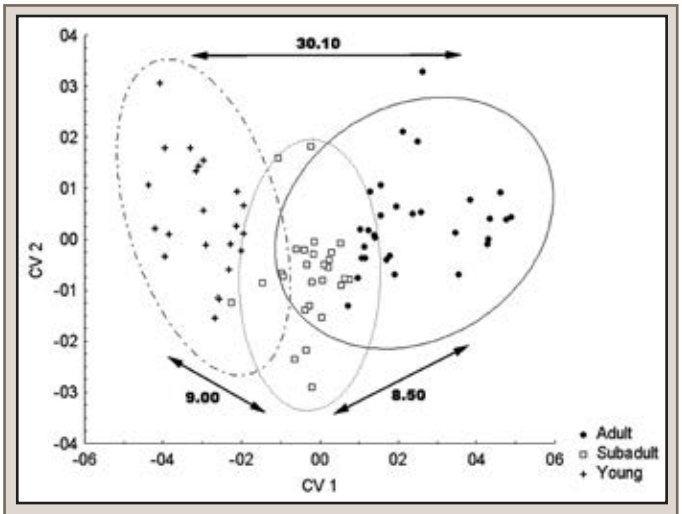


FIG. 3. Discriminant analysis of the ontogenetic categories of *Proceratophrys cristiceps*. The first axis responds for 95% of the observed variance. Arrows indicate the separation of the categories according to their Mahalanobis distances.

Results.—The discriminant analysis function demonstrated that the ontogenetic categories represented well–defined groups along a continuum, with the subadult category being clearly situated in an intermediate position. The results showed that Canonical Variable 1 (CV1) had elevated variance, with the variables SVL and IMT contributing to most to the distinctions

TABLE 1. Intraspecific growth in *Proceratophrys cristiceps*. Allometric coefficients ± standard error for three development categories calculated from the reduced major axis (RMA). Significant deviations from the isometry hypothesis are indicated in bold type.

	Adults (N = 30)			Subadults (N = 27)			Young (N = 22)		
Variables	*a*	*b*	p(α = 1)	*a*	*b*	p(α = 1)	*a*	*b*	p(α = 1)
HW	1.07 ± 0.07	-0.46 ± 0.10	0.33	1.09 ± 0.07	-0.50 ± 0.09	0.21	1.50 ± 0.20	-0.93 ± 0.22	**0.030**
IND	1.05 ± 0.12	-1.24 ± 0.18	0.66	2.03 ± 0.40	-2.55 ± 0.53	**0.02**	1.20 ± 0.30	-1.30 ± 0.30	0.52
END	1.12 ± 0.15	-1.31 ± 0.22	0.40	2.07 ± 0.40	-2.54 ± 0.53	**0.01**	1.32 ± 0.30	-1.43 ± 0.30	0.23
EL	0.96 ± 0.09	-0.89 ± 0.14	0.70	1.33 ± 0.23	-1.33 ± 0.31	0.20	0.97 ± 0.15	-0.82 ± 0.20	0.90
TL	1.15 ± 0.15	-0.67 ± 0.22	0.31	0.98 ± 0.14	-0.38 ± 0.18	0.90	1.19 ± 0.20	-0.70 ± 0.20	0.24
FL	0.98 ± 0.03	-0.23 ± 0.05	0.62	1.40 ± 0.23	-0.79 ± 0.30	0.08	1.21 ± 0.20	-0.50 ± 0.20	0.20
DNR	1.04 ± 0.11	-1.12 ± 0.17	0.70	1.32 ± 0.25	-1.45 ± 0.33	0.21	1.23 ± 0.24	-1.30 ± 0.30	0.30
IMT	1.19 ± 0.05	-1.19 ± 0.08	**0.001**	1.34 ± 0.25	-1.53 ± 0.33	0.20	1.20 ± 0.20	-1.30 ± 0.20	0.22

TABLE 2. Intraspecific growth in *Proceratophrys cristiceps*. Allometric coefficients ± standard error calculated from the reduced major axis (RMA). Significant deviations from the isometry hypothesis are indicated in bold type.

Variables	*a*	*b*	p(α = 1)
HW	0.98 ± 0.06	-0.3 ± 0.08	0.74
IND	0.81 ± 0.06	-0.9 ± 0.07	**0.002**
END	0.90 ± 0.10	-0.89 ± 0.08	0.04
EL	0.73 ± 0.04	-0.52 ± 0.05	**0.001**
TL	1.00 ± 0.07	-0.41 ± 0.09	0.96
FL	1.04 ± 0.07	-0.31 ± 0.09	0.54
DNR	0.82 ± 0.05	-0.80 ± 0.06	**0.0003**
IMT	1.01 ± 0.05	-1.04 ± 0.07	0.92

observed between the categories (FIG. 3) and having a consistent size progression; these two variables notably differed in terms of absolute size, indicating that they were reliable variables for allometric studies in this species.

Among the different categories of cephalic proportions examined, significant differences were observed with the traits HW, IND, and END (Table 1). Adults demonstrated typically isometric growth, characterizing a pattern distinct from those of the subadults and the young, as would be expected for this phase of development. The subadult category was different from the others as it demonstrated allometrically positive growth in terms of the internarial distance and the eye–nostril distance; allometrically positive growth in young individuals was only seen in terms of head width.

The three ontogenetic categories demonstrated little variability in terms of measurements related to the hind legs, and no significant divergence from the hypothesis of isometry in subadult and young individuals was noted (Table 1). Only adults demonstrated significant allometrically positive growth in terms of IMT. There was a tendency towards positive allometry in relation to foot development among subadults, although no statistically significant deviation was detected from the isometry hypothesis.

Proceratophrys cristiceps demonstrated relatively isometric growth during its terrestrial life cycle, except in terms of the variables IND, END, EL, and DNR, which demonstrated significantly reduced development in relation to the standard length (SL)—with the three categories demonstrating proportionally larger values when compared individually.

Discussion.—The morphological structures of anurans undergo significant modifications during their development from the tadpole stage to their mature adult terrestrial form, and this group is ecologically quite unique in demonstrating such divergent development (Duellman and Trueb 1994). Almost all anatomical, physiological, and behavioral characteristics are in some manner related to an animal's size and shape (Clutton-Brock and Harvey 1979), making it important to determine the ecological and/or evolutionary forces during ontogenetic variations.

Variation was observed to be significantly allometric in certain parts of the cephalic structure of *Proceratophrys cristiceps* (Table 2), indicating systematic changes in head shape during development (even though certain specific patterns were observed to differ among the different age categories analyzed) (Table 1). These allometric changes almost certainly reflect functional and behavioral changes as this species matures.

Young anuran individuals demonstrated allometrically positive development in terms of both head width and maxillary dimensions that were quite distinct from adults and subadults. This positive development, apparently common in anuran amphibians, suggests a maximization of their adaptation to their natural environment.

Proceratophrys cristiceps demonstrates seasonal behavioral patterns in its natural habitat—which is dominated by two strongly contrasting annual climatic regimes—a rainy season and a marked dry season. These animals excavate underground burrow during the dry season and remain in them until the rains return. Young toads must develop rapidly during the rainy period and store sufficient energy reserves to be able to grow and then survive the long dry period while in their burrows. Wide heads and proportionally large mouths will increase their chances of survival—as researchers have established a direct relationship between the numbers of prey types available and a predator's gape-size (Toft 1981, 1995)—so that allometrically positive head width and maxillary dimension values reflect an important strategy in this phase of anuran developmental.

As their global morphological dimensions become more proportional to one another, these young individuals of *Proceratophrys cristiceps* show reductions of 0.74 mm in their HW for each 1 mm increase in SVL, while subadults show HW decreases 0.4 mm for each 0.45 mm increase in SVL, and adults a HW increase of 0.04 mm for each 0.4 mm increase in SVL—as indicated by a linear equation of the corresponding regression line (data not shown).

While it is known that amphibian development is highly dependent on the regional environment, their growth rates also seem to depend on their ploidy levels. Individuals from seasonal environments marked by annual dry seasons are generally diploids (as seems to be the case for various species of the genus *Proceratophrys*) and they develop rapidly in comparison to animals that are adapted to more humid environments and have polyploid chromosome numbers (Goin et al. 1968).

The IND and END distance indices of subadults were quite elevated and demonstrated positive allometrics (characterizing an elongation of the rostrum) as compared to young individuals and adults. This observation can be understood in terms of the fact that several species of anuran amphibians pass through a phase of skeletal ossification during their post–metamorphic development (Duellman and Trueb 1994) and the alary processes of *Proceratophrys cristiceps* shorten as these animals pass into their adult stage, apparently due to greater ossification. Direct observations of the crania of this species (Vieira et al. 2008) confirmed the presence of wide and long alary processes in young and subadult individuals as compared to adults. The nasals in adults lose their pointed shape at the anterior end, being wide and long nearer the rostrum, contributing to the ontogenetic variations observed in terms of the internarial and eye–nostril distances during the terrestrial phase of this species.

Differences were also observed in terms of the internal metatarsal tubercle (IMT) between the different ontogenetic categories of *Proceratophrys cristiceps*, with the adults demonstrating greater intensity of IMT development—with values differing significantly from the isometric hypothesis. This is not an uncommon occurrence in some anurans, as this structure normally becomes more keratinized as the individuals grow, with young individuals having small and poorly keratinized internal metatarsal tubercles, while this keratinization increases in subadults and reaches a maximum in adults. This is an important trait for this species as this structure is fundamental to its cryptic habits and facilitates burrowing into the soil to hide or to escape from the long dry period (Boquimpani-Freitas et al. 2002; Giaretta and Sazima 1993; Weygoldt and Peixoto 1985)—a behavior trait of adults that appears to begin among subadults.

Young individuals were not observed burrowing into the ground, even when raised in terraria, reinforcing the results seen with the allometric coefficients. Although young toads can be very active (spending a large portion of their time jumping and moving around), both young and subadult animals tend to stay near substrates that can readily camouflage them.

A positive allometric tendency was also observed among subadults in terms of the parameter FL, as they demonstrated increases of 2.4 mm in FL for every 0.5 mm increase in SVL in the linear regression equation; this increase was only 0.13 mm for each 1 mm of SVL among young individuals (data not shown). These values are consistent with the jumping habits of the young and subadults, as long posterior feet are an important feature in jumping ability (Hildebrand 1988). We recorded increases of 0.6 mm in FL to every 0.5 mm increase in SVL among adults, reflecting isometric values. Adults spend most of their time moving very little—depending more on their camouflage to avoid predators and to capture their prey (Sazima 1978), which is consistent with the results observed for this parameter.

As a whole, the terrestrial developmental phase of *Proceratophrys cristiceps* appears to be marked by nonsignificant allometric trends (Table 2), whether positive or negative, that are not significantly different from the isometric hypothesis, especially in terms of body parts not including the head. However, as their standard length increased, IMT, FL, and TL proportionally accompany it—indicating that this species gradually invests in a fossorial habit during its terrestrial development (Table 1)—as demonstrated by the presence of a more cornified IMT, and longer and more robust legs among adults.

There have been relatively few studies of body size and allometry in amphibians, and few researchers have investigated intra- and interspecific variations within this vertebrate group. The present study was introductory, and it is still not possible to determine how much time is needed for young individuals of *Proceratophrys cristiceps* to become subadults and then adults, or fully understand the ecomorphological implications of this transition. Additional comparisons and analyses will therefore be necessary, especially among species that demonstrate similar ecomorphological functions but different phylogenetic histories.

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Food of Some Lizards from Cumberland Island, Georgia

Cumberland Island is the largest and most southerly barrier island off the coast of Georgia, USA. It is isolated by salt and brackish (estuarine) water. It is about 27 km (17 mi.) long and averages almost 2.4 km (1.5 mi.) wide. There are temporary freshwater ponds dependent on groundwater, which is recharged by precipitation. A rich assortment of habitats is distributed throughout the island and includes maritime forest, freshwater wetlands, beach and interdune, and flatwoods. Despite the occurrence of feral livestock, horses, and swine, the northern portion of the island is designated a Wilderness. There are relatively few small vertebrates present, probably because they are negatively affected by the presence of the feral livestock. Besides trampling, horses consume acorns, Spanish moss, and graze herbaceous understory plants, all food for small mammals and secondarily for reptiles. Besides trampling, hogs root decaying logs and stumps and eat small vertebrates. A mud turtle was once found by CR that had been smashed by trampling. Basic natural history information is required to understand future changes in populations of small vertebrates. Herein we present data on the diet of several species of lizards of Cumberland Island to help understand local population biology as well as to offer comparison between Cumberland Island populations and populations that have been studied elsewhere.

A total of 63 lizards from Cumberland Island was opportunistically collected and preserved over the last three decades by CR. All were taken by salvage (found dead on the road, drowned, or otherwise accidentally killed) from throughout the island and in various areas and months. Most were adults but various size and age classes were included. The lizards' stomachs were removed and sent to JOW. The contents were removed from the stomachs and placed in ethanol in Petri dishes, identified using a 10–70× zoom microscope (Olympus America SZH, Melville, New York), and the percent volume of each item from each stomach was estimated by visual observation (Whitaker et al. 2009). Visual observation was used because there were too many small pieces to bring them together to measure by water displacement. Data were summarized (Table 1) and total percentage volumes ([sum of individual volumes of food]/[total volume of all samples] × 100) were calculated for each food item. Percent frequency ([number of stomachs containing that food]/[total number of stomachs] × 100) was also calculated for each species, indicating the percentage of lizards eating a particular food. We hope that these data will serve as a baseline for further studies of the lizard community in this protected area.

Aspidoscelis sexlineata (Six-lined Racerunner).—The major foods of this species in our sample were spiders, caterpillars, crickets, and cercopids, those items totaling 75.9% by percent volume (N = 24, Table 1). Grasshoppers and crickets, leafhoppers and planthoppers, and spiders are consistently reported as the major foods of this species (Ballinger et al. 1990; Burt 1928; Force 1925; Hamilton and Pollack 1961; Hardy 1962; Hartman 1906; Paulissen 1987; Paulissen et al. 1997; Punzo 1990; Taylor et al. 2011). Adults and larvae of beetles and lepidopterans are frequently reported as well, and various authors (Burt 1928; Hardy 1962; Taylor et al. 2011) have reported land snails as a minor part of the diet of Six-lined Racerunners. In our sample caterpillars were eaten by 42% of individuals and formed 19% of the volume, but mollusks did not appear in our samples. A small amount of plant material (most bits of leaves) was found, probably taken incidentally. The diet of this species on Cumberland Island closely resembled that as reported in the literature except that caterpillars were perhaps more important, and few grasshoppers appeared in our sample.

Anolis carolinensis (Green Anole).—The main food items of the Green Anole in our sample (N = 11, 82.4% volume) were caterpillars, crickets, flies, chrysomelid and carabid beetles, true bugs, spiders, and ants (Table 1). Most anoles (*Anolis* spp.) are primarily insectivorous, but will also feed on plant matter, including leaves, fruit, and nectar (Bartlett 1995; Lazell 1972). While there are many studies of *A. carolinensis* in captivity, little is known of its diet in the wild. Individuals have been observed feeding on nectar and pollen (Himes 1998a; Liner 1996; McCoid 1994), sometimes in conjunction with foraging for arthropods (Campbell and Bleazy 2000). They have also been observed feeding on scorpions, lizards, and possibly bald-faced hornets (Buttenhoff and Hopkins 1996; Himes 1998b; Hughes and Parmalee 1993). Hamilton and Pollack (1961) reported flies, beetles, wasps, and caterpillars in stomachs of six individuals from Fort Benning, Georgia. No plant material was found in our study. Results were similar to those of the other Georgia study (Hamilton and Pollack 1961) except that we found no wasps, whereas they found no crickets, true bugs, or spiders. However, in both Georgia studies, samples were small and the diet appeared to be rather diverse. More study is needed on this species in the wild.

Sceloporus undulatus (Eastern Fence Lizard).—The food most commonly eaten by the Eastern Fence Lizard on Cumberland Island (N = 5, Table 1) was ants (Formicidae, 41% volume, 100% frequency), followed by caterpillars, true bugs, and spiders. These items totaled 87.0% of the food. Elsewhere the Eastern Fence Lizard usually feeds heavily on ants, but other small prey such as grasshoppers, beetles, various larvae, and spiders are often eaten as well (Burt 1928; Force 1925; Hamilton and Pollack 1961; Hartman 1906; McCauley 1939). Carr (1940) stated that beetles and their larvae were the major foods of Florida individuals, but noted that snails were found in a few. The food of this species on Cumberland Island was similar to that elsewhere.

Plestiodon inexpectatus (Southeastern Five-lined Skink).—The sample from Cumberland Island consisted of only two individuals (Table 1), one of which had eaten a wasp, apparently the first record for this species. The other had eaten spiders. Orthopterans and beetles accounted for approximately half of the diet by volume of 24 individuals from Fort Benning, Georgia (Hamilton and Pollack 1961). Rundquist and Collins (1974) found the

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TABLE 1. Food of seven species of lizards from Cumberland Island, Georgia. %V = percent volume; %F = percent frequency.

Food	*Aspidoscelis sexlineata* (N = 24) %V	%F	*Anolis carolinensis* (N = 11) %V	%F	*Sceloporus undulatus* (N = 5) %V	%F	*Plestiodon inexpectatus* (N = 2) %V	%F	*Plestiodon laticeps* (N = 4) %V	%F	*Scincella lateralis* (N = 5) %V	%F	*Ophisaurus ventralis* (N = 12) %V	%F
INSECTS														
Odonata: Zygoptera (damselflies)	0.8	4.2	—	—	—	—	—	—	—	—	—	—	—	—
Psocoptera	—	—	—	—	—	—	—	—	—	—	2.0	20.0	—	—
Homoptera														
Cercopidae	4.8	12.5	—	—	—	—	—	—	—	—	2.0	20.0	—	—
Cicadellidae	0.2	4.2	5.0	18.2	—	—	—	—	—	—	—	—	—	—
Hemiptera (true bugs)														
Lygaeidae	—	—	1.4	9.1	8.0	20.0	—	—	—	—	—	—	—	—
Pentatomidae	—	—	—	—	6.0	20.0	—	—	—	—	—	—	—	—
Hemiptera, unid./misc.	1.7	8.3	9.1	9.1	—	—	—	—	—	—	3.0	20.0	0.3	8.3
Neuroptera														
Sisyridae	0.8	4.2	—	—	—	—	—	—	—	—	—	—	—	—
Hemerobiidae	0.4	4.2	—	—	—	—	—	—	—	—	—	—	—	—
Coleoptera (beetles)														
Scarabaeid larvae	—	—	—	—	2.0	20.0	—	—	2.5	25.0	—	—	—	—
Elateridae, adult	0.8	4.2	3.6	9.1	—	—	—	—	18.0	25.0	3.0	20.0	—	—
Elateridae, larvae	0.4	4.2	—	—	—	—	—	—	—	—	—	—	—	—
Chrysomelidae	1.0	12.5	6.8	18.2	—	—	—	—	11.7	25.0	—	—	—	—
Curculionidae	—	—	—	—	2.0	20.0	—	—	—	—	—	—	—	—
Carabidae	—	—	4.6	18.2	4.0	20.0	—	—	—	—	—	—	1.3	8.3
Coleopteran larvae, unid.	1.7	4.2	0.9	9.1	—	—	—	—	—	—	—	—	—	—
Coleoptera, unid./misc.	2.9	12.5	6.4	27.2	3.0	40.0	—	—	9.3	50.0	2.0	20.0	3.0	16.7
Diptera (flies)														
Muscidae	—	—	2.7	9.1	—	—	—	—	—	—	—	—	—	—
Diptera, unid./misc.	—	—	8.2	18.2	—	—	2.5	50.0	—	—	—	—	0.2	8.3
Lepidopteran larvae	18.8	41.7	19.6	36.4	23.0	60.0	—	—	21.3	25.0	14.0	60.0	21.3	41.7
Hymenoptera														
Formicidae (ants)	0.8	4.2	7.7	18.2	41.0	100.0	—	—	—	—	—	—	—	—
Vespidae and other wasps	1.3	4.2	—	—	—	—	50.0	50.0	—	—	—	—	—	—
Hymenoptera, unid./misc.	0.2	8.3	—	—	—	—	—	—	—	—	—	—	—	—
Orthoptera														
Gryllidae (crickets)	18.8	41.7	12.7	18.2	—	—	—	—	—	—	21.0	40.0	44.0	83.3
Acrididae (grasshoppers)	2.9	8.3	—	—	—	—	—	—	—	—	—	—	7.1	25.0
Unidentified insect	3.3	8.3	—	—	2.0	20.0	—	—	—	—	8.0	20.0	—	—
CRUSTACEANS														
Brachyura (crabs)	—	—	—	—	—	—	—	—	—	—	4.0	20.0	—	—
Amphipod	—	—	—	—	—	—	—	—	3.8	25.0	—	—	—	—
Isopoda	2.1	12.5	—	—	—	—	—	—	—	—	3.0	20.0	—	—
ARACHNIDA														
Araneae (spiders)	33.5	70.8	9.6	18.2	9.0	40.0	47.5	50.0	33.3	25.0	35.0	100.0	19.6	33.3
Acari: Ixodida (ticks)	—	—	—	—	—	—	—	—	0.7	25.0	—	—	—	—
Phalangiidae	—	—	—	—	—	—	—	—	—	—	3.0	8.0	—	—
CHILOPODA	0.4	4.2	1.8	9.1	—	—	—	—	—	—	—	—	—	—
GASTROPODA (snails)	—	—	—	—	—	—	—	—	—	—	—	—	0.3	8.3
VEGETATION	2.3	12.5	—	—	—	—	—	—	—	—	—	—	—	—
Totals	99.9	100.1		100.0		100.0		100.6		100.0		100.5		

most frequent foods of 12 individuals from Kentucky to be spiders, crickets, and cockroaches. Our sample is too small to make any comparisons.

Plestiodon laticeps (Broad-headed Skink).—The foods accounting for the greatest volume in our sample (N = 4, Table 1) were spiders, elaterid and chrysomelid beetles, and caterpillars, comprising 84.3% of the diet. Orthopterans are apparently the major food of this species elsewhere, although many other arthropods, including beetles, lepidopterans, various larvae, isopods, and spiders, are also eaten, and vertebrates occasionally occur in the diet (Franklin 1999; Hamilton and Pollack 1961; Vitt and Cooper 1986). There are reports of this species feeding on fruit (Patton and Messinger 2002; Sorrell et al. 2006; Vitt and Cooper 1986), but it is evidently not a major component of the diet. On Kiawah Island, South Carolina, the prey of 64 individuals consisted mainly of species found in leaf litter or under surface objects (Vitt and Cooper 1986). Because of our small sample size, comparisons to other studies would not be particularly meaningful. CR observed a Broad-headed Skink catch and consume a carpenter bee, *Xylocopa* sp., apparently the first report of this food for this species.

Scincella lateralis (Little Brown Skink).—On Cumberland Island, the most important foods by percent volume from this species (N = 5, Table 1) were spiders, crickets, and caterpillars, totaling 70% of the diet by volume. This species is most often reported to feed on beetles, various larvae, and spiders, though a wide variety of other prey, including millipedes, amphipods, snails, and occasionally vertebrates, are also eaten (Brooks 1963; Burt 1928; Hamilton and Pollack 1961; Lewis 1951; McCauley 1939). Spiders, found in all the Cumberland Island stomachs, were also found in high frequencies in other studies of this skink (Brooks 1963; Hamilton and Pollack 1961; Lewis 1951, Slater 1949). Few beetles were found in our sample, but it was small and otherwise our sample was similar to those elsewhere.

Ophisaurus ventralis (Eastern Glass Lizard).—The most important foods of 12 Eastern Glass Lizards from Cumberland Island by both volume and frequency (Table 1) were crickets and grasshoppers, caterpillars, and spiders, totaling 84.9% of the volume. Hamilton and Pollack (1961) examined the stomach contents of 162 individuals of this species from Georgia and Alabama, most taken in July and August. Caterpillars accounted for nearly half the volume, with most of the rest being isopods, orthopterans, and beetles. Lizards and snakes were occasionally eaten. Orthopterans and spiders formed a higher proportion of the food in our sample, caterpillars a lower proportion.

The main food items of the lizards we examined from Cumberland Island were mostly similar to foods eaten by those species elsewhere. Main items of most were spiders, crickets, and caterpillars, although some species fed secondarily on true bugs and/or beetles, and Eastern Fence Lizards fed heavily on ants (41% volume, 100% frequency). Lizards feed based on availability, yet there is specialization to some degree, as illustrated by the utilization of ants by the Eastern Fence Lizard. Such differences may relate to differences in habitat, to different adaptations, or preferences of the lizards.

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TECHNIQUES

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Radio-Transmitter Attachment Method for a Small Burrowing Lizard

Research using radio telemetry is central to our understanding of animal behavior under natural field conditions, and is a valuable method for accruing important ecological information such as estimates of home range size, habitat use, habitat fidelity, and dispersal distance for all types of wildlife (Naef-Daenzer et al. 2005; White and Garrott 1990). Information collected can also provide direction when designing and implementing wildlife management strategies or investigating hypothesis driven research questions (Knapp and Abarca 2009). An overwhelming proportion of animal species are small (<20 g), and with reduction in mass and volume of transmitters, telemetry applications can be expanded to new taxa whose spatial behavior and population dynamics are largely unknown, such as arthropods, amphibians, reptiles and fish (Naef-Daenzer et al. 2005). One of the major limitations in radio telemetry is developing a reliable and safe attachment technique since radio-transmitters can affect mobility, increase visibility, or reduce the ability to perform certain behaviors (Blomquest and Hunter, Jr. 2007). An assortment of transmitter attachment methods are available for use on squamates and non-squamates (Hagen et al. 2011; Richmond 1998; Ussher 1999; Warner et al. 2006; Wikelski et al. 2006), and as telemetry becomes increasingly popular, new approaches are being introduced (Brewer et al. 2011; Knapp and Owens 2005; Logue 2007).

Aspidoscelis sexlineata, the Six-lined Racerunner, is a small burrowing lizard in the family Teiidae that is common and widely distributed throughout much of the United States (Conant and Collins 1998; Trauth and McAllister 1996) with the exception of Michigan where it only occurs in one location (Harding 1997; Harding and Holman 1990). Field work to monitor this population since May 2005 indicates low recruitment from juvenile to adult age/size class suggesting that the population may be at carrying capacity. *Aspidoscelis sexlineata* occupies a south-facing hillside located adjacent to a busy road. The lizards prefer bare, sparse, or thick vegetation over forested areas making habitat loss due to natural succession a cause for concern. Even normal roadside maintenance (e.g., mowing, pesticide application) could be a threat to such a small localized population. Recently elevated to Threatened Species Status (Michigan DNR 2009) in the state, data on daily and seasonal movements, habitat use, and home range size for individuals of this isolated population are critical to the development of a science-based management plan for this species in Michigan. Using radio telemetry on such a diminutive creature (mean mass = 5.3 g ± 0.3 g S.E., N = 23; Yoder 2007) presents a variety of challenges including locating individuals, soil interference with transmitter signal, loss of transmitter and animal injury or impairment. Our study is the first to use radio-transmitters on a lizard of this size and habit.

We initiated our radio-telemetry studies in June 2009 on *A. sexlineata* by following the method of Knapp and Owens (2005), who successfully attached transmitters to hatchling iguanas on Andros Island, Bahamas. This method uses monofilament (fishing) line to secure the transmitter anterior to the hind legs of the lizard. We did not try using Tygon tubing as suggested by Knapp and Owens (2005) because we deemed it would be cumbersome to the lizards given their small size. Transmitters used to track *A. sexlineata* were model A2414 (12 mm × 3 mm × 5 mm) from Advanced Telemetry Systems (ATS; Isanti, Minnesota, USA) with a mass of 0.3 g and average battery life of 3 weeks. Transmitters were encapsulated in a waterproof epoxy. They had an attachment tab containing a 1-mm hole on the anterior end and a 10.2 cm long AS-633 super light, flexible stainless steel wire antenna on the posterior end. Only lizards with a mass greater than 3.5 g were selected for transmitter attachment. All transmitters were attached in the field. Lizards were tracked on a south-facing hillside using a hand-held 3-element Yagi directional antenna and R410 Scanning Receiver from ATS. At the end of tracking, efforts were made to locate lizards before they emerged from their burrows, and if located, lizards were dug up to remove transmitters. Of the first six lizards to which transmitters were attached, one was never recaptured. A second lizard experienced significant skin abrasion from the monofilament line and a third suffered a severe laceration on a hind leg. The fourth lizard died when the monofilament slipped over both hind legs and rendered the animal immobile when the antenna became tangled in an underground root system. A fifth lizard escaped the transmitter with monofilament line intact. The sixth lizard was found dead

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on the surface with cause of death unknown. Of the two lizards recaptured for transmitter removal both lost mass, 0.2 g and 1.0 g. All recovered transmitters had lost antennae.

As a result of these negative effects, we modified the technique to be less harmful. During the remainder of the 2009 field season and in 2010, we substituted 0.5 mm diameter Stretch Magic bead and jewelry cord for the monofilament fishing line to attach transmitters. The transmitters were placed on the lizard's dorsal surface of the pelvic girdle, and secured with the bead cord wrapped snuggly around the lizard's body anterior to the hind legs and finished with a square knot. A drop of Gorilla Super Glue was placed on the knot to prevent it from slipping, and extra bead cord was trimmed after the glue dried (Fig. 1). On the bottom of the transmitter, a drop of glue was also placed to help hold it in place on the animal's dorsal surface. However, we discovered that this only triggered a shedding response and was not effective; therefore, this step was abandoned for all subsequent attachments. Transmitter antennae were trimmed to 1.3 cm.

Using the modified technique, *A. sexlineata* tracking was conducted from 29 June to 3 September 2009 and 25 June to 15 September 2010 at Murphy Lake State Game Area in Tuscola Co., Michigan. Drift fences and pit-fall traps were used to capture lizards in habitat composed of mostly sandy soils with sparse to thick grassy vegetation and various trees scattered throughout. During the 2009 field season, 11 lizards were fitted with transmitters via the modified method and another 14 lizards were fitted in 2010. Lizards ranged from 3.6–9.9 g in body mass (mean = 6.1 ± 0.2 g) and 51.1–71.5 mm in snout–vent length (mean = 59.3 ± 0.8 mm). Knapp and Abarca (2009) suggest a general rule that transmitter to body mass ratio for lizard species should not exceed 7.5%. Transmitter mass in this study represented 3–8% (mean = 5 ± 0.2%) of an individual's body mass. All transmitters were under 7% of the lizard's body mass, except for one, which was 8%.

Of the 25 lizards fitted with transmitters after modification, one lizard died, and two lizards slipped the transmitter attachment, leaving 22 lizards, which we were able to successfully track. Of these 22 lizards, 14 were recaptured for transmitter removal; our inability to recover the remaining lizards was mostly due to early battery failure. Before attachment, mean mass was 5.9 ± 0.3 g (N = 22). Most recaptured lizards increased mass (mean = +0.43 ± 0.08 g; N = 11); one stayed at pre-attachment mass and two lost mass (mean = –0.15 ± 0.05 g). None of these lizards were gravid. One lizard recaptured in 2010 was fitted with a transmitter from the previous year. This transmitter was attached for 340 days and was easily removed with only superficial skin abrasion. All other outfitted lizards recaptured had transmitters attached for a range of 12 to 21 days (mean = 16 ± 0.4 days). Transmitters were easily removed and also produced only superficial skin abrasions. After transmitter attachment mean mass was 6.4 ± 0.3 g, with a sample size of 14.

Radio telemetry studies require the assumption that an animal's movements and behaviors are not affected by the researchers' methods or techniques (White and Garrott 1990). Our modified method for attachment appears to have no significant effects on the racerunners abilities to run, climb or capture and eat prey. Lizards with transmitters were tracked every two hours for 12 to 21 days. Lizards with transmitters were observed foraging, climbing and running in the same fashion as lizards without transmitters. In June 2010, a lizard without a transmitter was observed eating a Green Danner Dragonfly and in August 2010, an individual with a transmitter was observed eating a large cicada.



FIG. 1. Radio transmitter A2414 from Advanced Telemetry Systems attached to *Aspidoscelis sexlineata* using the modified attachment method.

One downfall to this method is that there is no breakaway mechanism that would allow transmitters to break off as the lizard grows. However, we feel that since natural longevity for most individuals is only 2–3 years (Fitch 1958), the issue of transmitters constraining growth should not be an issue. There is little material needed for this attachment method, making it a quick and convenient procedure, only taking a few minutes to complete in the field. This attachment method has allowed us to reveal previously unknown aspects (e.g., dispersal movements, daily activity movements, burrowing locations, and home range size) of this lizard's behavior and ecology in one of its most northern populations. One particularly interesting discovery was the observation of a dispersal event. We witnessed a lizard move 310.4 m from an area of known habitat to private property previously not known to be occupied by lizards, doubling the known area occupied by lizards. This method should be applicable to other animals of similar size and habit.

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What the World Needs Is a Better Gopher Tortoise Trap

It is often necessary to capture Gopher Tortoises (*Gopherus polyphemus*) for research or to relocate them from sites slated for development. Tortoises may be captured by hand (McRae et al. 1981), snares, or pulling hooks (Diemer 1992), but most researchers set pitfall (bucket) traps (Breininger et al. 1991; Diemer 1992; Diemer Berish et al. 2000; Landers et al. 1980; McRae et al. 1981; Seigel et al. 2003; Tuberville et al. 2005) or wire live traps (Aresco and Guyer 1999; Brown et al. 1999; Boglioli et al. 2003; Diaz-Figueroa 2005; Eubanks et al. 2003). Many of these capture techniques are labor intensive and their effectiveness depends upon such variables as habitat, burrow location and conformation, season, weather, and trapping expertise.

Pitfall traps consist of 19-L plastic buckets buried at the mouth of adult *G. polyphemus* burrows, with smaller buckets or cans for subadult or juvenile tortoises. Commercially available wire live traps manufactured by Tomahawk™ or Havahart® have one or two doors and a treadle mechanism on the floor that closes the door(s) when triggered by an animal entering the trap.

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These traps are set facing the entrance to a tortoise burrow and the treadle mechanism is usually camouflaged with loose sand. The minimum trap size recommended for an adult tortoise is 25 x 61 cm and at least two sizes are needed to trap all size classes typically present in a group of *G. polyphemus* (Ashton and Ashton 2008). Ashton and Ashton (2008) claimed that pitfall and wire live traps were equally efficient at catching tortoises.

Wildlife technicians at Blackwater Wildlife Management Area (WMA) in Florida designed and constructed a new type of wire live trap (flap trap) that they hoped would be easier to install, safer for tortoises, and less disruptive of the burrow microenvironment than pitfall traps. We tested the effectiveness of the flap trap at catching tortoises, compared its trapping efficiency with that of pitfall traps at the same study site, and assessed the relative merits of flap traps, pitfall traps, and wire live traps.

Materials and Methods.—The flap trap sits atop the tortoise burrow entrance and has a one-way trap (flap) door on its floor that a tortoise pushes up when it exits the burrow and that falls shut behind the tortoise once it has fully entered the trap (Fig. 1). The flap door is hinged at the end of the trap closest to the burrow mouth. As the flap opens when a tortoise enters, contact with the top of the trap ensures that the flap will not flip backward and remain open (Fig. 2). In order to achieve a seamless transition between the burrow runway and the edge of the flap-door opening farthest from the hinge, loose sand can be dropped through the top of the trap to ensure that the edge of the flap-door opening is flush with the soil surface. It may be necessary to manually flatten a portion of the burrow apron (mound) to ensure proper positioning. The crawl space must be high enough for a tortoise to exit its burrow without pushing up the body of the trap before encountering the flap door, so adjustments to the position of the trap may be necessary. A tent stake placed on each side of the trap near the hinge of the flap door (Fig. 1) can prevent a tortoise from displacing the trap but may not be necessary for smaller

burrows. Traps may not sufficiently occlude burrow entrances that are large, eroded, or angled; if a tortoise could exit its burrow without entering the trap, soil or logs may be used to block these spaces.

The dimensions of these flap traps are 91 × 61 × 28 cm and the traps are constructed of 14-gauge, 2.54- × 2.54-cm welded cage wire (rabbit wire). A 3.8-m length of 61-cm-wide wire will make one trap (Fig. 3). Besides welded cage wire, materials required for making flap traps are wire cutters or fencing pliers for cutting the wire and ca. 70 J-clips and J-clip pliers for assembling the trap. A 30.5-m roll of wire cost us US$87–134 depending upon the supplier, and one roll made eight traps; each trap cost ca. US$15 in materials. Instead of separately cutting out pieces for the top, bottom, front, and back of the trap, a long piece can be folded to create these pieces (Fig. 3), and only the top and front or back of the trap need to be clipped together, saving construction time and requiring ca. 30% fewer J-clips.

We conducted preliminary tests on the effectiveness of flap traps in the Florida panhandle at Joe Budd Wildlife Management Area (WMA), Blackwater WMA, Pine Log WMA, and Eglin Air Force Base (AFB) in August–September 2008. We checked traps twice daily at 1100–1200 h and 1700–1800 h EDT. The habitat at the latter three sites was sandhill, but at Joe Budd WMA, we trapped in a pasture and along road edges and in clearings in a mixed pine-hardwood forest. If a trap lacked canopy cover, we cut Saw Palmetto (*Serenoa repens*) fronds and laid them over the top of the trap for shade.

We tested the relative effectiveness of pitfall traps vs. flap traps from 13 May through 14 June 2009 in a recently thinned and burned Slash Pine (*Pinus elliottii*) plantation in mesic flatwoods habitat at the Plum Creek/Lochloosa (PCL) site in Alachua County, Florida (Diemer Berish et al. 2012). We did not test wire live traps vs. flap traps. On 13 May, an 8-person team set 63 pitfall and 13 flap traps at potentially occupied burrows, including any with recent tortoise sign. From the potentially occupied burrows identified, we randomly selected 13 burrows for flap traps. We set traps in the morning when tortoises should still have been in their burrows and checked traps each morning. Additional traps of both types were deployed when burrows previously classified as abandoned showed evidence of tortoise use or when new burrows were found. Pitfall traps were 19-L or 11-L white buckets or 4-L black planting containers (depending upon the size of the burrow opening) with holes drilled in the bottom. These traps were sunk directly in front of burrow openings, covered with aluminum foil or newspaper, and camouflaged with loose sand. We shaded pitfall traps with tent-like covers constructed of aluminum (white ceiling soffit) to prevent trapped *G. polyphemus* from overheating. We shaded flap traps with aluminum foil-backed foam sheathing boards (reflective side up) laid on top of the half of the trap closest to the burrow entrance. We cut 61- × 46-cm shade covers from 1.2- × 2.4-m foam sheets and typically attached them to traps using plastic cable ties fed through holes punched in two diagonally opposite corners of the foam sheet. If loose sand or a heavy object is placed atop shade covers to hold them in place, traps may not have to be staked to prevent displacement by tortoises.

To compare the probabilities of capturing a tortoise by pitfall traps vs. flap traps, we performed nonparametric time-to-event analysis using the R statistical environment (R Development Core Team 2009) with the Survival package (Therneau and Lumley 2009). We computed Kaplan-Meier product-limit estimators (Harrell 2001) of the cumulative probability that a trap will have

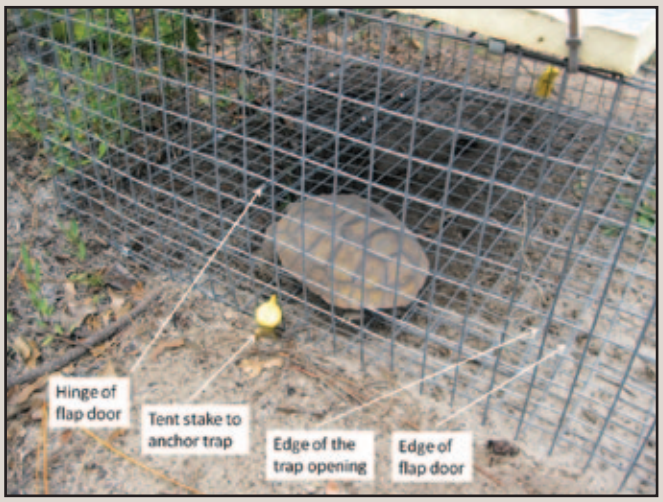


PHOTO BY ALLAN WOODWARD

FIG. 1. A flap trap showing the location of various parts of the trap and proper positioning atop a burrow. The edge of the flap door overlaps the edge of the opening by one square of mesh and the edge of the trap opening is flush with the entrance ramp into the burrow.



PHOTO BY KEVIN ENGE

FIG. 2. A flap trap with the flap door manually raised.

successfully captured a targeted tortoise emerging from its burrow a specified number of days after being set, while taking into account that, because of flooding or termination of the trapping period, some traps were removed before they had captured a tortoise. Removing a trap corresponded to right censoring the time that passed before it had captured a tortoise. We employed the surv and survfit functions from the Survival package to estimate the functions describing capture probability, and we used the survdiff function to compare the estimators for pitfall and flap traps by log-rank test.

Results and Discussion.—During our preliminary tests of flap traps in the panhandle, in two days of trapping, we captured two tortoises in 13 traps at Blackwater WMA, six tortoises in 16 traps at Eglin AFB, six tortoises in 11 traps at Joe Budd WMA, and nine tortoises in 15 traps at Pine Log WMA. During our comparison of flap and pitfall traps at the PCL site, most tortoises (64%) were captured in the first five days of trapping in May, with both trap types successfully capturing tortoises. Thereafter, captures tapered off. No tortoise was trapped in flap

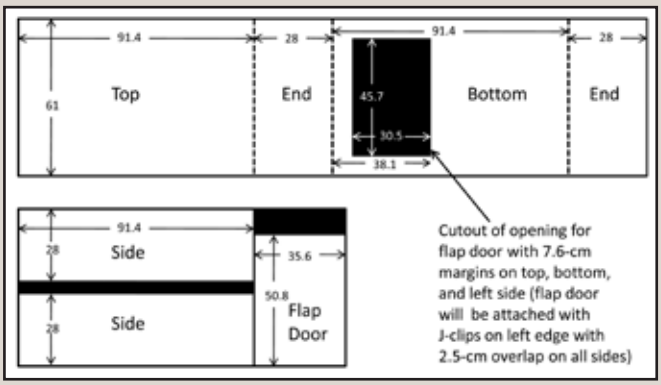


Fig. 3. Schematics of pieces needed to construct one flap trap from 14-gauge 2.54- × 2.54-cm welded cage wire (measurements are in cm and dashed lines indicate sections that can be folded instead of cut out).

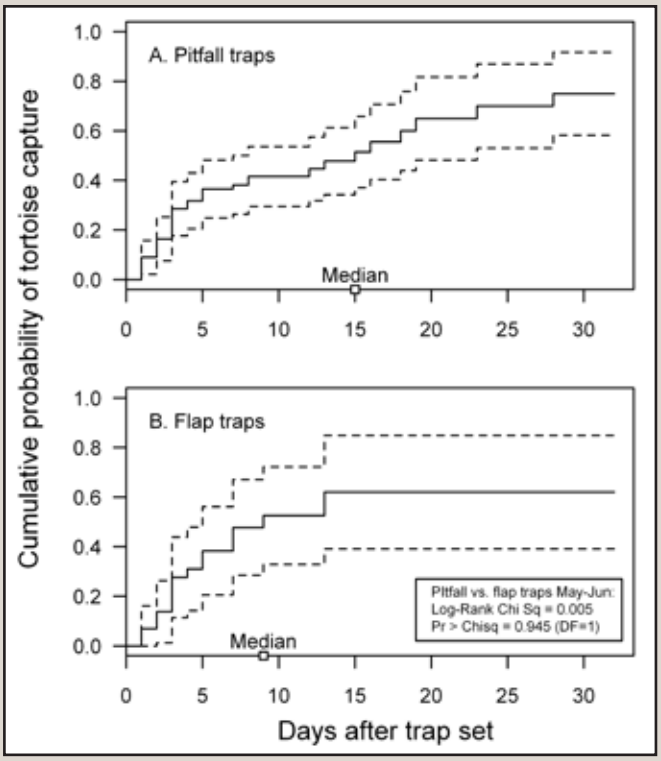


Fig. 4. Comparison of estimated cumulative *Gopherus polyphemus* capture probability between pitfall traps (above) and flap traps (below) during May–June 2009 on the Plum Creek/Lochloosa study site, Florida. Estimated median number of days until tortoise capture is indicated on the abscissa of each plot and 95% confidence limits are dashed.

traps after the first 13 days, whereas six tortoises were trapped in pitfall traps 15–28 days later (Fig. 4). Tortoises trapped in pitfall traps might have been entering burrows instead of exiting them. Capture rates for all tortoises in traps set on the primary trap placement day (13 May) were 68% after 7 days and 78% after 14 days. Capture success of individual tortoises by flap traps during the 13 May–14 June trapping period was 60%, although we never determined whether tortoises were actually present in burrows. When cumulative capture probability of pitfall traps vs. flap traps was compared for 13 May–14 June, the difference was not significant (χ^2 = 0.005, df = 1, P = 0.95; Fig. 4), despite pitfall traps potentially trapping tortoises entering and exiting burrows.

In a previous study in northern Florida involving three sites, including the PCL site, and 11 site-years of trapping, 0.67 tortoises per pitfall trap (excluding recaptures) were captured, and a mean of 76% (range 50–90%) of tortoises was captured within 14 days of traps being set in early or mid-May (Diemer 1992). At two sites during a five-year period, 90–100% of tortoises were captured by the 28th day, but only 64% were captured by the 28th day during one year of trapping at the third site, although 93% had been captured by the 34th day (Diemer 1992). Even in summer, some tortoises may not emerge from their burrows for at least one month (Ashton and Ashton 2008).

Tortoise size did not seem to determine whether a tortoise was captured in flap traps. The smallest tortoise trapped in a flap trap measured 90 mm carapace length. During a later study, we trapped a hatchling tortoise that we suspect entered when the door was pushed up by an adult tortoise that escaped, as evidenced by the presence of adult feces in the trap.

Nontarget species were occasionally trapped in flap traps. We trapped two adult Gopher Frogs (*Lithobates capito*) in flap traps at the PCL site, indicating that they were able to push the door open far enough to enter a trap. We captured two Nine-banded Armadillos (*Dasypus novemcinctus*) together in a flap trap that had been set for three days. We released the armadillos and replaced the trap at the burrow and trapped an adult female tortoise nine days later. We have used flap traps elsewhere to trap nuisance armadillos from their burrows in yards, and this use for flap traps may prove at least as popular as for *G. polyphemus*. A flap trap set at a *G. polyphemus* burrow in Hillsborough County, Florida, captured four juvenile Argentine Giant Tegus (*Tupinambis merianae*) in less than one day, although one tegu was small enough to escape through the wire mesh when approached (B. Kaiser, pers. comm.).

We assessed the relative merits of the three types of tortoise traps by looking at 21 attributes (Table 1). The flap trap had 13 positive attributes, whereas the wire live trap had 12 positive attributes and the pitfall trap nine positive attributes. These attributes are discussed in more detail below. We did not include the important attribute of trapping efficiency because wire live traps were not tested in our study. A study in Georgia using 278 wire live traps indicated that the wire live trap was at least as efficient as the other two types of traps at catching *G. polyphemus*; all tortoises were captured by the 23rd day, with a mean capture time of 4.2 days and a median capture time of three days (C. Guyer, pers. comm.). However, the Georgia study is not directly comparable because all burrows were known to contain tortoises and different environmental conditions may have affected tortoise activity and behavior.

A burrow may contain more than one tortoise and flap traps allow multiple captures at the same time; pitfall and wire live traps rarely catch two tortoises. A pitfall trap can catch tortoises entering or exiting a burrow, whereas wire live traps and flap traps capture only exiting tortoises. Thus, pitfall traps have an advantage when the goal is to catch as many tortoises as possible, but they have a disadvantage when trying to verify burrow occupancy. Tortoises rarely escape from traps of any type, but in our studies, a tortoise avoided entering a flap trap by dislodging it and another tortoise dug under one side of a trap.

The probability of death of trapped tortoises varies among traps. Tortoises trapped in pitfall traps can drown and are probably more susceptible to predation and overheating. We

TABLE 1. Relative merits of three types of *Gopherus polyphemus* traps (wire trap refers to a commercial Tomahawk™-type trap), with ++ indicating a highly positive attribute, + a slightly positive attribute, – a slightly negative attribute, and –– a highly negative attribute.

Attribute	Pitfall Trap	Flap Flap	Wire Trap
Cost	++	–	––
Trap assembly time	+	––	+
Trap installation time	–	+	+
Ease of installation (includes equipment needed)	–	+	+
Ease of transport and storage (assuming noncollapsible traps)	+	–	–
Trap durability (multiple reuse)	–	+	+
Capability of multiple captures without being reset	–	+	–
Amount of stress to captured tortoises	–	+	+
Likelihood of injury	+	–	–
Likelihood of burrow abandonment by trapped tortoise	–	+	+
Probability of death of trapped tortoises by			
drowning	–	+	+
overheating	+	–	–
predation	–	+	+
Potential for trap being tripped by nontarget species	–	+	+
Amount of disturbance to apron and burrow runway	––	+	+
Potential for trap being tripped by rainfall or other abiotic events	–	+	+
Capability of two-way captures (leaving or entering burrow)	+	–	–
Potential for destruction of eggs	–	+	+
Flexibility of installation (% of burrows that cannot be trapped)	+	–	–
Capability of capturing all sizes of tortoises (size bias)	++	+	–
Probability of trap being stolen	+	–	–

experienced no mortality of tortoises in pitfall or flap traps, even in the study in August–September using unshaded flap traps. However, we had to replace flooded pitfall traps with flap traps after heavy rainfall in May at the PCL site to prevent the drowning of tortoises. Heavy rainfall probably affected tortoise emergence and resulted in flooding of 14 burrows at which traps had been deployed. Rainfall also occasionally caused the covers of pitfall traps to collapse under the increased weight of the waterlogged covering sand. (If we had used paper instead of aluminum foil, all the pitfall trap covers would probably have collapsed.)

Tortoises trapped in flap traps occasionally scraped their forelimbs and feet trying to burrow through the wire of the flap traps, but none of these injuries appeared serious enough to require treatment. This type of injury rarely occurs in wire live traps (C. Guyer, pers. comm.). Such injuries could be avoided by using a smaller mesh size of the same gauge for flap traps, but this also might deter some tortoises from exiting their burrows because of greater visibility of the traps. If we had checked our traps more than once a day, stress and injury to tortoises may have been reduced. Although the pattern was not found to be statistically significant, *G. polyphemus* exhibited an increase in the stress hormone corticosterone when left in a Tomahawk™ live trap for up to 12 h, suggesting that trapped tortoises do experience a biologically meaningful capture stress (Ott et al. 2000). Although not tested, one might expect that a large tortoise stuck head-down in a pitfall trap would be more stressed than a tortoise able to move around in a flap trap.

The cost of materials needed to construct one flap trap was ca. US $15. Cutting out and assembling a flap trap took about 1 h. In contrast, a Tomahawk™ or Havahart® 1-door wire live trap measuring 81 × 25 × 30 cm (25 cm is the recommended minimum width for adult tortoises) cost ca. US $60, excluding shipping. Used 19-L buckets for pitfall traps can sometimes be obtained for free, but new buckets usually cost ca. US $4 each. In addition, an electric drill is needed to create drainage holes and a shovel or a post-hole digger is needed to excavate the holes for placement of the buckets. A machete, pruner, and axe are also sometimes needed. Installation of flap traps often requires no tools, but a hand pruner and a shovel or trowel help modify burrow aprons for proper placement of some traps. Installing a 19-L bucket takes approximately four times as long as setting a flap or wire live trap, which typically takes 1.5–4.0 min, including staking down the trap and attaching a shade cover.

The difficulty of installing pitfall traps depends upon soil type and the degree of soil compaction; presence and size of surface or buried roots, stumps, or rocks; presence of shrubs or trees; presence of Red Imported Fire Ants (*Solenopsis invicta*); and other factors. Flap traps cannot be set effectively if a burrow opening is immediately under a large log or stump or at the base of a berm. Burrows with a heavily eroded entrance sometimes cannot be effectively trapped because exiting tortoises can avoid entering the trap. The percentage of burrows at which flap traps cannot be used depends upon habitat type, amount of coarse woody debris, shrub cover, and microtopography. At some sites, we were able to set flap traps at ca. 95% of burrows.

As with other traps, flap traps set in open areas should be shaded to prevent overheating of trapped tortoises. We recommend shading (either with natural or manufactured materials) the portion of the trap closest to the burrow opening, because our preliminary research suggests that a shade cover positioned

there is less alarming to an exiting tortoise, possibly because the cover is not in its line of sight. An additional benefit of a shade cover in this position is that a trapped tortoise will be able to rest in the shade on top of the relatively cool air from its burrow instead of being exposed to radiant heat from its burrow apron. At the PCL site, we often provided additional shading along the sides of the flap trap, which might have affected our trapping success by spooking exiting tortoises. We tended to have better trapping success in our preliminary study, in which most traps were not shaded, but seasonal or geographical differences may have affected success.

Pitfall traps are much easier to transport and take up less storage space than flap and wire live traps. A loop of rope or other material attached to one end or side of a flap trap can serve as a handle to assist in carrying traps in the field. Plastic buckets degrade over time, particularly if exposed to sunlight. Flap and wire live traps are galvanized and will last a long time, although J-clips exposed to the elements will eventually rust and need to be replaced on flap traps. Tomahawk™ makes a collapsible one-door wire live trap that costs ca. US $83 and requires 1/10 as much storage space as a flap trap. A flap trap could be made collapsible for transport and storage by not clipping together the top and sides of the two ends of the trap, which could be assembled in the field using plastic cable ties. A flap trap has 1.8 times the surface area of a wire live trap measuring 58 × 25 × 30 cm; thus, fewer can be transported or stored.

A major drawback of pitfall traps is disturbance to the apron and runway of the burrow. While digging the bucket hole, a clutch of tortoise eggs may be disturbed or damaged. Tortoises nest most frequently in the apron of active burrows, and eggs are present from May through October (Butler and Hull 1996), when tortoises are most active and likely to be trapped. We do not know whether the degree of burrow and apron disturbance affects the likelihood of a tortoise abandoning a burrow; if so, based on our research, flap traps would be less disruptive.

All three types of tortoise traps have advantages and disadvantages. When trapping tortoises during hot, humid Florida summers, we feel that the greater ease of installation and potentially reduced burrow impact and stress to tortoises of flap traps compared to pitfall traps offset their higher cost in terms of materials and construction labor.

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An Inexpensive, Minimally Invasive Method for Sampling Gastrointestinal Tract Bacteria in Snakes

Gastrointestinal tract (GIT) microbiota perform important functions and provide multiple benefits to humans and agriculturally important vertebrates and are an essential component of mammalian physiology (Bäckhed et al. 2004, Turnbaugh et al. 2006, Dethlefson et al. 2007). In humans and agricultural animals GIT microbiota protect hosts from pathogens, synthesize vitamins, break down indigestible substances, and influence nutrient uptake and body fat accumulation (Xu and Gordon 2003, Turnbaugh et al. 2006). Our understanding of the diversity and function of GIT microbiota is based primarily on studies of humans, laboratory mice, and agricultural animals but GIT microbiota may be of similar importance to wild vertebrates (Hill et al. 2008).

If GIT microbiota of wild vertebrates perform functions similar those observed in humans and domesticated animals (immunity, digestion, vitamin synthesis) they may in turn influence their survivorship, growth, and reproduction – important life history parameters that affect the population dynamics of all organisms (Stearns 1992). All wild vertebrates are subject to the possibility of periods of fasting due to variation in the availability of food in their environments (McCue 2006). The vertebrates for which the diversity and function of GIT microbiota have been well studied (humans, laboratory mice, and agricultural animals) feed at relatively constant intervals and have diets more uniform in composition than snakes. From a biodiversity standpoint the condition of experiencing periods without food is probably the more general and animals with a steady diet are the exceptions. If we are to understand the role of microbiota in vertebrates in general then their function should be studied in wild animals with variable feeding frequency.

Relatively few studies have examined the diversity of GIT bacteria in wild vertebrates. Several studies have examined the microbial communities present in wild fish GITs (Rawls et al. 2006, Roeselers et al. 2011, Sullam et al. 2012). The majority of studies of GIT bacteria in wild vertebrates have been done on mammals including 4 wild African ungulate species (Nelson et al. 2003), the ceca of wild capybaras (Garcia-Amado et al. 2011), wild parrots (Xenoulis et al. 2010), and developing tammar wallaby's and brushtail possums (Lentle et al. 2006). Gastrointestinal tract bacteria of two wild and one captive snake species have been characterized (Hill et al. 2008, Costello et al. 2010). None of these studies have examined the function of GIT bacteria.

The digestive physiology of snakes is quite different from mammals and birds (Secor and Diamond 2000) which facilitates their use as a model system to expand knowledge of the diversity and function of GIT microbiota. Snakes are capable of surviving much longer periods of starvation than most vertebrates (Wang et al. 2006). How do the snake GIT microbiota respond to periods when the GIT is devoid of food? Does the snake's microbiota contribute to its ability to rapidly digest large prey items? The answers to these and other questions will broaden our understanding of host-microbe interactions and will shed light on the dynamics and functions of GIT microbiota in wild vertebrates in general.

Few studies have used modern molecular methods to characterize the diversity of gastrointestinal tract bacteria in snakes. Preliminary studies have shown that snake GITs contain microbial communities similar in diversity and species composition to mammals, including humans (Hill et al. 2008, Costello et al. 2010). Hill et al. (2008) quantified the GIT bacterial communities in individual specimens of *Agkistrodon piscivorus* and *Crotalus horridus*. They found that bacterial species diversity and composition was similar to that of mammals and birds and included bacteria from the phyla Firmicutes and Bacteroidetes. Costello et al. (2010) compared the GIT microbial communities of fasted and digesting captive Burmese Pythons (*Python molorus*). They too found that Bacteroidetes and Firmicutes dominated the GIT flora but the structure of the community changed depending upon whether the snakes were fasting or digesting. Bacteroidetes dominated the GIT of fasting snakes but Firmicutes dominated the GIT of digesting snakes. Digesting snakes also contained more diverse microbial communities. Costello et al. (2010) pointed out the potential of snakes as model organisms for studying the function of GIT bacteria and the need for the development of a non-lethal procedure for sampling microbiota in the snake GIT.

Because snake GITs are a relatively straight tube it should be possible to sample the GIT microbiota without injuring the snake by inserting some type of device into the cloaca and anteriorly to the intestine. The ability to sample GIT microbiota without injuring the snake would further enhance the utility of snakes as a model organism for studies of diversity and function of GIT bacteria. In humans GIT bacteria have been sampled through the use of an endoscope (Knutson et al. 1982) but such a device is too large to be used in most snakes. In the present study we test the effectiveness of two versions of a minimally invasive sampling device for characterizing the bacterial communities in the gastrointestinal tracts of juvenile Prairie Rattlesnakes.

Materials and Methods.—The five, 2-year old juvenile Prairie Rattlesnakes (*Crotalus viridis*) we used in this study were captive raised offspring of snakes collected from South Dakota and North Dakota in 2008 and 2009. They had been used for laboratory experiments on starvation and metabolic rates but had been on a normal (non-starvation) diet for six months prior to

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our study during which time they were fed laboratory mice approximately once per week and given water *ad libitum*. Prior to sampling for GIT bacteria we measured the snakes for snout-to-vent length (SVL) and total length (TL) using a tape measure with an accuracy of +/- 1% of body length .We weighed snakes on a Sartorius Balance (Model BP31000S) to +/- 0.1 g. Snakes were anesthetized during measuring and weighing as described below so we did not use a squeeze box (Quinn and Jones 1974).

We constructed sampling devices by attaching an absorptive material to the end of a 28 gauge stainless steel wire (Fig. 1). We used two different absorptive materials on the sampling devices. One material was a small amount of cotton swabbing which we attached to the wire by doubling the wire back and twisting it around the cotton. The other absorptive material was a small, commercially available, dental hygiene brush (Go Betweens®, Proxabrush Refills®, Sunstar America Inc., Chicago, IL). We attached the wire end of the brush to the sampling device wire using epoxy. We inserted absorptive ends of the wires into 20 cm pieces of teflon tubing (1/8 inch outer diameter) and positioned the end with the absorptive material close to the end of the tube. The end of the Teflon tubing containing the absorptive material was sealed shut with molten paraffin wax. We sterilized the completed sampling devices by exposure to UV light (LABCONCO Class II Biosafety Cabinet, LABCONCO Corporation, Kansas City, MO) for 30 minutes using the protocol described in Cone and Fairfax (2003) and the functioning of the UV hoods are verified once per year.

Prior to sampling we induced a deep plane of anesthesia in snakes using inhalation of isoflourane at a dosage of 2 ml/kg snake body weight. The Isoflurane was volatilized in a small chamber that enclosed the snake's head, but also allowed ample ambient air to enter. We then sampled the live snakes for GIT bacteria using two different versions of our device. Each time we inserted our device into the cloaca and pushed it anteriorly until resistance was encountered. We randomized the order in which the two device types were used to sample snakes. The device was not lubricated. We measured the distance to which the device was inserted as distance from the snout so that we could determine which portion of the GIT was sampled (eg. posterior small intestine, anterior large intestine etc.) by a *postmortem* dissection and so we could resample the same area by dissection. Once the anterior end of the sampling device was in position we held the Teflon tube in position and pushed the wire anteriorly, forcing the absorptive material through the paraffin seal and into the lumen of the snake's GIT. We used a pair of pliers to move the wire because the absorptive end of the sampling device fit somewhat tightly in the tube and did not move freely. We exposed the absorptive material to the lumen for several minutes so it could absorb intestinal materials. We subsequently pulled the wire posteriorly and into the Teflon tube and withdrew the entire device from the intestine and cloaca. We cut the absorptive material from the wire with a pair of pliers which had been sterilized in ethyl alcohol and placed it in a 15 ml centrifuge tube containing 2 ml of distilled water for later analysis for microbial DNA. We stored the samples at -20° C until extraction of genomic DNA the next day.

After sampling we euthanized each snake by decapitation (while still under deep plane anesthesia), dissected the gastrointestinal tract, and located the region of the intestine that was previously sampled by measuring the distance from the snout. We inspected the region of the intestine that had been sampled for any damage possibly caused by sampling and then removed a two cm section of the intestine which included the area sampled. We then gently squeezed the contents of the removed piece of intestine into a sampling vial containing 2 ml of distilled water and stored the samples at -20° C.

We analyzed all samples for bacteria by extracting the DNA, amplifying the gene for the 16s small ribosomal subunit, and analyzing PCR products by denaturing gradient gel electrophoresis (DGGE) according to methods outlined in Hill et al. (2008). Denaturing Gradient Gel Electrophoresis is an established method for characterizing bacterial communities (Ercolini 2003). Bands were visualized under UV transillumination and total number of bands and band similarity among lanes was analyzed using Quantity One gel analysis software (Bio-Rad, Richmond, California). The similarity of banding patterns among electrophoretic lanes was calculated using Dice Similarity Coefficients. Dendrograms were created based on the grouping and relatedness between samples (each lane) and the amount of relatedness is indicated by the percentage bar above each dendrogram. We did not attempt to identify bacterial taxa by sequencing the DNA in the electrophoretic bands because our goal was only to compare the banding patterns obtained by the different sampling methods. This approach assumes that bands from separate samples in similar positions on the gel are the same bacterial species.

Results.—Snakes averaged 46.1 cm SVL (range 39.7 to 49.5, SD = 4.0), 49.3 cm TL (range 42.3 to 53.5, SD = 4.4), and 68.3 g in weight (range 53.6 to 96.6, SD = 18.3).

We successfully sampled the GITs of all snakes using both types of sampling device. All 10 sampling devices were reliably inserted to the level of the anterior large intestine at which point bends in the intestine prevented further anterior movement. *Postmortem* dissections showed no evidence of injury to the snake GIT as a result of our sampling.

Electrophoretic gel lanes from our samples contained an average of 20.5 bands (range 18 to 23, SD = 1.7) as determined by the gel analysis software (Fig. 2). The three sample methods (device with brush, device with cotton, and dissection) had an average of 19.2 bands in common (range 18 to 20, SD = 0.8, Table 1). Dice Similarity Coefficients indicated that the samples obtained by the three different methods from the same snake specimens clumped together and were approximately 88% or more similar (Fig. 3).

Discussion.—Results of our study indicate that our sampling devices are useful to sample and characterize the snake GIT microbiota non-lethally, and without doing harm to the snake. Electrophoretic banding patterns from samples from both our minimally invasive sampling devices were very similar to those obtained by dissection (Figures 2 and 3) and thus appear to provide an adequate sample of GIT microbiota. No consistent differences were found in the results from the cotton vs. brush absorptive materials (Table 1) and we recommend using sampling devices constructed with the cotton absorptive ends because they are cheaper and simpler to prepare and are also probably less abrasive on the snake GIT than the brushes.

Some differences were observed in samples obtained from the same individual snake using different methods. Several specimens obtained using our sampling devices had different banding patterns than those obtained by dissection. It is possible that bacterial species present in the posterior region of the large intestine or cloaca, but not in the anterior region, were picked up by the sampling devices as they were withdrawn from the snake because the end of the Teflon tube was not sealed during withdrawal. There may be some minor differences between the affinity of bacteria or intestinal fluids for the different absorbent materials

TABLE 1. Electrophoretic banding patterns from samples of gastrointestinal tract bacteria from 5 juvenile *Crotalus viridis* (a–e) obtained by three different methods (as in Fig. 2). Numbers under columns for the different sampling methods show the number of bands unique to each sample compared to other samples from that individual snake. "Bands in Common" shows the number of bands in common to all samples from each individual snake.

Snake ID	Dissection	Brush	Cotton	Bands in common
a	2	2	2	18
b	1	2	3	20
c	1	0	0	19
d	0	4	0	19
e	2	0	1	20
			Average	19.2
			SD	0.83666

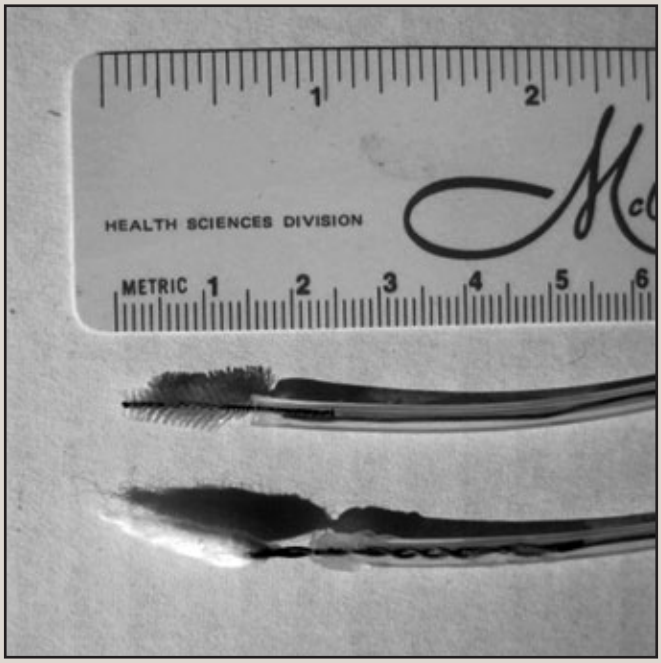


FIG. 1. Details of the two minimally invasive sampling device prototypes used in this study. The upper device contains dental brush absorptive material and the lower device contains cotton swab absorptive material.

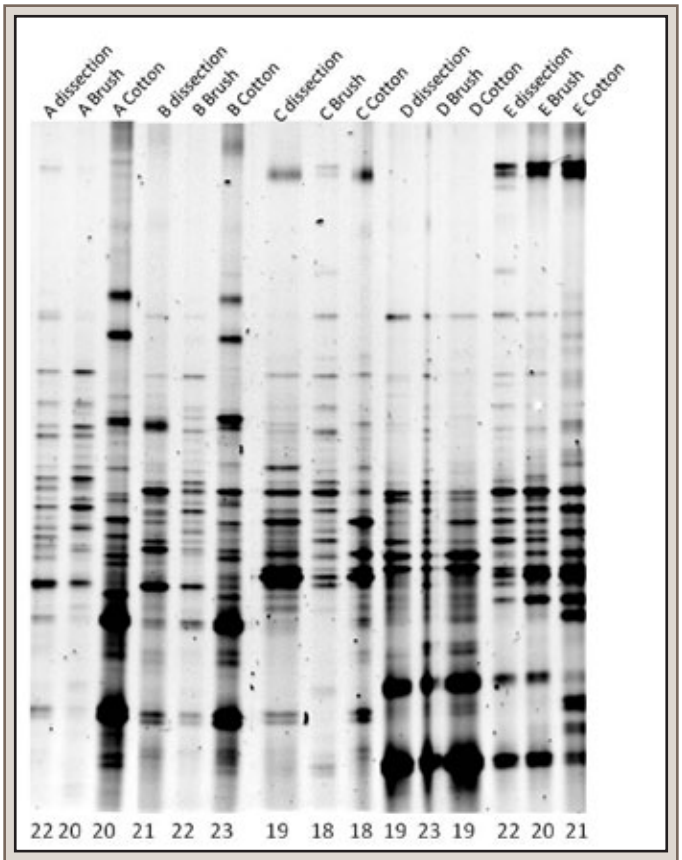


FIG. 2. Denaturing gradient gel electrophoresis banding patterns of bacterial samples collected from the large intestines of five juvenile Prairie Rattlesnakes (A through E) using three sampling methods: Brush = minimally invasive sampling device with brush absorptive end, Cotton = minimally invasive sampling device with a cotton absorptive end, and Dissection = lethal sampling by dissection. Numbers at the bottom of each lane indicate the number of bands as detected by gel reading software.

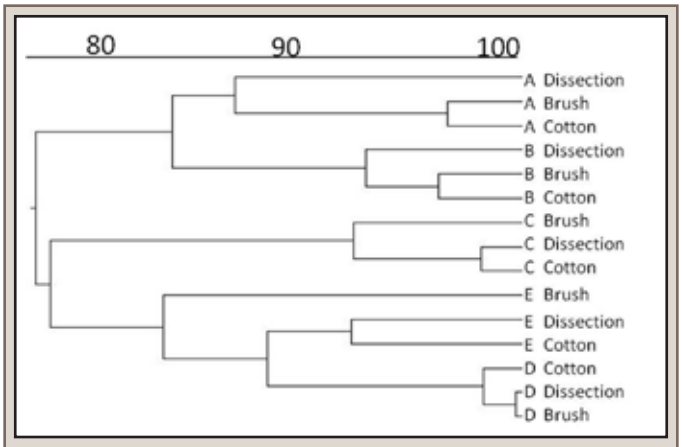


FIG. 3. Comparison of the similarity of the gel electrophoresis banding patterns of bacterial samples obtained from the large intestines of five juvenile Prairie Rattlesnakes (A through E) using three different sampling methods (as in Fig. 2). Scale bar above image indicates percent similarity.

on the sampling devices. The cotton material appears to have different banding pattern than the dissection and brush sampling methods. The cotton material is probably more absorbent than the brush. The brush is probably more abrasive than the cotton. No consistent trends of differences in results among the three different sampling methods were evident (Table 1, Figure 3).

Because we euthanized our snakes immediately after performing our sampling we cannot be certain that the sampling procedure did not have negative effects on the health of the snakes. *Postmortem* dissections did not reveal any damage of the GIT in the regions sampled so we believe no significant negative impacts resulted from the sampling procedure. In addition, snake guts are known for their physiological and morphological flexibility (Starck and Beese 2002, Secor and Diamond 2000). To ingest whole a food item that may be larger than the snake *per se*, requires extreme distensibility. Thus, we do not believe our sampling device poses any significant risk of damage. Nevertheless,

the snake large intestine is relatively thin and injury due to sampling is possible. Future studies should be conducted in which snakes remain alive after the sampling to confirm that the sampling devices do not negatively affect snake's ability to feed or digest food. Our technique represents a successful first attempt at a minimally invasive method to sample GIT microbiota in snakes but there is no doubt that refinements could be made to the device and/or sampling procedure. For example the sampling device should be modified so that the size of the wire is smaller relative to the inner diameter of the Teflon tube so that the wire moves more freely inside the tube.

One limitation of our method is that we could not sample the small intestine because we could not push the sampling device anterior to the large intestine. It is desirable to be able to sample the small intestine which probably contains a different microbial community, with different functionality, than that of the large intestine (Moran 2006; Quigley and Quera 2006). Perhaps the small intestine could be sampled non-destructively by a device inserted through the mouth or by a surgical technique. It may also be possible to insert a sampling device from the cloaca to the small intestine in large snakes (the snakes used in our study were juveniles). Another limitation of our method is that it only samples the bacterial DNA in the lumen of the gut and not necessarily that of the mucosa. Many GIT bacteria are adhered to the mucosa and may not be detected with our method.

Our method will be useful for monitoring changes in snake GIT bacterial communities in the same individuals over time. Bacterial communities are likely to vary in snakes, and other animals, due to variation in diet and frequency of feeding which may in turn may have implications for digestive efficiency and immunity and therefore growth rate, survival, and reproduction. Samples of the GIT microbiota can be obtained using our method whether or not the snake has digesta present in its gut, and in captive or free ranging animals. Our sampling techniques should prove valuable for future studies of GIT microbiota in snakes. The basic ability to sample the GIT microbiota without doing harm to the snake is required for investigations of the functional significance (if any) of snake GIT microbial communities.

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Effectively Sampling Louisiana Diamondback Terrapin (*Malaclemys terrapin*) Populations, with Description of a New Capture Technique

The Diamondback Terrapin (*Malaclemys terrapin*) inhabits coastal salt marshes, estuaries, bays, mangrove swamps, and tidal creeks from Massachusetts to Texas, USA (Ernst and Lovich 2009). Within Louisiana, collection localities are primarily from the eastern coastal marshes including St. Mary, Terrebonne, Plaquemines, St. Bernard, Orleans, and St. Tammany parishes (Dundee and Rossman 1989). There are limited records from the southwestern part of the state, with only a few collections from Iberia (Avery Island, three specimens; Marsh Island, one literature record), Vermilion (University of Louisiana-Lafayette Biological Field Station, one specimen), and Cameron parishes (outlets of Mermentau and Calcasieu rivers, seven specimens; Dundee and Rossman 1989, HerpNet Database Search, www.herpnet2.org, accessed 24 Feb 2012). Most of these records are from opportunistic encounters. Furthermore, none of the records came from Rockefeller Wildlife Refuge (RWR), which appears to have suitable brackish/salt marsh habitat.

Rockefeller Wildlife Refuge is a 30,700-ha coastal refuge in southwestern Louisiana (Cameron and Vermilion parishes) that is managed by the Louisiana Department of Wildlife and Fisheries. Approximately 60% of the refuge is comprised of intermediate salinity marsh units (impoundments), while the remaining 40% is tidally-influenced brackish and saline marshes. Along with providing seemingly suitable tidal marsh habitat for terrapins, there is also no commercialization of fisheries species on the refuge (including Blue Crabs, *Callinectes sapidus*) and the use of commercial or recreational crab traps is not permitted. This is important when considering this study site relative to the growing body of literature from other sites that have documented the impacts of crab traps and the crab fishery on Diamondback Terrapin populations (Dorcas et al. 2007; Gibbons et al. 2001; Grosse et al. 2009, 2011; Hart and Crowder 2011; Roosenburg et al. 1997).

A number of techniques have been used to capture terrapins with varying success throughout their range, including trammel nets, seines, trawls, modified and unmodified crab traps, dip nets, and manual searches for individuals on nesting beaches, in marshes, and in mangrove swamps (Table 1). Fyke nets with leads (Crowder et al. 2000; Roosenburg 1992) have also been used successfully to capture terrapins in Maryland and North Carolina, although there is no information about capture rates with this method. There are considerable differences in marsh types throughout the range of terrapins, and therefore, different methods may be better suited to certain habitat types, achieve greater results, or be more time- and cost-effective in these differing habitats. Within Louisiana marshes, there have been no extensive population studies on terrapins, with no described methods to reliably capture individuals.

A recent survey of 168 researchers with terrapin research backgrounds (across the 16 U.S. coastal states which have terrapins) found that no researchers thought terrapin populations were increasing in their states, while 14.8% said terrapins were stable, 29.6% said declining, and 55.6% responded that the status was uncertain (Butler et al. 2006). Louisiana respondents were unanimous that the status of terrapins was unknown within the state. Further, Butler et al. (2006) found that respondents from Louisiana considered the greatest threat to terrapins to be commercial harvest and that the most needed action within the state would be to "initiate field studies, distribution surveys, and habitat identification." Currently, there is no federal protection for terrapins, but they are considered vulnerable or imperiled in many states and listed as S2/Imperiled within Louisiana (Lester et al. 2005).

Descriptions of dependable capture methods are needed so researchers can begin to determine terrapin distribution and population status within Louisiana. This is relevant due to the 1) the continued loss and alteration of coastal marsh habitat; 2) unknown impacts of recreational and commercial crab fisheries; and 3) potential impacts of the 2010 Deepwater Horizon oil spill on coastal marsh habitat and terrapin populations. Herein, we compare capture efficiencies for previously described techniques and present a description of a new technique that may be applicable throughout the range of the species.

Methods.—We sampled for terrapins at seven localities on RWR during the spring and fall of 2011. All sites are classified as coastal brackish or saline marshes with all having current or historical connections to the Gulf of Mexico via tidal creeks or canals. Dominant marsh vegetation types were Oystergrass (*Spartina alterniflora*), Saltgrass (*Distichlis spicata*), and Hog Cane (*Spartina cynosuroides*), with water salinities during the study ranging from 7–31 ppt. Semi-diurnal tides occurred at the sites on RWR, with a tidal range from -0.326–1.051 m during the study (data from closest tidal station at Calcasieu Pass, approx. 58 km W of RWR; http://tidesandcurrents.noaa.gov/; accessed 3 July 2012). At many sites in the eastern portion of the refuge, there are a diverse number of available habitats including tidal channels, large tidal ponds, and some areas of broken marsh (i.e., marsh areas with a mix of many small ponds or pools).

We sampled terrapins at sites across the refuge from 21 March–2 June 2011. We sampled at each site for three consecutive days with baited modified crab traps, unbaited fyke nets with one or two lead nets, and we also used airboat manual searching. Sampling was also done in September and October 2011 using airboat manual searching only.

At each site, we fished 10 modified crab traps for three consecutive days and each trap was checked once per day for captures. Each crab trap was equipped with a live net extension and floats to prevent terrapin drowning (similar in design to Butler 2000 and Mann 1995). Each standard crab trap had a 3-m PVC pipe fixed through the live net, trap, and marsh bottom for

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TABLE 1. An overview of the methods used to capture Diamondback Terrapins (*Malaclemys terrapin*) throughout their range in studies that quantify catch per unit effort (CPUE). This list does not include traps with bycatch reduction devices, with some of that information summarized by Roosenburg (2004).

Capture Technique (with specific habitat or trap type)	Study	State	CPUE (terrapin catch/day unless noted otherwise) or Total Captures
Crab Trap			
	Avissar 2006	NJ	0.15
	Bishop 1983	SC	0.16
	Butler and Heinrich 2007	FL	0.007–0.147
	Cuevas et al. 2000	MS	0.0
	Guillory and Prejean 1998	LA	0.0
	Hart and Crowder 2011	NC	0.003–0.008
	Hoyle and Gibbons 2000	SC	0.027
	Rook et al. 2010	VA	0.20
	Morris et al. 2011	VA	0.10
	Roosenburg and Green 2000	MD	0.044–0.23
	Wood 1997	NJ	0.15–0.48
Modified Crab Trap			
	Butler 2000	FL	0.047
	Butler 2002	FL	0.013–0.025
	Hogan 2003	TX	0.0–.87
	Mann 1995	MS	0.163–0.48
	Roosenburg 1992	MD	1.2
	Roosenburg et al. 1997	MD	0.17
	Smeenk 2010	MD	0.38
	Present study	LA	0.0
Manual Searching			
Mangroves	Boykin 2004	FL	0.5/h
Land & Shallow Water	Haskett 2011	TX	1.22/h
Tidal Ponds	Present study	LA	3.64/boat h
Trammel/Gill Net			
	Butler 2000	FL	0.13/h
	Levesque 2000	SC	1.81/net set
Surface Hoop Net/Crab Trap			
	Mann 1995	MS	0.0
	Butler 2000	FL	0.0
Fyke Net			
	Present study	LA	0.5–0.8
Other Methods			
Nesting Beach Pitfall	Borden and Langford 2008	AL	0.05
Otter Trawl	Butler 2000	FL	0.23–0.77/h
Cast Netting	Butler 2002	FL	1.9/h
Eel Pot	Radzio and Roosenburg 2005	MD	0.458

support. Traps were baited with Striped Mullet (*Mugil cephalus*) and/or Gulf Menhaden (*Brevoortia patronus*), with each trap checked once per day. The efficiency of this method is described in capture per trap day.

Second, we used six double-throated hoop nets with diameters of 0.9 m; three nets had a single 7.6-m lead net and another three had two 7.6-m lead nets or "wings" (hereafter referred to as fyke nets; The Fish Net Company, Jonesville, Louisiana). The lead nets had floats affixed to maintain position at the water's surface, while weights on the bottom held the leads in a stretched position. The lead nets were stretched completely across tidal creeks and both ends were tied to 3-m steel pipes that were driven into the marsh bottom on the edges of creeks. This method stabilized the net, while it also prevented terrapins from going past the nets. Floats were also placed within the hoop net portion to prevent drowning of captured terrapins. Fyke nets were used in tidal channels and canals with widths ranging from 4.1–17.3 m, with the latter being the largest channel effectively trapped with the double-lead fyke net. At each site, we attempted to check nets every day for two or three consecutive days; this was sometimes not possible due to severe weather conditions. Total effort with fyke nets ranged between 8 and 18 total net days at each site. The efficiency of this method is described in terrapin captures per net day.

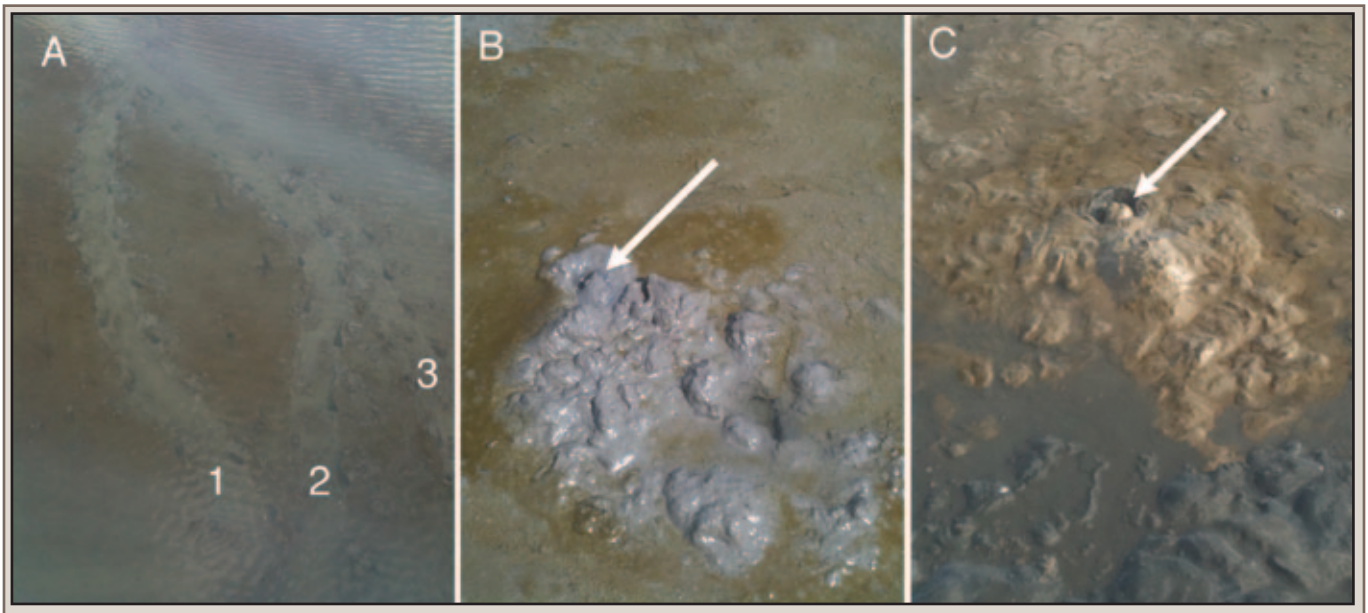


FIG. 1. Three different terrapin tracks on a tidal mud flat (A) and examples of terrapin "mud burrows" (B, C).

Third, from an airboat we conducted visual surveys for terrapins and terrapin sign near our trapping sites. During low water periods, particularly those associated with low tides or strong northerly winds, tidal ponds and mud flats were visually searched from the airboat while it was steered in a "zigzag" or "hairpin" fashion (with <20 m between search paths). Both the airboat driver and passenger looked for terrapins and their tracks or burrows. Terrapins were found by a) following recent terrapin tracks impressed on the bottom of tidal ponds (Fig. 1a), b) searching for "mud burrows" (Figs. 1b, 1c), or c) catching turtles opportunistically while they were moving. When tracks were found, they led us to either the edge of the pond and into the marsh (a lost trail and unsuccessful attempt), to an active terrapin, or to a terrapin burrow. Once a burrow was observed, either by following tracks or detection of the burrow by an observer, the passenger probed the suspected burrow with a long metal pole, feeling for the hardness of a terrapin shell. If a terrapin was found in the burrow, the pole could be used to pry the terrapin from the burrow. Occasionally, burrowed turtles would protrude their heads out of their burrows or above the surface of the water as the airboat entered or left a tidal pond. This permitted easy location of terrapins, which could then be extracted from their burrows by hand. Presumably burrowed terrapins are curious about the airboat, probably due to the noise or vibration. The efficiency of this method is described in captures per boat hour due to the divided duties of the operator between driving and searching for terrapins.

For each captured individual, we recorded capture method, sex, midline plastron length (PL, to the nearest mm), and whether the individual was a recapture. Since little is known about the timing of reproductive maturity in Louisiana terrapins, we considered juveniles as <9 cm PL for males and <13.2 cm PL in females based on previous terrapin studies (as cited by Ernst and Lovich 2009). Terrapins were permanently marked using drill holes on the marginal scutes according to Cagle (1939) and also PIT tagged (12 mm; Biomark, Inc., Boise, Idaho). Individuals were brought to the lab for a related dietary study and were released the following day at their capture locations.

We used a *t*-test to determine if catch rates (terrapins per net day) were equal for single- and double-lead fyke nets. Chi-square tests were used to determine if sex ratios were equal for fyke net captures and manual searching captures. We also used *t*-tests to determine if PL was equal for the capture method used (fyke nets vs. airboat manual capture); males and females were analyzed separately due to pronounced sexual size dimorphism in the species. JMP 8.0 (SAS Institute Inc., Cary, North Carolina, http://www.jmp.com) was used for all statistical analyses with significance levels of $p < 0.05$.

Results.—Trapping methods varied in success and we abandoned modified crab traps after one site due to zero captures (in 30 trap-days). Fyke nets with leads captured a representative sample of both sexes and juveniles (20 M, 22 F, 10 juv.) in 104 total net days. The overall CPUE of fyke nets at all sites was 0.5 terrapins/net day (max. of 7 terrapins in a single net), with site differences ranging from 0–2.1 terrapins/net day (0.06, 0.1, 1.0, 2.1, and three sites with zero captures). Since we are unsure if terrapins occurred at the three sites without a capture, the average CPUE was 0.8 terrapins/net day if only sites with terrapin captures are included. From the sites where terrapins were captured, there was no significant difference in the capture rates between fyke nets with single or double leads ($t = -0.57$, $P = 0.57$). Airboat visual searching was most productive (8 M, 60 F, 14 juv.), with 3.64 terrapins captured per boat hour (82 captures including 3 recaptures in 22.5 boat hours; Fig. 2).

Terrapin sex ratios did not differ from equality for fyke net captures ($\chi^2 = 0.36$, $P = 0.55$), while airboat manual captures were significantly biased toward females ($\chi^2 = 46.1$, $P < 0.0001$; Fig. 2). Mean PL was not significantly different between the two capture methods for males ($t = 0.47$, $P = 0.65$) or females ($t = -0.48$, $P = 0.64$; Fig. 2). However, it is noteworthy that the six largest females (>19.0 cm PL) were manually captured from an airboat.

Discussion.—We abandoned the use of crab traps after the first site primarily due to the lack of success with this method. The first site had the highest number of terrapin captures within tidal creek and surrounding ponds using the other two methods (37 by fyke net, 50 manual searching). Therefore, the lack of captures in crab traps was not due to a lack of terrapins in the vicinity. Another reason we discontinued the use of modified crab traps was that they were bulky and difficult to transport in

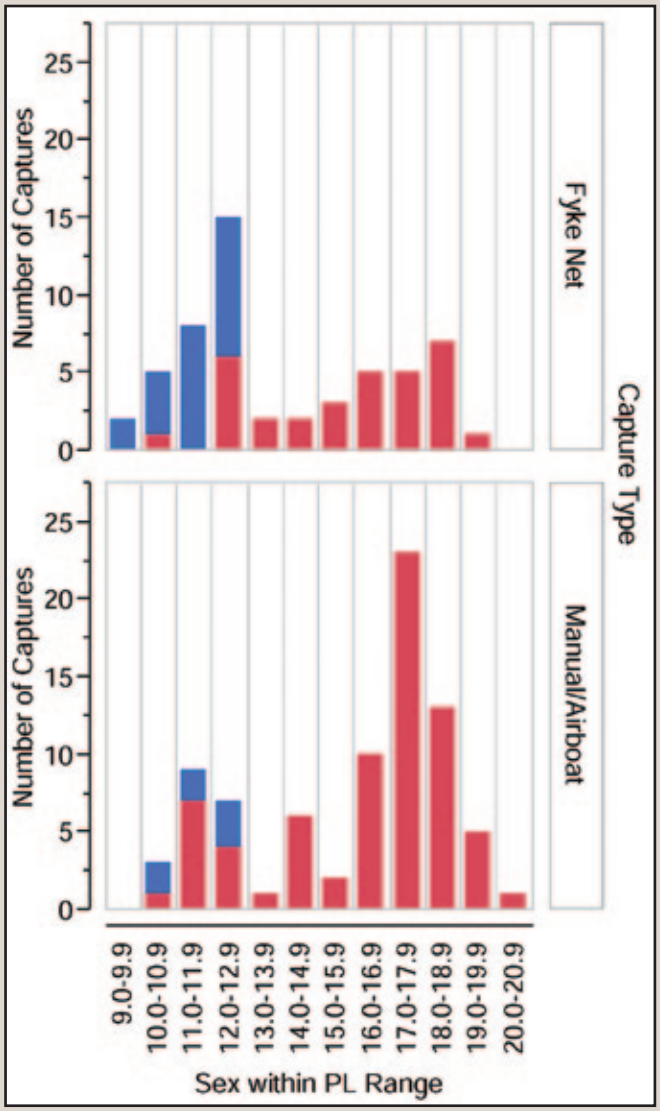


FIG. 2. Diamondback Terrapin (*Malaclemys terrapin*) plastron length comparisons for both sexes (male: blue, female: red) by capture method.

the airboat, our only means of access to field sites. In addition, two of the traps floated away from their sampling location (likely due to tides or wind) even with the support pipe fixed through the trap and into the marsh bottom. Similarly designed modified crab traps have been used with moderate success in Florida (Butler 2000, 2002) and Mississippi (Mann 1995), while other studies have experienced similar low to moderate success rates with crab traps or modified crab traps throughout the range of diamondback terrapins (Table 1).

Fyke nets provided an unbiased sampling method, with a relatively high CPUE compared to other studies and sampling methodologies. It took some time and effort to set and adjust the nets to changing marsh conditions (i.e., tide levels, reattaching nets following terrapin removal), but less effort than using the modified crab traps. Based on our results and observations, single-lead nets are preferable, however they must have strong enough mesh (>#15 size) to prevent tearing by large captured fish, particularly Alligator Gar (*Atractosteus spatula*). Lead nets also need sufficient buoyancy to keep them at the surface. Double-lead fyke nets did not catch more terrapins than single-lead nets and they were less efficient than single-lead nets, in both the longer time it took to set them and the higher cost. Fyke nets have been used successfully with other terrapin studies in Maryland (Roosenburg 2004), with varying levels of success depending on the time of year and length of lead net (W. Roosenburg, pers. comm.). A drawback to our method is that the lead net is stretched completely across tidal creeks and may prompt indignation from boaters if they experience difficulty in accessing tidal creeks. We did not have this problem due to the difficulty in accessing remote tidal creek sites on RWR, but this possibility should be considered before researchers use this method in public waters.

Visual searching was achieved primarily from an airboat moving through the marsh and tidal ponds. This method was more productive than expected, but it was most successful during low tide periods, when marsh water levels were low and shallow tidal ponds were easy to search from an airboat. Similarly, Haskett (2011) had success when searching manually for terrapins in tidal creeks and shallow ponds at low tides, while fishermen noted that they could search for terrapin "mounds" in shallow, still-water bays following passage of a cold front in winter (T. Mann, pers. comm.). Even though manual searching was female-biased, there was no difference in size for males or females caught with the two capture methods (fyke net vs. manual searching), thus making population comparisons easier when combining capture data. Airboat manual searching also had a higher CPUE than fyke net captures, but when time spent checking and setting nets is considered, CPUE would be considerably greater for airboat manual searching than for fyke nets.

For the many advantages of searching with an airboat, there are also several potential drawbacks to using this method: 1) female-biased capture rates, 2) need for low-water conditions in the marsh (either tide- or wind-driven), 3) difficulties in spotting or determining terrapin tracks and burrows, and 4) the expense of operating an airboat. Airboat manual searching was found to be female-biased, likely due to the larger size of the tracks and larger mud burrows that females make because of their larger body size (in length, height, and mass) compared to males. Second, optimal low tide/low water levels (typically <15 cm or when pond bottom is visible) are needed to search effectively for terrapins from an airboat. We often consulted tide charts to determine days when tides would be the lowest, but southerly winds sometimes counteracted the low tides and pushed more water into the tidal marshes. Conversely, strong northerly winds sometimes evacuated more water from the marsh than low tide levels. If water levels were too high in tidal pools, water conditions made it more difficult to see terrapins in the water due to excess turbidity. A larger wave was also generated by the airboat during high water which made capturing active terrapins more difficult. Third, it was initially difficult to recognize the difference between wading bird, crab, and terrapin tracks in pond bottoms, as well as distinguish between terrapin mud burrows and those of other mud-burrowing organisms (i.e., Blue Crabs). However, once we developed our "search image" for terrapin mud burrows, it became relatively easy to locate them. Last, the use of airboat equipment is expensive due to the maintenance costs and the increased cost of fuel (either aviation fuel or premium gasoline). If an airboat is not available to researchers, the user fees for an airboat and skilled airboat operator generally range between US $600–800 per day (P. Trosclair, pers. comm.). To our

knowledge, this is the first study to use airboats to search for and successfully capture terrapins.

In comparing our capture efficiency results with those reported in other terrapin studies, both airboat manual searching and fyke net efficiency are generally higher than in other studies; airboat manual searching has the highest reported CPUE of any terrapin study or capture method described (Table 1). These two techniques could be superior capture methods for terrapins in southwestern Louisiana, but it is also likely that the high CPUEs could be directly related to high terrapin densities, as we had very few recaptures during the study. Further, we saw no evidence of active commercial or recreational crabbing on the refuge. Sizable terrapin populations could be present on RWR due to: 1) the aforementioned lack of commercial fisheries, 2) lack of crab trapping, 3) the large available tidal marsh habitat, and 4) the diversity of marsh habitat types on RWR. Future use of these methods off the refuge would be valuable in order to better document the distribution and abundance of terrapins in southwestern Louisiana, while also documenting the interactions of the commercial crab fisheries on terrapin populations.

Acknowledgments.—We thank C. Baccigalopi and R. Hebert for their assistance in operating the airboat, while G. Nunez provided great airboat maintenance throughout the study. The comments and suggestions by J. Butler, T. Mann, and two anonymous reviewers greatly improved this manuscript. Louisiana Department of Wildlife and Fisheries approved of this project and we complied with all applicable animal care guidelines as outlined by the Society for the Study of Amphibians and Reptiles. Rockefeller Trust Fund provided funding for this project, as well as the costs of airboat equipment and maintenance.

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A New, Harmless Mesocosm Design for Field Rearing Ranid Embryos and Determining Clutch Sizes

As an important life history trait of amphibians, clutch size has been frequently used in a variety of ecological studies (e.g., Cooper et al. 2008; Morrison and Hero 2003; Woodward 1987). Since size and shape of egg masses vary considerably among amphibians (Duellman and Trueb 1994; Wells 2007), different methods may be required for counting eggs in taxa differing by these traits. The majority of temperate ranid frogs are characteristic for their large and compact egg masses (Arnold and Ovenden 2002), with a certain proportion of eggs unapparent within the center of the egg mass (Karraker 2007). In such cases, it is problematic to accurately count the eggs without harming them, and this usually requires manipulating the clutches (Ponsero and Joly 1998; Woodward 1982). It is clear that such handling can damage the disrupted eggs directly or increase their sensitivity to microbial or fungal attack (e.g., Ficetola and De Bernardi 2009; Karraker 2007). On the other hand, mere visual estimation may under- or overestimate clutch size because of difficulties associated with the counting of interior eggs (Karraker 2007).

Methods.—Here we present a new, simple device that was created and tested during studies on the Agile Frog, *Rana dalmatina,* in the North Bohemian brown coal basin in the Czech Republic (Smolová et al. 2010; Vojar et al. 2008). Our device allows for the counting of frog eggs in the field without harmful impact to the clutches. The device is positioned around a clutch and consists of a floating polystyrene ring placed inside fine elastic netting (Fig. 1F). The diameter of the ring depends upon the clutch size of a particular frog species. In the case of *R. dalmatina*, we used rings with an inside diameter of 15 cm. The polystyrene rings are used to hold the device on the water surface. We used nylon pantyhose as netting, which offers many advantages. The stockings are commonly available, inexpensive, sufficiently elastic, resistant to perforation, and, most importantly, they are permeable to water and food for the tadpoles (floating algae, small organic particles) while at the same time impermeable for hatching larvae and their predators. Device preparation is outlined in Fig. 1.

In the case of a clutch attached to a stem, as is often true for *Rana dalmatina* (Rehák 1992), the stem must be carefully cut both below and above the clutch before the device is installed. The stocking should be tied off from above (Fig. 1G), to protect eggs against potential predators (Henrikson 1990). To maintain the same position of the clutch on the water's surface, and particularly when the stem had to be cut off, the device might be attached to a stick. After the larvae hatch, the entire contents of the ring (i.e., larvae, undeveloped eggs and egg jelly) may be transferred to a basin with a little water and examined there. Immediately after their being counted, the larvae together with the original egg jelly should be returned carefully to the same place in the water.

Results.—The device was tested on 193 *Rana dalmatina* egg masses during two breeding seasons, in 2007 (N = 80) and in 2010 (N = 113). Only those clutches from 2010 were protected from above. The hatching success, i.e., the ratio of embryos that developed to hatching to total clutch size, varied significantly between seasons (2007 mean ± SE: 0.86 ± 0.02; 2010: 0.91 ± 0.01; Wilcoxon rank-sum test: $W = 5334$, $p = 0.03$). Even though such inconclusive differences could be due to factors other than egg protection (e.g., environmental conditions that varied between years, inclusion of different individuals in the samples), we observed egg predation by diving beetles (*Dytiscus* spp.) only in the case of unprotected clutches.

Discussion.—Using this device has several limitations. It can only be used for amphibians that spawn separate and compact eggs masses near the water surface, as well as having herbivorous larvae. The method should not be applied in case of clutches placed deeper in the water column. The change of clutch position in a water column can lead to changes in environmental conditions (e.g., water temperature, intensity of UV-B radiation) between the original, deeper location and a new one on the water's surface. This could have possible negative effect on embryonic survival (Pounds 2001). The stocking's inner surface quickly becomes covered by algae and organic particles. Thus, the device provides appropriate food conditions mainly for generalized grazers scraping the substrate (Duellman and Trueb 1994). The method is particularly suitable for ranid frogs. Because cannibalism has been observed in ranid tadpoles (reviewed in Alford 1999), counting should be performed directly after the larvae hatch. Nevertheless, clutch size may be slightly underestimated and hatching success overestimated, as the first hatching tadpoles may eat dying, dead, or decaying embryos.

The main advantages of the method are its reasonable accuracy and simultaneously its relatively non-invasive handling of amphibian clutches. As distinct from other methods, it is not necessary to disrupt all (Berven 1982; Woodward 1982) or even a

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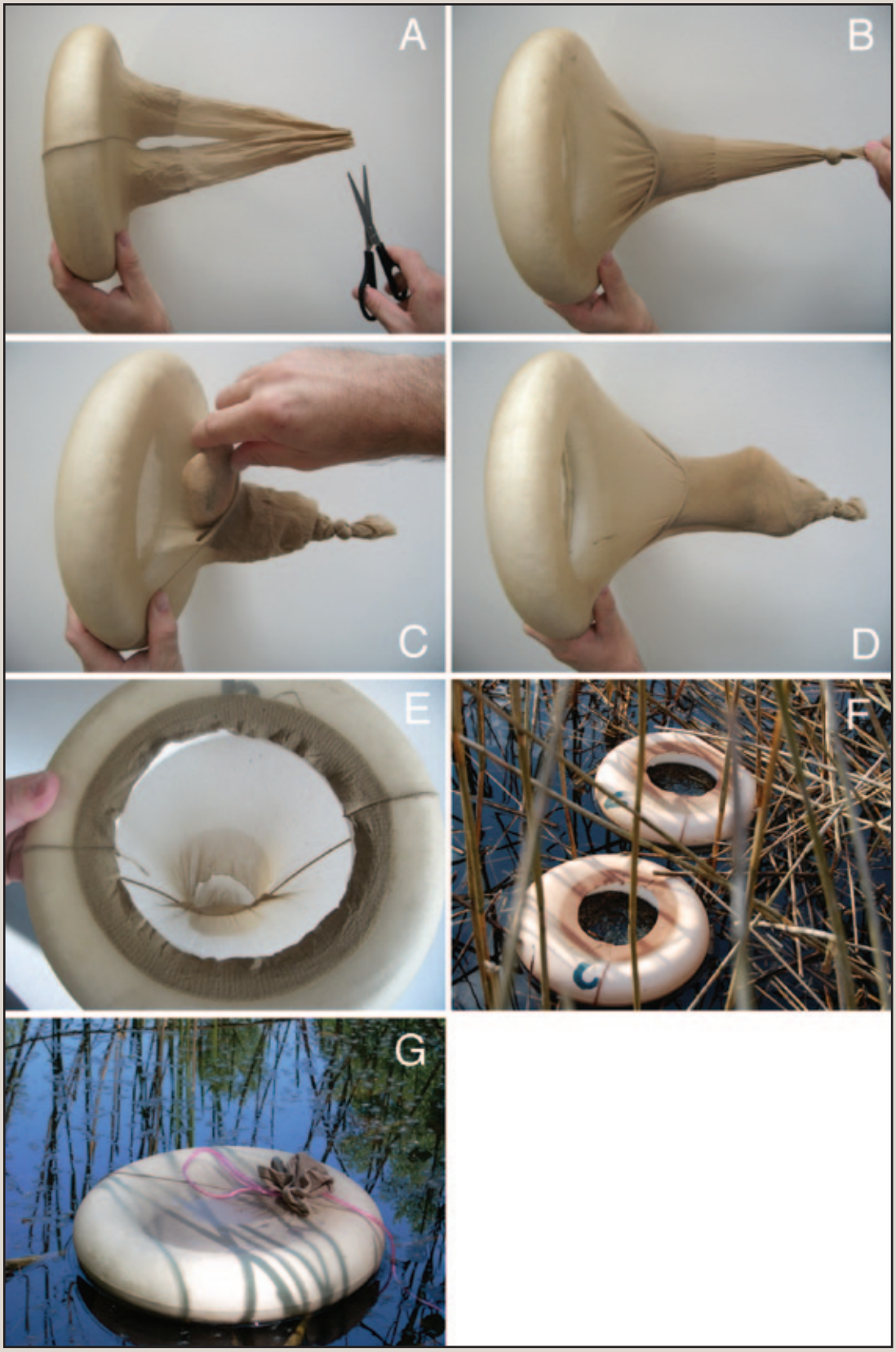


FIG. 1A–G. Device preparation: stocking legs should be cut off about 25 cm below the crotch of the pantyhose (A). One leg is then inserted into the second and both legs are tied into a knot together at the free end (B). A stone is inserted into the pocket thus formed (C). This provides weight (D) and creates sufficient space for a clutch (E). Since this weighting object is inserted from outside of the device (C), it can be later removed without making potentially harmful contact with tadpoles before their counting. The entire device is then positioned around a clutch (F). To protect eggs against numerous potential predators, the stocking should be tied shut from above (G).

part (Ponsero and Joly 1998) of the egg masses. As there is no manipulation of the clutches (except for cutting the stem in the case of stem-attached clutches), the use of floating rings is likely to be more harmless than flattening egg masses (Harris 1980; Karraker 2007) or using standard mesocosms (Skelly and Keisecker 2001).

The method represents a new and inexpensive mesocosm design that allows increased mixing of water, and thus fairly natural conditions. Presented design will be also useful for people who have to hike long distances to research ponds because of the lightweight materials. The device could be deployed in a wide range of ecological studies in a field due not only to its reasonable accuracy but also to its lack of invasiveness. Considering the evident global amphibian decline (Barinaga 1990; Houlahan et al. 2000; Wake 1991), conservation requirements and ethical principles should be strictly followed in amphibian research.

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HERPETOLOGICAL HISTORY

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Rhadinaea "sargenti," a Misspelled Patronym Honoring Commander William M. Sergeant (1902–1983)

The snake *Rhadinaea sargenti* is endemic to east-central Panama, where it was discovered about 1936 during surveys and mapping of the Río Chagres drainage—a watershed critical for lock operations in the Panama Canal. Type specimens are catalogued in the Museum of Comparative Zoology (MCZ) as having been collected by Dr. H.C. Clark, who, however, supplied the material but did not actually collect it. Herbert C. Clark, the first director of the Gorgas Memorial Laboratory (GML), oversaw a snake census in various parts of Panama during 1929–1953 (summary and references in Myers 2003:4–5). Clark's early material sent to MCZ was turned over by Director Thomas Barbour to his student Emmett Reid Dunn for identification. Dunn started visiting GML in 1939 and had access to background information on Clark's census. Later that year Dunn and Bailey (1939) described some species that Clark had sent to the MCZ, including *Rhadinaea sargenti*, which was collected by "Sargent's party." Dunn and Bailey (*op. cit.*: 4) noted that "Mr. W.M. Sargent, head of "B" [survey] party, was especially interested [in the snake census]. His party took 78 snakes, on most of which we have detailed field data."

Unfortunately the name of the engineer "especially interested" in collecting snakes was misspelled. His correct name is William Manuel Sergeant (Fig. 1). Sergeant wrote to Ernest Williams at MCZ in 1978, saying that "Sometime between 1935 and 1938, The Panama Canal conducted a field survey to locate the Chagres River divide [requiring] that machete-men cut over 100 miles of jungle trails along the divide . . . Among the snakes caught by my party was a small non-venomous snake [that] turned out to be a new find and my name (misspelled) was included in the classification." Williams supplied the reference wanted by Sergeant and copied his response to Myers, who picked up on the correspondence, asking Sergeant for further information about his work in Panama. Sergeant provided the following:

> In 1906, at age four years, I left New York for the Isthmus of Panama, where my father was employed by the Isthmian Canal Commission on the construction of the Canal. I returned to the States after graduating from the Canal Zone high school in 1922. I received the degree of Bachelor of Civil Engineering from Louisiana State University in 1929. From 1929 to 1941 I was employed by the Panama Canal on engineering projects, including the construction of the Madden Dam on the Chagres River. Upon completion of the Dam I worked on investigations in connection with the Dam, its appurtenances and its watershed, including the survey to locate and close the gap of the Chagres River divide at the headwaters of its two principal tributaries, the Pequeni and the Esperanza Rivers. Later I worked on the plans for a third set of locks for the Canal.
>
> I resigned from The Panama Canal in 1941 and went on active duty with the Navy. During World War II, I served with the Civil Engineering Corps of the Navy in the Canal Zone, Ecuador, continental United States, Hawaii and the Philippines. In 1946 I was detached from active duty with the Navy and resumed employment with The Panama Canal on engineering studies for a sea-level canal in Colombia and Central America, including several routes in Panama. In 1951 I was assigned to the Panama Canal Company as Supervising Construction Inspector for Government construction contracts in the Canal Zone.
>
> August 1, 1960 I retired from the Panama Canal Company after 32.8 years of Federal service and returned to the United States.
>
> September 1, 1962 I was transferred to the Naval Reserve Retired List with the grade of Commander, after 26.5 years in the Naval Reserve." [William M. Sergeant in letter to Myers, December 14, 1978, AMNH Herpetology Archives]

Much of Sergeant's employment history is corroborated in issues of *The Panama Canal Review* (October 5, 1951; January 3, 1958). We are unaware of publications by him, except for an editorial titled "Our Opportunities" in his 1922 high school yearbook (*The Zonian*, Balboa, Canal Zone); he expanded on the importance of learning Spanish in order for Americans "to get their full share of Latin American trade, which has been practically monopolized by European countries." William Manuel Sergeant was born in Havana, Cuba on August 17, 1902; he died on February 25, 1983.

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PHOTOGRAPH COURTESY PANAMA CANAL AUTHORITY



FIG. 1. William M. Sergeant, a Cuban American engineer responsible for the discovery of *Rhadinaea sargenti* during trail-cutting operations in the Panama Canal watershed. This photograph, dated July 15, 1960, was taken a few weeks before Sergeant's retirement.

PHOTO BY ROBERTO IBÁÑEZ D



FIG. 2. *Rhadinaea sargenti* Dunn and Bailey, a distinctive species roughly 300 mm in total length. This little snake is known only from central Panama, where it occurs east of the Panama Canal in low, forested mountains designated as the "Chagres Highlands" (Myers et al. 2012). The uniformly blackish sides are diagnostic; *R. sargenti* is most closely related to *R. vermiculaticeps* (Cope)—the generic type species, which occurs in highlands west of the Panama Canal.

Rhadinaea sargenti is a rare snake (Myers 1974:162–163, 245; Ibáñez et al. "1994" [1995]). It has been reported in print mostly from specimens obtained by Sergeant, whose "B" party "took five of the six specimens" (Dunn and Bailey 1939:4, 11). The sixth specimen, a paratype from the Piedras-Pacora ridge, may have been obtained by the "E party." The holotype and three paratypes are in the Museum of Comparative Zoology (MCZ 42764, 42787–42789); two other paratypes collected by Sergeant's party might have been discarded (see below). An additional specimen from the Panama snake census—not a type—was retained by Clark for his GML collection (Myers 1974:245). Five new specimens, however, have been collected in recent decades (unpublished, including Fig. 2).

The 12 known specimens come from localities widely scattered in low mountains east of the Panama Canal "in humid tropical forest that lies on the wet side of evergreen seasonal forest" (Myers 1974:162). These mountains, unnamed on most maps, are the "Chagres Highlands," which provide a lower montane forest refuge for some rare snakes and frogs. The specimen in Fig. 2 is from the northeastern periphery of the Chagres Highlands (at 9°19'45"N, 79°9'12"W); this geologically complex uplift contains the important Chagres drainage as well as more eastern streams that drain directly north to the Caribbean Sea or south to the Bay of Panama (Myers et al. 2012).

Dunn and Bailey (1939:11) included in the original description two uncatalogued heads; these are paratypes but their disposition is unknown to us. Most of Clark's Panama Snake Survey was based on heads. As summarized by Myers (2003:4), "Unfortunately, over 90% of the [13,745] GML specimens were apparently discarded after Dunn's study, except for whole specimens and selected heads especially of rare species that were placed in major museums. Fewer than 1000 specimens with data were saved from the Panama snake census, which spanned a quarter of a century."

Dunn was an influential herpetologist who left an important body of research. He, however, was not the most careful worker and left two misspelled names for the Panamanian fauna: *Rhadinaea* "*sargenti*" and *Colostethus* "*panamansis*." These cannot be corrected. The last name was an incorrect latinization that Dunn himself later emended to "*panamensis*" (Grant et al. 2006), but by a vote of 13 to 11 the International Commission of Zoological Nomenclature ruled that Dunn's original spelling must be maintained (ICZN 2008: Opinion 2195).

Myers had explained to Sergeant that "rules of nomenclature consider the stability of a name to be more important than the correctness of its formation." Myers promised to point out the misspelled name in a future supplement to his *Rhadinaea* monograph. That planned "supplement" was superseded by other publications on the genus, but we are pleased finally to note the misspelling and to honor Commander Sergeant's service to his profession and to his country.

Acknowledgments.—Our late colleague Ernest E. Williams called attention to Sergeant's 1978 letter of inquiry and José Rosado supplied information on the MCZ holdings. Grace Tilger obtained dates of Sergeant's birth and death from the U.S. Department of Veteran Affairs Death File. César A. Jaramillo, Daniel Medina, Ernie Osburn, Ángel Sosa, and Kelly Zamudio provided information on new specimens. María G. Bermúdez Kelly and Earl Barber, Autoridad del Canal de Panamá, searched and provided the archive photo of W. M. Sergeant. Patricia J. Wynne finessed and improved the electronic image for Fig. 1.

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A Chelonian Civil War Veteran

Within the last 15 years, there have been a few accounts published in *Herpetological Review* that document early photographs of reptiles (Table 1). Interestingly, all of these previously referenced photographs were recorded and produced outside of the Americas, and do not feature any species from this continent. Here, I present a very old photograph of a native and highly recognizable North American reptile—the Eastern Box Turtle, *Terrapene c. carolina*.

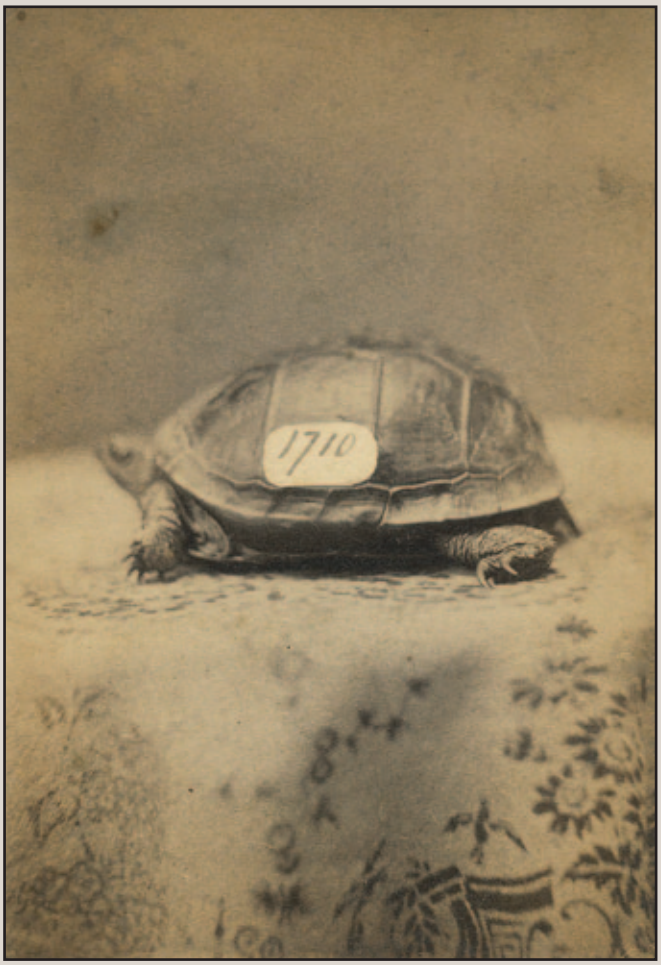
This peculiar item is a *carte de visite* (CDV)[1] depicting a turtle (apparently alive) in a studio setting (Fig. 1). A photographers' stamp on the verso indicates the CDV was produced by the "Tyson Brothers," of Gettysburg, Pennsylvania. According to William A. Frassanito, the foremost authority on early photography at Gettysburg, the style of this imprint dates the photograph to ca. 1864 (W. A. Frassanito, pers. comm.).

Quaker brothers Charles John Tyson (1838–1906) and Isaac Griffith Tyson (1833–1913) moved from Philadelphia to Gettysburg in 1859, where they opened a photography studio in August of that year. Although they were primarily portrait photographers, Isaac and Charles Tyson (Fig. 2) are perhaps best known for being the first Gettysburg locals to photograph battlefield scenes after the bloodiest conflict of the Civil War. The Tyson brothers' careers, as discussed here, are documented more thoroughly by Frassanito (1995).

After the start of the Civil War, hundreds of soldiers were sent to Gettysburg for training, and the Tyson brothers photographed many of these men in uniform. Even as the infamous battle commenced on the morning of 1 July 1863, Charles continued working at his studio (Fig. 3), racing to furnish portraits for crowds of Union soldiers. In a letter to a friend, Charles recounted his experience during this time in great detail. The following is a passage from that letter, which was transcribed in its entirety by Preston (1892; *in* Frassanito 1995):

> I arose to find Gettysburg swarming with Union soldiers . . . I opened the gallery and went to work, and was kept very busy till near ten o'clock. I had made an exposure, and the room was full. I went into the work-room to finish the picture. When I returned the room was empty . . . to my surprise, all the stores were closed and no one to be seen. . . . I met one of our officers riding up the street, warning all women, children, and non-combatants to leave the town, as General Lee intended to shell it.

Charles' letter goes on to describe how he fled to nearby Littlestown with his wife and a neighboring family, where they stayed until it was safe to return home. Fearing that his house and gallery had been "gutted" by confederate soldiers, once back in Gettysburg, Charles was relieved to find that while his house



COLLECTION OF ZACHARY A. CAVA

Fig. 1. *Carte de visite* (CDV) photograph of a box turtle by the "Tyson Brothers," ca. 1864. This photograph was likely taken at the Tyson brothers' studio (see Fig. 3).

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[1] A type of photograph consisting of a small albumen print (5.4 x 8.9 cm) mounted on cardstock (6.4 x 10.0 cm), which was most popular in the 1860s.

TABLE 1. A summary of early photographs of reptiles based on accounts published in *Herpetological Review*. "Year" and "Location" refer, respectively, to when and where an image was recorded. Animals are believed to have been alive when photographs were taken unless otherwise noted.

Year	Taxon	Location	Photographer(s)	Notes	Source
1853	Lace Monitor, *Varanus varius* (two preserved specimens)	Muséum National d'Histoire Naturelle (MNHN), Paris, France	"Bisson Brothers" (Louis-Auguste and Auguste-Rosalie Bisson)	Earliest known photograph of a herpetological specimen	Niekisch (2010)
1857	Nile Crocodile, *Crocodylus niloticus*	Egypt	Francis Frith	First known photograph of a living reptile	Niekisch (2010)
1864	Diamond Python, *Morelia s. spilota* Eastern Blue-tongued Lizard, *Tiliqua s. scincoides* Eastern Water Dragon, *Physignathus l. lesueurii*	Photographer's studio, Sydney, Australia	William Hetzer	Features herpetologist Gerard Krefft	Adler and Cogger (1998)
1865	*Boa constrictor*	London Zoo, London, England	Frank Haes	Features unknown zookeeper	Edwards (1998)

had been ransacked, nothing was "wantonly destroyed." Charles added that the gallery was found "undisturbed," although confederates had taken a barrel of alcohol from the cellar, and an artillery shell remained lodged in the building's brick façade, where it can still be seen today (Fig. 4).

Soon after the battle, the Tysons got back to work. Preparation of their first group of battlefield photographs, produced on 8 x 10-inch plates, was announced 10 August 1863. The brothers continued to manufacture battlefield views for the next few months, until demand waned.

Eventually the Tyson brothers parted ways. Charles had become interested in a nursery owned by his wife's family, and in 1864 purchased one-third of the business. In 1866 Isaac returned to Philadelphia, where he opened his own gallery. Charles gained full ownership of the nursery the next year, and in 1868 he sold the photography business to William H. Tipton and Robert Meyers. (Tipton, who began apprenticing under the Tyson brothers in 1863 at the age of twelve, would go on to become one of Gettysburg's most prominent photographers.)

Reptiles were relatively uncommon subjects for early cameramen, whose conventional repertoire focused on people, landscapes, architectural structures, and the occasional pet cat or dog. The Tyson Brothers CDV discussed here is certainly one of the oldest photographs of a living reptile. Might this image also represent the first photograph of a North American reptile species? The earliest surviving photograph of a turtle? The small, unassuming box turtle would seem like an unusual candidate for either designation, given the availability of larger, more "impressive," and presumably more desirable reptilian subjects (e.g., sea turtles, crocodilians). Indeed, this image differs from most early photographs of reptiles, which feature large animals (e.g., Niekisch 2010), humans (e.g., Adler and Cogger 1998), or often both (e.g., Edwards 1998). Why, then, did the Tyson brothers take the time to photograph a box turtle?

This brings us to the most intriguing—and ultimately perplexing—aspect of this photograph. Inscribed in the center of the negative, so as to be positioned (perhaps inadvertently) on the turtle's carapace, is the number "1710." Unfortunately, I could find no indication on the photograph or elsewhere as to the significance of this number, allowing only for speculation.

One possibility is that the "1710" represents a catalog or specimen number. Perhaps, as some have proposed, this photograph was not offered for sale, but rather belonged to the personal collection of Charles or Isaac Tyson. With respect to his interest in horticulture, might Charles have been documenting some of the local flora and fauna? Others have suggested the photograph could have been produced for the science department at Pennsylvania College (now Gettysburg College). Although these seem like plausible explanations, the high numerical value and unusual placement of the inscription in the photograph cast some doubt on the "catalog hypothesis." In any case, if the "1710" does signify a catalog or specimen number, we expect there to be other photographs in existence with similar numerical inscriptions. Searches of relevant archives have yielded no such images.

Alternatively, the number pictured on this CDV could represent a date. Well into the 20th century, it was common for people to carve initials (or sometimes full names) and dates into box turtles' shells.[2] This practice is evidenced, in part, by countless local newspaper reports dating at least as far back as the early 19th century, that speak of turtles found bearing decades-old inscriptions.

Although it has proven difficult to determine the maximum lifespan of *T. carolina*, there are several reputable accounts of individuals of this species exceeding 100 years in age (Graham and Hutchison 1969; National Park Service 2002), including at least one well-documented record of a box turtle thought to

[2] Names and dates are not the only things people have carved into turtles' shells. On 21 August 1865, local Gettysburg newspaper *The Compiler* reported that a man visiting the battlefield at Culp's Hill discovered a turtle bearing the inscription "Co. A, 102d N. Y." (Company A of the 102nd New York Infantry Regiment). "It was a relic of peculiar interest, as the marking was no doubt done by a New York soldier at the time of battle. Its possessor was highly delighted, and valued the turtle almost beyond price" (Stahle 1865).

be over 150 years old (Belzer 2008). The discovery of an animal considered to be of such great age would certainly explain this photograph's atypical subject matter. A date carved into the turtle's shell, however, might not have shown up clearly in a photograph, perhaps leading the photographer to write the numbers on the negative, where they could be easily seen. Thus, although it would seem unlikely, it is *possible* that the turtle pictured in the photograph was marked in 1710.

Of course, not all dates found on box turtles' shells are thought to be authentic (Dodd 2001; Graham and Hutchison 1969). On 24 August 1870, *The Lancaster Examiner and Herald* reported that an "ancient land turtle" had been found on a farm in East Hempfield Township, Lancaster County (~85 km NE of Gettysburg), bearing the inscription "J. L. 1717." Noting that many of these "apparent relics" had turned up in recent years, the author added, "many of the letters and dates carved on their backs are, no doubt, the work of boys who hoped to dupe persons who discover them afterwards" (Hiestand and Kline 1870).

Aside from youths playing practical jokes, the incentive for one to carve a fake date into a turtle's shell is unclear. Perhaps some hoped to capitalize on the possession of such a "curiosity." If this were the case, the possibility that a photographer might have perpetuated (knowingly or not)—or even orchestrated such a hoax (i.e., an early, crude example of photographic manipulation), cannot be ruled out.

Surely we would have a better idea of whether this animal could have actually been marked in 1710 if its age could be inferred from the photograph at hand. Although *T. carolina* is a species said to have "negligible senescence" (Miller 2001), box turtles still show some age-related changes, and it is sometimes possible to approximate a turtle's age by examining certain physical characteristics (e.g., presence and number of scute annuli; see Dodd 2001). Turtles thought to be very old typically exhibit significant shell wear, in which cases growth rings can be less discernable or worn away completely. Elderly chelonians may also have depressed scutes resulting from calcium resorption. Despite the relatively poor resolution of the Tyson Brothers photograph, annuli are visible on the carapace of the turtle pictured, and the animal's scutes do not appear sunken. Although these findings may be interpreted as an indication that this turtle was not of exceptional age at the time it was photographed, it is important to note that shell wear and morphology are influenced by many factors (environmental and physiological), and there may be considerable variation among populations and individuals in terms of how age-related changes manifest. Consequently, this photograph alone does not allow for any reasonable estimate of this turtle's age (C. K. Dodd, Jr., pers. comm.).[3]

Alas, it seems that for the time being, the identity of this chelonian Civil War veteran remains a mystery. Nonetheless, this is perhaps the earliest photograph of one of America's most charismatic, beloved, and currently imperiled reptile species, and is of great historical value.[4] Rarely does an item surface with



PHOTO COURTESY OF WILLIAM A. FRASSANITO, *GETTYSBURG: A JOURNEY IN TIME*

FIG. 2. Isaac G. (left) and Charles J. Tyson in their studio, ca. 1864.



PHOTO COURTESY OF GETTYSBURG DAILY

FIG. 3. The building that housed Charles and Isaac Tyson's "Excelsior Gallery" as it appears today. The Tyson brothers moved their studio to this location (9 York Street) in January 1861.



PHOTO COURTESY OF GETTYSBURG DAILY

FIG. 4. Artillery shell believed to have been lodged in the façade of the Tyson brothers' gallery during the Battle of Gettysburg.

[3] In instances where a turtle is found with a name or date carved on its shell, a close examination of the inscription can also potentially provide clues as to when the engraving was made, the type of tool that was used, and whether the turtle had reached maturity at the time it was marked (C. Kenneth Dodd, Jr., pers. comm.). Such an examination was obviously not possible in this case.

[4] The earliest known Anglo-American depiction of a box turtle is a watercolor painting by John White, ca. 1585 (Franklin and Killpack 2009; see Smith et al. [1990] for a history of White's illustrations).

the ability to captivate the minds of herpetophiles, Civil War aficionados, and antiquarians alike. In all likelihood, we will never learn what inspired the Tyson brothers, in the wake of the most notorious battle of the Civil War, to deviate from their standard battlefield views and portrait photography to document this animal—but the mystique makes this photograph all the more compelling.

Acknowledgments.—I thank Ken Dodd for his examination and analysis of the image discussed here. Useful reference material was provided by Kraig Adler. Bill Frassanito dated the photograph, and his extensive knowledge of the Tyson brothers was invaluable in the composition of this piece. Carolyn Davis, Carolyn Sautter, John Richter, Tim Smith, and Sue Boardman generously reviewed archives, offered helpful suggestions as to the possible origin of the photograph, and generally helped guide my research in the right directions.

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Successful Incubation of Common Chuckwalla (*Sauromalus ater*) Eggs at the Bronx Zoo Using Suspended Incubation Method

The Common Chuckwalla (*Sauromalus ater*) is a desert-dwelling iguanid native to the southwestern United States and parts of Mexico (Shaw 1945). Reproduction of wild *Sauromalus* has been only partially described. Egg deposition often coincides with seasonal rain in spring and early summer (Abts 1988; Johnson 1965). Individual females become reproductively mature at approximately 2 years of age and an average snout–vent length (SVL) of 125 mm, experience oocytogenesis yearly, and have a mean clutch size of 6.9 eggs (Abts 1987, 1988).

Montanucci (1997) documented captive *Sauromalus* breeding. Timing of oviposition in captive and wild chuckwallas is consistent, with eggs being deposited between 28 April and 21 June. Montanucci (1997) also summarized incubation temperature and duration of eggs in media. Incubation periods ranged from74–112 days at temperatures between 28–35°C, with shorter incubation at higher temperatures (Fig. 2). Using standard egg incubation, whereby eggs were partially buried in fine sand, Montanucci (1997) reported low survivorship, with only one egg in a clutch of seven hatching at 30°C. This single hatchling exhibited neurological defects, leading Montanucci (1997) to conclude the animal had experienced oxygen deprivation.

Suspended incubation has previously been employed in herpetoculture (Köhler 2005). In this technique, eggs do not directly contact the media, and thus are not subject to suffocation by elimination of air spaces around the egg due to substrate compaction (Douglas 1993). Suspended incubation also eliminates the risk of embryos "drowning" if incubation media is too wet. Squamata Concepts® (Squamata Concepts LLC, Staten Island, New York, http://www.squamataconcepts.com/) has recently introduced the Suspended Incubation Method (S.I.M.) container as a standard tool for this method. Additionally, there are claims that the use of the S.I.M. container results in shorter incubation periods, fully absorbed yolk sacs, and potentially larger hatchlings (J. Andragna, Jr. pers. comm.).

The Bronx Zoo Department of Herpetology successfully hatched 23 *S. ater* from a total of 24 eggs in three clutches in 2010 and 2011. Herein we document the successful incubation of these eggs using suspended incubation in S.I.M containers. We also report egg and hatchling morphometrics.

Incubation.—Clutch size, date and incubation temperatures are summarized in Table 1. Clutch 1 consisted of nine eggs and was removed from the exhibit for incubation on 14 July 2010. Clutch 2, consisting of eight eggs, was removed from the exhibit on 24 May 2011. Clutch 3 contained seven eggs and was removed from the exhibit on 26 June 2011. Clutches 1 and 2 were removed from the exhibit within 24 h after oviposition. Clutch 3 took slightly longer to find, but was removed no later than 48 h after oviposition. Upon removal, all eggs were numbered, weighed, and measured. Egg mass, lengths, and widths are reported in Table 2.

All eggs were placed in a S.I.M. container (Fig. 1) and incubated over super-saturated vermiculite in a Thermo Forma (Model #3940) incubator. Although we could have incubated the eggs directly over water, we utilized vermiculate to prevent splash hitting the eggs during maintenance. However, standing water was visible in the bottom of the container. Clutch 1 was incubated at 31.5°C and 85% humidity. Clutch 2 was maintained at 31°C and 85% humidity for the first 12 days of incubation, at which point parameters were lowered to 30°C and 70% humidity because of requirements of another species placed in the incubator on that date. Clutch 3 was incubated at 30°C and 70% humidity for the entirety of incubation. The % humidity refers to settings of the incubator; the S.I.M. containers maintained an internal humidity close to 100% for the entirety of incubation (Fig. 3). All S.I.M. containers were aired weekly by removing the top for 1–10 seconds. Without removing eggs from the container, candling was occasionally performed while containers were open to document the progression of embryo development. Embryo development was noted as early as six days after oviposition. An Onset HOBO® data logger (Model # U10-003) was placed in the S.I.M. container with Clutch 2 to record temperature and humidity within the container.

As incubation progressed, remarkable size differences began to occur among eggs within each clutch (Fig. 1). Several eggs in

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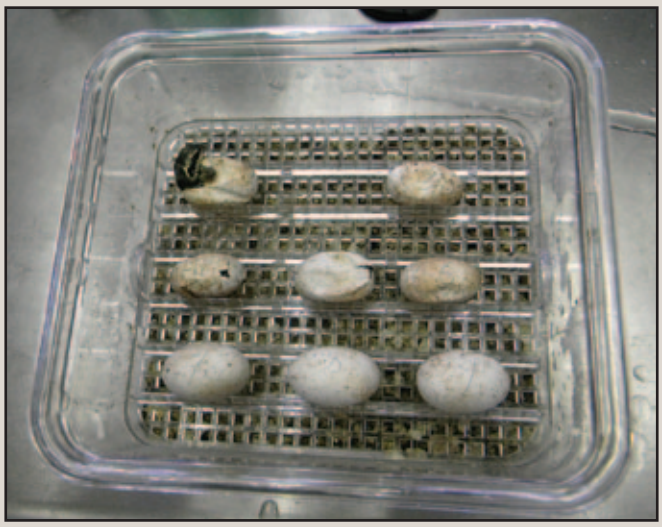


FIG. 1. Suspended Incubation Method container housing eight Common Chuckwalla (*Sauromalus ater*) eggs as they begin to hatch. Egg #2 (middle egg of top row) has already hatched and been removed. Note the disparity in sizes among the eggs.

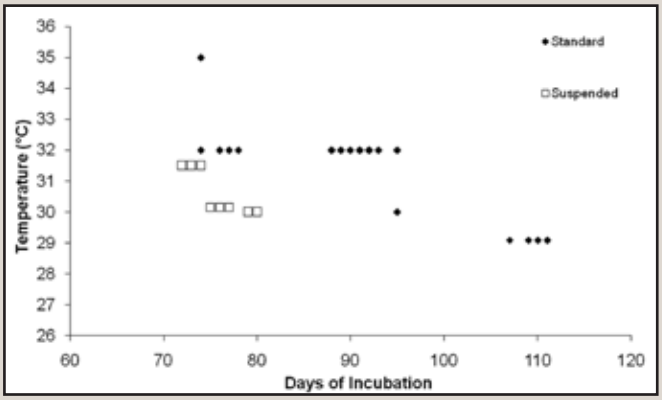


FIG. 2. Common Chuckwalla (*Sauromalus ater*) egg incubation period plotted against temperature for the Suspended Incubation Method (employed in this study) and data presented by Montanucci (1997) using the standard technique of incubating eggs directly in the media.

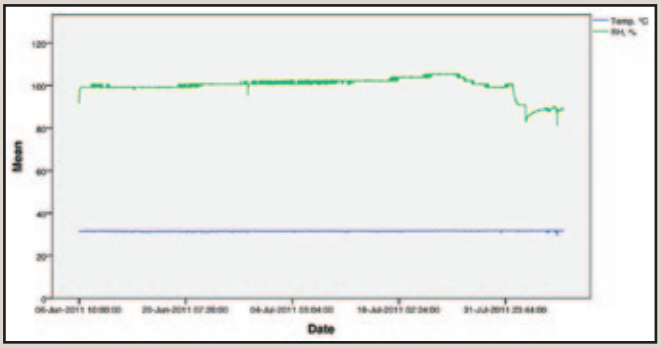


FIG. 3. Data obtained from an Onset HOBO® data logger (Model #U10-003) showing temperature and humidity inside S.I.M. container holding Common Chuckwalla (*Sauromalus ater*) eggs from clutch 2 (laid by female #2 on 24 May 2011) throughout the entire incubation period.

TABLE 1. Clutch size, collection date, temperature, and length of incubation for three clutches of Common Chuckwalla (*Sauromalus ater*) eggs.

Clutch #	# Eggs	Date collected	Incubation temp (°C)	Time to hatch (days)
1	9	14 July 2010	31.5	72–74
2	8	24 May 2011	31/30*	75–77
3	7	26 June 2011	30	79–80

*Clutch 2 was maintained at 31°C and 85% humidity for the first 12 days of incubation, at which point parameters were lowered to 30°C and 70% humidity because of requirements of another species placed in the incubator on that date.

TABLE 2. Mean (± 1 Standard Error) mass, length, and width of Common Chuckwalla (*Sauromalus ater*) eggs at time of oviposition. Clutch 1 (N = 9) laid by Female #1 on 14 July 2010; Clutch 2 (N = 8) laid by Female #2 on 24 May 2011; Clutch 3 (N = 7) laid by Female #1 on 26 June 2011.

	Clutch 1	Clutch 2	Clutch 3
Mean mass (g)	7.29 (± 0.138)	9.81 (± 0.188)	8.13 (± 0.078)
Mean length (mm)	34.67 (± 0.347)	37.63 (± 0.653)	34.69 (± 0.382)
Mean width (mm)	20.41 (± 0.151)	21.13 (± 0.295)	20.9 (± 0.282)

TABLE 3. Mean (± 1 Standard Error) mass, snout–vent length (SVL), and total length (TL) of Common Chuckwallas (*Sauromalus ater*) at time of hatching.

	Clutch 1	Clutch 2	Clutch 3
Mean mass (g)	5.27 (± 0.141)	8.49 (± 0.108)	7.03 (± 0.085)
Mean SVL (mm)	52.34 (± 0.694)	58.66 (± 1.056)	54.90 (± 0.675)
Mean TL (mm)	103.43 (± 1.157)	115.07 (± 1.202)	108.45 (± 1.057)

all three clutches grew so large as to necessitate pulling them upward and balancing them on top of the spacer rods to relieve pressure as they outgrew their allotted space within the S.I.M. container (Fig. 1). During the last 7–10 days of incubation, large amounts of condensation began forming inside the containers. We began opening the containers daily to wipe water droplets from the lid of the container to prevent these from raining down on the eggs. A drop in ambient humidity is seen on the data logger at this time (Fig. 3), which might be caused by the frequent opening of the containers during these last several days. Only one egg was lost during incubation; despite showing clear signs of fertility and early development, one egg from Clutch 2 sunk in and became moldy, necessitating its removal after 27 days of incubation.

Eggs in Clutch 1 began hatching on 24 September 2010 with the final hatchling emerging on 26 September, equating to an incubation period of 72–74 days. Clutches 2 and 3, incubating at a lower temperature, took longer to hatch. Clutch 2 began hatching 7 August 2011 taking 75–77 days and Clutch 3 hatched in 79–80 days beginning 13 September 2011 (Table 1). The minor difference in incubation times between clutches 2 and 3 was likely due to the difference in temperature at the beginning of incubation.

Hatchling morphometrics.—Mass, snout–vent length, and total length of all animals were recorded at the time of hatching (Table 3). All 23 chuckwallas lost weight in the first several weeks after hatching but a drop in weight after hatching is consistent with results for *S. hispidus* (Carl and Jones 1979). Our chuckwallas were observed eating as soon as five days after hatching; however, weight loss continued and animals did not rebound to birth weight until five to six weeks after hatching.

Discussion.—Suspended incubation is a common phenomenon in wild gekkonids (Henle 1990; Krysko et al. 2003) and has been reported in a wild colubrid snake by Kovac et al. (1995). In captivity, similar systems have generally been constructed using readily available materials, likely creating varying conditions that are difficult to replicate. The Squamata Concepts S.I.M. container is a valuable tool for herpetoculture, allowing suspended incubation data to be consolidated and easily replicated. We have utilized this tool to successfully incubate the eggs of various species, but prior to until now the use of this product has not been reported for many lizard species, including Common Chuckwallas (J. Adragna, Jr., pers. comm.).

Incubation of chuckwalla eggs using the suspended incubation method here was faster than expected based on data reported by Montanucci (1997). This observation potentially supports the claim that S.I.M. containers reduce incubation time (Fig. 2), although controlled studies would be needed to confirm this. Squamata Concepts also claims that hatchlings from eggs incubated in S.I.M. containers hatch without external yolk sacs. Our results support this claim as all 23 chuckwallas hatched at the Bronx Zoo had small umbilici at time of hatching, and all had fully absorbed yolk sacs.

Additionally, it has been shown that variations in moisture of incubation media might significantly affect the physical characteristics of hatchling lizards, with wetter media resulting in larger hatchlings (Overall 1994; Phillips et al. 1990; Phillips and Packard 1994). Alternately, Overall (1994) found that hatchling *Sceloporus merriami* incubated in very wet media grew slower than those hatched from drier media, particularly in later months. Although eggs in S.I.M. containers have no contact with media, they are exposed to an ambient humidity close to 100% (Fig. 3). We have included hatchling morphometrics (Table 3) to allow for future comparisons between these measures in chuckwallas hatched using suspended incubation and other incubation techniques.

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Captive Propagation of the Southern Dwarf Siren (*Pseudobranchus axanthus*)

Southern Dwarf Sirens, *Pseudobranchus axanthus* (Netting and Goin 1942) are small, fully aquatic, freshwater salamanders with external gills and a slender eel-like body (Conant and Collins 1991). Two subspecies are recognized, *P. a. axanthus* and *P. a. belli*, both endemic to peninsular Florida, USA. Currently, *P. axanthus* is listed by IUCN as a species of Least Concern (LC); however, the southern populations of *belli* are thought to have declined due to historic and ongoing habitat alteration including drainage of surface waters associated with development (Moler and Kezer 1993; Petranka 1998). Little is known about life history and reproduction of *P. axanthus*. There have only been two other successful captive breedings of *Pseudobranchus* to date: *P. striatus* (Pfaff and Vause 2002) and *P. axanthus* (Kowalski 2004).

Captive husbandry.—In September 2009, K. L. Krysko (FLMNH) donated nine (mixed gender) wild-caught adult *P. a. axanthus* from Alachua County, Florida, to the Central Florida Zoo & Botanical Gardens. The specimens were split into two groups of five and four individuals. Initially, they were housed indoors in 38-liter glass aquaria (30 cm depth; pH 7.0 ± 0.1) with sand substrate (12.9 cm depth), and leaf litter. No artificial lighting was offered, although tanks were set near windows to provide ambient lighting and a natural photoperiod. Specimens were fed a rotation of live tubifex worms (*Tubifex tubifex*), HBH brand Newt & Salamander Bites, Tetra brand spirulina flakes, and San Francisco Bay brand frozen brine shrimp three times per week. Small native snails were offered occasionally, but consumption was never observed. The preferred food item appeared to be tubifex worms. The Dwarf Sirens would burrow into the sand substrate with only their heads exposed. They would grab food items that landed near their heads. On many occasions, Dwarf Sirens were observed nosing food items around the enclosure before consuming them. No reproductive behaviors were observed during this initial period.

In April 2010, Tuff Stuff Product rubber cattle troughs measuring 152 cm (length) × 91 cm (width) × 61 cm (height) were established outdoors (Fig. 1). Initial water depth was set at 15.2 cm (90% tap water, 10% pond water). Rainwater was allowed to accumulate in the troughs until the water depth reached 30.48 cm above the bottom substrate. The bottom was covered with 2.54 cm of sand with a covering of leaf detritus 0.51 cm thick. Initial water temperature was 27.8°C. Various species of aquatic plants including Parrot Feather (*Myriophyllum aquaticum*), Alligator Weed (*Alternanthera philoxeroides*), and Spatterdock (*Nuphar luteum*) were added from a local stream (Fig. 2). The troughs were placed in a pen enclosed with 2.5 cm × 1.3 cm coated wire located in shaded ambient sunlight that received some direct sunlight in the morning. The troughs were set up early May 2010 and allowed to accumulate both terrestrial and aquatic locally

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PHOTOS BY DARRYL HEARD

FIG. 1. Outdoor enclosure.



FIG. 2. Aquatic plants used for egg deposition.

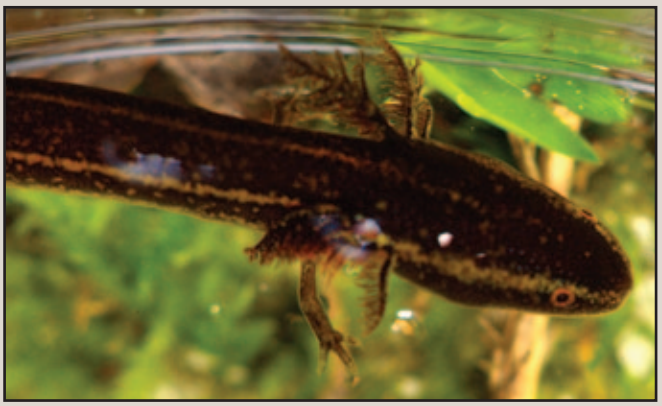


FIG. 3. Lateral view of the head of a *Pseudobranchus axanthus* larva.

occurring invertebrates for two weeks. *Pseudobranchus* are not sexually dimorphic, although female *P. axanthus* are generally more robust than the males (P. E. Moler, pers. comm., 2010). What were presumed to be two male and two female *P. axanthus* were added to the outdoor enclosure on 16 May 2010. They were fed frozen blood worms and brine shrimp as a supplement to the established invertebrates once a week. The sirens were expected to feed primarily on the aquatic invertebrates that had colonized the enclosure, predominately mosquito larvae (family Culicidae). Water in the outdoor tank had a pH of 7.8–8.0 during May and early June. By late June the pH had decreased to 7.2 ± 0.1. By December it had further decreased and remained at 6.5 ± 0.2. Water changes were not routinely performed during this experiment; however, rainwater was collected and added to the tank when needed. Water temperature never exceeded 32.2°C during the summer months and never went below 21.1°C in the coolest winter months.

Little is known about the method of reproduction for *P. axanthus*, but the oviposition period is thought to be November through March (Petranka 1998). A similar species, *P. striatus*, found from southern South Carolina, Georgia, and northern Florida (Liu et al. 2004) has a documented oviposition period of mid June through August in captivity (Pfaff and Vause 2002).

In the present study, single *P. axanthus* eggs (5) were first found on low roots and decaying leaves in late December 2010, within 18 cm of each other. The first larvae were observed on 4 February 2011. The jelly envelopes of the eggs could still be seen attached to leaf detritus and roots after larvae hatched. Egg incubation required 4–6 weeks. No mortality of hatchlings was observed; however, assessing an accurate count of eggs and offspring proved to be difficult due to the dense leaf detritus used as substrate. Twelve larvae were removed from the enclosure when seen during February and March 2011 (Fig. 3). At this time, larvae measured a mean total length of 2.73 cm (N = 12; 2.03–3.56 cm). After measurement, larvae were placed back into the original enclosure and fed the same diet rotation as described above. Adults were removed from the enclosure to prevent cannibalism of the larvae. After six months (September 2011) the tub was drained and the larvae were measured again. All 12 original larvae had more than doubled in size, measuring a mean total length of 6.41 cm (N = 12; 4.82–7.45 cm) and a mean mass of 0.31 g (N = 12; 0.22–0.48 g). In November 2011, all 12 larvae were thriving in the outdoor enclosures in nearly identical conditions as the adults. No further evidence of reproduction has been observed.

*Acknowledgments.*I thank Nick Clark, Charles Becker, and Ariel Horner with the CFZ&BG Department of Herpetology. I have much gratitude towards Scott Pfaff (Riverbanks Zoo), and Paul E. Moler and Bill Turner (Florida Fish and Wildlife Conservation Commission) for their guidance and critical comments on this note. I also thank Kenneth L. Krysko, Florida Museum of Natural History, for supplying the specimens used during this study.

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Observations on the Captive Maintenance and Reproduction of the Cascade Glass Frog, *Sachatamia albomaculata* (Taylor, 1949)

The Cascade Glass Frog, *Sachatamia albomaculata* (Centrolenidae), has a wide distribution from north-central Honduras to western Colombia and northwestern Ecuador (Savage 2002; Solis et al. 2010). This species has been observed from sea level to 1500 m in elevation where it is typically found along streams in humid lowland and premontane forests with little or no alteration, although it has also been found in more degraded habitats (Kubicki 2007). The International Union for the Conservation of Nature (IUCN) lists *S. albomaculata* as Least Concern with a stable population trend (Solis et al. 2010).

Herein we report the methods utilized for successful maintenance and reproduction of *Sachatamia albomaculata* at the Atlanta Botanical Garden (ABG) and Zoo Atlanta (ZA) in Atlanta, Georgia, USA, and the Como Park Zoo and Conservatory (CPZC) in St. Paul, Minnesota, USA. Of the 146 species of centrolenids described to date (Frost 2011), 54 are listed by the IUCN as Vulnerable, Endangered, or Critically Endangered (IUCN Red List), with a number of these recommended for *ex situ* management programs by Amphibian Ark (www.amphibianark.org). We

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FIG. 1. Adult *Sachatamia albomaculata* in the vicinity of El Valle de Anton.

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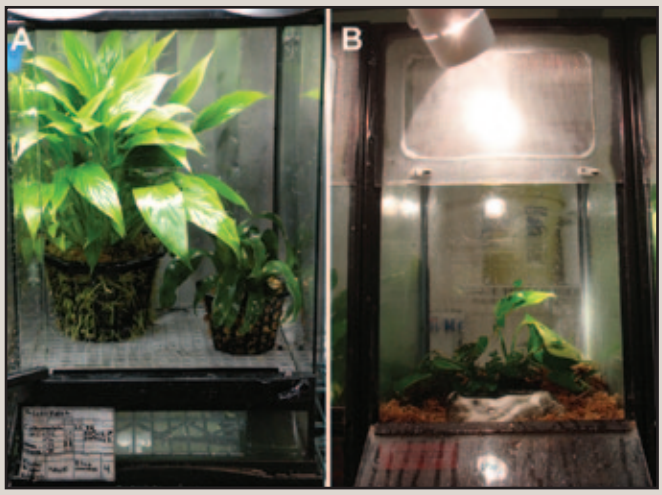


FIG. 2. Enclosure for adult *Sachatamia albomaculata* in the "Frog Pod" at ABG (A) and enclosure at SPCZ (B).

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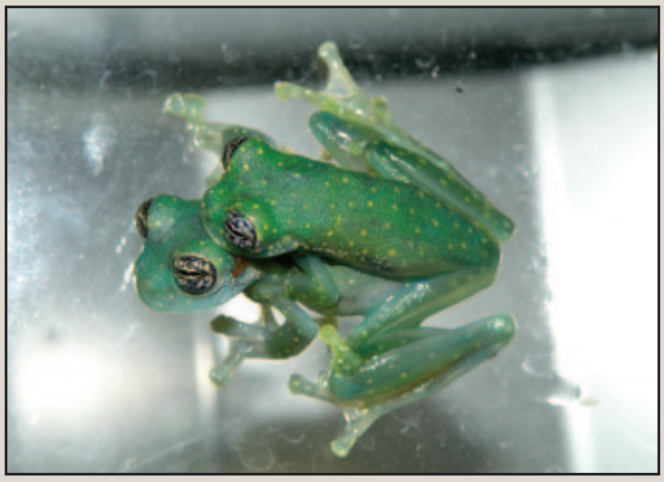


FIG. 3. Adult pair of *Sachatamia albomaculata* exhibiting axillary amplexus.

believe the information presented here will be useful in future efforts to maintain *ex situ* populations of threatened species of Glass Frogs.

Specimen Acquisition and Husbandry Methods.—A group of *Sachatamia albomaculata* (Fig. 1) were collected from the region of El Valle de Antón, Provincia de Coclé, Panamá and brought to ABG and Zoo Atlanta (ZA) in 2005 (Gagliardo et al. 2008). Following importation, specimens were quarantined for a period of 30 days during which they were treated for amphibian chytrid fungus (*Batrachochytrium dendrobatidis*) as outlined in Pessier and Mendelson (2010). After this quarantine period, 3.1 specimens were transferred to ZA, 1.1.2 to CPZC, and 5.2 to ABG.

The 5.2 ABG specimens were moved to an enclosure measuring 60 × 30 × 90 cm furnished with live plants for cover and to provide sites for egg deposition. A "false-bottom" substrate made from plastic light diffuser wrapped in plastic coated screening was used to allow for rapid cleaning and improved hygiene. Light was provided by a single 55-watt compact fluorescent fixture with a cycle of 12 hours on and 12 hours off. Temperatures ranged from 18–28ºC. Humidity and moisture were maintained through use of an automated misting system. Food items were offered three times weekly and consisted largely of 3–5 mm crickets (*Acheta domestica*), flightless fruit flies (*Drosophila hydei*), and occasional offerings of Bean Weevils (*Callosobruchus maculatus*). All food items were supplemented with alternate dustings of Repcal D3® and finely powdered Men's Health® vitamins. In 2010, Repashy Superfoods® Calcium plus ICB was added to the supplement regime.

In 2008, ABG acquired and outfitted an insulated shipping container as an amphibian breeding facility (Fenolio et al. 2009) into which the remaining 3.1 Cascade Glass Frogs from ABG and 2.1 from Zoo Atlanta were moved. Once transferred to this facility they were split into groups of 1.1, 1.1, and 3.0 each into Zoo Med® terrariums measuring 30 × 30 × 45 cm and furnished as above (Fig. 2A). Humidity and moisture were regulated through the use of an automated misting system operating six times daily during a simulated wet season from November–April and two times daily during a simulated dry season from May–October. Individual misting events ranged from three to 10 minutes each with the shortest misting events taking place during the simulated dry season.

Adults of *S. albomaculata* at CPZC were housed in terrariums with dimensions of ~30 × 25 × 50 cm. Substrate consisted of a layer of hydroponic clay which was covered with a layer of moistened sphagnum moss. A water dish and live plants (*Epipremnum aureum*) were also included. Temperatures ranged from 18–26ºC. Enclosures were misted six times daily for periods ranging from 3–10 minutes. Lighting was provided with an individual 50 watt Eiko ® Supreme halogen spot light with the glass lens removed. A 12:12 daily light cycle was maintained. The diet consisted of fruit flies (*D. hydei*) and small crickets (*A. domestica*) offered three times weekly. Initially, food items were dusted with a mixture of Rep Cal® without D3 and Nekton-Rep®. Beginning in 2011, all food items were dusted with Repashy Superfoods® Calcium plus ICB.

Specimens at Zoo Atlanta were housed similarly to those at CPZC. However, lighting was provided with fluorescent lights as opposed to Eiko ® bulbs. Misting was by hand and conducted once or twice daily. The diet was composed of fruit flies (*D. hydei* and *D. melanogaster*) and small crickets (*A. domestica*). On occasion, house flies (*Musca domestica*) were offered. Following the loss of the lone female in this group, a single female was sent from ABG in late 2007. However, in 2008, all individuals from Zoo Atlanta were moved permanently to ABG.

Specimens of *S. albomaculata* proved to be relatively hardy captives given that their environmental needs were met. However, some health concerns were noted, including: a male specimen at CPZC with chronic intestinal prolapse, susceptibility

to heavy infestation by nematodes in the genus *Rhabdias*, and in the case of one female specimen housed at Zoo Atlanta, an infection of the eye that resulted in its removal (S. Rivera, pers. comm.). Despite what would seem a large handicap, this specimen was still alive at the time of submission (March 2012) and had produced a number of offspring after transfer back to ABG (RLH, pers. obs.).

Breeding.—Regular breeding events did not occur at ABG until late 2008, although a few egg masses were produced between 2005 and late 2008. Axillary amplexus was observed (Fig. 3). Pairs at ABG produced eggs in most months, although the largest number of eggs was deposited from January–May. This is consistent with wild observations in Panama in which egg masses were observed throughout the year. However, the largest number of egg masses and individual frogs in the field were observed in the months of November and December (Griffith pers. obs.).

The number of eggs per clutch varied from 28–56 at ABG with eggs numbering from 30–60 at CPZC. Clutches were typically deposited on the upper surface of a leaf in a single-layer cluster with an opening in the center as described by Kubicki (2007; Fig. 4). On several occasions at ABG eggs were laid directly on the glass sides of the enclosure, within the phytotelma of a bromeliad, or on the enclosure floor. No parental attendance was observed following oviposition at ABG. However, males at CPZC were observed to sit adjacent to eggs. Of further interest, in two instances, a male was observed sitting in the water dish for a period, and then moving through the enclosure toward the egg mass. Although deposition of water was not directly observed in either instance, the behavior implies that males may be transporting water to hydrate eggs. Further observations are necessary to confirm this behavior.

Handling of Eggs and Larvae.—Once discovered, eggs at ABG were typically removed from the adults' enclosure (typically on a leaf of *Calathea*) and placed in a covered plastic container with a small amount of water until hatching. Eggs deposited on the glass or enclosure floor were gently scraped from the surface using a razor blade and then placed on top of a cut leaf in a container as described above. Eggs began hatching roughly 2–3 weeks post-oviposition. Larvae were transferred to plastic containers measuring 25 × 15 × 10 cm that were filled to a depth of 7–8 cm with carbon-filtered tap water and a thin substrate of sand and pea gravel (Fig. 5). Larvae were raised communally in groups no larger than 30 per container. Temperatures were maintained at 20–25°C. Live Java Moss (*Vesicularia* sp.) and small amounts of Common Duckweed (*Lemna minor*) were included to provide additional cover. Water was changed at a rate of approximately 50% daily.

Larval diet consisted mainly of Sera Micron®, a commercially-produced Spirulina-based finely-powdered fish food. This was mixed with water to form a thick paste and spread onto microscope slides as described by Hill et al. (2011). This method has proven successful for larvae of multiple frog species, including two other centrolenids in the ABG collection: *Cochranella granulosa* and *Teratohyla spinosa*. As such, it was expected to work for *S. albomaculata*. However, larvae failed to thrive when food was offered in this manner and would typically expire within 30 days of hatching. Similar results were observed at Zoo Atlanta. Following several failed attempts, in early 2009, one of us (JBK) offered Sera Micron® mixed with finely ground HBH Frog Bites ® in paste form directly on the substrate of the rearing containers (Fig. 6). Larval survival increased upon switching to this feeding strategy and the first metamorphosis occurred at ABG in March 2009 with additional successes following throughout 2009, 2010, and 2011.



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FIG. 4. Partially developed eggs of *Sachatamia albomaculata* at ABG.

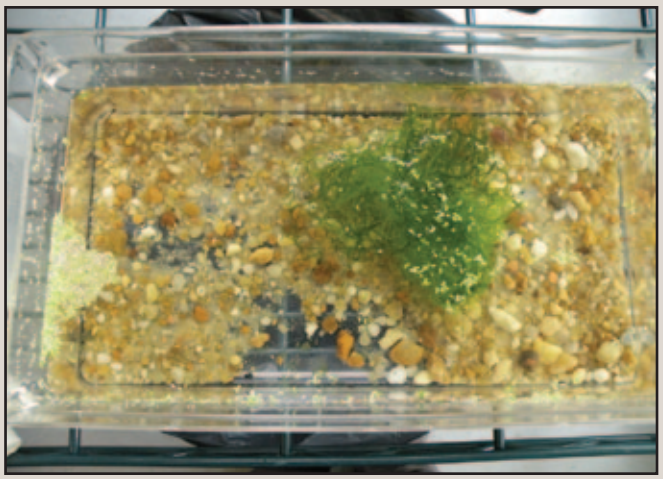


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FIG. 5. Container used for rearing larvae at ABG.

Larvae at CPZC were reared in glass aquariums measuring approximately 50 × 25 × 30 cm with water depth from 10–20 cm. Larval density did not exceed 30 per aquarium. Temperatures were maintained at 22–25°C with the use of aquarium heaters. Live plants, oak leaves, a small amount of sphagnum moss, and a layer of gravel were added. In addition, live snails were added to combat black algae growth. Partial water changes were conducted on a daily basis. At approximately eight months, water levels were lowered as larvae would appear stressed with deeper

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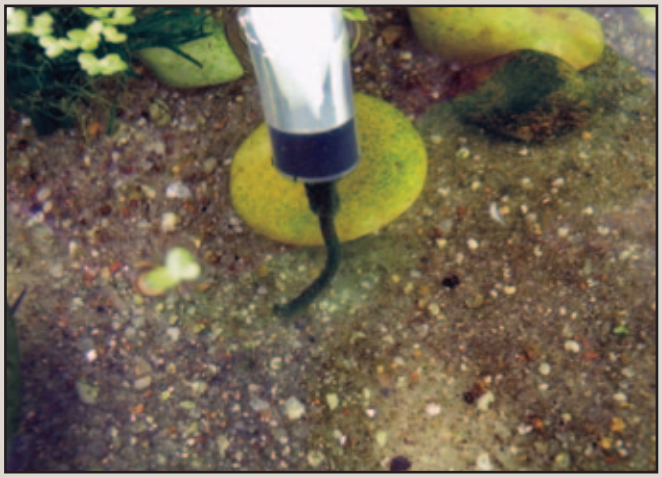


FIG. 6. Sera Micron ® and HBH Tadpole and Frog Bite ® mixture being injected onto larval enclosure substrate.

water at this stage of development. The diet consisted entirely of Sera Micron® on microscope slides. Why this method proved successful at CPZC but not at ABG or Zoo Atlanta is unknown.

Handling of Metamorphs and Juveniles.—At ABG, time from hatching to metamorphosis ranged from 12–40 weeks. Larvae from the same clutch metamorphosed at highly variable rates despite all being housed under similar conditions. The reason for this is unknown as manipulations using smaller numbers of larvae per rearing container still resulted in variable rates of metamorphosis within single cohorts. After emergence of all four limbs, newly metamorphosing individuals were moved into plastic quart-size deli cups with vented lids, roughly 1 cm of filtered water, and a small mound of moistened sphagnum moss as a haul out area. Each metamorph was housed separately and additional moss was added to prevent drowning once it started spending large amounts of time out of the water (typically within 3–5 days after front limb eruption). They began feeding on small flightless fruitflies (*D. melanogaster*) after full absorption of the tail, which took from 7–20 days, although some specimens were observed to feed before full tail absorption. As they grew, food item size was increased to match that of the adults. They were hand misted once daily and temperatures were maintained as for adults. Individuals were raised in this manner for 5–8 months to ensure easy access to food items and provide easy monitoring, then moved into larger enclosures as deemed necessary.

When rear limbs were well developed and dorsal patterning appeared, late-stage larvae at CPZC were moved into an enclosure measuring 50 x 25 x 30 fitted with a ramped polypropylene false bottom to serve as a haul out area. A vented lid was included to prevent escapes and partially covered with plastic wrap to maintain high humidity. The water portion was kept at a depth of approximately 7–8 cm and included furnishings similar to the larval enclosures. Partial water changes were conducted daily. Small plants and moistened sphagnum moss were added to the haul out area. This enclosure was misted twice daily. Sera Micron® slides were offered until metamorphs left the water, at which point they were offered springtails (*Collembola* sp.), fruit flies (*D. melanogaster*), and newly hatched crickets (*A. domestica*) daily. Once they doubled in size, young frogs were moved into Zoo Med® terraria as described above.

Conclusions.—*Sachatamia albomaculata* is currently listed by the IUCN Red List as a species of Least Concern and wild populations appear stable at this time (Solis et al 2010). However, it was postulated by Kubicki (2007) that *S. albomaculata* may contain multiple species. If this is proven to be the case, then the conservation status of this potentially cryptic species complex may change. Of the three currently recognized species of *Sachatamia* considered by the IUCN at the time of writing, one is listed as Vulnerable (*S. punctulata*). Another, *S. ilex*, which often is sympatric with *S. albomaculata*, has been listed as Least Concern. However, populations of *S. ilex* have experienced declines (Solis et al. 2010). A group of *S. ilex* from the El Valle region of Panama was brought to Zoo Atlanta in 2005 where a handful of breeding events occurred. However, as with *S. albomaculata*, early rearing attempts proved unfruitful and unfortunately, the US breeding population expired before any further successes were gained. The methods described above could be applied to *ex situ* management plans for other glass frogs deemed in need, not just members of the genus *Sachatamia*.

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Growth Rates of Neonate Red Cornsnakes, *Pantherophis guttatus* (Colubridae), When Fed in Mutually Exclusive Mass-Ratio Feeding Categories

Studies on growth rates of snakes have long been investigated (Barnard et al. 1979; Carpenter 1952; Ford 1974; Kauffeld 1943) and are still ongoing (Boback 2003; Hill and Beaupre 2008; Madsen and Shine 2001). There are two growth measurements that are generally recorded when measuring snakes: length and mass (Charland and Gregory 1989; Franz 1977; Kauffeld 1943; Myer and Kowell 1973). A third and easily acquired measurement is girth at mid-body but this is rarely reported. Straight-line length is occasionally used but the most commonly reported length measurement is snout to vent length (SVL; Seigel and Ford 1988). It is important to state which measurement technique is being used (Fowler and Salamao 1995).

In a study on *Nerodia sipedon*, Brown and Weatherhead (1999) reported two variables that are likely to affect snake growth rates: energy intake and climate. Laboratory investigations allow for control of both of these variables. Many studies hold temperature constant and investigate feeding regimes (Barnard et al. 1979; Dmi'el 1967; Ford and Seigel 1994). Myer and Kowell (1973) showed that frequency of feeding and food mass can affect growth in *Thamnophis sirtalis*. As a snake consumes more food its total body mass usually increases but this phenomenon may not accurately relate the size (mass) of a snake to its age because body mass can be impacted by multiple variables. Snake mass has been shown to fluctuate with feeding regimes (Myer and Kowell 1973) and varying reproductive efforts (Charland and Gregory 1989). Neonate *Pantherophis guttatus* have been shown to convert up to one-third of their food weight into added body mass (Love and Love 2005). However, age can be predicted based upon SVL if the sampling period of the growth model is large enough and the specimen collected is in close regional proximity to the growth model sample (Brown and Weatherhead 1999). Individual marine iguanas total length has been shown to shrink during times of low food availability (Wikelski and Thom 2000) but this growth reduction phenomenon has not been shown in snakes (Madsen and Shine 2001).

In an early field growth study, Kaufman and Gibbons (1975) evaluated the relationship of SVL and mass of thirteen species of snakes that were primarily road collected and reported a correlation coefficient between SVL and mass of ≤0.82 with *P. guttatus* being 0.97. Barnard et al. (1979) investigated the growth rates of ten sibling *P. guttatus* for ca. 2 years in a laboratory setting. Snakes were fed weekly meals of mice and were measured (total length and mass) monthly. A correlation coefficient of 0.978 was reported between total length and mass. They found that growth is more dependent on food consumed rather than age, length is logarithmically related to body weight, and weight gain and length are related to the amount of food ingested.

Many investigators have evaluated snake growth at different feeding frequencies (Dmi'el 1967; Wharton 1966) but to our knowledge, none have evaluated snake growth when fed in a mass-ratio feeding category with a constant frequency. A mass-ratio (MR) feeding category is a mutually exclusive feeding category calculated as the percent of prey mass to snake mass (Mehta 2003). The objective of this study is to evaluate the growth (length, girth, mass, and shedding rates) of neonate *P. guttatus* when fed in mutually exclusive MR feeding categories. We collected data on the growth rates and shedding frequencies of captive *P. guttatus*.

Materials and Methods.—The 18 hatchling snakes used in this study came from the personal collection of David Penning. Parents of the offspring were originally obtained from Miles of Exotics in Kansas City, Missouri. All snakes shared the same father and came from one of two mothers. All hatchlings displayed phenotypically normal traits but carried various non-expressed alleles that their mothers displayed but they did not. The first clutch of snakes began hatching on 8 June 2010 and all snakes hatched by 15 June 2010. All snake eggs were incubated in the same type of incubator (Little Giant® Still Air Incubator) with the same average temperature (28°C) and humidity (≤80%).

Each neonate was held individually in a cage internally measuring 27.9 × 27.9 × 15.2 cm. A sliding, clear piece of glass was used for the lid. Multiple 5-mm holes were drilled into the backs and fronts of the cages for proper air exchange. This allowed proper ventilation without exposing each snakes to the visual cues of the other snakes. Ambient room temperature averaged 27.9°C. Each cage was spot cleaned daily and bedding was changed *pro re nata*. No mites or parasites of any kind were observed during the experiment. Water was available at all times.

Hatchlings were then checked once per week for their first shed. The feeding trials began the following scheduled feeding day upon the discovery of each snake's first shed. The order in which the snakes were placed into each category was determined by a random number generator. House Mice (*Mus musculus*) were the only food given to snakes in the experiment. Each snake was put into a feeding schedule of one meal per week. The two feeding categories were labeled as small and large. The small feeding category had a prey mass-ratio of 20–40% of the snake's mass while the large category had a ratio of 41–60% of the snake's mass. The original categories followed the format of Mehta (2003) but hatchlings were born at a small size (mean = 4.4 ± 0.68 g) that prohibited the narrower ranges. Snakes were weighed using an AWS high capacity precision pocket scale (0.1 g) the day prior to each feeding trial and prey mass range was calculated for them. A prey item within the snake's range was chosen ca. one hour before trials began. Mice were transported to the university in containers in which all individuals of similar mass were grouped together. Mice were then chosen at random and weighed to match the appropriate snake. Snakes that failed

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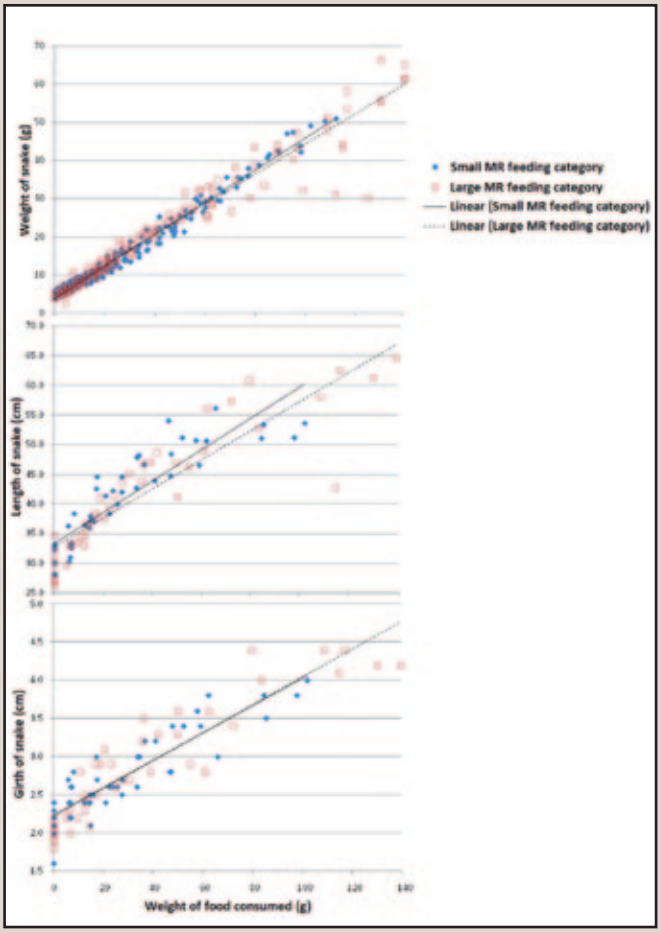


FIG. 1. Rate of growth increase for weight (A), length (B), and girth (C) based upon the growth rates of 18 individual Red Cornsnakes (*Pantherophis guttatus*) in two feeding categories over a 22-week feeding trial.

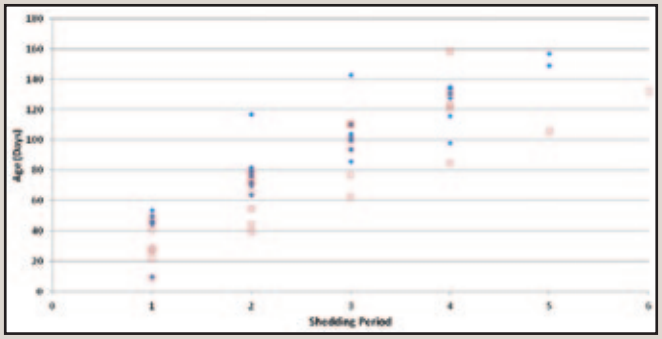


FIG. 2. Age of snakes at sequential shedding periods for both MR feeding categories. Blue fill indicates the small MR feeding category, red outline indicates the large MR feeding category.

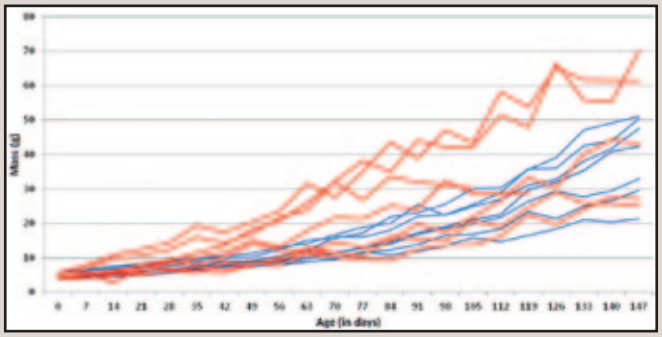


FIG. 3. Relationship between weight (mass) of individual snakes and age (in days). Blue lines represent snakes in the small MR feeding category and red lines represent snakes in the large MR feeding category.

to eat for four weeks in a row were removed from the study. A failed feeding trial was considered a period of 40 minutes at any point of the feeding trial in which the snake did not engage the prey.

Although previous studies measured snake length using snout to vent length (Fowler and Salamao 1995), we used snout to tail length for two reasons: the measurement data attained from this study came from a larger project requiring minimal handling; and to compare our data to that of Barnard et al. (1979). Because of this, snakes were digitally and not manually measured. Snakes were placed on a piece of 0.5 cm graph paper and photographed directly overhead approximately 100 cm above the snake. Pictures were then entered into the SnakeMeasurer© program to get total length. This allowed for the snake to orient its body in a natural position without being manually manipulated. Snake length was recorded to the 0.1 cm. Girth (in cm) was measured using a flexible measuring tape and wrapped around the snake at midbody and measured to 0.1 cm. Shedding events were recorded *pro re nata*. All statistical analysis was conducted on Minitab 14.

Results.—Snake mass is significantly related to the amount of food consumed in the small and large MR feeding categories ($P < 0.05$, small $r^2 = 0.974$, large $r^2 = 0.949$) and expressed by the following simple linear regression models: Small snake mass = 3.85 + 0.419 (total food consumed), Large snake mass = 4.84 + 0.395 (total food consumed). The intercepts and slopes of the two regression models are not significantly different (General Linear Model, $P > 0.05$).

Snake length is significantly related to the amount of food consumed in the small and large MR feeding categories ($P < 0.05$, small $r^2 = 0.795$, large $r^2 = 0.810$) and expressed by the following simple linear regression models: Small snake length = 33.3 + 0.263 (total food consumed), Large snake length = 32.7 + 0.244 (total food consumed). The intercepts and slopes of the regression models are not significantly different (General Linear Model, $P > 0.05$).

Snake girth is significantly related to the amount of food consumed in the small and large MR feeding categories ($P < 0.05$, small $r^2 = 0.807$, large $r^2 = 0.839$) and expressed by the following simple linear regression models: Small snake girth = 2.23 + 0.0180 (total food consumed), Large snake girth = 2.21 + 0.0183 (total food consumed). The intercepts and slopes of the regression models are not significantly different (General Linear Model, $P > 0.05$). Regression models can be seen in Fig. 1.

Correlations were run among all three growth forms. All correlations are significant at $P < 0.05$. Mass and girth Pearson correlation coefficients are 0.912 for the small MR category and 0.934 for the large MR category. Mass and length Pearson correlation coefficients are 0.881 for the small MR category and 0.889 for the large MR category. Girth and length Pearson correlation coefficients are 0.853 for the small MR category and 0.922 for the large MR category.

Snake shed cycles from this experiment are presented in the same format as that of Myer and Kowell (1973) in Fig. 2.

Discussion.—In both the small and large MR feeding categories, growth in mass, length, and girth was significantly related to total food consumed. There was no significant difference

between the regression slopes of the small and large MR feeding categories for all three growth forms. This statistically supports the concept that food ingested (regardless of how it is ingested) will result in similar growth. Snakes in the larger MR category attained a larger mass, girth, and length by the end of the feeding trials but the overall growth models were not significantly different. It took the snakes in the small MR category longer to attain similar size in all growth forms but arrived at similar sizes as the large MR category per total food consumed. Mass, length, and girth gained by the snakes in this study depended upon the total amount of prey ingested. This supports the idea that snake mass is not dependent upon age alone. These findings agree with Barnard et al. (1979) in that snake mass is not an accurate estimation of snake age. These findings also support Barnard et al. (1979) in that variation (in mass) among individuals increased as amount of food increased and is presented in a similar format in Fig. 3. Snake size (mass) should not be used as an estimator of age beyond reproductive status (which generally accompanies a minimum age bracket).

We report a similar correlation coefficient as Barnard et al. (1979) between snake length and body weight (mass) in *P. guttatus*. A longer study is needed to specifically examine the growth associations in mutually exclusive MR feeding categories as Barnard et al. (1979) was a much longer study than the 22-week length of this experiment. In both the small and large MR feeding categories the correlation coefficients were similar for mass and length, mass and girth, and length and girth. These correlation coefficients suggest that there is a close association between the two MR feeding categories growth forms. Length, girth, and mass all covary with one another in a similar manner.

Cornsnakes had a variable % mass gain [(current pre-feeding snake mass – previous pre-feeding snake mass) / (prey mass from previous week)*100] in body weight per feeding event. Love and Love (2005) stated that neonate *P. guttatus* can convert up to 33% of their food (prey) weight into body mass. Snakes in this study had a percent mass gain range of -15% to 93% mass gain per feeding event. The average percent gain for the small MR feeding category was 40 ± 19.3%. The average percent gain for the large MR feeding category was 45 ± 22.4%. The averages suggest that it is more advantageous to eat larger prey (if the goal is mass gained) but when accompanied by the standard deviations there is no discernible difference between the percent mass gains of the two MR feeding categories. This observation is a much more variable number than the percentage presented by Love and Love (2005). There may be varying metabolic factors impacting mass gain that were not addressed in this study. A mass gain ratio does not appear to be a reliable measure of energetic (body mass) gain.

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HERPETOCULTURE NOTES

TESTUDINES — TURTLES & TORTOISES

***PYXIS ARACHNOIDES ARACHNOIDES* (Spider Tortoise). DRINKING BEHAVIOR.** Animals from arid or seasonally dry habitats often have unique adaptations for capturing water from rare or unpredictable rainfall events (Costa 1995. Behavioural Adaptations of Desert Animals. Springer-Verlag, Berlin. 198 pp.). Water-capture behaviors have been described for certain arid-land tortoises of the genera *Psammobates* and *Kinixys*, which involved elevating the rear part of the carapace by extending the hind legs while splaying the forelimbs forward, allowing water to flow down the "gutter" formed from the flared marginal scutes and along the forelimbs to the mouth (Auffenberg 1963. Anim. Behav. 11:72–73).

I observed a very different drinking posture and behavior in 137 wild-caught, confiscated *Pyxis a. arachnoides* in Madagascar. The tortoises were being temporarily housed in Antananarivo after the confiscation of an illicit smuggling attempt, apparently to get them out of the country. Their general health was to be monitored before being transported to a facility nearer to their native range in preparation for repatriation. When being rehydrated via pipette from overhead to simulate rainfall, the tortoises assumed an unusual posture. Once contacted by water droplets, tortoises went from fully withdrawn into the shell to having limbs extended and head fully extended upward. Front limbs were extended downward while rear limbs were splayed and slightly bent so that the tortoise's anterior was higher than the posterior. Head and neck were extended upward or backwards over the carapace, and the tortoise would take in the water through both nares and mouth; swallowing was presumed due to visible gular undulation. Each tortoise pipetted assumed this posture, and several held it for more than 30 minutes, regardless of continued pipetting. A similar posture has been observed in another, closely-related Malagasy tortoise species (*Astrochelys radiata* [Radiated Tortoise]) during actual and simulated rainfall (pers. obs.), however it has not been linked to drinking. This is apparently the first report of this unique water gathering and drinking behavior in *Pyxis*, a critically endangered taxon (IUCN 2011. IUCN Red List of Threatened Species. Version 2011.2. <www.iucnredlist.org>).

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***STIGMOCHELYS PARDALIS* (Leopard Tortoise). BEHAVIOR.** These observations involve a pair of captive-bred adult *Stigmochelys pardalis* that live in an enclosed garden near the Gulf of Thailand (where is the Gulf of Thailandin the Hup Kapong subdistrict, Cha Am, Petchaburi Province, Thailand (12.760642°N, 99.912908°E). This pair has produced several clutches of hatchlings. The hatchlings are allowed to graze during the day in screen-protected pens while the adults are left free to roam in the enclosed garden. Normally therefore there is no contact between adults and juveniles.

Under a full moon on New Year's Eve 2011 the female was observed to lay eggs in a protected hilly area of the garden. One morning after a night of heavy rain, four hatchlings were found in the garden, approximately five months after oviposition. At about one week of age, the hatchlings were placed close to the mother and father. There were clearly audible vocalizations from the mother, directed toward the juveniles, and also from the juveniles to the mother. The calls were repeated low-pitched "cooing" sounds whose pitch rose and then fell and lasted between 1–2 seconds. Vocalizations began within a minute of the hatchlings being placed closed to the mother and continued for about 5 min. For the next several hours, the four hatchlings and the mother walked together in close proximity in the garden, stopping often to graze. The mother appeared almost hyperactive and was clearly intensely interested in the juveniles. Two days later the juveniles were again placed close to the mother. Again, there were bi-directional vocalizations as previously described and the five animals moved as a group through the garden. On subsequent trials, however, no additional vocalizations were heard when the juveniles were placed close to the mother, although occasionally one or two of the juveniles stayed close to the mother for several hours.

Acoustic vocalizations are well known between male and female *Stigmochelys pardalis* during courtship and mating. Vocalizations in turtles unrelated to mating have not often been reported. Recently, an underwater acoustic repertoire of the Long-necked Turtle, *Chelodina oblonga*, was reported (Giles et al. 2009. J. Acoust. Soc. Am. 126:434–443). However, to my knowledge, communication between mother and juvenile tortoises has not been previously observed. There is no way of knowing, from these observations, whether the female tortoise recognized the hatchlings as her own offspring, or whether she would react the same to any conspecific hatchlings. I hope to record these vocalizations when new hatchlings next appear. Meanwhile though, this anecdotal observation serves to emphasize how much social behavior and the part played by vocalizations remains to be described in tortoises.

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***TOMISTOMA SCHLEGELII* (False Gharial). DIET.** Few published observations are available on the diet, feeding, or predatory behavior of *Tomistoma schlegelii*, a little-known and threatened Southeast Asian crocodilian (Bezuijen et al. 2010. *In* S. C. Manolis and C. Stevenson [eds.], Crocodiles: Status Survey and Conservation Action Plan, 3rd ed., pp. 133–138. Crocodile Specialist Group, Darwin). Müller (1838. Waarnemingen over de Indische Krokodillen en Beschrijving van Eene Nieuwe Soort. Tijdschrift voor Natuurlijke Geschiedenis en Physiologie 5:61–87) stated the diet of *T. schlegelii* included fish, monitor lizards (*Varanus* spp.), water birds, and mammals. Predation of at least two wild primate species by *T. schlegelii* has been documented by direct observation in the wild and/or through stomach content analysis of wild specimens (Galdikas 1985. Primates 26[4]:495–496; Galdikas and Yeager 1984. Amer. J. Primatol. 6:49–51; Rachawan and Brend 2009. CSG Newsletter 28[1]:9–11). Stomach contents of juvenile wild *T. schlegelii* included shrimp (Bezuijen et al. 1998). There is a single confirmed report of predation on *Homo sapiens*

PHOTO BY MITTAL GALA



FIG. 1. Captive male *Tomistoma schlegelii* with an adult *Melanochelys trijuga* that it captured on land, attempting to break the turtle's carapace after entering the water.

by a *T. schlegelii* from Central Kalimantan Province, Indonesia (Rachawan and Brend 2009. CSG Newsletter 28[1]:9–11). Based on the distinctive narrow snout, some early reports stated that *T. schlegelii* is predominantly piscivorous (Neill 1971. The Last of the Ruling Reptiles: Alligators, Crocodiles, and Their Kin. Columbia University Press, New York. 486 pp.; Campbell and Winterbotham 1985. Jaws, Too! The Natural History of Crocodilians with Emphasis on Sanibel Island's Alligators. Sutherland Publishing, Ft. Myers, Florida. 267 pp.; Guggisberg 1972. Crocodiles: Their Natural History, Folklore and Conservation. Stackpole Books, Harrisburg, Pennsylvania. 195 pp.). Here I report on the first observation of predation on an Indian Pond turtle (*Melanochelys trijuga*) by a captive *T. schlegelii*.

Two captive *T. schlegelii* (a male, 3.8 m total length [TL] and female, 2.8 m TL) housed at the Madras Crocodile Bank Trust and Centre for Herpetology, India, are fed fish, whole chicken, and the occasional Lesser Bandicoot Rat (*Bandicota bengalensis*). The enclosure also houses several *M. trijuga*, which are successfully breeding within the enclosure. In September 2011, two separate incidents of predation on these turtles, by the male and female *T. schlegelii*, were observed.

In the first incident (15 Sept 2011, 1200 h), the female *T. schlegelii* caught a juvenile *M. trijuga* (straight carapace length [SCL] visually estimated to be 125 mm) in the pond, and held in its jaws for approximately 20 minutes, repeatedly cracking the carapace in many points before swallowing it whole. In the second incident (29 Sept 2011, 1200 h), the male caught a turtle (SCL visually estimated to be 250 mm) on land then entered the water, and alternately circled the pond and submerged and emerged, bubbling and hissing, with the (now dead) turtle in its jaws (Fig. 1). It repeatedly attempted to crack the carapace. After several minutes the male emerged without the turtle in his mouth. It is not known whether the turtle was swallowed or dropped, although *T. schlegelii* has been observed to swallow prey underwater (Brueggen 2003. CSG Newsletter 22[1]:21).

Recent information suggests *T. schlegelii* has a broad diet. The distribution of *M. trijuga* does not overlap with *T. schlegelli*, (Das and Bhupathy 2009. *In* Rodin et al. [eds.], Conservation Biology of Freshwater Turtles and Tortoises: A Compilation Project of the IUCN/SSC Tortoise and Freshwater Turtle Specialist Group, pp. 038.1–038.9. Chelonian Research Monographs No. 5), so it is unlikely that *M. trijuga* is a natural prey species in the wild. However, the present observations indicate that turtles are likely to be natural prey for wild *T. schlegelii*.

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SQUAMATA — SNAKES

***AGKISTRODON TAYLORI* (Taylor's Cantil). LONGEVITY.** An adult male *Agkistrodon taylori* was confiscated by UK wildlife authorities in February 1995 and donated to the collection at West Midland Safari Park (WMSP), Worcestershire, England. *Agkistrodon taylori* exhibits both sexual and ontogenetic dichromatism (Burchfield 1982. J. Herpetol. 16[4]:376–282) which clearly identified this specimen as an adult male upon arrival. After suitable quarantine, it was introduced to a female of the same species that had been in the collection since 1994. After mating in April 1996 without issue, the pair mated again on 14 March 1997, and were then separated. The female gave birth to nine neonates after 199 days, on 9 September, the first UK captive breeding of the species (O'Shea 1998. The Herptile 23[1]:16–19) and died a few years later, but the male remained in the off-show collection until 4 July 2012 when it was euthanized on health grounds, after 17 yr, 5 mo in captivity at WMSP.

Because this snake was an adult when it arrived, and the earliest the related *A. bilineatus* (Mexican Cantil) reaches sexual maturity is at 30 months (Peters 1979. Internatl. Zoo Yearbk. 19:100–101), a conservative estimate for this specimen's individual's total age could be 19 yr, 11 mo. The previous longevity record for this species is 15 yr, 7 mo, 13 d, for a male at the Houston Zoo, Houston, Texas, USA (Snider and Bowler 1992. Longevity of Reptiles and Amphibians in North American Collections. SSAR Herpetol. Circ. 21:1–40), while a lifespan of 24 yr, 4 mo, 19 d is documented for a *A. bilineatus* at the Instituto Historia Natural, Chiapas, Mexico (*ibid*). The North American members of the genus achieve similar longevities in captivity (*A. contortrix* 29 yr, 10 mo; *A. piscivorus* 24 yr, 6 mo; Snider and Bowler, *op. cit.*).

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AMPHIBIAN DISEASES

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Batrachochytrium dendrobatidis in the Adirondacks, New York, USA

The occurrence of *Batrachochytrium dendrobatidis* (*Bd*) in New York, USA is not well described (www.Bd-maps.net; accessed 22 April 2012). I surveyed for *Bd* in the Adirondack Mountains, New York, at two sites (Fig. 1).

I surveyed for frogs in Keene Valley, New York at Chapel Pond (44.139°N, 73.747°W; 488 m elev.) on 3 August 2011 and Giant Wash Bowl (44.073°N, 73.735°W; 731 m elev.) on 27 August 2011. Frogs were captured and placed in separate Zip-Loc® bags for temporary holding. Disposable gloves were used and changed after each specimen was handled. Skin swabs were collected by swabbing the rear foot, ventral surface of thigh, and ventral abdominal surface of each frog. Each swab was placed in a 2-ml vial with 70% EtOH. Mutations, sluggishness, and leathering of the skin of frogs were noted before their release at the site. None were present. To assess *Bd*-DNA presence, qPCR (modified from Hyman and Collins 2012) was conducted at the School of Life Sciences, Arizona State University.

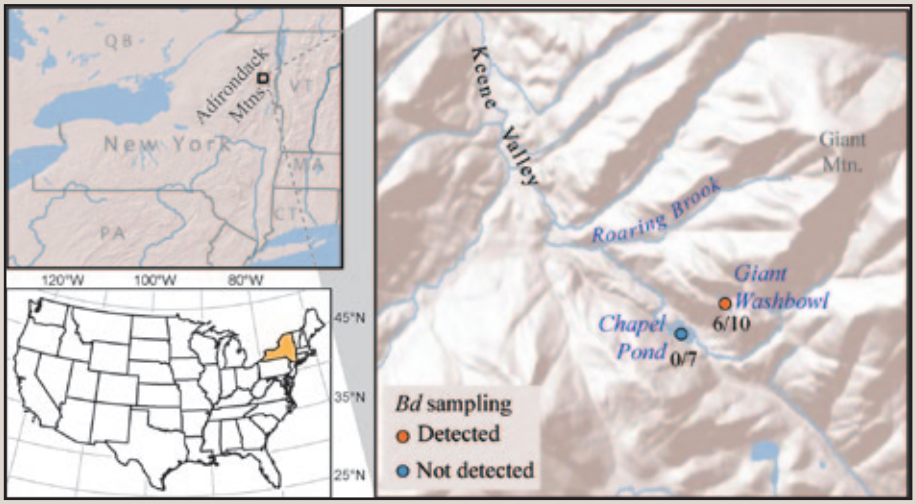


FIG. 1. *Batrachochytrium dendrobatidis* (*Bd*) sampling ponds in the Adirondack Mountains, New York, USA. Numbers indicate number of *Bd*-positive *Rana clamitans*/total number of *R. clamitans* sampled per pond.

At Giant Wash Bowl, 6 of 10 post-metamorphic Green Frogs (*Rana clamitans*) were positive for *Bd*, with zoospore loads ranging from 72-200 Genome Equivalents. All seven Green Frogs (one adult female, six metamorphs) collected from Chapel Pond were *Bd*-negative, although this low sample size may have precluded *Bd* detection if it occurred at a low level (Skerratt et al. 2008).

This is the first study to confirm the presence of *Bd* in the Adirondacks in New York. *Bd* has been detected in Green Frogs previously (e.g., Ouelett et al. 2005). Future studies would benefit from a larger sample size, collecting data over a longer period of time, sampling more species and life stages, and sampling different elevations and locations in the Adirondacks that likely have different climate conditions which may affect *Bd* growth. It would be interesting to conduct a more systematic study of *Bd* throughout all of New York to contribute to an assessment of the potential threat this disease poses to the State's native amphibian diversity.

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GEOGRAPHIC DISTRIBUTION

CAUDATA — SALAMANDERS

***AMBYSTOMA MACULATUM* (Spotted Salamander)**. USA: WISCONSIN: Taylor Co.: Chequamegon-Nicolet National Forest, S side of Forest Rd. 102 (Mondeaux Ave.) at 0.3 km NE from jct with Forest Rd. 566 (45.29178°N, 90.44624°W; WGS 84). 28 April 2012. Collected by Erik R. Wild. Verified by Joshua M. Kapfer. UW-Whitewater (UWSP 4289). New county record (Casper 1996. Geographic Distributions of the Amphibians and Reptiles of Wisconsin. Milwaukee Publ. Mus., Milwaukee, Wisconsin. 87 pp.; Herpetological Review 1996–present). Egg clutch was collected from among three other clutches at locality. Additional eggs clutches were observed at other locations in the area (UWSP Herp Photo 0157–0158). Specimen collected under Wisconsin Department of Natural Resources Permit SCP-131-WCR-C-11.

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***AMBYSTOMA OPACUM* (Marbled Salamander)**. USA: NORTH CAROLINA: McDowell Co.: Private forest, 2 km airline SSE Vein Mountain community (35.53474547°N, 81.95798924°W; WGS 84). 9 June 2012. Lori Williams, Rebecca Hardman, Lloyd Hill, Margaret Stroebel. Verified by William M. Palmer. North Carolina State Museum of Natural Sciences (NCSM 79565). First vouchered specimen for McDowell Co. (NCSM files). This record fills a distributional gap in North Carolina between the Piedmont and Mountain regions. Closest previous historical records in the state are from French Broad River floodplain and upland forest, Buncombe Co., 62 km airline W (NCSM 52284, 59016); and from marshy pasture in Gaston Co., ca. 73 km airline ESE (NCSM 32772, 32825, and 32889). Juvenile (TL = 63.7 mm, SVL = 38.8 mm) found during visual encounter surveys of downed woody debris on mixed hardwood/oak forested hillside, approximately 50 m upslope of dry, bottomland seep.

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***EURYCEA CIRRIGERA* (Southern Two-lined Salamander)**. USA: GEORGIA: Forsyth Co.: Dave's Creek Drive and Dave's Creek Road (34.14764°N, 84.13047°W; WGS 84). 3 August 2012. Todd Pierson and Daniel Thompson. Verified by Kenneth Krysko. Florida Museum of Natural History (UF 168566 photo voucher). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.).

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***HEMIDACTYLUM SCUTATUM* (Four-toed Salamander)**. USA: NEW YORK: Jefferson Co.: Indian River Lakes Conservancy Grand Lake Reserve (44.325552°N, 75.758454°W; NAD83). 26 June 2009. James P. Flaherty and Michael Reynolds. Verified by Alvin Breisch. New York State Museum (NYSM 6340, photo voucher). New county record (New York State Department of Environmental Conservation 2009. NY Amphibian and Reptile Atlas. www.dec.ny.gov/animals/7140.html. Accessed 19 September 2012). Nearest records ca. 40 km SE in Lewis County and ca. 18 km NW in Ontario, Canada (Oldham and Weller 2000. Ontario Herpetofaunal Atlas. Natural Heritage Information Centre, Ontario Ministry of Natural Resources. http://nhic.mnr.gov.on.ca/MNR/nhic/herps/ohs.html (updated 15-01-2010)). Found under fallen log*f* adjacent to forested sphagnum wetland during light rain.

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***OEDIPINA LEPTOPODA* (Narrow-footed Worm Salamander)**. HONDURAS: SANTA BÁRBARA: Nuevo Joconales (15.059583°N, 88.519056°W; WGS84), 1200–1400 m elev. 17 April 2011. MVZ 267195–96. Quebrada de Las Cuevas (15.053444°N, 88.516944°W; WGS84), 1150 m elev. 18–19 April 2011. MVZ 267197–98. James R. McCranie and Leonardo Valdés Orellana. All verified by David B. Wake. First records for Santa Bárbara, and extends range ca. 45 km NW of closest previously known locality near Los Pinos, Cortés (McCranie et al. 2011. Herpetol. Rev. 42:235–236). The salamanders were under leaves and rocks along two small streams flowing through slightly disturbed broadleaf forest.

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***PLETHODON DORSALIS COMPLEX* (Northern Zigzag Salamander)**. USA. TENNESSEE: Rhea Co.: East side of Broyles Branch, 0.25 km downstream from Blythe Ferry Road, Dayton (35.484767°N, 85.016590°W; WGS 84). 05 February 2012. David Hedrick. Verified by A. Floyd Scott. Austin Peay State University's

David H. Snyder Museum of Zoology (APSU 19192, "lead morph" individual). New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, 94 pp. Internet version with links to new records since 1996 available at Http://www5.apsu.edu/amatlas/index.html [accessed 9 July 2012]).

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***PSEUDOBRANCHUS AXANTHUS BELLI* (Everglades Dwarf Siren)**. USA: FLORIDA: Palm Beach Co.: J. W. Corbett WMA (26.844°N, 80.315°W; WGS 84). 5 April 2012. Joshua Young, Joshua Holbrook, Brett Bartek, and Melissa Dolinsky. Verified by Kenneth Krysko. Florida Museum of Natural History (UF 166813). New county record (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final report, Project Agreement 08013, Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida. 524 pp.) Nearest known records are from St. Lucie Co. to the north and Miami-Dade Co. to the south. Several dozen individuals were observed in shallow marshy pond habitat with approximately 4–6 inches of peat above a sand substrate. The ponds are temporary, and lack predatory fish. Individuals were collected with a dip net while kicking up mounds of peat. Individuals were also seen swimming in open water between 2130 h and 0530 h. A second population (10 individual observed; UF 167203) was found on 12 June 2012 at Grassy Waters Preserve (26.82955°N, 80.18589°W; Palm Beach Co.).

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***SIREN INTERMEDIA* (Lesser Siren)**. USA: VIRGINIA: Dinwiddie Co.: Petersburg National Battlefield (PETE), Five Forks Battlefield, 6.4 km SW Sutherland (37.153581°N, 77.614917°W; WGS 84). 26 August 2003. J. C. Mitchell, C. T. Georgel, E. J. Lathum, C. d'Orgeix, J. Jeffries, and T. Blumenshine. Verified by Kenneth L. Krysko. Florida Museum of Natural History (UF 167206). New county record (Mitchell and Reay 1999. Atlas of Amphibians and Reptiles in Virginia. Virginia Dept. of Game and Inland Fisheries, Richmond, Virginia. Spec. Publ. 1. 122 pp.). This site is 25 km SW of the nearest known location in Prince George Co. Extends the range of *S. intermedia* approximately 17 km into the Piedmont Physiographic Province. One individual with 35 costal grooves was caught in a minnow trap and released in a heavily vegetated beaver pond.

Field work was supported by a contract from the National Park Service and conducted by permits from the NPS (PETE-2002-SCI-003).

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ANURA — FROGS

***ACANTHIXALUS SPINOSUS* (African Warty Tree Frog)**. GABON: OGOOUÉ-IVINDO PROVINCE: Ivindo National Park, W of Ipassa Research Station (0.511089°N, 12.801772°E, WGS84; 538 m elev.). 7 April 2010. P. Carlino. Museo di Storia naturale del Salento, Calimera (MSNS-Amph 03). Verified by A. Durante (MSNS). SVL 32.2 mm. At night, on leaf, 1 m above forest floor. First record for Ivindo National Park and Ogooué-Ivindo Province. Closest documented record in Gabon is in Moukalaba-Doudou National Park, Ogooué-Maritime Province, ca. 380 km SW of Ipassa (Pauwels and Rödel 2007. Herpetozoa 19:135–148).

We thank Daniel Franck Idiata, Aurélie Flore Koumba Pambo (CENAREST, Libreville), Auguste Ndoutoume-Ndong (IRAF, Libreville), Alfred Ngomanda (IRET), Joseph Vivien Okouyi Okouyi (Ivindo National Park), and Antonio Durante (MSNS) for providing research and collecting permits.

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***ANAXYRUS FOWLERI* (Fowler's Toad)**. USA: ARKANSAS: Calhoun Co.: AR St. Hwy. 278, 8 km ENE of Harrell (33.540294°N, 92.324521°W; WGS84). 30 August 2012. M. B. Connior. Verified by S. E. Trauth. Arkansas State University Museum of Zoology Herpetology Collection (ASUMZ 32335). New county record filling a distributional gap among surrounding Bradley, Ouachita, and Union counties (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville. 421 pp.).

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***ANAXYRUS MICROSCAPHUS* (Arizona Toad)**. USA: NEW MEXICO: Luna Co.: Rancho del Rio, 5.2 km E of City of Rocks State Park Headquarters (32.586249°N, 107.918799°W; WGS 84). 18 July 2012. Mark L. Watson. Verified by Charles W. Painter. University of Kansas Digital Archives (KUDA 012270–71). New county record (Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. University of New Mexico Press, Albuquerque. 431 pp.).The nearest record of *A. microscaphus* is in Grant Co., approximately 20 km NW of this locality.

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***ANAXYRUS QUERCICUS* (Oak Toad)**. USA: ALABAMA: Escambia Co.: Escambia County Rd. 11, within Conecuh National Forest (31.12594°N, 86.73668°W; WGS 84). 11 June 2012. J. Newman and S. Graham. Verified by David Laurencio. AUM AHAP-D 520 (digital photo file). New county record (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn Printing Co., Auburn. 58 pp.). Calling male captured in ditch along road. Funding for this research was provided by IOS-1051367 to T. Langkilde.

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***ANAXYRUS (=BUFO) WOODHOUSII* (Woodhouse's Toad)**. USA: COLORADO: Saguache Co.: Deadman Creek near Alpine Camp (37.88599°N, 105.7253°W, NAD83; elev. 2325 m). 5 August 2006. L. J. Livo and L. Harvey. UCM Ancillary Collection #394 photo voucher. Verified by Bradley Lambert. New county record. Northernmost records in the San Luis Valley, and the highest elevations reported for populations east of the Continental Divide (Young 2011. The Guide to Colorado Reptiles and Amphibians. Fulcrum Publishing, Golden, Colorado. 170 pp.; Hammerson 1999. Amphibians and Reptiles in Colorado, 2nd ed. University Press of Colorado, Niwot, Colorado. 484 pp.; Degenhardt et al. 1996.

Amphibians and Reptiles of New Mexico. University of New Mexico Press, Albuquerque. 431 pp.; Werner et al . 2004. Amphibians and Reptiles of Montana. Mountain Press Publishing Co., Missoula, Montana. 262 pp.).

During fieldwork in and around the Great Sand Dunes National Park & Preserve in 2000 and 2006, we observed this species at several other locations in Saguache County. Fieldwork was conducted under permit GRSA-2006-SCI-0007.

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ELEUTHERODACTYLUS PLANIROSTRIS **(Greenhouse Frog)**. USA: FLORIDA: Monroe Co.: Pigeon Key (24.70418°N, 81.15518°W; WGS84). 21 August 2012. Verified by Kenneth Krysko. UF 168589–168590. New island record (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final report, Project Agreement 08013, Florida Fish and Wildlife Conservation Commission, Tallahassee. 524 pp.; K. L. Krysko, pers. comm.). This non-native species was introduced to Florida in the 1800s, and appears established on the island.

I thank Kelly McKinnon and the Pigeon Key Foundation for their assistance and hospitality.

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GASTROPHRYNE CAROLINENSIS **(Eastern Narrow-mouthed Toad)**. USA: GEORGIA: Dekalb Co.: Constitution Lakes Park (33.687122°N, 84.342085°W, WGS 84; elev. ~242 m). 29 May 2012. Robert L. Hill. Verified by John Jensen. UTADC-7590. New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. Univ. of Georgia Press, Athens. 575 pp.). This species has been documented from all counties adjacent to Dekalb. Specimen found under loose bark on fallen log ~2 m off of paved walking trail ~250 m from trail head.

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HYLA AVIVOCA **(Bird-voiced Treefrog)**. USA: GEORGIA: McIntosh Co.: 11.4 km SW Townsend (31.460631°N, 81.600559°W; NAD 83). 7 June 2012. D. Stevenson and A. Day. Verified by Kenneth L. Krysko. UF 167204. New county record and southernmost known locality documented for the Altamaha River drainage (Jensen et al. [eds.] 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.).

ANDY J. DAY, 1654 Montcliff Court, Decatur, Georgia 30033, USA; **DIRK J. STEVENSON**, The Orianne Society, Indigo Snake Initiative, 414 Club Drive, Hinesville, Georgia 31313, USA (e-mail: dstevenson@orianne-society.org).

HYLA GRATIOSA **(Barking Treefrog)**. USA: ALABAMA: Escambia Co.: Escambia County Rd. 11, 1 km S of U.S. Hwy. 29 (31.13243°N, 86.72640°W; WGS 84). 29 June 2012. S. Graham and G. Brooks. Verified by Craig Guyer. AUM 39892. New county record (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn Printing Co., Auburn, Alabama. 71 pp.) This record fills a distribution gap between Covington and Baldwin counties. Adult specimen found DOR; others sighted in the same area.

Funding for this research was provided by IOS-1051367 to T. Langkilde.

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HYLARANA HUMERALIS **(Groaning Frog)**. BANGLADESH: SYLHET DIVISION: Sylhet District: Ratargul Swamp Forest (25.013825°N, 91.9284291835°E; WGS84; 16.45 m elev.). 27 June 2012. S. C. Rahman and A. Ghose. Photographic voucher, Raffles Museum of Biodiversity Research, National University of Singapore (ZRC [IMG] 1.40 a–c). Verified by I. Das. First record from Sylhet District. Previously recorded from Habiganj (Rema-Kalenga Wildlife Sanctuary), Khagrachari, and Rangamati Districts (Chakma 2009. *In* Kabir et al. [eds.], Encyclopedia of Flora and Fauna of Bangladesh. Vol. 25. Amphibians and Reptiles, pp. 31–32. Asiatic Society of Bangladesh, Dhaka).

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INCILIUS MARMOREUS **(Marbled Toad)**. MÉXICO: SONORA: Municipality of Álamos: El Ojito, 25 km (airline) SE of Álamos (26.948980°N, 108.695615°W; NAD27), 487 m elev. 17 July 2011. Gert Palacio Baez and Erik Enderson. Verified by Georgina Santos Barrera. UAZ 57334-PSV. First record for Sonora (Enderson et al. 2009. Check List 5:632–672), extending the range ca. 90 km (airline) NE of the vicinity of San Blas, Sinaloa (Hardy and McDiarmid 1969. Univ. Kansas Publ. Mus. Nat. Hist. 18:39-252). The toad was discovered adjacent to a mesic canyon in tropical deciduous forest.

GERT PALACIO BAEZ, Universidad de Sonora, Blvd. Luis Encinas y Rosales S/N, Col. Centro, Hermosillo, Sonora, México; **ERIK F. ENDERSON**, Drylands Institute, PMB 405 2509 North Campbell Avenue Tucson, Arizona 85719, USA (e-mail: erikenderson@msn.com)

LITHOBATES PALUSTRIS **(Pickerel Frog)**. USA: GEORGIA: Dawson Co.: Dawson Forest Wildlife Management Area (34.35951°N, 84.16887°W; WGS 84). 3 August 2012. Todd Pierson and Daniel Thompson. Verified by Kenneth Krysko. Florida Museum of Natural History (UF 168561 photo voucher). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp).

TODD PIERSON, Odum School of Ecology, University of Georgia, Athens, Georgia 30609, USA (e-mail: twpierso@uga.edu); **DANIEL THOMPSON**, Chestatee High School, Gainesville, Georgia 30506, USA (e-mail: danielsthompson@gmail.com).

PHYSALAEMUS CICADA. BRAZIL: RIO GRANDE DO NORTE: Municipality of Santa Maria: 5.854°S, 35.701°W (datum WGS84), 137 m elev. 17 April 2010. J. S. Jorge. Coleção Herpetológica da Universidade Federal do Rio Grande do Norte, Natal, Rio Grande do Norte, Brazil (CHBEZ 3682, female 22.02 mm SVL; male 21.51 mm SVL, CHBEZ 3670). Verified by U. Caramaschi. This species was previously known from northeastern Brazilian states (Ceará, Paraíba, Pernambuco, Bahia) and southeastern regions (Minas Gerais) (Arzabe et al. 2005. *In* F. S. Araújo et al. [eds.], Análise das Variações da Biodiversidade do Bioma Caatinga, pp. 259–274. Ministério do Meio Ambiente, Brasília; Bokermann 1966. Rev.

Brasil. Biol. 26[3]:253–259; Borges-Nojosa and Santos 2005. *In* F. S. Araújo et al. (*op. cit.*), pp. 275–289; Loebmann and Mai 2008. Check List 4[2]:161–170). First state record, extends the distribution ca. 110 km from municipality of Araruna, Paraíba state, Brazil (Arzabe et al. 2005, *op. cit.*). This species was recorded calling in streams in rock outcrops, in Agreste region.

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***POLYPEDATES HIMALAYENSIS* (Himalayan Tree Frog)**. INDIA: MEGHALAYA: East Khasi Hills District. Five females and five males collected from three sites: 1) a paddy field at Umshing near North Eastern Hill University Permanent Campus (25.60000°N, 91.88333°E; WGS84; 1418 m elev.) on 16 May 2006; 2) a forested area near Lawsohtun (25.58333°N, 91.91667°E; WGS84; 1588 m elev.) on 24 May 2006; and 3) an agricultural field at Mylliem village (25.50000°N, 91.81667°E; WGS84; 1625 m elev.) on 6 May 2008. Adults heard calling from earthen holes, under grass cover near temporary pools, and paddy fields. SVL 41–49.93 mm (males) and 50.42–62.53 mm (females). Department of Zoology Museum, North Eastern Hill University Collection DH1–10. D. Rangad, R. K. L. Tron, and R. N. K. Hooroo. Verified by S. Sengupta and S. K. Dutta. New record for the state of Meghalaya.

DUWAKI RANGAD (e-mail: du2309@gmail.com); **RONALD KUPAR LYNGDOH TRON** (e-mail: xyloptz@gmail.com); and **RUPA NYLLA KYNTA HOOROO** (e-mail: rnkh@hotmail.com), Department of Zoology, North Eastern Hill University, Shillong, 793 022, Meghalaya, India.

***PSEUDACRIS CRUCIFER* (Spring Peeper)**. USA: TENNESSEE: Marshall Co.: Lewisburg, 1219 Bivins Road (35.365811°N, 86.772149°W; WGS84). 22 March 2012. Savannah Cole and Summer Cole. Verified by A. F. Scott. Austin Peay State University (APSU 19313 photographic voucher, vocalizing male). New county record (Redmond and Scott 1996. [updated 2008; latest update: 1 August 2012]. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12. Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Available at http://www.apsu.edu/amatlas/, accessed 7 September 2012).

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***RHINOPHRYNUS DORSALIS* (Burrowing Toad; Sapo de Tierra; Sapo Buche)**. HONDURAS: ATLÁNTIDA: Barra de Colorado (15.816667°N, 87.30000°W; WGS84), near sea level. 15 February 2011. Leonel Marineros. Verified by Steve W. Gotte. USNM 579691. First record for Atlántida, with the closest known locality ca. 85 km SW at San Pedro Sula, Cortés (USNM 579692). The frog was dug up by workers installing plumbing ca. 150 m from a beach.

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***SCINAX AURATUS* (Golden Tree Frog)**. BRAZIL: RIO GRANDE DO NORTE: Macaíba, Escola Agrícola de Jundiaí (93.24142°N, 224.8828°W; datum WGS84). 15 July 2010. W. Pessoa. Coleção Herpetológica da Universidade Federal do Rio Grande do Norte, Natal, Rio Grande do Norte, Brazil (CHBEZ 3861). Verified by U. Caramaschi. This Brazilian endemic species was previously known from the states of Bahia, Sergipe, Alagoas, Minas Gerais, and Paraíba (Alves et al. 2004. Rev. Brasil. Zool. 21[2]:315–317; Juncá 2005. *In* Juncá et al. [org.], Biodiversidade e Conservação da Chapada Diamantina, pp. 337–356. Ministério do Meio Ambiente do Brasil, Brasília; Nunes and Pombal Jr. 2010. Amphibia-Reptilia 31:347–353; Protázio et al. 2011. Herpetol. Rev. 42[1]:108–109; Santana et al. 2009. Check List 5[2]:246–248). First state record, extends the geographical distribution ca. 125 km from the municipality of Mamanguape, Paraíba state (Protázio et al. 2011, *op. cit.*).

JAQUEIUTO S. JORGE (e-mail: queilto@yahoo.com.br), **MATHEUS MEIRA**, and **ELIZA M. X. FREIRE**, Laboratório de Herpetologia, Departamento de Botânica, Ecologia e Zoologia, Centro de Biociências, Universidade Federal do Rio Grande do Norte, Campus Universitário, Lagoa Nova, CEP 59072-970, Natal, Rio Grande do Norte, Brazil.

***SPEA BOMBIFRONS* (Plains Spadefoot)**. USA: NEW MEXICO: Catron Co.: Goat Tank Canyon, ca. 0.4 km E of Pie Town Rd. (Rd. 41) (34.57495°N, 108.00669°W, NAD83; elev. 2209 m). 7 July 2011. Ian W. Murray and Christopher Newsom. Verified by J. Tomasz Giermakowski. University of New Mexico Museum of Southwestern Biology (MSB 78830, 78831). New county record (Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. Univ. New Mexico Press, Albuquerque. 431 pp.). Two calling males were collected from a large pool in a broad wash, which had formed from heavy rains within the previous two days. A large chorus of calling *S. bombifrons* and *S. multiplicata* were observed at 2345 h (~5 *S. multiplicata* for every *S. bombifrons*). Many clumps of eggs had already been laid around emergent grasses and weeds. Additionally, more calling and grappling males were noted relative to amplectant pairs, implying that this night was probably the second night of amphibian breeding activity.

IAN W. MURRAY, School of Physiology, Faculty of Health Sciences, University of the Witwatersrand, Parktown, 2193, Johannesburg, South Africa (e-mail: imurray@unm.edu); **CHRISTOPHER NEWSOM**, 9820 Compadre Lane Northeast, Albuquerque, New Mexico 87111-1549, USA (e-mail: herpsofnm@comcast.net).

TESTUDINES — TURTLES

***APALONE MUTICA* (Smooth Softshell)**. USA: TENNESSEE: Roane Co.: Emory River (35.89681°N, 84.49420°W; WGS 84). 28 July 2012. D. A. Steen. Verified by James C. Godwin. AHAP-D-598, photo voucher. New county record and range extension of >100 km (Scott and Redmond 2008. [latest update 6 May 2012] Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas [accessed 29 July 2012]; Reynolds and Niemiller [eds.], *in press*. The Reptiles of Tennessee. The University of Tennessee Press). Male individual captured as component of turtle-trapping efforts.

DAVID A. STEEN (e-mail: davidasteen@gmail.com), **MICHELINA C. DZIADZIO**, **TANIYAH D. PARKER, HENRY J. VOGEL**, **KALEB Q. WEBB**, and **WILLIAM A. HOPKINS**, Virginia Polytechnic Institute and State University, 106 Cheatham Hall, Blacksburg, Virginia 24061, USA.

***APALONE MUTICA CALVATA* (Gulf Coast Smooth Softshell)**. USA: ALABAMA: Elmore Co.: Tallapoosa River (32.45833°N, 85.87500°W; WGS 84). 19 May 1997. Malcolm Pierson, Steve

Krotzer. Verified by D. Laurencio. AUM AHAP-S 439, 440, photo vouchers. New county record (Mount 1975. The Reptiles and Amphibians of Alabama. Agric. Exp. Sta., Auburn Univ. 347 pp.). Extends the range ca. 15 km. Covington Co.: Conecuh River (31.29958°N, 86.53702°W; WGS 84). 10 May 2012. Clutch of 12 eggs collected, 6 hatched 10 August 2012, one retained as voucher. James C. Godwin. Verified by C. Guyer. AUM 39948. New county record (Mount 1975, *op. cit.*). Extends range ca. 50 km.

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***APALONE SPINIFERA* (Spiny Softshell)**. USA: GEORGIA: Burke Co.: 8.5 km N Girard; Savannah River at Griffin Landing Road (31.115879°N, 81.703969°W; NAD 83). 15 June 2012. D. Stevenson. Verified by Kenneth L. Krysko. UF 167186. New county record (Jensen et al. [eds.] 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.).

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***APALONE SPINIFERA* (Spiny Softshell)**. USA: TENNESSEE: Hardin Co.: Horse Creek (35.116669°N, 88.157236°W; WGS84). 18 June 2012. Brian P. Butterfield, Joseph B. Butterfield, Lee J. Barton, and M. LeAnn Self-Davis. Verified by A. F. Scott. Austin Peay State University (APSU 19310 photographic voucher). New county record (Scott and Redmond 2008 [latest update: 12 May 2012]. Atlas of Reptiles in Tennessee. Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/, accessed 7 September 2012. Captured in a hoop net baited with fish.

BRIAN P. BUTTERFIELD (e-mail: bbutterfield@fhu.edu), **LEE J. BARTON, M. LEANN SELF-DAVIS**, Department of Biology, Freed-Hardeman University, Henderson, Tennessee 38340, USA; **JOSEPH B. BUTTERFIELD**, 294 Sherry Lynn Drive, Finger, Tennessee 38334, USA.

***APALONE SPINIFERA ASPERA* (Gulf Coast Spiny Softshell)**. USA. TENNESSEE: Bradley Co.: Wetland adjacent to Mill Creek, 0.286 km due E of the railroad tracks inside Red Clay State Park (34.9925°N, 84.9390°W; WGS 84). 27 March 2012. David Hedrick, Rick Jackson. Verified by A. Floyd Scott. Austin Peay State University, David H. Snyder Museum of Zoology (APSU 19213, color photos). New state record. Scott and Redmond (2008 [latest update: 14 February 2012]. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/ [accessed 9 July 2012]). Identification of this specimen prompted a re-examination of a 1979 specimen in the North Carolina State Museum (NCSM 40861). NCSM 40861 has now been identified as *A. s. aspera* substantiating our record and the presence of a long-term population.

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***CHRYSEMYS PICTA* (Painted Turtle)**. USA: GEORGIA: Hall Co.: Reservoir One on Calvary Church Rd (34.22629°N, 83.82584°W; WGS 84). 3 August 2012. Todd Pierson and Daniel Thompson. Verified by Kenneth Krysko. Florida Museum of Natural History (UF 168564 photo voucher). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp).

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***CHRYSEMYS PICTA BELLI* (Western Painted Turtle)**. USA: NEBRASKA: Platte Co.: Columbus (41.420755°N, 97.36403°W; WGS 84; elev. 440 m). 18 September 2011. Natural History Museum of Los Angeles County (LACM PC 1571, photo voucher). New county record (Ballinger et al. 2010. Amphibians and Reptiles of Nebraska. Rusty Lizard Press, Oro Valley, Arizona. 400 pp.; Fogell 2010. The Amphibians and Reptiles of Nebraska. University of Nebraska, Lincoln, Nebraska. 158 pp.). Saline Co.: approx 2 mi. W of Crete on Hwy 103 (40.622817°N, 97.009893°W, WGS 84; elev. 431 m). 21 September 2011. DOR. LACM PC 1572. New county record (Ballinger et al. 2010, *op. cit.*; Fogell 2010, *op. cit.*). Both specimens observed and photographed by Brian Hubbs, and verified by Neftali Camacho.

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***DEIROCHELYS RETICULARIA* (Chicken Turtle)**. USA: ALABAMA: Covington Co.: County Rd. 24 (31.10239°N, 86.43944°W; WGS 84). 17 July 2012. J. Newman, G. Brooks, and C. Thawley. Verified by David Laurencio. AUM AHAP-D 597 (digital photograph file). New county record (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn Printing Co., Auburn, Alabama. 270 pp.). Funding for this research was provided by IOS-1051367 to T. Langkilde.

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***EMYDOIDEA BLANDINGII* (Blanding's Turtle)**. USA: NEW YORK: Franklin Co.: Hogansburg (44.966191°N, 74.647978°W; NAD83). 20 June 2009. Glenn Johnson. Verified by Alvin Breisch. New York State Museum (NYSM 6339, photo voucher). New county record (New York State Department of Environmental Conservation. 2009. New York Amphibian and Reptile Atlas. http://www.dec.ny.gov/animals/7140.html. Accessed 3 March 2011). Nearest record ca. 10 km SW in St. Lawrence Co. Found crossing State Route 37 on St. Regis Mohawk Tribe lands.

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***GRAPTEMYS GEOGRAPHICA* (Northern Map Turtle)**. USA: TENNESSEE: Polk Co.: Reliance (35.19654°N, 84.45650°W; WGS

84). 23 May 2012. Stephen K. Nelson, Ben Fitzpatrick, and Phil Colclough. Verified by A. Floyd Scott. David H. Snyder Museum of Zoology, Austin Peay State University (APSU 19304, 19305, photo vouchers). First county record (Redmond and Scott 2008. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/repatlas/ (updated 07 August 2012; accessed 24 August 2012). An adult female was found crossing a road at 1500 h. A second specimen, a juvenile, was found basking on a log jam (35.19413°N, 84.47128° W) on 6 June 2012. Extends the range ca 87 km to the east (Wilson et al. 2012. Herpetol. Rev. 43[1]:111–112) and to the southeast ca. 57 km (Redmond and Scott 2008, *op. cit.*). This is the first report of *G. geographica* in extreme southeastern Tennessee.

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***GRAPTEMYS OUACHITENSIS* (Ouachita Map Turtle)**. USA: MISSOURI: Adair Co.: S. Baltimore St. at intersection of Franklin St., Kirksville (40.163528°N, 92.571889°W; WGS 84). 31 July 2012. Anthony J. Wilmes and Chad E. Montgomery. Verified by Jeff Briggler. University of Missouri Columbia (UMC 2196P photo voucher). First county record (Daniel and Edmond 2012. Atlas of Missouri Amphibians and Reptiles for 2011. http://atlas.moherp.org/pubs/atlas11.pdf, accessed 10 September 2012). Adult male (carapace length 117 mm; mass 167.1 g). Extends known range by ca. 100 km. Due to the distance from permanent water habitat to the locality (~5–15 km depending on water source) it is possible that this individual represents a release rather than a naturally occurring population.

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***GRAPTEMYS PSEUDOGEOGRAPHICA PSEUDOGEOGRAPHICA* (False Map Turtle)**. USA: FLORIDA: Volusia Co.: Blue Springs State Park, 200 m E of the mouth of St. Johns River inside of the Blue Spring Run (28.94337°N, 81.341264°W; WGS84; elev. 6 m). 27 May 2011. Eric C. Munscher. Verified by Gerald R. Johnson and Kenneth L. Krysko. Florida Museum of Natural History (UF 168572). New county record (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final report, Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida. 524 pp.). Female (max carapace length = 233 mm, straight midline plastron length = 178 mm, mass = 927 g) captured by hand at 1000 h along the center of the lower Blue Spring Run toward the St. Johns River. The abundance of algae on the carapace (60% of surface area) suggests this is not a recently released captive. This is the first reported occurrence of *G. p. pseudogeographica* in the St. Johns River Basin. This non-indigenous turtle may be in the early phase of an introduction and may require monitoring. In Florida, *G. p. pseudogeographica* is commonly sold in pet stores and may replace the Red-eared Slider (*Trachemys scripta elegans*) as the most frequently released non-indigenous pet turtle. Given its omnivorous diet and the proximity to similar adequate habitat types (St. Johns River) to its native habitat in the Missouri and Mississippi River drainages, *G. p. pseudogeographica* could potentially thrive in the St. Johns River Basin.

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***PELODISCUS SINENSIS* (Chinese Softshell Turtle)**. BRAZIL: PARÁ: Municipality of Belém: 1.366°S, 48.392°W; datum WGS 84). Museu Paraense Emílio Goeldi, Belém, Pará, Brazil (MPEG 1214–1216). 10 February 2010. D. Félix-Silva, J. C. B. Pezutti, M. F. Wariss, E. J. Hernández-Ruz. Verified by M. S. Hoogmoed. Previously known from central and eastern China, Vietnam, and the islands of Hainan and Taiwan (Bonin et al. 2006. Turtles of the World. John Hopkins University Press, Baltimore, Maryland. 416 pp.; Vetter and van Dijk 2006. Turtles of the World, Vol. 4: East and South Asia. Edition Chimaira, Frankfurt am Main. 162 pp.) and was introduced to Thailand, Japan, and Hawaii, southeastern Siberia, Russia, and Korea (Fritz et al. 2010. Organisms, Diversity and Evolution 10:227–242). First vouchered record for Brazil and South America. Although mentioned as occurring in Brazil (Uetz 2012. The Reptile Database. Online database at: http://www.reptile-database.org/. Accessed 6 June 2012), this record appears to be unsupported by a voucher or bibliographic citation.

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***PSEUDEMYS CONCINNA* (River Cooter)**. USA: GEORGIA: Dawson Co.: Lake Lanier at the intersection of Henry Grady Hwy and GA 136 (34.39529°N, 83.99116°W; WGS 84). 3 August 2012. Todd Pierson and Daniel Thompson. Verified by Kenneth Krysko. Florida Museum of Natural History (UF 168562 photo voucher). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.).

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***STERNOTHERUS ODORATUS* (Eastern Musk Turtle)**. USA: TENNESSEE: Blount Co.: Townsend (35.68013°N, 83.78225°W; WGS84). 12 August 2012. Stephen K. Nelson and Bradley D. Moxley. Verified by A. Floyd Scott. David H. Snyder Museum of Zoology, Austin Peay State University (APSU 19303, color photo). First county record (Redmond and Scott 2008. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Internet version, available at http://apsu.edu/repatlas/ [updated 07 August 2012]; accessed 24 August 2012). Found foraging at night on sandy substrate. Three leaches were attached to plastron.

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37914-4416, USA (e-mail: snelso24@utk.edu); **BRADLEY D. MOXLEY**, Department of Herpetology, Knoxville Zoological Gardens, Knoxville, Tennessee 37914-4416, USA (e-mail: bmoxley@knoxville-zoo.org).

***TERRAPENE CAROLINA* (Eastern Box Turtle)**. USA: ALABAMA: Tallapoosa Co.: Rotton Creek (33.05366°N, 85.84159°W; WGS 84). 29 June 2012. Ian E. P. Turner. Verified by Craig Guyer. Auburn University herpetological collection (AHAP-D 00591 photo voucher). Two adult males were found along floodplain of creek. New county record (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn University Agricultural Experiment Station, Auburn, Alabama. vii + 347 pp.). *Terrapene carolina* is assumed to occur statewide in Alabama, but verified records are lacking for many counties.

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***TERRAPENE CAROLINA TRIUNGUIS* (Three-toed Box Turtle)**. USA: OKLAHOMA: Jefferson Co.: 3.22 km N and 2.41 km E of Terral, Oklahoma in an open field (33.92559°N, 97.91999°W; WGS 84). 18 July 2009. Cameron University Museum of Zoology (CUMZ 216). Collected by D. Doug Gunter. Verified by Stanley F. Fox. New county record (Sievert and Sievert 2011. A Field Guide to Oklahoma's Amphibians and Reptiles, 3rd ed. Oklahoma Department of Wildlife Conservation. Oklahoma City, Oklahoma. 211 pp.). Previously documented populations from adjacent Oklahoma counties to the north (Stephens Co.) and east (Carter and Love counties) as well as Cooke Co., Texas to the immediate southeast (Dixon 2000. Amphibians and Reptiles of Texas. Texas A&M Press, College Station. 419 pp.).

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***TRACHEMYS SCRIPTA ELEGANS* (Red-eared Slider)** USA: FLORIDA: Seminole Co.: Wekiwa Springs State Park, 0.17 km from the Wekiwa Springs boil (28.71361°N, 81.45859°W; WGS84; elev. 6 m). 26 March 2011. Eric C. Munscher. Verified by Kenneth L. Krysko, Florida Museum of Natural History (UF 168593). New county record (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final report, Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida. 524 pp.). Female (max carapace length = 242 mm, straight midline plastron length = 183 mm, mass = 1023 g) captured by hand at 1030 h along the eastern end of the Wekiwa Springs Lagoon. The lack of algal growth on this turtle's shell could indicate a recent release. In Florida, *T. s. elegans* has been commonly sold in pet stores for many years and as a result has become one of the most frequently released exotic species of turtle in the state.

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***TRACHEMYS SCRIPTA ELEGANS* (Red-eared Slider)**. USA: GEORGIA: Hall Co.: Reservoir One on Calvary Church Rd (34.22629°N, 83.82584°W; WGS 84). 3 August 2012. Todd Pierson and Daniel Thompson. Verified by Kenneth Krysko. Florida Museum of Natural History (UF 168565 photo voucher); New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp). More than five individuals of this non-native subspecies were observed, and this record likely represents an established population.

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SQUAMATA — LIZARDS

***ASPIDOSCELIS SEXLINEATA* (Six-lined Racerunner)**. USA: GEORGIA: Hall Co.: Reservoir One on Calvary Church Rd (34.22743°N, 83.82511°W; WGS 84). 3 August 2012. Todd Pierson and Daniel Thompson. Verified by Kenneth Krysko. Florida Museum of Natural History (UF 168563 photo voucher). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.).

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***CERCOSAURA OCELLATA* (Ocellated Tegu)**. BRAZIL: SERGIPE: Municipality of Areia Branca: Parque Nacional Serra de Itabaiana (PARNASI, 10.7488°S, 373447°W, 240 m elev.; datum SAD-69). 19 October 2008. M. V. Noronha-Oliveira. Herpetological Collection of the Universidade Federal of Sergipe, São Cristóvão, Sergipe, Brazil (C00191, collected in pitfall traps). Verified by D. Oliveira Mesquita. *Cercosaura ocellata* has wide distribution in Brazil, occurring in the states of Goiás (Vaz-Silva et al. 2007. Check List 3[4]:338–345), Distrito Federal (Colli et al. 2011. *In* M. E. Ribeiro [ed.], Reserva Ecológica do IBGE, Biodiversidade Terreste, pp. 130–145. IBGE. Rio de Janeiro. Brazil. 580 pp.), Mato Grosso do Sul (Uetanabaro et al. 2007. Biota Neotrop. 7[3]:279–289), Mato Grosso (Ávila and Silva 2011. Comp. Parasitol. 78[1]:129–139), Acre (Bernarde et al. 2011. Biota Neotrop. 11[3]:117–144), Rondônia (Macedo et al. 2008. Biota Neotrop 8[1]:133–139), Pará (Mendes-Pinto and Souza 2011. Salamandra 47[4]:199–206), Tocantins (Recoder et al. 2011. Biota Neotrop. 11[1]:263–282), Bahia (Couto-Ferreira et al. 2011. J. Threatened Taxa 3[8]:1990–2000), Ceará (Loebmann and Haddad 2010. Biota Neotrop. 10[3]:227–256), Minas Gerais (Souza et al. 2010. Biota Neotrop. 10[2]:129–138), Amapá (Gardner et al. 2007. Conserv. Biol. 21[3]:775–787), Amazonas, Maranhão, and Roraima (Avila-Pires 1995. Lizards of Brazilian Amazonia [Reptilia: Squamata]. Zool. Verh. 299:1–706), Rio Grande do Sul and São Paulo (Molina 2001. Herpetol. Rev. 32[4]:275), and other countries of South America: Paraguay (Motte et al. 2009. Cuad. Herpetol. 23[1]:5–18), Venezuela (Gorzula and Senāris 1998. Sci. Guianae 8:1–270), Bolivia (Langstroth 2005. Kempffiana 1[1]:101–128) Peru (Duellman and Salas 1991. Occas. Papers. Mus. Nat. Hist. Univ. Kansas 143:1–13), and Suriname, British Guiana, and French Guiana (Ávila-Pires 2005. *In* Hollowell and Reynolds [eds.], Checklist of the Terrestrial Vertebrates of the Guiana Shield, pp. 25–40. Bull. Biol. Soc. Washington 13). First state record, extends distribution of *C. ocellata* ca. 270 km from municipality Mata de São João, on the northern coast of Bahia, Brazil (Couto-Ferreira et al., *op. cit.*). However, large distributional gaps remain, indicating the need for additional field surveys (Noronha-Oliveira et al. 2010. Herpetol. Rev. 41[3]:512).

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***COPHOSAURUS TEXANUS* (Greater Earless Lizard)**. USA: NEW MEXICO: Cibola Co.: 13.7 km SSW of Correo and 4.1 km NNW of Black Mesa, W of Mesa Lucero in western Valencia Co. (34.8456°N, 107.2524°W, WGS84; elev. 1800 m). 2 August 2010. J Tomasz Giermakowski and Jobette Chour. Verified by Charles W Painter. University of New Mexico Museum of Southwestern Biology (MSB 77916). New county record (Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. Univ. New Mexico Press, Albuquerque. xix + 431 pp.). This represents the first record in the volcanic areas of eastern Cibola Co. and extends the known range by approximately 25 km WNW of the nearest verified locality at Hidden Mountain, Valencia Co., New Mexico (MSB 77903). This record and a recent specimen from northwestern Socorro Co. (MSB 79209) suggest that *Cophosaurus texanus* may be distributed more widely and at higher elevations throughout Rio Grande drainages than previously documented.

Collected under permits from the New Mexico Department of Game and Fish (Authorization 3329) and The University of New Mexico (IACUC Protocol 10-100453-MCC).

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***HEMIDACTYLUS MABOUIA* (Wood Slave)**. USA: FLORIDA: Monroe Co.: Pigeon Key (24.70418°N, 81.15518°W; WGS84). 21 August 2012. Verified by Kenneth Krysko. UF 168591, 168592. New island record (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final report, Project Agreement 08013, Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida. 524 pp.; K. L. Krysko, pers. comm.). Vouchers captured under coral limestone garden rocks. Numerous individuals of this introduced species were located on and around island buildings.

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***HEMIDACTYLUS TURCICUS* (Mediterranean Gecko)**. USA: ALABAMA: Covington Co.: Rome Pond, 0.5 km N of U.S. Hwy 29 (31.14377°N, 86.67436°W; WGS 84). 29 June 2012. S. Graham and G. Brooks. Verified by Craig Guyer. AUM 39893. New county record (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn Printing Co., Auburn, Alabama. 347 pp.) This specimen is the first record of *Hemidactylus turcicus* within the proclamation boundary of Conecuh National Forest. The individual was collected from the side of a private residence.

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***LEPIDODACTYLUS LUGUBRIS* (Mourning Gecko)**. COSTA RICA: GUANACASTE: Liberia: Liberia (10.755182°N, 85.351453°W; WGS84), 640 m elev. 4 September 2011. Katherine González, Francisco García-Fernández, and Juan G. Abarca. Verified by Gerardo Chávez. UCR 21395. First record for Guanacaste, and a range extension of 325 km NW of Golfito, Puntarenas (Kohler 2008. Reptiles of Central America. Herpeton, Offenbach, Germany. 400 pp.), and 314 km WNW from the record at Manzanillo, Limón (Abarca et al. 2009. Herpetol. Rev. 40:453). The gecko was encountered in buildings of Rincon de la Vieja Lodge in Rincon de la Vieja Volcano National Park.

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***MABUYA ARAJARA* (Arajara Mabuya)**. BRAZIL: PIAUÍ: Municipality of Itaueira: 7.649°S; 43.461°W (datum WGS84), 393 m elev. 10 September 2010. T. Pinto, L. Brito, and B. F. Menezes. Coleção Herpetológica da Universidade Regional do Cariri, Crato, Ceará, Brazil (URCA 166, adult female 9.0 cm SVL). Verified by R. Waldemar Ávila. This species was previously known only for the state of Ceará (Arajara, municipality of Barbalha, the type locality; Rebouças-Spieker 1981. Pap. Avul. Zool. 34[9]:121–123), and municipalities of Crato, Barbalha, Missão Velha, Crateús, and Ubajara (Roberto and Loebmann 2010. Herpetol. Bull. 113:4–10). First state record, extending the known distribution of the species ca. 445 km E from the municipality of Crato, state of Ceará, Brazil (Roberto and Loebmann, *op. cit.*).

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***MESOSCINCUS ALTAMIRANI* (Tepalcatepec Skink)**. MÉXICO: MICHOACÁN: Municipality of Taretan: Hoyo del Aire (19.274254°N, 101.880110°W; WGS 84), 914 m elev. 18 November 2009. Marco Antonio Domínguez de la Riva, Rubén Alonso Carbajal Márquez, and David Santiago García. Verified by Luis Canseco-Márquez. Herpetological Collection, Universidad Autónoma de Aguascalientes (UAA-CV-0329). First record for Taretan, extending distribution ca. 10 km (air) SE of closest know locality at Hacienda El Sabino, Uruapan, Michoacán (Mendoza-Hernández et al. 2011. Bull. Rev. Mex. Biodivers. 82:1049–1052). The skink was found at 0900 h beneath a rock in subtropical dry forest.

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***OPHISAURUS ATTENUATUS LONGICAUDUS* (Eastern Slender Glass Lizard)**. USA: TENNESSEE: Fentress Co.: Grimsley, Goney Road (36.259193°N, 84.979914; WGS 84), first week of September 2008. Linda Stephens. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19298). New county record (Scott and Redmond 2008 [latest update: 07 August 2012]. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://www.apsu.edu/reptatlas/, accessed 10 August 2012). Adult lizard was found DOR.

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***PLESTIODON INEXPECTATUS* (Southeastern Five-lined Skink)**. USA: TENNESSEE: McNairy Co.: Mt. Peter (35.288905°N, 88.532027°W; WGS84). 29 March 2012. Brian P. Butterfield, Chavonna C. Christy, Ashley R. Foster, and Abigail L. Vann. Verified by A. F. Scott. Austin Peay State University (APSU 19308 photographic voucher). New county record (Scott and Redmond 2008 [latest update: 7 August 2012]. Atlas of Reptiles in Tennessee. Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/, accessed 7 September 2012. Captured by hand under a piece of tin siding.

BRIAN P. BUTTERFIELD (e-mail: bbutterfield@fhu.edu), **CHAVONNA C. CHRISTY**, **ASHLEY R. FOSTER**, and **ABIGAIL L. VANN**, Department of Biology, Freed-Hardeman University, Henderson, Tennessee 38340, USA.

***SCELOPORUS MINOR* (Minor Lizard)**. MÉXICO: JALISCO: Municipality of Lagos de Moreno: Sierra Cuatralba, 28.5 km ENE of Lagos de Moreno (21.407890°N, 101.659761°W; WGS84), 2581 m elev. 19 June 2010. Rubén Alonso Carbajal Márquez, José Carlos Arenas Monroy, Christoph Grünwald, and Jason Jones. Verified by Fausto Méndez de la Cruz. La Sierra University Digital Photo Collection (LSUDPC 6328–6330). First record for Jalisco, extending the known distribution ca. 50 km (airline) NW from the nearest locality in the Sierra de Santa Rosa, Guanajuato (Mendoza-Quijano et al. 2001. Anal. Inst. Biol., Univ. Nac. Autón. México, Ser. Zool. 72:233–243). The lizard was found under a rock in a clearing surrounded by oak forest.

JOSÉ CARLOS ARENAS-MONROY, Universidad Autónoma de Aguascalientes, Ciudad Universitaria, C.P. 20100, Aguascalientes, Ags., México (e-mail: jca_exe@yahoo.com.mx); **RUBÉN ALONSO CARBAJAL-MÁRQUEZ**, Centro de Investigaciones Biológicas del Noroeste, C.P. 23090, La Paz, Baja California Sur, México; **CHRISTOPH I. GRÜNWALD**, Careterra Chapala-Jocotepec Oriente #57-1, Col. Centro, C.P. 45920, Ajijic, Jalisco, México; **JASON M. JONES,** 16310 Avenida Florencia, Poway, California 92064, USA; **CHRISTIAN MARTIN GARCÍA BALDERAS,** Universidad Autónoma de Aguascalientes, Ciudad Universitaria, C.P. 20100, Aguascalientes, Ags., México.

***SCELOPORUS POINSETTII* (Crevice Spiny Lizard)**. USA: NEW MEXICO: Luna Co.: 15.6 km ENE of town of Hachita and approximately 1570 m ESE of peak of Cedar Mountain (31.9669°N, 108.1659°W, WGS 84; elev. 1645 m). 14 May 2011. J Tomasz Giermakowski and Bruce L. Christman. Verified by Charles W. Painter. University of New Mexico Museum of Southwestern Biology (MSB 79208). Second record for Luna Co. (Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. Univ. New Mexico Press, Albuquerque, xix + 431 pp.).

The first record (ANSP 21121) from Deming, Luna Co., New Mexico was collected by H. A. Pilsbry in 1915. This specimen was likely collected from the nearby Black Range Mountains, in Sierra and Grant counties north of Deming because no suitable habitat existed in the immediate vicinity of Deming and because during August of 1915 Pilsbry is known to have collected in Black Range Mountains (Pilsbry and Ferriss 1917. Proc. Acad. Nat. Sci. Philadelphia 69:83–107). The nearest specimens were collected in July of 1908 and are identified as being from Hachita, Grant Co., New Mexico (USNM 45100–45102). This new specimen and another collected more recently (MSB 79499), both from the eastern portion of Cedar Mountains, represent first verified records for Luna Co. and suggest that the species may be present in other isolated mountain ranges throughout southern New Mexico.

Collected under permits from the New Mexico Department of Game and Fish (Authorization 3329) and The University of New Mexico (IACUC Protocol 10-100453-MCC).

J. TOMASZ GIERMAKOWSKI, Museum of Southwestern Biology, MSC03 2020, University of New Mexico, Albuquerque, New Mexico 87131-0001, USA (e-mail: tomas@unm.edu); **BRUCE L. CHRISTMAN,** 736 Cardenas SE, Albuquerque, New Mexico 87106, USA (e-mail: nattybrew@hotmail.com).

***SCINCELLA LATERALIS* (Little Brown Skink)**. USA: TENNESSEE: Chester Co.: Henderson, Mid-south Youth Camp (35.462163°N, 88.682263°W; WGS 84). 5 April 2012. Brian P. Butterfield, E. Ladd Kuykendall, and Melissa T. Marshall. Verified by A. F. Scott. Austin Peay State University (APSU 19312 photographic voucher). New county record (Scott and Redmond 2008 [latest update: 7 August 2012]. Atlas of Reptiles in Tennessee. Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/, accessed 7 September 2012). Captured within a pile of wood and metal debris.

BRIAN P. BUTTERFIELD (e-mail: bbutterfield@fhu.edu), **E. LADD KUYKENDALL**, and **MELISSA T. MARSHALL**, Department of Biology, Freed-Hardeman University, Henderson, Tennessee 38340, USA.

***VARANUS SALVATOR* (Water Monitor Lizard)**. BANGLADESH: DHAKA DIVISION: Narayanganj District (23.632285°N, 90.524397°E; WGS84; ca. 10 m elev.). Ten individuals seen basking on banks of ca. 0.25 ha urban pond, heavily covered with Water Hyacinth, *Eichhornia crassipes*, and surrounded by human settlements, 500 m from Shitalokkha River. 1 January 2008. Verified by S. M. A. Rashid. Photographic voucher, Raffles Museum of Biodiversity Research, National University of Singapore (ZRC [IMG] 2.171). First confirmed report from Dhaka Division. Nearest populations recorded from Sundarbans, Bangladesh (ca. 115 km SW) and Barisal (ca. 140 km S) (Ahsan 2009. *In* Kabir et al. [eds.], Encyclopedia of Flora and Fauna of Bangladesh. Vol. 25, Amphibians and Reptiles, pp. 104–105. Asiatic Society of Bangladesh, Dhaka).

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sayam_uc@yahoo.com); **SHAHRIAR CAESAR RAHMAN**, Department of Environmental Science, Independent University, Bashundhora, Bangladesh (e-mail: caesar_rahman2004@yahoo.com).

SQUAMATA — SNAKES

***AGKISTRODON CONTORTRIX CONTORTRIX* (Southern Copperhead)**. USA: ALABAMA: Covington Co.: DOR at the junction of State Rt. 137 and Bogganlevel Rd. (31.05804°N, 86.57669°W; WGS 84). 29 June 2012. S. Graham and G. Brooks. Verified by Craig Guyer. AUM 39894. New county record (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn Printing Co., Auburn, Alabama. 347 pp.)

Funding for this research was provided by IOS-1051367 to T. Langkilde.

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***COLUBER CONSTRICTOR* (North American Racer)**. USA: GEORGIA: Oconee Co.: Elder Road, 0.04 mi N SR 15 (33.79895°N, 83.33347°W; WGS 84). 27 April 2012. Todd Pierson. Verified by Kenneth Krysko. Florida Museum of Natural History (UF 123238 photo voucher). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.).

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***CROTALUS HORRIDUS* (Timber Rattlesnake)**. USA: ALABAMA: Crenshaw Co.: U.S. Hwy. 29, 150 m NE of the Covington Co. line (31.46863°N, 86.39745°W; WGS 84). 23 August 2012. S. Graham, C. Kelehear, and G. Brooks. Verified by David Laurencio. AHAP-D 609, photo voucher. New county record (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn Printing Co., Auburn, Alabama. 347 pp.). Found DOR.

Funding for this research was provided by IOS-1051367 to T. Langkilde.

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***CROTALUS HORRIDUS* (Timber Rattlesnake)**. USA: OKLAHOMA: Pushmataha Co.: 15.4 km S of Talihina off Indian Highway, Kiamichi Mountains (34.609899°N, 95.045986°W; WGS84). 08 August 2012. C. T. McAllister. Verified by S. E. Trauth. Arkansas State University Herpetological Museum (ASUMZ 32326). First record for the county (Oklahoma Biological Survey, Distribution of Oklahoma Amphibians and Reptiles by Recorded Sightings [DOKARRS Search], http://www.biosurvey.ou.edu; Sam Noble Oklahoma Museum of Natural History Reptile Database [SNOMNH Search], http://www/snomnh.ou.edu). Adult male found DOR; several *C. horridus* from the state housed in the SNOMNH are from adjacent Atoka, Latimer, LeFlore, and McCurtain counties.

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***DIADOPHIS PUNCTATUS* (Ring-necked Snake)**. USA: GEORGIA: Tift Co.: Park Ave, Tifton (31.48052°N, 83.50771°W; WGS 84). 28 April 2012. Todd Pierson and Malavika Rajeev. Verified by Kenneth Krysko. Florida Museum of Natural History (UF 123247 photo voucher). New county record (Jensen et al. [eds.], 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.).

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***FARANCIA ABACURA* (Mudsnake)**. USA: GEORGIA: Pierce Co.: 8.4 km SW Screven (31.436853°N, 82.082684°W; NAD 83). 23 June 2012. D. Stevenson. Verified by Kenneth L. Krysko. UF 167205. New county record (Jensen et al. [eds.] 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.).

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***FARANCIA ERYTROGRAMMA ERYTROGRAMMA* (Common Rainbow Snake)**. USA: GEORGIA: Jeff Davis Co.: 7.2 km N Hazlehurst, Hinson's Landing Road at Ocmulgee River (31.934832°N, 82.589699°W; NAD 83). 2 July 2012. P. Frank. UF 168014. Adult male captured in aquatic trap placed in shallow water along the edge of the Ocmulgee River. Laurens Co.: Dublin (32.48936°N, 82.86544°W; NAD 83). 26 August 2012. P. Frank. UF 168567. Adult male captured in aquatic trap placed in shallow water along the edge of the Oconee River. Both are new county records (Jensen et al. [eds.] 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.) and were verified by Kenneth L. Krysko.

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***GEOPHIS DUGESII* (Dugès' Earth Snake)**. MÉXICO: GUANAJUATO: Municipality of Jaral Del Progreso: Cerro El Culiacán, 4.5 km ENE of Victoria de Cortazar (20.342500°N, 100.989361°W; WGS 84), 2295 m elev. 29 June 2009. José Carlos Arenas Monroy and Christian Martin García Balderas. MZFC 26591. Cerro El Culiacán, 5.4 km ESE of Victoria de Cortazar (20.332735°N, 100.981738°W; WGS84), 2502 m elev. 16 October 2009. José Carlos Arenas Monroy and Rubén Alonso Carbajal Márquez. MZFC 26592. Both specimens verified by Luis Canseco Márquez. First records for Guanajuato, extending the known distribution ca. 102 km (airline) NE from the closest record at Zacapu, Michoacán (Duellman 1961. Univ. Kansas Publ. Mus. Nat. His. 15:1–148). MZFC 26591 is an adult male found under a rock in the ecotone between tropical deciduous forest and oak forest. MZFC 26592 is an adult female found on the ground in oak forest at a locality representing the highest elevational record for the species (Wilson and Johnson 2010. *In* Wilson et al. [eds.], Conservation of Mesoamerican Amphibians and Reptiles, pp. 31–235. Eagle Mountain Publishing, LC, Eagle Mountain, Utah).

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***GEOPHIS DUGESII* (Dugès' Earth Snake)**. MÉXICO: ZACATECAS: Municipality of Huanusco: Sierra del Laurel, 22.6 km NE of Jalpa (21.701639°N, 102.773444°W; WGS 84), 2350 m elev. 3 July 2011. Christian Martin García Balderas and Gustavo Ernesto Quintero Díaz. Verified by Luis Canseco-Márquez. CNAR-RH-39 a, b; photo vouchers. First record for Zacatecas, extending the range 6.9 km SW from the closest record at 0.5 km from Los Alisos, Municipality of Calvillo, Aguascalientes, in oak forest (Vazquez-Diaz and Quintero-Diaz 1999. Herpetol. Rev. 30:235). The snake was found in a ravine under decomposing plant litter near a small stream in subtropical dry forest.

CHRISTIAN MARTIN GARCÍA-BALDERAS (e-mail: chrisgarbal@gmail.com) and **GUSTAVO ERNESTO QUINTERO-DÍAZ** (e-mail: gequintmx@yahoo.com.mx), Universidad Autónoma de Aguascalientes, Centro de Ciencias Básicas, Departamento de Biología, Av. Universidad # 940, Aguascalientes, Aguascalientes 20131, México.

***LAMPROPELTIS CALLIGASTER* (Yellow-bellied Kingsnake)**. USA: TENNESSEE: McNairy Co.: Mt. Peter (35.288666°N, 88.532136°W; WGS84). 29 March 2012. Brian P. Butterfield, Catherine M. Combs, Whitney A. Pirtle, and Sara A. Tucker. Verified by A. F. Scott. Austin Peay State University (APSU 19308 photographic voucher). New county record (Scott and Redmond 2008 [latest update: 24 November 2009]. Atlas of Reptiles in Tennessee. Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/, accessed 7 September 2012. Captured by hand within a stack of tin siding.

BRIAN P. BUTTERFIELD (e-mail: bbutterfield@fhu.edu), **CATHERINE M. COMBS**, **WHITNEY A. PIRTLE**, and **SARA A. TUCKER**, Department of Biology, Freed-Hardeman University, Henderson, Tennessee 38340, USA.

***LAMPROPELTIS TRIANGULUM SYSPILA* (Red MilkSnake)**. USA: ARKANSAS: Sharp Co.: 36.29873056°N, 91.43293611°W (WGS 84); elev. 111 m. 25 April 1998. Brian Hubbs. Verified by Neftali Camacho. Natural History Museum of Los Angeles County (LACM PC 1601 photo voucher). New county record (Arkansas Herp Atlas. http://www.herpsofarkansas.com/wiki/uploads/Herp/Atlas/arherpatlas 2012; Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville. 421 pp.).

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***NATRIX TESSELLATA* (Dice Snake)**. PAKISTAN: GILGIT-BALTISTAN: Ghizer District: Gahkuch wetlands (36.171011°N, 73.775341°E; 1845 m elev.). 20 August 2011. Jamshed Iqbal Chaudhry, Pakistan Wetlands Programme. Verified by Sylvain Ursenbacher. Nine photographic vouchers, University of Basel, Switzerland (IMG_0807/14/19/26 and DSC07940/43/46/68/73, digital images). Adult female preserved as PMNH 2478, Pakistan Museum of Natural History, Islamabad. First record and voucher for Himalayan river valley (Karakoram Mountains) and Pakistan, and second known locality for Pakistan after records from near Mastuj, Chitral Valley, Hindu Kush Mountains (Wall 1911. J. Bombay Nat. Hist. Soc. 21:132–145) that remain unconfirmed. Eastern extension from Mastuj by 115 km aerial distance, and 170 km via river systems and mountain passes. However, this new record is isolated, as preferred river habitat would lead over currently ecologically unsuitable passes at 3700 m elev. Highest confirmed records at least up to 2800 m elev. (Bannikov et al. 1971. Zemnovodnye *i* Presmy - kayushchiesya SSSR. [Amphibians and Reptiles of the SSSR]. Publ. Mysl, Moscow. 303 pp.; Mebert [ed.] 2011. The Dice Snake, *Natrix tessellata*: Biology, Distribution and Conservation of a Palaearctic Species. Mertensiella 18, Rheinbach. xii + 456 pp.; 1 DVD).

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***NERODIA ERYTHROGASTER* (Plain-bellied Watersnake)**. USA: GEORGIA: Madison Co.: Danielsville, Moons Grove Church Road, 0.16 mi SE Hunt Road (34.10799°N, 83.28391°W; WGS 84). 5 May 2012. Todd Pierson and Grover Brown. Verified by Kenneth Krysko. Florida Museum of Natural History (UF 167815 photo voucher); New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.).

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***NERODIA ERYTHROGASTER ERYTHROGASTER* (Red-bellied Watersnake)**. USA: GEORGIA: Dekalb Co.: Constitution Lakes Park (33.681300°N, 84.339180°W; WGS 84; elev. ~240 m). 29 May 2012. Robert L. Hill. Verified by John Jensen. UTADC-7591. New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). This species has been documented from adjacent Fulton, Clayton, and Rockdale counties. Specimen photographed along vegetated edge of a channel connecting two ponds.

ROBERT L. HILL (e-mail: rhill@zooatlanta.org), **BRAD LOCK**, **DAVID BROTHERS**, and **CAMDELYN ROSE**, Department of Herpetology, Zoo Atlanta, Atlanta, Georgia 30315, USA.

***NERODIA ERYTHROGASTER ERYTHROGASTER* (Red-bellied Watersnake)**. USA: GEORGIA: Gwinnett Co.: Mill Creek Nature Center (33.06102°N, 83.98254°W; WGS 84; elev. 313 m). 15 August 2012. Robert L. Hill and Cynthia Moore. Verified by John Jensen. UTADC 7607, 7608. New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). This is first observation, verified with a voucher, from Gwinnett Co. This species has been documented from adjacent Fulton, Clayton, Rockdale, Walton, Barrow, and most recently Dekalb counties. Specimen was observed underneath a broken portion of a large fallen log on the edge of a drying wetland.

ROBERT L. HILL, Department of Herpetology, Zoo Atlanta, Atlanta, Georgia 30315, USA; e-mail: rhill@zooatlanta.org.

***NERODIA RHOMBIFER* (Diamond-backed Watersnake)**. USA: TENNESSEE: Chester Co.: Henderson, Mid-south Youth Camp (35.461188°N, 88.684558°W; WGS84). 5 April 2012. Brian P. Butterfield, Mark A. Cooper, Marcus E. Posey, and Lee J. Barton. Verified by A. F. Scott. Austin Peay State University (APSU 19311 photographic voucher). New county record (Scott and Redmond 2008 [latest update: 18 February 2010]. Atlas of Reptiles in Tennessee. Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/, accessed 7 September 2012. Captured on the bank of a small impoundment.

BRIAN P. BUTTERFIELD (e-mail: bbutterfield@fhu.edu), **MARK A. COOPER**, **MARCUS E. POSEY**, and **LEE J. BARTON**, Department of Biology, Freed-Hardeman University, Henderson, Tennessee 38340, USA.

***OPHEODRYS AESTIVUS* (Rough Greensnake)**. USA: ALABAMA: Crenshaw Co.: DOR at the junction of U.S. Hwy 331 and Ridgecrest Dr. (31.71716°N, 86.27496°W; WGS 84). 23 August 2012. S. Graham, C. Kelehear, and G. Brooks. Verified by David Laurencio. AHAP-D 608, photo voucher. New county record (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn Printing Co., Auburn, Alabama. 347 pp.).

Funding for this research was provided by IOS-1051367 to T. Langkilde.

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***OPHEODRYS AESTIVUS* (Rough Greensnake)**. USA: GEORGIA: Banks Co.: GA 164 (34.28479°N, 83.44173°W; WGS 84). 6 May 2012. Todd Pierson, Kevin Stohlgren, and Grover Brown. Verified by Kenneth Krysko. Florida Museum of Natural History (UF 168560 photo voucher). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.).

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***PANTHEROPHIS GUTTATUS* (Red Cornsnake)**. USA: FLORIDA: Monroe Co.: Pigeon Key (24.70392°N, 81.15587°W; WGS84). 21 August 2012. Verified by Kenneth Krysko. Photo voucher (UF 168558). New island record (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final report, Project Agreement 08013, Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida. 524 pp.; K. L. Krysko, pers. comm.). Three additional adults were observed and snake sheds were found throughout the island. This species has been documented throughout the Florida Keys, and is believed to be native to the island.

I thank Kelly McKinnon and the Pigeon Key Foundation for assistance and hospitality.

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***PSEUDOERYX PLICATILIS* (South American Pond Snake)**. PARAGUAY: DEPARTAMENTO CENTRAL: Asunción Bay (25.268280°S, 57.632394°W, WGS 84; 58 m elev.). 02 April 2011. A. Caballero. Colección Zoológica, Facultad Ciencias Exactas y Naturales, San Lorenzo, Paraguay (CZ 0683, female, 655.8 mm SVL, 171 mm TL. Found dead close to a temporary pond near the Paraguay River). Verified by P. Cacciali. Previously cited from Argentina, Bolivia, Brazil, Ecuador, French Guiana, Paraguay, Peru, Suriname, and Venezuela (Scartozzoni et al. 2010. Checklist 6[4]:534–537). In Paraguay, known from three records, in the north in the Department of Alto Paraguay and in the south in the Department of Ñeembucu (Aquino et al. 1996. *In* O. Romero [ed.], Colecciones de Fauna y Flora del MNHNP, Asunción, pp. 331–400). First Department record and fourth known locality from Paraguay, filling a distributional gap in Paraguay, 180 km SW of the Ñeembucu records and 560 km N of the Alto Paraguay record.

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***RAMPHOTYPHLOPS BRAMINUS* (Brahminy Blindsnake)**. MÉXICO: CHIAPAS: Municipality of Ocosingo: Frontera Corozal (16.823056°N, 90.886389°W; WGS84), 107 m elev. 15 July 2010. Alfonso Hernández Ríos. Verified by Tizoc A. Altamirano Alvarez. Amphibian and Reptile Collection, Museo de las Ciencias Biológicas "Enrique Beltrán," FES-Iztacala, UNAM (MCBFESI 254). First record for Chiapas, and a range extension of 332 km SW from the nearest locality at Chetumal, Quintana Roo (Cedeño-Vázquez et al. 2003. Herpetol. Rev. 34:393–395). The snake was under a log in tropical rain forest.

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***RENA* (=*LEPTOTYPHLOPS*) *DULCIS* (Texas Threadsnake)**. USA: COLORADO: Otero Co.: DOR on gravel road in Ninemile Valley (37.73353°N, 103.49602°W, NAD83; elev. 1295 m). 16 June 2012. N. Kreutzer and R. Kreutzer. UCM 67361. Verified by Mariko Kageyama. New county record, ca. 26 km N and 30 km E of the nearest (sight) record in Las Animas Co. and ≥ 75 km NW of vouchered specimens from Baca Co. Further, this is the northernmost locality for this species reported to date (Hammerson 1999. Amphibians and Reptiles in Colorado, 2nd ed. University Press of Colorado, Niwot, Colorado. 484 pp.; Taggart et al. 2012. Kansas Herpetofaunal Atlas: An On-line Reference. Electronic database accessible at http://webcat.fhsu.edu/ksfauna/herps. Sternberg Museum of Natural History, Fort Hays State University, Hays, Kansas; accessed 03 July 2012).

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***SALVADORA MEXICANA* (Mexican Patch-nosed Snake)**. MÉXICO: OAXACA: Municipality of San Pedro Tututepec: Parque Nacional Lagunas de Chacahua, Cerro Hermoso (15.971184°N, 97.543732°W; WGS 84), 14 m elev. 26 June 2009. Jesús García-Grajales. Laboratorio de Colecciones Biológicas, Universidad del Mar, Campus Puerto Escondido (CFH-UMAR-0046 photo voucher). Río Grande (16.024836°N, 97.433917°W; WGS 84), 30 m elev. 8 May 2012. Isabel Cortez Cristobal and Eduardo Mata-Silva. UTEP Natural History Collections (UTEP G 2012.3 photo voucher). Municipality of San Pedro Mixtepec: Puerto Escondido (15.890032°N, 97.075067°W; WGS 84), 76 m elev. 11 May 2011. Jesús García-Grajales. CFH-UMAR-0108. All specimens were verified by Aurelio Ramírez-Bautista. First records for both municipalities, extending the known range SE from the closest locality near Putla, Oaxaca; ca. 115 km to the Cerro Hermoso and Río Grande records, and ca. 150 km SE to Puerto Escondido (Webb and Baker 1969. An. Inst. Biol. Univ. Nal. Autón. México 40, Ser. Zool. [1]:139–152). CFH-UMAR-0046 was observed active on a sandy substrate surrounded by mangroves; UTEP G 2012.3 was found dead on an unpaved road on the northern outskirts of

the town, ca. 150 m away from the Río Grande (river); and CFH-UMAR-0108 was located in secondary vegetation on the Universidad del Mar campus.

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***STORERIA DEKAYI* (Dekay's Brownsnake)**. USA: GEORGIA: Banks Co.: Homer, Poole Road, 1.09 mi SE SR 51 (34.34717°N, 83.43757°W; WGS 84). 5 May 2012. Todd Pierson and Kevin Stohlgren. Verified by Kenneth Krysko. Florida Museum of Natural History (UF 167816 photo voucher). First vouchered record from county (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.).

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***TANTILLA TAENIATA*.** HONDURAS: ATLÁNTIDA: Lancetilla (15.733333°N, 87.45000°W; WGS84), 30 m elev. 29 November 2010. Leonel Marineros. Verified by Steve W. Gotte. USNM 579682. First record for Atlántida, with the closest known locality ca. 55 km SW at El Progreso, Yoro (McCranie 2011. Zootaxa 3037:37–44). The snake was run over by a bicycle while it was crossing a road on a cloudy day at 0850 h.

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***THAMNOPHIS MARCIANUS* (Checkered Gartersnake; Sochuate)**. HONDURAS: ATLÁNTIDA: Barra de Colorado (15.816667°N, 87.30000°W; WGS84), near sea level. 1 March 2011. Leonel Marineros. Verified by Steve W. Gotte. USNM 579689. First record for Atlántida, with the closest known locality ca. 120 km SW at Agua Azul, Lago de Yojoa, Cortés (McCranie 2011. The Snakes of Honduras. Systematics, Distribution, and Conservation. SSAR Contrib. Herpetol. 26: x + 714 pp.). The snake was coiled on floating water hyacinths (*Eichhornia crassipes*) during the afternoon in a swamp.

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***TRIMORPHODON VILKINSONII* (Chihuahuan Lyresnake)**. MÉXICO: CHIHUAHUA: Municipality of Nuevo Casas Grandes: Sierra La Escondida (30.52048056°N, 107.76448889°W; WGS84), 1622 m elev. 29 July 2008. Eduardo Macías-Rodríguez and Gabriel García-Elguera. Verified by J. D. Johnson. Colección Científica de Vertebrados, Universidad Autónoma de Ciudad Juárez, Sección Herpetológica, Digital Collection, (CCV-UACJ 1-16-2011). First record for the municipality and a ca. 265 km NW range extension from the nearest record in Chihuahua (Lemos-Espinal and Smith 2007. Anfibios y Reptiles del Estado de Chihuahua, México. UNAM-CONABIO, Tlanepantla, México, México. xiii + 613 pp.). The snake was found at night next to a dirt road in rocky terrain covered by Chihuahuan Desert scrub vegetation.

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ERRATUM

In a recently published geographic distribution note (Davis and DeSantis 2012. Herpetol. Rev. 43[2]:449), we identified two snakes in the Texas Natural History Collections (TNHC 85172, 85173) as *Pantherophis emoryi*. However, subsequent examination of TNHC specimens of *P. emoryi, P. guttatus*, and *P. slowinskii*, and consultation with Travis LaDuc suggests that our earlier specimens should be referred to *P. slowinskii* instead. Assignment to species based on external characters in this region of range overlap is difficult. Even with this change of species assignment, these specimens represent a new record for Fayette Co. (Dixon 2000. Amphibians and Reptiles of Texas. Texas A&M University Press, College Station. 421 pp.).

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New County Records for Ohio Amphibians and Reptiles

The historic and contemporary distributions of Ohio's herpetofauna have been recently summarized in atlases on anurans (Davis and Menze 2000), salamanders (Pfingsten and Matson 2003), and reptiles (Wynn and Moody 2006). The distributions of anurans at the county level were subsequently updated by Davis and Menze (2002). Southeastern Ohio remains only moderately sampled, and distributional gaps exist for many species. In addition, there have been relatively few records added in this region since the pioneering works of Walker (1946), Conant (1951), and Seibert and Brandon (1960). The lack of new records is particularly acute in the case of reptiles. To begin to address this situation, we utilized survey methods such as walking transects in habitat, searching under natural and artificial cover, and nocturnal road driving to detect the presence of amphibians and reptiles throughout Ohio, with emphasis on the southeastern counties. Here, we report 27 new county records since 2004, including at least one new county record for 23 species. Voucher specimens were deposited into the Herpetology Fluid Collections (CMC) and photographs into the Herpetological Photodocumentation Collection (CMC HP) of the Cincinnati Museum Center's Frederick and Amey Geier Research and Collections Center. Tissue samples from specimens were placed into the fluid collection. Identification of all records was verified by Jeffrey G. Davis, unless otherwise indicated. The datum for all GPS coordinates is WGS 84.

CAUDATA — SALAMANDERS

***AMBYSTOMA BARBOURI* (Streamside Salamander)**. USA: OHIO: Jackson Co.: Franklin Township, Clay Banner Rd. 0.5 mi. E of intersection with Franklin Valley Rd. (Co. Rd. 13) (38.94032°N, 82.59140°W). 20 April 2009. C. Brune. CMC 11570, CMC HP 3594–3602. Verified by Katherine R. Greenwald based on mtDNA sequences. New county record (Pfingsten and Matson 2003). This locality extends the known range eastward by approximately 65 km. It lies within the preglacial Marietta River Valley. In contrast to most of southeastern Ohio, the terrain here is relatively flat and rocks appear to be entirely lacking. Additional surveys in March 2010 revealed that this species is broadly distributed in the Franklin Valley area of Franklin and Jefferson Townships of Jackson Co. (CMC 12074, 12075).

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***AMBYSTOMA MACULATUM* (Spotted Salamander)**. USA: OHIO: Meigs Co.: Columbia Township (39.15108°N, 82.25647°W). 10 March 2006. J. Folt. CMC HP 4176. New county record (Pfingsten and Matson 2003). Animal found alive on Salem School Lot Road during a nocturnal road survey during a heavy rain.

***AMBYSTOMA TIGRINUM* (Eastern Tiger Salamander)**. USA: OHIO: Fairfield Co.: Violet Township (39.87822°N, 82.78783°W). 15 March 2008. D. Alessandrini, A. Avram, C. Brune, J. Folt. CMC HP 2732. New county record (Pfingsten and Matson 2003). Animal found alive on Schoolhouse Road during a nocturnal road survey.

***HEMIDACTYLIUM SCUTATUM* (Four-toed Salamander)**. USA: OHIO: Athens Co.: Waterloo Township, Waterloo Wildlife Area, Pine Run floodplain (39.34231°N, 82.28093°W). 15 April 2004. C. Brune. CMC HP 864–870. New county record (Pfingsten and Matson 2003). Pike Co.: Benton Township, Pike State Forest, Tobacco Barn Hollow (39.17510°N, 83.20813°W). 3 May 2008. D. Alessandrini, C. Brune, N. Cornell, B. Folt, J. Folt. CMC HP 3036-3038. New county record (Pfingsten and Matson 2003).

***PLETHODON ELECTROMORPHUS* (Northern Ravine Salamander)**. USA: OHIO: Hocking Co.: Starr Township, Wayne National Forest (39.45346°N, 82.32506°W). 10 November 2007. C. Brune. CMC HP 2677–2681. New county record (Pfingsten and Matson 2003).

***PSEUDOTRITON MONTANUS DIASTICUS* (Midland Mud Salamander)**. USA: OHIO: Pike Co.: Jackson Township (39.09534°N, 82.79655°W). 13 January 2007. C. Brune and J. Folt. CMC HP 2677–2681. New county record (Pfingsten and Matson 2003).

***PSEUDOTRITON RUBER* (Red Salamander)**. USA: OHIO: Monroe Co.: Jackson Township, Fly Gorge in the Wayne National Forest (39.57166°N, 81.00417°W). 25 March 2012.. C. Brune and M. Haughey. CMC HP 7274–7276. New county record (Pfingsten and Matson 2003).

ANURA — FROGS

***ACRIS BLANCHARDI* (Blanchard's Cricket Frog)**. USA: OHIO: Gallia Co.: Raccoon Township, Tycoon Lake Wildlife Area (38.92757°N, 82.34091°W). 3 June 2006. C. Brune. CMC HP 1711-1712. New county record (Davis and Menze 2002).

TESTUDINES — TURTLES

***APALONE SPINIFERA* (Spiny Softshell)**. USA: OHIO: Summit Co.: Boston Township, Cuyahoga Valley National Park (41.20080°N, 81.56860°W). 10 July 2012. Douglas W. Vogus. CMC HP 7286–7287. New county record (Wynn and Moody 2006). Observed basking along a bank of the Cuyahoga River near the Bolanz Road bridge.

***TRACHEMYS SCRIPTA* (Pond Slider)**. USA: OHIO: Clermont Co.: Union Township, Cincinnati Nature Center (39.12618°N,

84.24296°W). 16 July 2006. J. Folt. CMC HP 4441. New county record (Wynn and Moody 2006). Observed swimming in ponds on the park property.

SQUAMATA — LIZARDS

***PLESTIODON LATICEPS* (Broad-headed Skink)**. USA: OHIO: Gallia Co.: Greenfield Township, Wayne National Forest (38.77707°N, 82.53091°W). 20 April 2012. C. Brune. CMC HP 7278–7281. New county record (Wynn and Moody 2006).

SQUAMATA — SNAKES

***AGKISTRODON CONTORTRIX* (Copperhead)**. USA: OHIO: Gallia Co.: Ohio Township, Crown City Wildlife Area (38.60084°N, 82.25623°W). 26 July 2008. C. Brune. CMC HP 3238–3241. New county record (Wynn and Moody 2006).

***CARPHOPHIS AMOENUS* (Eastern Wormsnake)**. USA: OHIO: Gallia Co.: Greenfield Township (38.79158°N, 82.55307°W). 11 July 2009. C. Brune. CMC HP 3835–3838. New county record (Wynn and Moody 2006).

***CROTALUS HORRIDUS* (Timber Rattlesnake)**. USA: OHIO: Lawrence Co.: Symmes Township, Wayne National Forest, approximately 5 km S of Peniel, Ohio (38.7°N, 82.5°W). 3 July 2009. C. Brune, R. Brune, and B. Folt. CMC HP 3799–3807. New county record (Wynn and Moody 2006).

***DIADOPHIS PUNCTATUS* (Ring-necked Snake)**. USA: OHIO: Gallia Co.: Guyan Township (38.63268°N, 82.27974°W). 3 June 2006. C. Brune. CMC HP 1722. New county record (Wynn and Moody 2006).

***LAMPROPELTIS NIGRA* (Eastern Black Kingsnake)**. USA: OHIO: Pike Co.: Jackson Township, Ohio Road 335, north of Beaver, Ohio (39.13026°N, 82.86982°W). 26 June 2006. J. Folt. CMC HP 4415. First vouchered specimen for county (Wynn and Moody 2006). Found dead-on-road.

***LAMPROPELTIS TRIANGULUM* (Eastern Milksnake)**. USA: OHIO: Gallia Co.: Guyan Township (38.63268°N, 82.27974°W). 3 June 2006. C. Brune. CMC HP 1721. New county record (Wynn and Moody 2006).

***HETERODON PLATIRHINOS* (Eastern Hog-nosed Snake)**. USA: OHIO: Gallia Co.: Morgan Township (38.96563°N, 82.31209°W). 24 August 2006. C. Brune. CMC HP 1896–1898.
Lawrence Co.: Washington Township (38.79836°N, 82.61806°W). 13 April 2012. C. Brune. CMC HP 7277. New county records (Wynn and Moody 2006).

***NERODIA SIPEDON* (Northern Watersnake)**. USA: OHIO: Gallia Co.: Perry Township, Raccoon Creek County Park (38.78990°N, 82.34628°W). 3 June 2006. C. Brune. CMC HP 1715–1718. New county record (Wynn and Moody 2006).

***PANTHEROPHIS SPILOIDES* (Gray Ratsnake)**. USA: OHIO: Brown Co.: Lewis Township (38.83357°N, 83.95135°W). 2 June 2007. C. Brune. CMC HP 2467. New county record (Wynn and Moody 2006).

***STORERIA DEKAYI* (DeKay's Brown Snake)**. USA: OHIO: Lawrence Co.: Washington Township, Ironton Forest Wildlife Area (38.78656°N, 82.61074°W). 2 July 2011. C. Brune. CMC 12232–12236, CMC HP 7018. New county record (Wynn and Moody 2006). Mahoning Co.: Youngstown Township (41.09490°N, 80.63385°W). 14 April 2006. J. Folt, R. Folt and R. Novotny. CMC HP 4270. New county record (Wynn and Moody 2006). Found under trash littering abandoned road just off of Lane Road.

***STORERIA OCCIPITOMACULATA* (Red-bellied Snake)**. USA: OHIO: Lawrence Co.: Symmes Township, (38.76764°N, 82.54320°W). 13 June 2009. C. Brune. CMC HP 3787–3791. New county records (Wynn and Moody 2006). Summit Co.: Boston Township, Cuyahoga Valley National Park (41.250748°N, 81.522557°W). 27 May 2010. Jared Mizanin and John Mizanin. CMC HP 7282-7283. New county record (Wynn and Moody 2006). Found beneath discarded wood in a field.

***VIRGINIA VALERIAE* (Smooth Earthsnake)**. USA: OHIO: Lawrence Co.: Washington Township, Ironton Forest Wildlife Area (38.78656°N, 82.61074°W). 2 August 2009. C. Brune and B. Folt. CMC 3880–3881. New county record (Wynn and Moody 2006).

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NATURAL HISTORY NOTES

CAUDATA — SALAMANDERS

***AMBYSTOMA MABEEI* (Mabee's Salamander). REPRODUCTION.** The reproductive biology of Mabee's Salamander is the least studied of all the North American ambystomatids. Breeding migration and mating dates, as well as egg size and mode of egg deposition, have been described by Hardy (1969a. Chesapeake Biol. Lab., Nat. Res. Inst. Univ. Maryland, Solomans, Maryland. Ref. No. 60-20, 3 pp.; Hardy 1969b. Bull. Maryland Herpetol. Soc. 5:65–76), Russell et al. (1998. Herpetol. Rev. 29:36–37), and McCoy (2000. An analysis of migratory behavior, physiological condition, and life history strategy in the salamanders *Ambystoma mabeei* and *A. opacum* in southeastern Virginia. MS Thesis, Old Dominion Univ., Norfolk, Virginia). Clutch size, however, has not been reported for this species (Mitchell 2005. *In* M. Lannoo [ed.], Amphibian Declines: The Conservation Status of United States Species, pp. 616–617. Univ. California Press, Berkeley, California).

On 6 March 1988, we, along with K. A. Buhlmann, J. L. Elwood, and M. D. Poplawski, collected three gravid female *A. mabeei* in Newport News City Park, York Co., Virginia, USA (37.193056°N, 76.513056°W, NAD83). All were found under logs adjacent to a natural sinkhole pond. One unmeasured female deposited 110 infertile eggs in captivity on 15 March 1988 but retained 17 eggs in the oviducts (this specimen died and was lost). Total clutch size was 127. Two additional females were euthanized and dissected. One (67 mm SVL, Carnegie Museum 128266) contained 290 mature eggs (left 144, right 146) and the other (68 mm SVL, CM 128267) contained 163 eggs (left 74, right 89). Mean clutch size was 193.3 ± 85.6 (1 SD). Mean diameter of 11 mature ova in the former was 1.84 ± 0.14 mm and 10 ova in the latter measured 2.06 ± 0.13 mm. Deposited eggs in early cleavage were 5.1–5.9 mm in diameter (Hardy 1969a, *op. cit.*).

These specimens were collected prior to the listing of *A. mabeei* as a threatened species in Virginia (Mitchell 1991. *In* K. Terwilliger [Coord.], Virginia's Endangered Species, pp. 411–423. McDonald and Woodward Publ. Co., Blacksburg, Virgina).

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***AMBYSTOMA MACULATUM* (Spotted Salamander). PREDATION.** Amphibians are common prey to an array of taxa including many vertebrates, arthropods, and even carnivorous plants (Duellman and Trueb 1986. Biology of Amphibians. McGraw Hill, New York. 679 pp.; Burgason 1999. *In* M. L. Hunter et al. [eds.],Maine Amphibians and Reptiles, pp. 62–65. Univ. Maine Press, Orono, Maine). Although predation on ambystomatid salamander eggs and larvae has been well documented (Duncan 2005. Herpetol. Rev. 36:294; Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, DC. 587 pp.; Spohr 2005. Herpetol. Rev. 36:294), reports of predation on adults seem to be scarce. Frequently, either the predator or prey is left unidentified to species. For example, Bent (1938. Life Histories of North American Birds of Prey. USNM Bull. 170) records "salamanders" as part of the diet of the Northern Barred Owl (*Strix varia varia*) and Wilson (1938. Auk 55:187–197) is no more specific than "amphibians" when listing the food of this predator. Conversely, Petranka (1998, *op. cit.*) notes that "owls...snakes.... and other woodland predators" must prey upon *Ambystoma opacum*. Petranka (1998, *op. cit.*) cites but a single case in nature of adult *A. maculatum* being preyed upon; Raccoons (*Procyon lotor*) were recorded consuming three adults around a breeding site in Tennessee.

Here we report several cases of predation by the Barred Owl on adult *A. maculatum*. On 15 Oct 2011 at Hillsborough, Albert Co., New Brunswick, Canada (45.922°N, 64.642°W) a 782.3 g female owl was found fresh-dead on a roadway, presumably struck by an automobile. In the course of preparing the specimen for addition to the New Brunswick Museum bird collection (NBM 11768), the stomach was found to contain a whole, adult female *A. maculatum* 166.7 mm total length (estimated, tip of tail missing) and 24.0 g. Also, one of us (BF) has monitored Barred Owl nests in the Wolfville area of Kings Co., Nova Scotia (45.085°N, 64.343°W) from 1984 to the present. On four occasions among the 9–15 nests checked once annually during the first week of owl eggs hatching (~1–15 May), 1–2 adult *A. maculatum* have been encountered in nests. Both whole intact salamanders and salamander tails were observed, demonstrating (with the October record above) that *A. maculatum* is not only predated, but also consumed by *Strix varia*. This is in spite of the well-known noxious skin secretions and warning coloration of *A. maculatum* that are apparently effective at repelling many predators (Petranka 1998, *op. cit.*).

The observations above and other evidence suggest that amphibians may be more frequent (albeit a minor component) in the diet of the Barred Owl than other northeastern North American owl species. Snyder and Wiley (1976. Ornithological Monographs 20) summarize the diet of North American owls and report that lower vertebrates (fish, amphibians, and reptiles) make up 2.5% of this species' diet; among North American forest owls only the Pygmy Owl (*Glaucidium californicum*) and the Hawk Owl (*Surnia ulula*) take an equivalent percentage of lower vertebrates. Likewise, Bowsakowski and Smith (1992. Can. J. Zool. 70:984–992) found that among eastern forest owls only the Barred Owl fed on amphibians.

Adult *A. maculatum* live a mainly fossorial existence, emerging for about two weeks during a short breeding season in the early spring, although they may be found wandering about the forest floor on rainy nights in spring, summer, or autumn (Gilhen 1984. Amphibians and Reptiles of Nova Scotia. Nova Scotia Museum, Halifax. 162 pp.). During night-time overland migration to and from vernal pools or other wanderings, adult *A. maculatum* are clearly vulnerable to nocturnal predators such as the Barred Owl; it is also perhaps noteworthy that the breeding season for

A. maculatum in eastern Canada (late March to mid May; Gilhen 1984, *op. cit.*) coincides with the period when Barred Owl chicks may be in the nest (Karalus and Eckert 1974. The Owls of North America. Doubleday and Co., New York. 278 pp.)

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***AMBYSTOMA MACULATUM* (Spotted Salamander). REPRODUCTION.** The Spotted Salamander is a wide-ranging salamander of the eastern United States that typically breeds in winter or early spring in ephemeral pools in lowland forests. *Ambystoma maculatum* is known to deposit 2–4 egg masses per year, each containing 1–250 eggs (Bishop 1941. New York State Mus. Bull. 324:1–365; Shoop 1974. Ecology 55:440–444). A positive relationship between SVL of the female and clutch size (i.e., full complement of eggs produced in a season) has been documented (Kaplan and Salthe 1979. Amer. Nat. 113:671–689; Wilbur 1977. Amer. Nat. 111:43–68), though Woodward (1982. Copeia 1982:157–160) states this relationship existed at only one of his two sites. Conversely, Shoop (1974, *op. cit.*) determined that adult female size was not a reliable index of clutch size. It is not known if a positive relationship exists between the SVL of a female and the number of embryos in her egg masses. In most studies, unless determined through direct observations in the field or genetics, the female responsible for a particular egg mass is unknown (Karraker and Gibbs 2011. Hydrobiologia 664:213–218). We have determined by chance the female responsible for five egg masses in our population through a novel means.

As part of ongoing research into the ecology and reproductive biology of Spotted Salamanders in the Kisatchie District of Kisatchie National Forest in Natchitoches Parish, Louisiana, USA, we have been counting the number of embryos per egg mass. We accomplish this by taking a digital photo of an egg mass as it is pressed gently between two clear plastic trays in a technique similar to Harris (1980. Copeia 1980:719–722), but where the bottom tray is marked with black lines 1 cm apart and then spray painted white to aid in counting embryos in the photograph (Fig. 1).

On 26 Jan 2012, we checked minnow traps that were set the previous evening to catch adult salamanders. We captured seven female *A. maculatum* in a small pool, six of which were still gravid. We took standard measurements, including SVL, and then implanted a Passive Integrated Transponder (PIT tag) into each adult female as was the protocol. About an hour after processing these animals we marked new *A. maculatum* egg masses found in the same small pool using PVC pin flags pushed carefully through the outer jelly. We did not have enough time to process them that evening, and it was not until a few days later on 1 Feb that we photographed those masses. We discovered that one of the masses flagged on 26 Jan contained a PIT tag in the outer jelly that corresponded to one of the six gravid females that were marked that same evening (Fig. 1). Therefore, the mass was laid within an hour after releasing the individual on 26 Jan in the daytime hours. On 1 Feb we again flagged new egg masses in the small pool and photographed these masses later on 8 Feb. Four of the masses flagged on 1 Feb and counted on 8 Feb contained PIT tags that corresponded to four of the remaining five gravid females captured in minnow traps in the small pool and tagged on 26 Jan.

A linear regression model indicated a significant positive relationship between the SVL of the female and the number of embryos per egg mass (Fig. 2, $R^2 = 0.85$, $p < 0.05$). The model shows an increase of 3.5 embryos per egg mass for every one millimeter of increased SVL. This result may seem intuitive as we know that larger females tend to have higher overall clutches (Kaplan and Salthe 1979, *op. cit.*; Wilbur 1977, *op. cit.*), but because this species typically lays multiple egg masses, the increased clutch size commonly observed in larger females may be represented by a greater number of embryos per mass as seen in this small sample, or alternatively, by laying an additional mass or two with the number of embryos per mass similar to smaller-bodied females.

To our knowledge, this is the first report of PIT tags being the means, albeit coincidentally, by which a particular egg mass of *Ambystoma maculatum* has been assigned to a particular female. Though we did retrieve PIT tags in egg masses from five of the six gravid females implanted, we are uncertain of the reliability

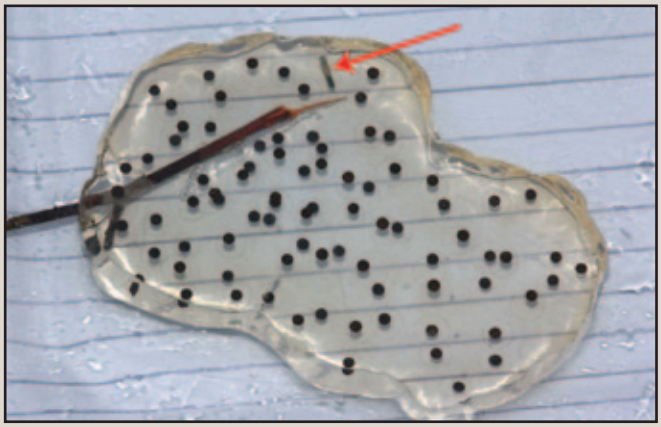


FIG. 1. An *Ambystoma maculatum* egg mass from Kisatchie National Forest, Natchitoches Parish, Louisiana, with a passive integrated transponder (PIT) tag laid with embryos in the outer jelly (top middle).

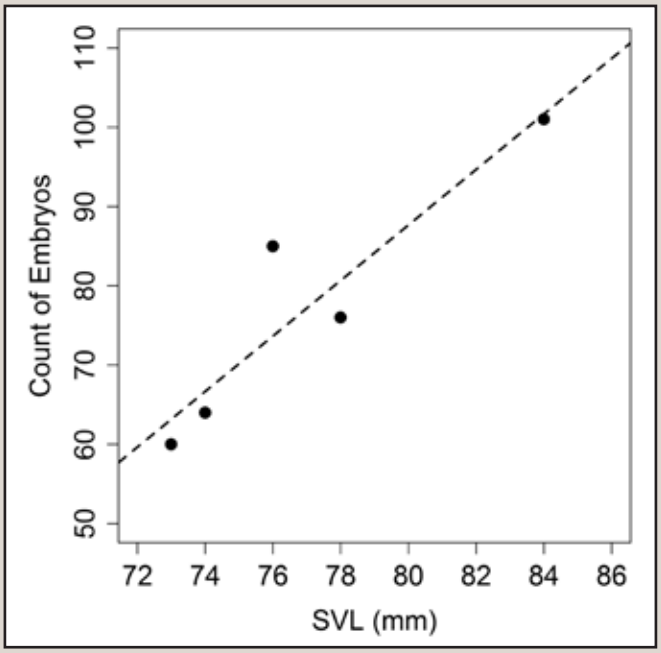


FIG. 2. The number of embryos per egg mass by snout–vent length (SVL) of female *Ambystoma maculatum.*

and safety of this technique to further elucidate the relationship between female body size and egg mass size. Besides potential harmful effects to the female or her clutch, only one egg mass would contain a PIT tag, and there may be considerable variation among multiple egg masses laid by the same female. For our purposes, losing the PIT tag from the adult female is counter to the goals of our study of this population, and we will no longer be implanting PIT tags into gravid females.

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***AMBYSTOMA TEXANUM* (Small-mouthed Salamander). MOVEMENT.** Understanding the amount of terrestrial habitat used by pond-breeding amphibians is critically important for their conservation (Semlitsch and Bodie 2003. Cons. Biol. 17:1219–1228). Reports on how far adult *Ambystoma texanum* move in terrestrial habitat are limited (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, DC. 587 pp.). To date there are only two studies reporting movement distances of this species based on a total of 15 marked individuals. On an island in southern Illinois, *A. texanum* was found to have moved a maximum distance of 19.7 m between terrestrial cover objects (N = 5; Parmelee 1993. Univ. Kansas Mus. Nat. Hist. Occ. Pap. 160:1–33), and in southern Indiana, the range of distances *A. texanum* moved away from a breeding pond was 0–125 m, with an average of 52.4 m traveled (N = 10; Williams 1973. Ph.D. dissertation. Indiana University, Bloomington, Indiana. 47 pp.). Here we report an account of *A. texanum* movement in northeast Ohio.

As part of an ongoing monitoring project in Cuyahoga Co., Ohio, USA (41.55937°N, 81.59275°W; WGS84), from 16 to 24 March 2011 adult *A. texanum* were captured in funnel traps placed in breeding ponds, marked with visible implant elastomer (VIE) and then released. While opportunistically searching terrestrial cover objects at the study site on 20 April 2011, a VIE-marked adult female *A. texanum* was captured under a small log 58 m from the breeding pond where it was originally marked. Our finding is comparable to the average movement found by Williams (1973, *op. cit.*), but over twice as large as that found by Parmelee (1993, *op. cit.*). This account will add to the number of documented movements, as well as increases the number of geographic locations *A. texanum* movement has been observed.

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***PLETHODON JORDANI* (Jordan's Salamander). NEST GUARDING.** Very little is known about the eggs and young of *Plethodon jordani*, a species endemic to the Great Smoky Mountains National Park, USA. Egg clutches have never been reported, but it has been conjectured that females oviposit underground in late spring or early summer and that hatchlings emerge in late summer or fall (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, DC. 587 pp.; Beane et al. 2010. Amphibians and Reptiles of the Carolinas and Virginia, 2nd ed. Univ. North Carolina Press, Chapel Hill, North Carolina. 288 pp.).

At 1045 h on 19 Jun 2010, I flipped a piece of decaying bark on the north side of the Appalachian Trail, Cocke Co., Tennessee, USA (35.72166°N, 83.24580°W) and observed an adult *P. jordani* with its body encircling a clutch of eggs. The adult quickly fled into a hole in the substrate. I counted at least 17 eggs in the clutch. Eggs were translucent, creamy white in color, and in a thin gelatinous mass (Fig. 1A). A second clutch that contained at least 25 eggs was observed under a similar sized piece of moss-covered bark ca. 30 m away at the same site (Fig. 1B). I attribute these eggs to *P. jordani* because they were similar in size, shape, and color to the previous nest and because *P. jordani* is the most common salamander species at the site. Eight other adult *P. jordani* and one adult *Desmognathus wrighti* were also observed under pieces of bark and decaying logs at the site. The habitat is comprised of spruce-fir forest with a substrate of moist needles.

This note is the first known record and description of *P. jordani* eggs. In addition, this species has never been observed to guard nests, though other *Plethodon* species (e.g., *P. cinereus*, *P.*



FIG. 1. A) Clutch of *Plethodon jordani* eggs found under decaying bark on 19 Jun 2010. An adult was observed encircling the clutch. B) Second clutch of eggs found under moss-covered bark ca. 30 m from the clutch in (A), also attributed to *P. jordani*.

glutinosus) are known to exhibit this behavior (Highton and Savage 1961. Copeia 1961:95–98; Petranka 1998, *op cit.*).

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ANURA — FROGS

***AGALYCHNIS CALLIDRYAS* (Red-eyed Tree Frog). VERTEBRATE DISPERSAL.** Effective dispersal via hitchhiking on vertebrates has been described for a number of plant and animal species. For example, some seeds have modified structures to grab onto fur, feathers, or socks of passing vertebrates (Sorensen 1986. Ann. Rev. Ecol. Syst. 17:443–463). Some species of flower mites (family Ascidae) are known to hitch rides between flowers in the nostril of hummingbirds (Colwell 1973. Am. Nat. 107:737–760). Despite the fact that vertebrate dispersal of organisms is common in nature, we were surprised to observe *Agalychnis callidryas* riding on the backs of Collared Peccaries (*Pecari tajacu*, Tayassuidae) at the Organization for Tropical Biology's La Selva Biological Station in Heredia Province, Costa Rica. On three independent occasions in different years researchers have observed *A. callidryas* riding on the backs of peccaries. Additionally, on one other occasion *A. callidryas* jumped onto the boot of a passing researcher and was carried for > 300 m, and could not be dislodged even by vigorous shaking of the leg. Because *A. callidryas* tadpoles must have access to standing water in ponds or swamps (Warkentin 2002. Physiol. Biochem. Zool. 75:155–164), and because peccaries often use low-lying swampy areas for mud bathing, contact between *A. callidryas* and peccaries could be relatively common.

The first observation of *A. callidryas* riding on a peccary was thought to be a fluke incident, and was fuel for much dinner discussion. After the three subsequent observations of *A. callidryas* riding on mammals, however, it appears frogs might use vertebrates as agents of dispersal more often than was previously appreciated. Interestingly, ours is not the first account of a frog riding on the back of a mammal. In 2007, Harry Greene provided an account of a *Leptodactylus chaquensis* riding on the back of a Capybara (*Hydrochoerus hydrochaeris*, Caviidae) in Brazil at the American Society of Ichthyologists and Herpetologists meeting (Donnelly 2008. Copeia 2008[1]:248–255).

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***ANAXYRUS PUNCTATUS* (Red-spotted Toad). PREDATION.** On 18 May 2012 at 2155 h an adult male *Anaxyrus punctatus* was found being subdued by a Giant Water Bug (*Lethocerus uhleri*) at a permanent spring in the northern Chihuahuan Desert. The site is characterized by Chihuahuan Desert scrub and is located in the western versant of the Indio Mountains Research Station (IMRS; 30.797215°N, 105.011220°W, WGS84; 1269 m elev.) in Hudspeth Co., Texas, USA. At the time of the observation, the water bug was immobilizing the prey by grasping it securely on either side of the body with its first pair of legs and injecting powerful enzymes into the lateral portion (Fig. 1). Although the toad made spasmodic movements for a few seconds to attempt to rid itself of the predator and come to the surface for air, it did not succeed and remained stationary during most of the time we observed it. When we returned to the spring ca. 25 minutes later, we found the toad already dead and the belostomatid still feeding on it. Rainstorms that had previously occurred in the area likely stimulated the gathering of adult male *A. anaxyrus* to call and mate at the spring, consequently allowing them to be susceptible to adult belostomatids (N = 8) present in the water. Giant Water Bugs grasp their prey and inject toxic saliva and eventually suck all the liquid contents from their prey (Schuh and Slater 1995. True Bugs of the World [Hemiptera: Heteroptera]: Classification and Natural History. Cornell Univ. Press, Ithaca, New York. 416 pp.). Observations of predation by Giant Water Bugs have been reported for several species of amphibians (Toledo 2005. Herpetol. Rev. 36:395–400, and citations therein). In addition to the observation reported herein, adult *A. punctatus* had been previously reported to be prey of the belostomatid *L. angustipes* in Baja California Sur, Mexico (Luja et al. 2008. Herpetol. Rev. 39:75–76). To the best of our knowledge, the observation reported herein represents the first record of predation of *A. punctatus* by *L. uhleri*.



FIG. 1. An adult male Red-spotted Toad, *Anaxyrus punctatus*, being preyed upon by a Giant Water Bug, *Lethocerus uhleri* at Indio Mountains Research Station, Hudspeth County, Texas, USA.

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***AUBRIA SUBSIGILLATA* (Brown Ball Frog). PARENTAL CARE.** *Aubria subsigillata* is a large frog that lives and breeds in still-water pools and swamps adjacent to streams and rivers in forested West and Central Africa (Rodel et al. 2005. Salamandra 41:107–127). Schiøtz (1963. The Amphibians of Nigeria. Vidensk. Medd. Fra Dansk naturh. Foren 125:1–92) reported schooling behavior for *A. subsigillata* larvae similar to *Aubria*'s sister taxon, *Pyxicephalus*. Based on this schooling behavior, Ohler and Kazadi (1990. Alytes 8:25–40) hypothesized that parental care exists

in *Aubria* similar to what is well documented for *Pyxicephalus adspersus* (Poynton and Broadley 1985. Ann. Natal Mus. 27:115–181). Yet, parental care has not been confirmed for any species of *Aubria*. During a trip to Gabon in 2011, we observed evidence for parental care by *A. subsigillata* on two occasions, each in a different national park. On both occasions, an adult was seen partially submerged in the water near a tight cluster of tadpoles (approx. 35 larvae). The first individual was observed 9 Feb 2011 at 0020 h in a shallow forested pool near the coast in Pongara National Park, northwestern Gabon (00.34293°N, 009.34470°E; 7 m elev.). The tadpoles were small (total length ca. 17 mm). The second individual was observed in a similarly shallow forested pool next to a river in Batéké National Park in southeastern Gabon (01.97626°S, 014.00377°E; 401 m elev.) on 3 March 2011 at 1345 h. The tadpoles at this site were larger (ca. 40 mm) than at Pongara suggesting some degree of extended parental care. Each time we approached the individual guarding a school of tadpoles, it quickly retreated under leaves at the bottom of the pool. In Pongara NP, we returned to the pool 30 min after the initial encounter and found the individual positioned back near the school of tadpoles. In Batéké NP, we returned to the same site on three occasions (35 min, 47 h 30 min, and 48 h 10 min after initial encounter), and each time we found the adult positioned near the cluster of tadpoles. Given the skittish behavior we observed in the adults each time they were approached, along with their readiness to return to their tadpoles, we suspect the adult is defending the tadpoles against predators, such as fish or possibly other *A. subsigillata*, as cannibalism has been reported for this species (Knoepffler 1976. Zool. Africana 11[2]:369–371).

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***BUFO MARINUS* (Cane Toad). PREDATION.** *Bufo marinus* was introduced into the Solomon Islands in the 1930s as a biological control for cane beetles and mosquitoes. Since then the species has become the most widespread invasive frog in the archipelago (Pikacha et al. 2008. Frogs of the Solomon Islands. Instit. Applied Sci., Univ. South Pacific. 68 pp.) and is even found on very small islands, and in submontane forests on the large islands (PP, pers. obs.). Outside of its native range a review of invertebrate predators include meat ants (*Iridomyrmex* sp), freshwater crayfish (*Cherax* spp., as *Euastacus hystricosus*, *E. suttoni*, and *E. valentulus*), crabs, beetles, and snails (Crossland and Alford 1998 Austral. J. Ecol. 23:129–137; Shine 2010. Quart. Rev. Biol. 85[3]:253–291; Ward-Fear et al. 2009. Funct. Ecol. 23[3]:559–568). All records have been from Australian studies, but very little has been reported from Pacific islands like the Solomon Islands.

In this paper we report our observations of predation by the Giant Australasian Centipede (*Ethmostigmus rubripes*) on *B. marinus* during field surveys on Guadalcanal, Solomon Islands. The initial observation was made on the night of 12 Dec 2010 in lowland forests, along the Tina River (9.59395°S, 160.0310333°E). We first spotted the centipede dragging the *B. marinus* at 2110 h along the forest floor before moving a meter from the original location where it climbed up an *Alpinia pupurata* ginger (Fig. 1). The centipede started eating the soft tissue on the underside of the *B. marinus*, first digging into the stomach contents, abdomen, skin, and side of jaw. By 2155 h it had made its way to the tip of the mouth, and by 2157 h feeding into the eye socket and lip. By 2200 h it was eating the soft underside of the jaw.

The vegetation here was riparian in a typical lowland forest type, dominated by *Broussonetia papyrifera*, *Macaranga*



COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND PHOTO BY P. PIKACHA

FIG. 1. An adult Giant Australasian Centipede (*Ethmostigmus rubripes*) preying on a subadult Cane Toad (*Bufo marinus*) on Guadalcanal, Solomon Islands.

tanarius, *Kleinhovia hospita*, *Alpinia oceanica*, *Leea indica*, and *Dendrocnide salomonense*. Various shrubs and herbaceous plants occupy the forest floor and understory canopy. Tall canopy cover was occupied by *Pometia pinnata*, *Alstonia scholaris*, and *Vitex cofassus* trees. There was evidence of forest disturbance with secondary trees, and camping and hunting remnants within the area.

After we observed the centipede predation on the toad, we further counted more than 10 *B. marinus* within close proximity to our initial observation site on the bank of the Tina River. Here we noted two more Giant Australasian Centipedes, both of which were dead. Upon close inspection, there were no lesions, abrasions, or damage to the centipedes' bodies to suggest attack by larger predators. We suspect that these centipedes had very recently killed and ingested Cane Toads and subsequently succumbed to the toads' toxins.

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***CHIROMANTIS VITTATUS* (Two-striped Pigmy Tree Frog). PARENTAL CARE.** *Chiromantis vittatus* is distributed in southern China, India, Laos, Myanmar, Thailand, and Vietnam. It has been reported that the congener *C. hansenae* of Thailand exhibits parental care that may enhance survival rates of eggs (Sheridan and Ocock 2008. Copeia 2008:733–736). Here we report the first documented observation of parental care exhibited by *C. vittatus* in the wild.

During a field survey at Bawangling National Nature Reserve, Hainan Island, China on 9 August 2010, at 2030 h we detected two

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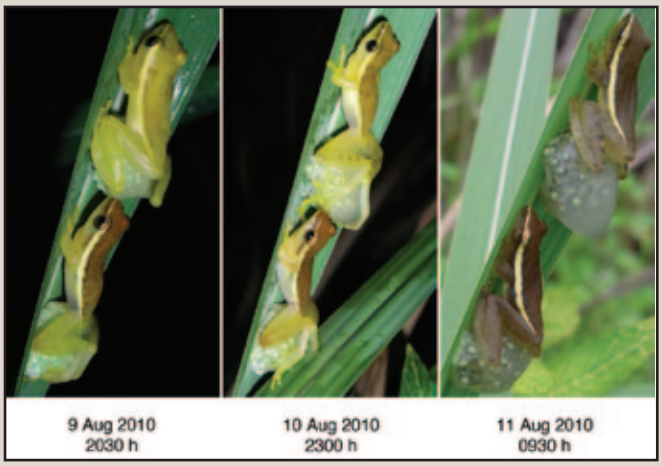


FIG. 1. Two adult *Chiromantis vittatus* covering egg masses on three consecutive days, Bawangling National Nature Reserve, Hainan Island, China.

unsexed *C. vittatus* each attending an egg mass. The egg masses were attached, positioned closely together, on the underside of a leaf of the grass *Miscanthus*, ca. 70 cm above ground, hanging above an ephemeral pond (19.11798°N, 109.10446°E, WGS84; elev. 350 m). The adults covered the egg masses with their posterior abdomen and hind legs (Fig. 1). On the next two consecutive days, we observed the adults attending these two egg masses at 2300 h (10 August 2010) and 0930 h (11 August 2010), suggesting they attended the egg masses continuously. It was evident that this species exhibits parental care by egg attending. The canopy cover of the site was about 20% so that the egg masses could be exposed to direct sunlight; daytime egg covering may help maintain the moisture level of the egg masses whereas nocturnal egg attending may help prevent fly infestation and fungal infection (Sheridan and Ocock 2008, *op. cit.*). It has been suggested that *C. hansenae* is a junior synonym of *C. vittatus* (Wilkinson et al. 2003. Proc. California Acad. Sci. 54:17–26), and our observation confirms the similarity of the unusual reproductive behavior of these two taxa.

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***COCHRANELLA GRANULOSA* (Granular Glass Frog). FEEDING BEHAVIOR.** Scarce information is available concerning the behavior and habits of juvenile and non-reproductive glass frogs in the wild, as most observations have been taken on calling males (Kubicki 2007. Glass Frogs of Costa Rica. INBio. Heredia, Costa Rica. 299 pp.*)* *Cochranella granulosa* is a medium to large nocturnal centrolenid frog that is common in the humid forests of Costa Rica (Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna between Two Continents, between Two Seas. Univ. Chicago Press, Chicago, Illinois. 934 pp.). This species is mostly observed along streams with little or no alteration but also occurs in streams associated with agricultural areas (Kubicki 2007, *op. cit.*). Like most species of this family, little is known regarding its ecology. On 24 June 2011, at 2215 h, we were surveying and monitoring the herpetofauna of a seasonal swamp located in The Osa Biodiversity Center at Río Piro, Península de Osa, Costa Rica (8.2478°N, 83.2024°W; WGS 84). There, we observed an adult male *C. granulosa* on the ground, feeding on small arthropods. We also documented the presence of common swamp-breeding species such as *Engystomops pustulosus* and *Leptodactylus fragilis*. The frog was collected and deposited at the Museo de Zoología, Universidad de Costa Rica (UCR21242). To our knowledge, this is the first case of a centrolenid frog feeding in a swamp. This species seems to use a wider variety of habitats compared to other glass frogs. The species has also been observed reproducing in a small pond in a humid forest (Kubicki 2007, *op. cit.*).

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***ELEUTHERODACTYLUS ZEUS* (Cuban Giant Frog). RECORD SIZE.** *Eleutherodactylus zeus* is an endemic Cuban frog of the subgenus *Syrrophus* (Hedges et al. 2008. Zootaxa 1737:1–182). This species is only known from the Cordillera de Guaniguanico, in Western Cuba and occurs in mesic broadleaf forest on a limestone base (Schwartz and Henderson 1991. Amphibians and Reptiles of the West Indies: Descriptions, Distributions, and Natural History. Univ. Florida Press, Gainsville. 714 pp.). It is saxicolous or clivicolous, always associated with limestone, and not recorded outside of forest habitats (Henderson and Powell 2009. Natural History of West Indies Reptiles and Amphibians. Univ. Florida Press, Gainsville. 945 pp.).

During a herpetological expedition to El Moncada, Viñales, Pinar del Río, during April 2012, a very large adult female *Eleutherodactylus zeus* (127.4 mm SVL) was sighted inside of the Santo Tomás Cavern, Sierra de Quemados (22.544496°N, 83.846895°W). This individual was found on the soil in total darkness, 20 m from the entrance of the cave at 1620 h, with 23.2°C air temperature and 87% relative humidity (Termohygrometer HANNA Instruments Hi 9565; ± 5% RH, ± 0.5°C). The voucher specimen was preserved in 70% ethanol, verified by R. Alonso and deposited in the Zoological Collection of the Natural History Museum of Pinar del Río province, Cuba (field number LYG-387).

Previously, Schwartz (1958. Proc. Biol. Soc. Washington 71:37–42) found that the large females of this species did not exceed the 90 mm SVL. Díaz and Cádiz (2008. ABC Taxa 4:1–294) reported an individual 123.2 mm SVL. To our knowledge, this new measurement constitutes a record size and reaffirms that *E. zeus* as the largest species in the Eleutherodactylidae from the West Indies.

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***HYLARANA PICTURATA* (Spotted Stream Frog). HABITAT.** *Hylarana picturata* is a moderate-sized anuran (to 70 mm SVL) with unmistakable coloration of black back and sides marked with blotches and lined with yellow orange or orange red stripes

from the snout up to along both upper eyelids (Das 2007. A Pocket Guide: Amphibians and Reptiles of Brunei. Natural History Publications [Borneo] Sdn. Bhd. Kota Kinabalu. viii + 200 pp.; Inger and Stuebing 2005. A Field Guide to the Frogs of Borneo. 2nd ed. Natural History Publications [Borneo] Sdn. Bhd. Kota Kinabalu. viii + 201 pp.; Malkmus et al. 2002. Amphibians and Reptiles of Mount Kinabalu [North Borneo]. A.R.G. Gantner Verlag K.G. Ruggell. 424 pp.). *Hylarana picturata* has been recorded in Peninsular Thailand (Das 2007, *op. cit.*), Peninsular Malaysia (Chan et al. 2010. Russian J. Herpetol. 17[3]:202–206), Sumatra (Inger et al. 2004. *Hylarana picturata*. IUCN 2011. IUCN Red List of Threatened Species. Version 2011.2. <www.iucnredlist.org>. Accessed 9 May 2012; Inger and Stuebing 2005, *op. cit.*), throughout Borneo (Frost 2011. Amphibian Species of the World: an Online Reference. Version 5.5 [31 January 2011]. Electronic database http://research.amnh.org/vz/herpetology/amphibia/. American Museum of Natural History, New York. Accessed 9 May 2012), and the Philippines (Malkmus et al. 2002, *op. cit.*). The species dwells in primary and old secondary forests from near sea level to below 1000 m elev. (Inger et al. 2004, *op. cit.*), and is closely associated with streams (Brown and Guttman 2002. Biol. J. Linn. Soc. 76:393–461; Keller et al. 2009. J. Anim. Ecol. 78[2]:305–314; Haas and Das 2012. Frogs of Borneo – The Frogs of East Malaysia and their Larval Forms: an Online Photographic Guide. Version 1.1.1. [4 May 2012]. http://www.frogsofborneo.org. Zoological Museum Hamburg, Germany. Accessed 9 May 2012; Sheridan et al. 2012. Tropical Natural History 12[1]:1–8) as the adults breed and tadpoles develop in leaf drifts in streams before the juveniles move away to live on the forest floor until reaching maturity (ca. 25 mm SVL) and permanently return to the streams (Inger and Stuebing 2005, *op. cit.*). Herein we report the first occurrence of mature *H. picturata* away from a stream in Malaysia.

On 10 April 2012 at 2204 h, a female *H. picturata* (61 mm SVL, 14.4 g) was sampled from among unused timber within the compound of Gunung (= mountain) Kuli Research Station (5.027°N, 117.048°E; 320 m elev.), Imbak Canyon Conservation Area, Tongod District, Sandakan Division, Sabah, Bornean Malaysia. Air temperature was 20.5°C. The individual was found 40 m from the nearest running water, Sungai (= river) Kuli, which is a shallow, rocky-bottomed torrential stream with calmer side sections. The stream has an average width of 11.8 m and average depth of 115.9 mm. The pH for the stream water was 6.67. Another adult female *H. picturata* (53 mm SVL, 11.7g) was sampled 12 April 2012 at 2250 h within the compound of the research station but from the base of a tree stump 80 m from Sungai Kuli. Air temperature was 20.9°C. The occurrence of the two individuals omits the causal factor of randomness or attempted escape from predation. No potential predators were observed throughout the duration of our fieldwork at the station. In fact, the research station houses several other forest and forest-edge anurans: *Chaperina fusca*, *Polypedates macrotis*, *P. otilophus*, and *Staurois latopalmatus*, in addition to the human commensal species: *Fejervarya limnocharis*, and *Polypedates leucomystax*. This finding is imperative to augment the natural history understanding of *H. picturata* to avoid sampling efforts of the species that only concentrate on riparian habitats for its adults, and may result in a false impression of its absence from localities. Such false information influences conservation strategies for the species. In accordance to the requirement of the management of Imbak Canyon Conservation Area, the two *H. picturata* were released on site after taking measurements and photographs. The photographic vouchers (10 April 2012: ICCA_Anuran_0089_2012, and 12 April 2012: ICCA_Anuran_0210_2012) are available from the first author.

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***HYPOPACHUS VARIOLOSUS* (Sheep Frog). DIET.** *Hypopachus variolosus* is distributed on the Pacific versant of Mexico, and the Atlantic versant from southern Texas to Costa Rica (Dixon and Lemos-Espinal 2010. Amphibians and Reptiles of the State of Querétaro, Mexico. Texas A&M University, UNAM and CONABIO, México, D.F. 428 pp.). Its diet has been reported to consist of invertebrates, especially ants and termites (Lee 2000. A Field Guide to the Amphibians and Reptiles of the Maya World: the Lowlands of Mexico, Northern Guatemala, and Belize. Cornell Univ. Press, Ithaca, New York. 402 pp.), without specific information. Herein we report a specific termite as prey of *H. variolosus*.

On 18 Sept 2011, during fieldwork around the edge of a pond in the Municipality of Chapala, Jalisco, México (20.323975°N, 103.218219°W; 1791 m elev.), we found an adult *H. variolosus* (45 mm SVL) at 0109 h. The specimen was observed actively feeding on termites, which were collected and identified as *Tenuirostritermes incisus* (Snyder 1922) (Isoptera: Termitidae: Nasutitermitinae). Specimens are deposited at the Entomological Collection, Centro de Estudios en Zoología, CUCBA, Universidad de Guadalajara (CZUG).

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***HYPSIBOAS RANICEPS* (Chaco Treefrog). ENDOPARASITES.** *Hypsiboas raniceps* is a hylid frog widespread in South America (Frost 2011. Amphibian Species of the World: an Online Reference. Version 5.5 http://research.amnh.org/vz/herpetology/amphibia/). In Brazil, it has been found across the major biomes, such as the Cerrado, Caatinga, Atlantic Forest, and Amazon (Guimarães and Bastos 2003. Iheringia 93:149–158). Despite its huge distribution, several aspects of its natural history are lacking, such as parasitism. To the best of our knowledge, there are three helminths reported from *H. raniceps*: the nematodes

Aplectana hylambatis (McAllister et al. 2010. Comp. Parasitol. 77:184–201), and *Cosmocerca parva* (Gonzáles and Hamann 2011. Comp. Parasitol. 78:212–216), and the trematode *Glypthelmins vitellinophilum* (Dobbin Jr. 1957. Mem. Inst. Oswaldo Cruz 56:153–157). Herein, we report a new nematode parasitizing *H. raniceps* from the Brazilian state of Ceará. An adult female *H. raniceps* was collected on 17 Nov 2011, at Trilha Ecológica do Grangeiro (7.279722°S, 39.438055°W), Crato municipality, state of Ceará, Brazil. The specimen were euthanized and deposited into the Coleção Herpetológica da Universidade Regional do Cariri (URCA-H 258). We examined the body cavity, esophagus, stomach, lungs, and the small and large intestines under a stereomicroscope for helminths. Helminths were cleared in Hoyer's solution, identified, and deposited in the Coleção Parasitológica da Universidade Regional do Cariri (URCA-P 262). Three specimens of the nematode *Rhabdias pseudospherocephala* were found in the lungs. Species of *Rhabdias* have been reported in a variety of anurans, mainly in toads of the genus *Rhinella* (Vicente and Rodrigues 1991. Rev. Bras. Zool. 7:549–626). To date, there are few reports of *Rhabdias* spp. parasitizing hylid frogs in Brazil (Holmes et al. 2008. Parasitol. Res. 102:621–623). Our identification fits with the description of *R. pseudosphaerocephala* (Kuzmim et al. 2007. J. Parasitol. 93:159–165), although this nematode has been indicated as host specific to bufonids (Santos et al. 2011. Mem. Inst. Oswaldo Cruz 106:433–440). Thus, *H. raniceps* is a new host record and Ceará state a new locality record for *Rhabdias pseudospherocephala.*

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***LITHOBATES CATESBEIANUS* (American Bullfrog). DIET.** The American Bullfrog is an aggressive competitor and generalist predator that is profoundly impacting ecological communities throughout its invasive range in the western United States (Nussbaum et al. 1983. Amphibians and Reptiles of the Pacific Northwest. Univ. Idaho Press, Moscow. 336 pp.). In Oregon, the American Bullfrog is implicated in the declines of several native species of conservation concern, including the Northern Red-legged Frog (*Rana aurora*), the Oregon Spotted Frog (*Rana pretiosa*), and the Western Pond Turtle (*Actinemys marmorata*) (Nussbaum et al. 1983, *op. cit.*). This is the first report that American Bullfrogs predate the Oregon Chub (*Oregonichthys crameri*), a threatened minnow endemic to the Willamette River basin of Oregon (Markle et al. 1991. Copeia 1991:277–293). Prior to this account, only anecdotal evidence for a predator-prey interaction between American Bullfrogs and Oregon Chub was available based on observations that the two species often occur syntopically in warm-water, off-channel habitats (Snyder 1908. Bull. U.S. Bur. Fish. 27:153–189). Scheerer (1999. Fish Research Project, Annual Progress Report EF-91 VII-1. Portland, Oregon. 24 pp.) and Scheerer and Apke (1998. Fish Research Project E96970022, Annual Progress Report. Corvallis, Oregon) previously noted that the largest chub populations were found at Willamette Valley basin sites devoid of bullfrogs, but subsequent diet analysis did not find evidence of bullfrog predation on chubs.

Our study site (44.4528°N, 123.3750°W) is a privately owned wetland located south of Corvallis, Oregon in the Beaver Creek drainage of the mainstem Willamette River. This wetland is part of a 30-acre restoration project initiated in 1992 consisting of three permanent ponds seasonally connected through flooding. The site is also unique in that it serves as prominent Oregon Chub reintroduction habitat under the Oregon Chub Recovery Plan (USFWS 1998. Recovery Plan for the Oregon Chub. Portland, Oregon. 86 pp.). A total of 573 Oregon Chub from three source populations (DeHaan et al. 2010. U.S. Fish and Wildlife Service, Abernathy Fish Technology Center. Final report) were introduced between 1997 and 1998 (USFWS 2010a. Fed. Reg. 75:11010–11067). Also inhabiting this site are Northern Red-legged Frogs (threatened), Western Pond Turtles (sensitive species), and invasive American Bullfrogs.

We collected six adult American Bullfrogs on 9 Aug 2011 via hook and line sampling as part of a regional study on invasive species community dynamics. We euthanized the animals following standard protocol and recorded measurements for weight, snout–vent length, and sex. Stomachs were excised and fixed in 95% ethanol for 36 h before contents were processed. Prey items were flushed with dechlorinated water and observed with a dissecting microscope to aid in identification to the lowest possible taxon. We aggregated contents to taxonomic order and assigned values of absolute and relative abundance (total count; N and N%) and frequency (number of stomachs containing item; F and F%), as well as occurrence (percentage of 6 stomachs containing item; 0%) (Table 1).

A total of 30 prey items were found in the six stomachs, with orders Hemiptera and Coleoptera representing the greatest percentage of the diet (23.3% and 20%, respectively). Three Oregon Chub (order Cypriniformes) were found in 2 out of 6 stomachs (33.3%). Although some digestive decomposition had occurred to the three specimens, enough tissue and distinguishing morphological features had been preserved for positive identification by Oregon State University ichthyologist, Doug Markle. Other vertebrates present in the diet included juvenile American Bullfrogs which were found in one-third of stomachs constituting 10% of the total diet, and Northwestern Salamanders (*Ambystoma gracile*), which were found in one-third of the stomachs and represented 6.7% of the total diet.

Since the Oregon Chub's listing under the Endangered Species Act in 1993 (58 FR 53800; October 18, 1993), the species' conservation status has improved from endangered to threatened in part due to actions outlined in the Oregon Chub Recovery Plan

TABLE 1. Diet of six American Bullfrogs collected from wetland in Corvallis, Oregon, showing absolute and relative values of abundance (N and N%), frequency (F and F%), and occurrence (O%).

Prey Order	N	N%	F	F%	O%
Anura	3	10.0	2	8	33.3
Aranae	1	3.3	1	4	16.7
Caudata	2	6.7	2	8	33.3
Coleoptera	6	20.0	4	16	66.7
Cypriniformes	3	10.0	2	8	33.3
Diptera	5	16.7	4	16	66.7
Hemiptera	7	23.3	4	16	66.7
Hymenoptera	1	3.3	1	4	16.7
Odonata	2	6.7	2	8	33.3
Plant material	–	–	3	12	50.0
Total	30	100.0	25	–	–

published in 1998 (USFWS 1998, *op. cit.*). Recovery strategies were enacted to reverse the decline of this species by protecting existing populations and designating critical habitat throughout its historic range (USFWS 1998, *op. cit.*; USFWS 2010b. Fed. Reg. 75:21179–21189). At the time of Oregon Chub reintroduction to our study site, threats to habitat integrity were identified as American Bullfrogs and agricultural runoff (USFWS 1998, *op. cit.*), although current management concerns are primarily over water quality (USFWS 2010). Our findings emphasize the importance of American Bullfrog removal and resistance strategies at chub reintroduction sites, especially since American Bullfrogs and chub have similar habitat requirements and frequently co-occur with other species of high conservation priority. Oregon Chub continue to face synergistic pressures from habitat loss and invasive species, so carefully planned reintroductions and persistent American Bullfrogs management will increase suitable habitat and aid in Oregon Chub population recovery.

Stomach contents were deposited in the laboratory in 174 Nash Hall, Corvallis, Oregon, 97331, USA. We extend our gratitude to Doug Markle and Joe Beatty for identifying stomach items, and to the members of our research lab at Oregon State University for their support during this study. We are also grateful for contributions from the Natural Resources Conservation Service and the Wetlands Reserve Program landowners who granted access to their wetland easements; without their help, this research would not have been possible.

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***PHYLLOMEDUSA AZUREA*. MULTI-MALE SPAWNING.** Multimale spawning has been rarely documented for neotropical anurans (Prado and Haddad 2003. J. Herpetol. 37:354–362; Prado et al. 2006. Herpetol. Rev. 37:206–207). We observed a polyandrous mating in *Phyllomedusa azurea* in an open area of Cerrado, at Nioaque municipality (21.186109°S, 56.178786°W), Mato Grosso do Sul, western Brazil. On 20 Jan 2011, around 0800 h, the behavior was observed occurring early in the morning of a cloudy day. Two males tried to join a pair already in amplexus. The female was laying eggs in a leaf of grass (*Brachiaria* sp.), while two opportunistic males tried to position their cloacae close to the eggs that were being deposited (Fig. 1A). After more than two hours, the opportunistic males moved away from the site, one at a time; the male in amplexus also moved away. However, the leaf of *Brachiaria* sp. containing the clutch was left opened, exposing the eggs to sun radiation, wind, rain, and extreme variations in temperature and humidity (Fig. 2B). We did not monitor the clutch, however, we believe that it has been partially or almost totally desiccated. Probably this leaf was not closed due to the weight of three males on the female, which pulled it down, preventing the pair from sealing the leaf. A similar event was described for *P. distincta* in south Brazil (Prado et al. 2006, *op. cit.*). In that event, two males were trying to fertilize the eggs while the female was spawning and their weight disturbed the female, preventing her from sealing the leaf. Consequently, almost the entire clutch desiccated (Prado et al. 2006, *op. cit.*). The few cases of multiple amplexus reported for anurans may indicate that the costs involved are higher than the advantages (Lodé and Lesbarrères 2004. Naturwissenschaften 91:44–47). However, multimale spawning has been described for three congeneric species of *P. azurea* (Oliveira et al. 2012. J. Nat. Hist. 46:117–129; Prado et al. 2006, *op. cit.*; Wogel et al. 2005. J. Nat. Hist. 39:2035–2045), indicating that polyandrous mating may be more common than reported, at least for species in this genus (Roberts et al. 1999. Anim. Behav. 57:721–726). Mating with several males may be advantageous for females by potentially increasing fertilization success, providing better quality sperm, or increasing offspring genetic diversity (Prado et al. 2006, *op. cit.*). For the opportunistic males, polyandry may increase the chances of fertilizing at least some of the eggs (Roberts et al. 1999. Anim. Behav. 57:721–726). Further studies should focus on such aspects, to elucidate the possible advantages related to multimale spawning in anurans.

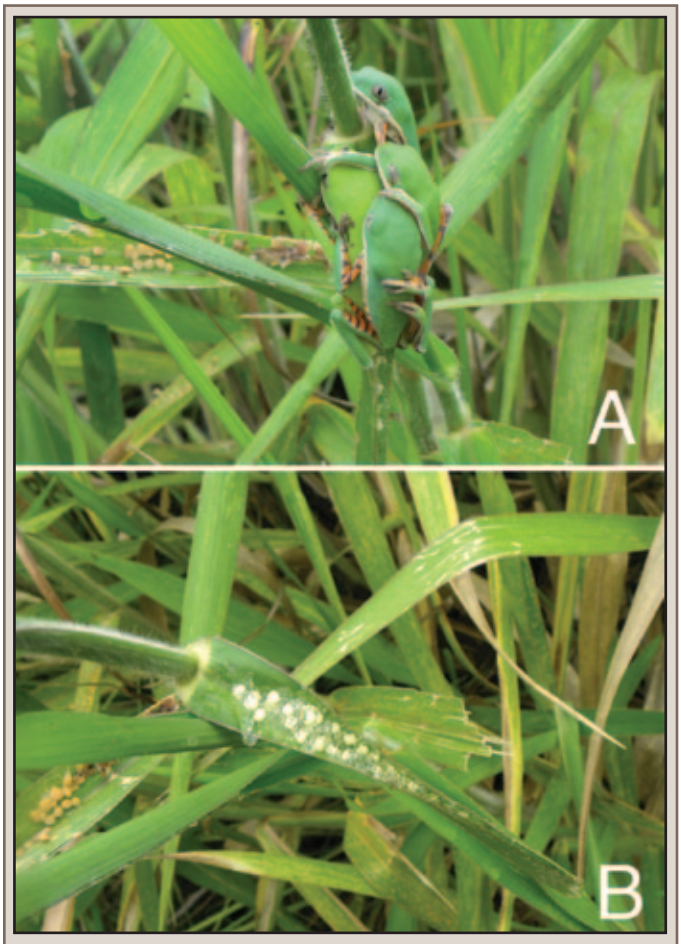


FIG. 1. Multimale spawning in *Phyllomedusa azurea*. A) One female of *Phyllomedusa azurea* with two opportunistic males in an open area of Cerrado, Brazil; B) Leaf of *Brachiaria* sp. exposing the clutch of *Phyllomedusa azurea* after the female and three males had left the site of oviposition in an open area of Cerrado, Brazil.

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FIG. 1. Males of *Phyllomedusa nordestina* in physical attack.

***PHYLLOMEDUSA NORDESTINA* (Northeast Orange-Legged Leaf Frog). PHYSICAL ATTACK.** Sexual selection occurs when there is competition for sexual partners (scarce resource) causing differences in fitness among individuals in the same population (Wogel 2007. Pap. Avulsos Zool. 47[13]:165–174). The territorial behavior combines acoustic interactions, attitudes, and struggles that are the result of male competition for calling sites, favorable spawning, and consequently females (Martins et al. 1998. Amphibia-Reptilia 19:65–73). Studies on agonistic behavior of *Phyllomedusa* show that males exhibit territorial behavior during the reproductive period (Abrunhosa and Wogel 2004. Amphibia-Reptilia 25:125–135), emitting territorial calls and getting into physical combat with the resident male (Costa et al. 2010. Phyllomedusa 9[2]:99–108; Wogel et al. 2004. Herpetol. Rev. 35[3]:239–243).

We observed an event with *Phyllomedusa nordestina* involving a dispute among three males (Fig. 1). This is the first record of physical attack in the genus *Phyllomedusa* in Caatinga. The event occurred on 24 April 2010 at 2038 h, in a temporary pond at Monumento Natural Grota do Angico, Poço Redondo, Sergipe (9.6638889°S, 37.6825000°W, 200 m elev., SAD69). Two males invaded the territory of the resident male emitting agonistic calls until they came into physical contact. Later, they were one above the other emitting advertisement calls. According to Vilaça et al. (2011. J. Nat. Hist. 45[29-20]:1823–1834) males of *P. nordestina* exhibit territorial behavior at vocalization sites, defending their territories through aggressive interactions or vocal activities.

The aggressive behavior of the genus *Phyllomedusa* can be considered a synapomorphy of the group, because it is similar among species and may result for similar reasons, such as disputes over territory or females (Abrunhosa and Wogel 2004, *op. cit.*; Costa et al. 2010, *op. cit.*; Wogel et al. 2004, *op. cit.*).

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***PLEURODEMA GUAYAPAE*. EGG PREDATION.** Complex oviposition strategies of tropical anurans, such as terrestrial oviposition or foam nests, are believed to be a fixed trait as a means to limit exposure to aquatic egg predators (Magnusson and Hero 1991. Oecologica 86:310–318). The floating foam nests constructed by the anurans of the family Leiuperidae are one such oviposition strategy that protects their eggs from predators as well as desiccation (Wells 2007. The Ecology and Behavior of Amphibians. Univ. Chicago Press, Chicago, Illinois. 1148 pp.).

On 7 Feb 2011 at 0800 h I observed the foam nest of *Pleurodema guayapae* in an ephemeral pond (ca. 2 m^2) that had been formed during the previous night's rain in the Isoceño community of Kuaridenda, Cordillera Province, Santa Cruz Department, Bolivia (19.17°S, 62.53°W; WGS84). The nest had been blown to the edge of the pond by the wind, where upon closer examination I observed dozens of small red ants (Hymenoptera; Formicidae) swarming the exposed eggs that were in contact with the pond's edge. I returned to the pond at 1500 h to find that the entire nest had been depredated by the ants.

Pleurodema guayapae constructs flattened foam nests, depositing them in temporary ponds that form after heavy rainstorms (Cei 1980. Monitor. Zool. Ital. Monogr. 2:380–382). By eliminating contact with the water's surface, these nests may provide suitable protection against aquatic predators, such as the carnivorous tadpoles of *Ceratophrys cranwelli*, which commonly occur in temporary ponds in the area (pers. obs.). However, these foam nests do not envelop the eggs completely, and the eggs are often visible and exposed at the top of the nest (pers. obs.). Thus these nests may be inadequate in their protection against terrestrial predators (Schalk 2010. Herpetol. Rev. 41:202). *Pleurodema guayapae* may compensate for this increased vulnerability to egg predators with a shortened egg life stage (Johnson et al. 2003. Can. J. Zool. 81:1608–1613), which could be explored further though experiments.

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***SACHATAMIA CF. ALBOMACULATA* (Yellow-flecked Glass Frog). LIFE HISTORY.** S*achatamia albomaculata* is a glass frog from Central and South America. Savage (2002. The Reptiles and Amphibians of Costa Rica: A Herpetofauna between Two Continents, between Two Seas. Univ. Chicago Press, Chicago, Illinois. 934



FIG. 1. Amplectant pair of *Sachatamia cf. albomaculata*, Bilsa Biological Station, western Ecuador.

pp.) reports the species is commonly found calling from vegetation 1–2 m above rivers all year around. I found something quite different for this species during a 10-month field season at the Bilsa Biological Station in western Ecuador. I had four encounters with *S. albomaculata,* totalling eight individuals. During 87 h I spent surveying along rivers, *S. albomaculata* was only ever encountered as pairs in amplexus (Fig. 1). Juliet Burmingham (pers. comm.), who worked at Bilsa for close to a decade, also reports having only ever seen this species in amplexus and published a photograph of an amplectant pair (Ortega-Andrade et al. 2010. Check List 6[1]:119–154). Paul Hamilton (pers. comm.), who led a research expedition in La Perda, Ecuador (about 60 km SE of Bilsa), observed the same breeding behavior in 2009. This 100% encounter rate of individuals in amplexus suggests that this species spends most of its life in the canopy and only descends to breed, which is markedly different from Savage's (2002, *op. cit.*) description for the species in Central America. The populations in Ecuador are isolated by some 400 km from populations in northern Colombia and Central America. Furthermore, Guayasamin et al. (2006. Check List 2[1]:70–75) reports that *S. albomaculata* in Ecuador is morphologically different from populations in Central America, having larger dorsal spots. This morphological difference, the different breeding habits, and its geographic isolation from northern populations suggests that this could be a distinct species of *Sachatamia*. Molecular research and further morphological and acoustic studies are required to settle the assignment of this species as distinct or as an aberrant population.

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***SCAPHIOPUS HOLBROOKI* (Eastern Spadefoot). POSSIBLE TRANSMITTER EXPULSION.** Expulsion of radio-transmitters via transintestinal absorption has been documented in fish (Meyer and Honebrink 2005. Trans. Amer. Fish. Soc. 134:602–606) and snakes (Pearson and Shine 2002. Herpetol. Rev. 33:261–263), and a study recently documented the first definitive account of radio-transmitter expulsion in amphibians (Tracy et al. 2011. Biol. Lett. 7:465–467), which reported the expulsion of transmitters in Cane Toads (*Rhinella marina*) via absorption through the bladder. As discussed in Tracy et al. (2011, *op. cit.*), with respect to anurans, this ability may be an adaptation to expelling objects (e.g., sticks or thorns) that may pierce their body cavity when landing during movement and/or to expel arthropod prey (or prey parts) that may burrow their way into the body cavity at some point during the digestive process.

During a radio-telemetry investigation of adult *Scaphiopus holbrooki* at Cape Cod National Seashore in Provincetown, Massachusetts (USA) during 2006, we observed three possible instances of radio-transmitter expulsion. In all three instances we found the radio-transmitters (model BD-2H, mass 1.7 g, Holohil Systems Ltd., Carp, Ontario, Canada; implanted into the body cavity) clean on the ground surface with no evidence of predation (i.e., no spadefoot remnants or predator fecal pellets found nearby, nor were there any scrapes on the radio-transmitter), and we found the transmitters on the ground surface 54 days (2 instances) and 111 days (1 instance) following radio-transmitter implantation surgeries. We observed two of these individuals alive on the surface during nocturnal telemetry surveys two nights prior to finding radio-transmitters on the surface. In addition, during radio-transmitter removal surgeries upon completion of fieldwork (132 days after radio-transmitter implantation), we noted that for 4 of the 8 individuals that underwent transmitter removal surgery the radio-transmitter was fully encapsulated in a thick, vascularized tissue, consistent with the finding by Tracy et al. (2011, *op. cit.*) for *Rhinella marina*, and were likely in the process of being voided from the body cavity. Unfortunately, we did not take note as to which internal organ this tissue was attached to, and thus cannot confirm if the route of expulsion is the same as that reported by Tracy et al. (2011, *op. cit.*; i.e., through the bladder).

Handling of animals was conducted under a University of Massachusetts Amherst Institutional Animal Care and Use Protocol and collection permits granted by the Massachusetts Division of Fisheries and Wildlife.

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***SCINAX RUBER* (Red Snouted Treefrog). PREDATION.** Neotropical anurans are abundant, small to moderate sized, and are common prey for all classes of vertebrates and some arthropods. Various predaceous spiders feed on anurans (Menin et al. 2005. Phyllomedusa 4[1]:39–47; Toledo 2005. Herpetol. Rev. 36:395–400; Toledo et al. 2007. J. Zool. 271:170–177). In some cases the frogs are hunted, killed, and eaten by tarantulas and other hunting spiders. Few snakes have been reported as predators of *Scinax ruber* (Bernarde and Abe 2010. Biota Neotrop. 10[1]:167–173; Mendes-Pinto et al. 2011. Biofar 5[2]:122–126).



COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND

FIG. 1. A female Wandering Spider, *Phoneutria boliviensis*, preying on a Red-snouted Treefrog, *Scinax ruber*, near Chácara de Jesus, Rio Branco, Acre, Brazil.

On 11 June 2011, we found a recently killed *S. ruber* in Chácara de Jesus (9.911880°S, 67.767382°W, 173 m elev.), Rio Branco, Acre, Brazil. The frog was caught on a tree leaf by a female Wandering Spider, *Phoneutria boliviensis*, which had partially consumed the frog (Fig. 1). The posture of the frog led us to suspect that it was attacked from the side.

Photographs of the frog and the spider were deposited in the Coleção Herpetológica da Universidade Federal do Acre. We thank Dr. Adalberto J. Santos, Departamento de Zoologia, Instituto de Ciências Biológicas, Universidade Federal de Minas Gerais for the spider identification and Evan Twomey for valuable suggestions on this manuscript.

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***TRACHYCEPHALUS TYPHONIUS*. PREY.** Predation among amphibians occurs when the predator-prey size relationship is favorable (Toledo et al. 2007. J. Zool. 271:170–177), and large frogs take larger prey including various vertebrates (Duellman and Trueb 1994. Biology of Amphibians. Johns Hopkins University Press, Baltimore, Maryland. 670 pp.). On 5 Aug 2011, at 2200 h in Porto Acre, Brazil (9.679851°S, 67.743126°W) an individual *Trachycephalus typhonius* (66 mm SVL) was found predating a *Dendropsophus leucophyllatus* (29 mm SVL) (Fig. 1) which was consumed head first. The specimens were captured and accessioned into the amphibian collection of the Universidade Federal do Acre (UFAC 5146, 5147). This is the first record of *D. leucophyllatus* as a prey item of *T. typhonius*.

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FIG. 1. The hylid frog, *Trachycephalus typhonius* preying on a *Dendropsophus leucophyllatus* in Porto Acre, Brazil.

TESTUDINES — TURTLES

***CARETTA CARETTA* (Loggerhead Seaturtle). DIET.** An adult female *Caretta caretta*, curved carapace length (CCL) of 91.5 cm, was found stranded on Arembepe Beach, northern part of Bahia, Brazil, on 19 September 2010 (12.75°S, 38.167°W). The turtle had a Porcupine Fish, *Cyclichthys spinosus* (Diodontidae), lodged in its buccal cavity (Fig. 1), and was bearing inconel tags on each front flipper (National Band Tag Co., USA), placed by Projeto TAMAR-ICMBio during 2004/2005 nesting season in Sergipe, nearly 260 km from the stranding site.

This is the first record of a Loggerhead Seaturtle ingesting a porcupine fish in Brazil. Loggerheads are primarily carnivorous and adults are generally bottom feeders. Despite eating opportunistic resources on the surface, they do not normally capture live fish (Dodd 1988. U.S. Fish Wild. Serv. Biol. Rep. 88[14]:1–110). In his extensive review of *C. caretta* prey taxa, Hughes (1974. S. Afr. Assoc. Mar. Biol. Res. Oceanogr. Res. Inst. Investigational Rep. 36:1–96) reported the ingestion of a porcupine fish in a South African study.

Limpus et al. (2008. Mar. Turt. Newsl. [120]:1–3.) found six cases of dead or moribund *C. caretta* with porcupine fish lodged in their mouths and throat. The authors suggested that the turtles might have fed on fish carcasses floating among discarded trawlers' bycatch. Fish can be intentionally ingested when found dead, or incidentally, when they capture medusa (Dodd 1988, *op. cit.*), and Loggerhead Seaturtles will presumably feed on fish bycatch discharged from fishing boats (Thomas et al. 2001. J. Zool. 255:525–532). The hypothesis of *C. caretta* feeding on dead fish was also supported by Bugoni et al. (2003. Chelon. Conserv. Biol. 4:685–688) by the co-occurrence of fish and the necrophagic isopod found in stomachs of stranded turtles.

The Porcupine Fish (*C. spinosus*) is commonly found in estuarine areas and occurs along the coast between Brazil and Argentina, in depths up to 190 m (Carvalho-Filho 1999. Peixes: Costa Brasileira. Editora Melro Ltda. São Paulo, SP. 3rd ed. 320 pp.), and has been reported as trawler bycatch (Bail and Branco 2003. Notas Técnicas. Facimar 7:73–82), suggesting that the turtle noted here had possibly ingested a dead or moribund fish.

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FIG. 1. Porcupine Fish, *Cyclichthys spinosus*, lodged in the buccal cavity of a dead Loggerhead Seaturtle, *Caretta caretta*, stranded in Arembepe, Brazil.

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***CARETTA CARETTA* (Loggerhead Seaturtle). EPIBIONT BIVALVES.** The neritic waters of the Baja California Peninsula (BCP) are one of the most important aggregation areas of juveniles of the North Pacific population of the Loggerhead Seaturtle. Though they nest exclusively at Japanese rookeries (Bowen et al. 1995. Proc. Natl. Acad. Sci. 92:3731–3734), some juveniles feed and grow to maturity in a relatively small area near the BCP, eventually returning to their Japanese breeding grounds (Nichols et al. 2000. Bull. Mar. Sci. 67:937–947; Peckham et al. 2011. Mar. Ecol. Prog. Ser. 425:269–280). The conservation status of this population, which was recently classified as Endangered (USFWS-NMFS 2011), requires special attention to elucidate their ecology and life history for proper species conservation. Loggerheads are the sea turtles most colonized by commensals, parasites, and symbiotic species (Frick et al. 2000. Mar. Turt. News. 88:3–5). Their carapace, plastron, and flippers represent habitat for several taxonomic groups, which has enabled the study of trophic relationships among epibiont community members (Frick et al. 2004. Southeast. Nat. 3[4]:613–620), the ecology of host turtles (Frazier et al.1992. Bull. Mar. Sci. 51:1–8), and the biogeographical patterns of sea turtle populations (Caine 1986. J. Exp. Mar. Biol. Ecol. 95:15–26).

The ecological constraints of epifaunistic habitats primarily consist of physical stabilization requirements and the ability for defense against predation (Frazier et al. 1985. Mar. Ecol. 6[2]:127–134). Loggerheads are typically found in tropical and temperate coastal waters (Dodd 1988. U.S. Fish Wildl. Serv. Biol. Rep. 88:100–110), coinciding with the ecology of their reported epibionts (Frick et al. 2002. Bull. Mar. Sci. 70[3]:953–956). The resting behavior of Loggerheads, in which they remain motionless at the sea floor, combined with the frequent peeling of their carapace result in facile attachment by mollusk larvae to the carapace (Frazier et al. 1985, *op. cit.*).

One hundred thirteen epibiont species have been documented to associate with Loggerheads nesting in North America, and on juveniles of the Spanish Mediterranean, ranging from Algae, Poriphera, Cnidaria, Mollusca, Platyhelminthes, Annelida, Arthropoda, and Urochordata (Badillo et al. 2001. *In* Margaritoulis and Demetropoulos [eds.], Proceedings of the First Mediterranean Conference on Marine Turtles, pp. 62–65; Caine 1986. J. Exp. Mar. Biol. Ecol. 95:12–26; Grammentz 1988. Naturalista Sicil. S. IV, XII [1–2]:33–46; Frick et al. 1998. Herpetol. Rev. 29[4]:211–214). Moreover, other detailed studies have been conducted on close relationships of several organisms with *C. caretta*, including *Balaenophilus* spp. (Ogawa et al. 1997. Zool. Sci. 14[4]:691–699), *Podocerus* spp. (Yamato 1992. Publ. Seto Mar. Biol. Lab. 35[4/5]:281–288), Cirripedia (Monroe and Limpus 1979. Mem. Queensland Mus. 19[3]:197–223; Stamper et al. 2005. J. Zoo Wildl. Med. 34[4]:635–641), and *Planes minutus* (Daveport 1994. J. Mar. Biol. Assoc. U.K. 74:735–737).

As part of the Grupo Tortuguero de las California's long term study of juvenile Loggerhead Seaturtles, in July 2011 we collected epibiont samples from the carapaces of 10 turtles (body mass 24.3–63.5 kg, and curved carapace length [CCL ± 0.1 cm] from 55–78.5 cm; mean CCL = 69.4 ± 6.9 cm) captured at Golfo de Ulloa (from El Vizcaino [27.8333°N, 115.0833°W] to Bahia Magdalena [24.5°N, 112.0°W]), Baja California Sur, Mexico. Typical of the region, all turtles carried barnacles (*Chelonibia testudinaria*), Amphipoda, red algae *Polysiphonia* sp., and some assorted bivalves. The microbivalve *Cymatioa pulchra* was present on one individual; the Winged Pearl Oyster (*Pteria sterna*; 0.1–0.4 g, and 11–13 mm length) and shell-loving oyster (*Ostrea conchaphila;* 27.7 g, and 53 mm length) were present in two and one turtles, respectively. The size of the oysters suggests that they were attached to the turtles for several months (Frick et al. 2002. Bull. Mar. Sci. 70[3]:953–956).

The ranges of the three epibiont species are within the limits of the tropical and subtropical habitats from California to Peru (Abbott 1974. American Seashells: The Marine Mollusca of the Atlantic and Pacific Coasts of North America, 2nd ed. Van Nostrand Reinhold Co., New York. 663 pp.). *C. pulchra* is generally symbiotic with other invertebrates to which it attaches with its byssus (Keen 1971. Seashells of Tropical West America. Stanford University Press, California. 854 pp.). The Winged Pearl Oyster, considered a potential resource for pearl production (i.e., mariculture) occupies epifaunal habitats continuously (Southgate 2008. *In* Southgate and Lucas [eds.], The Pearl Oyster, pp. 231–272. Elsevier, Oxford, UK); because of their planktonic larval phase substrate selection occurs prior to metamorphosis (Wada and Tëmkin 2008. *In* Southgate and Lucas, *op. cit.*, pp. 37–75). The shell-loving oyster is usually found attached to dead shells, rocks, and crab carapaces in depths up to 40 m (Abbott 1974, *op. cit.*).

High biological productivity of the Golfo de Ulloa and its sea surface temperature at neritic areas during the summer of 2011 (22.9 ± 1.3°C; from 19.1 to 24.6°C) allowed bivalves to have good metabolic rates. Research of growth and development of larvae and juveniles of these bivalve species suggests epibionts had been associated with the turtles at least 11 weeks, therefore Loggerheads were in neritic areas of the BCP several weeks before they were sampled for this study (Araya-Nunes et al. 1991. California Fish Game 77:181–193; del Rio-Portilla et al. 1992. Mar. Ecol. Prog. Ser. 89:221–227).

To our knowledge this is the first report of *C. pulchra*, *P. sterna,* and *O. conchaphila* associated with the carapaces of *C. caretta,* although symbioses have been reported between other molluscs and loggerheads (Caine 1986. J. Exp. Mar. Biol. Ecol. 95:1526). This represents a contribution to understanding of the ecology of both the bivalve and turtle species, with special emphasis on the interspecific relationships of immature turtles from the northern Pacific. We thank Alejandra Aguillón for her valuable help with taxonomic identifications.

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***GOPHERUS AGASSIZII* (Mojave Desert Tortoise). DIET.** Research into the diet of the Mojave Desert Tortoise has documented occurrences of rock and soil consumption, infrequently observed instances of osteophagy, and only a single previous documentation of consumption of a tortoise carcass (Esque and Peters 1994. Fish and Wildlife Research 13:105–111; Walde et al. 2007. Southwest. Nat. 52[1]:147–149). Consumption of deteriorating bone matter is thought to provide calcium to the otherwise herbivorous tortoise diet, supplying a necessary nutrient that is not abundant in the tortoise's desert range.

On 27 May 2011, beginning at 1013 h, I observed a juvenile *Gopherus agassizii* (CL 170 mm) approximately 32 km W of Needles,



FIG. 1. Juvenile Mojave Desert Tortoise consuming skeletal remains of a dead conspecific.

California, USA (34.68°N, 115.04°W) consuming portions of the disarticulated skeleton of a conspecific (Fig. 1). I stood at a distance of 5–7 m observing for approximately 10 minutes, and took several photographs and videos. The tortoise repeatedly picked up, broke, and consumed portions of disarticulated plastron. Approximately 5 minutes after initial observation, the tortoise recognized my presence and paused the behavior, but resumed a minute or two later. Osteophagy of tortoise remains by Desert Tortoises may represent a more likely occurrence than the relative scarcity of observations suggest. The highly ossified skeletal structure and longevity of this species suggests Desert Tortoises may provide a net calcium sink in their desert ecosystems. Upon death, tortoise carcasses can provide a concentrated source of calcium available to many desert dwelling organisms.

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***KINOSTERNON SUBRUBRUM* (Eastern Mud Turtle). DIET.** *Kinosternon subrubrum* is an omnivorous generalist, scavenging and preying on a wide variety of plants, vertebrates, and invertebrates (Ernst and Lovich 2009. Turtles of the United States and Canadá, 2nd ed. John Hopkins University Press, Baltimore, Maryland. 827 pp.). However, to our knowledge there are no reports of turtles consuming the shed skins of squamates. On 12 July 2012, we captured an adult female *K. subrubrum* on the Emory River across from the Tennessee Valley Authority Ash Recovery Site in Kingston, Tennessee, USA. Upon being held overnight, the turtle excreted portions of a shed snake skin. A large section of the skin protruded from the cloaca, confirming that it had been ingested. The pieces of the shed skin were relatively large and intact, suggesting limited digestion. Although precise identification of the snake was not possible, the keeled scales and size of the skin, together with our knowledge of the study site, strongly suggest *Nerodia sipedon*.

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***PODOCNEMIS ERYTHROCEPHALA* (Read-Headed Amazon River Turtle). KYPHOSIS.** Kyphosis is defined as "a dorsally convex deformity of the spine in the sagital plane of the animal" (Rhodin et. al. 1984. Brit. J. Herpetol. 6:369–373). Kyphosis is relatively widespread in many species of Cryptodira, however it has been reported for only one pleurodire, of the family Chelidae: *Emydura macquarii krefftii* (Limpus et. al. 2006. Marine and Freshwater Sciences Environmental Sciences Division. Conservation Technical and Data Report. 7:1–15; Trembath 2009. Chelon. Cons. Biol. 8:94–95). On 23 January 2008 we captured a kyphotic female *Podocnemis erythrocephala* (Fig. 1) in the Macacoapu branch of the Ayuanã River near its confluence with the Rio Negro, Amazonas, Brazil (0.5352694°S, 64.9253656°W; WGS 84). The turtle was an adult, 247 mm straight-line carapace length, 205 mm carapace width, and 202 mm plastron length. It weighed 1400 g and appeared to be in good health; it was marked and released at the site of capture. Trembath (*op. cit.*) commented that kyphosis is rare, even though it occurs in many different genera; he observed it in 0.36% of 833 individuals. In the Ayuanã River we marked 4432 *Podocnemis erythrocephala* (Bernhard and Vogt 2012. Herpetologica 68: *in press*) and found only one kyphotic turtle, 0.02% of the turtles collected. This is the first case reported for the Podocnemididae.



FIG. 1. Adult female *Podocnemis erythrocephala* with kyphosis.

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***STERNOTHERUS CARINATUS* (Razor-backed Musk Turtle). REPRODUCTION.** On 25 June 2012 at ca. 1735 h I observed two *Sternotherus carinatus* copulating under natural conditions. The copulating turtles were behaving in a generalized kinosternid courtship pattern that has been previously described (Mahmoud 1967. Copeia 1967:314–319). Copulation was visibly confirmed both by the male mounting and clasping of the female from above and the biting behavior of the female. The turtles were observed at a water depth of 0.85 m near a large boulder in the upper Little River in Pushmahata Co., Oklahoma, USA (34.530333°N, 95.026667°W, 234 m elev.). The water temperature was 27.1°C. After the accidental disruption of the copulation, both turtles were captured, measured, and weighed. The male

had a plastron to carapace length (PL/CL) ratio of 0.70 (CL = 118.61 mm; PL = 83.55 mm) and weighed 280 g. The female had a PL/CL ratio of 0.72 (CL = 92.29 mm; PL = 66.02 mm) and weighed 180 g. This is apparently the first reported observation of *Sternotherus carinatus* mating in the wild.

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***TERRAPENE ORNATA LUTEOLA* (Desert Box Turtle). DIET.** The ecology of *Terrapene ornata luteola* is poorly known, and in particular there is a notable paucity of information regarding diet (Ernst and Lovich 2009. Turtles of the United States and Canada. 2nd ed. Johns Hopkins University Press, Baltimore, Maryland. 827 pp.). We herein describe the diet of *T. o. luteola* collected in Presidio and Brewster counties, Texas, during 2008. To our knowledge, this is the first quantitative report on the diet of *T. o. luteola*. Our sample consisted of 14 turtles (mean carapace length = 121 mm; SD = 16 mm; range = 89–147 mm) opportunistically collected during June (1), July (5), August (3), and September (5); nine were found crossing highways, four encountered during the course of other field work, and one turtle was DOR. Turtles were found at elevations ranging from ca. 1065 to 1380 m in desert grassland with significant areas of shrub encroachment (Powell 1998. Trees and Shrubs of the Trans-Pecos and Adjacent Areas. University of Texas Press, Austin. 498 pp.). Precipitation in this region averages about 400 mm annually (Powell, *op. cit.*). We obtained feces by placing turtles overnight (12–18 h) in plastic buckets containing about 5 cm of water to stimulate defecation (Platt et al. 2009. Southeast. Nat. 8:335–346). The contents of each bucket were then passed over a sieve (2 mm mesh), and food items recovered, dried, and later identified to the lowest possible taxonomic level. We calculated the percent occurrence of each food item recovered as the number of samples in which a particular item occurred divided by the sample size. Percent occurrence is the appropriate metric when the number of individual food items cannot be quantified (Rosenberg and Cooper 1990. Stud. Avian Biol. 13:80–90). Each turtle was permanently marked by notching a unique series of marginal scutes (Cagle 1939. Copeia 1939:170–172) and released at the capture site within 48 h. We dissected the road-killed turtle, and removed, washed, sieved, dried, and later identified the gut contents.

Insect remains were recovered from every turtle (100%) in our sample. We identified the remains of dung beetles (Scarabaeidae), lady beetles (Coccinellidae), and grasshoppers (Caelifera) from 7 (50.0%), 2 (14.2%), and 1 (7.1%) turtles, respectively. The remains of insects we were unable to identify were recovered from 6 (42.8%) turtles. Similar to our results, others have found that insects comprise as much as 90% of the diet of *T. o. ornata*, with dung beetles being the most frequently consumed insect prey (Blair 1976. Southwest. Nat. 21:89–103; Legler 1960. Univ. Kansas Publ. Mus. Nat. Hist. 11:617–619; Metcalf and Metcalf 1970. Trans. Kansas Acad. Sci. 73:96–117). Representatives of seven Orders and 18 Families of insects have been reported in the diet of *T. ornata* (reviewed by Ernst and Lovich, *op. cit.*).

We recovered millipede (*Orthoporus* spp.) remains from 6 (42.8%) *T. o. luteola*, and observed a turtle consuming a living millipede (*Orthoporus ornatus*) on 30 August 2008. Millipedes (Diplopoda) have previously been reported in the diet of *T. ornata* (Ernst and Lovich, *op. cit.*). Millipedes secrete a variety of toxic compounds (e.g., hydrogen cyanide and benzoquinone) from glands in each body segment, which cause many predators to cease an attack and perform vigorous cleansing actions (Eisner and Meinwald 1966. Science 153:1341–1350). What effect, if any, these toxins have on *T. ornata* remains unknown; however, the prevalence of millipede remains found in our study and reported by others (Ernst and Lovich, *op. cit.*), strongly suggests these compounds do little to deter predation by *T. ornata*.

The molar of a small mammal found in the feces of one (7.1%) turtle perhaps originated from a carcass consumed as carrion. Scavenging of vertebrate carrion by *T. ornata* is well documented (Hill et al. 2005. Herpetol. Rev. 36:443; Jensen 1999. Herpetol. Rev. 30:95; Kolbe 1998. Herpetol. Rev. 29:235; Legler, *op. cit.*; Parker 1982. Southwest. Nat. 27:365). When available, carrion provides an energetically rich food that can be obtained safely without the cost of capturing and subduing prey (DeVault and Krochmal 2002. Herpetologica 58:429–436). Small stones were recovered from six (42.8%) turtles. The reasons underlying stone ingestion are unclear (Ernst and Lovich, *op. cit.*); stones could be ingested accidentally during feeding (Legler, *op. cit.*), although deliberate ingestion reportedly occurs among captives (Skorepa 1966. J. Ohio Herpetol. Soc. 5:108).

Unidentified leaves and seeds were each recovered from one (7.1%) turtle suggesting vegetation and fruit constitute a relatively minor component of the diet in our study area. However, our results could simply reflect the seasonal availability of foliage and fruit. Although considered "chiefly carnivorous," *T. ornata* is known to consume foliage and fruit from a wide variety of plants (Ernst and Lovich, *op. cit.*). Succulent vegetation is thought to serve as a significant source of water for *T. ornata* inhabiting arid regions (Nash and Gangloff 2010. Herpetol. Rev. 41:489; Thomasson 1980. Southwest. Nat. 25:438), and if available, large quantities of fruit may be consumed to the exclusion of other foods (Ernst et al. 1994. Turtles of the United States and Canada. Smithsonian Institution Press, Washington, D.C. 578 pp.). Some evidence suggests *T. o. ornata* might also play an important role in seed dispersal (Stone and Moll 2009. Southwest. Nat. 54:346–350).

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SQUAMATA — LIZARDS

***ANOLIS CAROLINENSIS* (Green Anole). ATTEMPTED SAUROPHAGY.** Most species of *Anolis* lizards consume primarily insect prey (Andrews 1976. Copeia 1976:477–482; Schoener 1968.



FIG. 1. Adult male *Anolis carolinensis* (perched on residential air conditioning unit) attempting to consume a juvenile *Sceloporus undulatus hyacinthinus*.

Ecology 49:704–726). However, anoles are known to be relative dietary generalists, consuming what they opportunistically encounter and can capture and swallow, including spiders, centipedes, snails, seeds, and on occasion, small vertebrates (Losos 2009. Lizards in an Evolutionary Tree. Univ. California Press, Berkeley, California. 507 pp.). Reports on predation by anoles on other lizards are relatively rare, but anecdotal evidence of saurophagy in a number of *Anolis* species indicates that anole predation on small (often juvenile) lizards may be more frequent than generally thought, especially for adult male anoles (Gerber 1999. Anolis Newsletter V:28–39).

Anolis carolinensis is a well-studied species common throughout the southeastern United States. As with other anoles, this species is mainly insectivorous, but large males will occasionally prey on smaller conspecifics (e.g., Gerber and Echternacht 2000. Oecologia 124:599–607). Observations of saurophagy by *A. carolinensis* on non-anoline lizards remain rarely reported, but one previous account described an adult male *A. carolinensis* feeding on an adult *Sceloporus undulatus* carcass (Himes 1998. Herpetol. Rev. 29:236–237). Because both of these lizards had approximately the same snout–vent length (SVL), the author concluded that it was unlikely that the anole was capable of killing the *Sceloporus* lizard, suggesting that the anole encountered and began feeding on the *Sceloporus* after it had expired. Here, we describe a second account of *A. carolinensis* attempting to consume a *Sceloporus undulatus*.

On 19 October 2008, an adult male *A. carolinensis* was observed attempting to eat a juvenile *Sceloporus undulatus hyacinthinus* at the residence of the first author (TJH) in Wake Co, North Carolina, USA. A single digital photograph (Fig. 1) was taken during this process, which lasted approximately 10 minutes. The *A. carolinensis* repeatedly attempted to reposition and swallow the *Sceloporus*, with the anterior end of the lizard in its mouth, but eventually dropped and abandoned the dead *Sceloporus* when it was unable to do so. While no measurements were taken of these lizards, the *Sceloporus* appears to have at least 50% of the SVL of the green anole. Mahler and Glor (2011. Herpetol. Rev. 42:272–273) previously reported that an adult male *Anolis cybotes* was successfully able to swallow an *A. marron* individual that was 64.3% of its own SVL, but it appears that the failed predation attempt reported here resulted from the large size of the *Sceloporus*, preventing consumption by the *A. carolinensis*.

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***ANOLIS SAGREI* (Brown Anole). PREY.** The anoles, family Polychrotidae, show an overwhelming dietary preference for invertebrates and Herrel et al. (2004. Oecologia 140:160–168) report that only 11.5% of species in this family are fruit eaters. Most frugivory reported in anoles has occurred among island-dwelling populations, and Herrel et al. (*op. cit.*) suggested that this may be due to low interspecific and high intraspecific competition on such islands. Most sources agree that *A. sagrei* does not prefer fruit (Herrel et al., *op. cit.*). This species has been observed to eat some "plant food" on Bimini, though details were not described (Schoener 1968. Ecology 49:704–726.).

In 2011, *Anolis sagrei* was observed eating fruit in two instances at the Palm Beach Zoo, Palm Beach Co., Florida, USA (26.667029°N, 80.069857°W). The first observation occurred on an unrecorded date in the month of March, where an adult male *A. sagrei* began consuming a fruit of a *Ficus* sp. on a paved footpath directly below a large *Ficus* sp. tree. The anole began eating the fruit shortly after it fell, perhaps indicating the consumption of the fruit was a result of a feeding response to movement. The second observation occurred 17 June at 1700 h and was photographically documented. In this instance, an adult female *A. sagrei* was observed running across a wooden railing with a *Ficus* sp. fruit in her mouth. In both instances there were other *A. sagrei* observed in the immediate area, the majority of them actively consuming ants.

Although fruit is not typically considered part of the diet of *A. sagrei*, no special adaptation is needed for insectivorous lizards to digest fruit pulp (Olesen and Valido 2003. Trends Ecol. Evol. 18:177–181). I have found one other instance of photographically or videographically documented fruit consumption by *A. sagrei*, an individual in the Bahamas was observed scavenging on the fruit of *Manilkara zapota* (AnoleAnnals.org/2010/12/05/frugivory-anolis-sagrei, accessed 18 May 2012).

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***ANOLIS SAGREI* (Brown Anole). INTERSPECIFIC KLEPTOPARASITISM.** *Anolis sagrei* is a common, invasive anole in Florida and is usually found close to human habitation. In April 2012, an open-ended wooden box (25 cm x 15 cm) filled with lengths of hollow bamboo and dried stems of forbs to attract hole-nesting bees and wasps was placed on a pot of aloe plants (approx. 60 cm above the ground) in a suburban garden in central Florida. Two days later, a large male *A. sagrei* was observed displaying on top of it. A rival male perched within 60 cm of him. The estimated SVL for both males was approximately 50 mm. For the next two weeks both males were seen in the same place, one perched above the box, and one slightly below it, along with several females.

Two weeks after positioning the box, wasps and a carpenter bee were seen exploring it. The wasps appeared to be eumenine vespids, which are hole-nesting caterpillar hunters. Both male anoles ignored these hymenopterans. On another occasion a paper wasp (*Polistes* sp.) was seen chewing a projecting stem of bamboo, presumably to make carton for the construction of a nest. Again, this wasp was ignored by the two male anoles.

Two weeks and three days after positioning the box, one of the male anoles was observed to rapidly jump onto the box, appeared to shake something vigorously and then return to its perch above the box. When approached, it was seen to be eating a small yellow-green caterpillar. Approximately 15 min after this observation, a eumenine wasp was seen approaching the box carrying a caterpillar. Both male anoles were present by the box and both were seen to cock their heads as the wasp landed. The anole that had been seen eating the caterpillar previously immediately ran down from its perch (approx. 15 cm away), turned its head on one side and grabbed the caterpillar as soon as the wasp landed. The anole shook its head twice and then wiped the caterpillar roughly against the bamboo tubes. The wasp was dislodged at the first shake and immediately flew away. The anole returned to its perch and ate the caterpillar.

Over the next four days both anoles were seen to kleptoparasitize eumenine wasps attempting to land on the box. The male first observed kleptoparasitizing a wasp was seen stealing caterpillars twice more and the other male was seen to kleptoparasitize a wasp once. On all occasions the anoles were seen to turn their heads on their sides, pincer the caterpillar in their jaws and rapidly shake their heads once or twice. On one occasion a large carpenter bee approached and landed on the box, a male anole immediately ran at it presumably mistaking the bee for a wasp which it could kleptoparasitize, but turned away again and when the bee flew away the anole retreated so rapidly that it fell to the ground.

Kleptoparasitism has been observed in lizards such as Broadley's Flat Lizards (*Platysaurus broadleyi*) (Whiting and Greeff 1997. Copeia 1997:811–818) stealing figs from conspecifics, and Balearic Wall Lizards (*Podarcis lilfordi*) stealing pieces of pear from conspecifics (Cooper and Pérez-Mellado 2003. Amphibia-Reptilia 24:219–224), but I could find no previous record of kleptoparasitism between a lizard and an invertebrate. The territorial behavior of male anoles and the resource of the nesting tubes attracting eumenine wasps likely means that many more instances of kleptoparasitism occurred than were observed.

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***ANOLIS SAGREI* (Brown Anole). VOLUNTARY AUTOTOMY.** Caudal autotomy is a defense mechanism common to many lizard species whereby the tail is shed, usually to escape a predation event (Bateman and Fleming 2009. J. Zool. 277:1–14). Autotomy occurs along breakage planes in the tail vertebrae and is under central control of the lizard, i.e. it is not simply forced removal (Fleming et al. 2007. Biol. Rev. 82:481–510.). No studies, however, have convincingly demonstrated that autotomy in lizards can occur without the aid of at least some form of external resistance, although this has been recorded in some invertebrates (Fleming et al. *op. cit*).

We held several male and female wild-caught *Anolis sagrei* in captivity at Archbold Biological Station in May and June 2012. Each anole was kept singly in a 10 L clear plastic terrarium with a sand substrate, a water dish and a palm leaf stem for a perch. Several of these anoles demonstrated evidence of previous autotomy and regeneration of their tails. On 31 May 2012, a female anole (SVL 42 mm, tail length 53 mm) was observed to have autotomized her tail, which lay on the sand substrate directly beneath her favored perch. Forty-five mm of the tail had been autotomized (9 mm of the tip of the tail had been previously lost and regenerated), and 4 mm from the point of autotomy the tail was wounded on the dorsal surface, with a cut about 2 mm in length, that had bled recently. This wound had been noted at the time of capture 18 days before and had failed to heal in that time, perhaps because it was at a flex point.

Apart from having food and water added to the terrarium every second day the anole was never handled or disturbed. The tail appeared to have been shed without being caught or trapped and therefore without any external resistance; it seems likely that the female voluntarily shed the tail in response to the unhealed wound and that this is therefore comparable to autotomy behavior observed in some invertebrates.

Although there has been anecdotal discussion of lizards that autotomize tails when in collection bags and not otherwise restrained, we could find no similar observations of caudal autotomy in response to a wound and with no apparent external resistance. This adds to the adaptive benefits of caudal autotomy in lizards: not only does it allow a lizard to escape from predators (see Bateman and Fleming, *op. cit.* for a review) but it also allows a lizard to deal with a wounded, but unautotomized, tail.

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***ANOLIS UTILENSIS* (Utila Anole). HABITAT.** *Anolis utilensis*, a member of the *pentaprion*-group, is endemic to Isla de Utila (Islas de la Bahia), located off the north coast of Honduras. This anole has thus far only been described from two areas of mangrove swamp forest on Utila (Gutsche et al. 2004. Salamandra 40:297–302; Köhler 2008. Reptiles of Central America. Herpeton, Offenbach. 400 pp.; Kramer 2010. Iguana-Rundschreiben 23:5–9). It is arboreal and well-camouflaged due to a lichenose gray-brown dorsal pattern and exhibits gecko-like behaviors. Based on limited locality information, *A. utilensis* was regarded as being exclusive to mangrove forest habitat. Here, we report on a novel habitat type for this species.

On 21 April 2011, we detected a male specimen of *A. utilensis* about 300 m S of the so-called "Bat Cave" near Pumpkin Hill, a volcano remnant in the north east of Utila. The anole was sitting on a fence post at a height of ca. 1.5 m directly at the edge of a dirt road. This locality (16.118739°N, 86.886136°W, WGS84; 8 m elev.) was about 850 m away in linear distance from each of the two areas where *A. utilensis* is also known to occur. The closest mangrove forest is ca. 250 m NW from this new location. The surrounding area of the new locality consisted of broadleaf forest with various bushes, and farmland. The ground was dry soil and loosely covered with leaves; the location was partly shaded by tree canopy.

The habitat type for this new locality is completely different from that reported previously. Mangrove forest is characterized by high humidity, lower average temperature, and the presence

of salt and/or brackish water (e.g., Gutsche et al. 2004, *op. cit.*), while the new locality was predominantly dry and only influenced by rain water. Andrea Martinez (IRBS) reported several observations of *A. utilensis* within the vicinity where we found the specimen reported here (A. Martinez, pers. comm. 2011). The occurrence of *A. utilensis* here suggests that this species is not restricted to mangrove forest and likely occurs in other locations on Isla de Utila. However, we recognize that our observation may reflect a displacement effect due to on-going deforestation in mangrove habitat, as also has been suggested for the endemic mangrove iguana *Ctenosaura bakeri* (Pasachnik et al. 2009. Conserv. Gen. 10:1247–1254).

The anole was caught and brought to the local Iguana-Station (IRBS) for identification. We also took digital photographs of the animal including its diagnostic characters, and subsequently released the lizard at the site of capture. The photographs were sent to G. Köhler, the describer of *A. utilensis*, who verified our initial identification.

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***ASPIODOSCELIS LABIALIS* (Baja California Whiptail). REPRODUCTION.** *Aspidoscelis labialis* is known from a narrow distribution along the Pacific coast from just south of Ensenada, Baja California, Mexico to 6 km SE of Guerrero Negro, Baja California Sur, Mexico (Grismer 2002. Amphibians and Reptiles of Baja California Including its Pacific Islands and the Islands in the Sea of Cortés. University of California Press, Berkeley. 399 pp.). A sample of 7 males (mean SVL = 51.3 mm ± 2.6 SD, range = 48–55 mm) and 13 females (mean SVL = 52.6 mm ± 4.2.SD, range = 48–58 mm) was examined from Baja California, Mexico collected in 1964, 1967, 1968, 1971, 1982. The specimens examined were those deposited in the herpetology collections of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California, USA (as LACM: 67354, 75404–75411, 75418, 75620, 75622, 75624, 78803, 78804, 109658, 114809, 134679, 135468) and the Museum of Vertebrate Zoology (MVZ), University of California, Berkeley, California, USA (as MVZ: 78803, 78804).

A small slit was made in the left side of the abdomen and the left testis was removed from males and the left ovary was removed from females for histological examination. Enlarged ovarian follicles (> 5 mm) or oviductal eggs were counted in situ. No histology was performed on them. Removed gonads were embedded in paraffin, sections were cut at 5 µm and stained by Harris' hematoxylin followed by eosin counterstain. Histology slides are deposited in LACM and MVZ.

Two stages were noted in the testicular cycle: 1) spermiogenesis (seminiferous tubules lined by clusters of sperm and/or metamorphosing spermatids); 2) regressed = post breeding (seminiferous tubules contain spermatogonia and Sertoli cells). Monthly distribution of stages in the testicular cycle were: April (N = 1) spermiogenesis; May (N = 1) spermiogenesis; June (N = 4) spermiogenesis; August (N = 1) regressed. The smallest reproductively active male (undergoing spermiogenesis) measured 48 mm SVL (LACM 75407) and was collected in June.

Four stages were present in the ovarian cycle of *A. labialis* (Table 1): 1) Quiescent, no yolk deposition; 2) Early yolk deposition, vitellogenic granules in ooplasm; 3) Enlarged follicles (> 5 mm); 4) Oviductal eggs. Three March females had not yet commenced reproductive activity. Females from May and June contained oviductal eggs. One June female exhibited early yolk deposition indicating reproduction would likely continue into July. Whether a second clutch is produced in the same season is not known. Mean clutch size for seven females was 1.71 ± 0.95 SD, range = 1–3. The smallest reproductively active female (oviductal egg) measured 48 mm SVL (LACM 75406) and was collected in June. My findings confirm *A. labialis* has a spring to summer breeding season as suggested by Grismer (*op. cit.*).

Table 1. Monthly stages in the ovarian cycle of *Aspidoscelis labialis*.

Month	N	Quiescent	Early yolk deposition	Enlarged follicles	Oviductal eggs
March	3	3	0	0	0
May	1	0	0	0	1
June	9	2	1	3	3

I thank C. Thacker (LACM) and C. Spencer (MVZ) for permission to examine *A. labialis*.

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***ASPIDOSCELIS LABIALIS* (Baja California Whiptail). ENDOPARASITES.** *Aspidoscelis labialis* is known from a narrow distribution along the Pacific coast from just south of Ensenada, Baja California, Mexico to 6 km SE of Guerrero Negro, Baja California Sur, Mexico (Grismer 2002. Amphibians and Reptiles of Baja California Including its Pacific Islands and the Islands in the Sea of Cortés. University of California Press, Berkeley. 399 pp.). We know of no reports of helminths from *A. labialis*. The purpose of this note is to establish the initial helminth list for *A. labialis*.

Five *A. labialis* (mean SVL = 51.8 mm ± 2.9 SD, range = 49–55 mm) deposited in the herpetology collection of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California, USA as LACM 67354, collected May 1967 at Camalú, Baja California, Mexico (30.8396°N, 116.0614°W, WGS84, elev. 21 m) and LACM 75405, 75414, 75619, 75621 collected June 1971 at Colnett, Baja California, Mexico (31.0667°N, 116.2000°W, WGS84, elev. 55 m) were examined for helminths.

The body cavity was opened and the digestive tract removed, opened by a longitudinal incision and examined under a dissecting microscope. Cestodes (from the small intestines) were regressively stained in hematoxylin, mounted in Canada balsam, studied using a compound microscope and identified as *Oochoristica bivitellobata* (prevalence: number infected/number examined × 100 = 40%, mean intensity: mean number infected individuals ± 1 SD = 2.5 ± 2.1 SD, range = 1–4). Nematodes (from the small and large intestines) were cleared in a drop of lactophenol on a glass slide, coverslipped, studied using a compound microscope and identified as *Pharyngodon warneri*, (prevalence = 60%, mean intensity = 7.0 ± 3.5 SD, range = 5–11). Helminths were deposited in the United States National Parasite Collection, Beltsville, Maryland, USA as *Oochoristica bivitellobata* (USNPC 105792) and *Pharyngodon warneri* (USNPC 105793).

Oochoristica bivitellobata and *P. warneri* are, to date, known only from teiid lizards. A host list for *O. bivitellobata* can be found in Bursey and Goldberg (2011. Comp. Parasitol. 78:312–315) and a host list for *P. warneri* in Goldberg et al. (1997. Great Basin Nat. 57:273–277). *Aspidoscelis hyperythra* (Goldberg and Bursey

2003. Herpetol. Rev. 34:142) should be added to the host list for *P. warneri*. *Aspidoscelis labialis* is the seventeenth teiid species reported to harbor *O. bivitellobata* and the tenth to harbor *P. warneri*. *Aspidoscelis labialis* represents a new host record and Baja California, Mexico is a new locality record for both *Oochoristica bivitellobata* and *Pharyngodon warneri*.

We thank C. Thacker (LACM) for permission to examine *A. labialis*.

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***ASPIDOSCELIS SEXLINEATA* (Six-lined Racerunner). COMMENSALISM.** *Aspidoscelis sexlineata* is a common teiid in Arkansas and Louisiana where it occupies open areas and requires exposed soil to hibernate and retreat from extreme temperatures (Dundee and Rossman 1989. The Amphibians and Reptiles of Louisiana. Louisiana State Univ. Press, Baton Rouge. 300 pp.; Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.). *Aspidoscelis sexlineata* may benefit from using the microhabitat of burrows of other vertebrates, specifically for thermoregulation. This species has been recorded as a burrow commensal of Gopher Tortoise (*Gopherus polyphemus*; Lips 1991. J. Herpetol. 25:477–481; Witz et al. 1991. Am. Midl. Nat. 126:152–158), Oldfield Deermouse (*Peromyscus polionotus*; Pearson and Nelson 1952. Copeia 1952:188–189), and Black-tailed Prairie Dog (*Cynomys ludovicianus*; Kretzer and Cully 2001. Southwest. Nat. 46:171–177). Pocket gophers (*Geomys* spp., *Thomomys* spp.) are a common group of fossorial rodents known for soil alteration via burrowing. This microhabitat created by pocket gophers provides habitat for a variety of organisms, including lizards. *Aspidoscelis sexlineata* were commonly encountered occupying the same habitat of Ozark Pocket Gophers (*Geomys bursarius ozarkensis*) in Arkansas but were never directly captured in a burrow (Connior et al. 2008. J. Arkansas Acad. Sci. 62:45–51). This teiid has been documented using the abandoned burrows of pocket gophers as retreats in Colorado (Vaughan 1961. J. Mammal. 42:171–174) and has been found in the mounds of Southeastern Pocket Gopher (*Geomys pinetis*) in Florida (Funderburg and Lee 1968. J. Herpetol. 1:99–100). Herein, we provide additional evidence to support commensalism between *A. sexlineata* and pocket gophers.

On 14 April 2008, while excavating a Baird's Pocket Gopher (*Geomys breviceps*) near Heber Springs, Cleburne Co., Arkansas, USA (35.448200°N, 92.084685°W; no datum available), an adult *A. sexlineata* was captured by SWC as it ran out of a freshly exposed pocket gopher tunnel. The individual was hand captured and identified to species. On 25 October 2009, while excavating a Baird's Pocket Gopher mound near Junction City, Claiborne Parish, Louisiana, USA (32.999252°N, 92.750636°W) a juvenile *A. sexlineata* was discovered in the mound by MBC. This specimen was deposited as a voucher specimen in the Arkansas State Museum of Zoology Herpetology Collection (ASUMZ 31388). Both of these areas were dominated by a variety of low-growing grasses and forbs without any other shade providing vegetation within the vicinity (~50 m). Ectotherms, specifically *A. sexlineata*, have minimal microhabitat to utilize for retreat from extreme ambient temperatures within this habitat. Historically, these areas were dominated by woody vegetation but the habitat has been altered to a landscape comprised of low-growing grasses and forbs. Historically, *A. sexlineata* probably did not primarily rely on the pocket gopher burrows for thermoregulation due to other available habitat characteristics (e.g., woody canopy cover). However, *A. sexlineata* has developed an apparent commensal relationship with pocket gophers due to current habitat characteristics resulting from alteration and the lizard possibly has not had a long term temporally dependent commensal relationship with pocket gophers within these altered areas. However, if the habitat remains altered in its current state, long term temporal commensalism between *A. sexlineata* and pocket gophers may persist.

These observations are the first documented records of *A. sexlineata* utilizing Baird's Pocket Gopher burrow systems as habitat. Although active pocket gopher burrows are typically closed off to the surface except for short durations of burrow maintenance, this microhabitat does provide important habitat for ectotherms. For instance, the sun-exposed dirt mounds provide areas for thermoregulation during cool ambient temperatures and abandoned pocket gopher burrows and mounds also allow refugia to retreat from warm ambient temperatures, especially in habitat that is dominated by low-lying vegetation and minimal shade providing cover. In a simulated burrow system containing both pocket gopher and *A. sexlineata*, the gophers only occasionally paused when the lizards ran by in the burrow (Hickman 1977. Texas J. Sci. 29:235–243), suggesting no negative physical or physiological interactions between the lizards and gophers. By providing thermoregulation sites and refugia for *A. sexlineata* and not any predation pressure, pocket gopher burrow systems may be an important habitat component for these lizards where they coexist. Furthermore, our observations when combined with other literature accounts lend evidence to a commensal relationship between *A. sexlineata* and other burrowing vertebrates.

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***CALLOPISTES MACULATUS* (Chilean Racerunner). PREY.** The diet of *Callopistes maculatus* is well documented from southern populations (Donoso-Barros 1961. Rev. Chil. Hist. Nat. 55:41–54; Donoso-Barros 1966. Reptiles de Chile. Ediciones de la Universidad de Chile. 458 pp.; Fuentes 1976. Ecology 57:3–17; Simonetti and Yañez 1984. Herpetol. Rev. 15:17), but few data are reported for northern populations. This species exhibits substantial plasticity in its food habits; its diet appears to depend on local and temporal prey availability (Castro et al. 1991. J. Herpetol. 25:127–129). Prey items that have been reported for this species include insects, seeds, lizards (*Liolaemus*), small snakes (*Tachymenis*), and rodents (*Abrothrix olivaceus* and *Octodon degus*).

For northern populations at Fray Jorge National Park (30.634167°S, 71.6675°W), Mellado (1982. Doñana Acta Vertebrata 9:372) reported preferences for micromammals (*Abrothrix olivaceus*, 74.3%) and secondarily, arthropods (21.2%) and *Liolaemus* lizards (4.5%). However, populations at Las Chinchillas National Reserve demonstrated a preference for insects (83.8%), and secondarily for mammals (8.9%) and reptiles (3.5%) with a record of predation on *Philodryas chamissonis*. Vidal and Ortiz (2003. Herpetol. Rev. 34:364–365) reported cannibalism, with a male hunting a juvenile female in the locality of Chacrita, Vallenar, Atacama region (28.39425°S, 70.713722°W, elev. 644 m).

At 1120 h on 18 October 2010, during a biodiversity study of Quebrada El Leon, Caldera, Atacama Province, Chile (26.958722°S, 70.737194°W; elev. 270 m) I observed an adult *C. m. atacamensis* capture a juvenile Darwin's Leaf-eared Mouse (*Phyllotis darwini*) behind a 1 m diameter rock surrounded by shrubs. The teiid then took the rodent to a small cave where it was consumed.

The lizard was an adult female (SVL = 166.5 mm; tail length = 230.4 mm) and was deposited in the Colección de Vertebrados de Zonas Áridas (CVZA 0148) of the Centro Regional de Investigación y Desarrollo Sustentable de Atacama (CRIDESAT) at the Atacama University. This is the northernmost observation concerning the diet of this species, and *Phyllotis darwini* is a new prey species reported for the diet of this teiid. I thank Carolina Urra for field assistance and Robert Langstroth and Cristián Abdala for revision of manuscript.

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***CALOTES VERSICOLOR* (Common Garden Lizard). AVIAN PREDATION.** *Calotes versicolor* is widely distributed in various habitats of the Indian subcontinent (Sharma 2002. The Fauna of India and the Adjacent Countries-Reptilia [Sauria] Vol. II. Director, Zoological Survey of India, Kolkata. 430 pp.). This species is known to be an ambush predator and also is known for its versatile camouflage abilities (i.e. to change color according to the surroundings). Several aspects of its ecology are well known, however, very little is known about its natural avian predators. The common known predators of *C. versicolor* are various snakes and large-sized lizards. Recently we observed this lizard being predated by a bird, the Shikra (*Accipiter badius*). This bird normally preys on small lizards such as skinks. Here we report a new known predator of *C. versicolor*.



PHOTO BY VIVEK SHARMA

FIG. 1. Shikra (*Accipiter badius*) predating an adult *Calotes versicolor*.

On 17 July 2010 at 1545 h, during a survey in Jiwaji University campus, Gwalior, Madhya Pradesh, India (26.5393°N, 77.75685°E; 119 m elev.), we observed an adult Shikra predating an adult male *C. versicolor* approx. 15 cm SVL (Fig. 1). The habitat where this observation occurred was comprised of dense canopy cover dominated by *Azadirachta indica, Mangifera indica,* and *Prosopis juliflora*. During our observation, a flying Shikra suddenly came down on the ground and grabbed the lizard in its talons and took it to a tree (*Prosopis juliflora*). This observation is the first photographic evidence of the predation of *Accipiter badius* on an adult *Calotes versicolor*.

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***HELODERMA HORRIDUM CHARLESBOGERTI* (Guatemalan Beaded Lizard). SHELTER USE.** *Heloderma horridum charlesbogerti* is endemic to the dry forests of Motagua Valley in eastern Guatemala and considered endangered. This subspecies is the only allopatric population of *H. horridum* and differs from other subspecies in coloration and attains a smaller size (Campbell and Vannini 1988. J. Herpetol. 22:457–468). Lizards of the genus *Heloderma* are considered nest specialist predators (Beck 2005. Biology of Gila monsters and Beaded Lizards. Univ. California Press, Los Angeles. 211 pp.).

We conducted a five-year radio-tracking study from July 2004 to September 2008 to investigate the ecology and behavior of *Heloderma horridum charlesbogerti*. Lizards were fitted with a radio transmitter (CHP-5P by Telonics, Mesa, Arizona, USA) and tracked using an ATS FieldMaster FM100 Receptor. The transmitters were attached within the second and third tail ring of each lizard (approx. 20 mm posterior to the vent). To improve the security of the transmitters, they were fixed using duct tape (Truper, USA), with care taken not to obstruct the cloaca. Each individual was also marked with PIT-tags (AVID microchips, Los Angeles, California, USA) inserted at the level of the right forelimb. The lizards were tracked using the homing method (White and Garrot 1990. Analysis of Wildlife Radio-tracking Data. Academic Press, San Diego. California. 383 pp.).

On 16 May 2007, we observed a female *H. h. charlesbogerti* hidden inside an underground nest of a bird of the family Momotidae, presumably of the species *Momotus mexicanus* (Russet-crowned Motmot) (Fig. 1). We did not observe any sign of bird activity within this nest or other surrounding nests that were ca. 50 cm away. This observation was made outside the breeding season of this bird, suggesting that this lizard was actively using the shelters as refugia and not predating the nest.

Another striking observation we made is that these lizards use temporal bodies of water that form within cavities of tree trunks at the beginning of the rainy season. We have observed this behavior in four different individuals on five different occasions. All of these observations were made at the beginning of the rainy season in July and August. On 29 July 2006, at 1030 h, a female



FIG. 1. Female *Heloderma horridum charlesbogerti* taken out from a momotid nest that it was using as shelter.



FIG. 2. Male *Heloderma horridum charlesbogerti* submerged into a body of water located in a cavity at the base of a Jocote Tree (*Spondias purpurea*).

H. h. charlesbogerti (No. 094.519.273; 295.mm SVL) was encountered in a flooded tree cavity at the beginning of the rainy season. This cavity was 2.58 m above the ground, located between two branches of the tree *Albizia idiopoda*. On 22 August 2006, a male (No. 094.333.040; 335 mm SVL) was found completely submerged in a body of water located in a cavity at the base of a Jocote Tree (*Spondias purpurea*), at a height of 0.20 m above the ground. It remained submerged for 18 min before lifting its head above the surface of the water (Fig. 2). All the other lizards were found resting with a portion of their heads held out of the water. On 17 August 2007, subadult No. 094.266.624 was encountered within a temporal water body within a cavity in the trunk of a *Leucaena diversifolia* tree, located 1.69 m above the ground. The cavities where the juvenile (No. 094.513.073) was found on two separate occasions were located in the trunk of a *Haematoxylon brasilleto* tree at 1.18 m above the ground (1 August 2007) and in a *Leucaena diversifolia* trunk at 1.32 m above the ground (21 July 2008). The average depth of water in these cavities was 39 ± 6 cm (N = 5).

The two new types of shelters used by helodermatid lizards presented in this report provide important implications in helping to understand the behavior and ecology of this species. The use of nest cavities dug out by birds of the Momotidae, such as *Momotus mexicanus,* as well as *Eumomota superciliosa,* could be for feeding purposes. The cavities are used by these birds during the beginning of the rainy season for laying eggs (Howell and Webb 2000. A Guide to the Birds of Mexico and Northern Central America. Oxford Univ. Press, Oxford. 851 pp.). It is possible that *H. h. charlesbogerti* uses these cavities because they are of difficult access to potential predators of this lizard, being located on steep cliffs, while also providing a relevant food resource.

The use of flooded tree cavities as shelters at the beginning of the rainy season may help explain a well-known behavior of captive helodermatid lizards. In captivity these lizards usually spend considerable time submerged in their water dishes, sometimes for more than 30 minutes or even a whole day (Beck 2005, *op. cit.*). It was previously believed that helodermatid lizards in the wild do not require the existence of above-ground water sources, but the water bodies used by the lizards tracked during this study had water from mid-June to late October (i.e., the rainy season). We suggest that this behavior observed in captivity is a reflection of the behavior in nature, where this species remains submerged in water at the beginning of the rainy season. This behavior probably evolved as a means to recover from severe dehydration suffered during aestivation in the dry season.

Fieldwork was conducted under CONAP permits. Funding was provided by grants from Zoo Atlanta, IRCF, Eli Lilly Co., Disney Worldwide Conservation Fund, San Diego Zoo, Oklahoma City Zoo, and The Nature Conservancy. This work was part of the Master's thesis of D. Ariano-Sánchez. Field assistance was provided by Erick Lopez, Cristian Beza, and Pablo Salazar.

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***HEMIDACTYLUS MABOUIA* (Wood Slave). PREDATION.** The African gekkonid lizard *Hemidactylus mabouia* is an exotic species in Brazil and is frequently associated with human dwellings (Ávila-Pires 1995. Lizards of Brazilian Amazonia (Reptilia: Squamata). Zoologische Verhandelingen, Leiden. 706 pp.; Vanzolini 1978. Pap. Avul. Zool. 31:307–343). Lizards can fall prey to many arthropods, including insects, spiders, centipedes and amblypygids (Zug et al. 2001. Herpetology: An Introductory Biology of Amphibians and Reptiles. 2nd ed. Academic Press, San Diego, California. 630 pp.) with several cases described in the literature (see Bauer 1990. Herpetol. Rev. 21:83–87).

The scorpion *Tityus metuendus* lives in tropical forests of Western Amazon in Brazil and Peru. It occurs in the Brazilian states of Amazonas, Pará, Acre, Rondônia, and Roraima

(Lourenço 2002. *In* Adis [ed.], Amazonian Arachnida and Myriapoda, pp. 399–438. Pensoft Publishers, Moscow). Scorpions are mainly insectivorous, but small vertebrates can be part of their diet (Cândido 1999. *In* Joly and Bicudo [eds.], Biodiversidade do Estado de São Paulo, pp. 25–34. Fundação de Amparo à Pesquisa do Estado de São Paulo, São Paulo). A predation event on *Hemidactylus mabouya* by *Tityus metuendus* is reported here.

On 16 December 2009 in a residence located in the suburbs of the municipality of Porto Velho, state of Rondônia, northern Brazil (08.7619°S, 63.9038° W) surrounded by forest, a female *H. mabouia* (SVL = 0.8 mm) was observed at ca. 2200 h being attacked by a female *T. metuendus* (SVL = 60.7 mm) on an external wooden wall at the back of the residence, at approximately 110 cm above the ground.

At the moment of observation, the lizard was still struggling, dying minutes later from the scorpion's venom. There were other specimens of *H. mabouia* nearby, foraging under the residence's light. The two specimens observed in the predator-prey interaction were collected and deposited as vouchers in the herpetological collection of Universidade Federal do Acre (*H. mabouia*, UFACF 2471) and invertebrate collection of Instituto de Pesquisas da Amazônia, INPA (*T. metuendus*, INPA 0723).

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***HEMIDACTYLUS MABOUIA* (Wood Slave). PREDATION.** *Hemidactylus mabouia* is native to Africa, widely distributed in the Americas (Vanzolini 1978. Pap. Avul. Zool. 3:307–343). It is found in different ecosystems in Brazil, mainly inhabiting urbanized areas (Rocha and Anjos 2007. Braz. J. Biol. 67:485–491; Rocha et al. 2011. Zoologia 28:747–754). *H. mabouia* appears to be an important prey item for some *Tropidurus* species, having been reported in the diet of *T. torquatus* in dune areas of the Brazilian coast (Araújo 1991. Rev. Brasil. Biol. 51:857–65). *Tropidurus hispidus* is a relatively large lizard reaching 35 cm total length (Freitas and Silva 2005. *In* Guia Ilustrado. A Herpetofauna da Mata Atlântica Nordestina. 161 pp.), and is a habitat generalist, often occuring near human dwellings (Rodrigues 1987. Arq. Zool. 31:105–230). The diet of *T. hispidus* consists mainly of insects, millipedes, gastropods, plant matter, and small vertebrates (Riberiro and Freire 2011. Iheringia, Sér. Zool. 101:225–232; Vanzolini et al. 1980. *In* Répteis das Caatingas. 161 pp.; Vitt 1995. Occas. Papers. Oklahoma Mus.Nat. Hist. 1:1–29).



PHOTO BY LEONARDO BARBOSA DA SILVA

FIG. 1. Predation of *Hemidactylus mabouia* by *Tropidurus hispidus* in the Parque Estadual Dois Irmãos, Recife city, Pernambuco, Brazil.

On 22 April 2011 at 1320 h, we observed a *T. hispidus* chasing a *H. mabouia* on a tree trunk. The decomposing trunk was a height of about 1.50 m from the ground on the edge of a forested area located in the Parque Estadual de Dois Irmãos, Recife City, Pernambuco, Brazil (8.001°S, 30.950°W; WGS 84). The gecko was captured by the *Tropidurus* by the hind limbs, followed by the *Tropidurus* grasping the gecko near the head and ingesting it. The predation event took about 5 minutes. This is the first record of predation reported for the species *H. mabouia* by *T. hispidus* in the northeast region of Brazil. The images of predation were filed in the collection of images of Herpetological and Paleoherpetological laboratory of Federal Rural University of Pernambuco - UFRPE, Recife, Pernambuco, Brazil.

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***IPHISA ELEGANS* (Glossy Shade Lizard). ENDOPARASITES.** *Iphisa elegans* is known from parts of Bolivia, Brazil, Colombia, Ecuador, French Guiana, Guyana, Peru, and Surinam (Avila-Pires 1995. Lizards of Brazilian Amazonia (Reptilia: Squamata). Zoologische Verhandelingen 299:1–706). It occurs in leaf and palm litter (Vitt and de la Torre 1998. A Research Guide to the Lizards of Cuyabeno. Museo de Zoologia, Centro de Biodiversidas y Ambiente Pontifica Universidad Católica del Ecuador, Quito. 165 pp.). We know of no reports of helminths for *I. elegans*. The purpose of this note is to establish the initial helminth list for *I. elegans*.

Five *I. elegans* (mean SVL = 38.2 mm ± 13.4 SD, range = 26–59 mm) from the herpetology collection of the Sam Noble Museum (OMNH, The University of Oklahoma, Norman, USA) collected February 1966 (OMNH 36964–36966) and April 1996 (OMNH 36967, 36968) in Brazil, Acre State, (ca. 5.0 km N Porto Walter, 8.25861°S, 72.77694°W, WGS 84; elev. 198 m) were examined for helminths. The stomachs had been previously removed and were not available for examination. The small and large intestine were removed, opened, and examined under a dissecting scope. Only nematodes were found. They were removed, placed separately on microscope slides, cleared in a drop of lactophenol, cover slipped, and studied under a compound microscope. Found were two species of Nematoda, *Cosmocerca vrcibradici*, one each in the large intestines of OMNH 36963 and 36968 (prevalence, number infected/number examined × 100 = 40%) and *Oswaldocruzia vitti*, six and one in the small intestines, of OMNH 36965 and 36967, respectively, prevalence = 40%, mean infection intensity = 3.5 ± 3.5 SD. Helminths were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland, USA, as *Cosmocerca vrcibradici* (USNPC 105758) and *Oswaldocruzia vitti* (USNPC 105759).

Cosmocerca vrcibradici was described from the gymnopthalmid *Prionodactylus eigenmanni* (currently *Cerosaura eigenmanni*) from Rondônia Province, Brazil (Bursey and Goldberg 2004. J. Parasitol. 90:140–145). Other hosts are in Goldberg et al. 2010 (Herpetol. Rev. 41:495–496). *Oswaldocruzia vitti* was described from *P. eigenmanni* from Amazonas Province, Brazil, by Bursey

and Goldberg (*op. cit.*). A partial host list is in Avila and Silva (2010. J. Venom. Anim. Tox. Trop. Dis. 16:543–572); additional hosts include *Arthrosaura reticulata* (Goldberg et al. 2010. Herpetol. Rev. 41:349–350), *Cercosaura ocellata* (Avila and da Silva 2011. Comp. Parasitol. 78:129–139), and *Plica plica* and *P. umbra* (Goldberg et al. 2009. Herpetol. J. 19:49–52). *Iphisa elegans* represents a new host record for *C. vrcibradici* and *O. vitti*.

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***LAUDAKIA STELLIO* (Roughtail Rock Agama). PARENTAL CARE.** Parental behavior, in various forms, has been documented in both oviparous and viviparous squamate species (Somma 2003a. The Linnean 19:42–46). Among agamids, only a few species are known to express parental behavior, mostly defending broods (e.g., *Uromastyx acanthinura* and *Pseudotrapelus sinaitus*), social assistance (e.g., *Agama agama*) and parental care (e.g., *Leiolepis belliana*) of neonates (Mendelssohn and Bouskila 1989. Comparative Ecology of *Uromastyx aegyptius* and *Uromastyx ornatus* in Southern Israel and Southern Sinai. First World Congress of Herpetology, Univ. of Kent, Canterbury, UK. [abstract]; Somma 2003b. Parental Behavior in Lepidosaurian and Testudinian Reptiles. Krieger Publ. Co., Malabar, Florida. 174 pp.). We have recently observed a new form of parental treatment in the Roughtail Rock Agama (*Laudakia stellio*), a species for which parental care has never been documented in the past to our knowledge.

PHOTO BY: ZOHAR YANAI



FIG. 1. A) An adult *Laudakia stellio* observed standing at the nest chamber entrance; B) the egg found inside the nest chamber.

The observation took place during the late morning hours of summer 2010, in a private garden in Pardes Hanna, Israel (32.2755°N, 58.3418°E).An individual *L. stellio* (gender unknown) was observed coming out of a nest chamber dug in the soil (Fig. 1). The chamber, about 10 cm deep, was placed in an eolianite plot (also known as kurkar), a common soil type along the coastal plain of Israel. This chamber was located in the middle of a bare, plain flowerbed, in an area where human, canine, and avian activity commonly occurs. The agama entered the nest chamber and came out holding an egg in its mouth. The egg was white, oval, and approximately 2 cm long. While the agama was holding the former egg in its mouth, another one was left in the chamber (Fig. 2). Upon noticing the observer (ZY), the lizard hastily dropped the egg and ran away. A few minutes later, after the observer moved away, the lizard returned and transferred both eggs (the one deserted on the surface and the other left in the chamber) into a safer location between nearby bushes.

In Israel, agamid species are known to avoid bare, plain, and homogeneous habitats (e.g., Arbel 1984. Plants and Animals of the Land of Israel. Vol. 5: Reptiles and Amphibians. Ministry of Defense, Israel. 244 pp.; Bouskila and Amitai 2006. Handbook of Amphibians and Reptiles of Israel. 3rd ed. Keter Publishing House, Jerusalem. 345 pp.; Schleich et al. 1996. Amphibians and Reptiles of North Africa. Koeltz Scientific Publishers, Koenigstein. 629 pp.). Therefore, the flowerbed, characterized by these features (Fig. 1), was probably not an optimal nesting site and thus we assume that this individual preferred to move its eggs to a safer or more appropriate site.

In this report we present two novel observations. First, the eggs were relocated to a more favorable nest site—a type of behavior already reported (Somma 2003b, *op. cit.*) as ME (manipulation or retrieval of eggs) for other squamates (e.g., Anguidae), but has never been observed in agamids. Second, this is the first documentation of any parental behavior for *L. stellio*. However, we must take into consideration that this observation may have potentially been an example of intraspecific competition, in which an individual sabotages another individual's brood. This interpretation is less likely, because we assume that if that was the case, the eggs would have been consumed, rather than moved, by the observed individual.

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***LEPIDOPHYMA MICROPHOLIS* (Cave Tropical Night Lizard). ENDOPARASITES.** *Lepidophyma micropholis* is known from San Luis Potosí and Tamaulipas, Mexico (Flores Villela and Gerez 1994. Biodiversidad y Conservacíon en México: Vertebrados, Vegetacíon uso del Suelo. Comision Nacional para el Conocimiento y Uso de la Biodiversidad y Universidad Nacional Autónoma de Mexico, Ciudad Universitaria, México, D.F. 439 pp.). The purpose of this note is to establish the initial helminth list for *L. micropholis*.

One *L. micropholis* female (SVL = 75 mm) from 8.6 km S of Valles, 2.0 km E of Hwy 89 (21.9877664°N, 99.0012607°W, datum WGS 84; elev. 2411 m) was collected in May 1981 and deposited in the Texas Cooperative Wildlife Collection (TCWC), Texas A&M University, College Station, Texas, USA as TCWC 59926. Four nematodes (1 male, 3 females) were visible through the wall of the large intestine. They were removed through a small incision in the intestinal wall, cleared in glycerol on a microscope slide, cover slipped, and studied under a compound microscope. Voucher helminths were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland, USA.

The nematodes were identified as *Aplectana herediaensis* and were deposited as USNPC (104768). *Aplectana herediaensis* was described from *Lepidophyma flavimaculatum* from Costa Rica (Bursey et al. 2006. Carib. J. Sci. 42:164–170). It was later found in *L. flavimaculatum* from Panama (Bursey et al. 2007. Comp. Parasitol. 74:108–140). *Aplectana* is a cosmocercoid nematode with no intermediate host; infection occurs by ingestion of eggs (Anderson 2000. Nematode Parasites of Vertebrates. Their Development and Transmission. 2nd Ed. CABI Publishing, Wallingford, Oxon, UK. 650 pp.). *Lepidophyma micropholis* represents a new host record for *A. herediaensis*; Mexico is a new locality record.

We thank T. Hibbitts (TCWC) for permission to examine *Lepidophyma micropholis*.

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***LEPIDOPHYMA MICROPHOLIS* (Cave Tropical Night Lizard). REPRODUCTION.** *Lepidophyma micropholis* is known from San Luis Potosi and Tamaulipas, Mexico (Flores Villela and Gerez 1994. Biodiversidad y Conservacíon en México: Vertebrados, Vegetacíon y uso del Suelo. Comision Nacional para el Conocimiento y uso de la Biodiversidad y Universidad Nacional Autónoma de Mexico. Ciudad Universitaria, México, D.F. 439 pp.). To my knowledge, there is no information on the reproduction of *L. micropholis*. The purpose of this note is to provide information on the reproductive cycle of *L. micropholis*.

A sample of 11 *L. micropholis* was examined, consisting of three adult males (mean SVL = 99.3 mm ± 5.5 SD; range = 93–103 mm), six adult females (mean SVL = 95.7 mm ± 5.3 SD; range = 88–100 mm), one subadult female (SVL = 75 mm), and one neonate (SVL = 28 mm), all collected in May 1981, from 8.6 km S of Valles, 2.0 km E of Hwy 89 (21.9877664°N, 99.0012607°W, datum WGS 84; elev. 2411 m) and deposited in the Texas Cooperative Wildlife Collection (TCWC), Texas A&M University, College Station, Texas, USA as: TCWC 59923–59926, 59962, 59963, 59965, 59975, 59976, 60766, 60767.

One gonad from each *L. micropholis* was removed for histological examination except for gravid females in which enlarged ovarian follicles (> 5 mm), oviductal eggs, or embryos were counted. Tissues were embedded in paraffin, sections cut at 5 µm, and stained by Harris hematoxylin, followed by eosin counterstain. Histology slides were deposited in TCWC.

Like other xantusiids, *L. micropholis* is viviparous (Vitt and Caldwell 2009. Herpetology, 3rd ed. Academic Press, Elsevier, Amsterdam. 697 pp.). All six adult female *L. micropholis* were gravid (mean litter size = 5.3 ± 2.7 SD, range = 3–10) with parturition due in late spring or, perhaps, early summer. One subadult female was not reproductively active. One neonate *L. micropholis* was collected in May. This agrees with the timing of parturition in other species of *Lepidophyma* (Goldberg 2009. Phyllomedusa 8:59–62). Testes of male *L. micropholis* were regressed, with seminiferous tubules containing spermatogonia. Whether the timing of sperm production in *L. micropholis* is consistent with other congeneric species in which spermiogenesis occurs in summer or autumn (Goldberg, *op. cit.*) will require histological examination of *L. micropholis* testes from this period.

I thank T. Hibbitts (TCWC) for permission to examine *L. micropholis*.

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***PETROSAURUS THALASSINUS* (San Lucan Banded Rock Lizard). LIMB REGENERATION.** One of the most well-known predator defense mechanisms employed by lizards is tail autotomy, accompanied by tail regeneration (Pianka and Vitt 2003. Lizards, Windows to the Evolution of Diversity. University of California Press, Berkeley. 333 pp.). However, limb regeneration can occur, and has been observed in such genera as *Lacerta*, *Liolaemus*, and *Sceloporus* (Bellairs and Bryant 1985. *In* C. Gans and F. Billett [eds.], Biology of the Reptilia, Vol. 15, Development B, pp. 387–392. John Wiley & Sons, New York), and *Ctenosaura* (Pasachnik 2011. Herpetol. Rev. 42:600). There are no reports of limb regeneration in lizards of the genus *Petrosaurus*.

We captured a sub-adult female *P. thalassinus* (SVL: 87 mm, TL: 98 mm, 17 g) on 14 April 2012, at El Chorro, 3.40 km W of Agua



FIG. 1. *Petrosaurus thalassinus* with a partially regenerated hind limb observed at El Chorro, Agua Caliente, Baja California Sur, México.

Caliente, Baja California Sur, México (23.43949°N, 109.80876°W; WGS84; 204 m. elev.). The left hind limb of the individual appeared to be regenerated and looked much more like that of a regenerated tail (Fig. 1). In some lizard species, the hind limbs are longer and typically more robust than the fore limbs, providing most of the propulsive force during locomotion (Pough et al. 2004. Herpetology, 3rd ed. Prentice Hall, Upper Saddle River, New Jersey. 726 pp.); nevertheless this individual did not seem to be disadvantaged by its deformity, as it was observed to climb and run like a normal *Petrosaurus*. A photo image was deposited in the La Sierra University Digital Photo Collection (LSUHCDPC 6331) and Centro de Investigaciones Biológicas del Noroeste Herpetological Collection (CIB 1476).

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***PLESTIODON EGREGIUS* (Mole Skink). MATING ACTIVITY.** Unlike most lizards native to the southeastern United States, Mole Skinks typically have peak courtship and mating activity during the cooler months of fall and winter (Mount 1963. Amer. Midl. Nat. 70:356–385). Mount (*op. cit.*) reported the onset of mating at his Levy Co., Florida study site as "sometime during September and October," and that sexually active male Mole Skinks were collected from the Fall Line Hills region of Georgia in September.

On a late summer afternoon (28 August 2009; high temperature for the day: 27°C), at Fall Line Sandhills Wildlife Management Area, Taylor Co., Georgia, USA (32.570384°N, 84.407161°W), we observed an adult male Mole Skink that had seized an adult female Mole Skink in his jaws, just posterior to her front left leg (Fig. 1). Although we did not observe actual mating, biting and seizure of the female by the male in her anterior trunk region is characteristic of previously documented courtship immediately prior to mating (Mount, *op. cit.*). We believe this represents the earliest report of mating in this species and the only occurrence of such activity during summer.

Additionally, due to the clear vulnerability Mole Skinks would present to potential predators while copulating, and because he never observed sexual activity of this species in the wild, Mount (*op. cit.*) suggested that perhaps *P. egregius* normally mates in sheltered situations such as inside Gopher Tortoise (*Gopherus polyphemus*) burrows and Southeastern Pocket Gopher (*Geomys pinetis*) tunnels. While that may indeed be the norm, the pair we observed were highly exposed on the surface in the middle of a sandy, vegetation-free road; the adjacent habitat was open-canopied xeric sandill dominated by Turkey Oak (*Quercus laevis*) and Longleaf Pine (*Pinus palustris*).

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***PLESTIODON INEXPECTATUS* (Southeastern Five-lined Skink). BIFURCATION.** Caudal bifurcation is considered to be a common phenomenon in lizards (Kumbar and Ghadage 2011. Herpetol. Rev. 42:94 and references therein; Mata-Silva et al. 2010. Herpetol. Rev. 41:352; Smith 1946. Handbook of Lizards of the United States and Canada, Cornell Univ. Press, Ithaca, New York. 557 pp.). Skinks seem especially prone to tail loss, regeneration, and bifurcation, and several permutations have been published and illustrated (e.g., Scott 1982. Herpetol. Rev. 13:46; Taylor 1935. Univ. Kansas Sci. 23:1–643; Walley 1997. Bull. Maryland Herpetol. Soc. 33:178–180). Here we describe an extreme example of caudal bifurcation in *P. inexpectatus*.

On 17 March 2012, we observed an adult female *P. inexpectatus* with two tails on a suburban porch in Davenport, Polk Co., Florida, USA (28.205522°N, 81.567944°W; NAD 84). The lizard was observed frequently over a period of several weeks. The bifurcation occurred at the base of the tail and resulted in two tails of approximately the same diameter and length (Fig. 1). Based on pattern and scalation, the left tail appeared to be the original one with the regenerated right tail articulating with the original immediately posterior to the cloaca. In addition, the left tail appears to have been broken just distal to the base with subsequent regeneration and again about 1.5–2 cm distally from that breakage plane with additional regeneration. This is the first report of caudal bifurcation in *P. inexpectatus* from Florida.

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FIG. 1. Courtship by male *Plestiodon egregius* biting and seizing female, Taylor Co., Georgia, USA.



FIG. 1. A female *Plestiodon inexpectatus* from Polk Co., Florida, expressing caudal bifurcation.

***PLESTIODON MULTIVIRGATUS* (Many-lined Skink). ENDOPARASITES.** *Plestiodon multivirgatus* is known from southern South Dakota to west Texas and Chihuahua, Mexico through New Mexico to southeastern Utah and central Arizona where it lives in a variety of habitats from 910 to ca. 2620 m elev. (Lemos Espinal and Smith 2007. Amphibians and Reptiles of the State of Chihuahua, Mexico. Universidad Nacional Autónoma de México. Los Reyes Iztacala Tlalnepantla, Edo. de México, México. 613 pp.; Stebbins 2003. A Field Guide to Western Reptiles and Amphibians. Houghton Mifflin, Boston, Massachusetts. 533 pp.). We know of no helminth records for *P. multivirgatus*. The purpose of this note is to establish the initial helminth list for *P. multivirgatus*.

The coelomic cavity of one male *P. multivirgatus* (SVL = 58 mm) collected in Bernalillo Co., New Mexico, USA in August 1949 and deposited in the herpetology collection of the County Natural History Museum of Los Angeles County (LACM), Los Angeles, California, USA, as LACM 14912 was examined.

The body cavity was opened and visually examined for helminths. One oval shaped whitish endoparasite ca. 2 mm in length was found. It was studied under a dissecting microscope. Based on body shape, pseudoannulation, and hook root morphology it was identified as an oligacanthorhynchid acanthocephalan cystacanth. It was deposited in the United States National Parasite Collection, Beltsville, Maryland, USA, as USNPC 105791.

Acanthocephalans require an arthropod intermediate host in which the cystacanth develops (Kennedy 2006. Ecology of the Acanthocephala. Cambridge University Press, Cambridge, UK. 249 pp.). Lizards become infected by ingesting an infected insect. Development to the adult acanthocephalan occurs when the infected lizard is eaten by a definitive host. Because the cystacanth does not develop in the lizard, they likely serve as paratenic (transport) hosts. *Plestiodon multivirgatus* represents a new host record for oligacanthorhynchid cystacanths.

We thank Christine Thacker (LACM) for permission to examine *P. multivirgatus*.

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***SCELOPORUS CLARKII* (Clark's Spiny Lizard). BODY TEMPERATURE.** *Sceloporus clarkii* is a medium-large arboreal lizard that inhabits a wide variety of habitats, from sea level to about 1840 m (Stebbins 2003. A Field Guide to Western Reptiles and Amphibians. 3rd ed. Houghton Mifflin, New York. 533 pp.). Little is known about ecology of this lizard, and even less about the thermal ecology within island populations. Here we present data on *S. clarkii* thermal ecology from Isabel Island, México.

During 15–17 April 2008, we conducted fieldwork in the Parque Nacional Isla Isabel (PNII) off the coast of Nayarit, México (21.84699°N, 105.88447°W, elev. 20 m, datum: WGS84). PNII is a small volcanic island dominated by tropical deciduous forest vegetation (e.g., *Crataeva tapia* and *Euphorbia schlechtendalii*), grasses, and volcanic rocks (CONANP 2005. Programa de Conservación y Manejo Parque Nacional Isla Isabel. México. 164 pp.). Data are based on 33 captures (12 females and 21 males) made between 800 and 1800 h on sunny days. Adult individuals were captured by noosing. For each capture, we measured body temperature (T_b) and air temperature (T_a) with a thermocouple of a quick-reading thermometer (Fluke 52 K/J type), and substrate temperature (T_s) with non-contact infrared thermometer (EXTECH instruments, Model 42529 ± 1°C). We took T_s at the exact point where the animal was first sighted and T_a 2 cm above the substrate, both immediately following capture. We also recorded snout vent length (SVL), sex, activity time, microhabitat type and perch light (full sunlight, filtered sunlight and full shade) for each individual.

Mean SVL was 78.6 mm (SD = 10.4, range: 57–99 mm, N = 33). Mean body temperature was 33.7°C (SD = 2.7, range: 26.9–36.6°C). No significant differences in T_b were found between sexes (t-Student, t = 1.4, $P = 0.17$). Mean air temperatures was 25.2°C (SD = 1.2, range: 23.4–28.5°C). Mean substrate temperatures was 33.1°C (SD = 3.8, range: 25–43°C). Body size did not have a significant influence on T_b (Spearman Rank Correlation, $r_s = -0.34$, $P>0.06$). Body temperature and T_s were significantly correlated (Spearman Rank Correlation, $r_s = 0.65$, $P < 0.0001$), but T_b and T_a were not (Spearman Rank Correlation, $r_s = 0.11$, $P > 0.05$). Most lizards were found on trees (N = 20), followed by rocks (N = 12), and ground (N = 1); and perched more frequently in full sunlight microhabitats (N = 19), followed by full shade (N = 9) and filtered sunlight (N = 5).

The positive correlation between T_b and T_s supports the well-known fact that *S. clarkii* is a thigmothermic species that gains heat by moving between substrates with different sunlight categories. This species presents a mean body temperature found within the range for other *Sceloporus* species: 28.6–37°C (Andrews 1998. J. Therm. Biol. 23[6]:329–334). Compared with other *Sceloporus* species on islands in the Gulf of California, the mean T_b for *S. clarkii* was lower (e.g., *S. orcutti* = 34.5°C and *S. grandaevus* = 35.7°C; Soulé 1963. Copeia 1963:107–115).

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***SCELOPORUS VARIABILIS* (Rose-bellied Lizard). PREY.** On 28 January 2012 just south of Playa Gigante, Departamento de



PHOTO BY M. E. BABCOCK

FIG. 1. Predation of a juvenile *Aspidoscelis deppii* by an adult male *Sceloporus variabilis*.

Rivas, Nicaragua (11.38279°N, 86.02512°W; WGS84), one of us (MF) observed and photographed an adult male *Sceloporus variabilis* predating a juvenile *Aspidoscelis deppii*. The juvenile whiptail was being consumed head-end first. The entire predation event took about 10 minutes. These two species commonly co-occur in arid habitats in Central America (Köhler 2008. Reptiles of Central America. Herpeton. Offenbach, Germany. 400 pp.). *Sceloporus variabilis* is known to feed on a variety of insects and other arthropods (Fitch 1973. Univ. Kansas Sci. Bull. 50:39–126; Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna between Two Continents, between Two Seas. Univ. Chicago Press. Chicago, Illinois. 934 pp.). This is the first published account of saurophagy in *S. variabilis*.

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***TILIQUA ADELAIDENSIS* (Pygmy Bluetongue Lizard). ALTERNATE REFUGE.** Suitable refuges can be critical for most animal species because they provide protection from predators and climate extremes (Grillet et al. 2010. Biodiv. Conserv. 19:2039–2051). Some species can construct their own shelters while others rely on burrows or structures built by other animals (Kotler et al. 2004. Ecology 85:917–922). The distribution of an animal is thus highly dependent on the availability of refugia and distribution of the refuge building species (Souter et al. 2004. Biol. Conserv. 116:403–408). One example is an endangered scincid lizard from South Australia, *Tiliqua adelaidensis*. This lizard normally uses burrows built by lycosid and mygalomorph spiders. The lizard uses these burrows as refuges, and basks at the burrow entrances, ambushing passing invertebrate prey (Fig. 1) (Milne et al. 2003. Wildl. Res. 30:523–528). Lizards of this species prefer deeper burrows (>30 cm in depth) (Fig. 2) with entrance diameters slightly wider than their head width (average 15.1 mm) (Milne and Bull 2000. Biol. Conserv. 95:295–301). In this note we describe observations of an alternate natural burrow system that can be used by *T. adelaidensis* and that might increase the range of options for the optimal management of existing populations, and for the possible selection of translocation sites.

On 25 October 2009, we moved eight male and eight female *T. adelaidensis* into four 15-m diameter circular cages in Monarto Zoo (35.10°S 139.15°E) approximately 70 km SE of Adelaide, South Australia. The cages had galvanized iron walls, 1 m high, that were buried 15 cm under the ground surface. Two male and two female lizards were released into each cage. There were no natural burrows in the cages initially. Instead we constructed artificial burrows from 30 cm lengths of wooden dowling with a drilled out center of 2 cm internal diameter (Fig. 3). Previous studies have shown *T. adelaidensis* accept and use these artificial



FIG. 1. Pygmy Bluetongue Lizard basking at the entrance of a natural burrow.



FIG. 2. A natural burrow built by a lycosid spider.



FIG. 3. A) Pygmy Bluetongue Lizard feeding at the entrance of an artificial burrow; B) an artificial burrow.



FIG. 4. A mouse hole.

burrows (Milne et al. 2003. J. Herpetol. 37:762–765; Souter et al., *op. cit.*). Seventy-one artificial burrows were hammered vertically into the ground in each cage. Experiments, set up to measure the responses of the lizards to various environmental conditions in the cages, are reported elsewhere (Ebrahimi and Bull 2012. Trans. Royal Soc. S. Australia 136:45–49; Ebrahimi et al. 2012. Wildl. Res. 39:295–300). We inspected each cage daily and removed any mice (*Mus musculus*) that had burrowed under the cage wall, and filled in any burrows they had made (Fig. 4). During two lizard seasons at Monarto Zoo we caught 57 mice (35 in 2009–2010; 22 in 2010–2011) inside the cages. Ninety mouse holes were composed of short tunnels under the cage walls with one entrance inside and the other outside the cage. Fourteen mouse nests were found within the cages (10 in the first season; 4 in the second season) with one or two entrances inside the cages. Two of those nests were unoccupied when discovered, but 10 nests were found with a single mouse, and two had two mice. In the 2010–2011 lizard season the average diameter of 40 mouse hole entrances was 2.14 ± 0.016 cm. We found two male lizards, in the second season at Monarto, one on 22 December 2010 and the other on 27 January 2011, basking at the entrance of mouse holes inside a cage while other lizards basked at the entrance of artificial burrows. Both lizards were caught and released back into the central area of the cage, and the entrance diameters of the mouse holes were measured (each was 2.0 cm) as they were destroyed. We did not find any mice inside these burrows. One of the mouse burrows was 85 cm long and 25.5 cm below the ground at its deepest point. It had an enlarged underground chamber and another entrance outside the cage. The other was 95 cm long, 35 cm deep, had two enlarged chambers, and had a second entrance (2.2 cm diameter) inside the cage. The two entrances of this second mouse hole were about 80 cm apart. We could not prolong our observations of the lizards in these alternative refuges because we needed to prevent them escaping from their enclosures.

Other observations were conducted over the lizard season of 2009–2010, in three 1-ha^2 areas within a natural population of *T. adelaidensis* located 9 km from Burra (33.683°S 138.933°E), South Australia. Fences and pitfall traps were established around each area (15 cm high black plastic drift fencing; 16 pitfalls, each 30 cm diameter and 40 cm deep placed along each side of each 1-ha quadrat), as part of a study of lizard population dynamics. We used an Olympus IF8D4X2-10L optic fiber scope to inspect each natural burrow within each area for burrow residents. Among the lizard captures we also trapped 90 mice in the pitfalls and we located and measured the entrance diameter (3.15 ± 0.14 cm) of 19 mouse holes within the study quadrats. Two mouse holes had 2.2 cm diameter entrances, within the range of entrance diameters preferred by adult lizards (Milne and Bull 2000, *op. cit.*). The fiberscope had a functional length of 35 cm, and each of the mouse holes extended beyond that length. Thus we could not determine if any mouse holes were occupied by lizards. Nevertheless, mice provided burrows that may have provided alternative refuges for *T. adelaidensis* in a natural field population. Many studies that have noted the importance of rocks, logs, rodent burrows, cervices, dead leaves, and thick bushes as a potential shelter sites for squamate reptiles (Grillet et al. 2010, *op. cit.*; Webb and Shine 2000. Biol. Conserv. 92:93–99), but some species are more specific in their choice of refugia. Previous reports have suggested that *T. adelaidensis* uses only spider burrows (Hutchinson et al. 1994. Trans. Royal Soc. S. Australia 118:217–226). Our observations in this report indicate this lizard will use another kind of shelter, in the form of mouse tunnels.

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***VARANUS GOULDII* (Sand Monitor) and *VARANUS PANOPTES* (Yellow-spotted Monitor). PREDATION.** Identifying trophic links is critical to understanding multiple areas of ecology, including food webs, predator-prey dynamics, and the impacts of invasive species. In tropical areas trophic links are often unknown or putative, and this is true of the Australian wet-dry tropics.

Varanus gouldii is a moderate-sized lizard (up to 1.6 m in total length) that inhabits adjacent open savannah, as well as sandhills, rocky areas, and desert habitats across much of Australia (Cogger 2000. Reptiles and Amphibians of Australia. Reed New Holland, Sydney. 808 pp.). *Varanus panoptes* is a larger-bodied species (up to 1.5 m in total length) inhabiting riparian areas and floodplains in tropical Australia (Cogger 2000, *op. cit.*). Although few predators are large enough to prey upon these species as adults, eagles are an exception. Herein we report monitor lizard predation by two Australian eagle species, based on prey item surveys at eagle nests, and an observation of predation near a nest at five sites in Western Australia (WA). We discuss the importance of monitor lizards as prey for eagles, and implications for the declines in monitors with the arrival of invasive Cane Toads (*Bufo marinus*) in northern WA.

On 16 May 2011 a male White-bellied Sea Eagle (*Haliaeetus leucogaster*) was observed feeding on a large (>40 cm SVL) *V. panoptes* near its nest at the junction of the Chamberlain and Pentecost rivers at El Questro Wilderness Park in the Kimberley Region (15.968847°S, 127.928739°E). The eagle carried the lizard between two high tree perches within 100 m of the nest. The sex of the lizard could not be determined, but based on size it was either a small adult male or a large adult female. The nest was ca. 30 m high in a *Eucalyptus* tree. On 27 May the nest tree was climbed, revealing two eggs, and both the male and female were seen repeatedly near the nest between the date of discovery and the date climbed. Prey remains under nest and perch trees included two individuals of the Northwest Red-faced Turtle, *Emydura australis*, a flying fox (*Pteropus* sp.), and various fish scales. Although it is possible that the eagle found the lizard as carrion, the prey item was well within the prey-size range of the raptor.

The contents of three Wedge-tailed Eagle (*Aquila audax*) nests near a breakaway (butte) on Mileura Station in the Murchison-Gascone Region of Western Australia (26.412168°S, 117.199255°E) were examined in June 2010, following breeding events in 2008 and 2009. Prey remains were analyzed by comparison to a reference collection of skeletal material and the number and species of prey animals identified. Data from the 2008 breeding event at one nest indicated the eagles had fed upon one large (>40 cm SVL) *V. panoptes*, as well as seven juvenile Euros (*Macropus robustus*) and two juvenile Feral Goats (*Capra hircus*). Data from two nests representing 2009 breeding diet revealed a total of eight monitor lizards: two *V. panoptes* from one nest and six unidentified varanids (either *V. panoptes* or *V. gouldii*) from the second nest, all having SVL of >40 cm. Other remains identified were those of juvenile *Macropus* spp. (N = 15), Feral Goats (N = 8), European Rabbit (*Oryctolagus cuniculus*) (N = 2), and a nestling Australian Kestrel (*Falco cenchroides*) (N = 1).

Another study in similar habitat conducted during October 2011 aimed to research potential impacts of eagles preying on reintroduced threatened mammals at a conservation reserve. Twenty-six individual animals were identified as eagle prey from a single 2011 breeding event at a single *A. audax* nest. Of these, five were monitor lizards (either *V. panoptes* and/or *V. gouldii*, based on location). Based on size, two of the monitors identified from large vertebrae and large claws were almost certainly *V. panoptes*, having an approximate SVL of >50 cm.

Two *A. audax* nests belonging to the same breeding pair of eagles were located near Chidlow in the Perth Hills Region (31.862433°S, 116.269298°E). The nests were climbed in two separate breeding years to examine food items in a study investigating the number of mammal species consumed at the edge of a wildlife sanctuary containing endangered species. In 2004, the carcass of one *V. gouldii* was identified at one nest, and in 2005 at the second nest, another single *V. gouldii* was noted. The total size and sex of these animals was unknown but the size of the vertebrae of the first individual indicated it was probably >30 cm SVL. Most other items observed in the nests were those of mammals and birds which formed a greater portion of eagle diet in this closed forest habitat (Cherriman 2007. Honours Thesis, Curtin University, Perth).

Dietary remains were collected from three *A. audax* nests within 25 km from the town of Narrogin in the Narrogin Region (32.931075°S, 117.179317°E) by an officer from the Department of Environment and Conservation of Western Australia, and sent to S. Cherriman for identification. These items represented breeding diet from 2006 and 2007. A total of five individual varanids (either *V. gouldii* and/or *V. rosenbergi*) were identified in the sample, one of which had a SVL <40 cm. Other prey animals eaten at all three nests included *Macropus* spp. (N = 71), rabbits (N = 49), birds (N = 29), Common Brushtail Possums (*Trichosurus vulpecula*) (N = 19), sheep (N = 10), skinks (N = 8), and agamid spp. (N = 3).

Both eagle species are previously unreported predators of *V. panoptes*, while *A. audax* has been reported to prey upon *V. gouldi* and the Lace Monitor, *V. varius* (Brooker and Ridpatch 1980. Austral. Wildl. Res. 7:433–452; Leopold and Wolfe 1970. Austral. Wildl. Res. 15:1–17). The lack of *V. panoptes* as a reported prey item for these species probably reflects the dearth of dietary studies in tropical Australia, rather than an infrequent trophic interaction. Large monitor lizards such as *V. gouldii* and *V. panoptes* are apparently important prey items for these eagles (Brooker and Ridpath 1980, *op. cit.*; Silva and Croft 2007. Corella 31:23–31). *Varanus panoptes* is one of three species of Australian monitor lizards that suffer severe population-level declines, via lethal toxic ingestion, with the invasion of *Bufo marinus* (e.g., 83–96%, Doody et al. 2009. Anim. Conserv. 12:46–53). Other Australian monitor lizard species such as *V. gouldii* also die when trying to consume *B. marinus*, although the effect on populations has not been quantified. In the case of severe population declines in *V. panoptes*, invading Cane Toads are essentially removing an important prey item for at least sea eagles, potentially influencing the energetics and reproductive success of these apex predators. At the very least we predict a significant shift in the diet in sea eagles as a result of toad invasion and declines in *V. panoptes*. Since the toad has not yet invaded most of the Kimberley Region, but is likely to do so within the next decade, dietary surveys of eagle nests before and after toad invasion in the Kimberley Region would test this prediction.

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SQUAMATA — SNAKES

***BOA CONSTRICTOR* (Boa Constrictor). AQUATIC HABITAT USE.** *Boa constrictor* is a large arboreal and terrestrial boid with a broad geographic distribution extending from northern Mexico into South America as far as Peru, Argentina, and Uruguay (McCranie 2011. The Snakes of Honduras. Systematics, Distribution, and Conservation. SSAR, Ithaca, New York. x + 714 pp.). On 28 April 2011, we visited Pedernales, a small village on the southwestern shore of Lago de Yojoa, in Santa Bárbara, Honduras (14.814194°N, 88.010750°W, datum WGS84; elev. 650 m). We inquired about snakes from several members of a crew of workers who were removing dense growths of the introduced water hyancinth (*Eichhornia crassipes*) from the lake. Two of those workers quickly produced a small (total length = 943 mm) dead *B. constrictor* (UNAH 5652) that they had killed that morning. According to the workers, the *B. constrictor* was coiled in the water hyacinths and partially submerged in the lake when it was found. The same workers also showed us a similarly-sized decomposing *B. constrictor* they had found in a similar situation several days earlier. Those two snakes were killed at the height of the dry season. Perhaps the boas had chosen the water hyacinth mats as a refuge from the mostly open and dry deforested surroundings of the lake. McCranie (*op. cit.*) reported finding boas submerged in a small stream and a shallow river in Honduras, but those situations were in primary humid lowland rainforest.

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***BOA CONSTRICTOR* (Boa Constrictor). DIET.** Diet is one of the most heavily studied aspects of snake ecology. Though strictly carnivorous, snakes feed on a wide variety of prey and may be dietary specialists or generalists. On 13 January 2006, a wounded juvenile *Boa constrictor* (SVL = 438 mm; tail length = 52 mm) was found near a group of Mango Trees on Pici Campus, Fortaleza, Ceará, Brazil. Dissection of the stomach revealed a bird, *Troglodytes musculus* (Southern House Wren or Rouxinol; 110 mm in length) (Fig. 1). Previous studies of *B. constrictor* indicate that

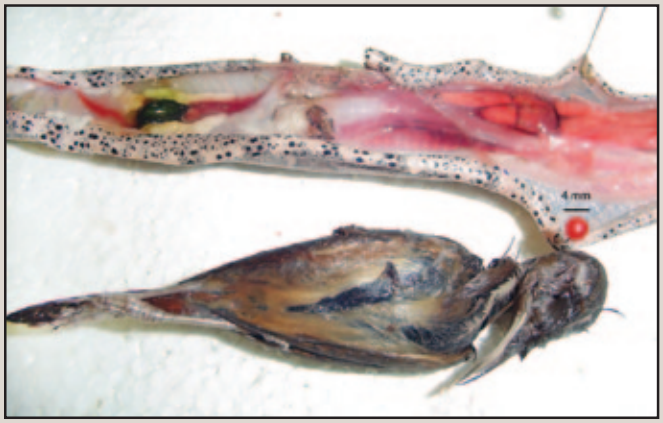


FIG. 1. *Troglodytes musculus* (Southern House Wren) recovered from the stomach of a juvenile *Boa constrictor* from Brazil.

this species is a dietary generalist, including mammals, reptiles, and especially birds as prey (Boback et al., 2000. Herpetol. Rev. 31:244–245; Greene 1997. Snakes: The Evolution of Mystery in Nature. Univ. California Press, Berkeley. 351 pp.; Quick et al. 2005. J. Herpetol. 39:304–307). This observation represents the first case of predation on *T. musculus* by *B. constrictor*. Both specimens are deposited in the herpetological collection, Núcleo Regional de Ofiologia, Universidade Federal do Ceará (CHUFC 2629).

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BOGERTOPHIS ROSALIAE **(Baja California Rat Snake). REPRODUCTION.** *Bogertophis rosaliae* occurs in the Peninsular Ranges from Imperial Co., California south to Cabo San Lucas, Baja California Sur, Mexico (Grismer 2002. Amphibians and Reptiles of Baja California Including its Pacific Islands and the Islands in the Sea of Cortés. Univ. California Press, Berkeley. 399 pp.). The purpose of this note is to add information on the reproductive biology of *B. rosaliae*.

Specimens were examined from the herpetology collections of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California, Museum of Vertebrate Zoology (MVZ), University of California, Berkeley, California, and the San Diego Society of Natural History (SDSNH), San Diego, California. A portion of the left testis and vas deferens was removed from two males and a portion of the left ovary was removed from one female, embedded in paraffin, cut into 5-µm sections and stained with Harris hematoxylin followed by eosin counterstain. Histology slides were deposited at LACM, MVZ, and SDSNH.

One male (LACM 126095) collected DOR on 10 June 1977 from San Ignacio, Baja California Sur measured 1229 mm SVL. The testes were autolytic and could not be interpreted. The vas deferens contained abundant sperm. A second male (MVZ 10672) collected 11 April 1927 at San Ignacio, Baja California Sur measured 933 mm SVL. The germinal epithelium of the seminiferous tubules was greatly reduced in size and contained only 3-4 layers of cells. There were occasional small and widely separated clusters of sperm, suggesting they were residuals left over from a full spermiogenesis during the previous autumn. The vas deferens contained abundant sperm. The presence of the second male with markedly reduced germinal epithelium and a male (LACM 126095) with abundant sperm in the vasa deferentia may support *B. rosaliae* breeding in the spring as suggested by Grismer (*op. cit.*). One female (SDSNH 68737) collected 19 October 1997 from Arroyo San Gregorio, Baja California Sur measured 1020 mm SVL. The ovarian follicles contained oocytes with vacuoles but no yolk granules. Large coelomic fat deposits were present. It is likely eggs would have been produced the following spring. Ottley and Jacobsen (1983. J. Herpetol. 17:189–190) reported a gravid female collected in May.

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BOIGA IRREGULARIS **(Brown Treesnake). DIET.** The extirpation of Guam's native forest avifauna has been attributed to the accidental introduction of *Boiga irregularis* (Savidge 1987. Ecology 68:660–668). *Boiga irregularis* preys primarily on lizards as juveniles and on birds and mammals as adults; this pattern has been observed both in the native range (Shine 1991. Copeia 1991:120–131) and in the introduced population on Guam (Savidge 1988. J. Herpetol. 22:275–282). However, since the collapse of endothermic prey populations on Guam, the weight of predation has fallen more heavily on lizards (Rodda and Fritts 1992. J. Herpetol. 26:166–174). Since 2000, several anuran species have accidentally been introduced to Guam, potentially constituting an additional food source for invasive *B. irregularis* (Christy et al. 2007. Pac. Sci. 61:469–483). However, actual observations of *B. irregularis* predation upon frogs have been scarce.

During a visual survey at 1946 h on 3 October 2011, an adult male *B. irregularis* (SVL = 1062 mm; 105 g), was observed preying upon an adult female *Polypedates megacephalus* (SVL = 77.2 mm; 22.9 g) while perched 0.1 m above the ground on a branch of *Scaevola sericea*. The snake was initializing ingestion over the head of the prey when encountered, but abandoned ingestion when disturbed by the observers. The snake was found within limestone forest habitat on the Ordnance Annex of Naval Base Guam (13.37535°N, 144.67374°E; datum WGS 84). *Polypedates megacephalus* is naturally distributed in southern China, Taiwan, Tibet, and northern India (Zhao and Adler 1993. Herpetology of China. SSAR, Oxford, Ohio. 522 pp.) and was initially detected breeding in southeastern Guam in 2004 (Christy et al., *op. cit.*). To date, this is the only known instance of predation on *P. megacephalus* by *B. irregularis* on Guam. Such observations provide information on *B. irregularis* feeding ecology and the role that invasive prey species may have in supporting invasive *B. irregularis* populations.

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BOTHROPOIDES ERYTHROMELAS **(Caatinga Lancehead). REPRODUCTION.** *Bothropoides erythromelas* is a small lancehead widely distributed in northeastern Brazil (Lira-da-Silva et al. 2009. Gaz. Méd. Bahia 79:7–20), occurring in arid and semiarid environments including tropical dry and deciduous forests,

rocky areas, undergrowth vegetation of terrestrial bromeliads and along river banks (Campbell and Lamar 2004. The Venomous Reptiles of the Western Hemisphere. Cornell Univ. Press, Ithaca, New York. 870 pp.). Little is known about reproduction in this species (Duarte and Zanotti 2005. Herpetol. Rev. 36:188–189; Lira-da-Silva et al. 1994. Rev. Bras. Zool. 11:187–193). Two gravid female *B. erythromelas* were captured in the municipality of Inajá, Pernambuco, Brazil (8.901667°S, 37.823889°W, datum WGS84; elev. 362 m). Both were kept in captivity at the Laboratory of Venomous Animals and Toxins of the Universidade Federal do Pernambuco, Recife, Brazil. The first snake (SVL = 430 mm, tail length = 70 mm, 55 g) was collected on 9 June 2011 and gave birth to three live neonates (SVLs = 170, 175, 156 mm; tail lengths = 30, 26, 20 mm; 4.0, 3.8, 3.7 g) on 4 January 2012. The second female (SVL = 500 mm; tail length = 60 mm; 95 g) was collected on 15 July 2011 and gave birth to seven live neonates (mean SVL 167.1 mm ± 2.5 SD, range 165–171 mm; mean tail length = 25.1 mm ± 3.8 SD, range 20–30 mm; mean mass = 3.6 g ± 0.2 SD, range 3.1–4.0 g). Our results are consistent with the idea that *B. erythromelas* parturition occurs between November and February (Almeida-Santos and Salomão 2002. *In* Schuett et al. [eds.], Biology of the Vipers, pp. 445–462. Eagle Mountain Publ., Eagle Mountain, Utah; Duarte and Zanotti, *op. cit.*; Lira-da-Silva et al., *op. cit.*), just prior to the onset of the rainy season. However, our data extend the reported litter sizes to range from 3 to 11 (Lira-da-Silva et al., *op. cit.*).

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***BOTHROPS MOOJENI* (Brazilian Lancehead). DIET.** *Bothrops moojeni* is a common semi-arboreal snake included in the *B. atrox* group and is found throughout the Cerrado domain in central and southeastern Brazil in open habitats, almost always associated to gallery forests (Wüster et al. 1996. Herpetologica 52:263–271; Wüster et al. 1999. Kaupia 8:135–144). The genus *Bothrops* is characterized by a generalist diet and ontogenetic shifts from ectothermic to endothermic prey (Martins et al. 2002. *In* Schuett et al. [eds.], Biology of the Vipers, pp. 307–328. Eagle Mountain Publishing, Eagle Mountain, Utah). Previous studies indicate that *B. moojeni* is mainly nocturnal and active during the hot and rainy months, preying mostly on mammals and frogs (Nogueira et. al. 2003. J. Herpetol. 37:653–659). At 1946 h on 11 October 2010, during fieldwork in the municipality of Sacramento (20.20°S, 47.12°W; datum WGS84), Minas Gerais state, southeastern Brazil, we observed an adult *B. moojeni* (SVL ca. 70 cm) feeding on an adult hylid frog, *Hypsiboas albopunctatus* (Fig. 1). The snake was at the margin of a stream in a swamp area, where many *H. albopunctatus* males were calling perched on vegetation. It was initiating ingestion of the frog, head first, and continued for seven more minutes, until the prey was consumed. This is the first record of *H. albopunctatus* as prey of *B. moojeni* and confirms the snake's opportunistic foraging behavior (Nogueira et al., *op. cit.*).

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FIG. 1. *Bothrops moojeni* preying on *Hypsiboas albopunctatus* in southeastern Brazil.

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***BOTHROPS PICTUS* (Desert Lancehead) and *PSEUDALSOPHIS ELEGANS* (Elegant Racer). PREDATION.** *Bothrops pictus* is endemic to Peru where it occurs mainly along the western slope of the Andes and in coastal deserts (Campbell and Lamar 2004. The Venomous Reptiles of the Western Hemisphere, Vol. 1. Cornell Univ. Press, Ithaca, New York. 475 pp.). *Pseudalsophis elegans* occurs in dry habitats along the Pacific coast from southern Ecuador to Chile (Myers and Hoogmoed 1974. Zoologische Mededelingen 48:187–194). Information on the ecology of both species is scarce. We herein report predation on these species by a large bird of prey, *Geranoaetus melanoleucus* (Black-chested Buzzard-Eagle).

On 18 September 2011, at 1127 h, in the Reserva Nacional Lomas de Lachay, Lima, Peru (11.3533°S, 77.3686°W; datum WGS84), we observed a *G. melanoleucus* perched in a Tara Tree (*Caesalpina spinosa*) feeding on a *Pseudalsophis elegans* (Fig. 1a). After it had finished feeding, the bird took flight and started circling low over the vegetation. After only about 4 min it descended to the ground and caught a *Bothrops pictus* in the dense herbaceous vegetation. The eagle carried the viper to another tree and immediately started to feed on it (Fig. 1b). *Geranoaetus melanoleucus* preys primarily on mammals, with its diet containing only a minor percentage of reptiles (Paves et al. 1992. J. Raptor Res. 26:27–32; Trejo et al. 2006. Hornero 21:31–36). Because of its high abundance at Lomas de Lachay, *G. melanoleucus* might nevertheless be an important predator of snakes in this region.

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FIG. 1. *Geranoaetus melanoleucus* feeding on a) *Pseudlsophis elegans* and b) *Bothrops pictus*.

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***CLELIA LANGERI*. DIET**. The pseudoboine snake, *Clelia langeri*, is a Bolivian endemic and inhabits the inter-Andean dry valleys of the Santa Cruz and Chuquisaca Departments, and possibly the dry valleys of Tarija Department (Reichle and Embert 2005. J. Herpetol. 39:379–383). Data on the diet of the species are lacking, as the only known prey item is a mouse (Muridae) found in one of the specimens from the original description (Reichle and Embert, *op. cit.*). Here we report a new prey item and the first occurrence of a snake in the diet of *C. langeri*.

On 8 February 2011, at 0730 h, we found a dead juvenile female *C. langeri* (SVL = 405 mm; tail length = 95 mm) that had been struck by a vehicle on the old Cochabamba highway (18.09°S, 64.14°W, datum WGS 84; elev. 1320 m), between the districts of Pampagrande and Mataral, Florida Province, Santa Cruz Department, Bolivia. When we inspected the *C. langeri*, we observed a snake protruding from the side of its body. Dissection confirmed that the prey item was a juvenile male *Philodryas psammophidea* (Chaco Racer; SVL = 255 mm, tail length = 105 mm) that had been consumed head-first. This observation not only provides the second known prey item for the species, but is also the first record of a snake in the diet of *C. langeri*. While anurans and small mammals are known prey items of *Clelia* species (Yanosky et al. 1996. Herpetol. Nat. Hist. 4:97–110), this report is consistent with previous observations of these species being ophiophagus predators (Delia 2002. Herpetol. Notes. 2:21–22, and references therein).

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***COLUBER CONSTRICTOR* (North American Racer). COMMUNAL OVERWINTERING.** At ca. 1500 h on 6 April 2008, we observed a snake hibernaculum at Swan Lake National Wildlife Refuge, Chariton Co., Missouri, USA (39.624962°N, 93.225670°W, datum WGS84; air temp. ca. 16°C) on the west embankment of a pond. The entrance of the den was a hole approximately 3 cm in diameter and four *Coluber constrictor* were attempting to emerge from the hole simultaneously, thus inhibiting other individuals from doing so. The lower jaw of one *C. constrictor* appeared severely dislocated or damaged, perhaps by the pressure of the three other individuals attempting to emerge, and at initial observation the snakes seemed dead. Further investigation revealed that the snakes were, in fact, alive. We were able to reach inside the den and capture 12 additional *C. constrictor* (more individuals were observed but we could not reach them for capture) and individuals of four other species: *Pantherophis obsoletus* (N = 4), *Nerodia erythrogaster* (N = 1), *N. sipedon* (N = 1), and *Lampropeltis calligaster* (N = 1). We believe this is the first reported instance of a "three stooges effect" in snake den emergence, whereby several individuals attempt to exit a hibernaculum and inhibit not only their own emergence, but also that of the other individuals. The "three stooges effect" poses several potential negative effects, including cranial damage that inhibits feeding, increased conspicuousness to predators, or ultimately direct mortality from injuries caused by this behavior.

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***CROTALUS ADAMANTEUS* (Eastern Diamondback Rattlesnake). REPRODUCTION / FEBRUARY AND MARCH BREEDING.** The majority of North American rattlesnakes have a single, annual mating season extending from late summer through early autumn (Aldridge and Duvall 2002. Herpetol. Monogr. 16:1–25). Courtship and mating of *Crotalus adamanteus* occurs in August and September throughout the geographic range, except in extreme southern Florida where *C. adamanteus* may also breed in December and January (Timmerman and Martin 2003. Conservation Guide to the Eastern Diamondback Rattlesnake, *Crotalus adamanteus*. SSAR Herpetol. Circ. 22). Here we provide observations of *C. adamanteus* engaged in breeding behavior outside of August and September in the northern half of the geographic range.

At 1440 h on 23 February 2012 (mostly cloudy, 27°C), JGP observed a copulating pair of adult *C. adamanteus* in Camden Co.,

Georgia, USA, in a heavily-thinned, open-canopied *Pinus taeda* plantation. When first encountered, the snakes were moving towards a branch pile, the female pulling the adjoined male. The snakes settled beneath the pile and had separated when JGP returned at 1528 h. At 1045 h on 3 March 2012 (overcast, 21°C), ZSB, MNM, and APD observed a copulating pair of *C. adamanteus* on Little Tybee Island, Chatham Co., Georgia, near the edge of coastal marsh. As the observers approached, the male detached from the female and crawled 3 m, hemipenes everted, into a hollow trunk of a fallen *Sabal palmetto*. On 18 March 2007, JLW, SHB, WGK, and JNH, observed a copulating pair of *C. adamanteus* on a private quail plantation in Colleton Co., South Carolina, in a mature, open-canopied, mixed-species (*Pinus elliottii, P. palustris, P. taeda*) savanna. Another adult *C. adamanteus* (sex unknown) was observed beneath the copulating pair. The breeding male was equipped with a radio transmitter and was previously observed copulating on 17 August 2006.

Our observations of copulatory behavior in *C. adamanteus* in February and March are at odds with previous observations of *C. adamanteus* mating behavior (Timmerman and Martin 2003, *op. cit.)* and with the peak in male plasma testosterone in July–September (which correlates with breeding; Hoss et al. 2011 Southeast. Nat. 10:95–108) in the northern portion of the geographic range. Our observations suggest the possibility of an extended breeding season (August–March) or a second, late winter–early spring breeding season in *C. adamanteus* in the northern portion of the range.

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***CROTALUS AQUILUS* (Queretaran Dusky Rattlesnake). DIET.** Although *Crotalus aquilus* is known to feed on frogs, salamanders, small rodents, invertebrates, and lizards of the genera *Sceloporus* and *Gerrhonotus* (Klauber 1972. Rattlesnakes: Their Habits, Life Histories, and Influence on Mankind. University of California Press, Berkeley. x + 1533 pp.), details on which species of lizards are consumed have not been provided. Here we report two neonate male *C. aquilus* feeding on *Sceloporus grammicus* in the municipality of Epazoyucan, Hidalgo, Mexico, 2234 m elev. Both snakes were collected on 28 August 2011. The first snake (SVL = 190 mm; tail length = 20 mm; 8 g) contained an adult *S. grammicus* (SVL = 52 mm; tail length = 55) that had been swallowed head-first. The second snake (SVL = 245 mm; tail length = 30 mm; 11 g) contained an adult *S. grammicus* (SVL = 64 mm; tail length = 68 mm) that had also been swallowed head-first. Predator-prey mass ratios were approximately 1.3:1. The lizards were deposited in the hepetological collection of the Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo (CH-CIB 4288, 4289).

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***CROTALUS LEPIDUS* (Rock Rattlesnake). DIET.** Several reports of *Crotalus lepidus* consuming other snakes exist in the literature (Beaupre 1995. Herpetologica 51:45–56; Mata-Silva et al. 2010. Herpetol. Rev. 41:235–236; Milstead et al. 1950. Texas J. Sci. 2:543–562; Williamson 1971. Herpetol. Rev. 3:18). On 16 August 2008, a male *C. lepidus* (SVL = 590 mm; tail length = 60 mm; 160 g) was found basking outside a burrow on Mesa Montoro, Sierra Fría, Municipality of San José de Gracia, Aguascalientes, Mexico (22.003794°N, 102.570860°W, datum WGS84; elev. 2374 m). Following capture, the snake regurgitated a small female *Lampropeltis mexicana* (Greer's Kingsnake; SVL = 520 mm; tail length = 100 mm; 45.49 g) that had been swallowed head-first. This is the first record of *L. mexicana* in the diet of *C. lepidus*. The rattlesnake was released, but the kingsnake was deposited in the Herpetological Collection, Universidad Autónoma de Aguascalientes (UAA-CV-0322). We later dissected the kingsnake's stomach and discovered a partially digested male *Sceloporus torquatus* (UAA-CV-0324; SVL = 80 mm; 18.84 g).

An additional male *C. lepidus* (SVL = 510 mm; tail length = 52 mm; 120 g) captured at the same locality on 2 August 2008, defecated body scales belonging to a *Phrynosoma orbiculare* (Mountain Horned Lizard; UAA-CV-0325), the only horned lizard known to occur in the area. This is the first record of *C. lepidus* consuming *P. orbiculare*, although the species is known to prey on other *Phrynosoma* species in other parts of its range (Dickerman and Painter. 2001. Herpetol. Rev. 32:46; Milstead et al. 1950, *op. cit.*).

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***CROTALUS OREGANUS CONCOLOR* (Midget Faded Rattlesnake). NURSERY AGGREGATION.** Over the past two decades, our perception of rattlesnake sociability has gone from completely asocial to remarkably social. Aside from intra- and intersexual interactions during the breeding season, the only other obvious social behavior is aggregation that was historically viewed as coincidental or due to a common attraction to limited habitat features for activities like hibernation, ecdysis, and during the stages of pre- and post-parturition. However, aggregation can provide defensive or thermoregulatory advantages during vulnerable activities (Greene et al. 2002. *In* Schuett [ed.] Biology of the Vipers, pp. 179–206. Eagle Mountain Publishing, Eagle Mountain, Utah; Reiserer et. al. 2008. J. Zool. 274:277–283). During gestation, most rattlesnakes are particularly vulnerable to predators due to their more sedentary behavior and it is not surprising that many species form aggregations during this time. For the same reasons, it seems neonates of virtually all species of rattlesnakes remain together and with their mother during the time it takes for them to complete their first ecdysis. Yet the relationship between mothers and neonates seems to extend

beyond these relatively passive advantages. Melissa Amarello (unpubl. data) documented more active tending of offspring in a post-parturition neonatal aggregation which more clearly demonstrates an active maternal behavior that goes beyond the general increase in defensiveness. To further elucidate these social interactions, we investigated the relatedness of female *C. o. concolor* and their associated litters based on 16 microsatellite loci (Holycross et al. 2002. Mol. Ecol. Notes 2:537–539; Oyler-McCance et al. 2005. Mol. Ecol. Notes 5:452–453; Oyler-McCance and Parker. 2010. Conserv. Genet. Res. 2:123-125; Villareal et al. 1996. J. Hered. 87:152–155). We estimated relatedness using the triadic likelihood estimator (Wang 2007. Genet. Res. 89:135–153) implemented in the software CoAncestry (Wang 2011. Mol. Ecol Res. 11:141–145).

We discovered two gravid female *C. o. concolor* at one of many known rookery sites in Sweetwater Co., Wyoming (Parker and Anderson 2007. J. Herpetol. 41:41–51). We visited the site daily until we found two clutches of offspring being attended by the two previously identified females. Although we had assumed that the groups of neonates were born to the females with which they were found, genetic analysis revealed that one female was attending a group of five offspring that were not related to her (average relatedness = 0.01; presumably she had not yet dropped her own clutch) and the other female was attending three offspring that were likely her own (average relatedness = 0.48; all confidence intervals overlapped 0.5) and one that was unrelated (relatedness = 0). Rather than a core family behavior to protect a female's own offspring, it appears that this social behavior is more like that of a nursery. Gravid *C. o. concolor* do not travel far from their hibernaculum and so all known rookery sites are in close proximity to hibernacula (Parker and Anderson 2007, *op. cit.*). While we have not yet looked at the relatedness within hibernacula, it is assumed that there is a higher degree of relatedness within hibernacula than between (Bushar et. al. 1998. Copeia 1998:411–422; Clark et. al. 2008. Mol. Ecol. 17:719–730). Thus, nursery aggregations appear to be a species level adaptation rather than kin selection.

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***DEMANSIA VESTIGIATA* (Lesser Black Whipsnake). DIET.** The diet of *Demansia vestigiata* is primarily composed of ectotherms, ~75% of which are lizards (Shine 1980. J. Herpetol. 14:381–389). Frogs of the families Hylidae and Myobatrachidae have been recorded as prey items for *D. vestigiata* (Fearn and Trembath 2009. Aust. J. Zool. 57:49–54) but few (*Litoria rothii*, *L. verreauxii*, *Adelotus brevis*, and *Opisthodon ornatus*) have been identified to species level (Shine, *op. cit.*; Trembath and Rowley 2005. Herpetofauna 35:114–115.). A road-killed male *Demansia* sp. (total length = 91.5 cm) was collected at 1730 h on 22 Apr 2011 on Anzac Parade, in the tropics of the Northern Territory, Australia (12.58°S, 131.32°E, datum: WGS84). The snake had 180 ventral scale rows (Dowling 1951. Copeia 1951:131–134) and was identified as *D. vestigiata* (the morphologically similar *Demansia papuensis* has >198 ventral scale rows: Shea 1998. The Beagle 14:41–61). The snake's digestive tract contained four undigested Rocket Frogs (*Litoria nasuta*; Fig. 1; SVLs = 27, 27.5, 38.4, and 40 mm) and two unidentifiable partially digested frogs. Because



FIG. 1. *Demansia vestigiata* with three *Litoria nasuta* pictured in the orientation that they were ingested. Centimeter rule.

Demansia spp. are primarily diurnal and terrestrial, it is probable that they consume frogs sleeping at ground level (e.g., in soil cracks) during the day.

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***DRYMARCHON MELANURUS* (Central American Indigo Snake). DIET.** *Drymarchon melanurus* is known to feed on anurans, lizards, and snakes, including those of the genus *Bothrops* (Pérez-Higareda et al. 2007. Serpientes de la Región de los Tuxtlas, Veracruz, México. UNAM. Distrito Federal, México. 189 pp.). On 23 January 2008 we captured a male *D. melanurus* (SVL = 1670 mm; tail length = 310 mm) in riparian vegetation in the municipality of Tlaquiltenango, Morelos, México (18.458188°N, 99.04315°W; datum WGS84). During handling, the snake regurgitated a young male *Crotalus simus* (Middle American Rattlesnake; SVL = 640 mm; tail length = 14 mm). Although Solorzano (2004. Snakes of Costa Rica. Instituto Nacional de Biodiversidad, Costa Rica. 791 pp.) listed a second-hand report of a *D. melanurus* consuming a *C. durissus* (= *C. simus*), to our knowledge, this is the first detailed account of *C. simus* in the diet of *D. melanurus*. The *D. melanurus* was released at the capture location; the prey was deposited in the Colección de Anfíbios y Reptiles de la Universidad de Morelos (CARUM).

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***HETERODON SIMUS* (Southern Hog-nosed Snake). PREDATION.** *Heterodon simus* is a relatively poorly known species (Tuberville et al. 2000. J. Elisha Mitchell Sci. Soc. 116:19–40) with few documented predators. A *Drymarchon couperi* (Eastern Indigo Snake) that disgorged an *H. simus* (Mount 1975. The Reptiles and Amphibians of Alabama. Agriculture Experiment Station, Auburn Univ., Auburn, Alabama. 345 pp.), and a *Lampropeltis getula* (Common Kingsnake) that had eaten three *H. simus* (Palmer and Braswell 1995. Reptiles of North Carolina. Univ. North Carolina Press, Chapel Hill. xiii + 412 pp.), appear to be the only published records of predation on this species. Here I report additional instances of natural predation on *H. simus* on Sandhills Game Lands, ca. 16.4 km NNE of Old Hundred, Scotland Co., North Carolina, USA.

At 1440 h on 18 July 2009, in open sandhills dominated by Longleaf Pine (*Pinus palustris*), Turkey Oak (*Quercus laevis*), and Wiregrass (*Aristida stricta*), I encountered a large adult *Coluber constrictor* (Eastern Racer) swallowing a juvenile male *H. simus* (SVL = 220 mm; total length = 270 mm). At my approach, the racer quickly disgorged its dead and partially-swallowed prey and fled. The *H. simus* was deposited in the collection of the North Carolina State Museum of Natural Sciences (NCSM 75976). On 16 May 2009, at ca. 1130 h, a *Buteo lineatus* (Red-shouldered Hawk) was encountered preying on a telemetered adult male *H. simus* (NCSM 75915; SVL = 338 mm; total length = 430 mm). The hawk, which fled when approached, had deposited the snake (fatally injured but still moving) on a large Turkey Oak limb ca. 8 m above the ground. On 23 May 2009, the transmitter from a telemetered adult male *H. simus* was found, accompanied by a single breast feather from a young *Bubo virginianus* (Great Horned Owl), providing probable, though circumstantial, evidence of predation. On 7 August 2009, at 1920 h, a large telemetered adult female *H. simus* (NCSM 75996) was found beneath a tree, freshly killed with the anterior half consumed. A *Buteo jamaicensis* (Red-tailed Hawk) was heard vocalizing and observed moving away from the area as I approached, again providing strong, though inconclusive, evidence of the predator's identity.

Between 18 January 1999 and 10 May 2008, nine additional telemetered adult *H. simus* were taken by undetermined predators on Sandhills Game Lands and private lands in Scotland Co., North Carolina. In three instances, only the transmitter was found. Of the remaining six, at least portions of the carcass were found. In at least three of these cases, pieces of the vertebral column were found along with the transmitter beneath trees, stripped of flesh in typical raptor fashion. It is likely that most, if not all, of these snakes were taken by raptors or other predatory birds. In at least four cases, predation occurred soon after prescribed warm-season fires, which probably rendered snakes on the surface much more visible and accessible to raptors. These observations suggest that raptors are important predators of *H. simus*.

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***LEPTODEIRA MACULATA* (Southwestern Cat-eyed Snake). DIET.** *Leptodeira maculata* was considered a full species by Duellman (1958. Bull. Amer. Mus. Nat. Hist. 114:1–152). Duellman (*op. cit.*) also recognized *L. annulata cussiliris* as a distinct subspecies but recent studies have synonymized Mexican populations of *L. a. cussiliris* with *L. maculata* (Daza et al. 2009. Mol. Phylogenet. Evol. 53:653–667; Mulcahy 2007. Biol. J. Linn. Soc. 92:483–500). The diet of *L. maculata* has been reported to include anurans, such as *Rhinella marina, Incilius mazatlanensis, I. valliceps, Dendrosophus robertmertensi, Scinax staufferi, Smilisca baudinii, Tlalocohyla smithii, Leptodactylus melanonotus, Hypopachus variolosus,* and an undetermined species within the *Lithobates* (*Rana*) *pipiens* complex, and lizards, such as *Norops* (*Anolis*) sp., *Aspidoscelis sacki, Hemidactylus frenatus, and Phyllodactylus lanei* (Duellman, *op. cit.*; Hardy and McDiarmid 1969. Univ. Kansas Publ. Mus. Nat. Hist. 18:39–252; Ramírez-Bautista 1994. Instit. Biol. Cuader. 23:1–127). Herein, we report the first record of *L. maculata* feeding on *Leptodactylus fragilis* (White-lipped Frog) in northern Oaxaca, México.



PHOTO BY R. MATA-SILVA AND A. MATA-RAIGOZA

FIG. 1. Juvenile *Leptodeira maculata* beginning to ingest an adult *Leptodactylus fragilis* on the outskirts of Papaloapan, Oaxaca, México.

On 29 April 2011, at 2020 h, a juvenile *L. maculata* was observed feeding on a live adult *L. fragilis*, during a rainy evening in the backyard of a home located on the outskirts of Papaloapan, Municipality of Tuxtepec, Oaxaca, Mexico (18.157883°N, 96.091658°W; datum: WGS 84; elev. 25 m). When the snake was first discovered, it was swallowing the hind legs of the frog (Fig. 1). After about five minutes, the snake had consumed the entire frog and retreated into nearby vegetation.

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***MASTIGODRYAS MELANOLOMUS ALTERNATUS* (Neotropical Racer). ELEVATION.** The sole representative of the genus *Mastigodryas* in Costa Rica, *M. melanolomus* is distributed from Mexico to Panama (Solorzano 2004. Snakes of Costa Rica. Editorial INBio, Santo Domingo, Costa Rica. 791 pp.). The elevational range is from sea level to 1760 m (Savage 2002. The Amphibians and Reptiles of Costa: A Herpetofauna Between Two Continents, Between Two Seas. Univ. Chicago Press, Chicago, Illinois. 934 pp.). Specimens in the Museo de Zoología at the Universidad de Costa Rica (UCR) confirm their presence up to 1500 m (Federico Bolaños, pers. comm.). On 25 December 2006 we found a dead *M. m. alternatus* (UCR 21210) at an elevation of 2137 m approximately 1 km from the start of the Sendero Catarata (Waterfall Trail) located in the community of San Gerardo de Dota, San Jose, Costa Rica (9.538°N, 83.818°W; datum WGS1984). Our observation is 377 m higher than any previous record of this species and may represent an up-slope range extension, similar to elevational shifts observed in Malagasy herpetofauna as a consequence of climate change (Raxworthy et al. 2008. Global Change Biol. 14:1703–1720.

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***OPHEODRYS VERNALIS* (Smooth Greensnake). REPRODUCTION / COMMUNAL NESTING.** *Opheodrys vernalis* is an oviparous species with reported incubation times ranging from four days (Blanchard 1933. Pap. Michigan Acad. Sci. Arts Lett. 27:493–508.) to 30 days (Messmer et al. 1995. North Dakota State Univ. Extension Service, Fargo. 2 pp.). Several instances of communal nesting have been reported (Cook 1964. Herpetologica 20:206; Fowler 1966. Herpetologica 22:231; Gregory 1975. Copeia 1975:185–186; Lawson 1983. Herpetol. Rev. 14:20; Stille 1954. Nat. Hist. Misc. 127:1–111), with nests containing up to 30 eggs (Arbuckle 1999. *In* Hunter et al. [eds.], Maine Amphibians and Reptiles, pp. 171–173. Univ. Maine Press, Orono). Here we describe the largest communal nest of *O. vernalis* eggs to date.

On 30 June 2010, a communal nest of 85 *O. vernalis* eggs was found in Lake Co., Illinois, USA near the Illinois-Wisconsin border. The nest was found beneath the bottom layer of a two-layer plywood sheet located in an old field lot slated for development. The eggs were found in three large cohesive clusters with one egg deposited separately. The clusters contained 14, 24, and 47 eggs; eggshells from past years were present beneath the plywood. Because of the imminent site development, the eggs were collected for incubation for a local *O. vernalis* recovery program with the Lake County Forest Preserve District and Lincoln Park Zoo. Eighty-three of the 85 eggs successfully hatched; one egg had desiccated prior to incubation and the lone egg that was separate from the clusters did not hatch. The incubation period ranged from 22 to 26 days (22–28 July). There were five synchronous bouts of hatching with 12 to 27 hatchlings per day. Mean SVL and mass of neonates was 102 ± 6.46 mm (range = 90–114 mm) and 1.17 ± 0.14 g (range = 0.97–2.0 g), respectively.

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***OXYBELIS WILSONI* (Yellow Snake). REPRODUCTION.** *Oxybelis wilsoni* is a large colubrid (to ca. 1982 mm total length; McCranie 2011. The Snakes of Honduras. Systematics, Distribution, and Conservation. SSAR. Ithaca, New York. x + 714 pp.) that is endemic to Isla de Roatán, Islas de la Bahía, Honduras. Groves (1995. Rev. Biol. Trop. 43:307–309) reported that a wild caught captive female laid eight eggs on 7 September (corresponding to the early rainy season on Roatán), two of which hatched 92 and 94 days later. Nothing else has been reported on reproduction of this species.

On 21 May 2011, we collected a gravid female *O. wilsoni* (MVZ 267201: total length = 1758 mm) 1 km E of Pollytilly Bight, Roatán, Honduras (16.406300°N, 86.388083°W, datum WGS84; elev. 25 m). Dissection of the snake revealed that it contained four large oviductal eggs (MVZ 267201) in an early stage of development, thus suggesting a deposition of the eggs during the early portion of the rainy season (July–January, with peak during October and November; McCranie et al. 2005. The Amphibians & Reptiles of the Bay Islands and Cayos Cochinos, Honduras. Bibliomania!, Salt Lake City, Utah. xiv + 210 pp.).

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***PHILODRYAS PATAGONIENSIS*. DEFENSIVE BEHAVIOR / THANATOSIS.** *Philodryas patagoniensis* is a medium-sized terrestrial snake that occurs in Brazil, Bolívia, Paraguay, Argentina, and Uruguay (Peters and Orejas-Miranda 1970. Catalogue of the Neotropical Squamata. Part 1, Snakes. Nat. Mus. Bull., Washington D.C. 347 pp.). This species feeds on a wide range of prey including anurans, fishes, lizards, birds, and snakes (Pontes et al. 2003. Herpetol. Rev. 34:154). Here we present the first case of thanatosis (death-feigning) in *P. patagoniensis*. At 1000 h on 3 November 2007, during a survey at Balneário Pinhal, Rio Grande do Sul state, southern Brazil (30.2042°S; 50.8700°W, datum: Corrego Alegre), we captured an adult male *P. patagoniensis* (total length = 940 mm) that exhibited thanatosis during handling. The behavior continued even after the animal was released on the ground. Thanatosis is usually exhibited in response to external stimuli (Greene 1988. *In* Gans and Huey [eds.], Biology of the Reptilia, pp. 1–152. Alan R. Liss, Inc., New York) and immobility might discourage sequential attacks, allowing the prey to escape (Santos et al. 2010. Biota Neotrop. 10:4).

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***SONORA SEMIANNULATA* (Western Groundsnake). PREDATION.** Greater Roadrunners (*Geoccocyx californianus*) are notorious for including lizards and snakes in their diet, although less is known about what prey items are fed to their nestlings (Maxon 2005. The Real Roadrunner. Univ. Oklahoma Press, Norman. xiiiv + 124 pp.). Potential prey items available to nest-bound young include arthropods, amphibians, reptiles, birds, and mammals (e.g., 90% vertebrates: Maxon, *op cit.*; primarily lizards: Ohmart 1973. Condor 75:140–149). Meinzer (1993. The Roadrunner. Texas Tech Univ. Press, Lubbock. 112 pp.) suggested that prey fed to nestlings were usually obtained opportunistically in response to their seasonal abundance, even though he saw adults feeding only on highly abundant grasshoppers, while at the same time more nutritious vertebrates were almost exclusively fed to the nestlings.

Sonora semiannulata is a small burrowing snake occurring in the deserts and grasslands of the southwestern U.S. and northern México (Conant and Collins 1998. A Field Guide to Reptiles and Amphibians of Eastern and Central North America, 3rd ed. Houghton Mifflin, Boston, Massachusetts. xviii + 616 pp.). It is normally nocturnal, although surface activity has been reported during daylight in early spring when temperatures are cool, and occasionally after heavy summer rains (Werler and Dixon 2000. Texas Snakes: Identification, Distribution, and Natural History. Univ. Texas Press, Austin. xv + 437 pp.). Predation on *S. semiannulata* has occasionally been documented by invertebrates (e.g., *Scolopendra heros*; Johnson et al. 2007. Herpetol. Rev. 38:93–94) and vertebrates (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Institution Press, Washington, D.C. 668 pp.). Herein we report the first account of a *G. californianus* transporting a *S. semiannulata* to its nest and subsequently feeding it to its nestlings.



FIG. 1. A) An adult *Geococcyx californianus* (Great Roadrunner) with a freshly killed adult *Sonora semiannulata*; B) one of the *G. californianus* nestlings (a) swallowing the *S. semiannulata* (b) on Indio Mountains Research Station, Hudspeth Co., Texas.

On 11 September 2010, at 1300 h, an adult male *G. californianus*, in association with a female, was observed near its nest in a Catclaw (*Acaccia greggii*) carrying a freshly killed adult *S. semiannulata* (Fig. 1A). The nest, which contained three chicks and an infertile egg, was positioned next to the old ranch house in the headquarters compound on Indio Mountains Research Station (IMRS); which is located in the northern Chihuahuan Desert, 40 km SW of Van Horn, Hudspeth Co., Texas, USA (30.776883°N, 105.016060°W, datum WGS84; elev. 1233 m). Initially the snake was given to one of the hungry nestlings, however, a second nestling started consuming the snake by the tail (Fig. 1B). Eventually the first nestling was able take the snake away from the other nestling and swallow it whole.

We thank A. Harris who kindly provided us with some of the literature sources. Field work at IMRS was partially funded by an NSF FSML RET supplement awarded to J. D. Johnson for supporting B. Barragan and D. Griffith.

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***TANTILLA IMPENSA*. REPRODUCTION.** *Tantilla impensa* is apparently the largest known species of *Tantilla* with adults reported to reach ca. 725 mm total length (Campbell 1998. Sci. Pap. Nat. Hist. Mus., Univ. Kansas 7:1–14). Almost nothing is known about the natural history of this species (summarized in McCranie 2011. The Snakes of Honduras. Systematics, Distribution, and Conservation. SSAR. Ithaca, New York. x + 714 pp.). On 22 April 2011, we collected a gravid female *T. impensa* (MVZ 267218; total length = 461 mm) under a log near the Quebrada Piedras Colorados on the northeastern slopes of Cerro Azul, Copán, Honduras (15.128583°N, 88.900250°W, datum WGS 84; elev. 1450 m). After sedating the snake prior to preservation, we removed two shelled oviductal eggs (MVZ 267218) that measured 25.9 x 6.1 mm and 26.0 x 6.3 mm, respectively (length x maximum diameter), three months after preservation in formalin. This is the first information on reproduction of *T. impensa*.

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***THAMNODYNASTES SERTANEJO*. HABITAT.** *Thamnodynastes sertanejo* was described from two specimens from the states of Bahia and Pernambuco, in the semiarid region of northeastern Brazil (Bailey et al. 2005. Phyllomedusa 4:83–101). The geographic distribution of the species was expanded to northern Minas Gerais (Silveira and Cotta 2006. Herpetol. Rev. 37:364) and now includes the state of Ceará (Roberto et al. 2009. Herpetol. Rev. 40:239). All localities lie in the Caatinga domain between 250 m and 700 m elevation (Roberto et al., *op. cit.*; Silveira and Cotta, *op. cit.*). Here, I report finding *T. sertanejo* at ca. 900 m elevation on the Santa Gertrudes farm (14.645278°W, 40.442500°W; datum WGS84), municipality of Planalto (Coleção Zoológica Gregório Bondar - CZGB 2552), now the highest elevation where the species has been recorded. Moreover, I present the first records of *T. sertanejo* outside of the Caatinga domain in vegetation types transitional to wetter areas of the Atlantic rainforest. One specimen (CZGB 6873) was found in liana forest (mata-de-cipó) on the Engenho farm (14.385833°W, 40.196111°S; datum WGS84), municipality of Boa Nova. Two specimens were collected in mesophytic forest. One of them on the Santa Gertrudes farm, referred above (CZGB 2552), another in the municipality of Itagibá (Museu de Zoologia da Universidade Estadual de Santa Cruz - MZUESC 4528). A fourth specimen (CZGB 6404) was found at the Bonfim farm (14.716982°W, 39.610057°S; datum WGS84), municipality Almadina, in ombrophilous forest near of the contact zone between mesophytic forest and ombrophilous forest. The new easternmost record of the species (Almadina) is only 60 km from the coast. All new localities are situated in the state of Bahia, Brazil.

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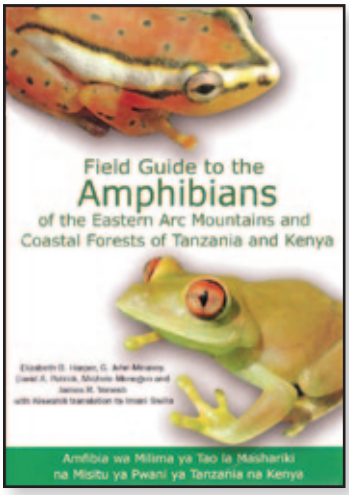
BOOK REVIEWS

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Field Guide to the Amphibians of the Eastern Arc Mountains and Coastal Forests of Tanzania and Kenya

by Elizabeth B. Harper, G. John Measey, David A. Patrick, Michele Menegon, and James R. Vonesh, with Kiswahili translation by Imani Swilla. 2010. Camerapix Publishers International, Nairobi (www.camerapixpublishers.com). Softback. 320 pp. 1500 Kenya Shillings (approximately US $15.00). ISBN 978-1-904-722-48-9.

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Approach a rain-fed pool at night in Kenya's coastal forests and you will appreciate the impact of the amphibian fauna; the ear-splitting cacophony that booms through the night tells you of the presence of fifteen or more species of frog, all shouting to attract a female. But for most of the 20th century, natural historians in East Africa had little visual material to aid in the identification of amphibians. We had to rely on local experts who knew a lot but published little; Arne Schiøtz has described this reluctance to commit to paper as the "Nairobi Museum cramp." Some South African-based books were useful, like Passmore and Carruthers (1979). Schiøtz's (1975) paper illustrated some 80-odd species of treefrogs, largely with black and white photographs but with a handful of color pictures, and his 1999 book covered, with maps and color illustrations, all the then-recognized African hyperoliids and rhacophorids. Hedges (1983) book had (generally poor) color pictures of some 16 East African anurans. With the turn of the century, matters improved, Channing's comprehensive 2001 guide to the amphibians of Central and Southern Africa covered a good number of East African species. Finally, Channing and Howell's authoritative 2006 *Amphibians of East Africa* provided us with a first comprehensive listing of the 203 amphibian species then known from East Africa. But even then no illustrations were available for some 48 species, an indicator that much was still to be done. So a well-illustrated book with maps, which adds to our knowledge of the eastern African herpetofauna, is to be welcomed, particularly one by a team of authors with extensive pertinent field experience.

This book covers the amphibians of the East African coastal region, and includes the Eastern Arc mountains, the sandwich of land between that mountain chain and the Tanzanian coast, and the southern half of Kenya's coastal strip. It is a fascinating area, and lies within two biodiversity hotspots, the coastal forests of eastern Africa and the eastern Afromontane (Mittermeier et al. 2004). The Eastern Arc is a chain of ancient crystalline metamorphic mountains, formed over 500 million years ago as the two blocks of East and West Gondwana crunched together, twice. Stretching from the Udzungwas in southern Tanzania north to the Taita Hills in Kenya, the hills rise up to over 2000 m altitude and attract orographic rainfall, often over 1500 mm annually. The entire area, the mountains and the coastal strip, receives what is—for East Africa—a relatively large amount of rain, over 500 mm per year. As northeastern Africa has gradually dried out during the last 3000 years, the peaks have retained their forest, and hence act as refugia for a number of species of flora and fauna. The isolation of the peaks as the intervening forest has shrunk has created isolated gene pools with resulting speciation. The enclaves of high land are evolutionary "islands in the sky;" the area is full of endemics. And the usual problems apply; such areas in developing countries are under pressure for use for agriculture, exploitative forestry, and mining to serve the needs of a booming human population, to whom esoteric conservation is of little significance.

The text of this book is in English and Swahili and it is thus accessible to all who live in the area. The translation to Swahili was done by Professor Imani Swilla (her surname, appropriately, means spitting cobra!). The volume opens with 37 pages of useful essays on the area, habitat types, the historical perspective, conservation, and includes some habitat photographs. The bulk of the book, 278 pages, is given over to describing the 122 species of amphibians (113 frogs, nine caecilians) found in the area, 20 of which are endemic to the mountains themselves, and several of these have been described in the last 15 years. The book concludes with a reasonable five-page bibliography. There is no index or keys. In almost all cases, each taxon described has a double-page spread, the English on the left hand page, Swahili on the right, each accompanied by a color photograph and a distribution map. On the top of the right-hand page are a set of symbols that tell the reader at a glance various bits of information, for example whether the animal likes reeds or grassland, is arboreal or not, is only found at high altitude, etc. The combination of picture, map, and symbol means that even an illiterate rural dweller can get something out of this book. For each species scientific name (using fully up-to-date taxonomy), authors and date, and English name are given and there are further headings for SVL (snout–vent length), description, similar species, habitat, natural history, call, distribution, type locality, elevational range,

and conservation status. The Swahili description uses the same headings (translated, obviously) but omits the call. Curiously, Swahili names are given for the first 20 or so species in the book (the *Leptopelis* and the Brevicipitidae) but no others. I'm not sure if this is a mistake or whether the authors simply gave up, as the Swahili names as given have been coined for this volume. Thus, *Arthroleptis stenodactylus*, the Shovel-footed Squeaker, has been given the Swahili moniker "Chura filimbi mwenye mguu kama koleo," meaning literally "the flute frog possessing legs like a spade." It doesn't trip off the tongue and is not a name I can imagine any Usambara farmer using.

The color pictures, by a range of talented photographers (mainly the authors) are mostly of credit-card size (there are a few full page spreads) but are simply excellent, virtually all are pin-sharp, with good depth of field and show the animal on a natural background. These are the gems of Tanzanian herpetology. Beauty, variety, and stunning colors jump out at you; there are purple and custard-yellow frogs, orange and green, and deep black frogs, and the vividly red-eyed *Leptopelis parkeri*. The tragic Kihansi Spray Toad, *Nectophrynoides asperginis* is here, but is no longer extant in the wild. No illustrations were available for a few species, including some such as *Amietia tenuoplicata*, described (as *Rana tenuoplicata*) by the eccentric English frog hunter Martin Pickersgill in his own 2007 book, *Frog Search*; the designated types for several new forms described in Pickersgill's weird book include specimens in his personal collection!

The maps in the guide are also small, but adequate, although the shades used are initially confusing; the lowland is blank, the mountains are lightly stippled. If a species occurs in the mountains its range there is shown in black, if it occurs elsewhere its range is hatched in grey. The maps also cover a huge area north and west of the mountain chain but no distributions are shown there, even if the species is found in that area.

It is often said that the more regional a guide is, the more useful it is, and this fits the bill perfectly, a comprehensive guide to all the amphibians of a relatively small and yet extremely important area where much is to be discovered (I have in my possession a photograph of an unknown snake found in the Usambara Mountains that I cannot assign even to a genus, let alone a species). This book will heighten awareness about a crucial zone in conservation terms. It will be a boon to local naturalists, the more so since it was produced by a Kenyan publisher, Camerapix (founded by the famous Mohammed Amin, the award winning photographer who documented the Ethiopian famine of 1984 and was tragically killed in an Ethiopian Airlines hijack). The description and other useful information make it more than just a field guide, and the Swahili text renders it useful to the budding local enthusiasts. It is small (slightly less than duodecimo), tough, well bound, and easily slipped into a rucksack. There are a few typos, one I noticed is on page 20 where it says the National Museum of Kenya in Nairobi has 300,000 amphibians and reptile specimens (it should be 30,000). There is slight confusion on page 306, where a caecilian (*Boulengerula uluguruensis*) and a blind snake (*Letheobia uluguruensis*) are given the English names "darker pink" and "lighter pink," the editor has confused the names and the caption. The pictures could do with being larger (there is lots of white space). The absence of an index and any sort of listing means you have to hunt page by page if you're looking for a particular species. But these minor glitches are unimportant; this book is exactly what conservation in Africa calls for—a colorful, attractive, and yet sound guide, small and inexpensive and in a language that the majority of local people speak. The authors have done a service to the people of Tanzania. A follow-up is called for, covering the reptiles of this unique area.

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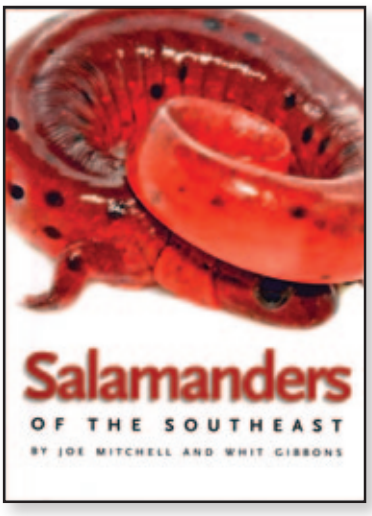
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Salamanders of the Southeast

by Joseph Mitchell and J. Whitfield Gibbons. 2010. The University of Georgia Press, Athens, Georgia (www.ugapress.org). [6] + 324 pp. Softcover. US $26.95. ISBN 978-0-8203-3035-8.

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In 2003 Whit Gibbons wrote that only 5% of surveyed biology majors at the University of Georgia—in a state with 53 species of caudate amphibians—had ever seen a live salamander; the percentage would certainly be much lower if one polled the general public. This disquieting reality inspired Gibbons and various coauthors to familiarize Southerners to the resident herpetofauna. The resulting series of books by Gibbons et al. have already covered snakes, lizards and crocodilians, turtles, and frogs and toads of the Southeast. In this concluding volume, Mitchell and Gibbons reiterate that few people are aware of the presence of salamanders, and write that their book is "meant to inspire an appreciation of salamanders." A quick flip through the pages of *Salamanders of the Southeast* reveals a wealth of information including images of the

spectacular range of colors and shapes of salamanders, insights into their mysterious world, and documentation of their distribution across the South.

Of the book Page 1 asks "Why salamanders?"—to which the authors reply: salamanders serve as environmentally sensitive links between terrestrial and aquatic systems, we are just beginning to understand their surprisingly complex social interactions, they constitute a very significant portion, both in diversity and biomass, of the ecosystems in which they live, and many are, to some degree, in danger of extirpation. Inspired to read further, I learned that the southeastern United States offers an excellent introduction to salamanders, being inhabited by one sixth of all known species, and seven of the ten extant families of Caudata. A "boot camp" introduction covers salamander diversity, energetics, feeding and defense, social behavior, reproduction, taxonomy, and a guide to characters useful in identifying species. The introduction concludes with a photographic essay of salamander habitats, with details of the sorts of species that inhabit each of them. In the battle between authors, trying to educate and disseminate science, and the publisher, doing its best to mass-market a product, everyone is a winner in this instance, as *Salamanders of the Southeast* is attractive, readable and educational. Like an elementary school textbook, it sports a number of highlighted "Did you know?" boxes in the margins. I only scored 83%, and now know that hellbenders, a.k.a. "snot otters," can drop one side of their jaw to vacuum prey into their mouths, female newts glue a leaf around each egg that they deposit, and male plethodontids vaccinate females during courtship to make the latter receptive.

Salamanders of the Southeast is very nicely produced; it is sturdy, with glossy pages in a stiff paper jacket. There are 463 color photographs of salamanders, most of exceptional quality, showing the variation within species as well as the larvae and eggs of some. There are pictures of salamanders eating and being eaten, fighting and courting, artfully posed against habitat backdrops, and having researchers conducting research upon them. The species accounts are segregated into obligate aquatic, stream and seep, seasonal wetland, and fully terrestrial taxa. An unfortunate result of the arrangement is that *Desmognathus marmoratus* and *D. wrighti* are widely separated in the text from their congeners. Each species account includes a shaded distribution map and a brief tabular summary of body form, color pattern and costal groove count. The text for each account provides a detailed synopsis of Description (adults, larvae and juveniles), Similar Species, Distribution, Habitat, Behavior and Activity, Food and Feeding, Reproduction, Predators and Defense, Conservation, and Taxonomy. The Similar Species section contains useful clues in distinguishing between closely related, sympatric taxa (e.g., *Desmognathus welteri* has dark toe tips), but often, though realistically, the key elements are subjective: "larger," "more," "darker," etc. Confirmation of the utility of the book as a field guide awaits my travel into regions with an abundance of "look-alike" species. Rare errors in the book should be inconsequential to the average reader (e.g., Grotto Salamander occurring in Texas; "artisan" springs should read "artesian"; no *Necturus* in Florida according to range map). Finally, just before a useful glossary and bibliography, the authors present a tabular list of the species that occur in each state.

The main text portion of the book concludes with a chapter titled "People and Salamanders." The first page asks "Why do herpetologists study salamanders?" I am often asked that question by the "what-good-are-they" crowd, and have never developed a satisfactory response. Mitchell and Gibbons, however, provide a commendable answer in this sub-chapter by explaining why salamanders are important research subjects, and by illustrating aspects of study such as setting minnow traps and looking under rocks (a picture of someone bundled in a coat or enshrouded in rain gear would have added some authenticity!). Next, "Keeping Salamanders as Pets" reads as though the authors were forced to address that topic. They begin their discussion with a neutral tone, but follow with a discouraging checklist of factors that must be addressed before anyone makes the grim mistake of removing an amphibian from the wild. In case the reader is oblivious to those hints, an adjacent marginal note provides a snippet about salamander extinctions. The last sub-chapter, "A Conservation Vision for Salamanders," contains some doom-and-gloom prospects for salamander survival, but there is a pleasant surprise—the authors provide solutions. Rather than touting pointless, protectionist "listings," the authors suggest a number of ways in which landowners can manage their properties from the perspective of salamander habitat, including resources to guide in restoration of degraded areas. With that concluding point, the authors have presented a perfect circle of argument within the book's covers: salamanders are in trouble—they are magnificent creatures of which you may know very little—here is a lot of information about them—and this is what you can do to help them out of trouble.

The authors make important points to the newly-inspired salamander watcher: "Salamanders will not show themselves to you" and "go out with a naturalist who knows how to find salamanders…." I recently had the opportunity to explore the salamander-rich Appalachians for the first time, along the Appalachian Trail straddling North Carolina and Tennessee. While attempting to prod a salamander out of a hole in a log, a young man with a burdening backpack stopped to ask what I was doing. At that moment the salamander leapt into my cupped hands and I announced that it was a Blue Ridge Dusky Salamander. Perceiving that I might be a salamander biologist (at the 83% level), the man began interrogating me about a salamander he had seen on his hike northward. Perhaps due to not having talked to anyone in days, or to being in no hurry to get to Maine, he followed me about as I zigzagged from log to log. He shared my excitement as I encountered species I had not previously seen in life: the satiny smoke-colored Gray-cheeked Salamanders, the brightly spackled Slimy Salamanders, and the two-handed, tomato-backed Yonahlossee Salamanders. My time was limited, and I left him searching the logs on his own. Whether coating one's hands with gluey secretions, or resplendently beaming from the printed page, salamanders present a mysterious fascination.

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Amphibiens d'Afrique centrale et d'Angola. Clé de détermination illustrée des amphibiens du Gabon et du Mbini. Illustrated identification key of the amphibians from Gabon and Mbini

by Thierry Frétey, Maël Dewynter, and Charles P. Blanc. Éditions Biotope, Mèze (www.biotope.fr)/Muséum national d'Histoire naturelle, Paris (www.mnhn.fr). 232 pp. Softcover. 85 Euros (approximately US $107). ISBN 978-2-914817-51-6.

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As its title indicates, this new opus provides an overview of the batrachofauna of Central Africa (Cameroon, Central African Republic, Gabon, Democratic Republic of Congo, Equatorial Guinea, Republic of Congo, and São Tomé and Príncipe) and Angola. It also offers an identification key to the amphibians of Gabon and Mbini (the continental part of Equatorial Guinea)—a most welcome and useful addition, since a key for these countries has not thus far been available.

The book is divided into six chapters (the first five exclusively in French), respectively presenting: a brief introduction to the geography of the area covered (pages 10–16), a list of the amphibian species of the area, with a synthetic table showing their occurrence in the countries treated (pp. 17–45), a zoogeographical analysis of the Central African batrachofauna (pp. 46–62), remarks on conservation aspects (pp. 63–64, 97–101), natural history notes on species from Gabon and Equatorial Guinea (pp. 102–109), and an identification key to amphibians of Gabon and Mbini, in French (pp. 111–166) and in English (pp. 168–205), abundantly illustrated by good black and white drawings. On pages 65–96, color plates show good photographs of main ecological habitats and of 60 species in life, some of them illustrated by several photographs. The book is printed on glossy, high-quality paper and is solidly bound. The bibliography includes 636 references. It is followed by a section classifying references by country, an extremely useful feature if ones wishes to build a good reference library on given countries.

The second chapter, on the distribution of amphibians, provides data at the species level, without details on the distribution of subspecies. The table listing species' distributions also lists synonyms. Frétey (pers. comm.) kindly drew our attention to a mistake in the synonymy provided for *Conraua goliath* (Boulenger, 1906) (Ranidae): *Rana* (*Conraua*) *niedeni* Parker, 1936 is not a synonym of the latter species, but of *C. robusta* Nieden, 1908. This chapter includes an interesting section on the rare species that should be searched for, mostly because they are still known only from their type series. Regarding *Leptodactylodon blanci* Ohler, 1999 (Arthroleptidae), Frétey et al. indicate that it is so far known only from its male holotype, but that Rödel indicated in a personal communication that more Gabonese specimens exist in the Berlin collections; these specimens are actually part of a series that one of us (OSGP) participated in collecting in Moukalaba-Doudou National Park (Burger et al. 2006).

The third chapter, on zoogeography, provides, among other useful features, a map showing the number of amphibian families, genera, and species per country, tables showing the levels of endemism per country, and a table providing details on the sites within the region for which the batrachofauna has been inventoried, including field effort for each. This section is missing references to several Gabonese sites that have been extensively inventoried, including Loango and Moukalaba-Doudou National Parks and the Rabi oilfields (Burger et al. 2006; Pauwels 2009).

The identification key includes all species (but does not treat subspecies) currently recorded from Gabon and Mbini, plus several species known from southern Cameroon and likely to be found in Gabon and Mbini. There is a short but useful introductory section explaining how to use the key. The key was designed for using only external diagnostic characters visible to the naked eye, making it possible to identify live animals in the hand. The key to all species is followed by a section specifically describing the external characters of the *Hyperolius* spp. found in Gabon and Mbini, as a help for these highly variable and difficult to identify frogs. In the English key on page 187, entry 73a, to *Hyperolius ocellatus* Günther, 1859 (Hyperoliidae) wrongly sends the user to Appendix F, as the species is actually dealt with in Appendix I. Entry 117b of the English key, to *Arthroleptis variabilis* Matschie, 1893 (Arthroleptidae) has an unfortunate mistyping: "atypical median clear line" should read "a typical median clear line." In several instances (entries to *Leptodactylodon* Andersson, 1903 on p. 197 and to *Hyperolius kuligae* Mertens, 1940 on p. 202) in the English key, the word "large" has been used while the authors actually meant "broad," due to a "false friend" translation from French. The English part of the book would have certainly benefitted from a language review by a native English speaker.

Some taxonomic changes are proposed by Frétey et al. in their book. They place *Leptopelis crystallinoron* Lötters, Rödel & Burger, 2005, an unusual tympanum-less species whose description was based on a single adult female, in the synonymy of *L. brevirostris* (Werner, 1898), with no other justifications than its external resemblance to *L. brevirostris* and the fact that Amiet informed them that he had already observed a *L. brevirostris* that was missing a tympanum on one side of the head, hence they compare *L. crystallinoron* to a "five-legged sheep." Lötters et al. (2005) had, however, also stressed and illustrated striking differences in vomerine teeth shape. Having collected *L. brevirostris* in Gabon, including at the type locality of *L. crystallinoron* we noticed that *L. crystallinoron* was more massive and had a stronger dorsal granulation than *L. brevirostris*, in agreement with observations made by Lötters et al. (2005). In addition, several

additional *L. crystallinoron* specimens have been collected at the type-locality (Bell et al. 2010; Bell, pers. comm., 2010). It consequently seems that this synonymization by Frétey et al. is unjustified and does not serve to improve the already complex taxonomy of western central African *Leptopelis* spp. Moreover the key will not be usable for identifying *Leptopelis crystallinoron*, as the entry for *L. brevirostris* does not make any mention of *L. crystallinoron* and does not mention the existence of individuals without a tympanum. Similarly, although Frétey et al. treated them as distinct species in their synoptic taxonomic list, they mentioned that *Werneria submontana* Rödel, Schmitz, Pauwels & Böhme, 2004 (Bufonidae) "would be a subspecies of *Werneria preussi* (Amiet, pers. comm.)," and that *Cardioglossa alsco* Herrmann, Herrmann, Schmitz & Böhme, 2005 (Arthroleptidae) is "in all likelihood a synonym of *Cardioglossa pulchra* (Amiet, pers. comm.)." In the species list, page 26, *Cardioglossa manengouba* Blackburn, 2008 is listed as a synonym of *C. oreas* Amiet, 1972, again mostly based on a personal communication by Amiet, as indicated in a short footnote. All these vague statements would have deserved some proper justifications, as such they are just adding taxonomic confusion.

The *Kassina* sp. (Hyperoliidae) from Gabon mentioned by Frétey et al. in the species list (p. 35) and the identification key (pp. 124 and 175) without any further detail actually corresponds to the undescribed *Kassina* sp. mentioned by Burger et al. (2004, 2006) and Pauwels and Rödel (2007) from the Monts Doudou, as confirmed by Frétey (pers. comm.).

As the authors indicate on p. 17, they took into account all available batrachological literature from 1834 to December 2008, with only a few references from early 2009. During the gap between end of 2008 and the publication of the book in 2011, due to a lengthy editing treatment by the publishing house, only one reference was cited because it described three species from the region treated (Barej et al. 2010), and the authors insisted on having it mentioned in an addendum (T. Frétey, pers comm.).

The map showing the protected areas in Central Africa (p. 98) does not show most of the national parks of Gabon; in 2002 a network of 13 national parks was created, which covers about 11% of the country's territory and houses 86% of the amphibian species known to occur in Gabon (Christy et al. 2008; Pauwels 2008; Pauwels and Rödel 2007).

The absence of commas in the authorships in the literature references renders some references very confusing, especially when there are multiple authors; this reference format, probably imposed by the publishing house, is certainly not to be encouraged.

The literature references list for São Tomé and Príncipe lists Haft and Franzen (1996), but this reference does not appear in the literature cited, so we list it below.

The taxonomical index provides an incomplete list of pages where taxon names appear in the work, for instance the listing of taxa in Table 2 (list of all species from Central Africa and Angola) is mostly not referred to in the index, the synonyms listed in the species list are not included, and the appearance of names in the English and the French keys is not at all referred to in the taxonomical index. The toponymic index unfortunately does not include the localities on the photos (the authors should by the way be congratulated for providing a locality for their photos, which too many authors still do not do). Mistypings are very few in the book, and are mostly concentrated in the English text.

We tried the key to identify ten Gabonese amphibian specimens; all could satisfactorily be identified except the two *Hyperolius* spp. we had. In spite of the appendix dedicated to this genus, we encourage the key users to double-check their identifications with other literature reference on the genus *Hyperolius*, and the same should be done with other difficult genera such as *Leptopelis* and *Ptychadena*.

The few criticisms above should not obscure the fact that this new book represents a major step in the study of the batrachofauna of Gabon and Mbini, since the best tools available so far were mostly descriptions and keys developed by Jean-Louis Amiet and Jean-Luc Perret in various papers, often outdated, for Cameroonian amphibians. This new identification tool will undoubtedly allow a faster development of local species inventories and a better understanding of the distribution and conservation status of the amphibians of Gabon and Mbini.

Acknowledgments.—We are grateful to Rayna C. Bell (Cornell University, Ithaca), Thierry Frétey (Médréac), and Mark-Oliver Rödel (Museum für Naturkunde, Berlin) for providing useful information.

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The Family Xenosauridae in Mexico / La Familia Xenosauridae en México



by Julio A. Lemos-Espinal, Geoffrey R. Smith, and Guillermo A. Woolrich-Piña. 2012. ECO Herpetological Publishing & Distribution, Rodeo, New Mexico. 106 pp. Softcover. US $16.95. ISBN 978-0-9832789-6-2.

The Xenosauridae is an enigmatic family of lizards consisting of a single genus, *Xenosaurus*, confined to Mexico and Guatemala. All species are live-bearing, with an unusually protracted gestation (up to nine months). These are mostly sedentary lizards, whose dorsoventrally flattened bodies reflect an intimate association with rock crevices. This book brings together a burgeoning scientific literature on xenosaurids, summarizing data on identification, morphology, coloration, distribution, habitat, behavior, diet, taxonomy, and etymology, all contained within individual species accounts. At present, there are six named species—all monotypic with the exception of *X. grandis*, with five subspecies. Information is presented for each species plus two undescribed forms from Hidalgo-Veracruz and Querétaro. The lizards and their habitats are illustrated with 81 color figures. A gazetteer presents specific distributional data for each species, including point-locality range maps and a list of known localities accompanied by geocoordinates. A comprehensive list of references is provided. A great deal of information is packed into this small book. The dual English/Spanish text will help make this volume accessible to a broad community of herpetologists and biologists.

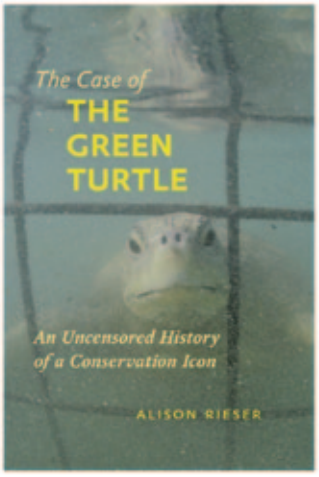
Frogs of South Australia, 3rd ed.



by Michael J. Tyler and Steven J. Walker. 2011. Michael Tyler and Associates, Belair, South Australia. 100 pp. Softcover. AUS $25.00 (approx. US $30.00 with shipping; available from Michael Tyler & Associates, PO Box 334, Belair, South Australia 5052). ISBN 978-0-646-56849-2.

Much has changed in our knowledge of South Australia's frog fauna since Edgar Waite's first treatment in 1929, at which time only 10 species were known to occur there. The present work recognizes 27 native species plus the introduced Cane Toad (*Bufo marinus*), and follows the first two editions of this book authored by Michael Tyler in 1966 and 1977. Of the native species, two are undescribed, one each belonging to the genera *Litoria* and *Pseudophryne*. For each species of frog there is a point-locality distribution map in color, together with a large, high quality color photograph of an adult frog (tadpoles are not illustrated). Informational text covers the essentials: description, advertisement call, breeding biology, habitat, and distribution. This small (15 x 21 cm), lightweight book is easily carried into the field, where it will efficiently serve to identify any frogs encountered.

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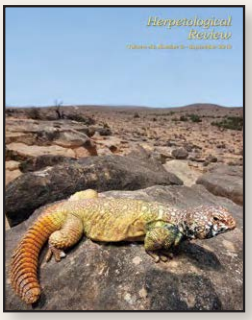
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ABOUT OUR COVER: *Uromastyx benti*



Bent's Spiny-tailed Lizard (*Uromastyx benti*, Agamidae) is part of a species complex that is found in northeastern Africa. It was described in 1894 by John Anderson, a leader in Arabian herpetology, and named for British explorer and archeologist James Theodore Bent. This is a small species of *Uromastyx*, belonging to the *U. ocellata* group (Wilms and Schmitz 2007. Zootaxa 1394:1–23), and is found only in Yemen, southwestern Oman, and possibly in Saudi Arabia (Wilms and Böhme 2007. Fauna of Arabia 23:435–468).

Bent's Spiny-tailed Lizard prefers rocky, arid habitats, and unlike some of the larger *Uromastyx* species (e.g., *U. aegyptia*) that dig permanent, elaborate burrows in open gravel plains, this species lives in rock crevices and small burrows constructed under rocks. Like other *Uromastyx*, it is herbivorous. Listed as a CITES Appendix II species, *U. benti* is exported (largely from Yemen) for the pet trade. The magnitude of this export, as well as its effect upon local populations, is largely unknown. Fortunately, the rocky habitat home to *U. benti* is under little threat of development and seems to be stable (CITES, *Uromastyx benti*. <http://www.cites.org/eng/com/ac/22/E22-10-2-A6b.pdf>).

In Oman, this species was known only from the immediate vicinity of the coastal city of Mirbat (Seufer et al. 1998. Herpetofauna 20:22–23). However, on an expedition to the area in July 2011, Theodore Papenfuss and Todd Pierson discovered a pair near the Arabian Leopard Preserve at an elevation of 1410 m (Pierson and Papenfuss 2012. Herpetol. Rev. 43:491).

Todd Pierson recorded our cover image with a Canon EOS Digital Rebel XSi (450D) mounted on a tripod and using a Sigma 10–20mm f/4-5.6 wide-angle lens. Natural lighting was supplemented with a bit of fill flash from a diffused Canon Speedlite 430ex II mounted on camera (shutter speed of 1/200 second, f/13, and ISO 100). This large, colorful male was discovered basking on the rock over his burrow, which also held a smaller female. Pierson is an undergraduate in the Odum School of Ecology at the University of Georgia. He was awarded a scholarship at UGA that provided funding for international study, and during a three-year period, he has searched for amphibians and reptiles in England, Italy, Guatemala, Honduras, Nicaragua, Costa Rica, Oman, the UAE, Korea, and China.



PHOTO BY T. J. PAPENFUSS

SSAR BUSINESS

Roger Conant Grants-in-Herpetology Program 2013

Proposals will be accepted for the 2013 SSAR Grants-in Herpetology Program starting in September 2012. This program is intended to provide financial support for deserving individuals or organizations involved in herpetological research, education, or conservation. In keeping with the Society's goal of encouraging participation by the broadest possible community of applicants, preference may be given to individuals who might not have access to other funding sources. *Applications must be submitted by individuals only* (but see special considerations for education categories below).

Grant proposals will be considered in the following categories:

1. CONSERVATION OF AMPHIBIANS AND REPTILES. Proposals should outline a conservation-oriented research project. This project may focus on species endangered or threatened at the state, national, or international level, or address research on potentially threatened habitats or species, or on introduced injurious species.
2. THE ANDREW H. PRICE FIELD RESEARCH GRANT IN HERPETLOGY. Proposals may address needs for field station fees or equipment and materials in field oriented projects, or the field work portions of broader studies. This might include in-situ behavioral studies, ecological, life history, or sexual selection studies. Survey work by individuals or regional societies may be submitted here or in TRAVEL below depending on how the funds are to be used.
3. LABORATORY RESEARCH. Proposals may address needs for equipment or materials in laboratory projects or laboratory portions of broader projects. This might include studies in behavior, biochemistry, molecular biology, biomechanics, or physiology.
4. HERPETOLOGICAL EDUCATION. Proposals may address an educational project or start up support for an educational program in a zoo, museum, park, nature center, regional herpetological society, etc. The project must focus on a herpetological topic. *Note*: Although proposals for institutional projects are accepted, education proposals must be submitted by an individual (either sole applicant or principle contact person for the project). Applicants need not be students or SSAR member.
5. TRAVEL. Proposals may address support for travel to field study sites near or far, or to utilize distant collections or facilities. If funding is sought to get from one place to another, proposals should be submitted in the TRAVEL category. Proposals normally submitted in the CONSERVATION or FIELD RESEARCH categories should be submitted here if travel funding is being sought.
6. INTERNATIONAL. Proposals may address needs in any of the above five categories. The applicant must be a student, but not necessarily a SSAR member. Preference will be given to



CELEBRATING THE 7TH WORLD CONGRESS OF HERPETOLOGY

SSAR To Reprint the Herpetological Classic

ERPÉTOLOGIE GÉNÉRALE

ou Histoire Naturelle Complète des Reptiles



Constant Duméril



Gabriel Bibron



Auguste Duméril



AMONG THE PUBLISHED WORKS IN herpetology over the last five centuries, only two can be said to cover all known species of amphibians and reptiles comprehensively and scientifically. One, in English, was by George A. Boulenger and based on the collections of the British Museum in London (9 volumes, 1882–1896). These books were reprinted in 1961–1966 and, despite their age, remain among the most frequently consulted references in herpetology. The other, in French, was by Constant Duméril, Gabriel Bibron, and the senior author's son, Auguste Duméril, and based on the collections of the Muséum d'Histoire Naturelle in Paris (9 volumes plus an atlas of colored plates, 1834–1854). This latter work, generally known as "D & B," has never been reprinted, yet it remains of continuing value to a broad community of academic zoologists, museum and zoo curators, and conservationists, and especially to herpetologists working in developing countries. D & B is, in fact, more comprehensive than its English counterpart, for in addition to having more detailed descriptions of genera and species, it also covers the internal anatomy, physiology, and the associated literature.





Karl Patterson Schmidt, a leading American herpetologist, wrote: **"The *Erpétologie Générale* was the crowning work of a century of herpetological studies, during which the leadership in the field had lain with the French."** At that time, Paris was the epicenter of world science and its museum boasted the greatest naturalists: Buffon, Geoffroy Saint-Hilaire, Lacepède, Lamarck, and the greatest of them all, Georges Cuvier. Also among them was Constant Duméril, who trained as a physician and became one of Cuvier's closest colleagues. The Paris museum then possessed the largest natural history collections in the world. D & B was the first work in which a natural arrangement of genera was attempted, and many of the genera and species were first described there.





This full-size facsimile is absolutely complete and carefully edited for clarity. The 120 finely executed plates are reprinted in *both uncolored and colored states* because the original coloring sometimes obscures details of scutellation. The nine text volumes, which total more than 7,000 pages, and atlas of 120 plates are sturdily bound in library-grade cloth and printed on durable, acid-free paper. The **new introduction by Roger Bour (Paris)** is an in-depth review of the book (including exact publication dates) with new biographies of the three authors. A **comprehensive index to the scientific names**, missing in the original book, has been added. The original book was issued in fewer than 500 sets and is rarely offered for sale today. When it is, a colored set costs about US$15,000. (This reprint is being offered at an affordable price because of a generous subsidy from Ronald A. Javitch of Montréal.) Herpetological centers in developing countries are invited to contact the editor (*Kraig Adler*: kka4@cornell.edu) about special arrangements for obtaining copies.

■ *SPECIFICATIONS*: Nine volumes (bound in five) of text, plus an atlas volume of 120 plates (each in colored and uncolored states), all 5½ × 8½ inches (14 by 21.5 cm). Library-grade cloth bindings. ISBN 978–0–916984–87–8. ***To be issued November 2012***.

■ *PRICES*: • **Regular Price:** $275. • **Special Price to SSAR members** (if order is received before 31 December 2012): $225. • **Shipping**: USA address, add $15; non-USA shipping at cost. • **Orders to:** SSAR Publications Secretary, P.O. Box 58517, Salt Lake City, Utah 84158–0517, USA (*telephone and fax*: 801–562–2660; *e-mail*: ssar@herplit.com). • **Payment:** Make checks payable to "SSAR." Non-USA orders must be paid in USA funds using a check drawn on an American bank or by International Money Order. Books may be charged to American Express, Discover, MasterCard or Visa (please give account number and expiration date). • **SSAR Membership and Other Publications:** Membership information and a list of society publications can be obtained from the Publications Secretary at the address given above or at www.ssarherps.org.

students with limited access to research funds and in countries where herpetological research has historically been under-funded. **Note Regarding Eligibility in the International Category**: In late 2011, the current President of SSAR, the Grants-In-Herpetology Chair, and several members of the SSAR Board of Directors decided that proposals in this category would only be accepted if they were submitted from institutions OUTSIDE of the United States. Proposals from students who are primarily affiliated with United States institutions are *not* eligible for this category.

Submitting your proposal: All proposals must be submitted electronically to Joshua Kapfer (e-mail: kapferj@uww.edu) as a single PDF file named "lastname-category.pdf" no later than 15 December 2012 to be considered (letter of support may be included with the proposal or sent separately). Exceptions to electronic submission and file format may be allowed for special cases with prior approval by SSAR-GIH Chair. Full details about the GIH program and proposal requirements are available on the SSAR website: http://www.ssarherps.org/pages/GIH.php

Grants-in-Herpetology Donor Information

Financial contributions by SSAR members, institutions, and other benefactors support this program significantly, and can increase the number and/or size of awards. Your tax-deductible contribution (US citizens) to this program will directly benefit meritorious research and education in herpetology. Contact the Treasurer of SSAR for additional information about contributing to the Grants-in-Herpetology program. If you are employed by an organization that will match donations made to nonprofit organizations, please notify your employer that you have made a donation to the Grants-in-Herpetology program.

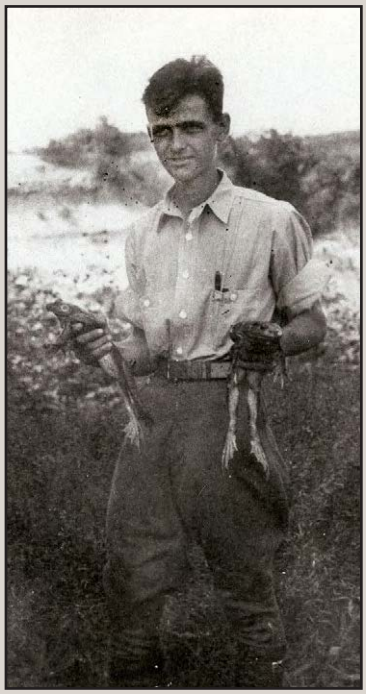
NEWSNOTES

Hobart Muir Smith Turns 100

Hobart Smith will celebrate his centennial birthday on 26 September 2012. In appreciation of Hobart's remarkable and unsurpassed contributions to herpetology, we invited a few of his colleagues and former students to offer comments.

—R. W. Hansen, Editor

PHOTO COURTESY OF ALAN H. SAVITZKY



Hobart Smith with frogs in hand, 10 miles S of Austin, Texas, while in the field with Howard K. Gloyd, 24 June 1930.

Hobart: Over the years you have been kind, helpful, and generous. Sixty years ago when, as a student at Michigan, I visited Urbana to examine Mexican specimens in your collection, you always welcomed me. You and Rozella were kind enough to take me into your home in St. Joseph. There, we all watched Gunsmoke, you and I talked into the wee hours, and I shared a room with Bruce. Your extensive experience with the Mexican herpetofauna was a great inspiration to me. You told me where to look for some species and how to catch some others. I found it difficult to believe you when, upon my asking about the location of Cuautlapan in Veracruz, you told me to take the road from Orizaba to Córdoba and turn right in the middle of the bridge! A few months later (March 1956) I travelled that road, and sure enough there was a narrow gravel road descending from the middle of the bridge. If that were not enough, upon parking the carryall under a tree we asked a man if we could scour his surroundings looking for herps. The man replied: "Conoce el Doctor Smith y el Doctor Taylor?" [Do you know Dr. Smith and Dr. Taylor?] Standing before us was Carlos Cerón, who two decades earlier had guided you and Taylor in the area.

Over the years you have helped me in many ways, and I have learned much from you. But, most of all, I am proud to have developed a friendship over the past six decades. As you now have achieved a new apogee in your attainment of the century mark, you have set new goals for many of us "youngsters" who have come to respect and admire Hobart Muir Smith, a man whose perspicacity and generosity are exceeded only by his modesty.

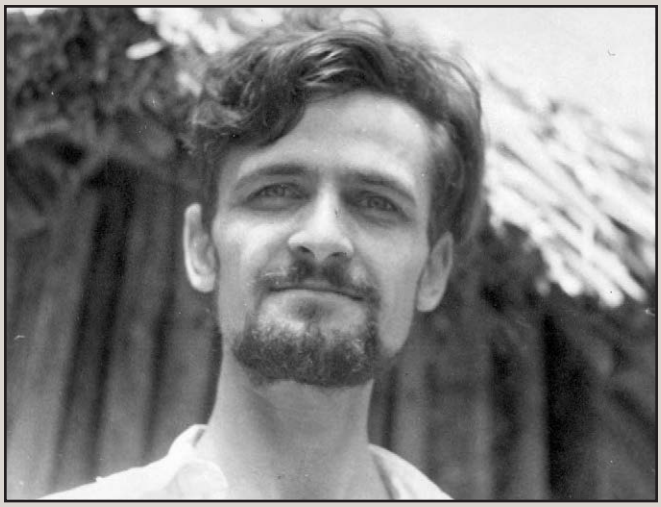
William E. Duellman
University of Kansas, Lawrence, Kansas, USA

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Almost 34 years ago I sent my first letter to Hobart Smith, in Spanish. I was asking for his help to obtain some publications that I was unable to find in Mexican libraries. His response was immediate. Since then, I have been corresponding with Hobart by letter and later by e-mail. Ten years after sending my first letter, I published a paper with Hobart, but our collaboration and friendship had started since I first wrote to him in August of 1978.

My relationship with Hobart has been very open and friendly, even though we do not agree in many fields of biology. We have talked about subjects other than Mexican herpetology—about politics, conservation, general science, and of course, Mexico. Throughout the years my relationship with Hobart became closer, until one day he sent an e-mail communicating to me his decision to donate his library to Mexico, in particular to Museo de Zoología, at UNAM. I made the arrangements to move Hobart's library, including logistic support, and raised the necessary funds. Our adventures

PHOTOS BY ROZELLA SMITH, COURTESY OF KRAIG ADLER



Smith outside his cabin at an archaeological site near Piedras Negras, Guatemala, May–June 1939.



Smith (left) and E. H. Taylor seining for *Ambystoma* salamanders in a pond about 12 miles NW of Toluca (Mex.), Mexico, September 1939. (This is from the only field trip to Mexico that Smith and Taylor made together.)

to move Hobart's library to Mexico were subsequently chronicled (Flores-Villela 2006. Bull. Chicago Herpetol. Soc. 41:225–227).

Although I did not study under Hobart's supervision, I have always considered him a mentor. Still these days, after he has retired from all professional activities, I e-mail him at least once a month, many times asking him about information regarding Mexican herpetology, or sending him manuscripts for his opinion. Hobart has been a very important person in my professional life and I have always received advice and support from him, and I am only one of many Mexican herpetologists Hobart has helped and advised. His dedication to Mexico has been the engine driving his many contributions to the study of Mexican species of amphibians and reptiles. I once wrote that Hobart Smith was the architect of modern Mexican herpetology, a title that no one can challenge and a status that still stands.

Oscar Flores-Villela
Museo de Zoología, UNAM, Mexico City

***

I had the good fortune of meeting Hobart when I came to do my graduate work at the University of Colorado (CU) in the late 1970s. Hobart was my advisor through 1981, and subsequent years were filled with many wonderful interactions. Above all, I've been astounded by his cheerful generosity. Even outside normal office hours, his door was always partly open, an invitation to anyone who might wish to talk with him. He always greeted visitors with a smile and enthusiastic welcome. It didn't matter if it was another faculty member, an undergrad, or a youngster bringing him a lizard or frog to identify. Seemingly, no visit was an intrusion or imposition. Later, when I came to Boulder to teach summer session courses, he proactively made sure I had plenty of space in his office/lab/magnificent library, and he even put me up in a room in his home, where I saw a new side of him (e.g., he simultaneously used his exercise bicycle, read a book, and watched football). A very few may have abused his unqualified generosity and trust yet—as kindness is another of Hobart's preeminent qualities—I never heard him utter a negative word about anyone.

His prodigious and amazingly long publication record is well known. Considering that I am now in my early 60s, it astonishes me to realize that he was publishing papers when my *parents* were still little children! His writing seemed effortless. While I struggled for weeks with a paper, he could write a finished paper in one day. And his prose is unique, particularly when unconstrained, such as in a book review, tribute, or obituary. I got so I could recognize his wonderfully distinctive style in an instant, without needing to see who the author was. Many of us who coauthored papers with him, with Hobart as a junior author, know a little secret. Once I confronted him with it: "Hobart, you wrote this paper, so why did you list me first and yourself second?" His response was that the discovery or idea was mine, so clearly I should be the senior author. I soon realized that almost all of those papers with Hobart listed as second or last author were in fact written by him.

Several years ago I participated in a reptile workshop in Jalisco, where my modest herpetological accomplishments understandably evoked only polite nods among the Mexican herpetologists. But when I happened to mention my connection with Hobart, faces instantly lit up with big smiles and exuberant testimonials. He quietly contributed to the endeavors of so many of us!

Hobart's era of maximum herpetological impact may have peaked before I met him, but not so his stature as a marvelous man and mentor. He never told me what to do or how to behave, but by example he showed the way. He engenders the affection of all who get to know him. During my years at CU, no one in the department was more beloved.

Geoff Hammerson
NatureServe.org

***

Hobart's influences over my academic/research development were many. I began working with him as a junior in college (1962) and stayed a student until I had finished my MS (1965). Surely his greatest influence was to propel me at *Eleutherodactylus*. He may have imagined that I would remain working on Mexican frogs but my appetites were already looking toward Ecuador and South America. In many ways, he induced me to tackle *Eleutherodactylus* with his praise to the effect that I had a taxonomic eye. Fifty years and some hundreds of *Eleutherodactylus* descriptions behind me, I must say that he was correct in his diagnosis.

He always claimed to know "nothing" about frogs (although he had described several from Mexico) and tried to compare me with his own major professor (E. H. Taylor). He likewise instilled

in me a serious respect for all the literature and that respect of what had been published has served me well these 50 years. We each delighted in detecting someone having read the literature superficially.

It is difficult, now 50 years later, to identify what other things he may have done, as a mentor, during those three years: for me, having encouraged me to tackle *Eleutherodactylus* and to respect (and to understand the context and to mine) the literature were his two greatest influences. During those three years, we published various things as coauthors and I learned much watching this dynamo at work and working directly with him.

Reflecting upon my career, I identify only a few professors playing crucial roles of raw encouragement: Hobart heads my list but is joined by George Byers (KU entomologist) and Philip Smith (herpetologist and ichthyologist of the Natural History Survey of Illinois). Byers almost convinced me to study hemipterans, Phil Smith almost convinced me to work on fishes, and Hobart set me upon my long path that ended up in Bogotá, Colombia.

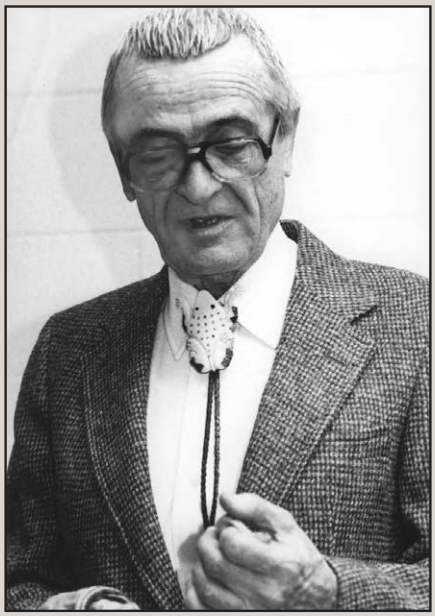


PHOTO BY KRAIG ADLER

Portrait of Smith with a small snake in his hand, dated about 1980.

His influence over my career was indirect but decisive. I recall now a seminar group to which he invited me to participate. We were dissecting a book by Sneath & Sokal (Numerical Taxonomy). Hobart expressed surprise that I found the book partly interesting while the other members of the seminar group thought it trash (for criticizing evolutionary taxonomy). Those debates led me to discover Willi Hennig and phylogenetic systematics; that discovery was crucial to my career development.

John D. Lynch
Instituto de Ciencias Naturales
of the Universidad Nacional de Colombia
Bogotá, Colombia

***

I had the great good fortune to be one of Hobart M. Smith's many graduate students. Smitty, as most students and friends called him, was a fantastic doctoral mentor. Under his tutelage, I learned a lot about doing research and a lot about life. As a doctoral mentor, I have tried to follow his example with my own students; and with less success, I have tried to adopt his view towards life. Three recollections of my interactions with Smitty during my graduate school days come to mind.

I was fascinated with vertebrate brains, particularly reptilian brains at the time, and I was trying to build a sizable collection of sectioned material. One day I went to Smitty and asked if there was any possibility of my obtaining one or two live tuataras. Amazingly, Smitty did not even ask what I wanted them for. Almost as surprising, in the context of today's grant-obsessed and "PI-driven" university environment, he did not indicate that his co-authorship would be required on any papers emanating from these animals. Instead, he simply said, "I'll see what I can do," and about a month later, two beautiful tuataras showed up on my desk.

On another occasion, I was in Smitty's office, ranting about a fellow graduate student, someone I believed had limited research ability and an obnoxious personality. Smitty listened patiently to my diatribe, and when I had finished, he smiled and said, "Glenn, did you ever consider that people are like crystals? Some have four sides, others eight, and some are even more complex." My first reaction was puzzlement: Why was Smitty talking about crystals? Finally, I realized I had just been taught an important lesson in life.

One day, when I was working in my student cubicle, Smitty came in and handed me the newly published translation of Hennig's *Phylogenetic Systematics*, with the comment that he thought I might be interested. As usual, he never asked what I thought of the book or made any attempt to discuss it. At the time, I did not know what to think of Hennig's revolutionary ideas, though I suspect Smitty had quickly discerned their heuristic value. It took me another few years to realize how critical phylogenetic systematics was to my own research, and even longer for Hennig's ideas to dramatically change the direction of my own research.

On the occasion of Smitty's 100th birthday, I salute him as a wonderful mentor, a good friend, and a remarkable human being. I only wish that Mary Sue and I could be present to help celebrate this occasion with him and his former students and friends. Happy Birthday, Smitty!

R. Glenn Northcutt
Department of Neurosciences
University of California, San Diego, USA

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Like many young herp enthusiasts growing up in the U.S., Hobart Smith's Golden Nature Guide to reptiles and amphibians, written with Herbert Zim, was my first book on the subject. Even now a frayed copy sits in my home library, its iconic paintings burned into my memory from countless hours spent imagining my own encounters with those species. For a child growing up in Connecticut, the book's vivid tableaux, such as *Crotaphytus* running beneath sandstone mesas and *Farancia* inhabiting cypress swamps, only heightened the allure of herpetology.

Years later, as I was considering attending the University of Colorado, I learned by lucky coincidence that Hobart would be moving to CU the same year, following his early retirement from the University of Illinois. That news determined my choice of institutions, and shortly after my arrival in Boulder I arranged a meeting with Hobart. I immediately received his warm encouragement, as well as a key to his lab and his extraordinary herpetological library. Over the ensuing four years I worked for Hobart and Rozella on their bibliography of Mexican herpetology, pursued taxonomic projects with Hobart on *Tantilla* and *Sceloporus*, and joined the legion of students whom he encouraged to conduct field surveys in Mexico. I also took his comparative anatomy course, which sealed my interest in comparative morphology. Upon graduation Hobart encouraged me to attend his alma mater, the University of Kansas, and provided what I am told was the decisive letter, assuring my future graduate institution that I

was worth the risk, notwithstanding my undergraduate grades.

I graduated from CU exactly 40 years ago, and although my interests have led me far from the taxonomy of *Tantilla*, my research continues to be shaped by Hobart's influence. Known by colleagues primarily for his faunistic and taxonomic works, Hobart has had a broad range of herpetological interests. I have recently had the satisfaction of turning my own attention to a keen observation Hobart published when I was five years old, the enlargement of adrenal glands in *Heterodon*. We now know that this intriguing condition occurs in several other toad-eating snakes, although its significance remains to be elucidated.

More than his research itself, however, Hobart's students know that his defining characteristic is his compassion, from which springs the encouragement he has given to several generations of young herpetologists. I am certain that many of Hobart's former students, like myself, continue to find themselves guided in their professional lives by his exemplary mentorship.

Alan H. Savitzky
Department of Biology, Utah State University, Logan, Utah, USA

***

I enrolled in comparative anatomy at the University of Illinois in the spring of 1954 under Hobart. I received a "B" and was delighted. However, difficulties in English and algebra put me on probation. I volunteered for the draft that summer and entered the Army. Eventually I ended up at Fort Bliss in El Paso, Texas. I was visiting the Post library when I came across a copy of "Lizards of the United States" by a guy by the name of Hobart M. Smith. I had the common childhood interest in reptiles, which had persisted, and thus I was intrigued by the book. I soon found that the El Paso area had numerous lizard species. I wrote Dr. Smith asking if he would be interested in specimens from the area and received a two-page reply indicating indeed he was, and since I was so close to Mexico why not explore the dunes south of Juarez. Needless to say I was ecstatic hearing from someone who had written a book and who had invited me to collect and come see him when I returned to Illinois. Thus began a long and cherished association with Dr. Smith. His patience with me in dealing with my poor writing skills and working my way to first a B.S. degree and then a M.S. at the University of Illinois were undoubtedly something no other professor would have done.

In retrospect, he is one of two people who are responsible for me accomplishing my professional career. My wife would be the other, without whose support it never would have happened. There are others along the way who have improved and aided me, but there is no doubt in my mind had I not had the luck to "stumble across" Hobart my life would be dramatically different.

In conclusion, I must mention that in a recent historical perspective on HMS (Chiszar et al. 2004. Copeia 2004[2]:418–424), I was dumbfounded to be mentioned with the likes of Glenn Northcutt and Karel Liem as the graduate students he was "in awe" of.

Kenneth L. Williams
Department of Biology, Northwestern State University, Nachitoches, Louisiana, USA

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Happy 100th, Dr. Smith! The year was 1960. I had transferred to the University of Illinois after two years at Millikin University in my hometown of Decatur, Illinois. By then, I had committed to working with ectothermic vertebrates, but began by developing an interest in fishes. It only took one course, however, under Dr. Hobart M. Smith, Comparative Vertebrate Anatomy, to shift my academic direction toward herpetology. It was his dynamism and outgoing nature that did the trick, as well as his production of a hugely significant body of work on the amphibians and reptiles of Mexico, that exotic land on the other side of the border. When I decided to pursue graduate education in herpetology, with my sights set on the American tropics, it was Hobart Smith who suggested the schools to which I should apply. That act, surely so simple for him, was what set the stage for all that has followed and I credit him as my principal mentor during my career.

With the onset of the 70s, our paths crossed professionally when I began to work on *Tantilla*. Smith's seminal 1942 study on Mexican *Tantilla* is the beginning point for serious systematic study of these small snakes. Of the 63 currently recognized species in this genus, Smith is responsible for naming more than 10% of them.

In 1983, I had a chance to acknowledge my debt to Hobart Smith when I organized a symposium in his and Rozella's honor held at the annual SSAR meeting. A number of prominent herpetologists working in Mesoamerica participated in that event. The paper I co-presented then finally appeared in 1987.

Hobart Smith's influence is still felt in my recent work, especially in the book *Conservation of Mesoamerican Amphibians and Reptiles* (2010). The longest chapter in this book, written by Jerry Johnson and I, cites 14 papers authored or coauthored by him and his name sits in the Acknowledgments.

I know I am only one of many people who are indebted to Dr. Smith in ways small and large. For me, however, his influence determined the direction of my career and, in a significant way, the nature of the contributions I have made to our field.

Larry David Wilson
Centro Zamorano de Biodiversidad
Escuela Agrícola Panamericana Zamorano, Honduras

Charles Stearns Grant-in-Aid for Herpetological Research at the California Academy of Sciences

The Section of Herpetology is pleased to provide limited financial aid—mostly to cover transportation and limited per diem expenses—to graduate students who wish to visit our collections to support research on amphibians and reptiles.

Proposals should include a short, one-page description of the research project, a budget, and a letter of support from the student's faculty advisor.

Applicants are encouraged to access the database of CAS amphibian and reptile holdings before writing their proposal. Access

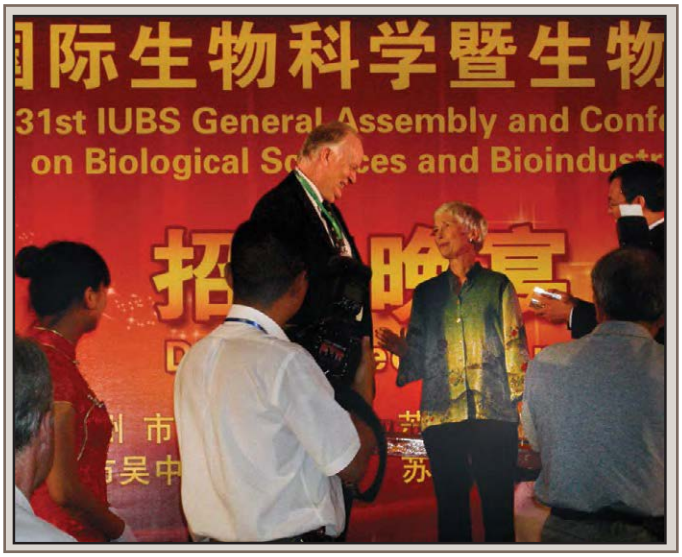
to the database could be found at http://research.calacademy.org/herp

Proposals are due on 30 October 2012, with notification by 1 December 2012. Grantees are expected to complete their Academy visit by 30 September 2013. Please call 415-379-5277 or email mhoang@calacademy.org for further information.

Send proposals—a single PDF document containing the proposal, budget, and letter of support— by email to mhoang@calacademy.org.

IUBS Honors Marvalee Wake

PHOTO BY DAVID B. WAKE



At the 31st General Assembly of the International Union of Biological Sciences, held in Suzhou, China in early July, 2012, Professor Marvalee H. Wake, of the University of California at Berkeley, was presented with the Inaugural IUBS Award "in recognition of her dedicated and meritorious contribution to the IUBS and to Biological Sciences." Professor Wake began her association with IUBS as a member, and then Chair, of the US National Committee of IUBS. She was elected Secretary-General of IUBS, located in Paris, in 1994 and served until 2000, when she was elected President, serving from 2000 to 2004. She was Past-President from 2004 to 2007, and has remained active in the organization. During her Presidency she inaugurated the scientific program "Towards an Integrative Biology," and she has been an articulate international spokesperson for development of integrative biology. She was the founding Chair of the Department of Integrative Biology at the University of California at Berkeley, starting in 1990.

Brett Stearns Award for Chelonian Research at the California Academy of Sciences

The Section of Herpetology is pleased to provide limited financial aid—mostly to cover transportation and limited per diem expenses—to researchers who wish to visit our collections to support their work in chelonian biology. Preference will be given to graduate students.

Proposals should include a short, one-page description of the research project and a budget. In the case of graduate students, a letter of support from the student's faculty advisor is required.

Applicants are encouraged to access the database of CAS chelonian holdings before writing their proposal. Access to the database could be found at http://research.calacademy.org/herp

Proposals are due on 30 October 2012, with notification by 1 December 2012. Grantees are expected to complete their Academy visit by 30 September 2013. Please call 415-379-5277 or email mhoang@calacademy.org for further information.

Send proposals—a single PDF document containing the proposal, budget, and the letter of support in case of graduate students— by email to mhoang@calacademy.org.

David J. Morafka Memorial Research Award 2013

In honor and memory of Prof. David J. Morafka, distinguished herpetologist and authority on North American gopher tortoises, the Desert Tortoise Council, with the aid of several donors, has established a monetary award to help support research that contributes to the understanding, management and conservation of tortoises of the genus *Gopherus* in the southwestern United States and/or Mexico: *G. agassizii, G. morafkai, G. berlandieri,* and/or *G. flavomarginatus.*

Award Amount: US $2,000 to be awarded at the Desert Tortoise Council's Annual Symposium, depending on the availability of funding and an appropriate recipient.

Eligibility: Applicants must be associated with a recognized institution (e.g., university, museum, government agency, non-governmental organization) and may be graduate students, post-doctoral students, or other researchers. They must agree to present a report on the results of the research in which award funds were used at a future symposium of the Desert Tortoise Council.

Evaluation Criteria: Applications will be evaluated on the basis of the potential of the research to contribute to the biological knowledge of one or more of the above gopher tortoise species, and to their management and conservation. Important considerations are the significance and originality of the research problem, design of sampling and analysis, preliminary data supporting the feasibility of the research, and the likelihood of successful completion and publication.

Application Procedure:

1. Download an application form from the Desert Tortoise Council's website: www.deserttortoise.org.

2. Provide all information requested on the application, including a description of the research project in no more than 1,200 words.

3. Submit the completed application to grstewart@csupomona.edu as a pdf attachment.

4. Applications must be supported by three letters of recommendation, one of which must be from the applicant's research

advisor, supervisor, or a knowledgeable colleague. Instruct the recommenders to submit their letters to grstewart@csupomona.edu as pdf attachments.

5. Completed applications and letters of recommendation must be received by **December 3, 2012**. They will be evaluated by a committee of gopher tortoise biologists appointed by the Desert Tortoise Council Board of Directors.

6. The research award recipient will be notified of his/her selection by **January 18, 2013** and the award will be presented at the 2013 Desert Tortoise Council Symposium, February 15–17, 2013.

New from PARC

Partners in Amphibian and Reptile Conservation (PARC) is pleased to announce that the newest edition of our popular and award-winning series, the PARC Habitat Management Guidelines (HMG), is now available! *Habitat Management Guidelines for Amphibians and Reptiles of the Midwestern United States* book is ~150 pages of full-color, practical, and proactive guidance for improving the compatibility of land management practices with these animals.

• WHAT do the HMGs have to offer?
These guides provide peer-reviewed, recommended management practices for amphibians and reptiles, along with alternatives when the ideal scenario is not possible.

• WHY are the HMGs useful?
They can inform individuals and agencies how to adapt their land management decisions to include herpetofauna, particularly in cases where they are not sure how best to begin. The HMGs are standardized in order to be applicable across regions.

REMINDER: The Southeast, Northeast, and Northwest regional guides are still on sale at 50% off (US $5.00). This price includes shipping, except to international destinations. See our HMG page (http://www.parcplace.org/publications/habitat-management-guidelines.html) for ordering information. All proceeds go to the production and printing of future HMGs and other PARC products such as these, never to operating expenses.

Also, keep checking back for our Southwest HMG—the last in our US-based regional series—currently in progress; it can be pre-ordered at the regular price of US $10.00 per copy.

MEETINGS

Southern California Association of Professional Herpetologists

The first meeting of SCAPH (Southern California Association of Professional Herpetologists) occurred at the Desert Studies Center (a field station of California State University) in Zzyzx, San Bernardino County, California on 8–9 June 2012. After socializing and some road patrolling on Friday, Saturday was spent on introductions, short presentations by those who wanted to talk about their research, and a discussion of the future of the group. We thank Bill Presch and others at the Center for their hospitality and Bobby Espinoza for spearheading organization of SCAPH and the trip.

PHOTO BY HILTON OYAMAGUCHI



Back row (L to R): Kris Lappin, Norm Scott, Greg Pauly, Glen Stewart, Jim Archie, Richard Etheridge, Todd Reeder, Brad Shaffer, Rulon Clark, Brad Hollingsworth, Bill Presch. Front row (L to R): Hilton Oyamaguchi, Ken Nagy, Erin Toffelmier, Genevieve Mount, Bobby Espinoza, Marion Preest, Julianne Goldenberg, Amanda Sparkman, Claire Forster, Morgan Hailey, Andrew Gottscho.

Red Listing Central American Squamates

Reptiles are conspicuously absent from the list of taxa that have been comprehensively assessed worldwide for extinction risk through the IUCN Red Listing process. Unassessed species are frequently overlooked in conservation planning exercises, and often ineligible for international assistance for conservation efforts. Although most North American reptiles have been assessed, there are big gaps for the diverse Latin American fauna. To begin to rectify the situation, a group consisting of NatureServe, Universidad de Costa Rica, Organization for Tropical Studies, IUCN, Fundazoo, CBSG Mesoamerica, and independent scientists co-convened a workshop to complete Red List assessments for Central American squamates. The goal was to review existing and create new Red List assessments for all species of Central American squamates, including threat category assignment, the compilation of supporting data, and the creation of range maps.

The workshop took place 6–10 May 2012, and involved 34 invitees, all either herpetologists with experience studying Central American reptiles in the field or scientists knowledgeable about the IUCN Red List criteria and database who served as facilitators of working groups. Rather than hold the workshop at a hotel conference room or university setting, the organizers chose to bring the participants to the Palo Verde Biological Station, located within Palo Verde National Park in Costa Rica. This tropical

dry forest location proved to be an exciting backdrop for a rather intense week of compiling data and assigning Red List criteria.

The workshop began with an introduction to Palo Verde and the project, followed by a thorough review of Red List criteria and the sometimes non-intuitive terms used in the Red List documentation. The remaining 4.5 days were spent in small working groups, arranged geographically, reviewing the assessments for each species. The groups began by focusing on single-country endemics and gradually coalesced to address bi-national and regional species. A separate group worked all week on widespread species in Central America. Thanks to heroic efforts, several late nights, and the lure of certain sugar cane-derived beverages as rewards at the end of each day, the assembled scientists succeeded in working through 468 currently recognized species of squamates native to Central America.

The formal IUCN process requires external review (in fact herpetologists with knowledge of Central American species who did not attend can expect to be contacted shortly to contribute in this regard), so the workshop results are preliminary. Nevertheless, there is a strong indication that nearly a fifth of the Central American squamate species are threatened with extinction. Many of these are endemic northern Central American lizards and snakes restricted to isolated cloud forests that are rapidly being destroyed by the advancing agricultural frontier. In many cases, personnel at designated protected areas simply do not have the wherewithal to hold the line against this onslaught of habitat destruction. Another observation made while looking around the room of assembled scientists is the paucity of female herpetologists working on the Central American reptile fauna. The field needs to diversify and actively attract women, especially Central American natives, to contribute to the considerable task of discovering, describing, and learning about the natural history and population status of these fascinating animals.

Why the focus on squamates and not all reptiles? IUCN specialist groups for freshwater turtles, sea turtles, and crocodiles have already assessed species in their purview. For the squamates, the viper, iguanid lizard, and anoline lizard specialist groups have made varying levels of progress at assessing species they cover, but none was complete for Central American species. The remaining lizards and snakes, making up the bulk of the reptiles, are not covered by an existing specialist group.

The workshop coincided with the first rains of the rainy season at Palo Verde. Afternoon downpours brought out toads, many of which had been inactive underground for months, frogs, as well as snakes eager to dine on the batrachians. The assembled regiment of herpetologists, some sacrificing measurable quantities of blood in the effort, succeeded in recording 24 reptile and 13 amphibian species during field forays organized around the margins of the meeting. Although the snake diversity and abundance was impressive, an emergence one evening of *Rhinophrynus dorsalis*, at the southern edge of its range in Palo Verde, stole the show for many.

Now that the workshop is concluded, the facilitators will upload the assessments to IUCN's central database, tie up any remaining loose ends on the accounts, and digitize the corrected range maps. The IUCN snake and lizard red list authority will then obtain two external reviews for each species account. After adjusting the accounts in accordance with the reviews and final quality control, they will be published on the IUCN Red List website. GIS files for the range maps will be available for download on the same site. A summary manuscript of the results is also planned for submission to a scientific journal. Similar workshops are planned for 2013–2014 to work through assessments of the Caribbean and South American squamates.



FIG. 1. Participants at the Central American Squamate Red List Workshop, held 6–10 May 2012 at Palo Verde National Park, Costa Rica. Standing (left to right): Phil Bowles, Erick Ballestero, Joseph Vargas, Quetzal Dwyer, Ileana Luque, Joe Townsend, Guido Saborío, Jerry Johnson, Mahmood Sasa, Javier Sunyer, Bill Lamar, César Jaramillo, Yolanda Matamoros, Roberto Ibáñez, Marcelo Tognelli, Bruce Young, Randall Arguedas, Geoff Hammerson, Louis Porras, José Hernández. Kneeling (left to right): Abel Batista, Larry Wilson, Fabián Bonilla, Gerardo Chaves, Daniel Ariano, Víctor Acosta, Jorge Rodríguez, Kirsten Nicholson, Oscar Flores, Alejandro Solórzano, Gunther Köhler. Not shown: Manuel Acevedo, Federico Bolaños, Neil Cox, Adrián García.



PHOTO BY PHIL BOWLES

FIG. 2. This *Leptophis mexicanus*, assessed as Least Concern, was one of 24 reptiles recorded by participants when not in their working groups.

The success of the workshop is due in equal parts to the convening organizations and the scientists (including some who were not able to attend but sent observations and distribution maps nonetheless) who so cheerfully contributed their knowledge, experience, and sweat to the project. Each organization contributed financially to the event, as did a National Science Foundation grant to NatureServe (DEB-1136586). The Palo Verde

Field Station was an ideal site for the event, combining comfortable facilities, delicious food, and interesting natural history observations right outside the meeting room doors (and sometimes even inside the doors). These contributions will help set the stage for stepped up efforts to conserve the remarkably diverse and sometimes critically threatened squamate fauna of Central America.

—Bruce E. Young, NatureServe, 4600 N. Fairfax Dr., Floor 7, Arlington, Virginia 22203, USA

Meetings Calendar

Meeting announcement information should be sent directly to the Editor (HerpReview@gmail.com) well in advance of the event.

4–6 October 2012—34th Annual Gopher Tortoise Council Meeting, Bainbridge, Georgia, USA. Information: www.gophertortoisecouncil.org/events.php

24–27 October 2012—Southwest Partners in Amphibian and Reptile Conservation (SW PARC) annual meeting, Las Vegas, Nevada, USA. Information: www.swparc.org/meetings.html

2–4 November 2012—Kansas Herpetological Society 39th annual meeting, Sternberg Museum of Natural History, Fort Hayes State University, Fort Hays, Kansas, USA. Information: http://cnah.org/khs/AnnualMeetingInfo.html

6–9 November 2012—XII Reunión Nacional de Herpetología, Sociedad Herpetológica Mexicana, Tuxtla Gutierrez, Chiapas, Mexico. Information: http://www.sociedadherpetologicamexicana.org/noticias/index.php

20–23 May 2013—World Crocodile Conference, 22nd Working Meeting of the Crocodile Specialist Group IUCN-SSC, Colombo, Sri Lanka. Information: www.csgsrilanka.com

OBITUARIES

Herpetological Review, 2012, 43(3), 370–375.
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In Memoriam: Andrew Hoyt Price (1951–2012), with Reflections from Colleagues and Friends

On 16 January 2012, herpetology lost one of its most dedicated and active professionals. Andrew Hoyt Price, age 60, succumbed to a long and courageous battle with multiple myeloma. He was born on 12 May 1951 in Brussels, Belgium, to his parents, C. Hoyt of Arkansas (USA) and Rosemary Price of England. Andy's father was a U.S. diplomat, so he grew up mostly abroad in Belgium, Vietnam, and Switzerland, with rotations in and out of Washington, D.C. He is survived by two brothers, Carl Price of Chandler, Arizona, and Roger Price of Pittsburgh, Pennsylvania. Andy's son, Alexander Hoyt Price, lives with his wife and Andy's two grandsons in Lovington, New Mexico.



PHOTO BY DEAN HENDRICKSON

Andy Price at the Texas Natural History Collections, Austin, 2009.

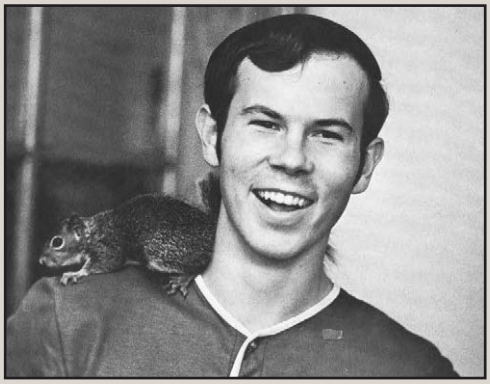
Andy's development as a biologist began with his Bachelor of Science in biology degree from the University of Miami in 1973. During 1973–1974, he spent a year in the sections of Mammalogy and Amphibians and Reptiles at the Carnegie Museum of Natural History in Pittsburgh, Pennsylvania. His job was to conduct vertebrate faunal surveys of the Allegheny County Regional Park System. At Carnegie, Andy found a life-long friend and mentor in C. J. (Jack) McCoy, curator of the herpetology section.

Although his academic interest was initially with mammals, Andy's childhood fascination with reptiles soon took over. Like many herpetologists, his interest for reptiles started at a young age. "When we cousins were playing together at our grandparents' farm, and someone yelled, 'Snake!' we all ran. The rest of us toward the house, Andy toward the snake." (From the eulogy by his cousin, Rev. Robert Price). After Carnegie, Andy spent the following three years at New Mexico State University (NMSU) working on scent glands in *Lampropeltis getula splendida* for his Master of Science degree under his advisor, the late Joe LaPointe (Price 1978; Price and LaPointe 1981). He remained at NMSU and completed his Ph.D., focusing on competition and parthenogenesis in whiptail lizards (*Cnemidophorus*, now *Aspidoscelis*; Price 1986a, Price 1992, Price et al. 1993). After graduating, he worked as a wildlife biologist with the U.S. Bureau of Land Management from 1980 to 1981. There he conducted herp, bird, mammal, and vegetation surveys of the Jornada Resource Area, Socorro District, New Mexico, as well as general surveys in other areas. In late 1981, he worked with the New Mexico Natural Heritage

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Program to computerize plant specimen data in the university herbarium. Throughout his entire time in New Mexico, Andy served as the assistant curator of herpetology at NMSU.

After completing his Ph.D. in 1986, he worked briefly for the Office of Quality Assurance at Holloman Air Force Base, New Mexico, where he was responsible for data auditing and study inspections to ensure compliance with FDA and EPA guidelines. His experience with the New Mexico Natural Heritage Program and knowledge of regulations helped him land a job as staff zoologist with the Texas Natural Heritage Program in Austin, Texas, in late 1986. Andy was often referred to as the "State Herpetologist" during his tenure at TPWD. His job required him to fulfill the usual state bureaucratic obligations including wildlife and scientific permitting, but he was adamant that he would perform his job with scientific objectivity and continue active participation in research whenever possible. He was responsible for monitoring the rare and endangered fauna of Texas and planning, administering, and conducting field surveys to determine their status. He doggedly pursued funding for these activities through Section 6 of the Federal Endangered Species Act and any other resources he could find. He aided development and review of conservation policy for the state, including a database abstracting the ecological characteristics of Texas vertebrates, conducted research, guided education, and provided technical guidance concerning the herpetofauna of Texas. His major research projects included long-term ecological monitoring, educational activities, and development and implementation of a habitat conservation plan for the Houston Toad (*Bufo houstonensis*) (Price 2003; Hatfield et al. 2004); phylogenetic studies of turtles in the genus *Trachemys*; a status survey of the Texas Horned Lizard, *Phrynosoma cornutum* (Donaldson et al. 1994); and the distribution, systematics, phylogeny, and conservation status of hemidactyliine plethodontid salamanders (Chippindale et al. 1993, 1998, 2000; Chippindale and Price 2005).



Andy befriending a squirrel (from his high school yearbook, 1969).

Andy's scientific objectivity did not always agree with TPWD administrators. He began state employment at a time when conservation issues were increasingly challenged politically, and the economics of conservation decisions in Texas were influencing the biology and science of rare and endangered species. Conservation of the Barton Springs Salamander (*Eurycea sosorum*), which lives only in the center of Austin, was one project that showcased these challenges. Andy was assigned to work with a team of four scientists over several months. Their tasks included taking field trips to the springs and other localities of related salamanders, conducting flyovers of the area, studying many documents from several agencies on water quality, regional hydrology and land use, and then combining it all into a comprehensive report. During this time period, the state dissolved Andy's title as Endangered Species Biologist and also eliminated the state biological survey. The politics at federal, state, and local levels were intense and covered regularly in the Austin press. Real estate developers hired lobbyists, lawyers, and their own consultants to fight anything in the report that might curtail their plans along the Edwards Aquifer recharge and contributing zones, some of the most valuable and environmentally sensitive property in the state. Despite their efforts, the city adopted the main recommendations of the scientific study team. Andy was indefatigable in his work on the project. His knowledge of the species' biology, conservation issues, and commitment to what he saw as his job was truly professional. The salamander was later listed as federally endangered (U. S. Fish and Wildlife Service 1997).

Andy retired from TPWD in 2008 after 22 years of state service. His first battle with multiple myeloma occurred while he was still employed. He was originally diagnosed in the summer of 2006 and had a bone marrow transplant in March 2007. He was in remission by the time he retired from TPWD and actively continued to work and fulfill professional obligations until it reappeared in mid-2010. During 2009–2010, he was a curatorial assistant in the Texas Natural History Collections at the University of Texas, Austin, and a part-time assistant professor of biology at Southwestern University in Georgetown, Texas, where he taught environmental science and ecology. From 2009 until his death, he was a scientific advisor for the Texas River Systems Institute, Texas State University. He also contracted with local biological consulting companies to work with sensitive, rare, and endangered species.

In 1994, Andy received the George Miksch Sutton Award in Conservation Research by the Southwestern Association of Naturalists (SWAN) and, in 2008, a Lifetime Achievement Award from the Texas Herpetological Society, Horned Lizard Conservation Society, and Southwestern Partners in Amphibian and Reptile Conservation. The Sutton Award from SWAN was for a paper he co-authored on the distribution and status of the Devils River Minnow, *Dionda diaboli* (Garrett et al. 1992). He was especially proud of his 26-year appointment as a research associate with the Section of Amphibians and Reptiles, Carnegie Museum of Natural History.

Andy's commitment to numerous state, national, and international professional societies reflected his dedication to the profession and love of natural history literature. At the time of his death, he was a member of 19 societies. Throughout his career, Andy served the professional herpetological societies in numerous ways. Notably, he served as Associate Editor for the *Journal of Herpetology* (1994–1996), Treasurer for The Herpetologists' League (1988–1993), Associate Editor of herpetology for American Midland Naturalist (1994–1997), and General Herpetology Editor for Copeia (1997–2000).

Andy was a bibliophile and especially adept at uncovering literature on herpetological topics. His lifelong goal was to have a hard or electronic copy of every known publication on lizards. His love of the literature and dedication to herpetology were reflected by his 26-year tenure with the *Catalogue of American Amphibians and Reptiles* (CAAR) series published by SSAR. He was the Sauria and Amphisbaenia section editor beginning in 1987 and editor-in-chief as well from 2005 until his death. He knew the literature so well that he frequently added citations to CAAR accounts missed by the authors. As Bob Powell noted, "It was a bit daunting when you thought you'd done everything only to have him send a list with another 10+ citations you hadn't seen." He authored or coauthored seven species accounts in this series

(Price 1980, 1982, 1986b, 1990; Price and Sullivan 1988; Bell et al. 1996; Thompson et al. 1998). Andy's last actions were to make recommendations to SSAR about the future of this publication series.

Andy was able to produce a steady stream of contributions to herpetology while working a state job that did not require him to publish. Between 1978 and 2008 he presented or co-presented two dozen papers at annual herpetology meetings, Texas herpetological societies, and in invited symposia. Andy's co-authored book, *Amphibians and Reptiles of New Mexico*, with Bill Degenhardt and Charlie Painter (Degenhardt et al. 1996), is the definitive treatise on this topic. Indeed, the authors received a Southwest Book Award for Literary Excellence in 1998 by the Border Regional Library Association (El Paso, Texas). Andy wrote two editions of a popular book on Texas snakes (Price 1998, 2009). At the time of his death, he was working on a compilation of literature on herpetological remains associated with Native American activities in North America and a summary of the conservation biology of the Houston Toad (*Bufo houstonensis*). Two field projects in which he was interested, taxonomy of salamanders in the genus *Siren* and distribution and ecology of the Rough-footed Mud Turtle (*Kinosternon hirtipes*) in Texas, were cut short by his untimely death.

Contributing substantially to one's profession is hard enough while working at an academic institution where there are such expectations. Being active in professional societies and consistently producing publications throughout one's career while working for a state government agency is exceptionally rare. Andy will be remembered for his life-long dedication to and support of the science of herpetology.

Recollections of Andrew Price

It has been my privilege to know Andy Price for several decades, almost from the time he earned his Ph.D. His knowledge of and contributions to herpetology have been multiple, but with a focus on lizard systematics and natural history. Others have duly noted these aspects of his career in this tribute. Instead, I want to comment on his service contributions to herpetology.

Every scientific society owes its existence to a relatively small handful of altruistic individuals who regard voluntary service to their profession as obligatory payback. Without them—the officers, editors, committee chairs, and meeting organizers—there would be no scientific societies, which are essential to the development of any scientific discipline. SSAR is no different from other societies, but has been blessed with an unusually large number of such individuals. Andy Price is a prominent example. His service to SSAR began in the usual way—as a member of various committees. In 1987, only a year after receiving his doctorate, he became Section Editor of Sauria and Amphisbaenia for the *Catalogue of American Amphibians and Reptiles*, which was to become the primary focus of his service contribution to the herpetological community. With his unusually broad knowledge of these reptiles, he was the ideal person to edit this section because he knew the right people to choose as authors and reviewers, and he then improved their contributions with his painstaking and informed editing. In 2005, he was promoted to Editor-in-Chief of the entire *Catalogue* and continued the high editorial standards of his predecessor, Bob Powell.

Through this editorship, Andy became fully invested in SSAR. He recognized that the success of his serial was dependent on the overall success of the society and was therefore an active participant at meetings of the Board of Directors. He got involved in almost every discussion and on a wide range of topics. Because of the quality of his editorial work and his clear thinking on so many topics, he was highly respected around the table. He continued to edit the *Catalogue* and attend Board meetings even while suffering through his final illness. Last year, the officers and editors of SSAR presented him with a signed and framed "Certificate of Recognition" for his editorship of the *Catalogue* and his many years of service to the herpetological community. His devotion to his colleagues and his discipline set a very high standard, but Andy did it because he thoroughly enjoyed editing and his other work within SSAR. I think he regarded these activities among the crowning achievements of his professional life. I certainly do.

Kraig Adler
Cornell University

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I met Andy Price in the fall of 1989 when I was a new graduate student in David Hillis' lab at UT Austin. Andy was the state herpetologist, and he and David had various collaborations in progress. Among these was a study of the enigmatic Texas cave and spring salamanders (*Eurycea* and what was then *Typhlomolge*). The group had been problematic for decades in terms of systematics and taxonomy, was rapidly becoming a major priority for conservation, and a molecular approach was essential to sort it all out. Until shortly before my arrival, David had a student who was working on this with him and Andy, but he suddenly and mysteriously disappeared (he briefly reappeared a few years ago, but that's another story). Mystery and intrigue have been a longstanding part of the Texas *Eurycea* investigation that was so much a part of our lives.

I had all sorts of ideas about Ph.D. projects, but David, although wide-open to various possibilities, was especially eager to see me tackle this one. He and Andy and I dived into fieldwork almost immediately after I arrived, and I quickly became fascinated with the group. There was no question that I'd pursue it, but I still had doubts as to whether this would be my major project. I think it was Andy who finally cemented it in my mind; he told me that I'd be crazy to pass up the opportunity, that there was enough there for multiple dissertations, and that chances like this don't come up every day. Initially I had found Andy a little distant and perhaps even cold, but nothing could be further from the truth. He and I rapidly became not only close collaborators, but also close friends. He was an invaluable field companion who made possible access to many very difficult sites (springs and caves, including some of the most uncomfortable caves you can imagine). Andy also was key in helping to secure funding from Texas Parks and Wildlife Department, U.S. Fish and Wildlife Service, and National Science Foundation that allowed us to carry out this potentially daunting study on a major scale. And throughout, he was a major inspiration for my research.

As my molecular results started rolling in, the situation turned out to be even more complex (and politically charged!) than I ever would have expected. I sometimes found this a bit overwhelming, but Andy's usually calm and practical demeanor (simultaneously a complement, but also a contrast, to David's boundless yet occasionally over-the-top enthusiasm) was a tremendous help. This was especially critical for me when Andy and I were involved in a tragic accident in which a military police officer who

was escorting us in a search for cave salamanders fell to his death, right in front of me. Andy's support when it happened, and later, when I kept questioning whether there was something I could have done to prevent it, made a huge difference. In retrospect, things like this just happen sometimes, but back then, Andy really helped me come to terms with it, practically and emotionally.

Andy, although often stoic and tough, also had his share of problems. He sometimes tried to do everything. I have no idea, for example, how many thousands of hours he put into his meticulous, multi-year tracking studies of Houston Toads. He often became frustrated by the sheer volume of work, the politics, the bureaucracy of it all, yet he maintained his drive and enthusiasm, and dedication to study and conservation of amphibians and reptiles. I'm glad that, especially as I matured as a scientist and a person, I was able to provide support and reassurance to him as he did for me. Over the years, Andy became one of my closest and most trusted friends, and our respect and help for one another extended far beyond the scientific arena. He made a huge and permanent difference in my life.

Even now, almost 23 years after I started as a Ph.D. student at Austin and first got to know Andy, others and I still use specimens and samples that we collected, and refer to his field notes, morphological data, and other information, much of which would be unobtainable now. There's still more work to be done, there are yet more species of Texas *Eurycea* to be described, and his contributions and insights are playing an integral role. Even though Andy is gone, he left an invaluable legacy, both scientific and personal, for so many of us and for preservation of the biodiversity that he loved.

Paul T. Chippindale
University of Texas at Arlington

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My remembrances of Andy go back to his graduate school days. He was much younger at the time, but a curmudgeon even then. While he was at New Mexico State University, he read one of my papers on the White Sands lizards and suggested I may have misidentified one of the species. One of my graduate students was also working on the same genus, and he and I thought we would play a joke on Andy without even knowing his personality (a mistake on my part). A letter was sent to Andy suggesting that he challenged my ability to recognize such a well-known species and he should get help from a local taxonomic expert about his own ability to recognize the species. This started a series of letters between Andy and me. You have to remember there were no computers, and letters required about a two-week turnaround time. Andy's third letter was so apologetic that I was afraid I had ruined his graduate career. I sent another letter apologizing for my original response, stating that I was trying to have some fun with him. We met later at a SWAN meeting and Andy and I had a laugh about it, but I realized that Andy was very serious about his science and I should tread lightly on this subject.

Following Andy's graduation and his employment with TPWD, Andy and I became friends and colleagues. I made several trips with Andy to Bastrop State Park, especially "ponds 9 and 10," where we marked a number of Houston Toads in the late 1980s. I also met several times with Andy in Presidio County where we met Dennie Miller at a study site for the Rough-footed Mud Turtle. Dennie and I always joked with Andy about his passion for obscure critters like Houston Toads and Rough-footed Mud Turtles. I finally found that Andy did have a dry sense of humor, but it took some time to bring it to the surface.

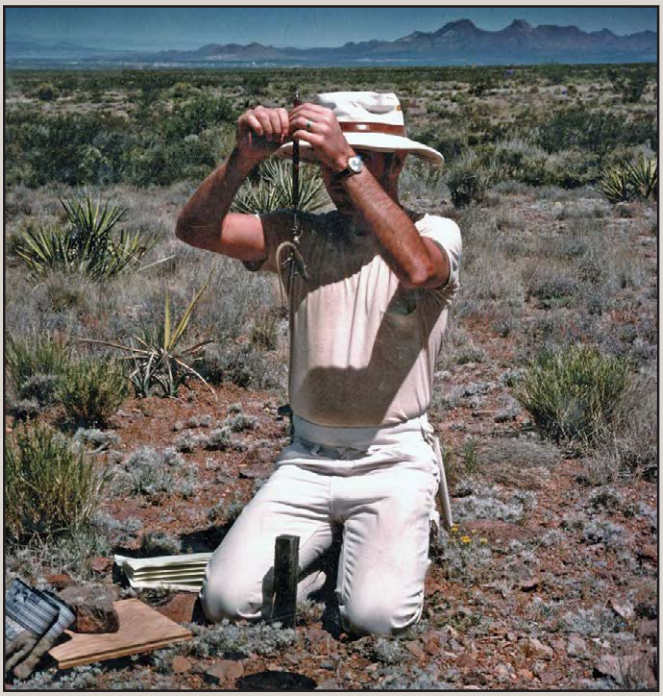


PHOTO BY ANDY PRICE

Andy weighing lizards for his doctoral research at his study sites in New Mexico.

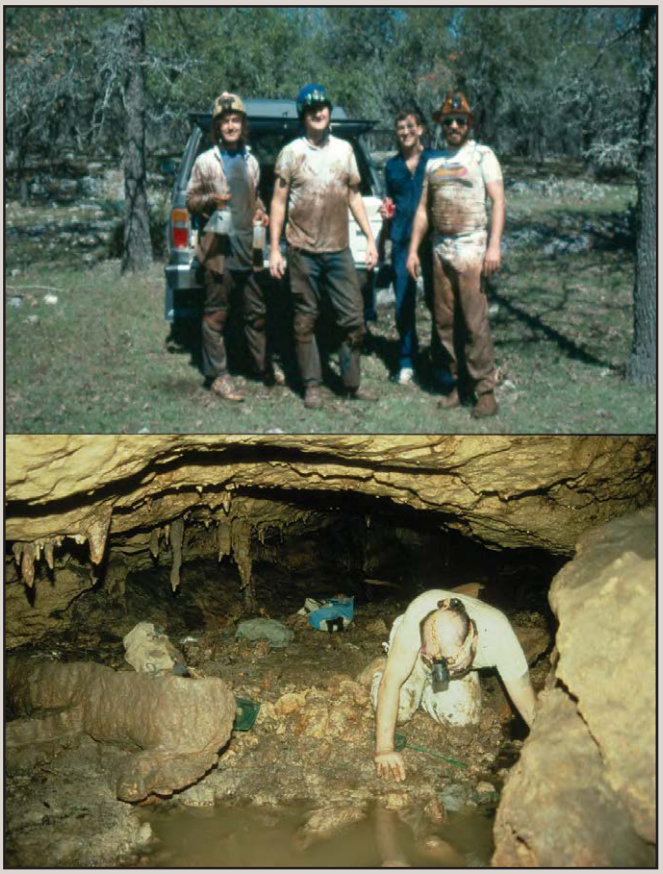


PHOTO BY PAUL CHIPPINDALE

Andy collecting salamanders at Badweather Pit, Comal County, Texas, in 1990 with colleagues. Above: Left to right: Paul Chippindale, David Hillis, Jim Mueller, and Andy Price on the surface after collecting *Eurycea tridentifera* specimens. Below: Andy collecting *E. tridentifera* underground.

I believe Andy was a curmudgeon from day one, and that was a part of his personality that we all learned to deal with. Andy would sometimes explode angrily, but if you listened and let him work it out of his system, he became the loveable curmudgeon we all enjoyed and admired. We all miss Andy, and especially the loveable part!

James. R. Dixon
Texas A&M University

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I first met Andy when I was working at The Nature Conservancy International (1986). I had to travel from Washington, D.C. to Austin, Texas, to spend a two-week internship with the local Natural Heritage Program where Andy worked. The first day I arrived at the Texas Natural Heritage Program, we had an instant connection; we talked about the Carnegie Museum and how Jack McCoy, our mutual friend, had jump-started his career, as well as mine. We had a few beers after work. Since then we remained good friends. Andy was a different person, some people may even say a strange guy, but with a big heart. I have visited with him a few times over the years with my wife and children, and he used to say, "These guys are some of my favorite people." He was one of our favorite people, too. I will remember Andy and will miss exchanging emails with him or having a beer.

Oscar Flores Villela
Museo de Zoología, UNAM

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I first met Andy Price at a Texas Herpetological Society meeting in the fall of 1994. He was the state herpetologist and I, being a naïve, young, graduate student, was the proverbial fly-on-the-wall bearing witness to a somewhat confrontational exchange initiated by several non-academic herpetologists about some rule or regulation about collecting long since forgotten. I remembered Andy as gruff, but holding his ground and arguing his point as much as helping the other side better elucidate theirs. He enjoyed giving that rough, stony persona as a first impression, but as my interactions with him increased when I moved to Austin for my Ph.D., I realized that was a bluff. He had a soft spot for students and for people genuinely interested in the organisms, but he had no patience for people using organisms to advance their politics or personal agendas. We became good friends, united by our passion for reptiles and amphibians (especially venomous snakes) and our mutual appreciation for herpetological literature.

To Andy, there was no gray literature, just literature he hadn't found yet. Several times at annual herpetology conferences, he'd be sitting in the hotel room at late hours of the night gleaning "obscure" feeding records while perusing several favorite search engines and databases. He was ideal as an editor for the *Catalogue of American Amphibians and Reptiles* series because of his obsession for finding everything published and persistence in vetting every citation listed in submitted catalog accounts. He was a true bibliophile and relished his opportunity to share his latest acquisitions with interested parties. He was also generous in making sure others could enjoy and use historical works. More than once, he saw a nearly destitute graduate student at a book dealer's table fondly gazing at a book important to the student's line of study, but priced well beyond their means. Andy would slip in later, buy that volume and then give it to the student, simply saying it was an important work and the student needed to have his own copy. He was very quiet with this generosity.

Following his cancer diagnosis, and with remarkable good humor, he persevered through many trials and tribulations during the ensuing treatment, which inevitably bought him six more years. Andy retired from Texas Parks and Wildlife in 2008 and was hired as a curatorial assistant at the Texas Natural History Collections at The University of Texas from 2009 to 2010. Andy clearly thrived in the collections setting and relished the interactions with the staff and students.

When the disease became ferocious in October 2011, we became much closer. I would visit him every other night following his hospitalization, and we talked for an hour or two about life. I took on the enabler role and smuggled in pints of chocolate chip ice cream. We talked turtles and toads, pushy relatives, and past relationships, academic and career choices, and the Pittsburgh Steelers. Even in the hospital, I would bring him his interlibrary loan requests, consisting of obscure archeological literature as he continued his search for the next missing citation for his project. He was determined that life should continue as uninterrupted as possible and that a return to a normal life was around the corner. I think of him often and I count our series of conversations over those last three months as some of the most meaningful interactions I've ever had with another human being.

I'll never be able to match Andy's dry, sardonic sense of humor, but his dogged pursuit of literature and his attention to detail as an editor are just two of the many things I've admired about him. His influence will live on as I continue to build my own library of reprints while at the same time reviewing literature cited sections with a critical eye for the erroneously cited page number.

Travis J. LaDuc
Texas Natural History Collection, University of Texas

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I remember the first day I met Andy Price. He was the gruff, bearded, reclusive member of the Natural Heritage Program, with the office at the far corner of the room, and I was the fresh-faced young TPWD wildlife biologist on a mission to build bridges and "have everyone get along." Andy later told me he also remembered the day he met that naïve young addition to the program and decided that we would indeed eventually get along.

"Learning to get along" happened in the best way possible—in the dark woods of Bastrop State Park, where my pastel-clad friend allowed me to re-experience and relearn the joys of basic ecological research—through capturing, measuring, and marking hundreds of Houston Toads. Those evenings in the field might have kept both of us sane during a tumultuous period when our day-time duties were filled with endangered species controversy and stress.

Eventually I chose to step back from the controversy and work with outreach and education, launching a citizen science program called Texas Nature Trackers (TNT). Andy served as a resource and encourager to TNT as we began to recognize the particular value of citizen scientists in monitoring reptiles and amphibians. His efforts with Wendy Hodges on the status survey for the Texas Horned Lizard provided the inspiration for Texas Horned Lizard Watch. He organized a statewide meeting on amphibian decline in 1998 that led to the development of Texas Amphibian Watch. He also wrote the background sections for the original Texas Amphibian Watch, Texas Horned Lizard Watch, and Texas Box Turtle Survey monitoring materials and introduced potential volunteers to the joys of box turtle watching by recounting his own childhood experiences with the species.

Despite his own research load, Andy was always ready to share advice with us in his own wry manner. Even after his retirement from TPWD, Andy helped promote Texas Nature Trackers by inviting us to give guest presentations at Southwestern University.

Though infamous for his gruff demeanor, Andy had a compassionate heart—one that my family experienced first-hand in 2006 when my daughter was hospitalized following an automobile accident. Andy himself was just recovering from his first rounds of treatment for multiple myeloma, but wanted to come and sit with my daughter in ICU so that our family could be together for a meal. In his final days, facing his own time in the hospital once again, he told my daughter how happy he was for her recovery. As the two of them shared a moment that only two individuals who have faced eternity could understand, I was very glad that I had braved that corner office and its curmudgeon with the secret soft heart back in 1990.

Lee Ann Johnson Linam
Texas Parks and Wildlife Department

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Andy Price was a unique individual, with an opinion and expertise in all things herpetological. He did not like the political realities of wildlife conservation and was outspoken on his feelings. It was a great pleasure working with Andy on the *Amphibians and Reptiles of New Mexico*. He understood the systematics of the genus *Cnemidophorus* (now *Aspidoscelis*) better than most herpetologists, so who better to write a section on the lizards of his beloved state, an area to which he had longed to return. He was a careful and knowledgeable editor and his expertise resulted in numerous books and manuscripts that were better after his touch.

Cancer is tough, sometimes it wins the battle, thankfully not always! Andy fought a gallant fight and openly shared what he was going through. He had an extremely tenacious grasp on life; I am sure most individuals could not hang on as long as he did and I told him so often. Last time I saw Andy was in his precious New Mexico; my wife, Andy, and I each ordered a plate of enchiladas and talked about New Mexico food, herpetology, and the Gila Wilderness that he loved and where he spent numerous days hunting for Tassel-eared Squirrels. When Andy passed on, the field of herpetology lost a great guy and someone with so much more to contribute. I will miss him, and I think of him often.

Charles W. Painter
New Mexico Department of Game and Fish

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Note: Those wishing to honor Andy's contributions to herpetology may send donations in his name to support the "Field Research" section of SSAR's Grants-in-Herpetology program, c/o Dr. Kirsten Nicholson, SSAR Treasurer, Museum of Cultural & Natural History, Central Michigan University, Mount Pleasant, Michigan 48859, USA.

CURRENT RESEARCH

The purpose of Current Research is to present brief summaries and citations for selected papers from journals other than those published by the American Society of Ichthyologists and Herpetologists, The Herpetologists' League, and the Society for the Study of Amphibians and Reptiles. Limited space prohibits comprehensive coverage of the literature, but an effort will be made to cover a variety of taxa and topics. To ensure that the coverage is as broad and current as possible, authors are invited to send reprints to the Current Research section editors, Beck Wehrle or Ben Lowe; e-mail addresses may be found on the inside front cover.

A listing of current contents of various herpetological journals and other publications is available online. Go to: http://www.herplit.com and click on "Current Herpetological Contents."

Molecular and Morphological Analyses Reveal Two New Neotropical Highland Vipers

Over the last decade, molecular studies have shed new light on Neotropical diversity within the family Viperidae. Vipers of the genus *Cerrophidion* occur in the high elevations of Central America. Recent work has winnowed this genus down to three species: a pair of species with small distributions in the Mexican states of Veracruz and Chiapas, respectively, and one species (*C. godmani*) discontinuously distributed from eastern Oaxaca through western Panamá. The authors of this study accumulated morphological and mitochondrial DNA sequence data for *Cerrophidion* specimens throughout their distribution and conducted molecular phylogenetic analyses to determine if there is cryptic diversity in this genus. These analyses demonstrated that *C. godmani* consists of at least three genetically divergent and geographically discrete clades: a northwestern clade occurring from Oaxaca through central Guatemala, a central clade in Honduras and El Salvador, and a southern clade in Costa Rica. These clades are as genetically distinct from each other as they are from the other two *Cerrophidion* species, supporting the authors' hypothesis that they represent undescribed species. In corroboration with previous studies of *C. godmani*, this study found no variation in hemipenial morphology and external morphological characters were found to exhibit a high degree of within-population morphological variation and an absence of strong differentiation between populations or regions. However, this and previous studies identified several morphological characters for which the recovered clades exhibit different mean values. The authors posit that the paucity of morphological divergence between regions, further obscured by high within-population variation, has prevented previous researchers from identifying cryptic diversity within this genus. The authors describe these three *C. godmani* clades as species (including a redefined *C. godmani*). This study enhances our understanding of Mesoamerican snake diversity and lays the framework for future studies that include analyses of morphological data explicitly testing hypotheses of morphological divergence and evolution, use of nuclear DNA data and recent molecular methods of species delimitation and species tree estimation, and additional sampling in areas where these snakes do occur (e.g., Chiapas, Panamá, southeastern Guatemala) and where they may occur (e.g., Nicaragua).

Jadin, R. C., J. H. Townsend, T. A. Castoe, and J. A. Campbell. 2012. Cryptic diversity in disjunct populations of Middle American montane pitvipers: a systematic reassessment of *Cerrophidion godmani*. Zoologica Scripta (*in press*) doi:10.1111/j.1463-6409.2012.00547.x.

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Common Wall Lizards Shake a Leg to Discourage Predators

Behaviors that could function to discourage predator pursuit, such as stereotyped tail movements, dewlap protrusion, and foot waving, have been documented for representatives of several squamate families. Although many instances of predator-deterrent behavior have been proposed, relatively few studies have sought to explicitly test this hypothesis against alternative hypotheses (e.g., courtship, intraspecific aggression, thermoregulation). Members of the family Lacertidae have long been known to engage in various forms of foot-waving (including a particular elliptical motion of the foreleg sometimes observed in lizards approached by humans), but whether this behavior ever functions in deterring predators has not been established. The authors of this paper conducted field studies of Common Wall Lizards (*Podarcis muralis*) aimed at determining if foot waving in this species conforms to a pursuit-deterrent behavior. Researchers approached *P. muralis* and observed lizard responses (fleeing, moving to another location, foot waving, or some combination of these), noting the "predator" distance that initiated the behavior. Statistical tests were performed to determine if the findings conformed to the following expectations of foot waving being a pursuit-deterrent behavior: 1) adult males no more likely to engage in foot waving than any other category; 2) the foot waved is most frequently the one closest to the threat; and 3) the farther away the threat is, the more likely the lizard is to engage in foot waving. Of 484 lizard approaches, 22.5% resulted in foot shaking. The lizards used the leg closest to the researcher significantly more often than the other, and the probability of the leg shaking rather than moving was positively correlated with distance. The distance at which adult males responded to approach did not differ from adult females; however, at any given response distance adult males were more likely to move than leg wave (perhaps because of their relatively conspicuous coloration). Finally, most observations of leg shaking occurred sufficiently far from conspecifics to rule out intraspecific signaling. Together, these findings provide support for this behavior functioning as a pursuit-deterrent. Future research should determine whether this type of foot shake is also used in situations other than interactions with potential predators.

Font, E., P. Carazo, G. Pérez i de Lanuza, and M. Kramer. 2012. Predator-elicited foot shakes in wall lizards (*Podarcis muralis*): evidence for a pursuit-deterrent function. Journal of Comparative Psychology 126:87–96.

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Female Common Lizard Dispersal Patterns Coincident with Ventral Coloration

Populations exhibiting multiple life history strategies serve as windows into how multiple phenotypes can be maintained in the face of drift and selection. Recent work on Common Lizards (*Zootoca vivipara*) in southern France has shown that in this region, female ventral coloration is polymorphic (orange, yellow, and mixed) and moderately heritable. These belly colors are correlated with the way litter size, breeding success, and sex ratio vary with different environmental and social conditions, indicating that ventral colorations are tied to alternative life history strategies. Furthermore, it has been established that individual reproductive success is tied to the ratio of color morphs in the population, namely the frequency of yellow-bellied females has an inverse relationship with the average female reproductive success, with a disproportionately larger effect on mixed females. The authors of this paper conducted an experiment to determine if the distance newborn female lizards disperse within populations is correlated with their ventral coloration (and thus strategy). They were also interested in the overall population's female ventral color ratios, as it would be beneficial for young lizards to disperse farther if in a situation where their strategy is disadvantageous. In four isolated populations, two with high frequencies of orange and two with high frequencies of yellow, gravid females were collected in the early summer and allowed to give birth in captivity. The females and their offspring were marked and released in the late summer into populations were their belly color was in the minority. Surveys of the populations were conducted in the fall and spring. These procedures were repeated for three years; by the end of the experiment the prevailing ventral color in each population had become a minority constituent and vice versa. These experiments revealed that as frequency of yellow females increased, offspring of orange and mixed (but not yellow) females dispersed less. Furthermore, as the frequency of orange females increased, the offspring of yellow females increased their dispersal distance, with offspring of orange and mixed showing no change. When dispersing, juveniles moved into areas with lower female densities. Offspring of orange and mixed females dispersed to areas with a higher proportion of yellow females, and the former also found areas with a lower proportion of orange females; all other comparisons were not significant. This finding seem to be at odds with the fact that females with yellow ventral coloration have been shown to be more aggressive than other females; the authors suggest that if they are superior competitors, yellow females inhabit higher-quality areas, which are good areas for dispersing lizards to settle (especially since the areas to which juveniles are relocating have lower densities than their original point of release). This study sheds more light on an interesting system and paves the way for genetic and long-term demographic studies of these populations.

Vercken, E., B. Sinervo, and J. Clobert. 2012. The importance of a good neighborhood: dispersal decisions in juvenile common lizards are based on social environment. Behavioral Ecology (*in press*) doi:10.1093/beheco/ars075.

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Most Widely-Distributed Amphibian Evaluated with Respect to Bergmann's Rule

Bergmann's Rule, which states that body size should increase with decreasing temperature (and therefore often increasing latitude or elevation), has long been accepted for endothermic groups. However, whether the rule applies to ectotherms has been a topic of heated debate, with numerous studies supporting and rejecting this theory for various reptile and amphibian groups. Recent studies of *Plethodon* salamanders have found an inverse Bergmann's pattern both within and between species, with the implication being that while thermoregulating ectotherms (animals that adjust body temperatures via behavior; e.g., frogs, turtles) may conform to Bergmann's Rule, thermoconformers may not. The authors of this paper studied the world's most widely distributed amphibian, *Salamandrella keyserlingii* (Hynobiidae), with the hopes of determining how life history and growth varied across the salamander's distribution, and in particular if it conformed to Bergmann's Rule. One population in Darhadyn, Mongolia (~51°N), was intensely studied through mark-recapture and skeletochronological (the study of patterns left by fluctuating bone growth activity to determine animal age) techniques to elucidate within-population size statistics (e.g., sex-specific size at metamorphosis, sexual maturity, and maximum size). These data were then compared with results from a similar study from Kushiro, Japan (~43°N) to identify potential latitudinal/temperature differences. Additionally, total length (TOL) and snout-vent length (SVL) maximum values were compared across 27 populations spanning 43° to 69°N. While Darhadyn males had a smaller SVL than their Kushiro counterparts, no significant differences were detected for females or metamorphs. Males and females did exhibit smaller a TOL in Darhadyn than in Kushiro. Both sexes showed a much older age at maturity at Darhadyn (~5 years) than in Kushiro (~2–3 years). These results alone support an inverse Bergmann's rule in this system. However, size data from across the distribution lead to a different conclusion. These data show that there is no correlation of SVL with temperature, latitude, or TOL. While TOL shows no significant linear relationship with either latitude or temperature, a "U" shaped polynomial equation shows a better fit to the data, with TOL decreasing from 8° to –7°C mean annual temperature and 43° to 57°N latitudes and increasing from –7° to –15°C and 57° to 69°N; no such polynomial relationship was seen for SVL. The authors suggest that this fits the converse of "Terentjev's Optimum Rule" (coined to describe some inverted U-shaped patterns of size variation across and environmental continuum, though no mechanism for this pattern has been proposed) rather than Bergmann's Rule. They further suggest that the U-shaped size distribution perhaps indicates that different factors may be operating throughout the distribution; for instance, below a certain temperature threshold, size might become a secondary determinant of persistence, and instead a size-independent characteristic such as freeze tolerance takes over as the primary determinant.

Hasumi, M., and L. J. Borkin. 2012. Age and body size of *Salamandrella keyserlingii* (Caudata: Hynobiidae): a difference in altitudes, latitudes, and temperatures. Organisms Diversity and Evolution 12:167–181.

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Complex Effects of Plant Material and Light Availability on Anuran Biomass Export

Numerous studies have investigated the effect of nutrient availability on stream biomass export in the form of arthropods to surrounding terrestrial habitats; however, fewer studies have looked at the effects of nutrient availability on biomass export in lentic systems, or biomass export attributable to amphibians. The authors of this study subjected water-filled cattle tanks to different plant material input treatments to determine the effects on amphibian biomass export. These tanks received varying amounts of sunlight, and either leaf litter, Prairie Cordgrass (a wetland plant serving as a proxy for within-system vegetation), or no additional plant material. These tanks were then seeded with larvae of Wood Frogs (*Rana sylvatica*), American Toads (*Bufo americanus*), or Southern Leopard Frogs (*Rana sphenocephala*) (depending on year) and monitored for metamorphs. Prior to metamorphosis, the tanks were evaluated for numerous variables, including four the authors identified *a priori* as potentially important for amphibian biomass export: dissolved oxygen, net primary productivity (NPP; determined by monitoring daily dissolved oxygen fluctuations), predators (dragonfly larvae), and interspecific competitors (treefrog larvae). Upon metamorphosis, animals were weighed and released. ANOVAs and path analyses were performed to identify and visualize the importance of these variables for frog biomass export. Availability of sunlight was found to have a strong, positive effect on NPP and competitor density. While biomass export appeared to consistently decline with increased NPP across all species and plant material treatments, no species' biomass export was found to be significantly affected by NPP alone. *R. sylvatica* and *B. americanus* showed a significant NPP by plant material treatment interaction, with significant decreases in export as NPP increased in the cordgrass and no-input treatments. Biomass export in *R. sphenocephala* was found to be significantly affected by treatment (but not NPP or NPP x treatment interaction), with the highest export seen in the leaf litter treatments and the lowest in the no-input treatments. In the path analyses, depending on the treatment and species, the four variables identified above combined to explain between 18% and 89% of the biomass export. These analyses revealed that NPP consistently had a strong, generally negative effect on anuran biomass export. Considering that NPP is indicative of algal densities, the authors suggest this negative effect of NPP on amphibian biomass export means that algae may not be as important for larval anurans as traditionally assumed. This conclusion is supported by the general finding that NPP had little effect on biomass export in the leaf litter treatments (indicating that the tadpoles were eating the leaves and associated microbes). The authors concede that this relationship may also be due to other effects of increased sunlight (which drives NPP) such as increased temperatures (which were monitored but not analyzed due to the non-independence of temperature and dissolved oxygen content).

Earl, J. E., and R. D. Semlitsch. 2012. Reciprocal subsidies in ponds: does leaf input increase frog biomass export? Oecologia (*in press*) doi:10.1007/s00442-012-2361-5.

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Diverse Male Reproductive Contribution Despite Female-Skewed Sex Ratios in Sea Turtles

Marine turtles all exhibit temperature-dependent sex determination (TSD), with females developing at higher incubation temperatures; this could lead to dangerously skewed sex ratios with anticipated climate change. As these species are generally imperiled worldwide due, among other factors, to the loss of egg-laying habitat and to adult mortality from fishing industry by-catch, the added impact of climate change could be too much for these species to overcome. To investigate potential consequences of a skewed sex ratio in marine turtles, the authors of this paper studied Green Sea Turtles (*Chelonia mydas*) in the Mediterranean Sea, where the female offspring have been documented to greatly outnumber male offspring. In 2008, tissue samples were taken at Alagadi beach, northern Cyprus, from 20 of 22 females who laid clutches that year and from 15 to 23 hatchlings from each successful female. All samples were genotyped for 14 microsatellite loci; these data were used to assign parentage and sibship to all of the offspring using parentage analysis software. While no molecular data on potential sires was collected, the nearly complete female and clutch sampling for the region allows maternal genetic contribution to be accounted for, leaving the remainder of the offspring's genetic signature to fathers. Finally, one adult male turtle was captured in the region, fitted with a satellite radio transmitter, released, and followed in order to shed light on male turtle movement patterns. Analyses of the hatching times revealed that the offspring were roughly 95% female. Despite this extreme observed sex ratio, the genotype analyses revealed that while some female turtles laid mixed paternal clutches, no male contributed to more than one clutch. Taking into consideration the number of females and clutches, 1.4 males reproduced for every one female. The satellite tracked male turtle revealed a possible explanation for this paradox. The turtle first swam north from the coast of Cyprus to Turkey; it then followed the coastline around the eastern edge of the Mediterranean Sea, ending along the Egyptian coast. This route passed in the vicinity of 58% of the Mediterranean *C. mydas* nesting grounds. The authors suggest that the breeding behavior of males may buffer the species from skewed sex ratios expected to result from increased regional temperatures.

Wright, L. I., K. L. Stokes, W. J. Fuller, B. J. Godley, A. McGowan, R. Snape, T. Tregenza, and A. C. Broderick. 2012. Turtle mating patterns buffer against disruptive effects of climate change. Proceedings of the Royal Society B 279: 2122–2127.

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Rampant Adhesive Toepad Gain and Loss in Gekkota

Once thought to be a derived character uniting crown geckos, recent molecular analyses of Gekkota have shown that adhesive

toepads likely have been acquired and lost independently multiple times in this group. To more rigorously test this hypothesis, the authors of this paper performed multilocus phylogenetic analyses using a dataset comprising 244 gecko species (107 of 118 genera) and about 4,100 base pairs of sequence data per species. Using the preferred phylogenetic tree (or a set of trees from the posterior distribution of trees), data on adhesive toepad condition were used to perform ancestral state reconstruction analyses aimed at determining where in the phylogeny toepad condition has changed. Finally, in addition to an unconstrained ancestral state reconstruction, analyses were performed wherein (1) the speciation rates and/or extinction rates were constrained to be the same in both padded and padless lineages, and/or the two rates of switching between conditions were constrained to be the same, and (2) either the acquisition or loss of the trait were constrained to a single instance. The fit of these different constraint models were then compared to the unconstrained models via Akaike information criterion (AIC) scores. These analyses supported previous studies in failing to recover toepad-bearing geckos as monophyletic. Ancestral state reconstruction found evidence for roughly 20 character state changes, with about eleven gains and nine losses. Models forcing converse parameters to share the same value did not significantly reduce the fit of models to the data; indeed, the best-fitting models were not the unconstrained model, but instead the models that constrained the rates of switching from one state to the other to be the same, and constrained either the extinction rates or the speciation rates to be the same. The two models that constrained either toepad gain or loss to a single event fared very poorly relative to all other models. While net diversification rates appeared to be higher in the padded lineages, this difference was not statistically significant, implying that the presence of adhesive toepads alone does not explain broad patterns of diversification among geckos. The authors provide detailed accounts of unambiguous toepad gains and losses, chart the repeated evolution of the "leaf toed" character state, and discuss the anatomical underpinnings of adhesive toepads and how they might have allowed this derived character state to have evolved repeatedly in this clade.

Gamble, T., E. Greenbaum, T. R. Jackman, A. P. Russell, and A. M. Bauer. 2012. Repeated origin and loss of adhesive toepads in geckos. PLoS ONE 7: e39429.

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Reconciling *Desmognathus* with Dollo's Law

Since the discovery that salamanders in the genus *Desmognathus* ("dusky salamanders") with free-living aquatic larvae are highly nested within Plethodontidae and that, therefore, a biphasic life history is very likely a derived condition in these salamanders, researchers have tried to reconcile this finding with Dollo's Law, which states that once lost, complex traits do not reappear, and therefore must be re-evolved *de novo*. Radical changes to the hyobranchial apparatus occur in biphasic salamanders during metamorphosis, as the need for gill support and suction feeding is replaced with terrestrial feeding and the need for tongue protrusion. If the ability to form a functional larval hyobranchial apparatus is lost, it would need to be re-evolved for a direct-developing salamander to acquire a free-living larva. Researchers studying direct-developing relatives of metamorphosing *Desmognathus* have found some developmental differences, namely the absence of several features associated with a free-living larval existence. In particular, these studies failed to find evidence of the fourth epibranchial cartilage, part of the hyobranchial apparatus present in biphasic *Desmognathus*, the early-diverging plethodontid *Hemidactylium*, and non-plethodontid salamanders. To more thoroughly investigate this question, the authors of this paper conducted a more detailed study of the development of *Plethodon cinereus*, a direct developing relative of *Desmognathus* that likely exhibits a developmental sequence similar to that of the most recent common ancestor of the two genera. They generated sectioned specimens and/or cleared and stained whole mounts for eleven developmental stages and scrutinized them for the appearance and development of hyobranchial features. The authors found a fleeting appearance of the fourth epibranchial during the early part of developmental stage 20. They posit that this vestigial feature was elaborated upon in the evolutionary branch leading to biphasic *Desmognathus*. Furthermore, they observed the larval hyobranchial apparatus initially forming and subsequently being replaced by the adult version, a developmental process previously thought to be restricted to metamorphosing plethodontids (as a study of the distantly related direct-developing *Bolitoglossa subpalmata* did not find evidence of this). While some features characteristic of biphasic plethodontids appear to have evolved independently in *Desmognathus* (such as the palatopterygoid bone), it seems that others were preserved in the larval stages of direct-developing species.

Kerney, R. R., D. C. Blackburn, H. Müller, and J. Hanken. 2012. Do larval traits re-evolve? Evidence from the embryogenesis of a direct-developing salamander, *Plethodon cinereus*. Evolution 66:252–262.

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First Discovery of Fossil Vertebrates Engaged in Reproduction

It is exceedingly rare for a fossil to encapsulate behavior; however, such fossils have been found that formed while the animal was engaged in combat, feeding, and rearing offspring. The authors of this paper describe a series of turtle fossils representing the first discovery of vertebrates to have died and been fossilized in the act of reproduction. Over the last three decades, nine pairs of *Allaeochelys crassesculpta* (Carettochelyidae) have been unearthed in the Messel Pit Fossil Site south of Frankfurt, Germany. The authors of this paper investigated these specimens for evidence of reproductive activity. They found that all the pairs consisted of one male and one female, seven of the nine were fossilized with the pair's posterior regions in contact, and two of the males had their tails wrapped beneath the females. This site boasts the only complete fossil carettochelyid skeletons ever found. During examinations of these, the authors discovered that the females possessed a hinged plastron which is not present in the species' sole living relative, *Carettochelys insculpta*, but is present in some non-carettochelyid turtle species and is hypothesized to aid in egg-laying. The authors posit that as these

turtles likely respire through their scale-free skin (as their sister family Trionychidae does), they may have succumbed to a deoxygenation of the water (perhaps caused by a release of volcanic gas), which killed them during the act of reproduction.

Joyce, W. G., N. Micklich, S. F. K. Schaal, and T. M. Scheyer. 2012. Caught in the act: the first record of copulating fossil vertebrates. Biology Letters (*in press*) doi:10.1098/rsbl.2012.0361.

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Cane Toad Larvae Readily Consumed By Australian Insects

Invasive populations of exotic species face different predators than populations in their native ranges, and to some degree their success can often be attributed to a release from predation pressures. Cane toads (*Rhinella marina* [*Bufo marinus*]) found Australia to be bereft of predatory vertebrates capable of tolerating the toad's toxins. However, little research has focused on potential invertebrate predators and the impacts they may have. The authors of this paper investigated the degree to which three Australian invertebrate species (one predaceous water beetle and two belostomatid bugs) eat *R. marina* eggs and tadpoles. First, representatives of the species were fed *R. marina* eggs and tadpoles to verify that they could eat them and survive. Individual insects were then offered two choices: *R. marina* eggs, hatchlings, or tadpoles, and an alternative (e.g., tadpoles of one of three native species, *R. marina* of a different developmental stage, small native fish). In a separate experiment aimed at testing the efficiency of these insect predators, individuals were placed in containers with a known number of *R. marina* tadpoles and six days later the surviving tadpoles were counted. An additional, similar test was performed with the diving beetle wherein tadpoles of two additional frog species were also present, and vegetation was included to add complexity to the environment. Finally, *R. marina* tadpole swimming performance was evaluated with respect to four native anuran species. Appropriate control treatments and replications were included for all experiments. These experiments revealed that indeed these three insects will consume immature *R. marina* and in doing so, experienced no significant increase in mortality. Differences in developmental stage preference were found, including the two belostomatid species preferring different tadpole stages, and only the beetle eating eggs. In the preference experiments, the beetle and smaller bug both preferred *R. marina* over any other offered prey items, while the larger bug preferred *R. marina* to fish but preferred tadpoles of two native frog species to toad tadpoles. The presence of all three insect predators significantly reduced survivorship of *R. marina* tadpoles, with the greatest impact observed in beetle treatments. In the complex environment experiment, *R. marina* experienced a fourfold increase in mortality when beetles were present; the effect on two native tadpoles present was negligible. In the swimming performance trials, *R. marina* were significantly slower than the four native species examined; toad tadpoles are much smaller and this factor largely explains the difference in speed. The authors suggest that the smaller size, slower speed, or some combination thereof could explain the insect species' preference for *R. marina* tadpoles, and that the lack of a coevolutionary history with Australia's native arthropod predators may leave *R. marina* particularly vulnerable. The authors suggest future work should investigate the population dynamics of insect predators in areas of *R. marina* invasion.

Cabrera-Guzmán, E., M. R. Crossland, and R. Shine. 2012. Predation on the eggs and larvae of invasive cane toads (*Rhinella marina*) by native aquatic invertebrates in tropical Australia. Biological Conservation 153:1-9.

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POINT OF VIEW

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Diagnostic Classification of Connective Tissue Encapsulating Transmitters and Data Acquisition Units: Evidence for Not Modifying a Classic Surgical Implantation Method

Since the introduction of Reinert and Cundall's (1982) procedure for the surgical implantation of radio transmitters, their paper has been cited extensively and has become the standard surgical implantation procedure for snakes (Table 1). However, a recent suggestion (Bryant et al. 2010) for modifying Reinert and Cundall's (1982) procedure requires an additional step for suturing and anchoring a transmitter to a rib and its pre- and post-intercostal musculature. Such modification (in our opinion) seems more invasive than necessary and might be avoided by simply revisiting the surgical implantation method and transmitter preparation described in Reinert and Cundall (1982) and Reinert (1992).

The suggested methodological modification stems from observations of implanted transmitters and other data acquisition units (e.g., iButtons®) migrating within (or being expulsed from) the body cavity of snakes (Bryant et al. 2010; Pearson and Shine 2002). However, numerous collaborations and extensive work with a diversity of snake taxa (Table 1), using Reinert and Cundall's (1982) surgical protocol, have not typically presented the observations and concerns outlined in Bryant et al. (2010). Here, we revisit an important, but apparently overlooked, procedural step presented in Reinert and Cundall (1982) and Reinert (1992) that aids in stimulating connective tissue encapsulation, thus circumventing the migration or expulsion of implants.

Connective Tissue Encapsulation.—It is our conviction, from extensive observations, that the "1:1 mixture of paraffin and beeswax" used in potting transmitters (see Reinert and Cundall 1982; Reinert 1992) causes a foreign body reaction—an important immunological response that encapsulates a foreign body that cannot otherwise be digested by histiocytes (macrophages) (Anderson et al. 2008). Transmitter potting as suggested by Reinert and Cundall (1982) is an important procedural step that may be ignored, particularly by researchers who do not build and pot their own transmitters. However, Reinert (1992) made a further recommendation that "Even if you purchase completely assembled and potted units from a manufacturer, I suggest that you dip them in a 1:1 beeswax/paraffin mixture." Commercially available transmitters are often encased with multiple layers of biologically inert compounds (e.g., silicones and Teflon) that prevent tissue reactions associated with immunological response. For example, surgical implantation of Holohil transmitters (Holohil Systems, Ltd., Ontario, Canada) in Cottonmouths (*Agkistrodon piscivorous*) by WIL (Roth 2005a,b) produced no tissue encapsulations until transmitters were later coated with a 1:1 paraffin-beeswax mixture.

Although this paraffin-beeswax coating was first suggested "to produce a non-abrasive, indigestible, tissue inert final package" (Reinert 1992), the adherence to this recommended procedure (Reinert and Cundall 1982; Reinert 1992) by investigators may have produced the same fortunate and successful outcomes of transmitter encapsulation that we now acknowledge. Herein we present histological images and provide a diagnostic classification of the tissues encapsulating iButton® temperature loggers resulting from immunological response and the foreign body reaction.

Tissue Sampling, Histology and Microtechniques.—We sampled tissues from four individual snakes (two Southern Copperheads, *Agkistrodon contortrix*, and two Western Cottonmouths, *A. piscivorous*) that were implanted with iButton® temperature loggers following the surgical procedure described for transmitters by Reinert and Cundall (1982). All temperature loggers were coated with a 1:1 paraffin-beeswax admixture prior to implantation. After 56 days, the implants were removed using the same surgical procedure. A sample of the tissue sheath encapsulating each iButton® (Fig. 1) was biopsied and fixed in AFA (alcohol, formalin, and acetic acid). We used standard histological procedures (Hamason 1962) where tissues remained in AFA solution for 24 h after collection. Dehydration was initiated in 70% ethanol and continued at 1 h intervals through a graded series of ethanol washes, ending in two final washes with 100% ethanol.

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Tissues were cleared to near transparency with three 1 h washes in histological grade xylene, permeated for 1 h in a 50:50 solution of melted paraffin and xylene, and transferred to melted paraffin to remove xylene residuum. We then cased tissues in paraffin molds utilizing standard blocking procedures. Tissues were sectioned at 7 µm thickness, floated in a warm water bath and mounted to slides with albumin adhesive (egg albumen and glycerol). Prepared tissue sections were stained in hematoxylin and counterstained in eosin. Stained sections were then dehydrated with ethanol through an ascending graded series, cleared in xylene and permanently mounted with Damar balsam mounting media.

Examination of prepared tissue sections was conducted using an Olympus B-Max 41 compound microscope with 10x, 40x, and 100x universal planapochromatic objectives with either bright field or phase contrast condensers. Digital photographs of microscopic images were taken using an Olympus DP-12 digital camera.

Tissue Diagnosis.—The encapsulating tissue examined was dominated by irregular and densely packed collagen fibers (Fig. 2). Two cell types were readily apparent within all planes of this encapsulating tissue. The small elongate cells responsible for secreting the collagen matrix are fibroblasts (Fig. 2; black arrows). Histiocytes (Fig. 2; white arrows) are responsible for initiating an immune response associated with engulfing foreign debris (Cline 1994; Leeson and Leeson 1979).

The Importance of the Paraffin-Beeswax Mixture in Potting Transmitters.—Anderson et al. (2008) outlined the inflammatory response following material implantation. Paraffin and beeswax, unlike inert coatings on some commercially potted transmitters, initiate the foreign body response. This is an additional response within a series of immune reactions normal to wound healing, specifically occurring in the persistence of foreign particles or bodies that may otherwise hinder healing. Foreign body reactions are ultimately characterized by the encapsulation of a foreign body that cannot otherwise be phaged by immune cells. However, several steps must occur before the process of encapsulation begins. Monocytes, once signaled by chemoattraction, leave the vascular system and enter connective tissue and become histiocytes. These histiocytes migrate by chemoattractive signals to the site of implantation (Anderson et al. 2008; Leeson and Leeson 1979) and begin adhering and interacting with the foreign body with the assistance of plasma and extracellular matrix proteins. Fusion of histiocytes results from their inability to phage the foreign body and become foreign-body giant cells which remain intimate with the surface of the foreign body (Anderson et al. 2008; Dee et al. 2002; MacLauchlan et al. 2009). During this foreign body reaction, residuum histiocytes initiate the remodeling of the extracellular matrix by secreting proteins that modulate fibrosis. Fibrosis (rapid production of the fibrous capsule) and the persistence of histiocytes are readily observed in Fig. 2A–B. Anderson et al. (2008) and MacLauchlan et al. (2009) discuss the benefits of effectively isolating the foreign body from host tissue. These benefits are easily realized in research efforts incorporating the surgical implantation of transmitters and data acquisition units where such units are encapsulated.

A More Recent and Related Implantation Issue.—Lentini et al. (2011) conducted histopathic and bacteriologic examinations of tissues resulting from the surgical implantation of transmitters into the intracoelomic space of Eastern Massasauga Rattlesnakes (*Sistrurus catenatus catenatus*). These transmitters were potted in a silicone coating, and the procedure of Reinert and Cundall (1982) was not followed reportedly because of prior difficulties with the technique (Lentini et al. 2011). After 14 months of implantation, transmitters were surgically examined *in situ* for tissue encapsulation, surgically removed and then swabbed for aerobic and anaerobic bacterial culture. The encapsulating tissues were also removed for histopathic examination. Both histopathic and bacteriologic findings were graded on a scale of 1 to 4 based on adhesion properties of the capsule and bacteria cultures, respectively. Lentini et al. (2011) concluded that these transmitters caused extensive irritation to internal tissues resulting in high rates of inflammation and infection. However, we question the findings presented in Lentini et al. (2011) as their histological images (i.e., figure 2, Plates A–D) are inconsistent with tissue growth associated with a foreign body reaction. Lentini et al. (2011) ascertained that the histology of the capsules was characterized by loose vascular connective tissue and simple cuboidal epithelium with eosinophilic cytoplasm. However, connective tissue types are diagnosed by differentiating the proportions of cells, fibers, and amorphous ground substance (Leeson and Leeson 1979).

Figure 2A in Lentini et al. (2011) clearly illustrates simple cuboidal epithelium. However, encapsulating connective tissue of a foreign body will not contain cuboidal cells which are specialized for secretion or absorption and thus predominate in glandular tissue. It is our conjecture that the glandular tissue presented in figure 2A by Lentini et al. (2011) may have been mistakenly isolated from the surrounding lumen or subcutaneous tissue (hypodermis) rather than the connective tissue encapsulation.

We further question the histological image described in their figure 2B as "loose connective tissue with scattered lymphoplasmacytic cells, histiocytes, and rare heterophils" with "a focal small granuloma characterized by low numbers with a few histiocytes surrounding refractile foreign material" (Lentini et al. 2011). Despite the poor magnification of figure 2B (Lentini et al. 2011), it appears that this tissue is not characteristic of loose (areolar) connective tissue. Our assessment is that figure 2B (Lentini et al. 2011) actually shows dense irregular connective tissue with an imbedded neurovascular bundle containing venules, arterioles (containing red blood cells), and a nerve fascicle characteristic of subcutaneous tissue. Venules and arterioles are readily identified by endothelial cells surrounding their lumens and residuum red blood cells, suggesting that the authors have mistakenly isolated subcutaneous tissue rather than the connective tissue encapsulating the foreign body. Finally, the low quality and poor magnification of figures 2C and 2D (Lentini et al. 2011) render them unsuitable for detailed cellular level diagnostics.

Contrary to the results presented by Lentini et al. (2011), Tucunduva et al. (2001) diagnosed the cells associated from the inflammatory processes following the subcutaneous implantation of cotton suture threads and circular coverslips in *Boa constrictor*. Their results are consistent with typical foreign body reactions and concur with our diagnostics presented here. The presence of histiocytes, foreign body giant cells, and various lymphatic cells are present in a matrix of dense irregular connective tissue surrounding the foreign body.

Recommendations.—Although many commercially prepared transmitters are potted in a supposedly inert coating, we recommend that researchers follow the procedures outline by Reinert and Cundall's (1982) surgical method which includes coating or potting the transmitter for implantation with a 1:1 paraffin-beeswax mixture. This ultimately allows for recognition and encapsulation of the transmitter following an immune response



FIG. 1. Image of an iButton® encapsulated by a thin sheath of connective tissue after 56 days of implantation in *Agkistrodon piscivorous*. Thicker encapsulations are seen with longer periods of implantation.

and foreign body reaction. Such tissue reactions "wall-off" the transmitter, preventing its migration within the body cavity. HKR examined a dead Pine Snake (*Pituophis melanoleucus*) that was implanted by a veterinarian with a transmitter that did not have a paraffin-beeswax coating. The snake had reportedly been sedentary and lethargic for several months prior to its death. It was found that the transmitter and antenna had migrated anteriorly and subsequently lodged in the snake's lung resulting in extensive irritation, inflammation, and eventual death.

The paraffin-beeswax coating described by Reinert and Cundall (1982) is a non-abrasive but organic compound, thus allowing it to be recognized by the body's immune responses. As a result, it is rapidly coated with connective tissue forming an anchored pouch within the peritoneum that may be used for repeated replacement of transmitters (Fig. 3). We recommend that all transmitters be dipped in a paraffin-beeswax mixture prior to implantation regardless of their original coating.

Although some snakes (e.g., Pythonidae) may have the ability to absorb and expel transmitters through the gut cavity (Pearson and Shine 2002) as documented in fishes (e.g., Rainbow Trout, *Oncorhynchus mykiss*), we assert that this problem in snakes and even fish may be circumvented with paraffin-beeswax coated implants (Helm and Tyus 1992). We also note that implants positioned in the "peritoneal" (Reinert and Cundall 1982) cavity are surrounded by the parietal peritoneum of the body wall and the visceral peritoneum of the surrounding internal abdominal organs. This placement of implants within the peritoneal membrane and posterior to the stomach and other internal organs may help circumvent the potential expulsion of transmitters through the feeding induced proliferation and dramatic up-regulation of the lumen demonstrated in Pythonidae (e.g., Secor and Diamond 2000).

We and our colleagues have collectively performed Reinert and Cundall's (1982) surgical procedure on hundreds of colubrid and viperid snakes over 40 years of combined research without the problems (e.g., high incidence of infection rates and transmitter expulsion) described by Bryant et al. (2010) and Lentini et al. (2011). HKR has removed transmitters from Timber

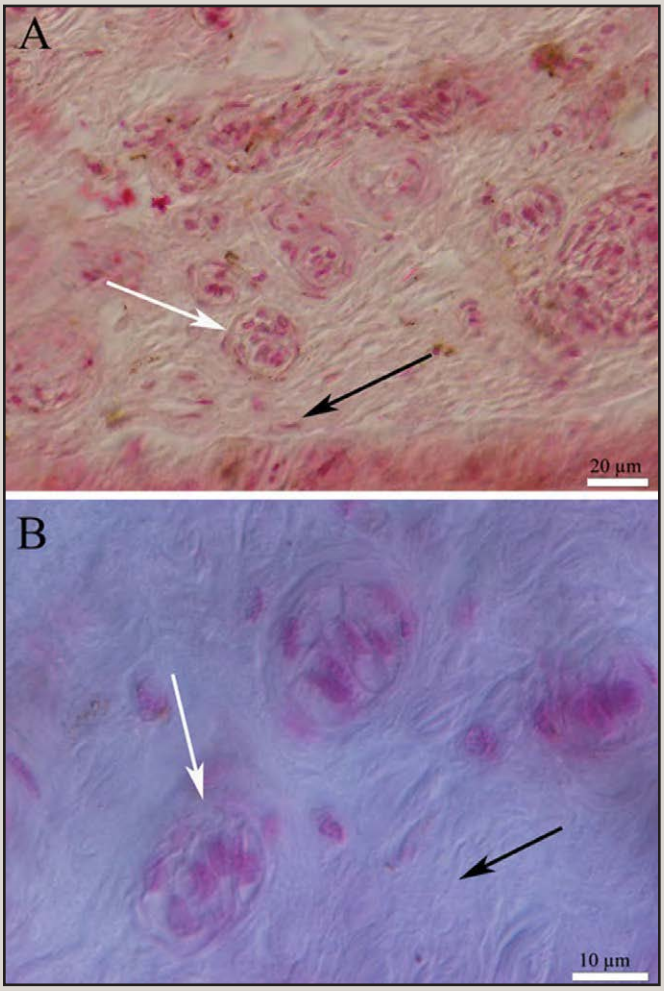


FIG. 2. Photomicrograph of encapsulating tissue taken from *Agkistrodon piscivorous* exhibiting the classic signs of a foreign body reaction. The dense irregular connective tissue consisting of tightly packed, irregularly woven collagen fibers is shown (A). Histiocytes in early stages of aggregation (white arrow) and small elongate fibrocytes (black arrow) are readily detected at 20x magnification. Histiocytes at 100x magnification (white arrow) and the tightly woven arrangement of collagen fibers (black arrows) indicate granular connective tissue allowing for the successful encapsulation of the foreign body within the peritoneal cavity (B).

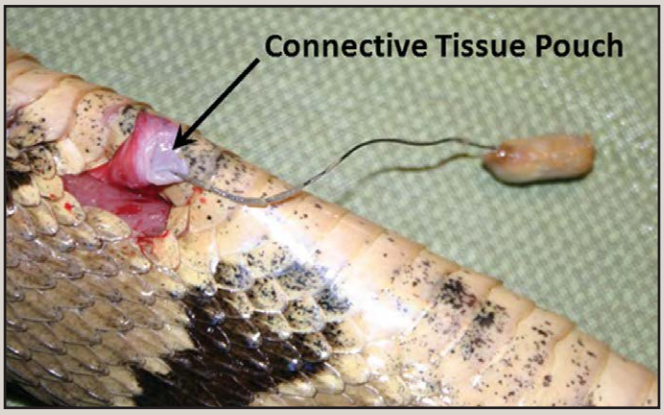


FIG. 3. A thick encapsulation and anchored pouch of connective tissue associated with a twelve-month implantation of a transmitter within the peritoneum of *Crotalus horridus*.

TABLE 1. Partial alphabetical listing of snake species studied by researchers that cite the procedure described by Reinert and Cundall (1982) for surgically implanting radio-transmitters or data acquisition units.

Snake species	Author (year)	Publication
Agkistrodon contortrix	Reinert (1984)	Ecology 65:478–486
Agkistrodon piscivorus	Roth (2005)	Copeia 2005:399–402
Boa constrictor	Reinert et al. (unpubl.)	
Boiga irregularis	Anderson et al. (2005)	J. Herpetol. 39:82–90
Bothrops asper	Wasko & Sasa (2009)	Biotropica 41:241–249
Calloselasma rhodostoma	Daltry et al. (1998)	Ecography 21:25–34
Charina bottae	Dorcas & Peterson (1998)	Herpetologica 54:88–103
Crotalus adamanteus	Waldron et al. (2006)	Anim. Conserv. 9:414–420.
Crotalus cerastes	Secor & Nagy (1994)	Ecology 75:1600–1614
Crotalus horridus	Reinert (1984)	Ecology 65:478–486
Crotalus lepidus	Beaupre (1995)	Herpetologica 51:45–56
Crotalus oreganus	Parker & Anderson (2007)	J. Herpetol. 41:41–51
Crotalus unicolor	Reinert et al. (2002)	Carib. J. Sc. 38:126–128
Crotalus viridis	Graves & Duvall (1993)	J. Herpetol. 27:33–41
Drymarchon couperi	Dodd & Barichivich (2007)	Florida Sci. 70:83–94
Epicrates inornatus	Wunderle et al. (2004)	Biotropica 36:555–571
Hierophis viridiflavus	Lelievre et al. (2010)	J. Comp. Physiol. B 180:415–425
Hoplocephalus stephensii	Fitzgerald et al. (2003)	J. Therm. Biol. 28:515–524
Lampropeltis getula	Wund et al. (2007)	Northeast. Nat. 14:343–360
Lichanura trivirgata	Diffendorfer et al (2005)	J. Herpetol.39:24–36
Masticophis flagellum	Johnson et al. (2007)	Southeast. Nat. 6:111–124
Nerodia sipedon	Roth & Greene (2006)	Copeia 2006:544–551
Pantherophis gloydi	Wilson & Brooks (2006)	J. Herpetol. 40:285–289
Pantherophis obsoleta	Blouin-Demers & Weatherhead (2001)	Ecology 82:2882–2896
Pituophis catenifer	Rodríguez-Robles (2003)	Copeia 2003:391–296
Pituophis melanoleucus	Burger & Zappalorti (1988)	Herpetologica 44:48–55
Python molurus	Mazzotti et al. (2011)	Biol Invasions 13:143–151
Thamnophis elegans	Arnold & Peterson (2002)	Am. Nat. 160:306–316
Thamnophis marcianus	Lutterschmidt (1994)	Herpetol. J. 4:11–14
Thamnophis sauritus	Bell et al. (2007)	Northeast. Nat. 14:279–292
Thamnophis sirtalis	Shine et al. (2000)	Physiol. Biochem. Zool. 73:325–334
Sistrurus catenatus	Durbian et al. (2008)	J. Wildl. Manag. 72:754–759
Zamenis longissimus	Lelievre et al. (2010)	J. Comp. Physiol. B 180:415–425

Rattlesnakes (*Crotalus horridus*) that have been encapsulated within anchored pouches of connective tissue in the peritoneal cavity for more than 12 years without migration, expulsion, inflammation, or infection (Fig. 3). Recently, we have performed this surgical procedure (Reinert and Cundall 1982) on more than 40 *Boa constrictor* (closely related to the Pythonidae). Similar to *Crotalus horridus*, these boas have shown no transmitter migration, expulsion, or detrimental inflammation, but rather connective tissue encapsulation, rapid healing, and long-term retention (up to 5 years). The utility of this surgical procedure has been employed and proven in a diversity of taxa (Table 1) including the Pacific Lamprey, *Lampetra tridentate* (Vella et al. 1999). Additionally, the procedure can be practiced both under laboratory and field conditions (Hardy and Greene 2000) and is widely accepted by institutional animal and care and use committees (Anderson and Talcott 2006). Consequently, we maintain that simple adherence to the original transmitter preparation recommendations and surgical procedure described by Reinert and Cundall (1982) will prove to be successful in most applications.

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"Cobra de Capello," Plate VII from James Forbes' *Oriental Memoirs: Selected and Abridged from a Series of Familiar Letters written during Seventeen Years' Residence in India: including Observations on Parts of Africa and South America, and a Narrative of Occurrences in Four India Voyages*, published in four volumes by T. Bensley, London (1813). A second edition was published in two volumes by Richard Bentley in 1834. The hand-colored illustration (24 x 30.2 cm) depicts a *Naja naja* that was drawn in 1770 based on a snake captured in Bombay (Mumbai) after it had bitten a woman at the market. Forbes (1749–1819) traveled to India in 1765 in the employment of the British East India Company and remained there until 1784, compiling 152 volumes (52,000 pages) of notes on the flora, fauna, architecture, religions, and indigenous cultures of India. When he returned to England, he assembled these notes into his *Oriental Memoirs* masterwork. The books contain 93 plates drawn by Forbes, of which 28 are hand-colored. In addition to "Cobra," three other plates depict herpetological subjects, but only the cobra is depicted by itself. Plate VIII is a sketch of a musician playing his flute to a swaying cobra as spectators look on (drawn in 1772); Plate XXV includes a *Chamaeleo zeylanicus* on a Neva Tree branch (1768 or 1772); Plate XC includes a "Malabar Spotted Frog" (*Hylarana malabarica*) on the ground with a Black and White Kingfisher in an aquatic plant above it (1784). The latter two plates also are hand colored. References to amphibians and reptiles are few in the text except for a detailed account of the effects of *Naja* snakebite on dogs. The book is still considered an exceptional source of information on India's west coast in the late 18th Century, and its colored plates are highly valued. The plates can be viewed at the British Library Online Gallery (http://www.bl.uk/onlinegallery/index.html).

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ARTICLES

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Negative Oral Responses of a Non-Canid Mammalian Predator (Bobcat, *Lynx rufus*; Felidae) to Ocular-sinus Blood-squirting of Texas and Regal Horned Lizards, *Phrynosoma cornutum* and *Phrynosoma solare*

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Horned lizards (*Phrynosoma* spp.) are noted for their commitment to restriction of movements and apparent reliance on crypticity for avoiding detection by predators (Cooper and Sherbrooke 2010a, b, c, 2012; Sherbrooke and Montanucci 1988), as well as a diversity of defensive responses to varied categories of predators once detected (Sherbrooke 1981, 2003). An ocular-sinus blood-pressure system regulated by two pairs of sphincter muscles surrounding major cranial veins is found in all lepidosaurs (Bruner 1907; Heath 1966). Apparently from this system horned lizards have evolved a unique antipredator defense of squirting systemic blood from their tear ducts into the mouths of selected predators that may find the chemical-containing blood distasteful (Middendorf and Sherbrooke 1992; Middendorf et al. 2001; Sherbrooke and Mason 2005; Sherbrooke and Middendorf 2001, 2004).

Reports of predators eliciting blood-squirting by horned lizards have been limited to members of the canid family (Dogs, *Canis familiaris*; Coyotes, *Canis latrans*; and Kit Foxes, *Vulpes macrotis*) and to humans (*Homo sapiens*, low frequency) (Middendorf and Sherbrooke 1992; Sherbrooke and Middendorf 2001, 2004; Hodges 2004; Sherbrooke and Mason 2005). Oral receptors for blood-borne chemicals eliciting strong negative behavioral responses in canids (Sherbrooke and Mason 2005) are apparently lacking in humans (Middendorf and Sherbrooke 1992, N = 4 humans; WCS experienced subsequent personal observations of a lingering very-mild, barely-perceptible, acrid after-taste lasting 30–45 min following tasting of freshly-squirted blood of *Phrynosoma cornutum*, N = 10+ lizards). This narrow taxonomic category (canids) of potential predators known to elicit the behavior persists in spite of testing of a broad variety of horned lizard species and a diverse spectrum of known predators (that either dismember or swallow prey whole). These include Greater Roadrunners (*Geococcys californianus*), Southern Grasshopper Mice (*Onychomys torridus*), Long-nosed Leopard Lizards (*Gambelia wizlizenii*), Western Diamondback Rattlesnakes (*Crotalus atrox*), and Coachwhips and Sonoran Whipsnakes (*Masticophis flagellum* and *M. bilineatus*) (Sherbrooke 1990, 1991, 2008; Middendorf and Sherbrooke 1992; Sherbrooke and Middendorf 2001, 2004; Sherbrooke and Mason 2005; Sherbrooke and May 2008). Middendorf and Sherbrooke (1992) suggested that some non-canid medium-sized mammalian carnivores might elicit blood squirting by horned lizards and respond negatively to the blood-borne chemicals, and thus be deterred from further attack.

We carried out predator-prey trial encounters with two species of horned lizards (*Phrynosoma cornutum* and *P. solare*) known to squirt blood defensively at canid predators and not at some other predators. We asked, "Might a threat by a distinctly different mammalian predator of another family (Felidae), a Bobcat (*Lynx rufus*), induce these lizards to utilize a blood-squirting defense?" We hypothesize that blood squirting induced by a bobcat threat would suggest that the lizards categorize canids and bobcats similarly when electing to utilize this antipredator defense. In addition we asked, "Do bobcats respond to ocular-sinus blood-squirting by horned lizards with negative behaviors indicating that they have oral-cavity receptors capable of sensing chemical compounds in the lizards' blood that are distasteful to them (similar to canids)?"

Methods

Texas Horned Lizards (*Phrynosoma cornutum*; 3 males, 83, 87, 98 mm SVLs; Iguania: Phrynosomatidae) were road collected from Hidalgo Co., New Mexico, USA, on 21–24 May 2010 and fed crickets (*Acheta domesticus*) in captivity in Portal, Arizona (through 6 June; Southwestern Research Station), and crickets

plus some seed-harvester ants (*Pogonomyrmex rugosus*) in Tucson, Arizona, prior to testing with bobcats at the Forever Wild Animal Rehabilitation Center in Tucson on 22 June 2010. Trials were video recorded (Sony 12x FullHD 1080), photographed, and notes were written following each trial.

Analysis of video recordings involved focusing on defensive behaviors of the lizards: run, freeze, raise horns (Sherbrooke 1987), dorsal shield (a behavior widely used with other predators; Sherbrooke 1990, 1991, 2003, 2008; Sherbrooke and May 2008), tail raising (Middendorf and Sherbrooke 1992; Sherbrooke and Mason 2005; Sherbrooke and Middendorf 2004), flipping on back (Sherbrooke and May 2008), swelling of eyelids (as a precursor to blood-squirting; Middendorf and Sherbrooke 1992), and blood squirting or emitting blood from around eyelids. Also, the video analysis focused on bobcat investigative behaviors of lizards and negative reactions of the bobcats to squirted blood (or skin-surface adhering or pooling ocular-sinus blood exuded around the lizard's eyes). These reactions by bobcats included retreating, lateral head-shaking, tongue extrusion and licking, lip licking, briefly rolling onto one body side on the ground, and salivation.

The three Texas Horned Lizards were separately introduced between 0920–1100 h into a cage (chain-link wire; 3.7 x 7.6 m, 3.7 and 3.85 m split height; with hardware cloth mesh wire along the lower 1 m) containing a surrogate mother and six sibling bobcats, 2–3 months old. On 27 June three recently collected (21 and 25 June, Pima Co., Arizona) Regal Horned Lizards (*P. solare;* males, 89, 90, 96 mm SVLs) were introduced into the same enclosure (0910–1005 h; 32°C) with the seven bobcats tested the previous week and responses were similarly recorded.

Trial times varied with bobcat and lizard behaviors. Due to cage arrangements some actions were difficult to interpret with certainty during video analysis by WCS. The adult female bobcat did not engage the horned lizards.

In 2011 six adult *P. solare* (males, 69, 72, 84, 87, 89, 97 mm SVLs) were collected southwest of Tucson, Pima Co., Arizona. Lizards were generously fed local seed-harvester ants (*Pogonomyrmex rugosus*), with some additional feedings of domestic crickets. The single female fifteen-month-old bobcat used in trials was housed at the Southwest Wildlife Conservation Center in Scottsdale, Arizona. This bobcat had become very tame, allowing handlers and filming crew to work within its 6 x 12 m, 3 m high chain-link cage (with hardware cloth mesh wire along the lower 1 m). The bobcat's trial activities and video recording (recorded by AM; Red Epic M video camera; for real time 30 frames/sec and slow-motion 120 frames/sec; not continuous throughout the trials; video reviewed by WCS) were largely confined to a single focused location. Trials on 23 June 2011 were in the late afternoon following the heat of day, 1648–1730 h. The durations of the three trials were approximately 12, 18, and 25 min. On 24 June five trials were held in the early morning, 0720–0900 h and lasted 10, 19, 40, 5, and 12 min. These trials included one lizard used on 23 June, and one used twice on 24 June; thus a total of six Regal Horned Lizards were exposed to the bobcat.

Results

Bobcats and Phrynosoma cornutum *(2010).*—In all three trials (2010) with *Phrynosoma cornutum* and seven bobcats in a single cage there were nearly continuous behavioral interactions between individual juvenile bobcats that often appeared to involve control (possession) of the lizard. Bobcat behaviors included pawing the lizard and picking it up in the mouth while emitting growling threats and lateral tail wagging. The lizard was held across its body (side to side) in the bobcat's mouth, usually from above, with the hindlegs, tail, forelegs, and head extending laterally to both sides, beyond the bobcat's jaws. The lizards were never bitten, chewed, or picked up by the head or limbs. A lizard-controlling bobcat often, but not always, caused other bobcats to retreat and then put the lizard down to be immediately held in place with a forepaw, talons not clearly extended. The lizard was often sniffed around the head and sometimes released and chased and recaptured under a forepaw. Extensive use of the forepaws in manipulating ("playing with") the lizard was noted. This tactile manipulation occasionally led to release of additional eye-sinus blood without a squirt projecting a stream of blood.

In the first trial (25 min) there was no swelling of eyelids or blood squirting by the lizard in response to the bobcat's activities. One bobcat controlled the lizard, carrying it around in its jaws or pinning it to the ground with a paw. During persistent sniffing of the forehead of the lizard, the lizard raised its horns on two occasions and it briefly raised its tail to a vertical position twice, for a second each time. No dorsal shield defensive postures were seen.

In the second trial (15 min) the lizard squirted blood within the first minute of the encounter resulting in several minor tongue-extention licks by the bobcat that was carrying it and had put it down. When the bobcat picked up the lizard in its jaws again the lizard squirted, leaving a streak of blood across fur on the lower left jaw of the bobcat. The lack of immediate reaction by the bobcat suggests that the squirted blood did not enter the bobcat's mouth. Areas around both of the lizard's eyes were already coated with blood prior to subsequent pawing by a second bobcat. The quantity of blood on the lizard's head appeared to increase during this second-bobcat's pawing, which may have involved a small squirt or oozing of blood from near the eyelids, which remained closed. The bobcat licked blood on the lizard's head and then moved away while exhibiting a series of tongue extending and licking actions, and shaking its head laterally. While walking away from the lizard it widely opened and closed its jaws and extended its tongue (about once per second) and flexed it in multiple directions while turning its head from side to side. This lasted for one minute following which the bobcat lay down and rolled onto one side and then back onto its other side before returning to a four-footed stance. A fresh patch of blood appeared on the side of the lizard's back (not an injury; probably due to a fresh blood-squirt not observed) and on the ground when the same bobcat returned to pawing the lizard. Investigation of the blood (licking and/or smelling) on the lizard's head by another bobcat then led to it retreating and exhibiting similar, but not as exaggerated, lateral head-shaking and rolling onto its two sides. There were no tail raised, dorsal shield, or horns raised displays by this lizard.

In the third trial (20 min) a group of three or four bobcats began pawing the lizard immediately after it was placed in the cage. The lizard responded with swollen eyelids, raised horns, raised tail, and blood around both eyes. One bobcat licked its own lips during this encounter. Bobcats continued to sniff the lizard's head and tentatively pawed it repeatedly for over five minutes before the actions of a single bobcat elicited a blood squirt from the lizard's right eye. Subsequently a bobcat licked blood from the lizard's head and this bobcat briefly shook its head and licked its open mouth. Both lizard eye areas were now blood-coated and the same bobcat returned to the lizard and during further



FIG. 1. A bobcat, reacting to ocular-sinus blood from a Regal Horned Lizard (*Phrynosoma solare*) contacting its oral tissues, exhibits multiple mouth opening-and-closings, eye closing, lip retraction, and contorted and varied tongue-extensions, all accompanied by vigorous lateral head-shaking.

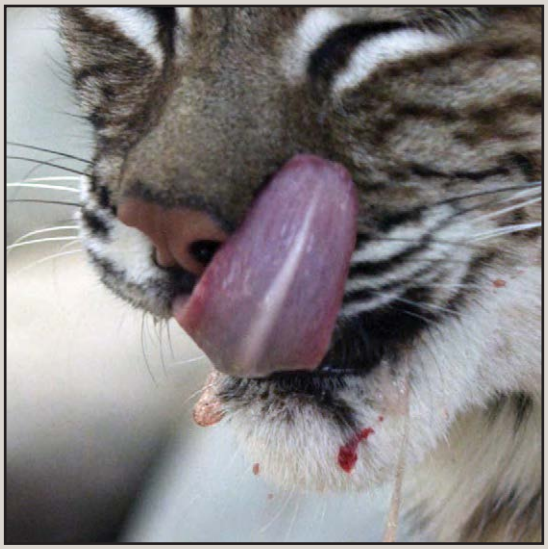


FIG. 2. Bobcat reacting to ocular-sinus blood from a Regal Horned Lizard (*Phrynosoma solare*) contacting its oral tissue surfaces. Note that the bobcat's eyes are closed, its tongue is extended in licking actions, there is a spot of horned lizard squirted-blood on its left chin hairs, and saliva strands are dangling from its lower fore-jaw on both right and left sides of its mouth.

pawing and sniffing again shook its head laterally. As the bobcats repeatedly pawed the lizard and briefly walked away before returning, the lizard either relaxed its swollen eyelids, or on recontact, it reenacted the swollen-eye state, at the same time raising its horns (tilting its chin downward) and lifting its tail. No bobcat picked up the lizard in its mouth in this final trial. No dorsal shield displays were observed.

Blood squirting was observed in trials 2 and 3, but not in trial 1. Negative reactions of three bobcats to the squirted blood occurred in trial 2, and with at least one bobcat in trial 3 (possibly a bobcat that also reacted in trial 2).

Bobcats and Phrynosoma solare *(2010).*—In all three trials the bobcats' behaviors seen in essentially continuous handling of Regal Horned Lizards were similar to those noted earlier with *P. cornutum*, including repeated pawing and chasing, paw holding, tapping of the lizards' heads with fore-paws, and frequent sniffing of lizards' heads. But the carrying of lizards crosswise through the bobcat's mouth while growling only occurred during the first trial. Lizards failed to raise their tails, raise horns, inflate their bodies, or display a dorsal shield defensively. Lizards usually maintained eyelids open between repeated paw patting/striking of the head and body throughout the trials. Only two very brief instances of eyelid swelling were seen late in trials (trials 1 and 3). An apparently small blood-squirt, 1.5 min into the third trial (duration 15 mins), resulted in a single lateral head-shake and nose-lick response by the bobcat. In trials 1 (duration 15 mins) and 2 (duration 10 mins) there were no indications of blood squirting by the lizards, in spite of continual manipulation.

Bobcat and Phrynosoma solare *(2011).*— During trials with this single somewhat-older juvenile bobcat, lizards were not picked up and carried around in the bobcat's mouth as was seen in 2010 with *P. cornutum* and *P. solare* when multiple bobcats were present. But similarly, the lizards were frequently "played with," pawed by the bobcat. Investigations by the bobcat of the lizards were intermittent and frequently involved sniffing and licking, particularly of the head.

On 23 July all three lizards exhibited swollen eyelids in response to the bobcat's investigation of the lizard and two of three lizards squirted blood during their trials. Following the first trial, in which no blood-squirting occurred, during the second trial the lizard squirted blood from its right eye. This resulted in the bobcat exhibiting multiple bouts of rapid lateral head-shaking with tongue extrusions, apparently trying to clear its mouth of the blood-borne chemical irritants. Late in the third trial the lizard was placed (by KS) on the bobcat's side after it was lying down. Initially the bobcat exhibited no interest in the lizard, but then the bobcat reached back with its jaws and grabbed the lizard by its horns and gently tossed it off its back to the ground. During this procedure the lizard reacted by squirting blood from both eyes. As the bobcat revisited and licked the lizard's head (now covered by a small increasing pool of blood), the bobcat reacted with violent bouts of lateral head-shaking (3 cycles/sec maximum) accompanied by tongue extrusions and contortions (Figs. 1 and 2). Within minutes, copious amounts of salivary secretion resulted in drooling from both sides of the bobcat's mouth (Figs. 3 and 4). This viscous saliva hung and dangled from the bobcat's jaws, swinging with the bobcat's head motions, while a fluid drop accumulated at its lowest point. This fluid exhibited pinkish coloration, suggesting the accumulation of lizard-squirted blood within the saliva and its expulsion from the bobcat's mouth (Fig. 4). The duration of these immediate responses was about 1 min.

During the five trials on the second day (24 July), no lizards squirted blood, but at least one exhibited swollen eyelids. As in the first trial on 23 July, without a blood squirting event the bobcat did not exhibit lateral head-shaking, tongue extrusion or salivation.

During all eight trials no *P. solare* exhibited a dorsal shield display, but four displayed horns raised and four raised their tails, both reactions during encounters with the bobcat. In two trials the bobcat grabbed the lizard's tail in its jaws and gently tossed it into the air, less than 50 cm above the ground and near the bobcat. In one of these encounters the tail-raise/tail-toss sequence was



FIG. 3. Bobcat continues to react to ocular-sinus blood from a Regal Horned Lizard (*Phrynosoma solare*) contacting its oral tissues. Following its initial responses, the bobcat continues licking while its eyes open and its extensive salivary response transports some of the lizard's squirted blood from its mouth cavity.

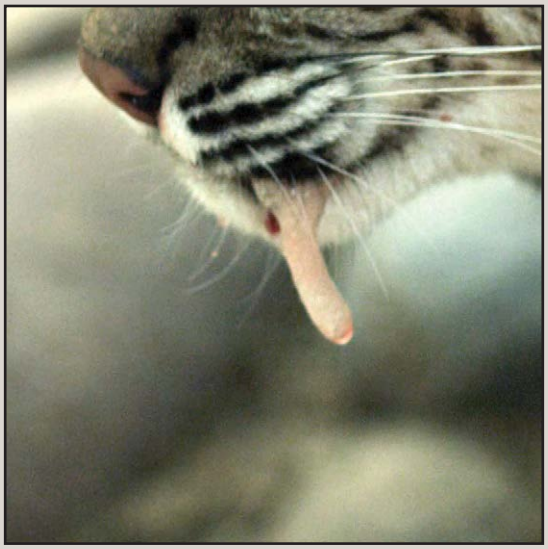


FIG. 4. Bobcat continues to react to ocular-sinus blood from a Regal Horned Lizard (*Phrynosoma solare*) contacting its oral tissues. At the tip of the strand of saliva dangling from the bobcat's mouth is watery-fluid with its pinkish color apparently illustrating contained lizard blood being expelled from the bobcat's mouth.

repeated three times within 1 min. In several trials the increase in eyelid bulging outward by the lizards was extensive, stage 3 or 3+ (Middendorf and Sherbrooke 1992) and sequentially repeated. Throughout the trials this pre-blood-squirting response was usually initiated as the bobcat lowered its face to close proximity to the horned lizard's head (often sniffing and sometimes licking). Eyelid swelling was reduced as the bobcat withdrew its head and then reinitiated on subsequent bobcat approach.

DISCUSSION

In earlier studies it has often proven difficult to determine if a species of horned lizard does or does not squirt blood ("non-blood squirting" species; Sherbrooke and Middendorf 2001) at a seemingly appropriate predator (dog bio-assays) or humans due to the difficulty in evaluating negative responses (Sherbrooke et al. 2004; Sherbrooke and Mendoza-Quijano 2005; Sherbrooke and Middendorf 2001; Sherbrooke and Rodriguez 2010). Nevertheless, a positive blood squirting response during exposure to canids by both *Phrynosoma cornutum* and *P. solare* is well established (Middendorf and Sherbrooke 1992; Sherbrooke and Mason 2005; Sherbrooke and Middendorf 2001, 2004). Blood squirting elicited by bobcats in the two species of horned lizard in this study, similar to canids, contrasts with numerous studies that resulted in a lack of a blood-squirting response to threats from other predators (Sherbrooke 1990, 1991, 2008; Middendorf and Sherbrooke 1992; Sherbrooke and Middendorf 2001, 2004; Sherbrooke and May 2008). These data support a hypothesis that the lizards select a single category, or somehow linked categories, of predator recognition in utilizing a blood-squirting defense.

Vital to the efficacy of a blood-squirting defense is a negative reaction by the recipient predator to chemical factors in the blood. Following five blood-squirting defenses by both *P. cornutum* and *P. solare* during trials with bobcats (in which blood entered the oral cavity) the felids demonstrated somewhat consistent negative responses. Quantities of squirted-blood reaching bobcat oral surfaces during any squirting or licking of blood were probably highly variable (Sherbrooke and Middendorf 2001). In all five cases the bobcat showed vigorous lateral head-shaking (of various duration), tongue extensions and retreat from the lizard. Following one blood-squirting defense by *P. solare* (2011) the bobcat showed excessive salivary production and extrusion of these fluids from the mouth, along with other vigorous responses. The consistency of negative gustatory behaviors following oral exposure to horned lizard squirted blood by at least five different bobcats demonstrates its potential utility as a defense against predatory threats by bobcats.

It is worth evaluating similarities and differences between reactions of bobcats to ocular-sinus blood-squirting by *Phrynosoma cornutum* and *P. solare* and reactions of kit foxes to *P. cornutum* blood squirting reported earlier (Sherbrooke and Middendorf 2004). Both kit fox and bobcat predators were juveniles with little or no pre-captivity experience in capture of live prey alone or with adults, thus their reactions were probably innate. In trials in which squirted blood entered into the predators' mouth both kit foxes and bobcats responded with lateral head shaking, mouth opening and closing sequences, closing eyes, and out-of-mouth tongue extensions (Sherbrooke and Middendorf 2004; this study). Tongue extrusions were less pronounced in kit foxes than in bobcats, and salivary drooling was not seen in kit foxes. Kit foxes did not roll onto a side, but in one case, where grass was available, the fox repeatedly laterally wiped its muzzle on the grass. Bobcats appeared to sniff the heads of lizards repeatedly, a behavior not consistently observed with kit foxes. The strong negative bobcat responses during licking of blood and their absence during bobcat sniffing of lizards' blood-coated heads suggest that, as in coyotes (Sherbrooke and Mason 2005), the sensory receptors detecting antipredator compounds in the lizard's blood are located in the oral cavity and the chemical agents are not volatile compounds detected, and reacted to negatively, via the olfactory system.

Middendorf and Sherbrooke (1992) suggested that vertical tail-raising, observed in Texas and Desert Horned Lizards (*P. cornutum* and *P. platyrhinos*) during trials with dogs (Middendorf and Sherbrooke 1992; Sherbrooke and Middendorf 2001) and in *P. cornutum* with coyotes (Sherbrooke and Mason 2005) and kit foxes (Sherbrooke and Middendorf 2004), attracts attention away from a horned lizard's head and may have survival value. Jaw grabbing of elevated tails resulted in the dog quickly lifting and tossing some lizards into the air, with subsequent difficulty in relocation. Vertical tail-raising was seen in two of three *P. cornutum* bobcat trials (2010), but was not seen in 2010 *P. solare* trials. But in 2011, with an isolated bobcat, Regal Horned Lizards raised their tails during some trials, and in several cases the bobcat responded by grasping the tail and tossing the lizard. Thus, the use of tail raising behavior (as a possible distractive defensive behavior), by *P. cornutum* and *P. solare*, was noted during threats by both bobcats and kit foxes. This tail-raising behavior is absent in encounters with a wide variety of other predators that are challenged during prey subjugation and ingestion events by their inability to dismember these lizards prior to ingestion (Sherbrooke 1990, 2003, 2008; Sherbrooke and May 2008). Thus, horned lizards may only utilize vertical tail-lifting, as with ocular-sinus blood squirting, with a certain category of mammalian carnivores capable of dismembering lizard prey. However, detailed studies are needed to confirm this hypothesis.

Many horned lizards utilize size and spinyness enhancing displays, dorsal-shield, or flipping onto their back, during attacks by predators that ingest their prey whole (Greater Roadrunners, whipsnakes, Long-nosed Leopard Lizards; Sherbrooke 1990, 2003, 2008; Sherbrooke and May 2008) or that are relatively small mammalian predators facing difficulties in dismembering larger horned lizards as prey (Southern Grasshopper Mice; Sherbrooke 1991). Size-enhancing behaviors have not been reported when horned lizards were attacked by canids, dogs or kit foxes (Middendorf and Sherbrooke 1992; Sherbrooke and Middendorf 2001, 2004), or coyotes (Sherbrooke and Mason 2005). This lack of observations suggests that horned lizards may preferentially utilize these defensive behaviors with categories of predators lacking prey-dismembering abilities. Canids and felids may not normally elicit this behavior because as large carnivores capable of dismembering prey the size of horned lizards, and larger, a dorsal shield display would be a relatively ineffective defense. A horns-raised display not only thwarts whole-prey ingestion but also enhances spiny armament that can inhibit mammalian exploration of prey with sensitive mouth-area tissues. Matching defensive behaviors to specific categories and threats, venomous and non-venomous predatory snakes, has been established with both species of horned lizards reported on in this study (Sherbrooke 2008; Sherbrooke and May 2008).

Here we present the first evidence of a non-canid mammalian predator, that occasionally takes lizards (Bobcat, *Lynx rufus*; Delibes et al. 1997, Hoffmeister 1986; including *Phrynosoma* sp., Delibes and Hiraldo 1987), eliciting blood-squirting by Texas and Regal Horned Lizards and responding negatively to the lizards' blood contacting oral receptors. This suggests a potential role for horned lizard blood-squirting as an antipredator defense against this felid, and (by implication) possibly other untested non-canid mammalian carnivores. Further efforts toward understanding the categorization by horned lizards of appropriate predators for employing this blood-squirting defense and the responses by a diversity of potential predators to the blood would be instructive in further evaluating its survival value.

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A Novel Approach to Counting Geckos: *Phelsuma* Density in Mauritian Forests

Variation in the ability to detect individuals is a key issue when estimating and comparing the density of animals in different habitats over time (MacKenzie et al. 2002; Mazerolle et al. 2007; Pollock et al. 2002). One suitable methodology that estimates density, while accounting for detectability, is distance sampling through line and point count surveys (Buckland et al. 2001). Most reptile surveys that have utilized the Distance methodology have been conducted on terrestrial species along line transects (see the distance sampling bibliography: http://www.ruwpa.st-and.ac.uk/distancesamplingreferences/). During a line transect survey an observer moves along a transect and records the perpendicular distance of each detected individual from the center line. These distance measurements are used to model detectability from an absolute number of detections at zero distance (Buckland et al. 2001). However, the detection of small arboreal reptiles from ground-based surveys in tall canopy forest is expected to be low and likely to violate the key assumption that all objects along the center line are detected with certainty (Buckland et al. 2001). Failure to detect all individuals on the center line results in a negative bias of the abundance estimate (Anderson et al. 2001; Buckland et al. 2001). To enhance the detection of canopy-dwelling reptiles it would be preferential to bring the center line closer to the canopy, but in most cases this would not be practical for line transect surveys. Another well known survey method that employs distance sampling is the point count survey, where the observer remains at a single location and records the distance to detected individuals in the surrounding area (Buckland et al. 2001). While the assumption of absolute detection at zero distance still applies, detection from a stationary point is likely to be higher at zero distance as there will be greater search effort than at any one point along a transect line where the observer is moving. Another potential benefit of point count surveys of arboreal reptiles in tall canopy forest is that the observer can conduct the survey from a stationary elevated position closer to or within the canopy to enhance detection at the zero point. The purpose of this research was to investigate the feasibility of conducting point count surveys of arboreal geckos from elevated survey platforms within the native forests of Mauritius in the Indian Ocean.

Despite the extinction of five endemic reptile species, Mauritius still supports a rich diversity of reptiles (Arnold 1980; Cheke and Hume 2008). However, only five of the twelve described endemic and extant species can be found on mainland Mauritius; the others are now restricted to small offshore islands (Arnold 1980; Cheke and Hume 2008; Cole 2009). Four of the endemic species not restricted to the smaller islands are arboreal day geckos: *Phelsuma cepediana* is a widespread and relatively common gecko; *P. ornata* is found in low to mid-elevation dry forest; *P. guimbeaui* is restricted to fragments of lowland scrub and dry to mid-humid forest in the west and southwest; *P. rosagularis* is restricted to highland forests in the southwest and southeast (Austin et al. 2004; Cole 2009; Vinson 1976). The Black River Gorges National Park (BRGNP), situated in southwestern Mauritius, supports the most intact remnants of native forest cover and is the last location to support all four *Phelsuma* species (Fig. 1; Cole 2009; Page and d'Argent 1997; Vinson 1976).

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Although the general distribution of these *Phelsuma* species is fairly well known, there are very little data on local densities and no means to compare *Phelsuma* density between different regions of forest, or to determine population trends in relation to habitat degradation or restoration. This is not only important for the conservation of the Mauritian *Phelsuma*, but also for the conservation of other threatened species, such as the Mauritius Kestrel (*Falco punctatus*) that feeds almost exclusively upon *Phelsuma* at certain times of the year and endemic plants that are known to be reliant upon *Phelsuma* for pollination and seed dispersion (Burgess et al. 2009; Fox et al. 1985; Hansen 2006; Hansen and Müller 2009; Jones 1985; Temple 1987).

Elevated point count surveys were conducted to determine the feasibility of obtaining relative abundance estimates of the *Phelsuma* species in the BRGNP and whether it differed significantly between regions. We also investigated the influence of cloud cover, wind strength, observer height above ground, and the start time of the survey on the detection probability of *Phelsuma*. We present our results and discuss the validity of using elevated point counts to offer suggestions for future monitoring.

Methods.—Point count surveys for *Phelsuma* were conducted from December 2009 to February 2010 at five regions within the BRGNP (Fig. 1). Surveys were conducted in relatively intact native forest, often within Conservation Management Areas (CMAs). Point count locations were randomly selected, but spaced at least 20 m apart from each other, as Mauritian *Phelsuma* are rarely detected at a distance of more than 10 m within forest habitats (see Results). Sixteen point count locations were selected within the Beloquet and Fixon CMAs at Bel Ombre, 23 locations within the Brise Fer CMA, 16 locations within Dr Vaughan's CMA and a recently weeded area of forest in Macchabée, 21 locations within the Morne Sèche CMA, and 11 locations within forest at Petites Gorge (Fig. 1).

Within each of the forested areas, trees were identified for point count surveys based primarily on their height, so that an observation point could be selected within the average canopy height and allow a 360º view of the surrounding tree trunks and canopy. Young tall trees growing between mature trees were preferred as they were straight, relatively narrow and did not have substantial branching, which made them easier to climb. The observer wore a climbing harness and a tape was wrapped around the trunk to provide a foothold. A second tape was also wrapped around the tree and clipped to the harness with a carabiner to prevent the observer from falling. Additional tapes were required to climb over tree branches. Once in the canopy the observer selected a sturdy branch that provided a good view of the surrounding trees and branches from which to conduct the point count. From extensive observations of *Phelsuma* behavior, the slow movement of an observer ascending a tree will only disturb geckos within the immediate vicinity of less than 2 m. However, if an observer has passed or remains motionless geckos will return to their original perch position or resume normal behavior within a short period of time. To account for potential disturbance and avoid underestimates of *Phelsuma* density, the observer waited immobile with eyes closed for a minimum of 10 minutes after arriving at the observation point. Directly after the immobile period the point count was conducted over the following 20 minutes. These time durations were selected following observations of *Phelsuma* behavior and the ability to thoroughly search the surrounding vegetation within a time period where climatic variables between the start and end of a survey would remain comparatively similar. At the start of each survey

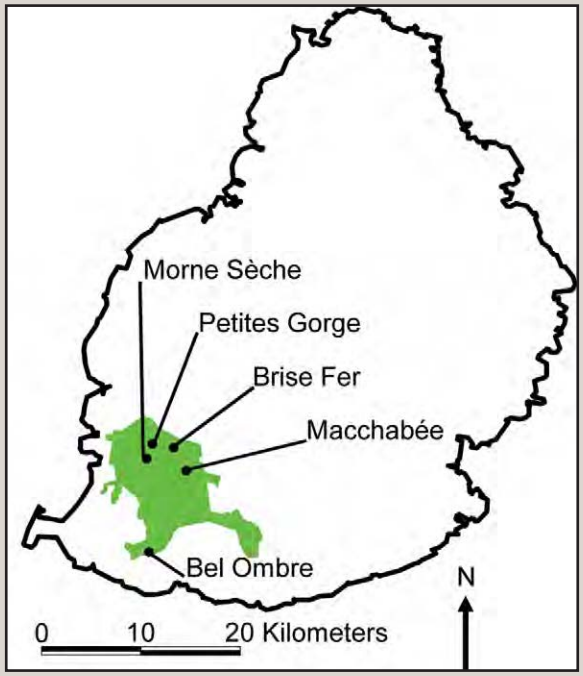


FIG. 1. Map of Mauritius and the Black River Gorges National Park (shaded green) with regions of native forest selected for point count surveys.

the time, percent cloud cover and wind strength (using the Beaufort scale) were recorded; observer height above ground was recorded after the point count. Point counts were not conducted during rain, as *Phelsuma* seek shelter and are hidden from view, and point count surveys occurred during hours of daylight between 0730 h and 1700 h when *Phelsuma* are known to be active. During each survey, any *Phelsuma* observed were recorded with the time of the observation and distance from observer. An extendable measuring tape was used for measuring distance to the nearest cm, and binoculars (Pentax XCF 8 x 40) were occasionally used to identify species. A minimum of 80 *Phelsuma* observations were recorded within each region. All observations and measurements at all of the sites were conducted by a single observer (T. Imlay).

Distance measurements from all point counts were imported into Distance 6.0 and region was assigned as the stratification layer to determine region-specific *Phelsuma* density and detection rate estimates (Thomas et al. 2010). Distance sampling utilizes a detection curve and abundance near the centerline to determine estimates of density (Buckland et al. 2001). The model assumes that all animals at a distance of zero are observed, animals are recorded at their initial position, and that distance measurements are precise (Buckland et al. 2001). Incomplete detection during the count can lead to underestimates of abundance, such that estimates should be treated as relative, rather than absolute (Rodda and Campbell 2002). Hectares were used as the unit of measure in Distance to create an index of relative density (geckos/ha). Point count surveys were conducted once from each of the selected trees within each region and were therefore assigned an effort value of one, unless the survey was cut short due to inclement weather. In these cases, effort was adjusted to reflect the observation time spent during the survey. At Morne Sèche, point counts conducted after 1500 h were excluded from the analysis as *Phelsuma* were not observed at this site after this time.

TABLE 1. Summary of region specific *Phelsuma* density estimates (D) with percent coefficient of variance (CV) and 95% confidence intervals (95% CI), where k is the number of point counts and n is number of observations pre- and post-truncation.

Region	k	n	D	CV	95% CI
Bel Ombre	16	88-81	753	20.5	499–1136
Brise Fer	23	80-72	607	19.7	412–896
Macchabée	16	82-70	576	26.0	338–981
Morne Sèche	21	80-74	627	18.5	435–904
Petites Gorge	11	80-76	1314	30.2	699–2472

TABLE 2. Probability values for Kolmogorov-Smirnov (KS) and Cramér-von Mises uniform (W-sq) and cosine (C-sq) weighted goodness-of-fit tests for distance data stratified by region and fitted to a half-normal model.

Region	KS	W-sq	C-sq
Bel Ombre	$p = 0.849$	$0.800 < p < 0.900$	$0.700 < p < 0.800$
Brise Fer	$p = 0.433$	$0.400 < p < 0.500$	$0.400 < p < 0.500$
Macchabée	$p = 0.850$	$0.600 < p < 0.700$	$0.600 < p < 0.700$
Morne Sèche	$p = 0.353$	$0.600 < p < 0.700$	$0.500 < p < 0.600$
Petites Gorge	$p = 0.705$	$0.500 < p = 0.600$	$0.500 < p < 0.600$

TABLE 3. Model selection results from the forward stepwise sequential addition of covariates on the half-normal detection model for all *Phelsuma* gecko distances stratified by region, where K is the number of parameters in the model and W is the Akaike weight.

Models	K	AIC	ΔAIC	W
Observation height and wind strength	15	5048.023	0.000	0.374
Observation height and start time	15	5048.067	0.044	0.366
Observation height, wind strength and start time	20	5049.030	1.007	0.226
Observation height	10	5053.025	5.002	0.031
Observation height and cloud cover	15	5058.134	10.111	0.002
Wind strength	10	5066.477	18.454	<0.001
Start time	10	5076.801	28.778	<0.001
Cloud cover	10	5078.625	30.602	<0.001
No covariates	5	5078.933	30.910	<0.001

Using the default settings, a detection curve was produced for each region to visually identify long right tails, which represent fewer gecko detections far from the observer. These outermost observations are difficult to model as they provide little information in estimating the density function at zero distance, which is the most critical part of the curve (Buckland et al. 2001). Long right tails were discarded by truncating the largest 10% of distances (Buckland et al. 2001). The multiple covariate distance sampling (MCDS) engine was used to include the covariates of time of day, percent cloud cover, wind strength and observer height above ground on all data stratified by region. Two models consisting of a key-function + series-expansion (half-normal + cosine and hazard-rate + simple polynomial) were fitted to the data. The most parsimonious model with the lowest Akaike Information Criterion (AIC) value, a compromise between the number of parameters and model fit, was selected. At each stage of the analyses default Kolmogorov-Smirnov and Cramér-von Mises uniform and cosine weighted tests were examined to assess the adequacy of the fitted models and to investigate any violations of the assumptions that underpin Distance methodology (Buckland et al. 2001; Thomas et al. 2010). Covariates were included one at a time and the one that gave the best model fit (the lowest AIC value) was selected, upon which the other covariates were sequentially added following a forward stepwise procedure until there was no further decrease in the AIC value (Thomas et al. 2009). If the difference between the AIC values (ΔAIC) was less than two units then the models were considered to be of equal suitability (Burnham and Anderson 2002).

Density estimates and detection probabilities with respective percent coefficient of variances and 95% confidence intervals were calculated for each region using the best-fitting model. An ANOVA followed by Tukey's *post hoc* comparisons was used to determine significant differences in the *Phelsuma* density between the five regions.

Results.—All four *Phelsuma* species were detected during the point count surveys. *Phelsuma cepediana* and *P. rosagularis* were detected at Bel Ombre, Brise Fer, and Macchabée; the former species was also detected with *P. guimbeaui* and *P. ornata* at Morne Sèche and Petites Gorge. A total of 410 individual *Phelsuma* were encountered during the 87 point count surveys conducted in the BRGNP, with at least 80 observations made within each region (Table 1).

Using the MCDS engine the half-normal key was selected as the best fitting model with a right truncation of the largest 10% of distances for each region. For each region the goodness-of -fit tests demonstrated good model fit in each case (Table 2). The stepwise inclusion of the covariates produced three suitable models whose ΔAIC values were less than two units and were of similar weight; these models included the covariates of observer height above ground, wind strength, and start time (Table 3). The detection of *Phelsuma* was enhanced at lower positions with the canopy at Bel Ombre and Brise Fer, at higher positions at Petites Gorge and observer height above ground had little influence on detection at Macchabée and Morne Sèche (Fig. 2). Overall *Phelsuma* detection was greater when the wind strength was low (Fig. 2). Detection was greater during the morning at Bel Ombre, Brise Fer and Morne Sèche and greater around midday and early afternoon at Macchabée and Petites Gorge (Fig. 2).

The model that included all three covariates was used to calculate the values of relative density for each region (Table 1). The relative density of *Phelsuma* was shown to differ significantly between the regions within the BRGNP ($F = 38.713$, $df = 4,82$, $p <$

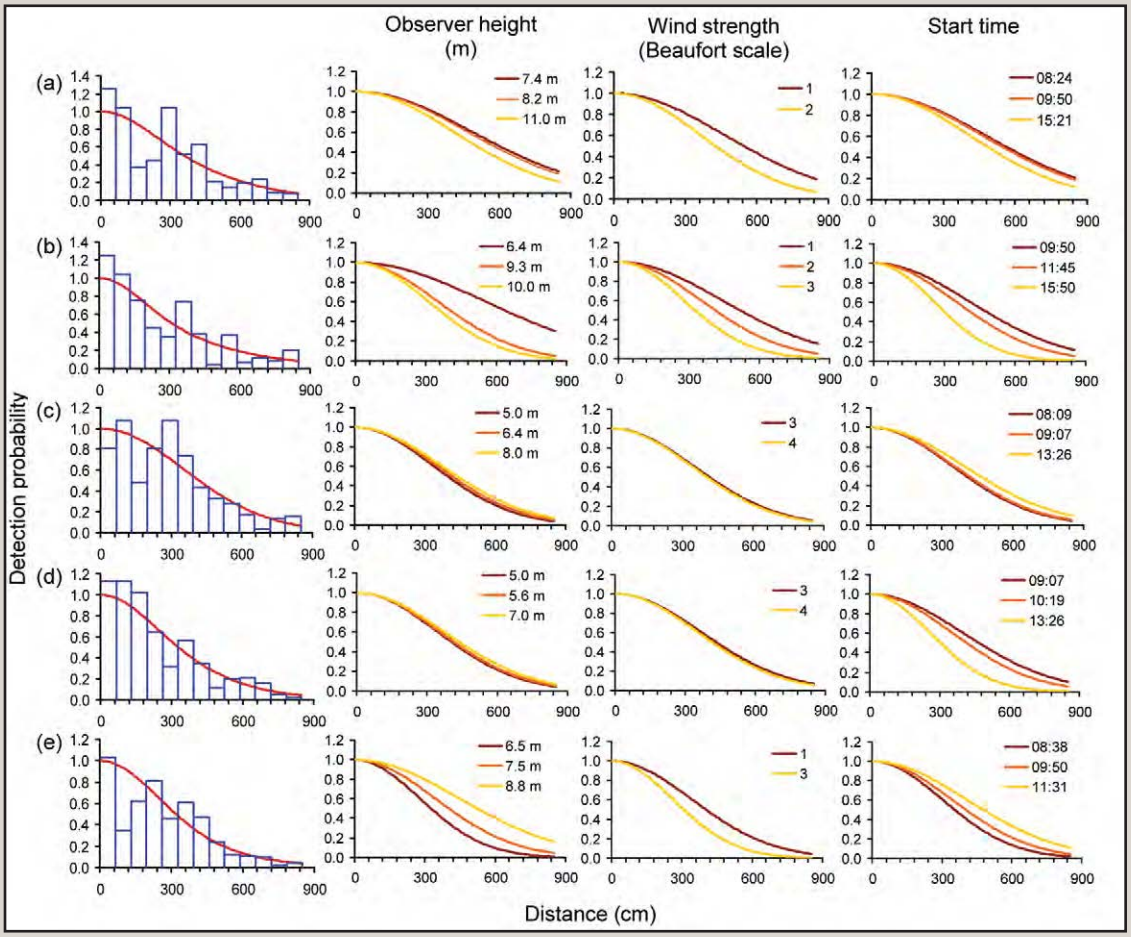


FIG. 2. Distance histograms with half-normal detection curves and the influence of the covariates on *Phelsuma* detection stratified by region: (a) Bel Ombre, (b) Brise Fer, (c) Macchabée, (d) Morne Sèche, and (e) Petites Gorge.

0.001). *Post hoc* comparisons demonstrated that relative *Phelsuma* density was similar between Brise Fer, Macchabée, Morne Sèche, but significantly greater at Bel Ombre and highest at Petites Gorge (Table 1).

Discussion.—Ground-based distance sampling surveys of arboreal lizards in tall canopy forest are unlikely to meet the key assumption that all individuals are detected on the zero point of observation with certainty (Buckland et al. 2001). Small lizards can easily go undetected at the zero point if they are hidden within tree cavities, or obscured by complex branching and dense foliage of the canopy several meters above the observer on the ground. Violation of this key assumption would lead to varying underestimates of density, such that comparisons between regions would produce spurious results. Conducting point count surveys at elevated positions are likely to enhance detection and reduce bias. The selection of tall young trees with few cavities and limited branching within the interconnecting canopy of neighboring trees permitted a clear view above and below the observation point, as well as the surrounding vegetation. The results from the goodness-of-fit tests demonstrate that there is little evidence to suggest that observations, particularly the zero point, were under- or over-dispersed. Nevertheless, in situations where there is some uncertainty in the ability to detect all individuals at the zero point, the double-observer method is recommended (Laake and Borchers 2004). In such cases the mark-recapture distance sampling (MRDS) engine can be used to relax the assumption that all objects are detected at the zero point (Thomas et al. 2010). Observer behavior on approach to the elevated observation point and the inclusion of the acclimation period are thought to have reduced responsive gecko movement permitting accurate measurements to be made of initial gecko locations during the survey period. This approach to counting geckos is considered to have met the other two key assumptions that objects do not move and measurements are accurate (Buckland et al. 2001).

The ability to detect *Phelsuma* was shown to vary in relation to the height of the observer within the canopy, wind strength, and start time. Both Bel Ombre and Brise Fer contained the most continuous canopy of native plant species with dense foliage and intertwining branches of all five regions. Lower observation sites in these forested areas provided a better view of the surrounding canopy. Petites Gorge contained the densest understory of invasive plant species and therefore, higher observation sites provided a better view of the surrounding vegetation. Sun penetration through the canopy at Bel Ombre, Brise Fer, and Morne Séche occurred earlier in the morning than Macchabée and Petites Gorge, providing excellent basking locations on tree trunks and branches. Dense understory vegetation at Macchabée and Petites Gorge limited the number of basking locations, and Macchabée received less direct sunlight early in the morning due to the westerly aspect of the gorge. The aspect of the region in the gorges also influenced gecko presence at the

northerly facing Morne Sèche which received very little daylight after 1500 h. Increasing wind strength resulted in the greater movement of vegetation within the canopy and this movement reduced gecko detectability. Wind strength may also be related to gecko activity, as during strong winds geckos tend to retreat to refuge sites. Regional and seasonal variation of other climatic variables, food availability and the presence of competitors and predators are also likely to influence *Phelsuma* activity and their use of refugia. The unavailability of individuals for detection can lead to a bias in the estimation of density (Rodda and Campbell 2002; Smolensky and Fitzgerald 2010). Variables that influence *Phelsuma* activity and thus detection must be accounted for and not differ substantially between regions and periods of time for direct comparisons of relative density. We recommend that surveys for *Phelsuma* within canopy forest are conducted on calm days when there is little wind, no rain and soon after sunlight first penetrates the canopy, when gecko activity and detection appears optimal. We also propose that an initial acclimation period of ten minutes is applied to account for disturbance related to reaching the observation point and tall young trees are selected to conduct point counts from a height where a suitable view of the surrounding trees and branches in the canopy is gained.

The four species of *Phelsuma* on mainland Mauritius are roughly the same size and color, with an average total length of 10–14 cm (Cole 2009). However, the detection rate of similar gecko species can vary greatly (see Rodda and Campbell 2002). Moreover, Harmon et al. (2007) demonstrated that in sympatry the Mauritian *Phelsuma* species compete for space and cause shifts in microhabitat use as reflected in perch height and type. These shifts are likely to alter species-specific detection rates under different species combinations in different habitat types. Further research is therefore required to determine the detection rates of each *Phelsuma* species in the presence and absence of congeners.

From this study we can tentatively suggest that Petites Gorge contained the highest density of geckos despite containing areas of relatively degraded forest in comparison to other sites (Page and d'Argent 1997). *Phelsuma ornata* was the most common species observed at Petites Gorge, which is dominated by boulders and rocky outcrops, a habitat feature known to support a high density of *P. ornata* on offshore islands (N. Cole, unpubl. data).

Elevated point count surveys appear to be an effective method for monitoring *Phelsuma* populations in tall canopy forest to determine their geographical distribution and documenting potential changes in their regional density in relation to habitat degradation or restoration. However, further work is required to determine species-specific variation in detection and what affects their activity to ensure surveys are conducted under appropriate conditions to remove potential bias. Elevated point counts may also be an effective method for monitoring other arboreal reptiles in tall canopy forest.

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The Ecology of the Mink Frog, *Lithobates septentrionalis*, in the Adirondack Park, New York, with Notes on Conducting Experimental Research

The Mink Frog (*Lithobates septentrionalis*) is a cold-adapted amphibian widely distributed in Canada, but with limited distribution in the U.S (Gibbs et al. 2007; Hedeen 1986; Moore 1952). This largely aquatic amphibian has its southern distributional limit at the highest latitude of any North American anuran, with evidence that more southern populations became extinct in the past century (J. Gibbs, pers. comm.). Its occurrence is linked to cold, well-oxygenated wetland breeding sites (Hedeen 1986), and as temperatures continue to increase, there is evidence that climate change has the potential to impact extant southern populations, such as the ones in the Adirondack Park (AP), New York State (Gibbs et al. 2007; Popescu and Gibbs 2009).

Despite the likely threat to this species, little research has been conducted and the species is receiving scant management attention in the southern part of its range. This lack of attention may be related to its cryptic nature: 1) it calls late in the night and is unlikely to be heard during regular anuran call surveys, which are often conducted during the early hours of the evening (Bevier et al. 2004; Bevier et al. 2006; Popescu and Gibbs 2009); and 2) eggs masses quickly sink to the bottom of the water column. It also resembles the more widespread Green Frog, *Lithobates clamitans*. The net result is that Mink Frogs can easily go undetected if present. This was confirmed by Popescu and Gibbs (2009), who investigated the effects of land cover, disturbance, and historic climate on pond occupancy in the AP and surroundings. Two important aspects that emerged from the study were the association of *L. septentrionalis* with beaver impounded wetlands and the potential effects of climate change on future distributions in the AP. However, at the time of model development, no information existed relating changes in water temperature to growth and survival of aquatic life-history stages. This information is particularly relevant as the largely aquatic Mink Frog is known to be sensitive to water temperature, with previous studies suggesting that these conditions may determine patterns of occurrence (Hedeen 1986; Moore 1952).

In 2011 we conducted research combining field surveys and experimental habitat manipulations with the goal of understanding the potential implications of climate warming on Mink Frog ecology and future distribution. One of the most useful products we derived from this study was a greater understanding of the ecology of this species. This information is of direct relevance to those wishing to conduct further research with an organism that may well be one of the most threatened species in the United States in regards to climate change.

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Methods

This study was conducted in the Adirondack Park in New York State (44.052470°N, 74.401623°W). This ~6-million acre upland region comprises the largest protected area in the contiguous United States. Our field studies focused on 73 wetlands, including both palustrine and lacustrine systems. These wetlands were selected to span a broad elevational (202–711 m) and latitudinal gradient (44.025293°N to 44.65734°N), with the goal of incorporating a range of climactic conditions.

Surveys were conducted from 28 June to 17 August 2011. Field technicians used canoes to make visual observations of calling behavior at a subset of five wetlands, and capture animals for experimental research. Wetlands were visited at night between 2200 and 0400 h, with observations being conducted over a minimum of a 2-h period. Each wetland was visited a minimum of four times during the survey period. Wetlands were also visited during the day on a sporadic basis during the survey period. Male frogs were almost always located from their calling, whereas female frogs were found through systematic sweeps across the wetland using canoes. Early attempts to capture animals using nets were relatively unsuccessful, whereas hand-capturing using a stealthy approach in the canoe was found to be far more effective. All animals captured were identified to species (using calls, odor, and the presence of mottles running down the length of the rear legs), and sexed using a combination of tympanum size (larger than the eye = male) and calling (Gibbs et al. 2007). The snout to vent length (SVL) was also measured by allowing animals to stretch along a plastic ruler while holding the rear leg.

In addition to the calling behavior assessed both in the field, we established breeding choruses in 3785-liter cattle tanks (~3 m diameter and 1 m deep). Although this aspect of the study was primarily for the purpose of obtaining eggs, it also allowed us to further evaluate calling. Cattle tanks had been previously filled with untreated water, with 100 liters of partially decomposed leaf-litter (~75% deciduous, 25% coniferous) added to each tank. We also placed a few lily pads and small branches in each tank to mimic natural conditions. We then placed ~10 Mink Frogs into each tank (approximately equal males and females). All of the frogs in a single tank were collected from the same wetland. Observations of calling males in cattle tanks were made anecdotally before looking for egg masses at night. Animals were not fed in tanks due to the abundance of natural food, and were released back to the point of capture within a week.

To assess oviposition behavior and egg mass characteristics, we looked for eggs in the field. We also placed pairs of animals (both in amplexus and prior to amplexus) in 53-liter plastic containers in the lab. These containers were filled halfway with lake water with a stick placed to encourage oviposition. Animals were left for a maximum of three days in these containers and were not fed during this time. Additionally, we made observations of any egg masses deposited in cattle tanks. To assess the characteristics of larvae we made observations of animals in the 53-liter containers and in cattle tanks.

Results

Calling Behavior.—Mink Frogs were heard calling throughout the study period and prior to the start of nocturnal surveying at a few sites. Calling was primarily nocturnal, although active choruses were heard on a few occasions throughout the day prior to the beginning of the survey period (early to mid June). A few individuals were also heard calling sporadically during the day in the survey period, but this represented a noticeable reduction in day-time calling compared to earlier in the season. Males were observed calling both while floating on the water's surface and from on lily pads (*Nymphaea odorata* and *Nuphar microphyllum*), with the latter calling behavior more prevalent in wetlands with high densities of lilies. When calling from lilies, males were partially in the water (front legs on the leaf, hind legs free). We did observe males sitting entirely on lily pads, but no calling was seen during these occasions. Males were typically spaced at least 2 m apart, whereas males would call in closer proximity in cattle tanks (typically at least 0.5 m apart). The location of breeding choruses was clearly related to the location of floating vegetation, specifically lily pads. In wetlands entirely dominated by lily pads, Mink Frogs appeared to prefer to call away from the edges of the wetland. In wetlands where lily pads were not common/present, Mink Frogs were typically less aggregated (often with over 10 m between animals), with one or two males calling from each submerged object such as a fallen tree nearer the shoreline. In one of our wetlands, both Green Frogs, *L. clamitans*, and American Bullfrog, *L. catesbeianus*, were also calling at the same time as the focal species. This beaver-created site was shallow (< 2 m deep) and dominated by lily pads across much of the water's surface. We observed clear spatial segregation among these species, however, with Green Frogs calling from the wetland margins and Bullfrogs from an area of emergent vegetation away from the Mink Frog chorus. In the early part of the season (June and early July), female Mink Frog were hard to locate, and were typically found floating in the water around the edge of the breeding chorus. Later in July and August, female Mink Frogs were often found intermixed with males.

Amplexus and adult size.—Amplexing pairs were rarely observed in the wild (a single pair was located in amplexus, out of the many hundreds of animals observed in breeding choruses). Amplexus could be readily stimulated by placing males and females in small (~10 liter) containers; however, many of these amplexing pairs did not lay eggs (see notes on oviposition below). When comparing the SVL of Mink Frogs captured in the field, we found males to be significantly larger than females (mean SVL [mm] ± Std. Dev.: Males [N = 47] 53.1 ± 3.6; females [N = 52] 46.9 ± 10.7; two-tailed *t*-test, $P < 0.001$). When comparing the SVL of Mink Frogs observed in amplexus, however (including animals that amplexed in the laboratory), we found males to be slightly smaller than females (males [N = 3] 54 ± 1.7; females [N = 6] 58.5 ± 6.74).

Oviposition.—Oviposition was observed in both the wild and under experimental conditions. Two egg masses were located during nocturnal surveys at a single site, Black Pond. Identification of these egg masses to species was facilitated by comparison with egg masses deposited under laboratory conditions. The first of these clutches was located on 28 July. Although these eggs had hatched, early-stage larvae were still associated with the egg mass suggesting that it had been laid within the week prior to discovery. The second egg mass was found on 10 August and did not contain any larvae. Both clutches were found in water that was ~1.5 m deep. The first clutch was attached to a slim branch of a submerged tree, approximately 70 cm below the surface of the water. The second clutch was at a similar depth in the water column, attached to the stem of a yellow pond lily (*Nuphar* sp.). Four egg masses were deposited under experimental conditions. The first two of these clutches were both laid on 7 July 2011 in 53-liter plastic containers filled approximately two-thirds full with pond water, with the remaining clutches laid in cattle-tanks. In the case of the clutches laid in cattle tanks, one clutch was observed attached to the stem of a floating lily pad (i.e., on the surface). The second clutch was not detected until after the tadpoles had hatched.

Time to hatching.—Egg masses laid in the 53-liter containers (water temperature 19.0°C) hatched within four days of being deposited. Initially, larvae remained motionless on the bottom of the container, with the first mobility observed eight days after hatching. The larvae in cattle tanks remained largely motionless during the day unless physically disturbed, but were observed to be active at night (observations conducted using flashlights).

Discussion

Our results support earlier findings on the general ecology of Mink Frogs. Specifically, we found Mink Frogs to be nocturnal breeders, with breeding aggregations closely associated with floating vegetation (Bevier et al. 2004; Bevier et al. 2006; Hedeen 1971; Leclair and Laurin 1996; Popescu and Gibbs 2009). We also found egg masses to be associated with submerged vegetation and to hatch rapidly. Beyond confirming existing information, however, we were also able to expand our knowledge of the focal species. Based on our results, Mink Frog breeding ecology differs from that of explosive breeders such as the Wood Frog, *Lithobates sylvaticus* (Gibbs et al. 2007). The explosive breeding strategy is portrayed as overwhelming potential predators through high number of breeding adults, eggs, and larvae concentrated in space and time such that predators can have little effect on population success. Mink Frogs, conversely, may "underwhelm"

predators, with a prolonged breeding season during which eggs and larvae are widely dispersed in wetlands and thus likely hard to find, making the cost of predation not worth the effort. The oviposition strategy of Mink Frogs also differs from the sympatric Green Frogs and American Bullfrogs, both of which deposit floating rafts of eggs on the water's surface (Gibbs et al. 2007).

We can offer two explanations for the fact that male Mink Frogs captured in the field were larger than females, whereas females were larger than males when considering amplexing animals only. The first is that juvenile males were misidentified as females in the field. We did observe juvenile animals during the course of this study; these animals were clearly much smaller than any of the animals associated with breeding choruses and occupied different habitat to calling animals (open pond margins during the day). None of these smaller animals was observed during nocturnal call surveys. We were also readily able to sex male animals associated with choruses during surveys (using clear differences in tympanum size and calling). The animals identified as females began entering the chorus some time after it had started (initially we only captured males); it is hard to think of a reason for a cadre of immature males to enter the chorus at the same time as reproductively active females, particularly if they themselves are not yet able to breed. The second explanation is that all of the animals identified as females were females, and only the larger females present in choruses may be reproductively mature.

Our results also have direct implications for researchers wishing to conduct experimental studies with the Mink Frog. We found that it was relatively challenging to acquire eggs and thus larvae for experimental purposes (~50 person hours in the field yielding four egg masses obtained prior to hatching). The most productive approach was to hand-capture breeding adults in the field (reaching out of a canoe and grabbing the animals being more effective than dip-nets) and to confine them to aquatic enclosures for oviposition observations. Even with this approach, it is unlikely that large numbers of egg masses can be obtained.

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Reducing Predation of Freshwater Turtle Nests with a Simple Electric Fence

The current vulnerability and widespread declines of nonmarine turtles are increasingly becoming a focus of conservation concern, adding to the decades-long attention paid to marine species (Gibbons et al. 2000). Various anthropogenic factors have increased the populations and ranges of certain medium-sized predators across much of North America (e.g., Larivière 2004; Oehler 1995). These changes are widely believed to have elevated turtle nest predation pressures and to have contributed to recent declines of many populations (Browne and Hecnar 2007; Garrott et al. 1993; Reynolds and Tapper 1996; Temple 1987).

While recognizing that ongoing efforts to reduce adult mortality will be essential for long-term turtle conservation success (e.g., Heppell 1998), turtles are limited in their ability to respond to increased mortality at any life stage, including the nest stage (e.g., Congdon et al. 1993). Lack of adequate recruitment causes changes in turtle community size and age structure (Jackson 1988; Rubin et al. 2004; Thompson 1983), sometimes to the point of species extirpation (e.g., Browne and Hecnar 2007). Thus, efforts to counter anthropogenic nest predation may augment overall conservation measures by enhancing recruitment of juveniles into local populations. As an alternative to currently practiced nest protection methods—largely nest screening—the present study investigated the nest protection potential of a novel electric predator exclusion fence designed to concurrently allow the safe and unhindered passage of almost all North American chelonians.

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Methods

Site descriptions.—Two traditional turtle nesting areas were located using satellite imagery of the lower Wisconsin River corridor

(http://www.weather.com/weather/map/interactive/; accessed 25 October 2007) to remotely survey likely habitat, followed by on-site inspections to confirm previous nesting activity via destroyed nests. Both areas are on level terraces on the south bank of the Wisconsin River within 10 km of Spring Green, Sauk County, Wisconsin. Site A is 52 m from the river and is bordered by mesic to dry-mesic, open woodlands. Site B, 7.3 km distant from Site A, is 15 m from the river, adjacent to an open sand beach. Both sites have bunch grasses (primarily switchgrass, *Panicum virgatum*) and various low, xerophytic herbaceous plants (primarily peppergrass, *Lepidium* sp.) covering approximately 20% of the substrate, with the remainder being open sand.

Study design and implementation.—At each study site two treatment (fenced) and two control (unfenced) areas were designated in areas of similar apparent historical nesting concentration as indicated by remains of destroyed nests. For practicality, treatments were located within nesting areas such that their combined area could be enclosed by one fence. Controls, typically adjoining treatments, were chosen such that apparent nesting density, distance to nearest water, topography, and vegetational composition aspects were similar between control and treatment areas.

Each of the control and treatment areas was monitored by a separate trail camera (combinations of Reconyx Silent Image™ RM30 and Reconyx HC600 HyperFire™), with the sizes of both treatment and control areas delimited by the useful size of camera field of view (FOV): approximately 58 m² per camera. Treatment camera FOVs also included some area immediately external to fence peripheries. Cameras were mounted on poles in protective boxes at heights of approximately 2.5 m, topped with an inverted 10-cm-diameter plastic funnel, into which was inserted a sharpened dowel to discourage perching by American Crows (*Corvus brachyrhynchos*). Cameras were programmed to take continuous time-lapse (TL) images at one-minute intervals and sequential rapid-fire series when triggered by motion (MT).

Nest predation rates (calculated as the proportion of initial camera-documented nests excavated by aboveground predators from deposition through hatchling emergence) were compared between control and treatment areas. Nests excavated by predators during a given nest's emergence period that contained only non-predated eggshells upon inspection were conservatively designated as "fate unknown" because undocumented predation on pre-dispersed hatchlings may have occurred.

Fence description.—Fences incorporated one electrified wire (hereafter referred to as the "hot" wire) of 17-gauge fencing wire 25.4 cm above the substrate and two non-electrified strands of 4-mm-diameter, green vinyl clothesline (containing a wire core to reduce rabbit [Leporidae] damage) 15.2 cm and 20.3 cm above the substrate (Fig. 1). A solar-powered charger (Parmak DF-SP-LI, 1.4 joules) energized the top, electrified strand. Each fence enclosed approximately 72 m² with a 35-m perimeter.

Before fence installation, the perimeter was cleared of coarse vegetation by a metal garden rake, leveled as needed using a 91-cm length of lumber, and tamped by foot. A light wire fence (12-gauge, 71-cm-wide Red Brand® Poultry and Rabbit fence) was then laid on this prepared perimeter (hereafter referred to as the "screen ground") in order to provide an effective electrical ground. (The xeric sand and sandy loam substrates often used by nesting turtles are generally non-conductive.) The screen ground was rolled out with the smaller mesh to the outside such that it sprang up, not down, during installation to facilitate a closer attachment to the substrate and was secured



PHOTO BY G. GELLER

FIG. 1. Bait station and fence strand array.



PHOTO BY G. GELLER

FIG. 2. Two Ouachita Map Turtles (*Graptemys ouachitensis*) entering fenced area.

to the substrate with wire "staples," approximately 30 cm in length, made from coat-hanger wires bent into a narrow U-shape. Fencing wire was used to sew together adjoining pieces of the screen ground to ensure a continuous electrical ground connection. On occasion, broom sweeping or gently raising and lowering the screen ground was necessary to re-expose it after heavy rainfall.

Fences were constructed using standard metal support rods and plastic insulators and were positioned over the screen ground 36–41 cm in from the outside edge. Fencing rods were placed at varying distances (0.5–4.0 m) as required to maintain consistent ground-to-fence strand clearances. Rods at corners and significant bends in the perimeter were supported by standard metal T-posts using short loops of fencing wire to allow significant hand tensioning of the strands. Further tensioning was provided via a screwdriver placed into these loops and rotated (a restorative method also used in subsequent maintenance visits). The T-post at the terminus of the fence near the charger was also used as a tie-off for the rope strands. Both the fence and the screen ground were connected to a 2.5-m galvanized ground rod using insulated hook-up cable. Electric fence warning signs were attached to fencing rods, one on each side of the fence, using 12-mm binder clips.

The fence was baited with pouches 25 cm^2 in area made of folded 3-mm galvanized hardware cloth containing bait (dry, fish-flavored cat food or commercial skunk paste bait, i.e., "Grubstake;" Jameson's Ultra Blend, Daisytown, Pennsylvania, USA), and wrapped vertically with a 19-mm-wide strip of aluminum foil (serving as a potential visual attractant). The foil strips were wound around bait pouches such that approximately 2.5 cm of excess provided a sheltering roof suspended over the applied bait. The pouches containing cat food alternated with empty wire pouches with approximately 1.25 cm^3 of the paste bait applied to the foil wrapping under the overhanging flap (Fig. 1).

Pouches were attached to the hot wire by a short length of fencing wire routed 2.5 cm away from the fence rod at the top insulator to prevent shorting and threaded through outside holes (already present) in the three insulators holding the fence strands. Another insulator positioned immediately below these three, at 10 cm above the substrate, served as a backing for the bait pouch and prevented electrical shorting. Bait pouches were attached to the connecting leads using 12-mm binder clips at approximately 3- to 4-m intervals and positioned close to the outside surfaces of the backing insulators.

Study timelines and schedules.—Sites were monitored from 2009 through 2011, following a pilot study in 2008. In all years but 2010 the treatment fences were enabled and baited and all areas were camera-surveyed from 10 May through 10 October—a few weeks before anticipated nesting activity to beyond the end of the typical emergence period. June floods in 2008 and 2011 allowed for at least partial nest survival and continuance of site monitoring, whereas a mid-July 2010 flood caused the loss of all nests and early termination of monitoring activities.

Sites were visited 2–3 times a week to change camera data cards. Baits were changed out at two-week intervals, regardless of intervening weather. Vegetation was usually removed from the screen ground by hand weeding to ensure optimal fence grounding conditions and to prevent electrical shorting by strand/bait station contact. On the uncommon occasions when hand weeding was impractical, glyphosate herbicide (Round-Up®, Monsanto Co., St. Louis, Missouri) was applied to problem areas.

Results

Turtle use of study sites and interaction with fences.—Ouachita Map Turtles (*Graptemys ouachitensis*) (N = 70), along with one Northern Map Turtle (*G. geographica*) and other unidentifiable *Graptemys* (N = 27), made up the nesting community. *Graptemys* also made up 90% (N = 77) of the transient turtles (moving through, but not nesting on monitored areas) identified to species on the study sites along with Snapping Turtles (*Chelydra serpentina*; N = 6), softshells (*Apalone* spp.; N = 3), and unidentified transient turtles (N = 37), most or all of which likely were *G. ouachitensis*.

Turtles displayed no aversion to traveling under the fence strands, as evidenced by counts of nesting and transient females on control and treatment areas (79 individuals exclusively in controls vs. 142 with presence in treatments for all years and sites combined) and the lack of route-diverting behaviors noted (Fig. 2). In total, 39 and 59 nests were constructed in control and treatment areas, respectively, during the study period.

Predator community.—Both TL and MT image counts were used to generate site visitation frequency indices for each predator species for the full season years of 2009 and 2011 (10 May–10 October). A separation criterion of 0.5 h was used to designate separate on-site occurrences. Raccoons were the most common predator at both sites by a wide margin (Table 1) and were the only species documented to destroy turtle nests.

Effect of electric fence exclusion on nest predation rates.—The fence exclusion efficiency for each predator species was assessed using ratios of treatment versus control area image counts (as above, but with breaches counted as separate events regardless of intervening time; Table 1). Lower values thus indicate greater exclusion effectiveness.

The fences were successful in reducing predation rates on turtle nests (89% for 37 control nests vs. 15% for 53 treatment nests; one-tailed Fisher's exact test, $P < 0.001$ for all years and both sites combined (Table 2)—primarily by fence effectiveness in reducing nest-focused raccoon access to treatment areas (Table 1).

Interaction of predators with fences.—Images from both the study itself and from supplemental off-site tests show that raccoons generally approach and investigate fences rather deliberately, enhancing the potential for teaching shocks. The 15.2-cm lowest strand setting requires considerable body flexing of adult raccoons attempting breaches under the fence, motivating most individuals to eventually try an over-the-top entry. While some raccoons receive shocks at their first interaction with the fences, others have successful breaches over several days before effective contact with soft tissue or lightly furred areas is made.

Five observations of adult raccoons being shocked were via hand touch of the hot wire and three were via bait pouch contact. Additional instances of raccoons inspecting bait pouches (N = 10) but lacking images of consequent effects indicate that bait contact may have been responsible for many undocumented shocks. However, off-site tests using non-baited fences demonstrated complete raccoon exclusion within a few days of first encounters, showing that adult raccoon exclusion is possible without fence baiting. Dry cat food appeared at least as attractive to raccoons as commercial skunk paste bait (eight vs. four images of bait inspection, respectively).

Low-positioned baits were used in this study primarily as a possible breach deterrent for smaller predators such as subadult raccoons, skunks (*Mephitis mephitis*), and opossums (*Didelphis virginiana*) that would not be vulnerable to shock from

hot wires placed well above substrate level. However, skunks and opossums routinely breached the fences (Table 1), with limited documented interest in either cat food or commercial skunk bait as presented. Regardless, skunks and other small predators were not documented to depredate turtle nests during this study, even though surviving treatment and control nests were available at hatching time, when these predators were most often present on-site. (Two nests were excavated by skunks: one after the typical hatchling emergence interval [at 19 days; considered not depredated], and another at four days after first hatchling emergence [considered "fate unknown"]).

Although infrequent (mean 3.5 per year/site; Table 3), fence breaches by raccoons occurred in every study year. Chance variables, such as the number of recently constructed nests inside the fence at a given predator breach, can significantly influence the protection rate in a given year. For example, seven of the eight depredated treatment nests during this study were destroyed during a single breach event. Raccoons often travelled along fence perimeters, suggesting that they would quickly exploit any newly available opportunities for entry.

Estimated costs.— Approximated yearly fencing costs (amortized over a projected 15-year fence life) for various-sized exclosures are presented in Table 4. Fencing costs reflect the sum of fixed costs (e.g., solar fence charger units) and variable inputs that scale with perimeter length (e.g., fencing rods and bait stations). Fencing costs per unit area decrease with increasing area protected (Table 4), since expenses either remain the same (fixed costs) or increase linearly (variable costs), while the area enclosed increases exponentially. The number of theoretically protected nests is based on 75% nest protection efficiency—less than that realized in this study as a conservative measure—applied against a mean study nest density of approximately one nest per 9.3 m². Labor rates ($19.57/h) are based on the 2010 starting base wage and benefits rate for a Wildlife Technician, Wisconsin Department of Natural Resources.

Discussion

Management implications.—The overall increase in turtle nest survival (74 percentage points) via fence-reduced raccoon access to nests in this study compares well with the performance of electric fences that have been used to protect the nests of ground-nesting birds (e.g., mean 34 percentage points, range 16–64%, N = 8, from Table 1 in Jimenez et al. 2001). In contrast to the traditional use of electric fencing to enhance nest success of game species, its use involving turtles (and other reptiles) is

Table 1. Relative frequency and fence exclusion ratio by predator species for both sites combined. (See text for details.)

Species	Relative Frequency (N)[a]	Image Counts[b] Controls	Treatments	Exclusion Ratio
Raccoons	92.3 (518)	680	21	0.031
Skunks	4.1 (23)	14	9	0.643
Opossums	2.1 (12)	7	7	1.000
Coyotes	1.4 (8)	10	0	0.000

[a] Based on full-season years of 2009 and 2011.
[b] Based on all years (2009–2011).

Table 2. Number (%) of depredated and not depredated turtle nests for control and treatment areas by year.

Year	Controls Depredated	Controls Not Depredated	Treatments Depredated	Treatments Not Depredated
2009	13 (81%)	3 (19%)	0 (0%)	9 (100%)
2010[a]	11 (92%)	1 (8%)	7 (39%)	11 (61%)
2011	9 (100%)	0 (0%)	1 (4%)	25 (96%)
Totals	33 (89%)	4 (11%)	8 (15%)	45 (85%)

[a] Not subject to late-season predation.

Table 3. Number (%) of raccoon fence breaches by period and year. (N = number of raccoons per period) (10 May–10 October in all years)

	Pre-nesting	N	Nesting	N	Post-nesting	N	Breach Count
Site A							
2009	0 (0)	7	1 (2)	58	1 (3)	39	2
2010[a]	0 (0)	4	3 (3)	93	1 (3)	33	4
2011	2 (15)	13	1 (1)	91	3 (2)	123	6
Site B							
2009	2 (18)	11	1 (3)	38	1 (3)	36	4
2010[a]	1 (6)	16	0 (0)	3	1 (3)	34	2
2011	0 (0)	10	0 (0)	47	3 (7)	45	3

[a] Post-nesting season truncated by flooding.

Table 4. Approximated cost per protected nest for electric fencing under various theoretical inputs.

Nesting area (m^2)	Theoretical Nests initial number	number protected	Time Inputs initial set-up (h)	weekly site visits (min)	Materials total cost ($)	cost per nest ($)	Labor total cost ($)	cost per nest ($)	Materials and Labor per nest ($)
83.6	9	7	3.00	20.6	27.58	3.94	171.89	24.56	28.50
148.6	16	12	3.75	22.8	31.80	2.65	190.81	15.90	18.55
232.3	25	19	4.50	24.5	34.01	1.79	205.65	10.82	12.61
522.6	56	42	6.00	29.5	42.84	1.02	248.38	5.91	6.93
929.0	100	75	7.00	34.5	51.00	0.68	290.45	3.87	4.55
2090.3	225	169	8.00	44.0	67.60	0.40	369.22	2.18	2.58

Based on a 25-week management period, 15-minute travel time for 1x week site visit, one minute to inspect 61 m of perimeter, and one minute to bait each station (based on field experience). See text for additional details.

relatively unexplored. As such, the development of a successful fence for this purpose appears unique in published literature and represents an addition to the currently small array of methods commonly used to protect turtle nests.

Electric fencing is frequently more cost effective than other methods for protecting nesting areas of various wildlife species (Jimenez et al. 2001). While it entails relatively high initial material costs, ongoing labor demands are relatively low (although paid labor remains the largest cost input by a considerable margin; Table 4). Additionally, materials costs can be amortized over several years, as turtles often use the same nesting areas year after year (e.g., Tucker 2001). Once fencing is installed, management is reduced to periodic fence inspections, low-level maintenance, and bi-weekly baiting, without the need to actively monitor turtle activity and search for nests several times a week (nest screening) or regularly trap and euthanize or translocate predators (predator removal).

Fencing also circumvents some of the potential detractors of turtle management common in alternate methods, including incomplete nest detection (e.g., Burger 1977; Burke et al. 2005; Nelson 2004) and potential disturbance of nesting females under nest screening (e.g., Burger 1977; Jackson and Walker 1997), and the possible ecosystem disruption (e.g., Barton and Roth 2007; Ratnaswamy et al. 1997; Ratnaswamy and Warren 1998; however, see Hecht and Nickerson 1999) and controversy (e.g., Hecht and Nickerson 1999) of predator control.

However, while the fences were effective overall, some of the breaches that did occur resulted in nest loss, suggesting the need for further context-dependent experimentation with strand arrays and baiting regimes. For example, lowering the bottom strand to 12.7 cm above the substrate may reduce under-the-fence breaches by raccoons while still allowing generally unimpeded turtle transit (including most Snapping Turtles; G. Geller, unpubl. data). In all situations the design should encourage over-the-fence predator breach attempts, rather than under—enhancing likelihood of hot wire contact with hands and other lightly furred areas—while still providing unhindered, safe passage of nesting turtles. Improvements seem particularly needed in the exclusion of skunks and other small predators, possibly by experimentation with different baits and bait replacement intervals. The possibility that non-baited fences would significantly exclude adult raccoons would reduce material and labor costs. However, the resultant potential for increased predation from young raccoons and other small predators without baiting is unknown and likely context-dependent.

The species composition of the local predator community, as well as the timing of their on-site presence, will influence protection results. For example, protection levels in this study may have been different if skunks had been commonly present during the nesting season *per se*, rather than later in the year as was found here. Likewise, predation by feral pigs (*Sus scrofa*), armadillos (*Dasypus novemcinctus*), foxes (e.g., *Vulpes vulpes*), Fish Crows (*Corvus ossifragus*) and other species (and size-differing geographical races) not encountered in this study may also produce different results, again prompting locally tailored modifications of the fencing scheme.

Implementation caveats.—Longer perimeters increase the chances for predator breaches due to increased chances for inconsistencies in strand height-to-substrate spacing, electrical shorting via fallen branches, etc., and thus require more attention to maintenance. Smaller, well-protected nesting areas are preferred to larger, less-protected ones, unless due stewardship can be ensured. In many cases it may be more productive to protect large nesting areas by using several smaller enclosures, all connected to one charger.

The positioning of the hot wire at 25.4 cm above the substrate in this fencing scheme greatly reduces the likelihood of electrical contact for all non-marine North American turtle species except Alligator Snapping Turtles (*Macrochelys temminckii*). It is thus important to employ this method only where the absence of this turtle (as well as marine species, Chelonioidea) can be reasonably expected given site history, or where effective approach-blocking mechanisms (e.g., size-filtering barrier fences) can be installed.

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Predation on Spotted Salamanders (*Ambystoma maculatum*) by the Red-shouldered Hawk (*Buteo lineatus*)

Snakes and mammals are commonly suggested predators of metamorphic and adult ambystomatid salamanders (e.g., Beneski et al. 1986; Ferguson 1961; Huheey and Stupka 1967; Liner 1954; Madison 1997; Nussbaum et al. 1983), although direct evidence is often lacking. The limited data are not surprising because mole salamanders occupy tunnels in the forest litter for all except a few days of the year during the breeding season. Information for the Spotted Salamander, *Ambystoma maculatum*, is no exception, and despite radio tracking of animals into the tunnel systems, just a few cases of predation by shrews (*Blarina)*, garter snakes (*Thamnophis*), and weasels (*Mustela*) have been recorded (Madison 1997).

Among potential avian predators of adult ambystomatid salamanders during the breeding season are owls and hawks (Errington and Breckenridge 1938; Granzinolli and Motta 2007; York et al. 2002). The Red-shouldered Hawk, *Buteo lineatus*, may be a frequent predator because it favors deciduous woodlands and flood plain forests (Dykstra et al. 2008; Portnoy and Dodge 1979; Scheffers et al. 2006), which are also favored by ambystomatid salamanders (Petranka 1998). The two species also begin breeding activity in early spring when many other potential prey of raptors (e.g., snakes, toads, frogs, many song birds) are not yet available, or like the meadow vole, *Microtus pennsylvanicus*, are at post-winter population lows (Taitt and Krebs 1985).

Reports of Red-shouldered Hawk predation on salamanders exist (Ernst 1945; Errington and Breckenridge 1938; Howell and Chapman 1998; Rathburn and Murphy 1996; Scheffers et al. 2006; Stewart 1949), but no study specifically reports that ambystomatid or any other salamander species may at times be prominent in the diet of this hawk species. This contrasts with reports of frog species having the greatest biomass in the pellets of the Red-shouldered Hawk (e.g., Howell and Chapman 1998). Here we report evidence of the yearly exploitation of a local breeding population of Spotted Salamanders by the Red-shouldered Hawk.

Methods.—We made observations at a private, woodland residence 8 km E of Ithaca, Tompkins Co., New York, USA (42.7°N, 76.85°W) from late March to early May 2006–2009. We placed a Swarovski™ ST80 (20x–60x) telescope inside a window of an isolated residence overlooking a 380 m^2 man-made, fishless pond, which began 10 m S of the residence. The pond was constructed in 2000 with a steep bank and a plastic liner. The steepness of the sides and the depth of 4 m at the center are not favorable for the growth of aquatic plants, yet several amphibian species readily adopted the pond for breeding. Our vantage point allowed identification of vertebrate prey captured and eaten by a Red-shouldered Hawk as it perched on various objects around the pond, including the roofs of three 1.6 m high bird nest boxes about 4 m from the pond edge. Mixed northern woodlands (beech/birch/maple/oak/hemlock), typical throughout the region, immediately surrounded the house and pond.

Observations in all four years began near the end of ice melt in March with the disappearance of the earlier breeding Jefferson's Salamander (*Ambystoma jeffersonianum*) and the concurrent appearance of breeding Spotted Salamanders (adults 15–25 cm total length; 14–33 g; Bishop 1941) and at least one Red-shouldered Hawk (referred to as RSHA). We believe the same individual hawk was responsible for all the observations because we noticed a unique patch of white feathers on its face whenever we had a frontal view of the hawk and were not focusing on other predation details. In addition, we never observed more than one Red-shouldered Hawk at the pond at a time. We will present the data as if only one hawk was involved, but we cannot say this for certain. We ended observations in early May when Spotted Salamanders and RSHA were no longer observed. We scanned the pond frequently weekdays between 0645 to 0830 h and after 1830 h, and on some weekends at various times throughout the day. During 2006, the number of foraging attempts and successful kills was not documented, but predation was observed on several

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TABLE 1. Predation tries and successes by an observed Red-Shouldered Hawk on various prey from the surface of the study pond (W) or from various locations on the ground nearby (G) over 4 years near Ithaca, New York.

		From water (W)			From ground (G)			Other*		Overall performance Successes #				Total
		Tries	Successes		Tries	Successes			Tries					
Year	Hrs obs.	#	#	%	#	#	%	#	#	A. mac	Rana sp.	Rodent	Total	%
2006	0	-	-	-	-	-	-	6	-	6	0	0	6	-
2007	1.8	2	0	0	4	2	50	1	7	2	0	1	3	43
2008	6.3	10	1	10	13	9	63	3	26	10	3	0	13	50
2009	0.3	0	0	0	2	2	100	0	2	2	0	0	2	100
2007–09	8.4	12	1	8	19	13	68	10	35	14	3	1	18	51

*Not known if from W or G



FIG. 1. Red-shouldered Hawk with either an *Ambystoma jeffersonianum* or *A. maculatum* in its talon on one of the nest boxes around the study pond immediately after successful predation, 6 April 2006.

occasions, and abandoned carcasses were collected and frozen for later identification. During 2007–2009, we left prey carcasses in the field, but documented the dates and times of foraging activity. Recordings began whenever the hawk was first noticed at the pond, sometimes perched on a nest box, sometimes transporting a kill, and sometimes eating a captured prey at a perch.

Results.—In the 2006 breeding season, we observed numerous predation events, photographed one (Fig. 1), and retrieved six abandoned carcasses from the tops of the nest boxes, all of which were Spotted Salamanders (Table 1). Two carcasses consisted of just the tail, three included the pelvic girdle along with the tail, and one had just the head removed. Swollen egg masses were occasionally observed on top of the nest boxes along with carcasses indicating that some prey were gravid females. As the eggs require water to swell up, these females were probably taken from the pond surface because water was only observed to drain off the legs of RSHA (onto the tops of the nest boxes and any exposed eggs) after pond surface attacks.

RSHA foraging and predation attempts were recorded continuously for 3 to 84 minutes during 1.8 h of observation in 2007, 6.3 hrs in 2008, and 0.3 hrs in 2009, with recording sessions beginning when RSHA was noticed at the pond (Table 1). Successful predation by RSHA on Spotted Salamanders was observed, but not documented, during the same salamander breeding period prior to 2006 and in 2010. In 2011, RSHA was not observed during the spring breeding period, but an unidentified Red-shouldered Hawk was observed eating frogs at the pond in early June of 2011 after adult *A. maculatum* had emigrated.

During the 15 days RSHA was seen at the pond from 2007 to 2009, we recorded 8.4 h of foraging activity during which RSHA was seen perched 39 times on various objects around the pond and made 35 descents to the ground or water surface in an attempt to capture prey or to feed on previously captured prey. Descents included 12 instances of swooping down and breaking the pond surface with the talons and lower legs, 19 attempts to capture prey at various locations on the ground (grass, pond bank), and 4 successful attacks when the observer did not record the strike location but recorded prey retrieval and consumption (Table 1). Included in the 19 known ground attacks were several instances where, upon landing, RSHA would search through leaves or 0.03 m high grass or reeds at the pond edge for a few seconds to two minutes until the prey was found. One of the 12 known pond surface attacks was successful, while 13 of the 19 known ground attacks were successful (Table 1). Of the 24 prey recorded over the four years, 20 were *A. maculatum*, three were ranid frogs, and one was a small mammal ("a mouse"). Of the 14 Spotted Salamanders observed killed in 2007–2009, 10 were eaten whole or in part at the pond with any remains being abandoned (Table 1). Of these 10, 3 were completely eaten, and 7 were eaten to various degrees down to the pelvic girdle (similar to the six partial carcasses collected in 2006). Of the 4 remaining *A. maculatum* kills, one was eaten in the grass without identification of the body parts consumed, one was carried away without being eaten at the pond, and two were partially eaten before being carried away. Those carried away were captured 19 March, and 4 and 7 April, before *B. lineatus eggs* hatch in New York State (Crocoll and Parker 1989). We had no evidence of RSHA transporting or eating egg masses, although some eggs may have been eaten when RSHA fed on gravid females.

On 6 April 2008, another observer in a bird blind monitored the pond from 0900 to 1000 h and observed six unsuccessful water surface attempts by RSHA, probably directed at Spotted Salamanders because these were the only animals noticed at that time (we frequently noted them surfacing from the depths in the clear pond water, presumably to gulp air).

Discussion.—Our observations of the Red-shouldered Hawk foraging around a small, man-made pond supporting an amphibian breeding population indicated that (1) the Red-shouldered Hawk killed and ate mostly *A. maculatum* at the site at the time of the study, (2) the anterior portion of the body of *A. maculatum* was preferred, and (3) foraging by the hawk was more successful on land-based prey than prey at the pond surface.

Factors that may have facilitated RSHA predation on Spotted salamanders at our study pond were the scarcity of pond vegetation and the depth of the pond. The scarcity of plants and fallen branches could have forced salamanders to be more exposed at the pond edge or to retreat to deeper water from which they had to surface frequently to gulp air because of possible anoxic conditions and the failure of cutaneous respiration to provide adequate oxygen in recently ice-covered, winter/spring ponds (Barcia and Mathias 1979). Both of these conditions would make the salamanders more vulnerable to hawk predation during the day.

Predator avoidance of the posterior body parts of *A. maculatum* has also been reported by Beachy (1991), who identified just the tail and pelvic girdle of 21 *A. maculatum* carcasses around a breeding pool in North Carolina. The avoidance of posterior body parts is consistent with toxic skin glands in this and other salamander species, particularly in the tail (Barach 1951; Brodie 1971; Brodie et al. 1979; Howard 1971). Eating few toxic prey, or the less-toxic portions of prey, are counter strategies of predators and herbivores to chemical defenses in their food (e.g., Karban and Agrawal 2002). Eating just the non-toxic portions of prey could easily increase the number of prey needed for food by the hawk, and concurrently increase the hawk's impact on the local *A. maculatum* breeding population. Because RSHA ate the entire salamander in 3 of the 10 observed eating events, our observations suggest that RSHA moderated its consumption of a moderately toxic defense chemical.

The greater success of prey capture on land than from the pond surface is consistent with the higher frequency of *A. maculatum* captures during the start of the post-breeding emigration when spotted salamanders take up temporary refuge in pond edge refuges (Madison 1997), as was apparent in the grass/reeds of our study pond. It is also consistent with mostly terrestrial prey in the diet of *B. lineatus* (Dykstra et al. 2008).

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TECHNIQUES

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Survival Blood Sampling in Small Frogs Using "Keyhole Cardiac Puncture"

As research animals, frogs are notoriously hard to collect blood from, particularly when compared to their mammalian counterparts. Studies relating to osmoregulation and water balance in amphibians frequently require the analysis of body fluids, as do studies on stress responses, exercise physiology, immune function, and freezing tolerance. Double-pithing followed by blood extraction from the heart is a common but lethal technique (Costanzo and Lee 2008; Edwards et al. 2000; Irwin and Lee 2003). Some workers obtain blood from major blood vessels like the ventral abdominal vein, the inguinal vein, or the femoral artery (Busk et al. 2000; Wright and Whitaker 2001; Zimmerman et al. 2007), from the orbital sinus (Lynch and Wilczynski 2008), or collect lymph (Reynolds et al. 2009). However, the most commonly used non-lethal method used to sample blood from larger (> 20 g) anurans has been standard percutaneous cardiac puncture (Daló et al. 2007; Tyler 1999; Wright and Whitaker 2001). Percutaneous cardiac puncture involves inserting a needle through the chest wall to withdraw blood from the ventricle. However, a number of problems can arise when using this method to sample blood from smaller anurans (body length < 5 cm; weight < 10 g). Due to its small size, the heart can be hard to locate with a needle, particularly since the position of the ventricle can vary relative to external landmarks (Tyler 1999), increasing the risk of inadvertent damage to other organs. Needles are dulled if the heart is not located on the first attempt, making the heart harder to puncture. The blood volumes that can be obtained from small anurans using percutaneous cardiac puncture often vary substantially and may be contaminated by lymph or other tissues (Rexer-Huber 2009; Wright and Whitaker 2001). The probability of failing to obtain any blood when using percutaneous cardiac puncture appears relatively high and may be affected by treatments that decrease heart rate/blood flow such as anaesthetic use or cold exposure (Cakir and Strauch 2005; Maniero and Carey 1997).

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It is therefore unsurprising that smaller anurans (< 5 cm and/or < 10 g) are often killed to obtain blood volumes sufficient for analysis (Edwards et al. 2000; Jenkins and Swanson 2005; Marler and Ryan 1996). However, terminal blood sampling is frequently not ideal, for example if sequential sampling is required, and may not be possible in small populations and/or endangered anuran species. We developed a nonlethal procedure for blood sampling from small anurans with the aim to minimize the risk of serious injury without causing unnecessary stress to animals. The study species *Litoria ewingii* Duméril and Bibron 1841 is a small frog species (adult length 3–5 cm, weight 1.5–7 g; Rexer-Huber 2009) of the family Hylidae, native to southern Australia and introduced to New Zealand.

The aim of this study was to develop a method to sample blood from small anurans that is easy to perform, reliable in terms of quantity and quality, and survivable. Here, we report on anaesthesia induction and recovery and describe the details of obtaining blood by keyhole cardiac puncture (k.c.p.) in *L. ewingii*.

Methods

Animal collection and housing.—Litoria ewingii (N = 75) were wild-collected from around ephemeral ponds in Central Otago, New Zealand. Life history stages from recently metamorphosed to mature adult were included, with frog body weight 1.37 ± 0.2 g (mean ± s.e.m.) and snout–vent length (SVL) 2.13 ± 0.09 cm. Adult *L. ewingii* weighed 1.02–7.39 g (SVL 2.21–4.93 cm), while juveniles weighed 0.53–1.00 g (SVL 1.82–2.42 cm). Metamorphs weighed 0.33–0.48g (SVL 1.51–1.81 cm). Within 5 h of collection, frogs were transferred to a well-ventilated 20°C incubator (MTR-153, Sanyo Electric, Japan) at 80–90% humidity and a 12:12 h light:dark photoregime, and sampled as soon as possible. *L. ewingii* were not acclimated to standard conditions before the study, since the aim of this study was to assess the utility of k.c.p. in field acclimatized frogs.

Following sampling, frogs recovered in individual plastic vivaria (10 x 11 cm height x diameter; 19–22°C, 12:12 h light:dark, 80–90% humidity) on damp paper towels, and were fed with

Drosophila and small locusts *Locusta migratoria* every second day. Because immune parameters recover from cardiac blood-sampling within a week (Maniero and Carey 1997), frogs were moved into group vivaria (35 x 23 x 22 cm length x width x height) one week post-sampling. Group tanks contained vegetation, stones and small ponds of filtered aged tap water and housed a maximum of five adult or eight juvenile *L. ewingii*. Frogs were fed weekly with *Drosophila*, locusts and houseflies *Musca domestica*.

Anaesthesia.—MS-222 (tricaine methanesulfonate) is a water-soluble anaesthetic commonly used for ectotherms (Wright and Whitaker 2001). Drug delivery is simple and non-invasive: frogs immersed in a solution of MS-222 absorb it across the skin, producing reversible general anaesthesia (Busk et al. 2000; Cakir and Strauch 2005; Tyler 1999). A pilot study indicated that MS-222 did not affect the blood volume that could be obtained or levels of plasma metabolites (glucose and glycerol) (Rexer-Huber 2009), so all frogs were anaesthetized using the following protocol. A fresh 0.1% MS-222 (Sigma-Aldrich, St. Louis, USA) solution was prepared each day and neutralized to pH 7.2 with 0.1 M NaOH (pH adjustment facilitates diffusion across lipid membranes, decreasing induction times; Cakir and Strauch 2005). Frogs were immersed in a 0.5 cm-deep MS-222 bath and monitored for induction of surgical anaesthesia. Surgical anaesthesia was defined as the loss of all three of gular respiration (the visible under-chin respiratory movement due to pulmonary breathing), the righting reflex and the withdrawal reflex. Loss of the withdrawal reflex is a standard method for diagnosing a level of deep surgical anaesthesia in frogs (Tyler 1999; Wright and Whitaker 2001). Loss of pulmonary breathing (seen externally as gular respiration) is not an acute lethal event in frogs because cutaneous respiration can occur (Duellman and Trueb 1986). Once gular respiration and neuromuscular reflexes had ceased, frogs were transferred from the bath onto a MS-222-soaked surgical pad to prevent drying of the skin and ensure anaesthesia was maintained during sampling. Heart rate was monitored visually throughout anaesthesia.

Frogs recovered from anaesthesia in a dish of frog Ringer solution (pH 7.2; in g/L solution: 6.8 NaCl, 0.09 KCl, 0.11 $CaCl_2$, 0.23 $NaHCO_3$) and were assessed for recovery signs. Recovery was checked every 15 min for the first 6 h post-sampling, then twice daily for five days thereafter. Frogs were considered recovered when they presented at least three of the following recovery criteria: a) heartbeat externally visible through the thoracic wall; b) gular breathing; c) withdrawal reflex (limb retraction within 1 sec of extension); d) righting reflex (righting within 2 sec of being placed on dorsum); e) spontaneous movement; and/or f) alert 'head-up' posture.

Blood sampling landmarks.—The anatomical landmarks for blood sampling in *L. ewingii* were examined by dissection. As in all amphibians, the heart was generally located on the ventral midline just posterior to the pectoral girdle, under the mesosternum (Fig. 1). However, in *L. ewingii* the heart was able to move around the thoracic cavity more than expected, making it difficult to locate and puncture using standard percutaneous cardiac puncture.

Keyhole cardiac puncture.— K.c.p. was developed as a refinement to minimize the risks associated with standard percutaneous cardiac puncture. The procedure is described below.

Frogs were measured for SVL, weighed and the maximum blood volume that could be safely removed calculated as 20% of the total amphibian blood volume (95 ml/kg) (Diehl et al. 2001; Hawk and Leary 1999).

Frogs were anaesthetized (immersion in 0.1% MS-222) to a surgical plane of anaesthesia.

To maintain surgical anaesthesia and prevent desiccation, frogs were transferred to a surgical pad soaked with MS-222.

Under a dissection microscope at 9x magnification, a small incision (0.2–0.4 cm, depending on animal size) was made in the skin with fine dissecting scissors along the ventral midline up to the base of the pectoral girdle to expose the mesosternum (Fig. 1, Fig. 2A).

Using forceps to raise the mesosternum, a small hole was cut in the connective tissue just under the mesosternum, making the heart visible (Fig. 2B).

Blood was sampled from the exposed ventricle with a 30 G needle (0.3 ml insulin syringe; BD Ultra-Fine II, Franklin Lakes, USA) (Fig. 2C), ensuring that the maximum safe volume was not exceeded. This type of needle was used since a) the needle hub is attached directly to the syringe, minimising wastage of blood entrapped in the hub; b) the hub rotates, allowing the needle to consistently be used bevel-up; and c) sample volume estimates read from the syringe are highly accurate.

After blood collection, the incision margins were opposed with a sterile cotton bud, drying fluids from the surrounding skin and applying pressure to the incision, before the incision was closed with a superglue droplet (Gorilla UltraBonder, Hamilton, New Zealand) (Fig. 2D).

After a 2–4 min period for the glue to partially dry, frogs were transferred to frog Ringer solution on their backs to regain consciousness. The skin was moistened regularly with Ringer to facilitate respiration during recovery, and 1–3 drops of MS-222 dispensed from a pipette were used for post-operative analgesia once frogs were alert.

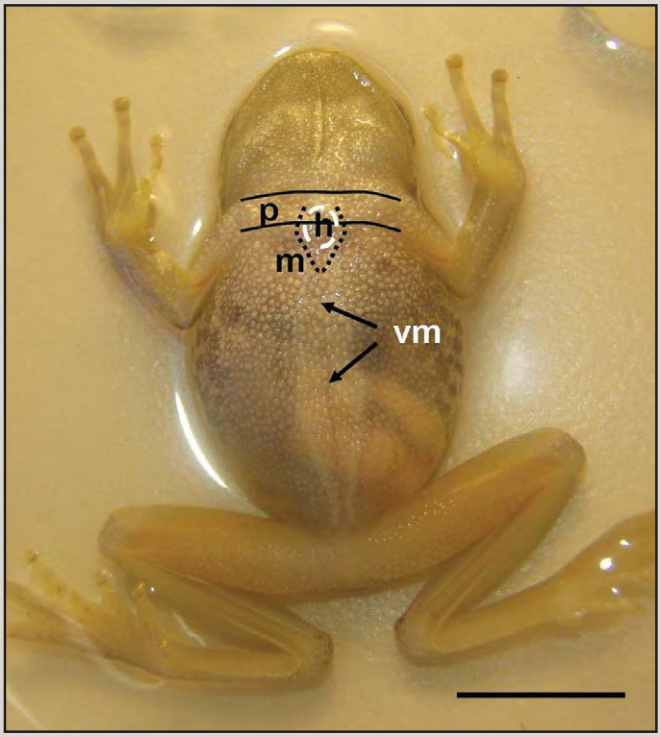


FIG. 1 Cardiac landmarks of *Litoria ewingii*. Unbroken lines indicate the position of the pectoral girdle (*p*) and arrows show the ventral midline (*vm*). The positions of the mesosternum (*m*; dotted line); and heart (*h*, dashed line) are indicated. Scale bars 1 cm.

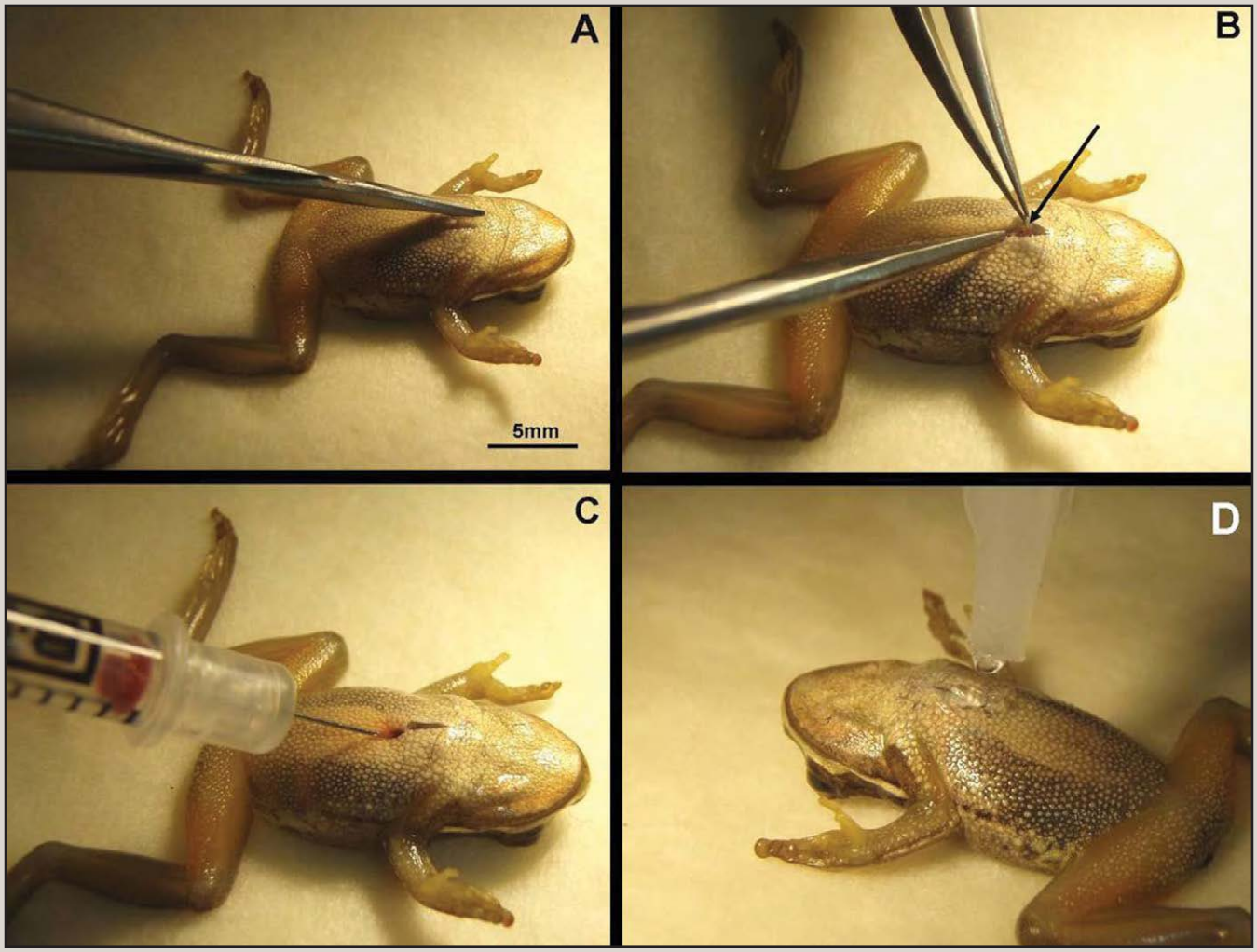


FIG. 2. Keyhole cardiac puncture in *Litoria ewingii*. A) Midline incision up to base of pectoral girdle. B) Tissue under mesosternum (*arrow*) cleared to reveal heart. C) Blood collection directly from ventricle with fine-gauge needle. D) Incision closed with small superglue droplet.

Each frog (N = 66) was only bled once for this study. Sampling instruments were cleaned thoroughly, disinfected in 70% alcohol, and rinsed with Ringer before use, and all efforts were made to maintain aseptic conditions during the k.c.p. procedure.

Recovery was monitored every 15 min (following the criteria for anaesthesia recovery) until normal behavior was regained, usually within an hour of completing sampling. Frogs were then transferred to recovery vivaria and twice-daily checks performed for a week, with twice-weekly checks thereafter. Frogs were euthanized (killed by decapitation, in accordance with University of Otago Animal Welfare Office euthanasia guidelines) if they failed to show any recovery signs after a maximum of two days monitoring. Frogs were monitored for up to 11 months to determine survival and ensure that there were no long-term adverse effects of k.c.p. Following this work, frogs were maintained in the University breeding colony.

Terminal sampling.—To determine the blood volume that could be obtained by terminal sampling, N = 9 frogs were killed by decapitation. The thoracic cavity was opened immediately to expose the heart and blood sampled from the tip of the ventricle with a 30 G needle (0.3 ml syringe; BD Ultra-Fine II, USA).

Sample volumes were compared among groups by t-test (SPSS 17.0) and the effect size statistic (r) calculated for each comparison. Results are reported as mean ± s.e.m. and significance is accepted at $P < 0.05$.

RESULTS

Plasma volume.—Blood could be sampled quickly and easily using k.c.p., requiring around 5 min per animal. Blood was reliably obtained from all 66 animals, with > 4 µl obtained in most cases (92%, 54/60). The number of samples differs from the number of animals as some samples were lost during centrifugation. Plasma volumes obtained by dissection fell within the range of volumes obtained from k.c.p. (Table 1).

Recovery and survival.— Frogs' normal postures and behaviors usually recovered within an hour of completing sampling. The small ventral incision healed rapidly and was completely closed when the glue patch dropped off after 4–6 days, and all frogs had resumed feeding (active capture of live prey) and defecation within that period.

Overall, 37 out of 40 juvenile and adult frogs sampled (93%) recovered from k.c.p. and survived with no adverse effects for at least 11 months. Healing progressed rapidly and the minimal scarring became undetectable within 2 months of k.c.p. Recovery rates were lower in metamorphs: seven of 26 metamorphs

TABLE 1. Plasma volumes obtained using different sampling methods.

Sampling method	Plasma volume (µl) range	mean ± s.e.m.	N
Keyhole cardiac puncture	1–45	10 ± 1	60
Terminal dissection	3–20	16 ± 4	9

These volumes are within the maximum plasma volume (20%) that is considered safe to remove during one-off sampling.

N differs from the number of frogs sampled since some samples were lost during processing.

recovered from k.c.p. (27%) and only three (12%) survived for over four months.

Since the technique is reliable (plasma samples > 4 µl obtained from 92% of frogs, no sampling failures) and non-lethal (93% of juvenile and adult frogs survived k.c.p.), it can be concluded that k.c.p. is a valid technique for sampling blood from small adult and juvenile anurans ranging from 0.5 to 7.4 g (~ 1.8–4.9 cm body length). Of the three juvenile and adult animals that died, two frogs had abnormal posture (head down, intermittent hind-leg twitch) before anaesthesia, suggesting that other unknown issues may have complicated recovery from k.c.p. The third case of mortality was most likely due to operator error during the procedure since hemorrhage occurred as tissue was cleared from under the mesosternum. As discussed above, mortality among metamorphs appears to be size-related. In all cases where none of the recovery criteria was observed, animals were considered moribund and euthanized.

Discussion

Blood can easily be obtained from small anurans via keyhole cardiac puncture. The technique is nonlethal to adult and juvenile frogs and is reliable, with blood collected from every animal sampled unlike conventional percutaneous cardiac puncture (Maniero and Carey 1997). Volumes from k.c.p. were comparable to those obtained from similarly-sized frogs using terminal dissection (Croes and Thomas 2000; Layne and Rice 2003; Marler and Ryan 1996) or survival surgery (orbital sinus puncture, Lynch and Wilczynski 2008), so k.c.p. does not limit the sample volumes obtainable. In addition, plasma volumes were large enough for analysis of various parameters including glucose (2 µl) and glycerol (4 µl) concentrations (Rexer-Huber et al. 2011). Recovery was prompt in juvenile and adult frogs, with rapid healing and no long-term adverse effects observed. External scarring could not be detected after two months, normal reproductive development and behaviour continued and growth appeared stable.

Metamorphs were sensitive to the sampling. This is somewhat puzzling since the "safe maximum" for one-off blood sampling (20% of total blood volume, i.e. 19 ml/kg; Hawk and Leary 1999) was followed. The major changes that take place over metamorphosis include changes in systemic blood supply (Duellman and Trueb 1986), so perhaps cardiac stability and/or venous return to the heart may still be sensitive in metamorphs. In addition, the needle is larger relative to the heart of a metamorph than it is to an adult's heart, which presumably results in relatively more pericardial and ventricular damage. Combined with the high mortality rate naturally seen in metamorphosing frogs (Duellman and Trueb 1986), these factors might explain why metamorphs did not cope with the physiological challenge of blood sampling by k.c.p.

K.c.p. addresses some of the limitations of standard percutaneous cardiac puncture by increasing precision, minimising the risk of inadvertent secondary damage that can complicate recovery. In addition, factors that influence heart contractility and blood pressure and may limit the success of standard percutaneous cardiac puncture (e.g., general anesthesia, cold exposure; Cakir and Strauch 2005; Maniero and Carey 1997) does not affect blood removal by k.c.p. (Rexer-Huber et al. 2011), making the technique useful in a broader range of studies.

Blood glucose increase is a well-known response to stress (Costanzo et al. 2006; Storey and Storey 1988) and hyperglycemia can be used as an index of how much various blood sampling techniques stress animals (Christensen et al. 2009). Glucose was measured from samples obtained by k.c.p as part of a separate study (Rexer-Huber et al. 2011). Plasma glucose levels of 0.03–6.84 mmol/L (range, N = 45) were measured, within the range seen when blood was sampled by terminal dissection (Costanzo and Lee 2008; Layne and Stapleton 2009), arterial cannulation (Rocha and Branco 1998) or puncture of the inguinal vein (Zimmerman et al. 2007). This suggests that k.c.p does not induce a hyperglycemic stress response. In future work, it would be interesting to confirm these observations within a single species by comparing glucose levels in equal numbers of frogs sampled by k.c.p. or via dissection (no stress response possible). In such a study, corticosterone could also be used as an index of acute stress.

This work provides a new and effective alternative to terminal blood sampling in anurans ranging from a body size of 1.8 to 4.9 cm (SVL; weight 0.5–7.4 g). Keyhole cardiac puncture is easy to teach and learn, good-quality samples are reliably obtained and sampling-induced stress is kept to a minimum, with no adverse effects detected during recovery or during long-term monitoring of survival.

Acknowledgments.—Housing and experimental protocols and procedures complied with the guidelines of the New Zealand Animal Welfare Act 1999, the National Animal Ethics Advisory Committee (NAEAC) Good Practise Guide, and the University of Otago Code of Ethical Conduct. All protocols and procedures were previously approved by the University of Otago Animal Ethics Committee. Our thanks to David Wharton for use of lab equipment and Ken Miller for help with image preparation. This work was supported by a University of Otago grant to K.R.H.

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Evaluation of a Simple Method of Externally Attaching Radio-transmitters to the Texas Alligator Lizard, *Gerrhonotus infernalis*

Radio-telemetry has been applied as a tool to study the ecology of a variety of lizards (Fisher and Muth 1995; Germano 2007; Goodman 2005). Different techniques of placing radio-transmitters have been proposed (Fisher and Muth 1995; Goodman 2005; Goodman et al. 2009; Knapp and Owens 2005; Warner et al. 2006), but these techniques are not suitable for all lizards. *Gerrhonotus infernalis* morphology is particularly problematic because of the slender body, smooth scales, slender and short limbs, and lateral abdominal folds (Smith 1979), making external radio-transmitter attachment difficult. Herein we describe a simple, inexpensive, and suitable technique of attaching transmitters to *G. infernalis* in a controled situation in the laboratory and under natural field conditions. This technique is adapted from that proposed by Madrid-Sotelo and García-Aguayo (2008) for the snake *Oxybelis aeneus*.

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Materials and methods.—From November 2008 to May 2009, *Gerrhonotus infernalis* (10 males and 10 females) were captured in Parque Ecológico Chipinque (PECh), part of Parque Nacional Cumbres de Monterrey, Nuevo Leon, Mexico. Lizards were transported to the Laboratory of Herpetology (Facultad de Ciencias Biológicas, Universidad Autónoma de Nuevo León), placed in individual terrariums (1 x 1 x 1 m) with leaf litter as substratum, and fed every three days on domestic crickets (*Acheta domestica*); water was supplied *ad libitum*, and rocks were provided as refuge sites. Laboratory temperature was maintained from 20–23°C with a 12:12 light-dark cycle.

Each lizard was attached with a radio-transmitter (TXB-003G by Telenax) in a manner similar to that described by Madrid-Sotelo and García-Aguayo (2008) for snakes. Each lizard was

immobilized by hand, carefully holding the head to avoid bites, and stimulated to inflate the abdomen in order to expand its lateral folds. Immediately, the transmitter was attached onto the lizard's dorsum, 3 cm anterior to the tail base and then wrapped with Micropore® tape (1 cm wide) (Fig. 1) pressing down softly to ensure adhesion to the skin. Unlike Madrid-Sotelo and García-Aguayo (2008), we did not use Tuck® but rather Micropore® tape, we did not use glue to cover the tape, and we adapted the Micropore® tape to the lizard's folds to avoid abdominal constriction. After attachment, each lizard was returned to the terrarium.

To assess the suitability of the technique, once per day over a month-long period, we registered time of attachment per individual, number of immobile individuals, causes of immobilization, and number of individuals with skin abrasions. Lizard mass ranged from 23.7–53.0 g (mean = 34.8 g); snout–vent length (SVL) ranged from 120–155 mm (mean = 130.6 mm). Once laboratory trials ended, every lizard was released at the site of capture.

From November 2009 to October 2010, *G. infernalis* (13 males and 10 females) were captured in PECh, attached with radio-transmitters as in the laboratory, and then released at the site of capture. Lizards were relocated 3–4 days per week with a receiver and 3-element Yagi antenna, registering the date and observations on any radio-transmitter attachment difficulties. Lizard mass ranged from 29.0–60.0 g (mean = 44.3 g); SVL ranged from 109–152 mm (mean = 139.9 mm). In both laboratory and natural field condition trials transmitters weighed less than 7.5% of the individual mass, as suggested by Knapp and Abarca (2009) for lizards.

Results.—Time of attachment for radio-transmitters in laboratory conditions varied from 1–30 days (mean = 6.5 ± 1.8; N = 20) while under natural field conditions it varied from 1–60 days (mean = 11.8 ± 3.5; N = 23). In the laboratory, 20% of transmitter detachments occurred with shedding. Problems noted were: a) early detachment; b) immobile individuals; c) lizards becoming entangled among vegetation or rocks; d) lizards getting stuck in crevice; and e) presence of skin abrasions (Table 1). Time of attachment in natural field conditions varied throughout the year and was longer during spring and summer (Table 2).

Discussion.—The technique we describe herein, similar to that proposed by Madrid-Sotelo and García-Aguayo (2008) for a small and slender snake species, can be adapted to *Gerrhonotus infernalis* because of its morphology. Advantages of the modifications we describe are: the tape can be adjusted to account for an individual lizard's morphology; when detached, transmitters can be recovered and reattached; and method of attachment causes minimal interference on behavior or lizard activity. Some disadvantages we noted were: early transmitter detachment, principally caused by the tape unraveling or by shedding; immobilization of individuals, caused by the adhesion of the hind limbs to the tape; entangled individuals among vegetation or rocks; and the presence of skin abrasions. Madrid-Sotelo and García-Aguayo (2008) and Goodman (2009) reported that this technique did not result in changes in behavior, activity, or health of their study animals. When a lizard was snagged by the presence of the attached transmitter, it was able to get free after less than 10 minutes of struggle, what means the technique caused minimal interference with its activity. We did not test for behavioral differences associated with this transmitter fixation method; however, behavior of test lizards did appear to be normal.

It is important to mention that difficulties presented with the technique were occasional, so we suggest that this technique can be improved covering the tape with glue, as described by Madrid-Sotelo and García-Aguayo (2008). This technique seems especially promising during dry weather and in less structurally complex habitats. We suggest that the technique we propose is simple, inexpensive, low-risk, and suitable for species sharing morphological features with *Gerrhonotus infernalis*. It should be applicable in small species, as well as juveniles or neonates, where other techniques are inappropriate.

Table 1. Difficulties in external attachment technique in *Gerrhonotus infernalis* in laboratory and natural field conditions, number of events (percentage).

Event	Laboratory conditions (N = 20)	Natural field conditions (N = 23)
Immobilized individual limbs	5 (20 %)	0
Entangled individuals	3 (15%)	2 (9%)
Stuck individuals in crevice	0	1 (4 %)
Presence of skin abrasions	0	1 (4 %)

Table 2. Season, number of individuals with transmitter attached, time of attachment (days, mean ± standard deviation), number of relocations in each season (days, mean ± standard deviation).

Season	Number of individuals M / F	Time period of attachment in days (mean ± SD)	Relocations in days (mean ± SD)
Spring	1 / 5	7–38 (24.0 ± 14.4)	1–16 (9.4 ± 7.3)
Summer	7 / 4	1–60 (14.0 ±19.0)	1–11 (3.3 ± 3.2)
Fall	2 / 3	3–25 (10.2 ± 9.4)	1–5 (3.4 ± 1.7)
Winter	0 / 1	1–22	1–15



Fig. 1. Attached radio-transmitter on *Gerrhonotus infernalis*.

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Construction and Use of Artificial Shelters to Supplement Habitat for Hellbenders (*Cryptobranchus alleganiensis*)

Hellbenders (*Cryptobranchus alleganiensis*) are large, aquatic salamanders found in moderate to swift-flowing streams and rivers in the eastern United States (Petranka 1998) with two subspecies currently recognized; the Eastern Hellbender (*C. a. alleganiensis*) and the Ozark Hellbender (*C. a. bishopi*). Both subspecies are found in the Ozark highlands of Missouri and are listed as critically imperiled and state endangered in Missouri (NatureServe 2011). Both subspecies have experienced severe population declines throughout much of their geographic range, especially in Missouri (Briggler et al. 2007; Wheeler et al. 2003), and recently the Ozark Hellbender was added as an endangered species under the U.S. Endangered Species Act (USFWS 2011). In addition, there has been a shift in age structure of Hellbender populations in Missouri, with larger, mature individuals being most prevalent and younger age classes being virtually absent (Wheeler et al. 2003; J. Briggler, unpubl. data). Causes of Hellbender declines are mainly linked to habitat degradation and alteration (e.g., impoundments, water quality, sedimentation, and disturbance), commercial exploitation, predation, and diseases (Briggler et al. 2007; Briggler et al. 2010; USFWS 2011). This species inhabits cavities under large rocks and crevices or holes in bedrock on the river bottom (Smith 1907). Snorkel diving coupled with turning rocks has been and continues to be the most successful method for capturing Hellbenders for research (Nickerson and Krysko 2003), but careful attention to placement of the rock back into its original position is important for continued use by Hellbenders. Therefore, changes in such habitat due to modification by land use practices (e.g., sedimentation and gravel loading of existing habitat) or increase human disturbance (e.g., careless rock turning and flipping) can change the microhabitat of the preferred rocks used for shelter and nesting, thus, rendering such sites less suitable (Briggler et al. 2007).

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Over the past several years, government agency biologists in Missouri (Department of Conservation, Department of Transportation, and Fort Leonard Wood Military Base) have augmented large rocks (approximately 1.2 x 0.91 m surface area with an average thickness of 20–25 cm) for mitigation measures in several rivers. These augmented rocks have been used by Hellbenders for shelter purposes, but they have not been successful in egg deposition. Only a limited number of nests have been found in the wild in Missouri (Nickerson and Mays 1973; Nickerson and Tohulka 1986; Peterson 1988), but it appears that specific features (e.g., tight narrow entrance, chamber for eggs in rear, etc.) of such nesting rocks are necessary for suitability for spawning and male guarding of nests (Alexander 1927; Bishop 1941; Kern 1984; Nickerson and Mays 1973; Smith 1907). Although the mechanisms for low recruitment (e.g., lack of breeding, high larval predation, disease, etc.) are unclear, biologists recognized the need to artificially propagate this species to sustain and restore populations while addressing the cause of the decline (Briggler et al. 2010). Part of these efforts is to collect egg clutches from the wild to head-start larvae and juveniles at propagation facilities for future releases and other research needs. With limited success in locating eggs in the wild and need to supplement habitat in the wild, we designed artificial shelters that can be used by Hellbenders to meet their biological needs (e.g., shelter, nesting, etc.), thus, making eggs easier to find and harvest for propagation efforts.

The use of artificial structures for ecological needs (e.g., nesting, shelter, overwinter, roosting, etc.) by birds, bats, and mammals have been well documented (Barclay 2008; Bellrose et al. 1964; Dawson 1967; Kibler 1969; Lambrechts et al. 2010; McComb and Noble 1981a; Purcell et al. 1997; Stebbings and Walsh 1988). Such structures have also been designed for some herpetofauna, especially arboreal amphibians and reptiles, alligators, and giant salamanders (*Andrias* spp.) (Boughton et al. 2000; Campbell and Mazzotti 2004; Kuwabara et al. 1989; McComb and Noble 1981b). Breeding habits of the Japanese Giant Salamander (*A. japonicus*) and Chinese Giant Salamander (*A. davidianus*) are similar to those of the North American Hellbender. Biologists have been successful in constructing artificial nesting structures used by these species for breeding in the wild (Kuwabara et al. 1989; L. Gang, pers. comm.). Therefore, we wanted to determine the feasibility of constructing such a structure for Hellbenders in North

America. To our knowledge, this is the first attempt to produce artificial shelters, especially for breeding purposes, for Hellbenders. For an endangered species that is in need of a "safety net" (collecting eggs and head-starting young), it was our hope that such artificial shelters would not only be used by Hellbenders in the wild, but also provide the necessary features for spawning and nesting to occur. The use of artificial shelters may advance our understanding of breeding behavior of this species similar to the knowledge gained for artificial cavities for birds. Herein we present a novel technique to designing artificial shelters for a habitat specialists and the use of such shelters by Hellbenders.

Material and methods.—The artificial shelter was constructed from hex netting (i.e., poultry or chicken wire) wire (61 cm height, 2.5 cm mesh, 20-gauge wire), hardware cloth (61 cm height, 0.6 cm mesh, 23-gauge wire), cable ties (9.6 cm), and a concrete mixture (1 part sand:1 part concrete mix:1 part quikcrete). A 91–102 cm length of hex netting wire was cut to make the appropriate size artificial shelter and was formed to the desired shape (Fig. 1a). Next, hardware cloth was inserted to the interior of the hex netting wire frame (Fig. 1b) and secured with cable ties to increase stability of the frame and for concrete mixture to adhere to wire frames. Approximately a 17 x 10 cm section was removed for the lid prior to adding concrete mixture (Fig. 1b). Next, concrete mixture was applied to the various sides of the artificial shelter wire frame and shaped accordingly (Fig. 1c). We were careful to smooth all interior surfaces prior to drying to eliminate rough edges or bumps that could injure a Hellbender. Once completely dry, the lid and associated handle of the artificial shelter was constructed (Fig. 1c) to allow accessibility to the inside chamber. Next, 3 small holes (4 to 5 mm) were drilled slightly above the centerline on the back portion of the shelter to allow a small amount of water to seep into the shelter chamber. We further experimented with the artificial shelter by removing some of the bottoms (~23 x 15 cm) to allow the river bottom to be the substrate of the shelter as recommended by Japanese biologists working with Japanese Giant Salamanders (Kuwabara et al. 1989; K. Kuwabara pers. comm.). Finally, we soaked the shelter in water for at least 30 days in an outside container to allow for leaching of concrete chemical residue and begin weathering of the shelter prior to installing in the wild. Contact the authors for a detailed photographic guide to the construction of these artificial shelters.

In the winter of 2007/2008, three experimental prototypes (boot, two-opening and duplex designs) were constructed with wire mesh netting and covered with concrete (Fig. 2). Two of each prototype (N = 6) were installed in the Eleven Point River, Oregon County, Missouri on 15 July 2008. These 6 shelters were installed at a location with relatively good Ozark Hellbenders numbers (18 Hellbenders tagged since 2002) and limited rock habitat to increase our odds of use by Hellbenders. Installation included 1) digging a hole in the gravel substrate, 2) placing and positioning the shelter in the hole with entrance located downstream of water flow, 3) filling the outside edges of the shelter with gravel/cobble to the rim of the lid, 4) depositing 2 to 3 L of sand inside the shelter chamber, and 5) placing a large rock on top to reduce light penetration and to conceal from human disturbance. Although a couple of the prototypes (boot and duplex) each attracted a female Hellbender, many modifications were made between 2007 and 2009 (e.g., longer and narrower tunnels, sealing the original camera hole in lid and smaller drilled holes for water flow) due to excessive light penetration and sedimentation. We believed that Hellbenders used the prototype shelters occasionally but such shelters were likely unsuitable for egg laying. Based upon our knowledge of the species and male breeding behavior, we made these important modifications for male Hellbenders to inhabit and use such a shelter for nesting purposes. The new and current design was modeled from the boot prototype and had a larger, open chamber with a longer, narrower tunnel entrance with a tightly secured lid, and smaller drill holes in the back of the shelter (Fig. 1c).

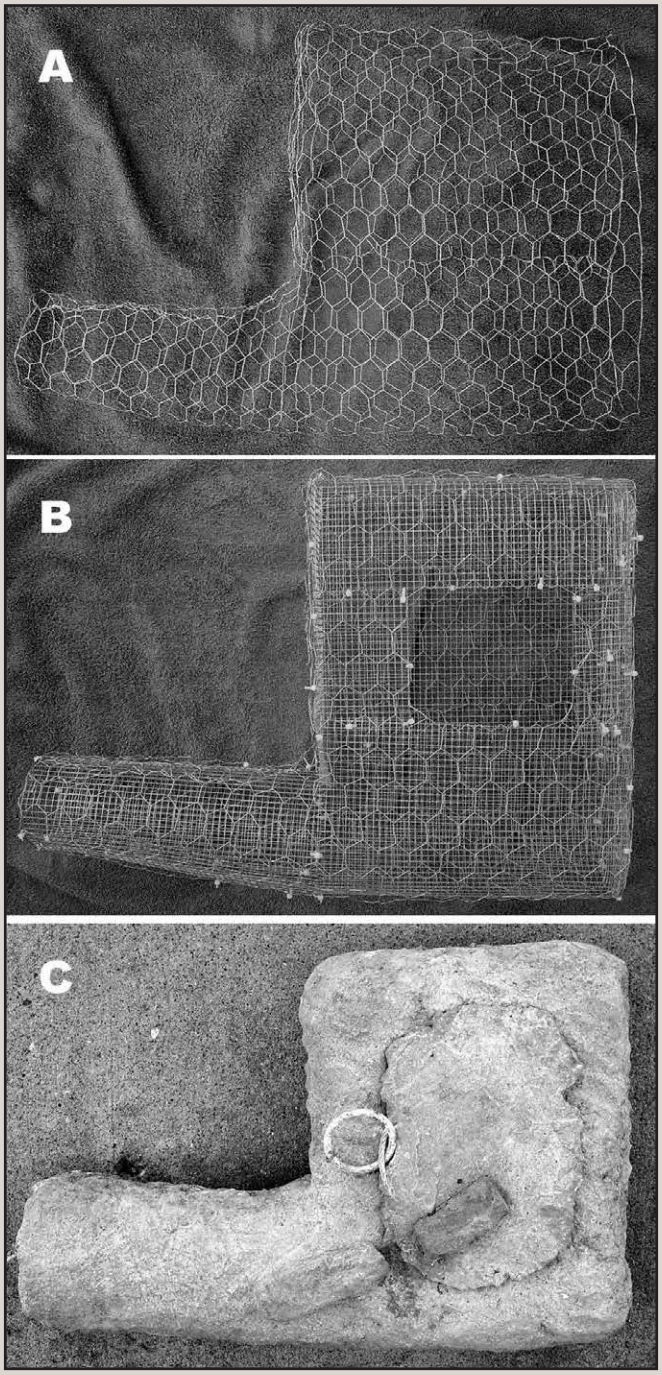


FIG. 1. Modified boot design showing hex netting frame (A), hex netting and hardware cloth frame (B), and completed artificial shelter (C).

In the winter of 2009/2010, seven new artificial shelters (modified boot design) were constructed for placement in the wild in 2010 (Fig. 1c). An additional 20 artificial shelters were

constructed in the winter of 2010/2011 for placement in two artificial outdoor raceways (10 in each raceway; approximately 12 m length by 1.3 m width with a water depth ranging from 0.5 to 1.3 m) at the Saint Louis Zoo for adult Ozark Hellbender breeding stock previously collected from Current and Eleven Point rivers in the summer of 2009, 2010 and 2011 for captive propagation efforts. The seven (four open and three enclosed bottoms) artificial shelters were installed on the Eleven Point River on 24 June 2010 while the other 20 shelters (10 open and 10 enclosed bottoms) were installed in the outdoor raceways at the Saint Louis Zoo on 23 August 2011. These shelters were installed into the gravel substrate of the raceways similar to the river; however, no large rocks were necessary to conceal the shelters from human disturbance. Adult breeding stock previously collected from the wild were moved into the outdoor raceways in September 2011.

Results.— Twenty-seven artificial shelters were constructed for use in the river (N = 7) and at two outdoor raceways at the Saint Louis Zoo (N = 20; Table 1). Although dimensions (e.g., entrance size, tunnel length, chamber size, etc.) of the artificial shelters are very similar, no two are exactly alike (Table 1).

On 27 July 2010, we checked the seven shelters on the Eleven Point River by use of an Aqua-Vu camera (manufactured by Outdoor Insight Inc.) to minimize disturbance to the animals. Two of the shelters (No. 9 and 13) had a Hellbender present (Table 2). Since the primary goal of these shelters was to obtain eggs for head-starting efforts, we decided to not disturb the shelters again until breeding season was completed. Upon our return on 03 November 2010, two male Hellbenders were captured in shelters 7 and 8 with a male guarding a clutch of 182 eggs well into development (Table 2; Fig. 3). These shelters were not checked again until the end of the following year breeding season on 31 October 2011, and a male Hellbender was present in shelter 12 and 13 (Table 2), but no eggs were present this time. Six Hellbenders were observed using 5 of the 7 shelters with shelter number 13 being occupied in both 2010 and 2011 (Table 2).

Artificial shelters installed in the outdoor raceways at the Saint Louis Zoo were checked approximately weekly (C. Schuette, pers. comm.). Minimum human disturbance was used due to breeding season, but many of the shelters were occupied by the adults. On 18 October 2011, eggs were discovered in an open bottom shelter with an attending male Hellbender. No additional eggs were found in the other 19 artificial shelters.

Discussion.—Declining numbers and lack of recruitment in the wild of both Ozark and Eastern Hellbenders in Missouri has necessitated a focused recovery effort, especially propagation and head-starting efforts to ensure long-term recovery (Briggler et al. 2010). The utilization of these artificial shelters to supplement habitat for adult Hellbenders is important, but the success of using such shelters for breeding and egg laying in the wild and at the Saint Louis Zoo propagation facility is extremely promising for future recovery efforts. The observations documented here were the first fertilized clutch of eggs found in the wild in the Eleven Point River, and the first clutch of eggs to be conceived in a captive propagation facility via use of artificial shelters. Current trends show that the shelters with the bottoms removed are utilized more often, especially for spawning and egg laying. However, this trend is based on a small sample size of Hellbender use and egg laying, and thus it remains to be seen if this trend will continue in the future. We strived to recreate habitat that would attract Hellbenders to spawn, but also produce such a shelter for males to defend from natural predators. Male guarding behavior of the nest is vital to the protection of eggs and subsequent hatchling from conspecifics and other predators (Nickerson and Mays 1973). Therefore, we created an artificial shelter with an entrance size similar to natural nests to ensure male control of the shelter from other natural predators. The male guarding the artificial shelter with eggs from the Eleven Point River aggressively defended (camera lens bitten) the entrance of the nest when we approached and apparently had successfully guarded this nest from natural predators for at least 4 weeks since egg laying based upon developmental stage of the eggs. To date, these few shelters have provided supplemental habitat for Hellbenders in the rivers, as well as reduced researcher disturbance (rock turning and flipping) of the natural rock utilized by Hellbenders. However, caution and concealment is warranted to discourage illegal poaching and disturbance of animals utilizing these artificial shelters in the wild.

With the success already achieved, we initiated the construction of an additional 60 artificial shelters to be used throughout

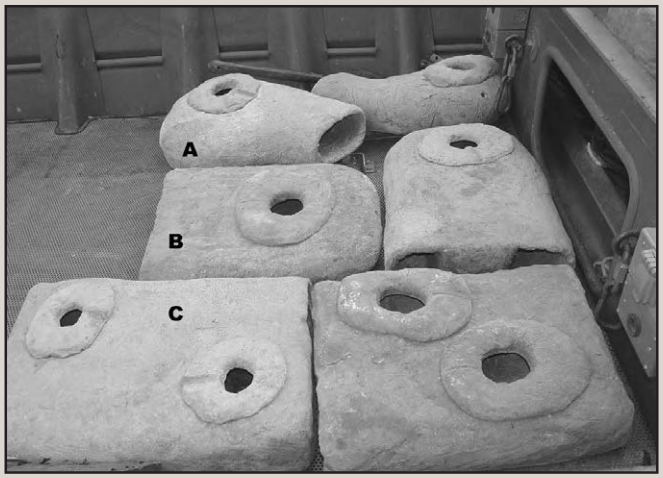


FIG. 2. Three experimental artificial shelter designs (A = boot; B = two-opening; C = duplex). Boot design has one entrance and one chamber. Two-opening design has two entrances on one side and one chamber. Duplex design has two entrances on opposite sides with two chambers inter-connected inside. Original designs had holes in the lid for potential use with camera, but were removed in recent designs due to concerns (i.e., increase light, flow and sedimentation).



FIG. 3. A clutch of fertilized Ozark Hellbender (*Cryptobranchus alleganiensis bishopi*) eggs found in artificial shelter number 8 in the Eleven Point River, Missouri on 03 November 2010.

TABLE 1. Mean dimensions of artificial Hellbender shelters installed in the Eleven Point River, Missouri and the two outdoor raceways at the Saint Louis Zoo.

	Eleven Point River (N = 7)		St. Louis Zoo Raceways (N = 20)	
Dimensions	Mean ± 1 SE	Range	Mean ± 1 SE	Range
Entrance Size (cm)				
Width	13.4 ± 1.2	10.0–18.0	10.4 ± 0.4	8.0–13.0
Height	8.4 ± 0.4	7.0–10.0	7.8 ± 0.2	6.5–10.0
Tunnel Length (cm)	22.2 ± 1.8	18.0–29.5	25.4 ± 0.5	21.5–30.0
Chamber Size (cm)				
Length	41.0 ± 1.3	35.5–46.0	34.6 ± 0.4	30.0–38.0
Width	36.5 ± 1.1	33.0–40.5	29.1 ± 0.6	25.5–31.5
Lid Size (cm)				
Length	16.3 ± 0.7	14.0–19.0	18.0 ± 0.6	14.0–23.0
Width	12.1 ± 0.7	9.5–14.0	13.5 ± 0.4	11.0–17.0
Open Bottom Size (cm)				
Length	24.5 ± 0.7	23.0–25.5	21.1 ± 0.7	17.0–24.0
Width	20.4 ± 0.8	18.0–21.5	14.6 ± 0.7	12.0–19.0

TABLE 2. Ozark Hellbenders (*Cryptobranchus alleganiensis bishopi*) observed using artificial Hellbender shelters installed on 24 June 2010 in the Eleven Point River, Missouri. TL = total length; SVL = snout–vent length. [1] Indicates adult Ozark Hellbender was observed with underwater camera, but not captured; [2] indicates Ozark Hellbender guarding nest. Features indicate whether the bottom of the shelter was removed (Open) or remained (Closed).

Shelter No.	Features	Date Checked	PIT Number	Gender	TL (cm)	SVL (cm)	Mass (g)
9	Closed	27 July 2010	Present[1]	–	–	–	–
13	Open	27 July 2010	Present[1]	–	–	–	–
8	Open	03 Nov 2010	102-814-339[2]	Male	40.1	27.0	408
7	Open	03 Nov 2010	051-565-019	Male	34.5	23.5	325
13	Open	31 Oct 2011	105-885-865	Male	44.1	29.0	504
12	Closed	31 Oct 2011	027-321-875	Male	44.1	29.1	529

Missouri's rivers for both Ozark and Eastern Hellbender populations. The use of such artificial shelters will likely advance the knowledge and understanding of breeding behavior and phenology of this species not only in the wild, but also in captive propagation programs. We believe that these artificial shelters will play a vital role in the recovery of this species in Missouri and may be of benefit rangewide.

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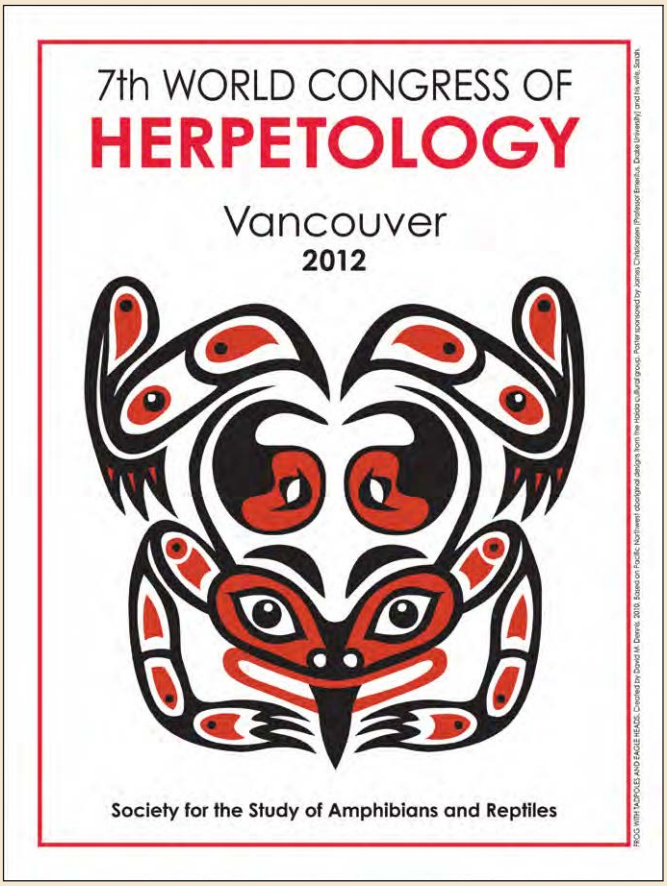
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Toad Trackers: Amphibians as Gateway Species to Biodiversity Stewardship

In the nationally recognized book, *Last Child in the Woods* (2005), author Richard Louv articulated a phenomenon based on a growing body of evidence that children are becoming increasingly disconnected from nature. He coined the term "nature deficit disorder" and proposed this divide may be the cause of many physical and mental maladies found in today's youth. Likewise, the failure to create broad-based support for the conservation of biodiversity may also be a function of the separation of people from nature (Miller 2005) and environmental psychologist Peter Kahn (2002) concluded "that the genesis of estrangement from nature lies in childhood and it is there that we must begin to address the problem" (quoted in Miller 2005).

In 2004, the Society for Conservation Biology set education as one of the most important goals for the protection and restoration for biological diversity. These conservation literacy guidelines propose that education programs should 1) develop in people a deeper understanding of the importance and tools of conservation biology; 2) provide direct experience which will further develop knowledge, skills, and attitudes; 3) utilize conservation biologists who have a unique set of knowledge, skills, and concerns to share with others (Trombulak et al. 2004).

One of the great challenges for environmental educators is how to link personal meaning to the abstract concept of biodiversity, and how to include it in a context in which a student can become physically and psychologically involved (Van Weelie and Wals 2002). To achieve this, ecological lessons often deal with easily accessible and immobile organisms outdoors such as invertebrates and plants because amphibians, reptiles, mammals, birds, and fish can be difficult to observe in a natural setting (Killermann 1998). With the support and expertise of the herpetological community, amphibians might serve as a more accessible vertebrate group to offer hands-on experiences due to their relative abundance, proximity to both urban and rural settings, and their benign nature with appropriate safety precautions.

A Houston Zoo Conservation Department-launched education program, Toad Trackers, is utilizing professional herpetologists to offer expertise and capacity building both in Texas and in international environmental eco-literacy programs. Toad Trackers provides opportunities for youth to engage in interactive discoveries with wild amphibians, explore science-related careers, and provide gateways to deeper investigation and personal meaning with the natural world. Research demonstrating the effectiveness of the use of amphibians in outdoor education is limited, although at least one recent study did find that students encountering living amphibians in field programs performed better on achievement tests, expressed increased well-being, and showed lower incidence of anger, anxiety, and boredom (Randler et al. 2005). Other surveys, focused on gathering information about school children attitudes regarding amphibians, conclude that importance should be placed in education programs that provide direct experience to positively affect their knowledge, attitudes, and feelings about them (Tomažič 2008, 2011). Through further development and evaluation of the Toad Trackers program, we hope to gain additional insight on the effectiveness of early encounters with amphibians in helping engender lifelong biodiversity stewardship and conservation action.

The Toad Trackers program has two overarching goals: 1) to generate an appreciation and conservation ethic for amphibians, the world's most imperiled vertebrate class; and 2) to introduce youth to the tools and research methods used by wildlife biologists to study animal populations, hopefully generating some enthusiasm for future careers in biology or conservation. The program is primarily managed for youth ranging from 8 to 18 years old, and has additionally been used with groups of adults such as formal educators, zoo docents, staff, and college interns. Since 2010, 172 participants have completed the course. Through a combination of classroom workshops and hands-on, field-based experiences, participants cover topics including amphibian adaptations, ecological roles, native frog diversity, and current conservation issues in an engaging atmosphere. Ranging in complexity based on the audience age, students also learn aspects of data collection, amphibian population monitoring, spatial analysis, and demography. All of this information is taught within the context of global amphibian declines with an emphasis on why monitoring local populations of "common" amphibians is important for detecting declines in our own region. Time during the course is balanced between the classroom and the field. Studies have shown that a combination of classroom activities designed to enhance knowledge prior to a field trip, paired with an involved outdoor activity, may be more effective for student retention of information than participating only in a novel field program (Falk 1983; Falk et al. 1978; Morgan 1992; Randler et al. 2005).

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FIG. 1. Students measure an *Incilius nebulifer.*

PHOTO BY RACHEL ROMMEL



FIG. 3. Amplectant pair of Common Rain Frogs, *Breviceps adspersus,* outside of Hwange National Park, Zimbabwe.

PHOTO BY WADE CARRUTH



FIG. 2. Students observe a Houston Zoo amphibian biologist microchip a toad.

PHOTO BY RACHEL ROMMEL



FIG. 4. Zimbabwe students learn how to measure and weigh rubber toads in the classroom.

In the classroom portion of Toad Trackers, a general overview of amphibians and special topics are covered, they meet and become familiar with a live Gulf Coast Toad (*Incilius nebulifer*) and learn to properly handle and collect morphometrics (mass, snout–urostyle length, and head width) utilizing rubber toads. They perform a rubber toad scavenger hunt during the day to learn Global Positioning System (GPS) and practice protocols used in the field portion of the course to ensure accurate data collection and the safety of students and the toads. The majority of the techniques for handling live amphibians were adapted from Fellers et al. (1994) and Kast and Hanna (2012). Further safety protocols were developed by the primary investigators to mitigate inherent risks

PHOTO BY RACHEL ROMMEL



FIG. 5. Zimbabwe students engage in a field activity and a rubber toad scavenger hunt.

PHOTO BY LEIGHTON DANCY



FIG. 6. Students observe tadpole behavior at a pond in Hwange National Park.

PHOTO BY RACHEL ROMMEL



FIG. 7. Deliverables from the course included personal journals and the creation of an amphibian field guide, which served as take-home resources for students.

of a lay audience working outdoors and with live animals. Cooperation among team members is emphasized to reduce holding time, minimize stress on the toads, and reduce risks of injury or trauma due to participants stepping on, or dropping animals. Complete methods and protocols for the Toad Trackers program will be submitted for publication at a future date.

The culmination of the Toad Trackers classroom activities results in teams of well-trained students embarking on an evening field expedition on Zoo grounds to gather environmental data, and to search for, and collect, as many *I. nebulifer* that can be found. The latitude and longitude of every toad collected is recorded using a Garmin 60CSx hand held receiver, and behavioral observations, microhabitat, and canopy cover information is recorded by the students. Under close supervision of conservation staff and trained volunteers, students handle toads to determine gender, as well as take and record morphological measurements utilizing appropriate equipment (Fig. 1). A trained staff member inserts a passive integrated transponder or PIT tag (Single Use Disposable Syringe, AVID Identification Systems, Inc. Norco, California) into each newly collected toad (Fig. 2).

The students name their toad and then release it at the point of capture. Subsequent toad round-ups during the same or following year provide valuable data through the ability to individually recognize toads, enabling the zoo staff as well as students to monitor individual growth rates and movement patterns of the toads on zoo grounds. Once the field portion is finished, students complete a post survey evaluation, and download Google Earth 3-D images of the locations where the toads were captured/recaptured on their field evening. Students complete the evaluation using basic arithmetic, data interpretation, and the knowledge acquired through the course to successfully complete a series of short answer, essay, and conservation discussion questions. The evaluation component of the program is an opportunity for students to see the compiled data from all of the teams and to be able to communicate valid conclusions based on their findings. Through this post survey we are also able to evaluate overall student competency, experience, understanding of the material, and receptiveness for conservation action. Survey results showed that 95% of Toad Trackers participants were able to list and discuss human activities that might have negative effects on amphibian populations, answers including, but not limited to, broad scale pesticide and fertilizer use, highway mortality, habitat loss and fragmentation. All (100%) participants were able to identify and discuss simple ways they could help amphibians, with answers including organic gardening, recycling, water conservation, helping with habitat restoration and protection, volunteering for FrogWatch USA or similar citizen science programs, as well as educating others. After the program is complete, students may stay connected to the activity of our tagged toads and ongoing Houston Zoo amphibian conservation efforts via social media outlets, enrollment in future classes, and/or workshops for state amphibian citizen science monitoring programs.

Toad Trackers has recently expanded its scope to an international conservation project in Zimbabwe. The Houston Zoo partnered with Painted Dog Conservation (PDC; http://www.painteddog.org/) just outside of Hwange National Park to pilot a new science education program as part of their youth bush camp. This bush camp has provided essential conservation education opportunities to thousands of local children with the goal to inspire a deeper connection with the local ecosystem. PDC hopes to provide additional opportunities to teens that have been through the bush camp to work closely with biologists to further engage them in explorations of the local flora and fauna. The study of amphibians and the methodology used in Toad Trackers was a good fit for a pilot program as frogs are abundant in the area and make great model organisms to explore further concepts in biology and ecology. A four-person team consisting

of a bat biologist, the PDC founder, the PDC educator director, and I conducted a three-day camp and workshop for eleven 14-year-old students and two teachers from a local village primary school, the education staff from PDC, a university student intern, and a game warden from Hwange National Park.

In preparation for the program, nightly visual and audio searches were conducted to document the presence of amphibians and to become familiar with local species. A Song Meter SM2+ "Froglogger" (Wildlife Acoustics, Inc. Concord, Massachusetts) was deployed at a pond close to the bush camp to record vocalizations for ten minutes every hour throughout the day and night. Approximately 2,000 minutes were recorded and 16 species of amphibians were documented either through vocalizations or visual encounters (Fig. 3).

In addition, the Houston Zoo representatives accompanied PDC education staff and community coordinators to local villages and schools to visit community gardens and PDC conservation clubs. Ideas were generated as to how conservation action for amphibians could be implemented by teachers and students to provide refuge for insectivores in order to help reduce crop pests. Discussions also focused on how to retrofit water features to allow frogs to escape entrapment. Compared with urban residents and affluent societies, traditional people and subsistence farmers, whose livelihoods depend directly on the benefits of ecosystem services, are threatened more severely by the effects of biodiversity loss (Millennium Ecosystem Assessment 2005). We had personal communication with several community members and PDC staff that noted frogs are generally killed by throwing salt on live individuals. Reasons cited for exterminating amphibians in this area included uncertainty as to the amphibians' motives, their strange behavior and physical features, especially when they are found in or around their residences. As such, and with many potentially dangerous animals and limited or unavailable emergency care, community members felt it was safer to eliminate these perceived threats around their homes. Therefore, education related to amphibian behavior, safety precautions, and their potential benefits to humans was provided. In particular, anecdotal evidence, and some research, suggests that amphibian larvae prey upon, or compete with, mosquito larvae (Blaustein and Chase 2007; Hagman and Shine 2007; Mokany and Shine 2003). Possible links between decreased insectivore populations and higher rates of malaria (the primary cause of human mortality in the area) were discussed with students, teachers, and community members.

The classroom portion of the workshop focused on natural history, adaptations, ecological roles, and services amphibians and bats provide to humans and specific ways students can help insectivores in their villages. Through several interactive field activities and exercises, students learned how biologists detect and monitor animal activity, and its relevance to research and conservation (Figs. 4, 5). Journal assignments (Q&A, drawings, labeled diagrams, discussion) throughout the course provided insight into "pre" and "post" understanding of material and concepts discussed throughout the duration of the program. Students spent two field evenings with biologists to assist in the capture, identification, and data collection of all amphibians encountered (Fig. 6). In addition, students listened to frog calls and noted activity utilizing the amphibian call index value (Weir and Mossman 2005).

A final project, an amphibian field guide (Fig. 7), was assembled by the students to present to their classmates and headmaster for use at their school. By the end of the course, all of the students were comfortable handling or touching an amphibian, and showed remarkable transformation in their knowledge, understanding, and appreciation of amphibians through verbal questioning, drawings, and journaling. For example, one pre-survey question requested students draw what they thought amphibians needed to survive in their habitat. All students illustrated less than one basic habitat need, usually a water body. Upon asking the same question in the post survey, students illustrated multiple needs ranging from aquatic and terrestrial vegetation and habitats, microhabitats, breeding sites for multiple reproductive modes, and a diverse diet. In pre-journaling, students did not believe amphibians were important to humans, were undecided, or left the question blank. In post-journaling, all students believed that amphibians were important to their own lives and were supportive of their conservation around their schools and villages.

Graduating students, now self-proclaimed ambassadors for amphibians and other insectivores, were tasked with coming up with specific ways their school could implement conservation efforts. Although continued evaluation for this particular program may prove challenging, PDC staff continues to follow up and engage students who went through the program, and have added some amphibian content and activities learned through the workshop into their existing curricula for new students. Education staff report there is continued interest from graduating pupils who have been raising awareness, through original poetry, to fellow students at their school and their villages about the importance of amphibians (W. Nsimango, pers. comm.).

We are continuing to develop our stateside program and in 2012–2013 hope to expand to audiences outside of the Houston city limits, specifically reaching rural youth residing in the current range of the endangered Houston Toad (*Anaxyrus houstonensis*) with the intention to help garner appreciation for amphibians with educators, as well as current and future landowners in these counties. Future goals also include the addition of habitat restoration opportunities for youth who have been through the program and would like to engage in conservation action for the Houston Toad. Needs for assessing the long term effectiveness of the Toad Trackers program include the addition of student surveys prior to the Texas program and evaluation of content retention at designated timelines and assessment of any consequent conservation action, behavior change, and/or continued interest of participants in herpetological or wildlife education after completion of the course. Although further empirical evidence is necessary to quantify the program's overall effectiveness, Toad Trackers has already shown great potential to provide deeper appreciation for amphibian and biodiversity conservation. One young Texan noted in her conservation discussion "each animal has a role in the community. Without frogs the food web would suffer, they also wouldn't be able to help with medicines for humans. If these actions from careless humans keep going the toads might be in for extinction. We, in the future, will probably suffer the same fate." An additional comment noted "my favorite thing about being a Toad Tracker was being able to learn about the toads and to be able to understand what we can do to help save the species. I also enjoyed being able to go out and catch the toads and be able to see them in real life." In the short answer evaluation survey at the end of the Texas program, 80% of respondents noted that some variation of actually touching, holding, or measuring a toad was their favorite part of the program. We hope this may provide motivation for both professional and recreational herpetologists to reach

out to partnering conservation programs, formal and informal educators, to implement similar programming to build capacity through their knowledge and field expertise to garner much needed support for herpetological conservation.

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AMPHIBIAN DISEASES

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Chytrid Fungus Screening in a Population of Common Frogs from Northern Finland

Recent studies suggest that many worldwide amphibian declines and die-offs could be attributed to an emerging infectious disease caused by the pathogenic chytrid fungus *Batrachochytrium dendrobatidis* (*Bd*; Berger et al. 1998; Bielby et al. 2008; Daszak et al. 1999; Lips 1999; Lips et al. 2006; Longcore et al. 1999; Schloegel et al. 2006; James et al. 2009; Duffus and Cunningham 2010). *Bd* is widespread on all continents except Antarctica, where amphibian hosts do not occur (Fisher et al. 2009). *Bd* infects over 350 amphibian species and has been implicated in driving the decline of over 200 of these by causing the disruption of cutaneous functions (Skerratt et al. 2007; Voyles et al. 2009). Therefore, *Bd* is classified as an emerging infectious agent in amphibians (Daszak et al. 1999) and considered to be a pandemic pathogen (Pasmans et al. 2006) belonging to a historically important group of virulent multihost pathogens that have had profound effects on entire communities and ecosystems (Fisher et al. 2009). The World Organization for Animal Health (OIE) recently listed *Bd* as a notifiable pathogen (OIE 2008), the first to be included for its threat to biodiversity (Voyles et al. 2011).

To assess the risks that *Bd* poses to European amphibians, scientists have gathered around the RACE (Risk Assessment of Chytridiomycosis to European Amphibian Biodiversity) project, which aims to develop tools and protocols to enable surveillance of *Bd* across Europe (http://www.bd-maps.eu/). *Bd* surveys are limited in northern Europe. To date, only samples from Denmark have been screened (Scalera et al. 2008), and additional information is lacking from Fennoscandia, the area encompassing Norway, Sweden, Finland, Karelia, and the Kola Peninsula. Among amphibians present in this part of Europe, the one extending its distribution furthest to the north is the Common Frog (*Rana temporaria*), a medium-sized anuran with a wide Palearctic distribution (Gasc et al. 1997). The aim of our study was to investigate the presence and the intensity of *Bd* on a population of Common Frogs in subarctic Fennoscandia where the species occurs at the margin of its distribution range.

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Our field survey was conducted during the Spring of 2011 in May, in Kilpisjärvi in Finnish Lapland (Fig. 1). The study pond (Tulli) is located in a mountain valley (ca. 69.0667°N, 20.7667°E) at an altitude of 480 m. The area is characterized hydrologically by brooks and wet meadows. The vegetation is characterized by low-growing shrubs and small Downy Birch (*Betula pubescens czerepanovii*) woodlands. The study area (ca. 680 m²) is bordered by a sand dune to the west, a parking lot to the south, a road to the east, and a customs station to the north (Alho et al. 2008). The Common Frog is an explosive breeder (sensu Wells 1977), which in our study site emerges from hibernation and migrates to the spawning sites in late May to early June, and breeding is usually finished by mid-June (Alho 2004). As revealed by skeletochronology, metamorphosed males reach sexual maturity at 3–5 years old and females at 6–8 years old (Alho 2004; Patrelle et al. 2012; ter Schure et al. 2002).

To obtain samples, adult frogs (N = 30) were caught during the breeding period using dip-nets. Because the frogs were tagged with individual PIT-tags, this ensured that each individual was sampled only once. Latex gloves were used and changed every time a new specimen was handled in order to avoid cross contamination of individuals. Infection status was determined through a standardized swabbing protocol (Hyatt et al. 2007) in which each individual was swabbed on the ventral surface and between the toes on each forelimb and hindlimb, on each thigh, on each side of the ventral abdomen, and on the pelvic region. Swabs were then stored at 4°C in dry conditions. All frogs were released at the site of capture after swabbing. No physical abnormalities were detected, and there were no indications of unusual mortality in the pond sampled. Simple hygiene protocols were implemented to prevent the spread of *Bd* among amphibian populations.

DNA extraction and real-time PCR were performed following the protocol described in Boyle et al. (2004). Swabs were cut and the final portion was mixed with 30–40 mg of 0.5-mm diameter glass beads (Scientific Industries, Inc.) and 60 ml of PrepMan

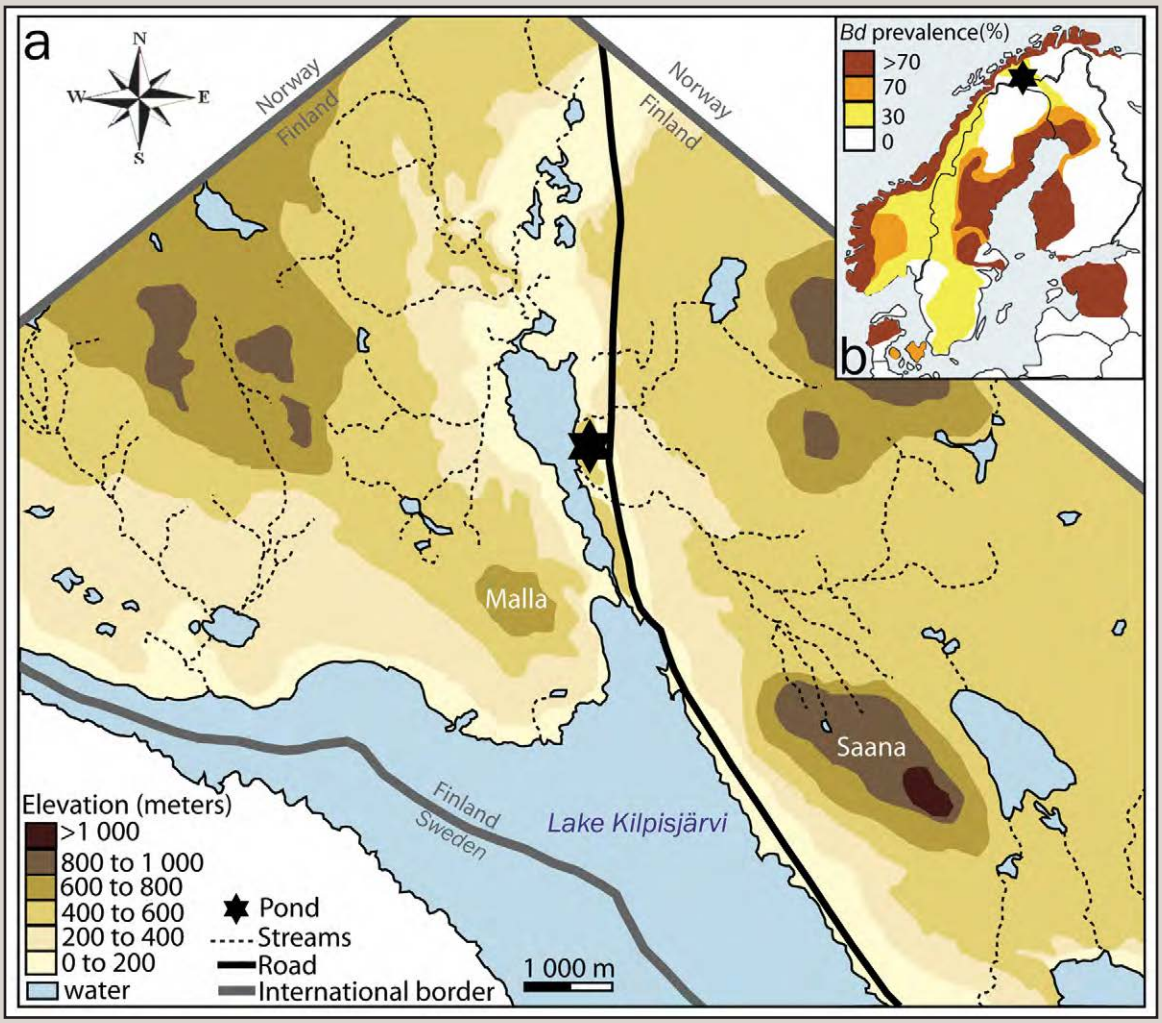


FIG. 1. a) Location of the site in Kilpisjärvi (Finnish Lapland) screened for *Batrachochytrium dendrobatidis* (*Bd*). b) Predicted distribution in Fennoscandia of the fundamental niche of *Bd* according Ron (2005) in his bioclimatic modelling. The darkest shading noted "> 70" are those where *Bd* niche presence was predicted by more models (*i.e.*, overlap index 1 means that ten out of ten models predicted presence; overlap index 0 means that none of ten models did), regions noted "70" are predicted by 70% of models, regions noted "30" are predicted by 30% of models, and white are regions without *Bd* presence.

solution (Applied Biosystems). The samples were homogenized for 45 s at 30 m/s in a QIAGEN TissueLyser II (Retsch Technology GmbH) and centrifuged for 30 s at 14000 g. The homogenization and centrifugation was repeated. Samples were then incubated at 100°C for 10 min, cooled for 2 min, then centrifuged at 14000 g for an additional 3 min. Liquids were collected and stored at -20°C. Samples were diluted 10 times and then analyzed twice independently (two replicates) through two quantitative real-time PCR (qPCR), with negative controls and standards on each plate. The PCR amplifications were performed in 25 µl reactions using IQ Supermix (BioRad) (instead of TaqMan Master Mix) and primers ITS-1 (forward): 5'-CCTTGATATAATACAGTGTGCCATATGTC-3' and 5.8S (reverse): 5'-AGCCAAGAGATCCGTTGTCAAA-3'. qPCR was performed using a Taqman assay with a Taqman MG probe 5'-CGA GTC GAA CAA AAT-3' (Applied Biosystems). Thermal cycling parameters were an initial denaturation step at 95°C for 3 min followed by 60 cycles of denaturing at 95°C for 15 s, annealing/synthesis at 60°C for 1 min (Boyle et al. 2004).

The 30 samples from Kilpisjärvi that we screened were all negative for *Bd* infection. Hence, the presence of *Bd* in this region of Lapland could not be confirmed, while the sample size was large enough to detect a 5% prevalence of infection (DiGiacomo and Koepsell 1986; Skerratt et al. 2008).

In Europe, the first report of *Bd* was from Germany in 2000 from imported animals from South America and from captive-bred individuals from both Germany and Belgium (Mutschmann et al. 2000). In the wild, the fungus was first reported in 2001 from Peñalara Natural Park in central Spain on recently metamorphosed Common Midwife Toads (*Alytes obstetricans*; Bosch et al. 2001). To date, the presence of *Bd* has been confirmed in multiple localities in Western Europe (Denmark, Italy, Spain, Portugal, France, UK, Switzerland, Belgium, Germany; Bosch et al. 2001; Cunningham et al. 2005; Garner et al. 2005; Scalera et al. 2008; Ohst et al. 2011). This is the first screening for *Bd* in Finland (The Finnish Food Safety Authority, pers. comm). This does not of course mean that *Bd* is absent from Finland or even from northern Fennoscandia: our sample size was quite small, and confined to individuals from one particular population. However, our results agree with those of Chestnut et al. (2009), who observed no occurrence of *Bd* in Wood Frogs (*Lithobates sylvaticus*) from interior Alaska, within the boreal zone. Moreover, our results are in accord with Ron (2005) who modelled the

fundamental niche of the chytrid fungus in the world, predicting a high risk of *Bd* presence in southern and western Finland, but low probability of occurrence elsewhere in the country (Fig. 1b). Nevertheless, other studies from similar latitudes have detected the presence of *Bd* in disagreement with predicted distributions based on niche models (e.g., Reeves 2008; Reeves and Green 2006; Schock et al. 2010; Slough 2009). *Bd* prevalence varies with many biotic and abiotic factors such as time of the season (Berger et al. 2004), altitude, rainfall, and temperatures (Collins et al. 2003), and climatic factors limit the extent and impact of *Bd* infections in amphibian populations (Pounds et al. 2006; Muths et al 2008). Hence, the apparent absence of *Bd* in the Common Frogs that we sampled from Kilpisjärvi could be also linked to variation in local environmental conditions and spatially as well as temporally more representative sampling is needed to verify its absence from Northern Fennoscandia.

In conclusion, our results suggest that if the pathogenic fungus *Bd* occurs in common frogs from Kilpisjärvi, the only amphibian species present in Lapland, the prevalence is less than 5% during the breeding season. To better assess the risks for amphibians of the northern Europe, it seems important to screen for the prevalence of *Bd* throughout all Fennoscandia, especially in southern Finland where more amphibian species are present (Gasc et al. 1997), and to identify the potential *Bd* lineage present at the northern range of *Bd* distribution. As in the rest of the world, the importance of simple hygiene protocols needs to be emphasized to prevent the human-mediated spread of *Bd*, especially potentially novel virulent forms, among amphibian populations.

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Ranavirus Infection in Native Amphibians at La Selva Biological Station, Costa Rica: First Report of Ranavirus in Central America

Ranaviruses are a globally widespread group of iridoviruses capable of causing mass mortality events in amphibian populations (Gray et al. 2009; Green et al. 2002), and are acknowledged to be a significant threat to amphibian populations in many parts of the world. Central America hosts a diverse, unique, and highly threatened amphibian fauna (Whitfield et al., *in press*), yet there have been only modest efforts to detect and characterize ranaviruses in the region. No information exists on impacts of ranaviruses to amphibian hosts or populations in the Neotropics—a significant gap in knowledge that may inhibit effective conservation planning.

Speare (1991) reported an iridovirus, likely a ranavirus, from *Rhinella marina* in Costa Rica. Picco and Collins (2007) tested 41 amphibians from Monteverde, Costa Rica and 43 amphibians from Las Cruces, Costa Rica but did not detect ranavirus at either site. Lips et al. (2006) assayed 38 amphibians during a mass mortality event at El Copé, Panama and detected no ranavirus. To our knowledge, there are only two reports of infection by ranaviruses anywhere in the American tropics: Galli et al.(2006) reported ranavirus infections in cultivated, non-native American Bullfrogs, *Lithobates catesbeianus*, in Brazil; and Zupanovic et al. (1998) reported infection by "Guatopo Virus"—a novel strain of ranavirus similar to frog virus 3 (FV3)—from wild frogs in Venezuela. Here, we provide the first robust evidence for the presence of ranavirus in amphibians in Central America.

We conducted this study at La Selva Biological Station, a 16 km^2 private biological reserve in the northeastern lowlands of Sarapiquí, Heredia Province, Costa Rica (10.433°N, 83.983°W) with a very well-known herpetofauna (Guyer and Donnelly 2005; Whitfield et al. 2007). We collected toe clip tissue samples from amphibians between July 2006 and May 2008 in association with a mark-recapture study using 19 study plots within primary forest. Our sampling for this study was focused on forest-floor amphibians, the majority of which are direct-developing species with no free-living tadpole stage. Toe clips were stored in 70% ethanol until we performed laboratory analyses.

We haphazardly selected 104 of these toe clip samples for molecular detection of ranavirus using quantitative real-time PCR (qPCR). We extracted nucleic acids from toe clips with Qiagen DNeasy spin columns, and used the extract to perform qPCR following the standard ranavirus protocol (Kerby and Storfer 2009). We used 13µL reactions containing 2µL of extracted DNA template, 900-nmol forward primer, 900-nmol reverse primer, 250

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TABLE 1. Results of qPCR assays for ranavirus at La Selva Biological Station in Costa Rica.

Taxon	Number positive / number tested
Bufonidae	
Rhaebo haematiticus	0 / 2
Hylidae	
Scinax eleaochroa	0 / 3
Eleutherodactylidae	
Diasporus diastema	0 / 9
Strabomantidae	
Pristimantis cerasinus	0 / 1
Prisimantis ridens	0 / 3
Craugastoridae	
Craugastor bransfordii	4 / 28
Craugastor crassidigitus	0 / 1
Craugastor fitzingeri	0 / 7
Craugastor megacephalus	0 / 8
Craugastor mimus	0 / 34
Craugastor noblei	0 / 1
Craugastor talamancae	0 / 5
Total amphibians sampled	4 / 104

nmol probe, and 2X Taqman Fast Universal Master Mix (Applied Biosystems, Foster City, California). We ran plates for one cycle of 95°C (20 sec) and 50 cycles of 95°C (3 sec) and 60°C (20 sec) on a StepOnePlus qPCR machine (Applied Biosystems, Foster City, California) in a molecular core facility at the University of South Dakota. Each plate included a negative control and a standard curve of $1 \times 10^3 - 1 \times 10^7$ copies of the complete major capsid protein sequence of FV3 (Mao et al. 1997), 3900bp in length, derived from a bacterial plasmid (pCRII) obtained from V. G. Chinchar. All samples were run in triplicate and samples with two or more positive wells were considered positive. Samples with only one positive well were rerun and designated as positive if further wells were positive and negative if further wells were negative.

We used DNA from one positive sample to sequence a 407-bp portion of the MCP gene with primers MCP4 and 5 (Mao et al. 1997) in 20µL reactions of Qiagen (Valencia, California) multiplex master mix following the manufacturer's instructions (no Q additive and annealing temperatures of 54.5° and 50.5°C). We cleaned PCR products by polyethylene glycol (Rosenthal et al. 1993), cycle sequenced with Applied Biosystems (Carlsbad, California) BigDye v3.1, and sephadex cleaned (Zoon 1987) prior to sequencing on an Applied Biosystems 3500 instrument.

Of the 104 individuals from 12 species and 5 families, four individuals tested positive for ranavirus, all from a single species: *Craugastor bransfordii*. All four individuals were determined to be adults on the basis of body size. Infected animals were detected in April 2007, May 2007, September 2007, and April 2008. Viral loads for infected animals averaged 5.16×10^6 viral copies (range 1.10×10^5 to 1.70×10^7). These are seemingly high concentrations—for comparison Brunner and Collins (2009) found ~10^5 plaque forming units (each of which almost certainly represents many copies of the viral genome) per nanogram of DNA, and Kerby and Storfer (2009) found ~10^6 viral genomes in *Ambystoma tigrinum* larvae that died of ranavirus infection—but we did not notice apparent symptoms of ranaviral disease in any of these infected individuals. The sequence produced in this study was identical to basepairs 205 to 611 of seven FV3 strains from Genbank.

This study provides strong evidence of infection by ranavirus in wild native amphibians in the lowlands of Costa Rica. Prevalence of infection among all species at La Selva was relatively low (3.8%; 95% CI 1.1–9.5%), although prevalence in the one species in which we detected infections, *Craugastor bransfordii,* was considerably higher (14.2%, 95% CI: 4.0–32.6%). We noted no obvious symptoms of ranaviral disease in these frogs, but have no data available to determine whether infections have any adverse effect on individuals or populations. Our genetic characterization of this FV3 strain is currently insufficient to assess whether this represents a strain native to Central America or a strain recently introduced from other areas.

This study represents the first report of ranavirus infection in amphibians from Central America, and one of very few reports from the hyper-diverse Neotropical region. Other studies from Central America have failed to detect ranaviruses (Lips et al. 2006; Picco and Collins 2007; but see Speare et al. 1991), but were based on small sample sizes (each <100 samples) and used traditional PCR for pathogen detection, which is less sensitive than the qPCR used in this study. We suspect that the absence of reports of ranaviruses from tropical regions is likely a result of limited sampling rather than a true absence of these pathogens. We expect that further studies of ranavirus in tropical regions are very likely to increase the known distribution of these pathogens. It will be important to determine how the ranavirus we detected is related to other ranaviruses, whether this strain is endemic or introduced, and whether it presents a risk to the neotropical amphibian assemblages already decimated by chytridiomycosis-associated declines.

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Batrachochytrium dendrobatidis and Ranavirus in Anurans Inhabiting Decorative Koi Ponds near Minneapolis, Minnesota, USA

Evidence of widespread chytrid infection in North American amphibian populations has been documented (Longcore et al. 2007; Ouelett et al. 2005; Woodhams et al. 2008) and *Batrachochytrium dendrobatidis* (*Bd*) has been reported from several locations in Minnesota (Rodriguez et al. 2009; Sadinski et al. 2010; Woodhams et al. 2008). Ranaviruses also have been linked to mass amphibian die-offs in North America (Daszak et al. 1999; Gray et al. 2009; Greer et al. 2005; Jancovich 2005), including Minnesota (Green et al. 2002; Vandenlangenberg et al. 2003). The geographic distribution of these pathogens in Minnesota is still unknown, however, and additional observations will aid assessment of the threat to local amphibian populations.

We report the presence of ranavirus and *Bd* in anurans inhabiting four decorative koi ponds in Burnsville, Minnesota, a suburb of Minneapolis (Fig. 1). The ponds were closely observed for indications of pathogenic activity following the discovery of dead Wood Frogs (*Lithobates sylvaticus*) floating on the surface during the last week of August 2011. Selected specimens were tested for *Bd* and ranavirus.

These four rubber-lined ponds were typical of those constructed by koi- and water-gardening enthusiasts. Their combined surface area was approximately 30 m^2 and their maximum depth was 1.05 m. Koi and goldfish were held in the ponds throughout the year. Total fish biomass was roughly 3.3 kg. The largest fish measured approximately 0.35 m, total length. Water was circulated through three of the four ponds by a pump connected to a simple filtering system employing fiberglass batting as filter material. A similar system was used to filter water in the fourth pond. Water lost via evaporation was replaced by precipitation and partial refilling from a tap connected to a chlorinated city water line.

The ponds were situated within a 260 m^2 area separated from a 970 ha park reserve by a short (100–150 m) strip of undeveloped land. The distance to the nearest permanent body of water was approximately 112 m.

From 25 August to 4 September 2011, three dead Wood Frogs were recovered from the ponds. All three specimens were fresh and exhibited significant reddening of the ventral surface. No signs of traumatic injury were observed and disease was determined to be a likely cause of death.

We visited the ponds daily from 7 September to 24 October 2011, following the initial frog deaths. During each visit, the ponds and immediate surroundings were visually surveyed for amphibians. Observations of dead and dying individuals were recorded and dead specimens were collected for examination, condition permitting. Anurans exhibiting unusual behavior were photographed.

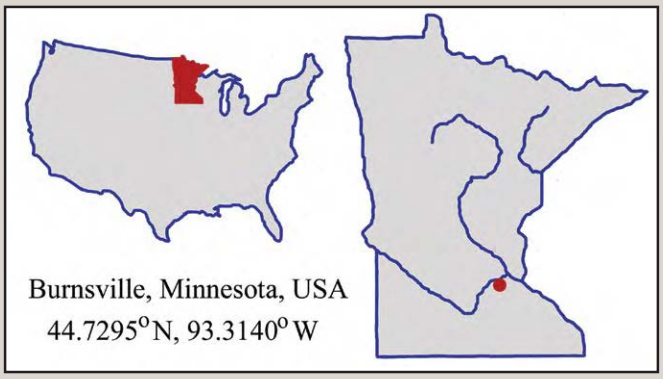


Fig. 1. Location of koi ponds in Minnesota, USA where frogs were found infected with *Batrachochytrium dendrobatidis* and ranavirus.

Our daily visits produced 202 sightings of six species (Table 1). Two dead Wood Frogs, one dead Green Frog (*Lithobates clamitans*), and two dead American Toads (*Anaxyrus americanus*, formerly *Bufo americanus*) were recovered from 7 September to 24 October 2011. Most of the dead specimens were retrieved from the ponds. The lone exception was an American Toad found within 0.25 m of a pond. Detailed examination of the Green Frog and one of the toads was precluded by advanced decomposition. The other toad was recovered in very good condition and transported

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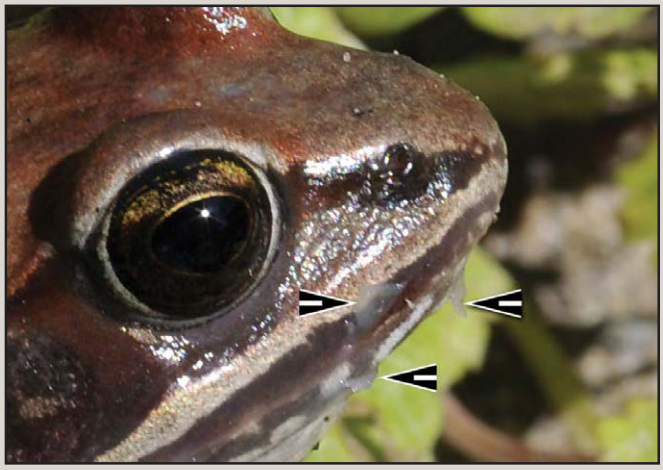


FIG. 2. Wood Frog (*Lithobates sylvaticus*) observed near koi ponds in Burnsville, Minnesota, USA, during the final 24 h of life. Arrows indicate sloughing of the epidermis bordering the mouth.



FIG. 3. Wood Frog (*Lithobates sylvaticus*) observed near koi ponds in Burnsville, Minnesota, USA, during the final 24 h of life.

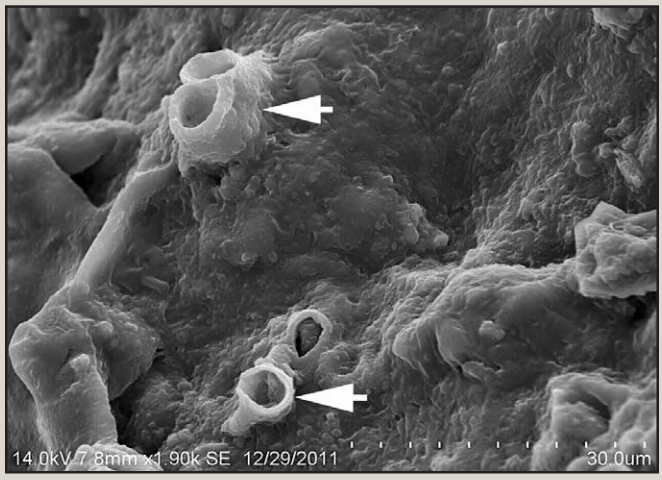


FIG. 4. Scanning Electron Microscope image of skin removed from the groin of a dead Wood Frog (*Lithobates sylvaticus*) collected from a koi pond in Burnsville, Minnesota, USA. Arrows indicate the presence of zoosporangia of *Batrachochytrium dendrobatidis*.

to the United States Geological Survey's National Wildlife Health Center (NWHC) in Madison, Wisconsin (USA). Chytrid infection was confirmed in this immature female by histological examination. The two dead Wood Frogs were observed during the final 24 h of life and photographed. Both were unusually sluggish and unresponsive to stimulation of the hindquarters. They were first observed in exposed locations, more than one meter from water. One of these frogs exhibited obvious sloughing of the epidermis bordering the mouth (Fig. 2). The other rested with the legs splayed out posteriorly (Fig. 3). The former specimen was found dead approximately 24 h after first being observed. The latter specimen was collected for observation and placed in a 300-gallon livestock-watering tank with moist soil and leaves. It died within 5 h of first being observed. Reddening of the ventral surface and legs was apparent in both specimens.

Over a four-day period, beginning on 24 October, the ponds were drained to inhibit possible pathogen dispersal to a nearby wildlife refuge. All anurans encountered in the process of draining the ponds were collected for examination. This included 27 Green Frogs and two Northern Leopard Frogs (*Lithobates pipiens*). Sixteen of the Green Frogs exhibited significant reddening of the ventral skin consistent with ranavirus and/or *Bd* infection. One adult Leopard Frog, seven adult Green Frogs, and five immature Green Frogs were submitted to the NWHC for ranavirus testing via PCR using 4/5 capsid protein primers (Mao et al. 1997). The Leopard Frog tested negative, but one immature and one adult Green Frog tested positive, as did a single pooled sample from two adult Green Frogs.

After draining, the ponds were partially refilled at various intervals by precipitation. We continued visiting the ponds on an irregular basis through the end of December. On 4 December, one dead Spring Peeper (*Pseudacris crucifer*), two dead Green Frogs, and two dead Wood Frogs were collected from several inches of water in one partially frozen pond. Their appearance followed an 11-day stretch of relatively warm weather (e.g., mean high 6.1°C) accompanied by approximately 8 mm of precipitation. None of the frogs showed signs of traumatic injury. One of the Wood Frogs was in particularly good condition and skin from the legs and groin was removed for electron microscopy. *Bd* infection was confirmed by the presence of zoosporangial discharge tubes (Fig. 4).

Bd has been reported in Minnesota anurans, but we believe this is the first confirmed report of *Bd* and ranavirus in a Minneapolis/St. Paul suburban area and the first report of *Bd* and ranavirus in decorative koi ponds.

Decorative koi ponds and water gardens, which are extremely simplified ecosystems, may be especially conducive to *Bd* propagation and viral transmission. Cladocerans and other grazers, which have been shown to significantly reduce zoospore densities (Buck et al. 2011; Hamilton et al. 2012; Woodhams et al. 2011), are likely to be absent from simple koi ponds and water gardens. The water in koi ponds and water gardens is seldom replaced during the summer and zoospores are very unlikely to be removed by the filtration systems popular with hobbyists.

It is clear from our observations that anuran densities in rubber-lined koi ponds and water gardens can be impressive and certainly adequate to facilitate disease transmission. We recorded an anuran density of approximately 1.04 frogs/m^2 of pond surface at the time of draining. In addition to creating conditions that might facilitate the transmission of important anuran pathogens, koi enthusiasts and water gardeners may be fostering the spread of *Bd* and ranavirus by importing infected

TABLE 1. Summary of koi-pond amphibian observations made 25 August to 31 December 2011 in Burnsville, Minnesota, USA. Live sightings = total observations of live animals among days, may count individuals multiple times; Minimum number of individuals was established by the number of specimens collected (*B. americanus, L. clamitans, L. pipiens, L. sylvaticus*) or the maximum number of unique individuals observed during a single observation period (*Hyla* sp., *P. crucifer*); *Bd* = *Batrachochytrium dendrobatidis*; Rv = Ranavirus. * One Ranavirus-positive animal came from a pooled sample, and one or both specimens from the pool could have been Ranavirus-positive.

Species	No. live sightings	Minimum No. individuals	No. known mortalities	No. specimens collected (No. *Bd*-symptomatic)	No. *Bd*-examined (No. *Bd*-confirmed)	No. Rv-examined (No. Rv-confirmed)
Anaxyrus (*Bufo*) *americanus*	4	2	2	2 (1)	1 (1)	0
Hyla sp.	7	4	0	0 0	0	
Lithobates clamitans	174	30	3	30 (16)	0	12 (3-4)*
L. pipiens	6	3	0	3 (0)	0	1 (0)
L. sylvaticus	10	7	7	7 (7)	1 (1)	0
Pseudacris crucifer	1	1	1	1 (0)	0	0

pond organisms. Bullfrogs (*Lithobates catesbeianus*), for example, are marketed to koi enthusiasts and water gardeners to control algae (https://www.pondmegastore.com/shop/home.php?cat=322; accessed 2 April 2012) and have been linked to *Bd* and ranavirus dispersal (Daszak et al. 2004; Garner et al. 2006; Miller et al. 2007). Water hyacinth was introduced to the ponds surveyed in this study from a company that advertises that its plants are grown organically, and that tadpoles are used to control algae (http://stores.ebay.com/HELENS-PERENNIAL-WATER-GARDENS/BIO-ECO-FRIENDLY-ORGANIC-GROWN.html; accessed 15 January 2012). Research clearly demonstrates that *Bd* can survive for several days in moist packing materials and it has been shown that the fungus can attach itself to plant material (Johnson and Speare 2005). The possibility that koi ponds and water gardens serve as loci for *Bd* dispersal would seem to warrant greater attention.

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An Artificial Nest Chamber for Captive *Crotaphytus collaris* that Increases Clutch Success and Promotes Natural Behavior

The Eastern Collared Lizard, *Crotaphytus collaris*, is a diurnal crotaphytid broadly distributed in the southwestern United States and northern Mexico that inhabits arid and semiarid environments (Ballinger and Hipp 1985). This wide-ranging species is commonly associated with rocky outcrops and boulder fields, including artificial rocky places such as dams with rocky rip-rap (Baird et al. 1996; Braun et al. 2010). Collared lizards use boulders within rocky outcrops as lookouts to scan their territories for prey, intruders, or predators, and as refugia by squeezing between and underneath the boulders to thermoregulate, spend the night, lay clutches of eggs, and hibernate (Baird et al. 1996; Braun et al. 2010; Curtis and Baird 2008; Legler and Fitch 1957; Santoyo-Brito and Fox, *in press*). Undoubtedly, the cavities formed under rocks play an important role during all the life phases of *C. collaris*. However, little has been reported about cavity characteristics and the way in which lizards use them as nesting sites, as well as the lizards' nesting behavior. This lack of knowledge is true for *C. collaris* and most other saxicolous lizards. Here, we report our experience with gravid *C. collaris* and their use of artificial chambers provided as nesting and refuge sites under laboratory conditions as part of a larger project.

Materials and methods.—Gravid adult female lizards whose reproductive status was determined by palpation were caught from the Glass Mountains of Oklahoma, USA (36.3536°N, 98.5848°W) from 15 May–28 July 2011. The lizards were transported to Oklahoma State University (OSU) where mass was determined with a Pesola spring scale and snout–vent length (SVL) and tail length measured with a ruler. At OSU, the lizards were maintained in a temperature and photoperiod-controlled laboratory and housed in large wooden cages (80 cm W x 120 cm L x 40 cm H) with wood-framed metal-mesh fronts. Each cage was divided into three sections (80 cm L x 40 cm W x 40 cm H each section), which were covered with a wood-framed metal-mesh lid (Fig. 1). Each section contained a single adult female. Clean gravel (approximately 0.5 mm in diameter) was used as the substrate. Lighting was from above using both 100-watt incandescent household bulbs and 40-watt UV-B fluorescent VitaLite tube lights. This setup allowed for behavioral thermoregulation by the lizards. Temperature gradients for the enclosures and UV-B wavelengths were not measured. The cage lights were set to a photoperiod of 12:12 h (light:dark), with the room lights turning on and off one hour earlier and later, respectively. Lizards were provided crickets and superworms (*Zophobas* sp.) *ad libitum* and the enamel-painted cage walls were sprayed with water each day. Each lizard was provided with an artificial chamber, which was designed to resemble some of the characteristics found in the natural hibernacula and refugia (Curtis and Baird 2007; Legler and Fitch 1957). Each chamber was built using five masonry bricks (20 x 10 x 5 cm), a sheet of black polyethylene plastic (30 x 30 cm), and a mixture of sand and peat moss. To form the chamber, one side of the wooden cage was used as the back wall, two of the bricks were placed as lateral walls (one brick per wall), two additional bricks were placed across these lateral walls (forming a roof), and the fifth brick was positioned at the entrance of the chamber (Fig. 2). A small opening between the roof and the fifth (front) brick allowed the lizard to crawl into the chamber. The polyethylene sheet was used to cover the inside of the chamber and to hold the nesting substrate (sand and peat moss mixture) moistened every two days with tap water using a water mister. The humidity of the substrate was not measured. The chamber was filled with the substrate mixture to a depth of 5 cm, or to the height of the bricks. Chambers were checked twice a day to ensure rapid detection and collection of eggs (eggs were collected no more than 16 h after being laid). Eggs were developed in incubators set at different temperatures as part of a larger study. Following oviposition, all adult females were returned to their site of capture.

Results.—A total of 17 gravid female lizards was used in the study. The lizards laid one clutch each for a total of 103 eggs. Clutch sizes ranged from 5 to 9 eggs (mean = 6). There was no statistical difference between any measured morphological character and the size of the clutch (Table 1). Of the 17 lizards, 12 laid a total of 74 eggs (mean clutch size = 6.1) inside of the nest chamber. All of these eggs were found turgid, considered viable, and assigned to different incubation temperatures as part of the larger research project. Hatching success was 62% (N = 46 eggs) for this group (but this result is confounded by incubating conditions). The remaining 38% (N = 28 eggs) had to be removed from the incubators at some point during their incubation due to mold or desiccation. Five females laid their clutches (mean clutch

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FIG. 1. Wooden cage divided into three sections.



FIG. 3. Nest chamber opened revealing clustered eggs.



FIG. 2. Top view of next chamber setup.



FIG. 4. Adult female *Crotaphytus collaris* in a second depression within nest chamber.

TABLE 1. Descriptive statistical analyses.

	Inside group[1]			Outside group[2]			t-test		
	mean	SD	N	mean	SD	N	t-value	df	p
SVL	82.59	6.51	12	81.60	9.76	5	0.24	15	0.80
TL	144.70	11.25	10†	140.60	10.71	5	0.00	13	1.00
Mass	26.54	5.75	12	26.50	8.34	5	0.01	15	0.99
Days in Captivity	14.67	4.20	12	19.60	2.96	5	-2.36	15	0.03
Clutch Size	6.17	1.46	12	5.80	0.83	5	0.51	15	0.61

SVL = Snout–vent length, TL = Tail length, † = two lizards were excluded due to tail break
[1]Females that laid eggs inside the nesting chamber
[2]Females that laid eggs outside the nesting chamber

size = 5.6, total of 29 eggs) on top of the roof bricks or outside the chamber. Of these, 23 were found desiccated and not considered viable. Six eggs were found turgid and were assigned to an incubator; however, mold developed on the shell during the first month of incubation for all of these eggs, and therefore they did not develop. In general, lizards were in captivity (first day in laboratory to the day they laid eggs) for an average of 16 days. Lizards that laid eggs inside the chamber were kept in captivity for 14.6 days on average and females that laid eggs outside the chamber were in captivity 19.5 days on average ($t = 2.37$, df = 15, $p = 0.031$) (Table 1). These two groups of females were not different in other respects (Table 1).

Females that laid eggs inside the chamber dug a depression where the eggs were deposited. This depression was always located at the end of the chamber opposite the small entrance, and was usually located in one of the chamber corners. Eggs were found clumped together and covered with substrate (Fig. 3); no eggs where found exposed. Curiously, we observed that females often dug and occupied a second depression inside the nest chamber after laying their clutch. When found in this second depression, the lizard's body was in a U-shape, with the tail tightly coiled (Fig. 4). After oviposition, all females had a slack and emaciated appearance (mass was not measured after oviposition), and were normally covered with wet substrate. No nest site defensive behavior was observed during egg removal.

Captivity seemed not to alter the period of activity of individuals. All lizards were active (out of refuge) and showed normal

behavior similar to that observed in the field. All individuals used the chambers as refugia to spend the overnight (dark) hours and were often found inside the chambers during the day (light) conditions. When found in the chamber during the daylight conditions, the lizard's body and tail were often in a position similar to that found after oviposition. Individuals were also observed basking on the roof of the chamber.

Discussion.—By replicating a naturalistic cavity, the chambers increased our ability to collect viable *C. collaris* eggs and allowed us to observe refuge and nesting behavior. A previous attempt to collect *C. collaris* clutches (also by bringing gravid females into captivity, but maintaining them in 5-gal glass terraria) experienced low success rates (Anderson, unpubl. data). This first attempt did not replicate natural cavities as nest sites or refugia, and the available space was considerably less than with the large wooden cages used during the second attempt.

Hatching success (62%) of the clutches deposited within the chambers starkly contrasts with the hatching success (0%) of clutches laid outside the chambers. Eggs laid outside or on top of the chambers did not develop. It is possible that the few females who laid eggs outside the nest chamber did so due to individual-specific stress associated with captivity and their significantly longer time in captivity, which resulted in abnormal nesting behavior. This same possibility has been suggested by Warner and Andrews (2002) for *Sceloporus undulatus*.

The chambers presented several advantages: their construction was inexpensive, they allowed easy access to monitor the nesting substrate and gravid individuals (the top bricks acting as a removable roof), and they replicated the natural cavities used by lizards in the field. An additional advantage was the ease to manipulate nest substrate characteristics such as temperature, moisture content, depth, or composition, all characteristics that may influence nest site selection. Nest site selection is an important aspect of lizard life history that directly affects fitness (Burger 1993; Huang and Pike 2011; Warner and Andrews 2002).

Our results show that lizards quickly accepted the chambers not just as refuges and basking sites, but as nesting sites. Thus, we recommend these chambers, or similarly constructed chambers, as a reliable technique to obtain viable clutches from *C. collaris* and as basking and refuge sites in a laboratory setting. The use of this chamber design may not be limited to use only with *C. collaris*; it is probable that species with similar nesting requirements would use the chambers as refuge and nesting sites.

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Training a Nile Crocodile to Allow for Collection of Blood at the Wildlife Conservation Society's Bronx Zoo

The Nile Crocodile (*Crocodylus niloticus*) of Africa is a wide ranging, large predator adapted to a variety of habitats. *Crocodylus niloticus* is a commonly kept crocodilian species in captivity; however their size and physiology creates many challenges to maintaining them in zoos. Like all crocodilians, the Nile Crocodile is able to spend long periods of time underwater and survive for months without food. Crocodiles can grow rapidly in artificial environments where food is readily available (Trutnau and Sommerlad 2006). In addition, these large crocodilians can be dangerous to zoo staff performing basic husbandry, particularly during periods of intense excitation such as feeding. Both of these problems can be exacerbated by small enclosures. In response to these challenges, we have utilized operant conditioning to alleviate many of the difficulties posed by keeping and breeding large crocodilians in captivity (Augustine 2009, 2010). Operant conditioning is a method of learning in which animals modify their behaviors in response to outcomes produced by their actions (Ramirez 1999). Positive reinforcement during training encourages and conditions animals to perform desired behaviors on cue.

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We began work with an eight-year-old male Nile Crocodile by conditioning the bridge (in this instance a whistle), a reinforcement tool that precisely indicates when an animal has correctly performed a requested behavior (Ramirez 1999). The bridge, or the whistle, is initially paired with a food reward, conditioning the animal to associate the whistle with food delivery. Once this association is established, crocodilian training programs at the Bronx Zoo progress by teaching targeting; a behavior by which an animal must touch the anterior portion of its snout to a pole with its mouth closed. After the crocodile targets reliably, station training is introduced whereby animals are expected to touch the station (a colored disk) with a closed mouth and remain in physical contact for a predetermined length of time. Trainers attach a disk to the end of a broomstick that can be clipped onto various hooks throughout the enclosure, allowing for mobility once the animal has mastered the initial stationing behavior. Therefore, crocodiles focus on a specific object rather than a location in their exhibit. The colors of the target sticks and stations are specific to each individual animal. Target and station training programs have been utilized with many of the crocodilians in the collection to increase safety and established a groundwork upon which more complicated behaviors are built.

A veterinary procedure such as a blood draw, where crocodiles are most commonly captured and restrained (Wise 1994), is a prime opportunity to apply positive reinforcement training. Crocodilians are good subjects for blood draw training as blood can be drawn from the caudal vein in the tail (Hernandez-Divers 2006). The benefits of utilizing positive reinforcement training to perform medical procedures without restraint are clear and include a notable reduction in stress hormones (Dettmer et al. 1996; Elvidge et al. 1976; Rheinhardt 2003) and stereotypic behavior (Priest 1991). It has been said that as a measure of safety crocodilians should only be captured when necessary (Wise 1994). In this paper, we discuss an alternative to the capture and restraint of crocodilians by utilizing operant conditioning training to obtain a blood sample on an unrestrained male *C. niloticus* at the Bronx Zoo.

Methods.—An eight-year-old Nile Crocodile arrived at the Bronx Zoo from KwaZulu-Natal, South Africa on 25 April 2008 with no previous training. A training program was initiated in May by conditioning the animal, while in the water, to a bridge. It took approximately one month for the animal to recognize the whistle as a precursor to feeding and begin looking for food at the sound of the whistle. On 3 June 2008, a black target pole was introduced to the animal for the first time; keeper staff would introduce the target pole over the enclosure wall. It took five weeks for this crocodile to consistently perform the targeting behavior anywhere in the enclosure. A station (a black plastic disk on the end of a broomstick) was introduced on 17 July. Once the crocodile had mastered these basic behaviors in the water, we began opportunistically training the animal when he was on land. Throughout the summer, we began entering the enclosure to target the crocodile and eventually began to stand next to him while he stationed on land. It was mandatory protocol that three keepers be present when entering the exhibit. The trainer would work the animal from the outside, while the other two keepers would enter the exhibit with guard sticks. On 2 September, we began touching the crocodile's tail with a bamboo pole while standing beside him on the beach. The animal accepted human presence easily and a protocol for blood draw was developed in which the animal would station on land against the wall opposite the access door of his enclosure, allowing trainers and veterinary staff to safely approach. This orientation allowed the crocodile to face his pool during the procedure for easy escape into the water. Although he never fled into the pool, this position may have made the animal more comfortable. By 13 September we began gently poking between the scutes of his tail after the verbal cue "touch" was given by the primary trainer. We also installed two 4 x 4 wooden posts grounded in 5-gallon buckets of cement that were buried in the sandy beach of the enclosure approximately 45 cm apart and one meter from the enclosure wall. The animal was trained to station between these posts and the enclosure wall, which prevents the crocodile from turning toward the keepers performing the "touch" cue. On 13 November, keepers began touching the animal with a dull probe to prepare him for the more focused touch that would precede a needle stick. At this time, trainers added the verbal cue "needle" prior to the poke. On 25 November, the probe was replaced by a shortened 14-gauge needle. In addition, the "touch" cue was now accompanied by swabbing with alcohol to prepare the animal for the smell during actual blood draws. On 4 December, approximately seven months after training was initiated, veterinarians performed the first full needle stick on this crocodile.



PHOTO BY JULIE LARSEN MAHER, WILDLIFE CONSERVATION SOCIETY

FIG. 1. Nile Crocodile demonstrating stationing behavior by maintaining contact between his snout and the disc. This animal's willingness to station for long periods of time allowed trainers to advance to voluntary blood draws.

Blood draw training was halted for exhibit maintenance on 13 December 2008. At this time the animal was moved to an adjacent exhibit where target and station training continued, though the confines of the new enclosure prevented us from working with the animal on land or entering his enclosure. Exhibit maintenance was completed in six months and the animal was moved back into his primary enclosure. On 9 July 2009, we began stationing the animal on land once again, approaching him inside his enclosure and manipulating his tail with a bamboo pole. Desensitizing the animal to this procedure took roughly the same amount of time as it had before the enclosure move. On 10 September a trainer began touching the crocodile with her hands, followed shortly by touching between his scutes with a probe on 17 September. The crocodile was prodded with a shortened 18-gauge needle on 1 October 2009. On 3 December, veterinary staff observed the training session and performed their first stick on 10 December. Veterinarians performed several unsuccessful sticks until 11 March 2010 when blood was successfully collected.

During the training, the crocodile would sometimes flick the end of his tail in response to pokes from both probes and needles, but few major movements occurred. He would occasionally back

approximately 50 cm away from the station, but would immediately return to the station when called by the primary trainer even with a needle fully stuck in his tail. And although the crocodile had the ability to escape to the pool, he did not attempt this during any blood draw sessions. Because this training was performed on a healthy animal, and sampling blood was not an imperative to his well-being, full needle sticks were performed no more than every other week. In addition, close attention was paid to the animal's mood, and the session was discontinued if we determined he was likely to become aggressive or retreat to his pool.

Training sessions were conducted two to three times a week and lasted approximately five minutes. The crocodile was given one minute to station on land, one minute to turn and station in between the wall and the posts, and the remaining minutes were for staff to enter the exhibit and the remainder of the blood draw procedure up to and including the "touch" command. Although stationing has a time limit of one minute, the crocodile rarely took the entire time to approach the disc, so typically the rest of the procedure took approximately three and half minutes.

Discussion.—Sampling blood from captive animals has many benefits. Samples can be used to gather biochemical data (Busk et al. 2000; Seymour et al. 1985), determine the health of an animal, or perform genetic studies (Dever and Densmore 2001). Training to allow for the collection of blood samples might increase staff and animal safety, and create an opportunity for mental stimulation in the animal.

In addition, training may present an opportunity to reduce the stress that is normally associated with handling an animal. Handling can cause dramatic hormonal changes in reptiles (Lance 1992), while stress may cause immunosuppression in crocodilians, predisposing them to disease (Nevarez 2006). Additionally, stress can lead to reduced growth, suppressed reproductive activity and increased mortality from disease (Lillywhite and Gatter 1995). Therefore, handling procedures performed for routine health monitoring or other purposes might be harmful and on an already compromised animal might contribute to illness. Hernandez-Divers (2006) recommends relying on serial blood sampling to determine biochemical and hematological changes, for diagnostic purposes, rather than results from a single collection. Ill crocodilians already desensitized to blood draw techniques through training might allow this procedure when needed as a diagnostic tool; also established blood levels from previous collections would improve diagnoses and treatments. This Nile Crocodile became so comfortable in close proximity to trainers that he allowed them to manipulate his feet using poles, making it possible that crocodilians habituated to blood draws might also be more likely to accept intramuscular injections (Priest 1991).

Seymour et al. (1985) discovered that exhaustive activity in laboratory crocodilians resulted in a significant decrease in blood pH and a significant increase in blood lactate levels. Lactate levels remained high for 10-20 minutes after the cessation of forced exercise, implying that blood collected during a forcible restraint is inherently altered in chemistry. In addition, compulsory restraint in laboratory primates has been shown to affect levels of cortisol, progesterone, testosterone and FSH, white blood cell count, and glucose regulation (Reinhardt 2003). Similar data for crocodilians could be generated through comparison between blood drawn from unrestrained crocodilians and that of restrained crocodilians.

It is clear that crocodilians are capable of rapid learning (Bustard 1968); this can be utilized in a zoo setting to improve husbandry and engage animals. Training techniques in many taxa have been widely documented and shared by organizations such as the Animal Behavior Management Alliance (ABMA), and The International Marine Animal Trainers Association (IMATA), demonstrating an increasing awareness of the benefits of positive reinforcement training in zoos. Similar work has been published by Weiss and Wilson (2003) in Aldabra Tortoises (*Geochelone gigantea*) and reptile keepers everywhere actively create and utilize training protocols to possibly improve the welfare of their animals. Techniques such as those discussed above are likely to improve captive animal care and promote safe interactions with potentially dangerous predators, in addition to verifying the vast potential of crocodilians to respond to advanced training programs. We hope to encourage the dissemination of protocols that will further document the learning capabilities of captive crocodilians as well as other reptiles.

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Captive Breeding and Husbandry of *Scinax perpusillus* at São Paulo Zoo: Preliminary Action for *ex situ* Conservation of *Scinax alcatraz* (Anura: Hylidae)

Scinax alcatraz (Lutz 1973) is a member of the *perpusillus* group (family Hylidae), which is characterized by species with a life cycle restricted to bromeliads (Peixoto 1987). This species is endemic to Ilha dos Alcatrazes off the coast of São Paulo, Brazil, and is listed as "Critically Endangered" by the International Union for Conservation of Nature (IUCN) Red List (Rodrigues and Cruz 2004). Due to a limited natural range (135 ha), *S. alcatraz* is susceptible to threats that can easily decimate the population, such as natural disasters or the introduction of new diseases or predators. For this reason the establishment of an *ex situ* breeding program, as well as maintaining a viable population in captivity, has been deemed necessary (IUCN 2002; Zippel and Mendelson 2008). Moreover, what intensifies the urgency of this conservation program is the historical use of Ilha dos Alcatrazes as an artillery target by Brazilian Navy (Bataus and Reis 2011).

Scinax alcatraz has never been maintained in captivity, so for that reason, we conducted a pilot study utilizing *Scinax perpusillus* as a surrogate (Fig. 1). This species is common in Brazil's mainland Atlantic forest and has a similar ecology to *S. alcatraz* (Alves-Silva and Silva 2009). Herein we present techniques utilized at São Paulo Zoo to maintain and reproduce *S. perpusillus* successfully in captivity as a precursor to establishment of an *ex situ* population of the endangered *S. alcatraz*.

Specimen Acquisition and Husbandry.—In March 2009, three adult males, one adult female, and six larvae of *Scinax perpusillus* were collected at Boraceia Biological Station (23.6333°S, 45.8667°W) (Cavarzere et al. 2010) in an area with abundant bromeliads. They were transferred to an isolation room (Pessier and Mendelson 2010) at São Paulo Zoo facilities, where they underwent a quarantine period of five months for observation and clinical exams. Following the quarantine period, this facility was used to house this group permanently.

Adult *S. perpusillus* were maintained in glass enclosures measuring 70 cm x 30 cm x 45 cm with screen covers and no substrate. One or two water dishes measuring 10 cm wide x 3 cm deep were placed in the enclosures. UVB lighting was provided with the use of a single 14 watt Exo Terra® Repti Glo 2.0 Compact Fluorescent bulb fixture in each enclosure. A 9 h on and 15 h off daily light cycle was maintained.

Initially, live potted bromeliads were used to offer a naturalistic micro-habitat. However, monitoring of eggs proved difficult when they were deposited in the phytotelmata of the bromeliads. For this reason, all bromeliads were replaced by *Dracaena* sp., which have broad leaves similar to bromeliads. These plants simulate the usual calling sites of males, but do not accumulate water. Small black plastic cups measuring 3 cm in diameter and 5 cm in depth were placed in the tanks to serve as replacements for phytotelmata (Fig. 2).

Because São Paulo Zoo facilities are located within the natural range of *S. perpusillus*, no additional heat sources were provided. Temperatures were maintained from 11.5°C–27.1°C, with a 20.1°C median temperature. The enclosures were manually misted once or twice daily. The ambient humidity ranged from 54–99%, with an 86.37% median.

Adults were offered newly hatched crickets (*Gryllus* sp.) dusted with Repashy Superfoods Calcium Plus ICB® vitamins twice weekly. The food was provided directly on the aquarium floor or, when the floor was inundated, crickets were offered in a glass dish to prevent drowning.

Breeding.—Initially, the four adults were divided into two enclosures: one housing a male/female pair and the other housing two males. On 1 December 2009, all were placed into the same enclosure. After 10 days an ultra-sonic fogger was used to increase the nighttime humidity (Fig. 3). It was turned on three times weekly, for about 10 hours each night, until the first two breeding events on 22 January 2010 (50 eggs) and 10 February 2010 (77 eggs). Following these breeding events two of the wild-collected adult males died, however it was not possible to identify the reasons on necropsy. Three adults (gender unknown) that initially were collected as tadpoles were introduced into the enclosure, bringing the population number to 1.1.3.

The fogger was utilized again from September–November 2010, with the same frequency of the first time. During this period, eggs were obtained on 29 September (N = 30), 28 October (N = 4), and 18 November (N = 46).

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PHOTO BY CYBELE LISBOA



FIG. 1. Adult *Scinax perpusillus* at Boracéia Biological Station.



FIG. 2. Small black cups utilized as an attempt to serve as replacements for phytotelmata.



FIG. 3. Fogger being utilized at the enclosure.



FIG. 4. Eggs deposited in the decanted water produced by the fogger.



FIG. 5. Tadpole maintenance.



FIG. 6. Tadpole during tail absorption period.

For the first 28 months, oviposition only occurred during periods when the fogger was operating, although calling and amplexus were still observed without it. The main oviposition site was not in the small black cups as expected, but in water collected on the bottom of the enclosure (Fig. 4). Sometimes eggs were not deposited in water, but instead on leaf surfaces, enclosure walls, and even on the screened cover. These eggs failed to develop and quickly desiccated. Eggs were typically in clusters of 3–4, but isolated single eggs and clusters of 8 eggs were also observed.

After the first five breeding events, the fogger was no longer used, with the intention to repeat the process the following summer. However, three clutches were obtained without the use of

Table 1. Representation of clutches.

	Clutch 1 22 Jan 2010	Clutch 2 10 Feb 2010	Clutch 3 29 Sep 2010	Clutch 4 28 Oct 2010	Clutch 5 18 Nov 10	Clutch 6 15 Jul 2011	Clutch 7 02 Aug 2011	Clutch 8 12 Aug 2011	Total
Eggs per clutch	50	77	30	4	46	18	32	18	275
Tadpoles hatched	16	17	0	1	34	11	26	9	114
Metamorphosed frogs	9	11	0	0	27	8	16	8	79

the fogger on 15 July 2011 (18 eggs), 01 August (32 eggs) and 11 August 2011 (18 eggs). In each of these three events eggs were deposited in the water dishes.

All eggs were maintained in the enclosure until hatching, which took from 6–8 days post-oviposition. From a total of 275 eggs, 114 tadpoles hatched (Table 1).

Nearly all eggs were laid by the original wild-collected adult female. It was not observed which animal produced the 29 September 2010, 15 July 2011 and 11 August 2011 clutches. The 28 October 2010 clutch was laid by one of the individuals that was originally collected as a tadpole in March 2009 and that completed metamorphosis in April 2009.

Care of Tadpoles, Metamorphs, and Juveniles.—Upon hatching, tadpoles of *S. perpusillus* measured approximately 20–23 mm SVL and 58–76 mm TL. They were housed individually in plastic cups measuring 4 cm in diameter and 7 cm in depth (Fig. 5) or communally in a glass enclosure with dimensions of 30 cm x 20 cm x 20 cm. Each enclosure type was filled to a depth of 2–4 cm with mineral water and no substrate. Alcon® Spirulina Flakes were mixed with water and offered daily each morning with any leftover food removed and water changed completely each afternoon.

Upon emergence of all four limbs, metamorphosing tadpoles were transferred to a water dish with a small stone (Fig. 6) housed within a 30 cm x 20 cm x 20 cm enclosure with a screened cover. No substrate was provided and no food was offered during the tail absorption period, which took 4–7 days. Time from hatching to metamorphosis ranged from 65–93 days (median of 76.05 days), however two individuals took 143 and 244 days to complete metamorphosis. We believe this slower development was due to lower temperatures experienced in the facility with the onset of winter, which the minimum temperature recorded was 11.5°C. According to Ultsch et al (1999), lower temperatures resulted in slower developmental rates and longer times to metamorphosis. Upon completion of metamorphosis, juveniles were maintained in groups of three or four individuals in similar enclosures to the one described above. Newly hatched crickets were offered daily dusted with Repashy Superfoods Calcium Plus ICB® vitamins. Post-metamorphic *S. perpusillus* measured approximately 107–123 mm SVL.

It was deemed essential to add a shelter (in this case a potted plant) to the enclosure housing post-metamorphic frogs, because it was observed that without this, the animals tried to hide in unusual places (between the cover and the wall) and eventually died because they were trapped.

Conclusions and Implications for Conservation.—The high humidity produced by the fogger initially appeared to stimulate breeding activity for our captive population, as observed by Alves-Silva and Silva (2009) in nature, but was unnecessary after a period in captivity. Despite being a bromeliad-dwelling species, that specific oviposition site was not essential in captive breeding once the animals found a viable site that replaced the bromeliads, which was the water collected on the bottom of the enclosure. This substitute site for egg deposition was important to this project because it enabled us to observe and gain control of the clutches, which is very difficult to do in natural bromeliads. Such observational capabilities and access to the eggs is important for an *ex situ* conservation program.

The husbandry and reproduction of *Scinax perpusillus* has proven successful in this pilot study. The skills acquired during this process (2 years and 6 months) can now be applied to the threatened species, *Scinax alcatraz*. When time allows, using a surrogate species to learn husbandry techniques which can later be applied to more threatened species is a beneficial course of action.

Acknowledgments.—We acknowledge Kevin Zippel and Ron Gagliardo from Amphibian Ark for encouraging *ex situ* amphibian conservation initiatives in Brazil and the IUCN Amphibian Specialist Group for funding to initiate this project. Joe Mendelson and Robert Hill provided useful editorial assistance and Cinthia Brasileiro assisted in field work. Permits were granted by the Ministério do Meio Ambiente (permit SISBIO/19200-1).

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GEOGRAPHIC DISTRIBUTION

CAUDATA – SALAMANDERS

***AMPHIUMA MEANS* (Two-toed Amphiuma)**. USA: VIRGINIA: Dinwiddie Co.: Petersburg National Battlefield (PETE), Five Forks Battlefield, 6.4 km SW Sutherland (37.153581°N, 77.614917°W, WGS 84). 26 August 2003. J. C. Mitchell, C. T. Georgel, E. J. Lathum, C. A. d'Orgeix, J. D. Jeffries, and T. Blumenshine. Verified by Kenneth L. Krysko. Florida Museum of Natural History (FLMNH 167184). New county record. Extends the range of *Amphiuma means* into the Piedmont Physiographic Province approximately 17 km W of the Fall Line (Mitchell and Reay 1999. Atlas of Amphibians and Reptiles in Virginia. Virginia Dept. of Game and Inland Fisheries, Richmond, Virginia. Spec. Publ. 1. 122 pp.). Six individuals were caught with minnow traps and released in a heavily vegetated beaver pond.

Field work was supported by a contract from the National Park Service and conducted by permits from the NPS (PETE-2002-SCI-003).

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***NOTOPHTHALMUS VIRIDESCENS* (Eastern Newt)**. USA: INDIANA: Dubois Co.: Ferdinand State Forest: (38.25047°N, 86.74758°W; NAD 83). 22 February 2012. Sarabeth Klueh and Jason Mirtl. Verified by Chris Phillips, Illinois Natural History Survey (INHS 2012f). New county record (Minton 2001. Amphibians and Reptiles of Indiana. 2nd ed., revised. Indiana Academy of Science. vii-404 pp.). Martin Co.: Martin State Forest: (38.69599°N, 86.72240°W; NAD 83). 21 February 2012. Sarabeth Klueh and Jason Mirtl. Verified by Chris Phillips, Illinois Natural History Survey (INHS 2012b). New county record. (Minton 2001, *op. cit.*).

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***PSEUDOEURYCEA MAXIMA* (Southern Giant Salamander)**. MÉXICO: GUERRERO: Municipality of Malinaltepec: Ejido Tres Marias (17.126583°N, 98.695111°W; WGS 84), 2331 m elev. 16 June 2006. Uri Omar García-Vázquez. MZFC 23207. Ejido Tres Marias (17.125722°N, 98.698028°W; WGS 84), 2255 m elev. 16 June 2006. Uri Omar García-Vázquez and Itzel Durán-Fuentes. MZFC 23173, 23206. First records for Guerrero and new elevational expansion, extending its know distribution ca. 87.02 km (airline) NW from the type locality at 6 km S of Putla de Guerrero, Oaxaca (Parra-Olea et al. 2005. Herpetologica 61:145–158). The salamanders were found under fallen tree trunks in pine-oak forest.

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***SIREN INTERMEDIA* (Lesser Siren)**. USA: LOUISIANA: Acadia Parish: Maxie area, Long Point Gully, 0.8 mi W jct. Hwy 13 and Hwy 98 (30.3275°N, 92.4140°W; no datum available). 16 March 2012. Jeremy Puissegur. Verified by Jeff Boundy. Louisiana State University Eunice Vertebrate Collection (LSUE 3546). New parish record. This record fills the gap between Allen and Cameron parishes, as mapped by Dundee and Rossman (1989. The Amphibians and Reptiles of Louisiana. Louisiana St. Univ. Press, Baton Rouge. 300 pp.). Single specimen recovered from a fish trap in Long Point Gully baited with dry dog food.

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ANURA — FROGS

***ANAXYRUS AMERICANUS* (American Toad)**. USA: TENNESSEE: Maury Co.: Chickasaw Trace about 150 m N of the bridge that enters the park (35.6351079°N, 87.0695661°W; WSG 84). 19 March 2012. Nicole Foster and Michele Dillashaw. Verified by A. Floyd Scott. Austin Peay State University (APSUMZ 19206). New county record (Scott and Redmond 2008 [latest update: 08 November 2011]. Atlas of Amphibians in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/amatlas/; accessed 19 March 2012). Found in the woods about 10 m from shallow stream.

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***CRAUGASTOR TARAHUMARAENSIS* (Tarahumara Barking Frog)**. MÉXICO: SONORA: Municipio Bacadéhuachi: Sierra de Bacadéhuachi, Rincón de Guadalupe, 16.5 km (by air) ENE of Bacadéhuachi, Arroyo Campo los Padres (Río Riito drainage). (29.844219°N, 108.977005°W; NAD27), 1680 m elev. 31 July 2011. George M. Ferguson, Dale Turner, Stephen F. Hale, and Robert Villa. Verified by Tom Van Devender. UAZ 57337-PSV. New municipality record and northernmost locality in the state, extending the range ca. 163 km (airline) N of the vicinity of Mesa del Campanero, Municipality of Yecora (Enderson et al. 2009. Check List 5:632—672), and ca. 197 km (airline) NNW of the closest known site in Chihuahua from the vicinity of Basaseachi and Ocampo (UAZ 57338-PSV, 47237). The frog was found during early evening after a thunderstorm near a pool of water in pine-oak forest.

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***ELEUTHERODACTYLUS CYSTIGNATHOIDES* (Rio Grande Chirping Frog)**. USA: LOUISIANA: Calcasieu Parish: Moss Bluff, Woodland Hills Drive area (30.3125°N, 93.1817°W; no datum available). 14 April 2012. Avery A. Williams, Avery J. Williams, and Kirk Manuel. Verified by Jeff Boundy. Louisiana State University Eunice Vertebrate Collection (LSUE 3547). New parish record (Dundee and Rossman 1989. The Amphibians and Reptiles of Louisiana. Louisiana St. Univ. Press, Baton Rouge. 300 pp.). Single male collected from a chorus calling from a wooded area of dense thicket and briar. This species was presumably introduced to the area (Beck and Dobbs 2008. Herpetol. Rev. 39:105; Hardy 2004. Southwest. Nat. 49:263–268).

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***ELEUTHERODACTYLUS CYSTIGNATHOIDES* (Rio Grande Chirping Frog)**. USA: TEXAS: Bastrop Co.: 146 Kaupo, Tahitian Village, Bastrop (30.084767°N, 97.2843167°W; WGS84; elev. 128 m). 19 June 2012. Jake Jackson, G. Lappert, M. R. J. Forstner, J. R. Dixon. Verified by Toby J. Hibbits. Texas A&M University, Texas Cooperative Wildlife Collection (TCWC 95609). New county record (Dixon 2000. Amphibians and Reptiles of Texas. 2nd ed. Texas A&M University Press, College Station, Texas. 421 pp.). An individual of this species was also detected by audio chorus survey for the first time in Bastrop County on 29 March 2012, 5 km ESE (30°03.93150N, 97°13.96386W) of the collection location above. Such chorus surveys have been conducted for Bastrop County in the area of the two locations irregularly since 1995, but annually since 2002. We consider this to be evidence of new occurrence documenting the continued expansion of this taxon outside its normal distribution in Texas. This specimen was detected during biological monitoring of recovery efforts from the Bastrop Complex Fire.

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***ELEUTHERODACTYLUS JOHNSTONEI* (Caribbean frog)**. COLOMBIA: TOLIMA: Municipality of Mariquita: 5.250623°N, 74.916608°W (WGS 84), elev. 466 m. 6 July 2011 and 3 May 2012. C. M. Montes and M. H. Bernal. Colección Zoológica de la Universidad del Tolima, Ibagué, Tolima, Colombia (CZA-UT 1259, 1260). Frogs were found in residential areas, calling from vegetation of house gardens. Verified by M. Vejarano. This species is originally from the Lesser Antilles and known from the islands of St. Martin, Saba, St. Eustatius, St. Christopher, Nevis, Guadeloupe, Montserrat, Martinique, Bequia, Anguilla, St. Lucia, St. Vincent, Barbados, Grenada, Mustique, Canouan, Carriacou, and introduced on Trinidad, Jamaica, Bermuda, Dominica, Venezuela, Panama, Colombia, Costa Rica, Curaçao, Guyana, coastal French Guiana, and likely on coastal Surinam (Frost 2011. Amphibian Species of the World: an Online Reference. Version 5.5. Electronic database accessible at http://research.amnh.org/vz/herpetology/amphibia, accessed 9 May 2012; American Museum of Natural History, New York). In Colombia, it has been reported in the cities of Barranquilla (Ruiz et al. 1997. Rev. Acad. Colomb. Cienc. 20:365-415), Cali (Kaiser et al. 2002. Herpetol. Rev 33:290–294), and Bucaramanga (Ortega et al. 2001. Herpetol. Rev 32:269), and now a fourth known locality for this species is reported, which is between Cali and Bucaramanga (575.8 km in straight line). As in the other Colombian cities, *E. johnstonei* was introduced for people who wanted to have this species in their gardens. According to Orlando Velásquez (forest guard from Mariquita), this species was brought from Barranquilla in 1980. The straight line distance from the new record, Mariquita, to Cali is 270 km (SW), Bucaramanga 291 km (NE), and Barranquilla 625 km (N).

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***ELEUTHERODACTYLUS PLANIROSTRIS* (Greenhouse Frog)**. USA: FLORIDA: Gilchrist Co.: Trenton, 250 m NNE from the intersection of SE 25th Ave. and SE 100th St. (29.594233°N, 82.763778°W; WGS84). 2 February 2010. Cody G. Godwin. Verified by Kenneth L. Krysko. Florida Museum of Natural History (UF 157499). New county record (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final report, Florida Fish and Wildlife Conservation Commission, Tallahassee. 524 pp.). Found in a hole in a Live Oak (*Quercus virginiana*) approximately 3.6 m above ground.

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***ELEUTHERODACTYLUS VERRUCIPES* (Bigear Chirping Frog)**. MÉXICO: GUANAJUATO: Municipality of San Felipe: Sierra de Lobos, 25 km NE of León de los Aldama (21.318886°N, 101.556811°W; WGS84), 2514 m elev. 20 June 2010. Rubén Alonso Carbajal Marquez, José Carlos Arenas Monroy, Christoph I. Grünwald, and Jason M. Jones. Verified by John D. Lynch. Colección de Vertebrados, Colección de Zoología, Universidad Autónoma de Aguascalientes (CVCZUAA 0342). First record for the state, extending the known distributional range for the species ca. 195 km (airline) NW from 3.5 km S of San Juan del Río, Querétaro (Lynch 1970. Univ. Kansas Publ. Mus. Natl. Hist. 20:1–45). The specimen was found under a rock on a rocky hillside covered by oak savanna.

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***FEJERVARYA ASMATI* (Bangladeshi Cricket Frog)**. BANGLADESH: DHAKA DISTRICT: University of Dhaka, Curzon Hall, Botanical Gardens (23.727711°N, 90.402622°E, WGS 84; 17.4 m elev.). 4 May 2012. Collected by Md. Abdur Razzaque Sarker. Adult male and female (MHLB-FA03 and MHLB-FA04) deposited in Museum of Herpetology Laboratory, Ichamati College,

Dinajpur, Bangladesh, also Kazi Zaker Hossain Zoological Museum, Department of Zoology, University of Dhaka, Bangladesh. Verified by Mohammad Sajid Ali Howlader. First record from Dhaka District, Bangladesh. Species described from Chittagong, Bangladesh (Howlader 2011. Zootaxa 2761:41–50), and also recorded from Nilphamari (Sarker 2011. Herpetol. Rev. 42:562). Current population < 200 km N of type locality. Adults collected on grassland. Habitat includes *Cynodon dactylon* plantations, in addition to *Cocos nucifera, Lawsonia inermis*, and *Eichhornia* sp.

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FEJERVARYA TERAIENSIS **(Terai Cricket Frog)**. BANGLADESH: DHAKA DISTRICT. Sher-e- Bangla Agriculture University Campus (23.770853°N, 90.378167°E, 13.4 m elev.; datum WGS 84). 19 June 2012. Collected by Md. Abdur Razzaque Sarker. Two adult males (MHLB-FT01, FT02), deposited in Museum of Herpetology Laboratory, Ichamati College, Dinajpur, Bangladesh, also deposited in Kazi Zaker Hossain Zoological Museum, Department Of Zoology at University of Dhaka, Bangladesh. Verified by Mohammad Sajid Ali Howlader. First record from Dhaka District, Bangladesh, and previously recorded from Chittagong (Hathazari), Cox's Bazaar (Himchari), Noakhali (Hatia Island), and Barisal (Sundargaon) southeastern Bangladesh (Rasel et al. 2007. Bannoprani- Bangladesh Wildl. Bull. 4:1–2). Current population < 7 km N of Dhaka and > 203 km NW of Chittagong (Hathazari), < 309 km NW of Cox's Bazaar (Himchari), < 137 km NW of Noakhali (Hatia Island), and < 377 km N of Barisal (Sundargaon). Adults collected beside paddy fields. Habitat includes *Cynodon dactylon* plantations.

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HYLA FEMORALIS **(Pine Woods Treefrog)**. USA: VIRGINIA: Dinwiddie Co.: Petersburg National Battlefield (PETE), Five Forks Battlefield, 8.1 km SW Sutherland (37.14065°N, 77.62038°W, WGS 84). 10 June 2003. J. C. Mitchell, C. T. Georgel, and E. J. Lathum. Verified by Kenneth Krysko. Florida Museum of Natural History (FLMNH 167183). New county record; 20.4 km SSW of the nearest locality in Chesterfield Co. Extends the range of *H. femoralis* approximately 16 km W of the Fall Line into the Piedmont Physiographic Province (Mitchell and Reay 1999. Atlas of Amphibians and Reptiles in Virginia. Virginia Dept. of Game and Inland Fisheries, Richmond, Virginia. Spec. Publ. 1. 122 pp.). Three individuals calling in a vernal pool in a mixed Loblolly Pine and hardwoods forest.

Field work was supported by a contract from the National Park Service and conducted by permits from the NPS (PETE-2002-SCI-003).

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HYPSIBOAS CURUPI. BRAZIL: RIO GRANDE DO SUL: Municipality of Sertão: Parque Natural Municipal de Sertão (28.045665°S, 52.214153°W, datum WGS84), 650 m elev. 14 December 2010. N. Zanella. Verified by Paulo C. A. Garcia. Coleção de Anfíbios da Universidade de Passo Fundo, Instituto de Ciências Biológicas, Universidade de Passo Fundo, Passo Fundo, Rio Grande do Sul, Brazil (CAUPF 2616, 2617, collected in mixed ombrophilous forest fragment in the middle plateau region). Previously known from Misiones, Argentina (Garcia et al. 2007. Copeia 2007:933–951), Paraguay (Brusqueti and Lavilla 2008. Check List 4[2]:145), Parque do Turvo, municipality of Derrubadas, Rio Grande do Sul (Iop et al. 2009. Check List 5[4]:860–862), and São Miguel do Oeste, Caxambú do Sul, Ponte Serrada and Concórdia, Santa Catarina (Lucas and Garcia 2011. Check List 7[1]:13–16). Extends range ca. 193 km E from Derrubadas, Rio Grande do Sul and ca. 85 km S from Concórdia, Santa Catarina, Brazil, the closest previous records.

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INGERANA TENASSERIMENSIS **(Tenasserim Eastern Frog)**. THAILAND: CHIANG MAI PROVINCE: Om Koi District: Mae Tuen Subdistrict, Ban Si Bare, Doi Nu La (17.572222°N, 98.352777°E; 1283 m elev.; datum WGS 84). THNHM 16981–16982. Y. Chuaynkern and S. Makchai. 15 February 2010. Verified by Michael Cota. From small stream by day, hiding under gravel. First provincial record for Chiang Mai Province, ca. 300 km N of previous nearest locality (Thong Pha Phum District, Kanchanaburi; Khonsue et al. 2006. Amphibians of Western Thong Pha Phum. Biodiversity Research and Training Program, Bangkok. 64 pp.). Previously known from southern and western parts of Thailand, from Kanchanaburi, Nakhon Sri Thammarat, Phuket, Ratchaburi and Trang provinces (Chan-ard et al. 2011. The Amphibians of the Eastern Region, with a Checklist of Thailand. National Science Museum, Pathum Thani. 160 pp.).

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LITHOBATES PALUSTRIS **(Pickerel Frog)**. USA: TENNESSEE: Davidson Co.: Tennessee Amphibian Monitoring Program (TAMP) Warner Parks, Burch Reserve East Stop 1, (36.06643°N, 86.90338°W; WGS84). 21 March 2012. Kim Bailey. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19216 Audio). New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Hard copy and Internet versions, the latter [http://www.apsu.edu/amatlas/] accessed 31 December 2011).

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LITHOBATES **(=** ***RANA*****)** ***SPHENOCEPHALUS UTRICULARIUS*** **(Southern Leopard Frog)**. USA: KANSAS: Lyon Co.: County Road 170, approximately 6.6 km E of Emporia (38.404933°N,

96.077000°W; WGS 84). 03 February 2012. Greg Sievert and Andrew W. Coleman. Verified by Curtis J. Schmidt. Sternberg Museum of Natural History, Fort Hays State University (FHSM 16382). New county record (Collins 2010. Amphibians, Reptiles, and Turtles in Kansas. Sternberg Museum of Natural History, Fort Hays State University, Hays, Kansas. 312 pp.) Extends known range approximately 35 km W of the nearest known locality in Coffey Co. Specimen was crossing the road on rainy night. The south side of Road 170 is primarily agricultural, but the northern side is interspersed with lightly wooded areas with numerous small ephemeral pools. A second specimen (FHSM 163383) was also found in Lyon Co. Both specimens were collected under a State of Kansas Wildlife Collecting Permit (SC-094-2012).

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***LITHOBATES SYLVATICUS* (Wood Frog)**. USA: WISCONSIN: Green Lake Co.: Princeton: White River Marsh State Wildlife Area: White River Road: ~2.7 miles NE of junction with County Road D (43.91216°N, 89.08668°W; WGS 84). 23 May 2012. Collected by Courtney H. Neumeyer and Stephanie C. Verjinski. UWSP 4231. Verified by Erik R. Wild. New county record (Casper 1996. Geographic Distributions of Amphibians and Reptiles of Wisconsin. Milwaukee Publ. Mus., Milwaukee, Wisconsin. 87 pp.). Other observations were made (UWSP Herp Photos 0159–0160). Fills a gap in the center of the range of the species in Wisconsin. Specimen collected under Wisconsin Department of Natural Resources Permit SCP-131-WCR-C-11.

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***PSEUDACRIS CRUCIFER* (Spring Peeper)**. USA: ARKANSAS: Mississippi Co.: Blytheville at Elmwood Cemetery, N. Division and W. Willow Street (35.933565°N, 89.920067°W, WGS 84). 22 April 2012. H. W. Robison. Verified by S. E. Trauth. Arkansas State University Museum of Zoology, Herpetological Collection (ASUMZ 32126). New county record. Partially fills gap in northeastern Mississippi Alluvial Plain (Bottomlands Subdivision) east of previous record in Craighead Co. (Trauth et al. 2004. Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.).

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***PSEUDACRIS CRUCIFER* (Spring Peeper)**. USA: ILLINOIS: Kane Co.: LeRoy Oaks Forest Preserve (41.927855°N, 88.346591°W; WGS 84) 3.5 km WSW of St Charles. 3 April 2012. T. G. Anton and M. J. Ignoffo. FMNH 281687. Verified by Alan Resetar. Single adult male of a large chorus collected at edge of small pond near access road. New county record (Phillips et al. 1999. Field Guide to Amphibians and Reptiles of Illinois. Illinois Natural History Survey, Urbana, Illinois. 282 pp.). This species had been heard calling from several localities in east-central Kane Co., but not documented with a photo or voucher specimen. Specimen collected under Illinois Department of Natural Resources Scientific Collecting Permit A12.0132, with funding provided by the Forest Preserve District of Kane County.

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***RHINELLA AZARAI* (Azara's Granulated Toad)**. BRAZIL: MATO GROSSO DO SUL: Municipality of Porto Murtinho: Serra da Bodoquena National Park (21.214500°S, 56.766000°W; datum WGS 84). 9 September 2005. Collected by F. L. Souza, M. Uetanabaro, and P. Landgref-Filho. Coleção Zoológica de Referência da Universidade Federal de Mato Grosso do Sul, Campo Grande, Mato Grosso do Sul, Brazil (ZUFMS AMP1188). Verified by P. Narvaes. *Rhinella azarai* exhibits a restricted geographical distribution in Argentina (Provincia Misiones), Paraguay, and Brazil (southwest of Mato Grosso do Sul state) (Narvaes and Rodrigues 2009. Arq. Zool., S. Paulo 40[1]:1–73) associated with Chaco lowlands, with only two records outside this region (municipalities of Bela Vista and Maracajú, Mato Grosso do Sul state, Brazil; Narvaes and Rodrigues 2009, *op. cit.*). The present record extends the species distribution ca. 100 km N from municipality of Bela Vista (22.108296°S, 56.533480°W) and 170 km W from municipality of Maracajú (21.633333°S, 55.150000°W).

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TESTUDINES – TURTLES

***APALONE MUTICA* (Midland Smooth Softshell)**. USA: MISSOURI: Livingston Co.: approx. 1.25 mi. SSW Chillicothe (U.S. Hwy 36) on Hwy 65, in Grand River (39.755047°N, 93.559124°W, WGS 84; elev. 205 m). 12 July 1977. Brian Hubbs. Los Angeles County Museum photo voucher LACM PC 1547. Verified by Neftali Camacho. New county record (Johnson 1997. The Amphibians and Reptiles of Missouri. Missouri Dept. of Conservation, Jefferson City, Missouri. 368 pp.; Missouri Herpetological Atlas Project. http://atlas.moherp.org/taxon/?Apalone_mutica; accessed 4 February 2012). The juvenile turtle was seen burying itself in sand at river's edge.

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***GRAPTEMYS GEOGRAPHICA* (Northern Map Turtle)**. USA: ILLINOIS: Kane Co.: 50 m S of junction of Bolz and Williams Rd., 2.6 km NW Carpentersville (42.139271°N, 88.277043°W; WGS 84). 4 August 2011. Road-killed female collected by Matthew J. Ignoffo. FMNH 282759. Verified by Alan Resetar. Photos of another live nesting female at Les Arends Forest Preserve on the Fox River taken 3 June 2011 are on file with the Forest Preserve District of Kane County. New county record (Phillips et al. 1999. Field Guide to Amphibians and Reptiles of Illinois. Illinois Natural History Survey, Urbana, Illinois. 282 pp.) and northernmost record for the Fox River watershed. This species is regularly observed on the Fox River, but no photos showing diagnostic characters or voucher specimens had been collected to date. Specimen salvaged under Illinois Department of Natural Resources Scientific

Collecting Permit A11.0132, with funding provided by the Forest Preserve District of Kane County.

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***GRAPTEMYS PSEUDOGEOGRAPHICA KOHNII* (Mississippi Map Turtle)**. USA: FLORIDA: Gilchrist Co.: Santa Fe River, 525 m downstream from Rum Island (29.832739°N, 82.683775°W, WGS84; elev. 7 m). 4 May 2012. Gerald R. Johnston. Verified by Kenneth L. Krysko. Florida Museum of Natural History (UF 167052). New county record (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final report, Florida Fish and Wildlife Conservation Commission, Tallahassee. 524 pp.). Female (straight midline carapace length = 176 mm, straight midline plastron length = 154 mm, mass = 687 g) captured by hand at 1300 h while snorkeling along southern shore of Santa Fe River. The abundance of algae on the carapace (90% of surface area) suggests this is not a recently released captive.

This is the second reported occurrence of *G. p. kohnii* in the Santa Fe River. Kail et al. (2011. Herpetol. Rev. 42:389) previously reported a female 3.4 km upstream in Alachua Co. This non-indigenous turtle may be in the early phase of an introduction that requires monitoring. In northern Florida, *G. p. kohnii* is commonly sold in pet stores and may replace the Red-eared Slider (*Trachemys scripta elegans*) as the frequently released non-indigenous pet turtle. Given its omnivorous diet and the similarity of the Santa Fe River to its native habitat in the lower Mississippi River drainage, *G. p. kohnii* could potentially thrive in the Santa Fe River.

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***KINOSTERNON SUBRUBRUM* (Eastern Mud Turtle)**. USA: TENNESSEE: Marshall Co.: Chapel Hill, Moss Road (35.664579°N, 86.753983°W; WGS84). 29 April 2012. Daniel Moss. Verified by A. Floyd Scott. David H. Snyder Museum of Zoology, Austin Peay State University (APSU 19222 color photographic voucher). New county record (Scott and Redmond 2008 [latest update: 16 May 2012]. Atlas of Reptiles in Tennessee. Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/; accessed 22 May 2012). Adult female observed near farm pond.

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***MESOCLEMMYS GIBBA* (Gibba Turtle)**. BRAZIL: RONDONIA: Municipality of Ji-Paraná: 10.1166°S, 61.9000°W (SAD69). Collected in Jaru Biological Reserve, in a permanent tributary of the Machado River, in a baited hoop trap. 22 January 2009. E. S. de Brito, C. Strüssmann, M. T. Pignati. Coleção Zoológica de Vertebrados do Instituto de Biociências da Universidade Federal de Mato Grosso, Cuiabá, Mato Grosso, Brazil (UFMT 9849). Verified by R. A. Kawashita Ribeiro. The species occurs in northern Brazil (states of Acre, Amazonas, Mato Grosso, Pará, and Tocantins), Colombia, Venezuela, eastern Ecuador, Peru, the Guianas, and on the island of Trinidad (Mittermeier et al. 1978. Herpetologica 34:94–100; Pavan and Dixo 2004. Humanitas 4–6:13–30; Vogt 2008. Amazon Turtles. Biblos, Lima, Peru. 104 pp.; Avila–Pires et al. 2010. Bol. Mus. Para. Emílio Goeldi Cienc. Nat. 5[1]:13–112; Bernarde et al. 2011. Biota Neotrop. 11[3]:117–144; Brito et al. 2012. Check List 8[2]:294–297). It is also found in Surinam (Medem 1973. Salamandra 9:91–98). First state record. The nearest locality record to the east is about 276 km in Aripuanã, state of Mato Grosso, Brazil (Brito et al., *op. cit.*), and the nearest locality record to the southwest is about 811 km away in Cuzco Amazonico Reserve, Peru (Duellman and Sallas 1991. Occ. Pap. Mus. Nat. Hist. Univ. Kansas 143:1–13).

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***PSEUDEMYS CONCINNA CONCINNA* (Eastern River Cooter)**. USA: GEORGIA: Jeff Davis Co.: 14.4 km NE Hazlehurst, Altamaha River at Bullard Creek Wildlife Management Area, 0.45 km S of Half Moon Landing (31.955318°N, 82.479412°W; NAD 83). 2 May 2012. Josh Parker and Dirk Stevenson. Verified by John B. Jensen and Kenneth L. Krysko. University of Florida Museum of Natural History Herpetology collection (UF 166975, photo vouchers). New county record. Adult female found in Altamaha River.

Montgomery Co.: 13.9 km NE Hazlehurst, Altamaha River at Bullard Creek Wildlife Management Area, 0.53 km W of Half Moon Landing (31.956993°N, 82.486680°W, NAD 83). 2 May 2012. J. Parker and D. Stevenson. Verified by John B. Jensen and Kenneth L. Krysko. University of Florida Museum of Natural History Herpetology collection (UF 166976, photo vouchers). New county record. Adult male found in Altamaha River.

Tattnall Co: 13.0 km SW Glennville, Big Hammock Wildlife Management Area, County Rte. 441, 0.29 km S of Watermelon Creek (31.846497°N, 82.016726°W, NAD 83). 25 March 2011. D. Stevenson. Verified by John B. Jensen and Kenneth L. Krysko. (UF 166978, photo voucher). Hatchling found alive-on-road. A second specimen (UF 166977 photo vouchers) was also found in Tattnall Co.

Telfair Co: 3.4 km SW Lumber City, Ocmulgee River at McRae Landing Road (31.903882°N, 82.699379°W, NAD 83). 3 July 2011. D. Stevenson.Verified by John B. Jensen and Lance D. McBrayer. Georgia Southern University Herpetology collection (GSU 24476, photo vouchers). New county record. Adult female found in Ocmulgee River.

The mainstem of the Altamaha River originates in the middle Coastal Plain of Georgia at the confluence of the Oconee River and the Ocmulgee River, which are Piedmont drainages. A major Atlantic Coastal Plain waterway and a slow-moving alluvial stream, the Altamaha River flows undammed 219 km from its

origin to the coast, where it empties into the Atlantic Ocean at Darien, Georgia. Despite recognition as an international bioreserve, the Altamaha River's herpetofauna has never been systematically inventoried. With respect to Georgia drainages, recent species accounts for the stream-inhabiting *Pseudemys concinna concinna* have included the Coastal Plain portion of the Savannah, Ogeechee, and Ohoopee Rivers (the latter an Altamaha River tributary) within the distribution of *P. c. concinna*, but have either not mapped the Altamaha River as within the suspected/putative range (Ward and Jackson 2008. *In* A. J. G. Rhodin et al. [eds.], Conservation Biology of Freshwater Turtles and Tortoises: A Compilation Project of the IUCN/SSC Tortoise and Freshwater Turtle Specialist Group. Chelonian Research Monographs No. 5, Chelonian Research Foundation), or have mapped but a single record for the Altamaha River proper (Williamson and Moulis 1994. Distribution of Amphibians and Reptiles in Georgia, Vol. 2, Locality Data, Savannah Science Museum, Savannah, Georgia; Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp. [specimen (Auburn University Museum 2185) from McIntosh Co., Georgia, 1.6 km upstream of Fort Barrington]).

Our *P. c. concinna* records herein supplement a recently published record for the lower Oconee River (Laurens Co., Georgia; Jensen et al. [2011. Herpetol. Rev. 42:250–255]) and include records from the lower Ocmulgee River and from the upper and middle sections of the Altamaha River mainstem. These records confirm the contemporary presence of *P. c. concinna* in the Coastal Plain section of the Altamaha River proper. Additionally, over the last eight years DJS has commonly observed moderate numbers of basking *P. c. cf. concinna* (of all size classes) scattered along the lower Ocmulgee River and the entire mainstem of the Altamaha River as far south as Fort Barrington, McIntosh Co., Georgia.

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***PSEUDEMYS NELSONI* (Florida Red-bellied Cooter).** USA: FLORIDA: Leon Co.: Lake Leon, Tom Brown Park, Tallahassee (30.4420°N, 84.2140°W, WGS84). 26 February 2011 and subsequent dates (below). Dale R. Jackson and Ghislaine C. Guyot. Verified by Kenneth L. Krysko. Florida Museum of Natural History, photographic voucher UF 167181. Lake Leon is a locally popular recreational site where wildlife, especially aquatic turtles, is readily observed within a few meters from a boardwalk that traverses the lake's shallow western end. The 1.76-ha eutrophic pond is an impoundment of a small stream that continues 1.15 km below the dam to the moderately large (767 ha) Lake Lafayette, a shallow lake-marsh-swamp basin. The natural emydid fauna of this and other area lakes consists of *Trachemys s. scripta*, *Pseudemys floridana*, and occasionally *Deirochelys reticularia*.

On 26 February 2011, we observed a small male (ca. 200 mm CL) *P. nelsoni* (UF 167181) with developed secondary sex characters (elongated foreclaws, enlarged tail) basking and subsequently feeding within a mixed group of turtles that included multiple *Apalone ferox*, *T. s. scripta*, and *T. s. elegans*. On 15–18 March and 14–16 September 2011, this foraging group also included a presumably immature female *P. nelsoni* (ca. 230 mm, vs. 280 mm for small mature females: Jackson 2006. *In* P. A. Meylan [ed.], Biology and Conservation of Florida Turtles, pp. 313–324. Chelonian Research Monographs 3) as well as one each of *P. c. concinna*, *P. f. floridana*, and *Chrysemys picta bellii*. The *P. nelsoni*, *P. concinna*, *T. s. elegans*, and *C. picta* clearly represent released animals stemming from the pet trade. Both *P. nelsoni* were still present 21 April 2012 following a winter pond restoration project that removed tons of dredged sediment. Because the pond minimally supports at least one pair of *P. nelsoni*, and turtles potentially can access Lake Lafayette and the adjacent St. Marks River system simply by traveling downstream, it is important to record this occurrence.

Long regarded with uncertainty, the validity of *P. nelsoni*'s patchy occurrence in the Florida Panhandle has been confirmed (Jackson 2006, *ibid.*). However, there remains an undocumented, ca. 200-km gap that encompasses most of the area between the Suwannee and Apalachicola rivers (eastern Panhandle). Previous reports and purported specimens from within this gap all are vague or problematic. USNM 95765 (Lake Iamonia, Leon Co.) was based on incorrect association of a shell of *P. nelsoni* with a skull of *P. floridana* (Jackson 2006, *ibid.*); Pritchard's 1980 (Chelonologica 1:113–123) statement that the species is common in Leon Co. between Tallahassee and St. Marks National Wildlife Refuge to the south (Wakulla Co.) was not specimen-based but stemmed from an anecdotal report almost certainly based on misidentification; and the single remaining specimen (CRI-1455, formerly PCHP-1140, the record sized specimen described in Pritchard 1980, *ibid.*; identity confirmed by us from photographs provided courtesy of Tim Walsh), though purportedly collected in 1979 west of Tallahassee, Leon Co., is of unauthenticated origin and hence suspect. The Lake Leon record provides solid evidence of the occurrence, based on presumably released animals, of *P. nelsoni* within this multi-county area.

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***STERNOTHERUS ODORATUS* (Eastern Musk Turtle).** USA: INDIANA: Pike Co.: Patoka Township: 38.37329°N, 87.30590°W; NAD 83). 1 June 2009. Lindsey Landowski. Verified by Chris Phillips. Illinois Natural History Survey (INHS 2012c). New county record (Minton 2001. Amphibians and Reptiles of Indiana. 2nd ed., revised. Indiana Academy of Science. vii + 404 pp.).

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***TERRAPENE CAROLINA* (Eastern Box Turtle).** USA: TENNESSEE: Maury Co.: Chickasaw Trace County Park on Santa Fe Pike at approximately trail mile 5 (35.6705604°N, 87.0894145°W; WGS 84). 15 March 2012. Nicole Foster and Colleen Conway. Verified by A. Floyd Scott. Austin Peay State University (APSUMZ19204). New county record (Scott and Redmond 2008 [latest update: 08 November 2011]. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/; accessed 15 March 2012). On a small hill between two trails.

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***TERRAPENE CAROLINA TRIUNGUIS* (Three-toed Box Turtle).** USA: ARKANSAS: Lincoln Co.: 7.8 km ESE Star City; AR State Hwy 293 (33.908656°N, 91.771477°W; WGS 84). 28 April 2012. M.B. Connior. Verified by S. E. Trauth. Arkansas State University Museum of Zoology Herpetology Collection (ASUMZ 32145). AOR. First county record filling a distributional gap between surrounding Jefferson, Arkansas, Desha, and Drew counties (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. Univeristy of Arkansas Press, Fayetteville. 421pp.).

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SQUAMATA — LIZARDS

***ANOLIS BIPORCATUS* (Neotropical Green Anole).** MÉXICO: QUINTANA ROO: Municipality of Bacalar: Instituto Nacional de Investigaciones Forestales Agrícolas y Pecuarias, Sitio Experimental San Felipe Bacalar (SESFB), Zona 4 (18.784647°N, 88.485381°W; WGS 84), 37 m elev. 3 May 1993. Josué Barbosa-Heredia. Verified by J. Rogelio Cedeño-Vázquez. Herpetological collection of the Museum of Wildlife "Juan Nava Solorio" of SESFB, Quintana Roo (SESFB-H-109). New municipality record and second for the state, extending the known range ca. 61 km SW from the only previous state record, 17 km SE of Andrés Quintana Roo (Calderón-Mandujano and Mora-Tembre 2004. Herpetol. Rev. 35:295–296). The adult male specimen was found in a seasonal forest.

We thank J. Rogelio Cedeño-Vázquez and Jorge Ramírez-Silva for assistance, and the staff of Sitio Experimental San Felipe Bacalar for logistics supporting project Mantenimiento de la Infraestructura de Investigación en la Colección de Fauna Silvestre de San Felipe Bacalar (652154A-SINCOPT).

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***ANOLIS SAGREI* (Brown Anole).** USA: TEXAS: Aransas Co.: Rockport, Harbor Oaks (28.07855°N, 97.06405°W; WGS 84) and Rockport Country Club (28.08003°N, 97.05°W; WGS 84) neighborhoods. 8 April 2012. Aaron R. Reed. Verified by Adam Cohen. Texas Natural History Collections (TNHC 85234, 85235). New county record (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. Texas A&M University Press, College Station, Texas. 421 pp.).

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***ASPIDOSCELIS SEXLINEATA* (Six-lined Racerunner).** USA: ALABAMA: Geneva Co.: Geneva State Forest Headquarters (31.11743°N, 86.16480°W; WGS 84). 29 April 2012. J. Newman, T. Robbins, and S. Graham. Verified by Craig Guyer. AUM AHAP-D 505 (digital photograph file). New county record (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn Printing Co., Auburn, Alabama. 171 pp.).

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***CNEMIDOPHORUS JALAPENSIS* (Whiptail Lizard).** BRAZIL: MATO GROSSO DO SUL: Municipality of Porto Murtinho: MS-467 road (22.147389°S, 57.547472°W; datum WGS84) and close to BR-267 road (21.723861°S, 57.447972°W; datum WGS84). 25 March 2011. F. L. Souza and M. Uetanabaro. Coleção Zoológica de Referência da Universidade Federal de Mato Grosso do Sul, Campo Grande, Mato Grosso do Sul, Brazil (ZUFMS REP 2166, 1320). Verified by G. R. Colli. *Cnemidophorus jalapensis* is a recently described species known only from the Jalapão region (northern Cerrado), Tocantins state (Colli et al. 2009. Herpetologica 65[3]:311–327; Recoder et al. 2011. Biota Neotrop. 11[1]:263–282). This is the first species record outside the Jalapão region and extends its distribution ca. 1700 km southwest (10.3°S, 46.95°W; Colli et al. 2009, *op. cit.*). Both collected specimens were associated with Chaco phytophysiognomy, with sandy and rocky soil, similar to the open cerrados of the type locality (Recoder et al. 2011, *op. cit*).

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***COLOBOSAURA MODESTA*.** BRAZIL: CEARÁ: Municipality of Barbalha: Floresta Nacional do Araripe (7.424°S, 39.296°W, WGS84; elev. 944 m). 2 August 2011. S. L. S. Muniz. Paleoherpetological and Herpetological Collection of the Laboratory of Herpetology and Paleoherpetology of the Universidade Federal Rural de Pernambuco - UFRPE, Recife, Brazil (CHPUFRPE 955, 956). Verified by E. M. X. Freire. The species was known in the states of Minas Gerais (Morro da Garça: 18.542°S, 44.595°W, WGS84; type locality), Bahia, São Paulo, Goiás, Mato Grosso do Sul, Maranhão, Pará, and Ceará. Previous records from Ceará were from the northwestern (Borges-Nojosa and Caramaschi 2003. *In* Leal et al. [eds.], Ecologia e Conservação da Caatinga, pp. 463–505. Editora Universitária, Recife, Universidade Federal de Pernambuco) and western (Borges-Nojosa and Cascon 2005. *In* Araújo et al. [eds.], Suporte as Estratégias Regionais de Conservação, pp. 245–260. Ministério do Meio Ambiente. Editora Eduardo Freire, Brasília) parts of the state. New municipality record, increasing the known geographic distribution about 310 km E of Crateús city (Borges-Nojosa and Cascon, *op. cit.*), the nearest locality known.

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***CORYTOPHANES CRISTATUS* (Smooth-headed Helmeted Basilisk)**. MÉXICO: QUINTANA ROO: Municipality of Bacalar: Instituto Nacional de Investigaciones Forestales Agrícolas y Pecuarias, Sitio Experimental San Felipe Bacalar (SESFB), Zona 4 (18.802164°N, 88.489692°W; WGS 84), 30 m elev. 24 June 1988. Juan Nava-Solorio. Verified by J. Rogelio Cedeño-Vázquez. Herpetological Collection of the Museum of Wildlife "Juan Nava Solorio" of SESFB, Quintana Roo (SESFB-H-126). This record extends the known range ca. 296 km S of Reserva El Eden and closes the depicted gap between the northern and southern populations on the Yucatán Peninsula (Lee 1996. The Amphibians and Reptiles of the Yucatán Peninsula. Cornell Univ. Press, Ithaca, New York. xii + 500 pp.). The lizard was found in a seasonal forest.

We thank J. Rogelio Cedeño-Vázquez, Jorge Ramírez-Silva for assistance, and the staff of Sitio Experimental San Felipe Bacalar for logistics supporting the project Mantenimiento de la Infraestructura de Investigación en la Colección de Fauna Silvestre de San Felipe Bacalar (652154A-SINCOPT).

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***EREMIAS INTERMEDIA* (Medial Racerunner)**. IRAN: SEMNAN PROVINCE: 73 km SE of Delbar Field Station, near Ahmad Aabad village, Touran Biosphere Reserve (35.776771°N, 56.638698°E), 966 m elev. 28 April 2012. Kamran Kamali. Aria Herpetological Studies Institute (ARIA0200, 0201: two adult males). Verified by Omid Mozaffari. Collected at 1100 h in sandy area with halophilic vegetation. Nearest reported localities along Iran-Afghan-Turkmen border, 800 km E of previously published locality (Anderson 1999. The Lizards of Iran. Society for the Study of Amphibians and Reptiles, Ithaca, New York. vii + 442 pp.). First record from Touran Biosphere Reserve as well as Semnan Province.

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***HEMIDACTYLUS FRENATUS* (Asian House Gecko)**. THAILAND: PHUKET PROVINCE: Ko Hay (Hay Island, also referred to as Coral Island; ca. 7.7333°N, 98.2667°E). 30 March 2012. O. S. G. Pauwels. Queen Saovabha Memorial Institute, Bangkok (QSMI 1308). Verified by L. Chanhome. Adult male (SVL 49 mm, tail L 49 mm, partly regenerated; 33 preanofemoral pores in a continuous series). Found active by day on boulders at edge between open secondary forest and beach, ca. 3 m elev., on northeasternmost part of island, along Banana Beach, 9 km off southeast coast of Phuket Island. First record for Ko Hay. Species previously recorded from nearby island of Phuket (Grossmann and Tillack 2001. Sauria 23:21–34). We thank Lawan Chanhome (QSMI) for working facilities.

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***HEMIDACTYLUS TURCICUS* (Mediterranean Gecko)**. USA: GEORGIA: Dougherty Co.: 31.58472°N, 84.19737°W (WGS 84), elev. 62 m. 28 March 2012. Stephen C. Mitchell. Verified by John Jensen. UTADC 7492–7493. New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. Univ. of Georgia Press, Athens. 575 pp.); previously documented in neighboring Baker Co. *Hemidactylus turcicus* is a non-native species that appears to be expanding its range in the state, although it seems to be restricted to urban areas. Multiple specimens were observed at ~2200 h on the side of a private residence, photographed, and left *in situ*.

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***HEMIDACTYLUS TURCICUS* (Mediterranean Gecko)**. USA: TEXAS: Matagorda Co.: Two specimens (male and juvenile female) captured at the Clive Runnells Family Mad Island Marsh Preserve (28.645328°N, 96.103178°W; WGS 84). 28 April 2012. James R. Dixon. Verified by Toby Hibbits. Specimens deposited in the Texas Cooperative Wildlife Collection (TCWC 95597, 95598) at Texas A&M University – College Station. New county record (Dixon 2000. Amphibians and Reptiles of Texas. 2nd ed. Texas A&M Univ. Press, College Station. 421 pp.). The species was previously recorded in all surrounding counties: Jackson, Wharton, Brazoria, and Fort Bend (Dixon 2000, *op. cit.)*.

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***PHRYNOSOMA HERNANDESI HERNANDESI* (Greater Short-horned Lizard)**. USA: OREGON: Malheur Co.: Oregon Canyon Mountains, 0.4 km S of Mud Spring, upper Whitehorse Creek drainage (42.236442°N, 118.047632°W, NAD 83; elev. 2054 m). 15 September 2011. A. St. John. Verified by Jens Vindum. California Academy of Sciences (CAS 249834). First vouchered specimen for this species in Oregon (Stebbins 2003. A Field Guide to Western Reptiles and Amphibians. Houghton Mifflin Co., Boston, Massachusetts. 533 pp.; St. John 2002. Reptiles of the Northwest. Lone Pine Publishing, Renton, Washington. 272 pp.) Specimen was found basking on a dirt spur road along a SW slope below rimrocks. Habitat of sandy-pebbly soil with a mixed association of dense sagebrush, bitterbrush, rabbitbrush, bunchgrass, and patches of mountain mahogany

Previously known in Oregon Canyon Mountains from casual observations during the late 1990s (D. Calvin); uncatalogued photographs taken during 2004 in Oregon Canyon Mountains and adjoining Trout Creek Mountains and Blue Mountain Pass (C. Tait); and genetic sampling verification in Trout Creek Mountains during 2009 (A. Ambos and T. Jezkova).

Nearest documented records are from the Santa Rosa Range, Nevada, 75 km to the SE (41.69°N, 117.51°W; NAD 83, Nevada Dept. of Wildlife).

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***PLESTIODON LATICEPS* (Broad-headed Skink)**. USA: TENNESSEE: Maury Co.: Chickasaw Trace County Park on Santa Fe Pike at approximately trail mile 4.5 (35.66944°N, 87.09111°W; WGS84). 28 March 2012. Nicole Foster and Colleen Conway. Verified by A. Floyd Scott. Austin Peay State University (APSUMZ 19214). New county record (Scott and Redmond 2008 [latest update: 07 February 2012]. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/; accessed 28 March 2012). Found under a fallen log in wooded region of the park.

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***PLESTIODON OBSOLETUS* (Great Plains Skink)**. USA: MISSOURI: Buchanan Co: Close to the junction of Commonwealth Drive and Commons Drive, near State Hwy A (39.71909°N, 94.79218°W; WGS 84). 27 August 2011. Voucher photo placed in University of Kansas Herpetology Collection (KUDA 012253). Verified by Mark S. Mills. New county record (Johnson 2000. The Amphibians and Reptiles of Missouri, 2nd ed. Missouri Department of Conservation, Jefferson City. 400 pp.). Partially fills gap in distribution in northwest Missouri. The adult male specimen was captured in a lumber yard and currently resides at MWSU.

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***SCELOPORUS LUNDELLI* (Lundell's Spiny Lizard)**. MÉXICO: QUINTANA ROO: Municipality of Bacalar: Instituto Nacional de Investigaciones Forestales Agrícolas y Pecuarias, Sitio Experimental San Felipe Bacalar (SESFB), Zona 4, cuadrante 1 (18.782442°N, 88.504444°W; WGS 84), 32 m elev. 18 June 1983. Juan Nava-Solorio. Verified by J. Rogelio Cedeño-Vázquez. Herpetological collection of the Museum of Wildlife "Juan Nava Solorio" of SESFB, Quintana Roo (SESFB-H-025). New municipality record, and third isolated locality for the state, extending its range ca. 249 km S and ca. 41 km W, respectively, from its closest known populations at Nuevo Xcan Village, Quintana Roo (Lee 1996. The Amphibians and Reptiles of the Yucatán Peninsula. Cornell Univ. Press, Ithaca, New York. xii + 500 pp.) and Bahía de Chetumal (Cedeño-Vázquez et al. 2003. Herpetol. Rev. 34:393–395). This record further closes the gap between the northern and southern populations on the Yucatán Peninsula. The lizard was found in tropical deciduous forest.

We thank J. Rogelio Cedeño-Vázquez and Jorge Ramírez-Silva for assistance, and the staff of Sitio Experimental San Felipe Bacalar for logistics support as part of project Mantenimiento de la Infraestructura de Investigación en la Colección de Fauna Silvestre de San Felipe Bacalar (652154A-SINCOPT).

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***SCINCELLA LATERALIS* (Little Brown Skink)**. USA: TENNESSEE: Maury Co.: Chickasaw Trace, 5 m N of the entrance bridge (35.6684040°N, 87.0806313°W; WGS 84). 20 March 2012. Nicole Foster and Michele Dillashaw. Verified by A. Floyd Scott. Austin Peay State University (APSUMZ 19209). New county record (Scott and Redmond 2008 [latest update: 01 November 2011]. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/; accessed 21 March 2012). Found in wooded area next to a branch of the Duck River.

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***STROBILURUS TORQUATUS* (Amazon Lava Lizard)**. BRAZIL: BAHIA: Municipality of Mata de São João: Fazenda Nossa Senhora da Paz (12.46194444°S, 38.23361111°W, WGS 84; elev. 93 m). 01 May 2011. M. S. Tinôco and others. Setor de Herpetologia, Coleção Herpetológica de Referência do Centro de Ecologia e Conservação Animal, Universidade Católica do Salvador, Salvador, Brazil (CHECOA 002609; survey license SISBIO Nº 23355-1; SVL = 69.6 mm, TL = 62.1 mm, HL = 16.7 mm). The species was previously recorded from Pernambuco to Rio de Janeiro and Minas Gerais (Jackson 1978. Arq. Zool., S. Paulo 30[1]:1–79; Rodrigues et al. 1989. Rev. Brasil. Genet. 12[4]:747–759); however, in Bahia it was only recorded from the southern portion of the state, concerning Baixo Sul extension (Rodrigues et al. 1989, *op. cit.*). Two lizards were sighted resting on a trunk in an Atlantic rainforest fragment, only one lizard was captured. Range extension, filling the distributional gap in northeastern Brazil. The known records from Bahia state are from the municipalities of Itabuna and Ilhéus in southern Bahia and the nearest northern record is in the municipality of São Miguel dos Campos in Alagoas state. Our record is located approximately 500 km NNE from Itabuna and Ilhéus and around 450 km SW from São Miguel dos Campos.

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SQUAMATA — SNAKES

***AGKISTRODON PISCIVORUS* (Cottonmouth)**. USA: FLORIDA: Bay Co.: 0.63 km E of Hwy 79 and Gumlock Cemetery Road intersection in Pine Log State Forest (30.39001°N, 85.86674°W;

WGS84). 31 December 2006. Verified by Kenneth Krysko. Florida Museum of Natural History photo voucher (UF 167074). New county record. Fills a distributional gap in the Florida panhandle (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final report, Project Agreement 08013, Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida. 524 pp.). Juvenile was captured in a funnel trap on the perimeter of an ephemeral wetland during drift fence studies by the Florida Fish and Wildlife Conservation Commission.

We thank Fred Robinette and Bethany Harvey for assistance in locating GIS data.

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***CARPHOPHIS AMOENUS* (Eastern Wormsnake)**. USA: GEORGIA: Whitfield Co.: Dalton State College Trail (34.77635°N, 85.00620°W; WGS 84). 21 April 2012. C. Manis, D. DesRochers, and J. K. Adams. Dalton State College Museum of Natural History (DSC Digital Collection-R001). Verified by John Jensen. New county record (Jensen et al. [eds.] 2008. Amphibians and Reptiles of Georgia. The University of Georgia Press, Athens. 575 pp.). One adult male captured during Dalton State College campus bioblitz survey.

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***CARPHOPHIS AMOENUS* (Eastern Wormsnake)**. USA: TENNESSEE: Marshall Co.: Henry Horton State Park along Hickory Ridge Trail, 11 m NNE of the Black Walnut information post (35.5932502°N, 86.7073202°W; WSG 84). 31 March 2012. Nicole Foster. Verified by A. Floyd Scott. Austin Peay State University (APSUMZ 19218). New county record (Scott and Redmond 2008 [latest update: 08 November 2011]. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/; accessed 31 March 2012). Snake's head had been crushed.

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***CARPHOPHIS VERMIS* (Western Worm Snake)**. USA: ARKANSAS: Howard Co.: 4.0 km NW of Athens off St. Hwy. 246 (34.334294°N, 94.015288°W; WGS 84). 9 May 2012. H. W. Robison. Verified by S. E. Trauth. Arkansas State University Herpetological Museum (ASUMZ 32155). New county record partially filling distributional gap among Hempstead and Polk counties (Trauth et al. 2004. Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.).

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***CLONOPHIS KIRTLANDII* (Kirtland's Snake)**. USA: TENNESSEE: Henry Co.: TN Hwy 69 at Terrapin Creek (Obion River drainage) just south of the TN/KY border (36.4986°N, 88.4900°W; NAD 84). 15 May 2009. Dave F. Frymire. Verified by Chris Gienger. David H. Snyder Museum of Zoology, Austin Peay State University (APSU 18970). Female (225 mm total length) found dead on a paved road after dark. Another specimen (subadult) was found in the same area on 2 June 2006 and released at the capture site. The specimen in the APSU Museum of Zoology represents the first specimen-vouchered record of the species from Tennessee (Scott and Redmond 2008. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/ [latest update 16 May 2012; accessed 29 May 2012]). Extends the range southward down the Terrapin Creek drainage into Henry Co., Tennessee. The nearest published locality for the species is in neighboring Graves Co., Kentucky, where the first specimen from the Jackson Purchase was found in 1997 (Shupe and Zimmerer 1998. Herpetol. Rev. 29:53).

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***COLUBER CONSTRICTOR* (North American Racer)**. USA: TENNESSEE: Marshall Co.: side yard of 1300 Chunn Road, Lewisburg 37091 (35.6465110°N, 86.7733246°W; WSG 84). 21 March 2012. Michael Williams and Nicole Foster. Verified by A. Floyd Scott. Austin Peay State University (APSUMZ 19212). New county record (Scott and Redmond 2008 [latest update: 07 February 2012]. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/; accessed 21 March 2012). Found among fallen logs and old leaves.

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***COLUBER FLAGELLUM FLAGELLUM* (Eastern Coachwhip)**. USA: FLORIDA: Osceola Co.: northeast of Road 11 in the Three Lakes Wildlife Management Area (27.9936°N, 81.0663°W, WGS84). 5 December 2007. Ashleigh Blackford and Christina Hannon. Florida Museum of Natural History photographic voucher (UF 155696). Verified by Kevin M. Enge. New county record (Ashton and Ashton 1988. Handbook of Reptiles and Amphibians of Florida. Part One: The Snakes. Windward Publ., Miami, Florida. 176 pp.). Juvenile captured under a cover board in scrub habitat.

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***CONIOPHANES MICHOACANENSIS* (Michoacán Black-Striped Snake)**. MÉXICO: GUERRERO: Municipality of Zihuatanejo: 7 km NE of Vallecitos (17.9432°N, 101.2802°W; WGS84), 800 m. elev. 27 July 2008. William H. Mertz and Jackson Shedd. Verified by Eric N. Smith. UTADC 6909. First record for Guerrero, and only the second known sample of the species; the other being known 160 km E at El Farito, Michoacán, the type locality (Flores-Villela and Smith 2009. Herpetologica 65:404–412). The snake was found in tropical deciduous forest.

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***CORALLUS HORTULANUS* (Amazon Tree Boa)**. BRAZIL: BAHIA: Municipality of Lauro de Freitas: 12.88449167°S, 38.329575°W, WGS 84; elev. 25 m). 15 September 2011. P. Amorin. Setor de Herpetologia, Coleção Herpetológica de Referência do Centro de Ecologia e Conservação Animal, Universidade Católica do Salvador, Salvador, Brazil (CHECOA 002801; survey license SISBIO Nº 23355-1; female, SVL = 1140 mm, TL = 310 mm, HL = 35.6 mm, 280 g). The species occurs in Costa Rica, Panama, Trinidad and Tobago, Guianas, Venezuela, Colombia, Ecuador, Peru, and Bolivia. In Brazil it is distributed in Acre, Amazonia, Minas Gerais, São Paulo, Rio de Janeiro, Bahia, Alagoas, and Ceará (Argôlo 2004. As Serpentes dos Cacauais do Sudeste da Bahia. Editus, Ilhéus, Bahia. 260 pp.; Bernarde and Machado 2010. Herpetol. Rev. 41[1]:89; Bernarde et al. 2011. Biota Neotrop. 11[3]; Henderson 1997. Carib. J. Sci. 33[3-4]:198–221; Martins and Molina 2008. *In* Machado [ed.], Livro Vermelho da Fauna Brasileira Ameaçada de Extinção, pp. 327–334. Ministério do Meio Ambiente/Fundação Biodiversitas, v.2, Brasília/Belo Horizonte; Salles and Silva-Soares 2010. Biotemas 23[2]:135–144; Silva et al. 2006. *In* Moura [ed.], A Mata Atlântica em Alagoas, pp. 65–76. Ed. Universidade Federal de Alagoas, Maceió). First record for Lauro de Freitas, filling the gap between Ituberá, southern Bahia (152 km SW) and Coruripe in Alagoas (400 km NE).

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***DRYMARCHON MELANURUS* (Central American Indigo Snake)**. MEXICO: ZACATECAS: Municipality of Mezquital del Oro: 4 km W Malacate (21.146556°N, 103.393083°W; WGS 84), 1630 m elev. 25 March 2011. Iván T. Ahumada-Carrillo. UTADC 6963, 6964. Rio Mezquital, Mezquital del Oro (21.214483°N, 103.363990°W; WGS 84), 1200 m elev. 31 July 2011. Iván T. Ahumada-Carrillo and Octavio Vázquez- Huizar. UTADC 6965. El Malacate (21.147224°N, 103.426136°W; WGS 84), 1375 m elev. 31 July 2011. Iván T. Ahumada-Carrillo and Octavio Vázquez-Huizar. UTADC 6966. All verified by Jacobo Reyes-Velasco. First records for Zacatecas that bridge a distributional gap between western populations, ca. 12 km NE from Río Grande de Santiago River, Jalisco (McCranie 1980. Cat. Am. Amphib. Rept. 267:1–4), and eastern populations, ca. 105 km from Calvillo, Aguascalientes (Vázquez Díaz and Quintero Díaz 2005. Anfibios y Reptiles de Aguascalientes. CONABIO/CIEMA. 318 pp.). All snakes were found in tropical deciduous forest.

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***FARANCIA ABACURA REINWARDTII* (Western Mudsnake)**. USA: TENNESSEE: Henry Co.: Hwy 69 where it traverses the wetland along Terrapin Creek (Obion River drainage) just south of the TN/KY border (36.5008°N, 88.4892°W; NAD 84). 12 May 2011. Dave F. Frymire. Verified by Chris Gienger. David H. Snyder Museum of Zoology, Austin Peay State University (APSU 19131). Found near death on a paved road at ca. 2100 h in an area adjacent to a wetland dominated by Bald Cypress (*Taxodium distichum*). Henry Co.: Red Top Hill Road at Blood River Bridge (36.4732°N, 88.1956°W). 1 June 2011. Heather Moore. APSU 19238. Other specimens have been observed dead and alive in the immediate area. These records extend the range in Tennessee ca. 64 km E from the nearest record in Obion Co. and represent the first records for Henry Co.; also, the Blood River record is the first report of the species from the Tennessee River Drainage in Tennessee (Scott and Redmond 2008 [latest update: 16 May 2012]. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/ [accessed 23 May 2012]).

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***LAMPROPELTIS GETULA* (Common Kingsnake)**. USA: ALABAMA: Crenshaw Co.: U.S. Hwy 29 (31.48897°N, 86.37473°W; WGS 84). 10 June 2012. J. Newman and S. Graham. Verified by Craig Guyer. AUM 39870. New county record (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn Printing Co., Auburn. 171 pp.). Found dead on road. Mount (*op. cit.*) illustrated a putative hybrid zone between *L. getula* and *L. g. holbrooki* (i.e., *L. nigra sensu* Pyron and Burbrink 2009. Zootaxa 2241:22–32) in Crenshaw Co., however this specimen shows no morphological evidence of hybridization.

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***LAMPROPELTIS TRIANGULUM* (Milksnake)**. USA: TENNESSEE: Marshall Co.: 1360 Mooresville Road, Culleoka (35.547448°N, 87.017658°W; WSG 84). 21 March 2012. Michael Williams and Nicole Foster. Verified by A. Floyd Scott. Austin Peay State University (APSUMZ 19211). New county record (Scott and Redmond 2008 [latest update: 25 July 2011]. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/; accessed 21 March 2012). Found in an overgrown field 300 m from Duck River.

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***LAMPROPELTIS TRIANGULUM* (Milksnake)**. USA: TENNESSEE: Maury Co.: Chickasaw Trace at about trail mile 7.1 (35.6693083°N, 87.0808592°W; WSG 84). 04 March 2012. Nicole Foster and Colleen Conway. Verified by A. Floyd Scott. Austin Peay State University (APSUMZ 19220). New county record (Scott and Redmond 2008 [latest update: 08 November 2011]. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/; accessed 04 March 2012). Found in a wooded area along Knob Creek.

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***LAMPROPELTIS TRIANGULUM SYSPILA* (Red Milksnake)**. USA: ARKANSAS: Newton Co.: 0.5 km NE of Fallsville off St. Hwy. 16 (35.789595°N, 93.459631°W, WGS 84). 28 April 2012. C. T. McAllister. Verified by S. E. Trauth. Arkansas State University Museum of Zoology, Herpetological Collection (photographic voucher ASUMZ 32125). New county record partially filling gap in northcentral Ozarks among Searcy (Connior 2010. Herpetol. Rev. 41:380) and Washington counties (Trauth et al. 2004. Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.).

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***MYRIOPHOLIS NARIROSTRIS* (Serpent-ver de Peters)**. GUINEA: forest gallery of Dakakoura (10.884°N, 13.608°W; 440 m elev.). 23 February 2011. Laurent Chirio (MNHN 2012–0215). Verified by Jean-François Trape. First record for Guinea, and westernmost record for Africa. Not included in herpetofauna of Guinea (Böhme et al. 2011. Bonn Zool. Bull. 60:67–71). *Myriopholis narirostris* was confused for a long time with *M. boueti*, which appears to be a different species (Adalsteinsson et al. 2009. Zootaxa 2244:1–50). All the other localities mentioned for *M. narirostris* in West Africa appear to refer to *M. albiventer*, *M. boueti*, and *M. rouxestevae* (Trape and Mané 2006. Guide des serpents d'Afrique occidentale - savane et désert. I.R.D. Editions, Paris. 226 pp.). Westernmost locality known for *M. narirostris* is in Aledjo, Togo (Trape, pers. com.). Extends range in Sudan Savanna, 1650 km WNW from this westernmost locality. Vegetation of coastal region of northwest Guinea is characterized by mosaic of savannas and forest galleries.

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***NERODIA FASCIATA* (Southern Watersnake)**. USA: TEXAS: Hays Co.: A. E. Wood Fish Hatchery (29.86609°N, 97.92969°W; WGS 84). 17 May 2012. Drew R. Davis. Verified by Travis J. LaDuc. Texas Natural History Collections (TNHC 85171). New county record along the western edge of this species' known range in Texas (Dixon 2000. Amphibians and Reptiles of Texas. Texas A&M University Press, College Station. 421 pp.). This specimen was collected from the edge of an earthen retention pond at night. Voucher specimen collected under a Texas Parks and Wildlife Scientific Collecting Permit (SPR-0511-126) to DRD.

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***OPHEODRYS VERNALIS* (Smooth Greensnake)**. USA: ILLINOIS: Kane Co.: Fox River Shores Forest Preserve, 9 km NW Carpentersville (42.127590°N, 88.286300°W; WGS 84). 8 May 2009. T. G. Anton and W. H. Graser. (FMNH 277114). Verified by Alan Resetar. Adult male collected under tin sheet in sedge meadow. New county record (Phillips et al. 1999. Field Guide to Amphibians and Reptiles of Illinois. Illinois Natural History Survey, Urbana, Illinois. 282 pp.). Fills gap among Cook, Du Page and De Kalb counties. This snake has been reported from several widely separated localities in Kane Co., but had not been documented with photos or specimens. Specimen collected under Illinois Department of Natural Resources Scientific Collecting Permit A09.0132, with funding provided by the Forest Preserve District of Kane County.

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***PANTHEROPHIS ALLEGHANIENSIS* (Eastern Ratsnake)**. USA: GEORGIA: Hall Co.: Elachee Nature Center (34.245842°N, 83.832004°W; WGS 84). 16 October 2011. Daniel Thompson. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50155 photo voucher). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp).

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***PANTHEROPHIS EMORYI* (Great Plains Ratsnake)**. USA: TEXAS: Fayette Co.: TX Hwy 95, 2.57 rd. km S jct. TX FM 2237 (29.80004°N, 97.20096°W; WGS 84). 18 June 2012. Drew R. Davis. Verified by Travis J. LaDuc. Texas Natural History Collections, TNHC 85172. A second specimen (TNHC 85173) was also found on the same day. These two specimens represent new county records along the eastern edge of this species' known range in Texas (Dixon 2000. Amphibians and Reptiles of Texas. Texas A&M University Press, College Station. 421 pp.)

Specimens collected under a Texas Parks and Wildlife Scientific Collecting Permit (SPR-0511-126) to DRD.

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***PITUOPHIS MELANOLEUCUS MUGITUS* (Florida Pinesnake)**. USA: FLORIDA: Osceola Co.: Captured at intersection of Road 9 and Road 10 in the Three Lakes Wildlife Management Area (27.8437°N, 81.1533°W; WGS84). 26 March 2012. Emily Rushton and Cliff Rushton. Florida Museum of Natural History photographic voucher (UF 166579). Verified by Kevin M. Enge. New county record (Krysko et al. 2011. Atlas of Amphibians and

Reptiles in Florida. Florida Fish and Wildlife Conservation Commission, Tallahassee. 524 pp.).

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***REGINA SEPTEMVITATTA* (Queensnake)**. USA: TENNESSEE: Maury Co.: boat ramp at Chickasaw Trace (35.6627842°N, 87.0934791°W; WSG 84). 04 April 2012. Nicole Foster and Colleen Conway. Verified by A. Floyd Scott. Austin Peay State University (APSUMZ 19219). New county record (Scott and Redmond 2008 [latest update: 08 November 2011]. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/; accessed 04 April 2012).

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***RAMPHOTYPHLOPS BRAMINUS* (Brahminy Blind Snake)**. THAILAND: PHUKET PROVINCE: Ko Hay (Hay Island, also referred to as Coral Island; ca. 7.7333°N, 98.2667°E). 30 March 2012. O. S. G. Pauwels. Queen Saovabha Memorial Institute, Bangkok (QSMI 1307). Verified by L. Chanhome (QSMI). Found by day under stone in leaf litter in open secondary forest, ca. 7 m elev., in northeasternmost part of island, above Banana Beach, 9 km off southeast coast of Phuket Island. First record for Ko Hay. Species previously recorded from nearby island of Phuket (Grossmann and Tillack 2001. Sauria 23:21–34). We thank Lawan Chanhome (QSMI) for working facilities.

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***SCAPHIODONTOPHIS ANNULATUS* (Guatemalan Neckband Snake)**. MÉXICO: QUINTANA ROO: Municipality of Bacalar: Instituto Nacional de Investigaciones Forestales Agrícolas y Pecuarias, Sitio Experimental San Felipe Bacalar (SESFB), Zona 2, Módulo (18.758472°N, 88.349064°W; WGS 84), 11 m elev. 10 May 1991. Juan Nava-Solorio. Verified by J. Rogelio Cedeño-Vázquez. Herpetological collection of the Museum of Wildlife "Juan Nava Solorio" of SESFB, Quintana Roo (SESFB-H-113). New municipality record, extending its known range in the state ca. 60 km NE from the closest known locality at the Kohunlich Archeological Site (Cedeño-Vázquez et al. 2003. Herpetol. Rev. 34:393–395), and closes the gap between the northern and southern populations on the Yucatán Peninsula.

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***STORERIA DEKAYI* (Dekay's Brownsnake)**. USA: INDIANA: Pike Co.: Pike State Forest (38.35704°N, 87.15107°W; NAD 83). 26 March 2009. Michael J. Lodato. Verified by Chris Phillips. Illinois Natural History Survey (INHS 2012d). New county record for Indiana (Minton 2001. Amphibians and Reptiles of Indiana, 2nd ed., revised. Indiana Academy of Science. vii + 404 pp.).

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***THAMNOPHIS RADIX* (Plains Gartersnake)**. USA: MINNESOTA: Mower Co.: private residence 2.95 km SW of Rose Creek, Minnesota (43.591131°N, 92.863899°W; WGS 84). 7 April 2012. Private landowner hit specimen while mowing lawn, photographic record was deposited in the James Ford Bell Museum (JFBM P448). Verified by Kenneth H. Kozak and Christopher E. Smith. First vouchered specimen for Mower Co., Minnesota (Oldfield and Moriarty 1994. Amphibians & Reptiles Native to Minnesota. Univ. Minnesota Press, Minneapolis. 237 pp.). Oldfield and Moriarty (*op. cit.*) list no museum record for this species in Mower Co. but do plot its occurrence with a symbol representing sighting or literature records.

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***THAMNOPHIS SIRTALIS* (Common Gartersnake)**. USA: TENNESSEE: Marshall Co.: front yard of 1151 Crigger Road in Lewisburg, Tennessee (35.4051707°N, 89.9459573°W; WSG 84). 21 March 2012. Michael Williams and Nicole Foster. Verified by A. Floyd Scott. Austin Peay State University (APSUMZ 19210). New county record (Scott and Redmond 2008 [latest update: 26 July 2011]. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/; accessed 21 March 2012).

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***THAMNOPHIS SIRTALIS* (Common Gartersnake)**. USA: TENNESSEE: Maury Co.: creek off of Chickasaw Trace at about mile 6.8 (35.6714714°N, 87.0820265°W; WSG 84). 19 March 2012. Nicole Foster and Michele Dillashaw. Verified by A. Floyd Scott. Austin Peay State University (APSU19205). New county record (Scott and Redmond 2008 [latest update: 26 July 2011]. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/; accessed 19 March 2012). Shallow creek in wooded area.

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New Distributional Records for the Herpetofauna of Mexico

Although distributional studies on the herpetofauna of Mexico have received much attention in recent years (reflected in Wilson and Johnson 2010), the actual number of amphibian and reptile species living in many geographic areas remains poorly known. Herein, we report on new records and significant range extensions of amphibians and reptiles in several states of Mexico.

During the years 2005 through 2010, we conducted herpetological surveys in the Mexican states of Colima, Guerrero, Jalisco, Michoacán, Nayarit, San Luis Potosí, and Veracruz. From those surveys, a total of 12 species are documented for the first time in several of those states, and significant range extensions are reported for five other species. We also discuss the validity of a single previous record of *Pituophis lineaticollis* in Jalisco. Voucher photographs of the specimens were placed in the Digital Collection, University of Texas at Arlington (UTADC). Coordinates and elevations of localities were taken with a GPS device using map datum WGS84. Common names are those proposed by Liner and Casas-Andreu (2008).

ANURA — FROGS

***ELEUTHERODACTYLUS NIVICOLIMAE* (Nevado de Colima Chirping Frog).** JALISCO: Municipality of Quitupan: 21 km SE of Mazamitla, on road to Manuel M. Dieguez (19.74352°N, 102.92755°W), 2180 m. elev. 13 July 2010. C. I. Grünwald, I. Ahumada-Carillo, and J. Reyes-Velasco. Verified by Eric N. Smith. UTADC 6933. Only the third known locality for the species, first for the east side of Nevado de Colima, and a range extension of 75 km W from the other side of Nevado de Colima (Dixon and Webb 1966); the other reported locality is from near Autlán, Jalisco (Lynch 1970). The frog was found in pine-oak forest.

***PLECTROHYLA BISTINCTA* (Mexican Fringe-limbed Treefrog).** JALISCO: Municipality of San Sebastian: 8.3 km S of La Estancia, Mascota – Puerto Vallarta Hwy (20.71023°N, 104.88474°W), 1580 m. elev. 5 July 2010. C. I. Grünwald and J. M. Jones. Verified by Jonathan A. Campbell. UTADC 6839, 6840. The records fill a distribution gap of 330 km between Santa Teresa, Nayarit, and 25 km SE of Autlán, Jalisco (Duellman 2001). The frogs were found at night on a road passing through pine forest.

***PTYCHOHYLA LEONHARDSHULTZEI* (Shultze's Mountain Stream Frog).** GUERRERO: Municipality of Tecpan de Galeana: 5.7 km W La Laguna, on road to San Luis (17.5106°N,100.777°W), 1700 m. elev. 8 September 2009. J. Reyes-Velasco and C. I. Grünwald. Verified by Jonathan A. Campbell. UTADC 6250. First municipality record, extending its range 53 km NW from the closest known locality, 1.6 km SW of San Andres de la Cruz, Guerrero (Duellman 2001). It is likely that this species occurs in the Sierra Coalcomán in southern Michoacán. Several of these frogs were found calling from low shrubs on humid nights in pine forest.

SQUAMATA — LIZARDS

***COLEONYX ELEGANS* (Elegant Banded Gecko).** MICHOACÁN: Municipality of Chinicuila: road from Aquila to Coalcomán, 30 km SW of Coalcomán (18.692670°N, 103.333941°W), 1360 m elev. 9 July 2005. J. M. Jones and C. I. Grünwald. UTADC 6936. Verified by Robert W. Bryson, Jr. First record for the state, extending the range 70 km NE of the closest known localities at Hacienda Paso del Río, Colima and 420 km NW of 4–5 miles (6.4–8 km) N of Acapulco, Guerrero (Klauber 1945). The lizard was found in an ecotone between oak and tropical deciduous forests.

***GERRHONOTUS LIOCEPHALUS* (Texas Alligator Lizard).** MICHOACÁN: Municipality of Aquila: 1.9 km E of Maruata (18.270758°N, 103.331923°W), 45 m elev. 10 November 2010. J. M. Jones, C. I. Grünwald, and L. Roman. Verified by Robert W. Bryson, Jr. UTADC 6935. New municipality record, second for the state, and first for the Pacific coastal region. Closest localities are from ca. 330 km NE at Zitácuaro, Michoacán (Alvarado-Díaz and Sanchez-Beltran 2008), and from 120 km NW from the vicinity of Colima, Colima (Good 1994). The locality coordinates reported by Alvarado-Diaz and Sánchez-Beltrán (2008) are probably in error, as they place the record in the state of México, not Michoacán. The lizard was found DOR in tropical deciduous forest.

***PHRYNOSOMA ORBICULARE* (Mountain Horned Lizard).** NAYARIT: Municipality of El Nayar: Sierra del Nayar, 2 km WNW Linda Vista, 13 km SW Santa Teresa (22.4001°N, 104.844°W), 2148 m elev. 30 August 2008. C. I. Grünwald. Verified by Robert W. Bryson, Jr. UTADC 6845. First record for Nayarit, and range extension from the closest known localities, 125 km SE at Bolaños, Jalisco, and 120 km NE at Rancho Las Margaritas, Durango (Montanucci 1981). The lizard was found basking during the morning on a rocky hillside in pine-oak forest.

***XANTUSIA SANCHEZI* (Sanchez's Night Lizard).** JALISCO: Municipality of Mezquitic: Sierra de Los Huicholes, 7 km W La Taberna (22.2339°N, 103.846°W), 2226 m elev. 5 October 2008. C. I. Grünwald and J. M. Jones. Verified by Oscar Flores-Villela. UTADC 3711. New municipality record, extending its range 124 km NW from the closest known record near the type locality at Moyahua, Zacatecas (Bezy et al. 1999). The lizard was found under a rock on a hillside in pine-oak forest.

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SQUAMATA — SNAKES

***CROTALUS AQUILUS* (Queretaran Dusky Rattlesnake)**. VERACRUZ: Municipality of Huayacocotla: La Selva (20.5769°N, 98.5176°W), 1950 m elev. 11 September 2010. C. I. Grünwald and J. M. Jones. Verified by Robert W. Bryson, Jr. UTADC 6910. First confirmed record for Veracruz (Campbell and Lamar 2004), with the closest known locality being from 3 km W at Carpinteros, Hidalgo, based on a specimen misidentified as *C. triseriatus* by Camarillo and Casas-Andreu (1998). Several authors have mentioned the possibility that this species occurs in Veracruz, but until now, these suggestions have not been confirmed. A specimen deposited in the collection at the University of Illinois Museum of Natural History (UIMNH 60804) was catalogued as *C. triseriatus aquilus* from Cofre de Perote, Veracruz, but that specimen is in fact a *C. triseriatus triseriatus*.

***CROTALUS PRICEI* (Twin-spotted Rattlesnake)**. JALISCO: Municipality of Mezquitic: Sierra de Los Huicholes, 4 km NE Bajio de Los Amoles (22.093°N, 103.876°W), 2823 m elev. 1 November 2008. C. I. Grünwald and J. M. Jones. Verified by Robert W. Bryson, Jr. UTADC 3703, 3704. New state record, filling about a 270 km distributional gap between Rancho Las Margaritas, Durango (140 km NW; Armstrong and Murphy 1979) and Sierra Fría, Aguascalientes (130 km E; Klauber 1972). The snakes were found basking during the morning on a rocky hillside in pine-oak forest. SAN LUIS POTOSÍ: Municipality of Real de Catorce: Sierra Real de Catorce, hills above Real de Catorce (23.69°N, 100.87°W), 2950 m elev. 16 April 2010. J. M. Jones, J. T. Fisher, and M. S. Price. UTADC 6841. New state record, filling a ca. 270 km distributional gap between the closest known localities at Sierra Fría, Aguascalientes (240 km SW; Klauber 1972) and Miquihuana, Tamaulipas (110 km E; Gloyd 1940). The snake was found basking during the morning in an open field surrounded by desert thornscrub.

***CROTALUS PUSILLUS* (Tancitaran Dusky Rattlesnake)**. COLIMA: Municipality of Comala: 3.5 km ENE of La Yerbabuena on Volcán de Colima (19.48°N, 103.65°W), 1850 m elev. 23 August 2008. C. Forbes and N. Varley. Verified by Robert W. Bryson, Jr. UTADC 6837, 6838. First record for the state (Campbell and Lamar 2004). The closest known localities are from 14.4 and 20.9 km W of Atenquique, Jalisco, on Nevado de Colima (Armstrong and Murphy 1976). The snakes were found in cloud forest.

***HYPSIGLENA JANI* (Texas Night Snake)**. JALISCO: Municipality of Ojuelos: Vaquerias (21.790982°N, 101.658222°W), 2451 m elev. 27 August 2007. C. I. Grünwald. Verified by Daniel G. Mulcahy. UTADC 6934. First record for the state, with the closest known localities being from the city of San Luis Potosí, San Luis Potosí, city of Guanajuato, Guanajuato, and Tupátaro, Michoacán (Tanner 1944). The snake was found in semidesert grassland.

***MICRURUS BROWNI* (Brown's Coral Snake)**. MICHOACÁN: Municipality of Aquila: 27 km S Maruata on Hwy 200 (18.2302°N, 103.2°W), 227 m elev. 10 September 2009. J. Reyes-Velasco and C. I. Grünwald. Verified by Eric N. Smith. UTADC 6429. First record for the state, and a range extension of 380 km NW of the closest known locality at Acapulco, Guerrero (Roze 1967). The snake was found DOR in tropical deciduous forest.

***MICRURUS PROXIMANS* (Nayarit Coral Snake)**. JALISCO: Municipality of Casimiro Castillo: 11 km WSW from Puerto Los Masos on Hwy 80 (19.6815°N, 104.423°W), 736 m elev. 29 July 2007. J. Reyes-Velasco. Verified by Eric N. Smith. UTADC 6918. First verified published record for the state, and a 130 km range extension SE of the closest known locality, an unpublished record (LACM 125380), from Boca de Tomatlán, Jalisco. The species was reported from Jalisco by Campbell and Lamar (2004) because of reference to a paper by Ponce-Campos and Smith, cited as "in press" but in fact was never published. The snake was found in an ecotone between oak and tropical deciduous forests. COLIMA: Municipality of Minatitlán: Agua Fría (19.3012°N, 104.0670°W), 783 m elev. 10 July 2008. C. I. Grünwald. UTADC 6917. 3.7 km W of Rastrojitos (19.4152°N, 104.012°W), 1108 m elev. 6 March 2010. J. Reyes-Velasco and I. Orozco-Corona. Verified by Eric N. Smith. UTADC 6836. First record for the state, extending the distribution of the species 50 km SE from closest known locality near the Casimiro Castillo, Jalisco record reported above.

***PITUOPHIS LINEATICOLLIS* (Middle American Gopher Snake)**. JALISCO. Ponce-Campos and Ustach (2004) reported on a specimen of *P. lineaticollis* supposedly caught by J. A. Campbell, W. W. Lamar, and D. M. Hillis (UTA R 25959) on 21 June 1983 near Tapalpa, Jalisco; it was the first record for the state at that time. The closest locality for *P. lineaticollis* to Tapalpa was said to be about 150 km NE at Dos Aguas, Michoacán. We recently had the opportunity to examine the information accompanying that particular snake, which mentioned only that the specimen died in captivity in 1989. There was no reference to the collector or to the locality where it was found. Because the Tapalpa record cannot be verified by any information accompanying the specimen, there is no substantiated evidence that it actually came from that region. Therefore, *P. lineaticollis* should be removed from the known herpetofauna of Jalisco until additional records become available.

TANTILLA CEBORUCA. COLIMA: Municipality of Cuahutémoc: 10 km by air NW of Queseria, on Volcán de Colima (19.4564°N, 103.6444°W), 1700 m elev. 24 November 2004. A. Hermosillo-Lopez, J. Reyes-Velasco, and C. I. Grünwald. Verified by Eric N. Smith. UTADC 6931, 6932. First record for the state, extending the known distribution of the species 200 km SE from the only known locality on Volcán Ceboruco, Nayarit (Canseco-Marquez et al. 2007). The snake was found in oak forest.

TESTUDINES — TURTLES

***KINOSTERNON OAXACAE* (Oaxaca Mud Turtle)**. GUERRERO: Municipality of Juchitán: 2.7 km NE of Juchitán on Hwy 200 (16.6395°N, 98.6011°W), 170 m elev. 28 August 2009. J. Reyes-Velasco, C.I. Grünwald, and C. Rodriguez. Verified by John B. Iverson. UTADC 6248. First record for the state, extending the range 47 km W from the closest known locality at Cacahuatepec, Oaxaca (Iverson 1986). The turtle was found during the morning crossing a road surrounded by tropical deciduous forest.

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New County Records of Amphibians and Reptiles in Georgia, USA

The publication of *Amphibians and Reptiles of Georgia* (Jensen et al. 2008) has encouraged many herpetologists and naturalists in Georgia to submit verifiable records of county-undocumented herpetofauna to the Georgia Department of Natural Resources and a variety of regional natural history museums. Herein, we report 88 new county records collected by, or provided to, us. Unless otherwise noted the GPS datum referenced is WGS 84. All records were corroborated using Jensen et. al. 2008. All records were verified by Lance D. McBrayer (GSU) or Kenneth L. Krysko (UF) except as otherwise noted.

CAUDATA — SALAMANDERS

***AMBYSTOMA MACULATUM* (Spotted Salamander).** TELFAIR CO.: State Hwy 117 at Lampkin Branch, 3.7 km SE Jacksonville (31.799975°N, 82.943231°W). 18 April 2011. D. Stevenson. GSU 18984.

***AMPHIUMA MEANS* (Two-toed Amphiuma).** JEFFERSON CO.: 1.8 km W Wadley (32.866880°N, 82.423912°W). 14 February 2012. D. Stevenson. GSU 24849. Adult under log in seepage-fed stream.

***EURYCEA CIRRIGERA* (Southern Two-lined Salamander).** MONTGOMERY CO.: 6.0 km WNW Normantown (32.317319°N, 82.431436°W) 18 November 2011. D. Stevenson. GSU 24851.

***EURYCEA GUTTOLINEATA* (Three-lined Salamander).** PUTNAM CO.: Oconee WMA at State Hwy 16 and Wallace Dam Rd. NE (33.33996°N, 83.15679°W). 31 March 2012. D. Stevenson and C. Camp. UF 166611.

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***HEMIDACTYLIUM SCUTATUM* (Four-toed Salamander).** Wilkinson Co.: Clear Creek Church, 0.15 mi NW State Hwy 18 and Cedar Creek Road (32.81441°N, 83.32525°W) 24 December 2011. C. Camp.UF 164365.

***NOTOPHTHALMUS VIRIDESCENS* (Eastern Newt).** Jeff Davis Co.: Bullard Creek Wildlife Management Area at State Hwy 221 (31.965610°N, 82.482357°W). 28 February 2011. D. Stevenson. GSU 18986.

***PLETHODON GLUTINOSUS* (Northern Slimy Salamander).** Lamar Co.: St. George's Episcopal School, 103 Birch Street, Milner (33.11747°N, 84.19838°W). 29 March 2010. T. Muise. UF 157430.

***PLETHODON GROBMANI* (Southeastern Slimy Salamander).** Echols Co.: 16.2 km SW Fargo (30.603047°N, 82.708070°W). 23 December 2011. D. Stevenson and K. Briggs. GSU 24855.

***PSEUDOTRITON RUBER* (Red Salamander).** Wheeler Co .: Little Ocmulgee State Park, 3.1 km NNE McRae (32.095575°N, 82.895263°W). 7 March 2012. D. Stevenson. GSU 24858. Adult under log in bay swamp seepage area.

***SIREN LACERTINA* (Greater Siren).** Brantley Co.: Basin Lake, 9.5 km NW Waynesville (31.279691°N, 81.871341°W). 8 July 2010. J. Bryan. GSU 18988. From oxbow lake on the east side of Satilla River.

ANURA — FROGS

***ANAXYRUS TERRESTRIS* (Southern Toad).** Pierce Co.: 9.8 km ESE Patterson (31.360627°N, 82.040587°W). 21 March 2012. D. Stevenson. GSU 24850.

***HYLA CINEREA* (Green Treefrog).** Cherokee Co.: 219 Jeffrey Drive, Woodstock (34.164634°N, 84.446162°W). 13 September 2010. V. Deloach. UF 165421. Mitchell Co.: Private residence at 5009 State Hwy 97, Camilla (31.2075°N, 84.3135°W). 30 April 2012. H. Butler. UF 166970.

***HYLA GRATIOSA* (Barking Treefrog).** Elbert Co.: 0.71 km NW of jct. Chastain Road and River Road (33.99162°N, 82.76158°W). 25 June 2011. R. McCarthy. UF 165502. Wayne Co.: Madray Springs Road just SW of jct. with Dent Road, S of Madray Springs (31.71750°N, 81.98694°W). 16 May 2009. G. Greer. UF 161250.

***LITHOBATES CLAMITANS* (Green Frog).** Muscogee Co.: 0.55 km W jct. Chattahoochee Riverwalk and S Lumpkin Road (32.4028°N, 84.9613°W). 26 April 2012. H. Butler. UF 166997.

***SCAPHIOPUS HOLBROOKII* (Eastern Spadefoot).** Jefferson Co.: 5895 U.S. Hwy 221 N (33.28777°N, 82.38232°W). 22 January 2012. H. Butler. UF 166459.

TESTUDINES — TURTLES

***APALONE SPINIFERA* (Spiny Softshell).** Coweta Co.: Line Creek at State Hwy 16 (33.25667°N, 84.49739°W). 13 July 2011. J. Jensen. UF 165535. Fayette Co.: Line Creek at State Hwy 85 (33.319204°N, 84.52237°W). 13 July 2011. J. Jensen. UF 165536. Gordon Co.: Oostanaula River at Reeves Station Road SW (34.45115°N, 85.02849°W) 9 August 2011. J. Jensen and K. Sorensen. UF 165653. Heard Co.: Chattahoochee River near Franklin (33.29083°N, 85.0986°W; NAD 83). 31 May 2012. J. Jensen and G. Greer. UF 167178.

***CHELYDRA SERPENTINA* (Common Snapping Turtle).** Lamar Co.: Community House Road 0.27 km E Leverette Road (32.993428°N, 84.105045°W). 2 May 2012. C. Muise. UF 166980. Paulding Co.: Silver Comet Trail ~100 m S of crossing with Willow Springs Road (33.933333°N, 84.909722°W). 6 June 2009. G. Greer. UF 161278. Warren Co: State Hwy 12 1.58 km W of Camak Road (33.42292°N, 82.60606°W; NAD 83). 14 March 2012. J. Jensen and C. Camp. UF 166570.

***DEIROCHELYS RETICULARIA* (Chicken Turtle).** Turner Co.: State Hwy 107, 16.4 km ENE Ashburn (31.720526°N, 83.480243°W). 24 February 2011. D. Stevenson. GSU 18991.

***KINOSTERNON BAURII* (Striped Mud Turtle).** Telfair Co.: State Hwy 117 at McRae Landing Road, 3.2 km SW Lumber City (31.908739°N, 82.702435°W). 16 April 2011. D. Stevenson. GSU 18992. Toombs Co.: State Hwy 1 at Altamaha River, 10.1 km SE Cedar Crossing (31.945504°N, 82.354663°W). 25 March 2012. D. Stevenson. GSU 24868.

***KINOSTERNON SUBRUBRUM* (Eastern Mud Turtle).** Jasper Co.: Charlie Elliott Wildlife Center (33.46281°N, 83.73348°W). 1 June 2012. J. Jensen. UF 167175. Tattnall Co.: State Hwy 196 (Baxter Durrence Road) at CR 313, 8.8 km SW Glennville (31.881028°N, 81.995218°W). 26 September 2011. D. Stevenson. GSU 24475.

***PSEUDEMYS CONCINNA CONCINNA* (Eastern River Cooter).** Coweta/Spalding Cos.: Line Creek (which forms the border between these two counties) at State Hwy 16 (33.256649°N, 84.497273°W). 21 July 2011. J. Jensen. Verified by Sean Graham. AHAP-D 318. Grady Co.: Ochlockonee River, 1 km E State Hwy 93 (30.79530°N, 84.15196°W). 16 May 1997. J. Jensen and M. Frick. UF 166460. Heard Co.: Chattahoochee River near Franklin (33.29083°N, 85.0986°W; NAD 83). 31 May 2012. J. Jensen and G. Greer. UF 167176.

***PSEUDEMYS CONCINNA FLORIDANA* (Florida Cooter).** Candler Co.: State Hwy 129, 7.0 km S Metter, and 0.6 km S of Canoochee River bridge crossing (32.333241°N, 82.062463°W). 6 March 2011. D. Stevenson. GSU 18994. Jeff Davis Co.: Union Springs Church Road, 0.4 km NNE Snipesville (31.764765°N, 82.750594°W). 13 March 2012. D. Stevenson. GSU 24859. Turner Co.: 17.6 km E Ashburn (31.704733°N, 83.465215°W). 24 February 2011. D. Stevenson and W. Taylor. GSU 18995.

***STERNOTHERUS MINOR* (Loggerhead Musk Turtle).** Appling Co.: Altamaha River at Falling Rocks boat landing, 18.3 km NNW Baxley (31.941324°N, 82.374909°W). 26 June 2011. D. Stevenson and M. Wallace. GSU 24852. Brooks Co.: Withlacoochee River at Clyattville-Nankin Road, 7.8 km WSW Clyattville (30.674589°N, 83.394334°W). 18 April 2012. D. Stevenson. Verified by Kenneth L. Krysko. UF 166884. Jeff Davis Co.: Bullard Creek Wildlife Management Area at State Hwy 221 (31.956723°N, 82.479082°W). 3 July 2011. D. Stevenson. GSU 24853.

***STERNOTHERUS ODORATUS* (Common Musk Turtle).** Toombs Co.: State Hwy 1 at Altamaha River, 10.1 km SE Cedar Crossing (31.945504°N, 82.354663°W). 25 March 2012. D. Stevenson. GSU 24867.

***TERRAPENE CAROLINA* (Eastern Box Turtle).** Jeff Davis Co.: 8.4 km WNW Hazlehurst (31.881520°N, 82.681194°W). 13 March 2012. D. Stevenson. GSU 24860.

***TRACHEMYS SCRIPTA SCRIPTA* (Yellow-bellied Slider).** Heard Co.: Chattahoochee River near Franklin (33.29083°N, 85.0986°W; NAD 83). 31 May 2012. J. Jensen and G. Greer. UF 167177. Muscogee Co.: 0.55 km W jct. Chattahoochee Riverwalk and S. Lumpkin Road (32.4028°N, 84.9613°W). 26 April 2012. H. Butler. UF 166996. Pierce Co.: 5.0 km NE Offerman (31.442451°N, 82.074991°W). 21 March 2012. D. Stevenson. GSU 24861.

SQUAMATA — LIZARDS

***ANOLIS SAGREI* (Brown Anole).** Chatham Co.: 8 Jamaica Run Drive, Whitemarsh Island (32.01414°N, 81.01701°W). 5 May 2012. R. Groves. UF 167045. Multiple individuals of this non-native species were observed.

***HEMIDACTYLUS TURCICUS* (Mediterranean Gecko).** Bibb Co.: 2720 Riverside Drive, Macon (32.876067°N, 83.665652°W; NAD 83). 24 March 2012. K. Stohlgren and E. Schlimm. UF 166825. Found on wall in parking lot of Holiday Inn Express. Tift Co.: 714 E. 44th Street, Tifton (31.487180°N, 83.496511°W). 25 March 2011. C. Bargeron. UF 165870.

***OPHISAURUS VENTRALIS* (Eastern Glass Lizard).** Screven Co.: 4145 Buttermilk Road, Sylvania (32.821735°N, 81.722428°W). 3 April 2012. G. Lanier. UF 166803.

***PLESTIODON INEXPECTATUS* (Southeastern Five-lined Skink).** Mitchell Co.: 0.95 km SE jct. State Hwy 65 and Old Thomasville Road (31.207320°N, 84.313376°W). 26 March 2012. H. Butler. UF 166591.

***PLESTIODON LATICEPS* (Broad-headed Skink).** Peach Co.: 15 Greer Road, Fort Valley (32.599814°N, 83.911775°W). 14 April 2012. B. Bond. UF 166906.

***SCINCELLA LATERALIS* (Little Brown Skink).** Mitchell Co.: 0.74 km SW jct. Pipeline Road and Richards Lane (31.213696°N, 84.315368°W). 27 March 2010. H. Butler. UF 166496.

SQUAMATA — SNAKES

***AGKISTRODON PISCIVORUS* (Cottonmouth).** Pierce Co.: State Hwy 121/15 2.3 km SE Blackshear (31.291794°N, 82.224631°W). 12 March 2012. D. Stevenson. GSU 24862. Warren Co.: Rocky Comfort Creek, 0.43 km SE CR 75 (33.31401°N, 82.64934°W). 31 March 2012. A. Higdon. UF 166878.

***CEMOPHORA COCCINEA* (Scarlet Snake).** Appling Co.: Morris Landing Road 17.5 km NNE Baxley (31.924819°N, 82.281841°W). 26 June 2011. M. Wallace and D. Stevenson. GSU 24854.

***COLUBER CONSTRICTOR* (North American Racer).** Talbot Co.: 0.55 km NW jct. State Hwy 41 and Lucile Drive (32.54724°N, 84.57292°W). 11 April 2009. D. Olive. UF 165273.

***COLUBER* (= *MASTICOPHIS*) *FLAGELLUM* (Coachwhip).** Mitchell Co.: 0.24 km SE jct. of Evergreen Road and Flats Road (31.196583°N, 84.283626°W). 19 May 2010. H. Butler. UF 166497.

***CROTALUS ADAMANTEUS* (Eastern Diamond-backed Rattlesnake).** Talbot Co.: 0.55 km NW jct. State Hwy 41 and Lucile Drive (32.54724°N, 84.57292°W). 10 October 2008. D. Olive. UF 165272.

***DIADOPHIS PUNCTATUS* (Ring-necked Snake).** Lanier Co.: State Hwy 221 at Grand Bay Creek, 6.7 km NW Naylor (30.951006°N, 83.127624°W). 23 December 2011. D. Stevenson and K. Briggs. GSU 24863. Pierce Co.: Riggins Road at State Hwy 121/15, 7.3 km SSE Blackshear (31.251025°N, 82.198686°W). 12 March 2012. D. Stevenson. GSU 24864. Talbot Co.: 1.48 km E jct. State Hwy 355 and Tree Farm Road (32.54520°N, 84.58547°W). 2 March 2012. D. Olive. UF 166536.

***FARANCIA ERYTROGRAMMA* (Rainbow Snake).** Wheeler Co.: 13.0 km NE Lumber City (31.979278°N, 82.554633°W). 25 April 2011. D. Stevenson. GSU 24480.

***HETERODON PLATIRHINOS* (Eastern Hog-nosed Snake).** Hancock Co.: State Hwy 15, 0.3 km N jct. with State Hwy 22 (33.314442°N, 82.968872°W; NAD 83). 17 October 2011. K. Stohlgren. UF 166824. Jeff Davis Co.: Check Station Road, Bullard Creek Wildlife Management Area, 13.9 km NE Hazlehurst (31.951999°N, 82.478673°W). 8 May 2011. D. Stevenson. GSU 24481. Pierce Co.: 11.4 km W Blackshear (31.297081°N, 82.360755°W). 21 March 2012. D. Stevenson. GSU 24856. Talbot Co.: Old Mauk Road 0.1 km NW CR 128, Almo Plantation (32.583542°N, 84.453669°W). 3 April 2012. M. Elmore and P. Howard. UF 166814. Turner Co: 17.6 km E Ashburn (31.704733°N, 83.465215°W). 24 February 2011. D. Stevenson and W. Taylor. GSU 18997.

***HETERODON SIMUS* (Southern Hog-nosed Snake).** Talbot Co.: 0.55 km NW jct. State Hwy 41 and Lucile Drive (32.54724°N, 84.57292°W). March 2008. D. Olive. UF 165215.

***LAMPROPELTIS ELAPSOIDES* (Scarlet Kingsnake).** Bleckley Co.: Magnolia Road at Shellstone Creek, Ocmulgee Wildlife Management Area, 11.8 km NW Cochran (32.452995°N, 83.451994°W). 29 November 2011. D. Stevenson. GSU 24865. Pulaski Co.: 3.4 km NW jct. Coley Road and Upper River Road, Ocmulgee Wildlife Management Area (32.36968°N, 83.48926°W). 10 May 2012. J. Sylvest. UF 167090.

***LAMPROPELTIS GETULA* (Common Kingsnake).** Lumpkin Co.: State Hwy 19, 0.5 km N of Olympic Drive, N of Dahlonega (34.58176°N, 83.97047°W). 30 March 2012. D. Stevenson and C. Camp. UF 166612. Upson Co.: On bank of Flint River (32.823888°N, 84.407777°W). 31 May 2009. G. Greer. UF 161272.

***NERODIA ERYTHROGASTER* (Plain-bellied Watersnake).** Jeff Davis Co.: Bullard Creek Wildlife Management Area at State Hwy 135, 8.7 km S Uvalda (31.956736°N, 82.516942°W). 25 March 2012. D. Stevenson. UF 166815. Peach Co.: 15 Greer Road, Fort Valley (32.599814°N, 83.911775°W). 13 April 2012. B. Bond. UF 166901.

***NERODIA SIPEDON* (Northern Watersnake).** Talbot Co.: Flint River (32.851111°N, 84.468611°W). 31 May 2009. G. Greer. UF 161264.

***NERODIA TAXISPILOTA* (Brown Watersnake).** Montgomery Co.: State Hwy 221 at the Altamaha River (31.958062°N, 82.516793°W). 8 May 2011. D. Stevenson. GSU 24483. Wheeler Co.: 13.0 km NE

Lumber City (31.979278°N, 82.554633°W). 27 April 2011. D. Stevenson. GSU 24482.

***OPHEODRYS AESTIVUS* (Rough Greensnake)**. Oconee Co.: 1341 Ashland Drive, Statham (33.90332°N, 83.58516°W). 13 July 2011. A. Yellin. UF 165532. Tattnall Co.: Mac Phillips Road, 13.0 km SW Glennville (31.846338°N, 82.016486°W). 8 October 2011. D. Stevenson and B. Willis-Stevenson. GSU 24484.

***PITUOPHIS MELANOLEUCUS* (Pinesnake)**. Irwin Co.: Lentile Tract (31.49841°N, 83.37635°W; WGS 84). 24 March 2011. K. Mainor. UF 165275. Pierce Co.: 11.4 km W Blackshear (31.297081°N, 82.360755°W). 8 March 2012. D. Stevenson and M. Wallace, Sr. GSU 24857. One of two individuals found in xeric sandhills on the east side of the Satilla River.

***REGINA SEPTEMVITTATA* (Queen Snake)**. Jasper Co.: White Oak Creek ~100 m downstream of State Hwy 212 E (33.29836°N, 83.66247°W). 29 March 2012. J. Jensen. UF 166580. Talbot Co.: Flint River near State Hwy 36 bridge (32.838055°N, 84.422777°W). 31 May 2009. G. Greer. UF 161270.

***STORERIA OCCIPITOMACULATA* (Red-bellied Snake)**. Mitchell Co.: State Hwy 97, 0.21 km NE Sassafras Tea Road (31.201647°N, 84.326957°W). 10 September 2011. H. Butler. UF 166514. Talbot Co.: 0.55 km NW jct. State Hwy 41 and Lucile Drive (32.54724°N, 84.57292°W). 11 April 2009. D. Olive. UF 165274.

***TANTILLA CORONATA* (Southeastern Crowned Snake)**. Talbot Co.: Entrance to Brown Sand Company, Wittichen Plant (32.572222°N, 84.441944°W). 25 May 2009. G. Greer. UF 161255.

***THAMNOPHIS SAURITUS* (Eastern Ribbonsnake)**. Jasper Co.: John Tillman Road at Falling Creek (33.195919°N, 83.691385°W). 31 March 2011. J. Jensen. UF 165422. Mitchell Co.: Flats Road 0.05 km N Wiregrass Road (31.179128°N, 84.286300°W). 10 September 2011. H. Butler. UF 166513.

***THAMNOPHIS SIRTALIS* (Common Gatersnake)**. Columbia Co.: 6686 Wrightsboro Road, Harlem (33.49057°N, 82.39546°W). 17 March 2012. H. Butler. UF 166807.

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New County Records for Amphibians and Reptiles in Tennessee

Here we report new county records for amphibian and reptile species across the state of Tennessee, USA. Despite having a diverse herpetofauna and an active herpetological community there are several regions, such as the Ridge and Valley and the Southeastern Plain and Hills ecoregions, that lack reports of many common and widespread species (Niemiller and Reynolds 2011; Redmond et al. 1990; Redmond and Scott 1996; Scott and Redmond 2008). These records contribute to the documented distributions for 15 species in the state.

All specimens reported herein were found opportunistically by visual encounter surveys and road cruising. All specimens were photographed on site and immediately released. Photographic vouchers were deposited into the Austin Peay State University (APSU) David H. Snyder Museum of Zoology. All records were verified by A. Floyd Scott. Geographic coordinates are in decimal degrees, datum WGS 84.

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CAUDATA — SALAMANDERS

***NOTOPHTHALAMUS VIRIDESCENS LOUISIANENSIS* (Central Newt)**. McNairy Co.: adult found under a log in a mature forest in Big Hill Pond State Park ca 0.25 km S of Big Hill Pond Lake (35.04033°N, 88.73370°W). 24 April 2011. APSU 19177.

***PSEUDOTRITON RUBER RUBER* (Northern Red Salamander)**. Grainger Co.: recent metamorph, with gill remnants present, found on Lea Lake Road ca 1.36 km NNW of junction with Rutledge Pike (36.18416°N, 83.69471°W), at night in heavy rain. 27 April 2011. APSU 19173.

ANURA — FROGS

***ANAXYRUS AMERICANUS AMERICANUS* (Eastern American Toad)**. Grainger Co.: adult found on Lea Lake Road ca. 0.22 km NW of junction with Rutledge Pike (36.17751°N, 83.68544°W), at night in heavy rain. 27 April 2011. APSU 19172.

***PSEUDACRIS CRUCIFER* (Spring Peeper)**. Grainger Co.: adult found on Lea Lake Road ca 2.71 km NNW of junction with Rutledge Pike (36.19483°N, 83.69282°W), at night in heavy rain. 27 April 2011. APSU 19171.

SQUAMATA — LIZARDS

***ANOLIS CAROLINENSIS CAROLINENSIS* (Northern Green Anole)**. McNairy Co.: adult male found basking on a fallen pine log adjacent to an active railroad track in Big Hill Pond State Park, ca. 0.40 km W of Big Hill Pond (35.03530°N, 88.73091°W). 24 April 2011. APSU 19175.

SQUAMATA — SNAKES

***COLUBER CONSTRICTOR CONSTRICTOR* (Northern Black Racer)**. Union Co.: adult found basking on a sidewalk in a rural subdivision ca. 0.20 km N of Satterfield Road (36.18091°N, 83.86079°W). 20 April 2011. APSU 19178.

***DIADOPHIS PUNCTATUS EDWARDSII* (Northern Ring-necked Snake)**. Union Co.: adult found dead on road ca 0.20 km N of Satterfield Road (36.18065°N, 83.86060°W). 19 April 2011. APSU 19121.

***OPHEODRYS AESTIVUS* (Rough Greensnake)**. Union Co.: adult found dead on Satterfield Road ca. 0.08 km NW of junction with Graves Road (36.18039°N, 83.87147°W). 20 July 2011. APSU 19181.

***PANTHEROPHIS GUTTATUS* (Red Cornsnake)**. Union Co.: adult found dead on Ailor Gap Road (State Highway 144), ca. 0.01 km SSW of junction with Bull Run Road (36.20024°N, 83.82998°W). 07 May 2011. APSU 19180.

***PANTHEROPHIS SPILOIDES* (Gray Ratsnake)**. Union Co.: adult female found dead with eggs on Satterfield Road ca. 0.30 km E of junction with Graves Road (36.17990°N, 83.86718°W). 07 July 2011. APSU 19179.

***STORERIA DEKAYI* (Dekay's Brownsnake)**. Union Co.: adult found dead on Satterfield Road ca. 0.38 km SE of junction with Maynardville Highway (State Highway 33) (36.18843°N, 83.88692°W). 01 August 2011. APSU 19182.

***STORERIA OCCIPITOMACULATA OCCIPITOMACULATA* (Northern Red-Bellied Snake)**. McNairy Co.: Big Hill Pond State Park just S of Big Hill Lake (35.04598°N, 88.73254°W). 24 April 2011. APSU 19176.

TESTUDINES — TURTLES

***CHELYDRA SERPENTINA* (Snapping Turtle)**. Union Co.: adult found dead on Ailor Gap Road (State Highway 144), ca. 0.28 km S of junction with Bull Run Road (36.19816°N, 83.82989°W). 08 May 2011. APSU 19183.

***STERNOTHERUS ODORATUS* (Eastern Musk Turtle)**. McNairy Co.: adult found attempting to cross railroad tracks just S of Big Hill Pond in Big Hill Pond State Park (35.03418°N, 88.72602°W). 24 April 2011. APSU 19174.

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NATURAL HISTORY NOTES

CAUDATA — SALAMANDERS

***AMBYSTOMA ANNULATUM* (Ringed Salamander) and *AMBYSTOMA MACULATUM* (Spotted Salamander). CLIMBING BEHAVIOR.** Climbing behavior is well documented in plethodontid salamanders and likely serves a variety of functions. While some members of the genus *Aneides* are truly arboreal (Spickler et al. 2006. Herpetol. Conserv. Biol. 1:16–26), climbing behavior by terrestrial species has been associated with olfactory orientation and homing (Madison and Shoop 1970. Science 168:1484–1487), periodic foraging (Jaeger 1978. Copeia 1978:686–691), and predator avoidance (Roberts and Liebgold 2008. Behav. Ecol. 19:621–626). For ambystomatid salamanders, however, observations of climbing behavior have not been previously reported. This may be because most observations of ambystomatid salamanders are of aquatic larvae or adults arriving at or leaving breeding ponds. Observations of juveniles emerging from their natal wetland and moving into novel terrestrial habitats are much less common. During this vulnerable time, juvenile ambystomatid salamanders must orient and navigate, while attempting to select microhabitat for best avoiding desiccation or predation (Rothermel and Semlitsch 2006. Can. J. Zool. 84:797–807).

In May through August of 2009 and 2010, while conducting enclosure experiments and fluorescent powder-tracking at Daniel Boone Conservation Area, in Warren Co., Missouri, USA, we observed juvenile *Ambystoma annulatum* and *A. maculatum* climbing on vegetation and the walls of plastic silt fence enclosures. We observed juvenile salamanders (N = 20) climbing small saplings, grass clumps, and stumps, as well as the trunks of large trees (Table 1). Ringed Salamanders may climb more readily than Spotted Salamanders (7.1% of powder-tracked Ringed Salamanders climbing, compared to 3.2% climbing in Spotted Salamanders; Pittman, unpubl. data). We observed Ringed Salamanders climbing to a maximum height of 152 cm (mean: 66.5 ± 9.59 SE) and Spotted Salamanders climbing to a maximum height of 100 cm (mean: 61.7 ± 8.72 SE). In addition to these observations, juveniles readily climbed over downed logs (ca. 20 cm in diameter) and where observed crawling out of pitfall traps (45 cm deep plastic plant pots) during wet conditions.

The observed climbing behavior in juvenile ambystomatids likely has two principle functions. Individuals climbing over downed logs may be attempting to maintain their current movement trajectory by traversing over obstacles in their path. Climbing over an obstacle may require less energy than moving around it. In contrast, individuals climbing up herbaceous vegetation or tree trucks were not climbing over obstructions in their path, but appear to have selected those structures specifically for the purpose of elevating themselves off the ground. Given high desiccation risk, it seems likely that juvenile ambystomatid salamanders moving through novel terrestrial habitats would possess behavioral mechanisms for efficiently locating suitable microhabitats. The orientation hypothesis for climbing behavior in *Plethodon jordani*, offered by Madison and Shoop (1970. Science 168:1484–1487), might also apply to juvenile ambystomatid salamanders. On the occasions where we directly observed individuals on vegetation, their posture (nose up, forelegs and neck extended) suggested that they were attempting to increase their sensory perceptual range. It is possible that by elevating themselves, juveniles may access less-obstructed air currents, thereby broadening their range of olfactory perception and possibly increasing detection of visual cues as well.

Climbing in ambystomatids is probably a much more common behavior than the scant documentation would suggest. We recommend that climbing behavior be considered when designing experiments. Depending on the nature of the experiment, it may be necessary to add lips angled inward to enclosures, drift fences, and pitfall traps to obstruct ambystomatid climbing. Because our observations were of juveniles, we cannot confirm if climbing behavior is as prevalent in adults.

TABLE 1. Observations of juvenile ambystomatid salamander climbing behavior.

Date	Structure	Height	Observation
Ambystoma annulatum			
5/11/2009	Grass clump	50 cm	Visual observation
5/14/2009	On leaf of sapling	30 cm	Visual observation
5/26/2009	White Oak stump	60 cm	Fluorescent powder trail
5/29/2009	On Sassafras sapling leaf	75 cm	Visual observation
6/10/2009	Plastic silt fence	100 cm	Visual observation
6/11/2009	Dead White Oak trunk	50 cm	Found under bark
6/14/2009	Downed woody debris	70 cm	Visual observation
6/14/2009	Branch of young tree	152 cm	Fluorescent powder trail
6/18/2009	On leaf of sapling	30 cm	Visual observation
6/18/2009	Grass clump	40 cm	Fluorescent powder trail
6/1/2010	Plastic silt fence	100 cm	Visual observation
7/10/2010	Sapling	25 cm	Fluorescent powder trail
7/26/2010	Persimmon tree trunk	49 cm	Fluorescent powder trail
7/27/2010	White Oak trunk	100 cm	Fluorescent powder trail
Ambystoma maculatum			
6/14/2009	Grass clump	100 cm	Visual observation
6/20/2009	Grass clump	50 cm	Fluorescent powder trail
6/20/2009	Grass clump	40 cm	Fluorescent powder trail
6/28/2009	Tree stump	60 cm	Fluorescent powder trail
7/7/2009	Tree stump	50 cm	Fluorescent powder trail
7/7/2009	Grass clump	70 cm	Visual observation

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***AMBYSTOMA OPACUM* (Marbled Salamander). UNUSUAL LARVAL DEATH.** *Ambystoma opacum* breed in autumn, and females typically deposit eggs in dry wetland basins or margins, and embryos develop to hatching stage (Scott 2005. *In* Lannoo [ed.], Amphibian Declines: The Conservation Status of United States Species, pp. 627–632. Univ. California Press, Berkeley). When the wetlands fill, embryos hatch immediately from eggs and begin development as free-swimming larvae. This occurs prior to the presence of other amphibian eggs or larvae in these wetlands. Here I report the unusual death of a free-swimming larval Marbled Salamander.

On 7 Feb 2012 while surveying ridge-top wetlands in the Daniel Boone National Forest, Morgan County, Kentucky, USA, I observed a larval *A. opacum* that had died and was located within the egg mass of a Wood Frog, *Lithobates sylvaticus* (Fig. 1). The egg mass was on the edge of a small cluster of eight egg masses. The larva was either attempting to eat the embryos, was inactive near the eggs as the jellies swelled, or was attempting to move through egg mass and was trapped. Larval *A. opacum* primarily eat macrozooplankton and other invertebrates (Scott 2005, *op. cit.*), so this was apparently not a predatory attempt. To my knowledge, this is the first report of a larval salamander being entrapped in an amphibian egg mass.

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FIG. 1. Larval Marbled Salamander, *Ambystoma opacum*, found dead within the egg mass of a Wood Frog, Lithobates sylvaticus.



FIG. 1. Female *Desmognathus folkertsi* found with her early-stage nest underneath a small rock in a headwater stream.

***DESMOGNATHUS FOLKERTSI* (Dwarf Black-Bellied Salamander). NEST.** On 22 July 2010, I uncovered two nests of *Desmognathus folkertsi* in Habersham Co., Georgia, USA. Eggs were early in development and attached to the underside of small, flat rocks in a first-order stream. Both nests were guarded by female *D. folkertsi*. The nest that was photographed contained 29 eggs. Upon returning on 28 Aug 2010, I flipped the same rocks and found the hatched larvae underneath, and the females had moved out. This is the first record of nesting behavior of *D. folkertsi*.

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***EURYCEA CIRRIGERA* (Southern Two-Lined Salamander). OVIPOSITION SITE.** For most oviparous species, female oviposition site selection can impact reproductive fitness by dictating offspring survival and phenotype, juvenile performance, as well as potential survival of the ovipositing female. Thus, oviposition-site choice is a life-history trait of critical importance (Bernardo 1996. Amer. Zool. 36:83–105; Refsnider and Janzen 2010. Ann. Rev. Ecol. Evol. Syst. 41:39–57; Resetarits 1996. Amer. Zool. 36:205–215).

We document oviposition by a female *E. cirrigera* inside a leaf litterbag sampling device, in Decatur Co., Georgia, USA (30.791667°N, 84.625°W). In February 2004, we retrieved a leaf litterbag containing a female *E. cirrigera* (3.7 cm SVL) tending a clutch of eggs on the underside of a curled leaf (Fig. 1). We estimated 30 eggs in the clutch, including ca. 6 eggs that fell into the stream upon retrieval. Leaf litterbags are a passive sampling device that mimic natural leaf packs in streams, serving as both refugia from predators and sources of prey substrate (Fraser 1976. Ecology 57:459–471; Waldron et al. 2003. Applied Herpetol. 1:23–36).

This oviposition observation was made during a study examining the effectiveness of leaf litterbags versus dipnetting (Talley and Crisman 2007. Env. Monitor. Assess. 132:505–519). We constructed leaf litterbags by gathering the corners of 30 x 30 cm squares of heavy gauge plastic mesh to form pockets we filled with litter debris from stream edges. We placed 12 litterbags in each survey stream at locations where debris naturally accumulated (e.g., channel bends, pools, and incised banks). Following a 30-day incubation period, where salamanders can freely move in and out of the litterbag, we remove litterbags from the stream to inspect the interiors.



FIG. 1. Female *Eurycea cirrigera* tending egg clutch.

Eurycea cirrigera typically breed December through March in the southern US, so that eggs are typically present January through April. The female deposits ca. 15–100 eggs per clutch, remaining with them until they hatch (1–2 months). Females typically attach eggs singly beneath submerged rocks or logs in slow-moving water, or to submerged vegetation when sufficient rocks are unavailable (Brimley 1896. Amer. Nat. 30:500–501; Jensen et al. 2008. Amphibians and Reptiles of Georgia. Univ. Georgia Press, Athens and London. 575 pp.; Mitchell and Gibbons. 2010. Salamanders of the Southeast. Univ. Georgia Press, Athens and London. 324 pp.).

The current observation supports the documented timing of oviposition in the southern populations of *E. cirrigera* mentioned above, and suggests the efficacy of salamanders to occupy leaf litterbags because they mimic the natural microhabitat. We may have found additional salamanders with egg clutches if we had checked the contents more frequently during breeding months or if we had placed them in microhabitats better suited for attracting adults (i.e., at stream edges where rocks are more available and litterbags are not fully submerged).

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***PLETHODON CINEREUS* (Eastern Red-backed Salamander). MORPHOLOGY.** *Plethodon cinereus* is one of the most common salamanders in the Maritime Provinces of eastern Canada (Cook 1984. Introduction to Canadian Amphibians and Reptiles. National Museum of Natural Sciences, Ottawa; Conant and Collins 1998. A Field Guide to Reptiles and Amphibians of Eastern and Central North America. Houghton-Mifflin Co., Boston, Massachusetts. 616 pp.). There are three commonly recognized color morphs: a deep red-striped back with black sides referred to as red-backed, a black pigmented back and sides, referred to as lead-backed, and the rarest of the three morphs, red with varying



PHOTO BY G. JONGSMA

FIG. 1. Leucistic *Plethodon cinereus* found in Fredericton, New Brunswick, Canada in 2010.

degrees of black mottling referred to as erythristic. Far less common across its range is the leucistic morph, which lacks pigmentation but has the regular black eyes and hence not considered albino. Across its range, three leucistic individuals have been reported from Maryland (Mitchell and Mazur 1998. Northeast. Nat. 5[4]:367–369), one each from West Virginia (Pauley 1974. The Restart 42:104), New York, and Massachusetts (Mendyk et al. 2010. Herpetol. Rev. 41[2]:189–190), two from Nova Scotia, one from Quebec (Moore and Gilhen 2011. Can. Field Nat.125:58–60) and one from Ontario (Rye 1991. Can. Field Nat. 10:573–574). The individual from New Brunswick, Canada was discovered 10 May 2009 at the UNB Woodlot in Fredericton (45.927841°N, 66.65769°W; WGS 84) under a rock next to a gravel road. This is the first confirmed record for New Brunswick. The individual was not collected; however John Gilhen (Nova Scotia Museum) verified that the individual was leucistic based on photographs.

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***SALAMANDRA SALAMANDRA GALLAICA* and *SALAMANDRA SALAMANDRA EUROPAEA* (Fire Salamander). AGONISTIC BEHAVIOR.** Rival combat between male salamanders has been described in a central European population of *Salamandra salamandra* (Kästle 1986. *In* Z. Roçek [ed.], Studies in Herpetology, pp. 525–528. Societas Eurpaea Herpetologica, Prague), as well as in other salamander species including *S. algira tingitana* (Bogaerts and Donaire-Barroso 2005. Zeitschrift für Feldherpetologie 12:137–141), *S. lanzai* (Andreone 1992. Bull. Brit. Herpetol. Soc. 39:31–33), *S. atra* (Häfeli 1971. Rev. Suisse Zool. 78:235–293), *Plethodon cinereus* (Jaeger 1984. Copeia 1984:309–314; Gabor and Jaeger 1995. Anim. Behav. 49:71–79), and *Ensatina eschscholtzii* (Wiltenmuth and Nishikawa 1998. Anim. Behav. 55:1595–1606). Herein we report this behavior in two Iberian subspecies of *Salamandra salamandra.*

On 11 Oct 2011, GV-A observed and filmed this behavior in *S. s. gallaica* (http://youtube.com/watch?v=qJPmSTwTBCM; Bueu, NW Spain, 42.286°N, 8.758°W). XB filmed the same behavior in *S. s. europaea* on 27 Oct 2011 (http://youtu.be/ULD_v1-2Q_k; Les Preses, NE Spain; 42.135°N, 2.460°E). Our observations agree with the combat sequence reported in *S. salamandra* (Kästle 1986, *op. cit.*) and lasted more than 10 minutes. Our field observations provide evidence of male combat in other lineages of *S. salamandra* and extend this behavior across its wide range. Male combat in natural populations of *Salamandra* is difficult to observe (Kästle 1986, *op. cit.*; Bogaerts and Donaire-Barroso 2005,

op. cit.) and our experience agrees with field observations in other lineages since this behavior has been observed only twice in *S. s. gallaica* (first observation on 24 Oct 1998 in Parque Natural das Fragas do Eume, NW Spain, 43.418°N, 8.103°W) after numerous field surveys during the last 20 years. In *S. s. europaea* it has been observed four times in Les Preses (twice on 23 Dec 2007 and twice on 27 Oct 2011) and twice in La Vall d'en Bas (on 3 Nov 2011 in Espai d'Interès Natural Puigsacalm-Bellmunt; 42.162°N, 2.412°E). However, due to the scarcity of male-male agonistic behavioral observations in *S. salamandra*, whether these observations correspond to mistaken matings or rival male combat to defend their territory remains unclear.

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ANURA — FROGS

***ANAXYRUS FOWLERI* (Fowler's Toad). HABITAT.** *Anaxyrus fowleri* is endangered in Canada where it reaches its northern range limit (COSEWIC 2010). Fowler's Toads at Long Point Ontario breed almost exclusively within a large complex of wetlands on the leeward side of Lake Erie shoreline beach dunes (Green 1989. Can. Field Nat. 103:486–496). After the breeding season has ended males and females return to the beaches and sand dunes for the remainder of the active season. During the post breeding period these toads spend their evenings foraging along the beach and shoreline. Daylight hours are spent buried in the sand, typically within the eroding face of dunes (Boenke, unpubl. M.Sc. Thesis). The daytime habits of toads during the breeding season have not been previously reported.

During the breeding season on 29 May 2010, we attached a radio-transmitter (BD-2N manufactured by Holohil) to a calling male in the back-dune wetlands of Long Point (UTM 17N, 552007N, 4714034E) at 2355 h. The following day at 0900 h we tracked this radio-transmitter to a vegetation mound (UTM 17N, 552029N, 4714051E) near the attachment location within the same wetland. Unfortunately we were unable to visually confirm the presence of the toad and assumed the transmitter had been shed. On 9 June 2010, at 2344 h, well after the breeding season had ended, the same toad was found on the beach (UTM 17N, 551723N, 4713877E) wearing the same radio transmitter as confirmed by its serial number.

We interpret this as the first documented evidence of Fowler's Toads making use of daily refuge sites in wetlands or vegetation mounds. Previous to this it was unclear if during the breeding season toads returned to the sandy beaches between each night of calling or took refuge within the wetlands. Different toads may employ different refuge seeking strategies and further research into this behavior is needed.

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***CORYTHOMANTIS GREENINGI* (Greening's Frog). REPRODUCTION.** Some anuran species are known by their short breeding activity, which occurs during a few weeks or days when it is possible to observe large reproductive choruses of individuals (Kopp et al. 2010. Iheringia 100:192–200; Wells 1977. Anim. Behav. 25:666–693). During spatial and temporal overlap in species reproductive activities, interspecific mating interactions are known to occur (Grogan and Grogan Jr. 2011. Herpetol. Rev. 42:89–90; Streicher et al 2010. Herpetol. Rev. 41:208). Herein we report an interspecific amplexus between individuals from two different species and families: Hylidae and Cycloramphidae. On 11 Nov 2006 at ca. 2000 h during the rainy season we found 12 anuran species in reproductive activity at a stream with small ponds in a transition area between Atlantic and Cerrado domains, near the city of Grão Mogol, Jequitinhonha River Basin, state of Minas Gerais, southeastern Brazil (16.5716°S, 42.7734°W, 599 m elev.). These species were: *Proceratophrys renalis, Odontophrynus carvalhoi, O. cultripes, Corythomantis greeningi, Dendropsophus minutus, Hypsiboas crepitans, Phyllomedusa burmeisteri, P.* gr. *hypochondrialis, Scinax* gr. *catharinae, Leptodactylus mystacinus, L. troglodytes,* and *Physalaemus cuvieri.* We observed amplexus between an adult male *Corythomantis greeningi* and a female *Proceratophrys renalis* (Fig. 1A, B) on rocks at the stream margin. The pair remained in amplexus and did not move while being observed for ca. 10 min. In the same chorus we observed conspecific amplexus of adult *P. renalis* (Fig. 1C) and *C. greeningi* (Fig. 1D). Although interspecific amplexus in anurans has been reported by numerous authors, amplexus between different families of anurans is only rarely observed.

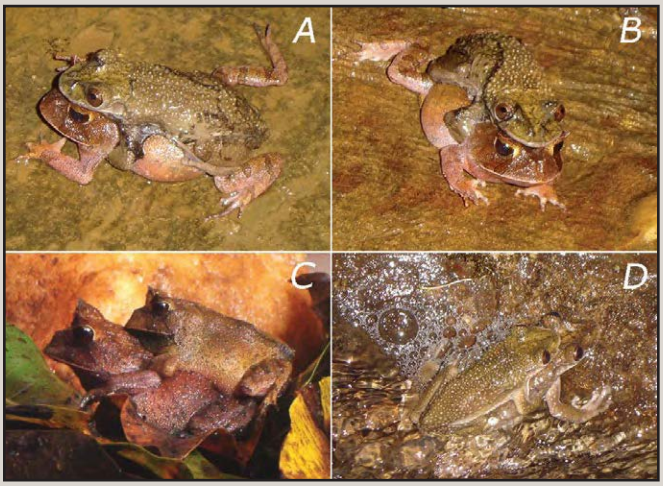


FIG. 1. A-B) Male *Corythomantis greeningi* in amplexus with female *Proceratophrys renalis*, from Minas Gerais, Brazil. C) Conspecific amplexus of *Proceratophrys renalis* from Minas Gerais, Brazil. D) Conspecific amplexus of *Corythomantis greeningi* from Minas Gerais, Brazil.

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***DUTTAPHRYNUS MELANOSTICTUS* (Asian Common Toad). PARASITISM.** *Duttaphrynus melanostictus* is a common toad throughout South Asia. Although there have been reports of parasitism of *D. melanostictus* by endoparasites such as nematodes

(Walton 1933. J. Parasitol. 20:1–32) and parasitoids such as dipteran larvae (Roy and Dasgupta 1977. Proc. Indian Acad. Sci. 86B:207–209), reports of this species being parasitized by leeches could not be found. On 30 May 2011 at 2048 h we observed a leech attached to the lower back near the urostyle of an adult female *D. melanostictus* in Tai Po Kau Nature Reserve, New Territories, Hong Kong, China (22.43°N, 114.19389°E). The leech was identified as *Tritetrabdella taiwana*, and was deposited in the Zoological Collection of Kyoto University (KUZ Z196). Its COI sequence was deposited in GenBank (AB685259).

Tritetrabdella taiwana is only recorded in East and South East Asia (Lai et al. 2011. ZooKeys 139:1–22). This species inhabits moist forests in mountains of low to middle-elevation and attaches to substrates like leaf litter, grasses, and bushes on the ground (Lai et al. 2011, *op. cit.*). A detailed description of this species is limited to a few publications from Taiwan (Lai and Chan 2010. Leech Fauna of Taiwan. National Taiwan University Press, Taiwan. 118 pp.; Lai et al. 2011, *op. cit.*). Amphibians are believed to be the primary host of this terrestrial blood-sucking leech as this species has usually been recorded to parasitize anurans in Taiwan (Lai et al. 2011, *op. cit.*). *Duttaphrynus melanostictus* is a newly reported host for this leech species.

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***ECNOMIOHYLA MIOTYMPANUM* (Small Eared Treefrog). PREDATION.** Numerous aquatic insects have been reported as anuran predators (Duellman 2001. The Hylid Frogs of Middle America, 2nd ed. SSAR Contributions to Herpetology, No. 18. Lawrence, Kansas. 1159 pp.; Duellman and Trueb 1994. Biology of Amphibians. Johns Hopkins Univ. Press, Baltimore, Maryland. 670 pp.). *Ecnomiohyla miotympanum* is endemic to Mexico, and inhabits pine-oak and cloud forest in the Sierra Madre Oriental from the states of Nuevo León and Chiapas to Veracruz (Duellman 2001, *op. cit.*). On 16 March 2008 during fieldwork at Rancho Badillo (20.73°N, 98.81°E; WGS84; elev 1930 m), Municipality of Eloxochitlan, Hidalgo State, at 2030 h, we observed an adult *E. miotympanum* (CIB 3040, Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo) being preyed upon on by a giant water bug of the family Belostomatidae (33.5 mm length; 1.4 g). The frog (44.0 mm SVL; 5.2 g;) was caught in the middle of the water body (Fig. 1). This is the first report of predation on *E. miotympanum* by an aquatic insect in the state of Hidalgo, México. We thank Diversidad Biológica del Estado de Hidalgo and FOMIX-CONACYT- HIDALGO 43761, 95828, and S52552-Q for funding our fieldwork.

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FIG. 1. *Ecnomiohyla miotympanum* being predated by Giant Water Bug (Belostomatidae) in the locality of Municipality of Eloxochitlan, Hidalgo State, México.

***EUPHLYCTIS CYANOPHLYCTIS* (Indian Skipper Frog). PREDATION.** Many vertebrates, invertebrates, and carnivorous plants prey on amphibians, which are generally small to moderate in size and have soft skin (Duellman and Trueb 1994. Biology of Amphibians. John Hopkins University Press, Baltimore, Maryland. 670 pp.). During the breeding season, adults, tadpoles, and metamorphosing young are concentrated and are easily acquired meals for predators (Duellman and Trueb 1994, *op. cit.*). Many authors suggest that the breeding strategies of anurans expose them to potential predation (Pough et al. 1992. *In* M. E. Feder and W. W. Burggren [eds.], Environmental Physiology of the Amphibians, pp. 395–436. University of Chicago Press, Chicago, Illinois; Toledo 2003. Phyllomedusa 2:105–108). Water bugs, (*Lethocerus* spp.) are known predators of larval and adult frogs (De-Andrade et al. 2010. Herpetol. Notes 3:53–54; Toledo 2003, *op. cit.*). Reported herein is the first record of predation of *Euphlyctis cyanophlyctis* by *Lethocerus indicus*.

Euphlyctis cyanophlyctis is widely distributed in Sri Lanka and occurs up to 1710 m elev. (Manamendra-Arachchi and Pethiyagoda 2005, 2006. Sri Lankawe Ubhayajeeven "Amphibian Fauna of Sri Lanka." Wildlife Heritage Trust of Sri Lanka). *Lethocerus indicus* and *E. cyanophlyctis* are common inhabitants of seasonal ponds in the Mihintale Sanctuary where *E. cyanophlyctis* are known to breed (Dissanayake et al. 2011. Diversity, Abundance, and Distribution of Amphibians in the Mihintale Sanctuary, Sri Lanka. 16th International Forestry and Environment Symposium 2011. 43).

On 12 Oct 2011 at 2245 h, we observed an adult *L. indicus* (71 mm total length) feeding on an adult male *E. cyanophlyctis* (32 mm SVL) on the margins of a seasonal pond located at Mihintale Sanctuary (8.34968°N, 80.50449°E; 117.6 m elev.), in the region of Anuradhapura, Sri Lanka. The *E. cyanophlyctis* was already dead, with the *L. indicus* biting its right side just below the head region (Fig. 1). The frog was strongly held by the forelimbs of the *L. indicus*. This observation lasted 20 minutes and occurred at



FIG. 1. Predation of *Euphlyctis cyanophlyctis* by *Lethocerus indicus* observed at Mihintale Sanctuary, Sri Lanka.

the beginning of the rainy period immediately after a drought season of about five months.

The effect that predation has on amphibian populations in Sri Lanka is not well studied. Therefore, further studies should be conducted in this area. We thank L. J. Mendis Wickramasinghe for valuable comments, and K. G. D. de. A Abeysinghe and C. Hassapakis who enriched this work.

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FIG. 1. Parachuting adult male *Hyperolius discodactylus* from Rwanda.

COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND

***HYPEROLIUS DISCODACTYLUS* (Disc-fingered Reed Frog). PARACHUTING.** Several species of frogs are capable of a controlled aerial descent (for definition see Dudley et al. 2007. Ann. Rev. Ecol. Evol. Syst. 38:179–201) which includes gliding flights and parachuting. Traditionally, a gliding flight has been characterized by a descent angle of less than 45° to the horizontal whereas in parachuting, the descent angle is more than 45° (Oliver 1951. Am. Nat. 85:171–176). The most famous of these species are probably the Southeast Asian flying frogs of the genus *Rhacophorus*, but controlled aerial descent is also known from several other Asian members of the Rhacophoridae, a number of New World hylids, a single member of the Eleutherodactylidae (*Eleutherodactylus coqui*), and a single member of the Hyperoliidae (*Hyperolius castaneus*) (Dudley et al. 2007, *op. cit.*; Mendelson et al. 2008. J. Herpetol. 42:750–759; Stewart 1985. J. Herpetol. 19:391–401). During field work in Rwanda in October 2010, I tested the aerial performance of *Hyperolius discodactylus*, a species endemic to the montane forests of the Albertine Rift in Central Africa. I collected four individuals in Nyungwe National Park in southern Rwanda in October 2010 and transported them to a laboratory in the city of Butare. To test their ability to perform parachuting flights, I positioned them at a height of ca. 2 m above the floor and made them jump to the ground by touching their back. Subsequent to the initial leap, the frogs flexed their limbs, spread the fingers and toes and held hands and feet in the frontal plane of the body, which was oriented parallel to the ground (Fig. 1). They remained in this stable posture until they landed on the ground. This posture is known from other species of frogs during controlled aerial descent and has been shown to be best suited for maneuvering in the air (Emerson and Koehl 1990. Evolution 44:1931–1946). Two of the frogs were released in the air upside down in a second test. In the air, the frogs turned their bodies by rapid movements of the limbs and quickly assumed the parachuting posture described above. Because the frogs always landed within a horizontal distance of 2 m from the starting point, I choose the term parachuting for the kind of the aerial descent reported here.

Currently, 129 species of *Hyperolius* are considered valid (Frost 2011. Amphibian Species of the World: an Online Reference. Version 5.5 [31 January, 2011]. Electronic database accessible at http://research.amnh.org/vz/herpetology/amphibia/. American Museum of Natural History, New York). Many of these species live in the canopy layer and show morphological characteristics—such as extensive webbing between fingers and toes—that suggest an ability to perform controlled aerial descents. Therefore, controlled aerial descent might be more widespread within *Hyperolius* than currently known.

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***ISTHMOHYLA PSEUDOPUMA* (Meadow Treefrog). PREDATION.** Likely predators of *Isthmohyla pseudopuma* include mammals, birds, snakes, aquatic insects, and even conspecifics (tadpole cannibalism) (Duellman and Trueb 1994. Biology of Amphibians. John Hopkins University Press, Baltimore, Maryland. 670 pp.; Pounds 2000. *In* N. M. Nadkarni and N. T. Wheelwright [eds.], Monteverde: Ecology and Conservation of a Tropical Cloud Forest, pp. 149–177. Oxford Univ. Press, New York; Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna Between Two Continents, Between Two



FIG. 1. Corpse of an *Isthmohyla pseudopuma* (Meadow Treefrog) that was observed in the cheliped of an *Epibolocera sinuatifrons* (Freshwater Crab) as it fed on the dead frog. Note the limited amount of decomposition, suggesting predation and not scavenging.

Seas. Univ. Chicago Press, Chicago, Illinois. 934 pp.). Crustacean predation of anurans has been documented during the pre-hatching, tadpole, and adult stages of life (Gutsche and Elepfandt 2007. Herpetol. Rev. 38:198–199; Hayes 1983. Biotropica 15:74–76; Heather and John 2000. Crustaceana 73:1023–1025); however, this is the first predation account in which a freshwater crab (*Epibolocera sinuatifrons*) was found preying on an adult *I. pseudopuma*.

Isthmohyla pseudopuma use lentic water such as small ponds, puddles, and water filled depressions for egg deposition (Savage 2002, *op. cit.*). It was in such a puddle in the Monteverde Cloud Forest Biological Reserve, Puntarenas, Costa Rica (Sendero Camino trail; 6.679519°N, 81.223459°E; ca. 1600 m elev.) that we observed presumed predation of *I. pseudopuma***.** On 1 June 2011 at 0900 h we encountered an *E. sinuatifrons* (39.5 mm carapace width) clutching the upper torso of an adult *I. pseudopuma* (33.3 mm SUL) in its left cheliped. From this observation we assume predation and consumption of the anuran. The puddle had been visited previously and found to contain two *E. sinuatifrons* and four clutches of *I. pseudopuma* eggs. Based on the absence of the *I. pseudopuma* corpse the previous night, the lack of decomposition (Fig. 1), and the observation of chorusing males and amplectic pairs the previous evening, we suggest the crab predated the frog during the breeding chorus. The puddle was minimally covered by about 40% canopy and was approximately 1 m x 0.3 m x 0.1 m deep. This observation documents yet another predation risk for *I. pseudopuma***.**

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***LEPTOBRACHIUM PULLUM* (Vietnam Spadefoot Toad). SITUS INVERSUS.** On 24 May 2009 a *Leptobrachium pullum* tadpole was collected from the Nui Ong Nature Reserve in Binh Thuan Province in Southern Vietnam (11.0657°N, 107.7360°E). Upon later examination of the preserved specimen (AMS R 173274; Gosner Stage 29 [Gosner 1960. Herpetologica 16:183–190], total length = 79.5 mm), it was observed to have a reversal in the position of external morphological characters including a dextral spiracle and sinistral vent tube. All other *Leptobrachium* tadpoles examined from this site and others throughout Vietnam and Cambodia (N = 46) had a sinistral spiracle, common to most tadpoles, and dextral vent tube, characteristic of the family Megophryidae (McDiarmid and Altig 1999. Tadpoles: The Biology of Anuran Larvae. Univ. Chicago Press, Chicago, Illinois. 444 pp.). Further examination also found that the internal gut coil was reversed and ran in a clockwise direction and that the kidney and associated fat bodies were larger on the left side. Most tadpoles have right-left asymmetry in the size of the kidneys and associated fat bodies, being larger toward the dextral side of the body (Malashichev and Wassersug 2004. BioEssays 26:512–522). This reversal of major asymmetric viscera is a relatively rare congenital disorder known as situs inversus.

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***LEPTODACTYLUS LATRANS* (Caçote Frog). PREDATION.** *Leptodactylus latrans* is a euryphagous anuran that feeds on small frogs, arthropods, fish, mollusks, and annelids (Meneyro et al. 2004. Iheringia, Sér. Zool., Porto Alegre 94[1]:57–61; Sanabria et al. 2005. Rev. Peruana Biol. 12[3]:472–477; Solé et al. 2009. Herpetol. Notes 2:9–15; Teixeira and Vrcibradic 2003. Cuad. Herpetol. 17[1-2]:111–118). On 24 Nov 2011, at 2230 h, in the "Sítio Pinheiros" (7.364°S 39.342°W, WGS84; 693 m elev.), district of Caldas, Barbalha City, Ceará, Brazil, we captured a *Leptodactylus latrans* (79.5 mm SVL) attempting to consume a *Hypsiboas raniceps* (66 mm SVL) (Fig. 1). Although there are records of small frogs in the diet of *L. latrans*, this event is significant because of the size of prey in relation to the predator and because this is the first report of *H. raniceps* in the diet of *L. latrans*. Additionally, these two species are generally found in different ecological niches (Silva and Santos 2011. Herpetologia no Estado de Pernambuco. 1:211–217. IBAMA, Brasília). The specimens were deposited in the Herpetological and Paleoherpetological collection of Federal Rural University of Pernambuco - UFRPE, Recife, Brazil (CHPUFRPE 981 *Leptodactylus latrans*; CHPUFRPE 982 *Hypsiboas raniceps*). This field work was authorized by ICMBio, Permit No. 27143-1.

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FIG. 1. Predation of *Hypsiboas raniceps* by *Leptodactylus latrans* in Barbalha, Ceará, Brazil.

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***LEPTODACTYLUS MYSTACEUS* (Basin White-lipped Frog). PREDATION.** Anurans are known to be preyed upon by a variety of vertebrates and invertebrates (Toledo et al. 2007. J. Zool. 271:270–277). Herein we here report predation by the amblypygid *Heterophrynus* sp. of an adult *Leptodactylus mystaceus*. This species is a medium-sized anuran (males 43–50 mm, females 47–60 mm) (Lima et al. 2006. Guia de Sapos da Reserva Ducke – Amazônia Central / Guide to the Frogs of Reserva Adolpho Ducke – Central Amazonia. Áttema Design Editorial, Manaus, Brazil. 168 pp.) known from Colombia, Venezuela, French Guiana, Guyana, Suriname, northeastern and central Brazil, Ecuador, Peru, and Bolivia (Frost 2011. Amphibian Species of the World: an Online Reference. Version 5.5 [31 January 2011]. Electronic database accessible at http://research.amnh.org/vz/herpetology/amphibia/. American Museum of Natural History, New York). It inhabits primary and secondary tropical rainforests, forest edge, and savannah enclaves in forest, flooded, and open environments. It lives on the ground around temporary ponds and other water bodies. It is somewhat adaptable to human modification of its habitat (Heyer and Rodrigues 2010. *In* IUCN 2011. IUCN Red List of Threatened Species. Version 2011.2).

On 23 Nov 2011 at 2030 h, we found an adult *L. mystaceus* being preyed upon by an adult *Heterophrynus* sp. at the edge of a temporary stream on the forest floor in the proximity of Cave Planaltina, Brasil Novo – Pará, Brazil (3.3761°S, 52.5761°W). The size relationship observed in this predation event is consistent with Toledo et al. (2010. Herpetol. Rev. 41[3]:340–341), where solitary, venomous invertebrate predators generally eat prey that are a little shorter or equal to their own size.

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***LIMNONECTES PALAVANENSIS* (Smooth Guardian Frog). ABERRANT COLORATION.** *Limnonectes palavanensis* is a primary forest leaf litter dwelling anuran (Inger and Stuebing 2005. A Field Guide to the Frogs of Borneo, 2nd ed. Natural History Publications [Borneo] Sdn. Bhd. Kota Kinabalu. 201 pp.; Malkmus et al. 2002. Amphibians and Reptiles of Mount Kinabalu [North Borneo]. A.R.G. Gantner Verlag K.G. Ruggell. 424 pp.) that can be found from near sea level to 1502 m elev. (Kueh et al. 2011. Herpetol. Rev. 42:261) in Palawan of the Philippines, and Borneo (Sabah and Sarawak of Malaysia, Brunei Darussalam, and Kalimantan of Indonesia) (Das 2007. A Pocket Guide: Amphibians and Reptiles of Brunei. Natural History Publications [Borneo] Sdn. Bhd. Kota Kinabalu. 200 pp.; Inger 2007. Systematics and Zoogeography of Philippine Amphibia. Natural History Publications [Borneo] Sdn. Bhd. Kota Kinabalu. 370 pp.). *Limnonectes palavanensis* is a small (to 40 mm SVL) anuran, which is recognizable by a characteristic reverse V-shaped ridge in the middle of its smooth and reddish to chocolate brown back with two thin, unbroken dorsolateral groin folds, several posterior dorsolateral dark spots, limbs with dark brown crossbars, as well as unmarked orange yellow chest, abdomen, and undersides of legs (Inger 2005. The Systematics and Zoogeography of the Amphibia of Borneo. Natural History Publications [Borneo] Sdn. Bhd. Kota Kinabalu. 402 pp.; Malkmus et al. 2002, *op. cit.*). Herein we report an aberrant color morph of *L. palavanensis*.

Two aberrantly colored adult *L. palavanensis* were collected on 27 June 2008 (36 mm SVL; 5.5 g) and 2 Dec 2008 (32 mm SVL; 2.9 g), between 1900 and 2200 h, from among dead leaves between a forested hill slope (Geludu Hill) and a gravel village road (Kinasaraban-Bundu Tuhan Road) (5.9989°N, 116.5377°E; 1280 m and 1319 m elev.), Bundu Tuhan, Ranau District, West Coast Division, Sabah, Bornean Malaysia. The frogs had a dark greenish brown back with a white vertebral stripe, limbs with dark greenish crossbars, and a fine white line on the upper surface of each shin, besides the typical posterior dorsolateral dark spots and ventral coloration of *L. palavanensis* (Fig. 1). The anurans were void of the reverse V-shaped ridge on the back. The two frogs were found together with typically colored individuals at a high frequency of 0.29 for the occurrence of the aberrant color morph in that population, and hence, excludes the causal factor of rare variation or random mutation. Further studies on the factors and advantages of such a color morph in *L. palavanensis* by revealing the form and microgeographical range of all color morphs would be informative. Blackburn and Droissart (2008. Herpetol. Rev. 39:208–209) suggested that color polymorphism in anurans contributes towards crypsis, mimicry, and even aposematism. The two specimens (27 June 2008: HEP00541, and 2 Dec 2008: HEP00759) were deposited in BORNEENSIS, the Bornean reference collection of the Institute for Tropical Biology and Conservation, Universiti Malaysia Sabah.

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FIG. 1. An aberrant color morph of *Limnonectes palavanensis* (left) compared to a typically colored morph (right), Bundu Tuhan, ranau, Sabah, Malaysia.

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***LITHOBATES BERLANDIERI* (Rio Grande Leopard Frog), *DRYMOBIUS MARGARITIFERUS* (Speckled Racer), and *PANTHERA ONCA* (Jaguar). SCREAM-CALLING.** Scream-calling in non-social vertebrates (outside of reproductive behavior) is a behavior exhibited by prey that can 1) startle a predator into releasing the prey (startle response), and/or 2) attract a secondary predator (P2) causing the primary predator (P1) to release the prey. Scream-calling has been reviewed in neotropical frogs (Hödl and Gollman 1986. Amphibia-Reptilia 7:11–21) and the P2 condition has been tested in leopard frogs (*Lithobates pipiens*) being predated by gartersnakes (*Thamnophis sirtalis*) under the premise that snakes cannot hear the higher frequency pitch of a distress call and thus will not release a prey based on the call (Schuett and Gillingham 1990. Bull. Chicago Herpetol. Soc. 25:137–142).

Schuett and Gillingham (1990, *op. cit.*) listed three conditions that must be met to validate the presence of scream-calling: 1) a scream call attracts P2; 2) P1 releases the prey upon arrival of P2; and 3) prey escapes predation. Critical to the second condition is that P1 releases the prey prior to physical contact with P2 and exhibits defensive behavior towards P2, presumably distracting possible further predation to the calling prey. Schuett and Gillingham (1990, *op. cit.*) noted that a secondary, minimal startle response could be induced from vibrations created by the scream of the captured prey item. They suggested further testing was warranted in neotropical and temperate regions and with predators of both the prey and P1.

Compared to sympatric large felids, the diet of wild Jaguars (*Panthera onca*) is diverse, with amphibians and reptiles comprising a noticeable portion throughout its range (Brown and López González 2001. Borderland Jaguars: Tigres de la Frontera. Univ. Utah Press, Logan. 170 pp.). In this regard, chelonians appear to be favored (Emmons 1989. J. Herpetol. 23:311–314) followed by iguanas, crocodilians, and large boids. Brown and González (2001, *op. cit.*) mention a Jaguar taken in southern Arizona whose stomach contained numerous frogs of undetermined identity.

On 24 March 2001, a distress call was heard in the Jaguar exhibit at the Belize City Zoo, Belize. The source was determined to be a *Lithobates berlandieri* that had been captured by the hind leg by a *Drymobius magaritiferus* near a pool of water. At this point a video recorder was used to film the frog and snake. The Jaguar became aware of the scream-calls and made its way to within about 1.2 m of the outstretched frog and snake. A crowd of people then gathered and the Jaguar retreated. At this point the recording stopped. After a short while, the frog then struggled free from the snake before escaping the lunge of another *D. margaritiferus* and retreating into the pool with other frogs. A video recording of this event is available at: http://www.youtube.com/watch?v=y38UN6TUl-4.

Although it appears the snake did not release the frog in response to the arrival of the Jaguar, the event involves the appearance of a potential predator of the prey and the P1 after hearing the scream-call of the prey as described by Schuett and Gillingham (1990, *op. cit.*).

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***LITORIA MOOREI* (Motorbike Frog). TEMPERATURE.** Many anurans have some form of resistance to evaporative water loss through the skin (see Tracy et al. 2010. Comp. Biochem. Physiol. A 150:102–108). Very high resistances occur in many burrowing species that form cocoons (Withers 1998. Aust. J. Zool. 46:405–418) but resistances are also relatively high in arboreal frogs (*Litoria* species) in northern Australia from seasonally arid, hot environments (Tracy et al. 2010, *op. cit.*). *Litoria* species from cooler areas generally have lower resistance but there are exceptions: e.g., *Litoria adelaidensis* from south-western Australia has a resistance approximately ten times that of the co-occuring and co-distributed *Litoria moorei* (Tyler and Doughty 2009. Field Guide to Frogs of Western Australia. Western Australian Museum, Perth; Withers 1998, *op. cit.*).

On 28 Dec 2011 we noticed a *Litoria moorei* in a curled piece of bark suspended in a passion fruit vine growing over two dead shrubs about 2.2 m above the ground in a suburban garden in Perth, Western Australia (31.93259°S, 115.81463°E). The frog was in the classic water conserving posture and stayed in that position from when it was first observed at 0830 h until it was last seen at 1911 h. We measured air temperature in the shaded section of the folded bark, ≈ 0.5 cm above the frog. Temperatures ranged from 34.1° to 40.7°C, averaging 37.7°C over 7 measurements made roughly hourly from 1130 to 1900 h. From about 1300 to 1900 h the left side of the head and body were in direct sun with about 1/3 of the upper body surface exposed for most of that time. At the Swanbourne climate station (31.96°S, 115.76°E, ca. 6 km SW of the observation site), shade temperatures peaked at 39.1°C and in the observation period (0830 to 1930 h) averaged 34.4°C (23.3° to 39.1°C), relative humidities averaged 21% (10–34%) and wind speeds 4.5 $m.s^{-1}$ (1.9–6.7; data from http://www.bom.gov.au/products/IDW60901/IDW60901.94614.shtml sites accessed 29 Dec 2011). These represent extreme conditions for Australian frogs (Tracy et al. 2010, *op. cit.*) and are close to or above Critical Thermal Maxima for many frog species from eastern Australia (Brattstrom 1970. Comp. Biochem. Physiol. 35:69–103).

The cutaneous resistance to water loss in *L. moorei* is the second lowest reported in Australian tree frogs (0.5 $s.cm^{-1}$; Tracy et al. 2010, *op. cit.*) and based on predicted patterns of water loss for frogs at air temperatures of 30°C, this species (a comparable sized frog captured that night weighed 28.69 g) would be at 70% of fully hydrated body mass in about 1 hour (Tracy et al. 2010, *op. cit.*). Main and Bentley (1964. Ecology 45:379–382), reported that weight losses of 31–45% were lethal for *Litoria moorei* (as *Hyla moorei*). If water was evaporating freely from the skin, this frog should have suffered extreme water loss leading to lethal levels of dehydration. That it did not, might indicate a facultative capacity to alter skin resistance not detected in the conditions used by Withers (1998, *op. cit.*). It is impossible to reliably estimate body temperature but if this was close to air temperatures then this frog must also have been close to its anticipated critical thermal maximum (mid 30s to low 40s °C for species from warm to hot locations (Tracy et al. 2008, *op. cit.*; 36.2°C for a closely related species, *Litoria aurea*, from eastern Australia, acclimated at 30°C, Brattstrom 1970, *op. cit.*).

Murray et al. (2011. J. Appl. Ecol. 48:163–173) reported chytrid fungus infections in *Litoria moorei* at several locations across south-western Australia and predicted a broad occurrence of

chytrid in south-western Australia. But, there is no evidence of chytrid induced, population decline in *L. moorei* or any other frogs species in this area (Hero et al. 2006. Pacific Cons. Biol. 12:315–320). This may be because frogs often voluntarily expose themselves to high temperatures: coincidentally, or, deliberately, eliminating chytrid fungus infections (Puschendorf et al. 2011. Cons. Biol. 25:956–964; Woodhams et al. 2003. Dis. Aquat. Org. 55:65–67).

Chance observations of frog behavior might give us useful insights into field capacities for frogs not determined by laboratory trials and should also caution us against rash conclusions about impacts of climate change on temperate faunas—frogs might be tougher than we think!

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***PELOBATES CULTRIPES* (Western Spadefoot Toad). DEPREDATION.** One factor in the decline of amphibian populations is the presence of invasive alien species. In addition to invasive alien species, there are examples of native species that have experienced significant population growth and negatively impacted amphibians. The Wild Boar (*Sus scrofa*), native to Europe, as well as domestic varieties descended from it, forming feral populations in various parts of the world, and is considered one of the "100 world's worst invasive species" (Lowe et al. 2004. 100 of the World's Worst Invasive Alien Species. A Selection from the Global Invasive Species Database. The Invasive Species Specialist Group. Species Survival Commission. IUCN. 12 pp. www.issg.org/booklet.pdf). In Spain, as in many other European countries, Wild Boar populations have increased rapidly in recent decades (Rosell et al. 2001. Galemys 13:1–25), leading to an increase in damage to meadows by the rooting activities of the animals. The negative impact on the natural environment is well known (Massei and Genov 2004. Galemys 16:135–145) and their detrimental effect on native herpetofauna has been documented (Jolley et al. 2010. J. Mammal. 91:510–524).

Traces of the rooting activities of the wild boar have become evident in recent years in the Natural Park of Corrubedo (Ribeira, A Coruña, Spain), making this activity a clear threat to amphibian populations, as observed throughout Galicia. Furthermore, in this natural area lives one of the few surviving Galician populations of *Pelobates cultripes*, considered the most endangered amphibian of Galicia (Galán et al. 2010. Bol. Asoc. Herpetol. Esp. 21:90–99), and listed as vulnerable by regional legislation (Xunta de Galicia 2007. Diario Oficial de Galicia 89:7409–7423).

On 23 Feb 2011, the remains of four adult *P. cultripes* were found around the periphery of one of the ponds where this species breeds (Vilar Pond, Natural Park of Corrubedo; 42.5567°N, 9.0228°W). These remains were found in a heavily rooted area showing numerous wild boar tracks, which covered nearly the entire periphery of the pond and nearby areas. The remains consisted of the heads of four adult *P. cultripes*, two of which had adherent pieces of skin (Fig. 1). Along with the heads were remains of the viscera. This date coincides with the breeding period of the species in the area, suggesting these individuals were likely breeding adults.

In the same pond in 2008 several adult *P. cultripes* were found depredated, but with signs of having been eaten by the American Mink (*Neovison vison*), from the marks left on the bodies (Galán and Ferreiro 2010. Bol. Asoc. Herpetol. Esp. 21:30–34). In the present case, however, the many tracks of Wild Boar found near the remains, together with the almost total consumption of the toads, suggest that the predator was the Wild Boar. During March 2008, a group of five Wild Boars were seen on the shore of the pond, rooting in the ground.

Vilar Pond is one of the few areas in the Natural Park of Corrubedo where *P. cultripes* still breeds, but this area has shown a sharp decline of this species in recent years (Galán 2006. Guía dos Anfibios e Réptiles. Parque Natural do complexo dunar de Corrubedo e lagoas de Carregal e Vixán. Xunta de Galicia. Dir. Xeral Conservación Natureza, A Coruña. 91 pp.), as has the whole of Galicia. In recent years an attempt has been made to quantify the number of *P. cultripes* in this area by counting larvae in the months of their maximum presence in aquatic environments (February to April). Samples were taken using a hand net, both at Vilar Pond in the southern part of the Park, where the adult toads were found depredated, and at five ponds in a sandy area located in Olveira in the northern part of the Park. In Olveira there was a notable presence of Wild Boar footprints, wallows, and rooting activities. The sampling results were expressed as the number of larvae captured by hand net passes (number of larvae/number of passes of hand net). During 2006 to 2011, the hand net was passed 100–150 times at each pond, making a similar sampling effort between years and different areas. At Vilar Pond, the number of larvae per pass of the hand net was: 2006: 1.71; 2007: 2.28; 2008: 0.12; 2009: 0.04; 2010: 0.07; 2011: 0.03. In the ponds of Olveira, the number of larvae per pass was: 2006: 0.65; 2007: 0.19; 2008: 0.18; 2009: 0.04; 2010: 0.04; 2011: 0.03.

According to these data, after a relatively high number of larvae during 2006 and 2007, especially in the Vilar Pond, the number decreased markedly, remaining low or very low during 2008–2011. Although quantification of the presence of Wild Boar during these years was not possible, the presence of tracks, trails, and rooting was much lower during 2006 and 2007 than in the following years. The number of observations of Wild Boar in the Park also increased during that time.

During these years, in the Natural Park of Corrubedo there were no other environmental changes that might account for the observed decline in the number of *P. cultripes* larvae, with the exception of the presence of the invasive alien species *Neovison vison*.

The European Wild Boar eats several amphibian species, such as anurans (Kuzmin 1999. The Amphibians of the Former



FIG. 1. Adults of *Pelobates cultripes* devoured by Wild Boar (*Sus scrofa*) in the Natural Park of Corrubedo (Galicia, Spain). These remains were found among an intensely impacted rooting area at the periphery of an amphibian breeding pond.

Soviet Union. Pensoft Publishers, Sofia, Bulgaria. 538 pp.) or Fire Salamanders (Carretero and Rosell 1999. Herpetol. Rev. 30:161). Consumption of European spadefoot toads by boars has been reported in *P. fuscus* (Nöllert 1984. Die Knoblauchkröte. *Pelobates fuscus*. A. Ziemsen Verlag, Wittenberg Luthersadt, Germany. 103 pp.), and *P. cultripes*, even in the Iberian Peninsula (Recuero 2010. *Pelobates cultripes*. Enciclopedia Virtual de los Vertebrados Españoles. Museo Nacional de Ciencias Naturales, Madrid. www.vertebradosibericos.org). However, the most comprehensive study on the effect of *Sus scrofa* (the feral domestic form) on North American *Scaphiopus* and *Spea* is that of Jolley et al. (2010, *op. cit.*). They examined the stomach contents of 68 Wild Boars from the southern United States, and highlighted the vulnerability of *Scaphiopus holbrookii* to depredation by the wild pig because of their terrestrial habits and massive displacements during migrations to breeding ponds (behavior similar to *P. cultripes*). For example, a single wild pig had eaten 49 *S. holbrookii*. This spadefoot was the most prominent of all species of amphibians consumed by pigs (21.4% of amphibians and reptiles and 4.4% of total prey consumed).

Studies similar to those of Jolley et al. (2010, *op. cit.*) have not been carried out in Galicia or Spain, but in view of the observations made at Corrubedo Natural Park the predation exerted by the wild boar may be a serious factor threatening this endangered amphibian.

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***PHYSALAEMUS ALBONOTATUS* (Menwig Frog). PREDATION.** Anurans are commonly predated by several species of vertebrates and invertebrates (Toledo et al. 2007. J. Zool. 271:170–177). Among the invertebrates, water bugs (Hemiptera: Belostomatidae) and spiders (Araneae) are the main predators of frogs in and out of water, with an important role in population control (Toledo 2005. Herpetol. Rev. 36[4]:395–400). *Physalaemus albonotatus* occurs in the states of Mato Grosso and Mato Grosso do Sul in Brazil, and regions of Chaco in Paraguay, Bolivia, and Argentina, adapting well to human disturbances (Aquino et al. 2004. IUCN Red List of Threatened Species. Ver. 2011.2. http://www.iucnredlist.org/). The only published predation of this species was by birds (Rodrigues and Arruda 2006. Herpetol. Rev. 37[2]:212).

On 17 March 2011 at 1709 h in a Cerrado area in central-western Brazil, we recorded an adult *P. albonotatus* being preyed upon by a spider of the family Lycosidae (Fig. 1). The event was observed at the margins of a swamp surrounded by exotic grass (*Urochloa* sp.), in the county of Vincentina, state of Mato Grosso do Sul (22.4841°S, 54.3946°W). Although this event is the first record of spider predation on *P. albonotatus*, spiders are considered an important predator of small frogs, with several records in the Neotropical region (Menin et al. 2005. Phyllomedusa 4[1]:39–47).

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***PHYSALAEMUS CUVIERI* (Cuvier's Foam Froglet). ALBINISM.** *Physalaemus cuvieri* is a small, nocturnal frog that occurs in Brazil and other portions of South America (Haddad et al 2008. Atlantic Forest Amphibians. Neotropica Press, São Paulo. 243 pp.; Frost 2011. Amphibian Species of the World: an Online Reference. Version 5.5 (31 January 2011). Electronic database accessible at http://research.amnh.org/vz/herpetology/amphibia/. American Museum of Natural History, New York). Herein we report an albino adult male *P. cuvieri* (23.8 mm SVL; Fig. 1) collected during the rainy season on 19 Nov 2010 in a little stream associated with a swamp in a transitional area with Atlantic Forest fragment, near the city of Morro do Pilar, near Serra do Cipó National Park, state of Minas Gerais, Brazil (19.1417°S, 43.3935°W, 724 m elev.). This specimen was observed in a nocturnal chorus on wet ground and was associated with conspecifics and 10 additional anuran species: *Dendropsophus branneri, D. elegans, D. minutus, Hypsiboas albopunctatus, H. pardalis, Scinax eurydice, S. fuscovarius, Phyllomedusa burmeisteri, Leptodactylus fuscus,* and *L. labyrynthicus*. The specimen had opaque eyes, a roseate coloration of the body, and blood vessels visible through the skin. Albinism in anurans has been reported in tadpoles, e.g., *Hypsiboas semilineatus* (Santos et al. 2010. Herpetol.



FIG. 1. Spider of the Lycosidae family preying on a juvenile *Pyhsalaemus albonotatus*, in the municipality of Vincentina, state of Mato Grosso do Sul, Brazil.



FIG. 1. Adult male albino *Physalaemus cuvieri* from Minas Gerais, Brazil.

Rev. 41:474), and adults, e.g., *Tomopterna cryptotis* (Wojnowski et al. 2010. Herpetol. Rev. 41:482). Sazima and Di Bernardo (1991. Mem. Inst. Butantan 53:167–173) suggested that albinism should be more frequent in nocturnal and cryptic species, but this hypothesis is difficult to evaluate in anurans (Toledo et al 2011. Herpetol. Notes 4:145–146). The specimen was deposited in the herpetological collection of Museu de Ciências Naturais da Pontifícia Universidade Católica de Minas Gerais (MCNAM 15022), Belo Horizonte, Minas Gerais, Brazil.

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***RHINELLA GRANULOSA* (Common Lesser Toad), *XENODON MERREMII*. PREDATION.** Anurans are important prey for numerous taxa, and are predated in all life stages from eggs to adults (Duellman and Trueb 1994. Biology of Amphibians. Johns Hopkins University Press, Baltimore, Maryland. 670 pp.; Wells 2007. The Ecology and Behavior of Amphibians. Univ. Chicago Press, Chicago, Illinois. 1148 pp.). Toads from the genus *Bufo* (= *Rhinella*) are described as the preferred prey of *Xenodon merremii*, which is immune to their cutaneous toxins (Vanzolini et al. 1980. Pap. Avul. Zool. 34:1–9). This diurnal snake is widely distributed in South America, occurring from the Guianas to Argentina, mainly in open areas (Hoogmoed 1985. Zool. Meded. 8:79–88; Marques et al. 2001. Serpentes da Mata Atlântica - Guia Ilustrado. Editora Holos. Ribeirão Preto, São Paulo. 184 pp.; Vanzolini et al. 1980, *op. cit.*). *Rhinella granulosa* is distributed in northeastern Brazil, predominantly in the Caatinga domain, in the states of Minas Gerais, Bahia, Espírito Santo, Alagoas, Ceará, Paraíba, Pernambuco, Piauí, Rio Grande do Norte, and Sergipe (Narvaes and Rodrigues 2009. Arq. Zool. 40[1]:1–7). Here we report predation of an adult *R. granulosa* by *X. merremii*.

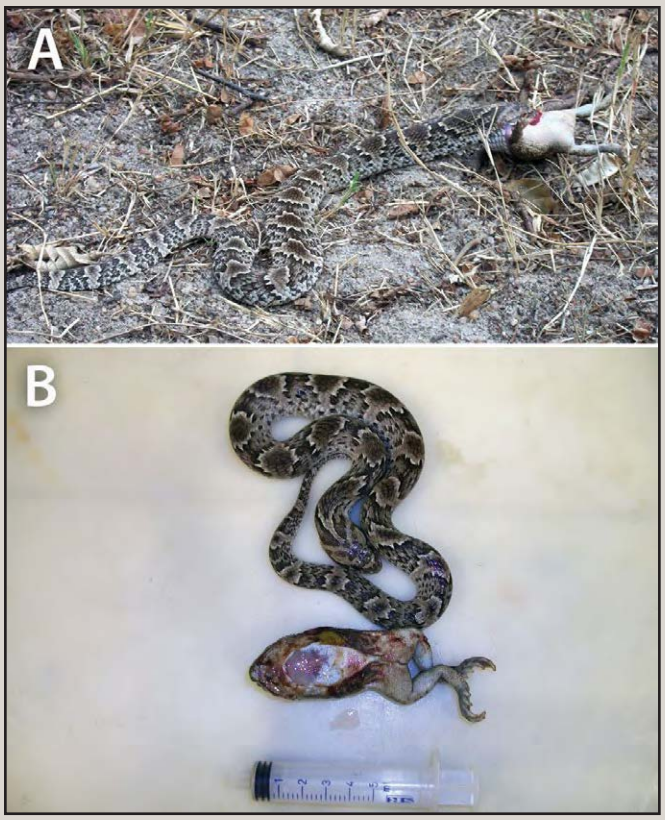


FIG. 1. A) Adult *Rhinella granulosa* being predated by an adult *Xenodon merremii*, in a fragment of the Atlantic Forest in the municipality of Macaíba, Rio Grande do Norte state, Brazil; B) View of the snake and toad after regurgitation.

On 21 Aug 2011 at ca. 1500 h, at Mata do Olho D'água in the municipality of Macaíba in Rio Grande do Norte, Brazil (93.24142°N, 224.8828°W, WGS84; elev. 40 m), we observed a *X. merremii* on the edge of a trail, under direct sunlight on exposed soil. This snake grabbed a *R. granulosa* by its forelimbs with the ventral region facing upwards (Fig. 1). After the snake totally consumed its prey, both were collected and taken to the laboratory and deposited together in the Herpetological Collection of the Department of Botany, Ecology and Zoology at the Federal University of Rio Grande do Norte, Brazil (CHBEZ 3779). This is the first report of the predation of *R. granulosa* by *X. merremii* in the Northeastern Atlantic Forest.

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***RHINELLA JIMI* (Cururu Toad). DIET.** *Rhinella jimi* is a euryphagous toad that feeds on centipedes, insects, spiders, frog, small snakes, small rodents, and bats (Gouveia et al. 2009. Herpetol. Rev. 40:210; Peña et al. 1996. Rev. Biol. Trop. 19[5]:702; Santos et al. 2010. Biotemas 23[2]:215–218). On 10 May 2011 at 1830 h we captured an adult *Rhinella jimi* (143.5 mm SVL; 340.0 g after prey removal) in Área do Horto Florestal Olho D´água da Bica (6.5°S, 36.73°W, WGS84; 667 m elev.), City of Cuité, Paraíba, Brazil. Upon dissection, we found a *Rhinella granulosa* (37.0 mm SVL, 5.1 g) in the *R. jimi* stomach; the prey had been ingested head-first. Small frogs are infrequent in the diet of adult *R. jimi* (Peña et al. 1996, *op. cit.*). This is the first report of *R. granulosa* in the diet of *R. jimi*. The frogs were deposited in the Herpetological Collection of the Paleoherpetological and Herpetological Laboratory of the Universidade Federal Rural de Pernambuco - UFRPE, Recife, Brazil (CHPUFRPE 979 *R. jimi* and CHPUFRPE 980 *R. granulosa*). This research was authorized by the ICMBio, permit number 23024-1.

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***RHINELLA MARINA* (Cane Toad). DIET.** *Rhinella marina* is an opportunistic predator that "will apparently eat almost every animate object it can catch" (Zug and Zug 1979. Smithson. Contr. Zool. 284:1–58). In both its native and introduced range, the diet of non-larval *R. marina* is primarily composed of a wide range of terrestrial invertebrates (Lever 2001. The Cane Toad. The History and Ecology of a Successful Colonist. Westbury Academic and Scientific Publishing, Otley, U.K.), especially beetles, ants, and termites (Murray and Lampo 1996. J. Herpetol. 30:73–76; Strüssmann et al. 1984. J. Herpetol. 18:138–146; Zug and Zug 1979, *op. cit.*). Except for the consumption of smaller conspecifics

(Pizzatto and Shine 2008. Behav. Ecol. Sociobiol. 63:123–133), and the suggestion that Cane Toads actively prey on chicks of Australian ground-nesting bee-eaters (Boland 2004. Biol. Conserv. 120:53–62, but see opposing results in Beckmann 2011. Impacts of the Invasive Cane Toad on Australia's Native Birds. PhD thesis, Univ. Sydney, Sydney), there are few cases reporting small vertebrates in the stomach contents of *R. marina*.

During the course of our studies on *R. marina* in tropical northern Australia we recorded 10 *Ramphotyphlops* sp. (Typhlopidae) in the guts or feces of ten individual toads (Table 1, Fig. 1). The snakes were identified by L. Pizzatto and R. Somaweera using Cogger (1992. Reptiles and Amphibians of Australia, 5th ed. Reed Books, Chatswood, NSW, Australia) as a guide. Specimens that were preserved in ethanol were deposited in the Museum and Art Gallery of the Northern Territory, in Darwin. Our results show that toads in northern Australia consume native *Ramphotyphlops unguirostris* and *R. guentheri* and introduced *R. braminus*. However the frequency of predation of blindsnakes by Cane Toads may be trivial (only 0.6% of the dissected Cane Toads from Lake Argyle contained blindsnakes). The 10 records reported herein are out of > 3,000 Cane Toads collected between 2008 and 2011 that we have dissected to examine gut contents or collected and kept overnight for other studies.

In the Philippines, snakes of the genus *Typhlops* were also found in very low numbers in the stomach contents of *R. marina* (19 out of ca. 5,000 stomachs examined; Rabor 1952. Copeia 1952:281–282). Most of our records of Cane Toads ingesting typhlopids occurred during the wet season (December to April) or early dry season (May), possibly as a result of flooding which induces fossorial snakes to move to the soil surface, rendering them susceptible to predation. In record 10 (Table 1), an entire, undigested *R. braminus* was found in the intestine of a Cane Toad, and in two other cases (records 1 and 3, Table 1) undigested *R. braminus* and *R. guentheri* were found in the feces. We speculate that these burrowing snakes were probably ingested alive, moved through the toad stomach, and found their way to the intestines, where they died from anoxia rather than succumbing to



FIG. 1. Whole *Ramphlotyplops braminus* (left; record 9: TL = 101 mm) and *R. guentheri* (right; record 3: TL = 225 mm), recovered from the intestines and feces of Cane Toads (*Rhinella marina*) in northern Australia.

TABLE 1. Typhlopid snakes preyed on by Cane Toads (*Rhinella marina*) in northern Australia. TL = total length, SUL = snout–urostyle vent. NT = Northern Territory, WA = Western Australia.

# Record	Date	Prey species	Prey TL	Location	Comment	Toad SUL	Toad sex
1	28 Feb 2009	*Ramphotyphlops braminus*	94	Darwin, NT 12°24'S, 130°51'E	In feces recovered from calico bag in which toads were kept overnight	—	—
2	2 Mar 2009	Unidentified typhlopid	105	Adelaide River, NT 12°14'S, 130°06'E	In the stomach; snake head was digested	147.2 (without the head)	F
3	4 Mar 2009	*R. guentheri*	225	Beatrice Hill, NT 12°37'S, 131°18'E	As for #1 (Fig. 1)	—	—
4	Nov 2009	*R. braminus*	108	Palmerston, NT 12°30'S, 130°59'E	In the stomach of a road-killed toad	90	M
5	12 Feb 2010	*R. guentheri*	76	Mary River National Park, NT 12°54'S, 130°39'E	Regurgitated live	80	M
6	24 Feb 2010	*R. braminus*	105	Palmerston, NT 12°29'12"S, 130°57'59"E	In the stomach; snake head was partially digested	105.7 (without the head)	M
7-8	Nov 2010	2 unidentified typhlopids	—	Eastern Lake Argyle, WA 16°29'S, 128°75'E	In the intestines of 2 out of 314 toads from same locality; partially digested	104.7, 122.6	F, F
9	Apr 2011	*R. unguirostris*	212	Kununurra, WA 15°39'S, 128°42'E	Regurgitated live	120	F
10	2 May 2011	*R. braminus*	101	Middle Point, NT 12°34'S, 130°18'E	In the intestine (Fig. 1)	123	F

the toad's digestive secretions. The predominance of the exotic *R. braminus* in our samples might reflect local abundance, the relatively smaller body size facilitating consumption, or perhaps specific behavior that facilitates predation.

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***RHINELLA MARINA* (Cane Toad). CROCODILE PREDATION.** *Rhinella marina* has had great success in invading new habitats and is considered one of the world's top 100 most invasive species. There are few recorded successful predators of the large, highly toxic adults in its introduced range. Because *R. marina* possess large parotid glands that produce bufotoxins, toxic skin secretions which cause cardiac distress when consumed, it is assumed that few potential predators can safely consume the adult toads (Toledo and Jared 1995. Comp. Biochem. Physiol. A. 111:1–29). There are limited reports of successful predators of adult and large juvenile *R. marina* in the toad's native range of Central and South America (Zug and Zug 1979. Smithson. Contr. Zool. 284:1–58). In Australia, where introduced *R. marina* has attained particularly high adult densities, populations of reptilian anurophagous predators have experienced notable declines (Shine 2010. Q. Rev. Biol. 85:253–291). While some native Australian snake species have begun to evolve morphologies that prevent the ingestion of *R. marina* (Phillips and Shine 2004. Proc. Natl. Acad. Sci. USA 101:17150–17155), Freshwater Crocodiles (*Crocodylus johnstoni*) continue to be negatively affected by *R. marina* consumption (Letnic et al. 2008. Biol. Conserv. 141:1773–1782). Herein we provide evidence that the American Crocodile (*Crocodylus acutus*) found in the native range of *R. marina* is an active predator of adult *R. marina*.

In late June through early July 2011, we observed two juvenile *C. acutus* (~1 m long) around a pond in the Santa Cruz area of Gamboa, Panama. These juveniles were consistently observed around the same pond three to four nights a week for two weeks. On the evening of 1 July 2011, we observed one of the juvenile *C. acutus* with an adult male *R. marina* in its mouth (Fig. 1). Although the fate of the toad is unknown, we did not locate the body of the dead toad on the following day and assume that it was killed and eaten by the juvenile *C. acutus*. After observing the juvenile *C. acutus* with the *R. marina* in its mouth, we continued to see the same two juvenile *C. acutus* around the same pond during the following week, suggesting that ingestion of the adult *R. marina* was not fatal to the crocodile. This observation suggests that, unlike their Australian congeners, *C. acutus* can safely consume adult *R. marina*; however, this apparent difference in the ability to consume *R. marina* deserves further study.

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***SCINAX FUSCOMARGINATUS* (Brown-bordered Snouted Treefrog). AMELIA.** *Scinax fuscomarginatus* is a small tree frog belonging to the *S. ruber* clade (Faivovich 2002. Cladistics 18:367–393; Faivovich et al. 2005. Bull. Am. Mus. Nat. Hist. 294:1–240.). This species occurs from southeastern Brazil to eastern Bolivia, Paraguay, and northwestern Argentina, inhabiting open areas such as those of the Pantanal and Cerrado biomes (Brasileiro et al. 2005. Biota Neotrop. 5[2]:93–109; Toledo and Haddad 2005a. J. Herpetol. 39[3]:455–464; Toledo and Haddad. 2005b. J. Nat. Hist. 39[32]:3029–3037). On 12 Feb 2011 at 1900 h, we observed a *S. fuscomarginatus* froglet without hind legs developed (MZUFV 11193; Fig. 1). The observation occurred in a swampy area (16.1118°S, 45.5451°W, 532 m, SAD 1969) in the rural zone of the municipality of Riachinho, Minas Gerais state, Brazil. The specimen had emerged from the water and was crawling on the grasses at the margin of a permanent pond.

Amphibians are often exposed to agents that cause malformations because they have permeable skin and shell-less eggs whose contents are directly exposed to the environment and readily absorb substances (Blaustein and Johnson 2003. Front. Ecol. Environ. 1[2]:87–94). Malformations that include the partial or total absence of limbs have rarely been reported in Brazilian amphibians (Vizotto et al. 1977. Naturalia 3:35–43). Some studies suggest that selective predation may be sufficient to account for the vast majority of deformities in natural populations of amphibians (Ballengée and Sessions 2009. J. Exp. Zool. 312B: 1–10). This observation occurred in an area highly disturbed by livestock activity.

We thank Agroflor Engenharia e Meio Ambiente for financial and field support.



FIG. 1. Juvenile *Crocodylus acutus* with an adult male *Rhinella marina* in its mouth. Photo taken on the evening of 1 July 2011 in the Santa Cruz area of Gamboa, Panama.



PHOTO BY M. R. MOURA

FIG. 1. *Scinax fuscomarginatus* (MZUFV 11193) collected in the municipality of Riachinho, Minas Gerais state, Brazil.

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***TRACHYCEPHALUS NIGROMACULATUS* (Black-spotted Casque-headed Treefrog). PREDATION.** Snakes are well-known predators of frogs (Greene 1997. Snakes The Evolution of Mystery in Nature. Univ. California Press, Berkeley, California. 366 pp.). On 20 Jan 2008 at 1750 h, we observed a *Trachycephalus nigromaculatus* being consumed by the snake *Bothrops leucurus* (Fig. 1) in the Atlantic Forest at Potiraguá Municipality, Bahia, Brazil. When disturbed, the snake immediately regurgitated the frog. This is the first report of predation of *Trachycephalus* by *Bothrops* in Brazil. The *T. nigromaculatus* was verified by Ivan Nunes at Museu Nacional do Rio de Janeiro MNRJ, Rio de Janeiro, Brazil, and is deposited in the amphibian collection of Museu de Zoologia da UFBA, Universidade Federal da Bahia, Salvador, Brazil (MZUFBA 7825).

PHOTO BY THIAGO MIRANDA



FIG. 1. *Trachycephalus nigromaculatus* being consumed by *Bothrops leucurus* in Potiraguá, Bahia, Brazil.

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***TRACHYCEPHALUS TYPHONIUS* (Milky Treefrog). PREDATION.** *Trachycephalus typhonius* is distributed from the lowlands of tropical Mexico south to northern Argentina (Frost 2011. Amphibian Species of the World. Electronic database accessible at <http://research.amnh.org/vz/herpetology/amphibia/>, American Museum of Natural History, New York). Species of this genus are known to emit a noxious skin secretion when handled, which is extremely irritating to mucous membranes and has been reported as being an antipredator defense (Leary and Razafindratsita 1998. Amphibia-Reptilia 19:442–446; Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna Between Two Continents, Between Two Seas. Univ. Chicago Press, Chicago, Illinois. 934 pp.). Probably due to this strategy, few predators have been reported. Two species of snakes, *Leptophis ahaetulla* (Prado 2003. Herpetol. Rev. 34:231–232) and *Liophis poecilogyrus*



COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND

FIG. 1. *Trachycephalus typhonius* being preyed upon by *Leptodactylus labyrinthicus* in Corumbá, Mato Grosso do Sul State, Brazil.

(Albuquerque and Di-Bernardo 2005. Herpetol. Rev. 36:325; Silva Jr. et al. 2003. Herpetol. Rev. 34:69–70) have been reported to prey upon adult *T. typhonius*.

On 27 Oct 2011 at 2000 h, we observed predation of *T. typhonius* by *Leptodactylus labyrinthicus* (Fig. 1) along the margin of the Arigolândia stream, Urucum plateau, in the city of Corumbá, Mato Grosso do Sul State, central Brazil (19.198427°S, 57.635756°W, WGS84). After predation, the *L. labyrinthicus* was observed for one hour to check for any ill effects, and we noted none. This is the first report of predation on *T. typhonius* by an anuran.

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***UPEROLEIA RUGOSA* (Wrinkled Toadlet). BEHAVIOR.** *Uperoleia rugosa* is a small (20 mm) myobatrachid, native to semi-arid inland areas of New South Wales, Australia. During the breeding season, frogs congregate around temporarily flooded grasslands and semi-permanent ponds. Male territoriality and fighting behavior has been recorded (Robertson 1986. Anim. Rev. 34:763–772). Since then, however, this genus has undergone several revisions and the population for which this behavior was originally recorded is now recognized as a different species (*Uperoleia laevigata*, Davies and Littlejohn 1986. Trans. Royal Soc. South Australia 110:111–143). Here I report on male aggression and fighting behavior for a population currently recognized as *U. rugosa*, several hundred kilometers from the Robertson study site.

On the 29 and 30 Nov 2010, 48 mm of rain fell over the Macquarie Marshes, a semi-permanent wetland, in the arid zone of northern central New South Wales. This was the first significant rainfall for three months. This rainfall filled a grassy depression (30.8619°S, 147.4793°E; GDA 94) on the edges of a Black Box (*Eucaplyptus largiflorens*) woodland to a depth of ca. 5 cm. From 2200–2300 h on 30 Nov, I observed over 20 male-male aggressive interactions and physical combat (air temp. 23°C). The observed behavior was as described in Robertson (1986, *op. cit.*). A calling male would emit a call different from its usual advertisement

PHOTO BY DAVE HERASIMTSCHUK



FIG. 1. Two male *Uperolia rugosa* engaged in a wrestling bout, Macquarie Marshes, Australia.

call, and start to move toward another male who had started to call near it. The first male would locate the second with touch, and engage in a wrestling bout (Fig. 1). The males could fight for up to 5 min, throwing each other numerous times. The loser of the battle, the one which was thrown last, would move away and the winner would resume normal calling. Robertson (1986, *op. cit.*) supposed the males to be defending a calling site large enough to prevent acoustic interference from other males, as the territories contain no resources and are not oviposition sites.

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TESTUDINES — TURTLES

***CARETTA CARETTA* (Loggerhead Sea Turtle). REPRODUCTION.** *Caretta caretta* eggs are classified as either normal or odd shaped. Normal eggs are typically about 4.0 cm long, weigh on average 36 g, and are spherical in shape with slightly flexible shells (Van Buskirk and Crowder 1994. Copeia 1994:66–81). Odd shaped eggs (e.g., dumbbell, elliptical, and pear-shaped) have previously been documented, some with multiple yolks enclosed within varying levels of tapered uninterrupted shell and others without yolk (Miller 1985. *In* C. Gans et al. [eds.], Biology of the Reptilia, Vol. 14A, pp. 269–328. Wiley-Interscience, New York; Miller 1999. *In* K. L. Eckert et al. [eds.], Research and Management Techniques for the Conservation of Sea Turtles, pp. 124–129. IUCN/SSC Marine Turtle Specialists Group Pub. No. 4). Irregularly shaped eggs result from a malfunction within the oviduct (Solomon and Baird 1979. Oceanography and Marine Biology Annual Review 17:347–361).

Herein, we provide documentation of irregularly large (i.e., 2x–3x larger than average) *C. caretta* eggs of varying shape, and length in one nest in northeastern Florida. Three irregular eggs with lengths of 9 cm (122.05 g), 12 cm (156.63 g), and a third, which appeared as though it had hatched, was 15.2 cm long (with a dry weight of 13.59 g) (Fig. 1), were collected from a single *C. caretta* nest deposited on 20 June 2010 and located 16 km N of the St. Augustine Inlet within the Guana-Tolomato-Matanzas National Estuarine Research Reserve, Florida, USA (30.0477°N, 81.3288°W; datum WGS84). Along with these three larger, oddly-shaped eggs, the nest was found to contain 86 hatched eggs, 2 dead hatchlings, 3 pipped (partially hatched) dead, and 65



FIG. 1. Three large irregularly-shaped *Caretta caretta* eggs documented in a single nest in northeast Florida.

whole, unhatched, undamaged eggs for a total clutch count of 154 eggs. The clutch depth was 56 cm, measured shortly after oviposition. Hatchlings emerged on 13 August 2010 and the nest was evaluated for reproductive success on 16 August 2010.

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***GOPHERUS AGASSIZII* (Agassiz's Desert Tortoise). SCUTE DYSECDYSIS / SCUTE SLOUGHING.** Tortoises have been observed with damaged or missing scutes, sometimes penetrating deep enough to expose the bone of the carapace or plastron. Suggested causes for such damage include disease (e.g., bacterial infection) or toxicosis (Jacobson et al. 1994. J. Zoo Wild. Med. 25:68–81; Seltzer and Berry 2005. Science of the Total Environment 339:253–265, Rose et al. 2001. J. Wildl. Dis. 37:223–228), although in many cases no direct cause has been confirmed. Shell necrosis in aquatic turtles can be caused by algae, fungi, and later stages of bacterial infection (Hunt 1958. Herpetologica 14:45–46). In many instances dysecdysis in tortoises may be secondary to trauma or infection of the integument (Jacobson 1994. J. Zoo Wildl. Med. 25:2–17).

Desert ttortoises of the southwestern U.S. are exposed to numerous detrimental impacts, both natural and anthropogenic. Fire has been documented to cause injuries and mortalities within natural populations of tortoises in the Mojave Desert (Homer et al. 1998. J. Wild. Dis. 34:508–523; Lovich et al. 2011. Fire Ecol. 7:75–87; Woodbury and Hardy 1948. Ecol. Monogr. 18:145–200) and in the Sonoran Desert (Esque et al. 2002. *In* T. R. Van Devender [ed.], The Sonoran Desert Tortoise: Natural History, Biology, and Conservation, pp. 312–333. University of Arizona Press & Sonoran Desert Museum, Tucson, Arizona; Esque et al. 2003. Southwest. Nat. 48:103–111). Herein, we document two instances of tortoise scute injury/ regrowth and dysecdysis due to natural and fire-related damage.

In July 2005, wildfire consumed 2767 ha of Mojave Desert habitat in southern Nevada ~75 km NW of Las Vegas. In 2006, we found 15 tortoises residing within the burned habitat, including two tortoises with fire-related injuries. One adult male tortoise (266 mm midline carapace length) in particular had suffered severe burns, including damage to the scutes and bone of the

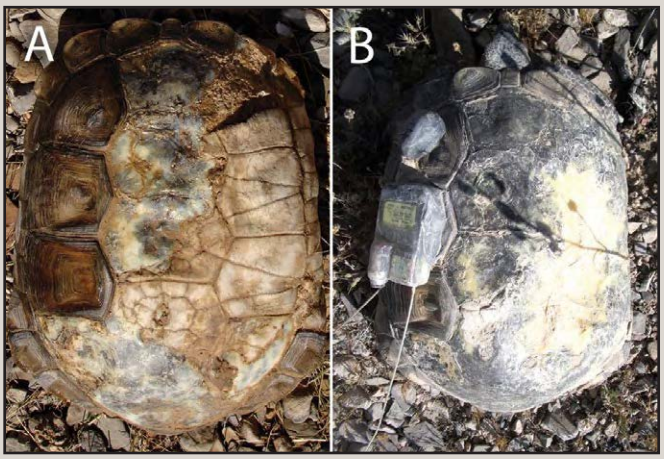


FIG. 1. A) Burned tortoise when first observed in 2006. B) Exposed bone and dermal tissue slowly being replaced with more keratinaceous tissue by 2009.

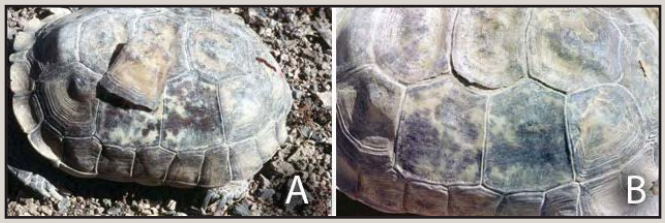


FIG. 2. A) Sloughed costal scutes first observed in 2003. B) Costal scutes in 2006 with vertebral scutes appearing to be loosened.

carapace and to the foreleg where scales appeared to have been melted and fused together (Fig. 1A, B). However, the tortoise's muscle tone and mass appeared to be normal. We attached a radio transmitter and GPS logger to the costal scutes in order to monitor the tortoise's health progress and movements. This tortoise was monitored monthly for the next 3 years. It exhibited annual home-range sizes and movements similar to tortoises that had not been burned but still resided in the same area. Prior to being lost in July 2009 due to transmitter detachment, this tortoise was observed with the bone on its right side becoming depressed and appearing to grow an opaque keratinaceous tissue over the previously exposed bone similar to the scars depicted in Lovich et al. (*op. cit.*), although no evidence of mortality was found.

In a second instance, we documented the sloughing of entire scutes from a tortoise under natural circumstances in Rock Valley, Nevada National Security Site, Nye Co., Nevada, USA, where long-term studies of *Gopherus agassizii* have been ongoing (Medica et al. 1975. Copeia 1975:630–643; Turner et al. 1987. Copeia 1987:974–979; Medica et al. *In press.* J. Herpetol.). In 2003, an adult male tortoise known to be 40 years old was observed with 4 costal scutes (number 2 and 3 on the right and left) that apparently had been sloughed from the lower keratinized fibrillar connective tissue layer. This sloughing of costal scutes exposed a smooth mottled layer very similar to that exhibited by the burned tortoise described above. Subsequently, the 2003 tortoise was recaptured in 2006 at 43 years of age with what appeared to be the initiation of the 3rd and 4th vertebral scutes beginning to slough along their anterior edges (Fig. 2A, B). The cause of the delaminating condition of this tortoise's scutes was not determined.

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***MACROCHELYS TEMMINCKII* (Alligator Snapping Turtle). GROWTH RATE.** *Macrochelys temminckii* is the largest freshwater turtle in North America, but little is known about rates of growth and ages at maturity in the wild (Ernst and Lovich 2009. Turtles of the United States and Canada. Johns Hopkins University Press, Baltimore, Maryland. 827 pp.; Pritchard 2006. The Alligator Snapping Turtle: Biology and Conservation. Krieger Publ. Co. Malabar, Florida. 152 pp.). Studies of specimens collected by commercial harvesters in Louisiana, Arkansas, and Mississippi (Dobie 1971. Copeia 1971:645–658; Tucker and Sloan 1997. Chelon. Conserv. Biol. 2:587–592) indicate these turtles require 11–21 years of growth to achieve sexual maturity. Harrell et al. (1997. Herpetol. Rev. 28:128–129) also reported that recaptured subadults (approximately 240–270 mm straight midline carapace length [CL]) in Louisiana grew a mean 13.3 mm CL per year. No known growth data have been published for *M. temminckii* from Florida. In this note, we provide data regarding growth rates of immature *M. temminckii* captured during a mark-recapture study in the upper Santa Fe River in northern Florida between August 2004 and October 2011. These turtles are part of the genetically unique Suwannee River drainage population that occurs at the southeastern edge of the species range (Roman et al. 1999. Conserv. Biol. 13:135–142).

Five immature *Macrochelys temminckii* were captured multiple times with inter-capture time intervals that allow estimation of growth rate (Table 1). Although absolute annual growth rates (CL) were similar among individuals, the annual percent increase in CL was negatively correlated with CL at first capture (Pearson Correlation, r = -0.965, p = 0.008). If this small sample is representative of the population in the upper Santa Fe River, approximately 19 years of growth would be required to reach sexual maturity by females (330 mm CL) and 22 years by males (370 mm CL). These data suggest *M. temminckii* in the upper Santa Fe River may exhibit delayed sexual maturity at least as great as reported for individuals in Louisiana, Arkansas, and Mississippi.

TABLE 1. Growth rates (straight midline carapace length [CL]) of five immature Alligator Snapping Turtles (*Macrochelys temminckii*) in the upper Santa Fe River.

CL (mm) (1st capture)	CL (mm) (2nd capture)	Days between captures	Growth rate (mm/day)	Growth rate (mm/yr)	Annual % increase (mm)
125	156	850	.036	13.3	10.6
134	173	1035	.038	13.75	10.3
194	215	401	.052	19.11	9.9
241	258	341	.050	18.20	7.6
290	313	445	.052	18.86	6.5

Our estimates are based on a small sample and certainly need to be supplemented by additional growth data to determine whether they are representative of the Suwannee River drainage population in general. However, the limited available data amplify the importance of continued conservation efforts directed at this genetically unique *M. temminckii* population.

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***MESOCLEMMYS TUBERCULATA* (Tuberculate Toad-headed Turtle). BEHAVIOR.** In general, chelonian movement patterns can be divided into two groups: intrapopulational (short-range) and extrapopulational (long-range) (Gibbons et al. 1990. Life History and Ecology of the Slider Turtle. Smithsonian Institution Press, Washington, D.C. 368 pp.). The first one is related with feeding, basking, courtship and mating, hiding, and dormancy, while the second one is linked with seeking food resources, nesting, mate seeking, migration, travel from nest by juveniles and departure from unsuitable habitats. Understanding these strategies is important for good conservation planning for these reptiles (Sutherland 1998. Anim. Behav. 56:801–809). However, opportunities for observing these behaviors under natural conditions may be difficult and rare, thus observations made on captive animals may offer important insights. This study describes the climbing ability in *M. tuberculata* under captive conditions. In 2010 and 2011, a group of turtles from the state of Ceará were maintained at the Núcleo Regional de Ofiologia da Universidade Federal do Ceará (NUROF-UFC). At least three times per week, specimens were removed from their indoor enclosures and placed in an outdoor enclosure to allow better thermoregulation. During these events, the turtles were able to move within a pool area with rough wall surfaces (2.7 m x 2.1 m x 0.3 m). Four individual *M. tuberculata* were observed climbing short and medium vertical distances on two of the rough-textured walls. This behavior was initiated when the animals rapidly approached the obstacle and took a vertical stance, with the two front limbs on the vertical surface and the rear feet on the ground; they then started the climbing process. They used their sharp claws to gain purchase on the wall, moving upward with alternate limb movements, until their rear limbs were placed over the top of the wall. In some cases vertical displacement was about four times the animal's length (average carapace length [CL] = 6.2 cm). At times the animals would fall during the action, but would quickly resume climbing again. Stress avoidance may have been an incentive for this behavior. When a turtle was approached when near a wall, it would rapidly turn away from the "stresser" and begin trying to climb the obstacle. However, the *M. tuberculata* also climbed the wall in the absence of obviously stressful stimuli. The ability and willingness to climb vertical surfaces may offer these turtles a potential escape or dispersal method, and thus increased survivorship, in their natural environments.

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***TRACHEMYS SCRIPTA ELEGANS* (Red-Eared Slider). REPRODUCTION.** Female body size for slider turtles at sexual maturity has been investigated extensively through the use of oxytocin induction, X-rays, or dissection of turtles to differentiate between mature and immature individuals based on the presence of eggs or sufficiently enlarged ovarian follicles. Geographic variation in female size at maturity is reported for populations of *Trachemys scripta scripta* where populations living in a thermally heated lake near a nuclear reactor matured at a plastron length (PL) of 200 mm versus a PL of 160 mm for populations living in a natural habitat (Gibbons and Greene 1990. *In* J. W. Gibbons [ed.], Life History and Ecology of the Slider Turtle, pp. 124–134. Smithsonian Inst. Press, Washington, D.C.). Mature female *T. s. scripta* as small as PL 140–150 mm were reported, although a minimum PL of 160 mm was proposed as the smallest average size for reproductive maturity (Gibbons and Greene 1990, *op. cit.*). Female *T. s. elegans* in Oklahoma were reported to reach maturity at PL 174–193 mm (Webb 1961. Am. Midl. Nat. 65:193–214) and in Illinois, *T. s. elegans* reached maturity at a minimum PL range of 150–195 mm (Cagle 1950. Ecol. Monogr. 20:31–54). Here, we report a successfully completed nesting event by a *T. s. elegans* female with plastron length less than 150 mm.

Populations of six species of turtles including *T. s. elegans* have been monitored since 1996 at Aquarena Center which borders Spring Lake in Hays Co., Texas, USA (Gaertner et al. 2008. J. Wildl. Dis. 44:519–526; Rose et al. 1996. Southwest. Nat. 56:61–65; Rose et al. 1998. Texas J. Sci. 50:89–92). On 3 June 2011, we observed a small female *T. s. elegans* nesting on a golf course at Aquarena Center. Upon completion, the nest was excavated and clutch size consisted of one egg. Plastron length was measured to the nearest 1.0 mm (PL = 146 mm). This nesting event is remarkable due to the small size of the mature female. Discounting this female, the PL range for nesting *T s. elegans* turtles at Aquarena Center is 167–298 mm. The female was marked, measured, weighed, and released.

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CROCODYLIA — CROCODILIANS

***ALLIGATOR MISSISSIPPIENSIS* (American Alligator). DIET CORRECTION AND GROWTH RATE.** In a note on the diet of *Alligator mississippiensis*, Kim et al. (2011. Herpetol. Rev. 42:269) incorrectly identified an *A. mississippiensis* prey item as *Regina rigida sinicola* (Gulf Crayfish Snake). The snake is actually *Nerodia cyclopion* (Mississippi Green Watersnake), which is already suspected of being a prey item of *A. mississippiensis* (Rossi and Rossi 2003. Snakes of the United States and Canada. Krieger Publ. Co., Malabar, Florida. 520 pp.). To validate the earlier note, we submit here the first report of *R. r. sinicola* as a prey item of *A. mississippiensis*. We also include an estimate of the growth rate from the alligator harvested. The following observation took place at Gus Engeling Wildlife Management Area (GEWMA), Tennessee Colony, Texas, USA.

On 4 June 2011, a female alligator (total length = 1828.8 mm) was harvested during the first annual public alligator hunt at GEWMA (31.939647°N, 95.880145°W; datum WGS 84). After inspection at the hunter check station, the alligator was identified by notched tail scutes as a recapture from an earlier population genetic study at GEWMA (Ryberg et al. 2002. J. Exp. Zool.



FIG. 1. *Regina rigida sinicola* removed from the stomach of a harvested *Alligator mississippiensis*.



PHOTO BY DAVID WIEDENFELD

FIG. 1. Nest of *Caiman latirostris* on a floating "island" of marsh vegetation of about 6 m of diameter at Lagoa do Rio Preto, municipality of Guaratuba, state of Paraná, southern Brazil. Trees and marsh vegetation in the background of the photograph are not part of the floating island, being at ground level and covered by about 2 m of water column.

294:325–333). During that study, this alligator was first captured on 25 July 2000, approximately 1.8 km away from the harvest location (31.936580°N, 95.861038°W; datum WGS 84). The total length of this alligator in 2000 was 1125.0 mm. The alligator grew 703.8 mm over the 10 year, 10 month, 10 day time period (~64.9 mm/year). This growth rate is very similar to those published for wild female alligators of the same size in Louisiana (~60 mm/year; Chabreck and Joanen 1979. Herpetologica 35:51–57). After the alligator was skinned, the stomach was removed and dissected. The only prey item identified was a large female *R. r. sinicola* (SVL = 595 mm; tail length = 149 mm; TCWC 95590; Fig. 1).

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***CAIMAN LATIROSTRIS* (Broad-snouted Caiman). FLOATING NEST.** The Broad-snouted Caiman (*Caiman latirostris*) is a Neotropical crocodilian that occurs from northeastern Brazil to the Plata River basin in Argentina. Nests of the species are made with leaves and other organic matter taken from the soil, and are established next to marginal vegetation at the rivers and lakes banks. Like other crocodilians, nests of this species are eventually affected negatively by fluctuations of water levels, with the flooding of river margins and lakes leading to a decrease in hatching success (Campos and Magnusson 1995. J. Trop. Ecol. 11:351–358). The nests of South American crocodilians are commonly attacked by several predators, such as tegu lizards (*Tupinambis* spp.), carnivorous mammals (e.g., *Nasua nasua*, *Procyon cancrivorous*, and *Cerdocyon thous*), and ants (Campos 2003. Boletim de Pesquisa e Desenvolvimento, Embrapa Pantanal. 22 pp.; Staton and Dixon 1977. U.S. Dept. of the Interior Fish. Wildl. Serv. Res. Report 5. 21 pp.), and the main protection strategy of the species usually consists of a constant vigilance of the nest by the female. However, this strategy is inefficient against small predators like ants, and is of no use at all to avoid fluctuations in water levels.

On 22 January, 2010, we found a nest of *C. latirostris* in a marsh (Fig. 1) at Lagoa do Rio Preto (25.753333°S, 48.713889°W, ca. 3 m elev.), municipality of Guaratuba, state of Paraná, southern Brazilian coast. The area is subject to periodic increases in water level, and to deal with this an individual *C. latirostris* built its nest in a patch of floating vegetation of about 6 m in diameter and that was >50 m from the surrounding upland margins. The nest consisted of a pile of *Fuirena* sp. (Cyperaceae) and *Panicum mertensii* (Poaceae) of about 1 m high, clustered in an area of about 4 m of diameter. Two weeks later, we found several hatchlings in the area. According to a local resident, *C. latirostris* was observed using nests in floating vegetation at the Lagoa do Rio Preto for several years. This represents the first record of a floating nest constructed by *C. latirostris*. Because floating marshes are not covered by water, including during rainfall (Reinert et al. 2007. Rev. Brasil. Ornitol. 15:493–519), we consider that the placement of a nest in floating vegetation represents an important nesting strategy, as it avoid the effects of fluctuating water levels and attack by predators that do not swim.

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SQUAMATA — LIZARDS

***AMEIVA BIFRONTATA* (Cope's Ameiva). ENDOPARASITES.** *Ameiva bifrontata* is known from northern Peru, Colombia, Venezuela, Testigo Island, Dutch Leeward Islands, Margarita Island, Aruba, La Tortuga Island (Uetz and Hallermann 2012. The Reptile Database, www.reptile-database.org, accessed 30 January, 2012). To our knowledge there are no reports of helminths from *A. bifrontata*. The purpose of this note is to establish the initial helminth list for *A. bifrontata*.

Eighteen *A. bifrontata* were examined, collected in November 1968 from Bellavista, (5.6622°S, 78.6756°W, WGS84, elev. 195 m), Cajamarca Region, Peru and deposited in the herpetology collection of the Natural History Museum of Los Angeles County (LACM) as: LACM 76864, 76865, 76868, 76869, 76871, 76862, 76874, 76877, 76878, 76880–76885, 76887–76889. A left lateral incision was made through the body wall and the digestive tract was removed. The esophagus, stomach, small and large intestines were opened longitudinally and searched for helminths utilizing a dissecting microscope. The body cavity was also searched. Helminths were cleared in lactophenol, placed on a microscope slide, coverslipped and studied utilizing a compound microscope.

Found were one species of Nematoda, *Parapharyngodon riojensis* (prevalence, number infected/number examined x 100 = 56%, mean intensity, mean number infected lizards = 2.2 ± 1.4 SD, range = 1–4), and one oligacanthorhynchid cystacanth (Acanthocephala) (prevalence = 6%). Helminths were deposited in the United States National Parasite Collection, Beltsville, Maryland as *P. riojensis* (USNPC 105267) and oligacanthorhynchid cystacanth (USNPC 105268).

Parapharygodon riojensis was described from *Phymaturus punae* from the province of La Rioja, Argentina by Ramallo et al. (2002. J. Parasitol. 88:979–982) and has been reported from *Liolaemus buergeri* and *Phymaturus palluma* from Argentina (Goldberg et al. 2004. Comp. Parasitol. 71:208–214) as well as *Liolaemus boulengeri, L. rothi, L. umbrifer, Phymaturus antofagastensis* and *P. zapalensis* also from Argentina (O'Grady and Dearing. 2006. Oecologia 150:355–361). Two South American species of *Parapharyngodon* (*P. riojensis* and *P. senisfaciecaudus*) have been described in which the ovaries are postesophageal. These two species are separated on the basis of egg morphology: egg shell thin and smooth in *P. senisfaciecaudus*, punctate and thick in *P. riojensis*. Our specimens possessed postesophageal ovaries and eggs with thick, punctate shells. Oligacanthorhynchidae is the only acanathocephalan family to possess robust, pseudoannulate cystacanths, an obvious character of our cystacanth specimen. Acanthocephalans utilize an arthropod intermediate host in which the cystacanth larval stage develops (Kennedy 2006. Ecology of the Acanthocephala. Cambridge University Press, New York. 249 pp.). Since development to the adult form does not occur in *A. bifrontata,* it is best considered as a paratenic (= transport) host. *Ameiva bifrontata* represents a new host record for *Parapharyngodon riojensis* and oligacanthorhynchid cystacanths. Peru is a new locality record for *P. riojensis*; however, undetermined cystacanths have been reported from Peru (Bursey et al. 2001 Comp. Parasitol. 68:21–35).

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***ANOLIS SAGREI* (Brown Anole). SAUROPHAGY.** *Anolis sagrei* is native to Cuba, the Isla de Juventud, the Bahamas, Swan Island, the Islas de la Bahia, Honduras (Schwartz and Henderson 1991. Amphibians and Reptiles of the West Indies: Descriptions, Distributions, and Natural History. University of Florida Press, Gainesville, Florida. xvi + 720 pp.). It also has been introduced to many parts of the world (Kraus 2009. Alien Reptiles and Amphibians: A Scientific Compendium and Analysis. Springer, [Dordrecht, Netherlands], 563 pp.), including Florida as early as 1887 (Garman 1887. Bulletin of the Essex Institute 19:1–29). In Florida, *Anolis sagrei* is known to consume mostly insects (Meshaka et al. 2004. The Exotic Amphibians and Reptiles of Florida. Krieger Publ. Co. Malabar, Florida. 166 pp.), but it has also been documented consuming lizards such as smaller conspecifics (Cochran 1989. Herpetol. Rev. 20:70) and native Green Anoles (*A. carolinensis*) (Campbell and Gerber 1996. Herpetol. Rev. 27:200). In this note, we report *A. sagrei* preying upon a nonindigenous Red-sided Curly-tailed Lizard (*Leiocephalus schreibersii*) in Florida.

On 14 October 2011 at 1614 h, we observed an adult male *Anolis sagrei* at 24305 SW 142 Avenue, Homestead, Miami-Dade County, Florida (25.540744°N, 80.420585°W, WGS84; elev. 4 m).



FIG. 1. *Anolis sagrei* consuming *Leiocephalus schreibersii* in Florida.

This anole was ca. 1 m above ground on a wooden post facing downward and had a neonate *Leiocephalus schreibersii* in its mouth (Fig. 1). The event was observed for ca. 4–5 min, at which time concluded with the *A. sagrei* consuming the *L. schreibersii*. Photographic vouchers were deposited in the Florida Museum of Natural History (UF 166507). This is the first known predation event on *L. schreibersii* in Florida, but also might provide an example for invasional meltdown by which short-term observations of facilitatory interactions between two species might have long-term consequences (i.e., enhancing the impact and/or probability of establishment and spread of the other) (Simberloff and Von Holle 1999. Bio. Invasions 1:21–32), as Florida has the most introduced and established herpetofaunal species in the world (Krysko et al. 2011. Zootaxa 3028:1–64).

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***ASPIDOSCELIS NEOTESSELATA* (Colorado Checkered Whiptail). FRAGMENTED HABITAT.** Valco State Wildlife Area (38.259361°N, 104.705824°W, WGS84; elev. 1445 m), managed by the Colorado Division of Wildlife, is immediately adjacent to the north side of Colorado Hwy 96 (i.e., Thatcher Avenue) in the western metropolitan area of the City of Pueblo, Pueblo Co., Colorado, USA. This small gem of reclamation, commonly known as Valco Ponds, receives numerous visitors in the modes of short rest stops from Hwy 96, day-use hiking and sightseeing, fishing, and birding. The ponds, wetlands, and wildlife areas are mostly reclaimed gravel pits and surroundings, two being no farther than ~20–30 m from the south side of the Arkansas River, which were mined out by the Valco Cement Co. located immediately east of the ponds. Because the surroundings did not appear to include suitable habitat for whiptail lizards, my first visit to Valco Ponds during a herpetological expedition to southeastern Colorado in 1999 was as a rest stop from the rigors of the day rather than the expectation of collecting lizards. However, I unexpectedly began to see hatchling lizards almost immediately after stopping there, all of which proved to be triploid *Aspidoscelis neotesselata* pattern class A (Walker et al. 1997. Herpetologica 53:233–259). Subsequently, using large rubber bands as projectiles, I obtained the following specimens of the species from Valco Ponds for study: 6 September 1999 (University of Arkansas Department of Zoology, UADZ 6657–6667, N = 11); 7 September 1999 (UADZ 6668–6672, N = 5); 10 June 2000 (UADZ 6878–6883, N = 6).

This description of the occupancy of Valco Ponds by *A. neotesselata* A is to show that a moderately large (maximum SVL ~100 mm), triploid, hybrid-derived parthenogenetic species not only subsists in a highly fragmented metropolitan environment which is intensively used by humans, but it is represented there in surprisingly large numbers. Parts of the site that I reference herein include the paved parking lot, a 15–40 m wide grove of mainly Eastern Cottonwood (*Populus deltoides*) between the length of the north side of the lot and the south side of the Arkansas River, a narrow riparian forest trail west of the lot along the river, a road/levee from east of the lot to the river, and two sections of roads/levees between the river and three Valco Ponds of 20, 15.5, and 10 acres stocked with game fish (see http://www.cfo-link.org/downloads/pueblo1.pdf). On 6 September 1999, within minutes of arriving at Valco Ponds, I began to see young-of-year (YOY) of *A. neotesselata* A as I walked along the ~120 m parking lot/Eastern Cottonwood interface. On one occasion I returned to the vehicle where I observed two lizards under it taking refuge from the sun. Lizards were also present along the ~3 m wide forest trail of ~300 m in length running west from the parking lot along the Arkansas River. The only exposed substrate was that of the trail which was critical to the presence of lizards living in this narrow band of habitat where they were frequently forced to retreat from foraging and basking behaviors as humans walk on the trail. Lizards were also observed east of the parking lot on the ~80 m long road/levee north to the river along the west side of the first pond. However, the true extent of the abundance of *A. neotesselata* A at Valco Ponds only became apparent when I explored the elevated narrow road/levee separating the Arkansas River from two of the ponds. This barrier, which is only ~20–30 m in width and 2-3 m above the river, extends eastward ~475 m where it bends northeastward for another ~300 m. Flooding of Valco Ponds by the river is largely prevented by the holding capacity of Pueblo Lake only ~2.05 km upstream to the northwest. The levee supports a complex assemblage of plants consisting of scattered trees (e.g., *Populus deltoides*; non-native Chinese Elm, *Ulmus pumila*; non-native Salt Cedar, *Tamarix ramosissima*, and juniper, *Juniperus* sp.), in addition to growths of grasses and shrubby/tall-growing plants (e.g., Kochia, *Bassia sieversiana*; Sandsage, *Artemisia filifolia*; and Rabbitbrush, *Chrysothamnus nauseosus*) bordering the unpaved road. Ample expanses of well-drained and exposed sandy/gravelly soil on the road, small adjacent areas cleared by ants, spaces among the plants, and gopher mounds provide opportunities for whiptail lizard activities such as foraging, basking, oviposition, and fleeing. A total of ~30 YOY of *A. neotesselata* A, but no second year or older lizards, were observed as I walked back and forth along the levee on 6–7 September 1999. The road/levee is also frequently used by humans, and occasionally by official vehicles, but such interference with lizard activities would be much less severe than on the previously mentioned much narrower west-directed forest trail. During a return visit to Valco Ponds on 10 June 2000, I observed ~20 second year and older individuals of *A. neotesselata* A in less than 2 h (only six collected) on the aforementioned levee, including as many as four individuals in the same field of vision. These older/larger lizards were much more easily approached and collected than were the YOY in the previous year, and the low number obtained in 2000 (N = 6) was by choice.

The Valco State Wildlife Area west of Pueblo Boulevard in Pueblo is among the most dramatic examples of high levels of abundance in a fragmented habitat that I have observed in any parthenogenetic species of *Aspidoscelis*. The habitat available for lizards (which totals ~2.1 ha) and the resulting pattern of lizard distribution at the site can be appreciated by typing in "Valco Ponds, Colorado" on Google Earth and viewing the results. This enclave, which is situated between Pueblo Lake State Park (west), urban Pueblo (east), Arkansas River (north), and Colorado Hwy 96 (south) certainly fits into the pattern of unusual/marginal habitats occupied by parthenogenetic whiptail species in the absence of gonochoristic species (i.e., *Aspidoscelis sexlineata viridis* which occurs elsewhere in the general area) that were discussed by Wright and Lowe (1968. Copeia 1968:128–138). Other nearby sites in the western metropolitan area of Pueblo where *A. neotesselata* A occurs in publicly owned areas extensively altered and used by humans, but not in a fragmented mosaic, also have been reported. Based on published records, the species is abundant

in the extensive surroundings of the Pueblo Raptor and Nature Center (38.270847°N, 104.676536°W; WGS84; elev. 1450 m) on the north side of the Arkansas River at 2.9 km (straight line, SL) east-northeast of Valco Ponds (Walker, *op. cit.*; Taylor et al. 2006. J. Herpetol. 40:294–304), but is not abundant at the type locality of the species in the spacious Juniper Breaks Campground (38.276514°N, 104.755075°W; WGS84; elev. 1498 m) on the north side of Pueblo Lake, Pueblo State Park, at 4.5 km (SL) northwest of the ponds (Walker, *op. cit.*).

Lizards were collected at Valco State Wildlife Area, Pueblo Raptor and Nature Center, and Juniper Breaks Campground in Pueblo County under authority of a permit from the Colorado Division of Wildlife. I am grateful to Tim Hogan who referred me to Dina Clark who identified plants in the photograph, and to Harry Taylor for constructive comments on the manuscript.

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***ASPIDOSCELIS TESSELATA* (Common Checkered Whiptail). NORTHERN LIFE HISTORY.** Since 1988, we have studied life history attributes pertaining to the ecological success of *Aspidoscelis tesselata* (*sensu* Cordes and Walker 2006. Copeia 2006:14–26; Reeder et al. 2002. Am. Mus. Novitat. 3365:1–61; Taylor et al. 2005. J. Herpetol. 39:266–277; Walker et al. 1995. Copeia 1995:650–658; Walker et al. 1997. Herpetologica 53:233–259), a diploid parthenogenetic lizard of hybrid origin (Neaves 1969. J. Exp. Zool. 171:175–184; Parker and Selander 1976. Genetics 84:791–805; Wright and Lowe 1967. Mamm. Chromo. Newslett. 8:95–96), in several areas of its vast latitudinal distribution area (Taylor et al. 1997. Copeia 1997:863–868; Taylor et al. 1999. Herpetol. Rev. 30:205–207; Taylor et al. 2000. Herpetologica 56:45–54; Taylor et al. 2005. Southwest. Nat. 50:258–262; Taylor et al. 2006. J. Herpetol. 40:294–304) extending from eastern-central Chihuahua State, México, to southeastern Colorado (Parker and Selander, *op. cit.*; Smith et al. 1963. Herpetologica 19:205–215; Zweifel 1965. Am. Mus. Novitat. 2235:1–49). This species is a member of many local guilds of whiptail lizards in Chihuahua, Texas, Oklahoma, New Mexico, and Colorado involving various combinations of four gonochoristic (*A. gularis* [including *A. scalaris* and *A septemvittata*; *sensu* Walker 1981a. Copeia 1981:826–849; Walker 1981b. Copeia 1981:850–868], *A. inornata*, *A. sexlineata*, and *A. tigris* [including *A. marmorata*; *sensu* Dessauer et al. 2000. Bull. Am. Mus. Nat. Hist. 246:1–148]) and/or six parthenogenetic (*A. exsanguis*, *A. dixoni*, *A. neomexicana*, *A. neotesselata*, *A. uniparens*, and *A. velox*) congeners in a variety of arid and semiarid habitats, some severely degraded and frequently impacted by presence of humans, over a south-north straightline distance of ca. 1100 km. Latitudinally (i.e., from ca. 27.990227°N, 105.264668°W, datum: WSG84, in Chihuahua to ca. 37.717304°N, 103.514567°W, datum: WSG84, in Colorado; Taylor et al. 2000, *op. cit.*; Taylor et al. 2011. Southwest. Nat. 56:180–186), this is the most extensive natural range for any of the parthenogenetic species of *Aspidoscelis*. Here, we interpret the northern life history of pattern class E of *A. tesselata* (*sensu* Zweifel, *op. cit.*) based on specimens collected between 1996 and 2010 from in and adjacent to the town of Puerto de Luna (see Taylor et al. 2003. Am. Mus. Novitat. 3424:1–40), Guadalupe County, eastern-central New Mexico, where it exists in syntopy with triploid parthenogenetic *A. exsanguis* and *A. velox*. We include data on sample composition (number of generations represented in samples), life cycle (length of annual activity cycle, age at maturity, and life span), reproductive characteristics ($\bar{x}$ ± SE and range for body mass [BM], SVL, clutch size, yolked ovarian follicle diameter, and oviductal egg diameter and length), and the relationship of clutch size to SVL and BM (of lizards with tails) for *A. tesselata* E at Puerto de Luna. Females were weighed, fixed in formalin, stored in ethanol, and dissected to count and measure oviductal eggs and yolked ovarian follicles. Statistical operations for this study were performed using JMP® 9 (SAS Institute Inc., Cary, NC), provided by a license to the University of Arkansas, with set at 0.05.

We examined 36 specimens of *A. tesselata* from the herpetology collections of the University of Arkansas Department of Zoology (UADZ) and 25 from Regis University (RU) obtained in and near the town of Puerto de Luna: site 1 (34.830833°N, 104.620278°W, datum: WGS84 , elev. 1369 m) (18 August 1996 [UADZ 5740–5741, N = 2]; 16 July 1997 [UADZ 5993–5994, N = 2]; 10 June 2000 [RU 0048–0052, N = 5]; 11 June 2000 [RU 0053–0062, N = 10]; 12 June 2000 [RU 0064–0073, N = 10]; 19 August 2001 [UADZ 7484, 7487, 7489–7495, 7497, N = 10]; 18 June 2010 [UADZ 8648–8651, N = 4]; 19 June 2010 [UADZ 8658–8659, N = 2]; 24 June 2010 [UADZ 8697–8703, N = 7]; 25 June 2010 [UADZ 8715–8721, N = 7]); site 2 (34.819167N, 104.613333°W, datum: WGS84, elev. 1363 m) (24 June 2010 [UADZ 8704, N = 1]); site 3 on east side of Pecos River at highway crossing south of town (34.826634°N, 104.625261°W, datum: WGS84, elev. 1359 m) (19 August 1997 [UADZ 6008, N = 1]).

At Puerto de Luna, most eggs of *A. tesselata* E hatch from late July–early August. This is the same time frame by which subadults from the previous summer and adults, having attained adequate mass and fat reserves to carry them through hibernation, become inactive for the year. On 18 and/or 19 August 1996 (N = 2), 1997 (N = 1), and 2001 (N = 10), all *A. tesselata* E either observed or captured at Puerto de Luna were young-of-year (YOY). The 19 August 2001 sample of *A. tesselata* E consisting of 10 YOY with a 9 mm range of variation in SVL (39, 40, 41 [2], 43 [2], 45, 46, 47, 48; $\bar{x}$ = 43.3 ± 0.98 mm) obviously represents several hatching dates. A similar range of size variation persists as YOY grow rapidly to ca. 50–60 mm SVL as declining fall temperatures in October force them into inactivity for the year, after which these individuals with variable SVLs emerge for their second activity cycle in late April–early May.

Based on the 10–12 June 2000 sample of *A. tesselata* E, it is possible to conclude that sexual maturity is not attained in the second year of life at Puerto de Luna. One group in the sample comprises 19 non-reproductive (i.e., subadult) lizards, hatched the previous year (i.e., in their second activity cycle) with an 11 mm range of variation in SVL (65 [2], 66 [2], 68 [2], 69 [3], 70 [2], 72 [2], 73, 74 [2], 75, 76 [2]; $\bar{x}$ = 70.4 ± 0.83 mm), which is similar to the magnitude of SVL differences among the 2001 YOY lizards. The second group comprises only six adults, all gravid, in their third or subsequent activity cycles with a 7 mm range of variation in SVLs (90 [2], 91, 95]2], 97; $\bar{x}$ = 93.0 ± 1.24 mm). However, based on the 18–25 June 2010 sample of *A. tesselata* E from Puerto de Luna, collected ca. two to three weeks later in the annual activity cycle than in 2000, we infer that some of the earliest hatchlings from 2009 had attained reproductive maturity in their second activity cycle. One subgroup in the sample comprises eight non-reproductive (i.e., subadult) lizards hatched the previous year and several months in their second activity cycle with a 12 mm range in SVLs (67, 72, 73 [2], 75, 77, 78, 79; $\bar{x}$ = 74.2 ± 1.37), and a 5.6 g range in BM ($\bar{x}$ = 10.9 ± 0.73 g). The other subgroup from 2010 comprises 12 gravid females, some apparently in the second activity cycle, others in their third, fourth, and/or fifth cycle, with a 20 mm range of SVLs (75, 76, 77, 79 [2],

82, 83, 90, 92 [2], 93, 95; $\bar{x}$ = 84.4 ± 2.15 mm) and a 13.1 g range in BM ($\bar{x}$ = 17.2 ± 1.42 g). In retrospect, using observations on the 2010 sample of *A. tesselata* E from Puerto de Luna, we infer that some of the larger juveniles in the 2000 sample could have attained reproductive maturity in their second season had they survived.

Gravid females in the early June 2000 sample (90–97 mm SVL) have clutches of 4–5 eggs ($\bar{x}$ = 4.5 ± 0.22, N = 6), and apparently represent year classes three, four, and perhaps five. Gravid females in the mid- to late June 2010 sample (75–95 mm SVL) have clutches of 2–5 eggs ($\bar{x}$ = 3.5 ± 0.34, N = 12), and apparently represent year classes two through four and perhaps five. Preovulatory females (75–95 mm SVL) in this sample have yolked ovarian follicles of 5.5–11.5 mm in diameter ($\bar{x}$ = 9.2 ± 1.04, N = 5); post-ovulatory females (79–92 mm) have oviductal eggs of 10.5–12.5 mm in diameter ($\bar{x}$ = 11.6 ± 0.28, N = 7) and 16.5–19.0 mm in length ($\bar{x}$ = 17.8 ± 0.34, N = 7). For the period 10–11 June 2000, 6 females with data had clutches (sample size in each category in parens) of 4 (3) and 5 (3). For the period 18–25 June 2010, 12 females with data had clutches of 2 (3), 3 (3), 4 (3), and 5 (3). Using the pooled sample of gravid females of *A. tesselata* collected from Puerto de Luna in 2000 and 2010, we observed a strong relationship between clutch size and SVL (based on adjusted r^2 = 0.61, P = 0.0001, N = 18). Surprisingly; however, one noteworthy outlier (UADZ 8719 from 2010) with a SVL of 77 mm and BM of 13.4 g, apparently in only the second activity cycle, possesses two right and two left oviductal eggs. The egg number in this specimen approximates the maximum clutch of five in the largest available specimens of 90–97 mm SVL, some of which could be in the fifth year. Pooling 2010 subadults, some with large fat bodies, and females with clutches of either ovarian or oviductal eggs confirmed the existence a strong relationship between SVL and BM in *A. tesselata* E (based on adjusted r^2 = 0.94, P = 0.0001, N = 20) from Puerto de Luna.

This study indicates that the composition of a single sample of *A. tesselata* E from Puerto de Luna could very well sway an investigator to conclude that the age at which first clutch is produced is a fixed attribute in the species at this site. For example, the RU sample from 2000 points to probable maturity in the third year; however, because hatching dates in the species span almost a month, the sample from 2010 indicates that the earliest hatchlings from the previous year likely produced clutches in the second summer, whereas the later hatchlings would likely produce their first clutch in the third summer.

Puerto de Luna is one of several areas between Santa Rosa Lake, Guadalupe Co., and Sumner Lake, De Baca Co., where the parthenogenetic species *A. exsanguis*, *A. tesselata*, and *A. velox* are syntopic; *A. tesselata* E is by far the numerically dominant species at site 1. Based on observations between 1996 and 2001, the habitat here (e.g., sandy roadsides, a mesquite [*Prosopis glandulosa*] invaded hillside, and mequite anchored dunes) received little in the way of unusual habitat disturbances. However, the dunes have since become heavily used by ATV enthusiasts. The abundance of both subadults and adults of *A. tesselata* E in the ATV tract, frequently criss-crossed by these vehicles, afford a dramatic example of the adaptability of the life cycle of *A. tesselata* E to a highly disturbed area frequented by presence of humans.

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***ASPIDOSCELIS TESSELATA* (Common Checkered Whiptail). SOUTHERN LIFE HISTORY.** *Aspidoscelis tesselata* (*sensu* Cordes and Walker 2006. Copeia 2006:14–26; Reeder et al. 2002. Am. Mus. Novitat. 3365:1–61; Taylor et al. 2005. J. Herpetol. 39:266–277; Walker et al. 1995. Copeia 1995:650–658; Walker et al. 1997. Herpetologica 53:233–259) is a diploid parthenogenetic lizard of hybrid origin (Neaves 1969. J. Exp. Zool. 171:175–184; Parker and Selander 1976. Genetics 84:791–805; Wright and Lowe 1967. Mamm. Chromo. Newslett. 8:95–96) having an extensive latitudinal distribution from ca. 27.990227ºN, 105.264668ºW, datum: WSG84, in eastern central Chihuahua, México, to ca. 37.717304°N, 103.514567°W, datum: WSG84, in southeastern Colorado (Parker and Selander, *op. cit.*; Smith et al. 1963. Herpetologica 19:205–215; Taylor 2000. Herpetologica 56:45–54; Taylor et al. 2011. Southwest. Nat. 56:180–186; Zweifel 1965. Am. Mus. Novitat. 2235:1–49). This species is a member of many local guilds of whiptail lizards in Chihuahua, Texas, Oklahoma, New Mexico, and Colorado involving various combinations of four gonochoristic (*A. inornata*, *A. gularis*, *A. sexlineata*, and *A. tigris*) and/or six parthenogenetic (*A, exsanguis*, *A. dixoni*, *A. neomexicana*, *A. neotesselata*, *A. uniparens*, and *A. velox*) congeners in a variety of arid and semiarid habitats, some severely degraded and frequently impacted by presence of humans, over a north-south straightline distance of ca. 1100 km. Latitudinally, this is the most extensive natural range for any of the parthenogenetic species of *Aspidoscelis*. Here, we contribute to interpretation of the life history of pattern class E of *A. tesselata* (sensu Zweifel, *op. cit.*; Parker and Selander, *op. cit.*) based on specimens collected by us in 1966, 1992, 1993, 1997, and 1998 from the southern extremity of the range in Chihuahua where it typically exists in syntopy with some combination of the parthenogenetic species *A. exsanguis* and gonochoristic species *A. gularis* (including *A. scalaris* and *A. septemvittata*; Walker 1981a. Copeia 1981:826–849; Walker 1981b. Copeia 1981:850–868) and *A. tigris* (sensu Dessauer et al. 2000. Bull. Am. Mus. Nat. Hist. 246:1–148). We include data on sample composition (estimated number of year classes represented in samples), life cycle (length of annual activity cycle, age at maturity, and life span), reproductive characteristics ($\bar{x}$ ± SE and range for body mass [BM], SVL, clutch size, yolked ovarian egg diameter, and oviductal egg diameter and length), and the relationships of clutch size to SVL and SVL to BM (of lizards with tails) for *A. tesselata* E from Chihuahua. Females were weighed, fixed in formalin, stored in ethanol, and dissected to count and measure oviductal eggs and yolked ovarian eggs, and to subjectively evaluate the size of postcoelomic fat bodies. Statistical procedures for this study were performed using JMP® 9 (SAS Institute Inc., Cary, NC), provided by a license to the University of Arkansas, with set at 0.05.

We examined 64 specimens of *A. tesselata* E from the herpetology collections of the University of Arkansas Department of Zoology (UADZ) and 17 from the University of Colorado Museum of Natural History (UCM) obtained from these sites

in Chihuahua, Mexico: south side of Río San Pedro at Meoqui (28.269209°N, 105.480599°W, datum: WSG84, elev. 1148 m) (15 June 1966 [UCM 37417, N = 1]); 21.1 km S of Cd. Delicias (28.056279°N, 105.319368°W, datum: WSG84, elev. 1230 m) (16 June 1966 [UCM 37418–37426, N = 9]); 1.6 km S of Saucillo (28.019581°N, 105.268201°W, datum: WSG84, elev. 1231 m) (16 June 1966 [UCM 37428–37429, N = 2]); 5.0 km S of Saucillo (27.990227°N, 105.264668°W, datum: WSG84, elev. 1231 m) (17 June 1966 [UCM 37430–7434, N = 5]); vicinity of El Pueblito on west side of Río Conchos (29.102227°N, 105.113768 °W, datum: WSG84, elev. 976 m) (30 May 1992 [UADZ 4563–4564, N = 2]; 7 June 1992 [UADZ 4593–4594, N = 2]; 12 June 1993 [UADZ 4841, 4850, N = 2), 10 July 1997 [UADZ 5831–5839, 5842, N = 10]; 11 July 1997 [UADZ 5846–5854, N = 9]; 12 July 1997 [UADZ 5856–5857, 5860–5861, 5863, 5865, N = 6]; 13 July 1997 [UADZ 5866, 5874–5875, 5878-5879, N = 5]; 14 July 1997 [UADZ 5888, N = 1]; 15 July 1997 [UADZ 5891–5892, 5898, N = 3]; 30 July 1998 [UADZ 6105–6114, N = 10]; 31 July 1998 [UADZ 6121–6126, N = 6]; 1 August 1998 [UADZ 6127–6130, N = 4]; 2 August 1998 [UADZ 6153–6156, N = 4]).

The June 1966 sample of *A. tesselata* E includes six subadults (based on lack of developing eggs) with a 5 mm range of variation in SVL (sample size in each category in brackets) (66, 68, 69 [2],70, 71; $\bar{x}$ = 68.8 ± 0.70 mm), and 11 adults (based on smallest to largest gravid individuals) with a 14 mm range of variation in SVL (77 [2], 78, 79 [2], 80, 81, 85, 88, 90, 91; $\bar{x}$= 82.3 ± 1.59 mm). We infer that the subgroup of non-reproductive lizards and the smaller individuals among the reproductive individuals are younger (~66–71 mm SVL) and older (~77–81 mm SVL) cohorts of the 1965 year class, respectively. Individuals of ~85–91 mm SVL are likely third and perhaps fourth year individuals. We attribute the absence of females of ~92–100 mm SVL in the sample to a life cycle of four years or less for most lizards of the species at the southern end of the range in Chihuahua, rather than an accident of sampling, based on paucity of this size class in the larger samples of *A. tesselata* E collected in Chihuahua in 1997 and 1998. The June 1966 sample of *A. tesselata* E was apparently collected prior to the hatching of young-of-year (YOY) lizards.

At El Pueblito near the Río Conchos, eggs oviposited by *A. tesselata* E begin hatching in early July. The emergence of hatchlings there is not accompanied by subadults from the previous summer and older adults starting to retire for the year for the winter inactivity period as was reported for pattern class E lizards which hatch in August at Puerto de Luna, eastern central New Mexico, by Walker et al. (2012. Herpetol. Rev., in press).The sample obtained at El Pueblito on 10–15 July 1997 contains YOY, subadults, and adults, whereas samples with YOY collected in August Puerto de Luna never included other age classes of larger individuals. The 1997 sample of *A. tesselata* E includes eight YOY with a 7 mm range of variation in SVL (40 [2], 41, 42 [2], 43 [2], 47; $\bar{x}$ = 42.3 ± 0.80 mm), a 1.3 g range in BM ($\bar{x}$ = 1.9 ± 0.15 g), and individuals from several hatching dates. Also present in the sample are five putative subadults (without developing eggs) with a 4 mm range of variation in SVL (73 [2], 76, 77 [2]; $\bar{x}$ = 75.2 ± 0.92 mm) and a 5.3 g range in BM ($\bar{x}$ = 12.2 ± 0.90 g), and 19 adults (based on smallest to largest gravid individuals) with a 13 mm range of variation in SVL (78 [3], 79 [3], 80, 81 [4], 83 [2], 84, 87 [2], 88, 91 [2];$\bar{x}$ = 82.6 ± 0.98 mm) and a 14.8 g range of variation in BM ($\bar{x}$ = 16.4 ± 0.70 g). Two live adults (UADZ 5891 and 5892) used in skin histocompatibility experiments were not included in the preceding analyses.

We also report an interesting relationship between reproductive status (e.g., not gravid, with developing ovarian eggs, and with oviductal eggs) and size of postcoelomic fat bodies in adults of *A. tesselata* E collected in 1997 in Chihuahua. That only nine (47.4%) adults from 1997 are gravid indicates that asynchronous clutch production is characteristic of *A. tesselata* E at El Pueblito. This aspect of the life cycle could reflect production of a minimum of two clutches by some lizards; this would result in numerous hatching dates and subsequent maturity dates in ensuing years. None of the three females (81–91 mm SVL) with oviductal clutches possesses discernable fat bodies, whereas six females (78–91 mm SVL) with ovarian eggs have either small (N = 1) or large (N = 5) fat bodies. These observations suggest that clutch development is dependent upon stored resources in fat bodies that are depleted during egg growth. Four size-conditions of the fat bodies were observed among the 10 non-gravid adult females: absent (N = 2), small (N = 1), medium (N = 3), and large (N = 4). This variation points to presence of a refractory period, either between successive clutches or preceding fall hibernation, in which fat bodies are replenished after the last oviposition in southern groups of *A. tesselata* E.

The composition of the sample of *A. tesselata* E obtained at El Pueblito on 30 July–2 August 1998 is quite unlike that of the sample obtained there approximately two weeks earlier in the year in 1997. The 1998 sample included only five non-reproductive lizards, one obvious YOY of 52 mm SVL likely hatched in early July and four lizards that could represent either older YOY or second year juveniles, with a 6 mm range of variation in SVL (62, 66, 67, 68; $\bar{x}$ = 65.8 ± 1.32 mm). Nineteen adults in the sample (lower limit based on smallest gravid individual) have a 30 mm range of variation in SVL (70 [3], 72 [2], 73 [2], 74, 75, 77, 79, 81 [2], 84, 87, 88, 90, 91, 100; $\bar{x}$ =79.3 ± 1.98 mm) and a 23.3 g range of variation in BM ($\bar{x}$ = 14.3 ± 1.31 g). These data necessitate substantial changes in our conclusions about reproduction in *A. tesselata* E from Chihuahua based on the 1966 and 1997 samples. Known minimum size at reproductive maturity is lowered from 77–78 mm and 14.0 g BM to 70 mm SVL and 10.4 g BM, and maximum size attained is raised from 91 mm and 25.0 g to 100 mm SVL and 31.4 g BM. Also, based on the 1998 sample, it is likely that all lizards of 70 mm or greater in the 1966 and 1997 samples could have attained reproductive maturity had they survived. Only five (26.3%) of 19 lizards of adult size in the 1998 sample are gravid. Based on their size (70, 72, 74, 75, 77; $\bar{x}$ = 73.6 ± 1.21 mm SVL and 10.4–16.5; $\bar{x}$ = 12.6 g BM), we infer that they are late-season maturing individuals from late-season hatchings of 1997. Larger individuals in the sample had apparently ceased reproductive activity for the year. Dearth of lizards of greater than 90 mm SVL was apparent in each of the four years which could indicate that in Chihuahua *A. tesselata* E has a life expectancy that seldom exceeds three years. Of 81 specimens of *A. tesselata* E examined from the state, only five (6.2%) lizards exceed 90 mm SVL (91 mm for each) and only two (2.5%) were 100 mm SVL.

Gravid females (77–91 mm SVL) in the mid-June 1966 sample of *A. tesselata* E have clutches of 3–5 eggs ($\bar{x}$ = 3.7 ± 0.29, N = 7), and likely represent year classes two, three, and perhaps four. Gravid females (78–91 mm SVL) in the early to mid-July 1997 sample have clutches of 2–5 eggs ($\bar{x}$ = 4.0 ± 0.37, N = 9), and likely also represent year classes two, three, and perhaps four. Preovulatory females (78–91 mm SVL) in this sample have yolked ovarian follicles of 3.7–11.5 mm in diameter ($\bar{x}$ = 6.9 ± 1.14, N = 6); postovulatory females (81–91 mm) have oviductal eggs of 10.0–10.5 mm in diameter ($\bar{x}$ = 10.2 ± 0.17, N = 3) and 15.0–17.0 mm in length ($\bar{x}$ = 16.3 ± 0.67, N = 4). Gravid females (70–77 mm SVL) in the late July–early August 1998 sample have clutches of

only 2–3 eggs ($\bar{x}$ = 2.6 ± 0.24, N = 5), and apparently represent only year class two. Preovulatory females (72–77 mm SVL) have yolked ovarian follicles of 4.5–8.5 mm in diameter ($\bar{x}$ = 6.7 ± 1.17, N = 3); postovulatory females (74–75 mm) have oviductal eggs of 9.5–10.5 mm in diameter ($\bar{x}$ = 10.0 ± 0.50, N = 2) and 17.0–17.5 mm in length ($\bar{x}$ = 17.3 ± 0.25, N = 2).

From 1966, seven females with data have clutches (sample size in each category in parens) of 3 (3), 4 (3), and 5. From 1997, nine females with data have clutches of 2, 3 (2), 4 (2), and 5 (4). From 1998, five females with data have clutches of 2 (2) and 3 (3). Using the pooled sample of gravid females of *A. tesselata* collected from Chihuahua in three different years, we found a strong relationship between clutch size and SVL (based on adjusted r^2 = 0.57, P = 0.0001, N = 21). We also report an even stronger relationship between BM and SVL (based on adjusted r^2 = 0.86, P = 0.0001, N = 58).

Time of collection during the year strongly affects sample composition of *A. tesselata* E from the southern part of the range in Chihuahua. This accounts for the 1966 and 1998 samples being the only significantly different (P = 0.05) pair of means for clutch size. Date of collection apparently accounts for the finding of synchronous clutch development in the June 1966 sample, but a finding of strongly asynchronous production in the later mid-July 1997 and late July-early August 1998 samples as second year lizards mature at different times. Minimally, clutch production involves parts of three months (June, July, and August) resulting in a variety of hatching dates and times at which lizards become reproductively mature. Based on an activity cycle from April to November, in Chihuahua, *A. tesselata* E matures in less than a calendar year at a SVL as small as 70 mm.

In the immediate vicinity of El Pueblito, on the west side of Río Conchos, there is a patchwork of agricultural plots, peripheral to and between which are islands of habitat used by whiptail lizards. Three species occur in the area: *A. gularis* (*sensu* Walker 1981a, b, *op. cit.*), *A. tigris* (*sensu* Dessauer et al., *op. cit.*), and *A tesselata* E (*sensu* Zweifel, *op. cit.*). Visits to the area by JEC and FMQ in 1992 and 1993 resulted in collection of large numbers of *A. gularis*, and small numbers of *A. tigris* and *A.tesselata* E. In 1997 and 1998, concentration of effort in disclimax areas along the periphery of fallow fields and pecan groves greatly increased the numbers of *A. tesselata* E observed/collected. As knowledge of the variety of habitats occupied by whiptail lizards at El Pueblito increased, it became possible to maximize collection of any one of the three species present by careful choice of where to expend search efforts. On some occasions, all three species were collected in close proximity; however, in all cases one of the three species was numerically dominant. That *A. tesselata* is occasionally inseminated by a syntopic gonochoristic species at El Pueblito is indicated by our collection of a hybrid of the genealogy *A. tesselata* × *A. gularis* (UADZ 4852) from near the Río Conchos on 12 June 1993 (Walker et al. 2000. Southwest. Nat. 45:527–533).

Live and preserved lizards imported from México by FMQ and JEC and referenced in this report were collected in Chihuahua under the authority of permits SEMARNAT 4295/97 and SEMARNAT 7182/98 granted to FMQ by the government of México. We thank Wade C. Sherbrooke for providing the address of FMQ (deceased).

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***CHALCIDES GUENTHERI* (Güenther's Cylindrical Skink). REPRODUCTION.** *Chalcides guentheri* is known from southern Lebanon, Israel, southwest Syria and northwest Jordan (Sindaco and Jeremcenko 2008. The Reptiles of the Western Palearctic. Edizioni Belvedere, Latina, Italy. 579 pp.). It is reported to be viviparous as are other congeners (Disi et al. 2001. Amphibians and Reptiles of the Hashemite Kingdom of Jordan. Edition Chimaira, Frankfurt am Main, Germany. 408 pp.). The purpose of this note is to provide information on the reproductive cycle of *C. guentheri* in Israel.

A sample of 27 *C. guentheri* consisting of 7 males (mean SVL = 90.9 mm ± 7.4 SD, range = 82–103 mm) and 20 females (mean SVL = 120.7 mm ± 18.7 SD, range = 164–122 mm), collected 1944–1989 in Israel (31.5°N, 34.75°E) and deposited in the Zoological Museum of the Department of Zoology. Tel-Aviv University (TAUM), Tel Aviv, Israel was examined TAUM: 758, 760, 766, 768, 773, 1069, 1476, 2538, 2714, 2903, 3874, 3886, 4681, 5172, 5191, 5537, 5848, 6080, 7438, 8456, 9511, 11107, 11108, 11437, 12867, 13309, 13787.

A cut was made in the lower abdominal cavity and the left testis or ovary was removed, embedded in paraffin, cut into 5 µm sections and stained with Harris hematoxylin followed by eosin counterstain. Enlarged follicles > 3 mm or oviductal eggs were counted. Histology slides are deposited in TAUM.

Three stages were noted in the testicular cycle: (1) recrudescence, a proliferation of germ cells has commenced in the seminiferous tubules for the next period of sperm formation, primary spermatocytes predominate; (2) late recrudescence (just prior to sperm formation), secondary spermatocytes and spermatids predominate; (3) spermiogenesis, lumina of the seminiferous tubules are lined by sperms or clusters of metamorphosing spermatids. One male from December exhibited recrudescence; five males from March exhibited spermiogenesis; one male from April exhibited late recrudescence. The smallest reproductively active male (undergoing spermiogenesis) measured 82 mm SVL (TAUM 760). This is an approximation of minimum size for sexual maturity as no males < 82 mm SVL were examined.

Four stages were noted in the ovarian cycle (Table 1). The presence of one April female with oviductal eggs and concurrent yolk deposition for a subsequent clutch (TAUM 2538) indicates *C. guentheri* may produce multiple clutches. Mean clutch size (n

TABLE 1. Monthly stages in the ovarian cycle of 20 *Chalcides guentheri* from Israel.

Month	N	Inactive	Early yolk deposition	Enlarged follicles >3 mm	Oviductal eggs
January	2	2	0	0	0
February	2	2	0	0	0
March	6	3	2	0	1
April	4	1	0	2	1*
May	2	0	1	1	0
June	1	1	0	0	0
September	1	1	0	0	0
October	1	1	0	0	0
December	1	1	0	0	0

* One female with oviductal eggs exhibited concurrent yolk deposition.

= 5) was 5.8 ± 2.3 SD, range = 3–8. The smallest reproductively active female (undergoing early yolk deposition) measured 85 mm SVL (TAUM 4881) and was collected in March. This is an approximation of minimum size for sexual maturity as no females < 85 mm SVL were examined.

Reproduction of *C. guentheri* in Israel commences in the spring although I am unable to state how long it continues. Reproduction in the congener *C. ocellatus* similarly begins in the spring in Egypt with parturition occurring from April through September (Badir and Hussein 1965. Bull. Fac. Sci., Cairo Univ. 39:179–185).

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***CYCLURA CYCHLURA FIGGINSI* (Exuma Island Rock Iguana). RODENT KILL.** Rodents are proficient invaders on a global scale and have been implicated in the extinction and decline of endemic reptiles, particularly on islands (Case and Bolger 1991. Evol. Ecol. 5:272–290; Towns et al. 2006. Biol. Invasions 8:863–891). Most studies (e.g., Towns et al. 2003. Conserv. Biol. 17:1361–1371; Towns et al. 2006, *op. cit.*) have rightfully focused on the negative consequences of non-native rodents on insular reptiles while neglecting neutral or even potentially positive effects. Though unclear if neutral or positive, here we report an Exuma Island Rock Iguana (*Cyclura cychlura figginsi*) attacking and killing a non-native Ship Rat (*Rattus rattus*) on 13.6 ha Gaulin Cay (24.12270°N, 76.40679°W; datum WGS84) in the Exuma Islands, The Bahamas.

During the afternoon of 11 December 2011, one of us (BL) was photographing Exuma Island Rock Iguanas on the western beach of Gaulin Cay when an adult iguana (ca. 30 cm SVL) approached to within 2 m, stopped, turned its head, flicked its tongue, and then lunged its head rapidly under a loose aggregation of flat limestone rocks. A squeal was heard, and a Ship Rat could be seen thrashing before being extracted from beneath the rock. The iguana readjusted his grasp on the rat from the neck to mid-body before slowly walking back to the vegetation (Fig. 1). While walking, other iguanas gave chase, perhaps to steal the rat, forcing the iguana further inland and out of sight. We cannot confirm that the iguana consumed the rat, though we suspect this to be the case as *Cyclura* iguanas have been documented killing birds (Hines et al. 2002. Herpetol. Rev. 33:306), and eating carrion (Gerber et al. 2002. Herpetol. Rev. 33:133–134).



FIG. 1. Exuma Island Rock Iguana (*Cyclura cychlura figginsi*) walking immediately after killing a Ship Rat (*Rattus rattus*) on Gaulin Cay, Exuma Islands, The Bahamas.

Rock iguanas of the genus *Cyclura* feed almost exclusively on vegetation (Alberts [ed.] 2000. West Indian Iguanas: Status Survey and Conservation Action Plan. IUCN, Gland, Switzerland. 111 pp.; Auffenberg 1982. *In* Rand and Burghardt [eds.], Iguanas of the World: Their Behavior, Ecology, and Conservation, pp. 84–116. Noyes Publications, Park Ridge, New Jersey) with animal matter typically comprising less than 3% of their diet (Cooper and Vitt 2002. J. Zool. 257:487–517). Predation on vertebrates has been reported infrequently, with only birds reported being killed (Hines et al., *op. cit.*). To our knowledge, this is the first documented report of a *Cyclura* species attacking and killing a mammalian vertebrate in the wild. Rock iguanas and rats have been sympatric on Gaulin Cay since at least 1980 (Iverson, unpubl. data) and the population has been under continuous study by CRK since 1997. The population is considered healthy both genetically (Malone et al. 2003. Conserv. Genet. 3:1–15) and demographically (Knapp, unpubl. data). The extent to which rock iguanas kill or consume rats on Gaulin Cay, and whether such attacks are motivated by potential nutritional benefits, warrants further study.

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***ELGARIA MULTICARINATA* (Southern Alligator Lizard). OVIPOSITION SITE AND EGG ATTENDANCE.** Despite being widespread and commonly encountered, observations of oviposition sites, egg attendance and parental care behaviors from wild Southern Alligator Lizards are lacking. Under captive conditions, *Elgaria multicarinata* has been reported to oviposit communally in sand under flat stones (Langerwerf 1981. Brit. Herpetol. Soc. Bull. 4:21–25) and 13 eggs were deposited in the side branch of a captive Ornate Box Turtle (*Terrapene ornata*) burrow in an outside enclosure (Fitch 1935. Trans. Acad. Sci. St. Louis 24:3–38). Other accounts (Gander 1931. Copeia 1:14–15; Burrage 1965. Copeia 1965:512) describe oviposition in captivity but lack physical descriptions of nest sites. Fitch (*op. cit.*) suspected that wild *E. multicarinata* laid eggs in rodent burrows such as *Spermophilus* and *Thomomys*, and a general account (Lemm 2006. Field Guide to Amphibians and Reptiles of the San Diego Region. Univ. California Press. 326 pp.) stated that oviposition occurs in "burrows, rock crevices, and the burrows of rodents such as the pocket gopher (*Thomomys bottae*)." Egg attendance occurred in three captive *E. multicarinata* (Langerwerf, *op. cit.*), but parental care remains undescribed from wild populations. Herein, we describe a natural oviposition site and egg attendance by *E. multicarinata*, and provide a representative thermal profile of the site.

On 30 June 2010, an adult *E. multicarinata* (113 mm SVL; 306 mm TL; 25.5 g) was discovered attending a clutch of eggs in a

PHOTO BY M. MULROY



FIG. 1. An adult *Elgaria multicarinata* attending a clutch of eggs in an exposed soil crack near Los Vaqueros Reservoir in Alameda County, California.

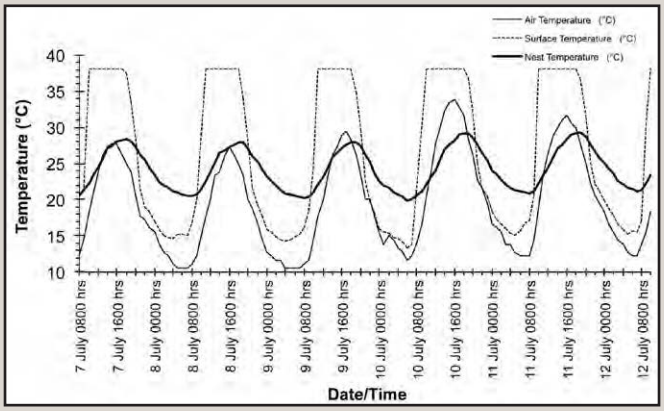


FIG. 2. Thermal profile of an *Elgaria multicarinata* oviposition site in relation to air and surface temperatures from 7 July–12 July 2010.

soil crack (approx. 2 cm wide, 20–23 cm depth) on a north-facing slope (approximately 14°) in grazed grassland near Los Vaqueros Reservoir, Alameda Co., California, USA (Fig. 1; 37.770617°N, 121.737583°W; WGS84; 241 m elev.). The oviposition site was discovered by investigating the soil crack using a shovel in an area proposed for excavation (approximately 2 m^2) with heavy equipment to expose a small portion of a buried natural gas pipeline. The adult lizard (assumed to be a female) was coiled around at least seven eggs (one measured 16.6 mm in length). Care was taken to minimize disturbance by gently replacing clods of dried soil (well-drained Altamont soil type; Nomad Ecology 2008. Wetland delineation and preliminary jurisdictional determination for the gas line 131 project; unpublished report prepared for Pacific Gas and Electric Company, 53 pp.). The surrounding vegetation was composed primarily of non-native annuals including *Brassica nigra*, *Bromus diandrus*, *B. madritensis*, *Carduus pycnocephalus*, and *Hordeum murinum leporinum* as well as *Malvella leprosa*, a native perennial herb (Nomad Ecology, *op. cit.*). The oviposition site was located approximately 15 m southeast of a small permanent wetland supporting *Distichlis spicata*, *Juncus cf. xiphioides*, and *Rumex crispus* (Nomad Ecology, *op. cit.*).

During two subsequent visits on 6, 7, and 12 July 2010, the adult was attending the eggs, using coils of its body to encircle them, and did not exhibit mouth gaping or attempt to bite. On 7 July 2010, two temperature data loggers (HOBO Optic Stow-Away®, Onset Computer Corporation) were placed at the surface of and within the soil crack, then removed on 12 July 2010. Air temperatures were obtained during this period from the Remote Automated Weather Station (RAWS) at Los Vaqueros (VAQC1; 37.7883°N, 121.7347°W; 338 m elev.) located 2.0 km N of the oviposition site. Temperatures within the oviposition site (range = 19.84–29.31°C; mean = 24.23°C; SD = 2.90) varied significantly less than air temperatures (range = 10.56–33.89°C; mean = 19.50°C; SD = 6.76; single-factor ANOVA, $F_{(1,241)} = 3.88$, $P<0.0001$) and surface temperatures (range = 13.34–38.14°C; mean = 26.26°C, SD = 10.09; single-factor ANOVA, $F_{(1,241)} = 3.88$, $P = 0.034$) from 7–12 July (Fig. 2). Surface temperatures during this period reached a maximum of 38.14°C (Fig. 2), likely due to the logger's upper threshold for temperature measurements. Langerwerf (*op. cit.*) reported captive incubation temperatures ranging from 27–30°C with most hatching success at 27°C, which is several degrees higher than the average oviposition site temperature (mean = 24.23°C).

The adult and eggs were not present on 4 August 2010, suggesting that egg attendance had occurred for at least 13 days (30 June–12 July 2010). There were no eggshells in or around the site and two lizard fecal pellets were presumably left by the adult *E. multicarinata*. The absence of eggshells suggests that: 1) the eggs hatched and shells were subsequently displaced or ingested by the parent, or 2) the nest had been depredated.

This observation confirms that egg attendance occurs in wild *E. multicarinata*, a behavior which has apparently not been observed from wild populations but would be expected considering parental care in related *Elgaria kingii* and many other anguid lizards (Greene et al. 2006. S. Amer. J. Herpetol. 1:9–19).

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***ENYALIUS CATENATUS.* PREDATION.** On 16 March 2008 a semi-arboreal *Enyalius catenatus* was predated by a young female Yellow-breasted Capuchin Monkey (*Cebus xanthosternos*), at about 10 m high at 1230 h. The predation event was observed at a secondary forest in Una Biological Reserve, Bahia, Brazil (39.050°W, 15.167°S; datum WGS84), one of the largest forest remnants in the Northern Atlantic Forest (~11,400 ha). A young male capuchin monkey begged for sharing, crying and staring at the lizard's body at one meter from the female. Vertebrate flesh seems to be a craved food among primates, as sharing and begging events are common during the consumption of this type of food item (Canale and Lingnau 2003. Herpetol. Rev. 34:136; Perry and Rose 1994. Primates 35:409–415). The female monkey ate the head and all viscera of the lizard, leaving fore and hind limbs, dorsal muscles, and tail intact. Very few specimens of *E. catenatus* have ever been collected, having previously been restricted to Bahia and Pernambuco (Rodrigues et al. 2006. Phyllomedusa 5:11–24). It is endemic to the northern Atlantic Forest, which is the most human-altered region within this biome (Ribeiro et al. 2009. Biol. Conserv. 142:1141–1153).

The lizard was collected and deposited in the Museum of Zoology of the State University of Santa Cruz, Ilhéus, Bahia, Brazil (MZUESC 6552).

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***GEKKO JAPONICUS* (Japanese Gecko). DEFORMITY.** On 30 August 2011, a free-living male *Gekko japonicus* was observed on a brick column in East Park of Fukuoka, Japan (33.604561°N, 130.420542°E; datum WGS84). The gecko was found to have multiple abnormalities on the left side of its body. The left forelimb appeared to be hypoplastic, with the overall size of the limb being reduced, and the manus on the affected limb had only two complete digits with a partial third (Fig. 1.). The left eye of the gecko exhibited esotropic strabismus with very little pupillary light reflex (Fig. 2.). The gecko did not seem to have a full field of view on the affected side; it showed no response when approached from a left posterior angle. However, when approached from the left anterior side of its head, the gecko would readily bite fingers and conspecifics. The gecko ran noticeably slower than normal and was easily caught. Based on data presented by Tochigi (1984. Jap. J. Herpetol. 10:80–88), it is estimated that this gecko, with a SVL of 45 mm, was about one year old at the time of the observation. The presence of a hemipenial bulge, pre-anal pores, and thick cloacal spurs clearly indicated this was a male. The gecko lacked its original tail, but its replacement appeared to be in the latter stages of regeneration. After capture, the gecko was examined and released at the site a few hours later.

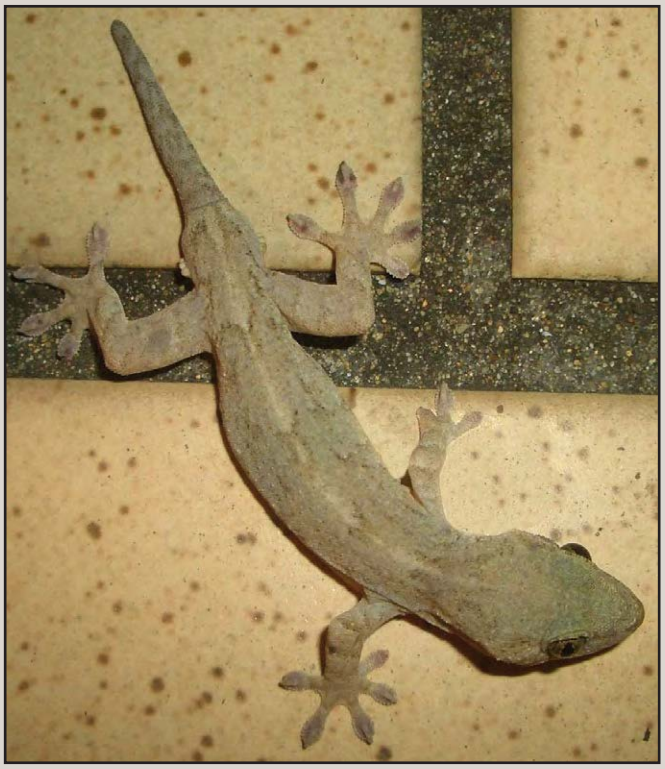


FIG. 1. *Gekko japonicus* with multiple deformities found in Fukuoka, Japan.



FIG. 2. Deformed *Gekko japonicus* exhibiting esotropic strabismus of the left eye.

In 2011, we observed at least 450 free-living *G. japonicus* in Fukuoka and this is the only specimen we observed with such significant deformities. Injury could account for lack of digits on the manus as well as the defects of the eye. However, although in anurans injury to tadpoles may result in limbs of reduced size (Ballengeé and Sessions 2009. J. Exp. Zool. [Mol. Dev. Evol.] 312B:1–10), we are not aware of any report of injury resulting in overall reduced proportions in the limbs of reptiles. It has been observed that extreme ranges in viable incubation temperature of developing reptile embryos may result in various deformities, including malformation of the eyes as well as limb anomalies (Deeming and Ferguson 1991. Egg Incubation: its Effect on Embryonic Development in Birds and Reptiles. Cambridge Univ. Press, Cambridge, UK. 448 pp.). It has also been suggested that environmental contamination might be linked to deformities in some reptiles (Khan and Law 2005. Proc. Pakistan Acad. Sci. 42:315–323), including malformation of the eyes and limbs (Bell and Congdon 2006. Environ. Pollut. 142:457–465). Genetic determining factors are also known to be responsible for abnormalities seen in reptiles (Olson et al. 1996. J. Evol. Biol. 9:229–242; Velo-Anton et al. 2011. PLoS ONE 6: e18714.doi:10.1371/journal.pone.0018714). In this case, genetic or environmental factors are both plausible causes for the deformities observed in the gecko. Photographs of the *G. japonicus* were deposited in the University of Texas at Arlington Amphibian and Reptile Diversity Research Center's digital slide library (UTADC 719–7193).

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***GERRHONOTUS LIOCEPHALUS* (Weigman's Alligator Lizard). DEFORMITY.** There are no previous reports of a wild adult *Gerrhonotus liocephalus* with deformities. Here we report an adult male observed on 18 July 2008, 453 m NW El Ocote (Aguascalientes, México; 21.787596°N, 102.561382°W; WGS84; 1938 m. elev.) with six digits in each rear limb. We conducted 26 field trips to this location during 2008–2009, finding many individuals of this species, including adults and juveniles, but only this specimen exhibited a deformity. The specimen was deposited in the Herpetological Collection of Universidad Autónoma de Aguascalientes (UAA-CV-00326).

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***GONATODES ALBOGULARIS* (Yellow-headed Dwarf Gecko). PREDATION.** The predation of frogs, lizards, and snakes by spiders in the tropics has been well documented (e.g., Ervin et al. 2007. Herpetol. Rev. 38:468; Jones et al. 2011. Herpetol. Rev. 42:441; Lange 2007. Herpetol. Rev. 38:460; Riehl et al. 2008. Herpetol. Rev. 39:77). In many cases, predatory species of arachnids specialize in capturing reptile and amphibian prey without the use of webs and instead utilize methods such as active foraging or ambush techniques (e.g., Dehling 2007. Herpetol. Rev. 38:444; Ervin et al. 2007. Herpetol. Rev. 38:185; Streicher et al. 2011 Herpetol. Rev. 42:432). Herein we report arachnid predation on *Gonatodes albogularis* by *Nephila clavipes* (Golden Silk Orbweaver Spider). Although spiders of the family Nephilidae (*Nephila* and *Nephilengys*) have been known to attack vertebrate prey (Peloso and Sousa 2007. Rev. Brasil. Ornitol. 15:461–463; Zippel and Kirkland 1998. Herpetol. Rev. 29:46), to the best of our knowledge this is the first account of predation on *G. albogularis*.

On 5 Sept 2011 at 1945 h, at Caño Palma Biological Station (Limon Province, Costa Rica, 10.3537°N, 83.31380°W, 11 m elev.) we observed an adult female *Gonatodes albogularis* in the web of a *Nephila clavipes*. The web was located on a building surrounded by a *Manicaria* palm swamp (Myers 1990. *In* Lugo et al. [eds.], Ecosystems of the World 15: Forested Wetlands, pp. 267–278. Elsevier Science Publishers, Amsterdam). Upon initial observation, the lizard was already subdued and located near the center of the web. The lizard's tail was severed near the midpoint, though the autotomized portion of the tail remained tethered to the body by the *Nephila*'s silk. At this stage there were tears in the lizard's skin, and extensive tissue damage to the left groin area, possibly indicating an envenomation site. There were also signs of previous mastication at the terminal end of the tail stub. We speculate that the exposed *Gonatodes* autotomy tissue would be the spider's access point for consumption. At 1950 h, the *Gonatodes* had come loose from its original position and fell to the lower portion of the web, forming a pocket where it hung for the remaining duration of observation. Subsequent observations were made every 20 minutes from 1945 h until 2245 h, and then resumed on 6 Sept 2011 at 0500 h until 0600 h. At this stage the observations ceased due the lizard falling out of the web. With the exception of the 2100 h observation, the spider fed consistently on the lizard. By 0500 h most of the remaining tail stub and rear right leg of the *Gonatodes* had been devoured. The spider appeared to be consuming the lizard in a manner which created a widening shallow depression in the lizard's flesh (Fig. 1). It is interesting to note that with the prospect of such a large meal, the *Nephila* made no attempt to re-secure the prey once it shifted position, chancing the loss of such a valuable meal. This may indicate a correlation between energy expenditure from applying additional silk against the potential gain from the meal. The shift of the lizard's position caused damage to the web's structure, though the web was already in need of repairs in the lower portion. Although the initial capture was not observed, it should also be noted that the spider was missing one leg, which was located in the lower extremity of the web. This is possibly a sign of immediate additional energy expenditure on the part of the spider, in the form of limb regeneration and web repairs, thus demonstrating the spider's motivation to conserve silk (Higgins 1987. J. Arachnol. 15:401–417; Weissman and Vollrath 1999. Bull. Brit. Arachnol. Soc. 11:198–203). No kleptoparasitic activity was observed.



FIG. 1. Adult female *Gonatodes albogularis* being predated upon by the spider *Nephila clavipes* at Caño Palma Biological Station, Costa Rica.

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***GYMNODACTYLUS GECKOIDES*. DEFENSIVE BEHAVIOR.** The behavior of lifting up and curling the tail over the body is a strategy employed by some lizards to avoid predation attempts (Pianka and Vitt 2003. Lizards: Windows to the Evolution of Diversity. Univ. California Press. Berkeley. 333 pp.). There are two hypotheses on how this behavior might have evolved. The first assumes that the position adopted exposes the lizard's tail to potential predators and this might result in tail autotomy if any predation attempt is made, distracting attention from the head. The second hypothesis is that the behavior constitutes Batesian mimicry, in which a harmless lizard species performs a display to appear as a harmful species.

Some authors have previously observed lizards that appear to be mimicking scorpions. The mimics include the geckos *Coleonyx variegatus* (Parker and Pianka 1974. Copeia 1974:528–531) and *Teratoscincus roborowskii* (Autum and Han 1989. Chinese Herpetol. Research 2:60–64). In Brazil there are reports of curling the tail over the back for *Gymnodactylus amarali* (Colli et al. 2003. J. Herpetol. 37:694–706), *Coleodactylus brachystoma* (Brandão and Motta 2005. Phyllomedusa 4:139–145), and *Gonatodes humeralis* (Costa et al. 2009. Herpetol. Rev. 40:221). Herein we report similar defensive behavior in another gecko species, *Gymnodactylus geckoides*, from a semi-arid area in Pentecoste municipality, state of Ceará, northeastern Brazil (3.81833°S, 39.33722°W).



FIG. 1. Adult individual of *Gymnodactylus geckoides* exhibiting the defensive display and detail of the banded ventral pattern of the tail.

Gymnodactylus geckoides exhibits terrestrial and saxicolous habits, nocturnal and crepuscular periods of activity, and is distributed in the Caatinga (thorny deciduous tropical savanna) of northeastern Brazil (Vanzolini et al. 1980. Répteis das Caatingas. Academia Brasileira de Ciências. Rio de Janeiro. 162 pp.; Vitt 1995. Occ. Pap. Oklahoma Mus. Nat. Hist. 1:1–29).

During field work from January 2008 to June 2010 we captured 22 individuals of *Gymnodactylus geckoides* by time-constrained search and pitfall-trapping. The specimens collected were deposited in the scientific collection Coleção Herpetológica da Universidade Federal do Ceará (CHUFC). In the field, all lizards (N = 22), including males, females and juveniles, displayed a tail-curling behavior after handling or simply provoked by the approach of other sympatric lizards (*Ameiva ameiva*, *Cnemidophorus ocellifer*, *Diploglossus lessonae*, *Hemidactylus agrius*, *Mabuya heathi*, *Phyllopezus pollicaris*), when confined in the same enclosure with these species. During the displays, the lizards lifted their tails and bent them over their bodies, exposing the ventral coloration of the tail consisting of contrasting light and dark bands (Fig. 1).

We observed at least three abundant scorpion species in the study area, *Bothriurus asper*, *Bothriurus rochai* (Bothriuridae), and *Rhopalurus rochae* (Buthidae). We cannot disregard the possible effectiveness of tail exposition to predators, but five components of our observations support the hypothesis that the behavior represents mimicry of scorpions by *Gymnodactylus geckoides*. First, the body shape of *G. geckoides* during the defensive display resembles that of a scorpion shape in defensive situations. Second, the geckos and scorpions are similar in body size. Third, the banded ventral color pattern of the lizard tail and the tails of sympatric scorpions are similar. Fourth, there is a high abundance of scorpions living syntopically with the lizards. Finally, *G. geckoides* shares the same activity period with the scorpions.

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***HETERODACTYLUS IMBRICATUS*. DIET**. *Heterodactylus imbricatus* is a gymnophthalmid that occurs in southeastern Brazil (Minas Gerais, Rio de Janeiro, São Paulo, and Espírito Santo states) in high altitude areas of the Atlantic Rainforest domain (Dixo and Verdade 2006. Biot. Neotrop. 6:1–20; Rodrigues et al. 2009. J. Herpetol. 43:605–611; Von Hering 1898. Proc. Acad. Nat. Sci. Philadelphia 50:101–109) and riparian forest associated with Cerrado (Novelli et al. 2011. Check List 7:30–31). This species is terrestrial with fossorial habits and lives in leaf litter or low vegetation (Marques et al. 2009. Biot. Neotrop. 9:1–12). Data on the feeding habits of this species are scarce and the few data reported on diet indicate that this species generally feeds on arthropods (Marques et al. 2009, *op. cit.*), but do not detail which groups of arthropods that compose the diet of this lizard species. Here we report the diet of *H. imbricatus* in detail from the analysis of stomach contents of eight adult specimens (five males and three females; CRLZ 000074, 000143, 000183, 000185, 000191, 000238, 000289, 000314) that were deposited in the Coleção de Répteis do Laboratório de Zoologia, Centro Universitário de Lavras (CRLZ) – UNILAVRAS. These specimens are from the Reserva Biológica Unilavras — Boqueirão (RBUB) (21.346389°S, 44.990833°W, datum WGS84; elev. 1250 m) in riparian forest associated with Cerrado plant communities. Food items were identified according to Triplehorn and Johnson (2011. Estudo dos Insetos. Tradução da 7. Edição de Borror and Delong's Introduction to the Study of Insects. Cengage Learning, São Paulo. 809 pp.). All food items present in the stomach contents were identified as belonging to the following arthropod orders: Coleoptera (abdomen and parts of the abdomen, parts of the thorax, antennae, elytra, legs and leg pieces, and wings); Orthoptera (legs, abdomen, mandibles, antennae); Isoptera (wings, legs, parts of the abdomen); Hymenoptera (heads); Blattodea (legs and leg pieces). As many arthropod taxa were detected only as fragments, accurate calculations for percentage by number or volume could not be made. The lack of more detailed studies, such as dietary data, reflects the low population density of *H. imbricatus*. This report is the first detailed record on the diet of *H. imbricatus* belonging to an area of Cerrado Biome in Brazil.

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***IGUANA IGUANA* (Green Iguana). PREDATION.** The list of known *Iguana iguana* predators is extensive. It ranges from snakes, lizards, and crocodilians to mammals such as wild cats, coatis, tayras, and monkeys (e.g., Rivas et al. 1998. Herpetol. Rev. 29:238–239; Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna Between Two Continents, Between Two Seas. University of Chicago Press, Chicago, Illinois. 934 pp.). This species is also known to fall prey to domestic animals such as cats and dogs (Meshaka et al. 2004. The Exotic Amphibians and Reptiles of Florida. Krieger Publ. Co., Malabar, Florida. 166 pp.) as well as being the target of human hunting (Savage 2002, *op. cit.*). The list of known avian predators is equally extensive with



FIG. 1. A Spectacled Owl (*Pulsatrix perspicillata*) preying upon a sub-adult *Iguana iguana* at La Gamba Field Station, Costa Rica.

raptors, falcons, herons, and toucans serving as a few examples (e.g., Rivas et al. 1998, *op. cit.*; Savage 2002, *op. cit.*). In the southern part of Florida, USA, where the Green Iguana is an established exotic species (Meshaka Jr. et al. 2004, *op. cit.*), there are reports of Burrowing Owls (*Athene cunicularia*) utilizing young Green Iguanas as a prey item (Meshaka et al. 2005. Florida Field Nat. 33:125–127). Herein we report predation by the Spectacled Owl (*Pulsatrix perspicillata*), which to the best of our knowledge has not been previously recorded.

On 22 Aug 2011 at 2150 h at La Gamba Field Station (La Gamba, Puntarenas Province, Costa Rica), we observed a Spectacled Owl consuming a sub-adult *Iguana iguana*. The iguana appeared to be decapitated, though we did not perform a closer inspection to see if the head had been completely removed (Fig. 1). Notably, although *Iguana iguana* utilize arboreal perches for sleeping (Savage 2002, *op. cit.*), the location of consumption was on the ground next to a lagoon. This leads us to believe that either the iguana was captured on its perch and then consumed on the ground, or the lizard made an attempt to escape and dove from its perch, where it was then subdued by the owl. Another interesting observation is the condition of the bird. The owl appears to be wet, however, the 11.5 mm of rain that fell on La Gamba Field Station that day ended before 1800 h. This might suggest that the iguana dove from its perch attempting to escape into the nearby lagoon, causing the owl to pursue its prey into the water. Upon returning to the site 30 minutes later, the owl was in the same location, still consuming the iguana.

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***OLIGOSOMA CHLORONOTON* (Green Skink). LONGEVITY, SITE FIDELITY.** Ecologically, the reptile fauna of New Zealand is characterized by extended longevity and generally low reproductive rates, which make many species vulnerable to human disturbance and introduced mammalian predators (Cree 1994. New Zealand J. Zool. 21:351–372; Daugherty et al. 1993. TREE 8:437–442). Reptiles of New Zealand can also show extreme site-fidelity (e.g., Lettink and Whitaker 2006. Herpetol. Rev. 37:223–224). Such knowledge of species biology and longevity is important for effective conservation management (Towns and Ferreira 2001. Biol. Cons. 98:211–222). However, general conclusions about the extended longevity and site fidelity in New Zealand lizards (currently estimated at ~100 known taxa and undescribed entities; Hitchmough et al. 2010. New Zealand J. Zool. 37[3]:203–224) are limited as few studies have followed individually identified lizards in the wild for the time required to trace individuals throughout their natural life span. Among those that have, considerable longevity and site fidelity are evident. For example, the gecko *Woodworthia brunneus* (as *Hoplodactylus maculatus* in Lettink and Whitaker, *op. cit.*) on Motonau Island can live for at least 42 years within 20 m^2 (Lettink and Whitaker, *op. cit.*), and the diurnal skink *O. lineoocellatum* on North Brother Island can live for at least eight years, but probably no more than 14 years, and all without moving more than 15–60 m (Hoare et al. 2005. Herpetol. Rev. 36:181). Here I augment longevity and site fidelity information on New Zealand reptiles with a report for the rarely observed Green Skink (*O. chloronoton*).

During mark-resight monitoring of critically threatened grand (*O. grande*) and Otago (*O. otagense*) skinks from a mainland site at Macraes Flat, New Zealand (45.4400ºS, 170.4300ºE; elev. 520 m), sightings of *O. chloronoton* were also recorded. From 2006 to 2011 in January and February (austral summer) a 0.5 km^2 area was visually searched on five fine-weather days spaced over 2–3 wks. The area searched consists of ~70 rock outcrops within native tussock grassland, and includes some native scrub. All lizards of interest (those that are not common) were photographed from the nose to the foreleg region to provide high quality digital images of both lateral sides. The digital photographs can be compared accurately over long time frames to provide individual identification (much like fingerprints in humans) and this technique has been used successfully in many *Oligosoma* species (e.g., Gebauer 1999. Trapping and identification techniques for small-scaled skinks (*Oligosoma microlepis*), Department of Conservation, Wellington, New Zealand. 24 pp.). Four adult-sized (max. 108 mm SVL; Gill and Whitaker 2001. New Zealand Frogs and Reptiles, David Bateman Ltd., Auckland, New Zealand. 112 pp.) *O. chloronoton* were seen during the five year survey and three were resighted at least once. All resighted *O. chloronoton* were within 20–40 m of their original location indicating limited dispersal. One *O. chloronoton* was observed five years after first being sighted as an adult. As New Zealand skinks take at least three years to reach sexual maturity (Whitaker 1976. Forest and Bird 202:8–11), the most conservative estimate for longevity in the wild is eight years. The four *O. chloronoton* were all found on north facing slopes; none were observed on south-facing slopes. All four individuals were seen on low rocks surrounded by vegetation with two present on rocks occupied by both *O. grande* and *O. otagense*.

Oligosoma chloronoton is part of a species complex (Greaves et al. 2007. Mol. Phylogen. Evol. 45:729–739), and is classed as "in decline" under the New Zealand Threat Classification system (Hitchmough et al. 2010, *op. cit.*). Yet, few data are available on its general biology, probably due to its cryptic nature and low capture/sighting rate. The finding that *O. chloronoton* live for at least eight years and have relatively high site fidelity in the wild agrees with data for other New Zealand skinks (e.g., *O. lineoocellatum* can live for 8–14 years within a 15–60 m area; Hoare et al., *op. cit.*), and further supports the suggestion that New Zealand lizards are relatively long-lived in comparison with other lizards (e.g., Read 1998. Aust. J. Zool. 46:617–629). The vulnerability of

reptiles from New Zealand due to habitat loss and introduced predators, along with their low annual reproductive output, extended longevity and limited movement, emphasize the need for on-going and effective conservation management.

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***POLYCHRUS MARMORATUS* (Common Monkey Lizard). ENDOPARASITES.** *Polychrus marmoratus* is known from Venezuela, Trinidad and Tobago, the Guianas, Brazil, Amazonian Colombia, Ecuador, and Peru (Ugueto and Rivas 2010. Amphibians and Reptiles of Margarita, Coche and Cubagua. Edition Chimaira, Frankfurt am Main, Germany. 350 pp.). There is one report of endoparasites from *P. marmoratus*; Guerrero (1971. Mem. Soc. Ciencias Nat. LaSalle 31:175–230) described the nematode *Pseudostrongyluris polychrus* from *P. marmoratus* from Venezuela. In this note we present a new locality record for *Pseudostrongyluris polychrus* from *P. marmoratus*.

Eight *P. marmoratus* (mean SVL = 103.5 mm ± 6.4 SD, range = 96–114 mm) were collected in June 1964 at Port of Spain (10.66666°N, 61.51667°N, datum WGS84; 0 m elev.), Trinidad and Tobago, and deposited in the herpetology collection of the Sam Noble Museum (OMNH), Norman, Oklahoma, USA as 31718–31720, 32084–32088. Lizards were fixed in 10% formalin and stored in 70% ethanol.

The digestive tract was removed, opened, and the contents were examined under a dissecting microscope. One female and five (two males and three females) nematodes were found in the large intestines of OMNH 31719 and 31720, respectively. They were cleared in a drop of lactophenol on a microscope slide, cover slipped, studied under a compound microscope, and identified as *Pseudostrongyluris polychrus*. Prevalence (percent infected hosts/number hosts examined x 100) = 25%; mean intensity (mean number helminths ± 1SD = 3.0 ± 2.8 SD, range = 1–5). Voucher nematodes were deposited in the United States National Parasite Collection, (USNPC), Beltsville, Maryland, USA as USNPC 105607. Trinidad and Tobago is a new locality record for *Pseudostrongyluris polychrus*. *Polychrus marmoratus* remains the only known host for *Pseudostrongyluris polychrus*.

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***PODARCIS MURALIS* (Common Wall Lizard). SAUROPHAGY.** *Podarcis muralis maculiventris* (Southern Alps lineage) is a medium-sized European lizard from northwest Italy, southern Switzerland, parts of Austria and one location in extreme southern Germany. It has also been introduced in Cincinnati, Ohio with satellite colonies in Kentucky and Indiana. *Lacerta b. bilineata* (Western Green Lizard) is a large-sized European lizard that has been introduced in Topeka, Kansas (Burke and Deichsel 2008. *In* Mitchell et al. [eds.], Urban Herpetology, pp.347-353. SSAR Herpetol. Conserv., Salt Lake City, Utah). The natural European range of *L. bilineata* is completely overlapped by *P. muralis*. Here we report on a Common Wall Lizard predating a Western Green Lizard in their natural range.



PHOTO BY MICHEL ANSERMET

FIG. 1. *Podarcis muralis* preying on a *Lacerta bilineata*.

On 24 August, 2011, MA observed an adult Common Wall Lizard seizing and killing a young Western Green Lizard near the village of Carena in the Morobbia valley, Switzerland, canton of Ticino (46.1777778°N, 9.0977778°E, 967 m elev.) (Fig. 1). The prey individual was approximately two-thirds of the predator's size, a remarkably large prey item. The wall lizard dragged its prey into a wall joint where it could no longer be observed. The only explanation we can offer is that the wall lizard did so in order to eat it, or perhaps parts of it (e.g., the tail). To our knowledge, this is the first documented case of *P. muralis* predating a *L. bilineata*.

Podarcis siculus, a species closely related to *P. muralis*, was reported to be saurophagic; Capula and Aloise (2011. Acta Herpetol. 6:11–14) documented two cases of *P. siculus* preying on small geckos (*Hemidactylus turcicus*). Grano et al. (2011. Biodiv. J. 2:151–152) and Burke and Mercurio (2002. Amer. Mid. Nat. 147:368–375) each documented an adult *P. siculus campestris* eating young of its own species.

We conclude that the saurophagic feeding behavior of these *Podarcis* species should raise concern about possible negative impacts on native lizard species where they are introduced. For instance, Deichsel and Walker (2010. Herpetol. Rev. 36:228–229) reported that introduced *P. muralis maculiventris* (Southern Alps lineage) were replacing *Plestiodon fasciatus* from a habitat in Indiana, and the return of the latter after removal of the introduced species.

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***SCELOPORUS COZUMELAE* (Cozumel Spiny Lizard). REPRODUCTION AND FEMALE COLORATION.** There are few reports on the natural history of *Sceloporus cozumelae*, a Mexican species restricted to coastal scrub habitat of the northern Yucatán Peninsula and associated islands (Lee 1996. Amphibian and

Reptiles of the Yucatán Peninsula. Cornell Univ. Press, Ithaca, New York. 500 pp.). Published data on breeding consists of female reproductive status (determined from dissection or palpation) and date of capture. Most females collected in the area of Progreso (Yucatán) in June and July had eggs, and three females captured in mid-December had shelled eggs "in the uterus" (Maslin 1963. Univ. Colorado Stud. Ser. Biol. No. 9, pp. 1–20). Females with vitellogenic follicles have been found in early January in Progreso (F. R. Mendez de la Cruz, pers. comm.). These data, in concert with scattered observations of hatchlings and juveniles, suggest that *S. cozumelae* has an extended breeding season (Lee 1996, *op. cit.*). Here I report observations that, while limited, nonetheless indicate that (1) individuals in populations of *S. cozumelae* on the eastern side of the peninsula are also breeding in late December and (2) females can exhibit an orange reproductive coloration. The eastern peninsula is more mesic than the western side where the above reports for this species were made, but northern storms produce a rainy period in December and January.

Four sets of observations from Isla Contoy (21.4725°N, 86.7891°W) on 27 Dec 2011 are consistent with winter breeding activity on the eastern side of the peninsula. I did not capture the lizards because Isla Contoy is a National Park. First, I observed a mating pair on the south end of the island in the middle of a sandy trail surrounded by dense coastal scrub vegetation (primarily *Suriana maritima*, Sea Lavender; *Coccoloba uvifera*, Sea Grape). The intromission, which was observed in its entirety, was relatively short (<1 min.) and occurred at 1145 h (28.3°C, 0% cloud cover). Second, I observed three large, apparently adult females, and each had a distended abdomen. These females looked like similar-sized *Sceloporus virgatus* I have studied when this species has late-vitellogenic follicles (e.g., Hews et al. 2004. Anim. Behav. 68:1201–1207). Third, I observed a large, apparently adult female with a pair of large, bright orange throat patches. Orange reproductive coloration has not been reported for *S. cozumelae*. Reproductive coloration probably is underreported for many species in this genus, and occurs in a number of phrynosomatid lizards (Cooper and Greenberg 1992. *In* Gans and Crews [eds.], Biology of the Reptilia Vol. 18, Physiology E, Hormones, Brain and Behavior, pp. 298–422. Univ. Chicago Press, Chicago, Illinois). In *S. virgatus* females, throat patch size and intensity increases with ovarian stage, and late-vitellogenic and gravid females have the largest, most-colorful throat patches (Weiss 2002. Ethology 108:793–813). These patches are highly conspicuous against a pure white throat and chest and are easy to observe with binoculars when there is sufficient light and the throat can be viewed; these were the conditions under which I observed the orange patches of the *S. cozumelae* female. Fourth, most adult-sized males viewed with binoculars had an enlarged ventral region at the base of the tail, consistent with enlarged hemipenes. In other *Sceloporus* this androgen-dependent swelling does not occur in subadult males, and regresses in non-breeding adult males (pers. obs. on *S. undulatus* and *S. virgatus*). I saw six males (all with enlarged hemipenes), four females and one juvenile (ca. 40 mm SVL) in 120 min of observation time. Hence, all adult-sized females were in reproductive condition (i.e. seen mating, or with apparently late-vitellogenic and/or with orange color), and all adult-sized males exhibited enlarged tail-base region.

Finally, on 28 Dec 2011, on the nearby mainland (21.291389°N, 86.818889°W) along the coastal Isla Blanca road north of Punta Sam (Quintana Roo), I saw 20 *S. cozumelae* during 100 min of observation time spent in extensive coastal scrub habitat, under windy, overcast (ca. 85% cloud cover) but warm (27–28°C) conditions between 1030 and 1210 h. Two *S. cozumelae* appeared to be the size of juveniles and the remainder appeared adult-sized. A number of apparently adult males were observed on conspicuous elevated perches, consistent with breeding activity of males. Two such males were captured and both had enlarged hemipenes.

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***THECADACTYLUS SOLIMOENSIS*. ENDOPARASITES.** *Thecadactylus solimoensis* is known from parts of Ecuador, Peru, Bolivia, Brazil, and Colombia (Bergmann and Russell 2007. Zool. J. Linn. Soc. 149:339–370.). We know of no reports of helminths for *T. solimoensis* and the purpose of this note is to establish the initial helminth list for this species.

A sample of 18 *T. solimoensis* (mean SVL = 104.0 mm ± 12.7 SD, range: 76–106 mm) collected 1994 and 1998 from the herpetology collection of the Sam Noble Museum (OMNH), University of Oklahoma, Norman, Oklahoma, USA were examined for helminths. Eleven (OMNH 36427–36437) were collected in Sucumbios Province, Ecuador; five (OMNH 37332–37336) were collected in Rondônia State, Brazil; two (OMNH 37635, 37636) were collected in Amazonas State, Brazil. Lizards were fixed in 10% formalin and stored in 70% ethanol.

The stomachs were not available for study. The intestines were removed, opened and the contents examined utilizing a dissecting microscope. Four nematodes were found in the large intestine of OMNH 37335, collected in Rondônia State, Rio Formoso, Parque Estadual, ca. 90.0 ± km N of Nova Mamoré, (10.38333°S, 65.38333°W; datum WGS 84, elev. ca. 147 m). The nematodes were cleared in a drop of lactophenol on a microscope slide, cover slipped, studied under a compound microscope and identified as one male and three females of *Spauligodon oxkutzcabiensis*. Prevalence (percent infected hosts/number hosts examined x 100) = 6%. Helminths were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland, USA as USNPC 105345.

Spauligodon oxkutzcabiensis has been reported in lizards from Mexico, Central and South America see (Goldberg and Bursey 2009. Herpetol. Rev. 40:224). Infection presumably occurs by exposure to eggs in fecal contaminated substrate as postulated for the congener *Spauligodon giganteus* (Goldberg and Bursey 1992. J. Parasitol. 78:539–541). *Spauligodon oxkutzcabiensis* in *T. solimoensis* is a new host record.

We thank Jessa L. Waters (OMNH) for facilitating our loan of *T. solimoensis*.

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***TROPIDURUS HYGOMI* (Reinhardt's Lava Lizard). PREDATION.** Predation is an important factor influencing ecological community structure (Morin 1983. Ecol. Monogr. 53:119–138). However, such events are rarely reported from natural interactions within the environment due to the rarity of observations (Shepard 2007. Herpetologica 63:193–202). Snakes have very diverse diets, preying on a wide variety of invertebrates and vertebrates (Greene 1997. Snakes: The Evolution of Mystery in Nature.

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FIG. 1. *Oxybelis aeneus* preying upon a juvenile *Tropidurus hygomi*, Sergipe, Brazil.

Univ. California Press, Berkeley. 365 pp.). Lizards are potential prey items of snakes in various environments (Silva and Araújo 2008. Ecologia dos Lagartos Basileiros. Technical Books, Rio de Janeiro. 271 pp.).

At 1032 h on 1 June 2008 we observed a Brown Vine Snake (*Oxybelis aeneus*) prey upon a *Tropidurus hygomi* (Fig. 1) in Parque Nacional Serra de Itabaiana, Sergipe, Brazil (10.7488889°S, 37.3419444°W, datum SAD 69; 240 m elev.). The snake was an adult male measuring 910 mm (SVL) and the lizard was a juvenile measuring 40.2 mm (SVL). This took place at the edge of a *Clusia* sp. (Guttiferae) shrub in an area with white sandy soil.

To our knowledge, this is the first report of predation of *Tropidurus hygomi* by *O. aeneus* or by any snake species.

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***UROMASTYX BENTI* (Bent's Spiny-tailed Lizard). MAXIMUM ELEVATION.** After revisions to the *Uromastyx ocellata* group (Wilms and Schmitz 2007. Zootaxa 1394:1–23), *U. benti* is known from southeastern Yemen and neighboring southwestern Oman. In Oman, it is known only from the immediate vicinity of Mirbat (Seufer et al. 1998. Herpetofauna 20:22–23). Mirbat is a coastal town, and all of these records from the region are from low elevations (e.g., MVZ 242745: elev. 35 m, 17.00933°N 54.70283°E; WGS 84). In Yemen, it is known from Makulla (e.g., NHMW 888:1 and NHMW 16174:1), Ayn Ba Ma'bad near Azzan (e.g., NHMW 21214: 1–2), and Wadi Abr in Hadramaut (e.g., BMNH 1953.1.8.52). All documented localities in Yemen lack elevational data, but the approximate elevation of Makulla is 21 m, Ayn Ba Ma'bad near Azzan is 33 m, and Wadi Abr in Hadramaut is 3 m. Thus, all previously recorded localities of *U. benti* are coastal and at low elevations. We report an adult male and female (MVZ ObsHerp 6 and MVZ ObsHerp 7 photo vouchers) observed basking on a rock at high elevation of 1410 m adjacent to the Arabian Leopard Reserve at Jabal Samhan in the Mirbat Wilayat of the Dhofar Governorate of Oman (17.1337°N, 54.7376°E; WGS 84) on 02 July 2011. This represents the highest elevational record for *U. benti* and may guide further explorations of the range of this poorly sampled species.

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***VARANUS PANOPTES* (Yellow-spotted Monitor). DIET.** *Varanus panoptes* is a large lizard (up to 1.5 m in total length) inhabiting riparian areas and floodplains in tropical Australia (Cogger 2000. Reptiles and Amphibians of Australia. Reed New Holland, Sydney. 808 pp.). It is a generalist carnivore, consuming mammals, frogs, reptiles, fish, invertebrates, and the eggs of reptiles and birds (Blamires 2004. Copeia 2004:370–377; Christian 2004 *In* Pianka and King [eds.], Varanoid Lizards of the World, pp. 423–429. Indiana University Press, Bloomington and Indianapolis; Shine 1986. Herpetologica 42:346–360). Not surprisingly, snakes have been reported in its diet, including the Keelback Snake (*Tropidonophis mairii*), the Brown Tree Snake (*Boiga irregularis*), and a file snake (*Acrochordus* sp.) (Blamires 2004, *op. cit.;* Shine 1986, *op. cit.*). Herein we report on *V. panoptes* feeding on two additional snake species in tropical northern Australia. We discuss the implications of one of these observations for trophic cascades induced by the invasive Cane Toad (*Bufo marinus*) via population declines in *V. panoptes*.

At 1629 h on 26 May 2001, four of us (SD, BG, DR, GD) discovered a *V. panoptes* eating a Water Python (*Liasis fuscus*) on a shaded sand bank along the Daly River, Northern Territory, Australia (13.939836°S, 131.183361°E). About 0.3 m of the tail of the approximately 1 m snake was hanging out of the mouth of the 1.3 m lizard. The monitor moved slowly away from us upon the approach of our boat, and appeared to be unable to swallow the remaining portion of the snake; it made no attempt to further swallow the snake. After 11 minutes of observation there was no change in the proportion swallowed, at which time we departed the site. The weather was clear and sunny with an air temperature of 26.8°C. Because the Water Python is nocturnal and the monitor diurnal, the snake was probably taken from its roost during the day (e.g., from within a hollow log).

At 1300 h on 17 October 2006, one of us (MH) observed a *V. panoptes* eating a Common Tree Snake (*Dendrelaphis punctulata*) in riparian habitat lining the Adcock River at Mornington Wildlife Sanctuary, Western Australia (17.537°S, 126.115°E).

PHOTO BY MICHELLE HALL



FIG. 1. A Yellow-spotted Monitor, *Varanus panoptes*, eating a Common Tree Snake, *Dendrelaphis punctulata*, from Mornington Wildlife Sanctuary, Western Australia.

Upon discovery, approximately 20 cm of the snake's tail was on the ground near the monitor as it gradually swallowed the snake from the head end (Fig. 1). Both the monitor and snake were >1 m long, and ingestion took more than 6 minutes. The weather was hot and sunny. Like *V. panoptes*, *D. punctulata* is diurnal (Fearn and Trembath 2010. Aust. J. Zool. 58:384–389), suggesting capture during the active period.

Varanus panoptes is one of three species of monitor lizards that suffer severe population-level declines, via lethal toxic ingestion, with the invasion of Cane Toads (e.g., 83–96%, Doody et al. 2009. Anim. Conserv. 12:46–53). Because *V. panoptes* is an apex predator, its marked reduction has been implicated in population or recruitment boosts in several species of its prey, including Gilberts' Dragons (*Amphibolorus gilberti*), Pig-nosed Turtles (*Carettochelys insculpta*), and Freshwater Crocodiles (*Crocodylus johnstoni*) (Doody et al. 2006. Wildl. Res. 33:349–354; Doody et al. 2009, *op. cit.*; Webb and Manolis 2010 *In* Manolis and Stevenson [eds.], Crocodiles. Status Survey and Conservation Action Plan, 3rd ed., pp. 66–70. Crocodile Specialist Group, Darwin, NT). Most recently, marked increases in annual counts of common tree snakes were attributed to the toad-induced decline in *V. panoptes* (Doody et al., *in press*), although published accounts of *V. panoptes* eating tree snakes were lacking. Our observation provides the "smoking gun" for that study by confirming the Common Tree Snake as a prey item of *V. panoptes*. Because this predation event likely reflects both tree snake population regulation by *V. panoptes* and a cascading effect of invasive Cane Toads in the tropical riparian vertebrate community, our observation reinforces the importance of publishing anecdotal accounts of diet.

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SQUAMATA — SNAKES

***BOA CONSTRICTOR* (Boa Constrictor). DIET.** *Boa constrictor* is a widely distributed species, ranging from Mexico to Argentina. This snake inhabits a remarkable range of habitats, from arid scrub to humid tropical forest, and feeds on lizards, birds and mammals, with endothermic animals comprising a large proportion of the diet of adult specimens (Greene 1983. *In* Janzen [ed.] Costa Rican Natural History, pp. 380–382. Univ. Chicago Press, Illinois; Quick et al. 2005. J. Herpetol. 39:304–307; Pizzatto et al. 2009. Amphibia-Reptilia 30:533–544). On 9 March 2011 an adult *B. constrictor* (CFL-CH-046; total length = 165 cm; 3.5 kg) was captured in the Campus Florestal of the Universidade Federal de Viçosa, municipality of Florestal, Minas Gerais, Brazil (19.87°S, 44.42°W, datum: SAD69; elev. 750 m), at the edge of a forest fragment near a marsh. In the snake's stomach, we found several feathers, some bones, and both feet of an *Aramides saracura* (Slaty-breasted Wood-Rail; Aves: Rallidae). This is a locally common medium-sized rail (ca. 500 g) found in forests and woodlands near marshes and riparian habitats throughout southeastern and southern Brazil, eastern Paraguay and northeastern Argentina (Taylor and Perlo 1998. Rails. Pica Press, Sussex). It is considered endemic to the threatened Atlantic Forest (Brooks and Balmford 1999. Anim. Conserv. 2:211–222).

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***BOTHRIOPSIS BILINEATA SMARAGDINUS* (Green Jararaca). REPRODUCTION.** Little is known about the reproduction of *Bothriopsis bilineata smaragdinus,* a relatively small, arboreal, prehensile-tailed pitviper distributed in western Amazonia. In September 2011, a pregnant female *B. b. smaragdinus* was rescued from Santo Antônio Hydroelectric Plant, Porto Velho - RO (08.8022°S, 63.9720°W, datum: WGS84) and sent to the Laboratory of Herpetology at Instituto Butantan, São Paulo, Brazil. The snake was housed in a plastic cage and was fed two *Rana catesbiana* tadpoles every 15 days. On 21 October 2011, the female (SVL = 600 mm; tail length [TL] = 90 mm; 87 g) gave birth to five neonates (two males and three females). Measurements of the male neonates were 230 mm SVL, 40 mm TL, 4.1 g and 210 mm SVL, 45 mm TL, 4.1 g; measurements of the females were 225 mm SVL, 40 mm TL, 3.7 g; 215 mm SVL, 45 mm TL, 3.7 g; and 230 mm SVL, 35 mm TL, 4.1 g. The post-partum mass of the mother was 56.5 g and the combined mass of the living neonates was 22.6% of the mother's pre-partum mass. In previous studies, four eggs were observed in the oviduct of this species (Dixon and Soini 1986. The Reptiles of the Upper Amazon Basin, Iquitos Region, Peru. Milwaukee Publ. Mus., Wisconsin. 157 pp.).

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***COLUBER CONSTRICTOR* (North American Racer), *PANTHEROPHIS ALLEGHENIENSIS* (Eastern Ratsnake), and *NERODIA FASCIATA* (Southern Watersnake). GOLF CART MORTALITY.** The benefit of golf courses as small-scale refugia and set-aside natural environments for herpetofauna within urban settings have been well documented (Hodgkinson et al. 2007. Biol. Conserv. 135:576–586). An important yet understudied aspect of golf courses is the potential for collisions between herpetofauna and golf carts. Although carts have been implicated in road mortality in at least one study (DeGregorio et al. 2010. Herpetol. Conserv. Biol. 3:441–448), direct evidence for golf cart induced mortality is absent. Here we present five cases in which golf cart collisions directly caused snake mortality on Bald Head Island, Brunswick Co., North Carolina, USA.

On 7 June 2009, we observed a gravid female *Coluber constrictor* (SVL = 826 mm) being struck and subsequently dying from a single collision with a golf cart. We observed a second snake, an adult male *Pantherophis allegheniensis* (SVL = 653 mm), being hit and killed by a golf cart on 1 July 2009. On 29 July 2009, we saw a neonate *C. constrictor* (SVL = 235 mm) get hit on the road and it was presumed dead by the time we arrived, although the body was still twitching. On 10 August 2009, a neonate female *Nerodia fasciata* (SVL = 180 mm) was hit by a golf cart while crossing a paved path on the golf course. Although the snake survived the initial collision, it died two hours later. The fifth observation occurred on 16 September 2009, when a juvenile *C. constrictor* (SVL = 361 mm) was hit by a single golf cart. As in the previous

observation, the snake survived the initial collision but died the following night. Although golf courses may provide benefits to many species of herpetofauna, the potential for increased mortality due to collisions with golf carts should not be ignored.

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***COLUBER* (=*MASTICOPHIS*) *FLAGELLUM FLAGELLUM* (Eastern Coachwhip). DIET.** *Coluber flagellum* is known to be a widely foraging predator, actively preying upon lizards, amphibians, small mammals, and birds (Halstead et al. 2008. Herpetologica 65:268–279; Secor 1995. Herpetol. Monogr. 9:169–186). On 30 April 2010, at 1330 h, we observed a male *C. flagellum* (SVL = 119 cm; tail length = 43 cm; 401 g) attempting to ingest an adult *Columbina passerina* (Common Ground Dove) in beach dune habitat within Guana Tolomato Matanzas National Estuarine Research Reserve (30.125753°N, 81.347092°W; datum: WGS84; elev. 3 m), South Ponte Vedra Beach, Florida, USA. The snake abandoned its prey and fled towards a nearby active *Gopherus polyphemus* (Gopher Tortoise) burrow upon our approach. To our knowledge this represents the first documented observation of *C. flagellum* preying upon *C. passerina*.

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***EUNECTES MURINUS* (Green Anaconda). DIET.** *Eunectes murinus* is a generalist predator that ambushes its prey along the edges of aquatic habitats (Rivas 2000. Life History of the Green Anaconda [*Eunectes murinus*], with Emphasis on its Reproductive Biology. Ph.D. Thesis, Univ. Tennessee, Knoxville. 269 pp.). While there are several accounts of the diet of adult individuals there is little information about prey consumed by young anacondas in nature. Here we report two records of predation on diurnal birds by a juvenile *E. murinus* in central Brazil.

At 1715 h on 9 July 1999, we found a juvenile *E. murinus* (CHUNB 12799; total length = 1069 mm; 451 g) along a stream in gallery forest 10 km W of the city of Palmas, Tocantins State, Brazil (10.1667°S, 47.4353°W, datum: WGS84; elev. 230 m). The snake was found under a dead log in a small backwater of the stream and was constricting a female *Rhamphocelus carbo* (Silver-beaked Tanager; total length = 102 mm; 59 g). Upon dissection, we found that the snake had also recently consumed a female *Claravis pretiosa* (Blue Ground-dove; total length = 190 mm; 59 g). The relative size of each prey item was 13% of the snake's body mass and their combined relative mass (26%) was close to those previously reported for other aquatic snakes of comparable size (Andreadis and Burghardt 2005. J. Comp. Psychol. 119:304–310). Small birds may play an important role in the diet of young anacondas before they grow large enough to subdue and kill larger prey (Rivas, unpubl. data).

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***GYALOPION CANUM* (Chihuahuan Hook-nosed Snake). PREDATION.** *Gyalopion canum* occurs in the southwestern United States into central New Mexico and west Texas southward into central Mexico in Zacatecas and San Luis Potosí (Tipton 2005. Snakes of the Americas: Checklist and Lexicon. Krieger Publ. Co., Malabar, Florida. xii + 477 pp.). Little is known regarding the predators of this species. During an examination of the stomach contents of a road-killed Kit Fox (*Vulpes macrotis*) collected 10 April 1997 on Sycamore Street, Roswell, Chaves Co., New Mexico, USA (33.7027°N; 104.5683°W; datum: WGS84) a mostly intact adult *G. canum* was found. Habitat was a pecan orchard in an agricultural area on the outskirts of Roswell, generally surrounded by Chihuahuan Desert grasslands and shrublands.

Cypher (2003. *In* Feldhamer et al. [eds.], Wild Mammals of North America, 2nd ed., pp. 511–546. John Hopkins Univ. Press, Baltimore, Maryland) lists snakes and lizards as a component of the diet of *V. macrotis* but does not provide details of the species involved. To our knowledge this is the first report of *G. canum* being preyed upon by *V. macrotis*. Both specimens are deposited into the University of New Mexico Museum of Southwestern Biology (*V. macrotis*, Division of Mammalogy MSB 231268; *G. canum*, Division of Herpetology MSB 61425).

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***HELICOPS ANGULATUS* (Watersnake). PREDATION.** There are few records of predation on aquatic snakes by invertebrates. Here we report a predation event on a young *Helicops angulatus* by an aquatic ant-lion larva (Corydalidae) in Cavalcante Municipality, Goiás, Brazil (13.8122°S, 47.4342W, datum: SAD6984). At 2200 h on 10 October 2011, we found a neonate *H. angulatus* (CHUNB 67470; SVL = 114 mm) being seized and consumed by a large Corydalidae larvae (total length = 66 mm) under a submerged rock along the margins of São Bartolomeu river. The larva was holding the snake by the neck, while remaining attached to the underside of the rock. The larva held the snake motionless by seizing it with its limbs. When we lifted the rock, the larva released the snake, which attempted to swim away. The snake was collected alive, but subsequently died from a deep injury to its neck.

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***HETERODON PLATIRHINOS* (Eastern Hog-nosed Snake). HIBERNACULA SITE FIDELITY.** *Heterodon platirhinos* is a wide-ranging snake in the eastern United States and southern Canada that occurs in greatest densities in locales with well-drained, sandy soils. *Heterodon platirhinos* are believed to brumate individually in mammal burrows and self-excavated dens under rocks, in logs, or under artificial cover and are thought to retreat

to hibernacula late in the fall and emerge early in the spring relative to sympatric snake species (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Institution Press, Washington D.C. 680 pp.). Aside from these generalities, there is limited information on *H. platirhinos* brumation or factors associated with hibernacula selection.

We conducted a radiotelemetry study of *H. platirhinos* between April 2009 and April 2011 at Cape Cod National Seashore, Barnstable Co., Massachusetts, USA. The study area was located at the northern terminus of the Cape Cod peninsula in an approximately 1800 ha sand dune landscape known locally as the Province Lands. Among the 16 animals radiotracked was a female (SVL = 610 mm; total length = 745 mm, 325 g) that was tracked to brumation in 2009 and 2010 and was found to use the same hibernaculum in both years. The hibernaculum consisted of a network of mammal burrows running through the root system of a stunted Pitch Pine (*Pinus rigida*). The snake was first documented underground at this location on 5 November 2009 and emerged between 16 March and 18 April 2010. During the 2010 active season, the snake utilized a large area (17.8 ha minimum convex polygon) and was as far as 466 m from the hibernaculum. The snake returned to the hibernaculum in early October 2010 and emerged between 3 April and 17 April 2011. Although Cunnington and Cebek (2005. Am. Midl. Nat. 154:474–478) documented inter-annual fidelity and clustering of oviposition sites in *H. platirhinos*, this is believed to be the first record of hibernaculum site fidelity in this species. Of three individuals tracked to hibernacula in consecutive years, this was the only instance of hibernaculum fidelity.

Mortality associated with brumation in temperate populations of snakes suggests that hibernacula are a limiting resource and that selection of an appropriate site is critical for survival (Mullin and Siegel 2009. Snakes: Ecology and Conservation. Cornell Univ. Press, Ithaca, New York. 365 pp.). Hibernacula site fidelity is well documented for species that brumate communally and is thought to be in response to limited availability of adequate brumation sites (Gibbons and Semlitsch 1987. *In* Siegel et al. [eds.], Snakes: Ecology and Evolutionary Biology, pp. 404–406. Macmillan, New York). For species that brumate individually (such as *H. platirhinos*), fidelity to successful overwintering sites would also seem to be advantageous, although the fact that they brumate individually may suggest that these species are not as severely limited by hibernacula availability. Of 11 instances where we radiotracked snakes to hibernacula in the fall, all emerged in the spring, suggesting that overwintering mortality is low and that hibernacula are not a limiting factor for *H. platirhinos* in our study area.

Work was carried out under scientific collecting permit #017.10SCRA issued by the Massachusetts Division of Fisheries and Wildlife and scientific research and collecting permit #CACO-2011-SCI-0005 issued by the National Park Service. Work was approved by the Institutional Animal Care and Use Committee of Montclair State University (Ref #2009-01).

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***LAPEMIS CURTUS* (Short Seasnake). DIET.** *Lapemis curtus* is widely distributed throughout tropical and subtropical Indo-Pacific, including coastal habitats in the Persian Gulf, Indian Ocean, South China Sea, Straits of Taiwan, Indo-Australian Archipelago, the Philippines, and the Pacific Ocean (Minton 1975. *In* Dunson [ed.], Biology of Sea Snakes, pp. 233–249. University Park Press, Baltimore, Maryland). It is a dietary generalist, known to consume fish from 33 families and two species of marine invertebrates (cuttlefish and amphipod; Lobo et al. 2005. Copeia 2003:637–641; Voris and Voris 1983. Am. Zool. 23:411–425). In November 2011, I collected 5 dead male *L. curtus* from the bycatch of a shrimp trawler in the coastal waters of Bandar Abbas, Persian Gulf, Iran. Dissection revealed that the stomachs of three snakes contained identifiable prey items. The first snake (Fig. 1; SVL = 72 cm, 331 g) contained a partially digested sardine (*Sardinella* sp. [Clupeidae]) and a Sulphur Goatfish (*Upeneus sulphureus* [Mullidae]; total length = 9 cm). The second snake (SVL = 74 cm, 356 g) contained a *Sardinella* sp. (total length = 13 cm), and the third snake (SVL = 75 cm, 360 g) contained a *U. sulphureus* (total length = 9.5 cm) and an unidentifiable fish. This is the first record of fish in the family Mullidae as prey of *L. curtus*, though they have been reported as prey for *Pelamis platurus* (Yellow-bellied Seasnake; Voris and Voris 1983, *op. cit.*). Fish in the family Clupeidae have been reported as the main prey of *L. curtus* along the western coast of India (Lobo et al., *op. cit.*). Both sardines and goatfish are active swimmers, but goatfish are primarily demersal, whereas sardines are pelagic. Further, investigation feeding habits of *L. curtus* is the Persian Gulf is important because the Persian Gulf represents the western distribution limit for the species and presents unique environmental conditions (e.g., high salinity and high temperature) and fish assemblages.

I thank the captain and seamen of the Tabas-9 for welcoming and supporting me on the ship during the fishing season.

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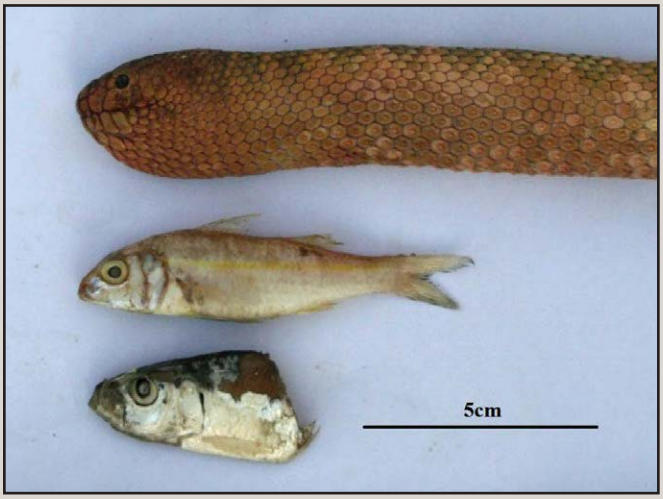


FIG. 1. Partially digested sardine (*Sardinella* sp.) and a Sulphur Goatfish (*Upeneus sulphureus*) consumed by a *Lapemis curtus* in the coastal waters of Bandar Abbas, Persian Gulf, Iran.

***MICRURUS DECORATUS* (Decorated Coralsnake). DIET.** Coralsnakes (*Micrurus* spp.) typically feed on elongated vertebrates, including amphisbaenians, snakes, legless lizards, and caecilians (Campbell and Lamar 2004. The Venomous Reptiles of the Western Hemisphere. Vol. 1. Cornell University Press, Ithaca, New York. 476 pp.). The last have been reported as prey for several coralsnake species (e.g., Campbell and Lamar, *op. cit.*; Horan et al. 2011. Herpetol. Rev. 42:294–295; Huber and Hödl 2010. Herpetol. Rev. 41:484; Saporito 2007. Herpetol. Rev. 38:199). The distribution of *Micrurus decoratus* is limited to the Atlantic Forest of southeastern and southern Brazil, usually in mid-elevation montane areas (Campbell and Lamar, *op. cit.*; Marques 2002. Amphibia-Reptilia 23:228–232). The two published surveys on the diet of this species (Marques, *op. cit.*; Terribile and Silva Jr. 2005. Herpetol. Rev. 36:457–458) reported only amphisbaenians and caecilians as prey. The latter were identified as *Siphonops* sp. in both studies. Here we report an additional case of *M. decoratus* feeding on a caecilian, and the first in which the caecilian prey was identified to species.

On 12 September 2010, two of us (DV and CCS) recovered a dead male *M. decoratus* (SVL = 510 mm; tail length = 35 mm) from a road at Theodoro de Oliveira (22.373889°S, 42.556667°W, datum: SAD 69; elev. ca. 1100 m), municipality of Nova Friburgo, state of Rio de Janeiro, Brazil. The snake's body had been completely flattened by the passing of cars, but we noticed a piece of a small caecilian protruding from its ruptured venter. Later, we dissected the snake and recovered the remaining pieces of the caecilian, which was identified as a *Siphonops hardyi*. The snake and its prey were deposited in the reptile collection of the Museu Nacional, Rio de Janeiro (MNRJ 19859). *Siphonops hardyi* is a relatively widespread caecilian species in southeastern Brazil, being found both in lowland and in montane sites (Maciel et al. 2009. Check List 5:919–921). To our knowledge, this is the first confirmed report of *S. hardyi* as prey of a coralsnake.

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***OXYBELIS FULGIDUS* (Green Vinesnake). DIET.** *Oxybelis fulgidus* occurs from Mexico to Argentina and is common in the Brazilian Amazon. It is an arboreal ambush predator, feeding mainly on lizards and medium to small passerine birds (Martins and Oliveira 1998. Herpetol. Nat. Hist. 6:78–150; Scartozzoni et al. 2009. S. Am. J. Herpetol. 4:81–89). On 19 May 2011, an *O. fulgidus* (ca. 2 m total length) was seen in a young avocado tree (*Persea americana*) in the Maracarana community, along the Uatumã river, south of the Balbina Dam, Brazilian Amazon (2.21°S, 58.83°W; datum NAD83/WGS84). The snake's presence was noticed only after it caught a *Sturnella militaris* (Red-breasted Blackbird) by the neck, causing the bird to emit loud alarm calls. The bird survived for approximately 5 min. and was subsequently consumed headfirst by the snake (Fig. 1). This is the first record of *S. militaris* in the diet of *O. fulgidus*.



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FIG. 1. *Oxybelis fulgidus* consuming its prey (*Stunella militaris*) headfirst after placing it on a horizontal branch.

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***OXYBELIS FULGIDUS* (Green Vinesnake). DIET.** *Oxybelis fulgidus* is a diurnal arboreal snake that forages among the lower strata of trees and shrubs (Martins and Oliveira 1998. Herpetol. Nat. Hist. 6:78–150). The diet for this species is known to consist primarily of birds and lizards (Beebe 1946. Zoologica 31:11–52; Cunha and Nascimento 1978. Publ. Avul. Mus. Par. Emílio Goeldi 31:1–218; Dixon and Soini 1986. Milw. Publ. Mus. Milwaukee, Wisconsin; Scartozzoni et al. 2009. S. Am. J. Herpetol. 4:81–89). At 1409 h on 1 March 2008, we observed an adult female *O. fulgidus* (INPA-H 21228; SVL = 1170 mm; 250 g) capturing a *Columbina passerina* (Common Ground Dove; 35 g) in a fragment of terra firme forest, in the Parque Residencial Acariquara II, municipality of Manaus, Amazonas, Brazil (03.08433°S, 59.96106°W; datum WGS 84). The snake was seen falling from a shrub with the bird in its jaws but remained anchored to the shrub by its tail, about 1 m off the ground. The snake remained holding the bird by the head for ca. 30 min, until it stopped moving. The long time being held could be associated with envenomation of the prey, a common behavior of opisthoglyphous snakes (Kardong 1982. Mem. Inst. Butantan 46:105–118). Soon afterwards, the snake began swallowing the bird head first (Fig. 1). The available literature reports *O. fulgidus* preying on the bird genera *Pipra*, *Thraupis*, *Volatinia*, *Dendrocincla*, *Carduelis*, *Elaenia*, and *Monasa* (Martins and Oliveira, *op.cit.*; Scartozzoni et al., *op.cit.*). This is the first report of *O. fulgidus* preying on birds of the genus *Columbina*.

COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND



FIG. 1. *Oxybelis fulgidus* consuming a *Columbina passerina* (Common Ground Dove) in the Parque Residencial Acariquara II municipality of Manaus, Amazonas, Brazil.

We thank M. Cerqueira and M. S. Dias for bird identification. Specimens were collected under IBAMA permit 14032-1 to R. C. Vogt. R. de Fraga received financial support from FAPEAM.

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***PANTHEROPHIS EMORYI* (Great Plains Ratsnake). DIET.** *Pantherophis emoryi* feeds primarily on small mammals and birds, but may also consume lizards, snakes, and frogs (Ernst and Barbour 1989. Snakes of Eastern North America. George Mason Univ. Press, Fairfax, Virginia. 282 pp.). At 1015 h on 31 July 2008 we collected a female *P. emoryi* (SVL = 53.7 cm; tail length = 10.2 cm; 69.0 g) in a sandstone crack on the northeast side of a bedrock outcrop on the north side of Two Buttes Creek canyon at Two Buttes Reservoir Wildlife Management Area, Baca Co., Colorado, USA. The snake was photo vouchered, with photos deposited in the University of Northern Colorado Museum of Natural History (UNC-MNH 4612). The snake contained an obvious food bulge and was in a loose coil partially sun exposed, likely to facilitate digestion. Upon transport to the field house, the snake voluntarily regurgitated a partially digested mouse (*Peromyscus* sp.) that weighed 18.15 g and was consumed head first. The relative size of meal by mass was 26.3%. The only other previous report of relative meal size for *P. emoryi* was an adult female that consumed a *Sceloporus olivaceus* representing 35.5% of the snake's mass (Ferguson and Dixon 2007. Herpetol. Rev. 38:340). Our report documents the first prey/predator weight ratio and the largest prey/predator weight ratio for a juvenile *P. emoryi* feeding on mammalian prey. In addition, our note documents only the third *P. emoryi* specimen from Two Buttes Reservoir SWA (Montgomery et al. 1998. Herpetol. Rev. 29:112).

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***PHIMOPHIS GUIANENSIS* (Troschel's Pampas Snake). DIET.** *Phimophis guianensis* is a xenodontine snake that is generally considered crepuscular or nocturnal. This species inhabits lowlands up to 1200 m elevation in Panama and northern South America, including Colombia, Venezuela, the Guianas, and northeastern Brazil (Lancini 1982. Mem. Inst. Butantan 46:95–103; Peters and Orejas-Miranda 1970. Catalogue of the Neotropical Squamata. Part I. Snakes. Bull. U.S. Nat. Mus. 297:1–347). Only a few confirmed diet records exist for snakes in the genus *Phimophis*: *P. scriptorcibatus* was documented feeding on lizards in the genera *Calyptommatus* and *Vanzosaura* (Rodrigues 1993. Pap. Avul. Zool. 38:187–198), *P. guerini* also feeds on lizards, rodents, and amphibians (França and Araujo 2006. S. Am. J. Herpetol. 1:25–36; Marques et al. 2005. Serpentes do Pantanal-Guia Ilustrado. Ed. Holos, Ribeirão Preto. 170 pp.; Yanosky et al. 1996. Herpetol. Nat. Hit. 4:97–110). Although *P. guianensis* has the widest distribution in the genus, few data exist on its natural history, other than suggestions that it feeds on arthropods and lizards (Starace 1998. Guide des Serpents et Amphisbènes de Guyane Française. Ibis Rouge Edit. Guadeloupe-Guyane. 449 pp.).

On 7 July 2004, during a field survey at Parque Nacional Cerro Saroche (10.154°N, 69.527°W, datum WGS84; elev. 765 m), a xeric region in Lara state, Venezuela, we found an adult *P. guianensis* preying on an adult *Ameiva bifrontata* (Fig. 1). We apparently detected the snake just after it had captured the prey. After a few minutes, the movements of the lizard stopped, the snake slowly uncoiled without releasing the lizard's head, and proceeded to consume the lizard. Chippaux



PHOTO BY JOSÉ ANTONIO GONZÁLEZ-CARCACÍA

FIG. 1. *Phimophis guianensis* preying on *Ameiva bifrontata* in Parque Nacional Cerro Saroche, Lara state, Venezuela.

(1986. Les Serpents de la Guyane Française. Éditions de l'Orstom XXVII. 165 pp.) found that in French Guiana *P. guianensis* is most active in the late evening and at night. However, our observation suggests that this species may also forage actively during the day.

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***RHABDOPHIS SUBMINIATUS HELLERI* (Red-necked Keelback). DEFENSIVE BEHAVIOR.** Snakes in the genus *Rhabdophis*, a widespread Asian genus, possess unique glands in the nape of the neck called nuchal glands (Hutchinson et al. 2007. Proc. Nat. Acad. Sci. 104:2265–2270). Mori and Burghardt (2008. J. Ethol. 26:61–68) examined several defensive behaviors associated with *Rhabdophis* species. Of the 18 behaviors they examined, three seemed to be closely associated with nuchal glands: 1) dorsal-facing posture, in which the dorsal neck region is directed toward the stimulus and elevated above the substrate; 2) neck arch, in which the chin is directed towards the substrate and the neck is bent upward; and 3) neck butt, in which the snake swings the arched neck so that it is butted up against the stimulus. On 4 August 2011, on Lantau Island, Hong Kong, we encountered an adult *R. subminiatus* in a hole on the side of a wall in a water conduit. Upon being extracted from the hole, the snake immediately arched its neck against our glove and began oozing secretions from the nuchal gland region (Fig. 1). This active "transport" of the nuchal fluid is undocumented. In prior observations of nuchal gland secretion in *Rhabdophis*, physical pressure on the nuchal region was required to induce secretion. Our animal did not experience any physical pressure aside from the mid-body capture we made with a glove. During closer approach of the animal for photographs, the nuchal gland fluid was sprayed into the air, apparently towards the approaching photographer. Explanations for the ease with which the animal expressed the nuchal gland fluid may include thin membranes surrounding the nuchal glands, coupled with flexing of the epaxial muscles during the dorso-lateral flattening of the neck (A. Savitzky, pers. comm.).

PHOTO BY DANIEL ROSENBERG



FIG. 1. *Rhabdophis subminiatus* neck arching and expressing nuchal gland toxins.

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***RAMPHOTYPHLOPS BRAMINUS* (Brahminy Blindsnake). PREDATION.** *Ramphotyphlops braminus* is a Southeast Asian parthenogenic, typhlopid snake, probably indigenous to India and Sri Lanka (Wallach 2008. Bull. Chicago Herpetol. Soc. 43:80–82). Because of its small average size (total length = 130 mm), and ability to be anthropogenically transported in soil (especially in potted plants and mulch), *R. braminus* currently has the most widespread, near worldwide, nonindigenous distribution of any snake (Kraus 2009. Alien Reptiles and Amphibians: A Scientific Compendium and Analysis. Springer, New York. 563 pp.). In Florida, USA, *R. braminus* is rapidly expanding its distribution and is established in numerous counties (Krysko et al. 2011. Zootaxa 3028:1–64). Predators of *R. braminus* in Florida include nonindigenous *Rhinella marina* (Cane Toad), nonindigenous *Anolis cristatellus* (Crested Anole), and endemic *Lampropeltis extenuata* (Short-tailed Snake) (Meshaka 2011. Herpetol. Conserv. Biol. 6:1–101).

On 24 March 2011, a *Dasypus novemcinctus* (Nine-banded Armadillo) was killed on the premises of the Division of Plant Industry (DPI), Florida Department of Agriculture & Consumer Services, 1911 SW 34th Street, Gainesville, Alachua Co., Florida, USA (29.635175°N, 82.370844°W, datum: WSG84). I examined its stomach contents and discovered an intact adult *R. braminus* (total length = 152 mm, UF 166054) which I deposited in the Herpetology Collection, Florida Museum of Natural History (FLMNH), University of Florida. A population of *R. braminus* previously has been documented on the grounds of this facility (Somma 2007. Herpetol. Rev. 38:355–356) and three additional specimens were collected in March and April 2011 (UF 166055–166057).

Dasypus novemcinctus, in Florida, is a nonindigenous, cingulatan mammal that has a primarily insectivorous diet but occasionally preys upon small vertebrates, including reptiles (Carr 1982. Anim. King. 85[5]:40–44; McBee and Baker 1982. Mamm. Species 162:1–9; Nowak 1999. Walker's Mammals of the World. Sixth Ed. Vols. I–II. Johns Hopkins Univ. Press, Baltimore, Maryland. 2015 pp.). In the U.S., *D. novemcintus* is implicated in zoonotic transmission of the 3I-2-v1 strain of leprosy, *Mycobacterium leporae* (Truman et al. 2011. New England J. Med. 364:1626–1633). This is the first record of *R. braminus* in the diet of *D. novemcinctus*. Whether established populations of *R. braminus* can subsidize populations of *D. novemcinctus*, *R. marina*, *A. cristatellus*, or other nonindigenous predators in Florida remains untested at this time.

I thank Jeff Butler for providing the armadillo specimen.

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***THAMNOPHIS ELEGANS VAGRANS* (Wandering Gartersnake). DIET.** The feeding ecology of *Thamnophis elegans* is highly variable, with some individuals or populations specializing on a narrow range of prey and others exploiting a wide variety of prey



FIG. 1. Three adult shrews (*Sorex* sp.) ingested by a single, pregnant *Thamnophis elegans vagrans* from Mink Creek, Bannock County, Idaho.

(Rossman et al. 1996. The Garter Snakes: Evolution and Ecology. Univ. Oklahoma Press, Norman. 332 pp.). Overall, the species has one of the broadest diets of any North American snake, including aquatic leeches, desert lizards, noxious slugs, shrews and other small mammals, and even cooked bits of chicken (Arnold 1977. Science 197:676–678; Fitch 1941. California Fish Game 27:2–32; Rossman et al., *op. cit.*; Storm and Ferguson 1954. Herpetologica 11:48). Here we document an additional case of shrew consumption by *T. elegans*, and suggest that predation on shrews is not incidental but likely represents a significant prey source for some *T. elegans* populations.

On 3 June 2007, along Mink Creek in Caribou National Forest, Bannock Co., Idaho, USA (42.734222°N, 112.407250°W; datum: NAD 1983; elev. 1600 m), CRF observed an adult female *T. elegans vagrans* (SVL = 518 mm) foraging on the bank of the creek. The snake was carefully investigating holes in the soil of the well-vegetated bank ~0.5 m above waterline, probing each hole with its head before moving on to the next. Upon being seized, the snake immediately regurgitated a shrew (*Sorex* sp.), and subsequent palpation produced two additional shrews (Fig. 1). The aggregate mass of the prey (13.5 g) was 27.6% of the mass of the snake (49 g), which was pregnant. Examination of tooth wear patterns on the prey suggests that all three shrews were old adults (but the amount of tooth wear prevented confident species identification).

The apparent foraging behavior of the snake and the age of its three prey items suggest the snake acquired the shrews by deliberately hunting. Shrews are highly asocial and maintain separate territories (Churchfield 1990. The Natural History of Shrews. Cornell Univ. Press, Ithaca, New York. 183 pp.), so it seems doubtful that the snake simply chanced upon three old shrews, or a group of shrews. Unlike the great majority of gartersnakes, some populations of *T. elegans* feed substantially on small mammals (Rossman et al. 1996, *op. cit.*) and the species has evolved at least one trait, constricting behavior (Gregory et al. 1980. Herpetologica 36:87–93), that is adaptive for feeding on such prey. These characteristics of *T. elegans* make it all the more probable that the observed snake was deliberately hunting for shrews. The *T. elegans* and its contents were deposited in collection of the California Academy of Sciences (CAS 241911).

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***THAMNOPHIS EQUES MEGALOPS* (Northern Mexican Gartersnake). DIET AND MORTALITY.** *Thamnophis eques megalops* are known to eat amphibians, fish, earthworms, leeches, and occasionally small mammals, lizards, and slugs (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Institution Press. Washington D.C. 668 pp.). As part of a long-term monitoring project for the species at Bubbling Ponds Hatchery (Yavapai County, Arizona, USA), we observed *T. e. megalops* apparently attempting to prey on nonnative Chinese Mystery Snails (*Cipangopaludina chinensis*) on two separate occasions.

On 18 August 2008, at 1128 h, we encountered an adult *T. e. megalops* (SVL = 505 mm) which had been run over by a vehicle along a hatchery road (34.766°N, 111.896°W; datum NAD83) while apparently attempting to eat a *C. chinensis*. Similarly, on 23 June 2011, at 1920 h, we observed an adult female *T. e. megalops* (SVL = 760 mm; 124 g) out of the water attempting to eat a large *C. chinensis* (Fig. 1; 34.766°N, 111.893°W; datum NAD83). The snake's upper jaw was inside the snail's shell, and appeared to be pinned in that position by the snail's closing operculum, prohibiting escape by either individual. We captured the snake and therefore interrupted the predation attempt. Although *T. eques* are known to occasionally consume slugs, they are not known to feed on shelled gastropods (Macias Garcia and Drummond 1988. J. Herpetol. 22:129–134; Manjarrez 1998. J. Herpetol. 32:464–468). Wood et al. (2005. Herpetol. Rev. 36:328–329) reported a similar instance of mortality in *T. validus celaeno*, in which the snake died of starvation or exhaustion after being unable to extricate its lower mandibles from the shell of the snail *Planorbella subcrenatum*.

We are unsure of why the snakes were attempting to eat the snails, but their lack of experience with this nonnative snail may have been a factor. Bubbling Ponds Hatchery provides a dense and varied *T. e. megalops* prey base of native and nonnative fishes, *Anaxyrus woodhousii*, *Ambystoma mavortium nebulosum*, and nonnative *Lithobates catesbeianus*, so it is unlikely that food is limited. In both cases, the snake's vision was completely obscured while it attempted to access the snail. The ease with which one snake was captured, coupled with the road mortality, suggests that a shift in diet to include this nonnative prey item might be deleterious.

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PHOTO BY MEGAN E. YOUNG

FIG. 1. Adult female *Thamnophis eques megalops* from Bubbling Ponds Hatchery, Arizona, attempting to eat a nonnative Chinese Mystery Snail, *Cipangopaludina chinensis*.

***TROPIDOLAEMUS SUBANNULATUS* (Bornean Banded Pit-viper). DIET.** *Tropidolaemus subannulatus* is one of the most commonly encountered snakes in lowland rainforest in Borneo. Despite being a common species there is little information about its diet. It is known to prey on small rodents and birds (Das 2010. A Field Guide to the Reptiles of South-east Asia. New Holland Publishers, London. 376 pp.). On 25 September 2009, at 2230 h, we found an adult male *T. subannulatus* (total length ca. 50 cm) feeding on an adult female *Polypedates leucomystax* in Kubah National Park, western Sarawak, Malaysian Borneo. The snake had already swallowed the head and right arm of the frog (Fig. 1). After another 30 min it had completely devoured its prey.

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COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND



FIG. 1. Adult male *Tropidolaemus subannulatus* feeding on adult female *Polypedates leucomystax*.

***VIPERA BERUS* (Common Adder). DEFENSIVE BEHAVIOR.** *Vipera berus* is a well-studied and often common snake with a wide distribution reaching into the Arctic Circle (Stafford 1987. The Adder. Shire Publications. Aylesbury, U.K. 24 pp.). At 1107 h on 23 April 2011 at Laughton Forest, North Lincolnshire, U.K. (53.4977°N, 0.7242°W, datum: WGS84), I witnessed a previously undocumented behavior by a small (209 mm total length) *V. berus*. The observation took place on a warm (25.6°C) sunny day and the adder was found basking on a patch of gorse (*Ulex* sp.) in a forest clearing with heath vegetation near a drainage ditch. Upon capture, the snake employed typical defensive tactics including hissing, striking, voiding cloacal contents, and hiding its head under body coils (Mori and Burghardt 2008. J. Ethol. 26:61–68). Prior to this, escape was attempted by moving quickly away. During these attempts the adder was observed to repeatedly tense its body in a corkscrew posture (helical rather than a coil) and then straighten out again in quick succession. The behavior was more intense when the individual was touched with a snake hook and superficially resembled the behavior of an earthworm when cut in two. Although this behavior was distinctive and warrants recognition, I can find no reference to corkscrewing in *V. berus*, although it may have been subsumed under more general categories in previous literature (such as Mori and Burghardt's [*op. cit.*] "jerk").

There are two possible reasons for corkscrewing: a functional antipredator mechanism or an aberrant behavior due to poor health. With regards to the latter, Funk (2006. *In* Mader [ed.], Reptile Medicine and Surgery, 2nd ed., pp. 675–682. Saunders Elsevier. St. Louis) briefly described an undiagnosed neurological problem in a captive *Lamprophis fuliginosus* (African House Snake). The snake would move normally until stimulated, at which point it "coiled into a series of loops and rolled across the substrate for 1 to 3 minutes." The accompanying photo of the animal shows a posture similar to the corkscrewing observed here. Although the *L. fuliginosus* apparently held the posture for a few minutes, in contrast to the *V. berus* described herein, I cannot rule out a neurological problem as a cause of the corkscrewing behavior.

Antipredator behaviors can function in a variety of ways. I can suggest three possible benefits of corkscrewing for *V. berus*. First, erratic movement in itself during escape, or "protean behavior," is a well known defensive tactic among animals (Ruxton et al. 2004. Avoiding Attack. Oxford Univ. Press. Oxford, U.K. 249 pp.) and presumably makes the prey difficult to follow or subdue. Second, because of the microhabitat in which the adder was found, the act of corkscrewing often resulted in it becoming tangled around vegetation, making it more difficult to extract. Third, the combination of the quick movements and the zigzag pattern may result in a motion dazzle effect. This has been shown using simulated prey on a computer screen and human predators to interfere with speed perception and make the prey more difficult to catch (Scott-Samuel et al. 2011. PLoS ONE 6:e20233; Stevens et al. 2008. Proc. Royal Soc. B 275:2639–2643). Despite this evidence however, few empirical, real-life examples have been documented. Further observations and studies may help to establish how widespread corkscrewing in *V. berus* and perhaps other snake species, and also shed light on the function of the behavior.

I thank Nick Burgess for assistance in the field.

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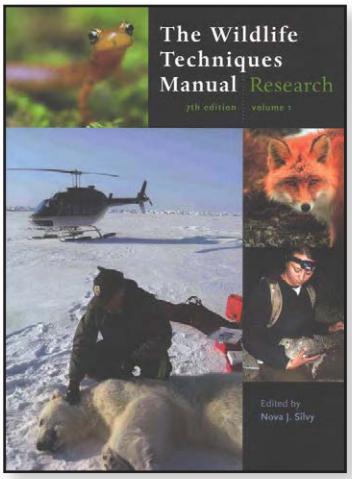
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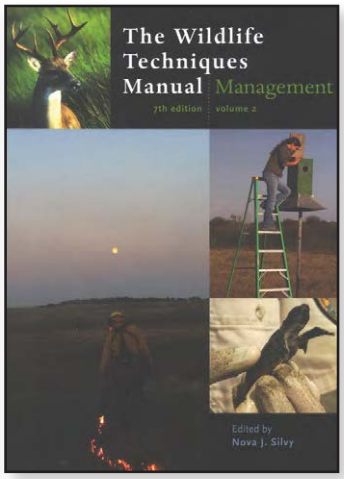
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The Wildlife Techniques Manual, 7th Edition

Edited by Nova J. Silvy. 2012. Johns Hopkins University Press (www.press.jhu.edu). 2 volumes: xv + 686 pages, xii + 414 pages. Hardcover. US $150.00. ISBN 1-4214-0159-2.

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The *Wildlife Techniques Manual* has been a mainstay of the wildlife profession for over 50 years. The 7th edition is the first edition that has not been published solely by The Wildlife Society (TWS). The current incarnation of the *Manual* was published under a new partnership with Johns Hopkins University Press and, for the first time, it has appeared in two volumes.

Each subsequent edition of the *Wildlife Techniques Manual* has expanded its coverage to include new technologies and techniques. The latest edition has 13 more chapters than the 6th edition (Braun 2005) and the number of contributors has increased to 109. These are all well-respected wildlife biologists and conservationists but unfortunately, none of them are members of the major herpetological societies.

The 37 Chapters are broken into nine sections. In the first volume, on research, there are two chapters on design and analytical techniques, five on capture and handling techniques, three on identification and marking techniques, five on measuring animal abundance, three on measuring wildlife habitat, and four on research on individual species. The second volume is geared toward management with three chapters on management perspectives, seven on managing landscapes for wildlife, and five on managing wildlife populations. The literature cited section, with 172 pages and approximately 7500 citations, highlights thoroughness of the chapters.

The *Wildlife Techniques Manual* was originally aimed at biologists working with game species. The information presented was about deer, elk, pheasants, grouse, ducks, and other traditional wildlife species. While these are still important species, each additional revision has included a wider range of topics and species. In the new edition, reptile and amphibian studies are highlighted in eleven chapters. This parallels an overall increase in amphibian and reptile related papers in TWS publications (Cristoffel and Lepczyk 2012). The increasing crossover between herpetology and wildlife conservation is needed for robust amphibian and reptile conservation efforts.

In addition to explicitly herpetofaunal material, any reptile or amphibian field study could benefit from chapters in the *Manual* that cover topics ranging from research and experimental design, wildlife radio-telemetry and remote sensing, and modeling vertebrate use of terrestrial resources, to human dimensions of wildlife management, communication and outreach, and habitat conservation planning.

There are a few areas, however, where I feel reptile and amphibian interests were short-changed. In the marking section Ferner (1979) is cited, but not Ferner (2007), which is a more complete and up-to-date reference on marking techniques. In the habitat sections there is no mention of the Partners in Amphibian and Reptile Conservation (PARC) habitat guidelines (Kingsbury and Gibson 2002; Pilliod and Wind 2008), nor of any chapters from *Urban Herpetology* (Mitchell et al. 2008). These are important publications that provide habitat and conservation techniques for taxa beyond amphibians and reptiles and they are available and known to the wildlife community.

TWS maintains a website for users of the *Wildlife Techniques Manual* that includes images of the all figures used in the book, powerpoint presentations of selected chapters, and potential questions and topics for instructors who may want to use this book as a text. This website will include additional materials that can be used with the book as they are developed.

The *Wildlife Techniques Manual* may not be the single resource for amphibian and reptile field researchers, but it definitely needs to be on their bookshelf next to *Reptile Biodiversity* (McDiarmid et al. 2012). The partnership with Johns Hopkins will make this important book known to a wider circle of researchers and managers beyond the traditional wildlifers.

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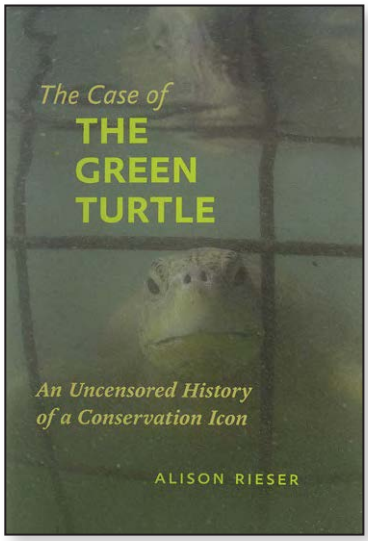
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The Case of the Green Turtle: An Uncensored History of a Conservation Icon

Alison Rieser. 2012. The Johns Hopkins University Press, Baltimore, Maryland (www.press.jhu.edu). Hardcover. xii + 338 pp. US $45.00. ISBN 9781421405797.

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In 1976, I joined the U.S. Fish and Wildlife Service's Office of Endangered Species (OES) as staff herpetologist. My Ph.D. was on Neotropical salamander behavior, and sea turtles were little known to me, much less their complicated biology and premier position among reptiles in the gourmet and indigenous food trade. I was never involved in the listing of the Green Turtle (*Chelonia mydas*), as that was handled through its completion in 1978 by Dr. Ron Nowak of OES. Nevertheless, I worked closely with Ron with the understanding that I would handle all endangered species matters for Green Turtles once listed. I never dreamed of the controversy that was to ensue over the question of Green Turtle farming, nor how I would be thrust into it complete with attempts to fire me for "impeding" commerce in this species. As I was to learn over the course of eight years at OES, personal attacks were just part of the job.

The Case of the Green Turtle: An Uncensored History of a Conservation Icon by Alison Rieser is an examination of the history of Green Turtle research and conservation, from its beginnings with the work of Frank Moorhouse in Australia, Tom Harrisson and John Hendrickson in Southeast Asia, and Archie Carr and colleagues in the Caribbean, to the later research and indigenous-based ranching system of Robert Bustard in Australia, the sociological studies of Bernard Nietschmann on turtling along the Miskito Coast (Nietschmann 1979), and the conservation advocacy of Wayne King, Frank Lund, David Ehrenfeld, and others. Relationships among sea turtle researchers were not always amiable. After all, a biography of Tom Harrisson was entitled *The Most Offending Soul Alive* with apparent good reason (Heimann 1998). Rieser is usually judicious in bringing tense interactions to light without casting aspersions upon character. She explains the origin of some of the long-standing personality clashes, a few of which were magnified considerably as Mariculture Ltd. and its successor, Cayman Turtle Farm, squared off in letters, court appearances, professional and private meetings, the press, and the scientific and popular literature, with federal officials charged with protecting the imperiled species.

Green Turtle is composed of 16 chapters, an epilogue, two short appendices, and an extensive section of supporting notes and literature citations. The first part of the book traces the history of turtling worldwide before shifting to summaries of early research attempts and discoveries from Australia, Sarawak, and Costa Rica. This is the part of the book that herpetological and chelonian historians will particularly enjoy. Rieser's writing style is crisp and clean, and she is adept at telling the human as well as the biological story of *Chelonia* and those who pursued it for subsistence, gourmet appetites, or for an understanding of its biological mysteries. I learned a number of interesting details, such as how John Hendrickson came across the idea of putting a cattle ear tag on sea turtles and how Tom Harrisson pilfered the idea (and much of Hendrickson's original data); how actress Polly Bergen's company was behind attempts to commercialize turtle oil in cosmetics; how initial protection of turtles in Australia was effected largely as a result of an anticruelty campaign in the early 1950s; and how the state of Florida consistently opted not to protect sea turtles, despite serious documented declines, in order to protect commercial interests (some things never change). I could not find anything in this section that I disagreed with or that Reiser overlooked, including finding reference to the early studies of Green Turtles along the south Texas coast.

The middle part of Rieser's book is devoted to a history of turtle farming, first as a conservation option and later as a commercial enterprise. She reiterates Archie Carr's initially favorable attitude toward farming, which evaporated in time under a wave of new scientific findings on Green Turtle biology and the intense pressure exerted on him and others in the IUCN Marine Turtle Specialist Group to sanction Mariculture Ltd. Archie never liked confrontation, and the more he was pushed the more he withdrew from conservation activism. Still, he was never shy about voicing his personal opinions based on the science as then understood. Rieser goes into extensive detail concerning all the various meetings and implications of classifying the Green Turtle as endangered or threatened, both from the IUCN's point of view and that of Mariculture Ltd. This

distinction rested largely on projections of decline based on past and current population trends rather than present (1970s) status. Should (wide-ranging) species be protected as populations are currently, or as they likely are to become? This is a vexing question even today.

Whether a species was listed as endangered or threatened in the United States had implications for commercial farming, since a threatened status could allow special regulations to exempt farmed products or at least allow their transshipment through US ports. If endangered, total protection from commerce would be automatic. Mariculture Ltd. wanted to open US markets to their Green Turtle products, or at least be able to ship the products through US ports to Europe. Rieser describes the history of Mariculture Ltd. and Cayman Turtle Farm (CTF) to give the reader a reasonably good understanding of the development of these enterprises, how they changed through time in practice and philosophy, and the motivations behind the financial backers. For example, I never really thought Dr. Judith Mittag (inventor of the OB tampon), the owner of CTF, desired the exploitation of this endangered species or the hornet nest she stepped into, but instead truly thought farming might help alleviate commercial pressure on the species; let's just say, I think she received some very bad business advice. Others in this saga, however, were not so conservation minded. Curiously, Rieser never discusses other turtle farms and their potential to impact conservation, particularly CORAIL, a French Green Turtle farm operating in Reunion.

The last half of *Green Turtle* is devoted to the political and legal maneuvering among the successive farms, sea turtle scientists, conservation organizations, and various federal agencies, especially the Fish and Wildlife Service (FWS) and National Marine Fisheries Service (NMFS). She touches upon the struggle between the conservation-oriented FWS and the commercially-oriented NMFS, but I found this section somewhat incomplete. Perhaps this is because Wayne Witzell and I were the only government scientists Rieser contacted, as listed in the acknowledgments. Other than for court and other public documents, Rieser gives little indication of the truly adversarial struggle between the agencies, the intense outside pressure put on government scientists and administrators (e.g., Senator John Danforth of Missouri tried to have me removed from OES; the Danforth fortune came from Purina Foods, which supplied the turtle farms with their expensive turtle chow), or even the reasoning for the positions adopted by those agencies. In many respects, the listing of the Green Turtle and the philosophical positions thus adopted toward protected species and commercial use set the subsequent direction of implementation of the federal endangered species program. How serious would the agencies be when confronted by severe legal challenges, and how effective would regulations be in protecting wildlife in the face of many uncertain and non-biological factors, such as the effect of sanctioned trade?

In terms of criticism from one who lived on the inside of the controversy, Rieser appears overly sympathetic to Mariculture Ltd., Cayman Turtle Farm, and some of those scientists (e.g., Leo Brongersma, Nicholas Mrosovsky) who supported turtle farming, perhaps relying too much on Fosdick and Fosdick (1994) published by Irvin Naylor, president of Mariculture Ltd. I found that book to be self-serving and one-sided, and I noted that Rieser's discussion frequently cites this book. Rieser also acknowledges the Fosdicks for their "meticulously researched and engrossing book." Well, I suppose that's a matter of opinion. Perhaps I remember a little too much of Mr. Naylor's personality when he described me as "a pretty-far-left-of-center character," "a phony 'scientist,'" and a "Dustin Hoffman look-alike, talk-alike, dress and manner" (letter from I. S. Naylor to Cecil Andrus, December 3, 1979; CKD files) in one of his many attempts to have me fired. Naylor has since departed this life, so perhaps I should let it go. As a person with no background in sea turtle research, policy, or connection to anyone involved, the only approach for me and others to take was to read all the literature and hear all the arguments, then make a decision based on the evidence presented. To this day, I believe the agencies made the correct decision based on science ("the best available scientific information" as per the Endangered Species Act of 1973 [ESA]), not hunches based on personal philosophy.

I have a number of other questions concerning *Green Turtle*. Perhaps it was beyond the scope of the author, but Rieser really never addresses the accuracy of biological claims of Mariculture Ltd. and CTF. Could they supply a superior product that would be easily identifiable in transshipments? Did they ever really attain a self-contained breeding population totally unreliant on wild populations? Was the research conducted there so important as to justify worldwide distribution of turtle soup and stuffed juveniles? Rieser discusses Bernard Nietschmann's work on the sociological effects of commercialization of a heretofore subsistence take, but never tackles the sociological implications of having a large European corporation take over the turtle trade from indigenous peoples. She never goes into the intense discussions concerning definitions of ranching as opposed to farming. And finally, she sees the preparation of an Environmental Impact Statement (EIS) by NMFS concerning the listing *C. mydas* as a delaying tactic (which it was), although this was not the only reason FWS opposed the EIS. Plainly speaking, the preparation of an EIS could have set a precedent for *any* listing proposal. Since FWS did nearly all federal listing under the ESA, it would have placed a tremendous burden on staff and resources, thus delaying innumerable listing proposals.

Rieser covers the turtle farming literature well, although she missed my paper rebutting Mrosovsky's (1983) book advocating exploitation, including farming, as a conservation option (Dodd 1985). She also had me as a "newly appointed herpetologist" in 1979, although as noted earlier I had been in OES for 3 years by then. I will end my critique with two points. One, I am confused about the word "uncensored" in the subtitle of *Green Turtle*. No one was ever censored, as indicated by the voluminous correspondence, *Marine Turtle Newsletter* editorials, and endless discussions on this topic. Because a policy was not adopted does not mean an idea was censored. Two, I am perplexed as to why Rieser puts such weight (in the introduction and the epilogue) on Judge George Mackinnon's *personal opinion* (i.e., entered as a private note to the Chief Justice of the Court of Appeals) that "the logic of this [the government's] case is appalling" while at the same time ruling in the Justice Department's favor in upholding a ban on CTF products. Judge Mackinnon may have been entitled to voice his belief, but he was no biologist, sea turtle scientist, or in the least bit familiar with the economics of exploitation of endangered species. The only thing that really matters is that he made a correct legal decision.

Whereas Rieser's final pages seem to say, "I guess we'll never know" about whether mariculture could "save" Green Turtles, one can as easily speculate about the reality of trying to stop a well-backed multinational commerce if the supportive conservation claims subsequently proved baseless, especially in today's political climate. While I recommend this book for readers

interested in sea turtle and herpetological history, it will also give readers with no knowledge outside of academia a glimpse into the world of policy and politics in the conservation of amphibians and reptiles; few hardy souls wade into this arena. Whether or not we know the effect on wild populations if every supermarket in the Western world stocked CTF Green Turtle soup, we need to remember that in conservation, *first do no harm* is more than a catchy phrase. Today, ecotourism to see sea turtles in the water or nesting brings tremendous economic value to the peoples of coastal waters throughout the tropics. If the Lord Mayor of London (mentioned by Rieser several times) must forgo his gourmet turtle soup, so be it.

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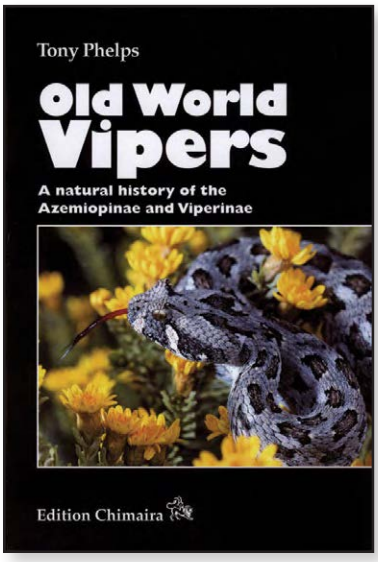
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Old World Vipers. A Natural History of the Azemiopinae and Viperinae

Tony Phelps. 2010. Edition Chimaira, Frankfurt am Main, Germany (www.chimaira.de). Hardcover. 558 pp. US $129.50. ISBN 978-89973-470-6.

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Snakes are fascinating creatures to most people; Harry Greene's (1997) popular and successful book with superb photographs by Michael and Patricia Fogden is proof of that. To narrow the field of books for comparison to the book I will review here, *Old World Vipers* (hereafter *OWV*) by Tony Phelps, a few others come to mind. First and foremost, Campbell and Lamar's (2004) opus on *The Venomous Reptiles of the Western Hemisphere*. This two-volume book sets the standard—it is comprehensive, detailed, and of high quality. Mallow et al. (2003) published a book titled, *True Vipers: Natural History and Toxinology of Old World Vipers*. This book appears closest in scope to Phelps' *OWV* (2011). The next two books fall partially within the scope of *OWV*. Spawls and Branch's (1995) book on *The Dangerous Snakes of Africa* includes all vipers in Africa (and the Sinai Peninsula). The second book is Brodmann's (1987) book on the venomous snakes of Europe and the genus *Vipera* (sensu lato) in Africa and Asia. It is written in German and stands out because of the large number of extraordinary photographs. The latter two books together review the majority of the snake species discussed in *OWV*.

OWV is a medium format book with solid binding and printed on high quality paper. For its 558 pages the book is heavy (1640 g)! When flipping through the pages the high number of large color photos and distribution maps is immediately apparent. Photos and maps dominate the book. In the beginning of the book one learns that the title "Old World Vipers" is not defined by geography but rather refers to viperine snakes, sometimes referred to as true vipers, which only occur in the Old World. Interestingly, the author includes the monotypic Azemiopinae and its only member, *Azemiops feae*, a seemingly rare snake restricted to a relatively small area in Asia. Molecular data thus far show it is not closely related to Viperinae. Recent phylogenies (Heise et al. 1995; Pyron et al. 2010; Vidal and Hedges 2002) all agree on the monophyly of *Azemiops* plus the subfamily Crotalinae (or pitvipers). Crotaline species are numerous in both the Old and the New Worlds. The choice to include *Azemiops* renders the focus group of *OWV* paraphyletic, which warrants a clear statement of why this arrangement was chosen. Almost ten years ago, with less phylogenetic evidence available at the time, Mallow et al. (2003) chose to include *Azemiops* in their book on true vipers. Phelps mentions that *Azemiops* "is said to be the sister group with regard to the origins of the pitvipers"(p. 14). No reference is given and he continues "but it is a unique viper and described here as a true viper." This is confusing and inconsistent with the literature.

The book contains a foreword, seven chapters, a glossary and a bibliography. Chapter 1 is a general introduction to the vipers. The author goes through a number of typical viper characteristics and explains them using examples. These examples often include pitvipers, which are not the focus of the book, but have been the subject of vastly more research. The author mentions that the serrated lateral saw scales and the related defensive behavior in *Cerastes* and *Echis* evolved to conserve water. The anatomical-physiological mechanism of this is not obvious to me, thus a substantiating reference would have been desirable. The author goes on to mention that the systematics and taxonomy of vipers (and systematics and taxonomy in general) have witnessed a revolution over the past decades. This revolution is based on the emergence of molecular genetics and its now dominant role. Molecular systematics is superior to traditional morphological approaches as DNA-based phylogenies are less sensitive to homoplasy and allow for more or less accurate timing of evolutionary events. Nonetheless, the author declares traditional morphological approaches to be "just as relevant" (pp. 36 and 40).

Chapter 2 is on the origins, biogeography and classification of vipers. A footnote for the genus *Adenorhinos* in Table 1 reads "can be included in *Atheris*." Why is that? Again, a reference to understand the reasoning behind that statement would be most welcome. Table 2 compares changes in pitviper systematics from 1980 to more recent, which seems to be outside of the book's

focus. The legend for Table 2 refers to many new genera and species being created. The choice of words is unfortunate as species are not created but evolve (!) and new species (to science) are discovered and described. On page 40 the loss of the rattle in the rattlesnake *Crotalus catalinensis* is linked to an arboreal lifestyle, which in other arboreal viper species has been related to feeding on birds. However, a recent study (Avila-Villegas et al. 2007) finds no such evidence of exclusive bird predation.

Chapter 3 deals with the viper's environment and moves through the different habitat types in subsections. This chapter includes a multitude of informative photographs. They allow the reader to gain a good general impression of different snake habitats. The legend to Figure 55 fails to mention a country. Multiple photos show snakes in their habitat and, if taken in situ, indirectly provide additional information on the snakes' life history (see Fig. 131, for example). On page 82 the author refers to three *Atheris* species and mentions that they are often found in papyrus and phragmites marshes where they eat small frogs. I find this very interesting and would like to follow up on this. The missing reference makes it hard to do so. In the subsection on mountains, one of the few true high altitude African species, *Montatheris hindii*, is not included.

Chapter 4 deals with habits and behavior and includes subsections on populations, activity cycles, reproduction, foraging and feeding, sympatry, predators, and survival and longevity. The nomenclature for the Great Basin Rattlesnake used is inconsistent: on page 122 *Crotalus oreganus lutosus* is used whereas the legend to Figure 137 states *Crotalus lutosus*. The meaning of the fifth paragraph on page 126 eludes me. It is not clear to me how radio telemetry can enhance the calculation of population densities. On page 140 the author introduces the Type IIFY female reproductive cycle for some North American pitvipers and provides references. However, not all readers have access to primary literature, which makes an explanation of technical terms like Type IIFY necessary (see review by Taylor and DeNardo 2010). The term is not in the glossary. It is also surprising that reproductive strategies, such as multiple paternity/sperm competition (Höggren and Tegelstrom 2002) and facultative parthenogenesis (Schuett et al. 1997) are not mentioned. Results of recent studies suggest that these strategies are more common and important than previously thought (Booth and Schuett 2011). The author repeatedly uses the term "inbred depression" (p. 177 for examples) while inbreeding depression is the correct term to describe a decrease in fitness and vigor as a result of inbreeding. The term is missing from the glossary.

Chapter 5 is entitled "Working with vipers." A section on field studies gives a general overview of what needs to be taken into account when engaging in such an effort. The section on radio telemetry (p. 194) is short and does not reflect the importance of this technology for the study of extremely elusive species such as snakes. Without radio telemetry our knowledge on ecology and behavior of snakes would be vastly diminished. Scientific studies should use the appropriate technology available to provide for up-to-date datasets at competitive cost. Labor is usually among the high cost budget items and modern technology such as radio telemetry allows us to use labor most efficiently. In snake field studies radio telemetry is an extraordinarily important technology. The author mentions that radio telemetry provides for environmental data which in reality is restricted to transmitter temperature (snake body temperature). He also mentions GPS radio transmitters, which is strange, as they, due to their large unit size, play no role in viper research. The section on vipers in captivity provides a thorough overview of husbandry of vipers. In the section on conservation I found it interesting that a bottlenecked viper population with severe inbreeding depression was managed to increase genetic diversity through the introduction of additional males from a neighboring population with the appropriate reference provided (p. 223, Madsen et al. 1999). However, it is strange that the follow-up publication by Madsen et al. (2004), in which the authors show the long-term effects of the time-restricted augmentation is not mentioned in the text (but listed in the bibliography). Table 6 provides a list of Old World snakes responsible for the majority of fatalities and morbidity. Information that relates to human health and medical planning should be based on thorough scientific standards. The reader has no possibility to check this and separate fact from fiction as no references or original data are provided.

Chapter 6 includes the species accounts and stretches over 282 pages. The species accounts are in alphabetical order with the exception of *Montivipera* and *Montatheris*. The chapter provides a short introduction for each genus and includes common name, description, reproduction, diet, habitat, distribution, taxonomy, venom, and field notes for each species. The author continues to use the monotypic genus *Adenorhinos,* while he notes that Lenk et al. (2001) have shown that *Adenorhinos* is nested within *Atheris*. The use of this outdated taxonomy appears inconsistent. The distribution maps for numerous species do not accurately represent the distribution described in the text. Examples are *Atheris broadleyi* and *Atheris chlorechis*. According to the *Bitis cornuta* species account, *B. atropos* and *B. cornuta* are syntopic in the southern part of the Cederberg range (p. 296). However, according to the distribution maps this is impossible, as their distributions do not overlap. Eleven *Bitis gabonica* were caught near the Zambian border in Tanzania in 1967 (Ionides, pers. comm. fide Phelps, p. 300). Unfortunately, the species' distribution map does not reflect this as the only area of occurrence in Tanzania lies in the coastal area in the northeast (p. 299). In the species account for *Echis jogeri* the author states a distribution in western and central Mali, the distribution map shows central Mali, whereas the figure legends for figures 397 and 398 state Bandafassi, Senegal. On page 327 the author writes that *Causus* is nested within Viperinae following Nagy et al. (2005) and Wüster et al. (2008). Based on the data in both publications the position of *Causus* within the Viperinae is not clear at all and mostly lacks statistical support. Therefore, the relationship of *Causus* to other viperine groups must be treated as unresolved. The mention of an undescribed species of *Causus* occurring in Cameroon and western Central African Republic without any further information seems far-fetched. The section on venom in the species accounts does not always match the information on envenoming in Chapter 7 (see *Atheris chlorechis* pp. 242 and 515). Due to the date of publication the book does not include the newly described species *Cerastes boehmei* (Wagner and Wilms 2010) and *Atheris matildae* (Menegon et al. 2011), which are mentioned here for completeness.

David Warrell wrote on the envenoming by Old World vipers and adders in Chapter 7. This chapter is concise and focused and excellently explains the subject in appropriate depth. It includes a list of envenomings by individual taxa and contains treatments and outcomes. A number of excellent (and sometimes horrifying) pictures add to these accounts. The accounts, in combination with their references make this chapter a unique resource.

In the glossary the term congener is defined as being of the same species while, in biology, its definition is: being within the

same genus. A large number of technical terms found throughout the book such as evolutionary convergence, hemipenis, holotype, Miocene, terra typica, torpor, toxinology, and vitellogenesis are missing in the glossary and remain unexplained.

In conclusion, this book has a large number of shortcomings. Some, but not all, are mentioned above. The book does not adhere to scientific standards as it is highly speculative or lacks references in many passages. For the non-scientist reader the book lacks a structured explanation and comprehensive and up-to-date treatment of methods and biological principles. New important fields of research and scientific progress are missing or mentioned too briefly. Some of the information is inconsistent, leaving the reader to wonder which species distribution, for example, is correct (text or map). David Warrell's excellent chapter is the exception and I recommend it without reservation. The book does include many photographs of rare snake species which have not been widely published. Overall, I can recommend the book only to the reader who is willing to pay a relatively high price for many good photographs and the information on envenoming. This is, however, unfortunate, especially because much of the criticism could have been avoided with a thorough review and editing process.

I thank Gordon Schuett for critical suggestions on the manuscript and my judgments.

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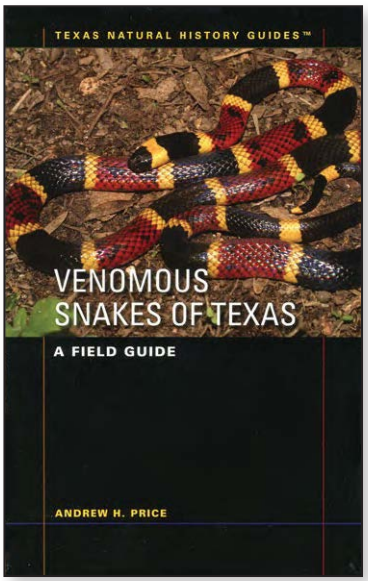
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Venomous Snakes of Texas: A Field Guide

Andrew H. Price. 2009. University of Texas Press (www.utexas.edu/utpress). xii + 116 pages. Softcover. US $15.95. ISBN 978-0-292-71967-5.

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This remarkable little book is not just a field guide. Within its 116 pages, one finds much more than characteristics for identification, range, and photos. Instead, by restricting himself to the venomous species of Texas, the author was able to expound upon many aspects of the biology of each species, while maintaining a convenient size for the pocket. With 15 recognized taxa (including subspecies), Texas has more venomous snake species than any other state in the U.S. except Arizona. The focus of the book is clearly to provide a convenient reference that will be useful to both a general audience of outdoor enthusiasts and

the scientific community. Unlike many field guides that have text in brief, telegraphic style, or even just a list of symbols to indicate habitat, diet, etc., this is a very readable book and I recommend reading it from cover to cover.

The cover of the book is tough but flexible and features a photograph of a Texas Coralsnake, *Micrurus fulvius tener* (*Micrurus tener* of some authors). The contents of the book are organized into three main sections beginning with 20 pages about snakebite, including prevention, symptoms and treatment. The middle and largest section of text consists of 61 pages of detailed species accounts that deal with identification and biological characteristics of each species. The back end of the book (34 pages) begins with a note about snake conservation, and then provides a number of reference sections including a glossary, bibliography, and index.

The introduction begins with a page on what snakes are and how they evolved. This brief introduction is surprisingly detailed, including the relationship of snakes to lizards, the fossil record of the earliest snakes, and hypotheses about snake origins, including the fossorial origins hypothesis and the marine aquatic origins hypothesis. The remaining 19 pages of introductory material cover the topic of snakebite in great detail. This section summarizes several studies of snakebite in Texas, providing details on the number of bites reported to given agencies during specific time intervals, with the cases broken down by species, gender, and ages of the victims, body parts bitten, season when bitten, symptoms, and treatment. An interesting table of the causes of human deaths in Texas from selected outdoor activities, including automobile and boating accidents as well as hunting accidents and lightning strikes, shows mortality rates on a yearly basis from 1997 to 2005 (from Texas Department of Health). It reveals that snakebite deaths are much less common than lightning strike deaths in each of those years. In fact, if one of the original purposes of this book was to help alleviate people's fear of snakes, these data indicate that it would be far more rational to fear automobiles! This section also provides detailed information on how to differentiate venomous snakes from nonvenomous snakes (in general), what venom is and how it acts; Price offers the most detailed, step-by-step accounts of how to significantly reduce the risk of snakebite, and proper courses of action in the event of a snakebite that I have encountered anywhere. This section also provides a list of eight things not to do if bitten by a snake, including many of the home and field remedies suggested in outdoor magazines and other places over the years, such as electroshock and cryotherapy. The section ends with a brief account of proper medical treatment for snakebite victims.

Each species account includes in its heading the common name of the species, as well as its scientific name (including author and date of publication). This is followed by a section labeled "Content" that gives the number of subspecies recognized, and the number of these that occur in Texas, and then gives the common and scientific name of each Texas subspecies. "Content" is followed by "Description" in which a detailed description of external characteristics is provided, including size range, maximum size in Texas, and scutellation. This is followed by a description of color and pattern together with intraspecific variation. The description section also tells us how to distinguish among the recognized subspecies. This is followed by a section called "Differentiating Similar Species," in which characters that differentiate the species as a whole from other snakes are recounted.

Each account has additional sections that deal with the biology of the species, especially as it is known from studies in Texas. These include: "Habitat" with comments on general habitat and microhabitat; "Behavior" which may include comments on daily activity, seasonality, predatory behavior, defensive behavior, and preferred activity temperatures; "Reproduction" deals with not only reproductive behavior, but also age of first reproduction, sperm storage by females, season of oviposition or parturition, association between mother and young, and even male combat; a section on "Prey and Predators" deals with dietary records of the snakes and of animals known to have fed on them in Texas, with records from nearby states added in some accounts. A section on "Venom Characteristics" offers information on such aspects as venom yield, toxicity based on LD50 studies in mice and lethality in humans, percentage of bites that result in human fatality, and functional characteristics such as hemolytic activity or neurotoxicity. A section on the fossil record includes references to Texas fossils and archeological remains identified as the species in question, giving the estimated age and county of occurrence. Finally, a "Remarks" section offers comments on lifespan, unusual records, and etymology. Each account also has one or more color photographs of each subspecies and a range map. Some accounts also have pen-and-ink drawings of specific identifying features.

The photographs are mostly of high quality, showing a close-up of an entire snake with background cropped to a minimum. Most of the photographs show an individual in a natural-looking coiled pose from a dorsolateral perspective with head and tail clearly visible. Most of the photos are well lit and crisp in detail, but a few examples appear slightly underexposed, such as figures 26 (Mojave Rattlesnake), 29 (Prairie Rattlesnake), and 31 (Desert Massassauga). The pen-and-ink drawings are of various types including simple line drawings, stipple drawings, and sketches of such things as head and body scutellation, skull characteristics, dentition, and illustrations of male combat postures. The drawings are adopted from previous editions of the book and although most of them have reproduced well, one (figure 6) shows line breaks, and some others (figures 13 and 15) appear a bit smudgy from stipple-bleed, perhaps from repeated copying of the originals through the various editions. Despite these minor flaws, the illustrations, and especially the photographs, are quite good overall.

The range maps provided with each species account are of exceptional quality. Each shows the entire state of Texas with each county outlined. The ranges of the species are indicated by coloring in each county of known occurrence. Although this is a crude method of indicating range in most states, the state of Texas is large enough and divided into a sufficiently large number of counties that this method provides a fair degree of resolution of the range outlines without revealing exact localities. Where there are multiple subspecies of a given snake, each is shown on the map in a distinct, bright basic color with zones of intergradations clearly marked in a third color.

The species accounts are followed by a brief essay on conservation of rattlesnakes in Texas in which the author takes the position that rattlesnakes should be conserved as much as any other species. In general, though, the argument takes a middle ground position that rattlesnake roundups should not necessarily be abolished, but that there has not been sufficient research to show how such harvest might be damaging to the populations of the state. He also takes a stand against the use of gasoline for flushing rattlesnakes from their dens because of the collateral

damage to other den inhabitants and because the effects of repeated use of gasoline on the habitability of dens in the long run has not been studied. In general, this discussion presents the idea that the more common species of rattlesnakes can be utilized for a wide variety of purposes to satisfy the needs of a broad cross-section of the human populace, but that proper management of rattlesnakes as a resource requires further study of the effects of current practices.

The remainder of the book consists of four reference sections. On pages 85 and 86 there is a list entitled "Useful Sources of Information" that consists entirely of the names, addresses, and phone numbers of poison centers and pharmaceutical companies. Clearly, "useful information" in this context means useful to those who have recently been, or are likely to be, bitten by venomous snakes in the near future. This section could have been improved and expanded by including some websites that would refer the reader to information on snake systematics, ecology, and conservation and perhaps list some of the major herpetological societies for the student who wants to learn more about snake biology. Pages 87–90 provide a brief glossary of terms including 65 entries. This section is replete with medical terminology and terminology related to the form and function of venom, with no fewer than 33 entries that fit into this category. Some of these are basic terms from organic chemistry like isoform and peptide. Yet, the glossary excludes such basic herpetological terms as pit organ and rattle (or shaker) that are used in the text.

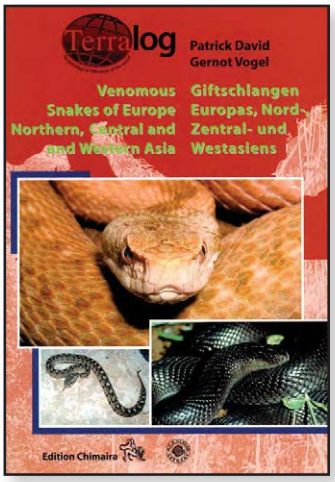
A curious feature of this book, and one of the most useful for the professional biologist, is the extensive bibliography, a feature that is not often emphasized in a field guide format. Entitled "References," this section consists of a list of relevant literature that, presumably, served as source material during the writing of the book. The entries are varied, ranging from books and papers on snake biology, snake behavior, and the predators and prey of various venomous snakes, to papers on the effects of snake venom and the fossil and archeological record of snakes. At 24 pages and 314 references, this bibliography will be a valuable resource to anybody working with venomous snakes in Texas and to other herpetologists, both professional and hobbyist. To the serious student of venomous snakes, it alone will be worth the price of the book. The book ends with a very brief index of two pages. Although it is simply titled "Index," it is really only an index to snake names, both common and scientific. This is an unfortunate shortcoming because the book could be an invaluable quick reference to a wide variety of topics related to venomous snakes, but instead may require a little patience to find a specific topic of interest. For example, if the reader is interested in dry bites they must consult the Table of Contents to find the several sections where this could be a topic of discussion, and then read or scan through the pages to find the topic. This done, they are amply rewarded with specific information about dry bites from venomous snakes in Texas (see page 14 under the section titled "Venom" where one finds that 20–40% of bites to human victims may be considered dry bites where little or no venom is injected into the bite wound). Fortunately, there are eight blank pages at the end of the book where one may jot down the page numbers for useful sections of text such as this, and also take notes on one's own field observations on venomous snakes in Texas.

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Venomous Snakes of Europe, Northern, Central and Western Asia

Patrick David and Gernot Vogel. 2010. Chimaira Buchhandelsgesellschaft, Frankfurt am Main, Germany (www.chimaira.de). Hardcover, 160 pp. EUR 44,80 (approx. US$ 56.00). ISBN 978-3-89973-366-2.

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This is the third book in the TERRALOG series that is devoted to the world's venomous snakes, following *Venomous Snakes of Asia* and *Venomous Snakes of Africa*. Conceptually these are picture books with a large selection of good quality photos of nearly every species known in the region covered. The better known species are represented by several pictures each. Regrettably, small maps give only a rough indication of the species' distribution. Information on habitat, ecology, life history, conservation and care in captivity is coded in pictograms. This means standardized information (e.g., eight types of habitats, representing general climatic zones). I could not find the pictogram "protected species" with any of the highly endangered and strictly protected species such as *Vipera ursinii* and *Macrovipera schweizeri*. This is a very regrettable mistake.

The text (bilingual, English and German) mainly concerns the adopted taxonomy. Given the ongoing debate about species delimitation in many viperid genera, this is of course more or less arbitrary and may invite some critique. Taxa described after 2008, such as *Cerastes boehmei* Wagner and Wilms, 2010, *Vipera altaica* Tuniyev, Nilson and Andrén, 2010, and *Vipera renardi puzanovi* Kukushkin, 2009, are not listed (although some literature published in 2009 is cited). Some taxa are not recognized, such as *Echis multisquamatus* (not even as a subspecies) or *Vipera transcaucasiana* and *V. nikolskii* (only as subspecies), whereas generally the authors follow a 'splitter' mode of taxonomy, listing even species that have been rejected in the literature, such as *Vipera magnifica* and *Vipera orlovi* (see Joger and Stümpel 2005). Literature is not always correctly cited. For *Montivipera* "*albizona*" from Turkey and *M.* "*albicornuta*" from Iran, two doubtful species, the authors refer to Stümpel and Joger (2009), who allegedly confirmed their validity, but this is not so (see cited paper). Another doubtful taxon, *Vipera aspis atra*, is named *V. a. aspis* (form *atra*), whereas "*Vipera pontica*" is put into quotation marks and a dark *Pseudocerastes* from Syria is called *P.* cf. *fieldii*. Within the Afrotropical snake community in southwestern Arabia, *Naja arabica* is recognized as a separate species, whereas the Arabian population of *Bitis arietans* is not even separated at the subspecies level.

There are also some erroneous maps. The Turkish mainland population of *Macrovipera lebetina lebetina* is shown as *M. l. euphratica*, and the distribution of *Vipera latastei* in northern Africa is not correctly shown. The ranges of *Vipera b. berus* and *V. b. nikolskii* are separated by a gap in the map, whereas in reality there is a broad zone of hybridization.

Overall, this is a recommendable picture book that gives a good overview of the venomous snakes of Europe and western and temperate parts of Asia, yet it does not give detailed information on the species shown.

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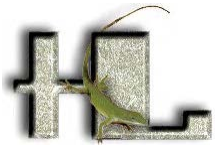
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HERPETOLOGICAL REVIEW

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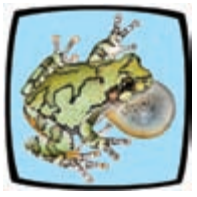
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The Society for the Study of Amphibians and Reptiles, the largest international herpetological society, is a not-for-profit organization established to advance research, conservation, and education concerning amphibians and reptiles. Founded in 1958, SSAR is widely recognized today as having the most diverse society-sponsored program of services and publications for herpetologists. Membership is open to anyone with an interest in herpetology—professionals and serious amateurs alike—who wish to join with us to advance the goals of the Society.

All members of the SSAR are entitled to vote by mail ballot for Society officers, which allows overseas members to participate in determining the Society's activities; also, many international members attend the annual meetings and serve on editorial boards and committees.

All members and institutions receive the Society's primary technical publication, the *Journal of Herpetology*, and its bulletin, *Herpetological Review*; both are published four times per year. Members also receive pre-publication discounts on other Society publications, which are advertised in *Herpetological Review*.

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SOCIETY FOR THE STUDY OF AMPHIBIANS AND REPTILES: REACHING THE WORLD



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Our society thrives on the passion of our membership for all-things-herpetological. No doubt, most of us were childhood herpers. When I am introduced to young herpetologists, I sometimes tell them how I turned my childhood hobby into a career into my profession—so, clearly I have the best job in the world (for me)! I will use this theme of reaching out in order to address two important topics related to SSAR. The 7th World Congress of Herpetology takes place this year, in August, and we also have a societal commitment to reach out to the world. Lots of exciting things are happening on both of those fronts, so let's review them.

The World Congress of Herpetology is a great tradition that periodically brings together a diverse gathering of herpetologists. SSAR has always been a strong supporter of WCH in every sense, including direct financial contributions to help ensure its ultimate success; we contribute all of the proceeds from our Live Auction to WCH whenever we meet with them concurrently. We also produce commemorative materials such as David Dennis's iconic painting of the Eastern Box Turtle inspecting the berry, produced as giveaway posters for the First WCH in Canterbury. Wait until you see what David has produced for the upcoming WCH! You'll see it first on the current covers of *Journal of Herpetology* and *Herpetological Review*. We also produce special publications, and this year we are distributing *gratis* copies of *Herpetological Review* and *Contributions to the History of Herpetology (Volume 3)* to all delegates. All of the usual SSAR activities will be in place, including the Student Social, Student Workshop, Silent & Live Auctions, and more.

As SSAR continues to advance its commitment to membership diversity, we are rolling out two new programs this year. One is a scholarship opportunity for a gradeschool-student herpetologist (and parent) to attend one day of the event, and the other is our new Mentorship Program. Kris Kaiser developed and leads this latter program to help first-timers navigate the myriad events that constitute the annual meeting, help them meet like-minded peers, and introduce them to key members relevant to their interests. This year will also mark the rollout of our extension of eligibility of our paper/poster competitions and travel grants to include undergraduates. Considered together, these programs demonstrate how SSAR continually is expanding and creating programs to suit the ever-changing nature of modern herpetology, and our ongoing efforts to encourage diversity and involvement in herpetology. They also remind us that the term "student" means *all students* interested in herpetology and wherever they might be in the world.

This last point leads me to another topic involving an expansive and inclusive view of herpetology that SSAR exemplifies and embraces. There is a lot of great herpetology going on these days that is taking place outside of our traditional view of professional societies. Indeed, modern herpetology is a shape-shifting creature to behold, and it is exciting. Facebook is alive with really active pages devoted to herpetology; SSAR's Facebook page has many more friends and "likes" than we have actual members! We want to engage and encourage anyone with an interest in herpetology, and outlets like Facebook are allowing us to do so, at no real cost, outside the more traditional media of printed journals and books. Another Facebook page, called *Herpetofauna Mexicana,* is a real favorite of mine and has become a valuable research tool. Friends of this page post photographs of species encountered all over Mexico. Sure, some images are better than others, some have questionable identifications, and not all are accompanied by detailed locality data. But some of them represent perfectly valid locality records of great importance, especially for the dwindling amphibians that I study. A similar approach is seen by the online Global Reptile and Global Amphibian BioBlitz websites (which are formally endorsed by SSAR). These sorts of efforts are informally churning out thousands of valuable sightings of species, most of them date- and geo-referenced. Sure, I will always prefer a properly documented museum specimen and tissue sample, but we have to acknowledge that collecting permits are increasingly more restrictive and, in some cases, it simply is not ethically or legally possible to collect the full specimen. I, for one, would clamor for an online photo voucher snapped by an ecotourist in a national park somewhere that demonstrates to me that one of my long-lost study species is still extant. I can then proceed to pursue my own permits to obtain actual specimens, as appropriate.

I recently read a scathing criticism of such programs distributed via e-mail by one of our esteemed colleagues (name withheld). They claimed that these online photographic records are utterly useless scientifically, because the photographers usually are amateurs and thus not to be trusted to properly read a calendar or use the GPS unit built into their smartphone, and because there is no formal museum specimen. Our colleagues at the Cornell Laboratory of Ornithology have pioneered such citizen-science programs with great success, for example with their data-rich Project Feederwatch. With all due respect, esteemed colleague, you are wrong! The Geographic Distribution section of *Herpetological Review* has long published important records based on photographic evidence. As for data veracity, we have all discovered misidentified specimens in major museums and also

specimens with inaccurate locality data. It happens, and just like notes published in *HR* and with some museum specimens, if you aren't satisfied with the veracity of the data at hand, then simply exclude them from your analyses. We have all been reviewing our own data in such ways for our entire careers. These new online efforts simply promise to provide us all with substantial numbers of important new records from the field. I will also remind this colleague that, if advanced degrees in biology were required to publish in herpetology then we would be missing many thousands of valuable contributions offered to us by the likes of Laurence Klauber, Bertha Lutz, Ernest Liner, Malcom Smith, Joan Proctor, or Raymond Rollinat.

It is cliché anymore to dwell on the information revolution that the internet has given our profession. During SSAR's 2011 Annual Meeting, Robert Hansen and Raul Diaz led us in a very informative open discussion to solicit ideas about how members envision SSAR using our webpage to better move forward our Mission. We got great feedback, especially from students, and I am happy to announce that recently the SSAR Board of Directors voted to approve significant funding to move our society forward in the realm of online herpetology. Watch for these developments over the next year. These are exciting times and SSAR is at the leading edge. We will use our substantial and creative membership to endorse and support the sorts of endeavors I have discussed and do so with our famously inclusive ethos.

In closing I want to thank you for being a member of our society and I hope you appreciate our efforts to modernize. If you are not a member, please come join us. I cannot overstate how sincerely I mean "Everybody is welcome in SSAR." If we have not yet met, please introduce yourself when we cross paths at WCH in the beautiful city of Vancouver. If you cannot come to Vancouver, please always feel free to contact me directly at: jmendelson@zooatlanta.org



Joseph R. Mendelson III,
President

ABOUT OUR COVER: *Hydromantes shastae*



The web-toed salamanders (*Hydromantes*) comprise a group of plethodontids that have long puzzled students of animal geography. With three species on the Pacific Coast of N America (all in California), and seven species in southern Europe (often placed in the genera *Atylodes* and *Speleomantes*), they present a distributional pattern unique among terrestrial vertebrates. Indeed, until recently, with the remarkable discovery of the Korean Crevice Salamander (*Karsenia koreana*) on the Korean peninsula (Min et al. 2005. Nature [435]:87–90), the southern European species were the only members of the Plethodontidae found outside the New World.

Among the three Californian species of *Hydromantes*, *H. shastae* (Shasta Salamander) is the most northern, comprising a series of disjunct populations distributed over a fairly small area in the Sacramento and Pit River drainages bordering Shasta Reservoir in northern California, at elevations of 300–900 m (Wake and Papenfuss 2005. pp. 784–785 *In* M. Lannoo [ed.], Amphibian Declines: The Conservation Status of United States Species, pp. 784–785. University of California Press, Berkeley). Although described in 1953 by Gorman and Camp (1953. Copeia 1953[1]:39–43, the first specimens were discovered many years earlier and examined by Camp in 1915 but could not be assigned to species because of their poor condition. Initially thought to be a cave-associated species, field work over the last 40 years (e.g., Nauman and Olson 2004. Northwestern Naturalist 85:35–38) has shown that Shasta Salamanders occupy limestone outcroppings well away from cave systems.

Recent work by Bingham (2007. Differentiation Across Multiple Scales in Three Californian Amphibians. Unpubl. Ph.D. dissertation. University of California, Berkeley. 164 pp.) analyzed genetic and morphological variation across the range of *H. shastae* and affirmed the existence of three deeply diverged clades. Plans to raise the level of Shasta Reservoir to increase water storage would inundate populations associated with one of these lineages. Currently, the species is recognized as Threatened by the state of California.

Joe Gorman (1918–1999), co-describer of *Hydromantes shastae*, also discovered and named *H. brunus*, the Limestone Salamander (Gorman 1954. Herpetologica 10:153–158). These salamanders were the focus of Gorman's Ph.D. research at the University of California, Berkeley, under Robert C. Stebbins. His dissertation (completed 1954) was an extensive review covering systematics, ecology, physiology, and reproductive biology, but was never published. Gorman has recently been profiled by Adler (2012. Contributions to the History of Herpetology Volume 3. Contributions to Herpetology. Society for the Study of Amphibians and Reptiles, Ithaca, New York. 564 pp.) in a volume being issued in conjunction with the 7th World Congress of Herpetology, meeting in Vancouver in August, 2012.

Charles L. Camp (1893–1975), Gorman's collaborator in describing *H. shastae*, much earlier (1916) discovered the first *Hydromantes* in the New World, from high elevation in the Sierra Nevada of California. Although Camp's early interests in herpetology eventually shifted to paleontology (he later served as Director of the Museum of Paleontology at the University of California at Berkeley), his most important herpetological legacy was his "Classification of the Lizards" (published in 1923, reissued in 1971).

Our cover image of an adult Shasta Salamander was recorded by **Rob Schell**, a California-based wildlife biologist with a passion for photography (http://robschellphotography.com/). Rob's interests in herps and photography have taken him throughout the western USA and Mexico. He captured this image in the field using a tripod-mounted Canon 7D with a 16–35mm F/2.8L II USM lens (at 32mm) at f/22, with a 2-second exposure. A Canon 580EX II was used for fill flash.



PHOTO BY DANIEL CHASE

SSAR BUSINESS

2012 SSAR Grants-In-Herpetology

Applicants and proposals selected to receive funding:

Conservation.—**Tyler D. Hoskins**, Miami University of Ohio, "Differential pesticide tolerance among Blanchard's cricket frog (*Acris blanchardi*) populations: can genetic variation predict susceptibility?" Advisor: Michelle Boone

Education.—**Jacob Ngwava Mueti** and **Beryl A. Bwong**, National Museums of Kenya, "Creating awareness on the conservation of amphibians and reptiles in Kenya"

The Andrew H. Price Field Research Grant In Herpetology.—**Jesse Delia**, Boston University, "Ecology and evolution of parent-embryo interactions in Neotropical glassfrogs." Advisor: Karen Warkentin

Laboratory Research.—**Robert Literman**, Iowa State University, "Studying the molecular mechanisms underlying temperature-dependent sex determination: how do embryos sense temperature?" Advisor: Nicole Valenzuela

Travel.—**Rebecca Tarvin**, The University of Texas at Austin, "Does alkaloid insensitivity facilitate aposematism and diet specialization in poison frogs?" Advisor: David Cannatella

International.—**Stefano Canessa**, University of Melbourne, Australia, "The decline of *Bombina pachypus* in northern Italy: do increasing extreme rain events threaten reproductive success and influence extinction risks?" Advisor: Kirsten Parris

SSAR thanks the following reviewers.—Rebecca Christoffel (Iowa State University), Robert Fisher (USGS, San Diego Field Station, CA), Emília Martins (Indiana University), Greg Pauley (Natural History Museum of Los Angeles County), Christopher Phillips (Illinois Natural History Survey), Gary Roloff (Michigan State University), Allison Sacerdote (Lincoln Park Zoo, Chicago), Cameron Siler (University of Kansas), Bryan Stuart (North Carolina Museum of Natural Sciences), Steve Sullivan (Peggy Notebaert Museum, Chicago), David Wake (University of California, Berkeley), Rod Williams (Purdue University). The GIH Chair is Josh Kapfer (University of Wisconsin, Whitewater).

2012 SSAR Election

SSAR will hold an election in September of 2012. As in previous years, electronic voting is encouraged. If you would prefer to cast a paper ballot, please contact the Secretary (Marion Preest; e-mail: mpreest@jsd.claremont.edu). We encourage all members of SSAR to participate in the election.

NEWSNOTES

Losos Recognized by National Academy of Sciences



Jonathan B. Losos, the Monique and Philip Lehner Professor for the Study of Latin America and curator of herpetology in the Museum of Comparative Zoology at Harvard University, is the recipient of the Daniel Giraud Elliot Medal. Losos is recognized for his novel and penetrating evolutionary studies of adaptive radiation in vertebrates, notably his comprehensive study of *Anolis* lizards in tropical America, as summarized in his recent book, *Lizards in an Evolutionary Tree: Ecology and Adaptive Radiation of Anoles* (reviewed in *HR*, vol. 42, number 2—June 2011 issue). Established by a gift from Margaret Henderson Elliot in 1917, the Elliot Medal recognizes "a most meritorious, recently published work in zoology or paleontology." The medal, announced in January 2012, is given every four years and carries an award of US $15,000. Losos joins a long list of luminaries in evolutionary biology, including such names as Archie Carr, Theodosius Dobzhansky, Alfred S. Romer, George Gaylord Simpson, and Sewall Wright.

Carlos Vasquez Almazan Named Recipient of Whitley Fund for Nature Award



PHOTO BY TODD PIERSON

Carlos Vasquez Almazan, an amphibian expert from Guatemala, is one of seven winners of this year's Whitley Fund for Nature Awards. Carlos, who is associated with the conservation non-profit, FUNDAECO, received the honor during a ceremony in May 2012 at the Royal Geographical Society in London, hosted by Whitley Fund for Nature (WFN) – the UK-based sponsoring charity. His Whitley Award comprises a project grant of £30,000—donated by Fondation Segré—an engraved trophy, membership in the influential network of past Whitley Award winners, and professional development training.

SSAR is pleased to announce republication of the herpetological classic

ERPÉTOLOGIE GÉNÉRALE



Constant Duméril Gabriel Bibron Auguste Duméril

THIS WORK, PUBLISHED IN 1834–1854 IN PARIS, IS *the first scientific account of the amphibians and reptiles of the world* including their anatomy, physiology, and systematics, with full synonymies and the associated literature. The original set consists of 10 volumes of text totaling almost 7,000 pages and a colored atlas of 120 plates. This reprint is being offered at a *special low price* because of a generous subsidy from RONALD JAVITCH, the natural history bibliophile of Montréal, Canada. **The complete set will be issued in October 2012.**



Special Features of the SSAR Reprint

- Extensive illustrated introduction by Dr. Roger Bour of the Muséum National d'Histoire Naturelle in Paris.
- Comprehensive index to scientific names (a Latin name index is lacking in the original book).
- Cloth-bound volumes with archival paper for long-term use.
- Plates in *both* colored and uncolored versions (details of scutellation are often obscured by original hand-coloring).
- Absolutely complete, high quality, and fully-edited for clarity.
- Low cost: US$275 for complete set of 10 volumes (for SSAR regular members, $225). If you are not a member of SSAR, maybe you should join now ($95 annually world-wide; includes 4 issues each of *Journal of Herpetology* and *Herpetological Review*); contact www.ssarherps.org.

Full details to appear in the September issue of *Herp Review*

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This publication is being issued to celebrate the 7th World Congress of Herpetology in Vancouver.

The award recognizes his efforts to establish Guatemala's first-ever nature reserve for amphibians in the Sierra Caral, following the discovery there of many species previously believed extinct or unknown to science, and to create a national network of other sanctuaries across the country.

Congratulating Carlos on his success, WFN's acting director David Wallis said: "The aim of the Whitley Award scheme is to identify and support conservationists who are inspiring real and positive change for people and wildlife and the habitats they share. In the case of Carlos Vasquez Almazan, the judges were particularly impressed by how he is changing attitudes to, increasing awareness of, and fostering pride in these fascinating creatures, and for his determination to make Guatemala a 'zero extinctions' zone for amphibians." A video describing his work and narrated by Sir David Attenborough, may be seen here: http://www.youtube.com/watch?v=JqYVKVVF7uY&feature=share

State of the Union: Legal Authority Over the Use of Native Amphibians and Reptiles in the United States

Native amphibians and reptiles provide a resource that can be used in a unique way relative to other vertebrates managed by State Fish and Wildlife Agencies in the public trust. Herpetofauna are harvested for human food consumption, for their skins, as pets, for bait, and for hobbyist collection as well as for traditional wildlife uses such as for research or educational purposes. Each state has adopted laws and regulations pertaining to many of these various uses of amphibians and reptiles. The Association of Fish and Wildlife Agencies' (Association) Amphibian and Reptile Subcommittee, in partnership with the Association's Law Enforcement Committee, created this document to summarize these existing laws and regulations. This report is up-to-date as of February 2012, and will be maintained to incorporate changes each year (for most current laws/regulations, be sure to contact an individual state directly). The Subcommittee will be using this report to guide the development of Association committee-reviewed companion recommendations for model regulatory approaches for these uses of amphibians and reptiles.

The purpose and intended use of this report is to:

- Determine the current "State of the Union" with respect to laws and regulations in place for ***native*** amphibians and reptiles, legal and regulatory approaches for specific uses, and other special protections or policies.
- Identify commonalities among states, and unique or particular approaches that could inform the development of recommendations for model approaches
- Provide a quick-reference and resource for state agency biological, law enforcement, or management personnel as part of their own state's regulatory processes
- Facilitate communication and collaboration among states to address challenges in regulating amphibian and reptile use and in enforcing existing laws

http://www.fishwildlife.org/files/SOU_FULL-lo-res.pdf

For questions regarding this report, please contact Priya Nanjappa (e-mail: pnanjappa@fishwildlife.org).

Department of Defense PARC Formed

The United States Department of Defense (DoD) has established an exciting new program for reptiles and amphibians. Beginning in 2009, *Department of Defense Partners in Amphibian and Reptile Conservation* (DoD PARC) was formed. This effectively develops a partnership between the Department of Defense and its services, and PARC. DoD PARC is made up of a coalition of DoD professionals that supports the conservation and management of amphibians and reptiles on DoD lands in support of the military mission.

The DoD landscape includes approximately 29 million acres of federal lands, containing the highest densities of federally listed threatened and endangered species, including herpetofauna, of any federal landowner in the United States. Significant resources are allocated by DoD each year to herpetofauna-related conservation and management. The Army, Navy, Air Force, and Marine Corps now have the opportunity to work across services, species, and installations to better manage their respective herpetofaunal communities.

DoD PARC has successfully completed several projects already, including two transcontinental *Bd* detection transects, the development of a database of herpetofauna by military installation, a photo website of herpetofauna from respective military installations (http://dodparcphotolibrary.shutterfly.com/), and the ongoing development of a general website (http://www.dodnaturalresources.net/DoD-PARC.html).

Additional information regarding DoD PARC is available from Robert Lovich (robert.lovich@navy.mil) or Chris Petersen (chris.petersen@navy.mil).

The Reptile Database: New Version Released

In April 2012, an updated version of The Reptile Database (http://www.reptile-database.org/) was released, reflecting the following statistics:

- 9,596 species (up from 9,547, i.e. plus 49, including resurrections, etc.).
- 29,700 literature references (+401), including 177 published in 2012.
- 5,892 photos, representing 2,278 species (plus 161 species).

As usual, contributions, papers, comments, photos, or corrections should be sent to: comments@reptile-database.org.

MEETINGS

Meetings Calendar

Meeting announcement information should be sent directly to the Editor (HerpReview@gmail.com) well in advance of the event.

8–12 July 2012—10th International Congress of Vertebrate Morphology, Barcelona, Spain. Information: http://icvn2013.com/ or http://www.facebook.com/ICVM10.

8–13 July 2012—17th World Congress of the International Society on Toxinology & Venom Week 2012, 4th International Scientific Symposium on All Things Venomous, Honolulu, Hawaii, USA. Information: http://www.istworldcongress17-venomweek2012.org/index.html.

24–26 July 2012—2012 Northeast Partners in Amphibian and Reptile Conservation (NE PARC) Annual Meeting, Crawford Notch, New Hampshire, USA. Information: www.northeastparc.org.

25–28 July 2012—35th International Herpetological Symposium, Hanover, Maryland, USA. Information: http://www.kingsnake.com/ihs/.

8–14 August 2012—World Congress of Herpetology 7, Vancouver, British Columbia, Canada (together with SSAR, HL, ASIH). Information: http://www.worldcongressofherpetology.org/

16–19 August 2012—10th Annual Symposium on the Conservation and Biology of Tortoises and Freshwater Turtles, Tucson, Arizona, USA. Co-hosted by the Turtle Survival Alliance and IUCN Tortoise and Freshwater Turtle Specialist Group. Information: http://www.turtlesurvival.org.

2–7 September 2012—4th International Zoological Congress (IZC), Mount Carmel Campus, University of Haifa, Haifa, Israel. To receive the first and subsequent meeting announcements, contact the organizers at: izc2012@sci.haifa.ac.il.

19–23 September 2012—48th Annual Meeting of the German Society for Herpetology and Herpetoculture, Gera, Germany. Information: http://www.dght.de/index.php?option=com_content&view=article&id=151&Itemid=199

24–27 October 2012—Southwest Partners in Amphibian and Reptile Conservation (SW PARC) annual meeting, Las Vegas, Nevada, USA. Information: www.swparc.org/meetings.html

2–4 November 2012—Kansas Herpetological Society 39th annual meeting, Sternberg Museum of Natural History, Fort Hayes State University, Fort Hays, Kansas, USA. Information: http://cnah.org/khs/AnnualMeetingInfo.html

A Book Issued to Celebrate the 7th World Congress of Herpetology in Vancouver

Contributions to the History of Herpetology

Volume 3 by Kraig Adler, John S. Applegarth, and Ronald Altig

From the reviews of volume 1 (1989) and volume 2 (2007):

"Here is a portrait gallery that to browse will delay your next paper in progress!" —Joseph Ewan (Taxon).

"Of extraordinary interest." —Javier Valverde (Reptilia).

"An important original contribution to the history of herpetology . . . exacting and exhaustive scholarship, and an unmistakable touch of class." —Hobart M. Smith (Herpetological Review).

This book consists of three sections, each worldwide in coverage. **The first and longest section, by Kraig Adler**, is a series of new biographies of the leading contributors to herpetology beginning with the author of the oldest surviving book on the subject, Nicander of Colophon of the second century B.C.E. The accounts have a portrait, signature, and references. These feature 349 herpetologists and also include information about their colleagues, students, and many other persons. The comprehensive index encompasses volumes 1 to 3 and covers nearly 5,000 individuals.

Among the biographies included in volume 3 are these:

• Authorities on venomous snakes and antivenoms—Abati, Haast, Mead, Phisalix, Russell, and Wiley.

• Forster, Linnaeus's apostles (Forsskål, Hasselquist, Kalm, and Sparrman), Natterer, Olivier, d'Orbigny, Quoy, Voeltzkow, Xántus, Zarudny, and others who explored then-unknown continents.

• The classifiers Boie, Garsault, Jarocki, and Ritgen.

• Brandt, Gronovius, Reinhardt, and Temminck who built great museum collections.

• The anatomists von Baer, Ecker, Francis, Gaupp, Home, Kingsbury, Müller, Panizza, Perrault, and Schmidt. And the experimentalists Benedict, Evans, Ferguson, Galvani, Gans, Norris, and Spemann.

• Huxley, Hecht, Kammerer, Lamotte, Orton, Reig, and other evolutionists.

• The conservationists Frazer, Mendelssohn, and Thorbjarnarson.

• Popular writers, among them Boulenger, Brehm, Cooke, Dürigen, Gosse, Knauer, and Staněk.

• Notable amateurs: Langerwerf, Liner, Malnate, Mittleman, and Necker.

Coverage is global: *Africa* (Bianconi, Domergue, Pooley, Wager); *Asia* (Baig, Bogdanov, Daniel, Ewart, Griffin, Hatori, Hu, Inukai, Mao, Mitsukuri, Nutphand, Rabor, Tzarevsky, Vogt); *Australia and Pacific* (Bavay, Frost, Gow, Main, Moore, Zietz); *Europe* (Buresch, Cetti, Curry-Lindahl, Darevsky, De Filippi, Fatio, Frivaldsky, Houttuyn, Kiriţescu, Lenz, Lier, Metaxà, Pennant, Reuss, Savi, Schreiber, Sturm); *North America* (Banta, Garden, Garman, Harper, Holman, Hurter, Kelly, Kirtland, Maslin, Martof, McIlhenny, Patch, Storer, Surface, Tanner, Werler); and *Central and South America* (Cei, Cunha, Gay, Herrera, Lancini, Prado, de la Sagra, Santos, Soini, Velasco).

Also included are experts on taxonomic groups such as *salamanders* (Anderson, Despax, Gorman, Hairston, Kezer, Nesterov, Oyama); *turtles* (Babcock, Goode, Lambert, Lindholm, Lortet); and *snakes* (Bailey, Burger, Deuve, Fitch, Kramer, Latifi, Roux-Estève, Volsøe). The book contains 197 additional full biographies plus 180 mini-biographies.

The second section, by John S. Applegarth, is an index of 5,290 authors in taxonomic herpetology. This alphabetical list includes the full names, dates, countries of residence, and orders of taxa for everyone who has proposed a new taxon (genus or below) or has had a taxon named in their honor. This is a unique resource for zoologists, historians, and librarians. In five years (since the 2007 edition), the number of persons covered has increased by nearly 50 percent and many previously incomplete entries are now made whole.

The third section, by Ronald Altig, is a listing of herpetologists giving the names of their doctoral university, their major professor, and the date of their degree. This extensive revision is 57 percent longer than the second edition of 2007. The information is arranged in such a manner that the academic lineages can be followed from generation to generation, both forward and backward in time. 5,562 names are included and fully indexed.



Specifications: 570 pages (8.5 × 11 inches or 21.5 × 28 cm), bound in library-grade cloth. Color plates, 322 portraits. ISBN 978–0–916984–82–3. To be issued August 2012. • **Regular Price:** $75. • **Special Price to SSAR members** (if ordered before November 2012)**:** $55. • **Shipping:** USA address, add $5; non-USA shipping at cost. • **Orders to:** SSAR Publications Secretary, P.O. Box 58517, Salt Lake City, Utah 84158–0517, USA (*telephone and fax*: 801–562–2660; *e-mail*: ssar@herplit.com). • **Payment:** Make checks payable to "SSAR." Non-USA orders must be paid in USA funds using a check drawn on an American bank or by International Money Order. Books may be charged to American Express, Discover, MasterCard or VISA (please give account number and expiration date). • **SSAR Membership and Other Publications:** Membership information and a list of society publications can be obtained from the Publications Secretary at the address given above or at www.ssarherps.org.

CURRENT RESEARCH

The purpose of Current Research is to present brief summaries and citations for selected papers from journals other than those published by the American Society of Ichthyologists and Herpetologists, The Herpetologists' League, and the Society for the Study of Amphibians and Reptiles. Limited space prohibits comprehensive coverage of the literature, but an effort will be made to cover a variety of taxa and topics. To ensure that the coverage is as broad and current as possible, authors are invited to send reprints to the Current Research section editors, Beck Wehrle or Ben Lowe; e-mail addresses may be found on the inside front cover.

A listing of current contents of various herpetological journals and other publications is available online. Go to: http://www.herplit.com and click on "Current Herpetological Contents."

World's Smallest Frogs Discovered in New Guinea

With the description of two new diminutive microhylid species, it is becoming clearer that miniaturization in anurans is not just a fluke. Their discovery of *Paedophryne amauensis* (Microhylidae, Asterophryinae) from the Central Province of Papua New Guinea is particularly noteworthy, coming in as the smallest known vertebrate with an average snout-vent length (SVL) of 7.7 mm. From the Morobe Province of Papua New Guinea, their second microhylid discovery, *Paedophryne swiftorum*, is also incredibly miniaturized with an average SVL of 8.52 mm. A molecular phylogenetic analysis places the two new species in a clade with the only other included *Paedophryne* (*P. oyatabu*) and also reveals the deep divergence between these three species. Additionally, the discovery of these two new species expands the genus's known geographic range. Both new species are morphologically distinct from closely related species, most notably their smaller size. Though both are crepuscular, *P. swiftorum* was found calling during rainy days. Each species' call is acoustically distinct, though both are described to resemble the song of an insect. Like other *Paedophryne* species, *P. amauensis* and *P. swiftorum* have reductions in digits, cranial elements, and number of vertebrae. These morphological reductions are also typical of miniaturized frogs from other clades. The 29 smallest frog species represent five families and 11 genera, showing non-independent phylogenetic patterns. Additionally, like most anurans of extreme small size, these *Paedophryne* inhabit tropical wet-forest leaf litter. With diminutive size and life histories that depend on constant moisture in terrestrial environments, the authors suggest that these tiny frogs represent a new ecological guild. The stable moisture levels of the tropical leaf litter may allow this microhabitat to serve as an adaptive zone for miniaturization. Based on calling data, the two new *Paedophryne* are likely very common in the leaf litter, suggesting that they are an important predator of small leaf litter arthropods, as well as a food source for larger predators.

Rittermeyer, E. N., M. C. Gründler, D. K. Thompson, and C. C. Austin. 2012. Ecological guild evolution and the discovery of the world's smallest vertebrate. PLoS ONE 7:e29797.

Correspondence to: Christopher Austin, Department of Biological Sciences and Museum of Natural Science, Louisiana State University, Baton Rouge, Louisiana, USA; e-mail: ccaustin@llu.edu

Snakes Adjust Constriction, Cuing on Prey Heartbeat

Constricting prey is an energetically costly behavior for snakes. Thus, it is important for snakes to only constrict for the minimum time necessary to ensure the prey is dead. Using wild-caught and naïve captive-born boas (*Boa constrictor*), the authors investigated the effect of prey heartbeat on constriction behavior. Warmed dead rats were implanted with a simulated beating heart and two internal pressure sensors. In a pilot study, snakes constricted rats with beating hearts for an average of 20 minutes. Boa response was measured during the following three treatments: prey with a heartbeat throughout constriction, prey with the heartbeat shut off after the first ten minutes of constriction, and prey with no heartbeat. Snakes responded to the rat with a heartbeat by adjusting their coils frequently, a behavior they almost never exhibited when faced with the rats without heartbeats. Rats with heartbeats were constricted almost twice as long and with more than twice the pressure as were rats lacking a heartbeat. The ten-minute heartbeat rats elicited an average response intermediate to the extreme treatments. This duration/pressure effect was more pronounced in naïve boas, though the wild-caught snakes constricted all prey for longer and with more pressure than did their captive-born counterparts. As both naïve and experienced boas responded similarly, this study suggests that these responses of increased duration, pressure, and adjustment of coils are innate responses to a heartbeat cue. Because the magnitude of these responses varied between the two groups, the authors posit that the degree of constriction response can be honed with prey experience. This work is the first to demonstrate that snakes use heartbeat to determine that the prey has been successfully killed.

Boback, S. M., A. E. Hall, K. J. McCann, A. W. Hayes, J. S. Forrester, and C. F. Zwemer. 2012. Snake modulates constriction in response to prey's heartbeat. Biology Letters (*in press*). doi: 10.1098/rsbl.2011.1105.

Correspondence to: Scott Boback, Department of Biology, Dickinson College, Carlisle, Pennsylvani, USA; e-mail: bobacks@dickinson.edu

Timber Rattlesnakes form Social Aggregations with Kin

It is becoming increasingly clear that Timber Rattlesnakes (*Crotalus horridus*) display complex social life-histories. Though most research on kin-based social grouping focuses on structured, complex groups such as those found in birds and mammals, some seemingly asocial taxa, such as squamate species, may be participating in "cryptic sociality" with relatives. Timber Rattlesnakes gather together in hibernacula over the winter, then disperse several days after emergence. Gravid female Timber Rattlesnakes forgo migration to birth their young at rookeries in the fall. Using microsatellite markers, the relatedness of grouping rattlesnakes was compared to random individuals in the population. Tissue samples were collected from 29 pregnant females at 12 rookeries and from 419 rattlesnakes of various

sex and age-class from outside 18 wintering dens, 113 of which were found aggregating. Though snakes from the same hibernaculum were not more related than random, this was not the case at rookeries. In groups of two or more pregnant females at rookeries, at least two females were related. Female kin pairs occurred both in same-age and intergenerational patterns. Groups of rattlesnakes leaving wintering dens were often in same age-class pairs. Though adult snake pairs leaving hibernacula were not related, pairs of juveniles of the same age were significantly related, possibly due to continued association of littermates. These results suggest that there may be benefits afforded to pregnant females and juveniles found with kin that are linked to life stage. The authors note that gravid females are often more at risk for predation and that a related conspecific would accrue more indirect fitness benefits from engaging a predator than would an unrelated individual. Neonate rattlesnakes are known to perform certain thermoregulatory behaviors in the presence of their mothers, which may suggest other group thermoregulation social complexities. This study adds to the growing knowledge about Timber Rattlesnake social behaviors and shows the usefulness of molecular genetics approaches to detecting these types of cryptic sociality.

Clark, R. W., W. S. Brown, R. Stechert, and H. W. Greene. 2012. Cryptic sociality in rattlesnakes (*Crotalus horridus*) detected by kinship analysis. Biology Letters (*in press*). doi: 10.1098/rsbl.2011.1217.

Correspondence to: Rulon Clark, Department of Biology, San Diego State University, San Diego, California 92182, USA; e-mail: rwclark@sciences.sdsu.edu

Everglades Mammals Experience Declines with Establishment of Invasive Burmese Pythons

Invasive Burmese Pythons (*Python molurus bivittatus*) have been sighted in Everglades National Park (Florida, USA) for the past 20 yrs, but have only been recognized as established in the area since 2000. Pythons are known to predate a wide range of mammals, birds, and sometimes other herps, including species considered declining or endangered. However, the impacts of pythons on native species have not been known. Using road survey data from 1996–1997 and 2003–2011, the authors compared surveys from before the pythons were common to contemporary mammal counts. In the earlier years, raccoons, opossums, and rabbits were the most common mammals encountered on roads, yet from 2003–20011, overall raccoon observations decreased by 99.3%, opossums decreased by 98.9%, and no rabbits were found. White-Tailed Deer numbers dropped 94.1% and Bobcat sightings fell 87.5%, though some other mammals, such as rodents and coyotes, experienced small increases, possibly due to cascade effects of the changing trophic landscape. Yet, providing more support to a Burmese Python linked decline, these mammal abundance patterns were not consistent across Everglades National Park. In areas where pythons have recently arrived and where their densities are low, mammal declines were less extreme than at sites longer populated by pythons. Moreover, at two sites outside of the pythons' range, raccoon and opossum numbers were comparable to the 1996–1997 abundances. Along with these findings, pythons are known to eat raccoons, opossums, bobcats, deer, and rabbits, providing a very compelling picture of invasive Burmese Python driven mammal declines. This study also shows that large snakes can be a generalist top predator exerting pressures on the rest of the ecosystem, including increases in other reptile species abundances (as raccoons are important predators of reptile eggs), increased competition among mammals, and even rebounds of currently declining mammal species such as Florida Panthers.

Dorcas, M. E., J. D. Willson, R. N. Reed, R. W. Snow, M. R. Rochford, M. A. Miller, W. E. Meshaka, P. T. Andreadis, F. J. Mazzotti, C. M. Romagosa, and K. M. Hart. 2012. Severe mammal declines coincide with proliferation of invasive Burmese pythons in Everglades National Park. Proceedings of the National Academy of Sciences 109:2418–2422.

Correspondence to: Michael Dorcas, Department of Biology, Davidson College, Davidson, North Carolina 28035, USA; e-mail: midorcas@davidson.edu

Exciting Caecilian Discoveries

In recent months, two exciting caecilian discoveries have surfaced. In one recent study[1], the authors announced the rediscovery of *Atretochoana eiselti* (Typhlonectidae), the enigmatic caecilian previously known only from a pair of specimens of unknown provenance or even century of collection. This caecilian is noteworthy for its large size (up to a meter in length) and the absence of lungs, making it the largest lungless tetrapod. Previous investigators have posited that given its small surface to volume ratio, this species is likely restricted to highly oxygenated mountain streams. The authors of this paper report specimens having recently been collected in two widely disjunct locations: one in the estuary of the Amazon River, and another in the Madeira River more than 3000 km upstream from the mouth of the Amazon. This is surprising, as both locations are characterized by warm, muddy water. More work is needed to further elucidate the distribution and ecology of this species and determine how such a large organism can respire sufficiently without lungs.

In a second study[2], the authors herald the discovery of a deeply-divergent, heretofore unknown lineage of caecilians existing in Northeast India. A poorly-preserved specimen collected in that region a century ago has since remained the sole Asian teresomatan (the tail-less crown group comprising about two-thirds of caecilian diversity) outside of India's Western Ghats. In an effort to rediscover this lost species and clarify caecilian diversity in Northeast India, the authors conducted extensive surveys targeting fossorial gymnophionans. Teresomatan caecilians were found at 58 sites, spanning the entire region. Genetic samples were taken, sequenced for multiple mitochondrial and nuclear DNA markers, and subjected to time-calibrated phylogenetic analyses aimed at revealing regional diversity and the placement of Northeast Indian teresomatans in the caecilian tree. These analyses showed that rather than forming a clade with Western Ghats teresomatans (Indotyphlidae), the sister group of the tail-less Northeast Indian caecilians resides instead in Sub-Saharan Africa (Herpelidae). However, as the split between the African and Northeast Indian caecilians predates the last Mesozoic connection between the two landmasses, neither tectonic rafting nor more recent overland dispersal can be ruled out in explaining this distribution. Furthermore, these analyses showed that these populations exist as numerous, geographically cohesive

haploclades, suggesting considerable species diversity in the region. The authors conclude by assigning these populations to a new family, Chikilidae (which is derived from a regional name for caecilians).

[1]Hoogmoed, M. S., A. O. Maciel, and J. T. Coragem. 2011. Discovery of the largest lungless tetrapod, *Atretochoana eiselti* (Taylor, 1968) (Amphibia: Gymnophiona: Typhlonectidae), in its natural habitat in Brazilian Amazonia. Boletim do Museu Paraense Emílio Goeldi. Ciências Naturais 6:241–262.

[2]Kamei, R. G., D. San Mauro, D. J. Gower, I. Van Bocxlaer, E. Sherratt, A. Thomas, S. Babu, F. Bossuyt, M. Wilkinson, and S. D. Biju. 2012. Discovery of a new family of amphibians from northeast India with ancient links to Africa. Proceedings of the Royal Society of London, Series B (*in press*). doi: 10.1098/rspb.2012.0150.

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Genetic Evidence Indicates Extinct Galápagos Tortoise Likely Still Living

A number of studies have been published in the last decade broadening our understanding of Galápagos tortoise diversity, both extinct and extant. These studies have contributed to a growing consensus that these tortoises constitute a species complex comprised of as many as 15 species (a third of which are extinct or close to it). In a rare case of a thought-extinct species being rediscovered via genetic evidence, the authors of this study found hybrid Galápagos tortoises in the vicinity of Volcano Wolf, Isabella Island, carrying genetic material from *Chelonoidis elephantopus* (= *C. nigra nigra*), a species identified through genetic analyses of sub-fossil material from the island of Floreana and thought to have perished there in the 1800s. First, genetic samples were amassed for as many Galápagos tortoise taxa as possible, including from sub-fossil material from putatively extinct taxa. These samples were genotyped for 12 microsatellite loci and subjected to statistical analyses aimed at identifying potential parental gene pools. These analyses revealed 12 parental gene pools, some consisting of more than one species and others representing a subset of a species. Importantly, the species occupying the Volcano Wolf area, *C. becki*, was found to consist of two parental gene pools. Tortoises from the Volcano Wolf region (1669 individuals; ~20% of the population) were then genotyped for the 12 microsatellite loci and using genetic assignment methods, were assigned to either purebred or hybrid classes (e.g., F1, F2, backcross) where statistically possible. Eighty-four of these turtles were found to have genetic mosaics most consistent with having a purebred *C. elephantopus* parent. Because these tortoises are so long-lived and as more than 35% of these hybrids were under 15 years old, it is likely that their *C. elephantopus* parents are still living. Based on the amount of genetic diversity observed in the hybrid offspring, there would need to be at least 38 different *C. elephantopus* individuals who contributed to the parentage of the sampled hybrids. Only 20 individuals are required to start a captive breeding program, suggesting that *C. elephantopus* could be resurrected. An additional 122 tortoises were found to have *C. elephantopus* genes in other proportions consistent with more distant ancestry and eight individuals had nuclear DNA of *C. becki* but mitochondrial DNA of *C. elephantopus*, a pattern consistent with four generations of backcrossing with *C. becki*. In addition to the strong evidence that *C. elephantopus* persist on Isabela Island, the authors' discovery of these *C. elephantopus* hybrids alone is of great conservation value as it shows "extinct" genetic material lives on in their genomes.

Garrick, R. C., E. Benavides, M. A. Russelo, J. P. Gibbs, N. Poulakakis, K. B. Dion, C. Hyseni, B. Kajdacsi, L. Márquez, S. Bahan, C. Ciofi, W. Tapia and A. Caccone. 2012. Genetic rediscovery of an extinct Galápagos giant tortoise species. Current Biology 22:R10R11.

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Four New Species of Chameleons from Madagascar Found to Rank Among the World's Smallest Amniotes

With the variable habitats of Madagascar come interesting evolutionary radiations. Micro-endemism is particularly common on this island, a phenomenon the authors of this paper also suggest is linked with small body size. Recently, four new morphologically distinctive chameleon populations belonging to the northern Madagascar *Brookesia minima* clade were discovered. Prior to this discovery, *Brookesia* (leaf chameleons) already contained 26 small-bodied, ground-dwelling species with small distributions. In multiple cases, their simplified external morphologies have led to taxonomic difficulties. Yet, previous analyses of the *Brookesia minima* group have found high levels of genetic differentiation. For this study, the authors accumulated morphological and molecular (two nuclear genes; one mitochondrial gene) data for all 12 described and proposed *Brookesia minima* group species. These data were then incorporated into standard molecular phylogenetic analyses and principal component analyses of morphology. The molecular analyses exposed deep genetic differentiation in the clade, extended the range of some known species, and along with the morphological analyses, confirmed the distinctiveness of four new species (which the authors describe within the paper). *Brookesia tristis* is limited to low perches in the dry forest in the limestone mountains of Montagne des Français, Antsiranana Province. *Brookesia confidens* was found only at one site in the Ankarana National Park; as they were abundant at this one site but were not found at nearby sites exhibiting apparently suitable habitat, the authors infer a strong microhabitat preference. The smallest of the new species, *Brookesia micra* (female SVL 18.7–19.9, male SVL 15.1–15.3 mm) also has a shorter relative tail length compared to the rest of the clade. While several gecko species have a shorter SVL, when the tail is included, males of *B. micra* rank as the smallest known amniotes. *B. micra* is found only on the Malagasy island of Nosy Hara, a site where no *Brookesia* had been recorded during an extensive survey several years earlier. The largest of the new species, *Brookesia desperata* (female SVL 27.3–30.0 mm, male SVL 25.0–26.7) was found only in the Forêt d'Ambre Special Reserve. Morphometric analyses revealed differences in body size and tail-length by species, but of particular

note were the divergences in hemipene morphology. Each species was identifiable by hemipene alone. Given the dimensions and distributions of its members, the *B. minima* clade represents an unparalleled system for the study of microendemism and miniaturization.

Glaw, F., J. Köhler, T. M. Townsend, and M. Vences. 2012. Rivaling the world's smallest reptiles: discovery of miniaturized and microendemic new species of leaf chameleons (*Brookesia*) from northern Madagascar. PLoS ONE: e31314.

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Modeling Predicts Worldwide Range Shrinkages for Turtles as the Result of Climate Change

It has been documented that anthropogenic global climate change has already changed patterns of biodiversity and will likely lead to large-scale biodiversity declines. Some taxa, however, are more susceptible to these changes than others, varying with physiological sensitivity and geography. Turtles are particularly sensitive to climactic shifts as broadly distributed poikilothermic organisms with temperature-dependant sex determination. Chelonians are already declining at alarming rates due primarily to overexploitation and habitat loss. Thus, for conservation purposes, it is important to understand how this taxon may be further challenged. The authors of this study have developed species distribution models to assess the potential niche shifts of 199 turtle species at a global scale using 11 climate change scenarios. Using over 20,000 species records (primarily from the Word Turtle Database), they calculated richness within a 200 km buffer region around each species record location. Four chelonian species diversity hotspots were identified: the southeastern USA, Thailand and Malaysia, the Ganges–Brahmaputra–Meghna basin, and the Amazon basin. Current and future climate information was gathered from multiple databases, including the Intergovernmental Panel on Climate Change climate projections for the year 2080 under three different socio-cultural scenarios. Ten independent bioclimatic variables were included to describe the climate of each location. Overall, the mean diurnal temperature range and the minimum overall temperature was found to provide the most explanation for species spatial distributions, though most informative factors varied by taxon and location, suggesting differing mechanisms of climatic response. Though this model was constrained to only interpolate to climates existing within the training data (and therefore not extrapolate to non-analogous climatic conditions), it still predicts dramatic changes in turtle niche sizes and distributions. The four chelonian diversity hotspots are predicted to experience the greatest changes in species numbers. Given that previous studies have demonstrated that at least some turtle lineages display a pattern of strong niche conservatism, it can be predicted that climate change will shift turtles' ranges to areas with preferred climatic conditions or lead to extinction rather than inducing a broader range of climate tolerances.

Ihlow, F., J. Dambach, J. O. Engler, M. Flecks, T. Hartmann, H. Rajaei, and D. Rödder. 2012. On the brink of extinction? How climate change may affect global chelonian species richness and distribution. Global Change Biology (*in press*). doi: 10.1111/j.1365-2486.2011.02623.x.

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Species Tree Analysis Elucidates *Liolaemus darwinii* Complex Relationships

The *Liolaemus darwinii* group (Liolaemidae) is comprised of 18 lizard species occurring in northwestern and central Argentina. In an effort to apply recent phylogenetic methods to this group as well as conduct empirical evaluations of these methods, the authors of this study performed species tree analyses using the software program *BEAST on a 20-locus molecular dataset encompassing 16 *L. darwinii* group species. Importantly, they also conducted a myriad of analyses where the loci, locus length and informativeness, locus gene tree concordance with species tree, samples per species, and software program were varied and assessed accuracy and precision via comparison with the results from the preferred analysis. The preferred species tree analysis found a basal split resulting in two clades consisting of ten (Clade A) and six (Clade B) species. Neither the analyses using an alternate species tree program (BEST) nor those excluding the most informative loci recovered topologies in strong conflict with the preferred analysis. However, an analysis employing nuclear loci parsed into constituent alleles recovered one basally diverging Clade A species (*L. uspallatensis*) as a basally diverging member of Clade B with strong support. The analyses performed using subsets of the data revealed the threshold for recovering results equivalent with those of the preferred analysis (see paper for specifics). However, the authors stress that these benchmarks may be sensitive to clade age and degree of post-divergence gene flow. The recovered clades are largely geographically cohesive, with the smaller Clade B restricted to the low elevation Monte Desert of central Argentina and the highly supported crown clade within Clade A occupying the Puna, Prepuna, and extreme northern Monte Desert of northwestern Argentina. The two earliest diverging members of Clade A (*L. chacoensis*, *L. uspallatensis*) occur farther south, suggesting a southerly origin for Clade A. The authors suggest a similar subsampling method could be useful in determining if and where additional sampling is needed in studies employing species tree methods.

Camargo, A., L. J. Avila, M. Morando, and J. W. Sites Jr. 2012. Accuracy and precision of species trees: effects of locus, individual, and base pair sampling on inference of species trees in lizards of the *Liolaemus darwinii* group (Squamata, Liolaemidae). Molecular Ecology 61:272-288.

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HERPETOLOGICAL NOMENCLATURE

Beginning with this issue of *Herpetological Review*, a section dealing with all aspects of zoological nomenclature as they relate to herpetology will appear from time to time. The main focus in this section will be to call attention of the herpetological community to major issues in zoological nomenclature, pending herpetological cases under consideration by the International Commission on Zoological Nomenclature (ICZN), rulings (Opinions) by the Commission on these cases, and related articles by members of SSAR on nomenclatural matters.

As most herpetologists are aware, the naming and determination of priority for names of zoological taxa are governed by a set of rules embodied in the International Code of Zoological Nomenclature, hereafter the Code, first adopted at a meeting of the International Congress of Zoology in Leiden, the Netherlands, in 1895. The Code is now in its 4th edition (effective January 1, 1999) and is under review by the International Commission on Zoological Nomenclature (ICZN) which is in the process of preparing a 5th edition. Members of the Commission are distinguished systematists with a wide variety of knowledge pertaining to many different animal taxa. They are elected by secret ballot by the members of the Section of Zoological Nomenclature of the International Union of Biological Sciences (IUBS) at meetings of that body. The principal duties of the Commission, in addition to considering revisions to the Code, is to rule on cases through the Plenary Power where strict application of the Code would disturb stability or universality or otherwise cause confusion. Usually such rulings are in response to an application by a zoologist or zoologists to set aside a rule in a particular case.

The Commission's activities are supported by staff (the Secretariat) directed by an Executive Secretary, currently Elinor Michael, who also serves as Editor-in-Chief of the *Bulletin of Zoological Nomenclature* (BZN). The *Bulletin* contains articles of nomenclatural interest, applications for waivers of the Code in particular cases, commentary on pending cases, and the rulings of the Commission, among other items. Detailed information on the Commission and its activities may be accessed at http://iczn.org where there is an online copy of the Code, index, and abstracts of material in the *Bulletin of Zoological Nomenclature*, and other pertinent items. Also, a source of information on nomenclatural matters will be a website being developed by the American Association of Zoological Nomenclature (AAZN), whose office is at the National Museum of Natural History (Smithsonian Institution) in Washington, DC.

Current Major Issues

Two major issues relate to the ongoing preparation of the 5th edition of the Code. The first is the proposal adopted in principle of allowing new names proposed in electronic only form to compete for priority with those in print sources. A tsunami of comments has engulfed the ICZN and the BZN relating to this proposal. While e-publishing of new names seems inevitable, the essential questions are how can e-publishing provide a permanent record followed by the question of can it be manipulated to change dates of publication and/or content after initial dissemination?

A second proposal is to establish ZOOBANK as a register of ALL systematic works and ALL taxonomic names in zoology from 1758 forward. Inherent in this proposed mechanism is the idea that new names published after a certain date must be registered in order to be available. Implementation of this concept requires an enomous amount of supporting structure and staff over the long term—none of which is financially possible for the ICZN nor likely to be provided by the many scientific agencies, institutions, or Academies of Science that depend on and should have responsibility for the enhancement of stability and universality of zoological nomenclature. In my opinion, ICZN missed a chance to partner with the Zoological Record to create such a registrar only because the majority of Commissioners regarded the past annual issues of the Zoo Record as incomplete. Hey, you have got to start somewhere in such an ambitious project! In any event, go to the ICZN website and investigate the pros and cons of these two controversial proposals published in many issues of the BZN.

Major Herpetological Cases Under Consideration

Probably the most rancorous case now under consideration by the ICZN is Case 3463 on the proposed conservation of *Testudo gigantea* Schweiger, 1812, currently *Geochelone* (*Aldabrachelys*) *gigantea*, BZN 66:34–50. Details on the various references cited in the following summary may be found in BZN 66:44–50. The name *Testudo gigantea* was first used by Schweiger (1812) for a large tortoise from "Brasilia" in the Paris Museum that had been liberated by the French from the Royal Museum in Lisbon during the Napoleonic Wars. Over time the name came to be associated with the Aldabra Atoll giant tortoise and during most of the 20th century it was applied to that species following Rothchild (1897). Until recently the type specimen was presumed to be lost. Later, Loveridge and Williams (1957) proposed a subgenus of the genus *Geochelone* to be called *Aldabrachelys* (type species: *Testudo gigantea*) for the Aldabra tortoise.

A complication in following the history of the names for giant land turtles relates to the generic names variously applied to them. During the 19th century and the early part of the 20th century all of these tortoises were included in the genus *Testudo*. During the latter half of the 20th century they were usually placed in the large genus *Geochelone* which was further divided into a number of subgenera. Currently, most of these subgenera, e.g., *Aldabrachelys*, *Cykundrophis*, and *Chelonoides*, have been elevated to generic status. Where appropriate the current generic names will be used below.

Bour (1982, 1984) presented evidence based on comparison of the original description with characters of known Indian Ocean giant tortoises that the name *T. gigantea* applied to an extinct Mascarene tortoise *Cylindrophis indica* (Schneider, 1783) making both *Aldabrachelys* and *T. gigantea* junior synonyms. Bour then decided that *Testudo elephantina* Dumeril and Bibron, 1835 was the correct name for the Aldabra species and proposed a new genus-group name, *Dipsochelys* (type species: *Testudo elephantina*), to replace *Aldabrachelys*. Pritchard (1986) generally followed Bour but differed in concluding that the original description of *T. gigantea* referred to the South American tortoise *Chelonoidis denticulata*, a form that occurs in Brazil and would likely have been in the collection of the King of Portugal which was the source of the holotype of *T. gigantea*.

Further complicating this already complicated case is the name *Testudo dussumieri* Gray, 1831 which was originally

proposed in the synonymy of what was then *Testudo indica* but later made available by Fitzinger (1835). The type specimen was said to be from Aldabra, although this remains a matter of controversy. Several authors consequently used the name *Dipsochelys dussumieri* for the Aldabra tortoise rather than *Aldabrachelys gigantea* or *Aldabrachelys elephantina*.

In attempt to bring stability to this situation, Frazier (2006a) designated a neotype, definitely from Aldabra Atoll, for *T. gigantea* pointing out the overwhelming use of that name for the Aldabra tortoise in the scientific and conservation literature. Shortly after the appearance of Frazier's paper, Bour (2006) announced the discovery of an unlabelled, stuffed specimen of tortoise in the Paris Museum (MNHN 9554) that he claimed was the type specimen of *T. gigantea*. According to the catalog "this very old specimen of unknown origin" was from "Bresil." This turtle was positively identified as a representative of *Chelonoidis denticulata* a common South American species.

Frazier (2009) then petitioned the ICZN to a) validate his selection of a neotype (USNM 269962) from Aldabra Atoll for *Testduo gigantea* and b) suppress the name *Testudo dussumieri* Gray, 1831. In addition, he asked that *Aldabrachelys* and *Testudo gigantea* be placed on the Official Lists of Generic Names and Specific Names in Zoology, respectively, and that *Testudo dusseurmeri* be placed on the Official List of Rejected and Invalid Specific Names in Zoology. In response, a voluminous flood of comments, many rather heated, engulfed the BZN (vols. 66–68). About 60 of these are by different authors favoring the application, 11 strongly against, and three or four neutral but favoring a definitive solution. Some of these comments are long counter arguments rich in detail by Bour, Pritchard, Iverson, Hoogmoed, and others, or long replies, principally by Frazier and co-authors, also rich in contradictory details to those opposing the application. All profess a desire to establish stability for their favored names. However, there are broad differences as to which view of "stability" should prevail, that of professional systematists versus user groups in conservation and government bodies.

Who said nomenclature is dull and boring stuff? The Aldabra tortoise case certainly is not, especially for the giant land tortoise crowd. Stay tuned as there are likely to be more heated comments appearing in the BZN prior to any decision. It will be most instructive to see how the ICZN rules in this divisive case.

Recent Rulings on Herpetological Names

- Opinion 2223 (Case 3345): Conservation of the family-group name Dendrobatidae (Amphibia, Anura) over Phyllobatidae whenever the two are considered synonyms. BZN 66:103–105.

- Opinion 2255 (Case 3420): Buettneria Marsh, 1922 (Amphibia): generic name not conserved. The applicants asked that two earlier senior homonyms be suppressed in favor of Marsh's use but this was denied. BZN 67:263–265.

- Opinion 2256 (Case 3446): *Anolis chrysolepis* Dumeril & Bibron, 1837 (Reptilia, Squamata) to have precedence over *Anolis nitens* Wagler, 1830 whenever the two names are considered synonyms. BZN 67:266–268.

- Opinion 2282 (Case 3502): Conservation of the specific name *Coluber nummifer* Reuss, 1834 (currently *Hemorrhois nummifer*) (Reptilia, Serpentes) by suppression of the name *Coluber tyria* Linnaeus, 1758. BZN 68:228–229.

Pending Cases of Herpetological Interest

- Case 3351: Proposed precedence of *Chelodina rugosa* Ogilby, 1890 (currently *Macrochelodina rugosa*) over *Chelodina oblonga* Gary, 1841 (Reptilia, Testudines). BZN 63:187–193.

- Case 3506: Proposed conservation of the name *Allosaurus* Marsh, 1877 (Dinosuaria, Theropoda). BZN 67:53–56.

- Case 3510: Proposed conservation of the *Cyclodina aenea* Girard, 1857 (currently *Oligosoma aeneum*) (Reptilis, Squamata, Scincidae). BZN 67:307–313; modified to conserve *Tiliqua ornatum* Gray, 1843 (currently *Oligosoma ornatum*) as well. BZN 68:144.

- Case 3527: Proposed conservation of the name *Anguis jamaicensis* Shaw, 1802 (currently *Typhlops jamaicensis* (Reptilis, Serpentes). BZN 68:197–203.

- Case 3536: Proposed replacement of the type species of *Stegosaurus*, 1877 (Dinosauria, Ornithischia). BZN 68:127–133.

- Case 3571: *Crotalinus catenatus* Rafinesque, 1812 (currently *Sistrurus catenatus*) and *Crotalus tergeminus* Say in James, 1822 (currently *Sistrurus tergeminus*; Reptilia, Serpentes); proposed conservation by designation of neotypes. BZN 68:271–274.

Two Rulings of Interest to Zoologists in General

- Opinion 2245 (Case 3407): *Drosophila funebris* Fabricius, 1787 to be maintained as the type species of *Drosophila* Fallen, 1823 (Insecta, Diptera). An application had been made requesting that *Drosophila melanogaster* Meigen, 1830 should be ruled to be the type species of *Drosophila*. Recent taxonomic study strongly suggested that *Drosophila* (*sensu lato*) was going to be divided into a number of separate genera with *D. melanogaster* placed in a different genus from *D. funebris*. Under that scenario there would not be a *Drosophila melanogaster*, one of the most cited names in the biological, broad scientific, and general literature; thus the reason for the application. However, the ICZN decided that the petition was based on a hypothetical as no generic splitting had occurred and declined the request. BZN 67:106–115.

- Opinion 2283 (Case 3390): Conservation of usage of the name *Archeopteryx lithographica* von Meyer, 1861 (Aves) by designation of a neotype. The original type specimen consists of a fossilized feather that could not be positively associated with one of several nominal fossil taxa from the type locality site. This designation associates the name with a well preserved skeleton with attached feathers imprints. BZN 68:230–233.

The Amphibia (currently Amphibia and Reptilia) of Carl Linnaeus, later Carl von Linné

I end this initial effort by calling the attention of all herpetologists to the recently published *The Herpetological Legacy of Linnaeus*, Bibliotheca Herpetologica vol. 8, no. 2, 144 pp., edited

by Richard Wahlgren and Aaron M. Bauer. This compact volume includes a nearly complete survey of Linnaeus' works containing information on amphibians and reptiles. Many of Linnaeus' early works contain the original proposal of generic and species names in herpetology which, however, are not available as they were originally published prior to January 1, 1758, the starting date for modern nomenclature under the Code and are thus pre-Linnaean. Wahlgren expertly details the historical setting and content of the early *Systema Naturae* (editions 1, 2, and 6) actually published by Linnaeus, the many dissertations, the *Amoenitates* and the magnum opus on the collections of King Adolph Fredrik (1754). Among the most important dissertations treated in detail are *Amphibia Gyllenberg*, 1745 (defended by B. R. Hast), Museum *Adolphus Fridericiarum* = *Musuem Principis*, 1746 (defended by L. Baik), and *Surinamensis Grilliana*, 1748 (defended by P. Sundius).

The 10th edition of the *Systema Naturae* (1758) brought together the information contained in these earlier works with many additions. The final edition of the *Systema* authored by Linnaeus was the twelfth (1766). It is well to keep in mind that this edition was used as the starting point of zoological nomenclature under the so-called Strickland code, actually the official code of the British Association for the Advancement of Science. References to the *Syst. Nat.* in the many herpetological works of Günther and Boulenger refer to the 12th not the 10th edition, a fact often overlooked by some modern herpetologists. Other sections treat the contributions to herpetology of Linnaeus' students who carried out field work throughout the world (K. Adler); the pre-Linnaen sources of many herpetological names used by Linnaeus (A. Bauer); Linnaen names for South American (W. Duellman) and North American (E. Liner) taxa; and those of Asia (I. Das). The only area missing separate coverage is Africa.

In conclusion, every systematic herpetologist or person interested in the history of our science should have a copy of this marvelous monograph. It is available from the International Society for the History and Bibliography of Herpetology (www.t-ad.net/ishbb).

—Jay M. Savage, Section Editor

OBITUARIES

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Joseph T. Collins, Jr. (1939–2012): Herpetological Organizer and Author of Wildlife Books

Joseph Thomas Collins, Jr.—editor, photographer, and writer of books on the wildlife of eastern and central United States, and an organizer of state and national herpetological organizations including the Society for the Study of Amphibians and Reptiles (SSAR)—died of a massive coronary on 14 January 2012, at his vacation home on Saint George Island, Florida. He was born on 3 July 1939 in Crooksville (Perry County), central Ohio, but grew up in Norwood, a Cincinnati suburb. In those days, he was called "Tom" Collins, to distinguish him from his father, a Cincinnati podiatrist. He was one of a group of local boys including his closest friend, Corson J. Hirschfeld, who developed a strong interest in reptiles. (See accompanying commentary by James B. Murphy.). In 1958 Collins joined The Ohio Herpetological Society (OHS), a club that had been founded by amateurs earlier that year and, together with Hirschfeld, he soon became one of its principal organizers. They were among that brash group, mostly of teenagers, sometimes referred to as "The Ohio Mafia" and reviled in some quarters, who led the Ohio herp society to spectacular growth in membership and invented its innovative programs that presaged its development into what is today the world's largest academic herpetological society. By 1962, Collins was OHS Secretary and, except for a six-year gap in the 1970s, he held one or another post (as officer, editor, or committee chairman) continuously through 1998—a total of 30 years including the period when OHS transformed into SSAR. He was President in 1978.


PHOTO COURTESY SUZANNE L. COLLINS

Joseph T. Collins, Jr., 2010. Formal portrait.

In 1962–1963, Collins served in the United States Army at Fort Jackson (South Carolina) and then attended the University of Cincinnati (A.A. 1966). In January 1968, he was hired by the University of Kansas Museum of Natural History as Preparator for the ichthyology and herpetology collections. As such, he was in charge of accessions, cataloging specimens, loans, preparing skeletons, and related activities. His organizational skills and close attention to detail, honed through his years of work for OHS and SSAR, were a decided asset in his new duties. He also developed photographic skills and soon recognized the

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PHOTO BY DAVID M. DENNIS



"Tom" Collins demonstrating the finer points of a live gartersnake at the Third Annual Meeting of The Ohio Herpetological Society, held at the Cleveland Museum of Natural History, June 19, 1960.

PHOTO BY JAMES S. JACOB



Former officers and editors of The Ohio Herpetological Society (1958–1966) at a banquet in August 1982 in Raleigh, North Carolina, celebrating the society's 25th anniversary. *From the left*: Kraig Adler, Ray Ashton, Paul Daniel, Steve Tilley, David Dennis, Barry Valentine, Roger Conant (honorary advisor), Corson Hirschfeld, Joseph Collins, Ronald Brandon, and Henri Seibert. It was Collins who dubbed this group "The Ohio Mafia."

PHOTO BY JAMES S. JACOB



Joseph Collins was the perennial auctioneer at SSAR/HL meetings for nearly two decades, beginning at the Memphis meeting in 1981. His last appearance as auctioneer was for the 50th anniversary meeting in St. Louis in 2007. He was especially good at bidding up prices by getting rival groups interested in the same item, and then challenging them with irresistible taunts. Ray Ashton is at the right.

need for public education, interests that he later put to use in writing books and pamphlets for the general public.

In 1981, Collins moved from his collections job to become Managing Editor of the museum's scientific publications. In the 1970s he had been editor of SSAR's news-bulletin, *Herpetological Review*, and in 1982 took over its pamphlet series, *Herpetological Circulars*. He had also promoted the development of the Kansas Herpetological Society (KHS), which he modeled after OHS, and used the bylaws and organizational structure of SSAR. More than anyone else, Collins maintained the academic orientation of KHS, at a time when most other regional herpetological societies were moving into captive breeding. He was also responsible for the regular field surveys by KHS members, which have accumulated many valuable records from throughout the state over many years.

As part of Collins's interest in public outreach, he produced several books, which gave him the opportunity to further develop his photographic and writing skills. The first was an update of Hobart M. Smith's "Handbook of Amphibians and Reptiles of Kansas" (1950; second edition 1956), which by the early 1970s was out of date. Collins's completely new replacement, entitled "Amphibians and Reptiles in Kansas," was highly successful and went through four editions (1974, 1982, 1993 [jointly with his wife, Suzanne L. Collins, an excellent wildlife photographer], and 2010 [with Suzanne Collins and their colleague at Fort Hays State University, Travis W. Taggart]). With the museum's Curator of Ichthyology, Frank J. Cross, Collins wrote two editions of a handbook on the fishes of Kansas (1975, 1995). Collins was also co-author of a volume on reptiles and amphibians of Eastern and Central United States in the series of field guides edited by the ornithologist-artist, Roger Tory Peterson. The herpetological volumes in this series had been initiated by Roger Conant with the photographic and artistic assistance of his wife, Isabelle Hunt Conant, and they produced two editions (1958, 1975) with Collins joining as second author for the third (1991). Because of his many books on the wildlife of Kansas and North America, Collins was proclaimed "Kansas Wildlife Author Laureate" by the Governor of Kansas, Bill Graves, in 1996.

Collins also co-edited several academic volumes. Two were on snakes: "Snakes: Ecology and Evolutionary Biology" (1987, with Richard A. Seigel and Susan S. Novak) and "Snakes—Ecology and Behavior" (1993, with Seigel). Two others, both published by SSAR, were on captive animals: "Reproductive Biology and Diseases of Captive Reptiles" (1980, with James B. Murphy) and "Captive Management and Conservation of Amphibians and Reptiles" (1994, with Murphy and Kraig Adler).

In 1997, Collins took early retirement from his editorial position at the museum. Three years earlier, he and his wife had founded a non-profit organization, the Center for North American Amphibians and Reptiles (re-named Center for North American Herpetology [CNAH] in 2000). With the help of Taggart, who handled the web design, and Suzanne Collins, CNAH developed into the most active, on-line portal for herpetology in North America. Its programs included a constantly expanding directory of herpetologists; a library of downloadable PDFs of important papers; links to other websites; a meetings calendar; and an announcement service for the herpetological community. At one time, CNAH sponsored a facsimile reprints program modeled after that of SSAR, in cooperation with a natural history book company in Minnesota. When Brian Crother, Jeffrey Demuth, and Taggart established the first open-access, on-line herpetological journal, *Contemporary Herpetology*, in 1997 (with

PHOTO BY LARRY L. MILLER



A field excursion with students to Sumner County, Kansas, in May 2009 with Joseph and Suzanne Collins (at right). Joe has a small snake in each hand.

Joseph Slowinski as editor), Collins offered the CNAH website as the backup, mirror site.

In 1977, Collins was appointed Chairman of SSAR's Common and Scientific Names Committee. The charge to them was to assume the function of a former committee of the American Society of Ichthyologists and Herpetologists, chaired by Roger Conant, that produced the first official list of standard names for North American amphibians and reptiles (published 1956 [1957]). SSAR's goal was to issue such a list on a regular basis, to reflect changes in scientific names and the addition of new taxa, through use of a committee of experts drawn from the herpetological community. The first two editions (1978, 1982) followed the plan and were authored by groups chaired by Collins, but beginning with the third edition (1990) Collins alone appeared as author, contrary to the original charge to the committee. SSAR's Board of Directors reminded Collins that the project was intended to reflect the communal judgment of the herpetological community through a representative committee. When Collins persisted, claiming the list was his own "intellectual property," and produced a fourth edition (1997) by himself (he was also editor of the *Circulars* series in which the standard names lists were published), he was terminated as chairman of the committee. He resigned as *Circulars* editor the next year. He then proceeded to produce his own standard names lists under the imprint of CNAH, as a rival to those produced by a new committee of experts in SSAR. This was the end of Collins's formal association with SSAR, although the society continued to honor him for his years of service to it, most recently at the society's 50th anniversary meeting in 2007.

Collins published research papers beginning in 1959 that covered his interests in distribution, life history, and systematics, originally on materials from Kentucky and Ohio, and later from Kansas and other parts of eastern and central United States. In one paper he co-authored the description of a new hylid frog (*Pseudacris fouquettei*). In 1991, he published a controversial, two-page paper in *Herpetological Review* in which he applied the then-new Evolutionary Species Concept to elevate 55 geographically disjunct subspecies of amphibians and reptiles to species status. He did not do so on the basis of any new research, but simply because these subspecies were, as he wrote, "mapped as allopatric" in various publications and were "in some way morphologically (and presumably genetically) distinct." There was an immediate reaction from the herpetological community, both positive and negative, and a series of follow-up articles in the *Review* including one by Collins himself (1992). There was much anticipation, therefore, at the 1992 SSAR meeting in El Paso (Texas) for a symposium dedicated to discussion of the subspecies concept in herpetology. Most of the persons who participated in the on-going debate on the pages of the *Review* were present in El Paso, including Collins. However, he left El Paso just before the symposium began.

Collins played a major role in the development of several herpetological organizations in the United States, as an innovative leader and a meticulous editor. He was a successful writer and photographer who produced a large number of popular books on amphibians, reptiles, and other wildlife. His role in promoting herpetology in Kansas is particularly noteworthy, and was instrumental in initiating the careers of many budding naturalists. Collins was also a lively speaker and raconteur whose intense focus on herpetology was contagious. "Birds are just herps gone bad," he used to say.

Joseph T. Collins's life's work made a significant difference in the way herpetology has developed in the United States. His presence will be greatly missed.

Joseph T. Collins: The Cincinnati Years and Beyond

When I came to Cincinnati, Ohio in 1957 to begin my undistinguished undergraduate academic career at Xavier University, I met a number of very strange herpetologists who were mostly unable to function well in polite society. These included George McDuffie, Marty Huelsman, Jim Corrado, Frank Kramer, and Joseph "Tom" Collins. For years, Collins used the name Tom and this appellation was what we called him; later, he wanted those of us from his Ohio days to call him Joe, but none of us was willing to accept his recommendation and refused to do so. This annoyed him greatly.

Collins was known as an incredibly poor poker player but wouldn't acknowledge this deficit. Each week we traveled to one of our abodes, pulled out the cards and chips, and played penny-ante poker until the wee hours. Usually when we played at the Collins household, his father would join us. Since I knew little about the game, both expected that I would be taken to the cleaners because I knew nothing about odds or showing a "Poker Face." For some miraculous reason, I regularly won, smiled broadly, and ceremoniously scooped up the pot after almost each game. Both Tom and his father became furious and so exasperated with my string of good luck that they would throw the cards on the table, walk away without a word, and barricade themselves in the bedroom. Naturally, we expected them to return but they rarely did, so we just continued playing.

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Huelsman, Corrado, Kramer, and Collins (and Collins's good friend Corson Hirschfeld) created the non-profit (vigorously so) Ohio Valley Herpetological Laboratory on the outskirts of Cincinnati. This building was in the middle of a sheep pasture, filled with metabolic waste so thick that it was hazardous to walk to the front door. Inside, a large room was divided in half with living reptiles and amphibians owned by the first two, and a large preserved collection curated by the latter two. Collins was planning to do a book on the herpetofauna of Kentucky so we often mounted collecting trips there to secure specimens, which were meticulously preserved. If a particularly desirable specimen was found, the herpetoculturists in the group wanted to keep it alive whereas Collins wanted it preserved as a voucher; this difference of opinion created major flare-ups and so the return trip was often traveled in silence. A few distinguished teenage visitors such as Kraig Adler and Dave Dennis from Columbus, were green with envy that this lab existed. Once again the boys from Cincinnati outstripped the Columbus crowd!

At the Lab one day, Collins pulled out a price list with a number of creatures (mealworms, newborn mice and rats, chicks, crickets, tree frogs, and so on), followed by dollar signs. When I asked what the purpose of this list was, he said that he would eat each of them for a fee, which was, he expressed explicitedly, not negotiable. This was to supplement his meager income. Although I was a destitute student, I saved up lunch money to watch him gulp down these strange food items. It was the highlight of my week!

One day, I complained to Collins that my social life was not robust; in fact, I was having trouble finding dates. He pointed out that he would instruct me as to proper grooming behavior and improving my fashion sense. He started by saying that my straggly beard and long hair looked like a Brillo pad and I should shave and get a short haircut immediately to be more presentable. He continued by comparing my wardrobe to an outfit worn by a clown: dirty plaid shirts, wrinkled pants, boots, and ill-fitting coats. He even called me a "hippie"! He felt that I needed to broaden my topics of conversation; incessant ramblings about herpetology were a real turnoff. Since my bank account was less than impressive, I was unable to incorporate his wardrobe suggestions to entice women and suffered the consequences as a result.

After I finally graduated and left town, our paths separated for some years. I saw the name Joseph T. Collins constantly but since he was only known as "Tom" to me, I never made the connection that he was at the University of Kansas. In 1971, I attended the SSAR meeting in Albuquerque, New Mexico, and saw this bald, bearded chap sitting at a table. I did not recognize him because he had been hirsute and clean-shaven in his younger days—until I overheard him speak. I sheepishly approached him and introduced myself; we reminisced throughout the meeting and remained in contact. When I was elected SSAR President in 1981, Collins signed up as Secretary because I was, as he told anyone who would listen, too disorganized to do the job by myself. In fact, during a visit to my home, he saw the ornately decorated SSAR president's gavel on my fireplace mantle and insisted that he carry it back to Kansas as it was inevitable that I would misplace it; I refused and did not lose it.

He was incredibly detail-oriented and organized. His penmanship was outstanding, unlike most herpetologists whose handwriting looks like chicken scratching. Collins was a superb editor, which I know firsthand because we worked on several projects together. One day in 1996, Kraig Adler and I visited his home in Lawrence and saw all of the old Ohio Herp Society correspondence between them encased in hardbound volumes. I spent many minutes reading through these papers to see how my two friends operated in the early days. There were plenty of disagreements, but clearly these were resolved and the herpetological community benefitted as a result.

My conversations with Collins about biology and herpetology were often very heated; we finally agreed to disagree but not be disagreeable, which took some self-control and negotiations as we both had strong opinions and did not easily compromise nor accept divergent opinions. It is a testament to the strength of our friendship, which lasted over 50 years, but we sometimes were quite frustrated with each other, especially if one of us was doing something that the other felt was self-destructive. It was an interesting dynamic between a "Zoo Guy" and a "Museum Guy" and we both benefitted greatly, in my view, by expanding our perspectives. Most importantly, I really loved this guy, warts and all, but he never understood that disagreeing with me was at certain risk to the truth.

HISTORY OF THE WORLD CONGRESSES OF HERPETOLOGY

Editor's note.—We are indebted to the following Secretaries-General: Kraig Adler, Marinus Hoogmoed, Marvalee Wake, Michael Tyler, Walter Hödl, and Local Committee Chair, Ernst Baard, for the retrospective summaries that follow. Each was asked to recall the key events associated with the planning, development, and hosting of "their" congress, as well as to note significant accomplishments and any congress-related publications. The result is the only comprehensive history available of the six World Congresses of Herpetology to date. Special thanks to Breck Bartholomew and Kenneth Dodd for their assistance.

Herpetology today is an international science, but this is a relatively recent development. If one compares current issues of *Copeia*, *Herpetologica*, and *Journal of Herpetology* to those of 30 years ago, there have been two relevant trends over this period: more articles by overseas authors and more articles by groups of authors from multiple countries. We are better connected today as an international community of herpetologists than ever before. And the six world congresses of herpetology that have been held to date* have played a role in this trend.

Other biological disciplines have enjoyed a tradition of world congresses for longer periods of time: the mammalogists since 1974, anatomists 1903, zoologists 1889, and the ornithologists 1884—the last group now for 128 years! In 1981, the three United States–based herpetological societies appointed a committee of three (David B. Wake, chair; William E. Duellman, and John W. Wright) to consider the possibility of establishing a world congress organization for herpetology, and they solicited comments from leading herpetologists throughout the world.

By coincidence, herpetologists were to meet in Raleigh (North Carolina) during August 1982 to celebrate the 25th annual meeting of the Society for the Study of Amphibians and Reptiles (Jacob 1982), and because this was a special anniversary meeting for SSAR, a large international attendance was expected. Letters of congratulations were received from US President Ronald Reagan and Governor James A. Rhodes of Ohio (the society was founded in Ohio in 1958), as well as from the leaders of numerous herpetological societies around the world. The SSAR President, Kraig Adler, had invited each society to send official delegates to the meeting and asked them to attend a special banquet in their honor on 2 August.

The Wake committee decided to recommend the formation of a world congress organization and used this banquet as an opportunity to discuss their proposal with a diverse group of herpetologists who were also the leaders of herpetological societies from all parts of the world. This group enthusiastically endorsed the committee's recommendation and voted to hold the first congress. Adler was presented by the Wake committee as the sole candidate for Secretary-General of the congress, and he was elected unanimously. He was given the task to establish an international advisory committee. By the end of the SSAR meeting, Marinus S. Hoogmoed of The Netherlands accepted Adler's appointment as Treasurer of the congress.

—Robert Hansen, Editor

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Foundation Meeting of the WCH. Leaders of national and international herpetological societies who voted WCH into existence at the SSAR meeting in North Carolina, August 1982. *Left to right* (*front row*): Mrs. Haslewood, G. A. D. Haslewood, Michael Lambert (all UK); Jorge Luis Piñero (Puerto Rico); James Fawcett (New Zealand); Marinus Hoogmoed (Netherlands); Hajime Fukada, Richard Goris (both Japan); (*rear row*): Jacek Szymura (Poland); Kraig Adler, Marvalee Wake (both USA); David Ball (UK); Robert Inger (USA); Konrad Klemmer, H. S. R. Glaser (both Germany); Benedetto Lanza (Italy); William Branch (South Africa); Mrs. Lanza (Italy). Also present for the meeting but not pictured: Jean-Marie Exbrayat (France) and Gregory Mengden (Australia).

*1: Canterbury, UK (1989); 2: Adelaide, Australia (1993–1994, over the New Year's period); 3: Prague, Czech Republic (1997); 4: Bentota, Sri Lanka (2001); 5: Stellenbosch, South Africa (2005); and 6: Manaus, Brazil (2008). The seventh congress will be held in Vancouver, Canada, during 8–14 August 2012.

History of the First World Congress of Herpetology (Canterbury, UK, 1989)



KRAIG ADLER*
(Secretary-General, WCH, 1982–1989)

The World Congress of Herpetology (WCH) was brought into existence on 2 August 1982 at a meeting of officers of national and international herpetological societies from around the world who came to Raleigh, North Carolina, to celebrate SSAR's 25th anniversary. This decision was based on a recommendation made by a committee headed by David B. Wake who pointed out the need for a global organization that could bring all herpetologists together from time to time in order to discuss common interests (Jacob 1982).

After establishing the WCH, the same group of officers elected me as Secretary-General and I was tasked to appoint an advisory committee to assist me to set up an ongoing congress organization and arrange for the first congress meeting. It is important to differentiate between the parent body, the WCH, which exists in perpetuity, and a particular WCH meeting, whose organization is temporary for the purpose of arranging and running a single congress. Each entity has its own officers, but there is occasionally some overlap.

Establishment of WCH Leadership and Its Initial Activities

My first act was to appoint Marinus S. Hoogmoed as WCH Treasurer. He became my closest colleague in founding WCH and in planning the First World Congress of Herpetology (1WCH) over the span of more than seven years. I then established the WCH Planning Committee (PC) consisting of an international group of distinguished herpetologists: Donald Broadley, Harold Cogger, J. C. Daniel, Ilya Darevsky, Toshijiro Kawamura, Michael Lambert, Federico Medem, Hubert Saint Girons, P. E. Vanzolini, and David Wake. The PC had the dual task to establish the WCH and to set the stage for the 1WCH.

Many questions had to be addressed—and most of them all at once! The PC decided that the dual themes of WCH would be science and conservation. We needed to announce our existence and goals to the herpetological community, so notices were placed in 16 herpetological journals, worldwide. The PC believed that WCH should have both a small Executive Committee (EC) to make decisions and a much larger advisory body, the International Herpetological Committee (IHC), to get the best advice from the diverse worldwide community of herpetologists. By September 1984, the PC had transformed into the EC with the addition of Robert Carroll, Gustavo Casas-Andreu, José Cei, Rainer Günther, Benedetto Lanza, and Ermi Zhao. The EC then elected the IHC, a group of 50 leading herpetologists from 30 countries.

The EC also established the category of Affiliated Organizations (AO) for national and international herpetological societies that wished to actively support the WCH and 1WCH. (By the time of the congress in 1989, 30 societies had joined as AO.) Because we also needed to build a budget to support WCH planning, we asked these societies to contribute funds proportionate to their memberships (one Dutch guilder per member, at that time about US$0.38). The AO served to channel advice to the EC and to advertise the upcoming congress in their respective country or region. In order to coordinate the EC with the IHC and AO, and to inform individual herpetologists who supported our work, a newsletter was established that requested feedback from all parties (Adler 1983–1988). This newsletter was also important in building global interest in the first congress.

Several other actions were taken at this early stage. To aid in identification of WCH, a logo was chosen (a chameleon, from Conrad Gessner's "Historia Animalium" of 1554), which has been used by WCH ever since (Fig. 1). In order to establish the legitimacy of WCH in the larger biological community, with advice from Marvalee Wake the WCH applied to the International Union of Biological Sciences (IUBS), which is the official body that sanctions world congresses, to become the Section of Herpetology of the IUBS. Among other reasons, this was important for delegates in some countries to obtain governmental travel funds to attend the congress. (This application required several years of advance planning, but was finally approved at the IUBS meeting in Budapest in 1985.)

There was also the matter of writing a Constitution for WCH. In June 1986, I appointed Harold Cogger to chair a panel (Natalia Ananjeva, Richard Goris, René Honneger, Jay Savage, and P. E. Vanzolini) to draft this document, which after several rounds of discussion with the EC, was approved by the delegates at the first congress. The overarching objectives of WCH, as stated in that document, are "to promote international interest, collaboration and co-operation in herpetology."

Selection of a Venue and Date for 1WCH

By early 1985, following discussion by the EC and IHC, we were ready to seek bids for the first congress. Criteria had been established for choosing a site and date. Several other related issues required careful consideration, for example, whether the congress would be an open meeting or by invitation only. At that time, another world congress organization had been embroiled in a destructive controversy over the issue of apartheid in South Africa. Protests were threatened for their meeting, so they excluded attendance by all South Africans. There were also the sensitive issues of China and Taiwan, and of ensuring attendance from the Soviet Union and Eastern Europe. The EC eventually decided that our congress would be open to herpetologists of all nations without prejudice.

Another controversial subject was the matter of whether there would be one official language or many at the 1WCH. The EC and IHC considered this point in depth, realizing that whatever we agreed to would set precedent. We decided to have an open discussion on the matter, which was held at the August 1985 meeting

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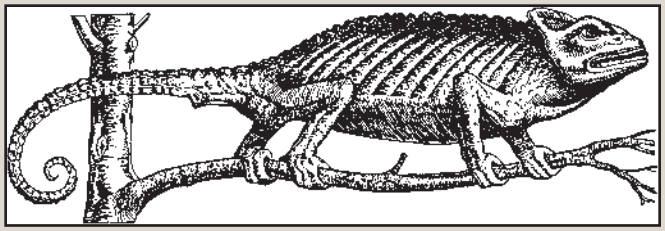


FIG. 1. WCH Logo. This chameleon image is from Conrad Gessner's book, "Historia Animalium" (1554). It has been used as the congress's logo ever since.



FIG. 2. WCH Executive Committee. The governing body of WCH in session at the 1WCH. *Left to right* (*seated*): Michael Lambert (UK); Marinus Hoogmoed (Netherlands); P. E. Vanzolini (Brazil); (*standing*): Gustavo Casas-Andreu (Mexico); Robert Carroll (Canada); Ermi Zhao (China); Ilya Darevsky (USSR); Rainer Günther (German Democratic Republic); Donald Broadley (Zimbabwe); Harold G. Cogger (Australia); Kraig Adler (USA); Ian Swingland (UK); Hubert Saint Girons (France). Also present but not pictured: José Cei (Argentina) and David Wake (USA).

of Societas Europaea Herpetologica (SEH) in Prague. The herpetologists assembled there felt that, to maximize communication and exchange of ideas, one language is preferred and that it should be English, although other languages would be permitted.

The EC and IHC nominated 50 possible venues, which were reduced to five finalists that were invited to submit proposals. One declined. By March 1985, the EC decided, by a narrow margin, to accept an invitation from Ian Swingland at the University of Kent, located in the ancient cathedral city of Canterbury in southeastern England. Following that vote, I visited Canterbury twice to inspect facilities and discuss logistics and costs. There was strong support from the British herpetological community, especially from The British Herpetological Society (BHS). We anticipated an attendance of 600 to 800, which turned out to be a conservative estimate.

By June 1986, the timing of the 1WCH was established—11 through 19 September 1989—not ideal for everyone in all parts of the world, but the best compromise that we could make. This information was widely announced over two years in advance so that would-be delegates could plan and raise funds to attend.

Establishment of a British-based Organization

The EC and IHC, being globally dispersed, could not be expected to do the detailed planning on the ground. Thus a new organization was formed—the First World Congress of Herpetology—a limited company whose sole purpose was to arrange the meeting including its financing. The WCH loaned a sum of money to 1WCH to cover their costs before they could raise their own funds. In addition, a local committee was formed at the University of Kent (Congress Secretariat; CS), headed by Swingland, the Conference Director. A national organization—the UK National Executive (UKNE)—headed by Roger Avery, was established to promote the congress in the UK and to assist the CS in the running of the meeting. So that the WCH EC could maintain its oversight of the planning, Hoogmoed, Lambert, and I were made members of the UKNE.

I took responsibility for the scientific program and recommended to the EC that no oral contributed papers be allowed, in order to give ample time for plenary lectures, topical symposia, and other activities. Contributed papers would be by poster only. Special attention was given to maximizing contacts by means of socials, workshops, roundtable discussions, commercial displays, excursions, audiovisual programs, and other activities. Because of the expected intensity of the congress, a break day was inserted into the middle of the meeting.

Fundraising for Delegates and the 1WCH

A wide range of mechanisms was employed to help delegates cover their expenses. The Royal Society of London was approached to provide funding for some persons in British Commonwealth countries. Books donated by Soviet herpetologists were sold to raise foreign exchange to cover their registration fees. National airlines were asked to donate vacant seats, on a standby basis, to the country's students. Two of the American-based herpetological societies (HL and SSAR) provided funds to support student travel to Canterbury. I wrote letters of invitation to any delegates who needed official invitations to obtain institutional funding. These and many other methods were tried, although not all were successful.

In order to better publicize the congress and raise interest and funds, I asked the Earl of Cranbrook, then the President of the BHS, to establish a group of honorary officers. Angus Bellairs was appointed Honorary President of 1WCH and 22 Vice Presidents were named including academics, conservationists, institutional leaders, and other UK notables. Among them were the Lord Archbishop of Canterbury, the Vice-Chancellor (in the UK system, effectively the president) of Oxford University, and the heads of the Natural History Museum and the Zoological Society of London. Later, H.R.H. Prince Philip agreed to serve as Patron of the 1WCH. Because of his active presidency of the World Wide Fund for Nature, Prince Philip's formal association with our congress gave special visibility to conservation issues.

Cooperation of Other Societies

To maximize our chances of a well-attended first congress, I approached three major herpetological societies to designate Canterbury as their own official meeting for 1989. Thus, HL, SEH, and SSAR did not hold competing meetings that year. In addition, BHS, the UK-based Fauna and Flora Preservation Society, and the Zoological Society of London became official co-hosts of the 1WCH. This wide support for the 1WCH from our sister organizations was essential to having a successful first congress, and thus provide a foundation for the future.

Scientific Program of the 1WCH

Our plan was to produce a program of broad scope. The EC, IHC, CS, and UKNE wanted to attract the largest possible international audience of herpetologists by creating a diverse and irresistible program of events. The scope and richness of that program is best illustrated by the abbreviated list given below.

• *Plenary Lectures* (held on the first and last days of congress): Carl Gans, Ilya Darevsky, Linda Maxson, Russell Mittermeier,

Gerald Durrell, Timothy Halliday, Ermi Zhao, Armand de Ricqlès, Donald Bradshaw, Eric Pianka, and David Wake.

• *Symposia* (Roger Thorpe, manager):
1. Conservation and Management of Species (Emilio Balletto and Brian Groombridge, convenors).
2. Effects of Environmental Pollution (Arnold Cooke and Claes Andrén).
3. Captive Management (René Honegger and Romulus Whitaker).
4. Health and Disease (John Cooper and Fredric Frye).
5. Sexual Selection and Communication (Murray Littlejohn and Stevan Arnold).
6. Environmental Sex Determination (Claude Pieau and Nicholas Mrosovsky).
7. Sensory Processing (Hans Schneider and John Phillips).
8. Long-term Studies (J. Whitfield Gibbons and Henk Strijbosch).
9. Ecology and Behavior of Snakes (Hubert Saint Girons and Richard Shine).
10. Ecology and Adaptations in Extreme Environments (Donald Bradshaw and Leo Borkin).
11. Amphibian Community Ecology (Robert Barbault and Masafumi Matsui).
12. Herpetofaunas: Explorations and Studies (Ermi Zhao and Donald Broadley).
13. Evolution and Phylogeny of Frogs (Raymond Laurent and Michael Tyler).
14. The Inter-relationships of Primitive Tetrapods: Fossil Evidence (Leonid Tatarinov and Robert Carroll).
15. Paleoherpetology: Impact on Neoherpetology (Richard Estes and Borja Sanchiz).
16. Evolution and Ecology of Island Herpetofaunas (Thomas Schoener and Ronald Nussbaum).
17. Evolution and Life Histories of Turtles (Justin Congdon and Colin Limpus).
18. Molecular Systematics (Herbert Dessauer and Eviatar Nevo).
19. Cytogenetics (Ettore Olmo and Midori Nishioka).
20. Modified Sexual Systems: Parthenogenesis and Hybridogenesis (John Wright and Rainer Günther).
21. Modern Approaches to Systematics and Phylogeny (William Duellman and Olivier Rieppel).
22. Biology of the Pipidae (Richard Tinsley and Linda Trueb).
23. Energetics (Warren Porter and Raymond Huey).
24. Determinants of Organismal Function (Harvey Pough and Roger Seymour).
25. Functional Morphology (Carl Gans and Jean-Pierre Gasc).
26. Reproductive Endocrinology (Paul Licht and Louis Guillette).
27. Developmental Processes (Angus Bellairs and James Hanken).

• *Roundtables* (organized discussion groups; Trevor Beebee, manager):
1. Conservation Needs Achieved (Keith Corbett, convenor).
2. Conservation Biology (Kenneth Dodd, Jr., Romulus Whitaker, and Gustavo Aguirre).
3. Optimal Sizes of Eggs and Clutches (Henry Wilbur and Laurie Vitt).
4. Antipredator Mechanisms (Edmund Brodie, Jr., and Harry Greene).
5. Ecology and Conservation of the Tuatara (Michael Thompson and Donald Newman).
6. Herpetofaunas: A Biogeographic Review of the Continents (Charles Blanc and Jay Savage).
7. Caecilian Biology and Evolution (Michael Delsol and Marvalee Wake).
8. Snake Systematics and Phylogeny (Herndon Dowling, Gregory Mengden, and Olivier Rieppel).
9. Laws, Research, and Conservation: A Conundrum (Harold Cogger and Stephen Edwards).
10. Amateur Contributions to Herpetology (Wolfgang Böhme).
11. Medical and Herpetological Aspects of Venoms and Skin Toxins (José Cei and Sherman Minton, Jr.).

• *Workshops* (practical demonstrations; Trevor Beebe, manager):
1. Skeletochronology and Aging Methods (Jacques Castanet and Ella Smirina).
2. Field Methods and Biotelemetry (Jan van Gelder and Stuart Mackay).
3. Molecular Techniques (David Hillis and Craig Moritz).
4. Amphibian Larvae (Barry Valentine and Richard Wassersug).
5. Quantitative and Phylogenetic Analysis (Roger Thorpe and Garth Underwood).
6. Photographic Techniques (David Curl and David Dennis).

• *Posters* (Richard Tinsley, manager).
250 posters were erected in 33 categories: Conservation and Management; Effects of Environmental Pollution; Captive Management; Health and Disease; Sexual Selection and Communication; Environmental Sex Determination; Orientation, Navigation, Nervous System and Senses; Egg Games–Optimal Size and Clutch Size; Long-term Studies; Snake Behavior and Ecology; Anuran and Urodele Ecology and Behavior; Lizard Ecology and Behavior; Chelonian Ecology and Behavior; Community Ecology; Herpetofaunas—Explorations and Studies; Skeletochronology; Field Methods and Biotelemetry; Origin of Amphibia and Reptilia; Paleoherpetology; Island Herpetofaunas; Caecilian Biology and Evolution; Molecular Systematics; Cytogenetics; Parthenogenesis and Hybridogenesis; Systematics and Phylogeny; Snake Systematics and Phylogeny; Phylogenetic Analysis; Energetics; Ecological Physiology; Functional Morphology; Reproductive Physiology; Developmental Processes; Medical and Research Aspects of Venoms.

The logistics of administering the many meeting rooms, projection, etc. were handled by several dozen stewards, mostly students. They were managed by Richard Griffiths and Henry Arnold.

Other Events Held During the Congress Week

Besides the main scientific program, several other events were held. The IUCN Species Survival Commission, chaired by George Rabb, met at the 1WCH, as did several of its specialist groups. Jay Savage arranged a meeting of the African Amphibian Group. Martha Crump and Garth Underwood organized a herp quiz.

Social activities were held every evening. The Lord Mayor of Canterbury hosted a welcoming reception at Westgate Gardens in the city, and the formal WCH banquet was held on another evening. The 70-member Regimental Band of the Royal Green Jackets, a regular British Army unit stationed near Canterbury, performed for the delegates. An auction of herpetological materials (books, prints, artwork) was held one evening, arranged by Michael Lambert. This event raised US$4,000 for herp conservation projects. Three different audiovisual programs were produced by David Dennis, Eric Juterbock, and me for evening







Fig. 3 (above left). The Abstracts volume contained half-page summaries of all oral and poster presentations. The drawings, by Tim Halliday, depict the six species of British amphibians. Britain's reptiles appeared on the cover of the Program volume.

Fig. 4 (above center). 1WCH Poster. This watercolor of an American box turtle (*Terrapene carolina*), drawn by David M. Dennis, was presented to all delegates at 1WCH by SSAR.

Fig. 5 (above right). This volume, entitled "Herpetology: Current Research on the Biology of Amphibians and Reptiles" and published by SSAR in 1992, includes the nine plenary lectures from the first congress. It was intended to be a benchmark for the status of herpetological science circa 1989.



Fig. 6. Delegates to the 1WCH. With an attendance of 1,368 persons from 61 countries, the Canterbury congress was the largest and most geographically diverse professional herpetological meeting ever held. The opening and closing sessions and the plenary lectures were held off-campus at the Marlowe Theatre in the city.

entertainment, entitled "Herpetology Past and Present," "Amphibians of the Appalachians," and "Herpetology of the American West."

Excursions were held on the free day midway through the meeting to London, Paris, etc., and to Down House, Darwin's home a short distance west of Canterbury. Commercial exhibits, managed by Thomas Langton, included books and print dealers, publishers, conservation displays, and herpetological society membership booths.

There was a staffed Congress Press Office to provide reports on congress news to television and print media.

EC Meetings and WCH Business Meeting

The EC (Fig. 2) met four times during the 1WCH to discuss various issues and to prepare recommendations to be acted upon at the WCH Business Meeting. About 200 delegates attended the Business Meeting. The Constitution drafted by the Cogger committee was approved and elections of new persons to the EC and IHC were made according to its provisions. To replace retiring members of the EC, the following persons were elected: Roger Avery, Wolfgang Böhme, William Duellman, Timothy Halliday, Konrad Klemmer, Jean Lescure, Jay Savage, Marvalee Wake, Yehudah Werner, and Romulus Whitaker. Among the 50-member IHC, 27 new members were elected representing 15 countries.

Two resolutions, both covering conservation issues, were approved at the Business Meeting. Formal invitations to host the Second Congress were announced: Adelaide (Australia), San José (Costa Rica), and Singapore. These were discussed and referred to the new WCH EC for decision.

Congress Publications

Each delegate received a 110-page "Programme" and a 334-page "Abstracts" volume, containing summaries of each oral and poster paper (Fig. 3). These were organized by Timothy Halliday. Delegates also received a copy of volume 1 of a book, "Contributions to the History of Herpetology," by John Applegarth, Ronald Altig, and me that was published by SSAR. The Society also donated the official congress poster (Fig. 4), depicting a North American box turtle (*Terrapene carolina*) feeding on some berries, that was drafted by David M. Dennis. Subsequently, a cloth-bound volume containing the plenary lectures, a full summary of the meeting, a list of 1WCH delegates with their addresses, and the WCH Constitution was published by SSAR (Adler 1992) (Fig. 5).

Final Results of the 1WCH

The success of the 1WCH can be measured in many ways. (A complete summary of 1WCH is in Juterbock 1990, and updated in Adler 1992.) We were treated to presentations of new research of great breadth and significance that clearly place herpetologists among the leaders of organismic biology. The congress reaffirmed the vitality and cohesiveness of herpetology as an interdisciplinary field of study and provided an impetus to its further development. That we are now about to celebrate our 7th congress in Vancouver later this summer is a testament to the sound foundation that we built in Canterbury in 1989. At the formal closing session of the 1WCH, I announced that the EC had elected Marinus Hoogmoed to be the new WCH Secretary-General and Robert Carroll the new Treasurer.

The final attendance at Canterbury was 1,368 persons from 61 countries, which was about double our original projections (Fig. 6). (As a result, the 1WCH secretariat repaid the loan made to it by WCH to the penny, but nothing more surprisingly.) With such a large and diverse international attendance, many friendships were made that doubtless have facilitated new research and other collaborations.

An Unexpected Further Result: Amphibian Declines as a Global Phenomenon

Perhaps the most important single result of the 1WCH, however, did not come from the scientific sessions but from hallway discussions and gatherings in local pubs. Herpetologists had noted declines in amphibian populations in eastern Australia, Brazil, Central America, and western United States, but until they met at the congress in Canterbury they had thought these were only local phenomena. Their discussions at the 1WCH, however, led them to think that the declines might result from some common global cause or causes.

This possibility required further discussion. David Wake quickly organized a "Workshop on Declining Amphibian Populations" in February 1990 (Wake 1991) at which an international group focused specifically on this issue. The popular press then picked up on this issue and specifically credited the 1WCH as the event where the conversation about amphibian declines first began (Barinaga 1990; Phillips 1990, 1994). Is this result not a perfect justification for continuing to have world congresses of herpetology?

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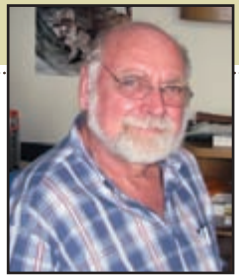
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World Congress of Herpetology in the Period 1989–1994, Leading up to and Including the Second WCH



MARINUS S. HOOGMOED*
(2nd Secretary-General of WCH)

After having served the WCH in the period 1982–1989 as Treasurer, with Kraig Adler as Secretary-General (SG), I was elected 2nd Secretary-General of the World Congress of Herpetology (WCH) at the last meeting of the WCH Executive Committee (EC) on September 19, 1989 in Canterbury, England. Both the EC and the International Herpetological Committee (IHC) that were to serve for the period 1989–1994 were elected at the Business Meeting of WCH in Canterbury as well (for names of members of the committees, see Juterbock 1990). After Kraig Adler had announced the election of Robert Carroll as Treasurer and of me as Secretary-General at the plenary closing ceremonies of the First WCH, my first task as new Secretary-General was to officially close the First WCH and wish all delegates a safe trip home.

Selecting a Venue for the 2 WCH

At the WCH business meeting in Canterbury three invitations for hosting the Second WCH were received, namely of Adelaide, Australia, Costa Rica and Singapore. In the period directly following First WCH, I started to look into the matter of the venue of the Second WCH and prepared a number of questions about organization, locality, possible field trips, and finances that had to be answered by the three prospective venues in a bid-book. These questions were submitted to EC and IHC for their approval and for further input. Finally all questions were submitted to the three prospective venues with the request to provide answers and formulate a budget. Unfortunately, during this process Dr. Douglas Robinson from Costa Rica died, and with his untimely death this venue became an impossibility. Thus only Adelaide and Singapore remained as contestants; each submitted a bid-book and additional (mainly touristic) promotional material, both printed and on video. Submitted to the postal vote of EC, Adelaide obtained the majority of votes, so Michael Tyler, the Australian proponent, was named Congress Director of the Second WCH and asked to go ahead and on behalf of WCH start the preparations for the Second WCH as outlined in the bid-book Adelaide had submitted. In contrast to the First WCH, which was run by a group of academic biologists, Adelaide had opted to contract a professional event organizer and also hired a full time Executive Director, Lyall Klaffer. The Scientific Committee was established with Dr. Michael Bull of Flinders University, Adelaide, as Chairman and an international group of herpetologists as members (Tyler 1994). WCH provided an interest free loan (duly repaid by the Second WCH) to start up the congress, but which only covered part of the initial expenses, so the organizers had to loan more money from several government and private organizations (Tyler 1994).

Planning for Adelaide

In March 1992, I was a member of the Dutch delegation to the CITES Conference of Parties in Kyoto, Japan, and on my way back to Holland I could make a detour via Australia in order to get acquainted with some of the key personnel in Adelaide (19–26 March 1993), inspect the premises of the University where the meeting would be held, and get an idea of the possibilities for mid-Congress fieldtrips. I also visited Hardy's Winery at Reynella, 20 km south of Adelaide, where the New Year's Eve party of 1993/1994 would take place, and got a foretaste of what could be expected there wine-wise. I liked what I tasted, and it was clear that there would not be a shortage of wine at the New Year's party to be held in the cellars of the winery. It was to be one of the highlights of the congress.

Michael Tyler and Lyall Klaffer started early trying to boost participation at Second WCH, by visiting herp meetings in the USA and in Europe and actively lobbying. I vividly remember a very animated evening with these two gentlemen in a wine cellar in Eger near Budapest, Hungary, during the Societas Europaea Herpetologica meetings in August 1991 (Fig. 1). Mike also had some postcards made, promoting Second WCH, figuring some very artistic, colorful and morphologically rather novel tree frogs, one card featuring a species with three toes on the hind limb, and another card featuring a species with four toes (Fig. 2). These cards were sold in order to raise money for WCH 2. Furthermore, Michael Tyler and his team started a campaign to interest Australian sponsors in the Second WCH and they succeeded in raising a considerable sum for running the congress and also obtained funds from several sources to support travel of 40 participants that applied for this assistance. WCH was able to contribute US $ 2500 to this end (Tyler 1994).

In 1992 Mike Tyler (*Herpetological Review* 23[2]:37) announced the dates of the Second WCH, to be held from 29 December 1993 to 6 January 1994, and at the same time asked for timely return of the Provisional Registration Forms. The decision to hold the Congress in the middle of a world wide family holiday was a risky one, but as turned out later, it paid off.

In contrast to the First WCH, none of the American or European herpetological societies was interested to hold their business meetings at Second WCH, partly because of statutory constraints, partly because of fear of lack of quorum in such a distant venue.

Plenary Lectures

Nevertheless we got a good number of participants (about 750) from all over the world (more than 80 countries), although there was a certain preponderance of Australians, as could be expected (Fig. 3). The venue of the meeting was the city campus of the University of Adelaide. The opening session of the congress was on 30 December 1993. During the sessions of the Congress

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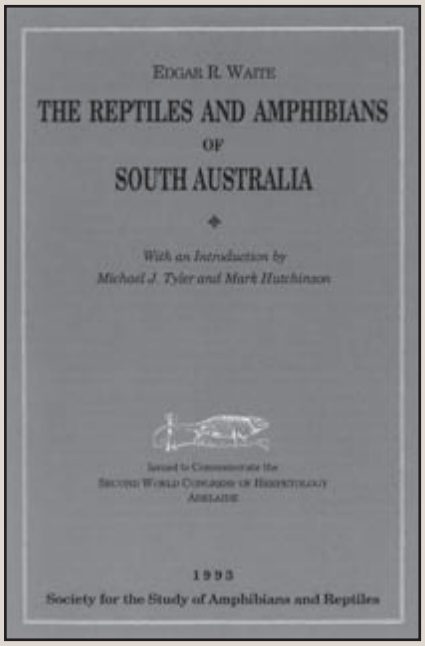


FIG. 1 (above left). Sixth meeting Societas Europaea Herpetological, Eger, Hungary. Wine party: Lyell Klaffer (left) and Marinus Hoogmoed (right).

FIG. 2 (above center). World Congress of Herpetology 2 promotional postcard.

FIG. 5. Edgar Waite's publication on the herpetofauna of South Australia was distributed gratis as a facsimile reprint to all delegates.

there were two plenary lectures each morning between 0900 and 1030 h on the following broad themes: Evolution (Arnold Kluge and Roger Thorpe, chairperson Marinus Hoogmoed), Zoogeography (Joel Cracraft and Paul Müller, chairperson Michael Tyler), Physiology (Raymond Huey and Roger Seymour, chairperson Kraig Adler), Ecology (Rick Shine and Joe Travis, chairperson Murray Littlejohn), Ethology (Michael Ryan and Judy Stamps, chairperson Rick Shine), and Conservation and Captive Care (Craig Moritz and Rene Honegger, chairperson Harold Cogger).

Specialized Symposia: The State of Our Science

The plenary lectures were followed by six concurrent symposia sessions dealing with the same subject matter as the plenary lectures, but subdivided in 30 specialized items (conveners in parentheses):

1. Evolutionary Insights from Molecular Biology and Karyology (Max King and Craig Moritz).
2. Paleoherpetology (Anna-Maria Baez and Robert Carroll)
3. Hybridization and Systematics (Yehudah Werner and Graeme Watson).
4. Functional Morphology (David Cannatella and Anthony P. Russell).
5. Development and Differentiation (Pere Alberch and James Hanken).
6. Biodiversity: Are Australian Ecosystems Different? (Harold Cogger and Graeme Watson).
7. Regional Faunal Patterns of Amphibians (John Poynton).
8. Island Biogeography (Ivan Ineich and Gregory Pregill).
9. Biogeograpy of Deserts (S. Donald Bradshaw and Roger Avery).
10. Reproduction and Environmental Endocrinology (Joan Whittier and Frank L. Moore).
11. Ecophysiology of Reptiles (S. Donald Bradshaw and Roger Avery).
12. Adaptations to Marine Life (Harold Heatwole and Harvey Lillywhite).
13. The Structure and Function of Anuran Skin (Phillip Withers and Stanley D. Hillyard).
14. Population Dynamics (Ross Alford and Keith Christian).
15. Parental Investment and Life History Strategy (Rick Shine and Laurie Vitt).
16. The Biology of *Bufo marinus*: Prospects for Biocontrol (Brian Green and Ross Alford).
17. Ecology of Varanids (Dennis King and Gerard Visser).
18. Ecology of Marine Turtles (Colin Limpus and Karen Bjorndal).
19. Communication (Murray Littlejohn and Neville Passmore).
20. Foraging and Food Choice (Dirk Bauwens and Richard Griffiths).
21. Antipredator Behavior (Dan Formanowicz and Edmund Brodie II).
22. Mating Behavior (Tim Halliday and Kent Wells).
23. Threatened New Zealand Species (Don Newman and Charles Daugherty).
24. Contraction of Ranges, Disappearance, and Extinction (James Vial and Robert Johnson).
25. The Role of Amateurs in Herpetology (Chris Banks and Helmut Zimmermann).
26. Diseases and Captive Care (W. Ahne and Helen McCracken).
27. Commercial Utilization of Reptiles and Amphibians (Grahame Webb and Rob Jenkins).
28. History of Herpetology (Liliane Bodson).
29. Thermal Biology of Amphibians and Reptiles: Fifty Years Since Cowles and Bogert (Raymond B. Huey and Victor Hutchison).
30. Snake-Bite (Julian White).

Roundtable Discussions

Moreover, there were roundtables on Data Recording (Marco Zuffi), Elapid Phylogeny (J. Scott Keogh), Caecilian Biology (Marvalee Wake), Galapagos Tortoises (Chris Banks), a workshop on



Fig. 3. Group photo of WCH2 delegates.

the Cane Toad *Bufo marinus*, an open forum on Commercial Trade in Reptiles and Amphibians, and contributed papers in 34 paper sessions. A total of 570 papers were presented in symposia or as contributed papers. Moreover there were 215 posters (Hoser 1994; Tyler 1994). The Australian SSC Amphibian and Reptile Specialist Group, the Australian Society of Herpetologists, the Society for Research on Amphibians and Reptiles of New Zealand, and the directors of the SSC Declining Amphibian Populations Task Force held meetings during the congress (Tyler 1994).

Herp-themed Auction

One of the nights an auction (traditional at SSAR meetings, and wholeheartedly adopted by WCH as a means to obtain some extra money for research projects by young herpetologists or other worthy herpetological projects) of all kinds of things herpetological (books, T-shirts used by herpetologists, herpetological art, etc.) was organized. Surprisingly (also to the Secretary General) just before that auction of herpetological items and books it turned out that the proceeds would go to the Australian Red Cross and would not be used for supporting herpetological projects of young herpetologists as was done at First WCH. Actually, the money from the First WCH auction went to herp conservation projects worldwide. Anyway, this fact apparently did not inhibit the bidding, which was vivid and animated and many objects obtained new owners, sometimes after heated exchanges of bids.

Apart from the auction and the New Year's Eve party there were many other possibilities for informal contacts during the congress.

Executive Committee Meetings

The EC met twice (29 December 1993 and 4 January 1994) at the Second WCH to discuss matters concerning finances, the election of a new SG and EC. One of the main items during these discussions was the fact that hardly any of the proceeds of the First WCH had been turned over to WCH as the mother organization, but instead had been used for projects of the University of Canterbury and the Congress Director. Only the money provided by WCH as a loan was repaid and helped to kick start the Second WCH. The auditing of the First WCH had been done in a rather peculiar, although apparently legal (in the UK) way, which did not meet with everybody's agreement. But as it seemed nothing could be done, the matter was put to rest.

Herpetologists Bring in the New Year

New Year's Eve was spent at Harvey's Winery, in Reynella, 20 km south of Adelaide, to where participants were transported by a fleet of buses. The evening was a huge success, both food and wine-wise. The menu card offered a range of rather strange items (Tyler 1994; Fig. 4), but in reality the food on the plates turned out to be rather normal and good. Everybody seemed to be enjoying themselves and at the change of 1993 to 1994 a real bagpiper played Auld Lang Syne, to which everybody of course joined in. The change of 1993 into 1994 was a good reason for many toasts on a healthy and herpetologically prosperous New Year. Apparently, after our return to Adelaide quite a lot of herpetologists continued the New Year festivities in the local bars until sunrise.

WCH Business Meeting

At the Business Meeting (2 January 1994) a number of motions on different subjects were adopted to be presented to several authorities. Fred Rocha, on behalf of the Brazilian herpetological community presented Rio de Janeiro as the next venue for WCH 3. No other proposals were presented, so the expectation of many was that Rio would be the next venue (Hoser 1994), although some people expressed worries about safety in Rio, apparently only based on press reports. At the plenary closing

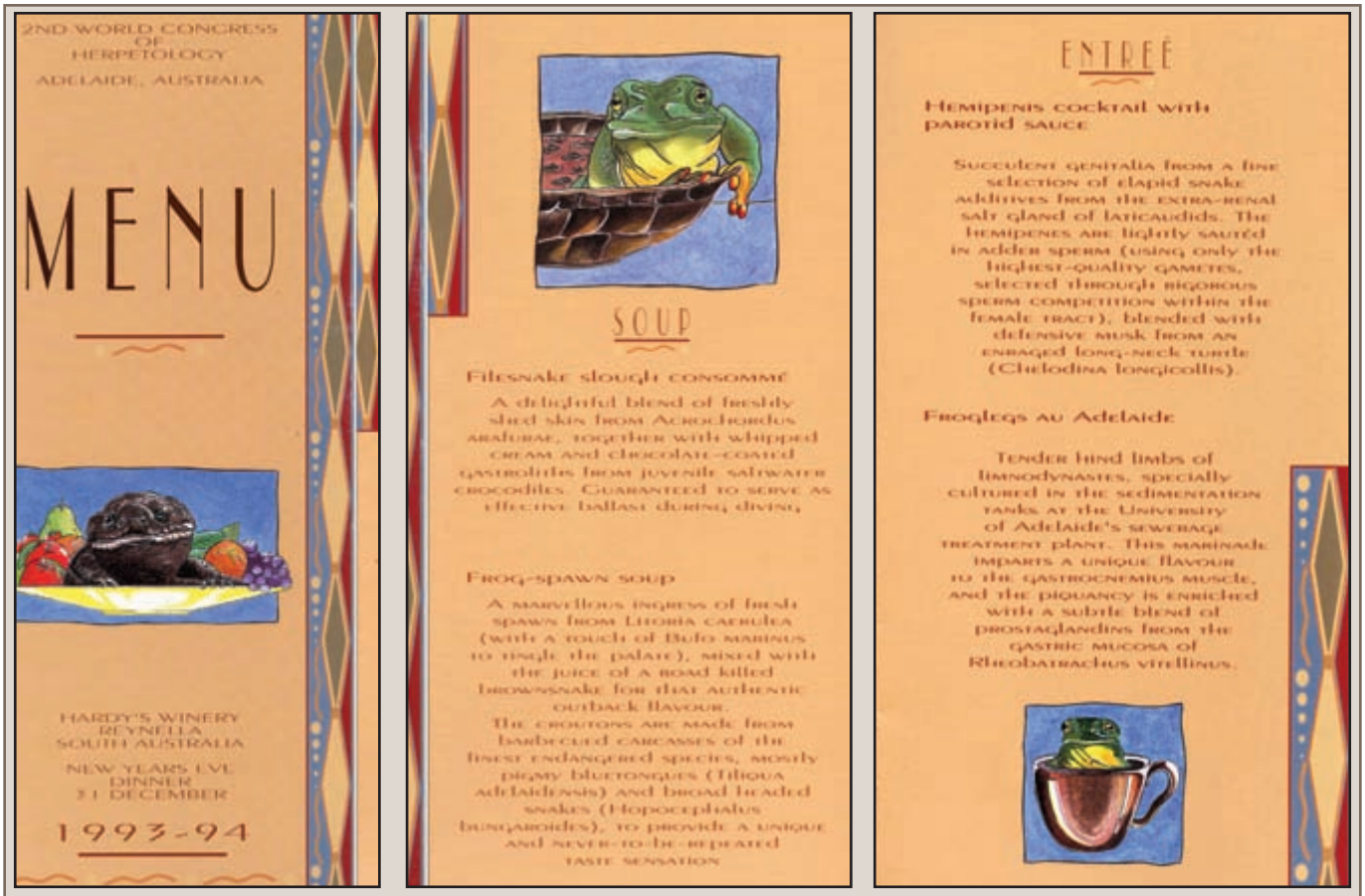


FIG. 4. A herpetologically themed menu awaited guests at the New Year's Eve party, but fortunately, more traditional fare was available.

session of the congress (6 January 1994) the newly elected members of EC and IHC were mentioned and it was announced that the Executive Committee had elected as new Secretary-General, Dr. Marvalee Wake of the USA, and as Treasurer, Dr. Roger Avery, U.K. Marvalee Wake took over from me to close the Second WCH.

Congress Publication

To commemorate the Second WCH, SSAR produced a reprint (1000 copies in a limp back edition were printed in Adelaide) of E. R. Waite's (1929) *The Reptiles and Amphibians of South Australia*, which was provided free (normal price US $35) to all participants of the Second WCH (Moriarty and Bartholomew 2007; Tyler 1994) at registration (Fig. 5).

Australian Herpetofauna on Display; Mid- and Post-Congress Field Trips

Coinciding with the congress was the large (temporary) exhibition of Australian herpetofauna "Narana," that offered an excellent opportunity for everyone to get a good impression of the Australian herpetofauna. The then recently re-discovered local *Tiliqua adelaidensis* without the shadow of a doubt was the star of the exhibition. Possibilities to photograph specimens were provided and enthusiastically used by many.

During the mid-week field trip to Parawirra on 1 January 1994 (the day after the New Year's Eve party) many of the non-Australians got their first view of wild kangaroos and a good sample of the Australian herpetofauna, including several of the more famous venomous snakes. After the congress many persons took the opportunity to make herpetological field trips to several parts of Australia. Here follows a sample of possible trips: Goanna Dreaming, Burgaree Sheep Station, Warrawong Sanctuary, Kuitpo Forest, Whyalla Reptile Park, Kangaroo Island, Outback, Great Barrier Reef, and Rainforests. Among the areas I visited after the congress were Ayers Rock and the Olga's where I met several herpetologists that had attended the congress and where some of us had the luck to see and photograph a specimen of *Moloch horridus*, high on any herpetologist's wish list.

Acknowledgments.—I want to thank Kraig Adler, Marvalee Wake, and Mike Tyler who helped to remember points that nearly got lost in the cracks of my memory. In making this report I heavily borrowed from Mike Tyler´s 1994 report in *Herpetological Review*.

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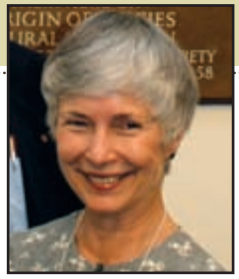
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The Third World Congress of Herpetology (Prague, Czech Republic, 1997)



MARVALEE H. WAKE*
(Secretary General, WCH 3)

Meeting in Prague

The Third World Congress of Herpetology was held in Prague, Czech Republic, 2–10 August 1997. It included the 9th Ordinary Business Meeting of the Societas Europaea Herpetologica. The Prague Congress Centre was the venue, easily accessible by public transportation from the many hotels in which participants were quartered (Fig. 1). The scope of the Congress was all of herpetology, as represented by its many foci, with special emphasis on the increasing awareness of the declines of amphibian populations and species at many places in the world, and the need to develop more knowledge about all species in order to develop maintenance plans for the protection of our biodiversity. 707 delegates were registered, representing 55 countries; the full list of registered participants is available on the WCH3 and the WCH7 websites. The host organizations were the Academy of Sciences of the Czech Republic and the Czech Herpetological Society. The planning for the meeting was ably led by the chair of the local organizing committee, Zbyněk Roček. He and his colleagues did virtually all of the arrangements for the venue and for the program, aided by a professional congress organizing firm associated with the Czech Medical Association. Sponsors and supporters included Czech Airlines; the Faculty of Natural Science, Charles University, Prague; the Geological Institute, Academy of Sciences of the Czech Republic; the Ministry of Environment of the Czech Republic; the National Museum, Prague; Northern Bohemian Mines, Bilina; A Rent Car, Prague; and many other organizations, institutions, and individuals, all acknowledged in the Programme. The International Union of Biological Sciences (IUBS; of which WCH is a Scientific Member) provided an interest-free loan for Congress start-up; individuals and institutions contributed to the WCH travel fund; contributions were received from two Czech concerns to support printing costs; many individuals provided field trip support and preparation; and Professor Rudolf Zahradnik, President of the Academy of Sciences of the Czech Republic was the Patron of the Congress and provided extensive support. The extensive report by the Secretary General to WCH3 discusses the planning and communication that took place from the end of WCH2 to the resultant WCH3; it is on the WCH3 and WCH7 websites for anyone interested in the details. My personal thanks continue to be extended to Zbyněk Roček, without whose diligence, hard work, management skills, and good humor the Congress could not have happened!

Plenary Lectures

Plenary speakers included Carl Gans, Michael Shishkin, Carl Gerhardt, Andrew Milner, Jean-Claude Rage, and Michael J. Tyler, with three plenaries in the opening session, and three preceding the closing ceremony on the last day. The Congress was a busy one. Typically each day, there were six concurrent sessions of symposia and contributed papers from 0900 to 1540 h, followed by poster sessions. The lists of all abstracts and authors, and of the poster titles and authors, are also available on the two websites mentioned above.

Symposia

Eleven symposia were organized, as follows:

- Herpetofauna and Environmental Contaminants
- History of Herpetology: Herpetological Expeditions and Voyages
- Declining Amphibian Populations: Geography and Possible Causes
- Climate Variation and its Impact on Herpetofauna
- The Eurasian Green Toad as a Model Species for Studies in Evolutionary Biology
- Sea Turtle: Biology, Ecology, Management
- Plasticity in Amphibian Reproduction, Development, and Evolution
- Africa—the Neglected Continent: Biodiversity and Biology of the African Herpetofauna
- Phylogeny and Systematics of the Viperidae
- Conservation Biology of Reptiles
- Neonatology of Reptiles: Character States Expressed Most Strongly within the First Year of Life
- Conservation of Europe's Threatened Herpetofauna (workshop).

I note considerable overlap with symposium topics for WCH7, and look forward to seeing how our science has advanced!

Contributed Papers

The contributed papers were organized into 32 topical sessions, representing the scope of herpetology—development, ecology, population biology, morphology, physiology, behavior, systematics, evolution, conservation, etc. of amphibians and reptiles broadly, and often for particular subsets of taxa. The caliber of the science presented was excellent! The opportunities for discussion by students and more senior folk from a great diversity of countries and areas of interest were facilitated by useful (and nutritious!) coffee breaks and lunches in the meeting arena (Fig. 2). Many publications resulted from the presentations at the Congress.

Meetings

In addition to the Societas Europaea Herpetologica business meeting, the Declining Amphibian Populations Task Force held its Executive Committee meeting and an extensive, open Business Meeting, and the Executive Committee and Business meetings of the World Congress of Herpetology held discussions of major issues.

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Fig. 1. The Prague Congress Centre is characterized by a dramatic two-story entryway, shown here filled with delegates outside of the sessions.



Fig. 2. Delegates enjoyed excellent buffet luncheons.



Fig. 3. Zbyněk Rocěk, Chair of the Local Organizing Committee, welcomes delegates to the concert in the Rudolfinum.



Fig. 4. The Rudolfinum was the site of a special concert for WCH delegates, here shown in a view from the balcony.



Fig. 6. A great benefit of international gatherings such as WCH is the opportunity to meet colleagues in person. Here, Marvalee Wake introduces Zbyněk Rocěk to George Rabb. Ilya Darevsky standing, left rear.

Social Activities

The splendid Social Programme included a welcome party with a plentiful buffet at the Prague Congress Centre on the first evening, a beer party and dinner in the well known Flek's Brewery (established in 1499), a steamboat cruise on the Charles River with music and dancing, an exquisite concert of old Czech music in the Rudolfinum (Figs. 3, 4), and it closed with a cocktail farewell party in the National Museum in Wenceslas Square. In addition, there was an extensive program of trips within and around Prague for accompanying persons, and several post-Congress tours were available.

Congress Publication

To commemorate the Third WCH, SSAR produced a facsimile reprint Leopold Fitzinger's *Neue Classification der Reptilien*, 1826 (Fig. 5), distributed free to all delegates.

Accomplishments of WCH3

WCH3 dealt with several substantive issues, both for perpetuating WCH and for the benefit of global herpetology. The report from the Secretary-General about all of the planning, discussions, contacts, and issues that arose during the three and one-half years between WCH2 and WCH3 and the Treasurer's report are available on the websites already mentioned. The SG established, with the advice of the Executive Committee, committees to deal with 1) review of the WCH Constitution, as mandated at WCH2 (chaired by Linda Trueb; the revision was approved by members at the Business Meeting); 2) a statement of ethics, also as mandated at WCH2 (chaired by Michael Tyler; also approved at the Business Meeting); 2) a Finance committee, charged with seeking a plan for short- and long-range financial stability for WCH and its work; 4) a committee to advise the International Commission on Zoological Nomenclature on herpetological matters (mandated at WCH1 and WCH2; chaired by Masafumi Matsui). Major areas of concern were the financial status of WCH (for example, more than 100 people requested travel support—more than 20 times the number that could be given any assistance) and the representation by WCH of herpetology in international and broadly scientific contexts—in other words, should WCH be content to present a Congress every 3–5 years, or should it be a proactive organization that promotes understanding of taxon-based biology, research on amphibians and reptiles, conservation of amphibians and reptiles, communication among herpetologists internationally, and species databases, etc., and other activities. The latter stance was encouraged by many (not all) participants; how to do it was not resolved. The International Herpetological Committee volunteered to maintain a WCH website that would facilitate communication; however, this was not followed up. It is difficult for all organizations, not just WCH, to maintain impetus and promise when delegates return to their normal responsibilities. Notwithstanding that problem, a number of individuals have stepped up over the years to provide leadership in communication and conservation, as well as basic research. Election of new and returning members of the WCH Executive Committee and the International Herpetological Committee helped to facilitate activity. Two substantive resolutions were produced at the WCH Business meeting; one dealt with commending the DAPTF for its activities and encouraging it to continue and extend its work, and endorsing its support by all organizations and individuals possible; its diversification, commitment, and success remain notable and important to herpetology to this day. The other resolution, presented by 20 signatories, was directed to the International Commission on Zoological Nomenclature regarding the problem of "phantom names," and requesting that the then-in-preparation revision of the Code should require a diagnosis, designation of a holotype, deposition of the holotype in a public scientific collection, and a description of the holotype. These resolutions were transmitted to the relevant international institutions.

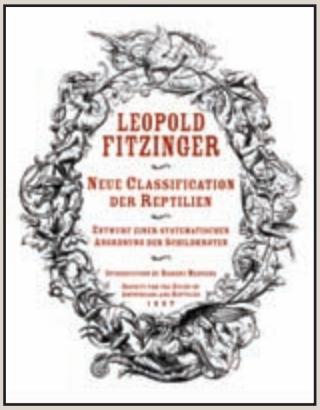


FIG. 5. SSAR reprinted Fitzinger's *Neue Classification der Reptilien* in honor of WCH3.

This dry and terse report on the scientific and social activities of more than 1000 herpetologists and colleagues in an exciting and stimulating venue in a spectacularly interesting city does not adequately capture the concerns and camaraderie about our science that were shared by the participants (Fig. 6). WCH3, in retrospect, illustrated the ongoing science and the communication about ideas that should characterize such international meetings. I expect that participation in WCH7 will have the same effect!

4th World Congress of Herpetology (Bentota, Sri Lanka, 2001)



MICHAEL J. TYLER*
(Secretary-General, 4WCH)

Planning for the 4WCH: Challenges from World Events

It is to be hoped that no future World Congress has to be organized under the difficult circumstances faced by the 4th WCH in Sri Lanka in 2001 (Figs. 1, 2). The choice of Sri Lanka was made following a detailed review of their facilities, but the Organising Committee progressively experienced numerous difficulties necessitating several complete changes of plan.

The most major of those changes occurred in September 2001 due to the horror of "9/11," which temporarily halted all international travel. Then, to compound those travel problems, the Tamil Tigers in the north of Sri Lanka travelled south to raid the international airport in Colombo and destroyed several aircraft lined up on the airstrip. Additionally, the Sri Lankan parliament had been dissolved.

Cancellation or Forge Ahead?

The consequence of those events was that many herpetologists who had planned to attend WCH4 withdrew their registrations. It was then proposed that the conference be cancelled. Although cancellation appeared attractive to the Organising Committee, it had been impossible to obtain any legal liability

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FIG. 1. Promotional piece developed for the 4th WCH.

PHOTO BY M. J. TYLER



FIG. 2. Snake charmers added to the local flavor of the meeting venue.

PHOTO BY M. J. TYLER



FIG. 6. Shown here are two examples of Sri Lankan frog art, in wood and bronze.



FIG. 5. A special set of stamps celebrating Sri Lankan frog diversity was released to commemorate the congress.



FIG. 3. Group photo of WCH4 delegates.

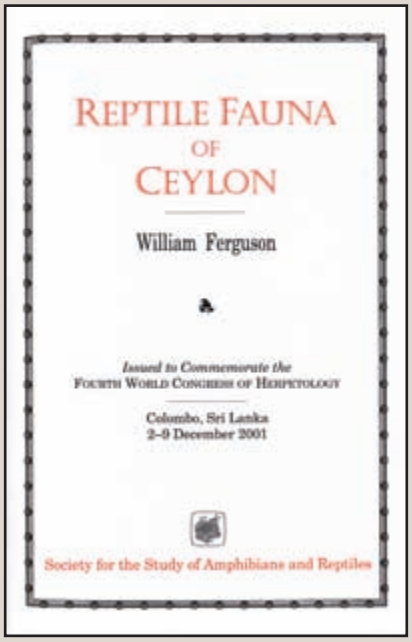


FIG. 4. SSAR produced a facsimile reprint of Ferguson (1877), distributed free to all delegates.



PHOTO BY M. J. TYLER

FIG. 7. This wooden plaque was presented to each of the WCH 4 delegates.

insurance. Thus cancellation would have exposed the Organising Committee, and possibly the Congress as an entity, to all expenses accrued to date. In those circumstances, despite the greatly reduced attendance, there was no alternative but for the Congress to proceed as planned. However, to ensure the utmost safety of all participants, the venue was changed from Peradeniya in central Sri Lanka, to Bentota on the southwestern coast. The nearby Colombo was avoided because of the risks associated with using the capital city.

The Venue and Attendees

The vast majority of delegates stayed in the five-star Taj Exotica Hotel Resort—a beautiful beachside area where baby turtles hatched. The total attendance was 208 delegates from 34 countries (Fig. 3). However, only six countries had representatives in double figures: UK 29, Sri Lanka 24, USA 21, Australia 20, Japan 16, and India 13. The number of presentations, including posters, is uncertain because the Abstracts volume had been prepared before many of the withdrawals were received. Nonetheless, the small attendance created a warm and relaxed atmosphere and the Conference Director, Anslem de Silva deserves particular praise for his efforts to ensure the smooth running of the program.

One topic rarely mentioned in conference reports is that of food. Sri Lanka is a major world center for the production of spices and especially curries. It is no exaggeration to describe the variety of dishes served at all meals as superb, unless you prefer cornflakes for breakfast!

Uncertainty about the possibility of another attack by the Tamil Tigers caused the imposition of a nighttime curfew by the Sri Lankan authorities, but some of the herpetologists present considered that as no more than a minor impediment to their nocturnal collecting activities! As a consequence they now have a more intimate understanding of the Sri Lankan Police!

Plenary Lectures

The tradition of excellent plenaries was continued at WCH4 by Anita Malhotra (evolution of Asian pitvipers), Yehudah Werner (foraging behavior in gekkonomorph lizards), Wolfgang Wüster (pitvipers and South American biogeography), David Warrell (current trends in toxinology), and Walter Hödl (visual communication in anurans). Details of special topic sessions were provided by Dodd and Bartholomew (2002). The reduction in the number of papers meant that there were no more than two concurrent sessions.

Congress Publications

Six publications were issued in association with WCH4. Among these were a facsimile reprint from SSAR of Ferguson's (1877) *Reptile Fauna of Ceylon* (Fig. 4) and a special issue of the journal *Lyriocephalus* featuring research on Sri Lankan amphibians (edited by Anslem de Silva).

Herp-themed Art and Collectibles

Of special note was the release of a commemorative set of four postage stamps featuring Sri Lankan frogs, issued to coincide with the congress (Fig. 5). A frog theme was prevalent in local art (Fig. 6), and delegates also received a special WCH4 plaque containing herpetological icons (Fig. 7).

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DODD, C. K. JR., AND B. BARTHOLOMEW. 2002. Fourth World Congress of Herpetology: 3–9 December 2001, Bentota, Sri Lanka. Herpetol. Rev. 33(1):3–5.

Fifth World Congress of Herpetology (Stellenbosch, South Africa, 2005)



ERNST BAARD*
(Congress Director, WCH 5)

WCH 5: A South African Setting

From 19 to 24 June 2005, the Western Cape Nature Conservation Board, trading as CapeNature (the provincial nature conservation agency), together with the University of Stellenbosch, hosted the Fifth World Congress of Herpetology at the Conservatorium of Music on the Stellenbosch University campus. Stellenbosch is the second oldest town in South Africa, next to Cape Town, the latter which was settled in 1652 by a Dutch governor and his people. Here the Europeans met up with the indigenous Khoi and San peoples who were important suppliers of fresh meat and other food to the settlers, as well as sea travellers around the Cape of Good Hope from Europe to the East Indies, as well as opening important trade routes to the South African interior. Stellenbosch is an historic town, established in 1680 by the then Dutch Governor at the Cape, Simon van der Stell, and to this day retains much of its Old Cape Dutch style and character with many historical buildings having been restored to their original style and declared as national monuments.

This international congress, the fifth one held since the inception of the WCH and held for the first time on the African continent (previously in the United Kingdom, Australia, Czech Republic, and Sri Lanka), brought together 407 academics and other scientists, conservationists, hobbyists, and students from 49 countries (all continents including North and South America, Europe, Africa, Asia, and Australasia) in total—all with an interest in amphibians and reptiles. For the vast majority of delegates, it was their first visit to Africa and many expressed their surprise at the fact that Stellenbosch was so developed, expecting perhaps an Africa filled with savannah, and streets roamed by lions and elephants! Instead, they were treated to typical South African and Western Cape friendliness, hospitality, good food, and even better wine. Some fine winter weather completed the ingredients required for a very successful meeting.

Local Committee

Ernst Baard (Chair), Andrew Turner, and Atherton de Villiers of CapeNature, together with le Fras Mouton and Alex Flemming of Stellenbosch University's Zoology Department formed the Local Organising Committee for the Congress; the committee who managed to get everything in place before the delegates arrived. Ms Eloise Costandius was appointed as the project manager, while Ms Sulet Gildenhuys and Ms Riki de Villiers helped with administration, and Ms Mandi Alblas assisted with arranging accommodation at the many Stellenbosch guest houses and one of the University's ladies' residences on campus to ensure an enjoyable stay for all the delegates.

The Science of WCH 5

The scientific program, very ably compiled by Aaron Bauer and Alex Flemming, comprised four and a half days of oral presentations with six parallel sessions each day. A total of 288 oral presentations and just over 150 posters were presented during the week of the conference. The scientific program comprised four plenary lectures by leading herpetologists (Simon Stuart and colleagues, Miguel Vences, Claude Miaud and Olivier Marquis, and Scott Keogh) and 11 symposia on the decline in international amphibian populations, African herpetological diversity, sex determination in reptiles, techniques for studying the ecology of freshwater turtles, biology of *Xenopus*, lizard visual ecology, South American anuran diversity, recent advances in the study of foraging modes, quantifying the ecology of burrowing herpetofauna, reptilian viviparity, and a symposium on

PHOTO BY ELOISE COSTANDIUS



FIG. 1. Delegates to WCH5 browsing herpetological reprints and original texts made available from various sources.

PHOTO BY ELOISE COSTANDIUS

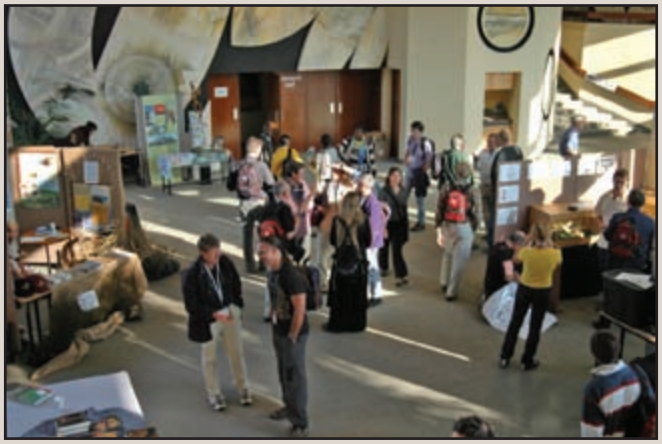


FIG. 2. Delegates to WCH5 gathering in the foyer of the Congress venue prior to sessions starting.

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caecilians in honor of Himstedt. Other sessions on chelonian biology, squamate ecology and behavior, morphology, captive breeding of frogs, road-kills in Europe, sexual selection in Kalahari geckos, reptile and frog diversity in remote mountains in Borneo, and training dogs to sniff out hard-to-find lizards in New Zealand formed part of the program as well.

Social Events

An opening function, hosted by the Stellenbosch University's Dean of the Faculty of Science, was held at the Conservatorium of Music on the Sunday evening prior to the start of the scientific program on Monday morning.

On Wednesday evening, delegates visited the Oude Libertas Art and Theatre Centre outside Stellenbosch for a traditional (and hopefully memorable) South African barbeque with African traditional music and dancing, loads of meat, side dishes, and good wine—some of it sponsored by the Jordan Winery (they produce a range of "Chamaeleon" white and red wines to "honour" Cape Dwarf Chamaeleons that frequent the area), and the Paddagang (= "Frog Alley") and Anura wine estates. Thursday evening was spent at the Moyo Restaurant of the famous Spier wine estate for the formal congress dinner. Everyone had a fantastic time enjoying the excellent food, good entertainment, and good wine! A number of successful post-Congress field trips were offered and a great time was had by all.

Congress Publication

In keeping with a tradition begun with the First WCH, SSAR produced a facsimile reprint of 10 herpetological papers by Andrew Smith on South African Herpetology, 1826–1838, distributed gratis to all delegates.

PHOTO BY ELOISE COSTANDIUS



PHOTO BY ELOISE COSTANDIUS

FIG. 3. Delegates enjoying the late afternoon wintery sun at the Congress venue. Marc Franch (Universidad de Barcelona, Spain), Reinier Mann (Univ. Aveiro, Portugal), Sara Rocha (CIBIO, Portugal), Vasco Batista (CIBIO), Antigoni Kaliontzopolou (CIBIO), and Miguel Angel Carretero (CIBIO).

All in all, the Fifth World Congress of Herpetology was a huge success, resulting in a major financial boost to the World Congress of Herpetology, and it is a pity that not more delegates could attend due to the great travel distance to South Africa for many. However, everybody enjoyed the South African hospitality and agreed that it would be wonderful to return.

The 6th World Congress of Herpetology (Manaus, Brazil, 2008)



PHOTO BY PETER NARINS

WALTER HÖDL
(Secretary-General, WCH 6)

Planning for the 6th WCH

After five WCH gatherings in Europe, Asia, Australia, and Africa it was generally understood that the 6th WCH would have to take place in the Americas. Originally there was an invitation to host the 6th WCH as a joint meeting with the American herpetological societies at Montreal, Canada, but this offer was withdrawn in early 2005. Due to his long-term connections to the Brazilian herpetological community and its rapidly increasing scientific activities, the then Secretary General-Elect negotiated with his Brazilian colleagues at the 5th WCH in Stellenbosch, South Africa in June 2005 to hold the next congress in Brazil. Richard ("Dick") Vogt, a highly renowned and charismatic specialist on neotropical turtles from the Instituto Nacional de Pesquisas da Amazõnia (INPA), offered to host the congress in Manaus in 2008. This proposal was approved unanimously by the Executive Committee of WCH. The international symposium committee with its thoughtful chair Carlos F. D. da Rocha, Universidade do Estado do Rio de Janeiro (UERJ), was responsible for selection of symposia and plenary lectures. The Secretary-General visited Manaus twice in 2007 and 2008 during the preparatory phase of the congress, which included an intensive correspondence of over 600 emails and (too) many phone calls between Austria and Brazil.

The congress was financed by funds provided by Conservation International, WCH, and the Brazilian Science Funds FAPEAM and CNPq, totaling about US $65,000. Unfortunately, funds approved by Manaus Tourism and IBAMA were never received.

Venue and Delegates

The Sixth World Congress of Herpetology took place at the Hotel Tropical in Manaus, Amazonas, Brazil, 17–22 August 2008 (Fig. 1). There were 565 delegates from 39 countries: Australia, Austria, Belgium, Brazil, Brunei, Canada, China, Colombia, Costa Rica, Cuba, Ecuador, Egypt, Estonia, France, Germany, Hungary, India, Iran, Israel, Japan, Lebanon, Luxemburg, Malaysia,

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PHOTO BY WALTER HÖDL





PHOTO BY EVA RINGLER



FIG. 1 (above left). The Hotel Tropical in Manaus, Amazonas, Brazil, was the venue for the Sixth World Congress of Herpetology.

FIG. 2 (above center). Peter Narins during his plenary lecture on ultrasonic communication in frogs.

FIG. 3 (above right). Walter Hödl (left) receiving his birthday present—a wood inlay art piece (representing *Allobates hodli*) created by the technique of intarsia—from Adolfo Amézquita and Albertina Lima.

Mexico, Netherlands, New Zealand, Peru, Poland, Russia, South Africa, Spain, Sweden, Switzerland, Thailand, United Kingdom, USA, United Arab Emirates, Uruguay, Uzbekistan, Venezuela. North America was represented by 117 (21%) registrants, South and Central America with 256 (45%), Europe with 98 (17%), Asia and Oceania with 83 (15%), and Africa 11 (2%). This cosmopolitan group of herpetologists included 270 professionals, 167 students, 18 accompanying persons, and 110 local committee and support staff.

Scientific Program

I continue by freely citing from the report of Vogt (2008): "The quality of the scientific presentations was outstanding. There were 293 oral presentations including the 15 distinguished plenary lectures, 15 symposia, and contributed oral paper sessions. The poster presentations were held at the end of each day in the book and equipment exhibition room complete with bar service, providing the exchange between authors and audience in a more relaxed atmosphere. Each day a different group of 50 posters was presented following various themes, most notably genetics, conservation, and ecology. The abstracts were available online prior to the meeting on the 6th WCH web site and also distributed on CD during the meeting. The meeting got underway early at 1230 h on Sunday August 17, with the Conservation International sponsored Amphibian Conservation Workshop. The event got a send off pitch from Claude Gascon and Jim Collins, followed by 13 reports from around the world. This well attended event was followed by the first two Plenary Lectures, Bill Magnusson speaking of the evolution of herpetological studies in the Brazilian Amazon and Russ Mittermeier delineating priorities for global reptile and amphibian conservation. Throughout the week each morning and afternoon session was initiated by a Plenary Presentation followed by six papers in five different lecture rooms simultaneously. One of the most exciting plenary lectures was that of Peter Narins, who enlightened us about the ultrasonic vocalizations made by some species of Bornean frogs, whose mating calls are given amidst the din of waterfalls. This opened up an entirely new dimension in anuran communication studies" (Fig. 2).


THE LIFE AND HERPETOLOGICAL CONTRIBUTIONS OF
AUGUST FRIEDRICH
SCHWEIGGER
(1783-1821)

With an Introduction by
ROGER BOUR

Society for the Study of Amphibians and Reptiles
Issued in commemoration of the Sixth World Congress of Herpetology, Manaus, Brazil, 17–22 August, 2008

FIG. 4. Delegates to WCH6 in Manaus received a free copy of Schweigger (1812–1814), courtesy of SSAR.

Social Events

The congress director R. Vogt organized all local activities and performed those duties in his legendary manner. Ably assisted by many dedicated students from INPA and the Universidade Federal do Amazonas (UFAM), he ran "his" congress at the fancy Hotel Tropical. Picnics and banquets as well as the auction were highly memorable events driven by Dick's characteristic style. Finally, in order to celebrate his 60th birthday with his collaborators, colleagues, and friends, the Secretary-General—at his cost—invited a group of over 150 herpetologists to enjoy Amazonian dishes and fish specialities at the Manaus Bier House, all organized by R. Vogt (Fig. 3).

Congress Publication

A facsimile reprint of Schweigger's *Prodromus Monographiae Cheloniorum*, 1812–1814, was produced by SSAR and distributed free to all delegates (Fig. 4).

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INTERNATIONAL AND REGIONAL ORGANIZATIONS

Herpetological Review, 2012, 43(2), 199–200.
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Herpetological Societies in Canada

The first Canadian herpetological organization was the Canadian Amphibian and Reptile Conservation Society (CARCS), formed in 1960. CARCS membership consisted of a mix of professionals in the field, amateur naturalists, and herpetoculturists, and the society published a bulletin twice a year. CARCS was centered in southern Ontario and never really spread much beyond that base. CARCS distributed its last bulletin in 1991 and then quietly disappeared.

During the CARCS era, few Canadian scientists called themselves herpetologists, but that began to change in the 1980s as, by then, interest in the biology of amphibians and reptiles and in their conservation had risen dramatically. A corps of professional academic herpetologists in Canada had begun to form and by the mid-1980s, there was significant interest in forming a more scientifically oriented herpetological society in Canada. The golden opportunity presented itself when the 66th annual meeting of the American Society of Ichthyologists and Herpetologists (ASIH) was held at the University of Victoria in British Columbia in 1986. During that conference, several Canadian herpetologists (including the two of us) met to discuss the possibility of forming a national herpetological society whose aim would be to disseminate news and information of particular relevance to Canadian herpetologists. Those in attendance were mostly academics, with interests in amphibians and reptiles ranging from morphology and systematics to ecology and behavior. From that meeting arose the fledgling Canadian Association of Herpetologists (CAH) / *Association Canadienne des Herpétologistes* (*ACH*). The first President of CAH was David Green.

Undoubtedly, the most important society officer for CAH has always been the Editor of the CAH/ACH *Bulletin*, which has been the society's publication vehicle from the outset. David Green initially did extra duty by also serving as the first Editor and guided the *Bulletin* through its first seven volumes, beginning in 1987. Tony Russell and Herb Rosenberg then took the reins for the next four volumes, after which they were succeeded by Shane de Solla. Altogether, this first incarnation of the CAH/ACH *Bulletin* was produced for 13 years, until 1999, when a replacement for Shane could not be found. CAH produced two issues of the *Bulletin* per year, although the final volume ended with just a single issue. For the next few years, CAH lay dormant but, in 2006, the CAH/ACH *Bulletin* was revived with Jackie Litzgus as new Editor.

Although the *Bulletin* has always been the centerpiece of the CAH, the society has also involved itself in other herpetological activities. In 1989, CAH coordinated and presented a symposium on "The Biology of Amphibians and Reptiles in Seasonally Cold Environments" at the ASIH meeting in San Francisco. The society also provides two travel grants of $300 each year for students to attend conferences and present their work. Finally, CAH recognizes lifetime accomplishments in Canadian herpetology with its Michael Rankin Distinguished Canadian Herpetologist Award. To date, there have been four recipients of this award—James P. Bogart, Francis R. Cook, Ronald J. Brooks, and David M. Green.

At heart, CAH has always been a fairly laid-back organization. For many years, the society had no formal meetings, but members attending conferences such as JMIH typically got together for a business meeting cleverly disguised as a dinner. The first item on the agenda, announced by the President, was invariably to order food and beer. Accompanying dessert would be brief reports from the Treasurer and other officers. CAH still has Canadian herpetologist dinners at meetings such as JMIH and WCH where members can get together, but in recent years, CAH also has started meeting more formally, co-hosting annual meetings with its sister organization, CARCNET.

The Canadian Amphibian and Reptile Conservation Network (CARCNET) / *Réseau Canadien de Conservation des Amphibiens et des Reptiles* (*RÉCCAR*) owes its origins to a 1991 meeting organized in Burlington, Ontario, by Bob Johnson and Christine Bishop to discuss the new recently recognized crisis of declining amphibian populations. Those participating agreed to form a Canadian working group of the global Declining Amphibian Populations Task Force (DAPTF), and David Green became its first National Co-ordinator. In subsequent years, DAPCAN, as the working group became known, met annually to discuss amphibian conservation and ecology, and to work on producing a report to the DAPTF. DAPCAN was a very goal-oriented organization and published news of its progress in the CAH *Bulletin*. In 1994, David Green stepped down as National Co-ordinator of DAPCAN to concentrate on preparing the group's report, which was published in book form (Green 1997).

In 1995, with its primary task of reporting to DAPTF on the conservation and status of amphibian populations in Canada apparently well in hand, the members of DAPCAN considered where to go next. The group decided to expand its interests to include reptiles as well as amphibians and to change its focus towards actively working for the conservation of Canada's herpetofauna. By 1996, DAPCAN had metamorphosed into the Working Group on Amphibian and Reptile Conservation in Canada, with Stan Orchard as its Chair and editor of a new newsletter, *The Boreal Dipnet*. The following year, the Working Group renamed itself the Canadian Amphibian and Reptile Conservation Network and set to work on another book, this time on reptiles (Seburn and Bishop 2007). The editorship of *The Boreal Dipnet* eventually passed to Kerrie Serben and then to Sara Ashpole.

CARCNET continued to hold annual meetings, as DAPCAN did, alternating their location among the east, west, and center of the country. CARCNET's meetings became Canada's most important gatherings for herpetologists from coast to coast, almost always culminating in a field trip to visit some of the local creatures, including the herpetofauna. The group instituted a

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number of awards. Annually, CARCNET gives out student travel and presentation awards and the Silver Salamander, given to an individual or an organization in recognition of a specific contribution to the conservation of amphibians and reptiles in Canada. CARCNET's premier award is the Blue Racer, which is given in recognition of long-standing contributions to the research and conservation of amphibians and reptiles in Canada. Honored recipients of the Blue Racer Award have been Francis Cook, Bill Preston, Bob Johnson, Ronald J. Brooks, Patrick T. Gregory, David M. Green, John Gilhen, and Wayne Weller.

Although CAH and CARCNET came together in 1997 for a joint meeting in Wolfville, Nova Scotia, until recently the two organizations have led fairly separate lives. Lately, however, CAH and CARCNET have begun collaborating more intently. CAH still has Canadian herpetologist dinners at meetings such as JMIH and WCH, but in recent years, CAH and CARCNET have also started routinely co-hosting the annual meetings. This year, CAH and CARCNET are co-sponsoring a symposium at the WCH7 in Vancouver entitled: "The Canadian Herpetofauna: What are the Threats?"

In addition, the two societies recently merged their two bulletins, the CAH/ACH *Bulletin* and *The Boreal Dipnet*, into a single twice-yearly publication jointly edited by Jackie Litzgus and Sara Ashpole. *The Canadian Herpetologist* (*L'Herpétologiste Canadien*) continues many of the regular offerings of both its parent publications, including summaries of herpetological meetings such as JMIH, feature articles on an eclectic variety of herpetological subjects, abstracts of Canadian theses and dissertations on amphibians and reptiles, book reviews, alerts to new papers by Canadian herpetologists, and news items. *The Canadian Herpetologist* Vol. 1, No. 1 appeared in spring 2011 and featured a 30-year career retrospective by Fred Schueler, field notes on herpetological work in England by Steve Hecnar, and assorted other articles, abstracts, and news items.

The time when Canada's herpetologists could not even fill a telephone booth is well and truly in the past. We now have a vibrant and active herpetological community in Canada, and CAH and CARCNET together represent our collective faces to the world. Both societies would be delighted to have more members from both Canada and other countries. To learn more, e-mail Jackie Litzgus (jlitzgus@laurentian.ca) for CAH membership details and visit http://www.carcnet.ca/ for information about CARCNET.

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Presidents of CAH (1987–present)
David M. Green (1987–1989)
Mike Rankin (1990–1991)
Lawrence E. Licht (1992–1993)
Bob St. Clair (1994–1995)
Ron J. Brooks (1996–2000)
Patrick T. Gregory (2001–present)

National Co-ordinators of DAPCAN (1991-1995) and Chairs of CARCNET (1995–present)
David M. Green (1991–1994)
Stan Orchard (1995–1999)
Christine Bishop (2000–2003)
David Galbraith (2004–2006)
Bruce Pauli (2006–2009)
Pam Rutherford (2010)
David M. Green (2011–present)

INSTITUTIONAL PROFILES

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Herpetology at the Redpath Museum, McGill University, Montreal, Canada

Herpetology at McGill University is centered at the Redpath Museum, which is located in the heart of McGill's downtown Montreal campus. The Redpath is one of the most prominent buildings of the university and enjoys the distinction of being the first building in Canada purposefully designed and constructed to be a museum (Fig. 1). It was commissioned in 1880 by local philanthropist, Peter Redpath, designed by local Montreal architects and opened to great acclaim in 1882. The "Peter Redpath Museum" was built expressly to serve Sir William Dawson, who was McGill's Principal at the time and an internationally respected natural scientist. It was intended to be his laboratory, teaching facility and, above all, repository for his extensive natural history and paleontology collections. Dawson made fundamental contributions to herpetology through his paleontological work, including the discovery of the earliest basal reptile, *Hylonomus*. He presided at the Redpath Museum's opening as its first Director and this year marks its 130th anniversary.

Research at the Redpath Museum today carries on from the scientific tradition established by Dawson. The current Director is Professor **David M. Green**, who studies the evolution, ecology,

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and conservation biology of modern amphibians. Green's current research centers largely on species' ranges and boundaries as an approach to understanding biodiversity origins and maintenance. Compared to the attention given to the factors that influence population size and persistence, little has been paid to what determines the extent of a species' range. Population declines leading to species endangerment are essentially species range contractions. Conversely, species invasions can be modelled as rapid range expansions. In this context, because amphibians exhibit a range of life history strategies, often breed in discrete sites such as ponds, are not highly mobile and often can be easily sampled, they are excellent subjects for landscape ecology and studies in conservation. Green maintains a long-term study of Fowler's Toads (*Anaxyrus fowleri*) at Long Point, Ontario, which has run continuously for over two decades (Fig. 2). Stemming from this work, numerous papers on population regulation, body size variation, habitat use, age structure, winter survival, movement, and dispersal are in progress.

Associate Professor **Hans C. E. Larsson,** who holds a Canada Research Chair in vertebrate palaeontology, studies macroevolution, largely among archosaurian reptiles of the Mesozoic. Larsson's research has two main thrusts. One focuses on paleomacroecology and estimating large-geographic scales of paleobiodiversity across large time scales. Much of this work collects fossils, some of which are amphibians and reptiles, in the Canadian High Arctic (Fig. 3), western Canada, and South America to assess how the ancient latitudinal diversity gradient evolved over the changing climates during the Mesozoic Era. Larsson's lab also examines large-scale patterns of phenotypic skeletal evolution in crocodiles (Fig. 4), dinosaurs, birds, and some amphibians to quantify evolutionary rates and types of skeletal changes, particularly across the fish-to-amphibian and dinosaur-to-bird transitions. From characterizing the evolutionary transformation, Larsson goes on to investigate the implicated developmental changes using embryological and molecular data (Fig. 5). The breadth of Larsson's research is not an accident. His approach is to synthesize new understanding from seemingly disparate research on large-scale themes, which he sees as the best training ground for intellectual growth and new understanding.

Emeritus Professor **Robert L. Carroll** remains active in vertebrate palaeontology though he is no longer accepting graduate students. Carroll is a leading authority on the origin, early evolution, anatomy, and natural history of Paleozoic tetrapods. His latest book, "The Rise of Amphibians," synthesizes findings from the rich fossil record of amphibians to trace their evolution back to their origins some 365 million years ago.

Green and Larsson both maintain links with many other departments, schools, and programs within McGill University. They teach undergraduate courses for both the Redpath Museum (REDM) and the Biology Department (BIOL). These include the lecture courses BIOL 305 *Animal Diversity* (Green and Larsson), BIOL 352 *Vertebrate Evolution* (Larsson), BIOL 427 *Herpetology* (Green), BIOL 465 *Conservation Biology* (Green), and REDM 400 *Science and Museums* (Green and Larsson). Field courses include BIOL 452 *Ecology and Development in Africa* (Green), BIOL 573 *Vertebrate Paleontology Field Course* (Larsson), and REDM 405 *East African Natural History* (Green). Aside from the Department of Biology, Green and Larsson are also affiliated with McGill's Department of Natural Resource Sciences and Department of Earth and Planetary Sciences, as well the McGill School of Environment.

Several research labs are housed within the Redpath Museum building, with facilities for specimen examination, microscopy, computer work, and fossil preparation. A 130-year old museum building does pose some problems for outfitting labs up to modern standards so the Museum's molecular ecology and evolution lab is set up in McGill's Stewart Biology Building. Field work opportunities for students studying in the Museum include McGill's many field stations. The Gault Reserve on Mont St.-Hilaire is located 30 minutes east of Montreal and preserves the only remaining old growth forest in the St. Lawrence Valley. Other field stations are located on Barbados in the Caribbean, Shefferville in the boreal forest of east-central Quebec, and Axel Heiberg Island in Canada's High Arctic. In addition, Green and Larsson maintain their own field research sites on Lake Erie in southern Ontario (Green) and southern Saskatchewan (Larsson). Green also participates regularly in McGill's African Field Study Semester in Kenya and Tanzania.

Three Ph.D. students, three M.Sc. students, and two postdocs are currently working in the Green lab, largely focusing on aspects of amphibian ecology and evolution. Katharine Yagi (Ph.D.) has begun to investigate the concepts of niche breadth and habitat partitioning using Fowler's Toads, *Anaxyrus fowleri*, and American Toads, *A. americanus*, in and around areas where their ranges overlap in southern Ontario and New England. Elizabeth McCurry (Ph.D.) is investigating the traits and ecological circumstances leading to declines and extinction with a series of field experiments and computer simulations. David O'Connor (Ph.D.) is looking into the ecology and phylogeography of American Toads in previously glaciated eastern North America. Among the M.Sc. students, Jay Ploss is using landscape models to map habitat for Spring Salamanders, *Gyrinophilus porphyriticus*, in Quebec, Jessica Middleton is studying somatic



PHOTO BY GORDON CAMPEY

FIG. 1. McGill University's 130-year-old Redpath Museum building is located in downtown Montreal.

PHOTO BY DAVID M. GREEN



PHOTO BY HANS LARSSON



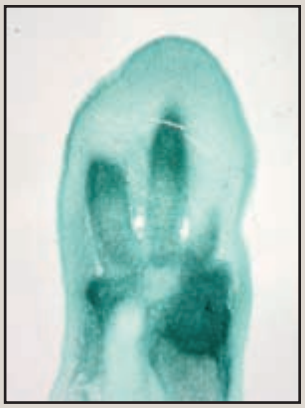


PHOTO BY HANS LARSSON

FIG. 2 (above left). Fowler's Toad (*Anaxyrus fowleri*), here represented by an individual sporting a radio-transmitter, has been the focal species for many studies in David Green's lab, including movement ecology.

FIG. 3 (above center). Much of Hans Larsson's work involves fossil collection in the Canadian High Arctic, as seen here at a site on Ellesmere Island, Northwest Territories.

FIG. 5 (above right). *Alligator* embryonic hand stained for early skeletal condensations, prepared for a paper supporting the idea that bird finger identities have evolved via a homeotic transformation shifting their identities backward.

PHOTOS BY ANTHONY HOWELL, MONTAGE BY DAVID M. GREEN



FIG. 6. A modest but growing collection of amphibians and reptiles comprise the Redpath Museum's herpetology holdings.

PHOTO BY FELIPE MONTEFELTRO AND HANS LARSSON



FIG. 4. *Pissarrachampsa sera*, exemplar of a newly described clade (Baurusuchia) of crocodylians from Brazil.



PHOTO BY DAVID M. GREEN

FIG. 7. The Dawson Gallery is a popular attraction for visitors to the Redpath Museum.

growth rate and population age structure in relation to density in Fowler's Toads, and Daniel Greenberg is beginning work on landscape resistance and connectivity of Spotted Salamander, *Ambystoma maculatum*, and Eastern Newt, *Notophthalmus viridescens*, populations in fragmented landscapes. Postdocs Trond Sigurdsen and Philippe Girard are, respectively, working on the early evolution and functional mechanics of frogs and individual-based modelling of salamander movements in relation to hydrogeography at Covey Hill, in southern Quebec. Also in the Green lab are recently graduated MSc students, Morgan Boenke, who is writing up papers from his thesis on terrestrial habitat use, home range, and movements by Fowler's Toads, and Alan Schoen, who is developing an image-based software system for recognizing individual animals, particularly toads, based on position, size, and shape of dorsal markings. Finally, B.Sc. student, Mohamad Rabbani, is investigating geographic variation in color pattern in Fowler's Toads to look for evidence of local adaptation and selection.

In the Larsson lab, Alex Dececchi (Ph.D.) studies dinosaurs and the ancestry of birds, more specifically the morphological changes in the forelimb and pectoral girdle of theropod dinosaurs as they began to take to the air. Alterations in bone morphology suggest changes in forelimb moblity, muscle attachment or utility involved with the origin of a novel locomotory mode—flight. Rui Tahara (Ph.D.) is looking at archosaurian cranial sinuses, which are important features shared among crocodylians, bird-like dinosaurs, and birds. This work uses non-destructive CT scanning of fossils and extant bird embryos in order to construct developmental evolutionary scenarios of these structures. Luke Harrison (Ph.D.) is examining the skeletal phenotypic changes associated with the fish-to-amphibian transition and compiling a large set of coding and non-coding gene sequences to test for evolutionary rates of candidate genes likely to have been involved. Ben Wilhelm (Ph.D.) is also examining the fish-to-amphibian transition by focusing on the muscles in the pectoral girdle and (fin or limb). This work incorporates gross dissections and micro-CT scanning of extant fishes and amphibians as a means to generate developmental evolutionary models explaining the origin of the complex tetrapod limb musculature.

With recent additions from the research of an increased number of professors and their students, the Museum has close to three million objects and specimens in its collections including, rather surprisingly, the second largest collection of Egyptian antiquities in Canada. Herpetologically, the Redpath Museum holds a modest collection of some 4,000 alcohol preserved specimens, largely from Quebec and eastern Canada, as well as skeletal material, tissues, and DNA (Fig. 6). It also contains some surprises and has considerable material from Peru, the West Indies, Congo, and New Zealand. Until fairly recently, though, the Redpath Museum had no herpetological collection to speak of and did not even acquire a reasonable teaching collection until Green's arrival in 1986. Initially in his career at the Redpath, Green sent his specimens to the Canadian Museum of Nature because the Redpath had no adequate storage for preserved specimens until the mid-1990s. In contrast, the Redpath Museum has an extensive and historic collection of fossil amphibians and reptiles. These are mainly from the Paleozoic, including the extensive collections made by Sir William Dawson and Bob Carroll. Lately, the Museum is acquiring more Cretaceous reptiles, including crocodylians and dinosaurs, via Larsson's work. Housing the Museum's growing collections, as well its growing number of personnel has become a considerable problem for the old building. This year, though, a new 2,000 square foot collections facility is being built for the Museum, marking the first time the Redpath has acquired new permanent storage space.

For well over half a century after it was opened, the Redpath Museum and its contents were reserved primarily for the professors and students of McGill College and University, and only secondarily for the education of public school students and the public. In 1952, the Museum changed course. It radically broadened its focus and for the next 20 years served, effectively, as a public natural history museum for Montreal elementary and high school students. In 1971, however, under extreme financial pressure, McGill chose to dramatically reduce public access and the Museum once again focussed entirely on its scientific research and university teaching roles. But the financial crisis passed and by 1985, the doors of the Redpath Museum once again were opened to the general public (Fig. 7).

Over the past 25 years, the Redpath has finally been able to strike a balance between its many roles as a university museum, research institute, academic unit, promoter of public education, and tourist attraction. In 1995, the Redpath was at last brought into the Faculty of Science and though it has rebuilt an extensive public program, it has not lost sight of its primary responsibilities as a university institution. The Redpath Museum now has more faculty members, more students, more courses, more programs, more outreach, more activities, more specimens, more research, and more prominence than ever before in its 130-year history.

ZOO VIEW

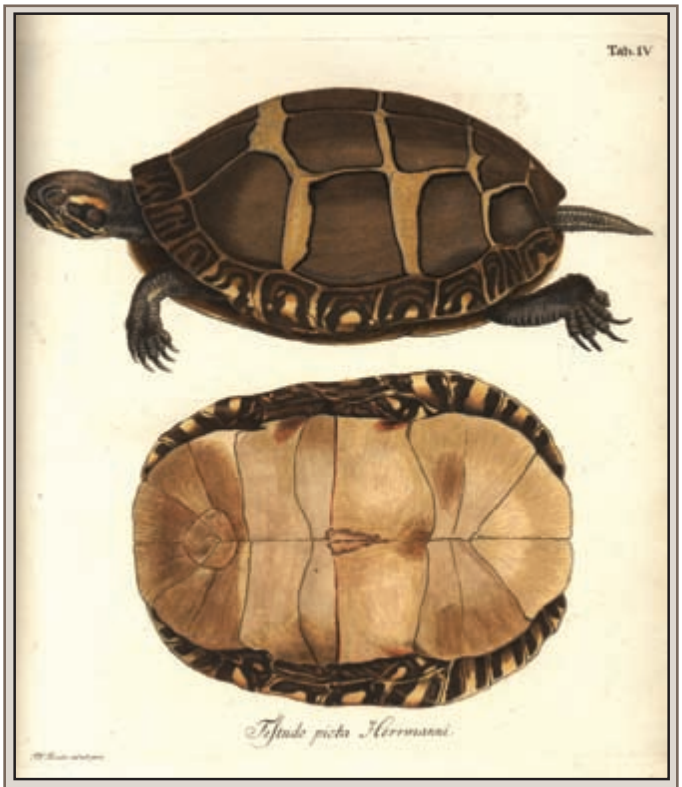
THE FIRST OF THE INNOVATIONS MADE BY THE STEM REPTILES WAS IN A WAY THE MOST EXTRAORDINARY AND AMBITIOUS OF ALL—THE MOST DRASTIC DEPARTURE FROM THE BASIC REPTILE PLAN EVER ATTEMPTED BEFORE OR SINCE. BY A CRYPTIC SERIES OF CHANGES, FEW OF WHICH ARE ILLUSTRATED IN THE FOSSIL RECORD, THERE EVOLVED A CURIOUS AND IMPROBABLE CREATURE WHICH, THOUGH IT RETAINED THE OLD COTYLOSAUR SKULL (WITH NO OPENING IN THE TEMPORAL REGION), HAD A HORNY, TOOTHLESS BEAK AND A BENT AND TWISTED BODY ENCASED IN A BONY BOX THE LIKE OF WHICH HAD NEVER BEEN SEEN. AND MORE THAN THIS, WITHIN THE BOX THE GIRDLES CONNECTING THE LEGS WITH THE REST OF THE SKELETON HAD BY SOME LEGERDEMAIN BEEN UPROOTED AND HAULED DOWN TO AN AWKWARD POSITION UNDERNEATH THE RIBS.

THE NEW ANIMAL WAS A TURTLE. HAVING ONCE PERFORMED THE SPECTACULAR FEAT OF GETTING ITS GIRDLES INSIDE ITS RIBS, IT LAPSED INTO A STATE OF COMPLACENT CONSERVATISM THAT HAS BEEN THE CHIEF MARK OF THE BREED EVER SINCE.

—ARCHIE CARR, *HANDBOOK OF TURTLES* , 1952

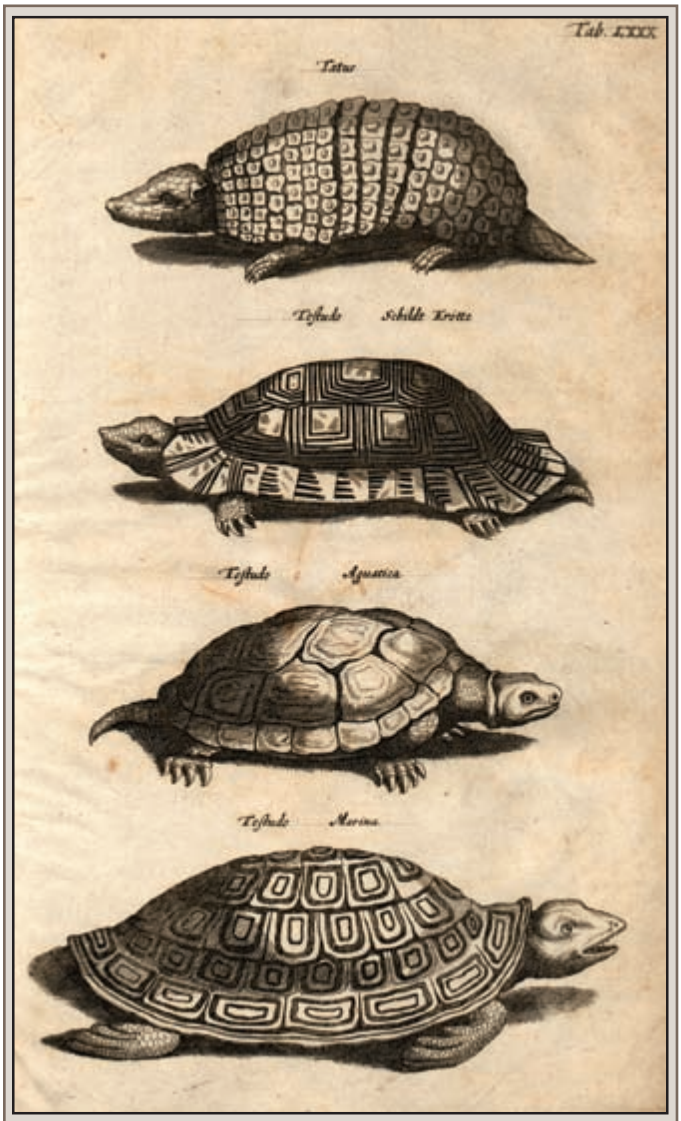
For zoos maintaining aquatic turtles, particularly those with outdoor exhibits in temperate climates, the book entitled *Life in A Shell. A Physiologist's View of a Turtle* by Donald C. Jackson (2011, Harvard University Press, Cambridge, Massachusetts; London, ISBN 978-0-674-05034-1) is a comprehensive treatment of the challenges confronted by turtles as they make their daily livings. The book is divided into eight chapters: "The turtle's shell," "Buoyancy," "The breathing turtle," "Tortuguero," "Overwintering without breathing," "Living without oxygen," "The heart of the turtle," and "Life in the slow lane."

With the advent of cell phones, visitors spend much more time taking pictures in a reptile building. Since aquatic turtles breathe infrequently, the public waits patiently to see turtles



COURTESY OF ERNST MAYR LIBRARY, MUSEUM OF COMPARATIVE ZOOLOGY, AT HARVARD UNIVERSITY.

Donald C. Jackson mainly discusses the physiology of three chelonians: Red-Eared Slider (*Trachemys scripta elegans*), Painted Turtle (*Chrysemys picta*), and Green Sea Turtle (*Chelonia mydas*). Shown here is the Painted Turtle from Ioannis Davidis Schoepff's *Historia testudinum iconibus illustrata* published in 1792[-1801]. This species is remarkably tolerant to low oxygen levels during hibernation.
IMPRINT: Erlangae [Erlangen] : Sumtibus Ioannis Iacobi Palm. [German edition *Naturgeschichte der Schildkröten* (Erlangen : J.J. Palm, 1792[-1801]).



COURTESY OF ERNST MAYR LIBRARY, MUSEUM OF COMPARATIVE ZOOLOGY, AT HARVARD UNIVERSITY.

Because an armadillo has a leathery armor shell, it was grouped with chelonians in this early plate! On the plate, it was called "Tatus" or Brazilian Hedge Hog by Jonstonus. He described the animal "as big as a Malta dog" so the drawing is the endangered Giant Armadillo (*Priodontes maximus*), also colloquially known as Tatou.
IMPRINT**:** Jonstonus, Joannes. 1657–1665. *Historiae naturalis . . . Cum aeneis figuris. / Joannes Jonstonus . . . concinnavit.* Amstelodami, apud I.I. Fil. Schipper.

surface to gulp air for that special picture and are bewildered when it takes so long. This book could be used as an excellent primer to develop graphics to explain the unique physiology of the turtle and its relationship to air.

Natura Artis Magistra's Animal Print Gallery

One of the world's oldest reptile buildings began its operation at this zoo in 1852. The reptile collection was worldwide in scope and had a sizeable number of giant reptiles in 1864, including giant constrictors, turtles, and crocodilians. Illustrators like Gerrit Schouten (Surinam, 1779–1839) made detailed drawings of all kinds of creatures, including the Four-toed Tegu (*Teius teyou*). Natura Artis Magistra, Amsterdam's Zoo, has just published its collection of prints of animals online.



COURTESY OF ERNST MAYR LIBRARY, MUSEUM OF COMPARATIVE ZOOLOGY, HARVARD UNIVERSITY.

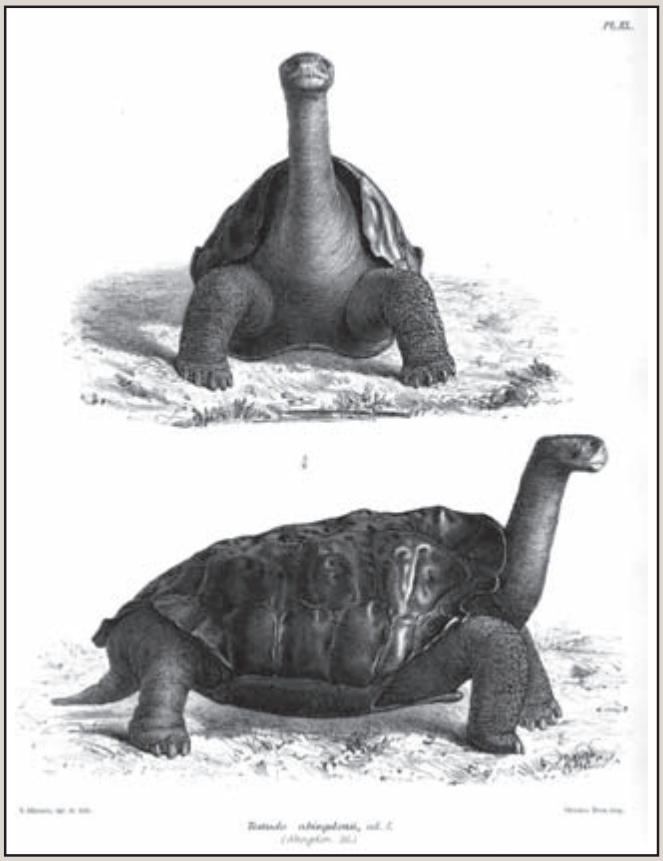
Natura Artis Magistra, Amsterdam's Zoo, has just published its collection of prints of animals online such as this illustration of Common Chameleon (*Chamaeleo vulgaris*, now *C. chamaeleon*). This colored plate is in Albert E. Brehm's *Illustrirtes Thierleben für Volk und Schule. Brehm's Illustrirtes Thierleben für Volk und Schule; bearb. von Friedrich Schödler. Mit, Abbildungen nach der Natur, ausgeführt unter leitung von R. Kretschmer. Neue Stereotypausg. Bibliographisches institut, Leipzig* (*Illustrated Animal Life for the People and the Schools; edited by Friedrich Schödler. With Illustrations from Nature, Made under the Direction of R. Kretschmer. New Stereotypical Edition, Bibliographic Institute, Leipzig.*).

Artis developed its own scientific picture library in 1881: the Iconographia Zoologica. This library contains thousands of prints, many of amphibians and reptiles, mostly from the 18th and 19th century. Over 20,000 of them are available for viewing on the Zoo's site.
http://www.rnw.nl/english/article/artis-zoo-puts-animal-print-gallery-online

Lonesome George

On 1 December 1971, American snail biologist Joseph Vagvolgyi and his wife Maria were on Pinta when they came face to face with a giant tortoise. "The tortoise was walking slowly when we first encountered him, but withdrew into his shell with a loud hiss as we moved closer to take his picture", Vagvolgyi recalled. "He soon relaxed, and resumed his walk." Vagvolgyi took a photograph and returned to the undergrowth and his search for snails. Neither he nor his wife realized the immense significance of their encounter. To most other visitors, the sight of a tortoise on Pinta would have been incredible. As far as everyone knew (except, it seems, the Vagvolgyis), there were no tortoises left on the island. Two centuries of exploitation at the hands of buccaneers and whalers had taken their toll; the last tortoise seen on Pinta was collected by scientists in 1906.

—Henry Nicholls , *Lonesome George*, 2010



COURTESY OF ERNST MAYR LIBRARY, MUSEUM OF COMPARATIVE ZOOLOGY, AT HARVARD UNIVERSITY.

Two view of Pinta Tortoise (*Geochelone nigra abingdonii*) from *The gigantic land-tortoises (living and extinct) in the collection of the British Museum*, by Albert C. L. G. Günther.
Imprint: London: British Museum (Natural History). Dept. of Zoology. Printed by order of the Trustees, 1877.

There are over 1000 Galápagos tortoises in zoo collections throughout the world but Lonesome George, likely the last remaining tortoise from Pinta Island (= Abingdon Island), is rarely used in presentations on endangered species. This perfect symbol could be effectively featured to stress the precarious future of all giant tortoises from these islands. Zoo graphics designers should craft their conservation messages by covering the history of human exploitation of Galápagos tortoises. In 1925, Charles Haskins Townsend, Director of the New York Aquarium, estimated that over 13,000 were removed from the islands. It has been a long time coming but conservationists are now trying to turn the tide—the elimination of feral animals from many islands, and the collection of wild tortoises for captive management programs featuring breeding, head-starting, and reintroduction.

To create this signage, read *Lonesome George: The Life and Loves of a Conservation Icon* by Henry Nicholls (2006, reprinted 2010; London; New York: Macmillan).

Free Download

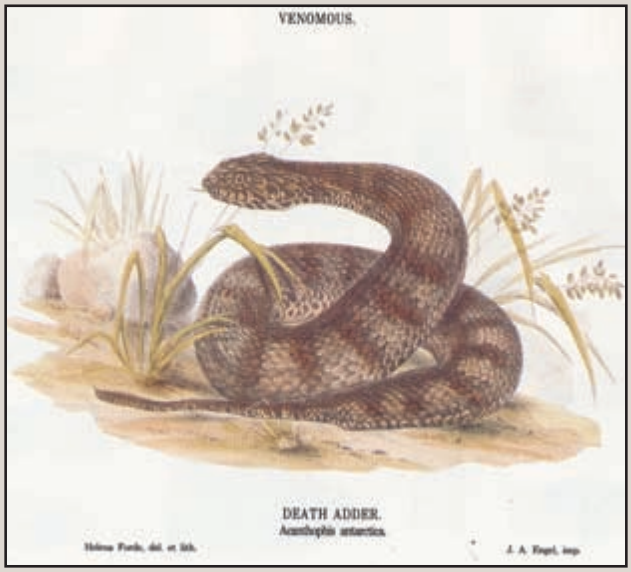
Tandora Grant from the Applied Animal Ecology Division of the San Diego Zoo Institute for Conservation Research has alerted the zoo community to a free download of an interesting book: *Conservation Biology for All*, by Navjot S. Sodhi and Paul R. Ehrlich (eds). Book in PDF from Oxford Press.

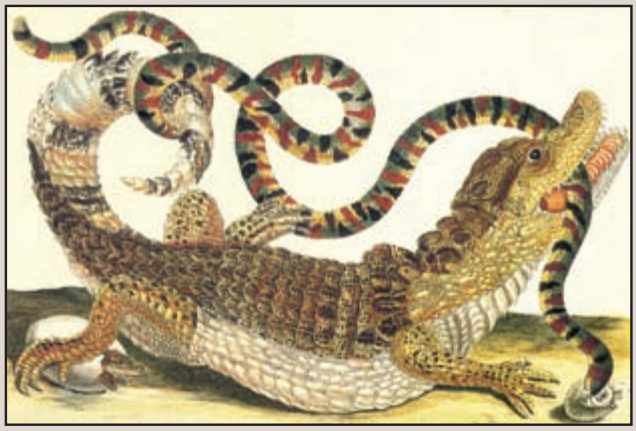
http://www.mongabay.com/conservation-biology-for-all.html

Snakes and Their Ways

> …surely the splendid colors and intricate patterns, beauty of line and motion, with which nature has endowed the snakes so generously, are sufficient to attract anyone who has a love of beauty and a reverence for life.
>
> And as one grows to know them better, snakes become more and more wonderful and satisfying —not only to the aesthetic sense, but to the intellectual as well.
>
> —Carl F. Kauffeld, *Snakes. The Keeper and the Kept*, 1969

During the past decade or two there are so many excellent books covering snakes that have appeared on the market. Editors Robert D. Aldridge and David M. Sever have added yet another one, *Reproductive Biology and Phylogeny of Snakes* (2011, CRC Press, Boca Raton, Florida. 759 pp.). Eighteen chapters cover many aspects of snake biology and thus are relevant to zoo herpetology: evolution and taxonomy (morphological and molecular), and an extensive review of development, placentation, spermatogenesis, male and female reproductive anatomy, hormonal control of reproduction, reproductive cycles, sex pheromones, and parental care. The Reproductive Biology and







Editors Robert D. Aldridge and David M. Sever have published a comprehensive book on snakes which includes these taxa: Common Death Adder (*Acanthophis antarcticus*) from *The Snakes of Australia: An Illustrated and Descriptive Catalogue of All the Known Species,* by Gerard Krefft in 1869; Coral Cylinder Snake (*Anilius scytale*) from *Dissertation sur la generation et les transformations des insectes de Surinam,* by Maria Sibylla Merian in 1717; Indian Cobra (*Naja tripudians,* now *N. naja*) from *The Thanatophidia of India,* by Sir Joseph Fayrer in 1874.

Phylogeny series, edited by Barrie G. M. Jamieson, includes other herpetological treatments: Urodela, Anura, and Gymnophiona.

Latest Zoo & Conservation News: Research Shows a Visit to a Zoo Boosts Science and Environment Knowledge

Research conducted by the University of Warwick at ZSL London Zoo shows that "a trip to the zoo can boost your child's science and conservation education more than books or classroom teaching alone." From the article (emphasis added): "[M]ore than 3,000 school children aged between seven and 14 were asked about their knowledge of animals, habitat and conservation and then tested again after their trip. *The results show that 53% had a positive change in educational or conservation-related knowledge areas, personal concern for endangered species or new empowerment to participate in conservation efforts.* The study proves that their trip around the zoo provided a statistically significant increase in scientific learning about animals and habitats. *When zoo visits were supplemented by an educational presentation by zoo staff this increase in learning almost doubled against self-guided visits.*"

The research showed that "children came away with a greater understanding of ideas such as conservation, habitat and extinction," and they were more likely to use correct scientific terms and place animals in the correct habitat after visiting a zoo.

http://esciencenews.com/articles/2011/05/27/research.shows.a.visit.a.zoo.boosts.science.and.environment.knowledge

Johnny Arnett

Johnny R. Arnett, longtime herpetologist at the Cincinnati Zoo and Botanical Garden in Ohio, has died after a long bout with diabetes. His background was unique. He was hired in the mid-1960s as the lone reptile keeper at the zoo through a federal job corps program but had no training with any herp. In fact, he was terrified of snakes. Slowly, by trial and error, he taught himself how to care for them. Later, he was the head of the herpetological department at the Knoxville Zoo, returning near the end of his career to Cincinnati. He is likely best known for his work with Komodo Dragons, collecting samples from wild and captive specimens for bacterial analysis by veterinarian Don Gillespie. In 1997, he returned to Indonesia to help researchers collect dragon saliva for medical research. The trip was chronicled in the documentary "Komodo: To Capture A Dragon," on the cable channel Animal Planet.



Johnny Arnett and one of his snappy charges at Cincinnati Zoo and Botanical Garden in 1966.

CINCINNATI ZOO AND BOTANICAL GARDEN ARCHIVES, PROVIDED BY WINSTON CARD.

Zoos and Biodiversity

> Because ex situ conservation programs can be challenged when called into action at the last possible moment with only a few remaining individuals of a species, captive breeding should not be simply seen as "emergency-room treatment." It is a tool that should be considered before the species has reached the point of no return.
>
> —Conde et al. 2011

Balmford, A., et al. 2011. Zoos and captive breeding [Letters]. Science 332:1149–1150.

Conde, D. A., et al. 2011. Response. Science 332:1150–1151.

Conde, D. A., N. Flesness, F. Colchero, O. R. Jones, and A. Scheuerlein. 2011. An emerging role of zoos to conserve biodiversity. Science 331:1390–1391.

—James B. Murphy, Section Editor

Herpetological Review, 2012, 43(2), 208–209.
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New Panama Amphibian Rescue and Conservation Project Exhibit at Smithsonian National Zoological Park

In 2008 Amphibian Ark and AZA launched a Year of the Frog campaign to highlight the global amphibian crisis and the leadership role that zoos and aquaria should be playing to mitigate impending extinctions (Gagliardo et al. 2008; Zippel and Mendelson 2008). Realizing that Panama was one of the most significant frontlines for conservation as chytridiomycosis continued to spread through Latin America (Woodhams et al. 2008), Africam Safari, Autoridad Nacional del Ambiente, Cheyenne Mountain Zoo, Defenders of Wildlife, Houston Zoo, Smithsonian Institution, Summit Municipal Park, and Zoo New England came together in 2009 to launch the Panama Amphibian Rescue and Conservation Project. In 2009, these institutions signed a Memorandum of Understanding providing funding and support for three complementary actions: 1) the construction and operation of the new Amphibian Rescue Center at the Summit Zoological



FIG. 1. Rescuing Panama's Frogs exhibit at Smithsonian National Zoological Park. Left panel shows SEM *Bd* image, the spread of *Bd* through Central America, and description of the project. Center panel called "Froggy Baths" shows the quarantine procedures and anti-fungal remedies used to treat amphibians that are at risk from *Bd*. Right panel shows the collection of wild amphibians and the installation of the shipping containers (called "rescue pods"). These are climate-controlled, disease-free units housing the new anuran residents.

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FIGS. 2a, b, c. Three endangered species are on exhibit: Lemur Frog (*Agalychnis lemur*), Spiny-Headed Treefrog (*Anotheca spinosa*), and functionally extinct Panamanian Golden Frog (*Atelopus zeteki*).



FIG. 3. Graphic panel of Panamanian Golden Frog (*Atelopus zeteki*).

Park in Panama; 2) the ongoing operation of the El Valle Amphibian Conservation Center in western Panama (with the Houston Zoo as the main partner); and 3) the amphibian chytrid cure research program to be initiated at the National Zoo in collaboration with other research institutions. The mission of this project is to rescue and establish assurance colonies of amphibian species that are in extreme danger of extinction throughout Panama and focus efforts and expertise on developing methodologies to reduce the impact of the amphibian chytrid fungus (*Bd*) so that one day captive amphibians may be re-introduced to the wild.

Work in Panama has progressed steadily over the last two years; see www.amphibianrescue.org for updates. The project has built an active online constituency (3700 Facebook fans, 1000 Twitter followers as of April 2011), but we realized that we needed to use our existing exhibit space better to highlight the global amphibian crisis and to link our field conservation programs to our zoo-going constituents. The objectives of this exhibit were:

- To promote the value of Panamanian frogs to zoo-goers by highlighting a few interesting Panamanian species.
- To tell the story of chytridiomycosis spread in Panama and our conservation actions to prevent further extinctions by building an amphibian ark, and efforts to develop a cure that will one-day allow reintroduction of captive amphibians back into the wild.
- To provide an interpretive tool for our volunteer docent community to engage the public.
- To raise funding for the project through a guide-by-cell 'Text FROG' campaign, where people can donate $5 to the amphibian project simply by texting the word 'FROG' from their cell phones to a certain number.

The goals of our education program through this exhibit and associated volunteer docents are to engage people in behaviors that will directly assist our project to 1) raise funds, 2) build a social media constituency and 3) to recruit volunteers to assist with our program in Panama. The real challenge now is in training the volunteer docents to use this exhibit to actively pursue our project goals.

Acknowledgments.—All photographs were taken by Mehgan Murphy, Smithsonian National Zoological Park. Judy Tasse from the Zoo's Graphics Department assisted in the development of this display. Paul Pallansch installed the panels for the exhibit.

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Herpetology in Japanese Zoos

Japan, a country about the size of Montana, USA, is heavily populated with zoos and aquariums. Nearly 160 live animal exhibit facilities (89 zoos and 67 aquariums) were listed by the Japanese Association of Zoos and Aquariums (JAZA, formerly Japanese Association of Zoological Gardens and Aquariums, or JAZGA) as of March 2010 (JAZA 2011). Although there exist non-JAZA member animal exhibit facilities, it is safe to assume that JAZA literature covers the basic data on the vast majority of animal collections open to the public. Little is known about those facilities outside of this island nation, creating a huge information and communication vacuum concerning the eastern edge of Asia. Not surprisingly the number of published herpetological collection accounts in English is limited (e.g., Kawata 2003, 2004, 2006; Murphy 2007). This article briefly examines the birth of the modern zoo in Japan, its expansion, cultural differences from the Western counterparts, growth of herpetological collections and various programs including breeding and conservation. Taxonomic nomenclature has been adopted from the JAZA publications; as needed, scientific names have been updated, based on Amphibian Species of the World Database (Frost 2011) and The Reptile Database (Uetz et al. 2012). Common English names are mostly taken from ISIS (2011) and Goris et al. (2004). Possible errors in data compilation from the Japanese sources are mine.

Dawn of the Modern Zoo: an Overview of History

The early residents.—As Japan was transforming itself to become a modern nation, feudal warlords began to lose the firm grip that they had held for centuries over the people and the land. It was in the late nineteenth century when a cluster of forward-thinking men emerged to formulate a plan for a national museum after a European model. The plan eventually included a zoo patterned after Menagerie du Jardin des Plantes in Paris (Itoh 2010; Kawata 2001). The first zoo in the country opened on 20 March 1882 in Ueno Park, Tokyo. Prior to the establishment of this zoo, the government opened an exhibit station, also in Tokyo; the emperor reviewed this facility on 13 March 1872. In this exhibit station, which could be defined as the origin of Japan's zoos, were the Japanese Giant Salamander (*Andrias japonicus*) and the Reeve's Pond Turtle (*Mauremys reevesii*). The first aquarium of the country was a small facility with a collection, including the Japanese Giant Salamander, which was added to the Ueno Park Zoo (hereafter Ueno Zoo) on 20 September 1882. This species was a regular exhibit material since it was the research subject of Professor Chiyomatsu Ishikawa of the Imperial University of Tokyo, who also held the title of the zoo administrator from 1900 to 1907. (It might be noted that Ishikawa's Frog, *Odorrana ishikawae*, was named in his honor.) By 30 September 1885 the herpetological collection increased to five amphibians in two species and 19 reptiles in eight species (Ueno Zoo 1982).

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Following Tokyo's example, and in order to commemorate the wedding of the crown prince, the second zoo in Japan was opened in the ancient capital of Kyoto on 1 April 1903 by the city government. In the inventory of 238 animals in 61 species at the opening, no amphibian or reptile was listed (Takizawa 1986). In the country's commercial hub of Osaka, on 1 January 1915 the third zoo, Tennoji Zoo (another municipal facility), opened its gate with 60 species of animals, which included American Alligator and pythons. The former marked the first arrival of its species in Japan (Osaka Tennoji Zoo 1985). (The Japanese nouns usually do not distinguish between singular and plural, hence these documents often do not reveal the exact numbers of the animals. Also, it was common in zoos to use generic terms such as "python" or "rattlesnake" until decades later, when identifying the taxonomic name became a common practice.) The small number of above specimens represented the first residents of amphibians and reptiles in Japan's animal exhibit institutions. However during the critical developmental stage of zoos and aquariums, herpetology, in terms of collection and husbandry, fell far behind other animal groups.

This becomes evident when Japanese zoos are compared with their Western counterparts. In Paris, many important scientific discoveries were made at the Menagerie in early years. The London Zoo opened the world's first reptile building in 1849 (Murphy 2007, 2009). As of 1858, Rotterdam Zoo in the Netherlands kept 28 reptiles in 10 species and one amphibian (Visser 2003). In Germany, at Leipzig Zoo within the first years of opening in 1878, large reptiles were kept and even bred (Schmidt 2010). On this side of the Pacific Ocean, Hornaday (1918) stated that in the Bronx, New York, "The Reptile House was the first large building erected in the Zoological Park." (The zoo opened in 1899.) In 1930, statistics revealed that there were five zoos in the United States that maintained more than 400 specimens in more than 70 species of amphibians and reptiles (Doolittle 1932). During the 1930s "reptiles were one of the central kinds of animals that zoos used to draw Americans through their gates" and thanks to the funds from President Franklin Roosevelt's New Deal programs, some zoos had large and modern reptile houses, built or improved by the New Deal (Donahue et al. 2010).

By contrast, even into the post WWII era, Japanese institutions paid little attention to the amphibians and reptiles. Looking for answers for this curious imbalance will necessitate a review on historical aspects.

The duo controls the zoo.—The liaison between the academic world and zoos has been historically rare in Japan. The aforementioned Professor Ishikawa abruptly resigned from the position of the Ueno Zoo administrator in 1907, after getting tangled up in politics with higher officials. This German-educated zoologist envisioned a grand zoo with Carl Hagenbeck as a consultant; had he stayed in the position, the future course of Japanese zoos might have been quite different (Ueno Zoo 1982). In Kyoto, Professor Tamiji Kawamura of the Imperial University of Kyoto, who was known as the father of ecology in Japan, was appointed the zoo director in 1934. His tenure lasted only 14 months, as he left the position after disagreements with city fathers (Takizawa 1986).

In 1924 the administration of Ueno Zoo was transferred to the City of Tokyo, and by then it became common for mainstream zoos to be municipally owned and operated. It also became a

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FIG. 1. A python arriving at Ueno Zoo, Tokyo, in 1898, was placed in a makeshift cage. Few tropical reptiles survived the first winter.

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FIG. 2. Treatment of a Reticulated Python (*Broghammerus reticulatus*) at Ueno Zoo, 1938.

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FIG. 3. A renovated indoor reptile exhibit, Ueno Zoo, 1937.

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FIG. 4. The first Komodo Dragons (*Varanus komodoensis*) to Japan arrived at Ueno Zoo in October 1942.

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FIG. 5. Aquatic and Reptile Building, Japan's first large-scale exhibit complex for amphibians, reptiles, fish, and invertebrates opened at Ueno Zoo in 1964.

PHOTO BY AKIYOSHI NAWA



FIG. 6. Ueno Zoo Vivarium aquatic exhibits.

practice to appoint a municipal manager with no training in zoology or zoo experience to the helm of a zoo for only a brief period. To cite an example, in its 50-year history beginning in 1942, Inokashira Nature and Culture Park (hereafter Inokashira Park Zoo), in a Tokyo suburb, had 21 directors. Being in Tokyo, this zoo uniquely had several transferees from Ueno and Tama zoos (Inokashira Nature and Culture Park 1992). Still, the average tenure of less than two and a half years barely gives a director enough time to familiarize himself with the operation of his institution (note: zoo directors in Japan are still predominantly male). Instead, the

position of a zoo director is a convenient stepping stone for municipalities to shuffle bureaucratic positions.

To assist the director with animal collections, the municipality assigns veterinarians, also for a brief period in most cases, transferred from other divisions that have little to do with wild animals or zoology, such as the public health department. As a result, the critical managerial positions of a zoo are occupied by those with no expertise or interest in zoos or wild animals. In the public's mind a veterinarian is automatically an animal expert, but at best, this is only partly correct. The education for veterinary medicine is limited to the health aspect of only a handful of domesticated species, mostly mammals. Besides, until the early 1980s the requirements to become a veterinarian consisted of only four years of post-secondary school, a lower level of training compared with the American system. Even today, they still are *the* college-graduated group responsible for wild animals in captivity, and they oversee keepers, often with a firm hand. In this situation there exists little professional continuity. Operational continuity, if any, is barely maintained by a small number of dedicated keepers, who are entry level employees. There are exceptional zoos and individuals, but they are in the minority. (Privately owned zoos have taken different developmental stages, but they are not considered mainstream institutions. By comparison to zoos, aquariums have evolved differently. However, that is a subject outside of the scope of this article.)

From a promising beginning in the dawn of modernization, Japan's zoos thus stumbled into a quicksand during infancy; to this day they lag far behind their cousins in Europe and America in nearly all aspects. Popular as they are to the public, zoos are diametrically different from their Western counterparts. They are regarded as a showplace of exotic animals, so far removed from the world of zoology. For a zoo director, his accomplishment is measured by an increased gate attendance during his brief tenure. To achieve this he brings in amusement rides, side by side with animal exhibits, an element alien to the modern zoo. For the same reason he focuses on high-profile animals, the "ABC animals" such as large felids, bears, primates, elephants, and giraffes. The animal collection becomes mammalocentric, and while it can be said that the same trend is predominant across the world, in Japan, the focus on mammals is so prominent that birds are given a second-class status, and other groups are pushed even further down. Amphibians and reptiles are outside the interest of veterinarians and non-zoologist directors, resulting in herpetological poverty.

This does not mean that the public has little interest in this group of animals. Reptiles had been in sideshows and traveling menageries from earlier times. Around the turn of the twentieth century, half a dozen large-scale traveling menageries crisscrossed Japan. The largest of them stayed in business from 1907 to the end of 1928, a surprisingly long period for a sizable animal collection with no permanent housing facility. Their picture postcards show a crocodile, a python (both appear adult), and a monitor (Kawata 2005). Returning to the municipal zoo operation, there is no doubt that zoos had a potentially fertile soil for patronage to be developed, had they spotlighted reptiles in a specialized facility. Unfortunately the public's curiosity went unsatisfied, as animal collections remained limited in scope. As Sasaki aptly pointed up (Sasaki et al. 1977), the duo of municipal bureaucrats and veterinarians hand in hand promoted the vulgarization of zoos, the modus operandi that firmly gripped zoos for generations. Fortunately, as we will later review, in more recent years there has been a crack in this monolith.

The sakoku mentality.—The uniqueness of Japanese zoos is also noticeable in the cultural aspect. From 1639 to 1868 the feudal government closed Japan's door to the outside world, a policy that was aided by its geographical isolation. This self-imposed seclusion, or *sakoku*, has cast a profound influence on the people; even today, they are unable to free themselves from the harness of *sakoku*. On the surface Japan appears to be a Westernized island nation floating on the edge of Asia, but this image is misleading. As Itoh asserts: "The *sakoku* mentality still gravely affects the Japanese mind. The Japanese public is unwilling to integrate foreigners into Japanese society and is reluctant to assume a more active role in the international community." She also notes: "Although Japan achieved its status as the world's second-largest economy more than a decade ago, it still has not been able to demonstrate international leadership ability or earn international respect" (Itoh 1998). Their reluctance to get involved in international affairs extends into the zoo world, and it refers back to the aforementioned information and communication gap between them and the outside world.

A herpetological editor once commented: "…until recently Japanese zoos and aquariums kept information about what herps and how many they had among themselves. In a world where coordination between those who care has become increasingly important, so the little resources like money and knowledge we have can be used wisely, this secrecy can only be called a moral crime" (Salzberg 2003). This view prompted an objection from a graduate program director of a university (A. H. Savitzky, pers. comm., 2003). Japanese culture is extremely deceiving; naiveté and ignorance would easily lead an outside observer to an inaccurate conclusion. In truth, Japanese *choose* to stay in their cocoon but do not purposely hide information, and therefore the perceived secrecy is by no means intentional. Simply put, the world outside of that arc-shaped archipelago does not exist in their perceptual radar and therefore, the need to share information internationally does not even occur to them.

Early Decades and World War II

Protection from winter.—Zoos in industrialized nations are primarily located in the northern temperate zone, where overwinter facilities are required to maintain ectotherms during cold months. In Japanese zoos resources to build and maintain heated buildings were traditionally allocated for popular mammals, such as primates and large herbivores. In Kyoto, a heated building was opened and a python was placed in it in 1923 (Takizawa 1986) but its size or the extent of the thermal capacity is not documented. The lack of heated housing capacity led to zoos' inability to keep tropical reptiles beyond the first summer after arrival. The way the Ueno Zoo staff had to cope with the rudimentary conditions was chronicled by Fukuda (1968): "13 November 1922, clear weather; preparation for winterizing reptiles." They placed 30 native turtles in a wooden box and buried the bottom half; American Alligators were put in a wooden box, water was added and then placed in the feed storing corner of the hippopotamus building.

When a three-meter long Saltwater Crocodile arrived in May 1932, the lack of a permanent reptile facility became all too evident. The crocodile was first housed in the heated hippopotamus building, but chronic anorexia developed. In December the crocodile was moved to a new building for small mammals and reptiles, but anorexia persisted and it died after nine months at the zoo (Ueno Zoo 1982). Many reptiles of tropical origin did not

survive the first winter, yet we find occasional exceptions. On 17 June 1936, Ueno Zoo's python, which had arrived in October 1925, died of hemorrhagic enteritis; it weighed 101.6 kg, and the total length was 6.47 m (Fukuda 1968). The exact species of this python is not listed but the geographic origin was said to be the Malay Peninsula, indicating it to be a Reticulated Python.

It was in January 1937 that a reptile house, capable of housing larger species, was finally completed, with a skylight that allowed tropical plants to grow (Ueno Zoo 1982). But across the country, the zoo reptile collections in the pre-WWII years were basically represented by giant snakes, monitors, and crocodilians, mostly from Southeast Asia due to geographic proximity, with the exception of commonly imported American Alligators. Every now and then, smaller species and some rarity arrived at zoos. The military often brought in reptiles, among other animals, to Ueno. February 1923 saw the Imperial Navy delivering Aldabra Tortoise, and on 30 October 1942 two Komodo Dragons, first in Japan, were donated. Captured by the navy on Komodo Island, they arrived during the war, the worst period in the zoo history when every supply was short; they died on 16 February and 12 June, 1943 (Ueno Zoo 1982).

Wartime zoo policy.—Military expansion over the vast regions of Asia led Japanese people to the ultimate disaster of WWII. Even before the attack on Pearl Harbor in December 1941, the signs of hard times were everywhere. At Ueno Zoo employees began to be conscripted to the armed forces in 1937. By 1940 zoos were under serious shortages of essential supplies, such as animal feed, as the nation's resources were directed to the war effort. Some zoo animals, such as goats and ducks, were used for feeding carnivores. Fuel shortage further jeopardized animal life (Fukuda 1968). Akiyoshi Nawa, who was a keeper at Ueno from 1941 through 1943, recalled (pers. comm., 2011): "Small reptiles, such as chameleons, were housed in a heated building with birds and mammals such as bats but they did not live long. After steam heating was discontinued large reptiles were placed in wooden boxes, which were then piled up in the building where chimpanzees were kept, or in the keeper service area. Many did not survive to meet the mandatory killings."

Itoh ably documented the wartime zoo policy by the government, which mandated that the so-called "dangerous" animals be destroyed, and how they were executed. Between August 1943 and December 1944, a total of 170 animals were killed in 14 zoos; nearly all were mammals but reptiles, such as rattlesnakes and pythons, were included. The policy did not exempt circuses; a total of 133 animals were destroyed, among them 58 snakes (Itoh 2010). The herpetological roster of three zoos as of September 1945 (immediately after the end of the war) shows the zoo staff's effort to maintain them under difficult conditions: Ueno Zoo, 10 reptiles in five species including two Chinese Alligators and a turtle from New Guinea (Ueno Zoo 1982); Kyoto Zoo, 85 native freshwater turtles in three species (Takizawa 1986); Tennoji Zoo, one giant salamander and one "crocodilian" (Osaka Tennoji Zoo 1985). Aside from the above, there were a few that continued to live through the war years into decades afterwards including an American Alligator, a Chinese Alligator and an Alligator Snapping Turtle (Murphy 2007). As for the ubiquitous American Alligator, it does appear that more survived the war in the private sector, such as a hot spring resort where aquatic thermal comfort was in unlimited supply. As a child in southern Japan, I saw a large American Alligator in a sideshow. It was in the post-war period before large-scale animal shipments began to arrive, and somehow the animal must have survived the war years.

Reconstruction and Expansion of Zoos

Reptiles begin recovery era.—As the nation's cities lay in ashes and ruins, Japan put itself on an almost forced march out of devastation and toward economic recovery, no small feat for a people who had lost everything. In zoos nearly all popular animals were gone; cages that previously housed lions and tigers were filled with farm animals, to the disappointment of visitors seeking out relief from the daily hardship. International traffic of animals began in small bits, such as pet Crab-eating Macaques (*Macaca fascicularis*) donated to the local zoo by soldiers of the occupation forces. At this point, previously little known Hogle Zoo in Salt Lake City, Utah, stepped forward to make zoo history by sending the first post-war good will animal ambassadors to Ueno Zoo. The Ueno Zoo staff wished to receive large carnivorous mammals that had been lost during the war, but bringing in meat-eating animals would have required approval from the occupation force at this time of severe food shortage for humans. On 17 April 1949, four musk turtles (*Sternotherus odoratus*) and four box turtles (*Terrapene* sp.) arrived by air from Salt Lake City, and were enthusiastically welcomed by the public. Soon Hogle Zoo sent mammals and birds of various species (Ueno Zoo 1982). Thus, just as they marked the beginning of Japanese zoos, reptiles made a mark again nearly eight decades later.

The boom years.—Around 1950 trade restrictions began to be relaxed, enabling large-scale wild animal importations, first from Southeast Asia. Somewhat ironically, the period of catastrophic disasters was followed by an era of unprecedented economic prosperity. As of 1940 when the first general assembly of JAZGA was held in Tokyo, there were 19 member institutions including 16 zoos (two of them were in Korea and Taiwan, which were exterior territories under Japanese control) and three aquariums. After the war, citizens began to enjoy peaceful life for the first time in decades, and aided by newly-gained economic base for the public, they were ready for more zoos. An unprecedented zoo construction boom swept Japan, as zoos spread from larger cities to middle-sized cities. By 1961, merely 16 years after the war's end, JAZGA listed 84 member institutions including 52 zoos and 32 aquariums. As for herpetological collections, the animal inventory of JAZGA member institutions as of 31 August 1961 listed 33 species of amphibians and 61 species of reptiles, or a total of 94 species. The largest holder was Ueno Zoo with 13 species of amphibians and 34 species of reptiles, or a total of 47, which added up to one-half of the species in the inventory (JAZGA 1962).

Tokyo still stood on top, but the balance of quantity was to shift appreciably in the coming decades. A number of animal housing and exhibit facilities were built, and the budding interest in herpetology was growing in other zoos and aquariums. Such changes, however, moved at the speed of a tortoise, certainly not that of a frog. This was because the zoo world was a conservative lot heavily guarded by the aforementioned duo, which possessed no passion for zoo work or zoology, and their firm belief "Zoos only need ABC mammals" continued to prevail. At this point, Tokyo made the move again.

In 1960, the senior staff of Ueno Zoo was well aware that herpetology was the area that was most left behind by Japanese zoos. Ueno Zoo's "new" aquarium, which was built as the seventieth year commemorative project in 1952, already showed wear and tear of its partially wooden structure, and was being outmoded by newer aquariums being built across the country. A plan was on the drawing board to design a large building to accommodate

exhibits of not only fish, but also marine invertebrates, amphibians, and reptiles. Fish, amphibians, and reptiles share common requirements for life support systems, it was argued, and combined exhibit buildings had precedents in Europe, such as Zoo Berlin and Frankfurt Zoo. The decision was made to build a large exhibit complex, tentatively named "aquatic and reptile building" as the eightieth year commemorative project for the zoo, to open in 1962 (Ueno Zoo 1982).

Growth and Development in Herpetology Underway

The trailblazer.—According to the plan of this four-storied complex, the first two floors were devoted to fish, aquatic amphibians were to be housed on the third floor, and the entire fourth floor was devoted to the rest of the amphibians and reptiles. Two years after construction began, the building with a floor space of 5,478 m^2 was opened to the public on 30 October 1964. However, due to construction delays the amphibian and reptile section was not completed until June 1973 (Ueno Zoo 1982). In some ways, this 1964 building reflected Japan's peculiar dichotomy; the country may be divided into two sectors, Tokyo the capital and the rest, and Tokyo often sets the pace for the rest in terms of politics, economy, and culture. To put it in the American perspective it is an equivalent of Washington, DC, New York, and Los Angeles all rolled up into one mega-city. The debut of Ueno's large multi-taxonomic exhibit complex was an epoch-making event, to set the stage for other zoos and aquariums, even though it took a decade for the trend to catch up. Gradually, medium-sized zoos began to follow suit.

In the prosperous port city of Yokohama, south of Tokyo, a new reptile house opened in Nogeyama Zoo in 1971, replacing the 1965 facility that housed only nine species. The new building was five times larger. In 1973 a reptile building opened in Nihondaira Zoo in Shizuoka. The following year saw the unveiling of a two-storied building in Asa Zoo, Hiroshima; nocturnal exhibits for small mammals occupied the first floor while reptiles took up the second floor. Another young and medium-sized zoo in Sendai in the northern part of Honshu, Yagiyama Zoo opened a reptile house in 1978. Although designs of these buildings followed the traditional style consisting of rows of individual cages, a debut of a large-scale indoor application of the immersion landscape concept made history in Osaka. Opened in 1995 at Tennoji Zoo, this exhibit complex was later named IFAR, representing invertebrates, fish, amphibians, and reptiles. As the name implies, a wide variety of animals are housed to depict the world's fauna and flora. Back in Tokyo, Ueno Zoo demolished the 1964 building in 1992, replacing it in 1999 with a new building named Vivarium, to exhibit amphibians and reptiles (Kawata 2004).

Beachhead for herpetology.—These facilities became the foundation for expanding exhibitory, specialized husbandry techniques and breeding, not only for the traditionally popular species such as giant snakes, monitors, and crocodilians, but also for smaller ones, particularly indigenous taxa. While this development was underway, the number of new zoos and aquariums kept growing. What captured zoo enthusiasts' eye was the birth of privately owned specialized reptile collections, such as Atagawa Tropical & Alligator Garden (opened in 1958) and Izu Andyland (opened in 1986). Also, it might be noted that the emergence of a large number of aquariums has made Japan "a nation of aquariums" (Kawata 2009). In recent decades, these aquariums have made contributions to various herpetological programs. These new institutions have begun to demonstrate the strength in the field. The old-establishment "classic" zoos with large, generalized animal collections, typically Ueno and Tennoji, could no longer continue to claim the leadership positions in expertise in all animal groups.

Growing collection size.—There is an impression in the American zoo scene that the collector's days are over. A large collection of taxa of a specific animal group is targeted for criticism by the mainstream zoo pundits as an anachronistic postage-stamp collection. The zoo's resources, they argue, should better be directed toward global conservation endeavors. Also, they prefer larger outdoor exhibit spaces and mixed species exhibits. Such a philosophy appears to be originated in mammalocentricism, as public-pleasing ABC zoo animals happen to be large mammals. However, biological programs in zoos and aquariums must be based on the characteristics and requirements of each taxonomic group. Thus the "yardstick" for mammal programs should not always be applied to amphibians and reptiles. A row of cages, each with a different species of monkey, may not be popular today, but can the same be said about other animal groups? A variety of taxa of one group, be it frogs or rattlesnakes, exhibited in an attractive indoor setting, will show visitors the diversity within a particular group. Formulating a plan for herpetological programs, therefore, should be independent of political correctness for mammals. As Table I shows, Japan's herpetological collections include a large number of species, yet

TABLE 1. Amphibian and reptile species held in Japanese collections, 1969–2009. The numbers in parenthesis represent institutions that do not have amphibians and reptiles.

Years	No. zoos ( )	No. aquariums ( )	Amphibian species	Reptile species	Total
1969	60 (16)	38 (4)	47	185	232
1979	63 (17)	44 (7)	67	220	287
1989	93 (30)	57 (1)	87	314	401
1999	98 (27)	65 (5)	117	295	412
2009	89 (16)	67 (7)	95	236	331

TABLE 2. Eight largest collections of amphibians and reptiles in Japan. Data taken from eight collections that hold a minimum of 50 species of amphibians and reptiles combined as of 31 December 2009.

Institutions	Amphibians species / specimens	Reptiles species / specimens	Total
Ueno Zoo	51/398	88/336	139/754
Higashiyama Zoo (Nagoya)	53/269	75/282	128/551
Izu Andyland	0/0	106/652	106/652
Toba Aquarium	26/119	50/172	76/291
Okinawa Children Land Zoo & Aquarium	7/39	62/524	69/563
Tennoji Zoo (Osaka)	13/77	43/174	56/251
Noboribetsu Marine Park Nixe	16/47	37/95	53/142
Echizen Aquarium	40/320	10/42	50/362


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FIG. 7. Yellow-margined Box Turtle (*Cuora evelynae*) at Ueno Zoo.


PHOTO BY TOKYO ZOOLOGICAL PARK SOCIETY

FIG. 8. Reeve's Pond Turtle (*Mauremys reevesii*) at Ueno Zoo.

this should not be viewed in a negative light. Data for the tables have been culled from the JAZGA/JAZA Annual Reports (JAZGA 1970, 1980, 1990, 2000; JAZA 2010b).

Some holders meticulously report subspecies and melanistic forms in their collections, but taxa in both tables have been lumped into full species to simplify statistics. Hybrids are not included. For these reasons, the actual numbers of "forms" of animals can be higher than what is shown in the tables. Table 1 depicts the chronological increase in species held by member institutions in the last half century. Some holders still submitted generic and non-specific designations such as "giant tortoise," "box turtle," or "monitor" for 1969; these were excluded from the Table, and thus the actual number of taxa may be higher for 1969. Also, one zoo and two aquariums failed to submit data for that year. With amphibians and reptiles combined, the largest holder for 1969 (167 species) and again 1979 (179 species) was Ueno Zoo. Probably due to the plan to demolish the 1964 building, Ueno's collection declined for 1989, and Higashiyama Zoo in Nagoya, another large urban and municipal zoo, took the lead, with 116 species. For 1999 Kusatsu Tropicana came out on top with 140 species, only to drop out for 2009, when Ueno Zoo, with the new Vivarium, again claimed the largest with 139 species; Nagoya was a close second in 2009, with 128 species.

Table 2 shows the eight largest holders as of 2009; combined, these eight kept one half of all species of amphibians and reptiles in the JAZA inventory. Large municipal zoos in Tokyo, Osaka, and Nagoya still held strength in the collection size. Yet, the shift toward aquariums (Andyland, a holder of a large number of reptiles, is listed as an aquarium) is quite obvious, illustrated by two relatively little known aquariums at the end of the list. It might be interesting to note that distribution of collection sizes leans heavily toward smaller holdings. Ten percent of the holders had 40 or more species each; only three holders had 80 or more species. Of all holders 80% had fewer than 20 species each; 45% had 10 or fewer species each. Active participations in herpetological programs by more institutions will require more holding spaces and skilled staff. This, however, will take a long period to materialize. Herpetology in Japanese zoos and aquariums is still in its infancy, and it shows not only in the limited diversity in collections, but also in the quality of exhibitory, husbandry, and conservation programs, compared to European and American institutions.

Husbandry, Breeding, Research and Conservation

Charismatic giant.—A special note is in order for the only Japanese species (of amphibians and reptiles combined) that carries a larger-than-life image in the international herpetological arena. The Japanese Giant Salamander (*Andrias japonicus*), a huge aquatic amphibian, is a folklore legend, often called hanzaki or hanzake, literally "cut in half" which refers to the superstitious assumption that it will regenerate itself even if cut in half. From early years it has been sought out by overseas zoos and aquariums. Aforementioned Rotterdam Zoo had one in its inventory as of 1858 (Visser 2003); the first captive breeding in the world took place in the Amsterdam Aquarium in 1903 (van Bruggen 2003). The species has been on the short list of candidates for good-will animal ambassadors along with the Manchurian Crane (*Grus japonensis*) and the Japanese Macaque (the so-called Snow Monkey, *Macaca fuscata*). Not too long after WWII a request for giant salamanders was made by William Mann, director of National Zoo in Washington, DC. At this time Japan was still under occupation, and the shipment was arranged through the office of General Douglas MacArthur of the Supreme Commander of the Allied Powers General Headquarters. In May 1947, 15 specimens were flown to Washington, DC, by an American military aircraft. Giant salamanders have since been sent to overseas institutions every now and then (Ueno Zoo 1982), including another group to the National Zoo in 2010.

In earlier times, this charismatic amphibian became the subject of research by Japanese scientists after the arrival of modern zoology from the West. As for zoos and aquariums, beginning in the 1970s, Asa Zoo and Himeji Aquarium have made significant contributions concerning this species in field research, husbandry, captive breeding, and public education, resulting in numerous publications. (Since 2005, the Himeji Aquarium program has basically been transferred to the Japan Hanzaki Institute.) Recent accomplishments have been introduced in English publications (e.g., Kawata 2006, 2008; Murphy 2007) and this article does not reiterate the work by Japanese biologists.

Husbandry.—The giant salamander programs stand out, and should be a model for similar programs for indigenous species. However, college-educated biologists assigned to herpetological collections are a relatively new phenomenon in Japan. Attempts to cultivate husbandry methods beyond feeding and cleaning

PHOTOS BY ASA ZOO



FIG. 9. Daruma Pond Frogs (*Pelophylax porosus*). A) adult; B) amplectant pair.

seem to have begun about four decades ago. It appears also, that the last three decades have seen more written accounts being published in various periodicals, almost all in Japanese. The variety of species covered by authors has also increased with time. These articles range from "case reports" of breeding and care procedures, to long-range reviews and data analysis. The contents of such reports often are intertwined with husbandry protocol, breeding, research, and conservation, and it becomes tricky to divide them into rigid categories. Here follow examples of analytical accounts beyond daily care procedures. Being surrounded by oceans, interest in marine biology is high in this island nation, represented by articles on sea turtles.

The staff of Enoshima Aquarium compiled data on sea turtles from 42 aquariums and 30 zoos as of July 1970 on the number, locations of collection, captive environments, feeding practice, diseases, sizes and weights, and longevity. The number in captivity was 326 in six taxa (Anon. 1970). More than three decades later, as the number in captivity flourished, breeding in captivity had taken place and awareness of sea turtle conservation was rising, Kamogawa Sea World staff conducted an update of the national survey, collecting data from 61 aquariums and 70 zoos as of December 2003. The number jumped to 842 in five taxa; in addition, there were 16 hybrids including those between Loggerhead and Green Turtles, and between Loggerhead and Hawksbill Turtles (Anon. 2006). As for unusual species, the former account reported that prior to 1970, 16 aquariums kept Leatherback Turtles (*Dermochelys coriacea*) but all adults died within one month (exceptionally a juvenile lived for 16 months), indicating the difficulty in maintaining this turtle in captivity. In fact there exist only a limited number of Japanese articles on this species. One of them deals with feeding practice, episodes of injuries and healing in an adult, kept at Shimonoseki Aquarium for 10 months at the time of writing (Oka et al. 1983). Another is a brief note from Kushimoto Marine Park Center, reporting of a specimen kept in a pool made of tent canvas (to avoid injuries on the snout); it passed benchmark duration of 250 days (Miyawaki 1984).

Breeding.—In 1957 JAZGA inaugurated the annual First Breeding Award, to be issued to member institutions that bred a species successfully for the first time in the country. Applicants must follow strict guidelines. Only entries based on records after 1945 can be considered and offspring conceived *in situ* will not be acceptable. Moreover, the offspring must survive for half a year to qualify (JAZA 2005). These rules can filter out viable data that might not reflect actual records. A case in point: the White-naped Crane (*Grus vipio*) reproduced in Kyoto Zoo shortly after its opening in 1903 although the exact date is not clear (Takizawa 1986); the Award was given to a zoo for a 1953 breeding. Also, behind the rewarded "first" there may have been neonates that perished before the required duration was met; such a rule may be taken as mammal-biased. The Award, nevertheless, encourages member institutions to promote captive breeding, and it also serves as an indicator of the accomplishments by members. Table 3 depicts the awarded taxa, and for the above reasons, it should highlight the selected or representative taxa that have been bred successfully by Japanese zoos and aquariums.

Some of the recipient institutions closed since, or are no longer JAZA members. Also, modifications were necessary when interpreting JAZA data for the table. The First Breeding Award rules allow multiple-award issuances for the same taxon under separate categories, such as via artificial insemination, artificially incubated, parent-raised, hand-reared, and the like. However, Table 3 takes only the first entry of a taxon and thus, the second and succeeding awards for the same taxon in the original documents were deleted. The Awards are also issued for full species as well as subspecies within the same species, again resulting in multiple issuances for one species. Table 3 follows this rule, therefore *Terrapene carolina* has been admitted as a full species as well as for subspecies. It might be noted also, that many award winners may represent single occurrences, and their offspring do not always establish self-sustainable, multiple-generation breeding groups.

A quick glance at the table reveals growing trends that began in the 1990s. Long-established, elite zoos in big cities, namely Ueno and Tennoji, used to be the domineering presence by breeding practically all classes of terrestrial tetrapods. Today they still project an impressive image (e.g., since the 1980s, Ueno has bred numerous small amphibian and reptile species). Increasingly, however, small to medium-sized zoos and emerging new aquariums, many of them lesser known, began to catch up.

TABLE 3. Selected taxa of amphibians and reptiles bred in Japanese collections, 1967–2008. Data have been tabulated from the following, all in Japanese: New Husbandry Handbook: Breeding and Related Material (2005), Japanese Association of Zoos and Aquariums (JAZA); Journal of JAZA 47/1, 47/2, 2006; 48/1, 48/2, 2006; 49/1, 2008; 50/2, 2009a; 51/1-2, 2010a. No breeding awards were issued for amphibians and reptiles for 1970, 1973, 1974, and 1982.

Year	Species	Collection
1967	Asian Rock Python, *Python molurus*	Ueno Zoo
1968	Diadem Snake, *Spalerosophis arenarius*	Ueno Zoo
	Speckled Kingsnake, *Lampropeltis getula holbrookii*	Ueno Zoo
	Rainbow Boa, *Epicrates cenchria maurus*	Ueno Zoo
1969	Leopard Gecko, *Eublepharis macularis*	Ueno Zoo
	Diadem Snake, *Spalerosophis diadema atriceps*	Ueno Zoo
1971	Ball Python, *Python regius*	Ueno Zoo
1972	Fire Salamander, *Salamandra salamandra*	Ueno Zoo
	Spectacled Caiman, *Caiman crocodilus*	Oga Aquarium
	West African Dwarf Crocodile, *Osteolaemus t. tetraspis*	Ueno Zoo
1975	Kenyan Sand Boa, *Eryx colubrinus loveridgei*	Asa Zoo (Hiroshima)
	Four-lined Ratsnake, *Elaphe obsoleta quadrivirgata*	Kyoto Zoo
	Taiwan Beauty Snake, *Orthriophis t. taeniura*	Tennoji Zoo (Osaka)
1976	Yellow-margined Box Turtle, *Cuora evelynae*	Ueno Zoo
	Paraguayan Caiman, *Caiman crocodilus yacare*	Nihondaira Zoo (Shizuoka)
1977	Florida Kingsnake, *Lampropeltis getula floridana*	Kyoto Zoo
	Yellow Anaconda, *Eunectus notaeus*	Tennoji Zoo
1978	Spotted Turtle, *Clemmys guttata*	Himeji Aquarium
	Puff-faced Watersnake, *Homalopsis buccata*	Tennoji Zoo
1979	Japanese Giant Salamander, *Andrias japonicus*	Asa Zoo
	Siamese Crocodile, *Crocodylus siamensis*	Nagashima Tropical Botanical Garden
1980	Reticulated Python, *Broghammerus reticulatus*	Takarazuka Zoo
	Water Monitor, *Varanus salvator*	Maruyama Zoo (Sapporo)
1981	Alligator Snapping Turtle, *Macrochelys temminckii*	Nagashima Sunny
1983	Hida Salamander, *Hynobius kimurae*	Kyoto Zoo
	Asian Brown Pond Turtle, *Mauremys mutica*	Himeji Aquarium
	Gulf Coast Bay Turtle, *Terrapene carolina major*	Miyazaki Safari Park
	Leopard Tortoise, *Stigmochelys pardalis*	Miyazaki Safari Park
	Corn Snake, *Pantherophis guttatus*	Yagiyama Zoo (Sendai)
1984	Red-footed Tortoise, *Chelonoidis carbonaria*	Kyoto Zoo
	South American Slider, *Trachemys scripta*	Yagiyama Zoo
	Congo Dwarf Crocodile, *Osteolaemus tetraspis osbornii*	Asa Zoo
1985	Asian Water Dragon, *Physignathus cocincinus*	Yagiyama Zoo
1986	New Guinean Snake-necked Turtle, *Chelodina novaeguineae*	Kyoto Zoo
	Snapping Turtle, *Chelydra serpentina*	Toba Aquarium
	California Kingsnake, *Lampropeltis getula californiae*	Asa Zoo
1987	Red-eyed Tree Frog, *Litoria chloris*	Ueno Zoo
	Eastern Box Turtle, *Terrapene c. carolina*	Asa Zoo
	Yellow Ratsnake, *Pantherophis o. obsoletus*	Tennoji Zoo
1988	Black Marsh Turtle, *Siebenrockiella crassicollis*	Himeji Aquarium
	Blood Python, *Python curtus*	Nihondaira Zoo
1989	Toad-headed Turtle, *Mesoclemmys gibba*	Korankei Snake Center
	Australian Snake-necked Turtle, *Chelodina longicollis*	Himeji Aquarium

TABLE 3. Continued.

Year	Species	Collection
1990	Reed Frog, *Hyperolius horstokii*	Higashiyama Zoo
	Green Tree Frog, *Hyla cinerea*	Higashiyama Zoo
	Ornate Horned frog, *Ceratophrys ornata*	Ueno Zoo
	Oriental Fire-bellied Toad, *Bombina orientalis*	Higashiyama Zoo
	East African Black Mud Turtle, *Pelusios subniger*	Izu Andyland
	Large-headed Mud Turtle, *Sternotherus m. minor*	Izu Andyland
	Yellow-spotted Amazon River Turtle, *Podocnemis unifilis*	Himeji Aquarium
	Australian Big-headed Turtle, *Emydura macquarii*	Izu Andyland
	Brown Basilisk, *Basiliscus vittatus*	Higashiyama Zoo
	Lined Gecko, *Gekko vittatus*	Higashiyama Zoo
	Tokay Gecko, *Gekko gecko*	Yagiyama Zoo
	Moorish Gecko, *Tarentola mauritanica*	Higashiyama Zoo
1991	Knight Anole, *Anolis equestris*	Higashiyama Zoo
	Milksnake, *Lampropeltis triangulum*	Higashiyama Zoo
	Western Ribbonsnake, *Thamnophis proximus*	Higashiyama Zoo
	Siebenrock's Snake-necked Turtle, *Chelodina steindachneri*	Toyohashi Zoo
	Okada's Five-lined Skink, *Plestiodon latiscutatus*	Ueno Zoo
1992	Japanese Warty Newt, *Echinotriton andersoni*	Nagasakibana Parking Garden
	Sword-tailed Newt, *Cynops ensicauda*	Nagasakibana Parking Garden
	d'Orbigny's Toad, *Rhinella dorbighyi*	Asa Zoo
	Amami Green Tree Frog, *Rhacophorus viridis amamiensis*	Nagasakibana Parking Garden
	Ryukyu Kajika Frog, *Buergeria japonica*	Nagasakibana Parking Garden
	Egyptian Tortoise, *Testudo kleinmanni*	Nogeyama Zoo (Yokohama)
	Brown Basilisk, *Basiliscus basiliscus*	Yagiyama Zoo
1993	Ishikawa's Frog, *Odorrana ishikawae*	Nagasakibana Parking Garden
	Red-bellied Short-necked Turtle, *Emydura subglobosa*	Toba Aquarium
	Spot-bellied Side-necked Turtle, *Phrynops hilarii*	Toba Aquarium
	Aldabra Tortoise, *Dipsochelys dussumieri*	Izu Andyland
	Green Crested Basilisk, *Basiliscus plumifrons*	Kusatsu Tropicana
	Blue-tongued Skink, *Tiliqua scincoides*	Higashiyama Zoo
	Hibakari, *Amphiesma v. vibakari*	Ueno Zoo
	African Rock Python, *Python sebae*	Tobe Zoo
	Uracoan Rattlesnake, *Crotalus durissus vegrandis*	Ueno Zoo
	Hime Habu, *Ovophis okinavensis*	Nagasakibana Parking Garden
1994	Ryukyu Brown Frog, *Rana "okinavana"*	Nagasakibana Parking Garden
	Rice Frog, *Occidozyga diminutivus*	Kusatsu Tropicana
	New Guinea Snapping Turtle, *Myuchelys novaeguineae*	Toba Aquarium
	Eastern Mud Turtle, *Kinosternon subrubrum*	Osaka Aquarium
	Sakishima Tree Lizard, *Japalura polygonata ishigakiensis*	Ueno Zoo
1995	Misty Salamander, *Hynobius nebulosus*	Nagasakibana Parking Garden
	Green-and-black Poison Dart Frog, *Dendrobates auratus*	Higashiyama Zoo
	Green Anaconda, *Eunectus murinus*	Sasebo Subtropical Zoo & Botanical Garden
	Loggerhead Sea Turtle, *Caretta caretta*	Kushimoto Marine Park Center
	Prehensile-tailed Skink, *Corucia zebrata*	Asahiyama Zoo
	Frilled Lizard, *Chlamydosaurus kingii*	Kusatsu Tropicana
	Blue Spiny Lizard, *Sceloporus cyanogenys*	Tennoji Zoo
	Warren's Girdle-tailed Lizard, *Smaug warreni*	Tennoji Zoo
	Elongated Tortoise, *Indotestudo elongata*	Izu Andyland
1996	Tohoku Salamander, *Hynobius lichenatus*	Marinpia Matsushima Aquarium
	Green Iguana, *Iguana iguana*	Kyoto Zoo
	Madagascar Giant Day Gecko, *Phelsuma madagascariensis*	Kusatsu Tropicana
	Ryukyu Watersnake, *Amphiesma p. pryeri*	Nagasakibana Parking Garden
1997	African Clawed Frog, *Silurana tropicalis*	Toba Aquarium
	Rio Madeira Poison Dart Frog, *Adelphobates quinquevittatus*	Higashiyama Zoo
	Geoffroy's Side-necked Turtle, *Phrynops geoffroanus*	Toba Aquarium
	Asian Brown Tortoise, *Manouria emys*	Nogeyama Zoo
	Peninsula Cooter, *Pseudemys peninsularis*	Tennoji Zoo
	Star Tortoise, *Geochelone elegans*	Oji Zoo (Kobe)
	Chinese Watersnake, *Enhydris chinensis*	Izu Andyland

TABLE 3. Continued.

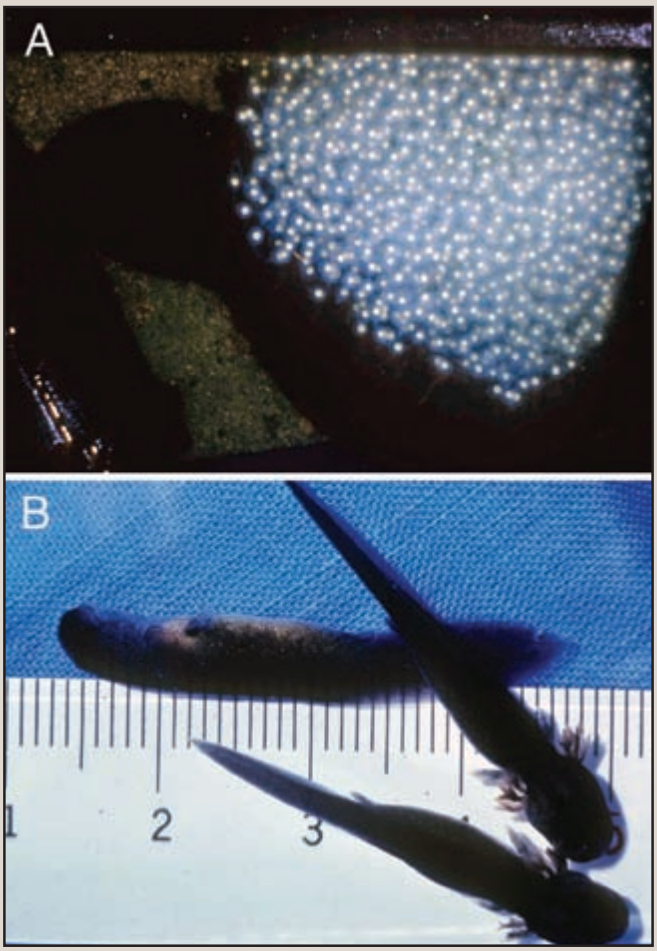
Year	Species	Collection
1998	Smoky Jungle Frog, *Leptodactylus pentadactylus*	Toba Aquarium
	Poison Dart Frog, *Epidobates tricolor*	Toba Aquarium
	Annam Leaf Turtle, *Mauremys annamensis*	Izu Andyland
	Pacific Boa, *Candoia carinata*	Ueno Zoo
1999	Emperor Newt, *Tylototriton verrucosus*	Higashiyama Zoo
	Yellow-and-blue Poison Dart Frog, *Dendrobates tinctorius*	Higashiyama Zoo
	Kokoe-pa Poison Dart Frog, *Oophaga histrionicus*	Higashiyama Zoo
	Yellow-banded Poison Dart Frog, *Dendrobates leucomelas*	Port of Nagoya Public Aquarium
	Golfodulcean Poison Dart Frog, *Phyllobates vittatus*	Port of Nagoya Public Aquarium
	Cuban Tree Frog, *Osteopilus septentrionalis*	Sunshine Aquarium
	South American Waxy Tree Frog, *Phyllomedusa hypocondrialis*	Toba Aquarium
	Green Turtle, *Chelonia mydas*	Okinawa Expo Aquarium
	African Pancake Tortoise, *Malacochersus tornieri*	Ueno Zoo
	African Spurred Tortoise, *Geochelone sulcata*	Kofu Yuki Park Zoo
2000	Otton Frog, *Rana subaspera*	Nagasakibana Parking Garden
	Bicolored Poison Dart Frog, *Phyllobates bicolor*	Port of Nagoya Public Aquarium
	Isla Mona Robber Frog, *Eleutherodactylus monensis*	Toba Aquarium
	Common Mud Turtle, *Sternotherus odoratum*	Izu Andyland
	Three-toed Box Turtle, *Terrapene carolina triunguis*	Kofu Yuki Park Zoo
	Inland Bearded Dragon, *Pogona vitticeps*	Tobu Zoo
	Common Blind Snake, *Ramphotyphlops braminus*	Ueno Zoo
2001	Hokuriku Salamander, *Hynobius takedai*	Ishikawa Zoo
	River Terrapin, *Pangshura tecta*	Nogeyama Zoo
	Burmese Star Tortoise, *Geochelone platynota*	Higashiyama Zoo
	Chinese Alligator, *Alligator sinensis*	Maruyama Zoo
2002	Florida Red-bellied Turtle, *Pseudemys nelsoni*	Tennoji Zoo
2003	Hawksbill Turtle, *Eretmochelys imbricata*	Port of Nagoya Public Aquarium
	Chinese Eyelid Gecko, *Goniurosaurus luii*	Higashiyama Zoo
	Yellow-billed Watersnake, *Enhydris plumbea*	Toba Aquarium
	False Gavial, *Tomistoma schlegelii*	Kusatsu Tropicana
2004	European Yellow-bellied Toad, *Bombina variegata*	Tennoji Zoo
	Indochinese Box Turtle, *Cuora galbinifrons*	Maruyama Zoo
	Johnson's Crocodile, *Crocodylus johnsoni*	Atagawa Tropical & Alligator Garden
2005	Schlegel's Foam-nest Frog, *Rhacophorus schlegelii*	Osaka Aquarium
	Surinam Toad, *Pipa pipa*	Noichi Park Zoo
	Splashback Poison Dart Frog, *Adelphobates galactonotus*	Sunshine Aquarium
	Common Watersnake, *Enhydris enhydris*	Toba Aquarium
2006	Lovely Poison Dart Frog, *Phyllobates lugubris*	Ueno Zoo
	Bell's Hingeback Tortoise, *Kinixys belliana*	Yokohama Zoo
	Forest Stumptail Chameleon, *Rieppeleon kerstenii*	Yokohama Zoo
	African Flat-tailed Gecko, *Hemitheconyx caudicinctus*	Fukuoka Zoo
2007	Japanese Black Salamander, *Hynobius nigrescens*	Gifu World Freshwater Aquarium
	Wrinkled Frog, *Glandirana rugosa*	Inokashira Park Zoo
	Central Asian Tortoise, *Testudo horsfieldii*	Chausuyama Zoo
2008	Japanese Brown Frog, *Rana japonica*	Tokyo Sea Life Park
	Fly River Turtle, *Carettochelys insculpta*	Port of Nagoya Public Aquarium

Along the way the variety of species that bred for the first time skyrocketed, as if it had passed the tipping point somewhere in recent history. Among the species, earlier years saw larger and "exotic" reptiles, such as giant snakes, frequenting the list. (To be fair, it is commendable to breed them, for it requires investment for larger captive spaces.) The newer data show reproduction by a wider range of families and genera, particularly smaller native species, both common and rare ones. Many of the latter are from small islands well off the mainland, and their ranges represent little dots on the map. This marks a significant step for professionals and public alike.

Japan forms a chain of islands strung out over a surprisingly vast area, and the general public has no idea about indigenous species from remote islands, such as those in the Okinawa region, home to unique wildlife. There is a need for the public to be made aware of these small living treasures, and having them in local zoos and aquariums signals a good start. Breeding results of these species seem to indicate refreshing interest taken by zoos and aquariums. Potentially, such successes could also signal the beginning of a departure from the tight grip by the aforementioned old-style duo of the typical municipal zoo. Symbolizing such a departure, possibly, are little-known small creatures with seemingly little public appeal, such as Sword-tailed Newt (*Cynops ensicauda*), Japanese Warty Newt (*Echinotriton andersoni*), Ishikawa's Frog (*Odorrana ishikawae*), Otton Frog (*Rana subaspera*), Ryukyu Brown Frog (*R. "okinavana"*), Amami Green Tree Frog (*Rhacophorus viridis*), Ryukyu Kajika Frog (*Buergeria japonica*), Sakishima Tree Lizard (*Japalura polygonata*), Hime Habu (*Ovophis okinavensis*), and Ryukyu Watersnake (*Amphiesma pryeri*).

Among examples of accounts on native species is a brief note on the Wrinkled Frog (*Glandirana rugosa*) from Inokashira Park Zoo in a Tokyo suburb, which indicates animal care employees' own initiative and interest in a common local species (Anon. 2009). For more uncommon species, a report from Nagasakibana Parking Garden reveals bits and pieces on reproductive biology of little known Ishikawa's Frog (*Odorrana ishikawae*), including reference to *in situ* survival of the larvae (Shiihara et al. 1995). As for common reptiles, an article on the breeding of the Japanese Burrowing Ratsnake (or earth snake, *Euprepiophis conspicillata*) at Yagiyama Zoo states that the opening of the reptile building in 1978 enabled the maintenance of parent snakes in an indoor setting (Takechi et al. 1984). This emphasizes the importance of such permanent facilities to accommodate the needs of the animals. The number and variety of taxa in Table 3 may not be impressive in the eye of experts in Western zoos, yet they reflect progress toward one of the goals of modern zoos and aquariums.

Research activities.—Herpetological research in zoos and aquariums tends to be empirical by nature. Much of the body of literature from Japan consists of applied fields and leans toward practicality, such as microbiological and pharmacological notes or pathological examinations by veterinarians, feeding methods, and data on reproductive biology. One report dealt with chemical immobilization of reptiles for sexing (Yamamoto et al. 1991); another was a summary of a 14-year experience in parasitology (Miyashita et al. 1987). Other accounts explore beyond the realm of problem-solving of daily care, and dig into more familiar areas of biology. For instance, Hatase (2001) made observations on parental behavior of the West African Dwarf Crocodile (*Osteolaemus tetraspis*). A rather unusual work by Doi (2005) reported that albino Black-spotted Pond Frogs (*Pelophylax nigromaculata*) were preferred over normal-colored individuals by predators.



PHOTOS BY ASA ZOO

FIG. 10. A) Eggs of the Japanese Giant Salamander (*Andrias japonicus*) and a defending male, den master (below left); B) larvae.

Among the published work inclined toward more analytical and quantitative bent are accounts on Loggerhead Turtles (*Caretta caretta*) by the staff of Port of Nagoya Public Aquarium. Opened in 1992, this newcomer has already laid down an impressive track record. However, inadvertently they have illustrated a familiar Japanese pattern, that in a technical domain such as scientific research, aquariums are ahead of zoos. Here follow a few examples. Authors helped to establish baseline values in hematologic characteristics and plasma chemistry in captive juvenile turtles, from one month to three years old (Kakizoe et al. 2007). Observations were also made on reproductive behavior, focusing on the relationship between mating history and reproductive successes of individual females, by fully utilizing the close proximity of subject animals in captivity, and sophisticated equipment such as supersensitive cameras (Sakaoka et al. 2007). Furthermore, they investigated the effects of the order of sequential matings in females on the paternity of their successive clutches (Sakaoka et al. 2011).

Ex situ conservation.—In 1988, the JAZGA (now JAZA) board created the Species Survival Committee of Japan, or SSCJ, to formulate a collective species management program similar to European Endangered Species Programme (EEP) in Europe, Joint Management of Species Group (JMSG) in the British Isles, and Species Survival Plan (SSP) in North America. An initial list of 32 taxa was heavily mammalocentric, with no amphibians or reptiles. During the conference in the following year the Japanese Giant Salamander was added. A coordinator was assigned


PHOTO BY PORT OF NAGOYA PUBLIC AQUARIUM

FIG. 11. Loggerhead Sea Turtles (*Caretta caretta*) copulating.


PHOTO BY PORT OF NAGOYA PUBLIC AQUARIUM

FIG. 12. Ovipositioning of a Loggerhead Sea Turtle (*Caretta caretta*) in an indoor facility.


PHOTO BY PORT OF NAGOYA PUBLIC AQUARIUM

FIG. 13. Emergence of Loggerhead Sea Turtle hatchlings.


PHOTO BY PORT OF NAGOYA PUBLIC AQUARIUM

FIG. 14. Hand-feeding of a Leatherback Sea Turtle.

to each taxon to oversee the program (Kawata 1991). By 2008, 15 herp species were on the list as follows: Japanese Giant Salamander (*Andrias japonicus*), Hokuriku Salamander (*Hynobius takedai*), Hakuba Salamander (*H. hidamontanus*), Japanese Warty Newt (*Echinotriton andersoni*), Ishikawa's Frog (*Odorrana ishikawae*), Aldabra Tortoise (*Dipsochelys dussumieri*), Radiated Tortoise (*Astrochelys radiata*), Spotted Pond Turtle (*Geoclemys hamiltonii*), Indian Roof Turtle (*Pangshura tecta*), Ryukyu Black-breasted Leaf Turtle (*Geoemyda japonica*), Chinese Alligator (*Alligator sinensis*), Dwarf Crocodile (*Osteolaemus t. tetraspis*), Gharial (*Gavialis gangeticus*), False Gavial (*Tomistoma schlegelli*), and Ryukyu Ground Gecko (*Goniurosaurus kuroiwae*) (JAZA 2009b).

During 2007, the ninth conference of amphibians and reptiles and the fourth giant salamander conference were held for various issues and problems. On the agenda for the 2008 SSCJ conference were timely topics, such as the Amphibian Ark Year of the Frog campaign, and JAZA was to participate in public education to increase the awareness concerning the critical status facing frogs of the world. Also, preventative strategies were discussed to keep the chytrid infection from spreading (JAZA 2009b).

In situ conservation.—More recently, interest in indigenous species and conservation activities have been gradually increasing across the country. (The giant salamander program represents by far the most significant accomplishment by zoo and aquarium staff; see above for references.) Subject species range from the larger and more prominent, to smaller and less noticeable to the general public. As an example for the former, Hitachi Zoo staff noted that the local coastal area is close to the northernmost breeding beaches of the Loggerhead Turtle in Japan. Eggs are often in vulnerable conditions, prompting zoo staff to collect and artificially incubate them and release the neonates. Between 1976 and 1992, 604 eggs were collected, 233 hatched and neonates were released (Oikawa 1993).

The Japanese Fire-bellied Newt (*Cynops pyrrhogaster*) was once considered a common species with a wide distribution. It now has disappeared almost completely from lowlands for many reasons (Goris et al. 2004). Beginning in 2002, staff members from Tama and Inokashira Park Zoos have been gathering various basic ecological data in the nearby field (e.g., Nakamura et al. 2008). Compared to this species, the Misty Salamander (*Hynobius nebulosus*) has a smaller distribution in western Japan, and its habitat is believed to be rapidly disappearing. Upon request by a municipal government in 2007, the staff of Gifu World Freshwater Aquarium took the first step toward saving the species by keeping egg sacs and larvae in captivity from collectors. This was an emergency measure, and future approaches include coordination of activities by various agencies (Tanoue et al. 2008). Another smaller institution with limited resources, Wanpaku Kochi Animal Land, made it an institutional commitment to inaugurate a conservation program of the locally threatened Oita Salamander (*Hynobius dunni*) in 2001. The staff has collected basic data on ecology and reproductive biology (Nakanishi et al. 2005). A similar project began in 2008 for the Japanese Black Salamander (*Hynobius nigrescens*) by another smaller institution, Nagano

PHOTO BY KEN KAWATA



Fig. 15. Atagawa Tropical Garden & Alligator Farm.

Chausuyama Zoo, after the staff was inspired by the international Year of the Frog campaign (Takada 2010).

For centuries, rice paddies in Japan provided home for wildlife including frogs, which harmoniously coexisted with humans. The Daruma Pond Frog (*Pelophylax porosus brevipoda*) spends its entire life in the rice paddies. As development began to encroach into rural areas its safe haven now faces serious threats. In 2008, construction site preparation was being planned in the frog's habitat in Hiroshima Prefecture, at the western limits of its distribution. To save them from certain destruction, 232 larvae were captured and taken to five organizations including Asa Zoo, a medium-sized zoo opened in Hiroshima in 1971. Thus began the zoo's conservation project, to breed and release the frogs into safer areas as well as to educate the public, especially children, about the importance of this native species. A breeding tank and overwintering facilities have been set up, where the frogs matured and began breeding in June 2005.

A total of 1600 tadpoles were hatched, and in July 2005 they were released at two new sites. In such a project it is vital for local residents to participate, and the staff made every effort to develop rapport with them. In one county the cooperation of the local people was obtained when the zoo staff conducted a meeting, attended by hundreds of enthusiastic residents along with elementary school students. Releases have continued every year in this community, and survival and breeding have subsequently been confirmed. Establishment at another site remains unconfirmed, and plans are being made to improve conditions at the site. The frogs are also on exhibit at Asa Zoo, and events are held to highlight the plight of the frogs (Chamura et al. 2008). Thus Asa Zoo, which inaugurated the pioneering giant salamander conservation project in the early 1970s, continues to make contributions to conserve native wildlife.

Envoy

For a special issue on herpetology for *Zoo Biology* in 1996, recruitment for authors was made: "…we sought colleagues who were conducting research at zoos and those at academic institutions who were conducting research that had relevance to zoo herpetology. Numerous workers have recently made compelling arguments that increased interactions between academic and zoo biologists would be mutually beneficial. They identified several areas of research that seemed important and would make wise use of the often under-utilized herpetological collections of zoos. A few key areas identified were stress and husbandry, competence of captive animals, and veterinary herpetology" (Garrett et al. 1996). What surfaces from this brief note, made a decade and a half ago, is the keen awareness for the need of productive interactions and collaborations between the two worlds. It also points up the existence of a core group of herpetologists, who have been the source of activities and published accounts.

By comparison, to the best of my knowledge Japan has yet to produce such a core group, despite persistent efforts by a small number of individuals. I often wonder if this lack of crystallization of a core group is partly due to Japan's culture that uniquely discourages individualism, embodied by the saying: "A nail that sticks out shall be hammered down." The culture does not allow an outstanding individual to grow, develop, and become visible. A potential high achiever is often forced to blend into the very fabric of the society: group loyalty and acceptance. Cultural difference or not, however, an embryonic movement in zoo herpetology has already begun, albeit slowly, as indicated in this account. From all indications the seed has been sown, and the movement is there to stay, but still largely unnoted by the Western zoo world. What will the future hold? This article is meant to be a brief review. More detailed accounts, including those that cover future events, have to be published and preferably that will be the work of authors from Japan.

Acknowledgments.—This article is dedicated to my long-time friend Richard C. Goris, a native of Buffalo, New York. A resident of Japan since 1950, he was the principal mover in founding the Herpetological Society of Japan in 1967, for which he served 12 years as president. Dr. Goris has been a mentor to generations of herpetologists in Japan. I am grateful to the Japanese Association of Zoos and Aquariums for providing publications over the decades and to Mr. Katsunori Sotani of Tokyo for giving me access to related literature. Photos for this article have been generously provided by Ms. Yoriko Mochimaru of Tokyo Zoological Park Society, Messrs. Shinichiro Chamura of Asa Zoo, Ken Sakaoka of Port of Nagoya Public Aquarium, and Akiyoshi Nawa of Tokyo.

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A KERANGAS FOREST FLOOR (2011)

acrylic on illustration board 30" x 20"

Of all of Borneo's varied ecosystems, perhaps none is more surprising than the biologically impoverished (by equatorial standards) dwarf forests that occur throughout the island, but more commonly in the west. The ecologist P. W. Richards called them "heath forests" after the similarly infertile lands of his native England, but they're better known by the Iban term *kerangas*, which means "land which will not support rice cultivation." Kerangas soil is typically acidic, sandy, and podzolized, or heavily leached. Essential elements enter the soil from decaying leaf litter, but most of these—magnesium, carbon, nitrogen, and calcium in particular—leach away very quickly, and are only available in the top few inches. Phosphorus seems to leach away more slowly. Continual deposition of leaf litter is critical to the system, and disease, fire, and logging or clearing for agriculture will convert kerangas to a barren habitat dominated by grasses and sedges known as *padang* ("field" in Malay).

Despite the poor soil, healthy kerangas forests are dense with trees, most of them under 30 feet tall and three inches in diameter. In contrast to most equatorial forests, only a few species are represented. Dominant tree species usually belong to the mangosteen family, Clusiaceae, and to one or more of the genera *Cratoxylum*, *Calophyllum*, and *Ploiarium*. Orchids show the greatest species diversity among kerangas plants, and terrestrial as well as epiphytic species are usually in evidence. Species of melastomes, laurels, myrtles, and gingers are also commonly represented.

Many kerangas plant species bear nitrogen-fixing bacterial nodules on their roots, and carnivorous plants also thrive. Borneo's kerangas forests are a center of diversity for the pitcher plant genus *Nepenthes*, which trap insects in leaves that are modified into water-bearing pitchers. At least one Bornean species, *N. rajah*, secretes a nectar that attracts tree shrews whose droppings are captured in the pitcher to nourish the plant. In perennially wet padang habitat, Bladderworts (*Utricularia* spp.) and Sundews (*Drosera* spp.) also trap small arthropods. Another famous kerangas denizen is the epiphytic ant plant (*Hydnophytum* spp.), which forms a symbiotic relationship with ants, providing them shelter, while receiving protection from the colony and nutrients from its wastes.

This painting depicts a small patch of kerangas forest floor. Included in the leaf litter are shed leaves of the dominant tree *Cratoxylum glaucum* and shed needles of the podocarp (primitive conifer) *Dacrydium becarii*. Various mosses of the family Calymperaceae and the showy terrestrial slipper orchid *Paphiopedilum javanicum* grow from the soil and a single dried *Nepenthes ampullaria* pitcher sits on the floor while pitchers of *N. stenophylla* hang from epiphytic vines. Duméril's Monitor (*Varanus dumerilii*) occurs near rivers in various types of forest throughout the island. The hatchlings, like the one shown, are well known for their striking coloration. It has been suggested that the colors, which begin to fade at the age of six weeks, mimic the dangerously venomous Red-headed Krait (*Bungarus flaviceps*), which shares its Southeast Asian range. Among Borneo's diverse and beautiful dragonflies, probably none is more conspicuous than the Red Swampdragon (*Agrionoptera insignis*), a member of the skimmer family, Libellulidae. Other subjects include the left-handed land snail *Dyakia kintana* and a Giant Forest Ant (*Camponotus gigas*), whose dimorphic workers forage for honeydew and other organic matter on the ground and in the canopy. At over an inch in length, the major workers of this species are among the world's biggest ants. Finally, a procession of *Longipeditermes longipes* termites returns to the nest with balls of lichen in tow. Both the workers and soldiers of this monotypic genus come in two sizes. Like other members of their subfamily, Nasutitermes, the heads of the soldiers are distorted into nozzles, through which they can spray noxious chemicals at enemies, chiefly ants.

The Artist

With over 20 years as a professional artist, naturalist, and author, **Carel Pieter Brest van Kempen's** artistic mission has always been to deepen awareness of the natural world and how it functions. His work has been exhibited worldwide in such venues as The Smithsonian, The American Museum of Natural History, The British Museum, and The National Museum of Taiwan. He has been named a "Most Honored Artist of Utah" (2002) and a "Master Signature Member" of the Society of Animal Artists (2008). He has illustrated over a dozen books, including *Dinosaurs of Utah* (1998), *Biology of the Gila Monsters and Beaded Lizards* (2005), *Biology of the Boas and Pythons* (2007), *Urban Herpetology* (2008), and *Conservation of Mesoamerican Amphibians and Reptiles* (2010), and authored the popular coffee-table book, *Rigor Vitae: Life Unyielding* (2006). His touring one-man show, "Biodiversity in the Art of Carel Pieter Brest van Kempen" has most recently been held over at the Hiram Blauvelt Art Museum in New Jersey through June of 2012. Additional paintings may be viewed at: http://www.cpbrestvankempen.com/.

ARTICLES

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Genetic Identity, Geographic Ranges, and Major Distribution Records for Frugivorous Monitor Lizards of Luzon Island, Philippines

Some of Southeast Asia's most enigmatic reptile species include the arboreal, frugivorous monitor lizards of the central and northern Philippines (Auffenberg 1988; Gaulke and Curio 2001; Welton et al. 2010). Comprised of just three known species, this morphologically, ecologically, and phylogenetically distinct group has even been assigned to its own subgenus, *Philippinosaurus* (Mertens 1962; Pianka et al. 2004) on the basis on cranial features and dentition.

Knowledge on the biology of the Philippines' frugivorous monitor lizards has been slow to accumulate. The first known species (*Varanus olivaceus*, of Luzon, Polillo, and Catanduanes islands; Fig. 1) has been shrouded in mystery and confusion from the time that it first became known to science (Gray 1845; Hallowell 1857; Mertens 1942a–c, 1959, 1962; Taylor 1922). For more than a century it was thought to be extinct, until a rediscovery made possible the first thorough taxonomic description (Auffenberg 1976). Later Auffenberg (1988) performed extensive studies of its diet, natural history, habitat, home range ecology, and demographic population structure. Unfortunately, no additional studies on this elusive and poorly known species have been published in peer-reviewed, scientific literature.

In 2001, Gaulke and Curio (2001) published the description of an exceptionally rare and severely threatened second species in this group, *V. mabitang*. The biology of this species has been studied in some detail and we now have a general appreciation of its diet, ecology, geographic range (Gaulke et al. 2002, 2005; Gaulke 2005, 2010; Gaulke and Demegillo 2008) and conservation status ("Vulnerable;" IUCN 2011) on Panay Island.

A third species, *V. bitatawa*, was described in 2010 (Welton et al. 2010; Siler et al. 2010) in the central and northern Sierra Madre Mountain Range of Luzon Island (Fig. 1). Although the study by Welton et al. (2010) demonstrated the morphological, ecological, and phylogenetic distinctiveness of *V. bitatawa*, no additional data on its distribution, natural history, or conservation status have been forthcoming.

For the past several years, as part of extensive biodiversity studies aimed at understanding the patterns of distribution of Luzon's amphibians and reptiles (Brown et al. 1996, 2000, *in press*; Devan-song and Brown 2012; McLeod et al. 2011; Siler et al. 2010), we have accumulated additional distribution records and genetic samples for *Varanus olivaceus* and *V. bitatawa*. Because little to no new information for the Luzon faunal region has been provided, aside from the studies of Auffenberg (1988) and Welton et al. (2010), our new findings constitute major range extensions for both species. Additionally, to circumscribe geographic ranges and species boundaries, we present new genetic data from the northern and western-most records for both species. Our results greatly extend the known ranges of both species, bolster species boundaries, contribute to our current understandings of genetic divergence between the taxa, and provide new opportunities for studies of natural history and conservation genetics of these rare, endemic Philippine forest monitors.

Materials and Methods.—Field survey protocols have been reported in Brown et al. (1996, 2000), Diesmos et al. (2005), Siler et al. (2011), and McLeod et al. (2011). We obtained vouchered (preserved specimens deposited in the National Museum of the Philippines, PNM, and Biodiversity Institute, University of Kansas, KU) genetic samples from new localities for *V. olivaceus* and *V. bitatawa*, and supplemented Welton et al.'s (2010) mitochondrial dataset with new genetic sequences from the NADH dehydrogenase subunit 1 (*ND1*) and flanking tRNAs (Welton et al. 2010). Because we prefer to use specimens from known localities whenever possible, we did not include Ast's (2001) *V. olivaceus* sequence (obtained from a zoo animal), which is of unknown provenance. We follow the same methods reported in Welton et al. (2010), including primer identity and use, PCR amplification and sequencing protocols, purification techniques,

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alignment methods, targeted gene region, and methods for phylogenetic analysis (additional details are provided in the supplemental information accompanying Welton et al. [2010]). Thus, we added four additional sequences to the same *ND1* data set presented in Welton et al. (2010) and re-ran the same analyses, including the new genetic samples reported here. All specimens were initially identified on the basis of patterns of coloration (Fig. 2) and scalation (Auffenberg 1976, 1988; Welton et al. 2010). The *V. olivaceus* specimens included PNM 9726, from the boundary between the Municipalities of Polillo and Burdeos, Polillo Island; KU 322186 from the Municipality of Presentacion, Camarines Sur Province; KU 329517 from Angat Dam Watershed, Bulacan Province; PNM 9780 from Mt. Palaya-Palay, Cavite Province. The *V. bitatawa* samples include PNM 9719 (holotype), from the Municipality of Casiguran, Aurora Province; KU 322188 (paratype), the Municipality of San Mariano, Isabela Province; KU 330730, Barangay Magrafil, Municipality of Gonzaga, Cagayan Province; and KU 330636, Barangay Santa Clara, Municipality of Santa Clara, Cagayan Province. New mitochondrial gene sequences collected in this study are deposited in Genbank (KU Catalog numbers/Genbank Accession numbers: KU 329517/JQ413241, PNM 9780/JQ413242, KU 330636/JQ413243, KU 330730/JQ413244).

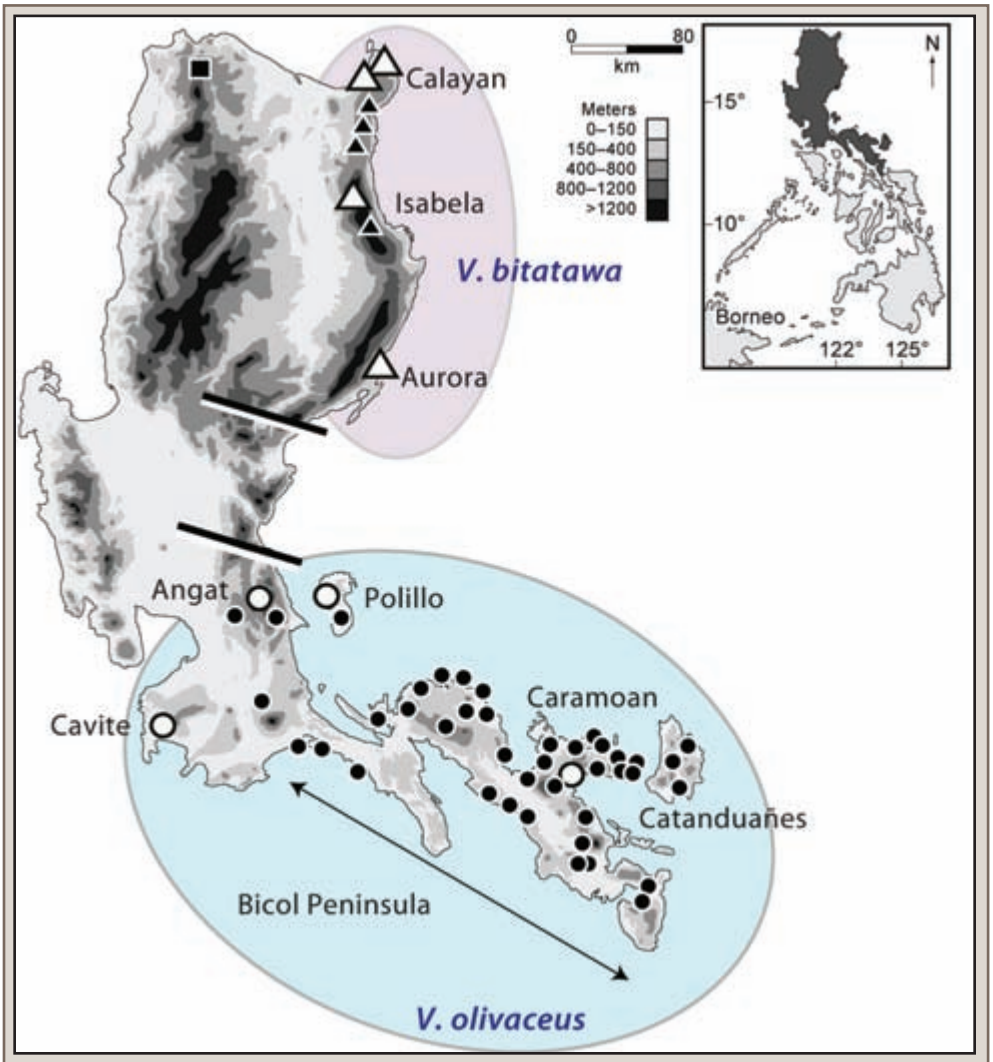


FIG. 1. Known distribution of Luzon's arboreal, frugivorous monitor lizard species. Circles denote known localities for *Varanus olivaceus*; triangles indicate vouchered localities for *V. bitatawa*. Small, closed symbols represent past records (Auffenberg, 1988; Welton, et al., 2010) and large, unshaded symbols are recent records for which genetic samples were available for the present study. The darkened square indicates the Municipality of Adams, where possible signs of an arboreal monitor lizard were observed in June 2011. Black bars indicate the approximate boundaries of the Mid-Sierra Filer Zone, as defined by Welton et al. (2010).

Results and Discussion.—Our record of *V. olivaceus* from the Angat Watershed of Bulacan Province constitutes the northernmost Luzon Island recorded occurrence for this species. Likewise the new specimen from Mt. Palay-palay, Cavite Province, represents the westernmost distributional record for *V. olivaceus*, and a major new range extension into the mountains of western Luzon, where no frugivorous or arboreal species of monitor lizard has ever been recorded (Auffenburg 1988; Devan-song and Brown 2012; Welton et al. 2010; Fig. 1). Finally, our new records of *V. bitatawa* from the Municipality of Gonzaga, Cagayan Province, constitute the northernmost records for this taxon.

Interestingly, despite targeted biodiversity surveys in the Municipalities of Maria Aurora and Mingan, Aurora Province (Siler et al. 2010), no known-locality records from within the 150 km gap, now recognized as the Mid-Sierra Filter Zone (Welton et al. 2010), have surfaced, although trade samples of uncertain provenance have been observed in markets in the town of Baler (ACD, pers. obs.). Although our new record of *V. olivaceus* from Angat Watershed narrows the distributional gap between the two species (Fig. 1), Welton et al.'s (2010) hypothesis that the Mid-Sierra Filter Zone may have led to the divergence of the two species still appears to be the best explanation for understanding the split between *V. olivaceus* and *V. bitatawa*. The coincident position of the three low-lying, arid river valleys (possibly serving as ecological barriers to dispersal for forest species; Welton et al. 2010), and the Lingayen-Dingalan geologic fault (possibly leading to physical isolation of species on different components of the Sierra Madre), within the Mid-Sierra Filter Zone (Defant et al. 1989; Yumul et al. 2003) are suggestive, but still do not provide definitive conclusions as to the exact mechanism of divergence between the two taxa.

The Mt. Palay-Palay, Cavite Province record of *V. olivaceus* was quite surprising, because no fruit-eating monitor species has ever been reported from western Luzon. This specimen could represent a natural occurrence of a population of *V. olivaceus* in

PHOTO BY D. S. McLEOD



PHOTO BY RMB



FIG. 2. Photograph in life of (above) *Varanus olivaceus* (Angat Dam Watershed Reserve, Bulacan Province) and (below) *V. bitatawa* (Municipality of Gonzaga, Cagayan Province).

PHOTO BY RMB



FIG. 3. *Varanus bitatawa* (KU 330636) as bush meat, frequently consumed by local Agta townspeoples, in Barangay Santa Clara, Municipality of Gonzaga, Cagayan Province).

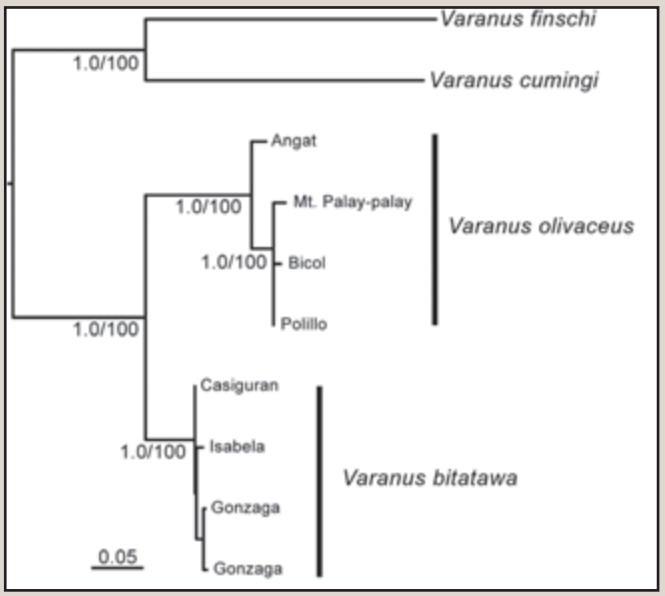


FIG. 4. Maximum likelihood phylogenetic estimate for Luzon frugivorous monitor lizards with support (Bayesian posterior probabilities/likelihood bootstraps) values plotted on selected nodes. Note presence of only minor intraspecific genetic variation within both species and the deep genetic split in *ND1* mitochondrial gene sequences between the two taxa.

the forests of southwestern Luzon, a relatively recent dispersal event (from eastern Luzon), or a human-mediated transplant. The fact that local hunters refer to *V. olivaceus* in Cavite Province with a unique common name, "Shabu," suggests to us that indigenous peoples in the area have a long cultural history with these animals. However, given the fact that illegally poached *V. olivaceus* individuals seized from pet traders have, in the past, been released in Mt. Palay-Palay National Park (C. Custodio, Protected Areas and Wildlife Bureau, Manila, pers. comm.), the possibility of an artificial transplant cannot be discounted. The lack of any appreciable genetic divergence between the Mt. Palay-Palay specimen and individuals from the Bicol faunal region and Polillo supports the interpretation of a recent dispersal event or transplant, but no strong conclusions can be derived from this study involving only a single locus and one mitochondrial gene fragment.

In the northernmost extent of the Sierra Madre Mountain Range, *V. bitatawa* is clearly a common species that constitutes an important food source for indigenous peoples' groups. During our three-week survey in the area in July–August 2010, we salvaged two specimens after they were snared in traps or hunted down by dogs belonging to Agta tribesmen (both specimens clearly were destined for immediate consumption by Agta family groups). Hunters interviewed in and around the Municipality of Gonzaga described *V. bitatawa* as a highly prized, commonly hunted, and valued trade item in the local bush meat market (Fig. 3).

To date, there are no substantiated records to suggest that arboreal, frugivorous monitor lizards are present in northwest Luzon. In 2011 we found characteristic scratch marks on fruiting *Pandanus* trees in the vicinity of Pagudpud, Ilocos Norte Province (Fig. 1; northern Cordillera Mountain Range) which suggests that *V. bitatawa* (or, possibly, some other arboreal and frugivorous species) may be present in the area (Brown et al., *in press*). Local residents at this site informed us of only one kind of *Varanus*, known locally as "Biawak," and described as a ground-dwelling species (clearly identifiable as *V. marmoratus*, the common Luzon water monitor). However, given the extreme secrecy of arboreal monitor lizards (Auffenberg 1988; Gaulke et al. 2002,

TABLE 1. Uncorrected pairwise sequence divergences (%, below diagonal) among individuals throughout the geographical ranges (sites in parentheses; see text) of *Varanus olivaceus* and *V. bitatawa*. *Varanus finschi* and *V. cumingi* were designated as outgroup in the phylogenetic analysis (Fig. 4).

		1	2	3	4	5	6	7	8	9	10
1.	*V. finschi*	—									
2.	*V. cumingi*	0.1550	—								
3.	*V. olivaceus* (Polillo)	0.1570	0.1651	—							
4.	*V. olivaceus* (Bicol)	0.1586	0.1663	0.0028	—						
5.	*V. olivaceus* (Bulacan)	0.1563	0.1642	0.0112	0.0146	—					
6.	*V. olivaceus* (Palay-palay)	0.1559	0.1697	0.0043	0.0043	0.0086	—				
7.	*V. bitatawa* (Aurora)	0.1551	0.1601	0.0374	0.0398	0.0396	0.0403	—			
8.	*V. bitatawa* (Isabela)	0.1606	0.1486	0.0622	0.0618	0.0442	0.0403	0.0034	—		
9.	*V. bitatawa* (Gonzaga–1)	0.1681	0.1486	0.0711	0.0740	0.0495	0.0389	0.0055	0.0078	—	
10.	*V. bitatawa* (Gonzaga–2)	0.1607	0.1461	0.0630	0.0650	0.0442	0.0431	0.0039	0.0061	0.0024	—

2005; Gaulke 2010; Welton et al. 2010), it remains distinctly possible that arboreal monitor lizard populations have yet to be discovered in the northern Cordillera Mountains.

Our preferred phylogenetic estimate (Fig. 4) suggests that specimens identified as *V. olivaceus* and *V. bitatawa* form clades of minimally divergent haplotypes and that the two species are sister lineages (Welton et al. 2010). Genetic divergence within each species was very low (*V. olivaceus* = 0.28–1.45; mean = 0.76%; *V. bitatawa* = 0.34–0.78; mean = 0.48%, Table 1) despite sampling from geographically distant extremes of the ranges of both species. The substantive genetic divergence between the two species (3.74–7.40; mean = 5.27%) (Fig. 4), and the topology of our inferred phylogenetic hypothesis provide further support for the recognition of two widespread, fruit-eating monitor lizard species, geographically partitioned on either side of Luzon's Mid-Sierra Filter Zone (Welton et al. 2010).

Although we have gathered important new data, bearing on the distribution, phylogeny and genetic identity of these poorly known monitor species, much work remains to be done. The IUCN currently lists *Varanus olivaceus* as "Vulnerable," with decreasing population trends "likely" (but unsubstantiated; IUCN 2011). Formal evaluations of the conservation status of *V. bitatawa* have yet to be undertaken. However, based on presumed habitat requirements (intact forest with the appropriate species of fruiting trees), and a clear conservation threat in the form of a substantial bush meat harvest, an informed, field data based, conservation status assessment for *V. bitatawa* would be desirable.

It should be emphasized, however, that for the continued existence of both species, the critical next step is actual field-based study of distribution patterns, natural history, diet, home range ecology, and habitat requirements throughout their known geographic ranges. Until these fundamental subjects receive at least some attention, effective conservation planning for these species will be very difficult, if not impossible (Brown et al., *in press*; IUCN 2011). Collection of these basic data would provide a solid foundation for an effective conservation action and management plan for Luzon's frugivorous monitor lizards and their unique forest habitats.

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Using a Species-Specif c Habitat Model Helps Identify Unprotected Populations of the Federally Threatened Red Hills Salamander (*Phaeognathus hubrichti*)

The Red Hills Salamander (*Phaeognathus hubrichti*) was listed as federally threatened by the U.S. Fish and Wildlife Service in 1976 (IUCN endangered; IUCN 2011) in response to concerns of local herpetologists regarding the impact of habitat degradation on the few known populations at the time (e.g., Jordan and Mount 1975; Mount 1975; Schwaner and Mount 1970). Since listing, research has reported that removal of canopy trees during timber harvest has a negative effect on the remaining populations of *P. hubrichti* (Dodd 1991; Godwin 2008). The federal listing of *P. hubrichti* has provided a degree of protection against the effects of timber harvest in the form of habitat conservation plans (HCPs), administered by USFWS with large landholders. Because the majority of *P. hubrichti* habitat is managed for timber production (Bailey and Means 2004), HCPs are an essential component for species persistence. However, for conservation efforts to expand, extant populations of *P. hubrichti* must be identified. Due to the fossorial life history and patchy distribution of the species, identifying populations outside of known localities is a challenging task.

In 2006, a new population of *P. hubrichti* was discovered in Wilcox County, Alabama, which was not known to harbor any salamanders (M. Bailey, pers. comm.). Prior to this discovery, it was believed that *P. hubrichti* only inhabited the Tallahatta and Hatchetigbee formations within the Red Hills (Dodd 1991). Significantly, the Wilcox County population was found in an entirely different geologic formation, the Nanafalia. The extent of additional, and unprotected, populations outside of the known range is unclear.

Identifying additional populations within Wilcox County is important to the conservation of this narrowly endemic species,

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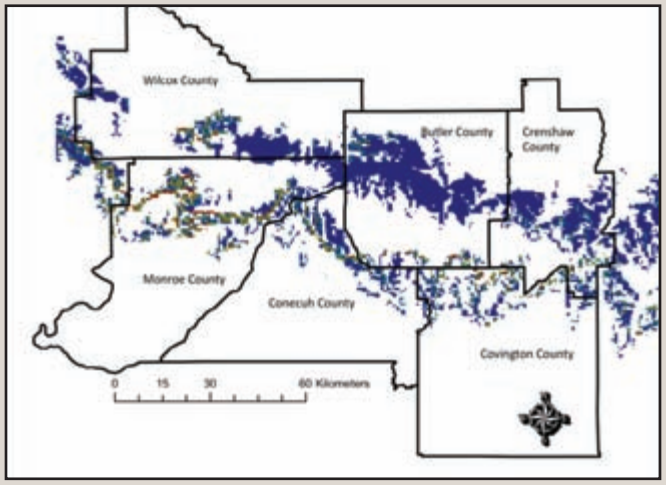


FIG. 1. Species-specific habitat model created for the Red Hills Salamander (*Phaeognathus hubrichti*). The colder colors (blue and greens) represent low model values (i.e., low quality habitat). Warmer colors (oranges and reds) represent higher model value (high quality habitat).

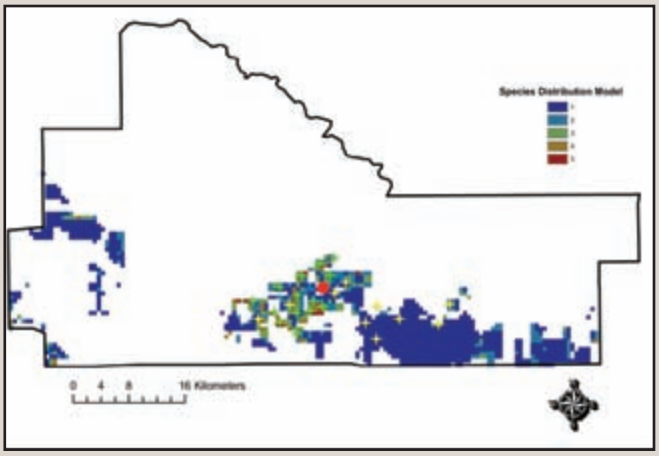


FIG. 2. Survey localities within Wilcox County, Alabama. Green symbols indicate that a population of the Red Hills Salamander (*Phaeognathus hubrichti*) was present; yellow indicates that we were not able to detect individuals or burrows. The red circle indicates the only population of the salamander identified prior to this study in Wilcox County; identified in 2006.

as the rugged terrain and steep slopes might harbor relatively large numbers of Red Hills Salamanders (Apodaca 2010). Our objective here is to identify additional populations of *P. hubrichti* in Wilcox County, Alabama with existing knowledge of habitat requirements integrated into a species-specific habitat model and to ground-truth these results with biological surveys. With this approach, we aim to bolster the conservation of the species and to refine the geographic range of this imperiled and endemic species. Additionally, we seek to demonstrate the utility of species-specific habitat models for identifying unprotected populations of imperiled species.

Methods.—*Phaeognathus hubrichti* is a monotypic plethodontid that is endemic to six counties in southern Alabama, USA. It is restricted to the Red Hills geologic formation, a narrow belt (< 5 km north/south) of Eocene-aged claystone, silt stone, and sandstone (Scott 1972). Within these formations, *P. hubrichti* are only found within mature hardwood or mixed conifer forests on steep (generally > 20°) slopes and ravines. Maintaining a closed canopy and moist forest-floor conditions are also important for population persistence (Dodd 1991; Jordan and Mount 1975). Individual salamanders spend nearly all of their time, including foraging and development of young, underground or at the entrance to their extensive burrows (Bakkegard 2002; Means 2003). Burrow entrances are found only on steep slopes and can be easily identified in the field by their smooth and circular entrance. Due to their straightforward identification, burrows are readily used to survey for *P. hubrichti* presence and population densities (e.g., Dodd 1991; Godwin 2008).

We developed a predictive habitat model based on factors important to describing where populations of *P. hubrichti* occur and combined it with ecological niche modeling to identify additional possible populations of *P. hubrichti*. We used three variables to evaluate suitability of individual grid cells including slope, habitat type, and geology.

Slope was calculated using the national elevational dataset (NED) from the U.S. Geological Survey with a resolution of 1/9 arc seconds (about 3 m). We used the ARCGIS v9.3 spatial analyst extension, which calculates slope as the maximum rate of change between each cell and its neighbors. Thus, the maximum change in elevation between neighboring cells receives the highest value, and flatter terrain receives a lower value. Because *P. hubrichti* commonly are found on steep slopes, this technique allows us to identify suitably steep areas (Dodd 1991). We categorized cells as unsuitable (<15°), poor (16–22°), suitable (22–30°), or excellent (>30°) based on how slope angle affects *P. hubrichti* densities (see Godwin 2008).

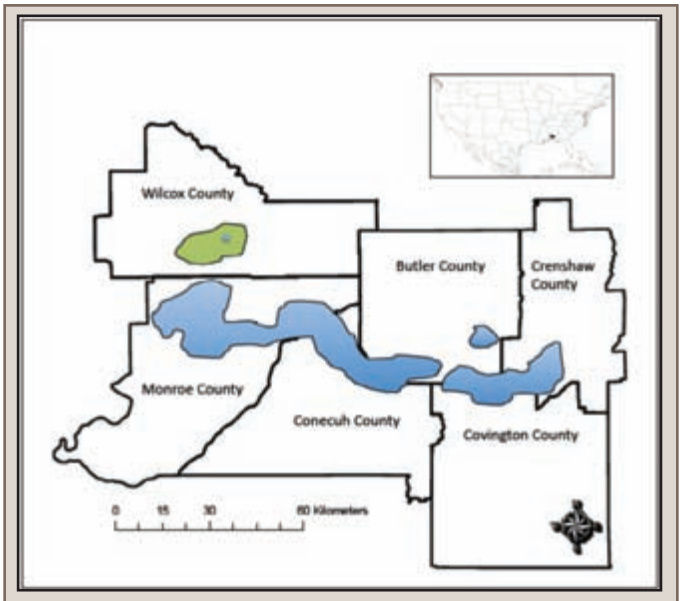


FIG. 3. Species distribution map for the Red Hills Salamander (*Phaeognathus hubrichti*). The blue polygons indicate the extent of the range known prior to this study. The green polygon represents the extent of the populations discovered in this study.

Second, we used the AL-GAP dataset (Kleiner et al. 2007) to identify suitable habitat types for *P. hubrichti*. Based on recently collected *P. hubrichti* localities and life history knowledge of the species (Apodaca 2010; Godwin 2008), we considered East Gulf Coastal Plain Southern Mesic Slope Forest (category 51) as *P. hubrichti* habitat (a detailed description of category 51 can be found at www.SEGAP.org). We assigned this category a value of 1 and all others a 0. Although it is likely that there are small patches

of suitable habitat not identified by this method, we felt they were too small or rare to support a viable population of salamanders. For the geologic formations, we used the Alabama geologic map from USGS (available online at tin.er.usgs.gov). From this data set, we selected the three geologic layers known to be used by *P. hubrichti* (Tallahatta, Hatchetigbee, and Nanafalia) (Bailey and Means 2004).

We divided the range of *P. hubrichti* and the surrounding area into grid cells of 0.005° (roughly 0.5 km^2) using ArcGIS 9.3 (ESRI, Redlands, California). Each cell was assigned a value of suitability based on the additive total of three variables described above: 1) slope, 2) proper habitat type, and 3) proper geologic layer. We eliminated cells that were outside of the climatic envelope created using environmental niche modeling (see methods below).

For the total additive model, cells were categorized using the Jenks optimization method (Jenks 1967) into four basic categories (1.unsuitable, 2.unlikely, 3.suitable, and 4.optimal). The Jenks method is also known as the goodness of variance fit, and is analogous to a one-way analysis of variance. Essentially this method seeks to maximize variance between natural breaks in the data by minimizing the squared deviations of the class means in order to best classify groups in the data.

Next, we used ecological niche modeling (ENM) to remove the areas from the predictive habitat model that are not climatically similar to known *P. hubrichti* populations using Maxent (Phillips et al. 2006). In general, Maxent uses a machine learning approach (i.e., maximum entropy) to predict the probability of occurrence of a species given an equal effort of sampling across the locality data. Maximum entropy modeling is part of a family of statistical approaches (machine learning) that typically outperforms traditional statistical approaches (e.g., generalized linear models) in complex ecological situations (Olden et al. 2008). We used a least point threshold (LPT) in order to determine the Maxent value that would serve as a cutoff for suitable climatic conditions. Although there are several threshold methods for niche modeling (see Pearson et al. 2007), the LPT is conservative and only identifies areas at least as suitable as where the species reportedly occurs. Only cells above the threshold were deemed as climatically suitable. Cells below the LPT were removed from the analysis.

To evaluate the range-wide accuracy of our distributional model we tested for a statistically significant difference between the values of the cells that contain known *P. hubrichti* localities and an equal number of randomly selected cells using an unpaired two-tailed t-test. We used the 130 unique known localities from the Alabama Natural Heritage Program (ALNHP). We then generated two sets of randomly selected cells, one set was randomly selected from the six counties known to contain *P. hubrichti* and another set that was selected just from the area within the six known counties that contained the proper geologic layers. This process evaluated whether our modeling technique identified *P. hubrichti* habitat significantly better than random.

We then used the model to identify areas within Wilcox County that may contain undocumented populations of *P. hubrichti*. We surveyed 16 localities predicted to be in high quality habitat (4.optimal), 4 localities predicted to be in suitable habitat (3.suitable), and 4 localities where the model did not predict presence (2.unlikely), but where topography was suitable for *P. hubrichti*. Since all of the predicted populations within Wilcox County is found on private land, sites were selected based on which sites we could obtain access. Exhaustive surveys were conducted by searching slope habitat for the characteristic burrows of *P. hubrichti*. Only sites with unmistakable burrows (burrows that have been smoothed down by the salamander feeding at the entrance (Godwin 2008)) or where salamanders were observed were considered to have active populations of *P. hubrichti* (see Dodd 1991).

Results.—Our model predicted the most suitable habitat for *P. hubricthti* (4.optimal) covered approximately 524 km^2 (0.54% of total model area) (Fig. 1). Suitable habitat was predicted to cover approximately 3,125 km^2 (3.24% of total model area). Low quality habitat (2.unlikely) accounted for approximately 6,042 km^2 (6.27% of total model area). The majority of the area was unsuitable habitat (89.9%).

Our model did significantly better than random when identifying suitable habitat for *P. hubrichti*. Known localities of *P. hubrichti* were found in cells that had significantly higher model values than locations drawn from random from the six counties that contain *P. hubrichti* ($t_{(129)} = 3.36$, $P < 0.001$). Additionally, known localities of *P. hubrichti* were found in cells that also had significantly higher model values than locations drawn from random from within the three geologic layers known to contain *P. hubrichti* ($t_{(129)} = 3.38$, $P = 0.003$).

Our field survey confirmed that our modeling technique was practical and effective for identifying previously undiscovered populations within Wilcox County, Alabama (Fig. 2). In total we discovered 14 previously undocumented populations of this rare endemic salamander. We found new populations in 13 out of 16 surveyed localities for the highest categories (4.optimal), 1 out of 4 in suitable habitat, and no new populations in the lowest category surveyed (2.unlikely). However, additional surveys should be completed to test this statistically.

Discussion.—Identifying unknown populations is fundamental to the conservation of threatened and endangered species. Several studies have demonstrated the utility of broad scale environmental niche modeling in conservation biology (e.g., Domínguez-Domínguez et al. 2006; Garcia 2006; Ferrier 2002; Raxworthy et al. 2003; Rissler et al. 2006). Here, we have shown that creating fine-scale species-specific models can be a useful approach for identifying areas that harbor unidentified populations of imperiled amphibians. Our model was effective at identifying areas that may harbor unknown populations of *P. hubrichti*. By applying this approach we were able to expand the total area of the known range of *P. hubrichti* by approximately 15% (Fig. 3).

The future persistence of *P. hubrichti* is dependent on the cooperation of land managers. However, proper precautions aimed at safeguarding habitat cannot be taken if populations remain unidentified. Our findings suggest that several other areas may harbor unidentified populations (Fig. 1). We only surveyed a small percentage of the predicted high-quality habitat for *P. hubrichti*, suggesting that other undocumented populations probably occur. Thus, we highly recommend that future surveys be conducted in other optimal and suitable quality habitats to improve the knowledge of the geographic distribution of this threatened species and identify additional opportunities for conservation and recovery.

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A Novel Color Morph and Additional Population of *Raorchestes akroparallagi* (Anura: Rhacophoridae) and a Second *R. chromasynchysi* Population in Karnataka, India

Both *Raorchestes akroparallagi* and *R. chromasynchysi* are recently described members of the frog family Rhacophoridae (Biju and Bossuyt 2009), endemic to the Western Ghats region of southern India. At the time of discovery, these species were considered members of the genus *Philautus*, which has since been revised after a thorough phylogenetic review of the family Rhacophoridae and erection of the genus *Raorchestes* (Biju et al. 2010). Conservation assessments of these species are not available due to a lack of data (IUCN 2011). We present findings of additional populations of these poorly-known species, the first records from Karnataka state.

Study Site and Methods.—In October 2009, we documented the presence of *R. akroparallagi* and *R. chromasynchysi* during biological surveys at Mojo Plantation, a 10-ha spice farm located approximately 10 km from Madikeri, Karnataka (12.47°N, 75.70°E). Certified organic by the Institute for Marketecology (IMO), Mojo Plantation grows a variety of native and exotic spice crops (e.g., coffee, cardamom, black pepper, vanilla) without the use of inorganic fertilizers, pesticides, or herbicides. Crops are grown in low density beneath the rainforest canopy, interspersed with patches of native vegetation. Two streams originate on the property, flowing south toward the Kaveri River. Frogs were collected on nocturnal and crepuscular surveys of this agroecosystem between 1 October and 15 November 2009. Each frog was enclosed in a terrarium, photographed, and released at the location of its capture within 48 h.

We placed each frog in a glass petri dish that was marked in ink with a 20 mm scale bar, and took digital photos at a perpendicular angle to the subject (i.e., straight above or below). We used ImageJ software (version 1.44, NIH, available from: http://rsbweb.nih.gov/ij/; Abramoff et al. 2004) to measure

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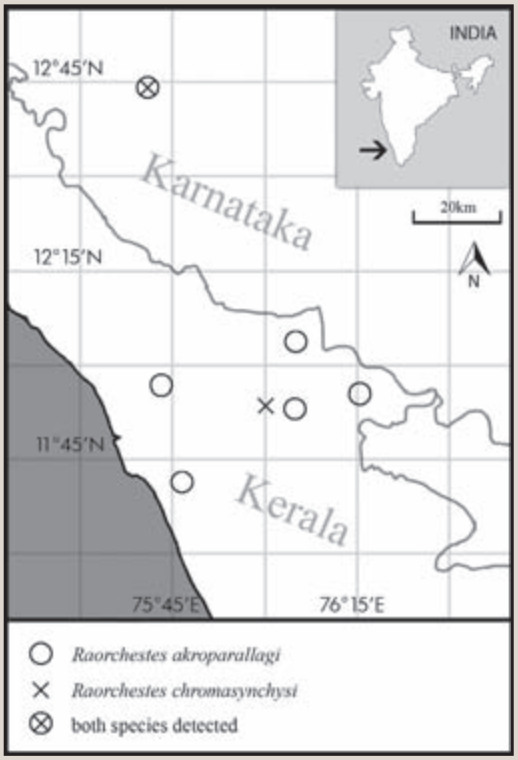
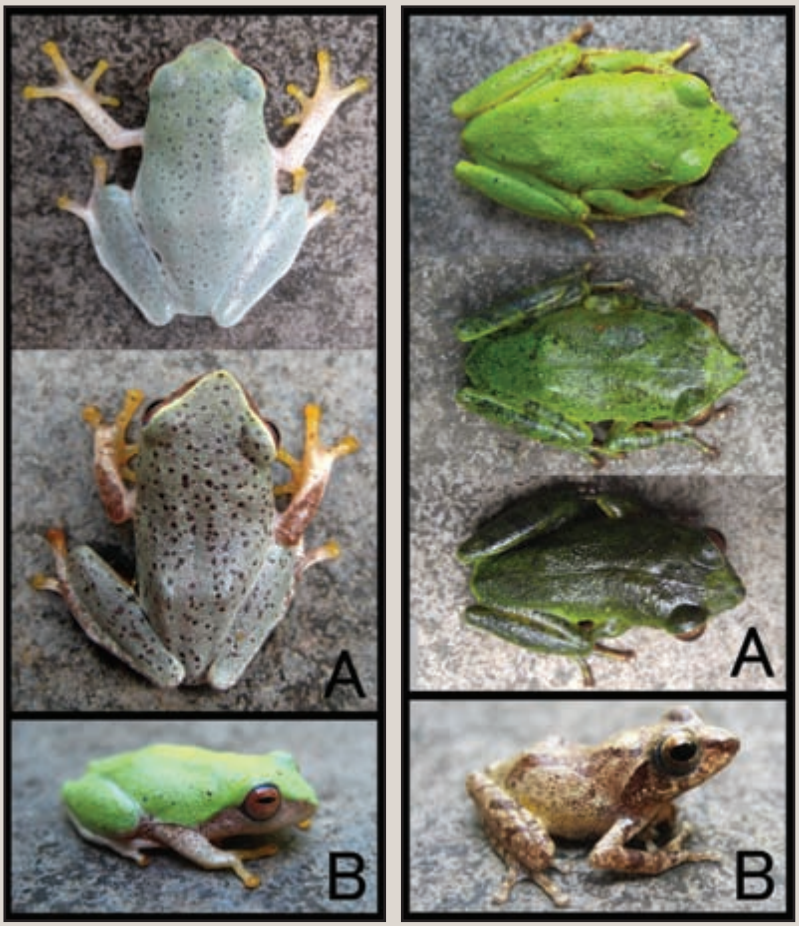


FIG. 1. Some previously known localities in northern Kerala (Biju and Bossuyt 2009) in relation to our study site near Madikeri, Karnataka, India.



PHOTOS BY MATTHEW HALLEY

FIG. 2 (left). *Raorchestes akroparallagi* A) color variation of a single blue morph individual due to metachrosis; B) green morph found in syntopy with blue morph.

FIG. 3 (right). *Raorchestes chromasynchysi* A) color variation of a single green morph individual due to metachrosis; B) brown morph found in syntopy with green morph.

morphometric traits from scaled digital photographs of live specimens (N = 7; Table 1) using the methodology of Antwis and Browne (2008). The following morphometrics were calculated: snout–vent length (SVL); head length (HL), measured from the rear of the mandible to the tip of the snout; head width (HW), measured at the angle of the jaws. Frogs could not be assigned to sex. Due to polymorphism and metachrosis, identification of *Raorchestes* frogs is difficult based on dorsal coloration alone (Biju and Bossuyt 2009); we documented color variation due to metachrosis by photographing individual frogs, in similar light conditions, multiple times over the duration of their captivity.

Raorchestes akroparallagi.—Biju and Bossuyt (2009) described *R. akroparallagi* from Ponmundi (8.75°N, 77.12°E), and reported populations at one site in Tamil Nadu and several sites in northern Kerala (Fig. 1). As its name implies (*akro* is Greek for "extreme," *parallagi* for "variation"), this species exhibits substantial polychromatism. Biju and Bossuyt (2009) described four color morphs from populations in Kerala: 1) grayish white, 2) light green without markings, 3) golden yellow with contrasting brown spots on dorsum and light brown bands on limbs, 4) dark green with yellowish stripe extending laterally from snout to near the vent.

We discovered an additional population near Madikeri, Karnataka, extending the range of this poorly-known species by over 75 km northward and representing a first state record. This population features a morph with a blue dorsum (Fig. 2A) in syntopy with a light green morph (Fig. 2B; similar to paratype BNHS 4388, but with small contrasting spots on the dorsum). A blue morph of this species has been previously found in Wayanad, Kerala, (S.D. Biju, pers. comm.) but has not been described in publication. The blue morph at our study site features a white line that traces the canthal ridge and anterior edge of the upper-eyelid (similar to BNHS 4392, but terminating at the posterior edge of the eyelid). This line appears in high contrast when the dorsum turns dark blue via metachrosis (Fig. 2A). Many dark spots are apparent on the dorsum and hindlimbs of both color morphs, varying in size and irregularly spaced. We collected three individuals (2 blue, 1 green) from leafy vegetation within 2 m of the ground and within 25 m of a stream. Morphometric data are lacking for one of the blue frogs, which escaped from the terrarium before scaled photos were taken.

We identified the specimens (N = 2; Table 1) as *R. akroparallagi* by comparing morphometric data to the identification criteria set forth by Biju and Bossuyt (2009): 1) small adult size (SVL = 20.6 ± 0.7 mm) is consistent with type specimens, 2) yellowish thigh and groin, 3) metachrosis of forearm, loreal and tympanic region ranges from light brown to dark brown (Fig. 2A), a trait that is found in nearly all color morphs of *R. akroparallagi* but absent in other green congeners from the Western Ghats. Blue morphs at our study site also exhibited metachrosis to a lesser extent on their feet (Fig. 2A). No other *Raorchestes* species in the region is known to exhibit this combination of traits.

Raorchestes chromasynchysi.—Biju and Bossuyt (2009) described *R. chromasynchysi* from a single locality; type specimens

TABLE 1. Morphometric measurements (in mm) of five *Raorchestes chromasynchysi* and two *R. akroparallagi* frogs found near Madikeri, Karnataka, India.

Species	Individual	Dorsum Color	SVL	HW	HL
R. akroparallagi	1	blue	21.0	8.2	7.3
	2	green	20.1	7.8	6.8
		Mean	20.6	8.0	7.1
		SD	0.7	0.3	0.4
R. chromasynchysi	1	green	29.4	11.1	9.3
	2	green	26.4	10.2	8.6
	3	green	27.0	9.8	7.1
	4	green	26.7	10.0	8.6
	5	brown	26.2	9.7	–
		Mean	27.1	10.1	8.4
		SD	1.3	0.6	0.9

were collected from a 30 km^2 area on an isolated mountain at Kurichiyarmala (11.57°N, 75.97°E). Our discovery of an additional population near Madikeri extends the range of this poorly known frog species northward by approximately 100 km, and represents the first record of this species from Karnataka state (Fig. 1). All five frogs were collected from leafy vegetation within 2 m of the ground and 10 m of a stream.

We identified all specimens (N = 5; Table 1) as *R. chromasynchysi* by comparing morphometric data to the criteria outlined in the species description (Biju and Bossuyt 2009): 1) medium adult size (SVL = 27.1 ± 1.3 mm) is consistent with type specimens, 2) spinular dorsum, 3) pointed snout, 4) canthus rostralis sharp, 5) posterior surface of thighs dark brown, and anterior surface of thighs and groin dark brown with yellow blotches, 6) dorsal metachrosis ranges from light green to dark green (Fig. 3A), or, in the brown morph, from light brown to dark brown. Four *R. chromasynchysi* frogs showed green dorsal coloration with few markings (similar to paratypes BNHS 4433, 4442), and the fifth frog (Fig. 3B) was light brown with contrasting dark brown markings in an hourglass shape on the limbs and dorsum (similar to BNHS 4438). These markings became less apparent when the dorsum turned dark brown via metachrosis.

R. chromasynchysi is also known for its polychromatism (*chroma* is Greek for "color," *synchysi* for "confusion"; Biju and Bossuyt 2009), and may be mistaken for three similar species with which it forms a monophyletic clade: *R. marki*, *R. tinniens*, and *R. signatus* (Biju et al. 2010). However, *R. chromasynchysi* is the only species of this group for which the groin and anterior thighs are dark brown with yellow blotches, a trait that Biju and Bossuyt (2009) found to be highly consistent in all polymorphs. All of our specimens match this description. Additionally, our specimens have spinular dorsums (vs. slightly granular dorsums of *R. tinniens* and *R. signatus*; Biju and Bossuyt 2009; Bossuyt and Dubois 2001) and lack a horny ridge between the eyes (as in *R. marki*; Biju and Bossuyt 2009).

There are some morphological differences between our *R. chromasynchysi* specimens and those of the Kurichiyarmala population that are worth noting (see Biju and Bossuyt 2009, figure 19): 1) both anterior and posterior thigh patterns are visible in dorsal view, as in other green *Raorchestes* of the Western Ghats (vs. patterns not visible in dorsal view), 2) toe webbing reaches the penultimate subarticular tubercle on both sides of toe IV (vs. up to the distal subarticular tubercle), 3) dorsum color does not extend onto fingers I and II. Further research may reveal these discrepancies to be artifacts of low sample size, representing variation among individuals, or unique characteristics of this population.

Acknowledgments.—We are grateful to Sujata Goel, Maya Goel, and the staff of the Rainforest Retreat for their hospitality and encouragement. We also thank S. D. Biju for assistance in indentifying the frogs, and the associate editor and two anonymous referees for improving the manuscript.

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Sexual Dimorphism and Color Polymorphism in the Wallum Sedge Frog (*Litoria olongburensis*)

Sexual dimorphism describes intraspecific differences in size, shape or other traits between males and females. One of the most common secondary sexual dimorphisms of anuran amphibians is a disparity in size, with adult females commonly exceeding adult males in body size (Howard 1981; Lee 2001; McGarrity and Johnson 2009; Monnet and Cherry 2002). Fecundity selection is proposed to be the driving force behind female-biased sexual size dimorphism (SSD; Darwin 1871), as clutch size and/or egg and subsequently offspring size increase with increasing female body size (Kupfer 2007; Shine 1979; Wells 2007). Selection may not only favor larger females, but also small males, as demonstrated in *Litoria xanthomera* and *L. chloris*, where smaller males used less energy when calling, had increased chorus tenure, and were more successful than larger males (Morrison et al. 2001). Sexual differences in growth, maturation, population age structure, and life history have also been suggested as possible driving forces behind SSD in some species (Howard 1981; Monnet and Cherry 2002; Shine 1979).

Many amphibians exhibit sexual differences in morphology or coloration that allow males and females to be readily distinguished (Hoffman and Blouin 2000; Wells 2007). An example of a secondary sexual characteristic of anurans is the presence of male vocal sacs, used to create advertisement calls to females during breeding events (Ryan 1991). Additionally, males of many anuran species develop nuptial pads, which are predominantly located on the inner surface of the thumb and are used for gripping a female during amplexus, and during male-male competition (Duellman and Trueb 1994). Nuptial pads are generally more developed in aquatic-breeding species (where males need to maintain a strong grip on females in rapidly flowing waters), and in species that engage in aggressive male-male encounters (Duellman and Trueb 1994). As nuptial pads are usually densely pigmented with melanin, and thus easily observed, they are commonly used to determine the sex of amphibians in the field (Duellman and Trueb 1994; Greene and Funk 2009). Additionally, some species display intersexual differences in forelimb size, allowing males to retain a firm grip on the female in amplexus (Lee 2001). Occasionally, males and females possess obvious differences in body coloration, which also facilitates sex identification (Hoffman and Blouin 2000). However, for some species, there are no obvious size or color differences and no nuptial pads, making identification of sex difficult.

The Wallum Sedge Frog, *Litoria olongburensis*, is a small (~25 mm) hylid restricted to coastal swamps of eastern Australia (Barker et al. 1995; Cogger 1995; Ingram and Corben 1975). The species is listed as vulnerable under the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999*, Queensland *Nature Conservation Act 1992*, New South Wales *Threatened Species Conservation Act 1995*, and by the International Union for the Conservation of Nature (IUCN 2010). *Litoria olongburensis* is known to be polymorphic for dorsal coloration, including gray-brown, beige or bright green, occasionally with dark flecking (Barker et al. 1995; Liem and Ingram 1977) (Fig. 1). However, little is known of the color and morphological differences between the sexes and field sex identification in this species can be difficult, predominantly due to their small size. Identification of sexes is essential to determine different habitat use, population sex ratios, and for captive husbandry. We examined sexually dimorphic characteristics of museum specimens and wild populations of *L. olongburensis* to expand our knowledge on the morphology of the species and sex identification in the field. We hypothesize that females will have a larger body length than males, and males will have proportionately larger forearms. Also, we hypothesize that males possess secondary sexual characteristics useful for field identification all year round, such as nuptial pads, vocal sacs, and different coloration relative to females. The results from this study may also assist with our understanding of sexual dimorphism and color polymorphism in congeneric species.



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FIG. 1. Brown (A) and green (B) color morphs of *Litoria olongburensis*.

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Materials and Methods.—Male (N = 40) and female (N = 62) *Litoria olongburensis* held in the Queensland Museum (QM) and originally collected from throughout their distribution in Queensland and New South Wales (NSW), were examined. Snout–urostyle length (SUL), right tibia length (TL), and forearm length (FL) were measured with vernier calipers to the nearest 0.1 mm. Frogs were sexed by inspection of nuptial pads, vocal sac slits under the tongue, and gonads. The numbers of eggs of four preserved females were counted and the mean egg diameter (MED) of ten eggs per female was measured with digital vernier calipers. This was recorded to fill a gap in our knowledge of fecundity in this species and may be used in future comparisons with congeners. Eggs of some females had been previously removed and kept aside, and others still remained within the female's abdomen. Thus, egg numbers may be underestimated due to possible loss of eggs during preservation. As color is greatly affected by preservation, no dorsal color analysis was undertaken on museum specimens.

Measurements of male (N = 104) and female (N = 92) *L. olongburensis* in wild populations were recorded in Queensland: Great Sandy National Park (Cooloola section; N = 73), Beerburrum Scientific Area 1 and Mooloolah River NP (N = 53); and from NSW: Yuraygir NP (N = 33) and Tyagarah Nature Reserve (N = 37). These locations represent the presumed current range of the species and were utilized as four latitudes in analyses (Fig. 2). The four latitudes used in decimal degrees were 26.01, 26.78, 28.61, and 29.85 (datum: WGS 84). Frogs were measured in March, April, and November, 2010. Up to 20 frogs first observed at each site were caught and the SUL was measured as described above. The presence of nuptial pads, vocal sacs, and skin folds, as well as coloration of the dorsum, thigh, and throat, was recorded. Frogs were categorized as green or brown based on the dominant dorsal color as observed by KL. A third category of partial green included any frogs that had approximately equal proportions of green and brown dorsal coloration. Males were identified by the presence of nuptial pads (where discernible), vocal sacs, and/or folds in the throat skin. Females were identified by the presence of thick, granular throat skin (opaque in males), and a lack of nuptial pads. Additionally, any metamorphs observed were measured to ascertain size at metamorphosis. Frogs were captured using small plastic bags and were released following measurements. Bags were not re-used, and aquatic equipment was treated with Virkon (fungicide) between sites to prevent disease transmission.

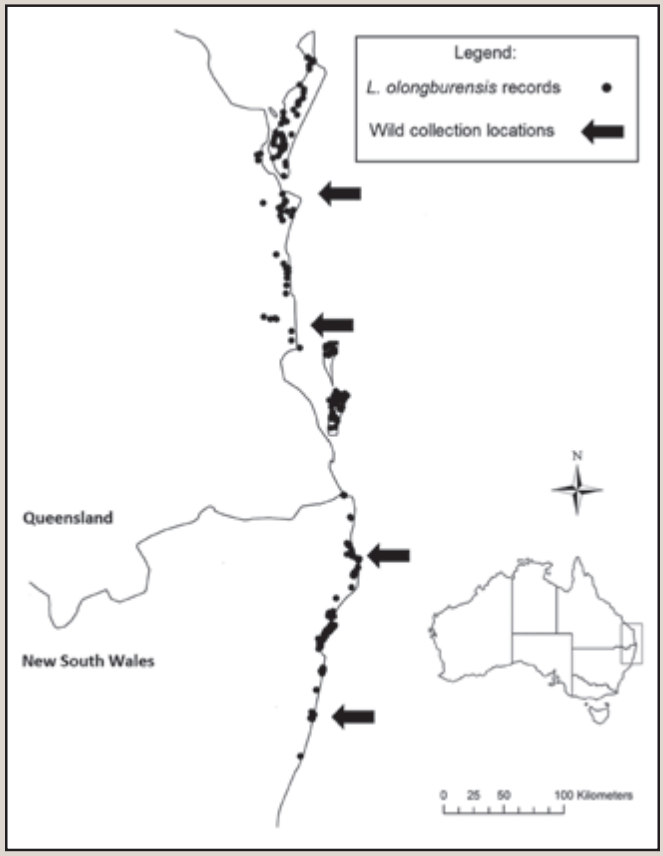


FIG. 2. Occurrence of *Litoria olongburensis* records along the east coast of Australia and the four latitudinal collection locations. Map of Australia shows enlarged area. Records sourced from the Australian Museum, Queensland Museum, South Australian Museum, Environmental Protection Agency/Queensland Parks and Wildlife Service WildNet database, New South Wales Dept of Environment and Conservation Wildlife Atlas database, and various biologists.

For museum frogs, linear regression analyses were used to analyze the relationships among SUL, TL, and FL. For both museum and wild frogs we developed a Generalized Linear Model, using a Gaussian family of SUL, with the explanatory variables sex and origin (wild or museum) as fixed factors. For wild frogs, we again used Generalized Linear Modelling, using a Gaussian family. The response variable was SUL, with the explanatory variable sex as a fixed factor, and latitude as a covariate. We also examined data to detect whether a latitudinal trend existed with SUL or SSD. Data were analyzed using PASW Statistics 18, Release Version 18.0.0 (SPSS, Inc., 2009, Chicago, Illinois, www.spss.com) and the statistical significance was set at $\alpha = 0.05$.

Results.—Both museum and wild (all latitudes) frogs displayed female biased SSD. Snout–urostyle length for each sex overlapped up to 28.7 mm, with all individuals greater than 28.7 mm being female. Female SUL (range = 20.0–34.1 mm, mean = 26.7, N = 154), was significantly larger than males (range = 19.3–28.7 mm, mean = 24.2 mm, N = 144; Wald $\chi^2 = 78.98$, P = < 0.001, Fig. 3). Origin (wild or museum) had a significant effect on SUL (Wald $\chi^2 = 14.94$, P < 0.001). There was no significant interaction between origin and sex (Wald $\chi^2 = 0.25$, P = 0.614; Fig. 3). Female TL (range = 11.2–18.4 mm, mean = 14.8) was also found to be significantly larger than male TL (range = 7.2–16.0, mean = 12.7; P = < 0.001); as was female FL (range = 3.9–6.8 mm, mean = 5.1) compared to male FL (range = 2.4–5.8 mm, mean = 4.6; P = < 0.01). Snout–urostyle length and TL of museum frogs were highly correlated (P < 0.001, $r^2 = 0.797$), as were SUL and FL (P < 0.001, $r^2 = 0.641$). Additionally, male and female FL and TL relative to SUL did not differ significantly (P = 0.466, P = 0.382, respectively). Thus, only SUL was recorded for frogs measured in the wild. For wild measured frogs, SUL was significantly affected by sex (Wald $\chi^2 = 4.26$, P = 0.039) and latitude (Wald $\chi^2 = 15.98$, P < 0.001).There was no significant interaction between sex and latitude (Wald $\chi^2 = 2.85$, P = 0.091; Fig. 4). Although latitude had a significant effect, there did not appear to be a latitudinal cline in SUL or SSD.

The smallest male with discernible nuptial pads on the inner side of the thumb had a SUL of 20.4 mm, and most males (93.2%) larger than this possessed nuptial pads (Fig. 5). Nuptial pad pigmentation was greater in the breeding periods, and occasionally indiscernible outside these periods. The average number of eggs from preserved females was 121 (range 75–160), and average MED was 1.03 mm (range 0.9–1.2 mm). The smallest size at metamorphosis recorded in the wild was 13.8 mm.

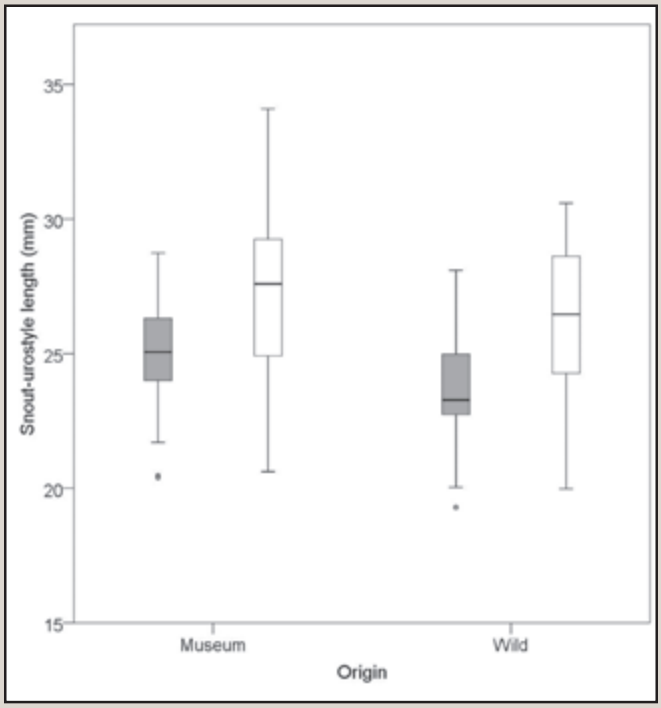


FIG. 3. Box plot of snout–urostyle length measurements of male (N = 144, gray bars) and female (N = 154, white bars) *L. olongburensis* taken from museum specimens (N = 102) and wild populations (N = 196). Significant female biased sexual size dimorphism was detected (P < 0.001), with no significant interaction between origin and sex (P = 0.614).

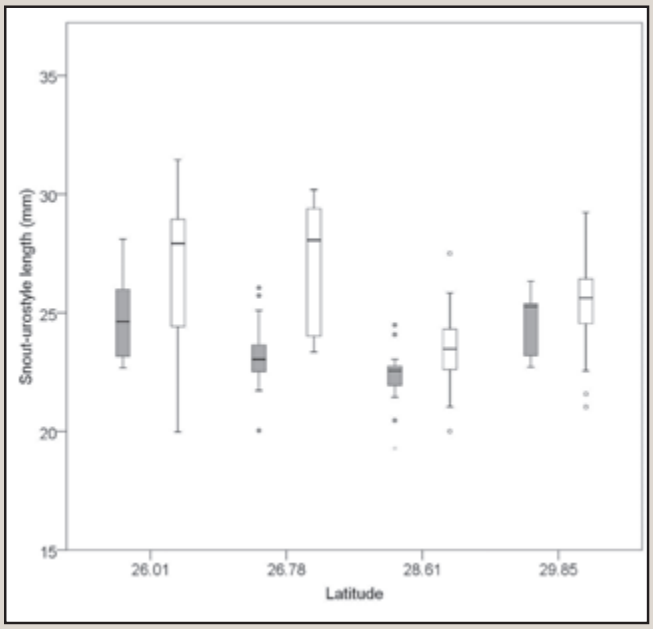


FIG. 4. Box plot of snout–urostyle length of wild male (N = 104, gray bars) and female (N = 92, white bars) *L. olongburensis* from four latitudes across the distributional range of the species (C, N = 73; MB, N = 53, T, N = 37, W, N = 33). Significant female biased sexual size dimorphism was detected (P = 0.039), with no significant interaction between origin and sex (P = 0.091)

The coloration of males and females was highly variable and there were no distinguishing color patterns for either sex (Fig. 6). For all wild frogs, dorsal coloration was measured as brown (48.3%), green (40.1%), and partial green (11.6%). The majority of frogs with green dorsal coloration were female (60.0%). Dark flecking on the dorsal surface was uncommon (four individuals). Throat color was either green (52.9%) or white/beige and the majority of frogs with green throats were female (60.04%). The largest proportion of measured frogs contained at least some blue thigh coloration (femoral streak) (59%), which was more common in frogs with green dorsal coloration (83.1%) than brown dorsal coloration (33%); and was present in both males (61.2%) and females (56.4%). However, thigh color was highly variable, including blue, orange, and brown; and combinations such as: blue/purple/orange, blue/brown/orange, blue/orange, blue/brown, brown/orange, orange/purple, and brown/purple.

Discussion.—The larger size of females (compared to males) found in *Litoria olongburensis* is consistent with the general trend in anurans (Monnet and Cherry 2002; Shine 1979). For field identification, nuptial pads and vocal sacs present in males, and the size disparity between the sexes are the best tools for sex identification. However, it must be noted that nuptial pads may be indiscernible outside the breeding periods, with differences in throat morphology becoming a more useful identification tool. Both sexes exhibited similar body coloration, thus coloration is a poor measure for sex identification. Although there were significant differences in SUL and SSD at different latitudes, we did not detect any latitudinal cline in SUL or SSD. Greater replication or more samples from along the latitudinal distribution of the species would offer more information on any latitudinal cline.

Although the selective pressures leading to SSD may be clear in some species, it may not be so obvious in others, as many selective processes mentioned in the introduction, such as fecundity selection, sexual selection and differences in life history, may occur in the same taxon (Monnet and Cherry 2002; Shine 1989). Whether there is a higher fecundity in larger females, differences in life history strategies, or selection for smaller males in *L. olongburensis* is unknown and would require further investigation.

Occasionally, male body size exceeds that of female body size, particularly in species with aggressive male encounters (Shine 1979). However, this is not true for most small species of the family Hylidae (Wells 2007), which includes *L. olongburensis*. Aggressive male-male encounters were observed in this species and appeared to be a defense of calling sites, with vocalizing males attempting to dislodge other males from a high position (KL, pers. obs.). However, it is unclear whether physical combats influence male reproductive success in this species, as no females were observed near the fighting males on these occasions.

Nuptial pads and vocal sacs were a useful characteristic for identifying males in the field. Although not quantified, we had the impression that nuptial pads were darker at the start of the breeding season. Thus, to reduce the frequency of misidentification, sex identification should occur at the beginning of the breeding season, when nuptial pad pigmentation is heightened. During the non-breeding period, when nuptial pads were indistinct, males could be identified based on faint vocal sac inflation creases or folds visible on the throat. Also, the two inner vocal sac openings were frequently visible through the outer surface of the throat. Whereas males had rather smooth and sometimes opaque skin on the throat, female throat skin was much more granular in texture and appearance. Positive identification of

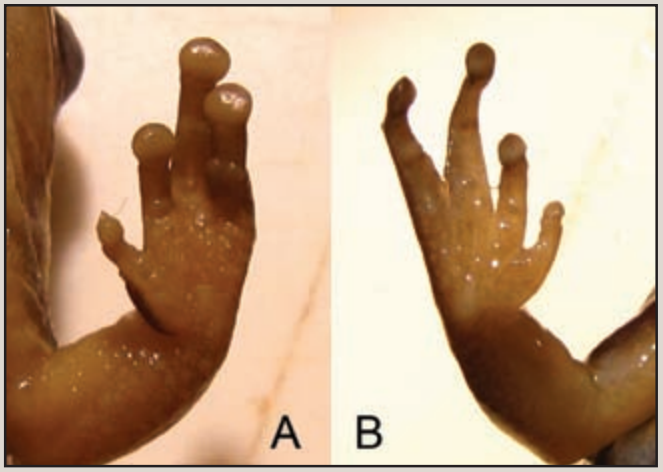
females may also be heightened during the breeding season, when eggs are more easily detected, however, outside this period, size and throat morphology are better tools for sex identification.

The majority of *L. olongburensis* in the wild had brown, or gray-brown, dorsal coloration, with a large subset having green dorsal coloration, and a small proportion with both. Although the majority of green frogs were female, there was no significant sexual color dimorphism in *L. olongburensis*. Juveniles with green dorsal coloration were occasionally observed, however, the degree of ontogenetic shift in color is unclear. Green dorsal coloration is most likely to appear after metamorphosis, but whether dorsal coloration is genetically programmed or environmentally determined, or both, remains to be examined. The majority of live specimens had some blue coloration in the thigh, characteristic of the species, but thigh coloration was highly variable, and the blue was distinctly absent in some individuals. Striking thigh coloration is thought to act as a possible anti-predator mechanism, serving to confuse an attacking predator or warn predators of the presence of toxins (Toledo and Haddad 2009). Although not quantified, field observations indicated that particularly bright dorsal and thigh coloration may be more prominent in females.

Color or pattern polymorphism has been described in many amphibians (Hoffman and Blouin 2000; Wente and Phillips 2003) and is, in some cases, due to females selecting for brightly colored males (Chunco et al. 2007; Roulin and Bize 2007; Todd and Davis 2007). However, many anuran amphibians exhibit fixed color or pattern polymorphisms in both sexes within natural populations, and some species exhibit seasonal color change (Croshaw 2005; Hoffman and Blouin 2000; Wente and Phillips 2003, 2005). Color polymorphism may be particularly advantageous in an environment consisting of spectrally heterogeneous microhabitats, and presumably makes it difficult for predators to form a reliable search image, which is more advantageous when individuals select microhabitats matching their pattern (Morey 1990; Zug et al. 2001). Indeed, *L. olongburensis* inhabits heterogeneous brown and green sedgeland microhabitats, and future studies should aim to determine whether individuals select microhabitats to match their dorsal coloration, and the extent of genetic and/or environmental influence on color polymorphism.

Disruptive coloration and patterning can also be an important component of crypsis, as blotches, stripes, bands, or spots break up the general outline of an individual (Merilaita and Lind 2005; Toledo and Haddad 2009). This may make it difficult to detect the whole animal, especially against a background containing a mixture of color (Zug et al. 2001). *Litoria olongburensis* possesses a dark brown loreal streak from eye to nostril, as well as a brown and ventrally cream streak from behind the eye to halfway down the flank (Liem and Ingram 1977). These pronounced lateral stripes may aid in breaking up the lines of the body, which may be especially suitable in the preferred sedgeland habitat of *L. olongburensis* (Lewis and Goldingay 2005). Although the closely related *L. fallax* possesses similar lateral streaking, it is less pronounced. The increased intensity of lateral streaking in *L. olongburensis* may be due to a more specialized requirement for sedgelands, whereas *L. fallax* is a more generalist species.

We have presented data that adds to our knowledge of morphology and sexual dimorphism of *L. olongburensis*. It is unclear what selective pressures may be acting to maintain different color morphs or sexual size dimorphism in *L. olongburensis* and it is likely that multiple factors may act synergistically.



PHOTOS BY K. LOWE

FIG. 5. Ventral surfaces of the hands of (A) a representative male *L. olongburenesis*, showing the pigmented nuptial pad on the inner surface of the thumb, and (B) a representative female hand for comparison. Photos are of preserved specimens from the Queensland Museum (Male, QMJ34282; Female, QMJ81483).

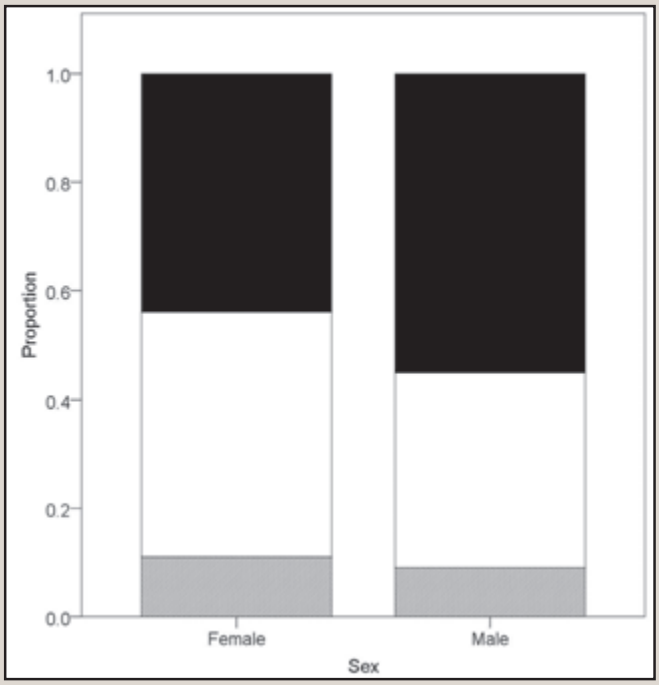


FIG. 6. The proportion of different color morphs of male (N = 93) and female (N = 79) *L. olongburensis*. Black bar, brown morph; white bar, green morph; striped bar, partial green morph.

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First Records of Limb Malformations in Wild Populations of the Endangered Balearic Midwife Toad, *Alytes muletensis*

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Limb deformities and developmental abnormalities in natural populations of amphibians have been reported for decades (Bishop 1947; Reynolds and Stephens 1984; Sessions and Ruth 1990; Woitkewitch 1961) but few reports involve deformities in rare and endangered amphibians.

The Balearic Midwife Toad *Alytes muletensis* (Sanchíz and Adrover 1977) is an endemic and threatened species of the Northeast Mallorca (Balearic Islands, Spain). Naturally, *A. muletensis* inhabits streams with vertical side walls and a bed with a stepped profile (Alcover et al. 1984). Thanks to conservation efforts, numerous anthropogenic constructions, such as fountains, and open and covered troughs, employed to provide water to livestock, have also been used as habitat for toads. These sites provide *A. muletensis* with new breeding locations, and may act as population reservoirs in the case of threats to natural

TABLE 1. Details of the malformed individuals and type of the observed malformation.

Individual	Stage	Sex	Size (mm)	Malformation Type
Cv-20	Subadult (metamorphosed)	Unknown	21.0	Bone projection
Cv-235	Adult (5 years)	Male	37.7	Syndactily
Cv-239	Adult (2 years)	Female	32.6	Polymelia
Cv-240	Subadult (metamorphosed)	Unknown	24.7	Micromelia, brachydactily and bone projection



FIG. 1. Locality 15.A, habitat of the monitored population of *Alytes muletensis*.



FIG. 2. Malformed individuals of *Alytes muletensis*: (Cv-239) Supernumerary hind limb (polymelia); (Cv-20) Small bone projection in left hind limb; (Cv-240) micromelia, brachydactyly and small bone projection in left hind limb; (Cv-235) syndactyly in third and fourth digits of the right forelimb.

populations (Román and Mayol 1995). Larval *A. muletensis* are found in permanent pools, while adults spend the day inside cracks and limestone crevices, emerging at dusk to search for food (Alcover et al. 1984). Like other species of the genus, males carry egg masses between their hind limbs until just prior to hatching, when they are laid in water.

Since its discovery as a living fossil (Mayol and Alcover 1981), *A. muletensis* has been the focus of a number of studies and conservation efforts (Román and Mayol 1997 and references therein). While the early detection and identification of the proximate causes of malformations is an important issue in managing an endangered species, no malformations have previously been reported for *A. muletensis*.

During 2005–2011, *A. muletensis* populations at six localities were monitored to determine the structure and dynamics of the adult fraction of their populations. Adults were captured, sexed, measured and a photograph of their dorsal surface was taken to identify individuals in future captures, following the methodology of Pinya and Pérez-Mellado (2009). Only one of these localities, site 15.A, had individuals with any kind of malformations. This locality is a small karstic canyon naturally excavated from limestone rocks (Fig. 1; 39.90°N, 03.01°E). The breeding pool has an approximate surface of 50 m^2 and a variable depth depending on the season (0.4–0.9 m). Vegetation around the locality is a steppe-grassland of *Ampelodesmos mauritanica* (Poaceae) spotted with *Chamaerops humilis* (Arecaceae) and *Rhamnus alaternus* (Rhamnaceae). The local population of *A. muletensis* was established in 1995, during the first recovery program for the species (Román and Mayol 1997). In 2005 the occurrence of the pathogen *Batrachochytrium dendrobatidis* was confirmed molecularly (Annis et al. 2004) in Mallorca from *A. muletensis* tadpole mouth-part samples (Oliver et al. 2008; Walker et al. 2008). The study population tested positive for *B. dendrobatidis* in 2006 with 19.05% of the samples

positive, but *B. dendrobatidis* was not detected in 2007–2010 (J. Bosch, unpubl. data).

During 19 sampling occasions from 2006 to 2011 at locality 15A, all during the peak activity period for the species (June–September), a total of 306 individuals (259 adults and 47 juveniles) were captured. All individuals were identified according to dorsal pattern and their age was determined using capture-recapture data. Four individuals had one or more malformations, with a total of five different types: polymelia, micromelia, brachydactyly, syndactyly, and bone projection (Fig. 2). The overall malformation rate was 1.31%, but was higher when each sampling occasion was treated separately. One malformed individual was captured on 9 August 2007 in a sample of 22 adults and 11 juveniles (malformation rate: 3.03%), and three were captured on 24 August 2011 from a sample of 48 adults and 7 juveniles (malformation rate: 5.45%) (Table 1).

Although there have been no previous reports of malformations in *A. muletensis*, our observations do not reveal any obvious cause. Because, *A. muletensis* is endangered, it was not possible to sacrifice living toads to check for the presence of trematode metacercarial cysts (for example of the genus *Ribeiroia*), the most commonly reported cause of this kind of limb abnormalities (Jonhson and Paull 2011). However, this parasite has not been reported in natural populations of *A.muletensis,* as previous studies have analyzed parasites only from fecal samples (Roca et al. 1998, 2004). Thus, *Ribeiroia* sp. may occur at the study sites.

Although *B. dendrobatidis* is not known to be a direct cause of malformations in adult amphibians (Altig 2007; Fellers et al. 2007; Vredenburg and Summers 2001), *B. dendrobatidis* may act synergistically with pathogens of the genus *Ribeiroia* to cause malformations (Romansic et al. 2011). In addition, possible immune system depression of tadpoles caused by environmental factors such us pollution, UV radiation or even the presence of *B. dendrobatidis* (Parris and Tommie 2004), could drive an increased susceptibility to parasites as *Ribeiroia ondatrae* and, consequently, increase malformations (Johnson et al. 1999, 2002).

It is possible that the abnormalities observed arose from mutation, developmental errors or traumatic events but these most often involve only missing digits or limb parts (Blaustein and Johnson 2003). The discovery of a concentration of gross abnormalities, with extra limb parts, raises the question of proximate causes and if these malformations are due to factors that could be considered a threat to this sensitive species.

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Diet of the Louisiana Pine Snake (*Pituophis ruthveni*)

The Louisiana Pine Snake (*Pituophis ruthveni*) is a large-bodied constrictor endemic to western Louisiana and eastern Texas (Sweet and Parker 1991). Surveys suggest that the species has declined in recent decades and is now restricted to isolated habitat patches (Reichling 1995; Rudolph et al. 2006). *Pituophis ruthveni* is listed as a Candidate Species under the Endangered Species Act by the U. S. Fish and Wildlife Service (USFWS 2011), and as a threatened species by the Texas Parks and Wildlife Department (TPWD 2011).

Ongoing fieldwork indicates that *P. ruthveni* is associated with sandy, well-drained soils with a well-developed herbaceous flora (Himes et al. 2006; Rudolph and Burgdorf 1997). Within this habitat, *P. ruthveni* is known to use the burrows of Baird's Pocket Gopher (*Geomys breviceps*) for foraging, escape from predators and fire, and hibernation (Ealy et al. 2004; Himes et al. 2006; Rudolph and Burgdorf 1997; Rudolph et al. 1998, 2002). Pocket gophers of the genus *Geomys* feed primarily on subterranean portions of herbaceous plants (Behrend and Tester 1988; Myers and Vaughn 1964). Habitat alteration, especially successional changes due to alteration of fire regimes resulting in increases in woody vegetation and declines in herbaceous vegetation, degrades habitat for *G. breviceps* with potential negative consequences for *P. ruthveni* populations. Within the range of *P. ruthveni* suitable habitat for *G. breviceps* is maintained by frequent fire that reduces competition from woody vegetation and stimulates the development of herbaceous vegetation, the primary food source for pocket gophers (Rudolph and Burgdorf 1997).

Rudolph et al. (2002) previously reported on 22 prey records of *P. ruthveni*. Small mammals were prominent in the diet (18 of 22 records) and *G. breviceps* comprised 10 of the 22 records. Based on habitat use and the close association with pocket gopher burrows, Rudolph and Burgdorf (1997) hypothesized that the decline of *P. ruthveni* in recent decades is due to habitat loss, landscape fragmentation, vehicle related mortality, and in remaining forested habitat to the alteration of fire regimes due to fire suppression. Less frequent fire return intervals allow the succession of woody vegetation to occur resulting in competitive decline of the herbaceous vegetation and ultimately of pocket gopher populations. The limited data on prey composition previously available support this hypothesis (Rudolph et al. 2002). We now report additional prey records for this rare and declining species.

Methods.—We have obtained additional prey records from fecal samples of 27 wild caught snakes obtained since 2002. Snakes were from throughout the current range of the species. These snakes were held in captivity for short periods of time during the course of other research activities. Snakes ranged from 112 to 141 cm snout–vent length (SVL). The 19 snakes sampled in Rudolph and Burgdorf (2002) also fell within this size range. Identifiable prey remains (hair, teeth, claws) were extracted from fecal samples and compared to a reference collection obtained from local species, fecal samples from captive snakes fed a known prey item, and published descriptions of mammalian hair and teeth. Prey biomass was estimated using median weights of species from Davis and Schmidly (1994). Masses for *Peromyscus* spp. and *Reithrodontomys* spp., which were not specifically identified, were estimated using values for each of the potential species present in the study area. All unidentified mammals were mouse-sized species. The value for *Peromyscus* sp., the largest mouse-sized taxon, was used for unidentified mammals. Mass of turtle eggs (presumed to be *Trachemys scripta*) was from Tucker et al. (1998).

Results.—A total of 31 additional prey records, primarily small mammals, were obtained from these 27 snakes (Table 1). Consistent with the previous report, *G. breviceps* was the most frequent prey item (18 of 31). An estimate of % biomass represented for the 53 total prey records known to date suggests that *G. breviceps* (28 of 53, 53%) comprises 75.4% of the estimated total prey biomass represented in the currently available prey sample for *P. ruthveni*. Overall, the preponderance of small mammals in the diet (47 of 53, 89%) is consistent with diets across the genus (Rodríquez-Robles 2002; Sweet and Parker 1991). The 53 prey records from a total of 46 snakes collected throughout the current range of the species provides a reliable estimate of the overall diet of *P. ruthveni*.

Discussion.—The abundance of *G. breviceps* in the known diet of *P. ruthveni* is consistent with the hypothesis presented by Rudolph and Burgdorf (1997). They hypothesized that changes in vegetation structure, i.e. the decline of herbaceous vegetation due to increasing fire-return intervals, resulted in declines of

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TABLE 1. Prey of *Pituophis ruthveni* as determined from field observations, analysis of fecal samples, and gastrointestinal tract contents.

	Rudolph et al. (2002)		This study		Total		
Species	Number	%	Number	%	Number	Estimated %	Biomass
Geomys breviceps	10	45.5	18	58.1	28	52.8	84.4
Scalopus aquaticus	4	18.2	3	9.7	7	13.2	6.7
Sigmodon hispidus	1	4.5	3	9.7	4	7.5	4.5
Peromyscus sp.	1	4.5	1	3.2	2	3.8	0.6
Reithrodontomys sp.			1	3.2	1	1.9	0.1
Unid. Mammal	2	9.1	3	4.7	5	9.4	1.5
Turtle eggs*	4	18.2	2	6.5	6	11.3	2.1
Totals	22		31		53		

*Probably *Trachemys scripta* based on egg size and habitat. A total of 20 eggs were recovered from six individual snakes.

pocket gophers and the consequent decline or extirpation of *P. ruthveni* populations.

The hypothesized dependence of *P. ruthveni* primarily on a single prey species, *G. breviceps*, may also be a factor in the reproductive biology of the species as hypothesized in Rudolph and Burgdorf (1997). *Pituophis ruthveni* has the smallest clutch size (mean = 4) and largest hatchling size (mean = 54.4 cm) in the genus (Reichling 1990). The large size at hatching may be a strategy to decrease the time required to achieve a size capable of ingesting adult pocket gophers, approximately 100 cm SVL, based on feeding trials of captive *P. ruthveni* offered live pocket gophers. Other *Pituophis* taxa with smaller hatchling sizes have a much more diverse small mammalian diet (Rodríquez-Robles 2002).

Feeding trials on captive neonates and juveniles (55–75 cm SVL) being head-started for an ongoing reintroduction effort provide additional insight on diet in this species. These captive *P. ruthveni* have refused all insect (cicadas, grasshoppers) and lizard (*Anolis carolinensis, Hemidactylus turcicus)* prey offered. They have readily accepted a variety of small mammals and birds, both live and dead, although most individuals refused shrews (*Blarina brevicauda*) and some reacted negatively to the presence of live shrews. Assuming animals in the field behave similarly, ectotherms, with the notable exception of turtle eggs, might not be a significant component of the diet of *P. ruthveni* of any size.

A number of snake species exhibit a dietary switch from ectotherms to endotherms that is based on snake size (Greene 1989; Rodríques-Robles et al. 1999; Shine and Slip 1990). A major compilation of prey records for *P. catenifer*, involving over 1000 prey records (Rodríquez-Robles 2002), found that mammals were a major component of the diet of all sizes including neonates, however lizards were only consumed by snakes less than 115 cm SVL. Only one arthropod was detected in this large data set. Our data set lacked records for snakes less than 112 cm SVL.

Specialization on a single prey species is hypothesized to have major consequences relating to the overall ecology, reproductive biology, and conservation status of the Louisiana Pine Snake. In addition, the proposed scenario is the basis of a recently initiated reintroduction program for *P. ruthveni. Pituophis ruthveni* neonates and head-started individuals are being released in habitat that has been restored by U.S. Forest Service managers primarily through restoration of a frequent fire regime using prescribed fire. The previously fire-suppressed reintroduction site currently has a well-developed herbaceous component with abundant pocket gophers and is presumably capable of supporting a *P. ruthveni* population.

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Ghost Nets Haunt the Olive Ridley Turtle (*Lepidochelys olivacea*) near the Brazilian Islands of Fernando de Noronha and Atol das Rocas

Fernando de Noronha (3.8333°S, 32.4167°W) and Atol das Rocas (3.8666°S, 33.8000°W) are Brazilian offshore islands that host breeding populations of Green Turtles (*Chelonia mydas*) and provide benthic foraging habitat for aggregations of Green and Hawksbill Turtles (*Eretmochelys imbricata*; Marcovaldi and Marcovaldi 1999) and occasionally Loggerheads (*Caretta caretta*; Bellini and Sanches 1998). The fact that Olive Ridley Turtles (*Lepidochelys olivacea*) also forage in the vicinity of these offshore islands is evidenced by carcasses found stranded on the beach and animals entangled in ghost nets, i.e., abandoned, lost, or otherwise discarded fishing gear.

From 1996 to 2011, 20 Olive Ridley Turtles were recorded by the Brazilian sea turtle conservation program (Projeto TAMAR-ICMBio), including 17 at Fernando de Noronha and 3 at Atol das Rocas. Of these, 18 were entangled in ghost nets (16 still alive and 2 dead) and another two individuals were found dead, stranded on the beach. The three turtles recorded at Atol das Rocas were alive and entangled together in the same ghost net, as were four turtles at Fernando de Noronha; all other entanglements were of single individuals. All the nets consisted of multifilament nylon, with mesh sizes of 17–22 cm (stretched mesh). The origin of these nets is unknown, neither is it clear if the nets were used in high seas or coastal fisheries or by national or international ships. Indeed, neither the scale nor magnitude of fishing activity (industrial or artisanal) in the area, or the target species, have yet been determined. Ghost nets are a well-documented threat for marine fauna including sea turtles (Halpern et al. 2008; Macfadyen et al. 2009). In spite of the fact that the origin of the ghost nets is unknown, the influence of the ocean currents seems to be clear. Atol das Rocas and Fernando de Noronha are located where the South Equatorial Current (SEC) flows from east to west (Kikuchi 2000; Renner 2004) and all recorded entanglement was east of the islands. This could indicate that ghost nets were upstream of the location where the turtles were found.

The size of nesting Olive Ridleys in Brazil ranges from 62.5 to 83.0 cm curved carapace length (CCL; Silva et al. 2007). The following size data are available for 17 of 20 turtles: seven (41.2%) were probably adults, as they measured 61–80 cm CCL; three (17.6%) were not measured but were reported to be sub-adults (Guy Marcovaldi, pers. comm.); five (29.4%) ranged from 41–60 cm CCL; and two (11.8%) were 21–40 cm CCL. Thus, they ranged in size from juveniles to adults, but most were sub-adults and adults. Nearby, in the western and central South Atlantic, Sales et al. (2008) reported a similar size distribution for incidental captures of Olive Ridley Turtles by pelagic longline fisheries. In addition, post-nesting Olive Ridleys that were satellite-tracked from the Brazilian state of Sergipe were recorded in the vicinity of areas where entanglement was recorded (Silva et al. 2011). In the western Atlantic, the main nesting populations of Olive Ridley Turtles are located in Brazil (annual nest numbers have been increasing since 1991, Silva et al. 2007; more than 6700 clutches were laid in the 2010/2011 nesting season, Projeto Tamar/ICMBio, unpubl. data), Suriname (between 150 and 200 clutches per year; with a declining trend; Kelle et al. 2009), and French Guiana (between 1716 and 3257 clutches each year, with an increasing trend; Kelle et al. 2009). In the eastern Atlantic, nesting sites are located from between Guinea-Bissau (200–300 clutches each year, with no trend discernable; Barbosa et al. 1998) and Angola (120 clutches per year, with no trend evident; Weir et al. 2007).

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Of the 20 Olive Ridley records reported here, 80% occurred between 2005 and 2011. This result may be correlated with an increase in fishing activity in the offshore waters of northeastern Brazil and at the west coast of Africa, the starting point of the SEC and where the potential fishery stocks are most likely to be found (i.e., the Benguela upwelling system; Japp and James 2003). This result could also be related to population increases observed in the two major nesting sites in the western Atlantic, Brazil (Silva et al. 2007) and French Guyana (Kelle et al. 2009).

As Fernando de Noronha Archipelago and Rocas Atoll have been monitored by Projeto TAMAR/ICMBio since 1984 and 1982, respectively (Marcovaldi and Marcovaldi 1999), the small number of *Lepidochelys olivacea* registered at both sites actually represents a low incidence of entanglement. Even in small numbers, as the occurrences were related to entanglement in ghost nets, it seems that turtles are likely to appear at these offshore islands only when something such as a ghost net takes them from their normal home range. The 18 entanglement events by ghost nets across 15 years do not seems to be a serious threat to this population, but collectively with bycatch in pelagic longline fisheries and satellite tracking data, they provide new evidence that the region plays an important ecological role for critical life stages (subadults and adults) of this species.

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TECHNIQUES

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A Technique for Field Maintenance and Transport of Cold-water Amphibians

A diverse array of amphibians have adapted to the physiological demands of cold-water environments throughout the world. Biologists are increasingly interested in studying these organisms in the laboratory, out of a desire to examine novelty under controlled conditions or because cold-water taxa occupy key phylogenetic positions (e.g., Essner et al. 2010; Pough 2007). Additionally, some cold-water amphibians are critically endangered, necessitating *ex situ* captive management (Pavajeau et al. 2008). A significant obstacle in bringing wild-caught amphibians into the laboratory is the absence of husbandry knowledge for most species (Pough 2007). Maintaining colonies of cold-water amphibians can be especially challenging due to their unusual requirements. These may include high flow rates and low pH levels, in addition to low water temperatures (~10°C recommended by Pough 2007). Laboratory husbandry protocols have been developed for some cold-water amphibians (e.g., *Ascaphus*; Essner and Suffian 2010; Held 1985). However, more proximate obstacles remain, including maintenance of cold-water amphibians in the field for extended periods during collecting activities, followed by safe transport over potentially long distances.

Field maintenance and transport of stream-dwelling cold-water amphibians, such as the Tailed Frogs, *Ascaphus* spp., are especially problematic since they are often highly stenotopic and extremely sensitive to changes in water temperature, in particular. For example, critical thermal maximums (CT_{max}), short term estimates of thermal tolerance based upon loss of righting response, for stream-dwelling forms are among the lowest recorded for amphibians (Bury 2008). The CT_{max} for adult *Ascaphus*, which inhabit torrential streams in the Pacific Northwest, ranges from 27.6 to 29.6°C (Claussen 1973). Mortality is known to occur at even lower temperatures over extended periods of time (Bury 2008). Larval *Ascaphus* (N = 48) kept at 22°C exhibited 88% mortality after 48 h, while adult frogs (N = 12) exhibited 100% mortality after 30 h (Metter 1966). Obviously, field maintenance and transport in animals for which "room temperature" is lethal, is a daunting task, requiring some forethought.

Herein, we describe a simple and inexpensive technique for maintaining cold-water amphibians, in this case, larval and adult Rocky Mountain Tailed Frogs (*Ascaphus montanus*) in the field for an extended period of time (11 days), followed by long distance transport (~3500 km) by automobile (3 days). Recently, Pramuk et al. (2011) described an effective technique for transporting another cold-water amphibian species, the Eastern Hellbender (*Cryptobranchus alleganiensis*). Their setup involved coolers filled with filtered water that was pumped through PVC plumbing to a heat exchanger filled with ice. Our setup is less elaborate, more compact and portable, and eliminates the need for ice.

Adult (N = 34) and larval (N = 16) *Ascaphus montanus* were collected by hand from streams at night with headlamps in the Coeur d'Alene National Forest, Kootenai and Shoshone Counties, Idaho, USA, from 10–20 June 2011. During collection, adults and larvae were placed temporarily in separate 740-ml plastic containers (GladWare) filled with stream water. Upon completion of collecting activities for a particular stream, individuals were transferred from temporary containers to the field maintenance and transport setup described below.

Our basic setup is illustrated in Fig. 1 and consists of the following: 1) a 12 V 38-liter thermoelectric cooler (Coleman PowerChill); 2) a 5-watt aquarium pump for aeration (Petco model #9904) with (4) air outputs, (4) airstones, (4) check valves, and ~2 m of plastic tubing (included with the pump); and 3) (4) latch containers (Sterilite; dimensions 29 cm x 18.5 cm x 7.5 cm). In addition, we added the following elements to the setup in order to provide portable power: 1) a portable power system (Statpower Technologies Portawattz PowerPAC); 2) a 12V sealed marine battery (Universal UB12900); and 3) a battery charger (Schumacher SpeedCharge).

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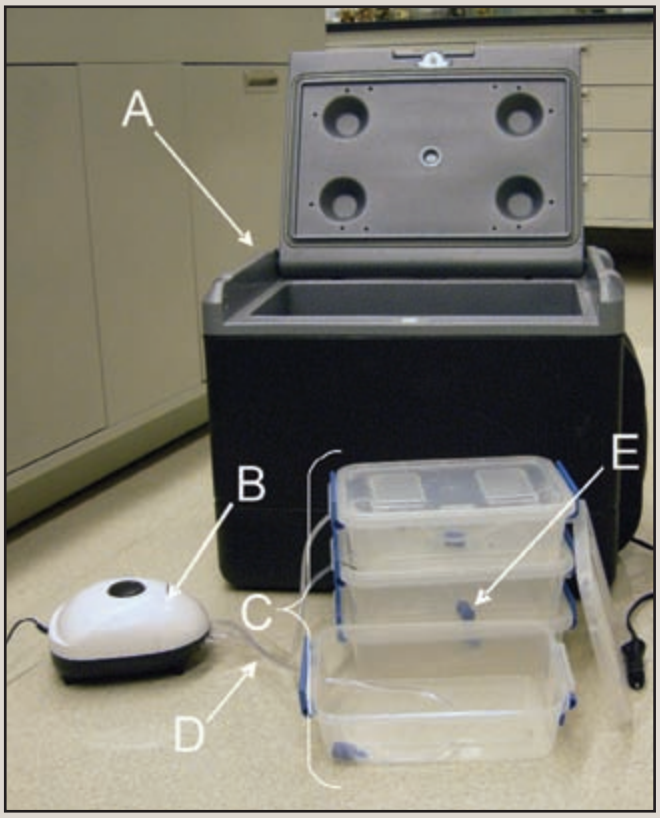


FIG. 1. Field maintenance and transport setup for cold-water amphibians. A) Thermoelectric cooler; B) air pump; C) latch containers; D) plastic tubing; and E) air stone. The thermoelectric cooler and air pump can be powered with conventional outlets when available. Alternatively, they can be plugged into a portable power system attached to a marine battery, providing cold temperatures and aeration over extended time periods.

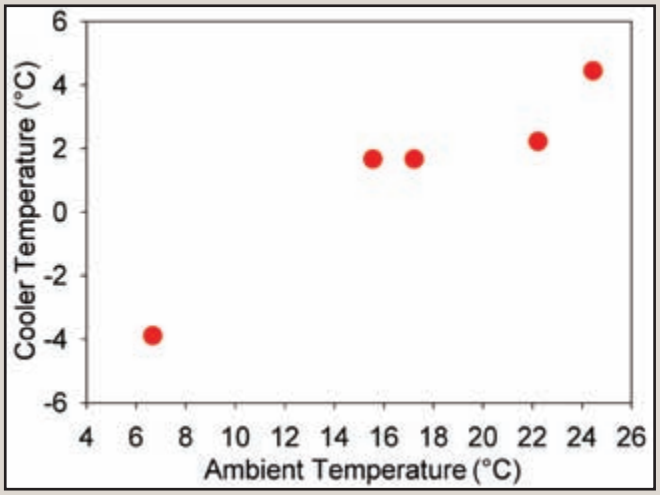


FIG. 2. Relationship between ambient temperature (T_a) and cooler temperature (T_c).

The plastic tubing was cut into (4) short sections of ~15 cm and (4) longer sections of ~35 cm. Each short section was connected to a longer section via a check valve which prevented water from back-siphoning. The open end of each longer section was connected to one of the air outputs on the pump. The open end of each shorter section was directed through a ~0.5 cm opening cut into the side of each latch container (just large enough to accommodate the outside diameter of the tubing) and attached to an air stone. Latch containers were filled halfway with stream water and stacked on top of one another inside the thermoelectric cooler. Adults were divided equally among three of the latch containers to reduce crowding, with larvae placed in the remaining container. Adult tailed frogs are highly aquatic. Since adults and larvae were collected from the same streams under the same conditions, they were treated identically in the setup. The air pump was positioned outside of the cooler, with the tubing exiting through a slight crack in the lid. The cooler and pump were powered during driving by plugging them into a two-outlet power inverter that was plugged into a cigarette lighter. When portable power was needed, the cooler and air pump were plugged into the PowerPac unit, which included its own lead acid battery and power inverter with two outlets. This device was capable of powering the cooler and air pump for ~4 h when fully charged. Connecting the PowerPac unit to the fully charged marine battery added an additional 20 h of power. The marine battery could then be recharged as needed with the battery charger.

Thermoelectric coolers rely on the Peltier effect, whereby an electric current is run across two different metals in order to create a heat pump. The manufacturer of the thermoelectric cooler used in the described setup states that it maintains temperatures up to 22°C below ambient. We tested the performance of the cooler over a range of ambient temperatures (T_a) by using a digital thermometer to measure temperatures inside the cooler (T_c; Fig. 2). The cooler was placed in a temperature-controlled room and allowed to acclimate for a minimum of 1 hour prior to recording T_c. We found that the difference between T_a and T_c did approach this level (~20°C) at typical room temperatures (22–24°C). However, this difference gradually decreased at colder temperatures. At the lowest T_a (6.7°C), T_c dropped below freezing (-4°C). Such a low temperature would jeopardize the well-being of the animals. Therefore, it is recommended that the cooler not be plugged in at T_a below 15°C.

Ambient temperature during the collecting trip never exceeded 21°C. Temperatures inside the cooler were checked frequently during daytime hours, (~6 times throughout the day), with a Fluke 179 digital multimeter for the duration of the trip. Cooler temperatures never exceeded 10°C, despite frequent disturbance due to the addition of newly captured individuals, and keeping the lid slightly cracked to accommodate the plastic tubing.

The entire setup is easy to fabricate and is relatively inexpensive (less than US $500). This approach allowed us to maintain and transport frogs over a combined 14-day period with no incidents of mortality. It should be adaptable to a variety of cold-water amphibians, keeping them at suitable temperatures without a need for ice.

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A Trial Use of Camera Traps Detects the Highly Cryptic and Endangered Grassland Earless Dragon *Tympanocryptis pinguicolla* (Reptilia: Agamidae) on the Monaro Tablelands of New South Wales, Australia

The use of remote, infrared, sensor-activated cameras (hereafter called camera traps) is becoming more widespread in wildlife research as they offer several advantages over traditional manual survey methods. Camera traps are less invasive, offer opportunities to increase detection of cryptic trap-shy fauna, and can collect data over long periods of time with minimal input (Cutler and Swan 1999; Swan et al. 2004). In Australia, much of the focus when using camera traps for threatened wildlife has been on small to large-sized native mammals (Claridge et al. 2004, 2010; Nelson 2009). Camera traps have also been used in Australia to monitor birds (Towerton et al. 2008) and introduced pests (Vine et al. 2008).

There are few publications relating to the use of camera traps for detecting reptiles in Australia. Milne et al. (2003) used video recorders on stands at known burrows to monitor burrow use by the Pygmy Blue-tongue Lizard (*Tiliqua adelaidensis*), Doody et al. (2009) used camera traps for monitoring nesting behavior of the freshwater Pig-Nosed Turtle (*Carettochelys insculpta*), and Somaweera et al. (2011) used camera traps to observe predation on the nests of the Freshwater Crocodile (*Crocodylus johnstoni*). To our knowledge, there has been no published research into the effectiveness of using camera traps to detect small and highly cryptic reptiles.

The Grassland Earless Dragon (*Tympanocryptis pinguicolla*) is a nationally listed, endangered species under the Commonwealth of Australia's *Environment Protection and Biodiversity Conservation Act 1999*. Because of the highly cryptic nature of the Grassland Earless Dragon, approaches to detecting and monitoring the species are very time consuming, labor intensive, and costly (Robertson and Evans 2009). A survey typically involves the use of artificial arthropod burrows in grids or transects, which implies a greater sampling effort since a large number of traps must be installed for a long period of time for the sampling to be effective. This methodology has been used to study the species in the Australian Capital Territory, where natural temperate grasslands lack large areas of rocky outcrop and surface rocks (Fletcher et al. 1999). In rocky landscapes, searching beneath rock (rock-turning) is also a recommended procedure (Robertson and Evans 2009).

These techniques have recently been trialled on the Monaro Tablelands of New South Wales (TM, unpubl. data). Monitoring of artificial arthropod burrows at five known locations across the Monaro Tablelands during the summer of 2010 resulted in the discovery of only two individuals at one of the five locations despite some 4253 trap days; furthermore, rock turning during the winter of 2010–2011 across the Monaro Tablelands resulted in only 15 individuals being discovered at five locations despite 73 suitable grassland sites being surveyed and > 23,000 rocks being turned (TM, unpubl. data).

This low detectability of the species using prescribed survey techniques motivated us to trial camera traps to detect one of Australia's rarest and most cryptic reptiles, the Grassland

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TABLE 1. A comparison of results from the camera trap trial and recent rock turning surveys at the study site.

	Rock turning survey 1	Rock turning survey 2	Rock turning survey 3	Camera trap trial	Rock turning survey 4
Survey date	June 2010	September 2010	April 2011	April 2011	June 2011
Number of Grassland Earless Dragons recorded	4	1	0	2	1
Total survey effort at study site	493 rocks	60 rocks	240 rocks	150 camera trap days*	20 rocks
Number of rocks turned / camera trap day to detect specimen during the survey	25, 70, 90, 120 rocks, respectively	20 rocks	0	42 and 66 camera trap days, respectively	20 rocks

* The memory cards of four of the camera traps were full upon retrieving the camera traps. The six camera traps operated on average for 25 days of the 75 days they were left on the study site (25 days x 6 camera traps = 150 camera trap days).



FIG. 1. Native temperate grassland paddock on the Monaro Tablelands of New South Wales, Australia (Travelling Stock Reserve study site within).



FIG. 2. Example of the camera trap set up used to detect the Grassland Earless Dragon in native temperate grassland of the Monaro Tablelands, New South Wales, Australia.

Earless Dragon, on the treeless basalt grasslands of the Monaro Tablelands of New South Wales.

Methods.—Six camera traps (Moultrie MFH-DGS-I60, ca. AU $360 each; www.moultriefeeders.com) were installed and set to photograph and record the Grassland Earless Dragon within a Travelling Stock Reserve (TSR) approximately 15 km S of Cooma on the Monaro Tablelands of New South Wales, Australia. Camera traps were left within the TSR for a period of 75 days between 7 April 2011 and 20 June 2011. The TSR is situated on an east-facing footslope and comprises treeless, rocky, native temperate grassland dominated by Kangaroo Grass (*Themeda australis*), spear grasses (*Austrostipa* spp.), and Red-leg Grass (*Bothriochloa macra*). The site is surrounded in three directions by extensive stretches of native temperate grassland and is generally representative of native temperate grassland across the Monaro Tablelands (Fig. 1). The study site had not previously been subject to recent standardized artificial arthropod burrow surveys in the region; however, *Tympanocryptis pinguicolla* had previously been recorded on the site through rock turning surveys (TM, unpubl. data).

Four of the six camera traps were each attached to a wooden stake approximately 20 cm above the ground at a 30-degree angle and focused on an artificial arthropod burrow which was installed approximately 40 cm away (Fig. 2). Artificial arthropod burrows are constructed from PVC tubing and designed to mimic an arthropod burrow, which are used as natural shelter sites by *T. pinguicolla* (Fletcher et al. 2009). As such, they do not trap *T. pinguicolla* because they can move in and out of them freely. The four camera traps were installed at 30-m intervals along a 120 m east to west transect. The remaining two camera traps were installed on fence posts along the northern boundary of the TSR each 30 cm from the ground and 30 m apart. All camera traps were programmed on a 24 h cycle and set to take a single photo upon each sensor trigger followed by 15 seconds of video footage. To minimize false camera trap triggers, the small section of grassland in sight of each camera trap, approximately 1 m x 1 m, was trimmed down to approximately 10 cm in height.

Results.—Camera traps took a combined total of 1296 photos and 1294 video recordings over the 75 days. Two of the camera traps were effective in capturing clear and easily identifiable photos (N = 12) and video recordings (N = 7) of the endangered

T. pinguicolla. The photos and video recordings occurred on 13 April commencing at 1120 h and 17 April 2011 at 1230 h.

There were other possible photos (N = 9) and recordings (N = 2) of *T. pinguicolla* on one other camera trap. We were not able to identify individuals on these photos or recordings due to poor focus as a result of the camera trap set up and these out of focus images could not be distinguished from other grassland lizards known to occur in the region, e.g., White's Skink (*Egernia whitti*).

The camera traps captured photos of *T. pinguicolla* at the edge of the artificial arthropod burrow and slightly overlooking the artificial arthropod burrow (Figs. 3, 4) as well as basking on a short tussock that had been trimmed beside an artificial arthropod burrow (Fig. 5). One camera trap recorded a *T. pinguicolla* basking on a nearby grassland tussock for three minutes before the lizard moved slowly to a nearby basalt rock. Another recording in this sequence showed the same lizard actively checking the inside of the artificial arthropod burrow (with its hind legs outside the burrow) until it rapidly exited the burrow. Earlier recordings on this camera trap did not show any evidence of anything entering the burrow prior to this recording. None of the *T. pinguicolla* took refuge inside the artificial arthropod burrows.

The remaining photos (N = 1275) and video recordings (N = 1285) were false trips appearing to be triggered by windblown grass, insect or arachnid activity (e.g., grasshoppers, butterflies, and wolf spiders), inquisitive Singing Bushlarks (*Mirafra javanica*), or Eastern Grey Kangaroos (*Macropus giganteus*). The study site had previously been subject to multiple rock turning surveys during the winter of 2010–2011 (TM, unpubl. data) and a comparison of the results of this trial use of camera traps with recent rock turning surveys is shown in Table 1.

Discussion.—Our trial involving the use of six camera traps at a single grassland site has proven effective in detecting the cryptic and endangered Grassland Earless Dragon. The results of this trial confirm that Grassland Earless Dragons are active on cool autumn days when temperatures reach a daily maximum of 13.2°C and 18°C and an overnight minimum of 2.6°C and -0.6°C, respectively (BOM 2011). Interestingly, the first recordings and photos of *T. pinguicolla* on 13 April occurred mid morning following the coolest night of the month which reached an overnight minimum of -1.5°C (BOM 2011). Despite not being the intent of this study, these results highlight the added bonus of using camera traps to survey for this species in that they have the potential to be used to investigate the activity periods of this highly cryptic lizard.

Despite being only a trial use of camera traps and not yet replicated, including at previously unsurveyed sites or sites with a history of non detection, the comparisons between rock turning surveys and camera traps at the site in Table 1 demonstrate the effectiveness and potential of camera traps to detect *T. pinguicolla*. Where a rock turning survey conducted during the same month as the camera trap trial (consisting of 240 rocks turned) failed to detect the species at the site, the camera traps succeeded.

There is much potential for camera traps to be a more desirable survey and monitoring technique than live trapping (Kays and Slauson 2004), and in some situations to be more effective (De Bondi et al. 2010). This trial offers insight into an innovative, less invasive and labor intensive alternative for detecting and monitoring a highly cryptic and endangered reptile across the basalt grasslands of the Monaro Tablelands of New South Wales. Furthermore this pilot study highlights the potential of camera traps for surveying other similar-sized cryptic reptiles in Australia and elsewhere.



FIG. 3. Grassland Earless Dragon approaching artificial arthropod burrow.



FIG. 4. Two minutes on, Grassland Earless Dragon overseeing artifical burrow.



FIG. 5. Four minutes on, Grassland Earless Dragon basking on a nearby tussock.

Pilot studies are a recommended means of gathering important information prior to embarking on a full survey

program using camera traps (Nelson and Scroggie 2009). A need to test other camera makes and models, appropriate camera trap distances from the burrow as well as the angle of the camera trap to burrow in order to get the best focus and therefore quality images will be required in future applications of this method. There is also the need to minimize false camera trap triggers caused by wind moving nearby vegetation and therefore allow for more extended periods of monitoring. Being a largely treeless and undulating ecosystem, some further consideration may also need to be given to the site selection, aspect, and positioning of camera traps to avoid prolonged shading of artificial arthropod burrows and increase the probability of detection. The kangaroos and birds photographed from camera traps along the fence line also suggests avoiding fence lines in future camera surveys and ensuring cameras are better stabilized.

The effective use of camera traps in this pilot study will enable us to address new and important questions that relate to use of artificial and natural burrows, activity patterns outside of key activity periods, behavioral attributes, predator-prey interactions, as well as the opportunity to investigate the effects of rock turning on the species. The ease with which camera traps can be installed and relocated across the landscape compared to the current labor intensive techniques (Robertson and Evans 2009) suggests camera traps could be ideal for improving detectability studies and implementing long term monitoring programs for the Grassland Earless Dragon.

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CONSERVATION

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Conservation Implications Following the Rediscovery of Four Frog Species from the Itombwe Natural Reserve, Eastern Democratic Republic of the Congo

The Albertine Rift (AR) of Central Africa is generally defined as the western, montane branch of the Great Rift Valley, which forms part of the Arabo-African Rift that extends from Palestine across the Red Sea to Mozambique for approximately 6,000 km (Vande weghe 2004). Plumptre et al. (2007) considered the AR to occur from ca. 30 km north of Lake Albert along the eastern border of Democratic Republic of the Congo (DRC) to the southern tip of Lake Tanganyika, including the flanks of the escarpment down to the valley. Ancient and recent historical geological processes have engendered numerous volcanoes in the AR, some of which are still active in eastern DRC (Draper 2011); Nyamulagira Volcano (near Goma) erupted as recently as November, 2011 (Thakur 2011).

Multiple studies have noted that the AR is the most species-rich area for vertebrates in continental Africa, and the rift also includes large numbers of endemic and threatened vertebrate, invertebrate, and plant species (Brooks et al. 2001; Burgess et al. 2004; Plumptre et al. 2003, 2007). Because of a substantial dearth of herpetological collecting in the AR following the violent aftermath of colonialism in the mid- to late twentieth century (Edgerton 2002; Lemarchand 2009), new species (defined herein as species new to science that require formal description) and genera of amphibians and reptiles continue to be discovered and identified, especially via the analysis of DNA sequence data (Evans et al. 2008, 2011; Greenbaum et al. 2011, 2012a, b).

The Itombwe Natural Reserve (INR, Fig. 1) is a recently established (October 2006) protected area in the AR on the western side of Lake Tanganyika. Although the exact boundaries of the reserve are not yet determined (Plumptre et al. 2010a), Doumenge (1998) defined the Itombwe Mountains as an area of appoximately 15,000 km^2 occurring between 2°40 and 4°35S, and 27°55 and 29°05E, with an elevation ranging from 900–3475 m. Vegetation and habitats of the reserve are exceptionally diverse. On the western side of Itombwe, the Congo Basin's widespread, lowland forests transition into mid-elevation forests associated with AR endemism. The mountains in Itombwe contain submontane, montane, and bamboo forests, grasslands, and subalpine vegetation (Fig. 2). The eastern side of the plateau is characterized by a steep escarpment that drops precipitously in elevation to the lacustrine plain of Lake Tanganyika, which continues to the western mountains of Burundi. Itombwe is one of very few sites in sub-Saharan Africa with a complete and continuous succession of forest types from low-elevation rainforest to montane forest, and Doumenge (1998) remarked that, "the Itombwe Mountains have the second largest, if not the largest, actual area of submontane, montane, and subalpine forests in continental Africa." Three major ecoregions converge at Itombwe, including Northeastern Congolian Lowland Forests, Albertine Rift Montane Forests and Central Zambezian Miombo Woodlands (Burgess et al. 2004). In general, precipitation varies from 3,000 mm/year in the western forests to 1600 mm/year at the highest elevations of the plateau, and 1200 mm/year in the southern and eastern savannahs, which experience a dry season lasting four months (Doumenge 1998). Temperature and rainfall in Itombwe varies considerably by ecoregion and elevation, and has been described in detail by Prigogine (1978).

In recent assessments of all well-studied AR sites, Itombwe had the most threatened species of amphibians (Stuart et al. 2008), and was tied (with Virunga National Park) for highest number of endemic amphibians (Plumptre et al. 2007). Following the description of the Itombwe-endemic pipid frog *Xenopus itombwensis* (Evans et al. 2008), Itombwe is now the most important site in the AR for amphibian diversity, which also renders it among the most important sites for amphibian conservation in continental Africa (Burgess et al. 2004). Itombwe also contains large numbers of endemic and threatened plants, butterflies, birds, reptiles, and mammals, including forest elephants and eastern lowland gorillas (Greenbaum et al. 2011; Omari et al. 1999; Plumptre et al. 2003, 2007). Prigogine (1977) discussed the avifauna of Itombwe in detail, and noted that the site contains 75% of all African forest species, including three species that are endemic to Itombwe; these data led Prigogine to suggest that

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FIG. 1. Map of east-central Africa showing the locations of the Itombwe and Kabobo Plateaus in South Kivu Province, eastern Democratic Republic of the Congo.

Itombwe is a center of montane speciation. Collar and Stuart (1988) also noted the extremely high numbers of endemic and threatened bird species at Itombwe, and Sayer et al. (1992) considered Itombwe's forests to be the most important for bird conservation on the continent of Africa.

Remarkably, Itombwe's status as a major area of endemism for African amphibians is based on relatively little fieldwork conducted in the 1940s and 1950s by Belgian herpetologist Raymond Laurent (Laurent 1950, 1951, 1955, 1964), who described several new species of frogs, including the monotypic treefrog genera *Callixalus* (Itombwe and Kabobo highlands, Rwandan highlands) and *Chrysobatrachus*, which is endemic to Itombwe's high-elevation grasslands. Tihen (1960) recognized one of Laurent's new species of dwarf toads as a monotypic Itombwe endemic genus, *Laurentophryne*. Recently, Evans et al. (2008) described a new species of clawed frog (*Xenopus*) from Itombwe, and with one additional exception (Roelke et al. 2011), there has been no taxonomic work on the Itombwe amphibian fauna since the mid-20th century, and the current status (i.e., extant vs. extinct, threatened vs. least concern) of the majority of Itombwe's amphibians is currently unknown.

In May 2011, we distributed a press release (Perez 2011; http://eligreenbaum.iss.utep.edu/lost_amphibians.htm) announcing the rediscovery of five frog species that had not been seen in the AR since 1954, including the hyperoliid treefrog *Hyperolius chrysogaster*, which was collected in montane forest near Kahuzi-Biega National Park. Herein, we focus on the remaining four species that were found at Itombwe during a brief herpetofaunal survey of several sites (Fig. 3): *Arthroleptis pyrrhoscelis* (Arthroleptidae), *Chrysobatrachus cupreonitens* (Hyperoliidae), *Hyperolius leucotaenius* (Hyperoliidae), and *Phrynobatrachus asper* (Phrynobatrachidae). Because of security limitations associated with armed militia in Itombwe, visual surveys were opportunistic and did not adhere to a consistent methodology. If the security situation in Itombwe improves in the future, additional surveys with a planned search methodology are needed at all field sites. Detailed locality information for the rediscovered Itombwe species is provided in Table 1.

Although *Phrynobatrachus asper* was listed by Behangana et al. (2009) from the AR, no detailed locality or date of collection was provided. *Chrysobatrachus cupreonitens*, *Hyperolius leucotaenius* and *Arthroleptis pyrrhoscelis* are endemic to Itombwe, but the latter species occurs at Itombwe and the Kabobo Plateau, a relatively small highland area just southeast of Itombwe (Fig. 1). Kabobo (Misotshi-Kabogo forest, *sensu* Plumptre et al. 2008, 2010a) is also considered here, because the plateau has a similar elevation, vegetation and climate to the proximate Itombwe Plateau, genetic samples from conspecific herpetofaunal populations at the two sites have minimal sequence divergence (EG unpubl. data), and Kabobo contains several endemic taxa (Table 2). Kabobo is also known to contain many rare species of birds in common with Itombwe (Prigogine 1960), and both sites contain significant populations of chimpanzees (Plumptre et al. 2008, 2009). Kabobo is also the largest tract of forest adjacent to Lake Tanganyika in DRC or Tanzania (Plumptre et al. 2008).

Our recent fieldwork suggests that the amphibian diversity of Itombwe and Kabobo is vastly underestimated. Analyses of amphibian specimens and DNA samples collected by us during expeditions in 2008–2012 identified several new species that seem to be endemic to narrow bands of elevation at the sites (< 5,000 km^2 extent of occurrence), and are thus likely to be classified as endangered under the threat criteria of the IUCN Red List (IUCN 2001). Most of these new species require additional sampling and male advertisement call recordings (anurans) for adequate species descriptions. Because our sampling of Itombwe and Kabobo has been mainly limited to forests that were not pristine, scores of additional, new amphibian species are likely to be discovered if future sampling can occur before catastrophic deforestation is complete. Moreover, chytrid fungus (responsible for global amphibian declines) has been detected (EG unpubl. data) in multiple amphibian species from Itombwe and Kabobo (including new species), creating an urgency for threat assessments of the sites' amphibian fauna (see also Greenbaum et al. 2008). We also observed that at least one Itombwe endemic amphibian species (*Phrynobatrachus asper*) is hunted for food, which is likely a consequence of its relatively large size (holotype snout–vent length = 55 mm, Laurent 1951). Given this hunting pressure, widespread destruction of Itombwe's forests, overgrazing of grasslands on the plateau and limited elevational distributions (Table 2), we recommend a critically endangered threat status (IUCN 2001) for the Itombwe endemic species *P. asper* and *Chrysobatrachus cupreonitens*, which are both currently classified by the IUCN as data deficient.

The impressive number of endemic amphibian species (Table 2), including two monotypic genera (i.e., phylogenetic relicts), suggests that Itombwe was either climatically stable over ecological and evolutionary time, or the forests are exceptionally resilient to climate-induced changes. According to Sayer et al. (1992), the Itombwe Plateau is a relict of the ancient relief that

TABLE 1. Locality data for four rediscovered species of anurans from the Itombwe Plateau, South Kivu Province, Democratic Republic of the Congo. UTEP museum catalog numbers are from the herpetology collection of the University of Texas at El Paso.

Species	Voucher No.	Locality	Habitat	Date
Arthroleptis pyrrhoscelis	UTEP 20392–20395	Near Tumungu village, 03.55873°S, 28.66603°E, 2022 m	Grassland	2 January 2011
Arthroleptis pyrrhoscelis	UTEP 20396	Near Tumungu village, 03.54172°S, 28.66970°E, 1900 m	Grassland	3 January 2011
Arthroleptis pyrrhoscelis	UTEP 20397	Near Tumungu village, 03.55594°S, 28.67029°E, 1960 m	Grassland	4 January 2011
Chrysobatrachus cupreonitens	UTEP 20398, 20403–20408	Mitamba village, 03.43184°S, 29.01411°E, 2852 m	Marsh	7 January 2011
Chrysobatrachus cupreonitens	UTEP 20399–20402	Mitamba village, 03.43153°S, 29.01164°E, 2848 m	Marsh	7 January 2011
Hyperolius leucotaenius	UTEP 20411–20413	Mikenge village, 03.74924°S, 28.74738°E, 2166 m	Marsh	30 December 2010
Hyperolius leucotaenius	UTEP 20414–20418	Elila River near Tumungu village, 03.54425°S, 28.67245°E, 1800 m	Gallery forest	1 January 2011
Hyperolius leucotaenius	UTEP 20409–20410	Near Tumungu village, 03.55370°S, 28.67422°E, 1869 m	Montane forest edge	4 January 2011
Phrynobatrachus asper	UTEP 20419–20425	Kamandende River near Mugegema village, 03.06184°S, 28.77858°E, 2675 m	Montane forest	25 May 2009
Phrynobatrachus asper	UTEP 20426–20429	Nakihomba River near Mugegema village, 03.07805°S, 28.76787°E, 2749 m	Montane forest	26 May 2009

TABLE 2. List of amphibian and reptile species that are known to be endemic to the Itombwe and/or Kabobo Plateaus. Data are taken from original species descriptions (Evans et al. 2008; Greenbaum et al. 2011; Laurent 1950, 1951, 1952, 1954, 1956), Laurent (1983), IUCN Red List (IUCN 2011) and Table 1 of this publication.

Taxon	Itombwe	Kabobo	Elevational distribution (m)	IUCN Red List Threat Status
Arthroleptis pyrrhoscelis	+	+	1900–2022	Near threatened
Arthroleptis vercammeni	+	—	1650	Data deficient
Cardioglossa nigromaculata inornata[1,2]	—	+	1900–2000	—
Chrysobatrachus cupreonitens	+	—	2400–2850	Data deficient
Hyperolius leleupi	+	—	2550–2650	Endangered
Hyperolius leucotaenius	+	+	1850–2500	Endangered
Laurentophryne parkeri	+	—	1850–1950	Data deficient
Phrynobatrachus asper	+	—	2400–2850	Data deficient
Phrynobatrachus dalcqi	—	+	1900–2000	Data deficient
Xenopus itombwensis	+	—	1800–2200	Critically endangered
Congolacerta asukului	+	—	2650–2900	—
Leptosiaphos rhodurus	+	—	1600	Data deficient
Lygodactylus angularis paurospilus[2]	—	+	1900–2000	—
Duberria lutrix currylindahli[2,3]	—	+	1900–2000	—

[1]Amiet (1972) and Blackburn (2008) noted this taxon likely represents a distinct species.
[2]These taxa likely represent distinct species, because they were described from isolated highlands that are hundreds, or even thousands of kilometers from their respective nominate species type localities.
[3]Laurent (1956) listed a specimen from "Kadjaga s/Tanganika, Urundi?" but the locality of Kadjaga in DRC or Burundi is unknown.

predates the mountains of the AR, which began forming in the Miocene 25–30 million years ago (Vande weghe 2004). This contention also supports the theory that Itombwe is in the area of the largest forest refugium (subrefugium of the AR refugium, *sensu* Prigogine 1986) in Central Africa, which likely harbored forest-endemic species throughout the Quaternary because of its ecological stability (Doumenge 1998; Sayer et al. 1992). In a discussion of the oldest forests in Africa, Lovett et al. (2005) noted that ecologically stable forests are characterized by the presence of aggregates of relictual lineages (e.g., monotypic genera), newly evolved species and ecological equilibration, where the forests are uniformly diverse over ecological gradients, thus optimizing diversity at a sustainable level. The theory behind this pattern is that long-term ecological stability depresses extinction rates, thus preserving phylogenetic relicts, and increases speciation rates, which enhances the survival of closely related variants that might be recognized as distinct species (Lovett et al. 2005).

Does Itombwe fit the pattern of an ecologically stable forest over time? Currently available data suggest the answer is yes. Although the monotypic genera *Chrysobatrachus* and *Laurentophryne* (the latter genus has not been seen since its description in 1950) have not been studied within a modern phylogenetic context, their distinctive morphology suggests they are substantially different from other closely related genera, and are likely to represent relictual genera (Laurent 1964). The monotypic genus *Callixalus* (now mostly restricted to Itombwe and Kabobo) fits this pattern as well, and the newly described genus *Congolacerta* is also a relatively ancient lineage, with one endemic species in Itombwe (Greenbaum et al. 2011). Preliminary analyses of mitochondrial DNA sequence data from multiple amphibian taxa (e.g., *Phrynobatrachus*, *Leptopelis*) suggest that Itombwe harbors several recently diverged sister taxa (< 2.5% uncorrected *p* sequence divergence) that are morphologically distinct, often with significant differences in variables of the male advertisement call (EG and F. Portillo unpubl. data). These relatively recently evolved species and several other new species that warrant recognition are mainly known from restricted geographic and elevational distributions (see Prigogine 1980 for similar patterns in birds), and support a pattern of ecological equilibration in Itombwe. If Itombwe was indeed a glacial refugium that was ecologically stable during past climatic shifts, there is hope that it could be a reservoir for its astounding biodiversity if future global climate change models are correct in predicting drastic shifts in temperature and rainfall in the 21st century. However, the mechanisms of speciation in Itombwe remain poorly understood, and further study is required.

Sayer et al. (1992) noted, "low human population density and the forest's isolation have proved, so far, to be Itombwe's best defences, but this state of affairs cannot continue forever. Despite recognition of its great value, no area of the massif is protected." Given the long history documenting the enormous conservation value of Itombwe's forests, it is surprising that concrete efforts to protect the site only commenced recently. An administration with a managing warden was established for INR in 2008. The reserve faces severe anthropogenic pressure from a growing human population that is migrating from the most heavily populated area in Central Africa (i.e., the border between DRC, Rwanda and Burundi) (Barnes and Lahm 1997), which is a result of one of the highest fertility rates in the world (Draper 2011). Reserve rangers have limited resources to ameliorate poaching, illegal mining and deforestation, which is currently not monitored. The influx of automatic weapons to Central Africa during the late twentieth century led to a sharp increase in poaching at Itombwe with accompanying, catastrophic declines in the numbers of forest elephants, gorillas and other endangered primates, and several species of ungulates (Hall et al. 1998; Mubalama et al. 2008; Omari et al. 1999; Plumptre et al. 2009). The grasslands in the highest elevations of the plateau are heavily impacted by numerous herds of domestic cattle, which are allowed to graze over vast areas. These environmental pressures will likely increase as a defunct, colonial-era road that bisects the Itombwe Plateau (between Mwenga and Fizi) is rehabilitated over the next year with funds from the European Union (CK, pers. comm.). The road will allow vehicles to extract resources (e.g., timber, gold and coltan) more efficiently and rapidly, and will likely lead to the establishment of additional human settlements with concomitant negative environmental impacts.



PHOTO BY WANDEGE M. MONINGA

FIG. 2. Photograph of the Itombwe Plateau near the village of Tumungu (ca. 1900 m), where *Hyperolius leucotaenius* was collected in montane forest (background) and *Arthroleptis pyrrhoscelis* was collected from grassland (foreground) in January, 2011.

In contrast to Itombwe, the southern extent of the Kabobo Plateau has not suffered from significant deforesation, but the site is completely unprotected, and illegal gold mining and hunting was observed by the authors in 2009. Based on positive meetings between the Institut Congolais pour la Conservation de la Nature (ICCN, i.e., Congolese Wildlife Authority), Wildlife Conservation Society (based in New York City, USA) and local chiefs and governmental leaders in 2009, plans are underway to establish Kabobo as a protected area (to be called Ngamikka National Park) with a surrounding buffer zone. However, prospecting mineral concessions were granted to several mining companies within some areas of the proposed national park, and these concessions must be annulled before conservation measures can move forward (Plumptre et al. 2010b).

Challenges to ongoing conservation efforts at INR are substantial and daunting. Preliminary conservation efforts discussed by Doumenge (1998) and Omari et al. (1999) were presumably abandoned during Africa's World War (Prunier 2009), which commenced in 1997. Since that time, at least three armed militia groups have become entrenched within the proposed boundaries of INR, and although UN programs are making some progress towards disarmament and reconciliation (CK, pers. obs.), militias continued to hamper the authors' scientific and conservation efforts as recently as January 2012. Many similar

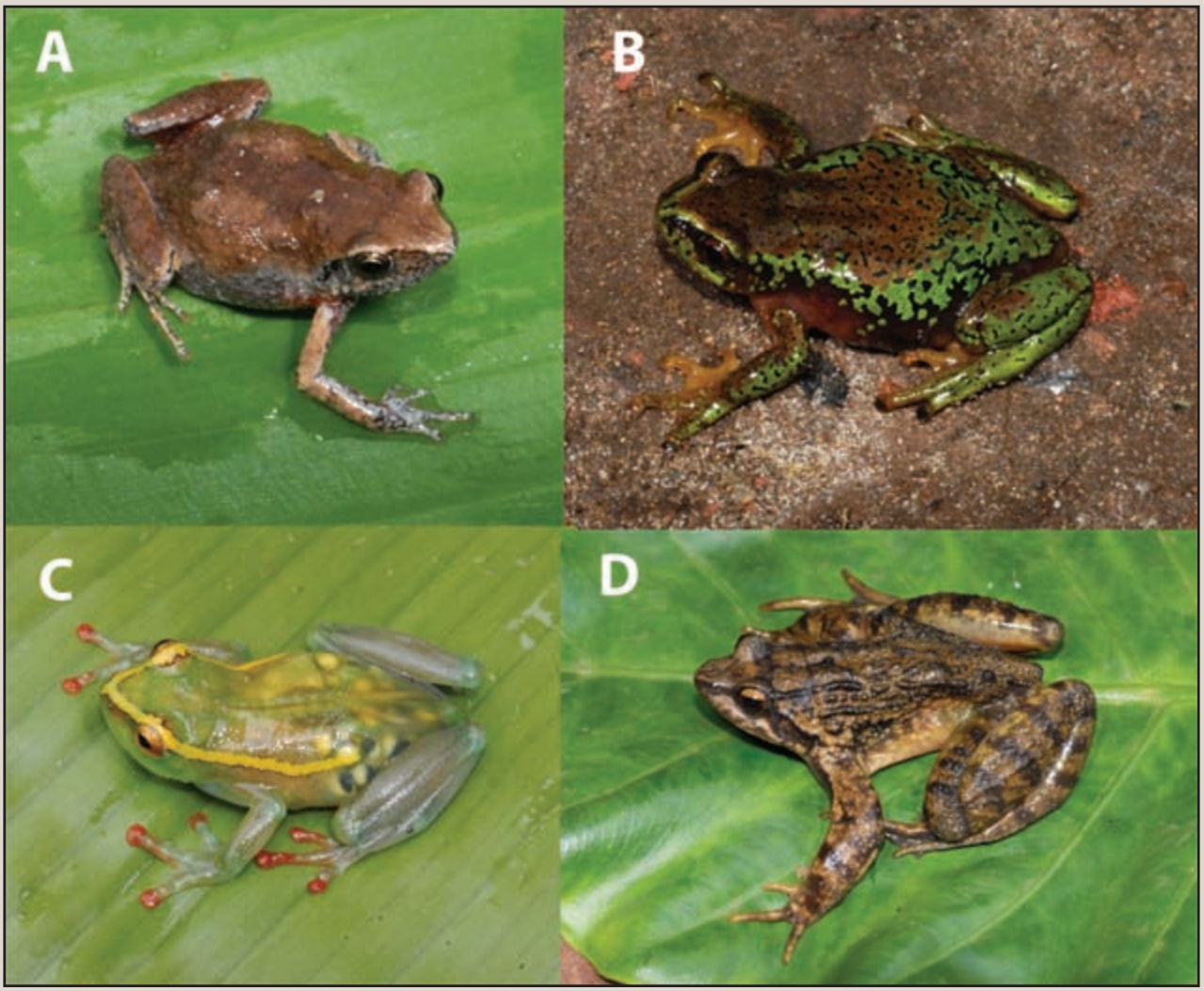


FIG. 3. Photographs of four rediscovered species of amphibians from the Itombwe Plateau. A) *Arthroleptis pyrrhoscelis*, B) *Chrysobatrachus cupreonitens*, C) *Hyperolius leucotaenius*, and D) *Phrynobatrachus asper*.

challenges occur in the more established Virunga National Park (Africa's oldest national park and a UNESCO World Heritage Site), where corruption and a lack of enforcement have allowed militias to destroy significant portions of the park's forests and wildlife (Draper 2011; Jenkins 2008). In Virunga (and presumably in INR), Ikoleki and d'Huart (2009) suggested that people living around the boundary of the park have the impression that the ICCN grants more importance to wildlife than to people, and that "objectives contributing to the promotion of socio-economic development of populations living around the protected areas" must be included in conservation activities. If peace could come to Itombwe in the future, the economic potential for ecotourism from birdwatching is enormous, given the staggering diversity of bird species that are known from the plateau. Habituation of gorillas and chimpanzees could also lead to ecotourism revenue, which is a significant source of income in neighboring Rwanda (Briggs and Booth 2006).

Despite these challenges, the rediscovery of four anuran species and discovery of at least a dozen new herpetological species at Itombwe (EG, unpubl. data) suggests that large areas of the plateau continue to harbor an impressive level of biodiversity. Several herpetological species found at Kabobo also seem to be in Itombwe (Table 2; EG, unpubl. data), suggesting the two sites were connected during geologically recent Pleistocene shifts in vegetation (but see Laurent 1983); both sites should be protected together to maximize conservation efforts and ensure that localized extirpation at one site does not result in extinction of a given species. For example, the monotypic hyperoliid genus *Callixalus pictus* is now extirpated from its type locality in Rwanda (Sinsch et al. 2011), underscoring the importance of protecting Itombwe and Kabobo, where most, if not all remaining populations occur. In conclusion, efforts to bolster INR should continue and expand to include Kabobo, predicted detrimental effects of the rehabilitated road through the Itombwe Plateau must be monitored carefully and linked to conservation benefits to local communities, and captive breeding programs must be initiated for the most vulnerable species if conservation efforts cannot improve by the end of this decade. Because additional, new herpetofaunal species await description, it is likely that the Itombwe Plateau's importance as a center of endemism and conservation concern will increase as biological exploration continues.

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Comparison of the Oral Bacteria Communities Among Five Lizard Species in a Captive Environment

The putative phenomenon of oral bacteria being part of complex predatory strategy in Komodo Dragon monitor lizards (*Varanus komodoensis*) has received considerable popular media coverage and a surprising amount of academic attention (Auffenburg 1981; Bull et al. 2011; Montgomery et al. 2002; Yogiari et al. 2001). In our experience in a zoo environment it also is evident that the general public has been convinced this is a valid phenomenon. Nevertheless, we fully concur with the review by Fry et al. (2009) that there is no direct evidence that *V. komodoensis* actually employs any such bacterial strategy in its feeding ecology. We also find it compelling that the phenomenon was entirely unmentioned in recent scholarly reviews of the ecology of *V. komodoensis,* Varanidae, or lizards in general (Bennett 1998; Ciofi 2004; King and Green 1993; Pianka and Vitt 2003).

In this study, we do not directly test the hypothesis implied by Auffenburg (1981). Rather, we present a comparison of the variation among the oral bacteria in several species of captive lizards, including Komodo Dragons, held in the same facility. Auffenberg (1981) isolated from the oral cavities of wild *V. komodoensis* four potentially pathogenic oral bacteria (*Staphylococcus* sp., *Providencia* sp., *Proteus mirabilis*, and *Morganella* [= *Proteus*] *morganii*). Montogomery et al. (2002) also found these taxa but attributed mortality of prey items from attack wounds by the lizards to the bacterium *Pasturella multocida,* which they isolated from wild-caught lizards but not from captive individuals. Examination of the oral bacterial community of a large group of *V. komodoensis* (N = 26 wild; N = 13 captive) found 57 bacteria species, with the mean number of species for wild-caught individuals being 46% higher than that of captive individuals (Montgomery et al. 2002). Gillespie et al. (2002) presented the same bacterial data as Montgomery et al. (2002), and presented preliminary observations regarding potentially effective antibiotic medicines and immune responses by *V. komodoensis* to their own bacterial flora. Yogiara et al. (2001) examined oral bacteria of 12 *Varanus* spp. (not including *V. komodoensis*) from captivity, but only reported on isolates of *Escherichia coli*. In contrast, Montgomery et al. (2002) found *E. coli* to be one of most common bacteria in wild-caught *V. komodoensis,* but absent from their captive specimens. They reported the most commonly isolated bacteria in captive animals were *Staphylococcus capitis* and *Staphylococcus caseolyticus*, which were not present in the wild-caught individuals. Considered together, these studies highlight that *V. komodoensis* harbors a wide variety of oral bacteria species, with the greater diversity appearing in wild animals and little overlap between wild vs. captive animals. Within the scope of their study, Yogiara et al. (2001) reported the possibility of cross-contamination (= transmission) of oral bacteria between individuals all held in the same captive facility and fed similar diets. Thus, transmission of oral bacteria is suspected to occur among individual lizards both in the wild and in captivity (Bull et al. 2010; Yogiara et al. 2001).

In this study, we sampled the oral bacteria of several varanid and non-varanid lizard species held in the same captive facility, to assess variation among individuals and species. Previous studies have compared only among individuals of *V. komodoensis* (both captive and wild) or have compared only varanid species (Auffenburg 1981; Montgomery et al. 2002; Yogiari et al. 2001). Our study compared oral bacteria among three species of carnivorous varanid lizards, one herbivorous scincid, and one herbivorous agamid that are maintained in the same facility and fed from the same kitchen preparation area. Our study was not designed to compare the oral bacteria of wild vs. captive animals, nor to directly address the hypothesis of oral bacteria as a predatory strategy in *V. komodoensis*.

Methods.—Species sampled included Komodo Dragon (*Varanus komodoensis*; N = 1 adult male, 1 juvenile male, 1 juvenile female), Desert Monitor (*V. griseus*; N = 1 adult male, 1 adult female), and Rough-necked Monitor (*V. rudicollis*; N = 1 adult male, 1 adult female). We additionally sampled Prehensile-tailed Skink (*Corucia zebrata*; N = 1 adult male) and Egyptian Spiny-tailed Lizard (*Uromastyx aegyptia*; N = 1 adult male, 1 adult female). Except for the adult *V. komodoensis*, all animals are maintained in the same building at Zoo Atlanta with separate enclosures for each species; individuals of the same species are maintained together or separately for variable amounts of time. The adult *V.*

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komodoensis is maintained alone in an adjacent building. All of these lizards are maintained by the same staff of keepers and all food is stored and prepared in the same kitchen. Utensils and food-preparation implements are washed and sanitized per standard precautions between uses, but no form of biosecurity protocols are in place that would prevent transfer of oral bacteria among animals in the living collection. The main building also houses a large collection of other reptile and amphibian species, plus a variety of insect cultures.

Saliva samples were collected from the oral cavity of each lizard using with two sterile cotton swabs that immediately were streaked onto two trypticase soy agar (TSA) plates and two MacConkey's agar (MAC) plates. One control swab was subsequently streaked onto one plate of each medium. As a safety precaution, saliva samples for the adult male *V. komodoensis* initially were collected on a sterile metal plate and then saliva was swabbed from the plate and the swabs streaked onto the TSA and MAC media. Plates were then sealed with parafilm and incubated at 37°C for 24–48 h. Initial isolates were chosen based on morphological assessment of the colonies. Isolation streaks were performed on clean TSA plates and MAC plates followed by incubation at 37°C for 24–48 h. Gram staining was done on samples from isolated colonies, then slides were observed using light microscopy. Gram-stain reaction and shape were recorded for each isolate. Colonies were inoculated into lysogeny broth (LB) cultures in 15-mL conical tubes.

Because DNA-sequences may offer less subjective assessment of bacterial diversity, we also extracted DNA from cultures in order to conduct a BLAST search for genetic matches of known taxa. Cultures were incubated overnight at 37°C in preparation for DNA isolation. The Wizard Genomic DNA Purification kit (Promega) was used to extract DNA from samples of the overnight cultures. Isolated DNA was stored at 2°C. Two sets of 16s rDNA primers were selected to amplify a wide range of Gram-positive and Gram-negative bacterial species. Gram-positive bacterial DNA was added to PCR tubes containing PuReTaq Ready-To-Go PCR beads (Illustra) along with fD1 and rD1 primers (Integrated DNA Technologies), and Gram-negative bacterial DNA was added with fD2 and rP2 primers (Weisburg et al. 1991). Primer controls were prepared for both primer sets. Samples underwent thirty-five cycles in a thermal cycler with each cycle consisting of one minute at 94°C for denaturing, one minute at 60°C for annealing, and one minute at 72°C for extension. Gel electrophoresis was performed at 125 volts for sixty minutes. PCR samples were applied directly onto the 0.8% agarose gel in 10µL aliquots after being mixed with 5µL of loading dye. Additionally, loading dye and 1µL of 1kb ladder was added to each gel. Primer controls allowed for the correct identification of primer dimer bands. DNA bands were excised from the gel and placed in 1.5-mL microcentrifuge tubes. The QIAquick Gel Extraction kit was used to isolate the DNA for sequencing. A Nanodrop spectrophotometer was used to measure DNA concentrations. Samples were prepared for shipment and sequencing by GENEWIZ. Sequences were compared to the nucleotide BLAST database. Comparisons of the number of culturable Gram-positive and Gram-negative bacteria observed among individuals within the species *V. komodoensis* and *U. aegyptia* were examined using the G-test of independence.

Results.—The oral flora of seven carnivorous lizards from the three varanid species consisted of 19 Gram-positive and 21 Gram-negative culturable bacterial colonies. No cultures were found on any control plates except a single colony Gram-positive cocci on the control TSA plate from the adult male dragon. However, these cocci on the control plate were aggregated into chains, and distinctively different from any other cultures appearing in other samples from the same individual; these cocci were assumed to represent contamination.

Individual variation within species was evident among the samples. For example, the adult male *V. komodoensis* did not contain any Gram-negative bacteria, though four Gram-positive species were found. Samples from the two juveniles of the same species showed different ratios ($P = 0.05$) of Gram-positive to Gram-negative bacteria, with the male having 2:1 ratio, in favor of Gram-positive bacteria, and the juvenile female had a 1:2 ratio, in favor of Gram-negative bacteria (Fig. 1). Similarly, samples from the male and female of the herbivorous *U. aegyptia* differed, with only five Gram-positive species isolated from the male and only three Gram-negative species from the female. Similarly, there was great variation among species, with the greatest numbers of morphologically distinct colonies being found in the juvenile male *V. komodoenis* and the single *C. zebrata* (nine colonies each; Fig. 2).

Results from DNA sequences discovered fewer species than were suggested by our morphological assessment of colonies (Table 1). Each lizard species possessed at least one bacterial species unique to them, and only one bacterial species

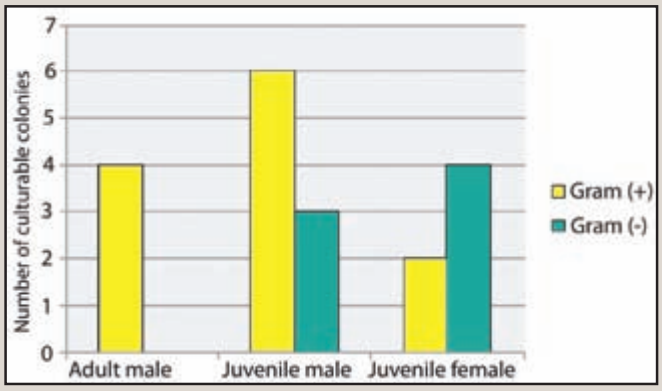


FIG. 1. Comparison of morphologically distinct culturable oral bacteria sampled from the oral cavities of three individual Komodo Dragons (*Varanus komodoensis*) in captivity. The three individuals were different ($P = 0.05$), and note that Gram-negative species were absent from the adult male.

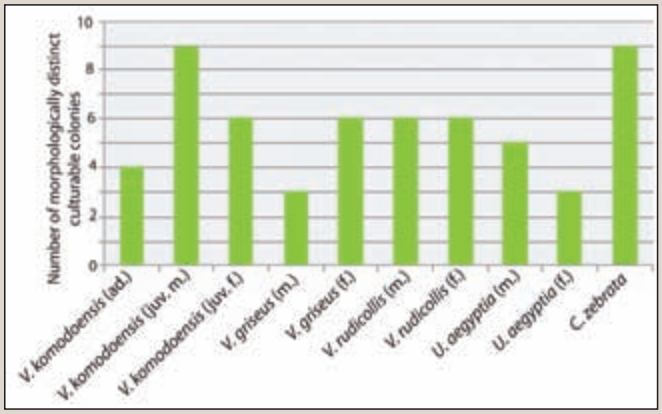


FIG. 2. Total number of morphologically distinct culturable oral bacteria sampled from the oral cavities of captive lizards (N = 1 for each entry).

TABLE 1. Bacteria species identified from oral swabs of captive lizards using DNA-sequences matched to known samples (BLAST search). Highlighted bars indicate bacteria species found in multiple individuals.

Bacteria Taxon	Maximum identification (%)	*Varanus komodoensis* (adult male)	*Varanus komodoensis* (juv. male)	*Varanus komodoensis* (juv. female)	*Varanus rudicollis* (male)	*Varanus rudicollis* (female)	*Varanus griseus* (male)	*Varanus griseus* (female)	*Uromastyx aegyptia* (male)	*Uromastyx aegyptia* (female)	*Corucia zebrata* (male)
Staphylococcus sciuri	100	X		X				X	X		X
Acinetobacter calcoaceticus	99			X							
Acinetobacter sp.	100		X								
Planomicrobium chinense	99		X	X							
Kluyvera georgiana	99		X								
Filibacter limicola	98			X							
Proteus vulgaris	99			X		X					
Aeromonas hydrophila	100				X						
Bordatella sp.	99				X						
Flavobacterium sp.	97				X	X					
Pseudomonas sp.	100					X					
Escherichia sp.	100					X					
Pseudomonas aeruginosa	100						X	X			
Streptomyces sp.	99						X	X			
Bacillus sp.	99								X		
Serratia marcescens	100									X	
Citrobacter sp.	99									X	
Morganella morganii	99									X	
Enterococcus sp.	100										X
Enterococcus sp.	100										X
Cronobacter sp.	92										X
Aeromonas punctata	94										X

(*Staphylococcus sciurii)* appeared in more than two lizard species. Samples from *V. griseus* were the least diverse among our samples, consisting only of three bacteria species between the two individuals while samples from three *V. komodoensis* were the most diverse. The herbivorous species *Uromastyx aegyptia* were the only species unique from all other species, with three unique bacteria species identified by DNA sequences. Some sequences we generated could not be allocated to species using the nucleotide BLAST database, so our results are conservative in terms of overall bacterial diversity among our sampled lizards yet are fully comparable within our study.

Discussion.—Because of the research foci of previous studies, the oral bacterial community of Komodo Dragons is the best characterized of the five lizard species we examined. Montgomery et al. (2002) examined 13 captive Komodo Dragons and found an approximate 2:1 ratio of Gram-positive bacteria (20) to Gram-negative bacteria (11), which is roughly comparable to what we found among the three individuals we sampled. We found a low number of bacteria species in Komodo dragons in our study, which is consistent with the reduced number of bacteria species that Montgomery et al. (2002) reported in captive vs. wild individuals. However, the taxonomic diversity in our captive samples is less (8 vs. 16) than that found in captive samples examined by Montgomery et al. (2002). We suggest that this difference is specifically attributable to our smaller sample size (N = 3 vs. N = 13), in a manner that is consistent across both studies. In other words, although not discussed by them, perusal of the data presented by Montgomery et al. (2002: table 1) evidences remarkable inter-individual variation in the oral flora of captive (and wild) *V. komodoensis*. For example, in their study, no bacteria species is common to more than 5 of their 13 sampled individuals (all from a single zoo), and many species were found only in single individuals. Further relevant to this point is our observation that of the eight bacterial species we discovered in our sampled *V. komodoensis*, only one (*Acinetobacter calcoaceticus*) also was found by Montgomery et al. (2002); their sample was found only in two (of 26) wild dragons, while ours was from a captive individual. In addition, we identified four novel microbial species in *V. komodoensis*: *Proteus vulgaris*, *Filibacter limicola*, *Kluyvera georgiana*, and *Planomicrobium chinense*. Similar to the results of Montgomery et al. (2002), we did not find the pathogenic species *Pasturella multocida* among our captive *V. komodoensis*.

Montgomery et al. (2002) did not compare their results from *V. komodoensis* to any other species of lizard. Yogiari et al. (2001) sampled multiple individuals and species but limited their survey to isolates of *E. coli* and did not present their data in a manner that allows evaluation of variation among their sampled individuals or species. Considered in conjunction with the results of Montgomery et al. (2001), our results suggest that oral bacterial diversity among lizards appears to be rather idiosyncratic. Although there was ample opportunity for transmission among individuals in the collection at Zoo Atlanta, we found no bacteria species to be ubiquitous among our samples. While bacterial communities were mostly distinct among host-species of lizards (i.e., some evidence for phylogenetic trends in host-bacterial relationships), we note that even pairs of individuals housed together (e.g., *V. rudicollis,* or the *U. aegyptia*) were not identical. Only a single "generalist" bacteria species (*Staphylococcus sciuri*) was found in more than a few individuals and in more than two species; we note that this same bacterium was relatively rare in the study by Montgomery et al. (2002), and was found only in their wild-caught animals. Montgomery et al. (2002:1) described their discovery of 57 bacteria species in *V. komodoensis* as a "wide variety of bacteria" but they did not emphasize that few of these bacteria species were found in more than two or three individuals, and none was ubiquitous. So, their study and our data underscore the idea that while some lizard species might be capable of hosting a wide diversity of oral bacteria, individual lizards do not appear to do so at any given time. Furthermore, evident opportunities for cross-contamination (e.g., captive individuals in the same facility) do not appear to result in widespread transmission (resulting in subsequent establishment in the oral cavity). These findings suggest that manipulative studies to investigate interaction, competition, and exclusion among bacteria species in the oral cavities of lizards might be informative. Temporal comparisons of the same individuals could reveal that bacterial colonizations are ephemeral, as was documented in snakes by Blaylock (2001).

Finally, with regards to the oral bacteria of Komodo Dragons, we suggest that because of the sensational image of such a morbid and unusual predatory strategy, the story has become quite established in popular and semi-technical accounts of the ecology of the species, including signage and oral presentations at zoos. We recommend that such messaging be carefully qualified until better evidence is presented that this phenomenon actually exists in the wild. That Auffenburg (1981) documented postbite infections from Komodo Dragons in both humans and nonnative water buffalo is wholly unsurprising. Oral bacteria are well known in squamates (e.g., Jho et al. 2011; Lam et al. 2011) and infections stemming from oral bacteria commonly are reported following bites by a broad diversity of vertebrates including sharks, birds, squamates, and mammals including humans (Abrahamaian and Goldstein 2011; Goldstein et al. 1984; Jorge et al. 1990), yet no speculation exists that oral bacteria constitute a specific predatory strategy in any of these species.

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HERPETOCULTURE NOTES

TESTUDINES — TURTLES

***CUORA GALBINIFRONS GALBINIFRONS* (Indochinese Box Turtle). POST-COPULATORY SNIFFING BEHAVIOR.** With the exception of a few species that are commonly kept and bred in captivity, relatively little is known about the breeding biology and reproductive behaviors of geomydid turtles belonging to the genus *Cuora*. In this note we describe an unusual post-copulatory behavior observed and video-recorded in an adult sexual pair of *C. galbinifrons galbinifrons* that had been introduced for breeding purposes at the Wildlife Conservation Society, Bronx Zoo.

The Bronx Zoo acquired an adult male *Cuora galbinifrons galbinifrons* from a dealer in November 1985 and an adult female in July 1986, which have been housed together for the majority of their time at the zoo. Copulation and egg laying by this pair has occurred in the past, but all eggs received to date have been non-viable. Since September 2010, the pair has been housed separately in plastic enclosures measuring 1.2 x 0.4 x 0.6 m (l x w x h). Beginning 5 November 2010, in an attempt to stimulate reproductive cycling, the pair was brumated inside their enclosures with a 25-cm deep mixture of coconut fiber and peat moss covered with leaf litter. Cork bark hides and a large water bowl were also provided.

Following a five-month-long period, during which temperatures dropped as low as 15°C, the pair was brought out of brumation on 4 April 2011, and first reintroduced in the female's enclosure for 15 minutes on 18 April. Although the male repeatedly attempted to mount the female during initial introductions, copulation was not observed until their sixth introduction on 22 May. After 16 min of unsuccessful mounting attempts by the male, the female emerged from her shell and became receptive to the male's advances. At this time, the female moved about the enclosure while manipulating her tail to reveal the cloaca. The male proceeded to mount the female, grasping the underside of the female's carapace with his hind limbs and wrapping his tail around the tail of the female. Copulation lasted for ca. 8 min. Following copulation, the male spent several minutes adjusting and retracting his penis, and the female turned to face the male. As the male turned away, the female approached the male's post-vertebral marginal scutes, lowered her head towards the male's cloacal region, and appeared to sniff the area for approximately eight seconds. Shortly thereafter, both turtles reversed their positioning and the male lowered his head and sniffed the cloacal region of the female for five seconds before turning away to charge at the observer.

Although limited to just a single observation, this account adds new information to what has been reported on the reproduction and behaviors of *C. galbinifrons* (e.g., Fiebig and Lehr 2000. Salamandra 36[3]:147–156; Fritzsche and Fritzsche 2005. Radiata 14[2]:48–49; Hiller 2005. Radiata 14[2]:44–47), and may be useful to other zoos and institutions seeking to reproduce this species in captivity. Moreover, this behavior may also provide further insight on the role of olfaction in turtles.

Cloacal sniffing has been observed in many chelonians as a precursor to copulation (see e.g., Mason 1992. *In* Gans and Crews [eds.], Biology of the Reptilia: Physiology E, pp. 114–228. University of Chicago Press, Chicago, Illinois; Halpern 1992. *In* Gans and Crews, *op. cit.*, pp. 424–532), and is currently thought to play important roles in species and gender discrimination as well as provide information on the reproductive status of females (Galeotti et al. 2007. Copeia 2007:980–985; Liu et al. 2009. Amphibia-Reptilia 29:185–195). The behavioral interactions described here for *C. galbinifrons* differ from earlier reports of sniffing behavior in that they took place after copulation had occurred, and sniffing was initiated by the female and then reciprocated by the male. Thus, this behavior in *C. galbinifrons* probably cannot be explained by previous explanations of sniffing behavior in turtles (e.g., Galeotti et al., *op. cit.*; Liu et al., *op. cit.*), but further observations are needed to understand its purpose as well as its importance in the reproduction of this species.

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SQUAMATA — SNAKES

***AGKISTRODON CONTORTRIX CONTORTRIX* (Southern Copperhead). MAXIMUM CAPTIVE LENGTH.** The current maximum documented total body length (TL) for any wild-caught form of *Agkistrodon contortrix* is 53 in. (134.62 cm) based on a specimen from White Plains, New York, USA, and reported by Ditmars (1931. Snakes of the World. MacMillan Co., New York. 207 pp.). Cagle (1968. *In* Blair et al. [eds.], Vertebrates of the United States, pp. 273–358. MacGraw Hill, New York) reported a specimen of *A. contortrix* with a total length of 57 in. (144.78 cm), although the subspecies was not indicated and a voucher specimen was not referenced.

Largest of the documented specimens of the southern form of *A. contortrix* include two Louisiana individuals, one 52 in. (132.1 cm) TL individual cited in Conant (1975. A Field Guide to the Reptiles and Amphibians of Eastern and Central North America, 2nd ed. Houghton Mifflin Co., Boston, Massachusetts. 429 pp.) and a 50.125 in. (127.3 cm) TL male measured by Douglas A. Rossman and cited in Gloyd and Conant (1990. Snakes of the *Agkistrodon* Complex: a Monographic Review. SSAR Contributions to Herpetology 6, vi + 614 pp.).

Captive specimens can clearly reach dimensions normally not obtained in wild populations; however, the following report suggests the possible body length that can occur in southern forms of *A. contortrix*. On 21 April 2001, an unsexed *A. contortrix* was captured by EC just west of CR 269, approximately 2 miles N of I-10, in Gadsden Co., Florida, USA (30.645°N, 84.820°W). No measurements were taken at the time of capture, although the snake likely was born in the fall of 2000. The specimen remained in captivity from initial capture until death, which occurred on 18 April 2012. Immediately following death, the specimen was measured by EC using a steel rule, and showed a total body length of 147.32 cm (58 in.) (Fig. 1). Sex was not determined. The specimen is believed to represent the largest documented wild-caught or captive *A. contortrix*, a voucher photograph of which has been deposited in the collection of the South Carolina State Museum, Columbia, South Carolina.

PHOTO BY ED CASSANO



FIG. 1. Record length *Agkistrodon c. contortrix* being measured following its death.

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***NERODIA SIPEDON* (Northern Watersnake). CAPTIVE LONGEVITY.** *Nerodia sipedon* is a common water snake of the northern and southeastern United States. The natural lifespan of this species is currently unknown but a longevity record of 9 years, 7 months, 24 days for a captive *Nerodia sipedon pleuralis* has been published (Slavens and Slavens 1999. Reptiles and Amphibians in Captivity: Breeding, Longevity, and Inventory. Slaveware, Seattle, Washington; Snider and Bowler 1992. Longevity of Reptiles and Amphibians in North American Collections. SSAR Herpetol. Circ. 21, 40 pp.). Here we report a *Nerodia sipedon sipedon* that attained a minimum known age of 21 years.

This snake had reportedly been captured near Traverse City, Michigan, USA in the fall of 1991 and donated to an elementary school for a class pet by the student who caught it. The student reportedly had kept the snake for some time (two or more years) before it was donated to the school, but confirming details on this point are unavailable. The snake was estimated to have been at least 45–50 cm in total length in 1993 when it came to the attention of the junior author (KR), but exact measurements were never taken. KR was given possession of the snake in 1995.

The sex of the specimen was unconfirmed but it was presumed to have been male, an assumption supported by its small relative size, as males are smaller than females in this species (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Books, Washington, DC. 668 pp.). Since 1995 it had been maintained in a screen-topped cage measuring 76 x 30.5 cm in horizontal dimensions, heated with a "hot rock," with bark bedding and two water dishes, and positioned near a south-facing window. It was typically fed about 12 small goldfish once per week, except during the winter months, when it would sometimes refuse food for several weeks at a time.

On 23 January 2012, after a prolonged fast, the snake was observed to have a swollen area near the tail, and was taken to a veterinarian and determined to have a "rectal prolapse" and possible septicemia. It died later that day. Although exact measurements were not made, the snake was approximately 68 cm in total length at death. It seems reasonable to assume that this Northern Watersnake was at least one year old in fall of 1991; thus its minimum attained age would be 21 years and perhaps 4–5 months (given that parturition in this species typically occurs from late July through early September in northern Michigan).

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HERPETOLOGICAL HISTORY

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Albert Patrick Blair (1913–2004) at the American Museum of Natural History



FIG. 1. Dr. Albert P. Blair, Assistant Curator, Department of Animal Behavior. Photograph taken at the American Museum in May 1946. (AMNH Photographic Archives 298739.)

A *History of Herpetology* at the American Museum of Natural History (AMNH) focused on the organization, staffing, and fieldwork of the department that was established for the museum's collection of Recent amphibians and reptiles (Myers 2000). Recently, Kraig Adler inquired whether herpetologist Albert Patrick Blair had had an AMNH connection. Adler called my attention to a newspaper obituary (*Tulsa World*, December 9, 2004), which stated that Blair had been a curator at AMNH. Indeed, the obituary was correct, A. P. "Pat" Blair (younger brother of F. W. "Frank" Blair) had held a noncollection curatorial appointment—not in Herpetology but in Animal Behavior (appointments in the Department of Animal Behavior and in the Department of Vertebrate Paleontology are not included in the *History*).

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A. P. Blair was a competent herpetologist, but, except for publications, he left few tracks in New York after finishing a fellowship at Columbia University in 1940–1941. In 1942 he may have been briefly at the New York Zoological Society (NYZS), where he was listed as "curator" in *American Men of Science* (1965, 11th ed.). That affiliation, however, could not be confirmed in NYZS Annual Report staff listings and other archival sources (M. Thompson e-mail to K. Adler, December 16, 2011). In any case, Blair came to AMNH in July of that year.

Blair was on the American Museum staff for about five years, but actually on the premises only for a year or so. The following account is based on old AMNH staff lists for Animal Behavior, correspondence in the Department of Herpetology Archives (Noble and Bogert collections), and on a one-page personnel record and an unpublished manuscript fragment in the AMNH Central Archives. This is a curious but historically interesting case.

Albert Patrick Blair (1913–2004).—"Pat" Blair was appointed Staff Assistant in the new Department of Animal Behavior in July 1942. Within weeks, he was promoted to Scientific Assistant (September 24) and then to Assistant Curator. His promotion to Assistant Curator supposedly was to be effective January 1943, but he was listed in that position in the 1942 annual report. This rapid succession of positions likely resulted from a juggling of available salary funds. Blair seems to have been considered as an Assistant Curator from the beginning but evidently could not be immediately paid at that rank.

At any rate, the 74th–77th AMNH annual reports show Blair as Assistant Curator of Animal Behavior from 1942 to 1946. The 78th ("1947") annual report mentions only his leaving the Department; he had resigned from the Museum in December 1946. (Starting in 1946 the Museum shifted from calendar-year to fiscal-year reporting—starting July 1 of one year and ending June 30 of the following year [Myers 2000: 165]).

Although Blair was formally associated with the American Museum for nearly five years, his total accumulated time spent there was only a year owing to military service in the Air Corps during World War II. It was noted in the 74th and 75th reports (1943 and 1944) that he was "on leave of absence in war service;" this note should have been repeated in the 1945 report. After getting out of the Air Corps, Blair returned to the Museum on March 15, 1946, but he left at year's end.

History Leading to Blair's AMNH Appointment.—Blair took his Ph.D. at Indiana University in 1940, under the mentorship of Alfred C. Kinsey. (It is seldom realized that Kinsey turned to studies of human sexuality only after a career as a taxonomist; he started as a systematist studying gall wasps—his huge wasp collection is at AMNH and his publications included four AMNH *Bulletins*). Blair's doctoral studies involved interrelationships of toad populations in eastern North America. On March 4, 1940, Blair wrote to G. K. Noble at AMNH saying that he hoped for a postdoctoral fellowship to work with Theodosius Dobzhansky at Columbia University in New York; he asked "is it possible that some arrangement can be worked out so that I can do part of my work with you?" Two days later, on March 6 (mail was fast in those days), Noble wrote that:

> Dr. Kinsey was very enthusiastic about your work. Unfortunately I missed seeing your demonstration at the Meetings but I heard numerous favorable comments in regard to it [re December 1939 meeting of AAAS, Columbus, Ohio, where Blair presented "an eco-genetical study of North American toads" fide 1940 *Science* 91 (2353): 118].
>
> At the present moment we are breeding *Bufo terrestris* and various *Rana* in this laboratory. We would therefore welcome a mature student like yourself who could continue work with Amphibia . . . What space, material and assistance we could give you would of course depend on the exact nature of your problem. We have had financial support for our studies on the hormonal and neural mechanisms involved in the social behavior of vertebrate animals and very much hope that we can continue to secure support for this field of study. I would be especially interested in knowing how the breeding behavior has been modified within the genus *Bufo*. In *Rana* the patterns of behavior have become enormously modified from species to species.
>
> I should like to know more of the work you intend to do at Columbia before advising you in detail . . . In general, I would say we would be very glad to welcome you in the laboratory and hope some arrangement may be made to continue your *Bufo* work into detained behavior studies.

Blair wrote back on March 26, 1940 saying that:

> I have just been notified that I have been granted a National Research Fellowship for the academic year beginning September 1.
>
> My past work has involved three main angles: (1) extensive field work, (2) subsequent analysis of field collections, and (3) experimental hybridization of the forms involved.
>
> Field work has involved approximately 20,000 miles travel in 20 states [reminiscent of his major professor Kinsey's entomological fieldwork] and has been concerned with the *fowleri-americanus-terrestris-woodhousii* group of toads. The exact determination of the western edge of the range of *fowleri* and *americanus* and of the eastern edge of the range of *woodhousii* has been given particular attention. Live material has been collected for experimental hybridization; preserved material has been accumulated until about 3,500 specimens (adult) are now at hand. Data has been collected on areas where there is apparently hybridization in nature.
>
> Laboratory analysis of field collections has been made biometric wherever possible, I have made some 25,000 caliper measurement as well as about the same number of "determinations" on less objective characters.
>
> I have experimentally hybridized *Bufo fowleri* with *B. americanus, B. americanus* with *B. woodhousii*, and *B. fowleri* with *B. woodhousii*. Pituitary injections have been used to induce breeding in a considerable percentage of the crosses. About 600 hybrids have been raised through metamorphosis. Due to limitations of space and food it has been possible to maintain only a small percentage of these.

Blair went on to detail other hybridization plans for the spring and mentioned having "some 10,000 immature toads and tadpoles" on hand. On April 3, 1940, Noble wrote that that "I shall run up to Columbia some time before long and learn what plans might be for your space and facilities."

As fate would have it, however, the 46-year-old Noble died unexpectedly on December 9, 1940 (Myers 2011: 39, 211, note 88). He died only three months after Blair's scheduled start at Columbia; it must have been a jolt to young Blair, but his budding relationship with Noble almost certainly helped pave the way for his hiring at AMNH following completion of his fellowship at Columbia.

At the time of the foregoing correspondence, Noble was curator of two AMNH Departments (the title *Chairman* was not introduced until 1942). By 1928 Noble had been offered positions at Cornell University and Columbia University (the latter to replace geneticist Thomas Hunt Morgan as full Professor of Experimental Biology). To keep him at AMNH, President Henry Fairfield Osborn and Museum Trustee (and Herpetology Research Associate) William Douglas Burden arranged for additional support and the renaming of Herpetology to the "Department of Herpetology and Experimental Biology." The last was split off as a separate department in 1934. Blair's proposed work would have meshed well with Noble's plans for Experimental Biology.

In 1942, a few years after Noble's death, the Department of Experimental Biology was renamed the Department of Animal Behavior. Its Chairman and Curator was one of Noble's Assistant Curators, Frank A. Beach—a psychobiologist who helped found the emerging discipline of behavioral endocrinology. Under Beach, the connection to herpetology was broken and Animal Behavior turned largely to studies of laboratory mammals. Nonetheless, Beach made room for herpetologist Blair, which would have pleased Noble.

Blair's AMNH Fieldwork with Charles M. Bogert.—Assistant Curator Bogert largely ran Herpetology during Curator Noble's preoccupation with Experimental Biology (Myers 2000:54–60); he continued doing so after Noble's death, becoming "Assistant Curator (In Charge)" for 1941, "Acting Curator" in 1942, "Curator" in 1943, and "Chairman and Curator" in 1944. The name of the Herpetology Department changed several times during these and other years (Myers and Zweifel 1993: 136; Myers 2000: endnotes 8, 21, 78, 82, 142, 143, and 152). Bogert and Blair had gotten friendly and certainly conversed during Blair's time at AMNH, but their archived written correspondence (1948–1964) starts after Blair had left the Museum. There is, however, an earlier (1945) letter from Bogert's Assistant Bessie Matalas [m Max Hecht], addressed to Captain A. P. Blair, Squadron "F", AAF, Pyote, Texas; she said that Bogert had left for summer teaching in California, but she provided identifications of three species of *Phrynosoma* that Blair had asked about.

A typed document from Blair in the AMNH Central Archives provides insight into Blair's postwar state of mind, and imparts some of the flavor of doing fieldwork with Bogert and colleagues.

The title is "Mexican Trip with American Museum Group." With page numbers 103–113 and a handwritten date of 1/29/93, Blair likely sent it to AMNH after extracting it from an unpublished autobiography. Some extracts from this 11-page manuscript:

> When I got out of the Air Corps in 1946 I wasn't sure whether I wanted to go back to the American Museum of Natural History and New York City or not. I wasn't even sure that I wanted to stay in biology and the academic life. I had a chance to stay with the service aviation program as a civilian employee but that didn't interest me at all. At any rate, after some agonizing I went back to the American Museum. Shortly after my return I learned that an expedition was being organized to go to Mexico in August [returning in September, 1946]. Chuck Bogert [an experienced Mexican field man] was the leader; he was the head of the Department of Amphibians and Reptiles. Rudy [Rodolfo] Ruibal, a 17-year-old Cuban in school in the U.S., was interested in herps and was a protégé of Bogert and was included. Dean Amadon of the Ornithology Department at the American Museum was another. John Moore, a research associate at the Museum was the 4th. John said to me one day, why don't you come along. I fell for it hook, line and sinker. My boss, Beach, said sure, go, and he would find some money. I was committed. . . . As transportation we had 2 surplus army vehicles, a jeep and a carryall. Both were to blow head gaskets before we got back.
>
> Finally we were rolling. About the second day, as I remember, Chuck disgustedly said he didn't see as how we couldn't ALL go to the bathroom at the same time, that he was tired of stopping for each guy as he got the urge. We stopped in Tulsa overnight and ate with my folks (fried chicken) and then went to the Illinois River overnight . . . [to] break in our camping gear. I put out a bunch of throw lines for catfish and caught the biggest string of channel cats I have ever caught. I acted like this was how many I always caught.
>
> On to Laredo where we had to clear customs. Amadon had not received his bird collecting permit nor his permit to take in a shotgun. A few pesos, about 5 as I recall, convinced the customs man that a shotgun was OK, in fact he said that a machine gun would only require 25 pesos for entrance. We entered Mexico at dusk and drove far into the night . . . We finally pulled off the road late at night . . . At morning's first light it appeared we were in a goat corral.
>
> On to Monterrey and then west. We were heading for Las Delicias [an isolated oasis at southern end of Chihuahuan Desert , Coahuila] , a tiny hamlet in a large valley surrounded by mountains with only one pass into the valley. It was far off the beaten track and we did quite a bit of wandering and asking directions. We spent a miserable night in a dry playa . . . where the dust was 6–8 inches deep. Toward evening we came to Las Delicias . . . with a half dozen primitive houses and . . . store, all of adobe. There was a pond supplied by a primitive aqueduct that carried a tiny stream of water from a spring 3 miles away at the base of a very forbidding mountain. I was so dry and dusty and half overcome by the heat that I started following the aqueduct toward the mountain to find the source. John went with me for a mile or so but turned back. I continued on alone determined to find where the water came from. Finally arriving at the spring (in a lovely canyon with great masses of maidenhair ferns along the sides) I was so overcome by heat and exhaustion that I was near collapse. I sat down in the spring with my clothes on and stayed there for maybe half an hour. The spring water was warm and actually cooled off as it ran in a tiny brook down the canyon before entering the little aqueduct for its journey to the village. I finally made up my mind to try and get back to the village. It was downhill all the way and that helped . . . Back at camp I was too ill to eat and spent the twilight hours lying on my cot beneath the enormous fig tree that provided about the only shade around. I was to climb that fig tree to feast on figs many times in the days that followed.
>
> It was terribly hot at Las Delicias and we soon learned (John and I) to do our exploring at night . . . One of John's reminiscences . . . was (he said, I don't recall it very clearly) of me returning to camp with a live rattlesnake in each hand . . . The heat didn't seem to affect the natives. Just after we arrived they had their annual mule roundup where they herded in all the mules of the valley and clipped their manes variously to indicate whose mule was whose . . . One of the cowboys came to Chuck Bogert with a large water turtle and sold it to him for 5 pesos. After the roundup was over and the cowboys had gone back to wherever in the valley they came from, the headman of the village came to Bogert and told him that the turtle hadn't belonged to the cowboy at all and he had no right to sell it. In fact, the headman said, the turtle was his wife's pet turtle. He would, however, be glad to sell it to Bogert for 5 pesos. So Bogert bought the turtle a second time.
>
> There were two species of toads around the pond so I crossed them and attempted to rear the hybrid tadpoles in some very primitive little clay pots I bought in the little "store" in the village. They were unglazed and promptly killed the toad larvae. So I put some hybrid larvae in little outdoor pools far away from camp at the spring at the base of the mountain, retrieving them after a number of days.
>
> One day a pickup truck pulled into our campground. It was K.P. Schmidt and his 2 sons. Bogert had told K.P. that we would be at Las Delicias at such and such a time but we had about given up on him finding the place, especially since we had had such a hard time finding it ourselves. K.P. was a gentle soul but I got quite mad at him one day when he went up in the canyon near the spring and ripped half the maidenhair ferns off the walls looking for a little frog which somebody (not me) had found an example of the day before . . . [Bogert's 1946 photo of Schmidt at Las Delicias was published in Myers (2000: fig. 6), although the original photo was misdated "1947."]
>
> Our next stop was on the Rio Nazas, a river that came out of the mountains and finally sank into the desert about 20 miles downstream from where we were camped . . . This is where I got mad at Amadon. I found a bird nest with mamma bird and young and told Amadon about it and he promptly went down and shot the mamma bird for a specimen.
>
> One day I told Chuck there was a *Natrix* (water snake) in the river and he said "Can't be", there's no *Natrix* within 600 miles of here, it must be a *Thamnophis* (garter snake). So that night Rudy and I went down to the river and I shot the snake and Rudy jumped in and grabbed it before it could sink. It was a *Natrix* of course . . . and it eventually got named for Bogert who was asleep on his cot when it was collected. Oh well, what the hell? [Blair had reason to be annoyed. Conant (1953) later collected additional specimens and named it *Natrix erythrogaster bogerti*, with Blair's specimen as a paratype but with collectors not given. Bogert (in litt.,

Sept. 27, 1946) had transmitted to Conant AMNH catalogue data explicitly giving Blair and Ruibal as collectors of the specimen; Conant responded (Oct. 2, 1946) that he wanted to talk about it with Blair. However, Blair went unmentioned when Conant published "named for Bogert . . . , who wrote to me from Mexico about this snake the day the first specimen was collected." As an aside, Bogert's name was *later* and improperly inserted in the catalogue as a third collector by an unknown hand.]

We came back to Monterrey and headed south, finally stopping and camping (after getting permission from Indians to camp on their ejido, a communal holding) at the Arroyo Sacahuite . . . This was jungle country with dense undergrowth stretching back from the creek. Trees were full of epiphytes . . . My nocturnal forays were concerned with a frog I had discovered the first day we camped here. It was a new species and I eventually named it for John . . . The frogs were very hard to catch, but I caught quite a few and marked them to see how far they wandered over the several days we were there . . . The last night we were at the Arroyo Sacahuite I collected all the frogs I could, about 20 as I recall . . . [see Blair 1947, for photos by Bogert and John Moore. Blair named the frog *Rana moorei*, but that name came to be preoccupied and he later (Blair 1984) provided the substitute name *Rana johni*—now *Lithobates johni* (Blair, 1965) fide Frost et al. 2006: 369.]

. . . Dean Amadon still did not have his bird collecting permit nor his permit to bring a shotgun into Mexico. After some palaver it was agreed that he and Rudy would take the jeep and go into Mexico city and try to get the permits. The carryall accompanied the jeep for a hundred miles or so before turning back . . . We drove back to the vicinity of Tamazunchale at night while the jeep went on to Mexico city. From the drive back late at night I remember a stop of the carryall while Bogert jumped out and grabbed a 6-foot fer-de-lance . . . and then a late night stumbling into a Tamazunchale motel where the shower had a big fat *Bufo marinus*, a toad, that said he got there first so please live and let live.

We (John, Chuck, me) went out to the Rio Axtla and camped waiting for Dean and Rudy to return from Mexico City . . . Amadon and Ruibal finally got back with a hair-raising tale. As they parked the jeep in Mexico city an old woman stepped out from the curb and was hit as the jeep backed up. She fell, hit her head on the curb, and died right there. Amadon was arrested and the trouble started. Amadon's statement to the police was deemed unsatisfactory and he was told (or Ruibal was told, since Amadon spoke no Spanish) that for a price he would be allowed to change his statement to something more suitable. The new statement stated that the old woman walked into the jeep, not that the jeep hit her. Once more he was allowed to change the statement, this time to the effect that the woman did not even come in contact with the jeep but simply fell down and hit her head. All this cost Amadon $600 American; he had to send home to the US and get this sum from his father. When released he was told to get out of Mexico in 30 days as the case had to be either reopened or dropped at the end of 30 days. He was bitter.

. . . Near Corpus Christi we stopped at a roadside cafe that had parking in a circle all around the establishment . . . Amadon and Ruibal came out first and didn't see the carryall and thought we had already left. So they hurried down the road to catch up with us. We realized they were ahead of us and tried to catch them, but we blew the headgasket on the carryall (the jeep headgasket had blown in Mexico) and were hours getting it replaced. We never saw the jeep again . . . At the Galveston-Port Bolivar ferry crossing they said the jeep crossed on the ferry before us. So each vehicle proceeded to NY city by itself.

Summary.—A. P. Blair had a well-founded graduate and postgraduate career with mentors Alfred C. Kinsey at Indiana University and Theodosius Dobzhansky at Columbia University. He was unfortunate in not having being able to work at the American Museum with G. K. Noble, who died shortly after Blair's arrival in New York for a fellowship at Columbia. However, Blair's initial association with Noble and the staffs of Noble's departments of Herpetology and Experimental Biology paved the way to an Assistant Curatorial appointment in the Museum's Department of Animal Behavior (new name for Experimental Biology). But Blair was able to spend little time in that post. His absence during the war seemed somehow to have dampened his spirits; he came back to the Museum unsure of what he wanted to do and soon resigned to return home to Oklahoma.

After his brief postwar return to the American Museum, Blair seemed to regain some of his earlier enthusiasm for research during his participation in a 1946 Mexican expedition, when he interacted in the field with herpetologists C. M. Bogert, J. A. Moore, R. Ruibal, and ornithologist Dean Amadon. Blair left the Museum in good standing at the end of 1946 and subsequently enjoyed a long teaching career at the University of Tulsa. His AMNH association led to five papers in the Museum's *Novitates* series (Blair 1946, 1947a, 1947b, 1947c, 1955).

A summary of Blair's life is being prepared by Adler (ms.) for volume 3 of *Contributions to the History of Herpetology*.

Acknowledgments.—I thank Kraig Adler for calling my attention to A. P. Blair's obituary in the *Tulsa World* and for sharing a communication about Blair from Madeleine Thompson, Librarian and Archivist at the Wildlife Conservation Society. I am grateful to Grace M. Tilger for archival assistance.

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A Much-Belated Obituary of an Important American Zoo Collector, with Discussion of the Type Locality for *Bogertophis subocularis* and *Lampropeltis alterna*

"Who knows the life of Meyenberg, Brown's collector?"
—Wright and Wright (1957)

In 1882, British cobbler and amateur naturalist Walter Drawbridge Crick sent Charles Darwin a beetle he had collected. The beetle had a small clam attached to its leg, and the discovery of this beetle helped to explain the mysterious migrations of freshwater bivalves from one pond to another, which was an important question at the time and also the subject of Darwin's last publication before his death. Remarkably, the collector of this beetle-hitchhiking clam indirectly linked Darwin to the discovery of the structure of DNA—Walter Drawbridge Crick was the grandfather of Francis Crick. Walter Crick died in 1903, but Darwin's rather interesting link to the co-discoverer of the DNA structure was not known until 2004 (Ridley 2004).



PHOTO COURTESY OF KRAIG ADLER

FIG. 1. Portrait of Arthur Erwin Brown, 1903.

It is unfortunate that the names and lives of amateur naturalists and collectors who make important contributions to science often remain obscure. Such is the case of another amateur naturalist and businessman, a dealer in leather products (in this instance, saddles), who in 1901 sent to Arthur Erwin Brown (Fig. 1), the second director of America's first zoo (Philadelphia), two species of snakes unknown to science at the time (Brown 1901a, b). In terms of lizard and snake species richness, the Chihuahuan Desert (source of the new snakes) is the veritable epicenter of squamate diversity in the United States, Canada, and northern Mexico (Hoekstra et al. 2010). The two undescribed species sent to Brown arguably are the two most iconic species of this region: the Trans-Pecos Ratsnake (*Bogertophis subocularis*) and the Gray-banded Kingsnake (*Lampropeltis alterna*). Both species have graced the covers, title pages, and endpapers of the many books and field guides of the region's herpetofauna. Despite his important discoveries, the collector's first name has not been known to the herpetological world for the past 111 years. Brown and others mentioned him in a number of publications only as "Mr. E. Meyenberg of Pecos, Texas."

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Undoubtedly, many students of reptiles and amphibians have read Carl Kauffeld's story of his yearnings to travel to the Chihuahuan Desert of West Texas to look for *subocularis*. Kauffeld stated that from boyhood he could recite from memory Raymond Ditmars' account of the species:

"Thus far, taken only in the Davis Mountains, southwest of Pecos, Texas…Less than a dozen specimens exist in collections." (Ditmars 1907 *in* Kauffeld 1969).

What perhaps is less generally known—and left out of the Kauffeld account—is that the very next line in Ditmars' book reads, "The collector of all these specimens, Mr. E. Meyenberg, is dead." We wanted to know more about E. Meyenberg and how he died.

Edmund Meyenberg was born to Julius Meyenberg and Kunigunde Oske Meyenberg on 25 January 1859 on a farm in Fayette County, Texas in the Bluff Community of La Grange, south of Buckner's Creek. His father, Julius, was a doctor, apothecary, and an amateur naturalist who held "one of the finest collections of insects and butterflies as is hardly equaled by the great institutions of learning in this country" (Lotto 1902: 277).

Brown reports that Edmund Meyenberg was a collector for the Zoological Society of Philadelphia. He collected and donated to the Society no less than 48 species and subspecies of reptiles from the vicinity of Pecos, Texas and also from the Davis Mountains. He collected and donated a variety of other vertebrates including multiple species of rodents, bats, passerine birds, and raptors (Brown 1902; 1903a; 1903b; 1904). Ditmars praised Meyenberg as a prolific collector of the Trans-Pecos region where he "did such good work" (Ditmars 1907). Indeed, Meyenberg supplied Ditmars and the Bronx Zoo (then the New York Zoological Park and now the Wildlife Conservation Society) with two richly colored orange-yellow and pinkish specimens of *Bogertophis subocularis* from the Davis Mountains (Brown 1903b; Ditmars 1907).

Little has been published as to the likely whereabouts of Meyenberg's collection site for the type specimens of *B. subocularis* and *L. alterna*. Suitable for the time but cryptic and outdated by today's standards of locality referencing, Brown reported that the *B. subocularis* specimens were found in "the Davis Mountains, fifty miles southwest of Pecos, near the head of Toyah Creek...Jeff Davis County" (Brown 1901a) and that the *L. alterna* specimen "came from the same locality…as the lately described [*Bogertophis*] *subocularis*" (Brown 1901b). The head of Toyah Creek rises at 30.92877°N, 103.81436°W at 1.65 miles (2.65 km) southwest

of Toyahvale in Reeves County and runs northeast for 50 miles (80.5 km) to its mouth on the Pecos River just outside of Pecos, in north central Reeves County (at 31.41301°N, 103.32725°W). Both of us (DDR and GTS) have independently come to the same conclusion—that this would likely place the type locality for these snakes in the northeastern quadrant of the Davis Mountains of Jeff Davis County in the vicinity of Madera Canyon, Little Aguja Canyon, and Big Aguja Canyon (Fig. 2), all of which flow into Toyah Creek and very close to what is now the entrance of the Buffalo Trail Boy Scout Ranch on FM 1832, roughly 11 miles (17.7 km) driving from Highway 17 in Jeff Davis County, Texas. These canyons would have been likely places for watering a horse near the headwaters of the Toyah Creek, indeed, one of the only places to do so "fifty miles southwest of Pecos" in Jeff Davis County (Brown 1901a), with the exception of San Solomon Spring (at present-day Balmorhea State Park at Toyahvale, Reeves County) which is located along the presumed route of Meyenberg's travel and approximately 40 miles (64.4 km) from Pecos.

Vernon Bailey criticized Meyenberg for not reporting reliable locality information for specimens that he allegedly found near the Guadalupe Mountains (Bailey 1905), but reported them to Brown as collected "in the neighborhood…at Pecos" (Brown 1903b). Though Meyenberg reported some of his collection localities from the vicinity of Pecos, it should be noted that his Davis Mountains collections were never questioned as to their true origins. Furthermore, both the photos and descriptions of the type specimens are characteristic of the geographic phenotypes recorded for both species from this locality. As briefly noted above, Ditmars described one of the zoological park's *B. subocularis* on display, stating, "The ground-colour was pinkish and the blotches sooty-black" (Ditmars 1907). In this part of the Davis Mountains, the terrain is strewn with Gomez Tuff, a 36.7 million-year-old layer of rhyolite composed of cemented volcanic ash, as well as basalt, which is a dark yellowish-brown, igneous rock. Weathered Gomez Tuff is dark reddish-brown or dark chocolate brown, and fresher surfaces of the tuff are pink (MacLeod 2005). There is strong natural selection for background color-matching in squamate reptiles (Norris and Lowe 1964), and dark brown, brownish-orange, pink, and reddish specimens with rich black markings have been regularly observed in several species of snakes in the northeastern Davis Mountains. These include *Crotalus lepidus* (Price 2009; Werler and Dixon 2000), *Pantherophis bairdi* (Hiatt 2005; Rhoads 2008), *B. subocularis* (Price 2006; Rhoads 2008; GTS, D. Salceies, and C. Trumbower, pers. obs.), and the *L. alterna* of this area are often of dark brown ground-color with a salmon pink or orangish blush suffused throughout (see Figs. 3 and 4; Tennant et al. 1998; also see northeastern Davis Mountains *L. alterna* examples in Merker and Merker 2005; *B. subocularis* examples in Rhoads 2008). Moreover, the type specimen of *L. alterna* collected by Meyenberg (Fig. 5) resembles the darker, busier-patterned specimens that inhabit the northeastern Davis Mountains (Fig. 3), as do also the thicker, dark H's of the type specimen for *B. subocularis* (DDR, pers. obs.).

Meyenberg was a well-connected and respected citizen in Pecos. He remained a proprietor of a saddlery in Pecos for about 10 years up until his death. He was a business owner at a time when the town had earned a reputation for violence after several gunfights occurred there. In fact, things got so rough during this time that a new slang word was coined; as one pair of historians put it: "To 'pecos' someone meant to ambush a man, steal his horse and money, kill him, and roll his body off down a

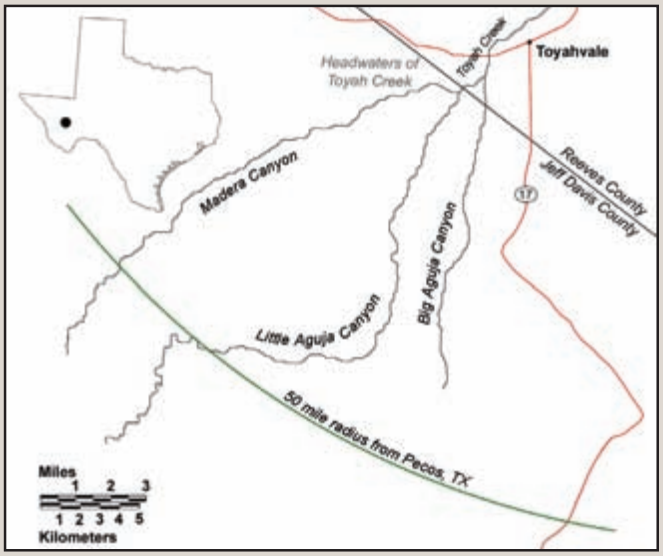


FIG. 2. Map of presumed region of the type localities for *Bogertophis subocularis* and *Lampropeltis alterna*.



PHOTO BY MICHAEL S. PRICE

FIG. 3. *Lampropeltis alterna* adult male, Little Aguja Canyon, Davis Mountains, Jeff Davis County, Texas.

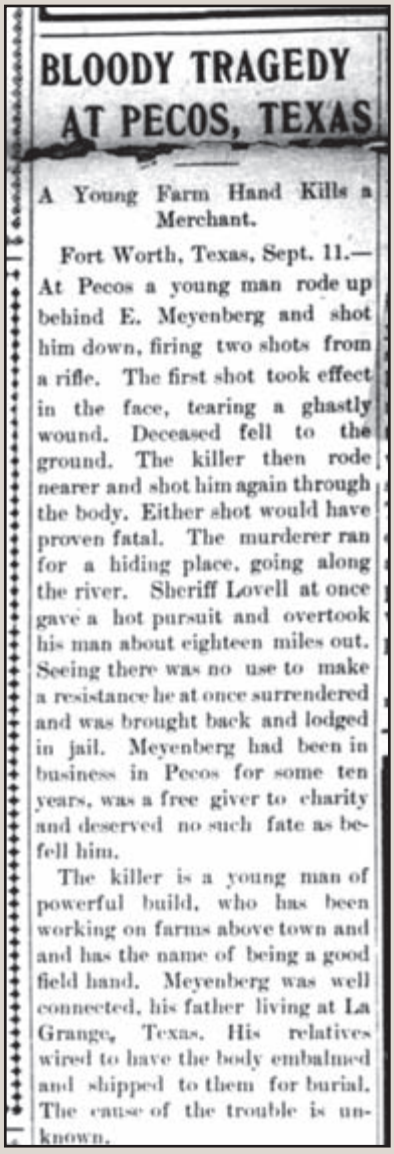


PHOTO BY MICHAEL S. PRICE

FIG. 4. *Bogertophis subocularis* adult male, from Big Aguja Canyon, Davis Mountains, Jeff Davis County, Texas.



FIG. 5. Photograph of the then-living type specimen of Gray-banded Kingsnake *Lampropeltis alterna* that Meyenberg sent to Arthur Erwin Brown, taken by R. D. Carson, Brown's photographer, in 1901, and published by Conant (1957).



BLOODY TRAGEDY AT PECOS, TEXAS

A Young Farm Hand Kills a Merchant.

Fort Worth, Texas, Sept. 11.—At Pecos a young man rode up behind E. Meyenberg and shot him down, firing two shots from a rifle. The first shot took effect in the face, tearing a ghastly wound. Deceased fell to the ground. The killer then rode nearer and shot him again through the body. Either shot would have proven fatal. The murderer ran for a hiding place, going along the river. Sheriff Lovell at once gave a hot pursuit and overtook his man about eighteen miles out. Seeing there was no use to make a resistance he at once surrendered and was brought back and lodged in jail. Meyenberg had been in business in Pecos for some ten years, was a free giver to charity and deserved no such fate as befell him.

The killer is a young man of powerful build, who has been working on farms above town and and has the name of being a good field hand. Meyenberg was well connected, his father living at La Grange, Texas. His relatives wired to have the body embalmed and shipped to them for burial. The cause of the trouble is unknown.

FIG. 6. Scanned photo of the original West Texas newspaper article reporting Meyenberg's death.

riverbank" (Galit and Simmons 2005). Another historian noted the term "a Pecos swap," which meant to steal (Wheeland 1892).

One newspaper article that we unearthed reports his death (Fig. 6). Unfortunately true to the "Old West" lawless stereotype, a young farmhand named Jim Pratt rode up behind Meyenberg and shot him down with a rifle on September 9, 1903 in, or near, Pecos, Texas (Nicholson 1903). A local law enforcement officer named Sheriff Lovell chased the killer and brought him into custody. Some three decades later, a number of Meyenberg's personal papers were gifted to herpetologist Albert Hazen Wright of Cornell University, having been incidentally purchased by Ellen Schulz Quillin, the curator and director of the Reptile Garden of the Witte Museum in San Antonio, many hundreds of miles from Pecos (Steinfeldt, undated). Among these was a copy of the 1901 description of *subocularis* that Brown had apparently personally sent to Meyenberg upon publication. Much to Wright's delight, attached to the back cover was a photograph of Meyenberg's live specimen of *L. alterna* taken by the zoo's photographer, R. D. Carson, under the direction of Brown at Philadelphia Zoo (Wright and Wright 1957). Above and below the print were handwritten compliments from either Brown or the zoo's photographer to Meyenberg. Even by this point in 1934, only this one specimen of *L. alterna* had ever been found, and though a photograph was included in the original 1901 description, this was the only other photograph of the animal known (Wright 1935).

The newspaper article reporting his death stated, "Meyenberg…was a free giver to charity and deserved no such fate as befell him" (Hamilton and Hamilton 1903). Until now, no one has endeavored to respond to the Wrights' question, "Who knows the life of Meyenberg, Brown's collector?" We hope that our report at least partially satisfies their inquiry, albeit somewhat belatedly.

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AMPHIBIAN DISEASES

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Geographic Variation in *Batrachochytrium dendrobatidis* Occurrence Among Populations of *Acris crepitans blanchardi* in Texas, USA

Differences in the susceptibility of amphibian species to infection by the fungal pathogen *Batrachochytrium dendrobatidis* (*Bd*), which can cause the disease chytridiomycosis, have been documented in the laboratory (Daszak et al. 2004) and among wild populations (Carey 2000; Lips 1999; Retallick et al. 2004). The severity of *Bd* infection has also been linked to climatic conditions, with temperature as a major determinant strongly affecting the outcome of infection at specific locations or seasonally (Berger et al. 2004; Bosch et al. 2007; Drew et al. 2006; Kriger and Hero 2007a, b). In addition to climatic conditions such as temperature, variability in site-specific environmental conditions also might affect the probability of infection, as indicated by large differences in abundance of *Bd* in replicate samples from the same site (Kirshtein et al. 2007), or large differences in infection of amphibians at different sites from the same area (Walker et al. 2007).

The goal of our study was to investigate the relationships of site-specific environmental conditions with the presence and the infection levels of *Bd* in amphibians. Blanchard's Cricket Frogs (*Acris crepitans blanchardi*) were selected as the focal species because it is the most abundant and conspicuous member of anuran breeding assemblages in our study area in eastern and central Texas, USA. Previously, we had detected *Bd* in *A. c. blanchardi* in central Texas, with seasonal variation in its prevalence and not accompanied by any detectable mortality or signs of chytridiomycosis (Gaertner et al. 2009). In south-central Texas, *A. c. blanchardi* occurs sympatrically with the endemic endangered Houston Toad (*Anaxyrus* [*Bufo*] *houstonensis*) at a few locations that include breeding ponds on the Griffith League Ranch (GLR) and the adjacent Welsh (WEL) property in Bastrop County. These properties are located in the Bastrop Lost Pines ecoregion and are characterized by deep sandy soils, with forest patches dominated by Loblolly Pine (*Pinus taeda*), Post Oak (*Quercus stellata*), and Eastern Red Cedar (*Juniperus virginianus*), with interspersed grassland patches and land cleared for grazing (Gaertner et al. 2010). We selected six ephemeral to semi-permanent ponds on these properties that ranged in size from ~300 to 2,400 m^2 and differed by their use in cattle ranching operations (cattle ponds C-1 GLR and D-5 GLR), overuse by feral hogs (feral hog ponds E-11 GLR and F-WEL), or lack of these practices (low use ponds A-12 GLR and B-16 GLR). The maximum distance between ponds was about 3 km.

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At these six ponds, *A. c. blanchardi* were collected by hand or net once a month over a one-year period starting February 2009. At least 20 adults were collected per pond from February to August (February to May for ponds C-1 and D-5), however, lower numbers or no captures were obtained at ponds from September to January, with drought conditions resulting in periodic drying of ponds. Animals were swabbed with sterile cotton tips with a wood handle following the method outlined in (Kriger et al. 2006b). To avoid potential cross-contamination, nets were treated with commercial bleach (final conc. 1% NaOCl) for 10 min and gloves were changed between captures. Swabs were placed in sterile 2 ml cryotubes and stored at -80°C until further processing. DNA was extracted from swabs with the Wizard Genomic DNA Purification kit (Promega Corporation, Madison, WI) following the protocol for extraction from animal tissue. DNA extracts were then tested for the presence of *Bd* using a TaqMan quantitative real time PCR (*q*PCR) assay (Boyle et al. 2004).

Temperature, total phosphorus (TP), and pH were analyzed in unfiltered water samples, while concentrations of chlorophyll *a* (Chl *a*), non-volatile suspended solids (NVSS), organic matter (OM), dissolved organic carbon (DOC), soluble reactive phosphorus (SRP), nitrate (NO_3^-), and ammonium (NH_4^+) were analyzed from filters or in filtrates of water samples. Water samples were analyzed in duplicate. In addition to water samples, a sediment core (approximately 5 cm deep) was taken at the shore-line of each pond. Sediment samples were dried, and subsequently combusted at 550°C for 4 h to determine percent sediment organic matter (SOM). Principal components analysis (PCA; SAS v.9.3) was then used to assess differences in environmental parameters among pond types and months. Environmental parameters were z-scored transformed (Krebs 1999) and

TABLE 1. Average temperature and cumulative precipitation data for the 30 days preceding sampling events at six ponds in Bastrop County, Texas, USA, during spring and summer of 2009. Values were obtained from the National Climatic Data Center and represent averages for the three closest surrounding stations (Elgin-412820, Smithville-418415, and Cedar Creek-411541). No frogs were obtained in September, October, December, and January.

Months	Feb	Mar	Apr	May	Jun	Jul	Aug	Nov
Temperature (°C)	12.1	15.4	17.1	23.8	25.4	31.2	31.2	17.9
Precipitation (mm)	21	55	35	82	61	3	42	14

TABLE 2. Percentage of Blanchard's Cricket Frogs (*Acris crepitans blanchardi*) infected with *Batrachochytrium dendrobatidis* during the spring and summer of 2009 (± 95% confidence interval) at six ponds in Bastrop County, Texas, USA. No frogs were collected in September, October, December, and January, and all frogs collected in November tested positive (pond A-12, N = 10 and pond B-16, N = 7; pond C-1, N = 1; pond D-5, N = 1). Nd represents times when no frogs were obtained.

Pond	February	March	April	May	June	July	August	Average
A-12	58 (± 22) N = 19	100 N = 20	65 (± 21) N = 20	100 N = 20	80 (± 18) N = 20	95 (± 10) N = 20	75 (± 19) N = 20	88
B-16	100 N = 20	85 (± 16) N = 20	85 (± 16) N = 20	90 (± 13) N = 20	65 (± 21) N = 20	Nd	94 (± 11) N = 17	89
C-1	90 (± 13) N = 20	100 N = 4	88 (± 23) N = 7	100 N = 6	Nd	Nd	Nd	90
D-5	100 N = 20	100 N = 8	85 (± 16) N = 20	100 N = 20	Nd	Nd	Nd	89
E-11	Nd	92 (± 16) N = 12	86 (± 26) N = 7	85 (± 16) N = 20	80 (± 18) N = 20	100 N = 20	100 N = 20	88
F-WEL	95 (± 10) N = 19	93 (± 13) N = 14	75 (± 42) N = 4	100 N = 13	100 N = 7	100 N = 20	88 (± 16) N = 16	73
Average	89	94	80	95	78	98	89	89

the appropriate number of principal components to retain in the model was determined using a scree plot as a guide.

Further analyses used a linear mixed-effects model (Program R v.2.9.1) to test for differences ($\alpha = 0.05$) among pond types and months in the number of *Bd* genome equivalents (GE) per individual. Number of *Bd* GE per individual were $\log_{10}$ (N+1) transformed to improve assumptions of the linear model. Interaction between pond type and months lacked sufficient replication and was therefore not tested. To further explore the factors associated with *Bd*-GE differences among months and pond type, the cumulative precipitation and mean temperature of the 30 d preceding sampling dates were downloaded from the National Climatic Data Center (Table 1). Because no station is available for Bastrop, daily values from the three surrounding stations (Elgin-412820, Smithville-418415, and Cedar Creek-411541) were averaged. Months were converted to day of collection (e.g., Julian date) and diagnostic plots were used to assess interactions between time and pond type on *Bd* GE per individual. In the absence of any apparent interaction, regression models were used to predict $\log_{10}$ (N+1) transformed *Bd* GE per individual from Julian date, air temperature, and precipitation across pond type.

Bd was detected on 89% (N = 572) of *A. c. blanchardi* collected. The overall monthly percentage of infected *A. c. blanchardi* ranged from 78% (N = 67) in June to 100% (N = 19) in November (Table 2). Although the percent of infected *A. c. blanchardi* were the same for each pond during November (100% of individuals tested were positive at ponds A-12, B-16, C-1, and D-5), percentages varied for different ponds within the same month by as little as 15% (pond C-1 [100%] and pond B-16 [85%] in March) to as much as 42% (pond D-5 [100%] and pond A-12 [58%] in February) (Table 2). These results confirm the occurrence of *Bd* in central Texas where it has been detected in different *Eurycea* species (Gaertner et al. 2008) and in an urban population of *A. c. blanchardi* (Gaertner et al. 2009). In the latter study, 83% of individuals tested positive for *Bd* in one sampling event, with none of the infected individuals showing clinical signs of infection during handling (e.g., lethargy, lack of righting reflex, excessive sloughing of skin), as was also the case in this study.

The number of *Bd* genome equivalents (GE) detected on *A. c. blanchardi* ranged from 0 to up to 3×10^5 GE per individual with an overall mean of 2,400 GE per individual. The highest values exceeded lethal levels reported for other species (Vredenburg et al. 2010), however, most values were within ranges obtained in other studies (Kriger and Hero 2007a, b). Although small variations in numbers of *Bd* GE were noted on *A. c. blanchardi* collected within ponds with a minimum of 15 individuals during some sampling events (e.g., 0–54 GE for *A. c. blanchardi* from pond A-12 in February and 0–153 GE for *A. c. blanchardi* from pond E-11 in June), differences as large as four orders of magnitude were not uncommon (e.g., $0–3 \times 10^4$ GE for *A. c. blanchardi* from pond F-WEL in March) (Table 3). Large seasonal variation in numbers of *Bd* GE were detected on *A. c. blanchardi* throughout

TABLE 3. Average number of genomic equivalents of *Batrachochytrium dendrobatidis* on individuals of Blanchard's Cricket Frogs (*Acris crepitans blanchardi*) from six ponds located in Bastrop County, Texas, USA during the spring and summer of 2009 (± 95% confidence interval). No frogs were obtained in September, October, December, and January, and average number of genomic equivalents of *Bd* (± 95% confidence interval) on individuals collected in November were: pond A-12, 370 (± 570); pond B-16, 71(± 24); pond C-1, 18 (N = 1); and pond D-5, 2,500 (N = 1). Nd represents times when no frogs were collected.

Pond	February	March	April	May	June	July	August	Average
A-12	12 (± 6)	2,100 (± 1,400)	1,600 (± 850)	170 (± 36)	40 (± 20)	120 (± 36)	210 (± 65)	870
B-16	1,300 (± 980)	9,100 (± 10,000)	13,000 (± 12,000)	360 (± 340)	100 (± 63)	Nd	160 (± 47)	3,800
C-1	270 (± 120)	780 (± 1,000)	670 (± 790)	5,500 ± 9,600	Nd	Nd	Nd	1,200
D-5	150 (± 67)	270 (± 170)	120 (± 57)	85 (± 47)	Nd	Nd	Nd	180
E-11	Nd	6,600 (± 7,400)	1,300 (± 850)	3,300 (± 3,100)	38 (± 17)	180 (± 26)	200 (± 40)	1,600
F-WEL	2,200 (± 2,100)	30,000 (± 43,000)	1,500 (± 2,600)	2,400 (± 2,700)	280 (± 310)	220 (± 23)	140 (± 55)	5,200
Average	760	9,400	4,000	1400	85	174	180	2,400

the study, with monthly average intensities peaking in March at 9,400 *Bd* GE per individual and decreasing in the summer to a minimum of 85 *Bd* GE per individual in June (Table 3). Our previous studies documented seasonal changes in infection rate but not in intensity, which was not previously analyzed, with high infection rates in spring and no *Bd* detections during summer when one cured individual was identified (Gaertner et al. 2009). Although these previous results seem to contradict our current investigation with high rates of *Bd* detection throughout the year, differences among infection rates are most likely attributable to different sensitivities of the detection methods. The *q*PCR detection method developed by (Boyle et al. 2004) has widely been accepted and used as adequate detection and quantification method for *Bd* (e.g., Kirshtein et al. 2007; Kriger et al. 2006a, b; Walker et al. 2007), with a sensitivity about 2–5 times higher than the nested PCR approach applied in our previous study (Gaertner et al. 2009). The low numbers detected during summer by *q*PCR in the current study (i.e., usually less than 10 GE) might therefore not have been detectable by nested PCR in our previous study (Gaertner et al. 2009).

Our PCA analysis of relationships between *Bd* and environmental characteristics demonstrated that ponds differed along two primary environmental gradients (Fig. 1). The first Principal Component explained 31% of the variation in *Bd* occurrence and described a gradient from relatively deep ponds with consistently lower nutrient levels to ponds that were shallow and thereby more prone to nutrient loading including organic matter (OM), total phosphorus (TP), and non-volatile suspended solids (NVSS). The second Principal Component explained 19% of the variation and contrasted aquatic habitats dominated by high respiration (high ammonium, nitrate, and pH) to those of high primary production (high dissolved organic carbon and chlorophyll *a*). Low-use ponds (ponds A-12 and B-16) were, on average, deeper (2.3–2.5 m) and had lower average concentrations of OM (10–27 mg l^{-1}), TP (80–110 µg l^{-1}), ammonium (36–133 µg l^{-1}), and nitrate (260–270 µg l^{-1}), whereas cattle ponds (C-1 and D-5) and those used by feral hogs (E-11 and F-WEL) were generally shallower (0.46–1.1 m) with high concentrations of OM (15–50 mg l^{-1}), TP (210–370 µg l^{-1}), ammonium (175–1,600 µg l^{-1}), and nitrate (385–1,100 µg l^{-1}).

The number of *Bd* GE per individual did not differ among low-use ponds, cattle ponds, or feral hog ponds ($F_{2, 3} = 3.8$, $P = 0.14$), but differences were apparent among months ($F_{7, 25} = 3.8$, $P < 0.01$). Whereas an association between numbers of *Bd* GE per individual and precipitation was not detected ($F_{1,36} = 0.6$, $P = 0.46$), we found that across pond type, numbers of *Bd* GE per individual were inversely related to day ($F_{1,36} = 7.4$, $P = 0.01$) and air temperature ($F_{1,36} = 6.7$, $P = 0.01$) (Fig. 2). Seasonal variation has been documented for *Bd* occurrence on amphibian hosts with peak prevalence of disease levels at temperatures less than 19.4°C (Kriger and Hero 2007b) and 21.6°C (Gaertner et al. 2009). These temperatures are in agreement with those in our study; for all sites, we found that the monthly peak in overall intensity of infection occurred in March (15.4°C) and April (17.1°C) (Table 1).

Air temperatures are often auto-correlated with water temperature. However, whereas all ponds warmed at the same general rate despite differences in size (not depicted), the strongly negative correlation for *Bd* GE for temperatures greater than 25°C was not observed for all ponds. Two of the ponds had relatively more stable year-round environmental conditions, likely a result of the larger volume of water for those sites (low use ponds A-12 and B-16). The seasonality of infection by *Bd* was fairly predictable in these ponds with the average intensity of infection rising to a peak in March and April and then declining through the summer months. These ponds showed negative correlations between *Bd* GE and water temperature (Figure 2). The remaining ponds were characterized by much more dynamic environmental characteristics. This included two ponds (cattle ponds C-1 and D-5) in which the greatest total *Bd* GE detections occurred at temperatures above 25°C. Admittedly, those *Bd* GE values were not notably high for either pond when scaled against all ponds, reaching only ~5,500 GE and ~275 GE, respectively. It is possible

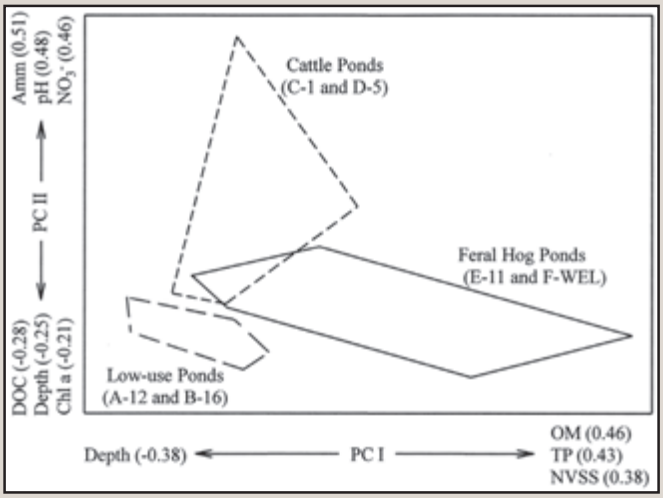


FIG. 1. Plot of sample scores from six sites, enveloped by pond type, on principal component axis I and II of environmental data (H+ [*pH*], ammonium [*Amm*], nitrates [NO_3^-], soluble reactive phosphorus [*SRP*], non-volatile suspended solids [*NVSS*], total phosphorus [*TP*], water temperature [*WaterTemp*], organic matter [*OM*], chlorophyll *a* [*Chla*], soil moisture [$SoilH_2O$], soil organic matter [*SOM*], dissolved organic carbon [DOC], and depth [*Depth*]) collected monthly from ephemeral to semi-permanent ponds located in Bastrop County, Texas.

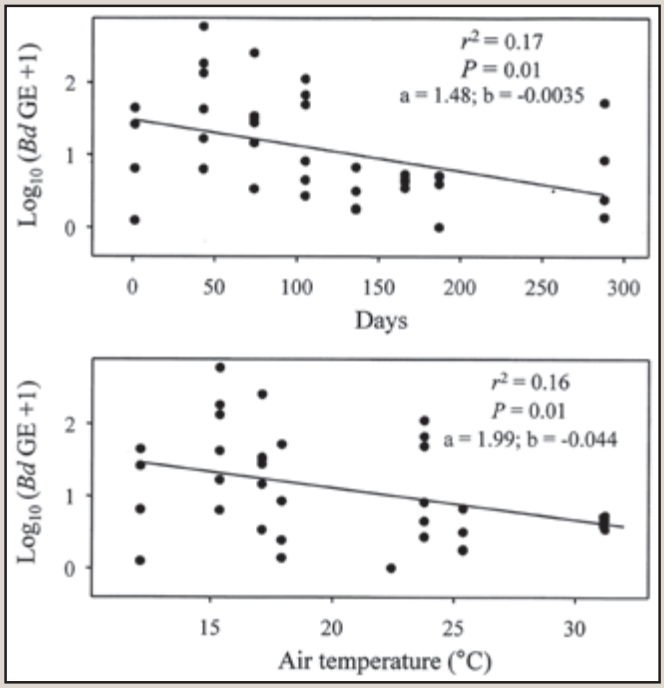


FIG. 2. Relationships between *Batrachochytrium dendrobatidis* genome equivalents (*Bd* GE) per individual *Acris crepitans blanchardi* and Julian date (starting February 1 and ending November 15) (top panel) and between *Bd* GE per individual *A. c. blanchardi* and air temperature averaged from 30 d preceding each sampling date (bottom panel) collected from ephemeral to semi-permanent ponds located in Bastrop County, Texas.

that the overall lower *Bd* GE rates for these two sites reflected their more ephemeral nature when compared with the other ponds examined here.

It also may be possible that the frogs sampled in the later, warmer periods at those two sites were migrants from larger, cooler ponds rather than residents and this could also explain the increased *Bd* GE values despite the seemingly unsuitable temperatures. We consider these more dynamic patterns of *Bd* prevalence to be consequent of their smaller size and the concomitant effect of evaporation and precipitation events (ponds C-1and F-WEL). The environmental variables measured in these ponds fluctuated widely between monthly sampling events as did the intensity of infection by *Bd*. Aside from temperature, we did not detect a strong trend among alternative environmental parameters for these ponds in association with the level of infection over time. None of the water quality assessment measures appeared to influence the prevalence or occurrence of *Bd* at those sites. Overall, the seasonal pattern in abundance was more pronounced in deeper ponds than in shallow or ephemeral ponds and was correlated with consistently lower nutrient levels in deeper ponds.

Bd has been found to be more prevalent in amphibians occurring in flowing rather than in standing waters, and more individuals of amphibians were infected with *Bd* and at higher levels in permanent water bodies than in ephemeral water bodies where detection of *Bd* was extremely rare (Kriger and Hero 2007a). Since the aquatic zoospore of *Bd* cannot survive desiccation (Johnson et al. 2003), desiccation may prevent *Bd* from causing significant infections at sites without standing water despite there being enough moisture to support amphibian populations. Impoundment construction and modifications of ephemeral ponds into permanent livestock water sources have increased the number of permanent water bodies over the last century with some negative potential impacts to rare amphibians (Gaston et al. 2010). Since central Texas has a large number of endangered and endemic amphibian species (Brown et al. 2012; Chippindale et al. 2000), an increase of permanent water sources might consequently result in an increase of the abundance and transmission of *Bd*, and might thus have detrimental effects on the amphibian assemblages in the area.

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Surveys for Frog Diversity and *Batrachochytrium dendrobatidis* in Jamaica

Jamaica is home to the world's second most endangered frog assemblage, with 16 of 21 (76%) endemic species recognized as threatened (IUCN 2011). There are 17 endemic *Eleutherodactylus* (Hedges 1989), five endemic *Osteopilus*, one of which is unnamed and thus has not been assessed by the IUCN (Moen and Wiens 2008; S. B. Hedges, unpubl. data) and four invasive anurans on the island (Mahon and Aiken 1977). We conducted the first large-scale assessment of the island's amphibians since the 1980s while sampling for the amphibian chytrid fungus, *Batrachochytrium dendrobatidis* (*Bd*). Prior to our work, *Bd* was known from all of the other Greater Antillian islands (Burrowes et al. 2004; Diaz et al. 2007; Joglar et al. 2007), several of the Lesser Antillian islands (Alemu et al. 2008; Garcia et al. 2009), and mainland North, Central and South America (Carnaval et al. 2006; Longcore et al. 1999; Fisher et al. 2009), but was not confirmed in Jamaica.

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Given the documented extinctions and population declines in congeners to Jamaica's frogs from chytridiomycosis in Puerto Rico (Burrowes et al. 2004; Longo et al. 2010) and Central America (Lips et al. 2004; Puschendorf et al. 2006), we were concerned about the conservation implications of epidemic outbreaks of *Bd* to Jamaica's amphibians. As of September 2010, 6 of Jamaica's 21 described endemic species had not been recorded in over two decades (Hedges and Diaz 2011). The timeframe of their last sighting was similar to that of some chytridiomycosis-related extinctions and extirpations elsewhere in the Caribbean (Burrowes et al. 2004). We conducted this project to investigate the occurrence of *Bd* per species and location, assess the status of Jamaican frog species, and to provide information to focus future conservation efforts directed at extant endemic species.

We sampled for amphibians across Jamaica, spending at least one person-day in the field in the known ranges of every endemic species on the island (Fig. 1; Table 1). We conducted our field work between October 2010 and June 2011. We defined a

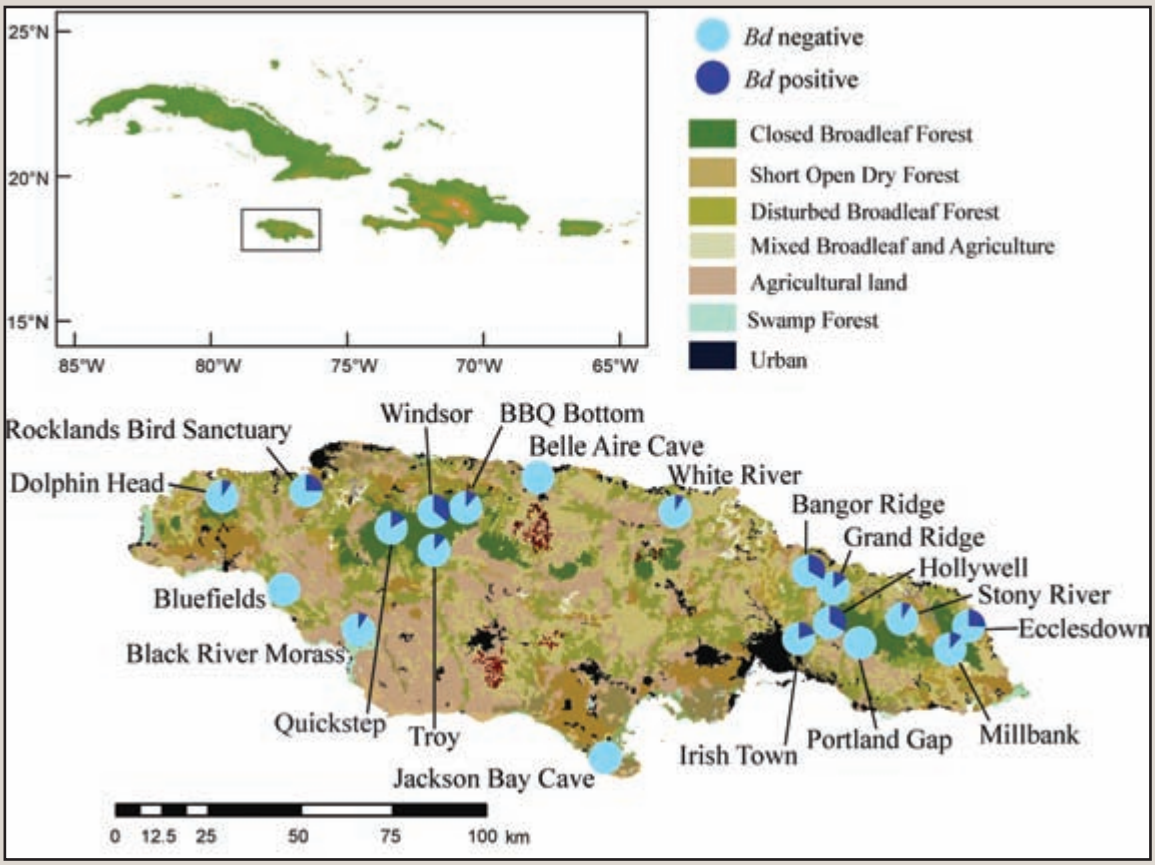


FIG. 1. Distribution of sampling locations in Jamaica for the amphibian chytrid fungus, *Batrachochytrium dendrobatidis* (*Bd*). Proportion of *Bd*-positive and *Bd*-negative individuals are indicated per site. Primary land cover types are shown (from Forestry Department, Jamaica: http://www.forestry.gov.jm/maps_data_page.htm [accessed 3 June 2011]).

person-day as the search effort of one person within a 24-h period, generally 2–5 h/day. We sampled closed broadleaf, disturbed broadleaf, short open dry, and swamp forest habitats, as well as mixtures of disturbed broadleaf and small plantations, and suburban habitats and caves. Our field sites ranged from sea level swamp and dry forests to elfin forest at 2250 m on top of Jamaica's highest peak.

We used visual/audio encounter surveys beginning at sunset and lasting 2–5 h per site. Frogs were caught by hand using an inverted plastic bag and were housed overnight in the bag. We recorded capture location using a Garmin Global Positioning System Map 60CS in the WGS84 datum. We identified captures to species, and swabbed them ten times on the bottom of each foot, under each thigh, along the stomach, and under the drink patch. We examined frogs for skin sloughing, unusual posture, and other known chytridiomycosis symptoms (Berger et al. 1998; Berger et al. 2005). Frogs that were not collected as voucher specimens were released at their capture location after processing. We thoroughly disinfected all of our gear between each sampling site with a 10% bleach solution, followed by air drying in direct sunlight. We stored the swabs dry at ambient temperature in the field and refrigerated them immediately on return to the laboratory (Hyatt et al. 2007; Skerratt et al. 2008). We extracted the total *Bd* genome, as well as any DNA

TABLE 1. Amphibian sampling locations in Jamaica (latitude/longitude; WGS 84 datum). Elevation is approximate average search elevation (m).

Site number	Location	Northing	Easting	Elevation
1	Ecclesdown	18.0533	-76.3497	600
2	Millbank	18.0302	-76.3671	600
3	Stony River	18.0858	-76.5149	250
4	Portland Gap	18.0481	-76.5842	1540
5	Hollywell	18.1911	-76.7274	1200
6	Irish Town	18.0745	-76.6919	900
7	Grand Ridge	18.0922	-76.6577	1100
8	Bangor Ridge	18.1694	-76.6808	300
9	White River	18.3651	-77.0484	130
10	Jackson Bay Cave	17.7349	-77.2224	20
11	Belle Aire Cave	18.4558	-77.3679	10
12	BBQ Bottom	18.3750	-77.5466	250
13	Windsor	18.3583	-77.6508	115
14	Troy	18.2639	-77.5991	550
15	Quickstep	18.2978	-77.7167	350
16	BLRM	18.0675	-77.8248	5
17	Rocklands Bird Sanctuary	18.4558	-77.9412	260
18	Bluefields	18.1662	-78.0092	40
19	Dolphin Head	18.3691	-78.1741	530

TABLE 2. *Batrachochytrium dendrobatidis* (*Bd*) occurrence on frogs in Jamaica. No. *Bd*–positive individuals/total no. individuals sampled per species and location are provided. For site names see Table 1. Genera are: O = *Osteopilus*; E = *Eleutherodactylus*; R = *Rana*; L = *Lithobates*. 0/0 indicates that the sampling location was in a species' range, but the species was not detected. A dash (–) indicates that the sampling area was outside of the species' range, and the species was not found. Bold numbering indicates that the species was found outside its known range. Asterisks indicate invasive species.

	Location																			
Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Totals (%)
O. brunneus	1/3	1/16	0/6	–	–	0/0	–	0/0	1/5	–	–	0/0	0/0	0/5	2/5	0/0	1/2	0/12	0/0	6/54 (11.00)
O. crucialis	–	–	–	–	–	–	–	–	–	–	–	0/0	0/0	0/0	0/0	–	–	–	–	0/0 (0)
O. marianae	–	–	–	–	–	–	–	–	–	–	–	–	0/0	0/0	0/0	–	–	–	–	0/0 (0)
O. wilderi	–	–	–	–	–	–	–	0/0	–	–	–	0/1	0/0	0/1	0/0	–	–	–	0/0	0/2 (0)
O. sp.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0/5	–	–	–	–	0/5 (0)
E. alticola	–	–	–	0/1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0/4 (0)
E. andrewsi	1/3	0/0	–	0/3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1/6 (16.70)
E. cavernicola	–	–	–	–	–	–	–	–	–	0/2	–	–	–	–	–	–	–	–	–	0/2 (0)
E. cundalli	–	–	–	–	–	–	–	–	0/1	–	0/4	3/15	0/0	0/0	1/9	–	0/0	0/0	0/0	4/29 (13.80)
E. fuscus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2/8	2/8 (25.00)
E. glaucoreius	7/17	0/0	1/4	0/0	1/3	3/5	0/1	0/0	0/3	–	–	–	–	–	–	–	–	–	–	12/33 (36.36)
E. gossei	0/8	2/7	1/5	–	–	12/63	–	0/1	2/19	–	–	0/9	2/5	0/4	0/0	1/2	0/1	–	–	20/124 (16.13)
E. grabhami	–	–	–	–	–	–	–	–	–	–	–	–	–	0/0	0/0	–	–	0/0	–	0/0 (0)
E. griphus	–	–	–	–	–	–	–	–	–	–	–	**0/11**	–	–	0/14	–	–	–	–	0/25 (0)
E. jamaicensis	0/0	0/0	–	–	–	–	–	–	–	–	–	0/0	0/0	0/0	0/0	–	–	–	0/0	0/0 (0)
E. junori	–	–	–	–	–	–	–	–	–	–	–	–	–	0/0	–	–	–	–	–	0/0 (0)
E. luteolus	–	–	–	–	–	–	–	–	–	–	–	**0/9**	–	–	4/16	–	–	0/5	0/4	4/34 (11.76)
E. nubicola	–	–	–	0/0	1/3	–	1/3	–	–	–	–	–	–	–	–	–	–	–	–	2/6 (33.33)
E. orcutti	–	–	0/0	0/0	0/0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0/0 (0)
E. pantoni	–	–	–	–	–	–	–	–	–	–	–	**4/15**	0/6	3/33	6/33	–	–	–	1/27	14/114 (12.28)
E. pentasyringos	1/5	0/0	0/6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4/26 (15.38)
E. sisyphodemus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0/0	–	–	–	–	0/0 (0)
*E. johnstonei**	–	0/1	–	0/1	–	1/13	–	1/2	0/3	–	–	–	2/2	3/8	–	1/8	0/1	–	1/2	10/43 (23.26)
*E. planirostris**	–	–	–	–	–	–	–	–	–	–	–	–	1/1	–	–	–	–	–	–	1/1 (100%)
*L. catesbeianus**	–	–	–	–	–	–	–	–	0/1	–	–	–	–	–	–	–	–	–	–	0/1 (0)
*R. marina**	–	0/1	0/1	–	–	–	–	–	–	–	–	–	–	–	–	0/12	–	–	–	0/14 (0)
Totals (%)	13/51	3/25	2/22	0/4	2/6	16/81	1/7	1/3	3/33	0/2	0/4	7/60	5/14	6/51	13/82	2/22	1/4	0/17	4/41	
(%)	(25.49)	(12.00)	(9.09)	(0.00)	(33.33)	(19.75)	(14.29)	(33.33)	(9.09)	(0.00)	(0.00)	(11.67)	(35.71)	(11.76)	(15.85)	(9.09)	(25.00)	(0.00)	(9.76)	

present from frog skin cells or other frog skin microbiota, from the swabs using the standard PrepmanUltra protocol (Hyatt et al. 2010). We ran quantitative PCR tests at the Cornell University Life Sciences Core Laboratories Center, Ithaca, New York. We ran samples in singlicate at a 1:10 dilution of the starting stock on an Applied Biosystems ViiA7 machine. All voucher specimens are stored in the Herpetology Laboratory, University of the West Indies, Kingston, Jamaica.

Site-specific *Bd* infection rates ranged from 0–33% (Table 2). All but four sites had at least one *Bd*-positive frog. The four *Bd*-negative sites included two caves and a high-elevation cloud forest, each with low sample sizes, and a relatively dry, disturbed coastal broadleaf forest in western Jamaica. The site with the highest *Bd* prevalence (5/14 frogs infected) was in central Jamaica, at the intersection of small-scale agricultural land and disturbed broadleaf forest. With these exceptions, little geographical pattern is apparent in infection rates. When *Bd* infection rates per species were pooled across all sites at which each species occurred, most species showed rates between 10 and 20%. Although *Bd* was not detected on *Eleutherodactylus griphus*, *Osteopilus wilderi*, *O.* sp. (S.B. Hedges, unpubl. data), and *E. cavernicola*, due to low sample sizes (Skerratt et al. 2008), we cannot reliably draw the conclusion that their infection rates differed from other species sampled. *Eleutherodactylus glaucorieus* had the highest infection rate at 36% (12/33). All frogs examined were adults, except a very recently metamorphosed *O. wilderi* sampled in Troy. We were limited to examining leaf litter, caves, and low vegetation, hence canopy-dwelling species (the *Osteopilus*) were not well represented in our sample. We found no dead or moribund animals, and saw no disease symptoms on the animals we sampled.

We were unable to locate seven endemic species during our surveys (Table 2). Two of these species, *E. orcutti* and *E. jamaicensis*, have not been observed since the 1980s, and are the island's only two semi-aquatic *Eleutherodactylus*: *E. orcutti* is a stream specialist; and *E. jamaicensis* a bromeliad tank specialist. Because *Bd* is often transmitted aquatically, semi-aquatic species may be more at risk of *Bd* infection than terrestrial species (Kilpatrick et al. 2009). We spent considerable search effort on these species, including visiting the type localities of both. We spent 71 person-days (with 2–5 h/day of sampling) searching in the historical range of *E. jamaicensis* and 27 person-days in the historical range of *E. orcutti* without seeing an individual or hearing a call of either species, raising concerns about the continued existence of these species. *Eleutherodactylus jamaicensis* searches were conducted in November 2010 and January, February, March, May, and June of 2011, whereas searches in *E. orcutti*'s range were carried out in January, March, April, May, and June of 2011. The other non-sampled *Eleutherodactylus* are of less concern, as they are highly cryptic terrestrial species. Although the *Osteopilus* share the semi-aquatic life history strategy with *E. jamaicensis,* we heard calls from these species while in their ranges.

Although we quantified *Bd* loads in our positive samples, we do not report those data here. Many of the swabs were not refrigerated for up to a week after sampling, due to the remoteness of our sampling sites. We stored the swabs dry in the field at ambient temperature, which was generally between 20 and 30°C. Storage at ambient temperature does not increase the risk of false negatives, but may reduce the detectable *Bd* zoospore load by up to 67% when temperatures are above 23°C (Skerratt et al. 2008; Van Sluys et al. 2008). Given that our samples were exposed to ambient temperatures for variable amounts of time, between several minutes and seven days, and that our study sites had considerably different ambient temperatures, our measured loads may be inconsistent representations of actual loads. However, we found no loads above 3,000 zoospore equivalents, and the majority of the infected individuals showed less than 100 zoospore equivalents. Even if these measurements represent an average of one third of the original load, they indicate that the frog populations we sampled may not be in immediate danger of chytridiomycosis-related decline (Vredenburg et al. 2010), at least under current environmental conditions and with the current (as yet not genotyped) strain of *Bd* on the island. Further habitat loss and the introduction of other diseases or more virulent *Bd* strains are ongoing threats to this highly endangered frog community. Additional sampling is warranted for endemic species which were undetected during this survey.

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Occurrence of *Batrachochytrium dendrobatidis* Among Populations of *Lithobates clamitans* and *L. pipiens* in Wisconsin, USA

Continued efforts to sample for *Batrachochytrium dendrobatidis* (*Bd*), the fungus that causes amphibian chytridiomycosis, in the U.S. have begun to provide a more complete understanding of its distribution (Longcore et al. 2007; Muths et al. 2009). In fact, some have even questioned the relevancy for additional non-targeted sampling and have suggested targeting gaps in our understanding of *Bd* distribution such as in the northern regions of the U.S. (Muths et al. 2009). One such significant northern gap is the state of Wisconsin.

The earliest reported detection of *Bd* in Wisconsin was from specimens preserved in 1969 and 1984 (Ouellet et al. 2005). Since then sampling for *Bd* has been performed along the Mississippi and St. Croix rivers bordering Wisconsin and Minnesota, detecting its occurrence at numerous localities. Sampling also was performed in southwestern Wisconsin but *Bd* was not detected there (Sadinski et al. 2010). Although states neighboring Wisconsin have been more thoroughly sampled for *Bd* (Minnesota [Rodriguez et al. 2009; Woodhams et al. 2008], Iowa [Loda and Otis 2009; Steiner and Lehtinen 2008], Illinois [Steiner and Lehtinen 2008], and Michigan [Steiner and Lehtinen 2008; Zellmer et al. 2008; Zippel and Tabaka 2008]), Wisconsin is largely separated from these by geologically and biologically significant borders. To the north and east, Wisconsin is bordered by Lake Superior and Lake Michigan, respectively, and to the west the Mississippi and St. Croix Rivers. Additionally, the state contains one of the highest concentrations of freshwater lakes in the world. Clearly, Wisconsin is not simply a biologically-arbitrary political designation, but rather corresponds to a biologically unique area within which an understanding of the distribution of *Bd* is important for a more complete documentation of this amphibian pathogen in the U.S. Herein we report the findings of broad-scale sampling for *Bd* across Wisconsin.

We sampled during fall 2009 (5–26 September) and summer 2010 (21 June–9 July) opportunistically at localities within each of the 24 Geographical Management Units (GMU's; Fig. 1) of the Wisconsin Department of Natural Resources. GMUs were used to assure a broad distribution of sampling across the state and because they are based on a mixture of hydrologic basins, county boundaries, and DNR regional boundaries for the purpose of managing water resources: *Bd* occurrence by GMU is potentially important information for future water resource management decisions. Ten arbitrarily chosen GMU's were sampled during Fall 2009 whereas the remaining 14 (plus two that were sampled

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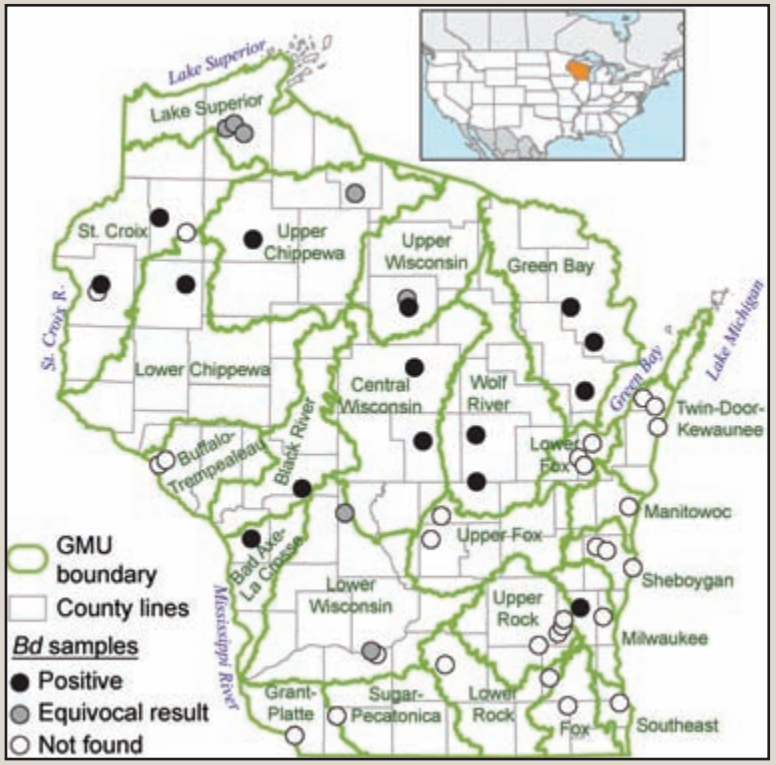


FIG. 1. *Batrachochytrium dendrobatidis* (*Bd*) sampling locations in Wisconsin, USA. Green lines indicate Geographical Management Units delineated by the Wisconsin Department of Natural Resources and used for our sampling design.

in fall) were sampled during summer 2010. From one to four localities were sampled within each GMU, depending partly on the size of the GMU and partly on the success of finding sufficient specimens at localities. Sampling focused on *Lithobates clamitans* and *L. pipiens*, two frogs common throughout Wisconsin and also known to be susceptible to infection by *Bd*. Sampling was performed following procedural suggestions of Brem et al. (2007), including swabbing each frog with a high quality medical swab on each rear foot, ventral surface of each thigh, and the ventral abdominal area. The swab was then stored in ethanol in a pre-filled vial until testing. After swabbing, frogs were measured and their health noted, and then they were released at the site of capture. The goal was to sample seven to fourteen individuals (split between the two species) from each GMU, depending upon the size of the GMU.

Upon completion of sampling, swabs were sent to the Real-time PCR Facility at Washington State University where DNA from swabs was extracted using Qiagen DNeasy Blood & Tissue Kits and quantitative real-time PCR (qPCR) was used to estimate the amount of fungal DNA present in swabs. Primers and MGB probe were generated from generally conserved areas of the ITS-1 and 5.8S regions of chytrid fungus rDNA; see methods in (Boyle et al. 2004). Twenty-five µl reactions containing 12.5 µl 2 × Taqman Master Mix (Applied Biosystems, Foster City, California, USA), PCR primers at a concentration of 900 nM, the MGB probe at 250 nM and 5 µl of DNA and run on an ABI 7300 Thermocycler (Applied Biosystems). PCR conditions are as follows: 2 min at 50°C, 10 min at 95°C, followed by 15 sec at 95°C and 1 min at 60°C for 50 cycles (Boyle et al. 2004). For PCR assays, samples were pooled to minimize cost yet still address our primary objective of a broad survey across the state using the GMU's as sampling units (Hyatt et al. 2007). Thus, pooled samples included samples from 3–8 individuals of the same species from the same GMU and usually from the same locality; pooling of individuals from multiple localities was done with individuals that remained after pooling within localities. Pooled samples never included samples from both species of frogs or frogs from multiple GMU's. Each pooled sample was run in triplicate and if the standard error of any unknown sample (across the triplicate wells) was > 0.2, the outlier was removed and quantification was estimated by using the remaining two replicates. If this did not produce a standard error <0.2, the sample was rerun. If only one replicate was positive, the sample was rerun. Two pooled samples that gave marginal results (Green Bay locality 10, Milwaukee River pooled localities 25 and 26) were subsequently analyzed by individual. Since pool sizes varied, mean zoospore quantity was divided by the number of specimens included in the pool to give an average spore count per frog as a standard to facilitate comparison across pools and with other studies.

A total of 233 frogs were sampled (199 *Lithobates clamitans*, 34 *L. pipiens*) from 50 localities across the 24 GMU's. None of the frogs exhibited any symptoms of chytridiomycosis. Swab samples were combined into 47 pools for PCR analyses. Analyses detected *Bd* at sites in 12 of 24 (50%) GMU's in Wisconsin (Fig. 1). Among those testing positive are all of the largest GMU's in the state, occupying approximately two-thirds of the geographic area of Wisconsin, and primarily in the northern half of the state (Fig. 1). Among the 50 individual localities, 14 (28%) were positive, 29 (58%) negative, and seven (14%) could not be unequivocally determined. However, given the small sample sizes from each locality (1-7 individuals) the probability of Type II error rates (false negatives) can be considerable and the true prevalence, not considering the equivocal results, could be 23 (46%) to 37 (74%), (upper CI = 0.35 for samples of N = 7, and CI = 0.78 for N = 1; Brem et al. 2007).

Twenty-one (45%) of the PCR sample pools tested positive for *Bd* with mean zoospore quantity ranging from 29.3883 to 0.0024, for an average spore count per frog of 5.2337 to 0.0005 (Table 1). The majority of these indicated extremely low quantities of *Bd* zoospores (Table 1) with only three of 47 pooled assays exceeding a mean of 5.0 zoospores or a per frog average spore quantity greater than 1: Bad Axe-LaCrosse1 = 29.3883 (average spore count per frog = 4.1983); Upper Wisconsin2 = 15.7012 (5.2337); and Lower Chippewa1 = 5.1748 (1.0350).

Since samples pooled for PCR analysis never included mixed species, and in most cases the presence or absence of *Bd* at a given locality for either species can be determined from the pooled samples (i.e., only a few cases had positive results for a pool of two or more localities), results for differences in prevalence of *Bd* between *Lithobates clamitans* and *L. pipiens* can be interpreted. Of the 50 localities sampled across all GMU's, 41 had only *L. clamitans* present, of which five were equivocal; of the remaining 36, 13 (36%) tested positive. Five localities had only *L. pipiens* present, all of which returned negative results. The remaining four sites had both species present, with *L. pipiens* testing negative at all four sites and *L. clamitans* testing positive at one, negative at another, and equivocal at two. Thus when unequivocal results could be obtained, *L. clamitans* tested positive

TABLE 1. Comprehensive listing of all localities where anurans were sampled (#1–50) for *Batrachochytrium dendrobatidis* (*Bd*) in Wisconsin, USA, grouped by Geographic Management Unit (GMU) and arranged roughly north to south. Indicated are the number of *Lithobates clamitans* (*lc*) sampled at each locality, the grouping of *L. clamitans* samples for qPCR assays (single locality or remainder pooled from multiple localities) including the resultant average spore count per frog, and whether they were *Bd*-positive (+), *Bd*-negative (-), or equivocal (?) results relative to *Bd* presence. NA = not applicable as no *L. clamitans* were sampled at locality. Because all *L. pipiens* tested negative, their presence at a locality is indicated by an asterisk followed by the sample size.

GMU	Locality No.	Locality Description	Coordinates	No. *lc*	Single locality analyses	Pooled analyses of remaining samples	*Bd*
Lake Superior	12	Bayfield Co.: Bass Lake: Small man-made pool ~ 5 m from lake at ~0.25 mi S on West Bass Lake Rd from jct with County Rd. H.	46.513069°N 91.379853°W	7	0.0000 (N = 5)		?
	13	Bayfield Co.: Marshy wetland ~0.25 mi S of Ruth Lake Rd. (at ~0.5 mi S jct of Ruth Lake Rd. and County Rd. H) on unknown logging road.	46.513244°N 91.385703°W	1		0.0005 (N = 5)	?*[1]
	14	Bayfield Co.: Delta: White River near parking lot at end of White River Reserve Rd. ~ 0.25 mi from jct with Delta-Drummond Rd.	46.453333°N 91.277400°W	7	0.0000 (N = 5)		?
St. Croix	31	Polk Co.: St. Croix Falls: wetland just west of 170th St. at 0.4 mi N jct with 140th Ave.	45.416122°N 92.510574°W	0	NA		NA*[2]
	32	Polk Co.: Loveless Lake: Boat landing, ~0.2 mi from jct of 160th St. and South Loveless Lake Lane.	45.435303°N 92.490506°W	5	0.3040 (N = 4)	0.0437 (N = 4)	+
	33	Washburn Co.: Little Bass Lake: Little Bass Lake Road less than ~0.1 mi S of jct with County Rd. E.	45.910514°N 92.009013°W	7	0.0381 (N = 4)		+
	34	Washburn Co.: Crystal Lake: wetland at SE corner of jct of Wohlford Dr. and State Hwy 70.	45.812239°N 91.697500°W	0	NA		NA*[4]
Upper Chippewa	39	Sawyer Co.: Ojibwa: Ojibwa Community Park Boat Landing N shore of Chippewa River at County Rd. G bridge.	45.798864°N 91.117756°W	7	0.0656 (N = 5)	0.0113 (N = 5)	+
	40	Iron Co.: Turtle-Flambeau Flowage: Springstead Landing off Flowage Landing Rd.	46.073367°N 90.173794°W	3			?*[4]
Upper Wisconsin	47	Lincoln Co.: Tomahawk: Road Lake: Big Moose Supper Club -N8796 County Rd. S (= W Grand Ave.), waters edge 77 m from parking lot.	45.435317°N 89.697106°W	3		0.0328	?
	48	Lincoln Co.: 3 ft to the east of State Hwy 107 at 0.15 mi S of jct with Hillcrest Rd.	45.397561°N 89.693119°W	4	5.2337 (N = 3)	(N = 4)	+
Green Bay	10	Marinette Co.: Governor Thompson State Park: Caldron Falls Reservoir Boat Landing #13, 1.4 mi from jct Boat Landing #13 Rd. and Fabian Ln.	45.344979°N 88.248635°W	7	0.0058 (N = 7)		+
	11	Oconto Co.: Stiles: Machickanee Flowage Public Boat Access off Chicken Shack Road 0.3 mi W of jct with State Hwy 141.	44.856731°N 88.055369°W	7	0.1155 (N = 3) 0.0137 (N = 4)		+

TABLE 1. Continued.

GMU	Locality No.	Locality Description	Coordinates	No. *lc*	Single locality analyses	Pooled analyses of remaining samples	*Bd*
Lower Chippewa	15	Chippewa Co.: Bloomer: Marsh Miller Lake: Birch Point, 210th Ave. boat landing and swampy area.	45.147117°N 88.049994°W	7	1.0350 (N = 5)	0.4333 (N = 5)	+
	16	Barron Co.: Rice Lake: Near Moon Lake, small culvert drainage SE corner of jct of Camelot Cir. And Camelot La.	45.469344°N 91.729178°W	7	0.0260 (N = 4)		+
Buffalo-Trempealeau	3	Buffalo Co.: Mississippi River: wetland at Rieck's Lake Park along Hwy 35, 2.5 mi N Alma.	44.354542°N 91.931783°W	0	NA		NA*[2]
	4	Buffalo Co.: pond 5 m off County Rd. I, 0.5 m N on I from jct with State Hwy 35.	44.361839°N 91.929417°W	2	0.0000 (N = 2)		-*[4]
Black River	2	Jackson Co.: Millston: Lee Lake 15: sandy swimming beach just off Woodland Rd., ~50 m SE jct of Woodland Rd. and County Hwy O.	44.188317°N 90.652158°W	7	0.1554 (N = 7)		+
Central Wisconsin	5	Portage Co.: Stevens Point: Wisconsin River: river bottom wetland along west shore, 0.6 mi NW (upstream) of parking area at S end of Mead Park.	44.530122°N 89.606533°W	7	0.0000 (N = 5)	0.0000 (N = 4)	-
	6	Marathon Co.: Wausau: Scholfield Park, ~100 m from the parking lot to the south and ~100 m from jct with E. Randolph St. to the north.	44.979803°N 89.630817°W	6	0.0010 (N = 4)		+*[1]
Wolf River	49	Waupaca Co.: Iola: Iola Veterans Memorial, off Main St.	44.515743°N 89.130317°W	7	0.1670 (N = 7)		+
	50	Waushara Co: Twin Lake, Twin Lake Campground.	44.237208°N 89.145175°W	7	0.0152 (N = 3) 0.0000 (N = 4)		+
Lower Fox	17	Brown Co.: DePere: 0.18 mi NE of jct S Broadway and State Hwy 172.	44.477817°N 88.051589°W	2			-
	18	Brown Co.: DePere: Apple Creek Campground, N3831 County Rd. U, fishing pond.	44.356472°N 88.190633°W	2		0.0000 (N = 7)	-
	19	Brown Co.: Wrightstown: 0.1 mi SW jct State Hwy 96 and Washington St. on shore of Fox River at end of Dock St., Brown Co. Parks System.	44.324856°N 88.165131°W	3			-
Twin-Door-Kewaunee	36	Door Co.: Brussels: 9245 Lovers Lane, Quietwoods South Camping Resort, permanent catch and release fishing pond, sandy beach area.	44.776753°N 87.591292°W	2			-
	37	Door Co.: Forestville: Forestville Flowage: Forestville Dam Park, 475 Mill Road.	44.693308°N 87.490239°W	1		0.0000 (N = 7)	-
	38	Kewaunee Co.: Algoma: Hwy 42 Olson Park at confluence of Silver Creek and Ahnapee River.	44.617789°N 87.444325°W	4			-

TABLE 1. Continued.

GMU	Locality No.	Locality Description	Coordinates	No. *lc*	Single locality analyses	Pooled analyses of remaining samples	*Bd*
Bad Axe-La Crosse	1	La Crosse Co.: West Salem: Veteran's Memorial Park ~100 m NW of bridge in park.	43.898639°N 91.115689°W	7	4.1983 (N = 7)		+
Lower Wisconsin	21	Juneau Co.: narrow trench along cranberry marsh perpendicular to Country Rd. H ~50 m SW from jct County Rd. H and Mulloney Road.	44.063664°N 90.291183°W	7		0.2401 (N = 8)	?
	22	Iowa Co.: Spring Green: Helena Unit Lower Wisconsin State Riverway off State Hwy 14 at S shore of Wisconsin River.	43.168492°N 90.040628°W	1			?
	23	Iowa Co.: wetland 0.15 mi NW jct of State Hwy 14 and County Rd. C.	43.162833°N 90.026442°W	6	0.0000 (N = 6)		-
Upper Fox	41	Marquette Co.: Westfield: On west shore of Westfield Pond 9, S side of County Rd. E bridge.	43.883081°N 89.495658°W	1		0.0000 (N = 4)	-
	42	Waushara Co.: Ice Age Trail Mecan Segment: Mecan River: ~0.1 mi NE from jct of 9th Ave. and State Hwy 21.	44.030117°N 89.444119°W	6	0.0000 (N = 3)		-
Manitowoc	24	Manitowoc Co.: Hartlaub Lake, ~125 m SE of jct Hartlaub Lake Rd. and Lakewood Lane.	44.047678°N 87.739278°W	7	0.0000 (N = 7)		-
Sheboygan	27	Sheboygan Co.: Kohler-Andrae State Park, Woodland Dunes Nature Trail.	43.652147°N 87.727619°W	1			-
	28	Sheboygan Co.: Elkhart Lake: Elkhart Lake Boat Ramp off County Rd. P.	43.830014°N 88.037453°W	3		0.0000 (N = 7)	-
	29	Sheboygan Co.: Elkhart Lake: Little Elkhart Lake Boat Ramp at end of Lauretta Ct., 100 m W of jct with Schwaller Drive.	43.806261°N 87.984175°W	3			-
Fox	7	Waukesha Co.: Waterville: Henrietta Lake off Waterville Rd. ~ 0.25 mi SW of jct Waterville Rd. and State Hwy 18 (= Sunset Dr.).	43.018578°N 88.442464°W	6		0.0000 (N = 7)	-
	8	Walworth Co.: Potter Lake just off County Hwy. L at ~0.25 mi SW of jct County Rd. L and Stone School Rd (near jct with Shorewood Dr.).	42.814069°N 88.341122°W	1			-
Milwaukee River	25	Ozaukee Co.: Saukville: permanent pond at 2644 Bach St. off Cedar Sauk Rd.	43.369039°N 87.996928°W	1		0.0138 (N = 7)	-
	26	Washington Co.: West Bend: Silver Lake: Henschke Hillside Lake Access 5607 Peter's Dr., 0.25 mi from jct Peter's Dr. and W Paradise Dr.	43.393217°N 88.213642°W	6			+
Grant-Platte	9	Grant Co.: Paris: Banfield Bridge Recreation Area off Indian Creek Road & W. Banfield Road, boat landing on west shore north of bridge.	42.630919°N 90.653014°W	0	NA		NA*[7]

TABLE 1. Continued.

GMU	Locality No.	Locality Description	Coordinates	No. *lc*	Single locality analyses	Pooled analyses of remaining samples	*Bd*
Sugar-Pecatonica	35	Lafeyette Co.: Belmont: Lake Joy: Lake Joy Campground 24192 Lake Joy Lane.	42.776214°N 90.296214°W	7	0.0000 (N = 7)		-
Lower Rock	20	Dane Co.: Madison: UW-Madison: shallow temporary pool midway between Walnut St. and Easterday La. and just N of Observatory Dr.	43.076906°N 89.423033°W	0	NA		NA*[7]
Upper Rock	43	Dodge Co.: Ixonia: Harnischfeger Park, W3048 Crawfish Rd.	43.210069°N 88.543700°W	1			-
	44	Washington Co.: Kettle Moraine State Forest Pike Lake Unit: Pike Lake: 0.75 mi S of State Hwy 60 on Kettle Moraine Rd.	43.309683°N 88.322783°W	2		0.0000 (N = 7)	-
	45	Washington Co.: Kettle Moraine State Forest Pike Lake Unit: Black Forest Nature Trail off Powder Hill Rd., 0.5 mi S State Hwy 60.	43.317328°N 88.309711°W	1			-
	46	Washington Co.: Druid Lake Boat Landing on N shore of Druid Lake off Clearwater Beach Rd.	43.281006°N 88.409072°W	3			-
Southeast	30	Racine Co.: Yogi Bear's Jellystone Camp Resort (near jct State Hwy 38 and 7 1/2 Mile Rd.): far NE corner @ Boo Boo's fishing pond & dock.	42.838219°N 87.908597°W	7	0.0000 (N = 7)		-

at 14 of 38 localities (37%) and *L. pipiens* tested negative at all nine (100%) localities where it occurred. Thus, these data indicate that no *L. pipiens* tested positive even in one case when they were sampled from a locality where *L. clamitans* did test positive. However, sample sizes for *L. pipiens* ranged from 1 to 7 individuals giving the probability of a Type II error (false negative) being from 0.78 to 0.35 (upper CI = 0.35 for samples of N = 7, and CI = 0.78 for N = 1; Brem et al. 2007).

The detection of *Bd* throughout much of Wisconsin is not surprising considering similar findings in other upper-Midwest states including Minnesota (Rodriguez et al. 2009; Woodhams et al. 2008), Iowa (Loda and Otis 2009; Steiner and Lehtinen 2008), Illinois (Steiner and Lehtinen 2008), and Michigan (Steiner and Lehtinen 2008; Zellmer et al. 2008; Zippel and Tabaka 2008). Likewise, the absence of any symptoms of chytridiomycosis in the presence of *Bd* is similar to results from previous studies (e.g., Oullet et al. 2005; Rodriguez et al. 2009; Woodhams et al. 2008). However, our results need to be interpreted cautiously because our sample sizes were small and our results potentially were biased by our seasonal sampling. All but one of the ten GMU's sampled in the fall 2009 tested positive for *Bd*, whereas only three of 14 GMU's tested in the summer 2010 tested positive, and, with a few minor exceptions, this seasonal sampling roughly corresponded to the north in fall 2009 and the south in summer 2010. This north-south, fall-summer sampling correspondence was an unintended flaw in our sampling design, and a more balanced sampling design is needed to address whether this was indeed a seasonal pattern in *Bd* detection, although such a seasonal pattern has been reported previously (Kinney et al. 2011; Oullet et al. 2005). Furthermore, our pooling of swabs, often from multiple localities within the same GMU, confounded any detection at finer spatial scales.

The apparent greater detection of *Bd* among *Lithobates clamitans* than among *L. pipiens* may simply be a result of false negatives from our small sample sizes. However, other factors cannot be eliminated. For example, it is possible that *L. pipiens* resists *Bd* zoospore attachment more than *L. clamitans*, although *Bd* has been detected on both previously (Loda and Otis 2009; Oullet et al. 2005; Woodhams et al. 2009). Also, *L. pipiens* calls and breeds early in the spring and thus tadpoles are more likely to metamorphose by the fall of that year and over-winter as juvenile frogs. In contrast, *L. clamitans* calls and breeds later during the summer months and their tadpoles are known to overwinter prior to metamorphosis. Thus, determining the time of the year when *Bd* is most infectious and the life cycle stages when these frog species are most vulnerable (e.g., Oullet et al. 2005), particularly in Wisconsin, could begin to help explain the results obtained herein, but clearly more work remains to further understand where *Bd* occurs and its effects in Wisconsin and elsewhere.

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Batrachochytrium dendrobatidis in Peru

The amphibian chytrid fungus, *Batrachochytrium dendrobatidis* (*Bd*), has been well-studied in Australia, North and Central America, and Europe, but relatively little information is available concerning the status of this pathogen in South America. This is especially disturbing given that South America contains the highest diversity of amphibian species in the world (Vié et al. 2009).

In Peru, sampling for *Bd* has been especially sparse, with only six studies in localized regions conducted to date (Table 3). The first record of *Bd* in Peru came from several dead *Atelopus patazensis* collected in 1999 (Venegas et al. 2008). Although recent surveys have shown that this species continues to persist, it is currently listed as critically endangered by the IUCN due to the combined effects of *Bd* and water pollution (IUCN 2011). Reliable data are not available on the status of other *Atelopus* species in Peru, though many appear to be declining (Venegas et al. 2008; von May et al. 2008), a trend seen throughout the range of this genus (La Marca et al. 2005). Population surveys for *A. pulcher* in northern Peru have not detected any adults in localities where they were once abundant, and one of the last individuals seen was found dead and later tested *Bd*-positive (Lötters et al. 2005). Another study in northern Peru failed to detect *Bd* in 23 individuals tested using histopathological analysis (Enciso et al. 2008). In southern Peru, the first record of *Bd* came from 3 of 4 *Telmatobius marmoratus* collected in 2002 in the Cordillera Vilcanota (Seimon et al. 2005). A later study in this region reported a range expansion in *Bd* to the highest altitude yet recorded (5348 m), which Seimon et al. (2007) posit might be due to the recent deglaciation and subsequent host population expansion in the region. Additionally, it appears *Bd* might be contributing to declines in one of the two host species in this study (Seimon et al. 2007). Most recently, Catenazzi et al. (2011) discovered dramatic declines in montane amphibian species richness and abundance in southern Peru between surveys from 1999 and 2008–2009. They attributed these declines to chytridiomycosis rather than habitat loss because *Bd* is widespread in the region and declines occurred within the well-protected zone of Manu National Park (Catenazzi et al. 2011).

Recently, it has been shown that the global trade of amphibians is a major contributor to the worldwide dispersal of *Bd* (Farrer et al. 2011; Fisher and Garner 2007). In Peru, trade of amphibians is fairly common; especially in large cities such as Lima and Cusco where Andean frogs (predominantly *Telmatobius* and *Batrachophrynus* species) are frequently sold in restaurants and markets as a protein source or for their perceived medicinal properties (Angulo et al. 2008). Investigations have shown that many of these frogs are *Bd*-positive (Catenazzi et al. 2010), indicating

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TABLE 1. Summary of amphibian study sites in Peru sampled for *Batrachochytrium dendrobatidis* (*Bd*). Surveys were performed during the dry seasons (June–August) 2007 and (May–July) 2008.

Locality	Latitude	Longitude	Altitude (m)	N	*Bd* Positive	Prevalence
2007						
Ahuashiyacu	-6.4578	-76.30843	722	15	2	0.13
Allpahuayo Mishana	-3.75067	-73.28228	102	1	0	0.00
Bocatoma	-6.4585	-76.34968	426	43	0	0.00
Chacos Valley and Llamaquizú	-10.61583	-75.35056	1800-2100	4	1	0.25
Chazuta	-6.5692	-76.12622	235-355	42	0	0.00
Huallaga River	-6.58899	-75.91939	171-232	36	0	0.00
Iquitos Km 23	-3.9586	-73.375	149	37	0	0.00
Iquitos Km 71	-3.75067	-73.33228	122	15	0	0.00
Lamas	-6.38493	-76.51527	645	1	0	0.00
Nanay River	-3.68572	-73.2835	96	17	1	0.06
Pampa Hermosa	-10.9925	-75.43278	1200-1550	10	0	0.00
Pond near Tunnel	-6.43118	-76.30882	846	16	0	0.00
Pongo de Cainarachi	-6.29388	-76.23598	190-220	58	0	0.00
San Jose	-6.4194	-76.2901	470-589	58	0	0.00
Santa Rosa	-5.4406	-78.55473	1234-1270	11	1	0.09
Sapasoa	-6.89635	-76.82817	315-416	32	0	0.00
Sauce	-6.72453	-76.25318	622	5	0	0.00
Seco River	-8.59656	-76.08714	771	20	0	0.00
Tahuayo	-4.17703	-73.15365	115	26	0	0.00
2008						
Aguaytia	-9.05734	-75.66543	429	6	0	0.00
Chacos Valley and Llamaquizú	-10.61583	-75.35056	1800-2100	2	0	0.00
CICRA Station	-12.56861	-70.09917	250-270	83	1	0.01
Cueva de las Lechuzas	-9.32867	-76.02715	656	19	1	0.05
Huampal	-10.18825	-75.57519	968	6	0	0.00
Ivochote	-12.46317	-72.96740	471-481	32	0	0.00
Lake Milagros	-9.14174	-75.99635	671-691	17	0	0.00
Lake Yarinachocha	-8.32561	-74.59022	188	29	0	0.00
Manu Learning Center	-12.78926	-71.39175	463	51	2	0.04
Oxapampa	-10.54556	-75.35835	2355	12	0	0.00
Pilcopata	-12.90997	-71.42281	480-525	49	0	0.00
Pozuzo	-10.04908	-75.54059	692	10	0	0.00
Puente Maranura	-12.96498	-72.66568	1068	22	0	0.00
Puerto Bermudez	-10.27102	-74.93673	243-309	37	0	0.00
Puerto Inca	-9.36759	-75.00175	202-229	23	0	0.00
San Pedro Market, Cusco*	-13.52384	-71.97128	3363	2	1	0.50
Satipo	-11.27665	-74.64673	719	23	0	0.00
Shima Venzo	-11.11832	-74.22433	394-474	37	0	0.00
Tambopata Research Center	-13.13333	-69.60000	350	61	0	0.00
Wayqecha	-13.17956	-71.60561	2623-3240	15	1	0.07

*Specimen purchased from market

that they are likely contributing to spread of the disease throughout Peru as they are moved from capture sites to markets.

The aim of our investigation was to conduct a systematic survey of the current distribution of *Bd* in amphibian populations throughout Peru. Our main goal was to obtain a "snapshot" of the current distribution of the infection to aid in planning future research and management of the disease.

Field surveys of *Bd* prevalence were conducted during June–August of 2007 and May–July of 2008, coinciding with the dry season. We surveyed 39 sites along the eastern slopes of the Andes, providing a collection of samples along both latitudinal (3.68572°S, 73.28350°W to 13.17956°S, 71.60561°W) and altitudinal gradients (90–3240 m; Fig. 1). Coordinates of each locality were determined using a portable GPS unit (Garmin *E*trex Vista). Sites were surveyed using the visual encounter technique (Lips et al. 2001). For each site, two surveyors performed a time-constrained survey for 4 h. The primary goal of each survey was to capture as many individuals and species as possible. During each survey, all amphibians encountered were captured by hand and a new plastic bag was used each time to eliminate the possibility of cross contamination between individuals. For ease of species identification, only post-metamorphic individuals were sampled. After capture, all specimens were kept in individual plastic bags and stored in a cool place until each transect was completed. Appropriate measures were taken to prevent cross-contamination between sites (i.e., disinfection of equipment and footwear between sites, clean clothing, etc.).

During processing, a new pair of latex gloves was worn for each individual, and all equipment was disinfected between animals. Processing consisted of: species identification, clinical examination for abnormalities (i.e., retained shed skin, reddening of skin) and collection of digital photographs of the dorsum

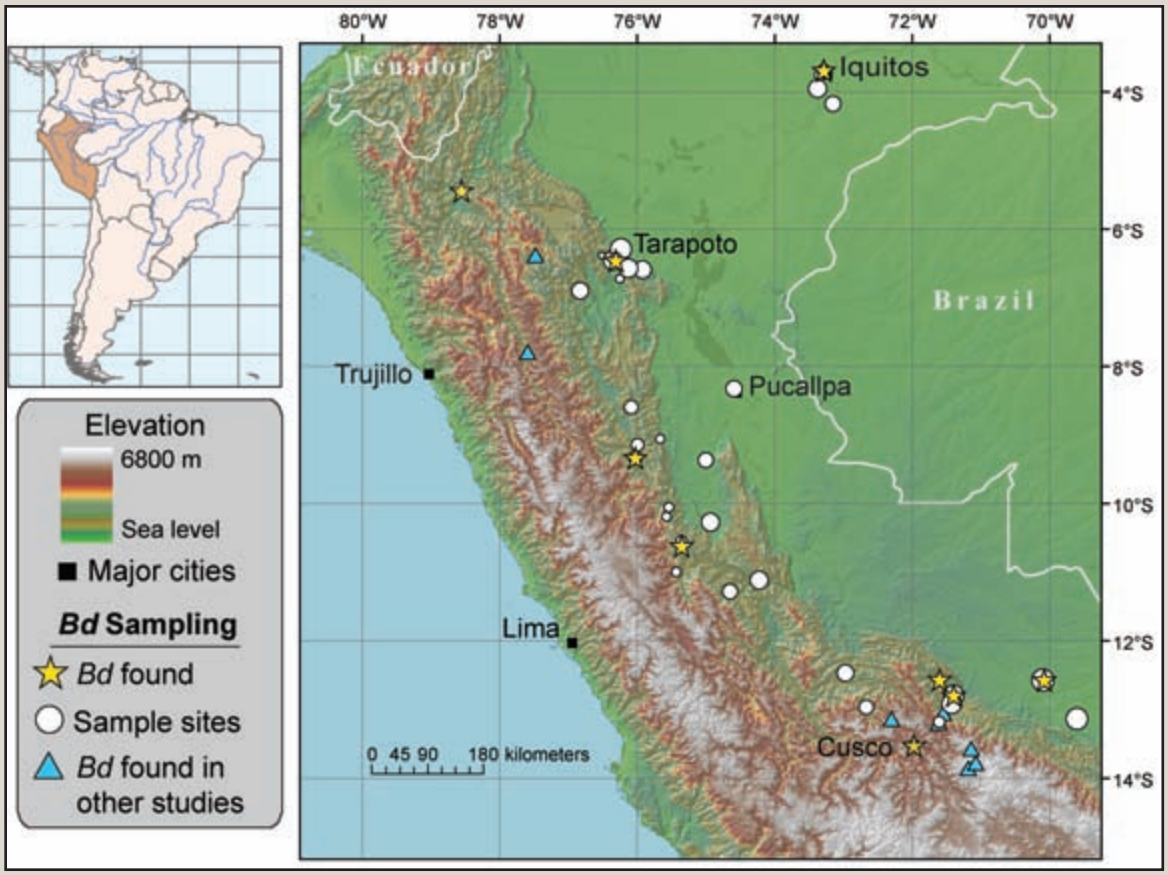


FIG. 1. Study sites in Peru sampled for *Batrachochytrium dendrobatidis (Bd)*. Circles = sample sites with circle diameter proportional to number of samples; stars = sites where *Bd* was detected, and triangles = *Bd*-positive sites reported by others (see Table 3).

and venter. The epidermis was swabbed using a dry sterile swab (Medical Wire and Equipment). Swabbing consisted of: running the swab 10 times over the dorsum, sides, venter, undersides of each thigh, and 5 times on the underside of each foot; for a total of 80 swab runs/animal (Kriger et al. 2006). After processing, all specimens were released within 2 m of their capture site (with the exception of the frogs purchased at the San Pedro Market which were euthanized after processing). Swabs were preserved at room temperature in individually labeled vials containing 95% ethanol.

DNA extractions for swabs were performed in the winter of 2008. The samples from 2007 were extracted in 2008 due to a delay in obtaining permits. During this time these samples were stored at the Museum of Natural History in Lima at room temperature. Upon arrival in the US, all samples were immediately placed at 5°C until DNA extraction. DNA extraction was performed using the PrepMan Ultra Sample Preparation Reagent (ABI), following methods outlined in Boyle et al. (2004). Samples were then analyzed using a highly sensitive endpoint PCR *Bd* assay (minimum sensitivity of 1 zoospore /ml) developed in our laboratory (unpublished), which uses *Bd*-specific primers developed by Annis et al. (2004; Bd1a: 5'-CAGTGTGCCATATGTCACG-3', Bd2a: 5'-CATGGTTCATATCTGTCCAG-3'). The reaction recipe was: 1.25 µl of DNA Gold Buffer (10x, ABI), 1.0 µl of $MgCl_2$ (16.7 µM), 2.4 µl of GeneAmp dNTP mix with dTTP (1000 µM, ABI), 0.5 µl of forward and reverse primers (5 µM, Invitrogen), 0.06 µl of AmpliTaq Gold with GeneAmp (5 units/µl, ABI), 4.29 µl of DNA grade water (Fisher Scientific), 2.0 µl of sample for a total reaction volume of 12 µl. Reactions were loaded into a 96-well plate and placed in the PTC-200 Thermal Cycler (Peltier). Initially all samples were run in duplicate (i.e., two separate PCR's/ sample/ plate) along with positive (previously amplified *Bd* DNA from culture) and negative controls (PCR master mix and H_20). Inhibition controls were not used. The thermal cycler program we utilized was: 1) 5 min at 95°C, 2) 45 sec at 93°C, 3) 45 sec at 60 °C, 4) 1 min at 72°C, 5) repeat steps #2–4, 44 more times, and 6) 10 min at 72°C. After thermal cycling, 8 µl resulting product was mixed with 1 µL of loading dye (6X; Apex) and loaded into a gel (8 ml of 1x TBE Buffer, 1.2 g of agarose; Apex). Additionally, one well per row was loaded with 100 bp DNA ladder (Promega), so that the size of the PCR amplicons could be estimated. Gels were then immersed in 1x TBE Buffer and run at 120 volts approximately 40 min, after which gels are examined and photographed using a UV viewing apparatus. The number of true positives and false negatives were determined by scoring the presence/absence of 300 bp bands on electrophoresis gels. For ambiguous samples, further PCR analyses were conducted. The data for each locality were summarized in terms of prevalence of infection (total number of infected individuals/total number of individuals sampled).

Over a two-year period, a total of 983 amphibian skin swabs were collected from 39 sites throughout Peru. We collected samples from 36 genera of amphibians belonging to 14 families (Table 2; Fig. 2). The results of our PCR assay showed that 11 of 983 individuals sampled were positive for *Bd* (overall prevalence = 1.0%; Table 1). *Bd* was detected in amphibians at 9 of 39 sites across a broad range of altitudes (96–3240 m; Fig. 1). Among-site

TABLE 2. Summary of study amphibian taxa tested for *Batrachochytrium dendrobatidis* (*Bd*) in Peru.

Family	N	*Bd* Positive	Prevalence	*Bd*-positive species
Aromobatidae	8	1	0.13	*Allobates marchesiansus*
Bufonidae	166	0	0.00	
Caeciliidae	1	0	0.00	
Centrolenidae	4	0	0.00	
Ceratophryidae	3	1	0.33	*Telmatobius cf. marmoratus**
Dendrobatidae	242	1	0.01	*Hyloxalus shuar*
Hemiphractidae	16	1	0.06	*Gastrotheca excubitor*
Hylidae	212	4	0.02	*Osteocephalus buckleyi, Hyloscirtus cf. phyllognatus, Scinax garbei, Hypsiboas melanopleura*
Leiuperidae	12	1	0.08	*Engystomops petersi*
Leptodactylidae	139	2	0.01	*Leptodactylus cf. andreae, Leptodactylus petersii*
Microhylidae	21	0	0.00	
Plethodontidae	4	0	0.00	
Ranidae	1	0	0.00	
Strabomantidae	154	0	0.00	

*Specimen purchased from market



FIG. 2. Three species that tested positive for *Batrachochytrium dendrobatidis* (*Bd*) in this study in Peru: A) *Hyloscirtus cf. phyllognatus*, B) *Telmatobius cf. marmoratus*, and C) *Gastrotheca excubitor*.

prevalence ranged from 0 to 25% (Table 1; only results from natural populations were used in this analysis, therefore results from San Pedro market were excluded). *Bd* was detected in 11 species of anurans from 7 families (Table 2).

The majority of *Bd*-positive individuals had reproductive modes associated with permanent bodies of water (6/11; *Allobates marchesiansus, Hypsiboas melanopleura, Hyloscirtus cf. phyllognatus, Hyloxalus shuar, Osteocephalus buckleyi, Telmatobius cf. marmoratus*) and/or had an aquatic tadpole stage (9/11; *A. marchesiansus, Engystomops petersi, Hypsiboas melanopleura, Hyloscirtus cf. phyllognatus, Hyloxalus shuar, Leptodactylus petersii, O. buckleyi, Scinax garbei, T. cf. marmoratus*). Five of the 11 *Bd*-positive individuals are known to utilize streams for reproduction *(Allobates marchesiansus, Hyloscirtus cf. phyllognatus, Hyloxalus shuar, O. buckleyi, T. cf. marmoratus)*. The family with the highest number of infected individuals was Hylidae with 4 infected individuals (Table 2). *Bd* was not detected in any of the *Atelopus* that we sampled (3 *A. pulcher*, 20 *A. cf. andinus*). One of the *Bd*-positive samples came from two *Telmatobius marmoratus* purchased at San Pedro Market in central Cusco (of unknown origin) where they were being sold for human consumption. Obvious clinical abnormalities consistent with possible signs of the disease chytridiomycosis were only detected in 3 of 983 individuals (all *Gastrotheca excubitor*), which had retained shed skin on their toe pads. One of these 3 individuals tested positive for *Bd* with the PCR assay.

The results of this and previous studies indicate that *Bd* is widespread throughout Peru, and from our limited data it appears that *Bd* presence may not be as tightly linked with altitude as suggested by others (Fig. 1; e.g., Bielby et al. 2008; Brem and Lips 2008; Lips et al. 2008). This adds to the growing body evidence (e.g., Kriger and Hero 2008; Walker et al. 2010) that altitude may not have as strong an influence on disease prevalence as originally believed. In this study, the majority of *Bd*-positive individuals had reproductive modes associated with permanent bodies of water and/or an aquatic tadpole stage, characteristics that are have been shown to be associated with high transmission and prevalence of chytridiomycosis (Kriger and Hero 2007; Lips et al. 2003). Of these species, five are known to utilize streams for reproduction, a characteristic associated with susceptibility and declines in other regions (Catenazzi et al. 2011; Kriger and Hero 2007; Lips et al. 2003). There was a greater frequency of *Bd*-positive individuals in the family Hylidae. Other researchers have reported a higher frequency of chytridiomycosis in this family (e.g., Stuart et al. 2004), which may be linked to reproductive mode (Lips et al. 2003) and/or evolutionary history (Corey and Waite 2008). Contrary to our expectations, we did not detect *Bd* in any of the *Atelopus* that we sampled. Although this is the first time that a population of *A. cf. andinus* has been sampled for *Bd*, this disease has been previously detected in other Peruvian *Atelopus* (*A. pulcher*; Lötters et al. 2005; *A. patazensis:* Venegas et al. 2008). Our data showing *Bd* in 1 of 2 *Telmatobius marmoratus* tested from the San Pedro market further supports the idea suggested by Catenazzi et al. (2010), that the trade of amphibians in Peru is contributing to the dispersal of *Bd* throughout the country.

The *Bd* prevalence we found among sites was lower than we expected, especially in mid-elevation regions where previous studies in other countries have reported high frequencies of infection (e.g., Sánchez et al. 2008). Other studies in Peru have reported among-site prevalence ranging from 0 to 100% (Table 3). In fact, Catenazzi et al. (2011) reported *Bd* prevalence as high 64–100% (in *T. marmoratus*) from some of the same sites that we visited in the department of Cusco. There are several possible reasons for this. First, our surveys were conducted in the dry season when climatic conditions may be less conducive to disease transmission and progression (but see Burrowes et al. 2004). Second, our within-site sample sizes may not have been large enough to detect the disease (mean sample size = 26 individuals; 95% CI = 0 to 55). Statistical modeling has shown that at least 30

TABLE 3. Studies of *Batrachochytrium dendrobatidis* (*Bd*) in Peru conducted to date.

Locality	Department	Study Year(s)	Altitude (m)	N	Prevalence	Citation
Provincia de Pataz	Piura	1999	2620	3	0.67	Venegas et al. 2008
Sibinacocha watershed	Cusco	2002	4450	4	0.75	Seimon et al. 2005
Sibinacocha watershed	Cusco	2003	4422–5244	24	0.21	Seimon et al. 2007
Cainarachi valley	San Martín	2003	600	1	1.00	Lötters et al. 2005
Sibinacocha watershed	Cusco	2005	5348	2	0.50	Seimon et al. 2007
Abra Huallahualla	Cusco	2008	3100–4550	65	0.26	Catenazzi et al. 2011
Abra Malaga	Cusco	2008	3300–4050	8	0.13	Catenazzi et al. 2011
Kosnipata Valley	Cusco	2007, 2008	1250–3700	1097	0.12	Catenazzi et al. 2011
Privada Huiquilla	Amazonas	2007, 2008	2800	23	0.00	Encisco et al. 2008

individuals need to be swabbed per locality in order to detect at least one positive individual at a site if the disease prevalence is 10% (Cannon and Roe 1982). As it was not always possible for us to collect 30 individuals per locality due to time limitations, this may explain the lower frequencies we observed. Lastly, although we know that the *Bd* assay that we used is equally sensitive to *Bd* detection techniques published by others (e.g., Hyatt et al. 2007; unpubl. data, laboratory comparisons of *Bd* assay performed by T. Kosch), another possibility for our lower number of *Bd* detections may be due to the presence of PCR inhibitors which were not accounted for in our assay and have been known to contribute to incorrect reporting of false negatives (Garland et al. 2009).

Another interesting observation from this investigation is that only 3 of 983 individuals had any obvious clinical abnormalities consistent with the disease chytridiomycosis, and we did not observe any die-offs or moribund individuals. This is may be because chytridiomycosis is difficult to detect by clinical examination (Green et al. 2002; Kriger et al. 2006), but may also indicate that the infection is not progressing to an advanced state, possibly due to host immunity or low virulence (especially if *Bd* has been present in Peru for long enough for adaptation to occur). Unfortunately, we are unable to distinguish between these possibilities with our limited data.

Although the results of this and previous studies demonstrate that *Bd* is widespread in South America (e.g., Brazil: Carnaval et al. 2006; Venezuela: Sánchez et al. 2008; Argentina: Barrionuevo and Ponssa 2008), the consequences of this disease are still relatively unknown due to the near complete absence of general population monitoring and *Bd* studies in these countries. In Peru, significant declines have been reported in multiple high-elevation species in southern Peru (Catenazzi et al. 2011), and several *Atelopus* and *Telmatobius* species are believed to already be extinct (Venegas et al. 2008; von May et al. 2008). Peru contains some of the highest amphibian diversity on record and the loss of this diversity could have severe consequences. This makes the lack of knowledge on *Bd* and population status of Peru's amphibians especially alarming.

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Further Presence of Ranavirus Infection in Amphibian Populations of Tennessee, USA

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An estimated 43% of amphibian species across the globe are in decline (Stuart et al. 2004). These declines have been attributed to various diseases and anthropogenic impacts such as habitat destruction (Daszak et al. 1999; Price et al. 2006). Of particular interest to this study are ranaviruses, which are known to be a causal factor in amphibian die-offs worldwide (Cunningham et al. 1996; Fox et al. 2006; Green et al. 2002). Gray et al. (2009a) suggested that ranaviruses can have detrimental effects on localized populations, potentially leading to species declines.

In the eastern United States, ranavirus infections have been documented in 33 amphibian species (Miller et al. 2011). In Tennessee, ranavirus has been found in plethodontid salamanders in the Southern Appalachian Mountains (Gray et al. 2009b) and in various species of anurans in farm ponds (Gray et al. 2007; Hoverman et al. 2011a). To date, ranavirus infection in amphibians has not been reported in western Tennessee. Our objective

TABLE 1. Prevalence and 95% confidence intervals of ranavirus infection in larval amphibians inhabiting four ponds located at the Milan Army Ammunition Plant, Milan, Tennessee, USA, April 2010. Pond coordinates are withheld as these locations are on U.S. Department of Defense property.

	Pond Prevalence and 95% Confidence Interval			
Species	Pond NC1	Pond NC3	Pond NC6	Pond NC9
Ambystoma maculatum		0.33 0.06–0.79	1.0 0.21–1.0	0.5 0.33–0.67
A. opacum		0 0–0.66		
A. talpoideum		0.1 0.02–0.40		
Hyla chrysoscelis / *H. versicolor* complex		0.06 0.01–0.26	0.04 0.01–0.18	0.43 0.16–0.75
Lithobates clamitans			0 0–0.43	
L. sphenocephalus	0.18 0.08–0.34			

was to test for the occurrence of ranavirus in larval amphibian populations at one site in western Tennessee.

We conducted our study at the Milan Army Ammunition Plant (MLAAP) in Milan, Tennessee, USA (35.911977°N, 88.702903°W). The MLAAP was established in 1941 with over 9124 hectares in Carroll and Gibson counties (Brew and Markol 2001). Although herpetological research has been conducted at the MLAAP, none has focused on amphibian pathogens.

We opportunistically captured amphibian larvae from four fishless ponds on the MLAAP during April 2010 using dip nets. Upon capture, larvae were rinsed with aged tap water, placed in separate containers, and transported to Austin Peay State University (APSU). In total, we captured 136 larvae of the following species: *Ambystoma maculatum* (N = 32), *A. opacum* (N = 2), *A. talpoideum* (N = 10), *Hyla chrysoscelis/H. versicolor* complex (N = 53), *Lithobates clamitans* (N = 5), and *L. sphenocephalus* (N = 34). Before moving between ponds, all field personnel disinfected boots, waders, and field collection equipment with a 5% sodium hypochlorite (bleach) solution (Bryan et al. 2009). At APSU, amphibian larvae were euthanized by complete immersion in 80% ethanol after sedation in a 5% ethanol bath. Approximately 50% of the liver was collected for ranavirus testing. The liver is a known site of ranavirus infection in North American amphibians (St-Amour and Lesbarrères 2007), and commonly used in surveillance studies (e.g., Hoverman et al. 2011a). Sterilized instruments and different gloves were used between each animal to prevent cross contamination.

We isolated genomic DNA using standard phenol-chloroform techniques. Liver samples were initially incubated in 100 µl of 1 mg/ml collagenase (Sigma-Aldrich Chemical Company, St. Louis, Missouri, USA) in phosphate buffered saline for 4 hours at 37°C followed by an additional incubation using 100 µl of proteinase K for 16 hours at 37°C. After incubation, the digested tissue samples were triturated to disrupt cellular matrixes, and an equal volume of a 1:1 ratio of phenol:chloroform was added. The sample was vortexed thoroughly for 10 seconds and set at room temperature for approximately 5 minutes. The sample was then centrifuged at 10,000 x g for 5 minutes, and the top aqueous layer was moved to a new tube. Approximately 5 volumes of 100% ethanol and 100 µl of 3 M sodium acetate were added to the sample for DNA precipitation. Samples were placed in a -80°C for at least 15 minutes then centrifuged at 10,000 x g for 10 minutes. The resulting DNA pellet was washed once in 80% ethanol and subsequently centrifuged at 10,000 x g for 5 minutes. The DNA pellet was vacuum-dried, resuspended in 20 µl of molecular grade water, and stored frozen for future ranavirus testing.

We tested for the presence of *Ranavirus* DNA in duplicate for each sample using polymerase chain reaction (PCR) with primers specific for the major capsid protein of the virus (Mao et al. 1997). We used the PCR primers for *frog virus 3* (FV3) published in Mao et al. (1997), which is the type species of *Ranavirus*. These primers have been shown to be reliable for detecting FV3-like ranaviruses in Tennessee amphibians (Gray et al. 2007). The PCR amplified products were visualized on a 0.84% agarose electrophoresis gel, which was stained with ethidium bromide. DNA sequence analysis of PCR samples amplified using the aforementioned primers revealed a greater than 98% DNA sequence identity to NCBI's genomic database for the FV3 major capsid protein gene with an accession number of JQ771299. The PCR amplified products were purified using a Promega Wizard PCR clean-up kit and sent to Vanderbilt University for genomic sequencing.

The major capsid protein of *Ranavirus* was detected in 29 specimens, including a first detection in a wild population for *A. talpoideum*. Percent positives ranged from 0–43% (Table 1), with the highest percentage of infection in *Hyla chrysoscelis/versicolor* complex. Infection was not detected in *A. opacum* and *L. clamitans*.

We detected FV3-like ranaviruses in four amphibian species, with a first species detection in *A. talpoideum* (Miller et al. 2011). Interestingly, Hoverman et al. (2011b) were unable to cause infection in this species when challenged in the laboratory with two strains of FV3-like ranaviruses. One of the highest percent infections was in *A. maculatum*, which are frequently associated with ranavirus die-offs in eastern North America (Brunner et al.

2011; Gahl and Calhoun 2010; Green et al. 2002; Petranka et al. 2003; Todd-Thompson 2010). In the laboratory, Hoverman et al. (2011b) reported that *A. maculatum* larvae had relatively low susceptibility to ranaviral disease. We also documented infection in larval *H. chrysoscelis/H. versicolor* complex and *L. sphenocephalus*, which has been reported previously (Miller et al. 2011). Our findings support previous surveillance and laboratory studies demonstrating that ranaviruses can infect multiple species in an amphibian community (Brunner et al. 2011; Duffus et al. 2008; Hoverman et al. 2010; Schock et al. 2008). Given that ranaviruses are common pathogens in North America that can result in disease emergence in amphibian, reptile, and fish populations (Gray et al. 2009a), state and federal natural resource agencies should consider establishing ranavirus surveillance programs.

Acknowledgments.—Funding for this project was provided by the Presidential Research Scholarship fund through APSU Department of Undergraduate Research and the Tennessee Herpetological Society (Chad Lewis Memorial Grant). We thank the Center of Excellence for Field Biology for the generous use of their equipment and facilities. We are grateful to Floyd Scott for his review of this manuscript and for field assistance provided by Nathan Parker and Michael Fulbright. All sampling was approved by the Tennessee Wildlife Resources Agency (Scientific Collection Permit #1990) and followed APSU Institutional Animal Care and Use Committee protocol #10-002R.

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GEOGRAPHIC DISTRIBUTION

CAUDATA — SALAMANDERS

***AMBYSTOMA BARBOURI* (Streamside Salamander).** USA: OHIO: Lawrence Co.: Hamilton Township (38.57403°N 82.77565°W, WGS84). 21 February 2011. Jeffrey V. Ginger. Verified by Herman Mays (based on DNA analysis). Cincinnati Museum Center (CMC 12206). New county record (Pfingsten and Matson 2003. Ohio Salamander Atlas. Ohio Biological Survey Misc. Contribution No. 9, Columbus).

The breeding site was a flooded ditch used as a breeding pool on Back Road. Collected from a ditch that was being used as a breeding pool instead of a first or second order stream, the typical habitat for the species (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, DC. 587 pp.).

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***AMBYSTOMA MACULATUM* (Spotted Salamander).** USA: GEORGIA: Hall Co.: Elachee Nature Center (34.245842°N, 83.832004°W; WGS 84). November 2011. Daniel Thompson. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50154 photo voucher); New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp).

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***AMBYSTOMA OPACUM* (Marbled Salamander).** USA: INDIANA: Fountain Co.: Portland Arch Nature Preserve (40.219310°N, 87.337699°W; WGS 84). 05 May 2007. Todd Pierson. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50137 photo voucher). New county record (Minton 2001. Amphibians and Reptiles of Indiana, 2nd ed. Indiana Academy of Science, Indianapolis. xiv + 404 pp.).

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***CHIROPTEROTRITON CHONDROSTEGA* (Gristle-headed Salamander).** MÉXICO: MÉXICO: Municipality of Santiago Tianguistenco: Ahuatenco (19.127083°N, 99.464389°W; NAD 27), 2605 m elev. 13 August 2011. Eduardo Mendoza-Almazan and Abraham Jardón-Perea. Colección de Vertebrados (Anfibios y Reptiles), Universidad Autónoma del Estado de México (CAREM-0000225). Verified by Aleida Cruz. First record for the State of Mexico (Smith and Taylor 1948. U.S. Nat. Mus. Bull. 194:i–iv, 1–118) and a 175 km SE (airline) range extension from the closest known locality, Los Reyes, Acaxochitlán, Hidalgo (fig. 1. in Ramírez-Bautista et al. (2010. Lista Anotada de los Anfibios y Reptiles del Estado de Hidalgo, México. Univ. Autó. Estado de Hidalgo, CONABIO, Lito Impresos Bernal, S. A., Pachuca, Hidalgo, México. x + 104 pp.). The salamander was found in pine-oak forest.

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***EURYCEA CHAMBERLAINI* (Chamberlain's Dwarf Salamander).** USA: ALABAMA: Covington Co.: Conecuh National Forest; Mossy Pond (31.13922°N 86.60119°W; WGS 84). 05 June 2011. C. Thawley and S. Graham. Verified by Craig Guyer. AUM 39521. New county record (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn Printing Co., Auburn, 347 pp.). Specimens of *Eurycea quadridigitata* reported from this county previously (Mount 1975, *op. cit.*) were collected before the description of *E. chamberlaini* and may instead be attributable to this taxon. However, populations of *E. quadridigitata* (sensu stricto) are found ca. 100 km to the E of this site in Houston Co., Alabama (Graham et al. 2008. Herpetol. Rev. 39:476), and populations of a possible undescribed dwarf salamander species (e.g., Jensen et al. 2008. The Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.) are also present within Conecuh National Forest in Covington and Escambia counties, Alabama (Graham et al. 2008, *op. cit.*). AUM 39521 is morphologically consistent with *E. chamberlaini*, suggesting that all three species may occur in close proximity and/or sympatrically in southern Alabama.

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***EURYCEA CIRRIGERA* (Southern Two-lined Salamander).** USA: INDIANA: Carroll Co.: Lake Freeman (40.709353°N, 86.754642°W; WGS 84). 25 May 2008. Todd Pierson. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50152 photo voucher). New county record (Minton 2001. Amphibians and Reptiles of Indiana, 2nd ed. Indiana Academy of Science, Indianapolis. xiv + 404 pp.).

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***EURYCEA GUTTOLINEATA* (Three-lined Salamander).** USA: GEORGIA: Franklin Co.: Victoria Bryant State Park (34.297397°N, 83.159190°W; WGS 84). 24 September 2012. Todd Pierson. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50161 photo voucher). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.).

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***NECTURUS BEYERI* (Gulf Coast Waterdog).** USA: TEXAS: San Jacinto Co.: ca. 9 air km W of Shepherd, in Big Creek 2.8 km S of SH 150 on 217 (30.506447°N, 95.088408°W; WGS 84). 27 December 2009. John T. Williams, Brandon C. Bowers, Scott A. Wahlberg, Matthijs Hollanders. Verified by Toby J. Hibbitts. Texas Cooperative Wildlife Collections, TCWC 94289–24290. New county record (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. University of Texas A&M Press, College Station. viii + 421 pp.).

Liberty Co.: in Menard Creek ca. 1 km N of FM 787 on County Road 2650 (30.455858°N, 94.738247°W; WGS 84). 11 December 2010. Brandon C. Bowers, John T. Williams, Scott A. Wahlberg, Matthijs Hollanders. Verified by Toby J. Hibbitts. TCWC 95131–95132. New county record (Dixon 2000, *op. cit.*). Menard Creek also flows through Hardin Co., where *N. beyeri* has been vouchered.

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***NECTURUS MACULOSUS* (Mudpuppy).** USA: TENNESSEE: Wayne Co.: Fortyeight Creek, 107 m upstream from US Highway 64, just above the Old Highway 64 Bridge. Accessed from Fortyeight Creek Rd. (35.341944°N, 87.660556°W, NAD 27). 4 April 2011. Michael C. Fulbright and Matthew D. Wagner. Austin Peay State University Museum of Zoology, APSU 19120. Verified by A. Floyd Scott. One adult caught via electrofishing. New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. [Hard copy and Internet versions, the latter of which includes links to information on Tennessee amphibians having appeared since 1996, http://www.apsu.edu/amatlas/, accessed 28 September 2011]).

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***NOTOPHTHALMUS VIRIDESCENS* (Eastern Newt).** USA: ILLINOIS: Kane Co.: Bliss Woods Forest Preserve (41.788133°N, 88.4388°W; WGS 84; elev. 219 m). 1 April 2010. K. Huschart and C. Milne-Zelman. Verified by Chris Phillips. Illinois Natural History Museum (INHS 21683). New county record (Phillips et al. 1999. Field Guide to Amphibians and Reptiles of Illinois. Illinois Natural History Survey Manual. 285 pp.). Scientific Research Permit issued to C. Milne-Zelman by Forest Preserve District of Kane County.

We thank Tom Anton and William Graser for field assistance.

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ANURA — FROGS

***ACRIS CREPITANS* (Northern Cricket Frog)** USA: ALABAMA: Crenshaw Co.: Blue Creek, N of Crenshaw County Rd. 30, 500 m W of Petrey (31.84672°N W 86.21233°W; WGS 84). 29 May 2011. S. Graham. Verified by John Jensen. AUM AHAP-D 307 (digital audio file). New county record (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn Printing Co., Auburn. 347 pp.). Chorus of males recorded calling in swamp.

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***ANAXYRUS AMERICANUS* (American Toad).** USA: INDIANA: Carroll Co.: Lake Freeman (40.709353°N, 86.754642°W; WGS 84). 14 April 2008. Todd Pierson. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50151 photo voucher). New county record (Minton 2001. Amphibians and Reptiles of Indiana, 2nd ed. Indiana Academy of Science, Indianapolis. xiv + 404 pp.).

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***ANAXYRUS AMERICANUS* (American Toad).** USA: TENNESSEE: Jefferson Co.: ~13 km W of Jefferson City (36.08435°N, 83.62905°W; WGS 84). 14 May 2009. Ted M. Faust and Mark Mayfield. Verified by Floyd A. Scott. Austin Peay State University Museum of Zoology (APSU 19083 [color photo]). New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Hard copy and Internet versions, the latter [http://www.apsu.edu/amatlas/ accessed 31 December 2011] including links to data on amphibians in Tennessee that have appeared since 1996). An individual was found crossing Beaver Creek Road at 2240 h during a downpour.

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***ANAXYRUS FOWLERI* (Fowler's Toad).** USA: INDIANA: Boone Co.: Starkey Park (39.951389°N, 86.322500°W; WGS 84). 14 June 2010. Todd Pierson. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50148 photo voucher). New county record (Minton 2001. Amphibians and Reptiles of Indiana, 2nd ed. Indiana Academy of Science, Indianapolis. xiv + 404 pp.).

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***CERATOPHRYS JOAZEIRENSIS* (Caatinga Horned Frog).** BRAZIL: RIO GRANDE DO NORTE: Municipality of Santa Maria: 5.854°S, 35.701°W (datum WGS84, 137 m elev.). 10 April 2010. J. S. Jorge. Coleção Herpetológica da Universidade Federal do Rio Grande do Norte, Natal Rio Grande do Norte, Brazil (CHBEZ 3633, female 7.55 cm SVL; and 3776, male 9.35 cm SVL). Verified by U. Caramaschi. This species was previously known for the states of Bahia, municipality of Juazeiro (type locality; Mercadal 1986. Amphibia-Reptilia 7[4]:313–334), Paraíba and Rio Grande do Norte (Vieira et al. 2006. Check List 2[2]:28–29), and Pernambuco (Moura et al. 2011. *In* Moura [org.], Herpetologia no Estado de Pernambuco, pp. 51–85. Ministerio do Meio Ambiente, Brasilia). Second record for the state of Rio Grande do Norte, extending the distribution of the species ca. 110 km NW from municipality of Passa e Fica, Rio Grande do Norte state, Brazil (Vieira et al., *op. cit.*). This is the first record for the Agreste region, a transitional area between the Caatinga and Atlantic rainforest ecosystems.

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***CRAUGASTOR OCCIDENTALIS* (Taylor's Barking Frog)**. MÉXICO: ZACATECAS: Municipality of Juchipila: Sierra Morones, 7.74 km WSW of Juchipila (21.39961°N, 103.18785°W; WGS84), 1847 m elev. 13 September 2009. Zaira Yaneth González-Saucedo, Rubén Alonso Carbajal-Márquez, José Carlos Arenas-Monroy, and José Jesús Sigala-Rodríguez. Verified by Lee Grismer. LSUHCDPC 6125 photo voucher. First municipality record, second record for Zacatecas, extending the known distributional range of the species ca. 49 km (airline) ESE from the type locality, La Hacienda, Municipality of Florencia de Benito Juárez, Zacatecas (Taylor 1941. Proc. Biol. Soc. Washington 54:87–94). The frog was found on ground leaf litter in the ecotone between tropical deciduous forest and oak forest.

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***ELEUTHERODACTYLUS CYSTIGNATHOIDES* (Rio Grande Chirping Frog)**. MÉXICO: HIDALGO: Municipality of Tecozautla: 1.62 km E La Paila (20.56925°N, 99.5843333°W; WGS84), 1724 m. elev. 31 May 2009. Víctor Vite Silva. Verified by Jesús M. Castillo. Colección Herpetológica, Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo (CIB-UAEH 2109). First municipality record, extending the range in the state ca. 31.76 km E from its closest reported locality at Arbolado, Municipality of Tasquillo on a nut farm (Morales 2010. Herpetofauna de Dos Ambientes Contrastantes del Municipio de Tasquillo. Tesis, Universidad Autónoma del Estado de Hidalgo. Mineral de la Reforma. 84 pp.). It is also the first record in Hidalgo from xerophytic scrub vegetation, as the species has previously been reported only from cloud forest (Canseco-Márquez et al. 2004. *In* Luna et al. [eds.], Biodiversidad de la Sierra Madre Oriental, pp. 417–437. Las Prensas de Ciencias, México, D.F.).

Fieldwork was funded by CONACyT- 95828 and CONABIO GT002.

ADRIANA LÓPEZ-MEJÍA (e-mail: alamo_87@hotmail.com) and **IRENE GOYENECHEA** (e-mail: ireneg28@gmail.com), Centro de Investigaciones Biológicas (CIB), Universidad Autónoma del Estado de Hidalgo, A.P. 1-69 Plaza Juárez, Pachuca, Hidalgo, México.

***ELEUTHERODACTYLUS NITIDUS* (Shiny Peeping Frog)**. MÉXICO: HIDALGO: Municipality of Tecozautla: 1.31 km E La Paila (20.56652778°N, 99.61519444°W; WGS84), 1665 m. elev. 29 May 2009. Adriana López Mejía. Verified by Jesús M. Castillo. Colección Herpetológica, Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo (CIB-UAEH 2116). First municipality record, extending the range in the state ca. 98.34 km SW from its closest reported locality in Acayuca, Municipality of Molango (Ramírez-Bautista et al. 2010. Lista Anotada de los Anfibios y Reptiles del Estado de Hidalgo, México. Universidad Autónoma del Estado de Hidalgo, CONABIO. x + 104 pp.) The frog was found in xerophytic scrub, but the only previous record of this species in Hidalgo was in cloud forest (Ramírez-Bautista et al. 2010, *op. cit.*) Fieldwork was funded by CONACyT- 95828 and CONABIO GT002.

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***ELEUTHERODACTYLUS PLANIROSTRIS* (Greenhouse Frog)**. USA: FLORIDA: Desoto Co.: Arcadia, Dee Oaks Nursery, 150 m S of Owens School Rd. and 250 m W of County Rd. 661 (27.17896°N, 81.93542°W; WGS84). 19 July 2010. C. Thawley. UAHC 16425. Verified by Leslie J. Rissler. New county records (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final Report, Project Agreement 08013, Florida Fish and Wildlife Conservation Commission, Tallahassee. 524 pp.). This introduced species has now been reported from approximately two-thirds of counties from peninsular Florida, suggesting that it is likely distributed across the entire peninsula.

Thanks to Walter E. Meshaka, Jr. for assistance and review of localities.

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***FEJERVARYA NEPALENSIS* (Nepal Cricket Frog)**. INDIA: UTTARAKHAND: Haridwar, Jhilmil Jheel Conservation Area (29.80556°N, 78.2277°E, WGS 84; 245.97 m elev.; 29.8722°N, 78.1882°E; WGS 84; 273.40 m elev.). J. P. Sati. 10 March 2011 (ZSI NRC 861). HARYANA: Yamuna Nagar, Kalesar National Park & Wildlife Sanctuary (30.3467°N, 77.5167°E; WGS 84; 332.237 m elev.) S. J. S. Hattar. 15 July 2007 (ZSI NRC 775). All verified by Karan Shah. First records for Uttarakhand and Haryana states. Previously known from Arunachal Pradesh, Assam, and Nagaland (Ao et al. 2003. Zoo Print J. 18:1117–1125; Mathew and Sen 2010. Pictorial Guide to Amphibians of North East India. Zoological Survey of India, Kolkata. xii + 144 pp.); and central and eastern midlands of Nepal (Anders 2002. *In* Schleich and Kästle [eds.], Amphibians & Reptiles of Nepal. Biology, Systematics, Field Guide, pp. 133–348. ARG Gantner Verlag K.G., Ruggell).

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***HOPLOBATRACHUS CRASSUS* (Jerdon's Bullfrog)**. BANGLADESH: NILPHAMARI DISTRICT: Koya Golahut, Saidpur (25.801969°N, 88.900531°E; WGS 84; 41.15 m elev.). 27 August 2011. Md. Abdur Razzaque Sarker. Verified by Ghazi S. M. Asmat. Museum of Herpetology Laboratory, Ichamati College, Dinajpur, Bangladesh (MHLB-HC01). First record from Nilphamari District, northern Bangladesh; previously recorded from Chittagong (Asmat et al. 2003. Univ. Rajshahi J. Zool. 22:141–143). Near Saidpur Bypass Road > 2 km N from Saidpur and > 17 km S from Nilphamari. Adults collected beside paddy field. Habitat includes *Cynodon dactylon* and *Bambusa arundinacea* plantations.

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***HYLA AVIVOCA* (Bird-voiced Treefrog)** USA: ALABAMA: Crenshaw Co.: Blue Creek, N of Crenshaw County Rd. 30, 500 m W of Petrey (31.84672°N W 86.21233°W; WGS 84). 29 May 2011. S. Graham. Verified by John Jensen. AUM AHAP-D 308 (digital audio file). New county record (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn Printing Co., Auburn. 347 pp.). Chorus of males recorded calling in swamp

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***HYLA BISTINCTA* (Mexican Fringe-limbed Treefrog)**. MÉXICO: MÉXICO: Municipality of Valle de Bravo: Velo de Novia (19.166072°N, 100.139875°W; NAD 27), 1895 m elev. 12 June 2010. M. Guadalupe López-Garduño. Colección de Vertebrados (Anfibios y Reptiles), Universidad Autónoma del Estado de México (CAREM 0000226–227). Verified by Gil Martínez. First record for Valle de Bravo, positioned 38 km S of the other reported locality in Estado de México, 19 km W of Villa Victoria (Duellman 2001. Hylid Frogs of Middle America, Vol. 2. SSAR Contrib. Herpetol. 18: x + 695–1159; Smith and Taylor 1948. U.S. Nat. Mus. Bull. 194: i–v, 1–118). The frog was found in a pine-oak forest (*Pinus* sp. and *Quercus sartorii)*.

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***HYLA VERSICOLOR* (Gray Treefrog)**. USA: INDIANA: Boone Co.: Stonegate Neighborhood (39.951389°N, 86.322500°W; WGS 84). 8 May 2009. Todd Pierson. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50146 photo voucher). New county record (Minton 2001. Amphibians and Reptiles of Indiana, 2nd ed. Indiana Academy of Science, Indianapolis. xiv + 404 pp.).

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***HYLARANA TYTLERI* (Yellow-striped Frog)**. BANGLADESH: NILPHAMARI DISTRICT: Berakuthi, Barua (25.822194°N, 88.827708°E; WGS 84; 43.89 m elev.). 30 September 2011. Md. Abdur Razzaque Sarker. Verified by Ghazi S. M. Asmat. Museum of Herpetology Laboratory, Ichamati College, Dinajpur, Bangladesh (MHLB-HT01). First record from Nilphamari District, northern Bangladesh; described from Dhaka District (Theobald 1868. J. Asiatic Soc. Bengal 37:7–88), and recorded from Chittagong District (Asmat et al. 2003. Univ. Rajshahi J. Zool. 22:141–143), and Barisal District (Howlader 2010. Russian J. Herpetol. 17:255–256). Near Primary High School, Berakuthi, Barua, Bangladesh, >14 km S from Nilphamari. Adults collected in late morning on pond. Habitat includes pond with *Eichhornia crassipes*, paddy fields, and *Musa acuminata* plantations.

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HYPSIBOAS NYMPHA. BRAZIL: AMAZONAS: Municipality of Coari: 4.38388889°N, 64.73694444°W (WGS 84; 73 m elev.). 13 December 2006. R. de Fraga and V. T. de Carvalho. Coleção de Anfíbios e Répteis, Instituto Nacional de Pesquisas da Amazônia, Manaus, Amazonas, Brazil (INPA-H 18303, SVL 34.7 mm; body mass in life 1.9 g; collected in Terra Firme Forest). Verified by J. Faivovich. *Hypsiboas nympha* is distributed in the western Amazon Basin, and is known from the northern and southern regions of eastern lowland Ecuador and from northeastern Peru at elevations below 600 m, and from lowlands of Colombia around Leticia (Faivovich et al. 2006. Herpetologica 62:96–108). This record is the easternmost limit known for this species, and the first Brazilian record, extending the known distribution 630 km E of the nearest record in Leticia, Colombia (Faivovich et al., *op. cit.)*

VINICIUS T. DE CARVALHO (e-mail: viniciustc@ig.com.br), and **RICHARD C. VOGT,** Instituto Nacional de Pesquisas da Amazônia – INPA, Coleção de Anfíbios e Répteis – Campus II, Av. André Araújo, 2936. C.P. 428. CEP 69.011-970 Manaus, Amazonas, Brazil; **RAFAEL DE FRAGA**, Programa de Pós-Graduação em Biologia Tropical e Recursos Naturais / Ecologia, Instituto Nacional de Pesquisas da Amazônia – INPA, Av. Ephigênio Salles, S/N, CEP 69.083-000 Manaus, Amazonas, Brazil.

***INCILIUS OCCIDENTALIS* (Pine Toad)**. MÉXICO: HIDALGO: Municipality of Tecozautla: 0.84 km E La Paila (20.56325°N, 99.61002778°W; WGS 84; 1617 m elev.). 30 May 2009. Nallely Morales Capellán. Verified by Jesús M. Castillo. Colección Herpetológica, Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo (CH-CIB 2111, 2113). First municipality record, extending the range in the state ca. 33 km SW from its closest reported localities at Puerto del Angel and Puerto Colorado, Zimapán (Huitzil-Mendoza 2007. Herpetofauna de Dos Localidades en la Región Norte de Zimapán, Hidalgo. Tesis, Universidad Autónoma del Estado de Hidalgo. Mineral de la Reforma. 92 pp.). It is also the first record from xerophytic scrub in Hidalgo. Previous reports in the municipalities of Agua Blanca and Tepehuacán de Guerrero were from cloud forest and pine-oak forest in Cuautepec de Hinojosa (Ramírez-Bautista et al. 2010. Lista Anotada de los Anfibios y Reptiles del Estado de Hidalgo, México. Universidad Autónoma del Estado de Hidalgo, CONABIO. x + 104 pp.). However, the species has been observed in xerophytic scrub in Querétaro (Dixon et al. 1972. Southwest. Nat. 16:225–237), Aguascalientes (Vázquez and Quintero 2005. Anfibios y Reptiles de Aguascalientes. CONABIO. México, D.F. 318 pp.), and México and Distrito Federal (Ramírez-Bautista et al. 2009. Herpetofauna del Valle de México: Diversidad y Conservación. UAEH y CONABIO. México, D.F. 213 pp.). Fieldwork was funded by CONACyT- 95828 and CONABIO GT002.

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***LITHOBATES BLAIRI* (Plains Leopard Frog)**. USA: NEBRASKA: Gosper Co.: 4.0 km S, 2.6 km W Bertrand (40.4893°N, 99.6634°W; NAD83). 19 July 2011. Alyx R. Lingenfelter and Keith Geluso. Verified by Curtis J. Schmidt. Sternberg Museum of Natural History, Fort Hays State University, Hays, Kansas (FHSM 15851, 15852). First county record (Ballinger et al. 2010. Amphibians and Reptiles of Nebraska. Rusty Lizard Press, Oro Valley, Arizona. 400 pp.; Fogell 2010. A Field Guide to the Amphibians and Reptiles of Nebraska. University of Nebraska, Lincoln. vi + 158 pp.). Fills gap in south-central parts of the state. Nearest prior records include all surrounding counties including Dawson, Frontier, Furnas, and Phelps. Frogs were captured along a waterway in the Peterson Federal Waterfowl Production Area.

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***LITHOBATES CLAMITANS* (Green Frog)**. USA: INDIANA: Boone Co.: Starkey Park (39.940888°N, 86.268396°W; WGS 84). 22 April 2007. Todd Pierson. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50140 photo voucher). New county (Minton 2001. Amphibians and Reptiles of Indiana, 2nd ed. Indiana Academy of Science, Indianapolis. xiv + 404 pp.).

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***LITHOBATES PALUSTRIS* (Pickerel Frog)** USA: ALABAMA: Jefferson Co.: Small tributary of Turkey Creek, 1 km S of Morris (33.72478°N 86.82260°W; WGS 84). 11 February 2012. S. Graham. Verified by Craig Guyer. AUM AHAP-D 499. New county record (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn Printing Co., Auburn. 347 pp.). Found in leaf litter along the tributary.

Funding for this collection trip was provided by a National Science Foundation grant (IOS-1051367, DEB- 0949483) to Tracy Langkilde.

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***LITHOBATES PALUSTRIS* (Pickerel Frog)**. USA: INDIANA: Montgomery Co.: Pine Hills Nature Preserve (39.938073°N, 87.058497°W; WGS 84). 23 July 2009. Todd Pierson. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50153 photo voucher). New county record (Minton 2001. Amphibians and Reptiles of Indiana, 2nd ed. Indiana Academy of Science, Indianapolis. xiv + 404 pp.).

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***LITHOBATES PALUSTRIS* (Pickerel Frog)**. USA: TENNESSEE: Jefferson Co.: ~13 km W of Jefferson City (36.08489°N, 83.62999°W; WGS 84). 14 May 2009. Ted M. Faust and Mark Mayfield. Verified by Floyd A. Scott. Austin Peay State University Museum of Zoology (APSU 19086 [color photo]). New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Hard copy and Internet versions, the latter [http://www.apsu.edu/amatlas/ accessed 31 December 2011] including links to data on amphibians in Tennessee that have appeared since 1996). An individual was found crossing Beaver Creek Road on a rainy night at 2235 h.

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***LITHOBATES PIPIENS* (Northern Leopard Frog)**. USA: INDIANA: Boone Co.: Starkey Park (39.940888°N, 86.268396°W; WGS 84). 18 April 2009. Georgia Museum of Natural History (GMNH 50141 photo voucher); Clinton Co.: Camp Cullom Park (40.312808°N 86.632811°W; WGS 84). 15 March 2008. GMNH 50139 (photo voucher). Specimens found by Todd Pierson and verified by Elizabeth McGhee. Both are county records (Minton 2001. Amphibians and Reptiles of Indiana, 2nd ed. Indiana Academy of Science, Indianapolis. xiv + 404 pp.).

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***LITHOBATES SPECTABILIS* (Showy Leopard Frog)**. MÉXICO: HIDALGO: Municipality of Tecozautla: 1.52 km E La Paila (20.559722222°N, 99.61591667°W; WGS 84), 1646 m. elev. 18 June 2008. Julián Bueno Villegas. Verified by Jesús M. Castillo. Colección Herpetológica, Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo (CIB-UAEH 1545). First municipality record, extending the range in the state ca. 31.28 km E from its closest reported locality in Arbolado, Municipality of Tasquillo (Morales 2010. Herpetofauna de Dos Ambientes Contrastantes del Municipio de Tasquillo. Tesis, Universidad Autónoma del Estado de Hidalgo. Mineral de la Reforma. 84 pp.). The frog was found next to a stream surrounded by xerophytic scrub vegetation. Fieldwork was funded by CONACyT - 95828 and CONABIO GT002.

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***LITHOBATES SPHENOCEPHALUS* (Southern Leopard Frog)**. USA: TENNESSEE: Grainger Co.: ~13 km W of Jefferson City (36.10105°N, 83.63563°W;WGS 84). 15 May 2009. Ted M. Faust and Mark Mayfield. Verified by Floyd A. Scott. Austin Peay State University Museum of Zoology (APSU 19084 [color photo]). An individual was found on McBee Island along the bank of the Holston River at 1030 h. New county record (Redmond and Scott. 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Hard copy and Internet versions, the latter [http://www.apsu.edu/amatlas/ accessed 31 December 2011] including links to data on amphibians in Tennessee that have appeared since 1996).

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PHYLLOMEDUSA BAHIANA. BRAZIL: BAHIA: Municipality of Jeremoabo: Raso da Catarina Ecological Station (9.916944°S, 38.698611°W, datum SAD-69; elev. 444 m). 28 March 2011. C. R. dos Santos Silva. Verified by F. Acuña Juncá. Herpetological collection, Feira de Santana State University, Feira de Santana, Bahia, Brazil (MUEFS 3712) and the Federal University of Sergipe, São Cristovão, Sergipe, Brazil (CHUFS 1737, 1738). The Raso da Catarina is the driest region in the Brazilian state of Bahia, and is composed of a mosaic of semi-deciduous forest habitats on sandy soils (Sick et al. 1987. Rev. Bras. Zool. 3[7]:441–463). The species is found in the municipalities of Aurelino Leal, Camacan, Conceição de Feira, Feira de Santana, Lençóis, Maracás, Miguel Calmon, Morro do Chapéu, Mucugê, Muritiba, Palmeiras, Rui Barbosa, Senhor do Bonfim, Salvador, and Uruçuca in Bahia (Brunes et al. 2010. Mol. Phyl. Evol. 57:1120–1133; Juncá 2008. *In* IUCN 2011. IUCN Red List of Threatened Species.Version 2011.2. on <www.iucnredlist.org>. Downloaded 29 January 2012) and Capela in Sergipe (Morato et al. 2011. Checklist 7[6]:756–762). The present record represents a new northern limit for the

distribution of the species, extending its range 175 km directly NE of Senhor do Bonfim, Bahia. In addition, this record is important for the conservation of the species in the Caatinga, given that it refers to a federal conservation unit.

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***POLYPEDATES LEUCOMYSTAX* (Common Tree Frog)**. BANGLADESH: NILPHAMARI DISTRICT: Berakuthi, Barua (25.822231°N, 88.834361°E; WGS 84; 47.24 m elev.), 15 November 2011. Verified by Ghazi S. M. Asmat. Md. Abdur Razzaque Sarker. Museum of Herpetology Laboratory, Ichamati College, Dinajpur, Bangladesh (MHLB-PL01). First record from Nilphamari District, northern Bangladesh; previously recorded from Chittagong Division, including Cox's Bazar District, Chokoria, Malumghat; Bandarban District, Bandarban, Milonchari; Rangamati District, Kaptai, Kaptai Village; Dhaka Division, Dhaka District, Savar (Mahony et al. 2009. Hamadryad 34:80–94). Near Saidpur Bypass Road >13 km S from Nilphamari. Adults collected on mango tree (*Mangifera indica*) at primary forest edge. Habitat includes *Cynodon dactylon, Azadirachta indica, Curcuma longa, Areca catechu,* and *Bambusa arundinacea* plantations.

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***PSEUDACRIS BRACHYPHONA* (Mountain Chorus Frog)**. USA: NORTH CAROLINA: Clay Co.: 14 March 2011. Lori A. Williams. Adult male frogs (N = >5) calling from Payne Branch and surrounding riparian and wet meadow habitat. Digital audio recordings were made from Pine Log Road (SR 1104) at junction with Payne Road (SR 1182), 3.3 km airline SSE of Brasstown (35.009987ºN, 83.94716ºW;WGS 84) and on Pine Log Road, 0.2–0.3 mi S of Payne Road, 3.6 km airline S of Brasstown (35.006115°N, 83.95076°W; WGS 84). Verified by Jeffrey C. Beane. North Carolina State Museum of Natural Sciences (1274 audio recordings). New county record (North Carolina Natural Heritage Program 2011. Biotics Database. Department of Environment and Natural Resources, Raleigh, North Carolina). Closest previous historical record in North Carolina is in Cherokee Co., 3.2 km airline NW (North Carolina Natural Heritage Program 2011, *op. cit.*).

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***PSEUDACRIS CRUCIFER* (Spring Peeper)**. USA: INDIANA: Clinton Co.: Camp Cullom Park (40.312808°N 86.632811°W; WGS 84). 16 March 2009. Todd Pierson. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50138 photo voucher). New county record (Minton 2001. Amphibians and Reptiles of Indiana, 2nd ed. Indiana Academy of Science, Indianapolis. xiv + 404 pp.).

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***RHINELLA CRUCIFER* (Striped Toad)**. BRAZIL: ALAGOAS: Municipality of Maceió: Serra da Saudinha (9.366667°S, 35.750000°W; WGS84; 150 m elev.) 18 February 2005. F. A. C. Nascimento and others. Setor de Zoologia, Coleção Herpetológica do Museu de História Natural, Universidade Federal de Alagoas, Maceió, Brazil (MUFAL 3892, 3894, 3895; collecting license IBAMA/RAN #184/05). Verified by S. T. Silva. This frog is known to occur in the Atlantic Forest of the Brazilian states of Ceará, Paraíba, Pernambuco, Sergipe, Bahia, Minas Gerais, Espírito Santo, and Rio de Janeiro (Baldissera Jr. et al. 2004. Arquivos do Museu Nacional 62[3]:255–282; Marques et al. 2006. Herpetol. Rev. 37[1]:98; Silveira et al. 2009. Biotemas 22[4]:231–235). First state record, extending the known distribution of species about 156 km SSE from the closest locality known (Municipality of Caruaru, Pernambuco state), filling a distributional gap between the states of Sergipe and Pernambuco.

BARNAGLEISON SILVA LISBOA (e-mail: bslgleison@gmail.com), and **FILIPE AUGUSTO CAVALCANTI DO NASCIMENTO** (e-mail: f lipe.bio@gmail.com), Setor de Zoologia, Museu de História Natural, Universidade Federal de Alagoas, Av. Aristeu de Andrade, 452, Farol, CEP: 57051-090, Maceió, Alagoas, Brazil.

***SCAPHIOPUS HOLBROOKII* (Eastern Spadefoot)**. USA: OHIO: Muskingum Co.: Wayne Township. Duncan Falls (39.88409°N, 81.90944°W; WGS 84). 09 September 2011. Richard Green. Verified by John W. Ferner. Cincinnati Museum Center (CMC 12317). New county record. (Davis and Menze 2000. Ohio Anuran Atlas, Ohio Biological Survey, Columbus). Fills a gap of approximately 94 km in the Eastern Spadefoot's distribution in the Muskingum River valley. Nearest records are approximately 52 km north in Coshocton County and 42 km south in Morgan County.

JEFFREY G. DAVIS, Cincinnati Museum Center – Fredrick and Amye Geier Research and Collections Center, 1301 Western Avenue, Cincinnati, Ohio 45203-1130, USA (e-mail: anura@fuse.net); **RICHARD GREEN,** Philo High School, 4000 Millers Lane, Duncan Falls, Ohio 43734, USA (e-mail: r.green@prodigy.net).

***SCAPHIOPUS HOLBROOKII* (Eastern Spadefoot)**. USA: TENNESSEE: Jefferson Co.: ~13 km W of Jefferson City (36.08389°N, 83.62811°W; WGS 84). 14 May 2009. Ted M. Faust and Mark Mayfield. Verified by Floyd A. Scott. Austin Peay State University Museum of Zoology (APSU 19082 [color photo]). New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Hard copy and Internet versions, the latter [http://www.apsu.edu/amatlas/ accessed 31 December 2011] including links to data on amphibians in Tennessee that have appeared since 1996). Two individuals were found crossing Beaver Creek Road on a rainy night at 2230 h.

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***UPERODON GLOBULOSUS* (Balloon Frog)**. BANGLADESH: NILPHAMARI DISTRICT: Berakuthi, Barua (25.825753°N, 88.829083°E; WGS 84; 44 m elev.), 8 September 2011. Md. Abdur Razzaque Sarker. Verified by Ghazi S. M. Asmat. Museum of Herpetology Laboratory, Ichamati College, Dinajpur, Bangladesh (MHLB-UG01). First record from Nilphamari District, northern Bangladesh; previously recorded from Dhaka Division, including Savar and Gazipur districts, also Tangail District, Rasulpur, Madhupur forest (Mahony et al. 2009. Hamadryad 34:80–94). Near Berakuthi > 13 km S from Nilphamari. Adults collected

from roadside paddy field. Habitat includes *Cynodon dactylon* and *Musa acuminate* plantations.

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***XENOPHRYS PARVA* (Concave-crowned Horned Toad)**. BANGLADESH: SYLHET DIVISION: Sylhet District: Khadimnagar National Park (24.9527°N, 91.9458°E; WGS 84; 65 m elev.). 9 July 2011. Animesh Ghose and Jay Prakash Ray. Photographic voucher, Raffles Museum of Biodiversity Research, National University of Singapore (ZRC [IMG] 1.38a–c). Verified by Guin Wogan. First record from Sylhet Division as well as northeastern Bangladesh, previously known from Chittagong and Chittagong Hill Tracts (Asmat et al. 2003. Univ. Rajshahi J. Zool. 22:141–143). Nearest records from Manipur, India (Bordoloi and Ningombam 2007. Zoo's Print J. 22:2688–2690), ca. 100 km E of Khadimnagar National Park and ca. 300 km N of Chittagong (Asmat et al. 2003. Univ. Rajshahi J. Zool. 22:141–143).

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TESTUDINES — TURTLES

***APALONE FEROX* (Florida Softshell)**. USA: FLORIDA: Monroe Co.: Big Pine Key, Blue Hole, National Key Deer Refuge (24.70536°N, 81.38044°W; WGS84). 28 November 2008. R. Powell. Verified by K. L. Krysko. Florida Museum of Natural History, University of Florida (UF) 166147 (image voucher only). First record of the species in the Florida Keys (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final Report, Project Agreement 08013, Florida Fish and Wildlife Conservation Commission, Tallahassee).

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***APALONE SPINIFERA* (Spiny Softshell)**. USA: INDIANA: Boone Co.: Starkey Park (39.940888°N, 86.268396°W; WGS 84). 2 August 2009. Todd Pierson. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50147 photo voucher). New county record (Minton 2001. Amphibians and Reptiles of Indiana, 2nd ed. Indiana Academy of Science, Indianapolis. xiv + 404 pp.).

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***CHELYDRA SERPENTINA* (Snapping Turtle)**. USA: INDIANA: Boone Co.: Starkey Park (39.940888°N, 86.268396°W; WGS 84). 23 April 2006. Todd Pierson. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50149 photo voucher). New county record (Minton 2001. Amphibians and Reptiles of Indiana, 2nd ed. Indiana Academy of Science, Indianapolis. xiv + 404 pp.).

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***CHRYSEMYS PICTA* (Painted Turtle)**. USA: GEORGIA: Franklin Co.: Starr's Bridge Road near GA-51 (34.322426°N 83.183005°W; WGS 84) 24 September 2012. Todd Pierson. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50163 photo voucher). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.).

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***CHRYSEMYS PICTA* (Painted Turtle)**. USA: INDIANA: Boone Co.: Starkey Park (39.940888°N, 86.268396°W; WGS 84). 18 April 2006. Todd Pierson. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50150 photo voucher). New county record (Minton 2001. Amphibians and Reptiles of Indiana, 2nd ed. Indiana Academy of Science, Indianapolis. xiv + 404 pp.).

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***CHRYSEMYS PICTA* (Painted Turtle)**. USA: OHIO: Muskingum Co.: Muskingum Township, Powelson Wildlife Area (a reclaimed strip mine pond) along County Road 49, ca. 0.6 km W of the intersection with Northpointe Drive (40.05112°N, 82.03005°W; WGS 84). 15 June 2011. Jeffrey E. Dawson and Cheri L. Dawson. Verified by Jeffrey G. Davis. Photo vouchers in Cincinnati Museum Center, Geier Collections and Research Center (CMC HP 6029–6030). First published county record and updates a 45-year-old specimen with incomplete collection data. Fills a distributional gap in eastern Ohio. The species is documented in adjacent Coshocton, Guernsey, Licking, Morgan, Noble, and Perry counties (Wynn and Moody 2006. Ohio Turtle, Lizard, and Snake Atlas. Ohio Biol. Surv. Misc. Contr. No. 10, Columbus. iv + 81 pp.). There is an unpublished museum record (CM 88997) from Muskingum County collected "about 2 mi N Zanesville" on 18 May 1965 by David M. Sever. The locality of this record is ca. 8 km S of our record. Data on the historical record were initially obtained through the HerpNET data portal (http://www.herpnet.org; accessed 18 November 2011), verified by Stephen P. Rogers, and provided with the permission of Carnegie Museum of Natural History.

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***DEIROCHELYS RETICULARIA* (Chicken Turtle)**. USA: FLORIDA: Clay Co.: Melrose, SR 21, 0.23 km S of 5th Avenue (29.72804°N, 82.04752°W; WGS84). 24 January 2012. Benjamin K. Atkinson. Florida Museum of Natural History (UF 166509). Verified by Max A. Nickerson. First Clay Co. record in >110 years, and the second specimen vouchered for the county (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final Report, Florida Fish and Wildlife Conservation Commission, Tallahassee. 524 pp.). Gravid female (195 mm SCL) found dead on road at 1000 h EST. Observation of shelled eggs in January (UF 166509) is not surprising given the species' winter nesting season in northern Florida (Jackson 1988. Florida State Mus., Biol. Sci. 33:113–158).

Herbert Hutchinson Brimley, accomplished naturalist and former Director of the North Carolina Museum of Natural Sciences (Cooper 1979. Brimleyana 1:1–14) donated the previous voucher, of unknown collection date, to the Milwaukee Public Museum (MPM 215) in April 1900. This sub-adult (101 mm SCL)

female (based on size of maturity, in Jackson 1988, *op. cit.*) was collected in Green Cove Springs, Florida (ca. 45 km NE of UF 166509).

Although Chicken Turtles are probably common in Clay Co., given the number of ephemeral wetlands (the species' preferred habitat: Ewert et al. 2006. *In* P. Meylan [ed.], Biology and Conservation of Florida Turtles, pp. 249–259. Chelon. Res. Monogr. No. 3), they do not readily enter baited traps (Jackson 1996. Chelon. Conserv. Biol. 2:105–108), rendering encounters by herpetologists sporadic and likely explaining the paucity of records.

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***GRAPTEMYS GEOGRAPHICA* (Northern Map Turtle).** USA: INDIANA: Boone Co.: Starkey Park (39.940888°N, 86.268396°W; WGS 84). 18 July 2008. Todd Pierson. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50145 photo voucher). New county record (Minton 2001. Amphibians and Reptiles of Indiana, 2nd ed. Indiana Academy of Science, Indianapolis. xiv + 404 pp.).

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***GRAPTEMYS OUACHITENSIS* (Ouachita Map Turtle).** USA: OHIO: Morgan Co.: Windsor Township. Muskingum River (39.52733°N, 81.74521°W; WGS 84). 05 June 2011. Lynn Barnhart. Verified by John W. Ferner. Cincinnati Museum Center Herpetological Photodocumentation Collection (CMC HP 5949–5951). New county record (Wynn and Moody 2006. Ohio Turtle, Lizard, and Snake Atlas, Ohio Biol. Surv. Misc. Contrib. No. 10, Columbus). Adult female was found moving over land probably to or from a nesting site. Specimen represents the second record from the Muskingum River drainage (Davis and Krusling 2010. Herpetol. Rev. 41[3]:391–392). Nearest record is from approximately 70 km upstream in the Muskingum River.

JEFFREY G. DAVIS, Cincinnati Museum Center – Fredrick and Amye Geier Research and Collections Center, 1301 Western Avenue, Cincinnati, Ohio 45203-1130, USA (e-mail: anura@fuse.net); **LYNN BARNHART,** 124 Muskingum Drive, Marietta, Ohio 45750, USA (e-mail: natureden@yahoo.com).

***HYDROMEDUSA TECTIFERA* (South American Snake-necked Turtle).** ARGENTINA: BUENOS AIRES: Partido de Tornquist: Sierra de la Ventana: near Río Sauce Grande (38.130633°S, 61.793490°W, WGS84; 250 m elev.). 12 March 2012. D. Di Pietro. Herpetological Collection of Museo de La Plata, Buenos Aires, Argentina (MLP R 5717 hatchling turtle, 32 mm carapace length, road-killed during a heavy rain). Verified by P. Bona. Species previously known from Uruguay, eastern Paraguay, southeastern Brazil, and northeastern and central Argentina (Cabrera 1998. Las Tortugas Continentales de Sudamérica Austral. Córdoba, Argentina, Privately printed, 108 pp., 6 pls.; Fritz and Havaš 2007. Vert. Zool. 57:149–368). Southernmost locality for the species and extends its known distribution ca. 495 km airline SW from Roberto Pairó, Partido de Magdalena, Buenos Aires province, which was the previous nearest known locality (Cabrera 1998, *op. cit.*).

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***INDOTESTUDO ELONGATA* (Elongated Tortoise).** VIETNAM: DAK LAK PROVINCE: Buon Don District: Yok Don National Park (12.8599°N, 107.7054°E; WGS 84; 195 m elev.). 1 July 2004. Mark R. Bezuijen. Verified by Brian Horne. Photographic voucher deposited in Zoological Reference Collection, Raffles Museum of Biodiversity Research, National University of Singapore (ZRC [IMG] 2.161a–c). Adult, straight carapace length 22 cm, in dry dipterocarp forest along Dak Ken, a vegetated perennial stream; caught by residents (Ede ethnic minority), encountered with turtle at capture site, 1500 h. Measured and released. First record for Dak Lak Province (Nguyen et al. 2009. Herpetofauna of Vietnam. Edition Chimaira, Frankfurt am Main. 768 pp.). Most turtle records from Indochina are of specimens in commercial trade; few published wild records are available (Stuart and Platt 2004. Asiatic Herpetol. Res. 10:129–150).

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***MESOCLEMMYS RANICEPS* (Amazon Toad-headed Turtle).** BRAZIL: AMAZONAS: Municipality of Beruri: 1) Piagaçu-Purus Sustainable Development Reserve, Tucumã Stream (4.75°S, 62.7°W; WGS84), Purus River in the Solimões River Basin. 26 September 2004. D. C. Balensiefer and R. C. Vogt. Collection of Amphibians and Reptiles, Instituto Nacional de Pesquisas da Amazônia, Manaus, Brazil (INPA-H 12482 inmature male captured in a trammel net in 2.5 m of water, 239 mm straight-line carapace length [CL], 180 mm carapace width, 80 mm carapace height, 210 mm plastron length, 41 mm femoral scute length [FML], and 54 mm head width [HW]. 2) Tapera, Rio Negro (0.14456°S, 64.10242°W; WGS84). Museu de Zoologia da Universidade de São Paulo, São Paulo, Brazil (MZUSP 2640). 3) Canutama, Rio Purus, (6.5°S, 64.33333°W; WGS84) (MZUSP 2834, 2838). 4) Municipality of Barcelos: City of Barcelos, hand collected in a drainage ditch, (0.93333°S, 62.98333°W; WGS84), in the Negro River Basin. 4 January 2004. R. C. Vogt. (INPA-H 11672, female of 287 mm CL, 210 mm CW, 90 mm CH, 235 mm PL, 43.5 mm FML, and 66.7 mm HW).

Specimens from MZUSP verified by P. A. Vanzolini, and specimens from INPA verified by R. Bernhard. Species known from the Amazon and upper Orinoco river basins, from Venezuela to Bolivia, including Colombia, Ecuador, Peru, and Brazil (Rueda-Almoncid et al. 2007. Las Tortugas y los Cocodrilianos de los Países Andinos del Trópico. Conservación Internacional, Andes CBC, Bogata. 537 pp.). In Brazil it is known from 20 dispersed localities in the following states: Acre (1), Amapa (1), Amazonas (13), Para (2), and Rondonia (3), with many gaps between the localities. INPA-H 12482 is a new municipality record and fills a gap in the known distribution of this species to the southwest between specimen MZUSP 2640 ca. 352 km to the north and MZUSP 2834 and 2838 ca. 496 km to the south. INPA-H 11672 is new municipality record, 396 km upstream from Manaus.

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***STERNOTHERUS ODORATUS* (Eastern Musk Turtle)**. USA: GEORGIA: Hall Co.: Elachee Nature Center (34.245842°N, 83.832004°W; WGS 84). 16 October 2011. Daniel Thompson. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50156 photo voucher); New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.).

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***STERNOTHERUS ODORATUS* (Eastern Musk Turtle)**. USA: GEORGIA: Stephens Co.: Yonah Dam Road (34.664497°N, 83.308047°W; WGS 84). 23 June 2010. Todd Pierson. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50144 photo voucher). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp).

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***TRACHEMYS SCRIPTA* (Pond Slider)**. USA: INDIANA: Boone Co.: Starkey Park (39.947679°N, 86.255742°W; WGS 84). 16 July 2007. Todd Pierson. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50142 photo voucher). New county record (Minton 2001. Amphibians and Reptiles of Indiana, 2nd ed. Indiana Academy of Science, Indianapolis. xiv + 404 pp.).

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***TRACHEMYS SCRIPTA SCRIPTA* (Yellow-bellied Slider)**. USA: GEORGIA: Whitfield Co.: Mill Creek at Heritage Point Park, (4.790655°N, 84.942505°W). 21 May 2010. Chris Manis and John Patrick. Verified by John Jensen. University of Tennessee at Chattanooga Museum of Natural History (UTC Digital Collection-4669TPW-GMU). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). Specimen was captured in a hoop net baited with sardines packed in soybean oil.

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SQUAMATA — LIZARDS

***ANOLIS CAROLINENSIS* (Green Anole)**. USA: GEORGIA: Franklin Co.: Victoria Bryant State Park (34.297397°N, 83.159190°W; WGS 84). 24 September 2012. Todd Pierson. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50159 photo voucher). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.).

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***ANOLIS CAROLINENSIS* (Green Anole)**. USA: GEORGIA: Taylor Co.: Fall Line Sandhills Wildlife Management Area (32.57815°N, 84.27017°W; WGS 84; elev. ~207 m). 02 February 2012. Robert L. Hill. UTADC 7413. Verified by John Jensen. New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. Univ. of Georgia Press, Athens. 575 pp.). Specimen observed moving on a fallen tree near the edge of a large ephemeral pond at ~1700 h, photographed, and released.

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***ANOLIS CAROLINENSIS* (Green Anole)**. USA: GEORGIA: Tift Co.: Tifton (31.480529°N, 83.507719°W; WGS 84). 23 November 2011. Malavika Rajeev and Meenakshi Rajeev. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50157 photo voucher). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.).

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***ANOLIS PETERSII* (Peters's Anole)**. MÉXICO: PUEBLA: Municipality of Xicotepec de Juárez: Xicotepec de Juárez-Itzatlán (20.34217°N, 97.95876°W; WGS84), 370 m elev. 20 August 2007. Jesús Hernández-Ortega. Verified by Luis Canseco-Márquez. UTADC 7195–7197. First record for Puebla, extending its known range from the closest reported locality 137 km (air line) NW of Mirador, Veracruz (Smith and Taylor 1950. U.S. Nat. Mus. Bull. 199:1–253; Lieb 2001. *In* J. D. Johnson et al. [eds.], Mesoamerican Herpetology: Systematics, Zoogeography, and Conservation, pp. 53–64. Centennial Mus., Spec. Publ. No. 1, University of Texas at El Paso, El Paso, Texas). The lizard was found on a tree in rain forest.

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***ANOLIS SAGREI* (Brown Anole)**. USA: TEXAS: Kleberg Co.: city limits of Kingsville, 1217 Lawndale Street, .06 km SW of Carlos Truan Blvd. (27.504161°N, 97.852633°W; WGS84). 11 June 2011. Robert W. Rabe, Cheryl J. Claunch, Eric O. Montalvo, Randy L. Powell. Verified by Travis J. LaDuc. Texas Natural History Collections (TNHC 85065, male). New county record (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. Texas A&M Univ. Press, College Station. 421 pp.). The collection site is ca. 8.25 km from Nueces/Kleberg county line. *Anolis sagrei* is an introduced species to the United States with established populations throughout several southern states including Texas (Kraus 2009. Alien Reptiles and Amphibians: A Scientific Compendium and Analysis. Springer Publ., New York. 576 pp.).

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***ANOLIS YOROENSIS*.** HONDURAS: COPÁN: Quebrada Las Piedras (15.128583°N, 88.90025°W; WGS 84), 1450 m elev. 21 April 2011. James R. McCranie and Leonardo Valdés Orellana. SMF 93369. San Isidro (15.122028°N, 88.933556°W; WGS 84), 1050 m elev. 15 November 2008. James R. McCranie and Leonardo Valdés Orellana. SMF 91311. Both are first records for Copán.

CORTÉS: Finca Naranjito (15.516667°N, 88.15°W; WGS 84), 1000 m elev. 15 April 1979 and 11 August 1993, respectively. James R. McCranie. SMF 91309–10. First records for Cortés. SANTA BÁRBARA: Nuevo Joconales (15.059583°N, 88.519056°W; WGS 84), 1150 m elev. 17 April 2011. James R. McCranie and Leonardo Valdés Orellana. SMF 93353. Quebrada de las Minas (15.061417°N, 88.490528°W; WGS 84), 1080 m elev. 17 April 2011. James R. McCranie and Leonardo Valdés Orellana. SMF 93354–58. Quebrada Las Cuevas (15.053444°N, 88.517056°W; WGS 84), 1150 m elev. 18–19 April 2011, respectively. James R. McCranie and Leonardo Valdés Orellanda. SMF 93359–61. All represent first records for Santa Bárbara. All anoles listed above verified by Gunther Köhler. These records extend the known distribution of this Honduran endemic 80–160 km W from the closest published locality on Cerro Pajarillos, Montaña de Pijol, Yoro (McCranie et al. 2002 [2001]. Amphibia-Reptilia 22:465–473). Santa Bárbara specimens were collected in slightly disturbed broadleaf forest, whereas Copán and Cortés lizards were found in highly disturbed broadleaf forests that had been converted to coffee and other types of agricultural fields. All lizards were active on low tree trunks by day and were sleeping in low vegetation at night.

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***BARISIA IMBRICATA IMBRICATA* (Imbricate Alligator Lizard)**. MÉXICO: GUERRERO: ca. 4 air km NW Taxco, Sierra Taxco (18.5813°N, 99.6453°W, NAD27), 2403 m elev. 17 June 2009. Jason M. Jones, Christoph Grünwald, and Robert W. Bryson, Jr. Verified by Edmundo Pérez Ramos. MZFC 26333. First record for Guerrero, extending the known range ca. 50 km S of records near Nevado de Toluca, Estado de México (Guillette and Smith 1982. Trans. Kansas Acad. Sci. 85:13–33). The lizard was found under a log near a cornfield in humid mixed oak forest.

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***BRACHYMELES CEBUENSIS* (Cebu Slender Skink)**. PHILIPPINES: CEBU ISLAND: CEBU PROVINCE: Municipality of Argao: Barangay Tabayag, Mt. Suyak (9.891°N, 123.514°W, WGS84; 700 m elev.). 12 December 2011. C. H. Oliveros. Verified by L. J. Welton. University of Kansas Natural History Museum (KU 331835). Adult specimen, collected by local farmer on ground under leaf litter. New municipality record, southernmost record, and third known locality (Siler et al. 2011. Herpetol. Monogr. 25:76–112), extending distribution 26.64 km S of type locality in Barangay Tapal, Municipality of Carcar. Previously recognized on basis of 12 specimens from two localities, and a recognized distribution spanning < 70 km of deforested eastern coast of Cebu Island, Philippines. Although currently classified as Critically Endangered (CR) by IUCN, observed at three locations, surviving in heavily disturbed, dry, deforested habitat. We therefore have re-evaluated this species against IUCN criteria for classification, and find that it qualifies for status of Vulnerable, VU, based: VU B2ab(iii); D2 (IUCN, 2011. Red List of Threatened Species. Ver. 2011.2. http://www.iucnredlist.org. Accessed 2 Mar 2012).

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***CHAMAELEO CHAMAELEON* (Common Chamaeleon)**. MOROCCO: ATLANTIC SAHARA: Mijk (23.705°N, 15.707°W, WGS 84; 70 m elev.). 18 November 2011. Franck Chevalier. Institut de Recherche pour le Développement at Dakar (IRD TR-4142). Verified by Jean-François Trape and Sébastien Trape. Also observed at Imlili sebkha (23.276°N, 15.915°W, WGS 84; 43 m elev.). Franck Chevalier (sight records, no voucher specimen). First records for Dakhla District, Atlantic Sahara region (Morocco), and southernmost records for Africa. These records extend the range on coastal areas of Sahara Desert 220 and 280 km SW from nearest record in Lamjayibir, 87 km S of Boujdour, Atlantic Sahara (Geniez et al. 2006. The Amphibians and Reptiles of the Western Sahara. Edition Chimaira, Frankfurt an Main. 228 pp.; Sindaco and Jeremcenko 2008. The Reptiles of the Western Palearctic. Edizioni Belvedere, Latina. 579 pp.).

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***CTENOSAURA HEMILOPHA* (Cape Spiny-tailed Iguana)**. MÉXICO: BAJA CALIFORNIA SUR: Municipality of Loreto: Isla Monserrat (25.663425°N, 111.6557194°W; WGS 84), 22 December 2007. William López Forment. Verified by José Alberto Cruz Silva. CNAR-IBH 25425 (almost complete skeleton with skin). First record from Isla Montserrat, extending its known range 49.4 km SE of Loreto (Grismer 2002. Amphibians and Reptiles of Baja California: Including its Pacific Islands and the Islands in the Sea of Cortez. Univ. California Press, Berkeley. xiv + 399 pp.).

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***HEMIDACTYLUS TURCICUS* (Mediterranean Gecko)**. USA: TEXAS: Johnson Co.: Cleburne: 1009 Willow Creek Road (32.3336°N, 97.3997°W; WGS 84). 03 August 2011. Collected by Robert J. Allen. Verified by Toby J. Hibbitts. Texas Cooperative Wildlife Collection (TCWC 95592). New county record (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. Texas A&M Univ. Press, College Station. 421 pp.). The specimen was collected from an exterior wall at a residence. Numerous individuals were observed at the collection site. The nearest documented populations are to the north in Tarrant Co., Texas, northeast in Dallas Co., Texas (Dixon 2000, *op. cit.*), and to the east in Ellis Co., Texas (McCluney 2003. Herpetol. Rev. 34:166).

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***HOLBROOKIA LACERATA LACERATA* (Northern Spot-tailed Earless Lizard)**. USA: TEXAS: Mason Co.: on the mid-section of the Captain Mike Hall Way Road, 30.4 km SW of the intersection of U.S. Hwy. 87 and State Hwy. 29 in Mason, Texas on the Blue Mountain Peak Ranch (30.559152°N, 99.458558°W; NAD 83, elev.

629 m). 24 May 2010. Wesley M. Anderson and Robert L. Gundy. Verified by Travis LaDuc. Texas Natural History Collection (TNHC 74704). New county record (Dixon 2000. Amphibians and Reptiles of Texas. Texas A&M University Press, College Station. 421 pp.; Dixon et al. 2007. Texas Herpetol. Soc. Publ. 2007[1]:1–56). The subspecies was previously known from 25 counties in central Texas. The new locality in Mason Co. is 6.7 km NE of the nearest previously known locality in Kimble Co. (WTSU 10739). Both records occur on Tarrant Complex soils and the Low Stony Hill ecological site, which are contiguous between the two localities (USDA Natural Resources Conservation Service. 2009. Soil Survey Geographic Database. http://soils.usda.gov/survey/geography/ssurgo/), therefore the occurrence of the subspecies at the new locality was not unexpected. *H. lacerata* has been extirpated from much of its historical range (Duran and Axtell 2010. A rangewide inventory and habitat model for the spot-tailed earless lizard, *Holbrookia lacerata*. Final Report to the Texas Parks and Wildlife Dept. 37 pp.). On 24 May 2011 the U.S. Fish and Wildlife Service issued a 90-day finding that listing the species as threatened or endangered may be warranted.

We thank Richard Taylor for allowing us to conduct surveys over several years on his Blue Mountain Peak Ranch.

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***LEPIDODACTYLUS LUGUBRIS* (Mourning Gecko)**. COLOMBIA: DEPARTAMENTO DE ANTIOQUIA: Municipio de Nariño: Vereda Puente Linda (5.571888°N, 75.123777°W, WGS 84), 655 m elev. 4 February 2010. Collected by Population Ecology Students 2009-2. Museo Herpetológico de Antioquia, Medellín, Colombia (MHUA-R 12031–12061 collected in a building construction site at 1900 h, approx. 20 m from the edge of premontane forest). Municipio de Medellín (6.190167°N, 75.581778°W, WGS 84), 1505 m elev. March 2010. (MHUA-R 12241–12246). L. C. Rubio-Rocha and E. Alzate. Verified by Eric N. Smith. This species is native to the western Pacific, and has probably been present in Panama and Ecuador from the mid-19th century (Smith and Grant 1961. Herpetologica. 17:68; Mechler 1968. Rev. Suisse Zool. 75:305–371) and has since then been reported in Nicaragua, Costa Rica, Suriname, and on the Caribbean island of Guadeloupe (Bauer et al. 2007. Appl. Herpetol. 4[1]:84–85; Henderson et al. 1976. Herpetol. Rev. 7:173; Lorvelec et al. 2011. Herpetol. Notes 4:291–294; Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna between Two Continents, between Two Seas. University of Chicago Press, Chicago, Illinois. 486 pp.). Its presence is suggested in Brazil and Peru, but the reliability of the Brazilian records has been questioned (Lorvelec et al., *op. cit.*). Early records of this species in Colombia were from along the Pacific Coast in Departamento de Nariño, municipality of Tumaco in 1942, and it was later reported in Departamento de Cauca, Isla Gorgona in 1961 and Departamento de Valle del Cauca, Municipality of Buenaventura, in 1965 (Medem 1979 *In* Von. Prahl et al.1979. Gorgona. Universidad de los Andes, Bogotá, Colombia) near the main ports. It is thought to have arrived by maritime shipping and to have subsequently spread to other municipalities of Departamento de Nariño, Departamento de Cauca, and Departamento de Valle del Cauca (Ayala 1986. Caldasia 15:555–571; individuals collected between 1971 and 1976). It has been found more recently in northern Colombia in Departamento de Boyacá and Departamento de Córdoba in 1981 and 2000, respectively (Moreno-Arias et al. 2006. Herpetol. Rev. 37[1]:100–101). First records for Departamento de Antioquia, extends range 170 km E and 140 km NE of the Rio Cabí at Quibdó, Departamento de Chocó, (García et al. 2006. Rev. Inst. Univ. Tecnol. Chocó D. L. C. 25:47–55) and are located 350 km S of the northernmost record and 298 km W of the most eastern record for the species (Moreno-Arias et al. 2006, *op. cit.*).

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***LEPIDOPHYMA GAIGEAE* (Gaige's Tropical Night Lizard)**. MÉXICO: HIDALGO: Municipality of Tecozautla: 1.62 km E La Paila (20.57175°N, 99.59725°W; WGS84), 1696 m. elev. 14 March 2009. Judith T. Pampa Ramírez. Verified by Jesús M. Castillo. Colección Herpetológica, Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo (CIB-UAEH 1948). First municipality record, extending the range in the state ca. 52.88 km W from its closest known record at El Atajo, Municipality of Zimapán (in pine-oak forest) (Ramírez-Bautista et al. 2010. Lista Anotada de los Anfibios y Reptiles del Estado de Hidalgo, México. Universidad Autónoma del Estado de Hidalgo, CONABIO. x + 104 pp.). This species is recorded for the first time in Hidalgo from xerophytic scrub, as it normally occurs in pine-oak forest associations (Ramírez-Bautista et al. 2010, *op. cit.*), although it has been reported in such within Querétaro (Dixon et al. 1972. Southwest. Nat. 16:225–237; González 1995. Herpetol. Rev. 26:15–17. Fieldwork was funded by CONACyT - 95828 and CONABIO GT002.

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***SCINCELLA LATERALIS* (Little Brown Skink)**. USA: GEORGIA: Tift Co.: Tifton (31.480529°N, 83.507719°W; WGS 84). 30 October 2011. Todd Pierson and Malavika Rajeev. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50158 photo voucher). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp).

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***UROSAURUS ORNATUS* (Ornate Tree Lizard)**. MÉXICO: SONORA: Isla Pájaros (27.88798°N, 110.84722°W, NAD 27), 10 m elev. 10 July 2007. J. Ventura-Trejo. Verified by Bradford D. Hollingsworth. San Diego Natural History Museum Herpetological Photo Collection (SDNHM-HerpPC 5205–5207). First record for the island, with the closest mainland locality being 6 km NE near Guaymas, Sonora, and the fourth insular locality for *U. ornatus* in the Sea of Cortés (Rorabaugh 2008. J. Arizona-Nevada Acad. Sci. 40:20–65). The lizards were common on rocky substrates.

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SQUAMATA — SNAKES

***COLUBER CONSTRICTOR* (North American Racer)**. USA: NEBRASKA: Buffalo Co.: 4.5 km N, 3.4 km E Odessa (40.7420°N, 99.21594°W, NAD83, elev. 695 m). 18 June 2011. R. Aric Buerer. Verified by Curtis J. Schmidt, Sternberg Museum of Natural History, Fort Hays State University, Hays Kansas (FHSM 15858). First county record. Fills distributional gap in south-central Nebraska (Ballinger et al. 2010. Amphibians and Reptiles of Nebraska. Rusty Lizard Press, Oro Valley, Arizona. 400 pp.; Fogell 2010. A Field Guide to the Amphibians and Reptiles of Nebraska. University of Nebraska, Lincoln. vi + 158 pp.). Species is known from adjacent Hall Co. to the east, Dawson Co. to the west, and Kearney Co. to the south (Fogell 2010, *op. cit.)*. Individual was captured in funnel trap in an upland grassland grazed by cattle.

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***CONTIA LONGICAUDAE* (Forest Sharp-tailed Snake)**. USA: CALIFORNIA: Del Norte Co.: Siskiyou National Forest, along USFS Rd. 4904 (Takilma Rd.) ~25 m S of Oregon border, and ~100 m SE of Dunn Creek and East Fork Illinois River confluence (41.999607°N, 123.622459°W; NAD 83). 11 October 2011. Bradford R. Norman and Alan D. Barron. Verified by Jens V. Vindum. Department of Herpetology, California Academy of Sciences (CAS 250101). First county record and northwestern-most record in California (Feldman and Hoyer 2010. Copeia 2010:254–267). Specimen fills a gap in the distribution of *C. longicaudae* in the Coast Ranges along the far northwest of California (Feldman and Hoyer 2010, *op. cit.*). The nearest specimen records are: 92 km NW, near South Fork Elk River, Curry Co., Oregon (UTA 24547, 24548), and 76 km S, at Fish Lake, Humboldt Co., California (HSU 470) (Feldman and Hoyer 2010, *op. cit.*; Hoyer et al. 2006. Northwest. Nat. 87:195–202). There is also reliable site record (no voucher) only 10 km N of the Oregon border (but 48 km WNW of CAS 250101), outside of Harbor, Curry Co., Oregon (Hoyer et al. 2006, *op. cit.*).

Along the western slope of the Coast Ranges, *C. longicaudae* typically occupies mixed evergreen forest dominated by Douglas Fir (*Pseudotsuga menziesii*) and Coast Redwood (*Sequoia sempervirens*), but can also be found in relatively open woodlands and forest clearings with mixed conifer and oak (*Quercus* sp.) overstories (Feldman and Hoyer 2010, *op. cit.*). Such habitat is common in northwestern California, suggesting the range of *C. longicaudae* is contiguous in this region.

Voucher specimen collected under California Department of Fish and Game license #D-0000628290-7 (to BRN); photographs of the specimen alive (by ADB) are hosted at http://www.californiaherps.com/snakes/pages/c.longicaudae.html.

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***CROTALUS HORRIDUS* (Timber Rattlesnake)**. USA: GEORGIA: Baldwin Co.: Browns Crossing Road NW (33.074277°N 83.377750°W; WGS84). 8 September 2011. Dennis Parmley. GCH 5429. Verified by John Jensen. Within expected range, but first county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). Single adult collected DOR on road flanked by pine/deciduous forest.

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***DIADOPHIS PUNCTATUS* (Ring-Necked Snake)**. USA: INDIANA: Fountain Co.: Portland Arch Nature Preserve (40.219310°N, 87.337699°W; WGS 84). 05 May 2007. Todd Pierson. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50143 photo voucher). New county record (Minton 2001. Amphibians and Reptiles of Indiana, 2nd ed. Indiana Academy of Science, Indianapolis. xiv + 404 pp.).

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***FARANCIA ABACURA* (Red-bellied Mudsnake)**. USA: ALABAMA: Crenshaw Co.: DOR on Crenshaw County Rd. 59, 6 km N of Luverne at Turkey Creek (31.77430°N, 86.21927°W; WGS 84). 06 June 2011. S. Graham. Verified by Craig Guyer. AUM 39513. New county record (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn Printing Co., Auburn. 347 pp.).

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***GEOPHIS DUGESI* (Chihuahuan Earth Snake)**. MÉXICO: SONORA: Municipio de Bacadéhuachi: Sierra Bacadéhuachi, Rincón de Guadalupe, Arroyo Campo los Padres (Río Riíto drainage), 16.5 km (by air) ENE of Bacadéhuachi (29.844444°N, 108.976944°W; NAD 27), 1680 m elev. 5 September 2011. David Bygott and Robert A. Villa. Verified by Erik F. Enderson. UAZ 57369-PSV. First record for the municipality and third for the state, extending the known range 166 km NNW of the closest known locality at Yécora (Recchio et al. 2007. Herpetol. Rev. 38:103–104). The snake was foraging at ca. 2300 h in a rocky montane canyon on a rocky road cut next to a stream, after sporadic daytime rains, in a sycamore-Arizona Cypress riparian forest surrounded by pine-oak forest.

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***IMANTODES LENTIFERUS* (Blunt-Headed Tree Snake, Dormideira)**. BRAZIL: ACRE: Sena Madureira, BR-364 highway, km 124, Ramal do 15, km 03, Fazenda Matão (9.151528°S, 68.543167°W, WGS84; elev. 154 m). 28 October 2011. P. R. Melo-Sampaio and J. M. L. Maciel. Herpetological Collection, Universidade Federal do Acre, Rio Branco, Acre, Brazil (UFAC 0372 found moving on branches, above small temporary pond in forest edge 2200 h). Verified by M. B. Souza. Species previously known from Iquitos, Peru (Dixon and Soini 1986. The Reptiles of the Upper Amazon Basin, Iquitos Region, Peru. Milwaukee Public Museum, Milwaukee. 154 pp.), eastern Pará, Brazil (Cunha and Nascimento 1978. Ofídios da Amazônia. Mus. Par. Emílio Goeldi Publ. Avuls. 31:1–218), and Rondônia state, Brazil (Jorge-da-Silva 1993. Herpetol. Nat. Hist. 1:37–86). First state record extends the known distribution to Acre state ca. 570 km W from Samuel – Rondônia (Jorge-da-Silva, *op. cit.*).

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***LAMPROPELTIS GETULA* (Common Kingsnake)**. USA: GEORGIA: Taliaferro Co.: GA-22 (33.604346°N, 82.923750°W; WGS 84). 21 October 2010. Todd Pierson. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50135 photo voucher). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.).

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***LAMPROPELTIS GETULA* (Common Kingsnake)**. USA: GEORGIA: Whitfield Co.: Heritage Point Park, (37.794705°N, 4.936594°W). 10 May 2010. Chris Manis. Verified by John Jensen. University of Tennessee at Chattanooga Museum of Natural History (UTC Digital Collection-4668TPW-GMU). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.).

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***NERODIA SIPEDON* (Northern Watersnake)**. USA: GEORGIA: Franklin Co.: Victoria Bryant State Park (34.297397°N, 83.159190°W; WGS 84). 24 September 2012. Todd Pierson. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50160 photo voucher); New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp).

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***OPHEODRYS AESTIVUS* (Rough Green Snake)**. USA: TENNNESSEE: Maury Co.: Chickasaw Trace County Park on Santa Fe Pike at approximately trail mile 3.5 (35.667739°N, 87.080534°W; WGS 84). 20 October 2011. Nicole Foster. Verified by A. Floyd Scott. Austin Peay State University (APSU 19184). New county record (Scott and Redmond 2008 [latest update: 08 November 2011]. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/, accessed 20 October 2011).

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***PORTHIDIUM VOLCANICUM* (Costa Rican Hog-nosed Pitviper)**. PANAMÁ: CHIRIQUÍ: Distrito Boquete: Boquete Equestrian Club, 15 km S Boquete (8.694857°N, 82.4496567°W; WGS 84), ca. 1000 m elev. 8 June 2010. Jessica Van den Burgh. Verified by J. A. Campbell. UTADC 6801–6806 (single specimen). First verified record from Panama, extending the range ca. 125 km SE of the closest known locality, Ujarrás de Buenos Aires, Costa Rica (Solórzano 1994. Rev. Biol. Trop. 42:695–701). According to Campbell and Lamar (2004. The Venomous Reptiles of the Western Hemisphere, 2 vols. Comstock Publ. Assoc., Cornell Univ. Press, Ithaca, New York. xviii + 870 pp.), old records representing *P. lansbergii* from Chiriquí, Panamá probably represent *P. volcanicum*. The snake was inadvertently killed by a weed whacker.

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***RAMPHOTYPHLOPS BRAMINUS* (Brahminy Blindsnake)**. USA: FLORIDA: Clay Co.: Keystone Heights, Jasmine Avenue near Keystone Lake (29.781319°N, 82.03615°W, WGS84; elev. 37 m). Benjamin K. Atkinson. 8 February 2012. Florida Museum of Natural History (UF 166510). Verified by Max A. Nickerson. New county record, expanding the known distribution of this fossorial, nonnative, parthenogenetic species. Extends the range 30 km NE of the nearest known locality in Alachua Co., Florida (Meshaka 2011. A Runaway Train in the Making: The Exotic Amphibians, Reptiles, Turtles, and Crocodilians of Florida. Monograph 1. Herpetol. Conserv. Biol. 6:1–101) and 70 km SW of a solitary record in Duval Co., Florida (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final report, Project Agreement 08013, Florida Fish and Wildlife Conservation Commission, Tallahassee. 524 pp.). Adult female found alive on residential sidewalk at 1200 h.

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***REGINA SEPTEMVITTATA* (Queen Snake)**. USA: GEORGIA: Franklin Co.: Starr's Bridge Road near GA-51 (34.322426°N, 83.183005°W; WGS 84) 24 September 2012. Todd Pierson. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50162 photo voucher). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp).

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***REGINA SEPTEMVITTATA* (Queensnake)**. USA: INDIANA: Boone Co.: Lion's Park (39.948807°N, 86.255936°W; WGS 84). 12 May 2011. Todd Pierson. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50136 photo voucher). New county record (Minton 2001. Amphibians and Reptiles of Indiana, 2nd ed. Indiana Academy of Science, Indianapolis. xiv + 404 pp.).

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***RHADINAEA LAUREATA* (Crowned Graceful Brownsnake)**. MÉXICO: CHIHUAHUA: Municipio de Bocoyna: near km 86 on Hwy 25 N of Creel (27.789694°N, 107.651972°W; NAD 27), 2355 m elev. 12 July 2008. Robert W. Bryson, Jr. and Mike Torocco. UAZ 57331-PSV. Municipio de Guadalupe y Calvo: ca.1 km N of Baborigame (26.425975°N, 107.268522°W; NAD 27), 1800 m elev. 10 October 2008. Ricardo Ramírez-Chaparro and Jesús Enrique-Fuentes. UAZ 57321-PSV. Both specimens verified by Irene Goyenechea and Charles W. Myers. These are first records for Chihuahua and their respective municipalities and are located ca. 154 longitudinal km from each other; UAZ 57331-PSV is the northernmost record for the species. They are positioned 460 and 312 straight-line km, respectively, NW from the closest known locality at Laguna del Progresso, Durango (Myers 1974. Bull. Am. Mus. Nat. Hist. 153:1–262). Both snakes were found in pine-oak woodlands on the Sierra Madre Occidental.

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RHADINAEA MONTANA **(Nuevo León Graceful Brown Snake)**. MÉXICO: TAMAULIPAS: Municipality of Gómez Farías: road from La Gloria-Las Palmas (23.0710°N, 99.1420°W; WGS84), 1900 m elev. 8 July 1996. Fernando Mendoza-Quijano. MZFC 8528. Verified by Luis Canseco-Márquez. First state record, extending its known range ca. 103 km (airline) NW from the closet locality at Sierra Nevada, Municipality of Zaragoza, Nuevo León, México (Lazcano et al. 2004. Bull. Chicago Herpetol. Soc. 39:181–187). The snake was found under a fallen tree trunk in pine forest.

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SIBYNOPHIS COLLARIS **(Collared Black-headed Snake)**. BANGLADESH: SYLHET DIVISION: Moulovibazaar District: Lawachara National Park (24.330963°N, 91.801120°E; WGS 84; ca. 50 m elev.). Two individuals found during day on leaf litter in mixed evergreen forest. 10 August 2011 and 5 November 2011. Five roadkilled individuals also found on former Dhaka-Sylhet highway, dissecting Lawachara National Park. Verified by Gernot Vogel. Herpetology Laboratory, Department of Environmental Science and Managment, Independent University of Bangladesh (SESM 003). First country record for Bangladesh. Nearest populations recorded from Bumdeling Wildlife Sanctuary, Bhutan (Wangyal 2011. Herpetol. Rev. 42:117–122; Meghalaya, India (Gray 1853. Ann. Mag. Nat. Hist. [2] 12:386–392); and Assam, India (Ahmed at al. 2009. Amphibians and Reptiles of Northeast India. A Photographic Guide. Aaranyak, Guwahati. 168 pp.).

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SISTRURUS CATENATUS TERGEMINUS **(Western Massasauga)**. USA: TEXAS: Taylor Co.: 58 km SW of Abilene (32.113805°N, 100.125419°W; WGS 84). 28 July 2004. Thomas E. Lee, Jr. Abilene Christian University Natural History Collection (ACUNHC 01521). Verified by Allen Landwar. New county record (Dixon 2000. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 260 pp.). This record fills a gap in the distribution of Southern Rolling Plains Western Massasauga among the most proximal counties: Jones, Runnels, Coleman, Shackelford, and Nolan. The Taylor Co. specimen was taken from a pocket gopher burrow in sandy soils.

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STORERIA OCCIPITOMACULATA **(Red-bellied Snake)**. USA: INDIANA: Pike Co.: Pike State Forest: (38.344827°N, 86.162614°W; NAD 83). 6 June 2010. Michael Lodato. Verified by Chris Phillips. Illinois Natural History Survey (INHS 2012a). New county record (Minton 2001. Amphibians and Reptiles of Indiana, 2nd ed. Indiana Academy of Science. vii + 404 pp.). Gravid female found on secondary road traversing mature forest.

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TANTILLA CORONATA **(Southeastern Crowned Snake)**. USA: GEORGIA: Talbot Co.: Found under a rock on top of an unnamed ridge, 1.5 km S of State Rt. 208, 3 km W of Talbotton (32.67420°N, 84.58326°W; WGS 84). 15 February 2012. S. Graham and D. Olive. Verified by Craig Guyer. AUM AHAP-D 498 (digital photo voucher). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.).

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THAMNOPHIS CYRTOPSIS **(Black-necked Gartersnake)**. USA: ARIZONA: Navajo Co.: Petrified Forest National Park (PEFO), (34.812093°N, 109.868271°W; NAD 83). 29 Aug. 2006. M. Wilkerson. University of New Mexico, Museum of Southwestern Biology (MSB 79534). A second specimen (MSB 79527) was found in the park in 2011. Both verified by Tom Giermakowski. First records for the species in PEFO (Brennan and Holycross 2006. A Field Guide to Amphibians and Reptiles in Arizona. Arizona Game and Fish Department, Phoenix, Arizona. 150 pp.).

Although there are scattered records from the lower edge of the Colorado Plateau these specimens constitute the first records for the species in PEFO. The park has been heavily surveyed for herpetofauna for over 15 years and in an area where there is little to no persistent water (Drost et al. 2001. *In* Proceedings of the Fifth Biennial Conference of Research on the Colorado Plateau, pp. 83–102. U.S. Geological Survey Report Series USGSFRESC/COPL/2001/24). Both specimens were juveniles collected DOR during night-time road cruising surveys on the main park loop road.

Both specimens were collected by PEFO Resource Management personnel and are on loan to the MSB under accession number PEFO-00922, and catalog numbers PEFO 36599 and 36600.

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THAMNOPHIS RADIX **(Plains Gartersnake)**. USA: NEBRASKA: Gosper Co.: 5.0 km S, 1.0 km W Bertrand (40.4803°N, 99.6448°W; NAD 83). 14 July 2011. Alyx R. Lingenfelter, Dustin J. Casady, and Mallory Irvine. Verified by Curtis J. Schmidt. Sternberg Museum of Natural History, Fort Hays State University, Hays, Kansas (FHSM 15853). First county record. Fills in gap in south-central parts of the state with the nearest published records from Dawson, Frontier, and Phelps counties (Ballinger et al. 2010. Amphibians and

Reptiles of Nebraska. Rusty Lizard Press, Oro Valley, Arizona. 400 pp.; Fogell 2010. A Field Guide to the Amphibians and Reptiles of Nebraska. University of Nebraska, Lincoln. vi + 158 pp.). Captured in a funnel trap set near a waterway in the Peterson Federal Waterfowl Production Area dominated by Smooth Brome (*Bromus inermis*) with scattered milkweed (*Asclepias* spp.), Dogbane (*Apocynum cannabinum*), and ragweed (*Ambrosia* spp.).

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***THAMNOPHIS RUFIPUNCTATUS* (Narrow-headed Gartersnake).** USA: ARIZONA: Yavapai Co.: Prescott National Forest, Verde River (34.87971°N, 112.30856°W, NAD 83). 9–10 September 2010 and 10 August 2011. Iain D. Emmons and Erika M. Nowak. Verified by George Bradley. University of Arizona Museum of Natural History. Digital photo vouchers (UAZ 57396-PSV, 57397-PSV, 57398-PSV). Range extension (Holycross et al. 2006. Surveys for *Thamnophis eques* and *Thamnophis rufipunctatus* in the Gila River Watershed of Arizona and New Mexico. Final report to Arizona Game and Fish Department). These specimens represent a new western boundary of the known geographic distribution of *T. rufipunctatus*, and extend the range 10 km SW of the closest unvouchered sightings and 24 km W of the last vouchered sighting from the upper Verde River watershed in 2001 (ASU HP-00016).

One adult female was captured in a Gee minnow trap on the edge of the main river channel, and one neonate male was captured by hand on the edge of a backchannel pool in 2010. One subadult female was captured in a Gee minnow trap on the edge of a river side channel, and one neonate was seen but not captured on the edge of the main river in 2011.

Thamnophis rufipunctatus has suffered dramatic population declines and fragmentation throughout its range (Holycross and Brennan 2006. Amphibians and Reptiles in Arizona. Arizona Game and Fish Department, Phoenix, Arizona. 150 pp.; Hibbitts et al. 2009. Southwest. Nat. 54:461–467) and the species is currently undergoing a status review pursuant to federal listing by the U.S. Fish and Wildlife Service. Recent surveys of historical localities in the upper Verde River watershed have failed to produce any sightings (Holycross et al. 2006, *op. cit.*; Emmons et al. 2011. 2010 Riparian Herpetofauna Surveys. Unpubl. final report to Prescott National Forest). Recent genetic analysis suggests divergence between disjunct populations in the United States and Mexico (Wood et al. 2011. Mol. Ecol. 20[18]:3856–3878). In this conservation context, the range extension provides a significant distribution record for the species.

Fieldwork was supported by the U.S. Forest Service. Permits were issued by the Arizona Game and Fish Department (SP710162 CLS) and Northern Arizona University (IACUC 09-004).

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***THAMNOPHIS SAURITUS* (Eastern Ribbonsnake).** USA: NORTH CAROLINA: Haywood Co.: Canton (35.4322°N, 82.8121°W; WGS 84; elev. 898 m). 18 September 2011. Candace Little. Verified by Jeff Beane. North Carolina State Museum Natural Sciences (12717, photo voucher). New county record (Palmer and Braswell 1995. Reptiles of North Carolina. University of North Carolina Press, Chapel Hill, North Carolina. xiii + 412 pp.). This record extends the range 36 km N of nearest record in Transylvania Co. (Palmer and Braswell 1995, *op. cit.)*.

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***THAMNOPHIS SIRTALIS* (Eastern Gartersnake)** USA: ALABAMA: Crenshaw Co.: AOR on U.S. Hwy 29, 3 km SW Dozier (31.47312°N, 86.38808°W; WGS 84). 29 May 2011. S. Graham. Verified by Craig Guyer. AUM AHAP-D 306 (digital photo voucher). New county record (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn Printing Co., Auburn. 347 pp.).

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***UROTHECA GUENTHERI* (Striped Glass-tailed Snake).** PANAMÁ: PANAMÁ: Distrito de Panamá: Cerro Azul, Parque Nacional Chagres, in backyard of Autoridad Nacional del Ambiente field station (ca. 9.195328°N, 79.401664°W; WGS 84), 680 m elev. 28 July 2009. Ángel Sosa and Jorge Guerrel. Verified by Gerardo Chaves Cordero. MVUP 2092. First record for the Province of Panamá, extending its distributional range approximately 100 km (airline) NE from La Mesa area, trail to Las Minas, El Valle, Coclé. Previously known only from four specimens in different localities of western Panamá (Lotzkat et al. 2010. Herpetol. Rev. 41:520–523; Myers 1974. Bull. Amer. Mus. Nat. Hist. 153:1–262). The snake was found at night in an open grassy area.

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The Second Known Contact Zone Between *Plethodon websteri* and *P. ventralis*, and Additional Records for Bibb County, Alabama, USA

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Bibb County, Alabama is situated at an interesting physiographic crossroads, and as a result has a rich and diverse herpetofauna (Mount 1975). The northern half of the county is the southwestern terminus of the Ridge and Valley physiographic province, and the southern half is below the Fall Line and is comprised of Coastal Plain soils and sandhills. Bibb County has experienced extensive herpetological collections, which have documented interesting disjunct populations of species associated with the lower Coastal Plain (e.g., *Micrurus fulvius*, *Pseudacris ornata*, *Anaxyrus quercicus*). We conducted a bioblitz competition (see Graham et al. 2007) to obtain additional records. Most searching took place within the Cahaba River National Wildlife Refuge (CRNWR) or Talladega National Forest (TNF). While researching this note, we discovered specimens in the AUM collections that represent unpublished, noteworthy records, and include them here.

Attempts were made to extend the range of species known from other areas of the Ridge and Valley and Cumberland Plateau (e.g., *Eurycea lucifuga*, *Aneides aeneus*, *Lithobates palustris*). Despite extensive searching, presence of appropriate habitat (limestone outcrops and crevices), and moist conditions, we were unable to locate these species. We also attempted to assess the current status of Bibb County Coastal Plain disjuncts, particularly the inhabitants of Ashby Pond, an historical collection site for *Ambystoma tigrinum*, *Pseudacris ornata*, and *Anaxyrus quercicus* (AUM collections). This pond was located and sampled thoroughly, but we failed to confirm the presence of any of these species.

All new records were verified by Craig Guyer or confirmed by molecular methods. Unless otherwise noted, all GPS datums are WGS 84.

CAUDATA — SALAMANDERS

***DESMOGNATHUS AENEUS* (Seepage Salamander).** FS 726/FS 715 intersection in TNF; gum swamp and beaver pond 400 m SW of intersection (32.906922°N, 87.392005°W). 04 April 2009. AUM 34910–34912. The presence of *D. aeneus* in Bibb County was previously questionable. Mount (1975) illustrates a locality on the Bibb County/Tuscaloosa County line. Mount's range maps for *Desmognathus* sp. were largely derived from Folkerts (1968), so this locality was presumably based on specimens contained in the CMNH, since no specimens from Bibb County are found in any other museum that Folkerts consulted (Folkerts 1968). Harrison (1992) and Harrison (2005) did not include Bibb County within the range of *D. aeneus*, possibly due to the lack of precise locality data for the CMNH specimens (Herpnet query). We include this as a valid county record to eliminate ambiguity.

***PLETHODON VENTRALIS* (Southern Zigzag Salamander).** CRNWR; seepage in ravine 400 m W of Cahaba River (33.065079°N, 87.087198°W). 04 April 2009. S. Graham. AHAP-D 218; GENBANK accession # GQ 464404 (See below for method of verification).

***PLETHODON WEBSTERI* (Webster's Salamander).** CRNWR; ravine E of Cahaba River (33.071646°N, 87.073708°W). 21 March 2009. S. Graham and K. Gray. AHAP-D 219; GenBank accession # GQ464403. The presence of a small *Plethodon* species in Bibb County was noted by Mount (1975), who treated it as *P. dorsalis*. Specimens from this county were not examined by Highton in his description of the cryptic species *P. websteri* (Highton 1979), and therefore specimens from this county are not currently assignable to either species. Specimens collected in different areas (~ 1.5 km apart) of CRNWR appeared different morphologically and we therefore undertook efforts to utilize molecular confirmation of their species assignment. Specimens were verified using the mitochondrial marker *cytochrome b* (~850bp) and compared against GenBank sequence data for small *Plethodon* species (DQ994903, DQ994904, DQ994913, DQ994930 DQ994980, DQ994981, DQ994982, DQ994993, DQ994994, DQ994996; Wiens et al. 2006). Results conclude that samples collected from different localities within the CRNWR are in fact two different species, *P. ventralis* and *P. websteri*. This locality represents the second known zone of sympatry for *P. websteri* and *P. ventralis*. The other known contact zone is ~ 80 km NE in adjacent Jefferson County, an interesting site in which the species exhibit character displacement in color pattern and have a similarly narrow contact zone (< 1 km; Highton 1985). Although

we found no firm evidence of character displacement at CRNWR (most specimens appeared to be striped morphs), we found that specimens identified as *P. websteri* occurred on the east side of the Cahaba River, and specimens of *P. ventralis* occurred on the west side. More work is needed to confirm if this is another case of a *Plethodon* species pair found at a contact zone with a stream as a geographical barrier (e.g., Highton 1995).

TESTUDINES — TURTLES

***GRAPTEMYS GEOGRAPHICA* (Northern Map Turtle)**. Cahaba River below Centreville. No date. J. Dobie. AUM 29574.

***MACROCHELYS TEMMINCKII* (Alligator Snapping Turtle)**. Cahaba River near Centreville. No date; 1996. J. Godwin. AUM 37814.

***STERNOTHERUS ODORATUS* (Eastern Musk Turtle)**. Trapped in slough along Harrisburg Rd. E of bridge over Cahaba River (32.855105°N, 87.196347 °W). 03 April 2009. S. Graham. AHAP-D 212–213.

***TERRAPENE CAROLINA* (Eastern Box Turtle)**. CRNWR, intermittent stream W of Cahaba River (33.091849°N, 87.066746°W). K. Nelson. 21 March 2009. AHAP-D 245.

***TRACHEMYS SCRIPTA* (Pond Slider)**. Trapped in pond at Cahaba River Park in Centreville (32.950533°N, 87.138352°W). 03 April 2009. S. Graham. AHAP-D 216.

SQUAMATA — LIZARDS

***ASPIDOSCELIS SEXLINEATUS* (Six-lined Racerunner)**. CRNWR; E side of Cahaba River near abandoned strip mine (33.082142°N, 87.060367°W). 04 April 2009. M. Connell and D. Steen. AHAP-D 215.

SQUAMATA — SNAKES

***AGKISTRODON PISCIVORUS* (Cottonmouth)**. CRNWR; 100 m N of Bibb County Rd. 24 (33.099975°N, 87.061766°W). 21 March 2009. K. Gray. AHAP-D 211. Found decapitated.

***CARPHOPHIS AMOENUS* (Eastern Wormsnake)**. CRNWR; Mesic slope NE of Caffee Creek, 0.3 km W of Cahaba River (33.079353°N, 87.073791°W). 21 March 2009. M. Connell. AHAP-D 210.

***PANTHEROPHIS GUTTATUS* (Red Cornsnake)**. TNF; Hilltop 0.16 km S of FS 718, 0.66 road km E of intersection with FS 726. (32.919167°N, 87.386944°W). 04 April 2009. K. Nelson. AHAP-D 209. NE corner of wildlife food plot, under fallen bark at base of dead pine snag.

***THAMNOPHIS SAURITUS* (Eastern Ribbonsnake)**. TNF; beaver pond 1.5 km SW of FS 726/FS 715 intersection along FS 715 (32.903290°N, 87.402926°W). 04 April 2009. S. Graham and K. Gray. AHAP-D 214.

Acknowledgments.—We thank Craig Guyer for reviewing these records. Additional participants of the bioblitz competition, including J. Apodaca, W. Smith, and C. Thawley are also thanked for their attempts to find new records. S. Graham is supported by NIH grant # R01-A149724 to Tom Unnasch under ADCNR Permit # 4268.

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New and Updated County Records for Amphibians and Reptiles in Minnesota

The following entries are either new county records or updates of previously reported specimens collected prior to 1961 as cited in Oldfield and Moriarty (1994), Moriarty (1996), and Gamble and Moriarty (2006). A new state record is reported for Minnesota, *Sternotherus odoratus*. *Sternotherus odoratus* could naturally occur in Minnesota, including the Zumbro River (Casper 1996, 1997; Oldfield and Moriarty 1994). However, the circumstances surrounding the two specimens found in Rochester make the notion of their natural origins seem unlikely. They were located near an area where *Trachemys scripta* was introduced, and I have witnessed *Sternotherus odoratus* for sale at

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local area pet retailers. All records are photo vouchers deposited in the James Ford Bell Museum of Natural History (JFBM) and all accession numbers are preceded by the letter "P." All photos were verified by Ben Lowe.

CAUDATA — SALAMANDERS

***AMBYSTOMA LATERALE* (Blue-spotted Salamander).** Carver Co.: Minnesota Landscape Arboretum (44.85697°N, 93.60948°W; WGS 84). 5 May 2007. New county record. Julia L. Bohnen and Matt Schuth. JFBM P320.

***NOTOPHTHALMUS VIRIDESCENS* (Eastern Newt).** Beltrami Co.: Lindgren Lake (47.66724°N, 94.54599°W; WGS 84). 5 July 2002. New county record. Jeffrey B. LeClere. JFBM P321a,b.

ANURA — FROGS

***ANAXYRUS (= BUFO) AMERICANUS* (American Toad).** Beltrami Co.: near County Road 22 N of Bemidji (47.59539°N, 94.86926°W; WGS 84). 2 July 2002. Updated county record. Jeffrey B. LeClere. JFBM P322.

***HYLA VERSICOLOR* (Gray Treefrog).** Beltrami Co.: County Road 22 near jct with 15 (47.59890°N, 94.88226°W; WGS 84). 3 July 2002. Updated county record. Jeffrey B. LeClere. JFBM P323.

***LITHOBATES (= RANA) PIPIENS*. (Northern Leopard Frog).** Beltrami Co.: Tower Rd NE near Turtle Lake (47.63435°N, 94.85591°W; WGS 84). 3 July 2002. Updated county record. Jeffrey B. LeClere. JFBM P324

***LITHOBATES (= RANA) SEPTENTRIONALIS*. (Mink Frog).** Beltrami Co.: Fox Lake (47.59891°N, 94.84497°W; WGS 84). 5 July 2002. Updated county record. Jeffrey B. LeClere. JFBM P325.

***LITHOBATES (= RANA) SYLVATICUS* (Wood Frog).** Beltrami Co.: On County Road 22 near jct with 15 (47.59891°N, 94.88152°W; WGS 84). 3 July 2002. Updated county record. J. B. LeClere. JFBM P327.

TESTUDINES — TURTLES

***CHRYSEMYS PICTA* (Painted Turtle).** Beltrami Co.: near County Road 22 N of Bemidji (47.59524°N, 94.86856°W; WGS 84). 5 July 2002. New county record. Jeffrey B. LeClere. JFBM P328.

***STERNOTHERUS ODORATUS* (Eastern Musk Turtle)** Olmsted Co.: Two specimens trapped in the Zumbro River close to Silver Lake in downtown Rochester (44.03018°N, 92.45730°W; WGS 84). July 2003. Quarry Hill Nature Center staff. JFBM P329a,b. New state record, likely introduced.

***TRACHEMYS SCRIPTA* (Pond Slider).** Olmsted Co.: Quarry Hill Nature Center (44.03227°N, 92.42530°W). May 2004. Quarry Hill Nature Center staff. JFBM P330a,b. First state record. Introduced. Hennepin Co.: Webber Park Pond (45.03432°N, 93.29215°W). Introduced. 1 August 2008. Jared Rypka-Hauer. JFBM P331.

SQUAMATA – SNAKES

***HETERODON PLATIRHINOS* (Eastern Hog-nosed Snake).** Isanti Co.: 2 mi N of Isanti next to Rum River (45.52418°N, 93.25332°W; WGS 84). 12 July 2009. Updated county record. Thomas K. Boysen. JFBM P332a-f.

***PANTHEROPHIS VULPINUS* (Western Foxsnake).** Rice Co.: Riverbend Nature Center in Faribault (44.27894°N, 93.24083°W; WGS 84) 6 June 2008. Updated county record. Jamie Pastika. JFBM P334.

***STORERIA OCCIPITOMACULATA* (Red-bellied Snake).** Beltrami Co.: just N of Fox Lake (47.61489°N, 94.84476°W; WGS 84). 5 July 2002. Updated county record. Jeffrey B. LeClere. JFBM P335.

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New Amphibian and Reptile County Records for Eight Counties in East Tennessee, USA

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The following is a report for new county records for eight counties in East Tennessee. There are several counties in this region that lack distribution records for common and rare amphibian and reptile species. Since 2004, biologists from the Tennessee Wildlife Resources Agency (TWRA) have been conducting nongame surveys across the state collecting species occurrence data on public and private lands. Several TWRA Wildlife Management

Areas (WMAs) were intensively inventoried following protocols written in the State Wildlife Action Plan (SWAP). Specimen localities were determined by using a Garmin or Magellan handheld global positioning unit (GPS) based on map datum WGS 84 with the decimal degree position format. Photo vouchers were verified by A. Floyd Scott and deposited in the Austin Peay State University (APSU) collection in Clarksville, Tennessee. The taxonomy used here follows Crother et al. (2008). All specimens are new county records based on Redmond and Scott (1996, 2008). Collector was Sterling D. Daniels unless otherwise noted.

CAUDATA — SALAMANDERS

***AMBYSTOMA OPACUM* (Marbled Salamander)**. Campbell Co.: Titus Creek drainage of the North Cumberland WMA, 80 m below Rector Cemetery (36.36695°N, 84.25163°W). 5 November 2008. APSU 19090. Adult specimen found under a wooden coverboard.

***AMBYSTOMA TIGRINUM* (Eastern Tiger Salamander)**. Jefferson Co.: Henderson Island Refuge at the end of Nichols Ferry Road, Dandridge (35.99426°N, 83.42632°W). 26 February 2008. Sterling D. Daniels, Scott A. Dykes, Tony Hickle, Chris Ogle, Bob Robertson, and R. L. Pete Wyatt. APSU 19114. Specimen was collected in the larger impoundment on the island adjacent to the drain. Twenty other adult individuals were captured.

***ANEIDES AENEUS* (Green Salamander)**. Union Co.: Whites Creek Road on Chuck Swan State Forest in Union County (36.33308°N, 83.92843°W). 28 May 2008. APSU 19115.

***EURYCEA LUCIFUGA* (Cave Salamander)**. Hancock Co.: Cave 20 m from the Clinch River off of Joe Alder Road on Kyles Ford WMA (36.56297°N, 83.04114°W). 10 October 2007. APSU 19158.

***NOTOPHTHALMUS VIRIDESCENS VIRIDESCENS* (Red-spotted Newt)**. Hancock Co.: Pond 500 m from the Clinch River on Kyles Ford WMA (36.58084°N, 83.01827°W). 10 October 2007. APSU 19093. Specimen was captured with a dip net.

***PLETHODON DORSALIS* (Northern Zigzag Salamander)**. Jefferson Co.: Henderson Island Refuge at the end of Nichols Ferry Road, Dandridge (35.99186°N, 83.42758°W). 25 October 2007. APSU 19088. This specimen was found under a log below a small permanent pond. Hancock Co.: 60 m from Joe Alder Road on Kyles Ford WMA (36.56297°N, 83.041114°W). 30 March 2009. APSU 19151. Found under a rock adjacent to a barn.

***PLETHODON GLUTINOSUS* (Northern Slimy Salamander)**. Hancock Co.: 100 m from Joe Alder Road on Kyles Ford WMA (36.56297°N, 83.041114°W). 30 March 2009. APSU 19097. This specimen was captured under a piece of tin.

***SIREN INTERMEDIA NETTINGI* (Western Lesser Siren)**. Campbell Co.: Cove Lake State Park 80 m from Old Hwy 63 (36.30405°N, 84.22266°W). 2 April 2009. Sterling D. Daniels, Scott A. Dykes, Randy Wolfe, R. L. Pete Wyatt. APSU 19104. 24 adults and 6 juveniles were collected.

ANURA — FROGS

***ANAXYRUS AMERICANUS* (American Toad)**. Claiborne Co.: Pond 15 m from Little Creek Road on private land (36.57699°N, 83.53673°W). 10 October 2007. APSU 19095. Hancock Co.: 150 m from the W side of Horton Ford Road on Kyles Ford WMA (36.58084°N, 83.01827°W). 14 April 2009. APSU 19111. Specimen was captured in a mitigation zone after it was heard calling.

***GASTROPHRYNE CAROLINENSIS* (Eastern Narrow-mouthed Toad)**. Greene Co.: 500 m from Oakwood Road on Lick Creek WMA (36.58084°N, 83.01827°W). 8 October 2007. APSU 19094.

***HYLA CHRYSOSCELIS* (Cope's Gray Treefrog)**. Hancock Co.: 150 m from the W side of Horton Ford Road on Kyles Ford WMA (36.58084°N, 83.01827°W). 14 April 2009. APSU 19113.

***LITHOBATES CATESBEIANUS* (American Bullfrog)**. Campbell Co.: Vernal pool 150 m from Old Hwy 63 on North Cumberland WMA (36.36801°N, 84.23833°W). 15 July 2008. APSU 19087.

***LITHOBATES CLAMITANS MELANOTA* (Northern Green Frog)**. Claiborne Co.: Pond 15 m from Little Creek Road on private land (36.57699°N, 83.53673°W). 10 October 2007. APSU 19092. Hancock Co.: Pond 500 m from the Clinch River on Kyles Ford WMA (36.58084°N, 83.01827°W). 10 October 2007. APSU 19091.

***LITHOBATES SYLVATICUS* (Wood Frog)**. Claiborne Co.: Pond 200 m from Forge Ridge Road on private land (36.5801°N, 83.53017°W). 4 March 2008. APSU 19089.

***PSEUDACRIS CRUCIFER* (Spring Peeper)**. Hancock Co.: 150 m from the W side of Horton Ford Road on Kyles Ford WMA (36.58084°N, 83.01827°W). 14 April 2009. APSU 19112.

TESTUDINES — TURTLES

***CHRYSEMYS PICTA PICTA* (Eastern Painted Turtle)**. Greene Co.: Pond 500 m from South Mohawk Road on Lick Creek WMA (36.159115°N, 83.074530°W). 20 August 2009. APSU 19142. Three individuals were captured by hoop traps.

***GRAPTEMYS GEOGRAPHICA* (Northern Map Turtle)**. Hancock Co.: Beneath Highway 70 Bridge on the Clinch River on Kyles Ford WMA (36.56935°N, 83.04093°W). 9 June 2010. APSU 19141

***GRAPTEMYS PSEUDOGEOGRAPHICA* (False Map Turtle)**. Hawkins Co.: 3.3 km upstream from Berry's Island Ecological Study Area at the end of Berry's Drive (36.31155°N, 83.19542°W). 4 November 2010. John Hammonds and Steve Henegar. APSU 19098. Specimen was caught by a TWRA fisheries crew in a trap net while sampling Cherokee Reservoir.

***STERNOTHERUS ODORATUS* (Eastern Musk Turtle)**. Campbell Co.: Cove Lake State Park 80 m from Old Highway 63 (36.30405°N, 84.22266°W). 2 April 2009. Sterling D. Daniels, Casey Pittman, and Randy Wolfe. APSU 19143.

SQUAMATA — LIZARDS

***SCINCELLA LATERALIS* (Little Brown Skink)**. Campbell Co.: 300 m from Flatwoods Road on the Ollis Creek Trail on the North Cumberland WMA (36.37487°N, 84.22261°W). 12 April 2010. APSU 19108. Specimen was captured under a coverboard. Hawkins Co.: Spring ca. 300 m W of Kyle Valley Road on Kyles Ford

WMA (36.55151°N, 83.01342°W). 5 May 2009. APSU 19107. Specimen was found under a log.

SQUAMATA — SNAKES

***AGKISTRODON CONTORTRIX* (Copperhead)**. Campbell Co.: Titus Creek drainage W of Interstate 75 on the North Cumberland WMA (36.36148°N, 84.23528°W). 26 June 2008. APSU 19099. Specimen was captured using a reptile funnel box located in a native warm season grass field. Hancock Co.: Hwy 63 just prior to Mulberry Gap (36.57438°N, 83.25282°W). 20 October 2009. APSU 19101. Unicoi Co.: adjacent to Flint Creek off of Rocky Fork Road on Rocky Fork WMA (36.07740°N, 82.56989°W). 19 May 2010. Sterling D. Daniels and Scott A. Dykes. APSU 19100.

***COLUBER CONSTRICTOR* (North American Racer)**. Hancock Co.: 100 m NE of Joe Alder Road on Kyles Ford WMA (36.56147°N, 83.04761°W). 15 April 2009. APSU 19146.

***HETERODON PLATIRHINOS* (Eastern Hog-nosed Snake)**. Campbell Co.: Titus Creek drainage W of Interstate 75 on the North Cumberland WMA (36.36148°N, 84.23528°W). 30 June 2008. APSU 19102. Hancock Co.: Hwy 33 S of Sneedville (36.49003°N, 83.32644°W). 8 October 2009. APSU 19103.

***LAMPROPELTIS GETULA* (Common Kingsnake)**. Claiborne Co.: Intersection of Hill Road and Little Creek Road (36.55569°N, 83.57195°W). 10 July 2010. APSU 19140.

***PANTHEROPHIS GUTTATUS* (Red Cornsnake)**. Hancock Co.: Intersection of Horton Ford Road and Hwy 70 on Kyles Ford WMA (36.56894°N, 83.03818°W). 20 October 2009. APSU 19106. Adult found in the roadway.

***PANTHEROPHIS SPILOIDES* (Gray Ratsnake)**. Hancock Co.: 100 m NE of Joe Alder Road on Kyles Ford WMA (36.56147°N, 83.04761°W). 14 April 2009. APSU 19144.

***STORERIA OCCIPITOMACULATA OCCIPITOMACULATA* (Northern Red-bellied Snake)**. Hancock Co.: Harris and Green Cemetery near Short Mountain (36.52036°N, 83.30878°W). 2 July 2011. Sterling D. Daniels, Dan Gibbs, and Ricky Harris. APSU 19145.

***THAMNOPHIS SIRTALIS SIRTALIS* (Eastern Gartersnake)**. Campbell Co.: Flatwoods road ca. 800 m past the Ollis Creek trail E of Interstate 75 on the North Cumberland WMA (36.30405°N, 84.22266°W). 10 July 2009. APSU 19105. Specimen was caught in an old field using a funnel trap.

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New County Records for Reptiles and Amphibians from South and Southeast Texas

The reptiles and amphibians of the state of Texas have been extensively studied (Dixon 2000; Werler and Dixon 2000). Nonetheless, there are still regions within Texas containing counties that have poorly documented herpetofauna (Dixon 2000). Herein we report 11 new county records for reptiles and amphibians from south and southeast Texas. Most of these records fill distributional gaps for common species.

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Our new findings indicate that *Eleutherodactylus cystignathoides* has a greater distribution in Texas than currently suggested in the scientific literature. This frog is thought to be native to the Rio Grande Valley in south Texas, but has been reported from geographically disjunct localities elsewhere in the state (Conant and Collins 1998; Dixon 2000). Because the county records we document for Jim Wells, Duval, and Kleberg counties are close to their native range, they may reflect recent range expansion, or a more widespread original distribution. A phylogeographic analysis of this species may prove useful for determining the limits of their native range and where they are invasive.

The following specimens were collected during March 2011. Geographic coordinates (WGS84) were obtained from a Garmin eTrex® handheld geographic positioning (GPS) unit. Specimens were deposited in the University of Texas at Arlington Amphibian and Reptile Diversity Research Center and all identifications were verified by Carl J. Franklin.

ANURA — FROGS

***ELEUTHERODACTYLUS CYSTIGNATHOIDES* (Rio Grande Chirping Frog)**. Duval Co.: town of San Diego (27.76846°N, 98.24720°W). 14 March 2011. Found under trash around an abandoned building. Christian L. Cox. UTA A 61031. New county record. Goliad Co.: ranch near town of Goliad (28.64176°N, 97.35498°W). 12 March 2011. Found under railroad ties in pasture adjacent to dry creek bed. Ruben U. Tovar. UTA A 60959–60961. New county record. Jim Wells Co.: town of Alice (27.72249°N, 98.09340°W). 14 March 2011. Found under trash in an abandoned lot. Utpal Smart. UTA A 61026–61028. New county record. Kleberg Co.: town of Kingsville (27.52993°N, 97.88897°W). 13 March 2011. Found in folds of plastic sheet near an abandoned building. Paul N. Pasichnyk. UTA A 60962–60963. New county record. Live Oak Co.: town of George West (28.32994°N, 98.11401°W). Found under board next to an abandoned trailer. 12 March 2011. Matthew A. Moseley. UTA A 60956–60958. New county record.

SQUAMATA — LIZARDS

***HEMIDACTYLUS TURCICUS* (Mediterranean Gecko)**. Duval Co.: town of San Diego (27.76846°N, 98.24720°W). 14 March 2011. Found on outskirts of town under bark on a fallen log. Christian L. Cox. UTA R 59354. New county record.

***ANOLIS CAROLINENSIS* (Green Anole)**. Bee Co.: town of Beeville (28.38935°N, 97.77164°W). 12 March 2011. Found under board leaning on an abandoned building. Christian L. Cox. UTA R 59351. New county record.

SQUAMATA — SNAKES

***SALVADORA GRAHAMIAE* (Eastern Patch-nosed Snake)**. Bee Co.: town of Beeville (28.38935°N, 97.77164°W). 12 March 2011. Found under trash in vacant lot in Beeville. Paul N. Pasichnyk. UTA R 59352. New county record.

***STORERIA DEKAYI* (DeKay's Brownsnake)**. Goliad Co.: ranch near town of Goliad (28.64176°N, 97.35498°W). 12 March 2011. Found under a board at the edge of a pasture next to a creek bed. Teddy Angarita-Sierra. UTA R 59353. New county record.

***TANTILLA GRACILIS* (Flat-headed Snake)**. Live Oak Co.: town of George West (28.32994°N, 98.11401°W). 20 January 2011. Found under boards next to a creek bed. Christian L. Cox. UTA-R 59301–59302. New county record.

***VIRGINIA STRIATULA* (Rough Earthsnake)**. Bee Co.: town of Beeville (28.38935°N, 97.77164°W). 12 March 2011. Found under an abandoned vacuum cleaner next to a burned field in outskirts of Beeville. Matthew A. Moseley. UTA R 59350. New county record.

Acknowledgments.— Our sincere appreciation is extended to Brett Mueller (Hensley Dos Ranch) for lodging and land access. We thank Carl J. Franklin for verifying identifications and curatorial assistance. We thank Toby J. Hibbitts for literature support in confirming county records, and Jeffrey W. Streicher for editorial assistance. All specimens were collected under the TPWD Permit SPR-0709-303 to Corey E. Roelke (C. L. Cox, sub-permittee). This trip was partially funded by an East Texas Herpetological Research Grant to C. L. Cox.

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New Geographic Distribution Records for Amphibians and Reptiles from Arkansas, USA

Since the publication of Trauth et al. (2004), a plethora of new geographic distribution records have been documented for various Arkansas herpetofauna. We here report 11 additional geographic (new county) records for two amphibians and eight reptiles from sites in Arkansas. Specimens were verified by Stanley E. Trauth, and vouchers were deposited in the Arkansas State University Herpetological Museum (ASUMZ), State University, Arkansas. Geocoordinates are based on datum WGS 84 and current common names follow Crother (2008).

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CAUDATA — SALAMANDERS

***AMBYSTOMA OPACUM* (Marbled Salamander)**. Pope Co.: 3.2 km SW of Pelsor off St. Hwy. 123 (35.773258°N, 93.073082°W). 20 April 2010. D. Allen. ASUMZ 31727. New county record that fills a distributional gap in the Arkansas River Valley.

ANURA—FROGS

***GASTROPHRYNE CAROLINENSIS* (Eastern Narrow-mouthed Toad)**. Baxter Co.: Junction of St. Hwy. 201 & 341 on 201

(36.224334°N, 92.289276°W). 16 April 2011. C. T. McAllister. ASUMZ 31728. Off county road 73 (Culp Road), vic. Culp (36.105976°N, 92.214287°W). 16 April 2011. C. T. McAllister. ASUMZ 31729. New county record that fills a hiatus between Fulton, Izard, Marion, and Stone counties. In addition, ASUMZ 31728 is a female measuring 38 mm in snout–vent length (SVL); this measurement equals a maximum SVL for *G. carolinensis* (Conant and Collins 1998; Trauth et al., *op. cit.*).

TESTUDINES — TURTLES

***CHELYDRA SERPENTINA* (Snapping Turtle)**. Johnson Co.: Clarksville, Clark Road (35.461833°N, 93.490733°W). 15 April 2010. J. Kremers. ASUMZ 31730 (photographic voucher). New county record that helps fill a distributional gap in the Arkansas River Valley.

SQUAMATA — LIZARDS

***PLESTIODON ANTHRACINUS* (Coal Skink)**. Baxter Co.: Off county road 73 (Culp Road), vic. Culp (36.105976°N, 92.214287°W). 16 April 2011. C. T. McAllister. ASUMZ 31735. New county record that fills a hiatus among Fulton, Izard, Marion, and Stone counties.

SQUAMATA — SNAKES

***AGKISTRODON PISCIVORUS LEUCOSTOMA* (Western Cottonmouth)**. Scott Co.: 3.2 km E of Waldron off St. Hwy. 80 (34.893816°N, 94.049149°W). 11 May 2010. E. Basehart. ASUMZ 31731. New county record filling a distributional gap in the western Ouachitas of the state.

***CARPHOPHIS VERMIS* (Western Wormsnake)**. Searcy Co.: 1.6 km NW of Leslie off US 65 (35.833263°N, 92.571144°W). 10 May 2010. J. Griffin. ASUMZ 31732. Yell Co.: Briggsville (34.933982°N, 93.494357°W). 27 April 2010. J. Kremers. ASUMZ 31733. New county records partially filling distributional gaps just north and south of the Arkansas River Valley, and among Newton and Stone counties, respectively.

***CEMOPHORA COCCINEA COPEI* (Northern Scarletsnake)**. Johnson Co.: Clarksville, 2019 Clark Road (35.461833°N, 93.490733°W). 5 May 2010. J. Kremers. ASUMZ 31736. New county record along the Arkansas River Valley.

***NERODIA RHOMBIFER RHOMBIFER* (Northern Diamond-backed Watersnake)**. Lincoln Co.: off St. Hwy 293 (Sorrels Ferry Rd.) at Cane Creek Lake (33.915123°N, 91.74983°W). 9 April 2011. C. T. McAllister. ASUMZ 31769 (photographic voucher). New county record in southeastern part of state among Desha and Jefferson counties.

***PANTHEROPHIS (=SCOTOPHIS) OBSOLETUS* (TEXAS RATSNAKE)**. Hot Spring Co.: off US 270 at Jones Mills, Smoky Ridge Rd. (34.437903°N, 92.875392°W). 15 June 2010. C. T. McAllister. ASUMZ 31792 (photographic voucher). New county record in central Arkansas among Garland and Grant counties; this snake has now been documented from 72 of 75 counties of the state (Robison 2006; Trauth et al., *op. cit.*).

***STORERIA DEKAYI WRIGHTORUM* (Midland Brownsnake)**. Johnson Co.: Clarksville, 2019 Clark Road (35.461833°N, 93.490733°W). 15 April 2010. J. Kremers. ASUMZ 31736. New county record between Franklin and Logan counties of the Arkansas River Valley.

Acknowledgments.—Thanks to S. E. Trauth (ASUMZ) for curatorial assistance and specimen verification, and J. Kremers for providing several vouchers. Specimens were collected under the authority of Arkansas Scientific Collecting Permits issued to CTM and HWR by the Arkansas Game and Fish Commission.

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NATURAL HISTORY NOTES

CAUDATA — SALAMANDERS

***PLETHODON CINEREUS* (Eastern Red-backed Salamander). MORPHOLOGY.** *Plethodon cinereus* is one of the most common salamanders in the Maritime Provinces of eastern Canada (Cook 1984. Introduction to Canadian Amphibians and Reptiles. National Museum of Natural Sciences, Ottawa. 200 pp.; Gilhen 1984. Amphibians and Reptiles of Nova Scotia. Nova Scotia Museum, Halifax. 162 pp.). There are three recognized color morphs: a deep red-striped back with black sides referred to as red-backed; a black pigmented back and sides, referred to as lead-backed; and the rarest of the three morphs, red with varying degrees of black mottling referred to as erythristic (Fig. 1). Morph frequencies in this species, which seem to be influenced by temperature, have attracted growing interest as a proxy for monitoring local and large-scale climate change (Gibbs and Karraker 2005. Conserv. Biol. 20:913–917). The lead-back morph is more closely associated with warmer, drier climates than the red-backed morph and erythristic individuals are reported to replace lead-back individuals at higher elevations (Gilhen 1984, *op. cit.*) There are apparently very few reports of the three morphs co-occurring (one site among 50 reported by Lotter and Scott 1977. Copeia 1977:681–690) and none from Maritime Canada (Cook and Bleakney 1961. Can. Field Nat. 75:53; Gilhen 1984, *op. cit.*). Recently, an area was discovered on 29 April 2011 with all three morphs in the Connecticut Audubon Society Croft Preserve in Goshen, Connecticut, USA (41.8926°N, 73.1914°W) (pers. comm., T. Leenders).

Odell Park is a 160-ha area of mature mixed hardwood and conifer forest situated in the city of Fredericton, New Brunswick, Canada, 20–100 m elev. Here all three morphs co-occur. Among 103 individuals observed in Odell Park between 6 May 2010 and 18 Sept 2011, red-backed morph was the most common (N = 85, 82.5%), followed by the erythristic morph (N = 11, 10.7%), with the lead-backed morph the least prevalent (N = 7, 6.8%). Four voucher specimens were collected from Odell Park and have been deposited in the New Brunswick Museum: two red-backed morphs (NBM 009072, 74), one lead-back morph (NBM 009073), and one erythristic morph (NBM 009071).

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***PLETHODON SERRATUS* (Southern Red-backed Salamander). CICADA BURROW USE.** *Plethodon serratus* is a lungless, terrestrial salamander that is dependent upon ambient moisture for its survival. When surface substrates dry, such as during the summer months or during drought periods, these salamanders must seek refuge in microhabitats with higher moisture content, including soils deeper underground. Although some salamanders have the capacity to dig their own burrows (Semlitsch 1983. Can. J. Zool. 61:616–620), this does not appear to apply to *Plethodon* salamanders (Heatwole 1960. Ecology 41:661–668). Instead, they utilize burrows created by other organisms (e.g., worms and beetles; Ransom 2011. Oecologia 165:745–754), or, as described by Heatwole (1960, *op. cit.*), use their heads as a wedge and force their bodies into cracks or small openings in the substrate by pushing with their feet, and in some instances, their tails.

The spring of 2011 was an emergence year for Brood XIX of the 13-year periodical cicada (Hemiptera: Cicadidae: *Magicicada* sp.) in south central Missouri. Cicada nymphs feed on tree roots at depths that can exceed 60 cm. They excavate and maintain underground burrows, which they abandon when they emerge at the soil surface and disperse in the late spring (Williams and Simon 1995. Annu. Rev. Entomol. 40:269–295), leaving behind abundant access to subterranean microhabitats at about the time *P. serratus* begin to seek underground refuge for the summer (Herbeck and Semlitsch 2000. J. Herpetol. 34:341–347). Annual, or "dog day" cicada nymphs (Hemiptera: Tibiceninae:

PHOTO BY TWAN LEENDERS



FIG. 1. The three morphs of *Plethodon cinereus*: red-backed, lead-backed, and erythristic.



FIG. 1. Adult *Plethodon serratus* encountered in a periodical cicada (*Magicicada* sp.) burrow during the Brood XIX emergence in May 2011 in south central Missouri, USA.

Tibicen sp.) emerge annually in late July and August, not long before *P. serratus* are detected utilizing surface habitats in the late summer/fall (Herbeck and Semlitsch 2000, *op. cit.*).

While conducting leaf litter surveys in the Ozark Mountains for terrestrial salamanders on 25 May and 27 Sept 2011 in the Sinkin Experimental Forest (US Forest Service), Dent Co., Missouri, USA, we encountered adults of *P. serratus* in burrows constructed by cicada nymphs. The salamander encountered in May slipped deeper into the periodical cicada burrow soon after detection, so we were unable to collect morphological data. The salamander encountered utilizing an annual cicada burrow in September was an adult male, 42 cm SVL (Fig. 1). Periodical cicada burrow densities in the spring ranged from 0.3–4.7/m^2 (mean = 1.5/m^2) and cicada burrow densities in the fall ranged from 0–3.1/m^2 (mean = 0.6/m^2) (Drake et al., unpubl. data).

We hypothesize that periodical cicada burrows greatly increase access to deeper subterranean microhabitats for terrestrial salamanders, and that greater access to more hospitable underground habitat via these burrows during inclement periods, such as seen in the summer or dry periods during other seasons, may result in increased survival into the fall.

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***PLETHODON WELLERI* (Weller's Salamander). NESTING LOCATION.** Few nests of *Plethodon welleri* have been found and all observations have been on Whitetop Mountain and Mount Rogers, Virginia, USA, at elevations ≥ 1585 m. Nests were located in surface crevices of downed, decaying logs of *Picea rubens* (Red Spruce) immediately below a layer of moss. Those with eggs were discovered in mid-August while nests with hatchlings were found in late August and early September. The number of eggs or hatchlings in nests ranged from 4–11 (Organ 1960. Copeia 1960:287–297; Hoffman et al. 1948. J. Washington Acad. Sci. 38:106–108).

We report a novel nest location from the north slope of Whitetop Mountain, Virginia at 1494 m. On 1 July 2011 we found a nest of *P. welleri* located in leaf litter composed of *Betula alleghaniensis* (Yellow Birch), *Fagus grandifolia* (American Beech), and *Acer pensylvanicum* (Striped Maple) 4.5 cm beneath the leaf litter surface. Eggs were found in leaves that had fallen from the previous year and were immediately above a layer of decomposed leaves. The nest was 3.5 cm from a downed, decaying Yellow Birch log that was 21 cm in diameter. A female *P. welleri* (35 mm SVL and 67 mm total length) was coiled around two eggs. The embryos had small limb buds.

Our observation documents the first nest of *P. welleri* in a location other than moss covered logs and provides support for the importance of leaf litter for this species. This nest had fewer eggs than had been previously documented. Embryos exhibited mid-term development indicating that deposition was complete and either egg predation had occurred or only two eggs were deposited (Organ 1960, *op. cit.*). Embryo development also suggests that the eggs were likely deposited in mid-June. Egg deposition dates have not been determined but have been suggested to occur in May or June and our observation provides evidence for this time period (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, DC. 587 pp.). This nest was 91 m lower than previously documented nests and in an area without *Picea rubens* which were the only logs in which Organ (1960, *op. cit.*) found nests.

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ANURA — FROGS

***ELEUTHERODACTYLUS CUNEATUS*. PREDATION.** During a one-year study of *Eleutherodactylus cuneatus* (Fong et al. 2010. Biotropica 42:348–354) we recorded three predation events by two different predators: crabs and spiders. The observations were made along a tributary of the Indio River (20.0°N, 75.6°W; NAD 27 Cuba datum) at La Gran Piedra, Santiago de Cuba province, Cuba.

On 18 Aug 2003 at 2024 h, we found a female freshwater crab (*Epilobocera cubensis* carapace length = 46 mm, carapace width = 68 mm) inside a burrow in the bank, on dry land, actively feeding on an adult *Eleutherodactylus cuneatus* (ca. 49.7 mm SVL). When discovered, the crab was pulling out pieces of the frog body, which was approximately half consumed. There was a large laceration on the frog's abdomen and the internal organs; the snout tip, one hind limb, and a half of other two limbs were missing. At 2000 h, water temperature was 20.0°C, air temperature was 21.1°C, and humidity was 94%. The frog was collected and deposited in the herpetological collection of the Centro Oriental de Ecosistemas y Biodiversidad (BIOECO), Santiago de Cuba (BSC.H 3460).

Later that night (at 0040 h), we witnessed a second freshwater crab (62 mm carapace width) consuming another adult *E. cuneatus* (>25 mm SVL). The crab was on dry land, 70 cm from the water's edge. The head of the frog had been eaten and the crab was grasping the prey with a chela and pulling out pieces of the frog with the other chela. The water temperature was 19.0°C, air temperature was 19.6°C, and humidity was 93%.

Although it was not possible to determine whether the frogs had been killed or merely scavenged by the crabs, injuries were consistent with crab predation and no other dead frogs were observed in ca. 8 h of survey in this stream. Predation by crabs is known in other anuran species, and includes egg, tadpole, and adult life stages (Gray and Christy 2000. Crustaceana 73:1023–1025; Hayes 1983. Biotropica 15:74–76;Ryan et al. 1981. Behav. Ecol. Sociobiol. 8:273–278). Considering the scarcity of papers reporting this event, it seems that crabs are opportunistic frog predators.

On 18 March 2004 at 1350 h, a female ctenid spider (*Ohvida vernalis*; 16.3 mm cephalothorax + abdomen length) was sighted motionless and camouflaged in the leaf litter, 137 cm away from the stream's edge, holding and biting a juvenile *E. cuneatus* (ca. 10 mm SVL). While we attempted to collect the spider, it released its prey and the frog escaped, taking refuge in the leaf litter before we could collect it. At 1524 h, the water temperature was 18.5°C, the air temperature was 20.7°C, and humidity was 89%. The spider was collected and deposited in the herpetological collection of the Centro Oriental de Ecosistemas y Biodiversidad (BIOECO), Santiago de Cuba (without a catalog number).

Frogs are common prey for spiders, as documented in recent reviews (Armas 2001. Rev. Ibérica Aracnología 3:87–88; Menin et al. 2005. Phyllomedusa 4:39–47; Toledo 2005. Herpetol. Rev. 36:395–400), but this is only the second record of spider predation on a Cuban frog (see Novo et al. 1985. Misc. Zool. 28:1–2).

Among the families of spiders, Ctenidae is one of the most frequently reported as an anuran predator (Menin et al. 2005, *op. cit.*); ctenids are ambush predators that catch prey on the ground (A. Sánchez, pers. comm.) hence increasing the opportunity of encounters with terrestrial frogs such as *E. cuneatus*.

This is the first study reporting predators of *E. cuneatus*, although Valdés de la Osa and Ruiz García (1977. Misc. Zool. 6:4) reported cannibalism in captive specimens of *E. cuneatus* (possibly *E. riparius*) and other workers have mentioned predators of other Cuban *Eleutherodactylus* (see revision in Armas 2001, *op. cit.*). It would be interesting to examine the relationship between predator abundance and *E. cuneatus* density.

We thank A. Sánchez for identifying the spider, and R. Viña, B. Lauranzón, and Y. Rivera for providing field assistance. S. Scherlowski kindly carried field equipment to Cuba. Financial support for the field work was from a Seed Grant from the Declining Amphibian Population Task Force (DAPTF). The Centro Oriental de Ecosistemas y Biodiversidad (BIOECO) provided permits and logistic facilities.

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***ELEUTHERODACTYLUS MONENSIS* (Coquí de Mona). REPRODUCTION.** *Eleutherodactylus monensis* is a medium-sized frog (49.4 mm max SVL for females), endemic to Mona Island, Puerto Rico. Females and males are found on the forest floor, leaf litter, fallen vegetation, and bromeliads. Males call from lower vegetation up to 1.0 m above the ground (Joglar 1998. Los Coquíes de Puerto Rico: Su Historia Natural y Conservación. Editorial de la Universidad de Puerto Rico, San Juan. 232 pp.). This is the first report on reproduction in this species and includes information on nesting site, clutch and egg size, and SVL of hatchlings. The clutch (Fig. 1) was found on 17 Sept 2011 in the Sardinera area on the western side of Mona Island. The clutch contained nine eggs ($\bar{x}$=4.62 mm diameter; range 4.0–5.2; N = 9) and was found on a *Cocos nucifera* palm frond buried ca. 28 cm deep within a pile of vegetation and debris that was 0.5 m high. While digging through the mound we observed an adult male (25.8 mm SVL) very close to the clutch, although we have no evidence of parental care at this point. On 25 Sept 2011, eight days after the clutch was discovered, 8 of the 9 eggs hatched and the SVL at birth was measured ($\bar{x}$= 6.28 mm SVL; range 6.0–6.5; N = 8). The hatchlings were deposited in the herpetology collection of the Museo de Biología, Universidad de Puerto Rico–Río Piedras as UPRRP V-00783345.

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***HEMISUS MARMORATUS* (Marbled Snout-Burrower). DEFENSIVE BEHAVIOR.** The Sub-Saharan African Hemisotidae includes nine species in the genus *Hemisus* (Frost 2011. Amphibian Species of the World: An Online Reference. v5.5. American Museum of Natural History, New York). The group is distinguished by the possession of sharply pointed snouts, modified shoulder girdles, well-developed forelimb muscles, and expanded metatarsal tubercles, all of which are adaptations for rapid, head-first burrowing (Channing 2001. Amphibians of Central and Southern Africa. Comstock Publ. Assoc., Ithaca and London. 470 pp.). One of the most widespread species is *Hemisus marmoratus*, which occurs in non-rainforest habitats from Senegal to Eritrea, and south to South Africa (Frost 2011, *op. cit.*). Although various aspects of the species' natural history and behavior have been described (Rödel 2000. Herpetofauna of West Africa. Vol. I. Amphibians of the West African Savanna. Edition Chimaira, Frankfurt am Main. 332 pp.; Schmidt and Inger 1959. Explor. Parc Nat. Upemba, Mission G. F. de Witte 56:1–264), large gaps remain, especially in poorly known populations from Central Africa.

Duellman and Trueb (1986. Biology of Amphibians. Johns Hopkins Univ. Press, Baltimore and London. 670 pp.) noted that several groups of heavy-bodied Neotropical anurans inflate their lungs in an attempt to appear larger to predators. This behavior is often coupled with elevation of the posterior part of the body and flexion of the head downwards in the direction of the predator. Such behavior has been noted in the African hyperoliid *Phlyctimantis verrucosus*, which is known to have aposematic coloration on the flanks and legs, and secretes a noxious latex-type liquid (Channing and Howell 2006. Amphibians of East Africa. Comstock Publishing Associates, Ithaca, New York.



FIG. 1. Egg clutch of *Eleutherodactylus monensis* photographed on top of a fallen *Cocos nucifera* palm frond on 17 Sept 2011 in the Sardinera area on the western side of Mona Island, Puerto Rico.



FIG. 1. Adult *Hemisus marmoratus* (UTEP 20347) in defensive inflate-and-bow display.

418 pp.). Channing (2001, *op. cit.*) referred to the latter display as the "unken reflex." However, Duellman and Trueb (1986, *op. cit.*) and Lillywhite (2008. Dictionary of Herpetology. Krieger Publ. Co., Malabar, Florida. 376 pp.) defined unken reflex as a warning display in which the back is arched, the hind legs are raised over the body with the soles upward, and the head is pulled back to display aposematic coloration. The unken reflex is typically associated with salamanders and the Asian frog genus *Bombina*. To avoid confusion with the unken reflex, we define the behavior described above for *Phlyctimantis* as the inflate-and-bow display. De Witte (1941. Inst. Parcs Nat. Congo Belge 33:xvii–261) illustrated, but did not discuss, a female *H. guineensis* engaged in this latter "emotional" display in Virunga (formerly Albert) National Park in northeastern Democratic Republic of the Congo (DRC). Herein, we report an identical defensive behavior for *H. marmoratus*.

At 1530 h (45°C air temperature) on 21 Jan 2010, we collected a single adult (32.4 mm SVL) *H. marmoratus* from a large, muddy pit on the road south of Nyunzu, Katanga Province, DRC (6.5122°S, 28.0564°E; elev. 799 m). This area is in the Central Zambezian Miombo Woodlands Ecoregion of Burgess et al. (2004. Terrestrial Ecoregions of Africa and Madagascar: A Conservation Assessment. Island Press, Washington, Covelo and London. 501 pp.). The animal was placed in a plastic container until the following morning, when it was photographed. During this process, the frog was handled repeatedly to prevent escape, and to remove debris from its skin. In response to this handling, the frog inflated its lungs, elevated the posterior half of its body with its hind limbs, and lowered the head in the direction of the individual who was handling it (Fig. 1). The frog maintained this position for ca. 1 min before lowering the posterior half of its body, and allowing its lungs to deflate. The specimen was deposited in the herpetological collection of the Laboratory for Environmental Biology at the University of Texas at El Paso (UTEP 20347).

Previous studies noted that *H. marmoratus* typically tries to escape predators by hopping towards water or burrowing rapidly (Noble 1924. Bull. Amer. Mus. Nat. Hist. 49:147–347; Wager 1986. Frogs of South Africa: Their Fascinating Life Stories. Delta Books, Craighall. 183 pp.). Our observations represent the first record of the inflate-and-bow defensive behavior in this species. Considered together with the published illustrations of *H. guineensis* (De Witte 1941, *op. cit.*), our observations suggest the inflate-and-bow display might be widespread among the Hemisotidae.

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***KALOULA KALINGENSIS* (Narrow-Mouthed Frog). PARENTAL CARE.** The microhylid *Kaloula kalingensis* was observed to exhibit bi-parental care on 18 Aug 2011 on Mt. Banahao in Luzon, Philippines (14.0932°N, 121.4912°E) at an elevation of 1100 m. An adult male (2.8 cm SVL; 2.7 g) was found guarding a clutch of 14 tadpoles in a phytotelm (water-filled cavity) of a tree 0.91 m above the ground. The phytotelm was 4.5 cm wide by 6.5 cm tall with a depth of 8 cm. The adult remained at the bottom of the cavity where it would emerge periodically to the surface to breathe (Fig. 1). The tadpoles continued to surface for air every couple of minutes as well. The adult male was collected and removed from the phytotelm. Two days later the phytotelm was resurveyed and an adult female (3.49 cm SVL; 4.7 g) was found guarding the remaining tadpoles, thus confirming that this species exhibits bi-parental clutch guarding. Other frogs (e.g., *Playmantis montanus*) in this area have been documented guarding direct-developing eggs but few species with tadpoles have been shown to exhibit parental care from the site of a phytotelm, as well as having both parents contribute to care of the tadpoles.



FIG. 1. *Kaloula kalingensis* (see arrow) in a phytotelm with tadpoles.

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***LEPTODACTYLUS ALBILABRIS* (Caribbean White-Lipped Frog). CALLING SITE.** Frogs are known to use burrows of a diverse array of animals as calling or retreat sites. Here I report the use of an active crab burrow as a calling site for *Leptodactylus albilabris*. A diverse array of invertebrate burrows are used by frogs as retreat sites, for example tarantulas (Blair 1936. Copeia 1936:115; Hunt 1980. Nat. Hist. 89:48–53; Powell et al. 1984. Salamandra 20:273–274; Cocroft and Hambler 1989. Biotropica 21:2–8), termites (Loveridge 1976. Zool. Afr. 11:319–333), scorpions (Rödel and Braun 1999. Biotropica 31:178–183), or crabs (McIntyre 2003. Herpetol. Rev. 34:52–53). Only one other anuran, the leptodactylid *Lithodytes lineatus*, is known to call from invertebrate dug burrows, calling from within the nests of leafcutter ants (*Atta* spp.) (Lamar and Wild 1995. Herpetol. Nat. Hist. 3:135–142). While *Leptodactylus albilabris* has previously been reported calling from crevices or burrows (Narins 1990. BioScience 40:268–274), which may play a role in the seismic communication reported for this species (Lopez et al. 1988. Anim. Behav. 36:1295–1308), the nature of these burrows or crevices was not described and other occupants were not reported.

I observed a single *Leptodactylus albilabris* calling at the mouth of an active crab burrow on three nights in August 2011 in El Combate, Puerto Rico. Other than the focal individual no other individuals of *L. albilabris* were audible during the observation period. The burrow was in a residential area between two outbuildings and under a pile of scrap plywood. The burrow measured ca. 15–20 cm in diameter at the opening and was always inhabited by a single Blue Land Crab (*Cardisoma guanhumi*)

with a carapace width of ca. 10 cm. The depth of the burrow was not determined, although it was filled with water to within 12 cm of the top. *Cardisoma guanhumi* is primarily herbivorous, although occasionally eating carrion, including frogs (Wolcott and Wolcott 1987. Physiol. Zool. 60:262–268). It is possible the crab was not perceived as a predator despite its considerably larger size. This crab was observed in the burrow both day and night, while the *L. albilabris* was only observed after dark. On each night of observation I removed the plywood after the frog began calling to confirm its location. The frog always retreated away from the burrow either under another piece of plywood or the concrete slab of the outbuilding (on the first night of observations the frog was captured to confirm identification before it retreated in this manner). The frog returned to approximately the same location each night to call suggesting that this location was preferred as a calling site but not as a retreat site.

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***LEPTODACTYLUS FRAGILIS* (White-lipped Foamfrog). DISTRESS CALL.** Although anurans produce a wide array of vocalizations, most studies have focused on studying advertisement calls with other call types receiving little attention. Additional types of vocalization include territorial, courtship, fighting, and defensive calls (Duellman and Trueb 1994. Biology of Amphibians. McGraw-Hill, New York. 670 pp.). Distress calls are defensive calls triggered by dangerous circumstances such as being captured by a predator (Hödl and Gollmann 1986. Amphibia-Reptilia 7:11–21). Although their function is unclear, it has been suggested that distress calls act as a defensive mechanism to reduce the chances of predation. Distress calls occur in numerous species of anurans but only recently these calls have been carefully characterized in a growing number of species (de Toledo and Haddad 2009. S. Am. J. Herpetol. 4:25–42). Several species in the family Leptodactylidae produce distress calls, but it is unclear how widespread this anti-predatory strategy is in this clade. Here I describe the defense call of *L. fragilis*. The observations took place in the canal area, Gamboa, Panama (9°07.0'N, 79°41.9'W).

During the evening of 12 July 2010 I captured a female *L. fragilis* (36.4 mm SVL) that was motionless by a breeding puddle. As it was captured, the frog produced an open-mouth vocalization strikingly different in acoustic structure from the mating call of the species (Fig. 1A). She produced over 35 distress calls (34 were recorded and 33 analyzed) and arched her body backwards two times between calls as if she was playing dead. The defensive calls were easily triggered by holding the frog from the rear legs or allowing it to escape and capturing it again. The distress calls are short (0.636 ± SD 0.17s), high frequency cries (dominant frequency: 11.32± SD 1.22 kHz) that are rich in harmonics, and can have from one to three notes (Fig. 1B). Most calls, however, have two notes (75.6%). The first note is longer than the other two that are similar in duration and structure (note 1: 0.297 ± SD 0.13s; note 2: 0.127 ± SD 0.02; note 3: 0.126 ± SD 0.01). This acoustic structure differs strikingly from the mating call of this species, which consists of a short and low-pitched upward sweep whistle with few harmonics (Ibañez et al. 1999. The Amphibians of Barro Colorado Nature Monument, Soberania National Park and Adjacent Areas. Editorial Mizrachi & Pujol, Panama).

During12 July–11 Aug 2011, I captured 16 *L. fragilis* (12 males and 4 females) and recorded when they produced a distress call. Only two individuals produced distress calls, the female mentioned above and a male (32.7 mm SVL) found on 28 July 2010.

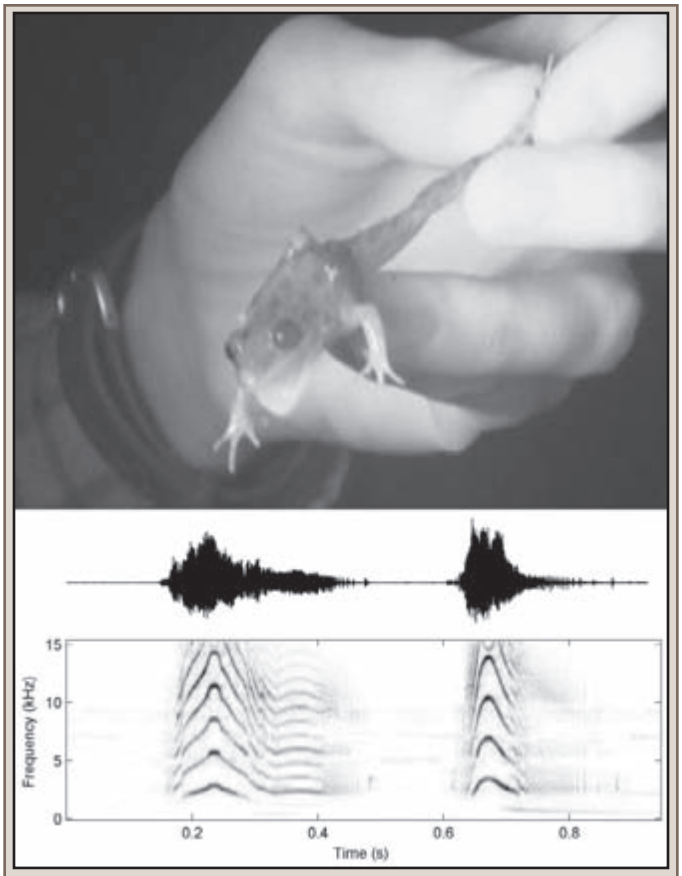


FIG. 1. (A) Female *Leptodactylus fragilis* producing distress calls with her mouth open. (B) Oscillogram (above) and spectrogram (below) of representative distress calls produced by a female *L. fragilis*.

When captured, the male also arched his body backwards between producing distress calls. In both cases, the distress calls were emitted with the frog's mouth open as has been observed for distress calls emitted by most anuran species studied (de Toledo and Haddad 2009, *op. cit.*, but see Figueiredo-de-Andrade et al. 2010. Herpetol. Notes 3:37–39). Distress calls in this species, as has been reported for other species, are not consistently triggered by humans handling the frogs.

The distress call of *L. fragilis* is similar in its general acoustic structure to the distress calls described for species in the *fuscus* and *pentadactylus* group (De Toledo and Haddad 2009, *op. cit.*: *L. pentadactylus*, *L. savage*, *L. mystacinus*, *L. fuscus*, *L. troglodytes*, and *L. vastus*; Toledo et al. 2005. Herpetol. Bull. 2005:29–31: *L. labyrinthicus*). Despite the large differences in advertisement calls among those species, the release calls are relatively similar, consisting of short, high-pitched screams. The characterization of the distress calls of *L. fragilis* reported here builds upon recent studies describing defensive calls in anurans. A robust set of descriptions of distress calls will allow further investigations to examine the function and evolution of this call type.

This observation was possible thanks to the support of Texas Tech University. I am thankful to L. Beaty who helped record the video of the female producing distress calls and to the Smithsonian Tropical Research Institute for help and logistics.

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***LEPTODACTYLUS FUSCUS* (Rufous Frog). PREDATION.** *Leptodactylus fuscus* is distributed in the neotropical region from

Panamá to Argentina, and to the eastern edge of the Andes Mountains. The species occupies open habitats and colonizes river edges and recently modified habitats in forested regions (Heyer and Reid 2003. Ann. Brazil. Acad. Sci. 75:39–54; Wynn and Heyer 2001. Tropical Zool. 14:255–285).

On 3 March 2010 we collected a DOR adult Burrowing Owl (*Athene cunicularia*). During examination of the stomach contents, a *Leptodacylus fuscus* was found along with 5 orthopterans, 5 coleopterans, and some unidentified material. Only the legs of the frog were well digested. The almost intact head and sacral region allowed identification. The owl was run over at km 46.7 at 0750 h on the route ES-060, a highway located in the Municipality of Guarapari, State of Espírito Santo, Brazil.

Athene cunicularia is a terrestrial species, with nocturnal and diurnal-crepuscular habits that occurs from Canada to Tierra del Fuego (Argentina). They live in fields, pastures, and salt marshes; populations are thought to be expanding due to increasing destruction of the forest landscape (Gervais et al. 2003. J. Wildl. Manag. 67:155–164; Sick 1997. Ornitologia Brasileira. Ed. Nova fronteira, Rio de Janeiro, Brazil. 862 pp.). The species inhabits holes in the ground. Several studies have shown this species has a generalized diet, consisting of arthropods and vertebrates (amphibians, reptiles, and mammals) (Martins and Egler 1990. Rev. Brasil. Biol. 50:579–584; Sick 1997, *op. cit.*; Motta-Júnior 2006. Ararajuba: Rev. Brasil. Ornitol. 14:359–377; Vieira and Teixeira 2008. Bol. Mus. Biol. Mello Leitão (n. Sér.) 23:5–14). This is the first report of *Leptodactylus fuscus* in the diet of *Athene cunicularia*.

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***LEPTODACYLUS AFF. MARMORATUS.* ALBINISM.** *Leptodacylus* aff. *marmoratus* is a frog widely distributed in the Atlantic Forest of northeastern Brazil (Freitas and Silva 2005. A Herpetofauna da Mata Atlântica Nordestina, Pelotas: Editora USEB). Here, we report an adult albino *L.* aff. *marmoratus* (17.2 mm SVL) collected on 14 June 2011 at 1530 h in the Parque Estadual de Dois Irmãos, municipality of Recife (8.002665°S, 34.942679°W, WGS 84) Albinism in adult anurans is rare in nature (Rodrigues and Oliveira Filho 2004. Herpetol. Rev. 35:373–373). This report is the first record of an albino *Leptodacylus* aff. *marmoratus*. The specimen was deposited in herpetological collection at the Universidade Federal Rural de Pernambuco/Unidade Acadêmica de Serra Talhada - UFRPE/UAST (CHUFRPE 1100), Serra Talhada, Pernambuco, Brazil.

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***LITHOBATES AREOLATUS CIRCULOSUS* (Northern Crawfish Frog). THWARTED PREDATION.** Heemeyer (2011. Thesis, Dept. Biology, Indiana State Univ.) has shown that snakes are major predators of Crawfish Frogs, but that frogs in burrows are 11.7 times less likely (deaths/day) to be preyed upon than frogs exhibiting breeding migrations or ranging behaviors. What is not clear is whether Crawfish Frogs in burrows are simply avoiding snakes, or whether burrows allow Crawfish Frogs to successfully defend themselves. When not breeding, Crawfish Frogs spend most of their time (up to 11 mo/yr) in or immediately adjacent to crayfish burrows (Heemeyer 2011, *op. cit.*). Crawfish Frogs will generally use the same burrow throughout the year unless forced to abandon it, for example, due to flooding (Heemeyer and Lannoo 2011. Herpetol. Rev. 42:261–262). This fidelity to specific burrows has allowed us to follow individual frogs for long periods of time using Cuddeback® (Non Typical Inc.) wildlife cameras set to photograph at 1-h intervals (the minimum interval programming allows; Hoffman et al. 2010. Bioscience 60:829–834). This monitoring effort has serendipitously allowed us to address the question of Crawfish Frog defense. On its feeding platform, a Crawfish Frog will typically position itself facing its burrow entrance, and when frightened will jump into the burrow, crawl a short ways down the burrow, then turn around to face the burrow entrance. Frogs in this position are usually within 7.5–15.0 cm of the soil surface (Thompson 1915. Sci. Pap. Univ. Michigan 10:1–7).

On 4 July 2011, Cuddeback® images showed that Frog 26 (110 mm SVL, 128 g) was out of its burrow most of the morning and early afternoon, through 1400 h (Fig. 1A). One hour later a Black Racer (*Coluber constrictor*) was photographed working the burrow entrance (Fig. 1B). One hour after that, the frog had not re-appeared (Fig. 1C), and in fact did not appear for another four hours, until 2000 h, when it assumed the same position it held at 1400 h (Fig. 1D). Black Racers will prey on Crawfish Frog adults and juveniles (Heemeyer 2011, *op. cit.*). A 110 cm total length Black Racer took a 97 mm SVL Crawfish Frog on 5 June 2010, and a 85 cm SVL Black Racer took a 105 mm SVL Crawfish Frog on 10 August 2010. From these data we suspect that the snake in Fig. 1 was large enough to have eaten Frog 26. Skin secretions from numerous dorsal granular glands of Crawfish Frogs exhibit antimicrobial properties (Ali et al. 2002. Biochim. Biophys. Acta 1601:55–63) rather than antipredatory properties, but see Heemeyer et al. (2010. Herpetol. Rev. 41:475). Altig (1972. Quart. J. Florida Acad. Sci. 35:212–216) has shown Crawfish Frogs

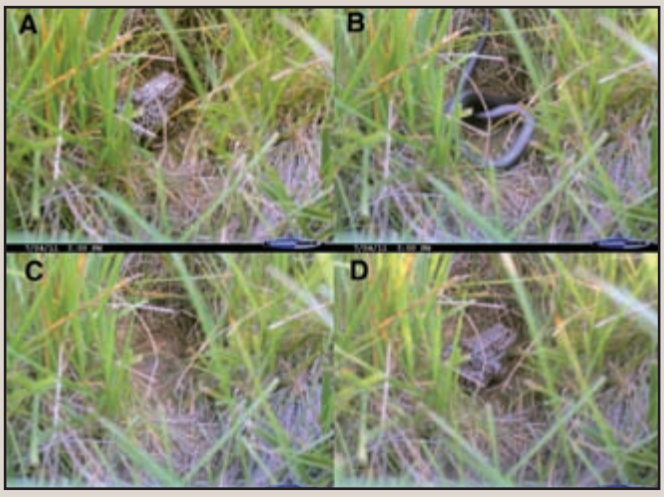


FIG. 1. Crawfish Frog number 26 on 4 July 2011. A) On its feeding platform at 1400 h; B) being attacked by an Eastern Black Racer at 1500 h; C) fate unknown; D) emerged from its burrow unharmed at 2000 h. When threatened Crawfish Frogs quickly jump into their burrow, turn around to face the threat, lower their heads, then inflate their bodies to forcibly press themselves against their burrow walls.

exhibit a defensive display, where they inflate their bodies and lower their heads. We have observed similar defensive displays in Crawfish Frogs inhabiting burrows. When inflating their bodies, adult Crawfish Frogs wedge themselves against their burrow walls (Engbrecht and Heemeyer 2011. Herpetol. Rev. 41:197) making extraction difficult (Heemeyer and Lannoo 2010. Herpetol. Rev. 41:168–170). Crawfish Frogs in burrows appear vulnerable to snake predation when lifting their head, which allows the snake to grab their jaws and gain purchase (Engbrecht and Heemeyer 2011, *op. cit*). With this exception in mind, it is clear from this sequence of photographs that crayfish burrows can assist Crawfish Frogs in defending themselves. Absent this protection, it is unlikely a Crawfish Frog would survive a snake attack such as the one recorded here.

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***PELOPHYLAX LESSONAE* (Pool Frog). PREDATION and REINTRODUCTION.** During surveys to monitor the reintroduction of the northern clade of *Pelophylax lessonae* at a site in Norfolk, UK (Buckley and Foster 2005. Reintroduction Strategy for the Pool Frog *Rana lessonae* in England. English Nature Research Report 642, Peterborough, UK) a male Grass Snake (*Natrix natrix*; 615 mm TL, 52 g) with a large prey bulge was captured (2 Aug 2009) and placed in a cloth bag, whereupon it regurgitated an adult male *P. lessonae* (58 mm SUL). The distal part of the left hind leg and most of the right hind leg had been digested, so body weight could not be measured directly. However, northern clade *P. lessonae* of this SUL weigh ca. 20 g (J. Buckley and J. Foster, unpubl. data), a relative prey mass of 0.38.

Natrix natrix feed primarily on amphibians, taking species depending upon availability (Gregory and Isaac 2004. J. Herpetol. 38:88–95). The frogs in this reintroduction program originate from Sweden where *N. natrix* also occur and presumably prey on this species. Nevertheless, at the present site anurans were scarce prior to the reintroduction of Pool Frogs. The current observation indicates that *N. natrix* there are able to exploit this new prey species, as they have done at a site in southeast England where they feed on the congeneric *P. ridibundus*, an introduced non-native species (Gregory and Isaac, *op. cit.*).

Grass Snakes are abundant at the reintroduction site but their impact on the Pool Frog program is unknown. The frog ingested was a relatively large male: mean SUL for males = 52 mm, range = 42–63, N = 54; females are a little larger, mean SUL = 54 mm, range = 42–74, N = 61 (J. Buckley and J. Foster, unpubl. data). Grass Snakes at this site are relatively small, although large adults in the population grow to 700–800 mm TL (unpubl. data), presumably large enough to prey on all sizes of *P. lessonae*.

I am grateful to Amphibian and Reptile Conservation, Anglian Water and Natural England for funding the Pool Frog reintroduction program.

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***PHYSALAEMUS ERIKAE*. DEFENSIVE BEHAVIOR.** One of the most common defensive strategies performed by some species of the family Leiuperidae is the elevation of the pelvic region, during which large dark inguinal glands are shown to potential predators (Duellman and Trueb 1994. Biology of Amphibians. McGraw-Hill Publ. Co., New York. 670 pp).

Physalaemus erikae is endemic to southern Bahia, Brazil and can be found on the borders of Atlantic Rainforest fragments, clearings, and cacao plantations (Cruz and Pimenta 2004. J. Herpetol. 38[4]:480–486). This species also shows inguinal glands, however these are much smaller than in other species that show the above described defensive display.

On 10 Oct 2009, in the municipality of Uruçuca we collected three *P. erikae* in a temporary pond near a cacao plantation. During a photo session in the laboratory one of the frogs (MZUESC 8417) assumed a defensive posture, lifting the body and opening its mouth when we pointed a finger in its direction. In most cases, the frog opened its mouth at the approach of the finger and closed it soon after, but in some cases the frog kept the mouth open even after the finger was removed. This behavior lasted about 90 seconds and was not displayed again by any of the collected frogs.

This behavior has been described for other amphibian species, but generally the behavior is more complex than the one related here. *Hemiphractus fasciatus* shows its orange tongue during the mouth opening display and may try to bite a predator; notably this species has a pair of odontoids on the lower jaw that are able to pierce human skin (Myers 1966. Herpetologica 22:68–71). When threatened, *Calyptocephalella gayi* inflates the lungs, raises its body, opens its mouth, emits loud vocalizations, and may even jump towards the potential predator (Veloso 1977. Herpetologica 33:434–442).

The defensive behavior observed in *P. erikae* is less complex, as the frog only adopted a threatening pose without any aggressive action towards the possible predator. This behavior is similar to that observed in species of the genus *Leptopelis* (Perret 1966. Zool. Jahrb. Syst. 93:289–464). Our report is the first case of this type of behavior in a species of the family Leiuperidae.

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***PROCERATOPHRYS AVELINOI, CYCLORAMPHUS ACANGATAN*. DEFENSIVE BEHAVIOR.** Frogs in the family Cycloramphidae exhibit defensive behaviors including thanatosis, contraction, chin-tucking, crouching down, inflating the body, and cloacal discharge (Toledo et al. 2010. J. Nat. Hist. 44:31–3.; Toledo et al. 2011. Ethol. Ecol. Evol. 23[1]:1–25).

Herein we report two species of the family Cycloramphidae performing the defensive behavior of contraction (sensu Toledo et al. 2010, *op. cit.*). The first observation occurred in the Parque das Perobas (23.483333°S, 51.983333°W) in the municipality of Maringá, state of Paraná, Brazil. Four *Proceratophrys avelinoi* were collected in pitfall traps on 9 Aug 2007, and when handled during removal from the bucket remained immobile for about two minutes, with hands and arms slightly raised at the side (Fig. 1A, B). The same behavior was observed on 2 Feb 2008, in a residual forest in the municipality of Embú-Guaçu (23.883333°S, 46.816666°W), state of São Paulo, Brazil. An adult *Cycloramphus acangatan* was caught in a pitfall trap, and when handled during removal from the bucket it remained motionless for three minutes with hands and arms slightly raised at the side (Fig. 1C, D). All individuals observed remained in this position for more than two minutes. After returning to the normal position, individuals of both species repeated the behavior after being handled again. Contraction is a defensive behavior exhibited by toxic species (Sazima 1974. J Herpetol. 8[4]:376–377). *Proceratophrys avelinoi* has a characteristically colored ventral region which might signal



FIG. 1. *Proceratophrys avelinoi* after being removed from a pitfall trap exhibiting contraction behavior; A) dorsal view, B) ventral view. Below *Cycloramphus acangatan* after being removed from a pitfall trap in a contracted position; C) dorsal view, D) ventral view.

toxicity. *Cycloramphus acangathan* is known to exhibit cloacal discharge (Toledo et al. 2011, *op. cit.*), although contraction has not been reported until now. This is the first record of contraction for the genus *Cycloramphus* and the first report for *P. avelinoi*.

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***PSEUDACRIS CRUCIFER* (Spring Peeper). PREDATION.** Cold tolerance and early emergence from hibernation may reduce overlap between breeding *Pseudacris crucifer* and ophidian predators. Nonetheless, *P. crucifer* is preyed upon by several species of snakes that forage in wetlands, including natricines (Gibbons and Dorcas 2004. North American Watersnakes: A Natural History. Univ. Oklahoma Press, Norman. 438 pp.; Carpenter 1952. Ecol. Monogr. 22:235–258; Test 1958. Copeia 1958:151–152). Despite moving long distances overland to forage in isolated ephemeral wetlands for amphibian prey (Roe et al. 2003. Biol. Cons. 188:79–89), *Nerodia erythrogaster* was not reported to prey upon *P. crucifer* by Gibbons and Dorcas (1994, *op. cit.*). Herein I provide observations of *N. erythrogaster* preying upon adult *P. crucifer* in breeding wetlands near Vicksburg, Warren Co., Mississippi, USA.

At ca. 1915 h, 13 March 1986, I observed a juvenile *N. erythrogaster* (28 cm total length) in an ephemeral wetland swallowing a gravid adult female *P. crucifer*. Several eggs had discharged through the frog's abdomen wall where pierced by the snake's teeth. Between 2030 and 2055 h, 13 April 1986, I observed five *N. erythrogaster* foraging in a borrow-pit pond in the floodplain of Hatcher Bayou. Upon capture, one snake disgorged an adult *P. crucifer* (sex not recorded).

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***RANA BOYLII* (Foothill Yellow-legged Frog). UPLAND MOVEMENT.** *Rana boylii* is primarily a stream-dwelling species that may make modest migrations along stream corridors (Fellers 2005. *In* M. Lannoo [ed.], Amphibian Declines: the Conservation Status of United States Species, pp. 534–536. Univ. California Press, Berkeley, California). It is usually found near water (Nussbaum et al. 1983. Amphibians and Reptiles of the Pacific Northwest. Univ. Press Idaho, Moscow, Idaho; Stebbins 2003. A Field Guide to Western Reptiles and Amphibians, 3rd ed. Houghton Mifflin Co., Boston, Massachusetts. 533 pp.) and rarely more than a meter from the shoreline (Storer 1925. Amphibia of California. Univ. California Press, Berkeley California). However, Nussbaum et al. (1983, *op. cit.*) reported finding small *R. boylii* over 50 m from a river. As this frog is considered a stream-dwelling species, the effect of the loss of adjacent uplands has not been well studied. Here we describe frequent observations of *R. boylii* far from a natal stream and in an urban setting.

We conducted evening road surveys during rainfall and other ad hoc visual encounter sampling in the vicinity of the perennial Sulphur Creek, east of Ukiah, California, USA. We also conducted egg mass surveys along a 0.8 km reach of Sulphur Creek. This study reach of the creek is surrounded by residential development on the south side consisting of over 70 houses with manicured lawns and/or landscaping accessed by two-lane asphalt roads that parallel Sulphur Creek. Most of our observations were on roads separated from the creek by one or more rows of residential houses. Piecemeal developments and a two-lane paved road parallel the creek on the north side.

We found a total of 60 juvenile *R. boylii* in the residential study area during spring and fall from 2008 to 2011. Fifty-six were found on residential roadways with 7 of these frogs apparently killed by vehicles. We also found two crushed *R. boylii* beneath a boat cover on a concrete driveway in front of a residential house and two more frogs in nearby landscaping. The largest single-evening observation was 40 *R. boylii* on 11 Oct 2011. Most observed frogs appeared to be moving away from the creek. Although not recorded, we observed frogs on roadways for several years prior to 2008. The distance of *R. boylii* observations from Sulphur Creek ranged from 16 m to 331 m with an average distance of 71.3 m. On 1 May 2011 we found 27 egg masses and two juvenile *R. boylii* in Sulphur Creek indicating that the study reach is a natal stream for the species. Other amphibians detected on roadways and front yards included California Newts (*Taricha torosa*), Western Toads (*Anaxyrus boreas*), and Pacific Chorus Frogs (*Pseudacris regilla*).

These findings suggest that *R. boylii* may use upland habitat far more than previously reported. Also, the loss of creek habitat and alterations to hydrology are major conservation concerns (Fellers 2005, *op. cit.*). Our observations of road mortality and other dead frogs suggest that *R. boylii* are susceptible to indirect impacts from urbanization.

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TESTUDINES — TURTLES

***CHELYDRA SERPENTINA* (Snapping Turtle). DIET.** *Chelydra serpentina* is an omnivorous species known to consume a wide variety of plants and animals (Ernst and Lovich 2009. Turtles of the United States and Canada, 2nd ed. Johns Hopkins University Press, Baltimore, Maryland. 827 pp.). In Florida, *C. serpentina* has been reported to eat *Colocasia esculenta*, *Elodea* sp., *Lemna* sp., *Najas* sp., *Nelumbo lutea*, *Nymphaea* sp., *Sagittaria* sp., *Spirodela polyrhiza*, *Typha* sp., *Utricularia* sp., and *Vallisneria* sp. (Aresco et al. 2006. *In* P. A. Meylan [ed.], Biology and Conservation of Florida Turtles, pp. 44–57. Chelonian Res. Monogr. No. 3; Punzo 1975. J. Herpetol. 9:207–210). Herein is the first report of *C. serpentina* feeding on Hydrilla (*Hydrilla verticillata*), an invasive aquarium species (originally from southern India) that has been established throughout Florida since the 1970s (Langeland 1996. Castanea 61:293–304).

On 3 April 2011 at approximately 2000 h, we observed an adult male *C. serpentina* (straight midline carapace length = 365 mm, mass = 10.25 kg) at Naked Spring, Gilchrist Co., Florida, USA (29.82993°N, 82.68124°W; WGS84; elev. 8 m) consuming *H. verticillata* continuously for approximately five minutes. Hydrilla is abundant in this spring and grows too rapidly to be controlled by the foraging activities of all resident animal populations at this site, but it may at least provide some nutritional value to *C. serpentina*.

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***EMYDOIDEA BLANDINGII* (Blanding's Turtle). RECORD CLUTCH SIZE.** Nesting activity in a population of *Emydoidea blandingii* in Algonquin Provincial Park, Ontario has been monitored annually since 2007. On 17 June 2011, an unmarked female was found nesting at 2100 h on a gravel road, and she laid 25 eggs. The female weighed 1920 g post-oviposition, and had a straight-line carapace length of 244 mm. A predator exclusion cage was buried over the top and down the sides of the nest to prevent predation of the eggs. Beginning in August, the nest was monitored daily for emerging hatchlings. On 17 September 2011, after 92 days of incubation, four hatchlings were observed on the ground surface under the cage. Upon excavation, another 21 hatchlings were found hatched and alive within the nest chamber (Fig. 1). This nest experienced 100% hatching success, defined as the proportion of eggs laid that hatched. Hatchling body mass ranged from 8.0 to 10.2 g (mean ± SE = 9.50 ± 0.09 g) and straight-line carapace length ranged from 31.1 to 36.2 mm (34.1 ± 2.2 mm). Hatchlings from this nest were similar in size to those emerging from nests with smaller clutch sizes (N = 91; mass: 8.74 ± 0.08 g, range 6.5–10.2 g; straight-line carapace length: 32.8 ± 0.1 mm, range 27.3–35.8 mm) at our study site.

Previously reported clutch sizes for *E. blandingii* range from 3 to 24 eggs (Ernst and Lovich 2009. Turtles of the United States and Canada, 2nd ed. Johns Hopkins University Press, Baltimore, Maryland. 827 pp.; Rowe 1992. Can. J. Zool. 70:1690–1695; Ruane et al. 2008. Copeia. 2008:771–779). As the clutch we observed is greater by one egg than the previous maximum of 24 eggs, our observation serves as a new record for the largest reported Blanding's Turtle clutch size. Our clutch size observation is from a population near the northern range limit for the species, where both female body size and clutch sizes may reach their maximum (Iverson et al. 1993. Can. J. Zool. 71:2448–2460).



PHOTO BY BETH McLAREN

FIG. 1. Hatchlings (N = 25) of *Emydoidea blandingii* in Algonquin Provincial Park, Ontario from a clutch of 25 eggs emerged on 17 September 2011.

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***GLYPTEMYS INSCULPTA* (Wood Turtle). AGGRESSIVE BEHAVIOR.** Male *Glyptemys insculpta* are believed to form linear dominance hierarchies which are enforced by ritualistic fighting (biting, lunging, and mounting) and may determine access to females (Kaufmann 1992. Herpetol. Monogr. 6:1–25). Dominance has apparently not been reported for female *G. insculpta* (or any freshwater turtle). However, Walde et al. (2007. Herpetol. Conserv. Biol. 2:49–60) reported that female *G. insculpta* bypassed suitable nesting beaches used by conspecifics. The observations reported below suggest that dominance relationships may exist among female *G. insculpta* competing for preferred nesting sites.

On 17 June 2009 I observed three female *G. insculpta* digging (presumably testing potential nest sites) on a 15 x 10 m gravel bar along the Ontonagon River in the western Upper Peninsula of Michigan, USA. At approximately 2130 h, I observed one female (Turtle 1) on this nesting beach digging in the gravel with her front feet. At 2131 h another female (Turtle 2) emerged from the river, crawled onto the nesting beach, and started digging about a 1.5 m from Turtle 1. At 2133 h, a third female (Turtle 3) emerged from the river, approached, then bit and lunged toward Turtle 1. Turtle 1 moved to another spot on the beach. Turtle 3 moved toward Turtle 2 and repeated the behaviors that she had just directed toward Turtle 1. Turtle 2 moved to a different spot on the beach as well. Both of the turtles that retreated moved to areas of the beach

that were lower and closer to the river, and then resumed digging. Turtle 3 started digging at 2140 h at the point where Turtle 1 had been digging at 2130 h. These turtles stayed in these positions until dark (~ 23 h) when I could no longer observe them.

The aggressive/ submissive behaviors of female *G. insculpta* reported here may represent competition for favored nest sites. Nest sites on higher ground may be favored over lower areas on the beach due to the chance of periodic flooding. Fighting over nest sites may be advantageous when they are a limited resource. While there appeared to be ample suitable nest sites on this particular gravel bar, the quality of a nest site from the standpoint of a nesting turtle is likely based on a number of variables. Substrate, soil temperature and moisture, elevation, and aspect are potentially important factors in nest site selection (Buech et al. 1997. *In* J. Van Abbema [ed.], Proceedings: Conservation, Restoration, and Management of Tortoises and Turtles—An International Conference, pp. 383–391. New York Turtle and Tortoise Society, New York; Hughes et al. 2009. Northeast. Nat. 16:321).

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***KINOSTERNON SUBRUBRUM* (Eastern Mud Turtle). OVERWINTERING.** *Kinosternon subrubrum* is one of a few freshwater turtle species that will reportedly overwinter on land or under water. Intriguingly, within a population, a few turtles may choose to overwinter in water, while most choose terrestrial environments (Ultsch 2006. Biol. Revs. 81:339–367). In an effort to determine the overwintering sites of a *K. subrubrum* population in the Coastal Plain of Maryland, we radio-tracked turtles during two consecutive overwintering seasons (November–February 2008–2010).

All turtles selected terrestrial overwintering sites in deciduous forests at distances of 55–224 m (N = 8; 2008–2009) and 61–190 m (N = 7; 2009–2010) from the wetland's edge. Turtles excavated burrows with mean depths of 13.2 ± 1.6 cm (10.4–15.3 cm, N = 6) in 2008–2009, and 12.1 ± 6.4 cm (7.0–25.0 cm, N = 7) in 2009–2010. These data suggest that Maryland *K. subrubrum* may use deep burrowing to avoid freezing temperatures. In contrast, the depth of terrestrial burrows was shallow (2–11 cm) and uncorrelated with the time of year in 27 South Carolina *K. subrubrum* (Bennett et al. 1970. Ecology 51:738–740). *Kinosternon subrubrum* appear to construct deeper overwintering burrows at higher latitudes as we report a maximum depth of 25 cm in Maryland, which is comparable to 24 cm in New York (Wetmore and Harper 1917. Copeia [45]:56–59). Our conclusions are preliminary and require validation through comparisons of burrowing depths at different times of year (i.e., summer versus winter). Also, habitat variables need to be accounted for. Nonetheless, these observations should be informative to future studies of overwintering strategies in kinosternid turtles.

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***TERRAPENE CAROLINA CAROLINA* (Eastern Box Turtle). MOVEMENT AFTER HURRICANE.** On 27–28 August 2011, Hurricane Irene passed through Abingdon, Maryland, USA (wind gusts = 80 km/h, precipitation = 11 cm). Most of the rainfall occurred on the evening of 27 August. The high winds continued into the morning of 28 August, but by the evening, it was calm and sunny. On 29 August, between 1200 and 1500 h, radio telemetry was used to locate eight *Terrapene c. carolina* (four males, four females) at the Anita C. Leight Estuary Center (Abingdon). Seven of these turtles were walking, and the one stationary female was sitting almost fully exposed in a pile of leaves (only the rear of her carapace was covered). Also, three additional box turtles (two males, one female) which did not have transmitters were randomly encountered; all three were walking.

This high level of activity is unusual for several reasons. First, turtles have been tracked at the Estuary Center since 2005 (2 in 2005 and 2006, 4 in 2007 and 2008, 13 in 2009, 11 in 2010, and 8 in 2011), but prior to 29 August 2011 we had never observed such a large number moving simultaneously. Generally, only a small proportion of telemetered turtles are active, while the majority are buried under leaves or hiding in bushes (even during and immediately following rainstorms). Second, at the Estuary Center, it is rare to randomly encounter three turtles within three hours, and previous instances have nearly always been during or immediately following a rainstorm. Third, it is well documented that box turtles are most active during rain (presumably for foraging), however, the forest floor was dry at the time that the above observations were made, and the sky was sunny and clear (31°C) (Strang 1983. J. Herptol. 17:43–47). There is typically relatively little turtle activity on days with these climatic conditions. Finally, we have observed (and it has been reported for other subspecies) that *Terrapene c. carolina* is typically active in the morning and late afternoon and is usually largely inactive during the afternoon (Dodd 2001. North American Box Turtles: A Natural History. Univ. Oklahoma Press, Norman, Oklahoma. 231 pp.).

It seems possible that *Terrapene c. carolina* may spend additional time exploring its home range immediately following large climatic disturbance events. This may enable the turtles to become familiar with changes that have taken place. Multiple studies have shown that box turtles have an excellent spatial memory, and the memorization of food-rich locations seems to play an important role in their foraging behavior (McKnight 2011. Herpetol. Notes. 4:97–102; Parker 1982. Southwest. Nat. 27:365). A large storm (such as Hurricane Irene) which knocks down many trees could potentially destroy key foraging areas (or create new ones), create barriers which prevent turtles from accessing foraging sites, or force turtles to take new routes to these sites. Therefore, after major storms, box turtles may benefit from quickly relearning attributes of their home ranges. Though admittedly speculative, this factor might explain, in part, the unusually high activity levels observed the day after Hurricane Irene.

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CROCODYLIA—CROCODILIANS

***CAIMAN CROCODILUS* (Spectacled Caiman). HOMOSEXUAL BEHAVIOR.** On 24 March 2011, I captured a *Caiman crocodilus* for a biological study in the Orinoco Llanos region, Natural Reserve Palmarito, Casanare, Colombia (4.820956°N, 71.635661°W). The caiman was measured (SVL = 103.4 cm), sexed as male by cloacal inspection (Brazaitis 1968. Brit. J. Herpetol. 4:54–58), marked with a metallic tag (No. AV005) and released at the point of capture, a small stream called caño Las Palomas, 4 m wide and



FIG. 1. Two *Caiman crocodilus* males in copulatory position during the dry season at Natural Reserva Palmarito, Casanare, Colombia.

1.2 m deep at that point. Once in the water, AV005 grunted softly several times and immediately another *C. crocodilus* swam towards him from 3 m away and stood on his back. During a period of 8 min. (from 1307 h to 1315 h), the second caiman tried to get into a latero-ventral position by grabbing AV005 with its hind leg and tail toward his body. This behavior has been described as the step prior to mating in *C. crocodilus chiapasus* in México (Álvarez del Toro 1974. Inst. Mex. de Recursos Renovables, 70 pp.) and for *C. crocodilus crocodilus* in Venezuela (Staton and Dixon 1977. Wildlife Research Report 5, U.S. Fish and Wildlife Service). During this time no aggression was observed and no sounds were emitted by the caimans. AV005 swam slowly twice for no more than 3 meters. He did not try to escape at any moment. As the size and behavior of the second caiman suggested that it was also a male and it was clear that it was trying to copulate, I asked the person providing field assistance (a local cowboy) to rope in the caiman. The second caiman was captured (SVL = 101 cm) and also was sexed as a male, as determined by the presence of a penis.

There is no doubt regarding the sex of either caiman, due to the presence of a penis and SVL measured >90 cm (Ayarzagüena 1983. Doñ. Act. Vert. 10[3], 136 pp.; Antelo, unpubl. data), nor is there doubt about the intent of copulation.

Homosexual behavior has been described for at least 470 species (for a review see Bagemihl 1999. Biological Exuberance: Animal Homosexuality and Natural Diversity. St. Martin's Press, New York. 751 pp.), including lizards (Cole and Townsend 1983. Anim. Behav. 31:724–728; Werner 1980. Zeitschrift für Tierpsychol. 54:144–150), but to my knowledge, this is the first observation of homosexual behavior for any species of crocodilian.

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SQUAMATA — LIZARDS

***AMEIVA AMEIVA* (Common South American Green Lizard). PREY AND FEEDING BEHAVIOR.** *Ameiva ameiva* is one of the most common teiid lizards found both in open and forested areas in South America, occurring from northern Argentina to the Amazon and northeastern Brazil (Vitt and Colli 1994. Can. J. Zool 72:1986–2008). Many ecological studies on this species exist (e.g., Colli 1991. Copeia 1991:1002–1012; Vitt and Carvalho 1995. Copeia 1995:305–329; Vitt and Colli 1994, *op. cit.*). *Ameiva ameiva* is known to prey mainly on insects, especially small beetles (Vitt and Colli 1994, *op. cit.*), however, feeding behavior and the relationship between body size of the lizard and its prey species remain poorly known. During a survey on 23 March 2009 conducted at Porto Trombetas, Oriximiná municipality, Pará State, Brazil (1.46333°S, 56.37083°W), an adult female *A. ameiva* (ca. 15 cm SVL) was observed preying on a large adult cerambycid beetle (total length >6 cm), the body of which was more than twice the width of the lizard's head. The skill shown by the lizard to kill and eat the beetle was remarkable and documented herein. The lizard was observed actively foraging in a grassland area at 1200 h. When the beetle was found within the grass, it was bitten by the lizard between the head and thorax, the lizard struggling to sever the head from the body. At this moment, the beetle was displaying defensive behaviors, opening its elytra and trying to bite the lizard. The insect's wing movements made manipulation difficult by the predator (Robinson 1968. Psyche 75:195–207), and cerambycid beetles also have strong maxillae that they use to cut wood and to provide protection against predators or conspecifics (Ray et al. 2008. Environ. Entomol. 38:425–432). The specimen being preyed upon by *A. ameiva* expressed great maxillae (ca. 1 cm), and while continually moving them, they eventually reached the tail and posterior legs of the lizard. The lizard continued biting the beetle between the head and the thorax and then turned it onto its back, pressing the articulation points of the open elytra and breaking them one at a time. Following this, the lizard continued to bite until the head was completely severed from the beetle's body. Grasping the beetle by its anterior legs, the lizard tore off its membranous wings and then discarded them, ingesting only the beetle's abdomen and the remaining thorax. Finally, the lizard swallowed the severed head posteriorly. The total time of the interaction was about five minutes.

The encounter of *Ameiva ameiva* and the cerambycid beetle presented here allows some considerations on the behavior of this lizard species. The ability to break the wings of the beetle one by one after turning it onto its back suggests that feeding behavior of this species shows cognitive deliberation abilities and perhaps this is one of the determinant conditions for the ubiquitous distribution of this lizard throughout several ecosystems of South America. The ability of *A. ameiva* to subjugate an aggressive, well-armored arthropod of such a large size suggests that the lizard probably is capable of preying upon several other great invertebrates, in addition to small vertebrates. Further, it is possible that the most frequent findings of small insects in the gut contents of this species (e.g., data presented by Colli [1991, *op. cit.*] and Vitt and Colli [1994, *op. cit.*]) might be the result of greater availability of smaller prey rather than indicating higher priority prey items in nature.

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***ASPIDOSCELIS COZUMELA* (Isla de Cozumel Whiptail). LIFE HISTORY.** The diploid parthenogenetic *Aspidoscelis cozumela* complex of whiptail lizards (sensu Reeder et al. 2002. Am. Mus. Novit. 3365:1–61) comprises either two species (*A. cozumela* and *A. rodecki*; Fritts 1969. Copeia 1969:519–535; Hernández-Gallegos et al. 1998. Biogeographica 74:117–124) or three species (*A.*

cozumela, A. maslini, and *A. rodecki*: Taylor and Cooley 1995a. Herpetologica 51:67–76; Taylor and Cooley 1995b. J. Herpetol. 29:583–592; Manríquez-Morán et al. 2000. J. Herpetol. 34:634–637; Taylor et al. 2005. J. Herpetol. 39:266–277; Liner 2007. Occas. Pap. Mus. Nat. Sci., Louisiana State Univ. 80:1–60; Elizalde-Rocha et al. 2008. Rev. Biol. Trop. [Int. J. Trop. Biol.] 56:1871–1881) depending on the taxonomic concept accepted. I agree with workers who regard *A. cozumela* as an endemic species to Isla de Cozumel, Quintana Roo (Taylor and Cooley 1995a, b, *op. cit.*; Manríquez-Morán et al. 2000, *op. cit.*; Taylor et al., *op. cit.*; Liner, *op. cit.*), the largest Mexican Atlantic island, situated in the Caribbean Sea ca. 25 km from Puerto Morelos of the Yucatán Peninsula. Manríquez-Morán et al (2000, *op. cit.*) hypothesized that *A. cozumela* was derived from an individual of *A. maslini* from the mainland possessing three centromeric fissions among its chromosomes, the latter species itself a hybrid derivative of *A. angusticeps* × A. *deppii* (Fritts, *op. cit.*; Moritz et al. 1992. Herpetologica 48:417–424; Hernández-Gallegos et al. 1998, *op. cit.*). Here, I provide data on reproduction (clutch range and $\bar{x}$ ± SE; SVL range and $\bar{x}$ ± SE; yolked follicle range and $\bar{x}$ ± SE; length and width of oviductal eggs range and $\bar{x}$ ± SE), sample composition (number of generations present), and life cycle (age at maturity and life span) for an insular species that utilizes human-modified (e.g., urban development) and hurricane-impacted (e.g., by Category 4 Wilma on 21 October 2005) coastal habitats elevated only a few meters above sea level. According to Konrad (1996. Caribbean Tropical Storms. RCM 1:98–130), the northeast tip of the Yucatán Peninsula near the island in question receives the greatest number of hurricane strikes in the region.

I examined 169 (86.2%) of the 196 specimens of *A. cozumela* listed by site from the University of Colorado Museum of Natural Histiory (UCM), including those transferred to the California Academy of Science (CAS), obtained in 1959 (N = 79) and 1961 (N = 117) by T. P. Maslin and associates (see McCoy and Maslin 1962. Copeia 1962:620–627) on Isla de Cozumel: 3 km N of San Miguel de Cozumel [26 June 1959 (UCM 12454, N = 1); 28 June 1959 (UCM 12455–12475, N = 21)]; 4 km N of San Miguel de Cozumel [29 June 1959 (UCM 12476–12500, N = 25); 5 km S of San Miguel de Cozumel [1 July 1961 (UCM 15415–15436, N = 22); 4 July 1961 (UCM 15437–15450, 15451–15460 (= CAS 94032–94041), 15461, N = 25); 9 km SE of San Miguel de Cozumel at a lagoon [30 June 1959 (UCM 12501–12532, N = 32); San Miguel de Cozumel [2 July 1961 (UCM 15400–15414, N = 15); 1–2 July 1961 (UCM 15462–15516, N = 55)]. I also examined specimens from the University of Kansas Natural History Museum (KU) collected in 1962 by W. E. Duellman and associates on Isla de Cozumel at 3.5 km N of San Miguel de Cozumel [8 August 1962 (KU 70762–70790, N = 29)]. I obtained size (as SVL to the nearest 1 mm) for all *A. cozumela* from KU, and all except 27 females of *A. cozumela* from UCM, transferred to museums other than the CAS, from the original UCM numbered sample. Females of this species from UCM were dissected to count and measure oviductal eggs and yolked ovarian follicles.

The 26–30 June 1959 UCM sample of *A. cozumela* included by sizes (as 5 mm SVL increments where applicable) these frequencies for 68 specimens: 30–34 (1, 1.5%); 50–54 (2, 2.9%); 55–59 (13, 19.1%); 60–64 (20, 29.4%); 65–69 (14, 20.6%); 70–74 (16, 23.5%); and 75–77 (2, 2.9%). Among these was 1 individual of 33 mm SVL hatched a few days before it was collected. With the possible exception of two individuals of 50–54 mm SVL, all other specimens in the sample were reproductively mature, some of the smallest of which possibly represented mature young-of-year (YOY) and the largest being in the second summer of life based on subsequent studies of *A. cozumela* by Oswaldo Hernández-Gallegos (pers. comm.). The 1–4 July 1961 UCM sample of *A. cozumela* included by sizes (as 5 mm SVL increments where applicable) these frequencies for 101 specimens: 30–34 (15, 14.9%); 35–39 (13, 12.9%); 40–44 (1, 1.0%); 55–59 (9, 8.9%); 60–64 (29, 28.7%); 65–69 (17, 16.8%); 70–74 (9, 8.9%); and 75–77 (8, 7.9%). This sample included a large number of YOY lizards (30–44 mm SVL, N = 29, 28.7%), apparently from asynchronous early clutches (see Manríquez-Morán et al. 2005. Herpetologica 61:435–439; fig. 1); all other individuals in the sample were reproductively mature, and possibly represented a minimum of two year classes. The 8 August 1962 KU sample of *A. cozumela* included by sizes (as 5 mm SVL increments where applicable) these frequencies for 29 specimens: 30–34 (2, 6.9%); 45–49 (1, 3.4%); 50–54 (2, 6.9%), 55–59 (2, 6.9%); 60–64 (11, 37.9%); 65–69 (7, 24.1%); 70–74 (2, 6.9%); and 75–77 (2, 6.9%). This sample included only three definite YOY lizards (30–49 mm, 10.3%); all other individuals in the sample were reproductively mature or nearly so. Based on the 1959 UCM sample, *A. cozumela* attains reproductive maturity at ca. 52 mm SVL. Each of the following statements for a SVL group includes the numbers of gravid females followed by clutch size based on the same or a smaller number of lizards with undamaged eggs. Among females 50–54 mm SVL, 2 (100 %) were gravid; clutch size was 1 in the undamaged lizard. Among 13 females 55–59 mm SVL, 2 (15.4%) were gravid; clutch size was 2 in the undamaged lizard. Among 20 females 60–64 mm SVL, 7 (35%) were gravid; clutch size was 1–2 ($\bar{x}$= 1.7 ± 0.17 SD, N = 7). Among 14 females 65–69 mm SVL, 6 (42.9%) were gravid; clutch size was 2 ($\bar{x}$= 2.0, N = 6). Among 16 females 70–74 mm SVL, 6 (37.5%) were gravid; clutch size was 1–2 ($\bar{x}$= 1.7 ± 0.21, N = 6). Among females 75–77 mm SVL, 2 (100%) were gravid; clutch size was 1–2 ($\bar{x}$= 1.5 ± 0.50, N = 2). Overall, 67 (98.5%) lizards examined in the 1959 sample were sexually mature; however, only 25 (37.3%) were gravid owing to apparent asynchrony in reproductive cycles among females (see Manríquez-Morán et al. 2005., *op. cit.*). Only 8 (11.9%) of these females contained oviductal eggs. Mean clutch size for all gravid 1959 females is 1.7 (1–2, N = 24); each individual with oviductal eggs had a clutch of 2. Based on the 1961 sample, *A. cozumela* attains reproductive maturity at ca. 55 mm SVL, 3 mm larger than reflected by the 1959 sample. That size at maturity is variable in this species is further evidenced by these data for smallest gravid females: 56 mm SVL in 1994–1995 (Manríquez-Morán et al. 2005, *op. cit.*) and 54–59 mm SVL in 1997–2002 (Hernández-Gallegos et al. (2003. Biogeographica 79:1–17). Pertaining to the 1961 UCM sample, among 9 females 55–59 mm SVL, 2 (22.2%) were gravid; clutch size was 2 ($\bar{x}$= 2.0, N = 2). Among 29 females 60–64 mm SVL, 7 (27.5%) were gravid; clutch size was 1–2 ($\bar{x}$= 1.6 ± 0.19, N = 7). Among 17 females 65–69 mm SVL, 8 (47.0%) were gravid; clutch size was 1–2 ($\bar{x}$= 1.6 ± 0.20, N = 8). Among 9 females 70–74 mm SVL, 1 (11.1%) was gravid; clutch size was 2. Among 8 females 75–76 mm SVL, 1 (12.5%) was gravid; clutch size was 3. Overall, 72 (71.3%) lizards in the 1961 sample were mature adults, 19 (18.8%) were gravid, and 3 (3.0%) contained oviductal eggs. Mean clutch size for all 1961 gravid females was 1.7 (1–3 ± 0.13, N = 19); individuals with oviductal eggs had clutches of 2.

In the pooled 1959 and 1961 UCM sample, females with data (N = 43) had clutches (sample size in each category in parens) of 1 (13), 2 (29), and 3 (1); mean clutch size and SVL for these females were 1.7 ± 0.08 (1–3) eggs and 65.4 ± 0.87 (52–77) mm, respectively. Among the 140 adult females ($\bar{x}$= 64.8 ± 0.51, 52–78

mm SVL) in the pooled sample of *A. cozumela* were 31 (22.3%) containing yolked ovarian follicle of 3–10 ($\bar{x}$= 6.1 ± 0.50) mm in diameter, 11 (7.9%) with oviductal eggs of 8–9.5 ($\bar{x}$= 8.4 ± 0.15) mm in width and 15–19 ($\bar{x}$= 16.0 ± 0.50) mm in length, and 97 (69.7%) that were not gravid. None of the variation in clutch size among 43 females could be explained by SVL (based on adjusted r^2 = 0.0365, P = 0.12).

Over 30 years after T. P. Maslin and associates obtained the large samples of *A. cozumela* in the vicinity of San Miguel de Cozumel (ca. 20.5117°N, 86.9462°W; datum: WGS84; elev. ca. 1 m) on the northwestern "corner"of Isla Cozumel in 1959 and 1961, Manríquez-Morán et al. (2005, *op. cit.*) reported on 70 specimens obtained in monthly sampling (November 1994–October 1995) ca. 25 km to the northeast on the eastern coast of the island (20.6000°N, 86.7333°W; datum: WGS84, elev. 2 m). Their data for 18 gravid females, clutch size based on oviductal eggs ($\bar{x}$= 1.8 ± 0.71, 1–4), SVL ($\bar{x}$= 64.5 ± 1.20) mm, and width ($\bar{x}$= 8.5 ± 0.68 mm) and length ($\bar{x}$= 15.3 ± 1.28 mm) of freshly laid eggs, for an east coast group of the species are similar to my findings for western groups. Moreover, the correlation reported by Manríquez-Morán et al. (2005, *op. cit.*) between clutch size and SVL in 18 *A. cozumela* (r^2 = 0.44, P = 0.0028) is contingent upon one female with 4 eggs, all other others having clutches of 1 (N = 5) or 2 (N = 12) eggs. Exclusive of the "outlier," among the remaining 17 specimens there is no correlation between clutch size and SVL (r^2 = 0.0869, P = 0.13), as was similarly reported for samples analyzed in this study. Combining data from both studies, only 2 (3.3%) females of 60 gravid *A. cozumela* had clutches greater than 2 eggs (i.e., 3 and 4).

Data presented by Manríquez-Morán et al. (2005, *op. cit.*; fig. 1) for *A. cozumela* revealed only immature lizards to be active in October–February; adult and immature lizards were present in March–September samples. Hernández-Gallegos et al. (2003, *op. cit.*) concluded that *A. cozumela* is an essentially annual species. Hatchlings produced over several weeks or months in one calendar year grow to adulthood at various time in the next year and most die in early fall. Hernández-Gallegos (2004. Ph.D. thesis, Universidad Nacional Autónoma de México) provided evidence of essentially annual life cycles for Yucatecan whiptail lizards based on survival rates for the parthenogenetic species *A. cozumela* (4.5%) and *A. maslini* (10.9%) and their gonochoristic ancestors *A. depii* (6.3%) and *A. angusticeps* (11.5%). Using these activity patterns, it is possible to infer the essentials of the life cycle of *A. cozumela* (i.e., account for the content of the 1961 UCM sample of *A. cozumela*). Individuals of 30–44 mm SVL were likely hatched within six weeks of the dates of collection 1–4 July; they would have remained active the rest of the year and into their first reproductive season beginning in March or April of the following year. SVL growth would continue as vitellogenesis began; by then most of these females in the 1961 UCM sample would have been 55–69 mm SVL. Based on this reasoning, most adult lizards in the 1961 sample of *A. cozumela* were hatched in the summer of 1960. However, it is reasonable to infer that a few lizards in the 68–77 mm SVL range were in their third summer of life (i.e., 2 calendar years of age); this would be consistent with the low survival rates reported *A. cozumela* and other Yucatecan species of *Aspidocelis* by Hernández-Gallegos (2004, *op. cit.*). In conclusion, *A. cozumela* is a small, rapidly maturing, and short-lived whiptail species. I concur that most individuals of *A. cozumela* die within a year of hatching as reported for the species by Hernández-Gallegos et al. (2003, *op. cit.*) and Manríquez-Morán et al. (2005, *op. cit*). Nevertheless, collecting success reflected by the museum holdings and published works recorded herein indicate that *A. cozumela*, characterized by small size, rapid maturation, and multiple clutches, continues to maintain high population densities in mostly coastal habitats on Isla de Cozumel (Manríquez-Morán et al. 2008. Revista Mexicana de Biodiversidad 79:421–426; fig. 1) allopatric to Yucatecan congeners (i.e., *A. angusticeps*, *A. deppii*, *A. maslini*, and *A. rodecki*).

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***ASPIDOSCELIS INORNATA CIENEGAE* (Cuatro Cienegas Whiptail). PREDATION.** On 7 September 2010 at 1214 h we observed a juvenile male *Coluber* (=*Masticophis*) *taeniatus* (432 mm SVL), predating an individual *Aspidoscelis inornata cienegae* at the base of a mesquite tree (*Prosopis glandulosa*) in the eastern portion of the Cuatrocienegas Basin, state of Coahuila, Mexico, 1.2 km W of Rancho Pozas Azules (26.80957°N, 102.01943°W, [datum WGS84] 717 m. elev.). The *C. taeniatus* was collected and deposited in the Collection of Museo de Zoología Facultad de Ciencias, UNAM (MZFC 25287). This is the first report of a predator of this endemic *A. inornata* subspecies (Wright 1994. Southwest. Herpetol. Soc. Spec. Publ. 5:255–271; Wright and Lowe 1993. J. Arizona-Nevada Acad. Sci. 27:129–271).

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***ASPIDOSCELIS RODECKI* (Rodeck's Whiptail). LIFE HISTORY.** Diploid parthenogenetic *Aspidoscelis rodecki* was described as a subspecies of *A. cozumela* (=*Cnemidophorus cozumelus*) by McCoy and Maslin (1962. Copeia 1962:620–627) and either redefined or confirmed as a species by Fritts (1969. Copeia 1969:519–535), Taylor and Cooley (1995. Herpetologica 51:67–76), Hernández-Gallegos et al. (1998. Biogeographica 74:117–124), Taylor et al. (2005. J. Herpetol. 39:266–277), Liner (2007. Occ. Pap. Mus. Nat. Sci., Louisiana State Univ. 80:1–60), and Elizalde-Rocha et al. (2008. Rev. Biol. Trop. [Int. J. Trop. Biol.] 56:1871–1881). Currently, all-female groups of lizards allocated to *A. rodecki* (*sensu* Reeder et al. 2002. Am. Mus. Novit. 3365:1-61; Elizalde–Rocha et al., *op. cit.*) are present on the Yucatán Peninsula at coastal Puerto Juárez and Punta Sam and nearby Caribbean Isla Contoy and Isla Mujeres; all are parts of Quintana Roo, México. Fritts (*op.*

cit.) provided evidence that *A. rodecki* is a hybrid-derivative of the gonochoristic species *A. angusticeps* × *A. deppii*; parthenogenetic *A. maslini* and *A. cozumela* were derived from a separate hybridization and postformational event, respectively, between these species (Moritz et al. 1992. Herpetologica 48:417–424; Hernández-Gallegos et al. 2003a. J. Herpetol. 37:527–532). Here, I provide data on reproduction (clutch range and $\bar{x}$ ±SE; SVL range and $\bar{x}$ ±SE; yolked follicle range and $\bar{x}$ ±SE; length and width of oviductal eggs range and $\bar{x}$ ±SE), sample composition (number of generations present), and life cycle (age at maturity and life span) in a species that utilizes human-modified (e.g., urban development) and hurricane-impacted (e.g., Category 4 Wilma on 21 October 2005) coastal and island habitats elevated only a few meters above sea level. According to Konrad (1996. Caribbean Tropical Storms. RCM 1:98–130), the northeast tip of the Yucatán Peninsula near the islands in question receives the greatest number of hurricane strikes in the region.

I examined 70 (76.9%) of the 91 specimens listed of *A. rodecki* from the University of Colorado Museum of Natural History (UCM), including those transferred to the California Academy of Science (CAS), obtained in 1961 by T. P. Maslin and associates (see McCoy and Maslin, *op. cit.*) from Quintana Roo: Isla Contoy, 21.4955°N, 86.7986°W, datum: WGS84 [23 June 1961 (UCM 15304, N = 1)], Isla Mujeres, 21.2419°N, 86.7391°W [22 June 1961 (UCM 15305–15341, 15342 = CAS 94030, 15343–15349, 15351–15370, N = 65); and Puerto Juárez (mainland, 21.1838°N, 86.7413°W [27 June 1961 (UCM 15371–15372, 15373 = CAS 94031, 15374–15395, N = 25)]. I obtained size (as SVL to the nearest 1 mm) for all except 21 females of *A. rodecki* (transferred to collections other than CAS) in the original UCM numbered sample. Females were dissected to determine reproductive status, and identify the number and measure oviductal eggs and yolked ovarian follicles when present.

The 22–27 June 1961 UCM sample of *A. rodecki* included by sizes (as 5 mm SVL increments where applicable) these distributions for 70 specimens: 30–34 (23, 32.9%), 35–39 (4, 5.7%), 40–44 (1, 1.4%); 50–54 (1, 1.4%), 55–59 (9, 12.9%), 60–64 (24, 34.3%), 65–69 (6, 8.6%), 70–74 (1, 1.4%), 75 (1, 1.4%). That the small number of lizards in the 65–75 mm SVL range (8, 11.4%) is indicative of a short life cycle in *A. rodecki* (i.e., few lizards live long enough to attain these lengths) rather than sampling error is consistent with life history data reported for another Yucatecan parthenogenetic species. Hernández-Gallegos (2004. Ph. D. Thesis, Universidad Nacional Autónoma de México) reported an annual die-off rate of 95.5% for individuals of the closely related Isla de Cozumel endemic *A. cozumela* (maximum SVL 77 mm), which like *A. rodecki* is an early-maturing and short-lived species derived via *A. maslini* from a hybrid of *A. angusticeps* × *A. deppii* (Moritz et al., *op. cit.*; Manríquez-Morán et al. 2000. J. Herpetol. 34:634–637).

Each of the following statements for a SVL group of *A. rodecki* includes the number of gravid females followed by clutch size based on the same or a smaller number of lizards with undamaged eggs. Based on the 1961 UCM sample, *A. rodecki* attains reproductive maturity at ca. 57 mm SVL. Among females 55–59 mm SVL, 7 (77.8%) were gravid; clutch size was 2 ($\bar{x}$ = 2.0, N = 5). Among females 60–64 mm SVL, 19 (79.2%) were gravid; clutch size was 1–3 ($\bar{x}$ = 1.9 ± 0.33 SD, N = 17). Among females 65–69 mm 5 (83.3%) were gravid; clutch size was 2–3 ($\bar{x}$ = 2.3 ± 0.50 SD, N = 4). The female of 71 mm SVL was gravid; clutch size was 3. The female of 75 mm SVL was gravid; clutch size was 5. Overall, 27 (38.6%) lizards in the sample are definitely young-of-year (YOY), 2 (2.9%) are either older YOY or second summer subadults, 41 (58.6%) are mature adults, 33 (47.1%) are gravid (5 damaged), and 8 (11.4%) contain oviductal eggs. Females with with either yolked ovarian follicles or oviductal eggs (N = 28) had clutches (sample size in each category in parens) of 1 (2), 2 (22), 3 (3), and 5 (1); mean clutch size and SVL for these females were 2.1 ± 0.13 (1–5) eggs and 62.6 ± 0.74 (57–75) mm, respectively. Asynchrony in reproductive cycles is indicated among the 41 adult females in the 1961 sample of *A. rodecki* ($\bar{x}$ = 62.3 ± 0.58, 55–75 mm SVL); 13 are not gravid, 20 (71.4%) of 28 undamaged individuals have yolked ovarian follicles of 3.5–10.0 ($\bar{x}$ = 6.6 ± 0.52) mm, and 8 (28.6%) have oviductal eggs of 7.5–8.0 ($\bar{x}$ = 7.8 ± 0.09) mm in diameter and 14.5–16.0 mm ($\bar{x}$ = 15.1 ± 0.14) mm in length. In the 1961 sample of *A. rodecki*, a correlation existed between clutch size and SVL (adjusted r^2 = 0.35, P = 0.0005). However, this correlation is contingent upon one extraordinary female (UCM 15333) of 75 mm SVL with 5 eggs (minimally in its second summer); removal of it from the model results in loss of the correlation between SVL and clutch size in the sample (adjusted r^2 = 0.03, P = 0.2006).

Using monthly samples of *A. cozumela* obtained from Isla de Cozumel in November 1994–October 1995, Manríquez-Morán et al. (2005. Herpetologica 61:435–439; Fig. 1) reported only immature individuals in October–February samples; immature and adult lizards were present in March–September samples. Hernández-Gallegos (2004, *op. cit.*) concluded that *A. cozumela* is an essentially annual species. Hatchlings produced over several weeks or months in one calendar year grow to adulthood at various times in the next year and most die by early fall. Hernández-Gallegos (2004, *op. cit.*) provided evidence of essentially annual life cycles based on survival rates for the Yucatecan parthenogenetic species *A. cozumela* (4.5%) and *A. maslini* (10.9%) and their gonochoristic ancestors *A. depii* (6.3%) and *A. angusticeps* (11.5%). Although his study of the life cycle of *A. rodecki* was terminated by urban development of lizard habitat, based on life cycle data for closely related Yucatecan species it is possible to approximate the number of generations represented in the 1961 UCM sample of *A. rodecki*. The 28 individuals of 30–44 mm SVL (40.0%) were likely hatched within six weeks of the dates of collection 22–27 June 1961; they would have remained active the remainder of that year and into their first reproductive season beginning in March or April of the following year. Growth in SVL would continue as vitellogenesis began; by then most of these females in the UCM sample would have been 52–65 mm SVL. Based on this reasoning, most adult lizards in the 1961 sample of *A. rodecki* were hatched in the summer of 1960. However, it is reasonable to infer that a few lizards in the 68–75 mm SVL range were in their third summer of life (i.e., 2 calendar years of age); this interpretation of data would be consistent with the low survival rates reported for other Yucatecan species of *Aspidocelis* by Hernández-Gallegos (2004, *op. cit.*). Based on the SVL range and numbers of specimens in the UCM samples from mainland Puerto Juárez and Isla Mujeres, *A. rodecki*, like *A. cozumela* (Hernández-Gallegos et al. 2003. Biogeographica 79:1–17), is a mostly annual whiptail lizard species that is capable of attaining high population densities in optimal habitats of limited availability (Elizalde-Rocha et al., *op. cit.*), sympatric with *A. angusticeps* at Puerto Juárez (Fritts, *op. cit.*), but on Isla Mujeres allopatric to all Yucatecan congeners (i.e., *A. angusticeps*, *A. deppii*, *A. maslini*, and *A. cozumela*). The size of a sample (N = 28) of live *A. rodecki* collected on Isla Contoy in 1995 and 1996 (see Hernández-Gallegos 2003a, *op. cit.*) indicates that the species is also well established on the small island of 317 ha, allopatric to congeners.

Nevertheless, I opine that collection of monthly samples of *A. rodecki* at mainland Puerto Juárez and on Isla Contoy and Isla Mujeres, which would only modestly extend our knowledge of reproduction in this species, would be questionable based on the precarious conservation status of this parthenogen owing to habitat destruction by activities of developers (see Elizalde-Rocha et al., *op. cit.*).

I thank Shi-Kuei Wu (UCM) and Robert C. Drewes (CAS) for the opportunity to examine specimens in their care. Oswaldo Hernández-Gallegos (Universidad Autónoma del Estado de México) kindly provided theses and manuscripts pertaining to *A. rodecki* in advance of publication. This study is further evidence of the long-term impact of field studies in the Yucatán region in the 1950s and 1960s by T. Paul Maslin (UCM, deceased), and his student, C. J. McCoy (later of the Carnegie Museum of Natural History, deceased). Oswaldo Hernández-Gallegos and Marc P. Hayes provided indispensable advice in the preparation of this report.

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***CHALCIDES SEPSOIDES* (Wedge-snouted Skink). ENDOPARASITES.** *Chalcides sepsoides* is widespread in the Middle East and is known from Tunisia, Libya, Egypt, Israel, Jordan, Saudi Arabia, Eritrea, and Yemen (Uetz and Hosek 2011. The Reptile Database http://www.reptile-database.org. Accessed 2 December 2011). To our knowledge there have been no helminths reported from *C. sepsoides*. The purpose of this note is to establish the initial helminth list for *C. sepsoides*.

The body cavity of one *C. sepsoides* collected 1 May 1958 at Elat, South District, Israel (29.5500°N, 34.9500°E; datum WGS84) and deposited in the Zoological Museum of Tel Aviv University (TAUM), Tel Aviv, Israel as TAUM 3064 was examined. One oval shaped whitish helminth ca. 2 mm in length was found. It was examined under a dissecting microscope, identified as an oligacanthorhynchid acanthocephalan cystacanth and deposited in the United States National Parasite Collection, Beltsville, Maryland as USNPC 105148.

Acanthocephalans require an arthropod intermediate host in which the cystacanth develops (Kennedy 2006. Ecology of the Acanthocephala. Cambridge University Press, Cambridge, UK. 249 pp.). Since no development beyond the cystacanth stage occurs in lizards, they likely serve as paratenic (transport) hosts. Development to the adult acanthocephalan occurs when a definitive host ingests the infected lizard. Cystacanths have been reported from a large number of lizard hosts (Bursey and Goldberg 2003. J. Parasitol. 89:573–576). *Chalcides sepsoides* represents a new host record for oligacanthorhynchid cystacanths.

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***CTENOSAURA BAKERI* (Utila Spiny-tailed Iguana). ENDOPARASITES.** *Ctenosaura bakeri* is known only from Utila Island, Honduras (de Queiroz 1987. Copeia 1987:892–902). To our knowledge, there are no reports of helminths from *C. bakeri*. The purpose of this note is to establish the initial helminth list for *C. bakeri*.

Nematodes were recovered from fecal matter and gut dissections from two recently diseased wild and one recently diseased captive *C. bakeri* from Utila Island, Honduras (16.1032°N, 86.8992°W, datum WGS84) during 2011 and fixed in 10% formalin for 24 h and preserved in 95% ethanol. Nematodes were cleared in glycerol, mounted on glass slides, examined under a compound microscope and identified as *Cyrtosomum scelopori*, *Oswaldofilaria brevicaudata,* and *Ozolaimus ctenosauri*. Voucher specimens were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland, USA as: *Cyrtosomum scelopori* (USNPC 104929), *Oswaldofilaria brevicaudata* (USNPC 104930), *Ozolaimus ctenosauri* (USNPC104931).

Cyrtosomum scelopori is widespread in lizards from the Caribbean, southern United States, Mexico, and Panama and is known to occur in over 50 species (McAllister and Bursey 2007. Comp. Parasitol. 74:179–184). The method of transmission of *C. scelopori* from host to host is not known, however, mating has been suggested as an infection route; once infected, autoinfection maintains the infection (Anderson 2000. Nematode Parasites of Vertebrates. Their Development and Transmission. CABI Publishing, Oxon, UK. 650 pp.). *Oswaldofilaria brevicaudata* is known from lizards in Mexico, Central and South America; hosts are summarized in Bursey et al. (2007. Comp. Parasitol. 74:108–140). Infection by *Oswaldofilaria* species occurs by injection of microfilariae from an infected mosquito (Anderson 2000, *op. cit.*). *Ozolaimus ctenosauri* was described from *Cyclura acanthura* from Oaxaca and Puebla Mexico (Caballero 1938. An. Trop. Med. Parasitol. 32:225–229) and occurs mainly in iguanids from Mexico (Moravec 1996. J. Parasitol. 82:1011–1016). It was also reported from *Ctenosaura oedirhina* from Honduras (Goldberg et al. 2011. Herpetol. Rev. 42:600–601). *Ozolaimus ctenosauri* is an oxyurid nematode, which does not utilize an intermediate host (Anderson 2000, *op. cit.*). Infection likely occurs by *C. bakeri* ingesting eggs while it forages for food. *Ozolaimus ctenosauri, O. brevicaudata,* and *C. scelopori* represent new host records for *C. bakeri*. Honduras is a new locality record for *Cyrtosomum scelopori* and *Oswaldofilaria brevicaudata*.

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***CTENOSAURA PECTINATA* (Mexican Spiny-tailed Iguana). ALBINISM.** On 12 July 2011 a young albino *Ctenosaura pectinata* was collected in the vicinity of Ahualulco de Mercado, Jalisco, Mexico (20.70134°N, 103.97356°W, datum WGS 84; elev. 1320 m) by local residents. The specimen was photographed by MVB and then returned to the wild where it was initially captured. This specimen presented typical albino characters including general lack of pigmentation, as exhibited by pink irises, red pupils, and yellow coloration all over its body (including limbs and tail). The normal color pattern of this species is black or grey with yellow-

ish flanks in males and orange in females; the tail has alternating light and dark bands. Hatchlings are green in color and darken as they age (Garcia and Ceballos 1994. Guía de Campo de los Reptiles y Anfibios de la Costa de Jalisco, México. Fundación Ecológica Cuixmala, A. C. Instituto de Biología, UNAM, México D.F. 184 pp.). This is the first report of albinism in this endemic Mexican species. Photographs of the specimen were deposited in the University of Texas at Arlington (UTADC 6980-82).

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***GALLOTIA GALLOTI* (Canary Lizard). NECTARIVORY.** Hardly known a few decades ago, the phenomenon of lizards as pollinators and seed dispersers within insular systems has received increased attention in recent years, as demonstrated by the growing list of mutualistic interactions and studies on lizard ecology in oceanic islands (Hansen et al. 2007. Am. Nat. 169:534–542; Olesen and Valido 2003. Trends Ecol. Evol. 18:177–181).

Within the genus *Gallotia*, endemic to the Canary Islands (with seven described species), the omnivorous *G. galloti* is one of the best-studied members, reported as an important seed disperser (fleshy fruit represents >50% of its diet; Valido and Nogales 1994. Oikos 70:403–411), and which also consumes nectar from several plant species (Valido et al. 2002. Acta Oecol. 23:413–419; Valido et al. 2004. J. Biogeogr. 31:1945–1953). Herein, we add to this increasing list of *Gallotia*-plant interactions two new records of nectarivory and putative pollination by *G. galloti* on two Canarian endemics: *Canarina canariensis* (Campanulaceae) and the threatened *Lotus maculatus* (*Rhyncholotus* group; Fabaceae) on the island of Tenerife.

Between 8 and 31 March 2005, we recorded several visits of *G. galloti* (two juveniles and one adult male) to flowers of *C. canariensis* for nectar feeding in cleared sites in a laurel forest from northwestern Tenerife (Monte del Agua y Pasos, 630–760 m elev.). Most of the flowers visited by lizards were situated on the ground (on rocky substrate), facilitating access (Fig. 1). In only one case, a juvenile individual had to climb to reach a flower resting on a tree branch, at ca. 1 m above the ground. All the interactions seemed to be legitimate, as the lizards had to contact stigmas and secondarily presented pollen on the style by inserting their entire heads into *Canarina* flowers to get to the nectar.

Our observations of Gallotia-Lotus interactions were made on the north coast of Tenerife (El Sauzal, approx. 10 m elev.). We used binoculars and video camera to observe the behavior of the lizards on and around the plants in a small, relict natural patch during three flowering periods (2006, 2007, and 2009). Between 26 and 30 March 2006, we monitored five plants during 12.5 h observation, in which 13 juvenile lizard individuals were detected. They visited a total of 28 flowers, but some of them made illegitimate visits (N = 13, 46.4%), since they tore apart one of the corolla lobes or chewed the calyx at the margin of its lobes to reach the nectar without contacting sexual organs. It was not until the 2009 monitoring that we could confirm legitimate visits by *Gallotia* adults, both female (Fig. 2) and male, as well as foraging movements between plants up to 6 m apart. In addition, *Lotus* flowers were visited for nectar by ants (Formicidae), solitary bees (Halictidae), the endemic butterfly *Cyclyrius webbianus* (Lycaenidae), and by an individual of the allochthonous micromammal *Mus musculus* (Muridae), but only the latter contacted floral reproductive organs.

Both plant species are considered to be bird-pollinated based on their floral characteristics (Dupont et al. 2004. Funct. Ecol. 18:670–676; Olesen 1985. Bot. J. Linn. Soc. 91:395–414), but bird visits have only been confirmed under natural conditions for *C. canariensis* (Valido et al. 2004, *op. cit.*; Rodríguez-Rodríguez and Valido 2011. Amer. J. Bot. 98:1465–1474). Therefore, our data are a stimulus for future assessments of the actual role of lizards in the reproduction of these plants. In the case of *C. canariensis*, this presumptive mutualistic interaction with *G. galloti* is expected to be favored at forest gaps and edges of roads crossing laurel forests, as road edges are proposed as dispersal corridors for this reptile (Delgado et al. 2007. Biod. Conser. 16:2949–2963). Introduced rodents *M. musculus* and *Rattus rattus* (Muridae), as well as the endemic gastropod *Plutonia lamarckii* (Vitrinidae), have also been observed feeding on nectar, although only the latter two are known for their herbivory effects on *Canarina* reproduction pattern, since they mainly consume floral reproductive tissues (Rodríguez-Rodríguez and Valido 2011, *op. cit.*).

Our observations on the relationship between *L. maculatus* and *G. galloti* during three consecutive years suggest that



PHOTO BY JOSÉ J. HERNÁNDEZ

FIG. 1. *Gallotia galloti* (male) approaching a *Canarina canariensis* flower to feed on nectar.



PHOTO BY PEDRO FELIPE

FIG. 2. *Gallotia galloti* (female) visiting *Lotus maculatus* flowers. By introducing the snout to reach the nectar, the reptile presses the keel down and consequently pumps the pollen out.

the foraging behavior of this lizard is not a rare phenomenon. The high risk of extinction of this plant, catalogued as "critically endangered" (IUCN 2011. IUCN Red List of Threatened Species. Version 2011.1. www.iucnredlist.org), seems to be due to a combination of anthropogenic factors (e.g., introduced herbivores, intense collection, gardening, and habitat destruction), but some authors have also suspected that it could be a consequence of the extinction of past avian pollinators (Olesen 1985, *op. cit.*). According to this, bird visitation on L. berthelotii, another representative of the Canarian bird-flower element, has been recently recorded in non-native populations (Ollerton et al. 2009. Naturwissenschaften 96:221–232). But for *L. maculatus*, the only potential pollinator bird species that had been observed close to the plants of this natural patch was *Sylvia conspicillata* (Sylviidae), just once during ca. 30 h obervation (F. Siverio, pers. obs.). This low arrival rate of a potential pollinating bird seems to be due to the absence of a shrubby corridor, apparently eradicated by human activity, between this species' habitat and the isolated *Lotus* patch. If the *Gallotia-Lotus* interaction has occurred earlier or is a consequence of the restricted distribution of the plant is not possible to assess, but reality is that individuals of this sympatric lizard population are presently the most frequent flower visitors.

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***LEIOCEPHALUS CARINATUS* (Northern Curly-tailed Lizard). DIET.** A recent review documented that insular species of lizards are more likely to incorporate plant material (e.g., flowers, nectar, pollen) into their diets than mainland species (Olesen and Valido 2003. Trends Ecol. Evol. 18:177–181). *Leiocephalus carinatus* is commonly found on islands across the Bahamas and has been described as a mostly terrestrial species with a relatively diverse diet (Schoener et al. 1982. Oecologia 53:160–169). Schoener et al. (1982, *op. cit.*) investigated prey specimens from *Leiocephalus* lizards in the Bahamas and found that plant matter comprised up to 47.4% of their diet. Flowers and buds were commonly included. Here we report two observations of *L. carinatus* feeding on the epiphytic orchid *Cattleyopsis lindenii*.

On the morning of 26 May 2011, we observed an individual *L. carinatus* (>70 mm SVL) on a small island in the vicinity of Snake Cay, Great Abaco Island, Bahamas, consuming the flower of the orchid *C. lindenii*. The lizard climbed up a relatively thin tree trunk (ca. 3 cm diameter) before orienting itself in a lateral position in order to reach for the flower petals on a nearby branch (perch height: 94 cm; perch diameter: 1 cm). From this position, the lizard consumed most of the flower; only the base of the stigma was left on the inflorescence. A second observation was recorded on the afternoon of 27 May 2011. On this occasion, the lizard (a male, 130 mm SVL) was observed slowly moving across the ground and appeared to exhibit a searching behavior, in which it frequently stopped, assumed an alert posture, and slowly moved its head in different directions. After performing one of these searches, the lizard quickly climbed up a tree trunk (ca. 5 cm diameter) to a height of 85 cm and tore one flower off the inflorescence of an orchid. After tearing off the flower, the lizard immediately returned to the ground, where it consumed the complete flower. While on the ground, the lizard repeatedly made exaggerated swallowing movements while engulfing the complete flower; this behavior lasted ca. 4 minutes. Although the lizards were not marked, the differences in SVL suggest that we observed two individuals.

On both of these occasions, the lizards climbed up perches in order to gain access to the flowers, and either consumed multiple petals or the complete flower. This suggests that the curly-tailed lizards were not eating the flowers as a byproduct of trying to catch an insect. Instead, *L. carinatus* might actively search for flowers as part of its diet. It has been suggested that lizards may act as pollinators for some species of plants (Olesen and Valido 2003, *op. cit.*), though in this case, by consuming the entire flower, *L. carinatus* may have an impact on the reproductive success of *C. lindenii*.

We thank M. Leal and D. Steinberg for encouraging us to report our observations and for reviewing the manuscript. We also thank the Bahamian Ministry of Agriculture and Bahamas Environment, Science, and Technology (BEST) Commission of the Ministry of the Environment for providing permits. These observations were made while participating on a Training Research Fellowship supported by National Science Foundation (DEB-0949357).

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***LIOLAEMUS cf. ELONGATUS*. TRAUMA SURVIVAL.** The ingestion of unnatural food items can provoke multiple complications in an animal, such as gastrointestinal blockages, perforations, suffocation, and poisoning, often leading to death, but little scientific information is published on this subject. Published accounts on reptiles typically include larger taxa such as turtles, crocodiles, or large-bodied lizards (e.g., Gillett and Jackson 2010. Biawak 4:99–102; Trembath and Freier 2005. Herpetofauna 35:48–49). Observations on this subject in smaller lizards are



FIG. 1. A) Lizard and chicken bone after extraction for size comparison (white arrow shows protrusion with scar mark; B) radiograph of the injured lizard, black line shows the major axis of the bone ingested.

poorly documented, and are particularly unknown for both the genus *Liolaemus* and southern South America.

On 8 February 2011, an adult male *Liolaemus cf. elongatus* (70.8 mm SVL) was collected on a rocky cliff on the north shore of Laguna del Maule, 1 km S Road 115, Talca Province, Maule Region (VII Administrative Region), Chile (36.016694°S, 70.562083°W, datum:WGS84; elev. 2210 m). This area is frequently used for such outdoor recreation activities as hiking, climbing and camping. When the lizard was inspected in the lab for conservation purposes, one of us (CHFP) noticed a deformation in the trunk with a bulge on the right side and a wound between the lateral scales in the left side of the chest. Palpation of the abdomen revealed a solid mass in the stomach region (Fig. 1A). After radiographic examination, a large object was observed (Fig. 1B) and a subsequent dissection revealed a triangular 29 mm long and 8.19 mm wide chicken bone inside the stomach, with its pointed tip (5.82 mm) protruding through the stomach wall. The pointed tip was in contact with the skin and probably generated the scar that was visible externally. The stomach was full with digested insects and perforation was completely cicatrized with connective tissue around the bone. This lizard did not appear to experience any obvious restrictions in prey capture, digestion, or mobility, as it was chased between rocks for around 10 m prior to capture. No sign of malnourishment was observed at the time of collection. Voucher specimen (LJAMM-CNP 14065) is deposited in the herpetological collection Luciano Javier Avila Mariana Morando (LJAMM-CNP) of the Centro Nacional Patagónico (CENPAT-CONICET), Puerto Madryn, Argentina.

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***MESASPIS GADOVII* (Gadow's Alligator Lizard). ENDOPARASITES.** *Mesaspis gadovii* is known from parts of Guerrero and Oaxaca, Mexico (Flores Villela and Gerez 1994. Biodiversidad y Conservacíon en México; Vertebrados, Vegetacíon y Uso del Suelo. UNAM, D.F., México. 439 pp.). To our knowledge there are no helminths reported from *M. gadovii*. The purpose of this note is to establish the initial helminth list for *M. gadovii*.

Four *M. gadovii* (mean SVL = 78.0 mm ± 6.3 SD, range = 70–85 mm) collected 1971, 1973, 1977 from Guerrero, Mexico and deposited in the herpetology collection of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California, USA were examined for helminths. The digestive tract was removed through a mid-ventral incision, and the esophagus, stomach and small and large intestines were examined for helminths under a dissecting microscope. Two species of nematodes were found which were cleared in glycerol, cover-slipped on a microscope slide, and studied under a compound microscope. Seventeen individuals of *Oswaldocruzia nicaraguensis* were found in the small and large intestines of LACM 109287, 127412 and 127413. Prevalence (number infected lizards/number lizards examined x 100) = 75%; mean intensity (mean number helminths per infected lizard ± 1 SD) = 5.7 ± 6.4 SD; range : 1–13. One nematode, *Physaloptera retusa* prevalence = 25%) was found in the stomach of LACM 127412. No helminths were found in LACM 75503. Helminths were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland as: *O. nicaraguensis* (USNPC 105146) and *P. retusa* (USNPC 105147).

Oswaldocruzia nicaraguensis was originally described from *Ameiva festiva* from Nicaragua by Bursey et al. (2006. J. Parasitol. 92:350–352) and was also reported in *Anolis capito* (as *Norops capito*) from Nicaragua (Bursey et al. 2007. J. Parasitol. 93:129–131). Other hosts include *Anolis biporcatus, A. limifrons* (Costa Rica, Panama), *A. capito, A. lionotus* (Panama) (Bursey et al. 2012. Comp. Parasitol. [in press], and *Sphenomorphus cherrieri* (Costa Rica) (Goldberg and Bursey 2007. Herpetol. Rev. 38:83–84). *Physaloptera retusa* is widely distributed in a few New World amphibians and many lizards; hosts are listed in Bursey et al. (2012, *op. cit.*). *Mesaspis gadovii* represents a new host record for *O. nicaraguensis* and *P. retusa*. Mexico is a new locality record for *O. nicaraguensis*.

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***PHELSUMA MADAGASCARIENSIS GRANDIS* (Madagascar Giant Day Gecko). CANNIBALISM.** Cannibalism in most species of reptiles appears to take place opportunistically as a normal predatory behavior and can be considered as the major mortality sources for certain juvenile lizard species (Siqueira and Rocha 2008. S. Am. J. Herpetol. 3:82–87; Stone and Snell 2002. Herpetol. Rev. 33:53). While passing through Betsiaka on 24 January 2010 at 0940 h in the District of Ambilobe, northern Madagascar (13.160°S, 49.240°E), we observed an adult male *Phelsuma madagascariensis grandis* eating a juvenile conspecific on a fence post. The juvenile day gecko was swallowed from its head to mid body upon our first observation and was completely ingested within 20 min. *Phelsuma m. grandis* is one the largest species in the genus, with a total length of up to 280 mm. Males are larger than females and are extremely aggressive (Glaw and Vences 2007. A Field Guide to the Amphibians and Reptiles of Madagascar. 3rd ed. Cologne, Vences and Glaw, Verlag. 496 pp). In captivity, this species feeds on fruits, a wide variety of invertebrates and vertebrates, and parent individuals may eat their young or harass them, leading to poor development or death (LaFerriere 2007. http://www.genevievesgeckos.com/site/care_sheet_Phelsuma.html. Accessed 25 October 2011). The cannibalistic observation reported here corroborates the statement by Siqueira and Rocha (2008, *op. cit.*) that most cannibalism in lizards appears to take place by males. This observation is also noteworthy because it is the first record of cannibalism in *P. m. grandis* outside of captive breeding, and provides supplementary information on feeding behavior of Malagasy lizards.

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***PHRYNOSOMA BRACONNIERI* (Short-tailed Horned Lizard). PREDATION.** The Loggerhead Shrike (*Lanius ludovicianus*) is a passerine bird that is known to feed on a wide variety of prey, including grasshoppers, small mammals, reptiles and other birds.


PHOTO BY SANDRA FABIOLA ARIAS-BALDERAS

FIG. 1. *Phrynosoma braconnieri* impaled on a leaf-spine of *Agave salmiana*.

One of the feeding strategies includes impaling a prey item onto a thorn, twig or barbed wire. This behavior allows the shrike to secure its prey while it tears pieces of flesh and also allows for food storage (Craig 1978. The Auk. 95:221–234). There are accounts of various lizard species being predated upon and impaled by this bird, including *Aspidoscelis sexlineatus* (Tyler 1991. Proc. Oklahoma Acad. Sci. 71:17–20), *Scincella lateralis, Eumeces inexpectatus,* and *Anolis carolinensis* (Yosef and Grubb 1993. The Condor. 95:127–131). Predation on *Phrynosoma* by this shrike has been reported for *P. platyrhinos* (Pianka and Parker 1975. Copeia. 1975:141–162), *P. mcallii* (Young et al. 2004. Science 304[5667]:65), *P. modestum* (Reid and Fulbright 1981. Southwest. Nat. 26:204–205), and *P. cornutum* (Lemos-Espinal et al. 1998. Herpetol. Rev. 29:168). Little is known about the natural predators of southern Mexican *Phrynosoma* species. To our knowledge, no predators or predation events have been reported for *P. braconnieri*.

On 27 June 2010, at San Nicolas Tepoxtitlán, Puebla, México (18.386389°N, 97.686111°W, datum WGS84; elev. 1915 m), an adult *Phrynosoma braconnieri* was found dead and impaled on the tip of a leaf-spine on an agave (*Agave salimiana*) (Fig. 1). The lizard was pierced by the agave's spine at the neck, and the spine exited the victim's head via the right eye. *Lanius ludovicianus* is common at the site of observation and we believe this observation to be the result of predation on the horned lizard by this bird species. Color slides were deposited (MFESI-REPT 862–865) at Colección de Anfibios y Reptiles, Museo de Zoología, FES-Iztacala, Universidad Nacional Autónoma de México. This is the first record of *P. braconnieri* being impaled as a prey item by a shrike and the first account of predation on this horned lizard.

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***PHRYNOSOMA MODESTUM* (Round-tailed Horned Lizard) × *P. SOLARE* (Regal Horned Lizard). PUTATIVE HYBRID**. The phylogenetic relationship of horned lizards, genus *Phyrnosoma*, has been difficult for taxonomists to resolve because there is incongruence between morphological and genetic characters (Hodges and Zamudio 2004. Mol. Phylog. Evol. 31:961–971; Leaché and McGuire 2006. Mol. Phylog. Evol. 39:628–644). However, at the species level, all are morphologically distinct (Sherbrooke 2003. Introduction to Horned Lizards of North America. University of California Press, Berkeley. 178 pp.). Phenotypic characters used to differentiate species include morphology, metrics, scalation (especially of the cranial horns and lateral fringe scales), color (recognizing that some species are highly polymorphic), and pattern. Taxonomists currently agree there is but a single genus of horned lizards, and species may occur sympatrically, but documentation of individuals exhibiting intermediate characters (i.e., hybrids) is rare. The exception is that of *P. mcallii* x *P. goodei* and *P. platyrhinos*, with morphological and genetic hybrids being described in their contact zone of southwestern Arizona and southeastern California (Pianka and Hodges 1998. Reptiles 6:48–63; Mulcahy et al. 2006. Mol. Ecol. 15:1807–1826; W. Flaxington 2007, see http://calphotos.berkeley.edu, ID number 0000 0000 0507 1961). These known or putative hybrids have intermediate phenotypic characters. In this note, we describe a putative hybrid between *P. modestum* and *P. solare* at a contact zone in southeastern Arizona.

On 17 March 2011, we were engaged in a long-term monitoring project of a lizard assemblage near Safford, Graham Co., Arizona, USA, when an unusual-looking horned lizard was observed (Fig. 1) on Forest Road 57 near the junction with Marijilda Creek (32.706735°N, 109.775670°W; WGS84; 1227 m elev.). Four *Phrynosoma* species have been documented from the vicinity: *P. modestum*, *P. solare*, *P. cornutum*, and *P. hernandesi* (Jones 2009. Sonoran Herpetol. 22:94–98), but only *P. modestum* and *P. solare* are common. At first glance, the lizard reported here appeared



FIG. 1. Putative *Phrynosoma modestum* x *P. solare* hybrid from Graham County, Arizona.



FIG. 2. Close up of the head and cranial horns.

to be *P. modestum*, but upon closer inspection we noticed it had a single row of lateral fringe scales. The cranial horn morphology was unlike any of the sympatric species (Fig. 2). The adult animal (ca. 70 mm SVL) was photographed and released on site. Although it would have been beneficial to collect the specimen for morphometric and genetic analysis, it was more important from our standpoint to leave the animal on site because a hybrid could contribute to the changing composition of the lizard community over time.

By comparing the photographs of the specimen with photographs and specimens of the other sympatric horned lizards, as well as published literature (Sherbrooke 2003, *op. cit.*; accounts in Jones and Lovich [eds.] 2009. Lizards of the American Southwest. Rio Nuevo Publ., Tucson, Arizona. 567 pp.), we believe the animal to be a hybrid between *P. modestum* and *P. solare*. The specimen had characters of one species or the other, both species, or intermediate characters. We also sent the photographs to a horned lizard expert, Wade Sherbrooke, to review; he suggested the same putative identification. The most diagnostic characters for comparison are probably the lateral scales and cranial horns. There is one lateral row of fringe scales in *P. solare*, *P. hernandesi*, and the putative hybrid, but none in *P. modestum*; *P. cornutum* has two rows. Both *P. modestum* and *P. solare* have four occipital horns, but the shape and size differs greatly. *Phrynosoma modestum* has relatively short, evenly sized, widely spaced occipital horns that do not touch at the base. The temporal horns are of moderate length. *Phrynosoma solare* has long, wide occipital horns that form a semicircle with the long temporal horns, all of which touch at the base. Also, in *P. modestum*, the rear of the head forms a relatively straight line between the posterior temporal horns, while in *P. solare* the rear of the head forms more of a semicircle. The cranial horns of *P. cornutum* and *P. hernandesi* are quite different; the former has three cranial horns (two long lateral horns and one very small central horn) while the latter has a notch in the back of the head with minute horns. In the specimen reported here, the horns were different than any of the four species in the area, but there were four occipital horns, as in the two common species. The occipital horns were fused into two pairs; the pairs were not touching at the base, nor were they touching the bases of the temporal horns. The occipital horns were intermediate in length between *P. solare* and *P. modestum*, and the temporal horns were shorter than *P. solare*. The snout–vent length was about as large as *P. modestum* attains (Hodges 2009. *In* Jones and Lovich 2009, *op. cit.*), which is the smallest of the local species. The tail in cross section appeared intermediate between *P. solare* (wide and relatively flat) and *P. modestum* (narrow and cylindrical), although this character was not quantified. The base of the tail was not broad, as in *P. modestum*; rather, it was similar to the other sympatric horned lizards. Qualitatively, the enlarged, keeled scales (spines) of the dorsum were most similar to *P. modestum* or intermediate between *P. modestum* and *P. solare*.

The general color pattern was not typical of any species in the study area, but was similar to both *P. solare* and *P. modestum*. Although there are specific differences, both species have a lighter central dorsal color with a darker dorsolateral color. Both of these species are weakly patterned, while *P. cornutum* is invariably strongly patterned, and *P. hernandesi* is highly variable. There were two other color patterns worth mentioning. In our specimen, there was a dark marking on the mid-dorsal area on the top of the head bordered by a lighter area. This same pattern has been seen in juvenile *P. solare* in the study area and elsewhere. It is also apparent in *P. cornutum* of all age classes. This feature is lacking in the *P. modestum* we have seen. Also, there were stripes radiating ventrally from the eye. This is fairly diagnostic in *P. cornutum*, but we have seen similar markings in some *P. modestum* and *P. solare*.

If our specimen were simply an anomalous *P. solare* with fused occipital horns, the bases of the pairs would be expected to touch each other, as well as the temporal horns. Also, it would be expected that the temporal horns would be long in our specimen, but this is not the case. This specimen also lacked the light mid-dorsal stripe, which is fairly diagnostic in *P. solare*. The specimen was not as spiny dorsally as typical *P. solare* and the tail was not as broad.

The study area was selected as a long-term monitoring site for lizards because it has among the highest diversity of lizards in the USA and it is situated at an ecotone in a convergence zone of physiographic provinces, so would be expected to show changes in the lizard assemblage concomitant with a changing environment (Jones 2009, *op. cit.*). This accounts for the presence of four sympatric species of *Phrynosoma* found in such a small area. The local distributions of the four species are imperfectly understood, but the two common species are microsympatric where their ranges overlap. *Phrynosoma solare* is primarily a Sonoran Desert species, while *P. modestum* is primarily a Chihuahuan Desert species. These two deserts meet in the San Simon Valley in the vicinity of our study area (Brown and Lowe 1980. Biotic Communities of the Southwest. USDA Forest Service Gen. Tech. Rep. RM-78 [map]). The study area has about equal numbers of Sonoran and Chihuahuan desert species (Jones 2009, *op. cit.*). Thus, a primary objective in our study is to track changes in the assemblage of horned lizards and other species in this contact zone, in an area commonly referred to as the Cochise Filter-Barrier (Morafka 1977. A Biogeographical Analysis of the Chihuahuan Desert Through its Herpetofauna. Dr. W. Junk, The Hague. 321 pp.). Individuals of the *Sceloporus magister* complex in the area are phenotypically similar to, or intermediate between, the Sonoran Desert ('*magister*') and Chihuahuan Desert ('*bimaculosus*') forms (Phelan and Brattstrom 1955. Herpetologica 11:1–14; pers. obs.). At least two parthenogenetic whiptails of hybrid origin also occur in the study area (Jones 2009, *op. cit.*), *Aspidoscelis uniparens* and *A. flagellum* (= *A. sonorae* complex). Because the changes in lizard assemblage we are tracking include species composition (e.g., Sonoran vs. Chihuahuan desert) and hybridization, the documentation of hybridization events and potential hybrid vigor is a significant component of the study.

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***PHRYNOSOMA TAURUS* (Bull Horned Lizard). PREY.** *Phrynosoma taurus* is a Mexican endemic lizard that occurs from southern Morelos eastward to eastern Puebla and southward to northwestern Oaxaca (Reeve 1952. Univ. Kansas Sci. Bull. 34:817–960). It feeds on a variety of arthropods such as ants (Formicidae), beetles (Curculionidae, Meloidae, Scarabeidae, and Tenebrionidae), termites (Termitidae), crickets (Acrididae and Gryllacrididae), flies (Calliphoridae) and butterfly larvae (Lepidoptera) (Canseco-Márquez and Gutiérrez-Mayen. 2010. Anfibios y Reptiles del Valle de Tehuacan-Cuicatlan. CONABIO. 137 pp.; Lemos-Espinal et al. 2004. Herpetol. Rev. 35:131–134). Up to 56% (by volume) of the diet of this species consists of ants (Pianka and Parker 1975. Copeia 1975:141–162). To our knowledge, there is no record of

vertebrate prey in the diet of this or any other *Phrynosoma* species in the wild. However, there is a report of cannibalism in *P. solare* held in captivity (Comstock A.B. 1939. Handbook of Nature Study. Cornell Univ. Press. 887 pp.), and saurophagy by *P. hernandesi* and *P. cornutum* seems to be well known among herpetoculturists, but not recorded in scientific literature (Lemos-Espinal J. A., unpubl. data).

On 12 August 1999, an adult female *Phrynosoma taurus* was collected (LEUBIPRO [Laboratorio de Ecología UBIPRO, Facultad de Estudios Superiores Iztacala, Universidad Nacional Autónoma de México] 3023; SVL 57.16 mm, TL 65.27 mm) in the Valley of Zapotitlán Salinas, Puebla (18.305694°N, 97.482056°W; WGS 84; 2100 m elev.) under the shade of an agave. As part of a dietary analysis in the reptile assemblage in this valley, we conducted a stomach content analysis of this specimen, which revealed a partially digested (without head and tail) juvenile *Sceloporus gadoviae* (neck–vent length 13.36 mm, femur length 4.79 mm, leg total length 15.68 mm). Other items found were ants (Formicidae: Ponerinae).

To our knowledge this represents the first record of a vertebrate in the diet of any *Phrynosoma* species in the wild.

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***SCELOPORUS OCCIDENTALIS* (Western Fence Lizard). NECROPHILIA.** Observations of necrophilia, the act of copulation or attempted copulation with a dead conspecific or heterospecific, are limited to few reports in the Lacertilia. To our knowledge, this behavior has been reported in four lizard species, including the Giant Ameiva, *Ameiva ameiva* (Costa et al. 2010. Herpetol. Notes 3:79–83; Vitt 2003. *In* Pianka and Vitt [eds.], Lizards: Windows to the Evolution of Diversity, p. 103. Univ. of California Press, Berkeley), Long-nosed Leopard Lizard, *Gambelia wislizenii* (Fallahpour 2005. Herpetol. Rev. 36:177–178), Lesser Earless Lizard, *Holbrookia maculata* (Brinker and Bucklin 2006. Herpetol. Rev. 37:466), and the Sleepy Lizard, *Tiliqua rugosa* (How and Bull 1998. Herpetol. Rev. 29:240; Sharrad et al. 1995. W. Austr. Nat. 20:33–35). Here we report on an observation of necrophilia in a fifth lizard species, the Western Fence Lizard, *Sceloporus occidentalis*.



FIG. 1. Male *Sceloporus occidentalis* initially attempting to mate with female corpse in typical copulatory position (A); male beginning to carry female corpse down cement wall (B); male then resuming a bite-hold on female corpse in nuchal region (C) and then assuming copulatory position once again (D).

On 11 April 2011, one of us (RE) found an adult female *Sceloporus occidentalis* that had apparently drowned in an outdoor Rubbermaid® tub (approximately 57 cm x 15 cm), filled to the brim with rain water in Butte Creek Canyon, Butte Co., California, USA (39.735847°N, 121.682378°W, datum: WGS 84; elev. 164 m). The dead lizard was removed from the water in the tub and placed on the outer rim in the open sun. At ca. 1730 h that afternoon, it came to the attention of RE that the dead lizard was no longer present where it had earlier been placed. Upon closer inspection, the corpse was being carried off by an adult male conspecific. As the behavior continued, it was photographed (Fig. 1). The male had a bite-hold on the female in the nuchal region, a behavior employed during copulation in many iguanian lizards (Noble and Bradley 1933. Ann. New York Acad. Sci. 35:25–100). It was attempting to carry the corpse along the top of a cement wall after orientating its body in a copulatory position. The male then attempted to carry the corpse down the vertical surface of the wall, but could not bear the weight, and dropped the corpse. It then proceeded to climb down to where the female corpse had landed on the ground. There, the male resumed biting the female corpse in the nuchal region and attempting to position himself for copulation. Noticeable everted hemipenes were not detected. At ca. 1742 h the male was frightened off by the activity of photographing the sequence of events. RE then placed the female back on the outer rim of the tub. The next morning (12 April), the female corpse was found back down on the ground where it had been dropped by the male the previous afternoon.

Some reported observations of necrophilia have been hypothesized to relate to pair-bonding in the monogamous *T. rugosa* (How and Bull 1998, *op. cit.*) or elicited by perceived copulation receptivity correlating to female nuptial coloration in *H. maculata* (Brinker and Bucklin 2006, *op. cit.*). However, *S. occidentalis* is a polygynous species (Massot et al. 2003. Behav. Ecol. 14:650–655) without known long-term pair-bonding behaviors and females of this species do not express brightly colored nuptial coloration. The behavior reported here is presumed to have been a direct result of hormonally mediated overstimulation, leading to the male's misconception of a receptive (but lifeless) female during breeding season as was concluded for similar behavior in *A. ameiva* (Vitt 2003, *op. cit.*). To our knowledge, this is the first report of necrophilia for this species.

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***SCELOPORUS POINSETTII* (Crevice Spiny Lizard). REPRODUCTION.** *Sceloporus poinsettii* ranges from southwestern New Mexico and central Texas, south to Zacatecas, Mexico, from 300–2560 m; it is live-bearing (Stebbins 2003. A Field Guide to Western Reptiles and Amphibians, Houghton Mifflin Co., Boston, Massachusetts. 533 pp.). Minimum litter sizes in the literature for *S. poinsettii* are variable, including 4 (Webb 2009. *In* Jones and Lovich [eds.], Lizards of the American Southwest: A Photographic Field Guide, pp. 246–249. Rio Nuevo Publ., Tucson), 6 (Ballinger 1973. Ecology 54:269–283), 7 (Stebbins 2003, *op. cit.*).

The purpose of this note is to report a new minimum litter size for *S. poinsettii*. Two females from Durango, Mexico, deposited in the herpetology collection (LACM) of the Natural History Museum of Los Angeles County, Los Angeles, California, USA, were examined: LACM 50871, SVL = 86 mm, collected August 1968 (23.7000°N, 105.7000°W, datum: WGS 84); LACM 97372, SVL = 102 mm, collected August 1967 (26.2333°N, 105.1500°W, datum: WGS 84). Each contained two enlarging pre-ovulatory follicles, 7 mm in diameter. Two is a new minimum litter size for *S. poinsettii*.

I thank Christine Thacker (LACM) for permission to examine *S. poinsettii*.

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***UTA STANSBURIANA* (Common Side-Blotched Lizard). MORTALITY.** On 18 October 2011 on Fort Bliss Army base at McGregor base camp (McGregor Range, New Mexico; 32.081505°N, 106.162715°W), I observed a hatchling *Uta stansburiana* (approximate SVL 30 mm) trapped in the web of a Black Widow Spider (*Latrodectus* sp.). The web was located inside an aluminum storage building with enough space between its rolling bay doors and frame that small wildlife species (lizards, snakes, rodents, invertebrates) could enter and exit freely. The web was occupied by a spider when this discovery was made (Fig. 1) and approximately six other Black Widows were present on different webs in the same building. The web was strong enough to trap the lizard by the tail, thus tethering it so that it could only run in circles to attempt escape, clearing the blown sand in a circular pattern where it had run (Fig. 1). This lizard was captured and released outside before a photograph was taken. Near the hatchling, at ground level, there was also a dead adult conspecific (approximate SVL 70 mm) trapped in the same web (Fig. 1). While there was one necrotic spot on the adult lizard's head suggesting a bite from the spider, there was no sign of it being consumed. It is believed that the spider may have bitten the larger lizard to subdue it (which may have killed it) as the lizard struggled to free itself from the web. As no evidence of the spider feeding on the dead individual was observed and the hatchling was left unharmed with the spider actively on its web, it is believed the two lizards became trapped in the web, which was near an opening to the outside, and were not recognized by the spider as prey under these circumstances. However, that the web of the Black Widow Spider is capable of capturing this lizard species could indicate that this and similarly-sized species could be potential food items for this arachnid. At the very least, the web of this species appears to pose a mortality risk for all age classes of this reptile.

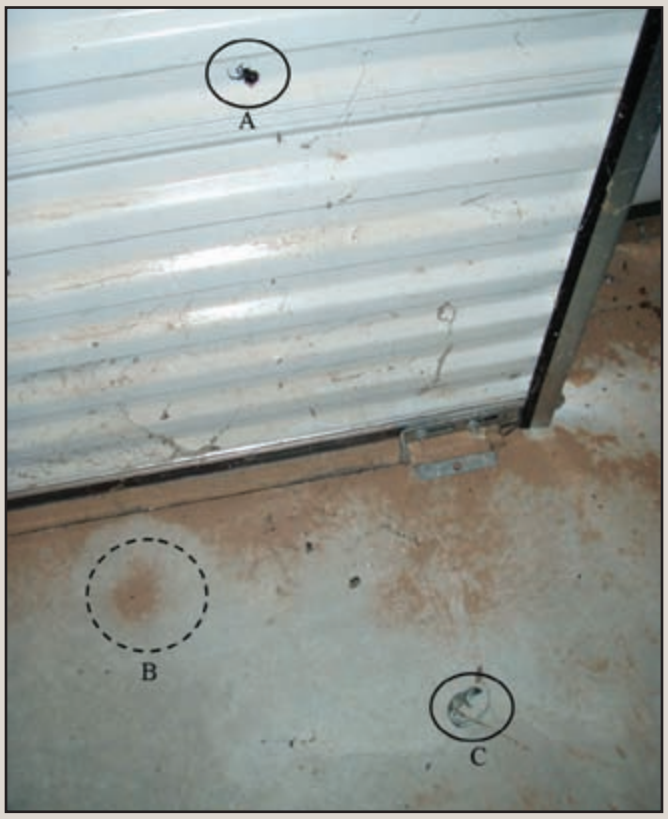


FIG. 1. Arrangement of (A) *Latrodectus* sp. on its web with (B) the path of the smaller *Uta stansburiana* being tethered and running in circles, and (C) the dead adult *U. stansburiana*.

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***VARANUS PANOPTES* (Yellow-spotted Monitor). DIET AND PREY CAPTURE.** The Yellow-spotted Monitor is a large, generalist carnivore inhabiting riparian areas and floodplains in northern Australia (Cogger 2000. Reptiles and Amphibians of Australia. Reed New Holland, Sydney. 808 pp.). This monitor consumes a wide variety of prey, including lizards (Blamires 2004. Copeia 2004:370–377; Shine 1986. Herpetologica 42:346–360). Recent research demonstrated dramatic declines in counts of *V. panoptes* with the arrival of invasive Cane Toads (*Bufo marinus*). Between 77 and 90% of two populations died due to lethal toxic ingestion of toads in the Northern Territory (Doody et al. 2009. Anim. Conserv. 12:46–53). During this same period, counts of the Gilbert's Dragon (*Amphibolorus gilberti*) increased dramatically (Doody et al. 2009, *op. cit.*). The Gilbert's Dragon is a small to medium-sized, carnivorous agamid that also occupies riparian habitats in northern Australia (Cogger 2000, *op. cit.*). Although the counts of *V. panoptes* and *A. gilberti* appeared to be linked, the latter was not reported in the diet of the former, and it was unclear whether the latter increased in numbers, or responded behaviorally (i.e., did the declines in *V. panoptes* lead to a mesopredator release, whereby *A. gilberti* populations boomed, or was the apparent increase in *A. gilberti* due to a shift in conspicuousness via reduced predation risk [Doody et al. 2009, *op. cit.*]?). It was also unknown if *V. panoptes* readily consumes *A. gilberti*. Here we provide four observations of *V. panoptes* preying upon *A. gilberti*. We discuss the implications of our observations for the diet of *V. panoptes*, predation risk for *A. gilberti*, and the indirect effects of invasive Cane Toads on *A. gilberti*.

At approximately 1230 h on 6 May 2009 we chanced upon a sub-adult *V. panoptes* (~90 cm in total length) foraging in the semi-shaded riparian area at Branco's Hole, a billabong along the Chamberlain River in El Questro Wilderness Park, Western Australia (15.979167°S, 127.911111°E). The immediate riparian area is sandy, with an overstory of freshwater mangroves (*Barringtonia racemosa*), paperbarks (*Melaleuca* spp.), and Pandanus (*Pandanus aquaticus*). As we surrounded the monitor for a closer look it ran between two of us (SD and DR) and under a freshwater mangrove tree, during which time it inadvertently flushed an *A. gilberti*. The dragon immediately ran rapidly in a perpendicular direction to the approaching monitor, towards patchy vegetation and logs. The monitor immediately gave chase

and captured the dragon (both on the full run) approximately 8 m from the area where the dragon was flushed. The monitor captured and held the dragon at mid-body, shook it vigorously 3–4 times before manipulating it and swallowing it head-first. The entire process took about two minutes.

A second observation took place by RL in January 2007. A sub-adult *V. panoptes* (~ 60 cm in total length) was observed thrashing about in dense grass at the base of a tree at Mornington Wildlife Sanctuary, Western Australia (17.5°S, 126.1°E). Upon closer inspection, the *V. panoptes* had captured a sub-adult *A. gilberti* (~25 cm total length). Once disturbed, the dragon, held by its shoulder and forelimb, was immediately dropped by the monitor. The *V. panoptes* then fled to nearby cover, while the *A. gilberti*, although clearly stunned, appeared fine and slowly disappeared into the dense grass.

In January 2008, RL observed an adult *V. panoptes* (~1 m in total length) in active pursuit of an *A. gilberti* at Marion Downs Wildlife Sanctuary, Western Australia (17.5°S, 126.1°E). The dragon was initially observed basking on the seat of a quad bike, and as it leapt off the bike onto the ground it was instantly pursued by the *V. panoptes*. The chase was rapid and both traveled about 40 m, by which time they disappeared together underneath a shipping container. Although the outcome is unknown, the close proximity of the monitor to the dragon at that stage suggested that the monitor successfully preyed upon the dragon.

In February 2008, a fourth observation was made by RL. A large, adult *V. panoptes* (~1.3 m in total length) successfully captured and consumed an *A. gilberti* at Mornington Wildlife Sanctuary, Western Australia (17.5°S, 126.1°E). The *V. panoptes* sprinted from underneath a building and grabbed a large (~35 cm total length) adult male *A. gilberti* by the head. Without too much struggle, and with a couple of large jerks and gulps, the dragon was consumed within ~20 seconds of capture. The *V. panoptes* then began foraging among the grass.

A dietary study using museum specimens did not yield *A. gilberti* in the diet of *V. panoptes*, although one specimen was found in the stomach of one *V. gouldii*, a closely related species (Shine 1986, *op. cit.*). However, in an internet article, an anonymous writer discussed how he "previously had a lot of quite tame Ta-ta Lizards (Gilbert's Dragons) hanging around my camp," in Arnhem Land, Northern Territory (http://cubits.org/crocodiles/articles/view/1059, accessed 20 October 2011). Upon the arrival of a 1.5 m *V. panoptes*, the writer added "The monitor ate some and scared the rest off." Based on that statement and our observations, *A. gilberti* may be a common food item for *V. panoptes*. This result supports the link between declines in *V. panoptes* and concurrent increases in *A. gilberti* associated with the arrival of Cane Toads in the Northern Territory (Doody et al. 2009, *op. cit.*). It also supports the possibility that the increases in *A. gilberti* were numerical responses to declines in *V. panoptes*. However, we cannot rule out the possibility that increases in *A. gilberti* counts reflected behavioral responses. Remarkably, *V. panoptes* is able to pursue and capture *A. gilberti* in full flight, making the former a major predator threat to the latter. Thompson and Thompson (2001. J. Royal Soc. W. Australia 84:153–158) observed *A. gilberti* to move rapidly to thick vegetation in response to approaching *V. mertensi* and *V. mitchelli*. The elimination or severe reduction of a key predator may decrease predation risk (or perceived predation risk), resulting in *A. gilberti* using more open areas and making it more conspicuous in population counts.

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SQUAMATA — SNAKES

***BOTHROPOIDES NEUWIEDI* (Neuwied's Lancehead). ENDOPARASITES.** *Bothropoides neuwiedi* is a terrestrial snake that occurs in temperate, tropical, and semitropical forests and restingas in Atlantic Rainforest biome of Brazil (Xavier 2004. *In* Campbell and Lamar [eds.], The Venomous Reptiles of the Western Hemisphere, vol. I, pp. 410–422. Cornell Univ. Press, Ithaca, New York). There are no previous reports of helminths parasitizing *B. neuwiedi*.

We examined a single female *B. neuwiedi* (CRLZ 00137; SVL = 61.3 cm) from the Coleção de Répteis do Laboratório de Zoologia (CRLZ) do Centro Univesitário de Lavras – UNILAVRAS of Reserva Biológica Unilavras – Boqueirão, municipality of Ingaí, state of Minas Gerais, Brazil (21.346389°S, 44.99083°W, datum: WGS84; 1250 m elev.). The snake was collected in 2009 and was identified according to Campbell and Lamar (2004. The Venomous Reptiles of the Western Hemisphere, v. I. Cornell Univ. Press, Ithaca. 475 pp.). The stomach and intestine were removed and examined for helminths using a stereomicroscope. Nematodes were cleared in Amann's lactophenol (1:1:2:1 phenol: lactic acid: glycerine: water) and were identified according to Vicente and Santos (1974. Atas Soc. Biol. 17:69–71). Nineteen individuals of one species of Nematoda, *Physaloptera liophis* (Spirurida, Physalopteroidea), were collected from the stomach and small intestine. Nematodes were deposited in the Helminthological Collection of Oswaldo Cruz Institute (CHIOC), Rio de Janeiro (CHIOC number 35801). *Physaloptera liophis* was first described from the stomach of *Liophis miliaris* from Brazil (Vicente and Santos, *op. cit.*) but has not been reported in other host species (Pinto et al. 2010. Neotrop. Helminthol. 4:137–147). Thus, our observation represents a new host record of *P. liophis* and the first helminth species reported in *B. neuwiedi*.

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***BOTHROPOIDES ERYTHROMELAS* (Jararaca). DEFENSIVE BEHAVIOR: DEATH-FEIGNING.** Death-feigning (thanatosis) is a state of immobility in response to external stimuli and is a defense mechanism against predators shared by various animals, including snakes (Vogel and Han-Yuen 2010. Russ. J. Herpetol. 17:15–21). *Bothropoides erythromelas* is a poorly-studied species found in northeastern Brazil, especially in semi-arid

northeastern region (Vanzolini et al. 1980. Répteis da Caatinga. Acad. Brazil. Ciências, Rio de Janeiro. 161 pp.). Here, we report two observations of thanatosis in *B. erythromelas*.

Two *B. erythromelas* were captured by hand at 1600 h on 12 March 2008 (male; SVL = 48 cm; 68 g) and at 1400 h on 3 April 2011 (male; SVL = 51 cm; 72 g) in Fazenda Saco, Sertão do Pajeú, municipality of Serra Talhada, Pernambuco, Brazil (7.929049°S, 38.295342°W, datum: WGS84). Each time the snakes were handled, they readily exhibited death feigning behavior with the mouth slightly open and the ventral part of the body facing upward; the behaviors lasted about 6 and 15 min, respectively. Playing dead is a behavior rarely seen in natural situations, but handling may induce this behavior in several species of snakes (Vogel and Han-Yuen, *op. cit.*). Photographs of the events were deposited in herpetological collection into the Universidade Federal Rural de Pernambuco, Unidade Acadêmica de Serra Talhada, Pernambuco, Brazil.

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***BOTHROPS JARARACUSSU* (Jararacussu). DIET.** *Bothrops jararacussu* is a large venomous snake (to 2 m total length) that is known to feed on mammals, birds, amphibians, and insects (Freitas 2003. Serpentes Brasileiras. Universidade Feira de Santana, Bahia, Brazil. 160 pp.). On 21 September 2009 an adult female *B. jarracussu* (SVL = 1039 mm; tail length 165 mm) was given to the Museu de Biologia Prof. Mello Leitão (MBML) after being killed by a rural worker on the trail between Banestes Association and Pousada Paradiso, Santa Teresa, Espirito Santo, Brazil (19.928068°S, 40.590666°W, datum: WGS84). Upon dissection, we discovered a female *Metachirus nudicaudatus* (Brown Four-eyed Opossum), with four young, in the snake's stomach (Fig. 1). The prey item had been swallowed headfirst and the lack of digestion indicated that it had been consumed recently.

Metachirus nudicaudatus is a strictly terrestrial didelphid (Grand 1983. Austral. J. Zool. 31:299–312) and a habitat and dietary generalist. The fact that the marsupial was carrying young may have made her more vulnerable to predation by the *B. jararacussu*. Both specimens were deposited in the MBML museum collection: MBML 2774 (*B. jararacussu*) and MBML 3491 (*M. nudicaudatus*).

PHOTO BY F. A. LANSCHI



FIG. 1. *Metachirus nudicaudatus* (Brown Four-eyed Opossum), with four young, that was consumed by a *Bothrops jararacussu* in Brazil.

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***CROTALUS ATROX* (Western Diamond-backed Rattlesnake), *CROTALUS RUBER* (Red Diamond Rattlesnake). LOSS OF RATTLE AND STYLE/MATRIX.** Loss of rattle segments commonly occurs in all species of rattlesnakes as a result of rattle position (age), injury, attempted predation, and other factors (Klauber 1972. Rattlesnakes: Their Habits, Life Histories, and Influence on Mankind, Univ. California Press, Berkeley, 1533 pp.; reviewed by Rowe et al. 2002. *In* G. W. Schuett et al. [eds.], Biology of the Pitvipers, pp. 385–404. Eagle Mountain Publishing, Eagle Mountain, Utah). However, in several species (e.g., *C. catalinensis, C. ruber lorenzoensis, C. willardi, S. miliarius*), complete or nearly

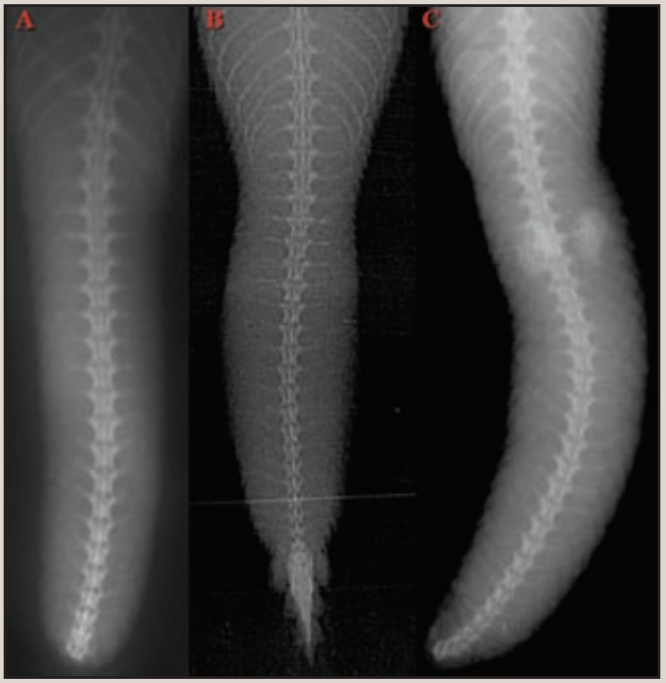


FIG. 1. Radiograph images of rattle-less *Crotalus atrox* and *C. ruber*. (A) Adult female *C. atrox* with rattles and style/matrix absent. (B) Adult female *C. helleri* with intact rattles and style-matrix for comparison. (C) Adult male *C. ruber* with rattles and style/matrix absent.



FIG. 2. Adult male *Crotalus ruber* (Fig. 1C) photographed in situ.

complete rattle loss is a stable feature in populations and appears to be heritable. In these cases, the gripping claws of the rattle segments are sufficiently smooth to permit slippage; hence, accumulation of segments to form a rattle string does not occur (Rowe et al., *op. cit.*). This condition is termed "rattle-less" (Klauber, *op. cit.*; Rowe et al., *op. cit.*; Setser et al. 2011. J. Herpetol. 45:333–335). Here, we report the loss of both rattle segments and the style/matrix in adults of *C. atrox* and *C. ruber*.

On 17 September 1999, at 2110 h, an adult female *C. atrox* (SVL = 740 mm; tail length = 50 mm; 333 g) was collected on Sun Valley Parkway, 15.2 km W of the McMicken Dam Spillway, 39 km W of Central Phoenix, Maricopa Co., Arizona, USA (33.6573°N, 112.6335°W, datum: Conus 27; elev. 418 m). It was noted that the snake lacked rattle segments and she was retained. Upon closer inspection it was determined that the basal segment of the rattle was also absent; hence, most likely, the style/matrix was damaged or absent (Zimmerman and Pope 1948. Fieldiana Zool. 32:355–413; Klauber, *op. cit.*; Meik and Pires-daSilva 2009. BMC Evol. Biol. 9:35). Scars to the tail were not detected nor loss of scales. Accordingly, it was concluded that there was no evidence of recent injury. Nonetheless, injury as a neonate or juvenile was a possibility. Subsequently, the tail region was subject to radiography, and it was confirmed that the style/matrix was absent (Fig. 1A). Thus, although the cause of this condition could be either congenital or the result of injury (e.g., predation attempt), we favor the former. Despite the loss of rattles, the snake exhibited classical defensive behaviors including coiling and tail vibration (Klauber, *op. cit.*).

On 10 April 2011, at 1538 h, an adult male C. ruber (SVL = 895 mm; tail length = 75 mm; 479 g) was collected in the Jamul Ecological Reserve, in San Diego County, California, USA, near the intersection of SR-94 and Otay Lakes Road (32.66610°N, 116.84090°W, datum: Conus 27; elev. 242 m). The snake was lacking a rattle, including the basal segment (Fig. 2), and no scars or scale losses on the tail were observed. Subsequently, the tail region was radio-graphed, and it was confirmed that the rattle style/matrix was absent (also exhibited classical defensive behavior including coiling, tail vibration, and hissing (Klauber, *op. cit.*).

Although the rattle-less condition occurs in certain insular populations of *C. ruber* from the Sea of Cortez (e.g., *C. r. lorenzoensis*), to our knowledge, loss of the style/matrix has not been described. Moreover, the rattle-less individuals have not been documented in mainland populations. There are, however, recent reports of rattle loss in *C. atrox* (Painter et al. 1999. Herpetol. Rev. 30:44; Holycross 2000. Herpetol. Rev. 31:177–178). Painter et al. (*op. cit.*) also provided radiographic evidence that clearly showed the absence of the style/matrix, which led the authors to conclude that the condition was likely congenital. Although the cause(s) for the absence of the style/matrix (e.g., congenital vs. injury) in our two cases are indeterminable, a congenital (heritable) hypothesis poses a set of testable research questions that warrant evaluation. If the condition is heritable, for example, examination of Hox gene expression domains along the primary axis would lend potential insights to the development of the style/matrix (e.g., Cohn and Tickle 1999. Nature 399:474–479; DiPoi et al. 2010. Nature 464:99–103; Woltering et al. 2009. Dev. Biol. 332:82–89), and hence the rattle itself.

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***DENDROPHIDION PAUCICARINATUM* (White-lipped Forest Racer). ELEVATION.** Ranging throughout premontane and lower montane regions of Costa Rica and western Panama, *Dendrophidion paucicarinatum* is one of four species within the genus represented in Costa Rica. Its elevational limit is poorly defined. Savage (2002. The Amphibians and Reptiles of Costa: A Herpetofauna between Two Continents, between Two Seas. Univ. Chicago Press, Chicago, Illinois. 934 pp.) notes its range as 1040–1500 m. Solorzano (2004. Snakes of Costa Rica. Editorial INBio, Santo Domingo, Costa Rica. 791 pp.) extends the limit slightly, with a range of 1000–1800 m.

On 25 February 2011, at 1430 h, we found a *D. paucicarinatum* (adult male; SVL = 72.5 cm; total length = 110 cm; 100 g) about 1 km up the Sendero Catarata trail in San Gerardo de Dota, Puntarenas Province, Costa Rica in the Chacon Private Reserve (9.54611°N, 83.80516°W, datum: WGS84; elev. 2260 m). The snake was discovered stretched out in the leaf litter at the base of a palm tree near a small stream. Another *D. paucicarinatum* (adult male; SVL = 86 cm; total length = 124 cm; 100 g) was encountered on 3 March 2011, at 1255 h. It was found on the Sendero Cascada trail, which is located in the same general region as the previous snake, though at a higher elevation (9.54575°N, 83.80216°W, datum: WGS84; elev. 2350 m). These discoveries extend the elevational range for this species by 460 and 550 m, respectively. Interestingly, *D. paucicarinatum* had never been recorded in extensive surveys conducted at the study site since 2006, suggesting that our observations may represent a recent elevational range expansion, possibly due to climate change or other factors.

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***DIPSAS GAIGEAE* (Gaige's Thirst Snake). REPRODUCTION.** *Dipsas gaigeae* is a relatively small gastropod-eating snake that is endemic to the Pacific versant of Mexico. The species occurs at moderate to low elevations between the states of Jalisco and Guerrero. The reproductive characteristics of this secretive species are poorly known. Based on preserved specimens from Colima and Jalisco, Kofron (1982. J. Herpetol. 16:270–286) reported finding a female with two eggs in September and a second female with five eggs on an unspecified date. Hale (1977. J. Herpetol. 11:374–377) reported the only known oviposition data for *D. gaigeae*. The snake was captured on 7 August 1972 and subsequently laid four eggs on 16 September 1972, which presumably hatched in December when the neonates were first noticed. Here we report on an additional instance of oviposition in *D. gaigeae*.

On 7 July 2009, at 0001 h, we captured a gravid female *Dipsas gaigeae* (UTA R-59482; Field ID, JAC 30673; SVL = 453 mm, total length = 569 mm) on a road near Ixtlahuacan, Colima, Mexico (19.05038°N, 103.78700°W, datum: WGS84 datum; elev. 326 m). The snake was brought back to the laboratory at the University of Texas at Arlington and maintained in captivity until she laid three eggs (32.07 x 12.14, 33.94 x 11.79 and 32.31 x 11.65 mm) on 14 August 2009. However, a fourth egg was retained ca. 1.0 cm from the entrance of the cloaca. After two days, in order to avoid

potential complications for the mother, some fluid was drained from the egg using a syringe. Shortly following this procedure the egg was passed, which was rubbery and slightly shriveled. The three potentially viable eggs were placed on wet vermiculite (1:1 weight ratio of water to vermiculite) in an incubator at 24°C. Unfortunately, none of the eggs hatched (UTA R-59481 for all four eggs).

The female was collected in July at the beginning of the rainy season, which is consistent with the previous reports of gravid females being found in Colima and Jalisco during the rainy season between July and October (Hale, *op. cit.*; Kofron, *op. cit.*). The number of eggs produced is also consistent with previous observations, further suggesting this species has a clutch size ranging from 2–5 eggs.

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***DRYMARCHON COUPERI* (Eastern Indigo Snake). JUVENILE OBSERVATIONS.** *Drymarchon couperi* is one of the largest North American serpents (to 2.63 m total length; Conant and Collins 1991. A Field Guide to Reptiles and Amphibians of Eastern and Central North America. 3rd ed. Houghton Mifflin, Boston, Massachusetts. 616 pp.). In the northern part of their range (i.e., northern Florida and Georgia), adult *D. couperi* have an intimate association with *Gopherus polyphemus* (Gopher Tortoise) burrows, which they use as overwintering sites (Hyslop et al. 2009. Copeia 2009:458–464). As a result, cool-season (November 1–March 31) visual encounter surveys (VES) of *G. polyphemus* burrows in xeric sandhills are an effective way to survey for *D. couperi*. Stevenson et al. (2009. Herpetol. Cons. Biol. 4:30–42) conducted a mark-recapture study of *D. couperi* on the Fort Stewart Military Reservation, Georgia, USA (31.88°N, 81.57°W, datum: WGS84). During multiple cool-season surveys conducted between 1998 and 2007, they captured and marked 93 *D. couperi*. However, only two (2%) individuals were young-of-the-year (i.e., juveniles, 35–90 cm SVL) and 19 (20%) were subadults (90.1–120 cm SVL). This apparent inability to detect juvenile and subadult *D. couperi* has resulted in a large deficiency in our understanding of the ecology of these age classes. Here we report additional observations of juvenile *D. couperi* in southern Georgia gleaned from on-going surveys at Fort Stewart (J. Macey, unpubl. data), the literature, the Georgia Department of Natural Resources' Natural Heritage Program database, major museum collections in Georgia and Florida, and interviews with local herpetologists.

Between 2007 and 2011, four additional juvenile *D. couperi* were captured on Fort Stewart during cool-season VES. All four of these observations were of snakes on the surface near or on the apron of active/inactive (N = 3) or abandoned (N = 1) *G. polyphemus* burrows. In contrast, 54 adults and 11 subadults were captured during those same surveys. We identified 13 additional observations of juvenile *D. couperi* in Georgia between 1975 and 2008. These observations included three juveniles found on the surface during the cool season near *G. polyphemus* burrows (N = 1), *Dasypus novemcinctus* (Nine-banded Armadillo) burrows (N = 1; Williamson and Moulis. 1994. Savannah Sci. Mus. Spec. Publ. No. 2., 418 pp.), and stump hole refugia (N = 1). Two observations were individuals alive or dead on roads during the fall (September 10 and October 2), another was in a trap at a drift fence array (October 21; Hyslop et al. 2009. Florida Sci. 72:93–100), and a third was under anthropogenic debris (April). Six observations were of individuals active on the surface but not associated with any cover, including four recent hatchlings found on the same day at the margin of a cypress pond (30 August; Williamson and Moulis, *op. cit.*). At least six of our 13 additional observations (46%) were made in xeric sandhill habitat and three (23%) were in the cool-season.

We are unsure of the reasons behind the extreme disparity between juvenile and adult *D. couperi* observations during cool-season surveys on xeric sandhills or the general paucity of juvenile *D. couperi* records. The success of cool-season VES on xeric sandhills in southern Georgia for finding adults suggests that juvenile detection rates are extremely low, juveniles rarely use *G. polyphemus* burrows as cool-season shelter, and/or juveniles use different habitats than adults. Lower detection rates could be a result of smaller size, more cryptic behavior, or fewer numbers of individuals. We feel this last possibility is unlikely since our Fort Stewart study site contains a robust, reproducing population (Stevenson et al. 2009, *op. cit.*). The small size of juvenile *D. couperi* may allow them to use smaller shelters as overwintering sites, although thermal data indicate that *G. polyphemus* burrows provide the warmest microclimates during the cool season (J. Bauder, unpubl. data). Juveniles may also rarely bask outside of or move among burrows, a behavior that adults readily exhibit (Stevenson et al. 2003. Southeast. Nat. 2:393–408). Juveniles may also avoid *G. polyphemus* burrows used by adults because of the threat of cannibalism, as adult *D. couperi* are strongly ophiophagus (Stevenson et al. 2010. Southeast. Nat. 9:1–18). However, on Fort Stewart we have observed juveniles using burrows < 100 m of burrows used by adults in the same season. Although juvenile *D. couperi* do use xeric sandhills during the cool-season, it is possible that juveniles also overwinter in habitats other than xeric sandhills.

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***EPICRATES CENCHRIA* (Rainbow Boa). DIET AND FORAGING BEHAVIOR.** Predation on bats by snakes has been reported infrequently. Esbérard and Vrcibradic (2007. Rev. Brasil. Zool. 24:949–953) reviewed this phenomenon in the Neotropics and

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FIG. 1. *Epicrates cenchria* preying on *Lonchorhina aurita* in Pedra Branca Cave, Sergipe, Brazil.

reported 40 records involving 20 snake species, with half of the events involving boids, particularly species of the genus *Epicrates*. *Epicrates cenchria* is a semi-arboreal species with a diet that includes birds, reptiles (lizards), amphibians, and mammals (Bernarde and Abe 2010. Biota Neotrop. 10:167–173; Henderson 1993. Herpetol. Nat. Hist. 1:91–96). This species may hunt actively inside caves, or lie in wait at the entrance to capture bats in flight (Esbérard and Vrcibradic, *op. cit.*). Similar behavior has been observed in *Epicrates* in Cuba (Hardy 1957. Copeia 1957:151–152), but there are few records of this phenomenon in Brazil, and none in cave environments. Here we report predation of a bat (*Lonchorhina aurita*) by an *E. cenchria* in a cave in the Brazilian state of Sergipe.

On the morning of 30 October 2010, we observed an *E. cenchria* preying on a bat, *L. aurita* (Fig. 1), in Pedra Branca Cave, municipality of Maruim, Sergipe, Brazil (10.776°S, 37.145°W, datum WGS84). Pedra Branca is registered as cave number SE-06 by the Brazilian Speleological Society. It is a 100 m-long limestone cave, with an entrance 1.10 m wide and 0.63 m high. The cave is located within an area of permanent protection in a fragment of secondary Atlantic Forest and mangrove vegetation, 20 m from the Sergipe River. Four bat species are found in this cave: *Carollia perspicillata, Desmodus rotundus, Phyllostomus hastatus*, and *L. aurita*. The event was first observed in the constriction phase, which lasted at least four minutes. During other visits to the cave, an *E. cenchria* was observed near the entrance, although it is not known if it was the same individual.

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***EPICTIA MUNOAI* (Uruguayan Blindsnake). AGGREGATION.** In July 2004 we discovered an unusually large aggregation of *Epictia munoai* during an ecological study along the road RS 615 in the region from Bagé to Candiota, Brazil (30.5°–31°S, 54°–54.5°W; elev. 200–220 m). The region consists of a grassy plain with many termite nests. Using a lever to open a large number of nests, we dug out galleries in which we found hundreds of specimens of *E. munoai*. All of the nests examined contained snakes, both adults and young. We collected a sample of 30 specimens for the herpetological collection of the Museu de Ciências e Tecnologia, in Porto Alegre, RS Brazil (MCTP). Several specimens had termite nymphs in their mouths. We examined the digestive tracts of about 20 specimens and all were found to have eaten nymphs. Additional surveys in the Bagé-Jaguarão to Candiota region consistently yielded many *E. munoai*, but few were found in surveys at lower elevations (Cazuza Ferreira, Encruzilhada do Sul, Porto Alegre, Santa Maria, Uruguaiana, all in RS). The total sample (about 100 specimens) is housed in the collection of Museu de Ciências Naturais of the Fundação Zoobotânica, Porto Alegre (MCNRS).

McCoy (1960. Copeia 1960:368) described a large aggregation of *Leptotyphlops dulcis dissectus* in Oklahoma, USA, which he suggested might be related to reproduction. Rafael Lucchesi Ballestrin (pers. comm.) and Arlete Ballestrin Outeiral (2006. Doctoral dissertation, Pontifícia Universidade Católica do Rio Grande do Sul) both studied the snakes of the Serra do Sudeste (RS) and commented on the rarity of *E. munoai* in hot seasons, when they are most frequently found under rocks. Our observations, however, agree with Hibbard (1964. Copeia 1964:222), who noticed a breeding colony of the species, concluding that it is gregarious.

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***ERYTHROLAMPRUS MIMUS* (Stripe-bellied False Coralsnake). DIET.** *Erythrolamprus mimus* is a relatively uncommon terrestrial and diurnal or crepuscular snake that ranges from Honduras to Peru and Ecuador. The diet is known to include small to medium-sized snakes and lizards (Savage 2002. The Amphibians and Reptiles of Costa Rica. Univ. Chicago Press, Chicago, Illinois. 934 pp.; Solórzano 2004. Snakes of Costa Rica: Distribution, Taxonomy, and Natural History. Instituto Nacional de Biodiversidad, Santo Domingo de Heredia, Costa Rica. 791 pp.) but also includes small frogs.

On 1 May 2011, at 1130 h, an adult *E. mimus* (SVL ca. 53 cm; US National Museum Field Series[USNM] 254191) was collected dead on the road on the entrance road to El Copé, Coclé Province, Republic of Panama (08.62343°N, 080.57100°W, datum WGS84), between the communities of Las Tablas and Las Tibias. The snake was split open and protruding from the body wall was a caecilian, presumably *Caecilia volcani* (USNM 254194). The anterior 21.6 cm of the caecilian was undigested. Anterior to the caecilian was a *Liotyphlops albirostris* (USNM 254195), also protruding from the body wall of the snake. The posterior 14.3 cm of the snake remained undigested. Both prey items were consumed tail-first, as suggested for ophidian prey consumed by *E. mimus* by Solórzano (*op. cit.*). This is the first record of *E. mimus* or other members of the genus feeding on a caecilian or non-colubrid snake.

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***LEPTODEIRA BAKERI* (Aruban Cat-eyed Snake). PREDATION.** Although predator-prey interactions typically involve vertebrate predators and invertebrate prey, there are several instances of invertebrates preying upon vertebrates (McCormick and Polis 1982. Biol. Rev. 57:29–58). However, many of these events are cases of specific ontogenetic vulnerability of the vertebrate prey, such as the case of aquatic insects preying upon larval amphibians (e.g., Formanowicz 1986. Herpetologica. 42:367–373). Herein, we report a large species of predatory invertebrate preying upon an adult snake.

On 1 July 2010, we observed a large *Scolopendra gigantea* (Amazonian Giant Centipede) consuming an adult *Leptodeira bakeri* within Arikok National Park, Aruba (Fig. 1). When encountered, the centipede had already consumed the flesh surrounding the head and approximately 5 cm of the flesh on the neck of the snake. The centipede was positioned on the trunk of an *Acacia tortuosa* (Twisted Acacia) approximately 0.5 m from the ground. Because of the location and positioning of both the snake and centipede, we interpret the event as a case of predation and not scavenging. Although centipedes are known to prey upon vertebrates (McCormick and Polis, *op. cit.*), and specifically snakes (Easterla 1975. Southwest. Nat. 20:411), many invertebrate-vertebrate encounters have involved nearly equally sized predators and prey. The observation by Easterla (1975, *op. cit.*) refers to a *Scolopendra heros* (Giant Desert Centipede) killing and consuming a juvenile *Rhinocheilus lecontei* (Long-nosed Snake) that was approximately twice its length. Although we did not measure the centipede or the snake, the snake appeared to be approximately three times longer than the centipede. Because both of these species are common on Aruba, this predation event may demonstrate a regular and significant ecological relationship that has been previously overlooked.



FIG. 1. *Leptodeira bakeri* being consumed by *Scolopendra gigantea* in Arikok National Park, Aruba.

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***LIOPHOLIDOPHIS SEXLINEATUS*. DIET.** *Liopholidophis sexlineatus* is frequently found in mountainous areas on the eastern coast of Madagascar (Cadle 1996. Bull. Mus. Comp. Zool. 154:369–464; Glaw and Vences 2007. A Field Guide to the Amphibians and Reptiles of Madagascar, 3rd ed. Vences, Cologne, Germany. 496 pp.; Vences et al. 2002. Ital. J. Zool. 69:263–284). It is a diurnal species with semiaquatic habits, and is thought to feed primarily on frogs (Vences et al., *op. cit.*), including *Ptychadena* spp., *Heterixalus* spp., and *Boophis microtympanum* (Glaw et al. 2007. Zool. Scripta 36:291–300). However, little is known regarding its diet and foraging behavior. Here we document an attempt of predation by a *L. sexlineatus* upon a *Trachylepis madagascariensis*, a common diurnal lizard that inhabits deforested habitats in mountain areas of central Madagascar.

At 1400 h on 5 February 2011, while walking in an area locally known as Andranolava, Andringitra Massif, southeastern Madagascar, (22.152500°S, 46.899222°E, datum: WGS84; elev. about 1970 m), we observed an adult male *L. sexlineatus* in the act of preying upon a *T. madagascariensis* on the ground near the trail (Fig. 1). The snake was wrapped tightly around the skink which had already lost the majority of its tail. The lizard attempted to escape by dislodging the snake using its limbs but ceased struggling after few seconds. The snake adjusted its prey in order to start swallowing. The skink was still alive with its broken tail facing the mouth of the snake. The snake tried to bite the broken tail



PHOTO BY G. M. ROSA

FIG. 1. Predation attempt by a *Liopholidophis sexlineatus* on a *Trachylepis madagascariensis*, in Andringitra National Park, Madagascar.

from various angles, but the position and direction of the hind limbs prevented the snake from swallowing the skink. After several failed attempts that lasted for slightly more than 3 min, the *L. sexlineatus* finally loosened its grip, allowing the skink to escape. This observation suggests that *L. sexlineatus* preys, at least occasionally, on *Trachylepis* skinks.

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***LYCODON AUCILUS* (Common Wolf Snake). PREDATION.** *Lycodon aucilus* is a nocturnal snake found throughout South Asia. It is common within the range and is frequently found near human habitations (Whitaker and Captain 2004. The Snakes of India. Draco Books, India. 481 pp.). *Hoplobatrachus tigerinus* (Indian Bullfrog) is the largest frog in South and Southeast Asia and is common in the region. It is nocturnal and preys on insects, crabs, small rodents and birds, skinks and snakes (Daniel 2002. The Book of Indian Reptiles and Amphibians. Oxford Univ. Press. UK. 238 pp.). On 14 July 2011, at 0200 h, we observed an adult *H. tigerinus* (SVL ca. 130 mm) preying upon a *L. aucilus* (total length ca. 770 mm) on an unpaved road located just outside of Lawachara National Park, Bangladesh (25.8907694°N, 88.8502083°E, datum: WGS 84). The *L. aucilus* was still alive even after we pulled it out of the frog's mouth.

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***MANOLEPIS PUTNAMI* (Thinscaled Snake). DIET.** *Manolepis putnami* is a small colubrid endemic to Mexico whose geographic distribution extends from the states of Nayarit to Chiapas, along the Pacific coast (Johnson 1978. Southwest. Nat. 23:538; Smith and Taylor 1945. Bull. U.S. Nat. Mus. 187, iv + 239 pp.). Little is known about the ecology of *M. putnami,* but it has been reported to feed on lizards, including *Sceloporus melanorhinus, S. uniformis,* and racerunners in the genus *Aspidoscelis* (Ramírez-Bautista 1994. Manual de Claves Ilustradas de los Anfibios y Reptiles de la Región de Chamela, Jalisco, México. UNAM, México. 127 pp.). However, the latter have been identified only to generic level. Herein, we report an observation of predation on *Aspidoscelis guttata* (Mexican Racerunner) by *M. putnami* in tropical deciduous forest of coastal Oaxaca.

On 10 June 2008, at 1300 h, an adult *M. putnami* was found constricting a juvenile *A. guttata* (Fig. 1) in deciduous tropical forest in the Jardin Botánico de la Universidad del Mar (15.916663°N, 97.076748°W; datum: WGS 84; elev. 91 m), located ca. 6 km N of Puerto Escondido, San Pedro Mixtepec, Oaxaca, Mexico. When the snake was found, it was constricting the lizard's body while biting the basal section of the tail. The snake continued constricting the lizard for ca. 15 minutes and then elongated its body, swallowed the prey, and retreated into the vegetation.



FIG. 1. An adult *Manolepis putnami* ingesting a freshly killed *Aspidoscelis guttata* in tropical deciduous forest of southern coastal Oaxaca, Mexico.

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***NATRIX MAURA* (Viperine Snake). DIET: SCAVENGING.** *Natrix maura* is a medium-sized snake (558–910 mm total length) that inhabits aquatic habitats in the north coast of Africa and southern Europe (Maso and Pijoan 2011. Anfibios y Reptiles de la Peninsula Iberica, Baleares y Canarias. Ed. Omega, Barcelona, Spain. 848 pp.). On 26 April 2011, during a monitoring visit to a small reservoir close to Pontevedra, Spain (42.29°N, 8.36°W, datum: ED50) we found a small juvenile *N. maura* attempting to swallow a dead *Lissotriton boscai* (Bosca's Newt; Fig. 1). Previous studies have suggested that the diet of *N. maura* consists primarily of amphibians and fishes, but it can also capture reptiles and small mammals. Younger individuals also prey on invertebrates such as earthworms, snails, leeches, and insects (Santos et al. 2000. Ecography 23:185–192). Consumption of carrion has not been reported in previous studies, although Hailey and Davies (1986. Herpetol. J. 1:53–61) mentioned that *N. maura* can locate dead prey using exploratory cruising foraging behavior. Scavenging has been reported in a congener, *N. natrix* (Luiselli et al. 2005. Herpetol. J. 15:221–230; Poschadel and Kirschey 2002. Zeitschrift fuer Feldherpetologie 9:223–226). Thus, it is possible that this



FIG. 1. Juvenile *Natrix maura* swallowing a dead *Lissotriton boscai* (Bosca's Newt).

behavior has passed unnoticed in *N. maura*, but the species is able to use carrion as a food resource when it is available.

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***NERODIA ERYTHROGASTER ERYTHROGASTER* (Red-bellied Watersnake). NECROPHAGY BY DUNG BEETLES (SCARABAEINAE).** On 7 August 2011, we discovered a partially decomposed carcass of a yearling (ca. 36 cm total length) *Nerodia erythrogaster erythrogaster* on an unimproved sand road through sandy, pine-oak hammock habitat close to a large alluvial swamp associated with the Altamaha River (20.1 km S Ludowici, Long Co., Georgia, USA [31.540929°N, 81.660126°W, datum: NAD 83]). Adults of two species of dung beetles (two female *Phanaeus igneus* and 6–8 *Canthon* sp.) and a number of calliphorid flies were on or very near the carcass (Fig. 1). We watched as beetles appeared to tear tissue from the snake carcass and push it about; additionally, the *Canthon* beetles had excavated fresh burrows into the sand near the carcass.

Although most species of Scarabaeinae are coprophagous or necrophagous (Woodruff 1967. Ph.D. dissertation, Univ. Florida), there are few published records of *Phanaeus* spp. or *Canthon* spp. utilizing reptile/snake remains. Young (1981. Coleopt. Bull. 35:345–348) noted that on Barro Colorado Island, Panama, the tropical *C. moniliatus* occurred on reptile carrion and was attracted to reptile feces. Most *Phanaeus* species exploit moist excrement of large herbivores, with the food preferences of *P. vindex* including omnivore, especially swine, feces (Price and May 2009. Acta Zool. Mex. 25:211–238).

To our knowledge, this observation represents the first record of North American dung beetles using snake remains. Because a fairly large population of feral pigs (*Sus scrofa*) occurs at the site, it is possible that the watersnake was ingested by a pig and passed through only partially digested. If this occurred, it is possible that the beetles we observed were in fact attracted by the odor of swine feces rather than the carrion. In either case, though, the dung beetles were performing an ecosystem service by advancing decomposition of a squamate.

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FIG. 1. Dung beetles (*Phanaeus igneus* and *Canthon* sp.) utilizing the carcass of a *Nerodia e. erythrogaster*, Long Co., Georgia, USA.

***NERODIA FASCIATA* (Southern Watersnake). ECTOPARASITES.** *Nerodia fasciata* is a common semi-aquatic species native to much of the southeastern United States (Conant and Collins 1998. A Field Guide to the Reptiles and Amphibians of Eastern and Central North America. Houghton Mifflin Co., Boston, Massachusetts. 640 pp.). Little is known about the ectoparasites of *N. fasciata*. Herein, we document the first account of a leech parasitizing a *N. fasciata*.

On 20 April 2011, at 2100 h, an adult *N. fasciata* (SVL ca. 76 cm) was observed in an ephemeral pond 0.18 km north of NW 82nd Boulevard and NW 51st Drive, Gainesville, Alachua Co., Florida, USA (29.73159°N, 82.39659°W, datum WGS84; elev. 58 m). The snake was in shallow water (< 15 cm deep) along the shoreline and allowed KLK to photograph it at a very close distance (approximately 7.5 cm). Upon examination of the photographs, we discovered nine leeches (Annelida: Clitellata: Hirudinida: Glossiphoniidae: *Placobdella papillifera*) on the head of the snake (Fig. 1). While typically encountered as free-living, this leech has also been collected as an ectoparasite from turtles (Klemm 1995. Identification Guide to the Freshwater Leeches [Annelida: Hirudinea] of Florida and other Southern States. Bureau of Surface Water Management, Florida Dept. Environmental Protection, Tallahassee. v + 82 pp; Readel et al. 2008. Copeia 2008:227–233).

Placobdella papillifera, one of 18 species in the genus (Klemm et al. 2011. Classification and Checklist of the Leeches [Phylum Annelida: Class Clitellata: Subclass Hirudinida] Occurring in North America North of Mexico. http://www.inhs.uiuc.edu/~mjwetzel/FWLeechesNA.html; accessed 20 July 2011), is widely distributed throughout the midwestern and eastern United States (Klemm, *op. cit.*), and has been reported to be widely distributed but low in abundance in Canada (Davies and Wilkialis 1982. Am. Midl. Nat. 107:316–324). Representative photographs of the snake and leeches were deposited in the Florida Museum of Natural History, University of Florida (UF 165479). Although leeches have been documented parasitizing *Regina septemvittata* (Queen Snake; Branson and Baker 1974. Tulane Stud. Zool. Bot. 18:153–171), this is the first known case of a leech parasitizing *N. fasciata*, or perhaps using the snake's smooth skin as an easy attachment site and/or mode of free transportation.

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FIG. 1. *Nerodia fasciata* with leeches (*Placobdella papillifera*) on its head.

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***NERODIA FASCIATA* (Southern Watersnake). FORAGING BEHAVIOR.** *Nerodia fasciata* is a common semi-aquatic species native to much of the southeastern United States (Conant and Collins 1998. A Field Guide to the Reptiles and Amphibians of Eastern and Central North America. Houghton Mifflin Co., Boston, Massachusetts. 640 pp.). Although recent observations have added considerable insight into diet partitioning and feeding strategies (Balent and Andreadis 1998. J. Herpetol. 32:575–579 ; Mushinsky and Hebrard 1977. Herpetologica 33:162–166; Mushinsky et al. 1982. Zoology 63:1624–1629), relatively little information is known about prey acquisition and capture (Gillingham and Rush 1974. J. Herpetol. 8:381–384). In this report, we document a noteworthy feeding behavior used by *N. fasciata* to effectively capture amphibian prey.

On 20 April 2011, at 2100 h, we attempted to photograph breeding frogs calling from the shoreline of an ephemeral pond 0.18 km N of NW 82nd Boulevard and NW 51st Drive, Gainesville, Alachua Co., Florida, USA (29.73159°N, 82.39659°W, datum WGS84; elev. 58 m). We observed two (apparently fat with recently ingested prey items) adult *N. fasciata* (SVLs ca. 60 and 76 cm) in shallow water (<15 cm deep) and aligned perpendicular to and within 7.6 cm of the shoreline. The larger snake swam along the shoreline and repositioned itself until it detected calling frogs, possibly by feeling vibrations (Friedel et al. 2008. Physical Rev. Lett. 100:048701). We observed this snake lunge forward and consume a *Hyla gratiosa* (Barking Treefrog) and *Lithobates sphenocephalus* (Southern Leopard Frog), yet still repostitioned itself along the shoreline once again (Fig. 1). About 9 m down the shoreline, the smaller snake was observed exhibiting the same behavior; one of the hundreds of nearby *H. gratiosa* tadpoles swam and touched the snake's body, upon which the snake quickly turned and unsuccessfully struck at the tadpole. At this same pond on 18 May 2011, at 2200 h, we observed six adult *N. fasciata*. Each snake was found exhibiting the same foraging strategy, with five of them were concentrated together within 3 m along the shoreline. We observed each of these snakes consume at least one frog, including *H. gratiosa, L. sphenocephalus, Acris gryllus* (Southern Cricket Frog), and *Anaxyrus terrestris* (Southern Toad). These observations augment the known complex feeding behavior exhibited by natricine snakes (Gillingham and Rush, *op. cit.*).



FIG. 1. Southern Watersnake (*Nerodia fasciata*) positioning itself perpendicular to the shoreline while foraging for amphibians.

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***NERODIA SIPEDON* (Northern Watersnake). DIET.** Watersnakes of the genus *Nerodia* are widely distributed in eastern North America but historically have not occurred west of the Colorado River. At least two species of *Nerodia* are now firmly established outside of their native range after being introduced to at least three localities in California. *Nerodia fasciata* is known from Los Angeles Co. (Balfour and Stitt 2002. Herpetol. Rev. 33:150) and Sacramento Co. (Balfour et al. 2007. Herpetol. Rev. 38:489), and *N. sipedon* is known from Placer Co. (Balfour et al. 2007. Herpetol. Rev. 38:489). Although all three populations occur in highly modified suburban or urban habitats, there is growing concern that wider establishment of these introduced species may have deleterious consequences for native wildlife. Concerns include possible competition with native snakes or impacts on native fish and amphibians.

On 5 July 2011, a female *N. sipedon* (SVL = 273 mm; 16.11 g) was captured by hand in Roseville City, Placer Co., California, USA. The snake was palpated to cause it to regurgitate its gut contents, which included another species introduced to California (a small, metamorphic *Lithobates catesbeianus* [American Bullfrog]), and a native amphibian, (an adult *Pseudacris regilla* [Pacific Chorus Frog]). To our knowledge, this represents the first confirmed report of a non-native watersnake feeding on a western species and partly validates concerns over impacts to native species.

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***PANTHEROPHIS SPILOIDES* (Gray Ratsnake). DIET.** On 12 June 2011, at 1409 h, I observed a mixed flock of birds mobbing a *Pantherophis spiloides* (ca. 1.2 m total length) in Macon Co., Alabama, USA (32.514536°N, 85.612337°W, datum WGS84/NAD83). The flock consisted of a male and female Summer Tanager (*Piranga rubra*), a Ruby-throated Hummingbird (*Archilochus colubris*), a Blue-gray Gnatcatcher (*Polioptila caerulea*), a Tufted Titmouse (*Baeolophus bicolor*), and a Northern Mockingbird (*Mimus polyglottos*). Initially, only the posterior portion of the snake was visible, while the anterior end was actively probing and moving within a Summer Tanager nest located 8.3 m high in a tangle of Muscadine (*Vitis rotundifolia*) vines suspended between several Loblolly Pines (*Pinus taeda*). After ca. 8–10 min, the snake exited the nest. There was a visible lump in the snake's belly, but it could not be determined if it had eaten eggs or hatchlings nor the number consumed. The snake crawled along the tangle of Muscadine vines into the adjacent trees and disappeared into a squirrel nest. There is an extensive list of birds and their young known to be eaten by *P. spiloides* (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Inst. Press, Washington, DC. 668 pp.). This observation is the first record of *P. rubra* eggs or young being consumed by *P. spiloides*.

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***PHILODRYAS OLFERSII* (Lichtenstein's Green Racer). DIET.** *Philodryas olfersii* is a non-venomous diurnal species that is distributed across several municipalities of Minas Gerais State, Brazil, in the transition areas between the Cerrado and the Atlantic Forest biomes (Bertoluci et al. 2009. Biot. Neotrop. 1:147–155; São-Pedro and Pires 2009. Ceres 2:166–171). It is considered terrestrial or semiarboreal and is known to feed on a variety of vertebrates, including rodents, anurans, birds, lizards, and snakes (Hartmann and Marques 2005. Amphibia-Reptilia 26:25–31; Sawaya et al. 2008. Biot. Neotrop. 8:127–149). In this study we report a *P. olfersii* preying upon a novel prey species in an urban environment.

On 12 January 2011, around 1550 h, we observed an adult female *P. olfersii* (SVL = 85.53 cm; total length = 117.26 cm; 310 g) in an urban household in the municipality of Lavras, Minas Gerais State, Brazil (21.9998°S, 44.2457°W; datum WGS84). The snake was discovered preying on a bird of the species *Melopsittacus undulatus*, popularly known as the Budgerigar (periquito australiano), which is widely commercialized in Brazil. The bird was being kept in a cage in the backyard of a house surrounded by walls approximately 3 m high. At the rear area of the home there was a small patch of remaining Cerrado vegetation. The snake (CRLZ 00270) was collected and deposited at the Coleção de Répteis do Laboratório de Zoologia, Centro Universitário de Lavras - UNILAVRAS, municipality of Lavras, Minas Gerais, Brazil.

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***PHILODRYAS PATAGONIENSIS* (Patagonian Green Racer). DIET.** *Philodryas patagoniensis* is a terrestrial species found in Argentina, Bolivia, Brazil, Chile, Paraguay, and Uruguay (Peters and Orejas-Miranda 1970. Catalogue of Neotropical Squamata Part I. Snakes. U.S. Nat. Mus. Bull. 347 pp.). It is considered to be a dietary generalist, feeding on amphibians, lizards, snakes, birds, mammals, fish, and amphisbaenians (Carvalho-e-Silva and Barros-Filho 1999. Herpetol. Rev. 30:170; Costa et al. 2010. Biot. Neotrop. 10:353–377). Here we report a new food item in the diet of *P. patagoniensis* in Brazil.

On 22 October 2009, an adult female *P. patagoniensis* (CRLZ 000157; total length = 92.1 cm; tail length 11.5 cm; 390 g) was found dead in an area of cerrado habitat in the Reserva Biológica Unilavras – Boqueirão (RBUB), Ingaí, Minas Gerais, Brazil (21.34638°S, 44.9908°W, datum: WGS84; elev. 1250 m). During necropsy we found an adult coleopteran in the snake's stomach and coleopteran elytra within the anterior portion of the small intestine. We also examined the gut contents of another female *P. patagoniensis* (CRLZ 000216; total length = 47.2 cm; tail length 8.2 cm; 40 g) of unknown provenance. In this specimen, the following food items were identified within the anterior portion of the small intestine: wings of Coleoptera, wings of Hemiptera, larvae of Coleoptera, and other insect body parts. These records represent the first instances of invertebrates in the diet of *P. patagoniensis*. Although it is possible that the invertebrate remains we observed were secondarily ingested (i.e., they were initially consumed by an anuran, lizard, or other animal that was subsequently eaten by the snake), we believe that this is unlikely because we found no other prey items in the stomachs, because the insects had relatively large dimensions, and because the elytra observed were already within the small intestine of the snake.

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***PITUOPHIS MELANOLEUCUS MELANOLEUCUS* (Northern Pinesnake). MALE-MALE COMBAT.** Combat behavior between male *Pituophis m. melanoleucus* in captivity was described by Shaw (1951. Herpetologica 7:149–168), but apparently few if any observations of this behavior in the wild have been published. R. T. Zappalorti (pers. comm.) reported never having observed male combat despite decades of fieldwork with *P. m. melanoleucus* in the New Jersey Pine Barrens.

On 30 May 2011, at 0950 h, while radiotracking a telemetered adult male *P. m. melanoleucus* (ca. 18.4 km WNW Wagram, Scotland Co., North Carolina, USA; 34.9938°N, 79.5381°W, datum: WGS84), I observed combat between two male *P. m. melanoleucus*. I had located the telemetered male underground in what appeared to be a Hispid Cotton Rat (*Sigmodon hispidus*) burrow complex in moderately dense ground cover at the edge of a large disturbed area. Air temperature was 30°C, and soil temperature 24°C. As I attempted to pinpoint the telemetered male's precise location, two untelemetered adult *P. m. melanoleucus* emerged from the burrow complex, the larger snake pursuing the smaller one. Both snakes were hissing loudly and thrashing about with their bodies intertwined, rubbing and shoving against one another (Fig. 1). At one point, the larger male was wrapped tightly around the smaller one, as if attempting constriction. The larger



FIG. 1. Combat between two male *Pituophis m. melanoleucus*, Scotland Co., North Carolina, USA.

male directed several short feint-strikes toward the smaller male's head and anterior body, and may have bitten him at least once. These behaviors are consistent with those described for captive *P. m. melanoleucus* by Shaw (*op. cit.*) and for various other Pituophis, both wild and captive (Bogert and Roth 1966. Am. Mus. Nov. 2245:1–27; Reichling 1988. Herpetol. Rev. 19:77–78).

After approximately 2 min, the snakes moved into thick vegetation and the smaller one attempted to retreat down a burrow. I captured both snakes at that point and they exhibited no further interest in each other after being handled. No attempt was made to measure lengths, but the larger male weighed 1442 g and the smaller one 823 g. I detected no female, but one could have been concealed nearby, likely underground. The telemetered male (intermediate in size between the two combatants) was underground nearby for the duration. Both male *P. m. melanoleucus* were implanted with transmitters and released at the capture site on 8 June 2011. No further interactions with conspecifics have since been observed in either snake. The infrequency with which combat behavior has been reported among members of the genus *Pituophis* under natural conditions suggests that such behavior may be relatively uncommon in snakes of this group.

The North Carolina Herpetological Society, Three Lakes Nature Center (Thomas J. Thorp), and Wake Audubon supported fieldwork leading to this observation. Jamie M. Smith assisted in extracting still images from my video footage. The North Carolina Wildlife Resources Commission provided endangered species permits.

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***RHABDOPHIS SUBMINIATUS* (Red-necked Keelback). DIET.** *Rhabdophis subminiatus* is a rear fanged, venomous snake that inhabits wet forests, tea plantations, grasslands, and paddy fields across Southeast Asia. It is diurnal, grows up to 1300 mm, and is known to prey on frogs, toads, lizards and small mammals (Whitaker and Captain. 2004. The Snakes of India. Draco Books, India. 481 pp.). On 22 July 2011, at ca. 1300 h, we captured an adult, *R. subminiatus* (total length = 530 mm) in a tea estate located just outside the Lawachara National Park, Bangladesh (24. 330963°N, 091.801120°E, datum: WGS 84; elev. 51 m). The specimen was euthanized and preserved in alcohol as a voucher. Upon dissection of the specimen, we discovered a *Fejervarya* sp. (Cricket Frog; SVL ca. 50 mm) in its stomach. The frog was not in sufficient condition to identify to species level.

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***RHABDOPHIS TIGRINUS* (Tiger Keelback), *ELAPHE QUADRIVIRGATA* (Japanese Striped Snake). PREDATOR-PREY INTERACTION.** *Elaphe quadrivirgata* is known to prey on other snakes, and there are at least five records of it feeding on *R. tigrinus* (Tanaka and Mori 2001. Current Herpetol. 19:97–111). On 14 August 2011, at 1217 h, on an unnamed road between the defunct Oka bus stop and Otsuba bus stop in Innai-machi, Usa-shi, Oita Prefecture, Japan (33.3708°N, 131.2993°E, datum WGS84; elev. 275 m), we observed a ca. 80 cm long melanistic *E. quadrivirgata* on the roadside along a narrow water-filled drainage ditch. About 20 sec later, a *R. tigrinus* of similar size began moving towards the ditch from the opposite side of the ditch. The *E. quadrivirgata* rapidly approached the *R. tigrinus* and made a strike from across the ditch. The *R. tigrinus* countered with a right lateral strike delivering a bite to the anterior body of the *E. quadrivirgata*. The snakes locked up over the ditch and disengaged very quickly. For approximately 15 sec the snakes faced each from opposite sides of the ditch. A bleeding puncture wound was observed on the *E. quadrivirgata* but no wounds were apparent on the *R. tigrinus*. Subsequently, the *E. quadrivirgata* slowly crossed the ditch and moved out of sight under the vegetation.

Rhabdophis tigrinus is reported to display a suite of defensive behaviors that vary according to temperature, but it is seldom reported to strike (Mori and Burghardt 2001. Ethology 107:795–811). In this case, the *R. tigrinus* responded with a strike immediately and, apparently, effectively. To our knowledge, this is the first documented incident of *R. tigrinus* directly rebuffing a predation attempt by *E. quadrivirgata*. Fourteen photographs of the event were deposited in the University of Texas at Arlington Amphibian and Reptile Diversity Research Center's digital slide library (UTADC 6943–6956).

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***SALVADORA HEXALEPIS DESERTICOLA* (Big Bend Patch-nosed Snake). DIET.** *Salvadora hexalepis deserticola* is a poorly studied Chihuahuan Desert species that is reported to feed primarily on lizards (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Institution Press, Washington DC. 668 pp.; Lemos-Espinal and Smith 2007. Anfibios y Reptiles del Estado de Chihuahua, México. UNAM. CONABIO, México, DF. 613 pp.). On 22 August 2006, at ca 1900 h, we found a dead *S. h. deserticola* on the ground at La Escondida ranch, Nuevo Casas Grandes, Chihuahua, México (30.521258°N, 107.764980°W, datum WGS84; elev. 1611 m). The snake (female; SVL = 450 mm;



FIG. 1. *Salvadora hexalepis deserticola* found dead with an *Aspidoscelis exsanguis* protruding from its body in Nuevo Casas Grandes, Chihuahua, México.

total length = 600 mm; 41.77 g) had an *Aspidoscelis exsanguis* (Chihuahuan Spotted Whiptail) protruding from its body at 190 mm post-snout (Fig. 1). The lizard (SVL = 95 mm; 14.14 g) had been ingested headfirst and represented 33.85% of the snake's body mass. There was also a smaller (1.59 g) *A. exsanguis* in the snake's stomach. The specimens are preserved in the herpetological section of the scientific collection of vertebrates of the Universidad Autónoma de Ciudad Juárez (CCV 661). On 15 September 2006 we observed another *S. h. deserticola* (30.508225°N, 107.774205°W, datum WGS84; elev. 1637 m) attempting to eat an *A. exsanguis*, but when disturbed, the snake regurgitated. To our knowledge, these are the first records of *A. exanguis* in the diet of *S. hexalepis*.

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***THAMNOPHIS BUTLERI* (Butler's Gartersnake). MORPHOLOGY.** Apical pits are single or paired translucent epidermal depressions located on the posterior end (the apex) of the dorsal scales of some snake species. The function of apical pits remains ambiguous. Ball (1996. Reptile and Amphibian Magazine. July/August 1996:112–116) provided a brief summary of proposed functions for apical pits which included aiding in ecdysis, serving as a site for the release of sex-specific hormones, and serving as detectors of thermal variations. H. M. Smith (pers. comm. 2005) has suggested that they may be associated with sensory nerve endings and serve a tactile function. In snakes that possess them, apical pits may be observed on the animal itself or on their shed stratum corneum. *Thamnophis butleri* has been reported to lack apical pits (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Books, Washington, DC. 668 pp.; Marx and Rabb 1972. Fieldiana Zool. 63:92–99). Herein, I report the observation of apical pits on the shed skin of a *T. butleri*.

Thamnophis butleri shed skins (N = 8) were acquired from specimens at two sites located in southern Ontario, Canada: five from Bright's Grove, near Sarnia, and three from Luther Marsh in Dufferin and Wellington counties. Shed skins were cut, moistened with 70% isopropyl alcohol, spread on perforated plastic sheets, blotted dry, then pressed in a plant press for ca. 24 h (Gray 2005. The Serpent's Cast: A Guide to the Identification of Shed Skins from Snakes of the Northeast and Mid-Atlantic States. Center N. Am. Herpetol. Monogr. No. 1, ii + 90 pp.). After being pressed, sections of shed skins were examined for apical pits with a dissecting microscope at 10x and 30x magnification.

Of the eight shed skins examined, one from Bright's Grove contained scales with apical pits (Fig. 1). The scales were located laterally, on both sides above the anal plate region. There is considerable intraspecific and interspecific variation in the occurrence of apical pits in the genus *Thamnophis* (Conant 1961. Am. Mus. Novit. [2060]:1–20; Gray 2006. Bull. Chicago Herpetol. Soc. 41:85–88). For example, the closely related *T. brachystoma* appears to lack them (Gray 2006, *op. cit.*), whereas in *T. radix*, apical pits are visible in the shed skins of some specimens but not others (Gray, unpubl. data). Apical pits may have been overlooked in *T. butleri* due to their very limited distribution on the body or because apical pits are difficult to observe in long-preserved specimens (Conant, *op. cit.*).

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***THAMNOPHIS EQUES MEGALOPS* (Northern Mexican Gartersnake). REPRODUCTION: LITTER SIZE.** As a result of extensive declines, *Thamnophis eques megalops* is a candidate for listing under the Endangered Species Act in the United States (U.S. Fish and Wildlife Service 2008. Fed. Reg. 73[228]:71778–71826). However, natural and life history of the species remains poorly known. As part of an Arizona Game and Fish Department monitoring and telemetry program on the species at Bubbling Ponds Hatchery (Yavapai Co., Arizona, USA), we captured an adult female *T. e. megalops* (SVL = 870 mm; 408 g) on 19 June 2009 (34.7649°N, 111.4940°W; datum NAD83). The female gave birth to 38 live young (no undeveloped ova) in the early morning of 20 June 2009 (Fig. 1). After parturition, the female's body mass was 229.5 g; neonates and placentas weighed 144.6 g. The 38 neonates had a mean SVL of 186.9 mm (range = 172–195 mm); mean total length of 243.4 mm (range = 225–258 mm); and a mean body mass of 3.71 g (range = 2.9–4.0 g). The female and 29 neonates were released near the point of the female's capture later that day; nine neonates were held in captivity and released in the same location on 18 September 2009. To our knowledge,

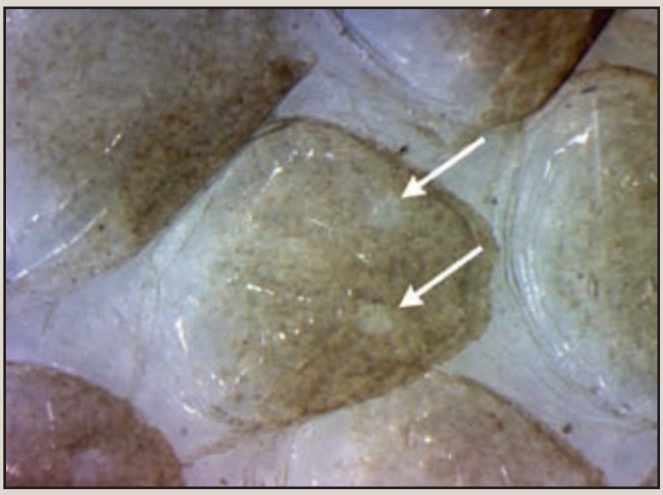


FIG. 1. Dorsal scales with apical pits on the shed skin of a *Thamnophis butleri* from Bright's Grove, Ontario, Canada.



FIG. 1. Adult female *Thamnophis eques megalops* and 38 newborn offspring, Yavapai Co., Arizona, USA.

this litter size is larger than previously reported (range = 4–26, mean = 14; Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Inst. Press, Washington, DC. 668 pp.). Litter sizes are possibly larger at this human-modified fish hatchery site compared to more natural sites, due to artificially dense prey base (native and nonnative fishes, native *Anaxyrus woodhousii*, and nonnative *Lithobates catesbeianus* and *Ambystoma mavortium nebulosum*).

This research was conducted under protocol #09-004 from the Northern Arizona University Institutional Animal Care and Use Committee. We thank Harry Sweet and David Boyarski for assistance with measuring the neonates.

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***THAMNOPHIS RADIX* (Plains Gartersnake). DEFENSIVE BEHAVIOR: TONIC IMMOBILITY.** Tonic immobility is an antipredator behavior that works under the assumption that a predator will treat an immobile prey item differently than one that is actively trying to escape. Differential treatment can occur because the prey item has become more cryptic, or because immobility reflects death, decreasing the predator's attack response. Tonic immobility is often equated to thanatosis, or death feigning, but death feigning employs more dramatic and elaborate displays (e.g., mouth gaping, supination; Gregory and Gregory 2006. J. Comp. Psychol. 120:262–268). Death feigning and tonic immobility have been well described in *Heterodon* (e.g., Burghardt and Greene 1988. Anim. Behav. 36:1842–1844) and *Natrix* (e.g., Gregory et al. 2007. J. Comp. Psych. 121:123–129), but these behaviors appear to be more widespread than previously thought. Here, we report the first account of tonic immobility in *Thamnophis radix*.

At 1700 h on 16 June 2011, we encountered an adult female *T. radix* in a grassy field 15 km W of Morris, Minnesota, USA (45.62637°N, 96.05555°W; datum: WGS 84). The snake was moving when first sighted, and was pursued for several minutes before capture. While attempting to capture the snake we repeatedly blocked its escape with a net. It was at this point that the snake stopped, writhed in place for several seconds, and then became completely still. It remained motionless and regurgitated an earthworm as we handled it to determine sex and reproductive state. Unlike the limpness observed in some species that feign death, this snake was tense and retained its muscle tone both during and after handling. We placed the snake in the grass next to the regurgitated worm. The head of the snake was slightly bent and barely tucked under the body, while the tail was coiled, exposing the underside (Fig. 1). It held this position even when gently nudged and remained immobile for at least several minutes, as long as we could see it as we were walking away. Our observation suggests that *T. radix* are capable of tonic immobility, as has been reported in *T. elegans* and *T. sirtalis* (Gregory and Gregory 2006, *op. cit.*). Tonic immobility and other death feigning behaviors may be more common in colubrid snakes than previously suspected.



FIG. 1. Immobile *Thamnophis radix* showing position of head and tail, next to regurgitated earthworm.

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***XENOCHROPHIS PISCATOR* (Checkered Keelback). DIET AND FORAGING BEHAVIOR.** *Xenochrophis piscator* inhabits wetlands and paddy fields across South and Southeast Asia and is known to prey on frogs, fish, tadpoles, and occasionally rodents and birds (Whitaker and Captain. 2004. The Snakes of India. Draco Books, India. 481 pp.) A study conducted at a large lake in Cambodia found that fish comprised 77% of the diet of *X. piscator* (Brooks et. al. 2009. Copeia 2009:7–20). Here, we report observations of *X. piscator* feeding three anuran species, *Fejervarya* sp., *Duttaphrynus melanostictus*, and *Hoplobatrachus tigerinus* from a village located just outside of Lawachara National Park, Bangladesh (24.330963°N, 91.801120°E; datum WGS84).

At 1200 h on 28 August 2011, we observed a *X. piscator* (male; SVL = 435 mm, tail length = 199 mm) in a paddy field on the side of a road. After capturing the snake, it regurgitated a live adult *Fejervarya* sp. (SVL = 40 mm) that had been swallowed leg first. At 1330 h on 8 September 2011, a loud calling sound attracted our attention to shrub on the side of a paddy field. Upon closer examination, we observed a *X. piscator* (male; SVL = 560 mm; tail length = 232 mm) preying upon an adult *H. tigerinus* (SVL = 73 mm). The snake was swallowing the frog leg first but released the prey when disturbed by our presence. At 2100 h on 15 September 2011, we captured an *X. piscator* (female; SVL = 910 mm; tail length = 335 mm) on the side of a pond. We examined the snake's stomach contents by forced regurgitation and found two adult *D. melanostictus* (SVL = 64 mm and 70 mm). Both of the toads were swallowed leg first.

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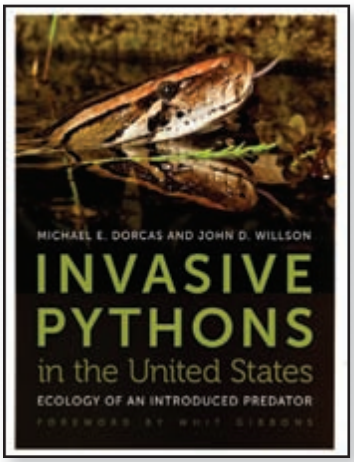
BOOK REVIEWS

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Invasive Pythons in the United States – Ecology of an Introduced Predator

by Michael E. Dorcas and John D. Willson. 2011. University of Georgia Press, Athens, Georgia (www.ugapress.org). Softcover. xii + 156 pp. US $24.95. ISBN 978-0-8203-3835-4.

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I was first confronted with the issue of invasive pythons in the southeastern United States, when Skip Snow (Wildlife Biologist in the Everglades) approached me in the late 1990s to ask about the construction and mechanism of python traps that I had built to capture wild Reticulated Pythons in western Borneo in 1996 (Auliya 2002). Clearly, this trap model did not get rid of the problem, and news of conflicts between the invasive Burmese Python and the native wildlife of Florida regularly makes the rounds in the international herpetological community.

The first time that I flicked through the pages of this book, I was impressed by the wealth of excellent photographs; the book includes approximately 180 color photos as well as color maps and graphs. I next realized that I was being introduced to numerous people dealing with this man-made problem, the majority of whom (even the authors!) were new to me, as my area of expertise is conservation herpetology in Southeast Asia. Thus I come to this book with a knowledge of the animals of concern in their native range, but totally impartial and objective with respect to this coverage of their role as invasives in America.

After identifying the pet trade as the reason behind the occurrence of Burmese Pythons in Florida the authors elaborate some disturbing facts: 1) maximum current numbers are estimated at hundreds of thousands (a more precise figure would have been desirable here); 2) the spread of these "invasives" into temperature regions is postulated; 3) potential threats to the native wildlife caused by these predators is indicated, however not yet clearly understood; and 4) these constrictors at a certain length pose a risk to humans. Interestingly, this first page also informs the reader that over the last 10 years alone 1600 specimens have been captured. If the maximum densities estimated are considered the scale of the threat can really be appreciated. Elsewhere in the introduction the authors emphasize the collection of accurate data on the Burmese Python in order to meaningfully evaluate its potential impact. The book is therefore intended to clear up any sensationalized information that has been previously published and to inform scientists and the general public about the reality of invasive pythons. Readers learn about the detrimental impacts that other invasive species (including plants) have on native environments in the southeastern United States before a final subsection "Why invasive pythons are important" outlines why these snakes are a threat.

The first chapter following the Introduction, "About Pythons," describes specific morphological and biological traits as well as behavioral ecology in just over 14 pages. As this book is also meant for the general public, some basic data on snakes in general and their similarities to lizards are also included. In this context five color photographs illustrate different snake and lizard species. A photograph illustrating the recurved teeth of pythons (p. 12) might have better been replaced by a photo showing the skull of a python to highlight its morphological distinctiveness. On page 13 the authors state, "some scientists believe that boas and pythons are closely related enough to be in the same family." Both groups were long been included in the Boidae (with some rare exceptions, see Hubrecht 1879), however, the definitive separation of Old World pythons from the Boidae into the Pythonidae follows Vidal and Hedges (2002), whose genetic research strongly supported the monophyly of pythons. Earlier approaches based on external morphological and osteological features distinguishing boas from pythons were initiated by Underwood (1976) and followed by Underwood and Stimson (1990) and Kluge (1991).

Additional information on python biology, also introducing other species (with excellent photographs) is provided, as is a short section on "Pythons as Pets." Here the authors briefly outline the python species most commonly kept as pets in the context of the owner's responsibilities and the problems that might arise should they escape. In a section entitled "Pythons as potentially invasive species," readers learn about specific natural history traits, e.g., reproduction and opportunistic feeding behavior, to understand why Burmese Pythons were able to become established and increase its population in southern Florida.

Part of the problem, as indicated by the authors, is the high density of reptile traders in this region. The question remains as to whether there is a regular intentional release of Burmese Pythons into southern Florida. I can very well imagine that some herpetoculturists do not see the invasiveness of Burmese Pythons as a true problem and have, at least in the past, restocked this introduced population (see pp. 66, 116). Man-made canals in South Florida have helped to support the dispersal and spread of these constrictors, even if they are not typically aquatic in the strict sense. Adults of some python species (e.g., *bivittatus, sebae,*

reticulatus) either move along water courses or wait to ambush prey that are attracted to water.

"Natural history of Indian and Burmese Pythons" gives information on taxonomy and native distribution, and explains how to distinguish between the two species. On p. 23, the authors state that Burmese Pythons occur on Borneo (which is incorrect), however the map on p. 25 and a statement on p. 27 correct this error. Distributional data on both species basically follows information provided by Reed and Rodda (2009), which, as the authors acknowledge, is an excellent and comprehensive source. A concise section on "Size" provides insights into the very large species and some size records, while the section "Habitats" is critical in order to understand and compare native habitats to those they are invading in South Florida. Other topics include: "Behavior and Physiology," "Food and Feeding," "Reproduction," "Predators and Parasites," and "Risk To Humans," all of which are very well illustrated.

"Scientific Research on Pythons" is one of the most important chapters. The authors correctly stress that without sound science it is not possible to make any concrete decisions about risk assessment and management strategies. This chapter introduces python researchers in the United States and the methodologies that they have applied. I was very impressed with this chapter, as it provides information otherwise not made transparent in any form of printed media, especially this comprehensively. Readers learn about how and why specific techniques are applied and gain an appreciation for the huge team of people including technicians and volunteers involved in the numerous aspects of python research.

The fourth chapter, "Burmese Pythons in the United States," may be the most important to readers in the US. Here the authors provide information about climate regimes and ecosystems used by Burmese Pythons in South Florida. An accompanying map illustrates the currently known distribution and spread of pythons in this region over the last 15 years. "How did pythons become established in Florida" includes a discussion of the hypothesis that Hurricane Andrew was one of the crucial reasons for the unintentional release of pythons, due to a destruction of reptile holding/breeding facilities in the vicinity. The authors detail and illustrate various model scenarios to explain and understand the potential range extensions of Burmese pythons, and rightly conclude that the "true potential for the spread of Burmese Pythons is likely to remain uncertain for many years." The book goes on to provide details on the morphometrics and biological and ecological traits of pythons established in South Florida "Impacts on native wildlife" is particularly depressing as it indicates that threatened native (e.g., the Florida Panther) may potentially be affected by pythons.

Chapter Five "Control measures for Burmese Pythons" provides information on capture techniques (traps, dogs), and elaborates on "Biological Controls" and "Regulations and Enforcement." I was shocked to read that even in 2010, most U.S. states "still had no laws preventing the release of exotic animals into natural environments," and that even though the state of Florida had adopted legislation in June 2010 to prohibit the possession of large constrictors, the capacity and financial resources to enforce this law were still lacking. Here the authors explain the conflicts of interest between the government and various stakeholders, demonstrating the complexity of this issue. On a related note I cannot help but note that in the period 2009–2010, the United States imported > 4200 live Burmese Pythons, with the majority originating from Vietnam, mainly sourced from "captive-bred" individuals (CITES Trade database – www.cites.org).

An important tool for readers is the short section "What if you see a python?" shedding light upon where and which authorities are in charge, if a python (as opposed to other snakes) has been encountered.

"Pythons in the Pet and Skin Trades" constitutes another essential component of this book, elaborating on the uses to which pythons have been put chiefly in the wealthier societies (i.e., the United States, Germany, Japan, among others). Readers are here made aware of the extent of the international commercial trade in reptiles (and of pythons in particular) and just how lucrative this is. The impact that the skin trade has on the Reticulated Python (in particular) is outlined (see also Auliya 2006). Besides legal imports of Burmese Pythons, the authors also mention the illegal trade from fraudulent labelling on behalf of exporting countries, as well as business relationships among American pet dealers (also see Smith 2011). Consequently, Dorcas and Willson have added the section "Responsible Pet Ownership" advising interested parties on how to correctly care for a python in captivity. The book closes with the rather pessimistic chapter "Other Species at Risk of Becoming Established in the United States," introducing African rock pythons, anacondas, boa constrictors, reticulated pythons and ball pythons. The final literature section provides a good selection of around 45 sources for additional reading on the topic and a six-page index makes the book even user-friendlier.

Michael E. Dorcas and John D. Willson superbly meet their objectives, maintaining objectivity throughout their presentation of this highly political topic. The book is not only highly informative but rather embarrassingly teaches us about where human behavior can lead. Indeed the book was necessitated by the largely uncontrolled and unregulated trade and keeping of exotic pets. On-going research will soon be able to tell how detrimental these "invasives" will be to native and threatened wildlife. All in all, this is a book that I highly recommend to all naturalists, especially those with a interest in herpetology and conservation.

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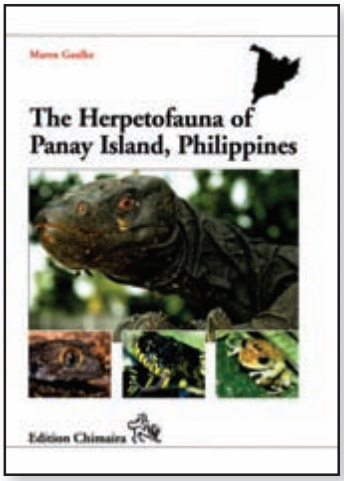
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The Herpetofauna of Panay Island, Philippines—An Illustrated Field Guide

by Maren Gaulke. 2011. Edition Chimaira (www.chimaira.de). Hardcover. 390 pp. US $99.50. ISBN 978-3-89973-481-2.

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The Philippines, a country of incredible biodiversity and high levels of vertebrate endemism, spans the area between the Sundaland-Eurasian and Philippine Sea plates (Brown and Diesmos 2009). Beginning in the Mesozoic, various geological processes shaped the distribution of land, including the collision of sea plates, strike-slip fault formation, and volcanic activity (Dimalanta and Yumul 2004; Rangin 1990; Yumul et al. 2003, 2009). In addition to the geological processes that created the island arc system, Pleistocene sea level fluctuations have caused repeated and dramatic changes in the size and connectivity of islands (Hall 1996, 1998; Heaney 1986; Karns et al. 2000; Rohling et al. 1998; Siddal et al. 2003), creating an excellent model for a wide variety of systematic and evolutionary studies. Although processes of diversification in the archipelago are quite dynamic, biodiversity in general is partitioned across several major faunal regions corresponding to historically connected island platforms recognized as Pleistocene Aggregate Island Complexes (PAICs: Brown and Diesmos 2002, 2009). Within the Visayan, or central Philippine, PAIC lies the island of Panay.

As many of the seminal works describing Philippine amphibians and reptiles now are decades old (e.g., Brown and Alcala 1978, 1980; Inger 1954), new field guides integrating what we now know of the Philippine herpetofauna have the potential to become immediate reference tools. Maren Gaulke is among the most active researchers focused on understanding the diversity of amphibians and reptiles in the Philippines. With a long-term research program based on the northwest peninsula of Panay, Gaulke is ideally suited for such a review of the island's herpetofauna. An elegant preface by Wolfgang Böhme sets the stage for what will surely serve as a broadly used reference for students and researchers alike interested in Philippine biodiversity, particularly amphibians and reptiles. The book has numerous strengths, from descriptive accounts, an identification key, and an incredible number of photographs, to its physically manageable size as a working reference tool that can easily be carried into the field. Although the book falls short of being comprehensive in several respects, it still represents an excellent contribution to our understanding of the amphibians and reptiles of the western Visayas.

Throughout nine introductory chapters, Gaulke provides brief, but suitable, summaries of Philippine geography, climate, geology, zoogeography and biodiversity, flora, fauna, conservation, and legislation as it pertains to the country's biodiversity. As the focus of this work specifically deals with the herpetofauna of Panay Island in the central Philippines, the brevity of these first few chapters on these subjects will provide many readers with an appropriate first introduction to the material. Those looking for a definitive, thorough reference on any one of these topics will likely discover they must supplement the summary information with external sources. Two examples of this pertain to summaries of Philippine geology and zoogeography and biodiversity. First, a number of recent studies on the geologic history of the Philippines unfortunately are missing from the book. Discussion of two studies in particular that summarize the geologic origins of Panay Island, as well as the unique origins of the northwest peninsula of Panay, or the Buruanga Peninsula, would have increased greatly the breadth of the chapter on Philippine geology (Zamoros and Matsuoka 2004; Zamoros et al. 2008). Additionally, the summary of Philippine zoogeography and biodiversity may be viewed as an overly simplified introduction to the unique and dynamic patterns of faunal partitioning across the archipelago. Gaulke does summarize how faunal demarcations in the Philippines have traditionally been explained by the geography of Pleistocene aggregate island complexes (PAICs: Brown and Diesmos 2002, 2009; Heaney 1985; Heaney et al. 1998, 2005), and highlights how recent studies have indicated diversification in the Philippines likely is more complicated. However, over the last decade alone, the results of a large number of studies on diversification patterns in the Philippines have created fertile ground for a thorough review on this topic. Unfortunately, much of this literature is absent from the book. Regardless of these few shortcomings, the first nine summary chapters provide a sound introduction to major topics concerning the study and conservation of Philippine biodiversity.

The book represents a substantial source of literature references with 192 citations, compared with the 104 references cited in the previously published herpetofaunal study of Panay Island (Ferner et al. 2000). Although a more comprehensive approach to incorporating relevant literature may have been taken, with the inclusion of more in-depth comparisons to what is known of the amphibian and reptile diversity in other regions of the Philippines, the book provides an excellent, focused account of Panay's herpetofauna. Furthermore, with 258 figures, Gaulke provides an incredible photographic account of the diversity of Panay's amphibians and reptiles. A methodology chapter details the methods followed to develop taxonomic accounts and various sections of the book. Species accounts are arranged by Linnaean rank and alphabetical order within families. Throughout the last sections of the book, Gaulke summarizes doubtful Panay records and useful information concerning snakebites and the few venomous species known from the island. Additionally, two tables provide a simplified summary of species habitat preferences and faunal comparisons to other sub-provinces.

In general, the accounts provide an excellent overview of each representative species. Each account references the authoritative publication for the focal species, and provides information on etymology, description, habitat, biology, and distribution. Additional taxonomic notes and specific literature references are provided for select accounts. Although minor errors in format, spelling, and grammar exist, Gaulke has done an excellent job of keeping these few in number. Missing in species accounts are diagnosis sections, references to vouchered, museum specimens, and IUCN criteria-based conservation

assessments. Although Gaulke provides a general description of each referenced species, a brief paragraph providing a diagnostic account would have greatly strengthened the practical applications of this book as a complete field guide and reference source. Additionally, Gaulke provides no reference to Panay Island collections housed in many large, reputable museums around the world. Significant collections from Panay Island exist at the University of Kansas Natural History Museum (KU), the Texas Natural History Collections (TNHC), California Academy of Sciences (CAS), Field Museum of Natural History (FMNH), National Museum of the Philippines (PNM), and the Cincinnati Museum of Natural History (CMNH). Finally, the impact of this work on conservation efforts in the Philippines would have been greatly improved if the author evaluated each species against the International Union for Conservation of Nature (IUCN) criteria for classification.

A resurgence of research focused on the herpetofauna of the Philippines has taken place during the last decade, and the incorporation of genetic data into studies of biodiversity has resulted in continual changes to accepted taxonomy within the region. Although many of these changes create greater taxonomic stability, it makes it difficult for any large-scale endeavor, such as this book, to present updated, recognized taxonomic nomenclature at the time of publication. Gaulke explains this issue in the book's methodology. Several key taxonomic changes have taken place since the publication of the book. A portion of the genus *Sphenomorphus* has been systematically revised as a result of a recent phylogenetic study (Linkem et al. 2011) resulting in the following taxonomic changes to several Philippine species: 1) *Sphenomorphus abdictus*, *S. llanosi*, *S. coxi*, and *S. jagori* are now recognized to be members of a newly described genus *Pinoyscincus*; 2) *S. arborens* is now recognized to be a member of the resurrected genus *Insulasaurus* Taylor, 1922; and 3) *S. steerei* is now recognized to be a member of the genus *Parvoscincus* Brown and Greer, 1997. As a result of other recent studies, species of the genus *Zaocys* are now recognized as members of the genus *Ptyas* (David and Das 2004), and species of the genus *Parias* are once again recognized as members of the genus *Trimeresurus* (David et al. 2011). Finally, a large-scale revision of Philippine Slender Skinks (genus *Brachymeles*) resulted in the elevation of *Brachymeles boulengeri taylori* to full species status (*B. taylori* Brown, 1956; Siler and Brown 2010).

With the availability of high resolution, topographic maps of the Philippines, it is disappointing that more detailed sampling and species distribution information is not available throughout the book. Although it is clear that Gaulke has been involved in biodiversity surveys across much of Panay Island and its surrounding islets, the description of survey sites remains vague, and no specific reference is made to exact localities throughout the island. Unfortunately, this makes it difficult to: 1) draw comparisons between species accounts presented in this book and previous faunal inventories that documented species' distributions across georeferenced sites (Ferner et al. 2000); and 2) evaluate survey efforts across this geographically complex island, leaving the research community in the dark as to where regional gaps remain in our understanding of the Panay herpetofauna. Additionally, with such a rich history of biodiversity research on Panay Island, it is surprising that the author chose not to provide distribution maps for each species. These visual details would have been useful to local government units, students, and researchers.

Gaulke provides several nice line drawings to assist readers in understanding key morphological characters discussed in the book. These include figures showing labeled head scales, body scales, and scale counts for snakes (figs. 15, 16), figures showing an unlabeled dorsal view of the head of a skink and illustrations of morphologically distinct gekkonid digits, respectively (figs. 17, 18), and a figure showing an unlabeled, lateral view of the head of *Parvoscincus sisoni* (fig. 137). However, the book does not provide any additional diagnostic figures that would assist readers in understanding the many different morphological features used to diagnose species. This is surprising considering the number of illustrations that are present in the scientific literature for species of amphibians and reptiles in the Philippines. Basic diagnostic illustrations defining key characters for frogs, lizards and snakes would have added greatly to the educational value of the book; however, without these visual references, readers still will be forced to refer to external literature when needing to explore key diagnostic features of Panay's amphibians and reptiles.

The book contains many wonderful photographs of vertebrate species from Panay Island, from beautiful, full-page photographs of the frugivorous monitor lizard *Varanus mabitang*, to close-up views of the Rufous-headed Hornbill *Aceros waldeni* and the Philippine sailfin lizard *Hydrosaurus pustulatus*. Additionally, Gaulke provides a nice series of developmental photographs, including pictures of foam nests of the arboreal frog *Polypedates leucomystax*, tadpoles of two genera, *Kaloula* and *Rhacophorus*, hatchling and juvenile lizards of 16 genera, and lizard eggs of species of *Gonocephalus*, *Gekko*, and *Eutropis*. Although a number of pictures provide a summary of the general habitat types found on the island, more detailed photographs of the many microhabitats preferred by focal species are missing from the book.

In summary, the book provides a sound, thorough reference tool to tourists, wildlife units of the government, students, and researchers. Unfortunately, in several respects, the work falls short of being truly comprehensive; however, this will not keep readers at all levels of interest from finding valuable data, photographs, and background information on the unique herpetofauna of Panay Island. I have no doubt that this book will immediately become a widely used field guide, reference tool, and cited work.

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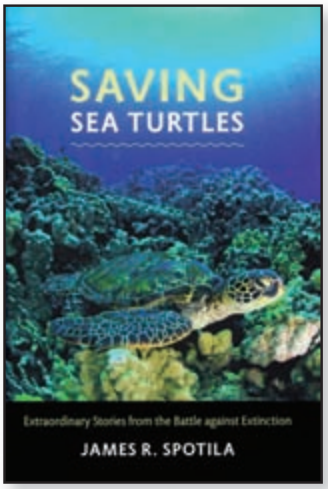
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Saving Sea Turtles: Extraordinary Stories from the Battle Against Extinction

by James R. Spotila. 2011. The John Hopkins University Press (www.press.jhu.edu). Hardcover. xi + 216 pp., 8 pp. pls. US $24.95. ISBN 978-0-8018-9907-2.

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Many books have been written on marine turtle biology, but this book is an exceptional one with its catchy and narrative style. Interesting stories make this book fun to read, even for those whose primary interests are not chelonian. Further, the accessible language makes the book suitable both for non-specialists and for those for whom English is a second language. The book comprises 15 sections which are accompanied by 12 color photos grouped near the middle of the volume.

The book starts with some general information about marine turtle biology. In most of the remainder of the book, noted sea turtle specialist Jim Spotila tells stories about his past experiences with marine turtles, especially leatherbacks. In doing so he also weaves in information about the pioneer researchers of marine turtle studies throughout the world. This information is especially useful for the younger generation of marine turtle biologists. The book summarizes global problems that threaten sea turtle survival and highlights some conservation actions that help to preserve their future generations.

Spotila's stories include some based on work carried out with his former students and he even recounts some stories about non-marine turtles. A particularly engaging story describes the rescue of a European family during field work and another interesting anecdote concerned meeting the sailor who was famously photographed for Life Magazine when he kissed a nurse in Times Square in August 1945. In addition to these there are also success stories of long-term conservation actions such as the implementation of TEDs (Turtle Excluder Devices) in the USA, which took almost 30 years, and the ongoing struggles with the Costa Rican government over the management of a national park. The most intriguing part of the book is the innovative approach of the leatherback team to raise money for the turtle conservation; they used the satellite tagged turtles for a sponsored turtle race—excellent idea!

Although the book is thoroughly enjoyable, there are some minor issues I would like to mention. The author states that Archelon is responsible for the conservation of marine turtles in the Mediterranean. However, this entity is responsible for the conservation and monitoring of marine turtles only in Greece.

In the Mediterranean, each country has its own monitoring and conservation programs and the responsibility for marine turtle conservation belongs to either universities or the ministry of environment of the relevant country. One omission of relevance concerns the time between hatching and emergence of hatchlings (4–7 days; Godfrey and Mrosovsky 1997). I also feel that the sections on genetics should have included more information, particularly because recent innovations in molecular techniques have contributed greatly to our understanding of marine turtle biology and ecology. These insights include trans-Atlantic and trans-Pacific developmental migrations (Bolten et al. 1998; Bowen et al. 1995;), multiple paternity (Harry and Briscoe 1988; Kichler et al. 1999; Zbinden et al. 2007), and the use of DNA fingerprinting for genetic tagging (http://www.seaturtle.org/tagging/genetic.shtml), to name a few. Finally, the author summarizes global warming and its negative effects on marine turtles and suggests some potential mitigation measures. One of his main recommendations is to engage with China and India, countries that are producing more CO_2 than the USA according to him. However, Dr. Spotila seems to forget that the USA is the only country that has signed but not ratified the Kyoto protocol, and yet has one of the highest rates of greenhouse emissions. Perhaps a better recommendation would be to focus on reducing greenhouse gas emissions from the US. These issues aside, the book contains lots of interesting information and I strongly recommend it to everyone interested in marine turtle biology, regardless of their knowledge base or experience.

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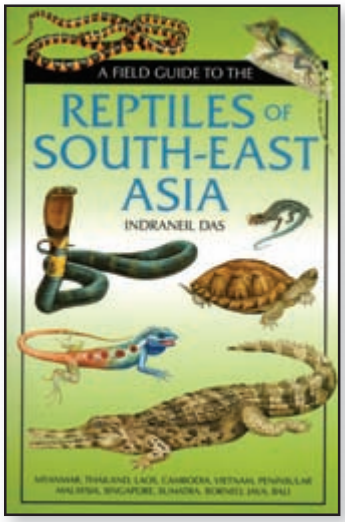
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A Field Guide to the Reptiles of South-East Asia: Myanmar, Thailand, Laos, Cambodia, Vietnam, Peninsular Malaysia, Singapore, Sumatra, Borneo, Java, Bali

by Indraneil Das. 2010. New Holland Publishers Ltd. (www.newhollandpublishers.com). Hardcover. 376 pages. £35.00 (approx. US $57.00). ISBN: 978-1-84773-347-4.

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South-East Asia is a biodiversity hotspot for reptiles and now Indraneil Das, one of the best known herpetologists of this region, has contributed an important work to our knowledge of reptiles in this geographic area (including Myanmar, Thailand, Laos, Cambodia, Vietnam, Peninsular Malaysia, Singapore, Sumatra, Borneo, Java, Bali; excluding the Lesser Sunda Islands, Timor, Philippines, and New Guinea). The book is the first comprehensive field guide in English covering species described up to 2008. For nearly every recognized species in the area (see comments below), a detailed account with characteristics, habitat, behavior, distribution, and conservation status is provided.

Beside some smaller chapters, the book is separated in two main parts: the species plates and their legends (pp. 18–165, 74 plates showing 489 taxa) and the species chapters (pp. 166–353). Instead of photographs the book uses well produced paintings by wildlife artists. As somebody who studied feathered reptiles before working with "true" reptiles, I am very satisfied with this kind of presentation. In bird field guides color paintings are the norm as they have the advantage that it is easy to compare different species on one plate. Moreover, all typical characters of a species can be shown in one specimen. Therefore, lay readers can easily use this book to identify reptiles they have seen on their holidays or it could be useful for e.g., customs officers as a guide to recognize CITES species. Even though the plates show nearly 500 taxa, only half of the 963 referenced species are imaged. A negative point is that there the plates precede the species chapters. The book would be more useful if at least families were described and imaged together. There are also some typographical errors, e.g., on the color plate showing pythons the names are mixed up. The same applies to the genus *Leiolepis* (plate 28). Here, the imaged *L. reevesii* is in fact *L. rubritaeniata*, whereas the imaged *L. rubritaeniata* is a true *L. reevesii* (easy to distinguish by the number of black lateral stripes).

It is mentioned in the introduction that all species described by the end of 2008 were included, but some taxa are lacking, e.g., *Bungarus niger* Wall, 1908 is not mentioned but occurs in the region. There are also few distributional errors. *Asthenodipsas vertebralis* is not endemic to the Malay Peninsula and *Boiga gokool* does not occur within the geographic region of the book. However, these are only minor mistakes for a few taxa in the context of the many species of reptiles in South-East Asia.

More important are taxonomic actions made by the author without any comments, e.g., *Ovophis convictus* and *Leiolepis ocellata* were both elevated to full species rank, whereas the synonymization of *Pareas macularius* was not accepted.

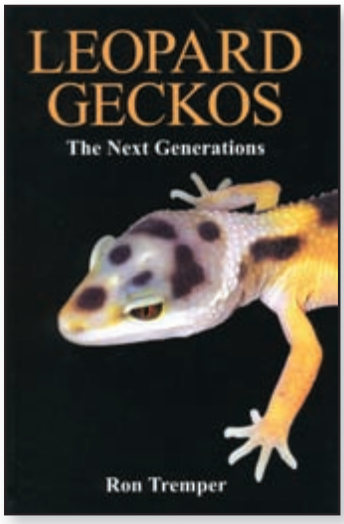
Unfortunately, there are several more critical remarks that must be made. Even in a field guide I would expect that the full scientific species names are provided, including genus and species name, author(s) and the year of the description. Also in a field guide I would prefer a systematic arrangement of the large evolutionary units rather than an alphabetical. It is curious to recognize the "Leiolepidae" (I prefer the usage of the correct name "Leiolepididae," but I think a family status for this group is overestimated) between Lanthanotidae and Scincidae, which does not reflect the relationships of these groups. More critically, unlike the field guides to feathered reptiles, no distribution maps are included; even simple shaded distribution maps would greatly increase the usage of the book. Finally, to make the book useful for professional herpetologists and other serious users, a species key should be added to the second edition, because many species are not imaged and the high number of described species precludes the enlargement of the species chapters to include more detailed descriptions.

Nevertheless, this book is an excellent summary of the reptiles from this area, and given the ever-increasing descriptions of new species from South-East Asia a second edition should follow. For now, the book is useful for professional herpetologists as it summarizes the reptile species of this biodiverse region in a single volume and includes a convenient 11-page (~400 references) bibliography. The book is an ideal guide for tourists, customs officers, and others who need an easy to use guide that covers the whole of this immense area of tropical Asia.

PUBLICATIONS RECEIVED

Leopard Geckos: The Next Generations

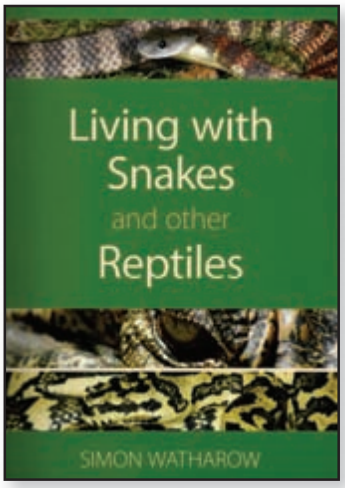
by Ron Tremper. 2012. Published by author (http://www.leopardgecko.com/book), Boerne, Texas. viii + 199 pp. Softcover. US $29.95. ISBN 978-0-615-610-535.



The Leopard Gecko (*Eublepharis macularius*) has become the most commonly kept pet lizard in the world. Although it is quite attractive in its native form, breeders have identified numerous genetic markers and have developed an extraordinary array of "designer morph" geckos whose ranks seem to expand every year as new traits make their debut. These novelties range from albinos to brilliantly orange or purple-and-gold geckos, and even a giant morph that is 50% larger than the standard Leopard Gecko. All of this is nicely summarized by Ron Tremper, the leading commercial breeder and innovator of Leopard Gecko morphs, and is a follow-up to an earlier volume (2005) coauthored with Philippe de Vosjoli and Roger Klingenberg that focused mainly on captive husbandry. In this latest work, Tremper presents a detailed visual catalogue (130 color images) of Leopard Gecko variation, and also offers a how-to-do-it-yourself manual in obtaining breeding stock, developing a breeding plan, and creating new variants.

Living with Snakes and Other Reptiles

by Simon Watharow. 2011. CSIRO Publishing (www.publish.csiro.au; available in the U.S. from Stylus Publishing: www.styluspub.com). Softcover. vi + 149 pp. US $29.95. ISBN 9780643097216.



Australia is home to a staggering number of reptiles, including a diversity of snakes that are potentially dangerous to humans. Encounters between humans and snakes can end badly, with envenomation occurring, or more commonly, the snake being killed. This book provides information on how to avoid such encounters. The book briefly covers snakes in history and why humans fear snakes before providing and overview of snake diversity, biology, and natural history in Australia. A 40 page chapter covers common representatives of both harmless and dangerous snakes likely to be encountered in different regions across Australia, with short species accounts and inset boxes listing commonly confused species. Like the rest of the book, this chapter is illustrated by color photos. A key chapter outlines way to make homes and properties less snake-friendly so as to avoid interactions. Suggestions focus on tidying landscapes to provide fewer retreats and reducing the prey base, particularly rodents, near the home. Shorter chapters cover "Living with Lizards" (with an emphasis on larger and more frequently encountered species), "Living with Crocodiles," and "Living with

Cane Toads." The last of these includes sections on euthanasia and disposal. Final chapters cover how to deal with snakes encountered in the home, the workplace, or outdoors and how to treat snakebite in humans and pets. An appendix lists common 'nuisance' snakes by Australian state and a glossary, list of contacts (government departments, snake catchers, etc.), two page bibliography, and index round out the book, which is also available electronically. This book is intended for people, especially those trying to avoid reptile encounters, living or paying extended visits to Australia, but it doubles as a portable guide to snakes, particularly those likely to be seen in and around the state capitols and other populated places.

Anfíbios Fazenda Rio Claro, Lençóis Paulista, SP Brasil

by Fábio Maffei, Flávio Kulaif Ubaid and Jorge Jim. 2011. Canal 6 Editora, Bauru-SP, Brazil (Contact the senior author: Maffei.fabio@gmail.com). Hardcover. 128 pp. Distributed to relevant schools and other institutions. ISBN 978-85-7917-163-5.



This Portuguese language guide covers the 40 species of anurans in seven families that may be found on the Fazenda (coffee plantation) Rio Claro, in the county of Lençóis Paulista in the Brazilian state of São Paulo. The area can be characterized chiefly as Mata Atlantica (Atlantic Rainforest), but with some influence from Cerrado. The book is illustrated in color throughout, with photos (many full page) showing pairs in amplexus, calling males, eggs, and tadpoles, as well as portraits of each species. One of the most striking images is of a spider eating a *Physalaemus marmoratus*. Each species account includes the Latin name and author, Portuguese name, and a brief text on biology, including vocalization. A standard graphic representation for each taxon combines information on the months of activity, a point locality map, an indication of whether the frog is a Mata Atlantica or Cerrado species, an indication of body size, and habitat (including types of water bodies used). The book closes with a short bibliography of 18 references. The volume provides residents and visitors with a detailed but accessible look at the composition of a southern Brazilian frog community. The fine photos and standardized graphics make it possible to use the book even if you don't read Portuguese.

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HERPETOLOGICAL REVIEW

THE QUARTERLY BULLETIN OF THE

SOCIETY FOR THE STUDY OF AMPHIBIANS AND REPTILES

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The Society for the Study of Amphibians and Reptiles, the largest international herpetological society, is a not-for-profit organization established to advance research, conservation, and education concerning amphibians and reptiles. Founded in 1958, SSAR is widely recognized today as having the most diverse society-sponsored program of services and publications for herpetologists. Membership is open to anyone with an interest in herpetology—professionals and serious amateurs alike—who wish to join with us to advance the goals of the Society.

All members of the SSAR are entitled to vote by mail ballot for Society officers, which allows overseas members to participate in determining the Society's activities; also, many international members attend the annual meetings and serve on editorial boards and committees.

All members and institutions receive the Society's primary technical publication, the *Journal of Herpetology*, and its bulletin, *Herpetological Review*; both are published four times per year. Members also receive pre-publication discounts on other Society publications, which are advertised in *Herpetological Review*.

To join SSAR or to renew your membership, please visit the secure online ZenScientist website via this link:

http://www.ssarherps.org/pages/membership.php

Future Annual Meetings

2012 — Vancouver, British Columbia, 8–14 August (with World Congress of Herpetology)
2013 — Albuquerque, New Mexico, 10–15 July (JMIH with ASIH, HL, and AES)

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ABOUT OUR COVER: *Protobothrops trungkhanhensis*



Most of the widely distributed pitvipers of Indochina and southern China have karst inclusions within their ranges, although these areas are mostly covered by forest in granite-basalt massifs. A number of narrowly distributed species of *Trimeresurus* senso lato appear to be highly adapted to karst habitats: *Viridovipera truongsonensis*, *Cryptelytrops honsonensis*, *C. venustus*, *C. kanburiensis*, *Tricerato-lepidophis sieversorum*, *Protobothrops cornutus*, and *Zhaoermia mangshanensis*. Unique characteristics of karst, such as an extreme surface irregularity, deep caves, ravines, and shelf-like laminations, along with low ambient light conditions, appear to have influenced morphology and behavior of the karst-associated pitviper species. Although basking is rare in the largely nocturnal green forest pitvipers, most grey-brown karst pitvipers periodically bask in sunny spots. Karst pitvipers have dark spots and "tiger" bands that provide excellent camouflage among stony outcrops, lichens, and leaf litter. These snakes have a rough integument that may facilitate mobility in rocks, although on leaf litter they are sluggish and clumsy (Orlov et al. 2010. Karst pitvipers: natural history and morphological correlations. Abstracts book, Biology of the Vipers, 3rd Conference, pp. 13–14, Pisa, Italy).

On the basis of this information, a team of Russian and Vietnamese herpetologists—Nikolai L. Orlov, Sergei A. Ryabov, Nguyen Thien Tao)—initiated field work in 2008, targeting hitherto unexplored karst regions of northeastern Vietnam and bordering southeastern China. Their efforts yielded a new karst-associated pitviper, *Protobothrops trungkhanhensis* (Orlov et al. 2009. Russian Journal of Herpetology 16[1]:69–82), as well as a new population of *P. cornutus*, a species otherwise known only from a handful of localities in western and central Vietnam. The new species is a dwarf form of *Protobothrops* (maximum size is 733 mm TL), and its muted colors are typical of the karst-inhabiting species of Asian pitvipers. With other recent discoveries (Orlov et al. 2009, *op. cit.*; Yang et al. 2011. Zootaxa 2936:59–68), the number of karst-associated pitvipers species now stands at seven.

Northeastern Vietnam exhibits high levels of endemism across various taxonomic groups, including a unique population of gibbons, undescribed species of frogs (*Theloderma*), a new cat-eyed snake (*Boiga*), and a new gecko (*Goniurosaurus huuliensis*), among others.

The cover subject, the adult male holotype of *Protobothrops trungkhanhensis* (Trungkhanh Pitviper) was discovered in September 2008 in Trung Khanh Nature Reserve, Cao Bang province, northeastern Vietnam, at an elevation of 600 m. The cover image was recorded at night by **Nikolai Orlov,** using a Nikon D700 DSLR and a Nikkor 105mm AF-2 micro lens, with lighting provided by two Nikon SB900 speedlights. Orlov is a senior research scientist in the Department of Herpetology, Zoological Institute, Russian Academy of Sciences (St. Petersburg, Russia; http://www.zin.ru/labs/herplab/index.html). Orlov has been thoroughly engaged in field explorations throughout Asia, resulting in a number of new discoveries and numerous publications. He has also had a long-standing interest in developing methods of captive breeding of rare and endangered amphibians and reptiles.



PHOTO BY NIKOLAI ORLOV

SSAR BUSINESS

SSAR Silent Auction Donations

SSAR announces the 16th Annual Silent Auction to be held at the 2012 World Congress of Herpetology in Vancouver, BC, 8–14 August. Again this year we are glad to accept any herp-related donations, including but not limited to, frameable art (photographs, paintings, and line illustrations), books, music, glassware, jewelry, clothing and gift certificates for Vancouver area services/events during the meeting week. The SSAR Student Travel Committee organizes the Annual Silent Auction to raise money to fund the student travel awards to the annual JMIH. Increasing travel costs each year make it more difficult for students to attend meetings and become involved in societies. However, your continued support through donations to the silent auction helps offset these costs enabling students to attend, network and present their research. If you are interested in donating an item or two (tax deductible for U.S. residents), please contact Vincent Farallo (e-mail: vfarallo@gmail.com) for more information.

SSAR Student Travel Awards — Call for Applications

Ten awards of US $400 each are available to students to help defray the cost of traveling to the 2012 World Congress of Herpetology. An applicant for a travel award must be a student and a current member of SSAR, must not have previously received a travel award from SSAR, and must be the first author of a paper or poster to be presented at the 2012 WCH. The application package must include: 1) a letter signed by his/her major advisor or department chair that states that he/she is not completely funded for travel from another source and, if the research is co-authored, that the work was primarily the product of the applicant; 2) a copy of the abstract that was submitted for either poster or oral presentation. The qualified applicants will be pooled and the winners will be drawn at random. Winning applicants must volunteer 5 hours during the 2012 WCH to work at the bidding table. Students from the immediate vicinity of the WCH, as well as current members of the SSAR Travel Awards Committee,

NEW BOOK FROM S.S.A.R.

A Contribution to the Herpetology of Northern Pakistan

by Rafaqat Masroor

(Pakistan Museum of Natural History, Islamabad)

"Masroor's book exceeds the scope of a field guide and turns it into a sound handbook on the herpetology of northern Pakistan." — Wolfgang Böhme (from the book's foreword)

This book on the herpetology of northern Pakistan is built around an intensive, 7-year-long survey of the Margalla Hills National Park—a 175-square-kilometer reserve that surrounds the country's capital city, Islamabad—together with further surveys of adjacent regions. This overall area, lying near the base of the Himalayan Mountains, contains the headwaters of Pakistan's major river system, the Indus. The habitats in this region range from arid desert-like biomes to monsoonal subtropical forests. Biogeographically, the region is the meeting place between the Palearctic and Oriental zones, as reflected in the diversity of its herpetofauna.

The book covers 16 families of amphibians and reptiles: three of amphibians: Bufonidae (1 genus: 2 species), Microhylidae (2:2), and Dicroglossidae (5:5); and 13 families of reptiles, including two of turtles: Geoemydidae (1:1) and Trionychidae (2:2); six families of lizards: Agamidae (3:3), Eublepharidae (1:1), Gekkonidae (2:3), Lacertidae (2:2), Scincidae (3:3), and Varanidae (1:1); and five of snakes: Leptotyphlopidae (1:1), Typhlopidae (2:2), Colubridae (8:9), Elapidae (2:3), and Viperidae (2:2).

Each species account contains: the animal's classification, its English name, diagnostic features, description (including tadpoles), habits and habitat, distribution, and remarks. There is a color-illustrated key to families and species, a chapter on distribution of species by habitat types, another chapter on threats to the herpetofauna with conservation recommendations, a glossary of technical terms, an extensive bibliography, and a comprehensive index. In addition, there is a complete, up-to-date *checklist of Pakistan's 210 species of amphibians and reptiles* (including marine species) with English names. Color photographs and country-wide distribution maps are spread throughout the book; the maps have individual localities plotted. Much new unpublished information is included in this book.



Fig. 77: Distribution of *Varanus bengalensis* in Pakistan.









The author: Rafaqat Masroor is in charge of the Herpetological Collections at the Pakistan Museum of Natural History, Pakistan's national museum located in Islamabad. He publishes regularly in international journals on the systematics and ecology of Pakistan amphibians and reptiles and has named several new species of lizards.

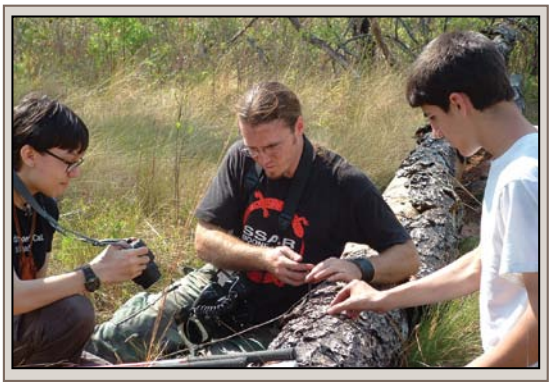
Specifications: *217 pages, 5½ × 8½ inches (14 × 22 cm), 3 color base maps, 107 color photographs of animals and habitats, 42 color distribution maps, illustrated keys to species, clothbound with dust jacket. ISBN 978-0-916984-83-0.* ***To be issued April 2012.***

Prices: **SSAR members US$35 before July 2012; Institutions, non-members US$45.** ***Shipping:*** **USA address, add US$5; non-USA, at cost.**

Send orders to: Breck Bartholomew, SSAR Publications Secretary, P. O. Box 58517, Salt Lake City, Utah 84158–0517, USA (*telephone*: area code 801, 562–2660; *e-mail*: ssar@herplit.com). Make checks payable to "SSAR." Overseas customers may make payment in USA funds using a draft drawn on American banks or by International Money Order. All persons may charge to MasterCard, American Express, Discover Card, or Visa (please provide account number and expiration date). SSAR membership details and a complete list of all Society publications can be obtained on request to the Publications Secretary (address above). For details, check the Society's website at www.ssarherps.org.

are excluded from applying for a travel award. Award checks will be disbursed at the SSAR Business Meeting to be held during the WCH. Application materials are preferred in electronic form (either PDF or Microsoft Word) and should be sent to Vincent Farallo by 1 May 2012 (vfarallo@gmail.com); however, hard copies can be mailed to Vincent Farallo, Ohio University, Department of Biology, 107 Irvine Hall, Athens, Ohio 45701, USA. Hard copies sent via postal mail must be postmarked prior to 1 May 2012 to be considered. For more information, contact: Vincent Farallo (vfarallo@gmail.com) or Mike Jorgensen (mjorgensen08@gmail.com).

New Student Mentorship Program



Attention Student Members! Would you like to have help making the most of attending the World Congress? SSAR will be introducing a mentorship program for undergraduate and graduate students for whom the World Congress of Herpetology (Vancouver, 8–14 August 2012) will be their first national or international herpetology meeting. Mentorship positions will be limited to seven applicants, chosen at random, with the expectation that this program will be expanded in future years. Mentors will be advanced graduate students who have attended international herpetology meetings in previous years and who can orient you to the meeting, help make introductions, and enhance your overall meeting experience.

If this is your first meeting, we invite you to apply for a graduate student mentor. Applications will be accepted during the meeting registration period. For more information, please contact Kristine Kaiser (Chair, SSAR Mentorship Committee) at kristinekaiser@gmail.com.

SSAR Thanks 2011 Seibert Award Judges

Although we published names of the winners of Seibert Awards from the 2011 annual meeting in Minneapolis, we failed to acknowledge the excellent work of the judges. Last year's judging panel consisted of Shawn Kuchta (Ohio University), Todd Jackman (Villanova University), Gerardo Carfagno (Gettysburg College), Robert Weaver (Central Washington University), Eric Juterbock (The Ohio State University), Carol Spencer (University of California, Berkeley), Patrick Owen (University of Cincinnati), Nancy Karraker (The University of Hong Kong), Kris Kaiser (University of California, Los Angeles), and David Lesbarrères (Laurentian University). Rafe Brown (University of Kansas) coordinated the judging efforts. Thanks to all!

NEWSNOTES

Kansas Herpetological Society Annual Meeting

The Kansas Herpetological Society held its 38th Annual Meeting at the Great Plains Nature Center in Wichita, Kansas, USA, on 5–6 November 2011. Over 125 participants attended scientific paper sessions presented by scientists and students from across the nation. Keynote speaker Richard Kazmaier from West Texas A&M University gave an excellent presentation on Western Indigo Snakes and Western Diamondback Rattlesnakes.

Jennifer M. Singleton, a student at Emporia State University, received the 2011 Howard K. Gloyd/Edward H. Taylor Scholarship, honoring the memory of two great biologists with strong ties to Kansas. The 2011 Alan H. Kamb Grant for Research on Kansas Snakes was made to Dexter Mardis (Friends University, Wichita, Kansas). Greg Sievert (Emporia State University, Emporia, Kansas) was chosen as the recipient of "The Suzanne L. & Joseph T. Collins Award for Excellence in Kansas Herpetology." Denise M. Thompson (Missouri State University, Springfield) was presented with the George Toland Award for the best student paper given at the meeting. Mary Kate Baldwin (Topeka Collegiate School) and Eric Kessler (Blue Valley School District Center for Advanced Professional Studies) each received the Bronze Salamander Award for their years of service to KHS. The "Henry S. Fitch-Dwight R. Platt Award for Excellence in Field Herpetology" was made to Eddie Stegall (Sedgwick County Zoo, Wichita).

The J. Larry Landers Student Research Grant

The J. Larry Landers Student Research Grant is a Gopher Tortoise Council competitive grant program for undergraduate and graduate college students. Proposals can address research concerning Gopher Tortoise (*Gopherus polyphemus*) biology or any other relevant aspect of upland habitat conservation and management. The amount of the award is variable, but projects up to US $2,000 have been awarded.

The proposal should be limited to four pages in length and should include a description of the project, a concise budget and a brief resume of the student. Submissions via e-mail as text files are preferred.

This is an excellent opportunity for undergraduate and graduate students to access funding for their projects. The deadline for grant proposals is 15 September 2012. Please send submissions to: Dr. Bob Herrington, Chairperson, Research Advisory Committee, Department of Biology, Georgia Southwestern State University, Americus, Georgia 31709, USA; e-mail: bherring@canes.gsw.edu.

Field Course in Tropical Herpetology

The Institute for Tropical Ecology and Conservation is offering a summer course at Bocas del Toro Biological Station, Boca

del Drago, Isla Colon, Panama. The biological station is located on a beach facing the Caribbean Sea. The course will run from 15 June to 10 July 2012. Class is limited to 15 students, and the deadline for registration is 15 May 2012. For details, please contact: Dr. Peter Lahanas, Institute for Tropical Ecology and Conservation, 2911 NW 40th PL, Gainesville, Florida 32605, USA (Tel. 352-367-9128; itec@itec-edu.org, http://www.itec-edu.org/index.html).

Fresno Chaffee Zoo Wildlife Conservation Fund

The Fresno Chaffee Zoo Wildlife Conservation Fund was established in 2006 to promote understanding and enjoyment of rare, threatened, and endangered animals and their habitats and to support zoological research that will directly benefit captive animal management. Awards may be made in any amount; however awards are typically in the range of US $1,000-$2,000. Awards are generally announced in August of each year. The principal investigator must be associated with a recognized institution (accredited zoo, academic institution, conservation or non-profit organization). Applications for exhibit development/graphics for zoos or facilities in North America will not be considered. Higher priority will be given to *in situ* conservation projects.

The application deadline is 1 June 2012. A copy of the application form may be downloaded here: http://www.fresnochaffeezoo.org/the-news/111-conservation.html. For additional information, please contact: Adrienne Castro (e-mail: acastro@fresnochaffeezoo.org).

MEETINGS

Meetings Calendar

Meeting announcement information should be sent directly to the Editor (HerpReview@gmail.com) well in advance of the event.

13 April 2012— Amphibian Taxon Advisory Group Annual Meeting, Miami, Florida, USA. Information: Diane Barber (e-mail: dbarber@fortworthzoo.org).

2–4 June 2012—Fifth Asian Herpetological Conference, Chengdu, China (including Annual Meeting of the Chinese Herpetological Society). Information: http://test.ox120.com/ahr/index.html

8–12 July 2012—10th International Congress of Vertebrate Morphology, Barcelona, Spain. Information: http://icvn2013.com/ or http://www.facebook.com/ICVM10.

8–13 July 2012—17th World Congress of the International Society on Toxinology & Venom Week 2012, 4th International Scientific Symposium on All Things Venomous, Honolulu, Hawaii, USA. Information: http://www.istworldcongress17-venomweek2012.org/index.html.

24–26 July 2012—2012 Northeast Partners in Amphibian and Reptile Conservation (NE PARC) Annual Meeting, Crawford Notch, New Hampshire, USA. Information: www.northeastparc.org.

25–28 July 2012—35th International Herpetological Symposium, Hanover, Maryland, USA. Information: http://www.kingsnake.com/ihs/.

8–14 August 2012—World Congress of Herpetology 7, Vancouver, British Columbia, Canada (together with SSAR, HL, ASIH). Information: http://www.worldcongressofherpetology.org/

16–19 August 2012—10th Annual Symposium on the Conservation and Biology of Tortoises and Freshwater Turtles, Tucson, Arizona, USA. Co-hosted by the Turtle Survival Alliance and IUCN Tortoise and Freshwater Turtle Specialist Group. Information: http://www.turtlesurvival.org.

2–7 September 2012—4th International Zoological Congress (IZC), Mount Carmel Campus, University of Haifa, Haifa, Israel. To receive the first and subsequent meeting announcements, contact the organizers at: izc2012@sci.haifa.ac.il.

CURRENT RESEARCH

The purpose of Current Research is to present brief summaries and citations for selected papers from journals other than those published by the American Society of Ichthyologists and Herpetologists, The Herpetologists' League, and the Society for the Study of Amphibians and Reptiles. Limited space prohibits comprehensive coverage of the literature, but an effort will be made to cover a variety of taxa and topics. To ensure that the coverage is as broad and current as possible, authors are invited to send reprints to the Current Research section editors, Beck Wehrle or Ben Lowe; e-mail addresses may be found on the inside front cover.

A listing of current contents of various herpetological journals and other publications is available online. Go to: http://www.herplit.com and click on "Current Herpetological Contents."

Behavior Enhances Anti-Predator Strategies in Poison Frogs

Though northern populations are generally red with blue legs, the Strawberry Poison Frog (*Oophaga pumilio*) exhibits radically different color patterns across Panamá. Previous authors

have hypothesized that these different color forms can be divided into aposematic and cryptic morphs and have demonstrated that aposematic morphs are more toxic and visually conspicuous than cryptic morphs. The authors of this paper set out to determine if aposematic and cryptic morphs also differ behaviorally in ways that complement their color strategy. They conducted observational field studies with two island populations (an orange-red aposematic population, and a green-with-black-spots cryptic population) in Panamá's Bocas del Toro Archipelago. A dozen focal males at each site were observed for movement patterns, location, and time spent performing various activities for 25 mornings. Flight distance (proximity of observer eliciting flight), ambient light, and frog and habitat reflectance were also calculated. From these data, home range, density, preferred position, and detectability under models of both frog and bird vision were determined. Aposematic frogs were found to be more active than cryptic frogs. Specifically, aposematic frogs had longer flight distances, spent more time foraging, moved more, and had larger home ranges than cryptic morphs. Under models of both bird and frog vision, aposematic morphs were more conspicuous than cryptic morphs. Furthermore, aposematic morphs chose tree trunk bases as calling sites, where their dorsal surfaces were significantly more conspicuous than on leaf litter to both frogs and birds. In contrast, cryptic frogs preferentially chose to call from bamboo trunks, where they were significantly less conspicuous than on other potential calling locations. Despite these differences, males in the two populations did not differ in amount of time spent calling or in their distance to the nearest male. This study reveals that crypsis and aposematism can be enhanced by coupling color pattern and behavior, and that closely related populations can independently adopt divergent anti-predator strategies requiring different color-behavior combinations.

Pröhl, H., and T. Ostrowski. 2011. Behavioural elements reflect phenotypic colour divergence in a poison frog. Evolutionary Ecology 25:993–1015.

Correspondence to: **Heike Pröhl**, Institute of Zoology, University of Veterinary Medicine of Hannover, Bünteweg 17, 30559 Hannover, Germany; e-mail: heike.proehl@tiho-hannover.de

Patterns of Snake Diversification Revealed

Many researchers have questioned why some clades are diverse while others are species poor. The simplest model of diversification assumes a simple birth minus death rate of species accumulation (a "rate-limited" process). Recognition that ancient, species-poor lineages (tuataras [Rhynchocephalia: *Sphenodon*] being a prime example) are in conflict with this model has led researchers to postulate a "diversity-limited" model, wherein at some point extinction rate and speciation rate converge and the lineage reaches a diversity ceiling (possibly because energy or space are limiting maximum diversity). However, when data from the fossil record are considered, many lineages that are currently species-poor are revealed to have once been significantly more diverse (again, rhynchocephalians are a good example). The authors of this paper propose an additional model, wherein after an initial period of rate-limited diversification (a lineage "half life"), lineages either decline toward extinction or, through the evolution of a key innovation or dispersal to a new region, produce daughter lineages which in turn exhibit rate-limited diversification (an "extinction-limited" model). Furthermore, they evaluate the fit of these different models to a new time-calibrated phylogeny of snakes with representatives from all families and subfamilies. Their phylogeny, generated using sequence data from 27 independent molecular markers, was concordant with other recent molecular phylogenies in regard to both relationships and divergence dates. A software program designed to locate shifts in diversification rate across a time-calibrated phylogeny using extant species diversity (MEDUSA) identified four significant rate shifts: increases in the blindsnake family Typhlopidae and in a clade containing most of Colubroidea, and decreases in the colubroid subfamilies Azemiopinae and Lamprophiidae. Simulations were conducted to evaluate the fit of several different models of diversification to the data. Generally, models where the parameter values were allowed to vary across taxa fit better than those where the parameter values were held constant. Furthermore, the diversity-limited models out-performed the rate-limited models. Only the extinction-limited model with a constant parameter value was evaluated; however, it was a better fit than the equivalent rate-limited model, and clade age-diversity correlation estimates from simulations under the extinction-limited model were a better fit to the observed data in this regard than those from simulations under the other models. Although the final verdict of these models awaits the evaluation of the extinction-limited model with variable parameter values as well as estimates of extinction rates incorporating fossil data, these analyses highlight the significance net diversification rate changes have had in generating extant snake diversity.

Pyron, R. A., and F. T. Burbrink. 2012. Extinction, ecological opportunity, and the origins of global snake diversity. Evolution 66:163–178.

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Phylogenetic Position of Turtles Unveiled

Considerable research has focused on determining the phylogenetic position of turtles. Through the years, morphological, mitochondrial DNA, and nuclear DNA datasets have failed to resolve the phylogenetic placement of Testudines relative to Archosauria (birds and crocodilians) and Squamata, leaving us to wonder if this problem is fundamentally intractable. To identify DNA regions that might be sufficiently conserved to allow amplification across amniotes and yet variable enough to be informative, the authors of this paper employed a novel method to identify new DNA markers. This method simultaneously compares multiple genomes and identifies variable regions flanked by highly conserved regions (and is detailed in the paper). Using this method, they identified 21 new potential markers. They then sequenced these markers, the nuclear gene RAG-1, and a section of the mitochondrial genome (a total of 21,137 base pairs) for 28 vertebrates, including representatives from most major teleost and sarcopterygian lineages. Traditional concatenated and recent "species tree" phylogenetic methods were used to reconstruct evolutionary relationships. The latter estimates individual trees for each independent marker and subsequently uses them to estimate the true species tree while accounting for gene-tree discordances. All analyses found turtles to be the sister

of Archosauria with strong support. Indeed, a jackknifing exercise demonstrated that only 14,000 base pairs of sequence data were needed to achieve this relationship with strong support. While the concatenated analysis was concordant with other recent molecular studies in finding strong support for Dibamidae being sister to a clade containing the remaining included squamates (skink, gecko, *Anolis*, and snake), the species tree analysis failed to resolve this clade with the exception of the Iguania-Serpentes relationship; the authors posit that this is indication of significant gene tree discordance within Squamata. These new methods for molecular marker discovery represent an important breakthrough in systematics and bioinformatics, and offer a path to resolving other problematic sections of the tree of life.

Shen, X.-X., D. Liang, J.-Z. Wen, and P. Zhang. 2011. Multiple genome alignments facilitate development of NPCL markers: a case study of tetrapod phylogeny focusing on the position of turtles. Molecular Biology and Evolution 28(12):3237–3252.

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Insights into Patterns of Galápagos Iguana Digestive Tract Microbial Diversity

Despite being sister taxa, the iguanas of the Galápagos Islands have very different diets, with Marine Iguanas (*Amblyrynchus cristatus*) eating marine algae and land iguanas (*Conolophus* spp.) eating cacti and other terrestrial plant material. As herbivores require microbes to digest the complex carbohydrates of vegetation, it follows that these divergent diets might be correlated with different gut flora. To investigate patterns of microbial diversity in this system, the authors of this study collected fecal samples from 25 Marine Iguanas and 16 land iguanas (from four and three islands, respectively). Additionally, samples were secured from other reptilian herbivores (four Galápagos Giant Tortoises [*Geochelone nigra*] and two Green Iguanas [*Iguana iguana*]), as their comparison with the ingroup could be instructive. Microbial diversity was assayed using next-generation DNA sequencing techniques. Samples were PCR amplified with universal 16S primers with attached sample-specific barcodes. These were then combined and subjected to pyrosequencing, wherein hundreds of thousands of individual strands of amplified DNA are simultaneously sequenced in a single run, and the resulting sequences were subsequently binned by fecal sample using the barcodes. These sequences were checked against a library of known 16S sequences to determine taxonomic identity, as well as compared with other within-set sequences to identify operational taxonomic units (OTUs). Despite not being able to assign a majority of the 16S sequences to a taxon below the level of class, each sample revealed from 112 to over a thousand OTUs. Marine Iguanas exhibited significantly lower microbial taxonomic diversity than the other reptiles. In particular, Marine Iguanas possessed significantly fewer methane-producing bacteria species than land iguanas, likely a consequence of dietary difference. A multivariate analysis of the microbial community membership and structure found that Marine Iguanas, land iguanas, and giant tortoises all exhibited different fecal flora, with the Green Iguana flora overlapping that of the land iguana. This study is an example of how cutting edge techniques can be employed to explore natural systems.

Hong, P.-Y., E. Wheeler, I. K. O. Cann, and R. I. Mackie. 2011. Phylogenetic analysis of the fecal microbial community in herbivorous land and marine iguanas of the Galápagos Islands using 16S rRNA-based pyrosequencing. International Society for Microbial Ecology Journal 5:1461–1470.

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New Revelations Regarding North America's Eocene Squamate Fauna

Because they are small and generally occur at low densities relative to other similarly-sized organisms, squamates are underrepresented in the fossil record, which obscures ancestral patterns of distribution. The author of this paper presents results from an investigation of a mid-Wasatchian (middle early Eocene) squamate fauna (excluding snakes) from northern Wyoming, USA. The Bighorn Basin site was deposited about 2.5 million years after the Paleocene-Eocene Thermal Maximum (PETM), a global temperature spike and crash likely caused by greenhouse gasses released from sedimentary material by magma along the Mid-Atlantic Ridge. Therefore, Bighorn Basin lizards could show whether North America's squamate fauna received intercontinental dispersal subsequent to the PETM as that seen for its mammalian fauna. Thirteen lizard taxa were uncovered at this site; most of these taxa, or close relatives, also occurred at another Wyoming site (Castle Gardens) deposited at the time of the PETM. One new iguanian species discovered at Bighorn Basin, *Anolbanolis geminus*, was represented by more material than exists for the *Anolbanolis* type species and close examination revealed that the genus is likely allied with the family Dactyloidae. Four Castle Gardens taxa lacked Bighorn Basin representatives, including *Lepidophyma*-allied Xantusiidae and Amphisbaenia (both of which are now restricted to below 30˚N, suggesting range contraction following the PETM). The most interesting discovery at the site was a lizard assigned to the genus *Scincoideus*. This genus was previously only known from the mid-Paleocene of Belgium and is thought to be a member of or allied with Scinciformata. As this was the most abundant lizard at Bighorn Basin, its absence from Castle Gardens strongly suggests an intervening range expansion into the region, possibly beginning in Europe. Therefore, despite the general pattern of intracontinental dispersal with limited dispersal out of the continent, this study adds to the growing list of squamate lineages found to have dispersed into North America during the Cenozoic.

Smith, K. T. 2011. The long-term history of dispersal among lizards in the early Eocene: new evidence from a microvertebrate assemblage in the Bighorn Basin of Wyoming, USA. Palaeontology 54:1243–1270.

Correspondence to: **Krister Smith**, Department of Palaeoanthropology and Messel Research, Senckenberg Museum, Senckenberganlage 25, 60325 Frankfurt am Main, Germany; e-mail: krister.smith@senckenberg.de

Snake-Primate Interactions Driven by Mutual Competition and Predation

Although anecdotal accounts abound, little concrete evidence exists supporting the idea that pre-modern indigenous cultures faced significant threats from giant constricting snakes. The authors of this paper present data from anthropological work conducted in 1976 with Philippine Agta Negritos, a hunter-gatherer society that coexists with Reticulated Pythons (*Python reticulatus*), the world's longest snake. This work revealed that 16 of 120 people living at the time had survived a total of 18 python attacks. Additionally, six recent python-implicated human deaths were corroborated by multiple individuals, including the deaths of two sibling children supported by the Catholic priest who presided over their burial. People survived recent python attacks with the aid of firearms or iron knives, implements unavailable in previous millennia; thus prehistoric rates of python mortality were presumably higher. The authors further document the taxonomic breadth of primate-eating and snake-killing/eating among snakes and primates, respectively. Additionally, they note the dietary overlap of co-occurring snakes and primates (e.g., the Agta Negritos and *P. reticulatus* both regularly consume mammals as large as 60 kg). These observations illustrate the degree to which both primates and snakes are simultaneously each other's predators and competitors. Finally, the authors remark that several extant snake lineages containing representatives of appropriate size for preying upon primates were well established prior to the rise and diversification of primates, indicating that primates have been killing, suffering predation from, and competing with snakes since their inception. Demonstrating how natural, cultural, and phylogenetic history can be combined to elucidate longstanding, clade-level predator-prey-competitor interactions, this study addresses the similarly interdisciplinary evolution of primate responses to snakes.

Headland, T. N., and H. W. Greene. 2011. Hunter-gatherers and other primates as prey, predators, and competitors of snakes. Proceedings of the National Academy of Sciences of the United States of America (*in press*) doi:10.1073/pnas.1115116108.

Correspondence to: **Harry Greene**, Department of Ecology and Evolutionary Biology, Cornell University, Ithaca, New York 14853-2701, USA; e-mail: hwg5@cornell.edu

Inducible Anti-Predator Phenotypes Not Expressed When Tadpoles are Exposed to Novel Predators

Invasive predators are a major threat to native wildlife, as indigenous species frequently lack appropriate defensive adaptations. However, it may sometimes be the case that native species possess useful defensive mechanisms, but initially lack the instinct to employ them when faced with a novel predator. The authors of this paper examined how captive Iberian Green Frog (*Pelophylax* [*Rana*] *perezi*) tadpoles from Doñana National Park, southwestern Spain, responded to the sustained presence of the Red Swamp Crayfish (*Procambarus clarkii*), an invasive species introduced to Europe from the USA and demonstrated to prey on larval *P. perezi*. Tadpoles were collected from two lakes in the park, one with invasive crayfish present and the other without. Subjects were kept alone, with caged predators that had been fed tadpoles, or with unfed caged predators. Predators were either dragonfly nymphs (*Anax imperator*; a native predator) or crayfish. Tadpoles were observed for activity patterns and subsequent to the experiment, evaluated for pigmentation and several morphological measurements. Finally, in a separate experiment, pairs of tadpoles, one raised with tadpole-fed dragonfly nymphs and one raised without predators, were placed in a container with free-ranging nymphs or crayfish to determine if any induced phenotype changes in the predator-exposed tadpoles confer increased fitness when faced with predators. Tadpoles raised under each dragonfly nymph treatment exhibited significantly deeper tails and decreased activity time relative to controls, and pigment in tadpole-fed nymph treatment was significantly greater than observed in controls, while neither crayfish treatment differed from controls in any of these regards. This indicates larval *P. perezi* are capable of developing an anti-predator phenotype when in the presence of native, but not introduced, predators. An analysis of variance revealed that while tail height and activity were slightly but significantly different for the two source populations, the two populations did not vary in their responses to the different treatments. Finally, while tadpoles with induced anti-predator phenotypes experienced 60% and 80% survivorship when exposed to crayfish and dragonfly nymphs, respectively, naive tadpoles experienced less than 10% survivorship in both treatments. These findings show that even species with pre-adapted defenses to novel predators may not necessarily have the innate behavior to make use of them.

Gomez-Mestre, I., and C. Díaz-Paniagua. 2011. Invasive predatory crayfish do not trigger inducible defences in tadpoles. Proceedings of the Royal Society B 278:3364–3370.

Correspondence to: **Ivan Gomez-Mestre**, Research Unit of Biodiversity (CSIC, UO, PA), c/Catedrático Rodrigo Uría s/n, Oviedo 33071, Spain; e-mail: igmestre@ebd.csic.es

Bd Genetic Diversity and Patterns of Virulence Revealed

Recent research has uncovered much about the anuran pathogen *Batrachochytrium dendrobatidis* (*Bd*), including patterns of frog susceptibility and potential biocontrol agents. However, evidence pointing to its genetic and geographic origin has remained elusive. The authors of this study used next-generation DNA sequencing techniques to reconstruct the mitochondrial and nuclear genomes of twenty *Bd* samples procured from sites where anurans have suffered *Bd*-implicated declines (North and Central America, Europe, and Australia) as well as a suspected source region (southern Africa). From across the nuclear genomes, 22,000 suitable single-base sites were genotyped for each sample for use in subsequent molecular analyses. These genotype datasets were subjected to phylogenetic analyses and the nuclear dataset was investigated for evidence of recombination. These analyses revealed three deeply divergent genetic lineages within *Bd*. In addition to a previously known widespread lineage (sixteen sites), the authors uncovered one new lineage occurring in both South Africa and on the Mediterranean island of Mallorca (three sites) and another lineage restricted to Switzerland (one site). Members of the widespread lineage were found to be

>99.9% identical and exhibited fourteen likely positions of recombination in the nuclear genome. Phylogenetic analyses of the individual recombination units found them to have different genealogical histories; together with the evidence for recombination and low genetic diversity, the authors interpret these results to be evidence for a rare meiotic event leading to increased virulence and followed by range expansion. To test this hypothesis, the authors exposed larval toads (*Bufo bufo*) to *Bd* of either the widespread lineage or one of the newly-discovered, localized lineages. Indeed, the toads in the widespread lineage treatment suffered significantly more mortality than those in the other treatment. The discovery of genetically divergent and apparently more benign *Bd* lineages might explain why some anuran communities appear to coexist with *Bd* while showing no ill effects. These findings also reveal the potential dangers to society and biodiversity posed by rare meiotic events occurring in otherwise clonal organisms.

Farrer, R. A., and colleagues. 2011. Multiple emergences of genetically diverse amphibian infecting chytrids include a globalized hypervirulent recombinant lineage. Proceedings of the National Academy of Sciences 108:18732–18736.

Correspondence to: **Rhys Farrer**, Department Infectious Disease Epidemiology, Imperial College, London W2 1PG, United Kingdom; e-mail: r.farrer09@imperial.ac.uk

Ancient Mummy DNA Helps Uncover Contemporary Cryptic Crocodile

As methods for obtaining DNA data have advanced, ancient samples have become increasingly available for molecular evolution analyses. The authors of this paper incorporated DNA data from 34 pre-1973 historical samples (including eight Egyptian crocodile mummies) and 48 contemporary samples into a range-wide molecular analysis of the Nile Crocodile (*Crocodylus niloticus*). They attempted to collect sequence data for two mitochondrial genes (12s and D-loop) for all samples as well as three additional mitochondrial and four nuclear genes for the contemporary samples (N ≥ 46) and outgroups (including six other *Crocodylus*). A phylogenetic analysis of the contemporary samples revealed a deep phylogenetic split within the species, forming two clades roughly corresponding to eastern Africa and equatorial western Africa; the eastern Africa clade was recovered as more closely related to the four New World *Crododylus* examined than to the western Africa clade. Close inspection of karyotype data revealed the two lineages possess different chromosome numbers, further supporting the distinctiveness of the two clades. The name *Crocodylus suchus* was determined to be the available name with priority for the western Africa clade (with the eastern clade retaining the name *C. niloticus*). When localities for the two species are separated into historical and contemporary maps, it is revealed that extralimital western localities of the *C. suchus* in the Nile River drainage basin (mostly Sudan and Egypt) have been extirpated during the last 30 years, leaving only the core distribution in areas of western Africa draining to the Atlantic Ocean (with possible remaining outliers in Chad and Uganda). This discovery answers an age-old mystery, as writings of Egyptian priests mention two crocodile forms, the smaller of which was preferentially used in ceremonies; as it turned out, all of the mummies were found to belong to *C. suchus*. As there is deep phylogenetic structure within each species (particularly *C. niloticus*), these findings underscore the importance of incorporating genetic structure into conservation plans, as solely protecting a single, Africa-wide *C. niloticus* would risk losing important, locally adapted lineages. Future studies of this system should employ broader karyotype sampling and investigate morphology and behavior in light of these new phylogenetic discoveries.

Hekkala, E., M. H. Shirley, G. Amato, J. D. Austin, S. Charter, J. Thorbjarnarson, K. A. Vliet, M. L. Houck, R. Desalle, and M. J. Blum. 2011. An ancient icon reveals new mysteries: mummy DNA resurrects a cryptic species within the Nile crocodile. Molecular Ecology 20:4199–4215.

Correspondence to: **Evon Hekkala**, Department of Biological Sciences, Fordham University, New York, New York, USA; e-mail: ehekkala@fordham.edu

Investigation into Enigmatic Montane Vipers Leads to the Erection of a New Genus

New World pitvipers are a diverse clade containing many poorly known species. Known from only a handful of specimens each, the species *Cerrophidion barbouri* and *Agkistrodon browni* co-occur in the central highlands of the Mexican state of Gurrero. *A. browni* has remained allocated to *Agkistrodon* despite longstanding suspicion that it is actually conspecific with *C. barbouri* (which, in turn, has undergone several generic reassignments). To investigate the species limits within this system, the authors of this paper amassed all but three known specimens of these snakes and performed detailed morphological examinations. Furthermore, they collected mitochondrial DNA sequence data for three *A. browni* and one *C. barbouri*, and along with previously published orthologous sequences from 50 other New World viperids, conducted phylogenetic analyses aimed at shedding light on the phylogenetic placement of these snakes. Morphological examination of the specimens revealed two distinct morphologies, each assignable to one of the two holotypes. In particular, the two hemipenial morphologies are radically different, and *A. browni* exhibits two unusual characteristics: large, unkeeled head scales and a prehensile tail. The phylogenetic analyses found the four focal samples to form a clade with the two species of the genus *Ophryacus*, montane Mexican snakes formerly placed in the genus *Porthidium*. *C. barbouri* and *Ophryacus melanurus* form a clade, which in turn is sister to *A. browni*. Because of morphological synapomorphies and the large genetic distance between this clade and the remaining *Ophryacus* (*O. undulatus*), the authors decided to erect a new genus *Mixcoatlus* to contain these three closely related species. The authors close with a systematic revision of these four species, as well as the remaining *Cerrophidion*, and a discussion of the natural history of *Mixcoatlus*.

Jadin, R. C., E. N. Smith, and J. A. Campbell. 2011. Unravelling a tangle of Mexican serpents: a systematic revision of highland pitvipers. Zoological Journal of the Linnean Society 163:943–958.

Correspondence to: **Robert Jadin**, Department of Ecology and Evolutionary Biology, University of Colorado at Boulder, N122 Ramaley Campus Box 334, Boulder, Colorado 80309, USA; e-mail: rcjadin@gmail.com

Florida's Introduced Amphibian and Reptile Species Problem Documented and Analyzed

In addition to a rich native herpetofauna, Florida (USA) boasts the world's most extensive roll of non-native amphibian and reptile species. Before the impacts on native species can be evaluated or insights into the process of invasion can be revealed, a systematic account of Florida's historical and current introduced herpetofauna is required. The authors of this paper compiled information on Florida non-native reptile and amphibian species from literature, museum collections, and almost two decades of field surveys. Importantly, they restricted inclusion to species for which a voucher specimen from Florida exists, as the literature is littered with uncorroborated claims of non-native species in the state. In addition to verifying presence in Florida, the invasion status of species was determined (escaped, established, localized or widespread, rare or abundant). In this effort, the authors either documented for the first time or found evidence of advanced invasion status for 83 reptile and amphibian species. In total, they documented vouchers for 137 species of non-native species. As 56 of these species are confirmed as established, the percentage of Florida's introduced species that have become established (~40%) more closely resembles an island ecosystem (such as Hawaii: ~50%) than a continental system (where the rule of thumb is 10%). Of the established species, 43 (77%) are lizards, which is interesting in light of Florida's relatively depauperate native non-ophidian squamate fauna (17 species). Further analysis of the data revealed that the pet trade was overwhelmingly responsible for the introduced species problem; indeed, ~23% of non-native species introductions can be traced back to a single animal importer. The authors discuss future problems invasive species could induce and compare Florida's situation with that of Guam and their Brown Tree Snake (*Boiga irregularis*) problem.

Krysko, K. L., and colleagues. 2011. Verified non-indigenous amphibians and reptiles in Florida from 1863 through 2010: outlining the invasion process and identifying invasion pathways and stages. Zootaxa 3028:1–64.

Correspondence to: **Kenneth Krysko**, Florida Museum of Natural History, Division of Herpetology, University of Florida, Gainesville, Florida 32611, USA; e-mail: kenneyk@flmnh.ufl.edu

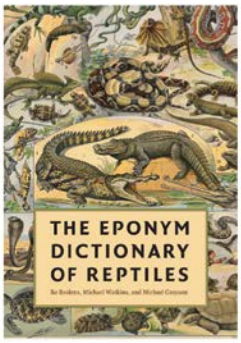
Patterns of International Python Trade Elucidated and Explained

Hundreds of thousands of wild *Python* from Southeast Asia and sub-Saharan Africa enter the international market annually, destined for Europe, America, and East Asia. To investigate patterns and trends in the python trade, the authors of this paper accumulated and analyzed pertinent data from the CITES wildlife trade database (http://www.cites.org). These data show the large majority of pythons originate from Southeast Asia (mostly Reticulated Pythons, *P. reticulatus*) and these are mostly destined for the leather trade; African pythons (mostly Ball Pythons, *P. regius*) are disproportionately destined for the pet trade. Additionally, the African python trade experienced a steep decline about a decade ago, likely linked to changes in monetary exchange rate between destination (USA) and source. During this period, Asian python exports have increased, likely beyond sustainable levels. The authors suggest that the python pet and leather trades are affected differently by changes in global exchange rates; these observations coupled with differences in demographic consequences (juveniles are sought for the pet trade while the largest females are sought for the skin trade) should be considered when designing conservation efforts.

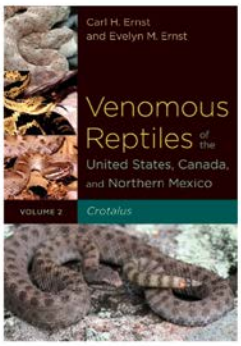
Luiselli, L., X. Bonnet, M. Rocco, and G. Amori. 2011. Conservation implications of rapid shifts in the trade of wild African and Asian pythons. Biotropica (*in press*) doi: 10.1111/j.1744-7429.2011.00842.x.

Correspondence to: **Luca Luiselli**, Environmental Studies Centre Demetra s.r.l., via Olona 7, 00198, Roma, Italy; e-mail: lucamlu@tin.it

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Findlay Ewing Russell: 1919–2011

"Do you want some water for your dog?" I stopped as I heard the voice call down from the road. It was a hot August afternoon in southeastern Arizona, and we were walking up the South Fork Cave Creek Canyon Road from Portal toward the Forest Service building. Looking up, I saw Dr. Findlay Russell standing at the driveway of his home, the Bar-M Ranch. As my black Labrador downed several gallons of water, Russell invited us back to join him that evening for "drinks on the veranda." Over daiquiris, with the spectacular Chiricahua Mountains as the backdrop for an impressive sunset, Russell talked of snakes, venoms, academia, and the desert. For this budding toxinologist, it was a rare opportunity to discuss science and life away from the hustle and constant interruptions that have characterized much of life since, and I have never forgotten Russell's mentoring and friendship at such a critical point in my early graduate career nearly three decades ago.

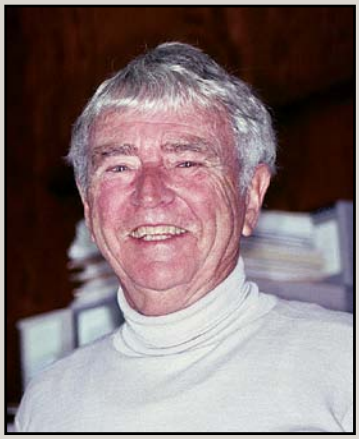


PHOTO BY A. E. LEVITON

Findlay Ewing Russell, 2001.

Findlay Ewing Russell was born in San Francisco on 1 September 1919, to William and Mary Jane Russell, but he spent most of his early years growing up in Los Angeles. As detailed in the Oral History Project at California Institute of Technology (Caltech) Archives (Cohen 1994), he attended grammar school at Santa Barbara Avenue Grammar School and then completed his public education at Foshay Junior High School and Manual Arts High School. Like many of us "herper types," he had an interest in venomous and poisonous animals in high school, an interest that would lie dormant but not dissipate. Awarded a scholarship after graduating, he initially attended the University of Southern California (USC) but finished his bachelor's degree at Walla Walla College in Walla Walla, Washington. He worked for a short time as a chemical engineer in Ohio and then joined the Army during the Second World War, serving as an army medic in the Okinawa Campaign. He received a Purple Heart and two Bronze Stars during his time in the military and left in 1946 after an injury. At this time, he decided to enter medical school where he completed his initial medical training at USC before transferring to Loma Linda University to finish his MD in 1952.

Russell was a Caltech research fellow from1951–1953, during which time he initiated research on stingray venom, work that was later supported by the Office of Naval Research. This early work marked the beginning of his professional research with venoms and venomous animals, research which would take him around the world and involve him in refining treatment of one of the most enigmatic and difficult to manage medical emergencies: snakebite. In addition to his research duties (and numerous practical jokes on fellow students and faculty), he sought to improve the social life of students and peers by teaching ballroom dancing; Russell and Dr. Albert Tyler also organized dances and invited female students from nearby Pasadena City College to join them. In 1951, Russell worked as an intern at the Los Angeles County General Hospital, and in 1953 he accepted a position at the Huntington Institute of Medical Research at the Henry Huntington Hospital in Pasadena. He remained at Huntington until 1955, when he received a professorship at USC. He was at USC for over thirty years, serving as professor of neurology, biology and physiology and as director of the Laboratory of Neurological Research and Venom Poisoning Center at Los Angeles County-USC Medical Center.

At the Center, he was intimately involved in the treatment of venomous bites. The tremendous population growth in southern California at that time meant that encounters with biting and stinging creatures were inevitable and increasing. A relatively common problem, particularly in the nearby southern Mojave Desert communities, was the treatment of black widow spider (*Latrodectus hesperus*) bites on rather delicate parts of the male anatomy, received while using outdoor toilet facilities. In those days before well-established regional Poison Centers, Dr. Russell served as an important consultant and source of information on emergency treatment for envenomations, and he became a leading world authority on the treatment of snakebite. Fortunately for me, and my bewildered attending physician, Russell was only 45 minutes away from the hospital where I received treatment for an all-too-close encounter with a neonate Southern Pacific Rattlesnake (*Crotalus oreganus helleri*) when I was a teenager. Although I did not know him personally then, I benefited from his near proximity and the treatments developed to aid my recovery.

While at USC, in spite of his considerable workload and in addition to his medical degree, Russell somehow found the time to earn a PhD in English. He also began work on his house in Portal, Arizona, spending as much free time as possible at his ranch there, away from the demands of emergency medicine, research, teaching, and other duties which occupied his life in Los Angeles. By the early 1980s, in fact, the call of the desert proved to be too much to resist. Russell joined the faculty of the University of Arizona College of Pharmacy in Tucson in 1981, where he remained until his retirement in 2006.

Russell was the first president and a founding member of the International Society of Toxinology (IST) in 1962. He and colleagues coined the term toxinology to distinguish this branch of study from the broader field of toxicology, and the society they established is dedicated to the study of venomous animals and their venoms, as well as toxic and poisonous plants, microbes, and fungi. Russell helped establish the Society's journal *Toxicon*,

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PHOTO BY KENT BEAMAN



Panel discussion at the Biology of Rattlesnakes Symposium, Loma Linda University, 2005. From left to right: Henry S. Fitch, Findlay E. Russell, and Robert C. Stebbins.

PHOTO BY S.P. MACKESSY



View from the porch of Bar-M Ranch, looking up the South Fork of Cave Creek Canyon, Chiricahua Mountains, Arizona, 2011.

which published its first issue in October 1962. He was editor of *Toxicon* from its inception through 1969, when Dr. Philip Rosenberg assumed that role. He was a frequent contributor to the new journal, with more than 80 publications over a 35-year span; his first paper in *Toxicon* was published in the inaugural issue in 1962 (Russell et al. 1962), and his last was published in 1997 (Russell 1997). His many contributions to the Society were commemorated at the 17th meeting of the European Section of the IST held in September 2011 in Valencia, Spain. When the IST hosts its 17th World Congress on Animal, Plant and Microbial Toxins in Honolulu, Hawaii in 2012, Russell would undoubtedly be pleased with the venue and to see how the Society has grown and matured over its 50-year history.

From his first publication listed in PubMed in 1953 to his last in 2006, he published over 160 papers on a variety of topics concerning venomous animals and their venoms, and envenomations. He also contributed many chapters on venoms and treatment of envenomation in medical, pharmacological, and toxicological textbooks. Russell published numerous books, and edited many more, but the book most familiar to herpetologists, physicians, and toxinologists is *Snake Venom Poisoning*, published in 1980 (and reprinted in 1983 with corrections). Though nearly 30 years old, this classic text still contains much useful information on the basic biochemistry of venoms, sequelae of envenomation, and treatment of snakebite (if one overlooks the rather bizarre treatment of "Hobbies" at the end of the book). In this landmark publication, he made a strong case for avoiding fasciotomy as a routine treatment for severe edema/swelling often accompanying rattlesnake and other viper bites, and he was a tireless champion for the use of massive quantities of antivenom to counter the necrotizing and potentially fatal outcome of snakebite and other envenomations. Though there have been many changes to emergency health care and tremendous improvements in supportive treatment, the basic approach advocated by Russell remains the standard for treatment of snakebite.

Over the course of his life, Russell was the recipient of numerous awards and recognition, including the receipt in 1974 of the Skylab Achievement award for his work with NASA. He received an Honorary Doctor of Laws degree from the University of California, Santa Barbara, in 1989. In 1992, the University of Arizona College of Pharmacy established the Findlay E. Russell Distinguished Citizen Award in his honor and named him as the first recipient. He was made an Honorary Member of the Society of Toxicology in 2000 and was awarded the Loma Linda University Alumnus of the Year in 2011. He was a Fulbright Scholar, a visiting professor at many universities throughout the world, and a consultant for the World Health Organization, Doctors Without Borders, and the National Science Foundation.

Russell passed away in Phoenix, Arizona, on 21 August 2011, just shy of his 92nd birthday. Less than a month before, I had again stood on the porch of his ranch in Portal, this time to pick up reprints and photographs from Dr. Russell's work given to me by his son, Mark Russell. Standing there that late summer afternoon, I had the opportunity to reflect once more on the career of a man who was a tremendous influence in his field of medical toxinology. Like many, Findlay was a complex person, at times brilliant beyond imagination, at other times arrogant beyond belief. He could rapidly alternate between astonishing and vexing to his colleagues. However, his contributions to the field of toxinology were beyond question. I found him to be a considerate and intellectually stimulating individual, and I am grateful to have had the opportunity to know him. He is survived by his children—Christa Russell Cessaro, Sharon Russell Boyle, Robin Russell, Connie Russell Lane, and Mark Russell—as well as ten grandchildren, and one great-grandson.

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Wilmer Webster Tanner: 17 December 1909 — 28 October 2011

Childhood and Youth.—Wilmer Tanner was born the fourth of five children to John Myron and Lois Ann Stevens Tanner in Fairview, Sanpete County, Utah. His family lived in an adobe house in town, but each summer moved north to the family's ranch in Indianola Valley. The family would work here during the summers and return each fall to the "village." Wilmer's tasks included tending milk cows, pigs, chickens, and by age 6 or 7, moving cows to pasture each day and returning them to corral each evening. He and his siblings were also responsible for feeding lambs, feeding chickens/gathering eggs, keeping the wood box filled, separating milk from cream in a spinning "bole" (that brought cream to the top), and caring for the work horses.



Wilmer W. Tanner, photograph taken in early 1990s.

Wilmer has noted in his autobiography (Tanner 1993) and in my interviews with him in the late 1990s for his ASIH-sponsored biographic "Historical Perspectives" (Sites and Stewart 2001), several "stand out" events in his youth. In his pre-teen years, two elderly Ute Indian women living near Fairview taught him how to gather and roast pine nuts (from the native piñon pine), and he continued this activity for some time after all Native Americans left the Indianola Valley. At about the same time he was learning to fish from his older brother Ray, and at age 12 his dad gave him a 22 Remington pump rifle and taught him to shoot ground squirrels in the grain fields. Wilmer soon learned to hunt sage grouse, cottontail rabbits, and snowshoe hares, and field-dressed all for the family kitchen. He remained passionate about hunting and fishing throughout his life, and was certain that both fostered his deep interest in nature at an early age.

Wilmer attended school for a few months during the war years (1917–1918), in a one-room building in which grades 1–6 were taught by a single teacher who apportioned some time of each day to each of the six grades. Because of Wilmer's chores on the ranch, these early school years were not very rewarding; little time was available for study and he struggled up until the 6th grade. His post-6th grade education was more stable and enjoyable; his grades improved, and as he moved through high school in church and school social functions, athletics (basketball, football, track & field, and swimming), and student government activities. Wilmer contracted scarlet fever and missed his high school graduation ceremony in April 1929.

In this same year Wilmer was called to serve a mission in Holland, an expectation for young men in the Church of Jesus Christ of Latter Day Saints (LDS, or "Mormon"). He postponed college and traveled to Europe via trains to Chicago and New York City, then by ship to Southampton, UK, and he arrived in Rotterdam on 13 December 1929. Here he served for 29 months and returned home in March 1932. During this time he recorded tremendous personal growth; he attained fluency in Dutch via "total immersion," and an in-depth understanding of Dutch and European culture and history. He credits this experience as one of singular importance in learning how to listen to and respect other points of view, and to work with different groups of stakeholders to achieve long-term goals.

Formal Academic Studies.—Wilmer returned to "years of desperation" in Utah, and although he began his college studies at BYU in the winter of 1932, he had to drop out and return to ranching for a while to help his family pay off debt. He returned in the fall of 1933, and despite the constant struggle for financial support ("too many B grades"), he enjoyed university life. By the winter of 1934, he was certain that his future was somewhere in science, and graduated with a BA in the spring of 1936 with a major and minor in Zoology and Geology, respectively.

While at BYU Wilmer met and married Helen Brown on 4 January 1935, and records his 60-yr marriage to Helen and their three children, Lynn, David, and Mary Ann, as his most enduring achievement. Wilmer attributed his academic and professional success to Helen's constant encouragement and in some cases her active participation; he was devastated by her death in 1995. He nevertheless maintained his academic and professional activities, and eventually married again (at age 90); his second wife was Otella Tyndal Devey, and she died in 1999.

Wilmer entered the BYU graduate program in Zoology to begin work on a MS degree in the fall of 1936. By 1938 he had completed this degree with a thesis on the snakes of Utah (Tanner 1939a,b; 1940, 1941; Tanner and Tanner 1939), but again he and Helen had to work to pay off debt. Wilmer wanted to pursue further graduate work, but the US entry into World War II and restrictions on tires, gasoline, etc., made travel impossible, so he took a teaching job at Provo High School while Helen worked in a Provo laundry for $7/week to help make ends meet. Wilmer spent parts of some summers at the Friday Harbor Marine Lab and the University of Michigan, and by late 1945, he could plan again for PhD studies.

In the fall of 1946 Wilmer started his graduate program at the University of Kansas, after being given a one-year leave from his teaching contract. For financial reasons, Helen and the three children remained in Provo for the first year of Wilmer's graduate program, but moved to Lawrence in June 1947. Wilmer's thesis advisor was Edward Harrison Taylor, and Taylor suggested to Wilmer a possible PhD project—a comparative study of throat anatomy and musculature of Mexican and Central American plethodontid salamanders. Wilmer completed his research by June 1949, and in August he defended his research and filed his dissertation (published three years later; Tanner 1952). He simultaneously received a contract to teach Zoology at BYU and moved his family back to Provo.

Development of an Interest in Herpetology.—In the last year of his BA program at BYU, Wilmer enrolled in a Herpetology class

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taught by his brother, Vasco M. Tanner. Vasco was the oldest of Wilmer's siblings, and at 17 yrs his senior, he was Wilmer's role model. Vasco had earned a PhD from Stanford under the famous ichthyologist David Starr Jordan, and joined the BYU faculty in the early 1920s, where he founded the zoological natural history collections and ultimately the Department of Zoology and Entomology (Welsh 2012). Vasco took his Herpetology class to a snake den on the west side of Utah Lake (near the present town of Lehi) in May 1936, where Wilmer collected the third specimen of *Hypsiglena torquata* (now *H. chlorophaea*) recorded in Utah, and at this point he was encouraged by Vasco to consider additional study in herpetology. Wilmer had focused his undergraduate studies on training for a possible career as a forester or a park naturalist, in part because this was an easy extension of the outdoor skills he had acquired in his youth. However, during the Great Depression, people were laid off in these professions, and early in Wilmer's MS program, Vasco advised him that he (Vasco) was working in the areas of Entomology and Ichthyology, and that another recently hired zoologist (Lynn Hayward) was working in Mammalogy and Ornithology, but that Herpetology was open throughout Utah and the Great Basin region, and much work was needed. So, heeding the advice of his older brother, Wilmer settled on doing the snakes of Utah for his MS thesis, and his career path was set.

Throughout his autobiography and during his oral interviews with me, Wilmer referred to early encounters with Joseph R. Slevin at the California Academic of Sciences, Laurence Klauber's willingness to loan his full collection of *Hypsiglena*, and E.H. Taylor's support of Wilmer's taxonomic and revisionary studies of this genus in parallel to his throat anatomy work on salamanders. Others who had very positive influences on Wilmer's herpetological career included Helen Gaige, Norman Hartweg, Carl Hubbs, and Albert H. Wright.

Professional Life and Contributions.—Wilmer's early academic career was characterized by heavy teaching loads (three classes per semester), and a zoology faculty that included his brother Vasco, D. Elden Beck, and C. Lynn Hayward. Wilmer's group in the Department of Zoology & Entomology was soon joined by entomologists Stephen L. Wood and Dorald M. Allred; as a group they taught a range of courses that spanned the entire breadth of zoology. During this time Stanley L. Welsh and other botanists were joining the Department of Botany & Range Science, and together the botanists and zoologists (all field-oriented) built representative collections of animals and plants as part of their research programs. At higher administrative levels there was no real support for or recognition of these activities for decades, but in the late 1960s and 1970s, BYU began a slow transition from a teacher-preparation institution to a bona fide teaching and research institution.

In herpetology, Wilmer and other BYU faculty conducted what research they could on their own time and out of their own pockets, while carrying heavy teaching loads. Wilmer's regular classes included general biology, general zoology, vertebrate anatomy, herpetology, and genetics, among others. Financial constraints limited his meeting attendance to regional events in his early academic career, and even these had to be covered from personal funds.

Things changed on 31 January 1960, when Chapman Grant turned over editorship and all materials pertaining to *Herpetologica* to Wilmer, at a time when both the journal and its sponsoring society, The Herpetologists' League (HL), "were desperately on the brink of self-destruction through exhaustion and frustration" (Smith 1986; p. 21). Wilmer served as editor of *Herpetologica* for eight years (1960–67), secured financial support from BYU for moving all HL records and back issues of the journal from southern California to Provo, provided storage space and secretarial help to re-organize this material, and BYU printed the journal at cost for the first six years after the transfer (1960–65). Despite having sought such a transfer, Grant could never really "let go" of the journal, and still regarded *Herpetologica* as his alone, and the HL as an adjunct irrelevant to the ownership and publication of the journal. Smith described Grant as hovering "like a wounded black spirit" over Wilmer (1986; p. 21) as the two fought over survival of the HL as the official sponsor of the journal. By August 1960 things had settled sufficiently for Wilmer to call a meeting of the HL officers at BYU to chart a future course for both the society and the journal.

Grant considered this an abrogation of an "agreement" he had with BYU (which never existed) to publish the journal institutionally (as a BYU publication) while continuing all of his policies, and he continued to make things difficult for both BYU and the HL. However, by the end of Wilmer's 8-yr stint as editor, the "Tanner Era" (Smith 1986) was credited with several major accomplishments, including: cessation of the newsletter, addition of covers and increase in number of pages for each issue, authorization of an editorial board to assist the Editor-in-Chief, enactment of a new constitution and bylaws for the society, initiation of a student paper award, and initiation of the "Herpetological Monographs" series. This last decision did not materialize until revived in 1977, and the first monograph was published in 1982.

The HL and *Herpetologica* had shifted from a "one man show" to professional society, and after Wilmer stepped down as editor, he served as HL Vice-President for two years, President for two years, and as a member of the Executive Council for six more years. This total of 18 yrs of service (1960–77) to the HL was longer than any other officer (Grant served from 1946–59) except for Peter Chrapliwy (Index Editor from 1956–1979). In the late 1970s, Wilmer was assisted by one of his PhD students, Nathan Smith (the life science librarian by BYU), in the sale of back issues of *Herpetologica* and other HL publications, when both served unofficially as publications secretaries of the HL. By the late 1960s and early 1970s the HL was facing competition "from an exuberant, innovative new national herpetological society (SSAR), which indeed the League attempted to discourage from advancement from regional to national status . . . , because it was thought that the country could not support two national herpetological societies" (Smith 1986; p. 31). The HL's prediction was close to accurate as the SSAR grew rapidly to the detriment of the HL, which saw a slump in membership and came close to bankruptcy. Only Wilmer's organization of ". . a massive publicity campaign (using a text and design supplied by Kraig Adler) to sell back issues of *Herpetologica*, bringing in some $12,000, averted bankruptcy. For the second time Tanner rescued the League" (Smith 1986; p. 31).

Dediction of a Natural History Museum at BYU.—By the early 1970s it became apparent that the biological collections then housed with the departments of Zoology and Entomology (arthropods, reptiles and amphibians, birds, and mammals), and Botany (the herbarium of dried, pressed, and mounted plants) required a centralized location apart from those departments. Given a history at BYU of departmental collections being degraded and sometimes destroyed by non-research related activities, the rationale for a change in administration of the collections was justified on the basis of their long-term security. About 1970, Professor of Botany Kent McKnight was given the task of exploring options for a collections facility separate from the departments.

McKnight soon moved away, and Wilmer was chosen as his successor, and quickly recruited Stephen Wood (curator of insects and related groups) and Stanley Welsh (curator of the herbarium) as the committee members. They worked together to outline goals and procedures for organization of a separate entity to initially oversee, and ultimately house the collections.

By 1972 this committee had guidelines established when a letter arrived at the BYU Development Office where Helen Tanner was working as a secretary. The letter was from Seattle businessman Monte L. Bean, who had amassed a collection of trophy animal mounts as a result of several decades of big game hunting around the world. Bean was offering to donate his trophy collection to BYU, but the administration had no interest and his letter was discarded. Helen saw the letter and with permission, retrieved it and showed it to Wilmer. Wilmer saw at once a possible opportunity to secure support for a separate facility to permanently house the animal and plant collections. With permission, Wilmer contacted the Bean family, and soon he and Helen were personally meeting with the Bean family, and shortly thereafter Bean's trophies arrived and were displayed temporarily in a portion of the Grant Library. The east end of the library reading room housed the herbarium, while the life sciences building housed the insect-arthropod, herpetology, bird, and mammal collections (under extremely cramped conditions). Wilmer and Monte, and members of the committee, worked together to define what would be required; a new building on the BYU campus large enough to house all of the research collections in a single place. Monte both listened and agreed, and he, Wilmer's committee, and personnel from the BYU Physical Plant office, worked together to draw up plans for this facility. The blueprint was presented to and approved by the Bean family, and construction began in the mid-1970s. The Bean family donated $3.5 million for construction of, and to establish an endowment fund for, the museum. The Monte L. Bean Life Science Museum was occupied in the autumn of 1977, and officially opened in the spring of 1978.

Wilmer served as the Bean Museum's first director (1977–79), and today it houses research collections of arthropods (mainly insects and crustaceans), mollusks, Antarctic "meio-fauna," birds, mammals, amphibians & reptiles, fishes, vascular plants, mosses & lichens, and fungi. These collections are curated by 10 faculty from two academic departments holding formal curatorial assignments. The largest collections (arthropods, vascular plants, vertebrates) are now overseen by PhD-level collections managers, and the museum manages several dedicated endowments for support of curation and collections-based research. For his pivotal role in securing support for the Bean Life Science Museum, Wilmer was given the W. Frank Blair Award by the Southwestern Association of Naturalists in 2004, for "outstanding contributions to the study of natural history."

In 1985, then-BYU president Jeffery Holland requested all academic departments to develop goals for building research excellence in a small number of "focal areas," which were to be chosen and justified on the basis of BYU's strengths and limitations. I was a member of the committee set up to draft such a plan for the Department of Zoology, and the presence of the Bean Museum made it easy for us to argue for a "directed hiring policy" centered on a museum-based evolutionary biology research focus. Wilmer was delighted when the Zoology Department adopted this plan (in 1986–87), and he was also proud of the fact that Zoology and Botany both retained a full complement of field-oriented natural history courses (the "-ology" courses), and that museum endowments continued to grow.



PHOTO BY RANDY BAKER

The five living current and former directors of the Bean Life Science Museum gathered in 2008 for this photo. From left to right: Dr. Larry St. Clair (present director), and past directors Drs. Stanley Welsh, Wilmer Tanner, Richard Baumann, and Duane Smith (these are not arranged in any chronological order).



Wilmer Tanner examining Bean Museum's bird egg collection, ca. 1978. Courtesy of M. L. Bean Museum, Brigham Young University.

Wilmer's Research Contributions in Herpetology.—Wilmer's research career includes 130 publications spanning 60 yrs (1939–1999) (http://mlbean.byu.edu/ResearchCollections/Collections/ReptilesandAmphibians.aspx), and focused mainly on systematics, anatomy/morphology, and ecology of a wide variety of taxa. Major foci included studies of the throat musculature of ambystomatid and plethodontid salamanders, the myology and osteology of iguanid lizards, taxonomic studies of the genera *Crotaphytus* and *Hypsiglena*, and the herpetofauna of western Chihuahua. As a result of a multi-year contract between BYU and the U.S. Atomic Energy Commission for ecological studies of the Nevada Test Site, Wilmer and his students completed a number of autecological studies of several desert lizards. His systematic studies included descriptions of about 50 new genera, species, and subspecies. These include two new genera—the plethodontid salamander *Lineatriton* (Tanner 1950) and the colubrid snake *Eridiphas* (Leviton and Tanner 1960; but see Mulcahy 2008)—and the rattlesnake *Crotalus lannomi* (Tanner 1966).

Wilmer's legacies.—Wilmer notes in his autobiography (Tanner 1993) that, outside of family, he was most proud of four professional accomplishments. In chronological order these are: 1) earning a PhD under E. H. Taylor at KU; 2) securing a teaching position at BYU, implementing a research program at a time when it was not supported or appreciated, and building a sizeable collection of amphibians and reptiles (Edwards 1975); 3) describing the novel genera *Lineatriton* and *Eridiphas*; and 4) securing support from the Bean family to build and endow a natural history museum on the BYU campus.

Long after official retirement Wilmer continued to work in the museum several days/week, even into his late 90s. The museum annually sponsors two guest lectureships and a Christmas party, and even at age 100, in a wheel chair and on oxygen, Wilmer faithfully attended all such events. For invited seminars he made certain that his family seated him near the front row in the Tanner Auditorium (which was officially dedicated to him), so that he could hear the speakers, and he always had questions, regardless of the topic.

I can think of no better tribute to Wilmer than this quote from E. O. Wilson's foreword in a recent book dedicated to field biology and field notes (Canfield 2011): "If there is a heaven, and I am allowed entrance, I will ask for no more than an endless living world to walk through and explore. I will carry with me an inexhaustible supply of notebooks, from which I can send back reports to the more sedentary spirits (mostly molecular and cell biologists). Along the way I would expect to meet kindred spirits . . . ." Wilmer, you'll be in great company!

Acknowledgments.—I thank Drs. Larry St. Clair and Stan Welsh, Director and Curator Emeritus of Botany, respectively, in the Bean Life Science Museum, and the Tanner family for their assistance in compiling this tribute.

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INSTITUTIONAL PROFILE

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Herpetology at the Zoologisches Forschungsmuseum Alexander Koenig (ZFMK), Bonn, Germany

German natural history museums and particularly their herpetological research sections and collections have been briefly reviewed and described for a US museological readership by Crumly (1984) who started his overview with the Zoologisches Forschungsinstitut und Museum Alexander Koenig (ZFMK), today renamed as Zoologisches Forschungsmuseum (= Zoological Research Museum) Alexander Koenig (Fig. 1). More than a quarter of a century afterwards it seems appropriate to give a short update. Among the German natural history museums with a significant herpetological collection, ZFMK—having been founded in 1900—is by far the youngest and, on average, one century younger than those in Berlin (ZMB), Dresden (MTKD), Hamburg (ZMH), Frankfurt am Main (SMF), Munich (ZSM), and Stuttgart (SMNS). Moreover, a dedicated curatorship for ZFMK's herpetological section has been in place only since 1951. Another distinction from the aforenamed institutions is that the scope of ZFMK comprises only zoology, i.e., there are no geological, botanical, and paleontological collections. In the herpetological collection, however, there are a few exceptions concerning single specimens of mid-Tertiary amber-preserved lizards and some subfossil skeletal material, both including type specimens.

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Within zoology, Museum Koenig has focused on arthropods and vertebrates. From the latter, ornithology has the longest tradition at ZFMK because the founder of the Museum, Alexander Koenig (1858–1940), had his main interest in ornithology since childhood. He was the son of a family of German immigrants to Russia where his father, Leopold Koenig, was the first to introduce sugar beets to Russia and subsequently created an imperium of sugar factories all over the Russian empire, centered in St. Petersburg. On the occasion of a holiday tour to Germany, the Koenig family visited Bonn and was so pleased by the mild climate of the Rhine River valley that Leopold Koenig decided to take residence in Bonn. The house he bought was situated on the Rhine River and was a representative villa that many decades later became famous as the "White House of Bonn" (Fig. 2), viz. the residence of the federal presidents of West Germany after World War II when Bonn had become the capital of the first Federal Republic. Its later and still current name is "Villa Hammerschmidt." Since the reunification of Germany, when capital status, government and parliament moved back to Berlin, Bonn retained a status as "Bundesstadt" (= Federal City) and this building, parental home of Alexander Koenig, is now the second residence of the German Federal President.



Fig. 2. "Villa Hammerschmidt," parental house of Alexander Koenig and later the residence of the German Federal Presidents.

Alexander Koenig was six years old when he moved with his parents from St. Petersburg to Bonn. He soon developed a nearly fanatical interest in collecting natural history items, particularly bird nests and eggs, subsequently also the birds themselves. After having finished high school, he studied zoology and achieved a doctoral degree and subsequently also received the title of professor. Following the death of his father, Koenig used part of his inheritance to build a museum to (1) accomodate his large collections in a proper way, and (2) to make them partly accessible to the public. Although construction began in 1912, the building was not finished and did not open for the public until 1934, due to World War I and the consequences for Germany in those years (Fig. 1). As noted above, the first herpetological curatorship was opened by A. Koenig's successor Adolf von Jordans in 1951. Karl F. Buchholz (1911–1967) worked first in the herpetological section, followed by Ulrich Gruber (born 1932) who left ZFMK in 1971 for the museum in Munich (ZSM). Both concentrated on the herpetofauna of southern Europe, mostly of the Aegean Islands of Greece. Curatorship by Wolfgang Böhme was held from 1971–2010, and was replaced by Dennis Rödder following his retirement. Böhme continues to work in the collection and guide students as Emeritus Curator of Herpetology on a voluntary basis.

Since 1951, there was always only one permanent curator post in ZFMK's herpetology section, along with a single support



Fig. 1. Museum Alexander Koenig, Bonn.

technician. Since 1978, technician position was filled by Wolfgang Bischoff (born 1945), who previously worked at the Magdeburg Museum in East Germany (former GDR). From 1978–present, further help and invaluable support has been provided by Ursula Bott (born 1957) although she was originally attached to the ichthyological section. Two long-term focal points of research involved genital morphology in lizards, together with biodiversity studies on amphibians and reptiles in West and Central Africa. Other projects included the compilation of the current knowledge within a treatise of European reptiles, and checklists including synonymies/chresonymies of chameleonid and varanid lizards. Side projects dealt with aspects of Tertiary and Pleistocene fossils including lizards embedded in amber, and the history of herpetology has also become an important area of interest. Recently, bionics (surface properties of lizards) became a topic of research for ZFMK's herpetology section, in cooperation with the Technical University of Aachen.

Since 1988 (when the senior author received his habilitation degree, i.e. the right to supervise graduate students in his own responsibility), the number of persons working on herpetological topics constantly increased. Apart from the 125 masters students who finished their theses under Wolfgang Böhme's supervision, there are 38 PhD students who successfully received their doctoral degrees. Of these, 30 worked with herpetological subjects, among them quite a number of well-known herpetologists (see below). Currently, the team comprises two postdocs, nine PhD students, and numerous bachelor, masters, and diploma candidates. The topics of their projects are manifold and have included, for example, studies on diversity, systematics, and biogeography of amphibians and/or reptiles of several tropical countries, such as Bolivia (Jörn Köhler, Lutz Dirksen, Steffen Reichle, Dirk Embert), Tanzania (Patrick Krause), Rwanda (Harald Hinkel), Madagascar (Frank Glaw, Miguel Vences), Vietnam (Thomas Ziegler, Nguyen Quang Truong), and Indonesia (Mark Auliya, André Koch); taxonomy, phylogeography, and phylogeny of various squamate groups such as cordyliform lizards (Mathias Lang), scincid lizards (Patrick Mausfeld, Andreas Schmitz), chameleons (Nicolà Lutzmann), uromastycine agamid lizards (Thomas Wilms), agamine agamid lizards (Philipp Wagner), monitor lizards (Hans-Otto Becker, Thomas Ziegler, André Koch, Evy Arida), boid snakes (*Eunectes*: Lutz Dirksen; *Calabaria*: Nicole Ernst), psammophiid snakes (Frank Brandstätter);



Fig. 3. Students working in the molecular lab.

autecology of amphibians and reptiles, both Palearctic and Afrotropical (Peter Heimes, Kirsten Osenegg-Leconte, Sigrid Lenz, Stephan Kneitz, Birgit Blosat, Daniel Ortmann); snake behavior (colubrids: Thomas Kölpin, psammophiids: Stéphanie de Pury); and more recently, evolution of environmental niches, assessed by means of species distribution modelling as well as assessments of invasive potentials in amphibians, reptiles, and other groups (Dennis Rödder).

ZFMK is able to provide a variety of important technical research facilities which are organized as central services open for all research sections of the institute. ZFMK was the first and is the only one among the German natural history museums having its own animal house, including a small greenhouse, as a facility to keep live animals for various purposes under proper conditions. As a matter of fact, this facility has been always nearly exclusively used by the herpetology section. Apart from its function as a quarantine station for reptiles kept in the museum's public vivarium, the animal house offers possibilities to work on behavior and reproductive biology of both amphibians and reptiles, and has played an important role in a number of masters and doctoral theses. A sound laboratory with a modern computer equipment serves to analyze animal voices including those of anuran amphibians. ZFMK's Scanning Electron Microscope (SEM), model Hitachi S-2460N, has often been used and is still in intensive use to investigate ultrastructure of reptilian skin, and a modern digital x-ray machine (Faxitron X Ray, Modell LX60) permits acquisition of anatomical (mostly osteological) data without destroying complete specimens.

The most important acquisition, however, is that ZFMK was allowed by the regional government of Nordrhein-Westfalen (the German federal state in which Bonn is situated) to create its own, new center for molecular biology (called "zmb") with several scientists and additional technical staff that offers central services for all taxonomic sections of ZFMK, including herpetology. It comprises several modern molecular laboratories (Fig. 3), a bioinformatics lab, and good computing capabilities.

ZFMK's herpetological collections comprise currently ca. 100,000 specimens, 93,000 of them being catalogued to date. This is remarkable because in 1971 when WB started his curatorship, the collection included only 9,500 specimens of amphibians and reptiles. This rather rapid growth was partly due to the acquisition of some historically important collections that came from other, much older university museums, and which for the first time gave ZFMK's relatively young collection a true historical dimension. The main sources of this valuable material were the university museums of Kiel, Heidelberg, and most important, Göttingen. The Göttingen collection contained invaluable type material of famous herpetologists such as Adolph Arnold Berthold, Wilhelm Keferstein, and Franz Werner (see also Böhme and Bischoff 1984; Böhme 2001, 2011). The most recent acquisition was the collection of the well-known biogeographer Prof. Paul Müller (1940–2010) of the Saarbrücken University who had collected mainly in SE Brazil in the 1960s and early 1970s. He donated his several thousand specimens to ZFMK upon his retirement in 2009.

The geographic focus of the collection in Bonn was originally rather narrow: western Palearctic, the Mediterranean Basin, with a focus on the Aegean islands of Greece. The former director of ZFMK, Prof. Martin Eisentraut (1902–1994), added an important stock of Central African material (Cameroon) to the collection. From 1971 onwards, more Middle East material (Turkey, Levant, Afghanistan) could be acquired but only after the transfer of the Göttingen collection to Bonn was a worldwide geographic scope



FIG. 4. View of the newly constructed "Snake Gallery" where the collection of snakes is accomodates in two floors..



FIG. 5. Alcohol preserved specimens of Grass Snakes, *Natrix natrix* ssp.

achieved. This was continued by the numerous biodiversity projects of our masters and PhD students in various tropical countries (see above). Only North America and Australia are relatively weakly represented, but in the latter case at least some invaluable historical type specimens are kept at ZFMK. Today, the collection comprises more than 530 species group names that are documented by type material. There are over 300 primary type specimens (i.e., name bearers or onomatophores) present in the collection, which chronologically range from 1801 to 2011.

The collection consists mostly of specimens kept in alcohol, but there is also an osteological collection of ca. 1000 skulls and skeletons; this has been used extensively by paleontological colleagues. Special small collections concern lizard hemipenes and lungs, former subjects of respective anatomical studies. For bioacoustic documentation, there are voice records of about 500 frog species, most of them, however, on commercial acoustic matrices. But there are also original recordings of several species. Except for Asia, all continents are represented. Several European species are documented with voice records from various geographic regions within their distributional ranges. The voice archive is kept in the central bioacoustic laboratory, together with mammalian, avian, orthopteran, etc., voice recordings. The same is true for the DNA tissue collection of amphibians and reptiles, which is also stored in the central molecular genetic facility of ZFMK.

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ARTICLES

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Intrasexual Aggression in Tuatara: Males and Females Respond Differently to Same-Sex Intruders

Intrasexual aggression patterns may reflect sex-specific strategies for maximizing fitness. Studies of aggression have typically focused on males because their behavior is often more dramatic and their morphology often more conspicuous than those of females (Andersson 1994). However, female intrasexual aggression is widespread and can serve several functions, including (1) competition for male parental care (e.g., preventing mates from courting and attracting other females; Slagsvold 1993; Slagsvold and Lifjeld 1994), (2) defending resources in a territory from other females (Berglund et al. 1993; Schofield et al. 2007), and (3) defending nests from females attempting to destroy them or deposit their own eggs (Bensch and Hasselquist 1994; McPhee and Quinn 1998).

Tuatara (*Sphenodon* spp.) are the last living representatives of the reptilian order Rhynchocephalia; they are endemic to New Zealand, sexually dimorphic, and highly territorial (Daugherty and Cree 1990). Tuatara are polygynous and polyandrous, and clutches can be multiply sired (Moore et al. 2008). Aggression has been documented in both sexes, but experimental studies of intrasexual aggression have only been conducted with male tuatara (Gillingham et al. 1995).

Aggressive behaviors among tuatara include erect and alert body posturing, inflation of the gular (throat) region, dorsal and nuchal crest erection, mouth gaping, lateral head shaking, chasing, and physical attack (Gillingham et al. 1995). Physical attacks can last for hours and sometimes end in serious injury. Male and female tuatara display nearly the same suite of aggressive behaviours. However, only males display pronounced dorsal and nuchal crest erection and lateral head shaking. In addition, females exhibit a head nodding behavior that may indicate their sex to other tuatara and thus promote the initiation of male courtship and help females avoid attack by aggressive males during the mating season (Gillingham et al. 1995).

Aggressive encounters between male tuatara follow a stereotyped pattern, beginning with alert posturing, body inflation and crest erection, followed by reciprocal mouth gaping and eventually biting and physical combat (Gillingham et al. 1995). Aggressive encounters among males take place throughout the year but are particularly frequent during mating season when testosterone levels peak (March; Cree et al. 1992). Larger males are more effective at monopolizing and guarding mates and territories by winning aggressive encounters with other males (Moore et al. 2009)

The extent of female-female aggression during mating season is unknown. However, female tuatara aggressively defend their nest sites from excavation by other females during nesting season (November; Refsnider et al. 2009). Females tuatara display nest-site fidelity, returning to the same communal rookeries outside of their home ranges to oviposit every 2–4 years (Refsnider et al. 2009). A study of intrasexual aggression, during mating season and in both sexes, is necessary for understanding the mating system of tuatara, and previous findings for males cannot be assumed to be true for females. Here we investigate (1) whether female-female aggression occurs during the mating season (8–10 months before nesting; Cree et al. 1992) and (2) if the form and pattern of aggression differs between the sexes.

Methods.—We assessed intrasexual aggression through a series of trials conducted during mating season in March 2007 on Stephens Island in Cook Strait, New Zealand, where the largest and most dense population of tuatara (*Sphenodon punctatus*) occurs (~2700 tuatara per ha; Moore et al. 2009). Tuatara occupy extensive, dense burrow systems. Although nocturnal foragers, tuatara emerge from their burrows during the day to thermoregulate and defend against intruders.

Resident male and female tuatara were presented with a non-moving model tuatara representing a same-sex territorial intruder (Fig. 1). Models were carefully placed by hand within territories approximately 1–1.5 m from individual tuatara basking near burrow entrances. Responses of tuatara to the models were either recorded on digital video (19 male trials, 11 female trials) or directly observed when a camera was unavailable (10 female trials). The camera or observer was within view of the focal animal but stationary for the duration of the trial; in very few instances did this process appear to alter the focal animal's immediate behavior. Trials were scored by one of two observers who similarly identified the suite of behaviors under study.

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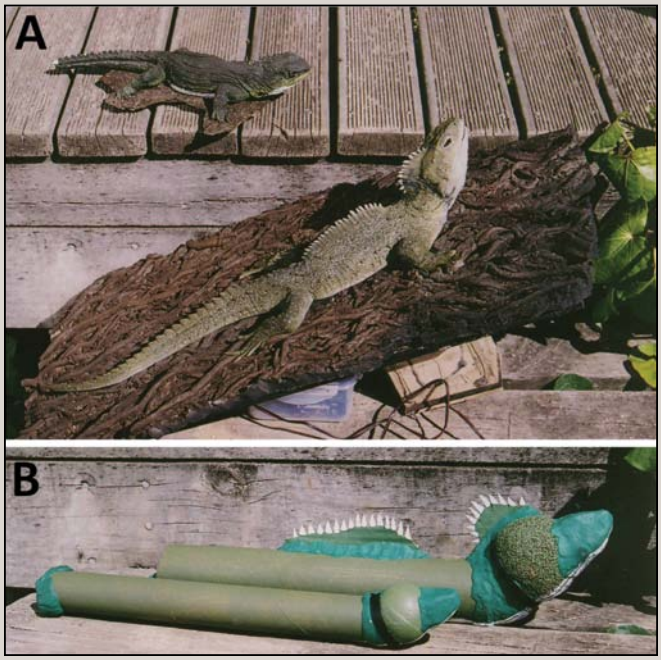


FIG. 1. Realistic (A) and abstract (B) models of male and female (smaller) tuatara. Realistic models were based on molds of deceased tuatara. Abstract models represent only the basic profile and shape of tuatara.

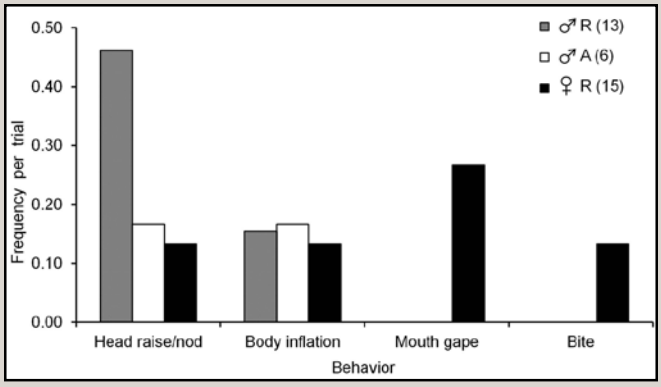


FIG. 2. Frequency of aggressive behavioral responses of tuatara to non-moving, same-sex models. Trials (total number conducted) were male tuatara presented with a realistic model (R), male tuatara presented with an abstract model (A), and female tuatara presented with a realistic model (R); data are the number of times each behaviour was observed divided by the total number of trials. Female tuatara showed no aggressive behavior toward abstract same-sex models.

Both abstract and realistic models for each sex were used in trials to increase the visual cues offered to the tuatara and maximise the possibility of eliciting a response. Realistic models were created from molds of deceased tuatara, while abstract models represented only the basic profile and shape of tuatara (Fig. 1). Models approximated the size and shape of adult tuatara and were similarly sized within sex.

A total of 40 tuatara (19 males and 21 females) were presented with models. Individual tuatara were used in only one trial and were captured when possible after the trial to measure total body length (tip of snout to tip of tail) and snout–vent length (SVL). Trials were conducted between 1100 h and 1800 h; more than 41 h of observation were conducted in total. Encounters between tuatara and models were discreet but varied in duration. Therefore, we did not equalize observation time among trials, but included only trials where the full encounter (tuatara first notices model or emerges from burrow until displaying or attack ceased) was observed (range 30–95 min, mean = 62 min). Data were summarized as counts of response and non-response trials and the frequency in which each behavior was observed (head raise/nod, body inflation, mouth gape, bite) in response trials. Differences in behavior between sexes and model types were assessed with chi square analyses and differences in mean body size between responding and non-responding tuatara were assessed with a two-tailed t-test; significance was assessed at $\alpha = 0.05$.

Results.—Body size was recorded for 14 of 19 male and 18 of 21 female tuatara used in trials. Total body length of the models (male: realistic = 520 mm, abstract = 415 mm; female: realistic = 310 mm, abstract = 370 mm) was within the body size range of captured male (range 373–593 mm, mean = 480.4 mm $\pm$ 33.0 95% CI) and female (range 257–427 mm, mean = 364.2 mm $\pm$ 20.7 95% CI) tuatara, and mean SVL did not differ between tuatara that did and did not respond to the models (males: $t_{12} = 0.036$, $p = 0.97$; females: $t_{16} = -0.490$, $p = 0.63$).

Aggressive responses to the models were recorded in 35% of trials (8 of 19 male tuatara or 42%, 6 of 21 female tuatara or 29%) and male and female tuatara were equally likely to respond aggressively to the models overall ($\chi^2_1 = 0.80$, $p = 0.37$). Female tuatara did not respond to the abstract model while male tuatara responded similarly to both abstract and realistic models (males: $\chi^2_1 = 0.28$, $p = 0.60$; Fig. 2). Where a response was observed, males and females differed in their type of response ($\chi^2_3 = 8.98$, $p = 0.03$; Fig. 2). Males tended to engage in head raises and body inflation; in no trial did a male tuatara mouth-gape at or physically attack a model (Fig. 2). Female tuatara showed similar body inflation to males, but engaged in fewer head nods than males and also mouth-gaped at the models and, in two trials, bit them on the head (Fig. 2).

Discussion.—Our study suggests that both male and female tuatara are aggressive toward same-sex intruders during the mating season, but that physical attack is more likely among female than male tuatara. This may indicate that the fitness cost of fighting (e.g., risk of injury, lost energy or courting time, tail loss) is lower, or the cost of intrusion is higher, among female than male tuatara.

In many birds, females are aggressive toward other females being courted by their mates, which functions to ensure paternal care (Liker and Szekely 1997; Slagsvold 1993; Slagsvold and Lifjeld 1994). Tuatara do not exhibit extensive parental care and do not show pair-bonding. Therefore, female-female aggression in tuatara during the mating season more likely functions as a way to defend individual burrows (i.e., retreat sites) or basking sites, while male-male aggression functions to establish dominance and defend mates. The extremely high density of tuatara in our study population suggests that there could be intense competition for burrows and basking sites.

Intrasexual aggression among female tuatara may have evolved in the context of nest defense. Male tuatara have evolved a stereotyped, reciprocal display that only rarely escalates to physical combat (Gillingham et al. 1995). However, female tuatara do not appear to have evolved a similar passive threat display (e.g., like that observed in female Loggerhead Sea Turtles *Caretta caretta*; Schofield et al. 2007). Outside of nesting, females may rarely come into direct contact because they occupy temporally

stable territories (Moore et al. 2009). However, females are in direct and sometimes aggressive contact when nesting at communal rookeries, and frequently excavate each others' nests (Refsnider et al. 2009). Thus, high fitness costs related to nest loss may promote immediate physical combat among nesting females rather than an escalating series of reciprocal displays. This could result in selection for aggression in females generally that is then evident during mating season.

Our observations of head nods in females and a similar, but much slower, behavior in males (here called a head raise) suggests that head raises and nods may be aggressive and not courtship behaviors as previously suggested by Gillingham et al. (1995). This is because both sexes performed this behaviour toward same sex intruders in their territory and head raises were typically the first step in the repertoire of escalating aggressive behavior among males. The behavior was so slow in males that we were often only able to observe it when viewing trial video at high speed, but otherwise closely resembled the head nod that has been previously observed in females.

Appropriate reciprocal movement may be necessary to elicit full attacks from male tuatara. Tuatara are cold adapted and largely sedentary reptiles (Daugherty and Cree 1990), and movement is an important cue used in detection of prey, mates, and competitors (Dawbin 1962; Gillingham et al. 1995; Meyer-Rochow and Teh 1991; Walls 1981). We suspect that movement is key in eliciting aggressive behavior in tuatara, and that reciprocal display may be necessary for aggressive encounters to escalate to physical combat among males. Future studies of intrasexual aggression in tuatara should consider using models that can be manipulated to move in response to aggressive behavioral cues from their same-sex rivals. The present study, however, indicates that movement is not required to elicit highly aggressive responses in female tuatara.

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Geospatial and Behavioral Observations of a Unique Xanthic Colony of Pelagic Sea Snakes, *Pelamis platurus*, Residing in Golfo Dulce, Costa Rica

Golfo Dulce is a curved tropical fiord positioned between 8.3666°N and 8.7500°N on the South Pacific coastline of Costa Rica. The embayment is approximately 50 km in length and 10–15 km wide, supplied with fresh water from four main rivers (Svendsen et al. 2006). The inner basin in the upper region of the inlet, north from 8.5000°N, is of tectonic origin and periodically anoxic (Hebbeln and Cortés 2001). Bathymetric studies show the waters there reach 215 m in depth and are protected by an effective 60 m sill and a submerged valley, ≤ 80 m deep, which extends southward to the mouth of the Gulf. This topography prevents free exchange between the deeper waters of the inner basin and adjacent coastal water masses (Svendsen et al. 2006).

The venomous pelagic sea snake, *Pelamis platurus* (Elapidae: Hydrophiinae), is the most widely distributed snake in the world. This monotypic genus (Pickwell and Culotta 1980) has been reported along the Pacific shores of Latin America since the early 1500s (Taylor 1953) and is the only sea snake on the west coast of Costa Rica (Solórzano 2004). Generally reliant on ocean currents for long distance movement, pelagic sea snakes are often associated with drift lines, and groups of a few to several thousand may aggregate in narrow bands of smooth water on the ocean surface, possibly for the purpose of passive transportation, feeding, and/or reproduction (Kropach 1971a; 1975). However, despite being a true pelagic species that ranges far out to sea, *P. platurus* is most commonly found 1–20 km off shore (Savage 2002). It opportunistically feeds on a wide array of small and young fish species at the water surface (Hecht et al. 1974) and can thrive in lower saline conditions (Dunson 1971).

Pelamis platurus displays diverse color variations (Kropach 1971b). In the Eastern Pacific, the majority of Yellow-bellied Seasnakes are tricolored with black dorsal coloring and brownish ventral coloring separated by yellow lateral stripes. The second most common are bicolored snakes, black and yellow with no brown (Bolaños et at. 1974; Tu 1976). Both variations display black spots or bands on the flat paddle-shaped tail. Such coloration is suggested to be aposematic (Kropach 1975); indeed, predation on *P. platurus* appears practically nonexistent (Rubinoff and Kropach 1970), and the species rarely dives due to disturbances at or above the surface (Dunson and Ehlert 1971; Tu 1976), suggesting there is limited, if any, predation pressure from that direction (Kropach 1975). Unicolor snakes have been considered very rare, merely noted in the Western Hemisphere (Leenders 2001; Mattison 2007; Solórzano 2004; 2011). Smith's (1926) seven color forms did not include an all-yellow variety and Kropach offered the first definitive description (Pickwell and Culotta 1980) after seeing individuals of the variety in both Golfo Dulce and the Gulf of Panama. During a 1970 expedition, Kropach (1971b; 1975) observed 278 *P. platurus* inside Golfo Dulce. Nine of the specimens, about 3%, were of the all-yellow variety. In 1973, Bolaños et al. (1974) captured 102 specimens of *P. platurus* in five localities along the northern Pacific coastline of Costa Rica, including one snake that was "yellow with a few black dorsal dots." Tu (1976) later reported collecting 3077 pelagic sea snakes on the Pacific Coast of Costa Rica. Of that sample, four specimens, approximately 0.1%, were all-yellow. Tu (pers. comm.) confirmed he did not find any of his snakes in or near Golfo Dulce. Those findings show that all-yellow individuals along coastal Costa Rica are not limited to the waters of Golfo Dulce and may naturally represent a small percentage of the population-at-large.

During previous work on the Osa Peninsula (Bessesen and Saborío-R. 2009), local residents described to me a population of all-yellow specimens of *P. platurus* living in Golfo Dulce. Based on that information, a marine sighting survey was designed to collect baseline distribution data for the yellow sea snakes during the dry season of 2010. These findings, which suggest a separate and behaviorally distinct xanthic (defined here as all-yellow or primarily yellow) colony, are reported here.

METHODS

With the aid of a Costa Rican research assistant/boat captain, 82 preliminary interviews were conducted with local fishermen and tour boat guides. Interviewees were asked to estimate the frequency with which they saw pelagic sea snakes inside Golfo Dulce (never, rarely, occasionally, frequently or always) and the color of those snakes. Photographs were made available but all interviewees seemed familiar with the snakes.

After interviews, 30 daily on-water surveys were undertaken, systematically investigating surface waters around the entire Gulf to document first-hand sightings of *P. platurus*. January–February study dates were selected in part because local sources reported pelagic sea snakes as being seen more frequently at the surface during the dry season, an observation also noted by researchers in other areas of Costa Rica (Bolaños et al. 1974).

The embayment was divided into four geographical areas, labeled GA1–4. GA1 and GA4 were designed smaller to account for distance from the operations base of Puerto Jiménez and additional time spent in GA2 and GA3 as corridors. The boat captain selected delineating landmarks he found clear and familiar, resulting in GA3 being slightly larger than intended. Each day we concentrated on a single area, traversing its full breadth in a large loose pattern, e.g., perimeter, figure-eight, zigzag, to ensure time near each coast and in the midwaters. A rotation of GA1, GA3, GA2, GA4 was generally employed. Waters outside the embayment, designated as GA5 (Fig. 1), were not actively surveyed; however, some sea snake sightings occurred in that area after inadvertently crossing the boundary of GA4. Typically we departed Puerto Jiménez just after sunrise and traveled 65–80 km per day, with daily observation periods lasting an average of 7 h and 46 min. We carried out three night surveys in GA1 and GA2 to observe yellow sea snakes in low-light conditions.

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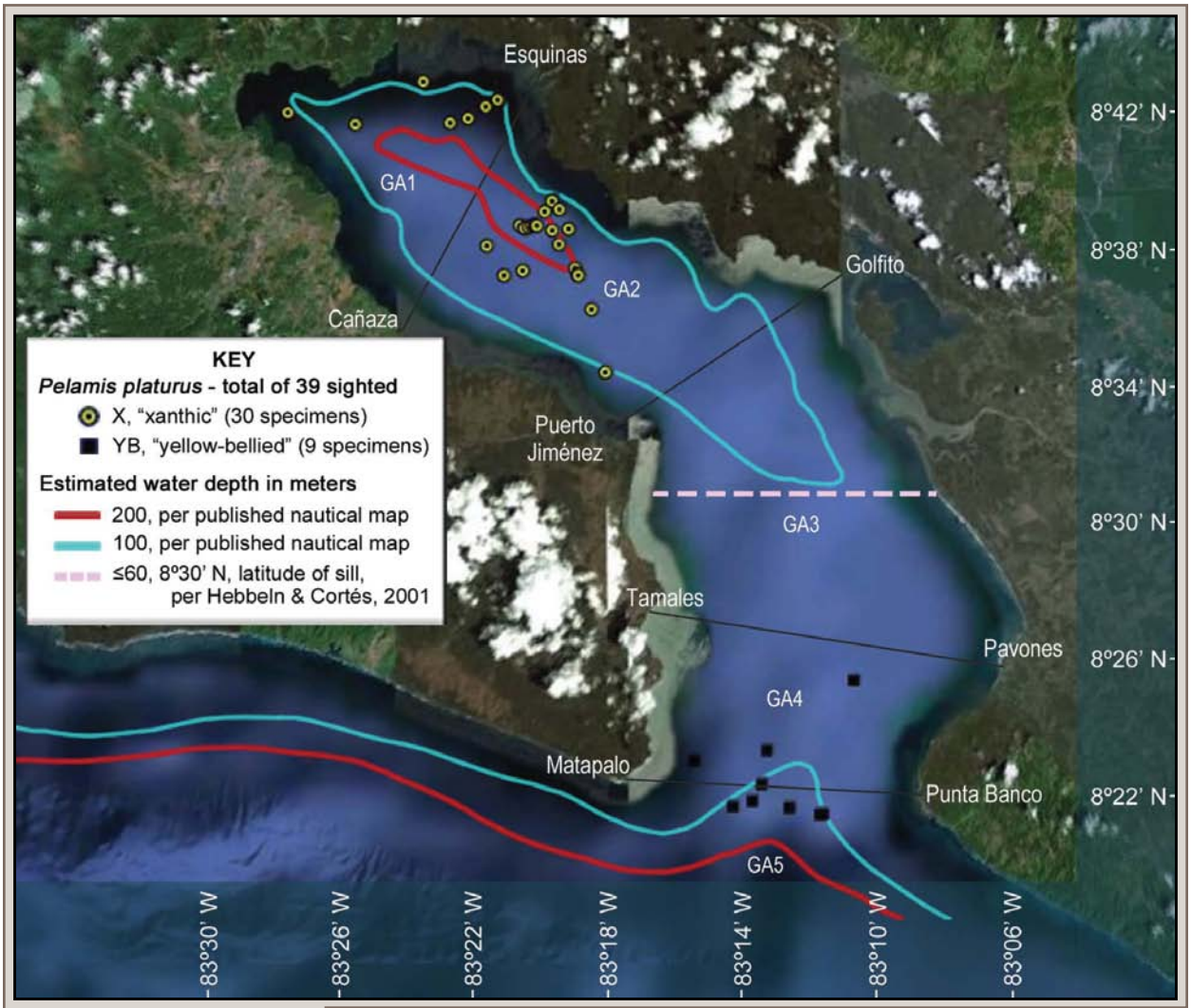


FIG. 1. GPS points for 39 first-hand sightings of *Pelamis platurus*, represented by 30 Xanthic sea snakes (yellow dots) and 9 Yellow-bellied sea snakes (black squares). Note the significant spatial gap that coincides with the graphic demarcation of the inner basin sill. Also shown, delineation of survey areas (grey lines).

GA1 = ↑ Cañaza 8.5948°N, 83.4006°W / Esquinas 8.7208°N, 83.3316°W;

GA2 = ↑ PJ 8.5425°N, 83.3038°W / Golfito 8.6217°N, 83.1821°W;

GA3 = ↑ Tamales 8.4521°N, 83.2820°W / Pavones 8.4203°N, 83.1086° W;

GA4 = ↑ Matapalo 8.3742°N, 83.2906°W / Pt Banco 8.3663°N, 83.1456°W;

GA5 = ↓ GA4 (outside gulf).



FIG. 2. Two typical Xanthic sea snakes found in upper Golfo Dulce. (A) This specimen was identified by two small black marks caudal and slightly medial to the supraocular scales (arrows). (B) Although predominantly yellow, some individuals retain larger black spots along the dorsal ridge. This sinusoidal posture was commonly seen when approaching at night. The slight halo effect was caused by the camera flash on the water.

COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND

TABLE 1. Geographical areas in Golfo Dulce with surface size, survey effort, and quantitative sighting distribution for Yellow-bellied and Xanthic specimens of *Pelamis platurus*.

Geographical areas		Survey effort		Snakes by color variation	
Location	Estimated surface size	Days of rotation	Approximate survey hours	Xanthic	Yellow-bellied
GA1, highest sector of gulf	130 km²	7.25	55.50	6	0
GA2, mid-upper gulf	192 km²	8.25	65.75	24	0
GA3, mid-lower gulf	256 km²	7.25	63.25	0	0
GA4, lowest sector of gulf	147 km²	7.25	47.50	0	4
GA5, outside gulf	—	—	01.00	0	5

Sightings were recorded using Global Positioning System (GPS; Garmin handheld GPS III) with 72% of sea snakes right next to the boat and none further than 5 m away. Typical bi- or tricolored *P. platurus* with black and yellow striae were logged as Yellow-bellied while all-yellow or primarily yellow individuals were logged as Xanthic. Two cameras, a Nikon D50 SLR digital camera and a Canon GL-1 mini DV video camera, were used to obtain photographic records. Daily solar and tidal charts were logged and time was recorded at the start and end of each observation period, along with environmental conditions, including air and sea surface temperatures, Beauford Wind Force, visibility and prevailing weather.

RESULTS

Interviews.—Of the 82 interviewees polled during this study, 72% (59) were professional fisherman (commercial and/or sport-tourist), 13% (11) worked in nonfishing tourism (boat tours/excursions), and 15% (12) of the subjects did both. The number of years experience in Golfo Dulce ranged from 1–40 with the average at 12 years. Average number of work days per week was 5. When asked how often pelagic sea snakes were seen inside Golfo Dulce, 44% reported that they were "rarely" seen, 18% answered "occasionally," 21% said "frequently," and 11% said "always." Only 6% of the interviewees had "never" seen *P. platurus* inside the Gulf.

Interviewees consistently reported that Xanthic sea snakes were found in the upper, deep water regions of Golfo Dulce, while Yellow-bellied sea snakes were down near Matapalo at the inlet's entrance, and that this was not a seasonal phenomenon. Some interviewees from the pueblo of Pavones on the southeastern shores of Golfo Dulce, who worked solely in the lower half of the Gulf, had never seen a Xanthic sea snake. The project's research assistant (Largaespada, pers. comm.) had observed Xanthic snakes in the upper Gulf for more than 35 years and never a Yellow-bellied snake in that region. Two resident biologists (Boston, pers. comm.; Bernal, pers. comm.) confirmed witnessing only Xanthic snakes around the inner basin, including possible reproductive aggregations in the month of July. Boston also reported never seeing a Xanthic sea snake in a drift line.

Field counts.—Between the dates of 13 January and 24 February 2010, a total of 233 observation hours was logged across all areas of Golfo Dulce (Table 1); most (89%) were conducted during daylight hours. In general, weather conditions presented minimal precipitation, relatively calm water and average visibility greater than 15 km. Daily temperatures, recorded near the marina of Puerto Jiménez, averaged 28.6°C for air and 30.5°C for sea surface. (The upper lethal temperature for *P. platurus* is from 33°C [Dunson and Ehlert 1971] to 36°C [Graham et al. 1971].)

A total of 39 pelagic sea snakes were documented, divided as 30 Xanthic and 9 Yellow-bellied. For the Xanthic variety, 80% (24) were seen in GA2 with the remaining 20% (6) found higher up in GA1. All Yellow-bellied snakes were seen within 7 km of the Gulf entrance, most near the border of GA4/GA5, although one individual was recorded a little further into the embayment. The distance between the southernmost Xanthic and northernmost Yellow-bellied specimens was 21.6 km. No pelagic sea snakes were found in GA3 (Table 1, Fig. 1).

Overall, sea snakes were infrequently seen; however, if one was sighted, others usually were seen, sometimes several in a short stretch of time, suggesting certain days and/or conditions were more conducive for surfacing. One example occurred under a full moon on 30 January, when 8 Xanthic snakes were sighted within an hour (2017–2110 h), no more than 300 m apart. In another instance, 5 Xanthic specimens were sighted over a span of about 4 km in only 23 min (1618–1641 h; 20 February). Although snakes were sometimes seen swimming across the water, most were found simply floating at the surface.

We were able to collect photographs and/or video footage in 77% of our total sea snake sightings, allowing for identification of individuals. Individual Yellow-bellied snakes were easy to recognize by the unique configuration of their markings and it was confirmed that nine different Yellow-bellied snakes were encountered. Although Xanthic specimens appeared unicolored and were consistently yellow with neither lateral demarcations nor prominent tail patterns, photos revealed that most had at least one black speck on the head or body. A few individuals (1–2% of the total Xanthic sampling) had one or more larger black spots (estimated <5 mm in diameter) along the dorsal ridge. One specimen had decidedly heavier dorsal markings, yet none of its spots were estimated at >20 mm. Using markings, it was determined that every Xanthic snake photographed during the investigation was also a distinct individual (Fig. 2A, B).

Behavioral observations.—Photographs were taken for 100% of the nine Yellow-bellied sightings, all of which took place during daylight hours. All of the Yellow-bellied snakes reliably remained on the surface while approached for documentation; two surfaced next to the boat when the motor was off; and 6 snakes were still on the surface after departure. On the two separate occasions that we touched the tails of Yellow-bellied snakes facing away from us, they both turned back and struck at the boat hull. Neither dove. All Yellow-bellied sea snakes were seen in relatively still water or smooth rolling waves and two snakes (22%), were floating in or near a defined drift line.

Photographing Xanthic snakes proved a greater challenge. They never surfaced near the boat and, in daylight conditions,

tended to dive if we slowed down anywhere near them. Despite clear views at every sighting, photographs of Xanthic snakes were captured only 50% of the time (5 of 10) in full daylight. Low-light conditions increased the success rate. For evening sightings from 1400–1600 h, photos were collected for 71% (5 of 7) of Xanthic sightings. During night surveys conducted after 1800 h, 85% (11 of 13) were photographed. Because the Xanthic snakes did not dive as readily at night, it was possible to directly approach and obtain close-range photographs and videotape using flashlights. However, the snakes often assumed a tight sinusoidal shape (Fig 4B; this posture was not observed in Yellow-bellied snakes). On the one occasion we touched a Xanthic snake, it did not respond by striking but immediately dove. Most Xanthic snakes were recorded in choppy water; a few were seen in slightly calmer morning and evening waters; none was found in smooth water. We occasionally saw drift lines in the upper half of the embayment; however, only one Xanthic snake was observed several feet outside a slick of floating scum and debris. The occurrence rate of drift lines in the upper and lower regions of the Gulf is unknown. One Xanthic snake was also videotaped while shedding its skin, using the knotting behavior described by Pickwell (1971, 1972).

DISCUSSION

After many interviews with local biologists, fishermen, and tour boat guides, and an expansive on-water survey of Golfo Dulce during the dry season, we have determined that all the sea snakes above about mid-Gulf appear bright canary yellow. The consistently yellow skin coloring of sea snakes found in the northern region of the Gulf and absence of yellow snakes below the sill suggest this population may be genetically disjunct from those in the Pacific. The data show clear geospatial, morphological, and behavioral distinctions between the Xanthic and Yellow-bellied populations, and phylogenetic studies would be of significant interest to determine if morphology has given rise to a distinct form of *Pelamis platurus* in Golfo Dulce.

Golfo Dulce's topography may help explain the almost 22 km gap between the Xanthic and Yellow-bellied populations and complete lack of sea snake sightings in GA3. Although the Xanthic colony appears to reside high up in the inner basin and no sea snakes were sighted near the sill, shallower waters south of the sill may play a role in habitat boundaries.

Hecht et al. (1974) listed several limiting factors for the establishment of resident populations of pelagic sea snakes, including annual range of surface temperatures, depth of water, prevailing currents, and storm pathways. They suggested that, demarcated by the 26°C isotherm correlated with the 100 m isobath, permanent breeding colonies should occur in many areas worldwide, including the western coast of Central America. Given the favorable yet insulated bathymetrics of Golfo Dulce, the idea of one such breeding population becoming sequestered, possibly by shifts in currents, is conceivable. Furthermore, the pelagic sea snake's nonspecialized food habits and ability to thrive in lower saline conditions would have allowed the original colonizing snakes to inhabit the fiord-like waters. Because *Pelamis platurus* spends about 87% of its time submerged (Rubinoff et al. 1986), and respires partially through its skin, meeting 12–33% of its oxygen requirements and excreting carbon dioxide by that mechanism (Graham 1974b), it would be interesting to investigate whether and/or how the Gulf's periodic anoxia affects the resident snakes.

Kropach (1971a, b) first reported the all-yellow variety of pelagic sea snake after conducting a one-year study of *P. platurus* in the Gulf of Panama, where "regular trips were made in the northern part of the [gulf]." Although the yellow variety was seen during that study, Kropach made no indication that the number of yellow specimens made up a greater concentration than the 3% he reported in Golfo Dulce. This decreases the likelihood that yellow snakes are predominant in the Gulf of Panama or are in any way isolated from the prevailing color varieties in that embayment, and suggests the Golfo Dulce population may be unique.

What are the adaptive advantages of xanthic coloring in Golfo Dulce when that variety exists in only a small percentage of the general population? Solorzano (2011) suggests temperature might play a role. Because *P. platurus* naturally collects solar energy while basking (Graham et al. 1971; Graham 1974a) and sea surface temperatures in Golfo Dulce are higher than other areas within the species' range (Hecht et al. 1974), perhaps lighter dorsal coloring reduces chances of overheating at the surface where it feeds.

Xanthic sea snakes were commonly found in rougher water than expected for *P. platurus*. Such conditions might play a role in surfacing and/or detectability. Xanthic snakes were also more likely to dive when approached, especially during daylight hours, and often took a seemingly defensive sinusoidal posture. Boat traffic and other human activity may influence sea snake behavior within the embayment and/or all-yellow coloring may not be entirely aposematic in Golfo Dulce. It also appears that Xanthic snakes make limited, if any, use of drift lines.

The findings of this study raise several interesting questions about the Xanthic sea snakes residing in Golfo Dulce and there remains much to learn about this unique colony.

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Headwaters and Headlamps: A Comparison of Nocturnal and Diurnal Surveys to Estimate Richness, Abundance, and Detection of Streamside Salamanders

Salamanders are sensitive to environmental stressors and are increasingly being used in monitoring programs (Davic and Welsh 2004). Surveys for salamanders commonly take place in conjunction with other biological surveys, such as fish and benthic macroinvertebrate sampling (Kazyak 2001). These surveys are often conducted during the day. Consequently, predominantly nocturnal individuals and species may go entirely undetected. Salamanders are thought to be primarily nocturnal, their activity on the ground surface increasing with relative humidity (Petranka 1998). This suggests that the optimum time to study or survey salamanders is at night. However, Southerland (1986a) demonstrated that *Desmognathus monticola* tends to move away from the stream margin at night, suggesting that surveys of the immediate streambank would be more effective during the day.

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Salamander surveys have been conducted during the night (Grover 1998; Hairston 1980; Petranka and Murray 2001), during the day (Foley and Smith 1999; Jung et al. 2000; Smith and Petranka 2000; Southerland et al. 2004), and during both day and night (Burton and Likens 1975; Hyde and Simons 2001; Southerland 1986b). If biases in relative abundance or detection probabilities exist due to differences in sampling time, then results from these studies may not be comparable. Few studies have examined this problem (Hyde and Simons 2001; Keen et al. 1987; Orser and Shure 1975) and our objective was to determine if species richness, abundance, and species-specific detection probabilities differ between diurnal and nocturnal streamside salamander surveys.

METHODS

Site selection. —We established paired sites at 12 headwater streams in small catchments (draining <120 ha) of relatively uniform habitat and gradient in the Savage River watershed (Fig. 1). This watershed is in the Appalachian Plateau region of Maryland and one of the most heavily forested regions in the state (Boward et al. 1999). Streams of this region generally have vegetated riparian zones, rocky substrates, steep gradients, low nitrate concentrations, and relatively high levels of dissolved oxygen (Boward et al. 1999). The canopies are dominated by Eastern Hemlock (*Tsuga canadensis*) and Yellow Poplar (*Liriodendron tulipifera*), and the understory is dominated by *Rhododendron* spp. The substrate along the streambank consists of boulders, cobbles, and leaf litter.

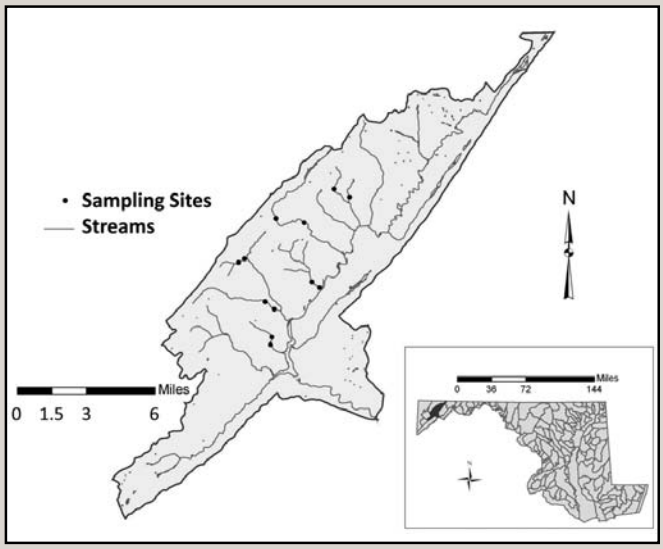


FIG. 1. Savage River watershed in Garrett County, Maryland, with locations of study sites.

Each paired site consisted of two 25 × 1 m transects, originating at the stream margin and running parallel to the stream. These transects were established along the same reach of stream, separated by ≥10 m. We took care to select two 25 m sections that were as similar as possible by visually estimating numbers of pools and riffles and relative proportions of boulders, cobbles, and leaf litter along the streambank (pairings were deemed suitable if they were >90% similar with respect to these attributes). Diurnal and nocturnal survey treatments were randomly assigned with a coin toss.

Surveys.—Salamander surveys were performed once at each site from 20–27 April 2007, with diurnal surveys conducted between 0900 h and 1200 h and nocturnal surveys conducted between 2245 h and 0130 h. Mean relative humidity was 62.6% and 71.7% and mean air temperature was 14.5°C and 9.9°C during diurnal and nocturnal surveys, respectively. No rainfall occurred during the survey or for several days preceding surveys; light fog was present during four diurnal surveys. Surveys took approximately 25 minutes to perform (min-max: 13–45 mins). When two sites were sampled on the same day, they were done so in a random order (i.e., the order in which they were sampled diurnally may not have been the order they were sampled nocturnally). The nocturnal survey time interval was chosen because it closely overlapped with the peak activity periods that Hairston (1949) reported for Appalachian salamanders, three species of which occurred in our study area (*Desmognathus monticola*, *D. ochrophaeus*, and *Plethodon glutinosus*). Diurnal and nocturnal surveys at each site were always conducted on the same day, and standard headlamps were worn during nocturnal surveys. Area constrained surveys (ACS) were used to sample salamanders. ACS consisted of two observers slowly walking in parallel along the streambank, looking for adult and juvenile salamanders on the surface and turning over all natural cover objects (excluding objects less than roughly 8 cm) to look for salamanders underneath (Crump and Scott 1994). Cover objects were returned as close as possible to their original position. All salamanders encountered were captured, identified to species, measured for snout–vent length (SVL), and released. Salamanders that eluded capture were noted and identified if possible.

Statistical analysis.—Each transect was considered an independent experimental unit, and paired t-tests were used to examine differences between diurnal and nocturnal surveys with respect to species richness and number of individuals (for each species and total; adults and juveniles were pooled within each species). Dependent variables (species richness, number of individuals) were all distributed normally with the exception of species richness of diurnal surveys; we assumed the test to be robust against this slight departure from normality.

Site occupancy models developed by MacKenzie et al. (2002; 2006) were used to estimate species-specific detection probabilities and evaluate the differences, if any, in those detection probabilities between survey types. In these models, it is assumed that sites belong to one of two states: unoccupied (the species will not be detected) or occupied (the species will be detected with a probability of less than one, MacKenzie et al. 2002; 2006). Two parameters, Ψ (occupancy) and p (detection probability) represent the probability that a site is occupied and the probability of detecting the species (given that it is present), respectively. Maximum-likelihood methods are then used to estimate the parameters for a set of sites for which presence/absence data for a species has been obtained via repeat surveys (MacKenzie et al. 2002; 2006). We analyzed data using program PRESENCE (Proteus Wildlife Research Consultants, Dunedin, New Zealand; MacKenzie et al. 2002). For this analysis, each site (which included both transects) was considered the sampling unit, and the diurnal and nocturnal transects were considered the two repeat surveys needed to estimate parameters (MacKenzie et al. 2006). For model selection, we used a single-season model with Akaike's Information Criterion adjusted for small sample size (AIC_c; Burnham and Anderson 2002). Our two candidate models for each species in this analysis were constant detection probability across surveys and variable detection probability across surveys (p(.) and p(SURVEY), respectively). Because of the short amount of time over the entire study (eight days) and between diurnal and nocturnal surveys (10–16 h), occupancy (Ψ) was assumed to be constant.

RESULTS

We encountered 348 salamanders comprising six species: *Eurycea bislineata*, *Desmognathus fuscus*, *D. ochrophaeus*, *D. monticola*, *Gyrinophilus porphyriticus*, and *Plethodon glutinosus* (Table 1). We encountered *D. ochrophaeus* in every survey; therefore the variance-covariance matrix could not be computed and thus that species was omitted from detection probability analyses. *Plethodon glutinosus* was excluded from the paired t-tests and detection probability analyses because only one individual was encountered during the entire study.

No significant differences existed between diurnal and nocturnal surveys for species richness, total number of individuals, or number of individuals of each species (Table 1). We performed post-hoc power analyses to determine our probability of avoiding type II error. A sample size of 12 and a paired difference standard deviation of 1.24 yielded a probability of detecting a 50%, 20%, and 10% difference in species richness of 0.99, 0.99, and 0.72, respectively. An increased standard deviation (5.61) for paired differences in total individuals decreased the probability of detecting a 50%, 20%, and 10% difference to 0.80, 0.20, and 0.09, respectively.

There was no overwhelming support that detection probabilities did or did not vary significantly between diurnal and nocturnal surveys: the data for *D. fuscus*, *D. monticola*, and *G.*

TABLE 1. Summary statistics and results of paired differences t-tests between diurnal and nocturnal streamside salamander surveys (diurnal – nocturnal) for species richness, total number of individuals, and number of individuals for each species encountered (N = 12; parentheses indicate +/- 1 SE; captures of *Plethodon glutinosus* were too low for analysis).

	Diurnal				Nocturnal					
Species	Mean	Min	Max	Total	Mean	Min	Max	Total	t statistic	p-value
Species Richness	2.75 (0.30)	1	4	5	3.33 (0.31)	2	5	6	-1.63	0.13
Total Individuals	13.6 (1.81)	3	23	163	15.4 (2.30)	4	32	185	-1.13	0.28
Desmognathus fuscus	1.5 (0.77)	0	7	18	1.3 (0.62)	0	7	15	0.31	0.76
Desmognathus monticola	1.7 (0.61)	0	7	20	1.6 (0.50)	0	6	19	0.13	0.89
Desmognathus ochrophaeus	8.2 (1.53)	3	17	98	8.4 (1.34)	2	14	101	-0.11	0.92
Eurycea bislineata	1.8 (0.52)	0	5	22	3.4 (1.14)	0	15	41	-1.59	0.14
Gyrinophilus porphyriticus	0.3 (0.18)	0	2	3	0.3 (0.19)	0	2	4	-0.36	0.72
Plethodon glutinosus	0	0	0	0	0.1 (0.08)	0	1	1	NA	NA

TABLE 2. Model selection analysis and parameter estimates (+/- 1 SE) of occupancy (Ψ) and detection probabilities (p) for salamander taxa between diurnal and nocturnal salamander surveys (K, number of parameters; the two estimates in the p column for Ψ(.)p(SURVEY) models represent diurnal and nocturnal survey estimates, respectively).

Species	Model	-2log-likelihood	K	ΔAICc	Akaike weight	Ψ	SE(Ψ)	p	SE(p)
Desmognathus fuscus	Ψ(.)p(.)	35.61	2	0.00	0.71	0.83	0.34	0.44	0.21
	Ψ(.)p(SURVEY)	37.41	3	1.80	0.29	0.84	0.35	0.40, 0.50	0.22, 0.25
Desmognathus monticola	Ψ(.)p(.)	29.11	2	0.00	0.70	0.78	0.13	0.80	0.11
	Ψ(.)p(SURVEY)	28.77	3	1.66	0.30	0.78	0.13	0.75, 0.86	0.15, 0.13
Eurycea bislineata	Ψ(.)p(SURVEY)	20.82	3	0.00	0.60	0.83	0.11	0.80, 1	0.13, 0
	Ψ(.)p(.)	23.59	2	0.77	0.40	0.84	0.11	0.89	0.08
Gyrinophilus porphyriticus	Ψ(.)p(.)	23.93	2	0.00	0.70	0.52	0.34	0.40	0.28
	Ψ(.)p(SURVEY)	23.59	3	1.66	0.30	0.50	0.32	0.33, 0.50	0.27, 0.35

porphyriticus were best modeled with constant detection probabilities whereas *E. bislineata* was best modeled with detection probabilities that varied between the two surveys (Table 2). However, the ΔAIC values of both models for all species analyzed were less than two, which suggests that both models have considerable support (Burnham and Anderson 2002).

DISCUSSION

We found no significant differences in richness, abundance, or detectability between day and night surveys for adult and juvenile streamside salamanders in the immediate streambank. This contrasts with Orser and Shure (1975), who found that for *D. fuscus* nocturnal density estimates using mark-recapture were always higher than corresponding diurnal estimates. They suggested the reason for this difference was due to bias related to the extent to which marked animals remixed with unmarked animals after release. Hairston (1980) sampled salamanders active on the surface at night because flipping cover objects repeatedly would result in habitat degradation. Undoubtedly, salamanders are more active at night, and individuals from nearby cover objects may be moving laterally into a study area or vertically from the larger pool of individuals underground (Hairston 1980; Petranka and Murray 2001). This possibility may have introduced bias into Orser and Shure's estimates as the assumption of population closure (Krebs 1999) may have been violated.

These types of estimates (i.e., mark-recapture, removal sampling) for streamside salamanders are problematic because model assumptions are routinely violated (Petranka and Murray 2001; Strain et al. 2009). Most agencies may not employ such intense methods because the data are simply not robust enough to warrant the high cost of obtaining them. Of course, the choice of response variable depends on management or research objectives. Metrics such as species richness and counts of individuals in different age classes or of different tolerances to degradation, which are being used in the development and refinement of a streamside salamander index of biotic integrity (Southerland et al. 2004), can be obtained with a single visit and minimal habitat alteration. The results of the present study indicate that these visits can be done during the day or at night in the immediate streambank.

Moisture level is an important limiting factor for salamanders (Hairston 1949), and we may have observed no difference in captures between day and night because heavy shading along our streams resulted in negligible differences between diurnal and nocturnal moisture levels. Streamside salamander density is severely decreased in disturbed riparian habitats (Orser and Shure 1972; Price et al. 2006), and the remaining salamanders at a site may reduce their diurnal activity due to reduced moisture levels associated the loss of shade and cover. Because of this possibility, further investigation should be undertaken to determine

how applicable our results are to other regions, habitats, and land use types.

We suggest a potential mechanism behind similar counts of streambank-dwelling salamanders diurnally and nocturnally: activity levels of streamside salamanders may be higher at night, due to decreased temperatures and increased moisture levels (Hairston 1949), but abundance may not be, due partly to interspecific interactions. Individuals under the surface may be prevented from emerging by the presence of individuals already occupying surface habitats (Jaeger 1988; Jaeger et al. 1998; Southerland 1986a); this competition and predation avoidance presumably occurs throughout the day and night. Thus, counts of salamanders diurnally and nocturnally represent the surface population, and are both likely an underestimate of the subterranean superpopulation (Bailey et al. 2004a).

Salamanders are most likely never detected without error (Bailey et al. 2004b), and exploration of this topic should include the estimation of detection probabilities and temporary emigration probabilities (Bailey et al. 2004a). Our results agree with other studies that have found variable detection probabilities across species (Bailey et al. 2004b; Dodd and Dorazio 2004), but we also found indication that detection of individual species may not vary significantly between the day and night. More research is needed to confirm this.

Our study suggests the quality of data obtained from diurnal surveys of the immediate streambank may be similar to that of nocturnal surveys. However, the sample size in our study was small, especially for analyses pertaining to detection probability estimation (small vis-à-vis both number of sites and number of repeat visits; MacKenzie and Royle 2005), so this topic would greatly benefit from further research.

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Diet of Amethystine (*Morelia kinghorni*) and Carpet Pythons (*Morelia spilota*) in North Queensland, Australia

Diet plays a key role in the ecology of a species (Slip and Shine 1988a). An organism's feeding habits can directly affect life-history characteristics such as body size (Pearson et al. 2002; Shine 1991a), growth rates (Madsen and Shine 2000), life stage (Slip and Shine 1988a), thermoregulation in ectotherms (Ayers and Shine 1997), reproduction (Shine and Madsen 1997), population dynamics (Madsen et al. 2006), and activity patterns and habitat use (Heard et al. 2004; Madsen and Shine 1996). Knowledge of foraging ecology allows us to understand the niche a species occupies in a community (Shine 1991b), which in turn assists our understanding of prey population dynamics (e.g., prey behavior and resource use; Kotler et al. 1993). For instance, the role of snakes as predators may not only contribute to the control of rodent populations (Shine 1991a), but may also lead to severe declines in prey species (Wiles et al. 2003). However, although the feeding habits of snakes vary with geographical location and latitude (Luiselli 2006), most studies of snake ecology have focused on temperate species (see references in Vitt 1983). As a consequence, there are few substantial studies on the diet of tropical python species, and scientific research on the ecology of the giant snakes of the tropics, particularly Australia, is considerably lacking (Fearn et al. 2005; Shine and Slip 1990).

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Fearn et al. 2005; Shine and Slip 1990).

Morelia kinghorni Stull, 1933 (formerly *Morelia amethistina* [Schneider, 1801]), is Australia's largest snake (total length up to 6 m, with unconfirmed reports of 8 m; Fearn and Sambono 2000; Wilson and Swan 2008). *Morelia spilota* (Lacépède, 1804) is a relatively common tropical and subtropical python species that reaches a total length of 2.5 m (Wilson and Swan 2008), although some variants can reach 3 m (Slip and Shine 1988b). While the behavior and habitat use of both species are well-documented (e.g., Fearn et al. 2005; Freeman and Bruce 2007; Freeman and Freeman 2009; Slip and Shine 1988b,c), accounts of diet are either largely anecdotal (*M. kinghorni*: Bickford 2004; Fearn 2002; Fearn et al. 2005; Martin 1995; Turner 2001), or geographically limited (*M. spilota*: Fearn et al. 2001; Shine 1991b; Shine and Fitzgerald 1996; Slip and Shine 1988a).

In this study we investigated the diets of these two python species in Northeast Queensland. We collected roadkilled specimens, examined them for stomach or fecal contents, and recorded any incidental observations of feeding. We used these data to answer several questions: 1) What is the diet composition of *M. kinghorni* and *M. spilota*? 2) What is the relationship between snake size and prey size and does this relationship differ between the two species? Knowledge of this relationship provides a basis for conjecture on the factors influencing predation in these species, such as gape size, capture ability, and prey encounter rates (Shine 1991b). 3) Do the species differ in their consumption of native versus non-native prey species? Predation on native versus non-native prey species provides some indication of the extent to which these pythons exploit human-modified habitats (e.g., *M. spilota:* Fearn et al. 2001) versus native rainforest (e.g., *M. kinghorni:* Freeman and Bruce 2007; Freeman and Freeman 2009). Consumption of a variety of non-native prey, for instance, would suggest that the predator was capable of exploiting human-modified environments where such prey thrive (Shine et al. 1999a,b).

MATERIALS AND METHODS

Study area.—We conducted our sampling in the Wet Tropics Bioregion of Northeast Queensland, which extends 450 km from Cooktown (15.4667°S, 145.2667°E) in the north to Townsville (19.2500°S, 146.7500°E) in the south. The majority of records were collected from Cardwell (18.2719°S, 146.0350°E) to the northern suburbs of Cairns (16.8967°S, 145.7161°E) and the adjacent Atherton Tablelands, with one outlier at the Bloomfield River (15.9353°S, 145.3417°E). This region supports the largest area of tropical rainforest in Queensland, and although much of

it has now been fragmented or cleared for agriculture and grazing on the tablelands and lowlands, large tracts still remain on the slopes of the uplands (Tracey 1982). The Wet Tropics experience a humid tropical climate with distinct wet (between November and April) and dry (between May and October) seasons, and an average temperature range from 24 to 33°C in the wet season and from 14 to 26°C in the dry season (Trott et al. 1996).

Sampling.—We used data on the diet of *M. kinghorni* and *M. spilota* collected over an 11-year period (2000–2010). These included dietary records from both species identified through incidental sightings and roadkilled individuals studied by Freeman and Freeman (2009) or collected in 2010, and also of radio-tracked *M. kinghorni* studied by Freeman and Bruce (2007). We did not force the regurgitation of prey for any snakes nor massage snakes for fecal samples; such samples were collected opportunistically when snakes were held for measuring or transmitter insertion. For all records, the snake species, date, and identity of the prey item were recorded. For the majority of sightings and roadkilled snakes, we recorded position with a handheld Garmin global positioning system (GPS), sex, snout–vent length (SVL), total length (TL), and body mass. Some records were obtained as reports of reliable sightings from other observers, so not all records included all of these parameters. Sex was determined for 77% of samples by probing the cloaca for the presence or absence of hemipenes. SVL was determined by running a string along the backbone of the snake from the snout to the vent, and cutting and measuring the string. Tail length was measured in a similar manner. Mass was measured using a Pesola™ spring balance. Stomach samples of roadkilled snakes, and stomach and/or fecal samples of observed snakes were collected and preserved in a 70% ethanol solution until ready for analysis. These samples were rinsed with water and placed in paper bags in a drying oven (65°C) for 12–24 h. Dried samples were stored in paper bags. Bones and largely intact prey specimens were stored as wet samples in 70% ethanol.

Dietary analysis.—Whole prey items obtained as unforced regurgitations from observed snakes were identified to species using van Dyck and Strahan (2008). Hair samples were analysed using the software Hair ID 1.0 program for Australian mammals (Triggs and Brunner 2002). This program uses four key features of mammalian hair for hair identification: the hair profile, the pattern and shape of the medulla, as well as of its cross-section, and the pattern of the cuticle. These characteristics are used in combination and matched to those of the species in the Hair ID program to determine the identity of the prey animal. Most specimens were also sent to Georgeanna Story of "Scats About" (Majors Creek, NSW) for confirmation of identification.

Statistical analyses.—Each individual prey item identified was treated as an independent feeding record. When a single snake had consumed multiple prey items, such as a radiotracked individual that consumed prey items on several different occasions, we treated each item as a separate feeding record, each accompanied by the same data for that individual snake except for the different date and location. If both stomach and feces from an animal contained the same prey species on a single sampling occasion, we treated it as a single record on a single date. If there were two separate species, however, these were treated as separate feeding records for that individual for that date. For all other cases where only a single prey item was identified, we assumed that only one item had been consumed.

Data analyses were performed using JMP v. 7.0 (SAS Institute, Inc., Cary, NC). To investigate the relationship between snake SVL and mammalian prey size, we performed a linear regression on SVL and the natural log of estimated prey mass. Estimated prey masses were obtained from van Dyck and Strahan (2008), and were calculated as follows: where average mass of the species for the prey item was specified, that value was used as the estimated prey mass; if a mass range was given for each sex of the species, we combined the ranges and used the average of the lowest and highest values, regardless of sex; and if an average mass was specified for males and females of a prey species, we used the average of those two values as the estimated prey mass. We note that estimated prey mass does not account for the high variability among the masses of individuals within a species. However, this is all that is possible when using scats as data. It avoids forced regurgitations by live animals of prey items that may not be accurately weighed due to high digestion rates (Bedford and Christian 2000). To determine if the relationship between SVL and prey mass was the same for both snake species, we performed an ANCOVA on the natural log of prey mass with species as a factor and SVL as the covariate. To assess whether python sex influenced this relationship, we also ran an ANCOVA with sex as a factor and SVL as the covariate on the subset of samples (N = 40) for which sex was determined.

We used chi-squared analyses to compare species in their consumption of native vs. non-native species. These tests were performed three times: once using all prey records, once for mammal prey items only, and once using only prey items from snakes for which we had SVL measurements. The three separate tests were done to check for a potential effect of possible prey misidentification, which would be least likely in data collected from measured snakes, which had their stomach contents confirmed via hair identification. The results were the same in all three analyses.

RESULTS

The identity and frequency of prey records for *M. kinghorni* (N = 23) and *M. spilota* (N = 29) are shown in Table 1. There were three records of non-mammalian prey; two instances of *M. kinghorni* feeding on Domestic Chickens (*Gallus gallus*), and one of *M. spilota* feeding on a Bourke Parrot (*Neopsephotus bourkii*) and the eggs of house canaries. These are not considered further in this paper. Feeding records of *M. spilota* consisted mainly of rodents (N = 24, 83% total prey items), primarily House Mice, *Mus musculus* (N = 10, 34% total prey items), whereas those of *M. kinghorni* contained a high frequency of larger marsupials (N = 14, 61% total prey items). These were primarily Red-legged Pademelons (*Thylogale stigmatica*), Northern Brown Bandicoots (*Isoodon macrourus*), and Long-nosed Bandicoots (*Perameles nasuta*).

There was a significant positive relationship between SVL and the natural log of estimated prey mass ($F_{1,35}$ = 35.4, P < 0.0001, R^2_{adj} = 0.489; Fig. 1). ANCOVA showed that the slope of this relationship did not differ between the two species (Interaction term: F = 0.887, df = 1, P = 0.353; Fig. 1), nor did it differ between sexes when species were pooled (Interaction term: F = 0.091, df = 1, P < 0.765). Snout-vent length of measured snakes ranged from 155–316 cm (mean = 258.9, SD = 16.0) in *M. kinghorni* (for sexed males: 208.5–316 cm, N = 10; females: 190–313.5 cm, N = 5) and from 94.5–225.5 cm (mean = 135.2, SD = 5.2) in *M. spilota* (for sexed males: 103–173 cm, N = 7; females: 94.5–225.5 cm, N = 18).

Finally, there was no relationship between snake species and prey origin (χ^2 = 1.401, P = 0.237, N = 55, df = 1). Both species

took similar proportions of native (*M. kinghorni*: N = 18, 72%; *M. spilota*: N = 17, 56.7%) and non-native (*M. kinghorni*: N = 7, 28%; *M. spilota*: N = 13, 43.3%) prey, representing a total of 35 native (63.6%) and 20 non-native (36.4%) prey items.

Table 1. Prey items identified from stomach and fecal samples, as well as observations of feeding, of *Morelia spilota* (MS) and *Morelia kinghorni* (MK) in northeast Queensland. The origin (N = native, NN = non-native) and number of feeding records are given for each prey item in order of decreasing estimated prey mass. Non-mammalian prey items were excluded from the prey size analysis.

Prey	Estimated prey mass (g)	MS	MK	Origin
Agile Wallaby (*Macropus agilis*)	15000	0	2	N
Red-legged Pademelon (*Thylogale stigmatica*)	4600	0	6	N
Domestic Cat (*Felis catus*)	4000	0	1	NN
Brushtail Possum (*Trichosurus vulpecula*)	2850	0	1	N
Northern Brown Bandicoot (*Isoodon macrourus*)	1600	2	1	N
European Rabbit (*Oryctolagus cuniculus*)	1580 (adult);	1	0	NN
	960 (juv)	1	0	
Long-nosed Bandicoot (*Perameles nasuta*)	925	0	4	N
Spectacled Flying-fox (*Pteropus conspicillatus*)	725	0	2	N
Black Flying-fox (*Pteropus alecto*)	725	0	1	N
Black Rat (*Rattus rattus*)	280	0	2	NN
Sugar Glider (*Petaurus breviceps*)	127.5	1	0	N
Canefield Rat (*Rattus sordidus*)	118	7	0	N
Eastern Chestnut Mouse (*Pseudomys gracilicaudatus*)	81.5	2	0	N
Fawn-footed Melomys (*Melomys cervinipes*)	76	2	0	N
Grassland Melomys (*Melomys burtoni*)	75	2	0	N
Pale Field Rat (*Rattus tunneyi*)	66	0	1	N
Tree Mouse (*Pogonomys* sp.)	66	1	0	N
House Mouse (*Mus musculus*)	16.5	10	2	NN
Domestic Chickens (*Gallus gallus*)		0	2	NN
Bourke Parrot (*Neopsephotus bourkii*)		1	0	NN
House canary eggs		1	0	NN

DISCUSSION

The correlation between predator size and prey size in *M. spilota* and *M. kinghorni* is supported by a wide body of literature documenting a positive relationship between snake and prey size in various snake families (Godley et al. 1984; Shine et al. 1998; Voris and Moffet 1981), but not in all (Shine 1987; Shine et al. 1999a). While previous studies have found that larger *M. spilota* take larger prey items (Fearn et al. 2001; Pearson et al. 2002; Slip and Shine 1988a), our study is the first to explore relationships between the size of *M. kinghorni* and its prey. Shine (1991b) proposed several reasons for a positive correlation between predator size and prey size in snakes, including biases in encounter rates between predator and prey, in prey choice, in capture rate, or in prey-handling and swallowing ability. The potential for retaliation by large prey can also influence this predator-prey relationship (Bonnet et al. 2010). Although *M. kinghorni* tended to take larger prey than *M. spilota*, the latter also took a few large items (e.g., *Isoodon macrourus*) and *M. kinghorni* took several small rodents (e.g., *Mus musculus*). Moreover, within each species, there were cases in which individuals of nearly the same SVL took large and small prey (Fig. 1). These results suggest that the same prey items were available to both large and small snakes, and the trend may have been driven by the inability of small snakes to capture, handle, or swallow larger prey items, or additionally, by the inefficiency of large snakes in capturing small prey. However, Shine (1991b) concluded that the lack of large prey items taken by small *M. spilota* in his study was neither a result of limited gape size in small snakes (which consumed large prey items in the laboratory) nor of capture and handling ability (which is facilitated by constriction), but was rather an indication of active prey size selection. Furthermore, *Pseudechis porphyriacus*, which consumes small prey across all body sizes (Shine 1991b), were not gape-limited but selected smaller prey because they consumed such items more efficiently (Shine 1991b). Thus, *M. spilota* and *M. kinghorni* individuals in our study may have been actively selecting prey sizes that allowed for most efficient consumption.

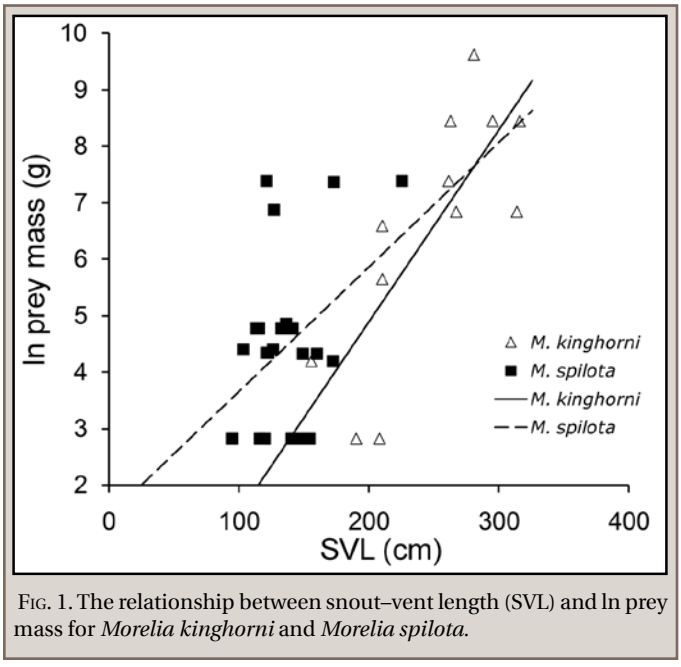


Fig. 1. The relationship between snout–vent length (SVL) and ln prey mass for *Morelia kinghorni* and *Morelia spilota*.

Our results showed no indication that either species selected more native or non-native prey. Therefore we cannot conclude that one species appears to use more artificial or natural habitats than the other species. Although these results may have been a reflection of the relatively small sample size, for *M. spilota* this is consistent with observations of this species in both urban and natural habitats. *Morelia spilota* has been previously documented to consume both native and non-native prey (Fearn et al. 2001; Shine and Fitzgerald 1996), including invasive non-native species (e.g., rabbits: Myers et al. 1989). Versatility in diet has been found in other species; for instance, in suburbia *Python sebae* prey upon animals such as dogs, goats and poultry, while in natural habitats they prey upon various mammals and reptiles (Luiselli et al. 2001). In Asia, smaller *Python reticulatus* individuals benefit from human habitat modification that increased rodent density (Shine et al. 1999b). Similarly, *Python*

brongersmai has successfully exploited disturbed agricultural habitats (Shine et al. 1999a). However, the consumption of both native and non-native prey by *M. kinghorni* is somewhat surprising given its preference for closed canopy rainforests and vine thickets (Freeman and Bruce 2007; Freeman and Freeman 2009). Freeman and Freeman (2007) suggested a preference in *M. kinghorni* for bandicoots (*I. macrourus* and *Perameles nasuta*) and Red-legged Pademelons (*Thylogale stigmatica*), while Fearn et al. (2005) reported regurgitations of a bird, a Bush Rat (*Rattus fuscipes*) and two Northern Brown Bandicoots (*I. macrourus*). But *M. kinghorni* has also been found, to a lesser degree, in sclerophyll forests and open habitats (Freeman and Freeman 2007, 2009), and has occasionally been observed to consume household pets or other non-natives in human environments (Bateman 2010; Squires 2008).

This study provides important initial insight into the feeding ecology of these python species in the Australian Wet Tropics. It forms the basis for more detailed research that is needed to elucidate their foraging ecology and predator-prey relationships, particularly with regard to *M. kinghorni*. Although we found no effect of sex on the relationship between python size and prey size in both species, future studies should obtain much larger sample sizes and more rigorously examine the potential role of sexual dimorphism in the feeding ecology of each species (Fearn et al. 2005; Pearson et al. 2002). Additional questions for future research include: Does either species prefer certain prey items when offered different items in an experimental setting? Do the two species compete for prey? What role do they play in the control of non-native species as suggested by their consumption of non-native species (e.g., *M. musculus*)? Available habitat and dietary data suggest that *M. spilota* may confer a significant economic benefit to farmers in rural Australia through predation on non-native species and on high-density populations of rodents (Shine and Fitzgerald 1996), thus removing agricultural pests. Conversely, incidental feeding observations of *M. spilota* suggest that introduced fauna, such as the Cane Toad (*Bufo marinus*) may have a negative impact on populations of their snake predators (Covacevich and Couper 1992; Shine 1991a). Studies investigating prey selection would be particularly useful in elucidating the role of these pythons as biological controls of non-native species. Future studies could estimate prey abundance and compare these data to the frequency with which prey species are eaten. These studies would also provide information on whether dietary differences in two species are in fact due to unequal distribution of prey items in the environment (Pearson et al. 2002), and whether prey selection influences body size. Answers to these important questions will further our understanding of the significance of these snakes as predators in the tropical rainforest ecosystem and of their place in regional conservation efforts.

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Measuring Body Lengths of Preserved Snakes

Preserved museum specimens of snakes offer an important source of information on morphology (e.g., scalation, body proportions) and ecology (gut contents, reproductive traits) (Plummer 1985; Shine 1989; Shine and Slip 1990). To interpret variation in such traits, it is important to know the overall body size of the specimen. Investigators working on live snakes have long recognized the need to standardize measurement techniques, because the elasticity of a live animal's body can introduce substantial error into any estimate of body length (especially for large muscular snakes: Madsen and Shine 2001; Blouin-Demers 2003; Setser 2007). Intuition suggests that such issues should be minor for preserved snakes, because they lack elasticity. Nonetheless, our studies on preserved snakes have revealed surprisingly large discrepancies between measurements of body length, suggesting that investigators need to carefully consider (and explain) their methods of quantifying this variable. The present paper was motivated by recent re-measurement of specimens of two python species (*Morelia viridis* and *Leiopython albertisii*) held in the collections of the Australian and Queensland Museums, that had been measured 27 years earlier. The two sets of measurements differed considerably from each other (and from sizes predicted by head-body size allometries in live snakes), with significant consequences for estimating traits important in conservation (e.g., minimum body size at maturity).

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Methods.—Eighteen *Morelia viridis* and 10 *Leiopython albertisii* in the collections of the Australian and Queensland Museums were measured by D. J. Slip and RS in 1984, and by DJDN in 2010. Many of the specimens were coiled and stiff, making it impossible to straighten them for measurement against a ruler. Thus, both sets of investigators measured SVLs (snout–vent lengths) by using a non-elastic string to trace the spine (DJDN) or the ventral midline (DJS and RS) and measuring the resulting length against

a steel ruler. Digital calipers were used to measure the length of the head from the tip of the snout to the base of the skull.

To clarify the relationship between measured lengths of preserved snakes versus live animals, we can compare the relative sizes of body components whose dimensions may be affected by preservation (e.g., SVL) to elements unlikely to be affected (e.g., head length). Thus, DJDN also made field measurements on 205 live *Morelia viridis* and 100 live *Leiopython albertisii* captured in Australia and West Papua, Indonesia. To measure SVL one researcher restrained the head while another held the snake by placing a hand either side of the cloaca and gently stretching the body along a steel ruler. Each snake was allowed to stretch and contract until it was relaxed and fully stretched. We used calipers to measure head lengths, as for preserved specimens.

Results.—The two sets of measurements of the museum specimens were highly correlated ($r^2 = 0.85$, $P < 0.001$), but the earlier set averaged 22% (range 2–56%) lower than the recent measurements. In both sets of measurements, the SVL was lower relative to head length than expected from our data on live snakes (paired t-tests, all P-values < 0.001).

Discussion.—Measuring the body length of a preserved snake seems like a simpler task than measuring a live animal, but our data show remarkably high levels of divergence between investigators, and suggest that neither set of measurements provided estimates as high as the body length of a live animal. In his study of preservation effects on length measurements, Reed (2001) reported errors of up to 27%; our study found much larger errors (of up to 56%) of the body length of some snakes. The divergence among investigators cannot be attributed to continued shrinkage over time, because the disparities were too great, and unrelated to the length of time since the animal was first collected (unpubl. analyses). Neither can the disparities be attributed to imprecision on the part of one set of investigators, because the two sets of measurements were highly correlated with each other (and were equally highly correlated with head lengths). The shorter lengths obtained by measuring along the ventral (rather than dorsal) midline may reflect a lack of clear morphological indicators (unlike the protuberant ridge of the spine), thus encouraging investigators to "cut corners" across highly coiled parts of the snake's body.

So long as measurement techniques are consistent, any given study (or related studies by the same investigator) should not be severely affected by this methodological issue. However, it will be difficult to compare the results of studies conducted by different investigators using different methods. The other problem arises when data from studies on museum specimens are extrapolated to the field, to make conservation recommendations about free-living animals. For example, Slip and Shine (1990) reported minimum sizes at sexual maturation of *Morelia viridis* to be 84 cm and 99 cm SVL in males and females, respectively. The conservation-focused analyses of Wilson and Heinsohn (2007) and Natusch and Natusch (2011) used these body-length measurements to estimate the number of mature individuals in a wild population. Re-measured by DJDN, the same animals had SVLs of 114 cm and 123 cm, suggesting that analyses based on the earlier (shorter) lengths would overestimate the number of adults in a population of this species (which has an average adult SVL of 120 cm; DJDN, unpubl. data).

What can we do to minimize such errors? We suggest that investigators should carefully compare the results of measurements using slightly different methods, and ideally should compare their estimates to the same measurements taken on live animals (either by measuring animals before versus after preservation, or by comparing allometric relationships between SVL and other body components [head size, tail length] less liable to error or to modification by preservation techniques). Even apparently trivial differences in methods of measurement may result in unacceptably high levels of error in SVL estimates. Having decided on a consistent method, investigators should describe that method in any publications. The growing availability of online data repositories also should make it easier for investigators to lodge their actual length measurements with specimen registration numbers, thereby allowing future studies to evaluate the magnitude of any measurement discrepancies.

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Intraspecific Density Dependence in Larval Development of the Crawfish Frog, *Lithobates areolatus*

The Crawfish Frog, *Lithobates areolatus*, is listed as state-endangered or rare in six of the 12 states within its range. Prior to 1970, *L. areolatus* were locally plentiful, but has declined markedly since that time (Minton 2001; Parris and Redmer 2005). Reasons for their decline are not well understood, but have been attributed to habitat loss, disease, introduction of predators, and failed juvenile recruitment (Palis 2009; Parris and Redmer 2005). Because of its secretive nature, we lack critical information on *L. areolatus* life-history and population demographics. A fundamental component to population stability is that recruitment equals mortality. Due to limited resources, larval-amphibian recruitment is affected by larval density (e.g., Altwegg 2003; Scott 1994). Overcrowding can delay or inhibit larval development (Adolph 1931; Morin 1986; Parris et al. 1999), resulting in increased mortality rates by predation (Caldwell et al. 1980; Travis et al. 1985), or desiccation from inadequate hydroperiods in breeding ponds (Rowe and Dunson 1995; Seigel et al. 2006). Parris and Semlitsch (1998) examined *L. areolatus* density dependence in artificial tanks and reported that interspecific competition reduced larval performance. They also examined intraspecific competition, but did not find a significant relationship between *L. areolatus* density and any of their response variables (i.e., body mass, larval-period length, survivorship; Parris and Semlitsch 1998). Therefore, the relationship between *L. areolatus* larval performance (i.e., growth and survivorship) and intraspecific larval density is not well understood. Further, the degree that density affects *L. areolatus* larval development in natural ponds is unknown. Although artificial tanks (as in Parris and Semlitsch 1998) provide insight on cause and effect relationships, field enclosures placed directly in breeding ponds include relevant environmental factors and incorporate greater realism (Semlitsch and Boone 2010; Semlitsch and Bridges 2005).

Thus, to better understand how larval-stage density affects juvenile recruitment in *L. areolatus*, we examined cohort density (i.e., intraspecific) dependence on size and time characteristics of larval development using field enclosures placed in five known *L. areolatus* breeding ponds, and one potential breeding pond. Our objectives were (1) to examine the extent at which metamorphosis was delayed or inhibited in high density treatments, and (2) to examine the efficacy of field enclosures as a management tool for repatriation efforts of *L. areolatus*. We hypothesized that larvae in low-density treatments would metamorphose earlier, and would be larger than high-density treatments. We also hypothesized that field enclosures would dramatically increase the survival rate in *L. areolatus* larvae, compared to natural populations, and would provide a valuable tool for managing this declining species.

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Methods.—We selected six temporary ponds on Big Oaks National Wildlife Refuge (located in southeastern Indiana, USA), for our study ponds. The ponds had similar size and depth characteristics (<0.15 ha, and <1 m deep). Five of the six ponds were known crawfish frog breeding ponds (i.e., male frogs were observed calling during previous breeding seasons). In each pond we placed two 378 L field enclosures (76.2 cm × 41.9 cm × 121.9 cm; Apogee, Dallas, Texas 75244, USA) side-by-side, in 20–30 cm of water. Field enclosures were orientated with the long end in the north–south direction. We placed 200 g (wet weight) of *Andropogon virginicus* (Broomsedge Bluestem) in each field enclosure for larval food and substrate. We collected the *A. virginicus* from a single site and then randomly placed it within each enclosure.

We collected one *L. areolatus* egg mass from a breeding pond at Big Oaks National Wildlife Refuge on 3 April 2010. To introduce larvae to the field enclosures we acclimatized them using a three-step process. First, we held the egg mass in a plastic circular pool (diameter = 1.2 m, depth = 15 cm), near the collection site from 3–9 April 2010. We did this to allow the larvae to disperse from the egg mass. Second, after the larvae dispersed (9 April 2010), we divided the larvae into six groups of approximately equal numbers of individuals and moved each group to plastic circular pools located within 5 m of each of our study ponds. The plastic pools were filled with water collected from their respective study pond. We held them in plastic pools near the study pond to allow larvae to acclimatize to the different water chemistry and to grow large enough to be held in the field enclosures. Third, on 4 May 2010, we haphazardly selected larvae with approximately the same size and vigor (i.e., the speed and amount of travel within the pools) for the field enclosures. Larvae were placed in one of two different field-enclosure treatments: low density (20 larvae), and high density (60 larvae); thus, we had 480 total larvae in our experiment.

The treatments were randomly assigned to the field enclosures with one low-density and one high-density treatment in each pond. Prior to being placed in the field enclosures, we measured the volume of each larva using water displacement, and estimated it to be negligible (mean difference <0.01 mL) between treatments and among ponds. Thus we had 12 total field enclosures that included six replicates of two treatments. One of our replicates was destroyed during rain runoff on 12 May 2010. We selected another study pond that was a known *L. areolatus* breeding site and added two more field enclosures with larvae on 14 May 2010. Although this replicate was initiated 10 days after our initial replicates, we followed the same protocols to introduce larvae to the treatments and therefore included it in our study. We monitored field enclosures twice weekly to remove dead larvae and to identify stages of metamorphosis. After the first frog completed metamorphosis (i.e., Gosner Stage 45 or 46; Gosner

1960), we began to monitor field enclosures daily to release frogs that completed their metamorphosis. We released frogs within 2 m of the field enclosures. We measured the mass and snout-vent length of larvae after they completely metamorphosed. We also recorded the date of complete metamorphosis. Additionally, to estimate body condition, we fit a linear regression equation between mass and snout-vent length and used the residuals.

We compared the mass, snout–vent length, date of metamorphosis of frogs, survival, and the relative body condition between the two treatments using paired 2-sample t-tests. We examined the relationship between larval mass at metamorphosis and time of metamorphosis by fitting a linear regression equation. We fit this equation at three different levels: (1) all of the combined data, (2) the pooled density estimates (low and high) for each pond (to compare a pond effect), and (3) to the pooled pond estimates for each density (to compare a density effect). We examined the regression coefficient for the slope to assess if there was a relationship between the size of the juveniles and the date they completed metamorphosis.

To examine for potential differences between ponds we measured pond chemistry and temperature weekly. We measured pond chemistry (ammonia, nitrate, nitrite, iron, dissolved oxygen, pH, sulfate, and phosphorus) using a colorimeter (LaMotte Company, Chestertown, Maryland 21620, USA). We measured pond temperature on the south side of the field enclosures. We randomized the time and the order we visited ponds. We compared pond chemistry and temperature of all the sample ponds using a single-factor analysis of variance for each metric. Additionally, we tested all metrics simultaneously using a multivariate analysis of variance (MANOVA), in which our sample ponds were the groups, and the chemistry metrics were the dependent variables.

Results.—Two hundred twenty-eight of the original 480 juvenile *L. areolatus* survived and were released from our field enclosures (overall survivorship = 48%); 85 of 120 were released from the low-density treatment, and 143 of 360 were released from the high-density treatment. The mean survival percentage in field enclosures was 68% (s = 18%) in low-density treatments and 38% (s = 29%) in high-density treatments, although this difference was not significant (t-test: P = 0.11, t = 1.89, df = 5). Two hundred fifty-two died in the field enclosures. Fifty-nine of these 252 died later in the summer after three of the six study ponds completely dried. All 59 were in high density treatments. Mean snout–vent length of larvae in the low-density treatment was 2.57 cm (s = 0.23 cm) and was 1.14 times longer (t-test: P = 0.0045, t = 4.89, df = 5) than the high density treatment ($\overline{x}$ = 2.26 cm, s = 0.22 cm). Mean mass of larvae in low-density treatments was 1.36 g (s = 0.35 g), and was 1.42 times larger (t-test: P = 0.013, t = 3.75, df = 5) than larvae in high-density treatments ($\overline{x}$ = 0.98 g, s = 0.25 g). Larvae emerged 17 days earlier (t-test: P = 0.0023, t = -5.70, df = 5) in low density treatments ($\overline{x}$ = 13 July 2010, s = 13 days) than high density treatments ($\overline{x}$ = 30 July 2010, s = 10 days). There was no difference in the body condition between treatments (t-test: P = 0.81, t = -0.25, df = 5); the mean residual distance for low-density treatments was 0.01 g (s = 0.06 g) and high-density treatments was 0.02 g (s = 0.07 g). The replicate with the earliest emergence dates, and largest juveniles for both the low- and high-density treatments was located in the one pond that had no record of *L. areolatus* calling.

None of the pond chemistry metrics or temperatures differed among ponds (ANOVA: P > 0.05; df = 5, 86; MANOVA: P = 0.22; approx. F = 1.24; df = 5, 65). The mean values of the pooled spatial and temporal chemistry data were: ammonia = 0.54 ppm (s = 0.66 ppm); nitrate = 0.11 ppm (s = 0.15 ppm); nitrite = 0.00 ppm (s = 0.02 ppm); iron = 1.86 ppm (s = 1.74 ppm); dissolved oxygen = 4.80 ppm (s = 2.48 ppm); pH = 5.83 (s = 0.81); sulfate = 5.04 ppm (s = 7.37 ppm); and phosphorus = 0.12 ppm (s = 0.26 ppm). The mean water temperature was 27.62°C (s = 3.28°C). There did not appear to be a strong relationship (P > 0.05) between mass-at-metamorphosis and date-of-metamorphosis at any of the three levels of data we examined (i.e., all data pooled, data pooled within each pond, data pooled within each treatment).

Discussion.—Our results suggest that *L. areolatus* larval development is affected by intraspecific density, and that these effects might have consequences for *L. areolatus* fitness. When reared in high-density treatments, larvae had smaller masses and snout–vent lengths, but did not have a significant increase in body condition (suggesting the change in size was not a trade-off from fat/lipid storage to structural growth; Perrin and Sibly 1993; Scott et al. 2007; Werner 1986). These results are consistent with patterns described for intraspecific competition in other anurans (Alford 1999). In other species, larval size at metamorphosis is positively correlated with adult size, and inversely correlated with the number of years until sexual maturity (Altwegg and Reyer 2003; Semlitsch et al. 1988; Smith 1987). If the same correlation exists in *L. areolatus*, low density ponds that produce larger juveniles may positively affect population growth because (1) frogs may reach sexual maturity faster, and (2) adults may be larger, thereby producing more eggs during reproduction (Redmer 1999). Therefore, adult lifetime fitness would be affected by larval densities; low larval densities would produce fitter adults.

In addition to size characteristics, our data suggest that high intraspecific density extends *L. areolatus* development periods in natural ponds. Extended development periods can have severe consequences for *L. areolatus* because they generally select temporary breeding ponds with abbreviated hydroperiods. Population growth and larval success depend on the appropriate larval-period length relative to the hydroperiod of the breeding pond (Semlitsch et al. 1996). Fifty-nine *L. areolatus* larvae died from desiccation in three different sample ponds after the ponds completely dried; all were in high-density treatments. Similar results may occur in natural ponds, where at some minimum hydroperiod length, there is a maximum density level, after which, increased densities will increase mortality. This is particularly important during drought years when the number of breeding ponds is reduced and higher concentrations of breeding adults use the same pond.

Increased *L. areolatus* larval-period length has been shown to be positively correlated with interspecific competition (Parris and Semlitsch 1998). Parris and Semlitsch (1998) identified the poor interspecific competitive performance of *L. areolatus* as a possible explanation for their low frequency and small population size in natural communities. Our results support the hypothesis that larval competition is affecting population size and distribution because, in addition to being poor interspecific competitors, larvae in our sample were negatively affected by intraspecific competition. Thus, competition may be limiting recruitment, and therefore population levels.

Although our data provided evidence for density-dependent effects, it is important to note that they were based on one egg mass, and therefore our sample contained little genetic variation. Differences in genetic variation are associated with differential responses by anurans to insecticide (Bridges and Semlitsch 2000; Semlitsch et al. 2000) and acid tolerance (Pierce and Sikand

1985). Likewise, increased genetic variation might facilitate differential response to overcrowding by increasing niche variation, thereby reducing resource competition (Benard and Middlemis Maher 2011). Therefore, if increased genetic variation causes differential response to intraspecific density, our results may be limited. Semlitsch and Bridges (2005) proposed a hierarchical approach, incorporating individual-level, population-level, and geographic-level genetic variation in studies on ecotoxicology. A similar study design would better describe the role of genetic variation in intraspecific competition.

Our study suggests that *L. areolatus* larvae grow and survive better when raised at low densities. However, our experimental design did not allow us to identify the critical density level at which larval development is inhibited. Further examination of a gradient of densities would better describe the relationship between density and growth, which would allow managers to maximize the number of frogs produced per unit area when using field enclosures. Additionally, examination of other environmental variables (e.g., food availability) may identify the mechanism that inhibits growth in high densities of *L. areolatus*. Our study did provide evidence that using field enclosures for repatriation may be an effective management tool for *L. areolatus* (when breeding habitat is not limiting) because it has the potential to dramatically increase juvenile survival when compared to survival in natural ponds (e.g., *L. areolatus* survival in a natural pond in southwestern Indiana was 0–2.3%; V. Kinney, Indiana State University, unpubl. data). However, further research comparing long-term survival of frogs raised in field enclosures to frogs raised in natural populations would better estimate the effect of repatriation on population recruitment.

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Growth and Activity of *Sceloporus cowlesi* (Southwestern Fence Lizard)



FIG. 1. Drift fence of a trap array installed in the riparian forest along the middle Rio Grande in Valencia County, New Mexico containing native cottonwoods (*Populus deltoides wislizenii*) and exotic saltcedar (*Tamarix* spp.)



FIG. 2. Ventral view of male *Sceloporus cowlesi* captured in the riparian forest along the middle Rio Grande, Valencia County, New Mexico.

Lizards from the *Sceloporus undulatus* complex have been the subject of many studies on lizard ecology (Hager 2001; Rosenblum 2006; Rosenblum et al. 2007), behavior (Hein and Whitaker 1997; Robertson and Rosenblum 2009), and reproduction (Vinegar 1975; Robertson and Rosenblum 2010). However, genetic data (Leaché and Reeder 2002) support reallocation of the subspecies of the *S. undulatus* complex (e.g., *S. undulatus consobrinus*, *S. u. tristichus*, and *S. u. cowlesi*) as distinct species (e.g., *S. consobrinus*. *S. tristichus*, and *S. cowlesi*). One of these species, *S. cowlesi*, occupies a variety of terrestrial habitats spanning grasslands to montane conifer forests (Jones and Lovich 2009) over its range from central New Mexico to southwest Texas. Females lay eggs between mid-May and mid-August and clutch sizes vary from 7 to 9 eggs (Degenhardt et al. 1996). However, since much of the research on natural history of this species was published under the former species name, *S. undulatus*, there is little specific information on *S. cowlesi* from New Mexico. The purpose of this study was to estimate growth and seasonal activity for individuals marked from a population of this species in New Mexico.

Materials and methods.—We conducted the study in the riparian forest along the middle Rio Grande in Bernalillo, Valencia, and Socorro counties, central New Mexico, USA. The climate in this region is semiarid to arid (Tuan 1962). Our study sites occurred in forests (Fig. 1) containing native cottonwood (*Populus deltoides wislizenii*) and non-native saltcedar (*Tamarix chinensis* and *T. ramosissima*) and Russian Olive (*Elaeagnus angustifolia*). As part of a larger project to evaluate the effects of removal of non-native plants and fuels on herpetofauna (Bateman et al. 2008), we monitored relative abundance of lizards at 12 sites (approximately 20 ha each) spanning 140 km of river from Albuquerque (35.008380°N, 106.681805°W) to Bosque del Apache National Wildlife Refuge (33.805122°N, 106.859980°W) from 2000 to 2006.

We captured lizards using trap arrays of drift fences, pitfall traps (5-gallon, 18.9 liter buckets) with cover boards, and funnel traps. Except for a shortened trap season of only two months in 2000 to establish study sites, traps were open continuously from June to mid-September each year and were checked three days per week. Lizards were identified (by species and sex), weighed, measured (SVL and VTL), given a unique toe clip (Waichman 1992), and released.

Results.—During the seven-year study, we had 5,183 captures of 2,470 individual *S. cowlesi* (Fig. 2). Of the total captures, 41.6% occurred in pitfall traps, and 58.2% occurred in funnel traps. Lizard length (SVL and VTL), mass, and sex were determined for adults, hatchlings, and juveniles (Table 1). *Sceloporus cowlesi*

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hatchlings were active in May when we opened traps and the number of captures peaked during the beginning of September when traps were closed (Table 2). Conversely, adult activity in terms of total captures, showed an earlier trend, with peak activity at the beginning of June (Table 2).

Over 40% of marked lizards were recaptured and most sightings occurred during the summer of marking. For example, 270 lizards were recaptured within the summer of their first capture, 70 were recaptured two summers later, 14 were recaptured three summers later, and four were recaptured four summers later. One individual was recaptured five summers later. From these histories of recapture, we determined that growth rates were similar between male and female *S. cowlesi* (Fig. 3). Lizards reach adult size by their second summer, although some individuals attained 60 mm SVL at the end of their first summer (Fig. 3).

Discussion.—Growth curves for male and female *S. cowlesi* were similar, with hatchling and adult females having slightly larger SVLs than their male counterparts. Although sceloporine lizards can grow quickly after hatching (Sinero and Adolph 1994), females may not reproduce until the following year. For example, studies in Colorado found that female *S. undulatus* can attain reproductive sizes during their first summer a few months after hatching but do not reproduce until the following season (Ferner 1976; Gillis and Ballinger 1992). In this study, we documented that individual male and female lizards could reach > 50 mm SVL in their first season, corroborating results of previous studies demonstrating rapid growth in the first year. However, we could not determine reproductive status of these individuals in their second year. Interestingly, our average SVL for adult *S. cowlesi* is about 15 mm shorter than reported in Jones and Lovich (2009).

Ferguson and Snell (1986) reported that in the lab, second clutch hatchlings of *S. undulatus* had greater mass compared to hatchlings from a first clutch. In our study, hatchlings captured in June had SVL > 40 mm and hatchlings captured in August had SVL < 30 mm. However, because hatchlings captured in June were

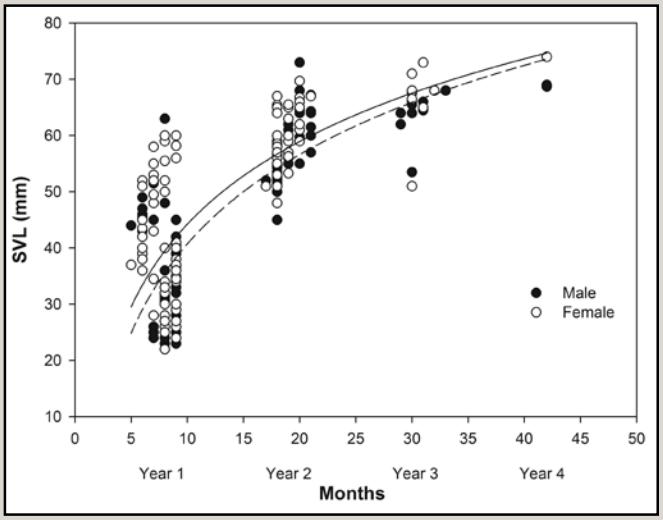


FIG. 3. Growth of male and female *Sceloporus cowlesi* captured as hatchlings from the riparian forest along the middle Rio Grande in central New Mexico. Months represent the number of months in four years, with months 0, 6, and 12 representing January, June, and December of Year 1, month 18 as June of Year 2, month 30 as June of Year 3, etc. Snout–vent length (SVL) of lizards is known from recaptures of uniquely marked individuals (63 males and 53 females) first encountered as hatchlings from 2000-2006. Individuals occur more than once in figure. Lines are fitted with a logarithmic curve (dashed line, $R^2 = 0.66$ for male; solid line, $R^2 = 0.56$ for female).

TABLE 1. Mean (±SE) of morphological characteristics of *Sceloporus cowlesi* captured during 2000–2006 from the riparian forest along the middle Rio Grande in central New Mexico, USA. Data are summarized by captures of individuals < 3 g mass (hatchlings) and > 3 g mass (juveniles and adults). Because the data include recaptures, individuals may be represented more than once in the table. Number of captures (N) may vary because some lizards escaped before all measurements were recorded; therefore SVL, VLT, and mass may have different sample sizes.

	Hatchling (< 3 g)				Juvenile, Adult (> 3 g)			
Sex	N	Mean SVL (mm)	Mean VTL (mm)	Mean Mass (g)	N	Mean SVL (mm)	Mean VTL (mm)	Mean Mass (g)
Female	341/341/342	29.3 (± 0.32)	37.2 (± 0.57)	0.8 (± 0.03)	2071/2070/2059	62.4 (± 0.15)	79.9 (± 0.33)	7.8 (± 0.07)
Male	365	29.8 (± 0.34)	37.9 (± 0.65)	0.9 (± 0.03)	2295/2291/2281	60.3 (± 0.13)	79.6 (± 0.35)	7.0 (± 0.04)
Unknown	11	30.1 (± 2.03)	33.8 (± 4.39)	0.9 (± 0.21)	5/5/4	43.8 (± 9.46)	59.6 (± 13.48)	7.0 (± 2.29)

TABLE 2. Capture activity, including mean and range for SVL, of hatchling (< 3 g) and adult (> 3 g) *Sceloporus cowlesi* from the riparian forest along the middle Rio Grande in central New Mexico. Data are summarized by captures per time period for each year from 2000 to 2006. Individuals may occur more than once in table.

	Hatchling (< 3 g)			Adult (> 3 g)		
Time Period	N (% of total)	Mean SVL (mm)	Range SVL (mm)	N (% of total)	Mean SVL (mm)	Range SVL (mm)
1–15 June	19 (3.2%)	43.3	36–48	1149 (27.1%)	60.2	41–80
16–30 June	7 (1.2%)	42.9	36–51	1077 (25.4%)	60.8	43–80
1–15 July	2 (0.3%)	34.0	24–44	419 (9.9%)	60.2	46-79
16–31 July	28 (4.7%)	26.5	22–36	507 (11.9%)	61.0	25–79
1–15 August	112 (18.8%)	25.7	21–34	343 (8.1%)	62.6	23–78
16–31 August	207 (34.7%)	27.5	21–45	442 (10.4%)	63.6	21–78
1–15 September	222 (37.2%)	30.0	21–45	306 (7.2%)	63.5	25–79

likely hatched in May when traps were not yet open, we cannot directly compare sizes of early and late season hatchlings. Little is known of field longevity for *S. cowlesi*; however, during a two-year study in Texas, Tinkle and Ballinger (1972) found that *S. undulatus* (presumably *S. consobrinus* based on distribution) rarely survived to their second growing season. From the 116 hatchlings recaptured at least one time during the period of study, only two individuals were captured during their fourth growing season, or three years later.

Because of the classification change of small-bodied sceloporine lizards (Leaché and Reeder 2002), less is known about specific natural history characteristics of *S. cowlesi*, which occupies a smaller range compared to other members of the *S. undulatus* complex. Therefore, our results provide important natural history data for growth rates, longevity, and activity patterns of *S. cowlesi*. These data can offer future comparisons of sceloporine lizards from different geographic regions and species.

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Feeding Analysis of *Hylarana cf. labialis*, *Leptobrachium hendricksoni*, and *Occidozyga laevis* (Amphibia: Anura) from a Lowland Dipterocarp Forest in Kedah, Malaysia

A knowledge of diet and feeding ecology is crucial to the understanding of life histories, population fluctuations, and the impact of habitat modification on frog populations (Anderson et al. 1999). Frogs are generally opportunistic feeders that target moving prey crossing their line of vision, though the size of their chosen prey is limited by their gape width (Toft 1981). Frogs are known to prey on a wide spectrum of invertebrates including annelids, arachnids, centipedes, millipedes, molluscs and especially insects (Anderson et al. 1999; Dietl et al. 2009; Hirai and Matsui 2000, 2002; Ibrahim and Nurul 2008; Santos et al. 2004; Solé et al. 2009).

Malaysia is among the "hot spots" for tropical diversity in the Indo-Malayan region and well-known for its varied and abundant assemblage of flora and fauna (Ibrahim and Nurul 2008). The Banjaran Bintang mountains in northwestern Malaysia, the

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TABLE 1. Weight (g), snout–vent length (SVL), and gape width (GW) of the frogs collected.

Species	Number of individuals	Weight (g)	Weight (g) Mean ± SD	SVL (mm)	SVL (mm) Mean ± SD	GW (mm)	GW (mm) Mean ± SD
Hylarana cf. labialis	11	1–6	3.6 ± 2.1	20.9–53.3	37.0 ± 10.8	6.4–28.6	13.6 ± 6.3
Leptobrachium hendricksoni	30	1–10	3.9 ± 2.7	8.4–34.2	34.2 ± 8.4	8.7–22.9	13.0 ± 3.9
Occidozyga laevis	22	1–7	2.9 ± 1.9	17.0–42.9	26.2 ± 6.3	4.9–19.0	8.5 ± 3.1
TOTAL	63						

TABLE 2. Stomach contents of the frogs collected, the frequency of occurrence of the prey item (Fi), and niche breadth. N = number of individual, ni = number of stomachs, A = percentage (%).

Taxon Class: Order: Family	*H. cf. labialis* N = 11		*L. hendricksoni* N = 30		*O. laevis* N = 22		
	ni	A	ni	A	ni	A	Fi
Insecta							
Blattodae							
Blattellidae	0	0	2	6.3	0	0	4.44
Termitoidae	1	10.0	1	3.1	2	14.3	8.89
Coleoptera	0	0	5	15.6	1	7.1	13.33
Diptera							
Culicidae	1	10.0	0	0	0	0	2.22
Unidentified	1	10.0	3	9.4	0	0	8.89
Hymenoptera							
Formicidae	1	10.0	4	12.5	4	28.6	20.00
Unidentified	2	20.0	1	3.1	0	0	6.67
Lepidoptera	0	0	2	6.3	0	0	4.44
Orthoptera	2	20.0	0	0	1	7.1	6.67
Arachnida							
Araneae	0	0	2	6.3	1	7.1	6.67
Oligochaeta							
Haplotaxida	0	0	0	0	1	7.1	2.22
Other							
Plant	0	0	2	6.3	0	0	
Mineral	1	10.0	5	15.6	0	0	
Unidentified	1	10.0	5	15.6	4	28.6	22.22
Empty	2	-	8	-	8	-	
Niche breadth (B)		8.33		15.97		8.16	
Total stomachs (63)							
Total stomachs with contents (45)							

TABLE 3. Organisms collected in 1 m^2 of forest floor litter of Gunung Inas Forest Reserve.

Class	Order	Family	No. of individuals	Percent of total
Insecta	Blattodea	Blattellidae	1	2.0
		Termitoidae	2	4.1
	Hymenoptera	Formicidae	14	28.6
		unidentified	3	6.1
	Coleoptera		11	22.4
	Diptera		2	4.1
	Orthoptera		1	2.0
	Embioptera		3	6.1
Arachnida	Araneae		5	10.2
	Pseudoscorpionida		1	2.0
	Subclass: Acari		1	2.0
Diplopoda			1	2.0
Chilopoda			4	8.2
Total			49	100

location of our study site, is known to harbor 43 species of amphibians (Grismer et al. 2010).

There are few publications on the diet of Malaysia frogs. We aim to (1) determine the prey items of the three abundant species of frog at the study site: *O. laevis*, *H. cf. labialis* and *L. hendricksoni*, (2) determine the dominant diet composition of these species, and (3) associate the food items of the species with their microhabitat and feeding strategies.

Materials and methods.—This study was conducted in Compartments 15 and 16 of the Gunung Inas Forest Reserve, Kedah Darul Aman (5.4197°N, 100.7997°E; Fig. 1) which are composed mainly of lowland dipterocarp forests from ca. 150 to 200 m above sea level (Ibrahim and Nurul 2008). The total forest cover of the whole Gunung Inas Forest Reserve is 37,346 ha. Sampling of frogs was carried out either weekly or fortnightly from 28 July 2009 until 6 January 2010. A plot sampling method was employed from July until October 2009 during the day from 1400 h to 1700 h. After October 2009, transect sampling was used in an effort to increase the number of individuals caught. Most sampling was conducted along a hiking track leading up to Gunung Bintang, and was carried out between 2000 h and 2200 h. Frogs were most often caught by hand, but sometimes with the aid of tools, such as nets and poles. Total search effort was 188.5 person-hours. The ambient temperature on a single representative day was 28°C at 1600 h, and 26°C at 2000 h. The average monthly cumulative rainfall was 261 mm, with an average daily rainfall of 12 mm during the rainy period from August to October, and 3 mm during drier months (Anon. 2010). The forest floor was almost wholly covered by leaf litter, and the leaf litter mass from a single representative 1 m^2 of forest floor was 1917 g, and the litter depth was 5 cm. Invertebrates on the forest floor were collected by sieving and the Tullgren funnel method (Sakchoowong et al. 2007).

Frogs were identified based on Berry (1975) and the species names were updated according to Frost (2011). Frogs were categorized into adult and subadult according to their snout–vent length (SVL). Males were identified based on the presence of vocal sacs. We used the adult SVL ranges of Berry (1975) to assign individuals to adult or sub-adults. *L. hendricksoni* males were identified as adult above 40 mm and females above 50 mm; *O. laevis* males were considered adult at above 20 mm and females at above 30

mm; for *H.* cf. *labialis*, males were considered adults at above 32 mm SVL and females above 44 mm SVL.

Frogs were euthanized with an injection of 70% benzocaine before 10% percent formalin was injected into their stomachs, to minimize digestion activities and to preserve stomach contents. SVL and gape width (GW) were measured using Vernier callipers to the nearest 0.1 mm. Frog body weight was measured using Acculab VI-400 digital scale to the nearest 1 g. Stomachs were then removed and dissected according to the standard procedure of frog dissection (Walker 1967). Stomach contents were washed with distilled water and then observed under a light microscope to identify the prey items. Stomachs were categorized as empty, or containing: unidentified item, plant, mineral, Arachnida, Oligochaeta, and/or nine groups within the Insecta (Blattellidae, Termitoidae, Culicidae, unidentified Diptera, Formicidae, unidentified Hymenoptera, Lepidoptera, and Orthoptera). Taxonomic identification of invertebrate prey items follows White and Borror (1970) and Hickman et al. (2008). Stomach content analyses performed were the Numerical Methods (Hyslop 1980), frequency of occurrence (Lima-Junior and Goitein 2001) and niche breadth using Simpson's index of diversity (Pianka 1973).

Results and discussion.—This study provides the first data on the diet of *Occidozyaga laevis, Leptobrachium hendricksoni*, and *Hylarana cf. labialis* from Malaysia. A total of 63 individual frogs were examined, comprising 11 *H. cf. labialis*, 30 *L. hendricksoni*, and 22 *O. laevis*. Of these, only 9 *H. cf. labialis*, 22 *L. hendricksoni*, and 14 *O. laevis* had prey items in their stomachs. The degree of digestion of the stomach contents ranged from freshly eaten to amorphous substances. Six male and five female *H. cf. labialis* were sampled, and among them were three sub-adults (SVL ≤ 30 mm). The 14 male and 16 female *L. hendricksoni* sampled consisted mostly of juveniles and sub-adults, as 24 of them had a SVL ≤ 40 mm. Of the 16 male and seven female *O. laevis*, only one was classified as sub-adult (SVL = 17 mm). Summary statistics for body weight, SVL and gape width in sampled frogs are shown in Table 1.

Diet composition varied among the three species studied (Table 2). The dominant prey of *H. cf. labialis* are insects. Other items found were mineral, such as a piece of stone, which most probably was incidentally ingested during prey capture (e.g., Santos et al. 2004). There were four main insect groups that *H. cf. labialis* fed on, namely Hymenoptera (30.0%), Diptera (20.0%), Orthoptera (20.0%), and Blattodea (10.0%) (Table 2). The high frequency of hymenopterans found in *H. cf. labialis* may simply be associated with the fact that Hymenoptera dominates the vegetation fauna of tropical lowland rain forests (Floren et al. 2002), and *H. cf. labialis* is likely to be a generalist feeder. Indeed, the availability of prey in the habitat is an important element for predators with a limited feeding territory (Dietl et al. 2009).

The stomach contents of *Leptobrachium hendricksoni* contained a wide variety of food items, mainly insects (56.3%), but also other terrestrial invertebrates, such as Araneae (6.3%) (Table 2). The dietary composition of *L. hendricksoni* and the large niche breadth value (B = 15.97) indicate that it feeds on a variety of preys items in similar proportions as found in the environment, and is therefore a generalist feeder. This correlates with the findings of Dietl et al. (2009) in another leaf-litter frog, *Ischnocnema henselii* in *Araucaria* rain forests on the Serra Geral of Rio Grande do Sul, Brazil, which is also a generalist feeder. Observations during this study suggest that *L. hendricksoni* is a cryptic "sit-and-wait" predator. *L. henricksoni* is a wide-mouthed predator, with an average gape width approximately 40% of its body length. Therefore, it is possible for *L. hendricksoni* to ingest



FIG. 1. Map showing location of our study site in Gunung Inas Forest Reserve, Kedah Darul Aman, Malaysia.

larger invertebrates, including large arachnids, homopterans, orthopterans, and coleopterans. In one *L. hendricksoni* stomach, a stone measuring 8.6 mm was found in a frog with GW of 9.1 mm. The sharp edge of the stone had cut through the stomach of the frog. It is not known if the ingestion of this stone was accidental or intentional feeding. Although consumption of plant material was recorded, *L. hendricksoni* should not be considered omnivorous, as plant material comprised less than 10% of the stomach contents (Cooper et al. 2002), and we believe that the plant material was likely ingested incidentally with prey.

We found that the *O. laevis* at our study site were insectivorous, with ants the dominant prey item (28.6%) (Table 2). Our results differ from those of Ates et al. (2007), who recorded the main diet of *O. laevis* in Terminalia Forest, Mindanao Island, Philippines being hemipterans, items not recorded by us in *O. laevis*. The likely explanation for this is differences in microhabitat and associated invertebrate fauna at study sites (Table 3). Hemipterans are few on the forest floor in localities where *O. laevis* were caught during this study (Yap and Ibrahim, pers. obs).

Dietary composition did not vary considerably among species, perhaps as all three species were observed to forage within a few meters of each other. The small difference in the prey items observed may reflect fine-scale difference in the microhabitat use. *Hylarana cf. labialis* were observed at lower levels on trees and shrubs, and the main prey items of *H. cf. labialis* can be obtained easily in this microhabitat (Floren et al. 2002). Although the microhabitat of *O. laevis* includes aquatic habitat such as shallow pools and muddy puddles, our study showed that the main dietary components of *O. laevis* were terrestrial arthropods. This finding corresponds with the study of Solé et al. (2009) that terrestrial invertebrates usually dominate the diet of most frogs even in aquatic or semi-aquatic species. Our results indicate that data on diet composition can support ecological and behavioral field studies (Toft 1981).

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A Quantitative Comparison of Two Common Amphibian Sampling Techniques for Wetlands

Obtaining reliable survey data is critical for amphibian conservation and management. Many techniques are established for collecting quantitative survey data, including call surveys, pitfall arrays, drift fences, box sampling, seining, dipnetting, and aquatic funnel traps (Heyer et al. 1994; Skelly and Richardson 2010). Multiple techniques are often used in management and research to account for different species and life stages (Ryan et al. 2002). These techniques can be passive (pitfalls, aquatic traps, call recording) or active (seining, dipnetting, searches).

In lentic habitats, the most widely used sampling technique is dipnetting (Shaffer et al. 1994), an active sampling technique. Dipnetting is often standardized by unit effort such as time or number of dipnet sweeps. Another common technique for surveying aquatic amphibians is funnel trapping (Heyer et al. 1994), which is passive. Many types of aquatic funnel traps, both commercially available and hand-made, have been used and evaluated, including those made from galvanized wire (Fronzuto and Verrell 2000), collapsible nylon mesh (Adams et al. 1997), and-PVC pipe with acrylic plastic sheeting (Smith and Rettig 1996). Augmentations to funnel traps such as aquatic fences (Willson and Dorcas 2004) and net leads (Buech and Egeland 2002) have also been implemented. Both dipnetting and funnel trapping provide capture-per-unit-effort estimates of relative density (Skelly and Richardson 2010), but differ in terms of action (passive vs. active), cost, and time investment. Crosswhite et al. (1999) compared multiple active and passive sampling methods for terrestrial reptiles and amphibians and found that passive methods captured the greatest number of individuals while active methods were the most efficient in terms of time cost. Few studies have compared active and passive aquatic techniques, but Gunzburger (2007) found that species richness was larger when using passive methods in aquatic habitat.

We compared the efficacy of a standardized dipnetting protocol with aquatic funnel trapping for capturing amphibians in 19 ridge-top ponds in the Daniel Boone National Forest (DBNF), Kentucky. We evaluated each pond using both techniques and surveyed for one, three-day period per month, May–August 2010. Dipnet sweeps were taken every five meters while walking

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the edge of each pond and the mean number of sweeps per pond ranged from 2.8–20.8. A sweep consisted of guiding a d-frame net in a 180-degree arc from the shoreline while jabbing the net into the detrital substrate. Each pond had 1–2 aquatic minnow trap arrays installed that consisted of two traps (4 mm mesh size, 46 × 26 × 26 cm dimensions, 6 cm openings) (Promar, Gardena, California; US $8.99 [TR-501]) placed on either side of an aquatic drift fence that extended perpendicularly to the pond's shoreline (Willson and Dorcas 2004). The number of traps per pond followed Adams et al. (1997): two traps (one trapping array) were placed for every estimated 25 m^2 of littoral zone. The two largest ponds (612 m^2, 440 m^2) were more than twice the area of the third largest pond (207 m^2), and two trap arrays were installed at these two ponds. The cumulative number of individuals of a species captured during a single, three-day sampling period was used as an index of abundance of that species for the month. All individuals were immediately released unmarked. We did not mark individuals because of our focus on comparing the number of captures, not the number of unique individuals. Six of the nineteen ponds sampled did not hold standing water during one or more of the sampling periods, so amphibian data from these ponds were based on fewer than three sampling events. We performed Wilcoxon signed-rank tests to compare abundance values between the two survey methods for each life stage detected of each species (Quinn et al. 2007).

The total number of captures from each method was large (minnow traps = 5435, dipnetting = 4281) and 13 species were detected (Table 1, Fig. 1). Adults of *Hyla chrysoscelis* (Cope's Gray Treefrog) and *Pseudacris crucifer* (Spring Peeper) were only detected by minnow traps, whereas larvae of *Lithobates palustris* (Pickerel Frog) and *Hemidactylium scutatum* (Four-toed Salamanders) were only detected by dipnetting. Twelve of the 13 species captured were detected at either larval or adult life stage by both methods and Four-toed Salamanders were only detected by dipnetting. Generally, dipnetting captured more caudate larvae than minnow trapping, a similar result to a previous comparison of dipnetting and funnel trapping in streams (Willson and Dorcas 2003).

Seven different technique comparisons were significantly different (Wilcoxon Sign-Rank Test, $\alpha = 0.05$; Table 1). Minnow trapping, a passive technique, was significantly more effective at capturing adult *L. clamitans* (Green Frogs) and adult *Notophthalmus viridescens* (Red-spotted Newts). Dipnetting, an active technique, was significantly more effective at capturing larval *H. scutatum*, larval *Ambystoma maculatum* (Spotted Salamanders), larval *A. jeffersonianum* (Jefferson Salamander), larval *P. crucifer*, and larval *N. viridescens*.

Some capture biases may be a product of a particular species' behaviors or morphology. Generally, those species caught in larger numbers using minnow traps were bigger and more mobile than those caught in larger numbers using dipnetting. Alternatively dipnetting may also be the preferred method for species like *H. scutatum*, which are difficult to catch in traps due to their small size, low breeding output, and relatively low larval activity pattern (Harris 2005).

Notophthalmus viridescens were often found in traps breeding in large numbers, most likely due to chemical cues released by females that attract males for reproduction (Dawley 1984), suggesting that species using chemical cues to identify potential mates may be efficiently caught using passive traps. However, if only one sex responds to the attractant, there may be a bias in the sex ratio captured. Trapping was inappropriate for species such as *Anaxyrus americanus* (American Toads), *P. crucifer*, and *H. scutatum*, which were often small enough to move through the mesh of the minnow traps, but large enough to be captured by the mesh in the dipnets. This study also suggests the difficulty in capturing adult, large frogs using dipnetting, likely due to the combination of their tendency to quickly jump away when startled and the speed with which they swim.

Because abundances for some species and life stages were not different between techniques, our study indicates that for such species (Table 1, Fig. 1), decisions about which techniques to use can be based on amount of time and equipment available to the researcher. Dipnetting is more efficient in terms of equipment and time and would often be the preferred method. However, as we have shown for a number of species, a species' attributes and life stage can bias its probability of capture by a given survey method. Hence, the behavior, size, and other aspects of life history should be considered before choosing a sampling technique.

Overall, our results reinforce the need to make species-specific decisions during the evaluation of surveying protocols. Conclusions based on aquatic trapping data alone would underestimate the abundance of ambystomatid salamanders and

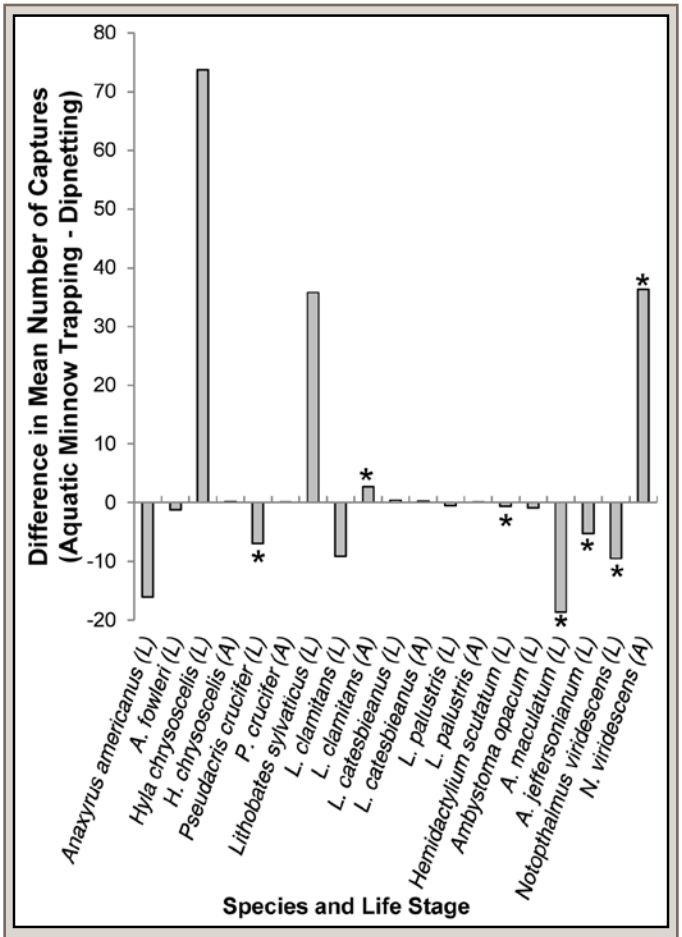


Fig. 1. Difference in mean number of amphibian captures (aquatic minnow trapping - dipnetting) from 19 ponds in the Daniel Boone National Forest, Kentucky, May–August 2010. Positive bars indicate more individuals captured using minnow trapping and negative bars indicate more individuals captured using dipnetting. Asterisks represent significant comparisons of mean number of captures between aquatic minnow trapping and dipnetting techniques using Wilcoxon sign-rank tests (Table 1). Life stage: A = adults, L = larvae.

TABLE 1. Mean abundance (mean no.) and standard error of 13 amphibian species by life stage among 19 ridge-top ponds in the Daniel Boone National Forest, Kentucky, May–August 2010.

	Aquatic Minnow Traps			Dipnetting			Wilcoxon[b]	
Species	n[a]	mean no.	SE	n[a]	mean no.	SE	Z	P
Anaxyrus americanus - Larvae	2	1.58	1.33	2	17.63	14.35	-1.34	0.180
An. fowleri - Larvae	2	0.32	0.23	3	1.47	1.21	-0.45	0.655
Hyla chrysoscelis - Larvae	8	84.42	77.77	7	10.68	4.51	-0.53	0.594
H. chrysoscelis- Adults	2	0.11	0.07	0	0.00	0.00	-1.41	0.157
Pseudacris crucifer - Larvae	2	0.79	0.60	6	7.68	3.69	-2.20	0.028
P. crucifer - Adults	1	0.05	0.05	0	0.00	0.00	-1.00	0.317
Lithobates sylvaticus - Larvae	4	135.26	76.74	4	99.47	59.57	-1.46	0.144
L. clamitans - Larvae	11	4.47	1.19	11	13.53	6.48	-1.51	0.130
L. clamitans - Adults	12	2.95	1.18	4	0.21	0.10	-2.85	0.004
L. catesbeianus - Larvae	8	5.16	2.02	9	4.74	1.68	-0.26	0.798
L. catesbeianus - Adults	3	0.37	0.23	2	0.11	0.07	-1.29	0.197
L. palustris - Larvae	0	0.00	0.00	2	0.47	0.38	-1.34	0.180
L. palustris - Adults	3	0.16	0.09	1	0.11	0.11	-0.38	0.705
Hemidactylium scutatum - Larvae	0	0.00	0.00	6	0.58	0.28	-2.26	0.024
Ambystoma opacum - Larvae	5	2.05	1.14	3	2.89	2.42	-0.27	0.768
Am. maculatum - Larvae	15	13.68	3.51	16	32.26	8.73	-3.07	0.002
Am. jeffersonianum - Larvae	14	3.00	0.83	13	8.21	2.55	-2.73	0.006
Notopthalmus viridescens - Larvae	8	3.84	1.68	12	13.31	7.49	-2.94	0.003
N. viridescens - Adults	17	48.32	13.63	13	11.95	2.82	-3.62	<0.001

[a.] Sample sizes (n) represent the number of wetlands of the 19 total where the indicated species and life stage were detected.
[b.] Wilcoxon paired sample test Z values and probabilities are from individual comparisons of each species and life stage by capture method.

overestimate the abundance of *N. viridescens*, and conclusions based on dipnetting alone would underestimate the abundance of *L. clamitans* adults. Hence, when evaluating amphibian populations, it is appropriate to include measures of detection probability to strengthen conclusions from count data (Dodd and Dorazio 2004). Additionally, this study supports the use of active and passive survey methods together when developing long-term monitoring of entire amphibian communities as well as providing evidence supporting active or passive survey methods chosen for a specific species or life stage.

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Cephalopod Ingestion by Juvenile Green Sea Turtles (*Chelonia mydas*): Predatory or Scavenging Behavior?

Immediately after emerging from eggs on sandy beaches, most sea turtle hatchlings disperse into the sea to enter a pelagic life-phase that may last several years (Meylan and Meylan 1999). During this stage, individuals are believed to associate with convergent oceanic fronts which accumulate floating structures (e.g., debris or algal mats such as *Sargassum* or *Macrocystis*; Nichols et al. 2001) that concentrate small pelagic animals (Carr 1987). Recent studies on the diet of post-hatchling Green Sea Turtles (*Chelonia mydas*) in the Pacific Ocean found no evidence of the association of this species with algal mats, but confirmed the importance of pelagic organisms in the diet of these animals (Boyle and Limpus 2008; Parker et al. 2011).

Asides from young turtles, pelagic ecosystems are comprised of many other organisms, including roaming predators like tuna, billfish, sharks, and dolphins (Dambacher et al. 2010). Oceanic cephalopods (e.g., squids) are also important components of pelagic food chains and serve as food for most of these predators (Clarke 1996; Croxall and Prince 1996; Klages 1996; Smale 1996) as well as for opportunistic scavengers (Croxal and Prince 1994). Because Green Sea Turtles seem to act as opportunists during their open ocean stage of life (Boyle and Limpus 2008), cephalopods might constitute as a complementary food source to their normal diets of cnidarians, gastropods, and crustaceans (Boyle and Limpus 2008; Parker et al. 2011).

Pelagic cephalopods have already been reported in the Green Sea Turtle's diet (e.g., Parker et al. 2011; Seminoff et al. 2002). For example, Parker et al. (2011) considered the presence of fisheries-caught squids in the diet of oceanic Green Sea Turtles as evidence of opportunistic feeding by the turtles on fishing-gear catches. However, implications of these observations and other possible explanations of how turtles may eat pelagic cephalopods have remained poorly discussed topics in the literature.

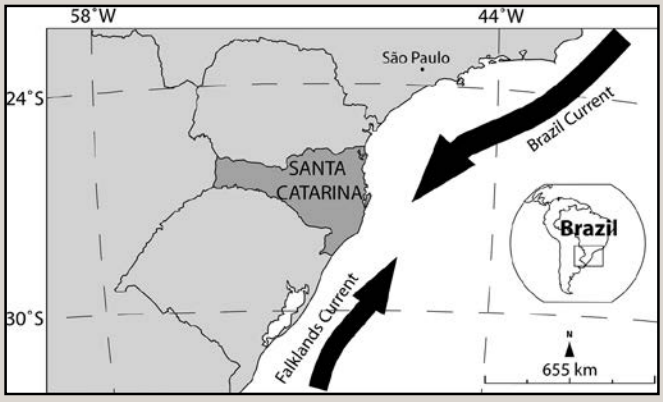


FIG. 1. Map of south Brazil indicating Santa Catarina state (dark shading), and the two converging oceanic currents, Brazil Current and Falklands Current.

The southern region of Brazil (Fig. 1) suffers direct influence of the Subtropical Convergence, an encounter of the cold-water, nutrient-rich Falklands Current with the warm-water, oligotrophic Brazil Current (Castro and Miranda 1998). Hence, the region is the southern limit of occurrence of many tropical marine species, including fishes (Carvalho-Filho 1999) and mangrove trees (Sobrinho et al. 1969). Its rocky reefs, mangroves, estuaries, bays, lagoons, and oceanic waters are also important feeding grounds for marine turtles, especially the Green Sea Turtle, *Chelonia mydas* (Almeida et al. 2011; Bugoni et al. 2003; Guebert-Bartholo et al. 2011). The only genetic assessment of a coastal green turtle juvenile population from southern Brazil indicated a mixed stock population, composed mainly from the rookeries of Ascension and Aves islands (Proietti et al. 2009).

Here we report the occurrence of cephalopod beaks in the gastrointestinal tracts of stranded juvenile *Chelonia mydas* in South Brazil and discuss possibilities regarding when and how the turtles ingested the cephalopods. To achieve this objective we consider how life-history traits could have influenced the

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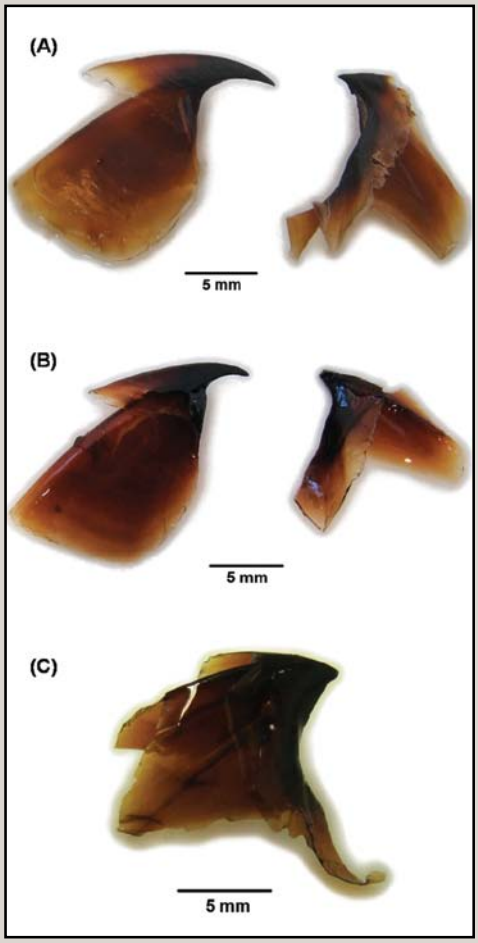


FIG. 2. Cephalopod beaks found in the guts of Green Sea Turtles in South Brazil. (A) Upper (left) and lower (right) beaks from *Chiroteuthis* sp. 1; (B) Upper and lower beak from *Chiroteuthis* sp. 2; (C) Lower beak from *Histioteuthis atlantica*. (©Roberta Santos).

possibility of these organisms coming into contact and whether this interaction occurred with the cephalopods alive (i.e., predation) or dead (scavenging).

Materials and methods.—A total of 27 Green Sea Turtles were found stranded along the coast of Santa Catarina State, southern Brazil, during a dietary study between 2006 and 2009. Gut contents were collected and dietary items were analyzed. Cephalopod beaks were encountered and singled out for this study. All beaks were identified at least to the genus level, based on beak morphology only, since there were no tissues remaining around any of the beaks (Fig. 2). Lower rostral length (LRL) and upper rostral length (URL) were measured to estimate the cephalopod's mantle length (ML, in mm) or ML and body mass (in g) using the regression equations of Clarke (1986) and Lu and Ickeringill (2002). All necropsied turtles had their curvilinear carapace length (CCL in cm) measured.

Results and discussion.—A total of 19 cephalopod beak pairs were found in the stomachs of three turtles and intestines of three others out of the 27 turtles analyzed (22%). Although some of them were cracked, most beaks were in relatively good condition and could be measured. All beaks pertained to six different morphospecies of squids (Cephalopoda: Teuthida) from two genera, *Chiroteuthis* (Chiroteuthidae) and *Histioteuthis* (Histhioteuthidae; Table 1). *Chiroteuthis* spp. had an average ML of 114.6 mm (SD 7.7 mm) and an average mass of 38.8 g (SD 8.0 g), according to the regression by Clarke (1986). *Histioteuthis* spp. had an average ML of 123.4 mm (SD 60.7 mm), although mass was estimated only for two individuals which were identified at the species level (Table 1), according to the regression by Lu and Ickeringill (2002).

The families Chiroteuthidae and Histioteuthidae are comprised of oceanic medium-depth to deep-water gelatinous squids (Young and Roper 1998; Young and Vecchione 2007). Both have ammonia-mediated fluctuation mechanisms (Voight et al. 1994), apparently undergoing ontogenetic and diel vertical migrations in the water column of offshore habitats (Roper and Young 1975). These animals are commonly found in the diet of pelagic predators such as tuna (Salman and Karakulak 2009), swordfish (Hernández-Garcia 1995), blue and short-fin mako sharks (Vaske-Júnior and Rincón-Filho 1998), petrels (Klages and Cooper 1997), albatrosses (Croxall and Prince 1994), and porpoises (Ohizumi et al. 2003). However, this is the first record of these families of cephalopods in the diet of Green Sea Turtles.

We hypothesize three possibilities regarding how turtles that ate oceanic cephalopods were found along the coast of Santa Catarina: 1) that turtles died while in the pelagic life-stage and were carried by oceanic currents to the shore; 2) that turtles were already recruited to the coast when they died, but the squids were ingested when they were still in the pelagic habitat; and 3) that these turtles manifest the uncommon life-history pattern in which individuals move constantly between coastal and pelagic habitats. This last pattern has recently been observed for Green Sea Turtles in the Pacific (Hatase et al. 2006; Parker et al. 2011; Seminoff et al. 2008) but so far there is no evidence that it may also occur in the South

TABLE 1. Information regarding cephalopod beaks found in the diet of stranded Green Sea Turtles in Santa Catarina, southern Brazil. CCL = curvilinear carapace length; ML = mantle length.

Individual	CCL (cm)	Gut region	Species identified	ML (mm)	Mass (g)
CT03	29.5	Stomach	*Chiroteuthis* sp. 1	–	–
			Chiroteuthis sp. 2	109.2	33.2
CT05	33	Stomach	*Histiotethis atlantica*	86.3	158.9
			Histioteuthis corona corona	79.6	137.3
CT08	23.5	Intestine	*Chiroteuthis* sp. 1	–	–
CT12	32.5	Stomach	*Chiroteuthis veranyi*	116.6	40.3
			Chiroteuthis veranyi	123.9	48.4
			Chiroteuthis veranyi	114.1	37.9
			Chiroteuthis veranyi	104.3	28.9
			Chiroteuthis veranyi	119.0	42.9
			Chiroteuthis veranyi	109.2	33.2
			Histioteuthis sp. 1	115.3	–
			Histioteuthis sp. 1	109.0	–
CT13	28.3	Intestine	*Histioteuthis* sp. 1	105.9	–
			Chiroteuthis veranyi	109.2	33.2
			Chiroteuthis veranyi	114.1	37.9
			Chiroteuthis veranyi	128.8	54.3
			Chiroteuthis veranyi	106.8	31.0
S/CT	–	Intestine	*Histioteuthis* sp. 1	244.1	–

Atlantic. Thus our discussion is based on the first two possibilities, of which the second one seems to be supported by two independent lines of evidence. First, cephalopod beaks are composed of chitin, which is almost indigestible to stomach acids, in contrast to the soft tissues that are rapidly digested; thus beaks may accumulate for months or years in the stomachs of vertebrates (Hernández-Garcia 1995). Therefore, these beaks might have accumulated in the turtles' stomachs while they inhabited pelagic waters, long before stranding. Second, the turtle's carcasses were not extensively decomposed, attesting that they died shortly before stranding.

Given that these squids were probably eaten before the turtles recruited to the coast, another question arises: whether these events occurred as scavenging or predation events? Other sea turtles, like the Loggerhead (*Caretta caretta*), are known to scavenge, for example, on dead fishes (Limpus et al. 2001; Limpus et al. 2008). Swimming organisms like fishes and squids have already been found in Green Sea Turtles' diets elsewhere (Bugoni et al. 2003; Parker et al. 2011; Seminoff et al. 2002) and in addition, this turtle species is known to opportunistically eat objects that float, as evidenced by the enormous amount of floating debris ingested by turtles in different places around the world (e.g., Guebert-Bartholo et al. 2011; Plotkin and Amos 1990). As a result, it is plausible that these animals, when inhabiting oceanic habitats, could eat floating carcasses of fishes or squids. It is noteworthy that squids from the families Chiroteuthidae and Histioteuthidae reproduce in large aggregations with post-spawning mass mortality (Jackson and Mladenov 1994; Rocha et al. 2001), circumstances in which they serve as an important food source for pelagic animals such as albatrosses (Croxall and Prince 1994). Whether or not these events result in floating dead squids at the surface is still unclear (Croxall and Prince 1994).

It is also important to consider the association of squids and sea turtles with commercial fishing practices in the open ocean. Individuals of *Histioteuthis* are relatively common by-catch in deep-water trawling operations in southeast and south Brazil (Perez et al. 2004) and may be discharged into the open sea. In addition, gut contents from eviscerated predatory fishes caught in long-lines may be a source of pelagic cephalopods for Green Sea Turtles (Vaske-Júnior and Rincón-Filho 1998). These fishes have the ability to dive deeply, swim rapidly, and locate prey and therefore are very efficient in capturing large numbers of pelagic squids (Hernández-Garcia 1995).

Regarding the possibility of predation, it is known that captive green turtles are capable of preying upon slow-swimming animals, such as cnidarians and ctenophores (Heithaus et al. 2002), injured fishes (G. O. Longo, pers. obs.), and even octopuses (Caldwell 2005). *Chiroteuthis* spp. and *Histioteuthis* spp. are slow-swimming squids with fragile muscles and bioluminescence (Young and Roper 1998; Young and Vecchione 2007). Despite inhabiting deep-waters during the day, during the night these organisms may be found in shallow waters (Roper and Young 1975). In fact, Green Sea Turtles are more active during the day (Hays et al. 2000, 2002), but there are records of nocturnal deep dives with unknown function (Rice and Balazs 2008) as well as records of individuals foraging at night (Jessop et al. 2002). This suggests that small juvenile Green Sea Turtles and pelagic squids might encounter one another during their lives and, therefore, that these cephalopods could be actively preyed upon by Green Sea Turtles.

Given the lack of information on the natural history of squid from the families Chiroteuthidae and Histioteuthidae and the pelagic life-stage of *Chelonia mydas* in waters of the Southwestern Atlantic, it is not possible to determine if individuals are scavenging or actively pursuing prey. We therefore suggest that studies focusing on the diet of Green Sea Turtles caught in oceanic fisheries (e.g., long-lines) and on the species foraging over eviscerated guts of fishes may yield important insights about the real importance of this interaction.

Pelagic deep sea squids are indispensable food sources for some marine pelagic predators (e.g., Clarke 1996; Croxall and Prince 1996). Although the number of analyzed turtles (27) is relatively small compared to the total number of stranded turtles in the region (147 animals from 2006 to 2009; Projeto TAMAR/ICMBio, unpubl. data), at least ten other non-analyzed dead or live in-treatment Green Sea Turtles had ingested cephalopod beaks, as noted during necropsies or examinations of feces for garbage (E. T. E. Yoshida, pers. comm.). Thus the described interaction might be common in the study region and we believe it could also occur in other parts of the southwestern Atlantic. If squids are commonly ingested through active predation or scavenging behavior, pelagic cephalopods may be an important energy and nutrient source for small juvenile Green Sea Turtles inhabiting oligotrophic waters.

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Seasonality of Algal and Leech Attachment on Snapping Turtles, *Chelydra serpentina*, in Southeastern Pennsylvania

The occurrence of algal colonies and leech parasites on North American semiaquatic and aquatic turtles seems to follow a seasonal cycle. It has apparently been assumed that algae attach to aquatic turtles throughout the year, although no data are available to substantiate this. Reports on algal attachment have dealt almost exclusively with the taxonomy and geographical distribution of the epizoophytic algae involved. The genus *Basicladia* is ubiquitous on several species of turtles in North America and the species *B. crassa* has been previously reported from *Chelydra serpentina* in Michigan, Minnesota, Oklahoma, and Texas/Mexico. A second species, *B. chelonum*, has been found on *C. serpentina* in Massachusetts, Michigan, Oklahoma, Texas/Mexico, and Nova Scotia (see references in Ernst and Barbour 1972, and Ernst and Lovich 2009; as well as Chute 1949; Garbary et al. 2007; Leake 1939, 1945; McCoy et al. 2007).

Leech parasitism and its seasonality in turtles have been reported from several localities on the continent and the genus *Placobdella* is ubiquitous on many aquatic and semiaquatic North American turtle species. The species of *Placobdella* involved are *P. ali, P. multilineata, P. ornata,* and *P. parasitica*. Watermolen (1996) presented an incomplete summary table of glossiphonid leech parasitism on North American turtles and Ernst and Barbour (1972) and Ernst and Lovich (2009) include references (see also Brewster and Brewster 1986; Davy et al. 2009; Richardson et al. 2010; and Ziglar and Anderson 2002).

Chelydra serpentina was studied in the vicinity of White Oak, Lancaster County, Pennsylvania, from 1964 to 1992 during March through October of each year. The research site is described in Ernst (1971b). Snapping Turtles were collected in baited hoop traps (Ernst 1965), with a dip net, or by hand. The date of each capture was recorded and the turtle was measured (greatest carapace length, CL; plastron length, PL), weighed to the nearest gram, aged by counting growth annuli, and sexed (Ernst and Lovich 2009). The incidence of algal colonies and leeches and the number of leeches attached were also recorded. Algae scrapings were preserved and later identified with a compound microscope in the laboratory using Prescott (1954); leeches were collected, fixed, and later identified in the laboratory with the use of a binocular microscope and keys and illustrations in Eddy and Hodson (1970). All turtles were notched for future identification (Ernst et al. 1974) and released at the point of capture. Air (AT), water (WT), and surface temperatures (ST, if on land) were also recorded with each capture. Statistical tests were executed using R, Version 2.12, with the level of significance set *a priori* at = 0.05. Presented below are the seasonal algae and leech attachments recorded on snapping turtles at White Oak.

Algae.—Only *Basicladia crassa* was found growing on *C. serpentina*. It was found solely on the carapace and occurred on 39% (110 of 280) of the total snapping turtles captured. Additional algae found attached to other turtles at White Oak include: *Basicladia chelonum* (*Chrysemys picta, Sternotherus odoratus*), *Basicladia crassa* (*Glyptemys muhlenbergii*), *Cladophora kuetzingiana* (*Chrysemys picta, Clemmys guttata, Glyptemys insculpta, Sternotherus odoratus* (Ernst 1969, 1976, 1986, 2001, 2011). The incidences of algal attachment on these White Oak turtles were: *Chrysemys picta*, 69%; *Clemmys guttata*, 46%; *Glyptemys insculpta*, 17%; *G. muhlenbergii*, 5%; and *Sternotherus odoratus*, 86%.

The annual activity cycle of *C. serpentina* at White Oak is March–October (Table 1), confirming that algae attach to the species throughout the year. However, fewer individuals had algae at either end of the annual activity period. Algae were found on the carapace, but not on the plastron, in increasing percentage from April through July. Afterwards, the incidence of colonies decreased with the approach of autumn into the winter months. Winter hibernation occurred while buried completely in the soft bottom of White Oak's pond and feeding creek and brooks. This suggests that decrease in light availability for algal colonies attached to turtles completely buried in a water body during the advancing autumn and winter may have played the major role in the disappearance of most algae during this period. That algae were not found on the turtles' shaded plastrons also supports an important role of light incidence for algal growth.

During autumn and winter ATs and WTs steadily declined, which may have played a role in the decrease of algae during those months. Although AT and WT drop at the end of summer and may inhibit further algal growth, these phenomena would not be expected to cause a complete disappearance of algae on the turtles' shells, supporting a greater role of light than by environmental temperatures in the growth of algae.

Increases in light, AT, and WT in the spring probably enhanced algal growth into midsummer. This occurred in spite of a greater incidence of water surface and shoreline basking by the Snapping Turtles which would have exposed algae to increased levels of killing ultraviolet rays. Basking was observed during April–June and then decreased through the remainder of the annual activity cycle. Only one turtle was observed basking in the fall (a recent hatchling on 1 October). In the warmest month, August, fewer *C. serpentina* were captured (only one while basking, possibly due to the turtles estivating or having been attracted to trap baits, as also observed in *Chrysemys picta* at White Oak and elsewhere). After this annual warm period, as light and temperature decreased through the autumn, less opportunity for algal growth occurred. However, the possible roles of both light and temperature presented are speculative and future studies are needed to clarify their relative importance regarding algal growth on turtles.

In North American middle latitudes male Snapping Turtles mature at a PL >14.5 cm and females at a PL >14.5–15.5 cm (Ernst and Lovich 2009). A contingency table Chi-square test showed

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no significant difference in the proportion of attachment (p = 0.9262) of attachment between adult males (54%) and adult females (53%). However, the same test showed a highly significant difference (p = 2.766e-13) in algal occurrence between adult turtles (combined sexes, 34%) and immature (<14.5 cm PL, 15%). Edgren et al. (1953) also found few juveniles with algae. No *Basicladia* were found on White Oak hatchlings or immatures in September or October. Most hatching and emergence occur at the site during this period. The small turtles probably inhabit shallower, warmer waters at that time than do adults and either come into less contact with algal spores or do not give the algae enough time to form distinct shell colonies before hibernation.

The relationship between algae and Snapping Turtles seems to be one of mutualism, with both parties gaining benefit from the others' presence (Edgren et al. 1953; Neill and Allen 1954). It is thought that turtles acquire a certain amount of camouflage through enhanced growth of algal colonies on their shell and skin, which conceals them from would-be predators, while also providing concealment from prey, allowing the turtles to use a sit-and-wait feeding strategy (Neill and Allen 1954). Adult *C. serpentina* spend much time submerged and sometimes obtain prey through ambush (Ernst and Lovich 2009). However, Edgren et al. (1953) thought camouflage of little importance in view of the general absence of natural predators upon adult turtles (especially *C. serpentina* at White Oak; Ernst, pers. obs.). Algae, in return, gain a point of attachment from which colonies can grow, a moving base providing better dissemination of spores as turtles migrate from one waterbody to another, and, possibly, protection from some small algae grazers. Unfortunately, neither of these hypotheses has been tested. A disadvantage of an algae-turtle relationship is the possibility that the algae may penetrate beneath the epidermal scutes of the shell and cause necrosis. Hunt (1958) reported a case of indirect necrosis of algal origin in the European turtle, *Emys orbicularis*.

Leeches.—The only species of leech found at White Oak was *Placobdella parasitica*, a commonly reported ectoparasite of *C. serpentina*. The occurrence of only one species of *Placobdella* at White Oak is unusual (see above references). The incidence of infestation of Snapping Turtles with leeches was 33% (92 of 280 captures). Other White Oak turtles experienced the following rates of *Placobdella* infestation: *Chrysemys picta*, 11%; *Clemmys guttata*, 12%; *Glyptemys insculpta*, 39%; *G. muhlenbergii*, 4%; and *S. odoratus*, 37% (Ernst 1971a, 1976, 1986, 2001, 2011).

Although *C. serpentina* were captured from March into October, leeches were only found attached from April through September (Table 2). Most infestation occurred during the period May through August (see below), when the incidence was more than 30% of the turtles collected during those individual months. Table 2 shows an increasing occurrence beginning in April (23%) and continuing through August, decreasing in September (12%). Colder ATs and WTs may possibly have contributed to the decrease in incidence at both ends of the turtle's annual cycle, with no leeches remaining attached during the winter months (as has been observed elsewhere; see above citations). In addition, the leech's normal behavior may contribute to their decline in the fall; it may be that more leeches that fed on the turtles became satiated, dropped off to digest their meals, and were then prevented from attaching by colder temperatures and the turtle's burying into the soft bottom. As snapping turtles hibernate most often totally buried in the soft bottom of some waterbody or buried beneath the soil on land (Ernst and Lovich 2009), a lack of oxygen at the hibernation site (Ultsch and Reese 2008) may also play a role in ridding the turtle of aerobic leeches.

As environmental temperatures increase with the advance of spring, the turtle emerges and comes once again in contact with leeches. Although relatively rare, *Chelydra* do bask out of water on occasion (Ernst and Lovich 2009). During aerial basking, attached leeches are sometimes observed to drop off (Saumure and Bider 1996; Saumure and Livingston 1994; Ernst, pers. obs.).

TABLE 1. Seasonal incidence of algal colonization on *Chelydra serpentina* at White Oak, Lancaster County, Pennsylvania; percent incidence of turtles in parentheses. Total captures reflects the total numbers of turtles captured; some individuals of both sexes were captured more than one time.

Month	Total turtle capture	Male turtles	Female turtles	Immature turtles
March	12 (8)	1 (11)	0	0
April	31 (23)	6 (46)	0	1 (33)
May	48 (48)	17 (77)	6 (50)	0
June	101 (45)	20 (51)	18 (56)	8 (27)
July	42 (57)	15 (63)	5 (71)	4 (36)
August	15 (33)	3 (50)	1 (50)	1 (14)
September	25 (12)	2 (50)	1 (100)	0
October	6 (17)	0	1 (100)	0
Total	280 (39)	64 (54)	32 (53)	14 (15)

TABLE 2. Seasonal incidence of leech infestation on *Chelydra serpentina* at White Oak, Lancaster County, Pennsylvania; percent of turtles infested in parentheses. Total captures reflects the total numbers of *C. serpentina* captured; some individuals of both sexes were captured more than one time.

Month	Total turtle captures	Male turtles	Female turtles	Immature turtles	Total leeches	Leeches per turtle
March	12(0)	9 (0)	3 (0)	0	0	0
April	31 (23)	4 (31)	1 (33)	2 (33)	26	3.7
May	48 (35)	14 (64)	3 (25)	0	164	9.6
June	101 (32)	15 (38)	8 (25)	9 (30)	236	7.4
July	42 (38)	9 (38)	3 (43)	4 (36)	238	14.9
August	15 (33)	2 (33)	1 (50)	2 (29)	33	6.6
September	25 (12)	2 (50)	1 (100)	0	13	4.3
October	6 (0)	0	0	0	0	0
Total	280 (33)	55 (47)	20 (35)	17 (28)	710	7.8

According to Hall (1922), *Placobdella parasitica* can withstand exsiccation to 70.4% of its body weight (or approximately 92% of total body water). Continuous leech reinfestation must occur during at least May through August, as the turtle's habit of foraging in shallow waters probably brings them often into contact with the annelids (Readel et al. 2008).

A contingency table Chi-square test showed no significant difference (p = 0.19) between the rate of attachment on the two adult sexes, but the same test revealed a highly significant difference (p = 0.0009) between the rate of leech attachment on adults (sexes combined) versus that of immatures. The difference in numbers of leeches attached between adults and juveniles is probably at least somewhat explained by the smaller turtles' preference for shallow, warmer waters, and the recent hatchlings' habit of hiding on land while migrating from the nest site to water. In addition, the hatching period at White Oak is September-October and the increased number of hatchlings then entering the population contributed to the smaller overall percentage of infested immatures. The rate of attachment may also be related to the difference in surface area for attachment between adults and immatures. The mean number of leeches attached on those *C. serpentina* harboring them was 7.8, with the greatest numbers occurring in all sexes and age classes during June and July.

Problems may arise from leech parasitism. As *P. parasitica* take blood from a turtle, it is possibly weakened, which may contribute to a greater chance of it being depredated at White Oak, especially in smaller individuals. If the leech load is great, exsanguination theoretically could occur to such a degree that the turtle dies (but unreported), a greater potential problem in hatchlings or small immatures than for adults. The maximum numbers of leeches attached to White Oak *C. serpentina* were found on adults: 61 (male, 31.7 cm CL) and 40 (female, 31.7 cm CL). These patches of leeches were largely composed of a hermaphroditic adult and several small, recently hatched worms and probably caused little damage to adult turtles. Leeches of the genus *Placobdella* exhibit a specific pattern of parental care that definitely contributes to the parasite load of a turtle. After mating, the leech deposits a cocoon containing fertilized eggs on a solid surface, often a turtle's shell. The cocoon is cared for by the adult leech until the young emerge when the adult carries them to their potential first blood meal. In correspondence with the worm's life cycle, the leech load probably increases on turtles during April–July as more young emerge and the adults bring them to their first turtle-provided blood meal.

A second greater threat is from the leeches acting as vectors for parasitic protozoans from turtle to turtle. Leeches of the genus *Placobdella* are known intermediate hosts of several species of the sporozoan genera *Haemogregarina* and *Haemoproteus*, as well as the flagellate species *Trypanosoma chrysemydis*. *Placobdella parasitica* can transmit these parasites from an infected turtle to an uninfected one and between species of turtles within a turtle community (Siddall and Desser 1991, 1992, 2001; Woo 1969), much as *Anopheles* mosquitoes transmit malaria from human to human. Ernst and Ernst (1979) reviewed protozoan parasitism in North American turtles; see also the more recent papers by Siddall and Desser (1991, 1992) and Strohlein and Christensen (1984).

Snapping Turtles normally have a greater incidence of haemogregarine parasitemia than other sympatric turtle species (McAuliffe 1977; Siddall and Desser 1992). This has been attributed to the turtle's life style (Readel et al. 2008). It spends most of its time buried in mud in shallow water with only its eyes and nostrils exposed to air and often basks just beneath the surface of the water as opposed to more frequent aerial baskers, such as emydid turtles, whose longer periods of basking probably contribute to the removal of attached leeches (McAuliffe 1977).

Collection of data concerning attachment of both algal colonies and leeches should be included in future ecological and behavior studies of *Chelydra serpentina*. This is especially important as the incidence of leech attachment may be an indicator of the amount of protozoan parasitemia in a population.

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TECHNIQUES

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Effectiveness of Leaf Litterbags for Sampling Stream-breeding Anurans: Tadpole Distribution, Composition, and Use

Amphibian population declines highlight the need to understand the limitations of sampling techniques and develop more effective means of assessing and monitoring. Leaf litterbags attract larval amphibians by mimicking natural substrate, while the bag's permeable exterior allows animals to pass freely in and out. Use of leaf litterbags in herpetofaunal surveys has been limited to sampling larval salamanders in the United States (e.g., Chalmers and Droege 2002; Nowakowski and Maerz 2009; Talley and Crisman 2007; Waldron et al. 2003). Leaf litterbags were used as early as the 1960s for examining benthic invertebrates (e.g., Anderson and Mason 1968; Crossman and Cairnes 1974; Hilsenhoff 1969). However, their employment has gained momentum in herpetofaunal research to improve our understanding of aquatic amphibians and larvae (e.g., abundance, as in Nowakowski and Maerz 2009) and reduce inter-observer differences that can affect visual encounter rates of more traditional sampling methods (e.g., dipnet sweeps: Shaffer et al. 1994). Additionally, litterbags can capture secretive or uncommon species that would be missed with more traditional sampling methods (Skelly and Richardson 2010).

Typically, tadpoles are sampled with dipnet sweeps, time-constrained searches, or opportunistic searches (Shaffer et al. 1994; Skelly and Richardson 2010). The usefulness of these techniques differs among observers based on effort and ability. Leaf litterbags minimize this type of error because investigators empty bag contents in the same way (Talley and Crisman 2007) or are trained to shake-out individuals without opening the bag using the same methodology between observers (see methods of Mackey et al. 2010). Therefore, scientists who are using untrained field assistants, or have a high turnover rate of field assistants may find their results more comparable among assistants when litterbags are employed versus another technique with a higher degree of inter-observer bias (e.g., dipnet sweeps: Shaffer et al. 1994).

Leaf litterbags create an artificial habitat to attract larval amphibians by mimicking natural leaf packs on the stream bottom (Skelly and Richardson 2010). Larvae are free to come and go from the litterbags, as long as their body size does not exceed bag mesh size. Mesh sizes vary among studies, and can bias results based on exclusion of larger larvae, prey, and predators when the mesh size is small (Waldron et al. 2003). The use of leaf litterbags has been limited to temperate zone stream-breeding salamanders (e.g., Chalmers and Droege 2002; Jung et al. 2000; Mackey et al. 2010) likely because it is a relatively new technique. Its application in the tropics may be useful in understanding anurans that breed in rocky streams where dipnet sweeps may miss tadpoles that retreat into crevices and naturally-formed leaf packs.

This study is the first to examine whether leaf litterbags can be used to sample tadpoles. We describe how tadpoles are distributed through time and space and among litterbags, including maximum densities recorded per litterbag. We use results of opportunistic searches for terrestrial adults to identify whether species composition resultant from tadpole-litterbag surveys yield reliable presence/absence composition estimates. Developmental stages are reported for the most abundant species so that biases for age-related selection using this method can be identified.

Site Description.— Cusuco National Park (CNP) is located in the Sierra de Omoa in northwestern Honduras. The Río Cusuco (15.494317°N, 88.2147°W) was sampled near the Visitor's Center at elevations from 1530–1560m. Water temperatures varied from 16–18°C during sampling events. River substrate is dominated by rocks, large boulders, and some sandy-bottom splash pools, with channel bends providing pools with low-flow areas where natural leaf litter and debris collects. Surrounding forest is Transitional Cloud Forest composed of *Pinus* and *Liquidambar* (Townsend and Wilson 2008), in the Lower Montane Wet Forest formation (Holdridge, 1967; McCranie and Wilson 2002). Most rainfall occurs from May/June through October/November, with April typically being the driest month (McCranie and Wilson 2002). Four anuran species within the study area could be encountered with leaf litterbags because they breed in streams (*Duellmanohyla soralia*, *Plectrohyla dasypus*, *Plectrohyla exquisita*, and *Ptychohyla hypomykter*; McCranie and Wilson 2002).

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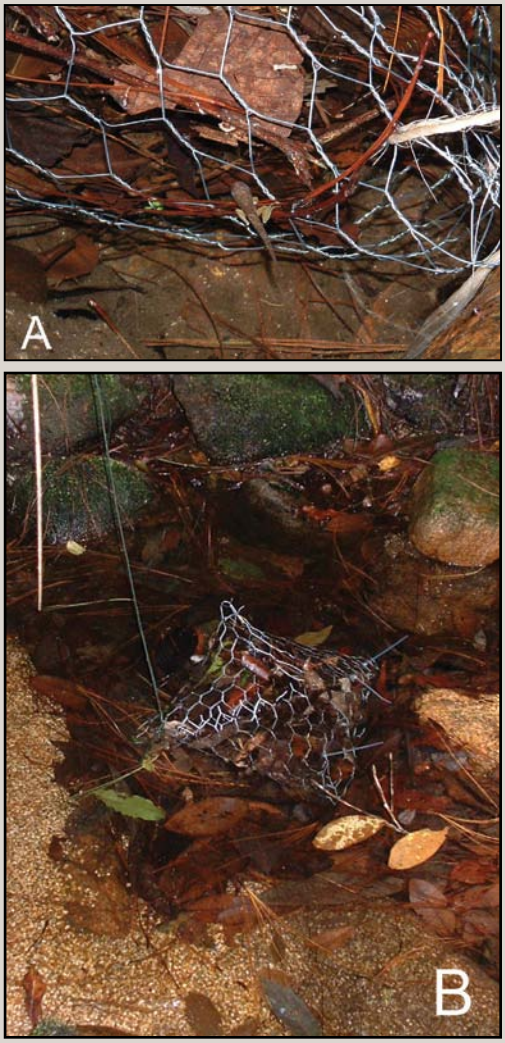


FIG. 1. A) A *Ptychohyla hypomykter* metamorph clings to vegetation at the edge of the leaf litterbag. Note the size of the metamorph relative to the mesh size of the litterbag. B) A leaf litterbag is visible in the middle of the photo, placed where leaf litter accumulates, secured to the bank with a piece of string.

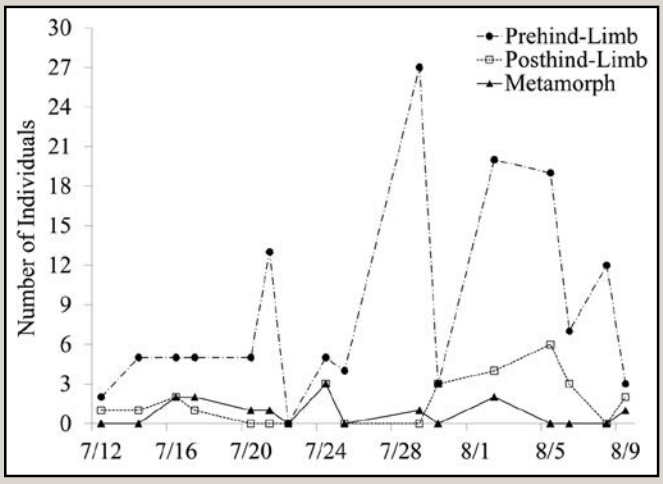


FIG. 2. Prehind-limb, posthind-limb, and metamorph developmental stages are represented in leaf litterbag samples for *Ptychohyla hypomykter* tadpoles.

Another stream-breeding anuran, *Lithobates maculatus*, has not been found in the park for several years, and is likely extirpated from the park (Townsend and Wilson 2008).

MATERIALS AND METHODS

The herpetological sampling expedition to Cusuco National Park had three overarching scientific objectives: daily monitoring of pitfall traplines for fossorial snakes, opportunistic searching to document all herpetofauna, and using leaf litterbags to document their effectiveness for sampling tadpoles. Pitfall traplines did not yield any stream-breeding adult anurans, so the specific methodology and results of that survey will not be discussed. Daily hikes through the forest to and from these traplines, however, were used to extend the stream-breeding adult frog species list when possible. Additionally, nighttime hikes were performed nearly every night (23 June–22 August 2005) to look for herpetofauna.

Leaf litterbags.— We designated five sample reaches in the Río Cusuco for litterbag placement. Six leaf litterbags were placed along each sample reach, with a total of 30 litterbags deployed in the river. Sample reaches were separated by approximately 35 m, and litterbag placement within sample reaches spanned approximately 20 m. Litterbags were not evenly dispersed within sample reaches because they were employed only in areas where there were pre-existing pools for leaf litter accumulation. Leaf litterbags were checked every 3–5 days from 11 July–8 August 2005, or exactly nine times for each leaf litterbag. This 3–5 day interval between sampling events allowed time for recolonization by tadpoles.

We constructed litterbags using easily obtainable materials (i.e., "chicken wire"). Additionally, we knew that our target species maximum larval size would not exceed the mesh size of the chicken wire (e.g., Fig. 1a), and, therefore, would not be excluded based on body size. Leaf litterbags were constructed by cutting 0.45 × 0.45 m (1.5 × 1.5 ft) squares, securing the corners together with plastic ties to form an 'envelope' shape ($V \cong 0.0054\ m^3$). Litterbag size was based on Waldron et al. (2003), who found medium and large litterbags to be most effective in small streams. The bag interior was filled with litter debris from the stream edge and bottom. To secure leaf litterbags in place, rocks of approximately equal mass were placed in the interior to weight the bags. Using twine, each leaf litterbag was tied to a nearby tree to prevent displacement and loss. During the 2004 field season, litterbags were not secured to the banks, and were displaced during a heavy storm. Leaf litterbags were placed in the river where debris naturally accumulated (Fig. 1b).

Upon retrieval, litterbags were rapidly pulled from the stream and placed into a plastic container to prevent escape of tadpoles. No tadpoles were ever observed escaping before the litterbags were placed in the plastic tub. Leaf litterbag contents were then placed in a dipnet to drain water. Tadpoles were placed in water-filled plastic bags for field identification. Tadpoles were identified in the field with a hand lens to determine species (based on McCranie and Wilson 2002) and Gosner (1960) developmental stage. Tadpoles with mouthpart malformations and those for which species identification was not certain in the field were collected and preserved for further analysis (N = 39); they will be deposited at Florida Museum of Natural History upon completion of future genetic analyses. All captured anuran larvae were classified into prehind-limb (Gosner Stage 25), posthind-limb (Gosner Stages 26–41) or metamorph (Gosner Stages 42–46) developmental stages.

Terrestrial Surveys.— Opportunistic searching during daytime and nighttime hikes was used to determine the presence or absence of adults of each species. All trails mentioned in Townsend and Wilson (2008) were used for daytime and nighttime hikes, as well as hiking along the Río Cusuco itself. As a minimum estimate, at least 6 h per 24 h day were spent searching for herpetofauna (morning trapline work: 3 h, afternoon litterbag surveys: 2 h, and night hikes: 1–2 h). Methodology included visually searching for herpetofauna in vegetation, beneath fallen logs and rocks, within the upper layers of soil, on boulder surfaces in the Río Cusuco, and within overhanging vegetation near river edges. We use qualitative comparisons of presence/absence data for adult species from terrestrial opportunistic visual encounter surveys with tadpole species presence/absence data from leaf litterbag surveys.

RESULTS

Tadpole distribution.—All but four litterbags yielded at least one individual. On average, 4.6 tadpoles (+/- 0.3 SE; range 0–16) were captured during 40 litterbag sampling events, where a sampling event is equivalent to checking an entire litterbag reach. Of the litterbag checks, where examination of one leaf litterbag equals one "litterbag check," most yielded zero (61.3%) or one tadpole (20.8%) (Table 1).

Adult and larval species composition.—Of the stream-breeding anurans in Cusuco National Park, the adult opportunistic survey found four of five possible species: *D. soralia, P. dasypus, P. exquisita,* and *P. hypomykter*. We found tadpoles of these same four anuran species in the litterbags (*D. soralia* [N = 1], *P. dasypus* [N = 4], *P. exquisita* [N = 1], and *P. hypomykter* [N = 175]) (Table 2). We did not detect one of the stream-breeding frog species known to occur in Cusuco National Park, *L. maculatus*, in any of our surveys. The visual encounter survey (VES) lasted for eight weeks, while the corresponding leaf litterbag survey (LLS) lasted for five weeks (Table 2). For both VES and LLS, *D. soralia* and *P. exquisita* were found at low frequencies. In contrast, *P. dasypus* and *P. hypomykter* were found with greater frequencies (Table 2). We were unable to identify one tadpole to species because of severe mouthpart malformations.

Developmental stage composition.—We collected only one tadpole of both *D. soralia* and *P. exquisita*. We found all three developmental categories of *P. dasypus* throughout the study. The majority of *P. hypomykter* tadpoles captured belonged to the prehind-limb developmental stage (N = 136), followed by posthindlimb (N = 26) and metamorph (N = 13) stages (Fig. 2).

DISCUSSION

We used leaf litterbags in a swift-flowing montane stream in Honduras to sample tadpoles of four stream-breeding species. As with previous larval salamander litterbag survey results (Talley and Crisman 2007), we found most litterbag checks contained no tadpoles. On the other hand, nearly 40% of the litterbag checks contained at least one individual (Table 1). Although the litterbag volume we used in this study (V ≅ 0.0054 m^3) was greater than that used by Talley and Crisman (2007) (V ≅ 0.0018 m^3), the number of individuals we found per litterbag was similar. If a litterbag contained at least one individual during a litterbag check in either study, it typically yielded only one or two individuals, with a maximum of nine salamander larvae (Talley and Crisman 2007) and seven tadpoles in this study (Table 1). The social biology of these species has not been studied, but *D. soralia* is the only species we detected known to aggregate, swimming upside down at the surface (McCranie and Wilson 2002), while at other times found separately on the stream bottom (Townsend and Wilson 2008). Because the other species are not known to aggregate, and were not observed aggregating in this study, the number of individuals we captured might simply represent natural tadpole densities for the given litterbag size. Additionally, these capture values might be affected by the amount of colonizable area and territory size requirements, inter- and intra-specific competition, and food source availability (Chalmers and Droege 2002; Fraser 1976; Talley and Crisman 2007; Waldron et al. 2003) because litterbag design mimics natural conditions.

Tadpoles of the four anuran species differed markedly in frequency of occurrence in litterbags, perhaps resulting from different larval periods, alternate microhabitat uses, or an over-abundance of the most common species. Honduran tadpoles typically metamorphose into adults at the end of summer months, with timing of emergence from water varying among species (McCranie and Wilson 2002; Townsend and Wilson 2008). The most commonly observed treefrog in Cusuco National Park is *P. hypomykter* (Townsend and Wilson 2008). Calling males, amplectant pairs, and tadpoles have been found in March, April, June, July, August, and September (Townsend and Wilson 2008). *Ptychohyla hypomykter* tadpoles made up 96.2% of those encountered in this study. Previous studies with larval salamanders found

TABLE 1. Tadpole distribution among leaf litterbags indicates that nearly half of those litterbags checked contained at least one tadpole, and as many as seven.

Individuals per litterbag	Number of litterbag checks	Percent of total litterbag checks (%)
0	147	61.3
1	50	20.8
2	24	10.0
3	8	3.3
4	3	1.3
5	3	1.3
6	2	0.8
7	3	1.3
Total	240	

TABLE 2. Species presence determined by terrestrial visual encounter surveys (VES) of adults and metamorphs, and leaf litterbag surveys (LLS) of tadpoles and metamorphs. 'X' denotes species presence. Shaded areas indicate survey weeks when litterbags were not sampled. The first survey week was 23–30 June, the rest following without interruption.

		Survey Week							
Species		1	2	3	4	5	6	7	8
D. soralia	LLS				X				
	VES	X							
P. dasypus	LLS				X		X		
	VES	X	X	X		X	X	X	X
P. exquisita	LLS						X		
	VES						X		
P. hypomykter	LLS			X	X	X	X	X	
	VES	X			X	X	X	X	X

similar distinctions in capture rates between species, with 95% of the total captures being larvae of a single salamander species (*Eurycea cirrigera*) (Talley and Crisman 2007). The relatively short duration (11 July–8 August 2005) might have contributed to the lower capture rates of some species if this study period did not encompass their larval periods. For example, Townsend and Wilson (2008) reported transformed *P. dasypus* on streamside boulders and vegetation during June and July; this indicates that the startup date of our study in mid-July was on the tail end of the larval period for *P. dasypus*. The likelihood of finding tadpoles in litterbags is reduced when their natural behavior does not favor leaf-pack colonization. For example, tadpoles of *P. dasypus* and *P. exquisita* often are observed on rocks in fast-flowing portions of stream, whereas *D. soralia* tadpoles tend to school near the surface or in the water column in deeper pools (McCranie and Wilson 2002; Townsend and Wilson 2008). Therefore, tadpoles of these three species might not normally utilize submerged leaf litter as preferred microhabitat. The prevalence of *P. hypomykter* tadpoles in our samples might be explained by any or all of these factors.

We determined that leaf litterbags contained tadpoles of all anuran species presumed to use the Río Cusuco based on prior knowledge of their reproductive strategies (Townsend and Wilson 2008) and the results of opportunistic terrestrial surveys conducted in this study. Based on presence/absence assessment of tadpole and adult species, we found that our study identified tadpoles in the leaf litterbag survey of the same species as adults in the terrestrial survey (*D. soralia, P. dasypus, P. exquisita,* and *P. hypomykter*) (Table 2). Previous studies dealing with salamander species presence/absence composition in leaf litterbags also found the same larval species as adults known to the area (e.g., Pauley and Little 1998; Chalmers and Droege 2002; Talley and Crisman 2007; Waldron et al. 2003).

We found representatives of all three major developmental stages (prehind-limb, posthind-limb, and metamorph) in our litterbag samples throughout the duration of our study period for *P. hypomykter* tadpoles (Fig. 2). The prehind-limb developmental stage (S 25) was most common (78%) in the tadpoles of *P. hypomykter* sampled, which likely reflects the abundance of this stage in the entire population. The distribution of tadpole stages (Fig. 2) does not appear to reflect an aging trend, where younger (prehind-limb) tadpoles were collected earlier in the survey and older (posthind-limb and metamorph) tadpoles were collected later in the survey. Therefore, the difference in relative abundance among developmental states is due either to bias in the capture probabilities from the sampling technique or is reflective of real differences in tadpole developmental stage structure.

Because our sample sizes were limited for some species, a decreased sampling effort could have missed *D. soralia* and *P. exquisita* tadpoles all together. Future studies employing leaf litterbags should first address whether tadpole species of interest are likely to be found in leaf litter. Additional sampling methods might be necessary for species that are difficult to detect, particularly if they are of critical conservation concern. Next, future researchers should choose sample sites that have natural leaf litter accumulation. Finally, they should pick the number of litterbags deployed, and duration of litterbag deployment based on the needs of their study. For example, if only a handful of tadpoles are desired for study, then fewer litterbags could be used. We found unequal litterbag occupancy between stream reaches, but know that when six litterbags were used, we detected an average of 4.6 tadpoles within that reach.

We provide information on the reliability and use of leaf litterbags, a technique typically used to monitor larval salamanders, for sampling tadpoles in the tropics. Use of this sampling technique on a wide range of other stream-dwelling amphibians worldwide could contribute to assessment of natural populations since amphibians are declining worldwide (Stuart et al. 2004). We demonstrate herein that leaf litterbags can be used to sample stream-breeding tadpoles in a swift-flowing montane stream. If a tadpole's association with natural leafpacks in the stream is unknown, the species is of particular conservation significance, or leaf litterbags do not yield any encounters, then an additional sampling method may be necessary.

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A Device for Restraining Gopher Tortoises (*Gopherus polyphemus*) During Blood Extraction

Collection of blood or other biological samples from Gopher Tortoises (*Gopherus polyphemus*) is necessary for assessments regarding health status, disease, and genetics. Researchers use a variety of techniques for restraining tortoises during sample collection, sometimes having one person draw the blood while a second person holds the tortoise. However, budget and manpower constraints do not always allow for two people to be present during blood extraction, especially in remote field situations. Some researchers place the tortoise on a large metal coffee can while drawing blood from the brachial vein in the forelimb (G. McLaughlin, pers. comm.); others restrain the tortoise in their lap or on a truck tailgate while extracting blood subcarapacially (P. Moler, pers. comm.). These techniques can be effective if the tortoise is not excessively active. The need for one person to be able to quickly and effectively extract blood under field conditions from gopher tortoises of varying activity levels was the impetus for constructing a portable tortoise restraint device (TRD).

The TRD is designed to be used with a pickup truck but can be modified for placement on other surfaces such as a portable field table. Two 12-in. lengths of pressure-treated two-by-two (a standard U.S. lumber product that actually measures 1.5 × 1.5 in.) are laid perpendicular to the back edge of the open tailgate, so that the tips are flush with the tailgate's edge. The outside distance between these parallel wood pieces is 13.5 in. Measurements are given in English units to correspond with lumber and fastener sizes in U.S. hardware stores. Two holes (3/8-in. diameter) are drilled through the side of each of the lengths of two-by-two (approximately 2 in. from each end) to facilitate attachment of the TRD to the truck (see below; Fig. 1). Two additional 3/8-in. holes are drilled from the top through each of the two lengths of two-by-two (approximately 1 in. from each end), with corresponding pilot holes drilled in the tailgate so that the wood can be secured to the tailgate with 2-in. long sheet metal screws. This completes the tailgate mount and support for the TRD (Fig. 1). To avoid drilling holes into a truck tailgate, C-clamps or cargo straps could be used to secure the TRD; alternatively, the TRD platform could be attached to a heavier base for use on tables, counters, or tailgates.

The outside distance (13.5 in.) between the two lengths of two-by-two mounted on the truck tailgate provides the basis for the dimensions of the TRD platform. Two 12-in. lengths of two-by-four (another U.S. standard lumber product, measuring 1.5 × 3.5 in.) lying on their shorter edge and positioned 13.5 in. apart at the inside, serve as the base of the platform (Fig. 1). Four holes (3/8-in. diameter) drilled into the sides of the base correspond to the four holes drilled into the two lengths of two-by-two previously attached to the truck. Four 4-in. bolts pushed through these holes secure the TRD to the truck during use (Fig. 1). A piece of ¾-in. plywood is cut to a width of 12 in. and a length of 16.5 in., laid atop the pieces of two-by-four flush to its ends and outer edges, and attached to them with decking screws. Two additional lengths of two-by-four, each 16.5 in. long, are sawed into trapezoids that have an outer angle of 60° and placed on edge atop the plywood base along the 16.5-in. side (Fig. 1). These pieces are attached through the bottom of the plywood with decking screws. Another piece of ¾-in. plywood measuring 12 × 12.5 in. is then attached to the top of the trapezoidal pieces with decking screws (Fig. 1). This completes the basic TRD platform. If desired, 3/8-in. holes may be drilled into the rear left quadrant of the upper plywood platform to provide storage for the four bolts when the TRD is not installed on the tailgate. Additionally, metal handles may be attached to each side of the TRD base to facilitate its placement and removal.

An 8-in. block of four-by-four serves as the pedestal on which the tortoise is placed during blood extraction (Figs. 1, 2). This block supports the center of the plastron and prevents

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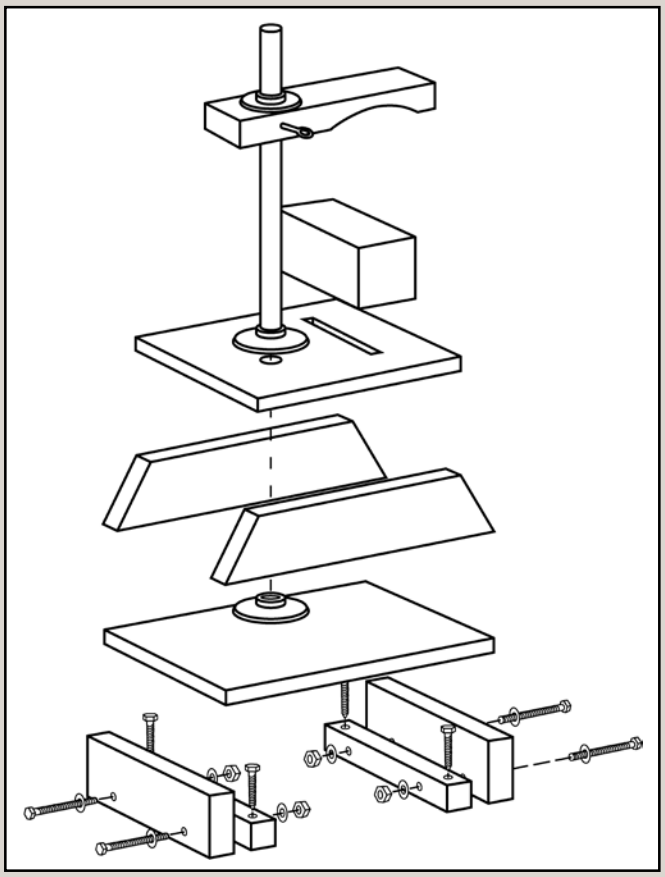


FIG. 1. Schematic illustration showing how parts of the tortoise restraint device come together.

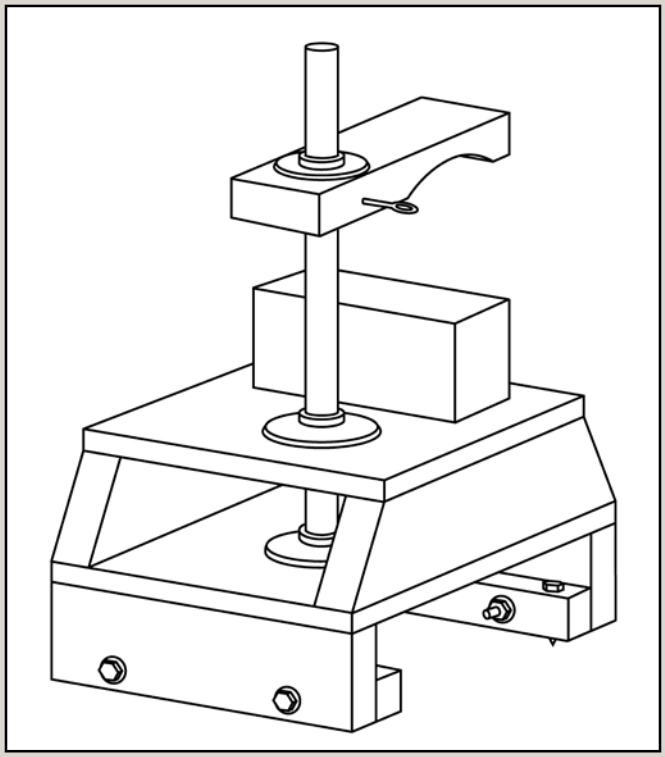


FIG. 2. The tortoise restraint device, lateral view.



FIG. 3. Radio-instrumented Gopher Tortoise in the restraint device. Note both the eye bolt that allows vertical adjustment of the clamp to fit individual tortoises and the bungee cord that goes between eye screws on the clamp and base to further secure the tortoise.

the tortoise from gaining traction with its feet (Fig. 3). Because of variation in the size of tortoises, the pedestal must be adjustable in relation to the fixed clamp that holds the tortoise in place (described below). A 3/8-in.diameter double-ended screw/bolt is placed in the center of the bottom of the block of four-by-four (the threaded end screws into the block, leaving the bolt end exposed). A 7-in. slit slightly wider than the bolt is cut into the top of the TRD platform 3 in. from the right side (Fig. 1). By inserting the bolt through the slit and securing it with a washer and wing nut, the block can be positioned fore and aft of the clamp. A block of four-by-four 6 in. long may be cut if desired to a width of 2.5 in. to accommodate smaller tortoises. Foam rubber pads, about ¼-in. thick, are hot-glued to the tops of these blocks to reduce slippage of the tortoise.

To create the clamp that holds the tortoise in place, a 1-in. diameter hole is drilled through the top of the TRD platform approximately 4 in. from the left side and 5 in. from the front. A ¾-in. galvanized female pipe stand is secured with screws to the bottom piece of plywood directly under the hole in the TRD platform. A ¾-in. diameter pipe approximately 18 in. long and threaded at both ends is inserted through the hole and screwed into the pipe stand (Figs. 1, 2). The top part of the clamp is made from a 15-in. length of two-by-four through which a 1-in. hole has been drilled in the center of the broad edge (approximately 3 in. from one end). The wood is placed on the pipe, inserting it through the hole and moving it down until it comes to rest on the block. An arc that approximates the shape of a tortoise shell is sketched on the narrow edge of the 15-in. piece, with the highest point of the arc falling directly over the center of the block (Figs. 1, 2). The arc is then cut out of the 15-in. piece with a scroll saw, leaving the wood thick enough (at least 5/8 in.) that it is not weakened. Because the area within the arc will be contacting the tortoise's shell, it is lined with soft foam hot-glued to the wood. Three additional 1-in. female pipe stands are fastened with screws to reinforce the pipe, one above the hole in the 15-in. piece, one below that hole, and one on the top tier of the platform (Figs. 1, 2).

With a ½-in. drill bit, a hole is drilled between the narrow edge of the 15-in. clamp and the 1-in. pipe hole. A threaded bolt insert

is screwed into this hole and a large 3/8-in. eye bolt is screwed into the insert. When threaded completely through the hole, the bolt makes contact with the pipe and allows the clamp to be secured in any vertical position along the length of the pipe (Fig. 3). Medium eye screws are fastened to the right end of the clamp and the lower right two-by-four of the base of the TRD platform. A bungee cord stretched between these two eye screws adds further strength to the clamp when a tortoise is in the TRD (Fig. 3).

The TRD should be coated with a water sealer to keep urine, feces, and blood from soaking into the wood. Additionally, the TRD should be rinsed with water to remove organic debris and then cleaned with a mild bleach solution (1:20 dilution of 5% household bleach in water) or a disinfectant such as Trifectant after each tortoise is sampled.

Although originally designed for extracting blood from the brachial vein of a tortoise's forelimb, this adjustable device can be used to restrain tortoises for other types of sample or data collection, assessment of clinical signs of disease, and attachment of radio transmitters (Fig. 3). The TRD safely secures the tortoise, allowing access for sampling while precluding excessive handling and manipulation. We found the TRD to be effective, practical, and versatile.

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Retention of Paint Markings for Individual Identification of Free-ranging Basking Aquatic Turtles (Suwannee Cooters, *Pseudemys concinna suwanniensis*)

Marking animals is often essential in ecological studies (Krebs 1999), but different taxa pose various challenges in applying marks with suitable retention periods (see Silvy et al. 2005 for an overview of methods). The bony turtle carapace provides convenient opportunities for permanent individual marking, such as the shell notching technique introduced by Cagle (1939). However, basking aquatic turtles (such as *Chrysemys*, *Graptemys*, *Pseudemys*, and *Trachemys* in North America) quickly fall from their platforms into the water and swim away rapidly when approached, making it impractical to read notches.

Methods that allow for distant recognition without capture, thereby resulting in minimal disturbance to individuals, are highly desirable. Although paint marking has been used in population studies of aquatic turtles (e.g., Jones and Hartfield 1995; Kramer 1995; Selman and Qualls 2008, 2009), assumptions of paint retention that are critical in interpreting recapture sightings are frequently untested. As part of a more comprehensive study of movement patterns and habitat use, we applied paint marks to an emydid species from the southeastern USA, the Suwannee Cooter (*Pseudemys concinna suwanniensis*). These large turtles (maximum carapace length = 437 mm; Pritchard 1980) are strong swimmers and inhabit various riverine habitats, where they spend extensive time basking above water (Jackson 2006; Ward and Jackson 2008). Here, we report observations on the retention of paint marks on free-ranging Suwannee Cooters to evaluate the utility of this method for monitoring this species.

Methods.—The study site encompassed a 3.4-km stretch downstream from the US Highway 441 bridge over the Santa Fe River, ca. 4 km downstream from where the river reemerges above ground from the Floridan Aquifer (Alachua and Columbia counties, north-central Florida, USA). Most of the study site and its surroundings are managed by River Rise Preserve State Park, part of the largest publicly protected area along the Santa Fe River. Within the preserve human take of turtles is illegal. Although the river water is normally dark brown from tannins, a drought in 2006–2007 lowered the river level, substantially resulting in clear water with good visibility during the study. Kornilev (2008) and Kornilev et al. (2010) describe the study site in more depth.

From 18 to 23 May 2007, we snorkeled and hand-captured 50 Suwannee Cooters (23 males, 25 females, 2 juveniles; mean straight carapace length [SCL] = 288 mm; range 164–375; SD = 53). After recording standard morphometric measurements, we removed algae from the dorsolateral side of the carapace, dried it, and detached any shedding scutes in order to facilitate paint retention. We then painted a unique identifying number on each side (Fig. 1). We used a white, non-toxic, oil-based paint marker designed for rugged industrial use (563 Speedry, Diagraph, Marion, Illinois, USA; price: US $3/marker). The width of the paint lines was 0.5–1.0 cm and the complete 2-digit number was usually ca. 7 × 7 cm. Each marker was sufficient to mark 30–50 individuals. In addition, we attached in the field a temperature-sensitive datalogger (iButton; Maxim Integrated Products, Sunnyvale, California, USA) on the marginal scutes above the right rear leg of each turtle (Fig. 1; Kornilev 2008). We coated the iButtons in black plastic, which increased their height to ca. 9 mm and radius to ca. 11 mm. Turtles were released at the point of capture after the paint dried completely (ca. 10 min).

We conducted intensive resampling for 60 days after the turtles were marked. During 26 visits to the river, one or two

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observers surveyed the length of the field site by kayak 3–4 times per week. With the aid of compact binoculars (7 × 35 power), we searched for, observed, and attempted to identify individually both basking and swimming turtles. Since the iButtons were usually visible from a distance, we could often determine if a turtle had been previously captured even when the painted numbers had worn off. Resighted animals that could not be unambiguously identified were classified as "Unidentified."

Visits to the field site between July 2007 and April 2008 were less intensive and we present here only incidental results from that period. While attempting to retrieve iButtons, we captured 39 additional, unmarked turtles. Some numbers quickly wore off or were too small and difficult to detect, so we subsequently increased the line width of the paint marks to 1–2 cm and the overall mark size to ca. 12 × 12 cm to improve detection and paint retention. After July, additional limited sampling also was conducted in the 4 km upstream of the US 441 bridge (Kornilev 2008; Kornilev et al. 2010).

Results.—Within the two months of intensive resampling, 41 turtles (82%; 16 males, 23 females, and both juveniles) were positively identified at least once. We successfully identified turtles 191 times, excluding daily resightings. Individuals were identified more than once per day on 44 occasions, primarily during the first 30 days. Marked individuals could not be identified on 125 occasions, principally due to deterioration of the paint marks, with just a few turtles escaping prior to identification. We observed a turtle with an iButton but without distinct numbers as early as six days post-marking (Fig. 2).

The mean number of days from the initial capture to the last identification or recapture was 22.75 (range: 4–52, SD = 10.98; N = 41). No significant difference between sexes was detected (ANOVA: $F(1, 37) = 1.019$, $p = 0.319$, $= 0.05$; Kolmogorov-Smirnov & Lilliefors test for normality: $p > 0.2$ for each sex).

The use of thicker and larger paint marks applied on the additional turtles captured after July 2007 resulted in discernible marks for longer periods of time than the thin marks initially used. On 31 March 2008, YK observed two turtles with faint paint marks but failed to identify them before they entered the tannin-stained water. The last date on which we painted marks was 28 September 2007; therefore marks could be retained for at least 186 days (>6 months).

Numbers on basking turtles could be identified from 20–30 m with the use of the compact 7 × 35 binoculars. Although water clarity varied slightly across the study site and period, swimming turtles often could be identified up to 3–4 m horizontal distance away from the observer and at depths of 2.5 m. Swimming turtles were occasionally detected because the paint number was observed prior to the turtle itself being visible.

Discussion.—Our results on paint mark retention are concordant with published reports of similar studies on freshwater turtles. Kramer (1995) reported paint mark retention for 1–3 months on Florida Redbellied Turtles (*P. nelsoni*) using rubberized or epoxy paint. Jones and Hartfield (1995) also reported retention rates of up to three months for *Graptemys oculifera*. Selman and Qualls (2008, 2009) did not address the question of mark retention in estimating population size of *G. flavimaculata* and *G. gibbonsi*; they did note flecks of paint on several individuals recaptured 8–14 months after applying a fluorescent spray paint, but the paint was probably not enough for a successful "resighting" (W. Selman, pers. comm.). However, all of the *Graptemys* studies noted that mark-resight surveys were completed within two weeks of the first individual being paint



FIG. 1. Representative paint mark and iButton (circled) on a female Suwannee Cooter (SCL = 365 mm). The inset shows an enlarged coated iButton (ca. 11 mm) next to a US quarter coin.

marked in order to prevent losing marks; similar population estimates across years for these studies indicate that paint marks were persistent shortly after application and that mark-resight is a valid population estimation tool. The differences in paint retention between the studies could be attributed to varying ecological factors (e.g., water chemistry, species behavior) as well as the properties of the assortment of brands of paint used. Similar to previous results, our study suggests that wide paint marks can be used for more than 1 month to monitor at least some individual turtles with minimal disturbance, but that decreased paint retention limits the effectiveness of this technique for longer-term studies.

In our study, abrasion, shedding of scutes, and rapid algal growth on the carapaces of some individuals reduced paint retention and detection. However, the width of the paint lines was not the only determining factor for the rate of paint loss. For example, individual #23 had thinner number lines painted than other turtles, but its marking lasted for 52 days, longer than on most other individuals. Although we documented extended retention for paint marks especially applied after July, this might have reflected decreased turtle activity (leading to less abrasion of the paint against floating vegetation, tree logs, etc.) and scute shedding during the cooler fall months when growth is slower than in summer (Huestis and Meylan 2004). The extent of algal colonization and shedding of scutes as well as the propensity to disperse likely reflect individual differences among turtles (Kornilev et al. 2010).

Suwannee Cooters are strong swimmers and dispersal beyond the study site may have led to our inability to observe some marked turtles (see Kornilev et al. 2010). For example, the paint marks on individual #44 started to fade when last seen 45 days after capture; on individual #46, the numbers were still well preserved and easy to read on the last observation 33 days after paint was applied. However, both individuals presumably emigrated from the field site since they were never observed or captured again even during several surveys outside of the study site.

The choice of paint color that provides the best visibility should be considered carefully. In our experience the white

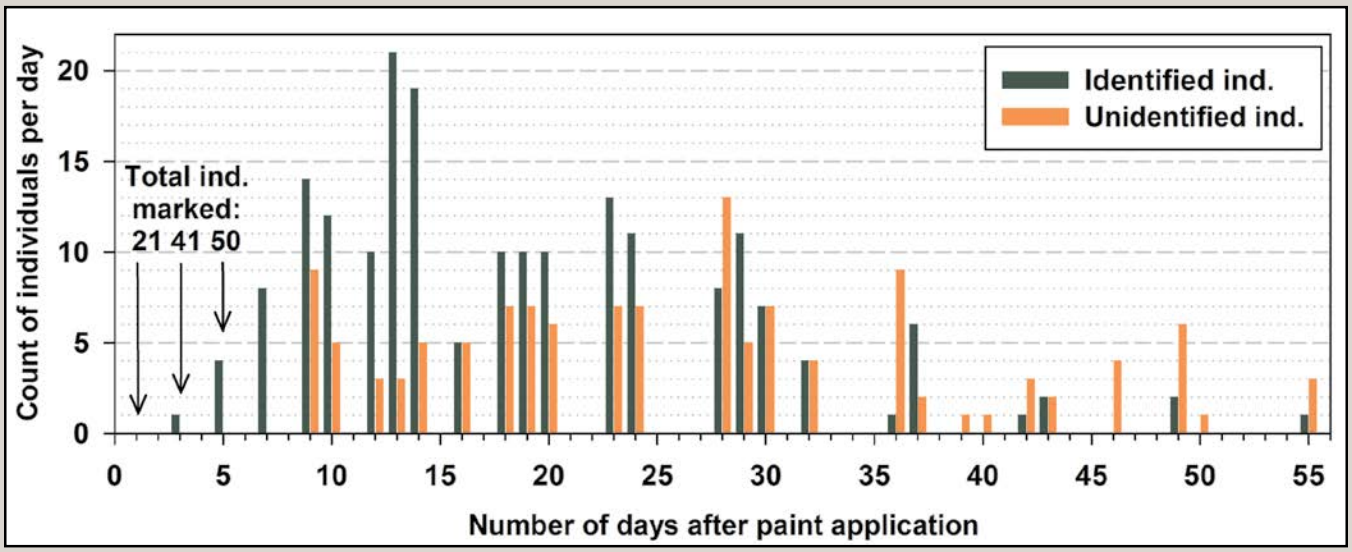


FIG. 2. Daily counts of identified individuals and unidentified but marked turtles based on double marking (individual paint marking and external temperature logger) of 50 turtles. "Unidentified" turtles lacked a clear paint mark but had a visible iButton or in a few instances escaped before a positive identification could be made. Turtles were marked 18–23 May 2007 (days 0–5).

paint was clearly visible in most instances against the contrasting black carapace of the *P. c. suwanniensis*. However, the glare from a dry carapace painted with orange made turtle identification problematic in full sunlight; blue or green marks could be difficult to distinguish against a background of vegetation along the river (R. Jones, pers. comm.).

The potential of differential fleeing responses by basking turtles to watercraft or observers on the bank should be considered and/or tested in mark/resighting studies or surveys. Habituation to boat traffic, interspecific differences, or stress caused by the marking procedure might skew the results, even when comparing data on a single species among sites within the same river (R. Jones, pers. comm.). In our study, turtles exhibited a range of behavioral responses, sometimes allowing us to approach them to less than 2 m, while at other times fleeing when observers were more than 50 m away. Observers might also be biased and initially focus their attention on counting marked turtles while conducting boat surveys, during which time unmarked turtles might escape without being recorded. Combining both spotting scope surveys from a hide with boat observations could minimize observer bias, increase detection probability, and provide for more accurate estimates of population parameters.

To improve mark retention and resightability, we suggest that researchers 1) completely remove algae and loose scutes from the carapace prior to marking, 2) thoroughly dry the shell before painting, 3) use wide paint marks with more paint, and 4) combine appropriate paint colors on the same individual while varying the position of the number on the carapace to facilitate identification even under suboptimal conditions.

A question not addressed by our study is whether the presence of highly visible marks increased depredation either directly on adults or indirectly on nests or females while depositing eggs. We do not have reason to suspect increased predation or take by humans on individuals during our study. Only a few basking alligators were observed diurnally, when marks were most detectable and turtles were susceptible to visual predators. Although alligator tooth marks have been observed on a few turtles in the river, none of our paint marked turtles bore fresh tooth marks or wounds that post-dated original capture and paint application. Still, we advise against application of paint on hatchlings and juveniles (SCL < 100 mm), since they favor spending time in cryptic microhabitats as an antipredatory strategy (Jackson and Walker 1997; Kornilev 2008).

Aside from the scientific information we collected, the visible paint numbers sparked the interest of recreational boaters on numerous occasions on the river and led to a short note in a local newspaper (Reinink 2008). The potential for publicity to serve a negative purpose, such as facilitating human harvest, should be considered prior to marking animals (e.g., Heinrich et al. 2010). However, publicity may also serve a positive purpose by raising public awareness of conservation issues. If properly planned, citizen scientists might even be trained to increase the amount of data collected.

Our experience supports the view that individual paint marking is suitable for short-term collection of ecological data and monitoring of basking turtles. It also provides an inexpensive tool for successful management and conservation, but retention, behavioral responses, and length of study need to be considered thoroughly before applying this technique and interpreting results.

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Blood Sampling in Testudinidae and Chelidae

Blood sampling is among the most common procedures in vertebrate studies. When done correctly, it may be less invasive than taking other tissues. In the case of DNA analysis, rather small amounts of blood are necessary, although the required amount may be larger for physiological studies.

An easy sampling technique is important for obtaining blood from chelonians for a variety of purposes, such as genetic analyses and clinical pathology diagnostics. Several blood sample sites have been described in chelonians, including heart, veins (jugular, brachial, ventral, femoral, coccygeal, or scapular), brachial artery, orbital sinus, a sub-carapacial venipuncture site, retro-orbital space, and trimmed toe-nails (Avery and Vitt 1984; Bulté et al. 2006; Dessauer 1970; Hernandez-Divers et al. 2002; Jacobson 1987; Rogers and Booth 2004; Stephens and Creekmore 1983; Ulsh et al. 2001). Some sampling methods have disadvantages, such as higher risk of infection (Strik et al. 2007). The orbital sinus has been used for collecting small volumes of blood through capillary tubes (Nagy and Medica 1986), however, this method results in dilution of the blood sample with extracellular fluids and secretions, which may alter the composition of plasma, affect the volume of cellular components, and result in incorrect interpretation of biochemical data. Because lymphatic systems are well developed in chelonian forelimbs and tails (Ottaviani and Tazzi 1977), obtaining blood samples from sites near the lymphatic system may result in hemodilution with lymph (Rohilla and Tiwari 2008).

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Most published techniques have been applied in long-tailed species such as *Graptemys geographica*, *Trachemys scripta*, *Macrochelys temminckii*, and marine turtle species (Bennett 1986; Bulté et al. 2006; Roman et al. 1999; Ulsh el al. 2001; Wibbels et al. 1998). However, the tail is very short in some species, e.g., in the genera *Chelonoidis* and *Phrynops*. This may cause some practical problems in blood sampling when utilizing the tail vein, such as sample contamination, because of the fecal discharge used as a defense mechanism and because animals may be difficult to hold firmly with recommended devices, such as those described for *Trachemys scripta* (Ulsh et al. 2001). Also, the amount of blood obtained from such sites is very low and sometimes not enough for lymphocyte separation and culture.

We collected blood samples from the testudinids *Chelonoidis carbonaria* and *C. denticulata* and the chelids *Phrynops*

PHOTO BY TIAGO LUCENA DA SILVA



FIG. 1. A) Blood sampling from the marginal costal vein for *Chelonoidis carbonaria* (Testudinidae; inset enlarged to show the exact position). B) Blood sampling from the external jugular vein for *Phrynops geoffroanus* (Chelidae; inset enlarged to show the exact position).

geoffroanus and *P. hilarii* (10 adult animals for each species). The animals were from the "Reginaldo Uvo Leone" breeding farm in Tabapuã, São Paulo, Brazil (20.9965°S, 49.12128°W).

The sampling site was first cleaned with distilled water and 70% ethanol. For testudinids, the marginal costal vein, lateral to the longitudinal axis of the animal, was used as a blood sampling site. An insertion of 5 mm is necessary and should access close to the forelimb (Fig. 1A). Some adjustment in angle, insertion, and position of the needle may be necessary.

In chelids, the external jugular vein is relatively dorsal and superficial in the neck. The biventer cervical and transverse cervical muscles are good dorsal landmarks for the external jugular. These muscles are externally obvious and are to either side of the vessels; the external jugular is located deep and between them and medial to the transverse cervical muscle. Correct insertion of needle requires a 90° angle downward, right before the cranium base, and a 2 mm deep insertion is necessary (Fig. 1B). However, the correct access depends on the size of the animal. The syringe was withdrawn slowly to create a vacuum for easy sampling.

The marginal costal and external jugular veins are located in the peripheral part of the body, hence there is no chance of injury to vital organs and sufficient blood can easily be withdrawn from adult animals. Some adjustment in the needle size may be necessary for hatchlings. The volume of blood taken from a healthy animal should be no more than 1% of its weight (Fudge 2000).

After blood collection, the skin was again swabbed with 70% ethanol to prevent microbial infection and the turtles were left in plastic boxes for observation for four hours. None of the animals used in this study showed any ill effects related to blood sampling.

Our procedure on these species allows collecting enough blood for several studies. The methods demonstrated do not require anesthesia and can be adopted for several other turtles, facilitating the study of this important vertebrate group.

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A Fully Adjustable Transmitter Belt for Ranids and Bufonids

Tracking free-ranging amphibians with radio telemetry yields invaluable data, but is difficult and laborious. Frogs and toads generally weigh <100 g, have thin, delicate skin without a protective covering, and a challenging body form for radio transmitter attachment. Because of these features, investigators must use small (<10 g) radio transmitters with limited range and battery life, and travel to the field on a regular basis to relocate each animal. For all this work and labor, the investigator needs a device that secures the radio transmitters to the animal without damaging its skin or otherwise harming it.

Transmitters can be either implanted (e.g., Carey 1978) or attached externally to anurans. Because external attachment generally has caused little or no effect on behavior or weight gain in anurans (Bartelt and Peterson 2000; Rowley and Alford 2007; Indermaur et al. 2008; Sullivan et al. 2008), and given the much less stress caused to the animal, it is the recommended approach for most study needs (Indermaur et al. 2008). A variety of attachment designs have been used to meet all the requirements of telemetry for anurans (e.g., beaded chains, Rathbun and Murphey 1996; 1 mm outside diameter plastic belts, Bartelt and Peterson 2000; nylon ribbons, P. Ritson and D. Pilliod, pers. comm.; see Bull 2000 for review). Some designs have worked better for certain species, study areas, or investigators. For example, plastic belts and nylon ribbons have worked well in some studies, but caused deep wounds on frogs and toads that we study in the Midwest; beaded chains, while working well for larger frogs, can be rather heavy for medium sized (20–30 g) frogs and their relatively widely spaced beads limits fine size adjustments; on toads, beaded chains tend to collect and hold dirt that then cuts into their rough, drier skin (F. Anderka, Holohil Systems, Ltd., pers. comm.). Other belts (e.g., Muths 2003; Rowley and Alford 2007) were designed for relatively short study periods (few weeks to a month) or included small beads that would seem to have a similar effect on toads as beaded chains. A "common" design (i.e., one that works well for both frogs and toads) could help simplify materials needed for telemetry. In addition, a belt that can be easily and finely adjusted to fit the animal as it grows throughout the season may help reduce the problem of skin sores. We developed a fully adjustable belt for our current study of Northern Leopard Frogs (*Lithobates pipiens*) and American Toads (*Anaxyrus americanus*). We describe its design and evaluate its performance over two seasons of study in north-central Iowa.

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Methods.—We attached 1.8 g model BD-2 radio transmitters (Holohil Systems, Ltd., Carp, Ontario) to post-breeding adult frogs and toads during the 2009, 2010, and 2011 (current) field seasons. These radio transmitters have an expected battery life of 14 weeks and, based upon our field measurements, a typical detection range of 400–650 m. The waist belt was made from two sizes of flexible tubing and a length of thin (0.28 mm diameter), copper wire. Holohil Systems imbedded a 1 mm inside diameter (ID) plastic tube within the epoxy of the transmitter. The length of copper wire, approximately equal to the circumference of the animal's waist, was passed through this tube. Two lengths of dark gray, flexible PVC tubing (PVC 105–18, 1.0668 mm outside diameter (OD); Alphawire, Elizabeth, New Jersey), each equal to about one-third the animal's waist circumference, were slipped over the ends of the copper wire (one length on either side of the transmitter). We secured these lengths of PVC tubing against the transmitter by bending the ends of the copper wire over their ends (Fig. 1). The belt is secured around the animal's waist by passing the ends of the PVC tubing into a length of silicone tubing (1/16" ID and 1/8" OD; Cole Parmer Instrument Company, Vernon Hills, Illinois), cut to approximately one-half the circumference of the animal's waist (Fig. 2). The belt was adjusted for fit by changing the amount of PVC tubing extending inside the silicone tubing. Because the OD of the PVC tubing was very close to the ID of the silicone tubing, friction held the belt together (i.e., similar to a Chinese finger trap). The average (± SD) weight of twelve finished belts was 0.274 ± 0.041 g.

Results.—We used this belt on a total of 14 frogs and 20 toads during the 2009 and 2010 seasons, and seven frogs and 34 toads during the 2011 season. Making and attaching the belt required 5–10 minutes and the double-tube design made it easy to make fine adjustments in the field in less than one minute. During 2009–2010, frogs weighed an average (± SD) of 38.3 ± 11.0 g (range = 20–65 g); toads weighed an average of 34.6 ± 7.7 g (range = 22.5–55.5 g). The average length of time that frogs and toads wore the belt was 29 ± 24 and 34 ± 16 days, respectively. Factors limiting the time of telemetry with these animals included escaping the belt (~50%), predation (~20%), lost signal (~9%) and death (~9%) (Table 1). Six of the 20 toads and two of the 14 frogs developed minor skin abrasions that were easily and effectively treated in the field by applying Vitamin E to the sore and adjusting the belt; two additional toads developed more serious abrasions that required removal of the belt. Half (N = 8) of those animals that escaped did so after the long whip antenna became entangled in dense herbaceous vegetation. We eliminated this problem by shortening the whip antenna from a length of 15 cm to 10 cm.

During 2011, frogs weighed an average of 3.2 ± 8.7 g (range = 27–52 g); toads weighed an average of 35.9 ± 6.9 g (range = 22–52 g). Additional experience with this belt resulted in fewer lost animals and much longer tracking periods (Table 2). At the time of this writing (mid-July 2011), no animals have been lost due to antennas becoming entangled in herbaceous stems. We have released only one animal due to skin wounds and only four others have escaped the belt. Fates of others include predation (~32%), death (~20%), and lost signal (~7%).

Discussion.—This belt is light-weight (i.e., adds < 0.3 g to the radio transmitter), was easily attached and adjusted in the field

Table 1. Average weight, fate, and number of days tracked for Northern Leopard Frogs (NLF) and American Toads (AT) during 2009 and 2010 field seasons. Half of those that escaped did so when the antenna of their radio transmitters became entangled in dense vegetation; shortening the antenna eliminated this problem.

No. of NLF	Avg. Wt.	Fate	No. Days Tracked
3	36.0 ± 9.1	released	49.0 ± 13.8
7	40.1 ± 13.7	escaped	26.7 ± 16.1
2	32.2 ± 3.2	predation	19.5 ± 13.4
1	50	died	7
1	33	signal lost	27
No. of AT	**Avg. Wt.**	**Fate**	**No. Days Tracked**
2	34.5 ± 0.7	released	78.5 ± 31.5
9	35.2 ± 6.9	escaped	23.2 ± 13.3
5	36.3 ± 12.7	predation	29.0 ± 9.7
2	28.0 ± 4.0	died	31.5 ± 0.71
2	34.5 ± 2.1	signal lost	54.5 ± 23.5

Table 2. Average weight (Avg. Wt.), fate, and number of days tracked for Northern Leopard Frogs (NLF) and American Toads (AT) during the 2011 field season (as of mid-July 2011).

No. of NLF	Avg. Wt.	Fate	No. Days Tracked
4	35.4 ± 11.6	predation	26.5 ± 9.6
3	30.3 ± 2.1	died	25.3 ± 12.8
No. of AT	**Avg. Wt.**	**Fate**	**No. Days Tracked**
9	34.5 ± 0.7	still tracking	> 70
1	47	released	25
4	32.3 ± 4.5	escaped	10.5 ± 10.3
3	30.3 ± 15.6	belt broke	61.9 ± 10.7
9	35.0 ± 7.6	predation	20.1 ± 12.4
5	33.8 ± 8.3	died	26.6 ± 9.0
3	37.3 ± 2.1	signal lost	34.7 ± 29.7

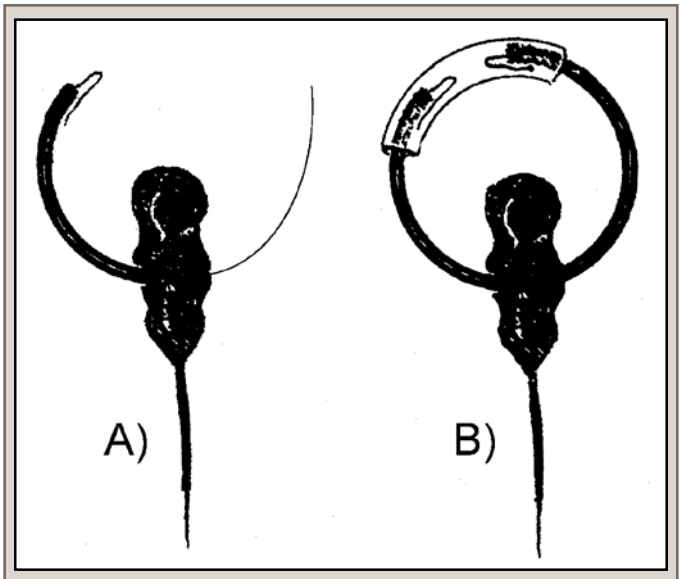


Fig. 1. Details of this belt design. A) Belt showing copper wire extending through one length of PVC tubing and 1 mm tube imbedded within the transmitter epoxy. The copper wire is bent over an end of the PVC tubing. B) Finished belt affixed to a radio transmitter. Both lengths of PVC tubing are held firmly against the transmitter by the copper wire. A length of silicone tubing fits snugly over each end of the PVC tubing and allows for easy and fine adjustments around the waist of a frog or toad. (A slight angle to this drawing makes the silicone tubing appear slightly off center.)



Fig. 2. Details of the belt attached to a Northern Leopard Frog. The length of silicone tubing, visible in the middle of the belt, makes the belt fully adjustable.

by one individual in under five minutes, seemed to be minimally invasive (affected normal behavior little and caused minimal injuries), and released the animal when it became entangled in dense vegetation. Two other attachment methods (a plastic belt, Bartelt and Peterson 2000, and a nylon ribbon, Pilliod and Ritson, pers. comm.) caused deep skin wounds on 19 of 30 animals. The smooth, rounded, larger diameter tubing of this belt distributed the point of contact over a larger area of the delicate skin. Its ease of attachment minimized the amount of time each animal was handled, lessening stress to the animal, and its ability to be finely adjusted throughout the season helps reduce skin sores.

The belt did not seem to interfere with normal, daily movements and behavior, or amplexus. Perhaps the biggest problem we encountered was when the long whip antenna became entangled in the dense growths of vegetation of restored prairies. The shortened antenna reduced the detection range of the radio signal by 50 m, or 10–15% of its previous detection range, but for this study the elimination of entangled antennas made this shortened range worthwhile. However, the shortened antenna may not be appropriate for tracking species that make longer distance movements, or use habitats that reduce detection ranges.

Belts with a feature that allows the radio transmitter to fall off the animal after many weeks helps ensure any animal whose signal is lost will not permanently carry the radio transmitter. We have recently discovered (2011) that the thin copper tends to

break after 9–12 weeks of wear in the field (= approx. battery life of the transmitter); we cannot yet claim this will happen consistently, but five have fallen off tracked toads (two radio transmitters were lying directly adjacent to the toads and reattached). If one needs to ensure the radio transmitter remains on an animal longer, a slightly thicker wire may be used, or the wire may be replaced with a continuous length of PVC tubing (the radio transmitter manufacturer will need to embed a tube with an ID of 1.1 mm). The weight of the 0.28 mm copper wire is approximately equal to the additional length of PVC tubing, so total transmitter weight would remain the same.

We tested this belt only on Northern Leopard Frogs and American Toads, but think it would be suitable for other medium to large species of ranids and bufonids for long-term (i.e. 3–5 month) studies. Like all other attachment methods, experience with this belt improved its success. We caution researchers to choose tubing colors that blend into the animals' natural habitats, check the animals frequently (e.g., once/week) for any sores or health problems, and to remove dead skin from the belt (dead skin clinging to belts seems to facilitate skin sores). This diligence can greatly diminish skin and health problems.

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Utilizing a Slide to Move Heavy-bodied Snakes



FIG. 1. Slide attached to exhibit with door open.



FIG. 2. Removing Gaboon Viper (*Bitis gabonica*) from exhibit with slide.

The manipulation of heavy-bodied snakes using traditional methods and tools can present difficulties for both the snake handler and the snake. The weight of a large animal feels substantially amplified at the end of a 36-inch (91.4 cm) snake hook and this increased weight can present a serious safety challenge with larger snakes.

For many heavy-bodied snakes that are primarily ground dwellers, being draped over a snake hook is very unnatural and will often result in excessive struggle leading to injury. In the process of manipulating these animals on traditional snake hooks, they commonly sustain rib fractures and less commonly spinal fractures (Altimari 1998). One technique to mitigate this challenge is to employ the use of two hooks to balance the weight

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FIG. 3. Metal lip used to attach slide to steel track of exhibit.



FIG. 4. Gaboon Viper (*Bitis gabonica*) inside holding cooler after being moved on the slide, prior to lid being secured.

of the animal more evenly (Altimari 1998). In addition, the preferred hooks to use when manipulating various species of heavy-bodied snakes are more flattened, rather than round to further support the animal with minimal injury (Altimari 1998).

Another technique that is commonly used for the manipulation of heavy-bodied snakes is termed "tailing." This method involves the use of one snake hook and then restraining the snake by holding the tail with a hand. For our department it was decided not to utilize this type of manipulation in order to avoid any unnecessary risks inherent with this method of venomous snake handling.

The method utilized to move Gaboon Vipers (*Bitis gabonica*) in and out of exhibit space at the National Zoo involves a "slide" in conjunction with a snake hook (Fig.1). The slide supports the majority of the snake's weight during the move, with the snake hook used only for guidance and minimal manipulation (Fig. 2). The slide is constructed of pine plywood, sanded and varnished to prevent splintering. At the top of the slide a piece of angled sheet metal (1 in. × 7/8 in; 2.5 cm × 2.2 cm) was installed and bent to fit securely into an existing steel track attached directly under the exhibit door (Fig. 3). The slide is 42 in. (106.7 cm) long and wider at the top (20.5 in.; 52.1 cm) where it attaches to the steel tract and tapers more narrowly at the base (13.5 in.; 34.3 cm). Rails (3 in. W × 42 in. L; 7.6 cm × 106.7 cm) were installed on each side of the slide to prevent the animal from falling off the edge. In addition to the sheet metal lip locking into the track of the concrete wall the slide is supported by two legs measuring (2 in. W × 24 in. L; 5.1 cm × 61 cm) that fold for easy storage. A 24-gallon (91 liter) cooler is placed at the base of the slide as a holding container. An eye hook was attached to the lid of the cooler, which allows the lid to be properly secured with a snake hook while remaining out of the snake's striking range. The snake can easily be manipulated with a snake hook onto the slide and slowly guided downward into the container (Fig. 4). Once secured within the container, the exhibit is worked safely and the snake is returned to the exhibit using the slide yet again. This method of moving *B. gabonica* and other heavy-bodied species of snakes has been employed for many years at the National Zoo with no spinal injuries or other health problems for the snakes involved.

Acknowledgments.—We thank Béla Demeter for the concept and design of this piece of equipment. Photographs were taken by Mehgan Murphy, photographer, Smithsonian National Zoological Park.

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HERPETOCULTURE NOTES

SQUAMATA — LIZARDS

LIOLAEMUS FORSTERI **(NCN). CANNIBALISM.** Cannibalism in lizards belonging to the genus *Liolaemus* has been reported previously (Rocha 1992. Herpetol. Rev. 23:60; Ripoll and Acosta 2007. Herpetol. Rev. 38:459, Kozykariski et al. 2009. Herpetol Rev. 40:89). This is the first report of cannibalistic behavior in *L. forsteri*, a species endemic to the higher elevations (4300–4900 m) of Bolivia (Baudoin and Pacheco 1991. *In* E. Forno and M. Baudoin [eds.], Historia Natural de un Valle en Los Andes, pp. 438–439. Instituto de Ecología, Universidad Mayor de San Andrés, La Paz).

On 9 August 2011 we observed a captive adult male *L. forsteri* (80 mm SVL) attack and eat a recently hatched individual of the same species (hatchlings have mean SVL = 34 ± 0.8 mm, N = 4). The attack occurred quite rapidly and concluded with the adult swallowing the whole body of the hatchling (Fig. 1). The adult male was evaluated using radiography 48 h after the event, but there was no visible evidence of the hatchling in the digestive track. However, fecal analysis confirmed the presence of skin remnants.

The species reported here as *L. forsteri* was considered as *L. signifer* until a recent taxonomic review (Aguilar-Kirigin 2011. Revisión Taxonómica y Sistemática del Género *Liolaemus* (Iguania:



PHOTOGRAPH TAKEN FROM VIDEO COURTESY OF MATÍAS BARCELÓ.

FIG. 1. Adult male *Liolaemus forsteri* swallowing a hatchling conspecific.

Liolaemidae) en el Altiplano y Valles Secos Interandinos del Departamento de La Paz-Bolivia. Licenciatura thesis. Univ. Mayor de San Andrés, La Paz. 106 pp.).

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***TROPIDURUS ITAMBERE*. ESCAPE BEHAVIOR.** Despite its wide distribution in Brazil (Rodrigues 1987. Arq. Zool. 31:105–230), there are few studies on the behavior of *Tropidurus itambere*. Escape behavior is expected to be under strong natural selection as predation is probably one of the most pervasive selective agents for most organisms. It is considered a secondary defense mechanism, and is used when errors occur in primary defense mechanisms (Edmunds 1974. Defense in Animals. Longman Group. New York. 357 pp.). Lizards can remain on their initial substrate type or escape to "preferred" substrates (Vanhooydonck and Damme. 2003. Funct. Ecol. 17:160–169.). Thus, specific locations and soils may increase an animal's chance of surviving a predatory attack (Vanhooydonck et al. 2007. Integr. Comp. Biol. 2007:1–11). Locomotor escape behavior is a defense mechanism widely used in lizards. Some species burrow into the substrate where they live or dive into sand (Greene 1988. *In* Gans and Huey [eds.], Biology of the Reptilia, pp. 1–50. Alan R. Liss, Inc., New York; Rocha 1993. Cienc. Cult. 45:116–122). To date, burial escape behavior in *T. itambere* has not been reported.

On 14 February 2010, we collected an adult male *T. itambere* (7.08 mm SVL) in Reserva Biológica Unilavras – Boqueirão (44.9172°W, 21.4011°S; 1250 m elev.), in a rocky field within Cerrado, in the municipality of Ingaí, state of Minas Gerais, Brazil. The behavior of this specimen was studied for 30 min. under laboratory conditions, using the focal animal method (Altmann 1974. Behaviour 49:227–267). The specimen was placed in a terrarium with sandy soil, with water, rocks, and natural vegetation obtained at the collection site. In the terrarium the lizard burrowed into the sand head first, using its forelimbs in fast, alternate movements of excavation. The lizard immediately curved its body into an "S" configuration and completed the burial using its hindlimbs, leaving only its head above the surface. In Cerrado areas, *T. itambere* is associated with rock fields (Rodrigues, *op. cit.*) and in Ingaí, these areas consist of rocky outcrops, usually in sandy soils (Pereira and Volpato 2005. Pro Hom. 4:27–34). *Tropidurus* is widely distributed geographically with both saxicolous and psammophilous forms, *T. itambere* being saxicolous (Faria and Araújo 2004. Braz. J. Biol. 64:775–786). It may be that burial escape behavior is an ancestral trait within *Tropidurus* that has been retained in the genus as speciation occurred across different substrate types.

The current study reports burial behavior exhibited by *T. itambere* from Brazil for the first time. The specimen (CRLZ 000178) was deposited at the Coleção de Répteis do Laboratório de Zoologia, Centro Universitário de Lavras - UNILAVRAS, municipality of Lavras, Minas Gerais, Brazil.

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SQUAMATA — SNAKES

***BOGERTOPHIS SUBOCULARIS* (Trans-Pecos Ratsnake). UNUSUAL BEHAVIOR DURING FEEDING.** On 14 November 2006, I observed a long-term captive adult male *Bogertophis subocularis* exhibiting an interesting tail movement behavior herein termed "pre-prandial caudal flicking." I have observed this behavior multiple times over the past five years in both wild caught and captive bred individuals of this species and in a captive bred *Pantherophis bairdi* (Baird's Ratsnake).

In each case, laboratory mice (*Mus musculus*) were offered as live prey or previously euthanized (frozen and thawed). All mice were placed behind cage furniture (e.g., a section of cork bark), which obstructed the view of the snakes to the prey item. It was apparent by the snakes' behavior (alertness, repeated tongue flicks and searching) that they were fully aware of the proximity of the prey item. After approximately 10 seconds of searching behavior, each snake would remain nearly motionless but rigid with only the tail moving. The movement of the tail is best described as intermittent bouts of rapid, spontaneous flailing in a wide-ranging motion. Each burst of movement was characterized by a thrashing or whipping action of the tail lasting approximately 2 seconds with periods of no movement lasting 4–6 seconds. As soon as the mice were located they were quickly seized and constricted.

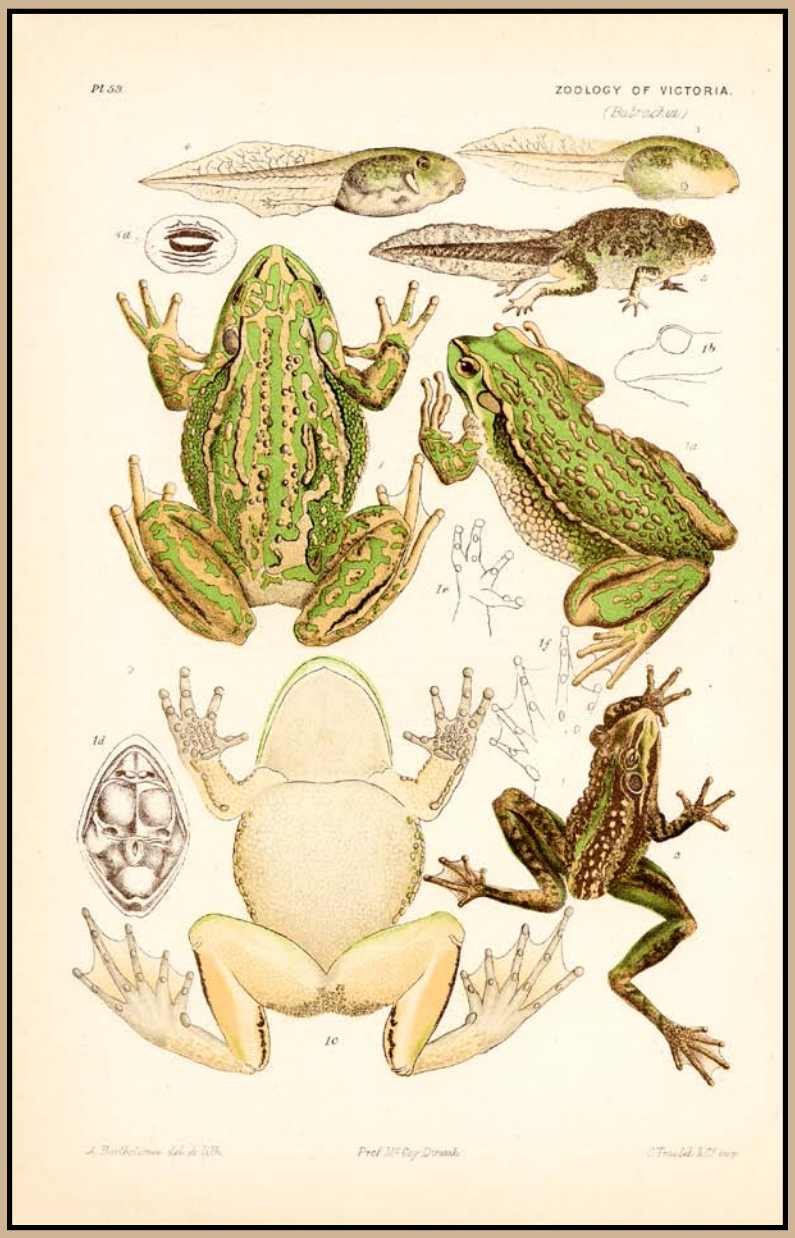
The type of movement described most resembled the frantic caudal trembling exhibited by many eublepharid geckos just before a predatory strike directed towards an invertebrate prey item (Kaverkin 2005. *In* A. Kirschner, H. Seufer, and Y. Kaverkin [eds.], Eyelash Geckos: Care, Breeding and Natural History, pp. 127–132. Kirschner & Seufer Verlag, Karlsruhe). However, it differed from

this behavior in that all caudal movement ceased when the prey objects were visually located by the snakes. The observed behavior is very different from the caudal luring behaviors described for New World pit vipers, (Sazima 1991. Copeia 1991:245–248) and the Green Tree Python (*Morelia viridis*; Murphy et al. 1976. J. Herpetol. 12:117–119; Maxwell 2003. The Complete Chondro: A Comprehensive Guide to the Care and Breeding of the Green Tree Python. ECO Herpetological Publishing, Lansing, Michigan. 247 pp.) where the tip of the tail is raised and moved in a slower "inch worm"-like motion. This is also vastly different from the tail buzzing or vibrating behavior that many species of snakes, including *B. subocularis*, use as a defensive, warning behavior when threatened by a predator (Rhoads 2008. The Complete Suboc: A Comprehensive Guide to the Natural History, Care, and Breeding of the Trans-Pecos Ratsnake. ECO Herpetological Publishing, Lansing, Michigan. 291 pp.).

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ART IN HERPETOLOGY



The illustration at left originally accompanied an article titled: "Ranoidea aurea, The Green and Golden Bell-Frog," *published in 1881 within the pages of Prodromus of the Zoology of Victoria; or Figures and Descriptions of the Living Species of All Classes of the Victorian Indigenous Animals*. This periodical, published in twenty parts from 1878 to 1890 by the National Museum of Melbourne was met with critical acclaim and wide popular support. John McCoy (1823–1899), director of the National Museum of Melbourne, wrote the text and employed a number of artists to illustrate his work, including Arthur Bartholomew, the illustrator and lithographer of this piece. Bartholomew was born in Bruton, Somerset Shire, England in 1834. In 1852, at 18 years of age, he left his homeland and moved to Australia. Not long after his arrival in Melbourne, he set forth to explore the Australian bush and ventured to Tasmania where he met his wife, with whom he had two children.

Bartholomew returned to Melbourne with his family where, in 1859, he was appointed Attendant in Melbourne University's department of Natural History. It was here he met McCoy, who recognized Bartholomew's artistic abilities. McCoy hired Bartholomew to complete a series of zoological and geological illustrations for several projects, including the *Prodromus*. Bartholomew was known to illustrate living specimens, which included several frog species that he tended to keep in the laboratory adjacent to McCoy's lecture room. A characteristic of Bartholomew's work is the use of line drawings within his illustrations to provide diagnostic features of each species. Examples of these line drawings can be seen in this piece. This is the first illustration showing the natural colors of the species, now known as *Litoria aurea*.

Bartholomew's career as a biological illustrator spanned 40 years, a period of time that would see him illustrate over 700 zoological specimens and an as-yet undocumented number of geological and paleontological specimens. He died in Melbourne in 1909. Additional information can be found at http://museumvictoria.com.au/caughtandcoloured/.

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AMPHIBIAN DISEASES

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Chytrid Fungus, *Batrachochytrium dendrobatidis* (*Bd*), Detected at Lower Elevations in Puerto Rico: Implications for Conservation of Puerto Rican Crested Toad (*Peltophryne lemur*)

The Puerto Rican Crested Toad, *Peltophryne lemur*, is federally listed as Threatened (U.S. Fish and Wildlife Service 1992) and Critically Endangered by the International Union for Conservation of Nature and Natural Resources (IUCN 2011). It is the only native toad of Puerto Rico and is a representative of an ancient and distinctive clade of Bufonidae that is distinguished from other species by its unique elongated snout and pronounced cranial crest (Pramuk 2006; Pramuk et al. 2007). Once widespread throughout the karst regions, the last remaining wild population has been reduced to a small area within the southwestern part of the island and fluctuates between 300 and 3,000 individuals (M. Canals, unpubl. data).

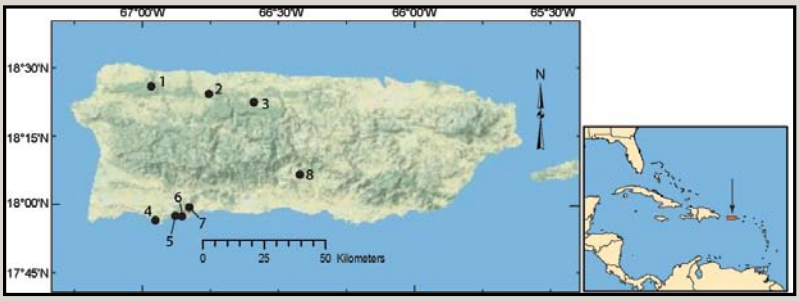


FIG. 1. Map of Puerto Rico. Numbers correspond to the following collection sites: Quebradillas (1), Arecibo (El Tallonal) (2), Rio Encantado (3), Manglillo (4), Aroma (5), Tamarindo (6), Ventana (7), Coamo (Gabia) (8).

Recovery efforts for this species include a reintroduction program directed by the United States Fish and Wildlife Service (USFWS), the Puerto Rican Department of Natural and Environmental Resources (PRDNER), and the Association of Zoos and Aquariums Puerto Rican Crested Toad Species Survival Plan (PRCT SSP). Since intensive reintroduction began in 1992, more than 179,000 tadpoles produced from captive-bred toads held primarily in North American zoos have been released onto the island. These efforts have resulted in the establishment of three new breeding populations. In recent years, monitoring efforts have increased at all current known toad localities, as well as historic and potential reintroduction sites. Random sampling for the chytrid fungus, *Batrachochytrium dendrobatidis* (*Bd*), began in 2006 (Table 1) in order to assess the overall health of the wild *P. lemur* populations and mitigate threats that might be introduced via disease from other amphibian species.

The earliest record of chytridiomycosis detected in Puerto Rico was from preserved *Eleutherodactylus* specimens collected in 1976 (Burrowes et al. 2008). *Bd* has been reported from 7 of 15 localities surveyed within the island, all of which were found at elevations above 600 m (Burrowes et al. 2008). Herein, I report the detection of *Bd* at two additional sites within Puerto Rico at lower elevations than previously reported (Table 1). These recent findings are important to consider relative to future *in situ* and *ex situ* conservation management strategies developed for *P. lemur*.

Random samples were taken of live amphibian species opportunistically while visiting known *P. lemur* sites and one potential new reintroduction site from 2006 to 2011 (Fig. 1). All *P. lemur* samples were taken from wild specimens (not recently metamorphosed from a reintroduction program). Juvenile and adult anurans were captured by hand. Latex gloves were worn and changed between each sampling event. Standard preventative measures were taken while processing specimens to prevent the risk of disease transmission and sample contamination. The ventral skin surface of each anuran was swabbed 25 times around the forelimbs, stomach, pelvic region, legs and toes using a sterile cotton swab. Each sample was stored in an individual vial containing 70% ethanol until processed. All samples were processed at Pisces Molecular LLC (Boulder, Colorado, USA) using a Polymerase Chain Reaction assay method developed by Seanna Annis, which was modified for greater specificity and sensitivity. A total of 157 samples were processed representing seven species at eight sites.

All samples were negative, with the exception of two samples rated as "strongly positive" by Pisces. *Bd* was confirmed from an *Eleutherodactylus antillensis* collected in 2010 from a potential new release site for *P. lemur* in Rio Encantado at an elevation of approximately 192 m. The second *Bd*-positive sample was collected from an *Eleuthrodactylus coqui* at a current reintroduction site in Arecibo at an elevation of close to 82 m (Table 1).

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TABLE 1. Localities in Puerto Rico where amphibians were sampled for *Batrachochytrium dendrobatidis* (*Bd*). Site numbers correspond to locations illustrated in the map (Fig. 1).

Site no.	Location	Elevation (m)	Sample date (mo/yr)	Species	No. sampled	No. *Bd* +	No. *Bd* –
1	Quebradillas (Bo. Cocos) 18.46767°N 66.91843°W	95	12/06	*Rhinella marina*	4	0	4
			12/06	*Eleutherodactylus antillensis*	1	0	
			12/06	*Osteopilus septentrionalis*	5	0	5
2	Arecibo (El Tallonal) 18.40677°N 66.73087°W	82	12/06; 12/07; 04/08 02/10; 05/10; 10/10 05/11	*R. marina*	20	0	20
			05/10; 05/11	*Leptodactylus albilabris*	6	0	6
			04/08; 05/10 ; 05/11	*E. antillensis*	4	0	4
			04/08; 05/11	*Eleutherodactylus coqui*	2	1	1
			04/08; 05/10; 05/11	*Peltophryne lemur*	8	0	8
			05/11	*Lithobates catesbeiana*	3	0	3
3	Rio Encantado 18.35718°N 66.53706°W	192	02/10	*E. antillensis*	2	1	1
4	Manglillo 17.93454°N 66.94710°W	6	12/06; 12/08	*R. marina*	4	0	4
			12/06; 12/07	*P. lemur*	5	0	5
5	Aroma 17.95473°N 66.85080°W	3	12/08	*P. lemur*	6	0	6
6	Tamarindo 17.95433°N 66.84838°W	2	12/06; 12/07; 10/10	*R. marina*	15	0	15
			12/07; 10/10	*P. lemur*	26	0	26
7	Ventana 17.96567°N 66.81408°W	2	12/08	*L. albilabris*	3	0	3
			12/08; 12/10	*P. lemur*	21	0	21
8	Coamo (Gabia) 18.03769°N 66.37582°W	55	12/06; 12/08; 05/10	*R. marina*	5	0	5
			12/07; 12/08; 05/08	*L. albilabris*	7	0	7
			05/10	*E. antillensis*	1	0	1
			05/10	*P. lemur*	8	0	8

Bd has been attributed to the possible extinction of at least three species of coqui (*Eleutherodactylus karlschmidti, E. jasperi*, and *E. eneidae*) in Puerto Rico (Longo and Burrowes 2010). It is unknown if *Bd* has contributed to the decline of *P. lemur*, or if it will affect populations in the future. The last known wild population inhabits dry, scrub forest, which might be too inhospitable for the pathogen due to high diurnal temperatures and lack of moisture. However, reintroduced *P. lemur* populations now exist in historic areas of karst habitat within moist rainforests, which are more favorable conditions for *Bd* persistence (Lips et al. 2008; Woodhams et al. 2008). Preliminary studies of skin peptides in a small sample of captive *P. lemur* suggest that they do not possess peptides with antimicrobial activity (J. D. King, pers. comm. 2009). Although these peptides often are present in species of amphibians that exhibit a natural immunity to *Bd* (Rollins-Smith et al. 2003; Rollins-Smith and Colon 2005), not all species secrete them (Conlon et al. 2009; Conlon 2011). Therefore, the susceptibility of *P. lemur* to an outbreak of *Bd* remains unknown. Studies are currently underway using non-genetically essential captive *P. lemur* to determine if this species can tolerate exposure to *Bd*. These findings have bearing on future reintroduction efforts and management decisions for wild populations of *P. lemur* within Puerto Rico.

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Current State of *Bd* Occurrence in the Czech Republic

Chytridiomycosis, a relatively new amphibian disease caused by the chytrid fungus *Batrachochytrium dendrobatidis* (*Bd*) (Berger et al. 1998; Longcore et al. 1999), is recognized as a global threat to amphibian biodiversity. The presence of *Bd* has had the worst impact on amphibia in Australia and the Neotropics. Other areas with intensive research and *Bd*-mediated population declines are North America and Western Europe. To date, Eastern Europe and Asia are among those areas with the least research in relation to *Bd* (Fisher et al. 2009).

The first results of broadscale *Bd* detection from Central Europe are just emerging (Ohst et al. 2011; Sztatecsny and Glaser 2011). According to these findings, *Bd* seems to be broadly distributed and quite unspecific in the hosts it infects. Although Central Europe is home to many amphibian species potentially susceptible to the disease, no adverse impact on populations or *Bd*-mediated deaths have been observed so far. Considering *Bd*'s recent emergence, we still have limited information as to its impact on species and populations here. In the Czech Republic, only negative results from limited sample sets were available until 2007 (Garner et al. 2005; Ouellet et al. 2005). Herein, we present recent results of *Bd* sampling done in the Czech Republic.

In 2010, a systematic large-scale sampling design was implemented among the diverse regions of the Czech Republic. *Bd* samples were collected primarily during spring and summer months by skin swabbing of live amphibians. This is a nondestructive method used by most chytridiomycosis researchers in the world (Hyatt et al. 2007). At each locality, we endeavored to reach a minimum of 30 samples per species/life stage in order to be able objectively assess *Bd* occurrence (Garner in litt. 2008). Individuals were captured by hand wearing disposable gloves or by dip net. All prescribed hygienic precautionary measures were taken (Wellington and Haering 2008). Sampled individuals were photographed and returned to their place of capture. In the case of dead individuals found, the last two toes from one leg were collected and preserved in 95% ethanol for future analysis. *Bd* detections were made using Taqman real time qPCR (Boyle et al. 2004), in part at the Institute of Zoology (Zoological Society of London) and in part at the Department of Biology and Wildlife Diseases (University of Veterinary and Pharmaceutical Sciences Brno, Czech Republic).

We detected *Bd* in 41 of 466 (9%) animals sampled overall, in 4 of 10 species sampled, and at 8 of 11 sites sampled (Table 1). In 2008, *Bd* was detected for the first time in the Czech Republic in the Common Toad, *Bufo bufo*, and water frogs of the genus *Pelophylax* (Baláž et al. 2009). In 2010, we found *Bd* in the

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TABLE 1. *Batrachochytrium dendrobatidis* sampling from specimens collected in the Czech Republic in 2010. Lat. = latitude, Long. = longitude, Elev. = elevation, Ad = adult animals, Sub = subadult animals, Tp = tadpoles, J = juveniles, Species (no. test. / no. pos.) = species and the number of tested and positive animals, **Bold** indicates *Bd*-positive samples, Bv = *Bombina variegata*, Bb = *Bufo bufo*, Bo = *Bombina bombina*, Ha = *Hyla arborea*, Ia = *Ichthyosaura alpestris*, Lv = *Lissotriton vulgaris*, Pf = *Pelobates fuscus*, Pr = *Pelophylax ridibundus*, Ps = *Pelophylax* sp., Pv = *Pseudepidalea viridis*, Rd = *Rana dalmatina*, Rt = *Rana temporaria*, Ss = *Salamandra salamandra*, Tc = *Triturus cristatus*, Prev. (95%) = prevalence by site with 95% confidence interval in brackets, Synt. sp. = syntopic species at a locality, GE = mean of genomic equivalent (amount of zoospores in sample tested).

Site	Site description	Lat. °N	Long. °E	Elev. (m)	Life history	Species (no. tested / no. pos.)	Prev. (95%)	Synt. sp.	GE
Most	Kopistská spoil bank	50.53913	13.59556	250	Ad (4) Sub (45) J (8)	Rd (23/0) Tc (4/10) **Bo (30/2)**	0.04 (0.01–0.12)	Lv	1.43; 0.77
Most	Růžodolská spoil bank	50.58246	13.62308	225	Ad (3) Sub (30) J (9)	**Bo (39/3)** Pr (3/0)	0.07 (0.02–0.19)	Lv, Tc	0.39; 0.50; 0.62
Most	Hornojiřetínská spoil bank	50.57635	13.57967	260	Sub (40)	Bb (40/0)			
Bojanovice	Hillside near a stream	49.84570	14.36443	260	Ad (10)	Ss (10/0)		Bb, Rt	
Temelín	Pond near a nuclear power plant	49.18041	14.36792	500	Sub (30)	**Bo (30/9)**	0.30 (0.16–0.48)		
Karlovy Vary	Albeřické fish ponds	50.15873	13.18304	603	Ad (30)	**Bo (30/2)**	0.07 (0.01–0.21)		0.89; 1.1
Karlovy Vary	Teleč pond	50.12191	13.05690	644	J (36)	**Bo (36/1)**	0.03 (0.00–0.15)	Pf, Ps	73.45
Chřiby Mt.	Municipal fire-fighting reservoir	49.14128	17.36536	250	Ad (18) J (43)	**Bv (61/11)**	0.18 (0.10–0.29)	Rt, Bb, Pv	0.4–8.8
Chřiby Mt.	Flooded track	49.15540	17.35579	300	Ad (25)	**Ia (25/1)**	0.04 (0.00–0.20)	Rt	
Moravský Písek	Flooded field	49.01034	17.34299	178	Ad (38) Sub (4) J (19) Tp (31)	**Bo (61/12)** Pf (31/0)	0.13 (0.07–0.22)	Pv, Ps, Ha, Lv	0.2–104
Staré Město	Pool in urban area	49.07396	17.45144	180	Ad (18) J (25)	Pv (43/0)		Ha, Ps	

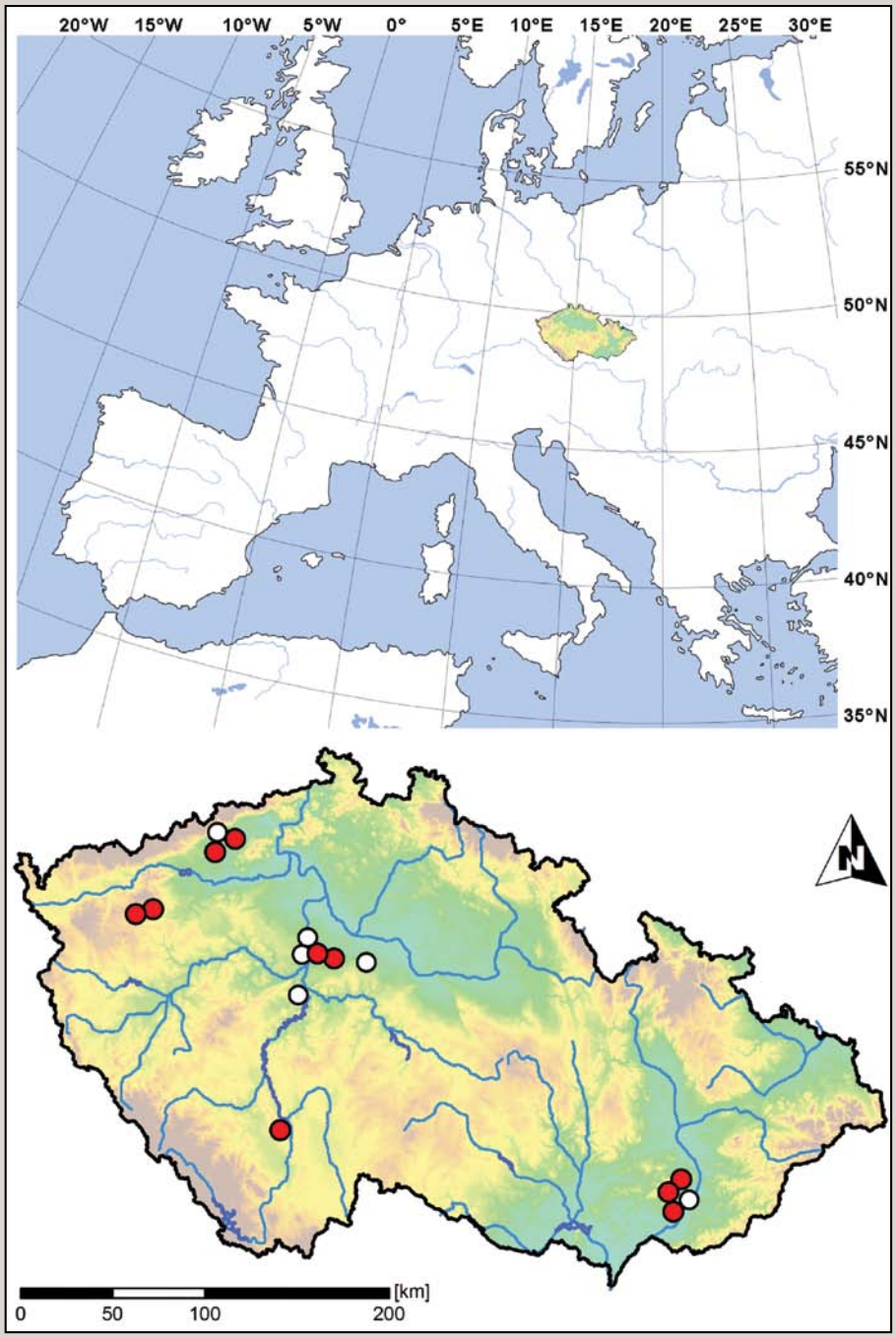


FIG. 1. Locations of amphibian populations in the Czech Republic that tested positive for *Batrachochytrium dendrobatidis* (red circles) and localities where all samples were negative (white circles). These data include the current study and unpublished data using the same methods from another six localities sampled during 2008–2009 (Vörös et al., unpubl.).

European Fire-bellied Toad, *Bombina bombina,* and the Yellow-bellied Toad, *B. variegata,* in eight discrete localities (Fig. 1, Table 1). *Bd* was most prevalent in the genus *Bombina,* however our results show very low GE values (genomic equivalent of 1 *Bd* zoospore). The observed prevalence might be underestimated because the PCR reaction that we used contained neither an internal positive control (IPC) (Hyatt et al. 2007) nor BSA (bovine serum albumin) for reduction of reaction inhibition (Garland et al. 2010). However, very similar prevalence data were already published from both Luxembourg (Wood et al. 2009) and Germany (Ohst et al. 2011), which support our observations. Several positive samples had GE values close to the detection limit of the method and only a few reached a magnitude of 10^1, but their fluorescence increase curves showed no problems with the qPCR reaction. Therefore, our results likely show low prevalence and low intensity of infection in the specimens carrying the pathogen. This is also supported by the fact that although all sampled individuals were photographed in detail, no visual symptoms of chytridiomycosis were found in *Bd*-positive animals. All dead and suspicious specimens (lethargic, abnormal sitting posture, fearless, half-closed eyes, etc.) sampled were *Bd*-negative.

In Europe to date, *Bd* has been found in more than one-third (29) of Europe's amphibian species in 13 countries (Austria, the Czech Republic, Denmark, France, Germany, Great Britain, Hungary, Italy, Luxembourg, Poland, Portugal, Spain, Switzerland) (Ohst et al. 2011; Sztatecsny and Glaser 2011; Civiš et al. 2010; Sura et al. 2010; Baláž et al. 2009; Wood et al. 2009; Garner et al. 2005; Vörös et al. unpubl.). These *Bd*-positive taxa include 19 of 21 species living in the Czech Republic.

Results from Austria (Sztatecsny and Glaser 2011), Germany (Ohst et al. 2011), Poland (Sura et al. 2010), and the Czech Republic (this paper) support the occurrence of *Bd* across Central Europe. However, the intensity of research is still notably lagging here relative to Western Europe. Thus, the data gathered to date do not allow for assessing the potential risks to Czech amphibians and their populations, which are in many cases already small and are in decline for other reasons unrelated to this disease. In the Czech Republic, therefore, at least essential precautionary steps via hygiene protocols could be established to address the disease, including approaches to mitigate its potential spread to new areas or species. Since 2010, we are conducting a more comprehensive sample, which should aid this assessment for the development of science-supported potential future management directions.

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Survey of Ranavirus and the Fungus *Batrachochytrium dendrobatidis* in Frogs of Central Virginia, USA

The Global Amphibian Assessment found that 42% of amphibian populations are in decline, and 32% of species globally face extinction in the near future (IUCN 2008). Emerging infectious diseases, including the fungus *Batrachochytrium dendrobatidis* (*Bd*) and ranaviruses, have been responsible for mass die-offs and are considered major international threats (Daszak et al. 1999; Schloegel et al. 2010). Ranavirus has low host specificity; fish, reptiles and amphibians can be lethally or asymptomatically infected and can serve as reservoirs for other vulnerable species (Chinchar 2002; Schock et al. 2008). Surveillance of these pathogens is important for understanding their distribution and potential threat to amphibians and other animals. We used non-destructive sampling to survey for *Bd* and ranavirus in central Virginia, USA. No amphibian die-offs had been recorded in this area, although dedicated monitoring had not previously occurred.

On eleven trips from 1 April through 2 July 2010 we swabbed adult animals and collected toe clips to assess the presence of *Bd* and ranavirus, respectively, in four anuran species in three water bodies in Prince Edward County, Virginia: Briery Creek Lake in Briery Creek Wildlife Management Area (north end of the lake; 37.2005°N, 78.4497°W), and two ponds on the campus of Hampden-Sydney College (Chalgrove: 37.2428°N, 78.4639°W and Tadpole Hole; 37.2452°N, 78.4529°W). Chalgrove and Tadpole Hole are both approximately 1 ha and located 0.8 km apart. Briery Creek Lake is a 342-ha lake located 4.5 km south of the other ponds. We collected adult frogs by hand, typically between 1900–2300 h. Each frog was placed in a new plastic bag, and nitrile gloves were changed between catching individuals. While processing animals, we used a recommended protocol with two people to prevent contamination of samples (Brem et al. 2007). To sample for *Bd*, frogs were swabbed five times with sterile cotton-tipped applicators on both sides of the abdomen, ventral abdomen, ventral surface of thighs, and rear feet (Brem et al. 2007). To sample for ranavirus, the front-right toes of large species (*Lithobates catesbeianus, L. palustris, Anaxyrus fowleri*) or 1–2 hind-right toes of small frogs (*Pseudacris crucifer, Acris crepitans*) were collected using sterile surgical blades (St-Amour and Lesbarrères 2007). Both swab tips and tissue samples were preserved in 70% ethanol. All animals were released within 1–3 h at the original site of capture. To prevent cross-contamination between sites, all supplies and equipment were disinfected with 1% Nolvasan. Although Nolvalsan has not been tested against *Bd*, it is used as a fungicide, bactericide, and virucide, has

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been proven to inactivate ranavirus at levels that are not toxic to amphibians, and is less caustic to equipment than bleach (Bryan et al. 2009; Kennedy et al. 2000). All materials that directly contacted animals (gloves, bags, scalpel blades, swabs) were used only once and contacted no more than one individual.

Of the 140 frogs processed, 103 were tested for ranavirus and *Bd*. Only species within a site that had ≥14 individuals were tested, because of the likelihood of misclassifying as uninfected sites with small sample sizes and low prevalence (Greer and Collins 2007). Disease testing was performed by the Veterinary Diagnostic and Investigational Laboratory in the College of Veterinary Medicine at University of Georgia. In brief, genomic DNA was extracted from toes following the tissue method of a commercially available kit (DNeasy Blood and Tissue Kit, Qiagen Inc., Valencia, California, USA). Conventional PCR was then performed using the protocol and primer sets reported by Annis et al. (2004) for Bd and those found in Mao et al. (1996, 1997; primers MCP4 and MCP5) for ranavirus. The PCR products were resolved via electrophoresis on a 1.0% agarose gel. Controls for all PCR runs included two negative controls (water and tissue from a ranavirus-negative tadpole) and two positive controls (cultured ranavirus and tissue from an experimentally infected and confirmed ranavirus-positive tadpole). The PCR reactions were repeated once to confirm results.

Bd was found in three of the five species tested, and at each of the three water bodies (Table 1). Among species with positives in a site, prevalence of the pathogen ranged from 6–20% (Table 1). No obvious pathological signs or dead or moribund animals were observed during the course of this study.

While ranavirus has been detected in a number of amphibian species sampled in the southeastern United States, including species in the current study: Bullfrogs (*Lithobates catesbeianus*), Cricket Frogs (*Acris crepitans*), Pickerel Frogs (*L. palustris*), Spring Peepers (*Pseudacris crucifer*), and Wood Frogs (*L. sylvaticus*) (Gray et al. 2009), none of the toe clips from the 103 frogs screened tested positive for ranavirus. Ranavirus was, however, detected in syntopic aquatic turtles, with prevalence ranging from 5–31.6% at these three sites, in a companion study using similar sample sizes and distal tissues (Goodman et al., unpubl.), which raises the question of whether we missed infections in the anuran populations.

We are confident that we did not miss infections in the animals we screened. St-Amour and Lesbarrères (2007) found that toe tips were comparable to liver tissue samples in detecting ranavirus in Green Frogs (*L. clamitans*), and although Greer and Collins (2007) demonstrated that tail clips were less sensitive than pulverized whole body samples in detecting ranavirus in salamanders, this difference disappeared after the first week post exposure. Our sample sizes were small within species at each site. However, combining species yields samples of 34 individuals at Briery, 33 at Chalgrove, and 36 at Tadpole Hole, which are sample sizes that should (with 95% confidence) be able to detect ranavirus prevalence of 10% or greater in a site (Brem et al. 2007). Importantly, we did not sample all species in each site, nor did we sample all life stages for any species. Thus if ranavirus was present, it was at likely at low prevalence, in an alternate life stage, or in another host species. Expanded monitoring is needed to establish whether ranavirus infects frogs at these sites.

Bd occurred with low prevalence in *P. crucifer*, *L. palustris*, and *A. crepitans*, but was not detected in *L. catesbeianus* or *A. fowleri* (each collected in one site). Larger sample sizes would be needed to rule out the possibility of infection in these species, especially

TABLE 1. Prevalence (number positive/number tested) and associated 95% confidence intervals (CI) for *Batrachochytrium dendrobatidis* (*Bd*) occurrence in frogs from three water bodies in central Virginia. Dashes indicate that small sample sizes precluded tested for that species and location. The 95% confidence intervals with no continuity correction were calculated using a program by Lowry (2011) based on methods in Newcombe (1998) and Wilson (1927).

	Lithobates catesbeianus		*Pseudacris crucifer*		*Anaxyrus fowleri*		*Lithobates palustris*		*Acris crepitans*		Site total	
Study Site	Prev	CI	Prev	CI	Prev	CI	Prev	CI	Prev	CI	Prev	CI
Briery WMA	0% (0/20)	0.0–16.1%	14.3% (2/14)	4.0–40.0%	—	—	—	—	—	—	5.9% (2/34)	1.6–19.1%
Chalgrove	—	—	—	—	0% (0/15)	0.0 –20.4%	5.6% (1/18)	1.0 –25.8%	—	—	3.0% (1/33)	0.5–15.3%
Tadpole Hole	—	—	20.0% (3/15)	7.0–45.2%	—	—	—	—	9.5% (2/21)	2.7 –28.9%	13.9% (5/36)	6.1–28.7%
Species Total	0% (0/20)	0.0–16.1%	17.2% (5/29)	7.6–34.6%	0% (0/15)	0.0–20.4%	5.6% (1/18)	1.0 –25.8%	9.5% (2/21)	2.7–28.9%		

because of the low prevalence of the pathogen estimated for co-occurring species. *Lithobates catesbeianus* has been shown to carry *Bd* but experience low morbidity and mortality due to infection (Daszak et al. 2004) and so it is surprising that infections were not detected. *Anaxyrus* species are also susceptible to *Bd*, though some studies have found absence or low prevalence in sites where other species tested positive (Rothermel et al. 2008; Tupper et al. 2011; Venesky et al. 2011). The current study adds to a body of research showing presence of the fungus *Bd* in frog populations that are seemingly asymptomatic. However, dedicated surveillance would be necessary to determine the potential impacts of *Bd* on local amphibian health and fitness.

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Batrachochytrium dendrobatidis Detected in Fowler's Toad (*Anaxyrus fowleri*) Populations in Memphis, Tennessee, USA

In North America, amphibian declines due to *Batrachochytrium dendrobatidis* (*Bd*) infection have primarily been documented in the western U.S. (Bradley et al. 2002; Fellers et al. 2001; Muths et al. 2003), yet *Bd* infections also have been detected in several southeastern U.S. states (e.g., www.Bd-maps.net; Green and Dodd 2007; Rothermel et al. 2008), including Tennessee (Chatfield et al. 2009). *Bd* has been detected in rural Shelby County, north of Memphis, Tennessee, USA (Venesky and Brem 2008). However, *Bd* infection prevalence in urban and suburban Memphis has not been evaluated, but may be important since the city is located on the Mississippi River and notably, is transected east-to-west by two tributaries of the Mississippi River, the Wolf River and Nonconnah Creek (Fig. 1), and by numerous small urban tributaries including ditches, storm drains, and creeks. Aquatic corridors likely serve as connectivity pathways for amphibians, and hence may also serve to transmit *Bd*. The goals of our study were to determine *Bd* infection prevalence in Fowler's toads (*Anaxyrus fowleri*; formerly *Bufo fowleri*) at several Memphis locations and examine *Bd* prevalence among locations relative to proximity to major nearby waterways, which may serve as toad dispersal corridors.

We sampled for *Bd* from 11 *A. fowleri* populations located across the Memphis metropolitan area (Fig. 1) in 2009 by opportunistically collecting individual toads by hand during walking surveys adjacent to ponds and lakes. We collected 10–24 adults (males and females) from each site and also 12 post-metamorphic juveniles of unknown sex from 5 of the 11 sites (Table 1). Adult animals were sampled during the breeding season (April–June) whereas juvenile animals were sampled following metamorphosis (June–August). Fresh nitrile gloves were used when handling each toad to prevent cross-contamination of samples and we used a sterile fine-tipped swab (Catalog #MW113, Advantage Bundling / Medical Wire Co., Durham, North Carolina, USA) to swab the abdomen, pelvic patch, ventral hind limbs, and hind feet of each toad. Swabs were individually placed into a sterile 5-ml vial (model #985744, Wheaton Science Products, Millville, New Jersey, USA) and stored in darkness at 25°C until sent to the San Diego Zoo Amphibian Disease Laboratory for analysis using real-time (Taqman) qPCR as described by Boyle et al. (2004). We calculated the percentage and 95% binomial confidence interval of both *Bd*-positive adult toads and study sites with *Bd*-positive toads.

We used a handheld GPS unit (model 60CsX, Garmin International, Inc., Olathe, Kansas, USA) to record the coordinates of the approximate center of each sampling site (Table 1). We used ArcGIS (ESRI version 9.3, Redlands, California, USA) to map the location of each sampling site and to add a circular buffer around each site to identify the potential for *A. fowleri* to access major waterways that could allow greater dispersal distances (Fig. 1). The buffer has a radius of 624 m, which is twice the maximum reported movement distance of *A. fowleri* (312 m; Clarke 1974), but is a reasonable estimate of greater possible movement distances in *A. fowleri* that are comparable to the similar-sized congeners *A. americanus* (Oldham 1966) and *A. boreas* (Muths 2003). We also measured the distance (m) from each sampling site to the nearest river and used a Student's t-test ($\alpha = 0.05$) to determine whether sampling sites with *Bd*-positive individuals were located closer to rivers than sites without *Bd*-positive individuals.

Eleven of 159 (6.9%; 3.9–12%) adult *A. fowleri* at 8 of 11 (72.7%; 43.4–90.2%) sites were *Bd*-positive, yet none of the 60 juveniles sampled were infected (Table 1). Notably, there were no more than two *Bd*-infected toads at any site and the qPCR Ct (Cycle threshold) values (Table 1) indicated that *Bd* infection intensities were relatively low (mean = 37.5; 95% confidence interval = 35.0–40.1). Ct values reflect the number of cycles required to amplify the *Bd* DNA to a detectable level, thus the lower the Ct value the more *Bd* DNA was initially present. Five of eight (62.5%) sites with *Bd*-positive individuals were located within 624 m of a river, yet all three sites without *Bd*-positive individuals were beyond this distance limit (Fig. 1). Despite this, *Bd*-positive and *Bd*-negative sites did not differ ($t = -1.22$, d.f. = 4.85, $P = 0.28$) in mean distance (m) to the nearest river.

Bd was present in the majority of *A. fowleri* populations sampled, however *Bd* infection was not widespread among individuals sampled from each population and was found only in adult toads (Table 1; Fig. 1). Non-detection of *Bd* in three adult populations and in all juvenile *A. fowleri* sampled must be interpreted cautiously because our sample size was low (Skerratt et al. 2008), however high *Bd*-infection prevalence can be detected with sample sizes similar to ours (e.g., McCracken et al. 2009; Zellmer et al. 2008). Moreover, *Bd* was confirmed in adult toads at four of five juvenile sampling sites (Table 1) so the potential for juvenile toads to have been infected exists, yet additional studies are needed to identify possible reasons why no juvenile *A. fowleri* in this study were infected with *Bd*. Transmission of *Bd* among individuals within each site may have been limited because *Bd*-infected toads in this study appeared to have relatively low intensity infections (depending on the efficiency of the system, qPCR Ct values > 35 are typically indicative of single digit copies of DNA; Heid et al. 1996; Table 1) and none presented clinical signs of chytridiomycosis. Other wild amphibians including *Lithobates catesbeianus*, *Litoria wilcoxii*, and *Taudactylus eungellensis*, have been shown to appear asymptomatic, yet carry light *Bd* infections (Hanselmann et al. 2004; Retallick et al. 2004). These results suggest that *A. fowleri* may mount effective immune responses to *Bd* or demonstrate seasonal variation in *Bd* infection incidence or intensity as shown in other species

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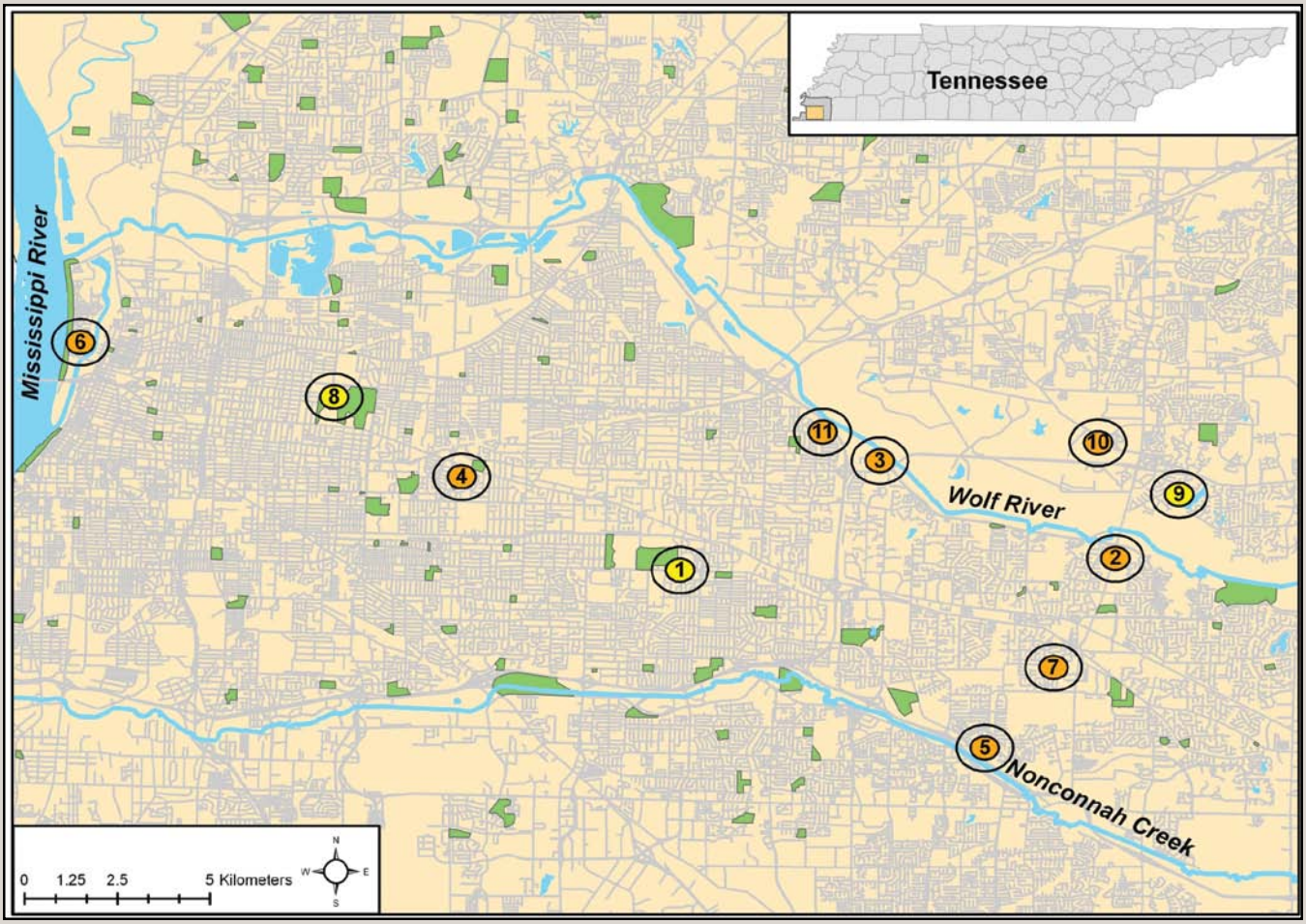


FIG. 1. Locations (N = 11) in Memphis, Tennessee, USA where adult and post-metamorphic juvenile *Anaxyrus fowleri* were sampled for *Batrachochytrium dendrobatidis* (*Bd*). *Bd*-positive adult toads were detected at eight sampling sites (orange fill) and we failed to detect *Bd* at three sites (yellow fill). The number within the circle indicates the sampling site (Table 1) and the circle around each site number represents a 624-m buffer, which was used to identify likely access to rivers that may be possible toad dispersal routes. Note that 5 of 8 sites with *Bd*-positive toads were within 624 m of a possible toad dispersal route.

TABLE 1. Results of *Batrachochytrium dendrobatidis* (*Bd*) sampling in adult and post-metamorphic juvenile *Anaxyrus fowleri* in Memphis, Tennesseee, USA. qPCR Ct values indicate *Bd* infection intensity, with a lower Ct value indicating a higher *Bd* level.

	Site location		Adults		Juveniles
Site No.	°N (NAD 83)	°W (NAD 83)	No. *Bd*-positive / total sampled (%)	qPCR Ct values	No. *Bd*-positive / total sampled
01	35.107	-89.908	0/10 (0)	N/A	
02	35.1099	-89.8024	2/24 (8.3)	38.6	0/12
03	35.1335	-89.8595	2/12 (16.7)	40.9	
04	35.1297	-89.9609	1/12 (8.3)	34.7	
05	35.0639	-89.8341	1/15 (6.7)	39.9	
06	35.1623	-90.0534	1/14 (7.1)	41.3	0/12
07	35.0834	-89.8173	2/24 (8.3)	38.9	
08	35.149	-89.9919	0/12 (0)	N/A	0/12
09	35.1254	-89.7869	0/12 (0)	N/A	
10	35.1379	-89.8066	1/12 (8.3)	35.5	0/12
11	35.1405	-89.8734	1/12 (8.3)	30.7	0/12

(Berger et al. 2004; Gaertner et al. 2009; Kriger and Hero 2006a, b; Richmond et al. 2009). Either mechanism would enable *A. fowleri* to be a *Bd* reservoir from which *Bd* infection could be transmitted to the local amphibian community. In order to elucidate the host-pathogen dynamics and environmental influences on *Bd* pathogenesis, further research including long-term mark-recapture studies to assess survivorship may be warranted for seemingly resistant species like *A. fowleri*.

The distance to the nearest river from most of the sampling sites with *Bd*-positive toads was less than 624 m, whereas all 3 sites without *Bd*-positive toads were > 624 m from these possible amphibian dispersal routes (Fig. 1). However, sites with and without *Bd*-positive toads did not differ significantly in mean distance (m) to the nearest river in this study. This may be attributable to a low sample size since retrospective power analysis indicated that 28

sampling sites would be required to determine whether distance to the nearest major river differs between sites with and without *Bd*-positive toads. Moreover, we did not survey small tributaries, ditches, storm drains, etc. that can support *A. fowleri* and provide potentially more continuous connectivity among locations. Regardless, adult *A. fowleri* can move up to 312 m (Clarke 1974) and we conservatively suggest that these toads are capable of traversing twice that distance since similar-sized congeners can do so (Oldham 1966; Muths 2003). Other sympatric amphibians at our study sites including *Pseudacris crucifer* (Delzell 1958) have maximum dispersal differences that are similar (573 m) to *A. fowleri*, and moreover *Lithobates pipiens* (Seburn et al. 1997) and *L. catesbeianus* (Ingram and Raney 1943) both have much greater dispersal distances (> 1 km), which make these species potentially important to long-distance transmission of *Bd*. Thus, further study is needed to understand the spatial epidemiology of chytridiomycosis and specifically, the potential for amphibians like *A. fowleri* to be *Bd* reservoirs whose movements may establish continuous connections between source populations (e.g., those at ponds and lakes) and rivers that may allow dispersal of *Bd*-infected amphibians.

The data presented herein contribute to our understanding of *Bd* spatial distribution and host ecology by documenting that *Bd* is present in Memphis, Tennessee, infection prevalence and intensity are relatively low in *A. fowleri*, and *Bd* infection status is unrelated to the distance to the nearest river (Table 1; Fig. 1). Additional studies are needed because the spatial epidemiology of chytridiomycosis and species-specific reactions to *Bd* infection are not well known, yet are vital to our understanding of possible treatment interventions for 'at risk' populations.

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First Record of *Batrachochytrium dendrobatidis* in *Physalaemus fernandezae* (Anura: Leiuperidae) for Buenos Aires Province, Argentina

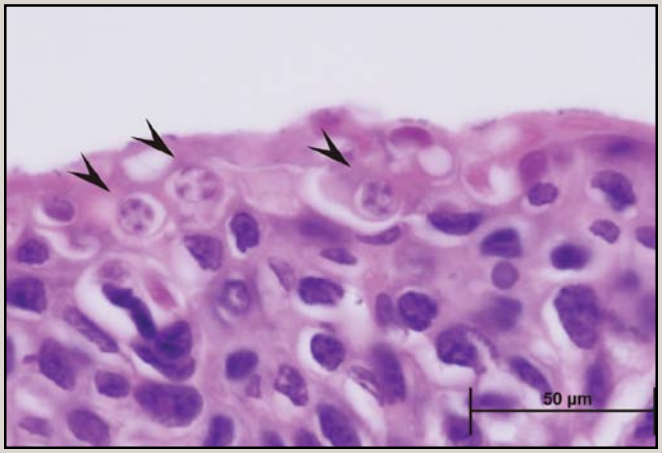


FIG. 1. Histologic section of ventral epidermis of an adult specimen of *Physalaemus fernandezae* from Punta Lara Natural Reserve, Buenos Aires province, Argentina. Arrows indicate the presence of zoosporangia of *Batrachochytrium dendrobatidis* with zoospores.

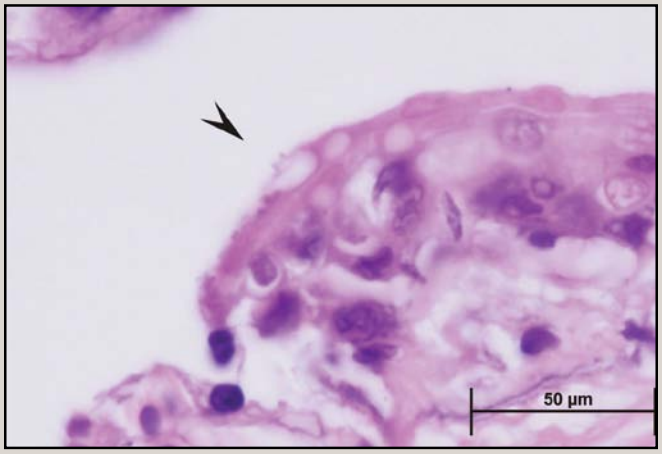


FIG. 2. Histologic section of ventral epidermis of an adult specimen of *Physalaemus fernandezae* from Punta Lara Natural Reserve, Buenos Aires province, Argentina. The arrow indicates an empty zoosporangium, with discharge tube.

In Argentina, *Batrachochytrium dendrobatidis* (*Bd*) is known from Buenos Aires, Córdoba, Misiones, Neuquén, San Luis, Salta, and Tucumán provinces (Arellano et al. 2009; Barrionuevo and Mangione 2006; Fox et al. 2006; Ghirardi et al. 2009; Gutierrez et al. 2010; Herrera et al. 2005). We provide the first record of *Bd* infection in a population of the pond-breeding anuran *Physalaemus fernandezae*, from Punta Lara Natural Reserve (34.8033˚S, 58.0099˚W), Ensenada, Buenos Aires province, Argentina.

Punta Lara Natural Reserve is located on the western bank of Río de La Plata. It has a warm-temperate climate with a mean annual temperature of 16˚C (-4˚C minimum; 42˚C maximum), and has a few days with frost, mostly in June and July. Annual precipitation is slightly over 1000 mm (SMN 2011).

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Physalaemus fernandezae is distributed in Buenos Aires and Entre Ríos provinces, Argentina, and some localities from southern Uruguay (Barrio 1964). It reproduces mainly in marshy grasslands with two reproductive events per year (Barrio, *op. cit.*). The dominant breeding season takes places between May and August (colder temperature months), but may extend until December, in many cases overlapping reproductive events with others sympatric anurans: e.g., *Hypsiboas pulchellus*, *Odontophrynus americanus*, and *Scinax squalirostris*. The second reproductive event involves fewer animals and takes place approximately between February to March, coinciding with reproduction activities of *Dendrosophus nanus*, *D. sanborni*, *Hypsiboas pulchellus*, *Pseudopaludicola falcipes*, *Pseudis minuta*, *Scinax squalirostris*, *S. berthae*, and *S. granulatus*. Currently, *P. fernandezae* has an IUCN conservation status of Minor Concern (IUCN 2011).

Seven adult specimens of *P. fernandezae* were collected at Punta Lara Natural Reserve in September 2007, preserved in 10% formalin and deposited in the herpetological collection of Museo de La Plata (MLP-A 5385–5391). A skin sample (length: 5 mm; width: 2 mm) was taken from the ventral zone of selected specimens, immersed in paraffin, thin-sectioned every 5 µm with a microtome (Leica, RM 2125 RT), mounted onto a microscopic slide and stained with haematoxilin and eosin, after Drury and Wallington (1980). Histological slides were analyzed for *Bd* following procedures described in Berger et al. (1999), with a binocular microscope (Olympus Optical Co. Ltd., Tokyo, Japan; model BX 50). Diagnostic images were taken with an Olympus DP 71 digital camera mounted to the scope.

The presence of *Bd* was confirmed for 3 of 7 (42.85%) skin samples analyzed. Different developmental stages of chytridiomycosis were clearly visible, namely: zoosporangia (isolated and grouped), empty and containing zoospores (Fig. 1), diagnostic

characteristics such as a septum and discharge tube (Fig. 2), and hyperplasic epidermis.

It is worth mentioning that the population of *P. fernandezae* used in this study has been studied by local herpetologists since 2001, but no moribund or dead specimens have been recorded to date. Moreover, the individuals on which infection was detected had been engaged in reproductive activities.

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Low Prevalence of *Batrachochytrium dendrobatidis* in Two Plethodontid Salamanders from North Carolina, USA

Although the pathogenic fungus *Batrachochytrium dendrobatidis* (*Bd*) was first isolated from anuran amphibians, subsequent research has clearly shown that it also infects many species of caudate amphibians. Opportunistic sampling surveys have shown that at least 56 species of salamanders from the families Ambystomatidae, Amphiumidae, Salamandridae, Cryptobranchidae, and Plethodontidae in the United States harbor *Bd* (reviewed in Bryne et al. 2008; Olson 2010). The effect of *Bd* on salamander demography, however, is less understood than its impact on anuran populations. Laboratory challenge experiments have shown that salamanders can be infected by *Bd* and show mortality from chytridiomycosis (Chinnadurai et al. 2009; Vazquez et al. 2009; Weinstein 2009), but more sampling and monitoring of salamanders will help elucidate potential ecological and/or climatic variables that may influence the susceptibility of salamanders in the wild. Here, we contribute information on the prevalence and distribution of *Bd* in salamander populations by testing 166 individuals from two localities in North Carolina, USA. Our results expand upon previous reports of *Bd* infection in amphibian populations in North Carolina (e.g., Bryne et al. 2009; Keitzer et al. 2011; Rothermel et al. 2008).

We opportunistically sampled two plethodontid salamander species at two collection sites on 8–12 August 2010 (Fig. 1). At Deep Gap, we collected salamanders by turning over rocks and logs that were located up to 15 m from a stream. The collecting site at Wayah Bald was a grassy area near the forest edge. We swabbed each salamander 30 times using sterile swabs (Medical wire No. 113) in the manner of Boyle et al. (2004) and Kriger et al. (2006). Each animal was handled with a clean pair of latex gloves. No animals showed any outward signs of disease. After swabbing, animals were retained for additional studies under permits issued by the North Carolina Wildlife Resources Commission and the U.S. Forest Service to LDH. Swabs were stored in 100% ethanol and transported to Cornell University, where molecular testing was performed by Kiemnec-Tyburczy.

Genomic DNA was extracted from the swabs using Prepman Ultra following the protocol of Boyle et al. (2004). The level of *Bd* zoospore load was assessed using the method of Boyle et al. (2004). Briefly, this method used Taqman quantitative PCR to determine the total number of *Bd* zoospore genome equivalents in each unknown sample, based on known standards that were run simultaneously. To maximize cost efficiency but retain individual information, PCRs were run in singlicates at 1:10

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dilutions. Studies have shown that there is no statistical difference in sensitivity or specificity between the singlicate and triplicate assays (Kriger et al. 2006). Every swab sample was run with (1) two negative controls, (2) an internal positive control (ABI Cat. No. 4308323) to test for potential inhibition and contamination, and (3) a range of *Bd* standards corresponding to 0.1, 1, 10, and 100 and 1000 zoospore DNA equivalents in duplicate (Hyatt et al. 2007). Samples that were positive for *Bd* in the first round of qPCR were re-run to confirm loads using the same template dilution. We categorized an individual as *Bd*-positive if its swab sample had ≥ 1 zoospore equivalent in both runs (Boyle et al. 2004). We calculated a mean prevalence (and 95% confidence interval) for each site using Clopper-Pearson binomial confidence intervals (Clopper and Pearson 1934).

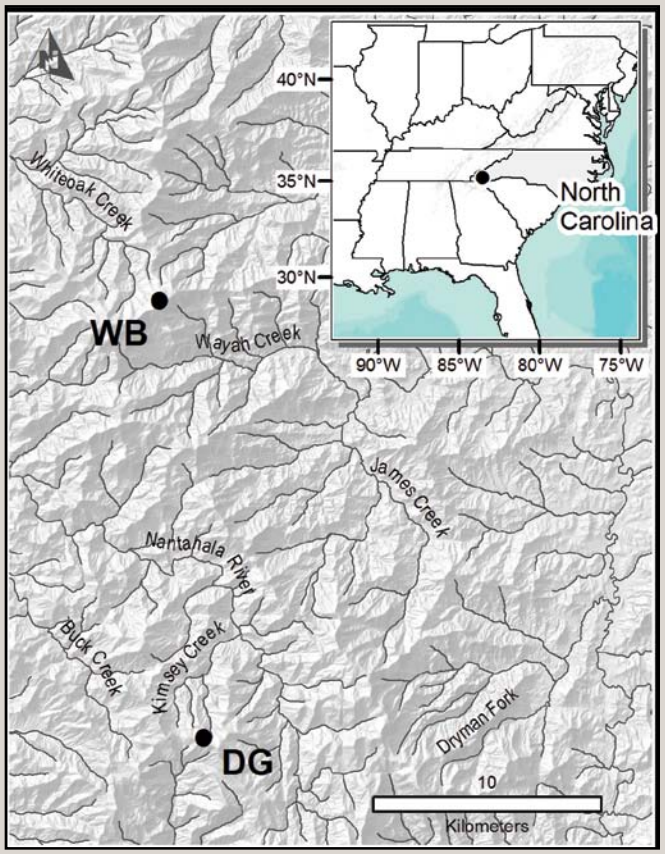


FIG 1. Specific location and topography of two sites in North Carolina, USA (inset; shaded state), where salamanders were tested for the presence of *Batrachochytrium dendrobatidis* (*Bd*). DG = Deep Gap, WB = Wayah Bald.

TABLE 1. *Batrachochytrium dendrobatidis* (*Bd*) prevalence (number of *Bd*-positive animals/total sampled) in plethodontid salamanders in North Carolina, USA.

Locality	Species	Prevalence ♀	♂	Juvenile	Total
Deep Gap (35.0389°N, 83.5431°W)	*Desmognathus ocoee*	1/23	1/31	2/16	4/70
	Plethodon shermani	1/11	0/6	0/13	1/30
Wayah Bald (35.1803°N, 83.5606°W)	*Desmognathus ocoee*	0/1	0/0	0/0	0/1
	Plethodon shermani	1/26	2/14	1/25	4/65

We found that 9 of 166 (5.4%) animals tested positive for *Bd*. Both species—*Desmognathus ocoee* and *Plethodon shermani*—had *Bd*-positive individuals (Table 1). *Plethodon shermani* is a direct-developing species that is commonly found under leaf litter, logs, and rocks. In contrast, *D. ocoee* has an aquatic larval stage and often is associated with seepages and streams (and thus may be more likely to come in contact with *Bd* zoospores). Despite these differences in life histories, both species had similar *Bd* prevalence levels. To our knowledge, this is the first published report of *Bd* infecting these two species, although Keitzer et al. (2011) tested one *P. shermani* and 53 *D. ocoee* at Coweeta Hydrologic Laboratory (Macon Co., North Carolina) but did not detect *Bd* on any individuals. We note, however, that our sampling occurred slightly later in the year and may have occurred at higher elevations. The elevation of our two localities, Deep Gap and Wayah Bald—approximately 1300 m and 1630 m, respectively—are in the upper end of the elevation range of the Coweeta area that was sampled (675–1592 m), and thus our localities may have been cooler and perhaps more suitable for *Bd*.

The prevalence of *Bd* at Deep Gap was 0.050 (95% CI: 0.016–0.11), whereas the prevalence at Wayah Bald was slightly higher at 0.061 (95% CI: 0.017–0.15). All of the zoospore loads we quantified were very low. The highest load we calculated was 57 zoospores, and most of the positive samples contained 3–4 zoospores (range 1–57 zoospores). We did not observe any trend towards particular life stages or sexes being infected within the two species (Table 1), although the animal with the highest load was a juvenile *P. shermani* from Wayah Bald. The low levels of prevalence, combined the lack of clinical signs of disease, suggests that *Bd* exists primarily as a subclinical infection in *D. ocoee* at Deep Gap and in *P. shermani* at Wayah Bald, at least during the summer months.

Our data are consistent with other studies of plethodontid populations that have shown that *Bd* prevalence in some populations is relatively low, but that *Bd* is present in North Carolina (e.g., Keitzer et al. 2011; Rothermel et al. 2008). *Bd* also has been found in other species of *Plethodon* and *Desmognathus* in other areas of the USA. Prevalence in *P. glutinosus* and *P. yonahlossee* in Watauga County, North Carolina was 1/40 and 1/41, respectively (Chinnadurai et al. 2009). *Desmognathus conanti* (Timpe et al. 2008) and *D. fuscus* (Grant et al. 2008) have also tested positive for *Bd*. In fact, *Bd* has been found on plethodontid species as diverse as *Pseudotriton ruber* (Montanucci 2009), *Batrachoseps attenuatus* (Weinstein 2009), *Bolitoglossa dofleini* (Pasmans et al. 2004) and *Plethodon neomexicanus* (Cummer et al. 2005). In other salamander families, population surveys have reported varying estimates of prevalence. A survey of *Notophthalmus viridescens* found 16 of 63 individuals infected in localities in Georgia, North Carolina, and Virginia (Rothermel et al. 2008), whereas another found prevalence in *N. viridescens* varied between 0–100% across multiple ponds in Pennsylvania (Groner and Relyea 2010). Prevalence in ambystomatid salamanders also varies widely; Ouellet et al. (2005) found 4/139 *Ambystoma maculatum* infected across Canada while Padgett-Flohr and Longcore (2005) found 2/11 *A. californiense* infected in two ponds. These studies highlight the need for further work investigating how disease-related mortality has impacted natural populations historically. Further testing across multiple seasons and years is necessary to better understand *Bd* infection dynamics in salamanders.

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Detection of *Batrachochytrium dendrobatidis* in Amphibian Populations of Northeast Ohio

The first North American occurrence of *Batrachochytrium dendrobatidis* (*Bd*) was documented in Quebec in 1961 (Ouellet et al. 2005). As of 2009, *Bd* had been detected in five Canadian provinces and at least 38 US states (for example, Hossack et al. 2010; Sadinski et al. 2010; Fisher et al. 2009; Slough 2009; Muths et al. 2008; Rothermel et al. 2008; Adams et al. 2007; Longcore et al. 2007; Steiner and Lehtinen 2007; Ouellet et al. 2005, and many others, see www.Bd-maps.net). In Ohio, *Bd* has been detected via PCR analysis in wild Northern Leopard Frogs (*Lithobates pipiens*), American Toads (*Anaxyrus americanus*) (Scott and Sheafor, unpubl.), and Blanchard's Cricket Frogs (*Acris blanchardi*) (Steiner and Lehtinen 2008). In addition, Fowler's Toads (*Anaxyrus fowleri*) and cricket frogs captured in Ohio and held at the Toledo Zoo were later found to be infected with *Bd* (G. Lipps, pers. comm.). It is uncertain, however, whether these animals were infected prior to arriving at the zoo, or if they contracted it from other infected species already present at the zoo. Histological surveys of Fowler's Toad museum specimens originally collected from Ashtabula County, Ohio in 1977 determined that the samples were *Bd*-positive (Scott and Sheafor, unpubl.), indicating that *Bd* has been in the northeastern Ohio region for at least three decades. Because *Bd* has been detected in field-collected amphibians from northeast Ohio, the possibility exists that the

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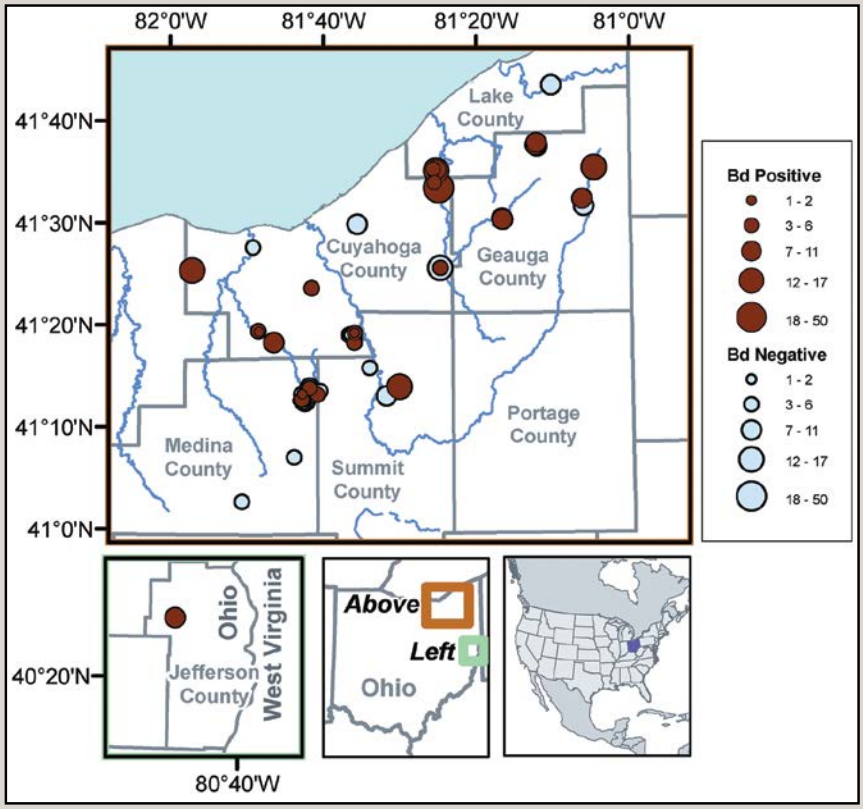


FIG. 1. *Batrachochytrium dendrobatidis* (*Bd*) sampling locations in Northeastern Ohio with both positive and negative sites in the five counties sampled. Circle size indicates sample size.

TABLE 1. Amphibian species sampled for *Batrachochytrium dendrobatidis* (*Bd*) in northeast Ohio, USA.

Species	No. Sampled	No. Positive (%)
Ambystoma jeffersonianum	32	12 (37.5)
Ambystoma maculatum	31	9 (29)
Ambystoma opacum	5	0
Anaxyrus americanus	24	5 (20.8)
Desmognathus fuscus	31	1 (3.2)
Desmognathus ochrophaeus	22	3 (13.6)
Eurycea bislineata	59	4 (6.8)
Eurycea longicauda	5	0
Pseudacris crucifer	15	4 (26.7)
Notophthalmus viridescens	16	8 (50)
Plethodon cinereus	61	10 (16.4)
Plethodon glutinosus	8	0
Pseudotriton ruber	16	3 (18.7)
Lithobates catesbeianus	8	4 (50)
Lithobates clamitans	54	5 (9.2)
Lithobates pipiens	1	0
Lithobates palustris	5	3 (60)
Lithobates sylvaticus	38	16 (41)
Total	431	87 (20.2)

current amphibian population may be descended from survivors of a previous, unrecorded population decline that occurred sometime after initial introduction of *Bd* to the area (Daszak et al. 1999). The purpose of our survey was to determine presence and geographic distribution of *Bd* in a portion of northeastern Ohio.

Sampling occurred in 2007 and 2008, from mid-March to October at a total of 68 sites in six Ohio counties (Cuyahoga, Geauga, Jefferson, Lake, Medina, and Summit). Volunteers, students, and staff from Cleveland State University, John Carroll University, Cleveland Metroparks, Geauga Park District, and Medina County Park District participated in the project. Most (56/72) sites were classified as forested (> 60% canopy cover), with 12 woodland (< 60% canopy cover), and four open sites. Streams were visited most frequently with 33 perennial and six intermittent streams sampled during the year. Fourteen vernal pools and eight permanent or temporary lakes and ponds were sampled across the region. Wet forests, marshes, and unclassified forests made up the remainder of the sites. Medina County streams were sampled heavily (23 streams) because one team is engaged in a headwater stream assessment project in Cleveland Metroparks Hinckley Reservation.

Two-person (minimum) crews followed an established swab-sampling protocol for collection and preservation of samples (Brem et al. 2007; Livo 2004). Extensive sampling occurred from March to May in forested vernal pools and semi-permanent ponds in woodlands and open areas across northeast Ohio. From mid-May through October, several sites were re-sampled, and additional sampling occurred in stream and riparian areas in Cuyahoga Valley National Park and Hinckley Reservation of Cleveland Metroparks. Amphibians were captured by hand, or with dip nets or minnow traps. When multiple individuals were captured in minnow traps no more than 5 individuals of each species was sampled to decrease pseudo-replication and limit the total number of samples obtained. All equipment and personal gear was disinfected with 10% bleach solution between sites. For each amphibian captured, a clean dip net was used, which was disinfected after use.

All swab samples were placed into individual, labeled microcentrifuge vials containing 70% ethanol. The vials were deposited at the University of Mount Union, Alliance, Ohio for qPCR assay. Microcentrifuge vials containing swabs in 70% ethanol were vortexed for 45 sec and then centrifuged for 3 min at 16,000 × g in an Eppendorf model 5415 microcentrifuge (Eppendorf North America, Hauppauge, New York). After removing the swab, each vial was centrifuged again and the supernatant was carefully removed by aspiration. Prepman Ultra™ (Applied Biosystems, Carlsbad, California) (50 µL) was added and the vial was vortexed for 20 sec to mix the contents. Samples were incubated for 10 min on a boiling water bath, cooled to room temperature, and then centrifuged as above. An aliquot of the supernatant from each sample was diluted 10× with distilled water and used for qPCR.

Quantitative PCR was performed on an MJ Mini thermocycler with a Mini Opticon Real-Time PCR system (Bio-Rad Laboratories, Inc., Hercules, California), according to the method employed by Kirshtein et al. (2007). The 25-µL reaction mixture consisted of 12.5 µL iQ™ SYBR Green Supermix (Bio Rad), 1.2 µM each of primers ITS1-3Chytr and 5.8Schytr, and 5 µL of DNA sample. After one 15 min Taq activation step at 94°C, 40 cycles of 95°C for 30 sec, 57°C, for 30 sec, and 70°C for 30 sec were performed. Melting curves were conducted at the end of each reaction to check for the appearance of primer dimers. Periodic verification of the 146 bp amplified fragment was carried out by electrophoresis on 1.5% agarose gels. Zoospore extracts were prepared from a *Bd* strain isolated from the skin of an infected Northern Leopard Frog found in the Oak Openings Metropark near Toledo, Ohio and maintained on 1% tryptone in our laboratory since 2006. A standard curve, expressed as genome equivalents (*ge*), was prepared from a dilution series of zoospore extracts of known concentration. Positive results were indicated when greater than 0.1 genome equivalent was detected in the qPCR sample.

In total, 431 amphibians were sampled, representing 18 species (8 anuran and 10 caudate) (Table 1). Green Frogs (*Lithobates clamitans*), Red-backed Salamanders (*Plethodon cinereus*), and Northern Two-lined Salamanders (*Eurycea bislineata*) comprised nearly 40% of the samples. Species frequency at any particular site was primarily a function of where field crews were operating and not necessarily an indication of species abundance. Eighty-seven (87) animals tested positive for *Bd* (20.2%), including 14 of 18 species sampled. Wood Frogs (*Lithobates sylvaticus*), Red-backed Salamanders, and Jefferson Salamanders (*Ambystoma jeffersonianum* complex) exhibited the three highest numbers of positive results; however, Pickerel Frogs (*Lithobates palustris*), American Bullfrogs (*Lithobates catesbeianus*), and Northern Spring Peepers (*Pseudacris crucifer*) comprised at least 50% of individuals testing positive for *Bd*; however for those four species testing negative, sample size was very small (N < 8).

Detection of *Bd* was geographically widespread and present in all six counties sampled (Fig. 1), with 37.5% (27/72) of sites containing at least one individual testing positive. Those sites testing negative may be a result of low sample size at a given site (min N = 1, max N = 16).

Our survey represents the largest known effort to document the presence of *Bd* in Ohio. The results confirm the presence of *Bd* in 14 amphibian species (6 anuran and 8 caudate), and *Bd* appears to be geographically widespread, with the lack of detection likely resulting from a low sample size or effort in a given location. With the majority of sampling conducted during March through May, we expected to document *Bd* in explosive-breeding species concentrated in vernal pools where infection can be easily transmitted. We did not expect to document such a large number of positive results in the more terrestrial Red-back Salamanders. These results support the possibility that the amphibian community in Ohio is composed of post-*Bd*-infection populations. Long-term effects of the documented widespread *Bd* infections are still unknown.

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Occurrence of the Fungal Pathogen *Batrachochytrium dendrobatidis* among Eastern Hellbender Populations (*Cryptobranchus a. alleganiensis*) within the Allegheny-Ohio and Susquehanna River Drainages, Pennsylvania, USA

In North America, *Batrachochytrium dendrobatidis* (*Bd*) has been detected among numerous anuran and salamander species in the northwest (Pearl et al. 2007), west (Muths et al. 2003), southeast (Grant et al. 2008; Rothermel et al 2008), northeast (Longcore et al. 2007), and Canada (Ouellet et al. 2005) (see also www.Bd-maps.net). Efforts to describe the taxonomic and geographic extent of *Bd* occurrence are comparatively limited in Pennsylvania. Three studies, examining two ranid, two hylid, two plethodontid, and one salamandrid species, detected the presence of *Bd* on two species, the Red-spotted Newt (*Notophthalmus viridescens*) in central and northwestern Pennsylvania and the Green Frog (*Lithobates clamitans*) in the northwestern region of the state (Glenney et al. 2010; Groner and Relyea 2010; Raffel et al. 2010). Representatives of families Bufonidae, Pelobatidae, Ambystomatidae, Proteidae, and Cryptobranchidae have not been tested for *Bd* in Pennsylvania.

The Hellbender Salamander (*Cryptobranchus alleganiensis*) is a cryptic, stream-dwelling cryptobranchid that has received considerable attention with regard to its population status and conservation needs (Briggler et al. 2007). During the past five decades, numerous researchers have noted changes in the distribution and size of hellbender populations throughout its range in the mid-western and eastern United States (Philips and Humphries 2005). Quantitative evidence of population declines has been reported for the Ozark Hellbender (*Cryptobranchus a. bishopi*) and Eastern Hellbender (*Cryptobranchus a. alleganiensis*) in Arkansas and Missouri (Trauth et al. 1992; Wheeler et al. 2003) and for *C. a. alleganiensis* in the upper Allegheny drainage of New York (Foster et al. 2009). Factors associated with declines include habitat modification and loss, introduced species, and exploitation by humans (Briggler et al. 2007). The disease ecology of hellbenders is poorly studied, although *Bd* has been detected in multiple populations of *C. a. bishopi* and *C. a. alleganiensis* in Missouri and Arkansas and among individual *C. a. alleganiensis* in one Georgia stream (Briggler et al. 2008; Gonynor et al. 2011). Our goal was to assess the occurrence of *Bd* among multiple populations of *C. a. alleganiensis* within the two largest river drainages in Pennsylvania.

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During June–August 2009–2010, we assessed *Bd* occurrence among populations of hellbenders associated with four streams within the north-central region of the Susquehanna River drainage and four streams within the Allegheny-Ohio River drainage (Fig. 1). Hellbenders were typically located and captured under large flat rocks and then placed in a plastic tote or mesh laundry bag during processing to obtain *Bd* samples. To minimize cross-contamination, disease sampling was performed while wearing new latex or nitrile gloves for each hellbender. Using a sterile cotton-tipped applicator cut to 2.5 cm length, we swabbed the ventral surface of the feet (fives times each), dorsolateral folds (five times each), and cloaca (five times) of each salamander. We used the cut end of the applicator to gently scrape dorsolateral folds (five times each) of each salamander and then immediately placed the swab in a labeled, 2 mL screw-cap vial containing 1 mL of 70% ethanol. For all hellbenders captured and swabbed, we measured individual total length (cm) and mass (g), qualitatively assessed each salamander for evidence of morbidity, and then released each salamander where it had been captured. Hellbenders ranging from 13–30 cm TL were assigned to the juvenile age class unless secondary sexual characteristics were evident. To minimize potential transfer of *Bd* among sites, all field equipment was treated with a 10% bleach solution, washed with warm water, and then allowed to dry for 24 h before reuse (Johnson et al. 2003). Storage totes and mesh bags were used to hold only a single hellbender on any given field day and then treated as described for other field equipment.

With the exception of hellbenders at one stream, our study populations had not been assessed for *Bd* so we chose to pool swabs for site-level assays of *Bd* occurrence. We split individual swabs into lengthwise halves in sterile laboratory conditions, saved one half-swab in the original screw-cap vial, and pooled the other half-swab with similarly prepared swabs collected from the same population. During pooling, half-swabs were placed in 15 mL screw-cap vials containing 70% ethanol (4–8 half-swabs = 1 pooled sample). In 2008, one hellbender from Loyalsock Creek was confirmed as *Bd*-infected so swabs collected from salamanders at this site were individually assayed. Pooled and individual samples were assayed for the presence of the *Bd* ribosomal RNA Intervening Transcribed Sequence (ITS) region by 45 cycle single-round PCR amplification. All *Bd* assays were performed by Pisces Molecular LLC, Boulder, Colorado.

We swabbed 59 juvenile and adult hellbenders collected from six streams during 2009 (Tubmill/Hendricks Creek, Little Mahoning Creek, Loyalsock Creek, Lycoming Creek, Little Pine Creek, and Kettle Creek) and 19 juvenile and adult hellbenders from two additional streams during our 2010 field season (Oil

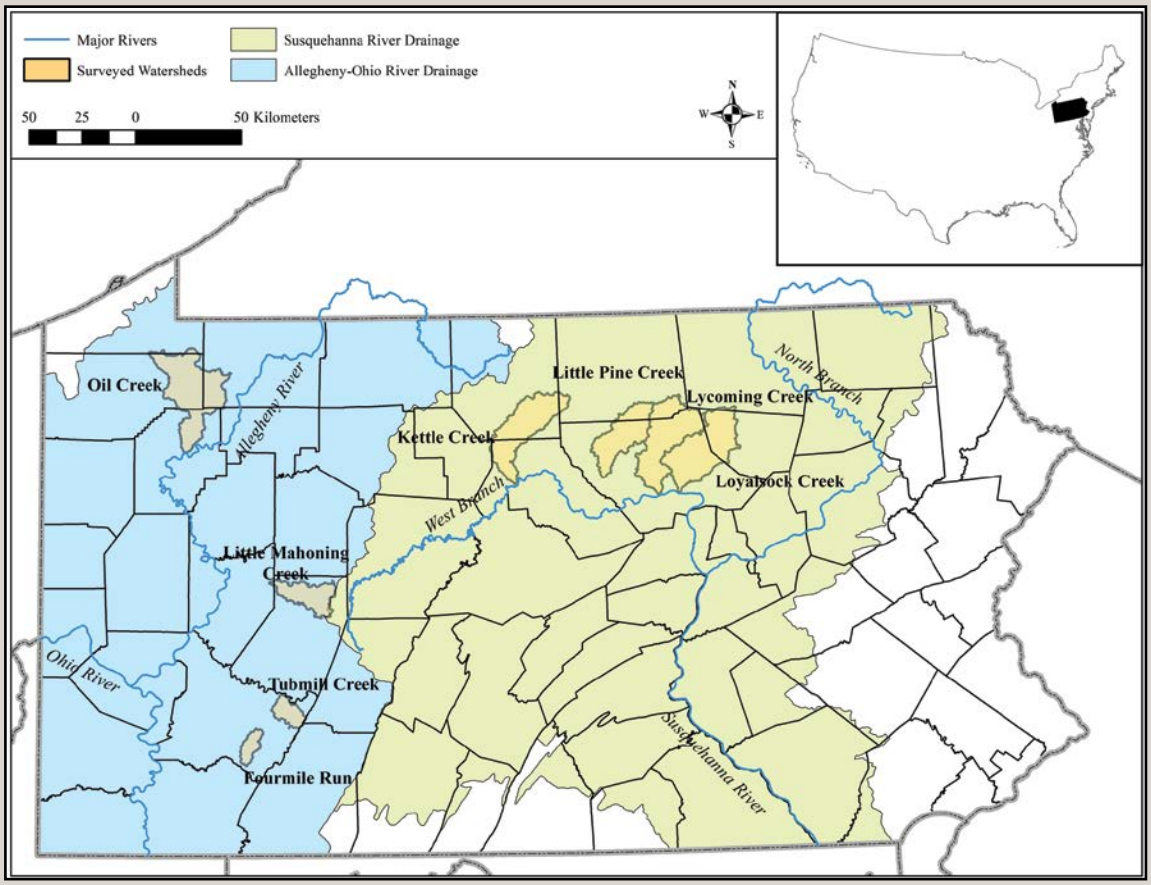


FIG. 1. Distribution of study sites associated with the Allegheny-Ohio River and Susquehanna River drainages, Pennsylvania, USA. Eastern Hellbenders (*Cryptobranchus alleganiensis alleganiensis*) were captured in four watersheds within the Appalachian Plateaus province and four watersheds within the north-central Ridge and Valleys province, and then tested for the fungal pathogen *Batrachochytrium dendrobatidis*. Exact sampling sites are not provided but general locations are indicated as surveyed watersheds.

Creek and Four Mile Run). In total, we assayed 12 pooled samples representing four populations associated with the Allegheny-Ohio River drainage and nine pooled samples representing four populations associated with the Susquehanna River drainage. Forty-three percent of pooled samples assayed provided positive test results for the presence of *Bd*, indicating the occurrence of *Bd*-infected hellbenders in four of the five counties that we examined (Table 1). We detected *Bd* among hellbender populations in two watersheds associated with the Allegheny-Ohio River drainage and two watersheds associated with the Susquehanna drainage. *Bd* was not detected on any swabs collected from hellbenders at Loyalsock Creek that were individually assayed. During the study period, we did not encounter any hellbenders with indications of morbidity or other obvious symptoms of poor health.

We found widespread occurrence of *Bd*, the amphibian chytrid pathogen, among *C. a. alleganiensis* in both major river drainages supporting breeding populations of hellbenders in Pennsylvania (Chapman, Petokas, and Regester, unpubl. data). These results represent the first systematic study of *Bd* occurrence on *C. a. alleganiensis* in Pennsylvania and the first documentation of *Bd* infection among stream-breeding salamanders in the state. Our findings, with those of Briggler et al. (2008) and Gonynor et al. (2011), confirm the occurrence of *Bd*-infected populations from widespread geographic regions within the hellbender's range and show that rates of *Bd* prevalence can be high (48%: Cooper Creek, Georgia) compared to other species of stream-breeding salamanders in the United States and Canada (0–22%: *Desmognathus* spp., *Dicamptodon aterrimus*, *Eurycea* spp., *Gyrinophilus porphyriticus*, *Pseudotriton ruber*: Byrne et al. 2008; Chatfield et al. 2009; Grant et al. 2008; Hossack et al. 2010; Ouellet et al. 2005; Rothermel et al. 2008; Timpe et al. 2008). Our results can be viewed as conservative with regard to the occurrence of *Bd* in Pennsylvania. The total number of hellbenders tested from four sites (Four Mile Run, Little Pine Creek, Loyalsock Creek, Oil Creek) was lower than the minimum sample size required to detect *Bd* in amphibian populations with relatively low rates of prevalence (Skerratt et al. 2008); hence, low sample size may have contributed to our lack of *Bd* detection in those watersheds.

Our study underscores the need for several areas of research. First, studies examining ecological predictors of *Bd* occurrence and testing for interactions between *Bd* prevalence and existing stressors are important for identifying high risk populations of hellbenders. In addition to the emerging pathogen *Bd*, hellbender populations in our region are subject to numerous threats to habitat quality (e.g., acid mine drainage, acid rain, increased sedimentation, and recent expansion of gas well drilling) that may potentially interact with *Bd* pathogenicity. In addition to continued long-term monitoring of hellbender population sizes, quantifying changes in *Bd* prevalence within and among populations and changes in *Bd*-status, condition, and survivorship among

TABLE 1. Distribution of the fungal pathogen *Batrachochytrium dendrobatidis* (*Bd*) among Eastern Hellbender (*Cryptobranchus a. alleganiensis*) populations by river drainage, county, and stream watershed in Pennsylvania, USA. Mean total length and mass (± 1SE, range) are provided for hellbenders tested for *Bd*. Swabs collected from salamanders in Loyalsock Creek were individually assayed.

River drainage	County	Stream watershed	Total length (cm)	Mass (g)	N	Pooled samples tested	Pooled samples *Bd*-positive
Allegheny-Ohio	Indiana	Little Mahoning Creek	51.4 ± 1.8 (24.0–64.0)	868.8 ± 64.3 (70.0–1520.0)	32	5	4
	Venango	Oil Creek	44.7 ± 4.4 (16.0–57.0)	771.8 ± 137.2 (25.0–1220.0)	11	2	0
	Westmoreland	Four Mile Run	47.4 ± 2.4 (37.7–54.3)	647.5 ± 73.9 (400.0–930.0)	8	1	0
	Westmoreland	Tubmill/Hendricks Creek	48.3 ± 1.7 (26.0–60.0)	719.8 ± 61.3 (100.0–1260.0)	25	4	2
Susquehanna	Clinton	Kettle Creek	39.1 ± 1.2 (32.9–44.8)	310.8 ± 27.4 (216.0–463.0)	10	2	1
	Lycoming	Little Pine Creek	35.3 ± 0.9 (32.2–40.0)	248.4 ± 16.4 (170.0–356.0)	10	2	0
	Lycoming	Loyalsock Creek	39.3 ± 2.8 (25.5–52.3)	337.5 ± 57.7 (93.0–663.0)	8	0	0
	Lycoming	Lycoming Creek	41.5 ± 1.3 (29.4–51.5)	412.1 ± 33.6 (149.0–725.0)	31	5	2
Total					78	21	9

hellbender individuals and life stages, will provide insights into the disease ecology of this species and help prioritize conservation efforts. Finally, we identify a need for a coordinated, systematic approach to *Bd*-sampling in Pennsylvania, in collaboration with federal and state agencies, academic institutions, and nongovernmental organizations. Collaborative studies can efficiently increase our knowledge of chytridiomycosis in Pennsylvania by using standardized sampling regimes designed to encompass the taxonomic breadth of the state's amphibian fauna and promoting geographically widespread sampling efforts.

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First Record of *Batrachochytrium dendrobatidis* in Paraná, Brazil

Batrachochytrium dendrobatidis (*Bd*) has been reported in seven of twenty-seven federative states of Brazil, including Minas Gerais, Mato Grosso do Sul, Pernambuco, Rio de Janeiro, Rio Grande do Sul, Santa Catarina, and São Paulo (Toledo et al. 2006). Despite its apparent widespread occurrence in Brazil, there are many distributional gaps in our knowledge that are yet to be filled. Understanding the distribution of *Bd* is urgently needed for the development and implementation of amphibian conservation action plans (Verdade et al. 2012). Herein, we provide the first report *Bd* in the state of Paraná, Brazil.

Samples were collected on 26 March 2011 at the municipality of Morretes, within the Atlantic Forest (Fig. 1). Nine tadpoles of two species [*Hylodes cardosoi* (Hylodidae; N = 8) and *Hypsiboas faber* (Hylidae; N = 1)] were collected at the Estrada da Graciosa (PR-410, 25.351297°S, 48.882148°W, 470 m elev.) and examined in the laboratory for *Bd*. Two methods of chytrid diagnosis were applied: cytology (direct observation under the microscope without stains); and isolation of fungus strains in cultures (Longcore et al. 1999).

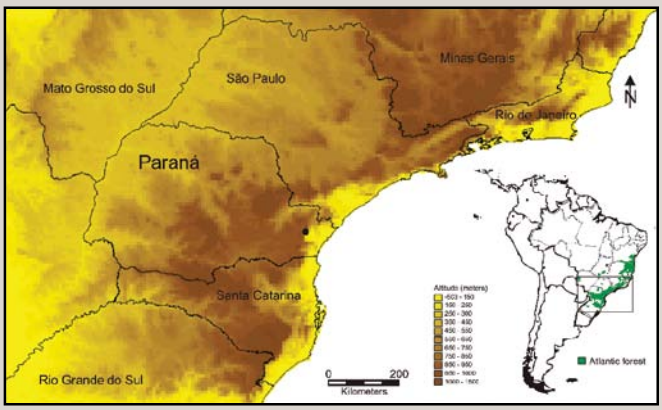


Fig. 1. Location of *Batrachochytrium dendrobatidis* sampling in the city of Morretes, state of Paraná, southern Brazil. SP = São Paulo, PR = Paraná, SC = Santa Catarina.

We detected *Bd* in 7 of 9 individuals we examined: 6 of 8 *Hylodes cardosoi* and 1 of 1 *Hypsiboas faber* were *Bd*-positive. Diagnosis was confirmed by the lack of keratin in mouthparts of the infected tadpoles, and the presence of *Bd* zoosporangia in the still keratinized regions of the mouth; some zoosporangia presented a medium septum (Berger et al. 2000) (Fig. 2). Following microscopic analysis, we isolated the *Bd* fungus (strain CLFT 024) in solid growth medium cultures of 1% tryptone agar (Fig. 2).

Our detection of *Bd* from Morretes fills a 200 km knowledge gap in the distribution of *Bd* in Brazil. The site is approximately 100 km north of São Bento do Sul, Santa Catarina, and 100 km

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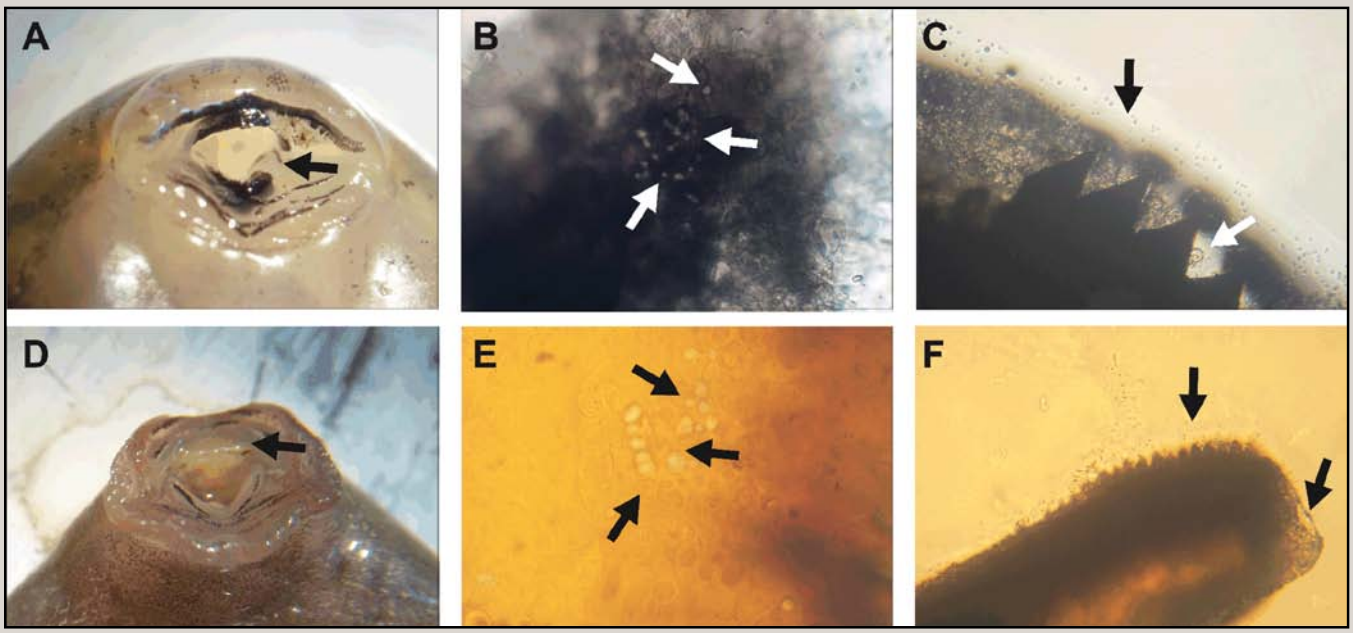


FIG. 2. *Batrachochytrium dendrobatidis* diagnosis by visual examination (A and D: lack of keratin in the tadpole mouthparts indicated by an arrow); cytology (B and E: optical microscope at 400× amplification, arrows indicating zoosporangia), and isolation (C and F: mTGh culture medium, with the arrows indicating zoospores and zoosporangia) methods. Top row of images A–C were taken from *Hylodes cardosoi*; bottom row images D–F were taken from *Hypsiboas faber*, as labeled.

south of Apiaí, São Paulo, which were the nearest sites last reported (Carnaval et al. 2006; Toledo et al. 2006). Also, this site is the type and only known locality of *Cycloramphus rhyakonastes* (Cycloramphidae; Heyer 1983), which is listed as endangered for the state (Mikich and Bérnils 2004). As the tadpoles of both species (*H. cardosoi* and *H. faber*) may live for one year or more in the water bodies, they may be serving as reservoirs of the fungus and infecting other species in the area. Hence, further *Bd* monitoring at this site is warranted to assess the potential threat of chytridiomycosis to these populations.

Other *Bd* distributional gaps exist in Brazil. For example, the occurrence of the fungus has not been studied between the states of Rio de Janeiro and Pernambuco, indicating a lack of sampling across the Atlantic Forest.

Three *Bd* strains have been previously isolated from Brazil; two (CLFT 001/10 and CLFT 021/01) from Serra do Japi, Jundiaí and Cabreúva, São Paulo, and one (CLFT 023/01) in Monte Verde, Camanducaia, Minas Gerais (unpublished data). We report the isolation of a fourth strain (CLFT 024) from the Brazilian Atlantic Forest. The isolation of strains is important because it provides the basis for studies of fungal molecular biology, virology, biogeography, physiology, morphology, and amphibian conservation. In particular, amphibian host-specific virulence patterns of different *Bd* strains are not well known, which could have direct relevance to amphibian conservation efforts.

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Resumo.—Reportamos aqui pela primeira vez a ocorrência do fungo quitrídio (*Batrachochytrium dendrobatidis*) no estado brasileiro do Paraná. A descoberta é preocupante, pois espécies endêmicas e ameaçadas de extinção vivem nos mesmos corpos d'água onde foi encontrado o fungo, organismo que pode ser letal para anfíbios.

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GEOGRAPHIC DISTRIBUTION

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These geographic distribution records will be accepted in a **standard format** only, and all authors *must* adhere to that format, as follows: SCIENTIFIC NAME, COMMON NAME (for the United States and Canada as it appears in Crother [ed.] 2008. *Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico*. SSAR Herpetol. Circ. 37:1–84, gratis PDF available (http://www.ssarherps.org/pages/HerpCommNames.php); for Mexico as it appears in Liner and Casas-Andreu 2008, *Standard Spanish, English and Scientific Names of the Amphibians and Reptiles of Mexico*. Herpetol. Circ. 38:1–162), LOCALITY (use metric for distances and give precise locality data, including lat/long coordinates in **decimal degrees** and cite the map datum used), DATE (day-month-year), COLLECTOR, VERIFIED BY (*cannot* be verified by an author; curator at an institutional collection is preferred), PLACE OF DEPOSITION (where applicable, use standardized collection designations as they appear in Leviton et al. 1985, *Standard Symbolic Codes for Institutional Resource Collections in Herpetology and Ichthyology*, Copeia 1985[3]:802–832) and CATALOG NUMBER (required), COMMENTS (brief), CITATIONS (brief and must adhere to format used in this section; these should provide a geographic context for the new record), SUBMITTED BY (give name and address in full—spell out state or province names—no abbreviations). Please include distance from nearest previously known record (provide a citation or refer to existing vouchered material to substantiate your report). If publishing specific locality information for a rare or endangered species has the potential to jeopardize that population, please consult with the Section Editor at time of record submission. If field work and/or specimen collection occurred where permits were required, please include permit number(s) and authorizing agency in the text of the note.

Some further comments. The role of the "Standard Names" lists (noted above) is to standardize English names and comment on the current scientific names. Scientific names are hypotheses (or at least represent them) and as such their usage should not be dictated by a list, society, or journal.

If the locality reported is clearly outside of the natural range of the species, a statement to that effect should be included in the note, along with relevant citation(s). Additionally, if an "introduced" species has become established at the new locality, please include supporting observations, as well as information concerning means of introduction and source population, if known.

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Please submit any geographic distribution records in the **standard format only** to one of the Section Co-editors: **Alan M. Richmond** (USA & Canada records only); **Jerry D. Johnson** (Mexico and Central America, including the Caribbean Basin); **Indraneil Das** (all Old World records); or **Gustavo J. Scrocchi** (South American records). Short manuscripts are discouraged, and are only acceptable when data cannot be presented adequately in the standard format. **Electronic submission of manuscripts is required** (as Microsoft Word or Rich Text format [rtf] files, as e-mail attachments)**.** Refer to inside front cover for e-mail addresses of section editors.

Recommended citation for new distribution records appearing in this section is: Schmitz, A., and T. Ziegler. 2003. Geographic distribution: *Sphenomorphus rufocaudatus*. Herpetol. Rev. 34:385.

CAUDATA — SALAMANDERS

***AMBYSTOMA MACULATUM* (Spotted Salamander).** USA: GEORGIA: Gwinnett Co.: Mill Creek Nature Center (34.06076°N, 83.98080°W, WGS 84; elev. ~312 m). 7 October 2011. Cyndi Moore and Robert L. Hill. Verified by John Jensen. UTADC 6979. New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. Univ. of Georgia Press, Athens. 575 pp.); has been previously observed in Gwinnett Co. though this report represents the first vouchered specimen. This species has also been documented in neighboring Fulton, Dekalb, Rockdale, and Walton counties. An adult specimen (~100 mm SVL) was discovered under a log ~3 m S of the hiking path and ~0.25 km from preserve entrance at Mall of Georgia Boulevard. It was photographed and returned.

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***DESMOGNATHUS FUSCUS* (Northern Dusky Salamander).** CANADA: NEW BRUNSWICK: Victoria Co.: Unnamed stream in Hillandover (46.71965°N, 67.7371°W; WGS 84). 20 July 2011. Gregor F. M. Jongsma, Wendy Wolman, Luke DeCicco, and Andi Emrich. New Brunswick Museum (NBM 009237–009238). New county record. Gorham (1970. The Amphibians and Reptiles of New Brunswick. New Brunswick Museum, Saint John) notes that along the New Brunswick-Maine border region *D. fuscus* occurs only as far north as southern Carleton Co. (south of Victoria Co.) and more recently, McAlpine (2010. *In* D. F. McAlpine and I. M. Smith [eds.], Assessment of Species Diversity in

Atlantic Maritime Ecozone, pp. 613–631. NRC Research Press, Ottawa) listed the species as hypothetical for the ecoregion that includes Victoria Co. Extends the known range of this species 60 km N from the nearest documented locality, near Woodstock (46.15814°N, 67.63716°W, WGS 84; NBM 009096). York Co.: Unnamed stream 4.6 ESE of Stanley (46.2695°N, 66.67605°W, WGS 84). 18 August 2010. Gregor F. M. Jongsma. NBM 009077. The individual, collected near Stanley, extends the range of *D. fuscus* 29 km N from the nearest documented locality, Killarney Park, Fredericton, York Co. (46.01793°N, 66.62197°W WGS 84; NBM 009075). All specimens were verified by Donald F. McAlpine.

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***EURYCEA CIRRIGERA* (Southern Two-lined Salamander).** USA: TENNESSEE: Weakley Co.: Beech Ridge Unit of the Obion Wildlife Management Area (36.228594°N, 88.942949°W; WGS 84). 12 November 2011. Tom Blanchard. Verified by A. Floyd Scott. Austin Peay State University (APSU 19185). New county record (Redmond and Scott 1996. [updated 29 November 2011] Atlas of Amphibians in Tennessee. Misc. Publ. No. 12. Center for Field Biology, Austin Peay State University. Clarksville, Tennessee. 94 pp. Internet version available at http://www.apsu.edu/amatlas; updated 29 Nov 2011, accessed 15 Nov 2011). Adult male found under log in dry bed of periodically flooded, forested wetland.

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***EURYCEA QUADRIDIGITATA* (Dwarf Salamander).** USA: ARKANSAS: Jefferson Co.: 6.6 km NW of White Hall (34.329828°N, 92.124281°W; WGS 84). 20 April 2001. H. W. Robison. Verified by S. E. Trauth. Arkansas State University Museum of Zoology Herpetological Collection (ASUMZ 31901). New county record; partially fills a hiatus among Cleveland (Trauth et al. 2004. Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.) and Grant (McAllister and Robison 2012. Herpetol. Rev. 43[*in press*]) counties. This records helps extend the range of *E. quadridigitata* further to the northeast in the state.

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***EURYCEA QUADRIDIGITATA* (Dwarf Salamander).** USA: LOUISIANA: Acadia Parish: Bayou Plaquemine Brule area (30.1990°N, 92.5337°W; WGS 84). 28 October 2005. Glen Maglalang. Verified by Jeff Boundy. Louisiana State University Eunice Vertebrate Collection (LSUE 2262). New parish record (Dundee and Rossman 1989. The Amphibians and Reptiles of Louisiana. Louisiana St. Univ. Press, Baton Rouge. 300 pp.). This record fills the gap between Jefferson Davis and Lafayette parishes.

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***NECTURUS MACULOSUS* (Mudpuppy).** USA: TENNESSEE: Cannon Co.: Brawleys Fork of East Fork Stones River, tributary to Stones River. Accessed from the junction of Tennessee Hwy 64 (Bradyville Road) and Barker Road (35.801944°N, 86.150833°W; NAD 27). 18 March 2011. Matthew D. Wagner and Shawn P. Settle. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19118 color photo). New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. [Hard copy and Internet versions, the latter of which includes links to information on Tennessee amphibians having appeared since 1996, http://www.apsu.edu/amatlas/, accessed 3 August 2011]). One adult caught via electrofishing on the downstream side of a bridge pylon.

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***NOTOPHTHALMUS VIRIDESCENS LOUISIANENSIS* (Central Newt).** USA: ARKANSAS: Jefferson Co.: Tar Camp Creek at US 65/I-530 (34.431264°N, 92.193714°W; WGS 84). 12 May 2003. B. Deeds. Verified by S. E. Trauth. Arkansas State University Museum of Zoology Herpetological Collection (ASUMZ 31902). New county record filling a distributional gap among Arkansas (McAllister and Robison 2009. Herpetol. Rev. 40:245), Lincoln (Robison and McAllister 2008. Herpetol. Rev. 39:104) and Lonoke (Plummer and McKenzie 2008. Herpetol. Rev. 39:104) counties.

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***PSEUDOTRITON RUBER RUBER* (Northern Red Salamander).** USA: SOUTH CAROLINA: Darlington Co.: Lauther's Lake, about 0.5 km N boat ramp, 13.3 km ENE of Darlington (34.32899°N, 79.72456°W; WGS 84). 29 March 2006. Jeffrey D. Camper. Verified by D. A. Beamer. Photographic voucher deposited in the Clemson University Vertebrate Collections (CUSC 1152). New county record. Extends the range of the species from the fall line sand hills southeast to the upper coastal plain. First record on the coastal plain in northern South Carolina (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, D.C. xvi + 587 pp.). Two specimens collected under logs in a seep during early afternoon.

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***STEREOCHILUS MARGINATUS* (Many-lined Salamander).** USA: GEORGIA: Telfair Co.: 3.3 km ENE Jacksonville, State Hwy 117 at Lampkin Branch (31.816883°N, 82.944207°W; NAD 83). 22 July 2010. K. Stohlgren and D. Stevenson. Verified by Lance D. McBrayer. GSU 11917. First record for county (Jensen et al. [eds.] 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.) Extends the species range ca. 62 km N of the nearest record (Satilla River drainage, Atkinson Co., Georgia). Additionally, this record extends the known range in the Altamaha River drainage ca. 83 km to the west of the nearest record (Tattnall Co., Georgia; Williamson and Moulis 1994. Distribution of Amphibians and Reptiles in Georgia. Savannah Sci. Mus. Spec. Publ. No. 3, Savannah, Georgia). Adult found in mucky seepage area within blackwater creek swamp.

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ANURA — FROGS

***DENDROPSOPHUS SANBORNI* (Sanborn's Treefrog)**. BRAZIL: MATO GROSSO DO SUL: Municipality of Três Lagoas: Fazenda Santa Marina (20.3636°S, 52.5815°W; SAD 69). 10 October 2010. F. L. Souza, P. Landgref-Filho, and M. N. Godoi. Coleção Zoológica de Referência da Universidade Federal de Mato Grosso do Sul, Campo Grande, MS, Brazil (ZUFMS-AMP 2156–2158), Museu Nacional, Rio de Janeiro, RJ, Brazil (MNRJ 73486–73488). Verified by U. Caramaschi. This species was previously known in western Rio Grande de Sul, Santa Catarina, Paraná, São Paulo, and Mato Grosso (Brazil), northern Argentina, Uruguay, and Oriental region of Paraguay (Ribeiro et al. 2005. Biota Neotrop. 5[2]:1–15). We present the first record of this species from Mato Grosso do Sul State, filling a distributional gap of 915 km across central Brazil, between the closest published localities, 330 km W from records in São Paulo (Vasconcelos and Rossa-Ferres 2008. Phyllomedusa 7[2]:127–142) and 624 km NW from records in Mato Grosso (Ribeiro et al., *op. cit.*). Individuals were associated with veredas (palm swamp) in a typical Cerrado vegetation.

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***HYLA CINEREA* (Green Treefrog)**. USA: MISSOURI: Jasper Co.: Oronogo, ca.14 air km NNE of Joplin (37.201074°N, 94.463260°W, WGS84; elev. 283 m). 04 September 2010. Nathan A. Mitchell. Verified by Richard Daniel. University of Missouri Columbia (UMC 1841P; digital image). New county record (Daniel and Edmond 2010. Atlas of Missouri Amphibians and Reptiles for 2009. <http://atlas.moherp.org/pubs/atlas09.pdf>). Abundant male calls recorded at wetland ca. 0.70 air km SSW of specimen collection point on 12 June 2011.

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***HYLA CINEREA* (Green Treefrog)**. USA: NEW JERSEY: Salem Co.: 75.542538°N, 39.617964°W (WGS 1984). 02 June 2011. Karena DiLeo. Verified by David Golden. ANSP 36840. New state record. (Aresco 1996. Am. Midl. Nat. 135[2]:293–298). Nearest previously known record in Delaware (Hammerson and Hedges 2004. *In* IUCN 2011. IUCN Red List of Threatened Species. version 2011.2; <www.iucnredlist.org>. Downloaded 07 November 2011).

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***HYLA SQUIRELLA* (Squirrel Treefrog)**. USA: GEORGIA: Baldwin Co.: City of Milledgeville (33.094111°N, 83.247077°W; WGS84). 27 September 2010. Sergio Patitucci Saieh and Dennis Parmley. Verified by John Jensen. GCH 5240. First county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). Single adult collected at apartment complex during heavy rain.

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***KALOULA TAPROBANICA* (Sri Lankan Bull Frog)**. BANGLADESH: DHAKA DIVISION: Bangladesh Agricultural University Campus (24.7196°N, 90.4267°E, > 18 m elev.). 11 June 2008. Mahmudul Hasan. Department of Fisheries Biology and Genetics, Bangladesh Agricultural University, Mymensingh, Bangladesh. Specimen deposited at Institute for Amphibian Biology, Hiroshima University, Japan (IABHU F5013). Verified by Mitsuru Kuramoto. First locality record for Mymensingh District, Bangladesh. Nearest population reported from Madhupur National Park, Tangail District (ca. 38 km to W; Reza and Mahony 2007. Herptol. Rev. 38:348). Other records from Assam, India, > 200 km to NE and Kolkata, West Bengal, India > 300 km to SW of this locality (Dutta 1997. Amphibians of India and Sri Lanka [Checklist and Bibliography]. Odyssey Publishing House, Bhubaneswar. xiii + 343 + xxii pp.). Supported by Grant-in-Aids for Scientific Research (C) (Nos. 17570082 and 20510216) to M. Sumida from Ministry of Education, Culture, Sports, Science and Technology, Japan.

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***LEPTODACTYLUS POECILOCHILUS* (Turbo White-lipped Frog)**. COSTA RICA: HEREDIA: San Ramón de Sarapiquí: Braulio Carrillo National Park, Estación El Ceibo (ca. 10.327363°N, 84.078677°W; WGS 84), 525 m elev. 10 January 2005. S. Mohammadi and J. W. Streicher. Verified by W. Ronald Heyer. USNM 561433; UTADC 526. First record for Heredia and one of only a few records from the Atlantic versant of Costa Rica (Savage 2002. Amphibians and Reptiles of Costa Rica: A Herpetofauna Between Two Continents, Between Two Seas. University of Chicago Press. xx + 934 pp.). The frog was caught at 2005 h during a light rain in a pasture bordering a forested portion of Braulia Carrillo National Park. It was secured under MINAE permit #0098520004 (License #38312) issued to both of us.

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***LITHOBATES CATESBEIANUS* (American Bullfrog)**. USA: KANSAS: Kiowa Co.: Greensburg (37.613774°N, 99.300071°W; elev. 679 m). 7 May 2011. Brian Hubbs. Verified by Neftali Camacho. Natural History Museum of Los Angeles County photo voucher LACM PC 1556. New county record (Collins 2010. Amphibians, Reptiles, and Turtles in Kansas. Sternberg Museum of Natural History, Fort Hays State University, Hays, Kansas. 312 pp.).

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***LITHOBATES* [= *RANA*] *CATESBEIANUS* (American Bullfrog)**. USA: NEW MEXICO: Taos Co.: Rio Grande, ca. 3.2 km N (upriver) of Pilar (36.29367°N, 105.77918°W, WGS 84; elev. 1830 m). 26 September 2009. J. N. Stuart. One juvenile photographed; many present. Digital Archives, Division of Herpetology, Biodiversity Institute, University of Kansas (KUDA 012246).

Los Alamos Co.: Pajarito Spring, on W side of White Rock Canyon above the Rio Grande (35.80396°N, 106.19689°W, WGS84; elev. 1707 m). 4 April 2010. M. Bjorklund. Adult male (KUDA 012251). Tadpoles were also found at Pajarito Spring, 16 April

2010 (KUDA 012252). All verified by Charles W. Painter from photographs. New county records (Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. Univ. New Mexico Press, Albuquerque. xix + 431 pp.).

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***LITHOBATES HECKSCHERI* (River Frog)**. USA: ALABAMA: Bullock Co.: The Wehle Tract (32.03151°N, 85.47390°W; WGS 84). 19 September 2011. Brian Folt. Verified by Craig Guyer. Auburn University Herpetological collection (photo voucher AHAP-D 326a,b). First county record and the first voucher for this species in Alabama since 1975 (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn University Agricultural Experiment Station, Auburn, Alabama. vii +347 pp.).

Found under log along shoreline of impoundment pond; captured by hand. Previously, *L. heckscheri* had been verified in only three localities in Alabama: one each in Mobile, Baldwin, and Escambia counties (Mount 1975, *op. cit.)*. Whereas the historic Alabama localities are exclusively within the Lower Coastal Plains, this new record is farther north (171 km ENE from the nearest known location in Alabama), situated within the transitional zone between the Red Hills and Black Belt regions. Because this species is thought to be restricted to the Coastal Plains (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.), this record is novel and suggests that other habitats might be suitable.

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***MELANOPHRYNISCUS KLAPPENBACHI* (Klappenbach's Red-bellied Toad)**. BRAZIL, MATO GROSSO DO SUL, Municipality of Porto Murtinho, Fazenda Santo Antônio (21.527163°S, 57.832186°W, SAD 69); Fazenda Carandá (21.554553°S, 57.781036°W, SAD 69). 30 May 2011. I. B. Amaral, P. Landgref-Filho, and D. I. Ferreira. Coleção Herpetológica do Museu de Ciências e Tecnologia PUCRS, Porto alegre, RS, Brazil (MCP/PUC/RS 11944-11946, 11949-11969). Fazenda Patolá (21.686749°S, 57.719681°W, WGS 1984). 27 October 2008. F. L. Souza, M. Uetanabaro, and P. Landgref-Filho. Coleção Zoológica de Referência da Universidade Federal de Mato Grosso do Sul, Campo Grande, MS, Brazil (ZUFMS AMP 1046). Verified by T. Grant. This species was previously known for Paraguay (southern Alto Paraguay, Presidente Hayes, and Ñeembucú Department: Brusquetti and Lavilla 2006. Cuad. Herpetol. 20[2]:1–79) and Argentina (Chaco, Formosa, and Northern Santa Fe and Santiago del Estero provinces: Baldo 2001. Cuad. Herpetol. 15[2]:141–142). First country record. The study site is located in the southern Pantanal, at the left bank of Paraguay River, the only Brazilian region encompassed by the Chaco biome. New localities extends know distribution 90 km N of Alto Paraguay, Paraguay, in Municipality of Porto Murtinho, Brazil.

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***PHLYCTIMANTIS LEONARDI* (Olive Striped Frog)**. CAMEROON: EAST PROVINCE: Ngoum-Bandi (aka PK27), S border of Lobéké National Park (02.13881°N, 15.65567°E; WGS 84; 620 m elev.). 28 May 2010. Václav Gvodík and Oldich Kopecký. National Museum, Prague, Czech Republic. NMP6V 74437/1–5. Verified by Jean-Louis Amiet and Mark-Oliver Rödel. Previously recorded in Gabon, Equatorial Guinea (mainland), Republic of Congo, and western Democratic Republic of Congo (Schiøtz et al. 2004. *In* IUCN 2011. IUCN Red List of Threatened Species, ver. 2011.1. <www.iucnredlist.org>). Four adult males (SVL 47.9–51.0 mm) and one adult female (SVL 54.8 mm) collected from small shallow pond at edge of primary forest. Males calling from grassy inundated banks and low bushes from dusk until ca. 2400 h. Pairs in amplexus and numerous tadpoles also observed. New record extends known range by ca. 50 km N from nearest localities in Republic of Congo. First species record for Cameroon and first record of genus from Cameroonian Congo Basin (cf. Amiet 2007. Rev. Suisse Zool. 114:87–126).

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***PSEUDACRIS CLARKII* (Spotted Chorus Frog)**. USA: NEW MEXICO: Quay Co.: Playa lake located on the south side of NM Hwy 231, 2.0 km W of intersection of NM Hwy 469 and NM Hwy 23; ca. 2.7 air km SW of Wheatland (34.89232°N, 103.37679°W, NAD1983; elev. 1440 m). 05 August 2011. Jessica A. Kissner. Verified by Toby Hibbitts. University of Kansas (KUDA digital images 012215–012218, and 012219 audio). First state record (Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. University of New Mexico Press, Albuquerque, New Mexico). Nearest previous record was at Muleshoe National Wildlife Refuge in Muleshoe, Texas, ca. 117 km airline SE from the new locality. At 2144 h, two adult males were heard and seen calling from the base of emergent vegetation after a 0.5 mm rainfall. Air temperature was 20.9°C and humidity was 83%, with cloudy skies and an average wind speed of 5.6 mph.

Field work was conducted under permit number 3318 issued by New Mexico Department of Game and Fish.

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***PSEUDACRIS MACULATA* (Boreal Chorus Frog)**. USA: NEBRASKA: Harlan Co.: Republican City (40.089455°N, 99.213149°W; elev. 612 m). 22 May 2011. Brian Hubbs. Verified by Dan Fogell. Natural History Museum of Los Angeles County photo voucher LACM PC 1563. New county record (Ballinger et al. 2010. Amphibians and Reptiles of Nebraska. Rusty Lizard Press, Oro Valley, Arizona. 400 pp.; Fogell 2010. The Amphibians and Reptiles of Nebraska. University of Nebraska Press, Lincoln, Nebraska. 158 pp.). Frog found in flooded roadside ditch.

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***RAORCHESTES PARVULUS* (Karin Bubble-nest Frog)**. BANGLADESH: SYLHET DIVISION: Sylhet District: Khadimnagar National Park (24.940556°N, 91.93889°E; WGS 84; 46 m elev.). 29 April

2011. Animesh Ghose and Abdur Rakib Bhuiyan. Photographic voucher, Raffles Museum of Biodiversity Research, National University of Singapore (ZRC [IMG] 1.36a–1.36b). Verified by Guin Wogan, California Academy of Sciences. A new country record for Bangladesh (Kabir et al. 2009. Encyclopedia of Flora and Fauna of Bangladesh, Vol. 25. Amphibians and Reptiles. Asiatic Society of Bangladesh, Dhaka. 204 pp.), and previously known from Myanmar, northeastern and southeastern Thailand, Cambodia, Lao People's Democratic Republic, northern Vietnam and northern Peninsular Malaysia (Inger 1999. *In* W. E. Duellman [ed.], Patterns of Distribution of Amphibians: A Global Perspective, pp. 445–482. John Hopkins University Press, Baltimore and London; Sukumaran 2003. Hamadryad 27:1–10).

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RHINELLA MARGARITIFERA. BRAZIL: PERNAMBUCO: Municipality of Tamandaré: Reserva Biológica de Saltinho – REBIO de Saltinho (8.710°S, 35.200°W; WGS 84). 23 August 2008. E. B. Ferreira Lisboa. Herpetological and Paleoherpetological Collection of the Universidade Federal Rural de Pernambuco – UFRPE, Recife, Brazil (CHPUFRPE 677, LHC 43.33 mm. Instituto Chico Mendes de Conservação da Biodiversidade permission number 19115-3). Verified by E. Maranhão dos Santos. *Rhinella margaritifera* is known from Bolivia, Colombia, Ecuador, Guyana, Peru, Venezuela, and Brazil. In Brazil it occurs in the states of Amazônia, Bahia, Ceará, Mato Grosso do Sul, and Rondônia (Bernarde and Macedo 2008. Série Zoológica 98[4]:454–459; Caramaschi and Pombal Jr. 2006. Pap. Avul. Zool. 46:251–259; Freitas and Silva 2004. Anfíbios na Bahia: um Guia de Identificação. Editora Politeno, Camaçari. 60 pp.; Freitas and Silva 2005. A Herpetofauna da Mata Atlântica Nordestina. Editora USEB, Pelotas. 161 pp.; Frost 2011. Amphibian Species of the World: An Online Reference, ver. 5.4 [8 April 2010]. Electronic database accessible at http://research.amnh.org/herpetology/amphibia.index.html; Lima et al. 2006. Guia de Sapos da Reserva Adolpho Ducke, Amazônia Central. Áttema Design Editorial, Manaus, 168 pp.; Santos and Silva 2009. *In* Congresso Interno de Iniciação Científica 2009. Barra do Bugres – MT. 2º Jornada Científica da UNEMAT, 2009. vol. 1, p. 1). New state record, partially filling the gap of 546 km between the states of Ceará and Bahia; this is 423 km NW from the nearest location in Ceará and 542 km SW from the nearest location in Bahia.

ELIZARDO BATISTA FERREIRA LISBOA, JORGE MÁRIO DE FIGUEIRÊDO JUNIOR, IRIS VIRGINIA CYPRIANO DE MELO, EDSON VICTOR EUCLIDES DE ANDRADE, and **GERALDO JORGE BARBOSA DE MOURA,** Universidade Federal Rural de Pernambuco, Paleoherpetological and Herpetological Laboratory, UFRPE, 52171-900, Recife, Brazil.

XENOPUS LAEVIS **(African Clawed Frog)**. MÉXICO: BAJA CALIFORNIA: Municipality of Rosarito: Bocana Cantamar (32.22969°N, 116.92132°W, WGS 84), 2 m elev. 27 March 2011. G. Ruiz-Campos and A. Andreu-Soler. Verified by Clark R. Mahrdt. UABC 2029. First vouchered record for México and Baja California, and a 40 km WSW range extension from an undocumented observational record from Río las Palmas, Cañon el Alamo, NE El Testerazo (Mahrdt et al. 2003. Herpetol. Rev. 34:256–257). Even though *X. laevis* has also been reported by others to occur in México, most likely in northern Baja California (e.g., Álvarez-Romero et al. 2008. Animales Exóticos en México: Una Amenaza para la Biodiversidad. CONABIO, Instituto de Ecología, UNAM, SEMARNAT, México, D.F. 518 pp.; Liner 2007. Occas. Pap. Mus. Nat. Sci., Louisiana State Univ. 80:1–59; Tinsley and McCoid 1996. *In* R. C. Tinsley [ed.], The Biology of *Xenopus*. Symposia of the Zoological Society of London, No. 68, pp. 81–94. Clarendon Press, Oxford, England), no vouchered specimens are available. The adult frog was captured by a minnow trap in a stream lined primarily by California Tule (*Scirpus californicus*).

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XENOPUS PYGMAEUS **(Bouchia Clawed Frog)**. GABON: HAUT OGOOÉ PROVINCE: Batéké Plateau National Park, Camp Ntsa (1.9816°S, 14.0011°E). 30 May 2011. B. M. Zimkus and J. G. Larson. Museum of Comparative Zoology (MCZ A-147875). Verified by José Rosado. Verification supported by mitochondrial data from 16S ribosomal DNA (Genbank Accession JQ302191). Species ranges from Bagandou, Etoi and Bouchia in southern Central African Republic, east to northeastern Democratic Republic Congo and Semliki in western Uganda. First confirmed country record in Gabon, extending range > 750 km SW from type locality in Bouchia, Central African Republic. Presence in Batéké Plateau National Park, southwestern Gabon suggests a distribution across border in Republic of Congo, for which there are currently no records.

BREDA M. ZIMKUS and **JOANNA G. LARSON**, Department of Organismic and Evolutionary Biology, Harvard University, 26 Oxford Street, Museum of Comparative Zoology, Cambridge, Massachusetts 02138, USA (e-mail: bzimkus@oeb.harvard.edu).

TESTUDINES – TURTLES

CHELYDRA SERPENTINA **(Snapping Turtle)**. USA: NEBRASKA: Sherman Co.: DOR on State Hwy 10 (41.066924°N, 99.082586°W; elev. 648 m.). 23 May 2011. Brian Hubbs. Verified by Neftali Camacho. Natural History Museum of Los Angeles County photo voucher LACM PC 1557. New county record (Ballinger et al. 2010. Amphibians and Reptiles of Nebraska. Rusty Lizard Press, Oro Valley, Arizona. 400 pp.; Fogell 2010. The Amphibians and Reptiles of Nebraska. University of Nebraska Press, Lincoln, Nebraska. 158 pp.).

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CHRYSEMYS DORSALIS **(Southern Painted Turtle)**. USA: TENNESSEE: Chester Co.: Henderson, Freed-Hardeman University (35.437317°N, 88.634083°W; WGS84). 31 August 2011. Sarah McReynolds. Verified by A. F. Scott. Austin Peay State University (APSU 19169 photographic voucher). New county record (Scott and Redmond 2008 [latest update: 8 June 2011]. Atlas of Reptiles in Tennessee. Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/, accessed 9 November 2011). Adult male captured in a baited hoop net.

SARAH M. McREYNOLDS (e-mail: sarah.mcreynolds@students.fhu.edu) and **BRIAN P. BUTTERFIELD**, Department of Biology, Freed-Hardeman University, Henderson, Tennessee 38340, USA (e-mail: bbutterfield@fhu.edu).

***CHRYSEMYS PICTA BELLI* (Western Painted Turtle)**. USA: NEBRASKA: Phelps Co.: Approx. 3/4 mi. SSW Holdrege (40.429085°N, 99.379989°W; elev. 704 m). 23 May 2011. Brian Hubbs. Verified by Neftali Camacho. Natural History Museum of Los Angeles County photo voucher LACM PC 1523. New county record (Ballinger et al. 2010. Amphibians and Reptiles of Nebraska. Rusty Lizard Press, Oro Valley, Arizona. 400 pp.; Fogell 2010. The Amphibians and Reptiles of Nebraska. University of Nebraska Press, Lincoln, Nebraska. 158 pp.).

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***GRAPTEMYS PSEUDOGEOGRAPHICA PSEUDOGEOGRAPHICA* (False Map Turtle)**. USA: KANSAS: Lincoln Co.: Lincoln (39.85907°N, 93.60844°W; elev. 412 m). 11 May 2011. Brian Hubbs. Verified by Curtis Schmidt. Natural History Museum of Los Angeles County photo voucher LACM PC 1558. New county record. This record fills a gap in the range (Collins 2010. Amphibians, Reptiles, and Turtles in Kansas. Sternberg Museum of Natural History, Fort Hays State University, Hays, Kansas. 312 pp.).

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***GRAPTEMYS PSEUDOGEOGRAPHICA PSEUDOGEOGRAPHICA* (False Map Turtle)**. USA: NEW MEXICO: Sierra Co.: Elephant Butte Reservoir, ca. 9.6 air mi upstream of Elephant Butte Dam, (107.147408°N, 33.289049°W; NAD 83). 30 Sept 2011. Charles W. Painter and Levi T. Cole. Adult female (233 mm SCL; 1486 g) preserved at time of capture. Verified by Kurt Buhlmann. University of New Mexico Division of Herpetology (MSB 79133). New state record (Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. Univ. New Mexico Press, Albuquerque. xix + 431 pp.; Ernst and Lovich 2009. Turtles of the United States and Canada, 2nd ed. Johns Hopkins Univ. Press, Baltimore, Maryland. xii + 827 pp.).

A male was previously captured 0.6 miles upstream on 15 June 2011 by Levi T. Cole and Luke D. Walker. That animal was photographed and released at capture site.

There is no indication these individuals represent a breeding population in New Mexico.

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***STERNOTHERUS ODORATUS* (Eastern Musk Turtle)**. USA: OHIO: Meigs Co.: Sutton Township, 2.5 km E of Syracuse on State Hwy 124 (38.99570°N, 81.94090°W; WGS 84). 23 May 2010. B. Folt. Verified by Scott Moody. Cincinnati Museum Center, Geier Collections and Research Center (CMC HP 7075, photo voucher). New county record (Wynn and Moody 2006. Ohio Turtle, Lizard, and Snake Atlas. Ohio Biol. Surv. Misc. Contr. No. 10, Columbus. iv + 81 pp.). Collected DOR.

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***TRACHEMYS SCRIPTA ELEGANS* (Red-eared Slider)**. USA: Texas: Goliad Co.: Naval Auxiliary Landing Field Goliad near a shallow pond (28.6112°N, 97.6124°W; WGS 84). Carapace collected on 19 October 2011. F. Weaver, C. Giggleman, and N. Mitton. Verified by Travis J. Laduc. Texas Natural History Collections (TNHC 85064). New county record (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. Texas A&M Univ. Press. College Station. 421 pp.). One juvenile specimen was seined at ca. 1 m depth at the same location, 19 April 2011 by C. Giggleman, A. Miller, P. Clements, and N. Mitton .

FRANKLIN J. WEAVER (e-mail: frank_weaver@fws.gov) and **CRAIG GIGGLEMAN**, U.S. Fish and Wildlife Service, Corpus Christi Ecological Services Field Office, 6300 Ocean Drive, Classroom West, Corpus Christi, Texas 78412-5837, USA.

***TRACHEMYS SCRIPTA ELEGANS* (Red-eared Slider)**. USA: WISCONSIN: Kenosha Co.: unnamed tributary of Des Plaines River on west side of Interstate 94 and north side of County Hwy C (93rd St.), T1N R21E Section 13 SE1/4 (42.545747°N, 87.955437°W; WGS84). 18 June 2009. Gary S. Casper, Thomas G. Anton. Verified by Alan Resetar. FMNH 281241. First reproductive record for the state (Casper 1996. Geographic Distributions of the Amphibians and Reptiles of Wisconsin. Milwaukee Public Museum, 87 pp.). A gravid adult female trapped in a baited hoop net.

Red-eared Sliders are occasionally reported from urban ponds and nature centers in Madison and Milwaukee, disjunct from the known natural range, and are presumed to be released pets (Bob Hay, Wisconsin DNR, pers. comm.). This gravid female represents the first Wisconsin record from a stream system within the natural range (Phillips et al. 1999. Field Guide to Amphibians and Reptiles of Illinois. Illinois Nat. Hist. Surv. Man. 8, Champaign, Illinois. 282 pp.), and is considered a natural occurrence in an industrial corridor without public access (as is typical of release sites). Recent (post-1985) records are available from the Des Plains River watershed in Cook (FMNH 267587, INHS 16868), DuPage (INHS 10775), and Will (FMNH 251323) counties, Illinois. A specimen was also collected in 1876 from Lake County, Illinois (FLMNH 51108). The eventual establishment of sliders in Wisconsin has been predicted, possibly abetted by ongoing climate warming (Casper 2008. Bull. Chicago Herpetol. Soc. 43[5]:73–79). Regardless of origin, sliders are now breeding in Kenosha Co., and should be added to the state herpetofaunal list.

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SQUAMATA — LIZARDS

***AGAMA GRACILIMEMBRIS* (Little Ground Agama)**. BURKINA FASO: HAUTS-BASSINS REGION: ca. 4 km W Koumi (11.125°N, 04.479°W; WGS 84; 445 m elev.). 2 March 2004. J.-F. Trape. Institut de Recherche pour le Développement at Dakar (IRD TR.473). Verified by Laurent Chirio. First record for Burkina Faso (Grandison 1968. Bull. Brit. Mus. Nat. Hist. 17:67–90; Uetz and Hošek 2011. The Reptile Database. http://www.reptile-database.org/. Accessed December 2011). Previously unreported west of Benin, the type locality.

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***AGAMA GRACILIMEMBRIS* (Little Ground Agama)**. MALI: SIKASSO REGION: ca. 3 km W Zambouroula (11.605°N, 07.576°W; WGS 84; 358 m elev.). 8 January 2004. J.-F. Trape. Institut de Recherche pour le Développement at Dakar (IRD TR.262). Verified by Laurent Chirio. First record for Mali and new westernmost

locality in Africa (Grandison 1968. Bull. Brit. Mus. Nat. Hist. 17:67–90; Joger and Lambert 1996. J. Afr. Zool. 110:21–51; Uetz and Hošek 2011. The Reptile Database. http://www.reptile-database.org/. Accessed December 2011).

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ANOLIS ORTONII. BRAZIL: PERNAMBUCO: Municipality of Abreu e Lima: CIMNC (Centro de Instrução Marechal Newton Cavalcanti) (7.82°S, 35.101°W; WGS 84, elev. 116 m, Google Earth). 18 October 2009. M. Miranda d'Assunção. Herpetological Collection of the Paleoherpetological and Herpetological Laboratory of the Universidade Federal Rural de Pernambuco UFRPE, Recife, Brazil (CHPUFRPE 567; adult male, LHC 34 mm and total length 86 mm).Verified by M. Trefault Urbano Rodrigues. Species known from Bolivia, Perú, Ecuador, Colombia, Venezuela, Guiana, Suriname, French Guiana, Guatemala, and Brazil (Barrio-Amorós and Duellman 2009. Boletín RAP de Evaluación Ecológica, 55:137–155; Duellman 1978. Misc. Publ. Univ. Kans. Mus. Nat. His. 65:1–352; Alonso et al. 2001. SI/MAB Series 7, Smithsonian Institution; Dirksen and Riva 1999. Graellsia 55:199–215; Peters and Donoso-Barros 1970. U.S. Natl. Mus. Bull. 293, viii+297 pp.; Stuart 1955. Misc. Publ. Mus. Zool. Univ. Michigan 91:1–31). In Brazil the species occurs in Rondônia, Roraima, Amazonas, Pará, Amapá, Tocantins, Paraíba, Alagoas, and Sergipe, with a gap of nearly 300 km between the states of Paraíba and Alagoas (Vanzolini 1992. Estudos Avulsos 6[15]:41–65; Avila-Pires et al. 2009. Bol. Mus. Para. Emílio Goeldi. Cienc. Nat. 4:99–118; Silva 2008. Diversidade de espécies e ecologia da comunidade de lagartos de um fragmento de Mata Atlântica no nordeste do Brasil. Dissertação apresentada ao Programa de Pós-graduação em Ciência Biológicas do Centro de Biociências, Universidade Federal do Rio Grande do Norte. 90 pp.; Souza 2008. Filogeografia em lagartos [Reptilia: Squamata] no baixo Tocantins, Ilha do Marajó e sul do Amapá, Brasil. Dissertação apresenta do Programa de Pós-graduação em Zoologia, Museu Paraense Emílio Goeldi e Universidade Federal do Pará, 53 pp.; Ribeiro-Júnior 2006. S. Am. J. Herpetol. 1[2]:131–137; Macedo et al. 2008. Biota Neotrop. 8[1]:133–139; Freire 1996. Rev. Bras. Zool. 13[4]:903–921; Moraes 2008. Diversidade beta em comunidades de lagartos em duas ecorregiões distintas na Amazônia. Dissertação apresentada ao Programa de Pós-graduação em Biologia Tropical e Recursos Naturais, 40 pp.). First state record, partially filling the gap between Paraíba and Alagoas states; the locality is 100 km S from Cabedelo, Paraíba, and 160 km N from Ibateguara, Alagoas.

MARIANA MIRANDA D'ASSUNÇÃO, DANILO SÁ BARRETO BARROS FILHO, ARMANDO DOS SANTOS ARAÚJO, and **GERALDO JORGE BARBOSA DE MOURA**, Universidade Federal Rural de Pernambuco, Paleoherpetological and Herpetological Laboratory, UFRPE, Rua Dom Manoel de Medeiros, Dois Irmãos - CEP: 52171-900, Recife, PE, Brazil.

***ANOLIS SAGREI* (Brown Anole)**. USA: GEORGIA: McIntosh Co.: Darien, GA Hwy 251, 0.6 km NW of I-95 (31.399967°N, 81.453167°W; WGS 84). 07 May 2009. Georgia Museum of Natural History (GMNH) 50126. First county record. Adult male collected from hotel landscaping and several dozen adults observed on hotel grounds and the edges of adjacent wooded areas. Hotel manager stated that *A. sagrei* were present throughout his two-year tenure. Adult female (GMNH 50127) collected during a subsequent visit on 08 June 2009, at which time several individuals were also observed in the parking lot landscaping of a nearby outlet mall.

Liberty Co.: near Midway, US-84, 0.5 km NW of I-95 (31.781033°N, 81.383250°W; WGS 84). 08 June 2009. GMNH 50128. First county record. Adult female collected from vegetation bordering a parking lot; three additional adult females observed in overgrown vegetation along the parking lot edge.

Brian Co.: Richmond Hill, US-17, 0.2 km E I-95 (31.928017°N, 81.327933°W). 08 June 2009. GMNH 50129. First county record. Adult male collected from fencerow vegetation aside a motel parking lot. Three additional adult males and two adult females observed in a 15-minute search of the motel grounds.

Chatham Co.: Port Wentworth, GA Hwy 21, 0.6 km NW I-95 (32.197267°N, 81.195617°W). 08 June 2009. GMNH 50130. First county record. Adult male collected and two adult females observed in hotel landscaping. Several additional lizards, likely *A. sagrei*, heard moving within dense shrubs. All specimens collected by N. W. Turnbough and verified by A. C. Echternacht.

These records fill a distributional gap between Glynn Co. in southeast Georgia (Campbell 1996. Herpetol. Rev. 27:155–157) and Jasper Co., South Carolina (Turnbough 2006. Herpetol. Rev. 37:361). They resulted from an attempt by the author to assess *A. sagrei* dispersal into the region via vehicular rafting (Godley et al. 1981. Herpetol. Rev. 12:84-86; Campbell 1996, *op. cit.*). An I-95 exit was selected for each county and a suitable site for searching was identified upon exiting—hotels/motels or truck stops with adequate landscaping or surrounding vegetation. *Anolis sagrei* were discovered with a single attempt for each county except Chatham, where the second attempt was successful. Such ease in finding *A. sagrei* suggests that the species was likely widespread throughout the I-95 corridor in Georgia, at least in exit areas, prior to the particularly severe winters of 2009/10 and 2010/11. Vehicular rafting appears to be the most parsimonious explanation for *A. sagrei* dispersal to all of the above sites, though transport in nursery plants may be a possibility for the hotel/motel sites.

South Carolina: Concurrent with or prior to the above collection efforts, the establishment of *A. sagrei* in previously reported South Carolina rest area localities (Turnbough 2006, *op. cit.*) was investigated. The Jasper Co. site was visited every year from 2006–2009, and in those years an established *A. sagrei* population spread throughout the site and became increasingly abundant. The Colleton Co. and Orangeburg Co. sites were each searched for approximately 15 minutes on 08 June 2009: three adult males and one adult female were observed in vegetation surrounding the Colleton Co. rest area facilities, and seven adult males and one adult female were observed around the Orangeburg Co. facilities. Because overwinter survival is probably the limiting factor for *A. sagrei* establishment in South Carolina, the increased abundance of *A. sagrei* at these two localities likely signified population establishment rather than higher rates of post-winter vehicular disembarkation. All of the reported South Carolina populations may have been extirpated by the unusually cold winter of 2010/11, however, as *A. sagrei* were not found in four searches of the sites by up to three observers in summer 2011 (L. Rubio-Rocha, pers. comm.). Notably, *A. carolinensis*, which was present at the Jasper Co. site and abundant at the other two sites in 2009, was still present at all three sites in summer 2011.

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***CHALCIDES DELISLEI* (de l'Isle Three-fingered Skink)**. SENEGAL: FLEUVE REGION: Bala (16.419°N, 14.926°W; WGS 84; 20 m elev.). 1 October 2003. J.-F. Trape. Institut de Recherche pour

le Développement at Dakar (IRD TR.2108). Verified by Laurent Chirio. First record for Senegal (Cisse and Karns 1978. Bull. IFAN 40A:144–211; Böhme 1978. Bonn. Zool. Beiträge. 29:360–417; Uetz and Hošek 2011. The Reptile Database. http://www.reptile-database.org/. Accessed December 2011).

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***CHALCIDES OCELLATUS* (Ocellated Skink)**. GREECE: Kyklades Pref.: NAXOS ISLAND: Plaka (37.053372°N, 25.388175°E; WGS 84; 25.3 m elev.). 25 May 2011. A. Belasen, B. Li, and J. Foufopoulos. Verified by P. Pafilis. University of Michigan Museum of Zoology, Division of Reptiles and Amphibians (Digital Image Collection Numbers 968–971, photographic vouchers, one individual). New record for island of Naxos, species has relatively wide distribution on mainland Greece (Valakos et al. 2008. The Amphibians and Reptiles of Greece. Edition Chimaira, Frankfurt, Germany, 480 pp.). Also first record from Cyclades archipelago, which has been isolated from the Greek mainland for >200,000 yrs. Several adults and juveniles observed on dry stone walls separating small fields at this south-facing site, a low elevation area characterized by sparse thermo-Mediterranean vegetation growing on granite substrate and loose sandy soils.

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***DRYADOSAURA NORDESTINA* (Briba Cabeçuda)**. BRAZIL: BAHIA: Município de Wenceslau Guimarães: Estação Ecológica Estadual Wenceslau Guimarães (13.600000°S, 39.716667°W, WGS 84; 800 m elev.). 16 January 2011. M. S. C. Delfino. Museu de Zoologia da Universidade Federal de Bahia, Salvador, Bahia, Brazil (UFBA 2974, 2975). Collected with pitfall traps in a well preserved Atlantic Forest fragment. Município de Salvador: Jardim Botânico (12.930000°S, 38.434722°W; WGS 84). 15 and 20 July 2010. M. S. Soeiro. (UFBA 2715, 2714). Collected with pitfall traps in a 17 ha fragment within the city of Salvador. Both verified by M. T. Rodrigues. Species previously known from Paraíba, Pernambuco, Alagoas, Rio Grande do Norte, Sergipe states, and north of Bahia, Brazil (Camacho and Rodrigues 2007. Herpetol. Rev. 38:218–219; Noronha et al. 2010. Herpetol. Rev. 41:512; Rodrigues et al. 2005. Zool. J. Linn. Soc. 144:543–557). This record extends the distribution almost 200 km SW from the closest record (Mata de São João, Bahia; Camacho and Rodrigues, *op. cit.*).

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***HELODERMA HORRIDUM* (Mexican Beaded Lizard)**. MÉXICO: OAXACA. Municipality of San Pedro Mixtepec, Jardín Botánico de la Universidad del Mar, km 239 on road to Sola de Vega-Puerto Escondido, ca. 6 km N of Puerto Escondido (15.916663°N, 97.076748°W; WGS84), 91 m elev. 17 June 2009. Guillermo Sanchez-de la Vega. Verified by Jerry D. Johnson. Laboratory for Environmental Biology, Centennial Museum, The University of Texas at El Paso photographic voucher (G 2011.2). First municipality record that fills a gap between the closest reported localities ca. 89 km WNW in Jamiltepec and ca. 193 km ENE in Cerro Guiengola on the Isthmus of Tehuantepec (Bogert and Martin del Campo 1956. Bull. Amer. Mus. Nat. Hist. 109:1-238). The individual was found trapped in a man-made depression in a tropical deciduous forest.

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***HEMIDACTYLUS TURCICUS* (Mediterranean Gecko)**. USA: ALABAMA: Wilcox Co.: 208 Caldwell Street, Camden, Alabama (31.992030°N, 87.292539°W; WGS84/NAD83). 3 September 2011. J. Diamond. Verified by Craig Guyer. AUM 39743. New county record (Mount 1996. The Reptiles and Amphibians of Alabama. University of Alabama Press. xi + 347 pp.). *H. turcicus* has been documented in many of the larger cities in Alabama but records and voucher specimens are lacking for many other portions of the state.

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***HEMIDACTYLUS TURCICUS* (Mediterranean Gecko)**. USA: GEORGIA: Dekalb Co.: 33.776392°N, 84.290554°W (WGS 84), elev. 309 m. 7 September 2011. Valerie Van Sweden. Verified by John Jensen. UTADC 6974. New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. Univ. of Georgia Press, Athens. 575 pp.). Has been documented in neighboring Clayton and Fulton counties. Different age class specimens of this introduced species have been observed at this private residence in downtown Decatur since May 2011. A juvenile specimen was found under a blown down tarp on the porch of a private residence.

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***LYGODACTYLUS GUTTURALIS* (Chevron-throated Dwarf Gecko)**. GUINEA: UPPER GUINEA REGION: Kalan-Kalan (10.107°N, 08.886° W; WGS 84; 602 m elev.). 18 April 2008. J.-F. Trape. Eight specimens. Institut de Recherche pour le Développement at Dakar (IRD TR.2449-2456). Verified by Laurent Chirio. GUINEA: FOUTA DJALON REGION: Poré (11.706°N, 12.274° W, 405 m elev.). 18 March 2009. J.-F. Trape. Institut de Recherche pour le Développement at Dakar (IRD TR.2541). Verified by Laurent Chirio. First records for Guinea (Böhme et al. 2009. Bonn Zool. Bull. 60:35–61).

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***LYGODACTYLUS GUTTURALIS* (Chevron-throated Dwarf Gecko)**. MALI: SIKASSO REGION: ca Laminina (11.220°N, 07.782°W; WGS 84; 370 m elev.). 15 June 2004. J.-F. Trape and I. Ineich. Institut de Recherche pour le Développement at Dakar

(IRD TR.690). Verified by Laurent Chirio. Niakoni (11.187°N, 07.803°W, 378 m elev.). 16 June 2004. J.-F. Trape and I. Ineich. Institut de Recherche pour le Développement at Dakar (IRD TR.938). Verified by Laurent Chirio. First records for Mali (Joger and Lambert 1996. J. Afr. Zool. 110:21–51; Uetz and Hošek 2011. The Reptile Database. http://www.reptile-database.org/. Accessed December 2011).

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***MABUYA UNIMARGINATA* (Central America Mabuya)**. MÉXICO: ESTADO DE MÉXICO: Municipality of Tonatico: La Puerta de Santiago, 5 km SE of Ixtapan de la Sal (18.751111°N, 99.626389°W; NAD 27), 1456 m elev. 25 June 2005. Rodrigo Macip-Ríos, Gabriel Barrios-Quiroz, and Victor Sustaita-Rodríguez. Verified by Luis Canseco Márquez. CNAR 21655–21656. First record for Estado de México (Casas-Andreu and Aguilar-Miguel 2007. *In* X. Aguilar-Miguel [ed.], Vertebrados del Estado de México, pp. 47–81. Ciencias Naturales y Exactas, Ciencias Biológicas, Universidad Autónoma del Estado de México, México) and a range extension of 35 km NW from the closest known locality in Puente de Ixtla, Morelos (Castro-Franco and Bustos-Zagal 2003. Acta Zool. Mex. [n.s.] 88:123–142). The lizards were collected by hand while they were basking on an abandoned stone wall.

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***MESALINA PASTEURI* (Pasteur's Desert Racer)**. MALI: MENAKA DISTRICT: ca 60 km NW Tidermene (17.0213°N, 02.1039°E; WGS 84; 340 m elev.). 10 February 2004. J.-F. Trape. Institut de Recherche pour le Développement at Dakar (IRD TR.395). Verified by Laurent Chirio. Second record for Mali, extends known range ca 250 km SW of Tin Amzi valley where frontiers of Mali, Algeria and Niger meet (Joger and Lambert 1996. J. Afr. Zool. 110:21–51; Sindaco and Jeremcenko 2008. The Reptiles of the Western Palearctic. Edizioni Belvedere, Latina. 579 pp.; Uetz and Hošek 2011. The Reptile Database. http://www.reptile-database.org/. Accessed December 2011).

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NOROPS CARPENTERI. HONDURAS: GRACIAS A DIOS: Bachi Kiamp (15.133333°N, 84.40°W; WGS84), 40 m elev. 16 July 2009. James R. McCranie. SMF 91746. Verified by Sebastian Lotzkat. First record for Honduras, extending range ca. 120 km NE from the closest known locality in Parque Nacional Saslaya, Atlántico Norte, Nicaragua (Sunyer and Köhler 2007. Salamandra 43:57–62). The lizard was active during the afternoon in secondary vegetation on a riverbank.

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***PANASPIS TOGOENSIS* (Togo Lidless Skink)**. MALI: SIKASSO REGION: ca Doussoudiana (11.1240°N, 07.7725°W; WGS 84; 341 m elev.). 15 June 2004. J.-F. Trape and I. Ineich. Four specimens. Institut de Recherche pour le Développement at Dakar (IRD TR.671-674). Verified by Laurent Chirio. First records for Mali (Joger and Lambert 1996. J. Afr. Zool. 110:21–51; Uetz and Hošek 2011. The Reptile Database. http://www.reptile-database.org/. Accessed December 2011).

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***PHRYNOSOMA MODESTUM* (Round-tailed Horned Lizard)**. USA: OKLAHOMA: Le Flore Co. 1940. W. C. Hobgood. Verified by Alan Resetar. FMNH 40808 (accessed through the HerpNet2 Portal, www.herpnet2.org, 26 Sep. 2011). This specimen was originally identified as *P. cornutum*, and was only recently corrected. The record represents a geographic range extension of approximately 550 km from the nearest confirmed county record of *P. modestum* in Hall Co., Texas (Dixon 2000. Amphibians and Reptiles of Texas. Texas A&M University Press, College Station. 500 pp.), excluding an unconfirmed Baylor Co. account that was considered erroneous (Axtell 1988. Interpretive Atlas of Texas Lizards [6]:1–18 + map. Southern Illinois University, Edwardsville).

The closest confirmed location of *P. modestum* in Oklahoma is approximately 790 km distant, in Cimarron Co. (Clarke 1983. Bull. Oklahoma Herpetol. Soc. 12:16). Museum records indicate that FMNH 40808 was collected in Le Flore Co., Oklahoma near Rich Mountain, Arkansas; we suggest this means the specimen was taken in Le Flore Co., Oklahoma very close to the Arkansas border adjacent to Rich Mountain, Arkansas. No additional locality information is available. There is apparently a peripheral population of *Crotalus atrox* in the Ouachita Mountains, another species with a more southwestern U.S. primary distribution (Sievert and Sievert 2011. A Field Guide to Oklahoma's Amphibians and Reptiles. Oklahoma Dept. Wildlife Conservation, Oklahoma City. 211 pp.). Future surveys for *P. modestum* in the area should be conducted to determine if the species persists in eastern Oklahoma.

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***PLESTIODON LATICEPS* (Broad-headed Skink)**. USA: OHIO: Lawrence Co.: Symmes Township, Wayne National Forest (38.76625°N, 82.53390°W; WGS 84). 5 June 2010. B. Folt and C. Brune. Verified by Scott Moody. Photo voucher in Cincinnati Museum Center, Geier Collections and Research Center (CMC HP 6543). New county record (Wynn and Moody 2006. Ohio Turtle, Lizard, and Snake Atlas. Ohio Biol. Surv. Misc. Contr. No. 10, Columbus. iv + 81 pp.).

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***POLYCHRUS MARMORATUS* (Green Lizard)**. BRAZIL: ALAGOAS: Municipality of Maceió: Serra da Saudinha (09.366°S, 35.750°W; SAD69). November 2005. U. Gonçalves and S.

Torquato. Setor de Zoologia, Coleção Herpetológica do Museu de História Natural, Universidade Federal de Alagoas, Brazil (MUFAL 3542; collecting license IBAMA/RAN 184/05). Verified by G. Skuk. Municipality of Campo Alegre: Fazenda Pindoba (09.758889°S, 36.235833°W; SAD69; elev. 121 m). 17 April 2007. I. C. S. Tiburcio and others. Museu de Zoologia da Universidade de São Paulo, São Paulo, Brazil (MZUSP 98144; collecting license IBAMA/RAN 204/06). Verified by H. Zaher. The species was previously recorded from rainforests of Guiana Francesa, Suriname, Guiana, Venezuela, Colômbia, Equador, Peru, and Brazil (Ávila-Pires 1995. Zool. Verh. 1–706). In Brazil the species was mentioned from Amazonas, Amapá, Maranhão, Pará, Roraima, Rondônia, Mato Grosso Ceará, Paraíba, Pernambuco, Bahia, Espírito Santo, and São Paulo (Vanzolini 1974. Pap. Avul. Zool. 18[4]:61–90; Vanzolini 1983. *In* Rhodin and Miyata [eds.], Advances in Herpetology and Evolutionary Biology: Essays in Honor of Ernest E. Williams, pp. 118–131. Museum of Comparative Zoology, Cambridge, Massachusetts; Ávila-Pires 1995, *op. cit.*; Kawashita-Ribeiro and Ávila 2008. Check List 4[3]:362–365; Santana et al. 2008. Biotemas 21[1]:75–84; Turci and Bernarde 2008. Bioikos 22[2]:101–108; Silva-Soares et al. 2011. Check List 7[3]:290–298). First state records, the localities (Serra da Saudinha and Fazenda Pindoba) are about 214 km and 268 km south of nearest occurrences, respectively (municipality of Timbaúba, state of Pernambuco).

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***SCELOPORUS TRISTICHUS* (Plateau Fence Lizard)**. USA: WYOMING: Natrona Co.: near Muddy Mountain Educational Center, on the southern slope of Casper Mountain in a small canyon north of County Road 505 (42.707490°N, 106.396642°W; WGS 84). 29 June 2011. K. J. Weber and K. P. Leuenberger. Verified by Adam Leache. INHS 2011o. New county record (Baxter and Stone 1985. Amphibians and Reptiles of Wyoming. 2nd ed. Wyoming Game and Fish Department, Cheyenne. 137 pp.).

One individual (male) was observed at this site. Subsequently an adult female was captured and observed (42.65369°N, 106.35277°W) on 27 July 2011. Four more individuals were captured near Casper, 20 km E (42.699509°N, 106.142660°W) on 30 June 2011. *S. tristichus* is known to occur in Albany, Laramie, Platte, and Converse counties where it exclusively inhabits rocky outcrops and crevices (Baxter and Stone, *op. cit.*). These observations extend the range of *S. tristichus* approximately 30 km.

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***TARENTOLA PARVICARINATA* (White-spotted Wall Gecko)**. MOROCCO: WESTERN SAHARA: Ca. 10 km NW Galtat Zemmour (25.218°N, 12.445°W; WGS 84; 465 m elev.). 1 October 2006. J.-F. Trape. Institut de Recherche pour le Développement at Dakar (IRD TR.1804). Verified by Philippe Geniez. First record for Morocco (Western Sahara), extends known range ca 400 km N of Adrar mountains in Mauritania (Geniez et al. 2006. The Amphibians and Reptiles of the Western Sahara. Edition Chimaira, Frankfurt an Main, 228 pp.; Padial 2006. Graellsia 62:159–178).

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***TROPIOCOLOTES TRIPOLITANUS* (Tripoli Pigmy Gecko)**. CHAD: KANEM REGION: Ca. 4 km W of Méchiméré (13.832°N, 15.769°E; WGS 84; 285 m elev.). Two specimens collected at night on sandy area near roots of *Acacia* trees. 16 January 2003. J.-F. Trape. Institut de Recherche pour le Développement at Dakar (IRD TR.02 and TR.04). Verified by Laurent Chirio. First records for Chad (Sindaco and Jeremcenko 2008. The Reptiles of the Western Palearctic. Edizioni Belvedere, Latina. 579 pp.; Uetz and Hošek 2011. The Reptile Database. http://www.reptile-database.org/. Accessed December 2011).

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***VARANUS DUMERILII* (Dumeril's Monitor)**. INDONESIA: SUMATERA SELATAN PROVINCE: Musi Banyuasin District: eastern lowlands of Sumatra, along border with Jambi Province (1.8186°S, 104.1206°E, Google Earth; 35 m elev.). 12 October 1995. Mark R. Bezuijen. Verified by Mark Auliya. Photographic voucher deposited in the Zoological Reference Collection of the Raffles Museum of Biodiversity Research, National University of Singapore (ZRC[IMG] 2.159). Adult, observed at 1100 h, motionless among sedges, *Pandanus* and felled timber on swampy ground, in large tract of selectively logged lowland dipterocarp forest with numerous small creeks (tree genera including *Shorea*, *Anisopthera*, *Gonostylus*; understory 5–10 m, canopy 25–30 m). Identified on basis of dark brown-black dorsum with dull yellow transverse bands; large nuchal scales, not arranged in longitudinal rows; large, oval and keeled dorsal scales; and tail laterally compressed with strong double keel (de Rooij 1915. The Reptiles of the Indo-Australian Archipelago. I. Lacertilia, Chelonia, Emydosauria. E. J. Brill Ltd, Leiden. xiv + 384 pp.). Widely distributed in Southeast Asia, but with few published locality records; some specimens mistaken for *V. rudicollis* (Bennett and Lim 1995. Malayan Nat. J. 49:113–116; Böhme 2003. Zool. Verh. 341:3–43; Bennett 2004. *In* Pianka et al. [eds.]. Varanoid Lizards of the World, pp. 172–175. Indiana University Press, Bloomington; Cota et al. 2008. Biawak 2:152–158). Previously recorded from eastern Sumatra (de Rooij 1915, *op. cit.*), although the provenance of some records is unclear.

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SERPENTES — SNAKES

***AGKISTRODON PISCIVORUS LEUCOSTOMA* (Western Cottonmouth)**. USA: TENNESSEE: Weakley Co.: N of Etheridge Levee Rd and White Clay Rd intersection on Obion River WMA (36.20054°N, 88.86903°W; NAD 83). 10 August 2011. Jeremy Dennison. Austin Peay State University Museum of Zoology (APSU 19160). New county record (Scott and Redmond 2008. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. http://www.apsu.edu/reptatlas [updated 14 April 2011; accessed 13 October 2011]).

Crockett Co.: 2.5 km NE of Hwy 152 on Horns Bluff Refuge. (35.851333°N, 89.091167°W; NAD 83). 23 June 2011. Robert Colvin and Jeremy Dennison. APSU 19137. New county record (Scott and Redmond 2008, *op. cit.* [updated 8 November 2011; accessed 9 November 2011]).

Specimen verifications were made by A. Floyd Scott. Voucher specimens collected under the authority of the Tennessee

Wildlife Resources Agency; field work supported by State Wildlife Grant (SWG) funding under the authority of the U.S. Fish and Wildlife Service.

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***BOIGA OCHRACEA* (Tawny Cat Snake)**. BANGLADESH: SYLHET DIVISION: Moulovibazaar District: Lawachara National Park (24.330963°N, 91.801120°E; WGS 84; ca. 50 m elev.). Road killed individual found on former Dhaka-Sylhet highway, dissecting Lawachara National Park. 13 July 2011. Verified by Gernot Vogel. Photographic voucher, Raffles Museum of Biodiversity Research, National University of Singapore (ZRC [IMG] 2.156). First confirmed record for Sylhet Division. First Bangladesh record from Chittagong Hill Tracts (Khan 1982. Wildlife of Bangladesh—A Checklist. Dhaka University Press, Dhaka. 173 pp.). Nearest record from Chittagong University Campus (ca. 200 km S; Ahsan & Parvin 2004. Asiatic Herpetol. Res. 10:235).

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***BOIGA SIAMENSIS* (Siamese Cat Snake)**. BANGLADESH: SYLHET DIVISION: Moulovibazaar District: Lawachara National Park (24.330963°N, 91.801120°E; WGS 84; ca. 50 m elev.). Two individuals found during day, on tea bushes (*Camellia* sp.) in Fulbari Tea Estate, adjacent to Lawachara National Park. 16 June 2011 and 17 June 2011. Verified by Gernot Vogel. Photographic voucher, Raffles Museum of Biodiversity Research, National University of Singapore (ZRC [IMG] 2.155). First confirmed locality record from Bangladesh. Kabir et al. (2009. Encyclopedia of Flora and Fauna of Bangladesh, Vol. 25. Amphibians and Reptiles. Asiatic Society of Bangladesh, Dhaka. 204 pp.) listed Sylhet and Chittagong Division, without locality information, voucher specimen or photographs. Nearest records from Gibbon Wildlife Sanctuary, Assam (ca. 349 km NE), Garo Hills, Meghalaya (ca. 201 km NW) and Sikkim (ca. 483 km NW) by Das et al. (2010. Russian J. Herpetol. 17:161–178), in India.

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***COLUBER* (= *MASTICOPHIS*) *FLAGELLUM* (Coachwhip)**. USA: KANSAS: Lincoln Co.: State Highway 232, 1.36 rd. km S jct. Hill Creek Bridge Rd. (38.911341°N, 98.475550°W; WGS 84). 11 August 2011. Verified by C. J. Schmidt. FHSM-H 15931. New county record (Kansas Herpetofaunal Atlas. http://webcat.fhsu.edu/ksfauna/herps/index.asp, accessed 6 September 2011). Adult DOR; extends the known range one county to the northeast.

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***CONOPSIS LINEATA* (Lined Tolucan Ground Snake)**. MÉXICO: ZACATECAS: Municipality Of Pinos: 2.64 km NE Pinos (22.311961°N, 101.554510°W; WGS84), 2884 m elev. 1 August 2010. Rubén Alonso Carbajal Márquez, Zaira Yaneth González Saucedo, Jason Jones, and Luis Gallegos Román. Verified by L. Lee Grismer. La Sierra University Digital Photo Collection (LSUDPC 6051). First record for the state, extending the known distributional range of the species ca. 69 km NW from Sierra de San Miguelito, Villa de Reyes, San Luis Potosí (USNM 46427; Goyenechea and Flores-Villela 2006. Zootaxa 1271:1–27). The snake was found under a rock in an oak savanna.

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***CROTALUS CULMINATUS* (Northwestern Middle American Rattlesnake)**. MÉXICO: OAXACA: Municipality of San Pedro Mixtepec: Jardín Botánico Puerto Escondido de la Universidad del Mar (JBPE UMAR), km 239 on Sola de Vega-Puerto Escondido Road, ca. 6 km N of Puerto Escondido (15.916947°N, 97.076694°W; WGS 84), 88 m elev. 28 January 2008. Guillermo Sanchez-de la Vega. Verified by Jerry D. Johnson. Laboratorio de Colecciones Biológicas, Universidad del Mar, Campus Puerto Escondido (Rep-42). First municipality record that fills a gap between the nearest confirmed localities, ca. 216 km WNW in Copala, Guerrero (Armstrong and Murphy 1979. Spec. Publ. Mus. Nat. Hist., Univ. Kansas [5]:i–vii, 1–88) and ca. 175 km ENE between Salina Cruz and Tequisistlán on the Isthmus of Tehuantepec (Gadow 1908. Through Southern México. Whitherby and Co., London. xvi + 257 pp.). Gloyd (1940. Spec. Publ. Chicago Acad. Sci. [4]:i–viii, 1–270) shows a map depicting a locality further west (possibly near Puerto Angel?) to the one reported by Gadow (1940, *op. cit.*), but he failed to include it in the localities he listed for Oaxaca. The same locality was seemingly mapped by Campbell and Lamar (2004. The Venomous Reptiles of the Western Hemisphere, Vol. II. Comstock Publ. Assoc., Ithaca, New York. xiv + 477–870 pp.). The adult female was DOR near the main entrance to JBPE UMAR. The vegetation in the area is represented primarily by tropical deciduous forest.

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***DIADOPHIS PUNCTATUS ARNYI* (Prairie Ring-necked Snake)**. USA: NEBRASKA: Harlan Co.: approx. 1.5 mi. NNE Alma (39.85907°N, 93.60844°W; elev. 624 m). 23 May 2011. Brian Hubbs. Verified by Dan Fogell. Natural History Museum of Los Angeles County photo voucher LACM PC 1562. New county record (Ballinger et al. 2010. Amphibians and Reptiles of Nebraska. Rusty Lizard Press, Oro Valley, Arizona. 400 pp.; Fogell 2010. The

Amphibians and Reptiles of Nebraska. University of Nebraska Press, Lincoln, Nebraska. 158 pp.).

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***HETERODON PLATIRHINOS* (Eastern Hognose Snake).** USA: TENNESSEE: McNairy Co.: Finger, 294 Sherry Lynn Drive (35.357800°N, 88.635583°W; WGS84). 4 October 2011. Brian P. Butterfield. Verified by A. F. Scott. Austin Peay State University (APSU 19168 photographic voucher). New county record (Scott and Redmond 2008 [latest update: 8 November 2011]. Atlas of Reptiles in Tennessee. Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/, accessed 9 November 2011). Juvenile male found in a residential garage located in a rural subdivision within an oak-hickory forest.

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***HYPSIGLENA CHLOROPHAEA DESERTICOLA* (Northern Desert Nightsnake).** USA: UTAH: Cache Co.: River Trail at Stokes Nature Center, south side, Logan Canyon (41.741938°N, 111.768623°W; WGS 84). 13 August 2011. A. M. Durso, K. P. Durso, N. M. Kiriazis, L. A. Neuman-Lee. Verified by Jack W. Sites, Jr. BYU 49957. Found crossing a dirt path at 2139 h. A second specimen (BYU 49958) was found in Logan Canyon.

These two records confirm the presence of *H. chlorophaea* in Cache Co. (Cox and Tanner 1995. Snakes of Utah. Bean Life Science Museum, Provo, Utah. 92 pp.), where it had not been recorded until recently (Mulcahy 2008. Mol. Phylog. Evol. 46:1095–1115), and expands the range of known localities within the county (B. Sutter, Utah Natural Heritage Database, pers. comm.). In October 2005, a single voucher specimen (CAS 235907) was collected in River Heights by a grade school student. Anecdotal reports exist for additional River Heights records (J. A. MacMahon, pers. comm.). Together, these three specimens fill a gap between the nearest records, from ca. 67 mi (airline) S at Fort Douglas, Salt Lake Co., Utah (CAS 30925, 30926) and ca. 81 mi (airline) NE at ~ 1 mi SE of Pocatello, Bannock Co., Idaho (Linder and Fichter 1977. Amphibians and Reptiles of Idaho. Idaho State Univ. Press, Pocatello. 78 pp.).

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***LAMPROPELTIS ALTERNA* (Gray-banded Kingsnake).** MEXICO: NUEVO LEON: Municipality of Mina: 58.7 air km SW of Sabinas Hidalgo along Mex. Hwy 53 (26.24959°N, 100.69002°W; WGS84), 785 m elev. 7 October 2007. Michael S. Price, Christopher R. Harrison, and David Lazcano. Verified by Robert W. Bryson. UANL 6986. New municipality record that fills in a distributional gap between Monclova, Coahuila (Lemos-Espinal and Smith 2007. Anfibios y Reptiles del Estado de Coahuila, México. UNAM, Tlalnepantla, Estado de México and CONABIO, México, D.F. xii + 550 pp.) and Monterrey, Nuevo Leon (Lazcano-Villarreal et al. 2010. Serpientes de Nuevo Leon. UANL, Monterrey, Nuevo Leon, México. 502 pp.). The snake was found in the Sierra Pedernales at the entrance of a large crevice in an east-facing rock outcrop surrounded by typical xeric Chihuahuan Desert scrub vegetation.

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***LAMPROPELTIS TRIANGULUM* (Milksnake).** MÉXICO: GUANAJUATO: Municipality of Tarimoro: 3.5 km NNW of La Moncada (20.316241°N, 100.811616°W; WGS84), 1763 m elev. 20 August 2011. José Carlos Arenas Monroy. Verified by Robert Hansen. UTA-DC 6973. First record for the municipality, third record for the State of Guanajuato, and it bridges about a 153 km (airline) gap SSW between the northern population, ca. 153 km (airline) SSW from 12.5 km SE Mineral El Realito, Victoria, Guanajuato (Campos-Rodríguez et al. 2010. Rev. Mex. Biodiv. 81:203–204), and southern populations, ca. 33 km (airline) NNW from Acámbaro, Guanajuato (Williams 1988. Systematics and Natural History of the American Milk Snake, *Lampropeltis triangulum*. 2nd ed., revised. Milwaukee Publ. Mus., Milwaukee, Wisconsin. x + 176 pp.) The specimen was found under a plastic pool cover near a pond in an agriculture field.

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***MICRURUS DISTANS* (West Mexican Coral Snake).** MEXICO: ZACATECAS: Municipality of Mezquital Del Oro: 8 km E Mezquital del Oro by road Malacate-Moyahua (21.267383°N, 103.313492°W; WGS 84), 1525 m elev. 3 October 2010. Octavio Vázquez-Huizar and Iván T. Ahumada-Carrillo. Verified by Jacobo Reyes- Velasco. UTADC 6967–6968. First state record, extending the range ca. 55 km (airline) N from Río Grande de Santiago drainage, Jalisco (Campbell and Lamar 2004. The Venomous Reptiles of the Western Hemisphere, Vol. I. Comstock Publ. Assoc., Cornell Univ. Press, Ithaca, New York. 476 pp.). The snake was found AOR in tropical deciduous forest.

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***NERODIA ERYTHROGASTER FLAVIGASTER* (Yellow-bellied Watersnake).** USA: TENNESSEE: Crockett Co.: 2.7 km NE of Hwy 152 on Horns Bluff Refuge (35.8575°N, 89.08777°W; NAD 83). 23 June 2011. Robert Colvin and Jeremy Dennison. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19138). New county record (Scott and Redmond 2008. Atlas of Reptiles in Tennessee. Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. http://www.apsu.edu/reptatlas [updated 8 November 2011; accessed 9 November 2011]).

Voucher specimen collected under the authority of the Tennessee Wildlife Resources Agency; field work supported by State Wildlife Grant (SWG) funding under the authority of the U.S. Fish and Wildlife Service.

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***NERODIA SIPEDON SIPEDON* (Common Watersnake)**. USA: KANSAS: Lincoln Co.: Lincoln (39.02889°N, 98.151527°W; elev. 412 m). 11 May 2011. Brian Hubbs. Verified by Curtis Schmidt. Natural History Museum of Los Angeles County photo voucher (LACM PC 1559). New county record fills a gap in the range (Collins 2010. Amphibians, Reptiles, and Turtles in Kansas. Sternberg Museum of Natural History, Fort Hays State University, Hays, Kansas. 312 pp.). Snake observed dead, caught in fishing net on log.

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***OLIGODON CYCLURUS* (Cantor's Kukri Snake)**. BANGLADESH: SYLHET DIVISION: Moulovibazaar District: Lawachara National Park (24.331524°N, 91.818104°E; WGS 84; ca. 32 m elev.). One live individual found at ca. 0700 h in Fulbari village, outside Lawachara National Park. Another individual, a road kill, found on former Dhaka-Sylhet highway, dissecting the Park. 22 July 2011 and 24 October 2011. Verified by Gernot Vogel. Photographic voucher, Raffles Museum of Biodiversity Research, National University of Singapore (ZRC [IMG] 2.158). First confirmed record for Sylhet Division. Nearest populations in Bangladesh from Lalmonirhat District (ca. 338 km to NW; David et al. 2011. Zootaxa 2799:1–14), and unconfirmed sightings from Sherpur District (ca. 182 km to NW; M. Khan, pers. comm.).

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***OPHEODRYS AESTIVUS* (Rough Green Snake)**. USA: TENNESSEE: Wilson Co.: Cedars of Lebanon State Forest on Cedar Forest Rd. approximately 1.45 km E of McCrary Rd. (36.08027°N, 86.404722°W; WGS 84). 30 September 2011. Tom Blanchard. Verified by A. Floyd Scott. Austin Peay State University (APSUMZ 19163). Found dead on gravel road in cedar-predominated forest. New county record (Scott and Redmond 2008 [latest update: 08 November 2011]. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/, accessed 30 September 2011).

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***RHABDOPHIS HIMALAYANUS* (Himalayan Keelback)**. BANGLADESH: SYLHET DIVISION: Moulovibazaar District: Lawachara National Park (24.330963°N, 91.801120°E; WGS 84; ca. 50 m asl.). Three roadkilled individuals were also found on former Dhaka-Sylhet highway, dissecting Lawachara National Park. 8 July 2011. Verified by Gernot Vogel. Photographic voucher, Raffles Museum of Biodiversity Research, National University of Singapore (ZRC [IMG] 2.154). First confirmed locality record from Bangladesh. Khan (2008. Protected Areas of Bangladesh- A Guide to Wildlife. Nishorgo Program, Bangladesh Forest Department, Dhaka, Bangladesh. 304 pp.) mentioned of a record in northwest Bangladesh, but without locality information, voucher specimen or photographs. Nearest populations recorded from Assam, Meghalaya, northern Bengal and Sikkim, in India (Ahmed at al. 2009. Amphibians and Reptiles of Northeast India. A Photographic Guide. Aaranyak, Guwhati. 168 pp.) Four live individuals found in mixed plantation forest.

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***RHADINAEA FLAVILATA* (Pine Woods Littersnake)**. USA: GEORGIA: Camden Co.: Cumberland Island (30.8153°N, 81.46956°W; WGS 84) 31 May 2011. C. Ruckdeschel. Verified by C. K. Dodd and K. Krysko. Florida Museum of Natural History (photo voucher UF 165513). New island record (Jensen et al. [eds.] 2008. Amphibians and Reptiles of Georgia. Univ. of Georgia Press, Athens. 575 pp.). Single adult in damp area.

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***RHADINAEA LAUREATA* (Crowned Graceful Brownsnake)**. MÉXICO: CHIHUAHUA: Municipio de Bocoyna: near km 86 on Hwy 25 N of Creel (27.789694°N, 107.651972°W; NAD27), 2355 m elev. 12 July 2008. Robert W. Bryson, Jr. and Mike Torocco. UAZ 57331-PSV. Municipio de Guadalupe y Calvo, approximately 1 km N of Baborigame (26.425975°N, 107.268522°W; NAD27), 1800 m elev. 10 October 2008. Ricardo Ramírez-Chaparro and Jesús Enrique-Fuentes. UAZ 57321-PSV. Both specimens verified by Irene Goyenechea and Charles W. Myers. The two localities are separated by ca. 154 km and are the first records for Chihuahua, representing range extensions of 360 km northwest and 312 km northwest, respectively, from the closest recognized records at Laguna del Progresso, Durango (UMMZ 113625–113627; Myers 1974. Bull. Am. Mus. Nat. Hist. 153:1–262); UAZ 57331-PSV is also the northernmost record for this species in Mexico. Both snakes were found in pine-oak woodlands on the Sierra Madre Occidental.

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***SINOMICRURUS MACCLELLANDI* (MacClelland's Coral Snake)**. BANGLADESH: SYLHET DIVISION: Moulovibazaar District: Lawachara National Park (24.333016°N, 91.800096°E; WGS 84; ca. 43 m elev.). Two road-killed individuals found on former Dhaka-Sylhet highway, dissecting Lawachara National Park. 17 October 2011 and 26 October 2011. Verified by Gernot Vogel. Photographic voucher, Raffles Museum of Biodiversity Research, National University of Singapore (ZRC [IMG] 2.157). First confirmed locality record from Bangladesh. Kabir et al. (2009. Encyclopedia of Flora and Fauna of Bangladesh, Vol. 25. Amphibians and Reptiles. Asiatic Society of Bangladesh, Dhaka. 204 pp.) mentioned its presence in forested areas of Sylhet and Chittagong Division, but with no locality information, voucher specimens, or photographs. Nearest populations recorded from Assam, India (Ahmed at al. 2009. Amphibians and Reptiles of Northeast India. A Photographic Guide. Aaranyak, Guwahati. 168 pp.).

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***STORERIA DEKAYI* (Brownsnake)**. USA: GEORGIA: Telfair Co.: 14.5 km SW Lumber City, Orianne Indigo Snake Preserve

(31.844090°N, 82.796237°W; NAD 83) October 2011. J. Parker, T. Warfel, and M. Ishimatsu. Verified by Kenneth L. Krysko. UF 165899. New county record (Jensen et al. [eds.] 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). Adult under debris in Ocmulgee River floodplain.

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***STORERIA DEKAYI DEKAYI* (Northern Brownsnake)**. USA. OHIO: Hamilton Co.: Delhi Township: (39.113290°N, 84.695231°W; WGS 84). 12 October 2011. Paul J. Krusling. Verified by Jeffrey G. Davis. Cincinnati Museum Center Herpetology Collection (CMC 12330). New county record (Wynn and Moody 2006. Ohio Turtle, Lizard, and Snake Atlas. Ohio Biol. Surv. Misc. Contrib. No. 10, Columbus).

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***STORERIA DEKAYI WRIGHTORUM* (Midland Brownsnake)**. USA: ARKANSAS: Searcy Co.: vic. Mull, off AR St. Hwy. 14, ca. 2 km S on Ramblewood Trail by private residence (36.056722°N, 92.604324°W; WGS 84). 4 November 2011. M. B. Connior. Verified by S. E. Trauth. Arkansas State University Museum of Zoology Herpetology Collection (ASUMZ 31892). First county record filling a distributional gap among surrounding Stone, Marion, and Newton counties (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville. 421 pp.).

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***STORERIA OCCIPITOMACULATA* (Red-bellied Snake)**. USA: ARKANSAS: Baxter Co.: On Baxter Co. Rd. 36, at a point 2.4 km W St. Hwy 201 (36.48333°N, 92.35334°W; WGS 84). 3 November 2011. S. E. Trauth. Verified by Benjamin A. Wheeler. Arkansas State University Museum of Zoology Herpetology Collection (ASUMZ 31893). DOR. First county record filling a distributional gap among surrounding Marion, Izard, and Fulton counties (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville. 421 pp.).

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***STORERIA OCCIPITOMACULATA* (Red-bellied Snake)**. USA: INDIANA: Washington Co.: Jackson-Washington State Forest: 38.70164°N, 86.01019°W (NAD 83). 7 June 2011. Sarabeth Klueh and Jason Mirtl. Verified by Chris Phillips. Illinois Natural History Survey (INHS 2011p). New county record. (Minton 2001. Amphibians and Reptiles of Indiana. 2nd ed., revised. Indiana Academy of Science. vii + 404 pp.).

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***THAMNOPHIS PROXIMUS PROXIMUS* (Orange-striped Ribbonsnake)**. USA: KANSAS: Ness Co.: approximately 3 mi. S of Ness City (38.40628°N, 99.89524°W; elev. 676 m) 1 May 2010. Brian Hubbs. Verified by Chad Whitney. Natural History Museum of Los Angeles County photo voucher (LACM PC 1561). New county record (Collins 2010. Amphibians, Reptiles, and Turtles in Kansas. Sternberg Museum of Natural History, Fort Hays State University, Hays, Kansas. 312 pp.).

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***THAMNOPHIS SAURITUS SAURITUS* (Common Ribbonsnake)**. USA: ALABAMA: Sumter Co.: Near a wet seep on a Selma Chalk exposure (32.98652°N, 88.21576°W; WGS84/NAD83). 18 October 2011. R. Birkhead. Verified by Craig Guyer. AUM 39703. New county record. *T. s. sauritus* is assumed to occur statewide, however verified records are lacking for some counties (Mount 1996. The Reptiles and Amphibians of Alabama. University of Alabama Press, Tuscaloosa. xi + 347 pp.).

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***TROPIDOCLONION LINEATUM* (Lined Snake)**. USA: WISCONSIN: Iowa Co.: specific locality information withheld due to the sensitive nature of the site. C. Raimond and J. M. Lorch. Verified by Joshua Kapfer and Rori Paloski. Illinois Natural History Survey (INHS 2011m photo voucher). New state record. Extends the known range of this species by approximately 95 km (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Books, 668 pp.; INHS 21335 from Jo Daviess Co., Illinois). Two adults were observed on a dry prairie remnant on 4 September 2011; an additional adult (based on differences in belly pattern) was located on 10 September 2011. The site lies within an historic prairie complex (Curtis 1959. The Vegetation of Wisconsin: An Ordination of Plant Communities. University of Wisconsin Press, Madison. 640 pp.) that is now a mixture of pastureland, active agricultural fields, and scattered prairie remnants. The main range of *Tropidoclonion lineatum* extends from southeastern South Dakota south to the Gulf Coast of Texas, but there are isolated populations in northern and central Illinois, southeastern Iowa, east-central Missouri, eastern Colorado, and New Mexico (Ernst and Ernst 2003, *op. cit.*). The nearest known population to the Wisconsin site occurs in southern Jo Daviess Co., Illinois (Bowen 2004. Herpetol. Rev. 35:413). It is unclear whether the Wisconsin animals represent a population disjunct from that of northwest Illinois or whether the secretive habits of this semi-fossorial snake are responsible for the paucity of records. Habitat similar to that found at the newly discovered site is present throughout large portions of Grant, Green, Lafayette, and Iowa counties, Wisconsin, and the species might be more widely distributed in the state than this one record indicates.

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***VIRGINIA STRIATULA* (Rough Earthsnake)**. USA: ARKANSAS: Sevier Co.: 5.1 km E of King off Co. Rd. 342 (34.144665°N, 94.238405°W; WGS 84). H. W. Robison. Verified by S. E. Trauth. Arkansas State University Museum of Zoology Herpetological Museum (ASUMZ 31903). New county record filling a distributional hiatus in extreme southwestern Arkansas near previous record in Miller Co. (Trauth et al. 2004. Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.).

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***VIRGINIA VALERIAE* (Smooth Earthsnake)**. USA: OHIO: Gallia Co.: Greenfield Township, Dry Ridge Road (Township Hwy 596) in the Wayne National Forest (38.78122°N, 82.54766°W; WGS 84). 5 June 2010. B. Folt and C. Brune. Verified by Scott Moody. Cincinnati Museum Center, Geier Collections and Research Center (CMC HP 6550 photo voucher). New county record (Wynn and Moody 2006. Ohio Turtle, Lizard, and Snake Atlas. Ohio Biol. Surv. Misc. Contr. No. 10, Columbus. iv + 81 pp.).

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New Distributional Records from the Lesser Sundas, Indonesia

The Lesser Sunda islands stretch from 114.43° to 127.37°E and lie between latitudes of 8 and 10°S. The islands are primarily volcanic in origin, and currently experience a tropical seasonally wet-dry climate which in general becomes increasingly xeric towards the east, and correspondingly, supports vegetation communities ranging from rainforest to grasslands. The associated herpetofauna is also greatly influenced by altitude and isolation, in addition to being an area of integration between faunas of Asian and Australopapuan origins, the much-discussed zone of Wallacea. Consideration of this zone, and biodiversity of the Lesser Sundas otherwise, has been intrinsically hampered by incomplete zoogeographical knowledge. Of the islands, the two best known are Komodo and Bali, with studies of 17 months (Auffenberg 1980) and nine months (McKay 2006), respectively. Both studies increased the known faunal content considerably, 25% in the case of Bali. Information for the rest of the archipelago is comparatively thinner, despite the efforts of various researchers over the course of the last one hundred years. Recent publications, de Lang's (2011) synthesis of the snakes and the results of the Western Australian Museum/Museum Zoologicum Bogoriense expeditions conducted during 1987–1993 (e.g., How et al. 1996a, 1996b; 1998; How and Kitchener 1997), provide the most modern overview of the herpetofauna, and supported by Merten's works during early to mid-1900s (e.g., Mertens 1927a; 1927b; 1928; 1957), other species-specific or taxonomic snippets (e.g., Das 1993; Iskandar et al.1996; Wüster 1996), and the baseline data of seminal publications, such as de Rooij (1915; 1917), Boulenger (1897) and van Kampen (1923), this forms the body of our herpeto-zoogeographical knowledge for the Lesser Sundas.

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From 2007 to 2011, we visited the Lesser Sundas, one of us was resident on Bali (RL), and in combination spent approximately 50 months on Bali, four months on Lombok, one month on Sumbawa, and one month on Flores. For islands other than Bali, field work was conducted mainly between October and March, the hottest and wettest time, employing searches on foot or from vehicle, and at a few locations (e.g., Sape, Sumbawa) the aid of local snake handlers. Locations were recorded with GPS in the datum WGS84; digital photographs as vouchers were lodged in the collection of the Museum of the Northern Territory, Australia (NTM). Here, we present the resulting new distributional records, again clearly demonstrating that the herpetofaunal composition of these islands remains incomplete, even those as well known as Bali. The use of traps, which in this case was not available to us, would undoubtedly yield further interesting results. In terms of conservation, viewing these islands as more biodiverse than we realize evinces the value of utilizing widespread societal change (i.e., changing attitudes and practices towards preserving natural ecosystems, vegetation or organisms), as equal in importance to the scattering of formally protected areas in Indonesia.

ANURA — FROGS

***DUTTAPHRYNUS MELANOSTICTUS* (Asian Eyebrow-ridge Toad)**. SUMBAWA: Sekongkang (8.9653°S, 116.7526°E). 10 Feb 2010. Dompu (8.5356°S, 118.4671°E).13 Feb 2010. NTM 05113Dmel. Sape (8.5744°S, 119.0082°E). 14 Feb 2011. Common and often breeding. In the Lesser Sundas, known from Bali, Lombok and Timor (McKay 2007). Notably, not yet recorded from Komodo or Flores.

SQUAMATA — LIZARDS

***CYRTODACTYLUS DARMANDVILLEI* (D'Armandville's Forest Gecko)**. LOMBOK: Kuta (8.9069°S, 116.3067°E). 14 Oct 2007. NTM 1007CrytoSpX. Common in rock outcrops. Previously known from Sumbawa and islands further east (Mertens 1930). First record for Lombok.



FIG. 1. *Lepidodactylus intermedius*, Flores, Lesser Sunda islands. First published photograph of a living example.



PHOTO BY J. L. MCKAY

FIG. 2. *Typhlops schmutzi*, Sumbawa, Lesser Sunda islands. First published photograph of a living specimen.

***HEMIDACTYLUS GARNOTII* (Fox Gecko)**. FLORES: Ruteng (8.6160°S, 120.4640°E). 18 Jan 2011. NTM 04343Hgar. Common on unlit walls in town. A widespread species, known from Lombok (Mertens 1927b), but apparently the first record from the eastern Lesser Sundas.

***LEPIDODACTYLUS INTERMEDIUS* (Komodo Mourning Gecko)**. FLORES: Reo (8.3071°S, 120.4997°E). 20 Jan 2011. NTM 04493Lint. One adult on mango tree in suburban situation (Fig. 1). Ota et al. (2000) distinguish preserved specimens of this species from preserved *L. lombocensis* by the extent of interdigital webbing and dorsal pattern. Examination of the dorsum of live specimens of both species (see also below) shows them to be highly similar. First record from the Flores mainland, otherwise known from the smaller islands of Komodo and Rinca (Auffenberg 1980).

***LEPIDODACTYLUS LOMBOCENSIS* (Lombok Mourning Gecko)**. BALI: Ubud (8.5096°S, 115.2619°E). 10 June 2010. NTM 02089Llom. One adult found climbing a divider outside a hotel room. Previously known from Lombok (Ota et al. 2000).

***CRYPTOBLEPHARUS RENSCHI* (Blue-tailed Snake-eyed Skink)**. FLORES: Labuan Bajo (8.4861°S, 119.8789°E). 10 Jan 2011. NTM 04175Cren. Pulau Seraya Kecil (8.4129°S, 119.8698°E). 3 March 2011. A common arboreal lizard. Auffenberg (1980) believed this taxon to exist on Flores on the basis of a personal sighting, although no specimens or records existed, and here, we confirm its presence on Flores. The species has a disjunct distribution occurring in the Kangean islands north of Java, parts of Bali, Komodo, Rinca, Longo, and Sumba.

***EMOIA ATROCOSTATA ATROCOSTATA* (Mangrove Skink)**. BALI: Gilimanuk (8.1757°S, 114.4408°E). 16 Nov 2007. NTM 1107EatroA. One adult in mangrove dominated by *Rhizophora* sp. LOMBOK: Gili Sulat (8.3230°S, 116.7107°E). 26 Jan 2010. One adult in mangrove dominated by *Rhizophora* sp. Kuta (8.9069°S, 116.3067°E). 3 Feb 2010. One adult on a beach with conglomerate boulders. SUMBAWA: Karumbu (8.7041°S, 118.8090°E). 16 Feb 2011. Three adults inhabiting small rocks on mudflat. Although ranging widely in Indonesia (Brown 1991), occurrence of populations is patchy, and these are the first specific records for these islands.

***EMOIA KITCHENERI* (Kitchener's Emoia)**. FLORES: Aimere (8.8380°S, 120.8531°E). 26 Jan 2011. NTM 04462Ekit. One adult climbing low on a banana plant in riparian situation. First record for Flores, previously only the type series from the vicinity of Ngallu, Sumba were known (How et al. 1998).

***EMOIA SIMILIS* (Dunn's Emoia)**. FLORES: Labuan Bajo (8.4861°S, 119.8789°E). 9 Jan 2011. NTM 04148Esim. One adult in savannah. How et al. (1998) mention *Emoia similis* from the opposite end of Flores (Larantuka) have colouration sufficiently different from the type to warrant taxonomic investigation. Brown (1991) includes Flores in the species' distribution without further details. Here, we confirm its presence on western Flores, from a specimen which agreed closely in appearance with the typical form known from neighboring Komodo and Rinca (Auffenberg 1980).

***LAMPROLEPIS SMARAGDINA* (Emerald Tree Skink)**. SUMBAWA: Pantai Lakey (8.8039°S, 118.3836°E). 28 Feb 2011. NTM 05102Lsma. Common in monsoon forest and on coconut palms of foreshore. Known previously from Lombok and Flores (Mertens 1930); notably, still unknown from Komodo (Auffenberg 1980).

***LYGOSOMA BOWRINGII* (Bowring's Supple Skink)**. FLORES: Labuan Bajo (8.4861°S, 119.8789°E). 9 Jan 2011. NTM 04167Lbow. Reo (8.3071°S, 120.4997°E). 21 Jan 2011. Adults taken in monsoon forest. First records for Flores. Previously known from Lombok (Mertens 1927b), Nusa Penida (McKay 2006), and areas further west.

***SPHENOMORPHUS SCHLEGELI* (Schlegel's Forest Skink)**. FLORES: Labuan Bajo (8.4861°S, 119.8789°E). 12 Jan 2011. NTM 04245Ssc. Near Reo (8.3071°S, 120.4997°E). 23 Jan 2011. Adults taken in monsoon forest. First records for Flores, previously considered endemic to Komodo and Rinca (Auffenberg 1980).

SQUAMATA — SNAKES

***TYPHLOPS SCHMUTZI* (Reverend Schmutz's Blind Snake)**. SUMBAWA: Sumi (8.6035°S, 119.0155°E). 15 Feb 2011. NTM 04931Tsch. One adult taken in a deep leaf litter bed at the base of a limestone outcrop in closely vegetated situation (Fig. 2). Previously known from Komodo and Flores (Auffenberg 1980), this is the first record for Sumbawa.

***BOIGA DENDROPHILA DENDROPHILA* (Mangrove Snake)**. BALI: Silakarang (8.5944°S, 115.2564°E). 18 Sep 2010 and 20 Sep 2010. NTM 3RL. One dead animal found floating in a stream, and two adults photographed sitting together in a coconut palm, ca. 20 m above ground. Previously known from Java, and further west.

***CALLIOPHIS INTESTINALIS INTESTINALIS* (Asian Coral Snake)**. BALI: Mas (8.5428°S, 115.2761°E). 23 Jan 2011. NTM 1 RL/NTM 4 RL. One specimen discovered during excavation work for a pool. Previously known from Java and further west.

***DABOIA SIAMENSIS* (Eastern Russell's Viper)**. SUMBAWA: Sumi (8.6035°S, 119.0155°E). 18 Feb 2011. NTM 04958Dsi. One adult in savannah. Ca. 15 km N of Bima (8.4145°S, 118.7730°E). 21 Feb 2011. Roadkill adult from highly transformed open shrubland. Sape (8.5744°S, 119.0082°E), without exact locality. Two adults collected in the vicinity by local snake handler. First records from Sumbawa; other Lesser Sunda populations occur sporadically eastwards to Lomblen (de Lang 2011).

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New Distributional Records for Reptiles from Tennessee, USA

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The geographic distribution of amphibians and reptiles in Tennessee has been well documented by Scott and Redmond (2002), and is regularly updated via online atlas (Scott and Redmond 2008). However, the southeastern region of Tennessee has not received the necessary attention or sampling effort to adequately document the presence of many common species. The following records will assist in filling these data gaps. All turtles were collected during a survey of riverine turtle populations in Marion and Hamilton counties, Tennessee. Other specimens were collected during biological field surveys in the aforementioned counties. Identification and distribution of species followed Powell et al. (1998) and Conant and Collins (1998), respectively. All specimens represent new county records. GPS datum is WGS 84. All county records were supported by Scott and Redmond (2008). All specimens were deposited in the University of

Tennessee at Chattanooga Natural History Museum Reptile Collection (UTC-R). Nomenclature follows Crother (2008). All specimens were independently verified by Timothy Gaudin (UTC) and Rico Walder (formerly of the Tennessee Aquarium).

TESTUDINES – TURTLES

***APALONE SPINIFERA* (Spiny Softshell)**. Marion Co.: Tennessee River Gorge, near Pryor Island (35.0714944°N, 85.5278806°W). Specimen captured in a 3-ft diameter hoop net trap baited with sardines and soybean oil. 14 August 2004. Thomas P. Wilson, Christopher B. Manis, Stefan L. Moss, Robert M. Minton. UTC-R Digital Collection 4658.

***GRAPTEMYS GEOGRAPHICA* (Northern Map Turtle)**. Marion Co.: Tennessee River Gorge, in a 3 x 5-ft basking-style trap (35.0899833°N, 85.401125°W). 14 July 2000. Christopher B. Manis. UTC-R Digital Collection 4659.

***STERNOTHERUS MINOR PELTIFER* (Stripe-necked Musk Turtle)**. Marion Co.: Tennessee River Gorge, in a 3-ft diameter hoop net-style trap (35.0900889°N, 85.3967583°W). 12 July 2000. Christopher B. Manis. UTC-R 4660.

***STERNOTHERUS ODORATUS* (Eastern Stinkpot)**. Marion Co.: Tennessee River Gorge, in a 3-ft diameter hoop net-style trap (35.0883278°N, 85.391°W). 13 June 2000. Christopher B. Manis. UTC-R 4569.

SQUAMATA – LIZARDS

***OPHISAURUS ATTENUATUS* (Slender Glass Lizard)**. Hamilton Co.: Walden Ridge (35.1999639°N, 85.3282083°W). Adult specimen found dead in an open meadow. September 2008. Evan Collins. UTC-R 4662.

***PLESTIODON FASCIATUS* (Common Five-lined Skink)**. Hamilton Co.: 0.3 miles S of Morrison Springs and Mountain Creek Road intersection. Specimen found in garden of residence (35.1223583°N, 85.3130611°W). 06 June 2009. Thomas P. Wilson and Tabitha M. Wilson. UTC-R 4663. Marion Co.: 2.6 mi. W on US-41 from the Marion Co. line (35.0196444°N, 85.4585722°W). 22 July 1997. UTC-R 40. Timothy Gaudin.

SQUAMATA – SNAKES

***CROTALUS HORRIDUS* (Timber Rattlesnake)**. Marion Co.: Tennessee River Gorge, crossing the Tennessee River, near Pot Point (35.0891417°N, 85.3899667°W). First county record. 2 August 2007. Thomas P. Wilson, Christopher B. Manis, Stefan L. Moss, Robert M. Minton. UTC-R Digital Collection 4664.

***LAMPROPELTIS GETULA* (Common Kingsnake)**. Hamilton Co.: Stuart Heights neighborhood at 3100 Lockwood Drive at intersection (35.1025417°N, 85.2850389°W). First county record. 11 July 1999. UTC-R 45. Timothy Gaudin.

***REGINA SEPTEMVITTATA* (Queensnake)**. Marion Co.: Found dead on road (35.0899639°N, 85.3996833°W). First county record. 01 April 2008. UTC-R 4666. Jennifer Grubb, Jill Harrison-Whitaker, and Thomas P. Wilson.

***STORERIA DEKAYI* (Dekay's Brownsnake)**. Marion Co.: Terrestrial area associated with Mullins Cove (35.0687306°N, 35.0687306°W). 24 November 1971. UTC-R 14. John Shadwick.

***THAMNOPHIS SIRTALIS* (Common Gartersnake)**. Hamilton Co.: Found dead on Mountain Creek Road (35.148325°N, 85.297925°W). 24 April 2010. UTC-R 4665. Thomas P. Wilson and Tabitha M. Wilson. Marion Co.: Terrestrial area associated with Mullins Cove (35.0664389°N, 85.4762°W). 04 September 1971. UTC-R 35. Kent Tapper, Georgia Tapper, and Carrol Tapper.

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Amphibian and Reptile Distribution Records for Louisiana – II

The following distributional records for Louisiana amphibians and reptiles have accumulated since an earlier list of records (Boundy 2004), and are based on Dundee and Rossman (1989) and subsequent sources. Many of the new records are the result of specimens collected for the Natural Science Museum at Louisiana State University (Baton Rouge, LSUMZ), whereas others were detected in a survey of the collection of the Louisiana State University at Shreveport Natural Science Museum (LSUS). Identifications of specimens at LSUS were verified by Laurence Hardy and/or Amanda Lewis. Specimens at LSUMZ were verified by Eric Rittmeier or Douglas Rossman. All specimens represent parish records unless otherwise noted. Geographic coordinates are based on NAD83 datum.

CAUDATA — SALAMANDERS

***AMBYSTOMA TALPOIDEUM* (Mole Salamander).** Webster Parish: 3.4 km E, 0.8 km of N Doyline (32.5392°N, 93.3691°W). 3 February 1994. Laurence M. Hardy. LSUS 8597–8600. A second specimen, LSUS 8601, was collected in this parish. Winn Parish: Kisatchie National Forest, Winn Ranger District, compartment 22 (approximately 32.10°N, 92.87°W). 30 April 2005. E. S. Walsh. LSUS 8977.

***AMPHIUMA TRIDACTYLUM* (Three-toed Amphiuma).** Claiborne Parish: Corney Lake (approximately 32.91°N, 92.74°W). 1 April 1989. K. Lutsch and D. Wyrick. LSUS 7587–7588.

***DESMOGNATHUS CONANTI* (Spotted Dusky Salamander).** DeSoto Parish: 18.4 km SE of Mansfield, Sec 7 at Cane Branch (31.9479°N, 93.6319°W). 28 February 1981. Joe Hollenberg. LSUS 7956.

ANURA — FROGS

***ANAXYRUS* (= *BUFO*) *TERRESTRIS* (Southern Toad).** East Feliciana Parish: Gilead Road, 10.9–12.2 km S of LA 10 (approximately 30.81°N, 90.86°W). 14 May 2004. Jeff Boundy. LSUMZ 87975. A second specimen, LSUMZ 87977, was collected in this parish.

***ELEUTHERODACTYLUS CYSTIGNATHOIDES* (Rio Grande Chirping Frog).** East Baton Rouge Parish: Hawthorne Drive at Buttercup Drive, Baton Rouge (30.3796°N, 91.0723°W). 16 July 2007. John D. McVay. LSUMZ 90427. Castle Kirk Drive, Baton Rouge (30.3752°N, 91.1217°W). 27 September 2007. Patti Faulkner. LSUMZ 90640. This exotic species has been established at the latter site for at least three years (P. Faulkner, pers. comm.).

***GASTROPHRYNE CAROLINENSIS* (Eastern Narrow-mouthed Toad).** West Carroll Parish: Big Colewa Wildlife Management Area, Bearskin Unit (32.42°N, 91.38°W). 28 April 2010. Jeff Boundy and Beau Gregory. LSUMZ 93800.

***HYLA CINEREA* (Green Treefrog).** La Salle Parish: N end of Dewey Wills Wildlife Management Area (31.5124°N, 92.0372°W). 9 May 2007. Jeff Boundy. LSUMZ 90290.

***LITHOBATES* (= *RANA*) *CATESBEIANUS* (American Bullfrog).** Red River Parish: Bayou Pierre, East side of Bayou Pierre Bridge (32.1921°N, 93.5545°W). 22 September 2004. Malcolm McCallum and E. S. Walsh. LSUS 8863.

***LITHOBATES* (= *RANA*) *CLAMITANS* (Green Frog).** West Carroll Parish: Big Colewa Wildlife Management Area, Bearskin Unit (32.42°N, 91.38°W). 28 April 2010. Jeff Boundy and Beau Gregory. LSUMZ 93798, 93799.

TESTUDINES — TURTLES

***DEIROCHELYS RETICULARIA* (Chicken Turtle).** DeSoto Parish: 0.4 km S, 5.6 km E of Longstreet (32.0932°N, 93.8904°W). 14 April 1972. Marilyn Brumley. LSUS 8146.

***MACROCHELYS TEMMINCKII* (Alligator Snapping Turtle).** DeSoto Parish: Toledo Bend, near Ace's Camp outside Logansport (approximately 31.91°N, 93.91°W). No date or collector. LSUS 8425. Livingston Parish: right descending bank of Natalbany River at LA 1048 (30.4820°N, 90.5568°W). 29 October 2004. Jeff Boundy. LSUMZ 88083.

***STERNOTHERUS CARINATUS* (Razor-backed Musk Turtle).** Bossier Parish: 0.4 km S, 0.8 km W of Magenta (32.3719°N, 93.5966°W). 7 February 1994. C. Cormier. LSUS 6224–6227. A more recent specimen, LSUS 8799, was collected in this parish. East Feliciana Parish: lake just E of LA 63, 0.8 km N of LA 37 (30.7360°N, 90.8547°W). 13 August 2005. Jeff Boundy. LSUMZ 88909–88912.

***TRACHEMYS SCRIPTA* (Pond Slider).** Winn Parish: LA 501, 2.4 km S of Brewton's Mill (32.0992°N, 92.8408°W). 10 June 1999. Laurence M. Hardy. LSUS 8427.

SQUAMATA — LIZARDS

***ANOLIS CAROLINENSIS* (Green Anole).** Cameron Parish: Peveto Beach, Johnsons Bayou (29.7490°N, 93.6583°W). 15 November 2003. Steven W. Cardiff and Donna L. Dittman. LSUMZ 87671–87674.

***ANOLIS SAGREI* (Brown Anole).** St. Tammany Parish: US 190 in town of Covington (approximately 30.46°N, 90.09°W). September 1998. Tom Lorenz. LSUMZ 80085.

***HEMIDACTYLUS TURCICUS* (Mediterranean Gecko).** Livingston Parish: Jordan Drive, Denham Springs (30.5027°N, 90.9326°W). 8 July 2007. Beau Gregory. LSUMZ 90415. Plaquemines Parish: Headquarters of Pass A Loutre Wildlife Management Area (29.1259°N, 89.2069°W). 23 October 2007. Beau Gregory. LSUMZ 90684.

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Extends range to structure at mouth of the Mississippi River. Sabine Parish: 600 m N of intersection of LA 6 and Marthaville Rd, Many (31.5781°N, 93.4768°W). 5 September 2009. Beau Gregory. LSUMZ 93442. Saint John the Baptist Parish: 1.1 km N of jct of US 61 and LA 54, Garyville (30.0900°N, 90.6258°W). 18 March 2009. Jeff Boundy. LSUMZ 92793. One of two found between boards at hunters' camp in swamp.

***PLESTIODON ANTHRACINUS* (Coal Skink)**. Bienville Parish: 4.5 km W, 9.3 km N of Lucky (32.3401°N, 93.0276°W). 30 May 2007. Beau Gregory. LSUMZ 90391. 3.2 km W, 1.0 km S of Lucky (32.2488°N, 93.0383°W). 18 April 2008. Beau Gregory. LSUMZ 90968.

***PLESTIODON FASCIATUS* (Common Five-lined Skink)**. West Carroll Parish: Big Colewa Wildlife Management Area, Bearskin Unit (32.42°N, 91.38°W). 28 April 2010. Jeff Boundy and Beau Gregory. LSUMZ 93801.

***PLESTIODON LATICEPS* (Broad-headed Skink)**. Ascension Parish: Bluff Swamp, directly E of Bayou Braud (30.2996°N, 91.0180°W). 17 March 1999. Jeff Boundy. LSUMZ 80891. Bienville Parish: 4.5 km W, 9.3 km N of Lucky (32.3401°N, 93.0276°W). 1 August 2007. Jeff Boundy. LSUMZ 90439. A more recent specimen, LSUMZ 90982, was collected at this location. La Salle Parish: Nature Trail area, N end of Dewey Wills Wildlife Management Area (31.5089°N, 92.0365°W). 30 March 2007. Jeff Boundy. LSUMZ 90022.

***PLESTIODON SEPTENTRIONALIS* (Prairie Skink)**. Lincoln Parish: 0.8 km W of Hico (32.7436°N, 92.7261°W). 15 September 1950. L. W. Herren. LSUMZ 24334.

SQUAMATA — SNAKES

***CROTALUS ADAMANTEUS* (Eastern Diamond-backed Rattlesnake)**. Tangipahoa Parish: no further data. 24 March 1982. G. Slade. LSUMZ 80833.

***CROTALUS HORRIDUS* (Timber Rattlesnake)**. Lincoln Parish: Choudrant (32.352°N, 92.507°W). 5 June 1973. A. Brad McPherson. LSUS 8793.

***DIADOPHIS PUNCTATUS* (Ring-necked Snake)**. Sabine Parish: 8.0 km SW of Negreet near Toledo Bend Lake (31.3950°N, 93.6154°W). 22 March 1969. Don J. Arceneaux. LSUMZ 82459.

***FARANCIA ABACURA* (Red-bellied Mudsnake)**. Winn Parish: LA 126, 1.9 km W of Brewton's Mill (32.1214°N, 92.8507°W). 30 June 1999. Laurence M. Hardy. LSUS 7333, 7399.

***HETERODON PLATIRHINOS* (Eastern Hog-nosed Snake)**. Red River Parish: 6.4 km E of Coushatta (32.0055°N, 93.2859°W). 30 April 1973. Len Barker. LSUMZ 88331.

***LAMPROPELTIS HOLBROOKI* (Speckled Kingsnake)**. Red River Parish: Bayou Pierre Wildlife Management Area around silos (32.1964°N, 93.5555°W). 20 May 2004. E. S. Walsh. LSUS 8796. West Carroll Parish: Big Colewa Wildlife Management Area, Bearskin Unit (32.42°N, 91.38°W). 28 April 2010. Jeff Boundy and Beau Gregory. LSUMZ 93803.

***MICRURUS TENER* (Texas Coralsnake)**. Claiborne Parish: Athens: R7W, T19N, Sec. 3 (32.647°N, 93.026°W). 20 September 1992. Aaron Callaway. LSUS 8044. Vermilion Parish: Vermilion River at Abbeville (29.980°N, 92.133°W). November 1973. C. Gremillion. LSUMZ 82116.

***NERODIA FASCIATA* (Southern Watersnake)**. Winn Parish: junction of PR-506 and LA 1233, section 3 between compartments 25 and 26 (32.1271°N, 92.8945°W). 20 May 1999. Laurence M. Hardy. LSUS 7351, 7382.

***PANTHEROPHIS OBSOLETUS* (Texas Ratsnake)**. Claiborne Parish: LA 519 just N of I-20 (32.5913°N, 92.9236°W). 26 May 1994. Michael L. Matthews. LSUS 8054.

***PANTHEROPHIS SPILOIDES* (Gray Ratsnake)**. Iberville Parish: Pecan Drive, 5.6 km airline N of St. Gabriel (30.3089°N, 91.1014°W). 7 May 1993. Jeff Boundy. LSUMZ 56499. A more recent specimen, LSUMZ 89189, was collected in this parish.

***SISTRURUS MILIARIUS* (Pygmy Rattlesnake)**. Bossier Parish: 9.6 km E via LA 2, 1.4 km S of Plain Dealing (32.8964°N, 93.6021°W). 8 September 1973. Laurence M. Hardy. LSUS 2446.

***STORERIA OCCIPITOMACULATA* (Red-bellied Snake)**. Pointe Coupee Parish: Little Alabama Bayou at LA 975 (30.5120°N, 91.7185°W). 19 February 2009. Jeff Boundy. LSUMZ 92229.

***THAMNOPHIS PROXIMUS* (Western Ribbonsnake)**. Bienville Parish: 1.9 km by air E of Kepler Lake bridge (32.3353°N, 93.1125°W). 8 October 2007. Beau Gregory. LSUMZ 90645. Jackson Bienville Wildlife Management Area (approximately 32.4°N, 92.8°W). 6 November 2004. E. S. Walsh and Victor Bogosian. LSUS 8888. Webster Parish: Bayou Dorcheat, 16 km N of Minden (approximately 32.72°N, 93.35°W). November 1985. A. Brad McPherson. LSUS 6897.

***VIRGINIA STRIATULA* (Rough Earthsnake)**. SABINE PARISH: 4.8 km E of Fisher on East Fisher Road (31.5006°N, 93.4121°W). 22 March 1973. Larry Cox. LSUMZ 88416.

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New County Records for the Rolling Plains of North Texas

The rolling plains region of north-central Texas is part of the Kansan biotic province (Blair 1949; Werler and Dixon 2000). This region has been poorly sampled for reptiles and amphibians (Dixon 2000; Werler and Dixon 2000). Here, new records are reported from surveys of this region. County records were determined by examination of Dixon (2000) and issues of Herpetological Review published since Dixon (2000). All voucher specimens and photographs are deposited at the Texas Natural History Collections (TNHC), Texas Memorial Museum. Travis J. LaDuc verified all specimens. Lat/long data were obtained via a handheld GPS using the WGS84 datum. All collections were made under Scientific Collecting Permit SPR-0305-036, issued by Texas Parks and Wildlife.

ANURA — FROGS

***BUFO DEBILIS* (Green Toad)**. Motley Co.: Double Helix Ranch, ca. 6.4 air km NW of Dumont (33.85157°N, 100.55209°W). 22 June 2007. Collected by D. M. Hillis and G. B. Pauly. TNHC 67360. This specimen fills a gap in the distribution.

***GASTROPHRYNE OLIVACEA* (Western Narrow-mouthed Toad)**. Motley Co.: Double Helix Ranch, ca. 5.8 air km NW of Dumont (33.84026°N, 100.53489°W). 21 June 2007. Collected by D. M. Hillis and G. B. Pauly. TNHC 67402. Previously reported from Floyd and Cottle counties, which are to the west and east of Motley Co., respectively.

***PSEUDACRIS CLARKII* (Spotted Chorus Frog)**. King Co.: Roadside ditch along U.S. Rt. 83, 0.8 km N of FM 193 (34.78110°N, 100.33865°W). 30 May 2007. Collected by G. B. Pauly. TNHC 67421–67423). These males were observed calling in a chorus of numerous *Gastrophryne olivacea* and one *Anaxyrus debilis*. Previously reported from Stonewall and Knox counties, which are to the south and east of King Co., respectively.

SQUAMATA — LIZARDS

***PHRYNOSOMA CORNUTUM* (Texas Horned Lizard)**. Foard Co.: Co. Rd. 361, 9.6 km SW of FM 263 (33.84260°N, 99.90765°W). 22 June 2007. Observed by D. M. Hillis and G. B. Pauly. TNHC 84400 (photo voucher). This specimen fills a gap in the distribution.

SQUAMATA — SNAKES

***ARIZONA ELEGANS* (Glossy Snake)**. Cottle Co.: DOR, U.S. Rt. 83, 0.5 km N of FM 3256 (34.12302°N, 100.29845°W). 29 May 2007. Collected by G. B. Pauly. TNHC 67574. This specimen fills a gap in the distribution.

***COLUBER CONSTRICTOR* (North American Racer)**. Foard Co.: DOR, U.S. Hwy 70, 3.5 km E of Cottle/Foard Co. line (34.07560°N, 100.01220°W). 22 June 2007. Collected by D. M. Hillis and G. B. Pauly. TNHC 67575. This specimen fills a gap in the distribution.

***LAMPROPELTIS GETULA* (Common Kingsnake)**. Foard Co.: DOR, U.S. Hwy 70, 3.2 km W of Crowell (33.98934°N, 99.76497°W). 22 June 2007. Collected by D. M. Hillis and G. B. Pauly. TNHC 67578. This specimen fills a gap in the distribution.

***LAMPROPELTIS TRIANGULUM* (Milksnake)**. Motley Co.: Double Helix Ranch, ca. 5.8 air km NW Dumont (33.84026°N, 100.53489°W). 21 June 2007. Observed by D. M. Hillis and G. B. Pauly. TNHC 84401 (photo voucher). This species is largely unrecorded from the rolling plains region of north Texas.

***PANTHEROPHIS EMORYI* (Great Plains Ratsnake)**. Dickens Co.: FM 193, 4.2 km W of Dickens/King Co. line (33.78112°N, 100.56343°W). 29 May 2007. Collected by G. B. Pauly. TNHC 67563. This specimen fills a gap in the distribution.

***SONORA SEMIANNULATA* (Western Groundsnake)**. Motley Co.: Double Helix Ranch, ca. 6.4 air km NW Dumont (33.85157°N, 100.55209°W). 29 May 2007. Collected by G. B. Pauly. TNHC 67583. This specimen fills a gap in the distribution.

***THAMNOPHIS PROXIMUS* (Western Ribbonsnake)**. Stonewall Co.: DOR, U.S. Rt. 83, 13.1 km N of U.S. Rt. 380 (33.29410°N, 100.24737°W). 23 June 2007. Collected by D. M. Hillis and G. B. Pauly. TNHC 67587. Previously reported from Fisher, Jones, and Haskell counties, which are to the south and east of Stonewall Co.

Acknowledgments.—I am grateful to D. M. Hillis and J. J. Bull for access to the Double Helix Ranch, to D. M. Hillis for field assistance, and to T. J. LaDuc for verifying all specimens.

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NATURAL HISTORY NOTES

The Natural History Notes section is analogous to Geographic Distribution. Preferred notes should 1) focus on observations in the field, with little human intrusion; 2) represent more than the isolated documentation of developmental aberrations; and 3) possess a natural history perspective. Individual notes should, with few exceptions, concern only one species, and authors are requested to choose a keyword or short phrase which best describes the nature of their note (e.g., Reproduction, Morphology, Habitat, etc.). Use of figures to illustrate any data is encouraged, but should replace words rather than embellish them. The section's intent is to convey information rather than demonstrate prose. Articles submitted to this section will be reviewed and edited prior to acceptance. Notes concerning captive animals should be directed to Herpetological Husbandry (see inside front cover for section editor contact information).

Electronic submission of manuscripts is requested (as Microsoft Word or Rich Text format [rtf] files, as e-mail attachments). Color figures can be submitted electronically as JPG files, although higher resolution TIFF or PDF files will be requested for publication. Please DO NOT send graphic files as imbedded figures within a text file. Additional information concerning preparation and submission of graphics files is available on the SSAR web site at: http://www.ssarherps.org/HRinfo.html. Manuscripts should be sent to the appropriate section editor: **Jackson Shedd** (crocodilians, lizards, and *Sphenodon*; jackson.shedd@gmail.com); **Charles Painter** (amphibians; charles.painter@state.nm.us); **J. D. Willson** (snakes; hr.snake.nhn@gmail.com); and **James Harding** (turtles; hardingj@msu.edu).

Standard format for this section is as follows: SCIENTIFIC NAME, COMMON NAME (for the United States and Canada as it appears in Crother [ed.] 2008. *Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico*. SSAR Herpetol. Circ. 37:1–84, available from SSAR Publications Secretary, ssar@herplit.com; for Mexico as it appears in Liner and Casas-Andreu 2008, *Standard Spanish, English and Scientific Names of the Amphibians and Reptiles of Mexico*. Herpetol. Circ. 38:1–162), KEYWORD. DATA on the animal. Place of deposition or intended deposition of specimen(s), and catalog number(s), if relevant to your report. Then skip a line and close with SUBMITTED BY (give name and address in full—spell out state names—no abbreviations). (NCN) should be used for common name where none is recognized. References may be briefly cited in text (refer to this issue for citation format).

Recommended citation for notes appearing in this section is: Medina, P., and R. L. Joglar. 2008. *Eleutherodactylus richmondi*: reproduction. Herpetol. Rev. 39:460.

CAUDATA — SALAMANDERS

***GYRINOPHILUS PORPHYRITICUS* (Spring Salamander). ALBINISM.** *Gyrinophilus porphyriticus* is a rather large, stout-bodied plethodontid with a salmon to pinkish orange ground color overlain with black streaks or spots that ranges from southern Quebec and southern Maine to central Alabama. In more mountainous regions of western North Carolina, Spring Salamanders can be found in or near springs, seepages, small streams, and wet roadside ditches (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, DC. 587 pp.). Herein we report on the observation of a wild albino specimen of *G. porphyriticus*.

At ca. 2140 h on 18 June 2011, we observed a sub-adult *G. porphyriticus* that appeared to lack black pigmentation. This *G. porphyriticus* was found on a wet rock wall above a ditch along the eastern edge of FR 70 (Tate City Road) in the Nantahala National Forest of Clay Co., North Carolina, USA, ca. 0.4 km N of the Georgia state line (34.99586°N, 83.55569°W, WGS 84; elev. 781 m). It still appeared to exhibit red and yellow pigmentation, giving it an overall light orange hue (Fig. 1A). The

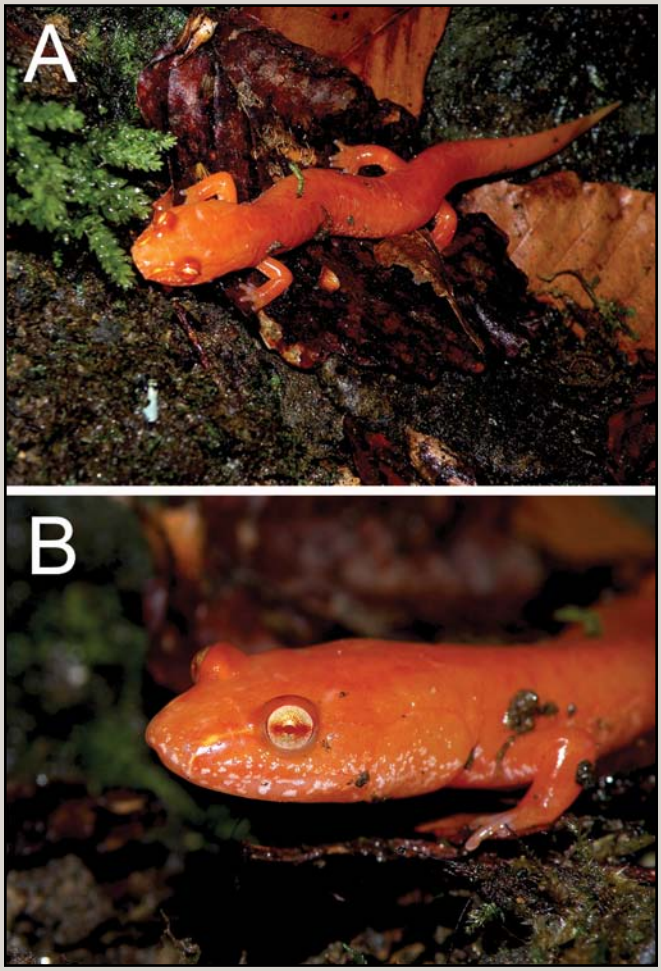


PHOTO BY ROBERT L. HILL

FIG. 1. A) Albino *Gyrinophilus porphyriticus* observed in Clay Co., North Carolina, USA. B) Close-up of the head.

COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND

canthus rostralis on this specimen was evident, although the typical dark border was absent. The eyes were pale yellow with a red horizontal line through the center and the pupils were red instead of black (Fig. 1B). The specimen was photographed and left *in situ*.

Albinism has been reported for larval *G. porphyriticus* (Brandon and Rutherford 1967. Am. Midl. Nat. 78[2]:537–540), however, to our knowledge this is the first documentation of albinism in a post-metamorphic specimen.

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ANURA — FROGS

***ACRIS CREPITANS* (Northern Cricket Frog). FIRE ANT ENVENOMATION.** Red Imported Fire Ants (*Solenopsis invicta*) are an aggressive invasive species that have spread throughout much of the southeastern United States after being accidentally introduced into the port of Mobile, Alabama in the 1930s (Wojcik et al. 2001. Am. Entomol. 47:16–23). A growing number of studies have reported both direct and indirect negative effects of *S. invicta* on native amphibians and reptiles (Allen et al. 1997. J. Herpetol. 31:318–321; Diffie et al. 2010. J. Herpetol. 44:294–296; Todd et al. 2008. Biol. Invasions 10:539–546). However, it is not known how frequently or to what extent *S. invicta* actively prey upon native herpetofauna, highlighting the importance of reporting anecdotal observations. Here I describe a natural agonistic encounter between a fire ant and a Northern Cricket Frog.

At ca. 0915 h on 9 June 2011,100 m S of Rome Pond, 150 m N of U.S. Hwy. 29, Covington Co., Alabama, USA (31.142559°N, 86.673418°W; WGS 84), I observed a Red Imported Fire Ant stinging an adult *Acris crepitans*. The ant had pierced the skin of the frog's right forelimb with its mandibles and was seen inserting its stinger repeatedly. This attack was observed more than 5 m away from the closest fire ant mound, in an open grassy area. I removed the ant to examine the frog for species identification. Upon identification, the frog was released at its point of capture. To the best of my knowledge, this is the first account of a *S. invicta* envenomating *A. crepitans*.

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***ANAXYRUS AMERICANUS CHARLESMITHI* (Dwarf American Toad). NEMATODE PARASITE.** Several parasites have been reported from the Dwarf American Toad. Herein we report a new host record for a nematode parasite of *Anaxyrus* (=*Bufo*) *americanus charlesmithi*.

A single *A. a. charlesmithi* was collected on 29 May 1994 from 3.2 km SW Shannon Hills, Saline Co., Arkansas (34.608622°N, 92.433261°W) and examined for helminths. It was killed with a dilute chloretone solution and a midventral incision was made to expose the entire length of the digestive tract. Two nematodes were removed from the rectum and cleared on glass slides with undiluted glycerol. These were identified as a male and female *Cosmocercoides variabilis* (Harwood 1930) Travassos, 1931. Voucher specimens were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland as USNPC 84402. A host voucher is deposited in the Arkansas State University Herpetological Collection (ASUMZ), State University, Arkansas as ASUMZ 19701.

Previous bufonid hosts of *C. variabilis* include *A. americanus americanus* (Vanderburgh and Anderson 1987. Can. J. Zool. 65:1666–1667), *A. boreas* (Goldberg et al. 1999. Bull. S. California Acad. Sci. 98:39–44), *A. debilis debilis* (McAllister et al. 1989. Proc. Helminthol. Soc. Washington 56:162–167), *A. hemiophrys* (Bursey and Goldberg 1998. J. Parasitol. 84:617–618.), *A. quercicus* (Goldberg and Bursey 1996. Alytes 14:122–126); *A. terrestris* (Harwood 1932. Proc. U.S. Nat. Mus. 81:1–71), and *A. woodhousii woodhousii* (McAllister et al., *op. cit.*).

This nematode has an extensive range and has been reported previously from Arizona, Arkansas, California, Florida, Idaho, Illinois, Iowa, Louisiana, Massachusetts, Michigan, Nebraska, New York, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, South Dakota, Texas, Utah, Virginia, Washington, West Virginia, Wisconsin, Alberta, British Columbia, New Brunswick and Quebec, Canada , Baja California Norte, Mexico, Costa Rica, and Panama (Bursey et al. 2007. Comp. Parasitol. 74:108–140).

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***BUFO* (= *ANAXYRUS*) *HOUSTONENSIS* (Houston Toad). HEAD-START JUVENILE DISPERSAL.** The Houston Toad is a federally endangered amphibian endemic to east-central Texas. A head-starting program was initiated in 2007 as a population recovery strategy for *Bufo houstonensis*. As part of the program, wild laid eggs are collected, reared at the Houston Zoo and post-metamorphosed juveniles are released to their natal pond. A genetic mark-recapture technique was developed to monitor the success of the head-starting program. Microsatellite markers were used to reconstruct family relationships based on the probability of individuals sharing alleles identical by descent. A small sample of tadpoles per egg strand (between 8 and 80) was sacrificed to obtain a genotypic "fingerprint" for 29 head-started egg strands. This mark-recapture technique accurately assigned 94–97% of all family members to their appropriate egg cohort (Vandewege 2011. Unpubl. MS. thesis, Texas State Univ. San Marcos, Texas. 84 pp.). A tissue sample was collected from any adult or juvenile captured after the release of head-starts to assess the frequency of captive-reared *B. houstonensis* on the landscape.

During a *B. houstonensis* reproduction survey conducted on 18 April 2010, an egg strand was harvested from a temporary pond on the Griffith League Ranch, Bastrop County, Texas, USA. Post-metamorphosed juveniles from this egg strand (N = 1908) with a mean weight of 0.09 g were released at their natal pond on 21 May 2010. On 23 June 2010 a juvenile *B. houstonensis* weighing 3.8 g was collected from a pitfall trap 1.34 km from the release point. This juvenile had a DNA genotype 100% consistent with the head-started individuals released five weeks prior. This is the longest confirmed distance a juvenile *B. houstonensis* has moved. Prior to this record, *B. houstonensis* had been monitored up to 50 m (Greuter 2004. Unpubl. MS. thesis, Texas State Univ. San Marcos, Texas 80 pp.) and 100 m (Hillis et al. 1984. J. Herpetol. 18:56–72) from their natal pond. A previous technique using fluorescent pigment proved successful for tracking daily movement patterns (Swannack et al. 2006. Herpetol. Rev. 37[2]:199–200), whereas this new technique allowed juvenile

B. houstonensis to be monitored over long distances and time periods. This record illustrates that juvenile *B. houstonensis* are capable of moving long distances in a short period of time. Although it remains unclear how far *B. houstonensis* typically disperse between metamorphosis and adulthood, this observation highlights the importance of increasing habitat connectivity in a highly fragmented environment for the conservation and recovery of this endangered species.

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***GASTROPHRYNE CAROLINENSIS* (Eastern Narrow-mouthed Toad). PREDATION.** A series of strong scattered thunderstorms passed through the Central Savannah River Area (CSRA) in Georgia and South Carolina, USA on 28 June 2011 from ca. 1400–2100 h and filled a few patchily-distributed depression wetlands with a few centimeters of standing water. One small (ca. 20 m × 10 m) wetland (Risher Pond Sloughs, Barnwell Co., South Carolina) hosted an anuran breeding assemblage of ca. 30 *Hyla femoralis*, 20 *H. squirella*, 20 *Gastrophryne carolinensis*, 6 *Pseudacris ocularis*, and 10 *H. chrysoscelis* by 2138 h. At 0016 h, an adult (499 mm SVL; 32.6 g) female *Thamnophis s. sauritus* was found ca. 1.7 m above the surface of the water in a stand of dead *Panicum hemitomon*. The *T. s. sauritus* was in the process of swallowing a gravid female *G. carolinensis* (32 mm SVL; 2.25 g) and moved slowly around in the *Panicum* with the front of the toad hanging out of the right side of its mouth. After observing the snake for four minutes, we captured it and removed the *G. carolinensis* from its mouth. Both animals were returned to the lab for measurements. The *G. carolinensis* was dead by 0800 h the next morning and the *T. s. sauritus* was released unharmed post-processing without any noticeable ill effects from exposure to the *G. carolinensis*. *Gastrophryne carolinensis* are toxic to many predators, which will often refuse to eat them (Garton and Mushinsky 1979. Can. J. Zool. 57:1965–1973), and few firsthand accounts of *G. carolinensis* predation exist, possibly because of this toxicity. *Thamnophis s. sauritus* is a generalist amphibian predator that is known to consume a wide variety of prey (Brown 1979. Brimleyana 1:113–124; Carpenter 1952. Ecol. Monogr. 4:235–258). Only one account of a *T. sauritus* eating a *G. carolinensis* exists as a personal communication from R. W. Gaul Jr. in North Carolina (Palmer and Braswell 1995. Reptiles of North Carolina. Univ. North Carolina Press, Chapel Hill, North Carolina), but to our knowledge, this is the first confirmed firsthand observation of a *T. s. sauritus* depredating a *G. carolinensis*.

Animals were captured under scientific research permit G-11-03 from the South Carolina Department of Natural Resources. Funding for this research was provided by the National Science Foundation (Awards DEB-0242874 and DBI-0139572) and the Savannah River Ecology Laboratory under Financial Assistance Award DE-FC09-96SR18-546 between the University of Georgia and the U.S. Department of Energy.

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***HYALINOBATRACHIUM ORIENTALE* (Oriental Glass Frog). MALE PARENTAL CARE.** One clade of glass frogs, the Hyalinobatrachinae, is distributed in tropical Central America, the tropical Andes, the coastal ranges of Venezuela, the island of Tobago, the upper Amazon Basin, and the Guiana Shield. Males of all species of *Hyalinobatrachium* call from the underside of leaves and females deposit their eggs on the underside of leaves; at least seven species have been reported to have males guard the eggs, a behavior that is considered a primary homology of the genus (Guayasamin et al. 2009. Zootaxa 2100:1–97; Kubicki 2007. Ranas de Vidrio de Costa Rica /Glass Frogs of Costa Rica. Editorial INBio, Santo Domingo de Heredia). Here we report the first observations of male *Hyalinobatrachium orientale* attending eggs. On the evenings of 4 and 5 June 2011 we detected the calls of male *H. orientale* along several of the streams that drain Tobago's Main Ridge, and on the evening of 5 June we observed and photographed males next to egg masses (Fig. 1), males covering egg masses with their bodies (Fig. 2), and guardian males calling. Calling males were 1–10 m above the stream and minimally separated by 2–3 m; usually the separation distance was greater.

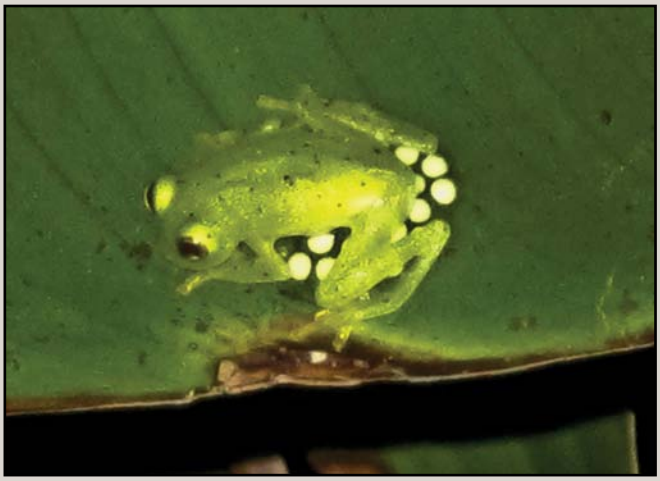


FIG 1. A male *Hyalinobatrachium orientale* covering an egg mass with its body, behavior that may reduce desiccation or deter predators. The leaf was about 4 m above the stream.



FIG 2. A male *Hyalinobatrachium orientale* calling from the underside of a leaf.

The male frogs were often on the undersides of *Heliconia* leaves, a position that may offer protection from desiccation, falling rain drops, and predators. Also, the leaves supporting the frogs and egg masses were frequently covered by a second leaf that would likely provide additional protection from wind and sun. Crabs were observed on the same plants that contained frogs and they may be a primary factor in the frogs of this genus selecting the undersides of leaves for calling stations and egg laying.

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***HYLA ARBOREA* (European Tree Frog). POTENTIAL CANNIBALISM.** Cannibalism is widespread in a variety of animals, including amphibians (Elgar and Crespi 1992. Cannibalism: Ecology and Evolution Among Diverse Taxa. Oxford University Press, Oxford, New York. 376 pp.). Cannibalism may occur during food shortages, desiccation of the habitat, or because of a high concentration of individuals (Crump 1983. Am. Nat. 121[2]:281–289; Pfennig and Frankino 1997. Evolution 51:1993–1999; Summers 1999. Oecologia 119:557–564; Michimae and Wakahara 2001. Behav. Ecol. Sociobiol. 50:339–345.). Studies show that cannibalistic individuals have a higher growth rate, a larger size at metamorphosis, a greater likelihood of survival, and better reproductive parameters (Fox 1975. Annu. Rev. Ecol. Evol. Syst. 6:87–106; Polis 1981. Annu. Rev. Ecol. Evol. Syst. 12:225–251; Crump 1990. Copeia 1990[2]:560–564; Babbit and Meshaka 2000. Copeia 2000[2]:469–474). Cannibalism in tadpoles of *Hyla intermedia* as a result of drying habitat was described by Grant and Halliday (2011. Herpetol. Rev. 42[1]:86).



FIG. 1. *Hyla arborea* tadpoles with damaged caudal fins.

On 20 July 2007 on the Krk island in Croatia (45.03°N, 14.55°E, 54 m elev.), we observed different stages of *Hyla arborea* tadpoles that exhibited noticeable signs of damage to the caudal fin, especially the smaller individuals (Fig. 1). No dead specimens were observed, and potential natural predators (e.g., *Dytiscus* sp., *Pelophylax ridibundus*, *Natrix natrix*) were not found associated with the tadpoles. The habitat was completely unnatural, a small enamel livestock tank with drying aquatic habitat and dense larval aggregations. The tank was about 100 × 40 × 50 cm, with water ca. 30 cm deep. We estimated ca. 150–200 tadpoles ranging in size from 1–2.5 cm. Although direct cannibalism was not observed, the size differentiation and high density of individuals may of lead to the wounds observed.

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***HYLA AVIVOCA* (Bird-Voiced Treefrog). CONSTRUCTED WETLAND COLONIZATION.** At the northern end of its range, *Hyla avivoca* populations have been extirpated or reduced in size due to drainage of Bald Cypress (*Taxodium distichum*) and Tupelo Gum (*Nyssa aquatica*) swamps (Redmer et al. 1999a. Illinois Nat. Hist. Surv. Bull. 36:37–66). Many remaining *H. avivoca* populations are isolated from each other by extensive deforested areas such as agricultural fields.

In the Cache River drainage of southern Illinois, USA, government agencies and private conservation groups are acquiring and reforesting cropland, and constructing wetlands. The Nature Conservancy's Grassy Slough Preserve (GSP) is an 1123-ha former vegetable farm bisected by a channelized portion of the Cache River in Johnson Co., Illinois. Fifteen shallow (< 2 m) wetlands (0.9–47.9 ha in area) were constructed or restored on GSP in 1999 and 2000, and seedling oaks (*Quercus* spp.) and hickories (*Carya* spp.) were planted on intervening uplands from 1999–2002. I studied herpetofaunal colonization of constructed wetlands from 2001–2004, when upland vegetation was dominated by pioneering herbaceous vegetation that over-topped the planted trees, and wetlands were vegetated principally by algae, Cocklebur (*Xanthium commune*), and Water Primrose (*Jussiaea repens*). Although I heard *H. avivoca* vocalizing from forested wetlands north and south of the former agricultural fields in 2000, *H. avivoca* was not among the 35 herpetofaunal species encountered at newly-constructed wetlands (Palis 2007. Trans. Illinois State Acad. Sci. 100:177–189).

On 15 June 2011, I heard choruses of *H. avivoca* in one restored and two constructed wetlands on GSP. Wetlands 3 and 1 are 65 m east and 485 m south, of a forest-bordered former channel of the Cache River where I heard *H. avivoca* calling in 2000 and 2008 (see Figure 1 in Palis 2007, *op. cit.*; available at www.il-acad-sci-org/publications). Wetland 3 (37.331222°N, 88.919189°W; geocoordinates derived from Google Earth), the restored wetland, is bordered on the west by a dense stand of young (≤ 7.5-m tall) trees including Sweetgum (*Liquidambar styraciflua*), Box Elder (*Acer negundo*), Red Maple (*Acer rubrum*), American Sycamore (*Platanus occidentalis*), Green Ash (*Fraxinus pennsylvanica*), oak, and River Birch (*Betula nigra*), as well as Buttonbush (*Cephalanthus*

occidentalis). The dense stand of young trees forms a continuous canopy from the wetland to the mature oak-hickory forest bordering the old river channel. With the exception of the forested edge, the wetland is treeless and vegetated principally with American Lotus (*Nelumbo lutea*), sedges (*Carex* spp.), rush (*Juncus* sp.), arrowhead (*Sagittaria* sp.), and widely-scattered buttonbush and Rose Mallow (*Hibiscus lasiocarpus*). An estimated 100± *H. avivoca* called from shrubs and trees along an ca. 500 m length of the western wetland edge examined from 2025–2150 h; air temp = 19°C). I also observed one amplectant pair. Wetland 1 (37.3269°N, 88.919061°W) is also dominated by herbaceous vegetation; ca. 90% of the surface is covered with Water Primrose. A continuous canopy of young trees occurs between Wetland 1 and Wetland 3 to the north. Approximately 10–15 *H. avivoca* called from a stand of Black Willow (*Salix nigra*) on the northern edge of the wetland (2155–2205 h). Wetland 10 (37.306528°N, 88.957806°W) is about 445 m north of a swamp where I heard *H. avivoca* in 2000. Dominant herbaceous and woody vegetation in Wetland 10 includes Water Primrose and Sweetgum, and a continuous canopy of young trees lies between Wetland 10 and the swamp. I heard approximately 10 *H. avivoca* vocalizing from the western end of Wetland 10 from 2247–2250 h.

Unlike 2001–2004, the uplands between constructed/restored wetlands and remnant forested wetlands support young forest in 2011. The tree canopy may provide an avenue for *H. avivoca* dispersal. Diet studies (Jamieson et al. 1993. Texas J. Sci. 45:45–49; Redmer et al. 1999b. Trans. Illinois State Acad. Sci. 92:271–275) suggest that *H. avivoca* is more arboreal than sympatric congeners (*H. chrysoscelis* and *H. cinerea*); therefore a continuous canopy may facilitate dispersal. Long-distance movements by *H. avivoca* away from breeding sites have also been observed in forested corridors (Palis 2010. Herpetol. Rev. 41:63–64).

At the northern end of its range, *H. avivoca* is thought to breed only in remnant Bald Cypress and/or Tupelo Gum swamps (Barbour 1971. Amphibians and Reptiles of Kentucky. Univ. Press of Kentucky, Lexington; Redmer et al. 1999a, *op. cit.*). My observations, however, indicate that newly-constructed/restored (11–12 years), herbaceous-dominated wetlands flanked by a rank growth of pioneering tree species can also serve as breeding habitat for *H. avivoca*. Thus, in Illinois, reforested agricultural fields and constructed/restored wetlands may provide habitat and movement corridors for *H. avivoca* which may, in turn, serve to expand and connect disparate populations of this state threatened species.

These observations would not have been possible without the kindness of E. Palmer; her assistance and companionship in the field is greatly appreciated.

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***HYLA CHRYSOSCELIS* (Cope's Gray Treefrog). CALLING/MATE CHOICE.** On 10 May 2011, at the Anita C. Leight Estuary Center (Abingdon, Maryland, USA; 39.45119°N, 76.26831°W), several *Hyla chrysoscelis* were observed using an unusual call to attract a female. Eight frogs were calling from four tanks of submerged aquatic vegetation. In two of the tanks, two males were positioned together on the inside of a corner with each frog on an adjoining wall (Fig. 1). The other four males were scattered around the tanks.

The frogs used the normal trilling call of *H. chrysoscelis*, but occasionally would use a chirping call that consisted of 3–5 rapid chirps rather than trills (Fig. 2). Chirping often was immediately

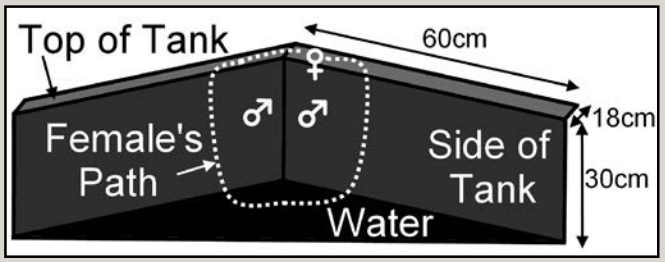


FIG. 1. An inside view of the corner of the tank from where the males called. Each male was on a separate wall and the female circled around them.

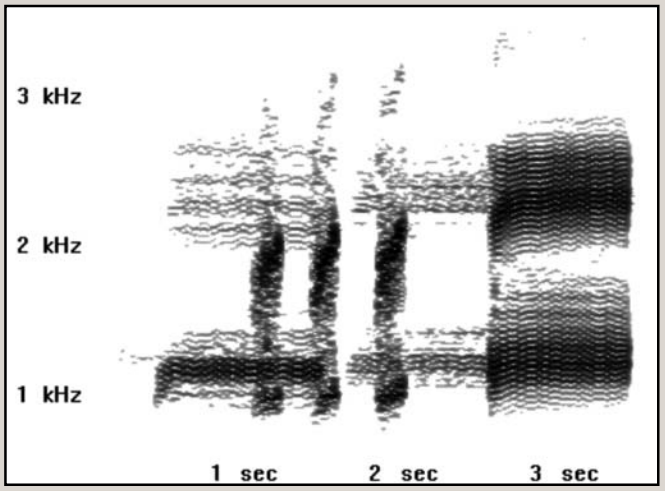


FIG. 2. A spectogram of a male *Hyla chrysoscelis* calling. Each of the three pulses between 1.25–2.25 seconds is a chirp, and the call from 2.5 seconds to the end is a normal trill. Everything else is background noise.

followed by trilling. Only the four males in the corners used the chirping call, but when one of them used it, the male that shared its corner almost always began chirping, and the two males in the corner of the other tank usually began chirping. The males also tended to discontinue chirping as soon as the other males stopped.

The frogs were easily disturbed while chirping. While trilling, they did not seem disturbed by observers, and would continue trilling even if a light was shone on them. While chirping, however, they almost always either stopped calling or switched to trilling the instant a light was shone on them.

As the frogs called, a female approached the corner where two of the males were calling. She began making loops around the males starting at the top, going down one side, through the water, up the other side, and back across the top (Fig. 1). She repeated this loop several times, sometimes switching directions part way through. The males seemed to use the chirping call in relation to her proximity. While going up or down the sides of the tank, the male that she was passing nearly always began rapidly and repeatedly chirping (usually stimulating the other male to chirp), and the chirping stopped once she reached the water or the top of the tank. Then, as she ascended or descended the other side, the other male would begin chirping (usually stimulating the original male to chirp). After making several loops, the female stopped at the top of the tank, and one of the males approached her. He walked up behind her, rubbed the side of her stomach with his front foot, and then mounted her. They both hopped into the water, and the female began laying eggs. It was

unclear how or if the female signaled her acceptance of that male over the other, but only one male moved, and the female showed no resistance when he approached.

It is interesting that the males used this short chirping call when the female was near because multiple studies have shown that female Gray Treefrogs (*Hyla versicolor*) prefer long calls to short ones (Fellers 1979. Copeia 1979:286–290; Schwartz et al. 2001. Behav. Ecol. Sociobiol. 49:443–455; Schwartz et al. 2004. Anim. Behav. 68:533–540). Perhaps, the handicap principal is at play. Chirping may be more noticeable to predators, thus putting the caller at a higher risk of predation, while simultaneously being highly attractive to females because it acts as a mechanism for judging male fitness. This makes sense in light of the observation that males were easily disturbed while chirping, and only the males that were in close proximity to another male chirped (the other males did not have as much direct competition and therefore did not need the more attractive but more dangerous call).

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***HYPSIBOAS CREPITANS* (Rattle-voiced Treefrog). PREDATION.** Snakes are major predators of anurans and depending on preference, abundance, and habitat, they can exert the greatest predation pressure on a frog community. It is not uncommon in Neotropical regions to find Dipsadidae snakes preying on adult anurans in the breeding season near ponds (Wells 2007. The Ecology and Behavior of Amphibians. Univ. Chicago Press, Chicago, Illinois. 1148 pp.). *Leptodeira annulata* is a nocturnal arboreal snake that inhabits primary and secondary forests (Vitt 1996. Herpetol. Nat. Hist. 4:69–76). On 09 March 2010 at 2145 h we observed an individual *L. annulata* (TL = 760 mm, JZ 1521) preying on an adult male *Hypsiboas crepitans*, that by the time of our observation was almost completely ingested (Fig. 1). The tree frog was in calling activity on the grass at the edge of a semi temporary water body. The predation event occurred in a transition area between patches of Caatinga and Atlantic Rain Forest at Serra do Brejo Novo (13.94472°S, 40.10942°W; 700 m elev.), municipality of Jequié, state of Bahia, Brazil. *Hypsiboas crepitans* has a long breeding season associated with temporary or permanent ponds (Arzabe 1999. Rev. Brasil. Zool. 16[3]:851–864). As typical prolonged breeders, males spend consecutive nights calling at the same site, which increases their exposure to predators (Wells 2007, *op. cit.*). Predation accounts like the current one, although anectodal, help form a theoretical basis for larger studies about the importance of these events on the structure of anuran communities (Toledo 2005. Herpetol. Rev. 36[4]:395–400).



FIG. 1. Predation of an adult *Hypsiboas crepitans* by an individual of *Leptodeira annulata* (TL = 760 mm).

Voucher specimens are deposited in Juliana Zina's personal collection pending installation of the Natural History Museum of Jequié, at the Universidade Estadual do Sudoeste da Bahia, UESB, Jequié, Bahia, Brazil.

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***KASSINA SENEGALENSIS* (Senegal Kassina). UNILATERAL HINDLIMB MICROMELY.** The discovery of frog populations with a large number of malformed individuals generated the need to list and better identify the causes of these malformations, a particularly relevant subject for the conservation of this highly endangered group (Lannoo 2008. Malformed Frogs. Univ. California Press, Berkeley, California. xvi + 270 pp.). Most of the documentation concerns metamorphosed individuals as the malformations are more conspicuous than in tadpoles. Furthermore, malformations in tadpoles can appear late in development, as in the cases involving limbs. A case of hindlimb developmental asymmetry was observed in a tadpole of *Kassina senegalensis* collected in an isolated lagoon with connections, Banhine National Park, Gaza Province, Mozambique (22.52917°S, 32.64583°E; WGS 84), 5 June 2005 and housed at the South African Institute for Aquatic Biodiversity, Grahamstown, South Africa under the collection number SAIAB 88010. The left hindlimb was in stage 40 (Fig. 1A) whereas the right hindlimb was in stage 32/33 (Fig. 1B) (Gosner 1960. Herpetologica 16:183–190). The right hindlimb presents a larger base than usually observed in other tadpoles as well as a strong indentation between the foot paddle and the proximal segment of the limb. However, the base of this hindlimb was still much less wide than in the stage 40 hindlimb. The cause of this developmental asymmetry is unknown. Frequency of this anomaly within the population is unknown as only this tadpole was collected at this locality. The malformations in amphibians are known to arise from pollution (radioactive pollution; agricultural or industrial chemicals), disease (infection by the fungus *Batrachochytrium dendrobatidis*) or parasitism, or may be of genetic origin (see Lannoo 2008, *op. cit.* for review). If the less developed hindlimb would stay shorter at the adult stage, this would be a case of unilateral hindlimb micromely. Another hypothesis could be a regenerating limb after failed predation. However, this limb and the surrounding tissue did not show the presence of any scars.

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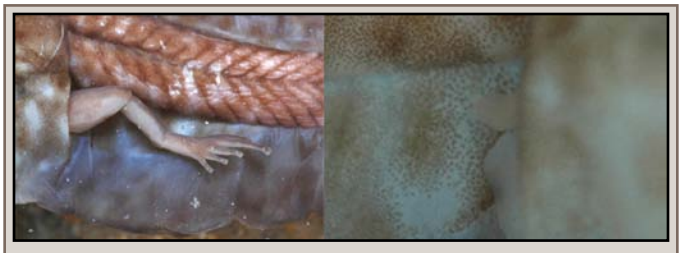


FIG 1. The left hindlimb in Gosner Stage 40 (left) and the right hindlimb in Gosner Stage 32/33 (right). Note that the two pictures are not at the same scale.

***LEPTOBRACHIUM ABBOTTI* (Lowland Litter Frog). MAXIMUM ELEVATION.** *Leptobrachium abbotti* is a stocky and large anuran (to 95 mm SVL) with a broad head and truncate but non-protruding snout, bulging dark eyes characterized by small bluish arcs, visible tympanums and supratympanic folds, rather smooth blackish top of the head and body, slightly granular venter distinctively mottled in black and white, slender and short limbs, rounded tips of digits, as well as toes webbed at bases (Inger 2005. The Systematics and Zoogeography of the Amphibia of Borneo. Natural History Publications [Borneo] Sdn. Bhd. Kota Kinabalu. 402 pp.; Malkmus et al. 2002. Amphibians and Reptiles of Mount Kinabalu [North Borneo]. A.R.G. Gantner Verlag K.G. Ruggell. 424 pp.). *Leptobrachium abbotti* occurs in Indonesia (West Sumatra, and Riau), and throughout Borneo (Sabah and Sarawak of Malaysia, Brunei Darussalam, and Kalimantan of Indonesia) (Das 2007. A Pocket Guide: Amphibians and Reptiles of Brunei. Natural History Publications [Borneo] Sdn. Bhd. Kota Kinabalu. viii + 200 pp.; Inger et al. 2004. *Leptobrachium abbotti*. *In* IUCN 2010. IUCN Red List of Threatened Species. Version 2010.4. <www.iucnredlist.org>. Accessed on 20 April 2011). The species inhabits the leaf litter of primary and old secondary forests with small to medium slow-moving streams with rocky bottoms for breeding, up to the maximum elevation of 1000 m (AmphibiaWeb: Information on amphibian biology and conservation. [web application] 2011. Berkeley, California: AmphibiaWeb. http://amphibiaweb.org/. Accessed on 20 April 2011; Haas and Das 2010. Frogs of Borneo. Frogs and Tadpoles of East Malaysia. Website: http://frogofborneo.org/. Accessed on 20 April 2011; Inger and Stuebing 2005. A Field Guide to the Frogs of Borneo. 2nd ed. Natural History Publications [Borneo] Sdn. Bhd. Kota Kinabalu. viii + 201 pp.). Herein we report a new altitudinal limit for *L. abbotti*.

On 8 Dec 2010 at 2050 h, an adult *L. abbotti* (51 mm SVL, 8.6 g) was found on a trail adjacent to Sungai Mayampak (5.9818°N, 116.5329°E; 1138 m elev.), Bundu Tuhan, Ranau District, West Coast Division, Sabah, Bornean Malaysia. Air temperature was 19.2°C, and relative humidity was 91%. The individual was found on the ground with minimal leaf litter as the trail is commonly used by local people. Due to the proximity to human settlement and forest, both groups of human commensal species (*Fejervarya limnocharis*) and forest-related species, such as *Ansonia longidigita*, *Leptolalax pictus*, *Megophrys nasuta*, and *Chaperina fusca*, occur along the trail. The finding suggests an extension of habitat for *L. abbotti*. As another *L. abbotti* has been found above 1000 m elev. (at 1081 m elev.) at Sungai Lidan (5.9844°N 116.5258°E), Bundu Tuhan, the new altitudinal limit finding holds taxonomic significance for *L. abbotti* to help avoid misidentification of the species at higher elevations. The specimens (Sungai Mayampak: HEP01824, and Sungai Lidan: HEP00536) were deposited in BORNEENSIS, the Bornean reference collection of the Institute for Tropical Biology and Conservation, Universiti Malaysia Sabah.

We are grateful to A. J. Lintanga for field assistance, J. Bulangai for field transportation, and the Haleluyah Retreat Centre for lodging. Collecting was conducted under permission of the Jawatankuasa Pemegang Amanah Hutan Simpanan dan Tanah Perumahan Bumiputera Kg. Bundu Tuhan, Ranau, to KBH. We also thank the Institute for Tropical Biology and Conservation, Universiti Malaysia Sabah for support.

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***LEPTODACTYLUS* AFF. *HYLAEDACTYLUS*. DEFENSIVE BEHAVIOR.** It is well known that frogs are included in the diet of many predators, although they have evolved several defense mechanisms to survive (Duellman and Trueb 1994. Biology of Amphibians. MacGraw-Hill Book Co., New York. 670 pp.). Different species of amphibians, when touched and in danger, inflate their bodies with arms outstretched and legs close to the body and remain motionless (Wells 2007. The Ecology and Behavior of Amphibians. Univ. Chicago Press, Chicago, Illinois. 1400 pp.). This defensive behavior is known as thanatosis. Observations reported herein occurred during January to March 2011 in the municipality of São Gonçalo do Amarante, west coast of Ceará State, Brazil (3.51525°S, 38.9188°W). We captured about 20 individual *Leptodactylus* aff. *hylaedactylus* that, when handled in the field for measurements and photographs, exhibited thanatosis. They inflated their bodies and turned arms and legs upward with the arms outstretched and the legs close to the body, maintaining a belly-up position in the hand of an observer (Fig. 1). The animals remained motionless for about 2 minutes and then slowly returned to normal position. Soon after righting themselves, they attempted escape by leaping away. This behavior was photographed and filmed with a Sony HX1 digital camera. This behavior has been reported for other *Leptodactylus* and other anurans (Azevedo-Ramos 1995. Rev. Bras. Biol. 55[1]:45–47; Hartmann et al. 2003. Herpetol. Rev. 34:50; Zamprogno et al. 1998. Herpetol. Rev. 29:96–97) but this is the first report of this behavior in *Leptodactylus* aff. *hylaedactylus*.



FIG. 1. Adult *Leptodactylus* aff. *hylaedactylus* exhibiting death-feigning behavior following handling.

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***LEPTODACTYLUS MELANONOTUS* (Sabinal Frog). PREY.** *Leptodactylus melanonotus* is known to prey mainly on Coleoptera and Lepidoptera (Greding and Hellebuyck 1980. Carib. J. Sci. 16[1–4]:23–31), but it has also been reported to scavenge on ranid tadpoles (Lewis et al. 2008. Herpetol. Rev. 39[1]:79).

On 6 Oct 2009, an adult *Leptodactylus melanonotus* (sex unknown) was found biting the back leg of an adult *Tlalocohyla*

PHOTO BY OSCAR AVILA-LÓPES



FIG. 1. Predation on *Tlalocohyla smithi* by an adult *Leptodactylus melanonotus*, Colima, México.

smithi, in a drying pond about 0.8 km NE of Paticajo, municipality of Minatitlán, Colima, México (19.3061°N, 104.148°W, WGS 84; 483 m elev.). The *L. melanonotus* slowly started ingesting the *T. smithi*, hind legs first, and about 25 minutes later the entire *T. smithi* was ingested. The frogs were not captured, but several photographs were taken during the process and are deposited in the Digital Collection of the University of Texas at Arlington (UTADC 6255, 6656).

To our knowledge, this is the first report of a *Leptodactylus melanonotus* feeding on an adult anuran.

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***LITORIA SERRATA* (Green-eyed Treefrog) and *LITORIA INFRAFRENATA* (White-lipped Treefrog). REPRODUCTIVE BEHAVIOR.** *Litoria serrata* and *L. infrafrenata* are tropical, arboreal frog species that inhabit rainforest and adjacent habitats of the Wet Tropics region of northeast Queensland, Australia. *Litoria serrata* is a relatively small species (SVL 37–80 mm) that is closely associated with streams and creeks where it breeds. *Litoria infrafrenata* is a considerably larger species (SVL 65–140 mm) that breeds in permanent or temporary ponds (Hoskin and Hero 2008. Rainforest Frogs of the Wet Tropics North-east Australia. Griffith Univ., Gold Coast, Australia. 96 pp.; Hero and Fickling 1994. A Guide to the Stream-dwelling Frogs of the Wet Tropics Rainforests. Dept. Zoology, James Cook University. Townsville, Qld. 27 pp.) Although examples of interspecific amplexus among frogs are relatively common (Grogan and Grogan 2011. Herpetol. Rev. 42: 89–90; Manzano and Corzas 2011. Herpetol. Rev. 42:84), Streicher et al. (2010. Herpetol. Rev. 41:208) commented on the lack of examples pertaining to tropical hylids. Herein I report one such example of amplexus between *L. serrata* and *L. infrafrenata*, despite differences in size and preferred breeding habitat.

At 1055 h on 11 Oct 1998, I observed a male *L. serrata* in amplexus with a small adult (sex unknown) *L. infrafrenata*. Conditions were overcast (shade temperature 24°C) and there had been rain the previous evening. The pair was encountered sitting stationary on a wet semi-secluded stone within the spray-zone of a small cascade of Polly Creek in the Seymour Range (60 m elev.) near the township of Innisfail (146.02917°E, 17.499444°S). The male *L. serrata* had a firm grasp around the chest of the *L. infrafrenata*. The eyes of the *L. serrata* were partially retracted into their sockets (which is typical for the genus when at rest) while those of the *L. infrafrenata* were not and the transparent eye-coverings were half-open. The pair was observed at close range for a period of ca. 15 min. during which time there was no



FIG. 1. Male *Litoria serrata* in amplexus with a small adult *Litoria infrafrenata*.

COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND

movement and they were flash photographed (Fig. 1). Although the pair was briefly manipulated, they remained in amplexus and both frogs were quite unresponsive. The pair was observed ca. two hours later in the same position. As both species are nocturnal, it seems likely that amplexus was initiated the previous evening when both were presumably active. The timing of this observation coincided with the start of the breeding season of *L. serrata* in the local area.

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***PHYSALAEMUS BILIGONIGERUS*. BURROW USE.** Burrows provide an amenable environment for anurans; they have cooler temperatures and higher moisture as compared to surface conditions (Franz 1986. *In* Jackson and Bryant [eds.], The Gopher Tortoise and its Community. Proceedings of the 5th Annual Meeting of the Gopher Tortoise Council, pp. 16–20. Florida State Museum, Gainesville). Cei (1980. Monitore Zool. Ital. Monogr. 2:74–75) reported that the anurans of the Gran Chaco often seek shelter in burrows of the Vizcacha (*Lagostomus maximus*; Rodentia: Chincillidae) but only listed Oven Frogs (*Leptodactylus bufonius*) and Coralline Frogs (*L. laticeps*) as occupants.

On 9 Feb 2011 at 2100 h, I observed a frog emerging from an entrance of a *L. maximus* burrow in the Isoceño community of Kuaridenda (19.17°S, 62.53°W; WGS 84), Cordillera Province, Department of Santa Cruz, Bolivia. I captured the frog and confirmed it to be a female *Physalaemus biligonigerus*. When the frog was released, it re-entered the burrow, emerging again ca. 10 min. later. The frog was not disturbed when it emerged the second time and proceeded to hop in the direction of a temporary pond that was ca. 30 m away. I also observed multiple *L. bufonius* utilizing these same sets of burrows. This observation confirms an additional anuran species as an occupant of *L. maximus* burrows.

Anurans of the Gran Chaco possess many strategies to limit water loss. Examples include coating their skin with waxy lipids (e.g., *Phyllomedusa sauvagii*; Shoemaker et al. 1972. Science 175:1018–1020) or forming a cocoon for aestivation (*Lepidobatrachus llaenis*; McClanahan et al. 1976. Copeia 1976:179–185). Those anurans, like *P. biligonigerus*, lack extreme physiological adaptations to limit water loss and may utilize these burrows as refuge from the environmental stress of desiccation. A more intensive survey of these burrows may yield a more complete list of anuran burrow occupants.

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***PHYSALAEMUS BILIGONIGERUS*. PREDATION.** *Physalaemus biligonigerus* is probably a complex of more than one species, and is known from northern and central-western Argentina, adjacent Bolivia, Paraguay, Uruguay, and southern and central Brazil. It is common throughout its range and occurs from sea level to 1400 m elev. It occupies grasslands near temporary and permanent lentic water where it breeds. Males call from the edge or from within the water, and the eggs are deposited in spherical foam nests that float on top of the water. It is able to adapt to anthropogenic disturbance, and is not generally considered threatened. However, the species is threatened in Argentina by the destruction of Chaco habitat for agriculture and wood extraction, and land and water pollution caused by agrochemical runoff. Taxonomic studies are needed to resolve the status of different populations that might represent different species (Kwet et al. 2004. *In* IUCN 2010. IUCN Red List of Threatened Species. Version 2010.4. <www.iucnredlist.org>).

This observation occurred near Fazenda Pinhal (30.2199°S, 50.2814°W), near the town of Palmares do Sul (Rio Grande do Sul, Brazil). This area is adjacent to the town of Pinhal and is coastal plain habitat. The region is largely urbanized and agricultural. During the night of 17 Jan 2010 we witnessed predation of *P. biligonigerus* by a young Wolf Fish, *Hoplias* sp., ca. 10 cm long. The frog was attacked on the bank of a slow moving, artificial stream. The Wolf Fish grabbed the frog by the back, and the frog instantly inflated its body; this caused the Wolf Fish difficulty in swallowing the frog as the inflated body of the frog made it difficult for the Wolf Fish to immerse underwater. However after ca. 10 minutes the Wolf Fish succeeded in swallowing the frog and swam away.

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***PHYSALAEMUS PUSTULOSUS* (Tungara Frog). DIET.** *Physalaemus pustulosus* occurs in northern South America and throughout much of the lowland tropical forests of Middle America (Ryan 2010. *In* M. Breed and J. Moore [eds.], Encyclopedia of Animal Behavior, pp. 453–461. Academic Press, Oxford). Ryan (1985. The Túngara Frog: A Study in Sexual Selection and Communication. Univ. Chicago Press, Chicago, Illinois. 246 pp.) reported that *P. pustulosus* eats primarily termites, in addition to ants, mites, dipterans, and snails; although no detailed information exists on the food habits of this species. Herein we provide data on the diet of *P. pustulosus* from Reserva Rio Manso (5.666°N, 74.77416°W; ca. 220 m elev.), municipality of Norcasia, departament of Caldas, Colombia.

We examined the diet of *P. pustulosus* by stomach-flushing 78 individuals, sampled by GGD and SEL from 12–20 May 2010, between 1900 and 2200 h, around ponds in pasture lands. We identified each prey item to order or family, and measured the length and width of each item using manual calipers (to nearest 0.1 mm). We estimated prey volume using the formula for a prolate spheroid.

TABLE 1. Types of prey in the diet of *Physalaemus pustulosus* from Reserva Rio Manso, Norcasia, Caldas, Colombia. Volume in mm^3.

Prey	Number (%)	Volume (%)	Frequency of occurrence
Arachnida			
Acari	102 (9.6)	13.2 (0.52)	15
Insecta			
Coleoptera			
Chrysomelidae	1 (0.1)	0.5 (0.02)	1
Melolonthidae	1 (0.1)	0.3 (0.01)	1
Mycetophagydae	2 (0.2)	7.0 (0.28)	2
Nitidulidae	1 (0.1)	0.1 (0.00)	1
Silvanidae	2 (0.2)	0.9 (0.03)	2
Staphylinidae	5 (0.5)	1.5 (0.06)	5
Trogossitidae	1 (0.1)		1
Diptera			
Chironomidae	1 (0.1)	0.1 (0.00)	1
Drosophilidae	6 (0.6)	6.4 (0.25)	4
Micropezidae	4 (0.4)	2.2 (0.09)	1
Psychodidae	11 (1.0)	2.7 (0.11)	11
Sphaeroceridae	64 (6.0)	3.6 (0.14)	3
Hemiptera			
Cicadellidae	1 (0.1)	0.4 (0.01)	1
Fulgoridae	2 (0.2)	0.4 (0.01)	2
Hymenoptera			
Diapriidae	1 (0.1)	0.1 (0.00)	1
Figitidae	1 (0.1)	0.1 (0.01)	1
Formicidae	199 (18.8)	38.7 (1.54)	34
Isoptera			
Termitidae	630 (59.4)	2432.1 (96.50)	22
Protura			
Dycirtomidae	16 (1.5)	0.6 (0.02)	6
Thysanoptera			
Thripidae	1 (0.1)	0.3 (0.01)	1
Larvae	3 (0.3)	0.7 (0.03)	2
Diplopoda	1 (0.1)	0.1 (0.00)	1
Chilopoda	4 (0.4)	2.9 (0.11)	2
Mollusca	1 (0.1)	5.6 (0.22)	1
TOTAL	1061	2520.3	

Of 78 individuals examined, 46 (58.9%) contained prey. These individuals ranged from 17.9–33.5 mm SVL (mean 26.01 ± 3.2). The diet consisted mainly of arthropods although mollusks were also present (Table 1). Insects (seven orders and 19 families, and larvae) and mites were the most important prey. Termites were dominant in the diet, representing 59.4% of the total number and 96.5% of the volume. Ants were also important, but consumed in less proportion (18.8% and 1.54%, respectively). Other prey groups were not as evident, with values below 9.6% total number and below 0.52% volume).

Duellman (1978. Univ. Kansas Mus. Nat. Hist. Misc. Pub. 65:1–352), Parmelee (1999. Sci. Pap. Nat. Hist. Mus. Univ. Kansas 11:1–59), and Menéndez-Guerrero (2001. Ecología Trófica de la Comunidad de Anuros del Parque Nacional Yasuní en la Amazonía Ecuatoriana. Pont. Univ. Catol. Ecuador. 173 pp.) reported that other *Physalaemus* species, e.g., *P. freibergi* and *P. petersi*, consume a lot of termites, up to 99% both numerically and volumetrically, and very small quantities of other prey such as Coleoptera, Hymenoptera, Dermaptera, Hemiptera, and Arachnida.

Frogs in the genus *Physalaemus* has been reported as active foragers, usually feeding on small and aggregated prey (Rodrigues et al. 2004. Rev. Esp. Herpetol.18:19–28), and proposed as a termite specialist (Duellman 1978, *op. cit.*; Vitt and Caldwell 1994. J. Zool. [Lond.] 234:463–476). Because of the large quantities of termites found in this work, we suggest that *P. pustulosus* in this region could be considered a termite specialist, and that the low values exhibited for other prey items might be due to accidental ingestions (Rodrigues et al. 2004, *op. cit.*).

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***RAORCHESTES MENGLAENSIS* (Mengla Small Treefrog). COLORATION.** *Raorchestes menglaensis* is a data deficient species. All information for the species is based on 10 individuals that were collected at one site in Zhushihe, Mengla county, Xishuangbanna prefecture, Yunnan province, China at 900 m elev. (Kou 1990. *In* Zhao, E.-M. [ed.], From Water onto Land. China Forestry Press, Beijing). During breeding surveys on 26 June 2009, we encountered a single individual in the Xishuangbanna Tropical Botanic Garden. The frog was found at night during a light rain, calling on a leaf ca. 0.4 m above ground. There was no standing water or streams anywhere nearby, further suggesting this species may breed via direct development. The individual was collected and held overnight for photographing. At night, the frog was largely tan in color with irregular darkened areas and faint banding visible on the hind limbs. The following morning the frog was dark brown to nearly black with light gray specks (Fig. 1).

During three months of weekly breeding surveys, we only saw *R. menglaensis* once. However, other individuals were heard calling on several occasions. This is likely a rare species in need of conservation attention given that its habitat is experiencing significant land use change (Li et al. 2007. Biodiversity and Conservation 16:1731–1745).

Photo vouchers documenting the coloration were deposited in the University of Wisconsin Zoology Museum (light coloration: UWZM V.20187, dark coloration UWZM V.20188). We thank Xishuangbanna Tropical Botanic Garden for access to breeding areas. Funding was provided by NSF DGE-0549369 and Fulbright.



FIG. 1. On left, *Raorchestes menglaensis* at night; on right *R. menglaensis* during the day. The same individual is depicted in both photos.

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***RHINELLA MARINA* (Cane Toad). PREDATION.** *Rhinella marina* is a widely distributed toad; in Mexico it is found in the southern region, and along the Atlantic and Pacific versants (Oliver-López et al. 2009. La Familia Bufonidae en México. UNAM, CONABIO, México. 139 pp.). Here we report on the first case of predation of a Cane Toad by the Barn Owl (*Tyto alba*), in the green areas of Instituto Tecnológico del Valle de Oaxaca, in the locality of Nazareno, municipality of Santa Cruz Xoxocotlán, Oaxaca, Mexico (17.0207°N, 96.7673°W; 1565 m elev.). The area is surrounded by remnants of tropical dry forest and arid tropical scrub, which have been replaced extensively by corn crops. Individuals of *T. alba* were observed while they were perching on palm trees, where the pellets of this species were collected. In one of these, we found a partly digested *R. marina* (ca. 132 mm SVL; Fig. 1). This was not in the typical pellet form; however, we were able to confirm ingestion by the owl by the presence of three rodent lower jaws that were associated with the partly digested *R. marina*. This partial digestion may be due to the parotoid glands of *R. marina*, which secrete toxins that are utilized for defense, forcing it to be regurgitated, along with other prey.

Predation on amphibians by *T. alba* has been documented elsewhere (Hernández-Muñoz and Mancina 2011. Rev. Mex. Biodiv. 82:217–226; Wells 2007. The Ecology and Behavior of Amphibians. Univ. Chicago Press, Chicago, Illinois. 1148 pp.), but the only two papers we found that mentioned a toad in the diet of *T. alba* are those of Arredondo and Chirino (2002. El Pitirre 15:16–24) who cited the species *Peltaphryne empusa* in Cuba, and Morales-Hernández (1997. Análisis de los Hábitos Alimenticios de la Lechuza *Tyto alba* en la Población de Chichicasco, Estado de México. Unpubl. BS thesis. BUAP, Puebla, México), who found an unidentified toad in the cave of Agustín Lorenzo in San Pedro Chichicasco, State of Mexico, Mexico. However, this is the first report of *R. marina* in the diet of *T. alba*.

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FIG. 1. Partly digested *Rhinella marina*, found in a pellet of the Barn Owl (*Tyto alba*), in Santa Cruz Xoxocotlán, Oaxaca, Mexico.

***RULYRANA OREJUELA* (Orejuela Glass Frog). PREDATION.** Spiders commonly prey on amphibians. Menin et al. (2005. Phyllomedusa 4[1]:39–47) provided an extensive review of spiders preying on amphibians in the Neotropics. Predators belong to several species of spiders, especially within the families Ctenidae, Lycosidae, Pisauridae, Sparissidae, and Theraphosidae. Hayes (1983. Biotropica 15:74–76) reported predation by spiders *Cupiennius* sp. (Ctenidae) on two species of glass frogs: *Hyalinobatrachium fleischmanni* and *Espadarana prosoblepon*. Herein, we report predation of *Rulyrana orejuela* by a spider of the family Clubionidae. This event was observed in an area at the southern border of Reserva Ecológica Cotacachi Cayapas, Provincia de Imbabura, northwestern Ecuador (0.33101°N, 78.93152°W; 670 m). The general locality includes a mixture of secondary and primary forests in the Low Montane Evergreen Forest. We observed a female *Clubiona* sp. preying on *Rulyrana orejuela* on 31 Oct 2009 at 2325 h on the Aguas Verdes stream. At the site, we observed at least three additional juveniles and two adult *R. orejuela*. The genus *Clubiona* was recorded only recently from Ecuador (Yánez-Muñoz and Cisneros-Heredia 2008. Check List 4[1]:50–54). The predation occurred on a dark night with cloudy sky and air temperature averaging 24°C. The spider (cephalothorax and abdomen length CAL = 14.5 mm) and the *R. orejuela* (SVL = 13.9 mm) were located over a leaf of *Selaginella* sp. at about 150 cm above the water surface of the stream, near a rock (1.5 m diam) in midstream. This large rock divided the stream into two parts and formed a small island with herbaceous vegetation, branches, and trunks. The stream had a depth of 25 cm and a width of 7 m. When first sighted the spider was about 10 cm from a dead juvenile *R. orejuela*. After about 5 minutes the spider was seen over the frog with its chelicerae embedded in the frog's body. About 80 cm away we found a nest of the spider with the male inside (CAL = 10.9 mm). The cone-shaped nest was built with a leaf of plant belonging to the Araceae. The nest had a depth of 81.4 mm (inner maximum diameter of nest entrance = 13.1 mm.)

PHOTOS BY L. A. COLOMA



FIG. 1. Female *Clubiona* sp. preying on a juvenile *Rulyrana orejuela*.

COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND



FIG. 2. Lateral (left) and dorsal (right) views of the nest of *Clubiona* sp. The male spider is visible at right photo.

Spiders of the genus *Clubiona* are small and are characterized by building their nests on the soil with dry leaves, though sometimes their nests are built with live green leaves. In general, they are hunters and specialize in hunting insects around their nests. Austin (1984. S. Austr. J. Arachnol. 1-2:87–104) reported the main prey of *C. robusta* were Hymenoptera, Coleoptera, and Heteroptera. The prey of *C. cycladata* mostly comprised the groups; Heteroptera, Hymenoptera, Araneae, and Coleoptera. Pollard (1984. J. Arachnol. 11:323–326), discussed oophagy in *C cambriggei*. However, this is the first report of a female *Clubiona* sp. eating a *R. orejuela*.

Voucher specimens were deposited at Museo de Zoología of Pontificia Universidad Católica del Ecuador (QCAZ 48616 *R. orejuela* and QCAZ uncatalogued spider).

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TESTUDINES — TURTLES

***CHELYDRA SERPENTINA* (Snapping Turtle). GROWTH RATES.** Standard carapace length (SCL) growth rates of adult *Chelydra serpentina* have been reported for Iowa, USA (Christiansen and Burken 1979. Herpetologica 35:261–266), and Ontario, Canada (Brown et al. 1994. J. Herpetol. 28:405–410). In Iowa, Christiansen and Burken (*op. cit.*) reported 4.4% growth for one *C. serpentina* re-captured after 11 months. Brown et al. (*op. cit.*) reported mean annual growth of 1.12% (N = 53) and 0.26% (N = 40) for adult female *C. serpentina* at two separate sites in Ontario, Canada.

On 25 May 2011 and 06 July 2011, within the Blood River and Panther Creek, Calloway Co., Kentucky, USA, we re-captured two *C. serpentina* initially marked with metal cattle tags on 14 May 2004 and 28 May 2004. Initial SCL measurements were 240 mm and 231 mm, and final SCL measurements were 315 mm and 277 mm respectively. Percent SCL growth for these two turtles was 3.4% and 2.4% annually, over a 7-year period. Two previous studies detail regionally specific age estimates for *C. serpentina*

based on carapace length (Christiansen and Burken, *op. cit.*; Galbraith et al. 1989. Copeia 1989:896–904). Based on these studies, the two Kentucky *C. serpentina* were captured at approximately 15–16 years of age (based on Ontario data) or between 11–12 years of age (Iowa); however, these may be over-estimates considering Kentucky's warmer climate and longer growing season compared with Iowa and Ontario.

Growth rates for periods exceeding five years have rarely been reported for *C. serpentina*. The 3.4% and 2.4% annual growth rates for two *C. serpentina* in Kentucky fall within the upper end of the range of previously reported annual growth rates for *C. serpentina* (0.26%–4.4%). These data are consistent with previous studies (Ligon and Lovern 2009. Chelon. Cons. Biol. 8:74–83; Parmenter 1980. Copeia 1980[3]:503–514) demonstrating a relationship between warmer water temperatures and increased annual growth rates of turtles.

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***GOPHERUS AGASSIZII* (Desert Tortoise). COHABITATION WITH AMERICAN BADGER.** American Badgers (*Taxidea taxus*) are known predators of juvenile and adult Desert Tortoises as well as their nests (Berry and Duck 2010. Answering Questions About Desert Tortoises: a Guide for People Who Work with the Public. Desert Tortoise Council, Ridgecrest, California. Available online at <http://www.deserttortoise.org/answeringquestions/index.html>). Despite this fact, on 8 August 2011, we observed a badger sharing a caliche cave retreat with an adult male Desert Tortoise in southern Nevada. The badger was seen peering out of the cave before retreating, upon which time some "shuffling" was heard and the tortoise appeared at the cave entrance, apparently unharmed, and proceeded to sit just inside the mouth of the cave. As the tortoise was part of a radio-tracking study, we relocated it a week later and it remained alive and healthy. Though badgers will occasionally kill Desert Tortoises, this observation suggests that they may, at least temporarily, share desert retreat sites with tortoises without antagonistic or predatory behavior.

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***KINOSTERNON BAURII* (Striped Mud Turtle). HABITAT AND AERIAL BASKING.** Reported Striped Mud Turtle habitats include lentic bodies of water such as canals, Carolina bays, ponds, swamps, slow-moving streams, and sloughs (Ernst and Lovich 2009. Turtles of the United States and Canada. Johns Hopkins Univ. Press, Baltimore, Maryland. 827 pp.). Observations of this species in riverine systems are rare. Norman (1989. Catesbeiana 9:9–14; M. Norman, pers. comm.) noted this species' (originally reported as *K. subrubrum*, see Mitchell 1994. The Reptiles of Virginia. Smithsonian Inst. Press, Washington, DC. 352 pp.) occurrence in the Blackwater River in southeastern Virginia but did not elaborate on whether captures were in the mainstem or in associated streams and swamps. Only 4 of 2552 turtles captured by Huestis and Meylan (2004. Southeast. Nat. 3:595–612) in the Rainbow River, Marion Co., Florida, were *K. baurii*. Johnston et al. (2011. Florida Sci. 74:126–133) reported two *K. baurii* in the Santa Fe River (Alachua and Columbia counties, Florida) but speculated that those turtles had immigrated to the river from surrounding floodplain swamps which had dried due to prevailing drought conditions.

During May 2007–July 2011, we captured by hand and with baited hoop traps 105 *K. baurii* in the mainstem and associated springs and spring runs of the Santa Fe River. Of these, 9 were caught in the mainstem and 96 were caught in springs and their associated outflow runs adjacent to the river. All river captures were in areas with submerged, emergent, or floating aquatic vegetation (Tapegrass [*Vallisneria americana*], Indian Swampweed [*Hygrophila polysperma*], Hydrilla [*Hydrilla verticillata*], Water Hyacinth [*Eichhornia crassipes*]), or snags. All individuals in the mainstem were adults. Our observations confirm the occurrence of a *K. baurii* population associated with the Santa Fe River mainstem and strengthen the known association between *K. baurii* and lotic habitats.

In addition, we observed five instances of daytime aerial basking by *K. baurii* along the banks of the Santa Fe River and associated spring runs. One juvenile was basking on a leaf overhanging the water and two adult males were on tree limbs (< 10 cm above water) in Blue Spring run, Gilchrist Co. (29.831041°N, 82.681915°W) on 10 August 2009 and 27 March and 4 April 2011, respectively. One adult (unknown sex) was basking on exposed roots along the margin of the mainstem at Rum Island Park, Columbia Co. (29.833143°N, 82.678346°W) on 16 March 2011. One adult male was basking on a small (14 cm diam) piece of limestone 0.28 km downstream from the Hwy. 441 bridge in High Springs, Alachua Co. (29.851967°N, 82.611310°W) on 23 March 2011. All observations were between 1100 and 1700 h. Most observations of these bottom-walkers occur when they are in shallow water or as they walk across the landscape (Ernst and Lovich 2009, *op. cit.*, Wilson et al. 2006. *In* P. A. Meylan [ed.], Biology and Conservation of Florida Turtles, pp. 180–188. Chelon. Res. Monogr. 3). Although aerial basking has been reported for other species of kinosternids, e.g., *K. subrubrum* (Ernst and Lovich 2009, *op. cit.*), *Sternotherus carinatus* (Lindeman 1996. Herpetol. Nat. Hist. 4:23–34), *S. minor* (Carr 1952. Handbook of Turtles. The Turtles of the United States, Canada, and Baja California. Cornell University Press, Ithaca, New York. 542 pp.)), and *S. odoratus* (Ernst 1986. J. Herpetol. 20:341–352), there appears to have been no published documentation of this behavior in *K. baurii* (Wilson et al. 2006. *op. cit.*; D. Wilson, pers. comm.). Basking behavior by *K. baurii* in the Santa Fe River population may have a thermoregulatory function, as we recorded air temperatures 1.7–3.1°C greater than water temperatures. Basking may also be related to ectoparasite removal, as suggested by a statistically significant difference in leech (*Placobdella* sp.) load between basking adult males (mean = 37.3 leeches/turtle, SD = 45.6, range = 10–90, N = 3) and non-basking adult males (mean = 1.9 leeches/turtle, SD = 3.0, range = 1–12, N = 43) (Mann-Whitney Rank Sum Test, U = 2.500, p = 0.004). These suggested causes of aerial basking in riverine environments need to be tested with other observations of basking *K. baurii* in lotic as well as lentic habitats.

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***STERNOTHERUS CARINATUS* (Razor-backed Musk Turtle). ECTOPARASITES.** To our knowledge, there have been no previous published reports of leeches infesting *Sternotherus carinatus*. Herein we report a new host record for a leech species found on this turtle.

Three adult *S. carinatus* were collected by dipnet on 5 June 2001 from the Caddo River off St. Hwy. 7, Clark Co., Arkansas, USA (34.176523°N, 93.07121°W). Turtles were returned to the laboratory and (because vouchers were required for parasitological surveys) they were killed with an overdose of sodium pentobarbital (Nembutal®), and examined for leeches and gastrointestinal helminth parasites. No helminths were found but one (33%) was infested with 15 leeches attached in the corners of its limbs. They were removed and placed in a vial containing 70% ethanol. These were subsequently identified as juveniles of *Placobdella multilineata* Moore, 1953. Voucher specimens of leeches were deposited in the Invertebrate Zoology Collection of the Department of Invertebrate Zoology, National Museum of Natural History (USNM), Smithsonian Institution, Washington, D.C. as USNM 2057950. Host vouchers were deposited in the Texas A&M University-Texarkana Herpetological Collection (TAMUT), Texarkana, Texas as TAMUT 1005–1006.

This leech is a relatively common blood-feeding species on amphibians and reptiles. Previously reported turtle hosts include the Eastern Snapping Turtle, *Chelydra serpentina* (Sawyer and Shelley 1976. J. Nat. Hist. 10:65–97; Stone 1976. Southwest. Nat. 20:575–576), Alligator Snapping Turtle, *Macroclemys temminckii* (Saumure and Carter 1998. Herpetol. Rev. 29:98), Yellow-bellied Slider, *Trachemys scripta scripta* (Sawyer and Shelley 1976. J. Nat. Hist. 10:65–97), and Bog Turtle, *Clemmys muhlenbergii* (Saumure and Beane 2001. Herpetol. Rev. 32:38; Saumure and Carter 1998. Herpetol. Rev. 29:98).

This leech has an extensive range in the southern United States, extending northward through the Mississippi River Valley and eastward to the Atlantic coast, including Alabama, Arkansas, Florida, Georgia, Kansas, Illinois, Iowa, Louisiana, Nebraska, North Carolina, Oklahoma, South Carolina, Tennessee, and Texas (Klemm 1982. Leeches (Annelida: Hirudinea) of North America. Environmental Monitoring and Support Laboratory, USEPA-600/3-82-025. Cincinnati, Ohio. 177 pp.). Moser et al. (2006. J. Arkansas Acad. Sci. 60:84–95) reported free-living specimens of *P. multilineata* from Arkansas for the first time in Conway, Jackson, Perry, Randolph, and Van Buren counties, all located north of the Arkansas River Valley; our site reported herein is south of the valley in the Ouachita Mountains.

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***STERNOTHERUS MINOR MINOR* (Loggerhead Musk Turtle). PREDATION.** A large number of likely mammalian, avian, and reptilian predators have been listed for the eggs and juveniles of *Sternotherus m. minor* (Ernst and Lovich 2009. Turtles of the United States and Canada. Johns Hopkins Univ. Press, Baltimore, Maryland. 827 pp.), but invertebrate predators have apparently not been noted, and few predators have been documented for adults of this species. These include Alligator Snapping Turtles (*Macrochelys temminckii*), American Alligators (*Alligator mississippiensis*), and humans (Pritchard 1989. The Alligator Snapping Turtle: Biology and Conservation. Milwaukee Public Mus., Milwaukee, Wisconsin. 104 pp.; Zappalorti and Iverson 2006. *In* P. A. Meylan [ed.], Biology and Conservation of Florida Turtles. Chelonian Res. Monogr. No. 3:197–206). In this note, we describe successful predation on adult *S. minor* by River Otters (*Lutra canadensis*), and attempted predation of a juvenile by an invertebrate.

In two separate observations on 10 and 11 January 2011, we observed an adult River Otter in the process of biting off the head and forelimbs of an adult *S. minor* in the Santa Fe River, 1.15 km downstream from Deer Spring (Gilchrist Co., Florida; 29.84757°N, 82.71074°W, WGS 84). In each instance, the otter set the turtle on a log near shore after eating it; the turtle's rear limbs were still moving a minute later, though most of the internal organs had been consumed. Together with *M. temminckii* and *Alligator mississipiensis* that also occur in the Santa Fe River (G. R. Johnston, pers. obs.), River Otters may be significant predators of *S. minor* and play a role in the population ecology of these turtles in this river system.

On 13 February 2011, we observed a female Giant Water Bug, *Lethocerus americanus* (Belostomatidae), manipulating a prey object as it was anchored on *Hydrilla* stems at the confluence of the Ginnie Spring outflow run with the Santa Fe River in Gilchrist County, Florida (29.83655°N, 82.69942°W, WGS 84). She was gripping a juvenile *S. minor* (34 mm carapace length, 22 mm plastron length, 5.5 g) at a depth of about 3 cm, holding the turtle by its anterior carapace and probing the shell with her proboscis. She had not yet penetrated soft tissue when discovered but would likely have killed and eaten the turtle had we not intervened. The turtle was marked and released. This is the first report of attempted predation of *Sternotherus minor* by an invertebrate and apparently the first such attempt reported for the genus.

Matthew Kail aided in the field observation.

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***TRACHEMYS ORNATA* (Ornate Slider). HATCHLINGS.** *Trachemys ornata* is a middle-sized emydid turtle that ranges from northern Sinaloa and Nayarit to isolated populations in Guerrero and Oaxaca on the Pacific coast of Mexico (Ernst and Barbour 1989. Turtles of the World. Smithsonian Institution Press. Washington, D.C. 313 pp.). There is little published information about the life history and reproduction of this species, other than anecdotal data on clutch size (12–20 eggs) and age of first reproduction (4–8 years) (Moll and Moll 1990. *In* J. W. Gibbons [ed.], Life History of the Slider Turtle, pp. 152–161. Smithsonian Institution Press, Washington, DC).

On 24 May 2005 we recorded hatchling emergence from one nest of 13 eggs located just a few meters away from a road in Playa Linda (17.681028°N, 101.644139°W), a beach resort in the tourist-oriented corridor Ixtapa-Zihuatanejo, in Guerrero, México. The nest had been deposited 25 m away from a small marsh and approximately 70 m from the sea coastline. After the last hatchling emerged, we excavated the nest and found one unhatched (decayed) egg. We measured the surviving hatchlings (N = 12) with a dial caliper (± 0.02 mm). The shell measurements (in mm) are given as: average (± SD, range). Carapace length 37.96 (± 2.58, 34.16–41.81), carapace width 34.72 (± 3.33, 28.77–39.04),

carapace height 18.25 (± 1.20, 16.91–20.71), plastron length 34.74 (± 2.29, 31.72–37.61), and plastron width 24.88 (± 1.23, 22.94–26.54). After measurement, the hatchlings were released at the marsh shore. This clutch size for *T. ornata* was similar to that reported for *T. venusta* (N = 12, 5–22 eggs); however, average hatchling carapace length was larger in *T. ornata* than reported for *T. venusta* (mean = 31.8, 25.0–37.8 mm) (Vogt 1990. *In* Gibbons, *op. cit.*, pp. 162–168).

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SQUAMATA — LIZARDS

***AMEIVA AMEIVA* (Giant Ameiva). BIFURCATION.** *Ameiva ameiva* is one of the most widely distributed Neotropical lizards, occurring from the Caribbean Islands and Costa Rica to southern Brazil, northern Argentina and the eastern Andes in South America (Vitt and Colli 1994. Can. J. Zool. 72:1986–2008). All teiid lizards are capable of caudal autotomy as a means of predation evasion. Occasionally an additional lateral tail can be produced if the original is broken, but not entirely lost.

On 26 March 2009 during the rescue activities of wildlife from the Project of Integration of São Francisco River (PISF) within the basins of Northeastern Setentrional, we collected an adult *A. ameiva* in the municipality of Sertânia, state of Pernambuco, Brazil (8.086°S, 37.384°W, datum: WGS84; elev. 558 m). The tail of the lizard was bifurcated in the medial region (ca. 35 mm posterior from the cloaca), and one of the regenerated tails was much shorter than the other (Fig. 1). Records of bifurcated tail regeneration have been published for many lizard species (see Kumbar and Ghadage 2011. Herpetol. Rev. 42:94; Mata-Silva 2010. Herpetol. Rev. 41:352–353, and citations therein), and some of these cases show that the bifid or multiple regeneration of tails involve damage to a vertebra. This is presumably what the *A. ameiva* incurred in this report.

The *A. ameiva* (LC 0969) was deposited in the scientific collection of the Centro de Conservação e Manejo de Fauna da Caatinga (CEMAFAUNA-Caatinga/UNIVASF), Petrolina, Pernambuco, Brazil. We thank the Ministério da Integração Nacional for financial support, and the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (Capes) for the research scholarship granted to ML; IBAMA provided the collecting permits (# 042/2007 and 125.r/2010 Process n° 02001.003112/2007-12).

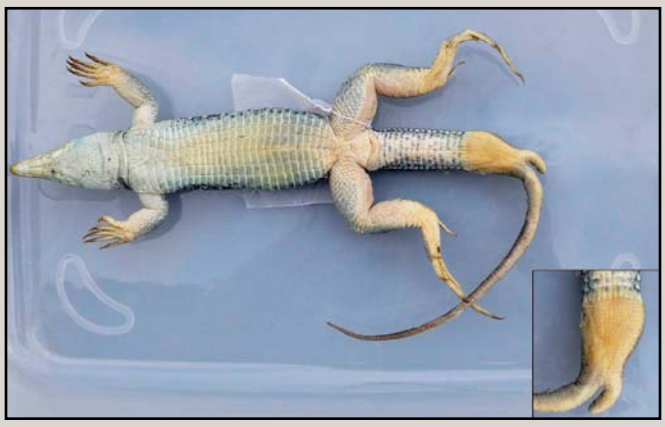


FIG 1. *Ameiva ameiva* (135 mm SVL) with bifurcated tail in the medial region (inset); length of broken tail: 35 mm; length of regenerated tails: 120 mm and 15 mm.

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***ANOLIS CAPITO* (Pug-nosed Anole). DIET.** Although some lizards are dietary specialists, most species consume a wide variety of arthropods (Magnusson and Da Silva 1996. J. Herpetol. 27:380–385). Some detailed dietary studies on small lizards in neotropical areas showed relatively few vertebrate prey (e.g., Garnier et al. 1994. J. Herpetol. 28:187–192; Vitt 1991. Can. J. Zool. 69:504–511; Vitt and de Carvalho 1992. Can. J. Zool. 70:1995–2006; Vitt et al. 1993. Can. J. Zool. 71:2391–2400; Vitt et al. 1998. Can. J. Zool. 76:1681–1688; Vitt et al. 1997. Can. J. Zool. 75:1876–1882; Vitt et al. 2001. Copeia 2001:401–412). However, *Neusticurus ecpleopus* (Gymnophthalmidae) includes frog larvae in its diet at an Amazon locality (Vitt et al. 1998. Can. J. Zool. 76:1671–1680) and *Kentropyx striatus* (Teiidae) has been found to have a high proportion of vertebrates, especially frogs, in its diet (Magnuson and Da Silva 1996, *op. cit.*; Vitt and de Carvalho 1992, *op. cit.*). Some other teiids such as *Tupinambis* also are known to consume frogs (Pianka and Vitt 2003. Lizards: Windows to the Evolution of Diversity. Univ. California Press, Los Angeles, California. 333 pp.), but these are large bodied animals. Frogs are consumed by *Anolis* lizards, especially relatively large-bodied species such as *Anolis punctatus* in Brazil (Vitt et al. 2003. J. Herpetol. 37:276–285). Here we provide the first report of frog predation by *Anolis capito*, a small species (SVL = 83–96 mm, females; 78–90 mm, males) (Savage 2002. Amphibians and Reptiles of Costa Rica: A Herpetofauna Between Two Continents, Between Two Seas. University of Chicago Press, Chicago, Illinois. 1056 pp.).

In Costa Rica, *Anolis capito* is found along the Caribbean slope and in the southwestern lowlands, in deeply shaded forest interiors (Leenders 2001. A Guide to Amphibians and Reptiles of Costa Rica. Zona Tropical, Miami, Florida. 305 pp.). It is most frequently observed on the ground or perched low on a trunk 0.25–2 m above the ground (Savage 2002, *op. cit.*). It feeds mainly on spiders, orthopterans, and caterpillars, and often also takes slugs (Savage 2002, *op. cit.*). It also takes small vertebrates such as other anoles (Leenders 2001, *op. cit.*). At 0950 h on 20 October 2001 in Golfito National Wildlife Refuge, Puntarenas Province, SW Costa Rica (8.638611°N, 83.167778°W), we found an adult male (85 mm SVL) *A. capito* eating a Pigmy Rain Frog (*Pristimantis ridens*) (18 mm long). Neither animal was collected. *Pristimantis ridens* is a very common nocturnal forager in low vegetation that often hides in the leaf litter during the day (Savage 2002, *op. cit.*). The two species have overlapping distributions along the Pacific and Atlantic slopes of Costa Rica. We do not know the frequency of predation or the importance of *P. ridens* in the diet of *A. capito*. This is one of relatively few observations of *Anolis* consuming a frog and is the first report of lizard predation on *Pristimantis ridens*.

Observations were made during a field trip of the "Reptiles" course of the School of Biology, University of Costa Rica (UCR).

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***BRACHYMELES BOULENGERI* (Philippine Slender Skink). DIET.** *Brachymeles boulengeri* is a pentadactyl, semi-fossorial lizard known from Luzon, Polillo, and Marinduque islands in the northern Philippines. Considered a model system for studying the evolution of limb reduction and loss in squamate reptiles, the genus *Brachymeles* possesses species with a full spectrum of body forms, including pentadactyl, non-pentadactyl, and limbless species (Siler and Brown 2011. Evolution doi:10.1111/j.1558-5646.2011.01315.x; Siler et al. 2011. Mol. Phylogen. Evol. 59:53–65). All species are known to burrow in loose soil and rotting logs, making it difficult to observe dietary preferences (Siler and Brown 2010. Herpetol. Monogr. 24:1–54). As a result of their secretive nature, no studies have reported on observed dietary preferences for any species within this unique genus, and it has long been presumed that the diet consists of small invertebrate species. This is the first record of saurophagy for the genus *Brachymeles*.

While conducting fieldwork in the Philippines, we observed a male *Brachymeles boulengeri* (total length = 178 mm; 17.9 g) consume an adult *B. bonitae* head-first. Adult specimens of both species were collected on 7 May 2011, and placed in the same specimen bag during the return trip to base camp Malaboo, Mt. Makiling Forest Reserve, Barangay Bagong Silang, Municipality of Los Baños, Laguna Province, Luzon Island, Philippines (14.13356°N, 121.20447°E, datum: WGS84; elev. 665 m). Between the time of collection and arrival in camp, the individual of *B. boulengeri* consumed the individual of *B. bonitae*. An autotomized tail fragment of the *B. bonitae* specimen was not consumed, and was preserved in 95% EtOH as a tissue voucher. Examination of the stomach contents of the *B. boulengeri* specimen confirmed the ingestion of the smaller species *B. bonitae* (Fig. 1). The *B. boulengeri* specimen, with intact stomach content, and the tail sample of the consumed individual of *B. bonitae*, were preserved and deposited at the Biodiversity Institute, University of Kansas (CDS 5626: *Brachymeles boulengeri*; CDS 5612 [Genetic Sample]: *Brachymeles bonitae*).



FIG. 1. An adult *Brachymeles boulengeri* (above) with dissected stomach contents showing an ingested adult *Brachymeles bonitae* (below) on Mt. Makiling, Luzon Island, Philippines.

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***CERCOSAURA SCHREIBERSII*. DIET.** *Cercosaura schreibersii* is a gymnophthalmid lizard with wide geographical distribution in South America that occurs in southeastern Peru, Bolivia, Paraguay, Argentina, Uruguay and southern Brazil (Lema 1994. Comun. Mus. Ciênc. PUCRS, Sér. Zool. 7:41–150). Information concerning the biology of the species is scarce and here we present basic information on diet of this lizard. Data were obtained from analysis of 28 adult individuals of *C. schreibersii* (10 males and 18 females; mean SVL 358 mm ± 32 mm) collected in coastal sand dune environments in Rio Grande, Rio Grande do Sul (32.1654°S, 52.1523°W, sea level), southern Brazil. The contents from stomachs and intestines were analyzed and each prey item was identified to order under a stereomicroscope. The results are presented in Table 1. Aranae were a predominant item in the diet, present in 67.9% of lizard contents and representing 46.3% of total items consumed. The second most important prey were Isopoda, present in 17.9% of lizards and representing 12.2% of the items consumed. Only 10.7% of lizards had no contents in the digestive tract. Our data support preliminary assessments concerning dietary specialization in *C. schreibersii* (Achaval 1984. Bol. Soc. Zool. Uruguay Seg. Epoc. 2:59–62). The consumption of spiders is known for some species of lizards but not as a predominant dietary item (e.g., *Anolis*, *Tropidurus*, and *Ophiodes*; Ávila-Pires 1995. Zool. Verh. Leiden. 1995:3–706; Vitt

TABLE 1. Prey items present in the digestive tracts of 28 adult individuals of *Cercosaura schreibersii* captured in sand dune habitats of southern Brazil.

Items	Frequency of occurrence (%)	% of total registered items
Arachnida		
Acari	3.6	2.4
Aranae	67.9	46.3
Scorpiones	3.6	2.4
Crustacea		
Isopoda	17.9	12.2
Unidentified	3.6	2.4
Insecta		
Coleoptera	10.7	7.3
Diptera	7.1	4.9
Hemiptera	3.6	2.4
Heteroptera	3.6	2.4
Hymenoptera	3.6	2.4
Homoptera	3.6	2.4
Larvae	7.1	4.9
Orthoptera	3.6	2.4
Trichoptera	3.6	2.4
Unidentified	3.6	2.4
Empty	10.7	—
Unidentified	14.3	—

and Caldwell 1993. J. Herpetol. 27:46–52). Dietary specialization suggests particular adaptation processes highlighting its potential for studying the evolution of foraging habits on lizards. The *C. schreibersii* vouchers (RGRM: 05, 06, 16, 17, 19–37, and 40–45) were deposited in the Coleção Herpetológica Laboratório de Ecologia de Vertebrados Terrestres of Instituto de Ciencias Biológicas, Universidade Federal do Rio Grande. We thank CNPq and Fapergs for financial support and ICMBio by collecting permits.

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***CROTAPHYTUS BICINCTORES* (Mojave Black-collared Lizard). ENDOPARASITES.** *Crotaphytus bicinctores* occurs in xeric rocky habitats in southeastern and northeastern California, parts of Arizona, Oregon, Idaho, Utah, and much of Nevada (McGuire 1996. Bull. Carnegie Mus. Nat. Hist. 32:1–143.). To our knowledge, there are no reports of helminths for this species. The purpose of this note is to establish the initial helminth list for *C. bicinctores*.

One nematode was found in the body cavity of one female *C. bicinctores* (SVL = 88 mm) collected October 1962 at Pisagh Crater, San Bernardino Co., California, USA (34.746378°N, 116.37557°W, WGS84; elev. 753 m) and deposited in the herpetology collection of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California, USA as LACM 21651. The nematode was cleared in a drop of glycerol on a glass slide, cover-slipped, and identified as an adult female *Thubunaea iguanae*. It was deposited in the United States National Parasite Collection, Beltsville, Maryland as USNPC 104864.

Thubunaea iguanae is a common stomach parasite of lizards from the southwestern United States and Mexico (McAllister et al. 2008. Comp. Parasitol. 75:241–254) and has been found in the congeners *C. collaris* (McAllister et al., *op. cit.*) and *C. vestigium* (Goldberg and Bursey 2010. Herpetol. Rev. 41:353). It also occurs in colubrid snakes (Goldberg and Bursey 2001. Bull. So. California Acad. Sci. 100:109–116). It is in the family Physalopteridae, species of which utilize insect intermediate hosts (Anderson 2000. Nematode Parasites of Vertebrates. Their Development and Transmission, 2nd ed. CABI Publishing, Oxfordshire, UK. 650 pp.). *Crotaphytus bicinctores* is a new host record for *Thubunaea iguanae*.

We thank Christine Thacker (LACM) for permission to examine *C. bicinctores*.

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***CTENOSAURA SIMILIS* (Gray's Spiny-tailed Iguana) and *IGUANA IGUANA* (Green Iguana). CARRION FEEDING.** Adult *Ctenosaura similis* and *Iguana iguana* are primarily herbivorous (Hirth 1963. Ecology 44:613–615; Krysko et al. 2008. Florida Sci. 72:48–58; Montanucci 1968. Herpetologica 24:305–315; Rand et al. 1990. J. Herpetol. 24:211–214). However, *C. similis* will opportunistically prey upon small vertebrates (summarized by Krysko et al., *op. cit.*), and an adult female ate a piece of meat from a discarded roast beef sandwich (Meshaka et al. 2004. The Exotic Amphibians and Reptiles of Florida. Krieger Publ. Co., Malabar, Florida. 155 pp.). In Panama, *Iguana iguana* purportedly will eat



FIG 1. An adult female *Iguana iguana* (foreground) and adult male *Ctenosaura similis* (background) feeding on the carcass of an *Odocoileus virginianus clavium* along with *Cathartes aura* on Big Pine Key, Monroe Co., Florida, USA.

human excrement (Swanson 1950. Herpetologica 6:187–193), and two adults were observed feeding upon the carcass of a putrefying opossum (probably *Didelphis marsupialis*) along with two Turkey Vultures (*Cathartes aura*) (Loftin and Tyson 1965. Copeia 1965:515).

In pine rockland habitat on Big Pine Key, Monroe Co., Florida, USA, a Wildgame© passive infrared camera was positioned near carcasses of three Key Deer (*Odocoileus virginianus clavium*) from 16–20 May 2011. As many as three iguanas were caught in a single image, and at least four different iguanas were recorded. The camera was set to 30-sec intervals and recorded 59 images of *I. iguana* and 20 images of *C. similis* between 0928 h and 1738 h. The longest feeding period recorded was >5 min (N = 2), and the shortest was <30 sec. *Cathartes aura*, *C. similis*, and *I. iguana* were recorded feeding together in multiple images (Fig. 1). Some images seemed to indicate that a large male *C. similis* was able to take possession of the carcass from *C. aura* for short periods. Biologists have noted high numbers of *I. iguana* at the deer carcass disposal site since at least 2009 but had not previously witnessed carrion feeding.

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***DIPSOSAURUS CATALINENSIS* (Santa Catalina Island Desert Iguana). PREDATION.** Little information has been reported about the natural history of Santa Catalina Island Desert Iguana (Grismer 2002. Amphibians and Reptiles of Baja California, Including its Pacific Islands and the Islands in the Sea of Cortes. University of California Press, Berkeley and Los Angeles. 399 pp.). The rattlesnake *Crotalus catalinensis* has been reported as a predator of *D. catalinensis* (Avila-Villegas et al. 2007. Copeia 2007[1]:80–84), but to date, reports of avian predation have not been documented for this species. We report here evidence of bird predation on *Dipsosaurus catalinensis* by the Loggerhead Shrike (*Lanius ludovicianus*), which preys on a wide variety of vertebrates including reptiles (mainly lizards) (Lefranc 1997. Shrikes: A Guide to the Shrikes of the World. Yale University Press, New Haven and London. 192 pp.).

On 3 April 2011 at 1450 h, we saw a shrike fly past us with a lizard in its bill. It perched on an Adam's Tree (*Fouquieria diguetii*) at 1.55 m off the ground, on Santa Catalina Island, Gulf of California, Mexico (25.60536944°N, 110.7747917°W, datum WGS 84; elev. 13 m). As the bird settled, it pierced the iguana's dorsal skin with a thorn, leaving it hanging on the branch and still alive. As we approached, the shrike moved to another branch and then flew away. We removed the iguana and measured it after taking some photographs. The juvenile *D. catalinensis* measured 87 mm SVL and weighed 13 g. After the measurement the iguana was returned to the same branch as first positioned by the shrike. After we moved away several minutes later, the shrike came back and took the iguana elsewhere to continue consumption.

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GEKKO MONARCHUS **(Warty House Gecko). BIFURCATION.** *Gekko monarchus* is a large house gecko from Southeast Asia found primarily in southern Thailand, the Philippines, the Malay Peninsula, Borneo, Java, Sumatra, and Indonesia. It occupies forest edges as well as human habitations and has been known to nest communally, with over 50 eggs discovered in a single area (Das 2010. A Field Guide to the Reptiles of South-east Asia. New Holland Publishers, London. 376 pp.). Near an electric light on 1 August 2011 at 2330 h, we observed a small (~60 cm SVL) individual *G. monarchus* with a bifid tail on an interior support beam of a wooden longhouse structure near Batang Ai National Park in Sarawak, Borneo (1.159064°N, 111.925263°E). The tail was bifurcated for roughly 2 cm at the posterior end, with one tail tip roughly 0.5 cm longer than the other. Although we observed neither predation nor intraspecific agonistic interactions, many of the other individuals found on this and nearby structures were missing limbs or had regenerated or damaged tails.

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HELODERMA SUSPECTUM **(Gila Monster). INJURY FROM NON-NATIVE SEED.** The deserts of the southwestern U.S. have been invaded by a multitude of non-native species of grasses and noxious weeds. Their establishment has had significant ecological effects on the landscape, including increased fire regime, competition with native flora for water and growing space, as well as injurious effects on wildlife. Among these invasive species, Red Brome (*Bromus madritensis* ssp. *rubens*) has established itself throughout much of the Sonoran Desert. In Arizona, Red Brome typically occurs in soils of low to mid-elevation regions (300–2843 m) in arid and semi-arid desert scrub. It has several modes of seed dispersal, including wind, caching by ants and rodents, and attaching to mobile organisms with the sharp, pointed florets that develop when it senesces (Esque and Schwalbe 2002. *In* B. Tellman [ed.], Invasive Exotic Species in the Sonoran Region, pp. 165–194. University of Arizona Press, Tucson, Arizona). The latter trait has been known to injure herbivorous animals that feed on it and predatory animals that forage in stands of it (McCrary and Bloom 1984. J. Wildl. Manag. 48:1005–1008; Medica and Eckert 2007. Herpetol. Rev. 38:446–448). Here I present an observation of Red Brome having attached to a Gila Monster (*Heloderma suspectum suspectum*) in central Arizona, with obvious deleterious effects.

On 22 April 2011, at 1825 h, I (and another observer) encountered an adult *H. suspectum* as it walked in the open on a public trail in a canyon adjacent to Roosevelt Lake in Gila Co., Arizona, USA (33.69575°N, 111.18861°W, WGS 84). The trail was at the north end of the canyon at the base of an east-facing slope. Associated vegetation included Brittlebush (*Encelia farinosa*), Ocotillo (*Fouquieria splendens*), Jojoba (*Simmondsia chinensis*), Flat-top Buckwheat (*Eriogonum fasciculation*), palo verde (*Parkinsonia* sp.), Saguaro Cactus (*Cereus giganteus*), and Red Brome. As I approached the animal it became alert and assumed a defensive position. I observed a grass seed caught in the left eye, and upon capturing the animal for further examination, found that the grass seed was Red Brome. The sharp end of the floret was wedged in the anterior portion of the left eye and had caused severe inflammation, fluid drainage in the form of pus, and the eye partially swelling closed. I proceeded to remove the seed from its eye and released the lizard, after which it quickly retreated under a nearby Jojoba plant.

This incident demonstrates the potential injurious effects of Red Brome on native reptiles. Whether injury caused by Red Brome is a common occurrence in *H. suspectum* is unknown. However, similar instances have been documented in other large desert reptiles such as the (Mojave) Desert Tortoise (Medica and Eckert, *op. cit.*).

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HELODERMA SUSPECTUM **(Gila Monster). DIET.** *Heloderma suspectum* is a predatory lizard of the southwestern U.S. and adjacent northwestern Mexico that specializes in raiding the nests of lagomorphs, rodents, and ground-dwelling birds (reviewed by Beck 2005. Biology of Gila Monsters and Beaded Lizards. Univ. California Press, Los Angeles and Berkeley. 224 pp.). Though other reptiles have been recorded as prey items (Ortenburger and Ortenburger 1926. Proc. Oklahoma Acad. Sci. 6:101–121), predation on non-egg life stages is a somewhat uncommon occurrence in the literature. Additionally, hatchling birds and adult rodents are rarely seen in the dietary spectra of *H. suspectum* (Beck, *op. cit.*).

From 2004 to 2008 we conducted radio-telemetry on sympatric *H. suspectum, Crotalus cerberus, C. atrox,* and *C. molossus* at Tonto National Monument, Gila Co., Arizona, USA. The site is characterized by steep rocky slopes, bajadas, and dry washes with upland Sonoran desertscrub, with elevations ranging from 695–1230 m. We documented prey use through blunt dissection of scats opportunistically collected when an animal defecated (Quick et al. 2005. J. Herpetol. 39:304–307), as well as regurgitated meals.

Prey use was documented for three *H. suspectum* (two adults, one subadult) by scat analysis. Two scats were collected from two of the adults (one male, one female, both telemetered) and one scat was collected from the subadult (female, not telemetered). One occasion when the subadult female was recaptured,

hairs were removed from her mouth and saved for analysis. Scat dissection/hair analysis revealed five types of prey consumed by the three individuals. The adult male had consumed *Peromyscus eremicus* (Cactus Mouse) and *Callipepla gambellii* (egg fragments and feathers); the adult female consumed *Sylvilagus audubonii* (Desert Cottontail) and an *Aspidoscelis* sp. (whiptail lizard); and the subadult female consumed *Eutamias dorsalis* (Cliff Chipmunk) (represented at separate times by both scat and the hairs in her mouth). In addition to the scat observations, two other feeding observations were made. The subadult female was observed feeding on cottontail pups in a burrow (number unknown) and a third adult (male, telemetered) regurgitated two cottontail pups during surgery while in captivity.

Because *H. suspectum* may consume several individual prey items in a single meal, especially when raiding nests, the number of individual prey items taken in a particular, single feeding event is unknown. Based on size and length of the chipmunk hairs analyzed, they were presumed to be adult hairs; however, because hairs were often damaged after gut passage, ontogenetic characteristics of some hairs may have been distorted. Given the typical nest raiding habits of this predator, the presence of adult mammal hair and feathers in the *H. suspectum* scats may be parental hairs and feathers associated with neonates in the nest. The presence of the *Aspidoscelis* sp. in the scat is unusual but has been previously documented once before (Ortenburger and Ortenburger, *op. cit.*). Based on previous inventories conducted at the Monument, the possible species of *Aspidoscelis* at the site are *A. tigris* (Tiger Whiptail), *A. sonorae* (Sonora Spotted Whiptail), and *A. flagellicauda* (Gila Spotted Whiptail; Albrecht et al. 2007. Vascular Plant and Vertebrate Inventory of Tonto National Monument. OFR 2007-1295. USGS, Southwest Biological Science Center, Sonoran Desert Research Station, Univ. Ariz., Tucson). A possibility for this prey item is opportunistic predation of a whiptail lizard cornered in a burrow (perhaps while it was sleeping) or the *Heloderma* scavenging a dead whiptail lizard.

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***HEMIDACTYLUS FRENATUS* (House Gecko). PREDATION.** On 28 April 2011 at 2015 h, we observed a Great-tailed Grackle (*Quiscalus mexicanus*) feeding on an adult *Hemidactylus frenatus* on the edge of a window of a house in Sanchez Magallanes, Tabasco, México (18.2888694°N, 93.8716167°W). The next day we made a second observation of a *Q. mexicanus* feeding on another *H. frenatus* at the same location at 0745 h.

This interaction is notable, given that *H. frenatus* is an invasive species native to Asia and the Indo-Pacific that has displaced native species in some regions (Case et al. 1999. Ecology 72:464–477; Cole et al. 2005. Biol. Conserv. 125:467–474). In México, this gecko typically inhabits tropical and subtropical regions, usually associated with urban areas. Knowledge regarding ecological interactions between *H. frenatus* and other species in this region is poor (Álvarez-Romero et al. 2005. *In* Vertebrados Superiores Exóticos en México: Diversidad, Distribución y Efectos Potenciales, pp. 1–5. Instituto de Ecología, Universidad Nacional Autónoma de México. Bases de datos SNIB-CONABIO. Proyecto U020. México. D.F.). This report contributes to the knowledge of ecological interactions of this invasive species and also serves as the first report of predation on *H. frenatus* by *Q. mexicanus*, an opportunistic feeder that is known to prey on lizards (Gurrola-Hidalgo et al. 2009. Acta Zool. Mex. [n.s.] 25:427–430).

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***HEMIDACTYLUS MABOUIA* (Tropical House Gecko). PREDATION.** This non-native lizard is broadly distributed throughout Brazil, occupying natural habitats despite commonly being associated with human settlements. Although relatively abundant in most regions, there is a considerable lack of information regarding its interactions with sympatric native species (Rocha and Anjos 2007. Braz. J. Biol. 67:485–491). Here we report predation on *Hemidactylus mabouia* (SVL = 133.9 mm) by a spider of the family Ctenidae (SVL = 20 mm).

At 1126 h on 20 October 2010, in the Museu de Biologia Mello Leitão, Santa Teresa municipality, Espírito Santo state, southeastern Brazil (19.5609°S, 40.3559°W; elev. 655 m), one of us (FAL) observed a ctenid spider on the wall of the Zoological Collection attached to and feeding on an adult of *H. mabouia*. The lizard was no longer alive. After minutes of observing the predation, FAL collected both specimens and transferred them to a small plastic container, where the spider remained attached to the lizards for two days.

Generally due to predation, non-native species have been considered the second most influential factor threatening biodiversity (McNeely et al. 2001. A Global Strategy on Invasive Alien Species. IUCN Gland. Switzerland and Cambridge UK. 50 pp.). This report adds to the literature that non-native species also play a role as prey for native species.



FIG. 1. Ctenid spider feeding on a *Hemidactylus mabouia*, in Santa Teresa, Espírito Santo, southeastern Brazil.

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***IGUANA DELICATISSIMA* (Lesser Antillean Iguana). ECTOPARASITISM.** *Iguana delicatissima* is a large, long-lived (up to 25 yrs) herbivorous generalist inhabiting less than 10 main islands in the Lesser Antilles from Anguilla to Martinique. *Iguana delicatissima* is primarily arboreal except on extreme xeric islands with limited tree diversity. Its historic range has been reduced dramatically because of habitat loss, non-native predators and competitors, hunting, road mortality, and genetic introgression with *I. iguana*. Consequently, *I. delicatissima* is listed as Endangered by the IUCN – the World Conservation Union (IUCN 2010. IUCN Red List of Threatened Species. Version 2010.4. <www.iucnredlist.org>. 13 June 2011).

Here we provide the first report of parasitism on *I. delicatissima* by the scale mite, *Hirstiella stamii* (Acariformes: Pterygosomatidae). To our knowledge, this is only the second ectoparasite (Kohls 1969. J. Med. Entomol. 6:439–442) reported for the species. From April to September 2009, and from April to June 2010, we captured and recorded body measurements from 906 subadult and adult *I. delicatissima* inhabiting the island of Dominica, West Indies. We also documented the presence of white, scale-like patches on the heads and dewlaps of 170 (18.8%) iguanas. Parasitized iguanas ranged in SVL from 16.3–36.3 cm (mean = 27.4, SD = 4.1), and body mass from 150–2050 g (mean = 928.3, SD = 347.5). Patches ranged in diameter from 2–10 mm and were located typically on the subocular, postocular, temporal, nasal, and/or canthal scales (Fig. 1). Patches also were located dorsally on the head in the region of the frontal, parietal, and/or interparietal scales. In five occurrences, patches were recorded on the dewlap. Voucher mite specimens are housed at the Museum of Biological Diversity, The Ohio State University with accession numbers OSAL0102567–70 (females), OSAL0102571 (male), and OSAL0102572–74 (larvae).

This is the first report of *I. delicatissima* parasitized by *H. stamii*. The mite was recorded previously from captive *I. iguana* at the Amsterdam Zoological Gardens in the Netherlands (Jack 1961. Ann. Mag. Nat. Hist. 13:305–314) and from non-native, wild-caught *I. iguana* in Florida, United States (Corn et al. 2011. J. Med. Entomol. 48:94–100).

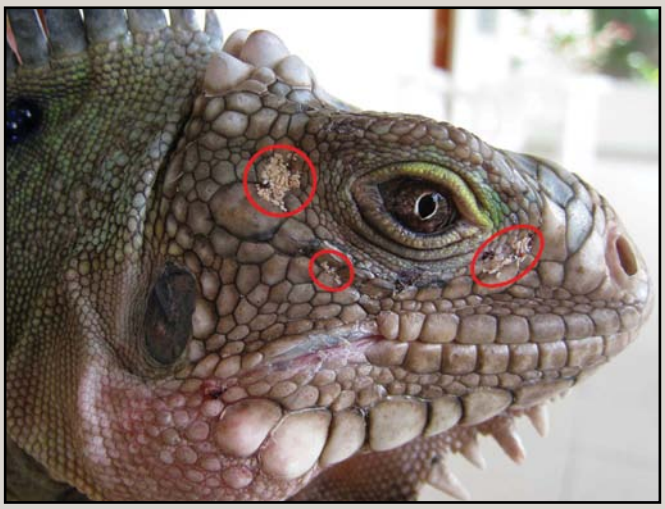


FIG. 1. Example of site attachment by the scale mite, *Hirstiella stamii*, on the head of *Iguana delicatissima* inhabiting the island of Dominica, West Indies. Patches circled in red.

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***IGUANA IGUANA* (Green Iguana). PREDATION.** Double-toothed Kites (*Harpagus bidentatus*) are known to eat lizards, including juvenile *Iguana iguana* (Greene et al. 1978. J. Herpetol. 12:169–176). Double-Toothed Kites often forage by following monkeys (Egler 1991. Wilson Bull. 103:510–512; Fontaine 1980. Auk 97:94–98), capturing prey that the monkeys have flushed out of the brush by their movements. We did not find any reports of these kites taking prey directly from primates.

On 13 June 2011 at 1110 h, we captured two hatchling iguanas on the south edge of Bohio Reach, Panama Canal, Barro Colorado Natural Monument, Panamá (9.191111°N, 79.846111°W). Hatchlings were <0.25 m off the ground and 0.5 m apart in a patch of Canal Grass (*Saccharum spontaneum*) ca. 0.5 m from the water's edge. Each of us held one hatchling as we processed them in our boat (ca. 3 m from site of capture). During processing, we observed a Double-toothed Kite swoop from a tree ca. 4 m from us, appearing to watch our activity. The kite was initially perched ca. 6 m in a tree and swooped to a branch 2 m off the ground, loudly rustling the leaves. Upon attempting to release the first iguana (72 mm SVL, 11.4 g) onto a rock 3 m from the grass, it ran back into the lap of BAW. Thereafter, BAW walked the iguana to the grass to release it, during which time the kite flew toward his hand, hitting his hand with its wing, and directly snatching the iguana with its talons in a quick motion. The kite flew into nearby trees and out of sight with the iguana in its talons.

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***LANKASCINCUS FALLAX* (Peters' Litter Skink). REPRODUCTION.** *Lankascincus fallax* is a subfossorial skink endemic to Sri Lanka (Somaweera and Somaweera 2009. Lizards of Sri Lanka, A Colour Guide with Field Keys. Edition Chimaira, Frankfurt am Main. 303 pp.). The purpose of this note is to present information on the reproductive biology of *L. fallax*.

Thirty-one *L. fallax* (15 males, mean SVL = 39.3 mm ± 2.2 SD, range = 36–45 mm; 16 females, mean SVL = 39.1 mm ± 2.4 SD,

range = 35–43 mm) were examined from the following localities: Central Province (7.2631°N, 80.6028°E), CCA (= Christopher C. Austin, field number) 1745, 2361, 2362, 2368, 2383, 2407–2411, 2413, 2416–2418, 2422–2424, 2448, 2453; North Central Province (8.3500°N, 80.3833°E), CCA 2375–2377, 2386, 2387, 2391, 2392; North Western Province (7.7500°N, 80.1667°E), CCA 2425, 2426; Sabaragamuwa Province (6.7500°N, 80.5000°E), CCA 2445; Southern Province (7.9500°N, 80.7500°E), CCA 2452; Western Province (7.1807°N, 79.8841°E), CCA 2359. *Lankascincus fallax* were collected in August 1999 and November 2002 and were deposited in the herpetology collection of the National Museum of Sri Lanka, Colombo, Sri Lanka.

For histological examination, the left gonad was removed to check for yolk deposition in females and spermiogenesis (sperm formation) in males. Counts were made of enlarged ovarian follicles (3 mm diameter) or oviductal eggs. Tissues were embedded in paraffin, sectioned at 5 µm using a rotary microtome and stained with hematoxylin followed by eosin counterstain.

All males of *L. fallax* were from November and were undergoing spermiogenesis. The smallest spermiogenic male measured 36 mm SVL (CCA 2413). Fifteen females of *L. fallax* were from November, one was from August. All were reproductively active, with 13 containing oviductal eggs and two containing enlarged follicles (> 4 mm). Mean clutch size for fifteen females was 1.8 ± 0.44, range: 1–2. Three females with two oviductal eggs, each (CCA 2383, 2387, 2391) were undergoing concomitant yolk deposition for a subsequent clutch indicating *L. fallax* produces multiple clutches annually. The smallest reproductively active female *L. fallax* measured 35 mm SVL (two oviductal eggs, CCA 2453).

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***LEPIDODACTYLUS LUGUBRIS* (Mourning Gecko). FORAGING MOVEMENT.** *Lepidodactylus lugubris* is a small (45 mm) gecko native to Indo-Australia. The species has been widely introduced in tropical areas throughout the world, including the Bocas del Toro islands of the Republic of Panama. This species is predominantly a nocturnal insectivore. However, individuals are known to supplement their diet with nectar and ripe fruit, and have been observed to forego insects when feeding on nectar (Perry and Ritter 1999. Herpetol. Rev. 30:166–167). They have also been documented to change their typical behavior to gain access to sugar sources (McCoid and Hensley 1993. Herpetol. Rev. 22:8–9). Thus, sugar and nectar may serve as a behaviorally influential dietary resource for this species.

A small population of *L. lugubris* located on Isla Coln at the Bocas Del Toro Biological Station in the Republic of Panama was noted to undergo mass concerted movements at dusk from their daytime retreat within a building to a nearby *Morinda citrifolia* tree. Within the tree, individuals were observed consuming excretions from the pores of the fruit, as well as nectar from the flowers. After initial observation, I removed all vegetation in contact with the building that was originating from, or in the vicinity of, the *M. citrifolia* tree. In place of the vegetation, I constructed a series of four rope bridges (diameter: 3.2 mm) that served to ensure access to the tree was limited to crossing the rope bridge. One rope bridge connected a building beam to the shortened *M. citrifolia* branch at their previous point of tree entry. The other three bridges were connected to nearby vegetation lacking fruit or flowers to ensure movement was non-random. The same building beam was connected to a mango tree (*Mangifera indica*) and to two independent, unidentified woody shrubs. After the first two nights it became apparent that geckos were only using the bridge connected to *M. citrifolia*, so additional bridges were not monitored on subsequent nights. Due to the diameter of the rope, individuals were only able to cross single-file, simplifying quantification. I recorded their movements across the *M. citrifolia* rope bridge at dusk for six days from the period of 30 June to 7 July 2005 (1830–2030 h) and from 0530–0630 h on 8 July 2005. Crossing individuals were marked on their back with a water-based, non-toxic permanent paint marker, similar to DECOCOLOR® paint markers. The number of marked and unmarked individuals was recorded each night.

The majority of movement occurred during or immediately after dusk. Movements after that period were less frequent and greatly interspersed. Over a standardized period of two hours following dusk, a mean of 39 (range: 35–54) geckos were observed to cross to the *M. citrifolia* each night. With the exception of the first night when all individuals were new to the altered pathway, approximately half of the individuals recorded crossing each night were unmarked. This suggests that individuals readily adapt behavior to gain access to foraging resources, and do not forage in the tree every night. On the morning of 8 July 2005, 69 individuals returned. I also observed marked individuals up to 12.49 m straight line distance from the crossing point, feeding under building lights in concert with *Hemidactylus frenatus* (House Gecko; native to southeastern Asia, widely introduced elsewhere). No *H. frenatus* individuals were observed to cross into the *M. citrifolia* tree.

The distance I observed marked individuals from the *M. citrifolia* crossing point suggests geckos were willing to move over a considerable distance of open space to gain access to nectar, and that nectar is an important food source for this population. Petren and Case (1998. Proc. Natl. Acad. Sci. 95:11739–11744) found that increasing topographic complexity of foraging areas drastically reduced competition between *L. lugubris* and *H. frenatus*. The presence of *H. frenatus* at the structurally simple insect feeding stations used by *L. lugubris* and their absence at the structurally complex *M. citrifolia* may indicate the observed phenomenon is one strategy used by *L. lugubris* to reduce interspecific competitive interactions.

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***LIOLAEMUS ESPINOZAI*. PREDATION.** *Liolaemus espinozai* has only been recently described and little is known about its natural history. It is found southeast of the Nevados del Aconquija in Catamarca province, Argentina, 2200–2800 m elev. (Abdala 2005.



FIG. 1. *Philodryas psammophidea* seizing a *Liolaemus espinozai* just below the neck.

Rev. Esp. Herpetol. 19:5–17). It is a medium-sized lizard (approx. 60 mm SVL). The colubrid *Philodryas psammophidea* occurs within the distribution of *L. espinozai* and is known to feed on lizards (Scrocchi et al. 2006. Serpientes del Noroeste Argentino. Miscelanea, Fundación Miguel Lillo. 174 pp.). Here we report on an occurrence of predation by this snake on *L. espinozai.*

On 18 February 2005, at ca. 1700 h, in Campo el Arenal, Catamarca (27.21°S, 66.23°W, datum WGS84; 2858 m elev.), an adult female *L. espinozai* was seen moving towards a shrub, perhaps responding to the presence of the observers. A *Philodryas psammophidea* happened to be in the aforementioned shrub. It immediately attacked the lizard, grasping it by the side of the body (Fig. 1). The lizard bit the snake on the side of its neck, a defensive response that might sometimes be effective as an antipredator mechanism (e.g., Leal and Rodríguez-Robles 1995. Copeia 1995:155–161). The snake slightly constricted the lizard, a technique many colubrids use to overcome larger prey (Zug 1993. Herpetology: An Introductory Biology of Amphibians and Reptiles. Academic Press, San Diego, California. 527 pp.). Later the snake located the lizard's head and ingested it headfirst.

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***MESALINA GUTTULATA* (Desert Lacerta). ENDOPARASITES.** *Mesalina guttulata* occurs in North Africa from Western Sahara to Egypt, Sinai, Israel, Jordan, Syria, Iraq, Saudi Arabia, W Yemen, Niger, and Eritrea (Sindaco and Jeremcenko 2008. The Reptiles of the Western Palearctic. Monografie della Societas Herpetologica Italica – I, Latina, Italy. 579 pp.). To our knowledge there are no records of helminths from *M. guttulata* and this note's purpose is to establish the initial helminth list for *M. guttulata.*

A sample of 78 *M. guttulata* (mean SVL = 42.9 mm ± 5.2 SD, range = 30–54 mm) collected 1949 to 2007 from Israel was borrowed from the Natural History Collections, Tel-Aviv University, (TAUM) Tel-Aviv, Israel for coelomic helminth examination. The body cavity was opened and examined for helminths. Four *M. guttulata* (TAUM 2979, 4004, 8468, 13172) collected in the Southern District, Israel, contained macroscopically visible, oblong, whitish bodies, of ca. 1 mm in length. They were regressively stained in hematoxylin, cleared in xylol, mounted in balsam on a glass slide, coverslipped, examined under a compound microscope and identified as larval cestodes, tetrathyridea of *Mesocestoides* sp. Prevalence (number infected/number examined × 100) was 5.1%. Mean intensity (mean number helminths per infected lizard ± 1 SD) was 32.8 ± 19.1 SD, range = 10–56. Vouchers were deposited in the United States National Parasite Museum (USNPC), Beltsville, Maryland as USNPC (104866, 104867).

Mesocestoides is a cosmopolitan genus with a unique larval form, the tetrathyridium; reptiles are common intermediate hosts in what is thought to be a three-host life cycle (Padgett and Boyce 2005. J. Helminthol. 79:67–73). A list of amphibian and reptile hosts for *Mesocestoides* spp. is in Goldberg et al. (2004. Comp. Parasitol. 71:49–60). *Mesalina guttulata* represents a new host record for tetrathyridea of *Mesocestoides* sp.

We thank Shai Meiri (TAUM*)* for permission to examine *M. guttulata* and Erez Maza (TAUM) for processing the loan.

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***PHELSUMA GRANDIS* (Madagascar Day Gecko). PREY.** *Phelsuma grandis* is native to northern Madagascar (Henkel and Schmidt 2000. Amphibians and Reptiles of Madagascar and the Mascarene, Seychelles, and the Comoro Islands. Krieger Publ. Co., Malabar, Florida. 319 pp.), and has been introduced to at least nine islands in the Florida Keys (Krysko and Hooper 2007. Gekko 5:33–38; Krysko and Sheehy 2005. Carib. J. Sci.



FIG. 1. Nonindigenous *Phelsuma grandis* preying upon a nonindigenous Bark Anole (*Anolis distichus*) on Ramrod Key, Monroe County, Florida.

41:169–172). *Phelsuma grandis* is known to consume mostly nectar, pollen, and arthropods (Demeter 1976. Internat. Zoo Yearbk. 16:130–133; Krysko and Hooper, *op. cit.*; Tytle 1992. Vivarium 2:15–19), but has also been documented consuming lizards such as neonate *P. grandis* (Krysko et al. 2003. Florida Sci. 66:222–225). In this note, we report *P. grandis* preying upon a nonindigenous Bark Anole (*Anolis distichus*) in Florida.

On 5 July 2011 at 1930 h, we observed an adult female *Phelsuma grandis* near the junction of West Indies Drive and Cayman Lane, Ramrod Key, Monroe Co., Florida, USA (24.65154°N, 81.40447°W, WGS84; elev. <1 m). This gecko was about 1.8 m above ground on a nonindigenous Umbrella Tree (*Schefflera actinophylla*) and had an adult female *Anolis distichus* in its mouth. We quickly took photographs with an 8 MP camera phone (Florida Museum of Natural History, photographic voucher UF 165521; Fig. 1), but after returning about 3 min later with other photographic equipment both lizards were gone. This is the first known record of this nonindigenous gecko preying upon a nonindigenous anole in Florida.

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***PHOLIDOBOLUS MONTIUM* (Lagartija Minadora). PREDATION.** *Pholidobolus montium* is a gymnopthalmid lizard known from interandean basins and valleys in northern and central Ecuador (Provincias Imbabura, Pichincha, Cotopaxi) and southern Colombia at elevations between 2000–3190 m (Montanucci 1973. Misc. Publ. Univ. Kansas Mus. Nat. Hist. 59:1–52; Reeder 1996. Herpetologica 52:282–289). Here we provide the first report on natural predators of this species.

On 10 April 2009, FAV collected a subadult female *Liophis epinephelus albiventris* (SVL = 221.0 mm, TL = 64.0 mm; QCAZ 8044) in Ecuador, Pichincha Province, Tababela (0.11362°S, 78.36331°W, 2374 m elev.), which had recently eaten. A few minutes after capture, the snake regurgitated two prey items: a full specimen of *Pholidobolus montium* (SVL = 47.5 mm; QCAZ 10064) and a hindlimb of the marsupial frog *Gastrotheca riobambae*. On 16 May 2009 at 1100 h in Tababela (0.0986395°S, 78.36936°W, 2346 m elev.), FAV observed a predation event in which a juvenile male specimen of the snake *Mastigodryas pulchriceps* (SVL = 218.0 mm, TL = 80.0 mm; QCAZ 8045) was found ingesting a specimen of *P. montium* (QCAZ 8046, SVL = mm). First, the snake grasped the lizard with its mouth (Fig. 1). Then the snake ingested the lizard starting at the posterior region of the body. The same predatory behavior has been reported for *Mastigodryas melanolomus* (Dehling 2009. Herpetol. Rev. 40:357). This is the first record of predation of *Pholidobolus montium* by *L. e. albiventris* and *M. pulchriceps*. The snakes and the lizards are deposited in the herpetological Collection of Museo de Zoología QCAZ, Pontificia Universidad Católica del Ecuador.



FIG. 1. Predation of *Pholidobolus montium* by *Mastigodryas pulchriceps*.

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***PHRYNOSOMA MODESTUM* (Round-tailed Horned Lizard). PREDATION.** *Phrynosoma modestum* occurs from extreme southeastern Colorado and western Oklahoma to western Texas, southern New Mexico (USA), and then south through Chihuahua, Coahuila, Zacatecas, and San Luis Potosi (Mexico) (Espinal and Smith 2007. Amphibians and Reptiles of the State of Coahuila, Mexico. Universidad Nacional Autónoma de México and Comisión Nacional Para El Conocimiento y Uso de la Biodiversidad. 550 pp.; Hodges 2009. *In* Jones and Lovich [eds.], Lizards of the American Southwest, pp. 186–189. Rio Nuevo Publ., Tucson, Arizona; Sherbrooke 2003. Introduction to the Horned Lizards of North America. University of California Press, Berkeley, California. 178 pp.). Tarantulas of the genus *Aphonopelma* (consisting of approximately 87 species that inhabit North America) are documented predators. Along with other genera of the subfamily Theraphosinae, the majority of the species are found in North America. Fifty-one species have been reported for the United States and 24 or 25 for Mexico (Smith 1995. Tarantula Spiders: Tarantulas of the U.S.A. and Mexico. Fitzgerald Publ., London. 196 pp.). Predation on *P. modestum* has been documented by Sherbrooke (2003, *op. cit.*; 2010 Herpetol. Rev. 41:356) and Hodges (2009, *op. cit.*), who mention that the species is predated by collared lizards (*Crotaphytus* spp.), Greater Roadrunners (*Geococcyx californianus*), Loggerhead Shrikes (*Lanius ludovicianus*), and grasshopper mice (*Onychomys* spp.).

While conducting a survey on 22 July 2011 on the araneofauna of the Bolson of Cuatro Cienegas Region, Coahuila, Mexico,



FIG. 1. A female *Aphonopelma* sp. preying on a female *Phrynosoma modestum*, in the valley of Cuatro Cienegas, Coahuila, Mexico.

near El Mezquite (26.92268°N, 102.43409°W, datum NAD27; 1030 m elev.), we came across a female *Aphonopelma* sp. (55.20 mm TL, 19.64 mm median length of the carapace) at 1745 h that had immobilized a female *Phrynosoma modestum* (SVL = 84.44 mm; TL = 154.53 mm). As we approached the tarantula, after taking a series of photos, it released the horned lizard. Inspecting the lizard carefully, we found no sign of puncture holes on the head or any other part of the body, but it appeared that a great quantity of blood had come from the left eye. After measuring the lizard we released it *in situ*, and it appeared to move with some difficulty, perhaps from the trauma of the event. The tarantula was collected for future behavioral studies (CAFCB-UANL-T500). At present the species has not been identified. This event occurred about 40 cm from a burrow (ca. 11.5 cm diam), which it may have occupied.

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***PLESTIODON FASCIATUS* (Five-lined Skink). HIBERNATION.** Few published observations of hibernation or hibernacula are available for *Plestiodon fasciatus* (COSEWIC 2007. COSEWIC Assessment and Update Status Report on the Five-lined Skink *Eumeces fasciatus* (Carolinian Population and Great Lakes/St. Lawrence Population) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 50 pp. [www.sararegistry.gc.ca/status/status_e.cfm]). At ca. 1000 h on 7 March 2011 at Point Pelee National Park (41.93148°N, 82.51252°W; WGS 84) in Essex County, Ontario, Canada, a skink was unearthed by a backhoe 34 m ESE of the Visitor Centre in an open area of deciduous forest during an archaeological inspection before septic tank installation. The field crew present (G. Almasi, D. Dawdy, J. Goundry, M. Teal, D. Kipping, S. Hossain, and A. Miller) notified park resources staff. The lone adult male *P. fasciatus* (70 mm SVL, 150 mm TL) was found ca. 23 cm deep in loamy sand soil that was under ca. 10 cm of snow. Ground frost penetration was ca. 8–10 cm in the vicinity but soil appeared unfrozen at the spot where the skink was observed. No stumps, logs, or large roots were present but a cedar stump was about 2.4 m from the skink. There was no sign of obvious tunneling by the skink. Ambient conditions were sunny (temp: -5°C; wind: NE 7 km/h; RH: 79%). The specimen appeared in good condition but was torpid upon capture. Slight movements and partial eyelid opening occurred during handling and photographing the specimen and it remained lethargic for the first two days of holding indoors. The specimen became fully active after about 5 days and was maintained on a cricket diet until being released on 28 April in healthy condition after annual skink activity resumed. Skink hibernacula have not been observed in the park but in several previous years we observed single or small numbers of individuals on the first day of annual activity adjacent to skink-sized holes under woody debris in sandy soils within their home ranges. Similar observations were reported from Kansas (Fitch 1954. Univ. Kansas Publ. Mus. Nat. Hist. 8:1–156). Skinks have also entered the Visitor Centre building during previous winters. Some literature has noted Five-lined Skinks hibernating alone, in pairs, or with small groups of other lizards, in or under logs, stumps, sawdust or debris piles, ground litter, mammal burrows, building foundations, under rocks, or within rock crevices (Conant 1951. Am. Midl. Nat. 20:1–200; Fitch 1954, *op. cit.*; Hamilton 1948. Copeia 1948:211; Harding 1997. Amphibians and Reptiles of the Great Lakes Region. Univ. Michigan Press, p. 231; Linsdale 1927. Copeia 1927:75–81; Neill 1948. Herpetologica 4:107–114) but few details have been published. Tihen (1937. Trans. Kansas Acad. Sci. 40:401–409) reported two *P. fasciatus* hibernating 2.5 m underground in Kansas. Point Pelee is a natural sandspit in Lake Erie so skinks must overwinter below the frost line but above the shallow and fluctuating water table where late winter–early spring flood mortality has occurred in communal snake hibernacula (T. Linke, unpubl. park records). Our note adds to the existing literature and provides the first report of overwintering conditions for the endangered Carolinian population of *P. fasciatus* in southwestern Ontario and for the northern portion of its range.

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***PLESTIODON FASCIATUS* (Common Five-lined Skink). BIFURCATION.** *Plestiodon fasciatus* is the only lizard species in Michigan known to occur outside of Tuscola County, and is relatively abundant throughout the Lower Peninsula (Harding 1997. Amphibians and Reptiles of the Great Lakes Region. University of Michigan Press, Ann Arbor. 378 pp.). On 11 July 2011 at 1000 h we observed an adult with a bifurcated (bifid) tail under a pine log in Northern Midland County (43.68073°N, 84.29604°W). The tail was bifurcated somewhat vertically at the posterior end, and appeared to have been lost and regrown at least once prior to the splitting event. The dorsal fork was longer than the ventral fork. A non-lethal tissue sample with accession number FTB2749 was collected under a permit to ADM from the Michigan Department of Natural Resources and Environment and deposited in the Burbrink genetic resources collection at College of Staten Island, Staten Island, New York.

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***PLESTIODON LATICEPS* (Broad-headed Skink). HERBIVORY.** *Plestiodon laticeps* is a common and widespread North American skink that, like most members of its genus, is generally regarded as a strict carnivore (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn Univ. Agric. Exp. Sta., Auburn, Alabama. 347 pp.; Jensen et al. [eds.] 2008. Amphibians and Reptiles of Georgia. Univ. Georgia Press, Athens. 575 pp.). At 1400 h on 29 May 2011, I observed herbivory by a free-ranging adult male in a partially wooded section of my backyard, which is situated in a large-lot residential subdivision that supports a substantial skink population in Tallahassee, Leon Co., Florida, USA (30.48341°N, 84.18301°W; datum NAD83; elev. 40 m). Observations were made in light shade at an air temperature of 32°C. Five minutes after leaving a ripe strawberry and canned dog food in front of a

captive adult female Florida Box Turtle (*Terrapene bauri*: Butler et al. 2011. Biol. J. Linn. Soc. 102:889–901), I returned to see the skink grasping the strawberry, which was at least as large as his head, directly beneath the turtle's mouth. Upon observing me, he carried the berry 1 m to feed on it beneath an azalea bush on the opposite side of a chain link fence, where I observed him for 15 minutes. During feeding, he repeatedly jerked his head and upper body to remove bites of strawberry, which he swallowed. No animal life was present on the berry. When I moved to within 1 m, the skink carried the remaining berry 75 cm to another spot, where he finished swallowing it, including the top rosette of greenery.

Although many other skinks regularly include some plant food in their diets (Cooper and Vitt 2002. J. Zool., Lond. 257:487–517; Sazima et al. 2005. Biota Neotrop. 5:185–192), this may be only the second report of herbivory in the monophyletic clade of East Asian and North American skinks recognized as *Plestiodon* by Brandley et al. (2005. Syst. Biol. 54:373–390). Cooper and Vitt (*op. cit.*) mentioned that *P. laticeps* sometimes eats grapes and berries in the field but offered no supporting data. These observations are perhaps not surprising given the association of large body size with herbivory and omnivory in lizards (Cooper and Vitt, *ibid.*). *P. laticeps* is among the largest members of its clade. Thus, plant matter potentially may form a larger portion of its diet than traditionally realized. Whether it responds to plant chemicals, a trait generally typical of herbivorous but not insectivorous lizards (Cooper et al. 2000. J. Chem. Ecol. 26:1623–1634), would be especially noteworthy.

I am indebted to John Iverson for facilitating a literature review of lizard herbivory.

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***PODARCIS HISPANICA* (Iberian Wall Lizard). CAUDOPHAGY.** On 23 February 2011 at 1320 h, while conducting field sampling in a rocky area close to Nava de Francia (Salamanca, Spain), we observed a male *Podarcis hispanica* eating the tail from a conspecific. We immediately started to video record this behavior for the next 1 min. and 32 sec. The video shows that the tail was extending about 17 mm out of the mouth of the lizard, and that the individual was trying to swallow it by rubbing the tail against the surface of a granite rock. The lizard moved forward ca. 40 cm and performed repeated movements during the whole process, probably to help in swallowing the tail: 1) The lizard rubbed the left side of the head against the rock 17 times and the right side four times. Of the left-side movements, 13 of them had an associated head rotation that made them more abrupt and vigorous; 2) the lizard made what appeared to be swallowing motions (raising the snout and pulling the head back) 23 times; 3) the lizard moved the head up and down on 7 occasions and side-to-side for at least 3 times (see Hews and Dickhaut 1989. Herpetol. Rev. 20:71 for a description of a similar movement); 4) the lizard opened and closed the mouth at least 12 times. The individual continued to bask in open sun, alternating between the described behaviors and returning to its basking position five separate times. The lizard kept its snout in contact with the rock for at least 45 sec., rubbing it on the substrate, and even might have used its right forelimb at least twice to facilitate ingestion of the tail.

We captured the lizard (47 mm SVL; 2 g) at 1342 h and it had swallowed almost the entire tail, with only 7 mm protruding from the mouth, compared with more than 17 mm protrusion detected at the beginning of the process. The lizard had a non-regenerated tail that was 92 mm long. The tail consumed was 48 mm long, likely from an adult. The lizard was released to the field immediately after measurement.

The contents of several stomachs from mainland *Podarcis hispanica* have been analyzed (Pérez-Mellado 1983. Studia Oecologica 4:89–114; Pérez-Mellado 1998. Fauna Ibérica 10:258–272) and conspecific remains were absent. Hence, this is the first record of conspecific caudophagy by *Podarcis hispanica*.

We thank the Consejería de Medio Ambiente of Junta de Castilla y León for issuing a permit of scientific capture (permit number: EP/CYL/472/2010), with research funded by the project: CGL2009-12926-C02-02 from the Spanish Ministry of Science and Innovation. The first author (ZOD) was benefited by a predoctoral grant of the University of Salamanca. For those interested, the video recording may be obtained by contacting the lead author.

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***QUEDENFELDTIA TRACHYBLEPHARUS* (Atlas Day Gecko). ENDOPARASITES.** *Quedenfeldtia trachyblepharus* is known from the Atlas Mountains of Morocco where it inhabits rock faces and boulders from 0–4000 m (Schleich et al. 1996. Amphibians and Reptiles of North Africa. Koeltz Sci. Publ., Koenigstein, Germany. 630 pp.). To our knowledge there are no helminths known from *Q. trachyblepharus*. The purpose of this note is to establish the initial helminth list for *Q. trachyblepharus*.

A sample of 69 *Q. trachyblepharis* (mean SVL = 38.7 mm ± 3.5 SD, range = 31–46 mm) collected in May 1974 at Igrherm, Taroudant Province, Souss-Massa Draa Region, Morocco (30.06250°N, 8.40833°W, datum WGS 84; elev 1600–1700 m) was borrowed from the herpetology collection of the Field Museum of Natural History (FMNH) for coelomic helminth examination. The body cavity was opened and examined for helminths. Two *Q. trachyblepharus* (FMNH 197642, 197718) contained 22 and 49 macroscopically visible, oblong, whitish bodies ca. 1 mm in length. One (FMNH 197652) contained fragments of a cestode protruding from the broken small intestine. Helminths were regressively stained in hematoxylin, cleared in xylol, mounted on a glass slide, coverslipped, examined under a compound microscope and identified as larval cestodes, tetrathyridea of *Mesocestoides* sp. (FMNH 197642, 197718). Prevalence (number infected/number examined ×100) was 3.0%. Mean intensity (mean number helminths per infected lizard ± 1 SD) was 35.5 ± 19.1). Found in FMNH 197652 were proglottids of an adult cestode consistent with *Oochoristica*. Voucher helminth specimens were deposited in FMNH.

Mesocestoides is a cosmopolitan genus with a unique larval form, the tetrathyridium; reptiles are common intermediate hosts in what is thought to be a three-host life cycle (Padgett and Boyce 2005. J. Helminthol. 79:67–73). A list of amphibian and reptile hosts for *Mesocestoides* spp. is in Goldberg et al. (2004. Comp. Parasitol. 71:49–60). Regarding the *Oochoristica* sp., the scolex was not present so species identification was not possible but ovary morphology was most similar to *O. chabaudi* described from *Chalcides mionecton* from Morocco by Dolfuss (1954. Arch. Inst. Pasteur Maroc. 4:654–714.). *Quedenfeldtia trachyblepharus* represents a new host record for *Mesocestoides* sp. and has not been previously reported for a species of *Oochoristica*.

We thank Alan Resetar (FMNH) for permission to examine *Q. trachyblepharis*.

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***SCELOPORUS MARMORATUS* (Northern Rose-bellied Lizard). KYPHOSIS AND SCOLIOSIS.** Kyphosis and scoliosis is occasionally seen in green iguanas and other lizards and these malformations can result from genetic defects, malnutrition or improper environmental conditions during incubation, primarily by temperature levels that are too high or too low for some or all of the incubation clutch (Mader 1996. Reptile Medicine and Surgery. W.B. Saunders Co., Philadelphia, Pennsylvania. 512 pp.). A case with both kyphosis and scoliosis in sceloporine lizards has been recently reported (Mitchell and Georgel 2005. Herpetol. Rev. 36:183–184).

On 15 September 2010, we collected a female *Sceloporus marmoratus* (SVL = 28 mm SVL; tail length = 39 mm; 0.91 g) active on soil litter in submontano scrubland in the federal natural protected area Cerro de La Silla in the municipality of Juarez, Nuevo Leon, Mexico (25.589861°N, 100.168306°W, datum WGS84; 531 m elev.). The lizard exhibited two vertical curvatures of the spine (kyphosis), one behind the head in the pectoral region and one over the pelvic girdle. In addition, the detached tail had four, alternating lateral curves (scoliosis). Apparently, these malformations do not appear to decrease the probability of survival of lizards (Frutos et al. 2006. Herpetol Rev. 37:468–469; Mitchell and Georgel, *op. cit.*; Norval et al. 2010. Herpetol. Rev. 41:224–225). The lizard was deposited in the herpetological collection of the Universidad Autónoma de Nuevo León, Facultad de Ciencias Biológicas (UANL 7250). To our knowledge, this is the first reported occurrence of these conditions in *S. marmoratus* in the wild.

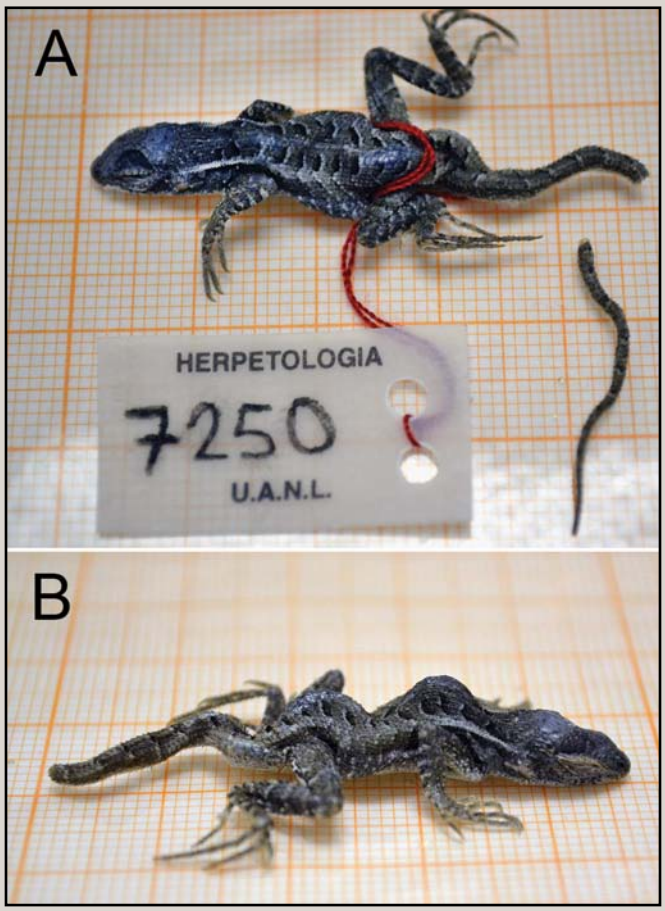


FIG. 1. Juvenile female *Sceloporus marmoratus* illustrating multiple kyphosis and scoliosis. A) Dorsal view with detached tail. B) Lateral view.

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***SCELOPORUS SMARAGDINUS* (Bocourt's Emerald Lizard), *SCELOPORUS TAENIOCNEMIS* (Guatemalan Spiny Lizard). ENDOPARASITES.** Both *Sceloporus smaragdinus* and *S. taeniocnemis* occur in southeastern Mexico (Chiapas) and Guatemala in pine and cloud forests; *S. smaragdinus* at 2000–4000 m elev.; *S. taeniocnemis* at 1200–2500 m elev. (Köhler 2003. Reptiles of Central America. Herpeton, Offenbach, Germany. 367 pp.). The purpose of this note is to establish the initial helminth lists for *S. smaragdinus* and *S. taeniocnemis*.

Specimens of the two species collected in Guatemala were borrowed from the herpetology collection of the Natural History Museum of Los Angeles County (LACM), California, USA, and examined for helminths: one male *Sceloporus smaragdinus* (LACM 39871; SVL = 61.0 mm; Huehuetenango Department, Chemal, April 1968; 15.5500°N, 91.5000°W WGS 84, 3288 m elev.); and three *S. taeniocnemis* (LACM 40285–40287; 2 females, 1 male, mean SVL = 73.7 mm ± 4.2 SD; range = 69–77 mm; Huehuetenango Department, Barillas, April 1968; 15.8036°N, 91.3158°W WGS 84, 1554 m elev.).

The digestive tract was removed and opened. One species of Nematoda was found in the large intestines of all specimens, cleared in a drop of glycerol on a microscope slide, coverslipped, studied under a compound microscope, and identified as *Spauligodon oxkutzcabiensis*. In *S. taeniocnemis*, prevalence (number infected lizards/lizard sample × 100) was 100% (3/3); mean intensity of infection (mean number of helminths per infected lizard ± SD) was 9.3 ± 10.2 SD, range = 2–21. For *S. smaragdinus*; prevalence was 100% (1/1). Selected specimens of *Spauligodon oxkutzcabiensis* were deposited in the United States National Parasite Collection, Beltsville, Maryland, USA as *Sceloporus smaragdinus*: USNPC 104832; *S. taeniocnemis*: USNPC 104833.

Spauligodon oxkutzcabiensis, an oxyurid nematode, does not utilize an intermediate host (Anderson 2000. Nematode Parasites of Vertebrates: their Development and Transmission. CABI Publishing, Oxon, U.K. 650 pp.). Infection likely occurs when lizards ingest eggs from infected soil while feeding. *Spauligodon oxkutzcabiensis* is a common parasite in lizards from Mexico, Central America (Bursey et al. 2007. Comp. Parasitol. 74:108–140), and South America (Goldberg and Bursey 2010. Comp. Parasitol. 77:91–93). *Sceloporus smaragdinus* and *S. taeniocnemis* represent new host records for *Spauligodon oxkutzcabiensis*. Guatemala is a new locality record.

We thank Christine Thacker (LACM) for permission to examine *S. smaragdinus* and *S. taeniocnemis*.

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***SCELOPORUS TRISTICHUS* (Plateau Fence Lizard) and *SCELOPORUS MAGISTER* (Desert Spiny Lizard). PREDATION.** On 25 August 2011 at 1838 h along the Virgin River in Zion National Park, Kane Co., Utah (37.205827°N, 112.978917°W, elev. 1211 m), one of us (CG) observed, photographed, and recorded video of an adult male *Sceloporus tristichus* predating a hatchling *S. magister* (*sensu* Leaché and Mulcahy 2007. Mol. Ecol. 16:5216–5233). The hatchling was being consumed tail-end first and being beat against a rock several times while in mouth of the adult *S. tristichus*. These two species commonly co-occur along stream habitats in Utah (Tinkle 1976. Herpetologica 32:1–6). There have been accounts of *S. consobrinus* (as *S. undulatus hyacinthinus*) predating other lizards in captivity (Groves 1971. J. Herpetol. 5:205), and also cannibalism within *S. magister* (Cardwell 1994. Herpetol. Rev. 3:121–122). However, this is the first published account of *S. tristichus* predating *S. magister*.

Digital video of this predation event is available. For those interested please contact the lead author.



FIG. 1. Adult male *Sceloporus tristichus* consuming a hatchling *S. magister* tail-end first.

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***SPHENOMORPHUS INCOGNITUS* (Brown Forest Skink). PARENTAL CARE.** Parental care is common in some terrestrial vertebrates, such as birds and mammals, but is much rarer in reptiles. About 140 reptile species have been reported to exhibit parental care, but many of these records are unconfirmed due to a lack of direct evidence of such behavior (Huang 2006. Anim. Behav. 72:791–795). Crocodilians are the most well-documented group of reptiles that provide parental care (Shine 1988. *In* C. Gans and R. B. Huey [eds.], Biology of the Reptilia, Volume 16, Ecology B: Defense and Life History, pp. 275–329. Alan R. Liss, New York), but relatively few squamate reptiles exhibit such behavior (Huang 2006, *op. cit.*, Huang and Wang 2009. Ethology 115:273–279; O'Connor and Shine 2004. Anim. Behav. 68:1361–1369). Here we describe an observation of nest defense, a form of parental care, by the skink *Sphenomorphus incognitus*.

Sphenomorphus incognitus is a small (ca. 8 cm SVL), surface-dwelling skink distributed from southern China to Taiwan. This oviparous skink produces 3–6 eggs per clutch, and reproduces from spring to summer (Huang 2010. Zool. Stud. 49:779–788). On



PHOTO BY I. C. RO

FIG. 1. Brown Forest Skink (*Sphenomorphus incognitus*) biting a Taiwanese Kukri Snake (*Oligodon formosanus*).

28 August 2008 at 1600 h on Orchid Island, Taitung County, Taiwan (22.0333°N, 121.5666°E), we observed a female *S. incognitus* (8.5 cm SVL) defending its nest from predation by a Taiwanese Kukri Snake (*Oligodon formosanus*; 41 cm SVL). *O. formosanus* is a reptile egg specialist, and regularly eats the eggs of other skink species in the area (e.g., *Eutropis longicaudata*; Huang 2006, *op. cit.*). Female *E. longicaudata* commonly protect their eggs from predation by viciously attacking *O. formosanus*, which causes the snake to leave the nest site (Huang 2006, *op. cit.*). In the current observation, we observed the snake attempting to eat a clutch of *S. incognitus* eggs buried in the soil. The female *S. incognitus* bit the snake at mid body several times over a period of a few minutes (Fig. 1), and by doing so was presumably attempting to deter the snake from eating the eggs. However, this attempt was unsuccessful, because after digging up the nest we discovered that the entire clutch had been eaten by the snake. Despite our long-term studies on Orchid Island (2001–2010), this is our first observation of *S. incognitus* defending a nest from predation. Unlike *E. longicaudata* (which reaches a SVL of ca. 12 cm), the smaller *S. incognitus* was unable to protect its eggs from snake predation, possibly because the snake was undeterred by bites from such a small skink. We suspect that this skink had recently laid the eggs, and was still in the area when the snake predated the nest, explaining the absence of other observations of similar behavior. Otherwise, most oviparous squamates bury their eggs, which makes it difficult to document instances of parental care.

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***TROPIDURUS HISPIDUS* (Calango). SAUROPHAGY.** *Tropidurus hispidus* has a wide geographical distribution, mainly in open landscapes of northeastern South America (Rodrigues 1987. Arq. Zool. 31:105–230). *T. hispidus* is considered a generalist predator that preys on several arthropod taxa as well as plant items (Kolodiuk et al. 2010. S. Am. J. Herpetol. 5:35–44; Van Sluys et al. 2004. J. Herpetol. 38:606–611; Vitt 1995. Occ. Pap. Oklahoma Mus. Nat. Hist. 01:01–29; Vitt et al. 1996. J. Trop. Ecol. 12:81–101).

Among tropidurids, saurophagy has been recorded for *T. montanus* (Kiefer and Sazima 2002. Herpetol. Rev. 33:136), *T. torquatus* (Galdino and Van Sluys 2004. Herpetol. Rev. 35:173), and *T. hygomi* (Kohlsdorf et al. 2004. Herpetol. Rev. 35:398). Herein, we report the predation of *Cnemidophorus ocellifer* by *T. hispidus*.

Observations were made during an ecological study on reproduction and diet of *C. ocellifer* in São Gonçalo do Amarante municipality, west coast of Ceará, northeastern Brazil (3.30495°S, 38.55127°W), where specimens of *C. ocellifer* were collected. On 29 July 2010, at ca. 0830 h, one of us (DZ) hit an individual of *C. ocellifer* (ca. 50 mm SVL) of unknown sex using an air gun (the lizard was stunned momentarily and then ran away). During its attempted escape, the *C. ocellifer* was detected by an adult male *T. hispidus* (ca. 100 mm SVL), which attacked the right side of its body, grabbing almost the entire lizard, with only the head and tail protruding from its mouth. Swallowing lasted for ca. 1 min., the resulting ingestion of the prey oriented tail-first.

This report indicates that *T. hispidus* is a potential predator of *C. ocellifer*, contributing to the knowledge of the ecology of both species in a coastal region of northeastern Brazil. Moreover, this record contributes to the notion that lizards are important components of their ecosystems, acting as predators of other vertebrate species (Rocha and Vrcibradic 1998. Ciência e Cultura 50:364–368).

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***TROPIDURUS HISPIDUS* (Peters' Lava Lizard). SLEEP-SITE FIDELITY.** Little attention has been given to the study of sleep, despite its essential role in the lives of lizards. The behavior of species during sleep has important implications in their natural history traits, such as predator avoidance, fitness related with proximity to feeding or basking sites, restorative functions, and partitioning of adequate microhabitats (Singhal et al. 2007. Behavior 144:1033–1052; and references therein). Information on sleep-site fidelity (SSF) is even more scarce, and has been reported in less than a dozen species of lizards (Singhal et al., *op. cit.*). Herein, we report on some observations of SSF in the lizard *Tropidurus hispidus*, a tropidurid distributed from northeastern South America to the northeastern and central-eastern regions of Brazil (Rodrigues 1987. Arq. Zool. 31:105–230).

Observations took place at the authors' house in the city of Fortaleza, State of Ceará, northeastern Brazil. Since we have resided at this house in August 2009, lizard residents (*T. hispidus*; *Hemidactylus mabouia*) have pacifically occupied their space. During this period observations *ad libitum* have been made on their behavior, leaving them undisturbed whenever possible. Measurements (snout–vent length and tail length) were calculated with the program ImageJ (Abramoff et al. 2004. Biophotonics Internacional 11:36–42) based on photographs we have taken. Although no individual was marked, daily contact enabled us to differentiate among individuals. From November 2009 to May 2011 four different individuals of *T. hispidus* were observed to display SSF. Observations were distributed between at least 3 months from one another and individuals' site fidelity ranged from 5 to 20 days, after which they were no longer seen. Size of these four lizards ranged from 54.73–101.89 mm and perch height from 1.6–3 m. Sleeping sites were usually behind objects, usually poorly hidden, although one individual used a conspicuous spool of string as perch. In all observations, individuals would maintain the exactly same site for the duration they used it, occasionally changing only the direction they were facing. On two occasions individuals left the sleep-site upon being disturbed, although in both cases they returned the following day to the same perch. Among tropidurid lizards, SSF has only been reported in *T. albemarlensis* from the Galápagos (Stebbins et al. 1967. Ecology 48:839–851). An important factor when choosing sleep sites is the risk of predation (Lima et al. 2005. Anim. Behav. 70:723–736). The use of exposed and poorly hidden sites in the present report indicates that lizards have become aware of their low risk situation, thus choosing circumstances they would probably avoid in nature. We hope these observations will serve as baseline data, aiding in future studies on the largely unknown study of sleep in lizards.

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***UROSAURUS ORNATUS WRIGHTI* (Northern Tree Lizard). NEMATODE PARASITE.** Examinations of *Urosaurus ornatus* from Arizona, New Mexico, and Texas have recorded three species of nematodes: *Parathelandros texanus*, *Spauligodon giganticus*, and larva of *Physaloptera* sp. (Goldberg et al. 1993. J. Helminthol. Soc. Washington 60:118–121; Specian and Ubelaker 1974. Trans. Amer. Microsc. Soc. 93:413–415). Herein we report a new distributional record for a nematode parasite of *U. ornatus*.

Four adult *U. o. wrighti* (two males, two females, SVL = 41–53 mm) were collected in mid-May 2011 by hand from 9.0 km S of US 191 on St. Hwy 279 at Williams Bottom Campground, Grand Co., Utah, USA (39.08579°N, 109.759167°W). Their feces were examined for coccidian and helminth parasites. Lizards were killed with an overdose of sodium pentobarbital and fecal pellets were removed from their rectum and placed in individual vials of 2.5% (w/v) aqueous potassium dichromate. Feces were concentrated by flotation according to previous methods (McAllister et al. 1991. J. Parasitol. 77:910–913) using Sheather's sugar solution (specific gravity = 1.30). Specimens were examined using a compound microscope.

No coccidian oocysts were found, but a single nematode was recovered from a 52 mm SVL male *U. o. wrighti*, placed in 70% ethanol, and cleared on glass slides with undiluted glycerol. It was subsequently identified as a male *Parathelandros texanus*. A voucher specimen was deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland as USNPC 104871. A host voucher is deposited in the Arkansas State University Herpetological Collection (ASUMZ), State University, Arkansas as ASUMZ 31775.

Parathelandros texanus was originally described from the Big Bend Canyon Lizard (*Sceloporus merriami annulatus*) from Brewster County, Texas (Specian and Ubelaker, *op. cit.*). Other hosts (all from Arizona, New Mexico, or Texas) include the Gray-checkered Whiptail (*Aspidoscelis dixoni*), Gila Spotted Whiptail

(*A. flagellicauda*), Texas Spotted Whiptail (*A. gularis gularis*), Trans-Pecos Striped Whiptail (*A. inornata heptagramma*), Plateau Spotted Whiptail (*A. septemvittata septemvittata*), Colorado Checkered Whiptail (*Aspidoscelis tesselata*), Western Marbled Whiptail (*Aspidoscelis tigris marmorata*), Southwestern Earless Lizard (*Cophosaurus texanus scitulus*), Canyon Lizard (*Sceloporus merriami*), and Eastern Fence Lizard (*S. undulatus, sensu lato*) as well as previously mentioned *U. ornatus* (Goldberg et al. 1995. J. Helminthol. Soc. Washington 62:188–196; McAllister 1990a. J. Wildl. Dis. 26:139–142; McAllister 1990b. Texas J. Sci. 42:381–388; McAllister et al. 1991. Texas J. Sci. 43:309–314; McAllister 1992. Texas J. Sci. 44:233–239; McAllister et al. 1995. Texas J. Sci. 47:83–88; McAllister et al. 2003. Texas J. Sci. 55:307–314; Specian and Ubelaker, *op. cit.*; Walker and Matthias 1973. Proc. Helminthol. Soc. Washington 40:168–169).

In conclusion, the geographic range of *P. texanus* now includes Arizona, New Mexico, Texas, and Utah (new distributional record) and at least 12 species of lizard hosts within two families (Phrynosomatidae, Teiidae). We expect additional hosts and localities for *P. texanus* will be reported with future surveys of lizards.

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SQUAMATA — SNAKES

***ARIZONA ELEGANS ELEGANS* (Kansas Glossy Snake). DIET AND FEEDING BEHAVIOR.** *Arizona elegans elegans* is known to prey upon lizards and small mammals (McKinnney and Ballinger 1966. Southwest. Nat. 11:410–412). *Dipodomys ordii* (Ord's Kangaroo Rat) is a known prey species of *A. elegans* (Rodríguez-Robles 1999. J. Herpetol. 33:87–92). In a literature review of carrion foraging in snakes, Devault and Krochmal (2002. Herpetologica 58:429–236) did not identify *A. elegans* as a scavenger. Herein we report the first observation of *A. elegans* foraging on a road-killed *D. ordii*.

On 12 June 2010, at 2300 h, we observed an *A. elegans* (SVL = 585 mm; total length = 694 mm) consuming a road-killed *D. ordii* (Fig. 1) on Highway 249, Chavez Co., New Mexico, USA (33.0185°N, 103.8723°W, datum: WGS 34; elev. 1320 m). To prevent the snake from being killed by oncoming traffic, we gently moved it to the south shoulder of the highway. Rodrigues-Robles et al. (*op. cit.*) investigated the stomach contents of approximately 700 museum specimens of *A. elegans*. Of the 107 prey items recovered, 43.9% were mammals. However the design of their study did not allow them to determine the disposition of the prey prior to consumption. Devault and Krochmal's (2002, *op. cit.*) literature review suggests that carrion foraging in snakes should not be considered unusual, however it was unclear until this observation if *A. elegans* could be counted among the snakes known to consume carrion in the wild.

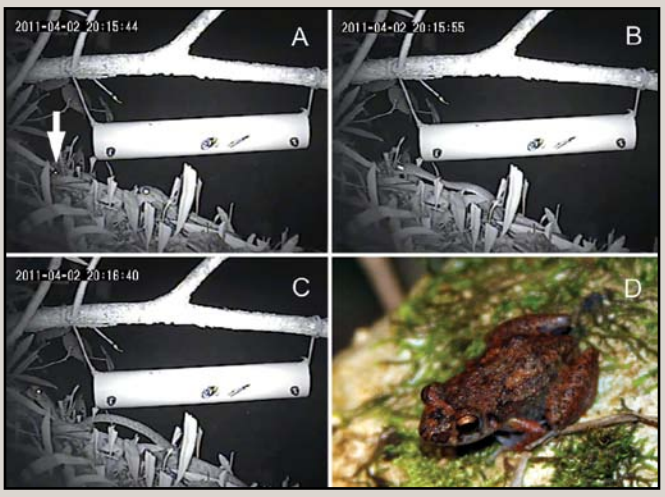


FIG. 1. *Arizona elegans elegans* consuming a road killed *Dipodomys ordii*. Note the rodent's viscera, confirming that it was a road kill.

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***BOIGA IRREGULARIS* (Brown Treesnake). DIET.** The invasive *Boiga irregularis*, having decimated most of the native species it preyed on in Guam, now preys heavily on other invasive vertebrates. *Eleutherodactylus planirostris* (Greenhouse Frog), which has recently become established on Guam (Christy et al. 2007. Pac. Sci. 61:469–483), may provide the snake with an additional food source because the frogs are active nocturnally and can attain high densities (12,500 frogs ha^{-1} in Hawaii; Olson 2011. Unpubl. dissertation. Utah State University, Logan. 116 pp.). *Boiga irregularis* consume *E. planirostris* in captivity (unpubl. data in Christy et al. 2007. Pac. Sci. 61:469–483), but it is unknown whether they take them in the field. Others have suggested that *B. irregularis* are unlikely to prey upon anurans because of learned avoidance after attempting to take a poisonous species, *Bufo marinus*, which is also introduced and common throughout Guam.

On 2 April 2011, during the course of video recording of nocturnal snake activity in roadside vegetation at U.S. Naval Computer and Telecommunications Station Guam (13.574758°N, 144.834967°E; datum WGS84), we observed two *E. planirostris* moving about on a moss and fern-covered log approximately 1 m above the forest floor. This location is approximately 7.7 km north of the discovery site for this recently-arrived species (Christy et al., *op. cit.*) At 2015 h, a juvenile Brown Treesnake (ca. 600 mm SVL) appeared on the side of the log approximately 10 cm from one of the frogs, which quickly leapt off of the log. The snake



PHOTOS BY TOM MATHIES

FIG. 1. *Boiga irregularis* feeding sequence on an *Eleutherodactylus planirostris*, northern Guam, USA. A. Snake approaches frog (arrow indicates eye-shine of frog); B. Snake lunging toward frog. C. Snake swallowing frog; D. *Eleutherodactylus planirostris* at study site.

rapidly swung around to face the direction of the departed frog, but did not follow. Soon after, the second frog emerged from cover and took a few steps toward the snake (Fig. 1A). The snake then moved toward the frog, paused, and then lunged at the frog (Fig. 1B), catching it in its mouth and consuming it immediately thereafter (Fig. 1C). To verify whether the frogs on our video recording were *E. planirostris*, we returned to the site the following night. A cursory visual search of a 1.5 × 4.5 m strip of forest floor beneath the log revealed approximately 15 small *E. planirostris* (Fig. 1D). If juvenile *B. irregularis* are taking substantial numbers of frogs as prey, the snake may become more difficult to control than at present. Moreover, large populations of *E. planirostris* (both on Guam and elsewhere) may facilitate the establishment of *B. irregularis* in new areas, such as Hawaii or other Pacific Islands.

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***BOTHROPS JARARACUSSU* (Jararacussu). DIET.** The South American pitviper *Bothrops jararacussu* is a large viperid, reaching up to 1.8 m in length, and is known to feed on small mammals, amphibians, and reptiles (Martins et al. 2002. *In* Schuett et al. [eds.] Biology of Vipers, pp. 307–328. Eagle Mountain Publ., Eagle Mountain, Utah). On 1 January 2011, we found a Brazilian squirrel, *Guerlinguetus ingrami* (33 cm; 150 g) in the process of being ingested by a female *B. jararacussu* (total length = 110 cm). The snake was found in the afternoon (1700 h) in the middle of a dirt road, near a secondary forest fragment in the municipality of Cascavel, Paraná, south Brazil. This location is part of Araucarian Forest (Atlantic Forest; Castella and Britez 2004. A Floresta com Araucária no Paraná. MMA Publ., Brasília. 233 pp.) and is in close proximity to a river. When approached the snake regurgitated the squirrel and tried to escape. To our knowledge, this is the first record of *B. jararacussu* preying on a *G. ingrami*. This observation is particularly interesting, given that *B. jararacussu* is terrestrial and primarily feeds on terrestrial prey (Martins et al. 2001. J. Zool. 254:529–538; Martins et al. 2002, *op. cit.*; Hartmann et al. 2009. Pap. Avul. Zool. 49:343–360), whereas *G. ingrami* is primarily arboreal (Bordignon and Monteiro-Filho 1997. Rev. Bras. Zool. 14:707–722; Bordignon and Monteiro-Filho 2000. Can. J. Zool. 78:1732–1739).

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***CHRYSOPELEA PARADISI* (Garden Flying Snake). DIET.** *Chrysopelea paradisi* is a common lowland snake in Southeast Asia (Inger and Stuebing 1999. A Field Guide to the Snakes of Borneo. Natural History Publications, Sdn Bhd, Kota Kinabalu. viii + 254 pp.), and a known predator of gekkonid lizards (Das 2010. A Field Guide to the Reptiles of Southeast Asia. New Holland Publishers Ltd., London. 376 pp.), the agamid *Bronchocela cristatella* (Lim and bin Peral 1959. Malayan Nat. J. 14:33–34), the scincid *Lamprolepis smaragdina philippinica* (Gaulke 1986. Salamandra 22:211–212), and the bamboo bat, *Tylonycteris* sp. (Leong and Foo 2009. Nature in Singapore 2:311–316).

On 30 December 2009, at ca. 1200 h, a *C. paradisi* was observed on a concrete walking path at the Piasau Boat Club (04.436541°N, 113.996485°E, datum: WGS84), Miri, Sarawak, East Malaysia. It was tightly coiled around a small struggling arboreal scincid lizard, *Apterygodon* [*Dasia*] *vittatum*, recognizable by the robust body shape and distinctive stripes along the head. This particular specimen had a truncated tail, presumably lost in a prior (near) predation event.

Over a period of ca. 10–15 min, the snake remained almost stationary, apparently constricting the skink, whose movements gradually became more erratic and less frequent. When the movements had almost ceased altogether, the snake changed position, and maneuvered the skink to begin consuming the skink head-first (Fig. 1). Once consumption started, less than a minute elapsed before the entire skink was swallowed.



FIG. 1. *Chrysopelea paradisi* ingesting an *Apterygodon vittatum* in Sarawak, East Malaysia.

COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND

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***CROTALUS CERBERUS* (Arizona Black Rattlesnake). DIET.** *Crotalus cerberus* is a denizen of mesic environments in higher-elevation regions of Arizona and western New Mexico (Brennan and Holycross 2006. A Field Guide to Amphibians and Reptiles in Arizona. Arizona Game and Fish Dept., Phoenix. 150 pp.). Prior to being recognized as a separate species from *C. viridis* [*oreganus*], it was presumed that *C. cerberus* was an opportunistic predator, taking a variety of prey taxa (Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. Univ. New Mexico Press, Albuquerque, New Mexico. 433 pp.; Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Inst. Press, Washington, DC. 668 pp.). Since being distinguished from *C. viridis*, its

diet has been documented to include lizards, including *Sceloporus* [*undulatus*] *tristichus* (Schuett et al. 2002. Herpetol. Rev. 33:210–211). Here, based on one of the first field studies of free-ranging *C. cerberus*, we present new information on prey use at a low-elevation site in Arizona.

From 2004 to 2008 we conducted radio-telemetry on sympatric *C. cerberus*, *C. atrox*, *C. molossus*, and *Heloderma suspectum* at Tonto National Monument, Gila Co., Arizona, USA. The site is characterized by steep rocky slopes, bajadas, and dry washes with upland Sonoran desertscrub, with elevations ranging from 695–1230 m. We documented prey use through blunt dissection of scats opportunistically collected when an animal defecated (Quick et al. 2005. J. Herpetol. 39:304–307). We also documented prey use from regurgitated prey items and through direct observation of predation.

Prey use was documented for three telemetered adult male *C. cerberus* from six separate feeding events. Through scat dissection, four distinct prey were identified: one unidentified bird (based on feather remains); two rodents (Cactus Mouse, *Peromyscus eremicus*; and Harris' Antelope Squirrel, *Ammospermophilus harrisii*); and one lizard (*Sceloporus* sp., likely *S. magister*). Importantly, four prey types (and therefore feeding events) were found in three scats of our subjects, indicating that a single scat may represent more than one feeding event. One male consumed the bird, the *P. eremicus*, and the *Sceloporus* sp.; of these, the mouse and lizard remains were found in the same scat. Two direct feeding observations were also made. One individual regurgitated a *Neotoma albigula* (White-throated Woodrat) after being captured on 14 July 2003, and was thought to contain a separate meal that was not regurgitated (J. Schofer, pers. obs.). A different adult male was observed consuming an adult Ash-throated Flycatcher (*Myiarchus cinerascens*) during a routine telemetric location on 5 June 2004 (A. Madara-Yagla, photo voucher).

Given the prey taxa documented for *C. cerberus* at this site, the species appears to be an opportunistic predator, supporting previous assessments. An apparent lack of lagomorphs in *C. cerberus* diet compared to other venomous species at the site (Nowak 2009. Unpubl. PhD dissertation. Northern Arizona University, Flagstaff, Arizona.) might reflect habitat partitioning (Beck 1995. J. Herpetol. 29:211–223) with other rattlesnakes, or it may reflect differences in body and gape size among the species (Klauber 1972. Rattlesnakes: Their Habits, Life Histories, and Influence on Mankind. Univ. California Press, Los Angeles. 1533 pp.). Nevertheless, the wide variety of prey types consumed by *C. cerberus* suggests that this species may play an important mesopredator role in certain ecosystems (Nowak et al. 2008. Biol. Rev. 83:601–620).

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***CROTALUS MOLOSSUS MOLOSSUS* (Northern Black-tailed Rattlesnake). DIET.** *Crotalus molossus* is a large-bodied rattlesnake whose dietary habits have been fairly well documented (Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. Univ. New Mexico Press, Albuquerque. 433 pp.; Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Inst. Press, Washington, DC. 668 pp.). Small mammals are most frequently consumed; however birds also comprise a portion of its diet (16.7%; Reynolds and Scott 1982. *In* N. J. Scott, Jr. [ed.], Herpetological Communities, pp. 99–118. U.S. Fish and Wildlife Service, Widl. Res. Rep. 13.) Though birds have been documented in the diet, which bird species are actually consumed is largely unknown. From 2004 to 2008 we conducted radio-telemetry studies on sympatric *C. molossus*, *C. atrox*, *C. cerberus*, and *Heloderma suspectum* at Tonto National Monument, Gila Co., Arizona, USA. Based on results from this study, we present a new dietary record for *C. molossus*.

Prey use was documented for a single, telemetered adult male *C. molossus* (SVL = 100 cm; 675 g) using scat dissection (Quick et al. 2005. J. Herpetol. 39:304–307). Two scats were collected from this individual; one on 26 March 2006 and one on 29 March 2006. Both scats contained feathers from a passerine bird, which was later identified as a Black-throated Sparrow (*Amphispiza bilineata*). No other remains were found in either scat. Because both scats were collected within one week of each other, it is likely that the remains in the scats represent the same prey item. To our knowledge, these observations represent the first record of predation by *C. molossus* on *A. bilineata*.

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***CROTALUS MOLOSSUS* (Black-tailed Rattlesnake). RAIN HARVESTING BEHAVIOR.** Opportunistic water gain from rain, sleet, dew, fog, or snow seems to be an adaptive strategy utilized by many reptiles in desert habitats, where accumulation of rain water on ground surfaces is infrequent (Sherbrooke 1990. J. Herpetol. 24:302–308). To date, there is a single documented episode of *C. molossus* drinking rainwater from a rock surface (Greene 1990. Pacific Discovery 43:10–19). Herein, we report the first observation of *C. molossus* consuming water from its own body during a rainstorm in the Chihuahuan Desert of west Texas.

On 26 June 2010, at 1840 h, we radio tracked an adult male *C. molossus* (SVL = 1000 mm; tail length = 80 mm; 820.0 g) as part of an ongoing study of rattlesnake spatial ecology at the Indio Mountains Research Station, Hudspeth Co., Texas, USA (30.770480°N, 105.013491°W, datum: WGS84; elev. 1221 m). The snake was located, prior to a rainfall event, in a coiled position on a rocky slope (10° angle) with its head pointing downward and its snout in contact with the lateral surface of the body. It began to rain and subsequently the snake was able to harvest water flowing off the tilted lateral mid-body section (Fig. 1). The rattlesnake continued consuming water during the entire rainfall episode (ca. 25 min.). Unlike previous reports of rain harvesting behavior by other rattlesnakes (e.g., Aird and Aird 1990. Bull. Chicago Herpetol. Soc. 25:217; Cardwell 2006. Herpetol. Rev. 37:142–144; Glaudas 2009. Southwest. Nat. 54:515–521), the *C. molossus* did not use its tongue to lick water from a dorsally



FIG. 1. An adult male *Crotalus molossus* harvesting water from its body at Indio Mountains Research Station, Hudspeth Co., Texas, USA.

flattened body section. We presume that the rattlesnake did not need to flatten its body to collect water due to constant flow from the ongoing rainstorm. After rainfall ceased, the rattlesnake continued harvesting water from the wet body surface, but in due course stopped and then crawled into a rock crevice.

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***ELAPOMORPHUS QUINQUELINEATUS* (Raddi's Lizard-eating Snake). DIET.** The rear-fanged *Elapomorphus quinquelineatus* is known to prey on other burrowing snakes and amphisbaenians (Greene 1997. Snakes: the Evolution of Mystery in Nature. Univ California Press, Berkeley. 351 pp.). On 3 February 2011, at 1800 h, an adult female *E. quinquelineatus* (SVL = 912 mm, tail length = 87 mm; 170 g) was found preying on adult male *Amphisbaena microcephala* (IBSP CRIB 0114; SVL = 440 mm; tail length = 25 mm; 108 g) in a backyard of Núcleo Residencial/Instituto Butantan, close to a remnant of secondary Atlantic Forest in São Paulo City, Brazil (23.34143°S, 46.43031°W, datum WGS84; 730 m elev.). After being collected, the snake voluntarily regurgitated the freshly killed amphisbaenian, which had been ingested head first and displayed spreading hemolytic signs in the gular region (Fig. 1). The prey/predator mass ratio was 0.63. To my knowledge, this is first record of *A. microcephala* in the diet of *E. quinquelineatus*. The snake was kept in captivity at Laboratório de Herpetologia, Instituto Butantan, São Paulo, Brazil.



FIG. 1. *Elapomorphus quinquelineatus* with an *Amphisbaena microcephala* that it had consumed.

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***ERYTHROLAMPRUS AESCULAPII* (Southern Mock Coralsnake). DIET AND PREY SIZE.** On 23 June 2008, at 1330 h, an adult female *Erythrolamprus aesculapii* (total length = 711 mm; 56 g after prey regurgitation) was caught next to a lake, in an anthropogenic habitat at The Instituto Cultural Inhotim, Brumadinho municipality, in Minas Gerais State, Brazil (27.125°S and 44.220°W, datum WGS84). While being handled, the snake, which appeared to have fed recently, regurgitated an adult female *Liophis poecilogyrus* that was longer and heavier than itself (total length = 803 mm, 85 g). A study on the diet and feeding behavior of *E. aesculapii* (Marques and Puorto 1994. Rev. Bras. Biol. 54:253–259), did not record *E. aesculapii* consuming snake prey greater than their own body weight. Sazima and Martins (1990. Mem. Inst. Butantan 52:73–79) reported juvenile snakes unsuccessfully attempting to ingest very large prey, a behavior that results in energy waste and increases the risk of injuries and predation. However, the small diameter of an elongated prey item (such as another snake) may alleviate gape limitation, allowing consumption of very large prey. To our knowledge, the relative size of this prey item (152% of predator mass) is the largest reported for *E. aesculapii* and is among the largest reported for snakes in general. Both snakes were deposited in the herpetological collection of the Museu de Ciências Naturais of Pontifícia Universidade Católica de Minas Gerais (MCNR 3751, MCNR 3750), in Belo Horizonte, State of Minas Gerais, Brazil.

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***GEOPHIS MUTITORQUES* (Highland Earth Snake). REPRODUCTION.** *Geophis mutitorques* is known from the Sierra Madre Oriental of the northeastern México; recorded from the highlands of San Luis Potosí, Hidalgo, Puebla, and Veracruz (Downs 1967. Misc. Publ. Mus. Zool. Univ. Michigan 131:1–193; Wilson and Townsend 2007. Zootaxa 1395:1–31). The natural history of this species is poorly understood and no data on reproduction are available. On 15 March 2011, three gravid female *G. mutitorques* (CIB 4121–4123) were collected in cloud forest habitat at the community El Xoté, Municipality Tenango de Doria, Hidalgo, México (20.2054°N, 98.160270°W, datum WGS84; elev. 1506 m). One female (CIB 4121) measured 384.7 mm SVL, body mass 30.0 g, with a clutch size of 6 eggs, and a total egg mass of 4.03 g; the second female (CIB 4122) measured 406.6 mm SVL, body mass 35.0 g, with a clutch size of 5 eggs, and a total egg mass of 3.89 g; and the last female (CIB 4123) measured 365.6 mm SVL, body mass 21.0 g, with a clutch size of 3 eggs, and a total egg mass of 1.09 g. This information is the first record of clutch size for *G. mutitorques* from cloud forest habitat.

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***LIOPHIS ALMADENSIS* (Almaden Ground Snake). PREDATION.** Snakes are an important component of the diet of many mammals, birds, anurans, crocodilians, lizards, other snakes, and even invertebrates (Costa et. al. 2009. Rev. Bras. Zool. 11:171–173; Mattison 1995. Cassel Paper. 256). Here we report the successful predation on a young *Liophis almadensis* (SVL = 240 mm) by a *Leptodactylus vastus* (Northeastern Pepper Toad; SVL = 148 mm). The predation event was observed on 10 October 2010, at 2132 h, in the U.C. Wildlife Refuge Mata do Junco (10.291037°S, 36.583701°W; datum: SAD 69), in the city of Capela, Sergipe, Brazil. The toad was found in a "clean field" (pasture), approximately 1 m from the margin of a temporary pond, with the snake in its mouth (Fig. 1). The snake was still moving, indicating that it had been attacked shortly before the viewing, and exhibited small wounds on the posterior regions. The anuran and the snake were both deposited in the Herpetological Collection of the Federal University of Sergipe (CHUFS C 1037 and C 1256).

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FIG. 1. *Leptodactylus vastus* found preying upon a young *Liophis almadensis* in Capela, Sergipe, Brazil.

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***LIOPHIS MILIARIS* (Watersnake). DIET.** *Liophis miliaris* is a semi-aquatic snake that is widely distributed in cisandean South America (Dixon 1989. Smithson. Herpetol. Inf. Serv. 79:1–28). Judging from records in the literature, this snake preys mainly on anurans (Hartmann et al. 2009. Pap. Avul. Zool., São Paulo 49:343–360; Marques and Sazima 2004. *In* Marques and Duleba [eds.], Estação Ecológica Juréia-Itatins. Ambiente Físico, Flora e Fauna, pp. 257–277. Holos, Ribeirão Preto; Michaud and Dixon 1989. Herpetol. Rev. 20:39–41). In spite of having semi-aquatic habits, there are few published records of this species feeding on fishes; to our knowledge, only two species of fishes have been reported as prey of *L. miliaris* in natural conditions: *Bathygobius soporator* (Gobiidae) and *Guavina guavina* (Eleotridae) (Marques and Sazima, *op. cit.;* Marques and Souza 1993. Rev. Brasil. Biol. 53:645–648). Lema et al. (1983. Comun. Mus. Ci. PUC-RS, Porto Alegre 26:41–121) also reported a specimen preying on the fish *Gymnotus carapo* (Gymnotidae) in captivity.

In the present note, we report a new prey item for *L. miliaris* based on the stomach contents of a female specimen from the region of Itaipuaçu, in Niterói municipality, state of Rio de Janeiro, Brazil. The snake (adult female; SVL = 455 mm; tail length = 135 mm) was brought to the first author in 2010, but the exact date of collection was unknown. The snake's head and neck region were badly damaged, suggesting that it had been bludgeoned to death. Upon dissection, the snake was found to contain an armored catfish (*Callichthys callichthys*; Callichthyidae) in the esophagus. The fish, which had been swallowed head-first, measured 68.6 mm in length, but was missing the tail (it was probably torn off during the bludgeoning of the snake). The original standard length of the specimen was estimated to be ca. 121 mm based on its head length of 32.5 mm, according to measurements of Lehmann and Reis (2004. Copeia 2004:336–343). The snake and its prey were deposited at the reptile collection of the Universidade Federal do Estado do Rio de Janeiro (UNIRIO 46).

Like other fishes of the Order Siluriformes, *Callichthys callichthys* has spines on the dorsal and pectoral fins which are equipped with friction locking mechanisms that, when activated, keeps them erect (Schaefer 1984. Copeia 1984:1005–1008). The fish was probably manipulated to be swallowed head-first in order to prevent its fin spines from locking, impairing ingestion (Sturaro and Gomes 2008. Bol. Mus. Para. Emílio Goeldi, Ciências Naturais 3:225–228). Also, *C. callichthys* has a body covered by an "armor" of plate-like scales, unlike the other fishes previously reported as prey for *L. miliaris* which are all "soft-bodied." Armored catfishes of the genus *Callichthys* have been previously reported as prey for the aquatic coral snake *Micrurus surinamensis* (Martins and Oliveira 1998. Herpetol. Nat. Hist. 6:78–150). Lema et al. (*op. cit.*) reported a specimen of another aquatic snake (*Helicops infrataeniatus*), which was found coiled around a *C. callichthys* and trying to swallow it, but the authors did not mention if it succeeded in consuming the fish. Aguiar and Di Bernardo (2004. Stud. Neotrop. Fauna Environ. 39:7–14) recorded another species of Callichthyidae (*Corydoras paleatus*) in the diet of *H. infrataeniatus*. The above observations, together with the present record, indicate that the "armored" body and the fin spines of *C. callichthys* and other callichthyids do not completely deter predation by snakes.

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***LIOPHIS POECILOGYRUS* (Yellow-bellied Liophis). DIET AND FORAGING BEHAVIOR.** *Liophis poecilogyrus* is a colubrid snake widely distributed across South America. The species is often associated with mesic habitats, which is reflected in its diet that primarily consists of anurans and fish (Michaud and Dixon 1989. Herpetol. Rev. 20:39–42; Schalk 2010. Herpetol. Rev. 41:366–367). Although its diet has been well documented, other aspects of its natural history (e.g., behavior) are lacking. Here we report an observation on the foraging behavior of a *L. poecilogyrus* on tadpoles of *Leptodactylus bufonius* (Oven Frog).

On 30 December 2010, at 2300 h, we observed a male *L. poecilogyrus* (SVL = 411 mm; tail length = 81 mm; 32 g) foraging in a flooded ditch (approximately 10 m long and 0.5 m wide) in the Isoceño community of Yapiroa (19.60721°S, 62.57492°W; datum WGS 84), Province Cordillera, Department of Santa Cruz, Bolivia. While swimming in the ditch, the *L. poecilogyrus* had its head submerged and its mouth open as it chased and captured tadpoles of *L. bufonius*. When the snake captured a tadpole, it would push and hold the tadpole against the mud until it was able to move its mouth onto the head of the tadpole, after which it was able to swallow the individual. After approximately 30 sec underwater without a successful capture, the *L. poecilogyrus* would stop and raise its head above water and remain completely still. The snake would then plunge its head back underwater, swimming with its mouth agape in areas of the ditch where we observed a high abundance of swimming tadpoles. The snake continued foraging in this manner for an additional ten minutes before it left the ditch. This observation is consistent with other reports of head-first prey ingestion by *L. poecilogyrus* (De Souza et al. 2009. Biota Neotrop. 9:263–269) and also suggests that *L. poecilogyrus* primarily relies on tactile cues to detect and locate its prey while foraging in water.

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***MICRURUS NIGROCINCTUS* (Central American Coralsnake). DIET.** Much remains to be learned about the natural history of many Central American snakes. *Micrurus nigrocinctus* is a relatively common terrestrial and semi-fossorial snake that ranges from southern Mexico to northern Colombia. The diet has been relatively well studied and is known to include caecilians, many lizards, and snakes of the genera *Anomalepis*, *Helmanthophis*, *Typhlops*, *Coniophanes*, *Geophis*, and *Ninia* (Savage 2002. The Amphibians and Reptiles of Costa Rica: a Herpetofauna Between Two Continents, Between Two Seas. Univ. Chicago Press, Illinois. 934 pp.) Solórzáno (2004. Snakes of Costa Rica: Distribution, Taxonomy, and Natural History. Instituto Nacional de Biodiversidad, Santo Domingo de Heredia, Costa Rica. 791 pp.) reports on hundreds of individuals and adds the snake genera *Boa*, *Conophis*, *Dendrophidion*, *Drymobius*, *Enulius*, *Imantodes*, *Masticodryas*, *Rhadinaea*, *Tantilla*, and *Urotheca*.

On 1 February 2011, at 0755 h, an adult *M. nigrocinctus* (SVL = 46.2 cm; US National Museum Field Series #254130) was collected dead on the entrance road to El Copé, Coclé Province, Republic of Panama, between the communities of Las Tibias and El Copé (8.62343°N, 80.57100°W, datum WGS84). The snake was split open and protruding from the body wall was a small black snake identified as *Liotyphlops albirostris* (US National Museum Field Series #254181). The anterior 14.5 cm of the snake was undigested. This is the first dietary record for *M. nigrocinctus* for the Republic of Panama and the first documentation of *L. albirostris* as a prey item for the species.

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***NERODIA ERYTHROGASTER TRANSVERSA* (Blotched Watersnake). ENDOPARASITES.** Twelve species of trematodes and seven species of nematodes have been reported previously from *Nerodia erythrogaster* (Ernst and Ernst 2006. SSAR Herpetol. Circ. 34:1–86); however, to our knowledge, no pentastomids have been reported from this host. Here we report two new endoparasite records for *N. e. transversa*.

A single adult Blotched Watersnake was obtained from an unknown locale in Harris Co., Texas, USA, and housed at the Houston Zoological Gardens where it remained until it died on 1 June 1992. A midventral incision was made to expose the entire length of the digestive tract. A single larval nematode and four nymphal pentastomids were recovered from dermal cysts and cleared on glass slides with undiluted glycerol. These were subsequently identified as larval *Eustrongylides* sp. (Nematoda) and nymphs of *Porocephalus* sp. (Pentastomida). A voucher specimen of *Eustrongylides* sp. was deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland as (USNPC 104634). The *Porocephalus* sp. was retained in our personal collection.

Adults of *Porocephalus crotali* Humboldt (Porocephalida: Porocephalidae) have been reported from various crotalids (Forrester et al. 1970. J. Parasitol. 56:977; Nicoli 1963. Ann. Parasitol. Hum. Comp. 38:483–516; Self 1969. Exp. Parasitol. 24:63–119). The life history of this parasite may be similar to the life history of another pentastomid, *Kiricephalus coarctatus* (Diesing), where ophiophagous snakes are the definitive hosts and other snakes can serve as paratenic hosts (Self, *op. cit.*). However, a mammal could be an alternative host (Layne 1967. Bull. Wildl. Dis. Assoc. 3:105–109; Self 1972. Trans. Amer. Micros. Soc. 91:2–8). *Eustrongylides* sp. Jägerskiöld (Trichuridea: Dioctophymatidae) have been reported previously from the stomach, mesenteries, body wall musculature, coelomic cavity, and subcutaneous tissues of several free-ranging and captive snakes, including *Agkistrodon contortrix, Bothrops atrox, Coluber constrictor, Drymarchon couperi, Masticophis flagellum, Nerodia sipedon, Pituophis catenifer, P. melanoleucus, Thamnophis eques, T. sirtalis,* and an unknown species of python (Bursey 1986. J. Wildl. Dis. 22:527–532; Ernst and Ernst, *op. cit.*). *Nerodia erythrogaster transversa* represents a new host record for nymphs of *Porocephalus* sp. and larva of *Eustrongylides* sp.

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***NERODIA RHOMBIFER WERLERI* (Diamond-backed Watersnake). ENDOPARASITES.** *Nerodia rhombifer werleri* is known from Veracruz, south through Tabasco and parts of Campeche and Chiapas, Mexico (Gibbons and Dorcas 2004. North American Watersnakes: A Natural History. Univ. Oklahoma Press, Norman. 438 pp.). Parasites of *N. rhombifer* are listed in Gibbons and Dorcas (*op. cit.*) and Ernst and Ernst (2006. Synopsis of Helminths Endoparasitic in Snakes of the United States and Canada. SSAR Herpetol. Circ. 34:1–86). To our knowledge, there are no reports of helminths from *N. r. werleri*. The purpose of this note is to establish the initial helminth list for *N. r. werleri*.

A sample of 38 *N. r. werleri* consisting of 17 females (mean SVL = 600.6 mm ± 114.6 SD, range = 330–740 mm) and 21 males (mean SVL = 614.8 mm ± 93.6 SD, range = 460–758 mm) collected in 1987 by (RDA) near Tlacotalpan (18.6667°N, 95.7500°W, datum WGS84; elev. 10 m), Veracruz, Mexico were examined. Snakes were deposited in the herpetology collection of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California, USA. The body cavity of each snake was opened and the digestive tract was removed, opened by a longitudinal incision, and examined under a dissecting microscope. Food contents of the stomach were previously removed (Aldridge et al. 2003. Herpetologica 59:43–51). In some cases stomach residuum remained, which was examined. One species of Cestoda, and four species of Nematoda were found. Cestodes were regressively stained in hematoxylin, mounted in Canada balsam. Nematodes were cleared in glycerol. All were mounted on glass slides, cover slipped, studied under a compound microscope and identified: Cestoda *Ophiotaenia perspicua* (small intestine) and Nematoda *Paracapillaria sonsinoi* (large intestine), *Terranova caballeroi* (stomach), *Contracaecum* sp. larvae (body cavity), and *Porrocaecum* sp. larvae (small intestine). Voucher specimens were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland as: *Ophiotaenia perspicua* (USNPC 104628); *Paracapillaria sonsinoi* (USNPC 104630); *Terranova caballeroi* (USNPC 104632); *Contracaecum* sp. (USNPC 104629); *Porrocaecum* sp. (USNPC 104631).

Prevalence (number infected snakes/number examined snakes × 100) and mean infection intensity (mean number helminths per infected snake) were: *Ophiotaenia perspicua* (prevalence 92%, cestodes were intertwined and could not be counted); *Paracapillaria sonsinoi*; (prevalence 8%, mean intensity 5.7 ± 5.7 SD, range = 1–12); *Terranova caballeroi*; (prevalence 11%, mean intensity 1.3 ± 0.5 SD, range = 1–2); *Contracaecum* sp. (prevalence 13%, mean intensity 2.4 ± 3.1 SD, range = 1–8); *Porrocaecum* sp. (prevalence 5%, mean intensity 2.0 ± 1.4 SD, range = 1–3).

The ascarid nematode *T. caballeroi* was described from specimens taken from the stomach of *Cubophis cantherigerus* from Cuba (Barus and Coy Otero 1966. Poeyana 23:1–16). The life history is unknown. The definitive hosts of species of *Contracaecum* are piscivorous birds and mammals; larvae hatch in water and are ingested by invertebrate hosts; fish serve as vertebrate intermediate hosts (Anderson 2000. Nematode Parasites of Vertebrates: Their Development and Transmission, 2nd ed. Publishing, Wallingford, Oxon, U.K. 650 pp.). Species of *Porrocaecum* sp. are parasites of the intestines of birds; earthworms serve as intermediate hosts and small mammals that consume earthwotms may serve as paratenic (= transport) hosts (Anderson, *op. cit*).

Contracaecum sp. and *Porrocaecum* sp. in *N. r. werleri* are new host records. Veracruz, Mexico is a new locality record for all helminths found in *N. r. werleri*.

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***NINIA MACULATA* (Banded Coffee Snake). REPRODUCTION.** *Ninia maculata* is a diurnal species distributed from Honduras to Costa Rica from 36 to 1800 m in elevation (Savage 2002. The Amphibians and Reptiles of Costa Rica: a Herpetofauna Between Two Continents, Between Two Seas. Univ. Chicago Press, Chicago, Illinois. 934 pp.). It is considered abundant across its range and inhabits a wide variety of habitats, including urban, semi-urban, and agricultural areas. To date, there has been little data published on the reproduction of this species. Here we report some observations on the nesting and reproductive ecology of *N. maculata* in an urban habitat in the Central Valley of Costa Rica, including an extension of the nesting season and information on an unusually large clutch based on the size of the female.

On 25 September 2003 we observed a female *N. maculata* (SVL = 215 mm; tail length = 70 mm) laying eggs at 2100 h in the leaf litter under closed forest cover in a small forested area at the Instituto Nacional de Biodiversidad Park (INBio Parque), which is located within the urban area of Santa Rosa in Santo Domingo de Heredia, Costa Rica (9.97365°N, 84.09310°W, datum WGS84; elev. 1128 m). The clutch consisted of three eggs measuring 28, 29 and 30 mm by 13, 14 and 15 mm, respectively. The eggs were deposited in a small hole in the leaf litter with high moisture levels, and the hole was entirely within the leaf litter and did not reach the mineral layer of the soil. All three eggs hatched on 15 March 2004, completing an incubation period of 5 months and 20 days, with offspring measuring 76, 80 and 86 mm SVL. The incubation period has not been reported previously for this species. This observation also increases the previously reported period for egg laying; Solórzano (2004. Serpientes de Costa Rica. Instituto Nacional de Biodiversidad. Santo Domingo de Heredia, Costa Rica. 791 pp.) reported that egg laying occurs between October and March and hatching between January and June. Our observation is in agreement with year-round reproduction observed by Fitch (1970. Univ. Kansas, Mus. Nat. Hist., Misc. Publ., 52:1–247). Finally, based on previous work by Goldberg (2004. Tex. J. Sci., 56:81–84), this observation represents an unusually large clutch based on the female's body size.

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***OLIGODON ARNENSIS* (Common Kukri Snake). DIET.** Snakes of the genus *Oligodon* are commonly known as Kukri snakes because of their knife-shaped hind teeth which are curved like a Nepalese knife (Kukri). The interesting morphology of their teeth is very effective for cutting open eggs, upon which this these snakes commonly feed (Green et al. 2010. Asian Herptol. Res. 1:1–21). Here we report an instance of *Oligodon arnensis* preying upon a lizard, the skink *Eutropis multifasciata*. On 27 February 2011, at 2030 h, we observed an *O. arnensis* in the process of subduing an *E. multifasciatus* in the botanical garden of Robertson College (23.16237°N, 79.9700°E, datum WGS 84; elev. 414 m) Jabalpur, Madhya Pradesh, India. The snake took approximately 25 min to completely swallow the skink, after which it retreated into a burrow on an elevated site nearby. To our knowledge, this is the first record of *E. multifasciatus* in the diet of *O. arnensis*.

COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND



FIG. 1. *Oligodon arnensis* preying upon a skink, *Eutropis multifasciata*, in Madhya Pradesh, India.

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***OXYBELIS AENEUS* (Mexican Vinesnake). DIET.** *Oxybelis aeneus* is a common colubrid snake inhabiting a variety of habitats throughout Mexico, Central America, and northern South America (Savage 2002. The Amphibians and Reptiles of Costa Rica: a Herpetofauna Between Two Continents, Between Two Seas. Univ. Chicago Press, Chicago, Illinois. 934 pp.). This species is known to consume a wide array of prey, including lizards, amphibians, arboreal mammals, small rodents, small birds and fledglings, insects, and fish (Henderson 1982, Amphibia-Reptilia 3:71–80; Hetherington 2006, Herpetol. Rev. 37:94–95). Studies indicate that lizards, particularly anoles, are important prey for *O. aeneus* (Lee 1996. Amphibians and Reptiles of the Yucatán Peninsula. Cornell Univ. Press, Ithaca, New York. 500 pp.). On 26 May 2010, at 1300 h, on Playa Ventura, Guerrero, México (16.54097°N and 98.90697°W, datum NAD27; elev. ca. 48 m), one of us (AN-A) observed an *O. aeneus* in the process of constricting an adult *Sceloporus squamosus* which later was ingested head first (CAREM 0001 photographic voucher). This observation is the first record of *S. squamosus* in the diet of *O. aeneus*.

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***OXYRHOPUS FORMOSUS* (False Coralsnake). ELEVATION.** *Oxyrhopus formosus* is a rare and poorly studied snake with a disjunct distribution in northwestern South America and in the Atlantic rainforest (Bailey 1986. *In* Peters and Orejas-Miranda [eds.], Catalogue of Neotropical Squamata. Part I. Snakes, pp. 229–235. Bull. U.S. Natl. Mus.). According to Bailey (*op. cit.*), *O. formosus* encompasses a complex of forms. In addition, several records identified as *O. formosus* in northern South America are, in fact, *O. occipitalis*, as pointed out by Lynch (2009. Pap. Avul. Zool. 49:319–337) and MacCulloch et al. (2009. Pap. Avul. Zool. 49:487–495). This taxonomic chaos makes it difficult to define geographic distribution limits of *O. formosus* sensu stricto, including the maximum elevations inhabited by the species. The holotype of *O. formosus* was collected in Mucuri, Bahia, Brazil, in the heart of Atlantic rainforest (Bailey, *op. cit.*). In this biome, the only information on the occurrence of the species in highlands is a photographic record from the Reserva Biológica de Duas Barras at an elevation between 550 and 738 m (Tonini et al. 2010. Biota Neotrop. 10:339–351). Here, we present the first elevational records of *O. formosus* in the mountains of the Atlantic rainforest biome.

In February 2010, an *O. formosus* was killed by farmers in a cocoa plantation on the farm Alto Bela Vista (14.61°S, 39.60°W, datum WGS84), ca. 780 m elev., in the Serra da Palha, municipality of Coaraci (Bahia), Brazil. A second individual was found at night (2200 h) on the edge of a stream in a forest (14.70°S, 39.60°W) at ca. 735 m elev. in the Serra do Corcovado, municipality of Almadina (Bahia) on 18 February 2011. These sites are about 10 km apart in Southern Bahian wet forest habitat. Voucher specimens (MZUESC 8485, 9250) are deposited in the Museu de Zoologia da Universidade Estadual de Santa Cruz, Ilhéus, Bahia, Brazil.

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***PANTHEROPHIS GLOYDI* (Eastern Foxsnake). REPRODUCTION-CLUTCH SIZE.** On 1 July 2009 we captured a *P. gloydi* at Shiawassee National Wildlife Refuge in Saginaw Co., Michigan, USA, as part of a radio telemetry joint project conducted by Central Michigan University and the U.S. Fish and Wildlife Service. The snake was a large gravid female (SVL = 1550 mm; total length = 1750 mm; 1654 g). The snake was radiographed after transmitter implant surgery, revealing a clutch of 34 eggs. To our knowledge, this represents a new maximum clutch size (previous maximum = 29 eggs, mean = 14.4 eggs) and near record length (previous maximum total length = 1791 mm; Conant and Collins 1998. A Field Guide to Reptiles and Amphibians of Eastern and Central North America. Houghton Mifflin, New York. 640 pp.). Evidence of vigorous reproduction in this species is of particular conservation interest, as this species is now uncommon or rare where it was once abundant (Harding 1997. Amphibians and Reptiles of the Great Lakes Region. Univ. Michigan Press, Ann Arbor, Michigan. 378 pp.).

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***PHILODRYAS OLFERSII*. DIET.** The colubrid snake *Philodryas olfersii* is widely distributed in South America, occurring in Brazil, Peru, Bolivia, Paraguay, Uruguay, and Argentina (Peters and Orejas-Miranda 1970. Bull. U.S. Natl. Mus. 297:1–347). The species is known to have semi-arboreal habits and inhabit forested areas. Studies have documented a variety of diet items, including small mammals, birds, and anurans (Hartmann and Marques 2005. Amphibia-Reptilia 26:25–31; Leite et al. 2009. North-West. J. Zool. 5:53–60; Vitt 1980. Pap. Avul. Zool. 34:87–98).

On 19 December 2010 we collected a female *P. olfersii* (SVL = 890 mm; tail length = 47 mm; mass = 203 g) in restinga habitat (coastal sand dune vegetation habitat of the Atlantic Rainforest domain), municipality of São João da Barra, State of Rio de Janeiro, Brazil (21.7374556°S, 41.0311306°W; datum WGS84). The snake was unresponsive, and when dissected, was found to contain the digested remains of a colubrid snake, probably *Clelia* or *Boiruna*, based on head scales, in its stomach. We also observed a large edema and a perforation at the posterior portion of the stomach and necrosis of adjacent tissues, including rib musculature (Fig. 1.). In that portion of the stomach, we found the decomposed remains of a keeled-scaled viperid snake, likely *Bothropoides neuwiedi*, *B. jararaca*, or *Bothrops jararacussu*. We suspect that the tissue necrosis may have been caused by the venom of the ingested snake, either through a bite, or release of venom into an existing wound in the stomach of the *P. olfersii*.

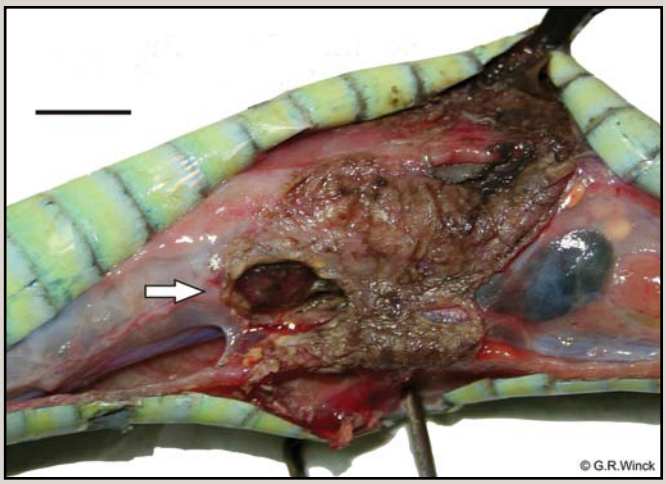


FIG. 1. Internal edema in the stomach of a *Philodryas olfersii* from the municipality of São João da Barra, state of Rio de Janeiro, Brazil. White arrow shows the perforation of the stomach, associated to the ingestion of a venomous snake.



FIG. 2. *Philodryas olfersii* found deceased with a tropidurid lizard, *Tropidurus torquatus*, protruding from its mouth. The specimen was collected at a restinga habitat, municipality of São João da Barra, state of Rio de Janeiro, Brazil.

On 21 December 2010 we collected another female *P. olfersii* (SVL = 434 mm, tail length = 200 mm, 91.1 g) in the same locality. The snake was dead with a partially ingested (head first) *Tropidurus torquatus* (SVL = 94 mm, tail length = 107 mm, 16.9 g; Fig. 2.) protruding from its mouth. Apparently, the snake failed in its attempt to ingest the lizard and was not able to regurgitate the large prey item. The inability of the snake to regurgitate may have been partially due to the lizard's scales, which are imbricated and oriented in posterior-anterior direction. Indeed, another case of a snake (*Bothropoides pradoi*) dying after attempting to ingest a large *T. torquatus* has been reported (Rocha et al. 1997. Herpetol. Rev. 28:153–154). Our observation represents an additional case of the not uncommon situation where a snake dies after being unable to regurgitate a large prey item. Voucher specimens of the snakes and the prey are housed at the Museu Nacional (MN-UFRJ), Rio de Janeiro, RJ, Brazil (the first as MNRJ 20107, and the second as MNRJ 20109).

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***PHILODRYAS TRILINEATA* (Argentine Mousehole Snake). DIET.** *Philodryas trilineata* is a large and robust colubrid snake endemic to Argentina (Leynaud and Bucher 1999. Misc. Publ. Acad. Nac. Sci. Córdoba 98:1–52). The diet of this species is known to include small vertebrates such as lizards, birds, and rodents (Cei 1993. Reptiles del Noroeste, Nordeste y Este de la Argentina. Herpetofauna de Zonas Áridas y Semiáridas. Mus. Reg. Sci. Nat. Torino. Monografie IV. 945 pp.). Here we report an observation of *P. trilineata* feeding upon a novel prey species, *Upucerthia ruficauda* (Stright-billed Earthcreeper) fledglings.

On 14 December 2008, at 1411 h, in Quebrada Vallecito, Andes Mountains, Calingasta Department, San Juan Province, corresponding to pre-Andean limit of the occidental Monte Phytogeographic Region, Argentina (31.2°S, 69.6°W, datum WGS84; elev. 2543 m) we discovered an adult female *P. trilineata* (total length = 1070 mm) lying motionless beneath a shrub (*Larrea coneifolia*). As we approached, we noticed that the snake had a dark prey item in its mouth, pinned to the ground. The prey item was found to be a fledgling *U. ruficauda*. Dissection of the snake revealed another intact *U. ruficauda* fledgling in the stomach. Together, they two prey totaled 50% of the snake's mass.

The snake and prey were deposited in the Colección Herpetológica de la Universidad Nacional de San Juan (CH-UNSJ 3212)

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***PITUOPHIS CATENIFER* (Gophersnake). DIET.** The feeding ecology of *Pituophis catenifer* is one of the best known of any snake species (Rodríguez-Robles 2002. Biol. J. Linn. Soc. 2002:165–183). While 213 (18%) of the more than 2600 specimens reviewed by Rodríguez-Robles (2002, *op. cit.*) contained birds or their eggs, only two contained the remains of owls or their eggs (Imler 1945. J. Wildl. Manage. 9:265–273, Short-eared Owl, *Asio flammeus*; 2 nestlings, Nebraska; McCallum et al. 1995. Wilson Bull. 107:530–537; Flammulated Owl, *Otus flammeolus* eggs, New Mexico).

On 25 May 2005, during routine nest burrow monitoring on Kirtland Air Force Base (KAFB), Bernalillo Co., New Mexico, USA, KCM and OCC discovered and photographed a dead *P. catenifer* (Fig. 1) lying approximately 15 m from an active burrow that was being utilized by a Burrowing Owl (*Athene cunicularia*) to incubate eggs that were expected to hatch around 31 May. The cause of death of the *P. catenifer* was not determined, although it contained an obvious large food bolus. After dissection, the bolus was identified as an adult Burrowing Owl which had been banded during an ongoing study of Burrowing Owls on KAFB.

During studies of Burrowing Owls on KAFB, it was suspected that adults, juveniles, or eggs had been predated by snakes. There were burrows where young chicks were observed one evening, but were missing the following morning with no signs of digging, tracks, or other mammal activity around the burrow, and also no owl feathers or carcass. To our knowledge this is the first verified report of a Burrowing Owl being preyed upon by *P. catenifer*.

PHOTO BY OCTAVO AND KIRSTEN CRUZ



FIG. 1. Dead *Pituophis catenifer* found near an occupied Burrowing Owl (*Athene cunicularia*) nest burrow, Kirtland Air Force Base, Bernalillo County, New Mexico, USA. Dissection revealed that it had consumed an adult Burrowing Owl.

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***STORERIA OCCIPITOMACULATA* (Red-bellied Snake). BEHAVIOR AND REPRODUCTION.** On 7 Sep 2006, at ca. 1530 h, we observed a cluster of four adult *Storeria occipitomaculata* wrapped around a branch about 1 m off the ground in a young Sourwood (*Oxydendrum arboreum)* tree. The area was located below the main sandstone cliff-line in a small ravine in southeastern Powell Co., Kentucky, USA, a rugged area with massive sandstone cliff-lines and extensive limestone outcrops. The snakes were in such a tight mass that we could initially only see two heads but two of them dropped to the ground in response to being disturbed by our group. The remaining pair moved down the tree and escaped. Since the four snakes were all of one species and were of adult size, and the time of observation falls within the known breeding period, it is likely that this was a mating aggregation. Although individual *S. occipitomaculata* have been observed in low vegetation (Barbour 1971. Amphibians and Reptiles of Kentucky. Univ. Press Kentucky, Lexington. 334 pp.; Green and Pauley 1987. Amphibians and Reptiles in West Virginia, Univ. Pittsburgh Press, Pittsburgh. 241 pp.). Our observation of aggregative behavior in these snakes is unique in that the site was open and arboreal rather than in burrows or under objects. This observation also confirms that this species mates in late summer. Previous reports indicate that mating occurs in spring and possibly in late summer and fall (Barbour, *op. cit.*; Martof et al 1980. Amphibians and Reptiles of the Carolinas and Virginia, Univ. North Carolina Press, Chapel Hill. 264 pp.; Green and Pauley, *op. cit.*; Willson and Dorcas 2004. Southeast. Nat. 3:1–12).

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***TANTILLA ARMILLATA* (Black-necked Crowned Snake). REPRODUCTION.** Much remains to be learned about the natural history of Central American snakes, particularly among the various small leaf-litter taxa. Snakes of the genus *Tantilla* are rare to common components of the leaf litter guild. Savage (2002. The Amphibians and Reptiles of Costa Rica: a Herpetofauna Between Two Continents, Between Two Seas. Univ. Chicago Press, Chicago, Illinois. 934 pp.) makes no mention of any aspect of the reproductive biology of *T. armillata* and Solorzáno (2004. Snakes of Costa Rica: Distribution, Taxonomy, and Natural History. Instituto Nacional de Biodiversidad, Santo Domingo de Heredia, Costa Rica. 791 pp.) notes only that this snake is oviparious, but that nothing is known of the reproductive cycle.

On 11 August 2010, at ca. 1130 h, a female *T. armillata* (SVL = 24.5 cm; US National Museum Field Series 254029) was collected from under a small wooden slab in cut-over forest on a hillside adjacent to La Barrigón Elementary School, 4 km N of El Copé, Coclé Province, Republic of Panama (8.6424111°N, 80.5899556°W, datum WGS84). When captured, it was noted that the snake had two eggs clearly visible through the body wall. When dissected, the eggs measured 21.39 mm × 5.28 mm and 21.04 mm × 6.29 mm. To our knowledge this is the first record of reproduction in this taxon. Pending a review of the taxonomy of the *T. melanocephala* group in Panama, we follow Savage (*op. cit.*) in the use of the name *Tantilla armillata*.

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***TANTILLA RETICULATA* (Lined Crowned Snake). DIET.** Although members of the colubrid genus *Tantilla* often are referred to as "centipede snakes," the use of this food source has been confirmed for relatively few of the 60 species currently recognized (Canseco-Márquez et al. 2007. J. Herpetol. 41:220–224), especially the numerous tropical species. *Tantilla reticulata* is found at low to moderate elevations (near sea level to 1430 m) of the Atlantic versant, from southeastern Nicaragua to Panama and both the Atlantic and Pacific versants of northwestern Colombia (Wilson 1985. Cat. Am. Amphib. Rept. 370.1; Solórzano 2004. Serpientes de Costa Rica/Snakes of Costa Rica. INBio, Santo Domingo de Heredia. 791 pp.). To our knowledge, information on the diet of this snake is unavailable, except for the presumption that it feeds on centipedes (Guyer and Donnelly 2005. Amphibians and Reptiles of La Selva, Costa Rica, and the Caribbean Slope. Univ. California Press, Berkeley. 299 pp.). Here we document the consumption of an adult centipede (*Scolopocryptops* sp.) by an adult *T. reticulata* (Fig. 1.). This interaction was observed in primary rainforest on Cerro Frío, Yorkín, Prov. Bocas del Toro, Panama (9.43730°N, 82.84164°W, datum WGS 84; elev. 850 m), on 25 October 2008, at 0840 h. The two animals were found in a crack in a fallen log. The snake and the centipede are deposited in the Museo de Vertebrados de la Universidad de Panamá (MUVP 1988).

We thank Angel Solís, who took the photographs during the Expedición de Proyecto Herramientas Básicas para el Manejo del Parque Internacional Lam Amistad: Costa Rica-Panamá, financed by Iniciativa Darwin del Reino Unido. We also thank Eduardo Boza for providing the collecting information on the specimen.

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COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND



FIG. 1. *Tantilla reticulata* found consuming a large centipede (*Scolopocryptops* sp.) at Cerro Frío, Yorkín, Prov. Bocas del Toro, Panama.

***THAMNOPHIS ELEGANS* (Terrestrial Gartersnake). DEFENSIVE BEHAVIOR.** Anti-predatory behavior of gartersnakes (*Thamnophis* spp.) has received considerable attention with respect to behavioral variation associated with either age, temperature or hormonal status of an individual under attack (e.g., Langkilde et al. 2004. Ethology 110:937–947). However, field observations under natural conditions are lacking. Here, we report variation in the anti-predatory behavior of a single *T. elegans*, exposed to mock predation by humans and dogs.

At 1000 h on a sunny day (air temp = 21°C) we captured a *T. elegans* (unsexed; ca. 700 mm total length) near the margin of a pool in an open meadow surrounded by Petran Montane Forest



FIG. 1. Dog approaching *Thamnophis elegans* from the front. Note the elevated tail of the snake.

(34.29931°N; 110.88642°W; datum NAD27; elev. 2300 m) in Coconino Co., central Arizona, USA. The snake was first captured at the pool's edge and was moved ca 10 m away to obtain photographs. As we photographed the snake, it consistently moved in the opposite direction from any person that walked toward the snake. With each approach, it reversed direction, and continued its evasive movements in the opposite direction from the nearest individual. After three minutes of these interactions, we allowed a leashed dog (Cardigan Corgi; Fig. 1) to approach the snake. Though the dog slowly approached the snake from the rear, the snake immediately ceased its forward motion and lifted its tail while simultaneously exuding cloacal contents and musk over the posterior portion of its body. The dog cautiously approached, but appeared irritated by the scent or lack of movement. The snake remained motionless for ca. 30 sec while the dog remained between ca. 30 cm to the rear of the snake. At no time did the snake re-orient to face the dog.

When the dog was removed and a person approached the snake from the rear, it again moved forward, resuming its previous pattern of escape behavior. When the dog was allowed to approach the snake a second time, from in front of the snake, it again stopped moving, elevated its tail and began exuding cloacal contents (Fig. 1). The snake remained motionless, except for tail movement, until the dog was removed, but resumed its straight-line flight behavior when approached by a person a third time. Thus, the snake's response to the approach of a human was flight, whereas it ceased movement and exuded musk and cloacal contents in response to the approach of a dog. It is unclear what proximate cues might play a role in the differential anti-predatory behavior we observed, and which natural predators may have prompted evolution of such behaviors, but our observations add to a growing list of species-specific defensive behavior exhibited by squamates when approached by potential predators. Gibbons and Gibbons (2009. Herpetol. Rev. 40:440) noted differential defensive behavior by *Coluber constrictor* in response to approaches by cats and humans, respectively, and Sherbrooke (pers. comm., 2011) has noted a number of predator-specific defensive behaviors of horned lizards (*Phrynosoma* spp.) in response to attacks by a variety of predators (carnivores, squamates).

Special thanks to Elizabeth Sullivan and Darci, the cautious dog predator.

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***THAMNOPHIS SIRTALIS SIRTALIS* (Eastern Gartersnake). COLORATION.** Unique color variations such as amelanism and leucism are not unusual in *T. s. sirtalis* and have been documented multiple times (Cook 1986. Herpetol. Rev. 17:23–24; Shively and Mitchell 1994. Herpetol. Rev. 25:30). *Thamnophis s. parietalis* and *T. elegans vagrans* have shown other color variations including axanthism and melanism (Mason et al. 1991. Herpetol. Rev. 22:61; Peterson and Fabian 1984. Herpetol. Rev. 15:113). Melanistic *T. s. sirtalis* have also been well documented in the Lake Eerie area (Conant and Collins 1998. A Field Guide to Reptiles and Amphibians of Eastern and Central North America. Houghton Mifflin, New York. 640 pp.). *T. s. similis* in northern Florida exhibits a blue coloration, but this is considered normal coloration and not axanthism (Conant and Collins, *op. cit.*). Axanthic individuals, however, have not been documented in *T. s. sirtalis*.



FIG. 1. An axanthic female *T. s. sirtalis* found at Table Rock State Park, Pickens Co., South Carolina.

An axanthic adult female *T. s. sirtalis* (SVL = 69 cm, 245 g) was captured on 25 May 2010 at Table Rock State Park, Pickens Co., South Carolina, USA (Fig. 1). The snake was dark gray and black with blue dorsal and lateral stripes instead of the usual yellow. Its ventral scales were also light blue in color. The snake was gravid at the time of capture and on 22 July 2010 gave birth to 31 live and 1 stillborn normal colored neonates. She later died in captivity and has been added to the Campbell Museum of Natural History at Clemson University.

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***UROTHECA EURYZONA* (Halloween Snake). REPRODUCTION.** *Urotheca euryzona* is an uncommon fossorial coral snake mimic distributed within humid forests of lowland and premontane Latin America, from northern Nicaragua south to Ecuador. On 10 March 2011, at 2345 h, we collected a gravid female *U. euryzona* (SVL = 414 mm; tail length = 222 mm, 22.2 g) moving on the ground in a section of *Manicaria* swamp forest at Caño Palma Biological Station, 8 km N of Tortuguero National Park, Limón Province, Costa Rica. One day later the snake died and was dissected, revealing five eggs. The eggs averaged 20.82 mm in length, 9.18 mm in width, and 1.10 g in mass. *Urotheca euryzona* was previously presumed to be oviparous based on the knowledge of oviparity in *U. elapoides* (Greene 1969. J. Herpetol. 3:27–31). Thus, this represents the first published account of oviparity and clutch size for *U. euryzona*. We deposited the specimen along with the eggs in the herpetological collections of the Universidad de Costa Rica. We thank the Ministerio del Ambiente y Energía Sistema Nacional de Áreas de Conservación for granting us research permits.

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BOOK REVIEWS

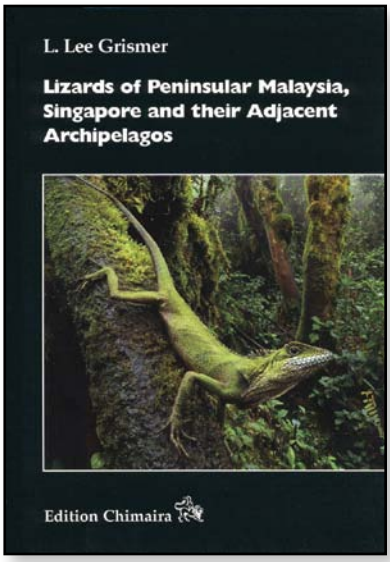
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Lizards of Peninsular Malaysia, Singapore and their Adjacent Archipelagos

by L. Lee Grismer. 2011. Edition Chimaira, Frankfurt am Main (www.chimaira.de). 728 pp. Hardcover. 98,00 Euros (approximately US $125.00). ISBN 978-3-89973-484-3.

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Many books have recently been published on the herpetofauna of Southeast Asia, but this is not just yet another of them. This new opus, a *chef-d'oeuvre* as we are tempted to say, is extremely informative and accurate, amazingly illustrated, and summarizes an impressive amount of knowledge and experience accumulated by the author on the subject treated. With its excellent glossy paper and high binding quality, it sets new, very high standards for herpetological books on the region. The author is already well known for his work on herpetological subjects in both the Old and the New Worlds and for his large number of mostly taxonomic publications on the reptiles of Peninsular Malaysia, including a recent guide on the reptiles and amphibians of the Seribuat Archipelago (Grismer 2011), and the (co-)description of 32 of the 124 Peninsular Malaysian native lizard species—i.e., more than a third!—, among them 14 of the 19 local *Cnemaspis* spp., and 8 of the 16 *Cyrtodactylus* spp.

The main sections of the book are the brief introduction (pp. 14–15), an abundantly illustrated presentation of the physical and natural environments and the climate found in the area covered by the book (pp. 17–80), a general presentation of the local herpetofauna with a history of the herpetological research on the area (pp. 81–96), the species accounts (pp. 97–703) which form the principal part of the book, including identification keys to families, genera, and species, a brief section on two introduced exotic lizard species (the iguanid *Iguana iguana* and the agamid *Physignathus cocincinus*) (p. 704), another brief section on conservation (pp. 705–707), and the bibliographic references (pp. 708–728).

With not a single exception, photographic illustrations in the book are absolutely astonishing. Among the 530 figures in the book, all in color, one is a map of Southeast Asia, two others are maps of Peninsular Malaysia, 96 show habitats (sometimes featuring a snake or an amphibian as well), and all others are lizard photographs, including lizards in their natural habitat and detailed views of body parts (such as heads with extended dewlaps or expanded wings of *Draco* spp.). Each photograph is accompanied by detailed locality data, which adds a lot of information. Actually a few photographs lack locality data (in particular, the *Gekko smithii* on pp. 82–83 was photographed on Pulau Perhentian Besar, Terengganu; the *Cyrtodactylus consobrinus* on p. 290 was in Hutan Lipur Sekayu, Terengganu; the *Eutropis multifasciata* p. 544 was in Bukit Larut, Perak, and the *Varanus salvator* on p. 683 was in Kuala Perlis, Perlis; L. L. Grismer, pers. comm.). Photos of Malaysian lizards were taken by the author in virtually all kinds of environments, from mangroves and highland cloud forests to karst caves, restaurants, and even massage parlors. One of the most extraordinary photographs in the book, on page 101, used to illustrate the introduction to Agamidae, shows a *Gonocephalus robinsonii* in its biotope. We asked Lee Grismer how this remarkable shot was taken: "The wide angle shot took several days to set up. I thought about it for a week before I shot it and I had very specific ideas and images in my head of what I wanted. I wanted a flashy upland endemic known only from a cloud forest and the shot to 'feel' cold and wet. I scouted out a place in Cameron Highlands to shoot the lizard and stayed throughout the day to determine at what time the best light would occur and hopefully get an idea of when the fog would arrive. Then I went to an area to where *Gonocephalus robinsonii* are the most attractive. I caught the lizard and brought it back to the site and set it on the log and got my gear ready. Just as I began shooting, the clouds began to roll in as you can see in the top of the photo" (L. L. Grismer, pers. comm.).

Each species account includes the scientific name of the species and its author(s), a common Malaysian name, a reference to the original description of the species with the type locality, a diagnosis, a morphological description, a coloration description, a distribution section, a natural history section, and a list of the examined museum material with collection numbers and localities. In some species, when appropriate, there is an additional section

on geographic variation. In those cases where the species is variable or suspected to be a species complex, the variation is often well illustrated in the several photographs provided, and several potentially undescribed species are illustrated (like the lowland form of *Cnemaspis mcguirei* shown on figures 287–288, which actually represents a distinct, undescribed species — L.L. Grismer pers. comm., as well as several atypically colored *Cyrtodactylus pulchellus*). Each species account is accompanied by a specific dot map, with a detailed caption listing the mapped localities (these maps are not counted among the 530 figures mentioned above). Maps are not provided for only four species: *Hemidactylus frenatus* and *Eutropis multifasciata*, because they are ubiquitous, and the two introduced alien species. About 90% of the photographs were taken by the author himself. Only nine species are not illustrated (*Pseudocalotes dringi*, *Cnemaspis argus*, *Cyrtodactylus stresemanni*, *Lygosoma bampfyldei*, *Sphenomorphus anomalopus*, *S. cophias*, *S. langkawiensis*, *S. malayanus*, and *S. sibuensis*), and just a few species were illustrated only by photographs taken out of Peninsular Malaysia (*Hemidactylus garnotii*, from Myanmar; *Eutropis novemcarinata* from Myanmar; *Lygosoma albopunctatum*, from India; *Lygosoma herberti*, from Thailand; *Sphenomorphus maculatus*, from Cambodia; and *S. stellatus*, from Cambodia and Vietnam). Such a huge proportion of photos taken of individuals native to the area covered by the book is absolutely remarkable. Too many books are illustrated by photos of individuals from populations outside the area covered, and that sometimes later turn out to belong to distinct taxa.

Detailed morphological data on Malaysian lizards were lacking for many species, and dispersed in many journal articles, often old and difficult to find. This new book offers a very complete and homogeneous description of each species, in a level of detail that has not been achieved in any synthetic work on Southeast Asian lizards since Taylor's (1963) opus on Thai lizards. These detailed morphological descriptions make the book an extremely useful tool for identification and for the future work of taxonomists.

The natural history section is based on very thorough field notes taken for 15 years and retrieved from taxonomic indices the author put in his notebooks at the end of each year, a method that was already successfully adopted for the author's book on Baja California (2002). It is by reading these field notes that one fully realizes how much field work actually entered into this book: many remote localities were visited at numerous occasions over a number of years and at different seasons, which allowed, among other useful information, a better understanding of the reproductive cycles of each species. Lee Grismer's *in situ* observations represent a really large proportion of what is presently known on the natural history of the local lizards. These natural history accounts testify to the quasi-obsessional dedication of the author to the improvement of our knowledge on each species. Another sign of this extreme dedication is the large number of Malaysian and American students and researchers Lee Grismer has trained and is still training on Malaysian herpetology through courses and group field trips, as notably reflected by the multi-authorships of many papers listed in the literature section.

The literature cited section includes 480 pertinent references, the most recent of which date from early 2011 (indeed on page 99 it is stated that the acquisition of data for the book terminated on 3 April 2011, a very useful bit of information that we would encourage all book authors to provide).

Negative points about this remarkable book are few, and to find most of them required a very thorough examination of the book. The introduction gives a list of the species with scientific and common names, but the latter are not always those used in the main text of the book. We regret the absence of an index in the book. More importantly, we feel there should be an introductory chapter on scale morphology and morphological characters used in identification keys. The keys are very well conceived, but are usable only by persons who already have a very good knowledge of lizard meristic characters. Drawings showing the various scale types, and a brief definition of each type, would have allowed more people to use the keys without needing recourse to other books describing and illustrating these characters. The key to *Draco* spp. (p. 158) largely uses the number of ribs supporting the patagium, but the variation in rib numbers in the key does not reflect the whole variation as indicated in the species accounts (see accounts for *D. formosus*, *D. sumatranus*, and *D. taeniopterus*), which might lead to some misidentifications. The key to scincid genera (p. 545) misses entries to the genera *Dasia* and *Eutropis*. The key to *Sphenomorphus* spp. (couplet 7) states that *S. langkawiensis* has 60–62 paravertebral 'scales' (actually 'scale rows'), while the species account indicates it has 60–72; this mistake has some consequences for the use of the key. In couplet 11 of the same key, there is an alternative between six and five supraoculars, but it does not take into account the variation within *S. scotophilus* (as given in the species account), which also makes the key to *Sphenomorphus* spp. a bit delicate to use. The type locality for *Lygosoma herberti* was copied and pasted from that of the former species account (*L. bowringii*: Hongkong), but is actually 'Nakhon Si Thammarat Mts., peninsular Thailand' (Taylor 1963). As the author states, the book does not intend to provide a detailed taxonomic history for each species; however, for a number of recently described species, natural history data, summarized in the species accounts' natural history sections, were published before their description, and it would have been useful to know under which name they had then been referred to. A number of references cited in the main text are missing in the literature cited section, and in the latter several references are not in alphabetical order. There are some typographic errors in the book, but these certainly do not occur with a frequency that would distract from the reading and consultation of the book. These few negative points are by no means significant in view of the extremely high general quality of the book.

Lee Grismer has to be congratulated to have restricted himself to a limited and manageable taxonomic group over a limited geographical area, and to have provided detailed and comprehensive information about it, as well as identification keys including all species treated and photographs illustrating nearly all of them. There is indeed a dangerous tendency, maybe motivated by commercial reasons imposed by publishers, for guides to cover too many species over a too large geographical area. This tendency is well examplified by a recent "field guide" that treats about 1000 reptile species and subspecies from eight Southeast Asian countries (Das 2010), including Malaysia and Singapore. This represents so many taxa and so much information to deal with that in the end, to fit in a single book, descriptions had to be extremely brief and not sufficiently diagnostic. Further, no keys were provided, more than a third of the lizards were not illustrated, and much information is missing or erroneous, rendering the guide very superficial and nearly impossible to use in the field for identification purposes (Pauwels and David 2011). Accounts on Malaysian lizards contained so many errors that in the opus discussed here, Grismer had to mention these mistakes in not less than 48 instances throughout the book.

Lee Grismer's latest book is absolutely exceptional by universal standards, and it is without any hesitation that we strongly recommend it to all naturalists, herpetologists, teachers, and conservationists who want to know more about Malaysian lizards and Peninsular Malaysia. The author is currently working on the description of more than 15 new Malaysian lizard species (Gekkonidae and Scincidae), that will be integrated into a next edition of the book; with Malaysian colleagues he is finishing up a book on Malaysian snakes, and he will as well participate in a book on Malaysian amphibians that should appear next year—all books will be of the same style as the one treated here (Grismer, pers. comm., Dec. 2011). Needless to say, we are waiting impatiently.

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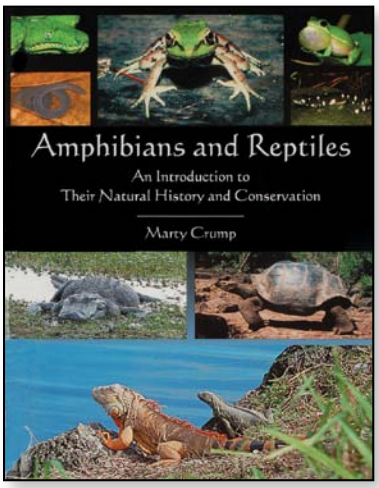
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Amphibians and Reptiles: An Introduction to Their Natural History and Conservation

by Marty Crump. 2011. McDonald & Woodward Publishing Company (www.mwpubco.com). 249 pp. Softcover. US $29.95. ISBN 978-1-935778-20-2.

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Herpetologists know that amphibians and reptiles are endlessly engaging of the mind and spirit, and deserving of our efforts to protect them and their habitats. We do require people, however, who can transition information from herpetological journals to popular outlets. We especially need those who can reach out to children, because as the author notes in her dedication to this book, children "hold the future of amphibians and reptiles in their hands."

According to information posted on Amazon.com, Marty Crump's latest book is intended for middle-school children and older. It is a revision of the first edition (2002), which became, according to the publisher's website, "the 'Outstanding Trade Book for Students, K-12' in 2004 and 'Selector's Choice,' an award given jointly by the National Science Teachers Association and the Children's Book Council."

Dr. Crump is well-known to readers of this journal for her work in tropical herpetology and behavioral ecology, which led her to author such books as *In Search of the Golden Frog* (2000), *Headless Males Make Great Lovers: And Other Unusual Natural Histories* (2007), *Sexy Orchids Make Lousy Lovers: & Other Unusual Relationships* (2009), and *Extinction in Our Times: Global Amphibian Decline* (2009, coauthored with James P. Collins). The book under review here is the second of her children's books; the other is the recently-published *Mysteries of the Komodo Dragon: The Biggest, Deadliest Lizard Gives Up Its Secrets* (2010). She is also the coauthor of one of the herpetology textbooks, now in its fourth edition (2009).

Since this book is pitched at children in grades 6–8, I ran the first paragraph of the first chapter through a test for readability scores, which provided a mean score of 7.7 grade level for five measures, which is appropriate. The book contains 17 chapters, which have an average length of 13.1 pages. This seems like a comfortable read for the intended 12–14-year-olds, especially as the chapters often are divided into sections and provided with numerous illustrations.

I found two features of the book's chapters especially inviting. One is that the illustrations, both black-and-white (135 of them) and color (eight multi-photo plates), have legends that provide the reader with some interesting information about the creature pictured. For example, the legend for figure 7 on page 9 of the first chapter reads: "Komodo dragons, the largest lizards in the world, get their food in three major ways. They ambush active prey, attack sleeping animals, and eat dead animals such as these fish washed up onto the beach." The photograph, naturally, shows one of these varanids consuming some dead fish.

Among the color photographs is one that is truly "suitable for framing." It shows Dr. Brady Barr hefting a 4-foot 9-inch *Andrias japonicus*. The question posed by the author is how he can manage to hold onto such a slippery creature. Although Brady is smiling (well, maybe grimacing), he is probably hissing "Quick, take the damn photo!" This photo also appears on the AmphibiaWeb site and must be seen to be believed. The information provided there indicates that the animal (the salamander, not Brady) weighed 86 pounds (39 kg).

Another color photo, of the Titicaca Water Frog (*Telmatobius culeus*), taken by Danté Fenolio, is rather eerie. Crump says, "What a face!" I agree. It is a good choice to place in this book, since this species is judged Critically Endangered by the IUCN, having undergone an 80% population decline in the last 15 years (amphibiaweb.org).

The other feature I found inviting is that words that might prove difficult for middle-schoolers are italicized, indicating they are defined in the four-page glossary. Nonetheless, an indication of their meaning often appears in the text, which helps the reading ease and promotes vocabulary expansion.

Dr. Crump's book also features three appendices. Appendix I lists additional resources (books and websites) on amphibians and reptiles, and their conservation (six pages). Appendix II provides names and addresses for 17 conservation organizations, ranging from the big, broad-scale groups like Conservation

International, World Wildlife Fund, and Worldwatch to groups with a narrower focus, such as Save the Frogs. Appendix III offers some "amphibian and reptile place names," such as Frog Suck, Wyoming, Toad Suck, Arkansas, and Lizard Lick, North Carolina, with an invitation for the reader to find more (the three I mention would be hard to beat). Appendix IV lists the photographic credits. The book concludes with a page and a half listing of the "main sources consulted," which are, as the author notes, "in addition to more than 100 scientific papers." An eight-page-plus index also is included, in which the references to illustrations are in boldface type.

The first six chapters are concerned with the natural history of amphibians and reptiles and the remaining 11 with their conservation. The initial chapter is entitled "Too Weird to Be True?" and is intended to pull the reader into the book. It deals with the appearance, defense mechanisms, parental care, and feeding of amphibians and reptiles and uses several unusual creatures as examples. The author notes that as "interesting as these isolated tidbits of information are, they really don't tell us much about reptiles and amphibians," so the next four chapters introduce more typical species to the reader. The first of these chapters answers the question "What are Amphibians and Reptiles?" by discussing their similarities and differences. Also, a two-and-a-half-page box introduces scientific classification and another provides four examples by using the seven standard taxonomic levels. Nevertheless, scientific names generally are avoided, although they could have been included in another appendix. The three chapters that follow, one of which deals with amphibians and the other two with reptiles, provide more details. As expected, each of these chapters is subdivided along ordinal lines, with discussions that summarize general information in a pleasant but information-packed narrative.

Chapter 6 describes the key roles amphibians and reptiles play in their ecosystems and sets the stage for the principal purpose of the book—to promote conservation. In doing so, Dr. Crump emphasizes the "conveyor-belt" role these animals play in "transfer[ing] energy from invertebrates to *endothermic* predators higher up the *food chain*." Thus, she provides a rationale for conserving amphibians and reptiles in their natural habitats by asking the question, "What would happen if Earth lost large numbers of amphibians and reptiles?" This central question is coupled with another, "How much longer will amphibians and reptiles be around to serve as critical components of ecosystems?," which provides the focus for the remainder of the book.

So, significant emphasis is placed on conservation, inasmuch as more than half of the book (131 of 249 pages) is devoted to this subject (indeed, this is the reason I was interested in reviewing this book). The author's examination of conservation issues begins with Chapter 7, entitled "Disappearing Acts." As its name suggests, this chapter deals with examples of decline and disappearance, the IUCN conservation status categories, numbers and percentages of amphibians and reptiles under threat, the six major causes of amphibian and reptile declines, and the features that render certain of these creatures more prone to population decline.

Chapter 8, entitled "Why Should We Care?" presents arguments explaining why amphibians and reptiles should be of concern to humans. Crump notes that we should care because we are responsible for most of the declines, we are still learning about these organisms, we put them to important uses, we recognize their importance in both aquatic and terrestrial ecosystems, and we acknowledge that "every living species has a right to exist."

The next two chapters explore direct and indirect reasons why amphibians and reptiles are undergoing decline. Chapter 9 considers the direct impacts, including the use of skins for leather and whole animals and parts as souvenirs, the use of flesh as food, the use of live creatures as pets, the use of body parts in folk remedies and modern medicine, and the use of living and preserved animals in research and teaching. Chapter 10 examines the indirect impacts of habitat modification and destruction, the introduction of exotic species, and environmental pollution.

Chapter 11 is entitled "Who Turned Up the Heat?" and obviously discusses global warming. The author indicates that humans have created the problem by burning fossil fuels, and disabled the fundamental solution by cutting down trees and plants, the carbon dioxide absorbers. She also notes that many amphibians and reptiles, including their eggs, might not be able to adapt to the warmer, drier conditions, as well as the predicted increase in UV levels.

The major environmental problem facing amphibians is discussed in Chapter 12, entitled "Attack of the Killer Fungus!" Logically, Dr. Crump begins the story of *Bd* with her personal story of watching *Incilius periglenes* disappear from the elfin forests at the Monteverde Cloud Forest Reserve in northern Costa Rica during the unseasonably warm and dry 1986–1987 period. Jay Savage had described this extraordinary toad only two decades earlier; since then, this anuran has become the "poster child" for amphibian conservation. Although the disappearance of *I. periglenes* has not been linked to *Bd* infection, this disease certainly has been demonstrated to be the causal agent in the decline of other amphibian populations on all continents where they occur. The author uses the El Valle, Panama, example of the "heroic airlift" that removed individuals of 35 species to sanctuary in Atlanta, Georgia, to ask a number of ethical questions about which species should receive our attention and for how long, especially since conservation dollars always are limited. Does it make sense to maintain certain species in captivity in the unconfirmed hope that their natural homes eventually might be able to support them in the indeterminate future? These kinds of questions can be used to set up debates in middle-school classes to teach students how to construct defensible arguments.

The remaining five chapters examine solutions for amphibian and reptile conservation, beginning with a chapter on human attitudes toward these creatures, entitled "Good or Bad? Love or Hate?" The author notes that people will "protect amphibians and reptiles only if they think these animals are worthy of protection." However, according to the author, only a nickel of every conservation dollar is spent on these animals. Then, the reader is regaled with stories of these organisms as symbols of both good and evil, depending on the nature of the superstitions and legends involved. She concludes the chapter by emphasizing the importance of knowing what people think about these creatures, as a prelude to changing negative attitudes that will increase our appreciation and desire to protect them.

Chapter 14 asks the question "We Can Live Together, Can't We?" The main point of this chapter is evident in the concept of living together and not apart. That is, conservation biologists must find ways to provide living spaces for amphibians and reptiles in a world that, as I write this sentence on Halloween, 2011, now supports a human population of seven billion. The seventh billion was added in just 12 years, the same length of time it took for the sixth billion to accrue. Dr. Crump emphasizes not only an obvious solution, preservation of land, but also ways in which we can change how we use the environment to promote amphibian

and reptile survival, such as building under-road tunnels (I am writing this review in Gainesville, Florida, where just south of town such structures have been installed in the road across the famed Payne's Prairie), digging ponds to facilitate amphibian breeding, and using shrimp nets equipped with turtle excluder devices.

The final three chapters deal with ways to help conserve amphibians and reptiles. Chapter 15 is concerned with "Research and Education." For herpetologists, it is self-evident that "We need more research to understand how we can best protect amphibians and reptiles." Clearly, we know much less about their lives than we have discovered to date, especially as new species continue to be discovered. As new taxa are named, the number and percentage of threatened forms will likely increase, and each new taxon will represent a new biology to explore. Since most species remain poorly-known, biologists are facing an enormous task. So, basic research is essential, as long as the right questions are being asked. Environmental education programs are the link between scientists and the public, and the author notes that such programs can be coupled with tourism to become ecotourism or provide opportunities for non-scientists to participate in scientific research. She also points out the importance of private individuals (read "children") educating themselves to become agents of change to benefit conservation.

Chapter 16, "What Else Can Be Done?," treats of other ways to protect amphibians and reptiles, such as through laws like the Endangered Species Act and the CITES treaty, which work when properly enforced. In addition, populations can be reestablished in their natural habitat, animals can be captive bred for skins, food, and pets, wild populations can be harvested more wisely, and alternatives to classroom specimen dissections can be used, like videotapes, CD-ROMs, and computer-based virtual dissections.

The last chapter is oriented toward the reader and asks, "What Can YOU Do to Help?" Actually, the discussion is divided among things for the reader to do—and not to do. The things not to do are somewhat limited, but the ones to do are more extensive, such as educating oneself about these animals, volunteering time to individuals and organizations, sharing information with others, supporting conservations organizations, being a responsible pet owner, and improving one's backyard to serve as habitat for amphibians and reptiles. The last paragraph of the book presents a simple, but powerful message—"You and I together can make a difference. Please help."

Marty Crump has done herpetologists a tremendous favor in creating this book directed toward middle-schoolers. She transferred our concerns about the fate of amphibians and reptiles expressed in our technical papers and books to the young people who can make a real difference in the years to come, in a way they can understand. She carefully crafted her book using the appropriate language level and engaging information about "our" creatures that can be read on more than one level. The text can be read straight through to provide a strong conservation message, but also can be explored more deeply by pursuing the information in the additional references and various appendices.

Although my elder grandson, at age nine, is still a bit young for this book, I think his burgeoning interest in herpetology will stand him in good stead and I plan to give him my copy. It won't be so long, anyway, before he will be ready to handle all this excellent book has to offer.

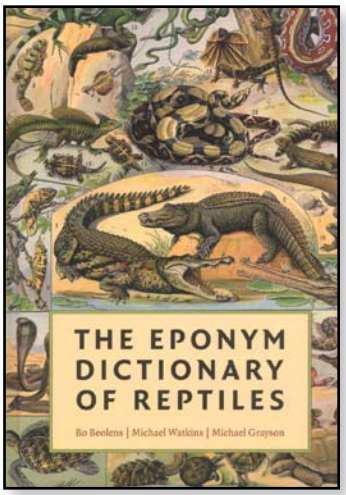
I have just a couple of suggestions for improvement, should this book go into a third edition. One is to turn the black-and-white illustrations into color. Amphibians and reptiles are colorful organisms and seeing their color patterns can increase their appeal to young readers. The other is to include ideas about appropriate projects and presentations for the target audience to make in school and other social settings.

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The Eponym Dictionary of Reptiles

by Bo Beolens, Michael Watkins, and Michael Grayson. 2011. Johns Hopkins University Press, Baltimore, Maryland (http://www.press.jhu.edu). xiii + 296 pp. Hardbound. US $100.00. ISBN 978-1-4214-0135-5.

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Most reptile aficionados will recognize that *Amphiesma boulengeri* has been named after George Albert Boulenger (1858–1937) or *Plestiodon copei* after Edward Drinker Cope (1840–1897). But who was the Dugand in *Leptotyphlops dugandi* (now *Trilepida dugandi*) or the King in *Anops kingi* (now *Amphisbaena kingii*)? Such questions are answered by the *Eponym Dictionary of Reptiles*, which tracks down the people after whom species have been named. This book is welcome because the issue at stake is not that trivial. For instance, there are quite a few species epithets which appear to be named for people but which originate from place names, such as *Chironius vincenti* named after the island St. Vincent. These cases are covered too. In addition, the dictionary contains those species that have been named after people but may not be obvious, e.g., *Eurydactylodes agricolae*, named after Aaron Bauer, whose last name means "farmer" in German, which is translated to "agricola" in Latin. Finally, some reptile names which may sound like people, such as *Anolis bicaorum*, have been named after organizations, here the Bay Island Conservation Association (BICA). While such cases are also included in the dictionary, they may not have been covered comprehensively as the origin of some names remains mysterious. Many older species descriptions did not explain their etymology, so once their authors have passed away it becomes a detective's job to figure out their history. In addition to the scientific names, Beolens et al. also catalogued those common names derived from people, such as Blanford's Pipe Snake (*Cylindrophis lineatus*), even though the scientific name is of purely Greek and Latin origin. Finally, a surprising number of species (or genera) have been named after mythical characters, be they from Tolkien's Lord of the Rings (*Liolaemus tulkas*) or Burroughs' Tarzan (*Calumma tarzan*), appropriately named after its arboreal lifestyle.

The Eponym Dictionary tracks down the names of a total of 4,130 species and subspecies and is alphabetically organized by eponym, that is, usually the last name of the person (or sometimes place, organization, etc.) after which species have been named. Each entry then lists the species named after that person. Most people have only one or two species named after them, but the superstars such as Boulenger or Cope can claim dozens of species named in their honor. For each person a very short biography is provided, sometimes only a sentence ("Charles Snell donated the holotype of this snake [*Vermicella snelli*] to the Western Australian Museum") but rarely exceeding a quarter of a page, even for the most famous herpetologists. While this heterogeneity is a certain weakness of the book, it may have been a necessary compromise to keep the book's size manageable. Nevertheless, it is one of those dictionaries which you may end up reading just for fun as it is a treasure trove of anecdotes, amusing factoids, and family gossip (many herpetologists named some snake or turtle after their wives [often!], sisters, uncles, mother-in-laws, or other family members and friends). We also learn about less pleasant aspects of being a herpetologist, such as the abrupt ends of Roberto Donoso-Barros (*Liolaemus donosoi* and other species) and Benoit Mys (*Carlia mysi*) in car crashes or Johan August Wahlberg (*Colopus wahlbergii*), who was killed by an elephant, or those scientists who died, perhaps fittingly, from snake bite (e.g., Robert Mertens and Joseph Slowinski).

Besides the heterogeneity of the entries, I have only few complaints: first, the introduction and background information is limited to a mere three pages. Here the authors explain how to use the book and how they dealt with dubious names (such as those common names erected by Frank and Ramus). I would have liked to see a bit more data analysis, e.g., some statistics (where the patrons came from, when they lived, etc.) or a list of epithets that are neither Greek or Latin nor derived from people. It would have been helpful to indicate for which names more extensive biographies or obituaries are available. While some resources are cited (e.g., Adler 1989, 2007; Rieck et al. 2001), there is no information on whose biographies they contain. Furthermore, the whole bibliography is less than two pages so you have to resort to other resources to find the original descriptions of the species listed (e.g., the supplement to Uetz 2010).

Despite its shortcomings, Beolens and co-authors have produced a great book that is fun to read. Notably, they have already published similar books on birds and mammals (Beolens and Watkins 2003; Beolens et al. 2009) and reportedly have a companion volume on amphibians in press. If they live long enough to work through the 30,000 species of fish, a future eponym dictionary of vertebrates may keep saving biologists from buying *People* magazine for years to come.

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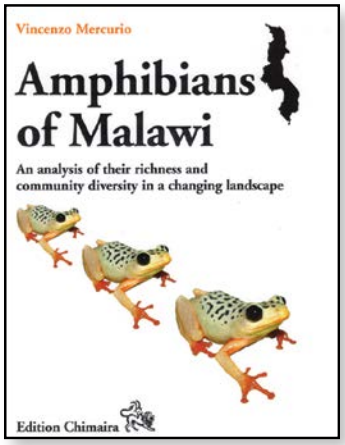
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Amphibians of Malawi

by Vincenzo Mercurio. 2011. Edition Chimaira, Frankfurt am Main (www.chimaira.de). 393 pp. Hardcover. 49,80 Euros (approximately US $65.00). ISBN 978-3-89973-495-9.

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Recent years have seen a welcome proliferation of high quality country and regional field guides to the amphibians and reptiles of various parts of Africa (e.g., Baha El Din 2006; Channing and Howell 2006; du Preez and Carruthers 2009) and a new book by Vincenzo Mercurio on the amphibians of Malawi continues this trend. Malawi is a comparatively small southern African country that is wedged in among Tanzania, Mozambique, and Zambia and extends along the southern part of the East African Rift Valley and Lake Malawi. Although Malawi has an interesting geographical position between the mountains of Southern Africa and those of the Albertine Rift and the Eastern Arc, it lacks the high number of endemic amphibian species found to the south and north. As such, Malawi has received relatively little attention and has usually been considered only peripherally in treatments of the herpetofauna of its more important southern and eastern neighbors. The only notable exception has been Margaret Stewart's (1967) seminal book *Amphibians of Malawi*—the first and only comprehensive guide to the amphibians of Malawi. With his new book, Mercurio presents a complete update of our knowledge of the amphibians of this country.

The book is based on Mercurio's Ph.D. dissertation, which explains the somewhat unconventional (for a field guide) arrangement of the different parts of the books into introduction, material and methods, results, discussion, abstract, German summary, and a bibliography. The first part comprises some 50 pages and contains more or less comprehensive introductions to the geography, geology, climate, and particularly the vegetation, with several subsections devoted to the various predominant vegetation types. Further sections are dedicated to the current state of conservation, list protected areas, and provide an overview of the history of herpetological research in Malawi as well as of studies using amphibians as biological indicators in Africa in general. The second part (Material and Methods) gives details on the survey methods used and on data analyses. Of more interest to most readers in this chapter will most likely be the detailed

descriptions of the sites visited for the study. Both introduction and material and methods are amply illustrated with a number of maps (political, geographical, hydrological, protected areas, study sites) and excellent, representative photographs of the different habitat types and study sites visited.

The bulk of the results section contains the systematic accounts, which cover 86 taxa including two possible new species and four subspecies and include keys to all genera and species. All species accounts contain a list of synonyms and list the pertinent literature, a brief diagnostic description of the species, the geographic range, the distribution in Malawi, and habitat. Every account is completed by a distribution map indicating known records from Malawi. Most species accounts further contain a section with remarks and, where applicable, a list of examined material (with museum/field numbers) and a description of the advertisement call complete with accompanying spectrograms and oscillograms. With a few exceptions, every species is illustrated by one, sometimes more, good quality photographs. In addition, some species accounts also include photographs depicting the typical habitat.

The remainder of the results contains a section describing the diversity of reproductive modes of the anurans of Malawi and another section with an analysis of species richness and community diversity. The section on reproductive diversity is largely identical to Mercurio et al. (2009) and contains descriptions of the anuran reproductive modes (following Wells 2007) found in Malawi, as well as a comprehensive table listing every species with its reproductive mode and further reproductive characters such as clutch size, egg deposition site, tadpole habitat, etc. Alas, information on whether the tadpole of a given species has been described or is unknown is missing.

The relatively short discussion mostly summarizes and synthesizes the distribution and abundance data from the results section. The main conclusion is that at the species level there is a "lack of a match between environmental degradation and amphibian diversity." As a reason for this result, the author suggests either considerable ecological plasticity of the Malawian anurans or a change in the amphibian communities in historical times due to progressive human habitat modification, a scenario which overall does not seem to be all that unlikely. As the author furthermore points out, true forest endemics or other habitat specialists are almost completely absent from the sampled species and most of them are habitat generalists, which may also account for the lack of correspondence between habitat degradation and amphibian diversity. These main results are furthermore even less surprising when considering that apparently only species with a good visibility and thus likelihood of detection were selected for the abundance analyses, whereas small ground-dwelling, aquatic, or fossorial species were excluded. Given that the resulting data set contains primarily species known to be tolerant of anthropogenic habitat modifications it is not surprising that the author arrives at his main conclusion.

Overall, as a field guide, the book seems well worth its price. Especially the detailed and well-illustrated introductory chapters and species accounts provide a lot of information; anyone planning on visiting Malawi or interested in the amphibians of the area in general will find plenty of interest here. Unfortunately a list of museum acronyms seems to be lacking. Moreover, some of the acronyms given for the examined material seem to indicate field numbers (VM – Vincenzo Mercurio?), rather than collection numbers, and I could not find any mention in the book into which museum collection these specimens will be accessioned, if they have not been already. What detracts further from the overall positive impression of the book are some entirely unnecessary errors and typos. The figure legends especially contain a disproportionately high number of errors; some examples: fig. 82 shows a specimen of *Leptopelis mossambicus* in "position of minimus traspiration" and refers to figs. 67 and 69, which supposedly illustrate the same specimen but in fact represent the distribution map and a photograph of *Arthroleptis xenodactyloides*. Figure 215 refers to a "*Hyperolius viridiflayassaevus*" instead of *Hyperolius viridiflavus*, fig. 298 to "*Ptychadena* cf. *fuscigula*" instead of *Amietia* cf. *fuscigula*, and fig. 304 to "*Afrana angolensis*" instead of *Amietia angolensis*. In Table 10, the percentages for the Chongoni sample do not add up to 100%. The records for *Phrynobatrachus perpalmatus* are indicated by giant red squares in the distribution map, instead of the small dots used in the other maps. In addition, there are a number of simple typos throughout the text (e.g., "*P. uzugwensis*," "*S. murumontanus*," "embrionic development") as well as grammatical errors. After all the work that went into this book, it is regrettable that neither the author nor the publisher seemed to have found the time for that final round of proof reading.

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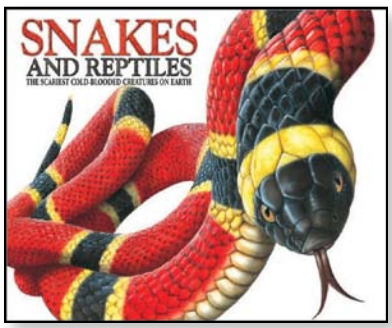
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Snakes and Reptiles: The Scariest Cold-Blooded Creatures on Earth

by Susan Barraclough. 2008. Sandy Creek Press, 122 Fifth Ave., New York. Hardcover. 192 pp. US $25.95. ISBN 9781435107748.

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Although one may find a review of a children's book a bit out of the ordinary from typical reviews of scholarly works in herpetology, I believe this one to be no less important. I appeal to my fellow herpetologists, colleagues, and parents who frequent the children's sections of local and national



FIG. 1. Examples of the overdramatized illustrations and accounts presented in this book creating undo fear among children. Examples presented here include a woman collecting timber from a woodpile in her garden who is subsequently bitten by a coral snake (A), a man bitten by a cottonmouth while canoeing in Florida (B), and a Brazilian fisherman bleeding out in his boat after attempting primitive first-aid on the bite wounds (C). Illustrations are copyrighted by Sandy Creek Press with arrangement with Amber Books, Ltd.

bookstores with their sons and daughters. What I found and present here is most offensive to our passionate and professional efforts to create an appreciation and respect for the animals we study. We are all too familiar with how the presentation of misleading and inaccurate information creates misconceptions in herpetology and the "only good snake is a dead snake" mentality. I, as do so many of my colleagues, dedicate countless hours to educating our youth about amphibians and reptiles in an attempt to shape future citizens that are well informed and educated so that they might also share our appreciation and respect for these unique animals and their interesting natural histories. The above author, Susan Barraclough, has now touched the minds of thousands (ca. 18,000 copies sold)[1] and has single-handedly undermined our efforts to properly educate and instill an appreciation and respect for reptiles. Instead, such appreciation is replaced with undue fear, misunderstanding, and a certain propensity for wanton killing.

This book is targeted toward a very impressionable age group of 8 to 10 year-olds and is littered with outrageous images (e.g., Fig. 1) in an attempt to create a true sense of fear rather than wonderment. Even the quote on the inside cover "…reptiles are the real-life monsters of the modern world" and the quotes within the cottonmouth account (e.g., "As dark and sinister as its swampland habitat, this fierce hunter haunts the sluggish waters of southeastern United States" and "After the snake plunges its fangs into a victim, it hangs on until its venom starts to work") are unconscionable statements for someone who is supposedly dedicated to the education of children. The book's jacket states that "Susan Barroclough is a highly experienced author and editor specializing in children's nonfiction and reference books" and "during her career she has written and managed a wide range of teen and children's titles on science and the natural world." It seems that the author has now managed to fit a project of science fiction into her repertoire.

In addition to this "reference book" being clearly overdramatized all for the sake of creating a fear factor, it is also riddled with errors and misconceptions (Table 1). However, my objective here is not to critically review the material presented in this book, but rather to draw attention to the educational "miscue" that has now influenced thousands of impressionable children. As true science educators we understand and share a basic educational philosophy for meeting curiosity with honesty and scientific integrity, especially when touching the minds of children. This book has failed in this basic and essential educational philosophy. In my professional opinion, this publication may be a perfect example of how not to educate our youth about science and natural history. As most of my colleagues will likely concur with my assessment of this book, I assure you that this book is one that I will be keeping off my son's bookshelf.

TABLE 1. Representative examples of errors and misconceptions presented in the book, *Snakes and Reptiles: The Scariest Cold-Blooded Creatures on Earth.*

Example	Error or Misconception
1	"Snakes and Reptiles" rather than "Snake and other Reptiles" (title page).
2	Perpetuation of the term "cold-blooded" rather than the use of ectothermic (title page).
3	Use of "*species*" rather than species or sp. to indicate a non-specified specific epithet of the genus (throughout book). By italicizing the word species this indicates that "species" is the specific epithet.
4	Species are organized alphabetically by genus (Throughout book). This becomes extremely noticeable and problematic in the "Turtles, Crocodiles, & Alligators" section (p. 147) when turtle species seem to be randomly present between crocodilian species.
5	"Relentlessly tightening its powerful coils, the mighty boa constrictor squeezes the last breath out of its victims, listening for their heartbeat..." (p. 21).
6	Description of a rattlesnake's rattle: "This is a series of horny shells…" (p. 38).
7	Tuatara is listed and classified under lizards (p. 130).
8	Why an amphibian section in a book entitled "Snakes and Reptiles"? (p. 165).

[1]Approximately 18,000 copies were sold estimated from the Amazon Best Sellers Rank (88,039 in Nov. 2011) where this rank is converted to the number of books sold per week using a logarithmic function (fonerbooks.com). This number is then used in a calculation (BeneathTheCover.com) to account for all national sales and years since publication.

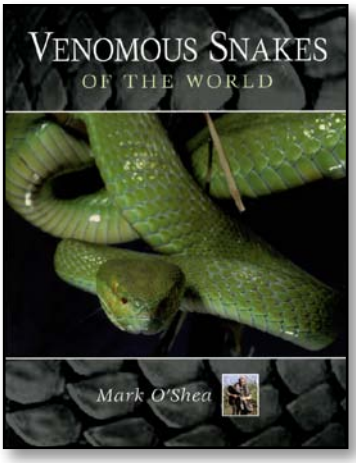
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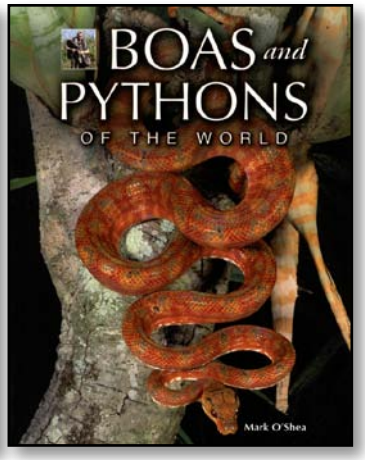
Venomous Snakes of the World

by Mark O'Shea. 2011. Princeton University Press, Princeton, New Jersey (http://press.princeton.edu) and New Holland Publishers, UK. 160 pp. Softcover. US $19.95, £13.95. ISBN 978-0-691-15023-9.

Boas and Pythons of the World

by Mark O'Shea. 2011. Princeton University Press, Princeton, New Jersey (http://press.princeton.edu) and New Holland Publishers, UK. 160 pp. Softcover. US $19.95, £13.95. ISBN 978-0-691-15015-4.





Both of these titles are newly issued softbound versions of books originally published in 2005 and 2007, respectively, with no changes evident. Both are characterized by outstanding color photography (ca. 150 images in each) and attractive graphics.

Venomous Snakes begins with an explanation as to which species are included in a book on "venomous" snakes, given the diversity of colubrid (*sensu lato*) species with some level of toxic secretions. The solution was to include those species whose bites are known or suspected to be dangerous. The book first presents a review of snake anatomy, with particular attention to features relevant for venomous snakes, followed by concise overviews of families of modern snakes containing venomous species, snake venoms and their actions, seasnake adaptations for marine living, and conservation. The snakes are then presented geographically: Americas, Eurasia, Africa, Tropical Asia, Australasia, and the Oceans.

An introductory section in *Boas and Pythons* provides current information about evolution, anatomy, diversity and distribution of basal snakes, constriction, giant snakes, man-eating snakes, and conservation. As in the preceding volume, the snakes are covered by geographic region. The book's title is a bit misleading, in that O'Shea includes all basal lineages (Scolecophidia + Alethinophidia), so readers might be surprised to see photos of blindsnakes alongside boas and pythons.

These attractive books are not only for a general readership, but also for herpetologists who will appreciate the beautiful photography of so many interesting species.

Reptiles de la Provincia de Río Negro, Argentina

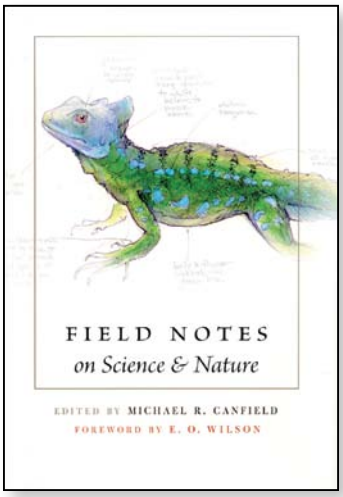
by Gustavo J. Scrocchi, Cristian S. Abdala, Javier Nori, and Hussam Zaher. 2010. Fondo Editorial Rionegrino, Nequen. 249 pp. ISBN 978-9-507-67042-8. $140.00 pesos (about US $33.00) plus shipping and handling. Available from Fundación Miguel Lillo (Centro de Información Geobiológico del NOA / Biblioteca: Sra. Mariá Angela Prieto - maprieto@lillo.org.ar).



This is an important contribution documenting the reptiles from an extensive and diverse area from the Argentinian portion of Patagonia. Since many of the species contained in this book are not endemic to this region, it will also be useful for people interested in the reptiles of other Argentinian provinces and the surrounding countries of Chile, Bolivia, Paraguay, Uruguay, and the south of Brazil. This handy-sized book is illustrated by more than 130 color photographs and other images, including maps showing the location of museum specimens from the four major Argentinian museum collections. The book includes a brief description of Río Negro province, including its geography, geology, phytogeography, and a concise account of its land use and location of protected areas. There is an easy to follow and very useful identification key accompanied by illustrations of the diagnostic characters. The guide covers the only turtle known from this province, two amphisbaenians, 17 snakes, and about 50 lizards. For each one of the species there is a brief morphological description, including comparisons with similar species, an account of the localities where the species has been reported, including areas outside Río Negro, conservation status, and, in some instances, ecological information. For some of the species the different vernacular names applied to each species in different areas are presented.

Field Notes on Science & Nature

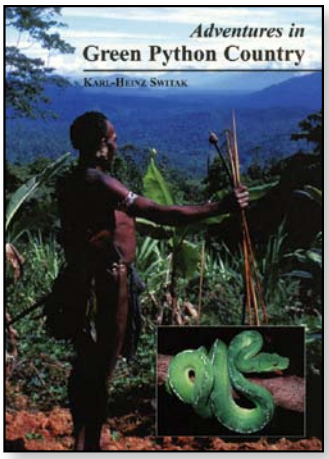
Michael R. Canfield (Editor). 2011. Harvard University Press, Cambridge, Massachusetts. 297 pp. Hardcover, US $27.95. ISBN 978-0-674-05757-9.



Despite the cover illustration, this is not a herpetological title, but nevertheless should appeal to field biologists of all stripes as well as those who simply enjoy observing nature. E. O. Wilson, in sharing examples from his own field notebook, introduces a collection of essays by eminent biologists who take readers into the field, sharing moments of exhilaration and inspiration, along with the inevitable challenges and drudgery that come with field work. All contributors stress the importance of recording field data, which might seem self-evident to most readers, but here we read of examples that emphatically reinforce that point. On display are various methods and systems for recording observations, especially useful for younger workers. George Schaller explains how he approaches study subjects (lions, mountain gorillas, giant pandas, etc.) and includes reproductions of pages from his field notebooks. Legendary birder Kenn Kaufman extols the virtues of list keeping, drawing examples from bird counts, Roger Kitching's skills as an artist/naturalist are displayed, and Jenny Keller offers a brief, but profusely illustrated, tutorial on making drawings in the field. Piotr Naskrecki explains his use of relational databases for organizing field data, likely an attractive option in this era of portable devices. John Perrine and James Patton provide an overview of the "Grinnell Method" of taking field notes, developed in the early 1900s by Joseph Grinnell, the visionary first director of the Museum of Vertebrate Zoology at UC Berkeley. This method has been adopted and adapted by legions of MVZ students and researchers, forming a data-rich historical foundation for vertebrate communities in California. In summary, this is an enjoyable read and an excellent resource for students.

Adventures in Green Python Country

by Karl-Heinz Switak. 2006. Natur und Tier – Verlag GmbH, Münster. 362 pp. Softcover, 39.80 Euros (approx. US $56.60). ISBN 978-3-937285-82-5. Available through Chimaira Buchhandelsgesellschaft mbH (www.chimaira.de).



Although published in 2006, this title remains barely known to most herpetologists. Karl-Heinz Switak is a native German who eventually became Supervising Herpetologist at the Steinhart Aquarium at the California Academy of Sciences in San Francisco. This book is another in a growing list of semi-autobiographical herp-adventure volumes in the spirit of Frank Buck and Carl Kauffeld. Switak recounts his travels to Indonesia, Australia, and most prominently, New Guinea, often in search of Green Tree Pythons. Although the writing at times seems as though from a different era, the large number of color photographs of herpetofauna (especially Green Tree Pythons), as well as people and places, make this a worthy addition to the bookshelves of herpetologists, python-keeping hobbyists, as well as those who enjoy reading about real-life adventures in exotic places.



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ABOUT OUR COVER: *Telmatobufo venustus*



The Chile Mountains False Toad is covered extensively in this issue (see Fenolio et al., pp. 514–519) but the unique, threatened area in which this rare creature lives is worth discussion. Recognized as one of the world's biological hotspots, the Chilean Winter Rainfall-Valdivian Forests Region (CWRVFR) is practically an island, albeit mostly surrounded by landforms. Unstable during the Eocene, under the ocean in the Miocene, and finally, profoundly modified by tectonic action during the late Pliocene and Pleistocene, CWRVFR was then subjected to glacial scouring. Bounded by the Pacific Ocean, the Andes Mountains, and the Atacama Desert, the region is covered by ancient forests of *Nothofagus*, *Araucaria*, and *Laurelia* dating from the Tertiary. These came into contact with tropical floras owing to the drastic geological changes. The resulting modern vegetation, like the fauna, reflects a high degree of endemism (Formas 1979. La herpetofauna de los bosques temperados de Sudamerica, pp. 341–369 *In* W. E. Duellman, Jr. [ed.], The South American Herpetofauna: Its Origin, Evolution, and Dispersal. Monogr. 7, University of Kansas Museum of Natural History, Lawrence).

Indeed, of the more than 40 species of amphibians in the CWRVF, the majority are unique to that region. Endemics include such oddities as *Rhinoderma* (two species), *Insuetophrynus*, *Calyptocephalella* (each with a single species), *Eupsophus* (several species), and *Telmatobufo* (with four species including *T. venustus*, the subject of our cover). *Rhinoderma darwinii* and *R. rufum* are considered flagship species for the region; the former is vulnerable "VU" while the latter is critically endangered "CR" (IUCN) or possibly extinct.

Overgrazing, invasive species, sedimentation and silting, urbanization, and logging are all contributing factors to the degradation of this habitat. Recent problems include development of coastal areas to foster tourism and the construction of major hydroelectric dams. A newly proposed dam project threatens the most pristine sectors of Patagonia. Many persons and institutions in Chile are concerned and struggling to protect her unique wilderness heritage, but the global economy and the country's burgeoning population make for a formidable obstacle. There is reason for optimism, both because of world conservation interest and the spirit in Chile, which abides by a local proverb: "No one has done well who has not suffered disillusionment."

Danté Fenolio (below), **Andrés Charrier**, and **Pilar Calderón** collaborated to produce the cover image. The frog was photographed on a mossy boulder at the site where it was encountered. A gold/silver mesh reflector and natural sunlight were used for illumination. A Sony Alpha 100 with a 10–20mm lens on a tripod with a 2.5-second exposure at f./20 with an ISO speed of 200, rendered the "foggy" look of the passing stream water.

Fenolio is the resident Amphibian Conservation Scientist for the Atlanta Botanical Garden's amphibian conservation program. His work with the Garden focuses on the population ecology of the Georgia Blind Salamander, *Eurycea* (=*Haideotriton*) *wallacei*, and in establishing assurance colonies of Chile's most threatened amphibian species at the National Zoo of Chile in Santiago. The first stage of the project, a breeding facility and captive assurance colony of Darwin's Frogs, *Rhinoderma darwinii*, now exists at the zoo and is producing offspring. New amphibians to the project include the cover species, *Telmatobufo venustus*. An avid wildlife photographer for most of his life, Fenolio is wrapping up a book focusing on wildlife that is adapted to darkness. Andrés Charrier and Pilar Calderón have been involved in the fieldwork in Chile for the Darwin's Frog Conservation Initiative. Both have made significant contributions to the project. Andrés Charrier (Centro de Estudios Avanzados de Ecología y Biodiversidad, Universidad Católica de Chile) now works on amphibian projects across much of south Chile.



PHOTO BY WILLIAM W. LAMAR

SSAR BUSINESS

2011 Annual Meeting, Minneapolis, Minnesota

The 54th Annual Meeting of SSAR took place from 6–11 July 2011 at the Hilton Minneapolis Hotel, Minneapolis, Minnesota, USA. The Organizing Societies were Society for the Study of Amphibians and Reptiles (in conjunction with the International Society for the History and Bibliography of Herpetology), American Elasmobranch Society (celebrating its 27th annual meeting), American Society of Ichthyologists and Herpetologists (celebrating its 91st annual meeting) and The Herpetologists' League (celebrating its 69th annual meeting). The meeting was hosted by University of Minnesota and St. Olaf College. The hard-working local hosts, Ken Kozak (Chair), Pat Ceas, and John Moriarty were assisted by the staff of Kansas State University Division of Continuing Education and many student volunteers.

Just over 850 herpetologists and ichthyologists from at least 27 different countries attended the 2011 JMIH. Following recent trends, this number was lower than last year. Almost 500 papers and approximately 250 posters were presented. Four symposia were held, including one in honor of the 80th birthday of John Legler ("Biology of Turtles of the Upper Mississippi River Basin: A Symposium in Honor of the 80th Birthday of John M. Legler and his 50 Years of Fieldwork with Turtles in the USA, Mexico, Central America, and Australia"). SSAR sponsored the symposium "Assisted Reproductive Technologies and Genetic Resource Banking: Tools for Conserving Declining

Amphibians." This symposium was organized by Jennifer Germano and Andy Kouba, who wish to thank SSAR and all of the participants and attendees. The symposium featured 14 speakers (ranging from graduate students to senior researchers) and was followed by a productive Skype-facilitated discussion that included colleagues from the UK, Russia, and Australia who were unable to be in Minnesota (Fig. 1).

After a busy day of Board and Executive Committee meetings, the 2011 JMIH began officially with the Plenary Session on the morning of July 7th. Ken Kozak, Chair of the Local Host Committee, welcomed attendees to the meeting and thanked the many student and postdoctoral volunteers, the JMIH Meeting Committee, and K-State for their hard work. He reviewed many of the upcoming social events and reminded people of the JMIH logo competition (see below). Susan Wells (Director, Bell Museum of Natural History, University of Minnesota) then welcomed us to Minneapolis and affirmed the importance of studying the whole organism. President Joe Mendelson summarized some SSAR events to look out for over the next few days, particularly the Ernie Liner Mardi Gras Live Auction. ASIH representatives presented a number of awards (the Robert Gibbs Award to William F. Smith, the Fitch Award to Raymond Semlitsch, and the Johnson Award to Henry Mushinsky). Cathy Bevier announced the second winner of the Meritorious Teaching Award in Herpetology, Dr. Robert Powell (Avila University). With this award, Bob (long time SSAR member and former editor of *Catalogue of American Amphibians and Reptiles*) is recognized for his exceptional accomplishments and contributions to herpetological education, particularly at the undergraduate level. Priya Nanjappa presented two awards from PARC (Partners in Amphibian and Reptile Conservation): the Alison Haskell Award for Excellence in Herpetofaunal Conservation to Alvin Breisch, and the Visionary Leader Award to Whit Gibbons.

AES Plenary speaker Kenneth Goldman gave a presentation on "The History of Studying Endothermy in Fishes: How many Places can you Stick a Thermometer?" He reviewed the history of temperature measurements, spoke about the many important contributions of Frank Carey, and reviewed the development of our understanding of endothermy in fishes.

Aaron Bauer, HL Distinguished Herpetologist for 2011, then spoke on "Hands, Sands, and Southern Lands: Geckos in Time and Space" during which he recalled 29 years of "geckomania," including 70 trips to Africa, 40 trips to Australia and the Pacific, 20 trips to tropical Asia, and over 100 trips to Europe. During these many trips, there were no deaths or serious injuries, however, he contracted one tropical disease, was involved in the destruction of two cars, and had one specimen stolen by a meerkat. Aaron spoke of the long, independent evolutionary history of gekkotans and the many factors that make them unique, particularly toe adhesion. In closing, Aaron, in his position as Secretary General of the World Congress of Herpetology (WCH), issued an invitation to next year's 7th WCH in Vancouver.

James Hanken was the last Plenary speaker of the morning and gave the ASIH past-Presidential address on "Plotting the Future of Comparative Biology." He views this as being both a very exciting time to be a comparative biologist, with the discovery and description of many new species in an "age of taxonomy," as well as a tragic time, with the increasing loss of biodiversity and threats to museums and natural history collections, with recent budget cuts and job losses. Jim noted declining memberships in many taxonomically-based societies, including some herpetological societies (although commenting that this is not the case for SSAR). He voiced concern of a growing recognition by some that our fields are too highly fragmented and that we lack a united voice. He indicated that changes in the ways professional societies operate and view themselves are likely if they are to continue to remain viable and have any meaningful impact on our field (e.g., more strategic actions, an increasing focus on the "big picture," greater collaborations among the societies) and suggested that we must play a more active role in counteracting the views expressed in reports such as that of U.S. Senator Tom Coburn on NSF. Jim is currently serving as chair of an AIBS Ad Hoc Committee on Biodiversity-related Sciences. The charge to this committee is to gather information on the feasibility of a biodiversity-related science policy initiative and submit a report on their findings by the end of this year. Jim's take-home message was that taxon-based societies can, and should, play an essential role in planning the future of comparative biology, but that they also need to change the way they do business if their efforts are to be effective.

Thirteen images were submitted to the JMIH logo competition. Attendees cast their vote for their favorite logo throughout the meeting. Congratulations to the winner, Kevin Wang. The image he created is now being used on the JIMH website (http://www.dce.k-state.edu/conf/jointmeeting).

Social and Professional Events

Phil Bishop (University of Otago, New Zealand) kicked off SSAR's many contributions to the 2011 JMIH with his President's Travelogue on the evening of July 6th. Phil spoke on "An Austral Perspective: Herpetological Adventures South of the Equator." He documented his travels and research on amphibians in South Africa, New Zealand, Australia, and Fiji. Phil was recently appointed by the IUCN as Chief

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Fig. 1.



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Fig. 2.

Scientist for the Amphibian Survival Alliance (ASA) and he gave a paper a few days later on the activities of the ASA ("The Amphibian Survival Alliance Jumps into Action").

The now-annual SSAR/HL Student Reception was held late afternoon on July 7th. The room was packed with students and invited professional herpetologists. President Mendelson gave a warm welcome to our student members and encouraged them to enjoy finger food, drinks, and meeting senior herpetologists (Figs. 2, 3). The student reception was followed by the Joint Meeting Reception. A short bus ride delivered us to the Nicollet Island Pavillion in the middle of the Mississippi River (Fig. 4). A stroll around the southern end of the island followed dinner for some, while others were content to sit and catch up with friends and colleagues (Fig. 5). The group photo (by Matthew D. Potenski) was taken outside the Pavillion (http://www.dce.k-state.edu/conf/jointmeeting/images/jmih2011_group.jpg).

Dawn Wilson and Robert Espinoza organized a highly successful and well-attended lunch-time student workshop, "Law and Order in Herpetology: Permits and Regulations for Importation and Exportation" (held on July 8th). Seven panel members from the zoological, museum, conservation, non-profit, and academic communities talked about their experiences obtaining permits to work in countries other than the US, as well as permits to import live and preserved material (Fig. 6). Attendance by students was so high that we ran out of pizza (sorry—we promise more next time!). The panel members had lots of great advice and responded to many questions from the audience, e.g., how to handle importation of specimens not definitively identified.

This year's very special Live Auction, the "ASIH/HL/SSAR Ernie Liner Mardi Gras-Auction" was held on July 10th. Ernie, a long-time member of The Ohio Herpetological Society and SSAR, and a former member of the Board of Directors passed away in September of 2010. The auction consisted entirely of materials from Ernie's estate that were donated to the three societies. Brian Crother (then SSAR President) and a number of his students from Southeastern Louisiana University (Chris Murray, Justin Rheubert, Jenifer Lee, and Ryan Willis) worked hard over several days to pack the materials Ernie had donated to the societies. Breck Bartholomew arrived in Houma, Louisiana with a 26-foot U-Haul truck and Brian, Breck, Chris, and Justin spent 10–12 hours simply loading the truck. Breck transported the collection to Salt Lake City and it is being processed for sale through online auction. SSAR is very grateful to Breck, Brian, and Brian's students for their work on behalf of the societies.

Breck showed up in Minneapolis with less than 1% of Ernie's collection. The range and quantity of items was truly impressive—books, jewelry, door mats, stuffed, blow-up, and plastic animals, porcelain figurines, snake sticks, artwork, fridge magnets, caps, bottles of herpetologically named wine, mugs, glasses, t-shirts, ties, newspaper clippings, and even Ernie's honorary doctorate diploma, mortar board, and hood from the University of Colorado! Auctioneers Brad Moon, John Moriarty, Steve Mullin, and Aaron Bauer were ably assisted by Greg Watkins-Colwell and a small and busy army of students (Heather Heinz, Jolene Rearick, Alicia Kennedy, Brittany Barker, and Jenny Gubler). President Mendelson created a slide show of Ernie's life that ran throughout the evening. Bidding on many items was spirited and the auction ran close to midnight. It was an appropriate way to celebrate Ernie's life and contributions to herpetology and it will be difficult to top the 2011 Live Auction (Figs. 7–9).

Breck also displayed many items from Ernie's estate at the SSAR Publications booth (Fig. 10). For a small donation to either the Ernie A. Liner or the Roger Conant Endowments one could select from an array of objects. Not many people left Minneapolis without an Ernie Liner fridge magnet!

Mike Jorgensen and Vinny Farallo organized this year's Silent Auction. The silent auction changed location this year in an effort to increase visibility and could be found outside the Plenary Session entrance in the main break area. Donors this year included Kraig Adler, Ronn Altig, Breck Bartholomew, The Herpetologists' League, Allen Press, and University of California Press, and helped to bring in US $1763 for the SSAR Student Travel Fund (more than doubling amounts earned in previous years). Once again, the ten recipients of the US $400 SSAR Student Travel Award (Fig. 11) took turns to work the silent auction table for 2–3 hrs throughout the course of the meetings; all agreed that this "service" was a great way to meet new colleagues at the meeting.

The end-of-meeting Banquet was held on July 11th. Larry Allen again served as Master of Ceremonies. On behalf of the JMIH Societies, he thanked the local hosts and K-State for another enjoyable and successful meeting. Larry then introduced those at the head table (including President Mendelson, Treasurer Nicholson, and Secretary Preest) and asked past-presidents of the societies in attendance to stand (including four past-presidents of SSAR). ASIH election results were announced, certificates of appreciation were presented, and resolutions were read. Various awards from ASIH, AES, and HL were announced. Pat Gregory (University of British Columbia) issued an enthusiastic invitation to herpetologists *and* ichthyologists to attend the World Congress of Herpetology in Vancouver, 8–14 August 2012. Larry thanked those in the room for attending what could be the penultimate traditional banquet and promised a "highly modified version" of the end-of-meeting banquet at the 2013 JMIH (10–15 July) to be held in Albuquerque, New Mexico.

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FIG. 3.

FIG. 1. Speakers in the SSAR-sponsored symposium. Back row (L to R): Lucia Arregui Almendral, Jonathan Aaltonen, Gina Della Togna, Tricia Rowlison, Michelle Wilkes Martin, Andy Kouba, Frank Molinia, Marlys Houck, Carrie Vance, John Clulow, Vance Trudeau. Front row (L to R): Wang Qijun, Natalie Calatayud, Aimee Silla, Jen Germano, Cecilia Langhorne. Not pictured: Chester Figel, Blair Hedges.

FIG. 2. Bob Aldridge (SSAR President-Elect) chatting to Tony Wilmes and Matt Rucker at the SSAR/HL Student Reception.

FIG. 3. Winners of door prizes at the SSAR/HL Student Reception. Steve Whitfield, Sue Kim, Daniel Paluh, and Maggie Hantak (L to R), with Dawn Wilson in the background.

Board, Long Range Planning, and Business Meeting Summaries

SSAR Board Meeting

Society President Joseph Mendelson called the Board Meeting to order at 0805 hrs on July 6th, 2011 in the Hilton Hotel, Minneapolis, Minnesota. In attendance were the following members of the Board of Directors, Editors, and Committee Chairs: Kraig Adler (Editor, *Contributions to Herpetology*; Chair, Long Range Planning Committee), Bob Aldridge (President-Elect), Breck Bartholomew (Publications Secretary), Aaron Bauer (Editor, *Facsimile Reprints in Herpetology*), Cathy Bevier (Chair, Herpetology Education Committee), Rafe Brown (Chair, Seibert Award Committee), David Cundall (Board Member, Reg. 2012), Raul Diaz (Webmaster), Kevin de Queiroz (Board Member, Reg. 2012), Tiffany Doan (Board Member, Reg. 2014), Richard Durtsche (Coordinator, Symposium Committee), Pat Gregory (Board Member, non-US 2012), Robert Hansen (Editor, *Herpetological Review*), Mike Jorgenson (Chair, Silent Auction Committee), Joseph Mendelson, III (President), John Moriarty (Editor, *Herpetological Circulars*), Erin Muths (co-Editor, *Journal of Herpetology*), Kirsten Nicholson (Treasurer), Ann Paterson (Board Member, Reg. 2012; Chair, Membership Committee), Gad Perry (co-Editor, *Journal of Herpetology*), Marion Preest (Secretary), Al Savitzky (SSAR Representative to AIBS and BioOne), Carol Spencer (Board Member, Reg. 2014), Greg Watkins-Colwell (Chair, Nominations Committee; Organizer, SSAR/HL Live Auction), and Dawn Wilson (Chair, Student Participation Committee). Additional society members present included Robin Andrews, Marina Gerson, and Henry Mushinsky. Introductions were made and minutes of the 2010 Board of Directors Meeting (Providence, Rhode Island) were approved.

Annual reports for 2010/2011 were submitted by all Officers, Editors, and Committee Chairs.

Officers' Reports.—President Joseph Mendelson reported that SSAR was involved as a Festival Partner with the USA Science & Engineering Festival in Washington D.C. in October, 2010. The first of the 2011 issues of *Journal of Herpetology* and *Herpetological Review* revealed changes in formats and increased use of color. Joe extended kudos to Editors Bob Hansen, Erin Muths, and Gad Perry. A Zoo Atlanta volunteer has begun the important and long-awaited task of completing and copyediting the indexing effort for *Herpetological Review*. This will allow *Herp. Review* to be searchable and posted in online databases. President Mendelson was involved in the work of the Long Range Planning Committee, the Membership Committee, and the JMIH Meeting Management and Planning Committee. He reported writing or signing a number of letters pertaining to SSAR business over the past year and made arrangements for Phil Bishop to be the 2011 SSAR President's Travelogue speaker. Joe was also involved in receiving the estate from Ernie Liner and organizing the three-society auction in Ernie's memory.

Past-President Crother reported appointing Kraig Adler as chair of the Long Range Planning Committee, Ann Paterson as chair of the Membership Committee, Raul Diaz as Webmaster, and Rafe Brown as chair of the Seibert Awards Committee. The EBSCO contract that was approved by the board at the 2010 meeting was completed and signed. Brian sent a letter of thanks to Thomas Beauvais for his generous donation to support increased use of color in our journals. He reported that, following discussion after the 2010 JMIH, the SSAR Board voted to approve changes to the Meeting Management Committee to make it a JMIH committee rather than an ASIH committee.

Treasurer Kirsten Nicholson reported that, overall, the finances of SSAR are quite sound and that 2010 was a good year for us. Expenses



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FIG. 4. Sundown on the Mississippi River, looking into downtown Minneapolis, as seen from the Nicollet Island Pavillion, site of the Joint Meeting Picnic.

were less than expected and income higher than expected, resulting in a net profit of $52,433. In addition, the stock market has steadily increased and our portfolio has returned to its pre-crash levels (as of May 2011). In our first year of participating as partners in the JMIH finances, SSAR paid approximately $500 to ASIH for SSAR-specific costs. Kirsten indicates that, in terms of our journals, we generally perform at the very edge of our expenses. We will have to increase our income to accommodate changes to the journals. The approved 2010 budget was balanced and about half of our expenses were over-budget with half under or right on budget, although overall we came in under-budget. Breck Bartholomew took over membership management and the society should be extremely grateful, as the cost to us is vastly less than we had with Allen Press, Inc. Our income from memberships was greater than anticipated and the number of members has increased from last year for both individual and institutional subscriptions. The Publications Office went over-budget, but that is largely due to the expenses incurred handling the Ernie Liner collection. Due to the nature of this year's auction, no funds will be collected in support of student travel. The Society's investments increased slightly during 2010, in keeping with the trends in the global market. The total market value increased 15% from US $493,004 to an ending value of US $571,156, although the book value increased by only 2%. As of May 2011, we had returned to our pre-crash values of over US $600,000, but this last month has seen a dive below US $600,000. The general strategy Kirsten has been employing is a balance between growing our investments as best we can, given our total circumstances, yet allowing for increased spending as it pertains to our initiatives.

Secretary Marion Preest provided Officers, Editors, and Committee Chairs with minutes of the 2010 Board Meeting and summarized the 2010 Annual Meeting for publication in *Herp. Review*. She keeps track of changes in personnel and regularly updates SSAR letterhead, informs the Editors of *Journal of Herpetology* and *Herp. Review* of these changes, and provides various updates to Webmaster Raul Diaz. She routinely writes letters to student winners of awards (e.g., Kennedy, GIH, etc) and prepares announcements for publication in *Herp. Review*. Marion compiled the 2011 Annual Report and prepared agendas for the Board and Business Meetings for the 2011 JMIH. She again organized a reception for student members of SSAR and HL to be held at the JMIH. There was some discussion by the Board of non-students and individuals who are not members of either SSAR or HL registering for the reception. We are trying to balance a desire to make this an open and inclusive event with our ability to cover costs. Marion corresponded with the Board regarding various issues that needed a vote, e.g. renewal of the JMIH memorandum of understanding, approval of JMIH symposia, etc. She ensured that SSAR members who do not provide email addresses to the membership office received paper ballots for the 2010 election. Voting participation (both electronic and paper) was again very low, even though electronic voting this year did not require login or a password, and thus was very simple. A suggestion was made that we publish a notification of upcoming elections in *Herp. Review* and/or on the website. Those who wish to vote, but are not able to do so electronically, could contact the Secretary and request a paper ballot.

Publications Secretary Breck Bartholomew reported that total income from the Publications Office in 2010 was US $57,715.13. He is requesting a budget for 2011 that includes funds to process the Ernie Liner bequest, which will eventually be paid back from proceeds from the sales. Breck would like to remainder books that are no longer selling well enough to justify storage space. The Board suggested that, prior to remaindering the books, Breck make them available to members at deeply discounted prices (plus costs of postage) and that he send them to libraries at academic institutions for outreach purposes. Joe asked that Breck summarize the discussion of the Board and then provide the Board with an outline of how he wishes to proceed, e.g., sell, give away, remainder.

George Pisani (Trustee) reported that he again filed SSAR's annual corporate report with the Office of the Kansas Secretary of State.

Editor's Reports.—Andy Price, Editor of *Catalogue of American Amphibians and Reptiles*, reported that accounts 881–900 (2 gymnophiones, 3 salamanders, 3 frogs, 2 turtles, 7 lizards, 3 snakes) will be published sometime this year. Andy suggested that the Board needs to make a decision about the future of *CAAR* in light of his decision to resign as Editor and difficulty in recruiting editors and authors. He raised two possible options. The first is to cease publication of *CAAR*. The second is to go digital and publish an account on the website whenever one is ready. Andy indicated that he is willing to modify his decision to resign if the Board approves the second option.

Kraig Adler, Editor of *Contributions to Herpetology*, reported that "*Biology of the Reptilia*, Volume 22, *Comprehensive Literature of the Reptilia*, by Ernest A. Liner was published in March 2010 and "*Snakes of Honduras*" by James McCranie was published in March 2011. "*Herpetology of Armenia and Nagorno-Karabakh*" (by Marine Arakelyan, Felix Danielyan, Claudia Corti, Roberto Sindaco, and Alan Leviton), will be published in late 2011. "*Contributions to the History of Herpetology*," vol. 3 (by Kraig Adler, John S. Applegarth, and Ronald Altig), "*A Contribution to the Herpetology of Northern Pakistan*" (by Rafaqat Masroor), "*A Guide to the Snakes of the Philippines*" (by Rafe Brown, Alan Leviton, Maren Gaulke, and Arvin Diesmos), "*Field Guide to Amphibians and Reptiles of the West Indies*" (by S. Blair Hedges), and "*Lizards of Southern Africa*" (edited by William R. Branch and Aaron Bauer) are planned beyond 2011.

Editor Aaron Bauer (*Facsimile Reprints in Herpetology*) reported that no new titles were published in the past year and a single publication is planned for 2012 (Duméril and Bibron's "*Erpétologie Générale ou Histoire Naturelle Complète des Reptiles*" (1834–1854) [to be guest edited by Kraig Adler]). As the result of a generous donation, Aaron expects to be able to sell this *Facsimile* at < US $300. This is a very large, multi-volume *Facsimile* and the costs of shipping (especially overseas) and storage will be high. Various options to reduce weight, e.g., combining individual volumes, are being evaluated. A suggestion was made to especially encourage prepublication sales so as to reduce storage costs by not overproducing. Eventually an electronic version will be available, but currently demand is for a paper copy. The majority of projects planned beyond *Erpétologie Générale* are in various states of completion and are collected works *Facsimiles*.

Aaron reported that, in consultation with Greg Watkins-Colwell, he had made the decision to cancel a reprint of J. E. Gray's series of catalogues of the amphibians and reptiles in the collection of the British Museum. Aaron believes that the playing field for *Facsimiles* has changed fundamentally recently and that serious reconsideration of the *Facsimile Reprints in Herpetology* series is required. The historical role of the *Facsimiles* series was to serve the herpetological community by making available difficult-to-obtain older literature, chiefly works of real utility to some subset of our community. The exponential increase in the availability of literature however has effectively narrowed SSAR's niche in this field. Aaron has come to the conclusion that it is not cost effective to continue with the reprinting of most single-volume titles that are 1) available through literature portals, and 2) do not have illustrations or have only simple black and white illustrations that reproduce well in electronic copy and hard-copy printouts therefrom and thus, that only certain types of publications are likely to be viable projects for reprints. The upcoming

facsimile of Duméril and Bibron is a case in point. This work, in addition to being very widely used and needed by the community, has many color plates, is represented online by relatively poor scans, and is so large as a whole that it is rather awkward to work with in an online format. Likewise, Aaron believes that the collected works of single authors (e.g., Peters, Peracca, Smith, etc.) are also strong candidates for facsimiles. These include tens to hundreds of individual publications that would be difficult for readers to assemble, even if most are available in some electronic format. They also provide complete annotated bibliographies and can include cumulative indices that offer added value. A third type of product might be a facsimile of a foreign language work with a complete English translation (a competing publisher has, for example, recently published a facsimile and translation of Laurenti's [1768] Latin work). There was brief discussion of Aaron's report and the Board indicated its trust that Aaron would do what is best for the series.

John Moriarty (Editor, *Herpetological Circulars*) reported that HC-39 (*A Guide to Tissue Collection, Preservation, and Management for Reptiles and Amphibians*) is in preparation, with publication planned for late 2011. The Seventh Edition of the *Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico* will be published as HC-40. The revision will be given away at the World Congress in Vancouver in 2012.

Joe Mitchell, Editor of *Herpetological Conservation*, reported that no inquiries for publication were received in 2010 and that no progress was made on the book covering herpetological conservation in agricultural landscapes.

According to Editor Robert Hansen, *Herpetological Review* continues to operate smoothly. Volume 41 consisted of 528 pages and Volume 42 is projected to run >600 pages. Personnel changes include Robert Reed (Associate Editor) stepping down and Jodi Rowley, Felix Cruz, Priya Nanjappa, and Wulf Schleip joining the staff as either Associate or Section Editors. Support from the Thomas Beauvais Fund permitted an increase in the selective use of color and the last half of 2010 brought a flurry of activity. Following board approval, many things were set in motion including recruiting new editorial personnel, hiring a professional design team (Eagle Mountain Publishing), developing new content sections, soliciting contributions, and evaluating design options. The first edition of the redesigned *Herp. Review*, featuring full color throughout, appeared in March 2011 and has been received favorably. Beginning in 2011 (vol. 42), Bob initiated a new section (Conservation) to better reflect the importance of conservation-related issues in herpetology. He also created a new section for the publication of captive-based observations (Herpetoculture Notes) and resurrected a long-dormant feature (Institutional Profiles) with the first contribution appearing in the June 2011 issue. Another section (National and Regional Organizations) will debut later in 2011.

Full-issue pdf files of *Herp. Review* are available to SSAR members on the ZenScientist website. To promote membership in SSAR, copies of the new *Herp. Review* were distributed *gratis* to attendees at the All Florida Herpetology Conference in April. Reciprocal advertising agreements have been reached with a number of other publications/organizations that will permit SSAR to advertise membership/subscription options. As mentioned in President Mendelson's report, a comprehensive index to back issues of *Herp. Review* is in the works.

Editors of *Journal of Herpetology*, Erin Muths and Gad Perry report that former Editor, Geoff Smith, continues to provide editorial assistance and that the current Associate Editor roster contains some new names. In order to save money and better fit the standard pdf page size for electronic reprints, the Journal switched format in 2011. This also allows it to be bundled with *Herp. Review* for mailing, providing further savings. Erin and Gad reported that overall submissions set a new record in 2010. Submissions so far for 2011 (115) are similar to the number submitted during the same period in 2010 (135) and much higher than during 2009 (61). Rejection rate has remained fairly stable over the past few years. The amount of time needed to reach an initial decision remains similar to that in the past few years. Duration to reach a final decision peaked for manuscripts accepted in 2009, but has been reduced in 2010 to the lowest level Allen Press reports for our journal. There is currently approximately a 9-month wait between acceptance of a paper and publication. Erin and Gad expect to be able to maintain these numbers, or improve on them, in 2011. The biggest challenge to doing so is obtaining timely reviews. Securing willing, capable, and available Associate Editors is becoming quite difficult as well. The USA remains the leading source of manuscripts. Brazil is consistently the second largest source of submissions. Argentina also tends to be high, as are Australia, China, and Mexico. The larger number of manuscripts from non-English speaking countries places an added burden on the editorial process. The Editors note that they need to find a Brazilian Associate Editor.

The Editors conducted a quality analysis this year using the ISI Impact Factor. Overall they feel that our position is strong and continues to improve, but they would like to see it advance even further.

Committee Chair Reports.—The Conservation Committee (Betsie Rothermel, Chair) took action on a number of significant items during the past year: a) they sent comments to the U.S. Fish and Wildlife Service (USFWS) regarding designation of critical habitat for the Mississippi Gopher Frog, specifically expressing concern that the proposed "buffer radius" was too small and that greater emphasis

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FIG. 5.

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FIG. 6.

should be placed on habitat quality and management issues within the areas considered for inclusion; b) in response to the USFWS issuing a Notice of Inquiry regarding a petition to list all live amphibians in trade as injurious unless free of *Batrachochytrium dendrobatidis* (*Bd*), they prepared and submitted an extensive report summarizing the current scientific knowledge of the biology of *Bd*, its impacts on amphibians in the U.S., and surveillance and control techniques. They expressed support for the concept of regulations to help control the spread of this pathogen, but argued that focusing solely on *Bd* was short-sighted and suggested that USFWS should also consider other emerging pathogens in the development of any regulations and control measures; c) they sent a joint letter to key House and Senate representatives asking them to preserve funding for the State Wildlife Grant (SWG) and North American Wetland Conservation Act programs.

Joe Beatty (Chair, Dean Metter Award Committee) received 27 proposals this year and two winners were chosen. They are: Brandon Fessler, an M.S. student in the Department of Biological Sciences at Central Washington University in Ellensburg, Washington, whose dissertation research deals with seasonal behavior, habitat use, and spatial ecology in *Dicamptodon tenebrosus*; and Jessica Wood, a Ph.D. student at the University of Missouri, Columbia, whose research will analyze call plasticity and mate recognition in *Hyla femoralis*.

Chair of the Grants-in Herpetology Committee, Josh Kapfer, received 49 proposals this past year. Most applications were in the "Laboratory Research" category. The winners each receive US $500 and they are:

Conservation - Anne G. Stengle, University of Massachusetts

Education - Michelle Lester, Yakima Area Arboretum

Field Research - Michael Habberfield, State University of New York, Buffalo

Laboratory Research - Beck A. Wehrle, California State University, Northridge

Travel - Denita M. Weeks, California State University, Northridge

International - Kerry L. Holcomb, Central Washington University

Josh reported that reviewer criteria were implemented this year to streamline the review process and reduce subjectivity in evaluations. Additionally, the deadline for proposal submission was moved to 15 December in the hopes of easing the burden on reviewers.

The organization of the SSAR-GIH announcement was re-worked after the 2011 grant submission deadline. This decision was based on questions received from potential grant applicants prior to the 2011 submission deadline. The new announcement is on the website.

The 19th annual Seibert Awards Competition (Pat Owen, Chair) was run at the 53rd Annual Meeting of SSAR in Providence, Rhode Island. There were 35 eligible presentations. The Seibert Award winners for 2010 were: **Systematics/Evolution**: *Cameron Siler* and Rafe Brown, University of Kansas, "Historical processes behind patterns of limb reduction and loss in an island radiation of fossorial lizards." **Ecology**: *Jennifer Stynoski*, Virginia Noble, Meredith Strider, University of Miami, Organization for Tropical Studies, University of Maryland, "To eat but not to be eaten: honest begging signals and visual detection of predators and mothers by tadpoles of the Strawberry Poison Frog (*Oophaga pumilio*)." **Physiology/Morphology**: *Denita M. Weeks* and Robert E. Espinoza, California State University, Northridge, "Geckos on ice: unexpected thermal tolerances and temperature-dependent performance of the world's southernmost gecko." **Conservation**: *Daniel Leavitt*, Texas A&M University, "*Sceloporus arenicolus*, an endemic lizard in an endangered ecosystem."

Honorable mentions were: **Systematics/Evolution**: *Philip L. Skipwith*, Aaron M. Bauer, and Todd R. Jackman, Villanova University, "Molecular phylogenetics of New Caledonian diplodactylid geckos." **Ecology**: *Oliver Hyman* and James P. Collins, Arizona State University, "Negative influence of phosphorus on prevalence of the frog killing pathogen, *Batrachochytrium dendrobatidis*." *James Paterson*, Brad Steinberg, and Jacqueline Litzgus, Laurentian University, Algonquin Park, "Comparisons of hatchling survivorship and spatial ecology between two sympatric turtle species."

All winners received a check for US $200 and a book from University of California Press compliments of Chuck Crumly.

Cathy Bevier (Chair, Herpetology Education Committee) indicated her decision to step down as chair of this Committee. The Herpetology Education Committee continues to update the committee website and to respond to various enquiries submitted to the Herp Hotline. Members have also been active in developing and encouraging educational activities in herpetology. The Committee received support in 2009 from SSAR, HL, and ASIH for a proposal for a Meritorious Teaching Award in Herpetology. Ten nominations were received and considered by a Committee consisting of professional and student members of the three participating societies. The winner for 2010 was Dr. Whit Gibbons.

Kennedy Award Chair, Lynnette Sievert, announced that the winning paper for 2010 is by Cameron Siler (co-authored with Arvin C. Diesmos and Rafe M. Brown), "New Loam-Swimming Skink, Genus *Brachymeles* (Reptilia: Squamata: Scincidae) from Luzon and Catanduanes Islands, Philippines." Journal of Herpetology 44:49–60. Cameron will receive a check for US $200 or $400 equivalent in SSAR publications.

The Long Range Planning Committee (*Chair*: Kraig Adler, *Members*: Breck Bartholomew, Rafe Brown, Indraneil Das, Tim Halliday,

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FIG. 7.

FIG. 5. Richard Wassersug and Marty Crump at Nicollet Island Pavillion.

FIG. 6. Panel members at the SSAR Student Workshop on permits and regulations (L to R): Linda Ford, Rafe Brown, Carol Spencer, Joe Mendelson, Robert Espinoza, Tiffany Doan, and Priya Nanjappa.

FIG. 7. Erin Muths, Meredith Mahoney, and Brad Moon enjoying themselves at the Ernie Liner Live Auction.

Robert Hansen, Kris Kaiser, Roy McDiarmid, Jim Murphy, Ann Paterson, Gad Perry, Marion Preest) was established in late 2010 by then-President Brian Crother. After familiarizing itself with the SSAR budget and several rounds of discussion, the committee submitted a series of recommendations to the Board in November regarding changes to *Herp. Review*. Since then, the committee has dealt with a number of issues including a proposal to increase membership dues and institutional subscriptions, a proposal from Allen Press to co-publish *Journal of Herpetology*, a proposal to assume management of *Contemporary Herpetology*, and a revision of the Society's website. In its deliberations, many members of the LRPC have pointed out that our website needs to be revised to make it more user-friendly (both for members and for SSAR officers and editors who need to revise or post information) and needs to be expanded to make it more beneficial for our membership. To date, the SSAR website has been staffed by loyal volunteers who have done a remarkable job, but our site no longer fully serves the many needs of our broad-based clientele. It was clear that only a few members of the LRPC had the necessary knowledge to contribute to this discussion, so a subcommittee was formed consisting of Bob Hansen, Breck Bartholomew, and Raul Diaz. Kraig asked them for a report by June 1st. This report was shared with the full LRPC and then discussed.

Kraig Adler ended his report with some personal comments regarding his view of the state of SSAR. His tone was optimistic and he particularly noted the recent increase in society membership, the receipt of the Special Libraries Association Award in 2009, the recent changes in *J. Herp.* and *Herp. Review*, and the important role of the Membership Committee. He also commented on the opportunities that will be presented to, and must be capitalized on by, SSAR at the WCH in 2012. Ann, Breck, and Kraig will work on producing a membership brochure to include with registration materials at the WCH. Joe will ask for assistance with this from the Media Department at Zoo Atlanta.

In his capacity as President, Joe Mendelson serves as SSAR representative on The Meeting Management and Planning Committee (MMPC). The Committee met in Minneapolis in March to develop a meeting schedule and review conference facilities. Future meetings are to be held as follows:

2012 — Vancouver (WCH)

2013 — Albuquerque

2014—TBA, possibly in the southeastern USA

Joe indicated that is it not entirely clear what role SSAR representatives will have in organizing the WCH, as the JMIH Planning Committee has no plans to meet before the 2012 meeting. Pat Gregory (Chair, WCH Vancouver Local Committee) indicated that abstracts will be submitted directly to WCH and the WCH Program Committee will put together the program. He is asking for symposia requests from SSAR, ASIH, and HL. Pat received some materials from Brian Crother two years ago describing SSAR's meeting requirements. He will send this to Joe for review. Pat promises "all the SSAR events without the work!" In terms of finances, each Society will cover the costs of society-specific events, e.g., room charges. The SSAR Board of Directors approved another three-year MOU that formalizes the JMIH in terms of cost- and profit-sharing.

Bob Cashner, chair of the JMIH Meeting Management and Planning Committee, reported that when the committee met in March there was discussion of a strategy of engaging hotel chains in multi-year contracts as a possible way to have less expensive accommodations. This has not been fruitful, however, the MMPC and K-State support efforts to find hotels that will reduce some of our meeting expenses.

Two symposia are already planned for 2012: "Biogeochemical Methods to Study Ectotherm Ecology and Physiology" (Chair: Sora Kim, sponsored by AES and ASIH); and "Technology and Innovation in Herpetology and Ichthyology Collections" (co-Chairs: Greg Watkins-Colwell and Mark Sabaj Perez), sponsored by SSAR, HL, and ASIH.

Bob Cashner also commented that committee members were aware of criticism of the JMIH and of suggestions that smaller meetings of a subset of the societies be considered. He remarked that we get the best offers from hotels when we fill our room blocks. A possible university venue was investigated for 2013, but without success. The MMPC has responded to concerns about costs by plans to cut the length of the meeting, replacing the banquet with an alternative activity, and selecting cities that allow for flights from a variety of starting locations.

Ann Paterson, Chair of the Membership Committee, assembled a committee of volunteers from a variety of backgrounds. During 2010–2011, the Membership Committee: 1) discussed and compiled a list of current membership benefits; 2) compiled a list of possible future benefits that could be offered; 3) prepared surveys of current SSAR members and of non-members to better understand the interests of these constituencies; 4) contacted varied organizations and outlets to attempt to survey a wide range of both members and non-members; 5) distributed a link to both surveys on the ZenScientist site; 6) compiled survey results to date as a basis for discussion; and 7) developed a proposal of ideas to pursue in 2011–2012.

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FIG. 8.



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FIG. 9.

The Nominations Committee (Greg Watkins-Colwell, Chair) compiled a list of nominees (see below) for the positions of President-Elect, Regular Board Member, Conservation Board Member and At-Large Board Member. Kirsten Nicholson and Marion Preest were willing to run again for the positions of Treasurer and Secretary respectively. *President-Elect*: Robert Aldridge, Frank Burbrink; *Treasurer*: Kirsten Nicholson; *Secretary*: Marion Preest; *Board Member* (*Regular*): Tiffany Doan, Lisa Hazard, Carol Spencer, Greg Watkins-Colwell; *Board Member* (*Conservation*): Jennifer Pramuk, Priya Nanjappa; *Board Member* (*At-Large*): Tony Gamble, Travis LaDuc.

Resolutions Chair, Robert Denton, presented resolutions at the SSAR Business Meeting in Providence in 2010. These have been published in *Herp. Review*.

Brian Crother, Chair of the Standard English and Scientific Names Committee, indicated that the 7th edition of the Standard English and Scientific Names List will be available online by the time of the 2011 JMIH. He thanks Raul Diaz (webmaster) and the members of the Committee. Each update of the online version will be given a different name, e.g., Version 6.0, 6.1, 6.2, etc. For the WCH in 2012, we will produce a hard copy to be distributed free to all of the meeting participants. The names list is sanctioned by SSAR, HL, ASIH, the Canadian Association of Herpetology, the Canadian Amphibian and Reptile Conservation Network, and Partners in Amphibian and Reptile Conservation (PARC).

Dawn Wilson reported that SSAR held a pizza lunch and workshop ("Grants: What is out there and how to write a successful grant proposal") at the 2010 JMIH. A panel of experts was assembled that included the following people: Robert Espinoza, Karen Warkentin, Al Savitzky, Rafael de Sá, Dawn Wilson, and Henry Mushinsky.

Mike Jorgensen and Vinny Farallo replaced Matt Venesky and Cari Hickerson as co-chairs of the Student Travel Awards Committee. In 2011, in an attempt to increase visibility, Silent Auction items were placed in the registration lobby at the JMIH. The winners of the Travel Awards were required to staff the display table throughout the meeting. US $733 was raised in 2010. An important goal this past year was to increase donations and diversify donors. To achieve this, Mike sent an email to approximately 20 distinguished herpetologists with a personal letter describing the Silent Auction and the Student Travel Awards and solicited herp-related donations. Mike and Vinny intend to solicit donations from herpetologists each year, but not to solicit a donation during consecutive years from the same individual(s). The Silent Auction and Travel Awards now have a Facebook page and applications for awards are being accepted from both graduate and undergraduate presenters.

The main addition to the SSAR website was the Standard English and Scientific Names page along with a SSAR Facebook group page. The new SSAR logo was posted, and updates to the homepage content were made. A subcommittee of the Long Range Planning Committee (Bob Hansen, Breck Bartholomew, Raul Diaz) has begun discussion of the design and functionality of the website, and a new website should be in the works this year.

Coordinator's Reports.—Election Officer, Dan Noble, reported that most ballots were submitted electronically and the following individuals were elected in 2010:

President-Elect – Robert Aldridge
Treasurer – Kirsten Nicholson
Secretary – Marion Preest
Board Members (*Regular*) – Tiffany Doan, Carol Spencer
Board Member (*Conservation*) – Jennifer Pramuk
Board Member (*At Large*) – Travis LaDuc

In 2010, the SSAR/HL Live Auction featured items from the Roger Conant collection. Auctioneers for 2010 were John Moriarty and Frank Burbrink. The Live Auction Committee (Greg Watkins-Colwell, Coordinator) discussed the involvement of HL in the running of the auction and ways to improve the collaboration. The live auction made US $4,107 which was split 50-50 with HL. Additionally, the Roger Conant portion of the auction was for SSAR only, and brought an additional US $1,706 for a total of US $3,759.50. The 2011 Live Auction will consist entirely of materials from Ernie Liner and proceeds will be split among SSAR, ASIH, and HL. The Board approved a request to donate a free membership to be given away at the auction.

Al Savitzky, SSAR representative to AIBS and BioOne, reported that AIBS continues to serve as an effective umbrella organization for societies concerned with organismal and environmental biology. AIBS is deeply involved in a strategic planning process to evaluate its own role in the biological community, its unique contributions as an umbrella organization, and the value of its various activities and services. In recent years, two of those services have emerged as especially important elements of the AIBS program: public policy and education. AIBS is facing many of the same challenges as its member organizations, including declining individual membership and rising costs of operations and meetings, and has taken a number of steps to reduce its costs.

BioOne is a nonprofit electronic publishing consortium that serves many society publishers of journals in organismal biology and

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FIG. 10.

FIG. 8. Heather Judd drumming up donations by selling beads at the Liner Auction.

FIG. 9. Kirsten Nicholson, Jenny Gubler, and friend at the sales desk during the Liner Auction.

FIG. 10. SSAR publication booth display of a (very) small selection of items from Ernie Liner for the live auction.

ecology, as well as a few other fields. Al attended the annual BioOne Publishers and Partners Meeting in 2011. This year marks the 10th anniversary of the launch of the first BioOne collection, and during this time, BioOne has returned US $13.5 million to its society publishers. Over the 10-year period, the cost of BioOne to libraries has increased only 9.2%, whereas the Consumer Price Index has increased 23.5%. Such cost containment is consistent with BioOne's role as a collaboration between scientific society publishers and academic libraries.

Al reported that those at the annual meeting heard from a number of speakers, including one who noted a trend among university presses nationwide to publish more works by their own campus authors rather than by off-campus authors, and another who likened the support of open access scientific journals to the support of lighthouses in 19th Century Great Britain, where dues were assessed to shipping companies based on the size of the ships. BioOne is considering a pilot experiment in which libraries are assessed an "open access sustainability surcharge" to support OA content. Finally, Al made his annual inquiry about the prognosis for continuing print publication of JMIH society journals. As expected, more journals are now pursuing online-only or online-primary options. It seems that online-only as the basic membership benefit, with optional print-on-demand, is likely to emerge as the most common model, probably within the next few years. With declining membership among many organismal societies (SSAR is a rare exception), the publication of archival quality print journals will encounter a negative economy of scale, rendering the publication of archival print journals unsustainable. Few societies are planning yet for that eventuality. Al drew the Board's attention to the potential royalties that could be made if *Herp. Review* was available through BioOne. Breck recalled that a number of years ago BioOne was approached about *Herp. Review*. However, they were not interested because they viewed this publication as a news journal. Al thought that it was worth going back to BioOne and asking them again.

This year, SSAR Symposium Coordinator, Richard Durtsche, received two proposals. The first proposal, "Rethinking Normal: Moving from Theory to Action in the Face of Invasive Species and Global Change," was submitted by Joseph Mendelson III as lead organizer, with James P. Collins, Michael E. Dorcas, Karen R. Lips, Priya Nanjappa as co-chairs. The goal of this symposium is to move the discussion of invasive species (both invasive herpetofauna and those species that affect native herpetofauna) beyond just reports of exotic species and the ecological changes they cause, and into the realm of "The New Normal." Participants will discuss how globalization and invasive species, including emerging infectious diseases, are affecting the concepts, principles, and ethics related to rapidly changing ecosystems. The second proposal, "Technology and Innovation in Herpetology and Ichthyology Collections" was submitted by Greg Watkins-Colwell and Mark Sabaj Perez. The organizers' goal is to provide a symposium that is dedicated to collections by providing a platform for introducing researchers to new issues relevant to collections and also providing an environment where recent collection-relevant findings may be shared. Both symposium proposals were sent out for external review (two reviewers each). The reviews and proposals were submitted to the SSAR Board for consideration of sponsorship.

New Business.—Several recommendations were received from the LRPC (Kraig Adler, Chair).

1) *A recommendation to increase membership dues and institutional subscriptions for 2012*: SSAR has not increased dues in several years. The proposed increases result in dues that are not out of line with those of our sister societies. Kraig remarked that we need to increase our revenue stream, not just reduce costs. Our profit margin is very small (or non-existent) for some categories of membership, e.g., student memberships are currently US $35/yr and the mailing costs *alone* for journals to international students annually are US $31.44! The LRPC thinks that increases are warranted in virtually all categories of memberships in order to cover the costs of changes in format in our signature journals, a professional redesign of our website, launching a highly-effective membership campaign, and many other enhanced member services (e.g., increases in the Student Travel Awards budget). In addition to recommending dues increases, the LRPC also recommended formation of a new category (Regular, > 70 yrs of age) at a rate lower than that of a Regular membership. The Board discussed the proposed dues increases and the possibility of some members and institutions dropping their memberships in the light of these increases. Although we have had some institutions drop subscriptions that provide paper copies of our journals in favor of cheaper electronic access, the difference in dues is made up for in royalties from BioOne. Joe Mendelson suggested that student and zoo memberships should be equal. Breck expressed concern that the "shock" of moving from a student membership to a regular membership may lead to some individuals not renewing their memberships. The Board realizes that offering an electronic-only option will happen in the near future. The net effect on our finances is difficult to predict (how will lower dues be balanced by reduced printing and mailing costs?). Some changes to the proposed dues scheme and the effect on the bottom line were discussed and the Board approved the following changes effective January 2012:

- Regular – increase from $70 to $95
- Regular, seniors over 70 (new category) - $50
- Family – increase from $85 to $105
- Sustaining – increase from $100 to $125

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Fig. 11.



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Fig. 12.

- Student – increase from $35 to $45
- Zoo – increase from $35 to $45
- *Herp. Review*-only – increase from $25 to $50
- Institutional, *Herp. Review*-only – increase from $50 to $75
- Institutional, *Herp. Review* and *J. Herp.* – increase from $140 to $195

2) *A recommendation to reject a proposal from Allen Press to co-publish Journal of Herpetology*: In February, President Mendelson referred to the Board a 37-page proposal from Allen Press (AP), which resulted from prior contacts by AP with the co-editors of *J. Herp.*, Gad Perry and Erin Muths. AP proposed assuming much greater responsibility for *J. Herp.* including storing the journals, billing for page charges, setting of market rates, etc. In effect, AP would become the publisher of *J. Herp.* and SSAR responsible only for its content. The LRPC had several rounds of comments and responses. Most members found the proposal unacceptable on several grounds, both philosophical as well as material. For example, some could not see SSAR giving up control of its own journal to this degree. Others were persuaded by SSAR's earlier experience with AP when they took over membership management services, which turned out to have numerous hidden charges and ultimately a cost that was unsustainable for the society. Some pointed out that, if AP collected all page charges, then the editors would not be able to waive these costs for students or authors in developing countries, as they do now, thus reducing the coverage and attractiveness of *J. Herp.* as an international journal. Ultimately, three questions were posed to the LRPC: 1) Accept proposal as is; 2) Send questions to AP to resolve issues; and 3) Decline AP's proposal. Nine votes were received to decline the proposal, two votes to send questions to AP, and there was one abstention. The LRPC recommends that the Board decline AP's proposal. However, from the committee's discussion there are certain specific elements of the proposal that, on further investigation, we may wish to adopt. For example, the ability for the editors to store large data appendices electronically at AP would save much space (and cost) in *J. Herp.* Thus, a specific proposal could be entertained for such a service on a simple fee basis.

Discussion by the Board focused on these additional services. Secretary Preest recalled that SSAR received a proposal from Steve Godley two years ago offering to make appendices to papers published in our journals available on the website. These appendices could include audio and video files, photographs, databases, etc. Raul Diaz indicated that this is something we can do ourselves and do not have to involve Allen Press. The Board voted to decline the proposal from Allen Press as written.

3) *A recommendation against SSAR adopting Contemporary Herpetology*: In February, immediate Past-President Crother asked the LRPC to consider the possibility of adopting the existing open-access herp journal, *Contemporary Herpetology* (CH). Because there is no print version, the relative costs are low and it has the advantage of being able to include color video clips. On consideration, however, the LRPC decided against recommending SSAR adoption. The reasons were varied, but include these: SSAR already sponsors seven different publication series; *CH* would be an additional drain on society resources and, especially, on the small cadre of capable editors needed to staff our many existing series; and the advantages of *CH* could be incorporated into existing SSAR serials (for example, if the society's web page is to be expanded, video clips supporting articles in *J. Herp.*, *Herp. Review*, and other SSAR publications could be posted there). The Board supported the recommendation of the LRPC. Because *CH* has several attractive features, like the ability to post video clips, they referred this matter to the LRPC's website subcommittee to see if there are features that could be adopted for the benefit of the herpetological community.

The Co-Editors of *Journal of Herpetology* brought six issues to the attention of the Board.

1) *Difficulties in obtaining qualified Associate Editors and reviewers*: Gad and Erin reported that this remains the biggest challenge to a more rapid manuscript handling process. Many leading journals provide AEs some sort of recognition for their services. The suggestion last year to provide AEs free membership was one attempt to address this problem, however this was rejected by the Board. Gad and Erin requested that the Board reconsider this matter. Joe suggested that the co-Editors expand their Editorial Board and use them to help review manuscripts. For example, when individuals agree to be added to the Editorial Board, they must also agree to review up to 15 manuscripts per year. There was some discussion of the use of "tokens" to reward prompt reviewers and of using graduate students to help with reviews. An op-ed piece from the President could be used to remind members of the importance of this service to the continued quality of our journals. An online check box could be provided for members to indicate that they are willing to serve as reviewers when they renew their membership. The Board rejected the proposal to provide Associate Editors with free memberships, but it was agreed that some sort of gesture might be appropriate. The co-Editors were asked to consider this matter further.

2) *Page charges*: The Editors submitted a proposal regarding page charges as requested by the Board in 2010. According to this policy the Editors would retain the ability to waive page charges in special circumstances. There was some concern expressed that making page charges mandatory might hold up publication, however the Editors did not view this as a problem. The Board requested that Gad and Erin consider policies being used by the Editors of *Copeia*

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FIG. 13.

FIG. 11. Winners of the Student Travel Awards (L to R): Jason Warner, Anthony Geneva, Rob Denton, Aimee Silla, Mike Jorgensen (Chair, Student Travel Award Committee), Daniel Paluh, Chris Howey, President Joe Mendelson, III, Travis Hagey, and Anne Stengle.

FIG. 12. Joe Mendelson, Kirsten Nicholson, and Kraig Adler—happy to be ending the Board Meeting with a balanced budget!

FIG. 13. Some of the winners and recipients of honorable mention in the 2011 Henri Seibert Award Competition along with the Chair of the Seibert Committee and President Mendelson (L to R): Rafe Brown (Chair), James Paterson, Steve Price, Joe Mendelson, Andrew Durso, Charles Linkem, and Yik-Hei Sung.

and *Herpetologica* and develop a coherent page charge policy that includes the use of color.

3) *Preparing for e-publishing*: Gad and Erin noted that journals are increasingly going wholly or optionally digital and that *J. Herp.* needs to be prepared for such a move. They acknowledged that the LRPC is considering this issue and support providing a digital-only subscription option.

4) *Second language abstracts*: International journals often offer the option of a second language abstract and Gad and Erin would like to do the same. Allen Press can handle a variety of languages, although Spanish and Portuguese are expected to predominate. Gad and Erin foresee the authors providing the abstract upon submission, and an independent reader confirming that the content indeed matches the English-language abstract upon acceptance. The Department of Classical & Modern Languages & Literatures at Texas Tech is offering to provide this service for $15/manuscript. The Board viewed this as an important and long overdue concept. There was discussion of the use of SSAR members to review abstracts. Robin Andrews suggested that authors provide JPEG (or other) files of abstracts in the case of languages Allen Press is unable to typeset. The Board voted to approve offering second language abstracts and the request for a budget to cover associated costs.

5) *Editorial office expenses*: In the past, institutions for which editors have worked have provided many services for free, e.g., phone service, mail service, occasional office services, and an editorial assistant. With budget cuts looming, Texas Tech University has indicated its desire to have SSAR assume those costs. The Board voted to assume these costs if/when necessary.

6) *Co-publishing*: Following inquiries about additional services that Allen Press provides to *Herpetologica* but not *J. Herp.*, Gad and Erin learned that The Herpetologists' League has a different kind of contract with AP than does SSAR. They therefore asked AP to provide SSAR with a similar offer. This offer was forwarded to the Board and Long Range Planning Committee (LRPC) for increased overview and in-depth assessment. Gad and Erin appreciate the job that the LRPC did in exploring the ramifications and agree with some of the concerns that have been identified. However, they asked the Board to overrule the recommendation of the LRPC. As noted above, the Board voted to adopt the recommendation of the LRPC and decline the proposal from Allen Press as written.

Henry Mushinsky presented a report from an *ad hoc* committee on increasing JMIH society interactions. Included in this report were suggestions to form a JMIH Conservation Committee, to have greater co-sponsorship of symposia that would be less taxonomically based and more problem-oriented or topically based, to develop a joint JMIH Society webpage, to enter into joint negotiations with publishers, and to form an umbrella society that would, for example, take control of membership tracking and treasurer duties. There was no discussion of this report, as it will be considered by the LRPC later this year, before coming to the Board.

Brian Crother developed a policy on complimentary life membership and receipt of *gratis* copies of SSAR publications. The Board approved the recommendation to provide an Honorary Life Membership to individuals who donate $\geq$ 10 times the current cost of a life membership. It also approved the recommendation that those listed on the SSAR letterhead (i.e., officers and editors) be provided with *gratis* copies of society publications. There was discussion of giving "gift certificates" valid towards purchase of SSAR publications to Associate Editors of our journals. This suggestion was tabled.

There was discussion of what to do with SSAR's share of the proceeds of the Ernie Liner Auction. An Ernie Liner Endowment will be set up to support up-and-coming herpetologists. Further discussion will occur once the endowment is in place.

Once again, the Board discussed a name for the new Student Poster Competition. Roger Conant's name was suggested. Kraig offered to consult Roger's will to determine if this is appropriate. Discussion followed the Board meeting and it was suggested we name the Grants in Herpetology program after Roger. The Board later voted unanimously to support this proposal and we are pleased to announce the Roger Conant Grants in Herpetology Program.

Copyright issues and electronic access to articles published in *Herp. Review* and *J. Herp.* were discussed. Free access to these articles affects royalties we receive from JSTOR and BioOne. SSAR needs to develop and enforce a policy regarding copyright issues. Breck, with assistance from Kirsten and Editors Hansen, Perry, and Muths will develop such a policy and the Secretary will distribute this to the Board for discussion and a vote. A copy of the policy will be displayed on the website and included in print journals once finalized.

The Herpetology Education Committee submitted two proposals for the Board to consider. The first was a proposal that, in all cases where appropriate (e.g., in Annual Meeting information), "students" or "graduate students" be substituted by "undergraduate and graduate students." The Board approved this proposal. The second was a proposal for a new program that will cover single-day meeting registration fees for a pre-baccalaureate student (plus accompanying person if appropriate). There was discussion of how such individuals would be identified and selected, e.g., selected by a random drawing of names. A suggestion was made that prospective students be identified by local herpetologists, and applicants submit essays to members of the HEC, who will then select a winner. The Board approved this proposal.

Ann Paterson summarized the many activities of the Membership Committee, focusing particularly on the results of an extensive survey they administered recently. The importance of the Society website to the activities of this committee was recognized, and Ann was added to the LRPC website subcommittee.

The Board voted to donate its share of the proceeds of the 2012 Live Auction to the WCH minus associated costs. SSAR would appreciate an acknowledgment from WCH of this donation.

An enquiry was received from Josh Kapfer regarding increasing the number of GIH Awards. Gad Perry suggested that awards could be split between US and non-US members of SSAR. The Board was in favor of increasing the number of awards, but upon review of the budget, decided that this was not the year to increase the GIH budget. They agreed to consider this request in the future.

A balanced budget for 2011 of US $394,800 was approved by the Board and the meeting was adjourned at 1525 hrs (Fig. 12).

LRPC Meeting

An open meeting of the Long Range Planning Committee (LRPC) occurred on July 9th. LRPC Chair, Kraig Adler, called the meeting to order. Approximately 30 members of SSAR were in attendance. Kraig distributed an agenda and introduced members of the LRPC and other officers present. Four topics were the focus of discussion: future meetings (specifically venues and programs), the SSAR website, electronic-only memberships, and SSAR as an international society. Kraig began with a brief history of the annual meetings of SSAR. Over the years, annual meetings have consisted of SSAR-only, SSAR + HL, SSAR + HL + ASIH, and SSAR as part of JMIH. Herpetologist-only meetings are smaller than those including ichthyologists and might permit meeting on a university campus (rather than at a hotel or large conference center), something that younger members of SSAR will not have experienced. A question was raised about why SSAR

stopped meeting on campuses; the response was that the change was made for convenience and because it was getting difficult to find individuals willing to put the effort into organizing meetings. Someone pointed out that universities don't "reward" or encourage the effort involved in hosting a university-based meeting. K-State's involvement means that meetings are less work for the local committee, but this also reduces valuable input from that committee. Breck Bartholomew voiced his opinion that, unless we can find committed local committees, we needed to stick with the JMIH arrangement. Dawn Wilson suggested that mistakes in planning are more likely with local committees "starting from scratch every year" rather than having continuity with K-State. Having a template that gets refined and passed on each year would help with this problem. Mo Donnelly pointed out that the JMIH had received an offer from the University of New Mexico for the 2013 meeting but, because of university regulations, this would need to be a dry meeting. Someone suggested that the costs of university-based meetings were likely to be substantially higher than we remember from past meetings, e.g., we would not receive complimentary rooms as we do with hotels (assuming we meet our room block). The meeting would not necessarily have to be held at a university, i.e., a smaller herps-only meeting could be held at a conference facility.

Discussion then turned to SSAR's web presence. A website subcommittee (Bob Hansen, Chair, Breck Bartholomew, Raul Diaz) was formed recently (Ann Paterson was added to this committee at the Board Meeting). Bob briefly reviewed the history of the Society's website and indicated that we are ready to start with a "clean slate." Raul Diaz projected websites of other organizations on a screen and showed us sites of increasing complexity. We want the site to inform members and the public about the Society and also about the field of herpetology. The new SSAR website needs to be able to accommodate membership functions (complementing the ZenScientist site), be a dynamic site that plays a large role in meeting the needs of our members, permit downloading of SSAR publications, provide links to other herp sites, etc. There were suggestions of President's blogs and posting of teaching modules. There was some discussion of member-only versus public access and of peer-reviewed Wiki forums within the website. These would only be available to SSAR members to write/edit, and work on the Wiki pages would not be anonymous.

The following suggestions were made: that we provide pictures of officers, editors, and committee chairs on the webpage, that we have a mentoring program available through the website, that we provide information about keeping captive animals, that we post herp-related advertisements (similar to those currently in *Herp. Review*) on the website, that we post downloadable photos, teaching modules, lectures, membership directory (with rules as to use and the ability to unsubscribe), access to articles, videos of President's Travelogues and Plenary Sessions, videos of field experiences, videos of presentations by Seibert Award winners, videos of Student Poster Award winners, etc.

Concern was expressed about the amount of work all of this would entail for our webmaster (currently Raul). If we adopted an open-source platform such as Drupal, it would be possible for others (officers, editors) to update relevant parts of the website. Having this succeed would require multiple volunteers being responsible and diligent.

There was brief discussion of electronic-only membership in SSAR. Kraig thinks we will have an electronic-only membership option available within a year. A poll was taken of those in the room under 40 yrs of age. Of the 15 individuals present, seven indicated they would select an electronic-only option, three would select print-only option and five indicated they would choose an electronic + print option. A suggestion was made that we ask the same question of the entire student membership

Finally, there was discussion of the role of SSAR as an international society. Despite the fact that most members and officers of SSAR are in North America and that most of the meetings are held in North America, SSAR very much considers itself an international society. Kraig asked whether there was interest in more international venues for meetings—there was! Kris Kaiser thought that holding meetings in regions other than North America sent a very important message to non-US members of SSAR, many of whom are financially unable to attend meetings in North America. There was talk of setting up an endowment for non-US student members of SSAR to attend meetings in North America. SSAR could think about broadcasting sessions at meetings on the website to non-US members and posting abstracts in languages other than English on the website. This would make them accessible to non-English speaking members as well as freeing up print space in *J. Herp.*

SSAR Business Meeting

Later that same day, the Annual SSAR Business Meeting was called to order by President Mendelson (1805 h on July 10th). Attendance was high—well over 100 members of SSAR were present. Joe commented on and held up for display, certificates of appreciation from SSAR to Bob Powell, Andy Price, and George Rabb. Robert Powell was Index Editor for *Catalogue of American Amphibians and Reptiles* (*CAAR*) from 1988–1991 and Editor-in-Chief from 1991–2004. Andrew H. Price has served as Section Editor for Sauria and Amphisbaenia for *CAAR* from 1987–present and as Editor-in-Chief from 2005–present. As Editors, Bob and Andy served *CAAR* from account no. 506 in 1991 through account no. 900 (appearing later this year). We greatly appreciate the dedication that Bob and Andy have shown to *CAAR* and SSAR. George B. Rabb, Director Emeritus of Brookfield Zoo, was presented with a life-time achievement award to recognize his career commitment to conservation of wildlife globally, with special reference to his leadership in implementing the IUCN Species Survival Commission, the Declining Amphibian Populations Taskforce, the Amphibian Ark, and most recently the Amphibian Survival Alliance. SSAR is proud to count George Rabb among our membership.

Officers, Editors, and Committee Chairs who were at the Business Meeting introduced themselves to the other attendees and gave brief summaries of their Annual Reports and relevant information from the Board Meeting. Bob Hansen requested that those interested in reviewing material for *Herp. Review* (students especially) contact him. Gad Perry echoed that sentiment and asked that, if you are contacted to review a manuscript and are unable to do so, you notify the editors of *J. Herp.* promptly. Winners of the 2011 Seibert Awards were announced (Fig. 13). The Society was asked to endorse a resolution from the Amphibian Survival Alliance to support amphibian conservation. The Board later voted electronically and unanimously supported this resolution. A proposal was received to unify the Conservation Committees of the four JMIH Societies (AES, ASIH, HL, SSAR). A committee representing all societies (5 members from SSAR, including one student) will be formed to investigate this proposal over the next year. The meeting was adjourned at 1935 h.

— Respectfully submitted by Marion Preest, SSAR Secretary

NEW BOOK FROM S.S.A.R.

HERPETOFAUNA OF ARMENIA AND NAGORNO-KARABAKH

by Marine S. Arakelyan, Felix D. Danielyan, Claudia Corti, Roberto Sindaco, and Alan E. Leviton

Paleontological notes by David Vasilyan

THIS VOLUME COVERS THE HERPETOFAUNA OF ARMENIA and its neighboring republic of Nagorno-Karabakh, situated in the mountainous South Caucasus between the Black and Caspian seas, and surrounded by Georgia, Azerbaijan, Iran, and Turkey. The geographic position of these republics, the complicated regional geological structure, and zonation contribute to many types of ecosystems and biodiversity richness. Located at the crossroads between Asia and Europe, the Caucasus has been identified by the World Wildlife Fund for Nature as a "Global 200 Ecoregion" and by Conservation International as one of the world's 25 most biologically rich global "hotspots." The herpetofauna of Armenia and Nagorno-Karabakh includes 59 species, more than half of which are threatened, and of which 11 are endemic to the Armenian Plateau and Lesser Caucasus.

The book covers 17 families: 4 of amphibians, including both salamanders and frogs: Salamandridae (1 genus: 1 species), Pelobatidae (1:1), Bufonidae (1:1), Hylidae (1:2), Ranidae (2:2); 12 families of reptiles, including 3 families of turtles: Emydidae (1:1), Bataguridae (1:1), Testudinidae (1:1); 5 families of lizards: Gekkonidae (1:1), Agamidae (3:3), Anguidae (2:2), Lacertidae (5:17), Scincidae (3:4); and 4 families of snakes: Typhlopidae (1:1), Boidae (1:1), Colubridae (12:16), and Viperidae (3:4). Among the lizards, the lacertid genus *Darevskia* is of particular interest because it was among these lizards and in Armenia that Ilya Darevsky, to whose memory this volume is dedicated, first discovered parthenogenesis in reptiles.





There is an historical review of herpetological studies in the region (beginning with expeditions by czarist Russia in 1835) and an extensive key to species (with 72 interpretive photographs). **Each species account includes:** synonymy, type locality, taxonomic notes, distribution, habitat, size, karyotype, conservation status, and major references. There is an extensive bibliography and a comprehensive index. The color plates contain 151 photographs of animals and their habitats plus 60 colored maps with individual localities plotted.

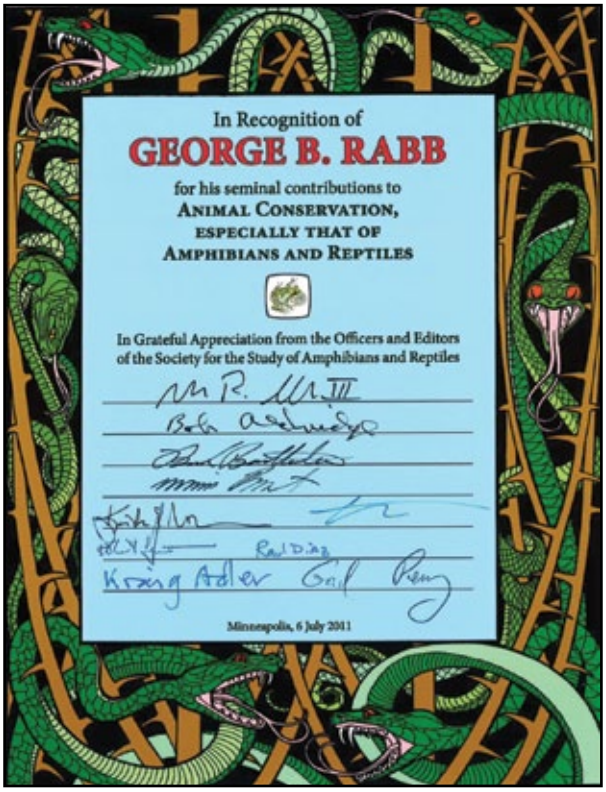
The team of authors consists of two Armenians (Marine Arakelyan and Felix Danielyan) and two Italians (Claudia Corti and Roberto Sindaco) who have conducted all of the field investigations, much of it spanning nearly two decades, and an American (Alan Leviton) who specializes on Asian herpetology.

Specifications: *186 pages, 7 × 10 inches, 60 color maps, 72 figures, 4 tables, 151 color photographs, clothbound. ISBN 978–0–916984–84–7.* ***To be issued December 2011.***

PRICES: **SSAR members US$35 before April 2012; Institutions, non-members US$40.** ***SHIPPING:*** **USA address, add US$5; non-USA, at cost.**

Send orders to: Breck Bartholomew, SSAR Publications Secretary, P. O. Box 58517, Salt Lake City, Utah 84158–0517, USA (*telephone*: area code 801, 562–2660; *e-mail*: ssar@herplit.com). Make checks payable to "SSAR." Overseas customers may make payment in USA funds using a draft drawn on American banks or by International Money Order. All persons may charge to MasterCard, American Express, Discover Card, or VISA (please provide account number and expiration date). SSAR membership details and a complete list of all Society publications can be obtained on request to the Publications Secretary (address above). For details, check the Society's website at www.ssarherps.org.

Lifetime Achievement Award for George Rabb



At the 2011 SSAR Board Meeting, George B. Rabb, Director Emeritus of Brookfield Zoo, was presented with a lifetime achievement award to recognize his career commitment to conservation of wildlife globally, with special reference to his leadership in implementing the IUCN Species Survival Commission, the Declining Amphibian Populations Taskforce, the Amphibian Ark, and most recently The Amphibian Survival Alliance. SSAR is proud to count George Rabb among our membership.

Seibert Award Winners for 2011 Announced

The 20th annual Seibert Awards were presented at the 54th Annual Meeting of the SSAR in Minneapolis, Minnesota, 6–11 July 2011. These awards are named in honor of Henri C. Seibert, an early and tireless supporter of SSAR (having served as an officer for over 20 years). In recognition of outstanding student presentations at the annual meeting, a single award was given in each of the following categories: Evolution/Systematics (9 presentations), Ecology (12 presentations), Physiology/Morphology (6 presentations) and Conservation (8 presentations). All awardees will receive a check for US $200 and a book from Chuck Crumly at University of California Press.

The Winners –Systematics/Evolution: **Daniel Scantlebury** (University of Rochester), "Patterns of Adaptive Radiation in West Indian Dwarf Geckos (Sphaerodactylidae: *Sphaerodactylus*)." Ecology: **James Paterson**, Brad Steinberg, and Jacqueline Litzgus (Laurentian University), "Generally Specialized or Especially General? Habitat Selection by Snapping Turtles (*Chelydra serpentina*)." Conservation: **Jeanine Refsnider** and Fredric Janzen (Iowa State University), "Nest-site Choice in Response to Climate Change and Effects on Offspring Performance in a Turtle with Temperature-dependent Sex Determination." Physiology/Morphology: **Angela Rivera** (Clemson University), "Evolution of Flapping in Turtles: A Comparative Examination of Forelimb Kinematics and Muscle Function across Three Lineages (Trionychidae, Carettochelyidae, Cheloniidae)."

The judges were Cathy Bevier (Colby College), Rafe Brown (University of Kansas), Tiffany Doane (Central Connecticut State University), Nirvana Filoramo (Wesleyan University), Mac Given (Neumann College), Noah Gordon (University of Evansville), Eric Juterbock (The Ohio State University), and Patrick Owen (University of Cincinnati).

SSAR Student Poster Awards, 2011

Because of the continuing success of the SSAR Seibert Award competition for best student presentation at the annual meeting, SSAR decided to expand its annual award offerings to recognize student poster entries as well. President Mendelson suggested the creation of the SSAR Student Poster Award to the Board of Directors during the 2010 meeting and it met with unanimous support from the Board. 2011 was the inaugural year for the award with 20 entries in three categories. This year's judges were Tiffany Doan (chair, Central Connecticut State University), Marina Gerson (California State University, Stanislaus), Carol Spencer (University of California, Berkeley), Greg Watkins-Colwell (Yale Peabody Museum), Matthew Gifford (University of Arkansas at Little Rock), Dana Drake (University of Missouri), and John Roe (University of North Carolina).

The Winners.—Evolution, Genetics, & Systematics: **Anthony Geneva** (University of Rochester), "A Multi-locus Molecular Phylogeny of Distichoid Anoles." Ecology, Natural History, Distribution, & Behavior: **Beth Pettitt** (University of Minnesota), "Oviposition and Tadpole-rearing Site Selection of a Phytotelm-breeding Frog, *Anomaloglossus beebei*." Physiology & Morphology: **Mingna Zhuang** (University of California, Berkeley), "Comparative Gliding Performance of *Anolis carolinensis* and *Anolis sagrei*."

NEWSNOTES

Jones-Lovich Grant in Southwestern Herpetology

Thanks to the generosity of Larry Jones and Rob Lovich, 100% of the proceeds from the sale of their book, *Lizards of the American Southwest* (2009, Rio Nuevo Press), goes to support herpetological graduate field research in the American Southwest, including the southwestern United States and northwestern Mexico. An award (US $1000) will be presented to one winner. This research can focus on any aspect of amphibian or reptile biology, including behavior, conservation, ecology, physiology, or morphology and systematics. See The Herpetologists' League web site for application form, complete rules and details, along with the cover page at: http://www.herpetologistsleague.org/dox/joneslovichgrant.pdf. Entries must be received by 5:00 pm Pacific Time on 9 January 2012.

New Smithsonian Graduate and Professional Course—Species Monitoring and Conservation: Amphibians

The Smithsonian-Mason Global Conservation Studies Program will offer "Species Monitoring and Conservation: Amphibians" at the Smithsonian Conservation Biology Institute, Front Royal, Virginia, USA from 26 March to 6 April 2012. Visit http://conservationtraining.si.edu or contact SCBItraining@si.edu for more information about this course and additional upcoming courses of potential interests to herpetologists.

MEETINGS

Exploring the Secret Lives of the World's Most Studied Snake Group: A Second *Biology of the Rattlesnakes Symposium*

As the lightning of a monsoonal thunderstorm lit up the night sky, the second *Biology of the Rattlesnakes Symposium* got underway on the evening of 23 July 2011, at the Tucson, Arizona, Marriot University Park hotel. Hotel employees marveled at the throng of rattlesnake devotees, some 240 strong (Fig. 1), that began the registration process in a room filled with vendors displaying ophidiophilic T-shirts, hats, books, artwork, snake hooks, and radiotelemetry equipment—not to mention the numerous live rattlesnakes on exhibit.



PHOTO BY BILL LOVE

FIG. 1. Participants at the Second Biology of the Rattlesnakes Symposium, July 2011, Tucson, Arizona.

The formal symposia commenced the next morning with a stellar keynote address by Harry Greene of Cornell University, New York: "*Fifty years after Klauber: What's it Like to be a Rattlesnake?*" Harry set a much-appreciated tone with his appeal to portray rattlesnakes in the best possible light (deemphasizing their danger) while articulating their capacity to "think" and solve survival-related problems. Upwards of 65 oral and 14 poster presentations then followed over the three-day period, which included one all-day session at the beautiful facilities of the Arizona-Sonoran Desert Museum. The majority of papers focused on field ecology research, though studies of behavior, morphology, physiology, systematics, venom, toxicology, and snakebite were also represented. Two photographers, Manny Rubio and Bill Love, showcased their beautiful images of snakes and snake lovers.

The formal meetings concluded with a banquet featuring Jonathan Campbell of the University of Texas at Arlington, who described his fascinating career work on rattlesnakes and other venomous snakes in Mexico and Mesoamerica. The banquet also included a lively auction to benefit a graduate student research fund. Many participants attended the barbecue the next day at the Chiricahua Desert Museum in Rodeo, New Mexico, with proceeds also benefiting the graduate student research fund.

This taxon-specific meeting continued the tradition of prior symposia devoted to venomous snakes. According to the 80 respondents of an online survey, fewer than half (only 35%) attended the first *Biology of the Rattlesnakes Symposium* at Loma Linda University, California, in 2005. Only a smattering (up to 8%) previously attended the *Biology of the Pitvipers Symposium* (1989), the *Biology of the Vipers Symposia* (2000, 2007, 2010), or the *Eastern Massasauga Symposia* (1992, 1998, 2005). Clearly, many of the participants at the Tucson meeting represented "new blood," enthralled by the latest research findings on the world's most studied group of snakes (Beaman and Hayes 2008). University faculty, staff, and students comprised the majority of participants, but those of other diverse professions attended as well, including government, zoo, museum, and healthcare employees. Although many individuals enjoyed herping in the nearby area, particularly during the night hours, socializing with other herpetologists rated as one of the favorite aspects of the symposium.

The popularity of this symposium assured a future encore. According to the survey, participants favored the idea of meeting every three years, preferably in the southwestern U.S. during the late summer. However, Mexico was deemed feasible by many as a future meeting locale, with Central America and South America less desirable.

Overall, the participants gave the meetings high praise. The organizers, Bob and Sheri Ashley of Ecouniverse and the Chiricahua Desert Museum, Rodeo, New Mexico, assisted by Lori King Painter, also of New Mexico, did an outstanding job. Generous donations kept the cost of the symposium appreciably affordable to many. The primary sponsors included BTG (marketer of CroFab antivenom for humans), Red Rock Biologics (marketer of rattlesnake vaccines for dogs and horses), Rare Disease Therapeutics (distributor of Bioclon antivenoms for snakes and invertebrates), the Arizona-Sonora Desert Museum, and the Chiricahua Desert Museum.

A refereed volume similar to *The Biology of Rattlesnakes* (following the 2005 meeting) and those generated by prior symposia (*Biology of the Pitvipers, Biology of the Vipers*) will be published in due course.

Reference

Beaman, K. R., and W. K. Hayes. 2008. Rattlesnakes: Research trends and annotated checklist. *In* W. K. Hayes, K. R. Beaman, M. D. Cardwell, and S. P. Bush (eds.), The Biology of Rattlesnakes, pp. 5–16. Loma Linda University Press, Loma Linda, California.

—Contributed by **WILLIAM K. HAYES**, Department of Earth and Biological Sciences, Loma Linda University, Loma Linda, California 92350 USA; e-mail: whayes@llu.edu.

Meetings Calendar

Meeting announcement information should be sent directly to the Editor (HerpReview@gmail.com) well in advance of the event.

12–13 January 2012—California-Nevada Amphibian Population Task Force Meeting, Placerville, California, USA. Information: bradford.david@epa.gov

14 January 2012—California Reptile and Amphibian Conservation and Management Forum, Placerville, California, USA. Information: Brian Todd (btodd@ucdavis.edu).

16–19 February 2012—"Connecting Efforts and Identifying Gaps in Southeastern Amphibian and Reptile Conservation." Southeastern Partners in Amphibian and Reptile Conservation (SE PARC) Annual Meeting, Fall Creek Falls State Park, Tennessee, USA. Information: SEPARC@SEPARC.org.

25–28 July 2012—35th International Herpetological Symposium, Hanover, Maryland, USA. Information: http://www.kingsnake.com/ihs/.

8–14 August 2012—World Congress of Herpetology 7, Vancouver, British Columbia, Canada (together with SSAR, HL, ASIH). Information: http://www.worldcongressofherpetology.org/

16–19 August 2012—10th Annual Symposium on the Conservation and Biology of Tortoises and Freshwater Turtles, Tucson, Arizona, USA. Co-hosted by the Turtle Survival Alliance and IUCN Tortoise and Freshwater Turtle Specialist Group. Information: http://www.turtlesurvival.org.

2–7 September 2012—4th International Zoological Congress (IZC), Mount Carmel Campus, University of Haifa, Haifa, Israel. To receive the first and subsequent meeting announcements, contact the organizers at: izc2012@sci.haifa.ac.il.

CURRENT RESEARCH

The purpose of Current Research is to present brief summaries and citations for selected papers from journals other than those published by the American Society of Ichthyologists and Herpetologists, The Herpetologists' League, and the Society for the Study of Amphibians and Reptiles. Limited space prohibits comprehensive coverage of the literature, but an effort will be made to cover a variety of taxa and topics. To ensure that the coverage is as broad and current as possible, authors are invited to send reprints to the Current Research section editors, Joshua Hale or Ben Lowe; e-mail addresses may be found on the inside front cover.

A listing of current contents of various herpetological journals and other publications is available online. Go to: http://www.herplit.com and click on "Current Herpetological Contents."

Anolis Lizards Demonstrate Problem Solving

Cognitive ecology is the study of how functional explanations of behavior, such as those provided by behavioral ecology, can be integrated with an understanding of the underlying neural and physiological mechanisms. An important component of cognitive ecology is the study of behavioral flexibility. According to theoretical predictions, species that need to exploit a variety of resource types or habitats, or have a complex social structure are likely to show elevated levels of behavioral flexibility. As a consequence, study of behavioral flexibility has concentrated on birds and mammals, as they are traditionally thought to have these characteristics. In contrast, these attributes are not normally associated with ectothermic vertebrates, and as a consequence, they have been neglected in studies of behavioral flexibility. In order to begin to redress this imbalance, the authors of this paper have examined behavioral flexibility in the arboreal lizard *Anolis evermanii* from Puerto Rico. A range of tasks were designed to test cognitive abilities. First, lizards were presented with an opaque grey platform with two wells. Habituation to this experimental setup was conducted over three steps. First, a reward (freshly killed *Hermetia illucens* larvae) was placed in one of the wells, then a small, blue-colored disc was placed next to the well, and finally, this disc was used to half cover the well. For the first part of the experiment, this disc was fitted tightly over one well containing a reward. Of the six lizards (three males and three females) used, four successfully removed the disc to access the reward using one of two strategies, either biting the edge of the disc or using their snout as a lever to dislodge it. These four lizards were used in two subsequent experiments in which the second well was covered with a 'distracter' (either a yellow disc or a disc colored with blue and yellow concentric circles). Overwhelmingly, using both distracters, each of the four lizards was able to successfully choose the target without mistake. Finally, trials were conducted to test reversal learning by placing the reward under the blue and yellow disc. Two of the four lizards were able to demonstrate reversal learning, while the other two stopped responding due to lack of reinforcement. The ability of these lizards to solve a novel motor task using multiple strategies, associative and reversal learning, demonstrates sophisticated cognitive abilities, including behavioral flexibility. The authors highlight that as a group, *Anolis* lizards are known to exploit a range of different ecological conditions and exhibit complex behavior, attributes normally associated with behavioral flexibility. The authors do point out that this group's ability to display behavioral flexibility may have facilitated its ecological diversification. These findings do suggest that the cognitive abilities of ectothermic tetrapods are more developed than previously thought.

Leal, M., and B. J. Powell. 2011. Behavioural flexibility and problem-solving in a tropical lizard. Biology Letters (*in press*). doi: 10.1098/rsbl.2011.0480.

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Impact of Small-scale Fisheries on Marine Turtles

The impact of industrial fisheries on non-target, 'bycatch' species has been well documented, and has been implicated as a key factor driving population extirpation in marine turtles. Recently, awareness has been growing that similar impacts could result from interactions with small-scale fisheries. Small-scale fisheries (SSF) are defined by smaller vessels with minimal levels of mechanization compared to industrial fisheries. Although bycatch by SSF may be less than industrial fisheries at the individual level, fleets may be extremely large, especially in developing countries. In this study, the authors examined the impact of SSF on marine turtles in Peru. Onboard and shore-based observers assessed bycatch levels of four different fisheries (bottom set nets, driftnets, and two longline fisheries) from three SSF ports in Peru from 2000 to 2007. In total, 264 fishing trips were observed, with 807 turtles captured, approximately 92% of which were released alive. Loggerhead Turtles made up 51.2% of this bycatch, Green Turtles 41.4%, Olive Ridley Turtles 3.2%, Leatherback Turtles 2.1%, and unidentified species 2.1%. From this survey effort, it was estimated that approximately 5900 sea turtles are captured annually from these three SSF ports alone. The authors estimate that there are greater than 100 SSF ports in Peru representing more than 950 vessels and 37,000 fishers and as a result, the impact of SSF on sea turtles in the region may be severe. The authors also discuss the use of marine turtles as important food sources for coastal communities, and how these issues should be considered when recommending management and conservation strategies.

Alfaro-Shigueto, J., J. C. Mangel, F. Bernedo, P. H. Dutton, J. A. Seminoff, and B. J. Godley. 2011. Small-scale fisheries of Peru: a major sink for marine turtles in the Pacific. Journal of Applied Ecology (*in press*). doi: 10.1111/j.1365-2664.2011.02040.x.

Correspondence to: **Brendan Godley**, Marine Turtle Research Group, Centre for Ecology and Conservation, University of Exeter, Cornwall Campus, Penryn, Cornwall, TR10 9EZ, UK; email: b.j.godley@exeter.ac.uk.

Seasnakes Shelter in Disused Seabird Burrows

Ecosystem engineers alter the physical environment to increase their own fitness, but in the process can benefit other species, by providing new habitats, increasing productivity of an area or enhancing the functioning of the local ecosystem. Burrowing species are one such example of ecosystem engineers providing habitat for sympatric species, however some burrowing species behaviorally exclude other sympatric species from using these burrows. In this study, the authors have examined the use of burrows created by the Wedge-tailed Shearwater (*Puffinus pacificus*), on New Caledonia in the Pacific Ocean. Two species of laticaudine seasnakes are abundant on New Caledonia: the primarily terrestrial Yellow-banded Sea Krait (*Laticauda saintgironsi*) and the more aquatic Blue-banded Sea Krait (*Laticauda laticaudata*). For this study, the authors used video cameras to inspect 102 burrows. It was found that *L. laticaudata* are restricted to burrows that are closer than 4 m to water's edge, while *L. saintgironsi* tended to utilize burrows further inland. Seasnakes and shearwaters were never observed in the same burrow, suggesting shearwaters actively defend these burrows. To examine burrow defense behavior more closely, model snakes were inserted into burrows, and the frequency of attack by adult shearwaters was recorded. In total, 165 model snakes were introduced into 55 burrows (three models per burrow: blue & black- and yellow & black-banded, to mimic *L. saintgironsi* and *L. laticaudata* respectively, and one all-black control model), eliciting 41 responses from resident shearwaters. In 34 cases, the model was attacked, on six occasions the resident bird stood or sat on the model and in one case the adult shearwater fled the nest. These experiments revealed that the likelihood that a bird would attack a model snake was unrelated to its color. The authors outlined the advantages of sheltering in burrows for seasnakes, including protection from predators, thermal benefits, and increased access to fresh water. This study provides an example of an ecosystem engineer acting both as a facilitator and a competitor of a sympatric species.

Lane, A. M., and R. Shine. 2011. When seasnake meets seabird: ecosystem engineering, facilitation and competition. Austral Ecology 36:544–549.

Correspondence to: **Richard Shine**, School of Biological Sciences A08, University of Sydney, Sydney, NSW 2006, Australia; e-mail: rick.shine@sydney.edu.au.

Effective Population Size Correlated with Breeding Pond Size in an Endangered Salamander

One of the fundamental goals of conservation biology is the maintenance of genetic diversity and population viability. Effective population size (N_e), essentially the number of individuals that will contribute genes equally to the following generation, is an important factor in maintaining genetic diversity, preventing inbreeding depression, and predicting the likelihood of population persistence. In this study the authors examined the correlation between breeding pond characteristics and effective population size in the endangered California Tiger Salamander, *Ambystoma californiense*. Microsatellite markers were used to assess effective population size as well as heterozygosity and allelic diversity. The area of each pond was calculated and each was classified as being either a hydrologically modified perennial pond or a naturally occurring vernal pond. Although no correlation was found between pond area and either heterozygosity or allelic diversity, there was a strong positive relationship between N_e and pond area, particularly for vernal ponds. The authors propose that this may be due to large vernal ponds drying out relatively slower than smaller ponds, and therefore suffering lower mortality. The relationship between N_e and pond size was logarithmic, which, according to the authors, suggests that there is an upper limit to N_e in large ponds. Despite the low effective population sizes in smaller ponds, there was no observable reduction in allelic diversity or heterozygosity, suggesting that these ponds are not experiencing the usual fitness costs associated with small populations such as bottlenecks and inbreeding depression. The authors suggest that understanding the relationships between N_e and habitat characteristics would be very important for wildlife managers designing comprehensive conservation plans.

Wang, I. J., J. R. Johnson, B. B. Johnson, and H. B. Shaffer. 2011. Effective population size is strongly correlated with breeding pond size in the endangered California tiger salamander, *Ambystoma californiense*. Conservation Genetics 12:911–920.

Correspondence to: **Ian Wang**, Department of Organismic and Evolution Biology, Harvard University, Cambridge, Massachusetts 02138, USA; e-mail: ijwang@ucdavis.edu.

Relationships Between Body Size and Habitat in Turtles and Tortoises

Chelonians, the turtles and tortoises, display remarkable size variation, spanning almost four orders of magnitude. At one end of the scale are tiny terrestrial species like *Homopus signatus*, the 80 g Speckled Padloper Tortoise, and at the other, the gigantic marine turtles such as the 500 kg Leatherback (*Dermochelys coriacea*). Despite the remarkable size variation observed, understanding of the evolutionary basis for this variation remains poor. In this study, the authors tested the hypothesis of a correlation between habitat (freshwater, terrestrial, oceanic, and insular) and body size by evaluating the fit of different models of turtle body size evolution to a time-calibrated phylogeny including about 70% of extant chelonians and replete with estimated ancestral habitat states. The results of these analyses provided strong support for different optimal sizes in chelonians that occupy different habitats. In the best performing model, optimal body size for marine chelonians and those from oceanic islands was large (island optimum = 82.6 cm, marine optimum = 132.6 cm) relative to optimal size in freshwater and mainland species (freshwater optimum = 33.7 cm, mainland optimum = 24.18 cm). Traditionally, large optimal body size in oceanic island tortoises was thought to reflect a preadaptation for increased dispersal ability, necessary for initial colonization. The authors suggest that the retention of large body size for chelonians on oceanic islands reflects the low predation and unpredictable climatic conditions, such as drought or low resource availability, characteristic of islands. In addition, long distance travel between feeding sites may still be important for island turtles. The authors suggest that the relatively large body size of marine turtles might

also reflect an adaptation to long distance travel, as well as to cold conditions encountered during these journeys. The greater variety of potential niches in terrestrial and freshwater environments may ensure that the relationship between body size and habitat is more complex for chelonians in these habitats.

Jaffe, A. L., G. J. Slater, and M. E. Alfaro. 2011. The evolution of island gigantism and body size variation in tortoises and turtles. Biology Letters 7:558–561.

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MicroRNA Analysis Used to Investigate Origin of Turtles

Despite a number of previous studies, the phylogenetic position of the turtles remains contentious. Some morphological analyses place turtles outside Diapsida, the clade that includes crocodiles, lizards, tuatara, and birds. Other morphological studies have placed turtles within Diapsida, close to the Lepidosauria (tuatara and lizards). Finally, although the majority of molecular studies do place turtles within Diapsida, they instead ally them most closely with Archosauria (crocodilians and birds). The authors highlight that the conflicting phylogenetic relationships inferred from these different analyses are just three different rooting hypotheses for a single, unrooted four-taxon tree (birds and crocodiles are always sister, which leaves three branches upon which the root can be placed). In this study, the authors examined a heretofore unevaluated molecular character type: microRNA (miRNA) genes. miRNAs are short (~22 base pair) RNA molecules that help determine the fate of messenger RNA molecules, and as new miRNAs are added to metazoan genomes infrequently over time and are rarely lost, they represent useful tools for shedding light on phylogenetic relationships. RNA was extracted from single individuals representing turtles (*Chysemys picta*), lizards (*Anolis carolinensis*), and crocodilians (*Alligator mississippiensis*). These were then compared to a number of previously published sequences, including mammals (platypus, opossum, and human), birds (Zebra Finch and chicken), and a frog. Maximum parsimony analysis was performed and Bremer support used to assess the support of each node. Results of this analysis unambiguously support a turtle and lizard clade, with these two groups sharing four unique miRNA gene families that are not observed in any other organism's genome. Further, no miRNAs are found in all diaspsids but not turtles, nor in turtles and archosaurs but not diapsids. The authors posit that these findings suggest that a number of morphological convergences and reversals have occurred within the reptile tree, and propose that the lepidosaur/turtle crown clade be called "Ankylopoda," meaning "fused foot."

Lyson, T. R., E. A. Sperling, A. M. Heimberg, J. A. Gauthier, B. L. King, and K. J. Peterson. 2011. MicroRNAs support a turtle + lizard clade. Biology Letters (*in press*). doi: 10.1098/rsbl.2011.0477.

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Simultaneous Polyandry Provides Genetic Benefits to Offspring of African Tree Frog

Polyandry, multiple female matings within a single reproductive cycle, is widespread across a range of taxa. It may be driven by males forcing copulation. However, in some cases females gain direct material benefits, such as parental care or nutrient donations, or genetic benefits that indirectly increase female fitness. Hypotheses of the genetic benefits of polyandry fall into three main categories. First, females that mate with multiple males reduce their chance of mating with an inferior quality male. Second, females may increase their chances of mating with a genetically compatible male. Third, polyandrous females have more genetically diverse offspring, which may benefit females because genetically dissimilar offspring compete less for resources, or because genetic diversity increases the likelihood that some will be able to respond to novel selective conditions. In some species, the females engage in simultaneous polyandry, where one female mates with multiple males at the same time. For instance, up to 90% of female Gray Foam Nest Treefrogs (*Chiromantis xerampelina*; a southeast African species) mate with up to ten males simultaneously. Although this represents an extreme example of polyandry, the hypothesis that females are gaining genetic benefits from this reproductive strategy has not previously been evaluated. In this study, the authors compared the fitness of offspring produced by polyandrous and monandrous matings. Body size did not differ between females involved in monandrous and polyandrous matings and offspring of these two matings did not differ in age or size at metamorphosis. However, offspring from polyandrous matings had higher mean survival and a reduced variation in offspring survival. The authors suggest that these results implicate genetic factors as a possible mechanism favoring polyandrous matings. However, a series of breeding experiments controlling for maternal quality and possible paternal material effects needs to be carried out to definitively determine whether paternal sire effects, genetic compatibility, or offspring genetic diversity underlies the advantage of this reproductive mode.

Byrne, P. G., and M. J. Whiting. 2011. Effects of simultaneous polyandry on offspring fitness in an African tree frog. Behavioral Ecology 22:385–391.

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Age Does Not Diminish Regenerative Capabilities in Newts

The regenerative capacity of newts is remarkable, encompassing both tissues and organs, as well as external limbs, tails, and eyes. This ability is particularly interesting for medical regeneration research, and as a consequence, newts have been studied in this context for over 200 years. Despite the long history of research, one persisting question remains: to what degree does age or repeated injury deplete a newt's ability to regenerate tissue? Previous studies have suggested that repeated

amputations still lead to regeneration, but occasionally with mistakes, such as missing bone structure. However, these studies may have lacked adequate controls. Further complicating these studies, newts generally do not thrive in captivity, and it is difficult to determine the age of wild caught individuals. In order to investigate the regenerative capacity of newts over time and repeated injury, the authors conducted a long term study in a captive population of Japanese Newts, *Cynops pyrrhogaster*. Newts were collected in 1994, and over the subsequent 16 years, eye lenses were removed from the same animals 18 times. Understanding regeneration of this specific tissue is of heightened interest, as lens loss is very rare in nature and therefore should not be under natural selection (lens regeneration in newts has also fascinated biologists for over a century). The 17th and 18th regenerated lenses were virtually identical structurally to the lenses removed from 14-year old adult newts with unaltered lenses. Further, quantitative PCR showed that gene expression patterns were very similar to those of the control group. These findings, which suggest that amphibian regeneration does not diminish with age or repeated injury, are contrary to traditional thought and are of great importance to medical regeneration research.

Eguchi, G., Y. Eguchi, K. Nakamura, M. C. Yadav, J. L. Millián, and P. A. Tsonis. 2011. Regenerative capacity in newts is not altered by repeated regeneration and ageing. Nature Communications 2:384.

Correspondence to: **Goro Eguchi**, National Institute for Basic Biology, National Institutes of Natural Sciences, Nishigonaka 38, Myodaiji, Okazaki, Aichi 444-8585, Japan; e-mail: shokei@shokei-gakuen.ac.jp.

Some Opossums have Rapidly Evolved a Resistance to Viper Venom

"Evolutionary arms races" are situations in which two species (frequently predator and prey) have undergone marked evolution in the effort to keep up with each other. Despite being accepted as a common evolutionary scenario, no evolutionary arms race between a predator and a venomous prey species has been demonstrated with molecular data. The authors of this paper used molecular data to test the hypothesis that one New World opossum lineage within the family Didelphidae has evolved a resistance to the venom of one of their preferred prey items, pit vipers (Crotalinae). Previous work had established that one venom toxin, C-type Lectin-like Protein (CLP), targets platelets, the structures in charge of forming blood clots. Specifically, CLP attacks a membrane protein called the von Willebrand Factor (vWF). The authors accumulated DNA sequence data representing a stretch of the vWF known from previous studies to be particularly affected by CPL for a series of didelphid opossums (including both venom resistant and non-resistant species) and other mammals. They then employed rigorous, likelihood-based methods to evaluate two models of evolution: one dividing nucleotide site substitutions into two categories for all taxa (no selection and purifying selection; H_0) and one allowing for a third category (positive selection) for venom-resistant opossums (H_A). The authors also used a Bayesian method to identify nucleotide sites along the sequence that are under particularly strong positive selection in the viper-eating opossum lineage. These analyses revealed that the vWF protein of venom-resistant opossums has experienced an elevated rate of evolutionary change relative to other mammals. The likelihood test found the alternative model was a significantly better fit than the null model, and 10% of the nucleotide sites were found to be under strong positive selection in the ophiophagous opossums. One interesting discovery was that the enigmatic South American Water Opossum (*Chironectes minimus*), which is thought to specialize on fish and crustaceans and is the sister taxon to the established viper-eating opossums clade, was found to have the molecular signal of venom resistance. Whether this species exhibits a derived diet and evolved from a viper-eating ancestor or if it is a secret ophiophage remains to be determined. Finally, the authors point out that in theory, arms races where the prey is dangerous to the predator should result in the most rapid rate of character evolution, and therefore the assumption that snake venom evolved primarily for prey apprehension should be re-examined.

Jansa, S. A., and R. S. Voss 2011. Adaptive evolution of the venom-targeted vWF protein in opossums that eat pitvipers. PLoS ONE 6:e20997.

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Daphnia magna as a Possible Control for Amphibian Chytrid Fungus

The chytrid fungus, *Batrachochytrium dendrobatidis* (*Bd*), is a nearly global concern with its negative impacts on amphibians well documented. Despite the extent of this crisis, the authors of this review paper (Woodhams et al. 2011) suggest that rescuing amphibian diversity in the face of *Bd* is an achievable aim. The authors examined different disease mitigation strategies, discussed the precedent for each strategy, and assessed their long-term potential. The authors suggest that sustainable conservation is dependent on long-term population persistence and co-evolution with the potentially lethal pathogens. As such, strategies should not rely exclusively on pathogen elimination or captive breeding, but also focus on reducing pathogenicity and host susceptibility in already infected populations. The authors propose population level treatments based on three steps: first, identify mechanisms that allow disease suppression in the population; second, the parameterization and testing of models of disease/host dynamics; and third, the trialing of adaptive management in field populations.

In line with the first of the three steps suggested by Woodhams et al. (2011), a recent study (Buck et al. 2011) has explored the use of biological controls, which could potentially aid in disease mitigation. The authors show in this paper that the zooplankton *Daphnia magna* consumes the infective stage of *Bd*, aquatic zoospores, 3–5 µm in diameter. According to previous studies, *Bd* infection leads to host mortality when a threshold density of sporangia is reached. By consuming infective *Bd* zoospores, *D. magna* may limit the numbers to below the mortality threshold. The authors suggest that increasing zooplankton densities where they are deficient could help at-risk anuran populations persist despite the presence of *Bd*.

Woodhams, D. C., J. Bosch, C. J. Briggs, S. Cashins, L. R. Davis, A. Lauer, E. Muths, R. Puschendorf, B. R. Schmidt, B. Sheafor, and J. Voyles. 2011. Mitigating amphibian disease: strategies to maintain wild populations and control chytridiomycosis. Frontiers in Zoology 8:8.

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Buck, J. C., L. Truong, and A. R. Blaustein. 2011. Predation by zooplankton on *Batrachochytrium dendrobatidis*: biological control of the deadly amphibian chytrid fungus? Biodiversity Conservation (*in press*) doi: 10.1007/s10531-011-0147-4.

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Environmental DNA Used to Detect Presence of Stream Amphibians

Methods for detecting the presence of aquatic organisms by assaying water samples for their DNA (environmental, or "eDNA" methods) have become useful tools for wildlife managers, such as in monitoring the spread of invasive species. Most applications of these methods have been in large bodies of standing or slowly moving water. The authors of this paper employed these methods to determine their effectiveness in detecting a pair of high-gradient, low-order stream amphibians: Idaho Giant Salamanders (Dicamptodontidae: *Dicamptodon aterrimus*) and Rocky Mountain Tailed Frogs (Ascaphidae: *Ascaphus montanus*). Water samples were taken in the spring and fall from streams known to be inhabited by these species. These streams were also evaluated for these species' larval densities. This water was passed through a filter, which was then subjected to several well-established molecular genetic methods for extracting and amplifying DNA. The authors were successful in detecting both species in the streams despite variability of success among the methods. Fall samples had a higher frequency of detection than spring samples, which the authors attribute to the reduced metabolic activity exhibited by these species early in the year. Indeed, detection was largely influenced by species and season, with no apparent correlation with density. The authors emphasize the utility of these methods in lotic systems and the promise they hold for assessing the presence of rare or otherwise hard to detect aquatic vertebrates.

Goldberg, C. S., D. S. Pilliod, R. S. Arkle, and L. P. Waits 2011. Molecular detection of vertebrates in stream water: a demonstration using Rocky Mountain tailed frogs and Idaho giant salamanders. PLoS ONE 6:e22746.

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Female Lacertid Lizards Can Use Scent to Determine Male Body Size

Although female mate choice is common in vertebrates, conclusive evidence demonstrating female choice in lizards is rare, especially in territorial species. Territoriality complicates female choice because females have access to relatively few males (depending on the relative sizes of male and female home ranges) or incur significant fitness costs sampling males far from home. Despite this, recent studies have shown that females of some territorial lizard species in the family Lacertidae can use scent marks to assess subtle aspects of male fitness, such as body condition, social dominance and parasite load. Additionally, males of the lacertid *Podarcis hispanica*, have been shown to use scent to assess important traits, such as body size, of rival males. However, the importance of similar scent marks in female mate choice in this species is unknown. In this study, the authors have examined whether female *P. hispanica* can use scent marks to determine male traits and if they can, how they use this information. Female lizards caught in Valencia, Spain, were simultaneously exposed to three choice areas marked with either the scent of a small male, the scent of a large male or a control (no scent). Results indicated that females preferentially associated with scent marked choice areas, but did not distinguish between large and small males. Interestingly, when exposed to simulated dusk conditions, females preferentially sheltered in refuges scented marked by small males. The authors suggest that these results are evidence that females of this species, like males, can determine body size from scent markings. The observation that females preferentially associate with males in simulated dusk may be a strategy to avoid the costs of harassment or forced copula by large males.

Carazo, P., E. Font, and E. Desfilis. 2011. The role of scent marks in female choice of territories and refuges in a lizard (*Podarcis hispanica*). Journal of Comparative Psychology 125:362–365.

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OBITUARIES

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Daryl R. Karns
July 23, 1949—June 7, 2011

Daryl Ralph Karns died unexpectedly at age 61 on June 7, 2011, near his home in Madison, Indiana. He left a legacy of global scientific research in the field of amphibians and reptiles, and a teaching career that spanned 27 years at Hanover College in Hanover, Indiana. Karns was born the son of Ralph R. and Lillian M. Heinze Karns on July 23, 1949. He is survived by his wife, Dr. Pamela A. Middleton, his brother, Rodney Karns, his sister, Jarmila Fuller, and their families. He grew up in Homewood, Illinois, on the far southeast side of Chicago and attended the Homewood-Flossmoor Community High School.



PHOTO BY SANDRA GUTHRIE

FIG. 1. Professor Daryl R. Karns, 23 July 1949 – 7 June 2011. This photograph was taken in March of 2011 adjacent to the trail head of the nature trail system now named *The Daryl R. Karns Natural History Trails* on the campus of Hanover College, Hanover, Indiana.

While a student at Homewood-Flossmoor High School, Daryl considered a career in theater and participated in the debate team. He loved to recall that at more than one debate competition he found himself paired up with John Belushi, from New Trier Township High School. However Daryl's career path was strongly influenced by other experiences. Foremost were several school field trips to the Field Museum of Natural History in Chicago where Daryl became a young expert on dinosaurs and other vertebrates. These were capped off with a personal "field trip" arranged by a close friend of his mother's to the home of Karl P. Schmidt, Chief Curator of Zoology at the Field Museum, who was also a resident of Homewood, Illinois. Thirty years later, sitting in what had been Schmidt's office at Field Museum, Daryl would recall the details of the artifacts in K. P. Schmidt's home "museum" and how it stimulated his interest in natural history.

For his undergraduate work Karns attended the University of Wisconsin-Madison from which he received his bachelor's degree in zoology in 1972. He went on to the University of Kansas where he served as a curatorial assistant in the paleontology collection at the Dyche Museum of Natural History, and earned a master's degree in systematics and ecology in 1974. While at the University of Kansas, he planned and designed a series of field identification guides to the vertebrates of Kansas utilizing an illustrated flow chart (Karns et al. 1974).

Next Karns joined the U.S. Peace Corps which led to his assignment in Senegal, West Africa, as a research scientist in the Smithsonian Institution-Peace Corps Environmental Program (SI-PCEP) from 1974 to 1976. SI-PCEP was an international initiative to develop biodiversity and conservation biology projects. While serving in Senegal, Karns collaborated with Mamadou Cissé of the Département de Zoologie des Vertébrés terrestres at the Institut Fondamental d'Afrique Noire (IFAN) and the University of Dakar. They conducted surveys and later published papers on the systematics and ecology of Senegalese lizards (Cissé and Karns 1977, 1978; Karns and Cissé 1975). Two of the three Cissé and Karns papers were published in French in the *Bulletin de l'Institut Fondamental d'Afrique Noire*.

Following his work in Senegal, Karns initiated his Ph.D. work at the University of Minnesota (Minneapolis). There he worked as a curatorial assistant and research assistant at the James Ford Bell Museum of Natural History, while conducting his doctoral research in the Department of Ecology and Behavioral Biology at the University under the direction of Professor Philip Regal. His research, which involved extensive field work in the peat bogs of northern Minnesota, focused on the effects of acidic bog habitats on amphibian reproduction (Karns 1984). Whenever Daryl talked about the temperature extremes and insect concentrations that he encountered during his year-round visits to the bogs, it gradually became clear that he really loved the challenges that came with working in difficult habitats.

Karns received his Ph.D. in 1984, and later published much of his thesis research in the *Journal of Herpetology* (Karns 1992a), and in a chapter on amphibians and reptiles in *The Patterned Peatlands of Minnesota* (Karns 1992b). In 1986, he published an 88-page guide to field study techniques entitled *Field Herpetology: Methods for the Study of Amphibians and Reptiles in Minnesota,* based on his field work experience in Minnesota and his studies at the University of Kansas (Karns 1986a). It was funded by the Minnesota Department of Natural Resources (MDNR) and the James Ford Bell Museum of Natural History. Karns geared the guide to amateur naturalists, citizen-scientists, agency personnel, and teachers in Minnesota. However the techniques are applicable beyond the Great Lakes region and include extensive coverage of drift fence and funnel trapping, breeding call surveys, and museum specimen preparation. This guide is still useful for undergraduate and graduate field biology courses. It is available as a pdf on the MDNR website. (http://files.dnr.state.mn.us/eco/nongame/projects/consgrant_reports/1986/1986_karns.pdf).

Karns joined Hanover College as an assistant professor in 1984. He was promoted to associate professor in 1990, and to

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full professor in 1997. He was also appointed Interim Director of the Rivers Institute at Hanover College for 2004–2005, and subsequently to the position of Director of Science Programs at the Rivers Institute.

While he was at Hanover, Karns met fellow college professor Pamela A. Middleton, whom he married in 1996. Pam received her M.D. that same year, having returned to medical school several years before. While Pam was participating in a medical program in Kenya as part of her training, Daryl returned to Africa to join her for travel, and it was there that he proposed.

From the time he arrived at Hanover Daryl was an enthusiastic and vibrant teacher who brought his passion for research into the courses he taught: introductory biology, biodiversity, herpetology, tropical biology, ecology, evolution, conservation biology and comparative anatomy of vertebrates. He also directed numerous student independent study projects, and his enthusiasm for working with students was characterized by energy, sensitivity, and genuine concern for their welfare and career paths.

Among Daryl's first field projects at Hanover College in 1985 and 1986, was an ecological study of the herpetofauna of the Jefferson Proving Ground (JPG), Clifty Falls State Park and natural areas on the Hanover campus, all located in Jefferson County (Karns 1986b, 1994). The JPG is a former weapons testing facility (closed in 1995) that is now partly within the 20,200 hectare Big Oaks National Wildlife Refuge. He was a key researcher at Big Oaks National Wildlife Refuge where he was a member of the Big Oaks Conservation Society and founder of the Heritage Conservancy, a trust to protect area lands. On the Saturday before his death Daryl had been out at Big Oaks, serving as an instructor at one of their public events and working with students on independent projects. Joe Robb, refuge manager at Big Oaks, had worked closely with Karns since 1998, and recalled that "Daryl had a level of curiosity and enthusiasm that was infectious."

In May 2007, Karns instituted the first BioBlitz at Hanover, a 24-hour intense species inventory of the campus. Daryl was a BioBlitz enthusiast and was one of the major organizers of BioBlitzes held by the Indiana Academy of Science. He, his students, and Indiana herpetological colleagues could always be counted on to participate. Karns also served as adviser to the campus Nature/Outdoors Club and directed numerous other off-campus environmental projects statewide.

The Indiana Department of Natural Resources established committees to review annually the conservation status of nongame animals. Karns joined the Nongame Amphibian and Reptile Technical Advisory Committee in 1985, and was chair from 1991 to 1999. Early meetings were held in the living room of Dr. Sherman Minton Jr., Indiana's premier herpetologist. Several hours of discussing Indiana herpetological matters were followed by lunch with persimmon pie for dessert, prepared by Madge Minton. In 1996, as chair of the Indiana Academy of Science Organizing Committee, Karns, and his wife Dr. Middleton, were instrumental in planning and conducting a celebration of the life and career of Dr. Minton on the occasion of the publication of the second edition of his book, *Amphibians and Reptiles of Indiana* (Minton 2001).

For the past 21 years, Daryl Karns was a primary investigator in field research at the Field Museum of Natural History that was so much a part of his early life. This began in the summer of 1989, when Daryl first met Harold K. Voris, Curator of Amphibians and Reptiles, at the American Society of Ichthyologists and Herpetologists meetings in San Francisco and they discovered their common connections with both Hanover College and the Field Museum. At that time Robert F. Inger and Voris were conducting a number of systematic herpetological surveys in Southeast Asia. They had initiated surveys in 1986 at Danum Valley in the Malaysian state of Sabah on the island of Borneo, and Harold's invitation to Daryl to join him for the work in Borneo proved too much for Daryl to resist. Harold vividly recalls Daryl's great excitement—especially since his primary research interest was in evolutionary ecology—on taking his first trip to Borneo where Alfred Russel Wallace had made evolutionary history through his collections and reports on the vast tropical diversity of Southeast Asia.

Daryl's formal affiliation with the Field Museum began in 1990 as a Research Associate. It was the beginning of an extremely productive period in his life in which he worked with Harold Voris, researching amphibians and reptiles of Southeast Asia, especially the aquatic snakes. But Daryl's affiliation with the Field Museum was more than a formality—he became a valued and welcomed member of the Field Museum community. He conducted tours for Field Museum, participated in Members' Nights, attended seminars, brought Hanover students to work there during the summers, and in general he became a Field Museum "regular" whose company and keen mind were enjoyed by all. At one point Daryl reflected on this experience, saying, "I was raised in the south suburbs of Chicago and visited the Field Museum many times as a child. Today, it is still a thrill for me every time I walk into the central hall of the Field Museum, one of the great museums of the world, and disappear behind those mysterious doors labeled 'Research Staff Only.' My Research Associate position over the last 14 years has allowed me to do things and go places that belong in the domain of National Geographic specials."

By 1992, Daryl began to work with Harold on the aquatic snakes of Southeast Asia with an emphasis on homalopsid snakes (Karns and Voris 1996). They began with field studies on *Enhydris plumbea* in an abandoned rice paddy in Sabah, Borneo. This wetland habitat was located with the help of Rob Stuebing, a faculty member of the University of Malaysia, Sabah campus.



PHOTO BY VICKY MERETSKY

FIG. 2. Professor Karns (on left) with his BioBlitz team in June 2009 at the Loblolly Marsh Wetland Preserve in Jay County, Indiana. The Hanover College student holding the snapping turtle is Andrew S. Hoffman.

PHOTO BY ALAN RESETAR



FIG. 3. Daryl Karns (on right) with John C. Murphy in Voris' research lab in the Division of Amphibians and Reptiles at the Field Museum of Natural History, March 2004.

Daryl and Harold benefited greatly from the generous logistical support and hospitality of Rob and his family, as well as that of the staff and administration at the Sabah State Museum. In fact, it was in Rob's lab that Daryl was bitten on the thumb by a large female *E. plumbea* while applying a PIT tag. After calmly removing the snake from his thumb he continued to work while remarking on how it stung. Later at a local coffee shop Daryl held his thumb in an iced coffee, hoping that it would reduce the swelling but it just drew stares. *Enhydris plumbea* is mildly venomous and much later the photograph of the bite on Daryl's thumb made it into print (Norris and Minton 2001) with an unintentional twist that became the basis for later joking—in the figure caption the snake identification was scrambled and *Enhydris plumbea* became *"Enhydrina plumbea"—Enhydrina* being a genus of extremely deadly true sea snake! After that Voris liked to introduce Karns to fellow herpetologists as the guy who suffered an *Enhydrina* bite and lived to tell about it!

Under the sponsorship of the Prince of Songkhla University in Hat Yai (Thailand) and Dr. Vachira Lheknim, a four-year project on the ecology of *Enhydris enhydris* on the edge of Lake Songkhla was initiated in 1995 by Karns and Voris. During this project Jack and Raynoo Cox generously provided hospitality in Bangkok that included many wonderful Thai meals at their home and in the numerous great local restaurants. This project was the first in which John Murphy (also a Research Associate at Field Museum), Harold, and Daryl worked together in the field and from this point on they worked as a research team. Daryl's enthusiasm in the field was very contagious. He was always interested in following the trail for another kilometer or looking over the next hill despite temperature extremes or rain. Typically, while exploring Angkor Wat in Cambodia one steamy sunny day, Daryl decided that he should not pass up climbing to the top of a Khmer pyramid despite the fact that the temperature was well above 40°C!

During Daryl's 2001–2002 sabbatical, the team focused on the ecology of mangrove-dwelling snakes at two locations on the island nation of Singapore. This work was sponsored and generously hosted by the faculty and students of the National University of Singapore (NUS) and the Raffles Museum of Zoology. It was here, with the industrious efforts of Siva (N. Sivasothi) at NUS that the "Snake Hunters" group was formed. This was a volunteer group of about 30 students and local naturalists who worked with the Field Museum team to conduct nightly snake surveys in local mangrove swamps. Bruce Jayne (University of Cincinnati and Field Museum Research Associate) also joined this effort, conducting feeding studies on two species of crab-eating homalopsids. Daryl's focus was on radio-telemetry of both the Bockadam Snake (*Cerberus rynchops*) and the Crab-eating Snake (*Fordonia leucobalia*). In this work he excelled. His trademarks—keen interest, patience, and careful data management—allowed him to succeed in tracking snakes in mangrove swamps, certainly among the most challenging habitats to work in on our planet (Karns et al. 2002).

Daryl's final field work in Southeast Asia began in 2004 with a focus on several species of snakes in Indochina, the center of distribution of the family Homalopsidae. This research was sponsored by Chulalongkorn University in Bangkok and the faculty and students of the Thai Turtle Lab led by Dr. Kumthorn Thirakhupt as well as Tanya Chanard and many others at the National Science Museum of Thailand. Our aim was to learn as much as possible about the natural history, ecology, distribution, dispersal abilities, and population relationships of the species in Thailand's wetlands. This field work extended through 2007 and left us with an inventory of results on three fascinating species: *Enhydris enhydris*, *E. plumbea*, and *E. subtaeniata*.

Karns' work on homalopsid snakes also became a vehicle for involving a number of Hanover College students in research at the Field Museum, in Singapore and Thailand, as well as at Hanover, yielding a long list of "homalopsid alumni"—biology majors who worked on homalopsid snake research at some point during their years at Hanover, usually as part of their respective independent studies. Financial support for these projects came from the Hanover College Richter Fund, the Rivers Institute Grant Committee, the Field Museum, the MacArthur Foundation, and the National Geographic Society. Students Jeff Goodwin, Ashley O'Bannon, Luke Starnes, Emma Thompson, Tom Goodwin, Emily Abernathy, Stacey Sellins, Jerry Suddeth, Bobak Kechavarsi, and Megan Rinehart co-authored published papers that resulted from their work. The majority of these students have continued their education in professional and graduate schools and pursued careers in science. Several decided to change career plans and go into research because of their Field Museum experience.

A prolific writer and presenter, Karns published nearly 40 peer-reviewed journal articles and technical reports. He authored or was involved in 18 popular articles, reviews, and videos, contributed 31 conference papers, and gave 43 seminars and public presentations. In addition, he secured a number of grants, awards, and fellowships for the College. As in the field work, during the data analysis and writing phase of our collaborations, Daryl's enthusiasm for discovery coupled with his careful analyses and love for scientific writing made working with him a joy. His skills as a proofreader extraordinaire and honest critic made him indispensable to our program. Tragically, Daryl's untimely death occurred before he could learn that a homalopsid snake species new to science was being described in his honor by John Murphy (Murphy 2011). Naming this new species after Daryl was a highly deserved tribute to his many contributions to our knowledge of homalopsid snakes, and he would have considered it one of his highest honors.

Karns will be remembered at Hanover for being an outstanding teacher, dedicated faculty member and colleague, and for his wide-ranging contributions to the Rivers Institute. To recognize the many significant contributions he made to his field, Karns received the first annual Hanover College Faculty Award for Excellence in Scholarly and Creative Activity at this year's Honors

Convocation, held April 7, 2011. The College has now renamed this award "The Daryl R. Karns Award for Faculty Scholarship and Creative Activity" in recognition of his many contributions and his exceptional academic standards, and as a memorial to its first recipient. In an additional tribute, at the memorial service held for Daryl on the campus of Hanover College, June 12, 2011, the President of the College officially named the nature trail system at the College, *The Daryl R. Karns Natural History Trails*.

Daryl had many wonderful characteristics that stood out in all the arenas of his life: he was a hard worker, very reliable, always respectful of others, and had great personal and intellectual integrity. His positive outlook, enthusiasm, and great sense of humor made us all want to have his companionship throughout our lives. He will be greatly missed by his many students, colleagues and friends at Hanover College, at Field Museum and in the field of herpetology at large.

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ZOO VIEW

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A Brief History of Crocodilian Science

The recent history and development of crocodilian science, and the people who made advances through pioneering studies on crocodilians spans more than 300 years. However, crocodilians were well known to ancient people thousands of years ago. Crocodilians were considered gods for their seemingly mystical powers, procreative ability, and longevity. Ptolemy X and Alexander I dedicated a temple to the crocodile god *Sebek* or *Souchos* about 95 BC. Crocodiles were accepted as the national emblem of Egypt and the Ptolemys, and appeared on imperial Roman coins. Lest we consider ourselves innovative in our care of zoo crocodilian collections, we should remember that the early Romans brought men from distant regions that were reported to have special skills to care for captive crocodiles (Grant 1992).

Although crocodilians and their ancestors have been around for about 200 million years, crocodilian science is relatively new. In this paper we attempt to put into perspective the history of crocodilian science and the people who were, and are today, part of this ongoing story. It is a starting point to be continued. The inclusion or omission of anyone in this paper should not be construed to discredit or endorse anyone or their work. It is not possible to include each and every scientist who worked in some aspect of crocodilian sciences. The majority may have conducted crocodilian research for specific projects and then moved on to other interests. Others have made crocodilian science their life's work. Some folks were lucky enough to be in the right place at the right time, with the right interests. Some still are making crocodilian history.

Periods in crocodilian science.—The history of crocodilian science falls into periods of special interest, each with its own focus and direction (Table 1). Scientific knowledge of crocodilians found its infancy during the golden period of global exploration and colonization. It was a time when the great nations of the world were establishing colonies, business interests, missions, and government offices in far-away regions where the fauna and flora were often new to science and a topic of curiosity. Government offices were often staffed by people with considerable education and wide interests. Many of today's great museum collections reflect the hunting activities and hobbies of district officers, government hunters, and "amateur" naturalists of the time, who collected and catalogued the rocks, insects, animals, and plants as a digression from the hardships and boredom of performing their official duties far from home.

Western science only became aware of the presence of a Chinese Alligator (*Alligator sinensis*) when it was reported by a Shanghai Customs Officer, A. A. Fauvel, in 1879 (Fauvel 1879), although it was known to Chinese scholars for 3,000 years.

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It is also during this period that many of the world's greatest museums were built. They became homes to the new breed of naturalist-scientists, and where heretofore unknown and unnamed specimens, including crocodilians, often found their way. They now make up the voucher collections that form the

Table 1. Historic events in crocodilian science.

Year	Event
1758	A system of classification described (Linnaeus 1758)
1768	Class Reptilia (Laurenti 1768)
1933	Mixed species of crocodilians exhibited, Bronx Zoo, NY (DeSola 1933; Ditmars 1913)
1935	First observations of wild American Alligators (McIlhenny 1935)
1963	Sexing technique developed for all crocodilian species (Brazaitis 1968)
1964	First museum quality record keeping system for zoos (Dowling and Gilboa 1968)
1966	Endangered Species Act, amended 1969, 1981, 1988
1970	Nesting ecology of alligators — field study (Joanen 1970)
1970	First crocodilian genetics study (Cohen and Gans 1970)
1971	IUCN Crocodile Specialist Group founded
1971	Species identification of crocodilian hides and products (King and Brazaitis 1971)
1973	Comprehensive identification account of living crocodilians (Brazaitis 1973a)
1973	Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
1977	First crocodilian behavior studies (Garrick and Lang 1977)
1980	First SSP/studbook initiated to coordinate breeding efforts for Chinese Alligator (Behler)
1980	Maternal behavior and vocalization, young and mother (Watanabe 1980)
1982	Temperature dependent sex determined (Ferguson and Joanen 1982)
1983	Biochemical and immunological systematics of Crocodylia (Densmore 1983)
1986	AZA Crocodilian Advisory Group founded
1986	St Augustine Alligator Farm joins AZA
1989	Social displays of American Alligators (Vliet 1989)
1994	Genetic fingerprint profiles described (Aggarwal et al. 1994)
2003	Phylogenetic approaches toward crocodilian history (Brochu 2003)
2006	*Mecistops* resurrected (McAliley et al. 2006)
2007	*Tomistoma* into Family Gavialidae (Willis et al. 2007)
2008	Molecular support for intergeneric crocodylian relationships (Gatesy and Amato 2008)
2009	Barcoding of crocodilian meat for species identification (Eaton et al. 2009)

Table 2. Natural history museums holding significant crocodilian collections.

Museum	Established
The Muséum national d'Histoire naturelle, Paris, France	1793
The National Museum of Brazil, Rio de Janeiro, Brazil	1818
Louis Agassiz Museum of Comparative Zoology, Harvard University, Cambridge, MA, USA	1859
The American Museum of Natural History, NY, USA	1869
Natural History Museum (British Museum), London, UK	1880
Florida Museum of Natural History of the University of Florida, Gainesville, FL , USA	1891
Field Museum of Natural History, Chicago, Ill, USA	1893
National Museum of Natural History, Smithsonian Institution, Wash. D.C., USA	1910
Senckenberg Natural History Museum, Frankfurt, Germany	1914
Yale Peabody Museum of Natural History, New Haven, CT, USA	1866

basis for the comparative studies that are so important to our understanding of animal relationships. Large crocodiles were often killed because of the danger they posed to people. Thus, the largest crocodile skulls found in collections today are usually animals killed out of necessity or sport, often dating back to the mid-to-late 1800s and early 1900s.

Although regional museums may have extensive collections of native species, or specialize in certain taxa, those museums that enjoyed national prestige or university support amassed collections representing species from around the world. Museums also made expeditions to remote or little known regions to fill their collections. For example, the expeditions of the Chicago Field Museum of Natural History to the Philippines in the 1930s produced extensive collections that included crocodilians, and yielded the first description of *Crocodylus mindorensis*, the Philippine Crocodile (Schmidt 1935). With the advent of molecular studies of crocodilians (Aggarwal et al.1993; Amato 1991, 1994; Amato et al. 1998; Cohen and Clark 1967; Cohen and Gans 1970; Densmore 1983; Densmore and Owen 1989; and many others), it became necessary for museum collections to change their specimen preparation methods and increase their storage. Tissue collections often grew out of research by individual scientists and the most extensive tissue collections are maintained in university museum collections or other research facilities. Several museums house collections of crocodilian specimens that are significant either in terms of specimen count, taxonomic importance, or historical value (Table 2).

Taxonomy.—Endemic people certainly were aware of the ferocious beasts that lived in nearby rivers and swamps, possibly accounting for a sudden disappearance of friends or family last seen bathing in the river. But crocodilians as a living group attracted scholarly interest after the Swedish botanist, zoologist, and physician Carolus Linnaeus published *Systema Naturae* in 1758 and 1766 (*Systema naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis*. Translated: "System of nature through the three kingdoms of nature, according to classes, orders, genera and species, with characters, differences, synonyms, places").

Linnaeus provided an organized system of classification that still stands, based on a division of Kingdoms: *Regnum Animale*, *Regnum Vegetabile* and *Regnum Lapideum*—animals, plants, and minerals. The tenth edition of this book, published in 1775, is considered the starting point of modern zoological nomenclature. The works of Laurenti (1768) and Linnaeus (1758, 1766) heralded a truly scientific period of interest in classifying all living creatures, including crocodilians.



Fig. 1. Gerard Krefft (1830–1881) (http://wikipedia.org/wiki/File:Krefft_Gerard_1830-1881.png).

Nearly all of the crocodilian species we know today (Table 3) were originally described between 1758 and 1828 (Table 4), with the exception of two species: the New Guinea Crocodile (*Crocodylus novaeguineae*) in 1928, and the Philippine Crocodile (*C. mindorensis*) in 1935 (Table 1). An overview of the original descriptions of reptiles is given by Uetz (2010).

The International Commission on Zoological Nomenclature was founded in 1895 and publishes the *International Code of Zoological Nomenclature* (ICZN) (1961). Probably one of the most interesting application of ICZN rules occurred in the naming of the Australian Johnston's Crocodile.

Johann L. G. Krefft, Director of the Australian Museum (Fig. 1), had sent a plaster cast (Fig. 2) of a crocodile discovered by a Mr. Johnston of Cardwell, Rockingham Bay, Queensland, Australia, to Dr. John Edward Gray (Fig. 3), Keeper of Zoology at the British

TABLE 3. Crocodilian species and their global distribution, derived from Brazaitis (1973), King and Burke (1989), Sill (1968), Thorbjarnarson (1992, 1996).

Species	Common name	Modern distribution
Family: Alligatoridae		
Genus: *Alligator*		
A. mississippiensis	American Alligator	North America: SE USA
A. sinensis	Chinese Alligator	Asia: middle Yangtse River - Wuhu, Anhui Province
Genus: *Caiman*		
C. crocodilus	Caiman	Central and South America
C. c. crocodilus	Common Caiman	S. America: Amazon River drainage basin
*C. c. apaporiensis**	Rio Apaporis Caiman	S. America: east of the Andes; middle Rio Apaporis
C. c. fuscus	Rio Magdalena Caiman	S. America: northern Andes: Rio Magdalena, Atlantic drainage; northwestern Venezuela
C. c. chiapasius	Central American Caiman	Mexico, C. America and S. America: west of the Andes
C. latirostris	Broad-snouted Caiman	South America
C. l. latirostris	Broad-snouted Caiman	S. America: W and S Atlantic drainages of Brazil, Paraguay, Uruguay, northern Argentina
*C. l. chacoensis**	Argentine Broad-snouted Caiman	South America: northern Argentina; Paraguay, Parana river drainages
C. yacare	Yacare Caiman	South-central S. America: Paraguay, Parana, Guapore river drainages, not Amazon
Genus: *Melanosuchus*		
M. niger	Black Caiman	S. America: Amazon River basin and drainages
Genus: *Paleosuchus*		
P. palpebrosus	Dwarf Caiman	S. America: tropical S. America
P. trigonatus	Smooth-fronted Caiman	S. America: Amazon (forest) basin
Family: Crocodylidae		
Genus: *Crocodylus*		
C. acutus	American Crocodile	N. and S. America: S. US; neotropical: Mexico, Central America; west coast S. America, Peru to Venezuela; Caribbean Islands
C. intermedius	Orinoco Crocodile	South America: Orinoco River and drainages
C. johnsoni	Johnston's Crocodile	Australia: northern territories
C. mindorensis	Philippine Crocodile	Western Pacific: Philippine Islands
C. moreletii	Morelet's Crocodile	Central America: Atlantic drainages; Mexico, Belize, Guatemala
C. niloticus	Nile Crocodile	Africa: Sub-Sahara, historically to Israel and Jordan; Madagascar
C. novaeguineae	New Guinea Crocodile	Western Pacific: Indonesia and Papua New Guinea
C. palustris	Mugger or Marsh Crocodile	South Asia, Indian sub-continent
C. p. palustris	Indian Marsh Crocodile	South Asia, Indian sub-continent: lowland India, Pakistan
*C. p. kimbula**	Ceylon Marsh Crocodile	South Asia: Sri Lanka
C. porosus	Saltwater Crocodile	N. Australia, SE Asia, India, Western Pacific, Palau, Solomon Islands, Vanuatu
C. rhombifer	Cuban Crocodile	Caribbean: Zapata Swamp, Isle of Pines
C. siamensis	Siamese Crocodile	SE Asia and Malaysia (historical); recent Laos, Cambodia
Genus: *Mecistops*		
M. cataphractus	African Slender-snouted Crocodile	Central West Africa: mostly tropical forest
Genus: *Osteolaemus*		
O. tetraspis	Dwarf Crocodile	Central West Africa
O. t. tetraspis	West African Dwarf Crocodile	Central West Africa: mostly tropical forest
O. t. osborni	Congo Dwarf Crocodile	Central West Africa: Congo Basin
Family: Gavialidae		
Genus: *Gavialis*		
G. gangeticus	Indian Gharial	India, Indian sub-continent: rivers of northern India and eastern Pakistan
Genus: *Tomistoma*		
T. schlegelii	Malayan False-gharial	SE Asia: lowlands of Thailand, Malaysia, Indonesia

*Subspecies not recognized by all authorities.

Museum, London. Krefft had earlier sent Gray a photograph in 1871, and had described the crocodile in a subsequent publication (Krefft 1873), where he called the taxon *Crocodylus johnsoni*, misspelling the name of the discoverer. Gray (1874) called attention to the error—but too late. The error stands to this day, in accordance with the rules of the International Commission on Zoological Nomenclature: once misspelled always misspelled with few exceptions. Taxonomists have revisited crocodilian systematics many times over the years (Boulenger 1889; Brazaitis 1971, 1973a, 1973b; King and Burke 1989; Mertens 1943; Mook 1921; Wermuth and Mertens 1977; Werner 1933). Determining the relationships among species draws more heavily on molecular data than physical appearance in modern studies. However, given the rich fossil diversity of the group, studies involving both molecular data and paleontology were inevitable (Brochu 2001a, 2001b, 2003; Brochu and Densmore 2001). Conservation genetics laboratories, such as those at the American Museum of Natural History's Center for Conservation Genetics (New York), Texas Tech University's Department of Biological Sciences (Lubbock, Texas), and the Yale Institute of Biological Sciences, Molecular Systematics and Conservation Genetics Laboratory (New Haven, Connecticut), have emerged as important centers for crocodilian genetics research.

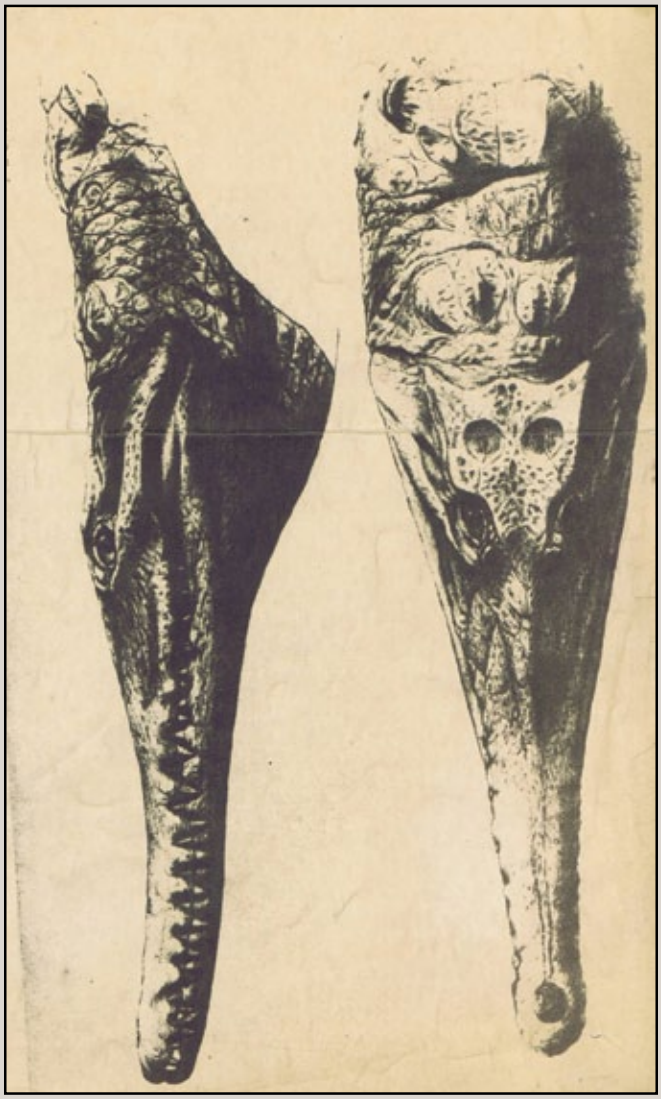


FIG. 2. Plaster cast of head of originally described as Johnston's Crocodile, *Crocodylus johnsoni*. (Adapted from Krefft 1873).

Disparities in morphology-based phylogenies and those based on molecular studies, as well as the impact of technical advances in phylogenetic analysis soon became apparent (Brochu 1997, 2001b; Gatesy and Amato 2008; Poe 1996; Willis 2009). Crocodilian phylogeny continues to be rearranged (Gatesy and Amato 2008), most recently with the transfer of *Tomistoma* from the Crocodylidae to Gavialidae (Willis et al. 2007), and the reassignment of *Crocodylus cataphractus* to the genus *Mecistops* (McAlily et al. 2006).

Crocodilian morphology and physiology.—The structure and morphology of crocodilians continues to interest and astound scientists and lead to discoveries as technologies improve. Few modern crocodilian morphologists can rival the early anatomical works of Albert M. Reese. Between 1901 and 1948, Reese published more than 30 papers ranging from bibliographies of crocodilian literature to all aspects of crocodilian anatomy and biology (Reese 1915). Angus d'Albini Bellairs, an evolutionary biologist, published extensively on crocodilian structure and evolution (Bellairs 1960).

Roland A. Coulson, Louisiana State University, published more than 50 papers on alligator metabolism between 1950 and 1983, pioneering much of what we know of how crocodilians function and use energy (Coulson and Hernandez 1964). His colleague, Thomas Hernandez, published at least 30 papers in a similar period (Hernandez and Coulson 1952). The Louisiana State University, Baton Rouge, continues to be a major resource for crocodilian management, nutrition, and veterinary science.

Perhaps some of the most important contributions to our knowledge of crocodilian eggs and embryonic development came from Mark W.J. Ferguson, a young oral surgeon at Queen's University in Belfast, Northern Ireland, with an interest in human cranial-facial reconstruction. The palatal development of



FIG. 3. John Edward Gray (1800–1875) (http://en.wikipedia.org/wiki/John Edward Gray).

alligators during developmental stages had direct application to his human work, and provided crocodilian science with an understanding of the stages of incubating alligator eggs and embryonic development (Ferguson 1981). Ferguson and Ted Joanen at Rockefeller Wildlife Refuge, in Louisiana, were the first to describe incubation temperature dependent sex determination in a crocodilian (Ferguson and Joanen 1982).

Saving crocodilians: a new era for crocodilian science.—The late nineteenth through the twentieth century were not kind to crocodilians. By 1971, burgeoning human populations encroaching on crocodilian habitat and abusive hunting for the exotic leather and pet trade threatened all of the commercially valuable species with extinction. Hunting meat for human consumption was a serious threat to crocodilians and continues today (Eaton et al. 2009). Demand from the exotic leather industry in particular had almost destroyed the very resource upon which the industry depended. Something had to be done.

In March 1971, the first meeting of crocodilian specialists was held at the Bronx Zoo Reptile House in New York. It was a precursor to the present IUCN Crocodile Specialist Group (CSG) and included zoologists, recognized crocodilian experts, conservation interests, and representatives of the crocodilian leather industry from around the world (Fig. 4).

Under the leadership of Harry Messel, Professor of Physics and Head of the School of Physics at the University of Sydney, and F. Wayne King (then Curator of Reptiles, Bronx Zoo), University of Florida, the CSG was the first and perhaps most successful of the Specialist Groups. It adopted a strategy for the conservation of crocodilians that was based on the sustainable utilization of a valuable wild resource. Crocodilians as a whole did not enjoy a favorable public image and were generally considered dangerous. However, their skins were well known to be of significant commercial value.

The CSG actively partnered with the commercial crocodilian skin industry to provide assistance in surveying and documenting the extent and health of wild crocodilian populations, developing a tailored strategy for utilization, and encouraged national regulation that might be favorable to both commercial trade and crocodilian conservation. Crocodilian conservation was inextricably tied to the market value of skins. Generally speaking, commercially valuable crocodilian species have particularly benefited from the collaborative strategy. Captive propagation has improved the numbers of animals of endangered species held in captivity many fold and made many thousands of skins available for commercial trade that might otherwise have come from wild populations.

However, wild populations of a number of species continue to decline for lack of conservation funding, continued loss or the degradation of critical habitat, and abusive hunting for bush meat and holistic medicines. These include critically endangered species such as the Chinese Alligator (*Alligator sinensis*), Philippine Crocodile (*Crocodylus mindorensis*), Orinoco Crocodile (*C. intermedius*), Indian Gharial (*Gavialis gangeticus*) and Malayan False Gharial (*Tomistoma schlegelii*), and perhaps the Cuban Crocodile (*C. rhombifer*), African Slender-snouted Crocodile (*Mecistops cataphractus*), and Mugger or Marsh Crocodile (*C. palustris*) (Table 3). Large-scale captive management of closely related species for enhancing skin production has also led to the purposeful hybridization of large numbers of otherwise rare species, such as Cuban Crocodiles and American Crocodiles *(Crocodylus acutus*); Siamese Crocodiles (*C. siamensis*) and Saltwater Crocodiles (*C. porosus*); and multiple species of caiman (*Caiman crocodilus*), possibly threatening the genetic integrity of some already endangered species (Brazaitis and Abene 2008).



Fig. 4. Top row from left to right: Tony Pooley, Nile Crocodiles, Natal Parks Board, South Africa; Max Downs, New Guinea Crocodiles, Papua New Guinea; Peter Brazaitis, Reptile Keeper, Bronx Zoo, NY, USA; Prof. Angus A. d'A. Bellairs, evolutionary biologist and anatomist, UK; Dr. Robert Bustard, Indian and Australia crocodilians; Dr. Hugh Cott, African ecology of the Nile crocodile, UK; Dr. F. Wayne King, conservationist, Curator of Reptiles, Bronx Zoo, NY; Prof. Federico Medem, South American crocodilian biologist, Instituto Roberto Franco, Colombia. Front Row: Moira A. G. Warland, IUCN; Mrs. Clare Hagan, CEO, Hagan and Co., New York; Utai Yangprapakorn, Samut Prakarn Crocodile Farm and Zoo, Thailand; Dr. Robert (Bob) Chabreck, Louisiana Department of Fur, Fish and Game, Louisiana, USA; Charoon Yangprapakorn, Thailand; James H. Powell, journalist, Mexican crocodiles; Fred Hauptfuhrer, World Wildlife Fund.



Fig. 5. Adult female Orinoco Crocodile, *Crocodylus intermedius*, captured for transit to Hato Masaguaral in 1984. The crocodile shown had come close to capturing Dr. Myrna Watanabe on a visit the previous year. From left to right: three ranch-hands, Tomás Blohm, Peter Brazaitis and capture chicken, ranch-hand (rear), John Thorbjarnarson (second row, originally hired by Tomás to study Orinoco Crocodiles), ranch manager, Mark Ludlow (field researcher), ranch-hand.

Two years after the CSG was formed, a plenipotentiary meeting was held in Washington, D.C. from 12 February to 2 March 1973 just prior to the Convention on the International Trade in Endangered Species of Fauna and Flora (CITES). CITES was ratified by the United States on January 14, 1974, as did five other

countries the same year, and went into effect in the United States on 1 July 1975. The "Washington Convention" (CITES), under the United Nations Environmental Program, would provide for the regulation of commercially traded species, including virtually all crocodilians.

A framework for controlling the international trade in wildlife had been created. Enforcement in the USA would fall to the US Fish and Wildlife Service under the provisions of the US Endangered Species Act (ESA) and a host of other new and broadened national and state wildlife legislation. Although mainstream biologists might be well known for their scientific writings and research, a host of state, national, and international law enforcement officers deserve no less recognition for their role in saving crocodilians from extinction, by their efforts to halt the contraband trade in crocodilians.

The structure for enforcing and prosecuting wildlife violations called for the application of wildlife sciences to the judiciary process in a new discipline: forensic wildlife sciences (Brazaitis 1986; 1987). As the majority of crocodilian species were now protected and violations were subject to civil or criminal prosecution, crocodilians and their derivatives became the immediate focus of enforcement. The Clark R. Bavin National Fish and Wildlife Forensic Laboratory was founded in 1988 in Ashland, Oregon by the US Fish and Wildlife Service. Under the directorship of Ken Goddard, the laboratory is a state-of-the-art forensic analysis facility and the only forensic laboratory in the world dedicated entirely to solving wildlife crime.

National and international attention was focused on endangered and threatened species including crocodilians. The International Union for Conservation of Nature (IUCN), founded in 1948, published the IUCN Red Data Book to identify threatened species (Groombridge and Wright 1982). In October 1991, in Gland, Switzerland, the World Conservation Union, the United Nations Environment Programme (UNEP), and what was then called World Wildlife Fund, the World Wide Fund for Nature (WWF) joined to adopt a universal strategy of *Caring for the Earth, A Strategy for Sustainable Living*. It was a perfect fit for improving the crocodilian image, conservation, and by default—for trade as well. It was a jump-start for crocodilian sciences. The IUCN Crocodile Specialist Group would become the advisory council of world specialists to CITES and countries around the world on matters of crocodilian management and conservation.

Outstanding crocodilian conservationists.—Many people and agencies, both governmental and private, played an important role in furthering crocodilian conservation. Tomás Blohm of Caracas, Venezuela, was the recipient of the Order of the Golden Ark, created by Prince Bernhard of the Netherlands for leadership in conservation in 1971. Blohm had traditionally maintained one of his cattle ranches, *Hato Masaguaral*, in a natural state and had for many years welcomed researchers from around the world to study the endemic wildlife. Blohm and his wife Cecilia M. de Blohm set the course for the conservation movement in Venezuela.

The Orinoco Crocodile is native to the Orinoco River and its tributaries in Venezuela. The species had become all but extinct in Venezuela as a result of exploitation for the skin trade. A few adult individuals had been sequestered on the ranches of a few landowners, to protect the remaining animals. In 1984 an adult pair of Orinoco Crocodiles was transported from a hidden lagoon on property owned by Blohm adjacent to Camatagua Reservoir near Caracas, to his ranch *Hato Masaguaral* (Fig. 5), to form the nucleus of a captive group of breeding crocodiles that would eventually produce offspring to reintroduce the species in Venezuela. To date, the Venezuela program has released over 6,335 animals of which 2,475 animals were produced from the *Hato Masaguaral* program.



PHOTO BY PETER BRAZAITIS

FIG. 6. A Cuban Crocodile, *Crocodylus rhombifer,* hatches from an egg at the Bronx Zoo, New York in 1983.

John Thorbjarnarson, University of Florida and the Wildlife Conservation Society, New York, was undoubtedly the best known field biologist in crocodilian field conservation in recent times. He began his career with studies of the Orinoco Crocodile in Venezuela. As a member of the IUCN Crocodile Specialist Group and the AZA Crocodilian Advisory Group, his crocodilian interests touched on virtually every species, in captive propagation and wild populations. His field studies of crocodilian populations and natural history have produced numerous scientific and popular papers (Thorbjarnarson 1991, 1992, 1996). Perhaps one of the most valuable to international crocodilian conservation was his comprehensive paper published by IUCN in 1992. Tragically, he died on 14 February 2010, in India, at the age of 53 from acute malaria.

New directions.—If crocodilians were to be saved from extinction, crocodilian sciences had to move in new directions: behavioral, population biology, ecology, captive management and husbandry.

Probably the single most important discovery to make selective crocodilian breeding and management possible was the simplest: a method for determining the sex of crocodilians. The story is amusing. Robert Chabreck (1963) reported a manual probing method for sexing alligators that had been employed in Louisiana, in the *Proceedings of the 27th Annual Conference, Southeastern Association of Game and Fish Commission.* Separately and without knowledge of Chabreck's presentation, one of this paper's coauthors, Peter Brazaitis, had applied a similar manual probing technique that successfully determined sex in a wide range of crocodilian species at the New York Zoological Society's Bronx Zoo. However, the technique was considered too risqué for the zoo's scientific journal *Zoologica* and it was not until a number of years after the initial study was completed that

TABLE 4. Chronology of original crocodilian classification.

Year	Author	Taxon
1758	Linnaeus, Carolus (Carl von Linné)	Species: *Lacerta crocodilus* (= *Caiman crocodilus**)
1768	ibid.	Class: Reptilia
1768	ibid.	Genus: *Crocodylus*
1768	ibid.	Species: *Crocodylus niloticus*
1789	Gmelin, Johann	Order: Crocodylia
1789	ibid.	Species: *Gavialis gangeticus*
1801	Daudin, François Marie	Species: *Alligator mississippiensis*
1801	ibid.	Species: *Caiman latirostris*
1801	ibid.	Species: *Caiman yacare*
1801	Schneider, J. G.	Species: *Paleoschus trigonatus*
1801	ibid.	Species: *Crocodylus porosus*
1801	ibid.	Species: *Crocodylus siamensis*
1807	Cuvier, Georges Léopold Chrétien Frédéric Dagobert	Family: Alligatoridae
1807	ibid.	Genus: *Alligator*
1807	ibid.	Family: Crocodylidae
1807	ibid.	Subfamily: Crocodylinae
1807	ibid.	Species: *Paleosuchus palpebrosus*
1807	ibid.	Species: *Crocodylus acutus*
1807	ibid.	Species: *Crocodylus cataphractus* (= *Mecistops cataphractus**)
1807	ibid.	Species: *Crocodylus rhombifer*
1811	Oppel, M.	Genus: *Gavialis*
1819	Graves,M. L.	Species: *Crocodylus intermedius*
1825	von Spix, Johann Baptist Ritter	Genus: *Caiman*
1825	ibid.	Species: *Melanosuchus niger*
1831	Lesson, R. P.	Species: *Crocodylus palustris*
1838	Müller, S.	Genus: *Tomistoma*
1838	ibid.	Species: *Tomistoma schlegelii*
1851	Duméril, A. M. C. and Bibron, G.	Species: *Crocodylus moreletii*
1854	Adams, A.	Family: Gavialidae
1861	Cope, Edward D.	Genus: *Osteolaemus*
1861	ibid.	Species: *Osteolaemus tetraspis*
1862	Gray, J. E.	Genus: *Melanosuchus*
1862	ibid.	Genus: *Paleosuchus*
1868	Cope, Edward D.	Species: *Caiman crocodilus fuscus*
1873	Krefft, G.	Species: *Crocodylus johnsoni*
1876	Bocourt, F.	Species: *Caiman crocodilus chiapasius*
1879	Fauvel, A. A.	Species: *Alligator sinensis*
1928	Schmidt, K. P.	Species: *Crocodylus novaeguineae*
1935	ibid.	Species: *Crocodylus mindorensis*

*Name in current use.

the data were published, without zoo permission, in the *British Journal of Herpetology* (Brazaitis 1968).

Population biology.—Paramount in this new era of crocodilian conservation was determining the status of wild crocodilian populations throughout the world to investigate possible harvest quotas and to encourage investments in crocodilian conservation initiatives. It was also important to determine population characteristics and distribution limits for species. Universities, international conservation organizations, and governments rushed to comply with CITES requirements for scientific data on population levels and sustainability in order to set harvest quotas. Some pioneers were already deeply involved in crocodilian field research.

Ornithologist John James Audubon (1785–1851) and botanist/naturalist William Bartram (1739–1823) made some of the earliest observations of American Alligator natural history during their wanderings through the southern United States (Audubon 1827; Bartram 1773–1774). However, E. A McIlhenny was probably one of the first to comprehensively document the life history of a crocodilian, the American Alligator in Louisiana (McIlhenny 1935). A comprehensive bibliography of the American Alligator was published by the US Department of Energy's Savannah River Ecology Laboratory (Brisbin et al. 1986).

Robert Chabreck and Ted Joanen continued field research on alligators in the coastal marshes of Louisiana. Joanen, who directed the management of the Rockefeller Wildlife Refuge of the Louisiana Department of Wildlife and Fisheries at Grand Chenier, and the Louisiana alligator program, took the lead to ensure the survival of alligator populations in Louisiana. This work began even before national and international interest focused on endangered crocodilians and the results were used to create conservation programs. They developed strategies for the captive

Table 5. Noteworthy biologists who pioneered crocodilian population science.

Name	Region of Study
Alvarez del Toro, Miguel	Mexico
Achaval, Federico	Uruguay
Blomberg, Goran	Botswana
Brazaitis, Peter	Brazil, Palau
Brisbin, I. Lehr	USA
Britton, Adam	Australia
Bustard, Robert	India
Campbell, George	USA
Campos, Zilca	Brazil
Chabreck, Robert	USA
Choudhury, B. C.	India
Cox, Jack	Borneo
Daniel, J. C.	India
David, Dennis	USA
Elsey, Ruth	USA
Godshalk, Robert	USA, Venezuela
Gorzula, Stefan	Venezuela
Graham, Allister	Uganda
Grigg, Gordon	Australia
Hall, Phillip	USA, Papua New Guinea, S. America
Herrera, Carlos G.	Colombia
Hines, Tommy	USA
Hollands, Martin	Papua New Guinea
Huang, Chu-chien	China
Hutton, Johnathan	Zimbabwe
Joanen, Ted	USA
Kar, Sudhakar	India
Kushlan, James A.	USA
Lamar, William	USA, Colombia
Lazcano-Barrero, Marcos	Mexico
Magnusson, William	Brazil
Manolis, Charlie	Australia
Maskey, Tirtha	Nepal
Mazotti, Frank	USA
McIlhenny, E. A.	USA
McNease, Larry	USA
Medem, Féderico	South America, Colombia
Moler, Paul	USA
Onions, J. T. Victor	Australia
Ottenwalde, Jose Alberto	Dominican Republic
Ouboter, Paul E.	Surinam
Plotkin, Mark	USA
Pooley, Tony	Natal, South Africa
Powell, James H.	USA, Mexico
Rao, Abdul Latif	Pakistan
Rao, R. J.	India
Rebello, George	Brazil
Rivero-Blanco, Carlos	Venezuela
Ross, Andy	USA, Philippines
Scott, Norman	Paraguay
Seijas, Andres Eloy	Venezuela
Singh, Lala A. K.	India
Stockwell, Jane Harvey	Australia
Subba, M. V.	India
Thorbjarnarson, John	USA, global
Trelancia, Ana Maria	Peru, Brazil
Varona, Louis	Cuba
Waitkuwait, Wolf-Ekkehard	W. Africa
Watanabe, Myrna E.	USA, China
Werner, Yehudah L.	Israel
Whitaker, Romulus	India
Woodward, Allen	USA
Yahoda, John C.	Ecuador
Yamashita, Carlos	Brazil

propagation, wild population management, and sustainable use of alligators that remain models for crocodilian management. Joanen and his colleague at Rockefeller, Larry McNease, published more than 40 papers on the natural history and management of alligators, beginning in 1970 (Joanen 1970) to 1982 (Brisbin et al. 1986). To many, they are the fathers of crocodilian conservation, population management, and captive husbandry technology.

As in Louisiana, the Savannah River Ecology Laboratory, Aiken, South Carolina, largely supported by the United States Department of Energy, under the leadership I. Lehr Brisbin, contributed immensely to our understanding of American Alligator ecology.

The Saltwater Crocodile populations of Australia enjoyed a similar benefactor. Harry Messel, University of Sydney, Australia, and his research team surveyed all of the river systems in northern and western Australia and developed field survey techniques that became the standard for crocodilian population studies. His series of monographs (Messel et al. 1981) on the status and ecology of *C. porosus* in Australia are monumental. This legacy of crocodilian research continues today at Australian universities.

Hugh B. Cott (1961), a zoologist, wildlife photographer, and military camouflage expert, was one of the first to extensively describe the natural history and nesting ecology of Nile Crocodile (*C. niloticus*) populations in Uganda and Northern Rhodesia.

The most prolific and adventurous South American crocodilian field biologist, and incidentally, a member of the royal family of Latvia, was Féderico Medem, Instituto Roberto Franco, Colombia. His field studies and extensive publications on South American crocodilians span decades (Medem 1952, 1955, 1958a, 1958b, 1960, 1962, 1963, 1967, 1968, 1969; Medem and Marx 1955). He was the first to conduct an exhaustive field survey of the distribution of South American crocodilians under the auspices of the New York Zoological Society. However, his work was not published until years later (Medem 1981, 1983).

Probably one of the most comprehensive field surveys of crocodilians ever undertaken was initiated as a result of CITES and the need to understand the identity, distribution, and taxonomy of South American caiman. Field investigations throughout central South America were conducted by three field teams: Bolivia—led by F. Wayne King, University of Florida (King and Roca 1989); Brazil—led by Peter Brazaitis (Brazaitis et al. 1997a, 1997b, 1998); Paraguay—led by Norman Scott (Scott et al. 1988).

In China, Huang Chu-chien (Zhujian) and colleague Zheng Zuoxin, Institute of Zoology, Chinese Academy of Sciences, Beijing, studied the distribution and natural history of the Chinese Alligator in south central China in Anhui, Zhejiang, and Jiangsu provinces. They observed life habits and described its extensive cave-building behavior. Aware that the species was critically endangered in the wild, Huang was instrumental in having the Forestry Bureau in Anhui Province set up the Xuancheng Alligator Breeding Farm in southern Anhui in 1980. He was assisted by Myrna Watanabe in 1981, the first westerner to have several months' access to the region since the Communist takeover of China in 1948. Watanabe reported the population to be critically near extinction and restricted to living on tree farms and in rice paddies (Watanabe 1982). John Thorbjarnarson confirmed the Chinese Alligator's approaching extinction in 2002 (Thorbjarnarson et al. 2002; Thorbjarnarson and Wang 2010). Although thousands of Chinese Alligators currently exist on alligator farms in China, the extinction of the wild population could be imminent. The first captive reproduction of Chinese Alligators in the

United States occurred in 1977 at the Rockefeller Wildlife Refuge, Grand Chenier, Louisiana. This successful program, developed by the late John Behler at the Wildlife Conservation Society, New York, contributed to the reintroduction of US captive-bred Chinese Alligators back into the wild in 2007.

It would not be possible to provide a complete list of field biologists and students who conducted surveys of crocodilians throughout the world. Table 5 is a partial list of field biologists known for their work in crocodilian conservation, particularly those who conducted initial surveys in the 1970s and 1980s, when the population status of most species was unknown, and crocodilian behavioral science was a new concept. The University of Florida and the Florida Field Museum of Natural History, Gainesville, Florida stand out as a seat of crocodilian population ecology and biology.

Field biologists are, by definition, some of the most dedicated of scientists, often giving up a life of comfort and family relationships and living in danger. They expose themselves to tropical diseases and death to unravel the secrets of living animals in their natural worlds. They deserve great credit.

Social behavior of crocodilians.—Crocodilian behavioral studies were pioneered by a handful of scientists in the late 1970s and 1980s. Kent Vliet extensively documented the social behavior of American Alligators and other crocodilians (Vliet 1989). He is particularly noted for documenting behaviors while in the water at eye-level with alligators.

Leslie Garrick, while an intern at the Bronx Zoo, New York, documented social signals of American Crocodiles in the Dominican Republic and crocodilians at the zoo (Garrick and Lang 1977). Garrick, together with Jeffrey Lang and Harry Herzog worked on many projects (e.g., Garrick et al. 1978). Lang continued his work in India on Mugger Crocodiles and the Indian Gharial.

R. Howard Hunt, Curator of Reptiles, Zoo Atlanta, was one of the first to successfully breed crocodilians in a zoological setting and reported maternal care behavior in Morelet's Crocodiles (Hunt 1975). Hunt and Myrna Watanabe studied American Alligator behavior (Hunt and Watanabe 1982), in wild populations in Okefenokee Swamp, Georgia, and Hunt later studied crocodile behavior in Belize.

Myrna E. Watanabe, New York University, recorded and documented American and Chinese Alligator vocalizations, and was the first to observe and report nest opening and communication between mother and young, and the maternal behavior of American Alligators (*A. mississippiensis*) in Okefenokee Swamp, Georgia (Watanabe 1980). She later continued her work in China, the first in recent times, collaborating with Chinese scientists on studies involving the Chinese Alligator (*A. sinensis*).

Crocodilian husbandry science.—Three primary strategies were employed for crocodilian conservation: ranching where the wild population remained a source for eggs and young; farming where breeding animals produced offspring that could be harvested when they achieved commercial size; direct harvesting of the wild populations, or in some cases a combination of more than one (Luxmoore et al. 1985). Eventually, farming and ranching initiatives would be present in most of the nations of the world where crocodilians were endemic.

Perhaps the oldest and best known continually operated crocodile farm is the Samut Prakan Crocodile Farm, Thailand, built in 1950. In the 1970s and 1980s, Ted Joanen pioneered modern farming and ranching techniques in Louisiana that are the current basis for commercial crocodile rearing as well as for the captive propagation of endangered and threatened species in zoos. In Africa, Tony Pooley (Natal Parks Board, St Lucia, South Africa) was developing farming strategies for the Nile Crocodile (*C. niloticus*). In South Africa and Zimbabwe, crocodile farms for skins and tourism were well established, and staffers were developing nutrition and immobilization techniques for transporting large crocodiles. In Papua New Guinea, Martin Hollands was developing a model ranching program for locals.

Today, more than 80 caiman farms in Colombia annually produce more than a million crocodilian skins that find their way into the commercial exotic leather trade, mostly comprised of caiman species that may be indiscriminately hybridized. Initiatives to translocate American Alligators, Nile Crocodiles, Saltwater Crocodiles, and other species to countries outside of their natural ranges for farming have been met with disapproval by the international conservation community. Hybridization of crocodilian species to enhance leather and meat production has already threatened the genetic integrity of endangered species, such as the Siamese Crocodile (*C. siamensis*), Morelet's Crocodile (*C. moreletii*), and Cuban Crocodile (*C. rhombifer*).

The crocodilian leather industry's place in the history of crocodilian science.—In 1973, the advent of CITES created an explosion in crocodilian interest and scientific research. To understand the industry implications for crocodilian science, it is important to understand the scope of the industry (MacGregor 2002). The first level of the industry is composed of the people who harvest and produce crocodilian skins. Producers include those who hunt the wild population, and crocodile farmers and ranchers. Suppliers, buyers, and skin graders are the next level in the industry, which move skins from producers to processors. The third level is tanneries, both in and outside producing countries. Another industry supplies chemicals and machinery. A fourth level includes the people who design fashions and the manufacturers who fabricate products made from tanned skins. Last are the buyers and retailers who market products. Until CITES came into force in 1975, the industry identified crocodilian species based on skin quality, skin characteristics, and the degree of processing difficulty (Fuchs 1974a, 1974b). The industry would have to learn a new scientific-based language, crocodilian taxonomy and classification (King and Brazaitis 1971). Compliance with CITES also meant that the industry would be deprived of access to CITES-listed crocodilian species, the crocodilians that had been the mainstay of the industry, whose populations the industry depleted. It was important for the industry to support crocodilian conservation, which, in turn, supported the industry.

Industry scientists reclassified and introduced new species of crocodilians to the scientific literature, although these classifications were largely based on skins of undocumented origins, (Fuchs 1971, 1974a, 1974b; Fuchs et al. 1990; Wermuth 1986; Wermuth and Fuchs 1978; Wermuth and Mertens 1977). This caused some concern about their taxonomic validity among crocodilian scientists (Frair and Behler 1983), but the names were, nonetheless, inadvertently incorporated into CITES identification manuals (CITES, 1981, 1983) for the purposes of international law enforcement.

Some members of the crocodilian industry were instrumental in altering the course of crocodilian science. They recognized that there had to be mutual cooperation to integrate the desire of scientists to halt the abusive use of crocodilians along with the reluctance of industry to conform to new regulation. They saw a need for a new way of dealing with the reality of the diminishing resource.

PHOTO COURTESY WILDLIFE CONSERVATION SOCIETY



FIG. 7. Male Cuban Crocodile, *Fidel*, original founder of a Cuban crocodile captive breeding dynasty, terrorizes the keeper staff during capture at the Bronx Zoo, Reptile House, New York, about 1969.

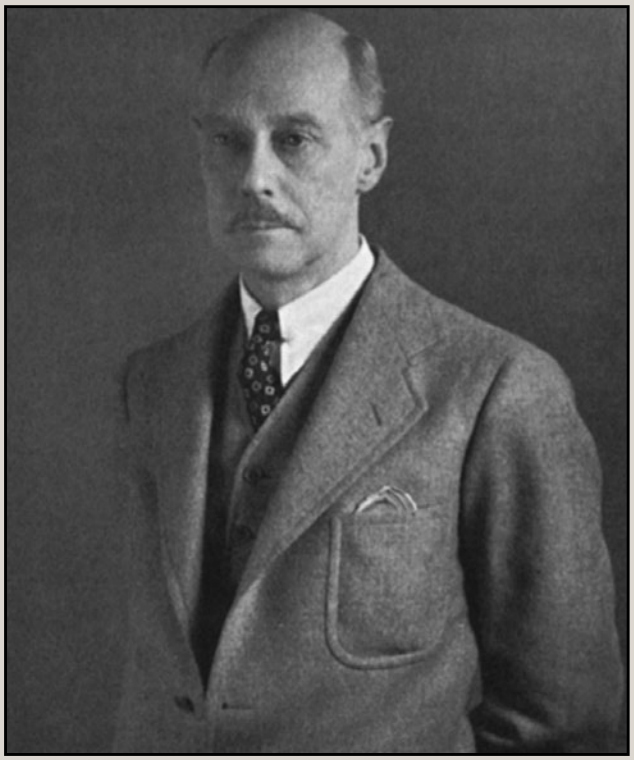


FIG. 8. Raymond L. Ditmars, first Curator of Reptiles at the Bronx Zoo, Wildlife Conservation Society, New York.

Don Ashley, a private alligator marketing consultant, recognized the economic needs of alligator farmers in Louisiana and Florida, yet urged close controls on crocodilian use in a market cleansed of illegal trade (Ashley 1979). Clare Hagan, Hagan and Co., New York, was a highly respected reptile leather product designer who immediately understood the need for change and set out to use her influence in the industry to support crocodilian and sea turtle conservation. Single-handedly, she put a stop to the use of sea turtle leathers in the fashion industry in the United States. Jay Wilson, a skin trader, assisted the IUCN CSG in making industry contacts at all levels of the trade, and helped sponsor South American students from leather-producing countries to go to US universities for education and training. Important leather tanners in the US, France, Japan, and Singapore funded population survey initiatives that would further crocodilian science, along with their own interests in procuring skins.

The AZA Crocodilian Advisory Group and international collaboration.—While international attention was focused on the development of political and national strategies for saving crocodilians and maintaining wild populations on a sustainable basis for commercial utilization, the zoological community recognized that for some species there were too few animals and sometimes no wild habitat left for sustainable populations. A small group of zoologists from some of the leading US zoological institutions met and were determined to take a hand in saving the critically endangered crocodilian species through captive breeding, starting with crocodilian collections already housed in US zoos. A Crocodilian Advisory Group (CAG) was formed and the initiative was sanctioned by the American Zoo and Aquarium Association in 1986. The CAG seeks to provide counsel on all aspects of zoo-based crocodilian conservation, and coordinates the use of available space and developing initiatives in North American zoos. The ongoing success of the AZA CAG would not be possible without the interest and commitment of David Drysdale, owner of the St. Augustine Alligator Farm, St. Augustine, Florida, and its staff.

John Behler, the late curator of reptiles at the Wildlife Conservation Society, New York, led the initiative and developed the first Species Survival Plan (Behler 1982) for a crocodilian, for the endangered Chinese Alligator. Following several unsuccessful attempts at the Bronx Zoo, Behler, Brazaitis, and Joanen, with founder stock from the Bronx Zoo and the Smithsonian National Zoological Park, Washington D.C., established the first collaborative breeding program for a crocodilian species. It stands as a model for AZA captive breeding programs for endangered species.

Colette Adams, Gladys Porter Zoo, Brownsville, Texas, led the initiative to restore Philippine Crocodiles to the wild as a result of a successful captive rearing program at the zoo. While the conservation of the Philippine Crocodile has suffered for lack of funding in the Philippines, Adams and Kent Vliet, CAG chair, are developing funding initiatives for continued captive propagation and future possible reintroduction programs.

The Bronx Zoo, New York, led the early effort to develop captive breeding technology beginning in the mid-1970s. Nine species of crocodilians, including critically endangered Cuban Crocodiles (Fig. 6), Siamese Crocodiles in 1983, and the first captive breeding of the endangered Malayan False Gharial (*Tomistoma schlegelii*) in 1985 in a North American Zoo (Brazaitis and Abene 2008). However, typically, "first breedings" are only a precursor to future successes as technology and husbandry improve and are tailored to the needs of individual animals and species. A pugnacious nature made Cuban Crocodiles particularly

difficult to manage (Fig. 7); juvenile Philippine Crocodiles were found to be totally intolerant, even to each other (Colette Adams, pers. comm.). Breeding of the Malayan False Gharial has now been successful in the private collection of AZA member Bruce Schwedick, and additional captive breeding facilities have been developed at the Virginia Aquarium, Virginia Beach, Virginia.

A global crocodilian community.—Crocodilians were already a subject of interest 100 yrs BC (Grant 1992). Private and zoological collections of crocodilians have existed in many parts of the world (Flower 1937; Honegger and Zeigler 1991; Trutnau and Sommerlad 2006).

The Atagawa Tropical & Alligator Garden in Japan, opened free to the public in 1958, conducted crocodilian breeding research and provided breeding stocks of crocodilians to zoos throughout the world.

The Samut Prakan Province crocodile farm in Thailand opened in 1950 and now houses over 60,000 crocodiles. The farm is a favorite tourist attraction, has published articles on crocodile biology and husbandry, and produces thousands of skins for the exotic leather trade.

The Madras Crocodile Bank Trust, in the state of Tamil Nadu, India, was established in 1976 as the idea of Romulus and Zai Whitaker. The mission of the Trust is to save India's three crocodile species, the Mugger Crocodile, Saltwater Crocodile, and the nearly extinct Indian Gharial.

Crocodile farms exist today throughout the world, in all of the warmer and temperate regions. Commercial husbandry practices were being developed in Australia, South Africa and Zimbabwe prior to the 1971 meeting of the crocodile specialists in New York.

The European zoological community has a long and venerable history involving crocodilian science. The European crocodilian community is part of the EAZA (European Association of Zoos and Aquaria) developing crocodilian captive breeding initiatives similar to those of the AZA CAG. As of 2008, 52 institutions, holding 147 animals, took part in a coordinated Dwarf Crocodile (*Osteolaemus tetraspis*) captive breeding effort that includes the latest in genetic modeling. A second program for the Malayan False Gavial is in development. Ongoing successful programs also include *Crocodylus johnsoni* at Frankfurt Zoo, with 100 offspring produced; a *C. mindorensis* program in development at the Chester, UK zoo; and *Mecistops cataphractus* at the Emmen Zoo, Holland, with more than 100 offspring produced (R. Sommerlad, pers. comm.).

Crocodiles not bad—crocodiles good!—The history of crocodilian science would be incomplete without calling attention to the importance of public awareness of crocodilians. While scientists studied the skulls and skins of crocodilians from the remote regions of the world in the obscure collections of museums and universities, the general public wanted to see and hear about these sometimes immense and terrifying creatures that obviously were related to mythical dragons and dinosaurs, and ate people if they could. This public interest came to the rescue of crocodilians worldwide when crocodilians needed attention most—at the brink of extinction.

Historically, nearly every zoo exhibited at least one crocodile or alligator, the bigger the better. Raymond L. Ditmars (Fig. 8) was curator of reptiles at the New York Zoological Park, New York, from 1899 until his death in 1942. He recognized the scientific value and visitor interest held by crocodilians (DeSola 1933; Ditmars 1913) and made the zoo's crocodilian collection (Fig. 9) one of the most important and well known at the time (Brazaitis and Abene

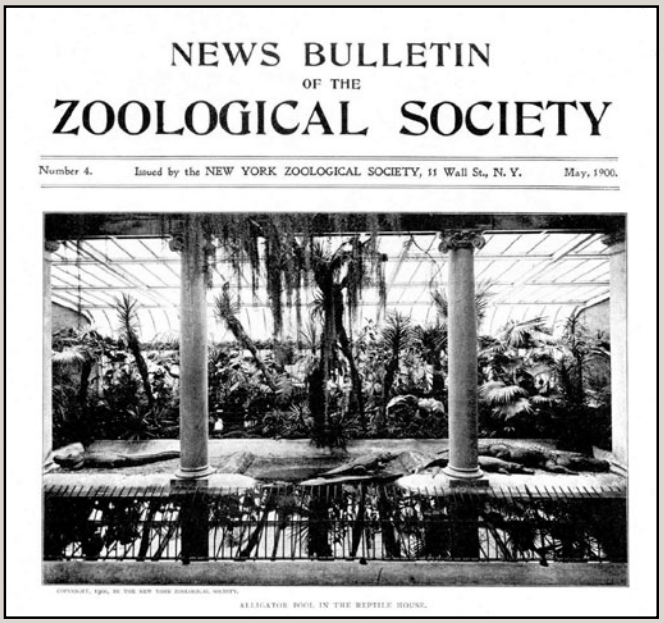

NEWS BULLETIN
OF THE
ZOOLOGICAL SOCIETY
Number 4. Issued by the NEW YORK ZOOLOGICAL SOCIETY, 11 Wall St., N. Y. May, 1900.

FIG. 9. Original 1900 crocodilian exhibit at the Bronx Zoo, Reptile House, designed by Raymond L. Ditmars.



The South Beach Alligator Farm and Burning Spring Museum in the 1890's.

FIG. 10. The St. Augustine Alligator Farm, St. Augustine, Florida, as it appeared in 1890.



FIG. 11. The St. Augustine Alligator Farm, St. Augustine, Florida, as it appears in 2011.

2008) through his popular and scientific publications. The legacy of Ditmars continues today through the work of the AZA CAG.

More than one private entrepreneur has made a living separating the curious from their money by offering a peek at "the biggest alligator in the world" for a small fee. The St Augustine Alligator Farm was never a farm for alligators but began as a tourist attraction that exhibited great numbers of American Alligators (Adams and Shiver 1993). Established in 1893, it continues to thrill and educate thousands of visitors from around the world. The "Alligator Farm" as it is locally called, became an accredited member of AZA in 1989 and under the ownership of David Drysdale, has become a pre-eminent center for crocodilian research and the captive breeding of endangered crocodilian species. It is the only institution in the United States to be dedicated entirely to crocodilian sciences and to exhibit all 23 recognized species of crocodilians.

E. Ross Allen was another early entrepreneur. He founded Ross Allen's Reptile Institute in Silver Springs, Florida, in 1929. The Institute exhibited a variety of crocodilians and other reptiles, and featured the role of the American Alligator in the life and culture of Native Americans. Allen died on May 17, 1981 at the age of 73, before realizing his dream of establishing "Alligator Town," dedicated to the preservation of the American Alligator.

Bruce Schwedick, a member of the AZA Crocodilian Advisory Group and a wildlife educator, pioneered mobile educational programs (Reptile Discovery Programs, Plant City, Florida) that take endangered species of reptiles, including crocodilians, to schools and audiences throughout the United States. As the U.S. representative to the international *Tomistoma* Task Force, he invests considerable time and personal funds to the conservation of endangered crocodilians.

In recent times, perhaps no other person has brought crocodilians to the attention of the public through the medium of worldwide television than Steve Irwin, best known as "The Crocodile Hunter." His television series reached millions of viewers around the world on nearly a daily basis. He and his wife Terri coowned and operated the Australia Zoo in Beerwah, Queensland, featuring Australian crocodilians and conservation. Irwin died on 4 September 2006 after being fatally stung by a stingray. Adam Britton, an Australian scientist, continues the effort to bring crocodilian science and education to the public forefront. There are many other private individuals who, in their own way, contribute immensely to the development of crocodilian sciences.

Many popular writers have contributed to crocodilian literature and science. Among the best known are Raymond L. Ditmars and Ralf De Sola of the then-New York Zoological Society (Ditmars 1913; DeSola, 1933), Wilfred T. Neill (Neill 1971), and C. A. W. Guggisberg (Guggisberg 1972).

It is fitting that this preliminary history of crocodilian science should end with illustrations of the precursor of the St. Augustine Alligator Farm as it appeared in 1890 (Fig. 10) and 120 years later (Fig. 11), spanning the period when crocodilian science has made some of its greatest advances.

Acknowledgments.—We acknowledge and thank David Drysdale, John Brueggen, Kevin Torregrosa, and the entire staff of the St. Augustine Alligator Farm for their support and continued interest in crocodilian sciences, the Association of Zoos and Aquariums, the AZA Crocodilian Advisory Group and its board of Directors, Kent Vliet, and especially the many zoological institutions that have taken part in furthering the science of crocodilian management. Thanks to James B. Murphy for his interest in historical manuscripts and the preservation of herpetological history. Thanks to the Yale Peabody Museum of Natural History, Division of Vertebrate Zoology , and the Wildlife Conservation Society, Department of Reptiles and Amphibians, and its staff, past and present. Thanks to Myrna Watanabe, for her patience and interest, and for reading very many manuscripts.

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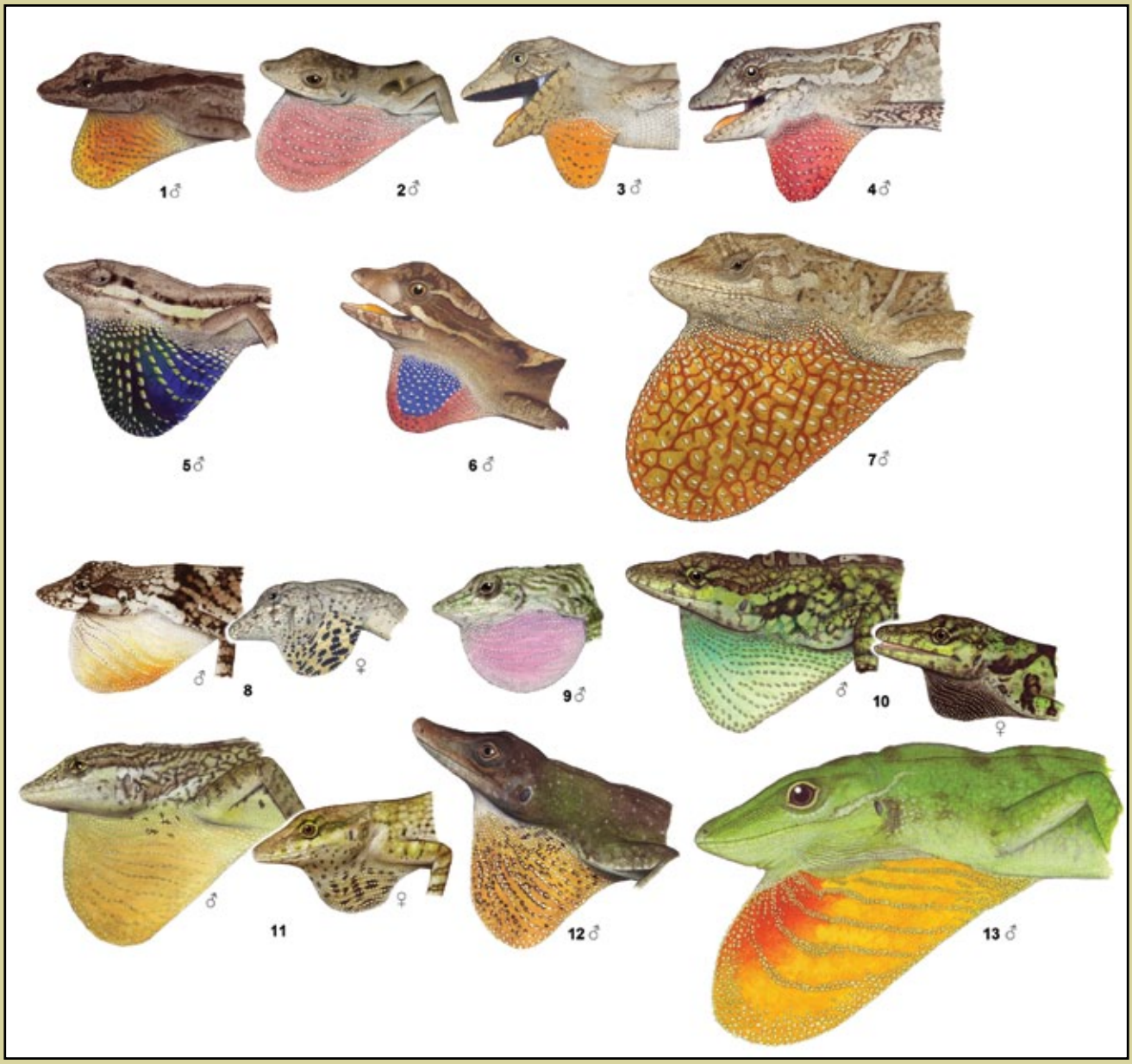
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Dewlap Coloration of Some Species of Anoles from Venezuela

One of the most conspicuous characteristics of anoles (genus *Anolis*) is the presence of an extensible and often colorful dewlap or throat fan, which these lizards extend during territorial or sexual displays. The dewlap is always conspicuous in males (reduced in only a couple of species), and is slightly smaller to rudimentary in females. Coloration, size, and squamation of the dewlap are often species-specific and of high diagnostic value. Illustrated here are the dewlaps of eleven of the 24 currently known species of Venezuelan anoles: 1) *Anolis tropidogaster* male, 2) *Anolis fuscoauratus* male, 3) *Anolis chrysolepis planiceps* male, from localities on northcentral and northwestern Venezuela, 4) *Anolis chrysolepis planiceps* male, from localities on southern Venezuela, 5) *Anolis auratus* male, 6) *Anolis chrysolepis scypheus* male, 7) *Anolis onca* male, 8) *Anolis tigrinus* male (left) and female (right), 9) *Anolis euskalerriari* male, 10) *Anolis anatoloros* male (left) and female (right), 11) *Anolis jacare* male (left) and female (right), 12) *Anolis punctatus* male, 13) *Anolis squamulatus* male.

Gabriel N. Ugueto is a graphic designer, illustrator, and herpetologist born in Venezuela, but he has resided in Miami, Florida, since 1999. He has worked for the past eight years on the systematics and taxonomy of the South American herpetofauna. Currently, Gabriel's main interests are the systematics of Teiidae, *Anolis, Polychrus, Phyllodactylus,* and the herpetofauna of the Venezuelan islands in the southern Caribbean. His recent publications have appeared in *Caribbean Journal of Science, Zootaxa, Herpetological Review,* and *Herpetological Monographs* and include descriptions of several new species and taxonomic revisions. Additionally, he is the senior author of *Amphibians and Reptiles of Margarita, Coche and Cubagua*, Edition Chimaira, 2010. His illustrations appear in his own publications and those of several colleagues. Recently, his illustrations of lizards were published in *Libro Rojo de La Fauna Venezolana.*

Gabriel prepared this panel of Venezuelan anoles using a mixed technique that includes crayons, watercolor, and gouache. Each illustration was based on color photographs or direct observation of live specimens. The illustrations were then scanned and final touches were added digitally. Some of his scientific illustrations can be viewed at http://kana-hebi.deviantart.com

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Professional and Amateur Herpetology in Germany and German-speaking Countries

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The DGHT, German Society for Herpetology and Herpetoculture ("Deutsche Gesellschaft für Herpetologie und Terrarienkunde e.V.," www.salamandra-journal.com, www.dght.de), was founded in 1964 as a successor of the German herp group "Salamander" going back to the year 1918. One of the founders of DGHT was the famous German herpetologist Robert Mertens. As implied by its name, DGHT philosophy is to bring together professional scientists and amateurs, thus promoting their dialog at an international scale. This gives the society a unique strength currently uniting more than 7,000 members including several, in herpetology, internationally well acknowledged honorary members.

The society's mission is to contribute to both research on amphibians and reptiles and captive keeping and breeding. DGHT is strongly engaged in herpetological conservation and is accredited by the German Federal Nature Conservation Act. The society runs three funds: the Wilhelm Peters Fund dedicated to herpetological research, the Hans Schiemenz Fund attributed to assessing and protecting natural populations of amphibians and reptiles, and, in collaboration with the Zoological Society for the Conservation of Species and Populations (www.zgap.de), a fund supporting conservation activities to protect threatened amphibian and reptile species.



FIG. 1. *Mertensiella* focuses on special topics such as varanid lizard research (Advances in Monitor Research I and II, published in 1991 and 1999, respectively).

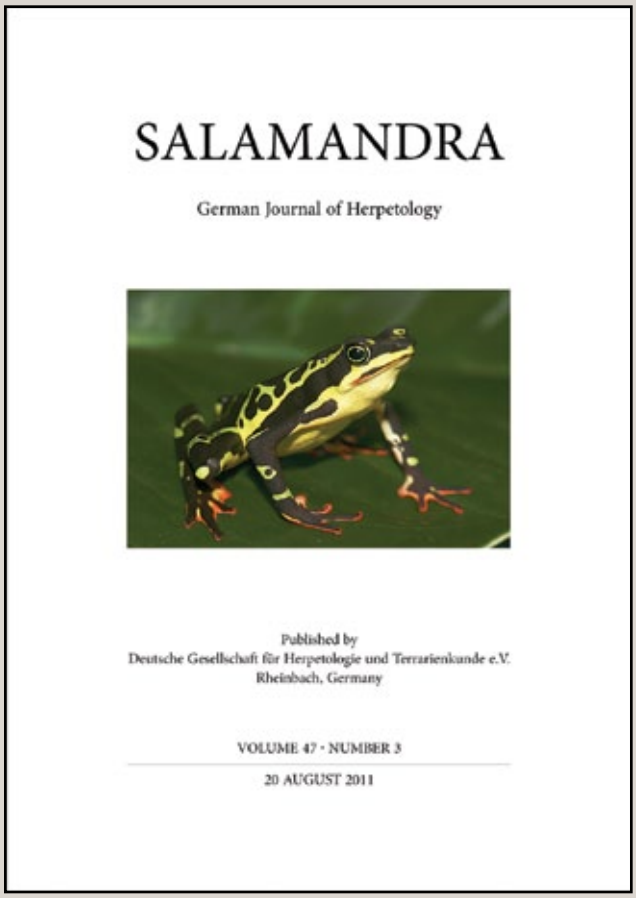


FIG. 2. *Salamandra* is the society's flagship scientific journal, published exclusively in English, covering broad range of topics, including systematics, ethology, ecology, and conservation biology.

Since the "Year of the Frog 2008," DGHT, in cooperation with the Association of German Zoo Directors (www.zoodirektoren.de), is involved in amphibian ex situ conservation efforts. Our activities especially unit conservation breeding projects run in Austria, Germany, and Switzerland and aims at a joint venture of zoos and private keepers. One of the target species is the critically endangered CITES Appendix 1 newt, *Neurergus kaiseri* (Luristan Newt), with currently more than 3,000 individuals, 85% of which are captive-bred.

DGHT is divided into more than 50 subgroups; besides local and regional branches in Germany, Austria, and Switzerland, there are working groups which put particular focus on different herps (e.g., anurans or chelonians), special topics (e.g., history of herpetology, veterinary science), or even more specialized on particular taxa (e.g., chameleons). Subgroups have their own meetings independent from the annual international meetings of the society combining herpetological science ("Deutscher Herpetologentag") and herpetoculturism, including herp travel reports, conservation, captive breeding, etc. ("DGHT-Nachzuchttagung"). Note that in September 2011, DGHT for the first time held a joint scientific meeting with Societas Europaea Herpetologica, SEH (www.seh-herpetology.org), the European herpetological society, at Luxembourg.

Among the print media of DGHT are *Salamandra—German Journal of Herpetology*, a quarterly journal publishing scientific contributions in English in all fields of herpetology, listed under Current Contents and soon under the Science Citation Index (available online), *Mertensiella*, a sporadically published supplement with special issues on particular topics (e.g., symposium volumes), *elaphe*, a colored quarterly German magazine reporting on different aspects of herpetology and herpetoculture, as well as internal political issues of DGHT. Furthermore, most of the working groups publish additional separate journals, e.g., *Radiata* (with English and German editions) (Figs. 1–4).

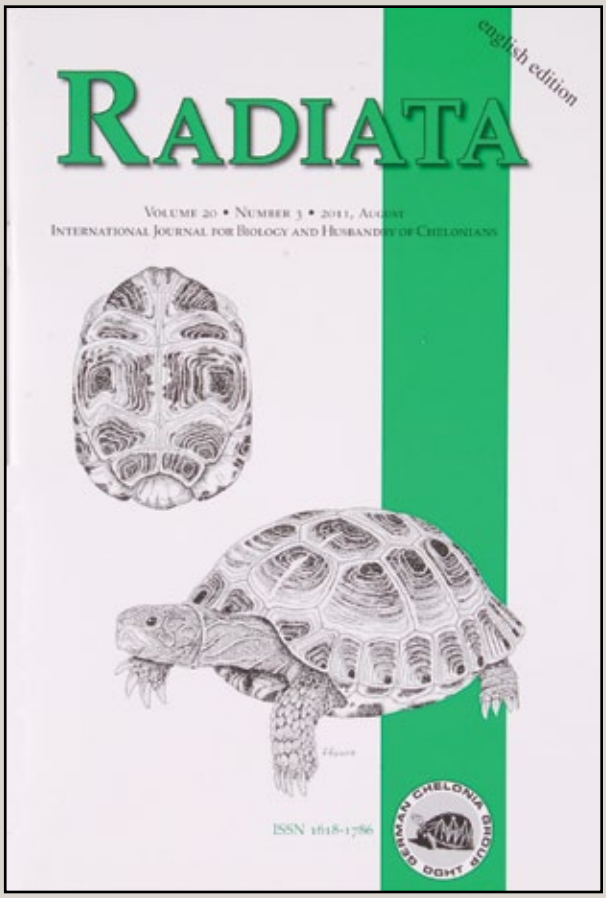


FIG. 3. *Radiata* focuses on the natural history, herpetoculture, and conservation of turtles and tortoises, and is published in German and English.

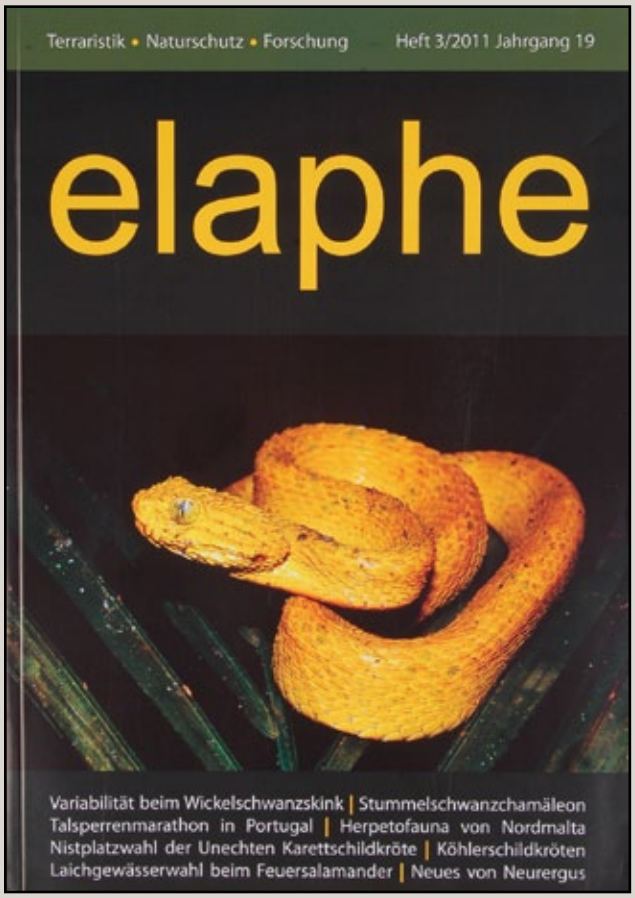


FIG. 4. The German language quarterly *elaphe* covers herpetology and herpetoculture, as well as news and information about the DGHT.

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Comment on the Conservation Status of the Desert Tortoise(s)

PHOTO BY JASON FOLT



FIG. 1. Adult *Gopherus morafkai* at burrow entrance, Maricopa County, Arizona, October 2010.



PHOTO BY TODD PIERSON

FIG. 2. *Gopherus morafkai*, Pima County, Arizona, August 2011.

Murphy et al. (2011) proposed that the Desert Tortoise (*Gopherus agassizii*) be split into two separate species. As suggested by their title, the authors made a significant effort to disentangle a dizzying array of confusion surrounding the taxonomy of the species. They elevated populations south and east of the Colorado River in Arizona and Mexico to species level and named them *Gopherus morafkai*, with tortoises north and west of the Colorado River retaining the name *Gopherus agassizii* (Figs. 1–4). Currently, *G. agassizii* (*sensu stricto*) is listed as Threatened under the U.S. Endangered Species Act (ESA), with the listed entity defined as a distinct population segment (Mojave population) of the larger species (*sensu lato*; USFWS 1990, 2010a). The Sonoran population segment (*G. morafkai*) was determined to be warranted for listing under the ESA, but precluded by higher priorities (USFWS 2010b). The boundaries and genetic basis for the species delineation proposed by Murphy et al. (2011) and the population designations recognized under the ESA are completely analogous, both divided precisely along the Colorado River.

After describing their taxonomic investigation, Murphy et al. (2011) comment on implications for conservation as a result of the proposed new species recognition, which would reduce the geographic range of *G. agassizii* to about 30% of its previously recognized range. These comments include several statements that are misleading or factually incorrect, which I wish to clarify here. Specifically, the paper's authors claim that "[t]he most important implication of describing *G. morafkai* is that Arizona and Mexico can no longer be considered to harbor a genetic reservoir for the Mojavian population of the desert tortoise" (and *vice versa*) and that the reduced range of *G. agassizii* indicates that the species may more appropriately be classified as Endangered, rather than Threatened.

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The first claim, that each species can no longer be considered a genetic reservoir for the other, is based on a premise with no historical basis, that tortoises on either side of the Colorado River were ever considered genetic reservoirs for one another. Recognition of genetic differences between the two populations/species of Desert Tortoises predates the listing of the Mojave population in 1990 (Jennings 1985; Lamb et al. 1989). Nothing in the listing rule, original recovery plan, or revised recovery plan suggest reliance upon the opposite population as a genetic reservoir. The final listing rule for the Mojave population recognized that the Colorado River "has been an effective geographic barrier, separating the Mojave and the Sonoran populations for millions of years" (USFWS 1990). The original recovery plan specifically recognized the importance of genetic differentiation in its recommendation that genetically homogeneous populations should be the sole basis for any research into translocations of Desert Tortoises (USFWS 1994). The revised recovery plan places greater emphasis on the use of experimental population augmentation as a recovery strategy, but it also specifically mentions the need to consider genetics in such a program (USFWS 2011). In summary, neither population/species has been considered a genetic reservoir for the other in Desert Tortoise management history.

The second claim, that the reduction in range of *G. agassizii* (*sensu stricto*) warrants species classification as Endangered, also ignores regulatory history. As noted above, the Fish and Wildlife Service recognized the distinction between the Mojave and Sonoran populations at the time the Mojave population was listed as Threatened. The status determination for the Mojave population of the Desert Tortoise was based on a threats analysis specific to that population (USFWS 1990; see also USFWS 2010a). Consideration of—or even the existence of—tortoises on the opposite side of the Colorado River played no part in determining that the Mojave population should be classified as Threatened, rather than Endangered. Likewise, the status determination for the Sonoran population was independent of the status, abundance, or existence of the Mojave population (USFWS 2010b). Taxonomic elevation of the Sonoran population to a full species has no effect on the Federal regulatory status of either species.

PHOTO BY KEVIN DURSO



FIG. 3. Adult *Gopherus agassizii*, Clark County, Nevada, May 2009.



PHOTO BY JACK GOLDFARB (WWW.JACKGOLDFARBPHOTOGRAPHY.COM)

FIG. 4. Adult *Gopherus agassizii*, Desert Tortoise Natural Area, Kern County, California, May 2009.

While Murphy et al. (2011) may have clarified long-standing confusion surrounding the taxonomy of the Desert Tortoise, clarifying the confusion their paper created about the conservation of the species is more than just an esoteric exercise. Press releases associated with the release of this paper generated a significant amount of media attention and public exposure about the new species and their supposed status (e.g., Center for Biological Diversity 2011; Danelski 2011). Incorrect public perception about how the proposed taxonomic change affects the species' status can only undermine the effectiveness of the ESA. Overstating a species' degree of endangerment, or otherwise misrepresenting important considerations relative to the species' status, opens the door to accusations by critics of the ESA of the distortion of science to serve ulterior, advocacy-based motives. On the other hand, setting unwarranted public expectations that new listing designations or regulatory changes should be forthcoming is destined to cause disillusionment among ESA proponents about the Act's effectiveness. Neither scenario serves the conservation purposes of the ESA.

Whether or not one agrees with the current official status designations of *G. agasszii* or *G. morafkai* under the ESA, tortoises on both sides of the Colorado River are recognized to be suffering from population declines. Conservation efforts are appropriately focused on factors contributing to these declines and on factors inhibiting the species' ability to maintain self-sustaining populations. Exaggerated claims of species imperilment distract from this focus.

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ARTICLES

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Natural History Notes on the Ecology and Conservation Status of the Honduran Endemic Frog *Isthmohyla insolita* (Anura: Hylidae)

The Honduran endemic frog *Isthmohyla insolita* (McCranie, Wilson, and Williams; Fig. 1) was previously known to occur only at its type locality (McCranie and Wilson 2002), a small stream in primary forest at 1550 m elevation in the Cerro Texíguat Wildlife Refuge in the Cordillera Nombre de Dios of north-central Honduras. Egg masses of this species have been found on vegetation overhanging the stream and males were reported to attend single egg masses at night (Wilson et al. 1994; Fig. 2). During 2–6 September 2003, we visited the type locality of *I. insolita* to determine its population status. Herein we report *I. insolita* from a second nearby stream and include information on spatial distribution of its nests, behavior of a male guarding an egg mass, and an apparent population decline of the species at the type locality.

The second *Isthmohyla insolita* locality (15.4305°N, 87.3089°W) is a small stream at 1690 m elevation that is covered by secondary growth vegetation, consisting mainly of bushes 1–3 m in height and some scattered trees attaining heights of about 5 m. Apparently a landslide destroyed the original forest because for about 10–20 m on either side of the stream there is little soil and leaf litter and the ground is littered with rocks, logs, large fallen trees, and other debris apparently carried down by the landslide. The stream was about 50 cm wide and about 30 cm deep at its deepest point in the area we worked. The immediate area above the landslide supports moderately disturbed broadleaf cloud forest (Lower Montane Wet Forest formation, Holdridge 1967). The vegetation structure at the second locality differs significantly from the complex forest structure and high plant diversity at the type locality stream. In addition, the second stream is considerably smaller than the type locality stream, where an average width of about 3 m and a depth of about 1 m occurred in many places during September 2003. This new locality is about 0.5 km N of the species' type locality.

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On 4 September 2003, we heard several male *Isthmohyla insolita* calling near this new locality stream. Males began calling at 1845 h (about 15 min before dark) from vegetation overhanging the stream. One egg mass and one male were located and two other males were calling along the same section of the stream. These males were still calling when we left the site at about 1950 h.

During the day of 5 September 2003, we searched for egg masses in about a 150 m transect along the new locality stream. We found five *Isthmohyla insolita* egg masses (not collected). The five egg masses contained 47–76 (mean = 62.0 ± 11.7) eggs and were 1.5–3.4 m (mean = 2.6 ± 0.96) above the water. Wilson et al. (1994) reported that six *I. insolita* nests contained 23–44 (mean = 33.8 ± 8.5) eggs at the type locality stream in primary forest. The number of eggs per nest was significantly greater in the disturbed habitat than in primary forest ($t = 4.61$, $p = 0.001$, $df = 9$). The significance of the higher egg numbers in the nests found in the disturbed habitat at the new locality is unknown, but we stress that our results are restrained by the lack of multiple site analyses. All egg clutches were placed on the upper surface of leaves directly over the water. Four of the five nests found in 2003 were exposed to direct sun light, at least during some hours of the day. *Isthmohyla insolita* probably breeds throughout the rainy season as we found egg masses in the process of hatching, as well as recently laid egg masses.

Also during the day of 5 September, we located an adult male *Isthmohyla insolita* near one of the egg masses mentioned above. The frog was apparently sleeping 1.2 m above the water, with the egg mass suspended 2.0 m above the male's daytime retreat and on a different plant. The frog was perched in a head up position on the vertical stem of a small plant. On the afternoon of 6 September, the frog was in the same place and position as the previous day. We waited nearby for dark and recorded its behavior from 1735 to 1914 h. The frog began slow movements towards the egg mass at 1740 h until it reached a point about 2 cm from the eggs at 1833 h. After its first initial movement of about 1 cm, the frog began an alternating series of face rubbing (with alternating movements of its hands) and push-ups that lasted about 6 min. These actions were followed by a series of yawns that lasted about 3 min. The frog then varied its movements between remaining motionless, short jumps, and short walking movements until it reached its perch site near the eggs.

At 1835 h, the frog hit the leaf five times (about one hit per second) with its left hand. Each hit was strong enough to agitate the eggs in the mass. The frog remained motionless in that position until the end of the observation period at 1914 h (neither the frog nor the eggs were collected due to concerns about the species' population status).

There is a considerable diversity of parental care known in anurans, but attendance of arboreal eggs placed above streams is rare in the Neotropics. The best-known example of this type of behavior is that of the centrolenid genus *Hyalinobatrachium* and in some species of that genus this behavior is related to hydric brooding and guarding the eggs from predators (Duellman and Trueb 1986; Savage 2002). The attendance of terrestrial nests by salamanders is related to mechanical agitation of the eggs and is thought to serve the purpose of aeration and prevention of adhesions (Duellman and Trueb 1986; Bruce 1998). The behavior observed in *Isthmohyla insolita* does not appear to be related to hydric brooding, but at least one of the observed frog's actions could be described as mechanical agitation of the eggs. Longer periods of observation are needed to decipher the purpose and benefits of this complex behavior.

During the period of 2–6 September 2003, we walked three nights for about 3 h each (from about 1800 to 2100 h) along the stream at the type locality of *Isthmohyla insolita*. We did not find nests or adults of *I. insolita* along this stream, and heard only two males calling the first two nights. Thus, the abundance of *I. insolita* at that time appeared to be lower at its type locality than that observed during the previous visits to the stream in 1991, 1993, and 1995. The reason for this apparent decline might be related to the availability of nesting sites. During October 1998, Hurricane Mitch caused severe flooding in this region of Honduras. Rivers draining the southern flanks of the mountains in which the *I. insolita* localities lie, now flow in central channels among wide boulder fields devoid of vegetation. Such damage was also evident along the *I. insolita* type locality stream during 2003. On the second author's previous visits to the locality, there was abundant leafy vegetation and moss covered tree branches overhanging the stream that were being used as nesting sites by *I. insolita* (see Wilson et al. 1994; McCranie and Wilson 2002). However, during September 2003, there was very little vegetation overhanging the stream and moss covered branches above the stream were absent. Thus, nesting sites were either unavailable or limited in scope at that time and might have been the reason for the few frogs along this stream at that time. However, complicating this scenario is that between 1993 and 1995 declines in other streamside frogs apparently occurred along this stream (McCranie and Wilson 2002). During August 1991 and July–August 1993, the hylid frogs *Plectrohyla guatemalensis* and *Ptychohyla spinipollex* and the craugastorid frogs *Craugastor aurilegulus* and *C. stadelmani* were frequently seen along this stream. However, during July 1995, *Ptychohyla spinipollex* was present in reduced numbers, but the other three frog species could not be found despite a concerted effort to do so. *Isthmohyla insolita* remained common at the site during July 1995, so the factors causing the decline of the other species did not appear to be affecting the *I. insolita* population at that time. During September 2003, *Ptychohyla spinipollex* remained in low population densities at the type locality stream, but was not found at the second stream. The other three species of frogs still could not be found in September 2003 at the former stream or at the second stream. The survey methods and number of man hours spent were similar in all visits to the locality.



FIG. 1. Adult male (KU 219987, top) and female (USNM 330193, bottom) of *Isthmohyla insolita* from the type locality.

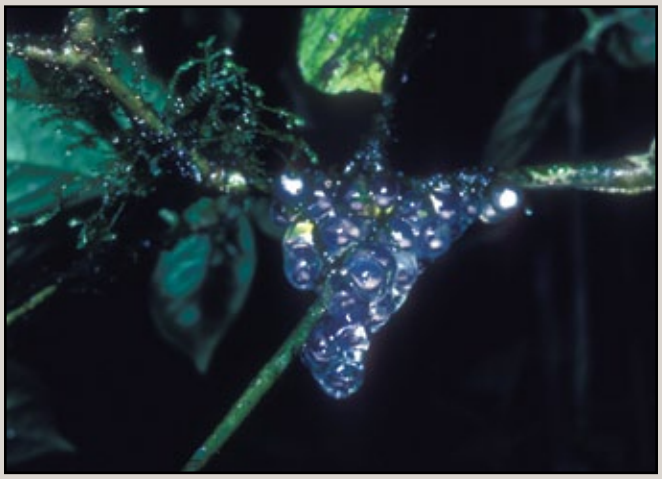


FIG. 2. Egg mass (USNM 330202) of *Isthmohyla insolita* from its type locality.

McCranie and Wilson (2002) used an Environmental Vulnerability Gauge in an effort to identify species that were most vulnerable to population declines. The higher the score for a given species, the more likely it is for that species to be vulnerable. *Isthmohyla insolita* scored a 15, just below the highest attained score (16). Wilson and McCranie (2003a, 2003b) modified that gauge with the highest attained score becoming 17. *Isthmohyla*

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insolita scored 16 in that revised gauge. Thus, it is evident that continued monitoring of this species and additional natural history studies are urgently needed.

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Live Fast, Die Young? A Six-Year Field Study of Longevity and Survivorship in Blanchard's Cricket Frog (*Acris crepitans blanchardi*)

Tetrapods typically have overlapping generations and are long-lived organisms; however, some remarkable exceptions to this pattern are known. For example, Karsten et al. (2008) recently documented a chameleon from Madagascar with a post-embryonic life span of only 4–5 months. Among frogs, a recent review of the literature found that some species can be quite long-lived under natural conditions, especially in the temperate zone (up to 37 years; Bell and Pledger 2010; Wells 2007). Relatively small-bodied species tend to have shorter life spans (~ 3–5 years). For example, Spring Peepers (*Pseudacris crucifer*) have been estimated with skeletochronology to survive a maximum of four or five years (Lykens and Forester 1987; Zimmitti 1999) and typically begin breeding in their third spring (as two year olds). In contrast, a number of tropical frogs are known to be short-lived (1–2 years; e.g., Galatti 1992; Kluge 1981; Lehtinen 2009; Ramirez et al. 1998). However, in environments with little seasonality, much of the year is presumably suitable for activity, permitting rapid growth and attainment of reproductive maturity. Thus, the apparent greater longevity of temperate frogs may in part reflect the reduced opportunities for growth and the necessity of dormancy during unsuitable times of the year.

One temperate frog species that is thought to have a very short life span is Blanchard's Cricket Frog (*Acris crepitans blanchardi*). Pyburn (1961) provided the first evidence of a short lifespan when he reported fall breeding populations in Texas that consisted almost entirely of known young of the year (see also Pyburn 1958). Similarly, Bayless (1969) found evidence of fast growth rates in Blanchard's cricket frogs, such that metamorphs could likely grow to reproductive maturity and breed within the same year they metamorphosed. Burkett (1984) captured over 3500 individuals in populations near Lawrence, Kansas and estimated that the average lifespan was only 4 months with complete population turnover occurring in approximately 16 months. More recently, McCallum et al. (2011) summarized data on the seasonal distribution of body sizes which also was suggestive of rapid growth and a short life span. Thus, a number of previous studies have been suggestive of a short life span in Blanchard's Cricket Frogs, yet none of these studies was explicitly focused on the determination of longevity and most were of relatively short duration. Given that an annual life history in a temperate frog would be highly unusual, additional confirmatory data are needed. This is particularly important at present, as this species is thought to be in decline over much of the northern portion of its range (Gray et al. 2005; Lannoo 1998; Lehtinen 2002; Lehtinen and Skinner 2006). Here, we use individual recapture histories and seasonal variation in body size from a six-year field study to provide data on longevity of this species under natural conditions.

Methods.—The study site consisted of seven ponds at or adjacent to St. Marys Fish Hatchery in Grand Lake St. Marys, Auglaize County, Ohio, USA (40.517°N, 84.417°W). Twenty-six site visits spanned 2004–2009 (Table 1) where from one to eight persons attempted to capture all post-metamorphic (or nearly metamorphosed) Blanchard's Cricket Frogs encountered. Most site visits occurred during daylight hours and frogs were captured by hand with the assistance of dip nets. We focused our sampling activity along the pond margins, where cricket frog activity is concentrated (Burdick and Swanson 2010; Martinez-Ortiz 2004; Pyburn

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1958; Smith et al. 2003) but also regularly checked adjacent grassland and woodland habitats. Ponds were sampled by walking in a single direction around the pond to avoid recapturing recently marked individuals (and thus artificially inflating recapture rates). All captured individuals were sexed externally (by the presence of breeding coloration in the throat of males - this was only possible during the breeding season) and measured (snout-vent length, SVL) using Mititoyo SC-6 digital calipers to the nearest 0.1 mm. All captured individuals were classified into one of three size categories: adult (≥ 23 mm SVL), subadult (17–22 mm SVL) and metamorph (10–16 mm SVL). These categories were based on the size at which we first observed secondary sexual characteristics and the observed range of sizes at metamorphosis (individuals with the tail not yet fully resorbed). This population of Blanchard's cricket frogs has tested positive twice for the fungal pathogen *Batrachochytrium dendrobatidis* (hereafter *Bd*): once in 1999 (see Zippel and Tabaka 2008) and again in 2006 (Steiner and Lehtinen 2008).

From 2004 to 2007, all captured cricket frogs received a year-specific toe clip (one toe only) to indicate the year in which they were first marked such that a minimum known lifespan could be established for recaptured individuals. Toes were clipped using scissors, which were sterilized with 95% ethanol after each use (Ferner 2007). In 2008, we more intensively sampled this population and used visual implant elastomer (VIE, Northwest Marine Technology Inc., Shaw Island, Washington, USA) to give individual marks to each adult captured. Only adults were marked in 2008 and 2009 as we sought to more rigorously assess both within-season mortality and inter-annual survival in adults. This method was used in favor of using multiple toe clips to uniquely mark individuals because some research has suggested that clipping more than one toe can decrease survival (McCarthy and Parris 2001, 2004). Two colors of elastomer were used (fluorescent pink and orange). Six ventral body locations were used as elastomer injection sites (upper arms and upper and lower legs) using 0.3-cc syringes. A deep-violet flashlight (λ = 405 nm) was used to aid in the detection of elastomer marks if the marks could not initially be detected under ambient light. In 2009, site visits were concentrated in May and June to attempt to recapture adults marked in the previous breeding season.

Kruskal-Wallis tests were used to test for significant differences in SVL among months (data pooled for all years). Sequential Mann-Whitney tests were then used as post-hoc tests to identify which groups differed significantly from one another. For these comparisons, the level of significance was adjusted with the Bonferroni procedure (α = 0.0033). Parametric procedures could not be used with the SVL data as test assumptions were strongly violated. An independent-samples *t*-test (assumptions checked using Kolmogorov-Smirnov, Shapiro-Wilk and Levene tests) was used to assess sexual size dimorphism in adults. Too few recaptures were obtained to estimate population sizes; therefore, we examined trends in abundance with a linear regression of catch-per-unit-effort (number of frogs captured per person-hour of sampling effort) versus time. Because of the goals of the study and the nature of the resulting data (see Results), longevity estimates were estimated empirically from recaptured individuals; we did not employ capture-mark-recapture models.

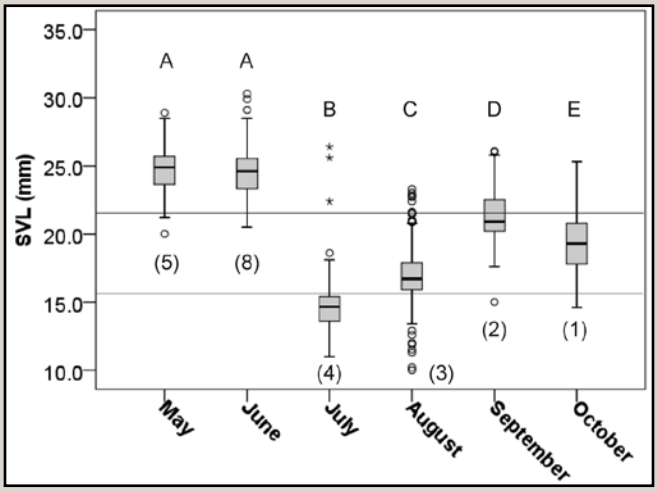


FIG. 1. Boxplot of cricket frog SVL versus month of collection (N = 961). Each box represents 50% of cases; the line across the box is the median value. The whiskers extending from each box represent the minimum and maximum values for that month (circles are outliers, asterisks are extreme outliers). Months that share letters above the boxes are not significantly different. The solid horizontal lines indicate the approximate boundary between metamorph and juvenile body size (below) and juvenile and adult body size (above). The number of site visits in each month is given in parentheses below each box. Note that body size data in this figure is pooled over all years and therefore mixes data from multiple cohorts together.

TABLE 1. Summary of 2004–2009 mark-recapture data from *Acris crepitans blanchardi*. CPUE = catch per unit effort (# frogs captured per person-hour of effort).

				Recaptures						
Year Marked	# Site Visits	CPUE	# Marked	2004	2005	2006	2007	2008	2009	Between-year Recapture Rate
Adults, subadults, and metamorphs marked										
2004	3	12.0	564	3	2	0	0	0	0	0.004
2005	5	2.5	64	-	0	0	0	0	0	0.000
2006	3	5.1	116	-	-	1	2	0	0	0.017
2007	3	1.9	51	-	-	-	2	3	0	0.059
Only adults marked										
2008	10	1.9	125	-	-	-	-	38	0	0.000
2009	2	10.5	41	-	-	-	-	-	0	0.000

Results and Discussion.—Previous studies have suggested that Blanchard's cricket frogs grow and attain sexual maturity quickly and have a short life-span (e.g., Bayless 1969; Burkett 1984; Pyburn 1961). However, all of these prior studies were relatively short-term (< 1–3 years) and most were conducted in southern portions of the geographic range. This left open the possibility that a longer-term study or one in a more strongly temperate climate might reveal different patterns. On the contrary, our data confirmed the patterns previously documented. A total of 961 individuals were captured and marked over the course of our study. Of these, 51 were recaptured (5.3% recapture rate, including individuals recaptured multiple times; Table 1). Forty-four of the recaptures occurred within the year the individual was initially marked (86%). The remaining seven recaptures (14% of total, Table 1) were all originally marked in the previous year. No individuals were recaptured that had been marked two or more years previously. The seven inter-annual recaptures were not necessarily two year olds because from 2004 to 2007 all individuals received the same year-mark and these individuals may have been marked initially as metamorphs. To further examine whether adults return to breed in a subsequent year, we marked only adults in 2008 (N = 125). None of these were recaptured in 2009 (Table 1). Within-season recapture rates were especially high in 2008, which we attribute to a larger number of sampling sessions that were more closely spaced in time. Thus, based on our six years of mark-recapture data, we found no convincing evidence of any individuals that survived to be more than one year old.

Our data on body size patterns are consistent with these conclusions. Blanchard's Cricket frogs showed a significant difference in SVL among sampled months (Kruskal-Wallis Test: $\chi^2 = 541.0$, df = 5, $P < 0.001$). Post hoc tests revealed that body size did not differ significantly between May and June but that all other months were significantly different from one another (Fig. 1). In May and June of all years, captured individuals were always adult-sized and in breeding condition. But by July, we were unable to find any adult-sized individuals (other than the three adults found in July 2008). Individuals captured in July and August were exclusively metamorphs and juveniles (the mean SVL dropped from 24.8 mm in June to 15.0 mm in July; Fig 1) indicating a shift from a strictly adult-based age structure to one dominated almost entirely by juveniles (i.e., complete population turnover—no overlapping generations). This result cannot be explained simply as adult emigration from ponds after breeding since no frogs were ever found in other habitats and we have no evidence that any individuals returned to breed in any subsequent year. Subadults were only found in August, September and October but never in May, June or July. Some individuals from September and October were beginning to approach full adult body size (Fig. 1). Note that in Figure 1 individuals captured in October are smaller on average than those captured in September. This is an artifact of pooling data among years (2 samples were available from September (2006 and 2007) but only one from October (2004)). Breeding adult Blanchard's cricket frogs showed a significant sexual dimorphism in body size ($t = 6.686$, d.f. = 89, $P < 0.001$), with females being 10.2% larger on average than males (male mean 23.7 ± 1.7 SD, female mean 26.4 ± 1.9 SD).

While these data and that from other studies (see citations above), have suggested that Blanchard's Cricket Frogs are short-lived, other evidence suggests that this is not always the case. For example, using mark-recapture methods Gray (1983) found a few cricket frogs that had survived two winters. Using skeletochronological methods McCallum et al. (2011) documented a two-year old individual from Texas, and unpublished skeletochronological data from central Indiana has documented three-year old individuals (S. Perrill, pers. comm.). Zippell and Tabaka (2008) reported Blanchard's Cricket Frogs surviving nearly four years in captivity (using individuals collected from the same study site as we report on here). Thus, from these studies it seems clear that Blanchard's Cricket Frogs are physiologically capable of surviving longer than a single year and yet our study and others (Burkett 1984; Gray 1983) indicate that this rarely occurs under natural conditions.

So, why is survivorship so low? At our study site, it was not obvious that any likely predators were particularly abundant and indeed, we never witnessed any predation events. It is possible that infection with *Bd* is directly or indirectly involved in the short lifespan and low survivorship observed in our study. However, this also seems unlikely to us for several reasons. First, previous studies on Blanchard's cricket frogs have reported similar results to ours (see above) and some of these studies were probably conducted before any *Bd* was present (although this is impossible to ascertain for certain). Secondly, while Steiner and Lehtinen (2008) reported the St. Marys population to be positive for *Bd*, the infection rate was only 14% (based on PCR amplification of skin swabs from 42 individuals in 2006) and in six years of work at this site, we never observed any dead or dying frogs. Thirdly, if the frogs collected by Zippel and Tabaka (2008) were infected with *Bd* when collected (which seems likely), they survived a remarkably long time with the infection. Lastly, while catch-per-unit-effort is a rather crude measure of abundance, a linear regression analysis showed no significant linear trend in catch-per-unit-effort versus year ($F = 0.013$, $P = 0.914$, $r^2 = 0.03$). Thus, we found no evidence of decline in overall numbers during the study period and the nature of the high mortality rates remains unexplained.

Like other previous studies, our data suggest that newly recruited individuals grow rapidly and can be near adult size by the time the activity season ends (Fig. 1). In this population, most individuals metamorphose in July or August and breeding begins the following May. Therefore, sexual maturity appears to be attained in 9–10 months after metamorphosis (and an appreciable proportion of this time is spent over-wintering; Irwin et al. 1999). Compared to many other temperate hylids, this is an extremely rapid attainment of sexual maturity. For example, Lykens and Forester (1987) showed that male and female *Pseudacris crucifer* breed for the first time in their third spring (as two-year olds) and can live up to five years. Freidl and Klump (1997) found *Hyla arborea* to reach reproductive maturity in two years with a maximum documented longevity of six years. Two chorus frog species (*Pseudacris nigrita* and *P. ornata*) from the southeastern US reach reproductive maturity at a similarly rapid pace to that documented here (Caldwell 1987). However, some individuals were found to survive to breed more than once (maximum annual survivorship at her study sites was 33% and 11% for *P. ornata* and *P. nigrita*, respectively). Our mark-recapture and body size data suggest that Blanchard's Cricket Frogs grow to reproductive maturity in less than one year and that the first reproductive attempt is likely the last. However, as other studies have found older individuals and captive individuals are known to live nearly four years, this seems like less of an evolved life history strategy (i.e., semelparity) and more of a situation where extremely high extrinsic mortality is present.

This "facultative annual" life history of Blanchard's Cricket Frogs may be a factor in its decline in the northern part of its range. More long-lived species can potentially put off reproduction in bad years but given the short life span, this may not often be possible in Blanchard's Cricket Frogs. While a variety of factors have been implicated in the decline (see Gray et al. 2005 and Lehtinen and Skinner 2006 for summaries), a demographic structure such as the one confirmed here would seem to predispose this species to rapid population dynamics and frequent turnover events. To separate natural population fluctuations and local extinctions from human impacts, monitoring efforts for this species would likely benefit from a adopting a monitoring strategy on a large spatial and temporal scale.

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Colonization of Hawaii Island by the Brown Anole (*Anolis sagrei*)

The Brown Anole (*Anolis sagrei* Dumeril and Bibron 1837) is a potent invasive lizard species. Native to Cuba and the islands of the Bahamas, it has been introduced to Florida, Hawaii, Taiwan, Jamaica, and Granada (Williams 1969; Campbell 1996; reviewed by Campbell, 2003). Florida introductions are the product of multiple colonization from across the native range of *A. sagrei* (Kolbe et al. 2004), and these highly admixed populations have further spread across the southeastern US displacing the native Green Anole, *A. carolinensis* (Voigt 1832) (Lee 1985; Tokarz and Beck 1987; Gerber and Echternact 2000; Campbell, 2003). In addition, molecular evidence indicates that Florida populations are the probable source of geographically widespread introductions to St. Vincent (Eales and Thorpe 2010), Hawaii, Grand Cayman, Taiwan, and Granada (Kolbe et al. 2004).

On the Hawaiian archipelago, *Anolis sagrei* was first reported from Oahu in 1992 and subsequently from Kauai and Maui (Kishinami and Kishinami 1996; Kraus 2003; 2006). McKeown (1996) observed this species in 1980 in a small residential neighborhood in Lanikai on windward Oahu, and further noted that, at that time, it had spread to adjacent towns and to the leeward side into Waikiki. Kraus (2002) reported establishment of additional satellite populations that included Pearl Harbor. He also noted that, where present, *A. sagrei* achieves high-density populations.

We report here that *Anolis sagrei* has new established populations on Hawaii Island. WJM first observed and collected *A. sagrei* on 29 May 2010 in irrigated ornamental vegetation on the grounds of a beach-front resort at Kahuwai Bay, a site (GPS 19.82828°N, 155.99130°W, WGS84, elev. 3 m) on the northwest coast of Hawaii Island approximately midway between Kona and Kawaihae. On 20 July 2010, we conducted a two-observer walking survey on the paths of this resort and an adjacent resort to the north (GPS 19.83006°N, 155.98877°W, WGS84, elev. 2 m). We conducted our survey during mid-day conditions with clear skies and light wind. We surveyed the more southerly resort between 1005 and 1150 h (105 min of continuous observation by two individuals), and observed 26 *A. sagrei*, 2 *A. carolinensis*, 4 Gold Dust Day Geckos (*Phelsuma laticauda*), and 1 Snake-eyed Skink (*Cryptoblepharus poecilopleurus*). We observed both juvenile and adult *A. sagrei* indicating that an established breeding population existed at the site. This resort is characterized by an open canopy with heavily irrigated, low ornamental shrubs and forbs along paved walkways, and scattered trees among the resort residences. At the adjacent resort to the north between 0935–1000 and 1340–1450 h (95 min total survey time), we observed 0 *A. sagrei*, 4 *A. carolinensis*, 6 *P. laticauda*, and 20 *C. poecilopleurus*. Although there was no apparent physical barrier to inhibit lizard movement between the two resorts (the two properties share a boundary), the northerly site is a cultivated xeriscape with a canopy of kaiwe (*Prosopis pallida*, a kind of mesquite), ironwood (*Casuarina glauca*), and ornamental palm trees with an open understory of scattered shrubs such as oleander (*Nerium oleander*).

Further to the south, a third resort at Kukio Bay offers irrigated habitat similar to the *Anolis sagrei*-inhabited resort, but is separated by an extension of a golf course that narrows to 50 m at the coast and expands inland. A second walking survey by one of us (WJM) on 2 December 2010 indicated that *A. sagrei* have not yet crossed this exposed, open grass barrier. Walks on three paths from the beach into the Kukio Bay resort (GPS 19.82127°N, 155.99661°W, WGS84, elev. 3 m) from 1053–1134 h (25 min observation time by one individual) in heavily irrigated habitat revealed 2 *P. laticauda* and 4 *C. poecilopleurus*, but no *A. sagrei*. Between 1150 and 1245 h, two segments of walking survey at the irrigated Kahuwai Bay resort (total 29 min observation time) yielded 4 *A. sagrei*, 1 *A. carolinensis*, 1 *Phelsuma laticauda*, and 1 *C. poecilopleurus*, while a 21-min survey of the northern xeriscaped resort between 1134–1150 h yielded 1 *A. carolinensis*, 1 *P. laticauda*, and 6 *C. poecilopleurus*. The three resorts at Kukio and Kahuwai Bay are collectively isolated from other suitable habitat for these *Anolis* lizards by extensive lava flows. These uncultivated lava flows are relatively young (1500–5000 yr B.P, based on USGS Misc. Investigations Series Map 1-2524-A), barren of trees and large shrubs, and receive less than 50 mm of annual rainfall (Juvik and Juvik 1998). We presume that *A. sagrei* cannot cross them without human assistance.

Another Hawaii Island colonization of *Anolis sagrei* has recently been reported from an eastern Hawaii Island residential neighborhood (19.68342°N, 155.08233°W, WGS84, elev. 102 m) in Hilo (Krysko and Granatosky 2010). On 27 January 2011, WJM surveyed this site and found that this species was distributed among a network of six residential streets south and west of the point of observation by Krysko and Granatosky (2010). The survey yielded 62 adult and juvenile *A. sagrei* and 2 Metallic Skinks (*Lamprophollis delicata*) over 47 min of walking where *A. sagrei* were present. The survey extended about 200 m beyond the last *A. sagrei* observation on any street direction away from the population center. GPS locations at the seven terminal points of *A. sagrei* observations yielded a circumscribed population with a minimum polygon area of 10.3 ha centered at 19.68218°N, 155.08287°W. No *A. carolinensis* were observed during the survey, although they are not uncommon in Hilo, and a resident confirmed that the newly introduced *A. sagrei* look different from the less abundant *A. carolinensis* typically seen among yard foliage.

Acting on the hypothesis that plant nurseries with inter-island wholesale plant outsourcing could be a pathway for anoles colonizing Hawaii Island, we visited two large retail nurseries in Hilo. *Anolis sagrei* was present in ornamental vegetation just outside one of these at the intersection of Railroad Avenue and

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Makaala Streets (19.69844°N, 155.05820°W, WGS84, elev. 27 m). Voucher specimens of the three separate populations of *A. sagrei* have been deposited with the Bishop Museum in Honolulu: BMNH 36981–36984.

The populations of *Anolis sagrei* on Hawaii Island are likely very recent colonists, presumably from established populations on other islands in the state. While *A. sagrei* may have arrived at Kahuwai Bay and Hilo in imported ornamental plants, they pose an immediate threat of future, human-mediated expansion. The presence of both young and adult lizards at both sites confirms that these are already established breeding populations, and the species is clearly proficient at such stratified diffusion expansion as documented by Campbell (1996) for *A. sagrei* spreading through Florida to Georgia, Louisiana, and Texas. If its populations expand on Hawaii Island, we might expect *A. sagrei* to partially or completely displace *A. carolinensis*, as it has in Florida. As *A. sagrei* achieves remarkably high density populations where present on Oahu (Kraus 2002) and in our lizard counts on Hawaii Island, the species, alone or in combination with other invasive lizards, might pose a more significant threat to native arthropod species than *A. carolinensis* has in the past. Given the current limited distribution of *A. sagrei* on Hawaii Island, we strongly recommend that immediate action be taken to eradicate it before it can spread further.

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The Harvest of *Antaresia maculosa* (Pythonidae) from West Papua, Indonesia

New Guinea is the largest tropical island in the world. It hosts 5–7% of the world's biodiversity (Dinerstein and Wikramanayake 1993; Myers et al. 2000) and 5% of the world's reptile species (Allison 2007). The island is politically divided between Indonesia and Papua New Guinea (PNG). The Indonesian provinces of West Papua (in the west) and Papua (in the east bordering PNG) were virtually closed to research through the latter part of the 21st century. As such, there are nearly 30% fewer reptile species recorded from Indonesian Papua compared to neighboring PNG (excluding islands in the Bismarck and Solomon Archipelagos), a difference likely explained by biases in search effort between the two countries (Allison 2007).

One family of large enigmatic snakes, the Pythonidae, has, however, been well documented. Australasia is home to the greatest diversity of python species in the world, with 12 species being known from mainland New Guinea (O'Shea 1996; Schleip 2008). Pythons are large bodied, non-venomous constrictors and are often brightly or contrastingly colored. As a result, they have been heavily exploited for the international pet trade, with large numbers of individuals being taken from West Papua each year to meet ever-growing domestic and international demand (Yuwono 1998).

Despite the relative conspicuousness of these snakes compared to other reptile species it was not until the year 2000 that O'Shea et al. (2004) discovered the genus *Antaresia* near the

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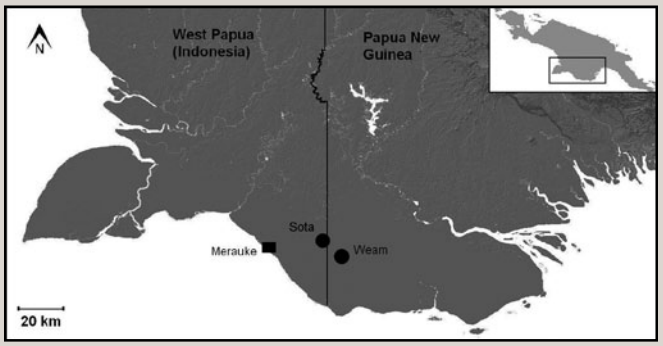


FIG. 1. Locality records of *Antaresia maculosa* in southern New Guinea (●) and the nearby port town of Merauke (■).



FIG. 2. An *Antaresia maculosa* from the vicinity of Sota, Papua, Indonesia.

village of Weam in southern PNG (Fig. 1). *Antaresia* is a genus of small, widespread python species common in many habitats in neighboring Australia (Wilson and Swan 2008). O'Shea et al. (2004) tentatively identified the species as *A. maculosa* (Spotted Python). Wuster et al. (2003) suggested that woodland species may have utilized two routes of migration between New Guinea and Australia (one from Queensland and another from the Northern Territory). *Antaresia maculosa* and *A. childreni* inhabit each area, respectively. Thus, further work is needed to validate the relationship of New Guinea specimens to those in Australia.

It is not currently known whether the lack of specimens collected in New Guinea is due to limited distribution, small population size, or merely limited collection effort in suitable habitat. Herein we report the first records of *Antaresia maculosa* from West Papua and discuss the implications of trade for the conservation of this python in New Guinea.

Observations.—While in the field between December 2010 and March 2011 we recorded four *Antaresia maculosa* individuals from the south of Papua (Fig. 2). These were collected by local people at three separate locations within a 5 km radius of the village of Sota (8.4280°S, 140.9916°E; WGS84) near the Indonesian/PNG border (Fig. 1). All pythons were found opportunistically; two were found at night while crossing a road. The snakes were collected by villagers and sold to two reptile traders in the nearby port town of Merauke. From Merauke, traders shipped the pythons to reptile dealers in the Indonesian capital, Jakarta, and we were told that they were destined for the international pet trade.

Discussion.—This is the first record of *Antaresia maculosa* from Papua. However, it is not surprising that the species occurs in the vicinity of Sota due to the habitat similarity with Weam in PNG (DJDN and JAL, pers. obs.). There are significant areas of suitable tropical woodland habitat in southern New Guinea (Bowe et al. 2007), so it is probable that the distribution of *A. maculosa* is considerably greater than the few records suggest.

Allison (2006) identified the conservation status of *Antaresia maculosa* from New Guinea as being of concern due to its restricted distribution and potential for exploitation by the pet trade. Of concern is that the genus was not previously known to occur in Papua, but has apparently been traded for at least the last five years. All Indonesian pythons are currently listed under Appendix II of the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES), which regulates their export. In Indonesia the CITES management authority (PHKA) sets harvest quotas for Appendix II listed species with guidance from the Indonesian Institute of Science (LIPI). Species that are not assigned a quota cannot be harvested and because *A. maculosa* has not previously been recorded in Indonesia it does not have a harvest quota so cannot be legally traded. Traders indicated that the snakes were highly sought after for the international pet trade fetching up to US $80 each in Jakarta. It is not currently known whether they were, in fact, exported from Indonesia; however, given that the Indonesian domestic demand for reptiles is in its infancy this is highly likely. Because *A. maculosa* is currently unknown to the Indonesian CITES Management Authority any export from Indonesia is illegal.

The international trade in exotic pets is a growing threat to the world's biodiversity (Nijman 2010). Large numbers of reptiles from Indonesian Papua are harvested annually (DJDN and JAL, pers. obs), however, the effects of this trade have not been determined. At present, the status of *A. maculosa* in Papua is unknown. Now that the species has been confirmed as occurring in the region, surveys are needed to establish the sustainability of the trade in these pythons. We suggest that until the non-detriment findings required under Article IV of CITES for Appendix II species has been undertaken, no quota be set for the wild harvest and trade of these snakes.

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Putative Predation and Scavenging of Two Sea Turtle Species by the American Alligator, *Alligator mississippiensis*, in Coastal Southeastern United States

The food habits of the American Alligator (*Alligator mississippiensis*) are well documented in many freshwater systems (salinity < 5 ppt) throughout its native range (Barr 1997; Delany and Abercrombie 1986; Gabrey 2010; Rice 2004). In marine (salinity > 25 ppt) and estuarine (variable salinity between 5 ppt and 25 ppt) habitats, however, the dietary interactions and food habits of *A. mississippiensis* have received little attention by researchers; limited data exist from Louisiana (Gabrey 2010; McNease and Joanen 1977; Wheatley 2010), Wassaw Island, Georgia (Tamarack 1988, 1993), and Cumberland Island, Georgia (Shoop and Ruckdeschel 1990). To date, no comparative analysis among marine or estuarine populations has been performed. The aforementioned studies indicate that *A. mississippiensis* foraging in marine and estuarine environments consume a variety of prey items including crustaceans (e.g., blue crab, shrimp, crayfish), horseshoe crab, teleost fishes (e.g., mullet, gar, shad, top-minnows), small mammals (e.g., nutria, raccoon, mink), and multiple species of wading birds. Here we report the first accounts of *A. mississippiensis* consuming marine reptiles: Green Sea Turtle (*Chelonia mydas*) and Loggerhead Sea Turtle (*Caretta caretta*).

Observations.—The most recent incident occurred on 25 September 2010 when a sea turtle flipper tag (# TTF-850) was recovered from the stomach of harvested adult male *A. mississippiensis* (total length [TL] = 352 cm, mass = 243 kg). This *A. mississippiensis* was harvested near the mouth of the New River, South Carolina, USA (32.100139°N, 81.088088°W), during a recreational hunt. The flipper tag was subsequently mailed to the Archie Carr Center for Sea Turtle Research (ACCSTR) to report the finding and to collect a returned tag reward.

During a sea turtle nesting survey along South Ponte Vedra Beach, Florida, USA on 17 September 2010 the carapace of a juvenile *Chelonia mydas* (straight carapace length [SCL] = 20.5 cm, straight carapace width [SCW] = 17.3 cm) was found in the sand along the surf (30.07329°N, 81.334190°W, Guana Tolomato Matanzas National Estuarine Research Reserve [GTM-NERR] catalog # 978). No plastron accompanied the carapace.

Eight conical puncture wounds were located laterally along the posterior of the carapace (Fig. 1). The puncture pattern was determined to be bite marks from an adult *A. mississippiensis* (K. Vliet and P. Gignac, pers. comm.). Verification was made chiefly due to the spacing between puncture wounds and the diamond-shaped indentations left when teeth did not fully perforate the bone, typical of crocodilian dentition (P. Gignac, pers. comm.). Given the size and spacing of the puncture wounds in the *C. mydas* carapace, we estimate that the *A. mississippiensis* involved was approximately 2 m TL. Additionally, markings on the turtle carapace indicate that the *A. mississippiensis* adjusted and manipulated the prey item in its mouth in an attempt to break up and swallow the *C. mydas* (Fig. 1).

Four observations of dead *C. caretta* being scavenged by *A. mississippiensis* were made on three separate Georgia barrier islands during ongoing sea turtle nesting surveys sponsored by the Georgia Department of Natural Resources (GADNR) and the U.S. Fish and Wildlife Service (USFWS). The most recent of these observations occurred at 2011 h on 10 May 1999. Caretta Research Project (CRP) personnel found the remains of a moderately decomposed sub-adult *C. caretta* (SCL = 55.0 cm, SCW = 45.9 cm, straight plastron length = 32.3 cm, straight plastron width = 37.9 cm, GADNR biopsy specimen # GA99051001-WASI) on the north end of Wassaw Island, Georgia (31.90395°N, 80.93882°W). CRP personnel pulled the carcass further up the beach toward the dunes so that it would not wash out later that night during high tide. Later that night, at 2300 h, the same personnel encountered a large *A. mississippiensis* (TL 2.7–3.0 m) investigating the aforementioned turtle carcass. The patrol left the *A. mississippiensis* and *C. caretta* carcass at 2330 h. The following day at 1200 h, CRP personnel traveled back the location of the carcass to take photographs of the specimen for GADNR documentation. Upon arrival, they found tracks from an adult *A. mississippiensis* originating at the stranding site and leading westward toward the dunes. The only remaining evidence of the turtle carcass at the stranding site was a depression where the turtle had been placed, two costal scutes, and the right front flipper. Pieces of the decomposing turtle were present along the alligator's route, which was

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indicated by tracks leading into the dunes. The parts included three scutes (with epibiota still attached), five ribs, two hyoplastra, the upper and lower tomia, marginal, and pygal bones, horse-shoe crab claws (presumably stomach contents from the turtle), and portions of the esophagus with visible papillae. Turtle parts and alligator tracks led directly to an alligator hole located on the eastern edge of Beach Pond (31.90500°N, 80.94000°W) approximately 150 m away from where the stranded carcass had originally been placed.

Researchers on other Georgia barrier islands have observed three similar instances of sea turtle scavenging. An *A. mississippiensis* was seen scavenging a *C. caretta* carcass on Blackbeard Island (31.46732°N, 81.21866°W) in 1998 (D. Keineth, pers. comm.). Additionally, two instances occurred on Little St. Simons Island (31.26932°N, 81.30078°W) in 1995 and 1996, in which *A. mississippiensis* were observed carrying decomposing *C. caretta* carcasses down the beach to freshwater wetlands located behind the dunes (M. Robinson, pers. comm.).

Discussion.—Two other crocodilian species have been reported to consume sea turtles. *Crocodylus porosus* (Estuarine Crocodile) on Crab Island, Queensland, have been observed patrolling beaches to capture nesting *Natator depressus* (Flatback Sea Turtle) and *Lepidochelys olivacea* (Olive Ridley Sea Turtle) as female turtles search for suitable locations to dig nests and oviposit (Limpus et al. 1983; Sutherland and Sutherland 2003). It was estimated that during sea turtle nesting season *C. porosus* will consume a minimum of one adult turtle per week in this location (Sutherland and Sutherland 2003). Additional records of *N. depressus* predation by *C. porosus* are reported from Papua New Guinea (Hirth et al. 1993). In Costa Rica, *Crocodylus acutus* (American Crocodile) were recorded consuming nine adult *L. olivacea* (Ortiz et al. 1997) following nesting events.

In freshwater systems, *A. mississippiensis* have been documented to prey upon several freshwater turtle species within the genera *Apalone*, *Deirochelys*, *Kinosternon*, *Pseudemys*, *Sternotherus*, and *Trachemys* (Barr 1997; Delany and Abercrombie 1986; Gabrey 2010; McNease and Joanen 1977; Wolfe et al. 1987). In three Florida lakes, Delany and Abercrombie (1986) found turtles to be the most common prey type recovered from the stomachs of adult male alligators greater than 3.0 m total length. With regard to the information reported here, only two of the six observations potentially represent predation of marine turtles; the other four most certainly represent scavenging of dead turtle carcasses by *A. mississippiensis*.

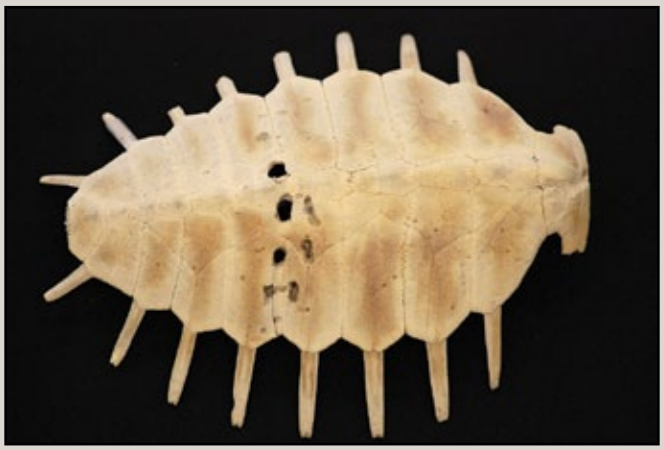


FIG. 1. Photograph of the carapace of a *Chelonia mydas* with bite marks identified as those of an *Alligator mississippiensis* measuring ca. 2 m TL.

Following the discovery of a flipper tag in the stomach of an adult *A. mississippiensis* on 25 September 2010, ACCSTR personnel found the tag had originally been applied to the right front flipper of a *Caretta caretta* that had been reared in captivity by the National Marine Fisheries Service Lab in Galveston, Texas, during 2005–2006. The turtle was used in the testing of turtle excluder devices and subsequently released off Sebastian Inlet State Park in Brevard County, Florida, on 6 July 2006. The last measurements taken in 2006 (SCL = 43.4 cm, SCW = 35.5 cm, mass = 10.63 kg) indicate that the turtle may have been >70 cm SCL in 2010 (P. Eliazar, ACCSTR, pers. comm.). At this size the *C. caretta* would have been far too large for an adult *A. mississippiensis* to consume whole (Erickson et al. 2003). Therefore, three plausible explanations exist for the presence of the flipper tag in the stomach of the harvested *A. mississippiensis*: 1) the alligator consumed the right flipper of the live turtle; 2) the alligator scavenged portions of the turtle after it had died; or 3) the alligator consumed the flipper tag after it had already fallen off the turtle. The type of flipper tag attached to this particular turtle (i.e., inconel metal) can remain attached for up to 5 or more years (P. Eliazar, pers. comm.) and it is highly resistant to corrosion. Thus, it is most likely that the flipper was removed from a live or stranded turtle and that the appendage was digested by the *A. mississippiensis*, leaving only the indigestible tag behind.

The second observation of potential predation was the finding of a *C. mydas* carapace on 17 September 2010. At the estimated size of 2 m TL, the alligator responsible for the bite wounds could not have swallowed the turtle whole. It is possible that the *A. mississippiensis* consumed the plastron, viscera, head, and appendages and then abandoned the remainder of the carcass, as these portions were missing from the turtle. We were unable to determine if the *C. mydas* was captured alive and killed by the *A. mississippiensis* or if the turtle was found stranded dead.

We speculate that one of two scenarios accounts for the *C. mydas* carapace on the beach. More probable, an adult *A. mississippiensis* crossed the 100–250 m of beach scrub habitat and FL-A1A from Guana Lake within the Guana Wildlife Management Area (GWMA) to access the beach shoreline. Guana Lake, a 10 mile long man-made impoundment (30.074216°N, 81.337261°W), is home to a large resident *A. mississippiensis* population as indicated from ongoing mark-recapture and GPS telemetry studies (J. Nifong, unpubl. data). Although rarely reported, *A. mississippiensis* have been observed on multiple occasions traversing FL-A1A and roaming in the surf along South Ponte Vedra Beach (J. Ellenberger, pers. comm.). Alternatively, the predation event could have taken place within the Intracoastal Waterway and the turtle remains subsequently carried out to sea through the nearby St. Augustine Inlet.

For sea turtle species that return to nesting beaches along the southeastern coast of the United States, peak nesting occurs in summer from June–August (S. Eastman, pers. comm.). Many of these nesting beaches are located within the home ranges of *A. mississippiensis* which occupy dune swales and coastal freshwater wetlands. *Alligator mississippiensis* using these coastal habitats regularly travel to estuarine and marine habitats in search of prey (Tamarack 1988), some spending as much as 87% of their time in fully marine waters as determined from GPS telemetry studies (J. Nifong, unpubl. data). During nesting season it is likely that *A. mississippiensis* encounter adult sea turtles along nesting beaches in shallow water or on-shore, providing the opportunity

for capture. In deeper open water, adult sea turtles would most likely evade capture by *A. mississippiensis*. Furthermore, a number of estuaries along this coast serve as nursery grounds for juvenile sea turtles such as *C. mydas* (S. Eastman, pers. comm.). Given that *A. mississippiensis* use the same habitat for foraging, it is possible that *A. mississippiensis* encounter juvenile sea turtles in these nursery areas while in search of prey. Although the observations reported here are widely separated both geographically and temporally (i.e., 15 years) we believe the predation of sea turtles by *A. mississippiensis* may occur regularly yet remain undetected in most cases.

Sea turtle strandings are often used to estimate the annual mortality of sea turtle species in the United States, even though two studies have questioned the practice (Shoop et al. 1998; Shoop et al. 1999). Because many factors influence the likelihood of a dead sea turtle washing ashore, the possibility exists that strandings represent only a fraction of the overall annual mortality actually occurring in near-shore waters. Additionally, because *A. mississippiensis* may removed a small percentage of beached turtles via scavenging, researchers are potentially underestimating the true number of dead turtles washing ashore, especially in coastal habitats supporting high alligator densities. More information is needed to determine the frequency of these scavenging events before we can accurately assess the effect of *A. mississippiensis* scavenging on the real number of dead turtles washing ashore annually along the southeastern Atlantic and Gulf coasts.

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CONSERVATION

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A Review of the Chile Mountains False Toad, *Telmatobufo venustus* (Amphibia: Anura: Calyptocephalellidae), with Comments on its Conservation Status

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Sandwiched between the Andes Mountains to the east, the Pacific Ocean to the west, and the Atacama Desert to the north, a narrow strip of southern Chile houses temperate humid forest (Aravena et al. 2002). These forests are biologically unique owing to their isolation. The temperate humid forests of southwest South America have been isolated since the Tertiary Period (Aravena et al. 2002; Villagrán and Hinojosa 1997) and house significant numbers of endemic plants and animals (Aravena et al. 2002; Armesto et al. 1996; Arroyo et al. 1996). Not surprisingly, the amphibian fauna is largely endemic. There are minimally 37 anurans unique to these forests, constituting no less than 85% of the regional amphibian fauna including three endemic genera and an endemic family to Chile (*Calyptocephalella*, *Insuetophrynus*, *Telmatobufo*, and the Calyptocephalellidae, respectively) (Díaz-Páez et al. 2008; Vidal et al. 2008). One of the amphibians found only in these southern forests is the Chile Mountains False Toad, *Telmatobufo venustus* (Figs. 1A–C).

In 1899, Philippi described *Bufo venustus* from four specimens collected in the Andean foothills of southern Chile. In 1952, Schmidt erected the genus *Telmatobufo*. Formas and Veloso reassigned *Bufo venustus* to *Telmatobufo venustus* in 1982. The genus contains three other species: *T. australis* (Formas 1972), *T. bullocki* (Schmidt 1952), and *T. ignotus* (Cuevas 2010). All known *Telmatobufo* are endemic to southern Chile. Formas et al. (2001) discussed taxonomic relationships among the then-recognized three species of *Telmatobufo*. Hypothesized phylogenetic relationships between *Telmatobufo* and *Calyptocephalella* (=*Caudiverbera*) have been proposed (e.g., Correa et al. 2006; Formas and Espinoza 1975; Frost et al. 2006; Lynch 1978; Núñez et al. 2000). Correa et al. (2006) indicated that the closest living lineage of frogs to *Telmatobufo* and *Caudiverbera* (now *Calyptocephalella*) (tribe Calyptocephalellini) are Australian myobatrachids and limnodynastids. The Calyptocephalellini may be ancient. Núñez and Formas (2000) indicated that the lineage that led to the Calyptocephalellini diverged around 35 million years ago and that the extant species of *Telmatobufo* emerged approximately 20–25 million years ago. Donoso et al. (2010) suggested that the Calyptocephalellidae may represent a relict lineage of Gondwanian origin.

Telmatobufo venustus is known from the western slopes of the Chilean Andes from 28.5° to 38.5°S, and between 1500 and 1700 m elevation (Díaz et al. 1983; Stuart et al. 2008). There are three known historical areas where *T. venustus* has been reported: Cordillera de Chillán, Provincia de Ñuble (VIII Región), Ralco, Provincia del Bío-Bío (VIII Región), and Altos de Lircay, Provincia de Talca (VII Region) (Formas et al. 2001). We refer to "areas" rather than localities because in one of the three cases above, the exact locality is not known. The specific location of the type locality within the Cordillera de Chillán was not included in the description of the species, but is simply referred

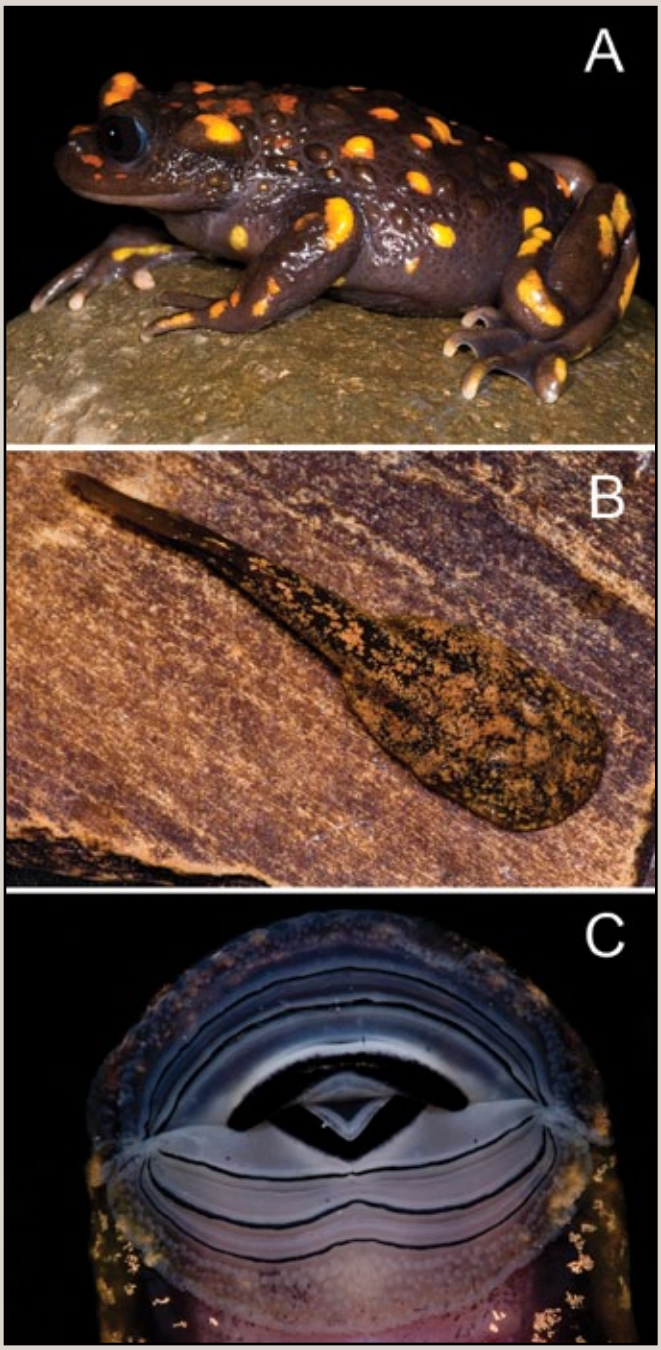
to as the Andean foothills of southern Chile, east of Chillán and Cautín (Philippi 1899). No observation of the species has been reported from that area since. One tadpole was reported from Ralco Province and no further observations have been reported there (Díaz et al. 1983); further, the locality now lies beneath a lake created by a dam that went in after the tadpole was observed there. The only locality for which recent observations have been made by the authors here and in the literature is Altos de Lircay, Provincia de Talca (VII Region) (Fig. 2).

The Chile Mountains False Toad inhabits temperate *Nothofagus* (Southern Beech) forests (Stuart et al. 2008). It has been proposed that a stream-adapted tadpole is a shared character among all *Telmatobufo* (Cuevas and Cifuentes 2009; Formas et al. 2001). This has been observed in *T. venustus* (Díaz et al. 1983) and in *T. australis* and *T. bullocki* (pers. obs.). Veloso et al. (2004; see also Stuart et al. 2008) indicated that "reproduction is unknown, though it probably takes place by larval development in water." The statement is partly inaccurate as the tadpole of *T. venustus* had already been described by Díaz et al. (1983) as a stream-adapted "mountain type larvae" with an oral disk that serves as an anchor in fast flowing mountain streams (Figs. 1B, 1C).

Telmatobufo venustus is secretive and all species of *Telmatobufo* appear to be seldom encountered. Cuevas (2010) indicated that "Since the description of this genus (Schmidt 1952), specimens of only 20 adults of the three species have been collected. These have been from Cabrerias, Llancahue, Cerro Pûschel (*T. australis*); Parque Nacional Nahuelbuta, Rucapehuen (*T. bullocki*); and Altos de Vilches (*T. venustus*)." Adult *T. venustus* were recorded for the first time in 100 years in 1999 (Stuart et al. 2008; Veloso et al. 2004). The larval form was not described until 1983, 84 years after the species' description. Veloso (2006) reported that only adult specimens, not juveniles or subadults, have been observed. During our recent (2011) surveys we encountered several specimens of the even rarer *Telmatobufo bullocki* (Figs. 3, 4) in *Nothofagus* forests of the Butamalal River drainage system (Fenolio et al., in prep.).

Habitat loss, particularly conversion of *Nothofagus* forests to pine and eucalyptus, is affecting *Telmatobufo* (Cuevas 2010; Rabanal and Núñez 2009; Stuart et al. 2008; Veloso et al. 2004). Cuevas and Cifuentes (2009) argued that the life history of frogs like *Telmatobufo*, having a stream-adapted tadpole with specific habitat requirements, puts them at risk owing to anthropogenic environmental changes in south Chile. One example concerns heavy sediments and siltation of the streams from human activities in the areas where *Telmatobufo* are found; siltation could adversely affect the larval stages of these ancient amphibians (Sánchez 2010). Forest fire comprises another significant threat to *T. venustus* (Veloso 2006). More survey work is needed to determine population status (Stuart et al. 2008; Veloso et al. 2004).

We performed visual surveys of streams in the Reserva Nacional Altos de Lircay, in the Región del Libertador Bernardo O'Higgins, Chile, from January through April of 2010 and 2011, for *T. venustus*. Fifty person-hours were spent searching two streams within the park; due to concerns about illegal collecting, the exact locations are not included here. We encountered 10 adults, all at night along mountain streams, on boulders, and in spray zones (Figs. 2, 5–7). Skin swabs from eight of the ten specimens were sent to the lab of one of the authors (M.G.L.). No frogs were removed from the wild. The swabs tested negative for amphibian chytrid fungus (*Batrachochytrium dendrobatidis*, or *Bd*). Amphibian chytrid fungus is a concern as it was first reported in Chile by Solís et al. (2010) in an invasive amphibian (*Xenopus laevis*) and subsequently by Bourke et al. (2010, 2011) in native species.



PHOTOS BY DANTE FENOLIO

FIG. 1. (A) An adult *Telmatobufo venustus* at rest on a streamside boulder; note the developed webbing between the toes. (B) *Telmatobufo* tadpoles are dorsoventrally flattened and have a suctorial disk (C) for attachment to the substrate in flowing waters.

Methods for detecting *Bd* were as follows: Frogs were collected and swabbed using a new set of vinyl gloves per specimen. Frogs were individually swabbed using sterile polyester tipped applicators (Puritan Medical, Guilford ME). Polyester tipped applicators were gently wiped on the gular region, the flank region, the bottoms of the hands and feet, and along the ventral surface for 12 passes per body region. When dry, the tips of the swabs were transferred to individual sterile tubes and stored at 4°C until



PHOTO BY ANDRÉS CHARRIER

FIG. 2. *Telmatobufo venustus* is known only from the Lircay River system.

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FIG. 3. *Telmatobufo bullocki*, critically endangered, is one of the rarest amphibians in the world. Until its recent rediscovery it was thought to be extinct.

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FIG. 4. Obstacles to finding *Telmatobufo bullocki* include difficult terrain and the frog's habit of burying itself deep under large logs. This adult female was found after hours of searching.

extracted and assayed. The tip of the polyester applicator was transferred to a 2 ml cryovial, 100 µl of Prepman Ultra (Applied Biosystems, Foster City, California) was added followed by 50 mg 0.5 mm glass beads for extraction. The tubes were vortexed and homogenized for 1 min in a Mini BeadBeate (Biospec Products), then placed in boiling water for 10 min, cooled for 1 min, centrifuged at 14,000 rpm for 3 min in a Marathon 16KM centrifuge (Fisher Scientific) after which the liquid was transferred using a micropipette to clean 0.6 ml microcentrifuge tubes. The recovered supernatant was then stored at 4ºC until assayed using the quantitative real-time PCR protocol of Boyle et al. (2004) using 1 µl of the extract as the DNA template.

The apparent absence of *Bd* in one remaining population of *T. venustus* may not be conclusive owing to the problem faced by all field biologists working with rare or reclusive species—small sample sizes. Invasive species have done irreparable damage to native Chilean fauna (De Buen 1959; Jaksic, 1998; Jaksic and Fuentes 1991; Jaksic et al., 2002; Lobos and Jaksic, 2004; Lobos and Measey, 2002; Lobos et al. 1999, 2005). Our field team has surveyed streams for three species of *Telmatobufo*. Where trout

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FIG. 5. The upper reaches of the Lircay River are subject to sudden snowfall and sleet. Nonetheless there is amphibian activity during this period.



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FIG. 6. *Telmatobufo venustus* select resting sites at night on boulders in the splash zone. All specimens of this species across the last 25 years have been found in headwater streams of the Lircay River.

are absent (one stream for *T. venustus*, one stream for *T. bullocki*, and one stream for *T. australis*), their tadpoles have been found. During the surveys in Reserva Nacional Altos de Lircay we have encountered adult *T. venustus* in two streams but found tadpoles in only one of them. Introduced salmonid fish (Rainbow Trout, *Oncorhynchus mykiss*) are common in the stream where we have been unable to locate tadpoles. A local park ranger and a former landowner indicated that trout were introduced to the first stream in the mid-1960s. Introduced trout could prey on the tadpoles, and in fact introduced fish have been implicated in other montane stream amphibian declines (e.g., Adams 1999; Collins and Storfer 2003; Kats and Ferrer 2003). If indeed successful recruitment has been dwindling, or has stopped altogether, we may have observed the last, aged individuals of a non-reproducing metapopulation at the first stream.

Based on these field surveys and an analysis of the literature, we make several recommendations for conservation measures with *Telmatobufo venustus*. This species is listed currently as EN, endangered (IUCN 2011) but it is now apparent that it meets two of the conditions for an elevated IUCN listing of CR, critically endangered (only one is required; IUCN 2011): 1) In category B, subcategory 1, of section V, this species has an estimated range of less than 100 km^2; Reserva Nacional Altos de Lircay is a small reserve of 12.163 hectares (= 0.12163 km^2) in size and encompasses the only known streams in the area where the species has been reported during the past 25 years. There are two subconditions: The first subcondition (category B, section 1, subsection a), is met in that if there are multiple remaining populations outside of Reserva Nacional Altos de Lircay, they are severely fragmented; however, we suspect that there is only a single location with viable populations of the species (Reserva Nacional Altos de Lircay). The second subcondition (category B, section 1, subsection b (iii)), is met in that the quality of larval habitat is degrading due to the presence of the introduced salmonid fish (Rainbow Trout, *O. mykiss*). Further habitat degradation may occur as a result of *Bd*, which has been reported in non-native *Xenopus* from Chile (Solís et al. 2010) and in native species from south Chile (Bourke et al. 2010, 2011).

2) Category A, subcategory 4, of section V, requires that a species have an observed, estimated, inferred, projected or suspected population size reduction of X ≥ 80% over any 10-year or three-generation period, whichever is longer (up to a maximum of 100 years in the future), where the time period must include both the past and the future, and where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (category A, section 1, subsection e): the effects of introduced species (Rainbow Trout, *O. mykiss*, in many of their breeding streams) and the potential arrival of an emergent infectious amphibian disease (*Bd*), now present in south Chile.

Second, based on significant and continuing habitat loss and on subsequent population fragmentation that all *Telmatobufo* species have suffered, we propose that ex-situ assurance colonies of *Telmatobufo*, including *T. venustus*, be established immediately within Chile. The National Zoo of Chile in Santiago and the Atlanta Botanical Garden have a four-year-old partnership that developed facilities to support a captive assurance colony of Darwin's Frogs, *Rhinoderma darwinii*, at the zoo. That facility is now operational, amphibian keepers have been trained and are in place, and the program has reproducing groups of *R. darwinii*. These stakeholders are looking to expand their program to support other threatened amphibians of Chile. Facilities exist now and permits have been obtained from the government of Chile for the immediate creation of assurance colonies of three species of *Telmatobufo* (*T. venustus*, *T. bullocki*, and *T. australis*). The goal is to create the assurance colonies before wild populations drop to numbers so low that assurance colonies cannot be created. Amphibian specialists from the Atlanta Botanical Garden's amphibian conservation program, with experience in captive breeding of endangered amphibians, will support the effort at the National Zoo of Chile in the same way that the zoo was supported while the Darwin's Frog facility was created and populated with groups of frogs. Fund raising is a joint venture. Involved stakeholders believe that retaining the assurance colonies within Chile provides the effort with local enthusiasm for the conservation of native and endangered amphibians, rendering a project that is likely to endure. Ensuring the future survival of the ancient Calyptocephalellidae requires an expansion of existing partnerships to involve the zoological community, amphibian conservation oriented programs (such as those at the Atlanta Botanical Garden), the Chilean Forestry industry, and governmental wildlife authorities and respective agencies. Only with support from all pertinent parties can work toward a comprehensive conservation program occur. Such a program could be modeled after a collaborative effort like Partners for Amphibian and Reptile Conservation (PARC; see Gibbons 2005; http://www.parcplace.org/).

PHOTO BY WILLIAM W. LAMAR



FIG. 7. Specimens of *Telmatobufo venustus* have been located at night perched beneath enormous streamside boulders.

Third, the remaining streams in which *T. venustus* has been observed are all within the Reserva Nacional Altos de Lircay. It would be presumptuous and inappropriate to mandate anything here but we recommend that the reserve consider the implementation of a program to control the trout in the headwater tributaries of these streams. The first step would have to include removal of the introduced salmonid fishes from the stream where surviving individuals of *T. venustus* have been observed. After this, fish exclusion devices would have to be implemented along lower regions of the streams, below the areas where frogs can still be found, to prevent recolonization of the headwaters by trout. Because these streams are the only remaining localities in which *T. venustus* has been recently observed, it is critical to take action within the reserve to protect remaining populations. A collaboration between the organizers of assurance colonies of *T. venustus* and the Reserva Nacional Altos de Lircay would be an ideal next step in that tadpoles could be released, post fish removal, in appropriate drainage systems to help bolster existing lineages (keeping careful track of and releasing appropriate genetic stocks per stream according to parentage). An additional step toward the conservation of *T. venustus* in Reserva Nacional Altos de Lircay might be signage for visitors to the reserve, making them aware of these unique natural treasures that are endemic to Chile and in fact, may now only be found within the boundaries of the reserve. Special funds pertaining to the conservation of Chile's critically imperiled amphibians, from the Chilean government, would also go a long way toward these ends.

Finally, we recommend regular monitoring of wild populations for emergent infectious amphibian disease such as *Bd* and ranavirus. Since monitoring of these diseases in wild populations of Darwin's Frogs already occurs via the partnership between the National Zoo of Chile and the Atlanta Botanical Garden, an expansion of that program to include regular disease monitoring in all *Telmatobufo* species is in progress.

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TECHNIQUES

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Using Spot Pattern to Identify Individual Long-Tailed Salamanders

The use of simple and inexpensive amphibian monitoring techniques is often necessary due to limited time and funds. When individuals can be uniquely identified, mark-recapture can be used to estimate abundance, other demographic variables (e.g., survivorship and recruitment), habitat use and individual growth rates (Donnelly and Guyer 1994). In comparison with other marking techniques, spot pattern recognition is less invasive and generally costs less than other methods. However, it is only useful when markings are variable and the pattern does not change ontogenetically (Donnelly et al. 1994; Plăiaşu et al. 2005).

Spot pattern recognition has been used successfully in a variety of studies for individual identification of amphibians (Ferner 2007, 2009; Schlüpmann and Kupfer 2009), and has been recommended as an ideal method for salamander identification by Ferner (2007) (e.g., Loafman 1991; Plăiaşu et al. 2005; Tilley 1980). Varying spot pattern recognition methods exist, but most rely on overall pattern, spot count, or a combination thereof. In this study, we tested whether head-spot counts can be used as a component of overall spot pattern recognition in order to identify individual Long-tailed Salamanders (*Eurycea longicauda longicauda*) in the field. We also employed digital photographs of Long-tailed Salamanders to determine if the number of head-spots was related to salamander size.

Methods.—Long-tailed Salamanders are found under rocks and woody debris near forested springs or streams (Petranka 1998). In southeastern Pennsylvania and northern Delaware, they are commonly found in springhouses because these houses are damp and dark and ideal substitutes for their natural habitat. These salamanders are yellowish-orange to yellowish-brown with black spots (Petranka 1998), which makes these salamanders an ideal study organism.

We captured Long-tailed Salamanders from four populations associated with springhouses in southeastern Pennsylvania and northern Delaware. We visited springhouses every 12–16 days during 2002–2006 during peak activity periods (April–May and August–November), and every 19–23 days during the summer (June–July). We waited until after dusk to search outside springhouses because Long-tailed Salamanders forage at night (Petranka 1998). Using aquarium nets inside springhouses and by hand when outside, we captured individuals and them placed into 25 × 25 cm zip lock bags containing paper towel moistened with water from the springhouse.

We measured, weighed, and determined the sex of each salamander, noting whether the individual was gravid or had any injury or deformity. For measuring, we placed salamanders into a 15 × 15 cm zip lock bag so they could easily be straightened and turned upside down without injury. We recorded snout–vent length (SVL) and tail length (TL) to the nearest 1 mm, noting broken or regenerating tails, and weighed each salamander to the nearest 0.01 g using a digital balance. We determined sex by checking for secondary sexual characteristics: specifically, enlarged teeth and a submandibular mental gland in males and the presence of white developing ova that can be seen through the skin lateral to the belly on females. After we documented physical characteristics, we digitally photographed each salamander in the dorsal orientation (Donnelly and Guyer 1994).

To identify individual salamanders, we counted each dorsal spot from the tip of the nose to the beginning of the forelimbs, ignoring the lateral spot pattern down the sides of the body (Fig. 1). We considered a spot to be any mark (oval or otherwise) that had a distinct black coloring. If a spot was faint or blurry, we classified it as a spot if we could see a definite black mark in the center as opposed to being uniformly faint throughout. This criterion was only used for faint or very small markings. If the marking was faint throughout but still large enough to be definitively seen as a spot, then we counted it. When two spots touched, we classified it as a single spot if the outline created was a generally continuously oval with minimal indentation where the spots conjoined. We classified two spots as independent if the outline created allowed for the two spots to have a major indentation at the point of contact. We counted spots if more than half of the total area of a spot fell anterior to the forearms.

We sequentially organized digital photographs from capture events for each study site. We then used this database to visually match more than 4000 photographs of newly caught individuals from subsequent capture events. Because it was not logistically feasible to inspect more than 4000 photographs, we took a random sample of the photographs. After identification, we sorted captures into seven 0.5-cm size categories based on SVL (range

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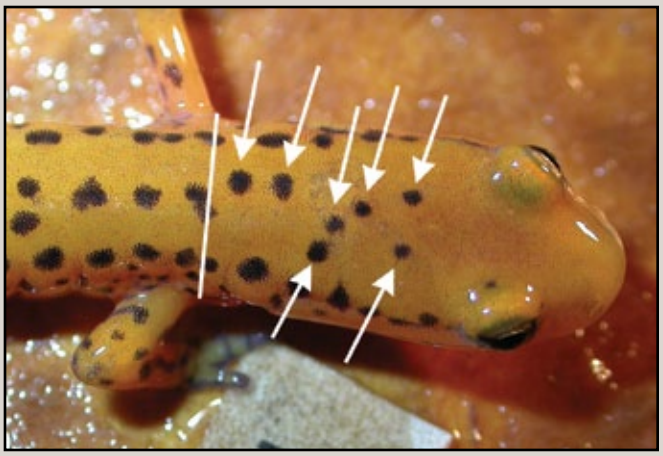


FIG. 1. Using digital photographs to determine spot number for an individual Long-tailed Salamander, we counted spots from the tip of the nose to the beginning of the forelimbs, ignoring the lateral lines running down the sides of the body. The solid line indicates where counting stopped.

3.5–6.9 cm). We established the seven categories by graphing the data to find natural breaks. For each study site, we randomly selected 40 individuals of each size group for a total of 926 individuals. We only selected unique individuals; recaptures were not included in the analysis. We used an ANOVA, blocked for site, to determine the relationship between spot number and size ($\alpha = 0.05$). When we detected differences, we used a planned Least Significant Differences mean separation test to determine differences among means (Sokal and Rohlf 1995). We did not use a linear regression because the relationship was curvilinear and the presentation of categories provided a clearer picture of the data as it related to our objectives.

Results.—Spot number increased with the size of salamander ($F_{6,925} = 20.87$, $p < 0.001$; range 13–21). The increase in number of spots was small (< 2) except for large salamanders (6.0–6.9 cm), which increased by 2.5–3 spots per size category. The number of spots was usually similar in adjacent size categories except for salamanders 6.0–6.4 cm and 6.5–6.9 cm, which were not similar to any other size categories (Table 1). Although spot number increased as a salamander grew, photographic analysis showed that the general pattern of spotting stayed the same. Identification of individual salamanders was possible because the addition or subtraction of a few spots did not deter recognition of the overall pattern (Fig. 2).

Discussion.—Head-spot counts varied by size groupings in *E. longicauda* suggesting that head-spot number changes over time; however, spot pattern recognition is still a useful technique. Approximately half (50.4%) of the salamanders caught were within groups 3, 4, or 5, which are the groups in which spot number remained similar. Therefore, half the captured salamanders had spot numbers that did not change among size groupings. When salamanders grew to 6.0–6.4 cm and 6.5–6.9 cm (groups 6 and 7, respectively), spot number increased. Because we did not determine the age of the salamanders, we cannot determine if spot addition is related to age or to size.

Despite an overall mean spot number increase, many potential points for identification existed so mismatches were unlikely to occur. Because we rarely observed spots disappearing and spots tended to appear rather than disappear, previous identification markers remained visible. As a result, the most important component to identification was overall pattern recognition despite the increase in mean spot number. These findings highlight the importance of understanding ontogenetic differences among salamander species before incorporating spot pattern recognition into a mark-recapture study. Our results challenge the assumption that pattern marks must stay constant in order for spot pattern recognition to be successful (Ferner 2009; Gill 1978) since changes in head-spot counts did not affect overall spot pattern recognition.

Many studies have successfully incorporated head-spot counts and spot pattern recognition techniques (Grant and Nanjappa 2006; Pliau et al. 2005; reviewed by Schlüpmann and Kupfer 2009). However, we recommend conducting a pilot study on head-spot counts to determine if data suggest spots remain constant through time for the species of interest. If head-spot counts do change, a pilot study could confirm that using overall



FIG. 2. Examples of three Long-tailed Salamanders that we recaptured after two years. Salamanders on top captured in 2004 (top) were recaptured again in 2006 (bottom). Note that addition or subtraction of a small number of spots does not deter recognition of overall pattern.

pattern recognition exclusively can still be a useful aid to individual identification.

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Very Small, Light Dipole Harmonic Tags for Tracking Small Animals

Tracking animals provides a detailed picture of their behaviour and can be important in understanding their ecology. Tracking is especially useful for elucidating the ecology of animals that are cryptic during all or parts of their life cycle (Heyer et al. 1994; Langkilde and Alford 2002; Reynolds and Riley 2002). Amphibians, for example, can be hard to study outside breeding aggregations, and wildlife telemetry can provide insight on otherwise unknown aspects of their biology (Heyer et al. 1994; Naef-Daenzer 1993; Naef-Daenzer et al. 2005; Rowley and Alford 2007a, b, c; Rowley et al. 2007).

Tracking devices should be small and unobtrusive (Hamley and Falls 1975; Heyer et al. 1994; Korpimaki et al. 1996; Ormingston 1985). Many guidelines recommend that the mass of tracking devices should not exceed between 5% (Wilson and McMahon 2006) and 10% (Blomquist and Hunter 2007; Gursky 1998; Richards et al. 1994) of the animal's body mass, particularly when tracking vertebrates. Package shape is also an important consideration; devices must not impede the tracked animal's movement (Blomquist and Hunter 2007; Greenwood and Sargeant 1973; Wilson and McMahon 2006). Finally, devices should have long useful lifespans, reducing the frequency of capture, handling, and other potentially stressful procedures (Langkilde and Alford 2002; Pereira et al. 2009). Tracking devices, therefore, typically reflect compromises among the needs for small size, low mass, long life, and high durability.

Two main approaches can be taken to track animals using radio signals. Tracking using tags containing active radio transmitters allows researchers to locate subjects and identify them individually (Heyer et al. 1994; Indermaur et al. 2008; Naef-Daenzer 1993; Naef-Daenzer et al. 2005; Rowley and Alford 2007a, b, c), and may enable the retrieval of additional information, such as the subject's physiological status and local environmental conditions (Reynolds et al. 2002), but the method is restricted to larger species or individuals, due to the relatively high weight of the battery, harness, and transmitter package (Langkilde and Alford 2002; Naef-Daenzer 1993; Naef-Daenzer et al. 2005; Rowley and Alford 2007c). Currently, minimum body mass of animals tracked using radio-transmitters is 2–4 g, based on a minimum package plus harness mass of 0.2 g for the smallest available transmitters and limitations to 5–10% of the body mass (Naef-Daenzer et al. 2005). These extremely light tags have extremely short battery lives, measured in days; this further restricts their usefulness in field studies, where animals may require some time to return to normal behaviour following tag attachment (Langkilde and Alford 2002; Rowley and Alford 2007c).

It is also possible to use tags that do not contain their own power sources. These tags fall into two categories: PIT (Passive Integrated Transponder) tags and harmonic radar tags. PIT tags,

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often used as implantable means of individual identification, eliminate the need for the battery by using an induction coil to provide the power to emit a very weak radio signal. However, the need for a powerful magnetic field and the very weak signal emitted limit their range and make them unsuitable for tracking applications (Ohashi et al. 2010; Vinatier et al. 2010). For tracking, the main alternative to self-powered transmitter tags is harmonic radar, also known as harmonic direction finding. The tracking devices used with this technology consist of a single diode with an attached antenna, weighing as little as 0.11 g (Pellet et al. 2006). They absorb radio waves emitted by a handheld transceiver, re-emitting some of the energy as radio signals at a harmonic frequency of the initial signal. The re-emitted signal is detected by the transceiver unit, using a directional antenna. Compared to typical radio transmitter tags, harmonic tags have some disadvantages. First, they do not emit individually identifiable signals, so individuals carrying tags have to be distinguished by means other than a signal ID (Rowley and Alford 2007c). Second, their maximum range is typically less than that of tags containing radio transmitters (Langkilde and Alford 2002; Rowley and Alford 2007c). Finally, harmonic direction finding is more difficult than radiotracking in environments in which radio signals are attenuated (i.e., dense vegetation may absorb signals), or in environments that naturally re-emit radio waves (i.e., some boulders and rocky outcrops; Rowley and Alford 2007c). The great advantages of harmonic direction finding are that (i) it allows tracking of vertebrates too small (typically approximately 2 g) for even the smallest available radiotransmitters, and (ii) tags are not limited by battery life, and so can be used as long as they remain attached to the subject (Rowley and Alford 2007c).

The small size of tags used in harmonic direction finding has allowed tracking of a variety of vertebrates (Pellet et al. 2006, Rowley and Alford 2007a, b, c; Rowley et al. 2007) and flying insects (Naef-Daenzer et al. 2005, O'Neal et al. 2004, Vinatier, 2010; Williams et al. 2004). Tags used with a harmonic direction finder are often constructed from Schottky diodes (Langkilde and Alford 2002; O'Neil et al. 2004; Rowley and Alford 2007c; Williams et al. 2004), which are commonly used in electronic circuits. Schottky diodes are semi-conductor diodes that lower the voltage in an electrical current, have a very low forward-voltage drop, and a fast switching action (hence their sensitivity to radio waves). In a harmonic direction finding tag, the diode receives a signal from a transceiver unit, such as the commercially available Recco™ transceiver, and re-emits a signal at a doubled frequency (Langkilde and Alford 2002; Rowley and Alford 2007c).

Many studies have used germanium Schottky diodes in standard cylindrical packages (Langkilde and Alford 2002; Rowley and Alford 2007c). Tags have typically consisted of one germanium diode with a single antenna soldered to the cathode (a monopole antenna). The diodes typically weigh approximately 0.2 g, and thus the minimum mass of an assembled tag is approximately 0.27 g, limiting the size of study animals to a minimum of 2.6–5 g depending on the particular rule for permissible package size that is followed (Blomquist and Hunter 2007; Gursky 1998; Richards et al. 1994; Rowley and Alford 2007c; Wilson and McMahon 2006).

We have developed a new design for harmonic tags that substantially reduces their size and mass while maximizing clarity and range of the signal. We use surface-mount diodes, which are smaller and lighter than germanium diodes but require a different tag assembly method (see Pellet 2008 for a technique using similar diodes). In contrast to Pellet and others (2008), we use a dipole antenna configuration that provides a strong signal using short, light antennae as well as a different attachment method (using a silicone belt integral to the package) allowing us to construct tags that weigh 0.13 g. These can be attached to animals weighing a minimum of 1.3–2.6 g. A previous study using monopole antennas (Rowley and Alford 2007c) found that detection distances were ca. 0.5 m when tagged animals were under rocks or in a few cm of water, and measured a maximum detection distance in the canopy of 12 m. Here our tags achieved ranges of more than 20 m when tested in open habitats, decreasing as antennae are trimmed further than the lengths described here. In addition to this, the anode antennae unique to our tag increases the range provided by submerged tags to 2–5 m depending on obstructions blocking the signal. Animals sheltering in shrubs and sub-canopy also benefited from the strongest signals as exposure of the antennae was maximised (very clear signal from animals 15+ m from the ground), but horizontal range close to the ground decreased rapidly when the animals moved away from the stream due to the density of the shrub layer at the study

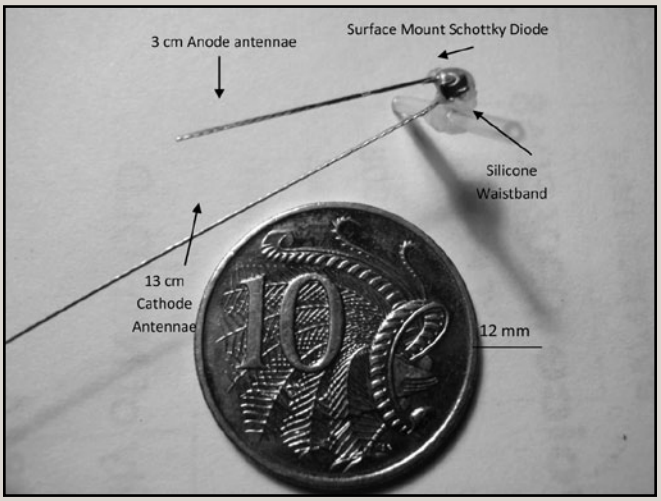


FIG. 1. A dipole harmonic tracking device with an Australian 10-cent coin (23 mm diameter) for scale.



FIG. 2. The Common Mistfrog, *Litoria rheocola*, exhibiting a natural posture directly after handling and the attachment of a harmonic direction finding tag. This individual is a male weighing approximately 1.9 g (package weight = 0.13 g).

sites (10–15 m from stream center, depending on steepness of edge and density of vegetation).

Our tags are based on surface-mount SOT-23 Low Distortion Attenuator Diodes (Manufacturer HSMS, model 205B-G Surface-Mount Schottky diode). The antennae are constructed from 9 lb. test fishing leader made up of seven individual strands of stainless-steel wire (any make but bare wire adheres better to the trace on diodes). We use fishing leader wire because it is very flexible and elastic, tending to remain straight rather than assuming a curled shape after being bent, as do many other forms of wire. The length, thickness and material of the antenna affect the resonance of the tracking device, and therefore dictate the strength and range of the signal (Langkilde and Alford 2002). We found that, with the fishing leader wire used here, the best combination of lengths was 13 cm for the cathode wire and 3 cm for the anode wire. Longer wires increased the range of the tag, but were impractical because of both size and weight when attaching the package to very small animals.

We used conductive epoxy (Chemtronics®, Circuit Works® - Conductive Epoxy CW2400) to attach the diode and antenna. Lead-based solder is impractical both because the tiny size of surface mount diodes makes it difficult to solder to them without heating them excessively and because the solder would add substantially to the mass of the final tag. In assembling tags, we first placed double-sided adhesive tape on the work surface, and attached the diode to the tape. We then applied the epoxy in very small amounts to one tip of each antenna wire, and placed this tip on the appropriate trace on the diode. Both antennas are attached to the diode such that they extend away from the same side of the diode in parallel to one another (Fig. 1). We left the assembly undisturbed for 24 h to allow the epoxy to cure, and then removed the assembled tag from the tape. To prevent contact between sharp metallic components or epoxy and the skin of the tracked amphibian, we coated the diode with silicone rubber (Selley's Glass Silicone Sealant®), in which is embedded a length of silicone tubing, oriented at 90° from the long axis of the tag as defined by the antennae; this is used as a harness to attach the tracking device to the frog (Fig. 1).

To minimize the weight of the assembled tag, the silicone in which the diode is embedded is trimmed after drying. We have found that when animals are located in the field, the distal end of the longer antenna is often easily visible, even if the individual is in a retreat site. The distal end of the antenna can be colour-coded using waterproof paint. We coated the color-bands on the antenna with a thin layer of silicone seal to prevent their removal by abrasion in the field.

Tags are attached to frogs by placing the silicone tube around the frog's inguinal region (or 'waist'). The tubing is trimmed so that it just reaches around the frog's waist, with its ends meeting on the ventral centerline. The attachment must be of the correct tightness, which can only be determined with some practice. If attached too loosely, the diode can rotate around the body of the frog to the ventral side, hindering the movement of the animal. If too tight, it can cause abrasion, eventually producing lesions on the frog's skin. Attachment is completed by passing a length of very fine, 100% cotton thread through the silicone tubing, placing the tag on the animal and tying off the thread so that it just draws the ends of the tubing into contact. Using extremely fine, 100% cotton thread ensures that the tag will eventually fall off as the thread deteriorates, in case the animal is not recovered for tag removal (the time taken for the thread to wear off and break is uncertain and would depend on humidity and abrasion).

We used tags constructed as above in densely vegetated habitats (low elevation rainforests of North Queensland, Australia) to track 26 individual frogs (*Litoria rheocola*, mass 0.95–3.30 g in the sampled population; only individuals weighing 1.8 g or more were tracked to meet ethical requirements) for periods of up to 5 days. Diurnally, frogs were found in retreat sites, with 51% found in water and 35% in vegetation near the ground. Apparently normal movement between diurnal retreats and nocturnal activity sites occurred: nocturnally, 100% of frogs moved to vegetation bordering the stream (from shrubs 1–2 m off the ground to some recorded in sub-canopy 12 m). Frogs appeared to climb, jump and swim as they did prior to tracking device attachment (Fig. 2). Tags constructed as we have just outlined have been used successfully by other researchers since our study, focusing on other species (*L. serrata and L. junguy*) as well as *L. rheocola* in lowland rainforests in the Wet Tropics.

Harmonic direction finding, using tags constructed as we outline here, makes it possible to track animals approaching the lower limits of adult vertebrate body size. Our construction method provides a sturdy and stable attachment method for tags that fulfil ethical requirements for tracking very small animals while maximizing the ability to relocate the tags at the greatest possible distances. The continued reduction in size and weight of tracking devices opens up many exciting new opportunities to describe habitat use and movement of particularly minute and discreet organisms, increasing our understanding of the ecology of these poorly understood animals.

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Assessment of Turtle Tracking Technologies in the Brazilian Amazon

Technological developments over the past two decades have contributed tremendously to the study of wildlife ecology, bringing new insights to the management and conservation planning of animal species. In the Amazon, study of Amazonian turtle species using traditional methods has been conducted for 20 years, but researchers have lacked data concerning where turtles go after nesting. The need for essential information not collected by dated methodology called for technological applications to answer specific ecological questions. This review was based upon experience acquired in three ongoing studies of the ecology of turtles in the Amazon Basin.

In this study, three technologies were applied to study freshwater turtles in the Amazon for the first time: Passive Integrated Transponder (PIT), Very High Frequency radio (VHF), and satellite radio. For decades, ecologists and wildlife biologists have used a technique called mark-recapture, in which animals are captured and then externally marked or tagged in some way with a personal identification number before being released (Gibbons and Andrews 2004). With the advent of PIT technology, animals may be internally tagged with the advantage of not being affected by external factors or not affecting intraspecific social interactions or altering behavior toward tagged individuals (Gibbons and Andrews 2004; Jackson and Bunger 1993). PIT tags are tiny identification chips which are injected into specimens for permanent identification and have been retrieved with great success for more than 20 years (Boarman et al. 1998). The tags are injected into the caudal musculature of the turtle and read by an external reader which bounces an electronic signal off the tags to identify them.

In VHF radio telemetry, a small electronic device is attached to an individual, allowing it to be accurately tracked and monitored using a receiving unit (Marshall et al. 1971; Schemnitz and Owen 1969). Over the years, the decrease in size of the electronic components, circuit boards, and batteries has resulted in transmitters smaller than 0.4 g, enabling the study of smaller species and even hatchlings (Warnock and Takekawa 2003).

The third and more recent technology used to track animals

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is the satellite system. This technology became an operational tool for tracking the long-range movements of animals in the 1980s. Applying satellite system technology initially represented a challenge because most animal species were smaller than the biggest pixel of public access satellites data (0.6 m) and the passage times of satellites over the equator in the Amazon were so infrequent that animal positions could not be determined. However, with the advents of ARGOS (Advanced Research and Global Observation Satellite), the tracking of animal movement patterns became more feasible (Gillespie et al. 2008).

These three technologies have been important in field studies driven by the need to answer new questions regarding the ecology of Amazonian turtles in order to develop rigorous conservation measures. However, these devices are generally designed and tested to work successfully in temperate climates where they have been developed. Conditions in the Amazon, a tropical rainforest environment, are sufficiently different to affect the use of these devices.

In this paper we report the use of technical equipment to identify and track freshwater turtles in the Amazon region and provides advice on how devices that may be designed for temperate areas can successfully be used in tropical climates. Advantages, disadvantages, problems, and possible improvements of using technologies to track animals in tropical areas are discussed.

MATERIAL AND METHODS

Study areas.—The Mamirauá Sustainable Development Reserve (MSDR; 01.8347°S, 65.7053°W) is located on the floodplain between the Middle-Solimões and Japurá rivers (Fig. 1). Mamirauá is a reserve covering an area of 1,124,000 ha (Raeder and Bernhard 2003). In this area, we conducted field work from 1996 to 2004 using PIT tags with *Podocnemis sextuberculata* and *Podocnemis unifilis.*

Rio Quimicuri (00.7069°S, 63.2325°W) is part of the Rio Negro Basin (Fig. 1) (De la Ossa 2007). The Quimicuri River is a blackwater river with well-defined high and low water seasons (Castillo et al. 2004). In this river, individuals of *Peltocephalus dumerilianus* were captured from 2001 to 2006 and fitted with VHF transmitters.

Reserva Florestal Adolpho Ducke (3.1333°S, 60.0667°W) is located 25 km E of Manaus (Fig. 1) and has gradually become isolated from adjacent forests by the development of villages and agricultural activities (Magnusson et al. 1997). In this reserve, VHF transmitters were used to monitor *Platemys platycephala* in 1993.

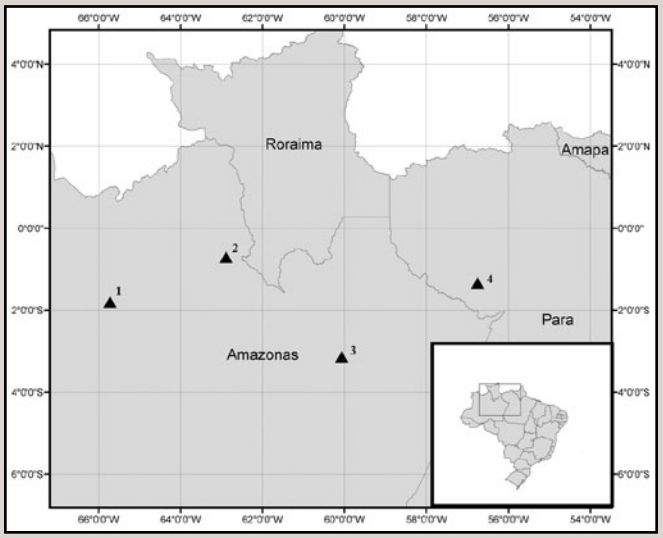


FIG. 1. Localization of the four study sites in the Amazon Basin with the Brazilian location on the right corner: (1) Mamirauá Sustainable Development Reserve, (2) Rio Quimicuri, (3) Reserva Florestal Adolpho Ducke, (4) Rio Trombetas.

The Trombetas Biological Reserve (1.3333°S, 56.75°W) is in northwestern Pará state, northern Brazil (Fig. 1). The Trombetas meanders generally southward for 760 km and joins the Amazon River in Obidos at Oriximina (Goulding et al. 2003). This area was selected for its large population of *Podocnemis expansa*, which is now listed as Critically Endangered by the IUCN and is the most threatened turtle species in the Brazilian Amazon. In this river, *P. expansa* and *P. unifilis* were studied at different times between 1989 and 2009, when all three technologies were used.

Equipment and brands applied.—Devices and species studied are detailed in Table 1. PIT tags were purchased from AVID Northwest Marine Technology, Inc. PIT tags are glass-encased electronic transponder tags that are inserted into turtle muscle. PIT tags have been used for over 20 years to permanently identify individual animals. The tag has no battery so the microchip remains inactive until read with a scanner. The scanner sends a low frequency signal to the microchip within the tag providing the power needed to send its unique code back to the scanner and positively identify the animal. Passive tags are designed to last longer than the life of the animal, providing a reliable, long-term identification method.

VHF-monitored radio tracking equipment was purchased from AVM Instrument Company, Ltd. The system consisted of a handheld Yagi 4-element antenna and receiver to collect signals from deployed transmitters. The system remained fully operational 24 h a day while the batteries were working. The modulation format used in this study is AM (amplitude modulation). Expected transmission lifespans range from 10–14 months for the 120 g transmitters deployed on the turtles.

TABLE 1. Locations of this study, detailing the devices used to mark and track freshwater turtles species in the Brazilian Amazon.

Location	Equipment	Species	No. of devices
RDS Mamiraua	PIT tags	*Podocnemis sextuberculata*	240
Rio Quimicuri	VHF Transmitters	*Peltocephalus dumerilianus*	10
Rio Trombetas	PIT tags	*Podocnemis expansa*	8150
		Podocnemis unifilis	2000
	VHF Transmitters	*Podocnemis expansa*	53
	Satellite Radio	*Podocnemis expansa*	10
R.F. Adolpho Ducke	VHF Transmitters	*Platemys platycephala*	4
		Phrynops rufipes	8



FIG. 2. Insertion of a pit tag in a hatchling of *Podocnemis expansa* in Rio Trombetas. Tags were inserted right below the carapace of the turtles.



FIG. 3. Insertion of a pit tag in hatchling turtles. Applicator needles supplied by the pit tags companies are too large to be used, so a 2 mm hole was made by piercing the skin with the point of a blood collector.

TABLE 2. Battery life expected by the manufacturers and actual results obtained in this study in the Brazilian Amazon.

Technology	Expected Life	Average life obtained (min. – max.)
Satellite radio	12 months	8.2 months (6–10)
VHF radio	12 months	8.3 months (8–11)
PIT tags	unlimited	Over 15 years

Satellite monitored radio technology requires satellite transmitters, known as Platform Transmitter Terminals (PTTs). In this study the PTTs were purchased from Sir Track, Ltd., and the satellite data were transmitted via satellite using the ARGOS System. The ARGOS environmental satellite system currently consists of six polar satellites orbiting at altitudes of 740–850 km with 5000 km visibility circles (footprints). During the satellite orbit, this footprint sweeps in a wide swath around the earth, receiving signals from the PTTs. The number of daily passes over a PTT increases with latitude. At the earth's poles, a PTT is within the visibility circle of the six satellites approximately 80 times per day, whereas at the equator (e.g., the Amazon region), a PTT can be visible perhaps 20 times per day (ARGOS 2008). Our study recorded a maximum of six passes per day, which is every four hours.

Transmitters can be programmed to send signals to satellites at periodic intervals. In salt water, transmitters are activated only when the turtle is at the surface and deactivated when submerged by a saltwater switch. Now new technology has been developed which includes a freshwater switch as well, which will increase the battery life by many months, since the transmitter will only be activated when the turtle is at the surface. To increase the life of the transmitter in our initial use in freshwater, the PTTs remained active for 24 h only for the first three months, then were active from 0600–1200 h every four days. Expected transmission lifespans for the 1800 g transmitters we deployed on 10 turtles ranged from 10 to 12 months. ARGOS satellites pass over about once every 4 h and if the turtle is on the surface of the water, both temperature and position are recorded.

Attachment of the equipment.—The PIT tags were inserted dorsally into the base of the tail just below the carapace in adult and juvenile turtles, using the injecting applicator needle supplied with the tags (Fig. 2). However, these applicator needles are too large to be used with hatchling turtles. Instead, a 2-mm hole was made by piercing the skin with the point of a blood collector (Fig. 3). The tag was inserted through the hole deep into the tail musculature using a fine tipped Inox 25 forceps. All material was sterilized first in an ethyl alcohol bath. After inserting a tag in an animal, the local area was cleaned using iodine and protected by liquid band aid.

Transmitters, both VHF and satellite, were glued to the carapace of the turtle with Turbolit, a marine product used for patching holes underwater in marine vessels. Two resins are mixed together with wet hands to form a uniform pliable paste. The turtle shell is prepared by scrubbing with soap and water and then roughened with sandpaper to ensure that the glue will hold the transmitter onto the turtle. The paste is then molded onto the front of the turtle shell, followed by pressing the transmitter into the paste and folding the paste over the transmitter to make a secure bond. The turtle is kept out of water for 24 h to make sure the gel has dried before release (Fig. 4). Prior to the discovery of Turbolit in 2005, VHF transmitters were first glued to the turtle carapace on the 9th–10th marginal scutes with epoxy quick-drying cement. When fixed in place, four 3-mm holes were drilled in these scutes, two on each side of the transmitter, and the transmitter was secured with 2 mm diameter stainless steel wire looped through the holes and around the transmitter. A cover of duropoxy was used to form a cap over the transmitter and wire such that it appeared as a tumor on the shell of the turtle with no jagged edges to catch on branches.

RESULTS

The devices used in this study were functional. However, because of the tropical rainforest environment of the Amazon, the high temperature decreased battery life. Regardless of the equipment efficiency, we also found problems with the discarding of equipment by poachers who caught turtles for illegal sale as food. Table 2 displays real battery life time in the Amazon environment compared to expected battery life, showing that the battery life obtained for VHF radio and satellite radio equipment was much lower than expected.

PIT tags.—The efficiency of PIT tag technology was difficult to analyze because it was impossible to distinguish unmarked

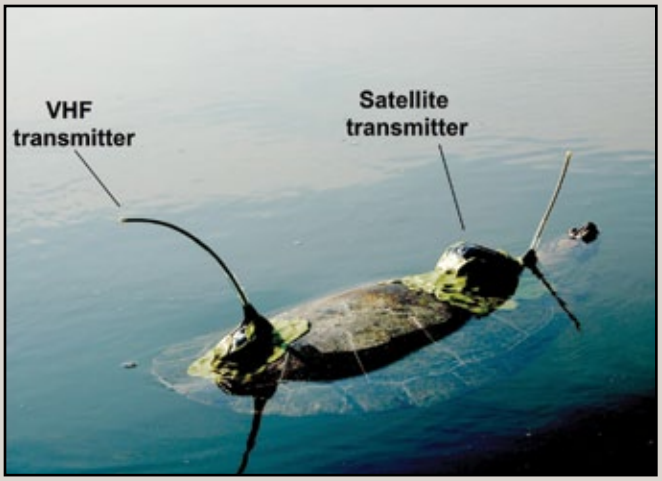


FIG. 4. Satellite and VHF Transmitters glued on the carapace of the turtle (*Podocnemis expansa*) with Turbolit. The paste is molded onto the turtle shell, followed by pressing the transmitter into the paste and folding it over the transmitter to make a secure bond. In this picture the turtle has just been released.



FIG. 5. *Podocnemis expansa* recaptured at the nesting beach with satellite transmitter attached four years after deployment, demonstrating the bonding potential of Turbolit glue. The PTT was easily pried off the turtle shell, leaving the carapace undamaged.

turtles from turtles whose PIT tags had ceased to function. However, from the 2000 PIT tags implanted in *P. unifilis* hatchlings in Rio Trombetas, seven were recovered still functioning. Three were found 13 years following implantation and four after 15 years. In addition, five PIT tags were encountered by people while eating cooked turtles. The tags no longer functioned, suggesting that the heat used in cooking the turtle meat destroyed the tags.

VHF radio.—A total of 76 VHF radios with a putative 12-month battery life were attached to turtles. Of these 76 VHF radios, eight were removed from the study by poachers. Eight were lost because of long-distance migration immediately following release and 16 either failed after three months operation or because turtles moved out of range. Most of the transmitters stopped working because the battery died: 36 after eight months, two after nine months, four after 10 months, and two after 11 months (Table 2).

In the study of *Peltocephalus dumerilianus*, two VHF radios worked for nine months and four for 11 months. All four VHF radios attached to *Platemys platycephala* worked for 10 months. With *Podocnemis expansa* in Rio Trombetas, of a total of 52 non-poached turtles monitored by VHF radios, seven were lost after three months because of the turtles entering deep into the flooded forest. Thirty-six VHF radios functioned for eight months. Finally, eight *P. expansa* were lost within five days after they had a VHF radio attached, by migrating far downstream from the nesting areas, moving up to 45 km in two days.

Satellite radio.—Of the 10 satellite transmitters used in this study, two were removed by turtle hunters almost immediately and one following eight months of use. Of the seven not discarded by local people, six suffered a reduced battery life, six failed to provide location signals after eight months, and one failed after 10 months (Table 2).

Two transmitters were recovered at the nesting beach four years later, still attached to turtles, demonstrating the bonding potential of Turbolit. Upon recapture, the PTTs were easily pried off the turtle shells with a Swiss army knife blade, leaving the carapace undamaged (Fig. 5).

DISCUSSION

Technology plays an important role in the monitoring of animal species. The choice of the technology to be applied depends mainly on the range of the species, its habitat, and the objectives for which the technology is used. Any decision to invest in and implement a technology should be based on an analysis of costs and benefits for a project to be successful. Any technology used must be appropriate for the operating conditions. This is true for the technology design, the resources required to implement it, and its ability to withstand challenging conditions. High temperatures and high humidity in remote field locations in areas such as the Amazon affect electronic devices negatively. Impacts of field conditions, such as dust, heat, humidity, water, and energy should be considered.

We strongly suggest that when choosing identification markers one consider consistency, standardization, and availability of a common database between researchers and organizations studying the same animal groups or animals studied. In addition, tag frequencies, manufacturers, and tag readers may not always be compatible. We suggest always using products compatible with those used in previous studies.

However, even though the VHF radios did not function for 12 months, the transmitters functioned satisfactorily until the batteries died, giving constant signals with an acceptable signal range.

The reduced lifespan of the satellite transmitters also was due to the high temperatures which reduced battery life. This could be improved by using devices which only give signals when they can be captured by the satellite and are more adapted to high temperatures. For this study the amount of energy consumed by the transmitter had not been calculated correctly, even though it was known that the transmitters consume more energy in hot climates. The transmitters were programmed based on ocean-going animals where the water is much colder than in the Amazon. It was not realized that the current drain would be so much higher in the Amazon heat. Now, reprogramming the two recovered transmitters on a different cycle with new batteries will enable them to function with the same number of batteries for the full 12 months or longer. This type of transmitter was used for the first time in a freshwater ecosystem and in the tropics. New transmitters can be programmed differently, using new calculations based on temperatures in the tropics, so that

they can produce signals for the entire year. There is also now available a freshwater on/off switch, such that the transmitter is only activated when it is at the surface out of the water, which will greatly conserve battery life.

We recommend that researchers collect data 24 h a day at the initiation of each study. After the movement patterns and activity patterns are determined, the transmitters may be programmed to operate only during the optimal time to send signals to satellites. If the turtles are relatively stationary for a period of time, battery life may be optimized by only activating the transmitter 6 h a day every four days, allowing for the collection of data for a longer time. The discarding of equipment by poachers complicates use of technology, because one cannot ascertain whether loss is due to emigration, equipment failure, or poaching. In this study we documented some transmitters that were disabled by poachers because some were recovered where the poachers had discarded them. The PTT was cut off the turtle and probably destroyed or thrown into the water, from which signals cannot be received. Local fishermen told us of one PTT that was recovered from where it was taken off a turtle. If the battery dies, signals will not be received either, but both the VHF signal and the satellite transmitter are not likely to die at the same time.

In the case of VHF radios applied to *Podocnemis expansa*, seven turtles were simultaneously marked with VHF and satellite technology. VHF signals were lost when these individuals entered flooded forest, while satellite technology continued to provide data.

APPLICATIONS AND RECOMMENDATIONS

Satellite radio versus VHF radio.—Locations derived from satellite tracking helped to delineate the reproductive, flooded, and dry season ranges of turtles to migration sites. Such information is essential to establish where females observed at a given beach live during the remainder of the year. For long-distance migrants, satellite tracking is a useful tool for monitoring migration routes. However, for species with limited migration or dispersal distances, satellite tracking may not be productive, while a VHF radio tracking system would provide better data

For some species the use of both methods might be appropriate, using satellite tracking to study their ranges, habitat use, and migratory routes and the VHF system to study habitat patch utilization and other fine-scale ecological interactions. When working with both technologies simultaneously, the satellite radio provides coordinates that facilitate approximating the general location of the individual so that the VHF radio may yield its exact position.

For an animal that does not move often, VHF is more precise and cheaper than satellite tracking. This system successfully collects continuous presence and absence data and turtle mortality data from local people and also estimates the amount of time that turtles spend on or near nesting beaches.

In the Amazon, the satellite system has shown high performance in tracking animals. However, Mantovani et al. (2003) reported that this method is not appropriate for tracking animals in fragmented areas and small rivers like those in the southeast region of Brazil. This was not a problem in tracking turtles in the Amazon Basin because, although there may be errors of hundreds of meters in their exact locations, the large size of rivers in the Amazon makes up for any error in the tracking location.

PIT tags versus plastic tags.—This study has confirmed that PIT technology is a reliable and promising method for identifying and monitoring individuals over long periods of time and is very efficient as a tool to study capture-recapture, movement, abundance, survival, and recruitment. In addition, the use of passive tags for animal identification and research provides many benefits, including the reduction of error in recording data, rapid data collection, and long-term reliability. They allow researchers to permanently mark animals internally without altering external appearance and eliminating negative impact on animals as they have little or no influence on growth rate, behavior, health, and predator susceptibility.

Previous experience indicates plastic tags were not as successful as the PIT tag system because plastic tags were lost faster and within four years of being marked. No turtles were recaptured with a plastic tag after four years.

Disadvantages and limitations.—Satellite and VHF-monitored radio tracking: The use of the satellite system is worth the expense because there is no need to track the animals in the field by boat or airplane which increases the costs. However, because turtles are a source of traditional local cuisine, they are heavily harvested by locals and consequently some of our equipment attached to these turtles is destroyed. Since a VHF radio is cheaper, it is therefore recommended if the species can be tracked and the signal received within the turtle's home range. In addition, VHF works better in fragmented areas, as already reported by Mantovani et al. (2003).

Passive Integrated Transponders.—The primary disadvantage of this technique is the cost (approximately US $4 per tag plus the cost of the tag reader). The standard version of this type of tag is 10–14 mm long and as the tag is inserted into the caudal musculature, experience and care are required in this procedure. However, when compared to plastic markers, PIT tags are still worth the cost.

Acknowledgments.—This study was supported by the Instituto Nacional de Pesquisas da Amazonia (INPA), Conservation International (CI), World Wildlife Fund (WWF), Comunidade Europeia, Wildlife Conservation Society (WWS), Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), Fundacao de Amparo a Pesquisa do Estado do Amazonas (FAPEAM), Mineracao do Rio Norte, Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (IBAMA), and Instituto Chico Mendes (ICMBio). The study was done under the auspices of IBAMA permits. We thank all the students who spent their time and effort helping with the monitoring of the turtles.

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Using Tattoos to Mark *Apalone ferox* for Individual Recognition

Researchers use numerous methods to mark turtles for individual recognition (Ferner 2007; Plummer 1979). The most widely used method for hard-shelled turtles is shell notching (Cagle 1939) or a variant thereof. Other techniques used for marking hard-shelled turtles include passive integrated transponders (PIT; Buhlmann and Tuberville 1998; Rowe and Kelly 2005; Runyan and Meylan 2005) and metal tags attached to the carapace (Obbard and Brooks 1981) or flippers (Balasz 1985). Techniques that have been employed for soft-shelled turtles include hole punching (Doody and Tamplin 1992), inserting plastic spaghetti tags (Dreslik 1997), branding (Woodbury and Hardy 1948), notching the edge of the carapace (Breckenridge 1955; Plummer 1977, 2008), and tattooing (Breckenridge 1955). Overall, few studies have examined the effectiveness of tattooing as a marking technique for reptiles but there are reports of limited success in snakes (Woodbury 1948) and turtles (Balazs 1978; Breckenridge 1955).

In 2007, we began capturing and marking the soft-shelled turtle *Apalone ferox* in a spring-run complex located in Wekiwa Springs State Park, Florida, USA. Turtles were captured by snorkeling or with baited hoop nets during biannual, five-day sampling sessions. Captured individuals were tattooed with numbers (beginning with "1") on the underside of the carapace posterior to each rear leg (Fig. 1). The areas to be marked were dried, blotted with alcohol, and tattooed using a battery-operated tattooing gun (Permanent Marker Cordless Tattoo'r). After tattooing, the areas were rinsed with alcohol, allowed to dry, and then coated with a thin layer of antibiotic ointment. The tattooing process required ca. 10 minutes to complete. Tattooed turtles were kept dry for ca. 1 h before release. The process caused minimal bleeding (Fig. 1), which stopped before turtles were released. Touch-up tattoos were reapplied to all individuals recaptured during subsequent sampling sessions. Photographs of individuals were taken and in 2009 we began PIT tagging turtles to verify tattoo effectiveness.

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Fig. 1 illustrates typical changes as observed in the tattoo of one turtle. The initial tattoo was dark (Fig. 1A) and when the individual was recaptured during the same five-day sampling session, it exhibited a dark and legible tattoo (Fig. 1B). Seven months after original marking, the tattoos had faded, but a clearly-visible scar reflecting the number remained (Fig. 1C). Touch-up tattoos were reapplied and the turtle was released. Five months after remarking, the tattoo had again faded but the scar remained clearly visible (Fig. 1D). (Marks were more apparent in the field than is shown in photographs.) To date, 39 individuals have been tattooed, of which 12 were recaptured and remarked during a second (subsequent) sample, five were recaptured and remarked during a third sample, and two were recaptured and remarked during a fourth sample. Table 1 summarizes the time elapsed (in days) between marking and recapture. All recaptured individuals exhibited a visible tattoo or scar and the numbers have always been discernable. The long-term effectiveness of tattoos is supported by four recaptures ca. 1 year after marking, one recapture ca. 2 years after marking, and one recapture ca. 2.5 years after marking (Table 1). The most faded tattoos observed during the study were similar to the marks in Figs. 1C and 1D. PIT tags have aided in the verification of eight recaptures (Table 1) during later sampling sessions. In one instance (turtle 18), a PIT tag was lost or malfunctioned and the animal had to be re-tagged. The tattoo, along with body measurement data and previous photographs, positively identified this turtle.

Using body measurements, photographs, and PIT tags, we consider it unlikely that any turtles were misidentified. While fading of tattoos may make tattoos inappropriate for studies with long periods (several years) between samples, our data indicate that studies with at least annual sampling can employ tattoos.

During this study, *A. ferox* with carapace damage sufficient to obscure marks from notching or hole punching have been observed. To minimize mark loss, animals were tattooed twice in locations which are subjected to minimal wear. Breckenridge

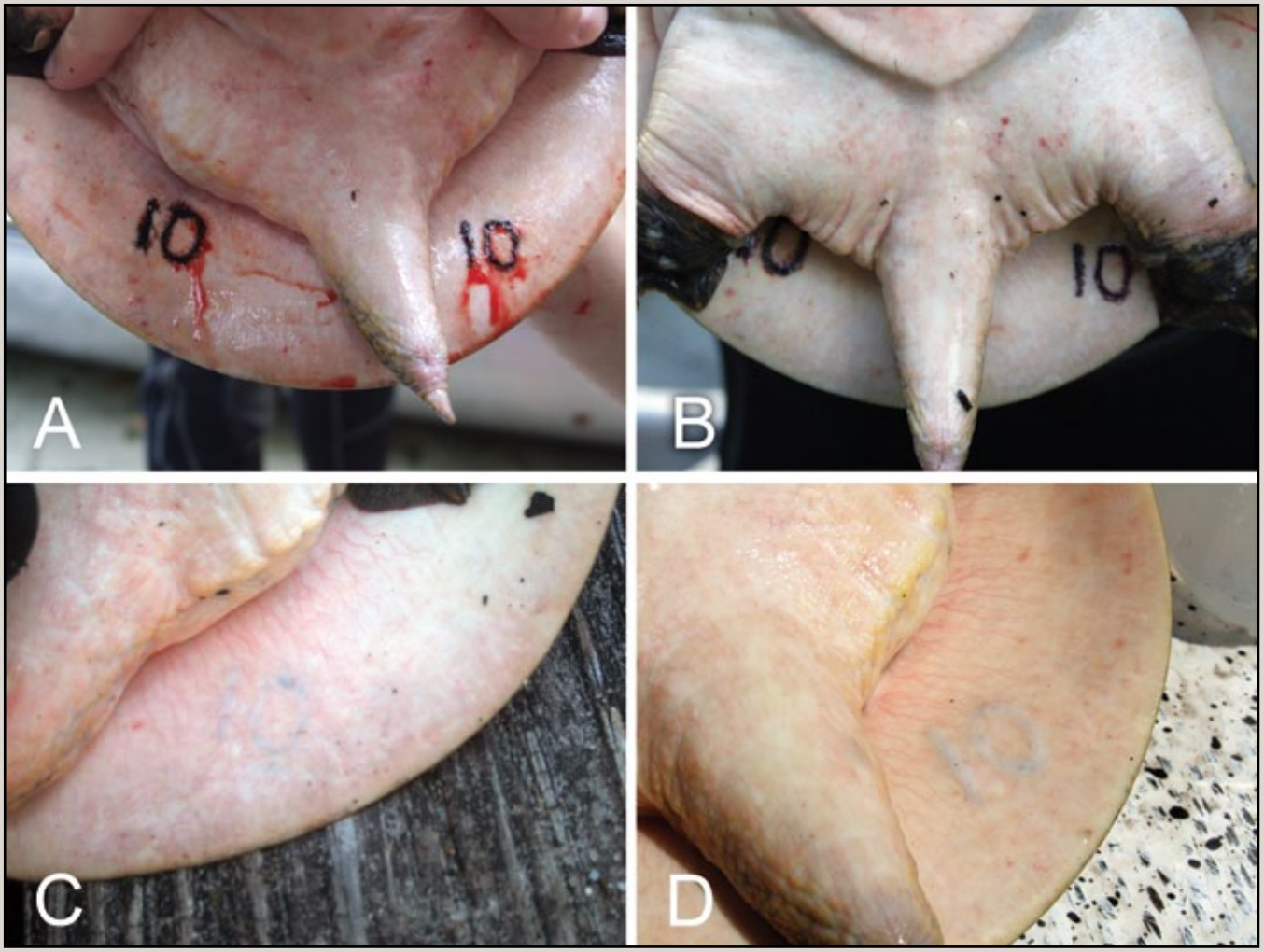


FIG. 1. Appearance of a tattoo mark in *Apalone ferox* A) immediately after the initial tattooing process; B) after recapture ca. 24 h after the initial tattooing process; C) 213 days after the initial tattooing process; and D) 349 days after the initial tattoo process and 136 days after its secondary tattoo.

(1955) placed tattoos in a high-wear area, the plastron. This may, in part, explain why he never recognized any recovered individuals as marked.

Tattooing does not require the removal of tissue, making it less intrusive than carapace notching or hole punching (Breckenridge 1955; Doody and Tamplin 1992; Plummer 1977, 2008). Tattooing is less expensive to employ than PIT tagging, which can cost ca. US $400 for a scanner (Rowe and Kelly 2005; Runyan and Meylan 2005) and ca. US $4–6 for each tag. The tattooing device used in this study cost ca. US $50 and required only new batteries, ink, and needles (which came with the device).

Apalone ferox is still a relatively little-known species compared to other North American freshwater turtles. We attribute this, in part, to the difficulty of marking these animals. Our method provides researchers with an inexpensive, effective technique for marking soft-shelled turtles. We hope this method will encourage more research on soft-shelled turtles.

Acknowledgments.—We thank the past and current staff of Wekiwa Springs State Park and the Florida Department of Environmental Protection for providing support and making this research possible. Thanks to Brian P. Butterfield for his role in initiating the study at Wekiwa Springs and for providing valuable comments on a draft

TABLE 1. The number of days that have passed between tattooing and subsequent recapture and tattoo reapplication for individual *Apalone ferox*. Asterisks (*) denote recaptures whose identity was verified through use of PIT tags.

Turtle Number	Number of days that have passed since Original Tattoo	First Reapplication	Second Reapplication
3	946		
4	209		
10	213	136	
12	213		
13	726		
14	350	373*	232*
15	213		
18	138	233	140*
21	233*	142*	
22	374*		
23	377*	138*	
24	239		
No. recaptures	12	5	2

of this manuscript. Special thanks go to Jessica T. Weber and Bradford A. Cox for the photographs used herein and to Shawn Roden for his advice using the tattoo wand. We would also like to express our gratitude to Brittany Taylor, Jessica Munscher, Philip Berry, Emily and Joel Kuhns, Heather Mosley, Jessica Wright, Megan Keserauskis, Graham Williams, and the many other individuals who have aided this research. Additional thanks go to Deborah Shelley and Marsha Butler from the Wekiva River Aquatic Preserve, as well as Friends of the Wekiva River and the Wekiva River Wild and Scenic Committee. All turtles were collected and handled in accordance with American Society of Ichthyologists and Herpetologists guidelines for animal care and use in research. This study was conducted under Florida Department of Environmental Protection permit number 06240913 and Florida Fish and Wildlife Conservation Commission permit number LSSC-09-0411.

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An Effective Method for Transporting Hellbenders (*Cryptobranchus alleganiensis*)

The Eastern Hellbender (represented by two subspecies, *Cryptobranchus alleganiensis alleganiensis* and *C. a. bishopi*) is an impressively large, strictly aquatic salamander endemic to eastern North America (Petranka 1998). Hellbenders can grow to 74 cm in total length and are gray, brown, or dark green with a dorsoventrally flattened body and a laterally compressed, keeled tail. Although hellbenders have lungs, they are cutaneous respirators and require pristine, cool, swiftly moving streams and rivers with high levels of dissolved oxygen that equates to approximately 100% saturation (Nickerson et al. 2002). Cutaneous respiration is aided by the hellbender's conspicuous, undulating vascular lateral skin folds, which increase surface area for gas exchange.

Populations of hellbenders have declined throughout their range (Foster et al. 2009; Petranka 1998; Wheeler et al. 2003) because of habitat alteration resulting from mining and agricultural activities, collection for the pet and bait trades, and potentially from chemical contamination (Foster et al. 2009; Petranka 1998). As a result, the species is listed as Near Threatened by the IUCN and is listed as Special Concern in New York State. The New York State Department of Environmental Conservation (NYSDEC) has acknowledged that without intervention, the hellbender in New York is expected to continue its decline (Bell et al. 2010). In an attempt to address this, a statewide recovery plan has been written by a team of experts from within and outside the NYSDEC (Bell et al. 2010); the plan includes headstarting of wild-collected hellbender embryos. The NYSDEC and the Buffalo Zoo have spearheaded an effort to develop captive rearing or headstarting efforts for the Eastern Hellbender in New York State. The Wildlife Conservation Society (WCS)/Bronx Zoo was presented with the opportunity to help with this effort through fostering a portion of the larvae, which will be reared in captivity for two years at the Bronx Zoo prior to their return to their natal river in western New York State. However, we had to find a safe and effective way to transport them from Buffalo, New York to the Bronx (an approximately 640 km journey) in July, the hottest month of the year in the New York Metropolitan Area with an average monthly high temperature of 29°C (National Climatic Data Center; www.ncdc.noaa.gov).

The particularly high oxygen needs of this species required that we manufacture a reliable system for maintaining low

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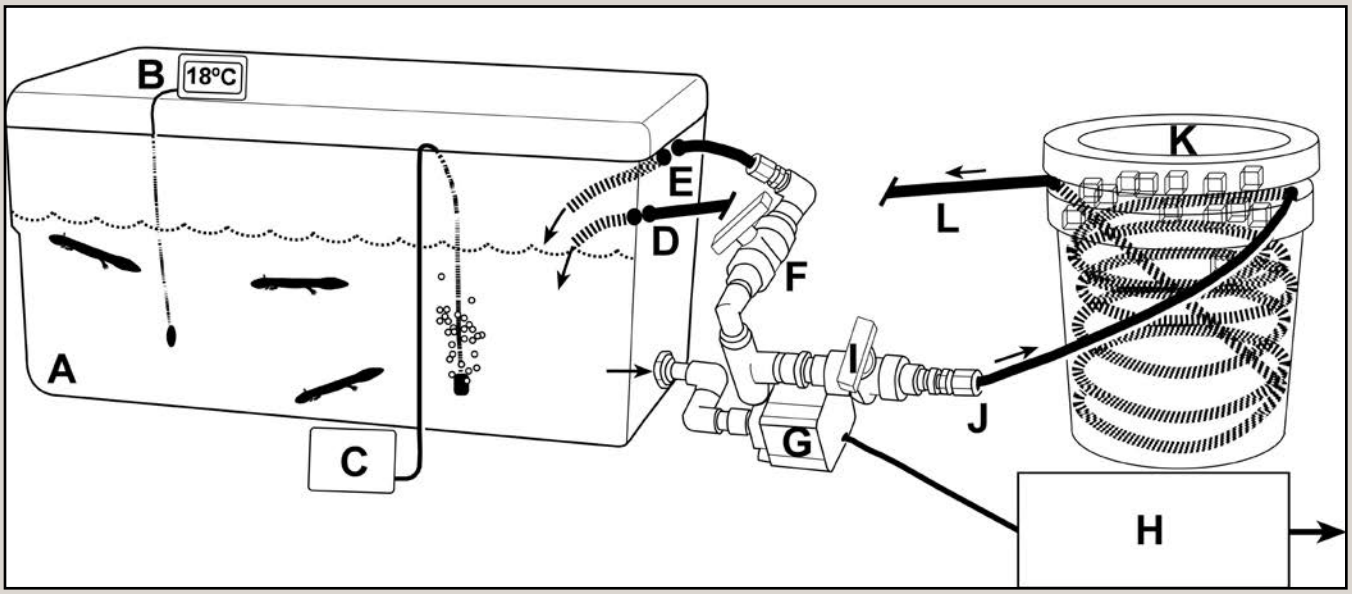


FIG. 1. The hellbender transportation device. Note that parts are not drawn to scale. Product brands are provided in the text. A) A 114 liter-capacity beverage cooler. Approximately 20 nine-month old juvenile hellbenders were transported in each container with the cooler lid closed during transport to keep the water cold. B) An external digital thermometer with an internal probe. The probe was secured underwater to the wall of the cooler with a suction cup that is provided with the product. C) A battery-operated aerator with an air stone; two were used for each cooler. D) The return hose from the heat exchanger, which passes through the wall of the cooler. E) The return hose from the pump, which passes through the wall of the cooler. F) The tank circulation valve, which can be closed completely to form a closed loop between the heat exchanger and the tank. To make the tank water warmer, this valve should remain fully open, while Valve I is shut off completely, thus shunting water flow to the heat exchanger and maintaining water current and oxygenation of the system. G) A 115-volt water pump. The pump is connected to a power converter (H). The power converter converts 12-volt DC power to 115-volt AC power, allowing us to run the AC water pump off of the vehicle's battery via the cabin power source or cigarette lighter. I) The heat exchanger valve. This valve can be completely opened or closed or closed partially to regulate the rate of flow of the water through the heat exchanger. The more open this valve is, the more quickly the water will cool. J) The outflow tube leading to the heat exchanger. K) The heat exchanger consists of a 431.8 cm long, 1.27 cm outer diameter HDPE plastic tube that is coiled inside a five gallon bucket filled with ice. The lid is placed tightly onto the bucket. The greater the number of hose coils inside the heat exchanger, the greater the surface area and efficiency of the heat exchanger; however hose length is negatively correlated with flow rate. L) The return or outflow hose from the heat exchanger to the hellbender tank. For illustrative purposes, the hose here is shown as an incomplete line but in reality it is continuous with D.

temperatures and high dissolved oxygen during transport. Although there are many published reports and accounts on the monitoring of wild *C. alleghaniensis* populations and proven methods of capture (e.g., Foster et al. 2008; Humphries 2007; Nickerson and Krysko 2003; Williams et al. 1981), there are very few notes and published reports on how to manage their safe transport and captive care (Indiviglio 2010). Moreover, although there are commercially produced refrigerated devices for transporting fish, they are prohibitively expensive. Herein we describe a simple and cost-effective method we developed to transport hellbender larvae.

Transporting cool-loving hellbenders in the middle of a North American summer presents logistical challenges. Originally, we investigated the possibility using a commercial airline to transport the hellbenders from Buffalo to the Bronx. However, because they breathe through their skin and through external gills as larvae, ground transportation was the safest option as when aboard a plane, it would have been impossible to observe them and to intervene in order to provide supplemental oxygen if needed. Only by driving the hellbenders could we carefully monitor their progress and troubleshoot oxygen levels if necessary. This problem necessitated the planning and manufacture of an efficient transportation container that could simultaneously cool and oxygenate the animals for their relatively long journey to the Bronx Zoo.

We constructed two transportation devices, which each housed approximately half of the 41 gilled hellbender larvae. Each hellbender transportation container was manufactured with a Coleman® Xtreme 114 liter-capacity cooler. Each cooler was filled with approximately 70 liters of water, which was brought from the filtered water supply at the Bronx Zoo. The water system at the Bronx Zoo's Amphibian Recovery Center (ARC) incorporates ozone treatment, carbon and cloth-bag filters, removes chlorine and chloramines, and reduces phosphate levels from the New York City municipal water. Water temperatures in the hellbender room at the zoo are maintained at 18°C during the summer. In order to acclimate the hellbenders during their ride to the Bronx Zoo, our goal was to maintain transportation containers at 18°C throughout the round trip.

Each cooler (A) was plumbed with a pump (Model 5® utility pump, 115 volt AC; Aquatic Ecosystems, Inc.), which was connected with PVC piping to the drain spigot of the cooler with a 2cm (3/4") exterior bulkhead and internal strainer (Fig. 1). The pump was powered with the transportation vehicle's battery, which is accessed with a voltage transformer (DC to AC voltage transformer with 12 volt DC input and 120 volt AC output with a power output of 700 watts or 5.8 amps; McMaster-Carr) connected to the vehicle's dashboard power source. The pump (G) circulated the water from the cooler to a heat exchanger and through the cooler. The heat exchanger (K) was made from a

20-liter plastic bucket filled with ice. Through this bucket, a 430 cm-long, coiled HDPE plastic hose (1.27 cm outer diameter) circulated the hellbenders' water. Our heat exchanger had five coils of water-circulating hose inside the bucket. Two PVC ball valves regulated the flow of the water through the system. Valve F continuously regulated the flow rate of water through the cooler. The other valve (I) regulated flow through the heat exchanger. The temperature of the water holding the hellbenders was regulated by adjusting Valve I. When Valve I was shut off completely, then water flow was only circulated through the cooler through Valve F and gradually became warmer. In contrast, when Valve I was fully open, it allowed maximum flow through the ice-filled heat exchanger, and decreased the temperature of the water inside the cooler (A). Thus, through closing or opening Valve I partially or completely, we could manage the water temperature very effectively, to within one or two degrees of our target temperature. The Coleman® beverage cooler also insulates very well and is highly efficient at maintaining stable temperatures. In each transportation container, two battery-powered aerators (Penn-Plax® Silent Air B10), each with airline hose and an airstone, were used to further aerate the water (C). The coolers were placed onto a sheet of insulating foam to help buffer them from the van's hot floorboards and also to prevent them from sliding on the floor of the van.

On 13 July 2010, two of us (JP and JW) traveled to the Buffalo Zoo, New York to transport 41 hellbender larvae to the Bronx, New York. The round trip was made the same day and was approximately eight hours in each direction including rest stops. The highest outdoor ambient temperature along the route that day was 29°C. The van's cabin was air conditioned with the ambient temperature fluctuating from 21°C to outdoor ambient. On our way to pick up the hellbenders we let the system run in order to make any necessary adjustments and to ensure that the optimal temperature could be maintained throughout the trip. Prior to their release into the water of the transport device, the hellbenders were suspended in plastic tropical fish bags for at least twenty minutes until the temperature inside the bag was at equilibrium with that of the transport container.

Both on the trip to Buffalo, New York, and during our return to the Bronx, we were able to maintain a nearly constant (~18°C) water temperature inside the transport containers. Approximately two, 2.2 kg bags of commercially prepared ice were used to fill the heat exchanger described above. The ice, purchased from convenience stores, was changed out twice during each leg of the trip.

Upon arrival at the Bronx Zoo, the hellbenders were transferred immediately from the coolers to their new 75-liter (20-gallon long) aquaria (1–2 hellbenders per aquarium) in a biosecure room in the Amphibian Recovery Center. The water temperature of their new aquaria was nearly identical to that of the water in which they were transported. All 41 hellbenders made the trip safely and are, as of publication, doing well at the zoo. This method was very effective for the transportation of hellbenders and may prove useful in the transport of other aquatic amphibians, particularly montane species such as frogs of the genus *Telmatobius*. The number of animals that can be carried in each device is dependent upon the dissolved oxygen (DO) needs and body mass of the particular species. It is recommended that users of this device research the physiological parameters required of the species being transported. In this case, we set up our device, allowed it to run for several hours, and used a digital meter to determine the DO levels in each to ensure that they would be within reasonable limits for transporting 41, 7 cm-long larvae.

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Captive Management and Reproductive Biology of Latifi's Viper (*Montivipera latifii*) (Squamata: Viperidae) at Razi Institute and Tehran University in Iran

Latifi's Viper or Lar Mountain Viper (*Montivipera latifii*) is a small, mountain-dwelling venomous snake occurring in Iran in Tehran Province (lar Damavand, Ab-Ask, Firuzkuh, Gajere, Gachsar and Afjeh) (Rastegar-pouyani et al. 2008). This species is found only in Iran and has been considered at risk since 1979, when there was concern about the possible extinction of this viper (Andén and Nilson 1979). Construction of an enormous earthen dam called Lar Dam inundated the habitat in the late 1970s and it appeared that the snake was forever lost. In 2000 an isolated population was found in the upper Lar Valley in the Elburz Mountains. In 1983 the snake was listed as Endangered and its future has not improved (Groombridge 2010; Red List of IUCN 2010).

In older Iranian literature on venoms and snakebites many *Vipera* species, including *M. latifii*, were referred to *Vipera xanthina* or *V. xanthina* ssp. (Mallow et al. 2003). Nilson et al. (1999) erected the subgenus *Montivipera* within the genus *Vipera*, which later was elevated to genus rank (Joger 2005). Nine taxa are contained in *Montivipera* including *M. latifii*. All are high-altitude mountain dwellers. We consulted Andrén (1986), Andrén and Nilson (1979), Latifi (1985), Mallow et al. (2003), Mertens et al. (1967), Nilson and Brodmann (1987), and Phelps (2010) for descriptions of *M. latifii*, especially color and pattern morphs (Fig. 1). Color photographs showing three of these morphs are available (U.S. Dept. of Defense Intelligence Document 1991).

Andrén and Nilson (1979) characterized the habitat of *M. latifii* as high alpine steppe located at an elevation of 2000–4000 m. The Lar Valley is surrounded by high mountains and is essentially closed. Adults were found in well-drained, sparsely vegetated rock habitats. We measured air temperatures in July 1973 and June 1976 (daytime 28–35°C, 10–13°C immediately after sundown, 0–5°C at night). Most of the time, the snakes were underground, perhaps in response to low temperatures. Behrooz (2009) described the habitat: mountainous areas, grasslands, rocky outcrops, and shrubland (Fig. 2).

The maximum length is 79 cm and the length of the tail is 5 cm (Farzanpay 1989; Latifi 1991). Andrén and Nilson (1979), Mallow et al. (2003), and Mertens et al. (1967), described four distinct color and pattern morphs and two are shown here from Latifi (1985; Fig. 1). Litter size varies from 3–10 neonates (Andrén and Nilson 1979; Latifi 1985; Mertens et al. 1967). The diet for this species in the wild consists of insects, grasshoppers, lizards, and mice (Behrooz 2009).

Today this species is highly threatened and has vanished from many parts of its range due to both the destruction of its natural habitat (Behrooz et al. 2009) and the overcollecting of snakes for the production of antivenin (Nilson 2008). The Razi Institute started in 1958 to produce antivenin and the first serum was issued for therapeutic use two years later; venom was extracted from 9397 vipers (Latifi 1978). In 1984 Latifi described venom extraction from nearly 8750 (additional?) snakes and described antivenin production at Razi Institute the following year. Mallow et al. (2003) describe the production of antivenin in detail. There are three main reasons for setting up a colony of *M. latifii* at Razi Institute: to eliminate the need to purchase snakes from local collectors for antivenin production, to increase numbers by improved captive management and expanded captive breeding, and to decrease mortality rates. At Tehran University 12 specimens are currently maintained to study reproductive biology and will be released after studies have been completed.

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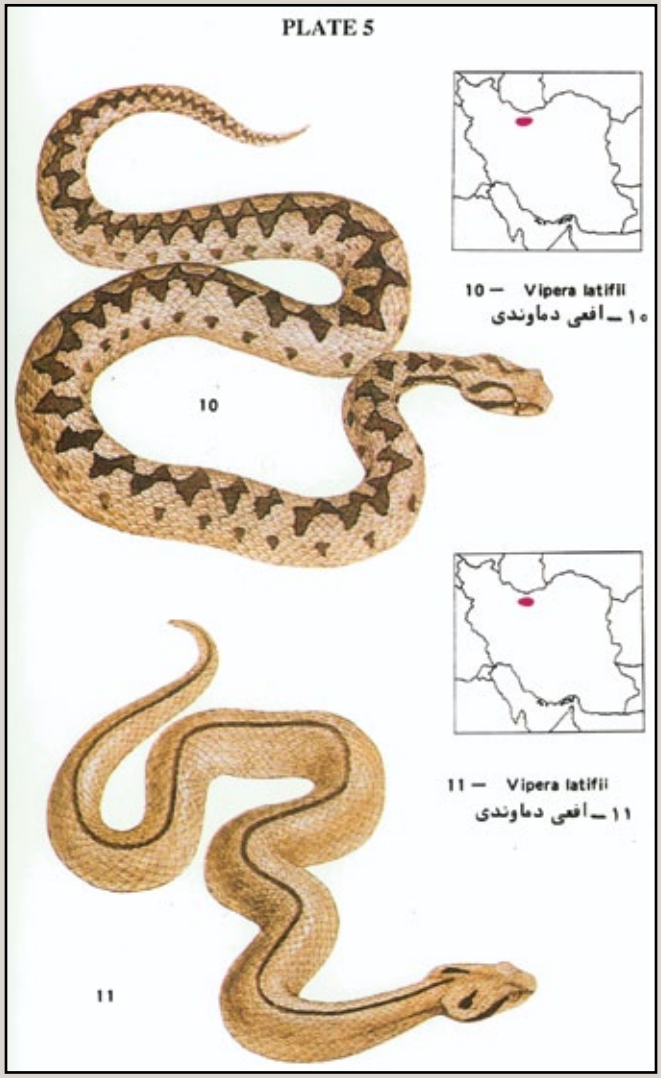


FIG. 1. Drawing of Latifi's Viper (*Vipera latifii,* now *Montivipera latifii*) from Mahmoud Latifi's *Snakes of Iran* published in 1985. Shown here are two pattern morphs: zig-zag pattern above and narrow vertebral line below.

PHOTOS BY ROOZBEH BEHROOZ



FIG. 2. Three views of habitat of Latifi's Viper (*Montivipera latifii)* in Lar Valley, Iran, now a national park. This viper is at risk due to increased human visitation and collection by snake hunters. The Razi Institute continues to produce antivenin to counteract potential snakebites.

CAPTIVE MANAGEMENT

Very little information is available on reproduction and growth under laboratory conditions. One of the reasons may be due to the low number of specimens in captivity. Mamet and Kudrjavtsev (1995) have published information on the breeding of *Montivipera latifii* at the Moscow Zoo.

In 2008 and 2009, 26 Latifi's Vipers were captured in the Lar Valley (Alborz Mountain, Kakamega Forest, Damavand District, Tehran Province, Iran) to form the nucleus for a captive breeding program at Razi Institute and Tehran University. The first group was collected in 2008 and consisted of eight female specimens that appeared to be gravid. The second group was collected later that year and consisted of six specimens (two females and four males). The snakes in these two groups were held at Razi Institute. The next year 12 individuals (six females and six males) were collected and maintained at Tehran University.

Our snakes had coloration and pattern variation as described by Andrén and Nilson (1979; Table 1); the markings were most often vertebral lines and zig-zags (Fig. 1). Variants were found with light grayish-yellow ground color with mid-dorsal dark brown spots and two diagonal dark brown to black stripes on each side of head. A few had pale yellow ground coloration with a pattern of black and white small spots.

TABLE 1. Parturition in captive Latifi's Vipers (*Montivipera latifii*) in 2008.

Number of neonate	Beginning emergence of neonates / egg masses from cloaca	Complete emergence of neonates / egg masses	Total time between initial appearance and total emergence of neonates/egg masses (min)	Intervals between births and egg mass extrusions (min)
1 (Neonate with spinal defect)	0950 hr	1000 hr	10	—
2 (Infertile egg mass)	1006 hr	1012 hr	6	6
3 (Infertile egg mass)	1022 hr	1028 hr	6	6
4 (Healthy neonate)	1103 hr	1122 hr	19	35
Mean			10.25	11.75
Total time = 102 min				

Data are presented here reflecting our two-year study on behavior, reproduction, and growth under laboratory conditions. Ettling and Marfisi (2002) described male-male combat behavior in *Montivipera wagneri* and *M. raddei*. Although many male *M. latifii* were maintained in the same enclosures during our study, we did not observe this behavior. Greene et al. (2002) described parental behavior in *Vipera berus*: "Some authors have claimed that Adders (*Vipera berus*) aggregate with their young for up to several days after birth, and that the young seek cover under the female when approached closely…Conversely, several experienced researchers at the conference on which this volume is based have not observed female *V. berus* attending their young (S. Anderson, C. Andrén, T. Madsen, and R. Thorpe, pers. comm.)." We have not observed this parental behavior in *M. latifii*.

The 26 individuals captured from the wild were housed in special vivaria with environmental parameters (temperature and humidity) similar to the native habitat as described below.

The enclosures.—In August 2008, two adult pairs were housed in one glass vivarium measuring 120 cm L × 45 cm W × 50 cm H with aluminum mesh on the top and front. Two males were put into another glass enclosure of the same size with aluminum mesh on the top and rear. In 2009, five enclosures were redesigned to increase space and improve ventilation (120 cm L × 60 cm W × 50 cm H).

Two of the new vivaria with increased floor space were used to house four adult pairs and two adult pairs, respectively. The substrate was peat moss. Pieces of broken flower pots were available as hiding places.

Temperature, humidity and lighting.—An incandescent light bulb (40 watt) was used as a heat and light source with an automatic timer set to duplicate daylight cycles. The thermal gradient ranged from 30–32°C beneath the lamp to 26–28°C at the far end. Every week the enclosures were sprayed with warm water. The humidity level prior to the spraying was 35% and increased to 50% after spraying was done. The relative humidity averaged 40–50%.

Disinfection and quarantine.—With any new animals coming into captivity, care must be taken to prevent cross contamination and any infectious disease should be treated in a timely manner (Murphy and Armstrong 1978). Quarantine procedures were strictly followed. The incoming vipers were quarantined for a minimum of four weeks, strictly following established protocols, as recommended by Ross and Marzec (1990), but we note here that due to the danger of Ophidian Paramyxovirus, recommendations today stress that quarantine should be extended to a minimum of 90 days (Elliott Jacobson, pers. comm.). To eradicate ectoparasites, the vipers were dusted with Opigal powder, a product used in Iran to treat fowl for mites, ticks, and lice.

Sex determination and marking.—The sexes of the animals were tentatively assigned based on tail length/body length ratio initially and later validated by probing male copulatory organs as described by Laszlo (1975) and Toriba and Hirabayashi (1995). The variation of unique and distinct markings among individual animals was used to keep track of males and females during the hibernation period and for tracking the feeding history of each snake. In addition, nail polish was painted on tails to track individual snakes; this approach was used as it was easily implemented, clearly distinguishable, and was not harmful to the marked individual (see Murray and Fuller 2000 for discussion on marking techniques).

Food and feeding.—Laboratory rodents were the most commonly available food items and were selected to decrease the risk of endoparasitic infection (Chanhome et al. 2001). Newborn and adult mice (*Mus musculus albinus*), and newborn rats (*Rattus norvegicus berkennhout*) were offered once a week; the vipers did not accept the lizards (*Mesalina watsonana, Eumeces schneiderii*) that were offered. In 2009 the food items were supplemented with the multivitamin "Rep-Cal Herptivite Multivitamin" (Rep-Cal Research Lab, Los Gatos, California). There was competition during feeding. In some cases snakes struck each other during predatory episodes.

Generally, gravid snakes lose normal body weight during the reproductive cycle due to birth of young and long periods without food during gestation. Body weight and accumulation of fat is necessary to enable the process of follicular maturation and neonate production. In 2008 the newly captured snakes did not accept food and the body weight of males and females declined; hence, females likely had no fat reserves for reproduction. The next year snake weight increased because the vipers were feeding with regularity. In 2009 the newly captured gravid viper started to take food earlier than usual, which indicated a need to increase the required body weight and fat for the next breeding cycle as described by Vyas (2002).

Availability and diversity of food are important for captive reproduction (Ambu et al. 1986; Kudrjavtsev et al. 1993). When food items were supplemented with multivitamins in 2009, this change had a positive effect on weight gain and resulted in more complete shedding of snakes (Grubant et al. 1973; Igolkina et al. 1989; Mamet and Kudrjavtsev 1995).

Nursery cage and neonatal husbandry.—Neonates were placed into separate plastic boxes that were ventilated by drilling holes on each side and lid. The box size was 30 × 10 × 10 cm and contained an inverted flowerpot (as a hiding place), paper substrata, and a water bowl. The temperature in one part of the box was kept at 28–30°C during the daytime by using an incandescent bulb (20 watt). The other part was kept at 26–27°C, and the

temperature and humidity at night corresponded to the seasons. The temperature was 22–24°C at night, accomplished by simply opening the windows. Spray-misting was done as needed in the cooler parts to ensure that the humidity remained at 40–50%.

Ecdysis.—Successful shedding depends largely on environmental temperature and the amount of food intake. The time between the onset of milky blue eyes and complete shedding averaged one to two weeks. Intervals between shedding ranged from one to several months. Shedding seemingly depended on temperature but might also have been influenced by the amount of moisture to which the snake was exposed. Adequate moisture was provided by spraying water into cages as needed. When snakes did not shed properly, they were soaked for ca. 20 minutes in water to facilitate ecdysis.

Hibernation.—According to some authors the most important aspect contributing to successful reproduction in captivity is artificial hibernation (Buzhansky and Kudryavtsev 1982; Grubant et al. 1973; Mamet and Kudryavtsev 1995; Strelkov 1986). Because this viper is found in mountainous areas where the temperatures remain seasonally cold, hibernation seems necessary for this species. In Lar Valley, the snake is found near bodies of water in the spring and summer where the temperature is higher than in other parts of the range and where slope and rocky habitat provides shelter (Behrooz 2009). In the lab after the vipers had been offered food for several months, the animals were placed into hibernation. On 15 October 2008 males and females were separated; the snakes were no longer offered food but water was provided. After a period of seven weeks the temperature of the cages was decreased to 10°C and the lamp was extinguished. The cooling period was 76 days. The temperature remained between 8–10°C throughout this time span. On 19 February 2009 the lamp was turned back on and natural sunlight penetrated the room; light was gradually increased from zero to three hours per week. After four weeks light was at 12 hours. On 20 March 2009 males and females were placed together.

In April 2009 we collected 12 additional vipers from Lar Valley that had emerged from hibernation in the wild. These snakes were sent to Tehran University where they were hibernated the following autumn, kept at temperatures ranging between 6 and 8°C. In March they emerged from hibernation.

RESULTS

First birth.—Of the eight gravid females collected on 22 July 2008 for Razi Institute, all but one had reproductive complications: stillborn young or infertile egg masses. On 30 August 2008, a lined-pattern gravid female was coiled at the center of the cage near the water container. During parturition muscular contractions of the posterior trunk were evident. The tail showed noticeable movements in an upward and downward plane. The first snake born had a lined pattern and died 2.5 h after birth because of a spinal chord defect. The second and third masses passed were infertile. The fourth neonate had a zig-zag pattern. Thus only one young snake was normal and healthy. Periods of time between births and passage of egg masses varied. Table 1 indicates the time for the entire process of parturition which lasted 102 min. After birth the spent female crawled to the cleaner corner of the cage, possibly to avoid the afterbirth. The young one crawled around the cage, shed on the fifth day, and started to feed soon after ecdysis. Newborn dead mice were the first prey items accepted. Tare and Renapurkar (1992) observed parturition in captive Russell's Viper (*Daboia russelii*) which was similar to what we observed with this female.

Second Birth.—On 24 April 2009, a group of 12 specimens were collected and housed at Tehran University. Of the six females collected in April 2009, one of the zig-zag patterned females spent almost all of the time under the heat lamp and was inactive. The posterior 1/3 of female's body was enlarged, indicating gravidity. On 21 August 10, neonatal vipers were born, and were weighed and measured: weight (3.8–4.9 g, mean = 3.8 g, variance = 0.1316); length (16.0–18.4 cm, mean = 17.5 cm, variance = 0.4921). Our snakes were smaller and lighter than those recorded by Mamet and Kudrjavtsev (1995), likely because our litter was larger. All had zig-zag patterns. Eight of ten neonates shed their skin in 5–7 days and two others shed after two months. After the first shedding none of the neonates accepted food readily so they often had to be stimulated to eat or forcibly fed. Moving food in front of the snake with long forceps stimulated a feeding response (see Murphy and Campbell 1987 for details). Neonates could be encouraged to accept small mouse parts such as a tail or leg. This was done by lightly touching the tip of the snake's snout or tail with the food item until a strike was induced whereupon feeding commenced. After one year the snakes accepted newborn mice without intervention by the caretakers. The survival ratio of neonates after one year was 50%.

In November 2009 the snakes were placed in hibernation. After emergence from hibernation on 30 March 2010 they were placed together to elicit courtship and copulation. During May courtship behavior by the male was noted but although copulation was not observed we are hopeful that future captive reproductive events will occur.

In summary, we conclude that artificial hibernation, type and diversity of food, vitamins, adequate fat reserves in females, and laboratory conditions based on environmental features duplicating the natural habitat of this species contributed to growth and courtship in the laboratory.

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AMPHIBIAN DISEASES

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Ranavirus Prevalence in Amphibian Populations of Wise County, Virginia, USA

Several factors have been linked to catastrophic amphibian declines, including habitat alteration and pathogens (Semlitsch 2003; Stuart et al. 2004). Ranaviruses (Family: Iridoviridae; Genus: *Ranavirus*) are one particular group of pathogens linked to massive amphibian die-offs (Daszak et al. 1999; Gray et al. 2009a; Green et al. 2002). Despite the evidence of ranaviruses becoming an emerging disease (Storfer et al. 2007), we still know relatively little concerning its geographic distribution among amphibian species. Rather, most recent amphibian pathogen studies center on *Batrachochytrium dendrobatidis* (Ohmer and Bishop 2011). However, *B. dendrobatidis* should not be the only pathogen that warrants investigative attention, as others are quite capable of exerting deleterious effects upon amphibian populations (Duffus 2009). Herein, we examine the occurrence of ranavirus infections in amphibians (including urodeles and anurans) present in the southern Appalachian Mountain areas. Ranaviruses have been associated with some mortality events in this region (Green et al. 2002), yet much of this area (and, much of North America in general) remains unsurveyed despite it being a hotspot for urodele diversity and endemism (Petranka 1998).

We sampled for ranavirus by collecting toe clips from dipnet and hand-caught amphibians of Wise County, Virginia, USA, from April to September 2010. Wise County is located in southwest Virginia (Fig. 1). Wise County covers approximately 1050 km^2, including approximately 3 km^2 of water coverage. Being in the midst of the Appalachian Mountains, Wise County has tremendously heterogeneous habitats along elevation gradients. Sample collections were conducted in the preferred habitats of all the amphibian species known to occur within the county (see Mitchell and Reay 1999 for complete amphibian species occurrence list) at various times of the day/night to increase the probability of capture success. We surveyed several regions of Wise County, including both private (with permission of landowner) and public land. However, the majority of sampling occurred on public-use land—mostly in various regions of the Jefferson National Forest. Indeed, a large portion of Wise County is part of the Jefferson National Forest. Our surveyed regions include: Cave Springs Recreation Area and Stone Mountain Trail (both near Big Stone Gap, Virginia); Guest River Gorge Trail, the Clinch River (and its numerous branches), and Little Stony Falls (all near Coeburn, Virginia); High Knob Recreation Area and Flag Rock Recreation Area (both near Norton, Virginia); Red Fox Trail and Pound Lake (both near Pound, Virginia); Cane Patch Recreation Area, Phillips Creek Recreation Area, and the main campus of the University of Virginia's College at Wise (all near Wise, Virginia). We are not reporting exact locations due to the vulnerability of these endemic urodele species in the area. No individual was sampled more than once during our approximately 121 person-hours in the field.



FIG. 1. Map of Wise County, Virginia, USA.

In order to minimize cross contamination between collected toe clip samples and between field sites, all equipment and instrumentation used were rinsed in a 10% bleach solution, followed by a dechlorinated tap water rinse between every use/sample acquisition. In addition, nitrile gloves were worn and replaced between each collected and handled amphibian. Individual toe clips were immediately preserved and stored in 1.0 ml of 70% ethanol in a 2.0 ml screw-cap vial. DNA extractions were completed using Promega® Wizard Genomic DNA Purification Kits (Promega® Corporation, Madison, Wisonsin, USA), as per manufacturer's instructions. Extracted DNA products were amplified using Fisher® BioReagents exACTGene PCR Kits (Fisher Scientific®, Fair Lawn, New Jersey, USA), using PCR primers #4 and #5 described in Mao et al. (1996 and 1997) that amplify an approximately 500 bp region of the ranavirus major capsid protein. PCR was performed using the following protocol slightly modified from Greer and Collins (2007) and Greer et al. (2009): an initial denaturation at 94°C for 5 min; denaturation

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TABLE 1. Ranavirus prevalence in the amphibians of Wise County, Virginia, USA.

Species	No. infected / total sampled	Prevalence of infection (95% confidence interval)
Caudata		
Desmognathus fuscus	7 / 12	0.58 (0.32–0.81)
Desmognathus monticola	8 / 12	0.67 (0.39–0.86)
Desmognathus ochrophaeus	0 / 1	0 (0–0.79)
Desmognathus quadramaculatus	3 / 3	1 (0.44–1)
Eurycea cirrigera	10 / 21	0.48 (0.28–0.68)
Eurycea longicauda	2 / 3	0.67 (0.21–0.93)
Eurycea lucifuga	1 / 4	0.25 (0.05–0.7)
Notophthalmus viridescens	1 / 9	0.11 (0.02–0.44)
Plethodon cinereus	0 / 3	0 (0–0.56)
Plethodon glutinosus complex	4 / 15	0.27 (0.11–0.52)
Plethodon richmondi	0 / 5	0 (0–0.43)
Anura		
Anaxyrus americanus	0 / 6	0 (0–0.39)
Hyla chrysoscelis	0 / 9	0 (0–0.3)
Pseudacris crucifer	0 / 2	0 (0–0.66)
Lithobates catesbeianus	2 / 10	0.2 (0.06–0.51)
Lithobates clamitans	0 / 1	0 (0–0.79)
Lithobates palustris	1 / 2	0.5 (0.09–0.9)
Lithobates sylvaticus	0 / 1	0 (0–0.79)
Total	39 / 119	0.33

at 94°C for 1 min, annealing at 55°C for 1 min, and extension at 72°C for 1 min, each cycled 35 times. PCR products, including a positive control and negative controls (an extraction control and a DNA-free PCR mixture control) for each gel, were visualized on 1.0% agarose gel stained with ethidium bromide in 1X TAE buffer under ultraviolet (UV) light. All DNA extractions were amplified and run in duplicate. A positive test was recorded only if each sample duplicate yielded the targeted ~500 bp fragment. If sample duplicates had conflicting results (i.e., a positive and a negative) or if both duplicates yielded a negative result, its respective sample DNA was re-extracted and PCR was conducted in duplicate twice more. All equipment and materials used for DNA extraction and PCR amplification were sterilized under UV light prior to and between uses.

A total of 119 samples were collected from 18 amphibian species in Wise County, Virginia, USA (Table 1). Overall, 39 of 119 (approximately 33%) samples tested positive for *Ranavirus*, of which 36 of 39 (approximately 92%) were caudates and 3 of 39 (approximately 8%) were anurans. However, no sampled individual showed external signs of ranavirus infection, such as erythema or edema. Three samples (two *E. cirrigera* and one *Lithobates catesbeianus*) were excluded from analysis after multiple extractions and amplifications still yielded mixed PCR results. However, other samples from these two species tested positive.

Our data are the first to show the presence of ranavirus infections in amphibian populations of Wise County, Virginia, USA. In addition, we show *Desmognathus fuscus*, *Eurycea cirrigera*, *E. longicauda*, *E. lucifuga*, and the *Plethodon glutinosus* complex as new plethodontids capable of acting as ranavirus hosts. However, it is not the first report of ranavirus in southern Appalachian Mountain amphibians. Gray et al. (2009b) reported the first occurrences of ranavirus infections in lungless salamanders (Plethodontidae) from Tennessee, with a prevalence of 81%. While our data do not suggest nearly as high prevalence among plethodontids (approximately 44%), our low sample size per species (thus, our subsequently large confidence intervals; Table 1) coupled with the use of toe-clips from numerous field locales may warrant caution when discussing true prevalence. Toe-clips have a false-negative rate of ~12% relative to livers in field samples (St-Amour and Lesbarreres 2007) and recent infections can be difficult to detect in peripheral tissues (Greer and Collins 2007), so we likely underestimate true prevalence. However, unless dead individuals were found in the field (and they were not), we did not desire to euthanize any amphibians—particularly some of the salamanders because of their endemism or due to ongoing mark/recapture studies.

In summary, we report the first occurrence of ranavirus in Wise County, Virginia, USA. Continual monitoring of ranavirus occurrence and possible infection in amphibian populations of the southern Appalachians should be part of future efforts because that region houses several endemic amphibians, particularly plethodontid species. In addition, we report five new plethotontids (*D. fuscus*, *E. cirrigera*, *E. longicauda*, *E. lucifuga*, and the *P. glutinosus* complex) as ranavirus hosts. To date, only 15 plethodontids, including our new accounts, have been reported as ranavirus hosts (see Gray et al. 2009b for other known plethodontid hosts). With more than 370 described plethodontid species, additional work investigating which species can act as ranavirus hosts is warranted and encouraged. In addition to investigating possibly new locations and new amphibian host species for ranaviruses, emphasis should also be placed on assessing ranavirus pathogenicity (Duffus 2009). Pathogenicity is not often addressed in amphibian disease investigations despite its importance to amphibian population dynamics (Duffus 2009). Studies addressing this knowledge gap are essential for furthering our understanding of amphibian host-virus interactions and molecular characteristics of potentially novel ranaviruses in these hosts.

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Detection of *Batrachochytrium dendrobatidis* on Amphibians in Pursat Province, Cambodia

Cambodia, along with other Southeast Asian countries, has an enormously diverse flora and fauna, but past turmoil has had a significant and disparaging impact on wildlife (Loucks et al. 2009). Despite the struggles and hardships faced by the country, some of the country's wildlife, particularly reptiles and amphibians, are still being discovered. A recent survey of amphibians and reptiles in the east of Cambodia, for example, has led to the discovery of various new species of frogs, snakes, and lizards (Stuart et al. 2006). New herpetofauna, particularly anurans, were also discovered in southwest Cambodia where surveys yielded new species in isolated areas of the Cardamom Mountains, implying the species had no prior exposure to humans and thus were not directly impacted by their activities prior to their classification (Grismer et al. 2007, 2008; Ohler et al. 2002). Global declines of amphibians have been linked to human activities resulting in habitat destruction and alteration (Alford and Richards 1999), accelerated global environmental change (Gibbs and Breisch 2001), or interspecific competition and hybridization (Kiesecker and Blaustein 1997), as well as to the emerging infectious disease chytridiomycosis caused by the fungus *Batrachochytrium dendrobatidis* (*Bd*) (Berger et al. 1998). The presence of *Bd* has been confirmed worldwide (www.Bd-maps.net), including Southeast Asia (Fisher et al. 2009b). The first studies on *Bd* in Southeast Asia have been performed within the last decade starting with island states or countries such as Hong Kong, Indonesia, Taiwan,

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Fig. 1. Location of Pursat province, Cambodia, where amphibians were sampled for *Batrachochytrium dendrobatidis* at creeks and other small pools of water in the village of Pramouy (12.3036°N, 103.1008°E), alongside a forest road about 10 kilometers outside Pramouy (12.1017°N, 103.1041°E), and within an isolated forest atop Mount Tumpor in the Cardamom Mountains (12.3740°N, 103.0568°E).

Table 1. Amphibians sampled for *Batrachochytrium dendrobatidis* (*Bd*) from the village of Pramouy (Village), alongside a forest road ~10 km outside Pramouy (Forest Road), and within an isolated forest atop Mount Tumpor in the Cardamom Mountains in Pursat province, Cambodia. Conservation status from www.icun.org: LC (least concern), VU (vulnerable), DD (data deficient). * indicates frogs that are likely a different species from those found in non-mountainous areas.

Location	Amphibian species	Conservation status	No. *Bd*-positive individuals /total no. samples
Village	*Duttaphrynus melonstictus*	LC	2/15
	Fejervarya limnocharis	LC	13/24
	Microhyla butleri	LC	0/1
	Microhyla fissipes	LC	0/3
	Microhyla pulchra	LC	3/5
	Occidozyga lima	LC	0/5
	Polypedates leucomystax	LC	5/11
Forest Road	*Fejervarya limnocharis*	LC	0/1
	Kalula pulchra	LC	1/1
	Microhyla heymonsii	LC	0/1
	Occidozyga lima	LC	0/1
	Occidozyga martensii	LC	0/1
	Polypedates leucomystax	LC	8/13
Mount Tumpor	*Limnonectes gyldenstolpei*	LC	1/6
	Microhyla berdmorei	LC	0/3
	Philautus cardamonus	DD	7/15
	*Polypedates cf. leucomystax**	DD	1/3
	Quasipaa fasciculispina	VU	0/2
	Rana faber	LC	7/16
	Rhacophorus bipunctatus	LC	5/8
	Rhacophorus bisacculus	LC	6/9

and Japan (Fisher et al. 2009b; Kusrini et al. 2008; Lehtinen et al. 2008; Rowley et al. 2007), eventually including detection from mainland countries like Thailand, South Korea, and China (Bai et al. 2010; McLeod et al. 2008; Wei et al. 2010; Yang et al. 2009). Consequently, the reported detection of *Bd* in the continent of Asia is a very recent event, and thus literature on this subject currently remains preliminary given the amphibian biodiversity.

The goal of our study was to increase the knowledge of the distribution of *Bd* in mainland Southeast Asia. We sampled amphibians for *Bd* occurrence in the Cardamom Mountains, in and around the small village of Pramouy in Pursat province, Cambodia (Fig. 1), with three levels of urbanization. The level of human influence was categorized as high (areas where people frequently congregate), medium (areas with minimal human disturbance), or low (areas where humans very rarely visit). Sample locations included creeks and other small pools of water in the village of Pramouy (high, 12.3036167°N, 103.1008333E; 240 m elev.), alongside a forest road about 10 km outside Pramouy (medium, 12.10175°N, 103.10405°E; 400 m elev.), and within an isolated forest atop Mount Tumpor in the Cardamom Mountains (low, 12.3740333°N, 103.05675°E; 1100 m elev.).

We sampled 144 amphibians at the three locations (village of Pramouy, N = 64; Forest Road, N = 18; Mount Tumpor, N = 62) during a five-day period starting on 25 April 2010 (Table 1). All captures were performed either at dawn or dusk using small nets. No amphibians showed clinical symptoms of chytridiomycosis (e.g., lethargy, lack of righting reflex, excessive sloughing of skin). For each individual, a sterile cotton swab was run ten times over each of the four feet, the medial and ventral area of the rear legs, on each of the sides from groin to armpit, and on the ventral surface of the body of each individual (Kriger et al. 2006). Swabs were placed in 2-mL cryotubes and kept at 4°C prior to molecular analyses.

DNA was extracted from cells on swabs using the Wizard Genomic DNA Purification kit (Promega, Madison, Wisconsin) in accordance with the protocol for extraction from animal tissue, and *Bd* was detected and quantified using a TaqMan quantitative real-time PCR (*q*PCR) assay according to Boyle et al. (2004). Samples were tested in triplicate, using 20-µL reactions containing 10 µL *q*PCR Fast-Mix™ (Quanta Biosciences, Gaithersburg, Maryland), PCR primers ITS1-3 Chytr and 5.8S Chytr at 900 nM, probe Chytr MGB2 at 250 nM, and a single µL of template DNA. A single µL of sterile water facilitated the negative control for each reaction (also performed in triplicate). Analyses were performed in an Eppendorf *realplex*^{2} thermocycler (Eppendorf, Hauppauge, New York) using a 50°C incubation for 2 min, followed by 95°C for 10 min, and finally 50 cycles of 95°C for 15 s and 60°C for 1 min (Boyle et al. 2004). Quantification of *Bd* was based on a standard curve created using a serial dilution of a standardized DNA control with known copy number (CSIRO Livestock Industries, Geelong, Australia).

We detected *Bd* on 59 of 144 (41%) individuals tested (Table 1). Of amphibians captured within the village (high human impact), along the forest road (medium human impact), and atop Mount Tumpor (low human impact), 36%, 50%, and 44% of the amphibians were *Bd*-positive, respectively. These values were statistically not different from each other (Pearson's Chi-squared test in R 2.11.1; $\chi^2 = 1.4475$, p = 0.48). The number of *Bd* genomic equivalents (GE) per individual ranged from 0 to 373.4 GE, and averaged 27.9 GE. The average (± SE) numbers of *Bd* GE on amphibians from the village, along the forest road, and atop Mount Tumpor were 25.2 GE (± 40.6), 22.3 GE (± 31.2), and 31.9 GE (± 56.0), respectively.

We demonstrate that *Bd* was prevalent in amphibians regardless of the perceived level of human influence among the environments, revealing approximately half of the amphibians tested from each environment were infected with the fungus. However, none of the amphibians had identifiable symptoms of chytridiomycosis. The dynamics and consequences of *Bd* infection are complex, and not well understood. Whereas there are numerous studies describing how introduction of *Bd* can quickly decimate a population of amphibians (Daszak et al. 1999; Lips et al. 2006; Pounds et al. 2006), there are also studies that show amphibians can be infected with the fungus with no apparent detrimental effects. In those cases the infected frogs act as asymptomatic carriers; examples of such carriers include the American Bullfrog, *Lithobates catesbeianus,* and the African Clawed Frog, *Xenopus laevis* (Daszak et al. 2004; Weldon et al. 2004), two species that have been introduced to non-native habitats in many parts of the world. In addition, it has been speculated that the fungus could have sub-lethal effects, for example it may stunt the growth of amphibians, or amphibians may be temporarily affected (Kriger et al. 2007; Walker et al. 2010). The potential

seasonality of infection rates have been noted (Gaertner et al. 2009; Kriger and Hero 2007). We sampled during the dry season which might have influenced *Bd* detection rates in our study. It is also possible that the genotypes of *Bd* were hypovirulent and thus less lethal than others (Fisher et al. 2009a), or that the critical threshold density for *Bd* on amphibians was not reached and thus amphibians were not showing symptoms of chytridiomycosis (Vredenburg et al. 2011). Also, it is known that amphibians have innate immune defenses to counter pathogens like *Bd* in the form of antimicrobial peptides secreted on the skin (Ramsey et al. 2011; Rollins-Smith et al. 2003; Rollins-Smith and Conlon 2005; Woodhams et al. 2007). Studies have indicated that immune-suppressed amphibians are more susceptible to acquiring diseases from their environment due to inhibited or decreased production of peptides during periods of stress or from pesticide use (Davidson et al. 2007; Rachowicz et al. 2005). We did not assess either sublethal effects on individuals or the stress levels of the amphibians in this study.

Anthropogenic influence appears to have played a significant role in the global distribution of *Bd* (Fisher et al. 2009b; Skerratt et al. 2007). Recently, it has been suggested that trade of American Bullfrogs for human consumption might be a key component in the dissemination of *Bd* in China as well as across the globe (Bai et al. 2010). The concept of pathogen pollution refers to anthropogenic movement of pathogens into new geographic locations via domestic and wild animals, products and materials (Daszak et al. 2001). This might explain how amphibians collected from the village and forest road were positive for *Bd* as human interaction with fauna may be frequent, however, it does not adequately explain how amphibian populations sampled atop Mount Tumpor first encountered the pathogen. Mount Tumpor, at least the area where we collected, is free of human influence, except for scientific expeditions (the nearest settlement being >1 km). However, *Bd* transmission pathways across landscapes are little understood. Previous studies have shown amphibians living in pristine environments have undergone population declines associated with *Bd* (Kolby et al. 2010; Lips et al. 2004; Puschendorf et al. 2006). Other studies indicate *Bd* prefers habitats at higher altitudes, cooler climates, and rainy or wet environments, which parallel the environmental conditions on Mount Tumpor (Drew et al. 2006; Rohr and Raffel 2010; Ruiz and Rueda-Almonacid 2008). If *Bd* were introduced as a novel pathogen to our study area in Cambodia by anthropogenic pathways at an earlier time, it might have spread to achieve its current distribution by other vectors of transmission.

In summary, we have reported the incidence of *Bd* in Cambodia across three environments that have different levels of human influence. We found there to be no difference in *Bd* infection with respect to the predicted level of human activity among the three sampling areas. To date *Bd* has been detected in almost every country bordering Cambodia (Bai et al. 2010; McLeod et al. 2008; Wei et al. 2010; Yang et al. 2009), suggesting that *Bd* has probably crossed the borders of Laos, Vietnam, and Myanmar despite the current absence of detailed reporting from those nations. Future studies are needed to both: 1) address the prevalence of *Bd* in these countries (Rowley et al. 2010), as well as in other Asian countries, in order to fully understand the dissemination of this pathogen and to maintain the well-being of amphibians worldwide, and 2) monitor these amphibian populations long-term in case their infection rates change and symptoms start appearing.

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Detection of *Batrachochytrium dendrobatidis* in Frogs from Different Locations in Cambodia

The recently emerged infectious disease chytridiomycosis caused by the fungus *Batrachochytrium dendrobatidis* (*Bd*) has been implicated as a significant contributor to amphibian population declines worldwide (Fisher et al. 2009; Kilpatrick et al. 2009; Schloegel et al. 2006). The presence of *Bd* has been confirmed for all continents with amphibians (Fisher et al. 2009), with a considerable number of reports available for Australia (Bell et al. 2004; Hero and Gillespie 1997; Kriger et al. 2007), Africa (Goldberg et al. 2007; Hopkins and Channing 2002; Lane et al. 2003), Europe (Bosch et al. 2001; Bovero et al. 2008; Garner et al. 2005; Walker et al. 2010), and North and South America (Bonaccorso et al. 2003; Davidson et al. 2003; Herrera et al. 2005; Ouellet et al. 2005; Rothermel et al. 2008) (see also www.Bd-maps.net). The presence of *Bd* also has been confirmed for Asia, however, reports are relatively recent and the surveys remain limited to a small number of countries (e.g., China, Indonesia, Japan and South Korea) (Bai et al. 2010; Goka et al. 2009; Kusrini et al. 2008; Yang et al. 2009).

We have recently demonstrated the presence of *Bd* on amphibians in the southwestern part of Cambodia, including an isolated area of the Cardamom Mountains, with comparable prevalence of infected amphibians observed in environments impacted by various degrees of human activities (Mendoza et al. 2011). With 40–50% of all amphibians from these environments being positive for *Bd*, prevalence of infection resembled that found in amphibians from South Korea (39%) (Yang et al. 2009), but were much higher than those reported for amphibians from natural environments in China, Japan and Indonesia with 15%, 4% and 3%, respectively (Bai et al. 2010; Goka et al. 2009; Kusrini et al. 2008). To validate our high prevalence of *Bd* infection, we expanded our sampling to sites throughout Cambodia, and included amphibians obtained from market environments that, as for those in pet shops (Goka et al. 2009), have been shown to display higher frequency of infection than those in natural environments (Bai et al. 2010). We also examined the pattern of *Bd* haplotypes among our samples.

Creeks and small pools of water were used as sampling sites in three locations which included the capital city Phnom Penh (11.5193167°N, 105.0100667°E), the Angkor Center for the Conservation of Biodiversity (ACCB) (13.67805°N, 104.0261°E), and the city of Kratie (12.4875333°N, 106.0159833°E). Market frogs were obtained from Sihanoukville (10.62325°N, 103.53285°E) (Fig. 1).



FIG. 1. Cambodia locations where amphibians were sampled for *Batrachochytrium dendrobatidis*, including Phenom Phen, ACCB, Kratie, and Sihanoukville Market.

A total of 238 amphibians were obtained across the four locations (Phnom Penh, N = 77; ACCB, N = 65; Kratie, N = 66; Sihanoukville Market, N = 30) during one-day sampling trips in 2009 (25 May, 8 June, 19 June, and 13 June, respectively) (Table 1). None of these amphibians showed symptoms of chytridiomycosis (e.g., lethargy, lack of righting reflex, excessive sloughing of skin). Individual amphibians were sampled with a sterile cotton swab following the instructions outlined in Kriger et al. (2006), and swabs placed in 2 ml cryotubes and kept at 4°C until DNA extraction with the Wizard® Genomic DNA Purification Kit (Promega, Madison, Wisconsin) using the protocol for extraction from animal tissue. A nested PCR approach was used to test for *Bd* (Gaertner et al. 2009). This approach was based on the initial amplification of the 5.8S rRNA gene and the flanking internal transcribed spacer (ITS) of all fungi (White et al. 1990). A portion of the purified amplification product of this reaction was then used as template in a second *Bd*-specific PCR reaction (Annis et al. 2004). These second reactions were then analyzed for the presence of 300-bp amplicons (Annis et al. 2004) using gel electrophoresis (2% agarose in TAE buffer) (Sambrook et al. 1989).

Of the 238 amphibians tested, a total of 86 (36%) were positive for the 300-bp fragment, indicating the presence of *Bd* (Table 1). At Phnom Penh, 9 amphibian species were caught, and *Bd* was detected on individuals from 5 species with an average

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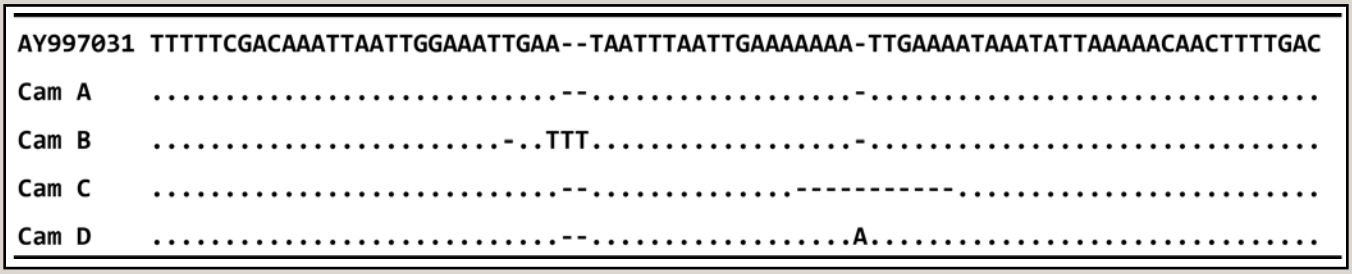


FIG. 2. Alignment of partial sequences of *Bd* isolate AFTOL-ID 21 (AY997031) and haplotypes Cam A to D, retrieved from frogs collected from different locations in Cambodia. The alignment covers bases 41 to 120 of the sequences (297 bp for *Bd* isolate AFTOL-ID 21 (AY997031), including primer sequences Bd1a and Bd2a), indicating only the differences in sequences among haplotypes CAM A to D and to *Bd* isolate AFTOL-ID 21 (James et al. 2006).

prevalence of infection of 35% (i.e., 27 of 77 individuals). A similar infection rate was obtained for Kratie (23 of 66 individuals) where 7 species were sampled and individuals of 5 species were found to be positive for *Bd*. A lower infection rate of 22% (14 of 65 individuals in 6 of 12 species) was obtained at ACCB, while market frogs all belonging to the species *Hoplobatrachus rugulosus* showed the highest prevalence of infection with 73% (22 of 30 individuals) (Table 1). These results demonstrate the presence of *Bd* in amphibians from different parts of Cambodia, revealing a similar detection prevalence compared to our previous study on amphibians from the southwestern part of Cambodia, including isolated areas in the Cardamom Mountains (Mendoza et al. 2011). The high prevalence of *Bd* in market frogs also confirms the previously reported trend of higher detection rates of *Bd*-infected amphibians in man-made environments such as pet shops or markets (Bai et al. 2010; Goka et al. 2009) which is likely a consequence of increased potential for cross-contamination due to the space limitations typically experienced by the large quantities of amphibians present.

TABLE 1. Detection of *Batrachochytrium dendrobatidis* (*Bd*) in frogs collected in Cambodia at Phnom Penh, the Angkor Center for the Conservation of Biodiversity (ACCB), Kratie, and Sihanoukville Market.

Species (no. samples)	*Bd*-positive samples (%)	Haplotypes (% of *Bd*-positive samples) A	B	C	D
Phnom Penh					
Bufo melanostictus (N=28)	39	64	9		27
Kaloula pulchra (N=5)	40	50			50
Occidozyga lima (N=2)	50	100			
Microhyla fissipes (N=8)	38	100			
Hylarana erythraea (N=23)	43	80	10		10
Four additional species (N=11)[1]	0				
Total (N=77)	**35**	**74**	**7**	**0**	**19**
ACCB					
Polypedates leucomystax (N=33)	24	50		25	25
Fejervarya limnocharis (N=7)	29	100			
Occidozyga lima (N=2)	50	100			
Bufo macrotis (N=5)	20	100			
Microhyla heymonsi (N=2)	50	100			
Microhyla pulchra (N=2)	50	100			
Six additional species (N=14)[2]	0				
Total (N=65)	**22**	**71**	**0**	**14**	**14**
Kratie					
Bufo melanostictus (N=36)	39	71		14	14
Kaloula pulchra (N=3)	33	100			
Fejervarya limnocharis (N=9)	44	100			
Occidozyga lima (N=8)	13	100			
Microhyla fissipes (N=8)	38	67		33	
Two additional species (N=2)[3]	0				
Total (N=66)	**35**	**78**	**0**	**13**	**9**
Sihanoukville Market					
Hoplobatrachus rugulosus (N=30)	73	59	27	14	
Total (N=30)	**73**	**59**	**27**	**14**	**0**

[1] *Polypedates leucomystax* (N = 2), *Fejervarya limnocharis* (N = 6), *Occidozyga martensii* (N = 2), and *Micryletta inornata* (N = 1)
[2] *Bufo melanostictus* (N = 2), *Kaloula pulchra* (N = 1), *Microhyla fissipes* (N = 5), *Microhyla butleri* (N = 1), *Occidozyga martensii* (N = 3), and *Hylarana mortenseni* (N = 2)
[3] *Polypedates leucomystax* (N = 1), and *Occidozyga martensii* (N = 1)

All 86 300-bp amplicons obtained in this study were purified, and then sequenced at the DNA Sequencing Facility of the Institute for Cellular and Molecular Biology at the University of Texas at Austin, Texas. Sequences were compared to GenBank/EMBL databases and aligned using BLAST (Pearson and Lipman 1988) and alignment functions in Geneious 4.8.3 (Drummond et al. 2009). Sequence diversity was limited with 4 haplotypes being discovered (Cam A, B, C, and D) (Table 1, Fig. 2). All haplotypes differed from each other by small sequence variation in the same region of the amplicon (Fig. 2). Compared to Cam A, haplotype Cam B differed by a 2-bp insertion and a single nucleotide substitution, while haplotype Cam C was characterized by a 10 bp deletion, and haplotype Cam D by one additional base. All haplotypes were represented by identical sequences of isolates in the GenBank/EMBL databases, except for Cam B where a 1-bp insertion in a different region resulted in only 99.6% similarity to the sequence of an isolate (Bd-08

[AB435218]). The sequence of Cam A was the most encountered in the database with sequences of more than 25 isolates being identical (e.g., AFTOL-ID21 [AY997031] or NE14 [EU779863]), while those of the remaining haplotypes were rare with sequences of 1 or 2 isolates being identical (Bd-04 [AB435214] for Cam C, and MF22879 [FJ232005], and MF22913 [FJ232007] for Cam D).

The prominence of haplotype Cam A in the databases was reflected by its detection frequency in our samples. Cam A was the most abundant haplotype at all locations representing 59-78% of all *Bd*-positive samples (Table 1). It was also present and most abundant on all amphibian species that tested positive for *Bd*. Haplotype Cam A is identical to "haplotype A" discovered in a large survey of *Bd*-infected amphibians in Japan (Goka et al. 2009). Similar to haplotype Cam A in our study, haplotype A was a major contributor to *Bd* infections, both in man-made and in natural systems, with most of the remaining 25 haplotypes B-Z recovered from Japan detected at much lower frequency. The distribution of haplotype A in Japan, however, was not as prominent as Cam A in our study. In Japan, only few species and individuals were infected per location, and large differences in prevalence amongst infected species was observed among locations (Goka et al. 2009). The remaining three haplotypes, Cam B, C, and D, were found in low frequency. Haplotype Cam C was identical to haplotype E identified in Japan, and Cam B was represented by haplotype I (though with one mismatch). For Cam D, however, no representative haplotype was found in that study (Goka et al. 2009). Consequent with their low frequency in detection, it is not surprising that these haplotypes were not present at all locations or for all amphibian species. Patterns of detection with Cam C absent at Phnom Penh, Cam B absent at ACCB and Kratie, and Cam D absent at Sihanoukville market (Table 1) might therefore entirely be due to the low frequency of detection. As this study only provides initial data for chytrid fungus and potential effects within Cambodia, any further statements about the significance of these distribution patterns would thus be highly speculative, and the matter requires additional studies.

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Chytrid Fungus in American Bullfrogs (*Lithobates catesbeianus*) along the Platte River, Nebraska, USA

Chytridiomycosis is an emerging infectious disease in amphibians that was discovered in the late 1990s (Berger et al. 1998; Longcore et al. 1999), with retrospective surveys indicating isolated cases dating to 1902 in Japan (Goka et al. 2009), 1938 in Africa (Weldon et al. 2004), and 1961 in North America (Ouellet et al. 2005). This disease is caused by the pathogen *Batrachochytrium dendrobatidis* (*Bd*), a species of chytrid fungus, and it is hypothesized to contribute to amphibian declines worldwide (Berger et al. 1998; Daszak et al. 1999; Lips et al. 2006; Collins 2010). *Bd* has been detected in amphibians on all six continents inhabited by amphibians, and large numbers of *Bd*-positive samples have been collected from various sites across North America (www.Bd-maps.net; accessed 7 June 2011). The central United States, however, has not been sampled extensively for *Bd*. To date, no published accounts of *Bd* exist for amphibians from Nebraska, USA, although two localities with *Bd* in Nebraska are noted online (www.Bd-maps.net; J. Krebs, Henry Doorly Zoo, Omaha, Nebraska, and Zimmerman Ranch, Dunning, Nebraska). Our objective was to determine whether *Bd* is present along the Platte River in south-central Nebraska.

We sampled anurans along the Platte River in Hall County, Nebraska, on land managed by Platte River Whooping Crane Critical Habitat Maintenance Trust, Inc., located on Shoemaker Island (40.7884°N, 98.4650°W). We prioritized capturing *Lithobates catesbeianus* (American Bullfrog) because they are nonclinical carriers of *Bd* (Daszak et al. 2004; Garner et al. 2006), are abundant in Nebraska (Fogell 2010), and are a concern for wildlife management worldwide due to their invasiveness (Ficetola et al. 2007). We targeted sampling along two sloughs (linear, water-filled depressions) surrounded by mesic, tall-grass prairie (Fig. 1; Slough 1 start: 40.7921°N, 98.4628°W; end: 40.7939°N, 98.4584°W; Slough 2: start: 40.7959°N, 98.4444°W, end: 40.7989°N, 98.4421°W). We also opportunistically collected *Anaxyrus woodhousii* (Woodhouse's Toad) and *Lithobates blairi* (Plains Leopard Frog) from these sloughs, as well as nearby point locations across the island, including isolated ponds, puddles, and roads (Fig. 1). Samples were collected 28 April, 5 June, 9 and 10 July, and 3 and 6 September 2010.

To minimize contamination, we captured amphibians by hand while wearing disposable vinyl gloves that we changed between each capture. We also captured some Plains Leopard Frogs with nets from ponds and puddles. Each animal captured was kept individually in plastic or cloth bags until processed in the field and then released; plastic bags were disposed after one usage whereas cloth bags were washed between samples. For each individual, we determined sex and visually examined for wounds and other abnormalities. We sampled for *Bd* following protocols of the Amphibian Disease Laboratory, Institute for Conservation Research at the San Diego Zoo and used their preferred sampling kits, comprised of plastic-handled, fine tip cotton swabs (Dryswab™; MW113; Medical Wire & Equipment Co. LTD., England) and screw-top storage tubes (Cryogenic Vials, Nalge Nunc International, New York). We swabbed the skin on ventral surfaces, targeting the pelvic patch, thighs, and toe webbing, making 5 passes on each surface with a single swab for each animal. The swab was air-dried, and the tip placed in an individually marked vial.

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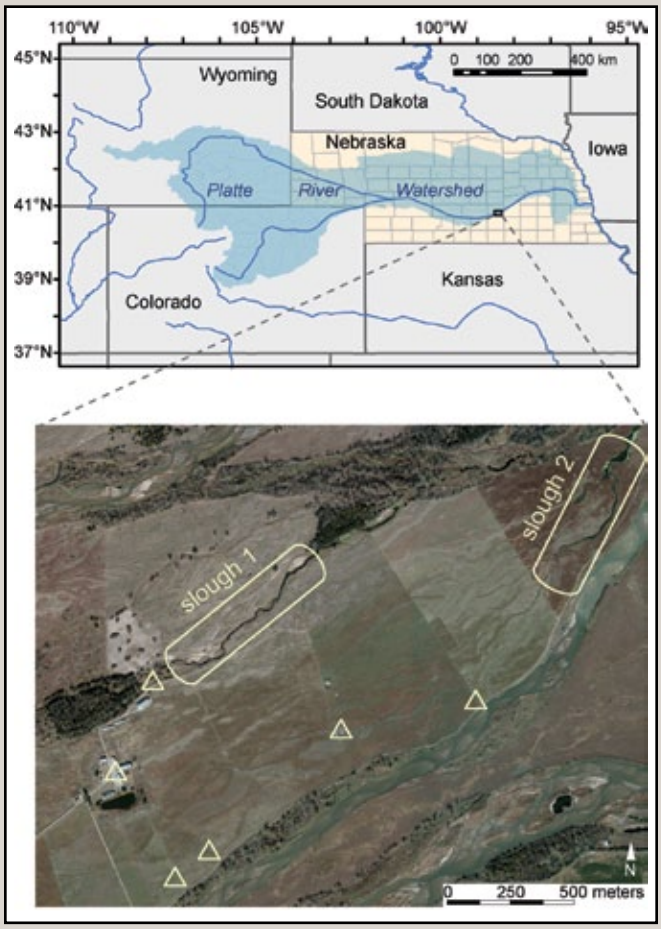


FIG. 1. Location of sampling sites along the Platte River in central Nebraska, USA. Locator map shows the study region within the Platte River watershed. Aerial photograph depicts Shoemaker Island (Hall County, Nebraska) where anurans were sampled. Most sampling occurred in sloughs 1 and 2, and opportunistic captures were collected from point locations (denoted by triangles). Aerial photograph was taken in October 2010.

Samples were shipped to the San Diego Zoo for processing where they were analyzed for *Bd* using real-time (Taqman) PCR to amplify the ITS1 region (Boyle et al. 2004). Results were reported as positive or negative. We examined associations among *Bd* presence, sex, sampling date, and sampling location with Pearson Chi-square tests in PASW Statistics version 18 (Chicago, Illinois, USA).

We captured a total of 118 amphibians, including 76 adult American Bullfrogs, 1 American Bullfrog tadpole, 20 Plains Leopard Frogs, and 21 Woodhouse's Toads. We detected *Bd* only in American Bullfrogs, with 31 adults (41%) testing positive. We did not detect an association between *Bd* infection and sex (χ^2 = 1.14, df = 1, P = 0.28) or sampling location (χ^2 = 1.81, df = 2, P = 0.40), but we found an association between *Bd* infection and sampling date (χ^2 = 14.12, df = 2, P = 0.001), with 67% of American Bullfrogs testing positive in April, 0% testing positive in June, and 39% testing positive in July. We observed infected American Bullfrogs in both sloughs; the one American Bullfrog sampled from an isolated pond located 600 m from the sloughs tested negative. No infected individuals were detected in the other two species, even in sloughs with infected American Bullfrogs (N = 2 Woodhouse's Toads collected from Slough 1, N = 18 Plains Leopard Frogs collected from Slough 1, and N = 1 Plains Leopard Frog from Slough 2).

We detected high prevalence of *Bd* (41%) in American Bullfrogs along the Platte River in central Nebraska. Other central USA accounts of *Bd* include surveys in the north-central United States (Iowa, Wisconsin, and Michigan), where *Bd* was detected in nine species, including American Bullfrogs (Sadinski et al. 2010); surveys in Colorado and Wyoming, where *Bd* was widely distributed (51% of sites examined) in Boreal Toads (*Bufo boreas boreas*), Western Chorus Frogs (*Pseudacris triseriata*), Northern Leopard Frogs (*Lithobates pipiens*), and Wood Frogs (*Lithobates sylvaticus*) (Young et al. 2007); and surveys along the Rocky Mountains, where *Bd* was detected in six species (Muths et al. 2008). Additional surveys of *Bd* throughout the central United States are warranted to gain baseline information about the presence of this pathogen, especially as it relates to species that have declined in recent decades for unknown reasons (e.g., Hayes and Jennings 1986).

Accumulating evidence supports the "novel pathogen hypothesis" to explain the recent worldwide invasion of *Bd* (Rosenblum et al. 2009). This specifically suggests that human-mediated movement of infected frogs, including the American Bullfrog, precipitated *Bd* range expansion (Fisher and Garner 2007; Schloegel et al. 2009a,b). In light of this, our results are a special concern for the region as American Bullfrogs were introduced to waterways throughout Nebraska in the 20th century and appear to be expanding their distribution (Fogell 2010). American Bullfrogs were not documented in surveys of herpetofauna in 1980 on an island adjacent to our study site (Jones et al. 1981), but they were abundant in our 2010 surveys. Expansion of American Bullfrogs could result in the introduction of *Bd* to the native amphibians in the region, notably Plains Leopard Frogs, Woodhouse's Toads, and Boreal Chorus Frogs. *Bd* infections already have been reported in Chorus Frogs (*Pseudacris maculata* and *P. triseriata*) and Northern Leopard Frogs (*Lithobates pipiens*) in Colorado and Wyoming (Young et al. 2007; Muths et al. 2008). Although we did not detect *Bd* in Plains Leopard Frogs or Woodhouse's Toads, a number of factors may have prevented this. Our sample size was small (Skerratt et al. 2008), and studies have shown lower prevalence of *Bd* during the summer (Longcore et al. 2007; Retallick et al. 2004; Voordouw et al. 2010). In our study, most positive detections of *Bd* were at the earliest sampling date (April) in American Bullfrogs, but we captured most Plains Leopard Frogs and Woodhouse's Toads at later sampling dates, thus we may have missed a seasonal peak in infection. In addition, recent work suggests that our collection method (swabbing) is less sensitive than other methods (toe clips and bag rinses) for detection (Voordouw et al. 2010).

Additional surveys of native anurans need to be conducted at this site to monitor potential cascading effects of transmission of *Bd* from invasive American Bullfrogs. Prevalence of *Bd* varies among American Bullfrog populations, but it is frequently high (Garner et al. 2006), and American Bullfrogs are often nonclinical carriers (Daszak et al. 2004; Garner et al. 2006). Despite high genetic similarity of isolates, different strains of *Bd* differ in virulence (Berger et al. 2005; Fisher et al. 2009; Rosenblum et al. 2009), yet there appears to be little host specificity (James et al. 2009; Rosenblum et al. 2009). Thus, *Bd* strains carried by American Bullfrogs likely are easily spread to other native species. Therefore, characterization of the strain of *Bd* in this region is needed because American Bullfrogs occur in the same water bodies with many native species and may threaten them, especially if carrying a lethal strain.

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Batrachochytrium dendrobatidis in *Plectrohyla arborescandens* (Anura: Hylidae) Larvae at a Montane Site in the Sierra Negra, Puebla, México

The amphibian chytrid fungus *Batrachochytrium dendrobatidis* (*Bd*) has been detected on all continents where amphibians occur (Berger et al. 1998; Bosch et al. 2001; Fisher et al. 2009; Hopkins and Channing 2003; www.Bd-maps.net, accessed 7 June 2011), causing a widespread cutaneous infection in young postmetamorphic and adult individuals that may result in death (Berger et al. 1999). Although anuran larvae do not seem to die from the infection, they nonetheless develop remarkable damage to their keratinized mouthparts (interrupted or misshaped tooth rows, and loss of pigmentation in these and jaw sheaths) and swelling and redness of the labial papillae and oral disc (Berger et al. 1998; Fellers et al. 2001).

During a field survey in June 1996, one of us (LCM) collected *Plectrohyla arborescandens* tadpoles in a stream in Zoquitlán, southeastern Puebla, México (18.3239°N, 97.01°W; 1860 m elev.), a geographic region known as the Sierra Negra (Fig. 1). Seven of 13 (54%) larvae lacked jaw sheaths and tooth rows (L. Canseco-Márquez, pers. obs.; specimens are retained at the herpetological collection of Benemérita Universidad Autónoma de Puebla, México; EBUAP 681–682). At that time, *Bd* was not yet described, its effects were yet unknown, and the cause of the missing jaw sheaths and tooth rows in larvae was not clear to the surveyors. Based on those original observations and more recent information regarding the existence and effects of *Bd*, our aim was to return to the region and sample *P. arborescandens* larvae for the presence of *Bd*.

Our study was conducted in Tilancingo, a stream located in the municipality of Coyomeapan, Puebla, Mexico (in the Sierra Negra; 18.3027°N, 97.0644° W; 2607 m elev., Fig. 1), where the vegetation (oak-pine forest) is relatively undisturbed. In June 2008, we collected four tadpoles (EBUAP 2114) of *P. arborescandens*, and took them to the laboratory to test for the presence of *Bd* using the wet-preparation technique (Frías-Alvarez et al. 2008). We also examined another 22 larval *P. arborescandens* (EBUAP 2109-13) for mouthpart abnormalities that were collected at the same site in March–June 2006.

To characterize the oral disc abnormalities in larvae, we examined mouthparts with a stereoscopic microscope. Individuals at Gosner stages 40–42 (Gosner 1960) were excluded from the analysis because during these stages atrophy of the oral disc is a natural process (Gosner 1960).

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The four tadpoles collected in 2008 (stages 26–37) were infected with *Bd*, which was determined by the presence of empty sporangia, sporangia with zoospores and septed sporangia. Further, these four tadpoles also had conspicuous oral disc abnormalities; loss of the jaw sheaths and tooth rows (with anterior and posterior mouthparts being affected in both cases). Of the specimens examined from 2006, 18 of 22 larvae (stages 26–35) had oral disc abnormalities. In total, the incidence of mouthpart abnormalities was 84.6% (N = 26).

The presence of *Bd* in Puebla State recently was documented by Frías-Alvarez et al. (2008) in *Ambystoma velasci*, so this represents the second report of the fungus in Puebla, and the first case associated with an anuran species. *Bd* occurrence in *P. arborescandens* is of particular concern because this is an anuran with conservation concerns. This frog is endemic to the Atlantic slopes of México, in the states of Tlaxcala, Puebla, and Veracruz, and is considered endangered and with a decreasing population trend (Stuart et al. 2008).

It warrants acknowledgment that other factors aside from *Bd* infection can cause loss of the keratinized mouthparts in anuran larvae. These include low temperatures, possibly related to decreased feeding (Rachowicz 2002), and DDT and corticosterone exposure (Hayes et al. 1997). However, the *Bd* pattern of loss presents differently. Whereas tadpoles infected with *Bd* show loss of jaw sheaths in form of 'gaps' (whitish areas on the jaw sheaths that are discontinuous, surrounded by darkened areas), those exposed to low temperatures experience a continuous reduction in tooth rows, and later in jaw sheath width (Rachowicz and Vredenburg 2004). On the other hand, tadpoles exposed to DDT and corticosterone lose the anterior jaw sheaths and tooth rows completely, with no posterior mouthparts being affected (Hayes et al. 1997). In our samples both anterior and posterior mouthparts were affected, about equally, and whitish gaps irregularly distributed in the jaw sheaths and tooth rows were found, which resembles the pattern described for tadpoles infected with *Bd* (Rachowicz and Vredenburg 2004). Additionally, although DDT or corticosterone may occur at the site (e.g., via aerial transmission), the area is surrounded by primary vegetation and direct applications of the chemicals are unknown. Moreover, tadpoles were collected in some of the warmest months, which reduces the possibility of mouthpart loss due to low temperatures. Based on these observations, we suggest that the fungus was the most likely proximate cause of the abnormalities reported herein.

The larvae we collected appeared healthy, as did the adults of *P. arborescandens* that we found (none dying or dead). However, the incidence of abnormalities in larvae was as high as other reports for anuran species inhabiting montane regions (Felger et al. 2007; Fellers et al. 2001; Lips et al. 2004), unlike lowland sites, where incidence is lower (Felger et al. 2007). This is consistent with reports on the prevalence of chytridiomycosis and *Bd* related declines; prevalence increases with altitude (Woodhams and Alford 2005), and declines due to the disease occur mainly

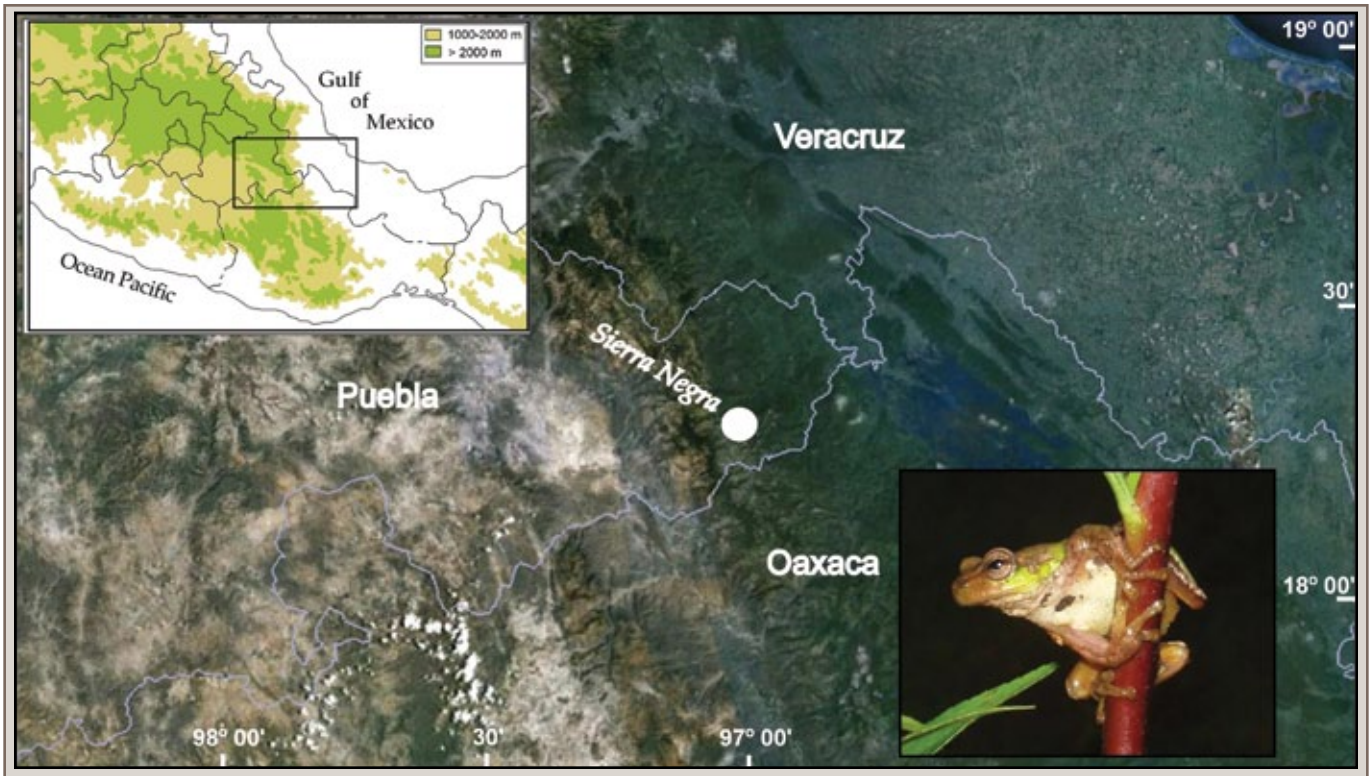


FIG. 1. Map of southeastern Puebla and adjacent states in México, showing the location of the Sierra Negra. White circle indicates Tilancingo stream, the area where *Batrachochytrium dendrobatidis* was detected on *Plectrohyla arborescandens* larvae. Also shown is an adult male *P. arborescandens* from this locality.

at montane sites (Berger et al. 1998; Lips 1999). *Bd* growth is favored at relatively cool environmental conditions, so this might explain the patterns described above (Daszak et al. 2003). Additionally, other factors, such as specific susceptibility to the fungus, length of larval period, and behavior of the tadpoles, might have an effect on the incidence of abnormalities in this life stage.

Because montane sites form a great proportion of the Sierra Negra, and many of its amphibian species are endemic to México (e.g., *Plectrohyla arborescandens, P. bistincta, Hyla euphorbiacea, Craugastor mexicanus*, and *Incilius occidentalis*) and some are endemic to this montane location in Puebla State (e.g., *Craugastor galacticorhinus* Canseco-Márquez and Smith 2004), studies are needed to evaluate the current distribution of *Bd* in the entire region, which species are affected, as well as its effects at both the individual and population level.

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Infectious Disease Screening of *Indirana* Frogs from the Western Ghats Biodiversity Hotspot

Amphibians are undergoing global declines, with 41% of amphibian species threatened with extinction (Hoffmann et al. 2010; Stuart et al. 2004). Emerging infectious diseases such as chytridiomycosis and *Ranavirus* have been implicated among the possible reasons for some of these declines (e.g., Collins and Storfer 2003; Daszak et al. 1999; Schloegel et al. 2010). Chytridiomycosis is a disease caused by the parasitic fungus *Batrachochytrium dendrobatidis* (*Bd*). It is known to cause mortality across a wide range of amphibian taxa by the disruption of cutaneous functions (Voyles et al. 2009). *Bd* infections were first reported in Panama and Australia in 1998, and are now known to affect amphibians across the globe, including species in North America, South America, Central America, Africa, Europe, New Zealand, and in parts of Asia (e.g., Berger et al.1998; Bradley et al. 2002; Changming et al. 2010; Garner et al. 2005; Kielgast et al. 2010; Lips 1999; Waldman et al. 2001). The viral amphibian pathogen *Ranavirus*, which is less well reported, also causes mass mortalities in the wild (Gray et al. 2009), in both common amphibian species and species thought to be in decline (e.g., Green et al. 2002). For example, it is known to cause mass mortalities in Eastern Tiger Salamanders (*Ambystoma tigrinum*) in North America (Bollinger et al. 1999; Collins et al. 2004; Jancovich et al. 1997) and in the Common Frog (*Rana temporaria*) in the United Kingdom (Cunningham et al. 1996). Furthermore, recent studies have shown that *Ranavirus* infection can cause long-term population declines in *R. temporaria* (Teacher et al. 2010).

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To the best of our knowledge, no screening for *Bd* or *Ranavirus* has been reported from the Indian sub-continent, representing a very large gap in our knowledge of the distribution of these diseases. This is also evident from the current global distribution map of *Bd* (www.bd-maps.net; accessed 2 May 2011).

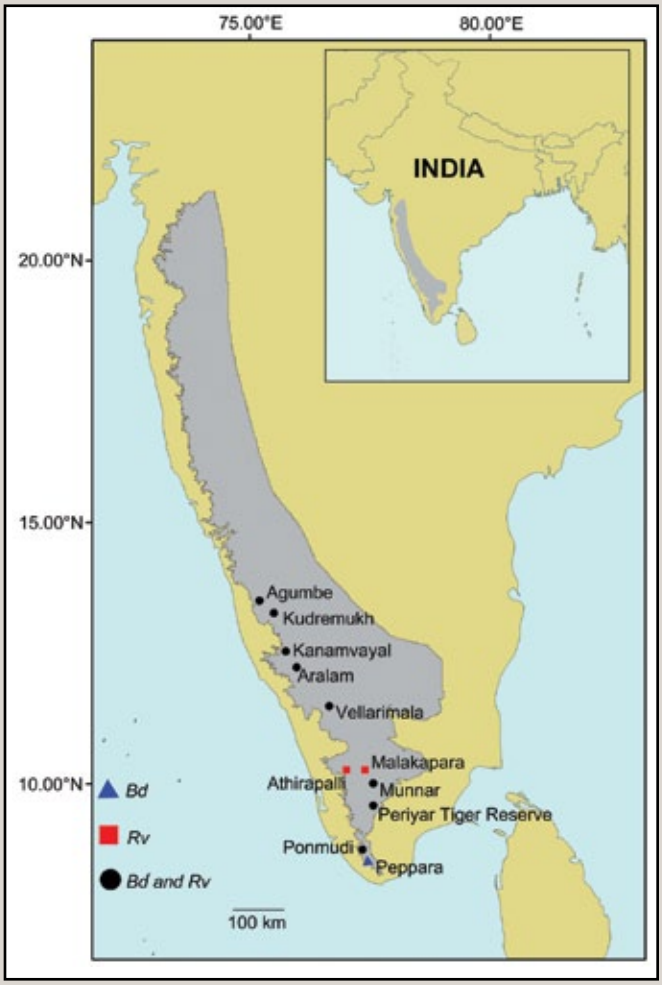


Fig. 1. Locations of the sites in India screened for *Batrachochytrium dendrobatidis* (*Bd*) and *Ranavirus* (*Rv*).

The Western Ghats in southwestern India is a biodiversity hotspot (Myers et al. 2000) which has a high diversity of amphibians with many endemic families and genera (Biju and Bossuyt 2003; Bossuyt et al. 2004; Daniels 2005; Dutta 1997). Currently, there are approximately 132 known amphibian species that are unique to the Western Ghats (Dinesh et al. 2009). We investigated the presence of *Bd* and *Ranavirus* in several species of *Indirana* frogs endemic to the Western Ghats biodiversity hotspot. In addition, *Bd* screening was performed for *Hylarana temporalis*, *Fejervarya keralensis*, and *Micrixalus fuscus* from the Peppara Wildlife sanctuary in Kerala, India.

Field surveys were conducted in the southern part of the Western Ghats between 2008–2010, including the states of Kerala and southern Karnataka (Fig. 1). Specimens were identified using published taxonomic information (Daniels 2005; Inger et al. 1984). For the *Ranavirus* screening, 138 samples were collected from 10 locations, including five known and one unknown species within the genus *Indirana* (Table 1). *Indirana beddomii*, *I. semipalmata*, *I. diplosticta*, and *I. brachytarsus* were collected from heavily littered trek paths in tropical evergreen and semi evergreen forests in Peppara, Ponmudi, Malakapara, and the Periyar Tiger Reserve. *Indirana beddomii* frogs were also collected along streams in low altitude sholas in Kudremukh National Park and Agumbe rainforest, as well as from trek paths in moist deciduous forests in Kanamvayal and Aralam. *Indirana leptodactyla* were collected along streams in shola forests in Munnar, and *Indirana* frogs of unknown species (*Indirana* sp.) were collected in semi-evergreen forests in Vellarimala. Toe clips (N = 68 for *I. beddomii*, N = 22 for *I. brachytarsus*, N = 24 for *I. leptodactyla*, N = 5 for *I. semipalmata*, N = 3 for *I. diplosticta*, N = 16 for *Indirana* sp.) were taken from adult specimens and stored in 95% alcohol. Swabs for *Bd* screening were taken from four species of frogs (N = 41 for *I. brachytarsus*, N = 20 for *M. fuscus*, N = 51 for *H. temporalis and* N = 30 for *F. keralensis*) from Peppara Wildlife Sanctuary. All specimens were caught using dip-nets and placed temporarily in separate plastic bags with ventilation. Latex gloves were used and changed every time a new specimen was handled in order to avoid cross contamination among individuals. All frogs were released at the site of capture after collecting the toe-clips and swabs. No physical abnormalities were detected, and there were no indications of unusual mortalities in any of the regions sampled.

For *Ranavirus* screening, total genomic DNA was extracted from the toe clips following the protocol used in St-Amour and Lesbarrères (2007), using the Qiagen DNeasy Blood and Tissue kit (Qiagen, New Delhi, India), following the manufacturer's instructions. DNA isolated from the infected cells of two *Ranavirus* isolates (one from *Bufo bufo*, and one from *R. temporaria*, obtained from the Institute of Zoology, London, UK) were used as positive controls. PCR amplifications were performed twice for each sample using FV3-specific primers (forward: 5'-GTCTCTGGAGAAGAAGAA-3', reverse: 5'-GACTTGGCACTTATGAC-3') which amplify a 420 base pair fragment of the major capsid protein (Gantress et al. 2003; Mao et al. 1996). The PCR amplifications were performed in 15 µl reactions consisting of 3 µl of 5x PCR buffer, 0.12 µl dNTPs (25 mM), 0.5 µl of each primer, 0.15 µl of Phire hot start DNA polymerase (Finnzymes, Finland), 9.23 µl of dH_2O and 1.5 µl of template DNA (10-20 ng). The following thermo cycling conditions were used for amplifications: 98°C for 30 s, followed by 40 cycles of 98°C for 5 s, annealing at 60°C for 15 s, extension at 72°C for 20 s, followed by a final extension step at 72°C for 1 min. The final PCR products were checked on 2% agarose gels, and a sample was considered positive if both the repeat PCR samples showed bands that matched the size of the band (420 base pairs) from the two positive controls.

For *Bd* screening, DNA was extracted from the swabs using a bead beating extraction method with 0.5 mm silica microbeads following the protocol described in Boyle et al. (2004). Some of the toe clip extractions also were screened for *Bd* (Table 1) following methods in Changming et al. (2010). The PCR amplifications were performed in 25 µl reactions using primers ITS-1 (forward): 5'-CCTTGATATAATACAGTGTGCCATATGTC-3' and 5.8S (reverse): 5'-AGCCAAGAGATCCGTTGTCAAA-3' (Boyle et al. 2004). Quantitative Real Time PCR (qPCR) was performed using a Taqman

TABLE 1. The results of *Batrachochytrium dendrobatidis* (*Bd*) and *Ranavirus* (*Rv*) screening for frogs from the Western Ghats in India. +ve = No. *Bd*-positive or *Rv*-positive frogs; N = total sample size; GE = genomic equivalent; SE = standard error; WLS = Wildlife Sanctuary. a) and b) refer to replicates of the same original sample. *Indirana* sp. = probable undescribed species.

Locality	Coordinates	Species	Tissue type	*Bd* (+ve/N)	Mean GE	*Rv* (+ve/N)
Kudremukh/Agumbe	13.2186–13.5227°N, 75.0889–75.1831°E	*Indirana beddomii*	Toe clip	0/5	—	0/22
Aralam/Kanamvayal	11.9316–12.2942°N, 75.4842–75.8358°E	*Indirana beddomii*	Toe clip	0/5	—	0/24
Athirapalli	10.2928°N, 76.565°E	*Indirana beddomii*	Toe clip	—	—	0/22
Periyar	09.4908°N, 77.1361°E	*Indirana semipalmata*	Toe clip	0/5	—	0/5
Periyar	09.4908°N, 77.1361°E	*Indirana diplosticta*	Toe clip	0/3	—	0/3
Munnar	10.1442°N, 77.0381°E	*Indirana leptodactyla*	Toe clip	0/5	—	0/24
Vellarimala	11.4463°N, 76.0789°E	*Indirana* sp.	Toe clip	0/10	—	0/16
Ponmudi/Periyar	08.7663–09.4908°N, 77.1094–77.2175°E	*Indirana brachytarsus*	Toe clip	1/5	a) 2.92 ± 3.1 b) 0.30 ± 0.1	0/12
Malakapara	10.2880°N, 76.8414°E	*Indirana brachytarsus*	Toe clip	—	—	0/10
Peppara WLS	08.5619–08.5981°N, 77.1647°E	*Indirana brachytarsus*	Swab	0/41	—	—
Peppara WLS	08.5619–08.5981°N, 77.1647°E	*Hylarana temporalis*	Swab	0/51	—	—
Peppara WLS	08.5619–08.5981°N, 77.1647°E	*Fejervarya keralensis*	Swab	0/30	—	—
Peppara WLS	08.5619–08.5981°N, 77.1647°E	*Micrixalus fuscus*	Swab	0/20	—	—

assay following Boyle et al. (2004) on a 7300 Real Time PCR system (Applied Biosystems, California). We used *Bd* zoospore genome equivalents of 100, 10, 1, and 0.1 to construct the standard curves. All the samples were replicated twice with negative controls on each plate. The genomic equivalents (GE) of the positive samples were derived from the standard curves. A GE score of above 0.1 in each replicate was considered as a positive signal of *Bd* presence. Samples that tested positive in one or both of the replicates were re-tested at Imperial College, London, by an independent researcher in order to confirm the *Bd* infection.

All 138 samples tested for the *Ranavirus* infections were negative: no bands matching the positive control bands were detected (Table 1). Although toe clip extractions have shown to be a good alternative to lethal sampling methods (liver extracts) for the screening of *Ranavirus* (St-Amour and Lesbarrères 2007), the possibility of false negatives cannot be excluded as St-Amour and Lesbarrères (2007) had only 88% success rate in detecting *Ranavirus* from known positive toe-clip extracts.

The 142 samples (DNA extracted from swabs) that were screened for *Bd* infection from Peppara Wildlife Sanctuary were negative for *Bd* infection. From the additional samples that were tested (toe clip extracts), one sample tested *Bd*-positive from *I. diplosticta*, but the replicate was negative for this sample. Another sample of *I. brachytarsus* tested *Bd*-positive and was also positive in the replicate (mean GE = 2.92). These two samples were again amplified with replicates, and tested at Imperial College, London. The *I. diplosticta* sample was found to be negative in both the replicates, and the *I. brachytarsus* sample was positive in both the replicates (Table 1).

From Asia, chytridiomycosis was first reported from captive amphibians in Japan (Une et al. 2008), and *Bd* infections have been reported subsequently from China, Indonesia, and South Korea (e.g., Changming et al. 2010; Kusrini et al. 2008; Yang et al. 2009). To date, we are not aware of any study that has screened for *Bd* or *Ranavirus* in India. In our study, we found one *Bd*-positive *I. brachytarsus* sample from Ponmudi, Western Ghats. The qPCR method is a very specific and sensitive technique for detecting *Bd* infection (Boyle et al. 2004; Kriger et al. 2006), although the infection detected in our study was at a very low level, it was replicable. Rowley et al. (2007) highlighted potential problems associated with contamination due to possible aerosolization of DNA. We believe that aerosol contamination is unlikely in our case, as we performed negative controls and replicated the positive result in a separate laboratory. Similar low-level infections of *Bd* (≤ 1 zoospore equivalent) in wild populations of native amphibians also have been reported from Indonesia and China (Changming et al. 2010; Kusrini et al. 2008). The occurrence of *Bd* infection in individuals with no apparent physical abnormalities is not unusual (e.g., Changming et al. 2010; Kielgast et al. 2010).

Amphibian trade and introductions are prominent hypotheses for the spread of *Bd* in many parts of the world (Fisher and Garner 2007). For example, the introduction of the North American Bullfrog (*Lithobates catesbeianus*) for trade and human consumption is likely to have contributed to the spread of *Bd* in Asia (Changming et al. 2010; Garner et al. 2006). China and Indonesia are well known for amphibian farming and the export of amphibians to Europe, the United States, and many regions in Asia (Kusrini and Alford 2006; Warkentin et al. 2009). Such exports could have facilitated the spread of *Bd* to other regions in southeast Asia. Amphibian trade in India has been banned since 1987 (Warkentin et al. 2009) but illegal trade in amphibians cannot be ruled out as a possible route for introduction of *Bd* to India. A recent study by Goka et al. (2009) also reported the presence of endemic strains of *Bd* in Japanese giant salamander, *Andrias japonicus*, with no disease symptoms. These strains were also present in stored specimens of *A. japonicus* collected in 1902 (Goka et al. 2009), suggesting a much wider and ancient presence of *Bd* in southeast Asia than was previously believed.

Chytrid infections are implicated to have caused extinctions of several species in central Panama even before the scientific description of the species in question were complete (Crawford et al. 2010). The Western Ghats mountains have high endemic amphibian diversity and several new amphibian species have recently been described from this area (e.g., Biju and Bossuyt 2009). Hence, it is highly likely that further new species will be described from this region in future (Biju 2001). In view of our results, and in consideration of the fact that 40% of the amphibian species in the Western Ghats are already threatened with extinction (Biju et al. 2008), we suggest that more organized and extended efforts need to be put into the screening of emerging infectious diseases of amphibians from the entire range of the Western Ghats biodiversity hotspot, and throughout India.

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Batrachochytrium dendrobatidis Detected in Amphibians of the Central Andean Cordillera of Colombia

Land use change, overexploitation, introduced species, global warming, pollution, and emerging infectious diseases are all proposed as causes of the world-wide decline and extinction of amphibians (Alford and Richards 1999; Blaustein and Kiesecker 2002; Collins and Storfer 2003; Fisher et al. 2009). In Latin America, the decline of amphibian populations has been observed from sea level (30 m) to the snow line (5300 m) (Díaz et al. 2007; Puschendorf et al. 2006; Seimon et al. 2007; Whitfield et al. 2007). The emergence of the fungal pathogen *Batrachochytrium dendrobatidis* (*Bd*) has been implicated in several of these declines (Cheng et al. 2011), and it is responsible for the extinction of several species worldwide (Fisher et al. 2009; Skerratt et al. 2007; Lips et al. 2006). In Colombia, *Bd* has been found infecting frogs in the Hylidae, Dendrobatidae, Leptodactylidae, Centrolenidae, and Bufonidae based on histological examination of museum specimens collected in the Eastern and Western Cordilleras (Ruiz and Rueda-Almonacid 2008; Velásquez-E et al. 2008). Here we report the occurrence of *Bd* in amphibians sampled in montane wet forests of the Central Cordillera of Colombia. To the best of our knowledge, this report corresponds to the first and northernmost record for *Bd* for the Central Andean Cordillera in Colombia.

Our field survey was conducted in Belmira, Antioquia, a region located in northwestern Colombia (Fig. 1). This region has an area of approximately 279 km^2, and is mainly covered by pastures and agricultural fields (60%), forests (18%), and shrub/paramo vegetation (21%) (Rodriguez et al. 2007). The forests in the region have been heavily disturbed by mining, cattle grazing, and forest clearance for timber or fuel wood (Corantioquia 2005). Four sites in the region were sampled (Fig. 1), located between 2550 and 2853 m elevation. The region has a bimodal precipitation regime with annual precipitation ranging from 2000 to 2500 mm, with peaks during the months of April–May and October–November (IGAC and IDEA 2007). The sampling sites are classified in the lower montane wet-forest life zone (bmh-MB) (Holdridge 1967). Two of the sites surveyed (Golondrinas and Quebradona) are old forest fragments of approximately 12 ha each. The other two sites (Salema and Santa Rita) are second-growth forest patches of approximately 2 ha each.

Amphibian species were sampled via visual encounter surveys between December 2008 and February 2009 (Table 1). In order to detect *Bd*, 111 individuals of five species were swabbed using methods described by Hyatt et al. (2007). Cross contamination was prevented using a new pair of disposable gloves every time that a new individual was handled. All samples were preserved in 70% ethanol and kept at low temperature (3°C) until quantitative PCR analyses were conducted.

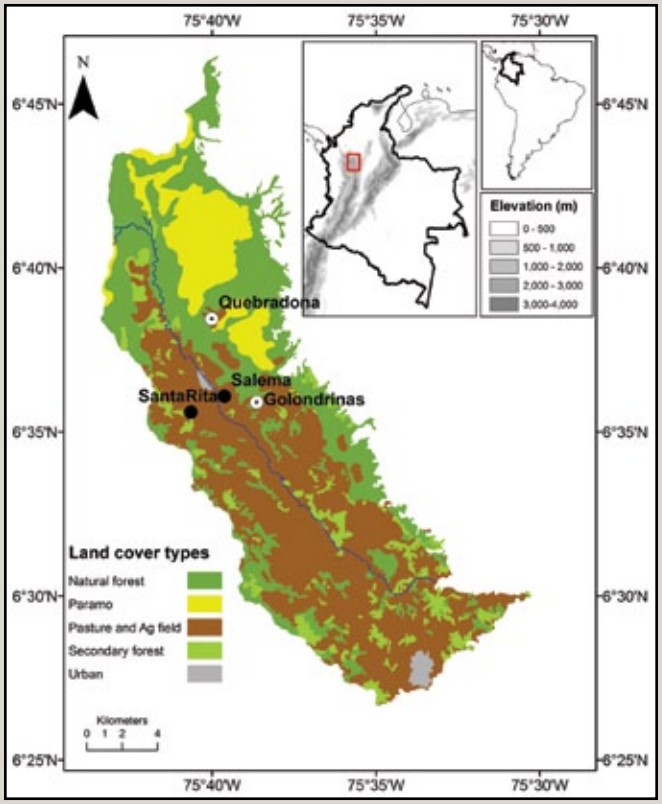


FIG 1. Sampling locations for *Batrachochytrium dendrobatidis* on amphibians in the Central Cordillera, Colombia (South America). White dots = *Bd*-positive locations; Black dots = *Bd*-negative locations.

Bd extraction and quantitative PCR analysis were conducted at the Institute of Zoology, Zoological Society of London, following Boyle et al. (2004). Prevalence of infection was calculated as the ratio between the number of individuals that tested positive for *Bd* and the total number of individuals sampled per species. *Bd* prevalence was estimated with 95% Clopper-Pearson binomial confidence intervals for each species per site. The number of *Bd* zoospores in each swab was estimated as the number of genomic equivalents (GE) per swab by multiplying the number of zoospores detected in each sample by 80, accounting for the number of dilutions between the extraction and the final sample. The number of *Bd* genomic equivalents (GE) is an estimate of the number of zoospores, or the intensity of infection.

We detected *Bd* infection in 32 of 111 amphibians sampled (Prevalence = 28%, CI [95%] = 21–38). However, our low sample

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TABLE 1. *Batrachochytrium dendrobatidis* occurrences in amphibians sampled at four sites in Belmira, Antioquia, Colombia. CI = 95% Clopper-Pearson binomial confidence interval for prevalence (%).

Species	Sites (elevation, m)	Coordinates	No. *Bd*-positive / Total no. samples (%)	CI	Mean no. zoospores/ individual (Low, High)
Bolitoglossa ramosi	Golondrinas (2693)	6.5956°N, 75.6406°W	0/10	0–25	0 (0–0)
	Santa Rita (2565)	6.5905°N, 75.674°W	0/45	0–7	0 (0–0)
Pristimantis dorsopictus	Salema (2550)	6.5986°N, 75.6569°W	0/2	0–63	0 (0–0)
Pristimantis piceus	Quebradona (2853)	6.6379°N, 75.6634°W	1/1 (100)	22–100	1263.4 (1263.4–1263.4)
Pristimantis uranobates	Golondrinas (2693)	6.5956°N, 75.6406°W	2/13 (15)	0–43	34.9 (0-389.7)
	Salema (2550)	6.5986°N, 75.6569°W	0/1	22–39	0 (0-0)
Hyloscirtus larinopygion	Quebradona (2853)	6.6379°N, 75.6634°W	29/39 (74)	59–86	459.6 (0–5319.3)

sizes at sites and per species may have precluded *Bd* detection if infection prevalence was low (Skerratt et al. 2008). *Bolitoglossa ramosi,* the only salamander surveyed in this study, was negative for *Bd* at the two sites where the species was found. *Pristimantis dorsopictus* was also negative for *Bd*. At the two second-growth forest sites, no individuals were positive for *Bd* (Table 1). Infected individuals belong to three species (*Hyloscirtus larinopygion*, *Pristimantis uranobates* and *P. piceus*) (Table 1). Intensity of infection ranged between 0 and 5319 zoospores (Table 1). Infected individuals did not show clinical symptoms of the disease.

Hyloscirtus larynopygion had the highest prevalence of the infection (74%), and the highest intensity of infection (Table 1). This high intensity may respond to a larger area of skin sampled in *H. larinopygion* whose size is larger than the other species studied, although we followed a standardized swabbing protocol. This species is listed as IUCN "Near Threatened" (NT), with habitat loss and pollution as the main threats (Bolívar et al. 2008). The absence of historical data on the populations studied here makes it difficult to understand the effects of *Bd* on these populations. However, the high *Bd* prevalence and high intensity of infection documented for *H. larinopygion* in our study suggest that it is imperative to identify whether chytridiomycosis should be considered as a major threat for the species. Monitoring of these populations is needed to better understand their susceptibility to chytridiomycosis. Also, identifying whether other populations in the region are being affected by *Bd* is relevant in order to inform species and land managers. A low number of individuals of *Pristimantis uranobates* and *P. piceus* were positive for *Bd*. These species are listed as "Least Concern" (LC) and although both species are considered adaptable and tolerant to disturbed habitats (Castro et al. 2004), after this study we suggest to consider the presence of *Bd* as one of the causes that can affect their populations even those located in protected areas.

Our study extends the known distribution of the chytrid fungus to the Central Andean Cordillera of Colombia, and to the best of our knowledge, represents the northernmost record for the chytrid fungus for this Cordillera. The results of this study support the hypothesis of habitat loss as a predictor of lower pathogen prevalence (Becker and Zamudio 2011). In our study, all individuals living in second-growth forest sites were negative for *Bd* while the prevalence for individuals from old forests was higher. This may suggest an effect of the structure of the forest on the *Bd* presence even for neighboring populations through changes in microclimatic conditions (Becker and Zamudio 2011), or potentially habitat heterogeneity with reduced pooled water sources that might serve as *Bd* reservoirs. However our modest sample sizes highlight the importance of continued monitoring in the area to include more species and individuals that allow evaluation of this hypothesis. Our new *Bd* report raises conservation concerns considering the high anuran endemism of forests in the northern central Andes (Duellman 1999).

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GEOGRAPHIC DISTRIBUTION

CAUDATA — SALAMANDERS

***AMBYSTOMA MACULATUM* (Spotted Salamander)**. USA: TENNESSEE: Haywood Co.: North of Hwy 70 at the Stanton city limits (35.2816°N, 89.2356°W; NAD 83). 4 April 2010. Robert Colvin and Amy Colvin. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19065). First county record (Scott and Redmond 2008. Atlas of Amphibians in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. http://www.apsu.edu/amatlas [updated 13 October 2010; accessed 16 December 2010]. Voucher image made under the authority of the Tennessee Wildlife Resources Agency; field work supported by State Wildlife Grant (SWG) funding under the authority of the U.S. Fish and Wildlife Service.

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***AMBYSTOMA TIGRINUM* (Eastern Tiger Salamander)**. USA: INDIANA: Howard Co.: Howard Township: 4379 E. CR 300 N (40.494031°N 86.043407°W; WGS 84). 23 March 2011. Matthew D. Schultz-Finkler and Michael S. Finkler. Verified by Robert Brodman. Indiana State Museum (INSM 71.7.0520). Five specimens (four live, one road-kill) found on roadway adjacent to drainage ditch. One live specimen collected as voucher. New county record (Minton 2001. Amphibians & Reptiles of Indiana, 2nd ed. Indiana Academy of Science, Indianapolis. 404 pp.). Fills gap in distribution in north-central Indiana.

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***NECTURUS MACULOSUS* (Mudpuppy)**. USA: NORTH CAROLINA: Macon Co.: Cullasaja River at Wells Grove, RM 0.9, 3.0 km airline SW Franklin (35.16452911°N, 83.35967785°W; WGS 84). 9 August 2011. Lori Williams, John Groves, David Strickler, Craig Pelke, and Dennis McNamara. Verified by Jeffrey C. Beane. North Carolina State Museum of Natural Sciences photo voucher 12705. First vouchered specimen at this location (North Carolina Natural Heritage Program 2011. Biotics Database. Department of Environment and Natural Resources, Raleigh, North Carolina). Closest previous historical record in North Carolina is from the French Broad River basin, Transylvania County, 60.7 km airline ENE (North Carolina Natural Heritage Program 2011, *op. cit.*). Adult male [TL = 18.5 cm, SVL = 12.0 cm, mass = 20 g] captured while conducting visual encounter surveys. Tissue sample collected. Substantiates an unvouchered record for this drainage obtained during electrofishing surveys in this drainage on 24 July 2000 by Bill McLarney, Cal Yonce, and Will Cobb.

LORI A. WILLIAMS, North Carolina Wildlife Resources Commission, 177 Mountain Laurel Lane, Fletcher, North Carolina 28732, USA (e-mail: lori.williams@ncwildlife.org); **BILL McLARNEY**, Little Tennessee Watershed Association, 93 Church Street, Suite 214, Franklin, North Carolina 28734, USA; **JOHN D. GROVES** and **DAVID STRICKLER**, North Carolina Zoological Park, 4401 Zoo Parkway, Asheboro, North Carolina 27205, USA; **CRAIG PELKE** and **DENNIS McNAMARA**, Virginia Zoological Park, 3500 Granby Street, Norfolk, Virginia 23504, USA.

***PSEUDOTRITON RUBER RUBER* (Northern Red Salamander)**. USA: TENNESSEE: Warren Co.: Hoover Branch of West Fork Hickory Creek, tributary to Caney Fork River. Accessed from Beacon Light Road 0.5 km W of King Road (35.588574°N, 85.912957°W; NAD 27). 6 April 2011. Matthew D. Wagner, Mark S. Hoger, and Andrew S. Riggs. Austin Peay State University Museum of Zoology (APSU 19125, color photo). Verified by A. Floyd Scott. New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. [Hard copy and Internet versions, the latter of which includes links to information on Tennessee amphibians having appeared since 1996, http://www.apsu.edu/amatlas/, accessed 3 August 2011]). One juvenile caught in seine.

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ANURA — FROGS

***ANAXYRUS AMERICANUS* (American Toad)**. USA: INDIANA: Vigo Co.: Fayette Township: (39.54589°N, 87.42184°W; NAD 83). 10 May 2011. Sarabeth Klueh and Jason Mirtl. Verified by Chris Phillips. Illinois Natural History Survey (INHS 2011m). New county record (Minton 2001. Amphibians and Reptiles of Indiana. 2nd ed., revised. Indiana Academy of Science. vii–404 pp.) Individuals were calling from a flooded agricultural field along with *Anaxyrus fowleri*. This species occurs commonly throughout most of Indiana but appears to be largely absent from a pocket of counties in the southwest part of the state (Minton, *op cit.*). This record partially fills a gap in the range of this species in southwest Indiana.

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***CHIROMANTIS SIMUS* (Assam Tree Frog)**. BANGLADESH: MOULVIBAZAR DISTRICT: Sreemangol, Lawachara National Park (25.8907694°N, 088.8502083°E, WGS 84), 13 June 2011. Verified by Ghazi S. M. Asmat. Digital voucher image, Herpetology Museum Laboratory, Ichamoti College, Dinajpur, Bangladesh (MHLB-CS01). First record for Moulivibazaar District. Species described from Assam, India (Annandale 1915. Rec. Indian Mus. 11:341–347); first report from Bangladesh was Chittagong (Asmat et al. 2003. Univ. Rajshahi J. Zool. 2003:141–143).

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***DISCOGLOSSUS GALGANOI* (West Iberian Painted Frog)**. PORTUGAL: ÉVORA: ca. 38.5269°N, 08.0168°W (WGS84). 17 November 2011. Luis Ceríaco. Photographic vouchers deposited at Colecção Fotográfica of the Museu de Ciências Naturais da Escola Secundária André de Gouveia (MCN/MB/F/A/10). Verified by Ana Pires. Species previously unrecorded from region, nearest population being at least 10 km S (Cruz and Rebelo 2010. *In* Loureiro et al. [eds.], Atlas dos Anfíbios e Répteis de Portugal, pp. 104–105. Esfera do Caos Editores, Lisboa). Photographed in water canal, in Herdade da Mitra, at ca. 2330 h.

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***ENGYSTOMOPS PUSTULOSUS* (Túngara Frog, Sapillo Túngara)**. HONDURAS: YORO: 5 km S of San Patricio (15.400000°N, 86.916667°W, WGS84; 250 m elev.). 5 October 2010. James R. McCranie and Leonardo Valdés Orellana. Verified by Steve W. Gotte. USNM 578911. First record for Yoro, with the closest known locality being ca. 35 km SE at El Díctamo, Olancho (McCranie 2006. Smithson. Herpetol. Inform. Serv. 137:1–38). The frog was calling at night in a rain pool on a dirt road in an area of badly degraded thorn forest.

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***FEJERVARYA ASMATI* (Bangladeshi Cricket Frog)**. BANGLADESH: NILPHAMARI DISTRICT: Darwny Textile Mills, Shokher Bazar (25.890769°N, 88.850208°E; 43–44 m elev.; datum: WGS 84). 13 June 2011. Collected by Md. Abdur Razzaque Sarker. Two specimens (MHLB-FA01, and MHLB-FA02). Museum of Herpetology Laboratory, Ichamati College, Dinajpur, Bangladesh. Verified by Ghazi S. M. Asmat. Species described from Chittagong, Bangladesh (Howlader 2011. Zootaxa 2761:41–50). Current population 1.83 km from Darwny Textile Mills Market and >600 km N of type locality. Adults collected on banks of pond. Habitat includes several *Cynodon dactylon* plantations, in addition to Bambuseae, *Bromus tectorum*, adjacent to a field of *Corchorus capsularis*.

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***FEJERVARYA PIERREI* (Pierre's Cricket Frog)**. BANGLADESH: NILPHAMARI DISTRICT: Berakuthi, Barua (25.821925°N, 88.8284°E, 43 m elev.; WGS 84), 29 August 2011. Verified by Ghazi S. M. Asmat. Collected by Md. Abdur Razzaque Sarker. Museum of Herpetology Laboratory, Ichamati College, Dinajpur, Bangladesh (MHLB-FP01). First record from Nilphamari District, northern Bangladesh, and previously recorded from Chittagong (Hathazari), Coxes bazaar (Himchari), Noakhali (Hatia Island), and Barisal (Sundargaon), southeast Bangladesh (Rasel et al. 2007. Bannoprani- Bangladesh Wildl. Bull. 4:1–2). Current population found near a Berakuthi, Barua, a primary school, >14 km S from Nilphamari and > 484 km NW of the Chittagong (Hathazari), < 570 km NW of Cox's Bazaar (Himchari), < 400 km NW of Noakhali (Hatia Island), and < 377 km NW fof Barisal (Sundargaon). Adult collected beside playground. Habitat includes *Cynodon dactylon* plantations, beside paddy field.

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***FEJERVARYA TERAIENSIS* (Terai Cricket Frog)**. BANGLADESH: MOULVIBAZAR DISTRICT: Sreemangol, Lawachara National Park (25.8907694°N, 088.8502083°E, WGS 84), 13 June 2011. Verified by Ghazi Asmat. Digital voucher image, Herpetology Museum Laboratory, Ichamoti College, Dinajpur, Bangladesh (MHLB-FT01). First record for Moulivibazaar District. Only reports from Bangladesh is Chittagong, Cox's Bazaar, Barisal, and Nokhali Districts (Rasel et al. 2007. Bannoprani-Bangladesh Wildl. Bull. 4:1–2).

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***HYLA GRATIOSA* (Barking Treefrog)**. USA: TENNESSEE: Benton Co.: 4185 Divider and Natchez Road (35.5943°N, 88.0905°W; NAD 83). 26 April 2011. Brian Elkins. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19130). First county record (Scott and Redmond 2008. Atlas of Amphibians in Tennessee. Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. http://www.apsu.edu/amatlas [updated 13 October 2010; accessed 12 September 2011].

Voucher image made under the authority of the Tennessee Wildlife Resources Agency; field work supported by State Wildlife Grant (SWG) funding under the authority of the U.S. Fish and Wildlife Service.

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***HYLARANA LEPTOGLOSSA* (Long-tongued Frog)**. BANGLADESH: SYLHET DIVISION: Golapganj (24.8583°N, 90.0208°E, WGS 84; > 200 m elev.). 1 June 2009. Md. Mukhlesur Rahman Khan. Department of Fisheries Biology and Genetics, Bangladesh Agricultural University, Mymensingh, Bangladesh. Specimen deposited at Institute for Amphibian Biology, Hiroshima University, Japan (IABHU 3784). Verified by Mitsuru Kuramoto. First locality record for Sylhet Division and only northeastern record for Bangladesh. Other records from Madhupur National Park, Mymensingh Division (ca. 210 km to W) (Mahony and Reza 2007. Herpetol. Rev. 38:350) and Chittagong Division (ca. 285 km to N), with no locality details, photograph, or voucher (Asmat et al. 2003. Univ. J. Zool., Univ. Rajshahi 22:141–143). Supported by Grant-in-Aids for Scientific Research (C) (17570082 and 20510216) to M. Sumida from the Ministry of Education, Culture, Sports, Science and Technology, Japan.

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HYPSIBOAS FABER. BRAZIL: BAHIA: Municipality of Mucugê: 12.59°S, 41.23°W (SAD 69), 985 m elev. 05 March 2010. M. Freitas and D. França. Museu de Zoologia da Universidade de São Paulo, São Paulo, Brazil (MZUSP 142498, collected in rupestrian field areas domain in "Chapada Diamantina" complex). Municipality Rui Barbosa: 12.13°S, 40.371°W. 530 m elev. 15 March 2010. M. Freitas and D. França. MZUSP 142569–71, collected in the estacional ciliar forest. Both verified by M. Rodrigues. Municipality of Senhor do Bonfim: 10.23°S, 40.11° W. 600 m elev. 10 June 2002. M. Freitas. Museu de Zoologia da Universidade Estadual de Feira de Santana, Bahia, Brazil (MZUEFS 1374, collected in the estacional ciliar forest). Verified by F. Juncá. This species is known from Paraguay, Argentina (Misiones), and Brazil (from Rio Grande do Sul, Santa Catarina, Paraná, São Paulo, Minas Gerais and east of Goiás, and coastal northeast region to Bahia, Sergipe, Alagoas, Pernambuco, and Paraíba state) (AmphibiaWeb 2011. Available: http://amphibiaweb.org/, accessed 8 January 2011; Frost 2011. Amphibian Species of the World: an Online Reference. Version 5.5 (17 April 2011). Electronic database accessible at http://research.amnh.org/vz/herpetology/amphibia/, accessed 17 April 2011. American Museum of Natural History, New York). First record for Mucugê, Rui Barbosa, and Senhor do Bonfim municipalities within Bahia State, extending the species range ca. 300 km W from Ilhéus municipality, Bahia (AmphibiaWeb 2011, *op. cit*).

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LITHOBATES CLAMITANS MELANOTA **(Northern Green Frog)**. USA: INDIANA: Howard Co.: Howard Township: 3680 E. CR 250 N. (40.513381ºN, 86.56.057004ºW; WGS 84). 23 March 2011. Michael S. Finkler. Verified by Robert Brodman. Indiana State Museum (INSM 71.7.0519). Live male found on roadway. New county record (Minton 2001. Amphibians & Reptiles of Indiana, 2nd ed. Indiana Academy of Science, Indianapolis. 404 pp.). Fills gap in distribution in north-central Indiana.

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LITHOBATES SPHENOCEPHALUS **(Southern Leopard Frog)**. USA: TENNESSEE: Marshall Co.: Lick Creek, ca. 0.5 km W of Mt. Vernon Rd and Hwy TN 90 intersection (35.666306°N, 86.672414°W; WGS 84). 19 October 2010. M. Anderson and D. Estabrooks. Herpetology Collection at Middle Tennessee State University (MTSU 351A). Maury Co.: Unnamed first-order stream that enters Negro Creek of the Duck River watershed (35.5958°N, 86.9244°W; WGS 84). 24 October 2010. M. Anderson, D. Estabrooks, and R. Johnston. MTSU 355A. Williamson Co.: Dry unnamed third-order tributary of the Harpeth River, ca. 0.5 km E of the intersection of Southall Rd and Carl Rd (35.8997°N, 86.9673°W; WGS 84). 24 October 2010. M. Anderson and R. Johnston. MTSU 354A. All three records verified by B. T. Miller. All represent new county records (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12. Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Internet version [<http://www.apsu.edu/amatlas>http://www.apsu.edu/amatlas] contains links to information regarding Tennessee distribution of amphibians recorded since 1996; accessed 19 and 26 October 2010).

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PSEUDACRIS CRUCIFER **(Spring Peeper)**. USA: GEORGIA: Lumpkin Co.: Chattahoochee National Forest near Dick's Creek Falls (34.67222°N, 83.90388°W; WGS 84; elev. 479 m). 08 May 2011. Leslie Phillips. Verified by John Jensen. UTADC 6940 photo voucher. New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. Univ. of Georgia Press, Athens. 575 pp.); previously documented in all adjacent counties with the exception of Fannin. Specimen was heard calling from the opposite side of the road from Dick's Creek at ~0130 h near the bridge at Corbin Crossing and found calling from a holly leaf.

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TLALCOHYLA LOQUAX **(Rana Trepadora Sonorense; Mahogany Treefrog)**. HONDURAS: SANTA BÁRBARA: SW corner of Lago de Yojoa (14.800004°N, 88.000015°W, WGS84; 650 m elev.). 1 October 2010. James R. McCranie and Leonardo Valdés Orellana. Verified by Steve W. Gotte. USNM 578910. First record for Santa Bárbara, with the closest known locality being ca. 5 km E at 1.6 km N of Pito Solo, Comayagua (McCranie 2006. Smithson. Herpetol. Inform. Serv. 137:1–38). The frog was calling at night from low secondary vegetation surrounding a rain-filled swampy area.

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CROCODYLIA — CROCODILIANS

ALLIGATOR MISSISSIPIENSIS **(American Alligator)**. USA: GEORGIA: Miller Co.: Mayhaw Wildlife Management Area (31.198069°N, 84.792064°W, WGS 84; elev. 48 m). 6 August 2011. Robert L. Hill. Verified by John Jensen. UTADC 6941. New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.); has been documented in adjacent Baker, Early, and Seminole counties. Has been previously observed in Miller Co., though this represents the first vouchered record. Two specimens observed from 0955–1035 h in water-filled borrow pit at entrance to Mayhaw Wildlife Management Area on Griggs-Lucille Rd ~2.23 km W of junction with Hwy 27.

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TESTUDINES — TURTLES

APALONE FEROX **(Florida Softshell)**. USA: SOUTH CAROLINA: Allendale Co.: County road SSR-292 (33.02096°N, 81.27335°W;

WGS 84) adjacent to Stony Lake, 2.5 km NE Allendale. 5 May 2010. J. D. Camper. Verified by S. Miller. Clemson University Vertebrate Collections (CUSC 2820). Dead adult male on road next to a Carolina Bay. New county record (Ernst et al. 1994. Turtles of the United States and Canada. Smithsonian Institution Press, Washington D.C. 578 pp.).

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***APALONE SPINIFERA* (Spiny Softshell)**. USA: LOUISIANA: Vernon Parish: Kisatchie National Forest, Mill Creek Rd and Whiskey Chitto Creek crossing (31.0822°N, 93.14789°W; WGS 84). 11 July 2007. Stephen M. Ecrement. Florida Museum of Natural History, University of Florida (UF165499). Verified by Kenneth L. Krysko. First parish record; extends distribution N from Beauregard Parish, W from Rapides Parish, and S from Sabine and Natchitoches parishes as mapped by Dundee and Rossman (1989. The Amphibians and Reptiles of Louisiana. Louisiana State University Press, Baton Rouge. 300 pp.).

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***CHELYDRA SERPENTINA SERPENTINA* (Eastern Snapping Turtle)**. CANADA: ONTARIO: Kenora District: Woodland Caribou Provincial Park: S of Talon Lake (50.6550°N, 94.7795°W). 10 August 2009. Jeff King and Matt Butts. This specimen and all others listed below are photographic vouchers verified by Ross D. MacCulloch. Royal Ontario Museum. The GPS datum for all records is WGS 84. One adult (ROMdm 00255) was filmed basking on rocky shoreline. Nearest record is 38 km N from a small unnamed lake near Hammerhead Lake (Ontario Herpetofaunal Summary database [OHS] entry number 212801). Aubrey Township: near Aubrey Lake ca. 10 km E of City of Dryden (49.7667°N, 92.9833°W). June/July 2007. Ray Schott. One adult (ROMdm 00256) found in grassy area. First township record. Nearest record is 24 km SE from Godson Lake on Highway 502 (NMC 24616, OHS 101519). MacNicol Township: Dixie Lake Rest Area, ca. 30 km E of City of Kenora on Highway 17 (49.8337°N, 93.9467°W). 13 July 2008. Graham Suffield. One adult (ROM dm 00264) swimming along rocky lakeshore. First township record. Nearest record 51 km E near Trial Lake in Buller Township (OHS 258765). Stokes Township: Gullwing Creek, ca. 12 km N of City of Dryden (49.8500°N, 92.9500°W). June/July 2007. Ray Schott. One adult (ROMdm 00257) found on cobbled bank. First township record. Nearest record 30 km SE from Godson Lake on Highway 502 (NMC 24616, OHS 101519). Unorganized township: Trap Lake, ca. 10 km S of City of Dryden (49.6500°N, 92.7833°W). June/July 2007. Ray Schott. One adult (33 cm CL, ROMdm 00258) caught in a trap net during fisheries work. New locality record. Nearest record 5 km S from Godson Lake on Highway 502 (NMC 24616, OHS 101519).

Rainy River District: Lake of the Woods Municipality (former Morson Township): Village of Morson, S end of Lake of the Woods (49.095056°N, 94.320681°W). 16 May 2008. Cheryl Gauthier. One adult (ROMdm 00262) on beach in small bay. First township record. Nearest record 13 km NE at Walden Island (OHS 59429). Quetico Provincial Park: Pickerel River between Pickerel and French Lakes (48.654°N, 91.177°W; WGS 84). 09 August 2008. Graham McGuire. One adult (ROMdm 00263) swimming in river. New locality record. Nearest record is ca. 5 km N from Eva Lake (OHS 111040). Unorganized township: Niobe Lake, near Village of Sapawe (48.732094°N, 91.319192°W). August 2004. Jeffrey N. Robinson. One adult (ROMdm 00266) caught in net during fisheries study. New locality record. Nearest record is 12 km E from Eva Lake (OHS 111040).

Thunder Bay District: Devon Township: Highway 593 N of Highway 61 and S of Highway 588 (48.083983°N, 89.802704°W). June 2004. Jeffrey N. Robinson. One juvenile (ROMdm 00267) captured in center of the highway. First township record. Nearest record 82 km E from Sibley Provincial Park (OHS 111265). Lybster Township: Village of Nolalu, near bridge on Old Mill Road (48.291972°N, 89.808882°W). July 2008. Robert Kamstra and Stephen J. Hecnar. One adult (18.7 cm CL, 1478 g; ROMdm 00265) found dead on roadside. Specimen photographed and placed in Lakehead University Biology collection (LUB 00227). First township record. Nearest record 74 km E from Sibley Provincial Park (OHS 111265). Inwood Township: Highway 17 ca. 4.8 km E of Town of Upsala (49.021372°N, 90.442424°W). 31 May 2008. Brent Gibbons. One adult female (29 cm CL) (ROMdm 00260) attempting to cross highway between lakes was captured and moved to other side. Specimen subsequently oviposited on sandy beach of Inwood Park Lake. First township record. Nearest record 64 km SW from Eva Lake (48.69539°N, 91.16547°W; OHS 111040). Laurie Township: near Matawin River ca. 3.8 km SW of Shabaqua railway crossing (48.545059°N, 89.928092°W). 13 June 2007. Herbert Bax. One adult (ROMdm 00261) found on log haul road near coniferous forest cutover. First township record. Nearest record 27 km E from Gravel Lake in Hardwick Township (OHS 266100).

Algoma District: Dahl Township. Highway 17 ca. 30 m from Normandy Lodge Road. (48.2987°N, 84.9659°W). 02 September 2005. F. Neil Dawson. One adult on shoulder of highway (ROMdm 00259). First township record. Record lies in a large gap between northwestern and northcentral Ontario records and may extend range to NE. Nearest records are 98 km W in Pukaskwa National Park (Ontario Herpetofaunal Summary, entry number 20279) and 37 km S in Wawa, Ontario (COSEWIC 2008. COSEWIC Assessment and Status Report on the Snapping Turtle *Chelydra serpentina* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa. vii + 47 pp.). These two records were suspected introductions but the new record suggests that the gap may be an artifact of insufficient sampling in the region. The specimens we report are significant because they represent new localities from areas of limited sampling near the presumed northern range limit for the species in the boreal region of Ontario (Schueler 1976. Blue Jay 34[1]:18–25).

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***CHELYDRA SERPENTINA SERPENTINA* (Eastern Snapping Turtle)**. USA: HAWAII: OAHU: Honolulu Co.: Kaneohe: Kamooalii Stream, within the Ho'omaluhia Botanical Garden (21.3840°N, 157.8025°W; WGS 84). 25 May 2011: Bishop Museum (BPBM 37715). Collected by Tag N. Engstrom. Verified by Allen Allison (BPBM). First vouchered record of a wild-caught

Chelydra serpentina from the state of Hawaii (Yamamoto and Tagawa 2000. Hawai'i's Native and Exotic Freshwater Animals. Mutual Publishing, Honolulu, Hawaii. 200 pp.). A mature male was captured in a funnel trap in the small reservoir above Lehua Dam in Kamooalii stream, in the Ho'omaluhia Botanical Garden. A previous, unconfirmed report of a snapping turtle in a different body of water in the botanical garden suggests that there may be an established population at this location. Introduction of another large non-native predator to the aquatic ecosystem of Hawaii could have major negative effects.

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***GRAPTEMYS BARBOURI* (Barbour's Map Turtle)**. USA: Georgia: Coweta and Spalding Cos.: Two adult females observed and photographed basking on a log in Line Creek (which forms the boundary between the two counties) at the Georgia Highway 16 bridge (33.256694°N, 84.497399°W; NAD 83). 7 July 2011. John B. Jensen. Verified by Sean Graham. AUM AHAP-D 317, photographic voucher. First county and creek records, as well as an upstream (Flint River drainage) and northerly range extension of approximately 15 river-km from a Flint River record in Meriwether Co. (Jensen et al. [eds.] 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.).

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***GRAPTEMYS GEOGRAPHICA* (Northern Map Turtle)**. USA: GEORGIA: Floyd Co.: 1.15 km W Black Buff Road. Multiple individuals were observed and photographed in the Coosa River near Rome (34.20591°N, 85.29058°W; NAD 83). 5 August 2011. Grover Brown and Owen Kinney. Verified by Kenneth L. Krysko. UF 165620. New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). This record conservatively fills a 475 km distribution gap between previous Coosa River drainage records upstream in the Conasauga River in Whitfield Co., Georgia (GMNH 19514) and the only other Coosa River record, a vague record downstream in Coosa Co., Alabama (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn Univ. Agric. Exp. Stat. 347 pp.).

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***KINOSTERNON LEUCOSTOMUM* (White-lipped Mud Turtle; Pochitoque)**. HONDURAS: SANTA BÁRBARA: SW corner of Lago de Yojoa (14.800004°N, 88.000149°W, WGS84; 650 m elev.). 1 October 2010. James R. McCranie and Leonardo Valdés Orellana. USNM 578922. First record for Santa Bárbara, with the closest known locality being from ca. 15 km NE at Agua Azul, Cortés (AMNH 70545–47, TCWC 19232). YORO: 5 km S of San Patricio (15.40000°N, 86.916667°W, WGS84; 250 m elev.). 5 October 2010. James R. McCranie and Leonardo Valdés Orellana. USNM 578921. First record from Yoro, with the closest known locality being from ca. 40 km N at La Ceiba, Atlántida (USNM 62981–90). Both vouchers were verified by Steve W. Gotte. The Santa Bárbara turtle was active at night on the bottom of a muddy, rain-filled flood plain. The Yoro turtle was active at night in a small lagoon formed by a small tributary of the Río Aguán in an area of badly degraded thorn forest.

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***KINOSTERNON LEUCOSTOMUM* (White-lipped Mud Turtle; Pochitoque)**. HONDURAS: El PARAÍSO: Mapachín (13.9830°N, 86.4910°W, WGS84; 830 m elev.). 8 July 2010. Alexander Gutsche, James R. McCranie, and Leonardo Valdés Orellana. USNM 578923–24. Verified by Steve W. Gotte. First records for El Paraíso with the closest known locality being ca. 65 km to the NE, 7 km E of Azacualpa, Olancho (UF 90019). The turtles were active at night in a man-made pond in an area of denuded pine forest. Fieldwork of A. Gutsche was supported by the Adolf and Hildegard Isler Foundation.

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***MACROCHELYS TEMMINCKII* (Alligator Snapping Turtle)**. USA: GEORGIA: Clayton Co.: Flint River, 0.35 km S of McDonough Road (33.45604°N, 84.38425°W; NAD 83). 21 July 2011. John B. Jensen and Sean P. Graham. UF 165542. Coweta Co.: Hutchins Lake, 0.24 km NW Rockaway Road (33.31982°N, 84.54592°W; WGS 84). August 2010. Clint Freeman. UF 165217. Fayette Co.: Flint River 0.29 km N of McDonough Road (33.46100°N, 84.38306°W; NAD 83). 21 July 2011. John B. Jensen and Sean P. Graham. UF 165541. Spalding Co.: Flint River, 0.76 km SW of Georgia Highway 16 (33.23941°N, 84.43340°W; NAD 83). 15 July 2011. John B. Jensen and Kristina Sorensen. UF 165533. Each record reported herein is a first record for their respective county (Jensen et al. [eds.] 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp). All specimens were verified by Kenneth Krysko.

During summer 2010, one of us (JBJ) was sent a photograph of a large, adult male alligator snapper from an impounded tributary (Keg Creek; Hutchins Lake) of the Flint River, which represented a significant upstream and northerly range extension well into the Piedmont physiographic province. This discovery led us to trap two other Piedmont stretches of the Flint River drainage to determine how widespread *M. temminckii* might be in what has largely been dismissed by biologists and former commercial trappers as habitat too far upstream and away from the Coastal Plain to harbor the species. In fact, Al Redmond, perhaps the most well-known commercial trapper of this species in Georgia, considered the Flint River near Reynolds, approximately 100 air-km S of our northernmost record and within the Coastal Plain physiographic region, to be the northern limit of the species' Georgia range (pers. comm. to P. Pritchard *in* Pritchard 2006. The Alligator Snapping Turtle: Biology and Conservation. Krieger Publishing Co., Malabar, Florida. 140 pp.). Our trapping effort yielded 13 alligator snappers in 19 trap-nights (TN), for a catch per unit effort (CPUE) of 0.68 turtles/TN. Of the 13 alligator snappers captured, eleven were juveniles. In a statewide status survey of this species from 1997–2001, Jensen and Birkhead

(2003. Southeast. Nat. 2:25–34) had a total CPUE of 0.20 turtles/TN in 281 TN, with the best stream producing a CPUE of 0.45 turtles/TN. Additionally, captures as part of the previous study resulted in a 4:1 adult:juvenile ratio. Clearly, the recently trapped Piedmont portion of the Flint River drainage appears to have a relatively dense and successfully recruiting population of this state "Threatened" species, perhaps because commercial trappers did not think they occurred there.

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***MACROCHELYS TEMMINCKII* (Alligator Snapping Turtle)**. USA: LOUISIANA: Vernon Parish: Louisiana Ave. and Bundick Creek crossing 100 m S of the Rt. 10 & LA Ave. jct. (31.03372°N, 93.19202°W; WGS 84). 27 June 2007. Stephen M. Ecrement. Florida Museum of Natural History, University of Florida (UF165500). Verified by Kenneth L. Krysko. First parish record, extending distribution N from Beauregard Parish and W from Rapides Parish as mapped by Dundee and Rossman (1989. The Amphibians and Reptiles of Louisiana. Louisiana State University Press, Baton Rouge. 300 pp.).

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***RHINOCLEMMYS PULCHERRIMA* (Painted Wood Turtle; Casco Rojo)**. HONDURAS: EL PARAÍSO: Mapachín (13.9830°N, 86.4910°W, WGS84; 800 m elev.). 7 October 2010. James R. McCranie and Leonardo Valdés Orellana. USNM 578920. Verified by Steve W. Gotte. First record for El Paraíso, with the closest known locality being ca. 40 km W at El Zamorano, Francisco Morazán (AMNH 70569). The turtle was active during the day in a tomato field in an badly degraded ecotone between thorn scrub and pine forest.

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***STERNOTHERUS ODORATUS* (Eastern Musk Turtle)**. USA: ARKANSAS: Calhoun Co.: vic. Calion, ~6 km N of Ouachita River off US 167 (33.388195°N, 92.496846°W; WGS 84). 28 August 2011. M. B. Connior.Verified by S. E. Trauth. Arkansas State University Museum of Zoology Herpetology Collection (ASUMZ photo voucher 31831). New county record partially filling a distributional hiatus in southern Arkansas (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville. 421 pp.). An intact carapace and plastron were collected along the bank of a small slough from the Ouachita River.

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***TERRAPENE CAROLINA* (Eastern Box Turtle)**. USA: ALABAMA: Coosa Co.: County Road 22, 0.8 km W of the intersection with County Road 9 (32.867369°N, 86.101247°W; WGS84/NAD83). 28 May 2011. B. Scott. Found alive on road. Digital images AHAP-D-310 311. Verified by Craig Guyer. New county record (Mount 1996. The Reptiles and Amphibians of Alabama. University of Alabama Press. xi+347 pp.). *T. carolina* is assumed to occur statewide, however verified records are lacking for many Alabama counties.

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***TERRAPENE CAROLINA* (Eastern Box Turtle)**. USA: ALABAMA: Russell Co.: Hwy 51 approximately 1.1 km N of the intersection with Hwy 26 in the town of Hurtsboro (32.255020°N, 85.416470°W; WGS84/NAD83). 22 Sept. 2011. R. Birkhead. Found dead on road, AUM 39694. Verified by Craig Guyer. New county record (Mount 1996. The Reptiles and Amphibians of Alabama. University of Alabama Press. xi+347 pp.).

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***TERRAPENE CAROLINA* (Eastern Box Turtle)**. USA: GEORGIA: Calhoun Co.: County Road 153, 1.12 km S of the intersection with State Route 37 near the town of Morgan (31.526898°N, 84.599696°W; WGS84/NAD83). 24 August 2011. W. S. Birkhead and Ricky Batts. Found alive on road. Digital vouchers AHAP-D-319a–e. Verified by Craig Guyer. New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). *T. carolina* is assumed to occur statewide, however verified records are lacking for many Georgia counties (Jensen et al. 2008, *op. cit.)*. This individual likely represents an intergrade between *T. c. carolina* and *T. c. triunguis* as it has three toes on the hind feet and the peak of the carapace is located posteriorly; however, it also has bright coloration on the head, legs, and carapace similar to *T c. carolina.*

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***TERRAPENE CAROLINA CAROLINA* (Eastern Box Turtle)**. USA: INDIANA: Jennings Co.: North Vernon, County Road 75 West & County Road 115 South, 0.45 miles S (38.966°N, 85.625°W; WGS 84; elev. 216 m). 24 October 2010. John B. Iverson. Verified by Dana J. Ehret. Florida Museum of Natural History (UF 165391). New county record (Minton 2001. Amphibians and Reptiles of Indiana. 2nd ed., revised. Indiana Academy of Science. 404 pp.)

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***TERRAPENE ORNATA* (Ornate Box Turtle)**. USA: NEBRASKA: Box Butte Co.: Alliance, east side of town on US Hwy 2 (42.09695°N, 102.85501°W; NAD 83). 8 July 2010. Shane Keane. Photographic voucher. Verified by Curtis J. Schmidt. Sternberg Museum of Natural History, Fort Hays State University, Hays, Kansas (FHSM 15599). First county record (Ballinger et al. 2010. Amphibians

and Reptiles of Nebraska. Rusty Lizard Press, Oro Valley, Arizona. 400 pp.; Fogell 2010. A Field Guide to the Amphibians and Reptiles of Nebraska. University of Nebraska, Lincoln. vi + 158 pp.). Fills distributional gap in northwestern Nebraska among Sheridan, Sioux, Scottsbluff, and Morrill counties. Female photographed on shoulder of highway near the western edge of the Sandhill Region of Nebraska.

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***TRACHEMYS STEJNEGERI* (Central Antillean Slider)**. USA: PUERTO RICO: Isla de Culebra (18.31°N, 65.28°W; WGS 84), 3–26 m elev. Twenty-six live *Trachemys stejnegeri* (10 males, 13 females, 2 juveniles, 1 unknown) were observed along a small, forested stream on the south side of Culebra Island by M. T. Jones and L. L. Willey. 1–2 January 2011. Verified by M. E. Seidel. Museum of Comparative Zoology (digital image MCZ R-188664).

Trachemys stejnegeri utilizes a variety of wetlands on Great Inagua (Bahamas), Hispaniola, and Puerto Rico. Of three subspecies, the nominate race *T. s. stejnegeri* occurs throughout the island of Puerto Rico. Seidel (1988. Am. Mus. Novit. 2918:1–41) cited anecdotal reports of *T. stejnegeri* from both Isla de Culebra and neighboring Isla de Vieques, located 30 and 10 km from the eastern shore of Puerto Rico, respectively. Subsequent authors (e.g., Ernst et al. 2010. Turtles of the World online database: *Trachemys stejnegeri* [http://nlbif.eti.uva.nl/bis/turtles.php?menuentry=soorten&id=327]; Iverson et al. 2010. EMYSystem: *Trachemys stejnegeri* (http://emys.geo.orst.edu/collection/species/Trachemysstejnegeri/Trachemysstejnegeri.htm) have indicated that the species is present on Culebra and Vieques, citing Siedel's (1988, *op. cit.)* unverified report.

Our findings confirm the presence of an established population of *T. stejnegeri* on Culebra. We observed *T. stejnegeri* in a variety of habitats: basking on rocks, submerged in shallow pools along the stream and one turtle in a stone cistern about 15 m from the stream channel. All sliders observed were consistent with the nominate subspecies *T. s. stejnegeri*, native to Puerto Rico.

Female SCL_{min} averaged 194 mm (N =12; range = 162–267 mm). Male SCL_{min} averaged 156 mm (N = 9; range = 124–184 mm). Five of nine males were melanistic, which is typical for the species (Seidel 1988, *op. cit.).*

We observed courtship in a shallow (20 cm) pool on 2 January 2011. Combined with the presence of juveniles, this suggests that the population is reproducing. Channel slope (= stream gradient) averaged 3.1%. Streamflow averaged 0.0112 m^3/sec. The stream may now be augmented by discharge from a municipal water facility located in its headwaters, but the channel is clearly visible in aerial images (U.S. Geological Survey) taken in 1994, before the facility existed. Total dissolved solids in the stream at 20 m elev. (4.6 ppt) indicate brackish origin, but within the range tolerated by *Trachemys* and *Pseudemys* in the Cayman Islands and Florida (Dunson and Seidel 1986. J. Herpetol. 20[2]:237–245).

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SQUAMATA — LIZARDS

***ACANTHODACTYLUS BOSKIANUS* (Bosc's Fringe-toed Lizard)**. IRAN: KHUZISTAN PROVINCE: ca. 30 km N of Dezful, around Vahdati village (32.6333°N, 48.5833°E; 220 m elev.; datum WGS 84). Collected by Roman Nazarov and Mehdi Rajabizadeh. International Center for Science, High Technology and Environmental Sciences Zoological Museum, Kerman (ICSTZM 6H1285). Verified by Nasrullah Rastegar-Pouyani. Associated with annual grasses, *Amygdalus* and Graminaceae as dominant vegetation in lowland sandy hills. First confirmed record for Khuzistan Province, and 500 km S of only record (Rastegar-Pouyani 1999. Asiatic Herpetol. Res. 8:85–89). Our specimens fit diagnosis and color pattern given in Anderson (1999. The Lizards of Iran. Society for the Study of Amphibians and Reptiles, Ithaca, New York. 415 pp.).

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***ASPIDOSCELIS LAREDOENSIS* (Laredo Striped Whiptail)**. USA: TEXAS: Kinney Co.: Rancho Rio Grande, 10–110 m from the Rio Grande (29.159721°N, 100.757492°W; datum WGS84, elev. 250 m), 6.08 km SW (all distances in straight lines) from the nearest point on US Hwy 277 (29.191475°N, 100.706570°W; WGS 84; elev. 268 m). 14 June 2000. James E. Cordes. University of Arkansas "Department of Zoology" (UADZ) 6731 (65 mm SVL), 6734 (78 mm SVL), 6738 (79 mm SVL). Verified by Mark A. Paulissen. First county record (Dixon 2000. Amphibians and Reptiles of Texas. Texas A & M Univ. Press, College Station. 421 pp.).

With reference to previous sites reported for *A. laredoensis* in the northern part of its range (Walker 1987. Texas J. Sci. 39:313–334), the new site is ca. 25 km SE of Del Rio, Val Verde Co., and ca. 56 km NW of Eagle Pass, Maverick Co., and fills in an apparent disjunction in the range (Walker 1987, *op. cit.*) . Based on collection data obtained on Rancho Rio Grande by JEC in May and June 2000, gonochoristic *A. gularis* was euryecious (present throughout the ranch), ubiquitous (regularly observed), and readily collectible (N = 118), whereas diploid parthenogenetic *A. laredoensis* B was stenoecious (restricted to a few areas influenced by the river) and rarely encountered or collected (N = 7).

Specimens were collected under authority of Texas Parks and Wildlife Department (TPWD) permit SPR-1090-298 to James E. Cordes. David H. Riskind and Mark Lockwood of TPWD made it possible for us to conduct herpetological studies in Texas. Research on the private ranch was enabled by consent, advice, and/or guidance provided by Bill Moody (owner), John and Elizabeth Kincaid (ranch foreman and spouse), Aurelio Castillo (ranch hand), and Bubba and the other federal Tick Riders (livestock disease abatement) who ply the border on horseback.

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***ASPIDOSCELIS NEOMEXICANA* (New Mexico Whiptail)**. USA: NEW MEXICO: Roosevelt Co.: 0.48 km E of De Baca-Roosevelt counties boundary in highly disturbed habitat near US Hwy 84/60 and BNSF railroad grade (34.450833°N, 103.942500°W; WGS 84; elev. 1288 ± 2 m WAAS). 10 July 2011. James E. Cordes. University of Arkansas "Department of Zoology" (UADZ 8898). SVL 71 mm. Verified by Harry L. Taylor. New county record. (Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. Univ. New Mexico Press, Albuquerque, 431 pp.). This location for this allodiploid parthenogen is ~27.8 km straight-line east of the nearest locality in Fort Sumner (34.479722°N, 104.228889°W; WGS84; elev. 1260 m), De Baca Co. (Taylor 2002. Herpetol. Rev. 33:223–224; Manning et al. 2005. Am. Mus. Novitat. 3492:1–56; Manning and Walker 2006. Am. Midl. Nat. 155:411–416), situated farther east in New Mexico than the records for the species at Conchas Lake (35.377222°N, 104.184444°W; WGS84; elev. 1271 m), San Miguel Co. (Leuck et al. 1981. Southwest. Nat. 26:72–74; Manning et al., *op. cit.*), and also inhabited by gonochoristic *A. sexlineata* with which it hybridizes (Cordes, unpubl.). Discovery of *A. neomexicana* in Roosevelt Co. also provides another detail of distribution for consideration in the controversy on whether the species is naturally occurring in De Baca, San Miguel, and Roosevelt counties (Walker et al. 1992. Southwest Nat. 37:82–86; Taylor, *op. cit.*; Manning et al., *op. cit.*) or the result of introductions of individuals (Leuck et al., *op. cit.*; Persons and Wright 1999. Herpetol. Rev. 30:207–209) well east of the main distribution area in the Rio Grande Valley in New Mexico.

Collections were made under authority of New Mexico Game and Fish permit number 1850 to James E. Cordes.

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***BLANUS CINEREUS* (Iberian Worm Lizard)**. PORTUGAL: ÉVORA: ca. 38.5256°N, 08.0211°W (WGS84). 25 July 2011. Luis Ceríaco. Photographic vouchers deposited at Colecção Fotográfica of the Museu de Ciências Naturais da Escola Secundária André de Gouveia (MCN/MB/F/R/22). Verified by Ana Pires. Species previously unrecorded from region, nearest population being at least 10 km SW (Ribeiro 2010. *In* Loureiro et al. [eds.], Atlas dos Anfíbios e Répteis de Portugal, pp. 160–161. Esfera do Caos Editores, Lisboa). Specimen was found under rock, in Herdade da Mitra, at ca. 1130 h.

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***CHALCIDES BEDRIAGAI* (Bedriaga's Skink)**. PORTUGAL: ÉVORA: ca. 38.5220°N, 08.0106°W (WGS84). 25 July 2011. Luis Ceríaco. Photographic vouchers deposited at Colecção Fotográfica of the Museu de Ciências Naturais da Escola Secundária André de Gouveia (MCN/MB/F/R/8). Verified by Ana Pires. Species previously unrecorded from region, nearest population being at least 30 km east, in Reguengos de Monsaraz region (Silero 2010. *In* Loureiro et al. [eds.], Atlas dos Anfíbios e Répteis de Portugal, pp. 156–157. Esfera do Caos Editores, Lisboa). Specimen was found under rock, in Herdade da Mitra, at ca. 1200 h.

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***CTENOSAURA HEMILOPHA* (San Esteban Island Iguana)**. MÉXICO: SONORA: Municipality of Hermosillo: Isla Alcatráz (28.813289°N, 111.96685°W; WGS84). 24 July 2005. Víctor Hugo Reynoso and Georgina González Monfil. Verified by Eugenia Zarza Franco. CNAR-IBH-RF 34-35. First record from Isla Alcatráz, extending its known range 35 km NE of Isla Cholludo (Grismer 2002. Amphibians and Reptiles of Baja California: Including its Pacific Islands and the Islands in the Sea of Cortez. Univ. of California Press, Berkeley. xiii + 399 pp.). This species is probably of recent introduction. One lizard was found in a hole on a cliff and the other on the ground below large rocks; both were in an arid environment.

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***CTENOSAURA SIMILIS* (Gray's Spiny-tailed Iguana)**. USA: FLORIDA: Monroe Co.: Big Pine Key 1.08 km SE of jct. Gulf Boulevard and Key Deer Boulevard (24.71265°N, 81.38109°W; WGS 84; elev. <3 m). 19 May 2011. Chad Anderson. Verified by Kenneth L. Krysko. Florida Museum of Natural History photo voucher (UF 165529). New island record and second island record from the Florida Keys (Enge et al. 2006. Herpetol. Rev. 37:494). Adult photographed at 1144 h by a Wildgame™ passive infared camera positioned near the carcass of a Key Deer (*Odocoileus virginianus clavium*) in pine rockland habitat. The sighting was 5.2 km W of a *C. similis* sighting on adjacent No Name Key, where a reproducing population apparently exists (Enge et al., *op. cit.*).

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***GONATODES ALBOGULARIS* (Yellow-headed Cecko; Geco Cabeza Amarilla)**. HONDURAS: EL PARAÍSO: Mapachín (13.9830°N, 86.4910°W, WGS84; 800 m elev.). 8 July 2010. James R. McCranie and Leonardo Valdés Orellana. Verified by Steve W. Gotte. USNM 578912–14. First records for El Paraíso, with the closest known locality being ca. 45 km NNW at Villa San Francisco, Francisco Morazán (USNM 578915–16). The lizards was found during the day in stacked roofing tiles in the yard of a resident.

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***HEMIDACTYLUS TURCICUS* (Mediterranean House Gecko)**. PORTUGAL: SETÚBAL: ca. 38.5167°N, 08.9047°W (WGS84). 24 July 2011. Luis Ceríaco. Photographic vouchers deposited at Colecção Fotográfica of the Museu de Ciências Naturais da Escola Secundária André de Gouveia (MCN/MB/F/R/16). Verified by Ana Pires. Species previously unrecorded from region, nearest population being at least 90 km E, in Évora region (Mateus and

Jacinto 2010. *In* Loureiro et al. [eds.], Atlas dos Anfíbios e Répteis de Portugal, pp. 130–131. Esfera do Caos Editores, Lisboa). Specimen observed on wall near dock, at ca. 2130 h. Presence of species in Setubal may be due to human-mediated dispersal, a common dispersal mode for species (Locey and Stone 2006. J. Herpetol. 40:526–530).

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***HEMIDACTYLUS TURCICUS* (Mediterranean Gecko)**. USA: ALABAMA: Shelby Co.: University of Montevallo's Regional In-Service Education Center, 2790 Pelham Parkway, Pelham (33.30904°N, 86.80465°W; WGS84/NAD83). 1 April 2011. R. Birkhead. Verified by Craig Guyer (digital image vouchers AUM AHAP-D 312–313). Two desiccated specimens removed from glue traps set for pest control. New county record.

Hemidactylus turcicus has been documented in many of the larger cities in Alabama (Mount 1996. The Reptiles and Amphibians of Alabama. University of Alabama Press. xi+347 pp.). The geckos were captured in a warehouse where packaging and refurbishing kits for the Alabama Math Science and Technology Initiative (AMSTI) occurs. A total of four traps were examined and all contained at least one *H. turcicus*. It is reasonable to assume that the warehouse harbors a breeding population and geckos are quite likely making into the crates of material being packaged and delivered to all the K-8 schools in the area.

Thanks go to Sean Graham for reviewing this note.

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***HEMIDACTYLUS TURCICUS* (Mediterranean Gecko)**. USA: OKLAHOMA: Comanche Co.: Lawton: exterior wall at 1709 NW Cache Rd, the Deluxe Inn Motel (34.623889°N, 098.416111°W; WGS 84). 04 July 2011. Cameron University Museum of Zoology (CUMZ 215). Collected by Jared W. White. Verified by Stanley F. Fox. New county record (Sievert and Sievert 2011. A Field Guide to Oklahoma's Amphibians and Reptiles, 3rd ed. Oklahoma Department of Wildlife Conservation. Oklahoma City, Oklahoma. 211pp.). Numerous adults and juveniles were found within a five-block radius of the specimen collection site. The nearest documented population is 82.3 km S in Wichita Co., Texas (Dixon 2000. Amphibians and Reptiles of Texas. Texas A&M University Press, College Station. 419 pp.). Several counties in eastern and central Oklahoma have documented populations, but all are greater than 100 km distant (Sievert and Sievert 2011, *op. cit.)*

JARED W. WHITE (e-mail: Jared.White@cameron.edu), **ERIC J. BECK**, and **MICHAEL S. HUSAK** (e-mail: michaelh@cameron.edu), Department of Biological Sciences, Cameron University, Lawton, Oklahoma 73505, USA.

***LEIOCEPHALUS CARINATUS* (Northern Curly-tailed Lizard)**. USA: FLORIDA: Pinellas Co.: Indian Rocks Beach, 9th Ave. N, 0.03 km W of Gulf Blvd. (27.8914°N, 82.8498°W; WGS 84). 29 July 2011. J. Steve Godley. Verified by Kenneth L. Krysko. (UF 165670 and 165671, and USNM 562740 and 562741). New county record. On the west coast of Florida this species has been reported from Collier Co. (McCoid 2002. Herpetol. Rev. 33:322) and Lee Co. 166.7 km to S (Campbell and Klowden 2003. Herpetol. Rev. 34:384;), an unpublished UF record (UF 159751, K. L. Krysko, pers. comm.) from Pasco Co., 36.5 km to N (review of Pasco Co. locality suggests the specimen was a waif with no established population). The Indian Rocks Beach population (ca. 10 adults of multiple size classes) seemed restricted to a two-block area. An expanded search of 2.2 km of Gulf Blvd. yielded no additional animals. Residents first noticed the species in ca. 2006 after city workers mulched beach access flower beds.

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***LIOLAEMUS CRISTIANI* (Cristian's Lizard)**. CHILE: IX REGION DE LA ARAUCANIA: Malleco Province: Malalcahuello-Nalcas Nacional Reserve, Sendero Piedra Santa (38.439250°S, 71.576880°W, WGS84; 1769 m elev.). 27 January 2009. G. Escobar H. Museo de Zoología de la Universidad de Concepción, Concepción, Chile (MZUC 32771, adult male; MZUC 32772–73, adult females) Verified by P. Victoriano. The species was known only from VII Maule Region and VIII Bío-Bío Region, Chile (Navarro et al. 1991. Bol. Mus. Nac. Hist. Nat., Chile 42:79–88; Torres-Pérez et al. 2009. Biol. J. Linn. Soc., London 96:635–650). New region record and southern boundary of the distribution, extends known range 215 km S of Cerro El Peine, Altos de Vilches in the Andean area (Navarro et al. 1991, *op. cit.*).

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***PHELSUMA MADAGASCARIENSIS* (Madagascar Day Gecko)**. USA: FLORIDA: Monroe Co.: Ramrod Key, near junction of West Indies Drive and Cayman Lane (24.65154°N, 81.40447°W, WGS84; elev. < 1 m). 5 July 2011. Kenneth L. Krysko, Catherine A. Smith, and Andrew P. Borgia. Verified by Anthony T. Reppas. Florida Museum of Natural History (photographic voucher UF 165521). New island record and ninth known island in the Florida Keys from which this species has been independently introduced (Krysko and Hooper 2007. Gekko 5:33–38; Krysko and Sheehy 2005. Carib. J. Sci. 41:169–172).

KENNETH L. KRYSKO (e-mail: kenneyk@flmnh.ufl.edu) and **CATHERINE A. SMITH** (hellcat@ufl.edu), Division of Herpetology, Florida Museum of Natural History, Dickinson Hall, University of Florida, Gainesville, Florida 32611, USA; **ANDREW P. BORGIA**, P.O. Box 4346, Key West, Florida 33041, USA; **JOSEPH P. BURGESS**, Florida Department of Environmental Protection, GTM NERR, Ponte Vedra, Florida 32082, USA (e-mail: Joseph.Burgess@dep.state.fl.us).

***PLESTIODON LATICEPS* (Broad-headed Skink)**. USA: TENNESSEE Madison Co.: Lowell Thomas Drive behind TWRA Region 1 office (35.3744°N, 88.4330°W, NAD 83). 10 May 2011. Robert Colvin. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19129). First county record (Scott and Redmond 2008. Atlas of Reptiles in Tennessee. Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. http://www.apsu.edu/reptatlas [updated 26 July 2011; accessed 12 September 2011].

Voucher specimen collected under the authority of the Tennessee Wildlife Resources Agency; field work supported by State Wildlife Grant (SWG) funding under the authority of the U.S. Fish and Wildlife Service.

ROBERT COLVIN, Tennessee Wildlife Resources Agency, Region I, 200 Lowell Thomas Drive, Jackson, Tennessee 38301, USA; e-mail: Rob.Colvin@tn.gov.

***SCINCELLA LATERALIS* (Little Brown Skink)**. USA.: INDIANA: Jackson Co.: Knobstone Glade Nature Preserve (38.82692°N, 86.06776°W; NAD 83). 1 June 2011. Sarabeth Klueh and Jason Mirtl. Verified by Chris Phillips. Illinois Natural History Survey (INHS 2011k). New county record (Minton 2001. Amphibians and Reptiles of Indiana, 2nd ed., revised. Indiana Academy of Science. vii–404 pp.) One adult out in the open in leaf litter.

SARABETH KLUEH (e-mail: sklueh@dnr.in.gov) and **JASON MIRTL**, Wildlife Diversity Section, Indiana Department of Natural Resources Division of Fish and Wildlife, 553 E. Miller Drive, Bloomington, Indiana 47401, USA.

STROBILURUS TORQUATUS. BRAZIL: MINAS GERAIS: UHE Barra do Braúna (ca. 21.4451°S, 42.4288°W, datum SAD69). J. P. Barbosa. 11 May 2009. Museu de Zoologia João Moojen, Universidade Federal de Viçosa, Viçosa, Minas Gerais, Brazil (MZUFV 860, SVL = 74 mm; MZUFV 861, SVL = 79 mm). Verified by D. Loebmann. This apparently rare lizard is known to occur in the Atlantic Forest of the Brazilian states of Ceará, Pernambuco, Alagoas, Bahia, and Espírito Santo, inhabiting both undisturbed and secondary forests (Borges-Nojosa and Caramaschi 2003 *In* L. R. Leal et al. [eds.], Ecologia e Conservação da Caatinga, pp. 463–512. Universidade Federal de Pernambuco, Recife, Brazil; Jackson 1978. Arq. Zool. 30[1]:1–79; Rodrigues et al. 1989. Rev. Brasil. Genet. 12[4]:747–759). The present note establishes the westernmost record of *S. torquatus*, and the first report of this species for the state of Minas Gerais, about 270 km straightline southwest from Aracruz, state of Espírito Santo, the closest known locality (Jackson 1978, *op. cit.*).

HENRIQUE CALDEIRA COSTA, Museu de Zoologia João Moojen, Vila Gianetti 32, Universidade Federal de Viçosa, CEP 36570-000, Viçosa, Minas Gerais, Brazil; e-mail: ccostah@yahoo.com.br.

***TARENTOLA MAURITANICA* (Moorish Gecko)**. PORTUGAL: TORRES VEDRAS: ca. 39.0197°N, 0.25779°W (WGS84). 24 July 2011. Collected by Mariana Marques. Colecção de Animais em formol of Museu de Ciências Naturais da Escola Secundária André de Gouveia (MCN/MB/AC/V/46). Species previously unreported from region, nearest population being at least 10 km S, in Mafra region (Perera et al. 2010. *In* Loureiro et al. [eds.], Atlas dos Anfíbios e Répteis de Portugal, pp. 132–133. Esfera do Caos Editores, Lisboa). Specimen collected from wall in urban environment, at ca. 2200 h. Many other individuals sighted in urban areas of Torres Vedras, where it is abundant. ÉVORA: ca. 38.5708°N, 07.9083°W. 27 May 2011. Luis Ceríaco. Photographic vouchers (MCN/MB/F/R/11). Species previously unreported from region, nearest population being at least 15 km SW (Perera et al. 2010, *op. cit.*). Specimen photographed on wall in urban environment, at ca. 2230 h. Many individuals sighted in urban areas of Évora, where it is abundant and occurs sympatrically with *Hemidactylus turcicus*. All specimens were verified by Ana Pires.

LUIS MIGUEL PIRES CERÍACO, Projecto "Salvem as Osgas!" and Centro de Estudos de História e Filosofia da Ciência, Universidade de Évora, Bairro do Bacelo, Rua do Viveiro nº 5D, 7005–638 Évora, Portugal (e-mail: luisceriaco@netcabo.pt); **MARIANA PIMENTEL MARQUES**, Projecto "Salvem as Osgas!" and Escola de Ciências e Tecnologias, Universidade de Évora.

***TRETIOSCINCUS ORIXIMINENSIS* (Oriximina Lizard)**. COLOMBIA: VAUPÉS: Serranía del Taraira (1.063875°S, 69.532764°W; datum Bogotá WGS 84). 01 August 1993. I. Stephen Ayala. Colección de Reptiles, Instituto de Ciencias Naturales, Universidad Nacional de Colombia, Colombia (ICN 7094). Mitú (1.1944167°S, 70.2399167°W). 14 July 2010. M. Calderón-Espinosa. ICN 12072. Verified by Juan E. Carvajal-Cogollo. This lizard was known from Venezuela in the Territorio Federal of the state of Amazonas at the confluence of Rio Mavaca and Rio Orinoco, upper Rio Mavaca and Rio Mawarinuma localities, and in Brazil in Amazonas state in Rio Negro, Tapurucuara locality and Oriximiná, Para state (in lower Rio Trombetas locality) (Ávila-Pires 1995. Lizards of Brazilian Amazonia [Reptilia: Squamata]. Zoologisches Verhandelingen, Leiden 299:1–706; Ávila-Pires 2005. *In* Hollowell and Reynolds [eds.], Checklist of the Terrestrial Vertebrates of the Guiana Shield. Bull. Biol. Soc. Washington 13:25–42). Avila-Pires (1995, 2005, *op. cit.*) suggested that this species might occur in Colombia and the present specimens confirm this prediction. These are the first records for Colombia, extending the known range to "Amazonía de Colombia," 450 km SW from nearest locality (Oriximiná, Pará, Brazil, the type locality; Avila-Pires 1995, *op. cit.*).

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SQUAMATA — SNAKES

***BOTHROPS ASPER* (Terciopelo)**. MÉXICO: HIDALGO: Municipality of Huehuetla; Barrio Aztlán (98.0822°N, 20.4666°W; WSG84), 566 m elev. 21 August 2008. Froylán Ramírez and Nallely Morales. Verified by Jesús M. Castillo. Colección Herpetológica, Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo (CH-CIB 1635). First municipality record, extending its range in the state ca. 91 km SE from its closest known locality at Molango, Acayuca (Ramírez-Bautista et al. 2010. Lista Anotada de los Anfibios y Reptiles del Estado de Hidalgo, México. Universidad Autónoma del Estado de Hidalgo, CONABIO. x + 104 pp.). The snake was found in tropical deciduous forest. Fieldwork was funded by CONACyT- 95828.

IRENE GOYENECHEA (e-mail: ireneg28@gmail.com), **NALLELY MORALES-CAPELLAN,** and **LEONARDO FERNÁNDEZ-BADILLO**, Centro de Investigaciones Biológicas (CIB), Universidad Autónoma del Estado de Hidalgo, A. P. 1-69 Plaza Juárez, Pachuca, Hidalgo, México.

***CHIRONIUS FLAVOLINEATUS* (Liana Snake)**. BRAZIL: RONDÔNIA: Pimenta Bueno (11.39°S, 61.11°W, SAD 69; 195 m elev). 26 May 2007. S. de Albuquerque. Coleção Herpetologica da Universidade Federal do Acre-Campus Floresta, Cruzeiro do Sul, Acre, Brazil (UFACF 1280). Verified by A. J. Suzart Argôlo. Specimen was found in patches of "cerrado" areas inside the Amazonian domain. This species is known in Brazil from west Pernambuco and Ceará states, Mato Grosso, Tocantins, Pará, Goiás, Minas Gerais; central and northeastern litoral of the Bahia state, and Central São Paulo state; also known from northeastern Paraguay; and central Bolivia (Borges-Nojosa and Lima 2009. Herpetol. Rev. 40:237; Cunha and Nascimento 1978. Publ. Avul. Mus. Paraense Emílio Goeldi 32:1–218; Dixon et al. 1993. Revision of the Neotropical Snakes Genus *Chironius* Fitzinger [Serpentes, Colubridae]. Museo Regionale di Scienze Naturali – Torino, 279 pp.; Freitas and Silva 2007. Herpetofauna das Caatingas e Áreas de Altitudes do Nordeste Brasileiro, USEB, Pelotas, 388 pp.). In Brazil, the western limit of the species range is central Mato Grosso state (Dixon et al., *op. cit.*). First state record, extends the species range 400 km N from Mato Grosso State (Dixon et al., *op. cit.*).

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CONOPHIS VITTATUS **(Striped Road Guarder)**. GUATEMALA: HUEHUETENANGO: Municipio de Nentón: Miramar, Finca Los Cimientos (15.881439°N, 91.807961°W; WGS84), 685 m elev. 23 November 2007. M. Acevedo and Q. Dwyer. Verified by Enio Cano. Colecciones Zoológicas de Referencia, Museo de Historia Natural, Universidad de San Carlos de Guatemala (MHN-USAC 1129). First record for Guatemala, with the closest known localities being in adjacent Chiapas, México (Köhler 2008. Reptiles of Central America, 2nd ed. Herpeton, Verlag E. Köhler, Offenbach, Germany. 400 pp.). The snake was found in an area containing subtropical dry forest.

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CROTALUS AQUILUS **(Qureteran Dusky Rattlesnake)**. MÉXICO: HIDALGO: Municipality of Atitalaquia: La Cantera (98.1863°N, 20.055°W; WGS 84), 2163 m elev. 15 September 2010. Melany Aguilar López. Verified by Jesús M. Castillo. Colección Herpetológica, Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo (CH-CIB 3403). First municipality record, extending the range in the state ca. 46 km SE and 70 km S from the closest known localities at Mineral del Chico, Presa Jaramillo (Ramírez-Bautista et al. 2010. Lista Anotada de los Anfibios y Reptiles del Estado de Hidalgo, México. Universidad Autónoma del Estado de Hidalgo, CONABIO. x + 104 pp.) and Ixmiquilpan, el Banxu (Fernández-Badillo and Goyenechea 2010. Rev. Mex. Biodiversidad 81:705–712), respectively. The snake was found in oak forest. Fieldwork was funded by CONACyT- 95828.

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CROTALUS ATROX **(Western Diamond-backed Rattlesnake)**. MÉXICO: HIDALGO: Municipality of Eloxochitlán: Hualula (98.6719°N, 20.7077°W; WGS 84), 1460 m elev. 8 March 1995. Rodolfo García Collazo. Verified by Jesús M. Castillo. Colección Herpetológica, Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo (CH-CIB 191). First municipality record, extending the range in the state ca. 32 km N and ca. 47 km NE from the closest known records at Meztitlán, Río Venados (Ramírez-Bautista et al. 2010. Lista Anotada de los Anfibios y Reptiles del Estado de Hidalgo, México. Universidad Autónoma del Estado de Hidalgo, CONABIO. x + 104 pp.) and Ixmiquilpan, San Juanico (Fernández-Badillo and Goyenechea 2010. Rev. Mex. Biodivers. 81:705–712), respectively. Fieldwork was funded by CONACyT- 95828.

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CROTALUS HORRIDUS **(Timber Rattlesnake)**. USA: ARKANSAS: Lonoke Co.: vicinity of Austin, AR Hwy 319; 8 km W US167 (35.055503°N, 92.039536°W; WGS 84). 27 August 2011. V. Wilson. Verified by S. E. Trauth. Arkansas State University Museum of Zoology Herpetology Collection (photo voucher ASUMZ 31830). New county record partially filling a distributional hiatus in central Arkansas (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville. 421 pp.). This adult individual was discovered in a residential backyard and was subsequently released unharmed.

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CROTALUS HORRIDUS **(Timber Rattlesnake)**. USA: GEORGIA: Dodge Co.: 8.8 km NNE Rhine, Wallace Ross Road (32.058699°N, 83.155414°W; NAD83). 22 April 2010. D. Hilliard and R. Little. Verified by Kenneth L. Krysko. UF 16585. New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp).

DELTON HILLIARD, P.O. Box 72, Rhine, Georgia 31077, USA; **RAYMOND LITTLE**, 2523 Mine 18 Road, Strunk, Kentucky 42649, USA; **DIRK J. STEVENSON**, The Orianne Society, Indigo Snake Initiative, 414 Club Drive, Hinesville, Georgia 31313, USA (e-mail: dstevenson@oriannesociety.org)

CROTALUS MITCHELLII PYRRHUS **(Southwestern Speckled Rattlesnake)**. USA: NEVADA: Lincoln Co.: Rainbow Canyon, near Elgin (37.31957°N, 114.4912°W; WGS 84). 20 May 2010. Tim Warfel and Mathew Cage. Verified by Jesse Meik. Brigham Young University (BYU 49910). Campbell and Lamar (2004. The Venomous Reptiles of the Western Hemisphere. Comstock Publishing Associates, Ithaca, New York. 870 pp.) show a large gap in distribution between southwestern Utah and northwestern Arizona in the distribution of *C. mitchellii* and *C. stephensi*. We collected a small female *C. mitchellii* (TL 508 mm; mass 72 g). The nearest specimens are BYU 42847 (59 km SE), MVZ 13102 (138 km W), and CAS 192745 (125 km S) (www.herpnet.org; accessed 27 April 2011). DNA sequencing confirmed species assignment to *C. mitchellii* (J. Meik, pers. comm.). In 1999, two other individuals were observed in this area but were not collected. Although not a new county record, this find represents a substantial range increase and helps fill a major distributional gap. Tissue is available by request from the authors.

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CROTALUS MOLOSSUS **(Black-tailed Rattlesnake)**. MÉXICO: HIDALGO: Municipality of Chapantongo: Rincón de las Víboras (99.5360°N, 20.2879°W, WGS 84; 2520 m elev.). 28 October 2009. Víctor Vite Silva and Alejandro Ramírez Pérez. Verified by Jesús M. Castillo. Colección Herpetológica, Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo (CH-CIB 2516). First municipality record, extending the range in Hidalgo ca. 46.5 km N from the closest known locality in the Municipality of Tepeji del Río (Ramírez-Bautista et al. 2010. Lista Anotada de los Anfibios y Reptiles del Estado de Hidalgo, México. Universidad Autónoma del Estado de Hidalgo, Pachuca, and CONABIO, México, D.F. 104 pp.). The snake was found in an oak forest. Fieldwork was funded by CONACyT - 95828.

IRENE GOYENECHEA (e-mail: ireneg28@gmail.com), **NALLELY MORALES-CAPELLAN**, and **LEONARDO FERNÁNDEZ-BADILLO**, Centro de Investigaciones Biológicas (CIB), Universidad Autónoma del Estado de Hidalgo, A.P. 1-69 Plaza Juárez, Pachuca, Hidalgo, México.

***CROTALUS MOLOSSUS* (Black-tailed Rattlesnake)**. USA: NEW MEXICO: Valencia Co.: Monte Largo Canyon, Manzano Mts. (34.60445°N, 106.47569°W; NAD83/WGS84; elev. 2090 m). 29 October 2010, 1253 h. Ralph Morris and Ian W. Murray. Verified by J. Tomasz Giermakowski. University of New Mexico Museum of Southwestern Biology (MSB 78227). New county record (Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. Univ. New Mexico Press, Albuquerque. 431 pp.). The specimen was basking within the shadow of a large rock. Ground surface temperature within the shade was 23°C, ground surface temperature in full sun was 37°C, and shaded air temperature was 29°C. During October 2009, RM found an adult *C. molossus* about 400 m W of this location, but it was not collected. A *C. molossus* (SDNHM 3197) collected in 1930 is listed as being collected in Valencia Co., but the collection locale, near Laguna, New Mexico, is in Cibola Co. This discrepancy results from the 1981 creation of Cibola Co., which occupies a large portion of land that was formerly within Valencia Co.

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***CROTALUS STEJNEGERI* (Long-tailed Rattlesnake)**. MÉXICO: SINALOA: Municipio de San Ignacio: Cerro del Burro, 6 km (airline) SE El Carmen (23.815389°N, 106.463778°W; 482 m elev.). 28 January 2010. Pedro Uriarte Garzón and Ana Morales-Villareal. Verified by Jonathan Campbell. UAZ 57312-PSV. New municipality record, extending the known range 51.4 km W of the closest known locality, 16.09 km (by Hwy 40) NE of Concordia, Municipality of Concordia, Sinaloa (LACM 37718). The snake was found in tropical deciduous forest.

ROBERT A. VILLA, 811 N. 10th Ave, Tucson, Arizona 85705, USA (e-mail: cascabel1985@gmail.com); **PEDRO URIARTE-GARZÓN,** Laboratorio de Recursos Naturales, Escuela de Biología, Universidad de Occidente, Unidad Guasave, Avenida Universidad S/N, Guasave, Sinaloa, México (e-mail: uriartegp@hotmail.com).

***DIADOPHIS PUNCTATUS* (Ring-necked Snake)**. USA: ALABAMA: Fayette Co.: Found under rocks along road cut on Hwy 13 (33.66620°N, 87.65127°W; WGS84/NAD83). 28 March 2011. R. Birkhead. AUM 39448–39449. Franklin Co.: along highway 13/43 north of Russellville (32.832150°N, 85.204133°W; WGS84/NAD83). 29 March 2011. R. Birkhead. AUM 39451–39452. Found in trash pile at abandoned home site. All specimens verified by Craig Guyer. New county records (Mount 1996. The Reptiles and Amphibians of Alabama. University of Alabama Press. xi+347 pp.).

Diadophis punctatus is assumed to occur statewide in Alabama; however, verified records are lacking for some counties. These specimens likely represent intergrades between *D. p. punctatus* and *D. p. stictogenys*. All four have complete neck rings. AUM 39448 and 39452 have belly patterns which anteriorally resemble *D. p. punctatus* but posteriorally resemble *D. p. stictogenys*. In addition, the two Fayette Co. individuals have distinct red tails while the Franklin Co. individuals have only a reddish tint to the tails. Thanks go to Sean Graham for reviewing this note.

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***DIADOPHIS PUNCTATUS* (Ring-necked Snake)**. USA: NEBRASKA: Hamilton Co.: 1.6 km N, 5.6 km W Marquette, Griffith Prairie and Farm (41.01874°N, 98.07371°W; NAD 83). 8 September 2010. Anthony E. Bridger. Verified by Curtis J. Schmidt. Sternberg Museum of Natural History, Fort Hays State University, Hays, Kansas (FHSM 15598). First county record (Ballinger et al. 2010. Amphibians and Reptiles of Nebraska. Rusty Lizard Press, Oro Valley, Arizona. 400 pp.; Fogell 2010. A Field Guide to the Amphibians and Reptiles of Nebraska. University of Nebraska, Lincoln. vi + 158 pp.). Fills gap in east-central part of the state where few record exist. Nearest prior records are from Sherman, Howard, Buffalo, and Platte counties Found under a wooden cover board in a mixed grass prairie about 30 m from the Platte River.

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***HETERODON PLATIRHINOS* (Eastern Hognose Snake)** USA: COLORADO: Prowers Co.: 38.028067°N, 102.068322°W (WGS 84), elev. 1027 m. 29 July 2011. Joshua and Timothy Warfel. Verified by Travis Taggart. Fort Hays State University, Sternberg Museum of Natural History, FHSM-H 15744. First documented record for the state of Colorado (Hammerson 1999. Amphibians and Reptiles in Colorado, 2nd ed. University Press of Colorado & Colorado Division of Wildlife, Niwot, Colorado. xxiv + 484 pp.) A single road killed adult was found at 1638 h.

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***LAMPROPELTIS GETULA NIGRA* (Eastern Black Kingsnake)**. USA: ALABAMA: Marion Co.: County Road 22 at the intersection of County Road 13 and Flat Creek Road between Haleyville and Bear Creek (34.24666°N, 87.67567°W; WGS84/NAD83). 22 June 2011. R. Birkhead. Found DOR (AUM AHAP-D 314–316 digital photo vouchers). Verified by Craig Guyer. New county record (Mount 1996. The Reptiles and Amphibians of Alabama. University of Alabama Press. xi+347 pp.). *Lampropeltis getula* is presumed to occur statewide; however, verified records are lacking for many northwest Alabama counties. Thanks go to Sean Graham for reviewing this note.

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***LAMPROPELTIS GETULA NIGRA* (Eastern Black Kingsnake)**. USA: INDIANA: Clay Co.: Sugar Ridge Township (39.386306°N, 87.088889°W; NAD 83). 10 May 2011. Sarabeth Klueh and Jason Mirtl. Verified by Chris Phillips. Illinois Natural History Survey (INHS 2011l). New county record (Minton 2001. Amphibians and Reptiles of Indiana. 2nd ed., revised. Indiana Academy of Science. vii+404 pp.). The snake was found DOR.

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***LAMPROPELTIS ELAPSOIDES* (Scarlet Kingsnake)**. USA: SOUTH CAROLINA: Richland Co.: Harbison State Park (34.1011°N, 81.117583°W). 16 March 2010. Theresa Stratmann.

Verified by Steve Bennett (SCDNR). Campbell Museum of Natural History (CUSC 2794 photo voucher). New county record (Beane et al. 2010. Amphibians and Reptiles of the Carolinas and Virginia. University of North Carolina Press, Chapel Hill. 288 pp.).

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***LAMPROPELTIS TRIANGULUM TRIANGULUM* (Eastern Milk Snake)**. USA. SOUTH CAROLINA: Richland Co.: Riverbanks Park at the confluence of the Saluda and Broad Rivers (34.008356°N, 81.07255°W). 19 May 2010. Scott Pfaff. Verified by Steve Bennett. Campbell Museum of Natural History (CUSC 2793 photo voucher); Riverbanks Zoo and Gardens living collection (RZG 10776). New county record. *Lampropeltis t. triangulum* has been recorded only in the mountainous areas of North Carolina, South Carolina, and Georgia (Beane et al. 2010. Amphibians and Reptiles of the Carolinas and Virginia. University of North Carolina Press, Chapel Hill. 288 pp.; Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens, Georgia. 575 pp.). This specimen, an adult male, approximately 900 mm TL, represents a significant range extension for this species in South Carolina.

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***LEPTOPHIS NEBULOSUS* (Yellow-Lipped Parrot Snake)**. PANAMÁ: COCLÉ: Omar Torrijos National Park (8.66°N, 80.61°W, WGS 84; 700 m elev.). 20 January 2007. Julie M. Ray. Verified by Andrew Hein. UTADC 6849–6850. First record for Coclé and fills a distributional gap between the Cordillera de Tilará, Puntarenas, Costa Rica (Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna Between Two Continents, Between Two Seas. Univ. Chicago Press, Chicago, Illinois. xx + 934 pp.) and Panamá Province, Panamá (Jaramillo and Ibáñez 2003. Herpetol. Rev. 34:265). The snake was found at 2025 h next to Río Guabal in an area covered by mature secondary (≥ 40 yrs since last cutting) cloud forest.

I thank A. González and J. A. Santana, Omar Torrijos National Park, the Smithsonian Tropical Research Institute, Autoridad Nacional del Ambiente for issuing collecting permit (SE/A-44-06), NSF for funding (IBN-0429223, IBN-0429223, IOB-0519458), and researchers of the TADS Project for field assistance.

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***MASTIGODRYAS CLIFTONI* (Clifton's Lizard Eater)**. MEXICO: ZACATECAS: Municipality of Teúl de González Ortega: Cañón del Río Patitos (21.351111°N, 103.566389°W; 1700 m elev.). 22 July 2010. P. Carrillo-Reyes, R. Ramírez-Delgadillo, and E. Ruiz-Sánchez. Verified by Uri Omar García-Vázquez. UAZ 57311-PSV. First record for Zacatecas, extending its known range 100 km E from the vicinity of Santa María del Oro, Nayarit (Ponce-Campos and Huerta-Ortega 1998. Herpetol. Rev. 29:176.). The snake was found in riparian vegetation at the bottom of a canyon surrounded by oak-juniper woodland.

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***NERODIA ERYTHROGASTER* (Plain-bellied Watersnake)**. USA: NEW MEXICO: Quay Co.: Pond at Horse Creek, 3.2 air mi ENE (5.16 km at 85°) Nara Visa (35.611172ºN, 103.043786ºW; WGS84). 23 May 2009. D. Burt (received from Ted L. Brown, New Mexico Herpetological Society). Verified by Tomas Giermikowski. MSB 75841 (female; 263 mm SVL, 86 mm tail). New county record (Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. University of New Mexico Press, Albuquerque. 431 pp.). A second snake was photographed by WGD as it swam in the same pond,1030 h on 24 May 2009. This location is ca. 358 km NNE of the nearest record from along the Pecos River in Eddy Co., New Mexico (Degenhardt et al. 1996, *op. cit.*); however, these records are only ca. 21.8 km (at 221°) SW of a locality along Punta de Agua Creek in Hartley Co., Texas (Werler and Dixon 2000. Texas Snakes Identification, Distribution, and Natural History. University of Texas Press, Austin. xv + 437 pp.).

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***OPHEODRYS AESTIVUS AESTIVUS* (Northern Rough Greensnake)**. USA: TENNESSEE: Madison Co.: Lowell Thomas Drive behind TWRA Region 1 office (35.3747°N, 88.4257°W; NAD 83). 11 May 2011. Steve Henderson. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19127). First county record (Scott and Redmond 2008. Atlas of Reptiles in Tennessee. Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. http://www.apsu.edu/reptatlas [updated 20 July 2011; accessed 12 September 2011].

Voucher specimen collected under the authority of the Tennessee Wildlife Resources Agency; field work supported by State Wildlife Grant (SWG) funding under the authority of the U.S. Fish and Wildlife Service.

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***PANTHEROPHIS GUTTATUS* (Red Cornsnake)**. USA: GEORGIA: Early Co.: Hilton Damascus Rd (CR 279) ~1.4 km NE of jct with CR 205 at Hentown (31.28944°N, 84.79865°W; WGS 84), elev. 54 m. 6 August 2011. Robert L. Hill. Verified by John Jensen. UTADC 6942 photo voucher, DOR. New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). This species has been documented in the adjacent counties of Baker, Miller, and Calhoun (Hill 2011. Herpetol. Rev. 42:395).

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***PHIMOPHIS GUERINI* (Argentine Pampas Snake)**. BRAZIL: ALAGOAS: Municipality of Campo Alegre: Fazenda Pindoba (09.758889°S, 36.235833°W, SAD69; elev. 121 m). 17 April 2007. I. C. S. Tiburcio and others. Verified by U. Gonçalves. Setor de Zoologia, Coleção Herpetológica do Museu de História Natural,

Universidade Federal de Alagoas, Brazil (MUFAL 8743; collecting license IBAMA/RAN 204/06). First state record. The species was previously recorded from Argentina (Arzamendia and Giraudo 2002. Cuad. Herpetol. 16[1]:15–32) and the Brazilian states of Amazonas, Goiás, Mato Grosso, Mato Grosso do Sul, Bahia, and São Paulo (Carvalho and Nogueira 1998. Cad. Saú. Públ. [14]:753–763; França et al. 2006. SNOMNH Occas. Pap. [17]:1–13; Recorder and Nogueira 2007. Biot. Neotrop. 7[3]:267–278; Sawaya et al. 2008. Biot. Neotrop. 8[2]:129–151; Valdujo et al. 2009. Check List 5[3]:405–417). The new record extends the known geographic distribution of species about 1027 km NE from the municipality of Cocos, Bahia state, and represents a new eastern boundary of this distribution.

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***PITUOPHIS CATENIFER* (Gopher Snake)**. USA: WISCONSIN: Polk Co.: River Rd., 5 m S of junction with Evergreen Ave. (45.59223°N, 92.70636°W; WGS 84.). 11 June 2011. Road-kill collected by Erik R. Wild (UWSP 4209). Verified by Joshua M. Kapfer. New county record (Casper 1996. Geographic Distributions of the Amphibians and Reptiles of Wisconsin. Milwaukee Publ. Mus., Milwaukee, Wisconsin. 87 pp.; WDNR Wisconsin Natural Heritage Inventory data; *Herpetological Review* 1996–present). Additional specimens represented by photographs (UWSP Herp Photo 0112–0122) and shed skin (UWSP 4218) were also found. Extends northern range of species in Wisconsin southward by 11 miles (Casper 1996, *op. cit.*). Specimens collected under Wisconsin Department of Natural Resources Permit SCP-131-WCR-C-11.

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***RHADINAEA FLAVILATA* (Pine Woods Littersnake)**. USA: SOUTH CAROLINA: Florence Co.: Lynches River County Park (34.05053°N; 79.78098°W; WGS 84) 11 km S Florence. 29 May 2011. J. D. Camper. Verified by S. Miller. Clemson University Vertebrate Collections (CUSC 2841). New county record (Martof et al. 1980. Amphibians and Reptiles of the Carolinas and Virginia. University of North Carolina Press, Chapel Hill. 264 pp.). Adult female collected under wood coverboard in open woodland along the edge of a sandhill.

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***SENTICOLIS TRIASPIS* (Green Rat Snake)**. MÉXICO: HIDALGO: Municipality of Huasca de Ocampo: 98.5127°N, 20.2766°W (WGS84), 1938 m elev. 17 April 2011. Nallely Morales-Capellán and Leonardo Fernández-Badillo. Verified by Jesús M. Castillo. Colección Herpetológica, Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo (CH-CIB 4137). First municipality and elevation records, extending the range in the state ca. 53.5 km SE from the closest known locality at Meztitlán, Laguna de Meztitlán, 1260 m elev. (Altamirano-Álvarez et al. 1993. Bol. Soc. Herpetol. Mex. 5:6–8). The snake was found in xerophytic shrubland. Fieldwork was funded by CONACyT- 95828.

NALLELY MORALES-CAPELLAN, **LEONARDO FERNÁNDEZ-BADILLO**, and **IRENE GOYENECHEA** (e-mail: ireneg28@gmail.com), Centro de Investigaciones Biológicas (CIB), Universidad Autónoma del Estado de Hidalgo, A. P. 1-69 Plaza Juárez, Pachuca, Hidalgo, México.

***STENORRHINA DEGENHARDTII* (Degenhardt's Scorpion-eating Snake; Alacranera de Degenhardt)**. HONDURAS: SANTA BÁRBARA: El Cedral (14.916677°N, 88.066884°W, WGS84; 1700 m elev). 2 October 2010. James R. McCranie and Leonardo Valdés Orellana. USNM 578917. Verified by Steve W. Gotte. First record for Santa Barbara, with the closest known locality being ca. 40 km SSE near the peak of Cerro San Juanillo, Comayagua (McCranie 2011. The Snakes of Honduras. Systematics, Distribution, and Conservation. SSAR Contrib. Herpetol. 26: x + 714 pp.). The snake was lying motionless and stretched out in leaf litter during the afternoon on a coffee farm carved from broadleaf cloud forest.

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***TANTILLA SCHISTOSA* (Red-bellied Earth Centipede Snake; Pequeña Traga-cienpiés)**. HONDURAS: SANTA BÁRBARA: El Cedral (14.916677°N, 88.066884°W, WGS84; 1700–1750 m elev.). 2–3 October 2010. James R. McCranie and Leonardo Valdés Orellana. Verified by Steve W. Gotte. USNM 578918–19. First records for Santa Bárbara, and highest elevation records from Honduras, with the closest known locality being ca. 60 km NNW at El Cusuco, Cortés (McCranie 2011. The Snakes of Honduras. Systematics, Distribution, and Conservation. SSAR Contrib. Herpetol. 26: x + 714 pp.). The snakes were found under logs and in leaf litter on a coffee farm carved from broadleaf cloud forest.

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***TRIMORPHODON LAMBDA* (Sonoran Lyresnake)**. USA: ARIZONA: Coconino Co.: Marble Canyon and vicinity. Three photographic vouchers deposited in the University of Arizona (UAZ) collection. The first voucher (UAZ 57324-PSV) is from the Echo Cliffs, on Hwy. 89 ca. 2 km E of the junction of Hwys. 89 and 89A (36.63720°N, 111.63054°W; NAD 27; elev. 1636 m). 4 June 2005. B. O'Connor and R. Gassaway. We report a second voucher (UAZ 57325-PSV) from Jackass Canyon and a third voucher (UAZ 57326-PSV) from near confluence of the Paria and Colorado Rivers. All vouchers verified by George Bradley. We also report an unvouchered sighting of a specimen found dead in the bed of Soap Creek, ca. 1.3 km upstream (N) of Hwy. 89A (36.754668°N, 111.75551°W, NAD27; elev. 1275 m) on 13 June 2005 by B. T. La Forest.

Collectively, these represent the first vouchers from Marble Canyon and vicinity (Brennan and Holycross 2006. A Field Guide to Amphibians and Reptiles in Arizona. Arizona Game and Fish Department, Phoenix. 150 pp.). They extend the range of this species 121 river km (75 river miles) upstream along the Colorado River in Grand Canyon from the nearest vouchered locality at the mouth of 75 Mile Canyon (GCNP 22079; Holycross, unpubl. data).

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Place, Phoenix, Arizona 85022, USA; **MICHAEL MALAWY**, 1229 North Alma School Road, Unit 26, Mesa, Arizona 85201, USA; **ANDREW T. HOLYCROSS**, School of Life Sciences, Arizona State University, Tempe, Arizona 85287, USA (e-mail: andrewholycross@gmail.com).

***VIPERA LATASTEI* (Lataste's Viper)**. PORTUGAL: ÉVORA: ca. 38.5372°N, 08.0033°W (WGS84). 25 July 2011. Luis Ceríaco. Photographic vouchers deposited at Colecção Fotografica of Museu de Ciências Naturais da Escola Secundária André de Gouveia (MCN/MB/F/R/5). Verified by Ana Pires. Species previously recorded from ca. 40 km SE, in Portel region (Brito 2010. *In* Loureiro et al. [eds.], Atlas dos Anfíbios e Répteis de Portugal, pp. 178–179. Esfera do Caos Editores, Lisboa). Specimen observed on rock, near Castelo do Giraldo, a Roman archeological site, at ca. 1040 h.

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County Records for Reptiles and Amphibians from Hayes County, Nebraska, USA

In Nebraska, USA, many species of reptiles and amphibians reach their distributional limits, and for some species, such limits are well documented (see Lynch 1985). For other species, distributional limits still are not well defined, and records of observation within known ranges are patchy (see Lynch 1985). This lack of records for some species is not a reflection of species abundance, but rather of a lack of intense survey efforts throughout many areas of the state. Few manuscripts have been published in recent decades involving herpetofauna in Nebraska, and until recently, work compiled by Lynch (1985) served as the standalone comprehensive account for their distributions. Within the last year, two field guides (Ballinger et al. 2010; Fogell 2010) have been published which provide an updated synopsis of the life history and distribution of amphibians and reptiles in Nebraska. Our manuscript originally was submitted prior to the completion of both of these recent publications.

Herein, we present detailed accounts of eight county records for Hayes County in southwestern Nebraska that contribute to the aforementioned field guides by providing details on localities of captures. All records were collected during a 24-h survey in July 2009. Voucher specimens with preserved tissues were deposited in Sternberg Museum of Natural History (FHSM), Fort Hays State University, Hays, Kansas. All specimens were verified by Curtis J. Schmidt. All are new county records supported by Lynch (1985). Coordinates were taken with handheld GPS units and are based on North American Datum 1983 (NAD83).

All specimens were collected under authorization of the Nebraska Game and Parks Commission (Scientific and Educational Permit No. 1031).

ANURA – FROGS

***ANAXYRUS COGNATUS* (Great Plains Toad)**. Hayes Co.: 5.8 km W, 5.9 km S Wellfleet (40.6994°N, 100.7978°W). 21 July 2009. Greg D. Wright, Angelina E. Graham, and Keith Geluso. MHP 14697. Fills in distributional gap among Frontier, Chase, and Lincoln counties.

***ANAXYRUS WOODHOUSII* (Woodhouse's Toad)**. Hayes Co.: 5.8 km W, 5.9 km S Wellfleet (40.6994°N, 100.7978°W). 21 July 2009. Greg D. Wright, Angelina E. Graham, and Keith Geluso. MHP 14694.

***LITHOBATES CATESBEIANUS* (American Bullfrog)**. Hayes Co.: Hayes Center State Wildlife Management Area (40.58485°N, 100.92707°W). 22 July 2009. Greg D. Wright, Angelina E. Graham, and Keith Geluso. MHP 14699. Fills a distributional gap between Hitchcock and Lincoln counties.

SQUAMATA – LIZARDS

***PLESTIODON OBSOLETUS* (Great Plains Skink)**. Hayes Co.: 5.8 km W, 5.9 km S Wellfleet (40.6994°N, 100.7978°W). 21 July 2009. Greg D. Wright, Angelina E. Graham, and Keith Geluso. MHP 14701. Fills in distributional gap at northernmost limit in southern Nebraska.

***SCELOPORUS CONSOBRINUS* (Prairie Lizard)**. Hayes Co.: 14.1 km S, 12.8 km W Wellfleet (40.6262°N, 100.88145°W). 22 July 2009. Greg D. Wright, Angelina E. Graham, and Keith Geluso. MHP 14707. Fills in gap among Lincoln, Chase, Hitchcock, and Frontier counties.

SQUAMATA – SNAKES

***COLUBER CONSTRICTOR* (North American Racer)**. Hayes Co.: 16.6 km S, 13.7 km W Wellfleet (40.60403°N, 100.89215°W). 22 July 2009. Keith Geluso, Angelina E. Graham, and Greg D. Wright. MHP 14678. Fills in distributional gap among Lincoln, Chase, and Frontier counties.

***LAMPROPELTIS TRIANGULUM* (Milksnake)**. Hayes Co.: 5.8 km W, 5.9 km S Wellfleet (40.6994°N, 100.7978°W). 21 July 2009. Angelina E. Graham, Keith Geluso, and Greg D. Wright. MHP 14677.

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THAMNOPHIS SIRTALIS **(Common Gartersnake)**. Hayes Co.: 5.8 km W, 5.9 km S Wellfleet (40.6994°N, 100.7978°W). 21 July 2009. Keith Geluso, Angelina E. Graham, and Greg D. Wright. MHP 14674. Fills in distributional gap among Lincoln, Chase, and Frontier counties. Individual was a gravid female containing 28 young.

Acknowledgments.—We thank Tad and Teresa Wright for assistance in the field and allowing us to search for herpetofauna on their property.

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New Amphibian and Reptile County Records for the Florida Panhandle

Despite recognition of the Florida panhandle as one of the most biologically rich regions in North America (Blaustein 2008), distribution records apparently do not exist for many amphibian and reptile species in Santa Rosa, Okaloosa, or Walton counties (Ashton and Ashton 1988a, 1988b, 1988c), which make up nearly half of this important area. These counties encompass Eglin Air Force Base (EAFB), an area containing the largest remaining tract of old-growth Longleaf Pine (*Pinus palustris)* forest, an ecosystem renowned for its high diversity and endemism of amphibians and reptiles (Guyer and Bailey 1993). The region has been subject to surveys targeting species of conservation concern; however, most of these remain unpublished reports to state agencies or non-profit organizations. A few recent articles reported species lists or research pertaining to amphibians and reptiles and specify county of capture (Bishop et al. 2006; Enge 2005; Palis 1998). We considered these as formal documentation for a particular species for a county, although museum records may not have been created or specimens vouchered. Here, we present 30 new county records for this region's herpetofauna that have not been previously published elsewhere. All new records are deposited as digital photos (denoted AHAP-D) or specimens in the Auburn University Herpetological collections (AUM), were geo-referenced using Google Earth (WGS 84), and verified by C. Guyer.

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ANURA – FROGS

ELEUTHERODACTYLUS PLANIROSTRIS **(Greenhouse Frog)**. Santa Rosa Co.: Multiple males observed (30.444672°N, 86.857625°W). 15 July 2009. B. Rincon and K. Jones. AUM AHAP-D 255.

TESTUDINES – TURTLES

APALONE SPINIFERA **(Spiny Softshell)**. Santa Rosa Co.: Sweetwater Creek and State Forest Rd 21, 2.41 air km S Munson (30.837485°N, 86.870571°W). 04 June 1982. J. Godwin. AUM 30578.

CHELYDRA SERPENTINA **(Snapping Turtle)**. Okaloosa Co.: AOR RR 636 (30.466111°N, 86.670278°W). May 1995. J. Jensen. AUM AHAP-D 232.

DEIROCHELYS RETICULARIA **(Chicken Turtle)**. Okaloosa Co.: Okaloosa Co. Rd. 4, 1.85 rd km SE jct. Okaloosa Co. Rd 4 and Okaloosa Co Rd 4-A (30.808380°N, 86.705953°W). 02 August 1981. J. Godwin. AUM 30114. Walton Co.: 12.07 km S Paxton at Merrifield Ponds (30.882931°N, 86.27252°W) 16 May 1969. R. Hall. AUM 12394.

LEPIDOCHELYS KEMPII **(Kemp's Ridley Sea Turtle)**. Okaloosa Co.: Dead, stranded specimens washed onto beach (30.389437°N, 86.779533°W). 28 April 2009. D. Varble and K. Jones. AHAP-D 263; (30.3883308°N, 86.536340°W). 04 May 2009. D. Varble. AHAP-D 265. Santa Rosa Co.: (30.384598°N, 86.826456°W). 30 December 2009. D. Varble. AHAP-D 264. Range maps in Moler (1992) and Hipes et al. (2000) show Okaloosa and Santa Rosa County as part of the range of *L. kempii*, however, it is unclear whether these maps are based upon actual documentation, sightings, or a presumed pan-Gulf/Atlantic distribution. The range maps of Ashton and Ashton (1988b), based upon museum records, show only a few recorded county occurrences of these turtles, and none for the counties we cover. We include these vouchered photographs to eliminate ambiguity.

MACROCHELYS TEMMINCKII **(Alligator Snapping Turtle)**. Okaloosa Co.: East Bay River just downstream from RR 259 bridge (30.431389°N, 86.774722°W). 12 May 1994. P. Moler, B. Mansell, and J. Jensen. AUM AHAP-D 239.

***PSEUDEMYS CONCINNA* (River Cooter)**. Okaloosa Co.: 8.45 air km WSW Blackman on Blackwater River (30.914452°N, 86.723748°W). 22 April 1984. J. Godwin and L. Malo. AUM 32486. Santa Rosa Co.: Yellow River, 3.7 km N Blackwater Bay (30.619346°N, 87.026330°W). 22 May 1971. L. Childers. AUM 20697.

***TRACHEMYS SCRIPTA ELEGANS* (Red-eared Slider)**. Okaloosa Co.: adults and subadults found in Fort Walton Beach (30.41764°N, 86.598194°W). 30 June 2009. K. Jones and S. Jones. AUM AHAP-D 256. Subsequent visits to this site revealed two hatchlings.

SQUAMATA – LIZARDS

***OPHISAURUS MIMICUS* (Mimic Glass Lizard)**. Okaloosa Co.: AOR RR 668 1.5 km E jct. RR 259 (30.418333°N, 86.771944°W). 18 April 1995. J. Jensen. AUM AHAP-D 240.

***OPHISAURUS VENTRALIS* (Eastern Glass Lizard)**. Okaloosa Co.: captured in funnel trap along drift fence (30.418333°N, 86.767778°W). 15 November 1993. J. Jensen. AUM AHAP-D 241. Santa Rosa Co.: 18.91 air km NE Milton (30.7185397°N, 86.8759099°W). 25 May 1982. J. Godwin. AUM 30530.

***PLESTIODON ANTHRACINUS* (Coal Skink)**. Okaloosa Co.: juvenile captured in funnel trap along drift fence. 21 March 1995 (30.418333°N, 86.767778°W). J. Jensen. AUM AHAP-D 233. Walton Co.: observed in seepage bog (30.609331°N, 86.225916°W). 25 April 2009. K. Jones and K. Roth. AUM AHAP-D 258–260.

***PLESTIODON EGREGIUS* (Mole Skink)**. Santa Rosa Co.: adult captured in pitfall trap (30.603167°N, 86.803167°W). 02 September 2009. D. Steen and M. Baragona. AUM AHAP-D 262.

***PLESTIODON LATICEPS* (Broad-headed Skink)**. Walton Co.: Morrison Springs, 9.66 km SE of Ponce De Leon (30.657499°N, 85.905047°W). 13 May 1972. R. Russell. AUM 21479.

SQUAMATA – SNAKES

***AGKISTRODON CONTORTRIX* (Copperhead)**. Okaloosa Co.: observed under cover object (30.933247°N, 86.612486°W). 04 April 2009. K. Jones and N. Friedman. AUM AHAP-D 254.

***CROTALUS ADAMANTEUS* (Eastern Diamond-backed Rattlesnake)**. Okaloosa Co.: observed DOR on Rattlesnake Bluff Rd (30.681750°N, 86.598278°W). 16 May 2009. D. Steen. AUM AHAP-D 237. Santa Rosa Co.: captured within box trap (30.560028°N, 86.847389°W; WGS 84). 06 July 2009. D. Steen. AUM AHAP-D 236.

***FARANCIA ERYTROGRAMMA* (Rainbow Snake)**. Okaloosa Co.: Blackwater River at Kennedy Bridge Rd; 9.5 air km W Blackman (30.933421°N, 86.735653°W). 29 May 1981. Collector unknown. AUM 29778.

***HETERODON PLATIRHINOS* (Eastern Hog-nosed Snake)**. Santa Rosa Co.: AOR (30.482449°N, 86.832121°W). 01 May 2009. K. Jones. AUM AHAP-D 257.

***LAMPROPELTIS GETULA* (Common Kingsnake)**. Okaloosa Co.: captured in funnel trap along drift fence (30.418333°N, 86.767778°W). 17 April 1995. J. Jensen. AUM AHAP-D 238.

***LAMPROPELTIS ELAPSOIDES* (Scarlet Kingsnake)**. Okaloosa Co.: captured under bark of dead, standing *Pinus palustris* just south of RR 668 between RRs 253 and 259 (30.425547°N, 86.771944°W). 29 March 2009. J. Jensen. AUM AHAP-D 231. Santa Rosa Co.: Captured in pitfall trap (30.573139°N, 86.843139°W). 18 August 2009. D. Steen. AHAP-D 222.

***MICRURUS FULVIUS* (Harlequin Coralsnake)**. Walton Co.: 14.48 km S Paxton, along U.S. Hwy 331 near swampy area (30.859637°N, 86.250497°W). 15 April 1969. M. Pridgeen. AUM 12397.

***TANTILLA CORONATA* (Southeastern Crowned Snake)**. Okaloosa Co.: 8.21 air km WNW Cannon Town (30.901740°N, 86.740125°W). 16 April 1983. J. Godwin. AUM 32181.

***THAMNOPHIS SIRTALIS* (Common Gartersnake)**. Okaloosa Co.: captured in funnel trap along drift fence (30.425955°N, 86.771645°W). 12 March 1996. J. Jensen. AUM AHAP-D 242.

***STORERIA OCCIPITOMACULATA* (Red-bellied Snake)**. Okaloosa Co.: 30.93435°N, 86.613979°W. K. Jones and N. Friedman. 04 April 2009. AUM AHAP-D 261.

Acknowledgments.—We obtained all relevant state and federal permits associated with collection of animals noted above. DAS was supported by the Strategic Environmental Reseach and Development Program (SERDP) Project Number: SI-1696.

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NATURAL HISTORY NOTES

CAUDATA — SALAMANDERS

***AMBYSTOMA BARBOURI* (Streamside Salamander). TERRESTRIAL BREEDING SITES.** Adult *Ambystoma barbouri* typically inhabit upland deciduous forests in the vicinity of ephemeral first- and second-order streams with exposed limestone bedrock. These low-order streams have relatively few predatory fish and are typically used as breeding sites by *A. barbouri*, with females laying eggs in a monolayer on the undersurface of flat limestone rocks in streams (Niemiller et al. 2006 Am. Midl. Nat. 156:394–399; Petranka 1998. Salamanders of the United States and Canada. Smithsonian Inst. Press, Washington, DC. 587 pp.). However, *A. barbouri* also breeds in ponds or roadside ditches. In these habitats, females attach eggs to the undersurface of rocks or logs, or attach them singly to vegetation (Petranka 1988, *op. cit.*). Although known to occur in the Central Basin of middle Tennessee since 1998, *A. barbouri* has only recently been reported breeding in first-order streams located in cedar glade habitats (Niemiller et al. 2011. Herpetol. Cons. Biol. 6:135–149). Herein, we report on unusual oviposition sites of *A. barbouri* in cedar glades of middle Tennessee.

Cedar glades are a fragile and imperiled ecosystem characterized by shallow soiled (< 20 cm in depth) treeless openings perched on Ordovician-aged limestone and surrounded by Eastern Red Cedar (*Juniperus virginiana*) or cedar-hardwood forests (Quarterman 1950. Bull. Torrey Botany Club 77:1–9). These openings are often strewn with bedrock fragments of varying size. Because of their association with karst topography, cedar glades lack perennial streams, and ephemeral streams are scant. Rainwater often flows in sheets across the surface of the glades before entering into a subterranean stream or the rare ephemeral first-order surface stream. Because of their unusual hydrology, cedar glades vary from very wet during the winter and spring to very dry during the summer and fall.

On 12 Feb 2011 we found eggs and early stage embryos of *A. barbouri* attached in a monolayer to the undersurface of a rock in the middle of a cedar glade located in Cedars of Lebanon State Forest in Wilson Co., Tennessee, USA (Fig. 1). We initially suspected that an adult confused the sheets of water flowing across the surface of the glades as a stream, and we believed the embryos would soon succumb to desiccation. However, on 25 Feb 2011, we found the egg mass in this glade to be in good condition despite the desiccation of several *A. barbouri* egg masses in a nearby streambed. On 25 March 2011, we again checked the status of the egg mass in the glade and discovered that the eggs had hatched and larvae were swimming in the waters moving across the glade. Furthermore, on 9 April 2011 we found not only late stage embryos attached to the undersurface of rocks in a nearby glade, but we also found newly hatched larvae in small puddles beneath the rocks. Although not visited daily, we now assume that the surface beneath the rocks in the glades remained wet through the late winter and early spring. Small first-order ephemeral streams are located near each of these glades and *A. barbouri* used each stream for breeding during the winter and spring of 2011. We are not certain if the larvae hatching in the glade are able to grow and complete metamorphosis beneath the rocks, or if they can move to a more stable body of water. Thus, we are not certain if our discovery of eggs on land represent ill-fated attempts at reproduction or an alternate breeding site for

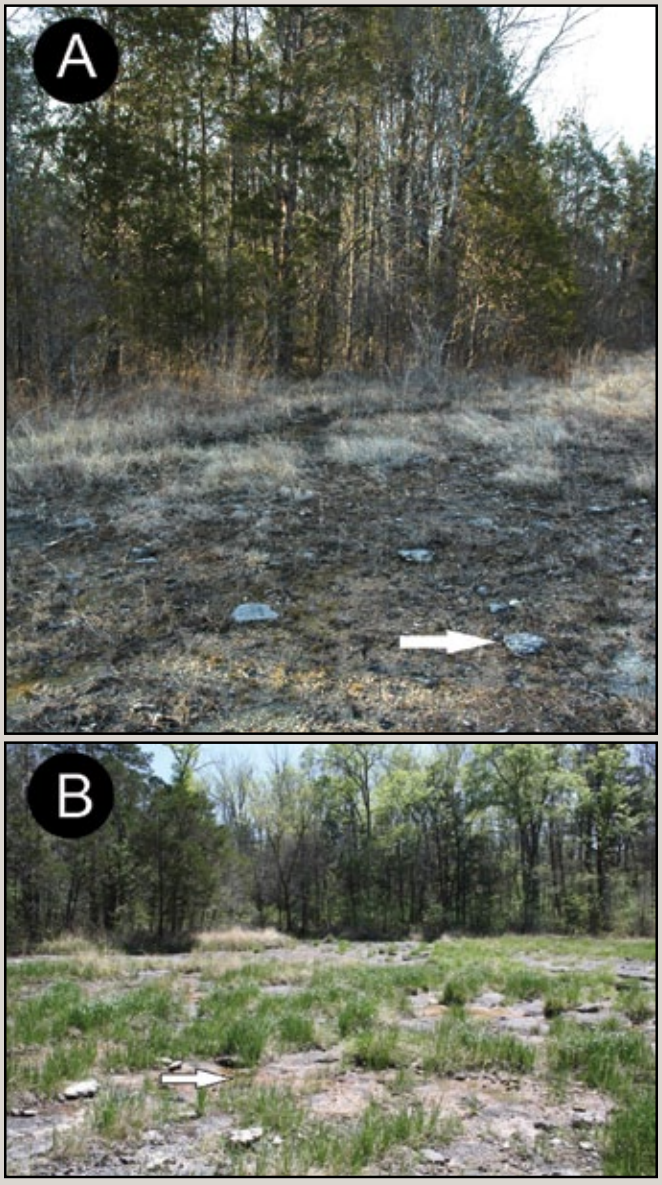


FIG. 1. Breeding sites for the Streamside Salamander (*Ambystoma barbouri*) in cedar glade habitat in middle Tennessee sites. The arrows depict rocks (A) or puddles (B) where egg masses or larvae were found.

A. barbouri in regions where streams are limited and natural ponds non-existent.

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***AMBYSTOMA TALPOIDEUM* (Mole Salamander). OVIPOSITION MODE AND TIMING.** *Ambystoma talpoideum* breeds in ephemeral, permanent, and semi-permanent depressional wetlands, often exhibiting facultative paedomorphosis in long-hydroperiod ponds (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Inst. Press, Washington, DC. 587 pp.). Depending on regional variation in annual rainfall patterns, peak migration and breeding of terrestrial adults typically occur between November and February throughout most of this species' range; paedomorphic adults are thought to breed as much as six weeks earlier than their terrestrial migrating counterparts (Gibbons and Semlitsch 1991. Guide to the Reptiles and Amphibians of the Savannah River Site. Univ. Georgia Press, Athens, Georgia. 131 pp.; Krenz and Sever 1995. Herpetologica 51:387–393; Patterson 1978. Copeia 1978:649–655; Petranka 1998, *op. cit.*; Scott 1993. Amer. Midl. Nat. 129:397–402; Semlitsch 1985. Copeia 1985:477–489). Oviposition occurs in late winter or early spring shortly after the peak in breeding activity (Semlitsch et al. 1993. J. Anim. Ecol. 62:344–340).

The Mole Salamander displays geographic variation in egg deposition mode, as well as other reproductive traits. Compared to eastern populations, individuals in the western parts of this species' range (Louisiana and Mississippi) deposit eggs in small clumps, with smaller overall clutch sizes and larger hatchlings. In some eastern populations (e.g., South Carolina), females produce larger clutches of smaller hatchlings, on average, and lay eggs singly (Petranka 1998, *op. cit.*). Such variation suggests the potential for genetic differentiation within this species, yet no subspecies are currently recognized (Petranka 1998, *op. cit.*). We provide additional information on the timing and mode of oviposition in *A. talpoideum* to aid in further understanding the geographic scope of variation in this species' reproductive traits.

From 30 March to 3 April 2009, we sampled 15 ponds at St. Marks National Wildlife Refuge, Wakulla Co., Florida, USA, for larval and paedomorphic *A. talpoideum*. Ponds ranged from short hydroperiod, isolated sink-hole ponds in sandhill and Long-leaf Pine (*Pinus palustris*) savanna habitat to longer hydroperiod ponds dominated by cypress (*Taxodium* sp.), blackgum (*Nyssa* sp.), and titi (*Cyrilla* sp. and *Cliftonia* sp.). We sampled each pond with four modified commercial crayfish traps (Johnson and Barichivich 2004. J. Fresh. Ecol. 19:263–269) (2.5 cm mesh, Lee Fisher International, Tampa, Florida, lined with 4-mm Vexar ®). Traps were placed in ≤ 0.5–0.6 m of water, for two trap nights per pond. On 31 March, 1 and 2 April 2009, this area received 33.5, 90.2, and 30 mm of rainfall, (total of 153.7 mm over the 3 d period). This total was the highest 3-d cumulative amount of precipitation that accrued since 1 Sept 2008, which corresponds to the earliest-documented date of migration for this species elsewhere in the Coastal Plain (Semlitsch et al. 1993, *op. cit.*). It also represented 21% of the total rainfall measured at this locality between 1 Sept 2008 and the time of our observations. On 2 April 2009, we captured an adult metamorphosed female *A. talpoideum* (i.e., there was no swollen cloaca typical of breeding males), 50 mm SVL, in one of our crayfish traps placed in 0.6 cm of water (pond W2: 84.4416°N, 30.0489°W; 0.24 ha in area). On 3 April 2009, in a separate, nearby pond (pond W3: 84.4416°N, 30.0489°W; 0.68 ha in area), we found a newly-deposited egg mass (< 24 h old; ≤ Harrison Stage 12, Rugh 1962. Experimental Embryology Techniques and Procedures, 3rd ed. Burgess, Minneapolis, Minnesota. 501 pp.). The mass contained 14 embryos and was attached to the mesh of the trap in the mouth of one of the funnels leading into the trap. These embryos were collected and returned to the laboratory where, upon hatching, we positively identified them as *A. talpoideum*. It is unknown whether these eggs were produced by a metamorphosed adult or by a paedomorph; the latter commonly occur in long hydroperiod ponds at our study site (pers. obs.).

In northwestern Louisiana, Hardy and Raymond (1980. J. Herpetol. 14:327–335) documented immigration by *A. talpoideum* as late as early March, and captured a terrestrial female with oviducal eggs on 2 March 1978 (Hardy and Raymond 1990. Herpetologica 46:371–382). In South Carolina, a few sexually mature females (metamorphosed and paedomorphic combined) may still have enlarged ova and presumably be capable of reproducing as late as March and April (Semlitsch 1985. Oecologia 65:305–313). In Florida, the latest date of new oviposition of which we are aware is 14 February, as reported by Carr (1940. A Contribution to the Herpetology of Florida. Biological Science Series III[1], Univ. Florida, Gainesville, Florida). To our knowledge, our observation of a new egg mass on 3 April is the latest reported date of new oviposition for this species on the Coastal Plain.

In contrast to populations in the Atlantic Coastal Plain, where females deposit eggs singly, our observation also reveals that individuals of *A. talpoideum* in the panhandle region of Florida produce egg masses, similar to populations of this species in western parts of its range (i.e., Mississippi and Louisiana: Raymond and Hardy 1990, *op. cit.*; Semlitsch and Walls 1990. Herpetol. Rev. 21:14–15). This observation suggests that the faunal break between populations that lay eggs singly, versus those that produce egg masses, is much farther east than has been previously reported and closer to the likely geographic point of separation between populations of the two egg-laying modes. Interestingly, a map of frequencies and distributions of mitochondrial DNA (mtDNA) haplotypes reveals extensive population subdivision in this species, with the greatest genetic diversity (i.e., two major haplotype clades abutt each other) occurring in the panhandle of Florida, where we made our observations (Donovan et al. 2000. Evolution 54:1449–1456). Donovan et al.'s results (2000, *op. cit.*) beg for closer scrutiny of egg-laying mode and other reproductive characteristics in populations throughout this species' range, but particularly from areas of the Gulf and Atlantic Coastal Plains that are adjacent to our study area. Such information would be informative for understanding the extent of geographic variation in reproduction and help pinpoint the location of a faunal break between populations of the two egg laying modes in this species.

Fieldwork was supported by the U.S. Geological Survey Amphibian Research and Monitoring Initiative (ARMI). This research was conducted with permits from the Florida Fish and Wildlife Conservation Commission (permit number WX08477), St. Marks National Wildlife Refuge (permit number 41640-2009-09), and the USGS Institutional Animal Use and Care Committee (approval number USGS/FISC 2006-04). We thank Jennifer Staiger and Mike Randall for assistance in the field. This is contribution 386 of the United States Geological Survey's Amphibian Research and Monitoring Initiative (ARMI).

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***CRYPTOBRANCHUS ALLEGANIENSIS ALLEGANIENSIS* (Eastern Hellbender) and *DESMOGNATHUS QUADRAMACULATUS* (Black-bellied Salamander). PREDATOR/PREY.** The diet of *Cryptobranchus alleganiensis* consists mostly of crayfish and small fish, although other invertebrates, tadpoles, a toad, aquatic reptiles, and a small mammal have been documented (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, DC. p. 144).

On 13 April 2011, I observed what likely was a predation event on a large adult *Desmognathus quadramaculatus* (ca. 94 mm SVL) by a juvenile *Cryptobranchus alleganiensis* (ca. 130 mm SVL) during a survey of Eastern Hellbenders in Cooper's Creek Wildlife Management Area within the Chattahoochee National Forest of Union County, Georgia, USA (34.75752°N, 84.08403°W; WGS 84). While turning over a rock in Cooper's Creek with subsequent dip netting, the aforementioned animals were both discovered in the net. Upon transfer from the net into temporary holding boxes, it was discovered that the *D. quadramaculatus* was freshly dead (i.e., not decomposed) and bore recent lacerations consistent with the mandibles and maxillae of the *C. alleganiensis* specimen (Fig. 1B).

It seems likely that the turning of the rock interrupted a predation event, causing the *C. alleganiensis* to release the *D. quadramaculatus*. I believe this is the first recorded occurrence of predation on an adult *D. quadramaculatus* by a *C. alleganiensis* and note that the presumed prey item was nearly as large as the predator. The C. *alleganiensis* was measured and released at the site of capture (Fig. 1A). The specimen of *D. quadramculatus* is deposited at the University of Texas at Arlington (UTA A-61186).

PHOTOS BY ROBERT L. HILL

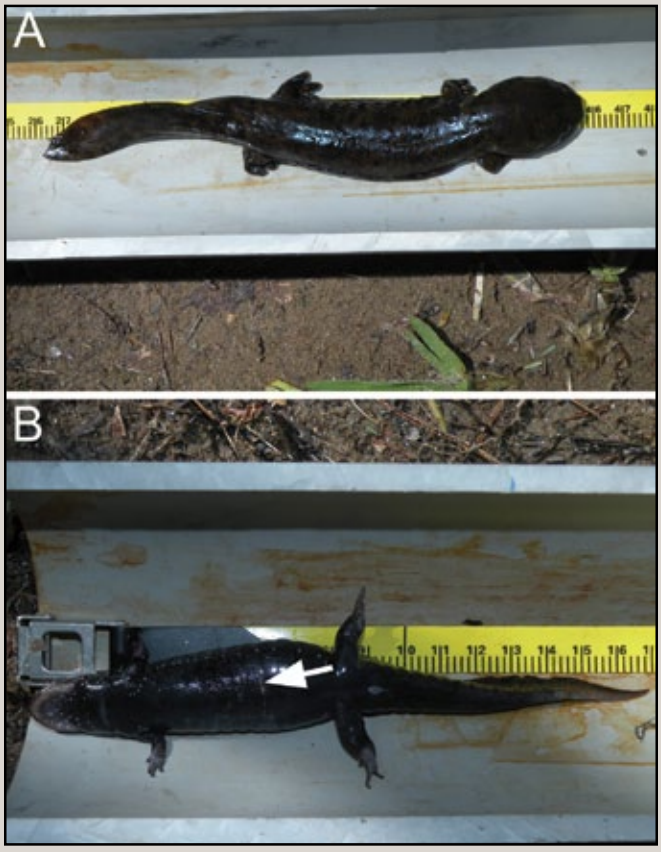


FIG. 1. A) Juvenile *Cryptobranchus a. alleganiensis* believed to have been attempting to ingest a large adult *Desmognathus quadramaculatus*. B) Arrow denotes ventral laceration that matches closely to the jaws of specimen depicted in 1A. Images near to scale.

Fieldwork was conducted under USDA Forest Service and Georgia Department of Natural Resources Scientific Collecting Permits. Funding was provided by a grant from the Zoological Society of Florida with field assistance provided by Leslie Phillips. Editorial assistance was provided by Joseph R. Mendelson, III.

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***EURCYEA CHAMBERLAINI* (Chamberlain's Dwarf Salamander). HABITAT.** Since the description of *Eurycea chamberlaini*, little additional natural history information for the species has become available, and distribution records outside of the Carolinas have accumulated slowly (Graham et al. 2009. Herpetol. Rev. 39:476; Jensen et al. 2008. The Amphibians and Reptiles of Georgia. Univ. Georgia Press, Athens. 575 pp.). Only very general information on this species' preferred habitat is currently available (e.g., seepages, streams, or ponds; Harrison and Guttman 2003. Southeast. Nat. 2:159–178), and this may make attempts to locate and study this animal difficult. We developed a general picture of the habitat preferences of *E. chamberlaini* while attempting to determine its distribution in Georgia and Alabama. We have located *E. chamberlaini* at 19 sites, one of which was in the Piedmont physiographic province, and one of which was in the Dougherty Plain region of the Coastal Plain physiographic province (Wharton 1978. The Natural Environments of Georgia. Georgia Geological Survey Bull. 114, Atlanta, Georgia. 227 pp.). The rest of the sites were within the Fall Line Sandhills or Fall Line Red Hills regions of the Coastal Plain physiographic province (Wharton 1978, *op. cit.*). Of these, nine (47%) could be categorized as bay swamps (Wharton 1978, *op. cit.*). Bay swamps contain an overstory of Sweetbay (*Magnolia virginiana*), a dense shrub layer of Doghobble (*Leucothoe axillaris*), greenbrier (*Smilax* spp.) vines, and often thick accumulations of sphagnum moss (Wharton 1978, *op. cit.*). These wetland forests occur in areas associated with first order streams and seepage flow at the base of sandhills, and are especially common in sites along the Fall Line. Three *E. chamberlaini* sites were along the edge of beaver ponds, which often exhibit similar microhabitats, including mats of sphagnum moss. Two sites were along the margins of isolated ephemeral wetlands, and four sites were along first order streams without readily apparent bay swamps, seepage, or sphagnum moss. One individual was found under a log in a xeric longleaf pine-turkey oak forest at least 100 m from the nearest source of water. The specific microhabitat occupied by *E. chamberlaini* was sphagnum moss mats at nine of the sites (47%). At the rest of the sites, salamanders were found either in wet leaf litter, washed-up accumulations of coarse woody debris, or under small logs.

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***PLETHODON CINEREUS* (Eastern Red-backed Salamander). COLOR VARIATION.** Two common color forms of *Plethodon cinereus*—redback and leadback—are known to occur through-

out eastern North America (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, DC. 592 pp.). This species is one of the most common vertebrates in New England, including central Massachusetts, where it is found in both color phases (DeGraaf and Yamasaki 2000. New England Wildlife: Habitat, Natural History, and Distribution. University Press of New England. 496 pp.).

While conducting field work at Cooks Pond, Worcester Co., Massachusetts, USA, on 19 October 2010, a salamander with unusual coloration was found under a decaying log (42.28607°N, 71.85545°W; NAD83). The dorsal surface was dark overall with small blue speckles (Fig. 1A). The anterior ventral surface was a pale cream color with variable speckles becoming darker and blue towards the posterior (Fig. 1B). This adult individual was found less than one meter from another log under which two redback form *P. cinereus* were found. Juvenile salamanders, one with the unusual color form and others with the redback form, were found during a subsequent survey in the same area on 20 October 2010.

We propose this color form is an undocumented variation of the leadback form of *P. cinereus*. The ventral markings of this individual are somewhat similar to both the leadback and redback form of *P. cinereus*; however, the blue speckles on the dorsal surface are a characteristic not found in either the leadback or redback form. The typical leadback form is primarily black or gray on the dorsal surface, while the redback form features a red or orange stripe along the dorsal surface (Conant 1975. A Field Guide to Reptiles and Amphibians of Eastern and Central North America. Houghton Mifflin Co., Boston, Massachusetts. 429 pp.). This individual was distinguished from species with similar appearance such as *Ambystoma jeffersonianum* and *Ambystoma laterale* by the number of costal grooves present, overall color pattern, body shape, and geographic range.



FIG. 1. Dorsal (A) and ventral (B) views of the undocumented color variation of *Plethodon cinereus* in Worcester Co., Massachusetts.

Climate change, habitat degradation (Gibbs and Karraker 2006. Cons. Biol. 20[3]:913–917), and predator defense (Venesky and Anthony 2007. Herpetologica 63[4]:450-458) might influence the variable color phases of *P. cinereus*. Whether these processes or genetic mutation are triggering the color variation at Cook's Pond has not been determined. The discovery of adults and juveniles of these two color phases within the same population of *P. cinereus* suggests that interbreeding is occurring, thereby supporting the possibility of genetic mutation as the cause.

We thank Alan Richmond and Joe Choiniere for assistance in identification of the salamander and Terry VanDeWalle for review and comments on this paper.

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***PLETHODON CINEREUS* (Eastern Red-backed Salamander). TENACITY AND HOMING.** Homing behavior is the ability or tendency for an individual to return to a particular site or home range after moving or being displaced from that site (Jaeger et al 1993. J. Herpetol. 27:236–239; Ousterhout and Liebgold 2010. Herpetologica 66:269–275). The home range of an individual can be defined by, but is not limited to, the area traveled to forage, mate, and raise offspring (Burt 1943. J. Mammal. 24:346–352). While salamanders might expand and occasionally shift ranges due to external pressures, the home range provides a suitable microhabitat to which the individual may return (Kleeberger and Werner 1982. Copeia 1982:409–415). Certain species of plethodontid salamanders have been known to establish and defend territories under cover objects (e.g., rocks and logs) and the surrounding areas which provide renewable resources, including prey and refugia (reviewed in Mathis 1995. Amphibian Biology 2:633–676; Jaeger 1976. Copeia 1976:686–691; Peterson et al. 2000. Ethology 106:781–794). Although territorial behavior has been well documented in *Plethodon cinereus*, less is known about geographic and phenotypic variation in territorial behavior. For example, most studies of territorial behavior in *P. cinereus* have been conducted on New York and Virginia populations and the effect of color morphology has not been addressed in these studies.

We tested whether striped and erythristic *P. cinereus* from Ohio exhibit homing behavior, a key component of territorial behavior. Between 22 Sept and 3 Nov 2010, we displaced 69 individuals (adults >32 mm SVL; 55 striped, 14 erythristic) 5 m from their original cover object. At least one week passed between displacement dates and recapture dates. Individuals were identified using digital photographs (Nikon D100; Sigma 50mm macro) of their unique dorsal spotting patterns (Anthony et al. 2008. J. Anim. Ecol. 77:646–653). Each cover object was checked at least once, and up to three times after salamanders were displaced.

Of the striped individuals, 12.7% (N = 7) were recaptured under their original cover object. The erythristic morphs had a recapture rate of 14.3% (N = 2). Homing behavior in the red morph has not been documented in previous *P. cinereus* studies and based on these observations the erythristic morph's homing tendency is similar to that of the striped morph. The recapture rate of the striped morph parallels results observed in other plethodontid studies, specifically Jaeger et al. (1993, *op. cit.*) where the

recapture rate of one group was 16.3%. This is the first report of homing behavior in *P. cinereus* from Ohio.

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***PLETHODON GLUTINOSUS* (Northern Slimy Salamander). ARBOREAL HABITAT USE.** *Plethodon glutinosus* is a common, terrestrial plethodontid salamander found broadly across the eastern United States from New York westward to Illinois and south to Alabama and Georgia. Habitat types for this species vary widely but have been reported primarily as beneath logs, stones, and humus in mature hardwood forests. Refugia in shale banks and cave/bluff systems have also been reported for this species (Beamer and Lannoo 2005. *In* M. Lannoo [ed.], Amphibian Declines: the Conservation Status of United States Species, pp. 808–811. Univ. California Press, Berkeley). *Plethodon glutinosus* is well known for using moist crevices in karst cave or bluff systems and typically exhibits stratification with sympatric Green Salamanders (*Aneides aeneus*). The superior competitive abilities of *A. aeneus* and inferior climbing abilities in *P. glutinosus* have been cited as factors that restrict *P. glutinosus to* lower portions of rock faces (Cliburn and Porter 1986. J. Mississippi Acad. Sci. 31:91–96.). However, *P. glutinosus* has not been shown to exhibit arboreal habitat use, similar to *A. aeneus*, when occurring in bluff systems. Here we report such arboreal habitat use in *P. glutinosus* on two separate occasions from sandstone canyon systems in northern Alabama.

In April 2010, an adult *P. glutinosus* was observed ca. 4 m above ground on a standing, live Canadian Hemlock (*Tsuga canadensis*) within Clear Creek Canyon in Winston Co., Alabama (34.03193°N, 87.37403°W; WGS 84). This individual was using a crevice beneath the outer bark layer of the tree as a refugium, with bark needing to be removed from the tree to gain access to the salamander. On 14 May 2010, a second adult *P. glutinosus* was observed ca. 2.75 m above ground on a standing, live Tulip Poplar (*Liriodendron tulipifer*) within Dismal's Canyon in Franklin Co., Alabama (34.32253°N, 87.78186°W; WGS 84). This individual was observed within a hollow portion of the standing tree and was located directly outside what appeared to be a maintained burrow within the tree. Other encountered salamander species sympatric with *P. glutinosus* at the aforementioned sites include *Eurycea cirrigera, E. guttolineata, Aneides aeneus*, and *Notophthalmus viridescens.*

To our knowledge, these are the first recorded observations of arboreal habitat use in *P. glutinosus*, despite this species' known climbing ability. However, our observations are consistent with other species, such as *A. aeneus*, which have been shown previously to use refugia in standing dead or live trees. Both of the trees observed in our cases were older, mature individuals with large diameters and well-developed crevice systems capable of holding moisture. We observed no salamanders on smaller and/or younger trees within these canyon systems. Both of the aforementioned individuals were also found on the sides of trees facing bluff walls. The sides of trees facing bluff walls within these canyon systems remain consistently wetter than those facing away, providing a near constant source of moisture that may allow for arboreal habitat use in this species. The widespread nature of such habitat use in *P. glutinosus* is questionable and deserves further study, although moisture availability might be a limiting factor in the utilization of arboreal refugia in this species.

Photographic vouchers for the behavioral observations listed above were deposited in the Auburn University Herp Atlas Project - Digital (AHAP-D 301, 302). The observation from Winston Co., Alabama was obtained during research funded by Legacy, Partners in Environmental Education.

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***PLETHODON NETTINGI* (Cheat Mountain Salamander). PREDATION.** *Plethodon nettingi*, a federally protected species, is a small-sized terrestrial salamander endemic to the spruce forests of the Allegheny Mountains of West Virginia, USA. To date, no natural predators have been documented, though many are suspected (Petranka 2010. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington D.C. 492 pp.). On 26 May 2010, while surveying a study site in Pendleton Co., West Virginia, USA, we captured a young male *Thamnophis s. sirtalis* (Eastern Gartersnake), ca. 45 cm in total length, under a rock on top of Spruce Mountain (1457 m elev.). *Thamnophis s. sirtalis* is a medium-sized terrestrial snake that is a generalist in nearly all aspects of its natural history, including habitat, diet, distribution, and temperature tolerance. The species is known to ingest earthworms, leeches, slugs, snails, millipedes, isopods, spiders, crayfish, insects, salamanders, frogs, toads, small snakes, nestling birds, mice, fish, and carrion (Ernst and Ernst 2004. Snakes of the United States and Canada. Smithsonian Institution Press, Washington D.C. 680 pp.). Salamander prey consists of 11 genera including *Plethodon*. The *T. s. sirtalis* had an obvious food bolus that was palpated until regurgitation (Fig. 1). The food bolus was a recently eaten adult *P. nettingi*, ca. 45–55 mm in total length. The prey item was doubled over on itself to accommodate the stomach. A juvenile *P. cinereus*, ca. 15–20 mm, was also present but was exceptionally small. This observation,



PHOTO BY KEVIN MESSENGER

FIG. 1. *Thamnophis sirtalis* regurgitating *Plethodon nettingi.*

long considered and expected but never documented, marks another entry on the list of prey items accepted by *T. s. sirtalis*. This observation also marks the first documentation of natural predation on *P. nettingi*.

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ANURA — FROGS

BUFO STOMATICUS **(Marbled Toad). DEFENSIVE BEHAVIOR.** *Bufo stomaticus* is widely distributed in the Indian subcontinent (Chanda 2002. Handbook of Indian Amphibians. ZSI, Kolkata, India; Daniel 2002. The Book of Indian Reptiles and Amphibians. BNHS and Oxford Univ. Press, India; Dutta 1992. Amphibians of India and Sri Lanka, Checklist and Bibliography, Odyssey Pub. House, Orissa, India). It is abundant in the vicinity of the Central Aravalli foothills (Sharma et al. 2010. Flora and Fauna 244–248). In spite of its common and wide distribution, little is known about its ecology and behavioral patterns, particularly the defensive behavior when disturbed or attacked by any predator.

On 23 Sept 2010 at 1400 h, during our visit to the Central Aravalli foothills, Rajasthan, India, (26.2666°N, 74.50°E) we observed an interesting defensive behavior when a subadult *Bufo stomaticus* was disturbed. Initially the individual tried to escape but when surrounded from all sides, it suddenly raised its body on its legs and inflated its body (Fig. 1). When the disturbance (a camera) was removed the individual resumed a normal posture, although it resumed the defensive posture when it was again disturbed by the camera.

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PHOTO BY VIVEK SHARMA



FIG. 1. *Bufo stomaticus* showing defensive behavior.

CYCLORAMPHUS LUTZORUM **(Lutz's Frog). REPRODUCTIVE MODE.** The cycloramphid frog *Cycloramphus lutzorum* has a restricted geographic range in southern Brazil. The call and tadpoles of this endemic species were recently reported by Lima et al. (2010. J. Herpetol. 44:360–371), and karyotypic evolution relationships have been investigated (Noleto et al. *in press*. Zool. Anz.). Nevertheless, the reproductive mode of the species remains uncertain, despite data presented by Lima et al. (2010, *op. cit.*). On 28 Nov 2010 an egg clutch was found at the municipality of Morretes, Parana State, Brazil (25.59055°S, 48.815°W). The eggs were laid at a site lacking daylight, in a moist rock crevice ca. 2 cm high and 50 cm deep under a waterfall along the Brejamirim River. No evidence of clutch attendance was observed. The eggs were counted, measured, and collected for a determination of the state of development. Thirty-six eggs were laid, with a diameter of 0.92 ± 0.04 cm. Eggs were Gosner Stage 18 and tadpoles hatched within 12 days in the lab. These tadpoles matched the description of *C. lutzorum*, which allows inference that the species fits the reproductive mode 19 of Wells (2007. The Ecology and Behavior of Amphibians. Univ. Chicago Press, Chicago, Illinois. 1148 pp.). These data support the notion that *C. lutzorum* is an endemic stream-dwelling species and reinforce the need for conservation of their habitat.

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LEPTODACTYLUS FRAGILIS **(Mexican White-lipped Frog). DIET.** *Leptodactylus fragilis* is a lowland species that occurs from southernmost Texas throughout Middle America to northern and west-central Colombia and northern Venezuela (Heyer et al. 2006. Cat. Amer. Amphib. Rept. 830:1–2). This species is reported to feed on arthropods (Rand and Myers 1990. *In* Gentry [ed.], Four Neotropical Rainforests, pp. 386–409. Yale Univ. Press, New Haven, Connecticut; Savage 2002. The Amphibians and Reptiles of Costa Rica. A Herpetofauna between Two Continents, between Two Seas. Univ. Chicago Press, Chicago, Illinois), but no information exists on food habits of this species. Herein we provided detailed informaton on the diet of *L. fragilis* from Reserva Rio Manso (5.666°N, 74.77417°W; ca 220 m elev.), municipality of Norcasia, Departament of Caldas, Colombia.

We examined the stomach contents extracted by stomach-flushing of 63 individuals of *L. fragilis* sampled by GGD and SEL from 12–20 May 2010, between 1900 and 2200 h, around ponds in pasture lands. We identified each prey item to order or family and measured the length and width of each item to the nearest 0.1 mm using a manual caliper. We estimated prey volume using the formula for a prolate spheroid.

Of the 63 individuals examined, 42 (66.7%) contained prey items. These individuals ranged from 24.4 to 58.4 mm SVL (mean 41.88 ± 7.92). Insects and spiders composed the overall diet. Spiders and beetles were numerically and volumetrically the prey most represented. Numerically, long-toed water beetles (Dryopidae) were the most important prey, followed by orb-web spiders (Araneidae) and wolf spiders (Lycosidae) (Table 1). Volumetrically, lycosids were the most important prey, followed by dryopids and crickets (Gryllidae) (Table 1). Dryopids, araneids, and lycosyds also were common prey in many individuals. The value of dietary niche breadth, measured with the Shannon-Wiener diversity index (H'), was 2.46.

We used the Spearman Rank Correlation for analysis of morphology and diet in the specimens with identifiable prey. A

TABLE 1. Types of prey in the diet of *Leptodactylus fragilis* from "Reserva Rio Manso," Norcasia, Caldas, Colombia. Volume in mm^3.

Prey	Number (%)	Volume (%)	Frequency of occurrence
Arachnida			
Acari	1 (<1.0)	0.004 (<0.01)	1
Araneae			
Araneidae	13 (12.6)	178.14 (5.49)	9
Ctenidae	1 (<1.0)	209.94 (6.47)	1
Lycosidae	12 (10.7)	1273.05 (39.25)	12
Insecta			
Blattodea			
Blatiidae	8 (7.8)	402.93 (12.42)	8
Coleoptera			
Dryopidae	27 (26.2)	343.23 (10.58)	13
Elateridae	5 (4.9)	31.55 (0.97)	4
Staphylinidae	1 (<1.0)	29.26 (0.90)	1
Trogossitidae	4 (3.9)	7.55 (0.23)	3
Diptera			
Culicidae	1 (1.0)	0.01 (<0.01)	1
Drosophilidae	4 (3.9)	2.90 (0.09)	4
Psychodidae	1 (<1.0)	0.02 (0.00)	1
Hemiptera			
Cicadellidae	6 (5.8)	20.12 (0.62)	4
Hymenoptera			
Formicidae	6 (5.8)	19.35 (0.60)	5
Evaniidae	1 (<1.0)	18.85 (0.58)	1
Orthoptera			
Acrididae	2 (1.9)		2
Gryllidae	1 (<1.0)	393.17 (12.12)	1
Larvae	8 (7.7)	208.90 (6.50)	3
Diplopoda	1 (<1.0)	99.57 (3.07)	1
Mollusca	1 (<1.0)	4.69 (0.14)	1
TOTAL	104	3243.19	

positive and significant correlation exists between SVL and mouth width (MW) ($r_s = 0.83$, $p < 0.001$). The number of prey ingested was negative and significantly correlated with predator SVL ($r_s = -0.37$, $p < 0.02$) but not with MW ($r_s = -0.30$, $p > 0.05$). The prey volume ingested was positive and significantly correlated with both SVL ($r_s = 0.36$, $p < 0.02$) and MW ($r_s = 0.36$, $p < 0.02$). These results indicate that each individual consumes fewer prey as the SVL increase, but these are voluminous as well (e.g. spiders, dryopids, cockroach, and crickets). In each individual, the average of consumed prey of great size varied between 1 and 2.1 (Table 1).

The consumption of arthropods, mainly insects, by *L. fragilis* is typical due to their insectivorous diet (Rand and Myers 1990, *op. cit.*; Savage 2002, *op. cit*), additionally insects are plentiful and easily found in most terrestrial habitats (Triplehorn and Johnson 2005. Borror and Delong's Introduction to the Study of Insects. Thomson/Brooks Cole, Belmont; Parmelee 1999. Sci. Pap. Nat. Hist. Mus. Univ. Kansas 11:1–59). The notable presence of aquatic insects like the dryopids is important because it associates *L. fragilis* with lentic bodies of water (Savage 2002, *op. cit.*). Unfortunately, we do not know if other *Leptodactylus* associated with lentic waters also prey upon dryopids as the reports only identify prey to order and not family as in our study.

The numeric and volumetric presence of beetles and spiders reported here is not different from the diet of other *Leptodactylus* (Cuevas and Martori 2007. Cuad. Herpetol. 21:7–19; Duré and Kehr 2004. Herpetologica 60:295–303; França et al. 2004. Stud. Neotrop. Faun. Envir. 39:243–248; Maneyro et al. 2004. Iheringia, Sér. Zool. 94:57–61; Rodrigues et al. 2004. Rev. Esp. Herp. 18:19–28; Sanabria et al. 2005. Rev. Peru. Biol. 12:472– 477; Solé et al. 2009. Herpetol. Notes 2:9–15. Teixeira and Vrcibradic 2003. Cuad. Herpetol. 17:111–118; Winter et al. 2007. Herpetol. Rev. 38:324). Ants and termites also have been reported as numerically important prey (n > 22) in *L. bufonis*, *L. latinasus*, *L. ocellatus*, and *L. podicipinus* (Duré and Kehr 2004, *op. cit.*; Maneyro et al. 2004, *op. cit.*; Rodrigues et al. 2004, *op. cit.*; Sanabria et al. 2005, *op. cit.*; Teixeira and Vrcibradic 2003, *op. cit.*), but here ants only were represented by six prey items and termites were not found. The low rates of consumption of other prey types might be as a result of limited availability or they may be patchy in the habitat (Rodrigues et al. 2004, *op. cit.*).

Parmelee (1999. Sci. Pap. Nat. Hist. Mus. Univ. Kansas 11:1–59) suggested that body size and the head width in frogs determine the maximum size of prey consumed. Thus, the ability of gaping in relation to the size of the frog is a limiting factor in the selection of prey (Toft 1981. J. Herpetol. 15:139–144). In this study, the SVL determined the number and volume of prey consumed by *L. fragilis* and the MW determined positively the volume of ingested prey. The above suggests that both the SVL and MW are influencing the type of prey ingested by *L. fragilis*. The wide range of prey types and sizes found in *L. fragilis* indicates the species is a generalist/opportunistic feeder with a "sit-and-wait" strategy for obtaining prey (Taigen et al. 1982. Oecologia 52:49–56), like other *Leptodactylus* species. The previous idea is also corroborated with the high value of dietary niche breadth.

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***LEPTODACTYLUS MACROSTERNUM* (Miranda's White-lipped Frog). PREDATION.** Amphibians are an important component of the trophic chain in natural ecosystems, being common prey for a variety of vertebrates (fishes, reptiles, birds, and mammals), arthropods (ants, beetles, water bugs, spiders, and crabs), and even carnivorous plants (Duellman and Trueb 1994. Biology of Amphibians. Baltimore and London, The Johns Hopkins Univ. Press; Toledo 2005. Herpetol. Rev. 36:395–400; Toledo et al. 2007. J. Zool. 271:170–177).

Members of the family Belostomidae are predaceous aquatic insects from medium to large size that colonize aquatic habitats in tropical and temperate regions (Lauck and Menke 1961. Ann. Ent. Soc. Amer. 54:644–657).Water bugs are cited by many authors as predators of larval and adult frogs (Martins et al. 1993. Amphibia Reptilia 14:307–309; Eterovick and Sazima 2000. Amphibia-Reptilia 21:439–461; Toledo 2003. Phyllomedusa 2[2]:105–108; Toledo 2005, *op. cit.*), acting to help regulate anuran communities through predation (Duellman and Trueb 1994, *op. cit.*). Here, we report the predation of a juvenile *Leptodactylus macrosternum* by the water bug, *Lethocerus* sp.

On 21 Apr 2011 at 1700 h, in a stream at the Fazenda São Bernardo, municipality of Sambaiba, state of Maranhão, Brazil,

a water bug nymph was observed preying upon an adult *L. macrosternum*. When observed the water bug was grasping the dead frog on its ventral region. When disturbed by our presence the water bug left the prey and dove into the water.

We suggest that such predator/prey interactions could be common when these species are found at the same environment, such as streams and permanent, semi-permanent, or temporary ponds.

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***LEPTODACTYLUS TROGLODYTES* (Caçote). LARVAL CANNIBALISM.** Bragg (1964. Herpetologica 20:17–24) reported that cannibalism occurs in the larvae of some frogs; Heyer (1975. Biotropica 7(2):100–111) described cannibalism in *Leptodactylus* larvae. During the night of 17 April 2009 in a permanent pond (ca. 30 × 18 m) in an urban area of the municipality of Natal (S5.838889, W35.205000) state of Rio Grande do Norte, Brazil, we observed the first record of cannibalism in tadpoles of *Leptodactylus troglodytes*. Tadpoles (ca. 12 mm SVL, Gosner Stage 25; Gosner 1960 Hepetologica 16:183–190) being consumed by larger congeners (20 mm SVL Gosner Stage 30) were near the vegetation on the edge of the pond when first observed. They were caught by the larger tadpoles and taken to the bottom of the pond, where parts of the head and abdomen were eaten. Identification of tadpoles was verified by M.N.C. Kokubum.

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***LITHOBATES JOHNI* (Moore's Frog). HABITAT AND MICROHABITAT USE.** Very little is known about the life history of *Lithobates johni* (Blair 1947. Amer. Mus. Nat. Hist. 1353:1–18; Ramírez-Bautista et al. 2010. Lista Anotada de los Anfibios y Reptiles del Estado de Hidalgo, México. Universidad Autónoma del Estado de Hidalgo, CONABIO. 104 pp.). Herein we report habitat and microhabitat use by *L. johni* from the tropical rain forest of Río Blanco (20.24646°N, 98.05434°W; WGS 84; elev. 601 m), Municipality of Huehuetla, Hidalgo, México. *Lithobates johni* are thought to be fully aquatic, however no studies have reported the habitat and microhabitat use of this species. On 15 March 2011, during 2000–2300 h, we found seven (CIB 4114–4120) *L. johni* in tropical rain forest (Fig. 1). These individuals were perched in a cave under a waterfall. Environmental and microhabitat temperatures were 18°C and 16°C. It appears the species prefers non-polluted waters as we did not find individuals in places where the river is polluted.

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PHOTO BY C. B. ISLAS

FIG. 1. A) Female *Lithobates johni* (photo by L.V. Saldaña); B) habitat of *L. johni*; C) habitat and microhabitat inhabited by *L. johni*, and D) microhabitat of *L. johni*, arrows indicate the microhabitats used by frogs.

***LITORIA COOLOOLENSIS* (Cooloola Sedge Frog). AMPLEXUS.** In many anurans, males vocalize to attract females but may grasp any female that comes within reach and retain their hold unless displaced by a rival male (Bruning et al. 2010. Biol. Lett. 6:322–324). The male's clasping response may, at times, not discriminate between species, and at the height of breeding, sometimes involves inanimate objects (Brown 1977. J. Herpetol.; Storm 1960. Herpetologica 16:251–259), non-reproductive and reproductive females (Marco and Lizana 2002. Ethol. Ecol. Evol. 14:1–8; Cheong et al. 2008. Anim. Cells Syst. 12:93–96), and even dead frogs (Marco and Lizana 2002. *op. cit.*).

In the Australian subtropical frog *Litoria cooloolensis*, breeding occurs in coastal wetlands in spring, summer, and autumn, where males call from reeds and emergent vegetation over or near water (Meyer et al. 2006. National Recovery Plan for the wallum sedge frog and other wallum-dependent frog species. Queensland Parks and Wildlife Service, Brisbane, report to Department of the Environment and Water Resources, Canberra; pers. obs.). Amplexus is axillary and eggs are laid in clumps in the water amidst vegetation (Meyer et al. 2006, *op. cit.*).

On 3 October 2010 at ca. 1915 h KL observed a male *L. cooloolensis* amplecting a *L. olongburensis* (presumably female) in Great Sandy National Park (Cooloola section), Queensland (Fig. 1). The *L. olongburensis* made no attempt to go to the water to commence egg deposition, nor did it attempt to dislodge or escape from the male. Both species were heard vocalizing during the survey, along with *L. fallax* and *Crinia tinnula*. Environmental air and water temperatures were 19.3°C and 20.1°C. Cloud cover was ca. 50% with no moon, thus a low level of illumination. Humidity was 91.9%, barometric pressure was 1014 hPa. The average pH of the wetland was 3.65 and salinity was 32.76 ppm.

COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND



FIG. 1. Axillary amplexus between a male *Litoria cooloolensis* and *Litoria olongburensis*.



FIG. 2. Inguinal amplexus between a male *Litoria cooloolensis* and *Litoria rubella*.

A second observation was made on 7 Jan 2011 at ca. 1945 h, where a male *L. cooloolensis* was in amplexus with *L. rubella* (Fig. 2), also in Great Sandy National Park (Cooloola section), Queensland. In this instance, the *L. rubella* was climbing higher up the vegetation and appeared to be attempting to dislodge the unwanted male. Again, both species were heard vocalizing during the survey, along with *L. nasuta, L. tyleri, C. tinnula, Uperoleia fusca, Limnodynastes peroni,* and *Limnodynastes terraereginae*. Environmental air and water temperatures were 23.1°C and 25°C. Cloud cover was 100%, thus a low level of illumination, with some rain that evening. Humidity was 92.8%, barometric pressure was 1001 hPa. The average pH of the wetland was 3.86 and salinity was 21.97 ppm. No release vocalizations were heard from either of the interactions. In both observations the amplected frog was larger than the male, most significantly in *L. rubella*, where the male had to modify its amplexus technique—from axillary to inguinal. Both of these observations were made at the beginning of breeding season in two different wetlands.

In any sexually reproducing species, determining which individual to combine gametes with is a critical determinant of individual fitness and likely to be under strong selection pressure (Andersson 1994. Sexual Selection. Princeton Univ. Press, Princeton, New Jersey). Mate choice is important for successful reproduction and females have been shown to discriminate between species, most commonly on the basis of difference in male vocalizations (Blair 1964. Q. Rev. Biol. 39:334–344). As is apparent from an examination of Figures 1 and 2, the morphological differences between the species are quite clear. Also, the calls of all three species can be readily distinguished, thus female selection is unlikely to have been the cause of these mismatches. Instead, the pairings are likely to have arisen from a male *L. cooloolensis* displaying indiscriminate amplexus, jumping on any frog nearby.

Amplexus confers substantial costs to the amplecting (McLister 2003. Can. J. Zool. 81:388–394) and amplected anuran (Bowcock et al. 2008. Anim. Behav. 75:1571–1579). Thus, it would be beneficial for females (and other males) to immediately terminate 'unwanted' amplexus (Bowcock et al. 2008, *op. cit.*; McLister 2003, *op. cit*). Furthermore, selection should act on males to terminate inappropriate amplexus by rapidly discriminating the sex and reproductive condition of the animal that they have seized (Bowcock et al. 2008, *op. cit.*).

The females may not have been receiving the correct chemical cues to proceed with breeding as neither was observed to commence with egg deposition. However some mechanisms for repelling unwanted suitors have been observed in other species. These include release vocalizations (Leary 2001. Anim. Behav. 61:431–438), inflating the body (Bruning et al. 2010, *op. cit.*), and laying fewer eggs when paired with heterospecific males (Hettyey 2009. Anim. Behav. 78:1365–1372).

KL has been surveying 16 Wallum Frog breeding sites over two years (approx. 500 survey hours) and has never observed a pair of *L. cooloolensis* or *L. olongburensis* in amplexus. This suggests that observations of such behavior might be rare, and might be quickly followed by egg deposition. The two observations discussed here lead to questions of hybridization between *L. cooloolensis* and *L. olongburensis,* as they share similar morphology, breeding habitat, breeding seasons, and calling perch sites. Further studies examining the viability of hybrid offspring and identifying the cause of matings between different species in hybrid populations would add to our understanding of hybridization and mate recognition in amphibians.

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***MEGOPHRYS KOBAYASHII* (Montane Horned Frog). ATYPICAL HABITAT AND MAXIMUM SIZE.** *Megophrys kobayashii* is endemic to the mountainous western Sabah, Bornean Malaysia between 1230–1675 m elev. (Inger and Stuebing 2005. A Field Guide to the Frogs of Borneo. 2nd ed. Natural History Publications [Borneo] Sdn. Bhd. Kota Kinabalu. 201 pp.; Frost 2010. Amphibian Species of the World: an Online Reference. Version 5.4 [8 April 2010]. Electronic database accessible at http://research.amnh.org/vz/herpetology/amphibia. Amer. Mus. Nat. Hist., New York. Accessed 1 February 2011), and is listed as Near Threatened in the 2010 IUCN Red List of Threatened Species (Inger et al. 2004. *In* IUCN 2010. IUCN Red List of Threatened Species. Version 2010.4. <www.iucnredlist.org>. Accessed 1 Feb 2011). The species has been reported to dwell in leaf litter of primary montane forests with small rocky-bottomed streams for breeding; maximum size reported to be SVL 109 mm (Inger and Stuebing 2005, *op. cit.*; Malkmus et al. 2002. Amphibians and Reptiles of Mount Kinabalu [North Borneo]. A.R.G. Gantner Verlag K.G. Ruggell. 424 pp.).

On 8 Dec 2010 at 1915 h, a gravid female *M. kobayashii* was found at the foot of a leaf-littered hill in the compound of Haleluyah Retreat Centre (6°N, 116.536°E; 1518 m elev.), Bundu Tuhan, Ranau District, West Coast Division, Sabah, Bornean Malaysia. Air temperature was 19.9°C, and relative humidity was 75.7%. The individual was found ca. 25 m from an artificial pond. However, the compound lacks a stream or brook thought to be necessary for breeding in *M. kobayashii* (Inger and Stuebing 2005, *op. cit.*; Malkmus et al. 2002, *op. cit.*). It is possible that an attempted escape from a predator might explain the presence of *M. kobayashii* in the compound although no predators were observed; additionally the species normally lives in permanent colonies (Malkmus et al. 2002, *op. cit.*). This observation suggests that *M. kobayashii* might utilize a wider variety of habitats than currently known.

This individual was 118 mm SVL and 151 g, and thus a new maximum size for *M. kobayashii*. Measurements were taken with a standard metric tape and an electronic balance. The individual was photographed *ex-situ* indoors and released on site the following day.

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***PLEURODEMA TUCUMANUM*. PREDATION.** Water bugs (Belostomatidae) are well known to prey on anuran larvae (Giaretta and Menin 2004. J. Nat. Hist. 38:1711–1722; Hinshaw and Sullivan 1990. J. Herpetol. 24:196–197; Kher and Schnack 1991. Alytes 9:61–69; Menin et al. 2005. Phyllomedusa 4(1):39–47) and adults (Bastos et al. 1994. Herpetol. Rev. 25:81; Haddad and Bastos 1997. Amphibia-Reptilia 18:295–298; Mijares-Urrutia et al. 1997. Herpetol. Rev. 28:84; Toledo 2003. Phyllomedusa 2[2]:105–108). Water bugs eat more frogs than invertebrates because anurans are better food items from an energetic viewpoint (Hidai and Hidaka 2002. Ecol. Res. 17:655–661); they use their piercing-sucking mouthparts to eat them (Lopez et al. 1998. Rev. Nica. Entomol. 46:1–5).

Herein we report predation of a juvenile *Pleurodema tucumanum* by the water bug *Belostoma discretum*. This observation took place during the night of 9 April 2009 in the vicinity of the Rio Claro (32.613°S, 66.139°W), near San Francisco, Ayacucho, San Luis 5570, Argentina, in a large pool enclosed by rocks at the river's edge. A juvenile *P. tucumanum* (19.6 mm SVL) was observed floating on the surface of the pool (no deeper than 0.2 m), with a *B. discretum* (24.8 mm long) attached to its abdomen. The water bug was holding the frog with its forelegs while piercing the frog's left hindlimb with its proboscis. At regular intervals the water bug swam with apparent difficulty carrying the frog to the bottom of the pool, where it rested for an instant before emerging for air and repeating these actions.

These individuals were photographed, collected, and preserved in 70% ethyl alcohol. The *B. discretum* was deposited in the UNSL Entomological Collection and the *P. tucumanum* (CH-UNSL 0429) in the Herpetological Collection of Universidad Nacional de San Luis. This is the first record of *B. discretum* preying on juvenile *P. tucumanum*.

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***POLYPEDATES LEUCOMYSTAX* (Java Whipping Frog). COMMUNAL NESTING.** Communal egg-laying is widespread in amphibians yet the exact reasons for it remain unclear (Doody et al. 2009. Quart. Rev. Biol. 84[3]:229–252). In nest building species, there appears to be plasticity within a population for nesting communally versus individually (Agostini et al. 2007. Herpetol. Rev. 38:441; Zina 2006. Amphibia-Reptilia 27:148–150), indicating that perhaps in certain contexts one method is more advantageous than another. Here we report communal nesting activity in *Polypedates leucomystax* at the Xishuangbanna Tropical Botanic Garden, Xishuangbanna Prefecture, Yunnan Province, China, during one of the driest rainy seasons on record (Qiu 2010. Nature 465[13]:142–143).

In weekly breeding site surveys, we recorded instances of communal nesting on 9 July and 12 Aug 2009. On 9 July, we encountered two large foam nests, the larger nest measuring ca. 59 cm × 48 cm, and the smaller one measuring 62 cm × 39 cm. In addition, at the same site but several meters away from the larger nest, we observed a single female actively mating with 4 males as has been recorded in this species before (Feng and Narins1991. Naturwissenschaften 78:362–364), however, when we approached the group, the males dispersed. On 12 Aug we recorded an additional large nest at the same site as the first two, and slightly smaller in size measuring 32 cm × 46 cm. On both dates we also observed multiple individual nests at the same site (see Fig. 1 for comparison of nest sizes). These communal nests are no doubt the product of multiple females ovipositing in the same location, but since we did not observe it, we do not know if oviposition happened simultaneously or separately.



FIG. 1. On left, the larger of two communal nests of *Polypedates leucomystax* observed on the night of 9 July 2009. On the right, an average-sized individual female nest. The 50 yuan note measures 15 cm x 7 cm.

In the three years of conducting breeding site surveys (2008–2010), these are the only instances of communal nesting we encountered for any species. Both dates that we recorded communal nesting were after major rain events (>50 mm rain) following significant dry spells (25–28 d) where no standing water accumulated. It is possible that since these populations rely heavily on ephemeral pools for reproduction there is high competition for the spots that retain water longest.

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***PRISTIMANTIS ACHATINUS* (Cachabi Robber Frog). PARENTAL CARE AND CLUTCH SIZE.** *Pristimantis* is the largest clade of frogs in the world with nearly 445 species, distributed mainly in northwestern South America (Amphibiaweb 2011.. [web application]. Berkeley, California. Available: http://amphibiaweb.org/; accessed 27 May 2011; Hedges et al. 2008. Zootaxa 1737:1–182). These frogs have terrestrial eggs and embryos undergo direct development (Hedges et al. 2008, *op. cit.*). To date, there are published data on clutch size, nest type, and parental care in 10 species of *Pristimantis*: *P. affinis*, *P. buccinator*, *P. caryophyllaceus*, *P. lymani*, *P. nicefori*, *P. percultus*, *P. racemus*, *P. simoterus*, *P. terraebolivaris,* and *P. verecundus* (Carrillo 2007. Herpetol. Rev. 38:183; Heatwole 1963. Carib. J. Sci. 3:17–23; Lynch and Duellman 1997. Univ. Kansas. Nat. Mus. Spec. Publ. 23:1–236; Lynch et al. 1996. Caldasia 18:329–342; Myers 1969. Am. Mus. Novit. 2396:1–52; Townsend 1996. *In* Powell and Henderson. Contributions to West Indian Herpetology, a Tribute to Albert Schwartz, pp. 229–239. SSAR Contrib. Herpetol. Vol. 12. Ithaca, New York; Vargas-S. and Castro-H. 1999. Rev. Acad. Colomb. Cienc. 23:407–410). Herein we provided the first data on nest site, clutch size, and parental care in *P. achatinus* from a premontane humid forest in the Central Andes of Colombia. This species occurs in Panama, Colombia, and Ecuador, at altitudes of 0–2330 m (Frost 2011. Amphibian Species of the World: an Online Reference. Version 5.5 [31 Jan 2011]. Electronic database accessible at http://research.amnh.org/vz/herpetology/amphibia/. American Museum of Natural History, New York; accessed 27 May 2011).

On 25 May 2011, we found an adult female *P. achatinus* (37.9 mm SVL) sitting on a clutch of 38 eggs (Fig. 1A) at Ecoparque Los Alcázares Arenillo, municipality of Manizales, Department of Caldas, Colombia (5.067°N, 75.533°W, 1730–1960 m elev.). Both the female and the egg mass were in a shallow depression (ca. 25 mm deep) on the ground beneath leaf litter, next to small shrubs. At the time of finding the nest, the female was completely covering the eggs with the body and head, so that the eggs were not visible, which could be evidence of parental care. However, minutes after being disturbed the frog moved, allowing us to see the eggs (Fig. 1A). The eggs were spherical with yellowish cream yolk and clustered in a grape bunch although not connected by a jelly or foam matrix (Fig. 1B). We examined 10 eggs that ranged from 4.1–4.6 mm diameter (mean 4.46 ± 0.17) and we estimated them to be approximately early stage 5 of development based on the limb buds elongate and attached to trunk, forelimbs round to ovoid, and hindlimbs round to ovoid-elongate, eyes prominent but unpigmented, and gill buds present (Townsend Stewart 1985. Copeia 1985:423–436).

Although there is a widespread lack of data on parental care *Pristimantis*, the available data and this report suggest that females attend nests. Based on the data summarized by Wells (2007. The Ecology and Behavior of Amphibians. University



FIG. 1. A) Egg attendance by female *Pristimantis achatinus* in the Ecoparque Los Alcázares Arenillo, Manizales, Colombia. B) *Pristimantis achatinus* egg clutch in a shallow depression in the soil.

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of Chicago Press, Chicago, Illinois) and others (Rodríguez and Alonso 2009. Herpetol. Rev. 40:204; Ryan 2005. Herpetol. Rev. 36:234–236; Whitfield et al. 2008. Herpetol. Rev. 39:76), in *Craugastor* and *Strabomantis* the females performed parental care, whereas in *Diasporus* it is the male, and in *Eleutherodactylus* the behavior is accomplished by females, males, or either parent.

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***RANA BOYLII* (Foothill Yellow-legged Frog). REPRODUCTION.** *Rana boylii* is an obligate lotic breeding ranid ranging from southern California north into southwestern Oregon, USA. *Rana boylii* breeds in spring (March–June) as winter flows subside, exhibits high breeding-site fidelity, and oviposition typically occurs on cobbles and boulders along river and stream margins in microhabitats with less than ambient flows (Fellers 2005. *In* Lannoo et al. [eds.], Amphibian Declines: The Conservation Status of United States Species, pp. 534–536. Univ. California Press, Berkeley). This species is listed as Near Threatened by the IUCN (Santos-Barrera et al. 2004. *In* IUCN 2010. IUCN Red List of Threatened Species. www.iucnredlist.org; accessed 10 April 2011) and has been a California Species of Special Concern since 1994 (Jennings and Hayes 1994. Amphibian and Reptile Species of Special Concern in California. California Dept. of Fish and Game, Rancho Cordova. 254 pp.). Annual census of egg masses is an effective means for quantifying population trends in frog species that lay one clutch per year at conspicuous oviposition sites (Crouch and Patton 2000. Wildl. Soc. Bull. 28:895–901). However, historical data on annual reproductive output for *R. boylii* populations throughout the range are limited, making it difficult to adequately assess the severity of population declines. Here we report the highest known density of egg masses for this species.

On 31 May 2009 (1100–1630 h) we conducted a visual encounter survey along a 2.25 km segment of the Mad River, in Humboldt Co., California, USA (40.8292°N, 123.9423°W, elev. 45 m) to quantify *R. boylii* egg masses. The sampled river segment is a low gradient meandering channel, with abundant gravel and cobble substrates, and adjacent uplands principally comprised of third growth Coast Redwood (*Sequoia sempervirens*) timberlands. We timed this survey to coincide with the final descending limb of the hydrograph and to be at the apparent peak of the breeding season. The peak of the 2009 breeding season was determined based on two visits to a known breeding site located downstream (7 km) from the sample reach. The mean surface water discharge of the river was 258 cfs (U.S. Geological Survey, Surface Water data for California: USGS Surface-Water Daily Statistics. http://waterdata.usgs.gov/ca/nwis/ dvstat?. Accessed 10 April 2011). We counted a total of 728 *R. boylii* egg masses for a resulting density of 323.5 egg masses km^{-1}. Forty-one egg masses (5.6% of the total counted) we observed were stranded on the river bank and presumably desiccated prior to hatching. The density we report here is 183% the maximum reported elsewhere. The highest reported density for *R. boylii* egg masses among 27 other rivers or streams is 176.9 egg masses km^{-1}, however the average among these sites is 16 egg masses km^{-1} (Kupferberg et al., *in review*). We believe that our finding on the annual reproductive output for *R. boylii* is a useful baseline for describing the population-level reproductive potential for the species and for comparison with other populations in similar river systems.

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***RANA BOYLII* (Foothill Yellow-legged Frog) and *ANAXYRUS BOREAS* (Western Toad). INTERSPECIFIC AMPLEXUS.** On 14 June 2010, during egg mass surveys on the South Fork Trinity River, Humboldt Co., northwestern California, USA, a male *Rana boylii* was observed in amplexus with a female *Anaxyrus boreas* at 1455 h (Fig. 1). Yearly surveys for egg masses and egg strings have been conducted since 2004, with numerous encounters of intraspecific amplexus being seen every year. In previous reports for Western Toads in interspecific amplexus, Brodie (1968. Herpetologica 24:86) witnessed a male Cascades Frog (*Rana cascadae*) in amplexus with a female Western Toad and Brown (1977. J. Herpetol. 11:92–94) reported a male Western Toad in amplexus with a female Northern Red-legged Frog (*Rana aurora*). It has been reported that non-native American Bullfrogs (*Lithobates catesbeianus*) that enter amplexus with native anurans could create reproductive interference (D'Amore et al. 2009. Herpetol. Cons. Biol. 4[3]:325–330; Pearl et al. 2005. Amer. Midl. Nat. 154:126–134) and this would be a case of heterospecific mating attempt (Groning and Hochkirch 2008. Quart. Rev. Biol. 83:257–282). This is the first observation of amplexus between a native ranid and a native bufonid in California and of these species pairing.

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FIG. 1. Male *Rana boylii* in amplexus with female *Anaxyrus boreas* in the South Fork Trinity River, Humboldt Co., California.

***RANA YAVAPAIENSIS* (Lowland Leopard Frog). LARVAL CANNIBALISM.** *Rana yavapaiensis* is known to oviposit primarily in

late winter-spring, with a much smaller pulse of oviposition in early fall (Sartorius and Rosen 2000. Southwest. Nat. 45:267–273) and large tadpoles sometimes overwinter (Collins and Lewis 1979. Southwest. Nat. 24:371–373). This situation occurred during winter 2005–6 in my semi-natural, urban backyard pond (3 × 4 m, 0.4 m deep), which has had a self-sustaining frog population derived from three southeastern Arizona populations for several years. In monitoring the 4th of eight egg masses deposited in February–early March 2006, I briefly noted about 5–6 large tadpoles (5.5–7.5 cm LOA) from a single September 2005 clutch active around and under the egg mass, which had just begun to hatch, on 5 March. On 7 March closer inspection of the 5th egg mass, which was estimated to be at developmental stages 16–19 and predicted to be 50% hatched on 9 March, revealed about 12–18 large tadpoles (of an estimated 48+ present in the pond) active under, around, and on the egg mass. Tadpoles were swimming lazily, pushing into the mass with actively moving mouthparts, and, in at least one case observed to swallow a dislodged embryo. Water was 11 cm deep at the mass, which was about 8 cm diameter, and temperature was 17°C (range 13–20°C over 24 h). The mass originally contained an estimated 1100 eggs based on previous counts of hatchlings in other clutches of similar size; 30 h later there were only 18 developing ova remaining, the egg mass was reduced in size but not dissociating as expected post-hatching, and no hatchlings were observed near the egg mass site, as would normally be seen. Other egg masses appeared to be less affected in proportion to the depth of water column below them, with hatchlings seen around all of them, and there was less activity of large tadpoles near them. However, the 8th and deepest-water egg mass, which hatched last (15 March), attracted about 15 large tadpoles on the bottom where a cone of detaching hatchlings from it would likely fall. Five of these tadpoles transferred to a screened-in observation tray with 10 hatchlings apparently consumed four hatchlings in a 24-h period.

The frog and tadpole densities involved here are similar to the highest *R. yavapaiensis* abundances I have seen in Arizona and Sonora during 1983–2005, and the only other vertebrate in the pond is the Gila Topminnow (*Poeciliopsis occidentalis*). An accumulating literature on oophagy, larvivory, and cannibalism in tadpoles (Gunzberger and Travis 2005. J. Herpetol. 39:457–571), and their occurrence in species with generalized tadpoles such as in this species and the American Bullfrog (*R. catesbeiana*; Kiesecker and Blaustein 1997. Ecology 78:1752–1760), may support suggestions in McDiarmid and Altig (1999. Tadpoles: the Biology of Amphibian Larvae, pp. 218, 246. Univ. Chicago Press, Chicago, Illinois) that these may be widespread and ecologically important phenomena.

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***RHACOPHORUS MARGARITIFER* (Java Flying Frog). DEFENSIVE BEHAVIOR.** *Rhacophorus margaritifer* is endemic to the island of Java in Indonesia. This species has received little treatment in the literature and many aspects of its natural history remain unknown. A recent monograph examining the genus *Rhacophorus* (Harvey et al. 2002. Herpetol. Monog. 16:46–92) described morphological diversity in *R. margaritifer* and briefly mentioned an *in situ* Unken reflex exhibited by one of the specimens examined. The individual described herein (along with several other *R. margaritifer*) was collected at the Taman Safari Park, in Cisurua-Bogor, West Java (06.716667°S, 106.95000°E; WGS 84), 1300 m elev., on 13 May 1996 and is deposited in the vertebrate collection of the University of Texas at Arlington (UTA A-54009). This and another specimen (UTA A-54010) were found active on low bushes, 1.4–1.8 m above the edge of a rocky stream flowing through primary forest on a warm night, ca. 18°C and 1945 h. The photographs taken of this reflex (Fig. 1), enable us to describe the behavior in detail. The behavior was expressed the day after capture while trying to photograph the specimen. This behavior involved the *R. margaritifer* covering its eyes with its hands and slightly arching its back (Fig. 1; bottom). These actions are consistent with those reported to occur during the Unken reflex of several anuran species (Stebbins and Cohen 1995. A Natural History of Amphibians. Princeton Univ. Press Princeton, New Jersey. 315 pp.). Interestingly, a similar reflex was reported from *R. feae* (Duong et al. 2010 Herpetol. Rev. 41:342). The behavior is also known to occur in a closely related rhacophorid *Nyctixalus pictus* (Das et al. 2004. Herpetol. Rev. 35:363–374). As such, a thorough survey across rhacophorids might provide valuable insight into the prevalence and modes of defensive behavior in this group. Collection and exportation were conducted with Bogor Zoological Museum permits (14/SI/MZB/VI/1996).

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PHOTO BY E. N. SMITH

FIG. 1. *Rhacophorus margaritifer* (UTA A-54009) from Java, Indonesia defensive behavior prior to (top) and immediately following (bottom) probing.

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***RHINELLA CRUCIFER* (Striped Toad) and *RHINELLA JIMI*. HETEROSPECIFIC AMPLEXUS.** Most members of the family Bufonidae are regarded as having an explosive breeding pattern (Wells 2007. The Ecology and Behavior of Amphibians, Univ. Chicago Press, Chicago, Illinois. 1148 pp.), where after the first heavy rains of the season males begin calling and actively searching for females. During this reproductive frenzy males may commit mistakes and try to amplex with male conspecifics, heterospecifics, other vertebrates, or even inanimate objects of adequate size (Marco and Lizana 2002. Ethol. Ecol. Evol. 14:1–8; Wells 2007, *op. cit.*).

On 25 Nov 2010, at Parque das Trilhas, municipality of Guaramiranga, State of Ceará, northeastern Brazil (4.266°S, 38.916°W; 865 m elev.), we observed males of *Rhinella crucifer* and *R. jimi* in amplexus with heterospecifics. These observations took place in an artificial water body at ca. 2000 h, when only these two species were heard calling (*R. crucifer*, N = 5; *R. jimi*, N > 50). One *R. crucifer* was found in amplexus with a female *R. jimi*. When first seen, the pair was already in an axillary amplexus position in which they remained for 10 min. Towards the end of this time period the female began to raise the rear part of her body and direct her snout towards the ground in an attempt to be released until it finally succeeded (the behavior was videotaped and is available from LB upon request). Fifteen minutes after this observation, a male *R. jimi* was found in amplexus with *Leptodactylus vastus* (sex undetermined), which made no apparent attempt to dislodge the male. When approached by LB, the *L. vastus* jumped into the deeper part of the lake taking with it the amplectant male.

Haddad et al. (1990. Rev. Bras. Biol. 50:739–744) reported a *R. crucifer* × *R. icterica* hybrid. Considering that *R. jimi* is closely related to *R. icterica* such mistakes might be relatively common in areas where these species occur in sympatry with *R. crucifer*. According to Sinovas (2009. Herpetol. Rev. 40:199) the cost of amplexing a reproductively inadequate specimen is probably outweighed by the benefits of being the first to encounter an appropriate partner, as this behavior has not been selected against. Machado and Bernarde (2011. Herpetol. Notes 4:167–169) reported heterospecific amplexus involving *Rhaebo guttatus* and *Rhinella marina* in the Amazon. Although most records of heterospecific amplexus have been made in temperate environments (Wells 2007, *op. cit.*), these recent observations from tropical areas suggest that such behavior is found in Bufonidae worldwide.

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***RHINELLA JIMI* (Cururu Toad). ECTOPARASITISM.** *Rhinella jimi* is a bufonid that occurs throughout northeastern Brazil where it inhabits forests along the Atlantic coast as well as open formations of Caatinga. It is the only species in the genus that inhabits the Fernando de Noranha archipelago (Stevaux 2002. Rev. Bras. Zool. 19[1]:235–242; Toledo and Ribeiro 2010. EcoHealth 6:351–357). Here we report parasitism of *R. jimi* by the tick *Amblyomma rotundatum* (Ixodidae).

On 19 Dec 2010 at 2114 h at the Unidade de Conservação Refúgio de Vida Silvestre Mata do Junco, municipality of Capela, State of Sergipe, Brazil (10.291037ºS, 36.58370ºW, 120 m elev. SAD 69), an adult R. jimi (167.5 mm SVL) was observed parasitized by five ticks of the species Amblyomma rotundatum (Fig. 1A). Three of the ticks were fixed on the posterior part of the toad's dorsum (Fig. 1B), and the other two ticks were located in the inguinal region between the folds of the rear legs. Amblyomma rotundatum, known as Toad Tick, has been reported to parasitize a variety of amphibians (Ahid et al. 2009. Rev. Bras. Zool. 11[2]:153–158; Guglielmone and Nava 2010. Zootaxa 2541:27–49; Rodrigues et al. 2010. Rev. Bras. Parasitol. 19[3]:174–178; Woehl 2002. Rev. Bras. Zool. 19[2]:329–333). Amblyomma rotundatum is native to Central and South America, but has been found in North America, where it was introduced via Rhinella marinus (Boffy and Santos 2010. Herpetol. Rev. 41:342–343; Rodrigues et. al. 2010, *op. cit.*).

The ticks are deposited in Coleção do Laboratório de Entomologia (ENTUFS 00001) and the toad in Coleção Herpetológica da Universidade Federal de Sergipe (CHUFS C 1248). This is the first report of parasitism of *R. jimi* by *A. rotundatum* and the first report of ticks parasitizing amphibians in the State of Sergipe.

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FIG. 1. A) Adult *Rhinella jimi* (167.5 mm SVL) parasitized by the tick, *Amblyomma rotundatum*. B) *Amblyomma rotundatum* attached to the dorsum of *R. jimi*.

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***RHINELLA MARINA* (Cane Toad). DIET.** Although the invasive Cane Toad's diet in Australia consists primarily of insects, vertebrates are occasionally ingested (Lever 2001. The Cane Toad. Westbury, Otley). Herein we report on predation by the Cane Toad on a nestling bird. As part of a larger study, LP collected a large female *Rhinella marina* (SUL 95 cm) on 1 Dec 2008, from the grounds of Walkabout Palms Caravan Park, Townsville, Queensland (19.3166°S, 146.8°E; WGS 84). Examination of the stomach contents from this specimen revealed one large beetle, and one nestling bird (Fig. 1). The bird was a House Sparrow, *Passer domesticus*, also an invasive species in Australia. These birds are cavity nesters, therefore it is likely the nestling somehow fell from the nest, or perhaps fledged prematurely. *Passer domesticus* nestlings fledge around 14 days of age (Lowther et al. 2006. The Birds of North America Online doi:10.2173/bna.12), and based on feather emergence the bird was approximately 11–12 days old. The nestling had a total body length (tip of bill to tail bud) of 50.7 mm, and was 15.6 mm at its widest point. *Passer domesticus* is commonly found in urban settings, and often uses cavities in buildings for nesting. To the best of our knowledge this is the first documentation of *R. marina* eating an invasive bird in Australia.

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FIG. 1. Female *Rhinella marina* with stomach contents of a nestling *Passer domesticus* and beetle.

TESTUDINES — TURTLES

***APALONE MUTICA* (Smooth Softshell). DIET.** Information on the diet of *Apalone mutica* in the Mississippi River is scanty. Routine fish surveys with trammel nets (Vogt 1983. Copeia 1980:368–371) in Cassville Slough, a side channel in Grant Co., Wisconsin, USA, resulted in the collection of 34 *A. mutica* during the period 2005–2011. We obtained gut contents from 17 adult females (carapace length: 239–301 mm, mean = 261 mm; mass: 0.97–2.22 kg, mean = 1.47 kg) that had died in the nets (living turtles were released), including at least one turtle from each year. Eight of the Cassville turtles were collected in late June, and the remaining nine in early August. Unpublished data were also available for a female (179 mm; 0.45 kg) collected in a fyke net in Devil's Run of the Fountain City Bay backwaters, Buffalo Co., Wisconsin (26 June 1975), and a male (182 mm; 0.40 kg) collected by seining in the Weaver Bottoms, Wabasha Co., Minnesota (24 August 1976) during a study of *A. spinifera* (Cochran and McConville 1983. J. Herptetol. 17:82–86).

Gut contents of *A. mutica* were dominated by aquatic insects. Sixteen of 17 turtles from Cassville Slough contained naiads of the large burrowing mayfly *Hexagenia*. Minimum counts in individual turtles, based on counts of head capsules or tusks, ranged from 10 to 151 (mean = 66.4). One of the Cassville turtles in August also contained remains of at least three adult *Hexagenia*. Two of the Cassville turtles each contained a caddisfly larval case, and one of these two also contained 17 pupae. One Cassville turtle contained a dragonfly naiad. The turtle from Devil's Run contained 7 *Hexagenia*, two dragonfly naiads, and 71 caddisfly larvae (many cases of sand grains or of leaf fragments had been swallowed whole), whereas the turtle from the Weaver Bottoms contained 23 caddisfly larvae, one dragonfly naiad, 15 chironomid larvae, and three unidentified insects.

One Cassville turtle contained a small crayfish (young-of-the-year), and ten contained the remains of small mollusks. One had eaten two helical snails (1–2 mm), six had eaten native mussels (< 1cm), and five had eaten Zebra Mussels (*Dreissena polymorpha*). Two turtles contained both native and zebra mussels. Most shells were unbroken, but shell fragments were present in five turtles.

Our results are consistent with some previous reports but provide new details. Although the importance of aquatic insects, including ephemeropterans, in the diet of *A. mutica* has been noted previously (e.g., Williams and Christiansen. 1981. J. Herptetol. 15:303–308), few studies have specifically mentioned *Hexagenia*. *Hexagenia* are abundant in many large aquatic habitats, including the upper Mississippi River (Fremling 1960. Iowa St. Univ. Agr. Home Econ. Exp. Sta. Res. Bull 482:842–852), where they are a major component of the diet of *A. spinifera* (Cochran and McConville, *op. cit.*). However, *Hexagenia* are also indicators of good water quality (Fremling 1964. Science 146:1164–1165); they declined in abundance historically in areas that were polluted or otherwise degraded and at least sometimes have reappeared when conditions ameliorated (Cochran and Kinziger 1997. Great Lakes Entomologist 30:89–92). Previous diet studies based on *A. mutica* collected in degraded habitats would not be expected to have found *Hexagenia* in great numbers.

Zebra Mussels have not been reported previously in the diet of *A. mutica*, but most studies pre-dated the colonization of the Mississippi River drainage by this exotic invasive species during the 1990s (McMahon and Bogan 2001. *In* J. H. Thorp and A. P. Covich [eds.], Ecology and Classification of North American Freshwater Invertebrates, 2nd ed., pp. 331–429. Academic Press, San Diego, California).

Unlike some previous surveys, we did not find terrestrial prey items in the diet of *A. mutica*. However, our samples were dominated by females caught in nets set in relatively deep, mid-channel habitat. Plummer and Farrar (1981. J. Herptetol. 15:175–179) noted that, unlike males, females foraged primarily in deep water and fed primarily on aquatic prey.

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***GOPHERUS AGASSIZII* (Desert Tortoise). BURROW COLLAPSE.** In the deserts of the southwestern U.S., burrows are utilized by the Desert Tortoise to escape environmental extremes (reviewed by Ernst and Lovich 2009. Turtles of the United States and Canada. 2nd ed. Johns Hopkins Univ. Press, Baltimore, Maryland. 827 pp.). However, the potential for mortality through burrow collapse and entrapment is poorly documented. Nicholson and Humphreys (1981. Proceedings of the Desert Tortoise Council, pp. 163–194) suggested that collapse due to livestock trampling may cause mortality. In addition, Lovich et al. (2011. Chelon. Cons. Biol. 10[1]:124–129) documented a Desert Tortoise that used a steel culvert as a burrow surrogate. The culvert filled completely with sediment following a significant rain event, entombing the animal and ultimately resulting in its death. We note that this mortality was associated with an anthropogenic structure; because tortoises are prodigious diggers, one might hypothesize that they have the ability to dig out of collapsed natural burrows in most situations. Circumstances described here presented us with an opportunity to test this hypothesis.

On 5 January 2011, we observed four occurrences of adult telemetered Desert Tortoises (one male and three females) hibernating in separate burrows that collapsed at our study site on a utility-scale renewable energy wind farm (33.95168ºN, 116.667295ºW; WGS84) in southern Riverside Co., California, USA. In mid December 2010, winter rainstorms in southern California caused the partial collapse of several burrows distributed throughout the study site (Fig. 1). Wet soil above the mouth of the burrows slumped into the openings blocking the entrance. The lengths of the collapsed segments were not measured relative to total burrow length but each completely occluded the burrow opening. The collapsed burrows were not located near any anthropogenic structures.

One Desert Tortoise, a female (CL = 25 cm, mass = 2950 g), was found (5 January) covered with dirt outside of a collapsed burrow from which she presumably extricated herself. By 5 May 2011, this individual had been relocated five times, producing two clutches of eggs, suggesting normal behavior unaffected by the temporary entombment. The second female (CL = 25 cm, mass = 3100 g) also successfully dug out of her collapsed burrow at some point in early February, and by 6 May 2011, had been relocated three times exhibiting normal behavior. The third female tortoise (CL = 23.3 cm, mass = 2750 g) began excavating her burrow, as observed by one of the authors while peering into a small opening in the dirt, but did not complete the process until early April 2011. By 5 May 2011 she has been relocated three times. By mid-April the last tortoise (male, CL = 32.8, mass = 6275 g) was still inside his collapsed burrow, on the right side of center of the original opening (from observer's perspective), apparently unable to extricate himself. A different female tortoise (separate from those above) began excavating into the left side of this male's burrow (from the outside) but did not complete the process. During the course of the spring the soil surrounding the male dried to an adobe-like consistency. On 14 April 2011, one of the authors used a shovel to remove soil from the top and left side of the male. Even with the body partially exposed, the tortoise was so firmly embedded in the soil that he could not be lifted out without digging away more soil on the right side of the body. The tortoise was completely encased in hard loamy soil with no space for moving the head, limbs, or body, exactly as the tortoise reported by Lovich et al. (*op. cit.*). It is our opinion that this animal would have remained entombed and would have died if not excavated.



PHOTO BY J. ENNEN

FIG. 1. A burrow of *Gopherus agassizii*, approximately 30 cm wide, caved in following winter rains in December 2010. The burrow depicted was the domicile of the third female to excavate herself (April 2011).

Because of the conditions under which the natural burrows collapsed, the survival of the three female tortoises contrasts with the impending mortality of the male observed in this study. This is likely due to the fact that the females were not entombed in burrows oriented so as to allow the sun to bake the collapsed soil. When entombed under these conditions it appears that some tortoises may be unable to free themselves. Given the digging prowess of Desert Tortoises we hypothesize that this is not a frequent cause of mortality. However, temporary entrapment may result in physiological stress or late egress that translates into a delayed or complete loss of opportunity for early spring feeding and reproduction.

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***GRAPTEMYS FLAVIMACULATA* (Yellow-blotched Map Turtle). UNIQUE AERIAL BASKING BEHAVIORS.** The genus *Graptemys* (Emydidae) is the most diverse genus of North American turtles, with most species occurring within river systems that drain into the Gulf of Mexico (Lindeman, *in press*. The Map Turtle and Sawback Atlas: Ecology, Evolution, Distribution, and Conservation of the Genus *Graptemys*). One of these species, *G. flavimaculata*, is

a small species endemic to the Pascagoula River system of southeastern Mississippi, USA (Selman and Qualls 2009. Herpetol. Cons. Biol. 4:171–184). This species is most commonly observed basking aerially, with high basking densities associated with river bends and associated emergent deadwood snags that provide basking platforms (Lindeman 1999. Biol. Cons. 88:33–42). I report on two unique basking behaviors observed in *G. flavimaculata* (Leaf River, Forrest Co., Mississippi): 1) extensive shuttling on/off basking structures, and 2) head dipping into the water. To the best of my knowledge, neither of these behaviors have been reported in this species, with the first rarely reported in other species and the second reported for only one other turtle species, *Trachemys scripta scripta* (Auth 1975. Bull. Florida State Mus., Biol. Sci. 20:1–45.).

On 20 June 2007, a female *G. flavimaculata* was observed shuttling on and off the same log eight times (1343–1511 h) for a total basking time of 74 minutes out of 88 total minutes (Table 1); unfortunately no data loggers were deployed at this time to collect temperature data. On 10 September 2007, a juvenile female shuttled eight times on and off different branches and tangles (0857 and 1400 h), for a total basking time of 163 minutes out of 303 total minutes. Lastly, a male individual was noted on 8 April 2008 to shuttle 9 times between a log and floating log (0939 and 1305 h), for a total time of 147 minutes out of 206 total minutes. Observations 2 and 3 had temperature data associated with behaviors (Table 1).

Basking turtles were also observed on multiple occasions head dipping in the water before submerging. This behavior was observed twice on 17 July 2007 with two different individuals (one male, one female). Before they returned to the water, both individuals dipped only their heads under the water surface. The male did this twice at 1020 h and then returned to the water following 141 minutes of basking; the female did this once for approximately 15–20 sec before submerging after basking for 138 minutes. During the week prior to these observations, the Leaf River basin received several inches of rain causing water levels to be abnormally high and water temperatures to be unseasonably cool for July. Another observation of this behavior was made on 7 May 2008 when a male *G. flavimaculata* submerged the anterior portion of his body while his hindlimbs were clinging to the basking structure. During the 1–1.5 minutes exhibiting this behavior, he raised his head out of the water twice and then submerged. Environmental temperatures for all three observations are described in Table 1.

Extensive shuttling behavior exhibited by *G. flavimaculata* has not been previously reported. Presumably this behavior allows basking individuals to thermoregulate on a fine scale, as the temperature data indicate that optimal body temperatures appear to fall within a relatively narrow window between the water [WT] and ambient air [AT]/log temperatures [LT]. During the two observations with associated temperature data, WT and AT were initially similar, but log temperature was higher than WT. By the end of the observations, both AT and LT increased considerably and were warmer than WT. A study with a similar species, *Graptemys geographica* (Bulté and Blouin-Demers 2010. Oecologia 162:313–322), found that individuals operated within a fairly narrow range of body temperatures throughout the day and individuals could raise their body temperatures well above water temperatures, thus playing a critical role in thermoregulation. Further, the three observations occurred across most of the active season of this species (April, June, September) and with different sizes/sexes, thus indicating that this behavior is not limited to a particular season and/or sex.

To the best of my knowledge, head dipping behavior has only been described in one study with *T. s. scripta* (Auth 1975, *op. cit.*) with little discussion of the behavior. From these observations, head dipping appears to be either 1) a thermal "test" of the water temperature prior to submergence, or 2) a method to gain olfactory cues of the nearby environment (i.e., detect conspecifics, predators, prey items). However, it is unclear if "water testing" is a better explanation than olfaction due to the inability to determine underwater conditions (i.e., presence of a predator). "Water testing" could be plausible as cooler WT relative AT or LT was documented, but one might expect this to occur more often due

TABLE 1. Description of extensive shuttling and head dipping behaviors with *Graptemys flavimaculata* (Yellow-blotched Sawback). Water (WT), ambient air (AT), and sunlit log (LT) temperatures describe the environmental conditions.

Date, sex of individual (shuttling [S], head-dipping [HD])	Initial emergence time	Initial final WT (°C)	Initial final AT (°C)	Initial final LT (°C)	Basking duration for each time individual emerged (in minutes)									Final submergence time
					1	2	3	4	5	6	7	8	9	
20 June 2007, female (S)	1343	n/a	n/a	n/a	17	13	10	8	5	7	8	6		1511
10 Sept 2007, juv female (S)	0857	26.9–29.4	26.6–32.2	28–33.6	80	9	52	19	8	8	29	31		1400
8 April 2008, male (S)	0939	20.1–24.4	19.0–26.2	22.5–32.4	3	2	17	9	39	2	1	2	72	1305
17 July 2007, male (HD)	n/a	24.7	28.3	31.4										n/a
17 July 2007, female (HD)	n/a	26.5	27.1	27.7										n/a
7 May 2008, male (HD)	n/a	24.7	27	30										n/a

to WT usually being cooler than AT/LT during the active months. Similarly, nesting female turtles have been observed "nuzzling" the ground (i.e., placing their head and chin on the soil surface) while on nesting forays, possibly to 1) gain olfactory cues to detect a better nest site, or 2) sense the texture, temperature, or moisture content of nesting substrate (Moore 2003. M.Sc. thesis, Southeastern Louisiana University, Hammond, Lousiana. 72 pp.; Morjan and Valenzuela 2001. J. Herpetol. 35:668–672). If head dipping and nuzzling are to test for water/soil temperatures, this could indicate that the head region of turtles might be acutely sensitive to temperatures and/or have a higher concentration of temperature receptors relative to the rest of the body; this would need to be verified in future studies. If head dipping was for olfaction, underwater cameras or a more controlled environment with addition of stimuli (i.e., conspecifics, predators) might elucidate the reason for this behavior.

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***PODOCNEMIS EXPANSA* (Giant South American River Turtle). NESTING RANGE EXPANSION.** *Podocnemis expansa* is gregarious during nesting; even today, beaches are found in the Brazilian Amazon where hundreds of females might lay their eggs in a single night. The high consumption of this turtle's meat and eggs, as well as the ease with which it is captured, especially during nesting periods, has contributed to the decline in populations throughout its entire range and to extirpation in some places. Despite conservation and enforcement efforts, the species has been classified by the IUCN SSC FTTG as Critically Endangered (October 2010) (www.iucnredlist.org). Areas with high concentrations are well known, but regions at the limits of its range, where there are few individuals, are not yet completely known, partly due to difficult access and the extensive area where the species occurs.

In the Lower Xingu River there are known nesting sites for *P. expansa*, most notably on Embaubal beach (2.6784°S, 52.0186°W), in Senador José Porfírio (Pará state), but information is still lacking on the species' occurrence throughout this hydrographic basin. Here we report the first occurrence of *P. expansa* in the Upper Xingu River, although regional studies have indicated that this area is a potential habitat for the species (Pritchard and Trebbau 1984. The Turtles of Venezuela. Society for the Study of Amphibians and Reptiles, Caracas. 403 pp.). In 2010 we recorded and monitored the temperature of two *P. expansa* nests in the Xingu Indigenous Park (11.9346°S, 53.5298°W). These were the only nests found on the sandy beaches that are formed during the river's dry season throughout a monitored area of 13 km where *Podocnemis unifilis* frequently nests, and *Phrynops geoffroanus* do so less often. Nesting of *P. unifilis* in this area has been monitored since 2006, but it was only in 2010 that *P. expansa* nests were seen. *Podocnemis expansa* nesting occurred when the water level reached its lowest point, which is standard for this species.

We used data loggers (Ibuttons Maxim DSG1921G) to monitor the temperature throughout incubation, at 60-minute intervals. For the two nests, incubation lasted 65 and 78 days and the thermo-sensitive-period temperature (in the second third of the incubation period) was 29.4 ± 0.86°C (range = 28–31°C) and 28.7 ± 1.01°C (range = 26.5–32°C), respectively. These incubation temperatures and durations are compatible with the production of males (Lubiana and Ferreira Júnior 2009. Zoologia 26:527–533). Hatching success was 57% in one nest with 101 eggs and 52% in the other nest with 73 eggs. No predation attempts were recorded for the nests.

On 29 October 2010, a female was captured by one of the Indians while fishing with a hook and line near the same beach where the two nests were found. This female had a straight carapace length of 33.6 cm, straight carapace width of 25.5 cm, plastron length of 28.1 cm, plastron width of 19.8 cm and weight of 3.38 kg. Tissue was collected from this individual for comparative genetic analysis with individuals from other regions in the future. The Indians confirmed that they do occasionally capture *P. expansa* when fishing. During the same incubation period in 2010 our group also saw *P. expansa* tracks on at least two other beaches in the area.

Reports from indigenous people suggest that *P. expansa* was introduced in the 1960s, when the Xingu Indigenous Park was created, by its founders and some indigenous people. These animals came from populations on the Ilha do Bananal, in the Araguaia River, in São Felix do Araguaia (Mato Grosso state). The animals were released at about 20 km upstream from the site where we observed the nests. Their introduction had been to provide an additional food source, mainly because the Indians of that region very much appreciate the meat and eggs of *P. unifilis*. In the 1980s a new release of young *P. expansa* took place in rivers in the Upper Xingu. This time the individuals were from Rio das Mortes (Mato Grosso) (Vera Lúcia Ferreira Luz, Environmental Analyst, Head of RAN/ICMBio, pers. comm.). On both occasions the translocation of animals was carried out without considering the species' ecological needs and without approval from the relevant environmental entities. There are various signs that the information about the introduction of the species may be reliable: the apparent rarity of *P. expansa* in the region; the lack of knowledge among the indigenous peoples of the nests and nesting sites; few reports of adult individuals being captured; scant knowledge of the capture techniques used for the species; the fact that this species is not part of the traditional indigenous diet (while *P. unifilis*, common in the area, is an important food item); and the absence of this species in local myths and rites.

Knowledge of all nesting sites is important for the establishment of the species' range, especially in regions that have been only lightly affected by agricultural inroads and intensive fishing. The report of *P. expansa* in the Xingu Indigenous Park is important because of the large changes foreseen with the damming of the Xingu River to generate energy. Hydroelectric plants are planned upstream and downstream of this recorded site, and it is vital that the feeding and nesting areas of the species are known, to study the possible effects on their ecology caused by the change in the river's hydric regime. The genetic diversity of these individuals should be compared with that of turtles from other areas (principally in populations from the Lower Xingu and Araguaia River Basin). This will lead to a better understanding of the evolutionary dynamic of the species in the reported site and of its diversity distribution within this area at the limit of its range.

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CROCODYLIA — CROCODILIANS

***ALLIGATOR MISSISSIPPIENSIS* (American Alligator). JUVENILE SITE FIDELITY.** *Alligator mississippiensis* is a highly adaptable, aquatic species, occupying a wide range of habitats in the southeastern United States (Elsey and Woodward 2010. *In* Manolis and Stevenson [eds.], Crocodiles. Status Survey and Conservation Action Plan. 3rd ed., pp. 1–4. Crocodile Specialist Group, Darwin). One prior telemetry study conducted on Rockefeller Wildlife Refuge in southwestern Louisiana found minimum home ranges of 12.0–616.5 ha (average 177.5 ha) for 15 immature female alligators, and minimum home ranges of 24.5–604.5 ha (average 228.6 ha) for 11 immature male alligators (McNease and Joanen 1974. Proc. SE Assoc. Game Fish Comm. Conf. 28:482–500). A recent large tag and recapture study found some juvenile alligators can disperse long distances (one moved >90 km), although many marked alligators stayed within the shallow marsh impoundments within which they were originally tagged (Lance et al. 2011. Southeast. Nat. [in press]).

Four recent major hurricanes impacted coastal marshes in Louisiana (Katrina and Rita in 2005, and Gustav and Ike in 2008, with massive storm surges in some cases pushing alligators previously tagged and marked for research studies northward (Elsey et al. 2008. Southeast. Nat. 7:737–743). Similar findings were noted after Hurricane Audrey with alligators being swept northward 4.8–16.1 km; it was also noted that alligator movement increases when marshes are flooded due to excessive rainfall or storm tides, with immature alligators responding more to flooding than adults (Chabreck 1965. Proc. SE Assoc. Game Fish Comm. 19:102–110). In one extreme case, a juvenile alligator from a local alligator farm was tagged and released to the wild in southwestern Louisiana six weeks before Hurricane Ike and was apparently swept away in the storm surge and recovered in extreme south Texas, some 489 km from its release site (Elsey and Aldrich 2009. Southeast. Nat. 8:746–749). In contrast, we herein report on four juvenile alligators from a group of eleven that were in a holding pen at Rockefeller Wildlife Refuge at the time of Hurricane Ike. All were presumably displaced by the storm surge (ca. 244 cm), yet have been recovered in close proximity to the original pen site, possibly demonstrating strong site fidelity.

As part of the alligator management program in Louisiana, a large scale tag and release program has been underway to monitor the survival of alligators released to the wild from farms. More recently we have considered the use of telemetry to evaluate survival and movement in the initial months after release to the wild. A pilot study was initiated in 2007 to evaluate transmitter attachment, retention, and detection capabilities under near field conditions (Wiebe 2008. Unpubl. report, Louisiana Department of Wildlife and Fisheries. 21 pp.). For these purposes, a 0.28 ha outdoor holding pen was constructed in early 2008 near the Rockefeller Wildlife Refuge headquarters in Grand Chenier, Louisiana to hold native wild and farm-raised juvenile alligators. The pen was initially stocked with 17 farm-raised alligators (obtained on 12 March 2008 from a commercial alligator farm) and 10 native wild alligators. The telemetry units were attached to the nuchal scutes (Wiebe, *op. cit.*) and the alligators were released to the outside pen over the next two days. The alligators appeared to easily adapt to the new environment, but by 29 March we observed one of the alligators basking on a feeding platform was missing the telemetry unit; the nuchal scutes were visibly torn. This was unexpected as similar attachment methods have been used successfully in other crocodilians (Brien et al. 2010. Herpetol. Rev. 41:305–308; Kay 2004. Herpetol. Rev. 35:354–357). However, those were larger animals with far more prominent nuchal scutes, and the relatively flat scutes in juvenile alligators likely being a contributing factor in unit loss. Despite the alligators readily accepting feed and exhibiting no evidence of intraspecific conflicts, loss of telemetry units continued to be a problem.

Over the next few months the pen was pumped dry and attempts were made to recover the animals and reattach telemetry units more securely (Wiebe 2008, *op. cit.*). On 20 May we replaced eleven of the alligators (previously farm-raised, mean total length 126 cm) back in the outside pen for further monitoring, each with one telemetry unit held in place by cables passing under the nuchal scutes and one attached to the tail.

Soon thereafter, Hurricane Ike impacted the region when it struck near Galveston Island, Texas on 13 September 2008, as previously detailed (Elsey and Aldrich, *op. cit.*). The storm surge at Rockefeller Refuge was estimated to be 244 cm and likely overtopped the fencing of the outside alligator enclosure, allowing alligators to escape or unwillingly be carried northward with the storm surge. We made a cursory inspection of the flooded pen area (accessible only by airboat) on 18 September, and could readily see loss of integrity to some areas of the fence, presumably allowing alligator escape. Refuge staff members were displaced from this site for several weeks due to localized flooding, lack of electricity, and general loss of infrastructure; thus we were unable to immediately monitor the fate of the eleven alligators that were in the pen at the time of Hurricane Ike's landfall.

On 15 October 2008, while doing landscape work in a pasture, an employee incidentally observed one of the alligators resting on a bank near a parked excavator. The alligator appeared well and was some 125 m from the enclosure (Fig. 1A). On a routine search for any remaining alligators that might still be within reception range, a second escaped/displaced alligator was recovered on 20 November 2008, using signals from the functioning telemetry unit(s) for guidance. This alligator was observed on floating vegetation, was then captured in good condition, and was determined to be ca. 135 m from the holding pen (Fig. 1B). With time, it became apparent many units were not functioning, possibly due to poor transmission in brackish water, loss of battery life, or damage due to saltwater corrosion after the

hurricane. Six months later, while catching wild alligators on 20 May 2009 for another research project, another of the 11 telemetered alligators was caught; it was recovered some 425 m (Fig. 1,C) from the outside holding pen site.

On 6 May 2011, an alligator was observed at ca. 1725 h basking near the refuge headquarters by one of us (RME) and the two missing tail notches were evident (suggesting it was an alligator released from a farm, Elsey et al. 2001. *In* Seebacher and Franklin [eds.], Crocodilian Biology and Evolution, pp. 426–441. Surrey Beatty and Sons, Chipping Norton, NSW). This prompted us to take some photographs for educational presentations and to possibly identify the year the alligator was released, due to the year-specific combination of tail notches used. One of us (WS) was able to identify the fifth and seventh tail scutes as having been removed (this "EG" tail notch identified it as a 2008 year release alligator). Upon closer observation, WS noted a telemetry unit was attached to the alligator's tail (Fig. 2). The site was some 475 m from the original holding pen (Fig. 1D), from where the alligator presumably escaped during Hurricane Ike, some 964 days earlier.

The following evening at ca. 1700 h, a similar-sized telemetered juvenile alligator with tail notches was again observed basking in nearly the same location. It was captured and appeared in excellent condition and both web tags in the feet were still present. The alligator was 167 cm in total length, compared to 127 cm when it was first measured on 12 March 2008. The alligator was released at the same site, and presumably the same alligator has been observed several times basking near the release site since (tail notches and telemetry unit on tail clearly seen).

Alligators have been shown to have a strong homing instinct (Chabreck, *op. cit.*; Rodda 1984. Behav. Ecol. Sociobiol. 14:241–246) as have other crocodilians (Read et al. 2007. PLoS ONE 9:1–5; Walsh and Whitehead 1993. Wildl. Res. 20:127–135; Webb et al. 1983. Aust. Wildl. Res. 10:403–406). It is unclear if the four juvenile alligators herein described were swept northward by the massive storm surge of Hurricane Ike and then returned, or if they were able to seek refuge in dens or burrows and avoid displacement. After the even more catastrophic Hurricane Rita in 2005, we documented (Elsey et al., *op. cit.*) a similar finding in 2007 of adult female alligators at nest sites within 20 m and 170 m of their prior nests sites (from seven years and three years earlier, respectively). Again it is unknown if this demonstrated a strong homing instinct if the alligators had been displaced, or if they remained on site despite the flooded conditions and high salinity environment post-hurricane.

The juvenile alligators in this study may have remained near the original pen site or returned to this area due to proximity to aquaculture fish ponds near the refuge headquarters, which provide permanent fresh water and seasonally available prey when ponds are stocked with fish fry or fingerlings. It is somewhat surprising however that the alligators remained in an area of relative high activity (despite being rural, all were located in very close proximity to the refuge headquarters, and were exposed to frequent vehicular traffic). Of note, staff had not (to our knowledge) observed marked alligators at the site where the most recently encountered alligator was seen, despite being immediately adjacent to a field work shop, perhaps suggesting the alligator recently returned to this site.

It also may be that alligators raised their entire life in a commercial farm setting are less likely to demonstrate a homing instinct, as reported in wild alligators after translocation (Chabreck, *op. cit.*). The alligators used in this study were obtained from a farm some 60 km west of the study pen site but to our knowledge made no attempts to return to that location. A short-term telemetry study likewise showed 75 of 78 farm-raised alligators and 43 of 44 native wild juvenile alligators dispersed less than 5 km from the release site or site of origin (Addison 1993. MS thesis, Louisiana State University, Baton Rouge, Louisiana. 79 pp.).



FIG. 1. Aerial map showing locations of four juvenile alligators relative to the original holding pen. Dates of recovery as noted in the text.



FIG. 2. The fourth alligator recovered, here seen basking on 6 May 2011. The telemetry unit is clearly visible on the tail.

It is of interest why some alligators seem to move extensively despite abundant, locally available quality habitat, while others remain within a relatively small area with little tendency to disperse. Individual behavior patterns of crocodilians may be an area for future studies.

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SQUAMATA — LIZARDS

***AMEIVA AMEIVA* (Giant Ameiva). PREDATION.** *Ameiva ameiva*, a diurnal teiid lizard widely distributed across Central and South America, ranges from Panamá to Argentina (Vanzolini et al. 1980. Répteis das Caatingas, Acad. Bras. de Cienc., Rio de Janeiro; Vitt and Colli 1994. Can. J. Zool. 72:1986–2008; Sartorius et al. 1999. Biol. Cons. 90:91–101). Hawks, owls and snakes are well-known predators of *A. ameiva* (Santos and Germano 1996. Herpetol. Rev. 27:143; Tozetti et al. 2005. Herpetol. Rev. 36:443–444; Granzinolli et al. 2007. Herpetol. Rev. 38:449), but few published reports of predation by mammals exist. Rocha and Vrcibradic (1998. Cienc. e Cult. 50:364–368) reported predation by the Four-eyed Opossum (*Philander frenata*); no reports involve armadillos. Hence, we add to the predator set reported for *A. ameiva* with an observation of predation by the Nine-banded Armadillo (*Dasypus novemcinctus*).

At 2205 h on 23 October 2008, we observed a *D. novemcinctus* prey on an *A. ameiva* while traveling a dirt road near the city of Miranda, Mato Grosso do Sul, central-west Brazil (20.07833°S, 56.32444°W, datum: WGS84; elev. 177 m). The event occurred in vegetation best described as upland Pantanal savanna. As soon as we stopped the car, a *D. novemcinctus* that had just been observed crossing the road began to forage in leaf litter beneath shrubs about 5 m off the road. Within seconds, it attacked an adult male *A. ameiva* (101 mm SVL, 268 mm tail). The attack lasted less than a minute, with the armadillo killing its prey with its mouth and foreclaws. When we approached, the *D. novemcinctus* abandoned its prey and fled. Bite wounds had been inflicted to the left shoulder and the right thigh of the *A. ameiva*.

Armadillos are opportunistic, preying principally on invertebrates, but occasionally consume small vertebrates like amphibians and reptiles and other items such as plant material (Galbreath 1982. *In* J. A. Chapman and G. A. Feldhamer [eds.], Wild Mammals of North America, pp. 71–79. Johns Hopkins Univ. Press, Baltimore, Maryland). This is the first documented predation of *A. ameiva* by an armadillo.



FIG. 1. *Ameiva ameiva* being predated by nocturnally foraging Nine-banded Armadillo (*Dasypus novemcinctus*).

The *Ameiva ameiva* specimen was deposited at the Coleção Herpetológica do Museu de Zoologia da Universidade Federal da Bahia (MZUFBA–LAG1329). Jeff King and Ryan Watson provided helpful suggestions.

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***ANOLIS* SPECIES. FRUGIVORY.** Frugivory has been reported for more than 200 species of lizards (Valido and Olesen 2007. In A. J. Dennis, E. W. Schupp, R. A. Green, and D. A. Westcott [eds.], Seed Dispersal: Theory and its Application in a Changing World. CAB International), including 17 species of the genus Anolis (Herrel et al. 2004. Oecologia 140:160–168). In Puerto Rico, the consumption of fruits has been reported for two intermediate sized Anolis species, A. evermanni (Lister 1981. Ecology 62:1548–1560; Reagan 1996. In Reagan and Waide [eds.], The Food Web of a Tropical Rain Forest, pp. 321–345. Univ. of Chicago Press, Illinois) and A. monensis (Schwartz and Henderson 1991. Amphibians and Reptiles of the West Indies. University of Florida Press, Gainesville, Florida), and for the giant species A. cuvieri (Losos 1990. Carib. J. Sci. 26:65–66; Perez-Rivera 1985. Carib. J. Sci. 21:101–103). Aside from reports of seeds from stomach content analyses or fecal pellets of these three species, little is known about frugivory in Anolis from Puerto Rico. Here, we report incidental observations of frugivory for another three Anolis species of small to intermediate size.

On 5 May 1998, between 0900 and 0930 h, we observed an individual of *A. stratulus* picking and carrying away a single sweet and sticky fruit of the Wild Balsam Apple (*Momordica charantia*) in a shaded coffee plantation at the north-central part of the island. The fruits of the Wild Balsam Apple are dark yellow to orange when ripe and split open to reveal several seeds 12–16 mm long, covered with a red flesh (Acevedo-Rodríguez and Woodbury 1985. The Vines of Puerto Rico Vol. 1: 202). *Anolis stratulus* also has been reported consuming intra- and extra-floral nectar (Perry and Lazell 1997. Herpetol. Rev. 28:150–151; Ríos-López 2004. Herpetol. Rev. 35:386).

During the morning of 16 April 1999, we observed an individual *Anolis gundlachi* eating fruits of Red Palicourea (*Palicourea crocea*) at the Río Abajo State Forest in the northern kasrt region of Puerto Rico. These fruits are ovoid to globose, 4–6 mm in diameter and dark red, purple, or black (Liogier 1997. *In* Descriptive Flora of Puerto Rico and Adjacent Islands. Vol. 5. Editorial de la Universidad de Puerto Rico, San Juan, PR. 436 pp.). This same day we observed a male *A. krugi* consuming the white fruits of a stinging nettle (*Urera baccifera*). These fruits are white or pinkish, spongy, and watery (Little et al. 1974. *In* Trees of Puerto Rico and the Virgin Islands. Vol. 2. Agriculture Handbook 449. U.S. Department of Agriculture, Washington, DC. 1024 pp.). Both lizards picked the fruits and ingested them while perching in the respective plants. The report for *A. krugi* represents the first for a grass-bush anole eating fruits (Losos 2009. Lizards in an Evolutionary Tree: Ecology and Adaptive Radiation of Anoles. University of California Press, Berkeley. 507 pp.).

Body sizes, as well as ecological factors such as food limitation, low predation pressures, and high lizard densities, have been proposed to explain frugivory by lizards within insular ecosystems (see Valido and Olese, *op. cit.*; Herrel et al., *op. cit.*; Olesen and Valido 2003. Trends Rev. Ecol. Evol. 18:177–181). Our observations suggest that frugivory in small-sized lizards (size range 40–63 mm) might be of ecological importance in nature. Detailed studies are needed in order to better understand the factors that determine frugivory in *Anolis* lizards, as well as their potential role as seed dispersers. Given that *Anolis* lizards occur at high densities in Caribbean Islands, omnivory and seed dispersal by these lizards must be important in energy and mass flow as well as in the succession and regeneration of tropical forests.

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***ATLANTOLACERTA ANDREANSKYI* (Atlas Dwarf Lizard). ABNORMAL SCALATION.** In snakes and lizards, femoral glands produce secretions used for intraspecific communication. These secretions may reveal chemical information including self-recognition, conspecific discrimination, marking of territories, male dominance status, and reproductive condition (Houck 2009. Annu. Rev. Physiol. 71:161–76; Martin et al. 2007. Ecology 21:568–576). Although there have been several reports of supernumerary femoral pores in lacertid lizards (Kaliontzopoulou and Carretero 2006. Herpetol. Rev. 37:470–471), this is the first observation of total absence of femoral pores.

During an extensive survey, we studied the morphology of 142 individuals (males and females) from seven localities across the distribution of *Atlantolacerta andreanskyi*, a high-altitude endemic lacertid from the Atlas Mountains, Morocco. In this species adult males typically exhibit enlarged femoral pores when compared with other lacertids (e.g., *Podarcis*) and the two rows of femoral pores come into contact at the base of the ventral scales, while in females, as in most lacertids, they are significantly smaller (Arnold and Ovenden 2002. A Field Guide to the Reptiles and Amphibians of Britain and Europe. Ed. Collin, 288 pp.) and the two rows are not in contact (Fig. 1). Interestingly, of 70 female individuals studied, 16% had incomplete rows and 56% did not possess any femoral pores (Fig. 2), while all males surveyed exhibited a normal development of the femoral pores. This observation was common and present in all the populations. Busack (1987. Amphibia-Reptilia 8:231–236) estimated mean adult body size of this species at 41.9 mm SVL with females with oviductal eggs ranging 44–53 mm SVL (N = 8), indicating that all individuals analyzed in our study were adults. Interestingly, the median size of the females analyzed with no femoral pores (47.8 mm) was slightly larger than the females with femoral pores (44.8 mm) (Busack, *op. cit.*).

Kaliontzopoulou and Carretero (*op. cit.*) reported accessory femoral pores in one specimen of the lacertid, *Podarcis bocagei*. The authors suggested environmental stress as a cause of this abnormality because the animal was found in a cornfield where pesticides were commonly used. Because *A. andreanskyi* occurs only at altitudes above 2000 m, in widely isolated populations with limited distributions, environmental stress seems unlikely to be the cause. Instead, factors such as isolation and inbreeding might be involved, as suggested by Walker (1980. J. Herpetol 14:417–418). In Walker's (*op. cit.*) observations, the abnormalities were found in both sexes, while we found it present only in females. This fact might be due to selective pressures acting on



FIG. 1. Female specimens of *Atlantolacerta andreanskyi* from Oukaimeden, Morocco (left and right). White arrows show the femoral pores.



FIG. 2. Female specimens of *Atlantolacerta andreanskyi* from Tamelt-elt (on the left) and Tizin-Tichka (on the right), High Atlas, Morocco. The black arrows show the place were the row of femoral pores should be.

males and related to sexual selection. Femoral pore secretions produced are directly related to the levels of circulating androgens (Houck, *op. cit.*) and they have been proposed to be the basis of female mate choice, being important in individual male recognition and dominance status, and related to a higher reproductive success (Houck, *op. cit.*).

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***CERCOSAURA ARGULUS* (Elegant Eyed Lizard). ARBOREAL BEHAVIOR.** *Cercosaura argulus* is a relatively uncommon inhabitant of the Amazonian forest (Avila-Pires 1995. Zoologische Verhandelingen Leiden 299:1–706). It is most commonly encountered in leaf litter (Vitt et al. 2003. Can. J. Zool. 81:302–312), but was documented up to 1.5 m on low vegetation by Vitt et al. (*op. cit.*) and up to 2.0 m by Duellman (2005. Cusco Amazonico. Comstock Publishing Associates, Ithaca, New York. 433 pp.).

On 20 March 2011, an adult specimen of *Cercosaura argulus* was captured at approximately 2145 h on the ground during a routine quadrat search at Sachavacayoc Centre, Tambopata

Province, Madre de Dios, Peru (12.86250°S, 69.36566°W; 94% relative humidity; 23.4°C ambient temperature). The animal was likely disturbed while sleeping and was caught while crawling through leaf litter. At approximately 2210 h the lizard was released near the base of a tree that measured ca. 43 cm DBH. The lizard walked briefly around the base and then started to climb directly up the trunk of the tree. Unlike most rainforest trees, this tree did not have buttresses, but had a straight trunk that was covered by foliose lichens, presumably making the surface texture easier to climb. We watched and video recorded the lizard for approximately 30 min., during which time the lizard slowly, steadily climbed straight up the trunk to over 10 m in height, stopping occasionally and then continuing to proceed. After the 10 m mark we lost sight of the lizard as it continued its upward climb. No previous records exist of a *C. argulus* climbing to such a height.

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***CROTAPHYTUS COLLARIS* (Eastern Collared Lizard). COMMUNAL BRUMATION.** *Crotaphytus collaris* can be found in appropriate habitat throughout central and western United States and northcentral Mexico. Southwestern Colorado and southeastern Utah represent the northwestern limits of the range of *C. collaris*. At 1545 h on 16 April 2011 with an air temperature of 16°C, three adult male *C. collaris* were observed in aggregation emerging from brumation from a hibernaculum opening on a south-facing rocky slope in extreme western La Plata Co., Colorado, USA, ca. 5.8 km W of Red Mesa, Colorado (1995 m elev.) (Fig. 1). The habitat at this site is pinyon-juniper woodland with expanses of agricultural land. Because weather prior to this observation had been unseasonably cold, it is very likely that 16 April was the first date of emergence for these lizards. The lizards spent considerable time basking at the burrow site, occasionally moving back and forth from the entrance. Occasional territorial posturing was observed, but for the most part they appeared uninterested in intraspecific interactions. The lizards were observed during a 1 h period.

The same site was revisited at 1150 h the next day (17 April) with an air temperature of 20°C. Three adult male *C. collaris* were seen again at the entrance and in close proximity to the same hibernaculum opening. It is presumed that, based on color pattern differences, these three males were the same as those observed the day prior. Again there was little activity over a 2 h observation period, although occasionally a single lizard would enter the burrow opening and re-emerge after several minutes. To our knowledge, observations of communal brumation for this lizard are unreported.



FIG. 1. Three adult male *Crotaphytus collaris* at the entrance of a communal hibernaclum during spring emergence at a rocky outcrop in western La Plata Co., Colorado, USA.

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***CTENOSAURA OEDIRHINA* (Roatan's Spiny-tailed Iguana). LIMB REGENERATION.** Limb regeneration has been observed in *Lacerta, Liolaemus,* and *Sceloporus* (Bellairs and Bryant 1985. *In* C. Gans and F. Billett [eds.], Biology of the Reptilia, Volume 15, Development B, pp. 387–392. John Wiley & Sons, New York). Here I report on the first case of this observation within Iguaninae.

On 20 October 2010, an individual *Ctenosaura oedirhina* was captured at Gumbalimba Park and Reserve on the western end of Roatan Island, Islas de la Bahia, Honduras (16.282883°N, 86.595083°W). The right hind limb of the individual appeared to be regenerated and looked much like that of a regenerated tail (Fig. 1). This individual was of normal size and did not seem to be disadvantaged by this deformity. Photos have been deposited under USNM Herp Image 2731, 2732.

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PHOTO BY S. A. PASACHNIK

FIG. 1. *Ctenosaura oedirhina* with a regenerated hind limb, observed at Gumbalimba Park and Reserve, Roatan, Honduras.

***CTENOSAURA OEDIRHINA* (Roatan Spinytail Iguana). ENDOPARASITES.** *Ctenosaura oedirhina* is known only from Isla de Roatán, Isla de Santa Elena, Isla Barbaretta, and various small islets around Roatán, Honduras (Pasachnik et al. 2010. *In*: IUCN Red List of Threatened Species. Version 2010.4. www.iucnredlist.org; accessed 18 April 2011). There are, to our knowledge, no reports of endoparasites from this species. The purpose of this note is to establish the initial helminth list for *C. oedirhina*.

One adult male (roadkill) *C. oedirhina* was collected on 25 March 2011, near Oakridge on Isla de Roatán, (16.408617°N, 86.364883°W, datum WGS84; elev. 73 m), Departamento de Islas de la Bahía, Honduras. The individual weighed 540 g, had a SVL of 240 mm and a tail-length of 346 mm, although visibly stubby. The intestines were found to contain numerous nematodes,

which were preserved in 95% ethanol. A subsample was cleared in glycerol, mounted on a glass slide, coverslipped, examined under a compound microscope and identified as *Ozolaimus ctenosauri*. Voucher nematodes were deposited in the United States National Parasite Collection, Beltsville, Maryland, USA as USNPC (104699).

Ozolaimus ctenosauri was originally described from the caecum of *Ctenosaura acanthura* from Oaxaca, Mexico by Caballero (1938. Ann. Trop. Med. Parasitol. 32:225–229). It has been reported from other Mexican reptiles: *Ctenosaura pectinata* by Prado-Vera (1971. Estudio taxonómico de algunos nemátodos parásitos de reptiles de México. Tesis, Univ. Nac. Auton. México, 101 pp.), Moravec et al. (1996. J. Parasitol. 82:1011–1016), and Mayen-Pena and Salgado-Maldonado (1998. J. Helminthol. Soc. Washington 65:108–110); an unidentified iguana by Caballero and Cerecero (1943. An. Inst. Biol. Univ. Nac. Auton. México 14:527–539); and a rattlesnake, *Crotalus polystictus*, by Caballero (1939. An. Inst. Biol. Univ. Nac. Auton. México 10:73–82). It has also been reported in *Ctenosaura similis* from Costa Rica by Bravo-Hollis and Brenes (1960. An. Institut. Biol. Univ. Nac. Auton. México 30:209). *Ctenosaura oedirhina* represents a new host record for *Ozolaimus ctenosauri*; Isla de Roatán, Honduras is a new locality record.

Parasites were collected under permit DICTAMEN DVS-ICF-054-20120, granted by the Instituto Nacional de Conservacion y Desarrollo Forestral, Areas Protegidas y Vida Silvestre.

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***CTENOSAURA SIMILIS* (Black Spiny-tailed Iguana). DIET.** Iguanas in the genus *Ctenosaura* have been documented to eat a wide variety of items, including, but not limited to: arthropods (some potentially noxious), birds, bats, rodents, their own skin, juvenile lizards, fecal material, ctenosaur eggs, parts of conspecifics, and a variety of plants including at least one noxious species, *Croton suberosus* (Alvarez del Toro 1960. Los Reptiles de Chiapas. Inst. Zool. Estado Tuxtla Gutierrez, Chiapas; Blázquez and Rodriguez-Estrella 2007. Biotropica 39:496–501; Campbell 1998. Amphibians and Reptiles of Northern Guatemala, the Yucatán, and Belize. Univ. Oklahoma Press, Norman, Oklahoma; Coti and Ariano 2008. Iguana 15:142–149; Durtsche 2004. Physiol. Biochem. Zool. 77:459–470; Fitch et al. 1971. Southwest. Nat. 15:397; Fitch and Henderson 1978. Univ. Kansas Sci. Bull. 51:483–500; Henderson 1973. J. Herpetol. 7:27; Mora 1991. Bull. Chicago Herpetol. Soc. 26:197–198; Van Devender 1982. *In* Burghardt and Rand [eds.], Iguanas of the World: Their Behavior, Ecology, and Conservation, pp. 163–183. Noyes Publications, Park Ridge, New Jersey). We report on *Ctenosaura similis* consuming a post-mortem *Rhinella marina*.

Herbivory is the most common dietary strategy within the iguanine lizard clade (Iverson 1982. *In* Burghardt and Rand [eds.], *op. cit.*, pp. 60–76; Sites et al. 1996. Mol. Biol. Evol. 13:1087–1105; Torres-Carvajal 2007. J. Herpetol. 41:528–531). Non-herbivorous diets are rarely described within this clade, although limited carnivory in *Cyclura* (Auffenburg 1982. *In* Burghardt and Rand [eds.], *op. cit.*, pp. 84–116; Hayes et al. 2004. *In* Alberts et al. [eds], Iguanas, Biology and Conservation, pp. 232–257. Univ. California Press, Berkeley, California; Iverson 1979. Bull. Florida St. Mus. 24:175–358), *Ctenosaura* (Blázquez and Rodriguez-Estrella, *op. cit.*; Grant 1967. Copeia 1967:223–224; SAP, pers. obs.), *Dipsosaurus* (Norris 1953. Ecology 34:265–287), and *Iguana* (Loftin and Tyson 1965. Copeia 1965:515), and limited insectivory in *Ctenosaura* (Blázquez and Rodriguez-Estrella, *op. cit.*; Montanucci 1968. Herpetologica 24:305–315), *Cyclura* (Goodman 2007. Carib. J. Sci. 43:73–86), *Dipsosaurus* (Minnich and Shoemaker 1970. Am. Midl. Nat. 84:496–509; Norris, *op. cit.*) and *Iguana* (Campbell, *op. cit.*; Hirth 1963. Ecology 44:613–615) have been described. A less common dietary behavior in iguanine lizards is scavenging of vertebrate carcasses, with observations only from *Ctenosaura pectinata* (Grant, *op. cit.*) and *Iguana iguana* (Loftin and Tyson, *op. cit.*). In addition, *Ctenosaura similis*, *C. pectinata,* and *C. palearis* exhibit generalized insectivory as juveniles, making the ctenosaurs the only iguanine genus to demonstrate a predominant diet other than herbivory in any life stage (Coti and Ariano, *op. cit.*; Durtsche 2000. Oecologia 124:185–195, and 2004, *op. cit.*; Fitch and Hackforth-Jones 1983. *In* Janzen [ed.], Costa Rican Natural History, pp. 394–396. Univ. Chicago Press, Chicago, Illinois; Montanucci, *op. cit.*; Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna Between Two Continents, Between Two Seas. Univ. Chicago Press, Chicago, Illinois).

Ctenosaura similis exhibits a further deviation from a fully herbivorous diet with an ontogenetic shift toward omnivory in adults (Savage, *op. cit.*; Torres-Carvajal, *op. cit.*), foraging on such things as vegetation, arthropods, birds, bats, ctenosaur eggs, conspecifics and other lizards (Campbell, *op. cit.*; Fitch et al., *op. cit.*; Fitch and Hackforth-Jones, *op. cit.*; Fitch and Henderson, *op. cit.*; Henderson *op. cit.*; Hotton 1955. Amer. Midl. Nat. 53:88–114; Mora, *op. cit.*; Traveset 1990. Amer. Midl. Nat. 123:402–404; Van Devender, *op. cit.*). Torres-Carvajal (*op. cit.*) has provided dental evidence correlated with a shift towards carnivory in adult *C. similis*, though it is not clear how large of a role carnivory plays, as field documentation of this sort is lacking.

One adult *C. similis* was observed feeding on and dragging away a dead adult Marine Toad (*Rhinella marina*) on 19 June 2008 in Esparza, Puntarenas, Costa Rica (9.989195°N, 84.711373°W). The iguana was first observed feeding on the toad at the edge of the road at approx. 1100 h. The iguana was thrashing its head violently, presumably to break the toad into pieces for consumption. When disturbed the iguana dropped the toad and fled from the road, but returned shortly and dragged the toad off of the



FIG. 1. Adult *Ctenosaura similis* consuming a post mortem Marine Toad, *Rhinella marina*.

road, and continued to dismember it. The iguana was clearly an adult based upon its size (Fig. 1). The entire observation lasted for approx. 20 min., and additional digital footage is available from the authors.

Though this is a single observation, it supports an ontogenetic shift to an omnivorous diet in *C. similis*, thus suggesting that carnivory in ctenosaurs may be more prevalent than previously thought. In addition this demonstrates that *C. similis* is one of few opportunistic scavengers of vertebrate carcasses in the iguanine lizard clade.

We thank numerous local volunteers who aided us in identifying areas where iguanas could be found, and John Iverson and Arthur Echternacht for their insight. Funding for this project was provided by the University of Tennessee, Knoxville. A permit for research in Costa Rica was obtained with the help of Francisco Campos Rivera and Organización para Estudios Tropicales and was provided by Ministerio del Ambiente y Energia Sistema Nacional de Áreas de Conservación. A photograph was deposited at the Milwaukee Public Museum as MPM Herp Photo P758. A digital recording of this observation is available from the authors.

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***ENYALIUS PERDITUS*. DEATH-FEIGNING.** *Enyalius perditus* is an Atlantic forest species of Brazil. It inhabits humid areas with lush vegetation and closed canopies (Jackson 1978. Arq. Zool. 30:1–79). This species is a semiarboreal forest-dweller that feeds exclusively on small invertebrates, and appears to be sensitive to forest structure and also sensitive to fragmentation, logging, and forest degradation (Dixo and Metzger 2009. Oryx 43:435–442). However, little is known about the natural history and ecology of *E. perditus*.

Death-feigning, also called tonic immobility or thanatosis, is an innate anti-predator behavior. In squamates, death-feigning is a widespread defensive tactic that is described from several different families, such as Anelytropsidae (Torres-Cervantes et al. 2004. Herpetol. Rev. 35:384), Leptotyphlopidae, Colubridae, Elapidae (Gehlbach 1970. Herpetologica 26:24–34), Crotaphytidae (Gluesing 1983. Copeia 1983:835–837), Scincidae (Langkilde et al. 2003. Herpetol. J. 13:141–148) and Tropiduridae (Bertoluci et al. 2006. Herpetol. Rev. 37:472–473; Machado et al. 2007. S. Am. J. Herpetol. 2:136–140). Herein we present data on death-feigning in *E. perditus* with a brief description of this behavior. The primary role of death feigning appears to be enhancing crypsis by ceasing movement.



FIG. 1. Death-feigning posture in a female *Enyalius perditus*.

We collected two *E. perditus* specimens during the inspection of drift fences with pitfall and funnel traps. On 12 October 2008, in the Reserva Biológica Municipal Santa Cândida (21.754917°S, 43.396833°W, WGS 84, 783 m elev.), in the municipality of Juiz de Fora, Minas Gerais State, Brazil, we collected a female (SVL 76.7 mm) and on 6 October 2008, in the Reserva Biológica Municipal Poço D'Anta (21.754278°S, 43.310889°W, WGS 84, 848 m elev.), we collected a male of *E. perditus* (SVL 71.4 mm) in the same municipality. Both lizards exhibited death-feigning behavior when they were removed from the traps and when manipulated in the laboratory to perform marking procedures and/or morphometric analysis. The lizards became immobile, lying belly-up, crossing the limbs over the stomach and closing the eyelids, although in some cases the eyes remained opened. Lizards remained motionless during manipulation with the legs and arms usually capable of being moved by the observer to any position with the lizard maintaining that position. The death-feigning posture persisted even after the animal was gently placed upside down. Lizards recovered after 15–30 min., subsequently fleeing.

Although we collected a total of 22 lizards, death-feigning behavior was observed only in these two specimens. However, we have previously observed death-feigning in many other individuals of *E. perditus* during the course of species inventories for study areas. Most specimens exhibited thanatosis when captured (Fig. 1). In all cases, the animals displayed a similar pattern of behavior and posture. We believe these observations to be the first records of death-feigning in *E. perditus*.

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***GALLOTIA CAESARIS* (Caesar's Lizard). NECTARIVORY.** Plant-lizard mutualistic interactions (pollination and seed dispersal) have been considered a phenomenon more frequently detected on islands due to the high densities commonly seen in insular lizards (Olesen and Valido 2003. Trends Ecol. Evol. 18:177–181). Lizards experience stronger intraspecific competition, favored by a lower predation risk and arthropod food supply compared to mainland taxa, expanding their diet to incorporate novel food resources (e.g., fruit pulp and floral rewards; Olesen and Valido, *op. cit.*). This appears to be the case observed in endemic Canarian lizards, *Gallotia* spp., which include a signicant amount of plant matter in their diets, whereas their closest continental relatives are mainly insectivorous (Carretero et al. 2006. Rev. Esp. Herpetol. 20:105–117; Martín et al. 2005. Zoology 108:121–130; Valido and Nogales 2003. Amphibia-Reptilia 24:331–344; Van Damme 1999. J. Herpetol. 33:663–674). The role of *Gallotia* spp. as seed dispersers of Canarian flora has been well established, with fleshy fruit as the most significant component of their

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FIG. 1. *Gallotia caesaris* visiting *Echium hierrense* (Boraginaceae) inflorescences from El Hierro, Canary Islands. The tail seems to play an important role as a prehensile appendix as the lizard climbs to higher flowers.

diet year round (e.g., *G. galloti*; Valido and Nogales 1994. Oikos 70:403–411). However, their role as pollinators has received less attention despite nectar-feeding field observations on native and exotic flora (Font and Ferrer 1995. Herpetol. Rev. 26:35–36; Valido et al. 2002. Acta Oecol. 23:413–419; Valido et al. 2004. J. Biogeogr. 31:1945–1953). Most of these observations refer to the Canary Lizard (*G. galloti*) from Tenerife, with the unique exception of *G. caesaris* from El Hierro observed visiting *Euphorbia lamarckii* flowers (Speer 1994. Salamandra 30:48–54). Here, we report a new account of nectarivory and presumptive pollinating behavior by *G. c. caesaris* on flowers of *Echium hierrense* (Boraginaceae); both are endemic taxa from El Hierro (27.733333°N, 18.05°W), the smallest and the westernmost island of the Canarian archipelago. Observations were made in the south of the island, at a xeric scrubland area known as El Lajial (255 m elev.).

From 20 to 22 April 2007, we performed daily 2-h monitoring (approximately 1000–1200 h), during which we observed *G. caesaris* visiting flowers of *E. hierrense*. In each of these periods, one male individual climbed the same plant three to four times, visiting different flowers from the same inflorescence (Fig. 1). Occasionally, we also saw the aforementioned lizard accompanied by a conspecific crawling up other inflorescences of the same plant. In both cases, lizards visited flowers legitimately (i.e., the snout brushed against the anthers and stigma of the flowers as they clearly licked nectar from them). We never detected agonistic interactions between lizards, nor did we observe lizards trying to capture pollinating insects (mainly Hymenoptera) while in the inflorescences.

Lizards are not the only flower visitor of *E. hierrense*. In the Canary Islands, *Echium* species are considered to be mainly bee-pollinated (Dupont and Skov 2004. Int. J. Plant Sci. 165:377–386). However, the endemic *E. wildpretii*, distributed in the arid high-altitude sub-alpine vegetation zone, is also visited by *Gallotia* lizards (Valido et al. 2002, *op. cit.*). Our observations suggest the possibility of more *Gallotia-Echium* interactions in the Canarian archipelago. This raises the question of what intrinsic (e.g., floral rewards) and extrinsic (e.g., water scarcity) plant factors promote interactions and how these interactions impact *Echium* reproductive success.

The observations described here were made as part of work for a documentary film series (Canarias, reductos de biodiversidad) on Canarian biodiversity conducted by Alas Cinematografía S.L. We thank Pedro Felipe and José J. Hernández for their invaluable help in the field, as well as Alfredo Valido, Rubén Barone, and Kimberly Holbrook for reviewing an early draft of the manuscript.

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***GEHYRA AUSTRALIS* (Northern Dtella). PREDATION.** *Gehyra australis* is a variably patterned, ~81mm SVL, arboreal and rock-inhabiting gecko native to the northern reaches of the Northern Territory and Western Australia (Wilson and Swan 2010. A Complete Guide to Reptiles of Australia, 3rd ed. New Holland Publishers, Sydney). I am unaware of any reports of predation on *G. australis* by an arachnid. I report here an instance of predation on *G. australis* by the Grey Huntsman Spider (*Holconia immanis*).

On 2 May 2011, near the town of Wyndham in the eastern Kimberley region of Western Australia, I was performing daily checks of nest-boxes, specifically designed to be utilized by breeding Gouldian Finches (*Erythrura gouldiae*). These boxes consist of a natural log (ca. 20–40 cm long) attached to a 10 cm^2 plywood nesting box, which can be removed to investigate the contents. At 0746 h I came across a Grey Huntsman Spider in the process of subduing an adult *G. australis* in the anterior section of one of the aforementioned boxes (15.5704°S, 128.1892°E, 79 m elev.). The gecko was clearly still alive and was attempting to break free of the huntsman's grip. Upon removal of the box, the huntsman crawled out onto the box's exterior (Fig. 1), descended the tree in which the nest-box was situated, and withdrew into tall *Sorghum* grass with the gecko still in its grip. These two species are frequently observed cohabiting these boxes, but this was the first instance in which I, or any other members of the Save The Gouldian Fund, have encountered such a predation attempt.

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FIG. 1. *Holconia immanis* in the process of subduing an adult *Gehyra australis* near Wyndham, Western Australia.

***HEMIDACTYLUS FRENATUS* (Common House Gecko). PREDATION.** Many spiders feed on a variety of vertebrates such as small mammals, birds, and lizards (Corey 1988. J. Arachnol. 16:391–392; McCormick and Polis 1982. Biol. Rev. 57:29–58; Rubbo et al. 2001. Can. J. Zool. 79:1465–1471). On 20 August 2010, at 2015 h we encountered a predation event involving



FIG. 1. Predation of *Hemidactylus frenatus* by the spider *Heteropoda venatoria*.

Hemidactylus frenatus by the spider *Heteropoda venatoria* at Shahbajpur (24.7058°N, 92.1913°E) in Barlekha, Maulvibazar District, Bangladesh. The incident took place on the wall of a resident's house within a tea garden where the gecko was ambushed by the spider (Fig. 1). The struggle lasted for a period of ca. 20 min., after which the spider dropped the lizard and fled, most likely due to human interference.

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***IGUANA IGUANA* (Green Iguana). COPROPHAGY.** *Iguana iguana* occurs from Mexico to Brazil as well as some Caribbean islands (Burghardt and Rand 1982. Iguanas of the World: Their Behavior, Ecology, and Conservation. Noyes Publications, New Jersey. 472 pp.). It is a largely arboreal (Iverson 1982. *In* Burghardt and Rand, *op. cit.*, pp. 60–76) and herbivorous species, eating mostly leaves, flowers, and fruits from a wide range of shrubs, vines, and trees (Rand et al. 1990. J. Herpetol. 24:211–214). The Green Iguana is reported to occasionally scavenge on animal carcasses (Loftin and Tyson 1965. Copeia 1964:515), as well as eating insects (Hirth 1963. Ecology 44:613–615), or other invertebrates (Fitch 1973. Univ. Kansas Sci. Bull. 50:39–126; Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna between Two Continents, between Two Seas. University of Chicago, Chicago, Illinois. 934 pp.). Consumption of bird eggs has also been reported (Schwartz and Henderson 1991. Amphibians and Reptiles of the West Indies: Descriptions, Distributions, and Natural History. Univ. Florida Press, Gainsville, Florida. xvi+720 pp.). In Florida, where the Green Iguana is a well-established exotic species, the examination of stomach contents revealed remains of snails in two individuals, including 12 snails in one juvenile (Townsend et al. 2005. Southeast. Nat. 4:361–354).

Coprophagy is generally rare in reptiles, and usually involves eating the feces of other taxa (Frye 1991. Reptiles: An Atlas of Diseases and Treatment. TFH, Neptune City, New Jersey. 637 pp.). The Green Iguana utilizes a microbial fermentation system in its elaborated hindgut to break down plant cell walls (Mackie et al 2004. Physiol. Biochem. Zool. 77:127–138). Hatchlings have been observed to actively associate with adults during the first weeks of life and to consume fresh fecal material from adult iguanas to obtain the complex microflora (Werner et. al 1987. Behav. Ecol. Sociobiol. 21:83–89). In Galapágos Archipelago, Land and Marine Iguanas (*Conolophus pallidus* and *Ampblyrhynchus cristatus,* respectively) have been observed eating feces of crabs and sea lions, and it has been speculated that this is done in order to acquire microorganisms, mostly bacteria, to properly digest various plant chemicals (Mackie et al., *op. cit.*). In a long term study on the endangered Grand Cayman Blue Iguana (*Cyclura lewisi*), Goodman (2007. Carib. J. Sci. 43:73–86) reported the consumption of Central American Agouti (*Dasyprocta punctata*) feces on one occasion. We have found no references in the literature regarding free-living juvenile or adult Green Iguanas feeding on the feces of other animals other than conspecifics. We report here on coprophagy of Green Iguana adults and hatchlings eating feces from Giant Otter (*Pteronura brasiliensis*) latrines.

Giant Otters live in social groups and use latrines to mark their territory (Leuchtenberger and Mourão 2009. Ethology 115:210–216). In December of 2010, during a Giant Otter research trip on the Vermelho River (56.7333°W, 19.6000°S, WGS84; elev. 60 m), in the southern Pantanal, camera traps were positioned at three Giant Otter latrines. These cameras were active in 24-h cycles during three days at latrines 1 and 2, and just one day at latrine 3, resulting in a total of 509 photos of Green Iguanas. All of these photos were during the diurnal period and revealed that both juveniles and adults lizards consumed feces of the otters. The eight photos taken from latrine 1 were consistently of the same adult female, while the five photos from latrine 3 indicated two adult females and one adult male. Detailed examination of the 495 photos taken from latrine 2 indicated that there were at least eight adult females, one adult male, and two juveniles visiting that locale. Often the iguanas visited the latrines soon after the otters left the area. For example, in one case one photo registered eight female iguanas eating feces together, just 15 min. after the otter group had left that latrine (Fig. 1).

Giant Otters feed mainly on fish, and their spraints are usually deposited in latrines that are used by the whole group (Duplaix 1980. Rev. Ecol. 34:496–620). Therefore, the spraints containing fish bones and scales probably provide a rich source of calcium for this herbivorous lizard species. Most individuals identified in the photo images were adult females or juveniles which would all have high calcium requirements; adult females due to the production of eggs and juveniles for growth. It may also be speculated that fecal samples provide the reptiles with special microorganisms and bacteria as hypothesized by Mackie et al. (*op. cit.*).



FIG. 1. *Iguana iguana* females feeding at a Giant Otter (*Pteronura brasiliensis*) latrine on the Vermelho River, Southern Pantanal, Brazil.

Another interesting aspect of this behavior is that lizards usually aggregated to the otter latrines. Aggregation of adult female iguanas has been described during the reproductive period where they exhibited a communal nesting strategy, which is often described as an antipredator tactic (Mora 1989. Herpetologica 45:293–298). Group behavior of hatchlings has also been reported as an antipredator strategy (Green et al. 1978. J. Herpetol. 12:169–176).

The importance of coprophagy in the dietary supplementation of *Iguana iguana* is difficult to evaluate. However, this behavior can certainly be precarious for the lizards. While on the ground, the arboreal iguanas are more susceptible to predators and coprophagy facilitates the transmission of parasites from the otters to the iguanas.

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***LAMPROLEPIS SMARAGDINA PHILIPPINICA* (Emerald Green Tree Skink). COLOR VARIATION.** *Lamprolepis smaragdina* is a widespread skink distributed throughout the Philippine Islands, eastern Indonesia, Papua New Guinea, and the islands of the West Pacific. This arboreal species is recognized to have a high degree of body color variation between populations (Mertens 1929. Zoologischer Anzeiger 84:209–220). One of three recognized subspecies, *L. s. philippinica* is endemic to the Philippine islands (Brown and Alcala 1980. Philippine Lizards of the Family Scincidae. Silliman University Press, Dumaguete City. 264 pp.; Mertens, *op. cit.*). Populations of *L. s. philippinica* range in color from green anteriorly and brown posteriorly, to mottled brown and black on a green ground color (Brown and Alcala, *op. cit.*). Outside of the Philippines, populations displaying a completely bright green body are known from the southern peninsulas of Sulawesi, Palau, the Solomon Islands, and the Marshall Islands (Buden 2007. Pacific Science, 61:415–428; Mertens, *op. cit.*). Here we report on the first records of green populations of Philippine *Lamprolepis*, discovered on the small, isolated islands of Caluya, in the west-central Philippines, and Siquijor, in the south-central Philippines.

In 1997, R. Brown and J. McGuire collected 12 specimens of a population of *L. s. philippinica* possessing bright green bodies with black rhomboid blotches on Siquijor Island in the south-central Philippines. Individuals were collected on 9 September 1997, on the trunks and small branches of trees, in two localities on Siquijor Island, Siquijor Province, Philippines (9.2°N, 123.5°E): (11 individuals) Barangay Kang-Adiang, Municipality of Siquijor; (one individual) Barangay Caitic, Municipality of La Arena. The specimens are deposited at the Texas Natural History Collections, University of Texas at Austin (TNHC 56434–65).

During recent fieldwork in the central Philippine islands, CDS collected five all green, adult *L. s. philippinica* (Fig. 1). The specimens were observed on 15 November 2004, in a mangrove swamp at sea level, on small branches of trees over water, in Barangay Tinogboc, Municipality of Caluya, Antique Province, Caluya Island, Philippines (11.93003°N, 121.54723°E, datum: WGS 84; elev. 0 m). The specimens are deposited at the herpetological collections of the Biodiversity Institute, University of Kansas (males: KU 302835–37; females: KU 302838, 302839).



COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND

FIG. 1 An adult female *Lamprolepis smaragdina philippinica* (KU 302839; total length = 232 mm; 14.0 g) from Caluya Island, Philippines.

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***LIOLAEMUS GOETSCHI*. PREDATION.** *Liolaemus goetschi* is an oviparous and insectivorous, medium-sized lizard (max. SVL = 73 mm) inhabiting the arid landscape of Monte Desert in northern Patagonia, Argentina. Its geographic distribution ranges through a narrow strip in northwestern Rio Negro Province along the boundary with Neuquén Province (Nori et al. 2010. Check List 6:3–4). To our knowledge, no studies are available on the biology of this species, including its natural predators. Here we report an observation of *Philodryas psammophidea* predation on *L. goetschi*. *Philodryas psammophidea* is an uncommon snake, with a large geographic distribution within Monte and Chacoan environments of Bolivia, Paraguay, and Argentina.

At 1930 h on 5 December 2010 during a collecting trip through northern Rio Negro Province we observed an adult female *L. goetschi* (SVL = 72.9 mm) basking in an open area between bushes outside National Road 151, 50 km S Catriel, General Roca Department (38.283861°S, 67.996278°W, WGS 84; 551 m elev.). As we approached, the lizard ran to seek refuge below branches of a *Larrea nitida* bush. When it reached the proximity

of the bush, a *Philodryas* (female; SVL 600 mm, TL 738 mm) appeared between the branches and chased the lizard for 3–4 m. It grabbed the lizard by its left forelimb and coiled around the lizard's body. We immediately grabbed the snake and forced it to release the lizard; it continued its grasp to the left forelimb with its mouth. After a minute of handling, the snake finally released the lizard. The *Liolaemus* was motionless after being released from the snake's grasp and did not appear to be alive. Two fang puncture wounds were evident in its leg and it likely died from envenomation. The specimens of *L. goetschi* (LJAMM-CNP 13731) and *Philodryas psammophidea* (LJAMM-CNP 13732) were deposited in the herpetological collection Luciano Javier Avila Mariana Morando of the Centro Nacional Patagónico – CONICET, Puerto Madryn, Argentina.

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***LIOLAEMUS QUILMES*. ULTRAVIOLET COLORATION**. *Liolaemus quilmes* is a liolaemid lizard from northwestern Argentina. It belongs to a genus of more than 223 species (Lobo et al. 2010. Zootaxa 2549:1–30) distributed throughout most of southern South America. Because *Liolaemus* species go from dull to bright coloration, they offer a model system for studies in visual communication (e.g., Font et al. 2010. Acta Zool. Lilloana 54:11–34; Fox et al. [eds.] 2003. Lizard Social Behavior. Johns Hopkins Univ. Press, Baltimore and London. 456 pp.). Some species of *Liolaemus* present blue-colored spots (e.g., those belonging to the *darwinii* complex of which *L. quilmes* is a member; Etheridge 1993. Bolletino Museo Regionale di Scienze Naturali, Torino 11:137–199), which in some lizards has been shown to be associated with ultraviolet coloration (UV, corresponding to wavelengths below 400 nm). This coloration and the ability to perceive it has been reported in more than 30 lizard species (Font et al. 2010, *op. cit.*) but it has not been studied in *Liolaemus*. Male *L. quilmes*, and females, to a lesser degree, exhibit blue spots, mostly on the lateral sides of their body (Etheridge 1993, *op. cit.*), which we hypothesized could indicate the presence of UV coloration.

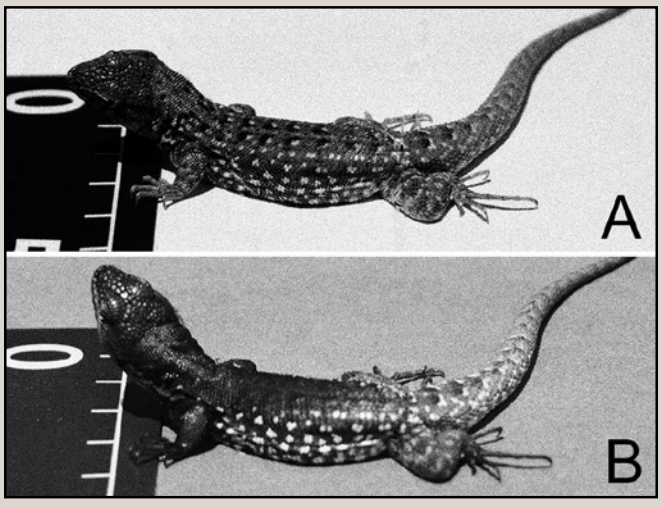


FIG. 1. Male *Liolaemus quilmes*: A) black and white picture taken without a UV filter (light white spots correspond to blue spots when seen by a human); B) black and white picture taken with a UV filter, showing brighter white spots where blue spots were, indicating UV reflectance.

We photographed live specimens of *L. quilmes* (2 males and 1 female) in their habitat, in Los Cardones, Tucumán, using a relatively simple method to confirm presence of UV coloration. Photographs were taken around noon, using natural sunlight. We first took a standard black and white photo with an analog camera (Canon EOS Rebel G), which was then compared to a second photo taken with the same camera and a filter B+W 403. This allowed only wavelenghts between 320 and 385 nm to pass through the filter, blocking the rest of the visible light spectrum.

We found that *L. quilmes* does reflect UV light corresponding to areas with light blue spots, this being the first report for a species in this genus (Fig. 1A, B). We then photographed live specimens of five congeners from Mendoza, Argentina, using the same method. These were *L. darwinii* (1 male), *L. grosseorum* (4 males), and *L. gracilis* (1 female), from El Nihuil, and *L. ruibali* (5 males and 1 female) and *L. bibroni* (1 male and 1 female) from Cruz de Paramillo. All of the individuals that were photographed reflected UV light except for those belonging to *L. gracilis* and *L. bibroni*. The latter two species are light to dark brown in coloration, explaining the lack of UV reflectance, whereas the other three species display blue spots, among other coloration. Our results open the opportunity for comparative research in the genus *Liolaemus* with respect to presence/absence of UV coloration and its communicative role within the behavioral ecology of each species (Fox et al. 2003, *op. cit.*; Font et al. 2010, *op. cit.*).

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***MESASPIS GADOVII* (Gadow's Alligator Lizard). REPRODUCTION.** *Mesaspis gadovii* is known from parts of Guerrero and Oaxaca, Mexico (Flores Villela and Gerez 1994. Biodiversidad y Conservacíon en México: Vertebrados, Vegetacíon y Uso del Suelo. Univ. Nac. Auton. Mexico, D.F., México, 439 pp.). Ramírez-Pinilla et al. (2009. J. Herpetol. 43:409–420) reported a mean litter size of 7.3 ± 1.9 SD, range = 4–12 for 16 females of *M. gadovii* from Guerrero. The smallest reproductively active female (vitellogenic follicles) measured 76 mm SVL (Ramirez-Pinilla, *op. cit.*). The purpose of this note is to report a new minimum litter size and minimum size for female reproduction of *M. gadovii*.

One *M. gadovii* female (SVL = 73 mm) collected on December 1971 in the Sierra Madre del Sur, (17.5000°N, 100.0000°W, WGS 84; elev. ca. 1000 m), Guerrero, Mexico, and deposited in the herpetology collection of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California as LACM 75504 was examined. A midventral slit was made and the reproductive system was examined. Two embryos were present. A litter size of two is a new minimum litter size, and the SVL of 73 mm is a new minimum body size for female reproductive activity in *M. gadovii*.

I thank Christine Thacker (LACM) for permission to examine *M. gadovii*.

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***OPHISAURUS VENTRALIS* (Eastern Glass Lizard). POSTMORTEM PREDATION.** Although several hawk species have been documented or implicated as predators of glass lizards (genus

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FIG. 1. Loggerhead Shrike (*Lanius ludovicianus*) with body segment of an Eastern Glass Lizard (*Ophisaurus ventralis*) held in its bill.

Ophisaurus; Fitch 1974. Condor 76:331–360; Fitch and Bare 1978. Trans. Kansas Acad. Sci. 81:1–13), we are aware of no other bird species reported to consume them. On 17 February 2010 at Skidaway Island, Chatham Co., Georgia, USA (31.95652°N, 81.02442°W), one of us (FOC) observed a Loggerhead Shrike (*Lanius ludovicianus*) fly down to a recently mowed berm along a weedy field, pick up a flexible and tubular item, fly back to its perch, and begin consuming this item. Photographs taken by FOC of this bird while back on its perch were shared with JBJ and JAC who positively identified the item as a body segment of an Eastern Glass Lizard (*Ophisaurus ventralis*) (Fig. 1). It is suspected that the glass lizard was killed (likely by the mowing activities) prior to its seizure by the shrike. The time it took for the shrike to fly from its perch and return with the motionless food item was estimated to be just 15–20 seconds. Although predation cannot be conclusively ruled out, the short duration of capture time, coupled with likelihood that a fully intact and live sub-adult or adult Eastern Glass Lizard would be too large for a shrike to attack, suggests it was seized postmortem. Although legged lizards have been reported in the diet of Loggerhead Shrikes (Yosef 1996. *In* Poole and Gill [eds.]. The Birds of North America, No. 231. Acad. Nat. Sci., Philadelphia, and Amer. Ornithologists' Union, Washington, D.C.), insofar as we can determine, this is the first reported observation of a Loggerhead Shrike consuming as carrion, or predating, any species of glass lizard.

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***PLESTIODON SUMICHRASTI* (Sumichrast's Skink). PREDATION.** There are many reports of large tropical spiders preying upon amphibians and reptiles (e.g., Antônio de Freitas et al. 2010. Herpetol. Rev. 41:202; Brito De-Carvalho et al. Herpetol. Rev. 2010. 41:336–337; Cicchi et al. 2010. Herpetol. Rev. 41:207; Hamidy et al. 2010. Herpetol. Rev. 41:66–67). Although many of these reports document predation on small frogs and lizards (< 4 cm SVL), larger prey items are occasionally taken or attempted (e.g., Silva Siqueira Nunes et al. 2010. Herpetol. Rev. 41:367–368). Here we report an instance of a relatively large lizard as a prey item for a tarantula from the highlands of southeastern Guatemala.



FIG. 1. Predation of *Plestiodon sumichrasti* (top) by *Brachypelma* sp. (bottom) in the Sierra Caral of Izabal, Guatemala.

On 2 October 2010 we were conducting a herpetofaunal survey in the Sierra Caral of Izabal, Guatemala. At approximately 1800 h while pulling apart a large fallen tree trunk, we discovered a cavity that contained a partially digested juvenile *Plestiodon sumichrasti* (ca. 6 cm SVL; Fig. 1 [top]). Further excavation immediately behind the partially digested lizard revealed a large male tarantula referable to the genus *Brachypelma* (Fig. 1 [bottom]). This observation occurred near Cerro Pozo de Agua at about 850 m (15.39367°N, 088.69183°W; WGS84 datum). The slightly dissolved skink was collected and deposited in the natural history collections of the Museo de Historia Natural of the Universidad de San Carlos in Guatemala City (USAC 2738; Field ID: CRVA 2162).

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***SAUROMALUS ATER* (Common Chuckwalla). ENTRAPMENT.** On 31 May 2008, we found an adult male *Sauromalus ater* dead in tortoise mitigation fencing along U.S. Highway 93, 1.0 km NW of Nothing, Mohave Co., Arizona, USA (34.48279°N, 113.35129°W, WGS84; elev. 965 m). The fence, originally intended to keep Desert Tortoises (*Gopherus agassizii*) off of the highway and direct them towards highway underpasses, is 60 cm in height, with galvanized mesh fabric (2.5 cm × 5 cm). The chuckwalla was caught between its rib cage and front legs at ground level probably as it tried to move through the fencing (Fig. 1). Use of fencing to modify animal movements away from roads should consider impacts to other small animals that may get stuck and die from starvation or exposure (Sherwood et al. 2002. Wildlife and Roads: The Ecological Impact. Imperial College Press, London. 316 pp.). One possible solution for this source of mortality would be to modify the fence mesh size at the bottom, however any modifications could change the level of hazard for other animals and affect the fence's effectiveness in preventing focal species from moving across the highway.

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FIG. 1. An adult male *Sauromalus ater* trapped in mitigation fencing for Desert Tortoises (*Gopherus agassizii*), resulting in its death.

***SCELOPORUS GRAMMICUS* (Mesquite Lizard). DIET.** Feeding is one of the most important aspects in the life history of amphibians and reptiles (Stearns 1977. Ann. Rev. Ecol. Syst. 8:145–171). It is well known that most reptile species are carnivores and omnivores. However; if they have the opportunity, many reptiles will feed on dead prey (carrion). Scavengery has been observed in lizards such as *Varanus panoptes* from Australia (Shine 1986. Herpetologica 42:346–360) and *Leiocephalus psammodromus* (Iverson and Smith 2006. Herpetol. Rev. 37:345–346). Within the genus *Sceloporus, S. grammicus* is particularly known for being insectivorous (Leyte-Manrique et al. 2006. Bol. Soc. Herpetol. Mex. 1:18–24) and Leyte-Manrique et al. (2005. Herpetol. Rev. 36: 454–455) reported cannibalism. However, to our knowledge, until now nothing has been reported on this species being a carrion-eater.

On 15 April 2008 at 1230 h, during a field trip to La Manzana, Zimapan (20.87056°N, 99.22417°W, WGS84; elev. 2531 m), Hidalgo, México, we observed an adult female *Sceloporus grammicus* (SVL = 52.6 mm, 6.0 g) in a crevice eating a female *S. minor* (SVL = 68.6 mm, 10.2 g). This observation suggests that *S. grammicus* could have opportunistic feeding habits. Moreover, a previous study reported that this *S. grammicus* eats neonates of its own species (Leyte-Manrique et al. 2005. Herpetol. Rev. 36:454–455) and skin of adult lizards (probably *S. spinosus;* Leyte-Manrique 2007. Bol. Soc. Herpetol. Mex. 15:23–24).

Both specimens (ZIMAPABR2-2008 and HAZIMAPSM-ABR1-2008) are deposited in the Laboratorio de Ecología de Poblaciones del Centro de Investigaciones Biológicas (CIB), de la Universidad Autónoma del Estado de Hidalgo.

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***SCELOPORUS MINOR* (Minor Spiny Lizard). HERBIVORY.** Herbivory in lizards has been well documented (Cooper et al. 1990. Herpetologica. 29:107–110). However, there are some species that display more than one feeding behavior, both insectivory and herbivory (omnivory) such as *Ctenosaura pectinata* (Durtsche. 2000. Oecología. 89:85–195) and *Tropidurus etheridgei* (Ávila et al. 2008. Herpetol. Rev. 39:430–433). Some species of the genus *Sceloporus* have been observed to feed on fruits, seeds and flowers, such as *S. torquatus* (Búrquez et al. 1986. J. Herpetol. 20:262–264). However, other species of this genus are thought to be completely insectivorous (Uribe-Peña et al. 1999. Anfibios y Reptiles de las Serranías del Distrito Federal, México. UNAM. 119 pp). The diets of many *Sceloporus* species remain poorly known in México. Herein, we provide information suggesting that one of these species, *S. minor,* has an omnivorous feeding behavior.

On 26 April 2008 at 1114 h at the locality of El Enzuelado, 7 km N of the Municipality of San Agustín Meztquititlán (20.57500°N, 98.62028°W, WGS84; elev. 1940 m), Hidalgo, México, we observed an adult male *S. minor* (SVL = 65.7 mm; 14.0 g) perching on a rock (26 cm high) within a xeric scrub community. We noticed that the lizard was eating the fruit of a cactus (163.1 mm^3; 0.0552 g; *Mammillaria* sp.); this fruit is locally known as *chilitos.* The fruit was eaten by the lizard within 15–20 seconds. After this feeding event, the lizard was captured and taken to the laboratory and later deposited in the Laboratorio de Ecología de Poblaciones del Centro de Investigaciones Biológicas (CIB), Universidad Autónoma del Estado de Hidalgo (SAM-ABR3-2008). This observation expands our knowledge about the diet of *S. minor,* possibly indicating this species is omnivorous and this opportunistic foraging provides evidence that *S. minor* may take advantage of chilitos as a food resource when available.

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***SCINCELLA REEVESII* (Reeves' Smooth Skink). REPRODUCTION.** *Scincella reevesii* is known from Vietnam, India, southern China, Korea, Thailand, and Malaysia (Van Sang et al. 2009. Herpetofauna of Vietnam. Edition Chimaira, Frankfurt am Main, Germany.768 pp.). *Scincella reevesii* is ovoviviparous with litters of 2–3 young born in late spring (Karsen et al. 1986. Hong Kong Amphibians and Reptiles. Published by the Urban Council, Hong Kong. 136 pp.). The purpose of this note is to report a new maximum litter size for *S. reevesii*.

One female *S. reevesii* (SVL = 48 mm) collected 12 June 1993 from Hong Kong, China (Port Shelter, Yim Tin Tsai (22.410278°N, 114.215556°E, datum WGS84; elev. 10 m) and deposited in the Museum of Comparative Zoology (MCZ) as MCZ R-177979 was examined. The posterior third of the body cavity was opened and four embryos were counted. Four is a new maximum litter size for *S. reevesi*.

I thank Jonathan Losos (MCZ) for permission to examine *S. reevesii* and Jose Rosado (MCZ) for facilitating the loan.

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***SCINCELLA REEVESII* (Reeves' Smooth Skink). ENDOPARASITES.** *Scincella reevesii* is known from Vietnam, India, southern China, Korea, Thailand, and Malaysia (Van Sang et al. 2009. Herpetofauna of Vietnam, Edition Chimaira, Frankfurt am Main, Germany. 768 pp.). To our knowledge, there are no reports of helminths from *S. reevesii*. The purpose of this note is to establish the initial helminth list for *S. reevesii*.

Twenty *S. reevesii* from Hong Kong, China (mean SVL = 42.3 mm ± 5.5 SD, range = 30–52 mm) collected 1991–1994, 1996, were borrowed from the herpetology collection of the Museum of Comparative Zoology (MCZ): (MCZ) R-176657–17663, 176666–176669; 177083, 177977, 177979–177981, 179465, 17946, 179482, 182293.

The body cavity was opened and the digestive tract was removed, opened by a longitudinal incision, and examined under a dissecting microscope. Nematode larvae in cysts were found in the stomach wall and supportive mesenteries, which were cleared in lacto phenol solution, placed on a glass microscope slide, cover-slipped and identified as Acuariidae gen. sp. Prevalence (infected lizards/all lizards x100) was 20%; mean intensity (mean number helminths per lizard) was 2.0 ± 1.4 SD, range = 1–4. They were deposited in the invertebrate collection at MCZ as IZ-124533–124536.

Members of the Acuariidae are gizzard parasites of terrestrial birds; insects serve as intermediate hosts (Anderson 2000. Nematode Parasites of Vertebrates: Their Development and Transmission, 2nd ed. CABI Publishing, Wallingford, Oxfordshire, U.K. 650 pp.). Their occurrence in lizards likely results from ingesting infected insects; no further development occurs (Goldberg et al. 2002. Amer. Midl. Nat. 148:409–415). The occurrence of Acuariidae in amphibians and reptiles is summarized in Goldberg et al. (2007. Comp. Parasitol. 74:327–342). *Scincella reevesii* represents a new host record for larvae of the Acuariidae.

We thank Jonathan Losos (MCZ) for permission to examine *S. reevesii* and Jose Rosado (MCZ) for facilitating our loan.

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***TUPINAMBIS MERIANAE* (Black-and-White Tegu). NEST CONSTRUCTION BEHAVIOR.** *Tupinambis merianae* is one of the largest lizard species indigenous to the New World. There is little information published on the ecological aspects within natural environments for this genus. Daily and annual activity for *T. merianae* have been reported for an Atlantic Rainforest area in Southeastern Brazil (Van Sluys and Rocha. 1999. Herpetol. Rev. 30:42–43). Recently the hibernation and emergence behavior of a natural population in Southern Brazil were described (Winck and Cechin. 2008. J. Nat. Hist. 42:239–247). Oviposition inside burrows is known, including the importance of the presence of the female to the eggs during their development (Chani et al. 1994. Acta Zool. Lilloana 42:295–299). However, ecological aspects related to nest construction remains unknown in natural populations.

On 5 December 2005, during the study of ecological aspects of a population of *T. merianae*, we witnessed an adult female (366 mm SVL; 1.9 kg) preparing its burrow for oviposition in sandy soil. The observation was made at Taim Ecological Station (Estação Ecológica do Taim), municipality of Santa Vitória do Palmar, State of Rio Grande do Sul, Brazil (32.836944°S, 52.643889°W). By palpation, we confirmed the presence of eggs. About two days before laying the eggs, the female had started to collect vegetation material around the burrow. Positioned with her back to the burrow opening, her movements were recorded chronologically as follows: 1) the female moved plant matter towards her belly to the pelvic girdle with her forelimbs; 2), then pushed the vegetation with its hind limbs until the full extension of the limbs was reached; 3) the lizard then turned around and pushed the pile of plant matter with its forelimbs into the interior of the burrow. We were not able to see how the vegetation was arranged inside, as the lizard entered the burrow and we opted to avoid disturbance. On 19 December 2010, GRW observed a similar behavior displayed by an adult female of a similar body size of that from the Taim site, in the municipality of São João da Barra (Grussaí restinga habitat), State of Rio de Janeiro, Brazil (21.737778°S, 41.034722°W). The nest at Grussaí was also constructed on the ground in sandy soil. The vegetation is likely to assist in the manipulation of internal temperatures of the burrow. These localities are more than 1600 km apart, suggesting that this nest construction behavior may be related to the natural history of the species, rather than a behavioral adaptation to a particular environment.

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***UROSTROPHUS VAUTIERI* (Brazilian Steppe Iguana). DEFENSIVE BEHAVIOR AND COLOR CHANGE.** *Urostrophus vautieri* occurs in southeastern Brazil, from Paraná to Rio de Janeiro State. Basic behavioral information for the genus *Urostrophus* is limited to unpublished notes made on one captive animal by Rand (*In* Etheridge and Williams 1991. Bull. Mus. Comp. Zool. 152:317–361). Herein, we describe the first field observation of defensive behavior for this lizard species.

On 11 November 2010, at Serra do Japi Municipal Reserve, Jundiaí, São Paulo state (23.235°S, 46.935°W; WGS 1984; elev ca. 1092 m. At 0936 h). The lizard was observed during a behavioral study of a group of Black-fronted Titi Monkeys (*Callicebus nigrifrons*) conducted in a semi-deciduous secondary forest area. The lizard fell onto the leaf litter from its arboreal perch in front of CBC, just before being contacted by a group of *Callicebus nigrifrons* travelling towards it. It fell off a fructifying *Maytenus robusta* branch at a height of approximately 8 m. Immediately after reaching the ground, its color gradually changed from a grayish green to a reddish brown (Fig. 1). The color change clearly diminished the lizard's conspicuous form on the forest floor. The lizard remained immobile for at least five min, until CBC was no longer present.

This is the second report on behavioral ecology of *Urostrophus vautieri* and the first on color change. We provide a first context for color change in this species regarding potential predation avoidance. The specimen was not captured or manipulated for photographs, as collection inside of the Reserve is prohibited without permits.

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FIG. 1. Color change in *Urostrophus vautieri*. Image at left taken immediately after lizard fell onto leaf litter from an arboreal perch. Image at right taken approximately 2 min later, indicating rapid color change toward substrate matching.

SQUAMATA — SNAKES

***ARIZONA ELEGANS ELEGANS* (Kansas Glossy Snake). DIET.** Medium-sized diurnal lizards comprise a large proportion of the diet of *Arizona elegans* (Rodriguez-Robles et al. 1999. J. Herpetol. 33:87–92). Rodriguez-Robles et al. (*op. cit.*) suggest that diurnal lizards may be captured "when they are inactive by nocturnal wide-foraging glossy snakes." Here we document the first record of *A. e. elegans* feeding on *Sceloporus cautus*, a lizard that is distributed in Mexico from the northeastern section of the Mexican plateau, west from the western edge of the Sierra Madre Oriental, barely entering Tamaulipas, and south from southwestern Coahuila and central Nuevo Leon to the southern portion of San Luis Potosi and northern half of Zacatecas (Lemos-Espinal and Smith 2007. Amphibians and Reptiles of the State of Coahuila, Mexico. Universidad Nacional Autónoma de México and Comisión Nacional Para El Conocimento y Uso de La Biodiversidad. 550 pp.).

While conducting a survey of the herpetofauna of the municipality of Doctor Arroyo, Nuevo Leon, Mexico, driving on state road No. 61 (23.8094°N, 100.0853°W, datum NAD27; elev. 1791 m), on 12 September 2009, we found a road-killed juvenile *A. e. elegans* (female; SVL = 202 mm, total length = 233 mm; 4.19 g), that had in its stomach a juvenile *Sceloporus cautus* (female; SVL = 35 mm; total length = 60 mm; 1.57 g); the lizard represented 37.5% of the mass of the snake. As *A. elegans* is nocturnal and *S. cautus* is diurnal, the lizard was likely captured while inactive. Both specimens were deposited in the herpetological collection of the Universidad Autonoma de Nuevo Leon (*A. e. elegans* = UANL 7128a; *S. cautus* = UANL 7128b). Research and collecting were conducted under the authorization of SEMARNAT scientific research permits OFICIO/NUM/SGP/DGVS/ 02262 issued to DL.

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***ASTHENODIPSAS MALACCANUS* (Malayan Slug Snake). DIET.** *Asthenodipsas malaccanus* is a rare lowland forest snake from southern Thailand, the Malay Peninsula, Sumatra, and Borneo (David and Vogel 1996. The Snakes of Sumatra. An Annotated Checklist and Key with Natural History Notes. Chimaira, Frankfurt am Main. 260 pp.). Its diet has been reported to consist of snails and slugs (Inger and Stuebing 1999. A Field Guide to the Snakes of Borneo. Natural History Publications [Borneo] Sdn Bhd, Kota Kinabalu. 254 pp.), without specific information. At ca. 2130 h on 19 September 2010, an adult female *A. malaccanus* (SVL = 357 mm; Fig. 1) was found crossing a paved road within lowland forest (01.6061°N, 110.1955°E, datum: WGS84; elev. ca. 200 m), leading to the summit of Gunung Serapi (elev. 911 m), in Kubah National Park, Sarawak, East Malaysia. The snake was collected (Universiti Malaysia Sarawak Museum, UNIMAS 9379), and taken to the lab. Overnight, it voided an intact slug (RMNH MOL.127788), which was identified as *Valiguna flava* (Gastropoda: Soleolifera: Veronicellidae; Fig. 1), a nocturnal/crepuscular lowland (elev. < 1000 m) terrestrial slug, endemic to Sumatra and Borneo (Gomes et al. 2008. The Veliger 50:163–170; Schilthuizen and Liew 2008. Basteria 72:287–306).

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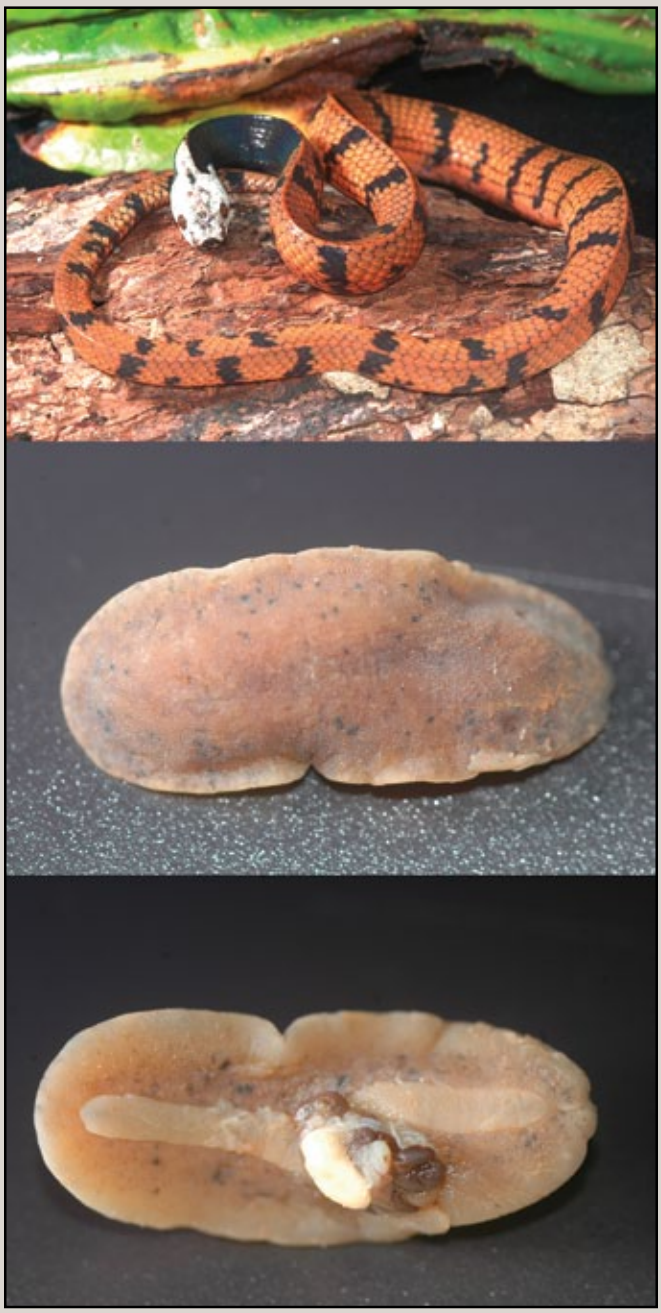


FIG. 1. Adult female *Asthenodipsas malaccanus* (top; UNIMAS 9379), with its prey, the slug *Valiguna flava* (bottom; dorsal and ventral views; RMNH MOL.127788).

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***BOTHROPS ASPER* (Terciopelo). ARBOREAL BEHAVIOR.** *Bothrops asper* is a common, large (up to 2.5 m total length), viperid snake ranging from southern Mexico to northern Venezuela and western Ecuador. Like many vipers, it is an ambush predator, remaining motionless in leaf litter for the majority of its activity budget and moving nocturnally to new ambush spots (Sasa et al. 2009. Toxicon 54:904–922). Although *B. asper* is typically regarded as a terrestrial snake (Henderson and Hoevers 1977. Copeia 1977:349–355), accounts of juveniles in low vegetation have been reported (Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna between Two Continents, between Two Seas. Univ. Chicago Press, Chicago, Illinois. 934 pp.; Guyer and Donnelly 2005. Amphibians and Reptiles of La Selva. Univ. California Press, Berkeley. 298 pp.) There are a few cases, however, of adults being observed in trees or other vegetation (Guyer and Donnelly, *op. cit.*). Here, we report a sighting of an adult *B. asper* in low-lying vegetation in central Panama.



FIG. 1. An adult *Bothrops asper* found in understory vegetation in El Copé, Panama.

At 1927 h, on 6 September 2010, we observed an adult (ca. 1.5 m total length) *B. asper* at a height of 2 m in a cluster of small understory trees (Fig. 1) at La MICA Biological Station, El Copé, Panama (8.374224°N, 80.345024°W, datum: WGS 84; elev. ca. 300 m). The *B. asper* attempted to cross a path by traversing a thin branch, but failed to do so. At 1955 h the snake left the vegetation and returned to the ground having moved a net horizontal distance of <2 m since the beginning of the observation. Because the snake was outstretched and moving, it seems that the purpose of ascending the vegetation was dispersal rather than ambush site selection. Sasa et al. (*op. cit.*) found that the majority of *B. asper* movements are short-range (<10 m), but that less frequently, longer-range movements (>50 m) related to foraging behavior also take place. This observation supports the idea that adult *B. asper* occasionally engage in arboreal behavior for various reasons.

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***CANDOIA ASPERA* (New Guinea Ground Boa). REPRODUCTION.** *Candoia aspera* is known from New Guinea and adjacent island archipelagos (McCoy 2006. Reptiles of the Solomon Islands. Pensoft, Sofia, Bulgaria. 147 pp.). In Papua New Guinea it occurs from 0–1300 m elevation (O'Shea 1996. A Guide to the Snakes of Papua New Guinea. Independent Publishing, Port Moresby. 239 pp.). Current information on *C. aspera* reproduction is reported by Harlow and Shine (1992. J. Herpetol. 26:60–66). The purpose of this note is to provide additional information on the reproductive cycle of *C. aspera*.

Eight male *C. aspera* (mean SVL = 451 mm ± 51.8 SD, range: 373–515 mm) and four females (mean SVL = 604 mm ± 148.7 SD) collected between1986–2007 from Papua New Guinea and deposited in the herpetology collection of the Bernice P. Bishop Museum (BPBM), Honolulu, Hawaii, were examined: BPBM 18932, 12174, 23168, 23436, 23437, 23439, 23440, 27338, 28282, 30797, 31321, 31323. The left testis was removed from males and the left ovary was removed from females for histological examination. Slides were stained with Harris hematoxylin followed by eosin counterstain. Slides of testes were examined to determine the stage of the spermatogenic cycle. Slides of ovaries were examined for the presence of yolk deposition and/or corpora lutea. Enlarged ovarian follicles (>10 mm) were counted. Histology slides were deposited in the BPBM.

Two stages were noted in the male cycle: 1) spermiogenesis (sperm production) in which the lumina of the seminiferous tubules are lined by sperm or clusters of metamorphosing spermatids; 2) regression in which the germinal epithelium is greatly reduced and contains primarily spermatogonia and interspersed Sertoli cells. Some residual sperm from the last period of spermiogenesis may remain. Monthly samples of males exhibited the following stages of the testicular cycle: February (N =1) regressed; May (N = 2) regressed, (N = 1) spermiogenesis; August (N = 2); September (N = 1); October (N = 1) all spermiogenesis. These data suggest there is seasonality in the testicular cycle of *C. aspera* as has also been reported for the congener *C. carinata* (Wynn and Zug 1985. The Snake 17:15–24.).

One female *C. aspera* each from February, May, and September contained quiescent ovaries with no yolk deposition. One female from August contained nine enlarged ovarian follicles (> 10 mm). The presence of three non-reproductive females may suggest seasonality in the ovarian cycle of *C. aspera* or that not all females reproduce annually as suggested by Harlow and Shine (*op. cit.*). Less than annual production of young by *C. aspesa* was also indicated in Parker (1982. The Snakes of Western Province. Widl. Papua New Guinea 82:1–78).

I thank Pumehana Imada (BPBM) for facilitating my examination of *C. aspera.*

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COLUBER CONSTRICTOR **(Racer). FORAGING BEHAVIOR.** Foraging strategies of snakes have been linked to their morphology, physiology, and ecology (Mushinsky 1987. *In* Seigel et al. [eds], Snakes: Ecology and Evolution Biology, pp.302–334, McGraw-Hill, New York). Snakes considered ambush predators balance low energy expenditure with low food intake, while active foragers have greater energy expenditure, but high food intake (Secor and Nagy 1994. Ecology 75:1600–1614). *Coluber constrictor* is considered an active generalist forager that routinely takes both endothermic and ectothermic prey (Klimstra 1959. Copeia 1959:210–214; Shewchuk and Austin 2002. Herpetol. J. 11:151–155). It has been suggested the fundamental food niche of *C. constrictor* is that of an insect eater (primarily orthopteran), with vertebrate prey being taken opportunistically and more frequently in fragmented feeding grounds, which necessitate larger movements by the snake, and more chance encounters with vertebrate prey (Fleet 2009. Southwest. Nat. 8:31–40). Active foragers such as *C. constrictor* typically rely on sight to target and capture food (Mullin et al. 1998. Am. Midl. Nat. 140:397–401), and frequently prefer moving over non-moving prey (Herzog and Burghardt 1974. Herpetologica 30:285–289; Cooper et al. 2000. Amphibia-Reptilia 21:103–115).

In May of 2004 at Flat Rock Cedar Glade and Barrens, located east of Murfreesboro, Rutherford Co., Tennessee, USA, a radio-telemetered adult male *C. constrictor* (SVL = 87.3 cm) was observed three times within a 10 min period aerially attacking a swarm of small gnat-like insects. These observations took place on a partly cloudy, warm, afternoon (1215–1225 h) in an open cow pasture with grass approximately 30 cm high. This snake spent much of its time in the pasture and, as indicated by scat samples collected from *C. constrictor* observed in this mixed habitat area, foraged on the abundant orthopterans. The swarm of insects hovered directly above where the snake was observed and the behaviors all occurred within a 25 m^2 area. The *C. constrictor* raised the anterior portion of its body off of the ground in a typical foraging posture and, with its mouth open, made a series of short, controlled, lunges toward the swarm of insects. Since these observations were made from a distance (~15 m) using binoculars, it was unclear if the snake was successful in capturing any prey. Whether for food, or out of annoyance, the actions of the snake suggested that it was targeting the swarm.

To our knowledge this is the first report of *C. constrictor* making aerial attacks on small swarming insects. Although anecdotal, these observations support the idea that *C. constrictor* is an opportunistic, generalist forager and suggest that food items are selected based on availability, with foraging efficacy playing a lesser role in prey selection.

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COLUBER (= MASTICOPHIS) FLAGELLUM PICEUS **(Red Racer). ARBOREAL/NOCTURNAL BEHAVIOR.** Many species of snakes display arboreal behavior and are often found in vegetation many meters above ground. Mojave Desert snake species rarely get very far above the ground surface and are perhaps limited by predominantly low growing vegetation. *Coluber flagellum piceus* is considered strictly diurnal and although may ascend vegetation while active, is thought to retreat to subterranean refugia at night. Werler and Dixon (2000. Texas Snakes: Identification, Distribution, and Natural History. University of Texas Press, Austin. 437 pp.) stated "The western coachwhip is active above ground only during daylight hours. It almost invariably retires to depths of an animal burrow before sundown, where it spends the night." The normal morning activity period for *C. flagellum* appears to be from approximately 0700–1000 h from June through September (Jones and Whitford 1989. Southwest. Nat. 34:460–467). Secor and Nagy (1994. Ecology 75:1600–1614), and Secor (1995. Herpetol. Monogr. 9:169–186) determined that the average body temperature for active above ground activity of *C. flagellum* was (33.1°C ± 0.1°C, range of 24.0°C–40.8°C, N = 502), stating that coachwhip snakes were seldom active on the surface with body temperatures below 28°C. Here, I report a *C. f. piceus* that apparently spent the night draped in a Creosote Bush (*Larrea tridentata*).

On 24 June 1995 I observed an unusual behavior exhibited by a half grown *C. f. piceus* (SVL ca. 650 mm) basking in a moderate-sized creosote bush approximately 1 m above the ground at 0610 h in Piute Valley, Clark Co., Nevada, USA. I approached the snake slowly taking numerous photographs while the snake remained motionless in the shrub (Fig. 1). When I was within arm's length of the snake I reached out and captured it by hand to find that it



FIG. 1. *Coluber flagellum piceus* moments after sunrise (0610 h) in a Creosote Bush, Clark Co., Nevada.

appeared as cold as the ambient air temperature at waist height, which was 20°C at the time. All indications are that the snake had spent the night above ground draped in the Creosote Bush where I first observed it that morning. Numerous other desert reptiles are known to be nocturnal although nocturnal activity for *C. flagellum* is not commonly observed. Therefore, I assert that this snake likely placed itself in this precarious position sometime near dusk or possibly even at night and spent the night as depicted in Fig. 1.

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***DRYMOBIUS MARGARITIFERUS* (Speckled Racer). DEFENSIVE BEHAVIOR: THANATOSIS.** Thanatosis, also known as letisimulation or death feigning behavior, has been recorded in several families and species of snakes, but is most often associated with the genus *Heterodon* (Gehlbach 1970. Herpetologica 26:24–34). Although *Drymobius margaritiferus* is a common and widespread species throughout much of Middle America (Lee 1996. The Amphibians and Reptiles of the Yucatán Peninsula. Comstock Publ. Assoc., Ithaca, New York. 500 pp.), little is known about its ecology and behavior. To our knowledge, thanatosis has not been recorded in *D. margaritiferus*.

At 1112 h (CST) on 29 October 2003, a juvenile *D. margaritiferus* (total length ca. 50 cm) was found crossing State Highway 66 in the Sierra Tamalave in an area of tropical deciduous forest in the Municipality of Ocampo, Tamaulipas, Mexico (22.820833°N, 99.289167°W, datum: WGS84; elev. 389 m.; air temp. 28.3°C). It was detained for ca. 30 min to collect data and photographs. The animal, which appeared to be healthy and alert, was photographed on the side of a nearby dirt road. The snake was in perpetual motion in its effort to escape and it attempted to bite repeatedly while being photographed. After a period of approximately 15 min of struggling, it suddenly became very weak and appeared to have difficulty moving. The snake grew increasingly weak and after about 30–45 sec its body went completely limp and motionless except for the tail, which squirmed and twitched for the next two or three minutes. Unlike snakes of the genus *Heterodon*, this specimen did not exhibit gaping, extend its tongue, or attempt to right itself or to move itself from any given position. When held by the tail or at mid-body the snake dangled, completely limp, and when placed on the ground the snake remained limp and motionless in whatever position it was placed. Believing the snake was in fact dead, it was posed in a lifelike position and a few photographs were taken. After a minute or two, my attention (and eye contact) turned away from the snake and while changing film and putting lens away, the snake was observed on the ground nearby tongue flicking and raising its head. The snake was gently picked up and examined, and although it seemed slightly more subdued and ceased to bite, it appeared to be normal and soon resumed its efforts to escape. The snake was released near the point of capture where it quickly retreated and disappeared into dense foliage.

A second observation of this behavior was observed in the Municipality of Gonzalez, Tamaulipas, 29 km N of the town of Gonzalez (23.087222°N, 98.469444°W, datum: WGS84; elev. 360 m.; 28.3°C) on 20 September 2006, 1100 h. (CST). An adult *D. margaritiferus* (SVL = 83.8 cm) was collected in tropical deciduous forest in the southern foothills of the Sierra de Tamaulipas in a riparian area of the Arroyo el Cedral. As above, the specimen went limp and became motionless while being photographed. When the anterior half of the snake was raised off the ground the head and anterior body hung limp and when released the head of the snake came to rest upside down, with an elevated coil in the neck, and the posterior half of the body dorsal side up. When left in this position, the snake remained motionless. Unlike the first observation, this snake seemed to show slight signs of recovery as it was being photographed for ca. 5 min. A few times it started to orient its head right side up and made some feeble attempts to move its body forward, but it repeatedly relapsed. The second snake was also released at the location of its capture after being photographed.

Finally, 30 *D. margaritiferus*, 21 alive and 9 DOR, were recorded in field surveys of Tamaulipas conducted between 2003 and 2007. Seven of the live specimens were collected, handled, measured, photographed, and then released. Two of the seven (28.5%) individuals that were handled exhibited thanatosis. Photographs of the two specimens were deposited at University of Texas Arlington Digital Collection (UTADC 6808–6810). DOR specimens were salvaged and deposited at the Universidad Autónoma de Nuevo León.

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***ERYTHROLAMPRUS BIZONA* (Black-Ringed False Coralsnake). ARBOREALITY.** *Erythrolamprus bizona* is a moderately common snake that ranges between Costa Rica and Colombia. All accounts suggest that the snake is terrestrial (Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna between Two Continents, between Two Seas. Univ. Chicago Press, Chicago, Illinois. 934 pp.; Solórzano 2004. Snakes of Costa Rica: Distribution, Taxonomy, and Natural History. Instituto Nacional de Biodiversidad, Santo Domingo de Heredia, Costa Rica. 791 pp.). On 6 January 2011, at 1005 h, at La MICA Biological Station in

El Copé, Coclé Province, Republic of Panamá (08.66°N, 80.61°W; WGS84) we observed an adult *E. bizona* two meters high in a small tree. The snake moved to the end of the branch and then dropped to the ground and crawled away. *Erythrolamprus bizona* have not previously been reported to be arboreal. This observation expands the habitats that may be used by this species.

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***EUNECTES BENIENSIS* (Beni Anaconda). DIET: CANNIBALISM.** Cannibalism has been reported four times in the genus *Eunectes* (O'Shea 1994. Herpetol. Rev. 25:14; Rivas and Owens 2000. Herpetol. Rev. 31:45–46; Barros et al. 2011. Herpetol. Rev. 42:290–291). Two of these records were considered sexual cannibalism (Rivas and Owens, *op. cit.*), where a large female consumed a male of the same species during the breeding season. In this contribution we present the first report of cannibalism in the recently discovered *Eunectes beniensis*.

On 24 January 2010, as part of a comprehensive study of the spatial ecology and life history of *E. beniensis* in the Beni River basin, Beni Department, Bolivia, we captured a female *E. beniensis* (total length = 220 cm; 6 kg without prey) in a rice field (14.8°S, 64.467°W; WGS84). Following capture, the female regurgitated a conspecific male (total length = 192 cm; 2.5 kg; sex determined by presence of exposed hemipenes). Although the cephalic region of the regurgitated specimen was partially decomposed, it was possible to recognize the color pattern typical of *E. beniensis*. Because prior records of cannibalism in *E. murinus* occurred during or directly following the mating season (dry season), Rivas and Owens (*op. cit.*) believed that they were examples of sexual cannibalism. However, this report of cannibalism in *E. beniensis* occurred in the middle of the rainy season and thus was not likely to be associated with reproductive activities. The presence of cannibalism in three species of *Eunectes* in different locations suggests that it may be a relatively common strategy in the group.

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***HOLOGERRHUM PHILIPPINUM* (Philippine Stripe-lipped Snake). REPRODUCTION.** One of four snake genera endemic to the Philippines, the genus *Hologerrhum* contains only two species, known from fewer than 20 specimens worldwide (Brown et al. 2000. Asiatic Herpetol. Res. 9:1–13; Leviton 1963. Proc. California Acad. Sci. 31:369–416; Leviton 1965. Phil. J. Sci. 94:519–533). The apparent absence of adult males in collections previously led taxonomists to speculate that *H. philippinum* might be an all-female, parthenogenetic species (A. Leviton, pers. comm.). During recent fieldwork in the northern Philippines, we collected an adult male *H. philippinum* (total length = 302 mm; 4.8 g; Fig. 1). The specimen was observed on 28 December 2010, in mixed primary- and secondary-growth forest, under a rock in a dry river bed, in the Angat Dam Watershed Reserve, Sitio Langud, Barangay San Lorenzo, Municipality of Norzagaray, Bulacan Province, Luzon Island, Philippines (14.93231°N, 121.20562°E, WGS-84; elev. 194 m). This is the first known reproductively mature male specimen of *H. philippinum*; the only other male specimen is a juvenile with hemipenes retracted (USNM 498718; Brown et al., *op. cit.*). The specimen is deposited at the herpetological collections of the Biodiversity Institute, University of Kansas (RMB 13628).



FIG. 1 An adult male *Hologerrhum philippinum* from the Angat Dam Watershed Reserve, Luzon Island, Philippines.

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***IMANTODES CENCHOA* (Brown Blunt-Nosed Vinesnake). MAXIMUM SIZE.** *Imantodes cenchoa* is a relatively abundant neotropical arboreal snake that ranges from southern Mexico to Argentina. It is recognized by its long slender body and extremely thin neck. Savage (2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna between Two Continents, between Two Seas. Univ. Chicago Press, Chicago, Illinois. 934 pp.) reported a maximum size of 1250 mm for female *I. cenchoa*. On 5 December 2006, at 2000 h, in Omar Torrijos National Park, Coclé Province, Republic of Panamá (08.66°N, 80.61°W, datum: WGS84), we found a female *I. cenchoa* that measured 1369 mm total length (SVL = 943 mm) and weighed 47.4 g. This snake was marked and released at the site of capture. On 8 March 2007, at 2236 h, in Omar Torrijos National Park we found a female *I. cenchoa* that measured 1439 mm total length (SVL = 986 mm) and weighed 36.0 g (without prey). This snake contained a *Dactyloa frenata* (19.1 g) and a large anole egg (1.3 g) prey items (Ray et al. 2011. Herpetol. Rev. 42:100). Photographs of this specimen were deposited at the Amphibian and Reptile Diversity Research Center, University of Texas at Arlington (UTADC 6526–27). The first record increased the maximum known total length of female *I. cenchoa* by 119 mm (8.6%) and the second by 189 mm (15.1%).

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***LAMPROPELTIS GETULA* (Common Kingsnake). DIET AND FORAGING.** The ability of a snake to successfully forage is a product of its morphology, physiology, and ecology (Mushinsky 1987. *In* Seigel et al. [eds], Snakes: Ecology and Evolution Biology, pp. 302–334, McGraw-Hill, New York). Consuming non-prey items by mistake could be detrimental to the snake and result in death. Thus, selection should favor behaviors that maximize a snake's ability to accurately discriminate between prey and non-prey items (Cooper et al. 1990. Chemoecology 1:86–91; Reiserer 2002. *In* Schuett et al. [eds], Biology of the Vipers, pp. 361–384, Eagle Mountain Publishing, Eagle Mountain, Utah).

Lampropeltis getula is an active forager that relies on both sight and chemoreception to locate and capture prey (Jackson et al. 2004. Zoology 107:191–200; Williams and Brisbin 1978. Herpetologica 34:79–83). This species, like others in the genus *Lampropeltis*, is known to routinely consume ectothermic (e.g., squamates) and endothermic (e.g., birds and mammals) prey, as well as squamate eggs (Clark 2009. Southwest. Nat. 54:352–353). Studies have investigated prey selection in snakes, including *Lampropelis* (Fitch 1978. Trans. Kansas Acad. Sci. 81:353; Greene and Rodriguez-Robles 2003. Copeia 2003:308–314), however, little is known about their ability to discriminate between certain qualitative traits of prey (e.g., color and texture).

In June of 2003 at Flat Rock Cedar Glade and Barrens, located east of Murfreesboro, Rutherford Co., Tennessee, USA, a *Coluber constrictor* nest was predated upon by an adult male *L. getula* (SVL = 71.6 cm). The snake consumed three *C. constrictor* eggs and an artificial egg, which had been constructed to record nest temperature, leaving behind two other *C. constrictor* eggs. Despite being of similar size, shape, and weight, the artificial egg was bright yellow in color (i.e., coated in Plasti Dip®), denser, and had a smoother texture than a *C. constrictor* egg. The oviposition site and artificial egg, which had only been there for approximately two weeks, were located in an ecotone between a cedar forest and a glade. The *L. getula* was located approximately 25 m away under a large rock, and the food items were palpated in order to retrieve the artificial egg. The snake was promptly release unharmed at the site of capture after recovering the artificial egg and recording basic measurements.

This observation indicates that *L. getua* will mistakenly consume non-prey items in the wild despite its visual and chemosensory capabilities. Similar observations have been made in other snakes (Ernst and Ernst 2003. Snakes of the United States and Canada, Smithsonian Institution Press, Washington, DC. 680 pp.; Souza et al. 2004. J. Herpetol. Med. Surg. 14:4–5) suggesting that despite some discriminatory abilities in prey selection, snakes may become confused when non-prey items that resemble prey are encountered while foraging. To our knowledge this is the first report of this type of behavior in *L. getula*.

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***LAMPROPELTIS GETULA HOLBROOKI* (Speckled Kingsnake). DIET.** *Lampropeltis getula holbrooki* is known to prey on reptiles and reptile eggs, amphibians, mammals, and several species of birds that construct open-cup nests (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Inst. Press, Washington DC. 680 pp.). One published account documents *L. g. holbrooki* depredating nestlings in open-cups: the Dickcissel (*Spiza americana*) and the Red-winged Blackbird (*Agelaius phoeniceus*; Facemire and Fretwell 1980. Wilson Bull. 92:249–250). These nests were located 15 cm and 70 cm above the ground, respectively. *Lampropeltis g. holbrooki* has also been documented to depredate nestling Indigo Buntings (*Passerina cyanea*) and Field Sparrows (*Spizella pusilla*), both species that construct open-cup nests within 1 m of the ground (Stake et al. 2005. J. Herpetol. 19:215–222). Although *L. g. holbrooki* has been observed depredating Eastern Bluebird (*Sialia sialis*) nest-boxes in Texas (Keith Kridler, pers. comm.), there is no published documentation of *L. g. holbrooki* climbing an artificial structure and consuming this species of cavity-nesting bird.

On 25 June 2010, at 1130 h, we discovered a *L. g. holbrooki* inside of a constructed Eastern Bluebird nest-box mounted 1.5 m above the ground. This nest box was mounted on a fence at the edge of a hay field off of state highway 51 in Payne Co., Oklahoma, USA (36.1152°N, 97.3007°W; datum WGS84). There were four 7-day-old bluebird nestlings inside the box being tended by both parents. The snake could only enter through the entry hole (3.81 cm in diameter). The snake was observed eating one nestling and constricting another. The observer opened a hinged door that was held shut with a nail and took photos, then closed the door without disturbing the snake. Only one nestling was consumed at this time and the rest remained alive. We monitored the box for the next two days and observed one nestling missing on each successive visit. Although we did not observe any other depredation events during our visits, we speculate these nestlings were preyed upon by the same snake. Similar return behavior to a nest was documented by Stake et al. (2005. J. Herpetol. 19:215–222). Only one nestling fledged from this box on 7 July 2010. To the best of our knowledge, this is the first documentation of *L. g. holbrooki* climbing and consuming nestlings inside of a secondary cavity.

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***LAMPROPELTIS ZONATA* (California Mountain Kingsnake). DIET.** *Lamproteltis zonata* is distributed from southern Washington state to northern Baja California and throughout the mountain ranges of California (Stebbins 2003. Peterson Field Guide: Western Reptiles and Amphibians, 3rd ed. Houghton Mifflin Co., New York. 366 pp.). The diet of this species has been examined in detail (Greene et al. 2003. Copeia 2003:308–314); it appears that the bulk of its diet consists of squamate reptiles



FIG. 1. *Lampropeltis zonata* constricting and beginning to consume a bat (*Myotis* sp.) headfirst.

and their eggs, but larger individuals may occasionally consume mammals and birds.

At 1350 h, on 20 October 2009, one of us (CW) observed a *L. zonata* constricting a bat of the genus *Myotis* along the Rogue River trail of southwestern Oregon just off BLM Rd. 34-8-1 (42.663661°N, 123.611255°W; datum WGS84) (Fig. 1). This section of the trail is adjacent to a talus slide. It is likely that the kingsnake found and captured the bat within the talus, and the two subsequently fell and rolled onto the trail. The two were not disturbed and actual consumption of the bat was not observed. This is the first record of *L. zonata* attempting predation upon a bat.

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***LEPTODEIRA PUNCTATA* (Western Cat-Eyed Snake). DIET.** Snakes in the genus *Letpodeira* prey primarily upon anurans and small lizards (Duellman 1958. Bull. Amer. Mus. Nat. Hist. 114:1–152), along with other reptiles and amphibians (Burchfield 1993. Bull. Chicago Herpetol. Soc. 28:266–267). Although species from the family Hylidae have been documented (Hardy and McDiarmid 1969. Univ. Kansas Publ. Mus. Nat. Hist. 18:39–252), *Smilisca fodiens* (=*Pternohyla fodiens*; Northern Casque-Headed Frog) has not been reported as prey of *Leptodeira punctata* (Duellman and Trueb 1966. Univ. Kansas Publ. Mus. Nat. Hist. 17:281–375). On 5 August 2008, at approximately 1930 h, we encountered an adult *L. punctata* with an adult *S. fodiens* in its grasp near the town of Concordia, Sinaloa, Mexico (23.2725°N, 106.03585°W; datum WGS84) (Fig. 1). The *S. fodiens* was inflated with air in an attempt to prevent the snake from consuming it. The *L. punctata* continuously chewed on the *S. fodiens* for approximately 45 min until the frog deflated and was consumed. This is the first documentation of a *L. punctata* preying upon a *S. fodiens*.

COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND



FIG. 1. *Leptodeira punctata* preying upon an adult *Smilisca fodiens* in Sinaloa, Mexico.

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***LIOPHIS DILEPIS* (Lema's Ground Snake) and *PHILODRYAS OLFERSII LATIROSTRIS* (Lichtenstein's Green Racer). BROMELIAD REFUGIA.** *Liophis dilepis* is colubrid species with a disjunct distribution, including Caatinga and Cerrado areas in northeastern and southern Brazil, and Chaco areas of Paraguay, northern Argentina, and southern Bolivia (Giraudo 2001. Serpientes de la Selva Paranaense y del Chaco Húmedo. L.O.L.A., Buenos Aires, Argentina. 328 pp.). In Argentina and southern Paraguay, the species inhabits savannas, xerophilous and semi-xerophilous forests in the Chaco biogeographic province (Giraudo, *op cit.*). *Philodryas olfersii* is a colubrid snake that is widely distributed in tropical and subtropical areas of cis-Andean South America from Guiana, Venezuela, and Colombia, to subtropical areas of Argentina and Uruguay (Thomas 1976. A Revision of the South American Colubrid Snake Genus *Philodryas* Wagler, 1983. Ph.D. dissertation, Texas A&M University, College Station. 338 pp.). In Argentina, *P. o. latirostris* is found in the humid Chaco phytogeographical region and other mesophytic vegetation and gallery forests along the Paraná River (Thomas, *op cit.*; Giraudo, *op cit.*).

We conducted periodic diurnal surveys to investigate the fauna associated with colonies of *Aechmea distichantha* (Bromeliaceae) at El Perichón, 10 km NE of Corrientes City, Argentina (27.4321111°S, 58.7466111°W, datum: WGS84). The area is included within the Chacoan Domain, Oriental Chaco District (Carnevali 1994. Fitogeografía de la Provincia de Corrientes. Gobierno de la provincia de Corrientes e INTA. 324 pp.), and is characterized by the presence of numerous temporary, semipermanent, and permanent water bodies. The original plant community at the study site was *Schinopsis balansae* "quebracho" forest, which is currently extremely degraded and largely replaced by sclerophyllous forest with prevalence of *Prosopis affinis*, *P. nigra*, *Acacia caven*, *Celtis* spp., and numerous colonies of *Aechmea distichantha* and *Bromelia* spp. (Carnevali, *op. cit.*). On 1 October 2007, at 1726 h, we found an adult *L. dilepis* inside

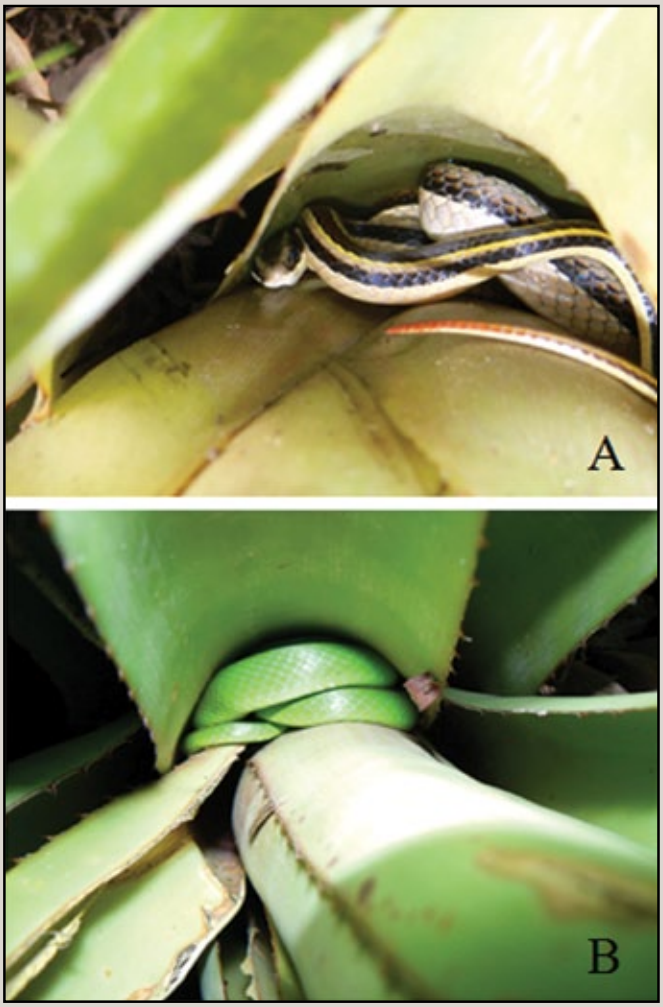


FIG. 1. A) *Liophis dilepis* and B) *Philodryas olfersii latirostris* hidden inside the axils of *Aechmea distichantha*.

an *A. distichantha* leaf axilla (Fig. 1A). Six days before, on 27 September 2007, at 1900 h, within another *A. disctichantha* colony, we discovered an adult *P. o. latirostris* hidden inside a bromeliad axil (Fig 1B). Considering that these snakes were found hidden in evening hours, it is possible that they use the axils of *Aechmea distichantha* as nocturnal shelter. It is also important to note that bromeliad axils have the capacity to store water for long periods and are used by several amphibian species. Thus, these plants may provide snakes abundant food in addition to shelter.

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***LIOPHIS EPINEPHELUS* (Night Ground Snake). DIET.** *Liophis epinephelus* is found in South America from Venezuela to Peru, at or above 2200 m in Ecuador and Peru (Dixon 1989. Smithson. Herpetol. Info. Serv. No. 79). *Liophis* are thought to feed primarily on anurans, but their diet is also known to include invertebrates, lizards, fishes, birds, small rodents (Esqueda et al. 2009. Acta Herpetol. 4:171–175), and squamates (Michaud and Dixon 1989. Herpetol. Rev. 20:39–41), including only a few records from the family Geckkonidae. In this note I report the first record of a *Liophis* feeding on gecko of the genus *Lepidobleparis*.

On 7 August 2010, a *Liophis epinephelus* (SVL = 140 mm) was captured in a disturbed-regenerating portion of Reserva Las Gralarias, a private 1064-acre reserve located in northwestern Ecuador, Pinchincha (elev. 1750–2350 m). Almost immediately upon being handled the snake regurgitated a *Lepidobleparis conolepis* (SVL = 38.5 mm). The gecko showed little evidence of digestion, indicating this was a very recent meal. The *L. conolepis* specimen was collected and deposited in the herpetological collection of Museo de Zoologia QCAZ, Pontifica Universidad Catolica del Ecuador and identification was verified by Omar Torres Carvajal.

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***MICRURUS MIPARTITUS* (Redtail Coralsnake). DIET.** New World coralsnakes are predators of elongate vertebrates, especially snakes, lizards, and amphisbaenians (Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna between Two Continents, between Two Seas. Univ. Chicago Press, Chicago, Illinois. 934 pp.). They apparently do not eat amphibians very frequently (Wells 2007. The Ecology and Behavior of Amphibians. Univ. Chicago Press, Chicago, Illinois. 1148 pp.), although some species prey upon caecilians (Roze 1996. Coral Snakes of the Americas: Biology, Identification, and Venoms. Krieger Publ., Malabar, Florida. 328 pp.). Here we report *Micrurus miparitus* preying upon a caecilian, *Caecilia thompsoni*.

On 25 May 2010, at 1240 h, we observed a *M. mipartitus* (total length = 46.5 mm) struggling with a *C. thompsoni* (total length = 47.3 mm) for about 25 min at ICA (Instituto Colombiano Agropecuario) station in Tolima, Colombia (4.4388889°N, 75.2319444°W, datum WGS84; elev. 1150 m). We observed the coralsnake pursuing and biting the caecilian, primarily on the neck (Fig. 1A). Once the caecilian was immobile, it was ingested head-first (Fig. 1B). However, the caecilian, which was longer than the coralsnake, could not be totally consumed and was eventually regurgitated.

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FIG. 1. *Micrurus mipartitus* biting (A) and ingesting (B) a caecilian, *Caecilia thompsoni*.

***OPISTHOTROPIS KUATUNENSIS* (Striped Stream Snake). DIET.** *Opisthotropis kuatunensis* is a non-venomous aquatic snake with an average total length of 35–48 cm (Karsen et al. 1998. Hong Kong Amphibians and Reptiles. Provisional Urban Council, Hong Kong. 186 pp.). This snake is endemic to southern China and inhabits rocky hill streams in forests. It has been reported to feed on tadpoles and fishes in captivity (Karsen et al., *op. cit.*). Information concerning the diet of this species, or any other species of *Opisthotropis* in the wild, is very limited. *Opisthotropis lateralis* has been reported to feed on crabs in its natural environment (Karsen et al., *op. cit.*). Here I report the first documented observation of *O. kuatunensis* feeding on a crab in the wild.

At 2120 h on 3 October 2010, on Tai Mo Shan (22.40847°N, 114.12895°E, datum WGS84; elev. 769 m), New Territories, Hong Kong, while conducting an amphibian survey, I observed an *O. kuatunensis* (SVL = 52.5 cm; total length = 64.0 cm; sex unknown) swimming in the stream with a dead freshwater crab, *Cryptopotamon anacoluthon*, in its mouth. Upon capture, the snake released the carcass of the crab, which was collected and preserved in ethanol. The crab was presumably freshly molted, since its carapace was soft and deformed by bites from the snake. Except for two left legs, all chelae and other legs were missing from the carcass and may have been consumed by the snake (Fig. 1). This observation of a crab being eaten by *O. kuatunensis* is surprising because this species' small blunt teeth and relatively small gape size suggest that it preys on small or soft-bodied animals. In this observation, the dimensions of the crab's carapace were 2.0 cm (width) by 1.5 cm (length) while the head width and body width of the snake was approximately 1 cm. Despite its small gape size, the snake probably could have eaten the crab because it was freshly molted. It is unlikely that *O. kuatunensis* would be able to swallow the crab intact if it was hard-shelled.



FIG. 1. *Opisthotropis kuatunensis* (above) found feeding on a freshwater crab (*Cryptopotamon anacoluthon*; above and below) on Tai Mo Shan, Hong Kong.

It is possible that the snake may have been scavenging on a dead crab. Aquatic snakes may scavenge more frequently than other snakes since they tend to rely on chemical cues for prey detection underwater (DeVault and Krochmal 2002. Herpetologica 58:429–436). Although I did not observe the initial encounter of the *O. kuatunensis* with the crab, the relatively intact carapace of the dead crab suggested that the crab was not likely remains left by another predator. Potential crab predators in the area include Big-headed Turtles (*Platysternon megacephalum*) and Giant Spiny Frogs (*Paa spinosa*), both of which would have inflicted obvious damage to the crab or consumed the crab whole.

The aquatic snake *Gerarda prevostiana* preys on crabs much larger than its head (Jayne et al. 2002. Nature 418:143). This species circumvents the constraint of its gape limit by selectively preying on freshly molted crabs; it tears off and consumes the crab's legs first by a "loop-and-pull" action and then discards body parts that are too large to swallow (Jayne et al., *op. cit.*). The carcass of the freshly molted crab with missing legs suggests that *O. kuatunensis* may represent another species that engages in this unusual crab-eating behavior. Additionally, *O. kuatunensis* may selectively prey on or scavenge freshly molted crabs that are more easily ingested. Becasue crab molting can be temperature-triggered and thus highly seasonal (Yamaguchi and Takamatsu 1980. Kumamoto J. Sci. Biol. 15:1–27), crabs may be a seasonally important food source for *O. kuatunensis*.

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***PITUOPHIS CATENIFER* (Gophersnake). DIET.** *Pituophis catenifer* feeds primarily on mammals, birds, lizards, eggs, and occasionally invertebrates (Diller and Johnson 1988. Herpetologica 44:228–233; Rodriquez-Robles 1998. Copeia 1998:463–466.; Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Institution Press, Washington D.C. 668 pp.). On 20 May 2009, we collected an adult male *P. catenifer* (total length = 99 cm) from a south-facing limestone outcrop directly below a large, shallow cave in Snake Creek Canyon, Great Basin National Park, Nevada, USA (38.9169°N, 114.1731°W; datum NAD83). Upon palpation, the snake regurgitated two male *Tamius dorsalis* (Cliff Chipmunk) pups (BYU 5660; verified by Jack Sites and Eric Rickart). To the best of our knowledge, this is the first record of predation on *T. dorsalis* by *P. catenifer*.

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***PITUOPHIS CATENIFER DESERTICOLA* (Great Basin Gophersnake). PREDATION.** A variety of taxa have been observed to prey upon *Pituophis catenifer*, including mammals, birds-of-prey, and other snakes (Ernst and Ernst 2003. Snakes of the Unied States and Canada. Smithsonian Institution Press, Washington, D.C. 668 pp.). Here, we describe an unusual two-day observation of predation on a mature Great Basin Gophersnake by a Brown Trout (*Salmo trutta*).

The observation took place in Jones Canyon, Utah, USA, on the grounds of the Jones Hole National Fish Hatchery (JHNFH). Jones Creek emanates from springs at the head of Jones Canyon on hatchery grounds, and flows north to south 6.4 km to the Green River, approximately paralleling the Utah-Colorado border. The stream runs for ca. 0.3 km through a concrete channel across hatchery property before exiting into Dinosaur National Monument. The stream forms a pool at the end of the channel, which is cordoned off from public access by a 2 m high chain link fence. All insects and small wildlife species that fall into the channel are swept into this pool. The hatchery provides a plentiful supply of trout for the stream (primarily *S. trutta, Oncorhynchus mykiss,* and *O. clarki*) through escapes and planned releases. Numerous trout, many large, congregate in this pool, where they are protected from angling and are clearly visible. We have frequently observed snakes of various species basking atop the concrete walls of the channel. Through being startled or other accident, they may drop into the channel and are swept downstream to the pool. Partial bodies of snakes were observed on the bottom of the pool.

On 2 May 2006 the posterior portion of an adult *P. c. deserticola* was observed streaming from the mouth of a large (total length ca. 60 cm) *S. trutta,* the largest trout observed in the pool at the time. The visible length of the snake was approximately the same length as the fish carrying it and the diameter of the snake at the fish's mouth was ca. 2.5 cm. We estimate that the total length of the snake was ca. 90 cm. On the following day, the fish carrying the snake remained clearly visible throughout the day, with no readily apparent changes from the previous day. However, on 4 May 2006 there was no fish carrying a snake in the pool. We do not know if the snake was disgorged, swallowed, or if the fish vacated the pool. No whole or partial remnants of the snake were visible in the pool, only the portions of smaller snakes that were in the pool when observations began. To our knowledge, this is the first account of a Brown Trout consuming a mature *P. catenifer deserticola.*

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***PSEUDOBOA NIGRA* (Mussurana). DIET.** Two color morphs of *Pseudoboa nigra* exist in Brazil. The most common is plain black; the other is black with irregular white patches and might represent a different species (Orofino et al. 2010. Phyllomedusa 9:53–61). Although the diet of *P. nigra* consists primarily of lizards (Vanzolini et al. 1980. Répteis das Caatingas. Academia Brasileira de Ciências, Rio de Janeiro. 161 pp.), only two wild feeding events, both involving the black morph, have been reported (Avila and Ferreira 2006. Herpetol. Rev. 37:82; Rocha et al. 1999. Herpetol. Rev. 30:229). Here we report the first wild feeding observation of the black and white morph of *P. nigra* from Reserva Natural Vale, municipality of Linhares, Espírito Santo State, southeastern Brazil (19.1519444°S, 40.0708333°W; elev. 34 m). At ca. 0800 h, on 5 February 2008, we encountered an adult *P. nigra* (total length ca. 120 cm) in the process of swallowing a *Tropidurus torquatus* (total length ca. 25 cm; Fig. 1). At the time, the lizard was apparently dead and there were blood spots on posterior leg and feet. Despite our approach, the snake continued ingesting the lizard headfirst until it was consumed, approximately 1 h later.

We thank Francisco L. Franco (IBSP) for snake identification and Marco Aurélio de Sena and Miguel T.U. Rodrigues (IBUSP) for lizard identification.



FIG. 1. *Pseudoboa nigra* preying on *Tropidurus torquatus* (Linhares, Espírito Santo, Brazil).

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***SISTRURUS MILIARIUS BARBOURI* (Dusky Pygmy Rattlesnake). PREDATION.** Known predators of *Sistrurus miliarius* include carnivorous mammals, hawks (*Buteo* spp.), and snakes (Ernst and Ernst 2002. Snakes of the United States and Canada. Smithsonian Institution Press, Washington D.C. 661 pp.). At 1852 h, on 13 November 2010, we observed a juvenile Yellow-crowned Night-Heron (*Nyctanassa violacea*) in the grass beside the road in Everglades National Park, Florida, USA



FIG. 1. Juvenile Yellow-crowned Night-Heron (*Nyctanassa violacea*) preying upon a *Sistrurus miliarius* in Everglades National Park, Florida.

(25.139098°N, 80.932128°W; datum WGS84). On closer inspection we ascertained the presence of an adult *S. miliarius* in the bird's beak (Fig. 1). We witnessed the heron thrash the snake approximately eight times in a 15-min span, with numerous tosses by the bird to adjust its grip on the snake, positioning its beak towards the head with each toss. The snake made several attempts to wriggle free but was apparently injured by the time we arrived and we assume the struggle commenced some time before our arrival. We watched until 1907 h when the heron ingested the entire *S. miliarius* and then flew off. The fact that we could see resistance from the snake as it writhed and tried to escape and the lack of any visible external injuries on the snake led us to believe the interaction was an act of predation and not scavenging of a road-killed animal by the *N. violacea*. Although wading birds are known to consume aquatic snakes (e.g., *Nerodia* spp.; Ernst and Ernst, *op. cit.*), to our knowledge, predation by wading birds on snakes of the genus *Sistrurus* has not been previously reported.

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***TANTILLA MELANOCEPHALA* (Black-headed Snake). DIET.** Little natural history data are available for the large genus *Tantilla*, with the exception of the North American *Tantilla gracilis* and *T. coronata* (e.g., Cobb 2004. Copeia 2004:397–402; Todd et al. 2008. Copeia 2008:388–394). The available information on the diet of the widespread *T. melanocephala* all pertains to southeastern Brazil and suggests an exclusively invertebrate diet consisting primarily of scolopendrid centipedes (Marques and Puorto 1998. Amphibia-Reptilia 19:311–318).

At 1430 h on 31 July 2010 an adult female *T. melanocephala* was found in a dry hole inside a steep-sided verge off a path in the Santa Lucía Cloud Forest Reserve, Pichincha, Ecuador (00.12917°N, 076.8048°W, datum WGS84; elev. ca. 1800 m). The specimen, which was in ecdysis, was found along with a number of eggs of the lizard *Riama oculata*. Upon capture one of the eggs was accidentally broken and the *T. melanocephala* subsequently started to 'lap up' the contents. It was unclear whether the specimen was intentionally in the area to feed upon the eggs. On closer examination, some of the eggs had hatched and others were complete but with two small holes in them, with no contents inside.

We thank Earthwatch Institute for funding our fieldwork, and all of the staff at the Santa Lucía Cloud Forest Reserve and Earthwatch volunteers for their support and help. We also thank Ernesto Villacis Perez for hatching out the eggs and Vanessa Aguirre P for identification of the *Riama oculata*.

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***THAMNODYNASTES HYPOCONIA*. DIET.** Snakes of the genus *Thamnodynastes* are widely distributed in South America, but little information is available on their biology (Franco and Ferreira 2002. Phyllomedusa 1:57–74). *Thamnodynastes hypoconia* is a small (mean SVL = 300 mm), semiarboreal, nocturnal species that inhabits riparian areas, the borders of gallery forests, marshes, and temporary ponds (Sawaya et al. 2008. Biota Neotrop. 8:127–149).

On 12 January 2010, at 2114 h, in an area of Cerrado in the municipality of Borebi, São Paulo State, Brazil (22.8035°S 49.0044°W, datum WGS84; elev. 652 m) we encountered an adult *T. hypoconia* (SVL = 350 mm) near a pond. The animal was next to the fence of a pitfall trap. The snake was collected and placed in a plastic bag. After about 30 min we observed that the snake had regurgitated a frog, which we subsequently identified as *Chiasmocleis albopunctata* (SVL = 37 mm), a microhylid that occurs in open areas in the central region of South America (Caramaschi and Cruz 1997. Herpetologica 53:259–268). The animals were collected and deposited in the Scientific Collection Jorge Jim, located at Departamento de Zoologia, Instituto de Biociências, UNESP, Campus de Botucatu, São Paulo State, Brazil (CCJJ 7932, License IBAMA/ICMBio - SISBIO 16778-1). On the same night, about 40 calling male *C. albopunctata* were recorded. *Thamnodynastes hypoconia* seems to specialize on anurans; Sawaya et al. (2008, *op. cit.*) reported one of these snakes trying to eat an adult *Elachistocleis ovalis*. This is the first record of *T. hypoconia* preying upon *C. albopunctata*.

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***THAMNOPHIS BRACHYSTOMA* (Short-headed Gartersnake). REPRODUCTION: MAXIMUM LITTER SIZE.** Maximum litter size for *Thamnophis brachystoma* has been reported as 14 (Hulse et al. 2001. Amphibians and Reptiles in Pennsylvania and the Northeast. Cornell Univ. Press, Ithaca, New York. xii + 419 pp.; Swanson 1952. Am. Midl. Nat. 47:161–182). Here I report two litters exceeding this number. On 22 July 2005, I found a gravid female *T. brachystoma* at a site 6 km SE of Wattsburg, Erie Co., Pennsylvania, USA, that I maintained in captivity until parturition. She produced 16 young on 8 August 2005, of which 15 were live and one was stillborn. The mean mass of these 16 offspring (mean ± SD, [range]) was 0.95 ± 0.069 g (0.85–1.07 g). An additional stillborn individual (not measured) was produced on 10 or 11 August, for a total litter size of 17. Mass of the adult female on 6 August was 46.05 g, and was 23.10 g on 8 August, after parturition. The female and her living young were released at the point of capture. On 22 July 2007, I captured another gravid female (SVL = 396.8 mm, total length = 511.3 mm) at the same site. This individual gave birth to 16 live young in captivity on 2 August. Mean SVL (mean ± SD [range]) was 112.6 ± 2.13 mm (109.0–116.8 mm), and mean total length (mean ± SD, [range]) was 146.3 ± 4.25 mm (139.6–152.8 mm). There were 7 females and 9 males. The female (TREC R- 00028) and her litter (TREC R- 00029) were deposited in the collection of the Natural History Museum at the Tom Ridge Environmental Center.

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***THAMNOPHIS ELEGANS* (Terrestrial Gartersnake). PREDATION.** At approximately 0715 h on 25 November 2009, 16 km N of Cabin City, Sanders Co., Montana, USA (47.474°N, 115.236°W, NAD83; elev. 1573 m) we observed a minimally digested *Tham-*

nophis elegans in the scat of a Gray Wolf (*Canis lupis*). The scat was fresh as it was still warm on top of melting snow at an air temperature of approximately -8°C. Snow depth was approximately 25 cm. We found tracks from at least five wolves in the area. The snake was intact and after cleaning it in the snow was clearly identifiable to species based on coloration. It is unknown whether the wolf found the snake active or removed the snake from its hibernaculum. In Montana, *T. elegans* are found at elevations up to 2499 m (Maxell et al. 2003. Herpetology in Montana. Northwest Fauna 5. Society for Northwestern Vertebrate Biology, Olympia, Washington. 135 pp.). Small animals including reptiles make up only a minor portion of a wolf's diet (Mech and Boitani 2003. Wolves: Behavior, Ecology and Conservation. University of Chicago Press, Chicago, Illinois, 428 pp.). However, this snake was not digested despite the gray wolf's efficient digestive tract (Mech and Boitani, *op. cit.*).

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***THAMNOPHIS SAURITUS SEPTENTRIONALIS* (Northern Ribbonsnake). REPRODUCTION: LITTER SIZE.** Litter size in *Thamnophis sauritus* is known to vary geographically (Rossman et al. 1996. The Garter Snakes: Evolution and Ecology. Univ. Oklahoma Press, Norman, Oklahoma. 332 pp.). The largest recorded litter was 26 from a specimen of *T. sauritus sackenii* collected in Florida (Telford 1952. Quart. J. Florida Acad. Sci. 15:175–185). Hulse (2001. Amphibians and Reptiles in Pennsylvania and the Northeast. Cornell Univ. Press, Ithaca, New York. xii + 419 pp.) reported a mean litter size of 11.3 (range 8–13) in a sample of 8 litters from Pennsylvania, but did not indicate which of the two subspecies native to the state were involved. Litter sizes reported for specimens from within the range of *T. s. septentrionalis* include 9 (Bishop 1927. Amphibians and Reptiles of Allegany State Park. New York State Museum. 141 pp.); 6, 9, and 10 (Gilhen 1984. Amphibians and Reptiles of Nova Scotia. Nova Scotia Museum. 162 pp.); and 7 and 9 (Langlois 1924, cited in Ruthven et al. 1928. The Herpetology of Michigan. Univ. Michigan. 229 pp.). Ruthven et al. (*op. cit.*) stated that they counted embryos in "a few specimens and they seem to average about a dozen." Carpenter (1952. Ecol. Monog. 22:235–258) reported an average litter size of 10 from 5 specimens in Michigan. Here, I report an unusually large litter of this subspecies from Erie Co., Pennsylvania, USA.

On 8 July 2007, I captured a gravid female *T. s. septentrionalis* (SVL = 565 mm; total length = 817 mm) in Pennsylvania State Game Land 109. I maintained her in captivity until parturition on 2 August 2007, when she produced 24 live young. There were 14 males and 10 females. Mean SVL of neonates (mean ± SD, [range]) was 156.7 ± 3.98 mm (147.8–163.5), mean total length was 225.9 ± 6.06 mm (214.3–239). The total mass of the litter was 39 g and the female's mass after parturition was 61 g, yielding a relative litter mass of 0.639. Photo vouchers of the female (TREC R-00086) and litter (TREC R-00087) were deposited in the collection of the Natural History Museum at the Tom Ridge Environmental Center. All snakes were released at the point of capture. I thank Brian Gray for useful input on the manuscript.

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***TROPIDONOPHIS DORIAE* (Barred Keelback). REPRODUCTION: MAXIMUM CLUTCH SIZE.** *Tropoidonophis doriae* is known from Indonesia (Irian Jaya, Aru Islands) and Papua New Guinea (Malnate and Underwood 1988. Proc. Acad. Nat. Sci. Philadelphia 140:59–201). Malnate and Underwood (*op. cit.*) reported seven clutches of *T. doriae* from New Guinea (mean 5.4 ± 2.0 SD; range: 3–8). The purpose of this note is to report a new maximum clutch size for *T. doriae*.

One female *T. doriae* (SVL = 904 mm) collected 27 January 2004 at Laronu, Central Province, Papua New Guinea (9.44387°S, 147.98383°E, datum WGS84; elev = 880 m), and deposited in the Bishop Museum herpetology collection (BPBM), Honolulu, Hawaii (BPBM 19486) was examined. A ventral incision was made in the lower body wall to expose the reproductive tract. Eleven oviductal eggs were counted which is a new maximum clutch size for *T. doriae*.

I thank Pumehana Imada (BPBM) for facilitating my examination of *T. doriae*.

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***TROPIDONOPHIS STATISTICUS*. REPRODUCTION: MINIMUM REPRODUCTIVE SIZE.** *Trophidonophis statisticus* occurs from southeastern Irian Jaya, eastward through the central massif of New Guinea (Malnate and Underwood 1988. Proc. Acad. Nat. Sci. Philadelphia 140:59–201). Malnate and Underwood (*op. cit.*) reported 18 *T. statisticus* females contained 3–9 eggs, of which the smallest female measured 483 mm SVL. The purpose of this note is to report a new minimum reproductive size for *T. statisticus* females.

One female *T. statisticus* (SVL = 415 mm) collected February 2003 at Siyomu Village, Milne Bay Province, Papua New Guinea (10.0171°S, 149.5970°E, datum WGS84; elev. 1300 m) and deposited in the Bishop Museum herpetology collection (BPBM), Honolulu, Hawaii as BPBM 17297 was examined. A rear ventral incision was made to expose the reproductive tract revealing three enlarged eggs > 6 mm length. Four-hundred fifteen mm is a new minimum size for reproductive activity in female *T. statisticus*.

I thank Pumehana Imada (BPBM) for facilitating my examination of *T. statisticus*.

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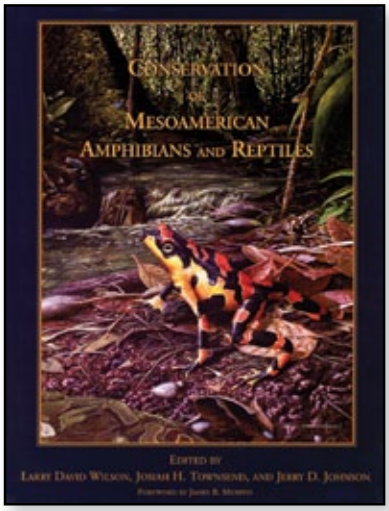
BOOK REVIEWS

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Conservation of Mesoamerican Amphibians and Reptiles

Edited by Larry David Wilson, Josiah H. Townsend, and Jerry D. Johnson. 2010. Eagle Mountain Publishing, LC, Eagle Mountain, Utah (available at: http://www.eaglemountainpublishing.com). xvii + 816 pp. Hardcover. US $135.00. ISBN 978-0-9720154-4-8.

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Mesoamerica is a region of megadiversity, with amphibians and reptiles especially well represented. Given the relative size of the region, diversity is extraordinary, yet despite decades of intense fieldwork the fauna is still not fully known. Sadly, this fauna is at great risk of extinction. Human population growth has been extraordinary. Costa Rica, with fewer than 900,000 people in 1950, is projected to have in excess of 5,900,000 in 2025. Mexico, which had fewer than 28,000,000 people in 1950, is projected to have about 130,000,000 people in 2025 (World Resources Institute 2011). These increases, roughly a factor of 5, are characteristic of the region. These dramatic increases in numbers of people are accompanied by rampant habitat modification that is taking a terrible toll. I made my first visit to Costa Rica in 1961, when a trip to Finca La Selva was still an adventure. Finca La Selva was a small, cleared area in a magnificent forest; today The La Selva Biological Field Station *is*, effectively, the forest.

Given the relatively small size of Mesoamerica compared to the great continents, its hepetological diversity is amazing. My favorite organisms, plethodontid salamanders, are especially well-represented. It is surprising enough that nearly 45% of all salamanders are the Neotropical plethodontids, but even more surprising is that 90% of these occur in Mesoamerica. One would like to think that we have a good understanding of amphibian diversity in the region. The message from salamanders is that we should not be so sure. In 1926 Dunn reported 30 species of tropical salamanders (Bolitoglossini). By 1976 the number had increased to 132 (Wake and Lynch 1976). Today 268 are recognized of which 241 occur in Mesoamerica (AmphibiaWeb 2011). This book lists 215, an indication of the rate of discovery and description of new species from Mesoamerica (and I know of more than 25 awaiting description). These are nearly all morphologically identifiable taxa; we are only beginning to appreciate how many cryptic species are yet to be described (Crawford et al. 2010). While distinctive new clades are still being discovered (McCranie et al. 2008), nonetheless it seems likely that we are largely at the stage of filling in details; the main dimensions of the herpetofauna are now known. Frankly, there is too little habitat remaining that has not been at least superficially surveyed for many more major discoveries to be made. Thus, the appearance of this book represents a benchmark in our understanding of the herpetofauna of Mesoamerica and the threats to it.

Following a Foreword by Jim Murphy and a somewhat longer Preface by the editors, the book is arranged in six major sections. Appropriately the first of these, entitled The Global Amphibian Assessment, is a chapter by Simon Stuart, Janice Chanson, Neil Cox, and Bruce Young. The Preface makes clear that this chapter was the first one completed for the book and that some time has passed since it was produced, due to delays in publication. The chapter is based on the 2004 assessment. Nevertheless, it is a nicely produced chapter that remains both useful and relevant.

The second section, by the editors, is a short, workman-like account of recent taxonomic changes. They recognize that this is a moving target. Unfortunately, by listing "previous names" and "present names" they inadvertently validate names that are currently in dispute. For example, debates continue over the content of such taxa as *Bufo*, *Rana*, and even less well-known taxa (e.g., *Hylobates*), and I do not think the authors are sufficiently clear that many such changes are matters of taste rather than rule, and are optional.

The largest and most ambitious section of the book is entitled "Distributional patterns of the herpetofauna of Mesoamerica, a biodiversity hotspot," by Wilson and Johnson. The chapter is more than 200 pages long. Following a well-constructed introduction to the natural setting of Middle America, the authors frame their analysis by recognizing 21 physiographic regions and 15 vegetation zones. They then proceed to categorize 731 species of amphibians and 1,148 species of reptiles with respect to these regions and zones. A key element of their analysis is calculation of a Coefficient of Biogeographic resemblance. They conclude that endemnicity of amphibians is very high, but reptiles, too, show strong endemism, with more than a half of the species endemic to specific countries. It is not surprising that Mexico has the highest levels of endemicity, given its relative size and topographic and historical geological heterogeneity. They also calculate a Coefficient of Habitat

Resemblence, which enables them to argue that Subalpine Moist Forest is most unlike other vegetation zones. This is not surprising to me, because salamander endemics, for example, are highly concentrated in cloud forests. This chapter is filled with tables, but also with words, and it is an impressive accomplishment. The data are up-to-date to the end of 2008. In an addendum they discuss 21 new studies (well into 2010) and discuss how these change their results. This is clearly a moving target and I think it was not worth the effort for such a short term update, given the rate at which publications on this region are appearing.

The remainder of the book is dominated by "country assessments," starting with Baja California, then proceeding from northern Mexico, central highlands of Mexico, southeastern Mexico, Belize, Guatemala, Salvadoran protected areas, Honduras, Nicaragua, Costa Rica, and finally to Panama. In addition to the three editors, authors include 26 people, mostly residents of the countries analyzed. The chapters contain lists of species, current conservation status (CITES, IUCN, and country-specific, where appropriate), environmental vulnerability scores, and occurrence in protected areas, but while there is general uniformity, each chapter has its own unique features. Overall the information content is valuable and the authors have made scattered information generally accessible.

Special conservation topics are covered in six chapters, mostly focused on particular taxa, but one, by Townsend and Wilson, deals with a vegetation type in a particular region (subhumid forest of Honduras). The book concludes with a section labeled "Looking Ahead," a ca. 50 page account by Wilson and Townsend summarizing the contents of the book and presenting a general discussion. A final appendix lists the conservation scores for the entire Mesoamerican herpetofauna. Their prognosis for the future of the unique herpetofauna of Mesoamerica is not very rosy.

Mesoamerica has an enormous herpetofauna, given its relatively small area, and levels of endemism are extraordinary. The book nicely balances analyses of political entities and those of physiographic regions and vegetation types. It was an audacious undertaking, and yet I think the results are substantive and illuminating. Probably most taxa are sufficiently well known (salamanders may be an exception) that the many tables and calculations will prove to be relatively robust.

The book is beautifully produced and it has a highly professional appearance. The individual chapters resemble journal articles in format, each with both English and Spanish abstracts and separate Literature Cited sections. The layout is attractive, the illustrations and photographs (although not numerous) are high quality and uniform in production, and the book is solidly bound with an attractive dustcover. However, the downside is that the book weighs 3.2 kg!

I congratulate the editors and authors for making a permanent contribution to our knowledge of the herpetofauna of Mesoamerica. Every student of the region will want to own this book.

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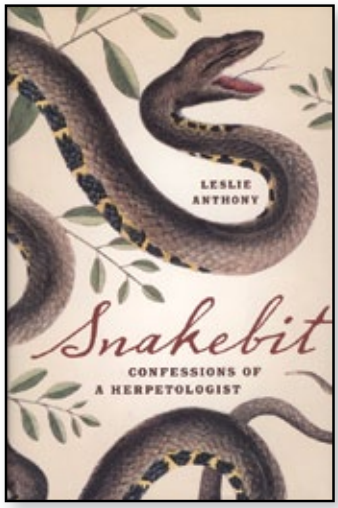
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Snakebit: Confessions of a Herpetologist

By Leslie Anthony. 2008. Greystone Books (http://www.dmpibooks.com/greystone-books). 292 pp. Hardcover. US $27.95. ISBN 978-1-55365-236-6 (also available in paperback and e-book editions).

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Reviewing books can sometimes be a tedious, dreary task for a scientist, foisted upon us by friendly (or pushy) editors-in-need. Hesitation to take on a book review is usually not so much based on disinterest in the matter presented in the book, but on the fact that there really isn't much "bang for the buck" in writing a book review: who really reads them anyway? Furthermore, considering the time commitment required for making a book review passably entertaining, we might rather spend our valuable time studying a real data set.

The request to review Leslie Anthony's *Snakebit* was different for two reasons, which gave the task an irresistible allure. Firstly, we know this ink slinger and most of his cabal well and, secondly, we are both immortalized in Chapter 8, entertainingly and ominously titled "Another Messy Freak Show." Playing a sufficiently prominent part in someone else's life to end up in "their book" is special, and led to instant agreement on our part to compose this review when approached. Little did we know how this freak show would play out, and we ask the reader's

forbearance if we respond to the author's literary kindness with our own sprinklings of humor.

To place *Snakebit* and its author into a proper context one must first deal with a nomenclatural issue. In professional herpetological circles, popular writer Leslie Anthony is none other than Leslie A. Lowcock, infamous and heretofore thickly mustachioed and otherwise hairy salamander geneticist, winner of the prestigious 1989 American Society of Ichthyologists and Herpetologists' Stoye Award. A search for publications under that name will reveal some fine research that lends Les lasting, indubitable scientific credibility. However, this path essentially terminates with the switch from Lowcock to Anthony, and it appears the herpetologist author of *Snakebit* morphed from passionate scientist to something much more tame and lame, a herp advocate. In fact, Les states that herpetology is his "distant past" (p. 7), one that he "released" (p. 8) some time ago. Despite this temporal break and the unjustified emendation of his name, and with forgiving admiration, his contributions to herpetology are still significant enough for us to accept that the moniker "herpetologist" still applies to Les. We simply marvel at Les's more recent fixation with a wide range of more popular prose, such as detailing adventures in places as divergent as the ski slopes of Scandinavia or the hunting grounds of Anticosti Island, through magazines such as *Powder*, *Skier*, or *Bike* (to name but a few), via an exposé of adventure skiing (and of skiing as an adventure) in his book *White Planet*, or in the interesting short film *Missing*.

Snakebit travels the classic arc of autobiography, from the protagonist's youth to his dotage, prefaced by a chilling experience in Finland that led to the writing of the book. The chapters provide appropriate thematic divisions to Les's story, and each chapter not only gives insights into the man we knew, but cleverly picks up one or more relevant scientific threads. Les masterfully integrates the science with his story and creates an intellectually appealing and entertaining narrative that will be attractive to the scientist and the interested amateur alike. A warning to those considering having their young children read the book, which, for its entertainment value, may be a draw: reality-based, but contextually gratuitous, f-bombs exist.

The trajectory of Les's life begins with a chapter describing the development for his initial interest in herps in suburban Toronto and at Camp Mil-da-ta-ca ("Into the Swamp"). A chapter introducing readers to some key herpetological influences for Les, which also serves as a well-timed introduction to herpetology as a science, follows ("Creepy Critters and Animals, Too"). Chapter 3 ("A Salamander Under a Log") showcases the on-goings in the lab of James Bogart at Guelph University (of particular interest to HK and TFS, since Jim is academic grandfather to us both). "Bulletin from the Pacific" is the story of a Fijian herp adventure with a solid exposé of hybridization, which completes a four-chapter set of what we classify as Les"s pre-professional life.

In the following five chapters, the author tells the story of Les Lowcock, the professional scientist. While this was the time in Les's career that included his greatest scientific contributions ("Slime Buckets"), it was also the time of fairly inane extracurricular activities ("Rommy, Can You Hear Me?"), noteworthy field trips ("A Day in Hell," "Boneheads") with über-scientists like the two Bobs (Murphy from the Royal Ontario Museum and Carroll from the Redpath Museum), and a postdoctoral fellowship ("Another Messy Freak Show"). The first of these chapters might best be summarized (with apologies to *The Producers*) as "Springtime for Leslie and Canada" as Les mud-wrestles hordes of "ambitious amphibian immigrants" (p. 95), salamanders in particular, as they emerge from the Canadian winter and need to be checked for their hybrid status. The chapter also includes a lot of valuable information on amphibian natural history and ancestry, as well as salamander genetics. In the Rommy chapter, Les follows on with a discourse on museum collections made lively by an introduction to his contemporaries at the Royal Ontario Museum. Having traveled widely ourselves, we are not convinced that Baja California is deserving of the chapter title "A Day in Hell," but we appreciated Les's perspective on deserts ("If the continents are the Earth's skin, then deserts are a patch of eczema on its butt." p. 132). We also applaud his insightful comments on biogeography, lizards, and the ancestry of birds. These are continued in "Boneheads" with well-placed paragraphs on fossils and the origin of snakes. The style of popular writing displayed in these chapters is probably why Les does so well outside the world of scientific journals. It is informative and captivating.

We separate out the chapter titled "Another Messy Freak Show" here since this is where Les includes us in his story. Doubtless, some interesting things did happen two decades ago, but memories can be deceiving. It is therefore with keen interest and satisfaction that we note the "Oprah Clause" on the book's dedication page, stating that in this book "anything to do with people is as close to true as the subjectivity of experience and the unconscious temptation to exaggerate will permit." We believe it likely that, as a result of an already addled brain, the "subjectivity of experience" failed Les. Characterizing TFS by a purported penchant for "hockey, hash, beer, and women" (p. 152) and HK as "Der Kaiser, [...] a cartoon character passing steam through his ears" (p. 159) could, in some circles, be considered unflattering. In the spirit of literary freedom, we understand these humorous depiction as more fiction than fact. We are convinced that neither the computer smash-up (HK was an early Apple adopter and used Macintosh computers even then, and there were definitely no old Mac parts anywhere in the PC-besotted museum) nor the frog-in-pee-snowglobe (even before getting a PhD, HK could tell "his" new species, a dendrobatid, from the eleutherodactylids of his research focus despite the purported tagging shenanigans) ever happened. We are happy to report that TFS repaid the soggy chair cushion in kind nearly two decades later at his office in Germany (TFS is the "former colleague" on p. 81). HK is still looking for a suitable snowglobe to fill and mail. Oprah Clause, indeed.

The remaining five chapters mostly form the Leslie Anthony component, or what may be considered the post-professional time of the story arc. Key episodes include additional fieldwork, in Vietnam ("Saving the World One Jungle at a Time"), Armenia ("Saving the World Redux"), the snake pits of Manitoba ("Ode to a Gartersnake"), and the Okanagan of British Columbia ("Riesling and Rattlesnakes"). "Geeks Like Us" introduces the reader to the discourse at scientific meetings, with particular mention of the early discussions about amphibian declines, with which Lowcock the Professional was intimately familiar in the Canadian context. Overall, the combination of science and storytelling is quite compelling and beautifully executed. Having now outlined the book in its entirety, let us be forthright and thank the two Finnish *kyy käärme* (*Vipera berus*) for leading Les onto the path of this autobiographical enterprise.

Of course, there are a few quibbles. In the first place, regarding the book's title it is unclear to us what Les is "confessing"—unless he is seeking absolution for occasional pranks that may not have been enjoyed equally by the prankees. We were also wondering why the snakebit poet-herpetologist would choose

cover art that, while doubtlessly meritorious, does not accurately depict its serpentine subject (we note with pleasure that this has been nicely remedied in the paperback). We found exactly two typos (p. 170: "Caldwell, Sharbel, Carroll, and me" instead of "and I"; p. 276: "Brughuel" should be "Brueghel") and want to note that the Grateful Dead did not play their unforgettable concert in Berkeley but in the Shoreline Amphitheatre in Mountain View (p. 237), where we were all enlightened by some serious second-hand smoke. Taxonomic quibbles are only minor (*Vipera* vs. *Pelias*, *Laudakia* vs. *Agama*, *Dolichophis* vs. *Hierophis*). We also take exception to the statement that "[animals were] waiting in the fridge for a governor's reprieve" (p. 61), since Canadian provinces are governed by Premiers and, at last accounting, Ontario was still a Canadian province. Furthermore, Cuban treefrogs, coquís, and Amazon forest frogs would have died in Jim Bogart's fridge and must have made their last home somewhere else. Lastly, it is incorrect to state (p. 102) that frogs of the genus *Eleutherodactylus* are the only vertebrate genus with a member in amber, as such specimens are also known for Hispaniolan *Anolis*, European lacertids, and geckos from three continents. All of this means that whereas the post-Lowcock Anthony *is* capable of scientific accuracy in listing by Latin binomials 13 species of salamanders, 20 frogs, 16 lizards, 10 turtles, 3 crocodilians, and 56 snakes, he nevertheless *is* a post-Lowcock Anthony.

The foregoing notwithstanding, nothing can detract from the genius of Les's writing. To use herpetological hyperbole, if David Dennis is the Robert Bateman of herpetology, then Leslie Anthony may be its Bard. How else does one explain flowing alliterations like "bevy of bewildered wildlife" (p. 12), "susurration of something sliding through grass" (p. 14), "dalliance of the decadent and deadly" (p. 250), or "As I wandered, waded, and wallowed, my nostrils flared daily with the pungent miasma of ... the Chthonic Domain" (p. 54). Who else could come up with "[The snake] brushes me with flickering tongue as a lover might" (p. 27), "[herpetology, a] lascivious vixen, with [a] dangerous embrace and many whispered secrets" (p. 167), or "the Trans-Canada Highway, [...] with the thawing carcasses of a zoo's worth of winter roadkill, draped on the shoulder like toys kids had shaken the stuffing out of and tossed from the car" (p. 218). Where else have herpetologists been exposed to new word creations like "the snake waterfalls between my hands like a slinky" (p. 27)? Since when is "waterfall" a verb? "Inculcated" (p. 133) or "mountebank," anyone? And then there are the plentiful, simply elegant expressions that convey in few words a fabulous image, such as "46 chromosomes ... lounging around in the nucleus in a great, unconcerned tangle" (p. 67), "Baja's deconstructionist landscape" (p. 137), "a bag of snakes can be a powerful carnet" (p. 139), and "Yerewan slid by like an unfinished basement" (p. 273). Given the magic of the writing, the book really ends too abruptly. Maybe we just wish for a reflective chapter so that the poetic journey through Scrabble didn't have to end so soon.

In approaching this review, we were initially mildly put out because of our own portrayal. However, we are content to allow Les his little bit of Oprah Clause-protected fiction in view of the undisputed service *Snakebit* does to bring some higher-level prose to herpetology. Just as *The Economist* magazine is capable of the twofer of excellence in news and writing, so Les is able to weave an appealing tale of solid scientific substance and choice composition (witness our feeble attempt at alliteration). Buy the paperback, because it has a real snake on the cover, and enjoy the read.

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Anfibios y Reptiles del Estado de Querétaro, México / Amphibians and Reptiles of the State of Querétaro, México

By James R. Dixon and Julio A. Lemos Espinal. 2010. Texas A&M University, Universidad Nacional Autónoma de México, and Comisión Nacional para el Conocimiento y Uso de la Biodiversidad, México, D.F. Available from Bibliomania (www.herplitsales.com). xvi + 428 pp. Hardcover. US $85.00. ISBN 978-607-7607-22-9.

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There is no denying the fact that México has become a world leader in assessing and conserving its herpetofauna. This is certainly due to remarkable growth in the number of professionally trained native herpetologists, along with the continued interest by international researchers, especially from the United States and Europe. Furthermore, several national and state organizations (e.g., Sociedad Herpetológica Mexicana, ECOSFERA, CONABIO, among others), including academic institutions, have been actively supporting and funding herpetological research projects on a state, regional, and national scale. *Amphibians and Reptiles of the State of Querétaro, México*, is one of the latest state oriented books, coauthored by two prominent herpetologists who have been investigating Mexican amphibians and reptiles for many years. James R. Dixon, now Professor Emeritus at Texas A&M University, along with many of his students, began visiting México around 1957 and was one of the first to begin assessing in detail the herpetofauna of Querétaro, the results of which formed a good portion of the baseline data used in the present volume. Julio A. Lemos Espinal is a Research Professor in the Laboratorio de Ecología of the Unidad de Biología, Technología y Prototipos de la Facultad de Estudios Superiores Iztacala UNAM. He has been studying the herpetofauna of northern and central Mexico and is well known for coauthoring, along with Hobart Smith, volumes on the amphibians and reptiles of Chihuahua, Coahuila, and Sonora. No two herpetologists were better suited for producing a book on the herpetofauna of Querétaro.

Amphibians and Reptiles of the State of Querétaro, México, is hardbound with a dust jacket and reasonably constructed for durability. It is bilingual in Spanish and English, most of which is divided by language in separate sections of the text. The introduction includes sections on historical herpetological perspectives, a description of the climate, geography, vegetation, an explanation of sections within species accounts, and a list of the current amphibians and reptiles known from the state. The bibliography,

maps (districts, topography, vegetation, and climate), photos of physiographic features and species (Appendix 1), gazetteer with mapped localities (Appendix 2), distribution maps (Appendix 3), and locality of collection (Appendix 4) are located near the end of the volume after species accounts. Accounts for the 117 listed species (29 amphibians, 88 reptiles) known from Querétaro are prefaced by descriptions of class, order, and family, and species accounts include sections on explaining title information ("title" here referring to scientific name, original author and date of original publication, and allocation to genus), common name, identification, morphology, coloration, distribution, habitat, behavior, diet, taxonomy, etymology, protected status, and references that are separate from the bibliography section located after the species accounts. The protection status section is based mostly on the classifications published in 2002 by Secretaria del Medio Ambiente y Recursos Naturales (SEMARNAT). Needless to say, the volume contains tremendous amounts of information not only gleaned from the literature, but most obviously from personal experiences by the authors. This is an essential book for anyone, including professional and amateur herpetologists, interested in the herpetofauna of Querétaro in particular and México in general.

The layout for the volume is good, although it would have been easier to use if the municipality, topography, vegetation, and climatic maps were placed closer to the section where they are discussed, but I suspect the placement was a publisher decision. There are a few minor typographical errors in the text, but none cause confusion. A very useful aspect of the species accounts are the dichotomous keys preceding each group, with depictions of valuable indentifying characters and figures of some species placed at appropriate positions within the keys.

The species accounts also include the "most important references" pertaining to each species, although it would have been helpful to the reader if a taxonomic cut-off date would have been designated in the introduction section to clear up any confusion of what literature sources were available for citation. That particular point leads to a related issue prevalent in not only the volume reviewed here, but in many recent comparable publications conveying significant taxonomic information. The issue is the lack of taxonomic synonymies being identified by literature sources, which if present would have aided readers unfamiliar with nomenclatural history. This is especially important today because of the large number of recent phylogenetic studies that have changed long established family and genus names (see Johnson et al., 2010 for a list of changes). In the case of the present volume, the following are pertinent (present names first followed by older names in brackets): *Anaxyrus*, *Incilius*, and *Rhinella* or *Chaunus* [*Bufo*]; *Craugastor* [*Eleutherodactylus*]; *Eleutherodactylus* [*Syrrhophus*]; *Ecnomiohyla* and *Scinax* [*Hyla*]; *Lithobates* [*Rana*]; *Spea* [*Scaphiopus*]; Scaphiopodidae [Pelobatidae]; Dibamidae [Anelytropsidae]; Corytophanidae, Phrynosomatidae, Polychrotidae [Iguanidae, in part]; *Plestiodon* [*Eumeces*]; *Aspidoscelis* [*Cnemidophorus*]; *Pantherophis*, *Pseudelaphe*, and *Senticolis* [*Elaphe*]; and *Rena* and *Epictia* [*Leptotyphlops*, Adalsteinsson et al., 2009]. The primary taxonomic rank of all accounts is noted as being at the species level, although the authors do comment on subpecies in several instances, a practice that in my opinion is outdated in modern phylogenetic systematics. In general, the taxonomic status of most species is up-to-date, although the authors chose to use a few names, without comment, that are contentious: *Norops* vs *Anolis* (Poe 2004) and *Coluber* vs *Masticophis* and *Rhinella* vs *Chaunus* (both discussed in Wilson and Johnson 2010).

A few major references are cited in different sections of the species accounts, although a small number were inadvertently left out of the reference section and were also not listed in the bibliography (e.g., Jameson, 1950 – *Craugastor augusti*; Roth, 1972 – *Hyla arenicolor*; Iverson and Berry, 1979 – *Kinosternon integrum*; Smith et al., 2008 – *Plestiodon tetragrammus*; Slevin 1942 – *Ninia diademata*; Goldberg, 1998 – *Oxybelis aeneus*; Anderson, 1960 – *Storeria storeroides*).

The range maps (Appendix 3) use dots to identify species locations listed in the locality of collection section (Appendix 4), but in at least one instance (*Chiropterotriton magnipes*), the distribution description in the species account does not match the mapped localities (Map 13) or collecting sites (Appendix 4).

There are 227 color photographs of varying quality for listed species (several with multiple photographs); there are no pictures for 17 forms. Several photographs were of individuals found as far away as Arizona, Texas, Chihuahua, Durango, Sonora, and in one case, from an exotic individual from Peru (*Hemidactylus frenatus*). It would have been more supportive if at least one photograph of species not pictured, even from a distant locality, were included in place of one from a species depicted multiple times. Many of the 17 species are not necessarily rare throughout their ranges, so a photograph of some of those may have been available from an outside source. Of course, the best photographic scenario would have depicted individuals from Querétaro, because geographic variation within wide-ranging species creates the possibility of showing an individual not typical of those found within the state. It would also have been better if all photographs would have identified both the sex and locality of portrayed individuals instead of listing them for some, but not for others.

In summary, the few weaknesses in the book do not overly influence its value to those interested in an information source with taxonomic keys and photographs of the amphibian and reptiles of Querétaro, México. The $85.00 price tag, which might seem high to some, is comparable to other hard-bound books on related herpetological subjects. I highly recommend *Amphibians and Reptiles of the State of Querétaro, México*, to professional and interested amateur herpetologists or to any wildlife enthusiast who wants to learn about the herpetofauna and natural landscape of a fascinating region of México.

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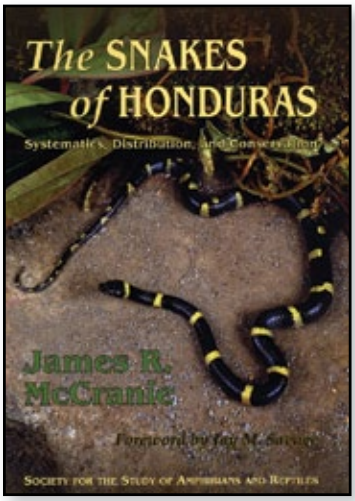
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The Snakes of Honduras — Systematics, Distribution, and Conservation

By James R. McCranie. 2011. Society for the Study of Amphibians and Reptiles (www.ssarherps.org). 724 pp. Hardcover. US $95.00. ISBN 978-0-916984-81-6.

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Given the astonishing species richness of tropical herpetofaunas, even the baseline exploration and documentation of their diversity is a laborious and time-consuming task. This holds equally true for the best-studied fraction of the neotropical realm, Central America. Notwithstanding the comparably small surface area of its nations, more than two centuries have passed since the first descriptions of amphibian and reptile species until, only during the last decade, the first truly detailed treatments (i.e., works that address various aspects of each species' biology and extend well beyond the scope of mere identification guides) of herpetofaunal groups at the country level could be compiled.

One such milestone summarizing all available information for a higher taxon within one country was *The Amphibians of Honduras* by Wilson and McCranie (SSAR Contributions to Herpetology Vol. 19, 2002), which has set a high standard in many ways. Now Randy McCranie has released its worthy successor, *The Snakes of Honduras*. This opus follows the format and concept of the amphibian book and constitutes a comprehensive scientific account of all 136 snake species known to occur within the country. The book is slightly more voluminous than its predecessor and, with 724 7x10-inch pages, is too bulky to carry around in the field. But that is not the purpose of this reference work.

Following a foreword by Jay M. Savage and a preface by the author, the Materials and Methods section introduces the structure of the species accounts and coherently explains how the data were obtained, processed, and presented. Readers will be pleased to learn that all content is updated to July 2010. They will be awestruck by the firm footing of the morphological and biogeographical data; as many as 6160 specimens were examined by the author, who has personal field experience with 90% of the species!

The introductory chapter on the Honduran environment is a revised update of its analogue in the amphibian book, detailing general information as well as the country's complex physiographic and climatic setting. The author places special emphasis on the nine general forest formations, including their respective distribution, climate, typical vegetational characteristics and important subtypes, snake diversity and conservation status. The maps in this chapter introduce the reader to the uncomplicated, concise map format employed consistently throughout the book.

After a brief history of reptile research in Honduras, the reader is introduced to the composition of the Honduran snake fauna, and provided with a key to the nine families known to occur in the country. Dichotomous keys to the 67 genera and 136 species are placed preceding the respective taxa. Each key is accompanied by an exact Spanish translation, allowing for the determination of any Honduran snake at hand to species level by anyone. The elaborate keys are perfectly practicable owing not only to the characteristics employed, but especially to their illustration; every distinctive feature is excellently clarified by accompanying drawings or photos and their truly informative legends.

The 136 species accounts themselves and the interspersed keys comprise almost 500 pages, leaving virtually nothing to be desired. After references to the original description and type specimens, synonyms applied to Honduran material are listed. The overall distribution as well as that within Honduras are given along with a map of actual collection localities. The in-depth descriptions of external morphology, hemipenes, as well as coloration in life and in preservative are almost exclusively based on explicitly listed specimens from Honduras, complemented with and compared to data from other countries where sensible. A short diagnosis leaves almost no possibility to confuse the respective species with similar ones occurring in Honduras. One highly appreciated feature is the illustration list, which is not limited to mere references, but actually specifies the content of the itemized figures. The obligatory remarks paragraph is succeeded by comments on natural history that include data from outside Honduras. After a brief explanation of the scientific name's etymology, the author concludes each species account by listing the specimens he has examined personally, as well as other reliable records plotted on the respective distribution map. The book's core section ends with a quick mention of four species reasonably expected to occur in the country.

The following biogeographical analysis scrutinizes the distribution of the Honduran snake fauna among political, physiographical, ecological, and historical units, revealing broad patterns as well as examples of endemism and distributional end points. Subsequently, the conservation status of all native species is assessed by analyzing population trends and known occurrences within protected areas, and the calculation of Environmental Vulnerability Scores and IUCN categories. Against the country's sociocultural and economic background, this thorough assessment necessarily draws a rather pessimistic picture of Honduras' environmental future as a whole—reason enough for the author to call for more biodiversity research coupled with actual enforcement of the existing environmental legislation by the hitherto rather passive authorities in charge. Yet, McCranie kindly offers his reader a little comfort by providing a very personal epilogue that is guaranteed to raise a smile on the face of anyone who has spent field time in the Neotropics.

Approximately 180 well-labelled color photographs exemplify major snake habitats and depict 132 of the species discussed, overwhelmingly showing specimens from Honduras.

Close to its end, yet another treasure of its own within this work is the gazetteer detailing not only the localities mentioned in the species accounts, but every single herpetological collection site known to the author within Honduras—most valuable

for anyone who works on Honduran biogeography. A glossary defining the terminology and abbreviations used throughout the text, references, and indices to both scientific and authors' names complete this work.

Probably the only drawback of this magnificent book is the photographs, many of which should have been further processed to appear a little clearer in print. Beyond that, one can hardly find anything to animadvert in this opus. Like its predecessor, *The Snakes of Honduras* is a meticulous, encyclopedic study of a complex and species-rich herpetofaunal group at the country level. Owing to over 30 years of research by the author and his companions, the book is bursting with clearly structured, reliable information resulting in a final product that is unparalleled within the realm of Latin American herpetology.

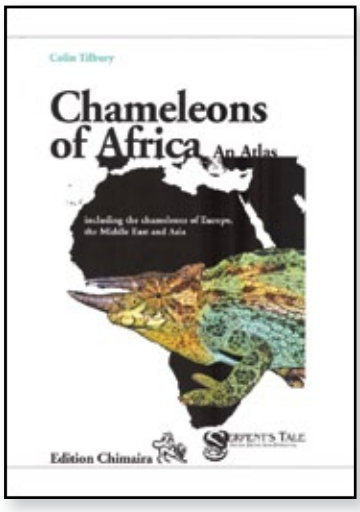
Taking into consideration the numerous publications by the author and his colleagues, one is bound to agree with McCranie's preface statement that they "have come close to achieving the goal of documenting the distribution and content of the Honduran herpetofauna." Indeed, Honduras will be the first country in Central America having its herpetofauna described in such detail once the equivalent treatment of the remaining reptile groups, which is already in preparation, is published. This final book will be much anticipated by members of the herpetological community who appreciate, work with, and rely on *The Amphibians* and now *The Snakes*.

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Chameleons of Africa. An Atlas including the Chameleons of Europe, the Middle East and Asia

By Colin Tilbury. 2010. Edition Chimaira, Frankfurt am Main (www.chimaira.de). Hardcover. 831 pp. EUR 98.00 (approx. US $140.00). ISBN 978-3-89973-451-5 (in the US available at Zoo Book Sales, www.zoobooksales.com).

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This voluminous book by Colin Tilbury in the Chimaira "white series" is a remarkable summary of knowledge about chameleons. However, despite the thickness of the volume only the species occurring in mainland Africa, southern Europe and Asia are included (the distinction between the Middle East and Asia in the title is, of course, unnecessary because the Middle East *is* part of Asia). If the author would have also included the species of Madagascar and the Indian Ocean islands, then this would indeed have much exceeded the possible number of pages for such a project, and a second volume would have been necessary. However, it is with the African continent that Colin Tilbury is most familiar and it is there that he carried out numerous excursions in order to take his own photographs in the field of as many species as possible. Generally, this geographic delimitation makes sense because Africa (including southern Europe, the Near East and southern Asia) and Madagascar harbor distinct evolutionary lines (genera in the taxonomic sense) of these most bizarre lizards. Only very recently, after the publication of this book, has it been revealed that the Seychelles might have better been treated with mainland Africa. The endemic Seychellean chameleon, now placed in the resurrected genus *Archaius* (Townsend et al. 2010) and formerly thought to be part of the Madagascan genus *Calumma*, is in fact sister to the East African dwarf chameleons of the genus *Rieppeleon*.

This example demonstrates how fast the current knowledge about chameleon species diversity is growing. Tilbury's book lists 102 currently recognized species from the non-Madagascan realm, whereas the checklist by Klaver and Böhme (1997) listed only 57 species for the area covered by the present book. This is nearly a doubling of the species number in just 13 years! Tilbury's count would have even been a bit higher if he had followed another species concept concerning the *Chamaeleo dilepis* complex within which, for example, the taxa *quilensis* and *roperi* are often considered to be good species by other authors (myself included). Although his species count includes a good number of recently elevated subspecies (e.g., in *Bradypodion* or in the *fischeri* group of *Kinyongia*), it is out of date due to the continuing discovery and recognition of new species. In some instances the increase of species is of course due to (1) the elevation of former subspecies as mentioned above, or (2) to the resurrection of synonyms, but (3) formerly unknown, truly new species are among this number as well. An example of the first case is *Trioceros perreti*, *T. serratus* exemplifies the second, and *Nadzikambia baylissi* as well as *Trioceros hanangensis* (Krause and Böhme 2009; Barej et al. 2010; Branch and Tolley 2010) are novelties.

It must be noted, that with respect to taxonomy, Tilbury has not restricted himself to compiling the systematic literature on chameleons, rather he has contributed significantly to the discovery and description of many new species, e.g., *Rhampholeon acuminatus*, *R. beraduccii*, *R. chapmanorum*, and *R. viridis* and the spectacular tree chameleons *Trioceros balebicornutus*, *T. conirostratus*, and *T. marsabitensis*.

What makes this book more exceptional are its illustrations. Colin Tilbury, who was already well-known for his brilliant photography, travelled through many parts of Africa in order to get his own photographs of common as well as rare species, and the result of this great effort is the impressive visual impact of this atlas of Africa's chameleons. It is, of course, also expected that an atlas will contain distribution maps, and this book does not disappoint: point distributions plotted on colored relief maps not only show the records where a species has been found but also provide information on whether this is a mountain or lowland, savanna or forest species, etc. Biogeographic patterns can be deduced from the maps: widespread vs. relictual, confined to the Rift Valley or the Cameroon highlands, etc.

On the other hand, this book exceeds the requirements of a distributional atlas because it provides also much general information, not only on the individual species, but also on this lizard family as a whole, starting with locomotion, vision, color

change, and many other general aspects, including some very interesting, but so far largely unstudied issues such as the strange buzzing behavior as an aposematic strategy and/or means of intraspecific communication; or the foul-smelling oral glands as a repellent and/or chemical bait which, if confirmed, would be unique in squamates.

Each species chapter, after giving the scientific, English and (if known) local name as well as the relevant synonyms and chresonyms, provides an exhaustive description also covering lungs, hemipenes, and karyotypes (these three character sets have previously been used for systematic purposes), sexual dimorphism, and colour pattern, followed by a listing of key distinguishing characters. These key characters are often accompanied by line drawings, most of which have also been prepared by the author himself. This is followed by a paragraph on distribution, linked to the relevant map, and finally ecology is dealt with by accounts treating habitats, natural history, reproduction, and conservation. A list of specific references concludes each species chapter.

It is not surprising that this enormous amount of information contains some errors, some of which could have easily been detected during proof-reading. For instance (p. 214) the head drawing of *Rieppeleon brevicaudatus* is still assigned to "*Rhampholeon*" *brevicaudatus*. The dot map for the genus *Chamaeleo* as a whole places a few dots where no populations of *Chamaeleo* (nor any other chamaeleonid) exist, e.g., in Albania or the Canary Islands (in the latter case only translocated single individuals are known and these were not even mentioned by Pleguezuelos et al. 2002; see also p. 475). But if accidental introductions of single individuals seem worth mentioning to Tilbury, he might also have cited the records published from the Caucasus area in western Georgia (Chkhikwadze and Bakradze 1993). On the other hand, Mauritania is devoid of mapped records although these are mentioned in the text (see Fig. 563 and map on p. 537). Figure legends 495 and 496 (*Chamaeleo chamaeleon*) read *C.* "*chamɛleon chamɛleon*" and *C.* "*chamaleon chameleon*" which is a bit more problematic than a simple misprint because it involuntarily creates a new "in error" synonym of the taxon. In the reference section, some citations are duplicated, e.g., Hofer et al. on chameleons in Cameroon; in other cases multi-authored papers precede citations of the first author alone (e.g., Klaver). But such faults are really rare in proportion to the total of 831 pages!

In two cases, new taxa discovered after the appearance of this book are already figured under other names: *Kinyongia uthmoelleri artytor* (figs. 439, 440–443) from the South Pare Mts. (Lutzmann et al. 2010) as a typical *K. uthmoelleri,* and *Trioceros hanangensis* from Mt. Hanang (Krause & Böhme), as *T. sternfeldi* (figs. 769, 770). A further taxonomic comment has to be made in respect to the restriction of formerly vague type locality designations, as done in this book with *Bradypodion gutturale* and *B. ventrale*. This procedure is not covered by the Code of Zoological Nomenclature (ICZN 1999), since such restrictions or redesignations of type localities may be only made together with designations of neotypic specimens individually bearing such new and precise locality data.

Some aspects can also provoke stimulating discussions: In the etymology section of the systematic paragraphs, here for the genus name *Chamaeleo* (formerly also *Chamaeleon*, p. 467), one finds a repetition of the old interpretation of Greek "chamaí" (on the soil) and "león" (lion), in the present book "earthlion," which—except for *C. namaquensis* and the likewise ground-dwelling dwarf chameleons of the genera *Rhampholeon* and *Rieppeleon*, all of which are unlikely to have been known to Aristotle and the ancient Greeks—does not really not make sense for these highly arboreal creatures! More plausible to me is the alternative, but largely overlooked or even forgotten interpretation given already by Keller (1913) who derived the name of these creatures (which actually can form a hump with their dorsal line when resting) from the Hebrew word for camel, viz. gamal, with the Arabian diminutive ending "-ún" which reads gamalún, i.e., a little camel. Tilbury's book contains many photographs showing chameleons in this position, e.g., figs. 467, 473, 474, 479, 482, 490, 505 (all from the *C. chamaeleon* group).

An unfortunate bit of information must be added for one of the rarest species: the recently discovered *Kinyongia vanheygeni* was known from the single holotype and one additional living male specimen which was not collected (Neças 2009). The catalogue number for the holotype (ZFMK 88383), cited in this book, had to be provided to the author, due to time pressures with manuscript submission, before the specimen physically reached the collection. When it was finally sent it was lost in transit and never reached the Museum Koenig in Bonn (P. Neças, pers. comm.). As if Colin Tilbury would have foreseen this misfortune, he fortuitously figured the unique living male of *K. vanheygeni*, photographed by E. van Heygen, no less than four times.

In summary, Tilbury's "Atlas" is a true handbook with lots of useful general and specific information on the African and Asian representatives of this fascinating Old World lizard family. It is even more impressive when one takes into account that its author was never paid for his herpetological work. As a medical doctor by profession, he is an illustrious example for what a herpetological "amateur" is capable of contributing to our science.

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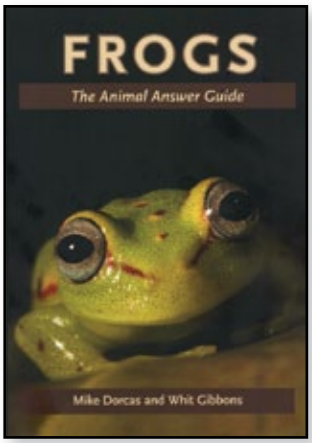
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Frogs: The Animal Answer Guide

By Mike Dorcas and Whit Gibbons. 2011. The Johns Hopkins University Press (http://press.jhu.edu). Softcover. xiii + 160 pp., 16 pp. pls. US $24.95. ISBN 978-0-8018-9936-2.

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The Johns Hopkins University Press "Animal Answer Guide" series includes recent books on fishes (Helfman and Collette 2011), rabbits (Lumpkin and Seidensticker 2011), and small wild cats (Sanderson and Watson 2011). This excellent volume, covering frogs worldwide, is second in the series to be co-authored by Gibbons, following the similarly-arranged *Turtles: The Animal Answer Guide* with Judy Greene (2009).

Structured as a series of questions and answers grouped by topic, this book begins with "Introducing Frogs" ("What are frogs?" "When did frogs evolve?" "What other types of amphibians are there?") and moves through chapters on coloration, ecology, reproduction and development, and so on. Three chapters cover human-frog interactions, including "Frog Problems" from a human viewpoint. Anurans get the last word with the chapter "Human Problems," which clearly highlights the decline of these animals, touching on pollution, habitat destruction, chytrid infection, climate change, and the synergistic effects of these threats combined. The final chapter covers the how and why of "Frogology," offering an inside look into the world of herpetological research.

Answers are in-depth enough to satisfy curiosity and perhaps spark further investigation by the intrigued reader. Additionally, primary research is occasionally cited throughout, serving as a welcome introduction to how scientists know what they know.

Over 120 questions are answered in manageable sections of one to several paragraphs in length. While the question-answer format can sometimes be repetitive if reading the book straight through, the overall result is that most answers are complete and self-contained. The book thus lends itself to being a handy reference for the intended lay audience.

Sentences are generally short, clear, and easily read and understood, expanding the book's appropriateness to younger audiences. There is no glossary, however, and the authors have sometimes elected to use a more difficult term when a simpler one might have sufficed (ingested instead of eaten, etc.). Further, technical terms such as aestivation, "sex recognition" and "simple Mendelian inheritance" are sometimes mentioned without explanation and are not always included in the index for cross-reference. Key terms are italicized, somewhat inconsistently, and would have been the natural starting list for forming a glossary.

There is a geographic emphasis on frogs in the United States, but the authors often mention European counterparts of common species and also discuss the more intriguing and unusual anurans of Africa, Australia, South America, and Asia. Despite including a chapter devoted to "Frogs in Stories and Literature," the discussion of traditional or cultural use of frogs is fairly limited apart from the consumption of frogs' legs and the use of poison dart frog skin secretions. Frog lore is largely concerned with western cultures, including modern pop culture references and the re-telling of several frog short stories and jokes.

Many fine photographs are included, liberally placed through the book in black and white. Additionally, sixteen pages of color plates showcase a variety of anurans, both familiar and lesser-known. The color portraits are aesthetically pleasing but fall short of their potential informativeness. The plates are not numbered and are not referred to in the text, even when they could have served to illustrate a concept discussed. Unlike those of the black and white images, the color figure captions do not even briefly mention concepts or behaviors illustrated, such as amplexus. There remains plenty of white space on the color plate pages where such information might have been provided. Additionally, a few of the color portraits might have been moved to the black and white pages in exchange for images that would have benefited from inclusion in the color plates. For example, the visual impact of a leucistic frog sitting on moss is reduced when the entire image is rendered in shades of gray.

Unlike other books in the series, no maps or illustrations are included where a few may have been educational. For example, an illustration of select Gosner stages (Gosner 1960) might have been appropriate for "How fast do frogs grow?" or perhaps a cutaway view of how a frog uses its eyes to assist in swallowing food in the discussion of "Do frogs chew their food?"

Given the target audience, discussion of taxonomy is left deliberately simple. Scientific names follow traditional taxonomy. An appendix references common species to their equivalents as indexed by the Amphibian Species of the World Database (Frost 2009). Another appendix lists internet resources, scientific and conservation societies, magazines and journals, and zoos with a focus on frogs and toads, all useful stepping stones for the lay person looking for more information.

It is easy to imagine this volume resting comfortably in the library of a high school biology teacher or on the shelf of a student who shows a budding interest in herpetology. It would likewise serve as a handy reference for the dedicated herpetologist who fields questions from non-specialists, for it is easy to direct inquiring minds to this book for succinct and accurate answers to common questions, up to and including a judicious response to the inevitable inquiry about toad-licking. Most importantly, this informative book deserves to be in the hands of the interested public, the non-scientists who stand to learn the most about the intriguing biology of anurans as well as their plight in a world increasingly modified by humans.

A hardcover edition of *Frogs: The Animal Answer Guide* (ISBN 978-0-8018-9935-5) is available for US $45.00. A version for the Kindle electronic reader is available from www.amazon.com for US $14.97.

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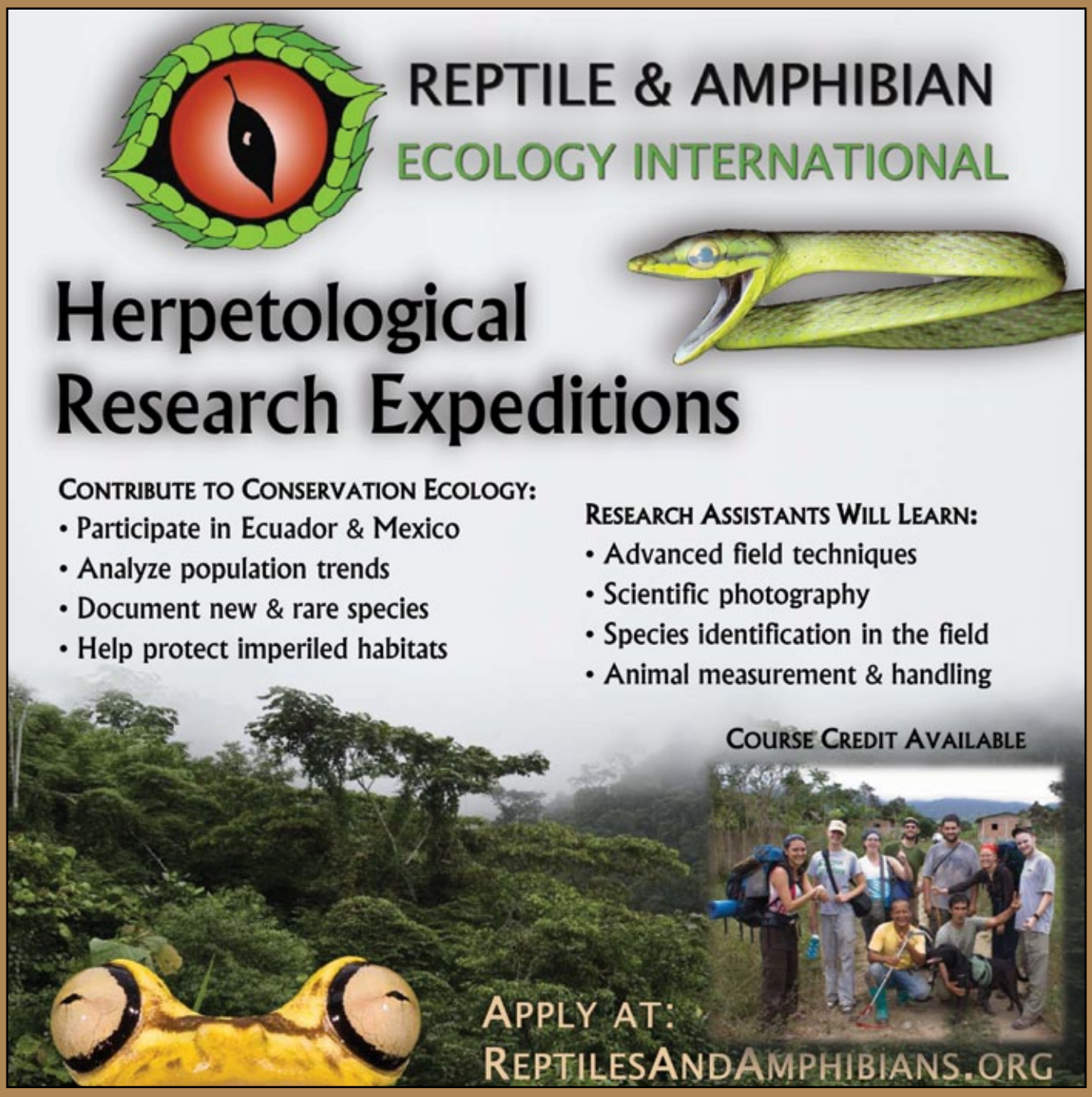
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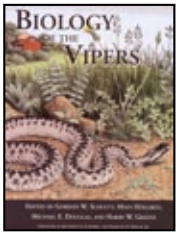
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Herpetological Review

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HERPETOLOGICAL REVIEW

THE QUARTERLY NEWS-JOURNAL OF THE

SOCIETY FOR THE STUDY OF AMPHIBIANS AND REPTILES

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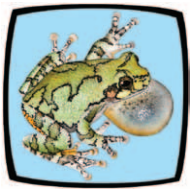
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SOCIETY FOR THE STUDY OF AMPHIBIANS AND REPTILES

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The Society for the Study of Amphibians and Reptiles, the largest international herpetological society, is a not-for-profit organization established to advance research, conservation, and education concerning amphibians and reptiles. Founded in 1958, SSAR is widely recognized today as having the most diverse society-sponsored program of services and publications for herpetologists. Membership is open to anyone with an interest in herpetology—professionals and serious amateurs alike—who wish to join with us to advance the goals of the Society.

All members of the SSAR are entitled to vote by mail ballot for Society officers, which allows overseas members to participate in determining the Society's activities; also, many international members attend the annual meetings and serve on editorial boards and committees.

All members and institutions receive the Society's primary technical publication, the *Journal of Herpetology,* and its news-journal, *Herpetological Review*, both are published four times per year. Members also receive pre-publication discounts on other Society publications, which are advertised in *Herpetological Review*.

To join SSAR or to renew your membership, please visit the secure online ZenScientist website via this link:

http://www.ssarherps.org/pages/membership.php

Future Annual Meetings
2012 — Vancouver, British Columbia, 8–14 August (with World Congress of Herpetology)
2013 — Albuquerque, New Mexico, 10–15 July

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FURTHER NEW DEVELOPMENTS IN SSAR

Change is coming quickly to SSAR. As I reported to you in March ("A Vision for SSAR's Future," *HR* 42: 1), SSAR is now undertaking sweeping changes in its publications and programs. I have just come from the society's meeting in Minneapolis, held jointly with the American Society of Ichthyologists and Herpetologists, Herpetologists' League, and the American Elasmobranch Society (as the annual Joint Meeting of Ichthyologists and Herpetologists—"JMIH"). Several SSAR events of interest occurred during this meeting and I wanted to give our members the highlights (Society Secretary Marion Preest's detailed report will appear in the December issue of this journal, as usual.) Responses to the dramatic changes in our two quarterly journals, *Herpetological Review* and *Journal of Herpetology*, have been overwhelmingly positive and the editors, Robert Hansen, Erin Muths, and Gad Perry, received widespread and well-deserved congratulations in Minneapolis. The journals look great and mailing them together represents a real financial savings for the Society.



PHOTO BY R. A. ODUM, TOLEDO ZOO

At the Plenary Session that opened the meeting, I drew attention to the special events sponsored by SSAR to be held during the week, in particular those designed for students. I reminded students about our third-annual Student Social (co-sponsored with HL), which is designed specifically for students to meet senior herpetologists. (Nearly 200 people attended, by the way.) James Hanken, director of the Museum of Comparative Zoology at Harvard University and Immediate Past-President of ASIH, delivered a sobering address about the prospects for biological research funding and the future of biological societies. He said that the national trend over the past decade is that the memberships of the smaller societies have gone down as much as 40%, but he noted that SSAR was an exception. Over the last decade, SSAR has increased 20% in size. As of the end of 2010, it is now the largest of the JMIH societies. As I mentioned in my last message, these promising numbers should not allow complacency, rather they should act as an impetus to continue to improve and expand SSAR programs and benefits for members.

BOARD OF DIRECTORS MEETING: Although the society is in good financial condition, our plans exceed our current income levels. The board took a bold step to make changes in its two journals last March, but to sustain full color imagery in *HR* and more color in *JH* (as well as other improvements to these serials), to remake and expand our website, to further enrich our meetings, and especially to provide more enhancements for students, we simply need to increase our revenue. Postage costs, both domestic and international, have dramatically increased. (The postage alone for overseas members now exceeds $31 per year!) We have not had a dues increase for several years. Accordingly, the board decided to adjust fees and these will be noted in the renewal reminder that will be sent to you this fall. I think members will find the increases to be modest and we anticipate that our improved programs and publications will be well worth the minor change. There will be a small increase of $5 for student and zoo members, but a *decrease* of $20 for seniors over 70 years of age. As I anticipated in my March letter to you, the board voted to establish a new category of membership, Associate Member, a non-voting category that will receive *HR* only. Given the great reception of the newly formatted *HR*, we anticipate that this will be a popular membership option.

Even at the new dues levels (which will be at or below those for our sister societies), we think that SSAR is still the best bargain in herpetology, worldwide. All of our regular, senior, student, and zoo members receive two quarterly journals and are offered discounts on SSAR books and other publications. Students get substantially reduced fees at our meetings and have the opportunity to win research awards, travel awards, and prizes for their research at our meetings. Equally important, our members support everything that SSAR does to promote herpetology in terms of research, conservation, and education. Nonetheless, we believe that SSAR's potential is still only partly realized. With the adjusted dues schedule and an increase in membership due to the many improvements, SSAR can do far more for the herpetological community, internationally, than it does today.

Incidentally, the Board of Directors' meetings, as for all SSAR-sponsored meetings, are always open to our members. We want our deliberations to be transparent and, indeed, we want feedback. And for those who wish to actively participate, we can find ways in which you can help to advance the goals of the society.

LONG RANGE PLANNING COMMITTEE MEETING: Because the LRPC is leading the changes in SSAR, an open meeting was held to attract members to provide feedback to the committee. About 35 members attended and it was especially gratifying to see so many students present. The LRPC previewed current issues under consideration: meeting venues, web page, electronic-only memberships, and international reach. Historically, our meetings have been SSAR-only or SSAR/HL joint meetings on university campuses, but in recent years now they have been JMIH events in downtown conference centers. LRPC will discuss the possibility of alternating herp-only, campus venues with JMIH events at conference centers, and also the feasibility of sponsoring more meetings at non-USA sites. (SSAR has met in Mexico twice and in Brazil, Canada, and the UK once each.) There was an extensive discussion of SSAR's current website and its limitations. Simply put, our website needs to provide a portal to all-things-herpetological, in order to serve both our membership and the general public. We are not there yet, and the LRPC will be considering a complete makeover of the site, making it more interactive and greatly expanding its function. The dues increase is partly in anticipation of the major changes we wish to make in our web page that will require professional development and maintenance. The assembled group, especially the younger members, was strongly in favor of getting their issues of *JH* and *HR* electronically. So, this will be a priority for SSAR to make this happen soon. Note that currently SSAR members can access entire electronic issues of *HR* via the ZenScientist website. Finally, there was discussion of SSAR's international status and how the society can be made more relevant and useful to overseas herpetologists. There was excellent feedback from the audience on all of these points and some good ideas, too!

BUSINESS MEETING: I was very pleased to welcome nearly 200 members to the Business Meeting. Numerous reports were delivered by the relevant society officers and editors. Our

Treasurer, Kirsten Nicholson, noted that our budget has dramatically increased from $263,500 in 2011 to $394,800 for 2012, although the latter figure is inflated by about $75,000 because of a major, one-time publication project (see below). Many student prizes and awards were announced and these will be detailed in the full report of our annual meeting in the December issue of *HR*. A new category of prizes was instituted this year for Best Student Poster, so that oral and poster presentations can now be accorded equal importance. (We expect to announce a major new endowment to support the poster awards in the near future.) It was announced that SSAR will be making significant contributions to next year's meeting at the 7th World Congress of Herpetology, to be held on the spectacular Vancouver campus of the University of British Columbia in August. These include a congress poster and several giveaway publications. SSAR will also run the auction, with all proceeds going to the congress. SSAR has long had a close relationship with the WCH and has provided gratis publications at each congress. (The WCH was founded at SSAR's silver anniversary meeting in 1982.)

It was officially announced at the Business Meeting that SSAR will be issuing a special set of volumes as its salute to next year's world congress, the first to be held in North America. SSAR will publish a facsimile reprint of Duméril and Bibron's classic work, "Erpétologie Générale" (1834–1854), one of the largest single works ever issued in herpetology and the greatest one in the French language. This consists of 10 volumes and an atlas, with over 7,000 pages of text and 120 color plates. Funding is now assured thanks to the generous support of Ronald Javitch, our long-time member and benefactor in Montreal. Duméril and Bibron's volumes still are a key work for systematists today, and are especially needed in developing countries. An original copy today with colored plates costs $20,000, if you can find it at all, but SSAR is hoping to price this set at no more than $300. Full details will appear in *HR* next March.

OTHER EVENTS IN MINNEAPOLIS: We hosted the best herpetological party of the decade, in the form of the Ernie Liner Mardi Gras auction (to develop an endowment to support, in Ernie's words, "up-and-coming herpetologists"). The event was well attended and a lot of fun as bidders fueled themselves with Hurricane beverages and competed for Mardi Gras beads. The auction items were all drawn from Ernie's vast collection of books, art, and whimsical herp-related toys and nicknacks. On a more serious note Jaime Garcia-Moreno and Phil Bishop of the IUCN Amphibian Survival Alliance were in attendance to network on behalf of that newly launched organization. The SSAR Board approved a resolution formally endorsing the organization.

Finally, I would like to highlight two motions that the SSAR Board approved during our meeting, because I feel that these two gestures exemplify the inclusive attitude of our society. From now on, all communications regarding students in our programs will be phrased "undergraduate and graduate students" in order to make explicit that we encourage participation from students at all stages of their career. One step further toward that notion is the new Board-approved program to offer a free 1-day registration fee for pre-baccalaureate (i.e., K–12) student (and an accompanying guardian) to attend our annual meeting. I can only imagine the thrill I would have felt had I had the opportunity to attend an SSAR meeting when I was in high school! These two gestures, approved by the Board, mean a lot to me as it helps me communicate that everyone is welcome at SSAR. We want your input and we want you to join and contribute to our programs and broad family of publications as we expand the society's programs and redirect them into areas relevant to where our field will be going during the 21st century.



Joseph R. Mendelson III, President



ABOUT OUR COVER: *OPHIOMORUS NUCHALIS*

The "snake skinks" of the genus *Ophiomorus* are characterized by an elongated body and reduced appendages, fully absent in some species. The ten described species collectively range from Greece through southwest Asia to northwestern India. Little is known of the ecology of this group, though several species occur in windblown dune sand habitats. These sand specialist species display a suite of adaptations for life in the dunes: wedge-shaped snouts, lack of external ear openings, elongate morphology, extremely smooth imbricate scales, prominent ventrolateral edge, and small grooves into which forelimbs are folded during subsurface locomotion. Snake skinks are nocturnal, emerging onto the surface after sunset to feed. Dune-dwelling species may be found by following their tracks.

The Plateau Snake Skink (*Ophiomorus nuchalis*) is a rare lizard, first described by Nilson and Andren based on two specimens from the Kavir Desert, in north-central Iran (1978. Copeia 1978:559–564). The type locality is a localized permanent spring in an otherwise hot, dry environment, and the population was presumed to be small. The species remained unrecorded until 1999–2000, when two additional animals were found at the type locality. In 2009, a second population was discovered, about 120 km distant from the first site and near the northern boundary of the Kavir Protected Region (Mozaffari et al. 2011. Russian Journal of Herpetology 18[1]:36–38), associated with loose soil under small desert shrubs. The recent discovery in a habitat that is common in desert regions of Iran's Central Plateau suggests that *O. nuchalis* is probably more widely distributed than previously thought.

Our cover image, depicting an adult male *Ophiomorus nuchalis*, was recorded by Iranian herpetologist **Omid Mozaffari**, in May 2010 near the village of Mobarakieh, Tehran Province, using a Fujifilm FinePix S9600 digital camera with fill flash. Mozaffari is one of the founding members of the Pars Herpetologists Institute (www.pars-herp.org), Iran's first herpetological society, begun in 2006. His field research is focused toward completing the Atlas of Reptiles of Iran project.



PHOTO BY BARBOD SAFAEI

SSAR BUSINESS

Dean E. Metter Memorial Award for 2011

There were 27 proposals submitted this year for the Dean E. Metter Memorial Award. The proposals all had considerable merit; however, two stood out from the others and President Mendelson granted permission to make two awards.

The first award winner is Brandon Fessler, a student in the Department of Biological Sciences at Central Washington University in Ellensburg, Washington. He is an M.S. student who is studying the seasonal behavior, habitat use, and spatial ecology of *Dicamptodon tenebrosus*. His graduate committee is chaired by Jason Irwin; other committee members are Daniel Beck and Marc Hayes.

The second awardee is Jessica Wood of the Division of Biological Sciences at the University of Missouri–Columbia. Jessica is a student of Carl Gerhardt's and her proposal details a segment of her PhD dissertation and is entitled, "Behavioral Analysis of Signal Plasticity and Mate Recognition in *Hyla femoralis*."

The Metter Award Committee extends its sincere thanks to all the students who submitted proposals this year. We wish all of you the best and look forward to reading about the results of your graduate work in the herpetological literature.

Kennedy Student Award

The Kennedy Student Award Committee (Bill Lutterschmidt, Mark Paulissen, Terry Schwaner, Lynnette Sievert, Chair) has completed its work for Volume 44 of the *Journal of Herpetology*. The Committee has selected "New Loam-Swimming Skink, Genus *Brachymeles* (Reptilia: Squamata: Scincidae) from Luzon and Catanduanes Islands, Philippines" by Cameron D. Siler, co-authored with Arvin C. Diesmos and Rafe M. Brown (vol. 44:49–60). The Kennedy Award carries with it a cash prize of US $200 or the winner's selection of any SSAR publications valued at twice that amount.

The Committee invites all student members of the Society to submit their work to the *Journal*, and encourages regular members who supervise the work of students to draw this award to the attention of those students.

SSAR Grants-in-Herpetology Program Guidelines for Proposal Submission

NOTE: In June 1999, the SSAR Board decided that past award recipients are not eligible for additional GIH awards.

Proposals are now being accepted for the **2012** SSAR Grants-in-Herpetology Program. This program is intended to provide financial support for deserving individuals or organizations involved in herpetological research, education, or conservation. Grant proposals will be considered in the following categories:

1. **CONSERVATION OF AMPHIBIANS AND/OR REPTILES.** Proposals should address research (particularly conservation biology) on species endangered or threatened at the state, national, or international level, or address research on potentially threatened habitats or species, or on introduced injurious species. Proposals must be accompanied by a letter of support from another member of the SSAR or a student's major advisor or committee chairperson.
2. **FIELD RESEARCH.** Proposals may address needs for field station fees or equipment and materials in field oriented projects, or the field work portions of broader studies. This might include in-situ behavioral studies, ecological, life history, or sexual selection studies. Survey work by individuals or regional societies may be submitted here or in TRAVEL below depending on how the funds are to be used. Proposals must be from individuals only and be accompanied by a letter of support from another member of the SSAR, the president of the sponsoring regional society (if applicable), or a student's major advisor or committee chairperson.
3. **LABORATORY RESEARCH.** Proposals may address needs for equipment or materials in laboratory projects or laboratory portions of broader projects. This might include studies in behavior, biochemistry, molecular biology, biomechanics, or physiology. Proposals must be from individuals only and be accompanied by a letter of support from another member of the SSAR or a student's major advisor or committee chairperson.
4. **HERPETOLOGICAL EDUCATION.** Proposals may address an educational project or start up support for an educational program in a zoo, museum, park, nature center, regional herpetological society, etc. The project must focus on a herpetological topic. Proposals must be from individuals only and be accompanied by a letter of support from the herpetological curator, the director of the facility, or the regional society president. Applicants need not be students or a SSAR member.
5. **TRAVEL.** Proposals may address support for travel to field study sites near or far, or to utilize distant collections or facilities. If funding is sought to get from one place to another, proposals should be submitted in the TRAVEL category. Proposals normally submitted in the CONSERVATION or FIELD RESEARCH categories should be submitted here if travel funding is being sought. Proposals must be accompanied by a letter of support from another member of the SSAR or a student's major advisor or committee chairperson, or the regional society president.
6. **INTERNATIONAL.** Proposals may address needs in any of the above five categories. The applicant must be a student, but not necessarily a SSAR member. Preference will be given to students with limited access to research funds and in countries where herpetological research has historically been under-funded.

In keeping with the Society's goal of encouraging participation by the broadest possible community, preference may be given to individuals who might not have access to other funding sources. All applicants must be students AND members of the SSAR with the following exceptions: 1) those applying for support of regional herpetological society projects need not be SSAR members; 2) those applying for the International category must be students but need not be SSAR members; 3) those applying for the Herpetological Education category need not be a student or a SSAR member.

Membership dues must be paid (to SSAR Treasurer) no later than 15 December 2011 for proposals to be considered. Applicants are limited to submission of one proposal in one category per year. Past recipients of an SSAR GIH award in any category are not eligible for future awards. Applicants must designate to which of the six categories their proposal is submitted (although the committee reserves the right to reassign proposals to categories). If proposals in any of the categories are not forthcoming, or judged not to be of sufficient quality, the funds in those categories may be transferred to other categories. Each proposal must include the following:

(A) TITLE PAGE giving the title of the project, the name, mailing address, office and home telephone numbers and, if possible, fax number and e-mail address of the applicant. The title page should also include the following numerated items completed in this format on the bottom left corner of the Title Page:

1) Category:
2) Word count:
3) Student status (give school):
4) SSAR membership since:
5) SSAR budget portion (amount and brief description):
6) a statement indicating that applicants "will comply with all applicable permit regulations, and adhere to all appropriate animal care guidelines in the course of conducting funded projects.";

(B) BACKGROUND AND OBJECTIVES of the proposed project.

(C) METHODS of carrying out the project.

(D) COMPLETE PROJECT BUDGET (regardless of whether the SSAR grant will entirely cover expenses). Include an explicit explanation of how an SSAR award of $500 would be applied toward the objectives of the project (here as well as on Title Page), and provide a listing of all current and pending support for the project.

(E) BRIEF RESUMÉ/CURRICULUM VITAE of the applicant or project coordinator.

(F) LETTER OF SUPPORT.

The proposal must be typed, double spaced, and must not exceed 1,200 words, excluding title page, literature cited, curriculum vitae (resume), and budget. All proposals are to be submitted electronically to kapferj@uww.edu as a single PDF file named "lastname-category.pdf" no later than 15 December 2011 to be considered (letter of support may be included with the proposal or sent separately). (Exceptions to electronic submission and file format may be allowed for special cases with prior approval by SSAR-GIH Chair). Failure to meet these guidelines may result in elimination of a proposal from consideration. The awards will be announced in April/May 2012.

These guidelines are also available online at: http://www.ssarherps.org/pages/GIH.php

Successful applicants are encouraged to submit the results of their research for publication in the *Journal of Herpetology* or *Herpetological Review*, or to present their findings at the annual meeting of the SSAR. Submit proposals or questions regarding application procedures to:

Joshua M. Kapfer
Chair, SSAR Grants in Herpetology
Department of Biological Sciences
University of Wisconsin-Whitewater
Whitewater, Wisconsin 53190, USA
e-mail: kapferj@uww.edu

Grants In Herpetology Donor Information

Financial contributions by SSAR members, institutions, and other benefactors support this program significantly, and can increase the number and/or size of awards. Your tax-deductible contribution to this program will directly benefit meritorious research and education in herpetology. Contact the Treasurer of SSAR for additional information about contributing to the Grants-in-Herpetology Program. If you are employed by an organization that will match donations made to nonprofit organizations, please notify your employer that you have made a donation to the Grants-in-Herpetology Program.

NEWSNOTES

Amphibian Survival Alliance

The Amphibian Survival Alliance (ASA) is a new initiative established by the International Union for the Conservation of Nature (IUCN) to coordinate and magnify conservation efforts to stop and reverse the ongoing crisis of global amphibian declines.

In 2009, a coalition of organizations agreed to set up an interinstitutional Amphibian Survival Alliance to oversee the implementation of the Amphibian Conservation Action Plan (ACAP) that was drafted in 2005—focusing initially on habitat destruction and climate change, the fungal disease chytridiomycosis, and over-harvesting. This is expected to promote synergies and facilitate communications both within the amphibian community and with all the relevant stakeholders. IUCN has recently appointed Dr. Jaime García-Moreno and Dr. Phil Bishop to serve, respectively, as Executive Director and Chief Scientist of the Amphibian Survival Alliance. They will oversee the formation and coordination of a global network of partner organizations to facilitate implementation of research, conservation, and assessment programs as outlined in the ACAP.

The ASA is supported by and will be working in collaboration with organizations such as Conservation International, the Zoological Society of London, the Detroit Zoological Society, the North of England Zoological Society, Wildlife Conservation Society, and Frankfurt Zoo, as well as related initiatives such as the Amphibian Ark and the Amphibian Specialists Group. Jaime García-Moreno will work from his office at EAZA (European Association of Zoos and Aquaria) and is based in the Netherlands, closely collaborating with the Zoological Society of London and other partners of the Alliance. Phil Bishop will remain based at the University of Otago in Dunedin, New Zealand. They may be contacted at: Jaime.GarciaMoreno@iucn.org and Phil.Bishop@iucn.org.

Amphibian Declines Teaching Module Available from Free Download

Now available, via the Network of Conservation Educators & Practitioners (NCEP; a program of The American Museum of Natural History), is an outreach teaching module reviewing all aspects of the global crisis of amphibian declines and extinctions. Module includes a thoroughly annotated and illustrated PowerPoint presentation, an overview synthesis monograph with extensive literature citations, as well as proposed in-class teaching exercises and solutions. The module is aimed toward university-level students (e.g., Conservation Biology, Herpetology courses) but it is open-format so it can be edited and customized to any particular need or audience.

Link for free download: http://research.amnh.org/biodiversity/ncep

Mendelson, J. R., III, and R. Donnelly. 2011. The Crisis of Global Amphibian Declines: Causes, Consequences, and Solutions. Network for Conservation Educators and Practitioners, American Museum of Natural History. CD-ROM. System requirements: IBM PC or Mac compatible. Windows 98 or higher. Also available electronically at: (PowerPoint Teaching Tutorial, plus associated pedagogical materials). 97+ pp.

The authors also are actively seeking K–12 and other educators to collaborate to prepare versions of this module appropriate for non-university students and public audiences. For more information, or copies of these materials, please contact Joe Mendelson: jmendelson@zooatlanta.org

New Blog on Lizards of the Genus *Anolis*

Anole Annals (http://anoleannals.wordpress.com/) is a new blog focused on all things *Anolis*. It aspires to be the clearinghouse for information, observations, and announcements of all matters involving anoles, including reports on new papers, description of natural history observations, information on ongoing research projects and interests, anecdotes, photographs, and news on anoles in commerce, history, and philosophy. Posts are encouraged from all interested in matters anoline.

The Herpetologists' League EE Williams Research Grant

The Herpetologists' League is pleased to announce competitive grants for graduate student research for 2012. These awards are named in honor of the late Ernest E. Williams, the first Distinguished Herpetologist of The Herpetologists' League. This is a cash award of US $1,000 in each of five categories (Behavior, Conservation, Ecology, Physiology, Morphology/Systematics), with an entry deadline of 15 December 2011. Please consult the HL web site for application form, complete rules and details: www.herpetologistsleague.org/dox/eewilliamsgrant.pdf

The J. Larry Landers Student Research Award

The J. Larry Landers Student Research Award is a Gopher Tortoise Council competitive grant program for undergraduate and graduate college students. Proposals can address research concerning Gopher Tortoise (*Gopherus polyphemus*) biology or any other relevant aspect of upland habitat conservation and management. The amount of the award is variable, but has averaged US $1,000 over the last few years.

The proposal should be limited to four pages in length and should include a description of the project, a concise budget, and a brief resumé of the student.

This is an excellent opportunity for undergraduate and graduate students to access funding for their projects.

The deadline for grant proposals each year is 15 September. Submissions should be sent to:

Dr. Bob Herrington
Department of Biology
Georgia Southwestern State University
Americus, Georgia 31709, USA
Tel. 229/931-2331; e-mail: bherring@gsw.edu

MEETINGS

Meetings Calendar

Meeting announcement information should be sent directly to the Editor (HerpReview@gmail.com) well in advance of the event.

25–29 September 2011—Joint 16th SEH European Congress of Herpetology & 47th DGHT Deutscher Herpetologentag (annual meeting of the German Society for Herpetology and Herpetoculture, scientific part), Luxembourg. Information: http://www.symposium.lu/herpetology

30 September–2 October 2011—47th DGHT-Nachzuchttagung (annual meeting of the German Society for Herpetology and Herpetoculture, herpetocultural part), Trier, Germany.

3–7 January 2012—Symposium: New Frontiers from Marine Snakes to Marine Ecosystems. Society for Integrative and Comparative Biology annual meeting, Charleston, South Carolina, USA. Information: http://www.sicb.org/meetings/2012/symposia/marine.php

12–13 January 2012—California-Nevada Amphibian Population Task Force Meeting, Placerville, California, USA. Information: bradford.david@epa.gov

8–14 August 2012—World Congress of Herpetology 7, Vancouver, British Columbia, Canada (together with SSAR, HL, ASIH). Information: http://www.worldcongressofherpetology.org/

2–7 September 2012—4th International Zoological Congress (IZC), Mount Carmel Campus, University of Haifa, Haifa, Israel. To receive the first and subsequent meeting announcements, contact the organizers at: izc2012@sci.haifa.ac.il.

CURRENT RESEARCH

The purpose of Current Research is to present brief summaries and citations for selected papers from journals other than those published by the American Society of Ichthyologists and Herpetologists, The Herpetologists' League, and the Society for the Study of Amphibians and Reptiles. Limited space prohibits comprehensive coverage of the literature, but an effort will be made to cover a variety of taxa and topics. To ensure that the coverage is as broad and current as possible, authors are invited to send reprints to the Current Research section editors, Joshua Hale or Ben Lowe; e-mail addresses may be found on the inside front cover.

A listing of current contents of various herpetological journals and other publications is available online. Go to: http://www.herplit.com and click on "Current Herpetological Contents."

Chytrid Assay for Formalin-fixed Specimens and Elucidation of an Amphibian Extinction Wave

The fungus *Batrachochytrium dendrobatidis* (*Bd*) is a pathogen of amphibians and both histological and polymerase chain reaction (PCR) methods have been developed for establishing its presence. While the utility of using PCR assays on formalin-fixed museum specimens has long been noted, previous attempts have failed to devise a reliable method, leaving only time-consuming histological assays. The authors of this study describe a method for PCR assaying formalin-fixed specimens for *Bd* infection. This method entails thoroughly swabbing the skin of the specimen, extracting DNA from swabs using standard protocols, and real-time PCR amplification/quantification of a 146 base pair segment of DNA (mtDNA: ITS-1). To determine effectiveness of this method, animals which had previously been assayed via the histological method were subjected to the PCR assay. This revealed that two or more PCR assays per specimen results in the same detection success as one histological assay. The authors attribute the success of this method to the short length of the target DNA segment, multiple tests per animal (resulting in a test with acceptable error rates), and targeting of the skin (where *Bd* is expected to be most highly concentrated). As a case study to demonstrate the utility of these methods, the authors performed PCR-based *Bd* assays on a number of formalin-fixed specimens from Mexico, Guatemala, and Costa Rica. Cumulatively, these results strongly support *Bd* as a causal agent in the recent declines and extinctions of neotropical amphibians, with precipitous frog and salamander declines immediately following the detected emergence of the pathogen. Together with previous studies, these results suggest a wave of *Bd* originating in southern Mexico in the early 1970s, spreading south across Guatemala in the 1980s, reaching Monteverde, Costa Rica, in 1987, and central Panama in 2004. To further investigate the susceptibility of neotropical amphibians to *Bd*, individuals of two bolitoglossine salamander species and a hylid treefrog species were exposed to *Bd* in the laboratory (all frogs tested positive for chytrid at time of collection; some salamanders were left uninfected to serve as controls) and their condition was monitored for seven weeks. During the experiment, all infected salamanders rapidly increased in *Bd* infection and died; all infected frogs maintained infection at low levels and did not exhibit disease symptoms. These studies indicate the susceptibility of species to *Bd* is unpredictable and that species-specific laboratory-based experiments should be performed when possible.

Cheng, T. L., S. M. Rovito, D. B. Wake, and V. T. Vredenburg. 2011. Coincident mass extirpation of neotropical amphibians with the emergence of the infectious fungal pathogen *Batrachochytrium dendrobatidis*. Proceedings of the National Academy of Sciences (*in press*) doi:10.1073/pnas.1105538108.

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Patterns of Detectability and Site Occupancy among American Aquatic Snakes

Determining the detectability of species is important when trying to interpret presence-absence data. The authors of this study investigated the relationships between detectability, fraction of sites occupied, and environmental variables in seven aquatic snake species. Capture-recapture data from repeated efforts using minnow traps was collected across twenty isolated wetlands in the Savannah River watershed of South Carolina, USA. Additionally, prey density (fish, crayfish, and aquatic salamander), distance from river, and water permanence were quantified and subjected to a principal components analysis. Subsequently, the modeling program PRESENCE was used to model detectability and number of sites occupied, allowing one to vary with one or both of the first two principal components while holding the other constant, or allowing both detectability and sites occupied to vary with the principal components. The authors discovered a wide range of detection probabilities and site occupancy fractions among the snake species, in harmony with studies of terrestrial snakes. Furthermore, many instances of strong correlation between detectability, site occupancy, and environmental variables were detected. For instance, the detectability for one widespread and generally detectable species, *Nerodia fasciata*, was positively correlated with crayfish abundance and negatively correlated with water permanence and fish and neotenic salamander abundance (principal component one; also correlated with population density). However, another widespread species, *Agkistrodon piscivorus*, exhibited the lowest detectability; the authors attributed this to the species' reluctance to enter minnow traps. These findings demonstrate the variable and generally low detectability of snake species and the importance of taking into account the potential correlates of detectability when modeling site occupation.

Durso, A. M., J. D. Willson, and C. T. Winne. 2011. Needles in haystacks: Estimating detection probability and occupancy of rare and cryptic snakes. Biological Conservation 144:1508–1515.

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Many Potential *Bd* Mitigation Methods on the Horizon

Much research of late has been directed toward stemming the tide of amphibian declines and extinctions due to the chytrid fungus, *Batrachochytrium dendrobatidis* (*Bd*). In an attempt to synthesize this body of work, the authors of this review paper tackle the variety of methods currently used to control *Bd*-triggered declines in amphibians. They demonstrate that most conservation strategies can be divided into three categories: large-scale prevention of the spread of *Bd*, establishment of captive "insurance" colonies, and *in situ* treatments aimed at preventing or limiting *Bd* infection. The authors then briefly discuss a long list of potential *Bd*-fighting methods currently being explored. These include modifying habitats to be less hospitable to *Bd*, captive breeding of *Bd*-resistant lines for reintroduction, and the protection of "climatic refugia," where *Bd*-susceptible species persist with or without *Bd* present. While generally optimistic about the potential of proposed *Bd*-mitigation strategies, the authors emphasize that amphibian density reduction measures (via culling) likely will have negative consequences. They urge people planning conservation efforts to prepare to take more active measures in combating *Bd*. Additionally, fundamentally different methods (i.e., habitat-based, medical) may need to be attempted before a remedy is found for any given situation. They conclude with a list of questions which if addressed, could prove indispensable to the global efforts to combat the *Bd* pandemic.

Woodhams, D. C., J. Bosch, C. J. Briggs, S. Cashins, L. R. Davis, A. Lauer, E. Muths, R. Puschendorf, B. R. Schmidt, B. Sheafor, and J. Voyles. 2011. Mitigating amphibian disease: strategies to maintain wild populations and control chytridiomycosis. Frontiers of Zoology 8:8.

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Parthenogenic Lizard Lineage Initiated in Laboratory

It is well understood that across evolutionary time, parthenogenic lineages of North American whiptail lizards (Teidae: *Aspidoscelis*) have repeatedly formed as the consequence of hybridization. However, this phenomenon has not been replicated in the laboratory and this failure has led some to conclude that the vast majority of hybridization events lead only to hybrid, sexual individuals, and that parthenogenic lineages have effectively lost the ability to reproduce sexually. The authors of this paper report the first captive establishment of parthenogenic lizard lineages. Males of a sexual, diploid species (*A. inornata*) were paired with females of a parthenogenic, triploid species (*A. exsanguis*). These are not the parental species of any described parthenogenic species. Six eggs (the product of a single parental pair) were laid and resulted in the hatching of two males and four females. Quantification of nuclear DNA via flow cytometry revealed the offspring to be tetraploid and DNA microsatellite data indicated that all progeny exhibited genetic contributions from both parental species. These four females have resulted in 25 second-generation and 22 third-generation lizards, demonstrated via microsatellite analysis to be tetraploid clones. These findings follow studies in fish and amphibians, where naturally-occurring parthenogenic species have been recreated in the laboratory. However, asexual reproduction in those systems requires sperm contribution (but not necessarily DNA) from a sympatric, sexual male. The authors close with a discussion of the taxonomic implications of creating a parthenogenic tetraploid *Aspidoscelis* lineage in the laboratory and urge people working in the area of sympatry of these species to look for lizards matching the phenotype of the laboratory-generated lineage.

Lutes, A. A., D. P. Baumann, W. B. Neaves, and P. Baumann. 2011. Laboratory synthesis of an independently reproducing vertebrate species. Proceedings of the National Academy of Sciences (*in press*) doi:10.1073/pnas.1102811108.

Correspondence to: **PETER BAUMANN**, Stowers Institute for Medical Research, 1000 East 50th Street, Kansas City, Missouri 64110, USA; e-mail: peb@stowers.org

Garter Snakes Direct Blood Flow Depending on Temperature

Ability to control blood flow to various regions of the body is thought to be an important thermal management tool across the vertebrate spectrum. However, this ability has not been definitively demonstrated in snakes. The authors of this paper aimed to investigate this phenomenon using Common Gartersnakes (Natricinae: *Thamnophis sirtalis*) surgically outfitted for the aortic administration of blood plasma proteins labeled with a radioactive isotope (^{99m}Tc-MAA). Snakes were either cooled to ~7°C or heated to ~30°C, injected with ^{99m}Tc-MAA, and photographed using a gamma camera. Image analysis software was used to quantify the blood flow to the head and tail. These analyses demonstrated that common garter snakes do indeed direct blood toward their heads and away from their tails when subjected to cold temperatures. Furthermore, these snakes are capable of performing the opposite task when exposed to high temperatures. The authors propose that the non-essential nature of their post-cloacal anatomy afford these snakes the opportunity to preserve heat by pulling blood cranially. Alternatively, under hot conditions snakes can utilize the high surface-to-volume ratio of the tail to cool down as well as prevent overheating of the sensitive head. The authors encourage others to perform these experiments on representatives of other snake lineages and caution that these findings may not extend to snakes with tails of demonstrated function (such as marine snakes, arboreal snakes, and rattlesnakes).

Amiel, J. J., B. Chua, R. J. Wassersug, and D. R. Jones. 2011. Temperature-dependent regulation of blood distribution in snakes. Journal of Experimental Biology 214:1458–1462.

Correspondence to: **JOSHUA AMIEL**, School of Biological Sciences, The University of Sydney, Heydon-Laurence Building (A08), Science Road, Sydney, NSW 2006, Australia; e-mail: jami3107@uni.sydney.edu.au

Fox Snake mtDNA Discordant with Current Taxonomy

The American fox snakes (Colubridae: *Pantherophis vulpinus* and *P. gloydi*) have had a tumultuous taxonomic history, first being treated as monotypic conspecifics, subspecies, and most recently distinct species (without universal acceptance). Despite being ecologically divergent and geographically disjunct populations, morphological evidence for considering them separate species is tenuous and molecular data have been lacking. To shed light on this system, the authors of this paper accumulated mtDNA (cytochrome *b*) sequences and morphological data from across the distribution of this group. Phylogenetic analyses revealed mtDNA haplotype distribution discordant with described species, with populations west of the distributional break exhibiting eastern haplotypes. Instead, the mtDNA clades largely corresponded to the east and west sides of the Mississippi River; this geographic feature is increasingly being recognized as an important barrier to gene flow for recently-diverged lineages. However, there appear to have been recent trans-river colonizations, blurring the line between the two mtDNA clades. Dorsal blotch count (the character originally used to define these species) was found to show the same difference at the Mississippi River as it does across the distributional break. A molecular clock analysis places the divergence of the two mtDNA clades within the Pleistocene; this is in accordance with the fact that all of the fox snake's current distribution was under ice at some point during the Pleistocene. The authors conclude with possible explanations for these incongruent lines of evidence, suggest a reassessment of the distributions of these species, and discuss accompanying nomenclatural repercussions.

Crother, B. I., M. E. White, J. M. Savage, M. E. Eckstut, M. R. Graham, and D. W. Gardner. 2011. A reevaluation of the status of the foxsnakes *Pantherophis gloydi* Conant and *P. vulpinus* Baird and Girard (Lepidosauria). ISRN Zoology 2011:436049.

Correspondence to: **BRIAN CROTHER**, Department of Biological Sciences, Southeastern Louisiana University, Hammond, Louisiana 70402, USA; e-mail: bcrother@selu.edu

Ancient Divergences at Stream Drainage Divides in Terrestrial Salamander

Researchers investigating the origins of biological diversity have long understood the effect river drainages have on freshwater organisms. However, water features can also serve to prevent gene flow in terrestrial organisms. The authors of this paper sought to identify the phylogeographic structure and its potential hydrological underpinnings in a direct-developing salamander species, *Plethodon caddoensis* (Plethodontidae), which is endemic to the sky islands of America's Interior Highlands. mtDNA sequence data from across the distribution of this species and its two close relatives, *P. ouachitae* and *P. fourchensis*, were assembled and subjected to phylogenetic analyses (including a time-calibrated analysis). DNA sequences were also analyzed in partial Mantel tests to probe for phylogeographic structuring due to geographic distance, watersheds, and their constituent stream drainages. Importantly, as these variables are correlated, these analyses were conducted using the molecular data and each variable, while controlling for the other variables. Finally, ecological niche model analyses were performed using the locality data. These analyses were aimed at identifying the ecological variables that may be important in defining the distribution of this species. Furthermore, results from this analysis and analyses conducted on *P. ouachitae* and *P. fourchensis* were included in a Principal Components Analysis (PCA) intended to discover how *P. caddoensis* differs ecologically from its close relatives. The phylogenetic analyses revealed *P. caddoensis* consists of four deeply divergent lineages, each comparable in age to the species *P. ouachitae* and *P. fourchensis*. These primary clades diverged in the Middle Miocene, a period marked by aridification and a general succession from deciduous forest to grasslands. Overall, the molecular data show strong correlations with distance, watershed, and stream drainage. However, the correlation between molecular and geographic distance disappears when only comparisons between mitochondrial clades are examined; the authors interpret this to mean distance has not been a contributor to major lineage diversification in this system. Nevertheless, the lineages do meet at divides between drainage basins, suggesting the arid divides have served as barriers to dispersal while the streams within the drainages have not. The environmental niche modeling analysis found surface geology and wet season precipitation level to be the most important environmental variables for this species. Finally, the PCA revealed *P. caddoensis* to occupy a niche different from those of its close relatives and to be instead adapted to a warmer, wetter climate. This study exposes more fine-scale, cryptic diversity in lungless salamanders and sheds light on the sources of this diversity.

Shepard, D. B. and F. T. Burbrink. 2011. Local-scale environmental variation generates highly divergent lineages associated with stream drainages in a terrestrial salamander, *Plethodon caddoensis*. Molecular Phylogenetics and Evolution 59:399–411.

Correspondence to: **DON SHEPARD,** University of Minnesota, Bell Museum of Natural History, 100 Ecology, 1987 Upper Buford Circle, Saint Paul, Minnesota 55108, USA; e-mail: dshepard@umn.edu

Continental Scale Climate Patterns Affect Lizard Phenology

One important tool for understanding the potential demographic effects of climate change is mechanistic modeling, where a species' physiological requirements are determined (often under laboratory conditions) and are used to establish when and under what biotic and environmental conditions the species can be in a positive energy balance or engage in certain behaviors. The authors of this study created a phenology model for Side-blotched Lizards (Phrynosomatidae: *Uta stansburiana*), field-tested their predictions for seasonal activity and reproductive timing in the deserts of eastern Oregon, USA, and examined long-term phenological trends in this population. As a metric of cumulative thermal energy, the authors used degree-days—the sum of daily temperature average minus the minimum body temperature needed for activity. Previous work established that these lizards require air temperatures at or above 10°C to

be active and have a preferred body temperature of 35°C, which the lizards can achieve through thermoregulation at air temperatures in excess of 15°C. Furthermore, in laboratory common garden experiments, the authors found that these lizards require a minimum of 550 degree-days for egg yolk formation. These values adequately mirrored estimates obtained over six years of field studies. Then, using these phenological parameter values and atmospheric temperature data from the site, they calculated beginning, end, and length of growing season and timing of reproduction for the past 70 years and performed linear regressions on the predictions. These estimated values were then included in a multiple regression analysis, where they were they were evaluated for correlations with two continental-scale climate phenomena: the El Niño-Southern Oscillation (ENSO) and Pacific Decadal Oscillation (PDO). As any given year's ENSO or PDO status is not independent of its thermal and phenological status, the authors were particularly focused on the fit of models not including year but instead previous and next year's ENSO and PDO status. The linear analysis of the 70 years of modeled phenological phenomena showed that growing seasons have shortened recently, both beginning later and ending sooner. Although this may seem contrary to general climate change trends, other climate studies have shown that the Great Basin Desert has cooled while surrounding regions have warmed. They also showed that large variations in annual phenology make any given year's pattern largely independent of climate fluctuations occurring at the scale of centuries or longer. The multiple regression analyses revealed shorter and earlier ending growing seasons to be correlated with the previous year exhibiting PDO conditions. Conversely, early timing of reproduction was found to be strongly correlated with ENSO conditions the previous year. Considering these two independent climate variables affect different phenological aspects of this lizard's life history, the authors posit that predicting future demographic changes in these types of systems may be difficult.

Zani, P. A., and M. E. Rollyson. 2011. The effects of climate modes on growing-season length and timing of reproduction in the Pacific Northwest as revealed by biophysical modeling of lizards. American Midland Naturalist 165:372–388.

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Bd Correlated with Amount of Surrounding Habitat Loss

With the fungal pathogen *Batrachochytrium dendrobatidis* (*Bd*) ravaging amphibian populations across the globe, understanding the correlates of infection is of great importance to conservation efforts. Many *Bd*-implicated amphibian extinction events have occurred at high elevations, which has been considered a consequence of *Bd*'s affinity for cool, moist habitats. The effect of habitat loss on *Bd* prevalence has not been determined, however, disturbed habitats generally are associated with increased disease prevalence. To elucidate potential correlates of *Bd* infection, the authors of this study collected data on frogs from three regions known to harbor *Bd*: *Craugastor fitzingeri* in Costa Rica, *Dendropsophus minutus* in Brazil's Atlantic Forest, and *Litoria lesueuri* in eastern Australia. Data were collected for habitat loss, frog species richness, elevation, latitude, as well as a large number of temperature and precipitation metrics. Additionally, using quantitative PCR, sites across these three regions were sampled for *Bd* prevalence (percent of animals infected) and intensity (zoospores per animal) (due to sample size restrictions, Costa Rica estimates limited to presence-absence); estimates of animal density were also determined where possible. These variables were then subjected to a series of regression analyses which explain (directly or indirectly) *Bd* presence, prevalence, and intensity. In all cases, habitat loss was found to be strongly correlated with *Bd*. Interestingly, this association was negative, with more *Bd*-infection in more pristine habitats. Additionally, anuran diversity was found to be positively associated with *Bd*. According to the authors, these findings suggest that the lack of diversity and relative aridity exhibited by isolated patches of frog habitat make for suboptimal *Bd* environments. Furthermore, the authors detected a strong interaction between elevation and habitat with regard to *Bd*, which they took to mean that the observation that high elevation frog communities have disproportionately suffered *Bd*-implicated declines is due in part to habitat loss being disproportionately a low-elevation phenomenon. The authors warn that this should not be viewed as a consolation, as habitat loss has even more dire consequences than *Bd*. As this study has shown, conservation biologists must be cognizant of all potential factors triggering declines, as well as their possible interactions.

Becker, C. G., and K. R. Zamudio. 2011. Tropical amphibian populations experience higher disease risk in natural habitats. Proceedings of the National Academy of Sciences (*in press*) doi:10.1073/pnas.1014497108.

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Fish Implicated in Decline of Salamander Species

Although fish can directly impact salamanders through predation, fish can also inhibit salamander activity by initiating defensive behavior in the salamanders. The authors of this paper investigated the interactions between Long-toed Salamanders (*Ambystoma macrodactylum*) and a freshwater fish, the Lake Chub (Cyprinidae: *Couesius plumbeus*), in Alberta, Canada. Surveys were made of adult salamanders returning to the lake, larvae, and egg masses, and these figures were then compared with similar estimates made fifteen years earlier in an attempt to determine the salamander population size trajectory. In the laboratory, experiments were conducted to determine behavior and survivorship of salamander larvae in the presence of fish. Furthermore, although the salamanders are expected to engage in cannibalism, the frequency of this behavior in this system is not known, and therefore the authors also attempted to identify the correlates of this phenomenon. The population size estimates showed the salamander population to be in a steep decline. Indeed, in the two years of sampling, only a single larva was observed. The laboratory experiments revealed that larval salamander survivorship increased with size and when in the presence of fish, salamanders decreased their activity levels as

well as occupied areas away from the fish. Additionally, larger salamanders were more likely to engage in cannibalism. Interestingly, salamanders were not observed engaging in anti-predator behavior when in the presence of a potentially cannibalistic conspecific. The authors conclude that this salamander species may be negatively affected by the Lake Chub, both directly through predation and indirectly by initiating anti-predator behaviors, and that this fish may be the cause of population size decline in this system.

Pagnucco, K. S., C. A. Paszkowski, and G. J. Scrimgeour. 2011. Wolf in sheep's clothing: Effects of predation by small-bodied fish on survival and behaviour of salamander larvae. Écoscience 18:70–78.

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OBITUARIES

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In Memoriam: Osvaldo Rodrigues da Cunha (1928–2011)

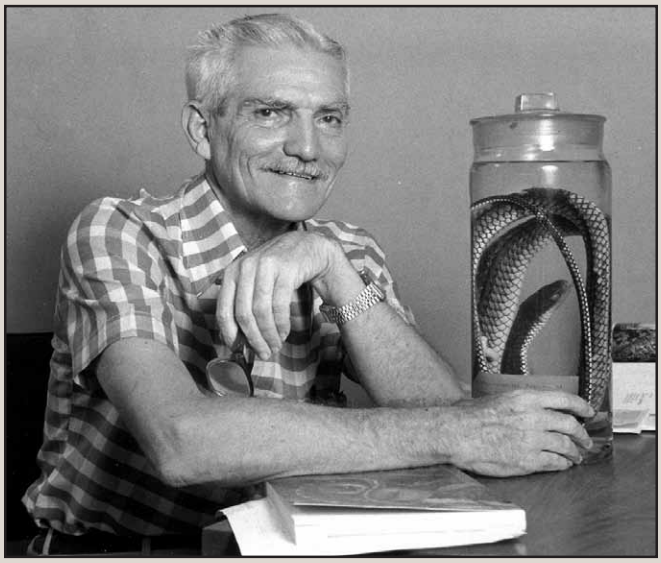


PHOTO BY JANDUARI SIMÕES, COLLECTION OSVALDO RODRIGUES DA CUNHA

Fig. 1. Osvaldo Rodrigues da Cunha in 1991, with a specimen of *Chironius carinatus* (Linnaeus, 1758) of the MPEG collection.

Osvaldo Rodrigues da Cunha, retired researcher of the Museu Paraense Emílio Goeldi (MPEG), founder of the sector of herpetology and of the herpetological collection of MPEG, tireless researcher of Amazonian reptiles and also of its scientific history, especially of the MPEG and persons connected to it, died on 11 March 2011 in Belém at the age of 82 years. The last three years he was plagued by weak health and loss of sight.

Osvaldo Rodrigues da Cunha was born on 6 April 1928, in Belém do Pará, Brazil, as the eldest son of the Portuguese couple Carlos Pereira da Cunha and Ana Cerqueira Rodrigues da Cunha, who had one more son and two daughters. Osvaldo Cunha attended primary school and gymnasium in Belém until 1946. He refused to follow university courses offered at that time because he considered them inadequate for the natural history studies that he wanted to do. His interest in natural history probably was instigated by frequent visits to the zoobotanical park of MPEG, close to his house. He preferred to prepare himself via practical work, initially in MPEG and later on in Museu Nacional (MN), in Rio de Janeiro, and Museu de Zoologia, in São Paulo (MZUSP), and by studying in the libraries of these institutions. With this in mind, he entered MPEG as a volunteer in the Zoology Department in 1945, where he started studying butterflies and beetles from the area around Belém. Between September 1949 and January 1951 he was a volunteer in the Zoology Department of the MN in Rio de Janeiro, where he also attended courses in Biology, Comparative Anatomy, Statistics applied to Biology, Practical Natural History, and General Biology. During this period in MN he met Antenor Leitão de Carvalho, who encouraged him to study reptiles. Finally, from September 1963 to December 1964 Cunha was a volunteer with Paulo Emílio Vanzolini, director of the Museu de Zoologia de São Paulo and trained as a herpetologist in the USA. In MZUSP he could participate in scientific projects, talks, meetings, and seminars. During this stay in São Paulo he also met Alphonse Richard Hoge, chief of the herpetological section of the Instituto Butantan, with whom he later on (1980) published a paper. During this initial phase, besides his studies in natural sciences, Osvaldo Cunha already showed his interest in the history of science, writing several articles on the subject for newspapers in Belém. It is also from this time on that he started his own library, which grew considerably until his retirement.

In MPEG, Osvaldo Cunha was appointed "Naturalist" on 17 December 1953 and Zoological Researcher in 1966, at that time already focusing on reptiles. Between 1955 and 1962, however, due to institutional problems, he worked in the Geology Department. Together with the geologist C. S. Ferreira he published during this period a number of papers on paleontology, but at the same time he continued his studies on reptiles. The first small paper on lizards, in 1958, dealt with a new occurrence (of *Bachia*) in Amazonia, but the second, from 1961, dealt with the species of lizards then known from Brazilian Amazonia. It is the first paper on a South American group of lizards that covers a large area. The study was based only on material from the MPEG collection, but this pioneering paper formed the basis for other more encompassing studies on lizards (e.g., Avila-Pires 1995, which also took into account material from the principal European and U.S. museums). These first papers on lizards were followed by six

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more in this series, up to 1981. Number IV of this series (Cunha 1971) was the description of a new genus and species (*Amapasaurus tetradactylus*) from Amapá, based on two badly preserved specimens collected in 1960 and 1969. It was not until 2004 and 2006 that more specimens were collected in Amapá (Tumuc Humac expedition of Conservation International), and in 2008 the species was also found in northern Pará (see Avila-Pires et al. 2010 for a photo of this rare lizard).

In June 1965 Cunha established the Herpetological section of MPEG, with a collection of 650 specimens (a number of specimens before this period had gone to other institutions, either as donations or as loans that never returned). In 1965 Cunha started to train Francisco Paiva do Nascimento, who became his most important collaborator, in herpetological work. The results of this cooperation were very successful for the knowledge of the Amazonian reptile fauna, especially that of Pará, and for the herpetological collection of MPEG.

In order to undertake an inventory of the herpetofauna of Pará, Cunha and Nascimento developed a simple, but effective system to obtain specimens for the collection, by enlisting the help of rural people in a number of localities in eastern and southern Pará and western Maranhão (see maps in papers of Cunha and Nascimento about snakes from these areas). In each locality they trained one person to fix specimens that were collected by injecting formol 4% (one part formaldehyde, nine parts water) and preserving them in a barrel with alcohol 70–80%. About every month Cunha and Nascimento visited all localities and assembled the material that had been collected. In this way, specimens collected during daily activities (including preparing agricultural ground) could easily be collected and added to the collection, including species that were rare, or which, due to fossorial habits or because of being very cryptic, are difficult to obtain during normal herpetological fieldwork. The herpetological collection of MPEG thus increased rapidly in a short time. This system was especially effective for snakes, but also for amphisbaenians and caecilians. It also yielded a large series of the lizard *Stenocercus dumerilii* (Steindachner, 1867), which until then was known from only a few specimens. This series formed the basis for a publication in which the species was redescribed (under the name *Ophryoessoides tricristatus*) and notes on its ecology and distribution were provided (Cunha 1981).

The abundant material obtained during these collections formed the basis for the pioneering and seminal series "Ofidios da Amazônia" by Cunha and Nascimento and numbered I–XXII (number I was written by Cunha, number XII had A. R. Hoge as a co-author), which appeared between 1967 and 1991. Number X ("As cobras da região leste do Pará," Cunha and Nascimento 1978) is of special interest because it described the snake fauna of a large Amazonian area and became a classic for the study of Amazonian snakes. In 1993 a second book was published that was presented as a revised second edition of the 1978 version, but in reality it is a complement to the 1978 book. It contains additional data and different photos (black and white), and it dealt with 87 species, 12 more than in the 1978 paper. This was the last publication in herpetology by Cunha (and also of Nascimento). The impact of the series of papers on lizards (1958–1981) and snakes (1967–1991) outside of Brazil was not optimal, because of distribution problems of the MPEG journals in which most papers were published; issues sometimes took years before they reached foreign libraries. Another problem was that Cunha was not very well connected outside Brazil and had little correspondence with foreign colleagues (he wrote only in Portuguese). Possibly these papers on Amazonian lizards and snakes might have had a greater impact had they been written in English. However, within Brazil the importance of especially the series on snakes was well recognized and due to the large interest in it the 1978 book soon was unavailable. The recognition of the value of the work by Cunha and Nascimento on Amazonian snakes was well expressed by Martins and Oliveira (1998), who dedicated their paper to "O.R. Cunha and F.P. Nascimento ……for their unparalleled contributions to the knowledge of Brazilian Amazonian snakes, including natural history, and the immense collection of snakes at the MPEG, an invaluable source of natural history information for years to come." This statement is still very appropriate, as shown by the present use of the MPEG collection by many students and researchers for taxonomic, anatomical, and ecological studies.

At the time of Cunha's retirement, the herpetological collection contained 38,000 specimens, an increase of nearly 60 times compared with the number in 1965. It was the largest collection of Amazonian material and the third largest in Brazil. The herpetological collection continued growing after Cunha's retirement and at the moment contains approximately 86,000 specimens, now with amphibians forming the largest group, followed by lizards and snakes. It ranks among the three largest in Brazil and the largest concerning Amazonian herpetofauna.

When in 1985 the herpetological collection was transferred to a new building at the Research Campus of MPEG at the Avenida Perimetral, on the outskirts of Belém, Osvaldo Cunha preferred to stay in his room at the Parque Zoobotânico of MEG, in the central part of Belém, and thus became separated from the herpetological collection. This was an important decision, because after 1985 his herpetological work practically came to a standstill, and until 1993 only four herpetological papers were published, in two of which he was third author.

The publications on the herpetofauna of Amazonia by Cunha and Cunha & Nascimento constitute a good base for more elaborate studies on the reptiles of Amazonia, which are being developed by researchers of MPEG and more recently also of the Federal University of Pará, together with graduate and master's students and doctoral candidates in herpetology. At least in part, Osvaldo Cunha was responsible for the presence of these researchers in these two institutions in Pará. Without his pioneering work and the herpetological collection that he built, the MPEG certainly would not be as attractive for herpetologists from other parts of Brazil and abroad as it is now.

Osvaldo Cunha retired in 1990 at the age of 62 years, but continued working in another area that held his interest: the history of MPEG and of the scientists who worked there. One of the most interesting papers by Cunha prepared during that time (Cunha 1991) was about the naturalist Alexandre Rodrigues Ferreira, who traveled in Brazilian Amazonia between 1783 and 1792. In this paper Cunha not only writes about Rodrigues Ferreira, but includes information about other naturalists who traveled in Amazonia during the 19th century, and maps of the trajectories covered by them. This publication is a rich source of information about the work of the traveling naturalists who collected the first data about fauna and flora of Amazonia. Unfortunately, the loss of sight prevented him from completing several biographies and other manuscripts.

Between 1954 and 1988 Cunha published many texts in Belém newspapers, both about zoology and about the history of science, indicating his interest in providing knowledge to the general public.

At first meeting, Osvaldo Cunha appeared to be a closed and difficult person, but those who had the opportunity to have more contact with him came to know him as an attentive person with a phenomenal memory, who could talk for hours about many subjects, apart from herpetology. With the death of Osvaldo Cunha, the MPEG lost a great researcher and an interminable source of knowledge about the museum and its personnel.

This "In memoriam" was largely based on the biography of O. R. Cunha published in 1991 by Francisco Paiva do Nascimento in the Boletim do Museu Paraense Emilio Goeldi, Zoologia 7(1), a number dedicated to Cunha, as well as on our contacts and long conversations over the years. One of us (TCSAP) arrived in MPEG in 1983, with a Masters degree in Zoology, but without any experience with Amazonian herpetofauna. She worked with Cunha and Nascimento, a partnership that resulted in three joint publications, and, more than that in learning, friendship, and admiration. The senior author (MSH) had regular correspondence with Osvaldo Cunha about the herpetofauna of the Guianan region, and in 1976 had the opportunity to meet him personally during a one week visit to the MPEG collections. After that, when he did more fieldwork in Brazil and finally when he moved there, the contacts became closer.

In conclusion, we present a list of species described by O. R. Cunha, patronyms, honors he received, and a list of his most important herpetological publications. This list of publications was copied from Nascimento (1991 [see reference above]), with some alterations and additions, mainly of papers published after 1990. Apart from the papers listed, Cunha participated as a co-author in seven papers on chromosomes of Amazonian reptiles. A complete list of Cunha's papers can be found in Hoogmoed et al. (2011).

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Taxa Described by O. R. da Cunha and Colleagues

(* indicates new genus)

Reptilia, Snakes:

Atractus albuquerquei Cunha & Nascimento, 1983
Atractus alphonsehogei Cunha & Nascimento, 1983
Atractus flammigerus snethlagae Cunha & Nascimento, 1983
[= *Atractus snethlagae* Cunha & Nascimento, 1983]
Liophis carajasensis Cunha, Nascimento & Avila-Pires, 1985
Mastigodryas bifossatus lacerdai Cunha & Nascimento, 1978
[=*Mastigodryas b. bifossatus* (Raddi, 1820)]
Micrurus psiches [sic] *paraensis* Cunha & Nascimento, 1973
[= *Micrurus paraensis* Cunha & Nascimento, 1973
Oxyrhopus melanogenys orientalis Cunha & Nascimento, 1993
Sibynomorphus mikani [sic] *septentrionalis* Cunha, Nascimento & Hoge, 1980 [=*Sibynomorphus mikanii* (Schlegel, 1837)]

Reptilia, Lizards:

**Amapasaurus tetradactylus* Cunha, 1970
Arthrosaura amapaense Cunha, 1967
[= *Arthrosaura reticulata* (O´Shaughnessy, 1881)]
Colobosaura landii Cunha, 1977
[= *Colobosaura modesta* (Reinhardt & Lütken, 1862)]
**Colobosauroides cearensis* Cunha, Lima-Verde & Lima, 1991
Gonatodes eladioi Nascimento, Cunha & Avila-Pires, 1987
Placosoma cipoensis Cunha, 1966

Reptilia, Chelonia:

Kinosternon scorpioides carajasensis Cunha, 1970
[= *Kinosternon s. scorpioides* (Linnaeus, 1766)]

Patronyms

Amphisbaena cunhai Hoogmoed & Avila-Pires, 1991
Leposoma osvaldoi Avila-Pires, 1995
Typhlonectes cunhai Cascon, Lima-Verde & Marques, 1991
[= *Typhlonectes compressicauda* (Duméril & Bibron, 1841)]

Honors Received

Cunha was honored by INPA, the Brazilian Zoological Society, the MPEG, the Brazilian Herpetologiocal Society, and the Brazilian Paleontological Society. In 1991 he was nominated Commander in the Order of Merit of Grão Pará.

Publications of Osvaldo Rodrigues da Cunha

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In Memoriam: Bern W. Tryon (1947–2011)

Bern W. Tryon, well known zoo herpetologist and Bog Turtle field researcher and biologist, died peacefully at home on 6 May 2011 after a long battle with cancer. He was 64. Bern was the Director of Animal Collections/Herpetology at the Knoxville Zoo and Director of the Tennessee Bog Turtle Project based in east Tennessee. He was preceded in death by his parents Willard William and Helene Kish Tryon. He is survived by his daughter Katherine Tryon and granddaughter, Sophia, of Richmond, Virginia.

Bern was born in Newburgh, New York, on 11 March 1947. The family moved to Terre Haute, Indiana, where Bern's childhood was happily spent collecting butterflies and searching for amphibians and reptiles, a hobby that became his life's work. One of his fondest memories occurred at the age of 10, when his family took him to Florida, and they visited Ross Allen's Reptile Institute in Silver Springs. He was thrilled to be able to talk to Ross Allen during the visit, and bought his first snake, an Eastern Indigo Snake, the first of many species he would care for over the next 54 years. Bern moved to Aiken, South Carolina, in 1969, and found work at the Savannah River Ecological Laboratory under the tutelage of Whit Gibbons and I. Lehr Brisbin. It was during this period that he honed his "search image" while collecting reptiles for the laboratory, and visited the famed "Okeetee" area in Jasper Co., South Carolina, for the first time.

PHOTO BY PHIL COLCLOUGH



FIG. 1. Bern Tryon tracking Bog Turtles in 2009 at the Ripshin Bog, a privately owned property in Tennessee. Over the past 20 years, 167 head-started Bog Turtles from the Knoxville Zoo program were released at this site.

In 1971, Bern received a BS in Biology from Gardner-Webb University in North Carolina. Upon graduating he began his illustrious zoo and herpetological career with the Atlanta Zoo (Zoo Atlanta), Atlanta, Georgia, as Reptile Keeper/Senior Reptile Keeper (1971–1974). His next zoo position was Assistant Supervisor/Supervisor of Reptiles at the Fort Worth Zoos (1974–1980), and then Supervisor of Herpetology at the Houston Zoo (1980–1984). Bern moved to the Knoxville Zoo in 1984, where he held the following positions: Curator of Herpetology (1984–2009), General Curator (1994–1997), and Director of Animal Collections/Herpetology (2000–present).

Bog Turtles (*Glyptemys muhlenbergii*) became one of Bern's major passions when he found his first in a Henderson Co., North Carolina, study site with long-time friend Dennis Herman in 1982. He continued to assist Herman in Bog Turtle field work after he moved to Knoxville in 1984. His decision to have the Knoxville Zoo become a leader in Bog Turtle captive propagation and conservation came to fruition when he converted an old outdoor alligator exhibit into a world class Appalachian Bog ecosystem replete with live bog plants and a core breeding group of Bog Turtles. The spring of 1986 became an important time in his quest to further the zoo's involvement in Bog Turtle conservation when the first Bog Turtle ever reported in Tennessee was found (Herman and Warner 1986). Bern found his first Tennessee Bog Turtle three days after the first had been discovered, and he laid the groundwork for what was to become the most complex and extensive Bog Turtle study ever attempted. An offshoot of his Tennessee capture-mark-recapture study also took root in 1986 when he decided to initiate a captive propagation, head-starting, and release project in a Carter Co., Tennessee mountain bog. This large bog site was determined to be devoid of Bog Turtles after nearly 50 hours of intensive search during 1986 and early 1987. There was initial skepticism and controversy from some quarters regarding the validity of such a project. Not to be deterred, and in single-minded fashion, Bern put together a coalition of partners to support such an endeavor, the likes of which had never been attempted for Bog Turtles. This partnership consisted of the Knoxville Zoological Gardens, American Association of Zoos and Aquariums (AZA), U.S. Fish & Wildlife Service, Tennessee Wildlife Resources Agency, and The Nature Conservancy. The first cohort of turtles was released in the site in 1991, with 167 released through 2011 (Fig. 1, 2). He began a radio tracking study and a trapping regime, with his project assistant Lynn Easton, to maximize recapture efforts of the released turtles. After years of collecting capture and movement data, and three years before he died, Bern experienced the thrill of finding the first neonates and nests in this artificially established population. He now had the evidence needed to validate this as a viable option for Bog Turtle conservation. The lesson he would try to pass along to skeptics and supporters alike, was that these types of studies are long-term—or life long, as he would say—and one should not expect instant results.

Bern's zoo career spanned 40 years, during which time he wrote over 30 papers and articles relating to herpetological techniques, reproductive biology, and conservation. Many of the species that were of special interest to Bern, as well as the places he frequented for field work, were heavily influenced by the writings of Carl Kauffeld, former reptile curator of the Staten Island Zoo. Two of Carl's books—*The Keeper and the Kept* and *Snakes and Snake Hunting*—were treasured by Bern and most of his contemporaries, and had significant impact on his herpetological pursuits. These books led him on many trips to the Trans-Pecos region of west Texas, the mountains of southeastern Arizona, and of course Okeetee, South Carolina. His most prolific publishing years were during his tenure at the Fort Worth Zoo (1974–1980) and reflected some of the Kauffeld influence. And though Bern was generally considered a turtle man, he was also a snake man

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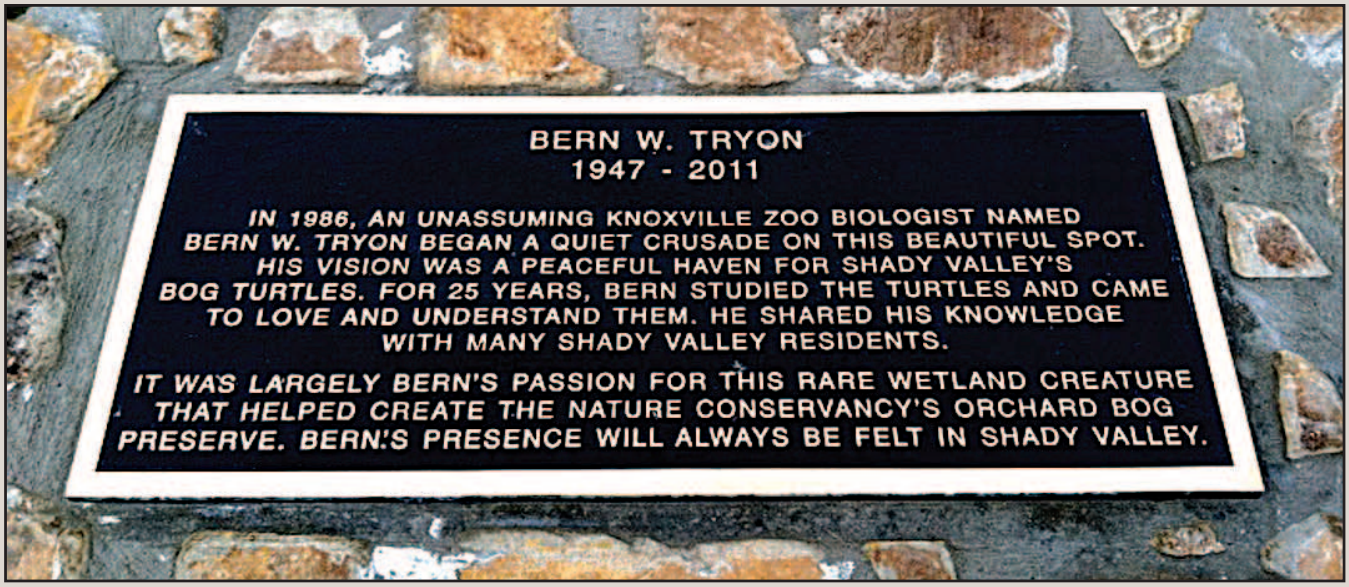


FIG. 2. This memorial plaque was placed in honor of Bern Tryon by The Nature Conservancy at the Orchard Bog site in Tennessee. Bern worked in this valley for 25 years helping to restore Bog Turtle populations to Tennessee.

par excellence with exceptional husbandry skills. He had a touch with snakes that was intuitive, almost instinctive, and was adept at enticing recalcitrant feeders. Many of his charges attained longevities unheard of at the time in captivity. He conducted some of the pioneering research on the reproductive biology of the Gray-banded Kingsnake (*Lampropeltis alterna*) and Ridgenose Rattlesnake (*Crotalus willardi*), both of which resulted in notable publications. Both species would become enduring passions of Bern's, in fact he was so taken with *C. willardi* madness that he once attended a Halloween party with his face painted with the characteristic *willardi* flash markings. His fascination with *L. alterna* would also become an obsession, taking him on numerous trips to west Texas to search for the elusive quarry. It took nine trips before he bagged his first one, ironically by field collecting and not road riding as was the tried and true method. His papers on aquatic turtle husbandry and incubation of reptile eggs—based on work at the Fort Worth Zoo—are considered classics, still referenced today, some 35 years after publication. His magnum opus was the 1980 publication on the reproductive biology of the West African Dwarf Crocodile (*Osteolaemus tetraspis*), which still stands as one of the seminal papers on crocodilian parental behavior, and is widely regarded as one of the definitive works on that species. Evidence that the seeds were sown early for what was to later become his life's work came in 1976 when he published a paper on breeding and rearing the Bog Turtle in captivity. During his tenure at Fort Worth, the zoo developed a reputation for designing some highly naturalistic herp exhibits. Bern had a keen eye for exhibit work, and several of his montane rattlesnake exhibits done in the late 1970s were still in use into the 1990s. Under Bern's leadership, the Herpetology Department at the Fort Worth Zoo received two AZA Significant Achievement Awards for breeding West African Dwarf Crocodiles and Angel Island Chuckwallas (*Sauromalus hispidus*). In 1985, during Bern's tenure at the Knoxville Zoo, his department was honored with the prestigious AZA Bean Award for breeding the Papuan Python (*Apodora papuana*).

Bern did not venture too far outside the U.S., but in 1984 accompanied Jonathan Campbell and Rick Hudson to Costa Rica, uniting three successive generations of Fort Worth Zoo Assistant Herp Curators on one expedition. A herpetological catastrophe was narrowly averted as the three were riding on the tailgate of a pickup when a driver nearly rear-ended their vehicle at high speed, swerving at the last second to miss them.

He was affiliated with various professional organizations such as the AZA, Turtle Survival Alliance (TSA), IUCN Tortoise and Freshwater Turtle Specialist Group (TFTSG), and AZA Chelonian, Crocodilian, and Snake Taxon Advisory Groups. He served as the Section Editor (Herpetological Husbandry) for *Herpetological Review* from 1979 to 1992. He was also on the Editorial Review Board for *Chelonian Conservation and Biology* (1993–2005), and was elected to the SSAR Board of Directors for1992–1994). He was the Tennessee Director for Project Bog Turtle since 2003.

Bern's hard work and perseverance paid off as he received numerous prestigious awards for his outstanding contributions to conservation and research for the bog turtle in the Southeast from the U.S. Fish and Wildlife Service, Project Bog Turtle, and the AZA. Then in 2010 he received one of the first Lifetime Achievement Awards for Turtle Conservation from the TSA and the TFTSG, in recognition of his long-standing commitment to the southern Bog Turtle. Bern believed that southern Bog Turtle work was under-funded compared to the northern form, and to help remediate this situation he bequeathed his substantial herpetological library to the TSA to establish an endowment specifically for Bog Turtle work in southern states.

Although only a handful of people had the opportunity to see the real Bern Tryon outside of his professional realm, the personal relationships that he cultivated from entry level keepers to executive directors were unmatched. Tradition dictates that keepers usually avoid their curators, or if the encounter looks imminent…look busy. Bern was quite the opposite. If there was a waft of blue pipe smoke in the air, then that was the queue to follow the smell to Bern, where the reward would be casual conversation ranging from rich herpetological history to cutting edge husbandry techniques. Bern recognized the value in these interactions and went to great lengths to keep that as a necessary part of the daily routine.

Bern's commitment to herpetological conservation was uncompromising and with his passing the turtle community has

lost one of its staunchest allies. He will forever be remembered for his dedication and passion for herpetology, his laid-back, easy-going personality, his wonderful sense of humor, and being a good father and grandfather. He never lost that sense of enthusiasm in the field, and we can still see that twinkle in his eyes whenever he found a Bog Turtle or a big Eastern Diamondback. He was a great friend to his herpetology buddies who met each spring for over 40 years to search for reptiles in the Okeetee area of South Carolina. He will be greatly missed by all those who knew him.

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INSTITUTIONAL PROFILE

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The Herpetology Collection at the North Carolina State Museum of Natural Sciences

With at least 92 amphibian and 72 reptile species, North Carolina has long attracted the attention of herpetologists, including such pioneers in early North American herpetology as John Edwards Holbrook, Edward Drinker Cope, and Emmett Reid Dunn (Martof et al. 1980; Beane et al. 2010). The herpetological richness of the state is attributed to its great diversity in topography, climate, and vegetation (Martof et al. 1980; Beane et al. 2010), and the herpetofauna consists of an admixture of temperate northeastern U.S. and subtropical southeastern U.S. taxa. The significance of North Carolina's herpetofauna is reflected in the amphibian and reptile collection at the North Carolina State Museum of Natural Sciences (NCSM), one of the largest and most complete regional collections in the United States.

The collection was started in the late 1800s by North Carolina naturalists and brothers Clement Samuel (C. S.) Brimley and Herbert Hutchinson (H. H.) Brimley. H. H. became the museum's first full-time curator in 1895 and its first official director in 1928 (Cooper 1979; Martin 2001). While C. S. was never officially employed by the museum, he collected or otherwise acquired many of the specimens that would later form the beginning of its amphibian and reptile collection. The oldest specimen known to be in the holdings, NCSM 431, is not a North Carolina specimen, but rather a Gulf Coast Toad (*Bufo valliceps*) collected in Waco, McLennan County, Texas, on 30 March 1895 and received by C. S. from an unstated collector (probably John K. Strecker, Jr., from whom he acquired several other specimens from that locality).

Most of the specimens have been accumulated since the 1960s, when William M. Palmer (Fig. 1) began caring for the fish, amphibian, and reptile collections. Palmer began working part-time for the museum in 1951, and was hired full-time as Curator of Zoology in 1963. Prior to then, the amphibian and reptile collection consisted of an assortment of uncatalogued specimens identified by museum accession numbers or associated data labels. In 1962, Palmer acquired archival catalog ledgers, fluid-resistant specimen tags, and adequate storage containers, and on 15 December 1962 he designated NCSM 1 to a *Necturus lewisi* (the first 20 specimens catalogued were of this species, a North Carolina endemic described by C. S.), thus initiating the cataloguing system still used today.

Alvin L. Braswell (Fig. 1) joined the staff in 1968, first as an intern, then as a part-time assistant. He became permanent staff in 1974 as Collection Manager of Lower Vertebrates, and then as Curator of Lower Vertebrates. Palmer and Braswell held joint positions as curators until Palmer retired in 1995. Palmer continues to work in the collection today in the supporting role of Emeritus Curator of Herpetology. Jeffrey C. Beane (Fig. 2) was hired in 1985 as a Research Technician and has held the position of Collection Manager of Herpetology since 1995. Most recently, Bryan L. Stuart joined the museum in September 2008 as Curator of Herpetology when Braswell moved into an administrative position as the museum's Deputy Director. At the time of writing,



PHOTOGRAPHER UNKNOWN

Fig. 1. William M. Palmer (right) and Alvin L. Braswell (left) herping in 1969 in the Croatan National Forest, North Carolina. The van was a North Carolina State Museum vehicle. Palmer's baseball cap stands for "Players' Retreat," a bar and restaurant in Raleigh that was founded in 1951 and remains popular today.

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all four generations of herpetologists, representing at least 114 person-years at the museum, are actively serving the institution (Fig. 3). Palmer, Braswell, and Beane have dedicated their careers to documenting the natural history, distribution, and conservation status of the amphibians and reptiles of North Carolina and adjacent states, and these three individuals have together built most of the collection. Stuart has added an interest in molecular systematics and species delimitation, as well as an international perspective (Southeast Asia and Central Africa), to herpetological research at the museum.

Despite the name similarity, the museum is not officially part of North Carolina State University, although the museum and university maintain a close association and many of the museum's curators have adjunct faculty appointments at the university. The institutional acronym of NCSM, used in cataloging specimens, is based on the earlier name of "North Carolina State Museum" (Leviton et al. 1985). The official name of the institution is now North Carolina State Museum of Natural Sciences, although the word "State" is often omitted from the institutional title for marketing purposes, such as on the museum's website.

As of June 2011, NCSM's amphibian and reptile collection contains over 78,300 cataloged records consisting of approximately 200,000 specimens. Approximately 80% of the collection consists of North Carolina material, although at least 45 states, 24 countries and 650 species are represented. Other states with substantial representation include California, Delaware, Georgia, Florida, Louisiana, New Jersey, New York, South Carolina, Tennessee, and Virginia. Other countries with substantial representation include Gabon, Laos, and Vietnam. The collection contains paratypes of seven amphibian taxa (*Eurycea chamberlaini, E. junaluska, Leptolalax aereus, L. bidoupensis, Leptobrachium leucops, Rana palustris mansuetii,* and *Rhacophorus vampyrus*) and two reptile taxa (*Ophisaurus mimicus* and *Nerodia sipedon williamengelsi*), and the holotype of one amphibian (*Leptobr. leucops*). From the 1960s to the late 1980s, then-curator Palmer transferred additional types (including holotypes) to the Smithsonian Institution National Museum of Natural History and the American Museum of Natural History when the long-term persistence of the collection appeared uncertain.



PHOTO BY DANIEL J. LYONS

FIG. 2. Jeffrey C. Beane in 1987 with preserved Pine Snakes (*Pituophis melanoleucus*) in the amphibian and reptile collection at the North Carolina State Museum.

Major acquisitions into NCSM's amphibian and reptile collection include the collections of Duke University (the late Joseph R. Bailey et al.), Virginia Commonwealth University (Charles R. Blem et al.), State University of New York at Binghamton (Ted D. Murphy et al.), the University of North Carolina's Institute of Marine Sciences (Frank J. Schwartz et al.), and the personal collections of the late Elmer E. Brown, Richard C. Bruce, Rufus W. Gaul, Jr., the late Julian R. Harrison III, and David L. Stephan. Numerous other individuals have made substantial contributions to the collection, often over many years; these include Stanley L. Alford, Rudolf G. Arndt, Michael E. Dorcas and students (Davidson College), Richard R. Montanucci, L. Todd Pusser, Thomas J. Thorp, the late George Tregembo and family, and numerous members of the North Carolina Herpetological Society, an NCSM affiliate group.

NCSM's amphibian and reptile collection formed the basis for three significant books on the state's herpetofauna. *Amphibians and Reptiles of the Carolinas and Virginia,* first published by Martof et al. (1980) and recently revised by Beane et al. (2010), is a guide to all the amphibian and reptile species of the state (and South Carolina and Virginia), including color images and maps of species. *Reptiles of North Carolina,* published by Palmer and Braswell (1995), is a comprehensive volume on all aspects of the biology of the state's reptiles. Other popular publications based heavily on the collection include a booklet on North Carolina's venomous snakes (Palmer 1974; revised by Braswell et al. 2003), a book highlighting NCSM and its collections (Martin 2001), and a book and CD guide to North Carolina anurans and their calls (Dorcas et al. 2007). Innumerable scientific publications have extensively utilized the NCSM amphibian and reptile collection, among them many student theses, such as those by Davis (1968), Fedak (1971), Braswell (1977), Reynolds (1980), Williams (1983), Gaul (1996), and Mebert (2003).

Since 1998, the amphibian and reptile collection has been housed at the museum's Research Laboratory (Fig. 4), a 20,296 square foot facility that was specifically designed for housing the museum's "wet" collections (invertebrates, fishes, amphibians and reptiles, and some fluid-preserved birds and mammals). The "dry" collections (most birds and mammals, paleontology, and geology) are housed approximately six miles away, in the main museum building in downtown Raleigh, where exhibits and events open to the public are also located. The amphibian and reptile specimen range is a 4,709 square foot room maintained at a constant 20ºC (68ºF) and 45 ± 2% relative humidity, without windows and with ultraviolet light filters on overhead fixtures. A Honeywell MDA Scientific Midas alcohol gas sensor system in the range trips an alarm if alcohol is detected from a spill. The collection maintains fluid-preserved specimens, skeletons, skins, dry taxidermy mounts, stomach contents, photographic vouchers, and other materials, as well as supporting documentation such as field notes, data sheets, and correspondences. Most amphibian eggs, amphibian larvae, and reptile hemipenes are stored in buffered 8-10% formalin; most other wet specimens are originally fixed in formalin and subsequently switched to 70% ethanol for permanent storage. Most wet specimens are stored on open metal shelves in glass jars, vials, or crocks; some larger specimens (such as crocodilians, turtles, and snakes) are in stainless steel tanks on wheels or in plastic buckets or barrels. Dry materials, such as skeletons, skins, and taxidermy mounts, are housed in glass containers or archival-quality storage boxes with lids. Taxa are arranged phylogenetically by order and family, and then alphabetically within family by genus, species, subspecies, and county. Type specimens, catalog ledgers, and some original field notes and other records are stored in fireproof cabinets. Adjacent to the range is a herpetology "wet lab" with a fume hood, microscopes, computers, and other equipment and supplies needed for processing, curating, examining, and loaning specimens. Offices for herpetology personnel are in close proximity to the wet lab and collection range. Tours of the facility are frequently conducted for interested individuals and groups such as university classes.



PHOTO BY ALVIN L. BRASWELL (SELF-TIMED)

FIG. 3. William M. Palmer, Alvin L. Braswell, Jeffrey C. Beane, and Bryan L. Stuart (left to right), 22 June 2011, in the amphibian and reptile collection at the North Carolina State Museum of Natural Sciences.



PHOTO BY ALVIN L. BRASWELL

FIG. 4. A view down the central aisle of the amphibian and reptile collection at the Research Laboratory, North Carolina State Museum of Natural Sciences, 22 June 2011.

Two major initiatives are underway in the collection. The first is to develop genetic resources in the amphibian and reptile collection to make tissues and DNA extractions available to users for molecular genetic analyses. The vouchered tissue collection has rapidly grown from a handful of tissues in 2008 to over 1,300 tissues in June 2011, and tissues now account for a large percentage of loan requests from the scientific community. A National Science Foundation-funded project, incepted in April 2011, provides for storing these tissues in labeled and barcoded cryogenic vials in an ultra-cold (-80ºC) freezer to minimize thermal degradation.

The second major initiative is to database and georeference the catalog ledgers to allow rapid and remote access of the collection's holdings by researchers, resource managers, the public, and other user groups. The development and success of the museum's database structure was extensively treated by Hogue and Raine (2006). At the time of writing, the amphibian and reptile collection database is online (http://collections.naturalsciences.org), but only a portion of the collection is in the database. Users should be aware that this digitization effort is a work-in-progress, and curatorial staff should be contacted for a complete list of holdings. The museum is a participant in HerpNET (http://herpnet.org), and plans are to have the digitized portion of the collection on the HerpNET portal by 2012. Readers are encouraged to consider utilizing the NCSM herpetological collection for their future research needs.

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Plural versus Singular Common Names for Amphibian and Reptile Species

Although scientific names are the accepted means of referring to species in the scientific literature, common names continue to serve important functions in both scientific and popular communication. That fact is evident from the inclusion of both scientific and common names in checklists published by various taxonomically specialized scientific societies (e.g., American Ornithologists' Union 1998 [birds]; Baker et al. 2003 [mammals]; Crother et al. 2008 [amphibians and "reptiles"]; Nelson et al. 2004 ["fishes"]). In this context, a relatively minor yet somewhat radical change concerning the use and formation of common names in a recent checklist of iguana species (Iguana Taxonomy Working Group 2011) deserves explanation. The change is minor in that it involves only a single letter, "s," reflecting the plural instead of singular nature of each name, but it is radical in that it affects the names of all species in the checklist and breaks a long-standing tradition. A description of the rationale for this change was outside of the scope of the checklist, and therefore I, as the instigator, am presenting the rationale here. I hope to convince herpetologists (and biologists in general) that the traditional use of singular common names as the equivalents of the scientific names of species is inconsistent with modern species concepts and the meanings of the words from which the names are formed, and therefore, that plural common names should be used instead. Although some may consider the inconsistency to be insignificant (and thus the proposed solution to be one to a "non-problem"), it reflects a fundamental and inappropriate assumption about the basic nature of taxa.

The term "common" (in "common name") is used here to mean "ordinary" or "familiar" (as opposed to "widespread" or "general") in the sense of being composed of ordinary or familiar words; it is therefore roughly synonymous with "vernacular," meaning "of the everyday language or dialect of a group of people." The common names used by different groups of people can be distinguished by specifying a region, country, or language (e.g., "English common names"). Other properties of common names can also be conveyed by using appropriate adjectives (e.g., "standard English names" for English common names proposed in an attempt to standardize usage). I will restrict considerations in this commentary to English common names, though they likely apply to those of other languages. With one exception, I will also restrict my comments and examples to names of amphibian and reptile species, though they obviously apply to those of other taxa as well.

MODERN SPECIES CONCEPTS AND THEIR IMPLICATIONS FOR COMMON NAMES

Although debate continues concerning the precise definition of the species category (reviewed by de Queiroz 1998; Mayden 1997; Wilkins 2006), all modern species concepts equate species more generally with population level lineages—that is, with populations or metapopulations (groups of connected populations) that extend through time as the result of ancestry and descent among their component organisms (de Queiroz 1998, 1999, 2007). Implicit in this general concept of species is the view that the species category is a level in the hierarchy of biological organization (Brown 1995; de Queiroz 2011; Mayr 1982), which includes at least cells, organisms, colonies, and populations/species, and perhaps entities at lower levels (e.g., genes) and higher levels (e.g., communities) as well. In this hierarchy of biological organization, entities at higher levels (e.g., species) are made up of those at lower levels (e.g., organisms).

In agreement with the recognition of a hierarchy of biological organization, different names are usually used for entities that occupy different hierarchical levels. For example, "Lonesome George" is the name of an organism that is part of the species named "*Chelonoidis* (formerly *Geochelone*) *abingdonii*." The common names of species, however, are often used in a way that is inconsistent with such distinctions; that is, the same common names are often used to refer both to individual organisms and to the species of which they are parts. For example, it would not be unusual for someone to say, "I saw a zebra-tailed lizard near Pisgah Crater in the Mojave Desert," using the name "zebra-tailed lizard" to refer to an individual organism. It would also not be unusual for someone to say, "The zebra-tailed lizard occurs in the Mojave Desert," using the same name, including the singular number, to refer to an entire species. This second use, however, is inconsistent with modern species concepts and the meanings of the words from which the common name is formed.

The common names of amphibian and reptile species are often formed by adding adjectives (e.g., "red-cheeked," "Sonoran"), including participles (e.g., "barking") and attributive nouns (e.g., "canyon," "rat"), or possessive nouns (e.g., "Baird's") to base names. Those base names—words such as "frog," "salamander," "turtle," "lizard," "snake," and "alligator"—are common nouns in that they refer to the members of groups of organisms. Those groups are now commonly conceptualized as the classes or sets of organisms that make up particular clades, or sometimes paraphyletic groups (e.g., "lizards"). A snake, for example, is an individual organism; it is an individual member of the set of organisms making up the clade Serpentes or Ophidia. Therefore, when we refer to a single organism in this set, we use the singular noun "snake" (e.g., "Amy anaesthetized a snake before performing surgery on it"), and when we refer to several such organisms, we use the plural noun "snakes" (e.g., "Steve has been radio-tracking 10 snakes at the same time").

When common names are formed using common nouns of the kind just described, it is inconsistent to use the singular form of those names as equivalents of the scientific names of species. The reason that this use is inconsistent is that singular common names properly refer to individual organisms, not to entire species, whereas scientific names of species properly refer to entire species, not to individual organisms. A zebra-tailed lizard, for example, is not a species; it is an organism that is a member

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or part of a species (*Callisaurus draconoides*). Conversely, *Callisaurus draconoides* is not a lizard, zebra-tailed or otherwise; it is a species the organismal parts of which are (zebra-tailed) lizards. Therefore, because species are almost always composed of more than one organism, the name "*Callisaurus draconoides*" is not equivalent to "[the] zebra-tailed lizard" but to "zebra-tailed lizards." And thus, the incorrectly stated sentence "The zebra-tailed lizard occurs in the Mojave Desert," is correctly stated using either a singular species name: "*Callisaurus draconoides* occurs in the Mojave Desert," or a plural common name: "Zebra-tailed lizards occur in the Mojave Desert."

Interestingly, the problem I am discussing is largely restricted to the common names of species. Analogous inconsistencies involving the common names of higher taxa (clades) are rare to non-existent. For example, it is not customary to equate the name "Squamata" with "[the] lizard" but with "lizards." Nor is it customary to equate "*Phrynosoma*" with "[the] horned lizard" but with "horned lizards." Nevertheless, it is customary to equate "*Phrynosoma solare*" with "[the] regal horned lizard," though consistency dictates that we ought to equate it with "regal horned lizards." All of the taxa just mentioned, whether clades or species, are composed of more than one organism.

SCIENTIFIC NAMES AND COMMON NAMES OF SPECIES

In contrast to English common names, the scientific names of amphibian and reptile species (as well as those of species in other clades) are commonly formed from Latin or Latinized words. Those words are often common nouns in their original language (e.g., "*rana*" is Latin for "frog"), but as scientific names, they are treated differently. In both popular and scientific discourse, the scientific names of species are commonly used in the singular, implying that they refer to species as wholes rather than to the organismal parts of species. In agreement with the treatment of scientific species names as singulars, several authors have argued that the scientific names of species are proper nouns (e.g., Ghiselin 1974; Hull 1976). Proper nouns, by definition, refer to individual entities (in this case, particular species) and thus are necessarily singular. Given that scientific names are singular, it is correct to say "*Plethodon petraeus* has a restricted distribution" but incorrect to say "*Plethodon petraeus* have a restricted distribution."

The use of scientific names as proper nouns is perhaps most natural in languages that are relatively distantly related to Latin (e.g., English and German more so than Spanish and Italian). Because the Latin or Latinized words from which scientific names are formed are more likely to be unfamiliar to speakers of such languages, it is natural to treat them as proper nouns, that is, as words (names) that simply refer to individual things, rather than common nouns, which refer to sets or classes of individual things and therefore often describe properties possessed by the members of those sets or classes. Just as the name "Doris Cochran" simply refers to a particular person, the name "*Apalone mutica*" simply refers to a particular species. That the name "Doris Cochran" means "of the sea" and "red" or "crimson" and the name "*Apalone mutica*" means "soft" and "unarmed" is irrelevant to their functions of referring to an individual person or species. That is to say, scientific names can be (and perhaps often are) used to refer to particular species regardless of whether the users of those names know or care about the meanings of the Latin or Latinized words from which the names are formed. Consequently, scientific names need not be descriptively accurate. For example, just as the name "George" works perfectly well for referring to a person who is not a farmer, the name "*Coluber constrictor*" works perfectly well for referring to a species whose members do not commonly constrict their prey.

Like the scientific names of species, the common names of species are sometimes interpreted as proper nouns (e.g., Parkes 1978; Potter 1984). That interpretation, however, is inconsistent with certain practices involving common names. Rather than simply referring to species, common names often describe one or more properties of species or their component organisms. This situation is reflected in changes in common names to improve their descriptive accuracy, a practice that is expressly forbidden with scientific names. For example, the common name "poison arrow frog" was changed to "poison dart frog" (and "dart-poison frog"), and the names "Mexican hook-nosed snakes" and "plateau hooked-nosed snakes" were changed to "eastern hook-nosed snakes" and "western hook-nosed snakes" (Crother et al. 2008), in all cases to improve descriptive accuracy. In contrast, the name "*Coluber constrictor*" cannot be changed for the sake of improving descriptive accuracy. Although that rule is imposed by a formal system of zoological nomenclature, which does not apply to common names, the way that the system operates reflects the fact that the primary function of scientific names is simply for referring to taxa and not for describing the properties of their included organisms.

The interpretation of common names as proper nouns is also inconsistent with the meanings of the words from which they are formed. Because the base words from which common names are formed are common nouns (e.g., "gecko"), modifying them with descriptive adjectives (e.g., "banded") and/or possessive nouns (e.g., "Switak's") creates names that are also common nouns. Declaring them to be proper nouns or capitalizing them does not change that fact. Using them in the singular goes further toward making them function as proper nouns in that the species to which they refer are individual population level lineages; however, many uses of common names in the singular are inconsistent with their interpretation as proper names of species. For example, the statement "The Eastern Red-backed Salamander is a small species" is either incorrect or incorrectly stated. If the name "Eastern Red-backed Salamander" is the name of a species, that species (*Plethodon cinereus*) is not small: It has an extensive geographic distribution (Highton and Webster 1976), and its component organisms are extremely abundant, resulting in a high species biomass (Burton and Likens 1975). Alternatively, if the statement is about the average body size of the salamanders that make up the species and not about the species as a whole, then the proper name of the species should not be used. That is, it would be more appropriate to say "Eastern red-backed salamanders are small animals." Again, this confusion results from using a word that refers to a kind of organism as the name of a species.

USE OF SINGULAR COMMON NAMES AS A HOLDOVER

The likely explanation for the inconsistent but traditional use of singular common names for species is that it is a holdover from an earlier age. This practice originated in the pre-evolutionary era (see Daudin 1802–03 and Shaw 1802 for French and English examples), when species were conceptualized at least partly as essences or types (e.g., Hull 1965; Mayr 1976, 1982). Species were also conceptualized as self-perpetuating groups of organisms (de Queiroz 2011); however, without the principle of

evolution, the similarity and reproductive compatibility among their members was explained by their being of the same essence or type in the mind of their creator (Darwin 1859). Under essentialism, the name of a species is the name of an essence, an eternal, abstract Idea or Form of which living organisms are its concrete manifestations (Hull 1965). Under typology, a species is a type, a class or category of entities (i.e., a group defined by a set of shared characteristics) of which organisms are its instances or examples. In either case, the essence or type of a species consists of those properties that are necessary and sufficient for species membership, and traditionally, those properties took the form of organismal traits (de Queiroz 1992, 1995; Sober 1980). Thus, species were conceptualized either as eternal, ideal organisms (essentialism) or as categories of organisms (typology). Also associated with these views is the idea that any traits that vary among the members of a species are incidental or accidental, since they are not important to the essence or type of the species.

The perspective just described contrasts with modern species concepts, according to which species are viewed not as essences or types but as population level lineages. That is to say, species are viewed as entities at a level of biological organization above the level of organisms, rather than as kinds or categories of organisms (and nothing more). Thus, under modern species concepts, organisms are parts or components of species rather than examples, instances, or manifestations of them. In addition, the organisms of a species are not required to share any particular set of traits (though they often do), and traits that vary among them are not viewed as intrinsically any less important than those that happen to be fixed. Moreover, as entities at a higher level of biological organization, species possess properties unique to the population level (e.g., population structure) in addition to the properties of their component organisms (e.g., body size). These and related views have been termed "population thinking" and are in contrast with those of essentialism and typology (e.g., Mayr 1959, 1976; O'Hara 1997; Sober 1980).

The use of singular common names in situations that, under modern species concepts, call for the use of plurals can be understood as a vestige of essentialist or typological species concepts. According to those doctrines, particularly when organismal traits are treated as the essential or defining characters, the name of a species (whether scientific or common) refers to a single organism: the single eternal, ideal organism of which tangible organisms are concrete manifestations, or the single concept of an organism possessing the properties that define the class of which actual organisms are examples or instances. To the extent that the essence or type of a species is conceptualized as an organism, it is appropriate to use singular common names, such as "the wood turtle," to refer to essentialist or typological species. Thus, the inappropriate use of singular common names based on terms that refer to organisms (e.g., "frog," "turtle," etc.) can be explained as a holdover from an era in which species were conceptualized as essences or types.

THE COMMON NAMES OF *HOMO SAPIENS*

Interestingly, people are less prone to using singular common names inappropriately when referring to our own species. Thus, we rarely, equate the scientific name "*Homo sapiens*" with the singular common names "[the] human" or "[the] human being;" instead, we use the plural common names "humans" and "human beings." For example, it would be normal to say, "Humans (*Homo sapiens*) are bipedal primates," but it would sound archaic to say, "The human (*Homo sapiens*) is a bipedal primate." Sometimes the singular common name "man" is used, though this practice is decreasing, presumably because it has inappropriate connotations with regard not only to number (singular versus plural) but also to gender. The singular common names "mankind" and "humankind" are also used. Those names, however, refer to the human species as a whole or the totality of human beings. Unlike the common names of amphibians and reptiles, they are never used to refer to individual people. For example, although one might say, "Henry is a tuatara who became a father at the age of 111," one would not say, "Leonard Stejneger was a mankind who published a monograph on the herpetology of Japan." Because we have different common names for referring to our own species as a whole and the organisms of which it is composed, inappropriate use of the singular "human" to refer to the human species as a whole is rare. In contrast, because humans have not developed separate common names for distinguishing between other species and their component organisms, inappropriate use of singular common names is not only common, it is the norm.

These patterns of use suggest that humans are less typological when referring to our own species than when referring to other species. Perhaps the reason is that we grant more importance to, or are more aware of, differences among individual humans than differences among the individual organisms of other single species. But regardless of the reason for this difference, the common names of other species, including those of amphibians and reptiles, ought to conform to the same standards that we adopt for the names of our own species. One way to achieve this would be to develop common names that clearly refer to other species as wholes rather than to their component organisms. For example, we could use names such as "the marine iguana species" or "marineiguanakind" for *Amblyrhynchus cristatus*. Up to the present time, however, such names have not been widely used for species other than *Homo sapiens*. As long as we continue to use common names that refer to kinds of organisms (i.e., names formed from base words such as "toad," "newt," "tortoise," "iguana," "boa," and "crocodile" without "species" or "-kind") as equivalents of the scientific names of species, those names should be used in the plural.

CAPITALIZATION

The considerations about common names described above also bear on the issue of capitalization. Under the interpretation of the common names of species as proper names (e.g., Parkes 1978; Potter 1984), those names are commonly capitalized. However, because common names are more appropriately interpreted not as the names of species as wholes but as names of the sets of organisms of which species (as population lineages) are composed (de Queiroz 1995), common names are not, strictly speaking, the names of individual species. Therefore, they are not proper nouns and need not be capitalized (compare Atkins 1983). This conclusion is consistent with the use of common names for the organisms comprising our own and other species ("humans," "dogs," "cats," etc.), which generally are not capitalized. I am not arguing however, that common names should not be capitalized. There may be other reasons for capitalizing common names, such as distinguishing the common names of species from general descriptions of organisms (e.g., "Green Frogs" versus "green frogs") and ease of recognition while reading (Nelson et al. 2002; Parkes 1978). However, the act of capitalizing a

common name does not thereby by make it a proper noun any more than does capitalizing a word in a section heading or at the beginning of a sentence.

CONCLUSION

In summary, plural rather than singular common names should be treated as equivalent to the scientific names of species. This practice is more consistent with modern species concepts and the meanings of the words from which common names are formed; it more clearly distinguishes between different hierarchical levels of biological organization; and it eliminates a vestige of typological or essentialist thinking. Moreover, although using plural common names for species may at first seem strange because it departs from a long-standing tradition, the change is relatively minor, it now has precedents in a checklist (Iguana Taxonomy Working Group 2011) and a taxonomic revision (Torres-Carvajal et al. 2011), and it should not be particularly difficult to become accustomed to.

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Skilled Forelimb Movements and Extractive Foraging in the Arboreal Monitor Lizard *Varanus beccarii* (Doria, 1874)

Scientists and enthusiasts who have studied, kept, or observed monitor lizards (Varanidae: *Varanus*) for extended periods of time usually recognize that monitors possess considerable intelligence when compared to other reptile groups. Scientific testaments to their "higher intelligence" date back more than a century, with both Ditmars (1902) and Werner (1904) recognizing monitors as the pinnacle of lizard intelligence. Since then, many herpetologists have followed suit in this claim (e.g., Burghardt et al. 2002; Mertens 1942; Phillips 1994; Pianka and King 2004; Sweet and Pianka 2003), supported by research and behavioral observations of their own as well as a growing number of published accounts describing unusual and insightful behaviors in the group (see reviews by Horn 1999 and Krebs 2007). Formal research on the memory and learning capacities of monitors has also contributed to the general understanding of their intelligence (Loop 1976; Manrod et al. 2008).

Despite numerous published accounts on monitor behavior, the insight and behavioral complexity of some species are better understood than others. It is not surprising, given their size and conspicuousness when compared to smaller tree-dwelling taxa, that large terrestrial species (> 1.5 m in total length [TL]) account for most behavioral observations which have led to the idea of intelligence in monitors (Horn 1999; Krebs 2007). Even captivity-based studies on learning and behavioral complexity have focused primarily on large terrestrial species (e.g., Burghardt et al. 2002; Firth et al. 2003; Loop 1976; Manrod et al. 2008). Thus, little is known about the problem-solving abilities and behavioral specializations of the more diminutive monitors, particularly arboreal taxa belonging to the subgenera *Odatria* and *Euprepiosaurus*.

Within *Euprepiosaurus*, the *Varanus prasinus* complex is currently comprised of nine highly arboreal species (to ca. 100 cm TL) endemic to tropical lowland environments of northeastern Australia, New Guinea, and adjacent islands (Ziegler et al. 2007). Behavioral observations on these species in the wild (e.g., Clarke 2004; Irwin 1994, 1996; Pattiselanno et al. 2007; Whittier and Moeller 1993) and in captivity (e.g., Eidenmüller and Wicker 1992; Garrett and Peterson 1991; Hartdegen et al. 1999, 2000; Irwin 1996; Kiehlmann 1999) are rather limited, but specific references to insightful behaviors are scant (Holmstrom 1993). Krebs (1991) doubted the insight of *V. prasinus*, grouping it together with "less-specialized" monitor species on account of a presumed "lower specialized learning ability." This was before several published reports describing diverse prey-handling tactics used by the *V. prasinus* complex (Hartdegen et al. 1999, 2000; Kiehlmann 1999), which Greene (2004) later recognized as highly specialized behaviors. Here, we call special attention to the insight and behavioral complexity of the *V. prasinus* complex by describing a remarkable prey extraction behavior used by the Black Tree Monitor, *V. beccarii* (Doria, 1874), which demonstrates complex problem solving abilities, fine motor coordination, and skilled forelimb movements.

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METHODS

History and husbandry of specimens.—An adult male (242 mm in snout to vent length [SVL]) and female (270 mm SVL) *Varanus beccarii* of unknown ages and of wild-caught origin have been maintained for several years in the private collection of RWM. Both specimens are housed in separate terraria each measuring 90 x 60 x 180 cm (l x w x h). A 6 mm thick sheet of acrylic doubles as a viewing window and access door for each terrarium. Each terrarium is furnished with large tree limbs and the walls are covered with cork sheeting and virgin cork slabs. Live *Pothos* plants provide additional cover. A basking spot of ca. 49°C is provided in each terrarium by outdoor Sylvania®100 watt halogen flood lamps, which also provide ambient lighting. Daytime ambient temperatures range in a vertical gradient from 23.8°C at the floor to 40.6°C at the ceiling. Nighttime ambient temperatures drop to 30°C. A small access door connecting the terraria is periodically opened to allow the monitors access to one another for breeding.

Since their acquisition, both specimens have been fed a rotating daily diet of *Zophobas morio* larvae, domestic crickets (*Acheta domesticus*), wood cockroaches (*Nauphoeta cinerea*), wax moth larvae (*Achroia grisella*), and frozen-thawed neonatal mice. Typical of many male monitor lizards in captivity, the male *Varanus beccarii* quickly developed a strong feeding response, and feeds aggressively from forceps. The female has remained timid with a weaker feeding response, and only occasionally accepts prey from forceps. Each specimen is fed at alternating locations throughout its terrarium to prevent habitual feeding locations and associated feeding aggression.

Beginning around April 2009, the male was infrequently offered neonatal mice and *Zophobas morio* larvae through a permanent 15 mm gap which had formed in the upper left corner of its terrarium between the acrylic door and the door frame. The gap, created by the warping of the acrylic door over time, was large enough to pass prey items through using forceps, but not large enough for the monitor to fit its head through.

OBSERVATIONS AND RESULTS

Initial behavioral observations.—On 25 January 2010, the male *Varanus beccarii* was fed a neonatal mouse through the gap in the terrarium door. Following its consumption, the monitor showed continued interest in the gap, now scented with mouse odor, by repeatedly tongue-flicking the area. After ca. 15 seconds of tongue-flicking, the lizard extended its right forearm through

the opening, and began reaching around the outside frame of the terrarium with its forehand. The lizard retracted its arm back into the terrarium, then after another series of tongue flicks, it extended its left forearm through the opening, performing the same reaching arm movements as before, but reaching a farther extension than with the right arm. This sequence of behaviors was repeated several more times over the next minute until the monitor apparently lost interest.

To determine if this behavior was intended to locate or retrieve prey, a neonatal mouse was held by forceps just outside the gap of the male's terrarium, visible to the lizard. Once the monitor noticed the mouse and recognized its scent, it immediately extended its left forearm through the gap, and began reaching and clawing at the mouse with its forehand. These efforts appeared frantic and were noticeably more coordinated than earlier attempts when a prey item was not present. After keeping the mouse out of reach for several unsuccessful retrieval attempts, it was moved within reach of the monitor. The *Varanus beccarii* hooked the prey with its claws using a grasping forehand movement, then quickly pulled it back into the enclosure where it was seized from the claws with the jaws and swallowed. Additional trials were successfully repeated with both the male and female (through a gap created by partially-opening the female's terrarium door), as well as with *Zophobas morio* larvae offered as prey (Fig. 1).

It is important to note that these reaching and grasping forearm movements involved highly coordinated wrist and digit manipulations (Fig. 1). A similar reaching behavior was observed at the base of the male's terrarium door whenever *Zophobas morio* larvae would fall into a 7 mm wide, 30 mm deep channel running along the length of the door (56 cm) between the door, frame, and weather stripping. Alternating use of both forelimbs, the male was able to retrieve the prey by inserting its forearm into this groove then using a series of side-swiping arm movements until the prey became snagged on a claw or was able to be pulled upwards and out of the opening.

Semi-natural experiments.—Following these initial trials and observations, a simple experiment was carried out to test the use of this behavior in a semi-natural situation. A series of four holes narrower than the width of the monitors' heads measuring 15 x 35, 15 x 65, 20 x 35, and 20 x 65 mm (width x depth) was drilled into one vertically-oriented and one horizontally-oriented tree trunk (trunks ca. 15 cm in diameter) in each terrarium. A variety of prey items, including *Zophobas morio* and *Achroia grisella* larvae,

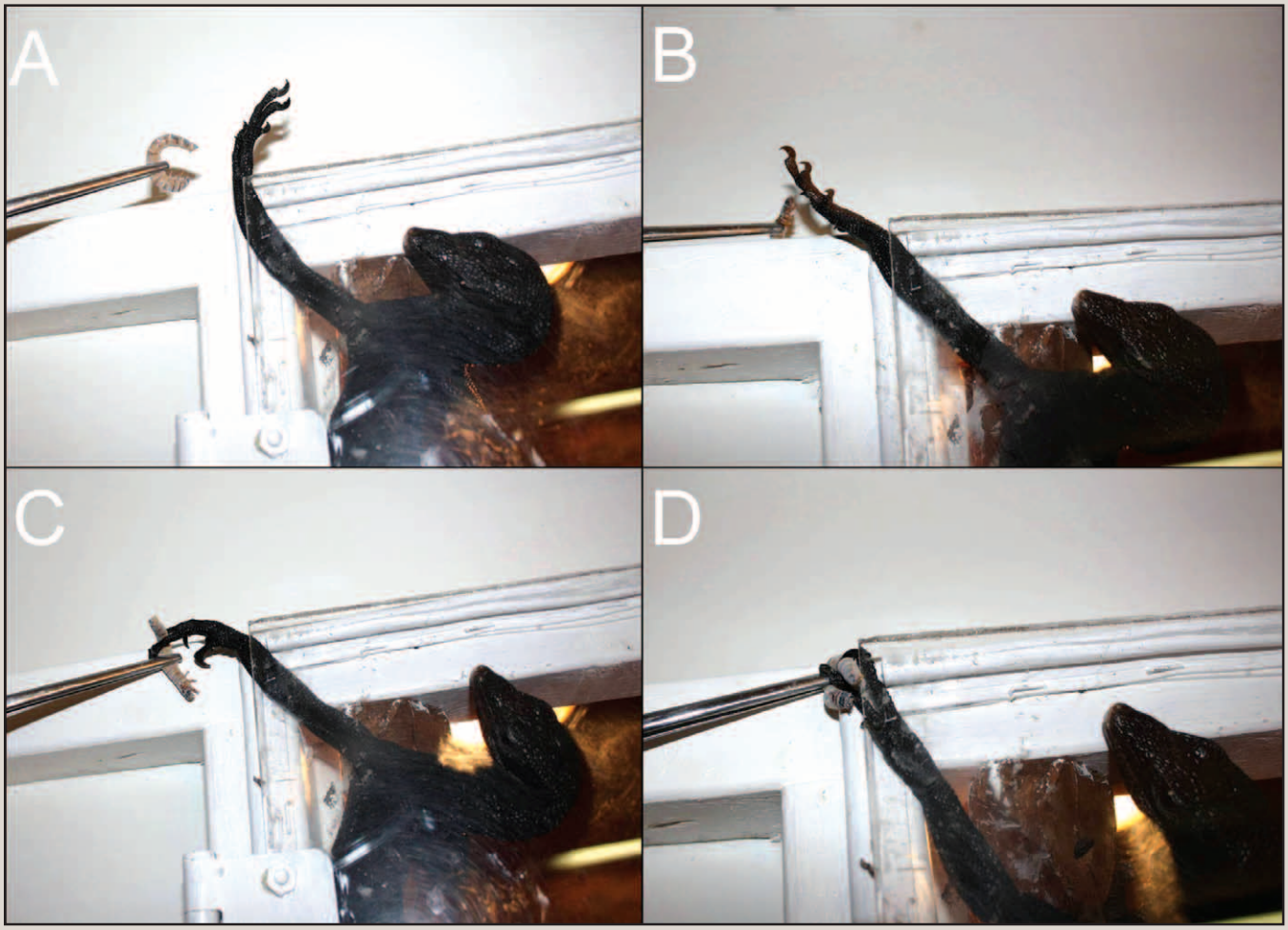


FIG. 1. Male *Varanus beccarii* using reaching arm movements to retrieve a *Zophobas morio* larva through a gap in the terrarium door. A) The forearm is extended through the opening, with the wrist angled back and the digits close together; B) the forearm reaches its furthest extension, with the wrist angled downward and the digits spread apart; C) contact is made with the prey item, and the digits are curled around the prey; D) the prey is pulled through the opening with the claws to be seized with jaws and swallowed.

neonatal mice, and *Acheta domesticus* were placed inside these holes during feedings to test whether each *V. beccarii* specimen was capable and willing to use its forelimbs to retrieve the prey.

Using coordinated forearm movements, both *V. beccarii* successfully retrieved all prey types from all four holes located in each tree trunk. Both individuals used identical extraction behaviors, including the same body positioning, reaching arm movements, and sequences of movements.

Prey is extracted from the holes in vertically-oriented trunks when the monitors are positioned either upright or inverted on the trunk. Once a prey item is detected in a hole either by sight (prey was seen as it was placed inside the hole) or smell, the monitor carefully inspects the hole with a series of tongue-flicks. After unsuccessfully attempting to enter the hole with its head, the forearm is skillfully inserted into the opening, all while maintaining eye contact with the prey inside (Fig. 2). The prey is then either flushed from the hole or pulled out with the foreclaws, where it is seized with the jaws and swallowed. The same behaviors are used on horizontally-oriented trunks (Fig. 3), though when extracting prey, the monitor must lift the prey upwards and out of the hole, requiring slightly different muscular movements and greater coordination, which appeared to take more concentration and effort than with holes in vertically-oriented trunks. Occasionally, prey items are impaled and extracted from the opening while still attached to the claws, where they are then seized with the jaws and swallowed. Both individuals regularly switch usage of each forelimb to maximize its depth of penetration into the hole, depending on its body positioning at the time.

Additional specimens.—Once this behavior was observed in both *Varanus beccarii* specimens in RWM's collection, another keeper of the species was asked to test for the usage of this behavior in an additional adult female (265 mm SVL). When offered mice through a small (ca. 13 mm) opening in the terrarium door, the monitor repeatedly used the same reaching forearm movements described herein to successfully retrieve the prey (S. Sweet, pers. comm.). Likewise, this female also used its forearms to successfully extract mouse parts from a 15 mm x 70 mm deep hole drilled into a 15 cm thick, diagonally-oriented tree trunk (Fig. 4).

DISCUSSION

Initial remarks.—Extractive foraging, the location and retrieval of food items from embedded matrices (Gibson 1986), is rarely performed by non-avian reptiles, limited mostly to

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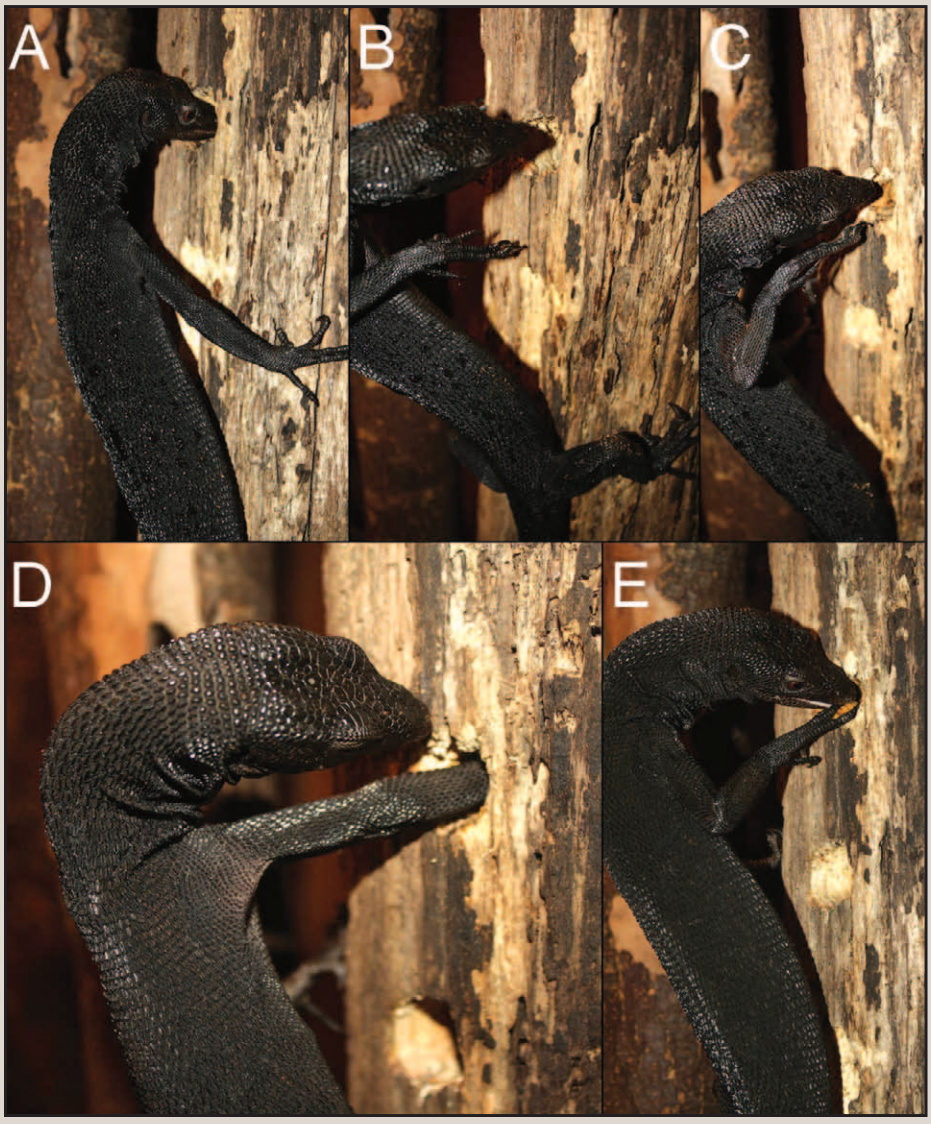




PHOTO BY ROBERT W. MENDYK

FIG. 2. (left) Male *Varanus beccarii* using coordinated forelimb movements to extract a *Zophobas morio* larva from a hole in a vertically-oriented tree trunk. A) A tongue flick into the hole confirms the presence of prey; B) the monitor pulls its arm back; C) the digits are pulled together, rendering them and the forearm streamline for insertion into the hole; D) the forearm is inserted into the hole and jostled around to either flush out prey or snag prey with the claws; E) the forearm is retracted, pulling the prey out of the hole with the claws where it can then be seized with the jaws and swallowed.

FIG. 3. (above) Male *Varanus beccarii* using coordinated forelimb movements to extract prey from a hole in a horizontally-oriented tree limb.

PHOTO BY SAM SWEET



FIG. 4. Female *V. beccarii* using forearms to extract mouse parts from a hole in a diagonally-oriented tree limb.

monitor lizards (e.g., Eidenmüller 1993; Gaulke 1989; Sweet 2007). Similarly, skilled forelimb movements such as the ability to reach for and grasp food items are well-documented in a number of mammalian groups (Iwaniuk and Whishaw 2000), but few reptiles have the processing skills, motor coordination, and dexterity needed to perform such movements. As far as we can determine, this report is the first description of a reptile using coordinated forelimb movements to extract prey from narrow and otherwise inaccessible holes in trees. Often associated with primates (e.g., Erickson 1994), tree hole prey extraction provides further support for the idea that monitors share many biological similarities with mammals (e.g., Wood et al. 1977; see also Horn and Visser 1997; Sweet and Pianka 2007). Moreover, it specifically highlights the problem-solving abilities and behavioral complexity of *Varanus beccarii*, thereby supporting Greene's (2004) earlier statements regarding further behavioral specializations in the *V. prasinus* complex.

Is forelimb-assisted extractive foraging learned or genetically-fixed?—Given its apparent rarity among reptiles, the origin of this foraging behavior in *Varanus beccarii*– whether independently learned through insight, genetically-fixed, or some combination of the two, is of particular interest. Extracting food from embedded matrices often requires complex problem solving skills (Gibson 1986). Monitors do not typically rely on extractive foraging because most prey is captured out in the open by dashing forward and seizing it with the jaws. If successful, and if the prey is of sufficient size, it is immediately swallowed. However, in cases of embedded prey, the situation is complicated by the monitor's inability to use conventional prey capture techniques. Unable to insert its head into a narrow opening to seize a prey item, the monitor must devise an alternate capture strategy otherwise the feeding opportunity may be lost. Here, in the case of *V. beccarii*, a conscious decision derived through insight is made to abandon use of the jaws and switch to an alternate technique that utilizes a completely different set of motor skills. The ambidexterity of *V. beccarii* while performing this behavior also exemplifies keen insight given that switching usage between forelimbs represents a foresighted decision that will enable the monitor to reach deeper into a hole, thereby increasing its foraging effectiveness.

Unlike the decision-making component of this behavior, we suspect that the skilled forelimb movements used by *Varanus beccarii* to extract prey are instinctive, rather than individually learned through insight. Because all three *V. beccarii* tested in the present study used the same reaching forelimb movements and body positioning while performing the behavior, and were capable of using them in different experimental situations, the most parsimonious explanation for these consistencies is that the movements have a genetic basis. Alternately, if the limb movements were independently learned, we would expect to have seen some individual variation in body positioning and the performance of this behavior.

Based on these interpretations, we consider forelimb-assisted extractive foraging in *Varanus beccarii* to be a mutual interaction between insight learning and instinct, and therefore expect it to occur in wild populations. However, the ability to learn and successfully perform this behavior might vary from individual to individual since monitors differ greatly in their intellectual abilities (Lederer 1933, 1942). Loop (1976) demonstrated that monitors are gifted with excellent memories, and can remember trained, food-oriented procedures even after several weeks of latency. Therefore, once learned by an individual and added to its behavioral repertoire, extractive foraging is unlikely to be forgotten if it reliably produces feeding opportunities.

Requisites for use in the wild.—If forelimb-assisted extractive foraging is to be a useful strategy for *Varanus beccarii* in the wild, we contend that several conditions must be met. First, *V. beccarii* would have to be an arboreal forager that feeds on tree-dwelling prey, and second, it must forage in environments where both arboreal prey and tree holes are abundant and accessible.

Scientific observations on the natural history of *V. beccarii* in the Aru Islands, Indonesia are lacking despite frequent collection for the live reptile trade (Pernetta 2009), and all that has been published on its occurrence to date appears to have originated through second-hand sources. Bennett (1995, 1998) reported that *V. beccarii* occurs in mangrove swamps whereas Sprackland (2009) claims that it inhabits lowland wet forests and swamps. Like all other members of the *V. prasinus* complex, *V. beccarii* is indeed highly specialized morphologically for an arboreal lifestyle (Greene 1986, 2004), and behavioral observations of *V. beccarii* in captivity further suggest that it is a skilled tree-dweller (Hartdegen et al. 1999, 2000; Krebs, pers. comm; pers. obs.).

Dietary studies indicate that members of the *Varanus prasinus* complex feed predominantly on arboreal arthropods (Greene 1986; Irwin 1994). Though not recovered from the single *V. beccarii* stomach analyzed by Greene (1986), we suspect that the soft-bodied larvae of some wood-boring beetles and bark-dwelling caterpillars may make appropriate prey items for this particular foraging behavior in the wild. During experimental

trials, soft-bodied prey such as neonatal mice and *Achroia grisella* larvae (but also more rigidly-bodied prey such as *Zophobas morio* larvae and *Nauphoeta cinerea*) were easily extracted from tree holes when impaled by the claws. The sharp foreclaws and reaching forearm movements of *V. beccarii* may also be useful for retrieving nocturnal geckos, tree frogs, and insects that seek refuge in tree holes and crevices by day.

When compared to other monitor lizards, members of the *Varanus prasinus* complex may possess the longest and slenderest forelimbs in relation to body size (compare drawings by Bellairs 1969). The long and slender forelimbs and elongated digits of *V. beccarii* clearly compliment tree hole extractive foraging well, and allow individuals to deeply penetrate narrow openings all the way up to the shoulder. This ability should enable *V. beccarii* to exploit an ecological niche that may not be utilized by many other predators within its range, and can potentially diversify the number of different prey items taken, maximizing the total number of foraging opportunities.

Comparisons of arboreal foraging in Varanus.—Limited observations on arboreal species in the field prevent a thorough analysis of tree hole foraging tactics used by monitors. However, field observations on the foraging habits of *Varanus glauerti* in northern Australia (Sweet 1999) enable direct comparisons between *V. beccarii* and this similar-sized arboreal species. Like *V. beccarii*, *V. glauerti* will also seek out hidden prey within holes and crevices in trees (Sweet 1999); however, the strategies employed by each to retrieve prey from narrow openings are markedly different. Once a prey item is discovered inside a tree hole that is too small to enter with the head, *V. glauerti* will attempt to widen the diameter of the opening by clawing at it margins until it is large enough for the head to enter, where the prey can then be seized with the jaws (Sweet 1999). Although captive *V. beccarii* will also enter holes to subdue prey if large enough for the head (pers. obs.), its use of the forelimbs to extract prey from smaller openings rather than attempting to widen them, distinguishes it behaviorally from *V. glauerti* as well as all other monitor lizards, as currently understood.

Forelimb-assisted prey extraction in additional taxa?—Given that several monitor species occur in forested environments and might have arboreal habits and diets similar to those of *Varanus beccarii*, it is possible that forelimb-assisted extractive foraging might be used by additional taxa. Given their relatedness, and the near-identical similarities in size, morphology, diet, and arboreality between *V. beccarii* and other members of the *V. prasinus* complex (Greene 1986; Sprackland 1991; Ziegler et al. 2007), we suspect that this behavior is also used by other members of the complex. Notably, Irwin (1996) reported seeing a wild *V. keithhornei,* sister taxon to *V. beccarii* (Ziegler et al. 2007), "on the ground scratching with its forefeet in a rotting log, obviously foraging for food." Whether this observation refers to the same prey extraction behavior reported here for *V. beccarii* is unclear; however, it necessitates the need for further investigation of forelimb-assisted extractive foraging in the *V. prasinus* complex.

It might seem obvious that the skilled forelimb movements described here for *Varanus beccarii* represent a specific behavioral adaptation for use in trees. However, we cannot rule out the possibility that this foraging behavior might also occur in terrestrial species. The ability to extract prey from rock crevices, tree stumps and felled trunks, burrows, and other narrow openings would benefit the foraging efficiency of terrestrial monitors. Indeed, some terrestrial species have developed unique and insightful methods of extracting prey from rock crevices and burrows using coordinated tail movements (Eidenmüller 1993; Gaulke 1989; Horn 1999). Use of the forelimbs in similar situations can be equally useful for extracting prey, and is perhaps more feasible from a developmental standpoint given that many species are known to use the forelimbs in various capacities while foraging (e.g., Auffenberg 1981, 1988, 1994; Blamires 2004) or handling and fragmenting prey (e.g., Auffenberg 1981; Hartdegen et al. 2000; Horn 1999; Kiehlmann 1999; Krebs 1979, 2007, pers. comm.; Stanner 2010).

Implications for future research.—Arboreal species offer unique opportunities for studying the insight and behavioral complexity of monitors, particularly because they inhabit complex, three-dimensional environments (Greene 2004) and may require more advanced processing skills and finer motor coordination than comparatively-sized terrestrial species. Studies on several mammalian groups have shown that brain sizes are positively correlated with arboreality (Budeau and Verts 1986; Eisenberg and Wilson 1981; Meier 1983). Because monitors vary considerably in habit from strictly terrestrial to largely arboreal, and share many ecological and physiological affinities with mammals (Wood et al. 1977; Horn and Visser 1997; Sweet and Pianka 2007), it is of interest whether selective pressures have favored a similar evolutionary trend in monitors. Surprisingly, the only direct study to compare relative brain sizes in monitors focused solely on the ecologically-dissimilar *Varanus salvator* complex and *V. glebopalma*, but did note distinct morphological differences between the two (Andres et al. 1999). Similar comparative studies on monitor brain sizes which sample a greater diversity of taxa can provide a framework for understanding the evolution of encephalization and intelligence within the genus.

Further investigations of skilled forelimb movements and extractive foraging in monitor lizards are planned. When applied to current phylogenies (Ast 2001; Fitch et al. 2006; Ziegler et al. 2007), confirmed usage of this behavior by additional taxa can allude to the evolution of skilled forelimb movements in monitor lizards, but more broadly in tetrapods as well (Iwaniuk and Whishaw 2000). Additionally, observations of forelimb-assisted extractive foraging in the field can yield important details about its usage and importance to wild monitor populations which cannot be inferred from captivity.

Finally, our observations have important implications for the management of *Varanus beccarii* in captivity. Given the importance of enrichment stimuli in the husbandry of monitor lizards (Burghardt et al. 2002; Manrod et al. 2008; Sunter 2008), replicating or modifying the drilled tree trunks described in this report and using them during feedings can provide a valuable source of behavioral enrichment for captive individuals. All specimens tested in the present study continue to show interest in the drilled tree trunks within their terraria, stopping to investigate holes and crevices as they are encountered through daily foraging activity. Such an apparatus can potentially increase activity, reduce boredom and stereotypic behaviors, and improve the overall quality of life for specimens of *V. beccarii* and possibly other members of the *V. prasinus* complex maintained in zoos and other captive situations.

We welcome correspondence and encourage feedback from zoos, researchers, and private keepers working with monitor lizards on the subjects of extractive foraging and skilled forelimb movements, as well as additional behavioral specializations in *Varanus*.

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Urban Students and Urban Serpents: The Effects of Hands-on Learning in Student Perception of Snakes

Snakes and teenagers share a common negative stereotype and are often maligned or feared because of this reputation. Here, I present observations and an analysis of shifts in high school students' perceptions of snakes after completing an intensive eight-week course, including participation in field studies of urban garter snakes. These observations support the inclusion of such experiential and in-depth programs in schools as means both to teach science and foster understanding and appreciation of the natural world. Programs providing such opportunity can work to reverse negative public image of both snakes and teens.

The involvement of non-scientists in scientific studies and conservation efforts has recently gained attention as a valuable, and even integral, component of such projects (Cooper et al. 2007). Wildlife education, specifically those programs which effect attitudinal change, can provide great benefit to conservation efforts and are much needed (Adams and Thomas 1986; Mitchell and Jung Brown 2008; Wojnowski 2009). Attitudinal changes toward nature are most effective when they result from an increase in factual knowledge of the natural world, which in turn can lead to a more full participation in democratic society (Hendee 1972), a goal at the core of public education. Additionally, Morgan and Gramann (1989) found that the most effective strategy to increase knowledge and improve attitudes toward snakes is a "full-treatment" approach, combining information-based and experiential activities. Such programs in a variety of subject areas provide a depth of understanding that promotes the possibility for positive shifts in attitudes and actions (Hooks 1994). Examples that have successfully integrated education and conservation can be found from Kenya (Wojnowski 2009) to Texas (Sosa et al. 2010). Such efforts work toward the goals of both collecting scientific data and developing public empathy toward native herpetofauna that are likely to be incidentally encountered by community members.

Snake mythology permeates our culture, often leading to undue fear and misunderstanding (Gibbons 1983). Public education about snakes and the roles they play in a variety of ecosystems is lacking (Wojnowski 2009) and, when it does occur, is often conducted by those without proper knowledge themselves (Gibbons 1983). Recent studies have even postulated that the human fear of snakes has an evolutionary basis and is not affected by direct experience (LoBue and DeLoache 2008). This analysis presents evidence to the contrary: that perception of snakes can shift as a result of educational experiences. Specifically, hands-on involvement of non-scientists in herpetological studies serves to increase both empathy and understanding, as well as benefits the collection of scientific data.

Materials and Methods.—From August to October 2010, I taught an interdisciplinary and hands-on class, "Snakes & Letters," at P.S. 1 Charter School in Denver, Colorado, USA. The eight-week class included curriculum in both science and English and was attended by 28 high school students (age range: 13–19 yrs), though not all students participated for the duration. The school is racially diverse, with 85% of students categorized as "high-risk" for not completing high school, as defined by Colorado law (Colorado General Assembly 2010). Students engaged in lectures, discussions, readings, demonstrations, and hands-on activities to develop their skills in the areas of scientific knowledge, use of scientific equipment, experimental design,

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FIG. 1. Students from P.S. 1 Charter School display the garter snakes they are studying at sites in Denver, Colorado, August to October 2010.

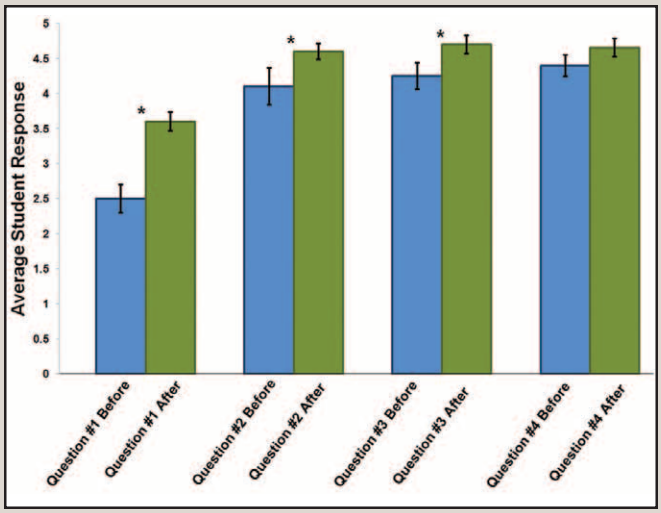


FIG. 2. Average student responses to questions in pre- and post-class questionnaires. Question #1: "How much do you know about snakes?" (1 = "I don't know anything" to 5 = "I'm an expert"); Question #2: "Are snakes an important part of nature?" (1 = "Snakes don't matter at all" to 5 = "Snakes are very important"); Question #3: "Should snakes be protected?" (1 = "Snakes should never be protected" to 5 = "Snakes should definitely be protected"); Question #4: "What is your attitude toward snakes?" (1 = "I can't stand snakes" to 5 = "I love snakes"). Error bars represent one standard error. Statistically significant changes ($p < 0.05$) denoted with an asterisk.

and writing. Students watched a presentation by a visiting biologist and photographer and visited the venomous snake laboratory at the University of Northern Colorado. Two live snakes were incorporated repeatedly into class activities and often handled by students, a Corn Snake (*Elaphe guttata*) and a Sonoran Mountain King Snake (*Lampropeltis pyromelana*). Additionally, there were eight extended outings in which students visited urban sites and participated in field studies of the Western Terrestrial Garter Snake (*Thamnophis elegans*) and Plains Garter Snake (*T. radix*) designed to better understand the impact of urbanization on these species (Fig. 1).

Snakes were located by broad-area visual survey, conducted by myself and the students, and hand captured. Because of variability in site size, student attendance, and scheduling constraints, surveys were conducted by fortuitous encounter and not standardized. Students participated in observing and recording data, including habitat description, weather, length, mass, and GPS-based locality and movement data. After processing, all snakes were released at the point of capture. The four sites visited are situated along a gradient of size, urbanization, and anthropogenic impact: a 10-ha downtown city park, a 20-ha unimproved watershed (12.0 km from downtown), a 50-ha nature preserve (13.7 km from downtown), and a 1050-ha suburban city park (31.2 km from downtown). While participating in these field studies, students encountered 14 live and two dead garter snakes and one live Racer (*Coluber constrictor*). Data were collected for all snake encounters, with one exception due to communication failure and release by students before measurements could be taken.

On the first and last days of the class, students completed identical written questionnaires, largely modeled after those of Sosa et al. (2010). These questionnaires included two primary sections, analyzed here. The first section involved four self-assessment questions, answered on a scale of 1–5, measuring student knowledge and empathy. The second section contained a list of twelve adjectives, which students circled if they believed to be an apt descriptor of snakes. Before and after results were compared using a paired t-test with a level of significance $\alpha = 0.05$ (Triola 2008).

Results.—Because of variable attendance and course changes, twenty students participated in the full curriculum and completed both the pre- and post-questionnaires. In the first section, students were asked to rank their response to questions on a gradient of 1–5, with the attitudinal equivalent of the low and high values given. Students showed a significant increase in self-assessed knowledge or empathy in the following questions: "How much do you know about snakes?" (1 = "I don't know anything" to 5 = "I'm an expert") ($p < 0.0001$); "Are snakes an important part of nature?" (1 = "Snakes don't matter at all" to 5 = "Snakes are very important") ($p = 0.0375$); and "Should snakes be protected?" (1 = "Snakes should never be protected" to 5 = "Snakes should definitely be protected") ($p = 0.046$). An increase, though not statistically significant, was found in response to the question "What is your attitude toward snakes?" (1 = "I can't stand snakes" to 5 = "I love snakes") ($p = 0.2$) (Fig. 2).

Statistically significant increases were found in students' use of the adjectives "strong" ($p = 0.005$) and "curious" ($p = 0.003$) and increases, though not statistically significant, were also found in their use of the adjectives "smooth" ($p = 0.56$), "boring" ($p = 0.33$), "mysterious" ($p = 0.49$), "angry" ($p = 0.3$), "cute" ($p = 0.21$) and "friendly" ($p = 0.16$). A statistically significant decrease was found in the use of the adjective "dangerous" ($p = 0.0021$) and decreases, though not statistically significant, were found in their use of the adjectives "slimy" ($p = 0.2$) and "scary" ($p = 0.6$) (Table 1).

Discussion.—The results of these questionnaires demonstrate an increase in student understanding of and empathy toward snakes, as shown by changes in student self-assessment and by the increased use of the positive descriptors "strong" and "curious" and a decrease in the use of the negative descriptor "dangerous." The students' belief that their knowledge increased was confirmed by classroom assessments, including quizzes, presentations, and written papers. Interestingly, the one survey question in the first section for which no significant increase was found ("What is your attitude toward snakes?") was also the question that received the highest average score in the pre-class questionnaire. Generally speaking, students chose this class over

TABLE 1. Number of students selecting adjectives to describe snakes in pre- and post-class questionnaires. Statistically significant changes ($p < 0.05$) denoted with an asterisk.

Adjective	# of students selecting before class	# of students selecting after class	Change
Slimy	4	1	-3
Cute	7	11	+4
Smooth	16	17	+1
Strong	12	19	+7*
Boring	0	1	+1
Curious	6	16	+10*
Mysterious	13	15	+2
Dangerous	15	7	-8*
Friendly	12	16	+4
Angry	0	1	+1
Scary	2	1	-1

four other such interdisciplinary project classes at the beginning of the term. It would be most revealing to conduct a similar study with students who were not self-selecting into a class explicitly studying snakes. Additionally, curriculum examining invasive snake species and their impact would offer students a more complex and realistic understanding of snake ecology.

These results support the claim of Hendee (1972) that an increase in knowledge can lead to a shift in attitude as well as the findings of Morgan and Gramann (1989) that wildlife education combining the presentation of information and hands-on experiences is effective in increasing student knowledge and improving attitudes toward snakes. Unlike these previous studies, however, this was a much longer course in which students experienced snakes in their natural habitat.

Scientific research can benefit from such student involvement in a variety of ways. The number of potential snake captures is positively related to the number of searchers; more snakes were captured with students than would have been captured otherwise. Additionally, these students' experience and knowledge make them better-suited for participation in citizen-science programs and more aware of the workings of local ecosystems. Even after the class had ended, students continued to inform me of other urban snake sightings. Moreover, students who are exposed to positive experiences in a particular field are more likely to pursue that path in their future education.

That such a class increases student knowledge should not come as a surprise; such an increase is a fundamental objective of science classes. In order for such knowledge to become an active part of students' lives, a concomitant increase in empathy must also occur. This affinity, developed through personal experiences, can allow students to recognize applications of classroom material to their world and communities and to develop a personal interest in such topics, which in turn can serve their academic development (Hooks 1994). Attitudinal changes are especially valuable in terms of urban and suburban conservation, where public perception and participation are integral to the success of many programs (Cooper et al. 2007). An educational program such as this, which combines traditional classroom techniques with hands-on experiential learning, can be successful in increasing student knowledge of the natural world, empathy for the organisms with which they share ecosystems, and confidence in their ability to understand both.

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Status and Distribution of the Rim Rock Crowned Snake, *Tantilla oolitica*

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The Rim Rock Crowned Snake (*Tantilla oolitica;* Telford 1966) is one of three species of small, burrowing snakes of the genus *Tantilla* found in Florida, USA. Restricted to extreme southeastern Florida, its range traditionally has been defined as the east coast of Miami-Dade Co. extending south to the Middle Florida Keys of Monroe Co., with its presence in the Lower Keys remaining uncertain (Campbell and Moler 1992). This area is highly developed and the rockland habitats this species has historically depended upon have been reduced to less than half their original extent (Enge et al. 2003; Snyder et al. 1990). In addition to its restricted range, this species is elusive and only 35 individuals were officially recorded as of 2004 (Scott 2004). *Tantilla oolitica* has been on the State of Florida's Threatened Species list since 1975, yet there have been no dedicated range-wide field surveys for the species. Given the species' increasingly limited habitat and apparently small population, a better understanding of its status and options for its conservation are needed.

Here I report the results of an extensive and intensive range-wide survey for *T. oolitica* between 2007 and 2010. In addition to survey work, I conducted extensive reviews of the literature and museum records and undertook wide-ranging personal interviews. My goal was to create a comprehensive understanding of *T. oolitica*'s distribution and current status to suggest conservation implications for this species.

Methods.—I conducted the study from 2007 to 2010 in southeastern Florida from northern Miami-Dade Co. through the Florida Keys to Key West. The study area covers all of the historical and potential habitat for the species. I concentrated on

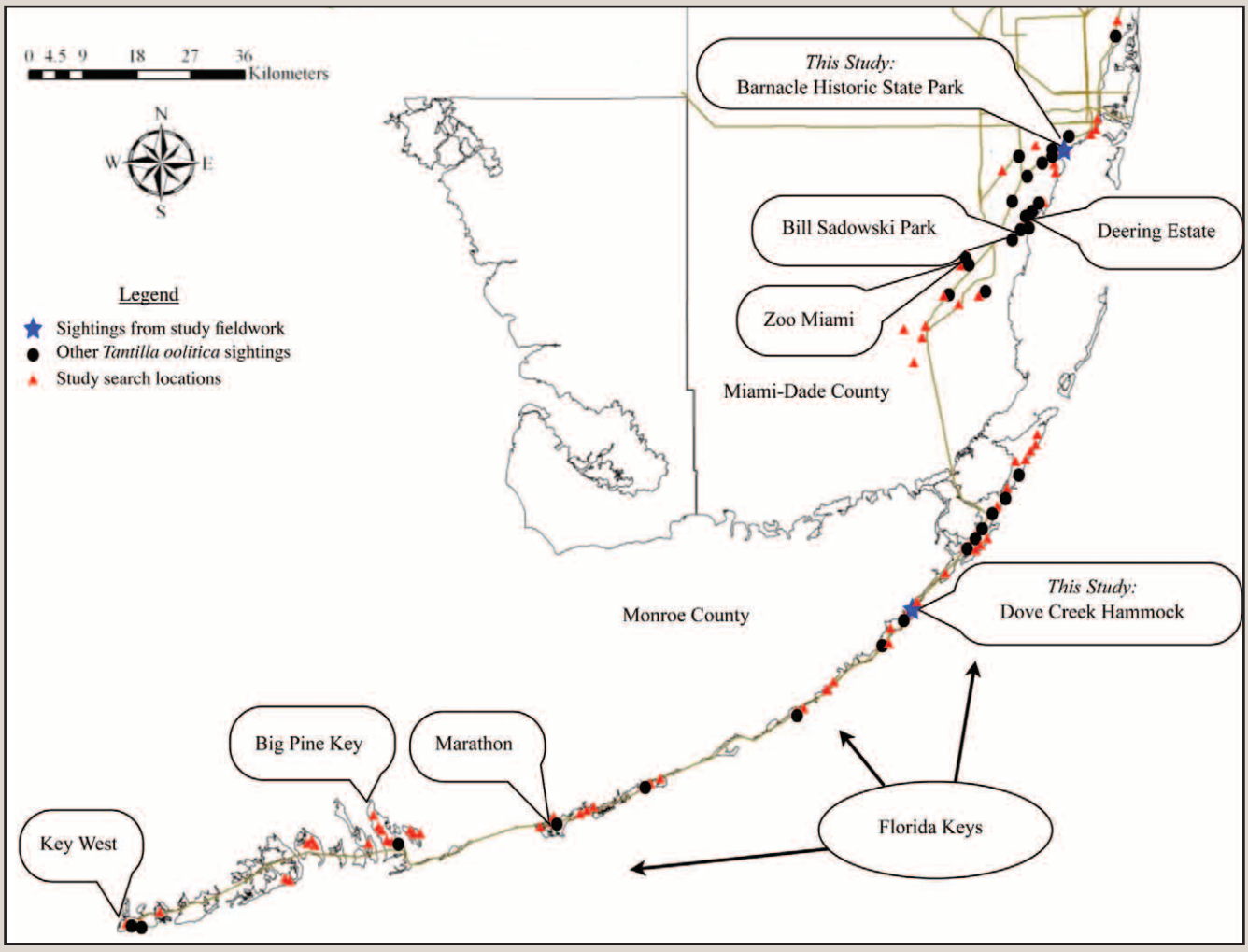


FIG. 1. Range of *Tantilla oolitica*, including all sightings from 1934–2010 and all locations searched during this study.

protected areas (parks, refuges, etc.) and occasionally private properties containing appropriate habitat—forests and pinewoods on a limestone substrate (Snyder et al. 1990), referred to locally as rockland hammocks and pine rocklands (FNAI 2010). From 2007 to 2008, I focused on the core of the historical range from downtown Miami to Marathon in the Middle Keys. Thereafter, I concentrated on the edges of the range, exploring the northern and western boundaries of the species in Miami-Dade Co. and potential habitat in the Lower Keys.

I conducted the survey using cover board arrays and concentrated searches. Cover board searches consisted of 1–3 arrays in each of 12 protected areas for a total of 28 arrays. Each array consisted of three 0.6 x 1.2 m pieces of 1.3 cm-thick plywood placed within a few meters of one another. I placed the boards in March 2007 and examined them every 1–2 months from May 2007 to April 2008, with one final check in August 2009. I thoroughly searched all leaf litter under the cover boards at each visit. I conducted monthly concentrated searches between May 2007 and April 2008 with additional, less frequent searches continuing through October 2010. Searches consisted of all participants spreading out within an area and systematically searching beneath all moveable rocks, logs, and other cover items. I recorded a GPS location at the start of each survey period and recorded time at the start and end of the search to standardize findings by search effort (person-hours). With few exceptions, I conducted concentrated searches in the protected areas containing cover board arrays on every visit between May 2007 and April 2008. During this period, I also searched other privately and publicly owned areas containing appropriate habitat within this core area as permission was granted. I searched protected areas and private lands at the edges of *T. oolitca*'s historical range from 2009 to 2010.

I made information requests for *T. oolitica* records and findings at museums with known *T. oolitica* holdings, Florida Natural Areas Inventory (FNAI), and the "Field Herp Forum" (www.fieldherpforum.com). In addition, I contacted 102 researchers, resource managers, hobbyists and others who might encounter *T. oolitica* for information on potential sightings. I compiled and mapped all sighting information gathered from reliable sources.

Results.—Cover boards were in the field for 880 days of sampling. I checked each of the 84 boards at least eight times during this period, with the 30 boards in Miami-Dade Co. being checked nine times. *Tantilla oolitica* was not found under any of the placed cover boards. A total of 393.4 person-hours were spent in concentrated searching for *T. oolitica* at 57 locations between north Miami-Dade Co. and Key West at the south end of Monroe Co. (Fig. 1). These searches yielded two *T. oolitica* sightings (Fig. 1). I saw one at the Barnacle Historic State Park in Coconut Grove (25.7259°N, 80.2434°W) on 8 May 2007 at 0845 h. This snake was discovered in hammock habitat in a loose pile of rock and moist, dark soil about 15 cm beneath the surface. The second *T. oolitica* was discovered during concentrated searches by Michael Rochford at 0950 h on 25 May 2007 at Dove Creek Hammock in Key Largo (25.0322°N, 80.5018°W) (Fig. 2). This individual was in hammock habitat coiled less than 10 cm beneath a rotting board in moist, dark soil. During the study period, three additional sightings were reported. Opportunistic sightings occurred on Big Pine Key in 2007 (Yirka et al. 2010) and Key West in 2009 (R. Sterling, pers. comm.). Zoo Miami staff caught an individual in a pitfall trap at one of their pine rockland drift fence arrays in 2009 (D. Smith, pers. comm.).

Information requests yielded reports of 49 *T. oolitica* sightings between 1934 and 2010 (Table 1). Sources included 23 museum specimens, 3 FNAI records, and personal accounts from 17 individuals. Seventy-five percent of the people interviewed reported no *T. oolitica* sightings. Most interviewees who had seen *T. oolitica* reported one or two sightings of separate snakes with four being the maximum. There was only one, unprecedented, report of more than four observations by one person. Glenn Fried, former naturalist at Bill Sadowski Park (25.6045°N, 80.3217°W) and the Deering Estate (25.6130°N, 80.3091°W), reported observing at least 33 individuals at those parks and a nearby abandoned lot (25.6078°N, 80.3114°W) between 1983 and 1998, including sightings of more than one snake at a time and repeated sightings of individuals. Given that these observations are so deviant from any others and are unsupported by documentation, I have included the sighting locations but have limited the counts to one per location.

The overall distribution of *T. oolitica* as documented in this study is shown in Fig. 1. Thirty-two site locations from North Miami to Key West suggest the extent of present distribution. Within this range, *T. oolitica* is found both within its historical rockland habitats (16 sightings in hammock, pine rockland, or hammock ecotone; Table 1) and disturbed areas (19 sightings from roadsides, vacant lots, or open fields; Table 1).

Discussion.—This study increases the number of *T. oolitica* reports since the Scott (2004) account from 35 to 49 and

COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND PHOTO BY KIRSTEN N. HINES



FIG. 2. *Tantilla oolitica* discovered in Key Largo, Monroe County, Florida on 25 May 2007.

TABLE 1. Compiled reports of *Tantilla oolitica* sightings between 1934 to 2010. Museum acronyms are based on Sabaj Pérez (2010) if available: MCZ (Museum of Comparative Zoology), MPM (Milwaukee Public Museum), CM (Carnegie Museum of Natural History), KU (University of Kansas Natural History Museum), USNM (United States National Museum of Natural History), UF (University of Florida, Florida Museum of Natural History), UMMZ (University of Michigan Museum of Zoology), LACM (Natural History Museum of Los Angeles County), FNAI (Florida Natural Areas Inventory).

Year	Month	Source	Location (all localities are within Florida, USA)	Habitat (# if more than 1)
1934	January	MCZ (H. Loomis)	Chapman Field, Old Cutler Road, Miami-Dade County	
1938		MPM (H. Jungmann)	Key West, Monroe County	
1941	March	CM (G. R. Campbell)	Coral Gables, Miami-Dade County	
1945	March	KU (G. Knowles)	Coral Gables, Miami-Dade County	
1948	May	USNM (W.E. Haast)	Kendall, Miami-Dade County	
1950	March	UF (W. Auffenberg)	SW Miami, Miami-Dade County	Pasture
1951	April	UMMZ (A. Shwartz)	SR-905 on North Key Largo, Monroe County	
1954	October	KU (R. Patterson)	Miami-Dade County	
1955	April	UF (D. Paulson)	SW 27 Avenue & SW 24 Street, Miami-Dade County	Vacant lot (2)
1955	April	LACM (D. Paulson)	SW 27 Avenue & SW 24 Street, Miami-Dade County	Vacant lot
1969	April	UF (T. Krakauer)	Old Cutler Road & Red Road, Miami-Dade County	
1976	September	UF (local resident)	near Marvin D. Adams Waterway, Key Largo, Monroe County	
1978	February	UF (L.D. Wilson)	Grassy Key, Monroe County	
1978	June	UF (J. Fernandez)	Grassy Key, Monroe County	Field adjacent to hammock
1979	July	Robert Ehrig	Tavernier, Key Largo, Monroe County	Hammock
1979	November	Robert Ehrig	Plantation Key, Monroe County	Secondary Hammock
1980s	May–June	Roger Hammer & Robert Line	Bill Sadowski Park, Miami-Dade County	Hammock-pineland ecotone
1980	March	UF (T. Barken)	US 1 & SW 154 Ave, Miami-Dade County	
1981	March	UF (L. Porras)	Old Cutler Road b/n SW 168 St & SW 178 St, Miami-Dade County	
1982	May	FNAI (K. Achor)	North Creek Hammocks (MM 105), Key Largo, Monroe County	Sidewalk
1982	May–June	Robert Line	Ned Glenn Pineland, Miami-Dade County	Pine rockland
1982	May–June	Robert Line	West of Old Cutler slough in the Palmetto Bay area, Miami-Dade County	Pine rockland
1983	April	FNAI (M. Minno)	Arch Creek Park, Miami-Dade County	Hammock
1983–1998		Glenn Fried	Old Cutler and SW 176th St, Miami-Dade County	Adandoned house and lot*
1983–1998		Glenn Fried	Bill Sadowski Park, Miami-Dade County	Hammock-pineland ecotone*
1983–1998		Glenn Fried	Deering Estate at Old Cutler, Miami-Dade County	Hammock-pineland ecotone and Pine rockland*
1984	May	FNAI (P. Moler)	SR-905 on North Key Largo, Monroe County	Roadside by hammock
1984	May–June	Robert Line	Ludlam Pineland area, Miami-Dade County	
1985	March	UF (A. Nielson)	old entrance to John Pennekamp Coral Reef State Park, Key Largo, Monroe County	Private backyard
1988	May	UF	Upper Matecumbe Key (MM 81), Islamorada, Monroe County	Near marina - 50 ft from shore
1988	Summer	Jonathon Decker	Lower Matecumbe Key, Monroe County	Disturbed hammock and edge
1989	June	UF (G. Dalrymple)	Old Cutler Road, Miami-Dade County	
1991		Dave Jimenez	Zoo Miami, Miami-Dade County	Pineland - in debris pile
1992	August	Barbara Gouldener	Bill Sadowski Park, Miami-Dade County	Hammock edge by playground
1992–1994		Joe Burgess	SW 112th Ave, north of Homestead Air Base, Miami-Dade County	Disturbed pine rockland, vacant lot

TABLE 1. Continued.

Year	Month	Source	Location (all localities are within Florida, USA)	Habitat (# if more than 1)
1992–1996		Jim & Janice Duquesnel	Bonito Ave, Key Largo, Monroe County	Roadside (2 inside roadkill coral snake)
1992–1996		Jim Duquesnel	SR-905 on North Key Largo, Monroe County	Roadside (1 inside roadkill coral snake)
1996	April	UF (J. Decker)	Marathon, Vaca Key, Monroe County	Hammock and edge
1997		Joseph Nemec	John Pennekamp Coral Reef State Park, Key Largo, Monroe County	Maintenance area of park
2000	June	UF (J. Decker)	Marathon, Vaca Key, Monroe County	Roadside
2002	October	Jonathon Decker	Marathon, Vaca Key, Monroe County	Hammock and edge
2004	October	UF (J. Duquesnel)	Blue Runner St, Key Largo, Monroe County	Roadside - roadkill
2007	May	Kirsten Hines (this study)	Barnacle Historic SP, Coconut Grove, Miami-Dade County	Hammock - in rockpile
2007	May	Michael Rochford (this study)	Dove Creek Hammock, Key Largo, Monroe County	Hammock - under rotting board
2007	December	Nathan Shepard & Adrian Yirka	Big Pine Key, Monroe County	Abandoned lot/ trash heap
2009	Spring	Randy Sterling	Key West, Monroe County	Private backyard - in wood pile
2009	August	Dave Jimenez	Zoo Miami, Miami-Dade County	Pineland - in pitfall trap

*Unkown number of sightings (see explanation in Results section)

confirms that the species range extends through the entire Florida Keys, matching the distribution of rockland hammock and surrounding pine rocklands. Historically, these habitats, supported by the relatively high ground of the limestone ridge (Lodge 2010), represented the only areas protected from flooding during the wet season. Drainage has created additional dry lands, but there is no evidence of *T. oolitica* leaving the rockland habitat footprint to inhabit previously submerged habitats, such as former marsh. Instead, as its scientific name suggests, much of the distribution of this species coincides with oolitic limestone (Miami Limestone) found in Miami-Dade Co. and the lower portions of the Florida Keys in Monroe Co. It also occurs on the Key Largo Limestone substrate found in the upper Florida Keys (Hoffmeister 1974; Randazzo and Halley 1997). Within Miami-Dade Co. it is restricted to the modestly elevated, narrow outcropping of limestone called the Miami Rock Ridge, which historically was a narrow peninsula of upland bordered by Biscayne Bay to the east and the Everglades to the west, but now is home to metropolitan Miami.

It is difficult to assess population size of *T. oolitica* because the species is not only rare, but elusive. Many Florida herpetologists (researchers and hobbyists) have never seen one despite their attempts to do so. A study by Enge et al. (2004) targeting *T. oolitica* in six Miami-Dade Co. parks failed to find any. Staff at Zoo Miami began reptile surveys with coverboards and drift fence arrays with pitfall traps in 2005. They expanded their trapping efforts in 2007 to specifically search for *T. oolitica* (S. Conners, pers. comm.). In all this effort, they found one *T. oolitica* in a pitfall trap in August 2009 (D. Smith, pers. comm.). In my study, 84 coverboards and over 393 person-hours of searching over a three-year period yielded only two *T. oolitica* sightings. Even on the Field Herp Forum, a venue for some of the most avid and successful field herpetologists, *T. oolitica* is one of the species most commonly lamented as lacking in South Florida reptile life lists. The success rate in finding *T. oolitica* is both historically and currently low, making population size estimates virtually impossible. Looking at observation rates instead, there is an indication of population stability since the numbers of sightings in the last ten years are comparable with those in previous decades. However, we have no way of verifying this population trend and a lack of repeated observations at any given location leaves room for concern.

Sites at and around Bill Sadowski Park in Miami and in Marathon of the Florida Keys yielded multiple sightings in the past. This trend seems to have stopped despite recent efforts to uncover this species. Some areas have been lost to development, but even protected Bill Sadowski Park has failed to yield sightings in almost 20 years after affording three over a ten-year period in the 1980s to 1990s. I placed nine coverboards at this park and spent 25.3 person-hours searching the property, but found nothing. Repeated sightings are admittedly the exception rather than the rule for this species, but many of the people I interviewed speculated that *T. oolitica* was not being seen, particularly in these areas of repeated sightings, because people were not looking for them. My study suggests otherwise. It was designed as a mark-recapture study, but that component never came to fruition because I never observed *T. oolitica* more than once at any given location despite repeated efforts. Although these results are insufficient for making population estimates, they do highlight the rarity of the species.

While much remains unknown about *T. oolitica*, it is clear that the species faces many threats. Less than 2% of the historical pine rocklands on the Miami Rock Ridge currently remain, and hardwood hammocks both in Miami-Dade Co. and throughout the Florida Keys have been reduced to less than half their original extent (Enge et al. 2003; Snyder et al. 1990). Fragmentation eliminates immigration between patches, and in an urban setting inevitably translates into road

fatalities (Table 1). However, *T. oolitica* does seem able to persist within remaining fragments. Conservation requires protection of these fragments, which is generally the case in Miami-Dade Co., but not in the Florida Keys where development and saltwater intrusion associated with sea level rise continue (Ross et al. 1994; USFWS 1999). Proper management of habitat fragments for *T. oolitica* includes protection from non-native species, illegal dumping and altered fire and hydrology patterns (USFWS 1999), the latter likely being the most critical. South Florida's water table has dropped by as much 1.2 m in areas (Sklar et al. 2002), creating drier rockland habitats than historic conditions (USFWS 1999). Centipedes, probably the main food source for *T. oolitica* (Campbell and Moler 1992; Todd et al. 2008), require moist conditions (Koehler and Oi 2003). Patch management must involve rehydration.

Tantilla oolitica is currently listed as Threatened by the State of Florida (FWC 2010) and as Endangered by the International Union for Conservation of Nature (IUCN) Red List (Hammerson 2007) based on restricted range and loss of habitat. This study confirms the appropriateness of these designations. The species also merits protection under the Federal Endangered Species Act, under the provisions for "the present or threatened destruction, modification, or curtailment of its habitat or range" and "the natural or manmade factors affecting its survival" (USFWS 2010).

Because of its scattered distribution across landscapes managed by diverse entities, a formal comprehensive conservation plan is needed. The plan's components, in addition to patch management, should include monitoring on all sites where it occurs (utilizing a combination of concentrated searches, coverboard arrays, and drift fences with pitfall traps), an educational campaign to increase public awareness, an official information repository, a captive breeding population and re-introduction since natural dispersion among patches is no longer viable.

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A New Technique for the Production of Large Numbers of Clay Models for Field Studies of Predation

One of the cornerstones of ecology is the study of interspecific interactions, such as predation, herbivory, and mutualism. Studies of predation have proven to be difficult since actual field observations are often limited. Synthetic prey models have proven to be useful tools for measuring predation attempts, as identical stimuli can be created and used without harming the test organism in question. In addition, replication of a particular prey phenotype is more tenable with models than with real organisms, and allows for careful manipulation of phenotypic traits of interest, such as color and size.

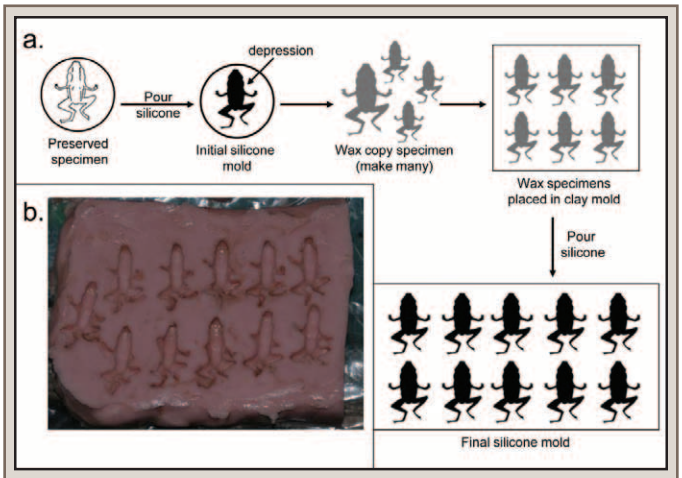


FIG. 1. A) Sequential procedure for making master silicone molds, B) Final silicone master molds.



FIG. 2. Clay well surrounding the preserved specimen.

Although predation can be studied relatively easily in captive settings (e.g., Lindström et al. 2006), studies of predation are more problematic, as they require models that withstand variable habitats and unpredictable weather conditions. Predation on several reptile and amphibian taxa (including snakes [Brodie 1993; Harper and Pfennig 2007], salamanders [Kuchta 2005], and frogs [Saporito 2007; Noonan and Comeault 2009]) has been subject to field research using clay or plasticine models. Similarly, for clay models of prey species that are highly variable in coloration and patterning, high attention to detail is warranted, but the development of highly realistic models is often prohibitively time-consuming or costly. Moreover, recent experiments (Noonan and Comeault 2009) have demonstrated that predation rates are often low, necessitating a large quantity of models to elucidate predation patterns.

We present a novel technique to generate large numbers of life-like models using customizable silicone master molds to produce clay models. Master molds allow for quick development of clay models of varying size and shape, which can subsequently be painted for patterning and coloration studies. Due to the nature of the clay used, marks left by predators can be scored for presence or absence of predation attempts, and in some cases used to identify predator species.

Materials and Methods.—Construction of the models began by taking an initial mold of a preserved specimen of a poison frog, *Ranitomeya imitator*, available from previous research. A small layer of modeling clay (Sculpey) was smoothed onto a small wood board and heated with an alcohol burner to soften it. A preserved frog was then placed into a life-like resting pose and lightly pressed into the clay in a posture similar to a sitting stance (Fig. 1). Although it is possible to make a 3-D mold that includes ventral characteristics, it would involve additional steps unnecessary for our purposes, so the ventral surface of the frog was flattened against the clay.

A well was then constructed around the frog approximately 2 cm high using the same modeling clay (Fig. 2). The clay and specimen were then coated with a Krylon Matte Finish Spray® (Krylon Products Group) to protect the skin of the specimen as well as seal in chemicals that could inhibit the curing process of the silicone. A mold release (Mann Ease Release 200™, Mann Formulated Products) was sprayed over the entire frog and clay bed/wall to allow for easy release of the silicone. The silicone and catalyst (Smooth-Sil 940®, Smooth-on Corp.) were mixed in a 10:1 ratio by weight. This mixture was then poured, from a height of approximately 1 m, into a thin stream in one corner of

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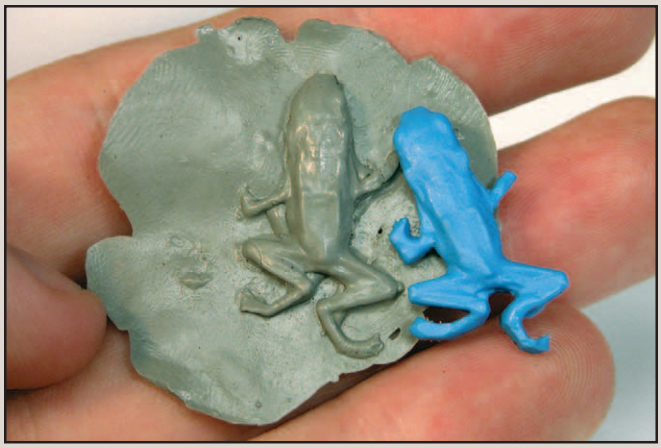


FIG. 3. Wax model (left) with resin model (right).

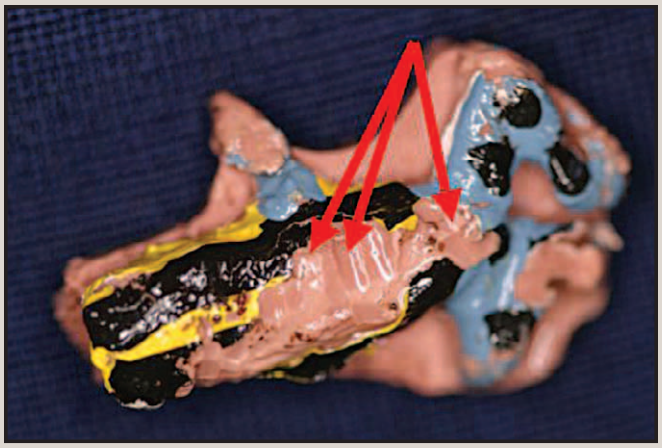


FIG. 4. Model *Ranitomeya imitator* with mammalian incisor marks (arrows depict attacked regions).

the well, allowing it to spread evenly over the specimen. Pouring in a thin stream away from the specimen allows for the spread of the silicone to cover all surfaces and avoids development of air bubbles. The silicone master mold cured in approximately 18 h at which point the preserved frog was extracted and returned to alcohol. Although specimens remain largely intact during creation of molds, damage to skin is likely as a result of the matte finish spray.

Following production of the mold, resin (plastic) forms were poured that were then used for the production of the final silicone production molds, in which the clay models are made (Fig. 3). The resin (Smooth-cast 300®, Smooth-on Corp.) was mixed according to the manufacturer's indications (1:1 by volume) and poured into the silicone voids using the pouring technique described above for the pouring of silicone. Curing time for this step is approximately 30 minutes. Two methods were tested to cure the resin, both curing them in ambient temperature and pressure conditions versus under high pressure. Both yielded similar results. There may be a possible benefit of using increased pressure to avoid air bubble imprints, although these benefits were minimal in our testing. The resin frog models were then spaced on the modeling clay (the same as originally used to make the initial silicone mold), in groups of 10–12 models per mold and the final silicone was mixed and poured. When the resin frogs were removed, the voids were used to pour melted plasteline clay.

To heat the clay we used a small crock-pot on the highest setting to melt no more than half of a two-pound block. The clay was heated in the crock-pot for approximately one hour, or until it was liquefied. Release agents can be added to the silicone prior to pouring clay to facilitate clay extraction, though this is not necessary. While release agents will extend the life of molds, it can also serve as an olfactory attractant to predators.

The clay was spooned onto the molds, tapping it in each form to eliminate air bubbles. An extra 1/4-inch of clay was added and smoothed over the molds to allow for easy separation from the silicone, as well as to strengthen the very thin legs. The tablets of clay then were painted using non-toxic acrylic paints. Alternatively, colored clays could for species with simple color patterns, avoiding the need to paint.

For our uses, we replicated the silicone master mold step 15 times to be able to make roughly 150 models with each heating of the clay block. While it is possible to do much larger master molds, extracting the models from smaller molds is easier as smaller molds allow for release of the clay out of the mold by gentle bending. This allows for finer detail of the models, such as small toes or tail tips, to be retained, with a reduced risk of breaking fragile body parts. When the molds are carefully handled and used in combination with a non-toxic release agent, they can be expected to last several years. We produced nearly 2,000 models with no noticeable detrimental effects to the master molds (Fig. 4).

Discussion.—We provide a novel method for the rapid production of large quantities of detailed models. This method is preferable to other production methods for clay models for several reasons. First, due to the ease of model preparation from master molds, models can be made in even the most remote locations, provided there is a way to melt the clay. Once the resin forms are made they can be used unlimited times to produce silicone master molds, potentially allowing production of thousands of models in a short time. Lastly, for predation studies, accurate models allow for the testing of specific hypotheses of color or specific traits, while partially alleviating concerns that predators will not recognize unrealistic forms. However, we note that investigators should conduct field trials of paint and model formulation prior to deploying models—as an example, we found that some paint formulations were subject to attack by ants in the Neotropics.

The future of clay models is promising with higher attention to detailed realism and faster production times allowing for more rigorous hypothesis testing. Our method provides a way to generate large amounts of accurate clay models with minimal effort.

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Toes versus Swabs? Evaluation of The Best Tissue Source for Detection of *Batrachochytrium dendrobatidis* in Field-Caught Amphibians

The pathogenic fungus *Batrachochytrium dendrobatidis (Bd;* Phylum Chytridiomycota, Class Chytridiomycetes, Order Chytridiales) has been associated with amphibian extinctions and declines throughout the planet (Berger et al. 1998; Crawford et al. 2010; Lips et al. 2006; Mendelson et al. 2006; Stuart et al. 2004). Since its discovery in 1998, researchers have documented the distribution of *Bd* (Fisher et al. 2009; Ron 2005; *Bd* maps: http://www.spatialepidemiology.net/bd-maps/), potential dispersal patterns and vectors (Johnson and Speare 2005; Lips et al. 2009), the effect of epidemics on amphibian communities (Brem and Lips 2008; Briggs et al. 2010; Lips et al. 2006; Vredenburg et al. 2010), and the life history traits and environmental factors that might contribute to pathogen virulence and/or host vulnerability (Bielby et al. 2008; Burrowes et al. 2008; Garner et al. 2009; Lips et al. 2003; Longo et al. 2010; Pounds et al. 2006). Regardless of the type of question that we are addressing, effective detection of infected individuals and estimation of *Bd* load is key to further understanding the dynamics of this disease among affected populations. At present, this is done via molecular assays using end-point PCR (Annis et al. 2004) or TaqMan quantitative real-time PCR (Boyle et al. 2004). However, the kind of tissue source (toes versus ventral skin swabs) used for detection has been rarely tested (Hyatt et al. 2007). The aim of this study is to evaluate the reliability of these sample methods applied to the same animal, in detecting *Bd* and estimating the intensity of the infection in the field at a given sampling time.

Although sampling toes are considered unethical by some authors because they may cause pain or hinder survivorship in some species (Hyatt 2007; McCarthy and Parris 2004, Phillott et al. 2007), *Eleutherodactylus coqui* is not negatively affected by toe-clipping and can regenerate a toe within 4–5 months to a round (versus the usual T-shape) disk, thus allowing for future recognition and re-sampling (Joglar 1998, Ulmar et al. 2011). In addition, the usefulness of this tissue for scientific studies such as population genetics (Burrowes and Joglar 1999), systematics (Gonsner and Collura 1996), and disease diagnostics (Longo et al. 2010; St-Amour and Lesbarrères 2007) has been recognized. In a study of population-level responses to *Bd*, toe-clips may be very valuable to assess the temporal progression of the disease and survivorship of marked individuals (Longo and Burrowes 2010). This is suitable for amphibians that can re-grow their toes quickly, but may not work well with other species. On the other hand, swabs are easily taken, non-invasive, conveniently stored, and have shown high sensitivity for *Bd* diagnosis (Hyatt et al. 2007).

Pushendorf and Bolaños (2006) compared the probability of detecting *Bd* using tissues from different body parts with histology and found that sections from the pelvic patch and the innermost finger with a fungal-specific stain (periodic acid-Shiff-PAS), were generally more effective. Hyatt et al. (2007) compared the diagnostic sensitivity of swabs, toe clips and water baths in detecting *Bd* via TaqMan qPCR assays in frogs inoculated with *Bd* in the laboratory. They define diagnostic sensitivity as the proportion of known reference animals that are *Bd* positive, that test positive for *Bd*. Their work revealed that toe clips were more effective in detecting *Bd* only at early stages of infection, and they recommend the use of swabs as the standard sampling method (Hyatt et al. 2007). Our study is different in that we evaluate the probability of detecting *Bd* in the field (unknown *Bd* status) from the same animal at a particular time using two sampling protocols. In addition, we assess the difference between swabs and toes at estimating the level of infection (*Bd* zoospore load) of individuals within a population. We expect that the results presented herein, may help scientists decide the best sampling method for *Bd* diagnostics according to the type of question they wish to address in future field studies.

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TABLE 1. Number of positive *Bd* samples from *Eleutherodactylus* species obtained from swabs versus toes, and number of mismatches, positive, and negative agreements and results of corresponding McNemar's test for association between positive diagnosis of *Bd* infection on swabs versus toes sampling protocols for a given individual in the field.

Sample	No. *Bd* + in swabs	No. *Bd* + in Toes	No. Mis-matches	No. + *Bd* Agreements	No. – *Bd* Agreements	N	McNemar's Statistics
All frogs	56	61	15	19	51	85	χ^2 = 1.067, df = 1, P = 0.3017
Adults	36	41	11	33	11	55	χ^2 =1.455, df = 1, P = 0.2278
Juveniles	20	20	4	18	8	30	χ^2 = 0.250, df = 1, P = 0.6171
Locality:							
El Yunque	29	33	8	27	5	40	χ^2 = 1.125, df = 1, P = 0.2880
Carite	17	16	7	25	13	45	χ^2 = 0.000, df = 1, P = 1.00
Species:							
E. coqui	27	33	8	26	10	44	χ^2 = 3.125, df = 1, P = 0.0881
E. portoricensis	15	16	5	13	3	21	χ^2 = 0.000, df = 1, P = 1.00
E. locustus	6	4	2	4	3	10	χ^2 = 0.500, df = 1, P = 0.4795
E. richmondi	7	9	0	4	6	10	—

Methods.—Fieldwork was done in El Yunque (18.29948°N, 65.77984°W) and Carite Forest (18.090453°N, 66.03265°W) during 2009–2010. We sampled 85 individuals in four species of direct-developing frogs in the genus *Eleutherodactylus* (*E. coqui, E. portoricensis, E. locustus, and E. richmondi*), and two age classes: juveniles (N = 30) and adults (N = 55) from populations known to be infected with *Bd*. We collected tissue from individual frogs by toe clipping the distal phalange of the third toe of the foot and the second toe of the hand without special attention to right or left, and swabbing the ventral pelvic-patch region and thighs for 30 strokes for adults and 15 for juveniles. We changed gloves and flamed instruments between frogs sampled. Toes were stored in 70 % ethyl alcohol and swabs were stored dry, and frozen at –20°C. DNA for diagnosis of *Bd* infection was extracted using a Prep-Man Ultra assay (Boyle et al. 2004). *Bd* loads (number of zoospores genomic equivalents) per sample were quantified via qPCR using a Stratagene MX 3005P system and following Boyle et al. (2004).

To answer the question if detection of *Bd* was associated with the sampling method, we used McNemar's test of association for paired-data measured in the same scale (*Bd* zoopspore genomic equivalents). This test calculates the probability of association with a continuity correction and it is compared to a Chi-square table value. The null hypothesis is that an infected animal will test positive in both swabs and toe tissue. To assess if there was a significant difference between toe-clip and swab samples in measuring the intensity of *Bd* infection in a given individual, we compared zoospore loads estimated by each tissue type using a Paired T-test. For statistical analyses we used Minitab-14, and Graphpad software (http://www.graphpad.com/quickcalcs/mcnemar1.cfm).

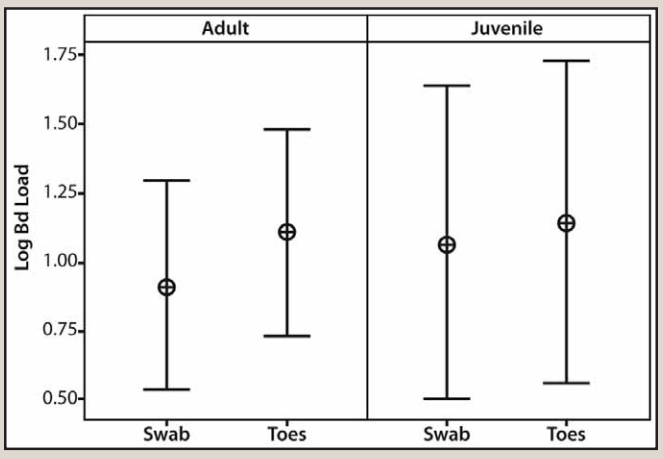


FIG. 1. Mean Log *Bd* zoospore load and 95 % confidence intervals detected by qPCR from two different tissue sources (skin swabs and toe-clips) of adults and juveniles *Eleutherodactylus* frogs.

Results.—We found no significant difference in the probability of detecting *Bd* from toe-clips or swabs. The number of mismatches in *Bd*-diagnosis between sample methods was low when compared to the times the diagnosis was in agreement (Table 1). As a result, McNemar's test for association between positive diagnosis of *Bd* and tissue source was non-significant for all samples considered in this study, as well as for every time the sample was subdivided by biologically meaningful criteria such as adults, juveniles, localities studied (El Yunque and Carite), or species (*E. coqui*, *E. portoricensis*, *E. locustus*, and *E. richmondi*; Table 1).

The *Bd* infection loads estimated by swabs versus toes, when at least one of the two tissue sources was positive, were not significantly different when all frogs were considered. When we subdivided the sample by age, we found that toes estimated a significantly greater number of zoospores than swabs in adult frogs ($\bar{x}$ swabs = 144.62 ± 47.5; $\bar{x}$ toes = 223.68 ± 74.11; T = –2.28, P = 0.013, N = 51). However, there was no difference in juveniles ($\bar{x}$ swabs = 1588.22 ± 1461.49; $\bar{x}$ toes = 672.97 ± 429.87; T = 0.87, P = 0.389, N = 29) where *Bd*-infection loads were higher than in adults and had a greater variance between samples (Fig. 1).

Discussion.—The probability of accurately detecting *Bd* on infected frogs is an important issue for studies regarding the mechanisms of *Bd* in the laboratory or prevalence of infection in the field. We show that this can be done without significant differences in the probability of detection using swabs or toes. Thus, the decision on what tissue type to use will depend on the scientist's need to mark individual frogs in species that cannot be easily distinguished by unique color marks. In amphibians that regenerate toes readily and in an identifiable manner, as *Eleutherodactylus coqui*, toes can be a useful way to distinguish individuals and follow the progression of *Bd* infection throughout a time period.

On the other hand, our results show that the estimates of infection loads are not comparable for adult *Eleutherodactylus*, where toes detect a significantly higher number of zoospores for a given individual. Hyatt et al. (2007) found higher detection

sensitivity in toe-clip samples than in swabs at early stages of infection in *Bd*-inoculated *Litoria caerulea*. The authors attribute this to low levels of hyperkeratosis and skin sloughing in recently infected hosts, which results in a lower probability of detecting the fungus using skin swabs. In Puerto Rico, we have found high prevalence and low levels of infection in adult *Eleutherodactylus*, characteristic of populations that persist in enzootic conditions (Longo et al. 2010; Longo and Burrowes 2010). Thus, the increased *Bd* infection loads obtained in toe samples from adult frogs may be due to similar physiological responses of their skin (less hyperkeratosis) at times when infection is not severe. The implication of this finding is that in enzootic conditions when *Bd* infection loads are low, the probability of false negatives may be higher when sampling with swabs versus toe clips. The fact that estimates of *Bd* load in juveniles were not significantly different between toe or swab samples is not surprising because juvenile *Eleutherodactylus* carry higher zoospore loads than adults (Longo and Burrowes 2010). In moderate to heavily infected small-sized frogs (as exemplified by juvenile direct-developers), the difference in tissue sample between tiny toes and skin swabs, may not contribute to significant differences in the estimate of infection intensity.

In summary, we have shown that *Bd* detection probability is independent of the sampling method (toe-clip versus skin swabs) in direct-developing terrestrial frogs, and that the intensity of the infection detected via qPCR in field animals may vary according to ontogenetic stage, and progression of *Bd*-infection. Since this knowledge is difficult to obtain without conducting long-term surveys, we recommend that unless necessary for marking purposes as mentioned above, scientists use swabbing as the main sampling technique, and remain consistent in the use of this source of tissue for comparisons of infection intensity between individuals in a population or a community of amphibians throughout time.

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Comparison of Immobilization Methods for PIT Tagging Three-toed Amphiuma (*Amphiuma tridactylum*)

Amphiuma tridactylum is a large (up to 1 m and 1 kg), slimy, aquatic salamander that can deliver a powerful bite, and thus is difficult and potentially dangerous to handle (Fontenot Jr. 1999; Fontenot Jr. and Seigel 2008). Even a simple task like PIT (Passive Integrated Transponder) tag implantation is virtually impossible without restraining the animal. We have observed that forced physical restraint is undesirable because it can result in skin abrasion (from gloves or a towel), physical trauma to internal organs (e.g., liver damage), and potentially death. Recently, Brown and Forstner (2009) reported a method of handling *Amphiuma* in the field using snake restraining tubes. We found this method difficult to implement with *Amphiuma*, especially when carefully examining specimens for bites. Burgmeier et al. (2010) developed the "bender" board for restraining Eastern Hellbenders (*Cryptobranchus alleganiensis alleganiensis)*. We sought a quick method of temporarily immobilizing *A. tridactylum* individuals for examination and PIT tag implantation, comparing one method of anesthesia (isoflurane) and immersion in a cold-water bath. Alamndarz (1975) used cold water to aid transferring adult crocodilians, and Mitchell (2009) refers to cooling as a method of minimizing movement with amphibians. Mitchell (2009) discusses several anesthetics for amphibians. We selected isoflurane because preliminary trials with *A. tridactylum* individuals indicated it was safe and effective.

Methods.—Eighteen adult *A. tridactylum* were collected with baited traps (flexible fish traps; Promar 36" x 12" with ¼" mesh) baited with raw beef heart, chicken livers or most effectively, canned cat food) from a ditch and small pond in East Baton Rouge Parish, Louisiana, USA. The specimens were maintained for 1–3 days in the laboratory in aquaria at 25°C and fed one earthworm per day each.

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We used isoflurane anesthesia for three of the specimens. Isoflurane anesthesia methods were those of Major et al. (2011)



Fig. 1. A Three-toed Amphiuma being weighed after cooling in ice water.



Fig. 2. A Three-toed Amphiuma after cooling in ice water. It is possible to examine the specimen leisurely, even to the point of placing them ventral side up.

and are only summarized here. We placed each individual into a body-size matched polycarbonate snake tube. We placed a cotton ball saturated with 0.2–0.5 ml (as needed) of isoflurane into head the end of the tube and plugged the ends with rubber stoppers.

Fifteen specimens were immersed in a container of water and ice for ten minutes or until they did not exhibit a righting response.

Prior to insertion, PIT tags and the syringe needle were dipped in 90% isopropyl alcohol to ensure aseptic conditions. While under anesthesia, with the individual in the clear plastic tube, the posterior third of its body was pulled from the tube, and the tail was held with a dry cloth. The PIT tag was inserted subcutaneously on the right side (dorsal view) of the body approximately 5 cm anterior to its cloaca, with the syringe provided by the manufacturer (Avid Identifications Systems, Norco, California). We inserted the syringe subcutaneously slightly farther than necessary, so as to leave ~ 1 cm of space between the PIT tag and the puncture made by the syringe, to allow subcutaneous space for fascia reformation. The insertion hole was then sealed with New Skin (solution of -Pyroxylin, Alcohol, Oil of Cloves, and 8-hydroxyquinoline).

Animals anesthetized with isoflurane were limp during and after PIT tag implantation, and the skin surface showed visibly dilated blood capillaries. When individuals were placed in water for recovery, we were concerned that they may drown, and so supported their heads above the water surface until they began moving on their own.

Because respiratory rate is reduced during anesthesia, and respiration is the primary method of voiding the isoflurane anesthetic, recovery can be facilitated by manually forcing expiration (inspiration then follows naturally by elastic recoil). Forced expiration can be induced with the investigator's thumb by pressing on the ventral side of the subject, beginning just anterior to the cloaca, and drawing the thumb in a posterior to anterior direction as far as the pectoral girdle. The lungs are basically hollow sacs that extend most of the length of the peritoneal cavity, so the sequential compression motion described above essentially squeezes the air out. This recovery facilitating method is effective, but applying it may be limited by the nature and location of the incision, etc.

Results.—For specimens subjected to isoflurane, anesthesia was achieved with less than 20 minutes of exposure, as indicated by lack of righting response and muscular tension. Recovery to the point of voluntary movement and regular breathing generally took 30–60 min, depending on the individual. However, one individual showed little or no reviving at 60 min, but was allowed to remain in shallow water, and eventually recovered after 4–6 h. Specimens subject to cold treatment retained a firm body and muscular tension. The skin surface showed visibly dilated blood capillaries, even more so than with the isoflurane treated individuals. However, the cold-treated individuals began moving on their own within one minute when placed in ambient temperature water, and showed no negative symptoms. They were able to swim and breathe as normal in 3–5 minutes, and cutaneous blood capillaries returned to normal condition within 30 minutes.

Discussion.—Both methods were effective for immobilizing *A. tridactylum*. However, the utility of each is dependent on the type of procedure being done, the amount of time required for the procedure, and the amount of time available for application of the anesthesia/immobilization procedure, recovery time, and post-procedure monitoring.

General anesthesia with isoflurane is suitable for procedures requiring a working time of 20+ minutes. This method can also work satisfactorily for short duration procedures, but it requires an extensive amount of time for application, monitoring, and recovery. Hence, its use may be impractical, particularly if a quicker temporary immobilization method is available.

The process and recovery time required for cold immobilization/narcosis may be most practical for use with a quick procedure like PIT tag implantation, which generally takes less than one minute. Applying cold to immobilize was quick and easy, as was recovery. Although it is not a replacement for chemical anesthesia when a long working procedure time is required as with general surgery, e.g., with radio transmitter implantation, we believe this method will useful to other researchers who need to perform simple procedures on difficult to handle amphibians such as *A. tridactylum*.

Acknowledgments.—The methods used in this work follow guidelines of the Society for the Study of Amphibians and Reptiles (http://www.asih.org/files/hacc-final.pdf) and were approved by the Animal Care Committee at SLU (IACUC, Protocol #0015) and LSU (protocol number 09-072).

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Photographing Herpetofauna in Nature

Photographs of amphibians and reptiles taken in their environment generally lack a scale of magnification, although information on size could help identification or appreciation. The assorted reasons include the photographer's concern lest placing a scale object would scare the animal away. The solution is simple. First photograph the animal in as undisturbed a posture as possible, in its natural location. Next, put your scale object next to it. If the animal escapes, photograph the scale object in the animal's deserted position. Comparing the separate photos, with animal and with scale, based on landmarks in the substrate, enables measuring the animal on the photo or adding a scale bar.

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As scale object, I carry a strip of white card or paper, on which a black ruler bar of 10 cm, with cm notches, is drawn. This is clearer than the mm notches on a real ruler, and is easier to position where needed, such as on a tree trunk (Fig. 1). However, when precise coloration is important, I use a color scale, a small ruler carrying a series of 1 cm standard Ostwald color patches (Streller and Ostwald 1939) (Fig. 2).

Sometimes it is instructive and efficient to photograph the animal on a mirror, thus including the ventral aspect (Fig. 3). One might carry a mirror in the field, to do this with animals that are to be released on the spot. However, positioning may have to take into account, that the surroundings are included in the mirror image.

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COLOR REPRODUCTIONS SUPPORTED BY THE THOMAS BEAUVAIS FUND



Fig. 1. Hand-drawn ruler, lighter and clearer than most ready rulers, applied to the north-Israeli Tree Gecko, *Mediodactylus kotschyi orientalis*, with regenerated tail, on olive-tree bark.

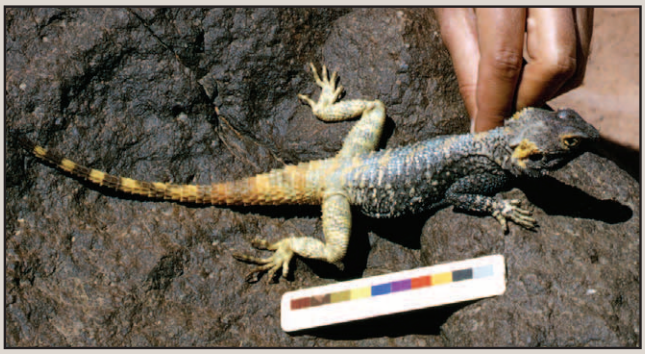


Fig. 2. The undesirable composition. A ruler carrying color scale and a male south-Sinai Hardun, *Laudakia stellio salehi*, held together in-situ to show the lizard's colors against its rocky habitat.



Fig. 3. Photographing the north-Israeli *Eirenis lineomaculatus* on a mirror shows the spotted ventral surface that distinguishes this species from all congeners in the Levant.

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Observations on the Captive Reproduction of *Colostethus pratti* (Boulenger, 1899)

Colostethus pratti (Dendrobatidae) is a diurnally active leaf litter and stream edge dwelling frog with a wide distribution in Panama and Colombia. In Panama, this species is known from the western cordilleras and western Atlantic lowlands through the central portion of the country to the eastern lowlands and cordilleras. *Colostethus pratti* is also present on Isla Colón in the Boca del Toro archipelago off of Panama's northeastern coast. In Colombia, it is known from northern portions of the central and western cordilleras in the departments of Chocó and Antioquia. This species has been recorded from 110–1160 m above sea level (Ibáñez et al. 1999; Solis et al. 2004).

Herein we report our observations on the successful captive maintenance and reproduction of *C. pratti*. Extensive information exists on the captive management for many dendrobatid frogs (e.g., Lotters et al. 2007), however there is very little information available for species of *Colostethus*. We believe the information provided herein may prove useful in future efforts to maintain *ex situ* populations of this and other species in this genus.

Specimen acquisition and husbandry methods.—1.1 *Colostethus pratti* were collected from the region of El Valle de Antón, Provincia de Coclé, Panamá and legally exported to the Atlanta Botanical Garden (ABG) in 2005 as part of the Amphibian Recovery and Conservation Coalition (ARCC) project initiated by ABG and Zoo Atlanta. The goal of the ARCC was to learn the logistics of an *ex situ* response to the rapid spread of the amphibian chytrid fungus (*Batrachochytrium dendrobatidis* [*Bd*]) through amphibian populations in Panama (Gagliardo et al. 2008).

Prior to and following importation, specimens were quarantined for a period of 30 days during which they were treated for *Bd* following a protocol suggested by Dr. Brad Lock (Zoo Atlanta, Atlanta, Georgia) and Dr. Brad Wilson (The Veterinary Clinic West, Marietta, Georgia). After quarantine and prophylactic *Bd* treatment, specimens were transferred to an enclosure measuring 60 x 30 x 90 cm furnished with live plants (*Calathea*, *Guzmania*, and *Peperomia*) for cover and to provide sites for egg deposition. The substrate consisted of a charcoal and soil mix overlaid with a layer of moistened sphagnum moss. A water source and site for tadpole deposition was provided in the form of a round glass dish measuring 10 cm in diameter and 5 cm in depth. A rock was placed in the dish at an angle to allow easy access for tadpole deposition and escape of feeder insects. Light was provided by a single 55 watt compact fluorescent fixture with a cycle of 12 hours on and 12 hours off. Temperatures ranged from 18–28°C. Humidity and moisture were maintained through use of an automated misting system. Food items were offered three times weekly and consisted largely of springtails (*Collembola* sp.) and flightless fruit flies (*Drosophila hydei* and *D. melanogaster*). Bean Weevils (*Callosobruchus maculatus*) and newly hatched Domestic Crickets (*Acheta domestica*) were offered occasionally. All food items were supplemented with alternate dustings of Repcal D3® and finely powdered Men's Health® vitamins.

In 2008, ABG acquired and outfitted an insulated shipping container, known as a "Frog Pod," for the housing of ARCC frogs, including specimens of *C. pratti* (Fenolio et al. 2009). Once transferred into this facility, the 1.1 founders were housed in a Zoo Med® terrarium measuring 30 x 30 x 45 cm (Fig. 2). Furnishings were provided as above with the addition of plastic plant pots measuring 6.35 x 6.35 x 6.35 cm placed in the enclosures on their sides to provide additional shelters and egg deposition sites. Lighting was provided in the same manner as described above. Humidity and moisture were regulated through the use of an automated misting system operating six times daily during a simulated wet season from November–April and two times daily during a simulated dry season from May–October. Individual misting events ranged from three to 10 minutes each with the shortest misting events taking place during the simulated dry season. Juveniles were housed under nearly identical conditions in groups of three or four per terrarium.

Breeding.—To date amplexus has not been observed in captive *C. pratti*, although it is assumed that this species has cephalic amplexus similar to other members of the genus in which this behavior has been observed and described (Savage 2002). Males have a loud, peeping call, appeared to establish small territories, and were observed to participate in chest-to-chest wrestling bouts.

Numerous breeding events have occurred at ABG, with the earliest taking place shortly after importation and clearance of the quarantine period in 2005. Few data exist of these early reproductions. Additional reproductive events have occurred since 2005 and the information provided herein is based on observations from 2007–2010.

Each egg mass contained 8–20 eggs laid in a single-layered cluster. These were deposited on top of leaves or within plastic hiding places at intervals of three to six weeks during the simulated wet season, with a reduction in egg deposition during the simulated dry season. Eggs were observed on the substrate and in the water dish on a few occasions. These were never viable. Both parent frogs have been observed in attendance of eggs together and independently (R. Hill, pers. obs.).

Hatching occurred 7–14 days post-oviposition. In instances where egg masses were left in the enclosure all larvae were transported to the water dish on the back of the female upon hatching (Fig. 1). In multiple instances, although an apparently adequate water source was continually available, larvae were carried for

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PHOTO BY DANTÉ FENOLIO



FIG. 1. Female *Colostethus pratti* with larvae.

PHOTO BY ROBERT HILL



FIG. 2. ZooMed® enclosure used to house adult *C. pratti*.

PHOTO BY ROBERT HILL



FIG. 3. Early (top) and late stage (bottom) larvae of *C. pratti*.

PHOTO BY ROBERT HILL



FIG. 4. Sera Micron® and example of slide used to feed larvae.

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an extended period of several days before deposition. Similarly, Wells (1980) observed females to carry larvae for up to nine days in *C. panamensis* (formerly *C. inguinalis*). On one occasion in late 2010, larvae were found in the axil of a *Guzmania* bromeliad instead of the water dish. After larvae were deposited, no further parental care was observed.

Handling of eggs and larvae.—Once discovered, eggs were typically removed from the adult enclosure on the surface on which they were deposited and placed in a covered plastic container with a small amount of water until hatching. In several cases, eggs were either left in the enclosure or not discovered until the female was seen carrying larvae. Once hatched, larvae were transferred to plastic containers measuring 25 cm x 15 cm x 10 cm that were filled to a depth of 7–8 cm with filtered tap water. Larvae were raised communally and showed no aggressive tendencies toward one another. No substrate was used and temperatures were maintained at 20–25°C. Live java moss (*Vesicularia* sp.) was included to provide cover to the tadpoles.

Larval diet consisted mainly of Sera Micron®, a commercially produced Spirulina-based finely powdered fish food, which was mixed with water to form a thick paste, and then spread onto microscope slides (Fig. 4). These were then allowed to completely dry before being offered to the larvae. Larvae were observed to rasp this dried paste off of the slides as well as incidental algal

PHOTO BY ROBERT HILL



FIG. 5. Rearing container for newly metamorphosed *Colostethus pratti*.

growth on the sides of the rearing containers. Success rearing *C. pratti* larvae was also achieved using New Spectrum® sinking fish pellets and Hikari® sinking algae wafers. Food was offered daily with any remaining food from the previous day removed. Water changes of 50–60% were performed twice weekly.

Handling of metamorphs and juveniles.—Newly metamorphosed *C. pratti* measured approximately 6–8 mm SVL. Time from hatching to metamorphosis ranged from 8–13 weeks (Fig. 3). All larvae from a single clutch typically metamorphosed within a few days of each other, although on one occasion the span from the first metamorphosed individual to last from a single cohort was nearly 30 days. After all four limbs developed, newly metamorphosed *C. pratti* were moved into plastic quart-size deli cups with vented lids, roughly 1 cm of filtered water, and a small mound of moistened sphagnum moss as a haul out area. If more than one was found with all four limbs from a group of tadpoles, they were placed into the above containers together. They began feeding on springtails, newly hatched crickets, and small flightless fruitflies (*D. melanogaster*) after full absorption of the tail, which took 7–10 days. Upon absorption of the tail, additional moss was added to prevent drowning. A refuge in the form of a PVC pipe 3 cm long x 1.27 cm wide was provided (Fig. 5). Individuals were raised in this manner for several weeks to ensure easy accessibility to food items and subsequently placed into groups then moved into successively larger enclosures and as they grew in size. Growth was rapid, with some young males heard calling at six months post-metamorphosis.

Conclusions.—As the World Conservation Union (IUCN), via the Amphibian Conservation Action Plan (Gascon et al. 2007) and Amphibian Ark (www.amphibianark.org) continue to call for establishment of captive survival assurance programs for amphibian species which currently cannot be safeguarded in nature, it is crucial that husbandry protocols are developed for diverse groups of species, and that this information be shared globally (Zippel and Mendelson 2008). *Colostethus pratti* is currently listed by the IUCN Red List as a species of Least Concern, though some wild populations are in decline (Solis et al. 2004). At some sites, such as in El Copé, Provincia de Coclé, Panamá, populations have shown drastic declines in association with the arrival of the amphibian chytrid fungus (Lips et al. 2006). Of the 21 species of *Colostethus* considered by the IUCN Red List, five are listed as Near Threatened, Endangered, or Critically Endangered with an additional 12 species listed as Data Deficient (IUCN Red List, 2011). The techniques and methods used in the successful husbandry and reproduction of *C. pratti* could be useful in the development of *ex situ* management programs for other members of this genus.

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HERPETOCULTURE NOTES

CROCODYLIA — CROCODILIANS

***CROCODYLUS NILOTICUS* (Nile Crocodile). INDUCED HATCHING.** The incubation period for *Crocodylus niloticus* eggs on commercial farms is normally 75–90 days, but occasionally exceeds 100 days (S. van As and R. Fergusson, pers. comm.). Six eggs (final trimester) from two clutches (2 + 4) laid by captive females in KwaZulu-Natal, South Africa were obtained for pox virus research underway at the Faculty of Veterinary Science, University of Pretoria. On the morning of 22 January 2010, the eggs were packed in a Coleman cooler box filled with vermiculite obtained from the same incubating room as the eggs. The eggs were isolated from each other and fully insulated by the vermiculite medium. The closed cooler was then flown in a turboprop aircraft from Richards Bay Airport to O.R. Tambo International Airport in South Africa. Precaution was taken when handling and transporting the cooler in order to prevent jarring or other disturbances. The six eggs were in the possession of J. Myburgh for the duration of transportation to and from the respective airports and for the 70-minute flight (total transport time = 210 minutes). The cooler was opened for inspection immediately prior to boarding, and all eggs were in the same condition and placement subsequent to packaging. During flight the cooler was kept wedged under the solid frame of a seat in the plane. Minor vibrations to the cooler associated with its position on the cabin floor were visibly evident during the flight.

Upon arrival at the virology laboratory, the cooler was opened and it was apparent that two of the eggs had hatched during transportation. Both hatchlings repeatedly issued the distress call typical of the species and were removed immediately. The cooler with the remaining four eggs was placed in an incubator (31°C) until the eggs could be processed after the weekend. However, one hatchling was discovered at 1000 h on 24 January and an additional two at 0730 h on 25 January. The remaining egg was sacrificed later on 25 January to salvage tissue for the planned virology study. The five hatchlings appeared healthy with intra-abdominal yolk sacs and had normal mass (mean = 75 g) and length (mean = 302 mm) values for hatchling *C. niloticus*. All hatchlings ate crickets within 24 h of emergence and exhibited normal behavior and development at time of publication.

The two eggs that hatched during transport were laid on 11 November 2009 and hatched after 72 days. The remainder of the clutch (42 eggs) that was not transported hatched 21 days later on 12 February 2010. Two eggs were infertile. Although date of deposition for the remaining four eggs could not be confirmed, most clutches from the same farm successfully hatched in the second half of February 2010.

We hypothesize that the early hatching of the *C. niloticus* eggs was induced either by vibrations the embryos were subjected to during transportation (especially in the aircraft), or by the change in barometric pressure experienced during the flight. Alternatively, hypoxic conditions in the cooler may have been responsible, but this is unlikely given the relative short transport time and the fact the cooler was opened at the airport. *Crocodylus niloticus* nests in the wild and captivity are known to hatch during low-pressure thunderstorm activity and in response to vibrations caused by the mother during nest excavation (R. Fergusson, pers. comm.). The three eggs that hatched in the two days following the flight, although still premature in regards to their respective clutch, may have come from a slightly younger clutch than the other two embryos and therefore were unable to hatch immediately due to developmental constraints.

Induced hatching caused by pathogenic (e.g., bacteria), chemical (e.g., pheromones) and physical (e.g., flooding and predator induced embryo vibrations) stimuli has been observed in a small number of vertebrates (for a review see Warkentin and Caldwell 2009. *In* Dukas and Ratcliffe [eds.], Cognitive Ecology II: The Evolutionary Ecology of Information Processing and Decision-Making, pp. 177–200. University of Chicago Press, Chicago, Illinois). Our observation suggests *C. niloticus* hatchling emergence may be significantly more plastic than previously thought. Such plasticity could allow clutches to hatch at optimum environmental timeframes, at the time chosen by the mother, or as a response to disturbance by would-be predators (triggering embryo vocalizations that signal the mother to come defend the nest). Future experiments with captive (i.e. farmed) clutches would contribute to understanding the commonality and mechanisms of induced hatching in crocodilians.

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SQUAMATA — SNAKES

***PHALOTRIS TRILINEATUS* (Littoral Blackhead). OPHIOPHAGY.** The usual diet of snakes in the tribe Elapomorphini consists of amphisbaenians (Lema et al. 1983. Comun. Mus. Ci. PUCRS 26:41–121). However, these snakes may also eat other elongate squamates. We have observed them to consume some harmless snakes (Lema et al., *op. cit.*), including an opistoglyph, which appeared to have been envenomated prior to consumption. In feeding trials we have conducted at the Laboratory of Herpetology of the Fundação Zoobotânica (FZBRS), and in those of Robert Baltar, a colleague at the Biosciences Institute of the Universidade Federal de Pelotas (UFPEL), *Phalotris lemniscatus* have consumed *Helicops infrataeniatus*, *Liophis semiaureus*, *L. pictostriatus*, and *L. sublineatus* (Lema et al., *op. cit.*). A young specimen of *Phalotris trilineatus*, captured by Roberto Baltar in Pelotas, Rio Grande do Sul, Brazil, was maintained in the Laboratóry of Herpetology of the FZBRS. It was offered a young *Oxyrhopus rhombifer*. The attack was immediate, with the *P. trilineatus* biting the *O. rhombifer* and holding on until the prey was immobilized. Subsequently, the *O. rhombifer* was swallowed in less than one minute. This observation confirms that *P. trilineatus* consumes other small snakes.

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Confirmed Amphibian Chytrid in Mount Mulanje Area, Malawi

The amphibian chytrid fungus, *Batrachochytrium dendrobatidis* (*Bd*) is responsible for widespread morbidity and mortality in susceptible species, leading to population declines (Berger et al. 1998; Bosch et al. 2001; Fisher et al. 2009; Lips 1999; Rachowicz et al. 2006; Skerratt et al. 2007; Stuart et al. 2004). Although *Bd* is believed to have originated in Africa (Weldon et al. 2004), relatively little work has been done on the continent to assess its occurrence and distribution. African countries where *Bd* has been identified include Botswana, Ghana, Kenya, Lesotho, South Africa, Swaziland, Tanzania and Zambia (www.Bd-maps.net, accessed 5 November 2010; Kielgast et al. 2010). More recently sources also indicate *Bd*-positive records from Cameroon, Malawi and Uganda (Goldberg et al. 2007; Sotoz-Azat et al. 2010), Democratic Republic of Congo (Greenbaum et al. 2008), Nigeria (Imasuem et al. 2009; Imasuem et al. 2011), Gabon (Bell et al. 2011), and Morocco (El Mouden et al. 2011).

Mount Mulanje (15.9352°S, 35.6202°E; Fig. 1) is situated in southern Malawi adjacent to the border with Mozambique. The mountain rises sharply and dramatically above the surrounding Phalombe Plain (about 600 m elevation) to 3000 m elevation. It is one of the largest inselbergs (isolated mountains) in the world, and the tallest peak in south-central Africa. The Mount Mulanje area has relatively high amphibian richness with an estimated 40 species (Branch and Cunningham, unpubl. data; Channing 2001; Poynton and Broadley 1985–1991; Stevens 1974).

An amphibian survey was conducted in the Mount Mulanje area during the onset of the rainy season in November 2009 and detected 24 different amphibian species. *Bd* swabs were taken of 76 adult frog specimens (Table 1). Standard field-sampling protocols and bio-security controls were followed for collecting the samples (Brem et al. 2007). Sterile cotton-tipped swabs with sleeves were used, stored at low temperatures and sent to the National Zoological Gardens (NZG) of South Africa where *Bd* DNA was isolated following the PrepMan® Ultra protocol (Applied Biosystems™, Foster City, California). The presence and quantity of the fungus was determined using a real-time PCR TaqMan standard curve assay according to Boyle et al. (2004). The StepOnePlus™ real-time PCR system from Applied Biosystems™ was used for the TaqMan assay.

We detected *Bd* in 14 of 76 (18.42%) specimens and in 8 of 24 (33%) species (Table 1). Low sample sizes likely affected *Bd* detection probability if infection prevalence was low (Skerratt et al. 2008). We observed the highest infection load in *Amietia angolensis* and *A. johnstoni* (Table 1). The presence of *Bd* in *Amietia* has been reported in Kenya (Kielgast et al. 2010), South Africa, and Lesotho (Weldon 2005), which might indicate an increased susceptibility in this genus.

This is the first report of *Bd* infecting a species of *Arthroleptis*, a direct developer. *Arthroleptis* species are associated with decaying leaf litter on forest floors, with eggs oviposited among the leaf litter; no free-swimming tadpole exists and development is completed within the egg capsule (Channing 2001; Du Preez and Carruthers 2009). *Nothophryne broadleyi* are associated with damp moss-covered seepage over rocks (Channing 2001); this is the first time that *Bd* has been recorded in this monotypic genus.

Our records confirm the occurrence of *Bd* in amphibians in Malawi, and the Mount Mulanje area in particular. Although Sotoz-Azat et al. (2010) found one Malawian *Xenopus muelleri* tadpole infected with *Bd*, they indicated it to be an incidental finding and not a true infection. *Bd* is only associated with the keratinized skin of adult amphibians and teeth of tadpoles (Longcore et al. 1999; Berger et al. 1998). Due to the fact that *Xenopus* tadpoles are filter feeders with no teeth they are unlikely to get infected.

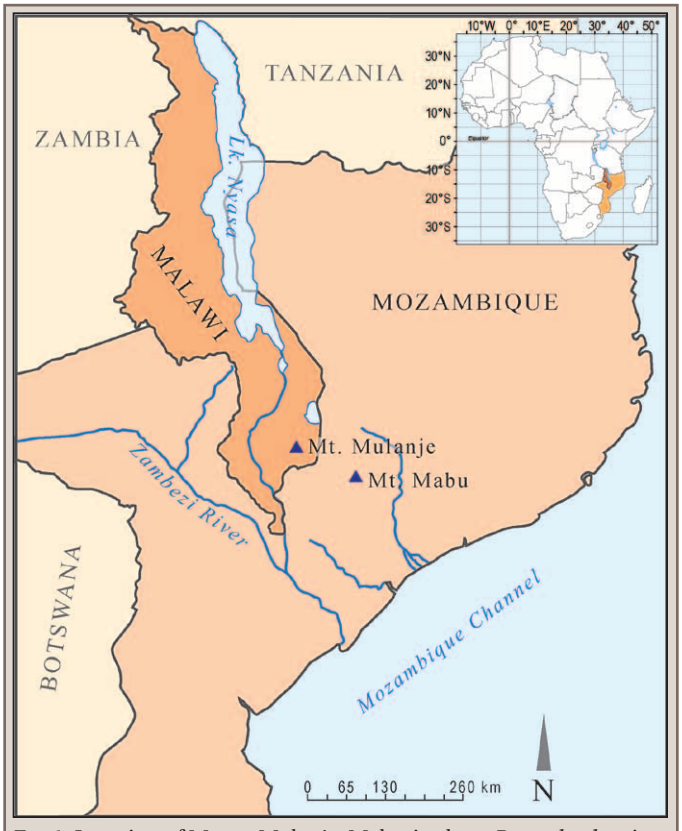


FIG. 1. Location of Mount Mulanje, Malawi, where *Batrachochytrium dendrobatidis* was detected on eight amphibian species.

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TABLE 1. *Batrachochytrium dendrobatidis* infection data for amphibians of the Mount Mulanje Area, Malawi. Altitude range is divided into Low (below 700 m above sea level), Medium (700–1000 m above sea level) and High (above 1000 m above sea level). LC = least concern, ED = endangered, DD = data deficient. Endemic = known only from Mount Mulanje, Malawi.

Species	No. specimens sampled/ No. infected	CT (mean) [a]	Zoospore equivalents (ZSE) [b]	IUCN status	Altitudinal range
Afrixalus brachycnemis	4/0	0	0	LC	Low
Afrixalus crotalus	4/1	38.8	0.1	LC	Low
Amietia angolensis	16/4	20.4–33.8	1000–10	LC	High and Low
Amietia johnstoni	7/2	27.2–37.3	80–0.9	ED/Endemic	High
Amietophrynus gutturalis	1/0	0	0	LC	Low
Amietophrynus maculatus	2/0	0	0	LC	Low
Arthroleptis sp. 1	1/0	0	0	DD/Endemic	Low
Arthroleptis sp. 2	1/0	0	0	DD/Endemic	Low
Arthroleptis francei	1/0	0	0	ED/Endemic	High
Arthroleptis stenodactylus	1/0	0	0	LC	Low
Arthroleptis xenodactyloides	3/2	36.7–39.4	1–0.1	LC	Low to medium
Chiromantis xerampelina	2/0	0	0	LC	Low
Hemisus marmoratus	2/0	0	0	LC	Low
Hyperolius tuberilinguis	3/0	0	0	LC	Low
Kassina senegalensis	2/0	0	0	LC	Low
Leptopelis broadleyi	4/0	0	0	LC	Low
Leptopelis flavomaculatus	1/0	0	0	LC	Low
Leptopelis mossambicus	2/0	0	0	LC	Low
Nothophryne broadleyi	4/1	39	0.1	ED/Endemic	High
Phrynobatrachus natalensis	4/2	31.6–40.0	12–0.1	LC	Low
Ptychadena anchietae	3/0	0	0	LC	Low
Strongylopus fuelleborni	2/1	39.0	0.1	LC	High
Xenopus laevis	2/0	0	0	LC	Low
Xenopus muelleri	4/1	39.5	0.1	LC	Low
Total:	76/14				

[a] The Ct (cycle threshold) is defined as the number of cycles required for the fluorescent signal to cross the threshold. Ct levels are inversely proportional to the amount of target nucleic acid in the sample. Samples with a Ct value of more than 40 cycles and a quantity of less than 0.1 were considered negative (indicated as 0 in the table).

[b] A standard curve was constructed from the control reactions containing 100, 10, 1 and 0.1 *B. dendrobatidis* zoospores and the concentration determined for the test samples expressed as the number of Zoospore equivalents (ZSE).

Rödder et al. (2009) predicted that species with aquatic life stages occupying small geographic ranges at high altitudes were most susceptible to *Bd*-related declines; this includes the higher altitudes of East and Central Africa (see Rödder et al. 2009, figure 2A). However, in adjacent Mozambique, preliminary screening of amphibians from Mount Mabu (N = 11) provided no evidence for *Bd*-infected amphibians (Conradie, unpubl. data), although a low sample size may have precluded detection (Skerratt et al. 2008). Mount Mulanje is under pressure due to increasing socio-economic development and population growth, leading to large areas of lowland and riverine forest being cleared in the region. The illegal harvesting of endemic cedar trees, presence of invasive alien pine trees, introduction of alien fish, and uncontrolled fires are additional threat factors that may increase stress on Mount Mulanje amphibian populations, especially compared to Mount Mabu where the habitats remain fairly pristine. This may indirectly lead to an increase in *Bd* prevalence or increased susceptibility to the pathogen in the Mount Mulanje area if there are interactions among multiple stressors and *Bd*-infection rates.

Species of particular conservation concern in the Mount Mulanje area include *A. johnstoni* and *N. broadleyi* which are currently listed as Endangered according to IUCN standards. Both species are under increasing pressure due to habitat destruction, uncontrolled fires and climate change (Lovemore and Poynton 2004a, 2004b). They also have localized distributions, which make them more vulnerable to decline or extinction (Bielby et al. 2008; Cooper et al. 2008; Sodhi et al. 2008). Although originally only known to occur at high altitudes of Mount Mulanje, *N. broadleyi* subsequently has been reported to be present on isolated mountains in Mozambique: Ribaue Mountain and Mount Namuli (Poynton 1966; Timberlake et al. 2009). Additional surveys are warranted to monitor the occurrence of *Bd* on these and other endemic populations on Mount Mulanje. Such surveys can inform land and natural resource managers whether intervention may be needed to preserve the integrity of these unique amphibian communities. *Bd* is considered to be a significant factor in the decline and extinction in the wild of at least one amphibian species in Africa, the Kihansi Spray Toad, *Nectophrynoides asperginis* (Krajik 2006).

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Rapid Assessment of the Presence of *Batrachochytrium dendrobatidis* in Bolivian Andean Frogs

The widespread chytrid fungus, *Batrachochytrium dendrobatidis* (*Bd*), causes a severe cutaneous infection to many species of amphibians worldwide, in some cases resulting in population declines or extinctions (Berger et al. 1998; Crawford et al. 2010; Lips et al. 2006; Mendelson et al. 2006). This fungus has been found in amphibians from five continents (Ron 2005; Une et al. 2008; www.Bd-maps.net), but has shown a broader geographic and taxonomic incidence in the Americas. Within South America, *Bd* has been reported from all countries except Paraguay and the Guianan region. In tropical America, the decline of many species in endemic genera and families, such as the genus *Atelopus* in the Bufonidae (La Marca et al. 2005), suggest a phylogenetically linked sensitivity to *Bd*. This may explain why the effects of chytridiomycosis in the Neotropics appear to be remarkably higher in relation to other continents (Corey and Waite 2008).

Given that *Bd* grows better in cool temperatures (17–23°C) (Piotrowski et al. 2004; Retallick et al. 2004), montane amphibian species are likely to be affected in tropical and sub-tropical areas. In the Andes, *Bd* has been found along the entire cordillera, with well-reported cases in Venezuela (Lampo et al. 2008) and Ecuador (Ron and Merino-Viteri 2000), and reports from more limited studies carried out in the Peruvian Andes (Catenazzi et al. 2011; Seimon et al. 2005, 2007; von May et al. 2008), Colombia (Ruiz and Rueda-Almonacid 2008; Velásquez et al. 2008), Argentina (Barrionuevo and Mangione 2006; Ghirardi et al. 2009) and Chile (Solís et al. 2009). The situation in Bolivia is less known; albeit the disease was assumed to be present because of the sudden declines observed in several species (Aguayo 2009; Cortez 2009; De la Riva 2005), it was not until recently that the first case of infection by *Bd* was documented (Barrionuevo et al. 2008). However, besides this particular case, the range of the disease and its taxonomic reach in Bolivia have been unknown. Our aim is to provide new qualitative information on the presence of *Bd* in Bolivia, and discuss patterns of amphibian declines in the area.

During February and March 2009, a rapid survey in the northern and central parts of the Bolivian Andes was done to get a better idea of the taxonomic and geographic occurrences of *Bd* (Fig. 1). Neither the total sample nor samples per species allowed for statistical analyses.

Geographic coverage for our study extended from the Chilean-Bolivian border in the Altiplano to the Cordillera Oriental in the Department of Chuquisaca, with a distance of nearly 500 km between the two most distant localities (1 and 4; see Fig. 1, Table 1) and an altitudinal range of 2650–4060 m. Four main types of habitats were surveyed (Table 2). Specimens, either adult or tadpoles, were collected by hand. Swabs were obtained by stroking the ventral pelvic patch and thighs of adults or the mouthparts of tadpoles using rayon swabs (Medical Wire 142). Selected voucher specimens were fixed in 70% ethanol and deposited in the herpetological collection of the Museo Nacional de Ciencias Naturales (MNCN, Madrid, Spain). Data on localities were recorded using a Global Positioning System (Table 1). Swabs were stored in their individual airtight plastic swab containers at ambient temperature in the high Andes (~ 15°C) during field work (30 days) and then at -20°C in the laboratory until processed for *Bd*. DNA extraction from swab samples was done using 50 µl of PrepMan Ultra (Hyatt et al. 2007). Detection and quantification of the level of infection by *Bd* on frog epidermal tissue was done with the Taqman qPCR method in an Applied Biosystems 7500 Real-Time PCR system according to Boyle et al. (2004). Infection intensity was calculated as the number of *Bd* zoospore genomic equivalents in each swab sample.

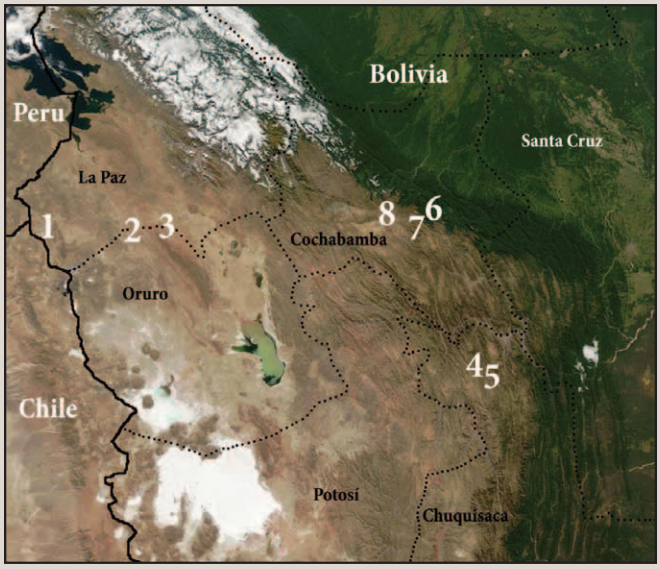


FIG. 1. Satellite map of the central Bolivian Andes showing the localities sampled for *Batrachochytrium dendrobatidis*, as numbered in Table 1. The dark blotch in the northwest is Lake Titicaca, on the Bolivian–Peruvian border; the white blotches in the south are the huge salt flats of Coipasa and Uyuni; near the center of the image is Lake Poopó.

We sampled 33 frogs of eight species and five families from eight different localities (Table 1). All individuals examined were apparently healthy, and no sick, dying, or dead individuals were found. Only one species, *Pleurodema cinereum*, was sampled in more than one locality (four locations). Overall, 18 of 33 (54.5%) individuals were infected with *Bd*, 6 of 8 species studied were *Bd*-positive, the infection was detected in all 4 habitat types sampled, and *Bd* was found at 7 of 8 localities surveyed (Tables 1 and 2). The level of infection among positive individuals was low, with *Bd* zoospore genomic equivalents ranging from 1–216 (mean = 16; SE = 11.1).

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We found a broad distribution of *Bd* in the Bolivian Andes, covering all kinds of habitats from cloud forests to high puna. An overall prevalence greater than 50% and the low zoospore load in all populations convey that *Bd* is widespread and might be enzootic in this area, and that the amphibians sampled persist with low-level infections. Amphibians sampled in moister habitats, such as cloud forest and humid paramo, appeared to have higher prevalence of *Bd* than those from drier environments (puna and dry valleys), independent of altitude, (Table 2), although sample sizes were low preventing statistical comparisons. This suggests that in the high elevation Andes of Bolivia, humidity may favor maintenance of high zoospore reservoirs in the environment.

Different indirect data from the genus *Telmatobius,* which, like *Atelopus,* is endemic to the Americas and has declined drastically in the past 30 years, indicate that these frogs may be particularly vulnerable to chytridiomycosis (De la Riva and Lavilla 2008). The sudden decline of *T. espadai* and other species (De la Riva 2005) in the early 1990s in central Bolivia (Department of Cochabamba) lead us to believe that *Bd* might already have been there at that time. The presence of abundant *T. sanborni* near the Peruvian border in 2001 implies that *Bd* did not enter Bolivia following a north-south epidemic wave (sensu Lips et al. 2008), but rather the pathogen appeared independently in the central part of the country at a time when healthy *Telmatobius* populations were still thriving a few hundred kilometers to the northwest. Catastrophic *Telmatobius* declines started first in Ecuador (1980s), then in Bolivia (1990s) and later in Peru (2000s). Likewise, several *Telmatobius* species from northern Argentina had crashed by 2001 and surely their decline comes back to the early 1990s (Barrionuevo and Ponssa 2008). If the endemic pathogen hypothesis (Pounds et al. 2006) is not invoked, and we infer that these declines are a response to a *Bd* epidemic, then mechanisms to explain the uneven dispersal of *Bd* must be explored. Incubation and transport of viable *Bd* zoospores in bird feathers has been demonstrated *in vitro* (Johnson and Speare 2005). Thus, migratory birds might represent a means of dispersal and implicates potential multiple introductions across mountains and valleys in the high elevation Andes; this potential transmission vector should be further investigated in the wild.

In this paper we report the presence of *Bd* in several species across a large geographical area without apparent symptoms of disease. These results, as well as the evident disappearance or decline of many species in the area, particularly in the genus *Telmatobius*, suggest that the amphibian fauna of Bolivia may have already suffered a wave of chytridiomycosis whereby some species went extinct locally, others suffered bottlenecks from which they are probably recovering, and still others were infected but managed to endure. From a conservation standpoint, this potential scenario is worrisome because amphibians that persist with *Bd* may show decreased survival, and could be at risk from synergistic effects of this pathogen with other environmental stressors (Longo et al. 2009; Longo and Burrowes 2010). Furthermore, infected species can serve as both *Bd* reservoirs and vectors of *Bd* to nearby areas where amphibians may still be naïve to the fungus, and hence may contribute to subsequent losses. More fieldwork and *Bd* testing are needed to have a better understanding of the effects of *Bd* infection on Bolivian amphibians. Our study serves as a baseline for further *Bd*-related studies while identifying species and locations that might be currently at risk and should be prioritized when considering conservation and management programs in the Andes.

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TABLE 1. Prevalence of *Batrachochytrium dendrobatidis* (*Bd*) among species sampled in eight localities in the Andes of Bolivia. Map number corresponds to localities in Fig. 1. Adults were sampled unless life stage is indicated. % *Bd* prevalence = (no. infected individuals/total sampled) x 100 per species per locality. *Bd* zoospore load = zoospore genomic equivalents.

Map No.	Location	Coordinates	Elevation (m)	Species sampled (No. sampled) Life stage (proportion infected)	% *Bd* prevalence	*Bd* zoospore load range
1	Rio Casapilla, detour to Khauniri, Prov. Pacajes, Dept. La Paz	17.7096°S 69.3496°W	4060	*Pleurodema cinereum* (5) - adults (none sampled) - tadpoles (1/5)	20	0–5
2	Between Curahuara of Carangas and Totora, Prov. Carangas, Dept. Oruro	15.8209°S 68.3751°W	3924	*Pleurodema cinereum* (1) - adults (none sampled) - subadults (1/1)	100	1
3	Stream between Totora and Huayllamarca, Prov. Carangas, Dept. Oruro	17.8129°S 68.0501°W	4062	*Telmatobius gigas* (9) -adults (2/4) -tadpoles (3/5)	56	 0–216 2–11
4	Between Tarabuco and Icla, Prov. Yamparaez, Dept. Chuquisaca	19.2045°S 64.8550°W	3115	*Hypsiboas riojanus* (1) *Rhinella spinulosa* (1)	0 0	— —
5	Tarabuco, Prov. Yamparaez, Dept. Chuquisaca	19.1762°S 64.9175°W	3310	*Pleurodema cinereum* (5) - adults (none sampled) - tadpoles (3/5)	60	 0–4
6	Sehuencas, Prov. Carrasco, Dept. Cochabamba	17.5444°S 65.2683°W	2650	*Pristimantis platydactylus* (3) *Yunganastes pluvicanorus* (1) *Rhinella quechua* (3) - adults (none sampled) - tadpoles (2/3)	67 100 67	0–1 3 3–17
7	500 m E of Jatun Pino, Prov. Carrasco, Dept. Cochabamba	17.5682°S 65.2939°W	3330	*Psychrophrynella adenopleura* (3)	67	0–3
8	Tiraque, Prov. Tiraque, Dept. Cochabamba	17.4277°S 65.7185°W	3361	*Pleurodema cinereum* (1)	100	3

TABLE 2. Variation in prevalence of *Batrachochytrium dendrobatidis* (*Bd*) infection among amphibian hosts according to habitat type and rainfall. Climate data are from Ibisch et al. (2003) and Molina (2005). Map numbers correspond to locations in Fig. 1.

Map no.	Habitat	Annual rainfall (mm)	No. frogs sampled	*Bd* prevalence (%)
1, 2, 3	Puna	250–400	15	0.46
4, 5, 8	Dry valley	500–700	8	0.50
7	Humid paramo	<3000	3	0.67
6	Cloud forest	1500–2200	7	0.71

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Additional Reports of the Amphibian Chytrid Fungus *Batrachochytrium dendrobatidis* from Georgia, USA

Batrachochytrium dendrobatidis (*Bd*), which causes the fungal disease chytridiomycosis, has been regarded as a contributing factor to worldwide amphibian declines (Daszak et al. 1999; Skerratt et al. 2007). *Bd* appears to be widespread within the southeastern United States, though relatively few surveys have been conducted to determine its prevalence within the region (Green and Dodd 2007; Hossack et al. 2010; Rothermel et al. 2008; Timpe et al. 2008). Our study further documents the occurrence and distribution of *Bd* in Georgia's amphibian populations with a focus on caudates. Georgia is home to a large and diverse assemblage of amphibian taxa, in particular salamanders (Jensen et al. 2008). We conducted surveys in four of five physiographic provinces in Georgia to document areas of occurrence. Subsequently, these areas can be more closely monitored over time, for example to determine *Bd*'s prevalence and any potential negative impacts as have been observed in other amphibian assemblages globally (Lips et al. 2006). This inventory-then-monitoring approach is especially important in regions of high amphibian diversity and endemism, such as Georgia.

We conducted surveys primarily in the Blue Ridge, Cumberland Plateau, and Piedmont physiographic provinces of Georgia from 5 March–12 September 2009. A small number of Striped Newts (*Notophthalmus perstriatus*) were opportunistically sampled during an unrelated survey in the Coastal Plain province (Table 1). Surveys took place on federal, state, county, and private land. Proper permissions from all stakeholders were acquired. While the main study focus was stream-dwelling and terrestrial caudates, anurans were also sampled when encountered. Only metamorphosed amphibians were sampled in this study. Three methods of detection were used: visual encounter, turning of cover objects (e.g., logs and rocks), and dip netting. A GPS coordinate was collected for each survey location (Garmin™ Oregon™ 400t; WGS 84). Once collected, each specimen was placed into an individual plastic container for a maximum period of 24 hours for on-site processing and was ultimately released at the point of capture. Powder-free vinyl or latex gloves were worn during all field collections with new gloves worn at each survey site. To prevent the spread of *Bd* or any other potential pathogens, a 10% bleach solution was used to disinfect all equipment (nets, boots, etc.) between survey sites.

Once each survey was completed, we swabbed specimens using polyester tipped plastic applicators (Fisherbrand®; Medical Wire & Equipment Company, Ltd.) following the method of Brem et al. (2007). A new set of gloves was used while swabbing each individual specimen. Each swab was placed into an individually numbered 1.8 ml plastic cryogenic vial for storage. Samples were refrigerated until shipment to the diagnostic lab at the College of Veterinary Medicine at North Carolina State University, Raleigh. Each sample was processed using *Bd*-specific real-time Taqman (Applied Biosystems, Foster City, CA) Polymerase Chain Reaction (PCR) according to the method of Boyle et al. (2004). Appropriate negative and positive controls were run concurrently with survey samples and the limit of detection was less than/equal to 0.5 zoospore equivalents.

From 5 March to 12 September 2009, we collected 300 samples from 21 caudate and nine anuran taxa in 11 Georgia counties (Table 1). Of these, *Bd* was detected in 11 samples from seven different taxa: Spotted Dusky Salamander (*Desmognathus conanti*), Seal Salamander (*D. monticola*), Southern Two-lined Salamander (*Eurycea cirrigera*), Red Salamander (*Pseudotriton ruber*), Eastern Newt (*Notophthalmus viridescens*), Green Frog (*Lithobates clamitans*), and Southern Leopard Frog (*L. sphenocephala*). With the exception of *E. cirrigera* (two positive results) and *N. viridescens* (four positive results), each of the remaining five taxa had one *Bd*-positive result (Table 2). None of the individuals that tested positive for *Bd* showed any obvious symptoms of chytridiomycosis (ventral redness, excessive skin sloughing, or diminished righting ability); they all appeared to be in overall good health at the time of collection.

Similar to past field studies examining *Bd* in southeastern United States amphibian populations (Green and Dodd 2007; Hossack et al. 2010; Rothermel et al. 2008; Timpe et al. 2008), overall detection of *Bd* in this study was low (< 4% of all samples). Eleven amphibians belonging to seven different taxa, including five caudate and two anuran species tested positive for *Bd* through PCR assay. The pathogen has been reported from all of these taxa in previous studies (Bakkegard and Pessier 2010; Byrne et al. 2008; Montanucci 2009; Rothermel et al. 2008; Timpe et al. 2008). It should be stated that sample size was small for many species (22 species with < 10 samples) such that our results may not accurately reflect the overall prevalence of *Bd* within the sampled populations (e.g., Skerratt et al. 2008).

Our detection of *Bd* on Eastern Newts (*N. viridescens*), Green Frogs (*L. clamitans*), and Southern Leopard Frogs (*L. sphenocephalus*) was not surprising because these species have produced numerous positive results within the southeastern United States, including Georgia (e.g., Bakkegard and Pessier 2010; Rothermel et al. 2008). Although our detections of *Bd* on a Seal Salamander (*D. monticola*), Southern Two-lined Salamanders (*E. cirrigera*), and a Red Salamander (*P. ruber*) are not the first for these three plethodontids (Byrne et al. 2009; Hossack et al. 2010; Montanucci 2009) our findings represent the first-reported occurrences in these species from the state of Georgia.

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TABLE 1. Amphibian species surveyed for *Batrachochytrium dendrobatidis* (*Bd*) in Georgia, USA. Bold indicates *Bd* detection.

Species	No. *Bd*-positive Specimens/ Total Sampled	County
Acris crepitans	0/3	Dekalb, Gwinnett, Walker
Aneides aeneus	0/3	Rabun
Bufo [*Anaxyrus*] *americanus*	0/3	Rabun
Bufo [*Anaxyrus*] *fowleri*	0/17	Dekalb, Gwinnett
Desmognathus aeneus	0/2	Union
Desmognathus conanti	**1**/33	Banks, Bartow, Dekalb, Gwinnett, **Walker**
Desmognathus monticola	**1**/42	**Banks**, Bartow, Lumpkin, Rabun, Union, Walker
Desmognathus ocoee	0/21	Rabun, Union
Desmognathus quadramaculatus	0/6	Rabun, Union
Eurycea cirrigera	**2**/12	**Bartow**, Dekalb , Walker
Eurycea guttolineata	0/5	Banks, Dekalb, Rabun
Eurycea longicauda	0/5	Walker
Eurycea lucifuga	0/2	Walker
Eurycea wilderae	0/8	Banks, Rabun, Union
Gyrinophilus porphyriticus	0/1	Rabun
Hyla chrysoscelis	0/1	Rabun
Notophthalmus perstriatus	0/8	Taylor
Notophthalmus viridescens	**4**/18	**Rabun**
Plethodon chattahoochee	0/58	Rabun, Union
Plethodon chlorobryonis	0/1	Banks
Plethodon glutinosis	0/9	Bartow, Gwinnett, Walker
Plethodon metcalfi	0/12	Rabun
Plethodon petraeus	0/5	Walker
Plethodon teyahalee	0/4	Rabun
Pseudacris crucifer	0/1	Gwinnett
Pseudotriton ruber	**1**/2	Rabun, **Union**
Lithobates catesbeianus	0/6	Fannin, Fulton
Lithobates clamitans	**1**/4	Dekalb, Walker, **Union**
Lithobates palustris	0/1	Walker
Lithobates sphenocephalus	**1**/4	Gwinnett, **Walker**

TABLE 2. Amphibians detected with *Batrachochytrium dendrobatidis* during our 2009 surveys in Georgia, USA.

Species	Age	Date	County	Location	Elevation (m)
Desmognathus monticola	Adult	2 April	Banks	34.40281°N, 083.58802°W	285.6
Desmognathus conanti	Adult	17 April	Walker	34.71059°N, 085.37840°W	296.9
Lithobates sphenocephalus	Juvenile	18 April	Walker	34.70395°N, 085.34389°W	274.9
Notophthalmus viridescens (4)	Adult	29 April	Rabun	34.97134°N, 083.43677°W	689.5
Eurycea cirrigera	Juvenile	29 August	Bartow	34.25626°N, 084.68904°W	256.9
Eurycea cirrigera	Juvenile	29 August	Bartow	34.25471°N, 084.68898°W	310.9
Pseudotriton ruber	Juvenile	10 September	Union	34.75878°N, 084.82399°W	709.6
Lithobates clamitans	Juvenile	10 September	Union	34.75878°N, 084.82399°W	709.6

The repeated detection of *Bd* on Spotted Dusky Salamanders (*D. conanti*) and Southern Leopard Frogs (*L. sphenocephalus*) at Crockford-Pigeon Mountain Wildlife Management Area in Walker County confirms the findings of Timpe et al. (2008). Long-term monitoring at this site warrants consideration because this is an exceptionally amphibian-rich area in Georgia (Jensen et al. 2008). This area is home to protected species such as the Green Salamander (*Aneides aeneus*), Tennessee Cave Salamander (*Gyrinophilus palleucus*), and endemic Pigeon Mountain Salamander (*Plethodon petraeus*). Only five individuals of *P. petraeus* were sampled during this study (Table 1), and although *Bd* was not detected on these individuals, a larger sample size would be required to properly determine prevalence in this species. Additional sampling effort is warranted for *P. petraeus* and other species with restricted ranges because studies have shown that terrestrial plethodontids may be detrimentally affected by chytridiomycosis in the wild (*Plethodon neomexicanus*, Cummer et al. 2005; three bolitoglossine species, Lips et al. 2006; *Batrachoseps attenuatus*, Weinstein 2009). Through experimental *Bd* inoculation, Vazquez et al. (2009) and Chinnadurai et al. (2009) found high susceptibility and mortality associated with chytridiomycosis in two species of terrestrial plethodontids (*Plethodon metcalfi* and *P. glutinosis*, respectively) but found two species of semi-aquatic plethodontids (*D. monticola* and *D. orestes*, respectively) showed few signs of illness and exhibited no mortality. The results of these experiments demonstrate that the overall effect of *Bd* on plethodontid salamanders is unclear and requires further focused study on populations in which it has been detected.

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Occurrence of *Batrachochytrium dendrobatidis* in Amphibian Populations of Okomu National Park, Nigeria

Amphibian declines are frequently due to a complex array of causative agents, many of which are poorly understood (Kiesecker et al. 2001; Garner et al. 2006). Although habitat destruction is the primary driver of biodiversity loss, infectious diseases have been identified as an important cause of some of the observed amphibian declines and mass mortalities (Skerratt et al. 2007). In particular chytridiomycosis caused by the amphibian chytrid fungus, *Batrachochytrium dendrobatidis* (*Bd*), has been associated with amphibian mass mortality events throughout the world (Berger et. al. 1998; Bosch et. al 2001; Lips 1998).

A number of surveys have established the occurrence of chytridiomycosis on the African continent, including South Africa (Hopkins and Channing 2003; Lane et al. 2003), Lesotho and Swaziland (Weldon 2005), Kenya (Kielgast et al. 2009), Tanzania (Moyer and Weldon 2006, Weldon and du Preez 2004), Uganda (Goldberg et al. 2007), Democratic Republic of Congo (Greenbaum et al. 2008), Ghana (Morgan et al. 2007), Gabon (Bell et al. 2011; Da Versa et al. 2011; Gratwicke et al. 2011) and Morocco (El Mouden et al. 2011). All of these records with the exception of those from Ghana are from wild caught animals. Some of the countries that represent the distribution gaps in sub-Saharan Africa (e.g., Guinea, Ivory Coast, Central African Republic) and Madagascar have been surveyed to some extent, but no evidence of *Bd* was found (Weldon 2005; Weldon et al. 2008). Furthermore, with the exception of Madagascar, small sample sizes restrict the reliability of the data from these surveys (e.g., Skerratt et al. 2008). Despite its prominence in Africa, chytridiomycosis has been associated with the extinction in the wild of only one species, the Kihansi Spray Toad from Tanzania (Weldon and du Preez 2004; Krajick 2006), although habitat alteration also was implicated in that species' decline (Krajick 2006). Contrary to the catastrophic host response in this east African case study, epidemiological evidence from histopathological studies indicates an endemic infection in southern Africa (Weldon et al. 2004).

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Due to disparities in host response to chytridiomycosis in sub-Saharan Africa, a high degree of uncertainty exists with regards to how species from currently unsurveyed regions will respond to infection. Here we report on a *Bd* survey that was conducted in Okomu National Park, Nigeria between April 2007 and July 2008. Our objectives were to assess *Bd* occurrence in all amphibian species captured during a broad census of Okomu National Park. We also investigated whether any prevalence differences existed among amphibian families, sexes, and seasons. We hypothesized that males would have higher prevalence than females in aquatic-breeding species, because they are resident in water bodies for longer time periods in their search for mates. We expected higher prevalence to occur in the wet season rather than the dry season due to *Bd* being an aquatic-dependent fungus. We also expected similar prevalence among members of the same family due to their ecological similarities which predispose them to comparative *Bd* exposure.

Okomu National Park is situated within the largest block of what is now left of Guinea-Congo lowland rainforest in southwestern Nigeria and is characterized by a variety of habitats from swamp-forest to open scrub, making it ideal for amphibian diversity. It is situated between North latitudes 6°15′ and 6°25′, and East longitudes 5°9′ and 5°23′ (Fig. 1).

Frogs were captured monthly from April 2007 to July 2008 for a total of five dry season months and 10 rainy season months. Samples were collected by swabbing sterile cotton swabs five times over the ventral surface of the feet, thighs and body. Swab tips were stored in 2-ml screw-cap vials containing 1 ml of 70% ethanol. The samples were tested with TaqMan real time Polymerase Chain Reaction for the presence of amphibian chytrid fungus (Boyle et al. 2004). Unpaired t-test assuming equal variance was used to determine significant difference in overall prevalence of *Bd* between the two treatments wet and dry seasons and overall prevalence between the male and female treatment groups. Thus *Bd* is the response variable, and the combined species the experimental units. Chi-square test was used to test for significant difference in chytrid infection for each species (experimental units) between the wet and dry seasons and for each species between males and females.

A total of 732 frogs representing 10 families were sampled over the 15 month period. Of these, 7 families, 8 genera and 21 species were infected with *Bd* (Table 1). Members of the families Bufonidae, Dicroglossidae and Hemisotidae tested negative for *Bd*. An overall prevalence of 43.6% was recorded for infected species at Okomu National Park. The majority of frogs were collected during the wet season, which had an infection prevalence of 44%. Exceptionally high prevalence was detected for members of the Hyperoliidae (*Afrixalus nigeriensis*, up to 83%; *Silurana tropicalis*, 69%; and *Chiromantis rufescens*, 62%). Overall infection during the dry season was significantly lower at 33% ($p < 0.05$).

For the majority of species, more males than females were infected with *Bd* (Table 1). These differences between infected sexes were very particularly pronounced for *Afrixalus dorsalis* (100% males vs. 26.1% females infected, $p < 0.001$), *Hyperolius*

sylvaticus (86.6% males vs. 14.2% females infected, $p < 0.001$) and *Hyperolius* sp. 1 (40% males vs. 14.2% females infected, $p < 0.001$). Unpaired t-test confirmed that overall males were significantly more infected than females ($p < 0.001$). Generally, no clinical signs of chytridiomycosis could be observed except in *Chiromantis rufescens*, which exhibited excessive skin sloughing in 20% of animals. Microscopic examination of skin sloughs confirmed the presence of *Bd* thalli.

Although restricted to a small geographic area, our survey at Okomu National Park included a large enough sample size to make meaningful deductions. We confirm the presence of *Bd* in Nigeria, supporting an initial anecdotal report of infected *Chiromantis rufescens* (Imasuen et al. 2009). The level of infection that we detected in southwest Nigeria is among the highest that has been recorded anywhere in Africa. High infection levels in hyperolid frogs are consistent with previous findings in Tanzania (Moyer and Weldon 2006) and Kenya (Kielgast et al. 2009). However, large variation in *Bd* prevalence among members of the Hyperoliidae suggest that susceptibility to infection in this family is not only due to taxonomic relatedness, but that host-specific factors, such as behavior or reproductive mode, may be involved (e.g., Lips et al. 2003; Rowley and Alford 2007).

Two distinct patterns emerged from this study: heightened susceptibility to infection in the wet season and higher susceptibility to infection in males. In contrast to a peak in infection levels during the wet season, it has been shown that a cool climate (average summer maximum < 30°C) is the most significant factor for the presence of *Bd* in Australia, as opposed to rainfall or altitude (Drew et al. 2006). However, Collins et al. (2003) demonstrated that synchronization of optimal temperature and hydric cycles influence *Bd* growth. Clearly no single model exists to predict *Bd* seasonal infection patterns in populations from different geographical regions. Gender has been identified as a



FIG. 1. Location of *Batrachochytrium dendrobatidis* sampling at Okomu National Park, Nigeria.

TABLE 1. Seasonal and gender infection levels of *Batrachochytrium dendrobatidis* (*Bd*) at Okomu National Park, Nigeria.

Family and Species	No. frogs collected (% *Bd* infected)			
	Wet Season	Dry Season	Males	Females
ARTHROLEPTIDAE				
Leptopelis hyloides	17 (47.0)	13 (00.0)	21 (33.3)	9 (11.1)
Leptopelis spiritusnoctis	10 (20.0)	7 (00.0)	10 (10.0)	7 (14.3)
HYPEROLIIDAE				
Hyperolius concolor	4 (50.0)	—	3 (33.3)	1 (00.0)
Hyperolius fusciventris burtoni	9 (33.3)	6 (16.6)	9 (44.4)	6 (00.0)
Hyperolius picturatus	9 (22.2)	12 (33.3)	14 (42.8)	7 (00.0)
Hyperolius sylvaticus	18 (66.2)	4 (50.0)	15 (86.6)	7 (14.2)
Hyperolius sp. 1	10 (10.0)	7 (57.1)	10 (40.0)	7 (14.2)
Hyperolius sp. 2	5 (40.0)	4 (00.0)	6 (33.3)	3 (00.0)
Hyperolius sp. 3	3 (00.0)	2 (50.0)	4 (25.0)	1 (00.0)
Hyperolius sp. 4	5 (40.0)	—	3 (66.2)	2 (00.0)
Afrixalus dorsalis	82 (75.6)	26 (46.1)	62 (100)	46 (26.1)
Afrixalus nigeriensis	42 (83.3)	—	35 (94.3)	7 (28.5)
Afrixalus paradorsalis	6 (66.6)	—	5 (80.0)	1 (0.00)
PHRYNOBATRACHIDAE				
Phrynobatrachus calcaratus	22 (54.5)	3 (00.0)	18 (38.9)	7 (71.4)
Phrynobatrachus liberiensis	9 (44.4)	16 (50.0)	20 (40.0)	5 (0.00)
Phrynobatrachus plicatus	22 (27.2)	11 (00.0)	21 (19.0)	12 (16.6)
PIPIDAE				
Silurana tropicalis	100 (65.0)	42 (54.7)	78 (78.2)	64 (57.8)
PTYCHADENIDAE				
Ptychadena longirostris	27 (3.7)	—	23 (4.3)	4 (00.0)
Ptychadena pumilio	5 (00.0)	30 (20.0)	17 (11.7)	18 (16.6)
RANIDAE				
Amnirana albolabris	6 (33.3)	5 (20.0)	7 (42.6)	4 (50.0)
RHACOPHORIDAE				
Chiromantis rufescens	60 (61.7)	4 (75.0)	38 (68.4)	26 (53.8)

factor that influences disease expression in humans and animals due to differences in behavior and physiology (Mohamed-Ali et al. 1999; Liesenfeld et al. 2001). In frogs, such behavioral differences are pronounced in species that make use of a prolonged breeding strategy where reproductive activity may range from a few weeks to several months. Since female arrival at breeding sites occur at variable intervals, males invest their energy in the establishment and defense of stationary call sites, resulting in large aggregations of calling males (Wells 1977). Choruses are characterized by a high turnover of individual males, because vocalization is energetically expensive and males regularly need to replenish energy reserves (Passmore and Carruthers 1995). It is therefore plausible that general differences in gender infection levels could be as a result of males congregating for longer at *Bd*-infected sites. Our understanding of the disease dynamics of chytridiomycosis in Africa remains limited.

The lack of comprehensive distribution data for *Bd* on this continent, together with the unpredictability of how amphibian species from different climatic regions react to *Bd*, as well as quantitative data on how disease transmission is shared among sexes of a species, warrants the need for comprehensive field surveillance.

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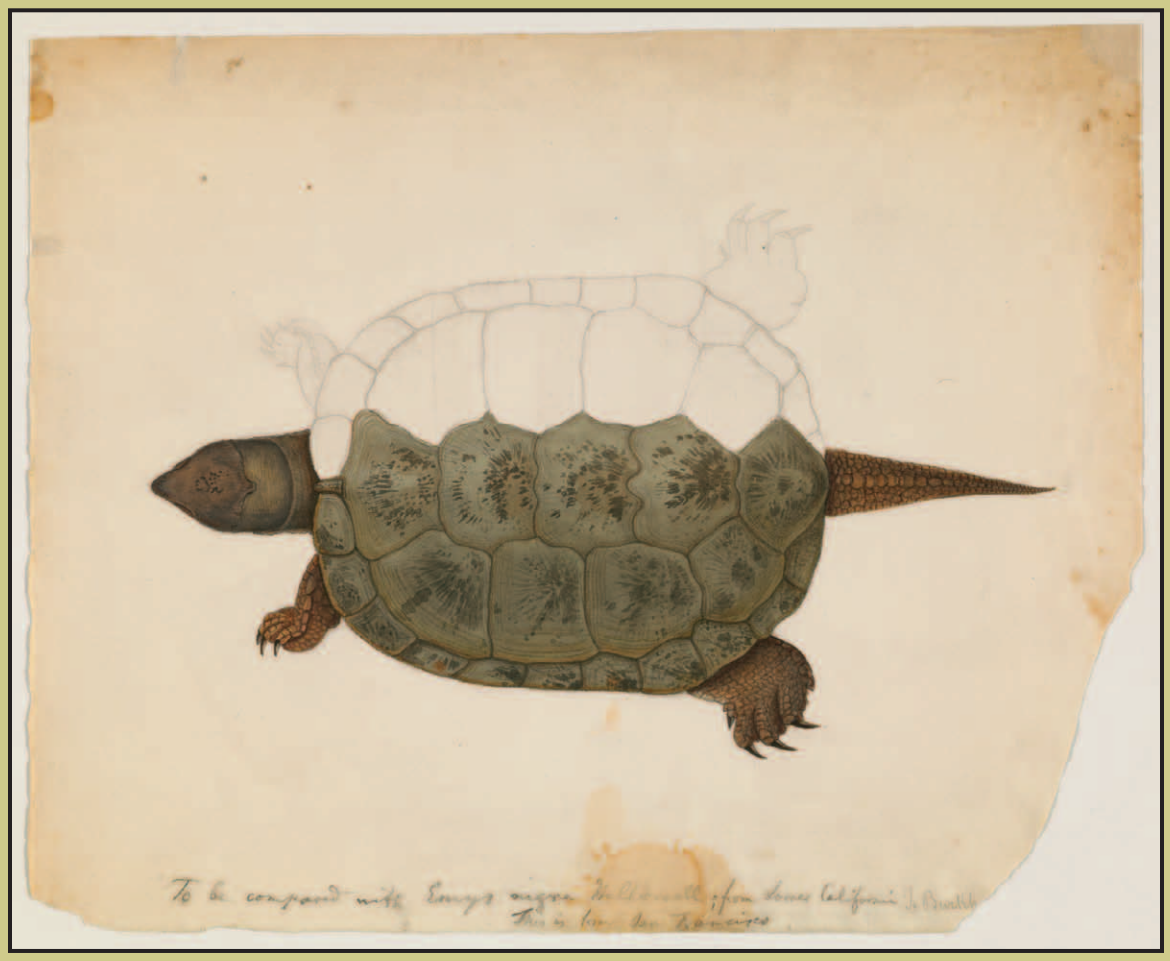
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ART IN HERPETOLOGY



The unpublished watercolor drawing of a Western Pond Turtle (*Actinemys marmorata*) figured here is one of more than 900 scientific illustrations in the Ernst Mayr Library's Jacques Burkhardt Collection, held at the Museum of Comparative Zoology (MCZ), Harvard University. This undated scientific illustration was drawn by artist Jacques Burkhardt, the personal and principal artist of MCZ founder Jean Louis Rodolphe Agassiz. Agassiz had commissioned such drawings in support of his seminal endeavor, *Contributions to the Natural History of the United States of America*, an anticipated 10-volume set of which only four volumes were realized. Lithographer A. (Auguste) Sonrel successfully adapted many of Burkhardt's turtle drawings for Agassiz's *Contributions* (vol. I: North American Testudinata, and vol. II: Embryology of the Turtle); however, this drawing of an adult specimen from San Francisco, California, was not selected for publication in Agassiz's failed masterpiece. The manuscript annotation penciled by Agassiz himself reads, "To be compared with *Emys nigra* Hallowell; from Lower California. This is from San Francisco." Agassiz's annotation no doubt refers to a second unpublished Burkhardt drawing of an adult Western Pond Turtle specimen collected in Southern California by naturalist Spencer Fullerton Baird. Additional information about the Jacques Burkhardt Collection can be found at: http://library.mcz.harvard.edu/. Special thanks to MCZ Director James Hanken for permitting reproduction of Burkhardt's work here.

—Contributed by **Matthew Bettelheim**; e-mail: matthew_bettelheim@urscorp.com

GEOGRAPHIC DISTRIBUTION

CAUDATA — SALAMANDERS

***AMBYSTOMA MACULATUM* (Spotted Salamander)**. USA: GEORGIA: Rabun Co.: 6.1 km NNE Pine Mountain. Heddon Bog, Chattahoochee National Forest (34.98941°N, 83.152288°W; NAD 83). 12 March 2011. C. Jenkins and D. Stevenson. Verified by Lance D. McBrayer. GSU 18983. New county record (Jensen et al. [eds.] 2008. The Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.).

CHRISTOPHER L. JENKINS and **DIRK J. STEVENSON**, The Orianne Society, Indigo Snake Initiative, 571 Hwy. 441 South, Clayton, Georgia 30525, USA.

***AMBYSTOMA TALPOIDEUM* (Mole Salamander)**. USA: ALABAMA: Montgomery Co.: City of Montgomery, Cypress Pond Park, 1.8 km NE of the Alabama State Capitol Building (32.39117°N, 86.29076°W; WGS84; elev. 61 m). 29 November 2010. Eric C. Soehren and William A. Campbell. Photographic voucher (AUM AHAP-D 298). Verified by Craig Guyer. New county record (Mount 1975. Reptiles and Amphibians of Alabama. Agricultural Experiment Station, Auburn University, Alabama. 347 pp.). Hand captured five individuals in forested wetland dominated by mature *Nyssa aquatica* (Water Tupelo) with scattered *Taxodium distichum* (Bald-cypress). *A. talpoideum* was found in association with *A. opacum* underneath decaying logs over saturated soil near pools of standing water. A comprehensive query of museum holdings through HerpNET (www.herpnet.org) revealed four previously unpublished vouchered specimens collected in Montgomery Co. They include one specimen collected in 1954 by R. L. Chermock (UAHC 7303) and three specimens collected on 3 May 1977 by S. N. Levy and R. O. Magram (CMNH 64991–64993). Collectively, these records partially fill in a gap between Dallas and Macon counties in the upper Coastal Plain of Alabama (Mount 1975, *op. cit.*).

We thank C. Guyer for verifying this record; L. Rissler and R. Downer for providing specimen information from UAHC; and S. Graham for reviewing this note.

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***AMBYSTOMA TEXANUM* (Small-mouthed Salamander)**. USA: ARKANSAS: Calhoun Co.: 2 km N of Calion, Ouachita River backwaters off US 167; (33.346344°N, 92.532132°W; no datum). 01 April 2011. M. B. Connior. Verified by S. E. Trauth. New county record (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville. 421 pp.). Arkansas State University Museum of Zoology Herpetology Collection (ASUMZ 31640). This adult individual was hand captured under a log in a small slough.

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***AMPHIUMA TRIDACTYLUM* (Three-toed Amphiuma)**. USA: MISSISSIPPI: George Co.: Upper Rines Lake, Pascagoula River Wildlife Management Area (30.818172°N, 88.734579°W; NAD83). 16 April 2011. James R. Lee and Donald J. Newman III. Verified by Robert L. Jones. Mississippi Museum of Natural Sciences (MMNS 17443). New county record (Boundy 2005. *In* M. Lannoo [ed.], Amphibian Declines: The Conservation Status of United States Species, pp. 646–647. Univ. of California Press, Berkeley, California). Including this record, the species has been reported from each county in Mississippi except Tishomingo and Jackson counties (Boundy, *op. cit.*). *A. tridactylum* occurs sympatrically with *A. means* at this site.

JAMES R. LEE (e-mail: jlee@tnc.org) and **DONALD J. NEWMAN III,** The Nature Conservancy, Camp Shelby Joint Forces Training Center, CS-JFTC-ENV Building 622, Camp Shelby, Mississippi 39407, USA.

***EURYCEA CHAMBERLAINI* (Chamberlain's Dwarf Salamander)**. USA: GEORGIA: Baldwin Co.: Baldwin State Forest; collected under sphagnum moss on the edge of a beaver pond (32.98201°N, 83.21257°W; WGS 84). 18 May 2011. S. Graham and J. Jensen. Verified by Craig Guyer. AUM 39511. New county record (Jensen et al. [eds.] 2008. The Amphibians and Reptiles of Georgia. University of Georgia Press, Athens, 575 pp.). This record fills a ca. 70 km distribution gap for this species between the nearest record to the west in Crawford Co., Georgia (Jensen et al. [eds.] 2008, *op. cit.*), and populations ca. 120 km E in Barnwell Co., South Carolina (Harrison and Guttman 2003. Southeast. Nat. 2:159–178). Specimens of *Eurycea quadridigitata* reported from this county previously (Jensen et al. [eds.] 2008, *op. cit.*) were collected before the description of *E. chamberlaini*, and are probably attributable to that taxon.

We thank Brian Lowe and Dennis Parmley for information about this site.

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***EURYCEA LUCIFUGA* (Cave Salamander)**. USA: OKLAHOMA: Sequoyah Co.: SQ-1 Cave (Oklahoma Cave Code), 5 km N of Marble City. 07 December 2003. Three individuals sighted, one photographed. Arkansas State University Herpetological Museum (ASUMZ 31183) Verified by Stan Trauth. New county record (Distribution of Oklahoma Amphibian and Reptiles by Recorded Sightings [DOKARRS]; Sievert and Sievert. 2005. A Field Guide to Oklahoma's Amphibians and Reptiles. University of Oklahoma Printing Services/Oklahoma Department of Wildlife

Conservation. Oklahoma City, Oklahoma. 205 pp.). An additional specimen was seen in SQ-5 Cave, in 2008. This range extension represents the southernmost known extent of the species' range in Oklahoma.

The above localities are caves containing federally-listed species (SQ-1) and other rare, sensitive cave fauna (SQ-5) so cave codes and cartographic localities are used to protect endangered species and other sensitive cave fauna.

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***NECTURUS PUNCTATUS* (Dwarf Waterdog)**. USA: GEORGIA: Screven Co.: 15.6 km NE Sylvania; Brier Creek at Brannen's Bridge Road (32.811587°N, 81.486299°W; NAD 83). 16 January 2011. D. Stevenson and K. Briggs. Verified by Lance D. McBrayer. GSU 18985. New county record (Jensen et al. [eds.] 2008. The Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). Larva dipnetted from Brier Creek.

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***PLETHODON SERRATUS* (Southern Red-backed Salamander)**. USA: GEORGIA: Habersham Co.: ca. 0.79 km NW of the intersection of Georgia State Route 197 and Henry Pitman Road (34.78142°N, 83.59137°W; WGS84). 23 March 2011. Javan M. Bauder and Christopher J. Aurora. Verified by Carlos D. Camp. Florida Museum of Natural History (UF 165354). First county record and the easternmost locality in Georgia (Jensen et al. [eds.] 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). Eight individuals were found under four logs and a concrete lawn ornament. One was collected as a voucher specimen. Two additional individuals were previously seen at this same location under a single log on 14 March 2011.

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***PSEUDOTRITON MONTANUS* (Mud Salamander)**. USA: GEORGIA: Atkinson Co.: 9.4 km SE Willacoochee (31.263008°N, 83.006990°W; NAD 83). 4 March 2011. D. Stevenson, J. Beane, T. Pusser, K. Briggs, and F. Snow. Verified by Lance D. McBrayer. GSU 18987. New county record (Jensen et al. [eds.] 2008. The Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). Three larvae from mucky seepage area in hardwood forest near Springhead Church.

JEFFREY C. BEANE, North Carolina State Museum of Natural Sciences, Research Laboratory, MSC #1626, Raleigh, North Carolina 27699, USA; **TODD PUSSER**, P.O. Box 122, West End, North Carolina 27376, USA; **FRANKIE SNOW**, Division of Natural Sciences, Mathematics, and Physical Education, South Georgia College, 100 West College Park Drive, Douglas, Georgia 31533, USA; **KILEY V. BRIGGS** and **DIRK J. STEVENSON**, The Orianne Society, Indigo Snake Initiative, 571 Hwy. 441 South, Clayton, Georgia 30525, USA.

***PSEUDOTRITON RUBER RUBER* (Northern Red Salamander)**. USA: TENNESSEE: Union Co.: Maynardville (36.169942°N, 83.890781°W, WGS84). 10 October 2010. Stephen K. Nelson. Verified by A. Floyd Scott. David H. Snyder Museum of Zoology, Austin Peay State University (APSU 19117, color photo). First county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, 24 pp. Internet version available at http://www1.apsu.edu/amatlas/index.html, accessed 13 April 2011). On road at night in light rain. Temperature 15.5°C.

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ANURA — FROGS

***ANAXYRUS COGNATUS* (Great Plains Toad)**. USA: TEXAS: Motley Co.: North of Matador, Texas on Farm to Market Road 2009 (34.163056ºN, 100.938611ºW; WGS 84; elev.796 m). 14 August 2008. Andrew M. Brinker and Gary W. Ferguson. Verified by Carl J. Franklin. University of Texas at Arlington Digital Slide Collection (UTADC 4030). New county record, fills gap in range (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. Texas A&M Univ. Press, College Station, Texas. 421 pp.).

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***CHIROMANTIS DORIAE* (Doria's Asian Treefrog)**. CHINA: GUANGDONG: Leizhou (20.841011°N, 109.994461°E; WGS 84; 8 m elev.). 25 June 2011. H.-K. Chan, R.-L. Li, and W.-L. Tse. Verified by Y.-Y. Wang. Sun Yat-Sen University, The Museum of Biology (SYS a001192–1197). First record for Guangdong Province. Extends distribution ca. 150 km into mainland China from nearest offshore Hainan Island (Fei et al. 2009. Fauna Sinica: Amphibia. Vol. 2: Anura. Chinese Academy of Science, Beijing, pp. 730–734), and outside range maps of IUCN Red List (http://www.iucnredlist.org/apps/redlist/details/58787/0) and AmphibiaWeb (http://amphibiaweb.org/cgi-bin/amphib_map?genus=Chiromantis&species=doriae). Males found perching on rice plants, 1 m above ground and actively calling.

HON-KI CHAN, School of Biological Sciences, The University of Hong Kong, Hong Kong (e-mail: honkichan@gmail.com); **JIAN-HUAN YANG,** The Museum of Biology, Sun Yat-Sen University, Guangzhou, Guangdong, China (e-mail: philautus@yahoo.com).

***HYLA CINEREA* (Green Treefrog)**. USA: OKLAHOMA: Marshall Co.: Fobb Bottom ca. 3.4 air km WSW of Willis; 14S (33.88556°N, 96.86557°W; WGS84). 25 May 2011. Richard D. Butler and David A. Juarez. Verified by Charles W. Painter. Sam Noble Oklahoma Museum of Natural History (OMNH 43542–43543). New county record (Sievert and Sievert 2011. A Field Guide to Oklahoma's Amphibians and Reptiles, 3rd ed. Oklahoma Dept. Wildlife Cons. vi + 211 pp.). Known populations occur in Johnston Co. ca. 40 air km to the northeast. Calling males were abundant in a shallow wetland, air temperature 25.6°C.

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***HYPOPACHUS BARBERI* (Montane Sheep Frog)**. HONDURAS: LA PAZ: ca. 10 km W of Guajiquiro (14.08792°N, 87.50654°W; WGS84), 2160 m elev. 24 May 2008. César A. Cerrato M., Lorraine P. Ketzler, Ileana R. Luque-M., Josiah H. Townsend, and Larry David Wilson. Verified by Max A. Nickerson. UF 152967 (series

of 18 samples). Easternmost record for this species in Central America and a ca. 28 km range extension ENE of Cantón Sabaneta, La Paz, Honduras (KU 184853–54; McCranie and Wilson 2002. The Amphibians of Honduras. SSAR Cont. Herpetol. 19, Ithaca, New York. x + 625 pp.). The frogs were collected from a breeding aggregation in a small cattle pond at the edge of a pasture located near a remnant patch of cloud forest.

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HYPSIBOAS PULCHELLUS **(Montevideo Treefrog, Ranita del Zarzal)**. ARGENTINA: SAN LUIS PROVINCE: capital city of San Luis, north shore of the Chorrillos river (San Luis river), between 33.308°S, 66.321°W and 33.303°S and 66.317°W (datum WGS84). 9 December 2009, 4 November and 9 December 2010. M. Calderón and M. Jofré. University of San Luis Herpetological Collection, San Luis, Argentina (CH-UNSL 0438–0439, 0452–0454). Verified by B. Espeche. *Hypsiboas pulchellus* is a widespread and abundant species, with an extensive distribution in Buenos Aires, Córdoba, Corrientes, Chaco, Entre Ríos, Misiones, La Pampa, and Santa Fe provinces in Argentina (Lavilla et al. 2000. *In* Lavilla et al. [eds], Categorización de los Anfibios y Reptiles de la República, pp. 2–25. Asociación Herpetológica Argentina). It is also distributed in Uruguay; Rio Grande do Sul and Santa Catarina in Brazil; and southern Paraguay (Nuñez et al. 2004. Smithson. Herpetol. Inform. Serv. 134; Machado and Maltchik 2007. Neotrop. Biol. Conserv. 2[2]:101–116; Colombo et al. 2008. Biota Neotrop. 8[3]:229–240). First province record and the westernmost in Argentina, extending range ca. 187 km W from the nearest locality known, Río Cuarto in Córdoba province (Kwet et al. 2004. *In* IUCN 2010. IUCN Red List of Threatened Species. Version 2010.4. <www.iucnredlist.org>. Downloaded on 06 March 2011; Martori and Avila 1992. Bol. Asoc. Herpetol. Arg. 8[1]:4–5;).

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INGERANA BOREALIS **(Northern Trickle Frog)**. BANGLADESH: COX'S BAZAR DISTRICT: Teknaf Thana: Teknaf Wildlife Sanctuary (21.08895°N, 92.17067°E; 21 m elev.). 16 June 2011. M. K. Hasan, M. Ibrahim Khalilullah, and M. M. Feeroz. Wildlife Museum, Department of Zoology, Jahangirnagar University, Savar, Dhaka, Bangladesh (JUHG 0328). Photograph voucher, Raffles Museum of Biodiversity Research, National University of Singapore (ZRC [IMG] 1.35). First verified record for Cox's Bazar District and southernmost record for Bangladesh. Nearest population recorded from Bandarban Hill District, >120 km N of present locality (Reza 2008. Herpetol. Rev. 39:235). Nearest extraterritorial records include Nameri National Park, Assam, > 600 km to N (Pawar and Birland 2001. A Survey of Amphibians, Reptiles, and Birds in Northeast India. CERC Tech. Rep. No. 6, Centre for Ecological Research and Conservation, Mysore. 118 pp.), Arunachal Pradesh (ca. 850 km to NE), and Meghalaya (ca. 500 km to NW) in India (Ahmed et al. 2009. Amphibians and Reptiles of Northeast India. A Photographic Guide. Aaranyak, Guwahati. 168 pp.). Two individuals were found in partially decomposed wet leaf litter near stream in front of cave at 1012 h. Fieldwork financed by Arannyk Foundation- Project BioTrack. Bangladesh Forest Department issued permits (CCF [Wildlife] 2M–37 [Part-3]/2010/409).

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ISCHNOCNEMA VERRUCOSA. BRAZIL: BAHIA: Municipality Amargosa: Timbó Farm (13.0721°S, 39.3940°W; SAD 69) 750 m elev. 10 January 2007. B. Hamdan. Museu de Zoologia da Universidade Federal da Bahia, Salvador, Bahia, Brazil (MZUFBA 6436, colected on the ground of Atlantica Rain Forest). Verified by M. Napoli. Previously known from the type locality in Minas Gerais, two localities in Espírito Santo, and one locality in the municipality of Camacan, state of Bahia (Dill Orrico 2010. Check List 6[2]:246–247; Frost 2011. Amphibian Species of the World. An Online Reference. Version 5.5 (17 April 2011); electronic database accessible at http://research.amnh.org/vz/herpetology/amphibia/, accessed 17 April 2011; American Museum of Natural History, New York). Record extends known distribution ca. 260 km N from Municipality of Camacan, Bahia, Brazil (Dill Orrico 2010, op. cit.).

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LITHOBATES JOHNI **(Moore's Frog)**. MÉXICO: HIDALGO: Municipality of Huehuetla: Río Blanco (20.24646°N, 98.05434°W, WGS84: 601 m elev.). 15 March 2011. Christian Berriozabal-Islas, A. Ramírez-Bautista, and Luis Badillo-Saldaña. Colección Herpetológica del Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo (CIB 4114-4120). Municipality of Tepehuacán de Guerrero: Río San Simón (20.00499°N, 98.49262° W, WGS84; 323 m elev.) 20 March 2011. Luis Badillo-Saldaña, Christian Berriozabal-Islas, Uriel Hernández-Salinas, and Jorge Tomás-Villegas. CIB 4127.. Municipality of Yahualica: Río Naranjos (20.54135°N, 98.25063°W, WGS84: 254 m elev.) 22 March 2011. Luis Badillo-Saldaña, Christian Berriozabal-Islas, Uriel Hernández-Salinas, and Jorge Tomás-Villegas. CIB 4128-4131. All are first municipality records and were verified by Adrian Leyte-Manrique. The records bridge a previous distributional gap between the only other known locality from Hidalgo on Río Pachula, Municipality of Calnali (Ramírez-Bautista et al. 2010. Lista Anotada de los Anfibios y Reptiles del Estado de Hidalgo, México. Univ. Autón. del Estado de Hidalgo, CONABIO, México D.F. x + 104 pp.) and near Arroyo Sacahuite, Palictla, Tamazunchale, San Luis Potosí (Blair 1947. Amer. Mus. Nov. [1353]:1–17). The frogs were found in rivers and fast flowing streams surrounded by tropical evergreen forest.

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***LITHOBATES PALUSTRIS* (Pickerel Frog)**. USA: TENNESSEE: Smith Co.: adult found in St. Mary's Branch of the Caney Fork River adjacent to St. Mary's Road ca. 1.5 km S of Hwy US 70N (36.227797°N, 85.841232°W, WGS 84). 21 March 2011. A. Carey and M. Anderson. Verified by Brian T. Miller. Deposited in the Herpetology Collection at Middle Tennessee State University (MTSU 353A). New county record (Atlas of Amphibians in Tennessee. Misc. Publ. No. 12. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Internet version [http://www.apsu.edu/amatlas] contains links to information regarding Tennessee distribution of amphibians recorded since 1996; accessed 31 March 2011).

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***LITHOBATES SYLVATICUS* (Wood Frog)**. USA: VIRGINIA: Fauquier Co.: Warrenton, 0.6 km S intersection of US Hwy 17/Culpepper St. (38.7042°N, 77.8047°W; WGS83; elev. 178 m). 04 March 2004. Ian W. Murray. Verified by Steve Gotte. National Museum of Natural History (USNM 561815). New county record (Mitchell and Reay 1999. Atlas of Amphibians and Reptiles in Virginia. Virginia Department of Game and Inland Fisheries, Richmond, Virginia. 122 pp.). The specimen was collected near a small roadside pool that held numerous calling *Pseudacris crucifer* and a lone calling *Hyla versicolor.*

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***PHRYNOBATRACHUS PALLIDUS* (Pale Puddle Frog)** KENYA: COAST PROVINCE: north end of Lake Peccatoni (alternative names: Lake Mpeketoni, Lake Mukunguya), northeast of Witu (2.416667°S, 40.683333°E; NIMA GNS database). 24 May 1934. A. Loveridge. MCZ A-20425–9. Kakoneni (3.169967S°, 39.86283E°; WGS84). 6 May 2000. D. R. Buchholz, T. B. Hayes, A. Vonk, E. Marquez, and A. Espira. MVZ 234153. Verified by José Rosado. Verification supported by mitochondrial data from 12S and 16S ribosomal DNA, transfer RNA valine, and nuclear data from the RAG-1 gene (Zimkus et al. 2010. Mol. Phylogenet. Evol. 55:883–900). Species previously known with certainly from coastal Tanzania, between Dar es Salaam and Tanga, with an unsubstantiated location at Lake Mpeketoni, Kenya (locality of MCZ A-20425–9 erroneously identified as Lake Kenyatta; Pickersgill 2007. Frog Search: Results of Expeditions to Southern and Eastern Africa. Edition Chimaira, Frankfurt am Main. 575 pp.). Loveridge (1936. Bull. Mus. Comp. Zool. 79:369–430) remarked that Lake Mpeketoni population morphologically different from other Kenyan populations of *P. minutus* (equivalent to *P. schefferi*), with specimens exhibiting well-defined digital disks, white throats, and overall pale coloration. First confirmed records for Kenya, extending range >340 km NNE from holotype locality in Tanga, Tanzania, to Lake Mpeketoni, Kenya. Presence of *P. pallidus* at these localities suggests species may be found in additional coastal areas in southern Kenya.

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***PSEUDACRIS FERIARUM* (Upland Chorus Frog)**. USA: TENNESSEE: Union Co.: Maynardville (36.197958°N, 83.896322°W; WGS84). 10 October 2010. Stephen K. Nelson. Verified by A. Floyd Scott. David H. Snyder Museum of Zoology, Austin Peay State University (APSU 19116, color photo). First county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, Center for Field Biology, Austin Peay State University, 24 pp. Internet version, available at http://www1.apsu.edu/amatlas/index.html, accessed 12 April 2011). On road at night in light rain. Temperature 15.5°C.

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***PSEUDACRIS MACULATA* (Boreal Chorus Frog)**. USA: NEBRASKA: Franklin Co.: 4.9 km S, 9.0 km W Hildreth (40.292467°N, 99.1579°W; NAD1983). 12 July 2009. Keith Geluso. Verified by Curtis J. Schmidt, Sternberg Museum of Natural History, Fort Hays State University, Hays, Kansas (MHP 14703). First county record. Fills distributional gap in south-central Nebraska (Ballinger et al. 2010. Amphibians and Reptiles of Nebraska. Rusty Lizard Press, Oro Valley, Arizona. 400 pp.; Fogell 2010. A Field Guide to the Amphibians and Reptiles of Nebraska. University of Nebraska, Lincoln. vi + 158 pp.). Known from adjacent Webster Co. to the east and Kearney Co. to the north (Fogell 2010, *op. cit.*). Captured in a flooded roadside area adjacent to an agricultural field.

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***SCAPHIOPUS COUCHII* (Couch's Spadefoot)**. USA: TEXAS: Motley Co.: North of Matador, on Farm to Market Road 2009 (34.175°N, 100.955556°W; WGS 84, elev. 812 m). 14 August 2008. Andrew M. Brinker and Gary W. Ferguson. Verified by Carl J. Franklin. University of Texas at Arlington Digital Slide Collection (UTADC 4029). New county record fills gap in range (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. Texas A&M Univ. Press, College Station. 421 pp.).

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***SCAPHIOPUS HOLBROOKI* (Eastern Spadefoot)**. USA: GEORGIA: Early Co.: Williams Bluff Preserve (31.199688°N, 85.083085°W; WGS 84; elev. 52 m). 10 April 2011. Robert L. Hill. Verified by John Jensen. UTADC 6907. New county record (Jensen et al. [eds.] 2008. Amphibians and Reptiles of Geórgia. Univ. of Georgia Press, Athens. 575 pp.); previously documented in adjacent Crawford, Macon, and Marion counties. Found inside of a rotting log on a hillside ~1.2 km W of Hwy 370. Specimen was photographed and released.

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***SCAPHIOPUS HOLBROOKII* (Eastern Spadefoot)**. USA: INDIANA: Greene Co.: 3.44 km E of the West Fork of the White River. (38.91506°N, 87.04493°W; NAD 83). 19 April 2011. Sarabeth Klueh and Jason Mirtl. Verified by Chris Phillips. Illinois Natural History Survey (INHS 2011-I, photographic voucher). New county record for Indiana (Minton. 2001. Amphibians and Reptiles of Indiana.

2nd ed., revised. Indiana Academy of Science. vii + 404 pp.) Adult male observed at night in a flooded agricultural field. This record fills gap for Indiana. There were existing records for counties south, west, and north of Greene Co..

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***SPEA BOMBIFRONS* (Plains Spadefoot)**. USA: Franklin Co.: 4.0 km S Wilcox (40.32965°N, 99.16133°W; NAD1983). 12 July 2009. Keith Geluso. Verified by Curtis J. Schmidt, Sternberg Museum of Natural History, Fort Hays State University, Hays, Kansas (MHP 14709). First county record. Fills distributional gap in south-central Nebraska (Ballinger et al. 2010. Amphibians and Reptiles of Nebraska. Rusty Lizard Press, Oro Valley, Arizona. 400 pp.; Fogell 2010. A Field Guide to the Amphibians and Reptiles of Nebraska. University of Nebraska, Lincoln. vi + 158 pp.). Captured on road surrounded by agricultural fields. Phelps Co.: Funk-Odessa Road, 17.5 km N Funk (40.621717°N, 99.2563°W). 24 June 2009. Keith Geluso. Verified by Curtis J. Schmidt, Sternberg Museum of Natural History, Hays, Kansas (MHP14708). First county record. Fills in distributional gap in south-central Nebraska between Dawson, Buffalo, Kearney, and Harlan counties (Fogell 2010, *op. cit.*). Individual was observed on road in agricultural area dominated by center-pivot irrigation. It specifically was captured in an area where the non-irrigated corners of the surrounding four center pivots came together.

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***TRACHYCEPHALUS ATLAS* (Bokermann's Casque-headed Treefrog)**. BRAZIL: PARAÍBA: Municipality of São João do Cariri: Olho D'água Farm (07.483333°S, 36.683333°W; WGS84). 13 March 2005. W. L. S. Vieira and G. G. Santana. Coleção Herpetológica do Departamento de Sistemática e Ecologia, Universidade Federal da Paraíba, João Pessoa, Paraíba, Brazil (UFPB 4887–4888). Verified by C. Arzabe. Previously known only from the type locality, Santo Onofre Farm, municipality of Maracas in Bahia State (Bokermann 1966. Neotropica 12[39]:210–124) and reserve Maurice Dantas and Exu in Pernambuco State (Borges-Nojosa and Santos 2005. Herpetofauna da área de Betânia e Floresta, Pernambuco. Ministério do Meio Ambiente, pp. 276–289). First state record extends known distribution 793 km from previously known locality. The specimens were collected as they called, floating in the water on a temporary pond in an area of Caatinga dry land vegetation during the early rainy season.

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TRACHYCEPHALUS MAMBAIENSIS. BRAZIL: BAHIA: Municipality of Santa Maria da Vitória: 13.23°S, 44.16°W (SAD 69), 460 m elev. 05 December 2009. M. Freitas and T. Lima. Museu de Zoologia da Universidade de São Paulo, São Paulo, Brazil (MZUSP 142649, collected on road). Verified by M. Rodrigues. Previously known only from cerrado biome of Mambaí, Goiáis, (Cintra et al. 2009. Zootaxa 1975:58–68). First state record and first for the northeastern region, extends distribution ca. 230 km NE from Mambaí municipality, Goiás State (Cintra et al. 2009, op. cit.).

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GYMNOPHIONA — CAECILIANS

***DERMOPHIS GLANDULOSUS* (San Isidro Caecilian)**. PANAMÁ: PANAMÁ: Distrito de Panamá: Corregimiento de Chilibre: Parque Nacional Chagres, trail to Cerro Brewster (9.32053°N, 79.28876°W, WGS 84; ca. 810 m elev.). 24 July 2009. Angel Sosa, Ernie Osburn, Charlotte Skov, and Daniel Medina. Verified by Marvalee H. Wake. Museo de Vertebrados de la Universidad de Panamá (MVUP 2307). First record for Province of Panamá, filling a 639 km distributional gap between the only two previously known localities in the country: Finca Santa Clara, Chiriquí, near the Costa Rican border on the west and Cerro Tacarcuna, Darién, near the Colombian border on the east (Savage and Wake 2001. Copeia 2001:52–64). This species was previously known only by two specimens from what appeared to be two disjunct populations in Panamá. The caecilian was found during daytime on a trail passing through submontane tropical forest.

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TESTUDINES — TURTLES

***CHRYSEMYS DORSALIS* (Southern Painted Turtle)**. USA: FLORIDA: Alachua Co.: Gainesville, Santa Fe College Northwest Campus (29.6827°N, 82.4353°W; WGS84; elev. 44 m). 25 June 2009. Matthew H. Kail. Verified by Kenneth L. Krysko. Florida Museum of Natural History (UF 159928). New county record. Female (straight midline carapace length = 112 mm, straight midline plastron length = 109 mm, mass = 205 g) captured by hand at edge of 0.2 ha pond.

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***CHRYSEMYS PICTA* (Painted Turtle)**. USA: Clay Co.: 0.5 km N, 7.3 km W Fairfield (40.437467°N, 98.185683°W; NAD1983). 23 June 2009. Keith Geluso. Verified by Curtis J. Schmidt, Sternberg Museum of Natural History, Fort Hays State University, Hays, Kansas (MHP 14673). First county record. Fills in distributional

gap in south-central Nebraska (Ballinger et al. 2010. Amphibians and Reptiles of Nebraska. Rusty Lizard Press, Oro Valley, Arizona. 400 pp.; Fogell 2010. A Field Guide to the Amphibians and Reptiles of Nebraska. University of Nebraska, Lincoln. vi + 158 pp.). Observed crossing roadway surrounded by an agricultural field and a homestead.

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***GOPHERUS BERLANDIERI* (Texas Tortoise)**. MEXICO: COAHUILA: Municipality of Cuatro Ciénegas de Carranza: Área de Protección de Flora y Fauna Cuatrociénegas, 2 km SW of El Venado (26.8398861°N, 101.9587278°W; WGS84), 762 m elev. 29 August 2010. L. M. Coghill and J. Chávez-Campos. Verified by Luis Canseco Marquez. Colección Herpetológica del Museo de Zoología Alfonso L. Herrera, Facultad de Ciencias, UNAM (MZFC ID-014). First confirmed record for the Municipality of Cuatro Ciénegas de Carranza, extending the known distribution 53.4 km SW from the closest localities between Ciudad Hermanas and Monclova, Municipality of Abasolo (Lemos Espinal and Smith 2007. Amphibians and Reptiles of the State of Coahuila, Mexico. UNAM and CONABIO, México, D.F. xii + 550 pp.). A previous record, without voucher or locality information, reported this tortoise as a likely introduced species in the Área de Protección de Flora y Fauna Cuatrociénegas (McCoy 1984. J. Arizona-Nevada Acad. Sci. 19:49–59). We found multiple adult individuals of varying sizes and sexes in a single day crossing a road, suggesting an established population; a genetic study is needed to determine if the population is native or introduced. All were photographed, but not collected, because they were found in a protected area.

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***GOPHERUS POLYPHEMUS* (Gopher Tortoise)**. USA: FLORIDA: Collier Co.: Ten Thousand Islands. Fakahatchee Island (25.868°N, 81.496°W; NAD83) and Dismal Key (25.890°N, 81.560°W; NAD83) are located 11 and 17 km W of Everglades City, respectively, and approximately 2 km offshore. One adult shell and one live adult tortoise were observed near the western edge of Fakahatchee Island on 26 October 2010, and four adult tortoises and five active burrows were observed near the center of Dismal Key on 27 October 2010 by MTJ and LLW. Verified by J. Martinez. Harvard University, Museum of Comparative Zoology (MCZ R-188665; photo voucher).

These observations represent previously unknown coastal occurrences of Gopher Tortoise along the 100 km section of coast between Marco Island (Collier Co.) and Cape Sable (Monroe Co.) (e.g., Kushlan and Mazzotti 1984. J. Herpetol. 18[3]:231–239; Mushinsky and McCoy 1994. *In* Bury and Germano [eds.], Biology of North American Tortoises, pp. 39–47. National Biological Survey, Fish and Wildlife Research 13; NatureServe 2010. NatureServe Explorer: An Online Encyclopedia of Life. ver. 7.1. NatureServe, Arlington, Virginia. http://www.natureserve.org/explorer. Accessed 15 April 2011). Furthermore, these occurrences are worthy of note because Fakahatchee Island and Dismal Key are largely of anthropogenic origin, constructed by Native Americans (Calusa) prior to the 16th century. They are part of a series of large Calusa shell mounds distributed throughout the northern Ten Thousand Islands (Widmer 1988. The Evolution of the Calusa: A Nonagricultural Chiefdom of the Southwest Florida Coast. University of Alabama Press. Tuscaloosa, Alabama). Tortoises may occur on other large, isolated shell mounds between Marco Island and Cape Sable, although we have failed to detect tortoises or burrows on three other large shell mounds in the vicinity of Fakahatchee and Dismal: Four Brothers Key, Russell Key, and Sandfly Island. It is unknown whether these tortoises naturally colonized Fakahatchee Island and Dismal Key or were introduced there by Calusa or more recent (i.e., 19th-20th century) settlers.

These observations were made while conducting surveys for box turtles under a research permit from the National Park Service (Everglades National Park; EVER-2009-SCI-0038), a special use permit from the U.S. Fish and Wildlife Service (Ten Thousand Islands National Wildlife Refuge), research authorization from the Florida Department of Environmental Protection (Rookery Bay National Estuarine Research Reserve) and a scientific collection permit from the Florida Fish and Wildlife Conservation Commission (LSSC-10-00103).

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***GRAPTEMYS GEOGRAPHICA* (Northern Map Turtle)**. USA: TENNESSEE: Cannon Co.: Hwy 70S at East Fork of the Stones River crossing, (35.8232°N, 86.089983°W, NAD83), ca. 28.3 km E of Rutherford Co. population at Murfree Spring Wetland and Lytle Creek (Landry 2010. Master's thesis, Middle Tennessee State University, Murfreesboro). 20 June 2010. Brian T. Miller. Verified by M. L. Niemiller. An adult female found dead on road. Deposited in the Herpetology Collection at Middle Tennessee State University (MTSU 20T). New county record. Extends known distribution of species into the upper East Fork of the Stones River (Scott and Redmond 2008 [latest update: 7 July 2010]. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available http///apsu.edu/reptatlas/, accessed 16 May 2011).

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***GRAPTEMYS OUACHITENSIS* (Ouachita Map Turtle)**. USA: IOWA: Washington Co.: Skunk River, Brighton Access, Brighton (41.19194°N, 91.79667°W). 27 August 2008. Chad Dolan. Verified by Richard Vogt. Photo vouchers in Drake University Research Collection (DURCPC# 101a,b,c). Adult found downstream of the boat ramp basking on log. New county record. Found in adjoining Louisa and Johnson counties (Christiansen et al. Reptiles of Iowa. University of Iowa Press, Iowa City, *in press*).

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Illinois Natural History Survey, Brighton, Illinois 62012, USA (e-mail: jktucker@inhs.uiuc.edu); **JEFF PARMELEE**, Department of Biology, Missouri State University, Springfield, Missouri 65897, USA (e-mail: jparmelee@missouristate.edu).

***GRAPTEMYS PSEUDOGEOGRAPHICA KOHNII* (Mississippi Map Turtle)**. USA: FLORIDA: Alachua Co.: Santa Fe River, 450 m downstream from Poe Spring (29.8268°N, 82.6537°W; WGS84; elev. 6 m). 13 August 2010. Matthew H. Kail. Verified by Kenneth L. Krysko. Florida Museum of Natural History (UF 159338). New state record (Johnston et al. 2008. Herpetol. Rev. 39:236). Female (straight midline carapace length = 185 mm, straight midline plastron length = 170 mm, mass = 931 g). Captured by hand during a survey of freshwater turtles in the Santa Fe River. This is the second subspecies of *G. pseudogeographica* documented from the upper Santa Fe River within O'Leno State Park

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***GRAPTEMYS PULCHRA* (Alabama Map Turtle)**. USA: GEORGIA: Floyd Co.: Numerous individuals of both sexes observed and photographed basking on logs in the Coosa River near Rome (34.20591°N, 85.29058°W; NAD83). 19 May 2011. John B. Jensen and Sean P. Graham. Verified by Jeffrey Lovich. AUM (AHAP-D 303–305, photographic vouchers). ALABAMA: Cherokee Co.: Weiss Reservoir (34.23245°N 85.52775°W; geo-referenced using Google Earth). 07 February 1970. John Chitwood. Verified by Craig Guyer. AUM 16654. These records partially fill a 200 km distribution gap between previous Coosa River drainage records upstream in the Oostanaula River in Gordon Co., Georgia (Santhuff and Wilson 1990. Herpetol. Rev. 21:39) and downstream in the Coosa River in Etowah Co., Alabama (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn Univ. Agricult. Exp. Sta. 347 pp.). Additionally, both represent first county records (Mount 1975, *op. cit.*; Jensen et al. [eds.] 2008. Amphibians and Reptiles of Geórgia. Univ. of Georgia Press, Athens. 575 pp.), and the former also represents the first Georgia record from the Coosa River.

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***HYDROMEDUSA TECTIFERA* (South American Snake-necked Turtle)**. BRAZIL: MINAS GERAIS: Municipality of São Roque de Minas: 20.569150°S, 45.567389°W (datum WGS 84), 937 m elev., area with typical cerrado vegetation. 2004. L. Eliege. Museu Nacional, Universidade Federal do Rio de Janeiro, Rio de Janeiro, RJ, Brazil (MNRJ19780). Verified by R. Fernandes. Species previously known from the states of São Paulo, Minas Gerais, Rio de Janeiro, Paraná, Santa Catarina, and Rio Grande do Sul, in Brazil; westward and southward through the Chaco, eastern Paraguay, and Formosa, northeastern Argentina, to Uruguay (Fritz and Havaš. 2007. Vert. Zool. 57[2]:149–368; Souza and Novelli 2009. Check List 5[3]:396–398), occurring in the basins of Paraná, Atlantic-Southeastern, Uruguay, and Atlantic Southern (Souza 2005. Rev. Esp. Herpetol. 19:33–46). Here we report the second record from the state of Minas Gerais, thus representing the second register for the Cerrado biome and in the São Francisco basin, extending its known distribution ca. 230 km NW from the first record in the state of Minas Gerais (Brazil, Minas Gerais, Ritápolis municipality; Souza and Novelli, *op. cit.*)

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***INDOTESTUDO ELONGATA* (Elongated Tortoise)**: INDIA: TRIPURA: West District: Tulashikar (24.096°N, 91.922°E; 92 m elev.). ZRC(IMG) 2.147. Verified by Kelvin K. P. Lim. Juvenile (carapace length ca. 200 mm) obtained from teak (*Tectona grandis*) forest during jhum (slash-and-burn cultivation) and kept as pet by member of Debbarma tribe. Widespread in Southeast Asia (Auliya 2007. An Identification Guide to the Freshwater Turtles and Tortoises of Malaysia, Singapore, Indonesia, Brunei, the Philippines, East Timor and Papua New Guinea. TRAFFIC Southeast Asia, Kuala Lumpur. 98 pp.), with isolated records in northern and eastern India (Das 1995. Turtles and Tortoises of India. Oxford University Press, Bombay. x + 176 pp + 16 pl.; Feroz et al. 2009. Colour Guide to the Amphibians and Reptiles of Northeast India. Aranyak, Guwahati. 169 pp.). First record from the Indian state of Tripura.

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***KINOSTERNON LEUCOSTOMUM* (White-lipped Mud Turtle)**. NICARAUGUA: Región Autónoma del Departamento Atlántico Sur: Little Corn Island, 50 m from the ocean on the southeast side of the island in a newly established marsh (12.25°N, 83.00°W; WGS84). 10 June 2008. Stesha A. Pasachnik. Verified by John Iverson. USNM Herp Images 2737–2743. First records for Little Corn Island, although species is known from Big Corn Island and adjacent mainland (Köhler 2001. Anfibios y Reptiles de Nicarágua. Herpeton, Verlag Elke Köhler, Offenbach, Germany. 208 pp.). The two individuals were captured at dusk, photographed, and released.

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***KINOSTERNON SUBRUBRUM* (Eastern Mud Turtle)**. USA: GEORGIA: Whitfield Co.: Heritage Point Park, canopied wetland (34.79076°N, 84.94025°W; WGS 84). 13 May 2011. C. Manis and T. P. Wilson. Verified by John Jensen. University of Tennessee at Chattanooga Museum of Natural History (UTC Digital Collection-4680TPW-GMU). New county record (Jensen et al. [eds.]

2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). One adult male captured in a baited hoop net.

CHRIS MANIS, Department of Natural Sciences, Dalton State College, 650 College Drive, Dalton, Georgia 30720, USA (e-mail: cmanis2@dalton-state.edu); **THOMAS P. WILSON**, Department of Biological and Environmental Sciences, University of Tennessee at Chattanooga, 215 Holt Hall, Department 2653, 615 McCallie Avenue, Chattanooga, Tennessee 37403, USA (e-mail: thomas-wilson@utc.edu).

***KINOSTERNON SUBRUBRUM* (Eastern Mud Turtle)**. USA: TENNESSEE: Cannon Co.: Burt Bergen Road (35.744047°N, 86.128678°W; NAD83). 14 May 2011. Brian T. Miller. Verified by A. F. Scott. Austin Peay State University (APSU 19123 phtographic voucher). New county record (Scott and Redmond 2008 [latest update: 10 June 2009]. Atlas of Reptiles in Tennessee. Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/, accessed 16 May 2011). Specimen found ca. 27.5 km SE of Rutherford Co. population at Black Fox Wetland (Varner 1995. Master's thesis, Middle Tennessee State University, Murfreesboro), and 38.5 km N of Coffee Co. population at Sinking Pond (Miller et al. 2005. Southeast. Nat. 4:51–62). Decreases the size of the hiatus in records for middle Tennessee. An adult found alive on road.

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***MACROCHELYS TEMMINCKII* (Alligator Snapping Turtle)**. USA: GEORGIA: Turner Co.: 17.9 km E Ashburn (31.697328°N, 83.463042°W; NAD 83). May 2010. Ryan Rigdon. Verified by Lance D. McBrayer. GSU 18993. New county record (Jensen et al. [eds.] 2008. The Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). Adult female nesting in sandhill near Alapaha River, Rigdon family property.

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***STERNOTHERUS CARINATUS* (Razor-backed Musk Turtle)**. USA: ARKANSAS: Calhoun Co.: 2 km N of Calion, Ouachita River backwaters off US 167 (33.346344°N, 92.532132°W). 01 April 2011. M. B. Connior. Verified by S. E. Trauth. Arkansas State University Museum of Zoology Herpetology Collection (ASUMZ 31682). New county record (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville. 421 pp.). This individual's intact carapace and plastron were collected along the bank of a small slough.

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***STERNOTHERUS MINOR* (Loggerhead Musk Turtle)**. USA: GEORGIA: Coffee Co.: 6.4 km SE Broxton; Broxton Creek at Apache Road (31.580842°N, 82.842726°W; NAD 83). 21 November 2010. F. Snow. Verified by Lance D. McBrayer. GSU 18996. New county record (Jensen et al. [eds.] 2008. The Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.).

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SQUAMATA — LIZARDS

***ANADIA OCELLATA* (Ocellated Anadia)**. COLOMBIA: CÓRDOBA: Tierralta: Cerro Murrucucú, Parque Natural Nacional Paramillo, (8.3533°N, 76.395°W; Bogotá WGS 84; elev. 700 m). 05 April 2009. J. E. Carvajal-Cogollo. Collection of Reptiles of the Instituto de Ciencias Naturales, Universidad Nacional of Colombia, Bogotá D.C, Cundinamarca, Colombia (ICN 11868). Verified by O. V. Castaño-Mora, Rafael A. Moreno-Arias, and Guido Medina-Rangel. First country record. Extends species range approx. 300 linear km E in the Caribbean region of Colombia (Savage 2002. The Amphibians and Reptiles of Costa Rica. A Herpetofauna Between Two Continents, Between Two Seas. University of Chicago Press, Chicago, Illinois. 934 pp.). Species historically known from Costa Rica and western Panama (Oftedal 1974. Arq. Zool. 25[4]:203–265; Savage 2002, *op. cit.*). Specimen collected under Agreement No. 5, between the environmental authority-CVS-and Universidad Nacional de Colombia.

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***ANNIELLA PULCHRA* (California Legless Lizard)**. USA: CALIFORNIA: Kern Co.: SE slope Piute Mountains, Jawbone Canyon watershed, approx. 19.47 airline km WSW jct Jawbone Canyon Rd. x State Hwy 14 (35.29464°N, 118.20119°W; WGS84 datum; elev. 1255 m). 02 June 2010. L. E. Hunt. Verified by Paul Collins. Santa Barbara Museum of Natural History collection (SBMNH 2503). Second record for Piute Mountains. First occurrence and nearest record is from Kern Co., Green Spring, Kelso Valley (CAS 236208), 11.66 airline km to the NNW. Present specimen is an adult male found beneath a board on south-facing slope in open California Juniper-Interior Live Oak-Gray Pine woodland.

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***ASPIDOSCELIS TESSELATA* (Common Checkered Whiptail)**. USA: NEW MEXICO: Lea Co.: Wallach Quarry, 4.0 km E and 2.0 km N of NM 18/Wallach Lane (32.45412°N, 103.08113°W; NAD83/WGS84; elev.1054 m). 24 June 2008. Lea Co.: Eunice, 1100 Main St. (32.43690°N, 103.15932°W; NAD83/WGS84; elev. 1051 m). 27 June 2008. Don S. Sias, Ian W. Murray, and Jack C. Olson. Verified by J. Tomasz Giermakowski. University of New Mexico Museum of Southwestern Biology (MSB 75701, 75696). New county record (Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. Univ. New Mexico Press, Albuquerque. 431 pp.). An adult specimen was collected in the broken and rocky terrain of an active quarry surrounded by sandy shinoak habitat and mesquite grassland. An additional three animals were observed, and one collected, alongside a weed-grown wall outside of a building in downtown Eunice, NM. These animals might represent an introduced population, as this region is surrounded by expanses of unsuitable habitat. We caution that care be used when examining putative *A. tesselata* from regions where they may be sympatric

with *A. marmorata*. The only two specimens of '*A. tesselata*' recorded from Lea Co. (ENMU 1501, MSB 50698) were determined to be *A. marmorata* after examination of the supraorbital semicircles, dorsal pattern, a lack of abruptly enlarged mesoptychial scales, absence of spotting on the tail, and a bulging tail base.

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COLEODACTYLUS BRACHYSTOMA. BRAZIL: BAHIA: Municipality of São Desidério: 12.36°S, 45.03°W (SAD 69), 680 m elev. 15 October 2009. M. Freitas. Museu de Zoologia da Universidade de São Paulo, São Paulo, Brazil (MZUSP 100222, collected in Cerrado biome). Verified by M. Rodrigues. Previously known from Mato Grosso, Goiás, and Tocantins states (Brandão and Motta 2005. Phyllomedusa 4[2]:139–145; Strussman and Carvalho 1998. Herpetol. Rev. 29:183–185). First state record and first for the northeastern region of Brazil, extending distribution ca. 200 km E from Cana Brava municipality, Tocantins state (Brandão and Motta 2009, *op. cit*).

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***CTENOSAURA HEMILOPHA* (Baja California Spiny-tailed Iguana)**. MÉXICO: BAJA CALIFORNIA SUR: Municipality of Comondú: Poza Honda, Rancho San Ramón, Arroyo Bebelamas (24.95948°N, 111.33476°W; WGS84), 121 m elev. 14 June 2010. G. Ruiz-Campos, J. Delgadillo, A. Andreu, and M. Ortíz. Verified by Bradford D. Hollingsworth. SDSNH-HerpPC 05210–05211. First municipality record and westernmost locality for the species, extending the distribution 34.5 km W of road to Los Dolores, San Pedro de La Presa, Sierra La Giganta (LACM 128247-48). *Ctenosaura hemilipha* was thought to be restricted to Arid Tropical and the Central Gulf Coast regions of the Sierra La Giganta and the Cape Region in Baja California Sur (Grismer 2002. Amphibians and Reptiles of Baja California, Including its Pacific Islands and the Islands in the Sea of Cortés. Univ. California Press, Berkeley and Los Angeles, California. xii + 399 pp.). In contrast, this new locality is situated in the Magdalena phytogeographic region. The lizard was found on a mesquite tree (*Prosopis articulata*).

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***CTENOSAURA OAXACANA* (Oaxacan Spiny-tailed Iguana)**. MÉXICO: OAXACA: Municipality of Santa María Colotepec: Tomatal (15.789578°N, 96.916317°W, WGS84; 28 m elev.). 8 August 2004. Víctor Hugo Reynoso and Georgina González Monfil. Verified by Jorge Morales Mávil. CNAR-IBH-RF 31–33. New municipality records, extending the known range 135 km W of Santiago Astata, Municipality of Santiago Astata (Köhler 2002. Schwarzleguane – Lebensweise, Pflege, Zucht. Offenbach Herpeton Verlag Elke Köhler. 142 pp.). The lizards were inside tree stumps used for fencing around an agricultural field adjacent to deciduous forest.

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***HEMIDACTLYUS FRENATUS* (Common House Gecko)**. HONDURAS: ISLAS DE LA BAHÍA: Roatán, inside and outside a private residence (16.406417°N, 86.3882°W; WGS84). 17 November 2010. Stesha A. Pasachnik. Verified by John Iverson. USNM Herp Images 2734–2736. First record for Roatan. Previously known from Islas de la Bahía only on Utila (McCranie et al. 2005. Amphibians & Reptiles of the Bay Islands and Cayos Cochinos, Honduras. Bibliomania, Salt Lake City, Utah. xii + 210 pp.). Many individuals of this species were observed throughout the island.

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***LEIOCEPHALUS CARINATUS* (Northern Curly-tailed Lizard)**. USA: FLORIDA: Osceola Co.: Kissimmee, 6000 West Osceola Parkway, Gaylord Palms Resort and Convention Center (28.34449°N, 81.52583°W, WGS 84; elev. 27 m). 29 May 2011. Rex Rowan. Verified by Kenneth L. Krysko. Florida Museum of Natural History (Photographic voucher UF 165483). Two or three individuals observed in the parking lot. New county record (Meshaka et al. 2004. The Exotic Amphibians and Reptiles of Florida. Krieger Publ. Co., Malabar, Florida. 155 pp.).

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***SPHAERODACTYLUS ROSAURAE* (Bay Island Least Gecko)**. HONDURAS: ISLAS DE LA BAHÍA: Bay Islands Province: Cayos Chocinos, Cayo Cochino Pequeño, northeastern side of island (15.953069°N, 86.497667°W; WGS84), 1 m elev. 25 November 2010. J. A. Frazier. Verified by J. H. Townsend. MPM P750–51. First record for Cayo Cochino Pequeño. Even though it has not been recorded from Cayo Cochino Grande, it is known from throughout the Bay Islands area (McCranie et al. 2005. Amphibians and Reptiles of the Bay Islands and Cayos Cochinos, Honduras. Bibliomania, Salt Lake City, Utah. xii + 210 pp.). The lizard was found in coral skeleton rubble, ca. 3 m from high tide line.

We thank the Honduran Coral Reef Foundation and Operation Wallacea for supporting our research on the Cayos Cochinos.

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STENOCERCUS QUINARIUS. BRAZIL: BAHIA: Municipality of São Desidério: 12.30°S, 45.10°W (SAD 69), 720 m elev. 05 Oct 2009. M. Freitas and D. França. Museu de Zoologia da Universidade de São Paulo, São Paulo, Brazil (MZUSP 100039–41, collected in "cerrado-carrasco"). Verified by M. Rodrigues. Previously known

only from cerrado biome of Parque Nacional Grande Sertão Veredas, Formoso municipality, Minas Gerais, Brazil (Nogueira and Rodrigues 2006. S. Am. J. Herpetol. 1[3]:149–165.). First state record and first for the northeastern region of Brazil, extends distribution ca. 300 km N from Formoso municipality (Nogueira and Rodrigues 2006, *op. cit.*).

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TUPINAMBIS QUADRILINEATUS. BRAZIL: BAHIA: Municipality of São Desidério: Sítio do Rio Grande city (12.2558°S, 45.5486°W; SAD 69) 650 m elev. 05 january 2003. T. Lima. Museu de Zoologia da Universidade de São Paulo, São Paulo, Brazil (MZUSP 100077, killed on the road, in the estacional ciliar forest). Verified by M. Rodrigues. Previously known only from cerrado biome of Tocantins, Minas Gerais, Goiás, and Mato Grosso states (Silveira, 2009. Check List 5[3]:442–445). First state record and first for the northeastern region of Brazil, extends distribution ca. 250 km SE from Mateiros municipality, Tocantins state (Silveira 2009, *op. cit.*).

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***XANTUSIA WIGGINSI* (Wiggins' Desert Night Lizard)**. MÉXICO: BAJA CALIFORNIA SUR: Municipality of Mulegé, 46 km SW of San Ignacio (26.99164°N, 113.41670°W; WGS84), 10 m elev. 14 February 2009. Adam Backlin and Robert Fisher. Verified by Bradford D. Hollingsworth. Photographic Collection, San Diego Natural History Museum (SDNHM_HerpPC_05208–09). Southernmost record for this species in Baja California Sur, extending the known range 36 km SSW from Rancho San Ángel (Grismer 2002. Reptiles and Amphibians of Baja California: Including its Pacific Islands and the Islands in the Sea of Cortez. University California Press, Berkeley. xii + 399 pp.). This record also reduces the distributional gap between *X. wigginsi* and *X. sherbrookei* by 96 km (Bezy et al. 2008. J. Herpetol. 42:680–688). The lizard was found under the bark of a decomposing Cardon Cactus (*Pachycereus pringlei*).

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SQUAMATA — SNAKES

***AGKISTRODON PISCIVORUS* (Cottonmouth)**. USA: GEORGIA: Jeff Davis Co.: 4.3 km SE Denton (31.705298°N, 82.652605°W; NAD 83). 20 March 2011. B. Preston. Verified by Lance D. McBrayer. GSU 19001. New county record (Jensen et al. [eds.] 2008. The Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.).

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***AGKISTRODON PISCIVORUS PISCIVORUS* (Eastern Cottonmouth)**. USA: GEORGIA: Taylor Co.: Fall Line Sandhills Natural Area (32.578298°N, 84.269315°W; WGS 84.; elev. 206 m). 10 April 2011. Robert L. Hill. Verified by John Jensen. UTADC 6901–6902. New county record (Jensen et al. [eds.] 2008. Amphibians and Reptiles of Georgia, Univ. of Georgia Press, Athens. 575 pp.); previously documented in adjacent Crawford, Macon, and Marion counties. This species has been observed in Taylor County, but there were previously no vouchered specimens. Specimen observed swimming near center of a large ephemeral pond ~1.25 km N of Hwy 92 just after midnight, was moved to shore, photographed, and released.

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ATRACTUS POTSCHI. BRAZIL: BAHIA: Municipality of Rio de Contas: Tapera Farm (13.517278°S, 41.901722°W; datum Córrego Alegre; 1200 m elev.). O. J. dos Santos. 10 November 2008 to 20 December 2009. Museu de Zoologia da Universidade Estadual de Santa Cruz, Ilhéus, Bahia (MZUESC 7929–7931). Verified by P. Passos. Species known form northeastern Brazil, from São Cristovão (11.016667°S, 37.200000°W) in the state of Sergipe southwestward to Poções (14.33333°S, 40.366667°W, 800 m. elev.) in the state of Bahia (Passos et al. 2010. Zootaxa 2364:1–63). These records in the Chapada Diamantina plateau extend the known range ca. 200 km NW from Poções and increases by 400 m the previous elevational limit (Passos et al., *op. cit.*).

ANTÔNIO JORGE SUZART ARGÔLO, JULIANA ALVES DE JESUS, MARCOS FERREIRA VILA NOVA, and **CARLOS AUGUSTO SOUZA COSTA,** Universidade Estadual de Santa Cruz – UESC, Km 16 Rodovia Ilhéus-Itabuna, CEP 45662-900, Ilhéus, Bahia, Brazil (e-mail: ajargolo@gmail.com).

***ATROPOIDES MEXICANUS* (Mexican Jumping Pitviper)**. PANAMÁ: COCLÉ: Omar Torrijos National Park (8.666667°N, 80.616667°W, WGS84; 718 m elev.). 2 October 2008. Julie M. Ray. Verified by Robert C. Jadin. UTADC 6814–15. First record for Coclé, with the closest known locality in Panamá being from Chiriquí Province to the west and Panamá Province to the east (Campbell and Lamar 2004. The Venomous Reptiles of the Western Hemisphere, Vol. I. Cornell Univ. Press, Ithaca, New York. xvii + 476 pp.). The snake was found on Los Helechos hiking trail, which is surrounded by mature secondary cloud forest.

JULIE M. RAY, La MICA Biological Station, El Copé de La Pintada, Coclé Province, Republic of Panamá; e-mail: julie.ray@lamica.org.

***BOA CONSTRICTOR* (Boa Constrictor)**. HONDURAS: SANTA BÁRBARA: 2 km E of San José de Colinas (15.033394°N, 88.283405°W, WGS84; 260 m elev.). 30 September 2010. James R. McCranie and Leonardo Valdés Orellana. Verified by Gustavo A. Cruz Díaz. UNAH 5640. First record for Santa Bárbara, with the closest known locality being ca. 30 km ESE at Agua Azul, Cortés (McCranie 2011. The Snakes of Honduras. Systematics, Distribution, and Conservation. Contrib. Hepetol. SSAR 26: x + 714 pp.).

The snake was killed by a local resident in an area of highly disturbed thorn scrub.

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***COLUBER (=MASTICOPHIS) SCHOTTI* (Schott's Whipsnake)**. USA: TEXAS: Victoria Co.: ca. 200 m N of intersection of US Hwy 59, and Hwy 77 (28.7308°N, 97.0399°W). 04 April 2010. Thomas Sinclair, John Williams, and Scott Wahlberg. Verified by Travis J. LaDuc, Texas Natural History Collections (TNHC 83101 photo voucher). New county record, extends range NE from previous known limit (Dixon 2000. Amphibians and Reptiles of Texas. 2nd ed., revised. Texas A&M Univ. Press, College Station, Texas. 421 pp.). Under artificial cover in wooded area.

THOMAS A. SINCLAIR, 12903 Cloverwood Drive, Cypress, Texas 77429, USA (e-mail: tsinclair2@comcast.net); **JOHN T. WILLIAMS**, 12607 Orchard Summit Drive, Sugar Land, Texas 77498, USA; **SCOTT A. WAHLBERG,** 715 Martinsville Street, Nacogdoches, Texas 75961, USA.

***CROTALUS MOLOSSUS* (Blacktail Rattlesnake)**. MÉXICO: CHIHUAHUA: Municipio Nuevo Casas Grandes: Sierra La Escondida (30.52033333°N, 107.76716667°W, WGS84; 1583 m elev.). 21 August 2006. Ana Gatica-Colima. Verified by H. Gadsden-Esparza. Sección Herpetológica, Colección Científica de Vertebrados, Universidad Autónoma de Ciudad Juárez (CCV-UACJ 677–678). First record for the municipality and a ca. 48 km NE range extension from the nearest record in Chihuahua at Bosque near Rio Piedras Verdes, 1 km S Red Rock, Casas Grandes (Lemos Espinal et al. 2007. Anfibios y Reptiles del Estado de Chihuahua, México. UNAM-CONABIO, Tlanepantla, México, México. xiii + 613 pp.). Both male individuals were found during late morning, one on top of a rock and the other on the ground, in Chihuahuan Desert Scrub. Collecting permit (# 04660) was kindly issued by Dirección General de Vida Silvestre, SEMARNAT.

ANA GATICA-COLIMA (e-mail: agatica@uacj.mx), **NICOLÁS CORDOVA-REZA** (e-mail: jcordova_uacj@hotmail.com), and **EDUARDO MACIAS-RODRÍGUEZ** (e-mail: eduardo26022003@yahoo.com.mx), Programa de Biología, Laboratorio de Ecología y Biodiversidad Animal, Universidad Autónoma de Ciudad Juárez, Anillo Envolvente del PRONAF y Estocolmo, Juárez, Chihuahua, México, CP. 32315.

***CROTALUS RAVUS RAVUS* (Central Plateau Pygmy Rattlesnake)**. MÉXICO: GUERRERO: Ejido Los Membrillos, Sierra Taxco (18.6312°N, 99.7238°W, WGS84 [estimated from map]; 2350 m elev.). 17 June 2009. Jason M. Jones, Christoph Grünwald, and Robert W. Bryson Jr. Verified by Edmundo Pérez Ramos. MZFC 25112. First record for Guerrero, extending the known range ca. 65 km SW of records near Huitzilac, Morelos (Campbell and Armstrong 1979. Herpetologica 35:304–317). The large adult male was found basking near a clump of agaves on a rocky hillside in dry mixed oak forest.

ROBERT W. BRYSON, JR., School of Life Sciences, University of Nevada-Las Vegas, 4505 Maryland Parkway, Las Vegas, Nevada 89154-4004, USA (e-mail: brysonjr@unlv.nevada.edu); **JASON M. JONES,** 16310 Avenida Florencia, Poway, California 92064, USA (e-mail: jasonjones@crotalus.com); **CHRISTOPH GRÜNWALD**, Carr. Chapala-Jocotepec Oriente #57-1, Col. Centro, Ajijic, Jalisco 45920, Mexico (e-mail: trimorphodon111@yahoo.com).

***DIPSAS TEMPORALIS* (Temporal Snail-eater)**. COLOMBIA: CÓRDOBA: Tierralta: Parque Natural Nacional Paramillo (8.3533°N, 76.395°W; Bogotá WGS 84; elev. 800 m). 10 June 2009. J. E. Carvajal-Cogollo. ICN 11409. Verified by O. V. Castaño-Mora, Rafael A. Moreno-Arias, and Guido Medina-Rangel. New state record. Northernmost record for South America, extends known range to Cordillera Occidental ca. 380 km airline N from nearest locality (Atrato River, Chocó, Colombia; Pérez-Santos and Moreno 1988. Ofidios de Colombia. Monografía VI. Mus. Reg. Sci. Nat. Torino. 517 pp.). Species previously known from Panama, Ecuador, and Colombia (Pérez-Santos and Moreno 1988, *op cit.*; Uetz et al. 2011. http://reptile-database.org/, accessed 16 July 2011). In Colombia it has been recorded from west of the Andes, in the Pacific plain, in the Atrato and San Juan rivers, Department of Chocó (Pérez-Santos and Moreno 1988, *op. cit.*).

JUAN E. CARVAJAL-COGOLLO (e-mail: juancarvajalc@gmail.com), **VLADIMIR A. BERNAL-GONZÁLEZ** (e-mail: vlacho83@gmail.com), Grupo Biodiversidad y Conservación, Línea Reptiles, Instituto de Ciencias Naturales, Universidad Nacional de Colombia, Apartado 7495, Bogotá, D.C., Colombia; **NESTOR NONZOQUE-LÓPEZ,** Grupo SisBio, Museo de Historia Natural "Luis Gonzalo Andrade," Universidad Pedagógica y Tecnológica de Colombia-UPTC, Tunja-Colombia (e-mail: pocholope3@gmail.com).

***DRYMARCHON MELANURUS* (Central American Indigo Snake)**. MÉXICO: DURANGO: Municipio Santiago Papasquiaro: San Juan de Camarones (24.927167°N, 106.411472°W, WGS84; 580 m elev.). 28 June 1997. Raúl Muñiz-Martínez, Verified by Luis Canseco-Marquez. CIIDIR-DGO 581-82. First published record for Durango and a 81 km ENE range extensión of the closest known locality outside the state, 13.4 mi. (21.4 km) N San Lorenzo, Sinaloa (Hardy and McDiarmid 1969. Univ. Kansas Publ. Mus. Nat. Hist. 18:39-252; McCranie 1980. Cat. Amer. Amphib. Rept. 267:1-4). There is one unpublished museum record (UMMZ 102478) from Laguna El Progresso, located in the Municipality of San Dimas, 126 km SW of our locality. Both snakes of record were collected in tropical deciduous forest.

RAÚL MUÑIZ MARTÍNEZ (e-mail: raulmm1 @yahoo.com) and **ROSAURA VALDEZ-LARES,** Laboratorio de Fauna Silvestre, CIIDIR-IPN-DGO, Sigma 119, Fracc. 20 de Noviembre II, 34220, Cd. Durango, Durango, México.

***DRYMOBIUS MARGARITIFERUS* (Speckled Racer)**. COLOMBIA: CÓRDOBA: Tierralta: Cerro Murrucucú, Parque Natural Nacional Paramillo (8.3533°N, 76.395°W; Bogotá WGS 84; elev. 700 m). 08 March 2009. J. E. Carvajal-Cogollo, V. Bernal, and N. Nonzoque. ICN 11560, 11909, 11910. Verified by O. V. Castaño-Mora, Rafael A. Moreno-Arias, and Guido Medina-Rangel. First country record. Extends species range approx. 153 linear km E in the Caribbean region of Colombia, from western Panama (Savage 2002. The Amphibians and Reptiles of Costa Rica. A Herpetofauna Between Two Continents, Between Two Seas. University of Chicago Press, Chicago, Illinois. 934 pp.). Species was previously known from United States, Mexico, Panama, Guatemala, Honduras, Belize, El Salvador, Nicaragua, and Costa Rica (Uetz et al. 2011. http://reptile-database.org/, accessed 16 July 2011).

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***FARANCIA ERYTROGRAMMA* (Rainbow Snake)**. USA: GEORGIA: Coffee Co.: 9.1 km SW Douglas, Bay Meadows subdivision (31.455084°N, 82.923252°W; NAD 83). 17 June 2009. R. Preston. Subadult DOR on Bay Meadows Road. GSU 19000. New county record (Jensen et al. [eds.] 2008. The Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.).

ROBERT PRESTON, JR., Office of Advancement, South Georgia College, 100 West College Park Drive, Douglas, Georgia 31533, USA; **DIRK J. STEVENSON**, The Orianne Society, Indigo Snake Initiative, 414 Club Drive, Hinesville, Georgia 31313, USA.

***HELICOPS INFRATAENIATUS* (Water Snake)**. BRAZIL: MATO GROSSO DO SUL: Municipality of Iguatemi: 23.17475°S, 54.37411°W (SAD 69). 01 Sep 2009. P. Landgref-Filho. Coleção Zoológica de Referência da Universidade Federal de Mato Grosso do Sul, Mato Grosso do Sul, Brazil (ZUFMS-REP 1267). Verified by N. R. Albuquerque. The distribution of *H. infrataeniatus* encompasses southern Paraguay, northeastern Argentina, Uruguay, and the states of southern (Rio Grande do Sul, Santa Catarina) and southeastern (São Paulo) Brazil (Giraudo 2001. La Diversidad de Serpientes de la Selva Paranaense y del Chaco Húmedo. Editorial Literature of Latin América, Buenos Aires, Argentina. 285 pp.; Lema 2002. Os répteis do Rio Grande do Sul. Atuais e fósseis—biogeografia—ofidismo. EDIPUCRS, Porto Alegre, Brazil. 264 pp.). First state record, extends range ca. 135 km NW from Palotina (Paraná state), the closest known locality.

PAULO LANDGREF FILHO (e-mail: paulograf@yahoo.com.br) and **CAMILA AOKI** (e-mail: aokicamila@yahoo.com.br), Programa de Pós-Graduação em Ecologia e Conservação, Centro de Ciências Biológicas e da Saúde, Universidade Federal de Mato Grosso do Sul. 79070-900. Campo Grande, MS, Brazil.

HELICOPS MODESTUS. BRAZIL: BAHIA: Municipality of Caitité: 14.03°S, 42.30°W (SAD 69), 970 m elev. 27 July 2008. T. Silva. Museu de Zoologia da Universidade Estadual de Santa Cruz, Ilhéus, Bahia, Brazil (MZUESC 7515, killed on the road, in the Caatinga biome). Verified by A. Argôlo. This species is found in Planaltina, Distrito Federal, Brazil, in cerrado biome (Nogueira 2001. Herpetol. Rev. 32:285–287), and Minas Gerais state (Peters and Donoso-Barros 1986. Catalogue of the Neotropical Squamata. Smithsonian Institution Press, Washington, D.C. 347 pp.). First state record and first for the northeastern region of Brazil, extending distribution ca. 580 km E from Planaltina municipality (Nogueira 2001, *op. cit.*) and ca. 660 km N from Belo Horizonte municipality (Peters and Donoso-Barros 1986, *op. cit.*).

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***HETERODON PLATIRHINOS* (Eastern Hog-nosed Snake)**. USA: GEORGIA: Early Co.: Williams Bluff Preserve: 31.19295°N, 85.07835°W; (WGS 84), elev. 54 m. 12 May 2011. Robert L. Hill and Leslie Phillips. Verified by John Jensen. UTADC 6905–6906. New county record (Jensen et al. [eds.] 2008. Amphibians and Reptiles of Georgia, Univ. of Georgia Press, Athens. 575 pp.); documented previously in adjacent to Baker, Clay, Miller, and Seminole counties. Specimen observed at 0915 h crossing sandy dirt road ~0.33 km N from gated entrance of preserve and ~0.7 km W from Hwy 370. Moved off road, photographed, and released.

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***LAMPROPELTIS TRIANGULUM* (Eastern Milk Snake)**. USA: IOWA: Washington Co.: IDNR SE District Office, Lake Darling State Park, Brighton (41.17916°N, 91.88611°W). 21 May 2008. Collected by Vance Polton. Verified by Jeff Tamplin. Photo vouchers in Drake University Research Collection (DURCPC# 100a,b,c). New county record. Adult found in boat garage. Found in Henry and Jefferson counties to the south and Johnson Co. to the north (Christiansen et al. Reptiles of Iowa, University of Iowa Press, Iowa City. *In press*).

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***LEPTODEIRA SPLENDIDA* (Splendid Cat-eyed Snake)**. MÉXICO: DURANGO: Municipio Santiago Papasquiaro: San Juan de Camarones (24.927167°N, 106.411472°W, WGS84; 580 m elev.). 3 February 2000. Raúl Muñiz-Martínez. Verified by Luis Canseco-Marquez. CIIDIR-DGO 600. First published record for Durango and a 61 km range extension ENE of the closest known locality outside the state, 6 km E Cosalá, Sinaloa (Hardy and McDiarmid 1969. Univ. Kansas Publ. Mus. Nat. Hist. 19:39–252). There is an unpublished museum record (CAS 169763) from Río Tamazula at Agua Caliente, Municipality of Tamazula, 50 km W of our record. The snake of record was found in tropical deciduous forest.

ROSAURA VALDEZ-LARES and **RAUL MUÑIZ-MARTINEZ** (e-mail: raulmm1@yahoo.com), Laboratorio de Fauna Silvestre, CIIDIR-IPN-DGO. Sigma 119, Fracc. 20 de Noviembre II, 34220, Cd. Durango, Durango, México.

***LEPTOPHIS DIPLOTROPIS* (Pacific Coast Parrot Snake)**. MÉXICO: DURANGO: Municipio Santiago Papasquiaro: San Juan de Camarones (24.927167°N, 106.411389°W, WGS84; 580 m elev.) 13 September 2000. Raúl Muñiz-Martínez. Verified by Luis Canseco-Marquez. CIIDIR-DGO 613. First record for Durango and a range extensión of 66 km NNE of the closest known locality, 66 mi. (105.6 km) SE Culiacán, Sinaloa (Hardy and McDiarmid 1969. Univ. Kansas Publ. Mus. Nat. Hist. 18:39–252). The snake was found in tropical deciduous forest.

ROSAURA VALDEZ-LARES and **RAUL MUÑIZ-MARTINEZ** (e-mail: raulmm1@yahoo.com), Laboratorio de Fauna Silvestre, CIIDIR-IPN-DGO. Sigma 119, Fracc. 20 de Noviembre II, 34220, Cd. Durango, Durango, México.

***MICRURUS PROXIMANS* (Nayarit Coralsnake)**. MÉXICO: NAYARIT: Municipio Ruíz: on paved road in route east to Mesa de Nayar from Estación Ruíz; ca. 1.6 km W El Naranjo (22.028303°N, 104.8791°W; ca. 1900 m elev.). 13 July 2009. Matt Nordgren and Robert Villa. Verified by Eric N. Smith. UAZ 57310-PSV. New municipality record and a range extension of ca. 43 km NE of near Cinco de Mayo, ca. 5 mi. (8 km) W of Fed. Rt. 15, Municipality of Santiago Ixcuintla (MSB 10205). The snake was found DOR in tropical deciduous forest.

MATT NORDGREN, 1210 Thornwell Drive, Athens, Georgia 30606, USA (e-mail: happyherper@gmail.com); **ROBERT VILLA**, 811 N. 10th Ave., Tucson, Arizona 85705, USA (e-mail: cacabel1985@gmail.com).

***NERODIA ERYTHROGASTER TRANSVERSA* (Blotched Watersnake)**. USA: TEXAS: Hidalgo Co.: McAllen, along S. 10th St. (26.16473°N, 98.23066°W; WGS 84). 31 March 2011. José Manuel Cantú Martínez and Edwin Quintero. Verified by Frank W. Judd. University of Texas – Pan American Vertebrate Museum (UTPA 03116.) New county record (Dixon 2000. Amphibians and Reptiles of Texas. 2nd ed., revised. Univ. of Texas A&M Press, College Station, Texas. viii + 421 pp.; Werler and Dixon 2000. Texas Snakes: Identification, Distribution, and Natural History. University of Texas Press, Austin, Texas. xv + 437 pp.). Male (55.2 cm SVL, 68.0 cm TL, mass 211.3 g) found foraging in an irrigation ditch at 1818 h. Habitat consisted mostly of tall cattail reeds in shallow water roughly 30 cm deep.

A previous photographic record of *N. erythrogaster transversa* from Estero Llano Grande State Park (Weslaco, Hidalgo Co., 26.12634°N, 97.95649°W; WGS 84), approximately 28 km E from the McAllen record, was taken by CRH on 06 June 2009. A second male from Hidalgo Co., near Donna (26.09488°N, 98.07272°W; WGS 84), 18 km ESE from the McAllen record, was captured on 10 April 2011 by N. de la Cruz, J. Martinez, R. Silva, and M. Valdez. These observations fill a distributional gap in the Lower Rio Grande Valley between Starr Co. (63 km WNW of McAllen) and Cameron Co. (85 km ESE of McAllen).

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***OPHEODRYS AESTIVUS* (Rough Greensnake)**. USA: GEORGIA: Wheeler Co.: 4.6 km SE of Scotland (32.029760°N, 82.774528°W; NAD 83). 7 April 2011. L. Wyrwich, D. Benboe, J. Godwin, and D. Stevenson. Verified by Lance D. McBrayer. GSU 18998. New county record (Jensen et al. [eds.] 2008. The Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.).

LUKE WYRWICH and **DANIEL BENBOE,** Zoo Atlanta, Department of Herpetology, 800 Cherokee Ave., SE, Atlanta, Georgia 30312, USA; **JAMES C. GODWIN,** Alabama Natural Heritage Program, Environmental Institute, 1090 S. Donahue Drive, Auburn University, Alabama 36849, USA; **DIRK J. STEVENSON**, The Orianne Society, Indigo Snake Initiative, 414 Club Drive, Hinesville, Georgia 31313, USA.

***OXYRHOPUS FORMOSUS* (Yellow-headed Calico Snake)**. COLOMBIA: CÓRDOBA: Tierralta: Cerro Murrucucú, Parque Natural Nacional Paramillo (8.3533°N, 76.395°W; Bogotá WGS 84; elev. 800 m). 03 March 2009. J. E. Carvajal-Cogollo and V. Bernal. ICN 10453, 11561. Verified by O. V. Castaño-Mora, Rafael A. Moreno-Arias, and Guido Medina-Rangel. New state record. Northernmost record for South America, extends range to Cordillera Occidental ca. 380 km airline N from nearest locality (Magdalena Valley, Department of Santander; Pérez-Santos and Moreno 1988. Ofidios de Colombia. Monografía VI. Mus. Reg. Sci. Nat. Torino. 517 pp.). Species was prevously known from Colombia, Venezuela, Ecuador, Peru, Guyana, Surinam, French Guiana, Brazil, Argentina, Bolivia (Uetz et al. 2011. http://reptile-database.org/, accessed 16 July 2011). In Colombia it has been recorded from the west of the Andes, in Eastern and Central Cordilleras (Pérez-Santos and Moreno 1988, *op. cit.*).

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***PANTHEROPHIS GUTTATUS* (Red Cornsnake)**. USA: GEORGIA: Calhoun Co.: 31.59013°N, 84.50880°W (WGS 84), elev. 73 m. 11 May 2011. Robert L. Hill and Leslie Phillips. Verified by John Jensen. UTADC 6903–6904. New county record (Jensen et al. [eds.], 2008. Amphibians and Reptiles of Georgia. Univ. of Georgia Press, Athens. 575 pp.); documented previously in adjacent Baker and Miller counties. Fresh DOR specimen observed at 2205 h on County Road 136, ~0.15 km S of jct with Hwy 234. Photographed and moved off road.

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***PITUOPHIS MELANOLEUCUS* (Pinesnake)**. USA: ALABAMA: Macon Co.: DOR 75 m W of the intersection of State Road 14 and Macon County Rd. 77 (32.55921°N, 85.79234°W; WGS 84). 26 April 2011. S. Graham. AUM 39504. Verified by Craig Guyer. New county record (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn Printing Co., Auburn, Alabama. 347 pp.). This record fills a ~50 km distribution gap for this species between the nearest specimens known from Tallapoosa Co. to the west and Russell Co. to the east. Like nearby specimens from Tallapoosa Co. (Mount, *op. cit.*), this specimen appears intergradient between *P. m. melanoleucus* and *P. m. mugitus*, having well-defined, black posterior blotches and a speckled anterior with no blotches.

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***RAMPHOTYPHLOPS BRAMINUS* (Brahminy Blind Snake)**. GABON: OGOOUÉ-MARITIME PROVINCE: Bendjé Department: Port-Gentil, Quartier SEEG. April 2008. P. Sarrazin. Institut Royal des Sciences naturelles de Belgique, Brussels (IRSNB 17969). Smithsonian Institution's Gabon Biodiversity Center, Gamba (Gamba 244). Verified by G. L. Lenglet (IRSNB). Both individuals found in cultivated house garden, where species reportedly is common according to local gardeners. First provincial record. This introduced species presently is known in Gabon from the capital city, Libreville, Estuaire Province and Port-Gentil (Pauwels et al. 2004. Hamadryad 29:138–139; Pauwels and Vande weghe 2008. Les reptiles du Gabon. Smithsonian Institution, Washington, D.C. 272 pp.). We thank G. L. Lenglet (IRSNB) for providing working facilities.

OLIVIER S. G. PAUWELS, Département des Vertébrés Récents, Institut Royal des Sciences naturelles de Belgique, Rue Vautier 29, 1000 Brussels, Belgium (e-mail: osgpauwels@yahoo.fr); **ELIE TOBI**, Smithsonian Institution, c/o Shell Gabon, BP 48, Gamba, Gabon (elie_tobi@yahoo.fr); **PHILIPPE SARRAZIN**, B.P. 1848, Port-Gentil, Gabon (e-mail: philippesarrazin@hotmail.fr).

***RAMPHOTYPHLOPS BRAMINUS* (Brahminy Blind Snake)**. CAPE VERDE: ISLAND OF SANTIAGO: Municipality of Santa Cruz:

Region of Achada Fazenda, Village of Zimbrão (15.061515°N, 23.626099°W). Late November 2009. Verified by Van Wallach. Florida Museum of Natural History, University of Florida. UF 157346, 157347. An invasive in many parts of Africa, particularly along coasts (Nussbaum 1980. Herpetologica 36[3]:215–221). Cape Verde, an archipelagic nation located ~500 km off west coast of Africa, has no native snakes (Heckman 1985. Environ. Mgmt. 9[2]:141–149). These specimens mark the first records of suborder Serpentes within the country. Two bricklayer's assistants located the specimens while cleaning around a house under construction (B. Nascimento, pers. comm.). Reports from Cape Verde indicated that farmers in Ribeira Zimbrão located two additional snakes in January 2010. We thank Jeff Lord for bringing these specimens to our attention.

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***REGINA RIGIDA* (Glossy Crayfish Snake)**. USA: ARKANSAS: Calhoun Co.: 2 km N of Calion, Ouachita River backwaters off US 167; (33.346344°N, 92.532132°W). 01 April 2011. M. B. Connior. Verified by S. E. Trauth. Arkansas State University Museum of Zoology Herpetology Collection (ASUMZ 31641). New county record (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville. 421 pp.). Has also been collected in neighboring Union Co. This juvenile individual was hand-captured under a log in a small slough.

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***STORERIA DEKAYI* (Dekay's Brownsnake)**. USA: GEORGIA: Effingham Co.: 12.0 km E Newington (32.579298°N, 81.375730°W; NAD 83). 2 February 2011. M. Elliott, D. Stevenson, and A. Day. Verified by Lance D. McBrayer. GSU 18999. New county record (Jensen et al. [eds.] 2008. The Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.).

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***THAMNODYNASTES ALMAE* (Jararaca False Snake)**. BRAZIL: RIO GRANDE DO NORTE: Municipality of Santa Maria: Fazenda Tanques (5.854°S, 35.701°W; datum WGS84), elev. 137 m. 17 October 2009. J. da Silva Jorge. Coleção Herpetológica do Departamento de Botânica, Ecologia e Zoologia, Universidade Federal do Rio Grande do Norte, Natal, Rio Grande do Norte (CHBEZ 3044–3046). Verified by F. L. Franco. The species was known only in Brazil from Bahia, Ceará, Paraíba, Pernambuco, Alagoas and Bahia states (Franco and Ferreira 2002. Phyllomedusa 1:57–74; Guedes 2010 Herpetol. Rev. 41:245; Roberto et al. 2009. Herpetol. Rev. 40:238). New state record, extending range 250 km NW from the municipality of Cabaceiras, state of Paraíba, Brazil (Guedes 2010, *op. cit.*). All exemplars were collected in rupicolous bromeliads (*Encholirium spectabile*) in rock outcrops in Agreste region.

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***THAMNOPHIS BRACHYSTOMA* (Short-headed Gartersnake)**. USA: OHIO: Trumbull Co.: Brookfield Township, Masury. Sharon-Bedford Road, 0.576 km W of junction with State Line Road (41.20738°N; 80.52574°W; WGS 84). 27 July 2009, Raymond J. Novotny. Verified by Timothy O. Matson. Cleveland Museum of Natural History (CM 13425). New county record (Wynn and Moody 2006. Ohio Turtle, Lizard, and Snake Atlas. Ohio Biol. Surv. Misc. Contrib. No. 10). Previously, BSG and MAL confirmed a population of *T. brachystoma* in Mercer Co., Pennsylvania at the Pennsylvania-Ohio border 2.4 km N of Interstate 80 (41.20625°N; 80.51859°W; WGS 84). Voucher specimen deposited at the Natural History Museum at the Tom Ridge Environmental Center (TREC R-00053). This find led RJN to search for and subsequently discover the species in Trumbull Co., Ohio at a site 0.5 km W of the Pennsylvania site. Extends the range ca. 15 km N of nearest Ohio locality in Mahoning Co. (Novotny 1990. Herpetol. Rev. 21:42). These observations are approximately 36 km W of the nearest Pennsylvania records in Mercer Co. (Hulse et al. 2001. Amphibians and Reptiles in Pennsylvania and the Northeast. Cornell Univ. Press, Ithaca. xii + 419 pp.).

We thank Gian Rocco for alerting us to the presence of this population.

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***THAMNOPHIS ELEGANS* (Terrestrial Gartersnake)**. USA: NEBRASKA: Banner Co.: 3 km S, 21 km W Harrisburg, Bull Canyon (41.52972°N, 103.9918°W; NAD 1983). 4 August 2010 and 19 September 2010. Keith Geluso and Kenneth N. Geluso. Verified by Curtis J. Schmidt. Sternberg Museum of Natural History, Fort Hays State University, Hays, Kansas (MHP 15627, 15625, respectively). First county records. Specimens represent a 100 km range extension to the south of localities in Sioux Co. (Ballinger et al. 2010. Amphibians and Reptiles of Nebraska. Rusty Lizard Press, Oro Valley, Arizona. 400 pp.; Fogell 2010. A Field Guide to the Amphibians and Reptiles of Nebraska. University of Nebraska, Lincoln. vi + 158 pp.). Individuals were captured along an intermittent stream on the floor of the canyon. Banks of the stream bed were grassy and shaded by Box Elders (*Acer negundo*). Steep slopes of canyonsides contained junipers (*Juniperus* sp.) and Ponderosa Pines (*Pinus ponderosa*).

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***THAMNOPHIS RADIX* (Plains Gartersnake)**. USA: ILLINOIS: Carroll Co.: Savanna, residence on the corner of Jefferson St. & 3rd St. (42.093380°N, 90.156288°W; WGS84). 23 May 2011. Collected by A. M. Durso. Verified by C. A. Phillips. INHS 2011-03. New county record (Phillips et al. 1999. Field Guide to Amphibians and Reptiles of Illinois. Illinois Natural History Survey Manual 8. 300 pp.). An adult female *T. radix* and three juveniles were discovered under paving stones in a residential garden in downtown Savanna.

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Noteworthy Records of Amphibians and Reptiles from Zacatecas, México

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The herpetofauna of Zacatecas is relatively poorly known judging by the few studies that have been published for the state. To date, 18 species of amphibians and 59 species of reptiles have been documented from Zacatecas (CONABIO 2006). Other papers listing species in Zacatecas include those by Smith and Taylor (1945, 1948, 1950), Baker et al. (1967), Wilson and McCranie (1979), and Baker et al. (1980). To help rectify this deficit in distributional information, we conducted field herpetological surveys in 2008 within the municipality of Atolinga, and during 2009 in the southern part of the state in the municipalities of Mezquital del Oro, Trinidad García de la Cadena, and Moyahua de Estrada (Fig. 1). Our collecting efforts produced nine new state and three new municipality records; all are presented herein. All voucher specimens and photographs were deposited in the Museo de Zoología, Facultad de Ciencias, UNAM (MZFC). All vouchers were collected by the first two authors and identifications verified by Luis Canseco Marquez. The map datum for locality coordinates was WGS84. Standard English names are those suggested by Liner and Casas-Andreu (2008).

ANURA — FROGS

***RHINELLA MARINA* (Cane Toad)**. Municipality of Mezquital Del Oro: 1 km N of Mezquital del Oro (21.22769°N, 103.37003°W), 1230 m elev. 19 April 2009. MZFC-ID 014. New state record and a ca. 56 km N range extension from closest reported locality north of Guadalajara, Jalisco (Ponce-Campos and Huerta-Ortega 2004). The toad was found in tropical deciduous forest.

***SMILISCA FODIENS* (Lowland Burrowing Treefrog)**. Municipality of García De La Cadena: 2 km S of García de la Cadena (21.18928°N, 103.47519°W), 1880 m elev. 31 August 2008. MZFC 23703. New state record, and a ca. 50 km NE (air line) range extension from the closet known locality at La Magdalena, Jalisco (Duellman 2001). This species was commonly observed under rocks in tropical deciduous forest.

***HYPOPACHUS VARIOLOSUS* (Sheep Frog)**. Municipality of Mezquital Del Oro: 1 km N of Mezquital del Oro (21.22769°N, 103.37003°W), 1230 m elev. 19 April 2009. MZFC 23716. Municipality of Atolinga, Ojo de Agua, 2 km W Los Adobes (21.74808°N, 103.49856°W), 2151 m elev. 28 July 2008. MZFC 23696. New state record, filling a distributional gap between localities at Guadalajara, Jalisco (Ponce-Campos and Huerta-Ortega 2004), and in the Municipality of Calvillo, Aguascalientes (Vásquez-Díaz and Quintero-Díaz 2005). The frogs were found in tropical deciduous forest and oak forest, respectively.

***LITHOBATES NEOVOLCANICUS* (Transverse Volcanic Leopard Frog)**. Municipality of García De La Cadena: 2 km S of García de la Cadena (21.19858°N, 103.47378°W), 1770 m elev. 31 August 2008. MZFC 23699. Municipality of Atolinga, Cerrito Pelón (21.82803°N, 103.41067°W), 2067 m elev. 26 October 2008. MZFC 23708. New state records, filling a distributional gap between localities north of Guadalajara, Jalisco (Ponce-Campos and Huerta-Ortega 2004), and in the Municipality of Calvillo, Aguascalientes (Vásquez-Díaz and Quintero-Díaz 2005). The frogs were found in grassland and aquatic vegetation, respectively.

***LITHOBATES PSILONOTA* (Smooth-backed Frog)**. Municipality of Mezquital Del Oro: 1 km N of Mezquital del Oro (21.22744°N, 103.16689°W), 1255 m elev. 17 May 2009. MZFC 23721. New state record, and a ca. 56 km N range extension from the closet known locality north of Guadalajara, Jalisco (Ponce-Campos and Huerta-Ortega 2004). It also fills a distributional gap between records in Aguascalientes and Jalisco (Hillis et al. 1984; Webb 2001). The frog was found in tropical deciduous forest near a water source.

SQUAMATA — LIZARDS

***CTENOSAURA PECTINATA* (Western Spiny-tailed Iguana)**. Municipality of Mezquital Del Oro: 1 km N Mezquital del Oro (21.22744°N, 103.16689°W), 1255 m elev. 17 May 2009. MZFC 23722. New municipality record. Previously known in Zacatecas from Santa Rosa, about 20 km (air line) to the northwest (Baker et al. 1967). The specimen was found in tropical deciduous forest.

***SCELOPORUS CLARKII* (Clark's Spiny Lizard)**. Municipality of Mezquital Del Oro: 1 km N of Mezquital del Oro (21.22769°N, 103.37003°W), 1230 m elev. 16 May 2009. MZFC 23719. New municipality record. Previously known in Zacatecas from Santa Rosa, about 20 km (air line) to the northwest (Baker et al. 1967). The specimen was found in tropical deciduous forest.

***SCELOPORUS UTIFORMIS* (Cope's Large-scaled Spiny Lizard)**. Municipality of Mezquital Del Oro: 1 km N of Mezquital del Oro (21.22769°N, 103.37003°W), 1230 m elev. 19 April 2009. MZFC 23717–718. New state record, with the closest previous known locality being from the Rio Santiago near Guadalajara, Jalisco (Ponce-Campos and Huerta-Ortega 2004). The specimen was found in tropical deciduous forest.

***UROSAURUS BICARINATUS* (Tropical Tree Lizard)**. Municipality of Atolinga: 3 km E of Cerrito Pelón (21.84442°N, 103.41564°W), 2120 m elev. 28 September 2008. MZFC 23705. New municipality record, and a range extension of ca. 73 km (air line) N of a

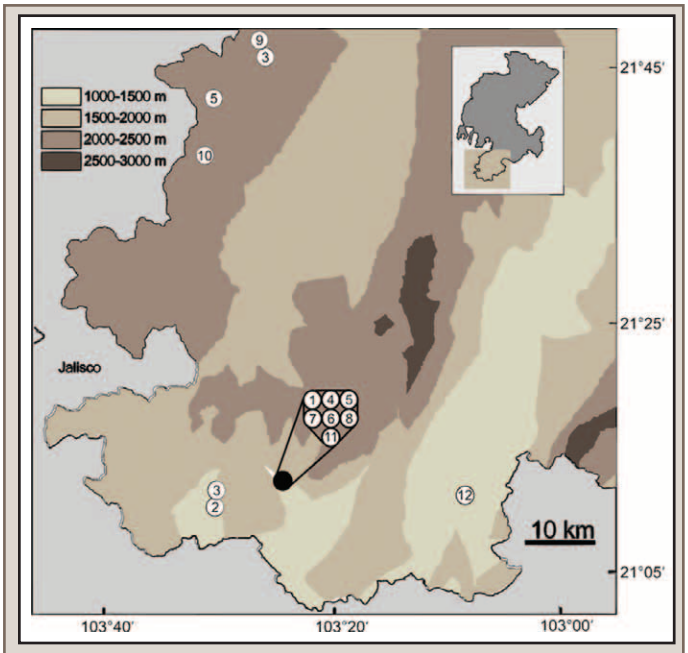


FIG. 1. Map of Zacatecas with localities of amphibians and reptiles reported herein: 1. *Rhinella marina* 2. *Smilisca fodiens* 3. *Lithobates neovolcanicus* 4. *Lithobates psilonota* 5. *Hypopachus variolosus* 6. *Ctenosaura pectinata* 7. *Sceloporus clarki* 8. *Sceloporus utiformis* 9. *Urosaurus bicarinatus* 10. *Lampropeltis mexicana* 11. *Leptodeira splendida* 12. *Crotalus basiliscus.*

previously known locality in the state at Santa Rosa (Baker et al. 1967). The specimen was found in oak forest.

SQUAMATA — SNAKES

***LAMPROPELTIS MEXICANA* (San Luis Potosí Kingsnake).** MUNICIPALITY OF ATOLINGA, LA CIENEGA: (21.66683°N, 103.51244°W), 2328 m elev. 29 September 2008. MZFC 23706. New state record, extending the known range in Zacatecas ca. 106 km SW from the closest known locality at Arroyo los Timones, 1 km S of Santa Rosa (Quintero-Díaz et al. 2001), and fills an east-west gap between the known localities in Aguascalientes (Vásquez-Díaz and Quintero-Díaz, 2005) and Nayarit (Hansen et al. 2011). The snake was found in oak forest.

***LEPTODEIRA SPLENDIDA* (Splendid Cat-eyed Snake).** MUNICIPALITY OF MEZQUITAL DEL ORO: 1 km N of Mezquital del Oro (21.22744°N, 103.16689°W), 1255 m elev. 17 May 2009. MZFC 23723. New state record, extending the known range ca. 42 km N from the closet known locality north of Guadalajara, Jalisco (Ponce-Campos et al. 2003). The specimen was found in tropical deciduous forest.

***CROTALUS BASILISCUS* (Mexican West Coast Rattlesnake).** MUNICIPALITY OF MOYAHUA DE ESTRADA: 2.25 km N (by road) of Santa Rosa (21.21256°N, 103.18183°W), 1148 m elev. 7 August 2009. MZFC-ID 013. New state record, with the closest known locality being 102 km S from Rio Santiago in Guadalajara, Jalisco (Ponce-Campos and. Huerta-Ortega 2004). The specimen was found in tropical deciduous forest.

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New and Noteworthy Records of Amphibians and Reptiles from Reserva de la Biósfera Bosawas, Nicaragua

Nicaragua has a diverse herpetofauna (Köhler 2001; Sunyer and Köhler 2010) that, until recently, has been relatively neglected by researchers when compared to its neighboring countries, Costa Rica (Sasa et al. 2010; Savage 2002) and Honduras (McCranie and Wilson 2002; Townsend and Wilson 2010). As the largest country in Central America, Nicaragua's herpetofaunal diversity is still one of the least known in the region, due largely to the inaccessibility of many areas, particularly along the Atlantic versant. Recent herpetological studies have targeted these inaccessible areas and our knowledge of the Nicaraguan herpetofauna has grown considerably ever since (Köhler 2001; Köhler et al. 2004; Köhler and Sunyer 2006; Sunyer and Köhler 2007, 2010; Sunyer et al. 2008a, 2009a, 2009b, 2010). Among these under-surveyed regions is the largest protected area in the country, Reserva de la Biósfera Bosawas (Bosawas). Covering a total area of 19,926 km^2, roughly 16.5% the total land area in the country, Bosawas is situated in north-central Nicaragua within the departments of Jinotega and Región Autónoma del Atlántico Norte (Atlántico Norte) (MARENA 2009). In addition to vast expanses of primary lowland broadleaf rainforest, Bosawas contains several intact cloud forests and is part of the southern end of the Nuclear Central American highlands. Five of these highland sites lying within the boundary of Bosawas have also been delineated protected areas: Parque Nacional Saslaya, Reserva Natural Cerro Kilambé, Reserva Natural Macizos de Peñas Blancas, Reserva Natural Cerro Banacruz, and Reserva Natural Cerro Cola Blanca (MARENA 2009).

While conducting surveys throughout Bosawas from June 2007 through October 2008, we documented 38 new departmental records, and several other noteworthy accounts of amphibians and reptiles that were poorly known within Nicaragua, reported herein. All specimens were verified by Sebastian Lotzkat and Robert Lara. Voucher specimens were deposited in the Florida Museum of Natural History (UF), Senckenberg Forschungsinstitut und Naturmuseum (SMF), or Museo Herpetológico de la UNAN-Leon (MHUL). Departmental and other records were confirmed using locality information summarized in Köhler and Seipp (1998), Köhler (2001), Köhler et al. (2004), Sunyer and Köhler (2007), Sunyer et al. (2009a), or in other references cited in the text. Geocoordinates are based on datum WGS84.

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ANURA — FROGS

AGALYCHNIS SALTATOR. JINOTEGA: Siwi Was (14.383407°N, 84.966888°W), 180 m elev. 30 July 2007. S. L. Travers, R. Picado, J. F. López, and S. Charley. UF 156023. New departmental record and only the third from Nicaragua, with the closest one being from Eden Mine and Siuna, Department of Atlántico Norte (Duellman 2001; King et al. 2007). The frog was sitting on a tree leaf at 2005 h, 2 m above forest floor.

CRAUGASTOR LAURASTER. JINOTEGA: Reserva Natural Cerro Kilambé, El Chiflón (13.5781°N, 85.707967°W), 1540 m elev. 5 October 2008. S. L. Travers, L. A. Obando, A. Velasquez, J. Lumbi, N. Lumbi, J. S. Lumbi, and A. Zelaya. UF 156037. New departmental record and slight upward elevational extension of 5 m (Sunyer and Köhler 2010). It is also known from the adjacent Nicaraguan departments of Matagalpa and Estelí (Köhler 2001). Atlántico Norte: Parque Nacional Saslaya, Campamento Pie Saslaya (13.76825°N, 85.024483°W), 1200 m elev. 3 July 2007. S. L. Travers, J. Sunyer, L. A. Obando, and O. Montalván. UF 156038. New departmental record.

CRAUGASTOR MIMUS. JINOTEGA: Reserva Natural Cerro Kilambé, Campamento Oedipina (13.574567°N, 85.696817°W), 1626 m elev. 16 July 2008. S. L. Travers, L. A. Obando, S. Doucette-Riise, A. Velasquez, M. Lumbi, I. Arauz, A. Zelaya, and M. Arauz. UF 156031. This record extends the known elevational range of this species by 686 m (Savage 2002).

HYPOPACHUS VARIOLOSUS. JINOTEGA: Reserva Natural Cerro Kilambé, La Escuelita (13.619633°N, 85.723317°W), 1070 m elev. 19 July 2008. S. L. Travers, L. A. Obando, S. Doucette-Riise, A. Velasquez, A. Zelaya, and M. Arauz. UF 156020. New departmental record. The frog was found dead at 1615 h on a dirt road.

INCILIUS COCCIFER. JINOTEGA: Wiwilí (13.62375°N, 85.798633°W), 353 m elev. 13 July 2008. S. L. Travers, L. A. Obando, and S. Doucette-Riise. UF 156022. New departmental record. The toad was found calling at 2000 h from a puddle in a cattle pasture.

INCILIUS CONIFERUS. JINOTEGA: Siwi Was (14.387767°N, 84.979917°W), 180 m elev. 29 July 2007. S. L. Travers, R. Picado, J. F. López, and S. Charley. UF 156033. Northernmost record for the species in Central America, extending its range 118 km NE from Cerro Kilambé, El Hielo, Jinotega (Köhler 2001). The toad was found active on a palm frond at 2030 h, 1 m above forest floor.

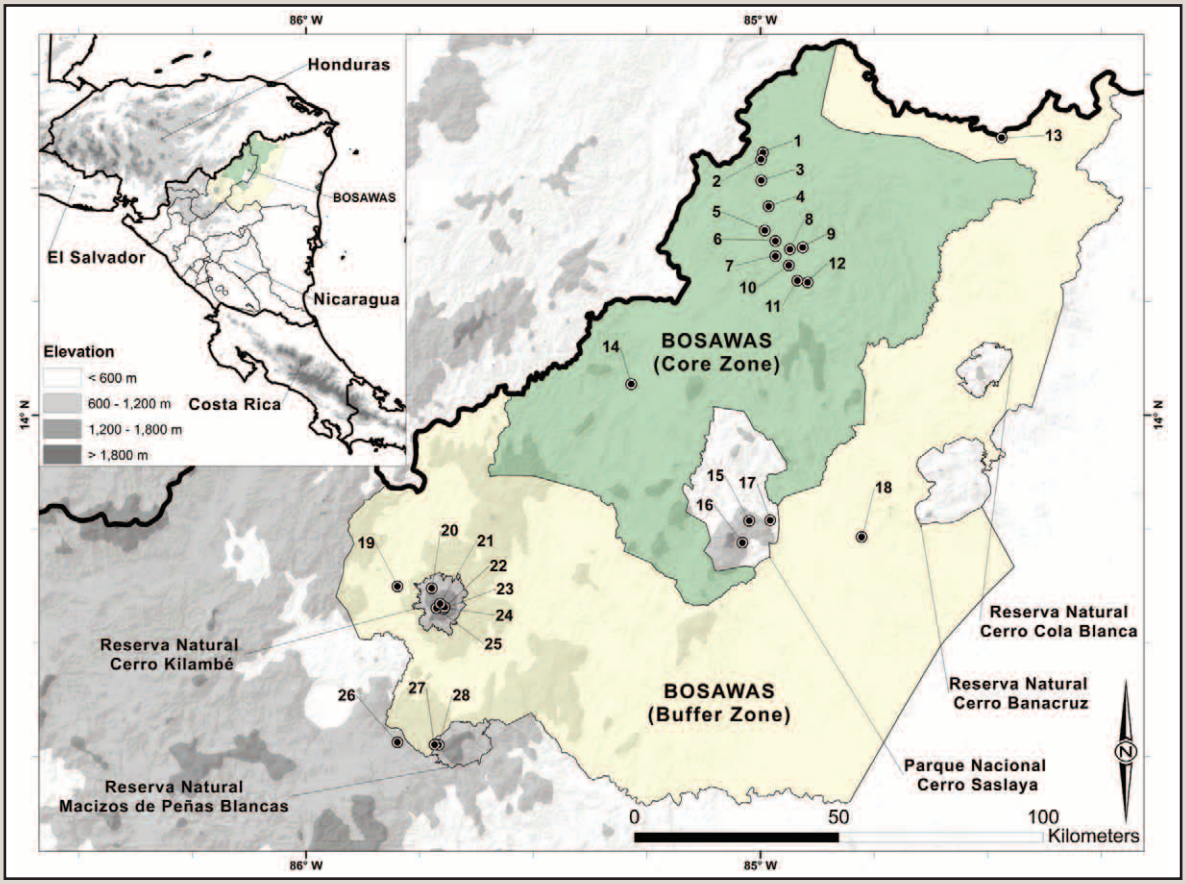


FIG. 1. Map of Reserva de la Biósfera Bosawas, Nicaragua. Numbers correspond to the following collection localities: Limi Tingni (1), Wailahka (2), Aran Dak (3), Supa Was (4), Maikawana (5), Siwi Was (6), Muru Ta (7), Pamka Buhna (8), Laka Papan (9), Kulum Kitang (10), Urus Was (11), Kama Pih (12), Krin Krin (13), Río Bocay near Amak (14), Campamento Pie Saslaya (15), El Revenido (16), Río Majagüe (17), Siuna (18), Wiwilí (19), La Escuelita (20), property of A. Velasquez (21), La Reculona (22), Campamento Oedipina (23), El Chiflón (24), El Desacuerdo (25), La Cascada (26), El Horno (27), El Fogón (28).

SMILISCA PHAEOTA. JINOTEGA: Reserva Natural Cerro Kilambé, La Reculona (13.5781°N, 85.69495°W), 1457 m elev. 15 July 2008. S. L. Travers, L. A. Obando, S. Doucette-Riise, A. Velasquez, M. Lumbi, and I. Arauz. UF 156034. New elevational record extending the range of the species upward by 207 m (Köhler 2001).

SMILISCA SORDIDA. JINOTEGA: Supa Was (14.4599°N, 84.981867°W), 175 m elev. 24 August 2008. S. L. Travers, D. Manzanarez, R. Picado, J. F. López, and S. Charley. UF 156323. New departmental record that fills in a distributional gap of 210 km between the northernmost Nicaraguan record (Duellman 2001) and the nearest known locality in Honduras (McCranie et al. 2006). The frog was active at 2054 h on tree branch, 8 m above forest floor.

TERATOHYLA PULVERATA. ATLÁNTICO NORTE: Laka Papan (14.369467°N, 84.906983°W), 220 m elev. 18 August 2008. S. L. Travers, D. Manzanarez, R. Picado, J. F. López, and S. Charley. UF 156029. New departmental record for this species (Köhler 2001) that was previously known only from three localities in Nicaragua (Köhler 2001; Sunyer et al. 2009a).

TERATOHYLA SPINOSA. ATLÁNTICO NORTE: Kama Pih (14.292533°N, 84.896067°W), 250 m elev. 26 July 2007. S. L. Travers, R. Picado, J. F. López, and S. Charley. UF 156012. New departmental record. The frog was calling from a tree branch at 1920 h, 1.3 m above a stream. Jinotega: Supa Was (14.4599°N, 84.981867°W), 175 m elev. 24 August 2008. S. L. Travers, R. Picado, J. F. López, and S. Charley. UF 156030, 156035. New departmental records. The amplexing pair was found on a leaf at 2040 h, 4 m above a stream. *Teratohyla spinosa* inhabits humid lowlands from eastern Honduras to northwestern Ecuador (McCranie and Wilson 2002; Savage 2002) and was only recently documented in Nicaragua (Sunyer and Köhler 2007). Our records fill in a previous distributional gap of 412 km between the northernmost Nicaraguan record (Sunyer and Köhler 2007) and the nearest known locality in Honduras (McCranie et al. 2006).

SQUAMATA — LIZARDS

ANOLIS BIPORCATUS. JINOTEGA: Reserva Natural Cerro Kilambé, on property of A. Velasquez (13.585583°N, 85.70485°W), 1300 m elev. 4 October 2008. S. L. Travers, L. A. Obando, and J. Lumbi. UF 156021. New departmental record.

ANOLIS CAPITO. JINOTEGA: Reserva Natural Macizos de Peñas Blancas, El Fogón (13.27498°N, 85.708067°W), 1405 m elev. 23 October 2008. S. L. Travers, L. A. Obando, and B. Alemán. UF 156024. New elevational record, extending its range upward by 105 m (Köhler 2001; Savage 2002).

ANOLIS CARPENTERI. JINOTEGA: Reserva Natural Macizos de Peñas Blancas, La Cascada (13.275783°N, 85.716967°W), 1058 m elev. 20 October 2008. S. L. Travers, L. A. Obando, and B. Alemán. UF 156032. New departmental record.

ANOLIS WERMUTHI. JINOTEGA: Reserva Natural Cerro Kilambé, El Desacuerdo (13.575917°N, 85.71285°W), 1658 m elev. 6 October 2008. S. L. Travers, L. A. Obando, A. Velasquez, J. Lumbi, M. Lumbi, J. S. Lumbi, and A. Zelaya. UF 156025. New elevational record, extending its upward range by 158 m (Köhler 2001; Sunyer et al. 2008b). Reserva Natural Macizos de Peñas Blancas, El Horno (13.280867°N, 85.7987°W), 1516 m elev. 24 October 2008. S. L. Travers and L. A. Obando. UF 156026. This site corresponds to the fifth known isolated population of *A. wermuthi*, all of which are within Nicaragua (Sunyer et al. 2008b).

HEMIDACTYLUS FRENATUS. ATLÁNTICO NORTE: Siuna (13.732483°N, 84.777217°W), 204 m elev. 28 July 2008. S. L. Travers, S. Doucette-Riise, and S. C. Gonzalez. UF 156028. New departmental record. The closest known locality in Nicaragua is from Rama, located 185 km southeast in the Department of Atlántico Sur (Köhler 2001). *Hemidactylus frenatus* is a non-native species in Nicaragua, and although poorly documented, it occurs in most developed areas throughout the country.

SPHAERODACTYLUS MILLEPUNCTATUS. JINOTEGA: Kulum Kitang (14.33°N, 84.9375°W), 180 m elev. 18 June 2007. S. L. Travers, J. H. Townsend, L. D Wilson, J. Sunyer, L. A. Obando, D. E. Griffith, R. Picado, J. F. López, and S. Charley. SMF 88137. New departmental record.

SPHENOMORPHUS CHERRIEI. JINOTEGA: Limi Tingni (14.578017°N, 84.994283°W), 139 m elev. 30 August 2008. S. L. Travers, D. Manzanarez, R. Picado, J. F. López, and S. Charley. UF 156027. New departmental record.

SQUAMATA — SNAKES

BOA CONSTRICTOR. JINOTEGA: Río Bocay near Amak (14.0688°N, 85.2843°W), 208 m elev. 9 June 2007. S. L. Travers, J. H. Townsend, L. D Wilson, J. Sunyer, L. A. Obando, and D. E. Griffith. SMF 89012. New departmental record. The snake was resting on vegetation at 1200 h, 1 m above a river.

CHIRONIUS GRANDISQUAMIS. JINOTEGA: Aran Dak (14.516883°N, 84.997983°W), 153 m elev. 14 August 2008. S. L. Travers, D. Manzanarez, R. Picado, J. F. López, and S. Charley. UF 155963. New departmental record. The snake was found sleeping on vegetation at 2100 h, 3 m above a stream.

CLELIA CLELIA. JINOTEGA: Maikawana (14.406733°N, 84.990383°W), 160 m elev. 14 July 2007. S. L. Travers, R. Picado, J. F. López, and S. Charley. UF 156002. New departmental record. The snake was found while active at 2000 h, on forest floor after heavy rains.

CORALLUS ANNULATUS. ATLÁNTICO NORTE: Pamka Buhna (14.365333°N, 84.93495°W), 186 m elev. 20 August 2008. S. L. Travers, D. Manzanarez, R. Picado, J. F. López, and S. Charley. UF 155940. New departmental record. This report represents the fourth known locality for Nicaragua that fills in a distributional gap of 290 km between the northernmost Nicaraguan record (Gaige et al. 1937) and the nearest known site in Honduras (McCranie et al. 2006). The snake was active on tree branch at 2040 h, 1.5 m above a stream.

DENDROPHIDION PERCARINATUM. JINOTEGA: Aran Dak (14.516883°N, 84.997983°W), 153 m elev. 14 August 2008. S. L. Travers, D. Manzanarez, R. Picado, J. F. López, and S. Charley. UF 155978. New departmental record. The snake was found sleeping on vegetation at 2130 h, 1 m above forest floor.

DENDROPHIDION VINITOR. JINOTEGA: Reserva Natural Cerro Kilambé, on property of A. Velasquez (13.585583°N, 85.70485°W), 1300 m elev. 5 October 2008. S. L. Travers, L. A. Obando, and J. Lumbi. UF 155977. New departmental record. The snake was brought to us by a local farmer who had recently killed it in a coffee plantation at ca. 1000 h.

DIPSAS BICOLOR. ATLÁNTICO NORTE: Kama Pih (14.292533°N, 84.896067°W), 250 m elev. 25 July 2007. S. L. Travers, R. Picado, J. F. López, S. Charley, and J. L. Henry. UF 155965. New departmental record. It was uncovered from inside of a hollow log at 0940 h, on forest floor. JINOTEGA: Supa Was (14.4599°N, 84.981867°W), 175 m elev. 24 August 2008. S. L. Travers, D. Manzanarez, R. Picado, J. F. López, and S. Charley. UF 155967. New departmental record. The snake was active on a tree branch at 2010 h, 4 m above ground. In Nicaragua the species was most recently known only from the holotype and type locality, 320 km S of the Atlántico Norte location at Chontales Mines, in the Department of Río San Juan (Günther 1895 [1885–1902]). Thus, our two specimens also represent the second and third records for the country (Köhler 2001).

DRYMARCHON MELANURUS. JINOTEGA: Muru Ta (14.350275°N, 84.966822°W), 180 m elev. 13 June 2007. S. L. Travers, J. H. Townsend, L. D Wilson, J. Sunyer, L. A. Obando, D. E. Griffith, R. Picado, J. F. López, and S. Charley. SMF 89016. New departmental record. The snake was detected along a riverbank while in the process of consuming an adult *Leptodactylus savagei*.

ENULIOPHIS SCLATERI. JINOTEGA: Muru Ta (14.3665°N, 84.976°W), 180 m elev. 15 July 2007. S. L. Travers, R. Picado, J. F. López, and S. Charley. UF 155949. New departmental record and only the fourth individual reported from Nicaragua (Köhler et al. 2004). The snake was emerging from a tree hole at 2100 h, 1 m above the forest floor.

IMANTODES INORNATUS. JINOTEGA: Wailahka (14.563233°N, 84.998533°W), 120 m elev. 6 August 2007. S. L. Travers, R. Picado, J. F. López, and S. Charley. UF 155943. New departmental record. This individual represents the third country record for this species from Nicaragua (Köhler 2001). It was active on tree branch at 2020 h, 2 m above forest floor.

LEPTODEIRA SEPTENTRIONALIS. ATLÁNTICO NORTE: Parque Nacional Saslaya, Río Majagüe (13.769233°N, 84.978567°W), 220 m elev. 30 June 2007. S. L. Travers, J. Sunyer, L. A. Obando, and O. Montalván. SMF 88980. New departmental record. The closest known locality in Nicaragua is located 124 km to the southwest at Finca Tepeyac, Department Matagalpa (Köhler 2001). The snake was found on branch at 2121 h, 2.5 m above forest floor.

MASTIGODRYAS MELANOLOMUS. JINOTEGA: Reserva Natural Cerro Kilambé, trail from La Escuelita to a property owned by A.

Velasquez (13.5943°N, 85.696817°W), 1178 m elev. 14 July 2008. S. L. Travers, L. A. Obando, and S. Doucette-Riise. UF 155990. New departmental record. The snake was found resting on vegetation at 1100 h, 1.2 m above trail.

OXYBELIS BREVIROSTRIS. JINOTEGA: Siwi Was (14.38776°N, 84.979917°W), 180 m. 30 July 2007. S. L. Travers, R. Picado, J. F. López, and S. Charley. UF 155922. New departmental record. The snake was sleeping on a tree branch at 2020 h, 2 m above forest floor.

PORTHIDIUM NASUTUM. JINOTEGA: Aran Dak (14.516883°N, 84.997983°W), 153 m elev. 4 August 2007. S. L. Travers, R. Picado, J. F. López, and S. Charley. MHUL 001. New departmental record. This specimen was brought in by one of the villagers who had killed it in secondary broadleaf forests outside the immediate vicinity of the community.

SIBON LONGIFRENIS. JINOTEGA: Kulum Kitang (14.33°N, 84.9375°W), 180 m elev. 18 June 2007. S. L. Travers, J. H. Townsend, L. D Wilson, J. Sunyer, L. A. Obando, D. E. Griffith, R. Picado, J. F. López, and S. Charley. SMF 88182. ATLÁNTICO NORTE: Urus Was (14.296217°N, 84.918517°W), 220 m elev. 19 July 2007. S. L Travers, R. Picado, J. F. López, and S. Charley. UF 155952. Both are new departmental records, representing the second and third localities known from Nicaraugua that fill a 490 km distributional gap between the Isla de Diamante on the San Juan River (Department of San Juan) near the Costa Rican border (Köhler 2001) and the nearest locality in Honduras (McCranie et al. 2006).

SIBON NEBULATUS. JINOTEGA: Wailahka (14563233°N, 84.998533°W), 120 m elev. 7 August 2007. S. L. Travers, R. Picado, J. F. López, and S. Charley. UF 155959. New departmental record. The snake was brought in this morning by a villager who had caught it the previous night as it crawled through his thatched-roof stilt house.

SPILOTES PULLATUS. JINOTEGA: Wailahka (14.563233°N, 84.998533°W), 120 m elev. 6 August 2007. S. L. Travers, R. Picado, J. F. López, and S. Charley. UF 155950. New departmental record.

TRETANORHINUS NIGROLUTEUS. JINOTEGA: Muru Ta (14.3665°N, 84.976°W), 180 m elev. 13 June 2007. S. L. Travers, J. H. Townsend, L. D. Wilson, J. Sunyer, L. A. Obando, D. E. Griffith, R. Picado, J. F. López, and S. Charley. SMF 87266. ATLÁNTICO NORTE: Laka Papan (14.369467°N, 84.906983°W), 220 m elev. 17 August 2008. S. L. Travers, D. Manzanarez, R. Picado, J. F. López, and S. Charley. UF 155979; Krin Krin (14.61115°N, 84.469167°W), 60 m elev. 16 August 2007. J. Sunyer and D. Manzanarez. MHUL 002. All the above are new departmental records. Villa (1970) provided a point locality map of *T. nigroluteus* that appeared to contain a record from northeastern Nicaragua. However, we are hesitant to consider this a confirmed record from Atlántico Norte because it is not supported by a voucher specimen or any matching locality information.

TROPIDODIPSAS SARTORII. ATLÁNTICO NORTE: Parque Nacional Saslaya, El Revenido (13.719933°N, 85.039633°W), 793 m elev. 1 August 2008. S. L. Travers, S. Doucette-Riise, S. C. Gonzalez, A. Baldonado, and I. Cruz. UF 155945. New departmental record. The snake represents the second country record that bridges a distributional gap between the other site located 240 m southwest at Casa Colorada, Las Nubes, Department of Managua (Köhler 2001; Villa 1971) and Arunta Tingni Kiamp, Department of Gracias a Dios, Honduras, which is located 135 km to the north. This is also the first record for the Atlantic versant of Nicaragua, and the southernmost record for its Atlantic slope distribution in Mesoamerica. The snake was found active on forest floor at 2152 h.

TESTUDINES — TURTLES

KINOSTERNON LEUCOSTOMUM. JINOTEGA: Siwi Was (14.387767°N, 84.97991°W), 180 m elev. 30 July 2007. S. L. Travers, R. Picado, J. F. López, and S. Charley. UF 156320. New departmental record. The turtle was found swimming in a stream that was ca. 2 m wide, at 2020 h.

TRACHEMYS VENUSTA. JINOTEGA: Rio Lakus, between Aran Dak and Muru Ta (14.416667°N, 84.966667°W), 160 m elev. 12 June 2007. S. L. Travers, J. H. Townsend, L. D Wilson, J. Sunyer, L. A. Obando, D. E. Griffith, R. Picado, J. F. López, and S. Charley. SMF 88199. New departmental record. The closest known locality for this species in Nicaragua is 130 km southeast at Alamikamba, Department Atlántico Norte (Köhler 2001).

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New County Records from Grundy County, Tennessee on the Mid-Cumberland Plateau of Southern Tennessee, USA

The southeastern United States is known for its high herpetofaunal diversity, which can be partly explained by high habitat diversity (Bailey et al. 2006). However, there are still many areas within the southeast that are not well studied, with little scientific documentation of species composition. One such area is the mid-Cumberland Plateau, in particular Grundy Co., Tennessee. Previous documentations for the area can be found in Anderson and Tilley (2003), Fontanella et al. (2008), Miller and Niemiller (2007), Miller et al. (2005) and Williams (1988). However, most of these reports dealt with a single species. Miller et al. (2005) provided the most extensive documentation of species composition in and around Grundy Co..

We implemented a research project addressing herpetofaunal response to oak-regenerating silviculture treatments in 2009–2010. We detected a total of 33 species and 11 are declared new county records. All records were deposited as photographic vouchers in Austin Peay State University (APSU) David H. Snyder Museum of Zoology. All verified by Arthur F. Scott. Along with verification by A. Scott, all specimens were referenced for accuracy by checking Redmond and Scott (1996) and Scott and Redmond (2008). Nomenclature and standard English names follow those used in Crother (2008). Locality coordinates are in decimal degrees in NAD83 UTM zone 16N.

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TESTUDINES – TURTLES

***CHELYDRA SERPENTINA SERPENTINA* (Eastern Snapping Turtle).** GRUNDY CO.: Burrow Cove. 5 September 2010. APSU 19073. Found crossing logging road (35.2351°N, 85.5037°W).

***TERRAPENE CAROLINA CAROLINA* (Eastern Box Turtle).** GRUNDY CO.: Burrow Cove. 2 August 2009. APSU 18991. Found in oak/hickory forest (35.2323°N 85.5039°W).

ANURA – FROGS

***SCAPHIOPUS HOLBROOKII* (Eastern Spadefoot).** GRUNDY CO.: Burrow Cove. 7 August 2009. APSU 19001. Caught in pitfall trap in oak/hickory forest (35.2219°N, 85.5050°W).

SQUAMATA – LIZARDS

***SCINCELLA LATERALIS* (Little Brown Skink)**. Grundy Co.: Burrow Cove. 8 June 2010. APSU 19075. Caught in a pitfall trap in oak/hickory forest (35.2218°N, 85.5050°W).

SQUAMATA – SNAKES

***AGKISTRODON CONTORTRIX* (Copperhead)**. Grundy Co.: Burrow Cove. 9 August 2009. APSU 18992. Caught in a funnel trap in oak/hickory forest (35.2255°N, 85.5109°W).

***COLUBER CONSTRICTOR* (North American Racer)**. Grundy Co.: Burrow Cove.14 June 2009. APSU 18999. Caught in funnel trap in oak/hickory forest (35.2232°N, 85.5048°W).

***CROTALUS HORRIDUS* (Timber Rattlesnake)**. Grundy Co.: Burrow Cove. 10 August 2009. APSU 18993. Caught in funnel trap in oak/hickory forest (35.2347°N, 85.5042°W).

***HETERODON PLATIRHINOS* (Eastern Hog-nosed Snake)**. Grundy Co.: Burrow Cove. 11 June 2009. APSU 19000. Caught in funnel trap in oak/hickory forest (35.2349°N, 85.5040°W).

***LAMPROPELTIS GETULA NIGRA* (Eastern Black Kingsnake)**. Grundy Co.: Burrow Cove. 21 July 2010. APSU 19072. Caught in funnel trap in oak/hickory forest (35.2230°N, 85.5052°W).

***STORERIA OCCIPITOMACULATA OCCIPITOMACULATA* (Northern Red-bellied Snake)**. Grundy Co.: Burrow Cove. 8 September 2009. APSU 19001. Caught in a pitfall trap in oak/hickory forest (35.2219°N, 85.5051°W).

***VIRGINIA VALERIAE* (Smooth Earthsnake)**. Grundy Co.: Burrow Cove. 7 September 2009. APSU 19003. Caught in a pitfall trap in Oak/Hickory Forest (35.2224°N, 85.5038°W).

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NATURAL HISTORY NOTES

CAUDATA — SALAMANDERS

***AMBYSTOMA OPACUM* (Marbled Salamander). SHREW PREDATION.** Laboratory studies demonstrate that ambystomatid salamanders have behavioral and chemical defenses against Northern Short-tailed Shrew (*Blarina brevicauda*) predation (Brodie et al. 1979. Copeia 1979:270–274). Nonetheless, indirect observations made during radio-telemetry studies of free-ranging Spotted Salamanders (*Ambystoma maculatum*) and Tiger Salamanders (*Ambystoma tigrinum*) indicate that Northern Short-tailed Shrews can overcome these defenses and prey upon ambystomatids in subterranean tunnels (Madison 1997. J. Herpetol. 31:542–551; Madison and Farrand 1998. Copeia 1998:402–410). Herein, I provide a direct observation of a Southeastern Short-tailed Shrew (*Blarina carolinensis*) attacking and presumably killing a post-ovipositional adult female Marbled Salamander (*Ambystoma opacum*).

Observations began at 1147 h, 7 Nov 2010, when I heard a rustle in the leaf litter along the elevated boardwalk in Congaree National Park, Richland Co., South Carolina, USA. I observed the salamander moving quickly across the top of the leaf litter. Within seconds, the shrew emerged from the leaf litter and quickly and repeatedly bit the salamander's back and tail. After the attack, the shrew retreated and the salamander resumed crawling across the leaf litter. The shrew, always moving beneath the leaf litter, repeatedly emerged to briefly attack the salamander, and then retreat beneath the leaves. In addition to quick bites, the shrew also latched onto the salamander's back or tail with its mouth and dragged the salamander backwards several cm. When grabbed on the back by the shrew, the salamander assumed a rigid posture, coiling its body and tail towards the shrew. After each attack, the salamander resumed unidirectional movement across the leaf litter and, during eight minutes of observation, moved ca. 2 m.

I broke observations briefly to climb down to ground level. When I relocated the salamander two minutes later, she had changed orientation and was moving in the opposite direction. The shrew was not present. I briefly captured and examined the salamander but found no open wounds. She was slightly sticky, presumably from the release of skin secretions, and pieces of organic debris adhered to her body. She was also sloughing portions of the outer epidermal layer. Soon after I released her, the shrew re-appeared and renewed its attack. During the first attack, the shrew grabbed the salamander's tail with its mouth and dragged the writhing salamander backwards through the leaf litter for ca. 30 cm. After ca. ten seconds, the shrew again grabbed the salamander by the tail and pulled her backward through the leaf litter for ca. 50 cm. At 1204 h, the shrew pulled the salamander into an underground cavity and both disappeared from view. Although the fate of the salamander is unknown, I assume she was killed by the shrew.

Analysis of Northern Short-tailed Shrew stomach contents suggest that salamanders constitute a small fraction (1.2%) of the diet (Hamilton 1930. J. Mammal. 11:26–39). However, studies of radio-telemetered salamanders suggest that shrew predation rates may actually be much higher. For example, Madison (1997, *op. cit.*) attributed half of observed Spotted Salamander predation to Northern Short-tailed Shrews, and Madison and Farrand (1998, *op. cit.*) implicated Northern Short-tailed Shrews in the death of one-third of telemetered Tiger Salamanders. My observation indicates that Marbled Salamanders are vulnerable to predation by Southeastern Short-tailed Shrews, a close relative of Northern Short-tailed Shrews (McCay 2001. Mammalian Species 673:1–7). Although laboratory studies show that Marbled Salamanders possess chemical deterrents to attacks by shrews, salamander granular gland secretions become depleted as the number of shrew attacks increase (DiGiovanni and Brodie 1981. Herpetologica 37:234–237). My observation suggests that the shrew used repeated attacks to circumvent the salamander's chemical defenses, rendering it vulnerable to predation.

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***EURYCEA QUADRIDIGITATA* (Dwarf Salamander). CENTIPEDE PREDATION.** Because of its diminutive size, *Eurycea quadridigitata* is likely vulnerable to a variety of invertebrate and vertebrate predators. However, the only confirmed predators are crayfish (*Procambarus* sp.; Franklin 2000. Herpetol. Rev. 31:98) and Pig Frogs (*Rana grylio*; Lamb 1984. Amer. Midl. Nat. 111:311–318). Herein I report centipede predation of an adult *E. quadridigitata*.

At 1305 h, 11 Dec 2010, I rolled a log in a dry, isolated, cutover *Taxodium ascendens* wetland in Camden Co., Georgia, USA and uncovered an approximately 65-mm long centipede, *Scolopocryptops sexspinosus*, feeding on a Dwarf Salamander (75 mm total length). The centipede had consumed ¾ of the soft tissue on the salamander's head, leaving the skull and mandibles, and had eaten all but the vertebrae from behind the head to approximately mid-body. A single uneaten cirrus indicated the salamander was a male. Upon handling, the salamander's tail slowly undulated, suggesting that capture by the centipede was recent. Inasmuch as these two species have overlapping ranges and select moist microhabitats (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Inst. Press, Washington, D.C. 587 pp.; Shelley 1987. Florida Entomol. 70:498–512), centipede predation of Dwarf Salamanders might occur more often than recognized.

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***PLETHODON CINEREUS* (Red-backed Salamander). ERYTHRISTIC MORPH.** Throughout its range in northeastern United States and southeastern Canada, *Plethodon cinereus* is a relatively abundant plethodontid inhabiting mixed hardwood-conifer forests. Polymorphism within the species includes the striped

or red-backed color morph, the unstriped or lead-backed color morph, and individuals with characteristics intermediate between the two (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Inst. Press, Washington, D.C. 587 pp.). Leucistic and erythristic individuals have been reported (Mendyk et al. 2010. Herpetol. Rev. 41:189–190; Reed 1908. Amer. Nat. 42:460–465). The erythristic morph, characterized by varying degrees of bright crimson pigmentation on the dorsal, lateral, and ventral surfaces, has been documented among populations in New Brunswick, Nova Scotia, Quebec, Ontario, Massachusetts, Connecticut, New York, and Ohio (Pauley et al. 2001. Northeast. Nat. 8:355–358). In Pennsylvania, the erythristic morph has been reported from Potter and Elk counties within the north central Allegheny High Plateau Province (Hulse et al. 2001. Amphibians and Reptiles of Pennsylvania and the Northeast. Cornell Univ. Press, Ithaca, New York. 419 pp.; Pauley et al. 2001, *op. cit.*).

On 9 Oct 2010 we discovered two adult *P. cinereus* with extensive crimson pigmentation on the dorsal and lateral surfaces of the body, moderate amounts of crimson pigmentation on the ventral surface, and relatively small amounts of dark mottling on the dorsal regions of the head and tail. These salamanders were found under coarse woody debris in a hemlock-northern oak forest ca. 160 m N of Smith Rd. within State Gamelands 69, Crawford Co., Pennsylvania (41.65621°N, 79.90249°W; WGS84). Specimens were measured (26.1, 26.6 mm SVL) and photographed in the laboratory, verified as erythristic morphs by W. E. Meshaka, Jr. (State Museum of Pennsylvania), and deposited in the Clarion University Vertebrate Collections and Museum (CUP A025). We frequently encounter striped red-backed morphs, less frequently encounter erythristic morphs, and have not found unstriped lead-backed morphs at this site. Our report represents the first verification of erythristic *P. cinereus* in Crawford Co. and extends the range of this color morph into the Northwestern Glaciated Province of Pennsylvania.

Several studies provide evidence that erythristic *P. cinereus* are Batesian mimics of the toxic juvenile life stage (red eft) of the Eastern Newt (*Notophthalmus viridescens*) (Tilley et al. 1982. Herpetologica 38:409–417). Throughout the range of *P. cinereus*, the highest population frequencies of the erythristic morph (35.2–47.4%) have been reported from Elk Co., Pennsylvania, where populations are syntopic with those of *N. viridescens* (Cassell and Jones 2005. Northeast. Nat. 12:169–172; Pauley et al. 2001, *op. cit.*). *Plethodon cinereus* and *N. viridescens* are similarly syntopic at our study site. Documenting the microgeographic distribution of both *N. viridescens* and color polymorphism in *P. cinereus* contributes to understanding ecological factors influencing the frequency of each color morph within a population and assessing selective advantages associated with mimicry.

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***PSEUDOTRITON RUBER* (Red Salamander). LEUCISM.** On 9 June 2009, a leucistic *Pseudotriton ruber* larva was captured in the headwaters of Little Lymans Prong, Macon Co., North Carolina, USA (35.0415°N, 83.5472°W). It was found in relatively deep, liquid mud mixed with detritus in a small seep area connected to a quickly flowing, sandy section of the small stream. Ten additional *P. ruber* larvae were found within the same mud-patch. Most of these larvae exhibited the typical dark brown coloration but some were in the early stages of metamorphosis and had a lighter, more reddish base color. The leucistic individual of unknown sex was entirely white except for darkly pigmented eyes and relatively faint dark mottling along its dorsal side (Fig. 1). The ventral skin was transparent so that some of the visceral organs were visible. The animal was captured alive and transported to the Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts, where it was kept until it died of unknown causes in late August without showing any signs of approaching metamorphosis. Snout–vent length is strongly correlated with age in *P. ruber* (Bruce and Castanet 2006. J. Herpetol. 40:85–90) and the animal (42 mm SVL) is estimated to have been around 30 months old at the time of its death. Leucism has been reported in a number of plethodontids (Harris 1968. Bull. Maryland Herpetol. Soc. 4:57–60; Mendyk 2010. Herpetol. Rev. 41:189–190; Miller and Braswell 2006. Herpetol. Rev. 37:198; Mitchell and Mazur 1998. Northeast Nat. 5:367–369; Pauley 1974. Redstart 42:104; Rye 1991. Can. Field. Nat. 105:573–574; Seeliger 1945. Copeia 1945:122), but to our knowledge this is the first documented case of leucism in the genus *Pseudotriton*. The specimen has been deposited in the herpetological collection of the Museum of Comparative Zoology, Harvard University (MCZ A-140304).

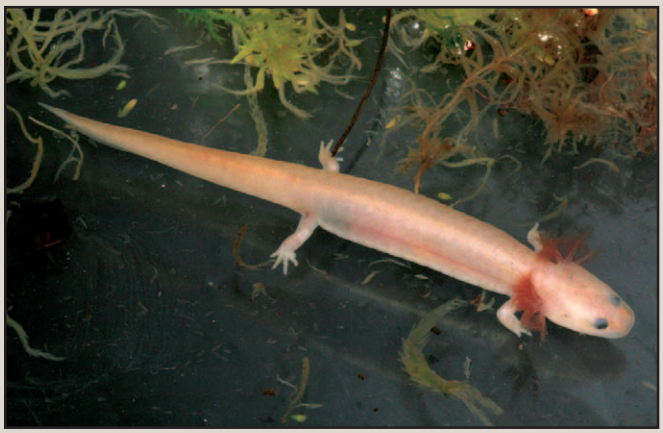


FIG. 1. Leucistic *Pseudotriton ruber* larva from Little Lymans Prong, Macon Co., North Carolina, USA.

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***RHYACOTRITON KEZERI* (Columbia Torrent Salamander). OVIPOSITON SITE.** To date, only eight instances of oviposition attributable to torrent salamanders (genus *Rhyacotriton*) have been described. Nussbaum (1969. Herpetologica 25:277–278) provided the first descriptions, involving *R. kezeri* at two sites in Oregon and Washington. Subsequently, six additional instances of *Rhyacotriton* oviposition have been reported; three more for *R. kezeri* (Russell et al. 2002. Northwest. Nat. 83:19–22), two for *R. variegatus* (Karraker 1999. Herpetol. Rev. 30:160–161; Karraker 2005. Northwest. Nat. 86:24–26), and one for *R. cascadae* (MacCracken 2004. Herpetol. Rev. 35:367). These descriptions reveal

that *Rhyacotriton* deposit large (4–6 mm ovum diameter), unpigmented eggs that are neither attached to the substrate nor to one another. These oviposition sites were concealed in substrates in low-flow headwater habitats (seeps and 1st- and 2nd-order streams). Our purpose here is to describe a sixth *R. kezeri* oviposition site, the first found within a recent clear-cut with no riparian buffer, and to provide the first photograph of a *Rhyacotriton* egg.

We discovered the oviposition site in the course of a landscape study that examined the effects of alternative buffer treatments on stream-associated amphibians in non-fish-bearing streams. The oviposition site was found during surveys of a highly obstructed stream reach (defined as ≥ 70% covered by in-stream woody debris and slash from recent forest harvest activities). Standard methods for surveying stream amphibians could not be effectively applied within these reaches because of the debris. Instead, we cut through or removed woody debris and harvest slash along two narrow lines positioned 3 m apart and perpendicular to the stream axis. Block nets were set flush with the substrate along these lines and all slash in the intervening reach was systematically removed, including excavating into the streambed to a depth of 30 cm or until bedrock was reached. All amphibians found during removal were recorded.

On 26 July 2010 at 1600 h, we discovered a *R. kezeri* oviposition site in one of our headwater study treatment sites. This treatment, a replicate of the most extreme in this study, was a clear-cut harvest with no stream-adjacent forested buffer. Harvest of this 39 to 49-year-old Western Hemlock (*Tsuga heterophylla*) stand had occurred November 2008–January 2009 and was completed 18 months prior to amphibian sampling. No vegetation recovery was evident within the slash-choked footprint along and over the stream channel. Growth of canopy, shrub, and understory vegetation in the adjacent uplands was limited; replanting of young trees had occurred in early 2010. The site was located on a 1st-order reach, 49 m below the upstream origin of the stream, on a quaternary tributary of the North River, Grays Harbor Co., Washington, USA (UTM Zone 10, 46.8121°N, 123.8652°W, WGS84; elev. 157 m). The excavated plot had slash dominated by material 2–10 cm in diameter and to a depth of 1 m. Beneath this slash we encountered 10 eggs buried 15–28 cm beneath a composite substrate of gravel, silt, and small decayed wood pieces. Water seeping through the gravel was 12.5°C (spot measurement with a HBE International Inc. digital thermometer; Collegeville, Pennsylvania; accuracy 1°C); a StowAway TidbiT™ data logger (Onset Computer Corporation, Bourne, Massachusetts; accuracy 0.2°C) 417 m downstream recorded 12.8°C at the same time. Eggs were found singly, unattached, and loosely scattered within this composite substrate over a roughly 30 cm^2 area. Several eggs were also found in the lower block net. The ova were all round and about the same size, but the precise stage of development could not be determined. The one egg measured had a 4-mm cream-white ovum with an 11-mm transparent and a relatively tough jelly capsule. Location of the eggs, carefully re-buried at the site and covered with original slash, was flagged to enable relocation. Two adult females (36 and 41 mm SVL), 2 adult males (42 and 45 mm), 1 adult of unknown sex (35 mm), and 4 larval *R. kezeri* (13, 14, 14, and 26 mm), as well as one neotenic *Dicamptodon* sp. (79 mm) were found in the surveyed stream segment.

We revisited the site twice. We relocated three eggs on 9 Sept 2010 at 1430 h. The ova were slightly elongated and measured 6 mm in long-axis diameter and the capsules measured 14 mm on the long-axis. The tails and heads had become visible and

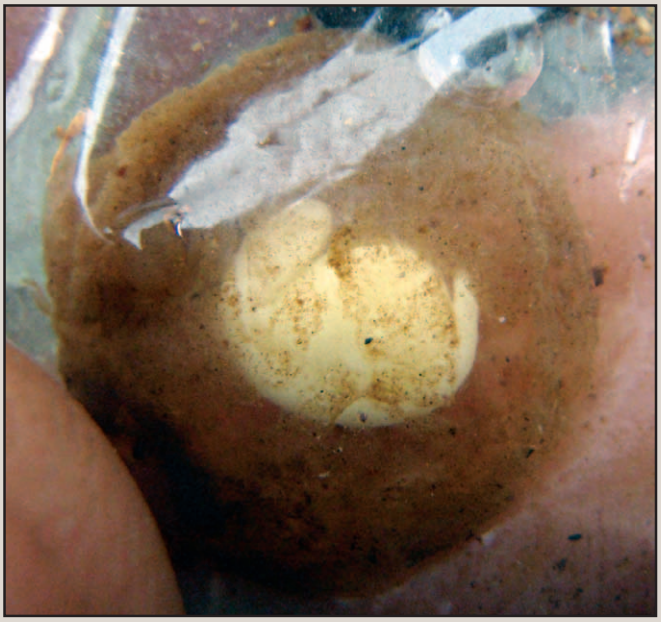


FIG. 1. *Rhyacotrition kezeri* embryo from 9 September 2010 visit. Head of the embryo is on the upper left, the yolk sac is centrally located, and the smaller tail is to the right. Note the fine debris covering the capsule surface.

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embryos showed no visible signs of movement (Fig. 1). One adult *R. kezeri* of unknown sex (not measured) was found within 30 cm of the eggs. Water temperature at the oviposition site was 11.8°C; downstream data logger temperature recorded 11.3°C at the same time. On 4 Oct 2010 at 1150 h, we relocated one empty capsule and one egg containing a live embryo. The yolk sack was elongated, the front arm buds had formed, the tail and head were more developed, the beginning of gills were apparent and the pigmented eyespots were present. Movement of the embryo was observed within the capsule. The empty capsule had a single slit-like opening. No amphibians were observed nearby during this latter visit. Downstream (data logger) water temperature on 4 Oct was 10.2°C.

Two aspects of our observation merit comment. All previous observations of *Rhyacotriton* oviposition sites except for one of *R. variegatus* (Karraker 2005, *op. cit.*) occurred on timber-managed landscapes, but ours is the first to describe oviposition so early in the harvest rotation at a location where no forested buffer was left. This adds to the recent body of data (Kroll et al. 2008. Forest Ecol. Manag. 255:3726–3735; Russell et al. 2004. J. Wildl. Manag. 68:405–417) that suggests that *Rhyacotriton* may not be as sensitive to forestry management practices as previously thought (Corn and Bury 1989. Forest Ecol. Manag. 29:37–57). Second, developmental data for *R. kezeri* are sparse. We observed development from a round egg in which we could not distinguish the developmental stage to a well-differentiated embryo in only 70 days, implying relatively rapid development compared to the only previous report for this species. Nussbaum (1969, *op. cit.*) estimated that development from oviposition to hatching required about 200 days based on the rearing of *R. kezeri* eggs found in the late tail-bud stage in water 8.3°C to hatching in the laboratory at 8.0°C. Our observation might simply reflect higher water temperatures during development; over the interval 26 July–4 October 2010, the downstream data logger recorded temperatures ranging from 9.7–13.3°C.

Fieldwork was supported by the Washington Department of Natural Resources Forests and Fish Adaptive Management Program through the Cooperative, Monitoring, Evaluation, and Research Committee. Weyerhaeuser Co. allowed access to, and facilitated work on, their land. Stephanie Estrella, Bill Ehinger, and Charlotte Wilson (Washington Department of Ecology) provided the temperature data logger data. Studies were done under a programmatic Washington Department of Fish and Wildlife (WDFW) handling permit provided to employees in the course of their work; conditions of this permit require adherence to the guidelines for use of live amphibians and reptiles in the field (Beaupre et al. 2004. Guidelines for Use of Live Amphibians and Reptiles in Field and Laboratory Research, 2nd ed. Herpetological Animal Care and Use Committee of the American Society of Ichthyologists and Herpetologists). J. C. Armstrong, E. M. Lund, and N. E. Gilman (WDFW) assisted with field data collection. Lisa Hallock refined our manuscript. This is contribution No. 28 of the WDFW Habitat Program Amphibian Research Group.

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***SIREN INTERMEDIA* (Lesser Siren). LARVAL AND JUVENILE MICROHABITAT.** Adult *Siren intermedia* inhabit a wide range of habitats from temporary and permanent ponds, canals, sloughs, and creeks (Funderburg and Lee 1967. Herpetologica 23:65; Gehlbach and Kennedy 1978. Southwest. Nat. 23:423–430; Neill 1947. Herpetologica 5:19–20; Petranka 1998. Salamanders of the United States and Canada. Smithsonian Inst. Press, Washington, DC. 587 pp.; Smith and Minton 1957. Amer. Midl. Nat. 58:341–351). Microhabitats known for eggs and larvae include leaf-litter depressions in vegetated and muddy pond bottoms (Fauth et al. 1990. Oikos 58:91–99; Noble and Marshall 1932. Amer. Mus. Nov. 532:1–17). We report here another microhabitat feature that apparently influences the distribution of larvae and juveniles in isolated wetlands.

During midday on 16 June 2007, while dipnetting we encountered larval and juvenile *S. intermedia* (four larvae 39–43 mm total length, three juveniles 129–142 mm total length) in a blackwater slough on Cherry Point Marine Corps Air Station, Craven Co., North Carolina, USA. All of the salamanders were closely associated with the extensive fingerlike root masses of *Nyssa biflora* (Swamp Tupelo) in 10–15 cm of water. Eight dipnet sweeps immediately adjacent to these root masses yielded 7 *Siren*. Eleven sweeps in open water >1 m from the root masses yielded no salamanders. The water in this shallow wetland had a suspension of fine, dark organic matter that precluded visibility. Water temperatures at the edge of the root masses (mean = 22.9°C, 21.2–25.0°C, N = 4) were significantly lower than temperatures in the open areas (mean = 26.4°C, 26.1–26.8, N = 4) ($t = -3.913$, $P = 0.008$). Sampling in this slough on 26 July yielded one juvenile *Siren* in the only one of 10 sweeps taken adjacent to the root masses. Larval and juvenile *Siren* may select these root masses to thermoregulate or escape the predatory fish (*Enneacanthus chaetodon, Lepomis macrochirus*) that co-occur in this wetland. Microhabitat structure is apparently a primary factor influencing the distribution and perhaps aggregation of larval and juvenile *S. intermedia* in freshwater wetlands.

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ANURA — FROGS

***BUFO BOREAS* (Western Toad). DAVIAN BEHAVIOR.** Misdirected copulation among amphibians has been noted in several species including *Rana boylii* (Bettaso et al. 2008. Herpetol. Rev. 39:462); *R. cascadae* (Garwood and Anderson 2010. Herpetol. Rev. 41:204); *Bufo bufo* (Ayres 2010. Herpetol. Rev. 41:192–193); *B. terrestris,* and *Osteopilus septentrionalis* (Meshaka 1996. Florida Sci. 59:74–75); and *B. marinus* (Lewis 1989. Cane Toads: An Unnatural History. Doubleday, New York. 98 pp.). Those authors alternately referred to Davian behavior as necrogamy. Ayres (2010, *op. cit.*) expanded the use of the term Davian behavior to include misdirected copulations with other species. Here I describe Davian behavior in the Western Toad (*B. boreas*) associated with the federally threatened California Red-legged Frog (*R. draytonii*).

While conducting monitoring surveys in February 2009 for California Red-legged Frogs in eastern Contra Costa Co,,



FIG. 1. Davian behavior by a Western Toad (*Bufo boreas*) attempting to amplex a California Red-legged Frog (*Rana draytonii*).



FIG. 2. Ventral (relative to the California Red-legged Frog, *Rana draytonii*) view of Western Toad (*Bufo boreas*) amplexing a California Red-legged Frog in a manner that has immobilized the frog.

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California, USA, I encountered an adult Western Toad in pectoral amplexus with an adult female California Red-legged Frog. Both the toad and frog were on the terrestrial bank of a livestock pond (Fig. 1). The toad was clasped tightly to the frog's thoracic region, while the California Red-legged Frog appeared completely immobilized by the toad.

Davian behavior has been considered an ecological trap because, in this case, the toad was not capable of successfully reproducing (Ayres 2010, *op. cit.*). In this observation, however, neither animal was able to reproduce successfully since both were on land, and reproductively viable conspecifics were in aquatic breeding habitat and not accessible to either individual. Predation events may increase during reproductive activity in many species (Magnhagen 2003. Trends Ecol. Evol. 6:183–186). Here, both individuals were exposed to an increased predation potential due to their distance from water (ca. 1 m). The California Red-legged Frog may have also been subjected to an unanticipated physical stress that was brought on by the Western Toad's grasp (Fig. 2).

On other occasions, I have observed Western Toad males amplexing a root ball of *Juncus balticus*, a piece of cattle dung, and a dead conspecific individual. Arak (*In* Bateson 1983. Mate Choice. Cambridge Univ. Press. New York, New York. 462 pp.) suggested explosive breeding is the reason for necrogamy (Davian behavior). Among the objects reported by Arak (1983, *op. cit.*) were fish and floating debris. I integrate the hypothesis that temporally compressed breeding anurans comprise males that will attempt to amplex appropriately sized nearby objects as a result of breeding pressure from conspecifics. Although Ayres (2010, *op. cit.*) proposed that chemical factors might influence necrogamy in *B. bufo*, I offer that objects of the appropriate size are targets for Davian behavior, and that there is little regard for their composition. I further add that a heterospecific individual attempting to escape amplexus attempts would facilitate complete amplexal behavior by the Western Toad. Although Davian behavior may represent an evolutionary trap for individual Western Toads, it also represents confounding stresses on a threatened species, in this case, the California Red-legged Frog. This observation represents reduced opportunities for reproduction and increased predation risk in both species. Western Toads appear to engage in this behavior at an observable rate, which was observed by me over several years. If the target is a sympatric species, local populations of both the California Red-legged Frog and the Western Toad might be effected.

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***BUFO TERRESTRIS* (Southern Toad). DIET.** *Bufo terrestris* has been reported to prey on a variety of invertebrate species including snails, ants, beetles, crickets, and bees (Dorcas and Gibbons 2008. Frogs and Toads of the Southeast. Univ. Georgia Press, Athens, Georgia. 238 pp.; Jensen et al. [eds.] 2008. Amphibians and Reptiles of Georgia. Univ. Georgia Press, Athens, Georgia. 600 pp.). On 12 July 2007 on Edisto Island, South Carolina, USA, a large adult female *Bufo terrestris* was observed consuming a Marsh Crab (*Sesarma cinereum*). The observation took place in an area where *S. cinereum* are common. This may suggest that *S. cinereum* is available as a significant food source for coastal populations of *Bufo terrestris*.



FIG. 1. *Bufo terrestris* consuming a Marsh Crab (*Sesarma cinereum*), Charleston Co., South Carolina, USA.

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***CERATOPHRYS CRANWELLI* (Cranwell's Horned Frog). DIET.** Data on the diet of the anurophagous frogs of the Gran Chaco in South America is sparse (Scott and Aquino 2005. *In* Donnelly et al. [eds.], Ecology and Evolution in the Tropics: A Herpetological Perspective, pp. 243–259. Univ. Chicago Press, Chicago, Illinois). One species, *Ceratophrys cranwelli*, is frequently encountered in the Gran Chaco, but only three anurans have been confirmed as comprising part of its diet; *Leptodactylus bufonius* (Schalk 2010. Herpetol. Rev. 41:471), *Physalaemus biligonigerus*, and an unidentified *Leptodactylus* sp. (Scott and Aquino 2005, *op. cit.*).

On 31 Dec 2010 at 2230 h we came upon a pair of *C. cranwelli* in amplexus in a temporary pond (19.60434°S, 62.57558°W; WGS 84) in the Isoceño community of Yapiroa, Province Cordillera, Department of Santa Cruz, Bolivia. While being grasped by the male *C. cranwelli*, the female was observed eating an adult *Physalaemus albonotatus* (Fig. 1). The *P. albonotatus* made continuous attempts to free itself from the mouth of the female, but it was consumed after approximately ten minutes. The pair remained on the edge of the pond for two minutes, after which the female (with the male still grasping her) then lunged at a male



FIG. 1. A female *Ceratophrys cranwelli* consuming a *Physalaemus albonotatus* while being amplexed by a male *C. cranwelli*. Located in the lower right of the photo is the male *Rhinella major* that the female *C. cranwelli* attempted to capture after ingesting the *Physalaemus*.

Rhinella major that was calling approximately 10 cm away (visible in Fig. 1). The female *C. cranwelli* failed to capture the *R. major*, which escaped into a nearby cluster of plants. The pair then swam into the middle of the pond, presumably to mate. This observation confirms one additional anuran species and supports the possibility of another anuran species in the diet of *C. cranwelli*.

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***CHAPERINA FUSCA* (Saffron-bellied Frog). OCULAR ANOMALY.** *Chaperina fusca* is a small anuran (to 26 mm SVL) with an oval-shaped body, small head, blunt and projecting snout, fine dermal spine on each elbow and heel, greenish or bluish black dorsum with whitish or bluish dots, brown limbs with dark bars, and the highly distinctive ventral coloration of numerous yellow to rich yellow blotches bordered by a dark brown network (Inger 2005. The Systematics and Zoogeography of the Amphibia of Borneo. Natural History Publications [Borneo] Sdn. Bhd. Kota Kinabalu. 402 pp.; Inger and Stuebing 2005. A Field Guide to the Frogs of Borneo. Second ed. Natural History Publications [Borneo] Sdn. Bhd. Kota Kinabalu. 201 pp.). *Chaperina fusca* dwells in primary or old secondary forests on the forest floor and sometimes in low vegetation from near sea level to 1800 m elev., and the adults move to water bodies, especially those with decaying plant materials, to breed (Inger 2007. Systematics and Zoogeography of Philippine Amphibia. Natural History Publications [Borneo] Sdn. Bhd. Kota Kinabalu. 370 pp.; Malkmus et al. 2002. Amphibians and Reptiles of Mount Kinabalu [North Borneo]. A.R.G. Gantner Verlag K.G. Ruggell. 424 pp.). The species occurs in Central Peninsular Thailand, Peninsular Malaysia, Borneo (Sabah and Sarawak of Malaysia, Brunei Darussalam, and Kalimantan of Indonesia), and southern Philippines (Palawan, Mindanao, and Sulu Archipelago) (Das 2007. A Pocket Guide: Amphibians and Reptiles of Brunei. Natural History Publications [Borneo] Sdn. Bhd. Kota Kinabalu. 200 pp.; Frost 2010. Amphibian Species of the World: an Online Reference. Version 5.3 [8 April 2010]. Electronic database accessible at http://research.amnh.org/vz/herpetology/amphibia/. American Museum of Natural History, New York. Accessed on 22 Dec 2010).

On 5 Dec 2010 at 1910 h, an adult *C. fusca* (21 mm SVL, 1.1 g) was collected at an artificial pond within the compound of Haleluyah Retreat Centre (6°N, 116.536°E; 1518 m elev.), Bundu Tuhan, Ranau District, West Coast Division, Sabah, Bornean Malaysia. Air temperature was 18.7°C, and relative humidity was 84.1%. The anuran was missing a right eye, while the left eye was normal (Fig. 1). Anuran deformities can be attributed to physical injuries, infections and diseases, exposure to chemicals, UV radiation, mutation, and developmental errors (Adams et al. 2008. Herpetol. Rev. 39:460–461; Silva and Toledo 2010. Herpetol. Rev. 41:333–334; Streicher et al. 2010. Herpetol. Rev. 41:208–209). Close examination showed no body injuries. The pond and surrounding vegetation are not adjacent to any source of chemical pollutants and effluents. pH of the pond water was 7.48. On the same night, another *C. fusca* (25 mm SVL, 1.5 g) was collected at the same pond but without ocular anomaly or other deformities. By comparison, the *C. fusca* with ocular anomaly exhibited lighter dorsal and ventral hues. Otherwise, the anuran seemed unaffected by the anomaly as it was agile during an indoor *ex-situ* photography session. The specimen (HEP01794) was deposited in BORNEENSIS, the Bornean reference collection of the Institute for Tropical Biology and Conservation, Universiti Malaysia Sabah. To our knowledge, this is the first observation of ocular anomaly in *C. fusca*.



FIG. 1. Left: Front view of an adult *Chaperina fusca* with ocular anomaly found in the Haleluyah Retreat Centre compound, Ranau, Sabah, Malaysia. Right: Dorsolateral view.

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***CYCLORANA AUSTRALIS* (Giant Frog). EMERGENCE.** Amphibians in seasonally dry or desert environments become active when water is available. During prolonged dry periods many frogs burrow to avoid desiccating conditions. Rainfall is required to facilitate emergence from burrows and induce aboveground activity (Cartledge et al. 2006. J. Exp. Biol. 209:3309–3321; Mayhew 1965. Amer. Midl. Nat. 74:95–109; Morton et al. 1993. The Beagle 10:67–70; Poynton and Pritchard 1976. Zool. Africana 11:313–318), including foraging and spawning (Balinsky 1969. Zool. Africana 4:37–93; Wells 2007. The Ecology and Behavior of Amphibians. Univ. Chicago Press, Chicago, Illinois. 1148 pp.).

Cyclorana australis is a fossorial species from northern Australia that forms a cocoon (Christian and Parry 1997. Aust. J. Zool. 45:13–20; Withers 1998. Aust. J. Zool. 46:405–418). Monsoonal northern Australia has markedly seasonal rainfall with the great majority falling in the summer rainy season. Each year during the prolonged dry season, *C. australis* spend approximately six months underground in shallow burrows (<15 cm deep; Tracy et al. 2007. Copeia 2007:901–912). From previous studies, it is known that the frogs usually bury in April and May as rainfall attenuates. The frogs emerge following intermittent rains during the pre-monsoonal period (usually October–November), but there are no data concerning the amount of rainfall required for mass emergence of frogs in this environment.

To determine the amount of rainfall required to induce emergence from underground burrows, field investigations were carried out during the onset of the wet season in 2007. The Mickett Creek area (12.4108°S, 130.9436°E) near Darwin, Northern Territory, was visited regularly at night and searched on foot with the aid of a spotlight. A transect through the area was followed and known breeding chorus aggregation sites were visited. The total number of *C. australis* observed by sight was noted (some individuals were located by call). Sex was determined as male if

TABLE 1. Emergence of *Cyclorana australis* and cumulative rainfall near Darwin, Northern Territory, Australia during onset of the 2007 wet season.

Date	Cumulative rainfall (mm)	Frogs observed	Male	Female
23 Oct.	0.5	0	0	0
1 Nov.	2.5	0	0	0
6 Nov.	49	3	3	0
12 Nov.	83	5	4	1
13 Nov.	114	32	24	8

the individual was calling, and if not calling the frog was captured and inspected for the presence of nuptial pads and dark throat coloration that develops in the males during the breeding season. The distance of calling males to the edge of the nearest standing water was estimated to the nearest cm. During each visit, rainfall data were obtained from a gauge at the site. Rainfall is reported as cumulative from the start of October.

Although *Crinia remota, Litoria nasuta, L. tornieri, L. microbelos, L. rubella,* and *L. bicolor* were observed at night in the dry season, *C. australis* was not observed at the site before November (and had not been observed since March). Emergence of some *C. australis* occurred with 49 mm of cumulative rainfall (ca. 47 mm fell over a period of three days), but near 100 mm was required before large breeding choruses formed on 13 Nov (Table 1). More than 10 specimens of the congeneric but smaller cocooning species *C. longipes* were also observed on that date. The sex ratio of observed *C. australis* was approximately 3:1 M/F, and included three amplectant pairs on 13 Nov. There is probably some bias in the sex ratio data due to the tendency of males to vocalize, thereby increasing the likelihood of detection. Males were invariably calling from positions on moist ground near puddles and small pools; mean distance to the water's edge was 2.18 ± 2.15 m SD (N = 19). All but two calling individuals were less than 3 m from water.

Rainfall intensity, the temporal spacing of rainfall events, topography, and substrate permeability are the main factors that determine water infiltration depth. Approximately 50 mm of rainfall was required to moisten the soil, allowing *C. australis* to emerge, and large choruses developed with further rainfall. Although some individuals emerged early, the overall pattern was of mass emergence with close synchrony in timing. Rainfall is an important trigger for emergence because dry savanna soils are impenetrable in the late dry season, and *C. australis* are likely entombed in the burrow chamber until the soil is moistened. *Cyclorana australis* is one of the first anurans to breed in the Darwin region, and it is probable that shallow burrows facilitate early emergence. In 2010 *C. australis* emerged in mid October following early rains, whereas in 2006 they were not observed until early December, suggesting that there is substantial interannual variation in emergence time.

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***INCILIUS CONIFERUS* (Green Climbing Toad). BREEDING BEHAVIOR.** *Incilius coniferus* is a moderate sized (53–94 mm SVL), semi-arboreal bufonid native to the Atlantic lowlands of southern Nicaragua and the Pacific lowlands of southwestern Costa Rica to northwestern Ecuador. It is known to breed in the dry season, which occurs from December to April in Costa Rica (Guyer and Donnelly 2005. Amphibians and Reptiles of La Selva. Univ. California Press, Berkeley. 367 pp.; Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna Between Two Continents, Between Two Seas. Univ. Chicago Press, Chicago, Illinois. xx + 934 pp.). Courtship typically occurs after rains in shallow pools in forests, as well as relatively open areas (Guyer and Donnelly 2005, *op. cit.*; Savage 2002, *op. cit.*). Crump (1989. Oecologia 78:486–489) reported that *I. coniferus* oviposits in May at the beginning of the wet season in Costa Rica. Porter (1966. Herpetologica 22:60–67) observed a calling male on 10 July in Costa Rica, but did not mention if mating occurred. Detailed reports of reproductive activity from Panama are lacking, but the timing is most likely similar. Here I report a pulse of breeding activity in Panama, outside of the expected breeding season for this species.

At 1800 h on 13 Sept 2010, I observed five male and one female *I. coniferus* in water-filled ruts formed by tires on a dirt road following the continental divide just inside the southern border of Parque Nacional Division General Omar Tarrijos Herrera, Panama (8.400859°N, 80.35345°W, WGS 84; elev. ~770 m). In the area where the wheel ruts collect water, the road widens from ca. 3 m to 13 m and is bordered by moderate to tall grass cover. The habitat is consistent with the description given by Crump (1989, *op. cit.*). Four of the five males were calling, while the remaining male was in axial amplexus with the female. At 0745 h the following morning, four pairs of toads in amplexus were depositing eggs, or had just done so (Fig 1). At 1645 h on that second day, no toads were present, except for two female specimens, both dead with their arms and legs removed, observed in two separate tire ruts. Although this could represent predation, it is also possible that the toads were killed by humans who believe negative superstitions about toads (J. Ray, pers. comm.). The following night at 2020 h, no *I. coniferus* were observed, but the eggs were still present. I surveyed areas within the park on three separate occasions for a total of eight days (17–19 Aug, 13–15 Sept, and 29–30 Oct) and did not encounter any additional *I. coniferus* other than the individuals reported here.

The wet season in Panama includes a reduction of rainfall in July, which averages 243 mm of rain, whereas June and Sept receive 300.8 and 342.4 mm of precipitation, respectively. Still, July receives more rainfall on average than the dry season (e.g., 94.7 mm in April; World Meteorological Organization 2010. http://www.wmo.int). Crump (1989, *op. cit.*) reported that *I. coniferus*

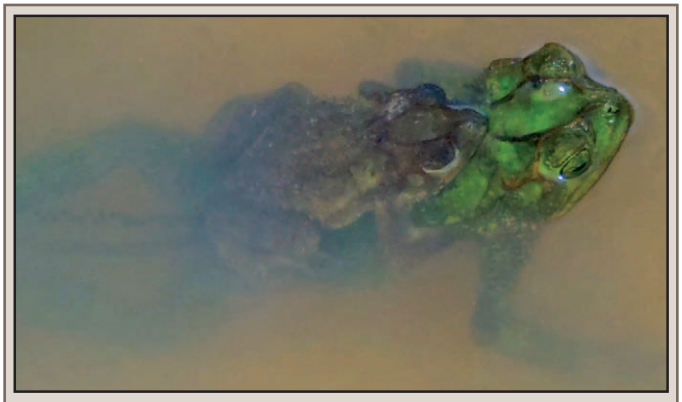


FIG. 1. A pair of *Incilius coniferus* in amplexus, with female depositing eggs, in Parque Nacional Division General Omar Tarrijos Herrera, Panama.

breeds in May, a time when precipitation is increasing. The climate in May is similar to Sept in that both months experience a marked increase in precipitation compared to the preceding months (mean monthly precipitation of 96.7 mm in April increases to 313.7 mm in May, and 243 mm in July increases to 342.4 mm in Sept). This climate pattern is similar to what is experienced in Costa Rica. It is possible that breeding is triggered by the increase precipitation at the end of the rainy season, and as a result the end of the mini dry season may trigger a similar breeding event. On first day of the observation (13 Sept) it rained from ~1300 h to ~1700 h, which is typical weather of the area in Sept. Considering the range of reported breeding activity, the reproductive cycle of *I. coniferus* warrants more investigation, particularly in Panama.

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FIG. 1. An adult *Osteocephalus taurinus* being preyed upon by an adult *Leptodeira annulata* in a gallery forest at Lucas do Rio Verde, state of Mato Grosso, Brazil.

***OSTEOCEPHALUS TAURINUS* (Manaus Slender-legged Treefrog). PREDATION.** Amphibians are common prey for a great variety of vertebrates, arthropods, and even carnivorous plants (Duellman and Trueb 1986. Biology of Amphibians. McGraw-Hill, New York; Pough et al. 1998. Herpetology. Prentice-Hall, New Jersey). Snakes are among the most representative vertebrate predators of anurans (Toledo et al. 2007. J. Zool. 271:170–177).

Male *Osteocephalus taurinus* may reach 71–92 mm, while females reach 90–101 mm (Lima et al. 2006. Guia de Sapos da Reserva Adolpho Ducke, Amazônia Central. Áttema, Manaus). The species occurs in the Amazon Basin of Ecuador, Brazil, Bolivia, Peru, Colombia, as well as in the upper Orinoco Basin of Venezuela, and Guiana (Frost 2010. Amphibian Species of the World: an Online Reference. Ver. 5.5 [31 January 2011]. Electronic database accessible at http://research.amnh.org/vz/herpetology/amphibia/. American Museum of Natural History, New York). It occurs in forested habitats throughout the Amazon Forest, and in gallery forests within the open Cerrado biome, in Mato Grosso and Maranhão, Brazil (IUCN 2010. Conservation International and NatureServe. Global Amphibians Assessment. http://www.globalamphibians.org. Accessed 22 Aug 2010). We here report predation of *O. taurinus* by *Leptodeira annulata*.

On 08 Jul 2010 at 1911 h, near the margin of a stream in gallery forest in the municipality of Lucas do Rio Verde, state of Mato Grosso, Brazil, a distress call in the leaf litter revealed an adult *O. taurinus* being predated by an adult *L. annulata* (Fig. 1). The snake seized the treefrog by the inguinal region, but freed it still alive, upon capture. After been placed in a plastic bag with its prey, the snake proceeded to swallow it. Both specimens were collected and deposited at the Coleção Zoológica de Vertebrados of the Universidade Federal de Mato Grosso (municipality of Cuiabá, Mato Grosso State, Brazil), accession number UFMT 8770.

Anurans are common prey of *L. annulata* (Cantor and Pizzatto 2008. Herpetol. Rev. 39:462–463; Martins and Oliveira 1999. Herpetol. Nat. Hist. 6:78–150; Morais and Ávila 2006. Herpetol. Rev. 37:76; Vitt 1996. Herpetol. Nat. Hist. 4:69–76). To our knowledge, this is the first report of *L. annulata* preying upon *O. taurinus*, one of the most abundant anurans among gallery forests at Lucas do Rio Verde. Much of the original vegetation in this municipality has been removed for the establishment of huge plantations of soybeans and other grains, and only narrow strips of gallery forest are left among the matrix of cultivated land. We here emphasize the importance of promoting effective measures for the conservation of these forested relicts, which offer conditions for the successful establishment of populations of anurans such as *O. taurinus*, and their predators, including *L. annulata*.

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***PLATYMANTIS SPELAEUS* (Cave Wrinkled Ground Frog). DIRECT DEVELOPMENT.** *Platymantis spelaeus* is endemic to southern Negros Island, Philippines, and is one of four recognized species of Philippine limestone forest frogs. All species of the genus *Platymantis* are recognized as direct developing frogs, often laying egg clusters on aerial leaves, branches, or ground leaf litter (Brown and Alcala 1982. Proc. Biol. Soc. Washington 95:386–391; Brown and Alcala 1983. *In* Rhodin and Miyata [eds.], Advances in Herpetology and Evolutionary Biology: Essays in Honor of Ernest E. Williams, pp. 416–428. Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts). It has been hypothesized that all four obligate karst forest species breed in limestone crevices and small caves (Brown and Alcala 2000. Haring Ibon 2:19–22; Brown et al. 2003. Haring Ibon 43:91–109; Siler et al. 2007. Herpetologica 63:351–364; Siler et al. 2009. Herpetologica 65:92–104); however, to date, no data have been presented in direct support of this hypothesis. To our knowledge, this is the first evidence of direct development in cave systems for species of the genus *Platymantis*.

While conducting fieldwork in the Philippines, we observed newly metamorphosed juvenile *Platymantis spelaeus* inside a

COLOR REPRODUCTIONS SUPPORTED BY THE THOMAS BEAUVAIS FUND



FIG. 1. An adult male (top) and a newly metamorphosed juvenile (bottom) *Platymantis spelaeus* in southwest Negros Island, Philippines.

small cave system, 2–4 m from the entrance to the cave. The observation was made on 27 Oct 2004, in secondary-growth forest, in the Municipality of Cauayan, Barangay Camalandaan, Negros Occidental Province, Negros Island, Philippines (9.8378667°N, 122.5053667°E, WGS 84; elev. 350 m). Adult specimens were observed calling on karst formations surrounding the cave system. One adult (CDS 266, male, 49.0 mm SVL, 8.9 g, Fig. 1a) and three juvenile (PNM Developmental Series 07; juvenile 1, 8.26 mm SVL, Fig. 1b; juvenile 2; 8.38 mm SVL; juvenile 3, 8.14 mm SVL) specimens were deposited in the herpetological collections of the Philippine National Museum.

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***PLEURODEMA CORDOBAE* (Octoploid Pleurodema). CLUTCH SIZE.** *Pleurodema cordobae* is only known from the type locality and little is known about the reproductive biology and natural history of this recently described species. The species is known to lay eggs in semi-submerged gelatinous egg masses that adhere to vegetation (Valetti et al. 2009. Zootaxa 2073:1–21). Herein we document the number of eggs per egg mass and the density of egg masses in two ponds at the type locality.

On 2 Dec 2010 we visited two ponds at Estancia Los Tabaquillos, Córdoba province, Argentina (32.3995°S, 64.926°W, ca. 2105 m elev.) and observed numerous egg masses of *P. cordobae*. The embryos in different egg masses were staged at Gosner 15 and 19 (Gosner 1960. Herpetologica 16:183–190). The area of the larger pond was 236 m^2; clutch number was 203, and density of egg masses was 0.86/m^2. In the smaller pond (7 m^2), clutch number was 27 and density of egg-masses was 3.82/m^2. The average number of eggs per egg mass was 137 (N = 11; range = 74–215; SD = 45.9).

The eggs masses were adhered to vegetation which was most abundant along the edge of the ponds, thus the greatest density of nests in the smaller pond could be due to the higher edge/area rate.

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***PSEUDOEPIDALEA BRONGERSMAI* (Brongersma's Toad). PREDATION.** Among arthropods, spiders are well known as predators of reptiles and amphibians (Armas 2000. Revista Ibérica de Aracnologia 3:87–88; Manzanilla et al. 2008. Bol. Soc. Entomológica Aragonesa 42:317–319; Barbo et al. 2009. Herpetol. Notes 2:99–100; Maffei et al. 2010. Herpetol. Notes 3:167–170).



FIG. 1. Dry metamorph of *Pseudoepidalea brongersmai*, partially eaten on the head and right foreleg (arrow).



FIG. 2. *Arctosa* sp. (Family: Lycosidae).

Most of the reports are from tropical areas where large species of spiders occur (Barej et al. 2009. Herpetol. Notes 2:137–139; Maffei et al. 2010, *op. cit.*), while similar observations in desert areas are lacking, although large species of spiders occur there.

Pseudoepidalea brongersmai (Frost et al. 2006. Bull. Am. Mus. Nat. Hist. 297:1–370) is the least known member of the family Bufonidae occurring in southwestern Morocco (García-Muñoz et al. 2009. Herpetol. Notes 2:231–233). Only a few reports on its biology have been published (Bogaerts 2001. Podarcis 2[3]:81–88; Gallix 2002. Unpubl. MS thesis EPHE. Mémoire, Ecole Pratique des Hautes Etudes, Montpellier; García-Muñoz et al. 2009, *op. cit.*; Grillitsch et al. 1989. Amphibia-Reptilia 10:215–229; Herrero et al. 1993. J. Herpetol. 27[4]:463–465; Hoogmoed 1972. Zool. Mededelingen 47[5]:49–64), and none of them provides information on predators. Here, we report the first case of predation by a spider on a juvenile *P. brongersmai*.

A dry stream north of Marrakech (Skour-rehamna, 32.493030°N, 7.908570°W) was searched for amphibians on 2 May 2010. Numerous recently metamorphosed *P. brongersmai* were detected under rocks and plastic debris, and 17 were collected and photographed against a grid paper (18.4 ± 3.6 mm SVL). In addition, one dry metamorph with signs of having been partially eaten by a spider (Fig. 1) was found in a spider (Lycosidae, *Arctosa* sp.; Fig. 2) burrow. Although we did not see the spider eating the toad, the association of the dead toad to other dry insect remnants typical of spider feeding, together with the wounds on the body, suggests predation. To our knowledge this is the first report of predation of *P. brongersmai* by a spider, providing new information on the predators and on the juvenile stage of this species.

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***PSEUDOPALUDICOLA* CF. *MYSTACALIS*. PREDATION.** Amphibians are consumed as prey by a large number of vertebrates and invertebrates at some stage of their life (Duellman and Trueb 1986. Biology of Amphibians. McGraw Hill, New York. 670 pp.). Although spiders are ingested by a large number of frogs, spiders predating on frogs have been reported by several authors playing an important role especially during the reproductive period or during metamorphosis (Pombal Jr. 2007. Rev. Bras. Zool. 24:841–843). However, in Brazil, predation by spiders is only reported from the Amazon (Menin et al. 2005. Phyllomedusa 4:39–47), the Mata Atlântica (Toledo 2005. Herpetol. Rev. 36:395–400), and the Cerrado (Maffei et al. 2010. Herpetol. Notes 3:167–170), but not from the Caatinga biome.



FIG. 1. *Lycosa* cf. *erythrognata* predating on *Pseudopaludicola* cf. *mystacalis*.

Our observations were conducted next to a permanent pond in an area of Caatinga situated in the municipality of Riacho de Santana (13.929397°S, 43.109864°W), state of Bahia, northeastern Brazil. At the margins of the pool, we detected numerous species of anurans including *Pseudopaludicola* cf. *mystacalis*. On 19 Oct 2009 at ca. 2100 h, we observed the spider *Lycosa* cf. *erythrognata* preying on an individual *P.* cf. *mystacalis* (Fig. 1). The spider attacked the frog at the edge of a puddle and held the frog for about three minutes, then pulled its chelicerae slowly out with the help of pedipalps. Once they were removed the frog was already dead. During our survey, we often found these spiders foraging at the study site. This observation suggests that spiders may be important predators of small frogs in the Caatinga.

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***RANA DRAYTONII* (California Red-Legged Frog). PREDATION.** Important causes for the decline of *Rana draytonii* are thought to be habitat loss, exploitation by the restaurant industry (Jennings and Hayes 1985. Herpetologica 41:94–103), and competition and predation from introduced fishes and frogs (Moyle 1973. Copeia 1973:8–22). By the time the California Red-legged Frog was federally listed in 2002, it had disappeared from much of its original range, leaving little opportunity to study interactions between this native species and the introduced American Bullfrog (*Rana catesbeiana*). Competition between the two species at the larval life stage has been described (Lawler et al. 1999. Cons. Biol. 13[3]:613–622), and two recent reports have established that adult American Bullfrogs prey upon the tadpole and juvenile stages of *R. draytonii* (Cook and Jennings 2001. Herpetol. Rev. 323:182–183) and on adults (Cook 2002. Herpetol. Rev. 33:303). The following account of a recent instance of opportunistic predation by American Bullfrogs illuminates their threat potential to the recovery of California Red-legged Frog populations.

On 3 Sept 2010, I discovered 23 recently metamorphosed *R. draytonii* distributed around the perimeter of an unnamed stock pond in Sonoma Co., California, USA (38.3301°N, 122.5818°W). This small pond (~270 m^2) was constructed approximately 20

years ago in heavily grazed rangeland, and this account marks the first sighting of California Red-legged Frogs at this location. The pond and its surroundings are devoid of vegetation; the newly transformed frogs were basking in shallow water or sought cover in refugia created by deep cow tracks at the pond edge. I also observed, collected, and dispatched seven adult American Bullfrogs present at the pond and analyzed their stomach contents. Among the seven American Bullfrogs (five gravid females and two males), each of four females (SVL 136–144 mm) had one newly transformed juvenile (SVL 26–31 mm) California Red-legged Frog in their stomach, and two of them had two each. Each of the seven American Bullfrog stomachs also contained at least one California Newt (*Taricha torosa*) larva (≤ 3) and aquatic insects (notonectids, ≤ 13).

Predator-prey interactions are seldom witnessed in the wild due to their short duration and disturbance by observer presence (Major 1990. Ibis 132:608–612), but predation events may be inferred from the stomach contents of predators. The above incident, and those described by Cook and Jennings (2001, *op. cit.*) and Cook (2002, *op. cit.*), suggest that predation by American Bullfrogs on California Red-legged Frogs might be more widespread than previously observed. Both species occupy the same ponds with some regularity (Cook and Jennings 2007. Herpetologica 63[4]:430–440). Considerable overlap occurs in the preferred diet of adult American bullfrogs and California Red-legged Frogs (Hayes and Tenant 1985. Southwest. Nat. 30[4]:601–605), and continued loss of habitat concentrates resources, bringing these two species together with greater frequency.

In a controlled experiment (Corse and Metter 1980. J. Herpetol. 14[3]:231–238) adult American Bullfrogs that were forcefed a diet of juvenile conspecifics completely digested their meal in 41 h. At the Sonoma Co. stock pond described above, two of the American Bullfrogs had each eaten two juvenile California Red-legged Frogs. If each adult American Bullfrog ate two California Red-legged Frogs, given the observed rate of digestion described above, the seven adult American Bullfrogs present could potentially consume all 23 of the observed juvenile California Red-legged Frogs over a four-day period. Adult California Red-legged Frogs probably prey on juvenile American Bullfrogs, but the coexistence of these two frog species at ponds may belie a dynamic predator-prey relationship that favors the larger American Bullfrogs. The presence of American Bullfrogs in historical California Red-legged Frog habitat could pose a serious threat to the recovery of this threatened species.

American Bullfrogs were collected under a California fishing license (059753-12). I thank D. G. Cook for his continued support.

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***SCINAX NASICUS* (Lesser Snouted Treefrog) and *SCINAX ACUMINATUS* (Mato Grosso Snouted Treefrog). REFUGIA.** *Scinax nasicus* occurs in Paraguay, northern and central Argentina (south to Córdoba and Buenos Aires provinces), Uruguay, eastern Bolivia, and southern Brazil. *Scinax acuminatus* occurs in southern Mato Grosso and Mato Grosso do Sul (Brazil), Paraguay, Bolivia (Santa Cruz), and northern Argentina (Frost 2011. Amphibian Species of the World: an Online Reference. Version 5.5, 31 Jan 2011. Electronic database accessible at http://research.amnh.org/vz/herpetology/amphibia/, American Museum of Natural History, New York). From Sept–Dec 2009, we conducted surveys ca. 10 km NE Corrientes City, Argentina (27.4321°S, 58.7466°W). The study site is part of the Chacoan Domain, Oriental Chaco District (Cabrera and Willink 1980. Biogeografía de América Latina. Secretaría Federal OEA. Monografía 13:1–122; Carnevali 1994. Fitogeografía de la Provincia de Corrientes. Gobierno de la provincia de Corrientes e INTA, 324 pp.), and is characterized by the presence of numerous temporary, semi-permanent, and permanent water bodies. Mean annual precipitation is 1500 mm and mean annual temperature is 23°C. According to Carnevali (1994, *op. cit.*), the original plant formation at this site was *Schinopsis balansae* "quebracho" forest, which is currently extremely degraded and largely replaced by sclerophyllous forest with a prevalence of *Prosopis affinis, P. nigra, Acacia caven, Celtis* sp., and numerous colonies of *Aechmea distichantha* and *Bromelia* sp.

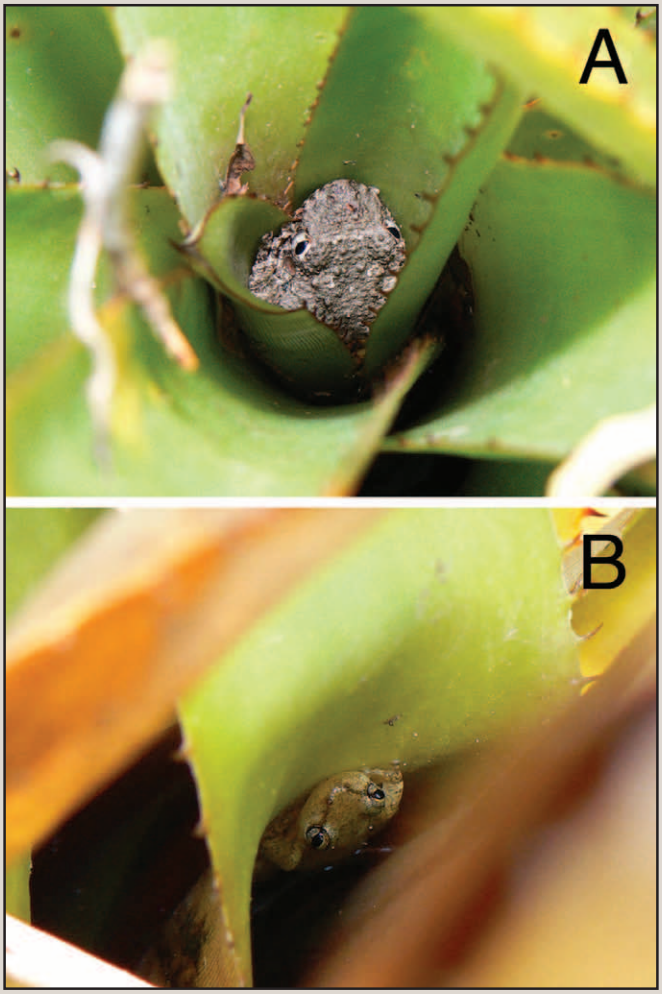


FIG. 1. A) *Scinax acuminatus* and B) *Scinax nasicus* hidden inside the axils of *Aechmea distichantha.*

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Numerous amphibian species are associated with bromeliads, using them strictly as shelter or for entire life cycle, reproducing and feeding inside the plant axil (Peixoto 1995. Rev. Univ. Rural, Sér. Ciênc. da Vida 17[2]:75–83). In the study area, the bromeliad *Aechmea distichantha* mainly is used as a refuge for various species of amphibians and reptiles. This species has a high structural complexity and the capacity to store water for long periods (phytotelmata), such that individual plants harbor a diversity of arthropods and thus provide shelter and food for amphibians.

In the study period we found *Scinax nasicus* (N = 60) and *S. acuminatus* (N = 5) using *A. distichantha* as refugia (Figs. 1A, B).

Often, we recorded more than one frog per plant. In some cases, we found up to five specimens of *S. nasicus* (juveniles) inhabiting the same plant, each positioned in different leaf axils. *S. acuminatus*, however, was found with much less frequency. The observations were made between 9000 to 1800 h and in all cases, the frogs were hidden, with no evidence of activity such as eating or vocalization. Unfortunately, in September 2010, the study area habitat was completely lost due to land conversion by property owners.

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TESTUDINES — TURTLES

***CHELONIA MYDAS AGASSIZII* (East Pacific Green Seaturtle) DIET.** The East Pacific Green Turtle is considered the most carnivorous of all Green Seaturtle subpopulations worldwide (Bjorndal 1997. *In* Lutz and Musick [eds.], The Biology of Sea Turtles, pp. 199–231. CRC Press, Boca Raton, Florida). Novel Green Turtle diet items have been reported, including the Sea Pen, *Ptilosarcus undulatus* (Seminoff et al. 2002. Copeia 2002:266–268), pelagic red crabs, *Pleuroncodes planipes* (Lopez-Mendilaharsu et al. 2005. Aquat. Conserv. Mar. Freshwater Ecosyst. 15:259–269), tunicates and crustaceans (Amorocho and Reina 2007. Endang. Species Res. 3:43–51), hydrozoans, scyphozoans, nematodes, annelids, mollusks (Carrion-Cortez et al. 2010. J. Mar. Biol. Assoc. U.K. 90[5]:1005–1013), and sponges, *Craniella* sp. and *Suberites aurantica* (Rodriguez-Baron 2010. MS thesis. Centro Interdisciplinario de Ciencias Marinas [CICIMAR-IPN]. 98 pp.). It has been suggested that such dietary diversity is a response to the energy requirements of these animals in the early life stages, facilitating nutritional (e.g., protein) gains for development and maturation (Bjorndal 1985. Copeia 1985[3]:736–751) and optimizing digestion time (Amorocho and Reina 2008. J. Exp Mar. Biol. Ecol. 360:117–124). It has also been noted that *C. mydas* diet is influenced by resource availability (Balazs 1980. NOAA Tech. Memo. NOAA-TM-NMFS-SWFS-7; Garnett et al. 1985. Wildl. Res. 12:103–112) and that diet selection is linked to the composition and capacity of the hind-gut microflora, which may change as turtles grow and/or occupy different habitats (Bjorndal 1980. Mar. Biol. 56:147–154).

During two field trips in 2009 we collected food samples from the esophagi of 21 Green Turtles (body mass 14–65 kg, and straight carapace length [SCL ± 0.1 cm] 40.3–73.4 cm; mean SCL = 54.83 ± 8.36 cm) captured at Laguna Ojo de Liebre (LOL; 27.5833–27.9166°N, 113.9666–114.1666°W) located in the El Vizcaino Biosphere Reserve, Baja California Sur, Mexico. The anemone *Palythoa ignota* was present in 18 of the total samples, and it comprised 68.76% of the total volume. Turtle mean body condition index (BCI) was 1.48 (range = 1.25–2.06), similar to the values reported for previous studies (Koch et al. 2007. Mar. Biol. 153[1]:35–46; Seminoff et al. 2003. J. Mar. Biol. Assoc. U.K. 83:1355–1362) which indicates that animals were in good health (Bjorndal et al. 2000. Ecol. Appl. 10:269–282). To our knowledge, this is the first report of targeted anenome consumption by *Chelonia mydas agassizii*. The fact that *P. ignota* occurred in such high proportion among a substantial number (85.7%) of turtles suggests that this colonial cnidarian is a major food resource for these turtles at LOL, and that Green Turtles have the capacity to assimilate nutrients from this invertebrate species (Bjorndal 1990. Bull. Mar. Sci. 47[2]:567–570). We thank the Grupo Tortuguero de las Californias A.C. for their assistance in the logistics field work.

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CHELONIIDAE (Marine Turtles). HATCHLING PREDATION. Sea turtle hatchlings are preyed on by a wide variety of predators (Stancyk 1982. *In* K. A. Bjorndal [ed.], Biology and Conservation of Sea Turtles, pp. 139–152. Smithsonian Institution Press, Washington, D.C.). However, reports of snakes preying on sea turtle hatchlings are rare. Hendrickson (1958. Proc. Zool. Soc. Lond. 130[4]:455–535.) stated that egg collectors on the east coast of Peninsular Malaysia observed mangrove snakes (*Boiga dendrophila*) and pythons (*Python reticulatus*) in the act of swallowing baby turtles (presumably *Chelonia mydas* hatchlings). LeBuff (1990. The Loggerhead Turtle in the Eastern Gulf of Mexico. Caretta Research, Inc. 216 pp.) noted a black racer, *Coluber constrictor priapus*, discovered in a *Caretta caretta* nest on the Gulf Coast of Florida but did not mention actual predation on eggs or hatchlings. Foote et al. (2000. Proc. Sea Turtle Symp. 18:189–190) mentioned the coachwhip as a predator on sea turtles on the Gulf Coast of Florida but did not provide details. Here we provide the first documentation of an Eastern Coachwhip, *Coluber* (= *Masticophis*) *flagellum flagellum*, preying on a hatchling sea turtle (apparently a *C. caretta*).

Since 1997 we have conducted sea turtle nesting surveys daily along the northern 9.7 km of Jupiter Island on the east coast of Florida in Martin Co. St. Lucie Inlet Preserve State Park comprises the northern 4.3 km of this survey area. Surveys are conducted every morning throughout the sea turtle nesting season (March–October). Three species of sea turtles (*Caretta caretta, Chelonia mydas*, and *Dermochelys coriacea*) nest every year in this area and *Lepidochelys kempii* has been documented nesting on three occasions (in 2005, 2008, and 2009). In addition to recording all sea turtle emergences, we also mark a sample of nests for the purpose of documenting nest fate and reproductive success. During the surveys, the beach is checked for hatchling tracks in an effort to document hatchling disorientation.

During the survey on the morning of 29 August 29 2010, one of us (IA) observed the tail of a *C. f. flagellum* protruding from an Atlantic Ghost Crab (*Ocypode quadrata)* burrow low on the beach at St. Lucie Inlet Preserve State Park (Fig. 1). As the burrow was approached, the snake's head appeared from an adjacent burrow approximately 30 cm to the south. As the snake emerged, a live sea turtle hatchling was observed in its jaws. The snake retracted into the burrow when approached, but reemerged after several minutes. As the snake began to emerge, a wave washed over the burrows, filling them with water and causing the snake to emerge rapidly with the hatchling still in its jaws (Fig. 2). The snake retreated quickly into the dunes, and no further observations were made. The snake was estimated to be approximately 150 cm long.

Based on direct observations and examination of photographs, the hatchling appeared to be a *C. caretta* though it would not be possible to distinguish it from a *L. kempii* or *Eretmochelys*

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FIG. 1. Tail of a *Coluber flagellum flagellum* protruding from an Atlantic Ghost Crab (*Ocypode quadrata)* burrow low on the beach at St. Lucie Inlet Preserve State Park, 29 August 2010.



FIG. 2. *Coluber flagellum flagellum* recently emerged from an Atlantic Ghost Crab (*Ocypode quadrata*) burrow with a hatchling sea turtle in its jaws, St. Lucie Inlet Preserve State Park, 29 August 2010.

imbricata based on the observable characters. Though neither of the latter two species was documented nesting in this area during 2010, *L. kempii* nests are difficult to distinguish from *C. caretta* nests and one may have been present. Loggerheads are by far the principal species nesting in the area.

Though this is the first documentation of a *C. flagellum* preying on a sea turtle hatchling, coachwhip snakes have been documented preying on other species of turtles. Ortenburger (1928. Mem. Univ. Michigan Mus. 1:1–247) reported an unidentified turtle in the stomach of a coachwhip from the western United States and Hamilton and Pollack (1956. Ecology 37[3]:519–526) found a newly hatched *Kinosternon subrubrum* in the stomach of a 1043-mm coachwhip from Georgia. Douglas and Winegarner (1977. J. Herpetol. 11:236–238) reported remains of a *Gopherus polyphemus* from the feces of a coachwhip in Florida and Amarello et al. (2004. Herpetol. Rev. 35:178) observed a coachwhip preying on a *G. agassizii* in Arizona.

During our monitoring of sea turtle nests on Jupiter Island, it is common to see *O. quadrata* burrows in nests. Ghost Crabs are documented predators on sea turtle eggs and hatchlings (Stancyk, *op. cit.*). It is also common to see signs that hatchlings that have emerged from their nests have been dragged by ghost crabs into their burrows (pers. obs.). This is evidenced by tracks left on the beach the morning after the incident. With respect to the incident reported here, the burrows in which the snake was found were low on the beach and hatchling tracks were observed coming from a nest higher on the beach. So it appears that, in this case, the snake did not invade a turtle nest via a crab burrow but rather invaded a crab burrow containing a hatchling turtle. It was also observed that the coachwhip had two bulges in its stomach. It is unknown whether these might represent additional hatchlings, crabs, or other prey. We could find no report of coachwhips preying on crabs despite the fact that, in the beach environment, they would provide an abundant food source for a snake that is known to eat a wide variety of prey (Hamilton and Pollack, *op. cit.*) and enter burrows (Dodd and Barichivich 2007. Florida Scientist 70[1]:83–94). This might be explained by the lack of studies on coachwhips in the coastal environment despite the fact that *C. f. flagellum* is abundant in these areas (Savannah River Ecology Laboratory 2010. http://www.uga.edu/srelherp/snakes/masfla.htm).

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***CHRYSEMYS PICTA BELLI* (Western Painted Turtle). MORPHOLOGY.** Additional carapace scutes (supernumerary scutes) arising from embryonic mutations have been reported in a number of turtles species (Fernandez and Rivera 2004. Biologica 59:85–88; Kazmaier and Robel 2001. Trans. Kansas Acad. Sci. 104[3–4]:178–182) but the extent of these anomalies within populations of *Chrysemys* is not well documented. We have been conducting a long-term study on the life history of *C. picta belli* at Chapman Lake near Durango, Colorado, USA (37.33010°N, 107.88677°W; WGS84) since 1994. Of the 299 individuals captured and released at this location, 13 individuals with supernumerary carapace scutes have been found to date. Of these, nine were females, three were males, and one was a juvenile of undetermined sex. In ten of the turtles (seven females and three males), the supernumerary scute was located between vertebral scute three (V3) and vertebral scute four (V4) resulting in a total of six vertebral scutes. Of the remaining three turtles, two individuals (one female and one juvenile) had six vertebral scutes with the supernumerary scute located between V4 and V5 and one individual (female) had eight vertebral scutes with the supernumerary scutes located between V2, V3, and V4.

Within this population, 4.3% of the individuals exhibited some type of carapace scute anomaly. Although the specific causes of these embryonic mutations are still unclear, a number of factors such as moisture levels during incubation (Hewavisenthi and Parmenter 2001. Copeia 2001:668–682; Lynn and Ullrich 1950. Copeia 1950:253–262), suboptimal environments, and inbreeding (Fernandez and Rivera 2004, *op. cit.*) can contribute to anomalies such as asymmetry and supernumerary scutes in turtle shells. Further research will be necessary to elucidate the underlying cause of this phenomenon within this population. Photographs available from CRC (contact information below).

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***EMYDOIDEA BLANDINGII* (Blanding's Turtle). RECORD EGG SIZE.** Several turtle nesting sites on the west side of Algonquin Provincial Park in Ontario, Canada are monitored annually as

part of a long-term study. Blanding's Turtles (*Emydoidea blandingii*) are rare on the west side of Algonquin Park, with only 3 nests and 14 sightings recorded between 1959 and 2003 (Brooks et al. 2003. Reptiles and Amphibians of Algonquin Provincial Park. The Friends of Algonquin Park, Whitney, Ontario. 48 pp.). On 8 June 2010, we observed a female *E. blandingii* (24.2 cm straight line carapace length, 1810 g mass) nesting. This female laid a clutch of nine eggs, of which one egg was noticeably larger than the others (Fig. 1A). The largest egg weighed 17.0 g, and had a length of 3.94 cm and a width of 2.71 cm. This egg mass is 1.2 g greater than the largest mass previously reported for this species (Ernst and Lovich 2009. Turtles of the United States and Canada, 2nd ed. Johns Hopkins University Press, Baltimore, Maryland. 827 pp.). The other eight eggs ranged from 11.4 to 12.3 g in mass (mean ± SE = 11.6 ± 0.13 g), 3.46–3.64 cm in length (mean ± SE = 3.53 ± 0.025 cm), and 2.33–2.49 in width (mean ± SE = 2.38 ± 0.018 cm). The large egg was 14.5, 6.2, and 6.5 standard deviations larger than the mean mass, length, and width, respectively, of the other eight eggs in the clutch.

The clutch was reburied and caged *in situ* to protect the eggs from predators, and the nest was monitored daily for hatchling emergence. On 3 September 2010, nine hatchlings were observed on the ground surface under the cage. One of these hatchlings was substantially larger than the rest, and this hatchling presumably emerged from the large egg (Fig. 1B). The largest hatchling weighed 13 g, and had a straight line carapace length of 3.85 cm. The other eight hatchlings weighed 8.4–9.0 g (mean ± SE = 8.7 ± 0.08 g) and had straight line carapace lengths of 3.36–3.46 cm (mean ± SE = 3.40 ± 0.012 cm). To quantify the change in mass during development, a ratio of hatchling mass to egg mass was calculated. This ratio was found to be similar between the largest egg (0.76), and the mean for the other eight eggs (0.75).

Pelvic aperture width constraints have been suggested as an explanation for deviations from egg size/clutch size relationships predicted by optimal egg size theory in small-bodied turtle species (Congdon and Gibbons 1987. Proc. Natl. Acad. Sci. USA. 84:4145–4147; Rollinson and Brooks 2008. Oikos 117:144–151). Our observation of an anomalously large egg relative to others in the same clutch supports the idea that, at least in this case, a large-bodied turtle's egg size may not be morphologically constrained, and may still deviate from optimal egg size theory. Also, because the change in mass during development was similar regardless of size, the requirements of embryological development may not constrain egg size. Overall, our observation suggests that Blanding's Turtles may not experience the same constraints on egg size as other species. This may leave traits, such as egg, clutch, and hatchling size, free to respond to external selective pressures making Blanding's Turtles an optimal model for examining such traits.

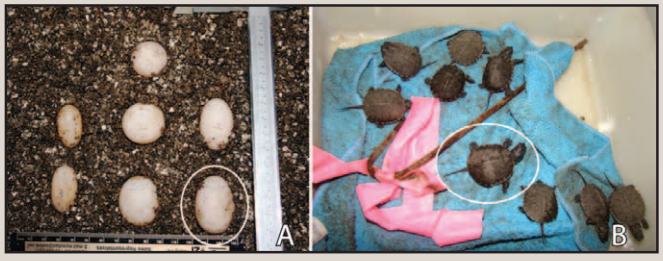


PHOTO BY DAVID LEGROS

FIG. 1. A) From left to right, two Painted Turtle (*Chrysemys picta*) eggs, three Snapping Turtle (*Chelydra serpentina*) eggs, and two Blanding's Turtle eggs. The unusually large Blanding's Turtle egg is encircled. Photo by Patrick Moldowan. B) A picture of the clutch of Blanding's Turtle hatchlings, with the unusually large hatchling encircled.

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***EMYDOIDEA BLANDINGII* (Blanding's Turtle). HATCHLING BEHAVIOR.** *Emydoidea blandingii* is a semi-aquatic emydine turtle that occupies wetland habitats in the northcentral and northeastern United States and southeastern Canada. Adults overwinter aquatically to avoid freezing and desiccation (Edge et al. 2009. Can. J. Zool. 87:824–834), but hibernacula used by hatchlings and juveniles are not well known. It has been suggested that hatchlings might overwinter in the nest cavity, in aquatic habitats, and occasionally on land outside the nest cavity (Ultsch 2006. Biol. Rev. 81:339–367), but conclusive field data are lacking.

Here we report on a putative communal terrestrial overwintering of post-emergent Blanding's Turtle hatchlings. Five individuals were found in a hollow subterranean root while conducting a radio-telemetry study of three species of hatchling turtles (*E. blandingii, Glyptemys insculpta, Chelydra serpentina*) in Algonquin Provincial Park, Ontario, Canada. Epoxy was used to attach VHF transmitters (0.55 g, Advanced Telemetry Systems [ATS], Isanti, Minnesota) to the carapace of hatchlings upon emergence from their nests. Hatchlings were tracked every 1–3 days using a 3-element Yagi antenna attached to a R410 Scanning Receiver (ATS, Isanti, Minnesota). On 17 September 2010, Blanding's Turtle hatchling #373 was tracked to the base of an alder root system but was not visually located. The location was narrowed down to a 1 m^2 area and marked with flagging tape. On 22 September, Blanding's Turtle hatchling #247 from the same clutch was tracked to the same 1 m^2 but neither turtle could be visually located despite several hours of searching through the leaf litter. After several days of not moving, the hatchlings were assumed to have been predated and cached below ground, so the area was excavated by hand to preserve any existing tunnels and animal remains. On 27 September 2010, the two hatchlings with transmitters were located alive and dormant inside a hollow root that was 14 cm in diameter and 25 cm below the soil surface. In addition, three other live Blanding's Turtle hatchlings were within 15 cm inside the same root. All five hatchlings were identified as siblings by a clutch-specific notch in their marginal scutes given at emergence on 20 August 2010. Because the turtles were observed inside the root in late fall, we presume that they had selected this site for overwintering. The root was along the border between an alder swamp and a softwood forest. This location was 63 m from their nest and it is unknown how the turtles entered the root.

There are two possible explanations for how the five sibling turtles chose the same hollow root. The first is that the hatchlings were using conspecific cues to follow each other. Although the use of chemical cues has been suggested for other species (Tuttle



FIG. 1. Five sibling Blanding's Turtle (*Emydoidea blandingii*) hatchlings in a putative hibernaculum consisting of a hollow tree root 25 cm below the soil surface. The turtles were observed on 27 September 2010.

and Carroll 2005. Northeast. Nat. 12[3]:331–348), their use has not been experimentally demonstrated for freshwater turtle hatchlings. The other possible explanation is that all five turtles were using the same cues to detect appropriate hibernacula to enter the root. Considering there were over 50 hatchlings from seven nests that hatched surrounding the wetland that fall, the probability of five hatchlings from the same clutch entering the same root without using conspecific cues would seem to be low. Although there is no experimental evidence of hatchlings following conspecific cues to reach hibernacula, our observations add to the body of evidence suggesting that chemical cues from other hatchlings are important.

The hatchlings were tracked again on 5 October 2010. The two turtles with transmitters (#s 247 and 373) were no longer inside the root and had moved 8 m and 6 m, respectively. Both hatchlings were buried in terrestrial forms, and there was no standing water at either location. The root was re-opened to check for the other three hatchlings, but none was found. It is likely that the disturbance we caused during excavation of the root system caused the hatchlings to move to a different overwintering site. However, because the hatchlings had been immobile in the root system for 5–10 days before being disturbed, we suspect that they would have overwintered in this location. Temperatures during the week of excavation were already dropping below freezing, which would have limited the mobility of hatchlings.

To our knowledge, our observations are the only known account of hatchling freshwater turtles using communal terrestrial hibernacula outside of the nest chamber, as well as the only account of Blanding's Turtle hatchlings using a hollow root system as a refuge. Future work should identify important characteristics of such sites, what cues hatchlings use to find hibernacula, and whether hatchlings can successfully overwinter in such sites.

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***ERETMOCHELYS IMBRICATA* (Hawksbill Sea Turtle). PELAGIC JUVENILE.** *Eretmochelys imbricata* occurs throughout the tropical and subtropical oceans (Meylan and Redlow 2006. *In* P. Meylan [ed.], Biology and Conservation of Florida Turtles, pp. 105–127. Chelonian Res. Monogr. 3). In the Western Atlantic Ocean they have been observed from the southern USA to southern Brazil, throughout Central America, the Bahamas and Caribbean Sea (Meylan and Redlow 2006, *op. cit.*). After hatching, a Hawksbill undergoes a pelagic phase until attaining about 20 cm in carapace length; thereafter, it migrates to coastal regions or islands and establishes a residence, changing to a benthic phase, where it feeds and finds refuge until reaching sexual maturity (Chacón 2004. WWF-Programa Regional para América Latina y el Caribe. San José, Costa Rica). *Eretmochelys imbricata* is currently listed as Critically Endangered by the IUCN (2010. IUCN Red List of Threatened Species. Ver. 2010.4. www.iucnredlist.org), and is included in Appendix I of CITES (CITES 2005. Convention on International Trade in Endangered Species of Wild Fauna and Flora. www.cites.org/eng/append/appendices.doc).

Here we present the first record of a pelagic juvenile Hawksbill Sea Turtle in the Marine Extractive Reserve Mãe Grande de Curuçá, located in the city of Curuçá, northeast of Pará, Brazil. This individual turtle was found dead, collected, and identified by Marcela M. Ramos and verified by Marinus Hoogmoed. It was deposited in the herpetological collection of Museu Paraense Emílio Goeldi, Belém-PA, Brazil (MPEG 1068). The specimen was recovered at Romana's Beach (0.54286°S, 46.0991°W), at Guarás Island (one of 14 islands in the marine reserve), on 18 August 2010, in an "estacada" net. The "estacada" is a gillnet commonly used by fishermen in the north region of Brazil (SEPAq 2008. Diagnóstico da pesca e da aqüicultura do Estado do Pará. <http://



FIG. 1. Juvenile of *Eretmochelys imbricata* captured at Romana's Beach, Resex Marinha Mãe Grande de Curuçá, Pará, Brazil.

www.sepaq.pa.gov.br/files/u1/diag_pesca2008.php>) that can cause death in sea turtles by preventing them from surfacing to breathe (Gallo et al. 2006. Chelon. Conserv. Biol. 5:93–101). The juvenile reported here had the following measurements: 10.58 cm straight-line carapace length, 8.10 cm straight-line carapace width, 7.54 cm plastron width, 8.14 cm plastron length, 1.36 cm pre-cloacal tail length, 2.0 cm post cloacal tail length, 2.37 cm head width, and weighed 170 g (Fig. 1).

The Hawksbill Sea Turtle has an oceanic-neritic developmental pattern, characterized by early development in the oceanic zone followed by later development in the neritic zone, appearing in this latter zone at about 20–35 cm caparace length (Bolten 2003. *In* Lutz et al. 2003. The Biology of Sea Turtles. Vol. II. CRC Press, Washington, D.C.). This open ocean phase has been called the "lost years" (lasting 5–20 years) because researchers have little information on where the turtles go during this time (Miller 1997. *In* Lutz and Musick 1997. The Biology of Sea Turtles. Vol. I., pp. 51–81. CRC Press, Washington, D.C.). It has been thought that these animals may be floating among seaweed or wandering adrift in the open sea, thus the potential importance of this first occurrence of a pelagic juvenile in the neritic zone. In addition, this report highlights the importance of monitoring the incidental captures on Pará's coast, an important area for artisanal fishing (IBAMA 2004. Estatística da pesca 2002: grandes regiões e unidades da federação. IBAMA/CEPENE, Tamandaré).

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***GLYPTEMYS MUHLENBERGII* (Bog Turtle). LOW INCIDENCE OF ALGAE AND LEECHES.** The interrelationships between algae and leeches and the Bog Turtle, *Glyptemys muhlenbergii*, have been essentially ignored by researchers. Major life history studies of the turtle (Arndt 1977. Chesapeake Sci. 18:67–68; Burton and Price 1955. Copeia 1955:159–165; Ernst 1977. Herpetologica 33:241–246; Holub and Bloomer 1977. Herpetol. Bull. New York Herpetol. Soc. 1:9–23) made no mention of either algae or leeches, and, apparently, no literature records of algae colonizing Bog Turtles exist. In view of this, data on algae and leech associations recorded from southeastern Pennsylvania Bog Turtles are reported here.

A total of 103 captures of Bog Turtles in a small population in Lancaster Co., Pennsylvania, USA were made from 1964–1992. The research site was described in Ernst (1971b. J. Herpetol. 5:151–160). At the time of capture, the presence or absence of algal colonies on the carapace and leeches attached to the soft parts were recorded; along with the date, plastron length, sex (Ernst and Lovich 2009. Turtles of the United States and Canada, 2nd ed. Johns Hopkins Univ. Press, Baltimore, Maryland), and other pertinent capture data (see Ernst 1971b, 1977, *op. cit.*). All turtles were notched for future identification and released.

Very few Bog Turtles were found with algae on their carapaces (5 records, 4.9% of captures). This is in direct contrast with data previously recorded for the other aquatic and semiaquatic turtles found at the site: *Chelydra serpentina*, 39.0% (Ernst et al., *in prep.*); *Chrysemys picta*, 69.1% (Ernst 1969. The Natural History and Ecology of the Painted Turtle, *Chrysemys picta* [Schneider]. Ph.D. dissertation, Univ. Kentucky, Lexington); *Clemmys guttata*, 46.4% (Ernst 1976. J. Herpetol. 10:25–33); *Glyptemys insculpta*, 17.0% (Ernst 2001. Chelon. Conserv. Biol. 4:94–99); and *Sternotherus odoratus*, 85.8% (Ernst 1986. J. Herpetol. 20:341–352). The species of algae involved was *Basicladia crassa*, a common colonizer of other turtle species, and a new host record. Although Bog Turtles were captured from March through August, algal colonies were only present on the turtles during April (4.3% of 23 captures) and May (6.3% of 63 captures). Also, algae colonization was only associated with adult males, 5 of 54 males (9.3%).

Likewise, the number of records of Bog Turtles with attached leeches was very small (4, 3.9%) compared with records from the other five species of turtles present: *C. serpentina*, 32.8% (Ernst et al., *in prep.*); *C. picta*, 10.7% (Ernst 1971a. J. Parasitol. 57:32); *C. guttata*, 12.1% (Ernst 1976, *op. cit.*); *G. insculpta*, 38.6% (Ernst 2001, *op. cit.*); and *S. odoratus*, 36.8% (Ernst 1986, *op. cit.*). As with algae, leeches were only attached to Bog Turtles during April (8.7% of captures) and May (8.7%). Three leeches were attached to adult females (6.3%), a single leech was found on an adult male (1.9%), and none was found on hatchlings or immatures; no turtle had more than one leech attached. The leech species at White Oak was *Placobdella parasitica*.

Leeches have been previously reported to parasitize *G. muhlenbergii* ("large blood sucking annelid"; Burton 1957. Our Knowledge of the Bog Turtle, *Clemmys muhlenbergi*, Further Augmented, M.S. thesis, Univ. Pittsburgh; Saumure and Carter 1998. Herpetol. Rev. 29:98; Saumure and Beane 2001. Herpetol. Rev. 32:38). Saumure and Carter (1998, *op. cit.*) found *Placobdella multilineata* on Virginia *G. muhlenbergii*, and Saumure and Beane (2001, *op. cit.*) reported both *P. multilineata* and *P. parasitica* from North Carolina Bog Turtles. Saumure and Carter (1998, *op. cit.*) noted a 52.2% incidence of *P. multilineata* attachment during June through August in Virginia, and Saumure and Beane (2001, *op. cit.*) found *P. parasitica* on 3 North Carolina female Bog Turtles in May, June, August, and September, with an average of 3 leeches per turtle. At other North Carolina sites they found 2 males and 2 females with an additional 8 *P. parasitica*. Although the total number of Bog Turtles captured was not reported, the incidence of parasitism there by *P. parasitica* seems low (2.4% on 7 turtles). In addition, Saumure and Beane (2001, *op. cit.*) found an average of 1.3 *P. multilineata* attached to 10 Bog Turtles during May and June (total number of captures not given).

In addition to the relatively small number of *G. muhlenbergii* involved in the Pennsylvania, Virginia, and North Carolina populations, the total number of leeches attached to individual turtles was also very low. In the Pennsylvania population, as many as 88 leeches have been found on individual turtles of the other species, and normally each infested turtle had more than one leech attached (see above studies cited).

Why is there such a low incidence of both algae and leech attachment for *G. muhlenbergii*? Some suggestions can be made, based on the limited data, and these relate to the microhabitat and behavior of *G. muhlenbergii* (summarized in Ernst and Lovich 2009, *op. cit.*). Essentially the species prefers very shallow, boggy sites with soft bottoms, abundant sedge (usually *Carex* sp.) tussocks or cattails (*Typha*), and numerous Meadow Vole (*Microtus pennsylvanicus*) runs. Its preferred microhabitat has been characterized as one where the Bog Turtle can "keep its feet

wet and its carapace dry." In such microhabitats the turtle forages along the shallow waterways and vole runs, and, at times of perceived danger, when becoming too warm, or at night, buries itself in the soft bottom or within the sedge tussocks. It is a confirmed basker (all age groups and sexes, although females may bask slightly more than males). Its microhabitat probably plays a major role in lowering the rate of incidence of both algal and leech attachment. Its extremely shallow water microhabitat is warmer than the cooler, deeper waters nearby, and may not be as conducive for leeches. Also, the turtle's carapace is exposed to the sun more often, even if not basking, than those of more aquatic turtles; and is thus drier and warmer (pers. obs.). Algae cells on the carapace and leeches attached to the soft parts have a greater chance of being killed by ultraviolet rays, overheating, or drying out. When not foraging or basking, the turtle is usually found under the surface of the soft bottom or within vole or Muskrat (*Ondatra zibethicus*) burrows, if available, and is then in reduced light or possibly total darkness which does not favor algae growth.

Algal and leech associations should be included in current or future ecological studies of Bog Turtles to confirm or refute the above assumptions and the apparent low incidence of colonizations.

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***GOPHERUS AGASSIZII* (Desert Tortoise) and *CROTALUS RUBER* (Red Diamond Rattlesnake). BURROW CO-OCCUPANCY.** I observed an adult Desert Tortoise and an adult Red Diamond Rattlesnake (sexes unknown) (Fig. 1) in a shallow tortoise burrow on 6 January 1997 at a wind energy generation facility near Palm Springs, Riverside Co., California, USA (33.9599°N, 116.6613°W). The site is located in the southeastern foothills of the San Bernardino Mountains just west of the Whitewater River. The air temperature was about 5°C at the time the photograph was taken. The burrow was located about 50 m from a row of wind energy turbines, not an unlikely location for tortoises in this population (Lovich and Daniels 2000. Chelon. Cons. Biol. 3:714–721). Both species are common at the site and Red Diamond Rattlesnakes have been seen at Desert Tortoise burrows during the summer as well. The time of year when the photograph was taken was well within the cool weather dormancy period for both Desert Tortoises (Ernst and Lovich 2009. Turtles of the United States and Canada, 2nd ed. Johns Hopkins University Press, Baltimore, Maryland) and Red Diamond Rattlesnakes (Ernst 1992. Venomous Reptiles of North America. Smithsonian Institution Press, Washington, D.C). In California the Red Diamond Rattlesnake is more commonly associated with coastal sage scrub and chaparral plant communities and the Desert Tortoise is emblematic of the desert, three very different but proximate ecosystems. Areas where the ranges of these animals overlap are comparatively small when considering their composite distributions but the transition area at the study site contains representatives of plant species from all three ecosystems. Although Desert Tortoise burrows can be occupied by many species of animals including other species of *Crotalus* (Ernst and Lovich, *op. cit.*) this is the first documented case of burrow co-occupancy for these two reptiles.



FIG. 1. *Gopherus agassizii* and *Crotalus ruber* hibernating in a shallow Desert Tortoise burrow together near Palm Springs, California, USA.

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***GOPHERUS POLYPHEMUS* (Gopher Tortoise). BURROW ASSOCIATE.** *Gopherus polyphemus* excavate and inhabit burrows in xeric, sandy habitats of the southeastern United States (Auffenberg and Franz 1982. *In* Bury [ed.], North American Tortoises: Ecology and Conservation, pp. 95–126. USDI Fish and Wildlife Service, Wildl. Res. Rep. 12). Because of the cool, moist microenvironment provided by tortoise burrows, a number of animals use them as refugia with 60 vertebrate and 302 invertebrate species documented utilizing burrows (Jackson and Milstrey. 1989. *In* et al. [eds.], Proceedings: Gopher Tortoise Relocation Symposium, pp. 86–98. Florida Game and Fresh Water Fish Commission, Tallahassee, Florida). Although the Six-lined Racerunner (*Aspidoscelis sexlineata*) has been observed using tortoise burrows for refuge, it has never been reported to nest in tortoise burrows or the burrow aprons, the mound of excavated sand deposited outside the burrow entrance. Here we present six instances of *A. sexlineata* nesting in the aprons of burrows of *G. polyphemus* at the Aiken Gopher Tortoise Heritage Preserve, Aiken Co., South Carolina, USA.

In the course of searching for and excavating *G. polyphemus* nests on 25 August and 1 September 2010, we unearthed six *A. sexlineata* nests at six separate burrows. All nests were buried shallowly on burrow aprons. Four of the nests consisted of neonates emerging from or recently emerged from eggs, while two nests contained clutches of two and three eggs each. We brought the clutch of two eggs to the laboratory where it subsequently hatched on 3 September (eight days later). Tortoise burrows have long been acknowledged as important microhabitats within open-canopied, sandy habitats for species seeking thermal refugia, moist hides, or foraging areas (Milstrey 1986. *In* Jackson and Bryant [eds.], The Gopher Tortoise and its Community, pp. 4–25. Proceedings 5th Annual Meeting Gopher Tortoise Council, Florida State Museum). Female Gopher Tortoises are also known to nest in the aprons of their burrows; however, these observations of *A. sexlineatus* highlight the potential for the aprons of Gopher Tortoise burrows to serve as important oviposition sites for other herpetofaunal species.

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***KINOSTERNON SUBRUBRUM* (Eastern Mud Turtle) MUSKING.** Many turtle species have externally secreting musk glands located in the bony bridge region that binds the plastron with the carapace. These glands are referred to as Rathke's glands, and their pores are generally located on the axillary and inguinal scutes (Ehrenfeld and Ehrenfeld 1973. Copeia. 1973:305–314). The number of glands varies from one to three (pairs) in extant species and up to four pairs in fossil turtles. The discovery of four pairs of Rathke's glands in *Kayentachelys aprix* from the North American early Jurassic (150 mya) suggested that turtles were among the first amniotic lineages to evolve skin glands (Weldon and Gaffney 1998. Naturwissenschaften 85:556–557). The purpose of Rathke's glands is not clearly understood, but the most common explanation is that they function as a predator deterrent, though this assertion has not been proven experimentally. Laboratory experiments focusing on the musk turtles (Kinosternidae: *Sternotherus*) suggested that Rathke's gland secretions function in mating behavior, but the effects of other chemical secretions could not be ruled out (Lewis et al. 2007. J. Herpetol. 41:349–353).

The secretion of musk or "musking" may be regulated in relation to the situation at hand. During predator deterrence musk could be secreted indiscriminately as a negative stimulus to the attacker. In intraspecific communication, a female may signal to a male that she is receptive, or a male may signal as a warning to another male of its presence. I use this reasoning to explain observations of differential musk secretion in 10 Eastern Mud Turtles (*Kinosternon subrubrum*) collected from forested floodplains and freshwater tidal marshlands of the Patuxent River in Maryland, USA (38.7839°N, 76.7093°W). Five adult males and five adult females were hand-captured, and marked in upland forests during April of 2008. All turtles excreted musk prominently when handled. Malodorous secretions accumulated and streamed from the surface of the axillary and inguinal scutes in up to three sizable drops. The turtles were then released at their exact capture locations in upland forests. When the original 10 turtles were recaptured in aquatic habitats (>5 recaptures/individual) in May–August, musk secretion was not observed, or at least was not appreciable. To test whether this lack of musk secretion was the result of acclimation to frequent human intrusion, an additional seven adult turtles were captured in water. Musk secretion in these individuals was not detected. It is feasible, but seemingly unlikely, that musk may not have been detected due to its being diluted by water.

I speculate that musking in *K. subrubrum* may not serve as an efficient anti-predatory strategy in the aquatic environment for at least two reasons (in addition to a possible dilution factor). First, gland pores may be blocked by debris that accumulates on the shell of this bottom-walking species. I observed that, in many cases, the entire plastron and marginal carapace was covered by a thick layer of algae or mud. Secondly, excessive musk secretion might advertise the presence of an individual to predators, and competitors of the same or different species. Kinosternid turtles are prey to larger bottom-walking chelydrids. Experiments have shown that *Sternotherus* is capable of using chemosensory cues to detect the presence of *Macroclemys temminckii*, but the reciprocal was not shown (Jackson 1990. Copeia 1990:557–560). It is thus possible that kinosternids may be able to use chemosensory cues to detect conspecifics. Aggressive behavior towards conspecifics in *K. subrubrum* can be severe while in water (Rigley 1973. Bull. Maryland Herpetol. Soc. 10:22–23). Therefore, it might be advantageous to regulate musk secretion in order to minimize detection. There is a modest body of evidence to suggest that turtles are capable of aquatic chemoreception in inter- and intraspecific interactions (reviewed in Polo-Cavia et al. 2009. Biol. Invas. 11:431–440). Based on my observations, *K. subrubrum* may tend to musk in the terrestrial environment to deter predators, but may reduce use of musk glands in the aquatic environment for reasons that remain speculative. For instance, in kinosternids or other turtle species, it is not clear whether Rathke's glandular secretions follow seasonal patterns. As such, the function of these glands remains obscure, and aspects of its behavioral and chemical ecology warrant further examination (Plummer and Trauth 2009. Herpetol. Cons. Biol. 4:207–220).

These observations were made while conducting research at the Jug Bay Wetlands Sanctuary in Lothian, Maryland. I thank Chris Swarth, Sanctuary Director, for logistical assistance, and the Friends of Jug Bay for funding.

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***PODOCNEMIS UNIFILIS* (Yellow-spotted River Turtle). NEST PREDATION.** In some localities, ants are considered important predators of turtle nests (Fachín-Terán 1994. Boletín de Lima 16:417–423; Moulis 1997. Chelon. Conserv. Biol. 2:433–436). However, the level of this impact is still poorly understood and rarely documented (Caut et al. 2006. Can. J. Zool. 84:908–915). Here we report on the impact of ants on the reproductive success of the freshwater turtle *Podocnemis unifilis* at a site in the Brazilian eastern Amazon.

Between 22 September and 27 December 2009 we daily monitored nests of *Podocnemis unifilis* at a 29.68-ha study site at Taboleiro da Água Preta (02.0912°N, 054.3717°W), western Pará State, Brazil. This site is a floodplain area in the lower Amazon River, near its confluence with the Tapajos River. Of the monitored nests, 1.2% (two nests) were partially predated by the fire ant *Solenopsis saevissima* (Formicidae: Myrmicinae). In the first depredated nest of 34 eggs, four hatchlings (11.8%) were lost to ants, and in second nest, also with 34 eggs, 14 hatchlings (41.2%) were predated.

The level of ant predation seemingly can vary widely between even closely spaced nests; for example, 52.4% of nests at a site in the Peruvian Amazon (Fachín-Terán, *op. cit.*), 8.3% in Georgia, USA (Moulis, *op. cit.*), and only 1.2% in the Brazilian eastern Amazon (this study). However, it is not yet known which factors might influence the probability of predation of turtle nests by ants. Future studies should better define the impact of ants on the nesting success of turtles.

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***PSEUDEMYS CONCINNA SUWANNIENSIS* (Suwannee Cooter). FISH PREDATION.** Fish predation on turtles is well known, but some large carnivorous fishes such as the Bowfin (*Amia calva*) have not been considered turtle predators (Ernst et al. 1994. Turtles of the United States and Canada. Smithsonian Inst. Press, Washington, D.C. 578 pp.; Jordon and Arrington 2001. Wetlands 21:155–159). On 4 May 2010 at the 0300 h we captured an adult female *A. calva* (812 mm total length, 4082 g) in Ginnie Spring (29.8361°N, 82.6997°W), High Springs, Florida, USA. While dissecting this specimen, we found a juvenile *Pseudemys concinna suwanniensis* (39 mm straight midline carapace length, 37 mm straight midline plastron length, 33 mm carapace width, 17 mm height) in the stomach contents. This observation might be the first record of turtle predation by *A. calva* and also expands the list of predators potentially influencing populations of *P. c. suwanniensis*, which is listed by the Florida Fish and Wildlife Conservation Commission as a Species of Special Concern.

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***STERNOTHERUS CARINATUS* (Razor-backed Musk Turtle). PREDATION.** On 6 June 2008, seven *Sternotherus carinatus* shells, one *Apalone spinifera* and *A. mutica* shell each, and several catfish (*Ictalurus* sp.) skulls were found on the ground below a Bald Eagle (*Haliaeetus leucocephalus*) nest on Kincaid Lake, Rapides Parish, Louisiana, USA.

All of the *S. carinatus* shells apparently are of adult size, and averaged 136.1 mm in carapace length (111.3–144.0 mm), 91.8 mm in carapace width (80.8–99.3 mm), 96.5 mm in plastron length (79.2–104.1 mm), and 59.7 mm in shell height (50.1–69.3 mm). The shells remained mostly intact and were all that remained of the turtles except for a few attached vertebrae and limb bones. This is the first report of a specific, non-human predator for adults of this species (Ernst and Lovich 2009. Turtles of the United States and Canada, 2nd ed. Johns Hopkins University Press, Baltimore, Maryland. 827 pp.; Lindeman 2008. Chelon. Res. Monogr. 5:012.1–012.6; Mahmoud 1969. Southwest. Nat. 14:31–66). There are, however, reports of Bald Eagles preying on the congeneric *S. odoratus* (Clark 1982. J. Field Ornithol. 53:49–51; Ernst and Lovich 2009, *op. cit.*) and both species of *Apalone* (Watermolen 2004. Bull. Chicago Herpetol. Soc. 39:69–70).

Voucher specimens are deposited in the University of Louisiana at Monroe Museum of Natural History: *Apalone mutica* (NLU 70630), *A. spinifera* (NLU 70629), and six of the seven *S. carinatus* (NLU 70631–70636). Turtles specimens were collected with LNGP permit #2008–043.

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***TERRAPENE CAROLINA CAROLINA* (Eastern Box Turtle). AGGRESSION / REPRODUCTION.** On 25 September 2010, on the campus of Messiah College (Grantham, Pennsylvania, USA; 40.1564°N, 76.9964°W), the interactions of two male and one female *Terrapene c. carolina* were observed. When they were first encountered, one of the males (designated α) was copulating with the female (♀) (phase 3) and the other male (designated β) was alternating between biting the front of the carapace and attempting to mount her (phase 1). (Note: these three phases of box turtle courtship and mating were described by Evans [1953. Herpetologica 9:198–192] as circling/biting/shoving [phase 1], mounting [phase 2], and copulating [phase 3]). Interestingly, neither male responded to the other's presence. α remained motionless in a typical phase 3 posture, and β made no attempts to dislodge him, but continued normal phase 1 behavior as if α was not there. The ♀ had the front of her plastron partially open, but she did not extend her head or limbs. This continued for 20 minutes, then α and the ♀ separated, and α righted himself. The ♀ began to rapidly leave, and both males chased after her, biting at each other's necks as they ran. β ran ahead of α. After a short distance, the ♀ stopped and partially closed up. Both males stopped as well, but they kept their necks stretched out. β bit the rear of the ♀'s carapace several times, then turned away from her and approached α. He stopped before reaching α, pushed himself up on his legs, and repeatedly raised and lowered his left front leg. This behavior, however, is typical of a male courting a female, not of a male fighting another male (Evans 1953, *op. cit.*). Other researchers have observed males trying to mate with other males (Harless and Lambiotte 1971. J. Biol. Psychol. 13:17–23). α did not appear to make any response to β. After seven minutes, the ♀ began to leave again. As soon as she moved, both males extended their necks even further, looked in her direction, and then chased after her. The ♀ stopped and closed her shell after moving a short distance. β was immediately behind her, and α was immediately behind him. This time, α continued to charge forward, and β turned 90° to the left and confronted him. α lunged at the front of β, and β immediately closed up. α bit at β several times, then walked off. After α had moved roughly 0.5 m, β opened up and charged after him. It was unclear whether this chasing was aggression or courting, but it is interesting that β left the ♀ who was sitting motionless beside him. As β approached, α turned 180° and lunged at β. Once again, β closed up immediately. This time, however, α stayed and continued to bite at β whenever β opened his plastron. Ten minutes later, the ♀ opened up and moved away. β was closed during her departure, and α was open and facing the ♀, but he did not chase after her.

It is possible that α may have been mate guarding; however, female Eastern Box Turtles can store sperm for several years, and it would presumably be inefficient for a species with delayed fertility to also exhibit mate guarding (Ewing 1943. Copeia 1943:112–14; Gist and Fischer 1993. J. Reprod. Fertil. 97:463–468). In defense of a mate guarding hypothesis, however, Tonge (1987. Dodo, J. Jersey, Wild. Preserv. Trust 24:111–120) reported that in a group of captive Aquatic Box Turtles (*Terrapene coahuila*) one dominant male prevented the other males from mating.

It might be possible to attribute most of the observed behaviors to the tendency of *Terrapene carolina* to respond to movement (Fitch 1965. Trans. Kansas Acad. Sci. 68:522–532). Male Box Turtles have been known to totally ignore a female that is immobile, but readily investigate a moving, turtle-shaped object (Belzer 2002. Turtle and Tortoise Newsl. 6:17–26). This may indicate that the various instances of α and β responding to each other and ignoring the ♀ were simply a result of the fact that the other male was moving, and the ♀ was not.

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CROCODYLIA — CROCODILIANS

***CROCODYLUS PALUSTRIS* (Mugger Crocodile). SIGNALING BEHAVIOR.** Although *Crocodylus palustris* is a common and well-studied species, the signaling behavior of adults during the mating season has never been studied. Observations on *C. palustris* were made during the mating season at three locations in India: in the wild in Sasan Gir National Park (Gujarat, 21.13°N, 70.78°E, January 2007) and Katerniaghat Wildlife Sanctuary (Uttar Pradesh, 28.34°N, 81.42°E, March 2007), and in captivity in Madras Crocodile Bank (Tamil Nadu, 12.74°N, 80.25°E, December 2006). At the first two locations, the crocodiles inhabited rivers of varying size and small forest ponds. At the third location, they were kept in concrete ponds within bare-ground enclosures.

Observations in the wild were conducted *ad libitum* by locating large individuals (the most likely to be males) and watching them and other crocodiles in view from a distance of at least 50 m. At each location, continuous 24-h observation was initially attempted to determine the approximate time of day when signaling behavior was most likely to occur. As soon as that time period was determined, observational efforts were concentrated with that time frame. At Madras Crocodile Bank, the animals were observed from 1600 to 1200 h, with two 5-min breaks.

The crocodiles produced roars and headslaps, performed in arched-back posture at the water's edge, and these behaviors were accompanied with body vibrations and "water dance" effects indicative of infrasound pulse, as described for the Nile Crocodile (*C. niloticus*) and the American Crocodile (*C. acutus*) (Garrick et al. 1978. Bull. Am. Mus. Nat. Hist. 160:153–192). Mugger roars are similar to those of Nile Crocodiles (pers. obs.), but louder (audible to a human observer at more than 1 km under ideal conditions) and longer (up to five sec in duration, as seen on spectrograms). Unlike Nile and American crocodiles (Dinets, in prep.), roars were used more frequently than headslaps; eight roars vs. two headslaps at Katerniaghat (in five days of observation), six roars vs. three headslaps at Sasan Gir (in seven days of observation), and one roar at Madras Crocodile Bank (in one day of observation).

Roaring on land was not observed in wild individuals, however, the only roar observed at Madras Crocodile Bank was produced by a male on land. Two smaller crocodiles (probably females) immediately approached the male and initiated courtship behavior (chin touching).

All roars and headslaps were produced by animals more than 2 m long (by visual estimate), and never by animals known from mating observations to be females. In most cases, roars and headslaps were produced within one hour before or after sunrise, and before the animals left the water to bask onshore. The only exceptions were the abovementioned roar on land and one roar in the water, produced by a male in Sasan Gir three hours after sunrise, following two hours of basking onshore on an exceptionally cold morning (minimum air temperature 11°C). Another male at the same location once produced a roar without an arched-back display immediately after (and possibly in response to) a roar by a lion (*Panthera leo*) half an hour before sunrise. In both cases the sex of each individual was known from observed matings.

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***MELANOSUCHUS NIGER* (Black Caiman). SIGNALING BEHAVIOR.** Observations presented herein on *Melanosuchus niger* were made between 15–19 August 2008 in Rupununi River and an adjacent oxbow lake near Karanambu Ranch, Region 9, Guyana (3.75°S, 59.26°W), and on 21–22 December 2010 at Laguna Añangucohoa in Yasuni National Park, Orellana Province, Ecuador (0.55°S, 76.45°W). In Guyana, three caimans were observed from shore or boat for one 16-h period each, from one hour before sunset to three hours after sunrise. In Ecuador, one caiman was observed from shore for three 11-h periods, from one hour after sunset to sunrise. During each observation period there was only one caiman in sight. The minimum observation distance was 50 m. The animals did not show any sign of disturbance or awareness of the observer's presence. No artificial light was used because moonlight was sufficient for observation (full moon on 16 August 2008 and on 21 December 2010). All caimans were visually estimated to be 3–3.5 m long. Animals of that size were most likely adult males (Herron 1991. Biol. Conserv. 55:103–113).

The animals performed roaring and head-slapping displays in arched-back posture, as described for the American Alligator (*Alligator mississippiensis*) (Garrick et al. 1978. Bull. Am. Mus. Nat. Hist. 160:153–192; Vliet 1989. Am. Zool. 29:1019–1031). Two roaring and four head-slapping displays were observed in Guyana; one roaring and two head-slapping displays in Ecuador. To a human observer, Black Caiman roars sound similar to roars of Spectacled (*Caiman crocodylus*), Yacare (*C. yacare*), and Broad-snouted (*C. latirostris*) caimans (pers. obs.), but are louder (probably audible at more than 300 m in ideal conditions) and longer (estimated to last for 1–1.5 sec). Body vibrations and "water dance" effect indicative of infrasound production (Garrick et al., *op. cit.*) accompanied all displays. All signaling behavior was observed at night (between 1 h after sunset and 20 min before sunrise).

Black Caimans breed during the rainy season: August in Guyana (Peter Taylor, pers. comm.) and in June in Ecuador (Serverio Pachac, pers. comm.). The observations in Ecuador were made during a two-week period of exceptionally heavy rains; this probably explains why the animal was displaying outside the mating season. To my knowledge, signaling behavior of the Black Caiman has never before been described in literature.

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***MELANOSUCHUS NIGER* (Black Caiman). LONG DISTANCE MOVEMENT.** The Black Caiman (*Melanosuchus niger*) is the largest of the four crocodilian species found in the Amazon River basin. Despite its economic and ecological importance, relatively little is known of its ecology and behavior (Vasquez 1991. Cat. Amer. Amphib. Rept. 530.1–530.4). Commercial hunting for caiman skins was common throughout the Amazon until the 1960s (Smith 1980. Biol. Conserv. 19:177–187) and in Brazil it was prohibited in 1967. However, over the last 20 years, *M. niger* populations have been recovering in many parts of the species' range, and today it is abundant in many parts of Brazilian Amazonia (Da Silveira 2002. *In* Larriera and Verdade [eds.], La Conservación y el Manejo de Caimanes e Cocodrilos de América Latina, pp. 61–78. C. N. Editoria, Piracicaba, São Paulo, Brazil).

As part of an evaluation of the Black Caiman population in the Mamirauá Sustainable Development Reserve (1,124,000 ha) in the western Brazilian Amazon (Da Silveira et al. 2008. Copeia

2008:425–430), we captured adults and subadults for a radio-telemetry study of movement patterns. Caimans were captured at night using a pole with a breakaway noose from a 4.7-m aluminum boat with a 15-hp motor (Da Silveira and Da Silveira 1997. Newsletter Crocodile Specialist Group – IUCN/SSC 16[2]:18–20). Caimans were marked by a monel toe web tag attached at the right rear foot and equipped with Advanced Telemetry Systems (ATS) transmitters (164 MHz) fixed with Kevlar® line to the dorsal surface of the tail between the double rows of caudal scutes, immediately anterior to the single scale row of caudal scutes (Da Silveira et al. 2010. J. Herpetol. 44:418–424).

On 26 September 1997, we captured a small adult male *M. niger* (167 cm SVL, 335 cm TL and 98 kg) in Lago Mamirauá (02.9847°S, 064.9167°W). After capture the caiman was marked, radio-equipped, and released one hour later. The radio-equipped male was located on 62 occasions between its capture and 24 April 1999 (= 580 days). Sixty percent of the subsequent movements were of ≤ 100 m, 76% were ≤ 500 m and 11% were between 2400 and 3900 m (mean = 614; SD = 887), totaling at least 38.1 km.

The *M. niger* used two core areas, a dry season core range in Lago Mamirauá and a wet season core range in Lago Acácio, an intermittent water body adjacent to Lago Mamirauá that dries entirely during the dry season. The Lago Mamirauá core area was composed of 16 locations between 57 and 1400 m (mean = 664, SD = 348) from the release site. Forty locations formed the Acácio core area, which had its center located 4.7 km from the capture site. After 29 April 1999 we lost the radio signal and assumed that the transmitter's battery had run out.

Four years and seven months later, on 1 December 2003, the male was killed in the Lago Atapi (02.8796°S, 064.6388°W) in the Amanã Sustainable Development Reserve, 33 km (straight-line distance) NE from the original capture site and 33.8 km (straight-line distance) from the last observed location in Lago Acácio. The caiman was killed by people from the community of Nova Jerusalém, and it was detected by the Hunting Monitoring Program of the Mamirauá and Amanã Reserves. The radio-transmitter and the monel toe web tag were still attached to the animal's body. At that time, the Black Caiman measured 380 cm (TL) and produced 60 kg of dried, salted meat for sale, probably to Colombian traders, a practice common in the upper Amazon River (called Solimões in Brazil) during the 1990s (Da Silveira and Thorbjarnarson 1999. Biol. Conserv. 88:103–109). Other body characteristics were not available, but we estimated an approximate SVL of 186.5 cm and weight of ca. 117 kg (Mendonça 2009. A Caça Comercial de Jacarés no Baixo Rio Purus e suas Implicações no Manejo Sustentável na Reserva Piagaçu-Purus, Amazônia Central. Unpubl. Masters thesis. Instituto Nacional de Pesquisas da Amazônia/Universidade Federal do Amazonas. Manaus, Amazonas, Brazil. 52 pp.).

Movements between the Mamirauá and Amana Reserves have also been reported for the Amazonian Manatee (*Trichechus inunguis*) (Arraut et al. 2009. J. Zool. 2009:1–10), and for the Six-tubercled Amazon River Turtle (*Podocnemis sextuberculata*) (Fachín-Terán 1999. Ecologia de *Podocnemis sextuberculata* (Testudines, Pelomedusidae), na Reserva de Desenvolvimento Sustentável Mamirauá, Amazonas, Brasil. PhD thesis. Instituto Nacional de Pesquisas da Amazônia/Universidade Federal do Amazonas. Manaus, Amazonas, Brazil. 189 pp.). All three species are commonly hunted for subsistence or illegal commercial trade in the Mamirauá and Amanã Reserves, and *M. niger* meat is also used as bait for *Calophysus macropterus*, a pimelodid catfish sold in Colombian markets (Da Silveira and Viana 2003. Crocodile Specialist Group Newsletter 22:16–18). Although movement patterns of *M. niger* are unknown aside from the data provided here, such a long-distance movement was unexpected.

Together, the Mamirauá and the Amanã Reserves comprise an area of 3,474,000 ha, representing an enormous and contiguous block of protected Amazonian habitats. The movement of the *M. niger* between these reserves reinforces the ecological importance of megareserves (> 1 Mha) for the effective conservation of populations of Amazonian top predators.

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SQUAMATA — LIZARDS

***AMBLYRHYNCHUS CRISTATUS* (Galápagos Marine Iguana). PREDATION.** On 18 December 2003, GM observed a large male Galápagos Sea Lion (*Zalophus wollebaeki*) prey on an adult-sized (>23 cm SVL) *Amblyrhynchus cristatus* at Bahia Paraiso on the island of Santa Fe, Galápagos (90.028°W, 0.829°S, datum: WGS84, elev. <1 m). The iguana was captured while walking on land 3 m from the shoreline, bitten at the base of the tail, and shaken back and forth for about 1 min in a manner similar to that employed by sea lions when preying on large fish (Everitt et al. 1981. Murrelet 62:83–86). The iguana was then bitten several more times and swallowed whole. Two additional predatory episodes were observed during the same morning, involving the same male sea lion biting and shaking adult-sized iguanas, but we were unable to observe whether these individuals were also consumed. Galápagos Sea Lions are frequently found in the vicinity of marine iguanas, but predation on iguanas has not previously been observed. Galápagos Marine Iguanas are thought to have evolved in the absence of terrestrial predators; this is the first record of predation on adult marine iguanas by any native predator that uses terrestrial habitat at least some of the time.

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***AMEIVA AMEIVA* (Giant Ameiva). PREDATION.** Despite its extensive distribution in South America (Vitt and Colli 1994. Can. J. Zool. 72:1986–2008) with various aspects of its natural history described (Colli 1991. Copeia 1991:1002–1012), there are few known predators for *Ameiva ameiva* (Martins and Oliveira 1998. Herpetol. Nat. Hist. 6: 78–150). Hence, we add to the limited data on *A. ameiva* predators with an observation of predation by Gray Hawk (*Buteo nitidus*).

On 16 June 2008, while conducting an ornithological survey as a part of the monitoring study of the Faxinal II Hydroeletric Power Plant in Mato Grosso state, Brazil, we collected an adult *B. nitidus* with a pressure gun from a grassland area of Aripuanã,

MT (10.108611°S, 59.410556°W, datum: WGS 84). Dissection revealed one adult *A. ameiva* in the stomach. Grasslands were surrounded by rain forest dominated by Brazilian Nut Tree (*Bertholletia excelsa*).

Buteo nitidus hunts in open woods, grassland, and edges of rainforest to dry open areas with scattered trees (Collins 2006. Field Guide to the Birds of South America: Non-passerines. p. 134., Harpercollins Pub. Ltd., Hammersmith, London). This species is known to prey on rats, snakes, lizards, and insects (Sigrist 2006. Aves do Brasil: Uma visão artística. Editora Avis Brasilis. São Paulo. 413 pp.), but to our knowledge, none of the lizards recorded as prey were identified to species.

The *B. nitidus* specimen (#1765; collection license 10698-1/SISBIO/IBAMA) (length: 37.5 cm; weight: 470 g) and its stomach contents were deposited in Laboratório de Ornitologia, Campus of Cuiabá, Universidade Federal de Mato Grosso (UFMT). We thank PASCON for logistical support and Robson W. Ávila for lizard identification.

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***AMEIVA AMEIVA* (Giant Ameiva). PREDATION.** *Ameiva ameiva* is widely distributed in the Americas (Vitt and Colli 1994. Can. J. Zool. 72: 1986–2008), usually associated with forest edges, along waterways where the canopy is absent, and in a myriad of disturbed habitats (Vitt et al. 2008. Guide to the Lizards of Reserva Adolpho Ducke, Central Amazonia. Áttema Design Editorial. 176 pp.). Records of predation on *A. ameiva* exist for snakes (Bernarde and Abe 2010. Biota Neotrop.10:167–173; Fischer and Gascon 1996. Herpetol. Rev. 27:204; Granzinolli et al. 2007. Herpetol. Rev. 38:448–449; Santos and Germano 1996. Herpetol. Rev. 27:143), birds (Batista de Pinho et al. 2010. Herpetol. Rev. 41:72; Tozetti et al. 2005. Herpetol. Rev. 36:443–444) and wild or domestic felines (Urich 1931. Trop. Agric. 8:95–97).

On 7 July, 2007, at 1428 h, we observed predation on *A. ameiva* by the Brown-nosed Coati (*Nasua nasua*) on an unpaved road from a private farm located in Pantanal, municipality of Miranda, Mato Grosso do Sul State, central Brazil (San Francisco farm; 20.086369°S, 56.616061°W, WGS84). The coati chased the lizard before capturing it, held it with its front paws, and then began biting the head. The lizard, a juvenile ca. 25 cm snout–vent length, died approximately 15 sec. after being captured. Total time taken for the coati to completely ingest the lizard was not possible to estimate, due to an approaching vehicle, which scared off the animal, however, more than one minute was spent ingesting the head. Our observation includes *N. nasua* as an addition to the known predators for *A. ameiva*.

The Brown-nosed Coati, is distributed in South America from northern Colombia to northern Argentina. It is diurnal, scansorial, and omnivorous, feeding mainly on invertebrates and fruit (Beisiegel 2001. Braz. J. Biol. 61:689–692; Gompper and Decker 1998. Mamm. Species 580:1–9). When present in the stomachs and/or intestinal contents, vertebrates generally make up a small percentage of the diet for these animals (Alves-Costa et al. 2004. J. Mammal. 85:478–482; Bisbal 1986. Mammalia 50:329–339; Santos and Beisiegel 2006. Rev. Bras. Biociênc. 8:199–203).

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***AMPHISBAENA MERTENSI* (NCN) HABITAT.** Many aspects of the natural history of amphisbaenians are difficult to observe due to their fossorial habits (Gans 1978. Trans. Zool. Soc. Lond. 34:347–416). In Brazil, few observations or studies regarding the natural history of these reptiles have been made *in situ*, and available observations on their biology have been recorded through opportunistic encounters (Sazima and Haddad 1992. *In* L. P. C. Morellato [ed.], Historia Natural da Serra do Japi. Ecologia e Preservação de uma área Florestal no Sudeste do Brasil, pp. 212–237. Editora da Universidade Estadual de Campinas, Campinas) or obtained from captive animals (Torres 2003. Notes Fauniques de Gembloux 53:63–69).

Between the months of January and December, 2007, we observed *A. mertensi* foraging in garbage at a residence in the city of Maringá, Paraná State, Brazil (23.4100°S, 51.9497222°W). The observations were of both diurnally and nocturnally active individuals on the following dates and times: 20 April at 1700 h, 1 May at 1800 h, 19 July at 1636 h, 22 July at 1542 h, 24 October at 2432 h, and 19 November at 1709 h. Some of these observations included two to three individuals. Voucher specimens were collected and deposited at the Laboratory of Zoology of Faculty Uningá (17a–c). During January, several *A. mertensi* were found run over on the street, always close to garbage bags. January had high rainfall (271.5 mm), and we noted that during the rains this species disperses over the ground surface. The largest number of individuals was observed in late afternoon and in early morning, as is also recorded for *A. alba* (Abe and Johansen 1987. J. Exp. Biol. 127:159–172; Sazima and Haddad 1992, *op. cit.*). In the remaining months of the year, individuals of *A. mertensi* were often found in yards or inside residences. The animals appeared to be attracted to the garbage from these residences. On some occasions we observed individuals (N = 3) pulling the used oiled paper from fried cooking out of the garbage bags. This behavior may be associated with foraging for small invertebrate prey upon which this species feeds (Cruz Neto and Abe 1993. J. Herpetol. 27:239–240; Pramuk and Alamillo 2003. Herpetol. Rev. 34:221–223); the odor of fried oil attracted various Diptera and Hymenoptera to the oiled paper. On one occasion we offered the amphisbaenian fried beef meat and raw poultry meat, but it showed no interest. The fossorial ecology of this amphisbaenian has allowed it to remain in disturbed areas, where it appears to now be implementing opportunistic foraging behavior within these new conditions.

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***ANOLIS LAEVIVENTRIS* (NCN). DEFENSIVE BEHAVIOR.** The behavior of "playing dead" is referred to as tonic immobility and is present in many species throughout the animal kingdom, perhaps most prominently observed in the Virginia Opossum (*Didelphis virginiana*), which famously "plays possum" (Hoagland 1928. J. Gen. Physiol. 11:715–741). Tonic immobility has been observed and studied in *Anolis carolinensis*, which readily displays

dorsal immobility (Webster et al. 1981. Behav. Neural Biol. 31:32–41), and *A. sagrei* (Regalado 1985. Ciencias Biológias 14:33–48). Similar behavior has also been observed in some Lesser Antillean anoles including *A. barbouri* and *A. oculatus winstoni* (Robert Hoogveld, pers. comm.). Hoagland (*op. cit.*) described the process of dorsal immobilization as placing the anole in the dorsal position and applying slight force to its thorax. This is similar to tonic immobility, except that it involves inverting the individual onto its dorsum before or during restraint.

On 26 May 2010, at Finca Haciendo Monimbó (Matagalpa Department, Nicaragua), two specimens of *Anolis laeviventris* were observed exhibiting tonic immobility, presumably as a defense mechanism. This behavior was observed around 2200 h with no natural lighting present. Upon capture, the individuals struggled to escape the grasp of one of the authors (JGP), and then suddenly went limp without further pressure being applied. In this state, both individuals exhibited the same body position: jaw wide open, dewlap extended, hind legs out, forelegs bent in over the venter. Initially, the individuals were thought to be injured from handling, but when the grip was loosened, the individuals immediately sprung to life and escaped. Both individuals observed were males. Out of seven *A. laeviventris* captured at Finca Haciendo, only the two mentioned above displayed this behavior. A total of nine *A. laeviventris* were collected in Nicaragua with no individuals at other locations displaying the same behavior.

Three days later on 29 May, 2010, at Finca Santa Elena (Boaco Department, Nicaragua), a male *A. cupreus* was captured and displayed the same behavior. Upon feigning death, its body was positioned in exactly the same manner with jaws open, dewlap extended, hind legs out, and forelegs directed inwards across the venter. This incident occurred around 1000 h in broad daylight. This individual was one of three or four captured in the same location at roughly the same time in the same day. A total of 41 *A. cupreus* were collected in Nicaragua from numerous locations, but no other *A. cupreus* captured displayed this behavior.

Presumably, the purpose of tonic immobility is to reduce the likelihood of further attack and thus, contribute to an individual's survival (Imhoff 1982. Proc. West Virginia Acad. Sci. 54:15). It is noteworthy that this behavior was observed during daylight hours in *A. cupreus*, and at night in *A. laeviventris*. Also, *A. cupreus* appears to be significantly more active than *A. laeviventris*. Therefore, this behavior is not limited to slow-moving organisms in the mode of several species of plethodontid, ambystomatid, and salamandrid salamanders (Brodie, Jr. et al. 2004. Herpetologica 30:79–85), nor to those that are more vulnerable in either day or night. It appears that this behavior has developed regardless of those factors. Hennig and Dunlap (1977. Behav. Biol. 20:523–528) reported similar conclusions about diurnal and nocturnal lizards expressing like behaviors, their study focusing on *A. carolinensis* and *Hemidactylus turcicus*. The tonic immobility discussed here regarding Nicaraguan anoles could be a result of predation by birds, which typically capture prey items with their feet instead of their beaks; the pseudo-death of the prey anole could cause a predatory bird to loosen its grip, allowing the lizard to spring to life and escape. Several bird species (especially *Margarops fuscatus* and *Falco sparverius*), are reported as significant predators of Caribbean anoles (McLaughlin and Roughgarden 1989. Ecology 70:617–628). Therefore, the hypothesis that tonic immobility in anoles is a defense mechanism against avian predators may be correct if the anoles in question have similar predators on the mainland. This defense mechanism is unlikely to be successful against predators that typically attack their prey with their mouths and fail to release the prey before mastication and swallowing, including some species of colubrids (Burghardt and Chmura 1993. J. Comp Psychol 107:116–121). It would be interesting to examine these behaviors plus the major predators of anoles in light of their phylogenetic relationships to understand the evolution of defensive behaviors.

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***ANOLIS SAGREI* (Brown Anole). DEFENSIVE BEHAVIOR.** Although *Anolis* displays consisting of dewlap extension are typically directed at individuals of the same species, they are occasionally directed at predators. It is difficult to study displays directed at predators, however, because predation is so rarely observed under natural conditions. Most studies describing *Anolis* responses to predators have used captive animals, humans as predators, or a stuffed predator presented as realistically as possible to wild anoles (Leal 1999. Anim. Behav. 58:521–526). Results of such studies are often difficult to interpret because of their artificial nature.

On 28 June 2004 near Lake Buena Vista, Florida, USA, I observed an adult female Boat-tailed Grackle (*Quiscalus major*) on a sidewalk with an *A. sagrei* in its bill. The anole was approximately 7 cm snout–vent length. The bird was vigorously shaking the anole with sideways flicks of its head. After about five seconds, it put the anole down on the pavement. The anole immediately arched its back, fully extended its dewlap, and became immobile. The bird looked at it and did not move for about five seconds. It then pecked the anole several times near the head, which caused the anole to withdraw its dewlap and run. The bird pursued it and picked it up. The anole thrashed in the bird's bill; it did not extend its dewlap. Again, the bird put it down and again it immediately displayed its dewlap. The bird paused for a few seconds, picked up the lizard by its midsection, and flew out of sight.

My observations are inconsistent with predictions of two hypotheses proposed to explain *Anolis* signaling to predators (Leal and Rodriguez-Robles 1997. Anim. Behav. 54:1147–1154). The "flash concealment" hypothesis predicts that an anole will flee immediately after dewlapping, when the predator's attention is most focused on where the dewlap was. The anole I observed, however, extended its dewlap and "froze," not fleeing until it was pecked by the bird. Although it withdrew its dewlap before fleeing, the withdrawal appeared to be a response to pecking rather than a distracting precursor to running. The "pursuit deterrent" hypothesis predicts that the only time an anole will display its dewlap to a predator will be immediately before a potential attack, when it can signal that it has seen the predator and will likely escape if pursued. In the case reported here, the anole had already been captured by the predator.

The observations herein most closely match those of Leal and Rodriguez-Robles (Copeia 1995:155–161), who reported that

A. cristatellus individuals in captivity immediately froze and extended their dewlap after being captured and released by a snake (*Alsophis portoricensis*). This behavior caused the snake to abort or temporarily stop its attack for up to 480 seconds. Leal and Rodriguez-Robles interpreted the display as bluffing—the dewlap presumably made the anole appear larger and more threatening to the snake, thwarting attack. The behavior of the anole during my observations appears to best fit with this interpretation of why *Anolis* species may display their dewlaps to predators, although the bluffing behavior that I observed in *A. sagrei* directed at the grackle was not as effective as it was with a different species of anole and a snake. This leads to further questions regarding whether this bluffing display behavior might be employed by these lizards differently when they are facing different predatory threats (i.e., different species), or may reflect behavioral differences among *Anolis* species.

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***ASPIDOSCELIS SACKI* (Sack's Spotted Whiptail). REPRODUCTION.** *Aspidoscelis sacki* is one of the "giant" species of North American whiptail lizards (males to 153 mm SVL; Walker 1981. J. Herpetol. 15:321–328). As presently understood, the geographic range of this species includes parts of the states of Guerrero, Mexico, Morelos, Oaxaca, Puebla, and Veracruz in México (Duellman and Zweifel 1962. Bull. Am. Mus. Nat. Hist. 123:155–210; Valdespino and García-Collazo 2000. Herpetol. Rev. 31:184; Walker and Cordes 1993. Texas J. Sci. 45:187–189). It has one of the largest clutch sizes (mean 5.9, range 3–10 eggs; Walker 1981, *op. cit.*) among species in the genus *Aspidoscelis* (Vitt and Breitenbach 1993. *In* Wright and Vitt [eds.], Biology of Whiptail Lizards [Genus *Cnemidophorus*], pp. 211–243. Oklahoma Museum of Natural History, Norman) based on specimens from Puebla and Oaxaca (Walker, *op. cit.*). However, additional information regarding the reproductive traits of this species is needed from other states in México.

Herein, we report data about clutch size, egg characteristics, and embryonic stage at oviposition of *A. sacki* at Tonatico, State of Mexico (18.75044°N, 99.62025°W; elev. 1597 m). On 1 May 2005 and 10 July 2005, we collected two gravid females, one measuring 125 mm (SVL) with 8 eggs and one measuring 110 mm (SVL) with 5 eggs. Measurements for the eggs of these lizards are: length: mean 18.6 ± 0.37 mm (range 16.7–20.5 mm); width: mean 10.0 ± 0.19 mm (range 8.7–11.1 mm), and total mass: 7.0 g (4.7 g, 9.3 g). Additionally, on 9 June 2010 we collected a gravid female measuring 118 mm (SVL), which oviposited 8 eggs; afterwards it was released. Oviposition took place on 23 June 2010, and the mean egg length was 18.3 ± 0.46 mm (range 17.5–19.2 mm). Both clutch size and egg dimensions for these three lizards were either within or similar to ranges reported for other populations of *A. sacki*, including the months with reproductive activity (Walker, *op. cit.*).

Based on the work of Dufaure and Hubert (1961. Archives Anatomie Microscopie Morphologie Expérimental 50:309–327), the embryonic stage at oviposition of *A. sacki* was 18, which is considerably earlier than stages 21–22 in *A. uniparens* (Billy 1988. J. Zool. 215:55–81; Cuellar 1971. J. Morphol. 133:139–166) and other lizards (Andrews and Mathies 2000. Bioscience 50:227–238; Shine 1983. J. Exp. Zool. 307A:106–112), but may be similar to *A. cozumela* (Manríquez-Morán, unpubl. data).

Individuals of *A. sacki* were collected in the State of Mexico under a scientific collecting permit (FAUT 0186, SEMARNAT), and preserved specimens were deposited in the Centro de Investigación en Recursos Bióticos.

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***CNEMIDOPHORUS ABAETENSIS*. REPRODUCTION.** *Cnemidophorus abaetensis* is endemic to the "Restinga" region from northern Bahia to south of Sergipe, Brazil. This species was only recently described and knowledge of its biology and ecology are lacking (Dias et al. 2002. Copeia 2002[4]:1070–1077; Dias and Rocha 2004. J. Herpetol. 38:586–588; Dias et al. 2005. J. Herpetol. 15:133–137; Dias and Rocha 2007. Braz. J. Biol. 67:41–46). This account presents preliminary data on oviposition and egg characteristics in *C. abaetensis*. On 9 April 2009, a gravid female (SVL = 64.5 mm; weight = 7.5 g) was captured at 0900 h in the Restinga of Abaeté, Salvador, Bahia, Brazil (12.9261°S, 38.3270°W; datum: WGS84; elev. 13 m) in a pitfall trap. The female was transferred to a terrarium (150 x 150 x 50 cm), with seven other individuals (one male and six non-gravid females) of the same species. After three days, two eggs (volume = 603.18 mm^3; measuring accuracy of 0.02 mm) were observed in a nest dug into the substrate, ca. 5 cm deep. Two days later, the eggs hatched. This observation coincides with other studies that show that congeners of this species have low fecundity, with females showing two to four eggs per clutch (Menezes et al. 2004. J. Herpetol. 38:120–122). This species is an active forager and this is a possible explanation for minimal egg production.

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***CTENOSAURA OEDIRHINA* (Roatán Spiny-tailed Iguana). DIET.** Little is presently known about the ecology of *Ctenosaura oedirhina* (Pasachnik et al. 2010. *In* IUCN 2010. IUCN Red List of Threatened Species. Version 2010.4. <www.iucnredlist.org>). The dietary structure in particular is understudied relative to other members of the genus *Ctenosaura*. During the early part of its life, *C. oedirhina* is assumed to be omnivorous, displaying an ontogenic shift to herbivory when adult. It is of note that most of the known information on the dietary habits of this species comes from observations of captive animals (Köhler 2002. Schwarze Leguane – Freilandbeobachtung, Pflege und Zucht. Offenbach 2. Herpeton, 142 pp.).

Here we present a report on the consumption of the fruit of the Hog Plum (*Spondias mombin*) by an adult male *C. oedirhina* on 14 August 2008 at approx 1300 h at West Bay (16.271414°N, 86.600392°W), Isla de Roatán, Honduras (Fig. 1). Individuals of both sexes and all life stages were observed at this location. To our knowledge this is the first photo-documented account of frugivory in wild *C. oedirhina*, and also the first identification of a specific dietary component for this species.

The fruit of *Spondias mombin* has previously been identified as a dietary component of *C. similis* (Janzen 1985. J. Trop.



FIG. 1. Adult *Ctenosaura oedirhina* consuming a fruit of the Hog Plum (*Spondias mombin*), Isla de Roatán, Honduras.

Ecol. 2:131–155). This species has also been regarded as a dispersal agent of the seeds of other fruiting trees (Traveset 1990. Am. Midl. Nat 123:402–404). Another congener, *C. palearis*, is also a documented frugivore. Its role as a seed disperser of the Organ Pipe Cactus (*Stenocereus pruinosus*) was suggested by Cotí and Ariano-Sánchez (2008. Iguana 3:143–149) who described *C. palearis* as "one of the most important species that feeds on fruits of the cactus *S. pruinosus*."

It is not possible to comment on the significance of *C. oedirhina* as a seed disperser for *Spondias mombin* based solely on the observation described here. A more detailed analysis of the feeding habits of this species is required to substantiate this. Further, it is possible that the consumption of the fruit of *S. mombin* documented here may represent an isolated occurrence, or perhaps a peculiarity of the population at this location. However, given the seed dispersing role of other *Ctenosaura* species and that pollination and seed dispersal by lizards is thought to be most common on islands (Olesen and Valido 2003. TREE 4:177–181), it is possible that *C. oedirhina* may play an important role in seed dispersal for this plant species on the island of Roatán.

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***CTENOSAURA OEDIRHINA* (Roatan's Spiny-Tailed Iguana). DIET.** Very little is known about the diet of *Ctenosaura oedirhina*. This species is assumed to be primarily herbivorous like other iguanas (Sites et al. 1996. Mol. Biol. Evol. 13:1087–1105; Torres-Carvajal 2007. J. Herpetol. 41:528–531). However, Hendry and Gandola (2011. Herpetol. Rev. 42:274) observed saurophagy within this species, as has been observed in *C. bakeri* (Dirksen and Gutsche 2006. Elaphe 14:51–52) and *C. similis* (Henderson 1973. J. Herpetol. 7:27–33). Here we report on the first case of turtle consumption within this species and, to the best of our knowledge, within Iguaninae.

On 15 May 2010, an individual *Ctenosaura oedirhina* was observed at Gumbalimba Park and Reserve in West Bay, Roatan Island, Islas de la Bahia, Honduras (16.282883°N, 86.595083°W) eating a hatchling *Trachemys venusta uhrigi* (Fig. 1). The same behavior was observed the previous year, during the period of turtle hatching. During our initial observations in 2009, the *Ctenosaura* had already captured the *Trachemys*. Both ctenosaurs had consumed the *Trachemys* within five minutes, headfirst after a period of intense chewing. Given these observations and the saurophagy previously noted, which SAP has also observed multiple times, it seems that this species might be much more omnivorous than previously thought.



PHOTO BY ZEILLER CHAVARRIA

FIG. 1. *Ctenosaura oedirhina* consuming *Trachemys venusta*. Observed at Gumbalimba Park and Reserve, Roatan, Honduras.

A photograph was deposited at the Milwaukee Public Museum as MPM Herp Photo P75. Identifications were verified by John B. Iverson.

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***HOLBROOKIA ELEGANS* (Elegant Earless Lizard). PATTERN and REPRODUCTION.** Taxonomy and nomenclature are poorly defined for lesser earless lizards (genus *Holbrookia*) from southeastern Arizona and adjacent New Mexico (Lovich and Jones 2009. *In* Jones and Lovich [eds.], Lizards of the American Southwest, pp. 85–91. Rio Nuevo Publishers, Tucson, Arizona; Jones 2010a. Sonoran Herpetol. 23:170–174). It is important to document natural history traits according to specific localities, so that if a satisfactory taxonomic revision of a species complex is completed, observations may later be attributed to a particular taxon. Lesser earless lizards of semi-desert grasslands and oak woodlands of southeastern Arizona are generally regarded as *H. elegans* (Axtell 2009. *In* Jones and Lovich, *op. cit.*, pp. 150–153). Very little natural history information has been documented for this species, including breeding information (Axtell, *op. cit.*). Here I present an observation of *H. elegans* of different pattern types courting and mating *in situ*. Jones (2010b. Sonoran Herpetol. 23:174–177) discussed the pattern types of *H. elegans*, noting that a patternless morph is found in several populations.

On 11 June 2010, I observed a patternless male *H. elegans* court and copulate with a typically patterned female at Kartchner Caverns State Park, Cochise Co., Arizona, USA. For the duration of the observation (30 min. [1715–1745 h]), the male and female stayed within about 0.5 m of each other. The female generally remained motionless on the surface of the ground, while the male was more active. During courtship, the male did frequent pushup displays, usually from atop small rocks. Most of the displays were "slow," as in territorial displays, including the extension of the dewlap. After a series of slow displays, the male exhibited a "rapid" display of head bobs. After the rapid display, the male would leave the rock and circle the female, possibly doing more displays, then return to a rock, or caress the female with his snout or front foot. The hind leg and tail sometimes touched the female during the caressing phase. The female remained

motionless during the courtship. Then the male would go back to a rock (usually the same cobble-sized rock) and repeat the process. Only on one occasion during my observation did the caressing advance to copulation. During copulation, the male bit the female on the loose skin of the right side of the neck. He then inserted his right hemipenis into the left side of the female's cloaca. The courtship and copulation were consistent with the stereotypical behavior of most other iguanids and phrynosomatids (Carptenter 1967. *In* Milstead [ed.], Lizard Ecology: A Symposium, pp. 87–105, Univ. Missouri Press, Columbia). When I returned the following day, the male and female (presumably the same pair) were still in the vicinity, but no additional mating behavior was observed.

Visual cues play a role in mate selection, mating success, or mate rejection; this has been the topic of several studies in other species of *Holbrookia* (e.g., Cooper 1991. Amphibia-Reptilia 12:57–66; Hager 2001. J. Herpetol. 35:624–632; Robertson and Rosenblum 2009. Biol. J. Linn. Soc. 98:243–255; Rosenblum 2008. J. Herpetol. 42:572–583). Even though some individual *H. elegans* in a population lack a dorsal pattern, they still exhibit the visual cue coloration necessary for social signaling; males possess black dorsolateral bars with blue areolae and often an orange-red throat spot, and females retain a distinctive red-orange throat spot and take on the orange and yellow lateral nuptial coloration signifying that they are gravid (Axtell, *op. cit.*; Jones 2010b, *op. cit.*). Thus, there is no evidence that patternless individuals are selected against for mating, presumably because they retain the social signaling coloration. This makes sense because the phenotype is currently present within several populations. This would ensure that the genes responsible for the lack of a pattern can remain in a population, as the plain dorsum may be selected for its cryptic benefits within an environment with a plain background (e.g. dunes, as is seen in *H. maculata ruthveni*) (Robertson and Rosenblum, *op. cit.*; Rosenblum, *op. cit.*).

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***IBEROLACERTA MONTICOLA* (Cantabrian Rock Lizard). LONGEVITY.** Maximum longevity in natural populations can be determined directly, by monitoring marked individuals, or indirectly, using methods such as skeletochronology. By using this latter method, the maximum age of *Iberolacerta aurelioi* was estimated at 14 years (females) and 16 years (males) (Arribas 2004. Herpetozoa 17:3–18; Arribas 2007. Istoria Naturau e Evolucion dera Cernalha Aranesa, *Iberolacerta aranica*. Consell Generau d'Aran, Huesca. 446 pp.), these being among the oldest known longevity estimates for a small-sized lacertid lizard. In *Iberolacerta monticola*, another endemic lacertid species of the Iberian Peninsula, a maximum longevity of 10 years was estimated via skeletochronology from a Portuguese population (Moreira et al. 1999. Bases para a Conservaçao da Lagartixa-da-montanha [*Lacerta monticola*]. Estudos de Biologia e Conservaçao da Natureza 25, Lisboa, 68 pp.). By tracking marked individuals, the maximum life span of the same species was determined to be 12 years in a population in northwestern Spain (Galán et al. 2007. Munibe 25:34–43). For other species of this genus, including seven species endemic to the Iberian Peninsula and one of the Balkans, maximum longevity is unknown.

Since the early 1990s I have been monitoring a population of *Iberolacerta monticola* in the Lambre River Valley (municipality of Vilarmaior, A Coruña province, northwestern Spain, 43.3172°N, 8.1396°W, datum: WGS 84; 40 m elev.) and have been able to calculate the maximum life span of some individuals by marking. This population lives in the walls of a hydroelectric plant, occupying a small area (Galán et al., *op. cit.*).

One male was marked as a subadult in 1995 (at one year of age). This individual was recaptured every year from 1995 until 2008, when it disappeared at age 14. At that time it measured 77 mm (SVL). Another male was marked upon hatching, in 1995, and was recaptured every year thereafter. The individual is still alive at the time of this writing (2010) at 15 years of age and measuring 76 mm (SVL). This longevity, however, does not appear to be common, as other males (ages based on mark-recapture data) of the same population have disappeared (and presumably died) at younger ages: two at six years of age, one at seven, two at eight, and one at nine years of age. All had large body sizes (SVL > 73 mm) at the time of last observation. Recapture rates of females were much lower, thus, sufficient data pertaining to most female maximum longevity were not obtained. Only the age and the year of disappearance (presumably death) are known for four females: one at five years of age, two at six years of age, and one at eight years of age.

This maximum longevity is of interest for a relatively small lacertid living at low altitudes (nearly sea level), with very long periods of annual activity (nine months; February–October). *Iberolacerta aurelioi*, which reaches a similar longevity (14–16 years) and is also small, lives in the high mountains (at altitudes of 2100–2900 m), where the annual activity period is only four months (May–August). This limits their annual body growth and for this reason, the acquisition of sexual maturity is delayed for several years, which contributes, among other factors, to increased longevity (Arribas, *op. cit.*). Species of small lacertid lizards with high annual growth rates living at low altitudes reach sexual maturity earlier, so their longevity is relatively shorter (Galán 1999. J. Zool., Lond. 249:203–218). There is a negative correlation between the duration of annual activity and longevity, indicating that the species living at higher altitudes has greater longevity. Therefore, in this population of *I. monticola* at Lambre, living at low altitude, a lower maximum longevity would be expected.

The study population also has a relatively high number of predators, ranging from saurophagus snakes, such as *Coronella austriaca*, to mammalian carnivores, such as *Genetta genetta* and *Felis catus* (Galán, unpubl. data). It is possible that other factors involved in the life history of this species might be responsible for the high longevity of some individuals.

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***IGUANA IGUANA* (Green Iguana). PREDATION.** *Iguana iguana* is an established, nonnative species in southern Florida (Krysko et al. 2007. Iguana 14[3]:2–11) that often lives in vegetation along the edges of bodies of water inhabited by the American Alligator (*Alligator mississippiensis*). Kern (2004. Dealing with iguanas in the South Florida landscape. Univ. Florida IFAS Fact Sheet ENY-714) claimed that *A. mississippiensis* may occasionally prey upon adult *I. iguana* in the water, but such predation has not been documented in the literature. In Central and South America, at least four crocodilian species have been reported preying upon *I. iguana* (Antonio Rivas et al. 1998. Herpetol. Rev. 29:238–239; Dugan et al. 1981. J. Herpetol. 15:409–414; Platt et al. 2006. Herpetol. J. 16:281–290). Here, we report a feeding attempt by an *A. mississippiensis* on an adult *I. iguana*.

PHOTO BY MICHAEL COHEN



FIG. 1. *Alligator mississisippiensis* with an adult male *Iguana iguana* in its mouth at Wakodahatchee Wetlands, Palm Beach Co., Florida, USA, 31 December 2010.

At 1149 h (EST) on 31 December 2010, one of us (MJC) observed an *A. mississippiensis* (ca. 2 m TL) with the head of an adult male *I. iguana* in its mouth (Fig. 1) at Wakodahatchee Wetlands, Delray Beach, Palm Beach Co., Florida, USA (26.4778°N, 80.1419°W, WGS 84; 5.5 m elev.). During the ca. 30 min of observation, the *A. mississippiensis* thrashed vigorously for ca. 30 sec, attempting unsuccessfully to dismember the carcass, which appeared fresh. When last observed, the *A. mississippiensis* had crawled onto land with the head of the *I. iguana* still in its mouth. The air temperature was ca. 25°C.

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***LIOLAEMUS CHACOENSIS* (Chaco Tree Iguana). CLUTCH SIZE.** *Liolaemus chacoensis* is an inhabitant of the arid chaco phytogeographical province (Cei 1993. Reptiles del Noroeste, Nordeste y Este de la Argentina. Mus. Reg. Sci. Nat. Torino Monogr. 14:1–949). The biology of this species is poorly known. In this note we report the clutch size for one lizard under laboratory conditions in order to contribute to the limited knowledge of this species' reproductive biology.

During January 2011, a female *L. chacoensis* (46.8 mm SVL, 3.3 g) was observed basking and was then hand-captured in the field at 1230 h in San Juan province, Valle Fértil Department, in La Mesada Creek (31.02377°S, 67.29694°W; datum: WGS 84; elev. 899 m). Six days post capture, on 1 February 2011, this female deposited three eggs in the laboratory, at an ambient air temperature of 25°C and 30% relative humidity. Total mass of the eggs was 0.9 g, equal to 27.2% of the lizard's mass (post laying). Mean egg length was 11.6 ± 0.65 mm and mean egg width was 6.3 ± 0.45 mm. Mean egg volume was also estimated (43.3 ± 3.03 mm^3) using the equation [$V = 4/3\ (L/2)\ (W/2)^2$] for an elliptical sphere (Dunham 1983. *In* Huey et al. [eds.], Lizard Ecology, pp. 261–280. Harvard University Press, London.).

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***PHOXOPHRYS NIGRILABRIS* (Black-lipped Eyebrow Lizard). REPRODUCTION.** *Phoxophrys nigrilabris* is restricted to Borneo (Manthey and Grossmann 1997. Amphibien & Reptilien Südostasiens. Natur und Tier – Verlag, Münster, Germany. 512 pp.). Information on reproduction of *P. nigrilabris* is limited to a report that it may occur around the middle of the year (Das 2006. A Photographic Guide to Snakes & Other Reptiles of Borneo. Ralph Curtis Publ., Sanibel Island, Florida. 144 pp.). The purpose of this note is to provide additional information on reproduction of *P. nigrilabris*.

A sample of 11 *P. nigrilabris* (ten males: mean SVL = 45.2 mm ± 6.4 SD, range = 31–53 mm and one female, SVL = 55 mm) from Sarawak, Borneo was examined from the herpetology collection of the Field Museum of Natural History (FMNH), Chicago, Illinois: Kapit Division FMNH 138477, 138483, 138485, 145673, 145676, 145677; Bintulu Division FMNH 147656, 148986, 195479, 269084, 273325. Lizards were collected 1962–1964, 1970, 2005, 2007. For histological examination, the left testis was removed to identify the stage of the testicular cycle in each male. The testes were embedded in paraffin, sections cut at 5µm using a rotary microtome and slides were stained with hematoxylin followed by eosin counterstain. Histology slides are deposited in FMNH. Males in the following monthly samples were undergoing spermiogenesis in which the lumina of the seminiferous tubules were lined by sperm or groups of metamorphosing spermatids: January (N = 2), February (N = 1), May (N = 2), July (N = 1), September (N = 1), October (N = 1). The smallest male to exhibit spermiogenesis measured 42 mm SVL (FMNH 195479). Two males (31 and 40 mm SVL) exhibited testicular recrudescence in which spermatocytes predominated; no sperm were present. These (FMNH 147656, 273325) were classified as subadults. One female (FMNH 145673) from March contained two yolking follicles (> 3 mm diameter) indicating a clutch of two eggs would be produced. The above suggests *P. nigrilabris* males exhibit an extended period of reproduction as has been reported for other species of agamid lizards (*Draco*) from Borneo (Inger and Greenberg 1966. Ecology 47:1007–1021).

I thank Alan Resetar (FMNH) for permission to examine *Phoxophrys nigrilabris*.

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***PLESTIODON SUMICHRASTI* (Sumichrast's Skink). PREDATION.** There are many reports of large tropical spiders preying upon amphibians and reptiles (e.g., Antônio de Freitas et al. 2010. Herpetol. Rev. 41:202; Brito De-Carvalho et al. Herpetol. Rev. 2010. 41:336–337; Cicchi et al. 2010. Herpetol. Rev. 41:207; Hamidy et al. 2010. Herpetol. Rev. 41:66–67). Although many of these reports document predation on small frogs and lizards (< 4 cm SVL), larger prey items are occasionally taken or attempted (e.g., Silva Siqueira Nunes et al. 2010. Herpetol. Rev. 41:367–368). Here we report an instance of a relatively large lizard as a prey item for a tarantula from the highlands of southeastern Guatemala.

On 2 October 2010 we were conducting a herpetofaunal survey in the Sierra Caral of Izabal, Guatemala. At approximately 1800 h while pulling apart a large fallen tree trunk, we discovered a cavity that contained a partially digested juvenile *Plestiodon sumichrasti* (ca. 6 cm SVL; Fig. 1 [top]). Further excavation immediately behind the partially digested lizard revealed a large male tarantula referable to the genus *Brachypelma* (Fig. 1 [bottom]). This observation occurred near Cerro Pozo de Agua at about 850 m (15.39367°N, 088.69183°W; WGS84 datum). The slightly dissolved skink was collected and deposited in the natural history

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FIG. 1. Predation of *Plestiodon sumichrasti* (top) by *Brachypelma* sp. (bottom) in the Sierra Caral of Izabal, Guatemala.

collections of the Museo de Historia Natural of the Universidad de San Carlos in Guatemala City (USAC 2738; Field ID: CRVA 2162).

We thank Mónica Barrientos, Obdulio Javier Villagran, Eric N. Smith, and FUNDAECO for field and logistical assistance. Chris A. Hamilton and his colleagues kindly helped with tarantula identification. This observation was made while conducting field work supported by Conservation International. Scientific collecting permits were issued by Consejo Nacional de Areas Protegidas ([CONAP]; 030/2010 to E. N. Smith, and 008/2010, 12809 to C. R. Vásquez-Almazán).

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***POLYCHRUS MARMORATUS* (Common Monkey Lizard; Bicho-preguiça). PREDATION.** *Polychrus marmoratus* is an arboreal lizard associated with forested habitats, occurring in northern South America east of the Andes in Amazônia and in the Atlantic Rainforest, from Recife, in Pernambuco state, to north of São Paulo state (Ávila-Pires 1995. Zool. Verh. Leiden 299:1–708). This lizard is known to be preyed upon by birds (Beebe 1944. Zoologica 29:195–216; Test et al. 1966. Misc. Publ. Mus. Zool. Univ. Michigan 128:1–63) and snakes (Cunha and Nascimento 1994. Bol. Mus. Par. Emílio Goeldi, Zool. 9:1–191). Herein, we make the first report of saurophagy for the Crested Capuchin Monkey (*Cebus robustus*) on *P. marmoratus*.

On 11 March 2010, at 1130 h, one of us (WPM) observed two adult Crested Capuchin Monkeys in the canopy of an area of reforestation at Reserva Natural Vale (RNV), Linhares municipality, Espírito Santo state, southeastern Brazil (19.153611°S, 40.039722°W; datum WGS84, elev. ca. 60 m), while studying the ecology and behavior of these monkeys. One of the capuchins had a lizard (*Polychrus marmoratus*) in its hand and ate parts of it (i.e., head, tail, thighs, and some lateral parts). The other Crested Capuchin assumed a position of submission, as if "begging" for a piece of the prey. After six minutes of observation, the individual that had consumed parts of the lizard then discarded it, whereupon it fell to the ground. This action did not appear to elicit any interest from the other monkey. On the same date at 1512 h, a juvenile Crested Capuchin (also in the same reforestation area) was observed with a lizard in his hand. The capuchin ate the tail and lateral parts of the animal and was furthest from the group without other monkeys around. After four minutes, it threw the animal to the ground. The remains were identified as the lizard *Polychrus marmoratus* (Fig. 1).

Cebus robustus is a poorly known, endangered species endemic to the Atlantic coastal forest from the Rio Jequitinhonha in southern Bahia state, through northern Espírito Santo and the Rio Doce in Minas Gerais state, Brazil (Martins 2005. Distribuição Geográfica e Conservação do Macaco-prego-de-cristas [*Cebus robustus*] em Minas Gerais, Brasil. Universidade Federal de Minas Gerais. Msc dissertation; unpubl. data). This finding suggests that *C. robustus* is an opportunistic, generalist predator, as is known for most species of this genus (Fragaszy et al. 1990.



PHOTO BY WPM

FIG. 1. The remains of the *Polychrus marmoratus* immediately after being partially eaten by *Cebus robustus* and dropped to the ground.

Folia Primatol. 54:114–118). Observations on the ecology of this monkey are needed and records for vertebrates in its diet are rare in the literature.

We are indebted to the Companhia Vale for support and allowing one of us (WPM) access to lodging facilities and the reserve. WPM was supported by grants from the Brazilian science council (CNPq), Primate Conservation Inc., Primate Action Fund (Conservation International/Margot Marsh Biodiversity foundation), and U.S. Fish Wildlife Service. JC was funded by Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP). We thank Jackson Shedd for helpful comments on this manuscript.

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***PTYODACTYLUS GUTTATUS* (Sinai Fan-fingered Gecko). REPRODUCTION.** *Ptyodactylus guttatus* ranges from northeastern Egypt, north to southern Syria, and east to Jordan where it inhabits mountainous and hilly country (Baha El Din 2006. A Guide to the Reptiles and Amphibians of Egypt. The American University in Cairo Press, Cairo. 359 pp.). *Ptyodactylus guttatus* has been reported to produce multiple clutches of one to two eggs in summer and utilize communal laying sites (Bouskila and Amitai 2001. Handbook of Amphibians & Reptiles of Israel. Keter Publishing House, Jerusalem. 345 pp.; Johnston and Bouskila 2007. J. Herpetol. 41:506–513; Werner 1985. *In* Rocek [ed.], Studies in Herpetology, Proceedings of the European Herpetological Meeting [3rd Ordinary General Meeting of the Societas Europaea Herpetologica], pp. 141–144. Prague). Breeding occurs mainly in spring and early summer (Disi et al. 2001. Amphibians and Reptiles of the Hashemite Kingdom of Jordan. An Atlas and Field Guide. Edition Chimaira, Frankfurt am Main. 408 pp.). The purpose of this note is to present additional information on the timing of the reproductive cycle of *P. guttatus*.

A sample of 28 *P. guttatus* consisting of eleven male (mean SVL = 71.1 mm ± 8.0 SD, range = 54–79 mm) and seventeen females (mean SVL = 70.3 mm ± 6.0 SD, range = 60–80 mm) from Israel were examined from the Zoology Museum of Tel-Aviv University (TAUM), Tel-Aviv, Israel. Lizards were collected 1958 to 1990. Lizards examined by District were: Central: 10137, 13576, 13629, 13866, 13869, 14034, 14035, 14144, 15604; Haifa: 10536; Jerusalem: 13573; Jordan Valley: 8535, 13196, 14036; Southern: 3041, 4226, 4228-4232, 4457, 4458, 4460–4462, 11116, 14032.

For histological examination, the left gonad was removed to check for yolk deposition or corpora lutea in females and to identify the stage of the testicular cycle in males. Counts were made of enlarged ovarian follicles (> 4 mm length) or oviductal eggs. Tissues were embedded in paraffin, sectioned at 5µm and stained with hematoxylin followed by eosin counterstain. Histology slides are deposited in TAUM.

Two stages were noted in the testicular cycle; (1) recrudescence in which there is a proliferation of spermatocytes for the next period of spermiogenesis (sperm formation) and (2) spermiogenesis in which lumina of the seminiferous tubules are lined by sperm or clusters of metamorphosing spermatids. Monthly samples were: March (N = 5) three in recrudescence, two in spermiogenesis; June (N = 1) spermiogenesis; October (N = 2) spermiogenesis; November (N = 3) two in recrudescence, one in spermiogenesis. The smallest reproductively active male (spermiogenesis in progress) measured 62 mm SVL and was collected in October (TAUM 13629). One male in recrudescence from March (TAUM 4461) measured 54 mm SVL and was considered a sub-adult.

Four stages were noted in the ovarian cycle: (1) quiescent, no yolk deposition observed; (2) corpus luteum from a previous ovulation; (3) enlarged ovarian follicles (> 4 mm); (4) oviductal eggs. Monthly samples were: February (N = 1) corpus luteum; April (N = 1) quiescent; May (N = 3) one quiescent, two with enlarged ovarian follicles; July (N = 1) quiescent; September (N = 1) quiescent; October (N = 6) five quiescent, one oviductal; November (N = 4) quiescent. Mean clutch size for three females was 2.0. The smallest reproductively active female (two enlarged follicles > 4 mm length) measured 65 mm SVL and was collected in May (TAUM 8535).

My data indicate that *P. guttatus* exhibits reproductive activity in both spring and autumn as some males were undergoing spermiogenesis in March, June, and October, November and females from May and October exhibited reproductive activity. One female from February contained a corpus luteum, which was likely from an autumn ovulation.

I thank Shai Mari (TAUM) for permission to examine *P. guttatus* and Erez Maza (TAUM) for processing the loan.

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***SCELOPORUS POINSETTII* (Crevice Spiny Lizard). ECTOPARASITES.** Ectoparasitism from mites of the genus *Eutrombicula* (Trombiculidae) is a common infestation on many vertebrate species (Brennan and Reed 1974. J. Parasitol. 60:699–711; Vercammen-Grandjean and Audy 1965. Acarologia Suppl. 7:280–294). However, little is known about the actual frequency of parasitic loads, how loads fluctuate in dissimilar environmental conditions, how long parasites infest their hosts (Goldberg and Bursey 1993. J. Wildl. 29:142–144), and how parasitic loads vary among individuals (sexes and life stages) in the same geographic area (Klukowski 2004. J. Herpetol. 38:141–144). We herein report changes in mite infestation on one adult male *S. poinsettii* before and after periods of significant rainfall on Indio Mountains Research Station (IMRS) located in the Trans-Pecos region of the Chihuahuan Desert, ca. 40 km SW of Van Horn, Texas, USA. Rainfall and temperature readings were recorded by a HOBO weather station located in close proximity to the event reported below.

On 11 September 2010, an adult male *S. poinsettii* (106 mm SVL; 42.2 g) was captured at 1130 h on a rocky outcrop (Fig. 1) located ca. 2.0 km N of the IMRS headquarters complex (30.79438°N, 105.01407°W, WGS84; 1268 m elev.); the area surrounding the outcrop was covered by typical Chihuahuan Desert scrub vegetation. The average ambient temperature for that day was 25.3°C. The lizard was immediately placed into a plastic zip-lock bag and quickly taken to the IMRS laboratory for processing. We measured and weighed the lizard and used a stereoscopic dissecting microscope to count the number of mites present on its body. The lizard had an infestation of immature mites (*Eutrombicula* sp.) under its cervical folds on each side of the neck; none was observed elsewhere on the body and none had fallen off into the plastic bag during the short transport time. We observed a total of 33 mites; 17 under left cervical fold and 16 under the right fold. Cervical folds seemed to be ideal places for

mites to invade because non-scaled skin is exposed inside the structure, and the fold itself provides partial shade from solar radiation. Also, this was one of the highest loads of mites observed among multiple species of lizards occurring on IMRS during prior mark-recapture studies. When finished, we marked the lizard with toe-clips and then released it a short time later back on the same outcrop.

Two weeks later, on 25 September 2010, we recaptured the same lizard on the same rock at ca. 1200 h. The lizard was placed into another zip-lock plastic bag and quickly taken to the laboratory for processing. The lizard gained 1.6 g during the two-week period (SVL was the same), but the mite infestation appeared much heavier than before. After carefully counting them several times, 79 mites were documented and again, they were only under the cervical folds. This time, the *S. poinsettii* had 51 mites under the left cervical fold, and 28 mites under the right fold. The parasite load increased 3x on the left side while increasing 1.75x on the right side. The overall increase in the ectoparasitic load was roughly 2.4x from that observed on 11 September.

The increase in abundance of mites could be attributed to different factors. However, in this case, due to the brief two-week period between the two captures, it is reasoned that rainfall, and possibly decreased temperature, influenced increasing mite infestation. Within that time period, two significant rain events occurred in the area. On 19 September 2010, eight days after initial capture and release, it rained 3 mm and the 24 h period had an average temperature of 21.6°C. Two days later, on 21 September 2010, it rained 9.15 mm and the average temperature for the day was 24.3°C. Thus, increased water availability, in possible combination with lower ambient temperatures, likely played a role increasing mite infestation on the lizard, a conclusion partially supported by another study investigating a similar situation. Phang and Manikumaran (1977. Southeast Asian J. Trop. Med. Publ. Health 8:217–20.) found a greater abundance of trombiculid mite larvae along transects during heavy rainfall events when comparing increased rainfall to periods of dryness, but they were hard to impossible to find during dry periods. They also exposed larval mites to simulated rainfall, which retained mite larval populations for longer periods during dry weather. Temperature and dryness were not determined to be a contributor to the frequency changes observed in the parasitic load, because they thought that the amount of time required for those factors to take effect on physiology and immunity processes was too short. We tentatively associate the load frequency changes on the *S. poinsettii* to environmental factors, especially rainfall, primarily because the lizard was caught during a brief two-week period when rainfall events occurred. Significant rainfall probably concentrates these larval mites in dry microhabitats, where they can be picked up by the lizards occurring in the areaby.

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***TROPIDURUS HISPIDUS* (Peters' Lava Lizard). PREDATION.** Predator-prey relationships play an important role in community structure (Miller et al. 2006. J. Anim. Ecol. 75:101–110), however, predation events in nature are often difficult to quantify due to the rarity of observations (Shepard 2007. Herpetologica 63:193–202). Birds are potential predators of small vertebrates including rodents (Motta-Junior and Talamoni 1996. Ararajuba 4:38–41), anurans (Toledo et al. 2004. Herpetol. Bull. 94:31–32), and lizards (França and Braz 2009. Biotemas 22:243–245). Lizards are commonly recognized prey items of birds in Neotropical habitats (Rocha and Vcbradic 1998. Ciência e Cultura 50:364–368).



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FIG. 1. *Rupornis magnirostris*, preying on an adult *Tropidurus hispidus*, Sergipe, Brazil.

On 18 October 2010 at 1002 h in retinga of Aruana Beach, south coast of Aracaju, Sergipe, Brazil (11.0122°S, 37.0650°W, 5 m elev., datum SAD69), we observed a Roadside Hawk (*Rupornis magnirostris*) preying on an adult *Tropidurus hispidus* (Fig. 1). The hawk was near its nest, in which we observed a chick. It is possible the prey was to feed the chick we but did not observe any interactions. The Roadside Hawk has a diet of reptiles, amphibians, insects, mammals, and birds (Panasci and Whitacre 2002. Wilson Bull. 114:114–121). Predation on lizards by birds have been reported for Brazil (França and Braz 2009, *op. cit.*; Sherpard 2007, *op. cit.*), however, this is the first record for the restinga area in the northeast.

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SQUAMATA — SNAKES

***BOIGA IRREGULARIS* (Brown Treesnake). PREDATION ATTEMPT BY CRAB.** The Coconut Crab (*Birgus latro*), also known as the Robber Crab, is the heaviest terrestrial invertebrate in the world with a mass occasionally exceeding 3 kg (Amesbury 1980. Univ. Guam Tech. Rep. 17:1–39). While primarily an omnivore

feeding on vegetative matter and scavenging for dead animals, it may also prey on live invertebrates and vertebrates such as sea turtle hatchlings and rats (Greenaway 2003. Mem. Mus. Victoria 60:13–26; Kessler 2005. Crustaceana 78:761–762).

On 8 March 2010 we were searching for snakes in northern Guam. At 2230 h we observed a Coconut Crab sitting at the entrance to a tree (*Premna obtusifolia*) hole ca. 0.7 m above ground, holding onto the tail of an adult *Boiga irregularis* with one of its claws. The snake was partly suspended in mid-air and had anchored the forepart of its body to some roots and branches close to the ground, apparently trying to pull loose. As we approached, the crab retreated into the tree hole while maintaining its hold of the snake's tail. A few minutes later, after more human disturbance, the crab released the snake. The crab had a thoracic width of about 45–50 mm, which would correspond to a thoracic length of about 22–25 mm (unpubl. data) and a mass of about 100 g (Amesbury, *op. cit.*). We captured the snake and determined that it was a gravid female (SVL = 1124 mm; total length = 1423 mm; 255 g). Close inspection of the tail revealed minor indentations from the crab's claw, but there was no bleeding, nor any visible rupture of the skin.

There have been several observations of both terrestrial and marine crabs feeding on snakes (Maitland 2003. J. Crustacean Biol. 23:241–246; Voris and Jeffries 1995. J. Tropical Ecol. 11:569–576) but most accounts deal with snakes smaller than the one we observed. It is possible that the crab eventually would have started feeding on the tail while it was still attached to the snake, even if it had failed to kill the snake (Maitland, *op. cit.*).

Of the 295 individual *Boiga irregularis* we have encountered and marked in our main study population to date, 15% suffered damage to the tail. Damage ranged from the tip to most of the tail lost, leaving only a short stump. In 21 cases the damage had occurred before we first encountered a snake, so we do not know the size of the snake at the time of the injury. But for 23 snakes that we captured before and after tail damage (including major and minor damage), the mean of the snakes' pre- and post injury sizes is 1095 mm SVL. Some of these tail damages might have been inflicted by coconut crabs (or possibly other terrestrial crabs, several smaller species of which inhabit the area) in attacks similar to the one we observed. The Orote Peninsula in Guam reputedly has high densities of crabs (*B. latro* and others) and 40% of the *Boiga irregularis* there have damaged tails (Deni Porej, pers. comm.), suggesting a correlation between crab densities and incidence of tail damage.

Among snakes in our study population, we have seen tail damage in only five snakes < 800 mm SVL, and in two of these, only the very tip of the tail was missing. However, crab attacks on small juvenile snakes are likely to end in death for the snake, hindering our ability to assess rates of attack and the effects of such predation attempts on snake fitness. Even so, careful analyses of size-dependent injury incidences may help reveal potential impact of predators on prey populations when direct observations of predatory attempts are lacking.

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***BOIGA IRREGULARIS* (Brown Treesnake). PREDATION ATTEMPT BY PRAYING MANTIS.** The Western Pacific island of Guam is known for its introduced population of *Boiga irregularis* that has had considerable negative effects on vertebrates native to the island (Rodda et al. 1997. BioScience 47:565–574; Savidge 1987. Ecology 68:660–668). Few animals in Guam are known to prey on the snakes, but Mangrove Monitors (*Varanus indicus*) and feral/domestic cats (*Felis catus*) may do so (Fritts and Rodda 1998. Annu. Rev. Ecol. Sys. 29:113–140; pers. obs.).

In Guam, on the evening of 11 November 2009, the first author was filming a small (SVL = 450–500 mm) *B. irregularis*, perched in vegetation 4 m above ground. The snake suddenly started thrashing violently and after about ten seconds it fell to the ground. The snake slithered through a meter of grass and coiled up under a flattened soda can. A praying mantis was observed next to where the snake first landed on the ground. A review of the video footage (http://vimeo.com/13407786) showed that the snake had been attacked by a large praying mantis (*Hierodula patellifera*) that held the snake's head with both forelegs. The mantis tried to hold on to the vegetation, but the snake eventually pulled the mantis from its perch and both fell to the ground. The snake was not closely examined after the event, but it did not appear to be harmed.

Mantids have been observed preying on birds, lizards, frogs, and mice (Benrekaa and Doumandji 1997. Entomologiste 53:253–256; Brothers 2008. Herpetol. Rev. 39:351; Nickle 1981. Proc. Entomol. Soc. Washington 83:801–802; Ridpath 1977. J. Aust. Entomol. Soc. 16:153–154). Our observation suggests that juvenile *B. irregularis* might also be at risk of mantid predation, as mantids have been observed to kill large prey even in situations where they are dragged around by the prey item (Reitze and Nentwig 1991. Oecologia 86:568–574).

In Guam, hatchling *B. irregularis* measure 290 mm SVL (Lardner et al. 2009. Herpetol. Cons. Biol. 4:313–323) to 430 mm SVL (Rodda et al. 1999. *In* Rodda et al. [eds.], Problem Snake Management: the Habu and the Brown Treesnake, pp. 44–80. Cornell University Press, Ithaca, New York). Average-sized hatchlings (SVL = 360 mm) typically weigh 7–8 g, but we have seen a *B. irregularis* that weighed merely 4 g. Assuming the snake observed measured 475 mm SVL, its weight would have been ca 15 g. Adult specimens of *H. patellifera* collected from the site where the predation attempt occurred have a mean head-body length of 69 mm and an average mass of 2.9 g (range 1.6–4.1 g; N = 6). Thus, the snake that was attacked probably weighed about five times as much as the praying mantis, but some hatchling *B. irregularis* weigh no more than a large *H. patellifera*. For a comparison, the large mantid *H. werneri* has been seen feeding on frogs and birds weighing as much as three times the mantid's weight (Ridpath, *op. cit.*).

Hierodula patellifera are common in trees and bushes frequented by small *B. irregularis* on Guam. It therefore seems plausible that encounters between small snakes and large mantids are not rare. Further information about the frequency and outcomes of such encounters, especially encounters that lead to death or serious injury for the snake, would be useful.

We thank Aubrey Moore for help with mantid identification and references. Any use of trade, product, or firm names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

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***BOTHROPS LEUCURUS* (Bahia Lancehead). CAUDAL LURING.** Caudal luring, the wriggling movements of a conspicuous tail tip made by an otherwise cryptically colored snake in the presence of potential prey, has been reported for several species of Boidae, Viperidae, and Elapidae (Sazima 1993. Copeia 1993:222–226). *Bothrops leucurus* is a terrestrial and nocturnal snake from the Atlantic Forest Domain of northeastern and eastern Brazil (Campbell and Lamar 2004. The Venomous Reptiles of the Western Hemisphere. Cornell Univ. Press, Ithaca, New York. 870 pp.). It is a generalist species that preys on amphibians, lizards, and rodents (Freitas 1999. Serpentes da Bahia e do Brasil. Ed DALL, Feira de Santana, Bahia. 80 pp.; Freitas 2003. Serpentes Brasileiras. Malha-de-Sapo-Publicações, Lauro de Freitas, Bahia. 160 pp.). We observed tail displays in three juvenile *B. leucurus* in the wild in Brazil, suggesting that this species uses caudal luring behavior to capture prey. The observations occurred as follows: 1) On 14 April 2007, at 2021 h, in a pond adjacent to Timbó River, Amargosa municipality, state of Bahia; 2) On 29 April 2007, at 0941 h, on the ground of the forest at Igrapiúna municipality, state of Bahia; and 3) On 24 July 2006, at 1440 h, in João Pessoa municipality, state of Paraíba. Similar evidence have been recorded for other Brazilian species such *Tropidodryas striaticeps*, *Bothropoides jararaca*, and *Bothrops jararacussu* (Sazima 1991. Copeia 1991:245–248; Sazima 1993, *op cit.*; Sazima 2006. Aqua, J. Ichthyol. Aquat. Biol. 11:117–124). Although the caudal luring display was observed, there was no case of predation attempts during our observations.

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***BOTHROPS* SP. (GR. *ATROX*) (Jararaca/Lancehead). DIET.** Snakes in the *Bothrops atrox* group are widely distributed in Brazilian territory as follows: *Bothrops atrox*, *B. marajoensis*, and *B. brazili* in the Amazon Rainforest, *B. moojeni* in the Cerrado, and *B. leucurus* in the Atlantic Rainforest and Caatinga (Campbell and Lamar 2004. The Venomous Reptiles of the Western Hemisphere. Cornell Univ. Press, Ithaca, New York. 870 pp.). Although other species of South American viperids have specialized diets, snakes in the *B. atrox* group are considered generalists and are known to consume mammals, frogs, lizards, birds, centipedes, and occasionally fishes and other snakes (Campbell and Lamar, *op cit.*; Freitas and Loebmann 2010. Herpetol. Rev. 41:234; Martins et al. 2002. *In* Schuett et al. [eds.], Biology of the Vipers, pp. 307–328. Eagle Mountain Publ., Eagle Mountain, Utah; Martins and Oliveira 1998. Herpetol. Nat. Hist. 6:78–150).

On 20 March 2009, we collected a juvenile male *Bothrops* sp. (gr. *atrox*) (SVL = 501 mm, 24.82 g without prey) in a relictual patch of sub-evergreen tropical nebular rainforest that extends about 150 km across the eastern and northern regions of Chapada da Ibiapaba, in the municipality of Ubajara, state of Ceará, Brazil (03.5042°S, 40.5604°W; datum: WGS84; elev. 851 m). Inside the gut of the specimen we found an intact *Oxyrhopus melanogenys orientalis* (Black-headed Calico Snake; SVL = 390 mm, 16.64 g; Fig. 1). The prey measured ca. 78% of the predator's length and ca. 67% of its body mass. To our knowledge, this is the first record of *B. atrox* preying on snakes of the genus *Oxyrhopus*. The specimen is housed on Universidade de Campinas Natural History Museum 'Prof. Adão J. Cardoso', Campinas, São Paulo, Brazil (ZUEC 3475).



FIG. 1. Juvenile *Bothrops* sp. (gr. *atrox*) with stomach contents, an *Oxyrhopus melanogenys orientalis*.

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***BUNGARUS CAERULEUS* (Common Krait). SCAVENGING.** We encountered a *Bungarus caeruleus* at Jhadeswar Hill, Ganjam district, Odisha, India (19.4589°N 85.0249°E, datum: WGS84; elev. 83 m) on 12 May 2010 at 2135 h. The krait (ca. 80 cm total length) was found near a hill stream feeding on a dead and decayed snake. After close examination, the prey was identified as a *Coelognathus helena helena*. The dead prey was caught by the middle of the body and was half inside the krait's mouth (Fig. 1). The dead snake was almost the same size or a little smaller than the krait and was swallowed in approximately two minutes. The krait then moved into a heap of boulders near the stream. After interviewing local inhabitants, I learned that a snake had been killed and thrown near the stream three days before.

Kraits are known to feed on frogs, lizards, and snakes (Whitaker and Captain 2004. Snakes of India, the Field Guide. Draco Books, Chennai. 481 pp.). Although scavenging has been documented in several species of snakes under natural conditions, and is considered a prevalent opportunistic foraging strategy for many snakes (DeVault and Krochmal 2002. Herpetologica 58:429–436), it has not previously been reported in *B. caeruleus*.

I thank Satya Narayan Mishra and Saroj Behera for assisting me in the field.

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FIG. 1. *Bungarus caeruleus* scavenging on a dead *Coelognathus helena helena.*

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***CARPHOPHIS AMOENUS* (Eastern Wormsnake). DEFENSIVE BEHAVIOR.** Due to their secretive and fossorial habits, little is known about the behavior of *Carphophis amoenus*. The most thorough studies of its ecology are the works of Clark (1970. Univ. Kansas Publ. Mus. Nat. Hist. 19:85–194), Fitch (1999. A Kansas Snake Community: Composition and Changes over 50 Years. Krieger Publ., Malabar, Florida. 165 pp.), and Willson and Dorcas (2004. Southeast. Nat. 3:1–12). Yet, these publications provide little information regarding the behavior of this small snake species. The most commonly reported defensive behaviors exhibited by members of the genus *Carphophis* include the probing of captors with their sharp, hardened tail tip, and releasing a foul-smelling musk (Clark, *op. cit.*; Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Books, Washington, D.C., 668 pp.; Fitch, *op. cit.*;). Recently, however, Diefenbacher and Pauley (2009. Herpetol. Rev. 40:94–95) reported a defensive behavior in *C. amoenus* from West Virginia (USA) that noted an individual that buried its head beneath its body coils, while exposing its tail tip in a vertical orientation. The authors suggested such behavior made the tail more prominent (perhaps mimicking the head), and might confuse potential predators. Here we describe an additional unique behavior that we have not previously witnessed nor read about in the literature, that we believe is exhibited in defense.

On 29 July 2010 near Elon University campus in Alamance Co., North Carolina, USA (36.11859°N, 079.49857°W, datum: NAD 83), an adult male *C. amoenus* (SVL = 204 mm; tail length = 52 mm; 6.5 g) was captured in a drift fence constructed in an upland mixed forest. Once removed from the drift fence trap, the snake was handled for ca. 5–10 min. as morphological data were collected. After its release, the snake only partially buried itself in ground debris, with the tail remaining exposed. At ca. 5 sec. post-release, we lightly stepped on the ground debris near the snake in an effort to expedite concealment. At this point, the snake raised the back 1/4 of its body in a semi-vertical orientation and waved or wagged its tail in an arcing, serpentine fashion for several seconds. It briefly stopped (with tail remaining exposed), until we once again stepped on the layer of fallen leaves near the snake, which caused it to again exhibit this tail waving or wagging behavior for several more seconds. Eventually, the snake stopped waving its tail and moved forward to completely conceal itself beneath the ground debris.

We are uncertain if the observed behavior was meant to distract potential predators from the buried head, or if waving the hardened tail tip may actually deter some species of small predators. Fitch (1999, *op. cit.*) reported that 5.3% of 209 adult *C. vermis* captured in Kansas (USA) were missing tails. He suggested such missing tails were the result of attack by predators, which supports the hypothesis that this behavior is exhibited to distract potential predators from attacking the head. It also supports Diefenbacher and Pauley's (2009) suggestion that the resting orientation they observed was adopted so that predators focus on the tail rather than the head.

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***COLUBER* (= *MASTICOPHIS*) *FLAGELLUM* (Coachwhip). DIET.** *Coluber flagellum* is known to take a variety of prey items including snakes (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Institution Press, Washington, D.C. 668 pp.; also *Pituophis catenifer*, Beaman and Harris 2002. Herpetol. Rev. 33:214–215; and *Crotalus viridis*, Tabor and Germano 1997. Herpetol. Rev. 28:90). Here we report a snake as a prey item not previously documented for *C. flagellum*.

In late April 2005, a *C. flagellum* was observed ingesting a live *Trimorphodon lambda* (Sonoran Lyresnake) at the residence of Donna Andress in Nelson, Clark Co., Nevada, USA (35.708°N, 114.823°W). The snakes were initially observed thrashing on the ground, with the *C. flagellum* eventually subduing the *T. lamba* by coiling its body around it. The snakes were photographed and a color print was deposited in the Natural History Museum of Los Angeles County (LACM PC 1430).

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***COLUBER* (= *MASTICOPHIS*) *FULIGINOSUS* (Baja California Coachwhip). REPRODUCTION.** *Coluber fuliginosus* ranges from extreme southwestern California south to Cabo San Lucas, Baja California Sur (Grismer 2002. Amphibians and Reptiles of Baja California, Including its Pacific Islands and Islands in the Sea of Cortés. Univ. California Press, Berkeley. 399 pp.). We know of no reports on its reproduction. The purpose of this note is to present the first information on the testicular cycle of *C. fuliginosus*.

A sample of ten adult male *C. fuliginosus* (mean SVL = 1054.5 mm ± 154.0 SD, range: 834–1358 mm) was examined from the herpetology collection of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California. Five *C. fuliginosus* were from Baja California (LACM 2228, 2231, 103250, 103256, 103257) and five were from Baja California del Sur (LACM 19271, 19273, 19276, 103252, 103253). *Coluber fuliginosus* were collected from April–August 1949, 1961, 1964, 1950, 1966, and 1967.

A section of the left testis and vas deferens was removed from each male, embedded in paraffin, cut into 5 µm sections and stained with Harris hematoxylin followed by eosin counterstain. Histology slides were deposited at LACM. Two stages were noted in the testicular cycle: regression, seminiferous tubules contain spermatogonia and interspersed Sertoli cells; spermiogenesis,

seminiferous tubules lined by sperm or clusters of metamorphosing spermatids. The following stages in the testicular cycle were observed by month and sample size: regressed April (2), May (1), June (1); spermiogenesis July (2), August (4). Vasa deferentia contained sperm during all months. The smallest reproductively active male (spermiogenesis in progress) measured 834 mm SVL.

Coluber fuliginosus appears to exhibit an aestival spermatogenesis (St. Girons 1983. Herpetologica 38:5–16) in which spermatogonial divisons commence in spring and spermiogenesis ends in autumn. Similar timing of events in the testicular cycle occurs in the congeners *C. lateralis* (Goldberg 1975. J. Herpetol. 9:361–363) and *C. taeniatus* (Goldberg and Parker 1975. Herpetologica 31:317–322) and has been frequently observed in many North American snakes (Aldridge et al. 2009. Contemp. Herpetol. 2009:1–31).

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***CORALLUS GRENADENSIS* (Grenada Bank Treeboa, Congo Snake). HABITAT AND ABUNDANCE.** From 3–20 June 2010, we conducted visual encounter surveys for *Corallus grenadensis* on Union Island (St. Vincent and the Grenadines) as in Powell et al. (2007. *In* Henderson and Powell [eds.], Biology of the Boas and Pythons, pp. 374–387. Eagle Mountain Publ., Utah). We had 37 encounters with *C. grenadensis* at eight sites at times from 2000–2345 h. All sites were variants of dry seasonal forest, although dominant species of trees (e.g., *Hippomane mancinella*, *Acacia* sp., *Conocarpus erectus*) varied. Elevations ranged from sea level to 130 m (mean ± SD = 50.8 ± 46.1 m). Snakes were always observed on tall vegetation (≥ 3 m); however, perch heights varied from 0.5 – 15 m (4.0 ± 2.9 m). Most snakes (78%) were young-of-the-year or juveniles. During 31 encounters, boas were actively foraging, moving slowly through vegetation with bodies extended; the others were stationary and coiled on a branch or branches.

Encounter rates of *C. grenadensis* on Union averaged 1.32 ± 0.86 snakes/h. Ideal habitat for *C. grenadensis* consists of edges of natural vegetation mixed with orchard trees (e.g., mango, cacao, nutmeg, breadfruit), in which encounters could exceed 20 boas/h (Henderson 2002. Neotropical Treeboas: Natural History of the *Corallus hortulanus* Complex. Krieger Publ. Co., Malabar, Florida. xiv + 197 pp.; Henderson et al. 2009. S. Amer. J. Herpetol. 4:186–192). Such habitat is lacking on Union. Consequently, encounter rates on Union are not comparable to those in ideal habitats on Grenada. However, when compared with sites on Grenada that are vegetatively similar to Union, encounter rates are much more similar. Mt. Hartman, in extreme southwestern Grenada, consists of dense stands of *Acacia* and mangroves (Henderson 2002, *op cit.*), which are similar to the *Acacia* flatland at some sites on Union (e.g., at Richmond Bay and the coastal mangrove along the road from Clifton to Ashton). Encounter rates at Mt. Hartman averaged 1.87 ± 0.23 snakes/h (Powell et al., *op cit.*). Similarly, the encounter rate at Levera at the extreme northeastern tip of Grenada was 1.62/h (RWH, unpubl. data). Both Mt. Hartman and Levera are in the two driest areas of the island (< 127 cm annually; Grenada Ministry of Agriculture, Land Use Division); annual precipitation on Union is about 100 cm (Adams 1979. Carib. Studies 15:5–45). Although many factors can contribute to low encounter rates (e.g., structure and complexity of vegetation, phase of the moon), based on samples in a variety of habitats on Grenada, Henderson (2002, *op. cit.*) observed that the lowest encounter rates for *C. grenadensis* occurred at elevations >400 m and in very xeric areas. Our comparisons with dry habitats on Grenada suggest that low boa encounter rates on Union likely reflect the reality that xeric habitats on a small, dry island with little topographical relief (Daudin and de Silva 2007. Appl. Herpetol. 4:163–176) support fewer snakes than more mesic habitats.

John S. Parmerlee, Jr., Matthew E. Gifford, Tess A. Bellah, Ehren J. Bentz, Luke G. Chambers, Hayden D. Hedman, Rebecca R. John, Deborah N. Muñiz Pagan, and Mel J. Rivera Rodríguez helped in the field. Mark de Silva and Amos Glasgow identified species of trees for us. Permits to conduct research on Union Island were issued by Mr. Brian Johnson, Director, Department of Forestry, St. Vincent and the Grenadines. Protocols were approved by the Avila University Animal Care and Use Committee. Fieldwork was funded by a grant from the National Science Foundation (USA) to Robert Powell (DBI-0851610).

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***CROTALUS ATROX* (Western Diamond-backed Rattlesnake). DIET.** Although the primary diet of *C. atrox* is small mammals, a variety of other food items have been reported, including insects, frogs, toads, lizards, and birds (Rubio 2010. Guide to the Rattlesnakes of the United States and Canada. ECO Herpetol. Publ. Distrib., Rodeo, New Mexico. 307 pp.; Werler and Dixon 2000. Texas Snakes: Identification, Distribution, and Natural History. Univ. Texas Press, Austin. xv + 437 pp.) Although doves are suspected to be part of the diet of *C. atrox*, only a single columbid has been reported and only to generic level (*Columbina* sp.;



FIG. 1. Male *Crotalus atrox* attempting to ingest a freshly killed *Zenaida macroura* (Mourning Dove) at the Indio Mountains Research Station, Hudspeth Co., Texas, USA.

Ernst and Ernst 2003. Snakes of the United States and Canada. Smithson. Inst. Press, Washington, D.C. 668 pp.). Herein, we report a failed predation attempt on a Mourning Dove (*Zenaida macroura*) by a *C. atrox* in the Chihuahuan Desert of Trans-Pecos, Texas.

On 13 October 2010, at 2120 h, an adult male *C. atrox* (SVL = 870 mm; tail length = 50 mm; 366.5 g) was found (Fig. 1) on a brightly moonlit night trying to swallow a freshly killed *Z. macroura* (115.0 g; air temp = 18.1°C; ground temp = 17.0°C). The event was observed in an arroyo surrounded by alluvial slopes covered by Chihuahuan Desert scrub vegetation, ca. 2.5 km SW of Indio Mountains Research Station Headquarters (30.776883°N, 105.016060°W, datum: WGS84; elev. = 1233 m), which is located ca. 40 km SW of Van Horn, Hudspeth Co., Texas, USA. After 20 min, the rattlesnake had swallowed the dove's head and neck, but was struggling to pass the breast section, which is the widest part of the bird's body. Eventually, the rattlesnake ceased the ingestion process, regurgitated the dove's anterior portion, and then moved away from the scene. Although the relative prey mass was low (= 0.3), we suspect that the snake suspended its ingestion attempt because of physical constraints imposed by the dove's anatomy, most likely the breast width.

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***CROTALUS LEPIDUS* (Rock Rattlesnake). FEEDING BEHAVIOR.** The diet of *Crotalus lepidus* reportedly includes arthropods, frogs, small rodents, snakes, and lizards (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Institution Press, Washington, D.C. 668 pp.). From the limited information on feeding behavior in the wild, it is assumed that *C. lepidus* consumes nearly any small animal that it can subjugate, although lizards, because of their usual abundance in habitats favored by *C. lepidus*, are probably the primary food item (Armstrong and Murphy 1979. Univ. Kansas Mus. Nat. Hist. Spec. Publ. 5:1–88; Beaupre 1995. Herpetologica 51:45–56). It has been stated that *C. lepidus* strike lizards on their body and hold them until comatose and, therefore, no poststrike trailing behavior occurs; whereas mice are struck, released, and later trailed (Chiszar et al. 1986. J. Comp. Psychol. 100:368–371). Here we report a wild *C. lepidus* striking, trailing, and consuming a *Cophosaurus texanus* (Greater Earless Lizard), at a site located in the Chihuahuan Desert of Trans-Pecos, Texas.

On 18 July 2010, at 1020 h, an adult male *C. lepidus* (SVL= 560 mm; tail length = 65 mm; 140 g), fitted with a radio-transmitter (Holohil Ltd. SB-2), was being tracked at the Indio Mountains Research Station, Hudspeth Co., Texas, USA (30.754507°N, 105.020513°W, datum: WGS84; elev. = 1214 m), in an area of rocky mountainous substrate covered by Chihuahuan Desert scrub vegetation. The snake, apparently unfazed by our presence, was situated in the open near a dying adult male *C. texanus* that had been recently envenomated, as evidenced by two bloody puncture wounds on its back. A few moments later the rattlesnake, while exhibiting tongue-flicking and frenzied searching behavior, located the lizard, grabbed it by the head, and dragged it under a nearby Fragrant Mimosa (*Mimosa borealis*). The snake then proceeded to ingest the lizard headfirst (Fig. 1). When about half the lizard's body was left exposed, the snake stopped the swallowing process and regurgitated it, possibly due to positioning



FIG. 1. Adult *Crotalus lepidus* ingesting a freshly killed *Cophosaurus texanus* (Greater Earless Lizard) at the Indio Mountains Research Station, Hudspeth Co., Texas, USA.

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problems that lead to difficulty passing the widest section of the lizard's body. Immediately thereafter, the snake reinitiated the ingestion process and fully consumed the lizard in about 20 min. To our knowledge, this is the first report demonstrating that lizards, like rodents, may be struck, released, and trailed, before being consumed by *C. lepidus*.

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***HETERODON NASICUS* (Western Hog-nosed Snake). DIET.** *Heterodon nasicus* is a medium-sized (total length to 154 cm but usually <80 cm) colubroid snake native to prairie habitats of central North America (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Inst. Press, Washington, D.C. 668 pp.). This species is a mildly venomous, opistoglyphous, nonconstricting dietary generalist that is known to consume a wider range of vertebrate prey items, including amphibians, small mammals, lizards and eggs of turtles and birds, than its congeners. Platt (1969. Univ. Kansas Mus. Nat. Hist. Publ. 18:253–420) reported that *H. nasicus* feeds on lizard eggs, but did not identify the species. Here we report a juvenile *H. nasicus* feeding repeatedly on eggs of *Aspidoscelis sexlineata* (Six-lined Racerunner), a previously unrecorded dietary component.

At 0845 h on 25 June 2010, a juvenile *H. nasicus* (male, SVL = 19.5 cm, 9.5 g) was found in a sand blowout at Thomson-Fulton Sand Prairie, Carroll Co., Illinois, USA (41.938562°N, 90.109196°W; datum WGS 84). The snake was exposed in open sand and had a cloacal temperature of 28.8°C. Palpation of the gut caused regurgitation of two oblong lizard eggs with leathery shells, both of which were ruptured so that the yolk was exposed. This individual was marked, released, and then recaptured the following day in approximately the same location, and again its gut contained two ruptured lizard eggs.

We infer that these eggs were depredated from a nest of *A. sexlineata* because this is the only lizard known to occur in Carroll Co. and is common at our study site. Trauth (1983. Am. Midl. Nat. 109:289–299) described the nesting ecology of *A. sexlineata* and reported that females use communal nesting

grounds, where egg density can be up to 10/m^2, and females may return to favored nesting sites year after year. This spatial and temporal predictability of *A. sexlineata* eggs may underlie the potential importance of this food source for young hog-nosed snakes.

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***MASTIGODRYAS BODDAERTI* (Boddaert's Tropical Racer). DEFENSIVE BEHAVIOR.** Defensive behavior in snakes is characterized by a series of tactics, ranging from immobility to biting, that act in sequence during a predatory event (Endler 1986. *In* Feder and Lauder [eds.], Predator Prey Relationships: Perspectives and Approaches from the Study of Lower Vertebrates, pp. 109–134. Univ. Chicago Press, Chicago, Illinois; Greene 1988. *In* Gans and Huey [eds.], Biology of Reptilia, Vol 16, Ecology B, Defense and Life History, pp. 1–152. Alan R. Liss, Inc, New York; Martins 1996. Anais de Etologia 14:185–199). *Mastigodryas boddaerti* is a terrestrial and diurnal colubrid snake that occurs in tropical areas of the Amazon, Cerrado, and Caatinga biomes of South America (Colli et al. 2002. *In* Oliveira and Marquis [eds.], The Cerrados of Brazil: Ecology and Natural History of a Neotropical Savanna, pp. 223–241. Columbia Univ. Press, New York; Cunha and Nascimento 1993. Boletim do Museu Paraense Emílio Goeldi Vol. 9[1]:1–191); Martins and Oliveira 1998. Herpetol. Nat. Hist. 6:78–150). During a field trip to the municipality of Caxingó, state of Piauí, northeastern Brazil (3.359926°S, 41.75247°W, datum: WGS84; elev. 106 m), I observed a sequence of defensive behaviors in a *M. boddaerti*. Here, I described them based on the classification of Greene (*op. cit.*).

On 30 July 2010, at approximately 2230 h, I observed an adult *M. boddaerti* coiled asleep 1.3 m high in the branches of a *Mimosa caesalpiniifolia* tree (*1 – inaccessibility*). When I moved the branches where the snake was located, it tried to escape among the branches (*2 – locomotor escape*). Then, when I grabbed the snake at mid-body, it started to vibrate its tail (*3 – tail vibration*). After I removed it from the tree branches it rotated and thrashed its body, trying to escape (*4 – body thrashing, 5 – rotate body*). The snake succeeded in getting free, but I immediately caught it by the tail, at which time the tail was autotomized (*6 – tail breakage*). Finally, the snake attacked and bit me (*7 –strike, 8 –bite*).

As seen in this event, *M. boddaerti* exhibits a series of defensive mechanisms, acting at different stages of a predatory event. This is the first report of tail autotomy in *M. boddaerti*, but this defensive tactic has been documented in multiple snake genera from several different families (*e.g., Mastigodryas, Scaphiodontophis, Dendrophidion, Coronella, Hemorhois, Macroprotodon*, and *Rhinechis* in the Colubridae; *Malpolon* in the Psammophidae; *Natrix* in the Natricidae; *Coniophanes* in the Dipsadidae; and *Vipera* in the Viperidae; Martins 1998, *op. cit.;* Pleguezuelos et al. 2007. Contrib. Zool. 76:179–186; Savage and Slowinski 1996. Biol. J. Linn. Soc. 57:129–194). As noted by Martins (1998, *op. cit.*), the diversity of snakes that exhibit tail autotomy might be explained by shared phylogeny or, more likely, this trait might have evolved independently in multiple lineages as a convergent response to similar predation pressures.

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***MICRURUROIDES EURYXANTHUS* (Sonoran Coralsnake). PREDATION.** There are occasional records of spiders eating snakes and other small vertebrates (Greene 1988. *In* Gans and Huey [eds.], Biology of the Reptilia, vol. 16, Ecology B. pp. 1–152. Alan R. Liss, New York; Kaston 1965. Amer. Midl. Nat. 73:336–356; McCormick and Polis 1982. Biol. Rev. 57:29–58). Many records are of very large spiders (e.g., tarantulas, Theraphosidae) eating small snakes, but there are also instances of smaller spiders catching and preying (or even scavenging) upon small snakes and other vertebrates. For example, Lazcano et al. (2005. Herpetol. Rev. 36:186) and Gerald (2006. Herpetol. Rev. 37:480) reported small snakes being consumed by a fishing spider, *Dolomedes tenebrosus* (Pisauridae). Zippel and Kirkland (1998. Herpetol. Rev. 29:46) found a dead *Opheodrys aestivus* wrapped in the silk of a Golden Orb Weaving Spider, *Nephila clavipes* (Nephilidae), high above the ground, but this may not have involved predation. Although these records suggest several families of spiders may feed upon snakes, most reports of snake predation from medium-sized spiders are of cobweb-weaver (comb-footed) spiders, Theridiidae. Kaston (*op. cit.*) mentioned that some members of the Theridiidae have strong webs and may fling silk over the bodies of snared prey. Theriids (especially *Latrodectus*) tend to take large prey (Hódar and Sánchez-Piñero 2002. J. Zool. Lond. 257:101–109; McCormick and Polis, *op. cit.*).

Pruett and Jadin (2010. Herpetol. Rev. 41:99) documented a theriid, *Steatoda* sp., preying on a *Tantilla gracilis* in Texas. Hall and Johnson (2008. Prairie Nat. 39:157–158) reported *Storeria occipitomaculata* in the web of a *Theridion* sp., but the authors thought the snake might have been entangled while seeking invertebrate prey in the web, and no signs of predation were observed. Most records of theriid spiders preying upon snakes refer to members of the genus *Latrodectus* (commonly known as widow, button, and redback spiders), all of which are morphologically similar and highly venomous. Neill (1948. Herpetologica 4:158) reported *L. mactans* (Southern Black Widow) preying upon the small snakes *Opheodrys aestivus* and *Storeria dekayi*, in Georgia, USA. Ervin and Carroll (2007. Herpetol. Rev. 38:468) reported a dead *Hypsiglena chlorophaea* in the web of *L. mactans* in Yavapai Co., Arizona, USA. Bayliss (2001. Herpetol. Rev. 32:48–49) reported three incidences (two direct observations and one



FIG. 1. Adult female *Lactrodectus* (presumably *L. hesperus*) feeding on *M. euryxanthus*, near Superior, Arizona, USA.

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reported to him) of Geometrid Button Spiders (*L. geometricus*) preying upon small snakes, *Lamprophis fulginosus* and *Crotaphopeltis hoamboaei*, in South Africa. McCormick and Polis (*op. cit.*), they also report on an Australian Redback Spider (*L. hasselti*) preying on a *Pseudechis porphyriacus*. A recent internet search revealed several stories with photographs of *Lactrodectus* capturing and feeding on small snakes.

Coralsnakes have rarely been documented as prey for invertebrates. Roze (1996. Coral Snakes of the Americas: Biology, Identification, and Venoms. Krieger Publ. Co., Malabar, Florida. 328 pp.) suggested that coralsnakes may fall prey to army ants. Recently, Nunes (2010. Herpetol. Rev. 41:367–368) reported a tarantula, *Pachistopelma rufonigrum* (Theraphosidae) attempting to prey on a *Micrurus ibiboboca*, in Brazil. Here we describe two instances of presumed predation by *Latrodectus* on the Sonoran Coralsnake (*Micruroides euryxanthus*) in Arizona, and discuss predation of small snakes by *Latrodectus*.

On 16 July 2010, one of us (PAS) was pressure washing a walkway to an outhouse in Sabino Canyon, Santa Catalina Mountains, near Tucson, Pima Co., Arizona, USA, when a subadult *Micruroides euryxanthus* wrapped in a spider web was dislodged. The snake had its head and forebody tightly wrapped in spider silk. Western Black Widow Spiders (*L. hesperus*) are common in this area and often build their messy webs near these structures.

On 29 August 2010, a second instance of a *L. hesperus* preying upon a *M. euryxanthus* was documented (Fig. 1). The incident was reported by visitors to the Boyce Thompson Arboretum, near Superior, Pinal Co., Arizona, USA, and witnessed by three of us (ADK, LLCJ, and PW). The dead snake was also a subadult. It was suspended about 10 cm above the walkway, under an overhang just outside the entrance of the Visitor's Center. The spider was seen feeding on the snake, near the tail end. The posterior one-third of the body and tail was collapsed, suggesting the spider had liquefied and sucked out the contents of that portion of the snake. As in the previous observation, the head and forebody of the snake were wrapped in silk. This was also reported in one instance by *L. geometricus* (Bayliss, *op. cit.*) and by Pruett and Jadin (*op. cit.*) for *Steotoda*.

There also are numerous reports of *Latrodectus* feeding on lizards. Painter and Kamees (2010. Herpetol. Rev. 41:227) discussed predation on a neonate of the lizard *Phrynosoma hernandesi* by *L. hesperus* in New Mexico. They also provide a literature review of several reports of lizards in the diet of *Latrodectus* spp., including five instances of lizard predation by *L. liliana* in Spain (Hódar and Sánchez-Piñero, *op. cit.*). They note that lizard remains (unlike invertebrate prey) were discarded from the web, presumably because the remains attract ants, so vertebrate prey might be an underestimated component of the diet. *Micruroides euryxanthus* feeds primarily on small snakes and lizards (Roze, *op cit.*; Stebbins 2003. Western Reptiles and Amphibians. Houghton Mifflin, Boston, Massachusetts. 533 pp.), so it seems unlikely that the snakes we observed were attempting to eat the spiders or other invertebrates in the web. It is more likely the snakes were simply entangled in the low-lying webs while active on the surface.

Based on the observations detailed above, as well as our own, a scenario emerges wherein small squamate prey may not be so unusual for *Latrodectus*, and may actually be part of the typical (albeit less frequently encountered) prey, along with large invertebrates. Adult female members of this genus seem well-adapted to subduing and feeding on small vertebrates, at least opportunistically. The webs of *Latrodectus* are often on vegetation or under overhangs and 10–50 cm above the surface of the ground. The spider sets highly adhesive hunting threads to the substrate to target mostly nocturnal prey. If large insects or small vertebrates encounter the web, they struggle, and become entangled. The strong, sticky strands of silk become detached from the surface, and the animal may become tangled higher up in the web, where it cannot gain purchase from the surface to help it escape. The spider can help subdue the animal's attempt to free itself by further wrapping it in silk (perhaps targeting the head area) and can safely immobilize and dispatch the snake or lizard with its extremely powerful venom (and liquefy the contents for feeding). Vertebrate prey remains may then be discarded to avoid ants in the web. Although there may be variations on this theme, large female *Lactrodectus* seems quite capable of dealing with small squamates. Because vertebrates are discarded after feeding, it is likely they are underreported as prey; even so, there are far more records of *Latrodectus* feeding on snakes and lizards than for other similarly-sized spiders.

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***MICRURUS SURINAMENSIS* (Aquatic Coralsnake). OPHIOPHAGY.** *Micrurus surinamensis* is a primarily aquatic, diurnal-nocturnal coralsnake, inhabiting a variety of wet habitats in the Amazon from Surinam to Bolivia (Campbell and Lamar 2004. The Venomous Reptiles of the Western Hemisphere. Cornell Univ. Press, Ithaca, New York. 870 pp.). This species feeds primarily on fishes (*Callichthys*, *Gymnotus*, *Synbranchus*; Cunha and Nascimento 1978. Publ. Avul. Mus. Par. Emílio Goeldi 31:168–170; Roze 1996. Coral Snakes of the Americas: Biology, Identification, and Venoms. Krieger Publ. Co., Malabar, Florida. 340 pp.), but is also reported to eat lizards occasionally (Martins and Oliveira 1999. Herpetol. Nat. Hist. 6:62–63). In South America, the snake genera most frequently consumed by coral snakes are *Atractus* and *Liophis* (Roze 1996, *op. cit.*). On 13 May 2006, we collected an adult male *M. surinamensis* (MCN-R 2740; total length = 1011 mm; SVL = 941 mm; midbody diameter = 24.3 mm) on the road in Porto Trombetas, Oriximiná municipality, Pará, Brazil (1.833°S, 56.517°W, datum SAD 69; elev. 83 m) that contained an adult female *Liophis reginae* (MCN-R 2743; total length = 570 mm; SVL = 420 mm; midbody diameter = 15.2 mm) in its stomach. Ophiophagy has been reported in many coralsnake species (Marques and Sazima 1997. Herpetol. Nat. Hist. 5:88–93), but to date no record of this habit has been reported for *M. surinamensis*. We suggest that this record represents an occasional prey item in the diet of this aquatic coralsnake.

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***NERODIA SIPEDON* (Northern Watersnake). RESPONSE TO MOBBING BY FISH.** Mobbing of snakes by birds (Fitch 1999. A Kansas Snake Community: Composition and Changes over 50 Years. Krieger Publ. Co., Malabar, Florida. 165 pp.) and mammals (particularly primates and rodents; Gursky 2005. Int. J. Primatol. 26:207–221; Owings and Coss 1977. Behaviour 62:50–69) is a commonly reported phenomenon. In the wild, mobbing may be a common occurrence; Timber Rattlesnakes studied in New York were harassed on average once every 6.4 days by birds (Clark 2005. Behav. Ecol. Sociobiol. 59:259–261). However, reports of mobbing of snakes by animals other than sciurid rodents and birds are relatively rare. Furthermore, mobbing of potential predators (including non-snakes) by fish is extremely rare (Dominey 1983. Copeia 1983:1086–1088). Here, we report the escape behavior of *Nerodia sipedon* in response to mobbing by a group of fish.

On 28 May 2010, at 1131 h, one of us (MR) observed an adult *N. sipedon* (ca. 70 cm total length) laterally undulating along the bottom of Devil's Lake in Devil's Lake State Park in Sauk Co., Wisconsin, USA (43.426031°N, 89.728481°W, datum: NAD83). The snake was found on the northeastern shoreline approximately 2 m from the shore in water approximately 0.75 m deep. The water was clear and the bottom was composed of small gravel (<3 cm in diameter), providing an unobstructed view of the snake. No spawning beds (of any species of fish) were observed anywhere along the shore. Within 5 sec of the initial observation of the snake, approximately 6–8 *Micropterus salmoides* (Largemouth Bass) approached the snake and surrounded it on both sides. The bass appeared to be about 15–20 cm in length. The bass approached the snake to within about 2–10 cm and oriented towards the head of the snake. The snake paused for ca. 5 sec, swam to the surface to obtain air, and then swam down to the lake bed and laterally undulated away at a faster rate than prior to the bass's approach. During this entire observation, the bass followed the movements of the snake, staying near the sides of the snake's head, but never in front of the head. The snake continued moving parallel to the shore and the bass continued to follow the snake for a minimum of 4 m until the group was out of the observer's view. As the bass continued to follow the snake, the bass got closer to the snake's head but made no attempt to bite the snake. The snake made no attempt to strike or otherwise ward off the bass, other than to swim away faster along the bottom of the lake.

Attempted predation or nest defense would be likely interpretations of the bass' behavior, however, we reject these hypotheses. Although Largemouth Bass are documented predators of Northern Watersnakes (Gibbons and Dorcas 2004. North American Watersnakes: A Natural History. Univ. Oklahoma Press, Norman. 438 pp.), none of the bass observed harassing the snake appeared to be large enough to consume the snake. Additionally, it would be logical that the fish were harassing a predator in their breeding grounds (Dominey, *op. cit.*), however, many of the fish involved were of non-breeding size and no spawning beds were observed. Another possible hypothesis is that the fish were following the snake in an attempt to capture prey flushed by the snake, however, no feeding by the bass was observed. Deterring a possible predation attempt by group harassment or mobbing is the most consistent hypothesis that fits with our observations. It is interesting to note that many of the bass were within possible prey size range for the snake.

In many examples of mobbing, actual contact (i.e., pecking and biting) with the snakes has been observed (Fitch, *op. cit.*); in this instance, we did not observe contact between the fish and the snake. The snake's response was similar to what has been observed for other species of snakes while being mobbed (Fitch, *op. cit.*). No attempt to orient towards the bass or strike the bass was made, despite the fact that several fish were within striking distance of the snake's head. The most common result of harassment is to abandon the foraging grounds (Clark, *op. cit.*) and relocate to new foraging grounds.

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***NOTECHIS SCUTATUS* (Tiger Snake). PREDATION.** Terrestrial-aquatic ecotones act as connection lines for species fluxes along river corridors (Pinay et al. 1990. *In* Naiman and Décamps [eds.], The Ecology and Management of Aquatic-Terrestrial Ecotones, pp. 141–169. Parthenon Publ. Group, Carnforth, UK). Rainbow Trout (*Onchorhyncus mykiss)* are distributed globally (MacCrimmon 1971. J. Fish. Res. Board. Can. 28:663–704) and this has led to countless diet studies indicating they predominantly prey upon fish and aquatic and terrestrial invertebrates (Buria et al. 2009. Rev. Chil. Hist. Nat. 82:3–15; Kido et al. 1999. Pac. Sci. 53:242–251). Terrestrial vertebrates are not a common prey item of Rainbow Trout.

A Rainbow Trout measuring 30 cm fork length was captured at 1230 h using a backpack electrofisher on the 19 April 2010 in the Cotter River (35.387°S, 148.866°E; datum WGS84), Australian Capital Territory. The individual was using submerged fallen timber as refuge in approximately 50 cm of water when captured. Upon dissection, it was noted that the stomach was extremely distended with stomach content analysis revealing a 26 cm (total length) juvenile *Notechis scutatus*. The intact snake dermis indicated that the snake had recently been ingested.

Rainbow Trout have been recorded preying on several species of reptiles including a snake of the genus *Natrix*, a *Podarcis muralis* (Common Wall Lizard) and an *Anguis fragilis* (Slow Worm; Bernini et al. 2006. Acta. Herpetol. 1:61–63), a *Eulamprus tympanum* (Southern Water Skink; Lintermans 1992. Herpetofauna 22:34), and a *Leiolopisma mettalicum* (Metallic Skink; Kido et al., *op. cit.*). Another observation recorded a Rainbow Trout attacking a *Natrix natrix* (Grass Snake) for five minutes after which the snake was able to free itself. The same study noted a Brown Trout (*Salmo truttta)* that had eaten a *N. natrix* and died in the process (Eder et al. 1998. Herpetozoa 1:69–71).

Notechis scutatus is found in Queensland, New South Wales, Australian Capital Territory, Victoria, South Australia, and Western Australia and is often associated with water bodies as frogs constitute a high proportion of its diet (Cogger 2000. Reptiles and Amphibians of Australia. Reed New Holland, Sydney. 808 pp.). Rainbow Trout are opportunistic visual predators (Buria et al., *op. cit.*; Kido et al., *op. cit.*). The predation on reptiles by salmonids is an occasional phenomenon and not considered a threat to populations living along a watercourse (Bernini et al., *op. cit.*).

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***PANTHEROPHIS SPILOIDES* (Gray Ratsnake). ATTEMPTED PREDATION AND AQUATIC ESCAPE BEHAVIOR.** There are few observations of fish predation on snakes, with most focused on *Micropterus salmoides* (Largemouth Bass; Szelistowski and Meylan 1996. Herpetol. Rev. 27:204–205). Herein, we describe a predatory encounter between a *Pantherophis spiloides* and a *Lespisosteus osseus* (Longnose Gar). The observation took place at ~1900 h on 8 July 2010, in a large ditch along IL Hwy 100 and bordering southwest edge of the Raging Rivers Water Park (Grafton, Madison Co., Illinois, USA; 38.96822°N, 90.40142°W; datum NAD 1984). The ditch continued under a large culvert near which several large (~60–90 cm) gar were basking, and continued west into the Mississippi River. We observed a *P. spiloides* (ca. 90 cm total length) swimming in this ditch. Upon reaching the proximity of the culvert, one of the gar attacked the snake. The gar grabbed the snake's tail which broke off, allowing the snake to escape. We could not tell if the fish consumed the tail. The snake raised its head high above the water and began to skip across the water very rapidly until it reached the shore. This skipping behavior emulated that of the side-winding behavior used by *Crotalus cerastes* to navigate sand dunes, only it was used across the surface of the water and performed rapidly enough to avoid sinking. The behavior was effective in that the snake did escape. This appears to be the only observation of attempted predation on a snake by gar and to our knowledge, is the first report of this escape behavior by *P. spiloides*.

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***PELAMIS PLATURA* (Yellow-bellied Seasnake). PREDATION.** *Pelamis platura* is unpalatable to many predatory fish (Rubinoff and Kropach 1970. Nature 228:1288–1290; Weldon 1988. Zool. Sci. 5:443–448) and documented instances of attempted predation on *P. platura* in the wild are rare. Crabs (likely *Ocypode* spp.) have been found scavenging dead *P. platura* (Duellman 1961. Univ. Kansas Public Mus. Nat. Hist. 15:1–148), and two marine mammals (*Hydrurga leptonyx* and *Zalophus californianus*) have been seen regurgitating *P. platura* and thereafter appearing sick (Heatwole and Finnie 1980. Herptofauna 11:24; Reynolds and Pickwell 1984. Copeia 1984:786–789). Moreover, *P. platura* has been observed being picked up and subsequently dropped by birds on two occasions, once by a Lava Gull (*Larus fuliginosus*; Reynolds and Pickwell 1984. Copeia 1984:786–789) and once by a Frigatebird (*Fregata magnificens*; Wetmore 1965. Smithson. Misc. Coll. 150:75). In the latter case, the author observed a frigatebird "pick up a sea snake [*P. platura*] swimming at the surface and carry it, as it twisted and coiled, for a short distance with other frigates in close pursuit, and then finally let it drop." Herein, we report a very similar event in Bahía de Culebra near las Islas Pelonas in Guanacaste, Costa Rica.

On 8 June 2010, at 0835 h, we observed a Frigatebird dive toward the sea, grab an adult *P. platura* at the surface with its beak, carry it partially out of the water for ca. 2 sec, and then drop it. The frigatebird then circled around and dove again in the same area, but stopped partway and flew off before reaching the water. We investigated the area for 10 min via boat and could not find the *P. platura* suggesting that it survived the "attack" and likely swam down to escape. Whether such events actually indicate attempted predation remains unknown. Predation on *P. platura* is thought to be minimal due to its apparently noxious flesh and aposematic coloration (Heatwole 1975. *In* W. A. Dunson [ed.], The Biology of Sea Snakes, pp. 230–250. University Park Press, Baltimore, Maryland). However, frequently we have observed scars on the Costa Rican *P. platura*, including some that are V-shaped or diagonal (Fig. 1), which suggests such incidents with birds may be relatively common in this area. Weldon (1988. Biotropica 20:174–176) suggested that such scars on *P. platura* probably were caused by humans (e.g., boat propellers). However, given the observations of birds picking up *P. platura* from the water and the shape of the injuries sustained, we consider attempted predation by birds to be a more likely explanation for these scars.

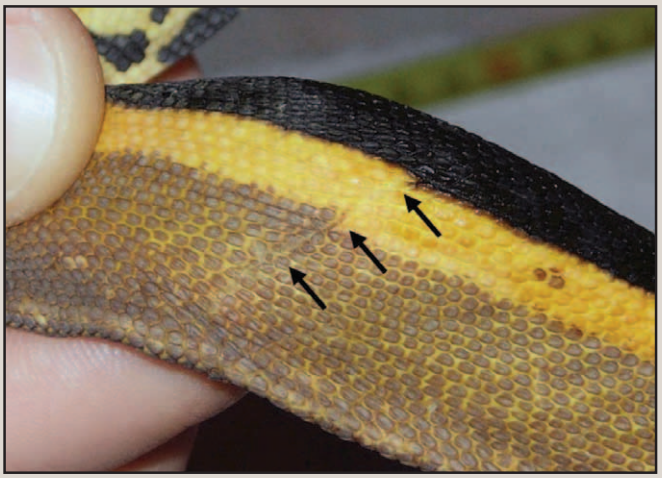


PHOTO BY C. M. SHEEHY III

FIG. 1. A long diagonal scar along the lateral midbody of an adult female *Pelamis platura* from Bahía de Culebra, Costa Rica (UTADC 6800).

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***PELAMIS PLATURA* (Yellow-bellied Seasnake). MATING BEHAVIOR.** The wide range of *P. platura* includes tropical and subtropical waters of the Western Hemisphere (Campbell and Lamar 2004. The Venomous Reptiles of the Western Hemisphere. Cornell University Press, Ithaca, New York, xviii + 870 + 28 pp.; Sasa et al. 2010. *In* Wilson et al. [eds.], Conservation of Mesoamerican Amphibians and Reptiles, pp. 511–603 Eagle Mountain Publishing, LC., Eagle Mountain, Utah).The reproductive cycle of this species apparently is continuous throughout the year, but two birthing peaks have been reported, one in December and January and other in July and August (Solórzano 2004. Serpientes de Costa Rica / Snakes of Costa Rica. Editorial INBio, Santo Domingo Heredia, Costa Rica, 791 pp.). On a sunny morning in August 2009 we observed two *P. platura* copulating while floating on the surface of calm water (Fig. 1) at Archipiélago Murciélago,

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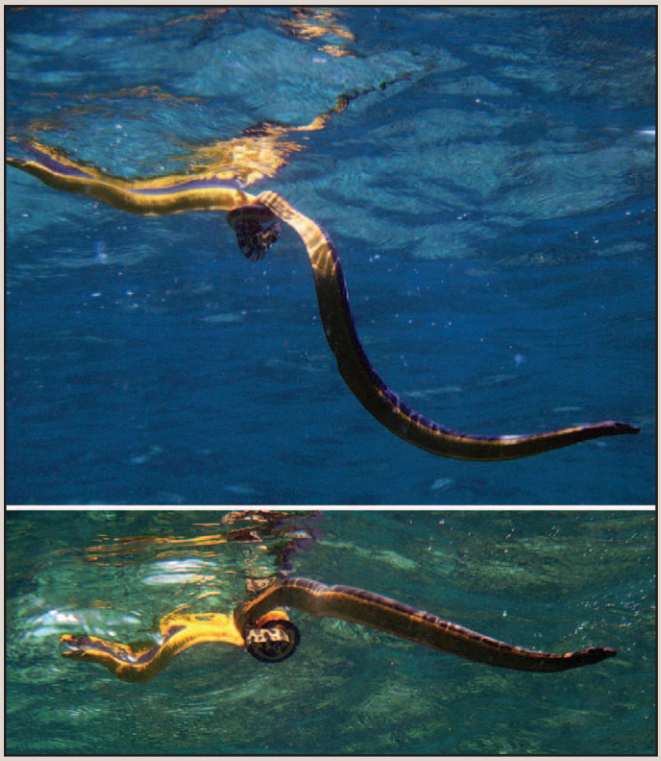


FIG. 1. A pair of *Pelamis platura* copulate while floating on the sea surface at San Pedrito, Archipiélago Murciélago, Guanacaste province, Costa Rica. Photos by Minor Lara, courtesy of María Marta Chavarría, Guanacaste Conservation Area (A.C.G.)

San Pedrito, Guanacaste Conservation Area (A.C.G.), Marine Protected Sector, La Cruz, Costa Rica (85.9541°W, 10.8559°N, datum: WGS84). Both individuals slowly moved their heads in a vertical motion, while their tails remained intertwined. This is the first report of mating behavior in this species.

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***RENA* (= *LEPTOTYPHLOPS*) *HUMILIS* (Western Threadsnake). PREDATION.** Reported predators of *Rena humilis* include scorpions, snakes, and coyotes (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Inst. Press, Washington, D.C. 668 pp.). Herein we report the first record of predation on *R. humilis* by the Pallid Bat, *Antrozous pallidus*.

On 1 May 2009, at 1600 h, a freshly-killed adult *R. humilis* was found under an *A. pallidus* night roost, along with various arthropod remains, at the entrance to the bathroom facility on Indio Mountains Research Station (IMRS), located in the Trans-Pecos region of the Chihuahuan Desert, ca. 40 km SW of Van Horn, Hudspeth Co., Texas, USA (30.782778°N, 105.015278°W, datum: WGS84; elev. 1233 m). The snake had been partially consumed, thereby missing about one-third of the posterior portion of its body. Nocturnal predation on small terrestrial reptiles by *A. pallidus* is due to the bat's unusual behavior of gleaning prey from the ground and low vegetation (Lenhart et al. 2010. Southwest. Nat. 55:110–115). The snake was deposited in the Herpetology Collection, Laboratory for Environmental Biology, Centennial Museum, University of Texas at El Paso (UTEP 20011).

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***STORERIA DEKAYI TEXANA* (Texas Brownsnake). DEATH FEIGNING.** Death feigning or thanatosis in snakes is defined as completely reducing responsiveness to stimuli while displaying secondary behaviors (coiling, releasing musk and feces, etc.) to thwart potential predators (Carpenter and Ferguson 1977. *In* Gans and Tinkle [eds.], Biology of the Reptilia, Vol. 7, pp. 335–554. Academic Press, New York). Liner (1977. Trans. Kansas Acad. Sci. 80:81–82) and Hayes (1987. Herpetol. Rev. 18:16–17) each reported that a few individual adult *Storeria dekayi* will lay upside-down and motionless following extensive prodding. Neonates will lie upside-down and motionless when placed in water within a few days after birth (Gerald 2008. Anim. Behav. 75:647–654). Here we provide the first report of an adult *S. dekayi* exhibiting thanatosis complete with secondary display behaviors.

On 10 September 2010 at 1950 h, we discovered a sub-adult *S. dekayi* (SVL = ca. 21 cm) on Saline River Road in Ellis Co., Kansas, USA (39.10398°N, 99.04007°W; datum: WGS84). When the snake was approached while on the road, it immediately released cloacal contents, spread contents over most of the body via violent writhing, and coiled. The snake was handled and flipped on its back where it remained upside-down and motionless for over 90 sec (Fig. 1). The snake then righted itself and remained motionless for several seconds before attempting to actively escape. Temperature of the road was 24.4°C. Two out of five other adult and sub-adult *S. dekayi* captured in the area over the next two days also spread cloacal contents over the body and remained motionless, but did not flip upside-down.

Death feigning has been shown to be influenced by temperature, size, locomotor performance, and distance from predators (Burghardt and Greene 1988. Anim. Behav. 36:1842–1844; Gerald 2008, *op. cit.*). This is the first report of an adult *S. dekayi* displaying death feigning immediately following encounter with a potential predator. Moreover, this is the first report on the use of



FIG. 1. *Storeria dekayi texana* from Ellis Co., Kansas, USA, exhibiting death-feigning behavior.

secondary behaviors that presumably adds to the effectiveness of the death feigning display that is often attributed to snakes of the genus *Heterodon* (e.g., Gehlbach 1970. Herpetologica 26:24–34). The scarcity of published reports and the lack of personal observations of death feigning behaviors in adult *S. dekayi* suggest that the presence of this behavioral strategy in this species is highly variable among individuals and populations and is likely not nearly as common as reported in other snake species (e.g., *Heterodon*).

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***TANTILLA RUBRA* (Red Black-headed Snake). MAXIMUM SIZE.** The maximum size reported for *Tantilla rubra* based on an examination of 48 adult specimens with complete tails from Mexico and Guatemala was 500 mm (Dixon et al. 2000. Southwest. Nat. 45:141–153). A maximum total length of 594 mm, with a maximum tail length of 130 mm is also recorded (Wilson et al. 2000. Cat. Amer. Amphib. Rept. 720.1–720.3).

On 20 September 2007, at 1205 h, WF and TB found a road-killed female *T. rubra* (SVL = 545 mm; tail length = 114 mm; total length = 659 mm; 43 g) in Tamaulipas, Mexico. This exceeds the maximum recorded total length for the species by 65 mm (10%). The locality was on the "old" Federal Mexican Highway 101 (a new four lane Federal Mexican highway was opened in 2004, diverting the majority of the traffic through the Sierra Madre Oriental between Jaumave and Cd. Victoria, bypassing this locality; however both highways retain the designation 101), 25.5 km NNE of the town of Jaumave (23.618889°N, 99.281667°W, datum: WGS84; elev. 1016 m). This locality is approximately at the border of the Jaumave-Victoria municipality line on the interior western slope of the Sierra Madre Oriental that separates the Jaumave valley from the Gulf Coastal Plain. The habitat in the area is a transition zone between arid thorn scrub of the Jaumave valley and oak forest at higher elevations in the Sierra Madre. The specimen was deposited in the collection at Universidad Autónoma de Nuevo León, Facultad de Ciencias Biológicas, preserved collection (UANL 6460).

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FIG. 1. Record size *Tantilla rubra* from the border of the Jaumave and Victoria municipalities, Tamaulipas, Mexico.

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***THAMNOPHIS ATRATUS HYDROPHILUS* (Oregon Gartersnake). DIET.** *Thamnophis atratus hydrophilus* inhabits sunlit streams and rivers of southwestern Oregon and northwestern California where its primary prey are small fish and amphibians. This species, like most aquatic snakes, exhibits distinct ontogenetic habitat and diet shifts. Neonate and small juvenile snakes are primarily sit-and-wait foragers that prey extensively on tadpoles, particularly those of *Rana boylii* (Foothill Yellow-legged Frog). Larger juvenile and adult snakes are active foragers and the proportion of fish in the diet and mean prey size increase with body size (Lind and Welsh 1994. Anim. Behav. 48:1261–1273). The most common fish reported in diets of *T. a. hydrophilus* are juvenile salmonids (genus *Oncorhynchus*), but they are also known to consume sculpins (genus *Cottus*; Brown et al. 1995. Reptiles of Washington and Oregon. Seattle Audubon Society, Washington. 176 pp.) and sculpin eggs (Bettaso et al. 2007. Herpetol. Rev. 38:212–213), and giant salamanders (*Dicamptodon tenebrosus*; Lind and Welsh 1990. J. Herpetol. 24:104–106; Lind and Welsh 1994, *op. cit.*). Here we present an observation of neonate *T. a. hydrophilus* preying on ammocoete larvae of *Entosphenus tridentatus* (Pacific Lamprey).

This observation took place at approximately 1300 h, on 3 September 2007, along the lower Klamath River, California, USA (41.5794°N, 123.5303°W; datum WGS84). We observed numerous neonate and juvenile *T. a. hydrophilus* basking and foraging along the river margin in areas dominated by exposed cobbles and small boulders interspersed among numerous alcoves and shallow side pools that contained extensive patches of fine sediment. One of us (ERP) captured a small *T. a. hydrophilus* (SVL = 188 mm) and while handling it, it regurgitated two recently ingested *E. tridentatus* ammocoetes measuring 54 and 61 mm total length. Gentle palpation of the upper digestive tract revealed that these were the only prey items in the snake's stomach. This observation is the first report of snake predation on lamprey ammocoetes, which are filter-feeders that reside in burrows in fine sediment (Moyle 2002. Inland Fishes of California. Univ. California Press, Berkeley. 502 pp.) and should, therefore, be highly cryptic to ambush predators such as juvenile garter snakes. It also suggests that garter snake foraging behavior and diet breadth may differ between large rivers and high gradient mountain streams, where much of the previous research on this species has been conducted (e.g., Lind and Welsh 1994, *op. cit.*).

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***THAMNOPHIS BRACHYSTOMA* (Short-headed Gartersnake). COLORATION.** The coloration of *Thamnophis brachystoma* typically consists of a background of olive to olive-brown, with a beige to yellowish vertebral stripe and two dull buff lateral stripes (Hulse et al. 2001. Amphibians and Reptiles in Pennsylvania and the Northeast. Cornell Univ. Press, Ithaca, New York. xii + 419 pp.). Schaefer (1972. Herpetol. Rev. 45:168) reported a



FIG. 1. Hypomelanistic *Thamnophis brachystoma* from Erie Co., Pennsylvania, USA.

leucistic specimen from McKean Co., Pennsylvania, USA. I know of no other color anomalies reported for *T. brachystoma*. Herein I report an instance of hypomelanism in this species.

On 4 September 2009, I found a neonate male *T. brachystoma* with a pale dorsal color under a piece of bark in an extralimital population in Springfield Township, Erie Co., Pennsylvania, USA (Fig. 1). The ground color was light beige and lateral stripes were not discernible. A lighter vertebral stripe was present, but only slightly contrasting with the lateral ground color. Small amounts of dark pigment occurred on the scales on either side of the vertebral stripe, corresponding to the dark border that is typically present in normally colored specimens. A pair of oblong black spots occurred just behind the parietal scales where the dark border is ordinarily thickened at the anterior terminus of the vertebral stripe. The seam between the parietal scales was thinly bordered with black, but the parietal spots usually present were not visible. The ventral color was the normal greenish gray, and the eye color appeared normal. The specimen has been maintained alive since capture, and after more than a year its overall color has darkened somewhat, but is still much lighter than is typical. Nine additional neonates were found at the site on the date of the observation, all showing normal coloration. The specimen (TREC R-00058) is being maintained at the Natural History Museum of the Tom Ridge Environmental Center at Presque Isle State Park, where it will be deposited upon its death.

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TRIMORPHODON VILKINSONII **(Texas Lyresnake). MATING.** Information on the timing of breeding in species of *Trimorphodon* is scarce (Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. Univ. New Mexico Press, Albuquerque. 431 pp; Werler and Dixon 2000. Texas Snakes, Identification, Distribution, and Natural History. Univ. Texas Press, Austin. 519 pp.). At 2240 h on 16 April 2006, one of us (CN) was driving on County Road DO 12 west of Las Cruces, New Mexico, located on the bajada of the Sierra de Las Uvas mountain range (32.48538°N, 107.12330°W; datum: NAD83/WGS84; elev. 1537 m). The moon was waning gibbous with ~91% of the moon's visible disk illuminated. Air temperature was 18.0°C with ~ 24–40 km/h gusts of wind. An object seen earlier on the road and ignored was investigated several minutes later and found to be an adult pair of breeding *T. vilkinsonii*, the female having just been run over. At this point, the male, who was still entwined with the female, became disturbed and began to move off of the road. He was photographed and released. The female was deposited in the Museum of Southwestern Biology (MSB 75692). In Arizona populations of *T. lambda*, spermiogenic males were found in spring, summer, and fall, and females with enlarged follicles were found in May (Goldberg 1995. Southwest. Nat. 40:334–335). To our knowledge this represents the first documented date of copulation for wild *T. vilkinsonii*.

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TROPIDODIPSAS PHILIPPII **(Philippi's Snail-eating Snake). ARBOREALITY.** *Tropidodipsas philippii* is a small, thin, snake species that has several morphological characteristics typically associated with arboreal habitat use such as protruding eyes, slight lateral compression of the body, and a relatively long tail. These characteristics, along with documented arboreality in closely related species, have led some authors to speculate that *T. philippii* is arboreal to at least some degree (Kofron 1987. J. Herpetol. 21:210–225; Scott 1967. Copeia 1967:280–287). However, no data exist to confirm this speculation.

Here we present the first documented case of arboreality in *T. philippii*. On 3 July 2008, between 0440–0520 h, during a herpetofaunal survey near Hwy 200 between La Placita and Maruata, Michoacán, México (18.48627°N, 103.54229°W, datum WGS84; elev. 126 m), we encountered a male *T. philippii* (SVL = 156 mm; total length = 207 mm) resting on a thin, arching dead stick ca. 20 cm above the ground (Fig. 1). Specimen identification was verified by E. N. Smith. A photographic voucher of this behavior is deposited in the University of Texas at Arlington Digital Image Collection (UTADC 6245). The specimen is deposited at the Amphibian and Reptile Diversity Research Center, University of Texas at Arlington (UTA R-58836).



PHOTO BY C. M. SHEEHY III

FIG. 1. *Tropidodipsas philippii* (UTA R-58836) in Michoacán, México, *in situ*, exhibiting arboreal behavior and possibly ambush posture.

Of particular interest is the position of the snake along the stick (Fig. 1). It was motionless and oriented head-down in a position similar to that often described as ambush posture for some arboreal snake species (e.g., *Corallus* spp., Henderson 2002. Neotropical Treeboas. Krieger Publ. Co., Malabar, Florida. 197 pp.). The snake was found after several hours of rain beside a dry riverbed and we suspect that it was using the stick perch as a vantage point from which to scan for snails and slugs moving in the damp leaf litter below. Preliminary data from a feeding behavior study led by CMS support this hypothesis in that captive *T. philippii* often use visual cues to initially locate and follow molluscan prey.

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***TROPIDONOPHIS DORIAE* (Barred Keelback). ENDOPARASITES.** *Tropidonophis doriae* is known from Indonesia (Irian, Java, Aru Islands) and Papua New Guinea (Malnate and Underwood 1988. Proc. Acad. Nat. Sci. Philadelphia 140:59–201). It is a terrestrial, nocturnal predator that eats frogs and fish (Malnate and Underwood, *op. cit*). To our knowledge there are no reports of helminths for *T. doriae*. The purpose of this note is to establish an initial helminth list for *T. doriae*. Two *T. doriae* from the herpetology collection of the Bishop Museum (BPBM), Honolulu, HI, USA each had nematodes protruding from a slit in their body walls (BPBM 31526, SVL = 254 mm; BPBM 31527, SVL = 327 mm). Both snakes were collected on 3 April 2007 in Madang Province, Wanang, Papua New Guinea (5.232118°S, 145.18068°E; datum: WGS84; elev. 600 m). Nematodes were removed, cleared in glycerol, placed on glass slides, coverslipped, studied under a compound microscope and identified as *Tanqua anomala* (eight from BPBM 31526) and (six from BPBM 31527). Voucher helminths were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland, USA as USNPC (103501) and the Bishop Museum (BPBM) as (H423). *Tanqua anomala* is common in snakes from southeast and southern Asia (Baker 1987. Occas. Pap. Mem. Univ. Newfoundland 11:1–327; Sood 1999. Reptilian Nematodes from South Asia, International Book Distributors, Dehra Dun, India. 299 pp.). There is a record of a larval *T. anomala* in *Hoplobatrachus tigerinus* (= *Rana tigrina*) in Baker (*op. cit*). As *T. doriae* feeds on frogs, frogs may act as paratenic (= transport hosts) for *T. anomala*. *Tanqua anomala* in *T. doriae* is a new host record. Papua New Guinea is a new locality record.

We thank Pumehana Imada (IBPBM) for facilitating our examination of *T. doriae*.

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***XENODON NEUWIEDII* (False Lancehead). DIET.** The dipsadid snake *Xenodon neuwiedii* has a diet composed predominantly of anurans, especially those in the genus *Rhinella* (Marques and Sazima 2004. *In* Marques and Duleba [eds.], Estação Ccológica Juréia-Itatins: Ambiente Físico, Flora e Fauna, pp. 257–277. Holos, Ribeirão Preto; Sazima and Haddad 1992. *In* Morellato [ed.], História Natural da Serra do Japi: Ecologia e Preservação de uma Área Florestal no Sudeste do Brasil, pp. 212–236. FAPESP, Campinas). However, anurans belonging to other families (Hylidae, Leptodactylidae, and Cyclorhamphidae) and even lizards (*Enyalius* sp.) are occasionally consumed (Hartmann et al. 2009. Biota Neotrop. 9:173–184; Marques and Sazima, *op. cit.*). *Rhinella abei* is a frog distributed in the southern Atlantic Rainforest from Paraná state to southern Santa Catarina state and northern areas of Rio Grande do Sul state, Brazil (Baldissera Jr. et al. 2004. Arq. Mus. Nac., Rio de Janeiro 62[3]:255–282). Here we report the predation of the frog *R. abei* by the snake *X. neuwiedii*.



PHOTO BY M. WACHLEVSKI

FIG. 1. An adult female *Xenodon neuwiedii* found preying on a *Rhinella abei* in the Parque Estadual da Serra do Tabuleiro, Brazil.

On 16 January 2009, in the Parque Estadual da Serra do Tabuleiro, Santo Amaro da Imperatriz municipality, Santa Catarina state, Brazil (27.7427°S, 48.8075°W, datum: SAD 69), an adult female *X. neuwiedii* (SVL = 489 mm; tail length = 113 mm; 59.5 g), was found at 1015 h on leaf litter in an area of dense ombrophilous forest ingesting an adult *R. abei* (SVL = 69.1 mm; 26.2 g; 44% of the snake's mass). The frog was being ingested headfirst, ventral side up, and was still alive (Fig. 1). Manipulation of the snake resulted in the release of the prey, which presented deep wounds in the abdominal region. Batracophagy seems to be the most frequent feeding habit of *Xenodon* (Marques et al. 2001. Serpentes da Mata Atlântica. Guia Ilustrado para a Serra do Mar. Ribeirão Preto, Editora Holos. 184 pp.) and some species have specialized skulls and dentition, facilitating the capture and ingestion of frogs (Kardong 1979. Evolution 33:433–443). The wounds we observed are evidence of the functionality of *X. neuwiedii*'s enlarged posterior teeth, which allow perforation of the prey and the consequent evacuation of air, which is accumulated in the toad's body for defense (Amaral 1978. Serpentes do Brasil, Iconografia Colorida, 2ª edição. Melhoramentos/EDUSP, São Paulo. 247 pp.).

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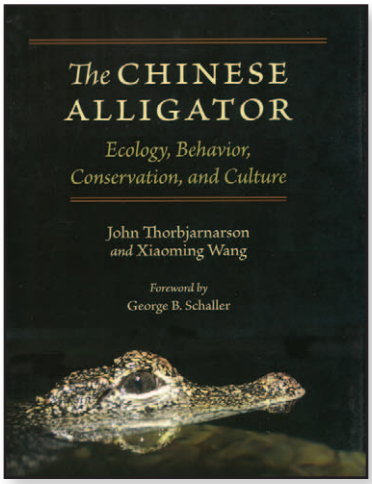
BOOK REVIEWS

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The Chinese Alligator, Ecology, Behavior, Conservation and Culture

By John Thorbjarnarson and Xiaoming Wang. The Johns Hopkins University Press (www.press.jhu.edu). Hardcover. xvii + 265 pp. US $85.00. ISBN 978-0-8018-9348-3.

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The Chinese Alligator is one of those rare technical books that is a really good read. As George Schaller so poignantly points out in his foreword, "too many plants and animals spiral toward extinction quietly and without someone to mourn their fate." Thorbjarnarson and Wang fulfil the imperative, as Schaller puts it "...that with meticulous science, tenacity, cultural awareness and hope, any species can be offered a future." And few species on earth could be held up as such a startling example of survival against all odds as the Chinese Alligator.

Chapter 1, 'The Earth Dragon,' is a quick outline of John T.'s first visits to China in pursuit of the last remaining wild alligators. In 1998 he was stunned that the alligator's wild habitat in Anhui Province was virtually gone; previous reports by the Chinese authorities had painted a much rosier picture. Long, discouraging forays down narrow country roads, winding through a horizon to horizon agricultural landscape to find the last survivors, ended in a devastating car wreck with John suffering a broken femur and shoulder. The following year John and his Chinese/American team were elated to find a wild nest, one of the very few, and the reality of the situation starts to unravel. There were thousands of Chinese Alligators in captivity and perhaps 150 in the wild and it was disturbing that the lines between captive and wild animals were getting blurry, with development of large captive facilities taking precedence over consolidation of wild habitats.

Chapter 2 is an introduction to the world's crocodilians, their conservation and utilization and you couldn't ask for a better concise rendition. In contrast to the Chinese situation, the success story of the American Alligator, with 100s of thousands happily cruising the swamplands of the southeastern USA, is a truly remarkable 21st century crocodilian situation. Being the State emblem of Florida is certainly a help. The point is well made that with adequate protection in the 1960s the resilience of the alligator allowed it to rebound so vigorously that the species is an important economic resource and wetlands are thereby valued for sustaining this resource. But the Chinese situation is so very different: there is little or no alligator habitat left.

The book then takes us on an historical journey, starting with the evolutionary history of Chinese Alligators and unravelling the complex mystery of why only China and the USA have alligators. After a crash course in the cooling and heating of the earth and how it facilitated the odd distributions of plants and animals, we are told that "...the affinities between the flora and fauna of the eastern United States and eastern Asia are the result of what was in the early Tertiary, a widespread, temperate forest biome that spanned the two continents." Fossil records indicate a much wider distribution for the Chinese Alligator in prehistoric times and that the expansion of human populations was probably responsible for its extirpation from its northern range. The authors delve into what seems every possible reference to the alligator from 5,000 year old oracle bone inscriptions to the *I Ching*, creating a fascinating montage of how the 'earth dragon' was visualized and personified over the millennia. Accounts of the alligator's biology and behavior are quoted from classical texts going as far back as the 1500s, but it was a French customs officer and amateur naturalist stationed in Shanghai, A. A. Fauvel, who first described the Chinese Alligator to the world. His treatise *Alligators in China: Their History, Description and Identification* was published in 1879 and was a compilation of everything that was then known about the species.

After the Giant Panda, the dragon is the first animal we think of in the Chinese context. The authors trace dragon myths worldwide and for China make the very obvious link to the alligator, an admittedly smallish dragon at only seven feet. There are few creatures that are as pervasive in world mythology as the numberless morphs of the dragon. Humans are intensely fascinated by the horror of being killed and eaten by a predatory animal and the authors narrate an incident that happened while they were writing the book. An American doctor was pulled from a canoe and killed by a crocodile in Botswana and the news sent shock waves through the world media. But if he had drowned or been killed in a car accident the press would have paid little notice.

The next chapter, 'A Dragon's Life' is literally a monograph of the ecology and behavior of this cryptic and perhaps least known (*Tomistoma* and Dwarf Caiman are also contenders) of crocodilians. It has a lot in common with American Alligators,

but, perhaps partly because of persecution, it is not the conspicuous animal its cousin has become. A prodigious tunneler, the Chinese Alligator has hard winters to put up with, floods, and, in most areas, a less than supportive human populace. Indeed as the authors say, it is their ability to remain hidden most of the time in underground burrows that has enabled them to survive in the modern agricultural landscape. Here one will find nest size, clutch size, and literally everything that has been found out about these beasts from Chinese biologists studying them in the field and in captivity and American biologists at the Bronx Zoo and Rockefeller Wildlife Refuge, where they were bred for the first time outside of China.

Next is a chapter on the 'Dragon's Demise,' a chronicle of what happened to what was once a wide-ranging crocodilian and to the Yangtze River, the wetlands of which were its primary home. In many ways this history typifies what has happened (is happening) in many parts of the world: rivers being raped, plundered, dammed, diverted, and emptied of water and life for the sake of agriculture to feed burgeoning populations of humans. The recent extinction of the Chinese River Dolphin in the Yangtze is a tragic and ominous portent of what is facing the other major wetland life form, the alligator. In the 1930s it survived "only in the great swampy lakes lying to the south of the Lower Yangtze" in Anhui, Jiangsu, and Zhejiang provinces. By the 1970s it was found only in a small region in Anhui and Zhejiang provinces.

The Chinese authorities have long been aware of the demise of the alligator and the initial response was for the Anhui Forestry Bureau to set up the National Chinese Alligator Reserve, a 433 km^2 area, later reduced to 308 km^2, with an estimated total population of 150 wild alligators. The chapter on habitat and population status graphically describes how the alligator became more and more confined to a few pockets as the human population increased by over 200% since the 1930s. In the past alligators were revered, but local beliefs that alligators make it rain worked against them in recent years when floods were blamed on them! But nothing was so devastating to the alligator as the spread of human settlements and agriculture into virtually every last wetland they inhabited in China. In the early 1980s the Anhui Research Center for Chinese Alligator Reproduction was established as a captive breeding facility and stocked with animals caught from the wild and for a long time every nest that was found in the wild was taken to the Center for hatching and rearing. Releases were made but follow up and monitoring was minimal so the results were questionable.

The final chapter in the book is the longest, 'The Future of the Alligator in China' and provides a comprehensive look at China's efforts so far and the authors' vision of what efforts should be made in future. Basically the authors bemoan the fact that the Chinese authorities seem quite complacent as long as there are plenty of captive animals (about 10,000 today), but precious little effort was being spent on securing wild habitat. This resonates strongly with Indian croc biologists as we watch the steady demise of the Critically Endangered Gharial, primarily due to loss of its riverine habitat. As in China, government schemes for egg collection and captive breeding have now become the visible 'feel-good' face of conservation efforts while habitats are distorted beyond ecological utility and river people are further alienated from conservation goals.

Altogether an excellent and important read (if I had one quibble it would be for more photos and in color), *The Chinese Alligator* is a rare combination of science, common sense, and a passionate plea to look carefully at what we have left in the world and to nurture the last dragons. In his foreword, George Schaller writes: "*The Chinese Alligator* shows with detail, insight and vision that an attempt must be made to save species no matter how complex the problems." The authors are optimistic: "Despite its present dilemma, the Chinese alligator is a species with a potentially promising, perhaps even dramatically successful, future. It is with this hope that we have written this book."

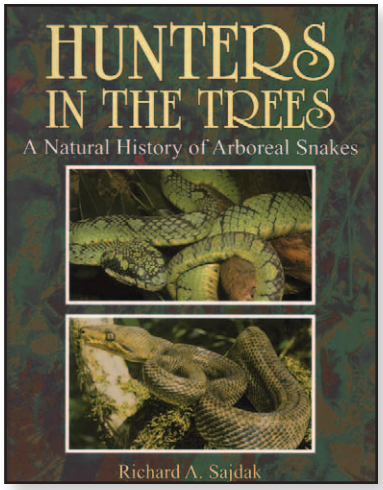
As I wrote this, I envisaged John T., dressed in his trademark Hawaiian shirt, smoking a Cuban cigar quietly holding forth about salties in Burma, gharial in India, Cuban crocs in the Zapata swamp, or Orinocos in Venezuala with other obsessed members of the croc biologist fraternity. A mosquito felled this titan and he is sorely missed across the planet.

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Hunters in the Trees: A Natural History of Arboreal Snakes

By Richard A. Sajdak. 2010. Krieger Publishing Co., Malabar, Florida (www.krieger-publishing.com). 192 pp. Hardcover. US $64.00. ISBN 978-1-57524-303-0.

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There are approximately 3309 named species of snakes, with arboreal forms accounting for more than 500 of these. Arboreal snakes do not represent a monophyletic lineage but rather a collection of species with arboreal habits, distributed primarily within the families Boidae, Colubridae, Elapidae, Pythonidae, Ungaliophiidae, and Viperidae. No strict definition exists for what constitutes an arboreal snake, but given that most snakes have the ability to ascend vegetation, and do so for various reasons (i.e., basking, sleeping, foraging, and predator avoidance), 'true' arboreal snakes are best considered those that spend the majority of their time, and carry out the bulk of their activity, in arboreal habitats.

Prior to this book, the only comprehensive examination of the biology of arboreal snakes was Lillywhite and Henderson's (1993) review chapter in *Snakes: Ecology and Behavior*. There exist a number of inherent difficulties associated with observing and studying arboreal snakes, thus hard data on the biology of arboreal snakes are scarce. Nonetheless, there is enduring interest in these animals as reflected in the 427 references cited by Sajdak, many of which will be of use to anyone studying not only snakes, but arboreal organisms in general.

The book contains 13 chapters, the first five of which review general snake biology as it relates to arboreal species. Chapter 1 serves as a fascinating introduction to the features associated with arboreality in snakes. It outlines the morphological specializations for an arboreal existence, emphasizes convergence and the repeated evolution of arboreality among distantly related species, and considers the global distribution of arboreal snakes. Convergence in morphology, ecology, and behavior are hallmarks of arboreal snake taxa, and it is convergence that is the main organizing principle used by Sajdak to arrange this book. Nonetheless, few studies have empirically tested convergence or measured morphological adaptations in arboreal snakes (e.g., Henderson and Binder 1980; Martins et al. 2008; Pizzatto et al. 2007).

The subsequent four chapters continue with conventional information pertaining to coloration and its function, locomotor styles and the functional demands associated with moving in a three dimensional environment, and diet. Of particular interest is Sajdak's discussion of the ideas of arboreal ecomorphs, niche partitioning, and community structure. In these chapters, readers gain insight into why the snake body plan is advantageous for an arboreal lifestyle and what changes occurred in morphology in order for snakes to become successful tree hunters. Sajdak does an excellent job in summarizing the literature in these chapters and clarifying much of the physics and physiology associated with arboreal habits as discussed in Lillywhite and Henderson (1993), making the book easily accessible to a wide audience.

The remaining eight chapters are dedicated to the diversity of arboreal snakes. Here, Sajdak provides readers with an appreciation for the number of times arboreality has evolved in snakes, the changes to morphology and ecology that accompanied these evolutionary shifts, and the role of arboreal prey types in allowing multiple snake lineages to radiate and flourish in the trees. These chapters are organized by snake family or by similarities in morphology and prey type (guilds). However, I find this approach somewhat subjective and exclusive. For instance, individual chapters are devoted to snakes specializing on frogs, birds, mammals, and invertebrates. Lizards as prey are accounted for in Chapter 6, "The Snipers—Vine Snakes," making it seem as if only vine snakes feed on lizards, when they are, in fact, taken by a diversity of arboreal snakes. Likewise, the titles of other chapters such as Chapter 11, "The Night Shift—Boas and Pythons" or Chapter 12, "The Poisoners—Tree Vipers," are also somewhat misleading in suggesting that only boids and pythons are nocturnal and only vipers are venomous. In addition, although discussed in the chapter on vipers, I was expecting to read in Chapter 8 ("Birds and Snakes") about the extraordinary role birds played in shaping the morphology and driving the evolution of *Gloydius shedaoensis* and *Bothrops insularis* to an arboreal existence. Nonetheless, this treatment of the diversity of arboreal snakes is a fantastic overview of how creatures of fossorial ancestry evolved to overcome physical and environmental challenges and conquered the trees.

Certain chapters would have benefited from subheadings, as topics change unexpectedly between paragraphs, interrupting the flow of the book. But if the book suffers from anything, it is the deficiency of data for many arboreal species. As a result, a great deal of the information presented in the book is drawn from research on just a few well-studied taxa; in some cases, entire chapters are almost wholly dedicated to such species. This is, of course, a consequence of the state of arboreal snake research, not a fault of the author, and indeed, Sajdak does provide commentary on lesser known species and indicates areas where more research is critically needed.

The book concludes with two appendices and a section entitled "Chapter Notes and References." Appendix 1 is a comparison of color patterns between arboreal and terrestrial snakes compiled from five regional guides and Appendix 2 is a list of blind snake species found in arboreal situations detailing the locality along with the height and substrate on which the snakes were found. However, 15 of the 19 records are from only a single reference. These two appendices might have been better presented as tables within relevant chapters. "Notes and References" does not include any notes, but simply lists the references used by chapter.

Of course no book on snakes is complete without color images. In this regard, the book lacks separate photographic plates, but instead intersperses images of varying size throughout the text. Some of the photos could be of better quality, but for the most part, they are superb images obtained from several photographers showcasing various arboreal species from around the world, often illustrating feeding behavior, threat displays, or other aspects of natural history. Other images show "non-arboreal" snakes captured in arboreal situations. Photographs aside, however, the book includes only five figures and no tables. The first two figures are the most useful, comparing the distribution of arboreal snakes with the distribution of the world's forests, suggesting that arboreality in snakes is predominately a tropical phenomenon. Unfortunately, Figure 1 also has a blatant spelling error that is hard to overlook. The remaining figures are less illuminating, but useful nonetheless, and I would have liked to have seen them adequately cited within the text.

Hunters in the Trees is undeniably a valuable compendium on the biology of arboreal snakes and will serve as a useful reference for researchers or hobbyists, and an excellent introduction to these snakes for members of the general public interested in tropical natural history. Sajdak's decades of field experience, knowledge, and passion for snakes are evident in his clear and simple writing style and engaging narrative, and readers will also appreciate his personal touch of illustrating postage stamps of arboreal snakes at the end of each chapter.

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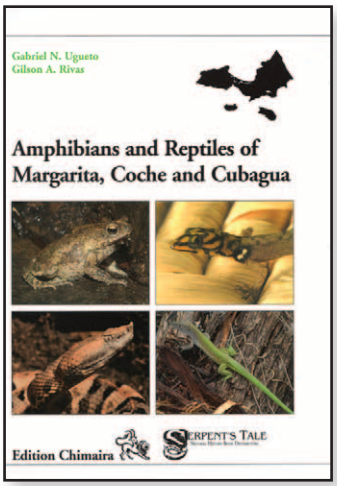
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Amphibians and Reptiles of Margarita, Coche and Cubagua

By Gabriel Ugueto and Gilson Rivas. 2009. Edition Chimaira (www.chimaira.de) / Serpent's Tale (www.zoobooksales.com). Hardcover. 44.80 Euros/US $65.00. ISBN 978-3-89973-479-9.

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Margarita, with an area of 1150 km², is Venezuela's largest island and its main tourist attraction (at least as measured by numbers of visitors). Despite a much less diverse herpetofauna than the Venezuelan mainland, and the near lack of endemics, Margarita and its satellite islands Coche and Cubagua still present an interesting introduction to the Neotropical herpetofauna, with five species of amphibians and 45 of reptiles. The herpetofauna of Margarita was treated extensively by Roze (1964) who mentioned four amphibians and 36 reptiles, and much later by Rivas et al. (2005), who added eight species to the previous list. But now, Gabriel Ugueto and Gilson Rivas present a new, improved, and more extensive treatment of the fauna in their new book.

The book starts with a foreword by Janis Roze, the former authority on Margarita herpetofauna (as well as on Venezuelan snakes), introducing the work of these two young Venezuelan herpetologists. A short acknowledgments section follows. An introduction briefly reviews the history of the discovery of Margarita and its satellite islands and the earlier work of herpetologists there. A "How to Use this Book" section explains the goals of the field guide and the categories of information supplied for each species. A more extensive chapter deals with the geography and habitats of the islands. This is followed by a brief geological history and a discussion of the zoogeography of the island, assigning all species to different categories: Widespread taxa, Caribbean coastal range taxa, Coastal arid lowland taxa, Cosmopolitan taxa, Amazonian taxa, Orinoco Basin taxa, and Lowland Guiana endemic taxa. It is curious that such a large island in the Caribbean does not harbor a higher number of endemics especially when compared with neighboring Trinidad and Tobago (see table 3 on page 47). To date only three reptiles are known to be endemic to Margarita: an undescribed species of *Gonatodes*, the recently described Gray-headed Whiptail *Cnemidophorus senectus* (Ugueto et al. 2009), and the Margarita Cribo (*Drymarchon margaritae*). *Scinax* aff. *x-signatus* may also be an undescribed species, but it remains to be better studied.

Margarita and Coche Islands are suffering from unrestrained touristic and urban development, affecting large areas of wilderness. As explained in the next section "Conservation," there are some attempts to conserve critical areas for important species and there are a few conserved areas, such as national parks and natural reserves on the islands.

A few species of amphibians and reptiles have been erroneously reported from the islands by previous authors or are of questionable presence. These include *Scinax ruber, Leptodactylus mystaceus, Crocodylus acutus, C. intermedius, Gonatodes ocellatus, Cnemidophorus lemniscatus, C. nigricolor*, and *Tupinambis teguixin*. All these cases are carefully explained by the authors.

Confirmed taxa are presented in a checklist of five species of amphibians and 45 reptiles known from Margarita, 12 reptiles from Coche and 13 from Cubagua. We take advantage of this review to add a few new localities for some species on Margarita and Coche. In a recent short casual visit by one of us (CLBA) to Coche Island, two previously unreported species were observed, the only amphibian known for the island, *Pleurodema brachyops*, and the expected but previously undocumented Gray-headed Whiptail, *Cnemidophorus senectus. Pleurodema brachyops* has also been known from the arid Punta de Piedras on Margarita for many years (OMLA, pers. obs.), but there are no vouchers. *Mabuya nigropunctata* is reported in the book only from one locality in Cerro Copey; it also has been observed in the little explored Cerro Tragaplata, in the northeast of Margarita. And finally, a dying specimen of *Dermochelys coriacea* arrived on the beach at Punta de Piedras in 1997 and was buried close to the Museo Oceanologico Hermano Benigno Roman. This constitutes the first report of the species on the southern versant of Margarita.

Before the species accounts there is a quite complete introduction to amphibians, and another to anurans (the only amphibians known to the islands) specifically, with a useful and easy to use dichotomous key to the family level. There are also introductions to each family, and if necessary (in families with more than one represented species), another key to the species level. The species accounts start with the five amphibians known from the islands, all widespread species on the mainland. Each account has a comprehensive identification section, followed by sections on habitat, natural history, diet, voice, reproduction, distribution, and remarks (when necessary). There is a distribution map and one or more photographs for each species. The reptile account part is also very comprehensive, with all the same sections as for amphibians except for "voice" and the addition of a "venom" section for the three venomous species of the islands. Between the amphibian and reptile sections are 12 plates illustrating all species from the islands except the Margarita Cribo, which has not been seen alive in recent times.

At the end of the reptile chapter, there is a section about species of possible occurrence, not yet confirmed, but with high probabilities of occurring on the islands. These include *Eleutherodactylus johnstonei* (introduced in Venezuela), and reptiles known from the adjacent mainland: *Mabuya falconsensis, Amphisbaena alba, Chironius spixi, Tantilla melanocephala, Clelia clelia, Ninia atrata,* and *Thamnodynastes ramonriveroi.*

The book closes with a chapter on venomous snakebite on these islands, and an appendix of examined material. The Literature Cited is comprehensive.

This is the first serious attempt to gather all the information about amphibians and reptiles of these islands in book form. Venezuela is one of the ten most biodiverse countries on Earth, with nearly 350 species of amphibians and 400 of reptiles. However, relatively little has been published about its herpetofauna and only a few attempts have been made to gather data, and then usually in a taxon-specific way (e.g., Roze 1966, Lancini 1979, Lancini and Kornacker 1989 for snakes; Pritchard and Trebbau 1984 and Rueda et al. 2007 for chelonians; Medem 1983 and Rueda et al. 2007 for crocodiles; and nothing exhaustive for lizards or amphibians).

This book accomplishes two goals. First, to be a comprehensive statement about the entire herpetofauna of a particular region (the state of Nueva Esparta in Venezuela), and second, to provide as much data as possible about each species, not only on these islands, but wherever they occur on the mainland.

Apart from the high quality information, which is accurate and well written, the most striking part of this book are the delightful plates by Ugueto. Few extraordinary works (e.g., Duellman 1970, 1978) have plates as beautiful and inspiring as the ones in this book. The plates illustrate all species on the islands except for the mysterious Margarita Cribo, and each one is both an artistic delight and a very accurate taxonomic aid. All the rest of the schematic drawings in the book were also executed by Ugueto, revealing his amazing skills as artist and designer, as well as a herpetologist.

The photos in the book also illustrate nearly all the species on the islands (except for *Scinax* aff. *x-signatus* and again the Margarita Cribo, and *Mastigodryas amarali* is represented only as a preserved specimen) and almost all the possible species (except *Clelia clelia* and *Thamnodynastes ramonriveroi*). All pictures are of good to very good quality. Not all, however, represent island specimens as would be desirable, although this is understandably difficult to achieve. Some habitat pictures (e.g., figure 5 on p. 19) are completely meaningless, and some are repetitive (e.g., figures 11 and 12 on p. 24). The pictures showing *Amazona barbadensis* and *Cebus apella margaritae* are not of good quality, seem irrelevant, and should have been excluded.

Otherwise, aside from a few typographical errors (we counted fewer than 10), a few considerations should be taken into count for the next edition of this book. First, we know of no place on Margarita with an annual precipitation of 1100 mm, as stated on page 15; the maximum recorded is 900 mm (Hoyos 1985). If there is such a place, it would be important to provide a specific reference. The correct name corresponding to the acronym MHNLS is Museo de Historia Natural La Salle, not as on pages 14 and 50, Museo de la Sociedad de Ciencias Naturales La Salle. It is unclear if the habitat map shown on page 20 is original or if it is taken from some source, in which case this should be referenced. In the "habitat" section of *Gymnophtalmus* sp. aff. *speciosus*, the text indicates that the species is "occasionally" found in and around human habitation. One of us (OMLA) used to live in Margarita for prolonged periods, and can verify that *Gymnophtalmus* is actually a very common lizard that is often found in backyards and gardens. On figure 85 (page 213), on an otherwise beautiful and useful schematic figure of squamation, the supraoculars appear twice. Figure 88 showing *Epictia goudotti* cross references figure 77, but should read figure 87. The lack of a life photo of one of the most characteristic species of snakes on Margarita, *Mastigodryas amarali*, should also be rectified. It is not a rare species, and we are aware of available photographs. Figure 121, showing a rattle of a preserved specimen of *Crotalus durissus cumanensis*, should be accompanied by the collection number. The Red-footed Tortoise is referred to *Geochelone* in the book, but is properly referred to *Chelonoidis*, as are the rest of the Neotropical tortoises (Le et al. 2006). The Lesser Antillean Coqui, *Eleutherodactylus johnstonei*, is treated as a species of possible occurrence. OMLA can verify that it is already established in gardens of Pampatar and Porlamar. On page 322, treating *Amphisbaena alba*, the authors commit a *lapsus* referring the species to an order within Squamata in the text, while in the heading of the species account it is correctly allocated to the Suborder Amphisbaenia. In relation to this species, Gilson Rivas and Oscar Lasso-Alcalá have recently received (in January 2011) from Luis Bermudez (Ministerio del Ambiente de Venezuela) two specimens from "Salamanca" and "La Asunción," that confirm its presence on the island. We found also a couple of references not quoted in the Literature section: Fry et al. (2006) on page 110, and Narvaes and Rodrigues (2009) on pages 67–68. The last thing to mention is that a Spanish edition of this book would be very useful to Venezuelan students who do not speak English. We understand that this is probably an editorial decision, but a bilingual book would be very useful. All of these issues can easily be updated or corrected in a new edition, and in no way diminish the significance and utility of this book.

Venezuela (and especially Nueva Esparta state) can be happy and proud that two young Venezuelans took so much time and combined their efforts to bring together so much information in such a beautiful book. This volume is not only a must for the libraries of all herpetologists interested in the Neotropics, but also for anyone who enjoys and appreciates superb herpetological artwork. Indeed, we predict that the plates will set a new standard modern herpetological works.

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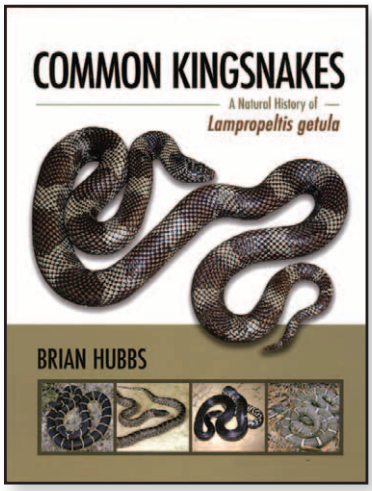
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Common Kingsnakes—A Natural History of *Lampropeltis getula*

By Brian Hubbs. 2009. Tricolor Books, Tempe, Arizona (tricolor_books@yahoo.com). Softcover. xxiv + 412 pp. US $60.00. ISBN 978-0-9754641-0-6.

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As Douglas Rossman retired from more than thirty years of teaching herpetology, I asked him how many of his students developed an interest in snakes from taking his course. His gaze turned contemplative, and after a moment, as if to emphasize what he was about to say, held up a finger. "One," he stated. He had confirmed my own observation that those who pursue herpetology as a career, avocation, or hobby usually develop that interest in childhood, often from the encounter with some fascinating reptile, whether in the wild or a pet shop. The youthful enthusiasm wanes in many, leaving drawers of decades-old field notes and fading photographs. There are likely hundreds, perhaps thousands of such unheralded, potential contributors to the field. On the other hand, many people maintain an uncurbed passion for reptiles, outside of the realm of academia. Sadly, the wealth of information accumulated by these individuals is rarely manifested outside of a circle of close associates, and is usually lost within a generation. What if just one of these nonprofessionals published their observations? Would they present a valuable contribution to herpetology? With *Common Kingsnakes* Brian Hubbs offers us an example.

Hubbs' first words in the Preface ostentatiously get right to the point: "This is the most comprehensive look at the species, *Lampropeltis getula*, the story of Common Kingsnakes, a synthesis of accumulated experiences and data about their lives and surroundings. If that's what you were looking for you've come to the right place…" With those sentences the reviewer's red pen began to tremble in grim, yet reluctant anticipation. I labored through the Introduction and first two chapters ("Discovering Common Kingsnakes" and "An Overview"), spending as much time critiquing as reading. The nineteenth page is written "ixx" instead of "xix," kingsnake musk is said to be excreted from the anal opening, and the loreals may be fused with the supraoculars (perhaps preoculars was intended). There are strange statements: "All Common Kingsnakes share…habitat preference," "habitat preferences may differ between subspecies," "The morphology of those snakes is extensive," "Like many kingsnakes, most herpetologists…" There are hackle-raising terms: "cold-blooded," "Water Moccasin," and brain-stabbing phrases: "… wake up from hibernation," "Most criteria is dorsally-related…," …"active during crepuscular times." One could quibble page after page about editing, sourceless statements, and mal-interpretation of data to the point of frustrated anger. But after some hours it occurred to me that I could drop the pen and enjoy the book, which I did.

As the writer's cramp eased, I got used to Hubbs' style, and each page became a welcome turn. I found that ten chapters follow the introductory material, each devoted to eight taxa (those usually recognized prior to Pyron and Burbrink 2009), with brief chapters on the Isla Santa Catalina and Outer Banks populations. Each chapter contains a block of photographs depicting the range of variation of each subspecies, as well as habitats. The block for *L. g. californiae* contains 143 color photographs, that for *L. g. floridana* has 30. The blocks for *L. g. splendida* and *L. g. sticticeps* are inexplicably black-and-white; without a second copy of the book for comparison, I cannot say whether this is an anomaly. For each taxon Hubbs provides sections on Description, Discovery and Name History (nomenclature), Scutellation (typically from Blaney 1977), Size, Pattern and Coloration, Similar Species, Range, Habitat, Prey, Behavior, Emergence, General Activity, Breeding and Reproduction, Later Activity, and Abundance. The chapter on *L. g. californiae* is exceptional (114 pages), with extensive details regarding 72 natural pattern variants. Each variant here, as well as for the other taxa, is described and mapped, and most are illustrated with excellent photographs. The chapter on the Florida Kingsnake is exemplary, beginning with a fun story of Hubbs' childhood meeting with Ross Allen, and the events leading to his first *floridana* capture. The remainder of the chapter presents the biology of the taxon based on the author's extensive field work, cited publications, and numerous quotes from his correspondence with biologists and commercial collectors, old-timers and graduate students who know *floridana* firsthand. He finishes the chapter with a timely discussion of kingsnake declines in Florida.

Chapter 13, "Kingsnake Collecting and Wildlife Management," is a terrific essay that presents the philosophy and history of snake collecting, and chronicles the imposition and effect of laws on snake populations, public perceptions, and hobbyists. Hubbs presents the issues of snake collection from the sides of the collector, the neutral academic, and those who enforce wildlife laws. He backs his opinions with logical and convincing observations, which make his conclusions circumspect in nature. In contrast, Chapter 14, "How to Search for Common

Kingsnakes," seems hastily patched together. The chapter begins with the author's reminiscences of a favorite collecting site, followed with brief coverage of the "where, what, and how" of locating kingsnakes (his admonition to learn local game laws is an important point). There are four pages on how to set up a board line—a search method that Hubbs praises throughout the book. Hubbs recommends spraying the underside of cover boards with female kingsnake musk, but does not tell us whether he has tried this, or if it makes any difference to capture rate. "Road hunting" is dangerously facile. There is no mention of the skills required to drive the recommended "50–55" mph, "hang a U'" without rolling the vehicle or hit oncoming traffic, and get back to catch a snake that was beating it across the road 20 seconds ago. Hubbs recommends salvaging roadkills, but offers no guidance on methods of preservation or locating repositories. The recommendation to "start at dusk or whenever conditions are right" is exceptionally vague.

The book winds down with a chapter on Designer Morphs, another on Captive Husbandry, an appendix of breeders and snake-related organizations, a glossary, and list of references. The Designer Morphs chapter contains 41 color photographs of some spectacular oddities in colors and patterns. The "Jelly Brooks" resembles how I would imagine an ancestral *getula-triangulum* link might have looked.

Hubbs' anecdotes and stories are well-written, and of a style beyond the ordinary recounting of activities. He acquaints the reader with events and surroundings that may seem less than tangential to the story, but pertinent to particular situations: having time off after work to climb a hill to look under a fallen sign (many avocational herpetologists will relate to time-budgeting around jobs), rising at 0400 hours to beat the horrid Los Angeles-Orange County commuter traffic, standing in an Ozark stream to escape the oppressive midsummer heat, desperately trying to find a Black Kingsnake in Kentucky before darkness and/or the West Virginia state line thwarts his efforts, and the apprehension one feels when discovering another snake hunter in a favorite locale.

After my pummeled trudge through the edge-effect of the introductory sections, I found Hubbs the scientist—the exceptionally detailed accounts of the pattern morphs of *californiae*, the studied citations of researchers, and the thoughtful contemplation of the evidence capped by Hubbs's speculative hypotheses and summation of available data. That is the underlying theme of the book—after forty years of devotion to finding and studying kingsnakes, Hubbs has discovered for himself many of the integral theories of the natural world. He substituted the desiccating lecture halls of academia with the kingsnake in its environment. I realized that the labored presentation of what I considered common science was Hubbs writing as though he is sharing with the reader the process by which he discovered new concepts. He describes the variable abundance of snakes along roadways without using the terms population source and sink, and the habit of some snakes using the same cover over a period of years without the term site fidelity. He discusses at length how kingsnakes coil under plywood during cool temperatures, devoting an entire section to the topic of thermoregulation. He discovers that the striped morph of *californiae* is restricted to grasslands, and concludes that striping has a cryptic advantage in that habitat.

Throughout the book, Hubbs makes philosophical points. He notes that if people understood kingsnakes, they would appreciate and begin to understand the snake's environment, and with that appreciation will come conservation of their habitat. He believes that some snake researchers are ignorant of snake population sizes, and emphasizes his calculations of abundance to confirm his belief. He argues that laws that prohibit catching kingsnakes create a generation of hobbyists who never seek kingsnakes in the wild, and are oblivious to the effects of man on the snake's environment. He infuses the text with personal anecdotes, and quotes from others, both published and personal communications. It is clear that Hubbs has researched *L. getula,* solicited data from both snake enthusiasts and professional herpetologists, and pursued leads to discover as much as possible about kingsnakes in their environment. I was educated on a number of topics: female kingsnakes musk significantly more often than males; the designer-morph industry eliminated the market for wild-caught morphs; some snake species are most active on roads on windy nights (during atmospheric pressure changes); dorsal striping occurs in some *L. getula* from the Gulf Coast of Florida.

From a scientific vantage, there is one flaw to the book, which is the inconsistent sourcing of information. Hubbs frequently makes statements without reference, and it is often difficult to determine whether a statement is based upon something he read, heard from others, learned from his own observations, or is purely speculation (e.g., "It is believed that kingsnakes shed roughly 4 to 6 times a year in the wild"). Some that seem speculative are reasonable, though no evidence is provided as to how such a conclusion was reached (e.g., "In grasslands, sand hills and open woodland, the snake will simply hibernate underground, and its home territory will normally be much smaller than those that must seek specific hibernaculum"). Similarly, he makes frequent reference to "his data." Having observed over 2000 kingsnakes in the wild, it is disappointing that quantitative data are rarely presented. The "data" occasionally manifest themselves: ratios of color morphs in *californiae* at different sites, some counts with which he estimates the number of *L. getula* per acre in certain habitats, and dates of winter emergence. He also presents numerical data on body temperatures, monthly counts of observations, and clutch sizes as published by others. Relating to the eventual loss of data accumulated by amateurs, Hubbs found it difficult to find information from collectors of the 1950s and 60s on pattern morphs in coastal California and numbers of snakes encountered on desert roadways.

Hubbs is inventive when he can find no standardized terminology or metrics. He categorizes color pattern as class, type, phenotype, and morph. Each is a sub-category of the previous, except that phenotype and morph are "interchangeable," though morphs are more subtle variants. The definition of each term is found in four paragraphs on page 19, which are again pasted on pages 38–39. A list of 37 Morphs of *L. g. californiae* is found on page 49, and a list of 34 Aberrant Morphs is provided on page 56. In case the reader is confused, Hubbs explains that the term "aberrant" describes patterns that vary from typical patterns, and that there are aberrant morphs and aberrant snakes. He quantifies the terms "common" (3–9 snakes per acre) and "abundant" (over 10 snakes per acre). What if one should find an even 10 snakes per acre?

Hubbs has the enviable option of limitless space and verbiage. His book consists of heavy, high-gloss pages within covers of heavier paper. It is sturdy. The spine states *Common Kingsnakes* in no-nonsense, bold, block letters. No matter where it is on my shelves, I will immediately be able to find it. The text is composed of relatively small font size, though of a bold, block

type that allows easy reading. The hundreds of photographs and maps are perfectly produced in size (usually about 10 x 7 cm) in tones and colors that optimize detail. In physical aspect the book is extraordinary.

Hubbs summarizes the dilemma of amateurs in the study of herpetology as "...a lack of credibility. Amateur herpetologists are not usually taken seriously, or as a valuable source of information.... In our society, it doesn't seem to matter what you know; it's all about qualifications, perceptions, and how many are on your side." With *Common Kingsnakes*, Hubbs has demonstrated that he is a valuable source of information, knows a lot about his subject, and is qualified to be an authority. He has shown what can be produced where laws allow citizens to catch, keep, and study native species, as opposed to countries or states in which those practices are forbidden. So, has Hubbs, an avocational herpetologist, made a valuable contribution to science? Indisputably so: he provides a wealth of unpublished information that compliments what is already known about *L. getula*—information that would otherwise be lost. As he stated in his Introduction, anyone interested in the Common Kingsnake has, indeed, "come to the right place." *Common Kingsnakes* was written, produced, and published solely by Brian Hubbs. For that reason, the book is a creation and expression of just what its author wished rather than what the reader wishes it to be. It is beyond criticism—it is Brian Hubbs at his literary finest.

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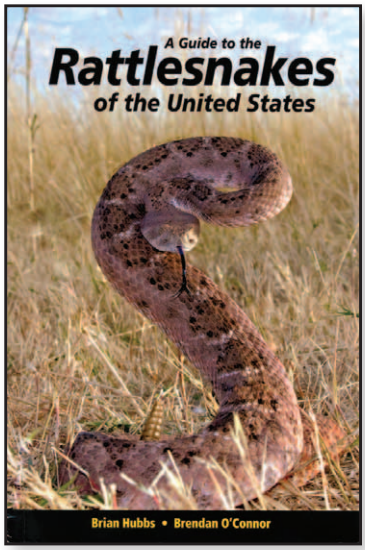
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PUBLICATIONS RECEIVED

A Guide to the Rattlesnakes of the United States

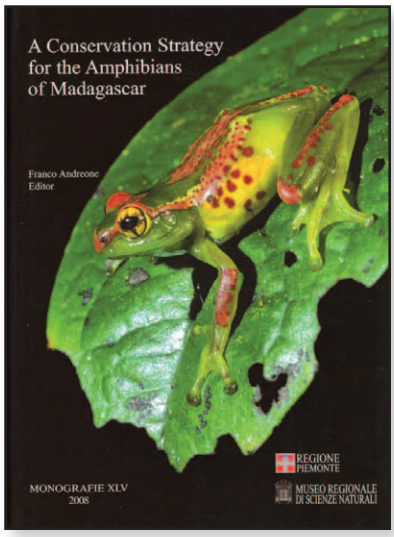
By Brian Hubbs and Brendan O'Connor. 2009. Tricolor Books, Tempe, Arizona (tricolor_books@yahoo.com). 96 pp. Softcover. US $20.00. ISBN 978-0-9754641-2-0.



This slim book is a nice introduction to U.S. species of rattlesnakes for persons who know little about them. General information about rattlesnakes (identification, venom, reproduction, legal protection, etc.) gives readers some necessary background. Brief accounts for 29 of 31 taxa (only subspecies of *Crotalus cerastes* are not accorded their own accounts) include color photographs, generalized range maps, and basic information about size, habitat, common names, and miscellaneous tidbits of interest ("trivia"). Color photographs (101 of them) are distributed throughout, and generally are of excellent quality; some of these depict particularly interesting behaviors (e.g., male combat in *Crotalus willardi*) as well as intraspecific variation. Herpetologists probably won't encounter much new information here, but will likely appreciate the large number of photographs, all of which look to have been taken in the field.

A Conservation Strategy for the Amphibians of Madagascar – Monografie XLV

Edited by Franco Andreone. 2008. Museo Regionale di Scienze Naturali, Torino (anna.grassini@regione.piemonte.it). Hardcover. 449 pp. 50,00 Euro (approximately US $72.00). ISBN 978-88-86041-72-0.

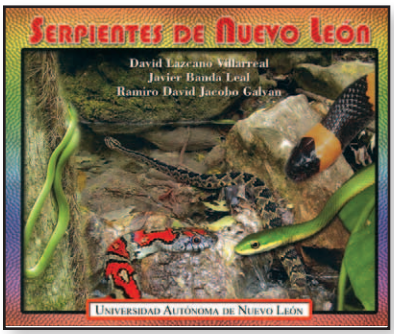


Madagascar is one of the most biotically rich areas of the world and one of the most imperiled. Its frog fauna is diverse and the number of species known continues to grow through the efforts of numerous active research groups working on the island. In addition to an introduction and a guest-authored preface, the book contains 27 chapters. Four of these are in French with English summaries; the rest are in English with French résumés. Many of the chapters are illustrated with color photos of frogs and their habitats, as well as field workers engaged in their research. Well known international herpetologists with established projects in Madagascar, including Miguel Vences, Frank Glaw, Christopher Raxworthy, and the editor, Franco Andreone, figure prominently among the authors, as do many researchers. This volume presents a diversity of topics broadly related to

amphibian conservation in Madagascar, including some taxon-focused contributions (e.g., *Mantidactylus* and *Mantella*) and others that are geographically circumscribed (e.g., the Isalo Massif, Menabe, and Andasibe). Other topics include captive breeding, resource management, global warming, and habitat modeling, and several chapters place the Madagascan situation into the context of the Global Amphibian Assessment. Of particular interest is the paper by Ché Weldon and colleagues that reports the apparent absence of the chytrid fungus *Batrachochytrium dendrobatidis* in Madagascar, a bright spot in a landscape that has seen tremendous declines in amphibian habitats. Chapters by Andreone and Vences et al. place the study of Malagasy frogs into historical perspective, demonstrating increasing trends in the publication of herpetofaunal conservation papers and in the participation of Malagasy researchers as authors. Although the conservation situation for amphibians in Madagascar remains precarious and is in constant flux, this book provides an excellent overview of the status of research, threats, and strategies as they stood at the time of publication. The book will be of value to anyone interested in the Malagasy herpetofauna, as well as to amphibian biologists and conservationists in general.

Serpientes de Nuevo León

By David Lazcano Villarreal, Javier Banda Leal, and Ramiro David Jacobo Galvan. 2010. Universidad Autónoma de Nuevo León, Monterrey, Nuevo León. 502 pp. Softcover. 500 pesos (approx. US $43.00). ISBN 978-607-433-528-6. [In Spanish]



The Mexican state of Nuevo León, home to the country's third largest metropolitan area and second most prosperous city (Monterrey), is situated in the northeastern part of the country in the northern foothills of the Sierra Madre Oriental. It borders the Mexican states of Coahuila, Tamaulipas, Zacatecas, and San Luis Potosí, and shares its northern border with the United States (Texas). The authors divide the state into three principal physiographic associations: Sierra Madre Oriental, Altiplanicie Mexicana (high elevation desert and near-desert regions west of the Sierra Madre), and Planicie Costera del Golfo (low elevation coastal plain). Each of these is further subdivided in an attempt to convey the complexity of this diverse, biotically rich region, and is accompanied by color photographs to illustrate various plant communities. Chapters cover such topics as evolutionary history of reptiles, snakes in captivity and scientific collections, and taxonomy. An illustrated key to the species of snakes in Nuevo León is provided. Individual species accounts (for 61 native and one introduced species) range from 4–8 pages and most are accompanied by good quality color photographs (though not all depict forms occurring in NL), as well as a color map outlining presumed range within the state. As is common with other recent regional works from Mexico, production quality is quite good. This book appears to be targeting a broad audience of amateur naturalists, students, as well as professionals looking for an attractive introduction to the snakes of the Nuevo León. A companion volume on the lizards of Nuevo León is in preparation by Lazcano and colleagues.

Herpetofauna de las Dunas de Viesca y Su Habitat

by J. Gamaliel Castañeda Gaytán, M. Cristina García de la Peña, and David Lazcano Villarreal. 2008. Universidad Autónoma de Nuevo León, Monterrey, Nuevo León. 154 pp. Softcover. 200 pesos (approx. US $17.00). ISBN not provided. [In Spanish]



The sand dunes near Viesca, Coahuila (located about 65 km SE of Torreón) are ecological islands within the broader Chihuahuan Desert landscape in northern México. Of particular interest to herpetologists is that these dunes are home to *Uma exsul* (Coahuila Fringe-toed Lizard), a species endemic to dune areas in southwestern Coahuila. This species is considered endangered because of anthropogenic changes to its fragile ecosystem. Brief and fairly general species accounts are provided for five species of amphibians and 13 reptiles, although the number for reptiles would undoubtedly be higher beyond the immediate environs of the dune areas. Each species account includes one or more color photographs of mostly fair quality. This section takes up less than 40 pages. The remainder of the book is devoted to a brief introduction, often with color photos, of predators and prey, plant species characteristic of the dunes, and habitat examples, concluding with a brief discussion of human impacts and conservation concerns.

ERRATUM

An incorrect address was given for Yehudah Werner ("Herpetology at a biogeographical junction: Research and teaching at the Hebrew University of Jersualem [Israel]", vol. 42, no. 2, pp. 150–159). Dr. Werner's current affiliations are:

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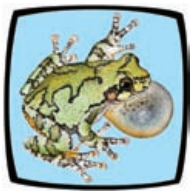
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SOCIETY FOR THE STUDY OF AMPHIBIANS AND REPTILES

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The Society for the Study of Amphibians and Reptiles, the largest international herpetological society, is a not-for-profit organization established to advance research, conservation, and education concerning amphibians and reptiles. Founded in 1958, SSAR is widely recognized today as having the most diverse society-sponsored program of services and publications for herpetologists. Membership is open to anyone with an interest in herpetology—professionals and serious amateurs alike—who wish to join with us to advance the goals of the Society.

All members of the SSAR are entitled to vote by mail ballot for Society officers, which allows overseas members to participate in determining the Society's activities; also, many international members attend the annual meetings and serve on editorial boards and committees.

All members and institutions receive the Society's primary technical publication, the *Journal of Herpetology,* and its news-journal, *Herpetological Review*; both are published four times per year. Members also receive pre-publication discounts on other Society publications, which are advertised in *Herpetological Review.*

To join SSAR or to renew your membership, please visit the secure online ZenScientist website via this link:

http://www.ssarherps.org/pages/membership.php

Future Annual Meetings
2011 — Minneapolis, Minnesota, 6–11 July (with ASIH, HL)
2012 — Vancouver, British Columbia, 8–14 August (with World Congress of Herpetology)
2013 — Albuquerque, New Mexico, dates to be determined

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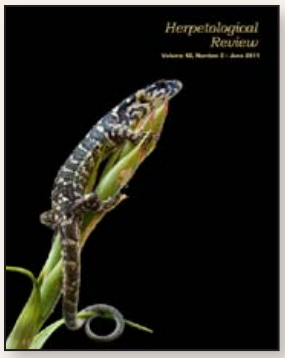
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ABOUT OUR COVER: *ABRONIA FROSTI*



The arboreal alligator lizards of the genus *Abronia* comprise a group of 28 species, ranging from Tamaulipas and Guerrero, Mexico southward to southern Honduras. The group is characterized by high levels of endemism, with many species confined to cloud forest uplands and in some cases known only from their type localities. Small natural ranges combined with rampant deforestation and profoundly inadequate protection measures offer a bleak prognosis for the future—as grimly recounted by Campbell and Frost (1993. Bulletin of the American Museum of Natural History, No. 216, 121 pp.; available online: http://hdl.handle.net/2246/823).

Given the precarious status of many of these forested ecosystems, a number of species of *Abronia* are seriously imperiled. In a recent assessment of the conservation status of Guatemalan herpetofauna, all 10 species of *Abronia* occurring in that country were considered highly vulnerable (Acevedo et al. 2010. *In* L. D. Wilson, J. H. Townsend and J. J. Johnson [eds.], Conservation of Mesoamerican Amphibians and Reptiles, pp. 406–434. Eagle Mountain Publishing, Eagle Mountain, Utah). Two species—*A. campbelli* and *A. frosti*, both Guatemalan endemics—have been considered extinct based on near-complete destruction of habitat at their only known localities (Acevedo et al. 2010, *op. cit*; Campbell and Mendelson 1998. Mesoamericana 3:21–23).

Recently, however, a small population of *A. campbelli* was rediscovered near the type locality in Guatemala (Ariano-Sánchez and Torres-Almazán 2010. Herpetological Review 41:290–292), offering hope that this species can be saved. The remaining habitat had been reduced to about 400 epiphyte-laden oak trees, an essential habitat element for these lizards. On the heels of that exciting news comes another report in this issue of *HR* of the discovery of a single sub-adult *A. frosti* near the type locality, a species not seen since 1996 despite considerable search effort. Daniel Ariano-Sánchez and colleagues (see pages 196–198) detail this important find, describe what remains of the habitat, and offer critical steps to assure this species' survival.

Our cover image, depicting a sub-adult female *Abronia frosti*, was recorded by **Thomas Schrei**. He used a Canon 40D digital camera and Sigma 180mm f3.5 APO Macro DG lens, mounted on a Manfrotto tripod. The image was shot at f16, ISO 400, with ½ second exposure. Considering that this specimen is the only known living individual of its species, special care was taken to avoid stressing the animal. After many failed attempts in which the lizard persisted in moving, it was allowed to climb the inflorescence of a bromeliad where it finally came to rest. The image was shot in studio against a velvet black background using natural light, with some fill light reflected from white cardboard. Schrei is a student and conservationist living in Guatemala City, in his final year toward a degree in biology at the Universidade del Valle de Guatemala. He works for the local NGO Zootropic as the coordinator of the Natural Reserve for the Conservation of the Guatemalan Beaded Lizard (*Heloderma horridum charlesbogerti*) and associated captive breeding program.



PHOTO BY HUGO VILLAVICENCIO

SSAR BUSINESS

Annual Report (2011) Grants-in-Herpetology Committee

An award in the amount of $500 was made to each of the following individuals:

Conservation.—**Anne G. Stengle**, University of Massachusetts, "Genetic Connectivity Within a Metapopulation of Timber Rattlesnakes (*Crotalus horridus*)."

Education.—**Michelle Lester**, Central Washington University, "Fresh Science: Amphibians".

Field Research.— **Michael Habberfield**, State University of New York at Buffalo, "Investigating the influence of pool and landscape features on the spatial patterns of amphibian breeding in a vernal pool complex in central New York."

Laboratory Research.—**Beck A. Wehrle**, California State University-Northridge, "Why Do Lizards Lounge? The role of sociality in exchanging microbial communities among hatchling *Iguana iguana*."

Travel.—**Denita M. Weeks**, California State University-Northridge, "Fundamental Niche Modeling and Implications of Global Climate Change for the World's Southernmost Gecko."

International.—**Kerry L. Holcomb**, Central Washington University, "Body Temperature and Water Regulation Strategies of Mexican Beaded Lizards (*Heloderma horridum horridum)* in a Tropical Deciduous Forest near Chamela, Jalisco, Mexico"

2010 Grants-in-Herpetology Committee.—Chair: Joshua Kapfer. Reviewers: Rebecca Christoffel, Brian Halstead,

Jerry Husak, Lucas Joppa, Richard King, Charles Knapp, Yu Man Lee, Chad Montgomery, Nicola Nelson, Michael Pauers, Robert Powell, Kevin Zippel.

SSAR congratulates the 2011 GIH recipients and thanks the committee members for their efforts.

Herpetology Courses and Graduate Programs: An Appeal

As an aid for students at all levels, SSAR is now compiling for its website a list of all herpetology courses and graduate programs, worldwide. This will be regularly updated. The list will cover all herpetology courses (or vertebrate biology courses having a sizable content on amphibians and reptiles) that are regularly taught at colleges, universities, biological stations, and other academic institutions anywhere in the world, with name of instructor and detailed course information. The availability of masters and/or doctoral degree-granting programs and names of relevant faculty and their contact information will be included.

Those who wish to have their courses and programs listed should send the following information (in this order, please):

1. Country (State or Province)
2. Institution: name and city
3. Department name
4. Course: number, title, frequency (annual or alternate years), undergraduate- and/or graduate-level course
5. Instructor: name and contact address (email if possible)
6. Graduate herpetology program: note if masters and/or doctoral level
7. Faculty involved in program: name and contact address (email if possible)
8. Special notes: limit to 30 words

Send this information to Prof. Kraig Adler at Cornell University (e-mail: kka4@cornell.edu; postal: Mudd Hall, Ithaca, New York 14853–2702, USA). As soon as the list is compiled, a notice will appear in *Herpetological Review* that will indicate how the list may be accessed and updated. Please help to make this list as complete and useful as possible.

MEETINGS

MEETINGS CALENDAR

Meeting announcement information should be sent directly to the Editor (HerpReview@gmail.com) well in advance of the event.

6–11 July 2011—Joint Meeting of Ichthyologists and Herpetologists (ASIH / HL / SSAR), Minneapolis, Minnesota, USA. Information: http://www.dce.k-state.edu/conf/jointmeeting/

17–22 July 2011—IX Congresso Latinoamericano de Herpetologia, Curitiba, Brazil. Information: http://clah2011esp.blogspot.com/

20–23 July 2011—Biology of the Rattlesnakes Symposium, Tucson, Arizona, USA. Information: http://www.williamkhayes.com/rattlesnakes/

27–30 July 2011—34th International Herpetological Symposium, Fort Worth, Texas, USA. Information: http://www.kingsnake.com/ihs/

10–11 August 2011—Annual Meeting of Southwest Partner in Amphibian and Reptile Conservation (SW PARC), Tucson, Arizona, USA. Information: www.swparc.org/meetings.html

15–16 August 2011—Current Research in Sonoran Desert Herpetology V, Tucson, Arizona, USA. Information: www.swparc.org/meetings.html

14–17 August 2011—9th Annual Symposium on the Conservation and Biology of Tortoises and Freshwater Turtles, Orlando, Florida, USA. Information: www.turtlesurvival.org.

17–18 August 2011—12th Annual Meeting of Northeast Partners in Amphibian and Reptile Conservation (NEPARC), Millersville, Maryland, USA. Information: http://www.pwrc.usgs.gov/neparc/

25–29 September 2011—Joint 16th SEH European Congress of Herpetology & 47th DGHT Deutscher Herpetologentag (annual meeting of the German Society for Herpetology and Herpetoculture, scientific part), Luxembourg. Information: http://www.symposium.lu/herpetology

30 September–2 October 2011—47th DGHT-Nachzuchttagung (annual meeting of the German Society for Herpetology and Herpetoculture, herpetocultural part), Trier, Germany.

8–14 August 2012—World Congress of Herpetology 7, Vancouver, British Columbia, Canada (together with SSAR, HL, ASIH). Information: http://www.worldcongressofherpetology.org/

2–7 September 2012—4th International Zoological Congress (IZC), Mount Carmel Campus, University of Haifa, Haifa, Israel. To receive the first and subsequent meeting announcements, contact the organizers at: izc2012@sci.haifa.ac.il.

NEWSNOTES

Roncadell Digital Library

Roncadell—a conservation organization based in Valencia, Spain—has established a digital library containing a number of important herpetological works long out of print, as well as a few modern titles. To view the catalogue and to download digital files, please visit their website at:

http://roncadell.jimdo.com/biblioteca-digital/llibres-antics/herpetologia-i-peixos/

Herpetological Reunion at Louisiana State University, Baton Rouge

Several former graduate students and friends of Dr. Douglas A. Rossman gathered with Doug and his spouse Sharon for a second reunion at the LSU campus from 2–6 April 2011. Present at the celebration were Doug's former students Janalee P. Caldwell, Donald E. Hahn, Jeff Boundy, Kenneth L. Williams, and Larry David Wilson. Guests included Laurie J. Vitt and Viola Williams. Robert A. Thomas from Loyola University joined "Rossman's Renegades" to recount tales from USL (now University of Louisiana at Lafayette). Former students unable to join the reunion, but remembered, were Frank T. Burbrink, Darrel R. Frost, Richard M. Blaney, Patricia K. Blaney, and Edmund D. Keiser. Also remembered were three colleagues now deceased: Ernest A. Liner, Gerald C. Schaefer, and Alexander Varkey.

Apart from enjoying the local world-class Cajun cuisine, the attendees reminisced with one another, admittedly with some embellishments. In addition, Christopher Austin provided a tour through the LSU Museum of Science herpetological range; thanks are due him for making arrangements for our visit. The highlight of the gathering was Doug's recounting of his move to Iowa and his activities in both herpetology and Norwegian mythology since his retirement. Long a passion of Doug's, his work in Norwegian mythology has resulted in the publication of five books since his retirement.



PHOTO BY PHOTO BY L. J. VITT

Doug Rossman and former grad students at recent LSU herp reunion. L–R: Ken Williams, Jan Caldwell, Doug, Don Hahn, Larry Wilson, and Jeff Boundy.

Jan and Laurie made a presentation on their work in Brazil and Don showed slides (yes, slides) of his early trips to Honduras, including to the Bay Islands with Larry and his then new wife Elizabeth. Later, at one of the dinners, Don was a hit with an impromptu comedy and magic show.

This reunion was the second get-together. The first took place in 1998 at LSU in connection with Doug's retirement from the institution. That gathering was a bit more formal and was emceed by Larry. Each of Doug's students rose to tell his or her story since graduation, again salted with appropriate embellishments. We all are looking forward to the next reunion in 2024.

Journal of Natural History Education and Experience

The *Journal of Natural History Education and Experience*, a publication of the Natural History Network, is an electronic, peer-reviewed, open-access journal. Its purpose is to foster a renaissance in natural history education and appreciation by providing a forum for disseminating information on views on the place of natural history in society and techniques, curricula, and pedagogy for natural history education at all levels: K–12, undergraduate, graduate, and general public.
Recent articles include:

- Rewilding Natural History (Peter Kahn and Patricia Hasbach)
- Revitalizing Natural History Education by Design (M. Kolan and W. Poleman)
- Natural History from the Ground Up: developing a college-level natural history program in the new millennium (D. Gilligan)
- A Bird in the Hand: A placed-based, hands-on curriculum in ornithology (S. Trombulak)
- Teaching Natural History and the Spirit of Place (F. Taylor and J. Tallmadge)

The Natural History Network (naturalhistorynetwork.org) is an affiliation of teachers, scientists, and nature writers who seek to promote the values of natural history through discussion and dissemination of ideas and techniques on its successful practice to educators, scientists, naturalists, artists, writers, the media, and the public at large.

The journal seeks papers that provide perspectives on natural history as a mode of engagement with the world as well as information that will promote the development of natural history curricula and are generally accessible to natural history educators. Content of the journal ranges from the applied to the philosophical, but entirely focused on the principles or practice of natural history education and experience.

Educators and practitioners who have perspectives or successful curricula that they would like to share are especially encouraged to submit articles for publication.

For more information, visit www.jnhe.org or write to Steve Trombulak, editor of the *Journal of Natural History Education and Experience*, at trombulak@middlebury.edu.

CURRENT RESEARCH

The purpose of Current Research is to present brief summaries and citations for selected papers from journals other than those published by the American Society of Ichthyologists and Herpetologists, The Herpetologists' League, and the Society for the Study of Amphibians and Reptiles. Limited space prohibits comprehensive coverage of the literature, but an effort will be made to cover a variety of taxa and topics. To ensure that the coverage is as broad and current as possible, authors are invited to send reprints to the Current Research section editors, Joshua Hale or Ben Lowe; e-mail addresses may be found on the inside front cover.

A listing of current contents of various herpetological journals and other publications is available online. Go to: http://www.herplit.com and click on "Current Herpetological Contents."

Intercontinental Dispersal in a Fossorial Reptile

Intercontinental dispersal has been a feature of the biogeographic history of many animals, either by passage across land bridges, or by long-distance oceanic rafting. The family Dibamidae consists of burrowing, essentially limbless lizards and has traditionally been split into two geographically disjunct clades: *Anelytropsis*, a monotypic genus with a restricted distribution in northeastern Mexico, and *Dibamus*, containing approximately 20 species occurring in southeast Asia. In this study, the authors collected molecular data (one mitochondrial and six nuclear genes) for nine dibamid species including *Anelytropsis* and used Bayesian methods to reconstruct a phylogeny and to estimate divergence times among the dibamid lizards. These analyses recover three deeply divergent but morphologically conserved clades: mainland and insular *Dibamus* clades and an *Anelytropsis* clade. Furthermore, all analyses find *Anelytropsis* to be the sister of one of the two *Dibamus* clades (to which clade analyses fail to distinguish with confidence). The dating analysis places the origin of these three lineages to between 90 and 49 million years ago. Therefore, if the intercontinental dispersal which must have occurred to lead to this disjunct distribution occurred by way of a land bridge, it most likely occurred across Beringia in the late Palaeocene or Eocene. Alternatively, oceanic-rafting across the Pacific remains a possible explanation. Additionally, the discovery of the deep genetic divide separating *Dibamus* is surprising, and given the tremendous similarity between species in both clades, constitutes a remarkable example of morphological conservatism.

Townsend, T. M., D. H. Leavitt and T. W. Reeder. 2011. Intercontinental dispersal by a microendemic burrowing reptile (Dibamidae). Proceedings of the Royal Society of London, Series B (*in press*). doi: 10.1098/rspb.2010.2598.

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Impact of Overwintering Conditions on *Bd* Infection and Mortality in Toads

As host/pathogen dynamics can be severely impacted by temperature variations, factors such as global warming are predicted to influence future patterns of disease. Despite this potential, few studies have experimentally tested the effects of changing temperature on host/pathogen interactions. In this study, the authors have experimentally tested the effect of overwintering temperature on susceptibility of common toads, *Bufo bufo*, to infection and mortality caused by the amphibian pathogen *Batrachochytrium dendrobatidis* (*Bd*). Two groups of newly metamorphosed toadlets were subjected to one of two overwintering treatments. The first saw toads held at 8°C for 36 days, 4°C for 11 days followed by 8°C for a further 36 days. The other group was held at 8°C for 16 days, 4°C for 51 days followed by 8°C for a further 16 days. Following overwintering (and a 16 day recovery period), animals from both treatments were either infected by a high dose of *Bd*, a low dose or a control treatment. Infection status was then determined. Toads from the warmer overwintering regime suffered a greater chance of infection, however once established, the proliferation of *Bd* was higher in toads from the colder overwintering treatment. There was no difference between treatments in survival, or in any consistent influence of disease on survival for that matter. Instead, condition, mass and mass lost over winter was the best predictor of toadlet survival, which led the authors to conclude that larval growth is a more important to survival of toadlets than overwintering conditions or *Bd* infection rate.

Garner, T. W. J., J. M. Rowcliffe, and M. C. Fisher. 2011. Climate change, chytridiomycosis or condition: an experimental test of amphibian survival. Global Change Biology 17: 667–675.

Correspondence to: **TRENTON GARNER**, Institute of Zoology, Zoological Society of London, Regent's Park, NW14RY, London, UK; e-mail: trent.garner@ioz.ac.uk

Evolution of a Cryptic Species Complex in Northern Australia

Cryptic speciation is the process whereby lineages separate and accumulate genetic differences without concurrent morphological divergence. This phenomenon provides an interesting opportunity to investigate morphological stasis and determine if phenotypic stability is a consequence of either adaptive or non-adaptive processes. In this study, the authors have examined a pair of sister species occurring in northern Australia: the agamid lizards *Diporiphora magna* and *D. bilineata*. A phylogenetic analysis based on one mitochondrial gene (ND2) and a nuclear gene (RAG1) revealed eight deeply divergent and geographically discrete clades. No consistent morphological differences were observed between the clades, confirming this system's status as a cryptic species complex. Morphological and ecological data was collected, analyzed in principal component analyses, and compared with phylogenetic data to determine whether evolution in these characters fit models of neutral drift (Brownian motion) or constrained or correlated evolution. These phylogenetic comparative methods favored a model of constrained evolution, suggesting adaptive processes are important in maintaining morphological similarity among clades. The authors suggest that the homogenous habitat structure, but highly variable environmental conditions has promoted morphological stability in these species. This study highlights the potential for adaptive processes to maintain morphological stasis and that dynamic environments may select for cryptic species.

Smith, K. L., L. J. Harmon, L. P. Shoo and J. Melville. 2011. Evidence of constrained phenotypic evolution in a cryptic species complex of agamid lizards. Evolution (*in press*). doi:10.1111/j.1558-5646.2010.01211.x.

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Behavioral Alleviation of the Costs of Reproduction in *Anolis* Lizards

The costs of reproduction for a female can be alleviated by modification of behaviors during reproductive periods. In this study, the authors examined these behavioral modifications in green anole lizards, *Anolis carolinensis*. The effect of reproductive load on three behaviors (locomotion, social displays and foraging) was examined. Observations were made of female lizards in the field and then focal individuals were captured and their reproductive load was determined (by measuring the total amount of reproductive tissue: eggs, follicles and oviducts). Locomotion and social display behavior both declined with reproductive load, however no effect of reproductive load on foraging behavior was detected. In the second part of the study, the authors conducted analyses to determine if these behaviors and reproductive loads were phylogenetically correlated across eight additional *Anolis* species. No associations were found between the evolution of reproductive load and any of the behaviors, and may represent varying life history strategies or selective ecological pressures across *Anolis* species instead.

Johnson, M. A., J. L. Caton, R. E. Cohen, J. R. Vandecar, and J. Wade. 2010. The burden of motherhood: the effect of reproductive load on female lizard locomotor, foraging and social behavior. Ethology 116: 1217–1225.

Correspondence to: **MICHELE JOHNSON**, Department of Biology, Trinity University, San Antonio, Texas 781212, USA; e-mail: michele.johnson@trinity.edu

Ageing and Fitness Correlates Determined in a Wild Population of Lizards

Ageing can have complex and interrelated impacts on a range of fitness traits, and therefore, it is essential that it is accounted for in studies investigating potentially age-related variation. Despite this, due to the complex nature of identifying age components of variation, especially in wild populations, they are rare. In this study, the authors have taken a comparative approach to investigation ageing in a wild population on the common lizard, *Lacerta* (*Zootoca*) *vivipara*, in southern France. Five fitness components were examined and three physiological traits (resting metabolic rate, corticosterone level, cell-mediated immunity). Age-related variation was discovered in multiple fitness aspects, including senescence in female reproduction, measured by litter success. Further, old females had a higher metabolic rate and T cell-mediated immune response compared to young females. Interestingly, only females that had a high investment in reproduction when young, displayed senescence later in life. This trade-off is expected theoretically but is rarely observed in the wild. Some of the effects of ageing were also related to differences in environment and individual characteristics. This study highlights the importance of taking an integrative approach to studies of ageing, as it is a complex and interrelated process, potentially involving a range of fitness traits.

Massot, M., J. Clobert, L. Montes-Poloni, C. Haussy, J. Cubo, and S. Meylan. 2011. An integrative study of ageing in a wild population of common lizards. Functional Ecology (*in press*). doi: 10.1111/ji.1365-2435.2011.01837.x.

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Impact of Environmental Conditions on Predator Responses in Tadpoles

Behavioral plasticity is a valuable capability, especially in unpredictable environments. However, an organism's ability to behaviorally respond to one environmental factor may be constrained by another, seemingly unrelated environmental factor. For frogs, a well-studied phenotypically plastic response relates to hatch timing. Embryos have been demonstrated to hatch in response to predators, certain abiotic conditions and changes in resource availability. In this study, the authors have examined the impact of environmental conditions on hatch timing in the neotropical treefrog, *Dendropsophus ebraccatus*. This frog lays eggs both above the water (attached to leaves) and directly in the water, exposing these eggs to different desiccation risks. The impact of desiccation on predator-induced hatching and escape success from two predators (terrestrial *Azteca* ants and aquatic tadpoles) was investigated. In response to both predators, eggs hatched prematurely (up to 67% earlier than unpredated clutches). however, when exposed to desiccating conditions, egg clutches subjected to attacks from the *Azteca* ants suffered lower predator escape success than those from hydrated clutches of either predator treatment. Indeed, desiccated eggs recently placed in the water showed no difference in early hatching success relative to eggs eggs having been submerged in water long term. The reduction in predator escape from desiccated clutches probably impacts recruitment in wild populations, and highlights the importance of other environmental factors in mediating phenotypically plastic responses.

Touchon, J. C., J. Urbina and K. M. Warkentin. 2011. Habitat-specific constraints on induced hatching in a treefrog with reproductive mode plasticity. Behavioral Ecology (*in press*) doi: 10.1093/beheco/arq192.

Correspondence to: **JUSTIN TOUCHON**, Department of Biology, Boston University, Boston Massachusetts 02215, USA; e-mail: jtouchon@bu.edu

Impact of Agricultural Land Use on Stream Dwelling Turtles

Anthropogenic modifications to riparian habitat can have serious consequences for stream dwelling organisms. In this study, the authors examined whether the diversity and abundance of freshwater turtles differed between agricultural riparian zones, and those that had been undisturbed or restored. This study was conducted in the Lower Flint River Basin (LFRB) in south-west Georgia, USA, which possess a high diversity of freshwater turtles. In total, nine species were encountered, from two streams within the LFRB. Diversity (species evenness) was positively correlated with the amount of undisturbed landcover in the riparian habitat. However, associations between riparian habitat and abundance differed between species. For some species, abundance increased in less-forested, more disturbed sections of stream, but for the state-protected and endemic *Graptemys barbouri* (Emydidae), abundance was lowest in disturbed riparian zones. The impacts of agriculture on species diversity could relate to the availability of prey species in these stream sections which are sensitive to runoff. This study indicates physical alterations such as increased sedimentation or a reduction in nesting sites may reduce the number of species that can be supported in a stretch of stream.

Sterrett, S. C., L. L. Smith, S. W. Golladay, S. H. Schweitzer and J. C. Maerz. 2011. The conservation implications of riparian land use on river turtles. Animal Conservation 13:38–46.

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Artificial Water Points Assist Cane Toads in Invading Arid Zones

In many cases, biological invasions occur from "invasion hubs," satellite populations that once established, facilitate expansion. By concentrating management effort on these invasion hubs, the spread of invasive species may be contained. While there is good theoretical support for this management strategy, it has rarely been practically demonstrated. Artificial water points (AWP) have been installed by humans throughout arid landscapes, increasing the availability of standing water. The increase in AWP has potentially opened up many otherwise inhospitable landscapes to colonization by invasive species. In this study, the authors have examined the importance of AWP in the invasion of northern Australia by the Cane Toad, *Bufo marinus*. They experimentally excluded toads from some AWP with fencing and by hand-counting the toads trapped within the fences and comparing toad abundance in areas with and without access to AWP, they demonstrated that AWP do provide dry season refuges for the toads as well as provide a resource subsidy. The authors suggest that AWP operate as invasion hubs for cane toads in arid Australia. The authors also modelled the impact of excluding toads from AWP throughout arid Australia, and predicted that this would reduce the area across which toads could colonize by 38%. This study highlights the importance of anthropogenic landscape modification in the spread of invasive species and illustrates the potential for controlling the spread of these species through cordoning off invasion hubs.

Florance, D., J. K. Webb, T. Dempster, M. R. Kearney, A. Worthing, and M. Letnic. 2011. Excluding access to invasion hubs can contain the spread of an invasive vertebrate. Proceedings of the Royal Society of London, Series B (*in press*). doi:10.1098/rspb.2011.0032.

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Logging Activity Does Not Impact Behavior of Timber Rattlesnakes

Forest management activities have the potential to profoundly alter the landscape, and as a consequence, may have serious impacts on the animals that live in these landscapes. For this study, the authors have examined the impact of commercial logging on the behavior of Timber Rattlesnakes (Viperidae: *Crotalus horridus*) in Pennsylvania, USA. Over a four-year period, behavior was examined using radiotelemetry, mark-recapture and visual surveys in areas both prior to and following logging. Direct observations of mortality during logging was low (observed mortalities represented less than 2% of the population per year), as were rates estimated from the mark-recapture data (less than 7%). Following logging, snakes maintained their previous ranges, and actually increased the divesity of utilized habitats to include sites in logged areas. Indeed, contrary to the concern that gravid females might suffer disproportionate mortality, the authors posit that their preference for areas with favorable thermoregulatory opportunities kept them out of the logging areas until operations were completed.. The authors propose that the most significant cause of mortality was direct killing by loggers, and suggest that to reduce the impacts of logging on rattlesnakes, workers in this region should be prohibited from killing encountered snakes.

Reinert, H. K., W. F. Munroe, C. E. Brennan, M. N. Rach, S. Pelesky, and L. M. Bushar. 2011. Response of timber rattlesnakes to commercial logging operations. Journal of Wildlife Management 75:19–29.

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African Geckos, Coalescent-based Species Delimitation Methods, and the ICZN

As methods for acquiring diverse DNA sequence data continue to accumulate, methods for analyzing these data are also improving. For a while now, researchers have had the ability to evaluate hypotheses of speciation using data from across the genome, rather than relying on single molecular markers or detectable morphological differentiation. More recently, advanced methods for extracting the underlying "species tree" from a suite of potentially discordant "gene trees" have opened the door for more rigorous tests of speciation. The authors of a recent study[1] investigated species limits in a clade of West African geckos (Gekkonidae: *Hemidactylus fasciatus* complex) using one of these new methods: Bayesian species delimitation (BSD). This method exploits the genealogical information inherent in DNA sequence data to evaluate hypotheses of species limits under expectations derived from coalescent theory. Using sequence data from five nuclear DNA genes from samples collected across the distribution of *H. fasciatus*, the authors conducted a genotype clustering analysis to identify genetic populations and constructed a species tree for these populations using the sequence data. Subsequently, they conducted an analysis which utilized coalescent theory to simulate gene trees based on the sequence data; these simulated trees were used to differentiate between ancestral polymorphisms and post-divergence gene flow (the latter being viewed as evidence against speciation). The structuring analysis identified four genetic groupings and the BSD analysis found strong support for all four groups being genetically independent and therefore distinct species. The same analysis conducted with the hypothesis of each population being a separate species found the same results with the exception of an insular locality representing a fifth species. The authors describe these four lineages as species, citing clustering with the respective holotype in their BSD model as the species diagnoses.

Several researchers subsequently published a commentary[2], taking exception to the use of model-based clustering analyses to describe new species and indicating that these analyses should be accompanied by explicit, character-based diagnoses (which could include molecular characters). While conceding that the focus on characters may be artificial, they argue that species descriptions lacking diagnostic characters are in strict violation of the International Code of Zoological Nomenclature (ICZN) and could lead to taxonomic inflation (a precipitous rise in "superficial" species descriptions that could ultimately undermine conservation efforts). Finally, they contend species delimitation should incorporate data from multiple, independent categories and species descriptions based solely on clustering in an analysis performed under a particular model should be avoided.

The authors of the original article responded in an invited reply[3] by addressing the claim of taxonomic inflation and the validity of solely using BSD to identify species. They argue that BSD simultaneously incorporates multiple, independent lines of evidence and is therefore less prone to taxonomic inflation than methods relying on a single character, such as a single-locus gene tree (as under the Phylogenetic Species Concept). Furthermore, they maintain that coalescence of independent genes across the genome is a more intrinsic feature of speciation than either the acquisition of unique morphological characters or single-gene reciprocal monophyly, making BSD a superior tool in the effort to rigorously identify species. Finally, they indicate that more detailed and ICZN-compliant descriptions of the species identified in their study are forthcoming.

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[2]Bauer, A. M., J. F. Parham, R. M. Brown, B. L. Stuart, L. Grismer, T. J. Papenfuss, W. Böhme, J. M. Savage, S. Carranza, J. L. Grismer, P. Wagner, A. Schmitz, N. B. Ananjeva and R. F. Inger. 2011. Availability of new Bayesian-delimited gecko names and the importance of character-based species descriptions. Proceedings of the Royal Society of London, Series B 278:490–492.
[3]Fujita, M. K., and A. D. Leaché. 2011. A coalescent perspective on delimiting and naming species: a reply to Bauer *et al.* Proceedings of the Royal Society of London, Series B 278:493–495.

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ZOO VIEW

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The Snake Handles

The Reptile House at The National Zoological Park in Washington DC is a splendid example of "Associationist" zoo design: exotic style used to enhance the spectacle of zoo going. The ten panels on the original entrance doors alternately display a lumbering *Stegosaurus* and battling yin-yang *Protoceratops* (Fig. 1, left). The panels are of gesso (a preparation of plaster of Paris, glue, and sometimes horsehair). Each of the four doors to the Reptile House held a bronze door pull which consisted of a ring formed by two intertwined serpents. It is generally assumed that John Joseph Earley was the artist connected with the design and execution of these handles, although where they would have been cast is not known.

In spirit, if not actual design, they are reminiscent of the staff of Mercury. These serpents are entwined, rather than opposing as on the caduceus. In Chinese mythology, the world was surrounded by two entwined snakes, symbolizing the power and wisdom of the creator.

In its original configuration, the art went beyond merely visual and into the tactile—one had to pull on the snake handle to open the doors. Therefore, most visitors would have had to place their hand on a reptile before entering the building. In 1980 the Reptile House was renovated and the entrance doors were refurbished and placed inside the building to the entrance of what was called HerpLab (now known as Resource Room). The original handles were replaced in 2005 with replicas cast through the lost wax process at a local foundry (Fig. 1, right).

A photograph of the original entrance door and herpetological history of the Zoo may be seen in Murphy and Xanten (2007). (Herpetol. Rev. 38:262–373).

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Murphy, J. B., and W. A. Xanten. 2007. Seventy-five years of herpetology at the Smithsonian's National Zoological Park: The facilities, collection, people, and programs. Herpetol. Rev. 38:262–273.

Editor's note.—Béla Demeter was a research biologist in the Department of Herpetology at National Zoological Park for many years until retirement. He now is a volunteer interpreter at the National Gallery of Art in Washington.



Fig. 1. **(left)** Battling *Protoceratops* on entrance door of Reptile Building at Smithsonian National Zoological Park in Washington DC. Photograph by Mehgan Murphy, Smithsonian National Zoological Park. **(right)** Replica of entwined snake handles on entrance door of Reptile Building at Smithsonian National Zoological Park in Washington DC. Photograph by Mehgan Murphy, Smithsonian National Zoological Park.

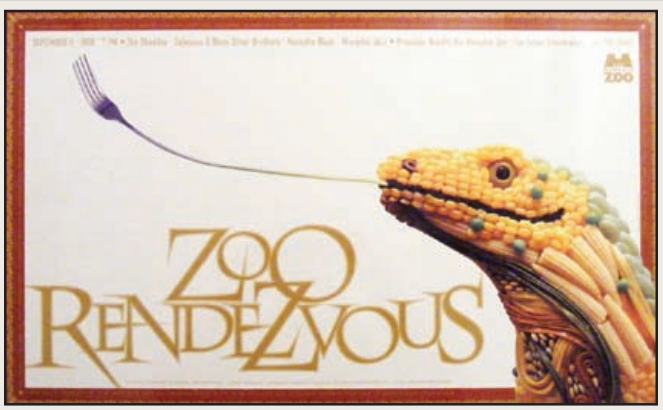
Snake Crushes Bus

The Copenhagen Zoo in Denmark has designed one of the most intriguing advertising campaigns: a Boa Constrictor constricting a city bus. Notice how cleverly they altered the apparent roof of the bus. The advertising agency was Bates Y & R in Copenhagen, Creative Director was Ib Borup, and Art Director was Peder Schack. Thanks to Britta Benzer Ankersen, Michael Jorgensen, and Gerard Visser for providing this image.



Jolly Green Giant

Curator of Herpetology Steve Reichling and Graphic Designer Tonya Kuhl, both of the Memphis Zoo in Tennessee, sent this poster of a vegetative Komodo Dragon for an event held at the Zoo in 1998. The format was developed by the company Good Advertising.



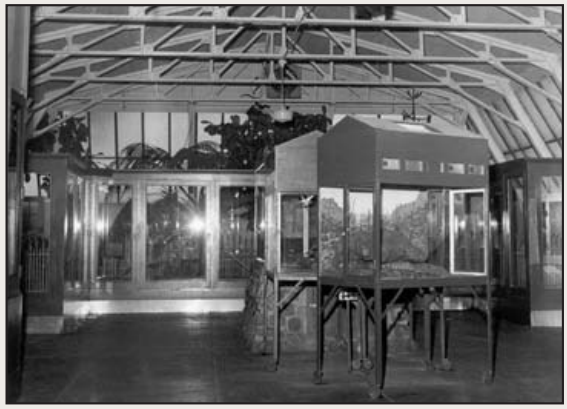
Reptile Buildings During the Great Depression in the 1930s

"But should snakes get any money at all? They are not the fuzzy, feel-good animals that one might have imagined would have received taxpayer money at a time when many Americans were going hungry." This was a question asked by Mrs. Charles J. Dolan in her editorial to a St. Louis newspaper: "What are the St. Louisans thinking of to let the gentlemen of the Zoo Board go ahead without protest with their amazing proposal to squander $100,000 of the taxpayers' money on a climax of absurdities —and worse—a chamber of horrors that nobody wants—a snake house."

—Jesse C. Donahue and Erik K. Trump, 2010







(**top**) Entrance to reptile building at Smithsonian Institution's National Zoological Park, opened in 1931 and still in operation. Credit: photograph by Jessie Cohen, Smithsonian National Zoological Park. (**center**) Postcard of St. Louis Zoological Park's reptile house in 1944, still in operation, which is one of the most beautiful facilities ever built for reptiles and amphibians. Credit: provided by Brint Spencer. (**bottom**) Exhibits in old reptile display at Philadelphia Zoo during the 1930s. Credit: undated photograph by Franklin Williamson, courtesy of Zoological Society of Philadelphia, provided by Brint Spencer.



Postcard of original Reptile House, now bird house, at Cincinnati Zoological and Botanical Gardens. Credit: provided by Brint Spencer.

In their book *American Zoos During the Depression. A New Deal for Animals* (2010, McFarland & Co., Jefferson, North Carolina; ISBN: 978-0-7864-4963-7), authors Donahue and Trump follow the amazing growth of zoo construction in the United States supported by federal programs. In Chapter 4, "Why snakes? The spectacle and science of snakes," they document the design and development of many reptile buildings that occurred during the 1930s. Some of the most spectacular zoo buildings were built or improved at that time: National (Washington, DC), Toledo, St. Louis, Brookfield, Cincinnati, San Antonio, San Diego, Buffalo, and Philadelphia. As a testament to their durability and beauty, some still are operational today.

It may surprise the reader, but the production of antivenin in North America during this period was supported in large part by zoo herpetologists, who provided venom to the manufacturers, raised public awareness about snakebite treatment, and distributed antivenin.

JAMES B. MURPHY, *Section Editor*

RESPONSES TO JOE MENDELSON'S ESSAY

In the last issue of *HR*, Joe Mendelson from Zoo Atlanta authored a thought-provoking essay on what it means to be an amphibian biologist today. His piece elicited many responses and has generated much discussion. In this issue, we are pleased to offer four companion essays from Kraig Adler, Harry Greene, Michael Lannoo, and Larry David Wilson. The focal species of Mendelson's essay, *Ecnomiohyla rabborum* (Rabb's Fringe-limbed Treefrog, now reduced to two living individuals, both male), is shown here with George B. Rabb. The frog was named in honor of herpetologists and conservationists George and Mary Rabb.

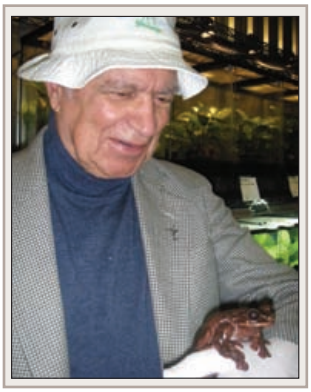


PHOTO BY LARA T. LONG

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No White Flags!

Joe Mendelson's essay provides heart-breaking affirmation of the state of the planet: even with the best efforts humanity can muster, we will lose a lot of existing biological diversity before this crisis bottoms out. Other commentators have stated that Polar Bears and Tigers are already toast, too far gone to save in the wild—can you imagine conceiving of that possibility when we were kids, that the largest mammalian carnivores on Earth would come so close to extinction in our lifetimes? Equally disturbing are a variety of looming threats—as just unstudied one example, what if

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PHOTO BY CYNTHIA PRADO

Harry Greene examining a Bolson Tortoise (*Gopherus flavomarginatus*), among a group of about two dozen that have been restored to their late Pleistocene range in New Mexico.

some critical factor changed just enough that dinoflagellates and diatoms, which provide much of our oxygen, crashed as suddenly and mysteriously as the Golden Toad? And in the face of this overall situation, conservationists and environmentalists are too frequently acting as if business as usual is sufficient, or at least all that we can hope to accomplish.

Can we find reasons for hope? Well, the undergraduates I teach are bright, talented, hard working, and idealistic—maybe they can pull off what we've thus far failed to accomplish, and I surely hope so. What else? Thanks to the Pleistocene rewilding initiative and Ted Turner's Endangered Species Foundation, Bolson Tortoises have a toehold back in New Mexico (Donlan et al. 2006; Truett and Phillips 2009) and thus TWO latitudinally disparate populations with which to face climate change. We have folks like Joe Mendelson attempting other bold, risky endeavors in the face of withering criticism from some of his peers. And there's the cowboy I met a few years back in a bar near the Pecos River, who when asked if he'd shot a big Indigo Snake, replied, "Hell no, why would we do that? Our boss won't even let us kill those ol Diamondbacks anymore, except right around the foreman's house, cause he's got kids and all."

Perhaps there's still room for optimism, and our rallying cry should be "no white flags!"

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Amphibian Extinction Crisis: The Key Threat of Habitat Loss and a Potential Major Role for Amateurs

I love amphibians. I once said that to one of my molecular biology colleagues at Cornell, who looked at me like I was totally crazy. The readers of *Herpetological Review* will know what I meant. Like many of them, I became fascinated with frogs and salamanders when I was a boy. Much later, amphibians became my primary study animals for behavioral research as well as some systematics and faunal work. Long ago I came to have a deep respect for the ways in which they make their livings and for their dazzling diversity and aesthetic beauty. Thus, Joe Mendelson's article in the March issue came as a real jolt—although not an altogether unexpected one, unfortunately. The world that he, Mike Lannoo, Karen Lips, Kevin Zippel, and my other young colleagues live in is far different from the one that those of my generation have enjoyed. While the chytrid fungus is the current plague, an even more insidious one is the loss of habitat—one pond here, a forest patch there, or a stretch of stream or riverbank. And this scourge is happening in the USA and in Europe as much as it is in the tropics. Joe's depressing observations have caused me to reflect on my own experiences with amphibians, the impacts that we have had on them, and their future prospects for survival.

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PHOTO BY DOLORES ADLER

Kraig Adler on a field trip in Ithaca, New York, with plastic box of salamanders, April 2011.

As high school students in Ohio in the 1950s, David Dennis, who became a natural history artist and photographer, was my constant field companion. We first explored Ohio for herps, then West Virginia, and finally worked our way south to Kentucky, Virginia, and North Carolina by the time we were in college in the early 1960s. Thus, we came to know many of the localities immortalized by E. R. Dunn, the first plethodontid expert: Grandfather Mountain, White Top, and Clingman's Dome; the French Broad River; and Yonahlossee Road (not the current road by that name). Dave and I have also enjoyed the Nantahala Mountains, Tusquitee Bald, Burke's Garden, and Bat Cave, among many other places. It was just east of Boone, North Carolina, late one night about 1960, that we saw our first Yonahlossee Salamander (*Plethodon yonahlossee*) (Fig. 1). I can still vividly remember Dave, Steve Tilley, another regular field companion, and me yipping and yelling at seeing that most handsome of salamanders. (Of course, we didn't yet have it in our hands, and that can be a real challenge.) In those days, we could stop at outcrops along the road or in ravines below bridges and find salamanders in large numbers almost anywhere we looked, especially if it was after nightfall.

PHOTO BY DAVID DENNIS



COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND

FIG. 1. *Plethodon yonahlossee* (Yonahlossee Salamander) during courtship in the field.

In August 1976, Dave and I led a three-car caravan after the SSAR meeting in Oxford, Ohio, for three days of salamandering in the Southern Appalachians. We saw and photographed 26 species (and those were the days before Dick Highton and Steve Tilley described a plethora of new plethodons and desmogs from that region). Tim Halliday, the British herpetologist and future amphibian conservationist who was visiting the USA for the first time, was part of our group. (He has only three species of salamanders in his country, all of them newts.) Late one night at Old Yonahlosee Road, along the foot of Grandfather Mountain near Linville, North Carolina, we observed literally hundreds of salamanders. Conditions were perfect: it was breeding season, warm, and a very light rain was falling. We saw eight species of *Desmognathus*, *Eurycea*, *Gyrinophilus*, and *Plethodon* in our headlamp beams. All were crawling about and many of them even high into the vegetation to feed. Several were courting including the Yonahlossees. Tim got a bit giddy. It was truly a Homeric scene!

Over the years, I have taken small groups of Cornell students to the Southern Appalachians for salamanders. To see a Cave (*Eurycea lucifuga*), a Red (*Pseudotriton ruber*), or a Green (*Aneides aeneus*) salamander for the first time is unforgettable. They make an impression on a student. By the 1980s, however, my favorite haunts were being converted to gated retirement communities, parking lots, and golf courses, even near Linville and the Yonahlossee Road itself. For me, one of the most telling experiences was at a meadow stream a few km south of Boone along Route 105 towards Linville, just behind the Lebanon Baptist Church. That was always the best place to reliably find the Long-Tailed Salamander (*Eurycea longicauda*; Fig. 2). They were very active in the tall grass along the edge of Willow Brook, making them tough to collect without damaging that magnificent tail. These animals were abundant there for decades until the early 1990s when, after only a two-year hiatus between our visits, we returned to find the area had been completely developed for upscale housing. I thought we must have taken a wrong turn, so went back to a landmark (the church) and tried again, only to find that the stream as I knew it was gone, and so too were those beautiful salamanders.

Dave Dennis and I once witnessed a local extinction. In 1961, we visited the type locality of the tiny Seepage Salamander (*Desmognathus aeneus*) together with Jesse C. Nicholls, Jr. In 1946, he had collected the types for Sherman C. Bishop, a specialist on salamanders who later wrote the standard handbook on the topic. When we arrived at the wooded, sphagnum-covered site, along a small tributary of Peachtree Creek about 5 km east of Murphy, North Carolina, bulldozers were clearing the area. When the operators took their lunch break, the three of us rushed in to search for salamanders. We eventually collected about 50 of them (Fig. 3). (These topotypes are now at the Carnegie Museum in Pittsburgh.) After lunch ended, the bulldozers started up again and cleared the rest of the site of all of its trees. The type locality is now in cultivation and unsuitable habitat for salamanders. It was depressing to watch the total destruction of an ideal habitat for this patchily distributed and uncommon species.

Overzealous scientific collecting is sometimes to blame for severe habitat destruction. In 1964, I visited the Sierra Madre del Sur of southern Mexico and along a stream at 1070 m on the southwestern slopes of Cerro Teotepec in Guerrero I found an odd hylid frog that I could not identify (Fig. 4). A few weeks later, our party of three encountered a much larger one composed of an American professor and his students. In my enthusiasm, I showed the professor my frogs, which he did not recognize either, and I stupidly noted where they were found. As luck would have it, our party revisited the Teotepec site a couple of weeks later and found it ravaged. Most of the emergent vegetation was uprooted and nearly all of the arboreal bromeliads had been dropped to the ground and dismembered. I half suspected what had happened and this was confirmed when, a month later in Oaxaca, we encountered the professor and his party again. Groups of students had been assigned to each side of the stream to tear up the water plants. Other students were sent up into the trees to throw down the bromeliads for their colleagues to tear apart on the ground. In fact, despite all the devastation, they got no adults

COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND







PHOTOS BY DAVID DENNIS

FIG. 2. (**left**) *Eurycea longicauda* (Long-tailed Salamander). FIG. 3. (**center**) *Desmognathus aeneus* (Seepage Salamander). FIG. 4. (**right**) *Hyla* (now *Exerodonta*) *pinorum* (Mexican Pine Woods Treefrog), Guerrero, Mexico. This species may now be extinct.

at all! (I had taken five males on my first visit by patiently locating them by their calls at night, without disturbing any vegetation.) I learned my lesson and, when I described three new hylids from this trip I purposely did not reveal precise directions to the type localities, although these data are in my field notebook. I don't know precisely what effect the damage at the Teotepec site had on the amphibians, but certainly that stream site was less habitable for frogs for a long time to come. Unwittingly, I had contributed to this desecration and I have never forgotten my role in it.

My attitude towards amphibian conservation and the protection of habitats in which they live has changed as a result of these and other experiences I've had. I am happy to see the emergence of hobbyist groups, like Tree Walkers International (TWI), that promote healthy wild populations of amphibians. Among other beneficial projects, TWI provides information for volunteers to create amphibian habitats in their own backyards. And my attitude toward more radical approaches may be surprising. For example, I harbor a waning hope that the Golden Toad (*Incilius periglenes*) of Costa Rica may still survive, not in the wild perhaps, but as a breeding colony kept by some amateur terrarist who has not divulged its existence. Because this species is rigidly protected under IUCN listing, any owner of live specimens in the USA could be prosecuted under the Lacey Act. The owner would be loath to reveal that he or she possesses these toads, but the real losers are the toad, Costa Rica, and all of us. If such a captive colony exists, we need to find a way to absolve the owner in order to recover this exquisite animal, one of the most sexually dimorphic frogs in the world. If the owner would have to pay a fine, I would happily contribute to the fund.

Let me go one step further. I believe we need to reevaluate the role of serious amateurs who, with patience and skill, have learned how to breed so many species of amphibians. Some are actually the world experts on particular species. We should ask them to help us conserve endangered species. Amphibian Ark (AArk), an NGO sponsored by the world's zoos and aquariums, is heavily involved in captive-breeding efforts, but AArk does not have the capacity to preserve all of the endangered species. At best, the resources of such organizations might be sufficient to save 10% of the endangered species. Who will help with the rest? If we continue to take a purist approach and say that such breeding can only be handled by accredited zoos, universities, and other public institutions, then surely many—probably most—species of disappearing amphibians are doomed. But if zoos were to provide breeding stock to amateurs (who would have to be properly certified), then amateurs must be willing to reciprocate in helping to restock zoos and provide stock for reintroductions in the wild. The permitting authorities would have to be receptive, but currently the United States Fish & Wildlife Service is not. In Australia, on the other hand, the first place the government turns is to the hobbyist community, Kevin Zippel informs me. I realize that the issues involved are not simple and all parties need to rise above their parochial interests. We must find a way to certify qualified amateur terrarists and ask for their help in this noble effort.

A novel effort involving amateurs has been underway since 2009 to breed the endangered Oregon Spotted Frog (*Rana pretiosa*) (see http://seattletimes.nwsource.com/html/localnews/2009421766_inmatefrogs06m.html). With guidance from Marc Hayes, a researcher with the state's wildlife department who is well known to herpetologists, two inmates at the minimum-security Cedar Creek Corrections Center in Washington State have been hatching frogs from eggs each April. They hold the tadpoles and froglets in plastic pools where they are fed every two hours and the water is refreshed regularly. Perhaps because of the inmates' intensive care for their animals, the mortality they observe is lower than that reported at several zoos where this species is also being bred. More than 1000 young frogs are then released each fall at sites where this species was once abundant. Why couldn't this low-cost method for headstarting endangered amphibians be copied elsewhere? I am told that a similar plan is being considered in New York State to headstart Hellbenders (*Cryptobranchus alleganiensis*). This idea could also be expanded to exotic species. Because of high security in a

prison facility, some of the Fish & Wildlife Service's concerns would be alleviated.

I do not wish to become an "extinction biologist," Tim Halliday's morbid term, or what Joe Mendelson calls a "forensic taxonomist." If we are to avoid this fate, we must think in new ways and find new solutions to old problems. And we must do it very quickly. Will a partnership with the amateur community make a difference in the long run? I don't know. Is it worth the gamble? Certainly. Are there better ideas? Let's hear them.

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No Retreat, Baby, No Surrender

Having written or edited more words on amphibian declines and malformations than most, it would be easy for me to look big picture and give up. We see the über rich convert, directly or indirectly, our favorite ecosystems into gated communities of manicured McMansions, copping an attitude of "this land was made for me not you." And we see that globalization has its unintended consequences, spreading disease and invasive species like a Biblical plague. Pesticides, now everywhere, are either deforming or de-sexing, and we can only wonder if chemicals are doing that to frogs, what are they doing to us, or more importantly, our kids?

There is an old John Prine song that puts a perspective on all this and our potential reaction to it. The chorus goes:

> "You can gaze out the window, get mad and get madder,
> Throw your hands in the air, say what does it matter.
> But it don't do no good to get angry, so help me I know.
> For a heart stained in anger grows weak and grows bitter.
> You become your own prisoner, as you watch yourself sit there,
> Wrapped up in a trap of your very own chain of sorrow."
>
> *—John Prine, "Bruised Orange (Chain of Sorrow)," Atlantic Records (1978)*

As amphibian biologists bearing witness to the sixth mass extinction (Wake and Vredenburg, 2008), we have to be careful not to lock ourselves down into some form of pre-clinical post-traumatic stress disorder. The world, whether it realizes it or not, needs us. My guess is that most of our angst does not come while doing fieldwork, but rather after we return. In the field (unless our study site has been ravaged), and right after we come back, we are dirty and itchy and maybe a little sore and bloodied, but happy and optimistic. We have seen our animals and they have shown something of themselves not seen before. Then we sit in our cramped little offices with our big flickering computer screens and we start to think. That's when the darkness creeps in (to paraphrase Greg Brown, 'People think small things when they stay too long in little rooms' ["One Night," Red House Records, 1982]), and that sets Prine's chain of sorrow reverberating between our amygdalas.



PHOTO BY LISA SCHMITT

MJL at Boundary Waters northwest of Ely, Minnesota August, 2009.

There are ways to cope (humans are nothing if not adaptable). The technique used by U.S. G.I.s during WWII in Europe (although certainly combatants everywhere for all time have used it) went like this. Observing that soldiers obsessed with their own death often froze during combat, producing the thing they most feared, savvy G.I.s played a mind trick: they told themselves, "Screw it, I'm already dead, I just don't know where or when, and when it happens I probably won't even know it." And they became themselves again and they fought, and many of them lived to see VE Day. Understanding this, at some level biologists can find happiness knowing they are recording something that no one in the entire history of the universe may ever see again. Then, perhaps, a good thing happens: because they were themselves and because of their energy and efforts, the thing is preserved; because they persisted, that thing continues to live.

A second way to cope is even more desperate and epitomized by the New York City firefighters at the World Trade Center on 9/11 who went into the North Tower and up the stairs after the South Tower had already collapsed. As with the G.I.s, they must have thought, "I'm already dead." But unlike the G.I.s, they probably also thought that today, maybe this very hour, was the time they were going to die. They went up anyway, and to hear stories, they were calm. Again, working with animals and ecosystems the experience is similar (although the extinction experience is happening to them, not to us; not yet). It is possible to know death is imminent and face it, head on. It is even possible to be calm while doing it. As Edward Abbey (1990) quipped, "When the situation is hopeless, there's nothing to worry about."

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FIG. 1. Drift fence around Crawfish Frog (*Lithobates areolatus*) breeding wetland in southwestern Indiana. Twenty-five years ago, this area was an open pit coal mine, since filled and recontoured, then purchased by the state as a Fish and Wildlife Area. The property was re-planted to native vegetation and is being managed as prairie, including using prescribed burns, shown here, to control for herbaceous and woody invasive species. Crawfish Frog populations can be robust under these conditions.

The trick in all this is to not lament the loss, whether it be us or the things we love, but to get on with it, and to find energy; and rather than mourn what is no longer, try to celebrate those things that are or were. Easier said than done, and for people in certain sub-professions of our field this can be more than difficult. My friends who work in zoos and aquariums, especially those who run captive breeding programs, are particularly vulnerable. Much like neurosurgeons, their jobs are high stress—they fail to succeed and there are forever consequences. To the extent that I can (without having a job with these sorts of ramifications), I empathize. I understand their loss of hope, which can sometimes descend deeper, into a place that is much darker and from where it is more difficult to rise. These are people who, if they drink, drink faster and more than your average herpetologist, which is saying something.

What our friends need to understand is that the problem does not lie with them; it lies within the situation they find themselves in. If roles were reversed it would be us on the floor next to that barstool. We are asking them to be on the front lines of the sixth mass extinction, and we're not giving them the financial or emotional support they need. They are frazzled and fraying. It is easy for them to think they're alone, and following a loss, it's easy for them to despair. But their fight is our fight, and they need our help.

I have never been privileged to work on amphibians in any place that was anywhere near pristine (I cut my herpetological teeth in Iowa—surely one of the most ravaged landscapes on earth). The ecosystems of my youth were wonders of existence. Not in the sense of wonder applied to many natural places; instead, in the sense of "I wonder how any wetland can possibly persist here?" These places never elicited any human emotion faintly resembling hope. I was working inside the Ed Abbey quote of desperate situations with nothing to worry about. But things have changed in the Midwest, some for the better, and I write this now to encourage colleagues who are losing, or who have lost, hope. I write this to celebrate the things that still are, and for things that remain possible. Specifically, I offer three examples of ecosystems involving Midwestern amphibians that have turned around, or where animals have found a way around, when there was no sane right to expect they would. And as I conclude, I suggest a mechanism to celebrate the forms of life for which this world is no longer "meant for one as beautiful as you" (Don McLean, "Vincent," Madacy Records, 1971).

Case Study 1: Mine-spoil prairies.— From the perspective of habitat loss, surface coal mining is about as nasty a business as you will find. One of our study sites is situated on the eastern margin of the Illinois Coal Basin. Here, coal seams lie about 30 m below the surface, shallow enough to be mined using surface drag-line techniques and the world's largest shovels. Companies currently mining this coal include Peabody, Foundation, Alliance, Armstrong, and Patriot. Surface coal mines are gigantic open pits with no recognizable ecology (except, perhaps to a microbiologist). Surface coal mining has taken place in our region for nearly a century, largely unregulated. Then, in 1977, the U.S. Federal Surface Mining Control and Reclamation Act became law. This legislation required that companies re-contour the landscape, replace topsoil, and re-vegetate. Our study site, 729 ha, was mined from 1976–1982, then reclaimed (Lannoo et al. 2009). It was re-vegetated by Peabody to non-native herbaceous vegetation (using the least expensive seed sources possible, for example, tall fescue, bush clover, and smooth brome). Then, in 1988, this land was purchased by the Indiana Department of Natural Resources, and land managers (two in particular, Ron Ronk and Randy Millar) have been eliminating non-native herbaceous plantings, replacing them with native grassland species, and instituting burning regimes for prairie maintenance. Using these processes they have created what we term mine spoil prairies. Reclaimed mine spoil prairies are not restorations *per se*, as these areas were not extensive grasslands at the time of European settlement. Instead, their history was primarily deciduous forest with scattered prairies, cleared for agriculture, and then dug for coal before being reclaimed.

During the first two field seasons of a large study designed to understand the biology of Crawfish Frogs (*Lithobates areolatus*), my graduate students Nate Engbrecht, Jennifer Heemeyer, Vanessa Kinney, and I captured or encountered an astonishing total of 33 amphibian and reptile species on this reclaimed coal spoil prairie, including two State Endangered species (Crawfish Frogs and Kirtland's Snake [*Clonophis kirtlandii*]) and three species of Special Concern (Blanchard's Cricket Frogs [*Acris blanchardi*], Eastern Box Turtles [*Terrapene carolina*], and Rough Greensnakes [*Opheodrys aestivus*]. We found 12 new county records (Lannoo et al. 2009; Kinney et al. 2010). Given the environmentally destructive reputation of surface coal mining, and the negative impacts that coal mining has had on amphibians, it is startling to

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FIG. 2. (**left**) Male Crawfish Frog (*Lithobates areolatus*) captured in a drift fence/pitfall trap array after leaving its breeding wetland. FIG. 3. (**right**) Neotenic Eastern Tiger Salamander (*Ambystoma tigrinum*) viewed along the bottom a freshwater reservoir at Badger Army Ammunition Plant, near Baraboo, Wisconsin, USA.

know that such a richness of amphibian and reptile species could exist on a mine spoil prairie. The diversity of amphibians at our study site today exceeds that of Kankakee Sands, a restored native prairie 150 km north, despite the fact that 25 years ago our field site was an open pit mine, supporting no ecosystem that any vertebrate, or vertebrate ecologist, would recognize. Regional reptiles and amphibians were abundant enough, and occupying landscapes connected enough, that 33 species found their way to this new ecosystem without anybody's help, or in fact, anybody noticing.

Case Study 2: Cannibal Morph Eastern Tiger Salamander Wetlands.—In 1981, working in the region of northwestern Iowa called Okoboji, I discovered cannibal morph larvae in Eastern Tiger Salamanders (*Ambystoma tigrinum*). At the time this observation was publication worthy (Lannoo and Bachmann 1984) but no big deal, because Eastern Tiger Salamanders and western Barred Tiger Salamanders (*A. mavortium*) were considered the same species (*A. tigrinum*), and cannibal morph larvae were well known from Barred Tiger Salamander populations. But today, Eastern and Barred Tiger Salamanders are considered separate species, and these Eastern Tiger populations host the only known animals that express the full cannibal morphology (large, wide heads and hypertrophied teeth). As such, I've always thought they deserve federal protection under the Endangered Species Act as a Distinct Population Segment.

At the time of this discovery, the effects of early twentieth century swamp busting efforts were no different in Okoboji than anyplace else in the Midwest, and the habitats available to Tiger Salamanders had been reduced to four wetlands and associated uplands in Gull Point State Park, the Nature Conservancy's Frieda Haffner Kettlehole, and a smattering of public or private semi-permanent wetlands that may or may not have held water, depending on the phase of the hydrologic cycle.

Then, beginning in the late 1980s and early 1990s, the U.S. Fish and Wildlife Service, through its Waterfowl Production Area (WPA) program (http://www.fws.gov/refuges/whm/wpa.html), and with help from the Iowa Department of Natural Resources, Ducks Unlimited, Pheasants Forever, and other groups , began purchasing land in the Okoboji region—their goal was 30,000 acres. They broke tile lines to create wetlands and planted emergent rushes and sedges to facilitate restoration, and they seeded uplands to native prairie using local genotypes. This program continues, and if the acreage goal has not been met, they are close. Today, classes out of the Iowa Lakeside Laboratory can explore three massive, created grassland/wetland complexes (Spring Run, Welch Lake, and Excelsior Fen) in addition to the 160-acre native Cayler Prairie and its 200-acre annex.

The Okoboji region once supported a Northern Leopard Frog (*Lithobates pipiens*) frog leg industry that saw something like 20 million Leopard Frogs a year captured and shipped along railroads to restaurants as far east as Philadelphia (Lannoo 1996). This level of commercialization was, surprisingly, sustainable. What caused the Leopard Frog decline was swamp busting in the 1920s and 1930s, which eliminated ~98% of breeding wetlands. Today, due to the restoration efforts detailed above, there are likely more Leopard Frog populations on the Okoboji landscape than there have been since the early 1930s. There are also more Tiger Salamander populations, and I have found cannibal morphs in these new populations. While I still feel these animals should have federal protection, I am newly confident that barring some disease that affects salamanders the way *Bd* has affected frogs, that Eastern Tiger Salamander populations exhibiting cannibal morphs are secure, for the time being.

Case Study 3: A Neotenic Population of Tiger Salamanders at Badger Army Ammunition Plant.—In 1942, the U.S. Army purchased 30 km^2 acres of farmland immediately south of Baraboo, Wisconsin, near the region of Aldo Leopold's famous Shack, to create Badger Army Ammunition Plant, built to manufacture smokeless gunpowder. The Army erected scores of buildings and required a water source for, among

other things, fire fighting (as you can imagine given the nature of the enterprise). Two large reservoirs (4 million and 6 million gallons—envision large swimming pools) were dug at elevation into the south side of one of the Baraboo Hills, lined with concrete, and filled with fresh water. The smaller reservoir is chlorinated, and nothing much lives there. But at some point, breeding adult Eastern Tiger Salamanders began entering the larger reservoir. Following breeding, adults could not exit the reservoir to return to their upland habitats, because a 15-cm vertical lip extends from the water surface to the walkway. These adults likely died, as did any offspring that metamorphosed. But permanently aquatic animals could survive, and did, and this reservoir now supports a neotenic population of Tiger Salamanders. Mike Mossman of the Wisconsin DNR, Gary Casper of Great Lakes Ecological Services LLC, and the University of Wisconsin-Milwaukee Field Station, Steve Kimble at Purdue, several members of the Wisconsin DNR and U.S. Army, and I have been investigating the biology of this population, and the implications of the biology of this population. For example, what are the consequences in terms of gene flow and speciation to having a neotenic population of Tiger Salamanders embedded in a landscape matrix hosting metamorphosing populations of Tiger Salamanders? An interesting question addressing the response of an ancient genome to a recent anthropogenic change. Could anyone have imagined this amphibian response—a form of herpetological flipping the bird—to what most would consider a major environmental insult to the majestic Baraboo Hills?

In the first example, I note that one unintended consequence of restoring coal spoils to prairie is the proliferation of native amphibian and reptile species. In the second, I suggest that native amphibian populations respond well to intentional wetland restorations, and that rare phenotypes can be preserved. In the third, Tiger Salamanders, which surely must be among the most adaptable of all organisms, have turned the presence of a fresh water reservoir if not entirely to their advantage, not entirely to their disadvantage, and may have created a population spinning off onto its own evolutionary trajectory. All represent Midwestern examples of amphibian survival from an overly exploited landscape that give us hope.

I realize that for those amphibian biologists on the front lines, this will not be enough. Victories for populations of common, widespread species may not provide salve when dealing with extinctions of some of the neatest little animals anybody has ever seen. Why wouldn't we expect burnout and despair, and the sorts of behaviors in bars typically reserved for returning soldiers and off-shift firefighters? Again, these are people that need to know they're not alone, and that they have our support. I propose *Herpetological Review* erect a new section called "From the Ark," that both gives us a sense of the animals being captive reared and their status, and their stories—front line accounts from the fight to stop the sixth mass extinction. Such a section would allow for both sharing of stories—stories we need to know as they are happening—and perhaps some much-needed venting. These stories could publicize our cause to a much larger audience.

I close with another lyric from the folk tradition; this one from a guy everybody knows:

> "Yes, we made a promise we swore we'd always remember.
> No retreat, baby, no surrender."
> Blood brothers in the stormy night with a vow to defend.
> No retreat, baby, no surrender."
>
> (Bruce Springsteen, "No Surrender"
> Columbia Records, 1984)

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Imperatives and Opportunities: Reformation of Herpetology in the Age of Amphibian Decline

Joe Townsend and I closed the final chapter of *Conservation of Mesoamerican Amphibians and Reptiles* (CMAR), published last year, with the following quotation from the chapter entitled "Exploration of a Little-Known Planet" in E. O. Wilson's masterful 2006 book *The Creation: An Appeal to Save Life on Earth*:

> "Despite the slow pace of exploration, biologists in the past two or three decades have found that Earth's biodiversity is disappearing at an accelerating rate, from habitat destruction, including habitat destruction now underway from climate warming, plus the spread of invasive species, pollution, and overharvesting. If these human-caused forces are left unabated, we could lose as many as half the species of plants and animals on Earth by the end of the century."

Taking E. O. Wilson's message to heart, Joe and I (Wilson and Townsend 2010:777) concluded that "Unless we act now, we [eventually might discover] that rationality provided us much better hindsight than foresight …"

Herpetologists have been slow to respond to imperatives facing the animals on which we work. As Joe Mendelson (2011) pointed out in his introspective essay, it was not until 1989 that "hallway conversations" at the First World Congress of Herpetology pointed to the possibility that amphibians might be in decline on a global scale. Two years later, David Wake formalized this concern with a paper in *Science* (1991). Since that time, however, global amphibian decline has become a hot topic, with attention given to this subject in a broad array of formats. Today, we have the Global Amphibian Assessment and its offshoots, including the GAA website, the AmphibiaWeb site, the seminal book by James Collins and Martha Crump (2009), and the conservation section in the *Journal of Herpetology*, to name a smattering of efforts to address this hugely important problem.

Much of the focus on global amphibian decline has been on the role of the chytrid fungus *Batrachochytrium dendrobatidis* (*Bd*; Longcore et al. 1999) in bringing about declines and extinctions among amphibian species, as evidenced in part by the Amphibian Diseases section in *Herpetological Review*. Bd is a major concern that must be controlled.

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LDW in Parque Nacional Cerro Azul Meámbar, Honduras, May 2008, with a *Mastigodryas dorsalis*, a Vulnerable species.

Unfortunately, the study of the ecology of this fungus with the hope of bringing it under control is not enough.

In light of the acknowledged impact of *Bd*, it is all the more significant an outcome of the Global Amphibian Assessment to declare that "Habitat loss and degradation are by far the greatest threats to amphibians at present, affecting nearly 4,000 species. The number of species impacted by habitat loss and degradation is almost four times greater than the next most common threat, pollution" (Stuart et al. 2010:13). This conclusion is consistent with those typically reached in environmental science and conservation biology textbooks. Evidently, the principal malfeasor for global amphibian decline is not *Batrachochytrium dendrobatidis*, but rather *Homo sapiens*. Humanity is the crux, both in the sense of "the basic, central, or critical point or feature" and "a puzzling or apparently insoluble problem" (American Heritage Dictionary, 3rd edition). At this point, the story becomes a constellation of problems so complicated that space here does not allow for a full elaboration of the causal labyrinth. My intention is not to rehash this story, because it appears as a series of recommendations in the closing CMAR chapter (Wilson and Townsend 2010:774), among other places in that volume. Nonetheless, we indicated that "Any serious, long-term approach to issues relating to conservation biology must be predicated on the understanding that biodiversity decline ultimately is created by uncontrolled human reproduction as measured against a fixed planetary resource base, which has produced an unsustainable existence for our species … ."

Apparently, we have entered an era in which our effort to control the planetary resource base is boomeranging on us. A few hours spent with any good environmental science text will justify this statement. We have entered into the Age of Environmental Superproblems (Bright 2000). As noted by Wilson and McCranie (2004: 13), this term is used to "describe environmental synergisms resulting from the interaction of two or more environmental problems, so that their combined effect is greater than the sum of their individual

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FIG. 1. (**left**) Adult female *Plectrohyla chrysopleura*, La Liberación, Refugio de Vida Silvestre Texíguat, Honduras, a Critically Endangered species. FIG. 2. (**right**) Adult *Duellmanohyla salvavida*, La Liberación, Refugio de Vida Sivestre Texíguat, Honduras, a Critically Endangered species.

effects. These problems represent an environmental worst-case scenario—the point when environmental problems become so serious that they produce unanticipated results, and a successful resolution threatens to slip forever from the grasp of humanity." In a sense, then, humanity has focused on the small picture to the point that the big picture has become even bigger—perhaps too big.

What humanity requires on a global basis is easy to state, but will be the most difficult cultural revolution ever undertaken by our species. The future human agenda must transform the emerging Age of Environmental Superproblems into the Age of Sustainability (Meadows et al. 2004). Sustainability often is defined as "The ability to meet humanity's current needs without compromising the ability of future generations to meet their needs" (Raven and Berg 2004:G-15). These authors also point out that "sustainability implies that the environment can function indefinitely without going into decline from the stresses imposed by human society on natural systems such as fertile soil, water, and air." The intent of this essay is not to detail how environmental sustainability can be accomplished; it is sufficient to say that it will involve creating a sustainable environmental footprint for humanity. Rather, its intent is to explore the role that the science of herpetology could and should play in the over-arching effort to achieve global sustainability.

Below are my suggestions for herpetologists to respond to the phenomenon of amphibian decline, and to transform the science into a force for achieving global environmental sustainability.

Transforming Pessimism to Realism.—I chose herpetology as my life work in that pivotal interval between undergraduate and graduate school. I credit Hobart M. Smith with helping me make that decision; his example as a herpetological speed demon and his counsel as a caring mentor pulled me away from ichthyology and pushed me into my eventual career. Hobart Smith's interest in the American tropics, especially Mexico, also became my interest. Years later, I visited Latin America, at the invitation of the late Ernest A. Liner, who then became another influential mentor. I briefly referred to that life-changing trip in my contribution to the remarkable seven-page obituary of Ernie that appeared in this journal. The following year, I accompanied John R. Meyer on a three-month sojourn to Honduras, an experience that 44 years ago set the hook for my career. During this time, there have been highs (the discovery of new species and the continuing series of publications about what we found) and lows (the specter of advancing habitat degradation and loss, the unexplained disappearance of once-plentiful streamside frogs, and the widespread calamitous damage done by Hurricane Mitch). Like Joe Mendelson, I also experienced the apparent loss of species my coauthors and I described, indeed one of the toughest blows a taxonomist can bear. In the face of the lows detracting from the highs, it would be easy to give up and move on to other pursuits. In this connection, I received the latest, heroically redesigned issue of this journal in which Jim Murphy, in the Zoo View section he edits, included a short piece entitled "Hopelessness" that remarked about "a continuing culture of despair" among conservation biologists, especially younger ones, who are bemoaning the absence of a message of hope in what they are hearing at conferences. Upon reading Jim's commentary, I was reminded of something Joe Townsend and I wrote in the concluding CMAR chapter (p. 777): "The extinction cycle described by conservation biologists … will assume tornadic dimensions, sweeping life's diversity into an ever-widening and ever more rapid spiral, leading to a crescendo the likes of which has not occurred on our planet since the close of the Cretaceous, which marked the most recent mass extinction episode." Had we ended the chapter on this point, we could have been accused of contributing to "the culture of despair." However, we went on to say (p. 777) that "Given our conclusions, three major approaches seem possible. Some people, the pessimists among us, will look at what we have written and decide that the conservation agenda will never be accomplished, no matter what is done. Other people, the optimists around us, will think that everything will turn out just fine, whether conservationists do anything. Neither of these approaches can be expected to move the conservation

agenda forward. The beliefs of both the pessimists and the optimists rob them of any opportunity to participate meaningfully in the process of designing workable solutions to the problems we face. Thus, it is left to the realists to assess any given situation or problem and design solutions that deal with things as they actually are, instead of how we wish them to be. This realistic approach marks the contributions to this volume."

Unfortunately, we need to hear the bad news to wake us out of our complacency, but if that is all we hear we are not stimulated to make things better. Giving up is easy, which is what the pessimists *and* optimists do. The work begins when the realists recognize where events seem to be heading, decide these trends are undesirable, and commit to the demanding, perhaps life-long task to make things better. So, the picture for conservation biologists is bleak, but if we give up, the outcome is determined. Instead, if we devote our time toward making the world a better place than when we arrived (in my case, when the world was embroiled in WWII), then the outcome becomes shaped by our efforts.

Reconceptualizing Herpetology.—Back in the early 1960s, when I was saddling up for graduate school, I thought the going would be rough but that trail's end would be rosy. I thought I would be doing what I enjoyed and get paid for it, too. The person I am today might think that young guy from the Great Corn Desert of central Illinois was a tad naïve, but it turned out that I had the opportunity to work with "my critters" while making a reasonably comfortable living. In retrospect, my study program was designed for a world that was fast disappearing. Had my instructors known then what I know now, that program might have been much different. My comments are meant primarily for the field herpetologist, but in my mind herpetology begins and ends in the field. Furthermore, the "field" turned out to be Mesoamerica, principally Honduras. Pretty much by accident, I became interested in a socioeconomically underdeveloped area with a rapidly-growing human population competing for habitat with the members of an imposing, diverse herpetofauna characterized by high endemism. This description of the Honduran herpetofauna would not have applied to the Honduras I entered in 1967, because in the interim the known herpetofaunal diversity in the country has just about doubled and the percentage of endemicity has become the highest in Central America (Wilson and Johnson 2010).

If I could design a modern program for graduate study, it would have to be grounded in the principles of environmental science and conservation biology. No matter where one's research interests might lead, they will be pursued against a backdrop of humanity's impact on the natural world. In his thought-provoking piece, Joe Mendelson (2011:22) opined that "There no longer exists a natural upland ecosystem in Mesoamerica." Although, in context, the statement is startling, it, unfortunately, is not surprising to anyone who has spent time working in this region. I first went to Honduras in 1967, and it took me two weeks before I found my first snake; unlike Joe Mendelson, I cannot claim that my lack of early success was due to the unexplained disappearance of my target animals. We did not describe our first new species in the country, *Leptodactylus silvanimbus*, until 13 years later (McCranie et al. 1980). We found the first specimen of that species *under a log in a pasture* cut out of cloud forest! For us, this came to be the rule rather than the exception. So, if one is interested in working in a natural ecosystem (i.e., one undisturbed by humans), one is in for a long hunt because in the age of global environmental problems (e.g., global climate change), there are only various approximations to natural ecosystems anywhere on Earth. That such is a given is evident by the lack of a warning in herpetological publications, similar to those on cigarette packages, that "This study was conducted in a disturbed ecosystem."

The next most important area to explore would have been the language, political science, and cultural history of my chosen region of study: Latin America. I would have reached that region better prepared to understand the people.

A lot more is involved with this story, but suffice it to say that real success is gained by never giving up, having the most destination-specific educational training, and coming to understand that people everywhere have similar goals and aspirations. For herpetology to have a meaningful role in human affairs, students will have to learn about the realities posed by life in the 21st century. They will need to understand the imperatives all humans face, and how these imperatives will shape the opportunities that will exist for herpetologists.

Imperatives and Opportunities for Fieldwork.—The imperatives are evident to those who wish to learn the "big picture;" the opportunities are what we wish to make of them. What follows are some of the ideas I gained over the last four and one-half decades on conserving the creatures we study.

Permits to work in foreign countries have become *de rigueur*, which is the imperative; the opportunity is to understand the operation of the permitting agency, to earn the confidence of its personnel, and to use whatever resources one has to contribute to the success of this agency. At a minimum, this last effort should include the submission of a detailed report on the findings, in the language of the host country (our 2010 Honduras project report, incidentally, was publicized recently in a long article in *La Tribuna*, one of Honduras' major newspapers). In addition, contributions can be made to agency efforts to publicize their work through posters and and other methods.

Permits provide a means of introduction to local people, including protected areas personnel (including those of involved NGOs) and community leaders; up-front explanations of the goals of the projected work help gain access to areas of interest, provide assistance and training opportunities on site, and, ultimately allow reporting the results of the work to those same stakeholders, including educators, schoolchildren, and print and TV journalists, with the help of the local people who were on the trip (e.g., *guardarecursos*). Therein lies both the imperative and opportunity.

In planning for fieldwork, look farther afield than in the past, because opportunities lie in such previously unsurveyed areas. For example, much has been made of the species richness of the Quebrada de Oro area of northern Honduras and its subsequent decline (McCranie and Casteñeda 2007; McCranie and Wilson 2002; Wilson and McCranie 1998). A number of endemic amphibians were thought to have disappeared from this area, and some have been presumed to be extinct. Recent work, however, in another area of the long Cordillera Nombre de Dios has allowed for reassessment of the conservation status of some of these heretofore-thought-to-be-absent amphibians (Townsend et al. 2011; Townsend et al., *in press*), including *Plectrohyla chrysopleura* and *Duellmanohyla salvavida* (Figs. 1 and 2). A similar example involving *Plectrohyla hazelae* was reported in the previous issue of this journal (Heimes and Aguilar 2011). These examples, along with that of *Incilius holdridgei* (Abarca et al. 2010), give us good reason to expect that others will also reappear.

The necessity to return to the capital of the country in question to obtain export permits and the like is yet another imperative that provides other opportunities. Such a requirement can allow for meeting with local biologists at colleges and universities for strategy discussions, content presentations, and development and maintenance of other longer-term associations, such as cooperative appointments (see my address above) and meeting organization. Promising local young biologists also turn up at such times, providing the chance to help further their education in one's own country. This accounting of the opportunities offered while "in country" just scratches the surface of what is limited only by imagination and commitment.

Since herpetologists are the ones who discovered that "their animals" are in decline, their research priorities can be reconfigured to include studies that determine the conservation status of the target organisms and highlight the herpetofauna of existing and proposed protected areas, as we are doing in Honduras (e.g., Townsend and Wilson 2008; Townsend et al., *in press*). Increasing the accessibility of this information can be accomplished by presenting scientific results either in a bilingual format (Townsend and Wilson 2008) or in the language of the residents of the area in question (e.g., Wilson et al., *in press*), or better yet, through dissemination of results to the general public through local media outlets and public presentations.

A Final Imperative and Opportunity.—That human beings are responsible for almost all environmental problems, including those of interest to conservation biologists, is a virtual given (Wilson and Townsend 2010). However, the scramble to determine the role of *Bd* in the global amphibian crisis almost has quarantined the attention of herpetologists searching for answers to the causes of this crisis. In my opinion, another of the basic rules of environmental science has been lost in the shuffle…sort of. This is the simple rule that in nature everything is connected to everything else. This statement also applies to the human world and its relationships with the natural world; humans are, after all, a product of the same processes that created the natural world. For herpetologists, the implication should be obvious. Although not yet officially tabulated to the extent done for amphibians, the reptiles, our *other* group (of course, including turtles and crocodilians, but excluding the feathered ones) is also in decline. While awaiting the Global Reptile Assessment, the contributors to CMAR conducted their own assessment of the conservation status of Mesoamerican reptiles (in addition to the amphibians), with the results summarized by Wilson and Townsend (2010), who concluded, using their Conservation Status Scores, that of 1139 species of reptiles scored, 966 (84.8%) fell into their very high category of conservation significance. With respect to the individual orders, only crocodilians, of which there are three species in Mesoamerica, had less than 80% of the constituent species in the very high category, based largely on their comparatively broad distributions. A higher percentage (93.0) of amphibians fell into the very high category, especially because of the scores for salamanders, but this indicates that amphibians are only slightly worse off than reptiles. Thus, it appears that another imperative faces herpetologists, especially those working in Mesoamerica, presenting another array of opportunities. So, how long will we have to await a Global Reptile Assessment? More to the point, how long will the reptiles have to wait to be given their fair measure of attention?

Acknowledgments.—I appreciate Jim Murphy asking me to write this essay. I am indebted to Louis W. Porras and Josiah H. Townsend for their extremely helpful counsel as this essay took shape. I also wish to thank Ileana R. Luque Montes for the use of the photo of me and J. H. Townsend for the use of the photos of the frogs that accompany this work.

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INSTITUTIONAL PROFILE

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Herpetology at a Biogeographical Junction: Research and Teaching at the Hebrew University of Jerusalem (Israel)

The herpetofauna and herpetology are particularly attractive in the southern Levant, the southwestern tip of the "fertile crescent." This area, historically known as Palestine and now shared by Israel and Jordan, serves as meeting arena for faunal elements from Africa, Asia, and Europe (Bodenheimer 1935; Por 1975) and the local herpetofauna is heterogeneous and rich in accordance (Disi 1996, 2002, 2011; Haas 1952a; Werner 1988). Herpetology is attractive here not merely because the species are ample and the open questions endless. Rather, mesic Mediterranean, semi-arid Irano-Turanian, arid Arabian and Saharan, and Afro-tropical ecosystems, and their assorted interactions, are all accessible at short range, by good roads, from universities. Moreover, a country-wide network of some twenty field schools and research stations provides bases for local research. The oldest university is the Hebrew University of Jerusalem, established in 1925. Its zoological collections were started earlier, as told below. It has a history of ramified herpetological research, especially collection-based but also in the field.

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History of the collection.—The Hebrew University's collection of amphibians and reptiles was started by Israel Aharoni before the university was even conceived. Aharoni, born in Lithuania in 1882, was studying Zoology and Semitic



FIG. 1. Israel Aharoni teaching about Palestine's vertebrates, 1941. The blackboard carries names and terms in Arabic, Hebrew, and Latin.

PHOTO BY NAHUM TIM GIDAL, COURTESY OF THE HEBREW UNIVERSITY OF JERUSALEM

languages in Prague until in 1901 he immigrated to the Palestinian province of Syria within the Turkish Empire. Residing at Rehovot and Jerusalem and teaching school, he continued to privately learn zoology and started to investigate the local fauna. Gradually he amassed collections of various groups from Palestine and adjacent areas, often assisted by Arab hunters, and became a knowledgeable and renowned animal expert, specimen supplier to institutions abroad, and Hebraist (Leshem 2000).

Soon after the opening of the Hebrew University of Jerusalem on Mt. Scopus in 1925 (under the British Mandate of Palestine), its head of Zoology, F. S. Bodenheimer (1897–1959), recruited Aharoni to teach vertebrate zoology. He came with his collections (those not earlier deposited in Palestinian clerical establishments or European museums and universities), including a significant reptile collection (Bodenheimer 1959). Specimen data tags, however, though commonly present, were often too generalized (e.g., "Syrian desert") or referred to Aharoni's location when receiving them from collectors (e.g., "Rehovot" for desert lizards). Cataloging the collection was later undertaken by his daughter Bat-Sheva Aharoni. The university, presumably regarding animal-lore as inferior, allotted to this treasure a humid cellar (Jacob Wahrman, pers. comm.). Gradually the collection grew through the additional activity of faculty (especially G. Haas) and students (especially H. Mendelssohn and H. Steinitz).

Aharoni was an enthusiastic teacher (Fig. 1). His textbook on the country's reptiles (Aharoni 1929) was pioneering in coining Hebrew species names, besides including interesting biological observations and eclectic anatomical details. It also bore witness to the collection having contained some representation of Europe's herpetofauna. Aharoni's book includes some European species, notably *Lacerta agilis,* ostensibly as part of the local fauna; this has been explained as probably resulting from his having had a jar with European material on his desk when writing. Aharoni succumbed to a heart attack in 1946.

The war of independence (1948–1949), while establishing the state of Israel, left the Mt. Scopus campus, Israel's university, as an Israeli enclave locked within Jordanian-occupied territory. Libraries and collections were held hostage on the campus; Jordan forbade their evacuation. Until June 1967 the Israeli garrison was replaced every fortnight through a UN-supervised convoy of armored cars traversing the Jordanian territory. Each convoy carried also supplies for a fortnight.

A few Hebrew University representatives were permitted to participate in order to inspect and care for the cultural treasures on the mountain, susceptible to shooting from the outside and vandalism on the inside. This was an adventurous mission for the staff. The Jordanians would inspect the returning cars and people's bags for items smuggled out but refrained from bodily search. So in all weather the staff wore coats, ascended slim and descended obese, with books tucked in belts, large preserved snakes strapped across



PHOTO BY Y. L. WERNER

FIG. 2. Georg Haas (left) explaining his fossil snakes to visiting former student, president-of-Israel Ephraim Katzir, 1977.

breasts, and small specimens filling pockets and specially contrived carton receptacles strapped to shins under long pants.

By this and other means the Department of Zoology's reptile collection was gradually growing in its temporary home, tall wood cabinets along one wall of the spacious office of Dr. Georg Haas (Fig. 2), in the Italian Nunnery St Antonio College in Jerusalem's Talbiye quarter. Since 1950 this was the department's location, because the university, banned from its campus, was scattered throughout Jerusalem (see History of teaching). Haas (1905–1981; Werner 1982a, b), leading the development of this and some other collections, endeavored to include instructive exotic specimens. He cultivated international relations, arranged exchanges, and extracted donations. The amphibian collection was rather the project of Dr Heinz Steinitz (1909–1971; Boschwitz 1971; Kuehne 1972; Por 1973), otherwise ichthyologist, histologist, and experimental morphologist.

Meanwhile the young generation, led by Jacob Wahrman (1924–2005; Richler 2006), was conducting collecting trips all over the country, with emphasis on the poorly explored southern desert, the Negev. During the 1950–60s the Department of Zoology had two jeeps (one shared with the Department of Parasitology, Medical School). These served in trips planned to survey the country with a view to mapping species distributions. Many trips were systematically multi-purpose, with emphasis on trapping rodents (Zahavi and Wahrman 1957) but some were primarily herpetological. These survey efforts contributed much to the animal distribution maps in the Atlas of Israel (Wahrman 1970).

In 1965 the Department of Zoology and the Collections were moved from the Italian Nunnery to a group of buildings adjoining the Russian Compound (downtown) that had been evacuated by the Medical School, which moved to its

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FIG. 3. *Discoglossus nigriventer* Mendelssohn and Steinitz, 1943, the only two specimens comprising this species. The smaller one (HUJR-236), dorsal view, is the type. The larger one (HUJR-544), caught 1955, shows the typical ventral coloration, somewhat faded. Scale, number tags are 22 mm long.

PHOTO BY NURIT WERNER



FIG. 4. The tank containing *Varanus griseus* (mostly roadkills) has been rolled out from under the shelves, opened, and two specimens exposed. The human scale is Yehudah Werner, 2010.

salem's western outskirts. Here the collections had their own separate masonry building and herpetology occupied two spacious rooms.

The collection today.—In 1985 the Department of Zoology moved to the HUJ sciences campus at Giv'at Ram, and its population-oriented staff and the collections moved into the Berman and Lubin buildings, evacuated by the Department of Psychology that had moved to the resurrected Mt. Scopus campus. The herpetological collection remains in the Lubin Building, occupying a hall housing the wet material and an adjoining work space housing also literature and dry specimens.

The collection comprises over 22,000 catalogued specimens of amphibians and reptiles, derived in principle from three sources. 1) Most specimens are from the "survey area," Israel with the Golan plateau, and Sinai. This is the most extensive regional record of Levant taxa. It is the world's only collection with the full Israeli herpetofauna, having the only two existing specimens of the extinct *Discoglossus nigriventer* (Fig. 3). It also includes one of the last local crocodiles. 2) Comparative material from surrounding countries. 3) Instructive material representing systematically or geographically important groups (e.g., *Sphenodon*). Recently the type material in the collection, 17 species and 23 subspecies, has been reported by Ben-Eliahu and Golani (2010a).

The bulk of the collection (85%) is in 75% ethanol (amphibians and geckos, 70%) denatured with 5% methanol, after fixation with formalin. In recent years fixation is preceded by taking tissue samples for DNA work. Because the collection is much used for research, specimens are individually tagged with their main data, and assembled in glass jars carrying the list of numbers. The jars are on open metal shelves. Large (75 liter) plastic "tanks" contain straight-fixed snakes and bulky specimens such as turtles. It is a local innovation that these tanks rest on individual wheeled bases and are on the floor under the jar shelves, from where they are easily rolled out (Fig. 4.).

The rest comprises stuffed or dry specimens, skeletons, and skins. A unique (largely uncatalogued) resource is a large collection of microscope slides, mainly of karyology, ontogeny, cranial morphology, and tail regeneration of amphibians and reptiles, from the work of several researchers. Since 1994 tissue samples from fresh specimens have been preserved separately for future DNA analysis (several hundred samples). Several hundred shed skins, feces, eggshells, and donated specimens await cataloguing.

In recent decades the sources of new material have been changing (Ben-Eliahu and Golani 2010b). The planned collecting trips have receded and ceased for both economics and conservation. Course field trips have stopped in 1999 upon the teacher's retirement. Currently an estimated annual average of 250 specimens come as vouchers from specific research projects or, mostly as roadkills, from the Israel Herpetological Information Centre (of the Society for the Protection of Nature in Israel), individual rangers of the Israel Nature and Parks Authority, students, and others, including herpetoculturists abroad.

Cataloging.—Before the computerization era, cataloging was retrieval-friendly through three devices. 1) The single set of serial numbers serving the whole collection is subdivided into sections for groups: 1–800, Amphibia; 801–1000, Chelonia; 1001–3000 Sauria; 3001–5000, Ophidia and 5001–7000

TABLE 1. Expeditions and projects that significantly contributed specimens.

Dates	Expedition or project	Collectors	References	N
1928; 1936	Iraq, Egypt (research trips)	F. S. Bodenheimer, O. Theodor & G. G. Wittenberg	Haas 1952b	~65
1935–1965	Vouchers: cephalic anatomy	G. Haas	Haas 1935; 1936; 1937; 1947; 1952c; 1959; 1964	Many
1936, 1945	Transjordan (two collecting trips)	G. Haas et al.	Haas 1943; Werner 1971; 2004a	22
1949–1951	Display collection	M. P. Pener		~65
1956–1957	Sinai (collecting trips)	Y. L. Werner, J. Wahrman, J. H. Hoofien et al.	Werner 1973	~60
1956–2006	Vouchers: lizard life history & eco-morphology	Y. L. Werner	Frankenberg & Werner 1992a; Werner 1968; Werner & Lampl 1992; Werner & Seifan 2006; Werner et al. 1993	Many
1959	Eastern Africa (research trip)	E. Nevo		~40
1960–1968	Vouchers: evolution of frogs	E. Nevo	Nevo 1968	~50
1962–1964	Vouchers: physiology of Australian lizards	M. R. Warburg	Warburg 1965; 1966	~140
1965	Cyprus & Lebanon (collecting trip)	H. Zinner	Zinner 1967	~155
1966	Greece, Turkey, Syria, Lebanon, north Jordan (collecting trip)	H. Zinner	Zinner 1967; Werner 1991	~390
1967–68; 1993–94	Vouchers: hearing in lizards	Y. L. Werner	Gehr & Werner 2005; Werner 1972,1976; Werner & Igic 2002; Werner & Wever 1972; Werner et al. 2001a,b, 2005, 2008; Wever & Werner 1970; Withers et al. 2000	~300
1967–1981	Sinai (methodical survey)	Y. L. Werner, A. Haim, et al.	Werner 1982c; 1988	~930
1969	Turkey (research trip)	Y. L. Werner	Almog et al. 2005	~20
1970–1971	Australia (vouchers: hearing and voices in lizards)	Y. L. Werner	Johnstone & Werner 2001; Weber & Werner 1977; Frankenberg & Werner 1984, 1992b	~290
1971	Namibia (research trip)	Y. L. Werner	Werner 1978	33
1972–1995	Warburg teaching collection	M. R. Warburg		138
1992	Golan plateau student survey trip	Y. L. Werner et al.	Sivan & Werner 1992	~200
2007–2011 (ongoing)	Ongoing research project on roadkills	G. Vine (INPA ranger)		~215

again Sauria, and so on. Each group is catalogued in a separate volume, so searching for a snake does not require leafing through all the frogs and lizards. 2) A card file of locality names, each card carrying the geographical coordinates, and a brief record of specimens from that locality. 3) A cross index by species on large durable cards. Entering specimens into both card indexes was discontinued when computerization started. The species index had been initiated by Jacob Wahrman, to whom the collection owes much of its professional 'law and order' spirit.

PHOTO BY Y. L. WERNER



FIG. 5. "Prehistorical" faunistics lesson by H. Mendelssohn, at the students' request given in the fresh air, 1955. The barracks were an extension to the biology premises in the Italian nunnery, necessitated by the immigration-driven rise in student numbers.



PHOTO BY Y. L. PHOTO BY JACOB WAHRMAN

FIG. 6. "Historical" field trip of the faunistics course to the Negev (11 March 1963). Jacob H. Hoofien, invited to reinforce the staff as reptile expert, speaks to the students using an improvised board suspended on a jeep.

Computerizing the HUJ collections has been a chronic effort for some decades, involving trial-and-error with programmers and programs. Now, however, the herpetological catalog approaches completion and functionality in Microsoft's Excel.

Staff.—During 1953–1973 a student 'research assistant' (parallel to the teaching assistants), 18 hours/week, helped in the collection. In 1972 the Department of Zoology established the 'Zoological Museum' (a term later outlawed). The department's chairperson, Hefziba Eyal-Giladi, appointed Adam Ben-Tuvia (1919–1999; Golani 1999) as museum Director, and Yehudah Werner as Curator of Amphibians and Reptiles. From 1973, the university budget started to deteriorate. Since then, technical assistance in the herpetological collection diminished to an on-and-off basis, with expectable consequences. In 1999, upon the mandatory retirement of Curator Werner, a part-time collection manager was appointed—Naomi Sivan, MSc, formerly Werner's academic technical assistant and research associate. But she was soon replaced (on budget grounds) by Boaz Shacham, then BSc. Recently the collection's research capacity has been reinforced by the appointment of a Research Associate, Hervé Seligmann.

Research.—The collection has been serving research by staff, research students, student course-projects, visitors, and investigators abroad (through lending). The local research goes far beyond the classical issues of systematics (e.g., Werner et al. 1999) and distribution (e.g., Werner 1987). Subjects have ranged from developmental morphology (e.g., Eyal-Giladi 1964) through polymorphism (e.g., Shacham 2004), functional morphology of tails (e.g., Werner 1961, 1968), eyes (e.g., Werner and Seifan 2006), and ears (e.g., Werner et al. 2008) to longevity (e.g., Werner et al. 1993) and reproductive biology (e.g., Frankenberg and Werner 1992a). In addition, the collection houses the voucher specimens of projects from cephalic anatomy (e.g., Haas 1973) to auditory physiology (e.g., Werner 1972).

Current research includes the northwards penetration, along the Jordan Valley, of lizards and snakes from the Negev Desert (Shacham et al. 2009); identification and distribution of some *Acanthodactylus* lizards (Werner); sexual dimorphism in snakes with emphasis on eye size (Werner, Babocsay [Budapest], Faiman [Parasitology], Razzetti [Pavia], and Seligmann); sexual size dimorphism in Israeli snakes (Werner and Ventura); size variation in Israeli tortoises and the identity of *Testudo floweri* (Meiri, Itescu, H. Shacham, and Werner); sizes of parietal eyes in lizards (Labra [Oslo] and Seligmann; Labra et al. 2010); left-handed *Sphenodon*s grow more slowly (Seligmann, *in press*); error coordination between codon-anticodon mismatch and tRNA misacylation decreases developmental instability in lizards (Seligmann); and off-frame stops increase developmental stability (Seligmann).

Field research, in addition to leading or aiding routine conservation-oriented surveys, focused in recent years on the foraging mode of geckos. Several projects explored the synergism of the many factors modulating the foraging activity pattern (e.g., Werner et al. 2006; Seligmann et al. 2007).

Teaching.—Teaching herpetology at HUJ has comprised an undergraduate course, a graduate course, field trips, and student projects at all levels. All these have interacted with the collection, although for the courses a designated teaching collection also exists.

History of teaching.—With the redeployment of the HUJ after the 1948 War of Independence, its teaching was resumed in rented quarters scattered throughout Jerusalem. Biology was studied directly towards the MSc and comprised one major and two minors, such as Botany with Zoology and Biochemistry or Zoology with Botany and Parasitology. Since Israel Aharoni had passed away in 1946, "Faunistics" was taught throughout the 1950s by Heinrich Mendelssohn, fortnightly visiting from the Biological-Pedagogical Institute of Tel Aviv (Fig. 5).

PHOTO BY Y. L. WERNER



FIG. 7. The two historical specimens of *Testudo kleinmanni* that were found separately on 11 March 1963, photographed in the lab (left, ventral aspect).

After some provisional locations, by 1950 the Departments of Botany and Zoology had settled in a wing of the Italian Nunnery St. Antonio College in Jerusalem's Talbiye quarter, where Georg Haas (Werner 1982a, b) and others endeavored to assemble new collections. By 1963 when Mendelssohn, tired of travelling to Jerusalem, resigned, the collections could already provide specimens for demonstration. A year-long lecture course was developed, obligatory for all 120 Biology sophomores: one semester vertebrates (headed by G. Haas), one semester invertebrates, including entomology. Haas opened the herpetology chapter saying Israel harbored 40 species of lizards, 33 snakes, and four non-marine turtles (a recent count had 44 lizards and 44 snakes; Werner and Sion 2008).

The course included field trips. One of the first of these yielded the re-discovery of the Egyptian Tortoise, *Testudo kleinmanni*, in Israel. Its occurrence had been reported in the older literature ("Testuco leithi," Lortet 1883; Tristram 1884) but in the intervening decades even targeted quests had failed to find it. It took the combination of numerous searchers and correct season and weather to find it in the northern Negev sands ("14 km S of Beer Sheva") on 11 March 1963 (Figs. 6, 7). Later the Israeli population was defined a separate species, *Testudo werneri* (Perälä 2001), but this has since been contested (Široký and Fritz 2007).

The BSc course.—In 1967 the Life Sciences Institute was founded, comprising the departments of Biochemistry, Botany, Genetics, and Zoology. Thereupon BSc studies were established, and the mandatory faunistics course was subdivided into four elective one-term fauna courses accompanied by a mandatory common course on shared principles (it soon became a biogeography course), all in the third year. Among the four courses, "Introduction to the Knowledge of Amphibians and Reptiles" was somewhat unique in its integration of different zoological disciplines, from chromosomes to thermoregulation, leaning on teacher's research experience (Werner 2004b, 2005). Fig. 8 shows the course's view of the

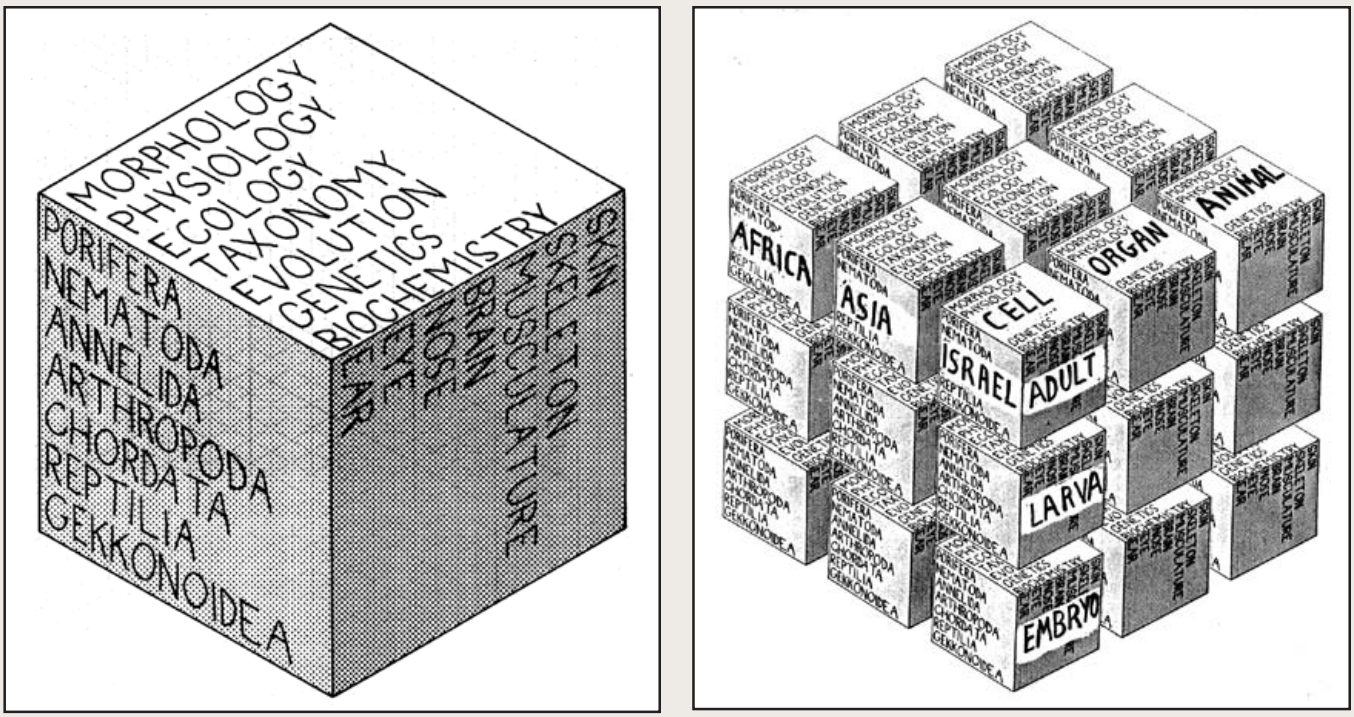


FIG. 8. Scheme of the composition of zoology. A) Primary cube showing three main dimensions: discipline, organ system, systematics. Journals exist for all subdivisions, and most internal intersection cubes exist (e.g., physiology of eye of reptiles). B) Additional dimensions require piling copies of the primary cube: geography, organization level, ontogenetic time. The last can be replaced with paleontological time. In each dimension, only a few units are shown as examples. Herpetology is conceived as intersecting and including all six other dimensions.

PHOTO BY Y. L. WERNER



FIG. 9. Herpetology course 1980 field trip. Using a school's art classroom (at Ma'ale Efrayim) to identify the collected live reptiles, each protected in an inflated plastic bag.

PHOTO BY A. BOUSKILA



FIG. 10. Dror Hawlena (sitting) explains pitfall-trap operation to students of Ben Gurion University of the Negev, Western Negev desert, Israel, 1999.

multi-dimensionality of zoology and hence of herpetology. A typical five-hour session presented both some Israeli taxa and some natural history topic(s), preferably matched, such as systematics of lizards, and tail regeneration. Course activity comprised teacher's lectures, students' proseminars, individual lab work, and museum-style 'demonstrations.' Field trips included meeting the species, comparing the habitats, and experiencing field methods. In later years, transportation expenses constrained the course to 17 students. Usually it was full, occasionally including a student from another university, a schoolteacher on study leave, or a zoo staff member.

The MSc course.—Among the fauna courses, only in herpetology was a viable MSc course developed, "Herpetology for Advanced Students," starting in 1975–1976. Following initial experimentation with contents, it comprised a planned symposium-like journal club, and individual research projects planned for potential later merging. Some of these student projects (mostly partly collection-based) were published (notably Perry et al. 1990). This course was normally given every other year to 5–7 students, in alternation with moderately reptile-biased 'Projects in Comparative and Functional Morphology'.

The field trips.—The field trips of the two herpetology courses were sometimes held together (Fig. 9). The BSc students emphasized acquainting themselves with species, habitats and methods but the MSc students mostly collected data for their projects. Initially we depended on the collection to know and plan in advance what the students could encounter everywhere; later (with budgets dwindling) the course field trips became research expeditions planned to fill data (and specimen) voids, so that students shared the experience of discovery. In the 1990s students increasingly opposed the collecting of specimens. We discussed the difference, even clash, between conservation and avoidance of cruelty to animals, and the conservation role of collections through the clarification of biodiversity.

Other student projects.—Many BSc student research projects within the frames of other courses (mainly but not only Prof. J. Heller's systematics course), were carried out in the herpetology collection. Typically these were performed by a team of two or three students, each reporting on her or his share (e.g., comparing meristic, respectively mensural, characters in two lizard samples) towards later merging. Several of these were published (respectably), including descriptions of new taxa. One of the first projects made the Biological Reviews, Cambridge (Wolf and Werner 1994).

Theses.—In the course of time, many morphological, developmental, and especially comparative-anatomical MSc or PhD theses on amphibians or reptiles, and some on their behavior, have interacted with the collection to varying extent. These included for example the MSc theses of Zakbach (1939), Eyal-Giladi (1949, 1964), Nevo (1957), Stettiner-Kallner (1958), Ginzburg (1965), Frankenberg (1972), Shy (1978), Bouskila (1984), Shani (1990), Por Efrati (1991), Bogin (1999), and Shacham (2004), and the PhD theses of A. Moscona (1950), H. Moscona (1950), Feldman (1952), Boschwitz (1958), Werner (1961), Kochva (1962), Nevo (1964), and Frankenberg (1978). The PhD of Seligmann (2003), 99% collection based,

has significantly impacted the field (e.g., Lachman et al. 2006). One foreign student obtained his PhD here (Babocsay 2006). Additionally, the collection has occasionally served in the MSc theses of students from other Israeli universities.

Outreach.—Questions from the public and especially herpetology students, often by e-mail from neighboring countries, are regularly answered. Groups of visitors to the collection are introduced to reptile biology and its research. During 1982–1998, and again in recent years, the staff has been playing a leading role in organizing national herpetological symposia ("study days") for the general public, including rangers, inspectors, teachers, students, amateurs, and others.

Prospects.—With the (mandatory) retirement of Werner in 1999 the teaching activity (not the research) has largely abated. However, currently one PhD student and one MSc student work respectively on behavioral ecology and reproductive ecology of geckos. The collection is now poised to receive a new curator. Thanks to the appointment of Dror Hawlena (Fig. 10), presumably the educational activity will soon be revived and rejuvenated.

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*Marks titles translated from Hebrew by YLW.

Editor's note: Dr. Werner joined the university in 1950 as student and in 1953 as employee, and since 1999 has serves as Professor Emeritus.

Note added in proof: The following relevant paper appeared too late for inclusion in the text:

Shay, O. 2011. Zoological museums and collections in Jerusalem during the late Ottoman period. J. Museum Studies 5(1):1–19.

ARTICLES

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Ecological Consequences of Continual Volcanic Activity on the Lizard, *Anolis lividus*, from Montserrat

Understanding the effects of environmental disasters on ecosystems and mechanisms of ecological recovery is a central pursuit in biology. Acute episodes, such as tsunamis or volcanic eruptions, can decimate entire ecosystems, but research has shown that recovery from single devastating events can prove to be rapid. For example, following the destructive eruption of the Krakatau islands in Indonesia in 1883, which left its land and associated waters completely sterilized, both the terrestrial and marine life rebounded quickly (Barber et al. 2002; Dammerman 1929; Thornton 1996). Furthermore, under certain conditions ecosystems can prove to be resilient to environmental devastation. For example, corals growing on hard substrate, such as rock, were largely unaffected by the tidal waves of the tsunami in Aceh, Indonesia in 2005, whereas corals growing on rubble and sand, and their associated communities, were devastated (Baird et al. 2005).

Many contemporary environmental disasters occur continually, and require that ecosystems respond to recurrent assault. Beginning in 1995 the island of Montserrat in the West Indies has suffered acute and persistent volcanic activity from the Soufrière Hills Volcano (Robertson et al. 2000). The most devastating volcanic events are pyroclastic flows, or high-speed currents of rocks and gas resulting from dome collapse, and periodic ash clouds composed of volcanic gases and particulate matter (Montserrat Volcano Observatory Team 1997; Fig. 1). There are also periodic landslides termed lahars that deposit meters of pyroclastic material into the river valleys, and acid rain that affects the areas closest to the volcano. These events occur regularly and are undoubtedly traumatic to the Montserratian ecosystem, particularly in communities in the southern half of the island, where volcanic impact is more severe and continual. Knowledge of how persistent volcanic activity affects the island's endemic flora and fauna can inform efficient conservation efforts, but little is currently known.



FIG. 1. View of Plymouth, the defunct capital, where *Anolis lividus* was once quite abundant, as seen from the sea following the January 2010 dome collapse.

Research has shown that the long-term effects of the volcano on local wildlife can be severe. For example, despite intense sampling, many endemic coleopteran species have not been captured since volcanic activity began (Marske et al. 2007). Furthermore, the rare endemic oriole, *Icterus oberi*, is in imminent threat of extinction (Lovette et al. 1999). More than half of the oriole's habitat has been destroyed due to eruptions from the Soufrière Hills (Hilton et al. 2003), while periodic ash episodes further deplete populations and nesting sites (Dalsgaard et. al. 2007). The endemic galliwasp, *Diploglossus montiserrati*, was commonly found before the eruption of 1995, but only a handful of individuals have been captured since, despite extensive sampling by the Department of Agriculture (G. A. L. Gray, pers. comm.). And while efforts are focused on the northern half of Montserrat, even

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less is known about populations in close proximity to the volcano, especially in the permanent exclusion zone of the island, where human traffic is prohibited.

Beginning in 2009 we have been monitoring populations of the endemic anole, *Anolis lividus* (Fig. 2), both in the safe zone (northern Montserrat) and in the permanent exclusion zone (southern Montserrat). In comparison to many other reptiles and amphibians on the island, much is known about the biology of *A. lividus*, such as its natural history (Lazell 1972; Schwartz and Henderson 1991; Underwood 1959; Williams 1962), malarial parasites (Staats and Schall 1996), and evolutionary relationships (Losos and Thorpe 2004; Schneider et al. 2001; Thorpe and Malhotra 1996). Despite more general knowledge of the species, there has been no assessment of how populations have been affected by volcanic activity until now. We present the first field observations of lizard habitat conditions from six sites within the permanent exclusion zone in southwestern Montserrat. The extent of environmental damage due to ash, gas venting, and acid rain varies in the exclusion zone, but some areas appear qualitatively similar to sites in northern Montserrat, which are comparatively less affected by volcanic activity. Despite the availability of apparently suitable habitat, we captured only a single adult male lizard in the permanent exclusion zone, suggesting that volcanic activity in this area may have a dramatic impact on lizard abundance.

Additionally, we compared body size among populations of *A. lividus* across the island, and compared current average body size to those of ethanol-preserved specimens in the Museum of Comparative Zoology collections at Harvard University, which were collected before the major volcanic eruption. We find that average body size (snout–vent length) is lower in recently-sampled populations, which may indicate that persistent volcanic episodes periodically deplete populations, making it rare for males to attain larger body sizes. Interestingly, however, the sole male found in the exclusion zone was also the largest collected to date, suggesting that large body size may facilitate colonization or persistence in this highly disturbed area. Because lizard abundance in the exclusion zone is extremely low, it is possible that volcanic activity may cause local extinction and may also delay or hamper recolonization.

Materials and Methods.—Because of the periodic fluctuations in volcanic activity, Montserrat is subdivided into zones that vary according to risk, which the Montserrat Volcano Observatory (MVO) monitors and updates according to current conditions (Fig. 3). While most of the north is permanently open, areas south of Salem in the west and Jack Boy Hill in the east are restricted, especially when volcanic activity increases. Even when the volcano is relatively calm, these areas are more affected by acid rain, ash, and pyroclastic activity than the northern half of the island. Travel into the permanent exclusion zone is prohibited, but the MVO granted our team special permission to enter the northwestern fringe of the exclusion zone for one day (29 June 2009) to survey *Anolis*



FIG. 2. Adult male *Anolis lividus* captured in Jack Boy Hill, in northeastern Montserrat.

COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND

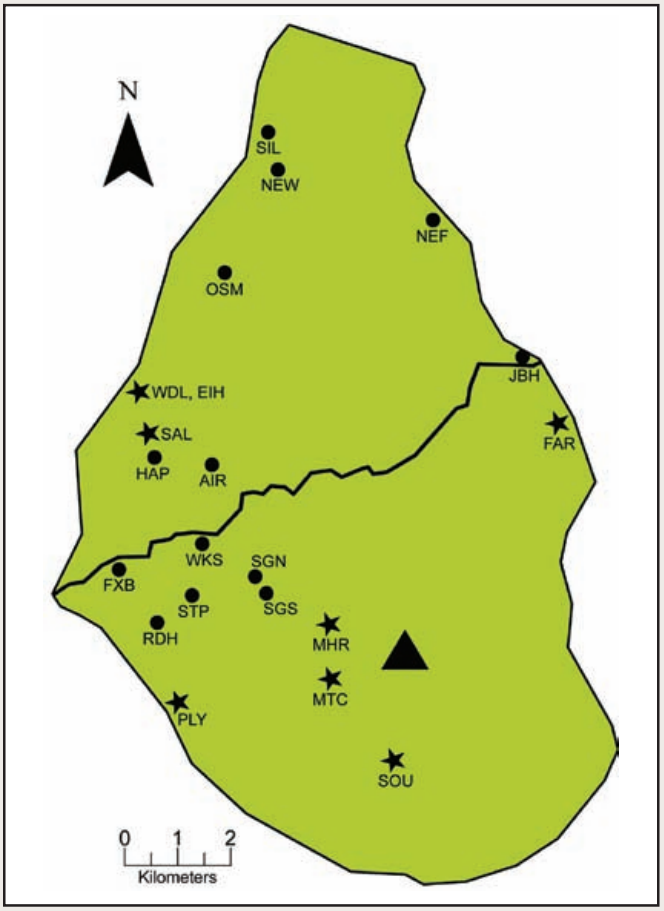


FIG. 3. Map of Montserrat showing our sampling strategy. Black dots denote localities sampled in 2009 and 2010 and stars denote localities sampled before the eruption (museum specimens). The black line shows the permanent exclusion zone boundary, and the triangle shows the location of the Soufrière Hills volcano.

TABLE 1. Data for body size and habitat conditions collected from wild-caught and museum specimens. Sites visited in the exclusion zone are denoted with an asterisk (*).

Locality	Abbreviation	Coordinates (lat, long)	Individuals	Min SVL (mm)	Max SVL (mm)	Ash Impact	Sulfur Odor	Acid Rain Impact
Summer Sampling (June 2009)								
Air Studios	AIR	16.74, -62.22	13	43.3	60.4	Low	Absent	Absent
Jack Boy Hill	JBH	16.76, -62.16	5	41.8	60.7	Low	Absent	Absent
Northeast Field	NEF	16.78, -62.18	13	47.2	64.5	Low	Absent	Absent
Sturge's Park*	STP	16.72, -62.22	0	-	-	High	Present	Absent
Richmond Hill*	RDH	16.71, -62.22	0	-	-	High	Present	Absent
Weeke's*	WKS	16.73, -62.22	1	-	67.9	Low	Absent	Absent
Fox's Bay*	FXB	16.72, -62.23	0	-	-	Low	Present	Absent
St. George's Hill - N*	SGN	16.72, -62.21	0	-	-	High	Present	Present
St. George's Hill - S*	SGS	16.72, -62.21	0	-	-	High	Present	Present
Winter Sampling (January 2009, 2010)								
Silver Hills - Rendezvous Bay	SIL	16.81, -62.20	11	44.7	63.9	Low	Absent	Absent
New Town	NEW	16.80, -62.20	13	48.6	63.5	Low	Absent	Absent
Old Sugar Mill	OSM	16.78, -62.21	7	41.3	58.2	Low	Absent	Absent
Happy Hill	HAP	16.74, -62.22	10	44.7	64.5	Low	Absent	Absent
Summer Sampling Museum Specimens								
Emerald Isle Hotel	EIH	-	5	56.3	68.4	-	-	-
Farmer's Estate	FAR	-	7	48.2	70.8	-	-	-
Monkey Hill River	MHR	-	2	55.5	62.0	-	-	-
Mount Chance	MTC	-	2	50.8	58.9	-	-	-
Plymouth	PLY	-	14	50.0	64.7	-	-	-
Salem	SAL	-	2	48.9	50.0	-	-	-
South Souffriere	SOU	-	1	-	55.4	-	-	-
Woodlands	WDL	-	7	51.5	62.8	-	-	-
Unknown	UNK	-	1	-	64.8	-	-	-

lividus, providing a first glimpse into lizard habitat conditions in this area.

In the exclusion zone we visited six sites of varying degrees of volcanic impact and seven sites outside of the zone (Table 1, Fig. 3). Because our time was limited in the exclusion zone, we qualitatively assessed each site we visited for relative ash, sulfur, and acid rain impact as compared to sites we visited in the safe zone. Ash impact referred to abundance of standing ash. We considered a site to have low ash impact if only a light coat of ash was present, no more than a few centimeters deep, and high impact when large quantities of standing ash were present, often at least half a meter high. Two observers confirmed the odor of sulfur and the presence of trees denuded of leaves with blanched trunks and branches were considered strong evidence of acid rain damage.

We captured adult male lizards with a standard noose and using digital calipers we measured body length (snout–vent length; SVL), which is the distance from the tip of the snout to the cloaca. We captured and measured individuals from populations outside of the exclusion zone in the winters of 2009 and 2010 (N = 43) and in the summer of 2009 (N = 30). We kept summer and winter individuals separate for statistical analyses because population body size can vary by season in lizards.

We also measured SVL for 41 ethanol-preserved specimens of adult male *A. lividus* from the Museum of Comparative Zoology at Harvard University, all of which were captured before the 1995 eruption (Table 1). While there was no minimum body size for inclusion in our analyses, we only considered samples captured in summer because of low sample size for museum specimens captured in winter. Because exact coordinates are unavailable for these animals we provide approximate localities based upon the available information of capture site. We performed all analyses on log-transformed data using SPSS ver. 16.0 statistical software (SPSS Inc., Chicago, Illinois; http://www.spss.com). We conducted



FIG. 4. Image of several trees and a satellite dish damaged by acid rain in St. George's Hill (SGS), in the exclusion zone. The damaged trees are defoliated with blanched trunks and branches.

a one-way ANOVA on mean body length to determine if SVL of ethanol-preserved specimens differed from that of the animals we captured in summer and in winter. We performed post-hoc tests (Tukey) to identify populations that differed from each other.

Results.—While sites in the north are qualitatively quite similar to each other, there are pronounced environmental differences between the sites visited in the exclusion zone (Table 1). Ash impact in Fox's Bay and Weeke's was low and comparable to sites outside of the exclusion zone (Air Studios, Northeast Field, Jack Boy Hill), but the remaining sites had considerably more ash present. Acid rain damage was noticeable only in St. George's Hill, although it may affect other sites to a lesser extent (Fig. 4). We noticed a distinct sulfurous odor in the air in all exclusion zone sites except Weeke's, and it was not appreciable anywhere outside of the exclusion zone. While the sites within the exclusion zone differed from each other environmentally, they were similar in that lizard abundance was very low. While lizards were abundant in the sites sampled outside of the exclusion zone, we observed only two animals (a mating pair) in a day of surveying, both of which were perching on the same tree in Weeke's.

We divided our data into three groups: winter 2009/2010, summer 2009, and summer-collected museum specimens. Histograms (Fig. 5) show the distributions of body size for the summer 2009 (N = 30, mean = 56.9 mm, SD = 5.7), winter 2009/2010 (N = 43, mean = 53.9 mm, SD = 6.8), and museum collection lizards (N = 41, mean = 59.9 mm, SD = 5.8). The male we caught in the exclusion zone (SVL = 67.9 mm) is also the largest lizard we have sampled to date across all seasons. However, several lizards from the museum collections were larger than this male, and the largest lizard sampled on Montserrat is 70.8 mm in body length. An analysis of variance (ANOVA) revealed that mean SVL differed significantly between groups sampled ($F = 9.785$, df=2, $p < 0.001$), and a post-hoc test (Tukey) showed that only the winter samples and the museum specimens were significantly different from each other ($p < 0.001$).

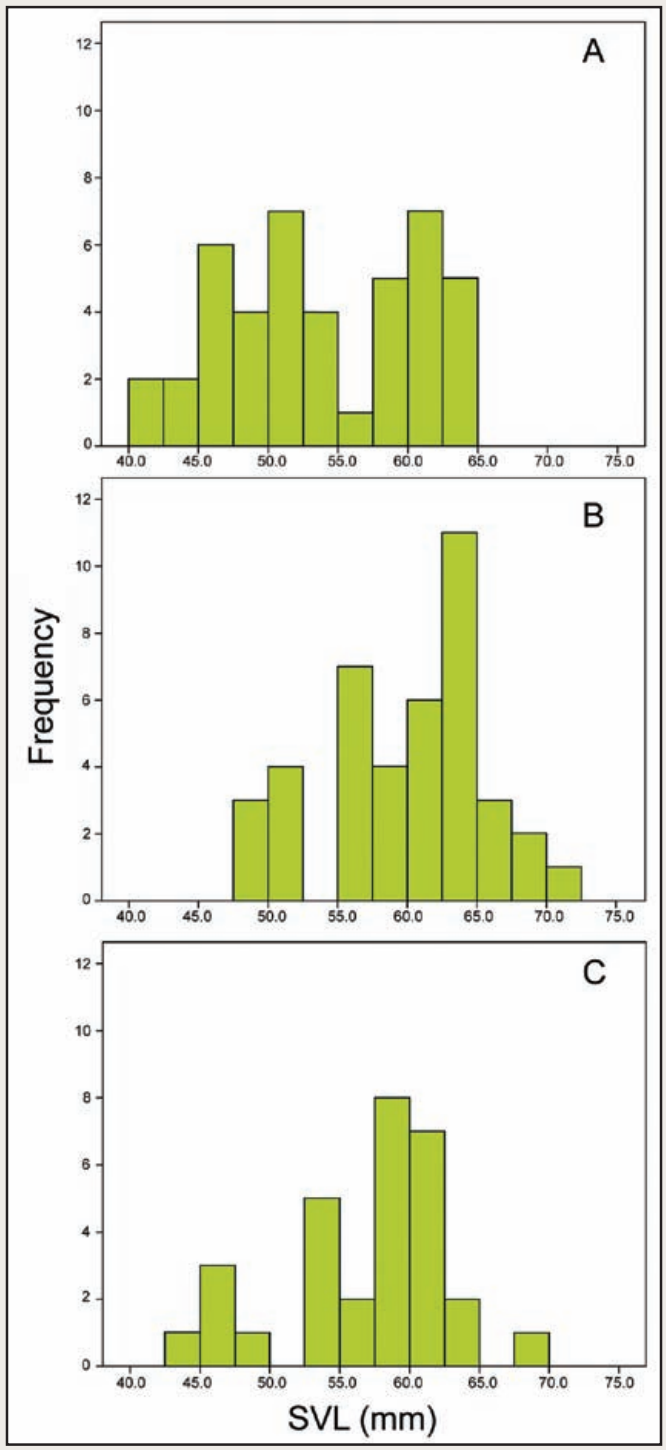


FIG. 5. Histograms depicting distributions of body length (SVL) for (a) lizards captured in winter 2009/2010, (b) museum specimens captured in summer before the eruption of 1995 (c) lizards captured in summer 2009.

Discussion.—Our field observations revealed that habitats within the exclusion zone differed qualitatively in their degree of volcanic impact. Most importantly, the sites closest

to the boundary of the exclusion zone, Fox's Bay and Weeke's, appeared very similar to our sampling sites outside the zone, except that a sulfurous odor was appreciable in Fox's Bay. Despite being qualitatively more similar to the northern portion of Montserrat, all sites within the exclusion were alike in that *Anolis lividus* was uniformly scarce. We sampled as close to Plymouth as we could safely get (Richmond Hill), where *A. lividus* was considered ubiquitous before the eruption and now appears absent or nearly so (Lazell 1972). The only two lizards that we found in the exclusion zone were a mating pair in Weeke's, the site that is physically closest to the exclusion boundary and also qualitatively most similar to the north. Furthermore, this male was the largest lizard by more than 3 mm that we have sampled to date (although it is also 3 mm smaller than the largest museum specimen).

Mean body size in winter-caught lizards was significantly smaller than the summer-caught museum population, which is not unexpected because body size increases from winter into the breeding season. However, if seasonal effects alone could account for the difference in body size between museum and winter-caught specimens, then the winter specimens should also be significantly smaller than our summer-caught specimens, but this is not the case. Although not significant, there is a trend towards larger average body size in the museum specimens than in the summer 2009 samples. This may reflect a collection bias towards larger animals in the museum collections, but cannot explain why we have not caught larger animals. The largest museum specimen (SVL = 70.8 mm) is much larger than the biggest (SVL = 67.9 mm) and second largest (SVL = 64.5 mm) specimen, collected at Weeke's and Happy Hill, respectively. Our collection technique is completely agnostic; we capture any adult males we see and given that larger males should be more conspicuous it appears that larger males are potentially less abundant..

Population size in anoles can be quite large, especially in the West Indies, and is fairly constant between years (Andrews 1979; Losos 2009; Schoener 1985, but see Schoener and Schoener 1978). The scarcity of anoles in the exclusion zone, an area where *A. lividus* once abounded, suggests that populations within the exclusion zone potentially go locally extinct more often, and that more persistent environmental assaults in that area may retard recolonization efforts as compared to sites further north. Although recolonization by canopy insect populations is quite rapid (Marske et al. 2007), it would likely take more time for lizards, which have a longer generation time and take longer to disperse than flying insects. Furthermore, dispersal from the north into more suitable parts of the exclusion zone may be hampered by the Belham River valley, a wide mudflat straddling the exclusion boundary, as this barren riverbed is periodically covered in ash and pyroclastic material. However, long-term ecological surveys are needed to tease apart the patterns affecting local abundance and extinction. As we sample populations at a single point in time we lack detailed data regarding the ecological fluctuations a given region has undergone due to volcanic activity that can affect local extinction and recolonization.

If periodic episodes deplete populations closer to the exclusion zone more often, then it would be rare for males to live long enough to grow very large in that area, but the largest male we sampled in our trip came from Weeke's, in the exclusion zone. It is possible that larger animals are more resilient to periodic environmental fluctuations, such as crashes in insect populations. Larger lizards are socially dominant over smaller males, and have better territories, which may be more important in areas that are periodically food-limited by crashes in insect populations (Rand 1967; Stamps and Krishnan 1994; Stuart-Smith et al. 2007; Trivers 1976). Again, more sampling in the permanent exclusion zone is needed to determine if the male we caught was rare, or if there is greater size spread in populations close to the volcano. Further investigation of *Anolis lividus* both within and outside the permanent exclusion zone will provide insights into the ecological processes influencing response to continual volcanic activity.

Material Examined.—All samples are from the Herpetology collections at the Museum of Comparative Zoology (MCZ) at Harvard University. Specimen numbers and corresponding localities are provided. MCZ 18318 (Plymouth), MCZ 38379 (Plymouth), MCZ 57785 (Plymouth), MCZ 57786 (Plymouth), MCZ 57787 (Plymouth), MCZ 65333 (Plymouth), MCZ 65335 (Plymouth), MCZ 82022 (Plymouth), MCZ 82023 (Plymouth), MCZ 82024 (Plymouth), MCZ 82025 (Plymouth), MCZ 82026 (Plymouth), MCZ 82027 (Plymouth), MCZ 82028 (Plymouth), MCZ 82032 (Woodlands), MCZ 82033 (Woodlands), MCZ 82034 (Woodlands), MCZ 82035 (Woodlands), MCZ 82036 (Woodlands), MCZ 82037 (Woodlands), MCZ 82038 (Woodlands), MCZ 82044 (Farm Estate), MCZ 82045 (Farm Estate), MCZ 82046 (Farm Estate), MCZ 82047 (Farm Estate), MCZ 82048 (Farm Estate), MCZ 82049 (Farm Estate), MCZ 82050 (Farm Estate). Collected by Julian Boos in 1970: MCZ 125465 (Salem), MCZ 125466 (Salem), MCZ 125468 (Monkey Hill River), MCZ 125469 (Monkey Hill River), MCZ 125470 (Emerald Isle Hotel), MCZ 125472 (Emerald Isle Hotel), MCZ 125473 (Emerald Isle Hotel), MCZ 125474 (Emerald Isle Hotel), MCZ 125475 (Emerald Isle Hotel), MCZ 65331 (South Soufrière), MCZ 82042 (Mount Chance), MCZ 82043 (Mount Chance), MCZ 55837 (Unknown).

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Slevin's Bunchgrass Lizard (*Sceloporus slevini*) Population Barely Extant on the Sonoita Plain, Arizona

Species can be rare because they are truly rare, highly spatially clumped, or elusive due to species characteristics, and when all three determinants are operating there is a compounded effect on rarity (McDonald 2004; Rabinowitz 1981). For species that are truly rare it is important to obtain reliable information on population trends and to determine whether downward trends are simply natural population fluctuations or trajectories likely to result in extinctions (Barrows 2006). Ultimately, however, the critical need is to determine the reasons for rarity so that appropriate conservation measures can be implemented (Barrows 2006; Roberts et al. 2009). Slevin's Bunchgrass Lizard, *Sceloporus slevini* (formerly *S. scalaris slevini*, see Smith et al. 1996) meets all three of the above determinants of rarity within its limited range in the United States. This small and secretive species is a bunch grass specialist that is rarely observed far from its bunch grass refugia (Fig. 1). Although widely distributed at high elevations along both axes of the Sierra Madre Occidental of Mexico from northern Durango to northern Chihuahua, in the United States it occurs in a limited series of disjunct populations, largely within the Madrean Archipelago of southeastern Arizona where populations are mainly confined to isolated montane meadows above 2100 m (Smith et al. 1997). In addition, several disjunct lower elevation populations (~1300–1600 m) have been recorded in the plains grasslands of Arizona and New Mexico (Bock et al. 1990; Dixon and Medica 1965; Lowe 1964; Smith et al. 1998; Stebbins 2003).

Anthropogenic and non-anthropogenic events have been implicated in the reports of past and recent population declines of *S. slevini* at sites where they were once abundant. Ballinger and Congdon (1996) searched the study areas they worked in the Chiricahua Mountains in the 1970's when densities ranged from 100–200 lizards per hectare (Ballinger and Congdon 1981), but found only four juveniles, attributing the decline to overgrazing by cattle. In 1998 *S. slevini* was reported "decimated" at the National Audubon Society Appleton-Whittell Research Ranch (ARR), a relatively low elevation site (~1478 m) on the Sonoita Plain of Arizona (Smith et al. 1998). Despite intensive searching during June–September of 1997, a group of researchers failed to find any *S. slevini* (Smith et al. 1998). Nine years previously, relatively high numbers of lizards had been recorded at the same sites (Smith et al. 1998). For example, from 12–20 August 1989, 53 adults were recorded from ARR and adjacent areas of the Sonoita Plain (Bock et al. 1990). One of us (TM) also worked at ARR during the mid-1990's when lizards were abundant (Mathies and Andrews 1995) and similarly noted their subsequent disappearance. The decline and potential extirpation of this population was attributed to a prolonged drought (Smith et a1. 1998).

The population of *S. slevini* at ARR is considered important, in part, because it is one of the few large populations known in plains grassland (Bock et. al. 1990). There are also differences in life history attributes between the ARR population and montane populations, including the phenology of reproduction, two vs. one clutch of eggs a season (Mathies and Andrews 1995), and a larger body size (Mathies and Andrews 1995; C. d'Orgeix, unpubl. data). Genetic differences are implied by the absence of unicolor individuals in the ARR population (Smith et al. 1990; T. Mathies, unpubl. data). Unicolor individuals occur in various proportions in the montane populations in northern Chihuahua, Mexico (22%; Anderson 1972) and the United States (20%; Van Devender and Lowe 1977). Unicolor individuals also occur in populations in close proximity to the ARR population in the Huachuca Mountains at Ramsey Canyon (Smith 1946), and on Carr Peak (C. d'Orgeix and T. Mathies, unpubl. data), indicating a lack of genetic exchange between ARR and montane populations. Because of the possible differentiation of this population from other nearby populations, our objectives were to determine whether the species is still extant at ARR, and if so, to establish survey plots and methodology for future monitoring efforts.

Materials and Methods.—Our study area is on the 3160-ha ARR on the Sonoita Plain, Santa Cruz County, Arizona, a plains grassland-oak savanna, which unlike the surrounding region, has not been grazed by livestock for over 42 years. Stratified sampling was used to select 10 sites in areas that appeared to be good habitat for *S. slevini*, having primary coverage of bunch grasses interspersed with low woody shrubs and patches of bare soil. One 100 x 100 m plot was established on each site by selecting a random position as plot corner and then mapping out the other three corners in Universal Transverse Mercator coordinates (Datum: NAD27 CONUS) using handheld global positioning system (GPS) units (Models: GPSmap 60CS and Rhino530, Garmin International Inc., Olathe, KS, USA). Three of the 10 sites were located within the area where Bock et al. (1990) initially found *S. slevini* to be abundant (C. Bock, pers. comm.), and where Smith et al. (1998) later found them apparently absent. Plots

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were surveyed 10 June to 29 July, 2007 [10 years after Smith et al. (1998)] and again 24 July to 4 August, 2009. Each plot was surveyed three times each year on three different days. A GPS unit was used to navigate a series of parallel non-overlapping "transects" across the width of each plot. Each transect was surveyed by two to three persons walking side by side approximately two meters apart. Plots were surveyed between 0730 h and 1800 h when conditions were sunny, or if overcast, when air temperatures were high enough for lizard activity (see Mathies and Andrews 1995). We walked 8 to 11 transects per plot per day at about 2.5 kph with each person walking a total of about 1080 m distance per plot. Lizards were located visually while walking transects and captured by hand. To identify individuals we recorded their sex and measured each lizard's snout–vent length (SVL) to the nearest 1 mm, body mass to nearest .01 g and removed 2–4 mm of tissue from the tip of the tail. GPS location was recorded and the lizard was released at its point of capture. Individuals were subsequently identified based on the missing tail tip, location, sex, SVL, and mass. Coordinates of plot corners and individual *S. slevini* were mapped using ArcView (Version 3.2, ESRI, Redlands, CA, USA) Geographical Information System (Fig. 2).

Results and Discussion.—We confirmed that *S. slevini* was present at ARR on both years of the study. However, despite intensive searching, few were encountered in 2007 (N = 5, 2 males and 3 females) and in 2009 (N = 3, 2 females and 1 male). Thus, densities appear to be quite low (1–2.5 lizards per 100 m^2, for occupied plots). Lizards were detected on four of our ten plots. The only plot on which lizards were detected in both study years was Plot 2, which was within the area censused by Smith et al. (1998). Four of the five lizards detected in 2007 were on Plot 5, but we detected no lizards there in 2009. Within years, only one of the eight lizards found was recorded on a subsequent census. These data contrast with 2006 and 2007 censuses of a high elevation population in the Huachuca Mountains where the same individuals were seen on subsequent days at the same locations (D. Bridgers, C. d'Orgeix, and T. Mathies, pers. obs.).

In 1989 when lizard densities were high, Bock et al. (1990) encountered approximately 9 lizards per man-hour. However, in 1997 Smith et al. (1998) walked a total of 7 km in June and again in August reporting a total absence of *S. slevini*. We found that detection of a single *S. slevini* on our plots in 2007 and 2009 required coverage of about 6.4 km and 10.7 km of transect at about 2.5 and 4.3 man-hours, respectively.

Smith et al. (1998) suggested that *S. slevini* is adapted to the more mesic high elevations and that the two consecutive years of severe drought (1995–1996) preceding the observed decrease was the cause of the ARR population decline. Precipitation data from ARR support both contentions; prior to the observed abundance in 1989, the study area experienced two consecutive years of much higher than average precipitation (1983, 1984) followed by another four consecutive years of above average precipitation (Fig. 3A). Except 2000,



FIG. 1. Male *Sceloporus slevini* in the bunchgrasses *Bouteloua gracilis* and *B. curtipendula* at the National Audubon Society Appleton-Whittell Research Ranch, Santa Cruz County, Arizona.

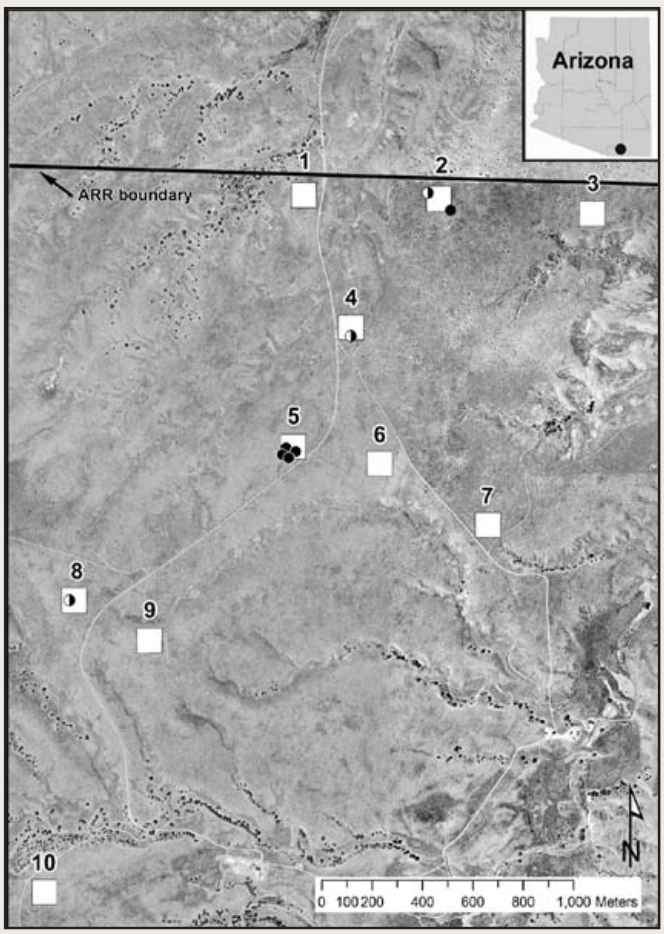


FIG. 2. Distribution of the ten 100 x 100 m survey plots for bunch grass lizards, *Sceloporus slevini,* on the National Audubon Society Appleton-Whittell Research Ranch (ARR), Santa Cruz County, Arizona. The filled circle in the inset indicates the general location of the study area. Numbers above plots are plot numbers. Filled (2007) and half-filled (2009) circles are the locations of the eight *S. slevini* detected in this study.

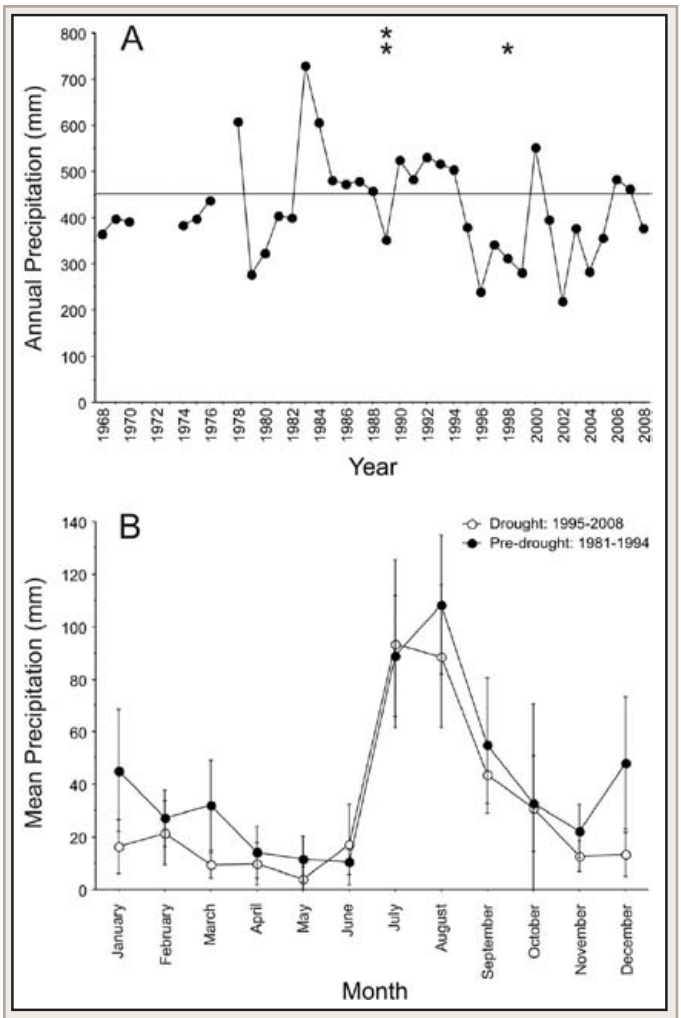


FIG. 3. A) Annual precipitation at the National Audubon Society Appleton-Whittell Research Ranch, Santa Cruz County, Arizona. Data for years 1971–1973 and 1977 were not available. The horizontal line represents the mean precipitation for 23 years of available data from 1968–1994 prior to onset of drought in 1995. Double asterisks indicate year when high densities of *Sceloporus slevini* were observed (1989: Bock et al. 1990); single asterisk indicates year when no lizards were observed (1998: Smith et al. 1998). B) Mean (± 95% confidence interval) precipitation by month. Filled circles are for 14-year period prior to onset of drought (1981–1994); unfilled circles are for 14-year period from when recent drought began (1995) to present (2008).

2006, and 2007, below average precipitation totals have continued to present (Fig. 3A).

Certain life history attributes of *S. slevini* enable rapid population increase under favorable environmental conditions. Unlike females in nearby montane populations, females in the ARR population can produce two clutches a season (Mathies and Andrews 1995; see also Ortega and Barbault 1986). Moreover, *S. slevini* is an early maturing species; because hatchlings are periodically active on sunny winter days and exhibit winter growth, sexual maturity is attained by the first spring (Ballinger and Congdon 1980; Newlin 1976). However, other attributes would result in rapid population decline if this species is sensitive to drought. Adults are short-lived with an estimated yearly mortality of 62-76% in a montane population (Ballinger and Congdon 1981). Thus any population sustaining two consecutive years of no recruitment could be reduced to low levels or extirpated.

Precipitation data for the months when nesting and egg incubation occur do not support the idea that drought directly affected egg laying and hatching success. Again, when comparing the 14-year period of pre-drought years and the subsequent 14-year period of drought years, mean monthly precipitation for the three months when egg laying and hatching occur (July–September: Mathies and Andrews 1995) did not differ (two-factor ANOVA; $F_{1,75} = 1.16$, $P = 0.28$), nor was the interaction significant (Fig. 3B; $F_{2,75} = 0.99$, $P = 0.38$). The drought has instead been primarily manifest in the months outside the July–September nesting-hatching season (two-factor ANOVA; $F_{1,224} = 12.19$, $P = 0.0006$). Because *S. slevini* is an early maturing species with rapid population turnover, population persistence requires that hatchlings of both sexes grow substantially during these months in order to reach sexual maturity by first spring. Maturing females, in addition to obtaining resources necessary for growth, must also acquire food for the fat body growth required for egg production. Food abundance and growth rates of all size classes of *S. slevini* were shown to be lower in a drought year than a non-drought year (Ballinger and Congdon 1980) and the phenology of fat body development in females indicates that reserves accumulated in the fall are used for egg production in the spring (Newlin 1976). Regardless, a proximate mechanism for a drought-induced population crash remains unclear.

Climate change (warming) has recently been implicated in local extinctions at 12% of 200 sites surveyed since 1975 for 48 *Sceloporus* species in Mexico, and lizard extinctions are projected to increase globally (Sinervo et al. 2010). The population crash of *S. slevini* at ARR may therefore be symptomatic of this larger trend. However, another low-elevation Sonoita Plain population, approximately 30 km SW of ARR, appears to have relatively high numbers of lizards (C. d'Orgeix and T. Mathies, pers. obs.), and high elevation populations in the Huachuca and Chiricahua Mtns. appear to be robust (C. d'Orgeix and T. Mathies, pers. obs.). These data contrast with the expectation that either other nearby low elevation populations should show similar declines in population numbers, or that lower elevation populations should be less adversely affected by global warming than higher elevation populations (Sinervo et al. 2010). Furthermore, the contrasts in population numbers between ARR and other nearby populations indicate that environmental complexity (Barrows and Allen 2007) masks the proximate causes for the decline at ARR.

Our primary finding that the population at ARR remains extant, albeit at extremely low numbers, presents a unique opportunity to compare this population's dynamics with those of other populations of *S. slevini* at both low and high elevations to test hypotheses of drought influenced

population declines (Barrows 2006), differences in environmental complexity between populations (Barrows and Allen 2007) and climate change extinctions (Sinervo et al. 2010).

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Using Scrape Fishing to Document Terrapins in Hibernacula in Chesapeake Bay

Chesapeake Bay's Diamondback Terrapin (*Malaclemys terrapin terrapin*) population has made considerable recovery from the commercial exploitation that led to its near extirpation in the late 19th and early 20th centuries (Carr 1952; McCauley 1945). Nevertheless, it continues to face increasing threats from human population growth, degradation of the Bay, exposure to man-made hazards (Butler et al. 2006; Roosenburg 1991; Siegel and Gibbons 1995), and, during the period of this study (2003–2005), continued commercial harvest in the Maryland portion of the Bay. The state of Maryland maintained an active terrapin fishery that was closed only during the terrapin nesting season (May–July), had no daily or seasonal catch limit, and exclusively targeted breeding-age females, i.e., terrapins with plastron length ≥15.2 cm. Although the fishery was perceived as small, with little market demand, the long season and 'no limit' regulation left the fishery vulnerable to overharvest. Concern over this vulnerability led us to examine the method of traditional winter harvest and characteristics of terrapins occupying hibernacula. Although generations of Chesapeake Bay watermen have pursued winter harvest of terrapins, fishing methods, locations of hibernacula, and the terrapins occupying them have not previously been documented.

Here we utilize watermen fishing skills and harvest methods to locate, sample, and describe terrapins occupying estuarine bay hibernacula. Because the region has long been a center for the commercial harvest of Blue Crabs (*Callinectes sapidus*), we also examine terrapin captures for potential effects of selective by-catch mortality of small terrapins associated with decades of commercial crab pot use in the region (Roosenburg et al. 1997; Warner 1977; Wood 1997).

MATERIALS AND METHODS

We sought collaboration with a former terrapin harvester to learn fishing methods and to access hibernacula in the Tangier Sound region of Chesapeake Bay (Fig. 1). Tangier Sound is bordered by extensive brackish tidal marshes and historically has harbored large terrapin populations (McCauley 1945). Sampled hibernacula were chosen to be geographically separated and to represent a selection of sites of former terrapin harvest. Four sites were chosen near large marsh islands ca. 8–12 km offshore (Smith Island, South Marsh Island, and Bloodsworth Island) and two additional sites were located near the mainland (Janes Island and Nanticoke River; Fig. 1). Two sites located within tributaries (Nanticoke River and Janes Island) and a third located within interior South Marsh Island were within zones where commercial crab potting is prohibited by state regulation. The remaining three sites (Smith Island–N, Smith Island–S, and Bloodsworth Island) were within areas of heavy potting activity. We also selected St. Jerome Creek, a site of former harvest on the western shore of Chesapeake Bay that differed in being located in a navigable tidal creek having forested shoreline in lieu of extensive bordering salt marsh.

To capture terrapins watermen adapted a dredge, or scrape, used to capture molting blue crabs from shallow, near-shore waters using locally built, shallow-draft vessels (also called scrapes; Warner 1977). Being hand-made, terrapin scrapes vary in size, but most are based on a 1.5 m wide blue-crab design. In 2003, we used a blue crab scrape that was modified by attaching a larger mesh catch bag and welding 12 short 7.6 cm teeth every 13 cm along the scraping bar. The larger mesh bag (8 cm) helped minimize fouling and the teeth dug terrapins from bottom sediment. In 2004 and 2005, we used a slightly larger scrape framed from heavier 2 cm diameter steel stock. Its entrance measured 1.7 m × 0.4 m and its overall length was 2.4 m (Fig. 2a). The noteworthy difference of this scrape was the addition of numerous (30), longer (15 cm), and more closely spaced (6 cm) teeth on the scrape bar.

The scrapes were towed in a circular pattern behind a 12 m work boat and retrieved by hydraulic winch. The length of the tow rope was critical to proper operation as it adjusted the drag or "bite" of the scrape in bottom sediment. Capture success was measured by the number of terrapins captured/tow. Although there was no fixed time limit for each tow, several hundred tows averaged about 7 min in length, or a rate of 8.6 tows/h. While some commercial scrapes were equipped with side baffles to help guide terrapins into the catch bag, neither of our scrapes had baffles.

Captured terrapins were given a visible mark by drilling a 5 mm diameter hole in the 10th right marginal scute through which we attached a serially numbered monel fish tag (tag no.1005–3: National Band and Tag Co., P.O. Box 72430, Newport, Kentucky 41072). Passive integrated transponders, or PIT tags (model TX1400L: Biomark, Inc., 7615 West Riverside Drive, Boise, Idaho 83714), were used as permanent marks. Size dimorphism and tail characteristics (tail length and anus position in relation to edge of carapace) were the primary

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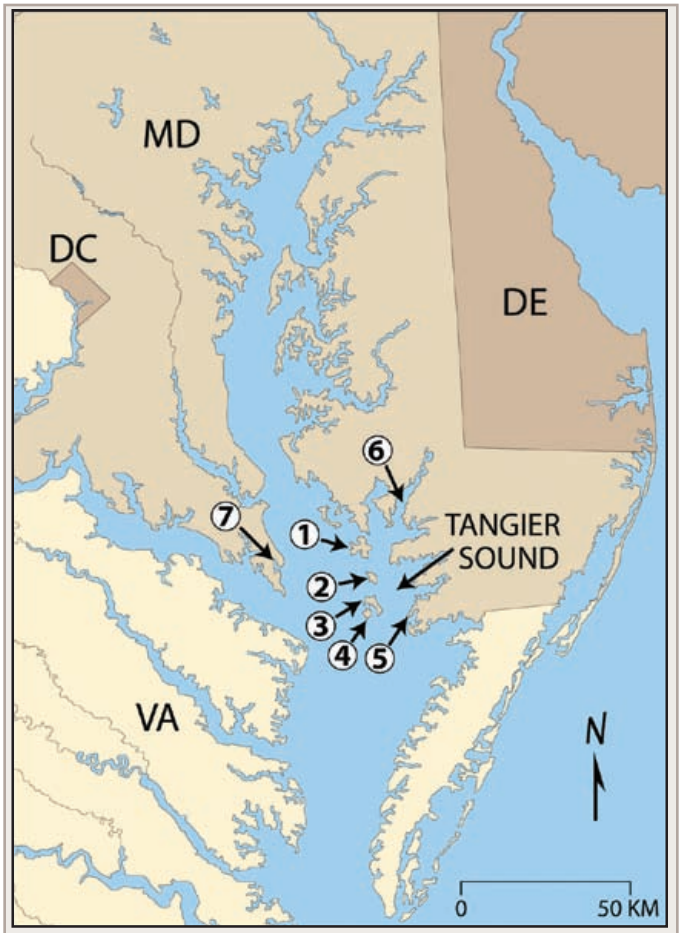


FIG. 1. Chesapeake Bay and vicinity showing Tangier Sound and the location of sites of winter sampling of Diamondback Terrapins, 2003–2005: 1) Bloodsworth Island, 2) South Marsh Island, 3) Smith Island–North, 4) Smith Island–South, 5) Janes Island, 6) Nanticoke River, and 7) St. Jerome Creek.

criteria used to sex terrapins (Carr 1952). Because only terrapins about 10 years of age (YOA) or younger could be aged by annular growth rings (as read from plastral pectoral scutes), we separated captures into two basic age classes: those ≤10 and those >10 YOA. Body mass was measured with a digital electronic balance to the nearest g and midline plastron length (PL) was measured with calipers to the nearest mm.

To dispel concerns about possible detrimental physiological effects associated from removal of terrapins from hibernacula, we conducted a field study to determine if short-term acute effects did occur. This question has management relevance because we observed commercial terrapin harvesters leaving captures on boat decks for up to several hours before sorting their catch and returning culls to the bay. In our experiment, one set of 12 newly captured terrapins (6 of each sex) were maintained in bay water (5°C) while simultaneously exposing a second set of 12 terrapins in a heated boat cabin at ca. 24°C, a temperature well above the range of ambient air temperatures (10–15°C) experienced on a boat deck on a mild winter day. Both sets of terrapins were held for a

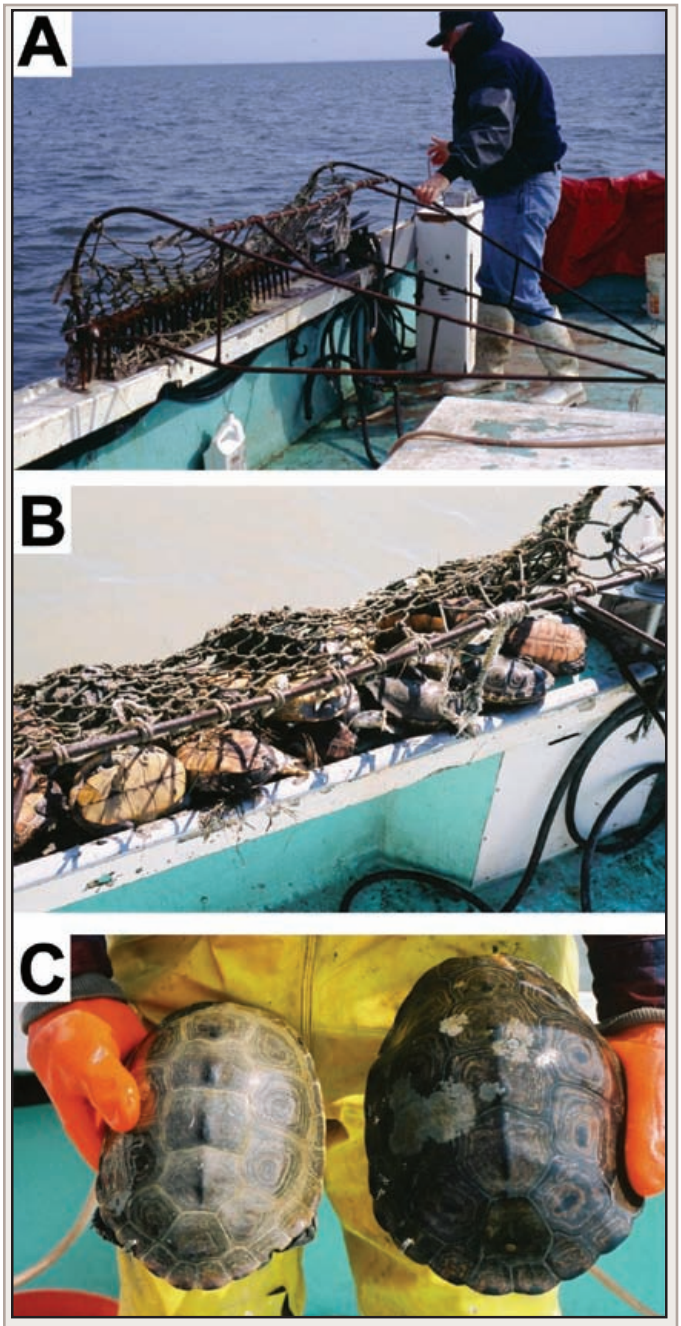


FIG. 2. A) A scrape, or dredge, used to harvest Diamondback Terrapins in winter in Chesapeake Bay. Design is based on a scrape used to harvest blue crabs but with heavier construction, addition of teeth on the scrape bar, and a larger mesh catch bag (see text for details). B) A retrieved scrape resting on the boat gunwale showing a good catch of terrapins. The scrape did not injure terrapins and as many as 24 were captured in a single tow. C) Two females caught 18 March 2005 from St. Jerome Creek demonstrate size and age in the diamondback terrapin. The female on the left (body mass of 1922 g, PL of 202 mm) was known to be 20 years of age by previous marking on the nearby Patuxent River (W. Roosenburg, pers. comm.). The female on the right is of unknown age and was the largest terrapin caught during our study (3022 g, PL of 228 mm). This specimen approximates the maximum size for the species within the Chesapeake Bay and likely within the species' range.

TABLE 1. Numbers and sex ratios of Diamondback Terrapins captured from six hibernacula in Tangier Sound and the St. Jerome Creek Site on the western shore of Chesapeake Bay, winters 2003–2005. Sites are listed by rank in cumulative sex ratio given as proportion female (*pf*).

Site	No. captures	Sex ratio (*pf*)
St. Jerome Creek	33	0.970 A[a]
Smith Island–S	74	0.784 B
Janes Island	222	0.734 B
Smith Island–N	377	0.719 B
South Marsh Island	141	0.709 B
Bloodsworth Island	160	0.588 C
Nanticoke River	168	0.345 D
Totals	1175[b]	0.660

[a] Values sharing the same letter are not different: individual 2-tailed z-tests of proportions ($\alpha = 0.05$).
[b] Totals exclude between-year recaptures (N = 22).

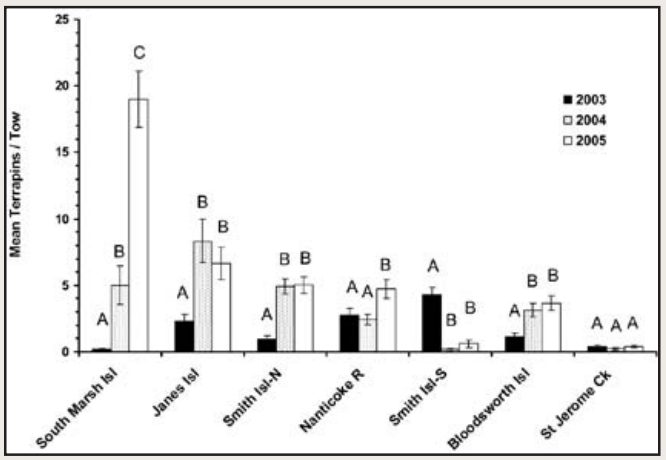


FIG. 3. A composite histogram of year- and site-specific terrapin capture rates (mean ± SE captures/tow) using a modified crab scrape in 2003 and a slightly larger scrape in winters 2004–2005. Capture rate had marked year and site effects ($P < 0.001$, individual tests using Kruskal-Wallis one-way ANOVA on ranks). Means within sites sharing the same letter do not differ: Dunn's multiple comparison test ($\alpha = 0.05$).

period of 2 h. Following the holding period, all terrapins were returned to the location of capture and placed in a 1.8 m × 2.4 m × 1.8 m wire holding cage made of 2.5 cm mesh galvanized chicken wire. The cage sat on the bottom and extended above tide level. After 3 weeks, the cage was retrieved and survival and outward condition of the terrapins assessed.

We used SigmaStat 3.1 (Systat Software, Inc, Point Richmond, California 94804) to evaluate assumptions of normality and homogeneous variance and to conduct analyses of variance. When necessary, we either transformed data to meet normality and equal variance or applied the nonparametric Kruskal-Wallis ANOVA test on ranks. Contrasts were tested using Tukey's test (parametric) or Dunn's method (non-parametric). Sex ratios and proportion of females <10 YOA were tested by 2-tailed *z*-tests of binomial proportions (Sokal and Rohlf 1995). We generated a simple Lincoln-Petersen estimate based on site-specific between-year recaptures to estimate hibernaculum population size (Seber 1973). This estimate is made under the assumption of population closure and equal catchability. We tested for two potential effects of selective by-catch mortality of smaller terrapins in crab pots as noted by Dorcas et al. (2007) and Wolak et al. (2010): larger size of both sexes based on PL and reduced presence of younger female terrapins. Data were combined across years within pot and no pot sample sites.

RESULTS

Hibernacula.—Hibernacula were located in semi-protected estuarine bays in near-shore shoal waters adjacent to extensive salt marsh. Sites had bottoms of moderately soft mud and were deep enough (1.5–3.5 m) to offer little risk of dewatering even under unusually low storm tides. Most bottoms were relatively clean of shell and organic debris; all were exposed to good tidal circulation but limited wave energy because of reduced wind fetch. Because terrapins were often buried in soft mud, continued scraping at such sites often increased capture success. On firm bottoms terrapins were only partially buried or not at all. Terrapins were not injured by capture and only rarely were they marked by the metal teeth or frame of the scrape (Fig. 2b).

Capture success.—During February and early March, 2003–2005, we captured 1175 terrapins from seven hibernacula (Table 1). Capture rate had a marked site and year effect ($P < 0.001$: individual tests, Kruskal-Wallis one-way ANOVA on ranks; Fig. 3). Capture rate for sites in Tangier Sound averaged 4.18 ± 1.02 SE captures/tow (N = 18), or about 36 terrapins/h. Capture rate generally increased in 2004 and 2005 with the use of the heavier scrape with longer, more closely spaced teeth (Fig. 3). The exceptions were the Smith Island–S site where harvest activity was suspected to have depleted the population in 2004 and 2005, and the St. Jerome site where capture success was low in all years (mean = 3.1 terrapins/h). St. Jerome Creek was the deepest site sampled at 3.5 m and during three winters produced the fewest (32 females and one male), but on average the largest terrapins. The largest, a 3022 g female with PL of 238 mm, was considerably larger than a known-age 20-year-old terrapin captured at the same site (Fig. 2c) and marked previously on the Patuxent River (W. Roosenburg, Ohio University, pers. comm.). Mass of 26 females averaged 2151 ± 56 g and PL ranged from 191 to 228 mm (mean 205 ± 1.6 mm). At our South Marsh site, heavy growth of eelgrass (*Zostera marina*) precluded capture of terrapins in 2003. However, in the absence of vegetation in 2004, capture success increased sharply, and in 2005, the site was our most productive hibernaculum, averaging19 terrapins/tow, or 160 terrapins/h (Fig. 3).

Sex ratio.—Sex ratio across all sites and years favored females: 0.66 proportion female (*pf*), or 1.94 females/male (N = 1175; Table 1). Cumulative yearly sex ratio declined from 0.730

pf in 2003 to 0.654 in 2004 and 0.641 *pf* in 2005 (P < 0.05: individual 2003 vs 2004, and 2003 vs 2005 *z*-tests of proportions). Discounting possible year effects, the decline in sex ratio was likely a result of use of the larger scrape with more numerous and closely spaced teeth that increased capture efficiency of males. Not only were generally more males captured, but the minimum size was lowered in some cases by as much as 15 mm. For sites within Tangier Sound, year- and site-specific sex ratio varied from a low of 0.32 *pf* to a high of 0.91 *pf*. The Nanticoke River, a site of known frequent terrapin harvest, was the only site where male captures outnumbered females (Table 1).

Estimate of female recruitment.—Using growth annuli to age terrapins, we found females ≤10 YOA to comprise 19.2% (145) of 764 captures. Site- and year-specific percentages varied from 0 to 39%. We estimated annual recruitment by assuming 100% annual survival in the 6-to-9 YOA classes and averaging the percent of these year classes to total annual female captures. Terrapins <6 YOA were not included because only 9 were captured (8 five-year-olds and 1 four-year-old); and 10-year-olds were excluded because advanced shell wear obscured growth annuli limiting the number that could be identified (N = 8). The 128 terrapins in the 6-to-9 year-old age classes represented 10.4%, 18.3% and 21.6 % of female captures during the respective three winters and yielded estimates of annual recruitment of 2.6%, 4.6%, and 5.4% (mean = 4.2 ± 0.83).

To eliminate potential error associated with reading growth annuli, we additionally estimated recruitment based solely on size metrics. We used mean size statistics from 44 known 9-year-old females, i.e., mean mass (1043 g), PL (165 mm), and mass-to-plastron ratio (6.340 g/mm), to separate females ≤9 YOA from all older females. The resulting mean estimates of percent annual recruitment were about 50% higher than those based on growth annuli: 6.0 ± 0.29% based on PL, 6.5 ± 0.35% based on mass, and 6.7 ± 0.16% based on mass-to-PL ratio. Although we recorded 19.2% of females ≤10 YOA, only 29 3-to-8-year-old males (7.9% of male captures) were so captured (χ^2 = 22.8, P < 0.001, 1 df). We concluded that too few males in the younger age classes were captured to provide a meaningful estimate of recruitment.

Growth rate.—Females in the 5-to-10-year-old age classes exhibited marked growth as mean mass increased by a factor of 3 (from 397 to 1184 g) and mean PL increased 50% (from 115.9 to 174.0 mm; Fig. 4). Based on the Maryland harvest regulation of a minimum PL of 152 mm, most female terrapins would reach harvestable size at between 7 and 8 YOA. Too few males were captured to adequately interpret growth in the 5-to-9-year-old age classes.

Recaptures.—We recaptured 102 terrapins (8.7% of captures) by various means up to four years after initial capture, but only 22 terrapins, 21 females (2.6% of female captures), and a single male (0.25% of male captures) were recaptured during winter sampling. All 22 recaptures were recorded at the site of original capture. Recaptures were sufficient to estimate hibernaculum population size only at the Smith Island–N site, where sampling was increased as part of an ongoing population study. Based on 13 female recaptures in 2005,

TABLE 2. Mean mass of male and female terrapins captured at six sites within Tangier Sound and St. Jerome Creek on the western shore of Chesapeake Bay, winters 2003–2005. Includes only unique adult captures (excludes between-year recaptures) of females >10 years of age and males >9 years of age. For the six Tangier Sound sites there was no rank correlation between site-specific mean mass of males and females (r = 0.54, P > 0.05, 4 df).

	Mean mass (g) ± SE			
Site	N	Female	N	Male
St. Jerome Creek	26	2150.6 ± 56.4 A[a]	—	—[b]
Smith Island–S	49	1589.2 ± 34.1 B	16	455.2 ± 5.03 A[c]
Smith Island–N	236	1386.7 ± 17.3 C	104	407.3 ± 5.03 C
Bloodsworth Island	81	1324.8 ± 34.5 CD	63	436.5 ± 7.91 AB
South Marsh Island	72	1285.8 ± 34.0 CD	32	390.9 ± 13.03 CD
Janes Island	111	1248.1 ± 23.2 D	53	358.3 ± 7.14 D
Nanticoke River	46	1181.7 ± 30.9 D	101	412.3 ± 5.39 BC
Combined	621	1393.5 ± 22.6	369	407.3 ± 3.19

[a] One-way ANOVA found marked site effect for female mass ($F_{6,614}$ = 52.2, P < 0.001). Means within columns sharing the same letter do not differ: Tukey's test (α = 0.05).

[b] Insufficient sample size.

[c] One-way ANOVA on ln transformed data found a marked site effect for male mass ($F_{5,363}$ = 16.0, P < 0.001). Means within columns sharing the same letter do not differ: Tukey's test (α = 0.05).

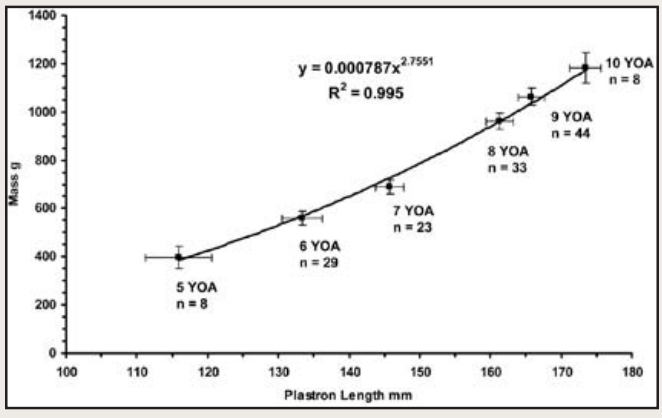


FIG. 4. Growth curve for 5- to 10-year-old female terrapins captured during winter sampling in the Tangier Sound region of Chesapeake Bay. Age was determined by counting growth annuli on plastral pectoral scutes. Points are means; brackets are ± SE. Small sample size in 5-year-olds resulted from general absence of these and younger (smaller) terrapins in estuarine bays in winter. Small sample size of 10-year-old terrapins resulted from shell wear that obscured growth annuli and limited the number that could be identified.

TABLE 3. Mean plastron length (PL) for male and female terrapins and the proportion of young females (*pf*) ≤10 years of age (YOA) captured at six sites within Tangier Sound, winter 2003–2005. Ranking in relation to zones with and without crab potting is shown. PL means include only unique captures (excludes between-year recaptures) of females >10 YOA and males >9 YOA.

Crab potting zone	Site	Mean plastron length (mm) ± SE Male (N)	Rank	Female (N)	Rank	*pf* ≤10 YOA	Rank
Pots	Smith Island–S	120.9 ± 1.16 A[a] (16)	1	186.8 ± 1.33 A[b] (49)	1	0.157 AB[c]	4
Pots	Bloodsworth Island	118.3 ± 0.73 A (63)	2	176.3 ± 1.49 BC (81)	3	0.133 B	6
Pots	Smith Island–N	116.2 ± 0.59 AB (104)	3	179.2 ± 0.72 B (236)	2	0.135 B	5
No pots	Nanticoke River	115.2 ± 0.57 B (101)	4	167.8 ± 1.40 D (46)	6	0.300 A	2
No pots	South Marsh Island	113.7 ± 1.24 BC (32)	5	174.5 ± 1.43 C (72)	4	0.309 A	1
No pots	Janes Island	111.5 ± 0.84 C (53)	6	173.9 ± 0.98 C (111)	5	0.186 AB	3
Combined		115.6 ± 0.33 (369)		178.2 ± 0.53 (595)		0.192 (764)	

[a] Kruskal-Wallis one-way ANOVA test on ranks found a marked site effect for plastron length (H = 48.0, P < 0.001, 5 df). Means within columns sharing the same letter do not differ: Dunn's test (α = 0.05).
[b] One-way ANOVA found marked site effects for plastron length ($F_{5,588}$ = 18.3, P < 0.001). Means within columns sharing the same letter do not differ: Tukey's test (α = 0.05).
[c] Values sharing the same letter are not different: individual 2-tailed z-tests of proportions (α = 0.05).

a mark-recapture estimate of 1210 females populated the site in winter 2004 (normal 95% C.I.: 684–1737; Seber 1973). Males were excluded from the estimate because no males were recaptured. However, based on the 2004 sample sex ratio of 0.744 *pf*, the estimate increases to 1613 when males are included. Based on capture rates, populations at two other hibernacula, Janes Island in 2004 and 2005 and South Marsh Island in 2005 (Fig. 3), likely exceeded this estimate.

Size characteristics.—Off-shore sample sites near Bloodsworth, Smith, and South Marsh Islands, had slightly heavier females than the near-shore sites of Janes Island and the Nanticoke River (Table 2). The largest females were at the St. Jerome site and the smallest at the Nanticoke River, a site of frequent harvest. Similarly, the mean mass of adult males (all >9 YOA) was highest for off-shore Smith Island–S/Bloodsworth Island sites and lowest for near-shore Janes Island (Table 2). As essentially all males are immune to commercial harvest by virtue of their small size, Nanticoke River males ranked comparatively higher in site-specific mean mass (third) versus the females captured there that ranked sixth (last). For the six Tangier Sound sample sites, site-specific mean mass of males and females was not correlated (Spearman rank *r* = 0.54, P > 0.05, 4 df). Consistent with the known dimorphism in the species, the mean mass of female terrapins (1276 g, N = 767) was about three times greater than that for males (401 g, N = 399). Only 4.6% of females (35 of 767) fell below a PL measurement of the largest male (138 mm).

Effects of crab pot bycatch.—We tested for the effect of selective crab pot mortality on female size and found female PL to be greater in pot versus no-pot zones (one-way ANOVA: $F_{1,593}$ = 47.7, P < 0.001; mean PL, pot zone = 179.6 ± 0.61, N = 366; mean PL, no-pot zone = 172.9 ± 0.73, N = 229). Because the male PL distribution was found to be non-normal, we applied the Kruskal-Wallis ANOVA test on ranks and found a larger median value in pot versus no-pot zones (*H* = 25.6, P < 0.001, 1 df; pot zone median PL = 117, N = 183; no-pot zone median PL = 114, N = 186). Site-specific tests showed a marked pattern of larger PL means at sites with crab potting that produced a consistent alignment of ranks to pot and no-pot zones (Table 3). We also found females to have a higher proportion of young ≤10 YOA in no-pot versus pot zones (one-way ANOVA: $F_{1,13}$ = 5.2, P < 0.04; mean proportion no-pot zone = 0.26 ± 0.13, N = 8; mean proportion pot zone = 0.11 ± 0.11, N = 7). Individual site-specific tests produced a

similar pattern of a higher proportion of females at sites in no-pot zones with a consistent alignment of ranks to pot and no-pot sites (Table 3).

Testing for acute effects.—On initial placement of the 24 terrapins in the holding cage, three individuals were active enough to swim to the top of the water column. This indicated that their metabolism had increased enough to become active swimmers, but none were observed to breathe air at the surface. The swimming activity ceased shortly after placement suggesting that any increase in body temperature and metabolism was quickly reversed by return to cold water. All other terrapins were less active and simply sank to the bottom of the cage. Following the three-week holding period in February 2005, all terrapins were alive and observed to behave normally, i.e., were sluggish but active; there was no sign of morbidity.

DISCUSSION

Our discovery that upwards of a thousand or more terrapins can be concentrated at heavily populated hibernacula underscores the vulnerability of the species to winter scrape harvest. Our capture of 160 terrapins/h at South Marsh Island demonstrates how, in certain instances, hundreds of terrapins can be removed from a local area in a matter of hours, a majority of which would be harvest-size females. Because terrapin population traits include low recruitment, delayed maturity, long life, and limited dispersal (Gibbons et al. 2001; Harden et al. 2007; Tucker et al. 2001), high survival of long-lived adults is critical to sustaining populations (Mitro 2003). It follows that harvest removal of a large portion of breeding-age females would be devastating to local populations. Terrapins, like other long-lived turtles, have no compensatory means to replace such losses (Brooks et al. 1991; Congdon et al. 1993; Heppell 1998) and recovery would be predicted to be especially protracted.

As estuarine bay hibernacula have never been studied previously, no comparative data exist on numbers, size, and sex ratios. Moreover, we have no knowledge of how our capture characteristics have been altered by the confounding influence of two principal anthropogenic effects: 1) the direct loss of females to commercial harvest and 2) selective mortality of small terrapins as bycatch in crab pots (Roosenburg et al. 1997; Roosenburg 2004). Because our data show that heavy terrapin harvest would quickly devastate the adult female portion of the population, the prevalence of a female biased sex ratio in Tangier Sound is strong evidence of minimal harvest activity in the region in the recent past. Terrapin mortality in recreational (not commercial) crab pots primarily affects smaller terrapins (males and young females) that occupy habitats near shore where they are at risk to recreational crab pots (Roosenburg et al. 1997; Roosenburg 2004). Terrapin exposure and subsequent mortality in commercial crab pots in Tangier Sound therefore seems mediated by virtual restriction of commercial pots to offshore use. Indeed, Roosenburg (2004) suggested that Maryland's deep-water restriction on commercial crab potting likely has averted the decimating losses to Bay terrapin populations such as have been reported in Florida (Seigel 1993), South Carolina (Dorcas et al. 2007; Gibbons et al. 2001; Hoyle and Gibbons 2000; Tucker et al. 2001), and more recently, Georgia (Grosse et al. 2009). Nonetheless, decades of crab pot exposure seem apparent as our results indicate an effect of increased size of both sexes and reduced number of young females. These results are consistent with demographic effects attributed to selective crab pot mortality in tidal creeks of the Kiawah River, South Carolina (Dorcas et al. 2007), and at the Goodwin Islands at the mouth of the York River, Virginia (Wolak et al. 2010). Although other interpretations are possible, a non-normal PL distribution for males, in contrast to a normal distribution for females, lends support to an active mortality process affecting males. Additionally, and most significantly, we found the proportion of young females in the no-pot zone to be 2.4 times that in the pot zone. It follows that this apparent loss of females to crab pots, and the projected loss in recruitment it represents, would have the greatest long-term effect on terrapin productivity in Tangier Sound.

Our winter sampled sex ratios and the sex- and age-related vulnerability of terrapins to crab pots also may be driven by a fundamental distribution process related to size, i.e., larger terrapins dominating open-water estuarine bays and smaller terrapins seeking protected areas in tidal creeks and interior salt marsh. Roosenburg et al. (1999) provide evidence of larger adult females moving farther and spending more time offshore while smaller males and juveniles remain in near-shore shallow water. Findings from our summer captures at Smith Island support this notion as our interior salt marsh bait-trap captures yielded smaller terrapins of more even sex ratio (0.58 *p*f) and open-water Bay-shore fyke net captures produced primarily large females (0.87 *p*f; P. Henry, USGS, pers. comm.). That terrapins overwinter in interior tidal creeks and creek banks also has been documented (Yearicks et al. 1981). Our samples show that few females <6 YOA (with mean PL of 134 mm and mean mass of 560 g) and few males <6 YOA (mean PL of 105 mm and mean mass of 300 g) occupy estuarine bays in winter.

The comparatively pristine nature of Tangier Sound, in contrast to highly developed areas of the Bay, likely provides resilience to terrapin populations, as evidenced by our estimated female recruitment rate of 4–7%. This recruitment level seems favorable and sets a bench mark for future winter sampling, but its relation to population status is unclear without knowledge of other vital population statistics, especially an estimate of population growth rate (Mitro 2003). Further demographic study is needed to better establish the status of Tangier Sound terrapin populations.

Although terrapins were generally abundant in Tangier Sound, the paucity of numbers in St. Jerome Creek, a former harvest site, is enigmatic. The loss of terrapins at this formerly productive site may be related to harvest or perhaps a broader population decline documented during long-term

study of terrapins on the nearby Patuxent River (W. Roosenburg, Ohio University, pers. comm.).

CONCLUSIONS

The nature of adult female terrapins to aggregate in hibernacula often in high densities and in easily accessible estuarine bays has made them exceptionally vulnerable to commercial winter harvest. Such harvest, if unregulated, can be devastating to local terrapin populations. Although no exact history can be reconstructed, winter scrape fishing may have played a part in the near extirpation of the species in Chesapeake Bay in the early 20th century (Carr 1952; Ernst and Lovich 2009; McCauley 1945). In 2007, a well-organized conservation movement successfully lobbied the Maryland legislature to permanently close the terrapin fishery. Commercial harvest of diamondback terrapins is now prohibited throughout Chesapeake Bay.

Now that the commercial terrapin fishery is closed, adopting scrape fishing as a winter sampling method could be of particular value in assessing the past effects of harvest and recovery of terrapin populations. Scrape fishing of hibernacula offers unique access to a large portion of the adult female segment of the population, including females approaching breeding age. Moreover, scrape sampling offers a novel means to advance scientific study of terrapins in winter, an aspect of the biology of the species that has been little addressed. In this light, we recommend further work be conducted to better understand physiological effects of removal from hibernacula and effects on long-term survival. We believe winter scrape sampling could be an important element of terrapin population and scientific study in Chesapeake Bay and perhaps elsewhere throughout the north temperate range of the species.

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A Large-Scale Snake Mortality Event

Road mortality has been shown to constitute a considerable threat for a variety of herpetofaunal species. A number of possible explanations for movement onto or across roads resulting in mortality have been proposed, including seasonal movements between habitats (Bernardino and Dalrymple 1992; Smith and Dodd 2003), seasonal dry-down of suitable habitats (Aresco 2005; Bernardino and Dalrymple 1992; Enge and Wood 2002), desire to access resources on the other side (Andrews and Gibbons 2005), movement to new areas for breeding (Lebboroni and Corti 2006), and movement and foraging following rainfall events (Ashton and Ashton 1988; Carr 1963; Cook 1983; Gibbons and Dorcas 2004; Tennant 1997).

In addition to the hazards of entering or attempting to cross roads, it appears that aspects of snake natural history may put them at a greater risk of road mortality than other herpetofaunal species. Snakes are known to use warm road surfaces for thermoregulation (Bernardino and Dalrymple 1992; Enge and Wood 2002; Rosen and Lowe 1994). Andrews and Gibbons (2005) report that snake roadkill may be magnified by immobilization behavior with some snake species stopping on the road during crossing. Some authors have suggested that snakes are commonly intentionally targeted by drivers (Ashley et al. 2007; Rudolph et al. 1999; Shepard et al. 2008).

In March of 2006, we observed a snake roadkill event along a newly opened road leading into the Southwest Florida International Airport located in Fort Myers, Lee Co., Florida, USA (26.5123°N, 81.7726°W). The airport developed a new terminal, which included the opening of this new road to the public in September 2005. The initial report of a snake roadkill event came from observations taken on 12 March 2006, suggesting that the majority of dead-on-road (DOR) snakes were killed during the preceding week (5–11 March). The observations were made along 1.5 km of the new airport access road; no snake carcasses were found before or after this section of the road. We documented this large-scale snake roadkill event, which appears to have been greater in magnitude and density than any other snake mortality event reported in the literature for this small of an area for this short of a time period (Beck 1938; Hellman 1956; Smith and Dodd 2003), with the exceptions of mass snake roadkill events associated with a hurricane (Carr 1963) and a snake migration event (Tennant 1997).

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Methods.—The airport expansion included construction of a new four-lane roadway and creation of a canal (Figs. 1A and 1B). The roadway consisted of both an east and westbound terminal road with a grassy median separating them. The speed limit was 45 mph. Bike paths were located exterior to the roadway and had a width of 1.6 m as compared to a single road lane width of 3.6 m. Grassy shoulders were located exterior to the bike paths. The southern shoulder extended 10–12 m to a low (0.5 m) berm which separated the shoulder from a 20–25 m wide stormwater treatment swale. A second berm (1.5 m high and 15 m wide), located south of the swale, ran parallel to the canal which was approximately 15 m in width.

From 19–22 March, 2006, 1.5 km of the eastbound terminal road (Fig. 1B) heading towards the Southwest Florida International Airport was walked and snake species were recorded. The road was divided into 10 m segments. The location of each roadkilled snake along the eastbound side was recorded as follows: in the left hand lane of the road near the median, in the right-hand lane of the road near the bike path, on the bike path, or on the grassy shoulder. The area of grass along the road edge that could be reliably observed

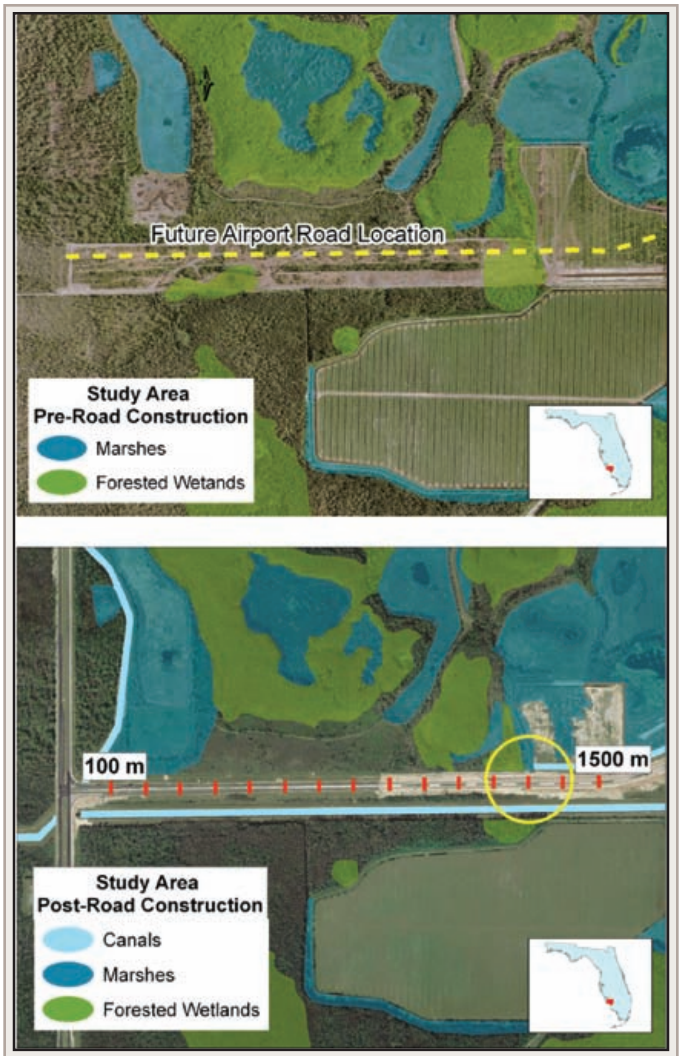


FIG. 1. A) Aerial photograph taken April 2002. B) Aerial photograph taken January–February 2005. Locations of the 100 m points along the road are indicated. The circled area represents road segments 12–14, where the highest proportion of DOR snakes occurred.

was approximately equal to the width of a single lane. Each 10 m road segment was visited only once during the four day sample. After each sampling event, the west-bound side of the road was carefully searched for carcasses, but no DOR snakes were located. If possible, DOR snakes were identified to species. No effort was made to sex the snakes, but immature individuals were distinguished. All snakes were categorized as "old" (dried or with considerable decomposition) or "new" (with moist, flexible body tissues, and assumed to have been killed within the previous 24 h). If any of the "old" snakes could not be identified due to extensive decomposition, they were recorded as an unidentified species.

We summarized the data for the entire sample and combined the data into 100 m road segments in an effort to identify a corridor for future protection. We tested for significant differences in position along the 1.5 km of the road length and for differences on the areas of the road (right lane, left lane, bike path, shoulder) using the single classification Goodness of Fit Test, with expected frequencies defined by relative areas (Sokal and Rohlf 1981) using SPSS Version 16.0 for Windows ($\alpha = 0.05$).

Results.—A total of 395 DOR snakes were recorded during the surveys. Of the species identified, *Nerodia fasciata pictiventris* was observed the most often (N = 140), almost double the amount of the next closest species, *Thamnophis sauritus sackenii* (N = 75). Other species identified include *Thamnophis sirtalis sirtalis* (N = 29), *Agkistrodon piscivorus conanti* (N = 15), *Storeria victa* (N = 4), *Pantherophis guttatus* (N = 1), and *Regina alleni* (N = 1). A large number (N = 130) of unidentified individuals were also recorded. Eight immature snakes were recorded, representing 2% of the DOR carcasses. Two live snakes were observed attempting to enter the road during our surveys, one of which was removed from the roadway, while the other was struck by a vehicle and killed. In addition, sixteen carcasses (4%) were scored as 'new,' thereby indicating that the event was a prolonged period of snake movement and mortality during the second and third weeks of March 2006. Six DOR frogs and two DOR turtles were also recorded.

The most DOR snakes were observed in road segments 12–14 (1200–1400 m) (Fig. 2). These segments exhibited significantly higher numbers of roadkilled snakes than other segments ($G = 177.4$, $P < 0.001$). Of the snake species observed, only five individuals were found in the left-hand lane. There were 116 individuals discovered in the right lane, and 77 in the bike path. The most individuals (N = 197) were found in the grassy shoulder. This distribution is significantly different than random ($G = 237.5$, $P < 0.001$). All three of the species with sample sizes large enough to allow for individual tests (i.e., *Nerodia fasciata pictiventris, Thamnophis sauritus sackenii,* and *Thamnophis s. sirtalis*), as well as the unidentified snake carcasses, showed significantly greater distributions toward the right-hand side of the road ($P < 0.001$ in all four tests).

To explore a possible weather-related explanation for the snake movement, we examined the pattern of rainfall and temperature at the Southwest Florida International Airport during the month of March in recent years. Almost all of the measurable rainfall recorded in March 2006 was from a single rainfall event on March 23, which was after the roadkill event. During the second and third weeks of March 2006 (5–18 March), the mean minimum temperature at the airport was 16.1°C and the mean maximum temperature was 28.3°C. During this same period, nine days had temperatures above the mean daily maximum as compared to the two previous and two post years.

Discussion.—Several studies have found that reptile carcasses are more often located closer to the edge of the road than the center of the road. In 1950, an unusually large number (N = 478) of juvenile mudsnakes (*Farancia a. abacura*) were discovered along U.S. Highway 441 in Paynes Prairie, Alachua County, Florida, almost half of which were DOR (N =

223) (Hellman 1956). Of these, only 10–20 snakes were found in the western half of the road and its adjacent shoulder; the remainder were located in the eastern half of the road and its shoulder. Approximately 12 individuals were found on the eastern slope of the embankment. A study conducted in 1998–1999 on this same highway discovered that carcasses were distributed unevenly on the paved surface, with most being located in the outside lanes (Smith and Dodd 2003). In Lake Jackson, Leon Co., Florida, 95% of turtles were killed as they first entered U.S. Highway 27 adjacent to the shoulder, and the remaining 5% were killed in the first two traffic lanes (Aresco 2005). A similar pattern was discovered in a road impact study conducted on a major road in Tuscany (Scoccianti 2006), with most of the reptile remains found very close to the edges of the road, and less frequently in the middle of the road.

Based on results from the aforementioned studies, it can be assumed that most reptiles are killed as they first enter a highway. This indicates that a majority of the snakes in our own study entered the highway from the south, and were hit as they first entered the east-bound lane of traffic. We assume the snake carcasses found on the bike path and in the grass were actually struck on the road, and the snakes attempted to move to safety after being injured. As seen on the aerial photograph (Fig. 1B), the wetland system located south of the newly opened road ends around road segment 13 (1300 m). It appears that the snakes may have followed the natural landscape to the east, which in effect funneled snakes onto the roadway when the wetland ended. This could explain why a majority of DOR snakes were found between road segments 12 and 14. Beyond road segment 15, the roadway curves north and the area between the shoulder and the canal berm rapidly expands to over 100 m in width.

Although we speculate that the snakes were attempting to cross the road to reach wetlands on the other side, the results may also suggest that snakes might have been moving onto the road to thermoregulate. The road surface in this study is comprised of asphalt. Shine et al. (2004) documented that during the day, mean substrate temperatures are similar on asphalt road surfaces as to those on surrounding surfaces (i.e., grass, dirt, and gravel). However, after sunset, the asphalt surface of the road is substantially warmer (4–9°C) than other surfaces. Since asphalt holds more heat than other surfaces, it is likely that the asphalt road surface leading into the airport warmed during the daytime and held the heat after sunset, thus attracting snakes to the roadway to thermoregulate. Because March 2006 was dry and had several warmer than mean daytime temperatures, with some cool nights, it is possible that most snakes were killed on the road after sunset as they attempted to warm themselves on the roadway.

It is possible that some snakes were not included in the survey count due to the presence of scavenging animals (e.g. crows [*Corvus* sp.], Raccoons [*Procyon lotor*], etc.) and/or fast deterioration due to the climatic conditions of southwestern Florida. Other studies have found that the number of DOR

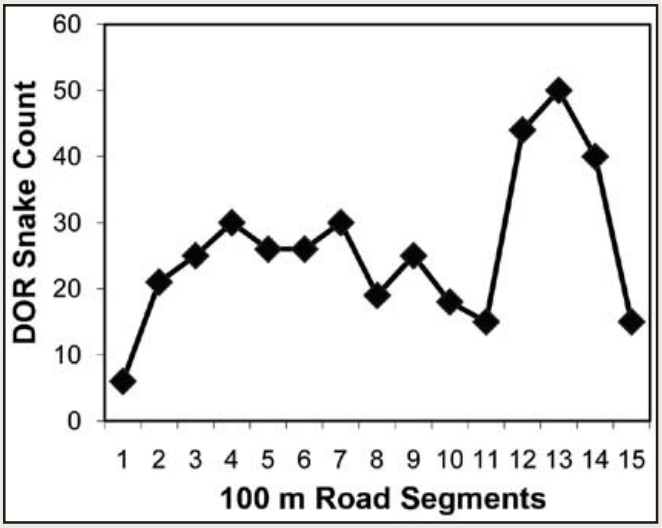


FIG. 2. Count of DOR snakes along road. Data were combined for 100 m segments of the road, from west to east. Counts include only confirmed snake carcasses.

individuals recorded is actually an underestimate of the true number killed (Bernardino and Dalrymple 1992; Enge and Wood 2002; Hels and Buchwald 2001; Smith and Dodd 2003). Even with possible underestimation of the magnitude of this event, the snakes counted in this survey constitute the most numerous mortality event for this spatial scale (1.5 km) reported in recent literature, and presumably comprised a significant portion of the snake community in the associated wetlands.

There are several potential ways to avoid mortality events such as this in the future. Aresco (2005) found that a drift fence system connected to existing drainage culverts significantly reduced road mortality of turtles. The fence physically prevented access to the roadway and directed the turtles through culverts beneath the road. Similarly, Scoccianti (2006) described a drift fence installed along both sides of a road in combination with a viaduct constructed by raising the road. Bernardino and Dalrymple (1992) discussed several options available to decrease the rate of road mortality, including the construction of wildlife underpasses, temporary closing of roads on main migratory nights, and installation of reduced speed zones. Smith and Dodd (2003) described the construction of a barrier wall and underpass system. Because not all of these strategies may be an option due to cost or impracticability, mitigation efforts should be restricted to those areas identified as important travel corridors or as connections between areas of significant habitats (Jackson 1999).

Future research should include quantifying roadkill dynamics following road construction or landscape modification where snake populations may be displaced and concentrated. These conditions appear to create the opportunity for large-scale roadkill events, and may require mitigation efforts. Because this snake mortality event only occurred along the portion of the road that was adjacent to the newly created

canal, future studies should focus on similar types of road development. The construction of the roadway and the canal impacted forested wetland habitats; most of these impacts occurred between road segments 12 and 13 (Fig. 1B), which is also where a majority of the snake mortality took place. Further studies should be conducted to determine if this was a unique event, or if this is a common occurrence for this type of road development. If a trend is discerned, planning for future transportation infrastructure could more effectively focus on minimizing and mitigating impacts to these critical areas (Jackson 1999). The success of any mitigation efforts should also be carefully monitored.

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TECHNIQUES

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Using a Portable Reader for Non-invasive Detection of PIT-tagged Skinks Under Coverboards

A variety of methods exist for uniquely marking animals for mark-recapture studies. Due to its directness and accuracy, the mark-recapture method is an effective technique used to assess demographic parameters and life history and behavioral data such as density, survivorship, growth rate, and individual patterns of space use and social behavior (Fox and Shipman 2003; Hokit and Branch 2003; Tinkle et al. 1993). For lizards such as North American skinks, which are often secretive, delicate, cryptically colored, and difficult to capture, demographic studies can be problematic and produce incomplete and unsatisfactory results due to lack of recaptures (Cavalieri 2010; Somma 1985). Coverboards are the most reliable way to repeatedly observe such skinks (Cavalieri 2010; Sutton et al. 1999), but the success of actual capture using this method depends more on prowess than other techniques such as passive trapping. Thus, the family Scincidae, with the exception of a few species (Cooper 1999; Cooper and Vitt 1989, 1993; Fitch 1954), has remained an under-studied taxon in North America. Due to the difficulty of attaining recaptures and the risk of stress or injury to the lizard during hand capture, we strove to develop an alternative methodology to augment relocations of marked individuals.

Passive integrated transponders (PIT tags) are often used as a backup or alternative to toe-clipping, scale-marking, or other traditional marking techniques (Ferner 2007; Gibbons and Andrews 2004). The use of subcutaneously-implanted PIT tags in mark-recapture studies offers the unique advantage of a system of internal, permanent identifiers that are completely unambiguous if read correctly from the scanner (Gibbons and Andrews 2004; Hill et al. 2005).

The purpose of our study was to evaluate the performance of a modified PIT-tag system by determining: 1) the greatest distance at which a PIT tag can be read, both on the surface and under coverboards, 2) the effect of antenna orientation, and 3) the effects of experience level and fatigue of field workers on detection of field-employed PIT-tags.

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FIG. 1 Horizontal and vertical orientation of the antenna hoop and illustration of how to scan a coverboard with PIT-tag reader.

Materials and Methods.—Our study site, located in mixed-grass prairie in Payne County, Oklahoma, USA, was a 1-ha grid with 100 1.22-m × 0.61-m × 1.91-cm coverboards placed at the centers of the 10-m × 10-m cells. The soil was a well-drained silty clay loam with native prairie and old field grasses and approximately 4 cm of thatch.

We modified a Destron Fearing Portable Transceiver System (model 2001F-ISO, Biomark, Inc.) by mounting the racket antenna on a PVC pipe (Fig. 1). To prevent interference with the antenna, we used all non-metal construction. We

glued a T-joint to a 45º elbow joint and attached this section to a 1.22-m PVC pipe (2.54 cm diameter) that served as a handle. We drilled two holes perpendicular to the elbow joint and passed the racket antenna through the opening in the T-joint so that the hoop portion was facing away from the opening of the 45º elbow joint. We threaded a plastic zip tie through each hole and the internal opening of the racket antenna and secured it to prevent the antenna from sliding forward out of the handle. We suspended the transceiver upside down from a belt in a harness to allow the person wearing it to easily read the display. We used 8.5-mm × 2.12-mm, 134.2-kHz ISO, 0.067-g glass-encapsulated, implantable passive integrated transponders from Biomark, Inc.

We first determined the maximum horizontal range at which a PIT tag could be read when placed on the ground and holding the antenna 4 cm above the substrate using two different orientations of the antenna hoop (Fig. 1): horizontal orientation (i.e., the opening of the hoop parallel to the ground) and vertical orientation (i.e., the opening of the hoop perpendicular to the ground). We determined reading distance by setting the transceiver to continuous scan and holding the antenna stationary while moving a PIT tag along a wooden measuring stick lying on the ground until the serial number registered. The point on the measuring stick at which the number was first read was the maximum horizontal reading distance at 4-cm height. We performed two sets of trials, one with the PIT tag in a plastic microcentrifuge tube and one with the PIT tag subcutaneously implanted into a Great Plains Skink (*Plestiodon obsoletus*) held in a mesh bag. We conducted 20 repetitions of each set at the study site, using a freshly charged transceiver for every repetition.

Because the horizontal antenna orientation gave the greatest horizontal reading distance in the trials above (see Results), we then determined the maximum vertical distance at which a PIT tag could be read through a coverboard with the antenna in the horizontal orientation. As before, we separately scanned a PIT tag in a microcentrifuge tube and a PIT tag implanted in a skink. We placed a tag under a coverboard (1.22 m × 0.61 m × 1.91 cm) and then held the antenna by the handle 1.37 meters above the coverboard, moving it in the horizontal orientation slowly down the wooden measuring stick until the tag registered. The vertical distance from the point at which the tag first registered from the lower edge of the antenna hoop to the surface of the coverboard was the maximum vertical reading distance. As before, we conducted 20 repetitions of each set, using a freshly charged transceiver.

In order to assess the accuracy of the PIT-tag reader system, we placed each of 20 PIT tags in microcentrifuge tubes under 20 randomly selected coverboards in a set of 100 in the field and recorded the serial number for each tag. We assembled two groups of volunteers: experienced (N = 7), those who had used the PIT-tag reader two days a week from May to August 2008 in this fashion, and novice (N = 10), those who had no prior experience with PIT-tag readers. We gave each isolated volunteer the antenna mounted on the handle with the transceiver in the holster, a clipboard, a pencil, a datasheet to record the serial numbers and location of detected PIT tags, and a demonstration of how to scan a coverboard and read the serial numbers. Each volunteer stood and passed the antenna in a serpentine pattern over each coverboard as closely as possible without touching it while holding the antenna in the horizontal orientation, record the serial number if a tag was detected, and then proceed to the following coverboard until all 100 coverboards were scanned in order. Each volunteer scanned coverboards while alone at the study site with no other volunteers observing, and was given unlimited time to scan coverboards.

We tested the following null hypotheses: 1) all tags have an equal chance of being found, 2) the success of finding tags is independent of experience level, and 3) the likelihood of finding tags does not vary with increased search time per coverboard. We used a Chi squared goodness-of-fit test to determine if all tags had an equal chance of being found, and a Chi-squared heterogeneity test to compare level of experience with success at finding tags. We used a linear regression of number of tags found vs. average duration of search per coverboard to determine if the likelihood of finding tags varied with increased search time per coverboard.

Results.—The maximum horizontal distance beyond the outside of the antenna hoop at which a PIT tag was read with the antenna held 4 cm above the ground in the horizontal orientation for a PIT tag in a microcentrifuge tube and for a PIT tag implanted in a skink was mean = 4.13 cm ± 1 SD of 0.55 and mean = 3.88 ± 0.70, respectively. In the vertical orientation, the maximum horizontal distance for a PIT tag in a microcentrifuge tube and for a PIT tag implanted in a skink was mean = 2.08 cm ± 0.60 and mean = 2.08 ± 0.81, respectively. The maximum vertical distance at which a PIT tag was read in the horizontal orientation through a coverboard for a PIT tag in the microcentrifuge tube and for a PIT tag implanted in a skink was mean = 13.10 cm ± 2.00 and mean = 12.24 ± 2.77, respectively.

The horizontal antenna hoop orientation allowed a greater range for detecting PIT tags than the vertical orientation, and a PIT tag enclosed in a microcentrifuge tube had approximately the same maximum read distance as a PIT tag implanted in a skink. Therefore, during the next portion of the experiment, we treated centrifuge tubes as skink surrogates and had volunteers use the horizontal antenna orientation to find PIT tags randomly placed under coverboards. The mean proportion of tags found was 71.8% and all tags had the same chance of being found (χ^2 = 4.85, *df* = 19, P = 0.999). Experience level affected ability to find tags (χ^2 = 5.37, *df* = 1, P = 0.020), with experienced readers finding 65% and novice readers finding 76.5% of tags. The likelihood of finding tags did not vary with increased average search time per coverboard (r^2 = 0.058, $F_{1,15}$ = 0.930, P = 0.350).

Discussion.—All tags had the same chance of being found. This indicates that there was no bias for tags under different

coverboards, suggesting that this is a good methodology for augmenting relocations of secretive, partially fossorial animals that are difficult to recapture.

Experience affected ability to find tags, but in an unexpected way. Novice readers found more tags than experienced readers. This is possibly because novice readers followed directions more thoroughly than experienced readers who had more confidence in their abilities and a *laissez-faire* attitude toward the process. Blomquist et al. (2008) made a similar comparison between an observer informed of the location of the tags and an uninformed observer, with PIT tags placed underground. The informed observer found more tags in one pass than the uninformed observer did with 3 passes though the study area. This is not directly comparable to our study because experience with the technique differs from actual knowledge of the location of the tags; however, our volunteers did know that PIT tags were only under coverboards, which helped focus their searching. We suggest that fieldworkers can find tags more easily when given a focal object, e.g., a coverboard, than when searching broadly in the field. The likelihood of finding tags did not vary with increased search time. This indicates that this technique works well without the need for slow, intensive searching.

Traditionally, PIT-tagging relied on physically recapturing an individual in order to scan the tag. Recently, there has been an increase in the number of studies using automatic remote interrogation systems that do not rely on subsequent recaptures. Harper and Batzli (1996) used fixed hoop antennae and transceivers over vole runways in enclosures to remotely assess movement of individuals; over a period of four months, they were able to detect 1645 uses of runways (or remote PIT-tag recaptures) having marked only 893 animals. Boarman et al. (1998) marked 172 tortoises within 3 km of their automated interrogation system; only 5 tortoises were scanned for a total of 77 recaptures by PIT-tag identification. Gruber (2004) marked 29 animals and had 178 remote PIT-tag recaptures using antennae coiled around the bases of trees to determine the movement of PIT-tagged geckos. These systems are advantageous because they collect data continuously with reduced man-hours once the initial setup of equipment has been completed. The drawbacks of automatic remote interrogation systems include the need for a power supply and preventing theft of unattended equipment. Our system is a hybrid of traditional and automatic remote interrogation systems, with higher labor needs (as compared to completely automated systems) balanced by the ability to cover more ground and check more refugia.

Although there have been other studies using PIT-tag readers mounted on poles (Blomquist et al. 2008; Sasaki et al. 2009), none has used this method as a means of identifying animals under coverboards. Because we used a commercially available antenna, our system is easier to implement than others (Blomquist et al. 2008; Gruber 2004; Zydlewski et al. 2006), and may represent a useful tool for mark-recapture studies of small reptiles that commonly use cover objects.

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A New Rapid Assessment Technique for Amphibians: Introduction of the Species List Technique from San José de Payamino, Ecuador

The urgent need for baseline amphibian data in light of global population declines (Stuart et al. 2004) has led to a call for accurate and robust rapid assessment techniques for amphibian assemblages. This is especially pertinent in areas such as wet tropical rainforest where there is a scarcity of data (Duellman 2005; Gardner et al. 2007) and where robust and comparable data are particularly required to underpin difficult management decisions. The lack of amphibian data from wet lowland forest habitats is often a result of the logistical problems of conducting research in such areas (Doan 2003; O'Dea et al. 2004; Poulsen et al. 1997) where dense understory vegetation, inaccessible terrain, extreme rainfall and humidity, and seasonality (Doan 2003) hinder research. High species diversity and clustered distributions further complicate surveying (O'Dea et al. 2004; Poulsen et al. 1997). Amphibian survey methods used in temperate climates are not applicable to the rainforest environment in many instances (Doan 2003). This, coupled with the fact that rainforest inventorying is often abbreviated due to both the urgency of conservation concerns in the tropics (O'Dea et al. 2004; Heyer et al. 1994; Poulsen et al. 1997; Poulsen and Krabbe 1998) and by cost (Doan 2003; O'Dea et al. 2004; Pellet and Schmidt 2005), points to the need for amphibian rapid assessment techniques specifically designed for work in the difficult tropical rainforest environment (Doan 2003; Poulsen et al. 1997).

The aim of this paper is to introduce the Species List Technique (SLT) (MacKinnon and Phillipps 1993) as a rapid assessment technique for inventorying amphibian assemblages in tropical rainforest environments. We discuss the suitability of this technique to assess species richness and species accumulation. Results are compared over short (21 day) and longer (48 day) time periods to allow assessment of effectiveness in a rapid assessment context. Impact of the methods on the habitat and fauna, plus time and financial costs are also considered qualitatively. A set of standardization suggestions are made to ensure comparability between studies.

The Species List Technique (MacKinnon and Phillipps 1993) was designed for rapid assessment of avifauna especially in tropical rainforest environments (O'Dea et al. 2004; Poulsen et al. 1997). This straightforward technique is standardised to provide an index of effort for opportunistic encounters, meaning no data are excluded from analysis (O'Dea et al. 2004). Cumulative species richness is related to the number of observations, rather than space or time, allowing for moderate differences in field technique and observer experience (Herzog et al. 2002). This standardization makes the SLT much more valuable for species assemblage comparisons between studies and sites than species inventories alone (Herzog et al. 2002). The time efficiency of the method, through constant data collection while in the field, lends itself for use in a rapid assessment setting.

All species seen or heard are recorded in species lists of predetermined length. The number of species recorded per list is chosen to reflect species richness. Lists of 8 to 20 species have previously been used for bird surveys (Bibby et al. 1998; Herzog et al. 2002). Different geographic areas can only be compared when species lists of the same length have been used. Therefore, it is important that standard amphibian list length should reflect species richness of all tropical areas where the SLT may be used. We assessed the use of lists of 3, 5 and 10 species for our amphibian survey in order to provide a balance between robust sample size for formation of species accumulation curves and comparability between sites of varying richness. The lower the number of species in a list, the more the shape of the accumulation curve (and therefore

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the species richness prediction) varies depending on sample size (Herzog et al. 2002). However, a high number of species per list will reduce the number of lists compiled and thus the accuracy of the accumulation curve. We found that the number of lists formed using 10 species lists was low (25 lists) and in less diverse tropical regions insufficient data may be collected to create an accumulation curve. Both 3 and 5 species lists gave a large enough sample size to create species accumulation curves. Therefore, based on Herzog et al.'s (2002) conclusion that longer species lists give more robust accumulation curves, we chose to use 5 species lists.

Species List Technique list formation begins when the first individual is observed. Each subsequent species (not individual) is added to the list until 5 species have been observed. Once a list is complete, a new list is started. Species can be repeated between, but not within, lists (Fig. 1). List formation continues throughout the length of the data collection period. Any species that cannot be immediately identified are assigned placeholder names until the species can be identified so that their order in the list is not affected. This data collection method has the key advantage that multiple observers can form their data into a single set of lists by recording the date and time each individual was observed to allow sequential addition of species to form lists during analysis, making time in the field as productive as possible.

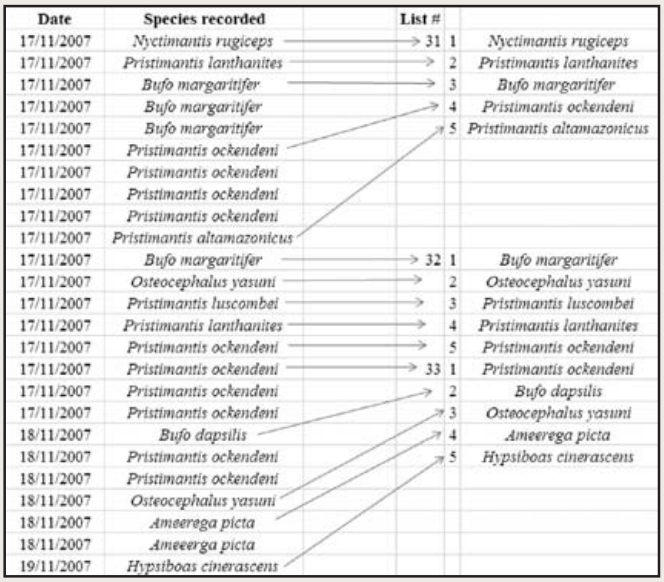


FIG. 1. An example of data collected in San José de Payamino and subsequent creation of Species Lists. Arrows highlight how individual observations are amalgamated into lists based on the order in which they are observed. Note that species are recorded only once per list regardless of number of individuals observed.

Data collection took place between June 2007 and May 2008 in the 27,000-hectare lowland tropical rainforest territory of the Kichwa community San José de Payamino, Orellana Province, Ecuador. Three sites within this territory (Sacha huasi, Bigay, and Paushiyacu) were each visited three times in one year and data were collected over the period of a week at each site (three weeks per site in total). However, due to logistical constraints, data collection could not take place during every day spent at the sites. Therefore, the number of days spent in data collection varied between 4 and 7 days during the week spent at each site. The methods were assessed separately over a short term (1 week at each site, totalling 21 days of data collection) and longer term (3 weeks at each site, totalling 48 days of data collection) period.

Species were recorded during night visual surveys utilizing pre-existing transects, opportunistic daytime observations and identification of calls. Each of three sites contained five parallel cut transects, each 100 m in length, with 20 m separation between transects. Visual sweeps were conducted along each transect, 2 m either side and up to 2.5 m in height, including low intensity disturbance of leaf litter, rolling small logs and turning over leaves. Detectability differences among species due to visibility, size or volume of calling were partially addressed by this methodical searching during night transects as reflected by the fact that one caecilian species (*Oscaecilia bassleri*) and two salamander species (*Bolitoglossa altamazonica* and *B. peruviana*) were observed. However, biases due to detectability are of concern with, although not unique to, this method (Bibby et al. 1998) and care must be taken to limit this bias. Transects are not a pre-requisite for SLT data collection and it is possible to include targeted areas while in the field, for example high density sites such as breeding pools in order to catalogue as many species as possible. Targeting like this is important for species where there are detectability issues and is not possible in more rigid sampling methods (Herzog et al. 2002). Opportunistic daytime observations included any amphibians observed around camp and on forest walks that were not part of targeted searches. Once a week, the first five calls heard at dusk were identified by comparison with reference recordings (Read 2000). Species accumulation curves were constructed by plotting the cumulative number of species observed as a function of list number (Gotelli and Colwell 2001). Species accumulation curves can be used as an indication of whether sufficient sampling effort has been undertaken to catalogue the total species richness of the area (Bibby et al. 1998). Species accumulation curves can also be extrapolated to show whether expected total species richness varies between areas (O'Dea et al. 2004). Chao 2 (Chao 1987) was used as an estimator of species richness as it has been shown to be effective in areas where many species are rare (O'Dea et al. 2004).

During the short term collection period, 35 species were recorded using SLT, with this number increasing to 55 in the longer time period. The accumulation curves were used to quantify whether the study area had been comprehensively surveyed (Fig. 2). The species accumulation curves did not reach an asymptote over either the short or longer time period. Thus, the number of new species being recorded had not declined, indicating that the species inventory for this study site had not yet reached completion. This is a reflection of

the high amphibian species richness of San José de Payamino and the amount of effort needed to inventory such diverse areas. The Chao 2 estimator value of 41±10.74 for short term SLT is an underestimation of the total species richness and with a large standard deviation has limited accuracy. However, the longer term SLT Chao 2 value of 80.08 ± 0.24 is plausible given known species numbers in nearby lowland rainforest areas of Ecuador (84 amphibian species recorded in Jatun Sacha: Vigle 2008) and has a small standard deviation. Regression lines, extrapolated from the accumulation curves to give a prediction of total number of species in the area, gave predicted species numbers of 60.19 with the SLT long term trial and 60.45 with the SLT short term trial. These values, however, do not match with the Chao 2 estimate of species richness, which is much higher. This could be due to the large number of rare species, for which only one or two individuals were observed. Chao 2 has been shown to be a robust estimator in these circumstances (O'Dea et al. 2004). The prediction made by extrapolating the accumulation curves will be inaccurate due to the curves not having reached an asymptote (Gotelli and Colwell 2001). The SLT method has demonstrated that this area is not yet adequately inventoried and that amphibian surveying needs to continue in San José de Payamino. The complete number of species present is undoubtedly higher than the 55 thus far observed and the richness of this area needs to be accurately estimated before it can be compared with other sites. The high conservation value of this area has been shown by the amphibian species observed thus far. Further study must be undertaken for its full importance to be realized.

In light of amphibian sensitivity to habitat disruption (Gardner et al. 2007), it is important to consider the impact to the environment of any biological surveys. The Species List Technique requires no cutting of transects, and species searches can be carried out in any manner. Frequent disturbance to a site through having to repeat data collection at specified transects is avoided. If call surveys are included in list construction, site disturbance can be further decreased. Logistically, SLT needs little in the way of equipment, other than a notebook, ID guide and pencil, and therefore the expense associated with this methodology is negligible. Efficient data collection leads to rapid recording of species present, permitting more comprehensive, comparable inventories to be created during the time available. Personnel with a moderately varied range of experience can carry out data collection without creating bias (O'Dea et al. 2004) as richness is standardized in terms of number of observations rather than time. Therefore, sufficient time can be taken to ensure accurate identifications. This has obvious benefits to expeditions, where every member can take part in data collection, increasing the likelihood that an area will be comprehensively surveyed in the time available.

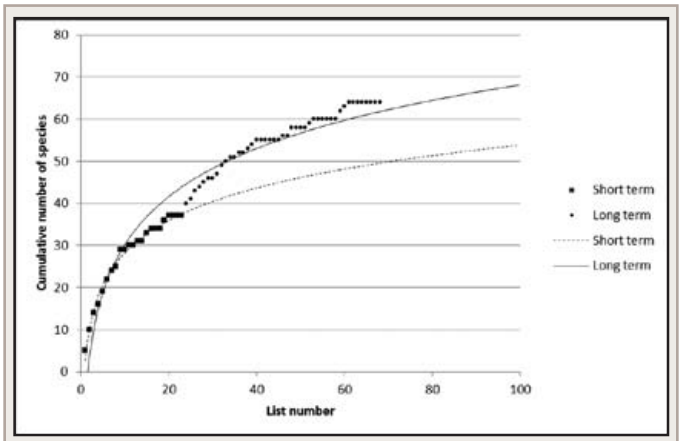


FIG. 2. Logarithmic species accumulation curves by list shown in terms of short or longer data collection periods. For longer-term data each curve represents the average value of 30 randomizations of sampling order and 10 randomizations for short term data. Logarithmic regression lines forecasted forward by 32 periods.

Standardization of SLT between users and sites will maximize comparability, a key benefit of the technique. Therefore, we recommend that five species lists are used for all studies. Researchers should ensure systematic as well as opportunistic searches to allow for differences in detectability between species. Species observations should also include day and night active species, as well as all habitat types within the area being surveyed to ensure comprehensive coverage. In seasonal areas, timings of surveys must also reflect activity periods of different species. Call surveys should only be carried out for areas where applicable reference recordings are available and the observer is confident in accurate identification. Areas should not be compared until they have been comprehensively surveyed, as assessed by reaching an asymptote in their species accumulation curve.

No single method will ever satisfy all scientific preferences and logistical constraints that befall field investigations (Doan 2003; O'Dea et al. 2004). Therefore, a compromise must be reached to take into account expense, environmental limitations, time constraints and the findings that can be taken from an investigation. When time is severely limited due to expense and the necessity for baseline biodiversity data in areas of conservation concern, then rapid assessment of a site is the best compromise (Heyer et al. 1994). The aim of this study was to assess whether SLT, previously only used to survey avifauna (O'Dea et al. 2004; Poulsen et al. 1997; Poulsen and Krabbe 1998), could be applied to amphibian assemblages. The Species List Technique facilitates rapid species inventorying alongside richness estimation, allowing standardized comparisons between areas where time for surveying is constrained. We therefore recommend the Species List Technique for the rapid assessment of amphibian assemblages in rainforest environments.

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A Taping Method for External Transmitter Attachment on Aquatic Snakes

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Radio telemetry is extremely useful for studying habitat use and movements of free ranging snakes. Surgically implanting radio transmitters into the body cavity of snakes is standard practice in most studies (e.g., Reinert and Cundall 1982; Weatherhead and Blouin-Demers 2004), but this implanting method has its drawbacks. Surgery itself is risky for individual snakes because of the potential for infection or incomplete healing of the incision site. Also, transmitters that are small enough to be carried by small or slender snakes have a relatively short battery life and need to be removed or replaced often, thus requiring frequent surgeries. In rare or endangered snake species, the risk of using invasive implantation surgery may not be merited. External attachment methods are relatively non-invasive and allow removal and replacement of radio transmitters on smaller snakes. The Giant Gartersnake (*Thamnophis gigas*) is a semi-aquatic snake endemic to wetlands of the Central Valley of California, USA, and is federally and state listed as threatened (U.S. Fish and Wildlife Service 1999). Telemetry studies of the habitat use and movements of this species typically used surgically implanted radio transmitters, but this method is limited to larger snakes, primarily females, because of size requirements for surgery (> 250 g). To



FIG. 1. Radio transmitter attached to a *Thamnophis gigas* by the off-tail method using surgical tape.

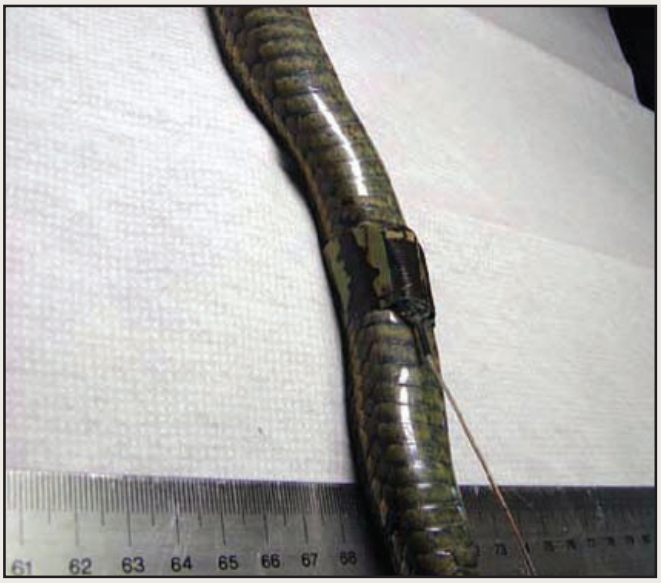


FIG. 2. Radio transmitter attached to a Thamnophis gigas by the body method using camouflage duct tape.

overcome difficulties and biases associated with radio telemetry of *T. gigas*, we developed and evaluated several alternative techniques to attach external radio transmitters using tape.

Materials and Methods.—We captured individual *T. gigas* by hand or in modified minnow traps (Casazza et al. 2000) at two sites in Colusa County (Colusa National Wildlife Refuge, 2003 and 2004, and Colusa Basin Drainage Canal, 2006). We measured, weighed, and marked each individual with a passive integrated transponder (PIT) tag in the field. In most cases, we attached transmitters to snakes while in the field and released them immediately after processing. However, if snakes appeared close to ecdysis, we held them in the laboratory until they shed. We taped transmitters to these snakes after shedding and released them at their capture locations as soon as possible.

We used 1.3 g radio transmitters (model R1620, Advanced Telemetry Systems, Inc., Isanti, Minnesota, USA), measuring 8 × 19 × 4 mm with a 10 cm whip antenna. The flat, oblong shape of this transmitter has a low profile when attached to snakes (Fig. 1). Nominal battery life was 34 days, but many units exceeded this duration.

Initially, we used the method of Rathbun et al. (1993), which incorporated several strips of 3M™ Blenderm® clear plastic surgical tape. We also tried a type of cloth-backed gaff tape manufactured by Shurtape® that had been successfully used to mount transmitters onto penguins (C. Ribic, pers comm.). In 2004, we began using camouflage Duck® brand duct tape.

In addition to the various tape products we tried, we also modified the position of the transmitter on the snakes over the course of the study. Initially, we taped the antenna to the ventral surface of the snake and left the transmitter trailing off the end of the tail ("off-tail" method; Fig. 1), following Rathbun et al. (1993). In 2004, we changed the attachment site so that the transmitter was positioned on the ventral surface of the snake, about three-quarters of the distance from the snout to the vent, and the short antenna was directed caudally ("body" method; Fig. 2). We encircled the snake's body and the transmitter using one piece of tape (about 3 × 9 cm), which overlapped slightly on the dorsum of the snake. We secured the tape to the snake's ventral scutes anterior to the transmitter to prevent the transmitter's leading edge from snagging on obstacles in the environment. The reasoning for this ventral placement is that the radio transmitter would push into the body cavity by the weight of the snake thereby minimizing changes in the cross section of the snake as it moves through the environment. In removing transmitters from snakes, we carefully cut the tape with surgical scissors and cleaned any remaining adhesive on the skin with isopropyl alcohol.

We located snakes with transmitters 5–10 times per week from May through September, and 1–5 times per week thereafter until transmitters dropped off, were removed, or failed. Each time we located a snake, we attempted to confirm that the transmitter was still attached. We conservatively calculated retention time as the period from the snake's release to the last time the transmitter was known to be on the snake, either through visual contact or subsequent movement. Distances that individuals carried transmitters before dropping them were calculated as the sum of all movements from the release site to the final location. To determine if one attachment method or type of tape remained on snakes longer, we compared distances and durations by the type of tape and attachment technique. We used Kruskal-Wallis one-way analysis of variance to make these comparisons (JMP IN 5.1.2, SAS Institute, Inc., Cary, North Carolina, USA).

We attached radio transmitters to 62 *T. gigas* (39 females and 23 males) a total of 75 times in the course of three field seasons. Telemetered individuals averaged 76 cm (range: 60–98 cm) in snout-vent length and 271 g (range: 93–600 g) in mass.

For off-tail gaff tape attachment, snakes ranged from 69–72 cm and 138–600 g. For body gaff tape attachment, snakes ranged from 72–90 cm and 110–480 g. For body duct tape attachment, snakes ranged from 60–98 cm and 93–515 g.

TABLE 1. Summary statistics for different locations and materials for externally attaching radio transmitters to snakes. N = number of attachments.

				Duration (days)		Distance (m)	
Method	Tape	Year	N	Mean	Range	Mean	Range
off-tail	surgical	2003	5	–	–	–	–
off-tail	gaff	2003, 2004	42	11.1	1.0–31.9	371	24–1700
body	gaff	2003, 2004	6	5.9	0.2–17.8	345	20–1505
body	duct	2004, 2006	22	22.9	0.2–88.0	440	35–1432

Results.—Nine individuals dropped their transmitters prior to the first relocation. The remaining 66 transmitter attachments remained on the snakes for a mean of 14.3 days (range: 0.16–88 days), and were carried a mean distance of 391 m (range: 20–1700 m). All functioning transmitters were eventually recovered.

Our first attachments using the off-tail method with surgical tape (N = 5) failed almost immediately because of lack of adhesion of this tape, and we obtained no usable data from these individuals. Individuals with transmitters attached using the off-tail method with gaff Shurtape® tape (N = 42) traveled a mean distance of 371 m and retained their transmitters for a mean of 11.1 days (Table 1): however, radios in the off-tail position became entrapped in the environment in 13 individuals. Using gaff tape and the body method (N = 6), we were able to track snakes for a mean of 5.9 days (Table 1). We discontinued use of gaff tape after we discovered that its adhesive qualities were diminished after storage during the winter. With duct tape on the body (N = 22), individuals traveled a mean of 440 m and kept their transmitters for a mean of 23 days (Table 1).

We found no statistical differences ($p > 0.10$) in distance travelled ($\chi^2 = 0.907$, $p = 0.341$, $df = 1$) or duration of transmitter retention between transmitter attachment site ($\chi^2 = 0.254$, $p = 0.614$, $df = 1$) or tape type ($\chi^2 = 2.003$, $p = 0.157$, $df = 1$). We found no evidence of entrapment problems with radios attached by the body method. We found no discernable relationship between snake size and duration of radio attachment ($r = 0.13$, $p > 0.15$).

We recaptured 21 snakes that had external transmitters 95 times after their first attachment. Our overall recapture rate at both study sites from 2003 through 2006 was 2.0 captures per snake. We noted five snakes with scarring resulting from the off-tail attachment technique and four snakes with scarring from attaching the transmitter to the body. Several snakes could have carried transmitters longer and farther than we were able to measure. We were unable to recover nine transmitters before the batteries discharged or otherwise malfunctioned. On four occasions we removed attached, functional transmitters from snakes at the end of the field season. The longest duration for snakes retaining taped radio transmitters was in the late summer to early winter of 2006: three snakes were marked with the body taping method using Duck® tape from late summer into early fall. These radios remained on one snake for 42 days, and 87 and 88 days for the other two snakes.

Discussion.—Other investigators have used various techniques to attach transmitters to various snake species with mixed success. Ciofi and Chelazzi (1991) passed rubber tubing beneath the 22nd and 27th subcaudal scales of *Coluber viridiflavus*, providing an anchor through which they attached transmitters with nylon thread, which facilitated replacement of batteries without removing transmitters. Gent and Spellerberg (1993) studied movement rates for short periods (mean = 4.7 days) in *Coronella austrica* by mounting small transmitters on the dorsal side of the tail with surgical tape. Of 50 attachments, five were dropped on the first day and seven became snagged on vegetation and were removed by the researchers. Rathbun et al. (1993) taped transmitters onto the tail of nine *Thamnophis hammondii* using several strips of surgical tape. *Thamnophis hammondii*, another semi-aquatic gartersnake, retained their transmitters for a mean of 24.2 days. Cobb et al. (2005) and Figueroa (2006) glued small transmitters onto neonate *Crotalus horridus* and *C. oreganus helleri*, respectively, using cyanoacrylate glue, as did Jellen and Kowalski (2007) for neonate *Sistrurus catenatus*, with transmitters lasting 13–56 days. Although we did not evaluate a gluing method, it may not work well on the thin, smooth-scaled skin of *T. gigas* compared to the thick, rough scales of rattlesnakes.

More recently, Tozetti and Martins (2007) and Madrid-Sotelo and Garcia-Aguayo (2008) used duct style tape to externally attach radio transmitters to *Crotalus durissus* and *Oxybelis aeneus*, respectively, with an average monitoring time of 69.2 and 48.3 days, respectively. These attachments were dorsal compared to our ventral method. Madrid-Sotelo and Garcia-Aguayo (2008) also used cyanoacrylate glue in addition to the tape to affix the radio transmitters. Our monitoring time and that of Tozetti and Martins (2007) shows that duct tape alone can provide sufficient adhesion of radio transmitters to snakes. Again, our work shows that tape sufficiently adheres to these smooth-scaled snakes as well as the rough-scaled snakes in the study by Tozetti and Martins (2007). Also our work shows that ventral attachment of radio transmitters can work successfully in wetland habitats.

By attaching transmitters externally, we were able to obtain movement data on those *T. gigas* that were smaller than implantation procedures permit. We were also able to increase our sample size for snakes of all sizes. In addition, we were able to attach transmitters in the field immediately following snake captures, thereby reducing the interruption caused by captivity, anesthesia and surgery. An externally

attached transmitter that fails prematurely will be lost by ecdysis, whereas implanted transmitters will remain in the body of the snake with unknown long-term consequences. During the active season, *T. gigas* shed their skin every 4–6 weeks, which invariably resulted in the loss of the transmitter. We found that *T. gigas* are often out of their burrows just prior to shedding, which permitted us to replace transmitters and continue tracking individuals.

We found the off-tail transmitter attachment technique was potentially more hazardous to the snakes than the body attachment. Four off-tail transmitters we recovered were snagged in vegetation, and the attached tape had distal pieces of tail that were pulled off by snakes. The shed radios we recovered that were attached with the body method showed no evidence of harming the snakes, but tape adhesive occasionally caused some superficial scarring. The small amount of tape used to affix transmitters with the body technique confers an additional advantage over the multiple pieces required to secure the antenna in the off-tail technique. When compared to the invasiveness of surgical implantation (Rudolph et al. 1998), the complications from taped transmitters are relatively minor. Taping did not cause any apparent mortality of the individuals in our study. The location of the radio attachment should be sufficiently posterior to allow for passage of gut contents at that location; we found no evidence of blockage of food items. We also did not detect any interference with shedding by taped radio transmitters.

We attribute our success of taping transmitters to *T. gigas* to several factors. The wetland habitat used by *T. gigas* has very little lignified vegetation and rocky outcroppings, and thus may be particularly forgiving to ventrally-mounted transmitters. Additionally, radio telemetry was conducted with concurrent, intensive snake trapping so we were able to recapture many animals, replace transmitters, and continue collecting data on the same individuals. A number of animals lost transmitters quickly and our dataset includes a long period of trial and error. In addition, our conservative calculations of distance and duration were designed to illustrate minimum expectations using our attachment method. Thus, our results may not reflect the full potential of this technique.

Taping radio transmitters to snakes is a simple, non-invasive and cost-effective way to collect movement data on individuals. This technique circumvents some of the limitations imposed by surgical implantation of transmitters, such as precluding studies of small snakes, poor recovery in cool weather (Rudolph et al 1998), and erratic behavior following periods of captivity while snakes recuperate from surgery. After surgically implanting transmitters in *T. gigas*, it is necessary to maintain them in captivity for up to two weeks to facilitate healing of the incision (Smith et al. 1988). Following this prolonged period of captivity, snakes often made unusually large movements immediately after release. Taping a transmitter to a newly captured snake and releasing it immediately rarely resulted in this response.

The period of time that a taped transmitter remains on a snake is not conducive to examine seasonal patterns in movement or annual home ranges. However, external transmitter attachment may facilitate research goals requiring one to monitor snake behavior over a within-season period (e.g., to measure rates of movement, Gent and Spellerberg 1993), or to monitor neonatal dispersal (Cobb et al. 2005; Figueroa 2006), reproductive behavior, habitat use, dispersal from hibernacula, and responses to landscape edges or features such as roads. The use of tape to attach radios in the fall facilitated location of winter hibernacula. Additionally, basking behavior associated with ecdysis facilitated transmitter replacement and continued long-term monitoring of individuals in spring and summer. Thus, our taping technique for the external attachment of radio transmitters to snakes, in addition to the variations tried by Tozetti and Martins (2007) and Madrid-Sotelo and Garcia-Aguayo (2008), demonstrates the potential for diverse applications of this technique in snake ecology and conservation. We recommend the use and further evaluation of the duct tape "body" method for use in future studies of snake movements.

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Shell Hardness Measurement in Juvenile Desert Tortoises, *Gopherus agassizii*

Thick, hard shells of adult tortoises and many turtles confer protection from predators and have apparently evolved among chelonians largely in response to predation pressures (Wilbur and Morin 1988). When threatened, turtles and tortoises pull in their heads and limbs, tuck in their tails, and present an armored surface and relatively round, smooth shape to their attackers—a defense that is usually successful in deterring injury or death from most predators (but see Emmons 1989; Medica and Greger 2009). However, hatchlings and young juveniles of many species have very soft, un-ossified shells and may suffer high mortality from predation (Ashton and Ashton 2008; Gilbert et al. 2008; Van Devender 2002). The rate at which shells harden (ossify) apparently has not been studied, but such information is important, especially in conservation efforts. For example, field studies of the threatened Desert Tortoise (*Gopherus agassizii*) have revealed very high predation pressures on young, mainly from ravens (Boarman 2003; K. A. Nagy, L. S. Hillard, S. Dickson, and D. J. Morafka, unpubl. data).

Chelonian species recovery programs involving head-starting procedures, which protect nests, hatchlings, and juveniles from predation until the young animals have grown through the highly-vulnerable stages, will involve decisions about when to release the juveniles into the wild. Such decisions should benefit from information regarding rates of development of shell hardness and shell size. Paired with data on predation and survivorship, knowledge of shell hardness would allow researchers to more fully understand how shell hardness influences predation risk and survivorship and identify particularly vulnerable periods in the life of juvenile chelonians. This information would allow for the development of better-informed conservation and management decisions. Also, knowledge of rates of shell hardening and shell growth can contribute to basic understanding of shell ontogeny among chelonians, as well as help answer ecological questions about effects of variability in average annual temperatures and rainfall, invasive species, and competition for food by other species on shell growth rate and ossification.

Finally, comparisons of juvenile shell hardness development between populations or species may elucidate patterns of life-history evolution in response to differential predation patterns. Accordingly, we developed a reliable method for measuring shell "hardness" (compressibility) using machinist's calipers and applied it in a preliminary study of juvenile desert tortoises living and growing under essentially natural conditions in fenced enclosures in the open desert to predict the age and size at full shell hardening.

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MATERIALS AND METHODS

Instrumentation.—Shell compressibility was measured using a 4-inch (maximum gap size), tension-calibrated, digital micrometer (Aerospace® brand; Fig. 1). The micrometer had a measurement range (spindle "throw") of only one inch, but we used 1-, 2-, and 3-inch inserts to allow measurement of shells ranging from zero to 102 mm (4 in) in height. The inserts were actually the calibration standards that came with the set of four micrometers (having jaw sizes of 1-, 2-, 3-, and 4-inches). Preliminary tests indicated that each of the four micrometers had rather different factory-set release tensions. Accordingly, we used only the largest micrometer, so as to minimize instrument error across various sizes of tortoises, adapting it to accommodate tortoises smaller than 75–100 mm by using the inserts. We fitted each of the three calibration standards with its own machined plastic collar



FIG. 1. Micrometer (4-inch), fitted with the 3-inch insert and machined white plastic collar to hold the insert in place, and shown attached to the wooden stand that was used for support in the field. This configuration allowed measurement of shell heights of up to 25 mm (one inch). Shell heights between 25–100 mm (1–4 in) could be measured by using either of the two shorter inserts (for 25–50 mm or 50–75 mm shells) or no insert (75–100 mm shells).

with set-screw so it could be attached and secured flush with the lower cylindrical measuring face of the micrometer. The micrometer was attached to a wooden stand to enable hands-free use (Fig. 1). The small knurled knob ("thimble") on the end of the handle advanced the spindle via a tensioned ratchet. When the spindle applied a factory-set force to the object being measured, the ratchet slipped, producing clicks, and the spindle no longer advanced.

The force exerted by the spindle at the pressure point where the ratchet slipped continuously averaged 636 g (SD = 37, CV = 5.8%, N = 7). The surface area of each measurement face was 28.3 mm^2, thus the force being exerted by both micrometer faces combined on the shell of tortoises when measuring CSH was 11.2 g/mm^2. No tortoises or shells showed any damage from our measurements. We purposely did not make measurements on hatchling tortoises due to their very thin and rubbery shells.

Measurement technique.—To measure shell heights, we held a tortoise level in its normal horizontal posture, then positioned the tortoise in the micrometer at its maximum shell height point, with its plastron just touching the lower caliper spindle face, or insert face, as appropriate for the size of the tortoise. We then determined the uncompressed shell height (USH) by slowly lowering the upper spindle by turning either the large knurled cylinder or the small knurled knob until the upper measuring face just touched the carapace, while being careful not to press the tortoise's plastron down on the lower measuring face and not to allow the tortoise to rest on the lower measuring face so its body weight deformed its plastron. We confirmed this "loose fit" in the caliper by very slightly sliding the tortoise back and forth, to assure that both caliper measuring faces were barely touching the tortoise's shell. The micrometer reading was recorded as USH, then the compressed shell height (CSH) was determined by continuing to rotate the small knob until the ratchet slipped continuously and at least six ratchet clicks in a row occurred. We recorded the micrometer reading at that point as the compressed shell height (CSH) value. It was important to make the CSH measurement gently but quickly, for two reasons. Small tortoises, which had the most compressible shells, sometimes began moving their legs after a short period of being compressed, adding uncertainty to the CSH measurements. Second, the shells of smaller tortoises were sufficiently elastic that if a tortoise was allowed to remain in the calipers at the compressed height position for another 10 or so seconds, it was then possible to compress them further before the six-click tension was again reached.

Hardness calculation.—Shell Hardness Index (SHI) was calculated with the equation:

$$SHI = 100\ (CSH/USH)$$

where CSH is compressed shell height and USH is uncompressed shell height. Both heights in this study were measured to ± 0.001 inches.

SHI Reproducibility.—We evaluated the "machine" repeatability of the USH, CSH, and SHI determinations by making repeated measurements of USH and CSH on a flexible "tortoise mimic," which was a rubber pipette bulb. To evaluate "animal" repeatability, we made duplicate measurements of SHI on four yearling tortoises. We only made two measurements per animal because their soft shells were slow to recover their original shape following a SHI determination. We allowed 30 min between duplicate measurements to allow for shell recovery. The force exerted by the spindle at the pressure point where the ratchet slipped continuously was measured by inserting a small portable balance into the micrometer in place of a tortoise.

Field measurements.—We made initial applications of this method on two populations of Desert Tortoises (*Gopherus agassizii*) living in the field. Juvenile tortoises were studied at the Fort Irwin head-start facility (described in Morafka

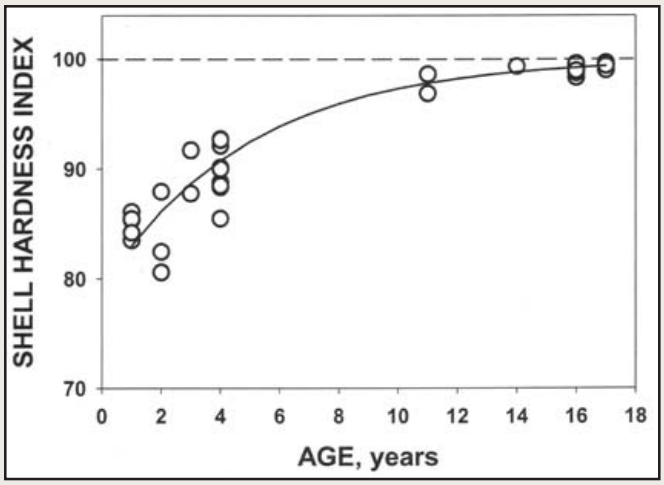


FIG. 2. Relationship between shell hardness and the age of juvenile tortoises living under natural conditions in the Mojave Desert. The solid line is an asymptotic curve fitted to the data, and the dashed line indicates a fully rigid shell, as in adult tortoises.

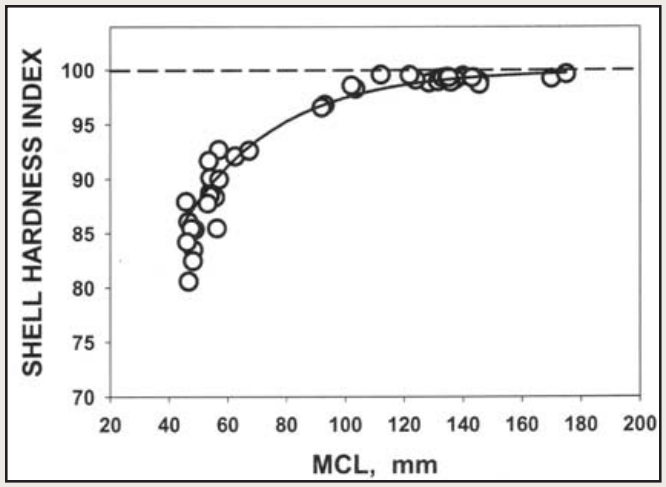


FIG. 3. Relationship between shell hardness and shell size (midline carapace length) of juvenile tortoises. The solid line is an asymptotic curve fitted to the data, and the dashed line indicates a fully rigid shell, as in adult tortoises.

et al. 1997 and Nagy et al. 1997), near the southern boundary of the US Army's National Training Center (35.1333°N, 116.4833°W) and at the Edwards Air Force Base head-start facility (34.7833°N, 117.7833°W) during 2007. The 28 tortoises studied at Fort Irwin were hatched inside predator-resistant, natural habitat enclosures between 1991 and 2003 and lived there under essentially natural conditions until their release into nearby open habitat in 2005 and 2006. They have been radio-tracked regularly since release. During recaptures in 2007 we measured SHI and midline (straight-line) carapace lengths (MCL in mm, measured from the notch just above the head to the notch above the tail to the nearest 0.1 mm with either digital or dial stainless steel 6-inch calipers). The 13 juveniles at Edwards AFB were also hatched inside fenced enclosures in natural habitat and their enclosures received only natural rainfall. They ranged in age from 1 to 4 years old when studied and we measured their MCLs and SHIs also during 2007.

Statistics.—We analyzed the relationships between SHI and tortoise age or MCL graphically, using SigmaPlot® (9.0) software. For regression analyses, we converted SHI values to shell compressibility values by subtracting SHI values from 100 so that "shell compressibility index" asymptotically approached zero as either age or MCL increased. The semi-logarithmic plots of these data yielded linear relationships, which we subjected to least-squares linear regression analyses with SigmaStat® (3.1) software. We used $\alpha = 0.05$ in tests for significant differences of the slopes and intercepts from zero.

RESULTS

Measurement reproducibility.—"Machine" repeatability measurements indicated that for USH the coefficient of variation (CV = 100 [SD/mean]) for 6 measurements was 0.15 %. For CSH, the CV was 1.32 % and for the SHI the CV was 1.35 %. "Animal" repeatability measurements indicated that the differences between duplicate SHI estimates were <4 % of the average measured SHI values of the four juveniles.

Field application results.—The shells of the 41 juvenile Desert Tortoises we measured had SHI values ranging from 80 to 100 (where SHI = 100 represents an incompressible shell). Among 39 juveniles for whom we had reliable age estimates, shells became harder in an apparently asymptotic manner as age increased (Fig. 2). There was more variation in shell hardness within younger cohorts than in older cohorts. The relationship between SHI and shell length, for 41 animals in this case, was also apparently asymptotic (Fig. 3). The relatively high variation in SHI among the smaller juveniles was again evident.

Predicting age and size at full shell hardening.—The relationship between SHI and age was significant ($F_{1,37} = 635.78$, $P < 0.001$, $R^2 = 0.945$) and gave an equation of ln(100-SHI) = 3.036-(0.203*AGE). Similarly, the relationship between SHI and size was significant ($F_{1,39} = 406.14$, $P < 0.001$, $R^2 = 0.912$) and gave an equation of ln(100-SHI) = 4.036-(0.031*MCL). If solved for an assumed SHI value of 98% of full shell hardness, predicted age is 11.5 years and predicted shell length is 109 mm. If the equations are solved with an assumed SHI value of 99%, predicted age is 15 years and predicted length is 130 mm MCL.

DISCUSSION

Shell hardness of young Desert Tortoises can be successfully and harmlessly evaluated using measurements of shell dimensions made with a micrometer equipped with a tension-developing ratchet-release thimble. A 4-inch micrometer along with 1-, 2-, and 3-inch spacer inserts allows a single micrometer to be used on tortoises ranging in shell height from yearlings <25 mm high up to 100 mm high. The advantage of using a single micrometer is that its unique ratchet

release force should be the same for all animals measured, thus reducing error. The micrometer we used came from a set of four that ranged in size from 1 to 4 inches. Tests on the other three micrometers indicated that each had its own unique ratchet release force and all were precise but the mean forces developed differed by as much as 33% between micrometers. Thus, using a single micrometer can reduce measurement error substantially. Measurements of compressed shell height (CSH) were an order of magnitude more variable than those for uncompressed SH (CVs of 0.15 % and 1.32 %, respectively, for the rubber bulb "tortoise mimic") because of the added variability of the ratchet's slipping point and variation in the exact position and orientation of the compressed rubber bulb in the micrometer jaws. Nevertheless, the reproducibility (precision) of the shell hardness index (SHI) measurements was good (<2% CV for the rubber bulb and about 4% CV for living year-old tortoises). By using an "Index" rather than actual dimensions for shell hardness, results for tortoises of different sizes and ages can be compared directly.

Shells of neonate Desert Tortoises were quite soft during the months following hatching, with shells being compressible by more than 40% under moderate pressure. Because of the apparent discomfort some neonates showed and because of the possible injury to their very soft and thin shells, we did not make formal SHI determinations on neonates. Instead, we waited until the following spring, when neonates were about 7 months old, to begin measurements. At this age, SHI values were quite variable but averaged about 85% of full hardness. Over the next several years of life, shells hardened in an asymptotic fashion, and the log-transformed regressions of shell hardness with both age and shell size were linear. The high R^2 values for these relationships suggest that age and shell length account for most of the variation in log shell hardness in juvenile desert tortoises. Their shells became essentially incompressible (within 2% of complete shell inflexibility under a moderate force of 11.2 g/mm^2) by the age of about 11 years and a size of about 110 mm MCL.

These results can be useful in current tortoise conservation efforts. The Mojave Desert populations of *Gopherus agassizii* suffered severe declines in the 1970s and 1980s and were listed as Threatened in 1990 under the Endangered Species Act. The Recovery Plan (U.S. Fish and Wildlife Service 1994) included increased predation, particularly on hatchlings and juveniles, as a reason for listing. Natural mortality of the young of several species in the genus *Gopherus* is known to be quite high (Germano 1994; Morafka 1994; Tom 1994; Wilson et al. 1994; but see Bjurlin and Bissonette 2004). Hatchlings and young juveniles are small and have soft shells that make them much more vulnerable to predation than the hard-shelled and relatively large adults (Bjurlin and Bissonette 2004). The soft shells of juveniles may also be involved in their more rapid loss of body water and increased susceptibility to dehydration during droughts as compared to adults (Nagy et al. 1997). Several head-start projects are now underway in the Mojave Desert to protect tortoise nests, eggs, and juveniles from predators until they can be released with an expectation of high survivorship. We recommend that such tortoises be maintained under protection of the head-start pens until they reach a shell hardness of at least 98%. Tortoises in our sample, which were receiving natural rainfall and eating natural vegetation, reached this hardness by about 11 years of age or about 110 mm midline carapace length.

Shell hardness likely confers resistance to predation. Knowledge of the rates of development of shell hardness, paired with information regarding local predator populations and predation rates on juveniles with differing shell size or hardness, would allow managers of head-start programs to make informed decisions regarding the timing of the release of captive-raised juveniles based upon shell size and hardness. For example, understanding the relationship of juvenile desert tortoise shell size and hardness to predation risk by common ravens would allow managers to make decisions that maximize survivorship rates of released juveniles in areas with high raven densities. Additionally, knowledge of the effects of experimentally varying the growing conditions within head-start pens may provide information (1) to evolutionary biologists examining environmental influences on life-history evolution, (2) to population ecologists developing life tables for population modeling and conservation plan development, and (3) to managers maximizing the productivity of a head-start program using rearing techniques that enhance shell growth or hardness. For example, knowledge of differences in shell growth and hardness for juveniles raised in areas or in pens having differing proximate climates, watering/precipitation regimes, annual or seasonal food abundance or quality, or competition from other herbivorous species or pen mates (crowding effects) would reveal the importance of these ecological influences on juvenile tortoise ontogeny and life-history evolution.

The ability to determine degree of shell hardness or compressibility may be useful in studies of the ontogeny of shell growth and ossification in a variety of tortoise and turtle species. From an evolutionary perspective, comparisons of the development and growth of juvenile tortoise shells and their effects on reducing predation risk or enhancing survivorship among different populations or between species can be instructive in determining the effect of predation on life-history evolution. For example, researchers could examine whether juvenile tortoises in environments with lower predation risk allocate more energy toward shell growth at the expense of shell hardness, thereby growing and maturing faster than juveniles in populations or species located in areas of higher predation risk.

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CONSERVATION

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Rediscovery of *Abronia frosti* (Sauria: Anguidae) from a Cloud Forest in Cuchumatanes Highlands in Northwestern Guatemala: Habitat Characterization and Conservation Status

Species of *Abronia* are known to occur from southern Tamaulipas and Guerrero, Mexico, to southern Honduras. Guatemala has been a center of diversification of this group, with 10 species, eight of which are endemic (Ariano-Sánchez and Melendez 2009; Campbell and Frost 1993). A number of species of *Abronia* are critically endangered in the wild and two species (*A. campbelli* and *A. frosti*) were thought to have become extinct shortly after their discovery (Acevedo 2006; Acevedo et al. 2010; Brodie and Savage 1993; Campbell and Brodie 1999; Campbell and Mendelson 1998; Campbell et al. 1998). These two species had not been recorded in Guatemala since the late 1990s. Recently, however, a remnant population of *A. campbelli* was discovered in the country (Ariano-Sánchez and Torres-Almazán 2010). Acevedo et al. (2010) reported that three trips to the type locality between 1997 and 1999 failed to find any individuals of *A. frosti*. These authors also reported that the entire habitat in the area had been burned and that the species was presumed extinct. The rediscovery of *A. frosti* in this report was a result of a project focused on research and conservation of the Guatemalan species of *Abronia*. This project began in June 2009 and is operated by the Guatemalan NGO Zootropic.

Materials and methods.—Beginning in October 2009, a number of trips were made to the type locality of *A. frosti* (Campbell et al. 1998), in the northwestern part of Sierra de los Cuchumatanes, Guatemala, to search for the species. Standardized interviews with local villagers were conducted to determine the presence of *A. frosti* within the area. Interviews included showing local inhabitants photographs of *A. frosti* taken from Campbell et al. (1998), as well as images of the locally common species *Mesaspis moreletti* and *Sceloporus taeniocnemis* that are reasonably similar in appearance to *Abronia*. In addition, visual searches for the species were made in suitable habitat (including climbing oak trees) in the region.

Results.—Answers to standardized interview questions during the early trips to the area determined that local villagers were able to distinguish *A. frosti* from the other species of lizards in the area. In addition, villagers reported still seeing this species locally when they cut down old oak trees for firewood and within fresh masses of moss recently fallen from high tree branches after storms. Standardized interviews also revealed that the local inhabitants used to kill the lizards, until recently, because of a belief that seeing these animals is a bad omen; the very recent reduction in the killing of lizards by the local villagers is likely due to a very effective education program initiated in the area by our group.

The cloud forest inhabited by *A. frosti* is composed mainly of two species of oak: *Quercus boruscana* and *Q. acatenangensis* (Fig. 1). The trees of this forest are heavily covered by thick masses of moss and epiphytes and have an average height of 45.5 ± 4.26 m and an average diameter at breast height of 178.15 ± 19.83 cm. During our survey visits we found that the cloud forests in the region had been severely degraded due mainly to harvesting of the original oak forests for firewood (Fig. 2).

A sub-adult specimen of *A. frosti* with a SVL of 70 mm was found in October 2010 resting on a recently cut oak tree within a cloud forest remnant near the type locality in the highlands of Sierra de los Cuchumatanes, Huehuetenango, Guatemala (Fig. 3). The specimen was captured for the initiation of a captive breeding survival assurance colony, as part of the short-term conservation program for this species.

Discussion.—*Abronia frosti* has not been documented in the wild since its original discovery, 12 years ago, despite specific efforts to do so by different groups of herpetologists

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(Acevedo et al. 2010). One of the main factors for the success reported in this paper was the participation and support of local villagers within the area. This cooperation by local inhabitants was due to an awareness campaign conducted by Zootropic. Educational workshops with villagers were conducted in the Cuchumatanes region in order to increase the public awareness about the importance of the conservation of the cloud forest this species inhabits. Cloud forest in the area is severely fragmented, consisting mainly of small patches of intact habitat surrounded by a matrix of deforested land and plantations of native pine trees. In contradiction to Acevedo et al. (2010), the survey in this report finds that despite the degradation and fragmentation of the habitat, there remain some oak forest remnants within the area that should be considered for protection.

The height and diameter of the trees where *A. frosti* is found (Campbell et al. 1998; this report) suggest that this species is probably restricted to mature cloud forest habitat. The main factor leading to the decline of cloud forests in this region is logging for the production of firewood for both local use and commercial sale in the regional population center of San Mateo Ixtatán. Main conservation actions for the species should focus on preserving the last cloud forest remnants within the area and also the initiation of a captive breeding survival assurance colony of the species.

The rediscovery of *A. frosti* reported here and the recent rediscovery of breeding populations of *A. campbelli* in small forest remnants (Ariano-Sánchez and Torres-Almazán 2010) provide hope that these species may be somewhat resilient to the effects of forest fragmentation and habitat destruction. The discovery of a sub-adult *A. frosti* may mean that a breeding population of animals persists in the area lending further evidence to the persistence of this species in the midst of habitat degradation. Although the resilience of *A. frosti* to extinction is encouraging, there are a number of critical steps that need to be taken to ensure the long-term survival of this species in the region: 1) increase the connectivity within remaining, intact forest patches; 2) preserve the remaining cloud forest remnants; 3) reduce or eliminate the taking of individuals (killing and collection for illegal trade) by local villagers; and 4) promote the restoration of critical oak forest habitat.

The implementation of the above-proposed conservation measures may be difficult to accomplish due in great part to the complicated system of land use in the region. The majority of the forest range of *A. frosti* is managed as communal property. The residents of this region are not in agreement on the best use of this forest, including any reforestation program. In order to preserve the last remaining stands of mature oak forest in the area it will be critical to develop a program, along with the San Mateo Ixtatán municipality, to decrease logging for firewood in the area. One consideration in this area would be to increase the efficiency of ovens and kitchens of local villagers. Another strategy would be the promotion of establishment of plantations of fast growing tree species, suitable for firewood, in deforested areas near towns



PHOTO BY DANIEL ARIANO

FIG. 1. Patch of cloud forest habitat still remaining at the site where *Abronia frosti* was rediscovered.



PHOTO BY DANIEL ARIANO

FIG. 2. Habitat destruction caused by logging of oaks for firewood in the area where *Abronia frosti* was rediscovered.



PHOTO BY THOMAS SCHREI

FIG. 3. Specimen of *Abronia frosti* found within moss in a fallen oak tree in Catelac-Yolcutac Mountains in northwestern Cuchumatanes, Huehuetenango, Guatemala.

as an alternative to oak forest harvest. Another option is to promote the conservation of the last forest remnants through the formal participation of these communal properties within the Guatemalan system of protected areas. This strategy would require a strong political effort by the leaders of the communities that own the land. For these political leaders to promote these conservation actions will require the implementation of an effective and sustained program for the conservation of the last cloud forest remnants in northwestern Sierra de los Cuchumatanes.

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Note added in proof: In May 2011 another specimen of *Abronia frosti* (SVL 79.62 mm) was found by a local villager near the type locality. This individual is probably a female and was captured for the captive breeding program at Zootropic.

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Prime Time for Turtle Conservation

In the race to extinction among all large groups of well-known animals, turtles hold the lead with 47.6% of 320 currently recognized turtle species identified as "Threatened" with extinction (Turtle Taxonomy Working Group [TTWG] 2010). Hoffmann et al. (2010) calculated threat levels a bit differently, by excluding data deficient or unevaluated species from the calculation; this method yields a higher percent of Threatened turtles, 54%. This exceeds global threat estimates for amphibians (41%), mammals (25%), bony fishes (15%), and birds (13%), and is similar only to primates, with 48% Threatened (Hoffmann et al. 2010). Furthermore, if our view is expanded to include 'modern' turtles and tortoises, those species that have occurred in the last 400 years, then 50% are threatened or already extinct (TTWG 2010). This percentage increases to 57% if data deficient and unevaluated species are eliminated from the calculation. By any of these approaches, turtles are in dire straits.

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Partners in Amphibian and Reptile Conservation (PARC) is working with turtle and tortoise conservation groups to raise awareness for turtles by designating the year 2011 as the 'Year of the Turtle.' Their hopes are to: 1) communicate the need for conservation, research and education to the public, nature enthusiasts, biologists, and managers; 2) showcase ongoing work and species concerns; 3) acquire critical new

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information for selected species; 4) look for opportunities to leverage across diverse efforts to enhance effectiveness of actions; and 5) work to develop new procedures and policies that will benefit chelonians. Their website (www.yearoftheturtle.org) features monthly newsletters, calendar pages, partner links, and selected project information. Modeled, in part, after the highly successful 2008 – Year of the Frog that was organized by the Association of Zoos and Aquariums, the 2011–Year of the Turtle is a mechanism to network among those doing turtle and tortoise work, and those private citizens, groups or specialists that are interested in their plight.

Although Year of the Turtle is gaining worldwide momentum, it has a particular focus on chelonians in North America, where PARC has a growing constituency. Also, among world nations, the United States is a turtle and tortoise biodiversity hotspot. There is heightened concern to preserve the unique natural heritage of turtles in this geographic area. Currently, 57 of the 320 (18%) species of turtles known worldwide occur in the United States, with Mexico being the second-most turtle-rich nation, having 46 species (TTWG 2010). Furthermore, these two North American nations rank highest in turtle species diversity if the counts exclude sea turtles, with USA having 51 species (81 species and subspecies) and Mexico having 40 species (58 species and subspecies) (TTWG 2010). Twelve species of freshwater turtles and tortoises occur in Canada. Retaining the North American turtle natural heritage is a specific conservation concern. Here, we offer a primer on the status of world turtles, with some specific information and conservation and research recommendations for the North American fauna.

TURTLE STATUS AND THREATS

The conservation status of world turtles and tortoises is currently under reassessment. The International Union for the Conservation of Nature (IUCN) Red List is the official list of the conservation status of turtles and tortoises. An update to the list will be released this year, 2011, with scores of new species evaluations to be added. The current Red List, version 2010.4, includes 207 species (Table 1). Draft Red List designations for re-evaluated and newly evaluated turtles were released in December 2010, showing a raise in species in Threatened categories, from 129 to 152 (shaded rows, Table 1). The Convention on Trade in Endangered Species (CITES) species lists address international trade guidance. International law is enforced by countries that are party to this treaty; nearly all countries are signatories. CITES classifies species into three Appendices that are grades of protection. These Appendices are due for revision in 2012, and draft revisions to turtle and tortoise listings are being made now. Currently, there are 21 species of freshwater turtles and tortoises, as well as all sea turtles, on Appendix I, the most endangered group. CITES prohibits international trade for these species, except when the purpose of import/export is not commercial (e.g., scientific research). There are 23 species, seven genera, and one family (tortoises: Testudinidae)



PHOTO BY DAVID BURKWALL

FIG. 1. Eastern Box Turtle (*Terrapene carolina*).



PHOTO BY GREGORY LIPPS

FIG. 2. Spotted Turtle (*Clemmys guttata*).



PHOTO BY JEFFREY G. HALL

FIG. 3. Bog Turtle (*Glyptemys muhlenbergii*).

on Appendix II, the list that identifies species that may become threatened unless trade is closely controlled. There are 18 species and one genus (*Graptemys*) on Appendix III, the list that identifies species of concern by a Party (country) that already regulates trade in the species and needs cooperation of other countries to prevent unsustainable exploitation. Permits or certificates are needed for international trade of these species. One USA species is on Appendix III.

North American turtle conservation concerns can be further assessed by their national status ranks. In the USA, 9 of 57 (16%) freshwater turtle and tortoise species are listed under the Endangered Species Act (ESA, Table 2). In Canada, 6 of 12 species have conservation status by the Committee on Status of Endangered Wildlife in Canada (COSEWIC, Table 3). These lists do not overlap. It should be noted that the COSEWIC species appear on species of concern lists for certain US States.

The two top threats to turtles worldwide and in the US and Canada are habitat loss and fragmentation, and overexploitation for food, traditional medicines, and pets. Exacerbating these threats is the basic life history of most turtles and the small total ranges of many species. Their low fecundity and the several years it takes for young turtles to achieve maturity result in populations that are not resilient to sudden losses (Congdon et al. 1993). Small ranges mean that there are fewer total individuals and that there are fewer options for conservation action. All Canadian turtles are at the northern extent of their range, attributing to concern status for half of them.

Some examples of US turtles in peril and the reasons for concern are given below. Many more could be given. Each case is an example of the general issues, but the details are always different and they do matter.

The Plymouth Red-bellied Turtle (once recognized as the subspecies *Pseudemys rubriventris bangsi* and now understood as a highly isolated population) is confined to approximately 17 ponds entirely within Plymouth County, Massachusetts, more than 400 km from the mid-Atlantic populations of the same species. Similarly, the Alabama Red-bellied Turtle (*Pseudemys alabamensis*) occurs only in parts of Mobile Bay drainage in Baldwin and Mobile counties in Alabama, and Harrison and Jackson counties in Mississippi. Other species have specific habitat requirements so that the total amount of real estate available to them is small. The threatened Bog Turtle (*Glyptemys muhlenbergii*) requires very specific, nearly pristine, bogs to thrive so that although it ranges from upstate New York to Georgia, there is too little habitat left. The Flattened Musk Turtle (*Sternotherus depressus*) occurs only within the Black Warrior River system of Alabama, but cannot now live in much of that river because of water pollution and increased human activities.

A group of special interest is the map turtles of the Gulf South. Here, eight species are restricted to one or a small number of associated drainages in the southern USA that lead to the Gulf of Mexico. For example, the Pascagoula Map Turtle (*Graptemys gibbonsi*) is restricted to the Pascagoula River drainage in Mississippi and the newly described Pearl River Map Turtle (*Graptemys pearlensis*) is confined to the Pearl River drainage only in Mississippi and bordering Louisiana. Because each of these species is only found in riverine habitat the total amount of area occupied is necessarily quite small. Scientists are currently preparing a new Red List assessment of these species and it is likely that many of them will be found to be vulnerable or endangered.

Two of three species of US tortoises, the Gopher Tortoise (*Gopherus polyphemus*) and the Desert Tortoise (*Gopherus agassizii*), are threatened by the enormous expansion of urbanization within their ranges. In Florida, the primary home of the Gopher Tortoise, development has been displacing tortoises at an alarming rate as that state has had one of the highest human population growth rates in the country. Similarly, much of the western portion of the Mojave Desert in California has seen most of the available land put to human use in the last two decades. For example, in Victorville, California, the human population grew from 64,000 in 2000 to approximately 112,000 in 2010. Unfortunately, Desert Tortoises have also been severely affected by disease outbreaks even in relatively remote areas (USFWS 2006).

Other turtles that have in the past been both widespread and common are now suffering from habitat fragmentation and the effects of roads. This creates a pattern of many small populations that cannot interact with each other. As road density increases, many scientists believe that a tipping point will be reached where many of the small populations will go extinct. The concern has been raised for the Common Box Turtle (*Terrapene carolina*), a mostly terrestrial species (Dodd and Franz 1993). So, even species that were formerly regarded as common may be prone to widespread decline.

Exploitation of turtles for Asian commercial markets has skyrocketed and is now a major conservation concern worldwide, including in North America (Turtle Conservation Coalition 2011). Turtles have played an important role in Chinese civilization at least since the Bronze-Age Shang Dynasty over 3,000 years ago. At that time, hundreds of thousands of turtles were used in divination rituals in which tortoise and turtle shells were heated and the cracks obtained were interpreted for guidance. These oracle bones fill archaeological sites. Turtles also have always been recognized for their longevity and the Chinese have sought to acquire that virtue from them. Today, turtles are consumed in China for long life and for traditional medicine. The problem, known as the Asian Turtle Crisis (van Dijk et al. 2000), arises from the combination of this long tradition with a population of over 1 billion people who are becoming wealthier. The demand for turtles in China is now almost impossible to overestimate. But the result is clear: turtles are being sent from all over the world to China for consumption at a scale unimaginable only a few years ago (Compton 2000; Chen et al 2009). Southeast Asian countries such as Vietnam now have their entire turtle fauna (over 30 species) critically endangered due to this trade (Hendrie 2000). The economic incentives for local peoples to

TABLE 1. International Union for the Conservation of Nature (IUCN) Red List current turtle designations (version 2010.4), re-evaluations to update the current list (updated numbers), provisional designations of previously unevaluated species, and sum of these columns to represent draft new list (TTWG 2010). Shaded rows are considered "Threatened" categories. * Indicates a category being phased out. — Indicates number not available or not relevant.

	No. Species		
IUCN Red List Category	Current List	Re-evaluations	Provisional List
Extinct	6	+1 (7)	1
Extinct in the Wild	1	–1 (0)	1
Critically Endangered	30	+7 (37)	6
Endangered	40	+2 (42)	4
Vulnerable	59	–9 (50)	13
Lower Risk	41	–11 (30)	9
Conservation Dependent*	1	–1 (0)	—
Least Concern	18	+3 (21)	63
Data Deficient	11	+2 (13)	16
Not Evaluated	—	—	8
Total No. Species	207	121	

TABLE 2. United States Endangered Species Act (ESA) turtle listings. Available at: www.fws.gov/endangered/species/us-species.html.

Common Name	Scientific Name	Status
Flattened Musk Turtle	*Sternotherus depressus*	Threatened
Sonoyta Mud Turtle	*Kinosternon sonoriense longifemorale*	Candidate
Desert Tortoise	*Gopherus agassizii*	Threatened
Gopher Tortoise	*Gopherus polyphemus*	Threatened
Plymouth Red-bellied Turtle	*Pseudemys rubriventris bangsi*	Endangered
Alabama Red-bellied Turtle	*Pseudemys alabamensis*	Endangered
Bog Turtle	*Glyptemys muhlenbergii*	Threatened
Ringed Map Turtle	*Graptemys oculifera*	Threatened
Yellow-blotched Map Turtle	*Graptemys flavimaculata*	Threatened

TABLE 3. Committee on Status of Endangered Wildlife in Canada (COSEWIC) turtle listing. Available at: www.cosewic.gc.ca/eng/sct1/searchform_e.cfm

Common Name	Scientific Name	Status
Eastern Musk Turtle	*Sternotherus odoratus*	Threatened
Blanding's Turtle (Nova Scotia population)	*Emydoidea blandingii*	Endangered
Spotted Turtle	*Clemmys guttata*	Endangered
Wood Turtle	*Glyptemys insculpta*	Threatened
Spiny Soft-shell	*Apalone spinifera*	Threatened
Western Painted Turtle (Pacific Coast population)	*Chrysemys picta bellii*	Endangered

participate in this global trade are staggering. Any turtle is worth serious money to a Vietnamese peasant, but some species, such as the Three-striped Box Turtle (*Cuora trifasciata*), sell for several thousand dollars apiece (Blanck et al. 2006). They are literally worth their weight in gold.

Commercial markets for turtles include the pet trade. Around the world people keep pet turtles and tortoises. In the last few decades they have become much more popular and, most importantly, the number of species found in the pet trade has increased dramatically (Shepherd and Nijman 2007; Shepherd and Nijman 2008). While most pet owners have relatively common species and do not pose a major conservation threat, some collectors become fanatic about getting rare or unusual species. Today, almost every species of turtle can be found for sale, legally or not, on the internet. Fanatic collectors can buy the world's rarest turtles if they have enough money, and many do. Prices for adult Ploughshare Tortoises (*Astrochelys yniphora*) from Madagascar can range to well over US $10,000 (Smith 2011). This market has driven many species to near extinction (Turtle Conservation Coalition 2011). Especially frustrating to turtle biologists is that when a new, rare species is described in the scientific literature, this publication immediately creates a market for the new turtle (Stuart et al. 2006). For example, the Roti Island Snake-necked Turtle (*Chelodina mccordi*) was described from a single small island in Indonesia and within a very few years most of the population had disappeared into the international trade.

Several US states have tightened their regulations over the commercial exploitation of any turtle species (P. Nanjappa, pers. comm.), in part because of increased evidence for the growing demand for turtles in Asia and worldwide. Turtles are still captured for the pet trade but it is hard to know how much of a conservation concern this harvest is. Formerly, both Common Box Turtles (*Terrapene carolina*) and Ornate Box Turtles (*Terrapene ornata*) were sent to Europe in large, unsustainable numbers. But this trade has been much reduced after the genus was put on CITES Appendix II. The individual state laws governing collection of turtles in general are a patchwork with most states allowing collection for personal use

and others not. State herpetofaunal regulations have been compiled recently to aid in management of these animals (P. Nanjappa, unpubl. data). Unfortunately, much of the trade in rare species is illegal and therefore very hard to track, and few states have the capacity to establish effective monitoring programs.

An emerging threat for turtles is hybridization and genetic swamping. A major discovery in the biology of turtles became apparent recently when it was determined that almost any species of Old World freshwater turtle (Family Geoemydidae) could hybridize with any other species even if they were in different genera. More startling is that these hybrid offspring are fertile and capable of reproduction. Turtle farms in China have now produced turtles descended from three different genera between their parents and grandparents (T. Blanck, pers. comm.). These turtles are like orchids - endless new varieties can be produced. Hybrids have no legal protection under international law so a hybrid of two of the rarest turtles in the world is legal anywhere. These hybrid turtles show that habitat alteration that permits species that do not normally encounter each other to mix could cause a distinctive form to be lost through genetic swamping. Similarly, although this has not happened yet as far as we are aware, releasing hybrid turtles could cause the loss of native species. This threat is new and there is no other group of animals that faces a similar problem. We really have no idea how dangerous it could be. In the US, the chief concern is the introduction of the Red-eared Slider (*Trachemys scripta elegans*) into habitats of its close relatives, such as the Big Bend Slider (*Trachemys gaigeae*) which occurs in the Rio Grande drainage of Texas and New Mexico. This hybridization has the potential to wipe out the Big Bend Slider as a distinct species (T. J. Papenfuss, pers. comm.).

CALL TO ACTION: CONSERVATION AND RESEARCH RECOMMENDATIONS

Hoffmann et al. (2010) demonstrated that conservation actions can improve species status. We have the opportunity to change the fate of turtles around the world by taking steps implementing conservation actions, and doing so quickly. Let us use the Year of the Turtle as our Call to Action – we can work together to benefit turtles worldwide. The Partners page at the Year of the Turtle website (www.yearoftheturtle.org) lists some organizations that work on turtle and tortoise conservation, and many more groups and individuals are working to benefit these animals. Join one or start a new one. A source to learn more about the challenges and opportunities is Craig Stanford's *The Last Tortoise* (Stanford 2010). The most endangered species are reviewed by the Turtle Conservation Coalition (2011).

An important lesson that has emerged from consideration of the difficulties of turtle conservation is that all possible conservation tools must be considered and that each species and country have their own opportunities and challenges. This lesson leads to an overall ecumenical approach in which the effective use of any one conservation tool does not preclude the use of another tool. Sometimes there are conflicts between strategies, such as when trade regulations are written so tightly that they exclude (often unintentionally) the development of assurance colonies that may be needed for some species. It is important to global turtle conservation that these conflicts be minimized.

We can divide the strategies into 3 basic approaches: 1) rare species management; 2) keeping common species common; and 3) crisis management. Furthermore, we have learned much about the threats to turtles and how to combat them. These lessons result in additional key guidelines for both conservation and research directions; the common thread among these guidelines is the need for monitoring both to understand the status of species and to determine if conservation actions are working. The following are 7 conservation action examples from North America, combining these basic approaches and guidelines.

Manage rare species.—Rare species management is the traditional focus of conservation. The primary tool is, of course, native habitat protection and preservation. In the best of circumstances this may be all that is needed. In other cases the habitat may have to be restored and repopulated by animals raised elsewhere, often in captivity. Conservation efforts for the Bog Turtle (*Glyptemys muhlenbergii*) have involved protecting good habitat, restoring degraded habitat, and releasing captive-bred animals that have been raised to a size to offer them a better chance of survival ("headstarting"). Taken together these efforts have resulted in real success in strengthening this species' hold on survival. To aid communication among headstarting efforts, for which trial-and-error management is common, PARC is compiling projects for all herpetofauna (www.parcplace.org). Long-term monitoring of populations is a critical element in the management of both rare and common species.

Manage common species.—More conservationists are focusing efforts on managing common species to keep them common. There are three reasons for this approach. The first is that, as the case of the Passenger Pigeon (*Ectopistes migratorius*) reminds us, being common, even abundant, is no guarantee that a species will never go extinct. Second, we now realize that it is much less expensive to save a species while it is common rather than to wait for it to become rare before acting. The sooner action is taken, the greater the options available are, and when there are more options, one can be more effective. Third, if no one pays attention to a species because it is common, problems and declines may go unnoticed because of a faulty assumption. The Common Box Turtle (*Terrapene carolina*) is generally perceived to live up to its name. But many turtle researchers have emphasized that being complacent about this species is a serious mistake. One of the most important aspects of managing common species is addressing mortality and population fragmentation caused by roads. Fencing roads has proved useful for the Desert Tortoise (*Gopherus agassizii*) and may work for

other species. Road patrols during Diamondback Terrapin (*Malaclemys terrapin*) nesting season are a labor intensive, but mainly successful method for reducing road mortality for that species. The search for creative solutions to this problem continues.

Manage crises.—Environmental crises can affect turtles. The Gulf oil spill of 2010 imperiled sea turtles and those species became icons of the disaster. In fact, the Diamondback Terrapin (*Malaclemys terrapin*) was perhaps even more at risk. There are three subspecies of terrapin living only in the estuaries along the Gulf of Mexico and their narrow ribbon of habitat was affected by oil washing on shore. Although only some populations were affected, terrapin biologists organized and were prepared to move animals out of harm's way if that became necessary. For sea turtles, over 25,000 eggs were moved during the Gulf oil spill, and this proved to be an effective conservation measure (Pittman 2010).

Almost unique to turtles is the crisis management problem presented by large-scale confiscations of illegal animals. Sometimes these confiscations can include thousands of turtles of over a dozen species. Emergency programs by turtle conservationists and veterinarians have been set up to sort, treat and relocate these animals that are often in very poor health.

Regulate commercial turtle harvest.—A recent compilation of herpetofaunal regulations for US states (P. Nanjappa, pers. comm.) shows that little capacity currently exists for coordination or monitoring of harvests of wild or captive herpetofaunal species. There is great variation among state fish and wildlife agencies with some having generally prohibited all commercial exploitation of wild turtles and others offering fewer restrictions. In 2009 and 2010, representatives of many of the US state fish and wildlife agencies met to begin to address regulatory issues and needs. This process will continue in 2011. Sea turtles benefit from federal regulation and funding, due to their rarity and international migratory nature; similar federal protections are afforded to tortoises, and could be considered for freshwater turtles. The US Fish and Wildlife Service is actively engaged in these turtle issues as well, and is a key player, with state fish and wildlife agencies, in the revision of CITES Appendices. Realistically, we may not be able to prevent or ask for bans on all harvest. However, we can encourage and support closely-monitored and well-regulated harvest; with such measures, some commercial turtle harvest could be acceptable.

Turtle farming operations have not been closely monitored or studied. In particular, how much do farms rely on native wild turtles for brood stock? In addition to understanding 'take' in wild populations, a greater understanding of the contribution of US turtle farms to US and world commercial markets is needed. This need is growing as production grows.

Create and institutionalize local interest groups for localized species.—Highly localized species need highly localized support groups; that is, groups of people that champion their local turtle. Such groups, formal and informal, exist for some species. Even in 1952, Archie Carr could write of the Plymouth Red-bellied Turtle population that "If it were not for the interest shown by local inhabitants of Plymouth County in the conservation of this interesting population of turtles it would soon be wiped out." The turtle conservation community needs to facilitate the creation of such groups. For example, this community could help folks living near some of the Gulf South *Graptemys* to develop a sense of pride and appreciation for their neighborhood endemics.

Implement range-wide population, habitat, and risk analyses for widespread species.—GAP Analysis is a conservation evaluation process where the ranges and populations of species are overlaid on protected areas such as National Parks to determine how well protected they are over their entire range. For example, we need a range-wide GAP analysis of the Common Box Turtle (*Terrapene carolina*) to estimate how many populations are currently protected and an assessment of the real risk that this species faces. Data from all states and Canada would be needed for this type of synthesis. The PARC-initiated USA Turtle Mapping Project (www.yearoftheturtle.org) is a necessary preamble for such a large-scale species assessment.

Additionally, a meta-population analysis for widespread species is needed to look for 'tipping points.' Many species of terrestrial turtles and tortoises live in populations that are more or less loosely connected by individuals who move between the local populations. This pattern is called a meta-population, and understanding how meta-populations work, and how they can fail, is an important aspect of the conservation of these species. Connectivity focal areas could be identified in such an analysis. As increasing road traffic prevents any movement from one population to another, isolated populations may have a greater chance of going extinct. We must determine at what point fragmentation of a meta-population causes a species to go extinct, and where the critical connection points exist. Many researchers believe there is a tipping point as meta-populations become increasingly isolated where they can fail and go extinct. We must determine how and when this may be true of turtles, and geographically where the important areas are to maintain connectivity.

Develop methods to assess and ensure high genetic diversity for greater evolutionary potential to respond to global change.—Genetic diversity is the basis of evolutionary adaptation to changing environments. Many turtle environments are predicted to shift under climate change scenarios. The details of these changes as they apply to particular species are generally unknown. With this uncertainty about environmental change, it becomes important to ensure that turtle and tortoise populations are genetically diverse so that they can respond to whatever change does actually occur. This is a strategy of hedging one's bets on the future. Increased efforts are warranted to evaluate turtle genetic diversity and the trade-off between how well-adapted turtles are versus how resilient turtles are to changes based on their genetics (i.e.,

their "adaptedness" versus their "adaptability"). This knowledge is especially important for reintroduction programs where animals may be reared in captivity and then released into the wild.

CONCLUSION

Our turtle heritage is diminishing at a rate outpacing that of other main animal groups. The 2011–Year of the Turtle partnership and campaign is an opportunity to raise awareness for turtles, celebrate our turtle heritage, herald conservation and research successes, and identify gaps in our understanding that can be the focus of future work. We outline seven conservation and research implications of the current turtle crisis, and associated conservation opportunities and actions. If we, the turtle conservation community can accomplish efforts in these selected areas, we can greatly help to sustain species and bolster the recovery of declining turtle species.

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AMPHIBIAN DISEASES

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Chytrid in a Canopy Amphibian: Picado's Bromeliad Treefrog, *Isthmohyla picadoi* (Hylidae), Persists at a Site Affected by *Batrachochytrium dendrobatidis*

The pathogenic fungus *Batrachochytrium dendrobatidis* (*Bd*) has been implicated as the cause of many global amphibian declines (Berger et al. 1998; Bosch et al. 2001; Briggs et al. 2005; Longcore et al. 1999; Ron and Merino 2000; Skerratt et al. 2007). Central American amphibians have experienced substantial declines (Stuart et al. 2004, 2008) and *Bd* has been identified as the cause in a number of these (Crawford et al. 2010; Lips et al. 2006). A more thorough understanding of the natural history and ecology of *Bd* is still needed, and knowledge of the geographic distribution of this fungal pathogen is important for biological conservation (Adams et al. 2007; Young et al. 2001). Likewise, modes of *Bd* dispersal are poorly understood; amphibians and water sources are implicated as the primary vectors, but birds and soil are potentially important vectors as well (Johnson and Speare 2005). *Bd* has also been implicated in historic die-offs in the highlands of western Panama (Lips 1999; pers. obs) and has been detected in environmental water gathered from both lotic and lentic sources (arboreal phytotelmata) in the region (Cossel and Lindquist 2009).

Picado's Bromeliad Treefrog, *Isthmohyla picadoi* (Dunn 1937), is an arboreal, bromeliad-dwelling species found in primary, secondary, and transitional humid montane forests of Costa Rica and Panama (Duellman 2001; Faivovich et al. 2005; Savage 2002; Solis et al. 2008). Stuckert et al. (2009) found that *I. picadoi* inhabits phytotelmata with source water temperatures that fall within the reproductive thermal range of *Bd* in laboratory settings as found by Piotrowski et al. (2004). The population of *I. picadoi* from the highlands of western Panama studied by Stuckert et al. (2009) persists despite catastrophic declines and extinctions of other amphibian species in the region due to *Bd* (Lips 1999). Although no data on the population exists prior to the arrival of *Bd*, the population currently appears to be stable based on the number of vocalizations heard throughout the study site over multiple years ranging from 2000 to 2008 (pers. obs.). Stuckert et al. (2009) suggested *I. picadoi* may be a potential vector of vertical stream-to-canopy *Bd* zoospore transfer as well as stream-to-terrestrial dispersal. However, their study did not present evidence of *Bd* infection in *I. picadoi*, nor any correlation between infection in *I. picadoi* and presence of *Bd* in phytotelmata. In this study, we set out to determine: 1) whether *Bd* is detectable in the population of *I. picadoi* at the study site described by Stuckert et al. (2009) and Cossel and Lindquist (2009); and if so, 2) the prevalence of infection; and 3) whether any connection exists between *Bd* infections in individual frogs and phytotelmic water sources.

We studied a population of *I. picadoi* immediately north of Guadalupe Arriba, Chiriquí Province, in the Republic of Panama (8.869444°N, 82.566806°W) between 3 and 29 January 2008 [same population as Stuckert et al. (2009)]. Study sites included primary, secondary, and transitional riparian humid forest, ranging in elevation from 1,950 to 2,300 m elevation. Sites were located in a private forest preserve owned by Los Quetzales Lodge and Spa, and in a small forest tract in the Finca Dracula, owned by Andrés Maduro. Both properties border the Parque Internacional La Amistad and Parque Nacional Volcán Barú.

We located *I. picadoi*, via two techniques: 1) randomly searching bromeliads (leaf axils and phytotelmata) at both day and night; and 2) triangulating male nocturnal position immediately after vocalization. Epiphytic bromeliads and mosses were searched at heights ranging from 0 to 33.5 m

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above the ground. Trees and epiphytes were searched using three methods: ground searches, ladder searches, and climbs using the Single Rope Technique (SRT) (Maher 2006). Ground searches entailed examining fallen bromeliads or those within standing reach. Ladder climbs employed a 7.3 m extension ladder to access higher bromeliads. Tree climbs using the SRT, which safely reached heights up to 33.5 m, were used to sample bromeliads otherwise inaccessible to ground and ladder searches. For a more detailed discussion of searching methods, data, and three-dimensional forest position in this species, see Stuckert et al. (2009).

Clean nitrile gloves were used when capturing frogs and were changed between handling different individuals. After capture, frogs were kept outside in individual bags to collect any shed skin for 24 h in order to assess individual health. All were kept at ambient temperature, yet protected from rain and potential predation. No frogs exhibited any of the typical symptoms of chytridiomycosis as described in Berger et al. (1999) such as abnormally high epidermal sloughing, reddening of ventral surfaces, lethargy, or loss of righting reflex. Individual frogs were systematically processed as given in Stuckert et al. (2009) and skin swabbing protocols followed Brem et al. (2007). Individual frogs were swabbed dorsally, ventrally, and along limbs and digits with wooden-handled non-adhesive cotton swabs, as suggested by Livo (2004). Although Lee and Cooper (1995) have suggested that the use of wooden medium inhibits PCR amplification, Retallick et al. (2006) did not find this to be the case (both studies used wooden toothpicks to swab their samples). Additionally, *Bd* cultures also were swabbed with wooden-handled non-adhesive cotton swabs and all yielded positive results, indicating that PCR amplification was not inhibited in our study. Therefore we are confident that the swabbing protocol we used did not contribute to false negatives. The cotton tips were removed from the wooden handle of all swabs and placed into a 2 ml screw capped vial with 70% ETOH and labeled. Samples were refrigerated upon return to the United States.

Traditional PCR and qPCR analyses were conducted. DNA from samples containing shed epithelial fragments was prepared from the fragments using genomic extraction protocols outlined by Boyle et al. (2004). Traditional PCR methods, described by Annis et al. (2004), were utilized to detect and amplify *Bd* sequences with the following changes to the PCR reaction: PCR amplifications were performed in 50µl consisting of 0.4 µM of each primer, 1x Roche FastStart *Taq* buffer with 2mM $MgCl_2$, 0.2 mM of each dNTP, and 2.5 U of Roche FastStart *Taq* polymerase enzyme.

Swab samples were prepared for real-time qPCR analysis according to the procedure outlined by Boyle et al. (2004) and Kriger et al. (2006a). However, samples returning positive in singlicate analyses were subsequently analyzed in triplicate to determine relative infection intensity as suggested by Kriger et al. (2006b). Due to the larger-sized swabs used with our collection protocols, nucleic acids were extracted using 75 µl PrepMan Ultra to ensure sufficient supernatant for analysis. We used an Applied Biosystems StepOne™ real-time PCR system to detect and quantify *Bd* sequences. TaqMan Exogenous Internal Positive Control Reagents were used as internal positive controls (VICTM dye, Applied Biosystems No. 4308323, Hyatt et al. 2007) to ensure there was no inhibition of amplification. Positive controls for the amplification of *Bd* DNA were achieved by using standards as described by Boyle et al. (2004) and a negative water control was run on every 48-well PCR plate.

We caught and swabbed 32 individual *I. picadoi*: 15 males, 3 females and 14 juveniles. Preliminary sample analyses using traditional PCR methods indicated the presence of *Bd* in one swab sample which contained visible, but minor shed epithelial fragments. This was similar to other individuals that had similar amounts of epithelial shedding, but not unusually high amounts that would have indicated clinical chytridiomycosis. Independent quantitative PCR analyses confirmed the presence of *Bd* in the same sample (individual), but in none of the other 31 swabs, indicating an infection detection prevalence of 3.125% in our study (7.91×10^{-4}, 1.62×10^{-1}; 95% exact binomial CI). The mean number of zoospore equivalents calculated from triplicate samples drawn from the infected frog was 366.50 ± 150.82 (SE). The sole infected individual was a large adult male (SVL = 34.3 mm/SUL = 32.85) found in a bromeliad 1.5 m off the ground.

Stuart et al. (2008) cite chytridiomycosis as a likely cause of observed declines in *Isthmohyla* and Lips (1998) observed a dying *Isthmohyla calypsa* individual in Costa Rica during the beginning of a local *Bd* epidemic. Although not tested for chytridiomycosis, this individual was likely infected. Further, species distribution modeling by Lötters et al. (2010) has shown that *I. calypsa* and a number of critically endangered congeners (*I. angustilineata, I. debilis, I. graceae, I. rivularis,* and *I. tica*) have geographical ranges that overlap with known localities of *Bd* and their rapid enigmatic decline is associated with chytridiomycosis. Although *Bd* has been implicated in other *Isthmohyla* declines, to our knowledge *Bd* has only been confirmed in *I. pseudopuma* from populations near Monteverde, Costa Rica (Picco and Collins 2007; Puschendorf et al. 2006; JOC, unpubl. data). These findings represent a confirmed second *Isthmohyla* species infected with *Bd* and provide support to the suggestion that amphibians of this genus are susceptible to infection (Lötters et al. 2010). These findings are also significant because they corroborate findings from Cossel and Lindquist (2009) that demonstrated the presence of *Bd* in both lotic and lentic environmental water sources at the same site which has been heavily impacted by *Bd*.

The detection of *Bd* in an extant species in this region has some notable implications. First, the persistence of *I. picadoi* in the Chiriquí highlands of Panama may simply be associated with the species' arboreal life history. The prevalence of infection may be lower in *I. picadoi* than in stream breeding congeners because *I. picadoi* not only lives in bromeliads, but breeds in them as well. Thus, they rarely if ever come into

contact with lotic bodies of water such as streams which are shared by many different amphibian species. This species' life cycle and microhabitat usage might explain why *I. picadoi* persists while formerly sympatric riverine species such as *Rana warszewitschii* and *Atelopus chiriquiensis* were extirpated or may have gone extinct, respectively (Lips 1999). This could also explain why populations of *I. picadoi* seem to remain stable (pers. obs.) despite living in sympatry with *Bd* while congeners that are more closely linked to streams (like *I. calypsa*) are declining or have completely disappeared (Lips 1998). The one frog that tested positive for *Bd* was found in a bromeliad with a significantly elevated zoospore load of 6,780 ± 85 Eq/L (Cossel and Lindquist 2009). The study by Cossel and Lindquist (2009) only found *Bd* in one other bromeliad (4.2% of all bromeliads sampled were *Bd* positive). This bromeliad was near another captured *I. picadoi*; however, *Bd* was not detected on this frog. The low prevalence of *Bd* in bromeliads (Cossel and Lindquist 2009) and the positive *Bd* association between frogs and bromeliads may further support the notion that the canopy presents lower, but not completely eliminated, potential *Bd* exposure risks. The *Bd* positive frog and bromeliad this frog was found in were located roughly 200 m away from the nearest stream (also positive for *Bd*) and raises the possibility that *I. picadoi* may serve as a vector and/or reservoir for *Bd* (although we cannot fully rule out some other vector). Second, an apparently low level of *Bd* prevalence occurs in *I. picadoi*, perhaps suggesting some adaptive and/or innate immune response exists. A discussion of immunity scenarios has been explored in detail by Richmond et al. (2009), and good evidence of antimicrobial peptide and symbiotic cutaneous bacteria in some species exists in the literature (Lam et al. 2010; Rollins-Smith et al. 2002, 2005, 2006). Further evidence is provided by Carver et al. (2010), who have shown that individuals initially infected and showing signs of clinical chytridiomycosis may be able to fully recover, and although aclinical, may still be infected with the pathogen. Finally, some species have been shown to be able to behaviorally thermoregulate, likely to fight *Bd* infections (Richards-Zawacki 2010). Local or regional *Bd* persistence may be explained by reservoir amphibian species that are sublethally infected (Briggs et al. 2005; Daszak et al. 2004; Davidson et al. 2003; Garner et al. 2006; Woodhams et al. 2007) and additionally, not all species that come into contact with the fungus are at risk of clinical chytridiomycosis (Gascon et al. 2007; Stuart et al. 2008). The one frog which tested positive for *Bd* did not show signs of clinical chytridiomycosis and appeared healthy. However, we did not keep frogs long enough to see if they developed clinical chytridiomycosis.

The presence of *Bd* in this canopy-dwelling species provides evidence that some canopy amphibians may serve as vectors for the fungus (Stuckert et al. 2009). Further, it emphasizes the suggestion by Cossel and Lindquist (2009) that arboreal sites may serve as environmental reservoirs, facilitating the persistence of *Bd* in local environments.

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Prevalence and Distribution of *Batrachochytrium dendrobatidis* at Montane Sites in Central Washington State, USA

The fungal pathogen *Batrachochytrium dendrobatidis* (*Bd*) causes mortality in some amphibians (Berger et al. 1998; Nichols et al. 2001) and has been implicated as one cause of amphibian declines (Pounds et al. 2006; Stuart et al. 2004). Recent studies have found *Bd* in Oregon, Alaska, and Idaho, USA, as well as in British Columbia, Canada (Adams et al. 2007; Garner et al. 2006; Pearl et al. 2007; Reeves 2008; http://www.spatialepidemiology.net/Bd-Maps/), but few data are available on its distribution in Washington, USA. *Bd* has been detected in samples collected in western, central and eastern Oregon but was absent from two sites in Washington (Pearl et al. 2007). *Bd* has been detected in the Oregon Spotted Frog (*Rana pretiosa*) in two other sites in southwestern Washington (Hayes et al. 2009; Pearl et al. 2009). In addition, the fungus has been isolated from amphibians associated with large die-offs in the Cascade Range of Washington (Snoqualmie Pass area; R. S. Wagner and J. E. Johnson, unpubl. data). We investigated the prevalence and distribution of *Bd* on Table Mountain in the Blewett Pass area of central Washington (Fig. 1) to assess the presence of *Bd* in the region and to determine the prevalence for local anurans.

We collected anurans from three sites on Table Mountain, Washington (elevation 1430–1550 m), between June and September 2008. The area is characterized by dry coniferous forest with heavy snowfalls (typically 2–3 m). Species collected were the Columbia Spotted Frog (*Rana luteiventris)*, Cascades Frog (*Rana cascadae)* and Northern Pacific Treefrog (*Pseudacris regilla)*. Animals were hand collected during visual surveys and held individually in clean plastic bags until processing. The sample size at each site was determined by plotting the cumulative number of sampled individuals within a species (x-axis) versus cumulative infection rate (y-axis) for that site. Sampling ended once this plot had stabilized at a plateau, because further sampling would have had little effect on the overall estimate of prevalence.

After capture, skin cells were collected from each frog by swabbing its ventral surface vigorously for fifteen seconds. Swabs were stored in sterile 1.5 ml mirocentrifuge tubes filled with 70% ethanol, and kept at -20°C until they were processed. We also recorded snout–vent length, sex, presence of secondary sexual characteristics, and the presence of typical signs of *Bd* infection (e.g., redness, skin lesions, lethargy, etc.; as in Pessier et al. 1999) for each individual. In addition, the digit second from the outside on the right hind limb of each frog was removed to prevent resampling. Toes were preserved in 70% ethanol and frozen at -80°C. Field gear was sterilized between sites and a clean pair of powder-free latex gloves was used per frog to prevent the spread of infection.

To identify the presence of *Bd* in the samples, skin cells were dislodged from swabs by vortexing for 15 sec. The swabs were removed and the remaining mixture was centrifuged at 13,400 rpm for 7 min. The supernatant was removed and the pellet was resuspended in 20 mL distilled water. Approximately 10 ml of this mixture was then mounted on a glass slide and examined using differential interference contrast microscopy for *Bd* zoosporangia. A sample was considered

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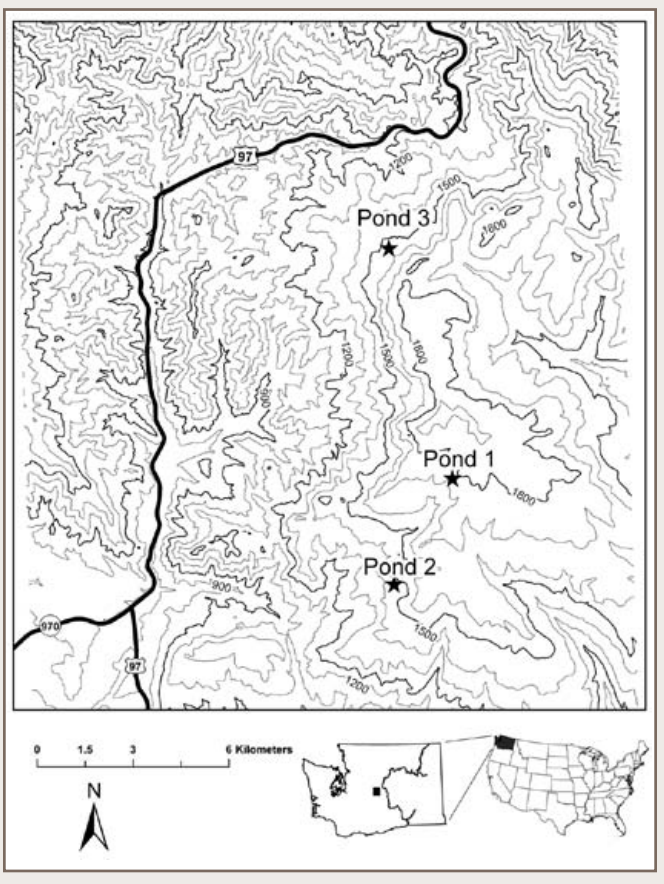


FIG. 1. Sites surveyed for *Batrachochytrium dendrobatidis* on Table Mountain in central Washington, USA, west of the Columbia River (see inset) and east of Highway 97.

TABLE 1. Adult and juvenile amphibians that tested positive (+) or negative (–) for *Batrachochytrium dendrobatidis* in central Washington, USA. Species were *Rana cascadae* (RACA), *Rana luteiventris* (RALU), and *Pseudacris regilla* (PSRE).

Site	Latitude / Longitude	Elevation (m)	Total Sample Size	Species	No. Adults		No. Juveniles	
					+	–	+	–
Pond 1	47.14223°N, 120.34485°W	1760	39	RACA	12	10	2	7
				PSRE	3	5	0	0
Pond 2	47.12467°N, 120.36016°W	1430	22	RACA	0	5	11	4
				PSRE	0	0	1	1
Pond 3	47.18142°N, 120.35890°W	1540	35	RACA	10	8	0	2
				RALU	7	6	1	**1**

negative if no *Bd* structures were found within 10 min. of searching.

We found *Bd* at all sites and in all species sampled. Overall, 49% of the anurans tested positive for *Bd* (Table 1). *Pseudacris regilla* had the lowest infection rate of 40%, whereas *R. cascadae* and *R. luteiventris* had infection rates of 52% and 53%, respectively. Fifty percent of juveniles and 52% of adults tested positive for *Bd*. Across sites, the adult infection rate ranged between 50% and 63%, and the juvenile infection rate ranged between 22% and 50%. None of the differences in infection rate between species, sex, pond site, and life stages were significantly different when compared using contingency tables. No frogs showed the typical signs of infection (i.e., redness, bleeding, lethargy, etc.) and no dead frogs were found during collection.

We report some of the first published accounts of *Bd* in central Washington State, USA and our data are consistent with other studies within the state (Hayes et al. 2009; Pearl et al. 2009), but we observed a higher prevalence than samples from the Northeastern USA (Longcore et al. 2007). Histological methods that sample from clipped toes are known to be less sensitive than PCR methods for detection of *Bd* (Hyatt et al. 2007). We maximized sensitivity by swabbing ventral skin, where zoosporangia are more likely to be found (Berger et al. 2005). Whereas our methods are very unlikely to yield false positives, it is possible that false negatives occurred when infection loads were very light. Considering our conservative methods, our infection rates are very high and consistent with the data of Pearl et al. (2009) for *R. pretiosa*. The high infection rates are very similar between the sites and among the species used in our study. More study is needed to determine if any significant differences exist in *Bd* prevalence at larger spatial and temporal scales (Kriger and Hero 2007). Given that the infected individuals appeared asymptomatic and no dead frogs were found (again similar to the observations of Pearl et al. 2009), the current impact of *Bd* on Washington amphibians is unclear; more study is needed to accurately determine the extent of the threat posed by this pathogen.

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First Detection of Ranavirus in *Lithobates pipiens* in Quebec

Ranaviral disease and chytridiomycosis are emerging infectious diseases implicated in mortality events among wild and captive amphibians (Chinchar 2002; Daszak et al. 1999; Longcore et al. 1999). Ranaviral disease is caused by infection with members of the genus *Ranavirus* and afflicts both larval and adult amphibians (Gray et al. 2009). Chytridiomycosis is a cutaneous disease caused by the fungal pathogen *Batrachochytrium dendrobatidis* (*Bd*) that occurs only in post-metamorphic amphibians, although larvae can be infected (Berger et al. 1998). Both were recently listed as notifiable diseases by the World Organization for Animal Health (Fisher et al. 2009; Gray et al. 2009).

In Canada, amphibian die-offs associated with ranaviruses have occurred in the provinces of Saskatchewan, Manitoba, Ontario, and New Brunswick (Bollinger et al. 1999; Charbonneau 2006; Greer et al. 2005; Forzàn et al. 2009; Jancovich et al. 2005; Schock et al. 2008). *Bd* is present in several Canadian provinces and may have caused population declines in the past (Carey et al. 1999; Deguise and Richardson 2009; Ouellet et al. 2005; Schock et al. 2009). This report describes the incidental detection of ranaviral infection in frogs during their collection for experimental use, the first record of infection of this type in amphibians from Quebec, Canada.

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Methods.—In late July 2007, Northern Leopard Frogs (*Lithobates pipiens*) intended for experimental use were caught with nets, in grass and near a pond situated in a privately-owned wildlife preserve in Boucherville, Quebec (45.6477°N, 73.4350°W). Upon capture, small groups were temporarily held in moistened cotton bags and transferred to iceboxes containing pond water. A total of 400 metamorphs and 5 adults were screened for deformities, and except for four unilaterally anophthalmic (missing one eye) and two ectromelic (missing leg below the femur) metamorphs (Table 1), all animals appeared clinically healthy. As only 175 young-of-the-year frogs were required for the planned experiment, these were measured (mean snout–vent length ± SD: 29.95 ± 1.31 mm), transferred to a single icebox holding pond water, and transported to the laboratory. The additional animals were released on site.

In a laboratory held at 22 ± 0.9°C, the froglets were housed in groups of 10 inside tilted 33-L aquariums that contained 2 L of dechlorinated water, to acclimate prior to experimental use. Feces were removed and live crickets were provided daily. Within three days of capture, 7 out of 175 frogs (4%) died; five among them exhibited erythema (i.e., reddening) of the thighs and ventrum. To stabilize the animals, the survivors were individually isolated in 1.84-L plastic shelters containing 50 ml of dechlorinated water, along with platforms to allow them to exit the water. They were also fed crickets injected with tetracycline (50 mg/kg frog weight dissolved in double distilled water) to eliminate potential pathogenic bacterial infections. However, frogs only received half of the recommended dose (i.e. once rather than twice daily) due to time constraints. Mortality reached 40% (70 out of 175 frogs) within eight days of capture, then slowed and was not recorded.

In early August 2007, 100 more juvenile Northern Leopard Frogs were collected from the same site, and they all

TABLE 1. Prevalence (%) of infection by two pathogens and of two types of deformities in juvenile Northern Leopard Frogs (*Lithobates pipiens*) collected in the Parc de la Frayère located in Boucherville, Quebec, Canada, in 2007.

Occurrence	N	Prevalence (%)
Ranavirus	20	85
Batrachochytrium dendrobatidis	20	0
Unilateral anophthalmia	500	0.8*
Ectromelia	500	0.4*

* Five adult frogs that were captured did not exhibit deformities.

appeared healthy. The first 20 were captured by hand, immediately isolated for transport in individual Ziploc® containers holding dechlorinated water, and used only for disease testing; separate gloves were always worn to handle each individual. The other 80 were captured and transported together in an icebox as before, and used to replace dead frogs for the planned experiment.

In the laboratory, the 20 isolated test frogs were swabbed three times over the abdomen, back, thighs, vent, and plantar surfaces of all feet with two sterile cotton swabs. They were immediately killed by immersion in 0.8% tricaine-methanosulfonate (MS-222) and frozen for later necropsy. The swabs were inserted into autoclaved Eppendorf tubes for PCR analysis, to test for ranaviral and *Bd* infections. The other 80 frogs were immediately housed in separate containers, prophylactically administered tetracycline using the same methods and dosage frequency (i.e., once daily) as before, and monitored for signs of disease.

Frog swabs were rehydrated in nuclease-free water for 2 h, vortexed at high speed for one minute and centrifuged briefly. Sample homogenates were then extracted using a QIAamp DNA mini kit (Qiagen, Canada) following manufacturer's specifications. To test for *Bd*, a real-time PCR assay designed to target the ITS1 gene of the fungus (Boyle 2004) was run using an Agpath ID PCR kit (Applied Biosystems, Canada). To test for ranavirus, a conventional PCR assay targeting the major capsid protein (MCP) gene of frog ranavirus (GENBANK Accession Number M19872) was performed using illustra puReTaq RTG PCR beads (GE Healthcare, Canada), and primers designed using DNASTAR software (DNASTAR Inc., USA), at the Department of Veterinary Pathology, Western College of Veterinary Medicine, Saskatoon, Saskatchewan (Anita Quon, pers. comm.). Each bead was hydrated in a total volume of 25 µl containing 1 µl each of forward primer MCP-1 (5'-GCA GGC CGC CCC AGT CCA-3') and reverse primer MCP-2 (5'-GGG CGG TGG TGT ACC CAG AGT TGT-3'). The PCR reaction produced a 482 base pair product which was resolved on a 2% agarose gel and visualized using UV light.

Selected samples that tested positive for frog ranavirus DNA were sequenced by first cleaning the PCR products with a microcon column system (Millipore, Canada). Samples were then diluted 1:10 and run using a Big Dye Terminator v.3.1 cycle sequencing reaction followed by a BigDye Xterminator purification reaction. Purified sequencing samples were run on an Applied Biosystems 3130 genetic analyzer.

Results.—Within 9 weeks of capture, 22 of the 80 (27.5%) newly-captured frogs intended for experimental use died (N = 17) or were killed (N = 5) due to severe ulceration. Signs of disease that the 22 frogs exhibited included anorexia (N = 16), erythema of the hind limbs (N = 16), ulceration on the limbs (N = 5) exposing bone tissue in one case, papillary constriction (N = 1), excessive shedding of the skin (N = 1), petechiation (pinpoint intradermal hemorrhaging) on the chest, and loss of the righting reflex (N = 1). Immediate necropsy of 3 of these frogs revealed white hepatic foci in one case.

Necropsy of the 20 test frogs revealed no signs of disease. However, while the results of the PCR analyses indicated that none of the frogs were infected by *Bd*, 17 of 20 (85%) were infected with a ranavirus (Table 1). DNA sequencing determined the three sequenced viruses to be a 100% match to FV3 (accession number DQ897669) over the PCR target segment.

Discussion.—Our results provide the first documentation of ranavirus infections in Quebec, and suggest that ranavirus can reach a high prevalence (85%) in juvenile Norther Leopard Frogs. While our swab-based screening may have underestimated ranavirus infections, which at least initially may be internal, thus producing false negatives (Gray et al. 2009), the chances of false positives due to surface contamination by virions (Gray et al. 2009) are minimal since the metamorphs were captured on land, where virus persistence outside of hosts is limited, and they were immediately isolated. Our results also suggest, although we cannot be definitive, that these ranavirus infections can be quite lethal. In two groups of metamorphs brought into the laboratory, a sizeable fraction (40% and 27.5%, respectively) died, often with signs that are consistent with ranavirus infection. Only in the latter group was ranavirus identified, and even then we cannot be sure that it was the cause of the mortality, but it is known that *L. pipiens* are susceptible to ranavirus infection (Granoff et al. 1965; Schock et al. 2008), so this seems to be a reasonable hypothesis.

While none of the 20 test frogs tested positive for infection by *Bd*, we were not able to establish that the population was *Bd*-free. Assuming a large population of Northern Leopard Frogs in the area (e.g., 10,000), and given the fact that only 20 frogs were tested for *Bd*, a prevalence of infection as high as 13.9% could have gone undetected in this case (Cannon and Roe 1982). In the surrounding regions of Quebec, prevalence of infection by *Bd* may fall below this level in amphibian populations during the summer and winter months (Ouellet et al. 2005). Thus, although our result may reflect an absence of *Bd* infection in this population (Tennessen et al. 2009; Woodhams et al. 2008), it may also reflect insufficient sampling effort (Speare et al. 2005) or seasonal patterns of infection prevalence (Ouellet et al. 2005).

We recorded four incidences of unilateral anophthalmia among 500 (0.8%) examined froglets. This appears to be a

rare condition in Northern Leopard Frogs, and in amphibians generally (Harris et al. 2001; Hoppe 2000; Johnson et al. 1999; Ouellet et al. 1997; Schoff et al. 2003). Although we did not examine the afflicted eyes for a causal mechanism of the malformation, the ranavirus FV3 was recently associated with reduced eye size in a metamorphic Green Frog (*Lithobates clamitans*) (Burton et al. 2008). Hence, an investigation into possible links between ocular malformations and ranaviral infection may be worthwhile.

In conclusion, juvenile Northern Leopard Frogs from a population in Quebec, Canada tested positive for ranaviral infection without manifesting signs of disease. Untested frogs from the same population developed signs of ranaviral disease (Gray et al. 2009), and some among them died. We cannot affirm ranaviral infection as the cause of death, as a full veterinary diagnostic analysis was not conducted on the dead frogs. It is also not known whether the stress of transport and the captive conditions exacerbated the infections, whether the virus is persistent in this population, or what impact it may be having. It is nonetheless important to note this as the first detection of a ranavirus in an amphibian population from Quebec, making this the fifth Canadian province in which a virus of this type has been found.

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Occurrence of *Batrachochytrium dendrobatidis* in Amphibians of Wise County, Virginia, USA

Batrachochytrium dendrobatidis (*Bd*) has been implicated as a deadly pathogen at least partially responsible for global amphibian declines (Berger et al. 1998; Daszak et al. 1999; Stuart et al. 2004). Despite this fungal pathogen being considered as an invasive species (Weldon et al. 2004), we lack knowledge regarding its geographic distribution in many regions (e.g., www.Bd-maps.net). In addition, there is a significant knowledge gap concerning which amphibian species are infected by *Bd* (Steiner and Lehtinen 2008). We address these knowledge gaps by assessing the occurrence of *Bd* in amphibians of Wise County, Virginia, USA. Wise County is located in southwest Virginia, in the heart of the Appalachian Mountains. Amphibian biodiversity, particularly caudate species richness, is high in this region (Lannoo 2005). It is of particular importance to assess the occurrence of *Bd* in the areas of high amphibian biodiversity and endemism because these areas could be more vulnerable to cross-contamination and potential losses. One previous study of *Bd* in Virginia, conducted in the Appalachian Mountains in Warren County, detected *Bd* on only one of 211 salamanders sampled (Gratwicke et al. 2011).

We sampled for *Bd* by collecting toe clips from Wise County, Virginia amphibians from April to September 2010. Toe clips, once collected in the field, were immediately preserved and stored in 1.0 ml of 70% ethanol in 2.0 ml screw-cap vial. In order to avoid cross contamination between toe clippings, all equipment and tools used for toe collection were rinsed in a 10% bleach solution. In addition, nitrile gloves were replaced between each amphibian collected and sampled. Once back in the laboratory, DNA extractions were completed using Promega® Wizard Genomic DNA Purification Kits (Promega® Corporation, Madison, Wisconsin, USA), following the manufacturer's instructions. Amplification of extracted DNA samples was completed using Fisher® BioReagents exACTGene PCR Kits (Fisher Scientific®, Fair Lawn, New Jersey, USA), using specific PCR primers for *Bd* (Bd1a and Bd2a) as reported by Annis et al. (2004). PCR was performed under the following conditions: an initial denaturation of 94°C for 5 min; 30 cycles of denaturation (94°C for 45 sec), annealing (50°C for 45 sec), extension (72°C for 1 min); and a final extension of 72°C for 5 min. PCR products, including both a *Bd* positive and *Bd* negative control, were visualized on ethidium bromide stained 1.0% agarose gel dissolved in 1X TAE buffer under ultraviolet light. A positive *Bd* test was confirmed by the presence of an approximately 300 kb band.

We collected 119 samples from 18 amphibian species (Table 1). Overall, 21 of 119 (17.6%) amphibians tested positive for *Bd*. Specifically, 15 of 21 (71.4%) *Bd*-positive samples were caudates and 6 of 21 (28.6%) were anurans.

To our knowledge, this is the first published report of *Bd* in amphibians of Wise County, Virginia. In addition, we are the first to report *Bd* in several caudate species, including *E. longicauda*, *E. lucifuga*, and *P. cinereus* (although, *Bd* has been documented to infect *P. cinereus* under laboratory settings; Becker and Harris, 2010). *Bd* occurrence here, despite being low, is not altogether surprising given that it has been

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reported in Virginia (Gratwicke et al. 2011; Rothermel et al. 2008), Pennsylvania and Tennessee (Groner and Relyea 2010; Todd-Thompson et al. 2009; Venesky and Brem 2008). What is interesting is the comparatively high *Bd* occurrence rate between our study and a recent study conducted in Warren County, Virginia. For example, Gratwicke et al. (2011) report an overall occurrence rate of approximately 2.1% in several caudate species, some of which were sampled for in our study, yet we report an overall occurrence rate of 17.6%. One possible explanation for this difference lies within *Bd* sampling methods. Gratwicke et al. (2011) used cotton-tipped swabs for sample collection, while our study collected tissue samples via toe clipping. Future studies could examine whether there is a *Bd* detectability difference between skin surface swabs versus tissue collection via toe clipping. *Bd* surveillance and amphibian population monitoring should continue in this region to determine the extent and polarity (whether increasing or decreasing over time) of infection in amphibians of the Appalachian Mountains, and potential effects of this infection. Amphibian population losses are alarming; but, in an area of high amphibian endemism such as the Appalachian Mountains, the potential loss of biodiversity is potentially further magnified.

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Table 1. Prevalence of *Batrachochytrium dendrobatidis* in amphibians of Wise County, Virginia, USA.

Species	No. infected / total sampled	Prevalence of infection
Caudata		
Desmognathus fuscus	2 / 12	0.167
Desmognathus monticola	1 / 12	0.083
Desmognathus ochrophaeus	1 / 1	1
Desmognathus quadramaculatus	1 / 3	0.333
Eurycea cirrigera	5 / 21	0.238
Eurycea longicauda	1 / 3	0.333
Eurycea lucifuga	1 / 4	0.25
Notophthalmus viridescens	1 / 9	0.111
Plethodon cinereus	1 / 3	0.333
Plethodon glutinosus complex	1 / 15	0.067
Plethodon richmondi	0 / 5	0
Anura		
Anaxyrus americanus	1 / 6	0.167
Hyla chrysoscelis	3 / 9	0.333
Pseudacris crucifer	0 / 2	0
Lithobates catesbeianus	0 / 10	0
Lithobates clamitans	0 / 1	0
Lithobates palustris	1 / 2	0.5
Lithobates sylvaticus	1 / 1	1
Total	21 / 119	0.176

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Batrachochytrium dendrobatidis in *Siren intermedia* in Illinois, USA

We report the first case of *Batrachochytrium dendrobatidis* (*Bd*) in a wild-caught *Siren intermedia* from Illinois, USA. We add to the growing list of amphibian species susceptible to *Bd* infection in North America (Adams et al. 2007; Longcore et al. 2007; Ouellet et al. 2005; Pearl et al. 2007). Examples of fully aquatic salamanders with *Bd* originate from wild populations (*Cryptobranchus alleganiensis*, Briggler et al. 2007, 2008; *Andrias japonicus*, Goka et al. 2009), the pet trade (*Necturus maculosus* and *Siren lacertina*, Speare and Berger 2000), and zoos (*C. alleganiensis*, Briggler et al. 2007; *A. japonicus*, Goka et al. 2009). Internal parasitic helminth infections (McAllister et al. 1994) and two external copepod parasites (Frick 1999; Graham and Borda 2010) have been reported for Sirenidae, but our report is the first infectious disease of any kind reported in a wild-caught animal for this family (Hendricks 2005; Leja 2005; Moler 2005a, 2005b).

We sampled in a roadside ditch along Route 3 in Jackson County, Illinois (37.7241°N, 89.4634°W) on 9 March 2009 (1800–1830 h). Emergent vegetation and accumulated sediments were present, typical of *Siren* habitat (Petranka 1998; Wells 2007). Temperatures of the sampling date varied from 0°C (daily low) to 18°C (daily high); water temperature at time of sampling was 17°C. We captured two *S. intermedia* (SVL_1 = 132.1 mm, $Mass_1$ = 18.5 g; SVL_2 = 75.4 mm, $Mass_2$ = 3.9 g).

We handled sirens with latex powder-free gloves, and kept them in clean plastic sandwich bags filled with on-site water until we completed all data collection on site at which point we released all animals. We gently wiped each animal with a standard rayon-bud swab along their body lengths' ventral surfaces, as well as the front limbs (Hyatt et al. 2007). We stored the swab at room temperature in 70% ethanol until we ran real-time quantitative PCR analysis for *Bd*.

We used standard *Bd* DNA extraction and real-time PCR protocols (Hyatt et al. 2007), except we ran single samples instead of in triplicate to reduce costs (Kriger et al. 2006). Running single samples instead of triplicate is currently accepted as a reliable practice for *Bd* assessment (e.g., Vredenburg et al. 2010; Kriger et al. 2006). We used standards (i.e., 100, 10, 1, and 0.1 zoospore equivalents) and negative controls to ensure repeatability and continuity between runs.

The larger of the two *S. intermedia* that we captured tested positive for *Bd* (3.14 zoospore equivalents) while the other had no infection.

Because of their secretive nature (Petranka 1998) and the lack of population information (Leja 2005), the effect of *Bd* on Sirenidae populations is not known. Previous research on populations of fully aquatic salamanders in natural habitats is limited to *A. japonicus* in Japan (Goka et al. 2009) and *C. alleganiensis* in the Ozark Highlands, USA (Briggler et al. 2008). The former represents a commensal relationship that may have co-evolved with *Bd* over a long time period (Goka et al. 2009), while the latter identifies populations that have experienced declines likely resultant from synergistic negative effects of widespread *Bd* and other biotic and abiotic factors (e.g., habitat degradation, chemical contamination, introduced species, and commercial exploitation) (Briggler et al. 2008). We show that an individual *S. intermedia* carries a low-level *Bd* infection in Illinois. Future research should focus on if the fatal effects of chytridiomycosis are realized in Sirenidae.

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Low Prevalence of *Batrachochytrium dendrobatidis* Detected in Appalachian Salamanders from Warren County, Virginia, USA

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Salamanders are one of the most important features of America's vertebrate fauna and the Appalachian region of the United States is a global salamander biodiversity hotspot (Young et al. 2004). Despite numerous studies of their biology at the species level, we have a poor understanding of overall threats to salamander biodiversity (Gratwicke 2008). We also have a poor understanding of the susceptibility of different salamander species to diseases, such as the fungus *Batrachochytrium dendrobatidis* (*Bd*). To date, there has been no systematic threat assessment of *Bd* on Appalachian salamanders, but several Appalachian salamander species are known to be susceptible to *Bd* in the wild including: *Ambystoma tigrinum* (Davidson et al. 2003); *Cryptobranchus alleganiensis* (Briggler et al. 2008); *Desmognathus conanti* (Timpe et al. 2008); *D. quadramaculatus* (Bartkus 2009); *D. fuscus* and *D. monticola* (Hossack et al. 2010); *Eurycea bislineata* (Grant et al. 2008); *E. cirrigera* (Byrne et al. 2008) and *Notophthalmus viridescens* (Bakkegard and Pessier 2010; Chatfield et al. 2009; Rothermel et al. 2008; Timpe et al. 2008; J. Ware and K. Duncan, unpubl.data; www.Bd-maps.net). *Bd* can also infect *D. monticola* and *Plethodon metcalfi* (Vazquez et al. 2009); *D. orestes* and *P. glutinosus* (Chinnadurai et al. 2009); and *P. cinereus* (Becker and Harris 2010; Becker et al. 2009) in laboratory settings. The effects of *Bd* on salamanders in both wild

TABLE 1. Salamanders encountered and swabbed to test for *Batrachochytrium dendrobatidis* (*Bd*) as part of the 2009 salamander bio-blitz on the Smithsonian Conservation Biology Institute in Warren County, Virginia, USA.

	Total Counted	Total Swabbed	*Bd* Positives	Number of Sites
Eurycea bislineata	13	13	0	4
Desmognathus fuscus	4	4	0	2
Desmognathus monticola	134	25	1	5
Gyrinophilus porphyriticus	3	3	0	1
Plethodon cinereus	225	142	0	25
Plethodon cylindraceus	21	19	0	7
Pseudotriton ruber	4	4	0	4
Total	404	211	0	34

and laboratory settings, however, are extremely variable depending on temperatures, salamander species, and skin flora (Becker and Harris 2010).

There has been no systematic effort to monitor *Bd* throughout Virginia, although the disease has been detected on amphibians in: 1) Virginia at Mountain Lake Biological Research Station and Upham Brook (Rothermel et al. 2008); 2) the Shenandoah National Park (Grant, unpubl. data); and 3) on A*cris crepitans*, *Lithobates catesbeianus*, *L. clamitans*, *L. spenocephalus*, and *N. viridescens* in Richmond and Charles Counties (J. Ware and K. Duncan, unpubl.data; www.Bd-maps.net). In order to investigate the status of *Bd* and its potential impact on wild salamanders, we surveyed the *Bd* status of salamanders on the 3200-acre Smithsonian Conservation Biology Institute, Front Royal site (SCBI-FR) in Warren County, Virginia (38.893279°N, 78.152381°W). SCBI-FR occupies a low point (elevation range ~300–600 m asl) on the western slope of the Blue Ridge Mountains of Virginia, with a topography characterized by a series of rolling hills and small valleys. Wooded areas are mainly covered by mature secondary Eastern mixed deciduous forest, with Tulip Poplar (*Liriodendron tulipifera*), Pignut Hickory (*Carya glabra*), Black Gum (*Nyssa sylvatica*), Mockernut Hickory (*C. alba*), Red Oak (*Quercus rubra*), and White Oak (*Q. alba*) being the major dominant canopy species.

On 9 May 2009, a salamander bio-blitz event was held for 40 volunteer participants recruited from various local natural history and herpetology groups. Teams surveyed a total of seven stream sites that were selected by dividing each stream on the property into 500-m segments and then selecting stream segments for survey using a random number table. At each survey site, two 25-m transects were sequentially established along one stream bank and all cover objects 1 m either side of the transect line were searched. An additional 27 terrestrial transects were established by dividing the wooded portion of the property (excluding animal enclosures) into 1-km^2 blocks and using a random number generator to select 50 blocks; the transect was placed in the center of each block. At each site, two parallel 25-m transects were established 10-m apart from each other, running in a randomly assigned cardinal direction. All cover objects within 1 m of either side of the transect line were searched. Amphibians encountered in either survey were captured and identified to species level, and fresh powder-free nitrile gloves were used for each animal handled. The first 10 individuals of each species at each site were swabbed for *Bd* by rubbing a cotton-tipped swab 15 times in both directions along the salamanders' ventral surfaces and five times on each foot. Exact GPS coordinates for each specimen were recorded.

Swabs were stored dry at room temperature for four weeks before analysis. Anywhere from one to three swabs were incubated together in an oscillating thermal incubator at 56°C and 30 rpm in 400 µl of lysis buffer and 30 µl proteinase K (Qiagen) for 24 h. After incubation, DNA was extracted from the lysate solutions using a Qiagen Biosprint 96 DNA Blood Kit according to the instructions. Testing for the presence of *Bd* was performed using Qiagen's QuantiTect SYBR Green PCR Kit, using the primers ITS1-3Chytr and 5.8sChytr, developed by (Boyle et al. 2004). Positive and negative controls were included in both the extraction and the realtime-PCR reactions. A melt-curve analysis was used to ensure only *Bd* DNA was amplified. No contamination was present in the DNA or subsequent analysis of these swabs.

Seven salamander species (404 individuals) were encountered in the survey transects, and 211of these individuals were swabbed (Table 1). Only a single *D. monticola* swab tested positive for *Bd* (georeference 38.895383°N, 78.151369°W). Other amphibian species encountered on the property that day during unconstrained searches, but were not swabbed include: *Ambystoma maculatum; Anaxyrus americanus; Anaxyrus fowleri*; *Hyla versicolor*; *Lithobates catesbeianu;*, *Lithobates palustri;*, *Lithobates clamitans*; *Lithobates sylvaticus*; and *Pseudacris crucifer.*

We used a binomial distribution calculator (http://faculty.vassar.edu/lowry/binomialX.html) to calculate the maximum prevalence rate using a 95% confidence limit with our sample of 1 infected swab (success) from 211 salamanders (trials). Assuming 100% detectability on all animals swabbed, we estimate that overall prevalence rates in the combined aquatic and terrestrial salamander assemblage are lower than 2.1%. We did not have sufficient sample sizes to conduct species-specific prevalence rates.

Bd is present in salamanders at very low prevalence rates in Warren County, Virginia. Other studies testing for *Bd* on salamanders in the Appalachians found very low occurrences (Bartkus 2009). The actual level of threat that *Bd* poses to wild Appalachian salamander populations remains an unresolved question. *Bd* is very temperature dependent and varies seasonally, therefore, spring was selected as a time of year when temperatures are optimal for *Bd* (Longcore et al. 2007). The observed prevalence levels of less than 2.1% on the 3200-acre SCBI property at a time of year optimal for detecting the pathogen means that it is unlikely that *Bd* is significantly affecting the salamander populations at that site. Furthermore, our observations in Virginia are consistent with observations elsewhere in the Appalachian region, where others have found that although *Bd* appears to be widely distributed, it is found at low prevalence rates in aquatic salamanders (Bartkus 2009; Byrne et al. 2008; Hossack et al. 2010), but is uncommon in terrestrial salamanders (e.g., Chatfield et al 2009).

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Batrachochytrium dendrobatidis on the Endemic Frog *Litoria raniformis* in South Australia

Since the end of the 1970s, many mass mortalities and population declines of amphibians in Australia have been attributed to the chytrid fungus, *Batrachochytrium dendrobatidis* (*Bd*; Berger et al. 1998, 2004; Longcore et al. 1999). To date, 29% of 223 (62 native and one introduced species from four families) Australian amphibian species have been found to be infected with *Bd* (Murray et al. 2010). The pathogen is considered to be established in Queensland, New South Wales, Australian Capital Territory, Victoria, Tasmania, and Western Australia, however very little is known about its distribution in South Australia (Murray et al. 2010; Simpkins and Hero 2010; Speare and Berger 2005).

The Southern Bell Frog, *Litoria raniformis*, was once a common frog from southeastern South Australia, the Murray Darling Basin, most of Victoria, the Australian Capital Territory, southwestern New South Wales, and eastern and northern Tasmania (Cogger 1975). However, there are reports of serious declines and local extinctions in New South Wales and Tasmania (Obendorf and Dalton 2006; Wassens 2008), likely due to many factors including increased levels of ultra-violet radiation, possible changes in drought incidence and intensity, predation by the introduced mosquito fish, wetland drainage, and *Bd* (Pyke 2002; Wassens 2008). The species is listed as vulnerable both nationally and in South Australia. In South Australia, *Bd* infection of *L. raniformis* was reported from a captive specimen from Adelaide sampled in 1988 (Speare and Berger 2005) and from a wild-caught specimen from Mount Compass in the Mount Lofty Ranges sampled in 1998 (Murray et al. 2010). In Tasmania the presence of *Bd* in wild populations coincided with the locations of population declines of *L. raniformis*, and the species has been considered highly susceptible to chytrid infection (Obendorf and Dalton 2006; Speare and Berger 2005). Hence the existence of *Bd* in *Litoria raniformis* populations in other bioregions is expected. Also, in a preliminary molecular genetic survey of *L. raniformis*, Vörös et al. (2008) found two distinct genetic groups, one with an inland distribution and a second with a coastal distribution including Tasmania. The two groups have differences in their behavior and ecology (S. Wassens, pers. comm.) and hence could show different environmental sensitivity, including susceptibility to pathogens such as *Bd* (Daszak et al. 1999).

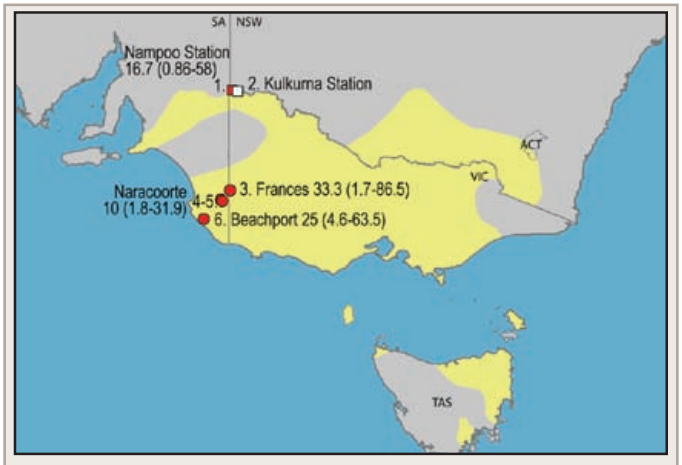


FIG. 1. Historical distribution of *Litoria raniformis* (yellow area) in Australia (after DEWHA 2008 and Thomson et al. 1996), and sampling locations in the Murray Darling Basin (□) and southeastern South Australia (●). Lines represent state borders between South Australia (SA), New South Wales (NSW), Victoria (VIC), Australian Capital Territory (ACT), and Tasmania (TAS). Numbers refer to localities indicated in Table 1. Locations where *Bd* was detected are marked with red and related prevalence and confidence intervals are presented.

Pounds et al. (2006) hypothesized that *Bd* is most prevalent in areas with cool temperature close to the fungus' optimum temperature of 23°C and the constant presence of free water. Hence, within the range of *L. raniformis*, the level of *Bd* infection is expected to be lower in the inland Murray Darling Basin, due to higher maximum temperature and recent extended serious drought conditions, than in coastal populations which have more maritime, cooler and moister, climate conditions (Kriger et al. 2007). The aim of our study was to conduct a pilot survey of the distribution of *Bd* on *Litoria raniformis* in two bioregions in South Australia, the Murray Darling Basin ("Lower Murray") and southeastern (SE) South Australia, representing the two different genetic groups described by Vörös et al. (2008).

We sampled both the Lower Murray and SE South Australia (Fig. 1) regions in early December 2008 and early February 2009. Because *L. raniformis* is active between November and March, our sampling represented the breeding season when frogs gathered in water bodies, which might facilitate the transmission of aquatic chytrid zoospores (Rowley and Alford 2007), and also allowed us to examine metamorphs before they left the water. In the Lower Murray, we sampled

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TABLE 1. Prevalence of *Batrachochytrium dendrobatidis, Bd*, in adult and metamorph *Litoria raniformis* from six locations in two bioregions of South Australia, sampled in December 2008[a] and February 2009[b]. Location numbers are shown in Fig. 1.

Location	No. Analyzed (No. Positive) % Positive (95% CI)		Mean No. *Bd* Zoospores (SD)	
	Adults	Metamorphs	Adults	Metamorphs
Lower Murray - total	8 (1) 12.5 (0.64–50)	70 0 (0–5.36)	403.05 (8.83)	0
1. Nampoo Station (34.03°S, 141.15°E)	6 (1)[a] 16.7 (0.86–58)	0	403.05 (8.83)	0
2. Kulkurna Station (34.02°S, 141.03°E)	2[b] 0 (0–77.6)	70[b] 0 (0–5.36)	0	0
SE South Australia - total	35 (5) 14.3 (5.8–29.7)		2634.69 (5677.25)	
3. Frances (36.71°S, 140.95°E)	3 (1)[a] 33.3 (1.7–86.5)	0	157.95 (18.31)	0
4. Naracoorte airport road (36.98°S, 140.74°E)	4[a] 0 (0–52.7)	0	0	0
5. Naracoorte crayfish farm (36.97°S, 140.72°E)	20 (2)[a,b] 10 (1.8–31.9)	64[b] 0 (0–5.8)	101.325 (51.02)	0
6. Beachport (37.40°S, 140.12°E)	8 (2)[a] 25 (4.6–63.5)	0	6406.4 (9027.2)	0

frogs from the Murray River in New South Wales at two sites about 10 km apart at Nampoo Station, in December, and at Kulkurna Station, in February. Unfortunately, low population sizes, especially at Nampoo Station, limited our sampling. In SE South Australia, we sampled frogs from dams or weirs where the number of adult specimens was low. The largest population of *L. raniformis* was found in ponds in a crayfish (*Cherax destructor*) farm on private land in Naracoorte, where we were able to capture 13 adult specimens. Altogether we sampled 8 adults and 70 metamorphs in the Lower Murray (6 adults in December, 2 adults and 70 metamorphs in February), and 35 adults and 64 metamorphs in SE South Australia (28 adults in December, 7 adults and 64 metamorphs in February). We did not find larvae during either sampling period.

We collected samples from adult and juvenile frogs with skin swabs using sterile, single-use 7.5 cm applicators from Defries Industries Pty Ltd (Keysborough, Victoria, Australia). We used new gloves or plastic bags when handling each frog in order to prevent cross-contamination. Each frog was swabbed five times on the back, side, abdomen, groin, and webbing area. The swabs were stored frozen until processing (Van Sluys et al. 2008).

We used real-time PCR (Boyle et al. 2004) to detect *Bd*; this method allowed us to quantify the abundance of zoospores within a sample. We ran every sample in duplicate with a dedicated internal positive control (TaqMan Exogenous Internal Positive Control Reagents) for each sample that helps to identify inhibitors present in the DNA extractions. We considered a sample to contain *Bd* DNA only if both amplifications gave positive results. The templates were run and analyzed on a *Rotor-Gene 6000* real-time rotary analyzer (Corbett Life Science). Genomic equivalents (GE) for all positive samples were estimated from standard curves based on known positive controls, considering 0.1 as the minimum value indicative of infection. We estimated prevalence for each population as the proportion of individuals testing positive with 95% confidence intervals for each prevalence

rate using the software Quantitative Parasitology (Rózsa et al. 2000). The same software was used to conduct a Chi-Square test to compare prevalence between the two regions, and a bootstrap 2-sample t-test (with 2000 bootstrap replications) for comparing mean abundances of zoospores between the two regions, separately for adults and metamorphs.

We detected *Bd* from 1 of 8 adults in the Lower Murray, and from 5 of 35 adults in SE South Australia (Table 1). No metamorphs were *Bd*-positive. We detected inhibition in extracts from three samples. All *Bd*-positive samples were collected in December, and all samples collected in February were *Bd*-negative. *Bd*-prevalence of the adult specimens did not differ between the two regions ($\chi^2 = 0.017$, $P = 0.895$), and the abundances of zoospores between the regions were similar ($P = 0.434$).

Although we detected *Bd* at low levels in natural *L. raniformis* populations in both bioregions of the species distribution in South Australia, the Lower Murray and SE South Australia, our sample sizes were generally low. Skerratt et al. (2008) recommended that sample sizes >59 be used when prevalence is low. Only two of our metamorph samples met this criterion, and *Bd* was not detected on these animals.

Several studies have shown that elevated temperatures and desiccation may limit the spread of the disease (Berger et al. 2004; Laurance et al. 1996). We studied two populations in two sites in the Lower Murray, where habitats are much more exposed to desiccation than in SE South Australia. One site was sampled in December where we detected one *Bd*-positive individual , and one site in February, which seemed to be free from *Bd*. In SE South Australia, which is a coastal bioregion with lower temperature and higher rainfall, a preferred habitat type of *Bd* (Berger et al 2004), we sampled four sites in December. *Bd* was present in 3 of 4 sites. At one site (Naracoorte crayfish farm) we managed to swab both in December (7 adults) and in February (13 adults and 64 metamorphs). Only adult specimens swabbed in December carried *Bd* (2), and no positive samples were found among the adults or metamorphs examined at the end of the summer. This finding is consistent with the hypothesis that summer high temperatures or low rainfall could reduce *Bd* abundance in the environment and on the frogs (Kriger et al. 2007). A more comprehensive assessment of *Bd* on *L. raniformis* is warranted, including a survey across its life cycle incorporating an assessment of seasonal and regional climate influences (Kriger and Hero 2007).

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Ranavirus Outbreaks in Amphibian Populations of Northern Idaho

Ranavirus outbreaks, caused by pathogens in the genus *Ranavirus* (Family Iridoviridae), were the largest single cause of reported amphibian mass mortality events in the United States from 1996–2001 (Green et al. 2002). Mortality events associated with ranaviruses have been documented on five continents and throughout the latitudes and elevations where amphibians occur (Gray et al. 2009). However, the threat of ranaviruses to amphibian and reptile populations in specific regions is still largely unknown (Chinchar 2002; Gray et al. 2009).

In Idaho, ranavirus was first documented as the cause of death for Tiger Salamanders (*Ambystoma tigrinum*) in 2000 near Yellowstone National Park (USGS 2001); however mass mortality events have not been reported since by the USGS National Wildlife Health Center (NWHC) in Idaho or the eastern parts of neighboring Washington and Oregon. In the Palouse region of north Idaho, multiple species of amphibians and aquatic reptiles, including Long-toed Salamanders (*A. macrodactylum*), Tiger Salamanders, Columbia Spotted Frogs (*Rana luteiventris*), Sierran Treefrogs (*Pseudacris sierra*), Western Toads (*Anaxyrus boreas*), Rough-skinned Newts (*Taricha granulosa*), and Painted Turtles (*Chrysemys picta*), co-occur at small man-made ponds where ranavirus could potentially be a threat. Here we report ranavirus outbreaks in two amphibian species (Columbia Spotted Frogs and Sierran Treefrogs) at two ponds in north Idaho during the summer and fall of 2009.

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In 2009, we visually-surveyed and trap-surveyed seven ponds in Latah County, Idaho, USA for amphibians during three seasons (spring, summer, and fall). All footwear and field equipment were disinfected using 10% bleach solution between pond visits to inactivate pathogens and prevent transmission of disease between ponds (Bryan et al 2009). During our survey period, we observed mortality events at two of the seven ponds, one documented on 17 July 2009 at Latah Trail Pond (46.4423°N, 116.4818°W) and one documented on 4 October 2009 at Mort Pond (46.4811°N, 116.5838°W).

We collected 14 dead amphibians (Table 1) for disease diagnostics. A new pair of nitrile gloves was used to handle and place each specimen separately in a new container. Specimens were preserved within 1 h of collection; those analyzed using PCR were preserved in 95% ethanol, and those used for histological analysis were preserved in 10% buffered formalin for 25 hours and then transferred into 70% alcohol. Unpreserved samples for inoculating cell lines were processed on the day of collection.

Dead specimens were analyzed by one of three laboratories to employ multiple methods for diagnostics and obtain independent evidence for causes of death. The NWHC

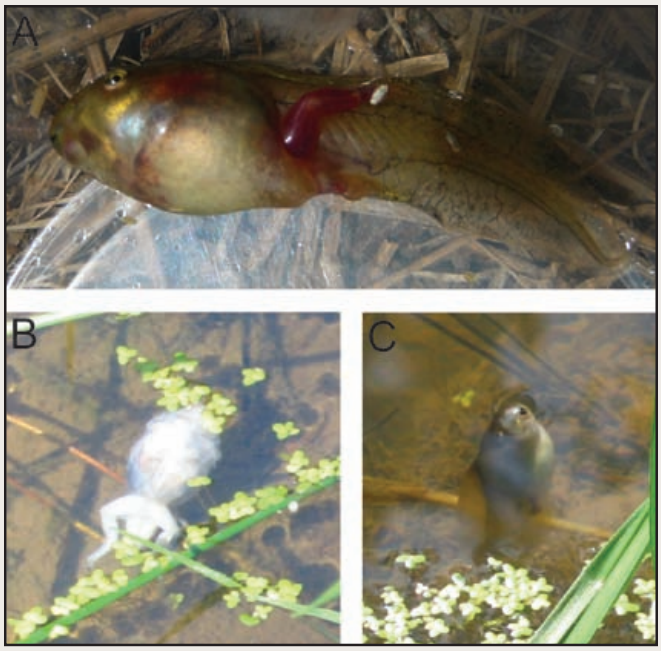


FIG. 1. Tadpoles with ranavirus infection, Latah County, Idaho, USA, 18 July 2009. (A) Columbia Spotted Frog with leg hemorrhage, (B) dead Sierran Treefrog, (C) moribund, bloated Columbia Spotted Frog.

analyzed five specimens using histology. At the NWHC, diagnostics for ranavirus were based on characteristic histological changes in the livers, spleens, mesonephroi, and blood vessels of the frogs. The U.S. Fish and Wildlife Service Idaho Fish Health Center (IFHC) analyzed five specimens using cell culture and PCR. At the IFHC, liver tissue was removed aseptically, ground with a Hank's balanced salt solution (HBSS), spun down, and incubated for 24 hours. Samples were then plated on *Epithelioma papulosum cyprini* (EPC), fathead minnow (FHM), and CHSE-214 (derived from Chinook Salmon) cell lines to culture virus. Ranavirus infection was confirmed using PCR with nested FV3 primers (Bollinger et al 1999; Kattenbelt et al 2000). The Laboratory of Conservation and Ecological Genetics (LCEG) at the University of Idaho analyzed three specimens using PCR and sequencing. To confirm the strain of ranavirus, DNA was extracted from tail-clips of three tadpole samples using a DNeasy Tissue Kit (Qiagen, Inc., Valencia, CA). DNA was amplified using MCP4 and MCP5 primers (Mao et al. 1997), and the resulting 508 base pair PCR product was sequenced with the amplifying primers using a 3130xl Genetic Analyzer (Applied Biosystems, Foster City, CA). Resulting sequences were compared with those in the GenBank database.

On the day before the mortality event was first observed at Latah Trail Pond, we had set 15 minnow traps throughout the pond overnight. We repeated trap sampling on 24 July 2009 at this location to compare amphibian captures seven days after the mortality event was first documented. In addition to trapping, we conducted visual surveys at this pond every other day during the mortality event where one person walked the perimeter of the pond for 5 minutes.

We observed a mass mortality event totaling approximately 200 Columbia Spotted Frog and Sierran Treefrog tadpoles, at least five Long-toed Salamander larvae, and at least seven adult Columbia Spotted Frogs at Latah Trail Pond on 17 July 2009. Another mortality event involving at least 12 adult Columbia Spotted Frogs was observed at Mort Pond on October 4, 2009. Due to the extremely small population sizes of the Columbia Spotted Frog in this system (Davis and Verrell 2005), we also consider the Mort Pond event a mass mortality. The probable cause of death in both cases was infection by ranavirus (Table 1). At Latah Trail Pond, dead and dying amphibians had clinical signs of ranavirus disease, specifically bloated abdomens, leg hemorrhaging, and irregular swimming (Bollinger et al.1999; Docherty et al. 2003; Jancovich et al. 1997; Fig. 1). Histological analyses indicated characteristic changes in livers, spleen, mesonephros, and blood vessels of frogs. DNA sequence for the major capsid protein gene was identical to several frog virus 3 (FV3) sequences (Tan et al 2004), including one from a Northern Leopard Frog (*R. pipiens*; Holopainen et al. 2009) and the *Terrapene carolina* ranavirus (TV3, Mao et al. 1997).

The mass mortality event at Latah Trail Pond lasted at least seven days, with the majority of carcasses found on the first day of observations. By the third day, the majority of amphibian carcasses were gone. Minnow traps at Latah Trail on 17 July captured 63 Long-toed Salamander larvae, 40 Sierran

TABLE 1. Dead amphibians collected from ponds and tested for ranavirus in Latah County, Idaho, following mass mortality events. Species are: Columbia Spotted Frog (CSF) and Sierran Treefrog (ST). Laboratory tests were conducted at the USGS National Wildlife Health Center (NWHC - full necropsy and viral cultures), the Idaho Fish Health Center (IFHC – viral cultures and PCR), and the Laboratory of Conservation and Ecological Genetics (LCEG - PCR and sequencing).

Pond	Date	Species	Age	N	Laboratory	Result
Latah Trail	18-Jul-09	CSF	Tadpole	3	LCEG	Ranavirus
Latah Trail	20-Jul-09	CSF	Metamorph	2	IFHC	Ranavirus
Latah Trail	20-Jul-09	ST	Tadpole	2	IFHC	Ranavirus
Latah Trail	20-Jul-09	CSF	Adult	2	IFHC	Ranavirus
Latah Trail	20-Jul-09	CSF	Adult	2	NWHC	Ranavirus
Mort	4-Oct-09	CSF	Adult	2	NWHC	Ranavirus
Mort	4-Oct-09	CSF	Adult	1	NWHC	Reproductive tract disease

Treefrog tadpoles, and 16 Columbia Spotted Frog tadpoles. Resampling on July 24 yielded only one tadpole and one adult Columbia Spotted Frog. In addition to amphibian mortality, one Painted Turtle at Mort Pond was found alive but lethargic, had difficulty breathing, and was unresponsive to handling, which are consistent with signs of ranaviral disease in turtles with TV3 (De Voe et al. 2004).

This study describes two mass mortality events due to ranavirus in north Idaho. Diagnostic tests indicated that this infectious disease was the cause of mass mortality of Columbia Spotted Frog tadpoles and adults and Sierran Treefrog tadpoles. The presence of sick and dead Long-toed Salamanders and a moribund Painted Turtle during the outbreak suggests that the virus may have affected additional species, however, we did not conduct diagnostic tests on these species. We identified the north Idaho ranavirus as FV3 using sequence from the major capsid protein. Ranaviruses identified as FV3 are multi-host pathogens with a large geographic range in North America (Schock et al. 2008).

Our trapping data indicate that the summer ranavirus outbreak we observed may have removed much of the reproductive output for Latah Trail Pond in 2009. While the drop in trap captures could have been due to metamorphosis during the weeklong mortality event, most tadpoles were several stages from metamorphosis at the beginning of the outbreak (Fig. 1), making this unlikely. As long as ponds in the area do not experience mass mortality events simultaneously or continuously, the high amount of gene flow between sites (Goldberg and Waits 2010) should help maintain population persistence for Columbia Spotted Frogs. Gene flow, however, may also indicate high potential for pathogen transmission. Columbia Spotted Frogs in this region experience a range of stressors and have low numbers of breeding adults (Davis and Verrell 2005). Local populations are subject to aerial spraying of pesticides, disturbance by cattle [which has been shown to increase prevalence of FV3 in Green Frog (*Rana clamitans*) tadpoles (Gray et al. 2007)], and infection by *Bd* (since at least 2004 for Latah Trail and 2005 for Mort; CSG and LPW, unpublished data), among other factors. Additional population monitoring will be required to detect any long-term impacts of the observed mass mortality events on these populations.

Our observations underscore the difficulties of detecting ranavirus outbreaks. Due to variation in timing of metamorphosis and the short time frame in which the visual evidence of mortality was gone (ca. 2 days), it could be difficult to distinguish a mass mortality event from a metamorphosis and dispersal event. Ranavirus outbreaks are therefore likely underreported and may represent a greater threat to native amphibians than currently recognized.

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Effects of Captivity on Female Reproductive Cycles and Egg Incubation in Ball Pythons (*Python regius*)

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Although published studies on reproductive data from wild populations of snake species are widely available (Brown and Shine 2007b; Farrell et al. 2009; Luiselli et al. 1996; Madsen and Shine 1996; Slip and Shine 1988), comparatively few publications have presented reproductive data from large populations of captive snakes over multiple years. Specifically in pythons, the studies that have been published on captive populations have generally been on small sample sizes (N < 30 clutches), and have been limited to reporting averages and ranges for reproductive traits (Barker and Barker 2006; de Vosjoli et al. 1994; Ross and Marzec 1990). The larger sample sizes and correlative data generated in studies on wild snake populations have provided researchers with the ability to study various aspects of reproduction such as: optimal clutch

size (Aubret et al. 2003; Brown and Shine 2007b), repeatability of reproductive traits (Brown and Shine 2007b; Farrell et al. 2009; Ford and Seigel 2006), non-linear correlation between female size and snout–vent length (Brown and Shine 2007a; Luiselli et al. 1996; Madsen and Shine 1996), and female reproductive frequency (Farrell et al. 2009; Madsen and Shine 1996; Slip and Shine 1988). Comparable research in captive populations could provide a foundation for the development of captive breeding programs to increase reproductive efficiency. Knowledge such as this has been used to significantly increase breeding efficiencies in livestock animals for decades (reviewed in Hackmann and Spain 2010; Harris 1998). Moreover, an enhanced understanding of python reproductive traits and the correlations between them could increase success in reproducing endangered species, and other species that have been problematic to breed in captivity; such as the Black Python (*Morelia boeleni*) (Austin et al. 2010).

A commercial reptile breeding company, The Snake Keeper, Inc. (Spanish Fork, Utah) has been breeding Ball Pythons (*Python regius*) in captivity for over 20 years. Since 2002 they have been collecting reproductive data on their Ball Python breeding colony. During this time they have collected data on 5344 eggs from 783 clutches. A review of these extensive data provides novel information about Ball Python reproduction and how various reproductive traits are associated with each other. Data presented in the present study on the duration of reproductive events in Ball Pythons are similar to data that have been published previously (Barker and Barker 2006; de Vosjoli et al. 1994; Ross and Marzec 1990). Novel data presented in this study supply information about age at first reproduction, frequency of female reproduction, effects of desiccation on hatch rate, and optimal clutch size. A correlation matrix for reproductive traits is also provided. These data provide a foundation for the design of future experiments, and for enhancing efficiencies of current and future breeding programs.

Materials and Methods.—Adult Ball Pythons were housed in individual cages measuring 81 cm L x 43 cm W x 18 cm H with mesh tops within rack systems (Fig. 1). The substrate used in the caging was chipped aspen bedding. Water was available *ad libitum* and whole prey was offered each week. During the warm months (March to October), the rodents offered were approximately 95 g, and during the breeding season (November to February) they were approximately 65 g. The ambient temperature was controlled from March to October to prevent it from exceeding 29.5°C, and November to February from dropping below 21°C. Throughout the year, a hot spot was available in each cage that was 32°C during the day and 29.5°C at night. Humidity was maintained in the breeding facility at approximately 60% year round by a Humidifirst MP15 ultrasonic humidifier (Humidifirst, Inc., Boynton Beach, Florida).

From November to June, females >1500 g were placed in the cages of males >500 g for one to two days and any observed breeding activity was recorded. An attempt was made



PHOTO BY DAN SUTHERLAND

FIG. 1. Rack system used to house adult Ball Pythons.



PHOTO BY DAN SUTHERLAND

FIG. 2. Female Ball Python brooding a clutch of eggs in which one egg was excluded from her coils.

to ensure that each female was bred at least once each month during this time. Once females were gravid, they were no longer placed with males. The date was also recorded for the following reproductive events when they were observed: ovulation, post ovulation shed, oviposition, and hatching.

Gravid females were checked daily for eggs once they were 30 days past their post-ovulation shed. Eggs were removed immediately from each female, weighed as a clutch, counted, separated, weighed individually, measured (length and width), and placed into an incubation box that was then placed in the incubation room. Each female was also weighed at this time, and a relative clutch mass (RCM) was calculated by dividing the mass of the clutch by the post oviposition mass of the female. The age of the sire and dam at the time of oviposition, when known, was also recorded. From these data, the age at first reproduction was recorded for all the breeders that first reproduced in 2003 or later. In addition, for each female that laid two or more clutches between 2003 and 2009, the number of years between reproductive events (inter-oviposition interval) was recorded as the female reproductive frequency.

The incubation boxes used were Styrofoam shipping containers that measured 28.5 cm L x 39 cm W x 18 cm H externally and were 2.4 cm thick. The incubation medium used in

these boxes was a mixture of one part perlite and two parts vermiculite. Five parts incubation medium to one part water by volume was then mixed, and the box was placed in the incubation room several days prior to incubating eggs in order to allow the contents of the box to reach incubation temperatures. The top of each incubation box was covered with a 1 cm thick pane of glass. The incubation room was temperature controlled by a Helix DBS 1000 (Helix Control Systems, Inc, Vista, California) to stay between 31.4°C and 31.7°C from 2002–2005, and between 30.9°C and 31.1°C from 2006–2009.

Data were also collected per egg on whether the egg was infertile, died during incubation, contained a fully formed embryo that was dead in the egg, embryo was live but deformed, or contained a healthy hatchling. For the eggs that hatched, the hatch date was recorded for each egg and each hatchling was weighed. After hatching, a hatch rate was calculated for each clutch. For the calculation of average oviposition and hatch dates over the years, both oviposition date and hatch date are reported as number of weeks of the year.

GraphPad Prism 5.0 was used for all statistical analyses performed in this study. All traits were analyzed for normality and homoscedasticity and transformations were made when needed. Female mass and clutch mass were log-transformed prior to use in any statistical analyses.

Results.—Data were collected on 5344 eggs from 783 ball python clutches between 2002–2009. Novel information from these data include sire and dam age at first reproduction, dam reproductive frequency, and duration from last copulation to oviposition. A comprehensive summary of clutch, breeder, reproductive event, and egg data is presented in Table 1.

TABLE 1. Mean, standard error (SE), minimum, maximum, and sample sizes for the data collected.

	Mean	SE	Min	Max	N
Clutch Info					
Clutches/Year	97.88	22.73	34	192	8
Week Laid	23.90	0.19	4	52	708
Clutch Size	6.83	0.06	3	14	783
Clutch Mass (g)	604.61	6.69	91	1270	775
Female Mass (g)	1464.97	11.29	830	2874	759
RCM	0.42	0.004	0.07	0.71	758
Breeder Info					
M Age	4.30	0.08	1	13	605
M Age at 1st Rep	2.25	0.04	1	6	354
F Age	6.08	0.09	2	18	771
F Age at 1st Rep	3.96	0.06	2	8	321
F Rep Frequency	1.97	0.05	1	6	251
Reproduction Events (days)					
Last Copulation to Oviposition	97.18	1.06	46	174	558
Ovulation to Shed	19.64	0.29	12	32	125
Shed to Oviposition	31.36	0.25	15	46	321
Ovulation to Oviposition	51.52	0.48	37	78	155
Shed to Hatch	90.35	0.31	78	111	285
Oviposition to Hatch	58.87	0.07	53.25	66	582
Ovulation to Hatch	110.84	0.58	99.71	137	139
Egg Info					
Egg Length (mm)	75.71	0.24	42.08	99.8	759
Egg Width (mm)	45.39	0.14	24.15	54.4	757
Week Hatched	32.37	0.18	19	51	597
Hatchling Weight (g)	62.20	0.31	27.25	90.2	685
Infertile/Clutch	0.77	0.06	0	10	783
Egg Died/Clutch	0.35	0.03	0	7	783
Dead in Egg/Clutch	0.10	0.03	0	12	783
Deformed/Clutch	0.13	0.02	0	4	783
Healthy Offspring/Clutch	5.49	0.09	0	12	783
Hatch Rate	0.81	0.01	0	1	783

During this study, 27 clutches (3.4%) were recorded as having been found late (> 24 h post oviposition). The clutch mass, RCM, number of healthy offspring, hatch rate, egg length, egg width, and hatchling mass averages were compared between these 27 clutches and averages from all the clutches from this study (Table 2). Student's *t*-test was used on all data except hatch rate for which Mann Whitney test was used due to extreme non-normality.

Oviposition anomalies, such as exclusion of eggs from the dam's coils or early laying of eggs, occasionally occur during the laying season (Fig. 2). Excluded eggs or early eggs were found in 15 (1.9%) and 7 (0.89%) of the clutches, respectively. The RCM, female mass, and clutch mass averages from clutches with one or more eggs found outside the coils of the female and those laid > 24 h prior to the rest of the clutch were compared to the averages from all the clutches from this study (Student's *t*-test) (Table 3). Figure 3 presents the hatch rates calculated for: eggs that were found outside the female's coils (OE), clutches that had eggs pushed outside the coils (OC), eggs that were inside the coils from outside egg clutches (OC - OE), eggs that were laid early (EE), clutches with eggs that were laid early (EC), the eggs that were laid with the majority of the clutch from laid early clutches (EC - EE), and all clutches in this study (ALL). Statistical differences were calculated using the Mann-Whitney test due to extreme non-normality.

In order to analyze relationships between the reproductive traits measured in this study, a Pearson correlation matrix was generated (Table 4). Strengths of correlations are termed as follows: 0.0 to 0.2, negligible; 0.2 to 0.4, weak; 0.4 to 0.7, moderate; 0.7 to 0.9, strong. Among the

28 correlations, 25 (89%) were significant at the P < 0.05 level, and 16 (57%) were above negligible strength (r > 0.2).

Discussion.—Information regarding reproductive traits of captive snakes is sparse. Published reports on pythons are limited to small sample sizes, and to discussing averages and ranges for reproductive traits. Previous studies specifically on ball pythons have reported average clutch sizes, duration from ovulation to post-ovulation shed, duration from post-ovulation shed to oviposition, RCM, egg length, egg width, egg mass, and duration of incubation (Barker and Barker 2006; de Vosjoli et al. 1994; Ross and Marzec 1990; Van Mierop and Bessette 1981). These data have been widely used by private and professional python breeders in order to increase breeding efficiencies. Similar data presented in this study (Table 1) provide larger sample sizes for these traits, and the results are similar to those published previously (Barker and Barker 2006; de Vosjoli et al. 1994; Ellis and Chappell 1987; Ross and Marzec 1990). In addition, this study provides data on the time duration from last copulation to oviposition.

For the 783 clutches studied from 2002 to 2009, an average of 97.88 clutches were laid per year. Although ball pythons in this study appeared to generally be pulse breeders, clutches were laid during all weeks of the year except the first three

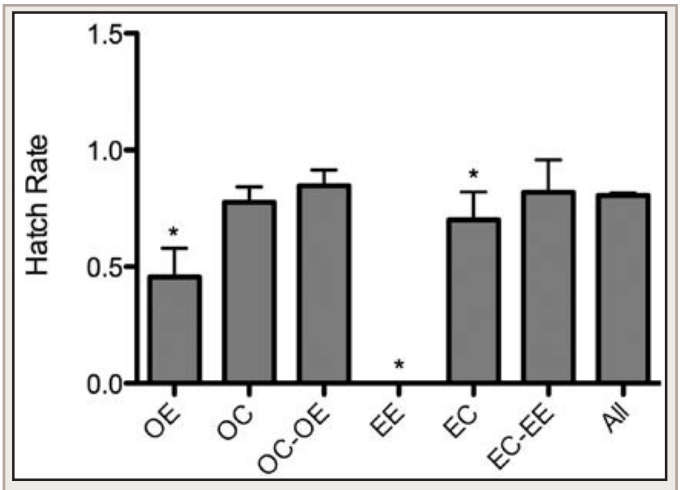


FIG. 3. Hatch rates for eggs that were found outside the female's coils (OE), clutches that had eggs pushed outside the coils (OC), eggs that were inside the coils from clutches with some eggs laid outside the coils (OC - OE), eggs that were laid early (EE), clutches with eggs that were laid early (EC), eggs that were laid with the majority of the clutch from clutches where some eggs were laid early (EC - EE), and all clutches in this study (All). Asterisks denote hatch rates that are significantly different from the overall hatch rate for all clutches from this study (Mann-Whitney test). Bars above columns represent the standard errors of the means.

TABLE 2. P-values for comparisons between clutches found >24 h after being laid and all clutches from this study (Student's *t*-test and Mann-Whitney test).

Trait	P-value
Clutch Mass	0.003
Relative Clutch Mass	0.009
Healthy Offspring	0.002
Hatch Rate*	0.002
Egg Length	0.057
Egg Width	0.038
Female Mass	0.409

P-values in bold were significant at the P < 0.05 level.
*Mann-Whitney test used due to extreme non-normality.

TABLE 3. P-values for relative clutch mass (clutch mass divided by female mass), mass of the female post oviposition (female mass), and mass of the clutch (clutch mass) for clutches with one or more eggs that were not within the dam's coils for maternal incubation and those in which eggs were laid early compared to all clutches (Student's *t*-test).

Trait	Outside Coils	Laid Early
Relative Clutch Mass	**0.004**	**0.012**
Female Mass	0.3	0.199
Clutch Mass	0.179	**0.01**

P-values in bold were significant at the P < 0.05 level.

TABLE 4. Pearson correlation matrix of the following reproductive traits: number of healthy offspring per clutch (Healthy Offspring), post-oviposition mass of each female (Female Mass, Fe Ma), age of the female at time of oviposition (Age), number of eggs per clutch (Clutch Size, CL Size), mass of each clutch (Clutch Mass, CL Ma), relative clutch mass (RCM), egg length (EL), and egg width (EW). Strengths of correlations are termed as follows: 0.0 to 0.2, negligible; 0.2 to 0.4, weak; 0.4 to 0.7, moderate; 0.7 to 0.9, strong.

	Fe Ma	Age	Cl Size	Cl Ma	RCM	EL	EW
Healthy Offspring	**0.18**	-0.01	**0.53**	**0.72**	**0.69**	**0.11**	**0.60**
Female Mass		**0.38**	**0.56**	**0.50**	**-0.14**	**-0.09**	**0.27**
Age			**0.13**	**0.12**	**-0.12**	0.05	0.05
Clutch Size				**0.73**	**0.50**	**-0.46**	**0.27**
Clutch Mass					**0.76**	**0.17**	**0.81**
RCM						**0.17**	**0.67**
EL							**0.48**

Correlations in bold were significant at the P < 0.05 level.

weeks in January (Table 1). Further, preliminary data suggest that the week of the year a Ball Python female lays her eggs in captivity is heritable and is significantly affected by both maternal and permanent environmental effects (unpublished data). Reproduction throughout the majority of the year in captive Ball Pythons is in stark contrast to what has been reported to occur in nature. Wild Ball Pythons in southern Togo, Africa generally lay their eggs during one month of the year (Aubret et al. 2003). The fact that female Ball Pythons can proceed through their reproductive cycles at almost any time during the year in captivity could have important implications for those trying to reproduce other python and snake species. Methods such as follicle palpation and ultrasound may significantly enhance success in reproducing these species in captivity by helping to identify times during which males should be introduced to females for copulation. This would be especially important in situations in which keepers are attempting to breed multiple females with single males.

The age at first reproduction (age when oviposition of first clutch occurs) for males in this study varied from 1 to 6 years (average 2.25 years), and for females it varied from 2 to 8 years (average 3.96 years) (Table 1). The average reproductive frequency for females was 1.97 years. Although no data has been published on captive or wild ball pythons for these traits, reproductive frequency has been studied and discussed for other python species. Captive Reticulated Pythons (*Python reticulatus*) and Diamond Pythons (*Morelia spilota spilota*) have been shown to reproduce every other year (Fitch 1970; Harlow and Grigg 1984). Slip and Shine (1988) provided evidence that the reproductive frequency of wild Diamond Pythons was also likely to be every other year, or potentially even longer. In wild Water Pythons (*Liasis fuscus*) reproductive frequency is closer to being yearly (Madsen and Shine 1996). Therefore, a reproductive frequency of every other year in captive Ball Pythons is similar to that found in other python species.

Aubret et al. (2005) incubated Ball Python clutches from wild-bred females by three different methods: maternal brooding until hatching (N = 10), maternal brooding for the first 15 days of incubation followed by artificial incubation (N = 10), and artificial incubation only (N = 10). They observed that the more time clutches were artificially incubated, the more desiccated they became, and hatching success decreased. They concluded that artificial incubation led to desiccation and decreased hatching success. During the current study, 27 clutches were not found until they had been laid for 24 h or more. When the eggs were found, the dam was brooding them. They were then removed from the females and artificially incubated for the remainder of the incubation period. Statistical analysis on averages for clutch mass, RCM, healthy offspring, hatch rate, egg length, egg width, and hatchling mass between these 27 clutches and all the clutches from this study showed evidence for desiccation and decreased hatching success in the clutches that were found late (Table 2). All the traits measured were statistically lower ($P < 0.05$) in the clutches that were found late, except egg length and hatchling mass. Data that suggested desiccation had occurred in clutches that were found late include decreased clutch mass, decreased RCM, and decreased egg width. The decreased hatch rate and number of healthy offspring per clutch suggest lower hatching success in these clutches. In assessment of Aubret et al. (2005), Barker and Barker (2006) suggested that desiccation itself, independent of incubation type, is the cause of decreased hatching success. Because clutches that were found late in this study were desiccated and suffered decreased hatching success even though they were artificially incubated for the majority of the incubation period, these data support the assessment of Barker and Barker (2006).

A previous study by Aubret et al. (2003) assessed optimal clutch size in Ball Pythons. In their study, wild-bred gravid females were caught and brought to a holding facility. Then, ten unmanipulated clutches, nine artificially enlarged clutches (added eggs to increase initial clutch size by 50%), and nine artificially reduced clutches (removed eggs to decrease initial clutch size by 42%) were set up for maternal incubation. Hatching success and hatchling fitness were assessed for the clutches in these three groups. For the clutches that were artificially decreased in size, no benefit to the dam or offspring was detected. However, artificially increasing clutch sizes did significantly decrease hatching success. Therefore, the data from this study suggest that a female's ability to cover her entire clutch is important to hatching success. During the current study, clutch sizes were reduced by the dam when one or more eggs were laid early, or one or more eggs were excluded from the dam's coils during brooding. Although the female mass average from females that produced these reduced clutches was not significantly different from the overall female mass average from all clutches laid in this study, clutch mass was significantly higher in clutches that were laid early, and RCM was significantly higher in both types of reduced clutches (Table 3). Therefore, clutches were reduced in size when they were large in comparison to female mass (higher RCM), which would potentially lead to females experiencing difficulty in covering the proportionately larger clutches. Also, the hatch rate for clutches that had eggs laid early was significantly lower than the hatch rate for all clutches in this study, but the hatch rate for these same clutches once they were reduced (i.e. not including eggs that were laid early) was not significantly different than the overall average (Fig. 3).

Many conclusions can be drawn from the correlations presented in Table 4, but a few we find particularly interesting. Age was correlated at the level of $r > 0.2$ only with female mass, while female mass was also correlated at $r > 0.2$ with clutch size, clutch mass, and EW. This suggests that the mass of the female is more important than age for predicting reproductive output. Further, because female mass was correlated at $r > 0.2$ with clutch size and clutch mass, but not RCM, it seems that the proportion of energy allocated to a clutch is independent of the mass of the female even though both the mass of the clutch and the number of eggs in the clutch

are moderately correlated with the mass of the female (0.50 and 0.56, respectively). Also of interest, EW was correlated at $r > 0.2$ with all traits in the matrix except age. Therefore, EW could be a useful predictor of reproductive output. Lastly, the moderate negative correlation between EL and clutch size, and the weak positive correlation between EW and clutch size support previous research suggesting that as clutch sizes get larger, the eggs get smaller and more round in shape (Brown and Shine 2007b; Ford and Seigel 1989; Madsen and Shine 1996).

The large sample sizes attained in this study have allowed us to study certain aspects of ball python captive reproduction. Novel data presented in this study provide a foundation for the design of future studies, and for the development of more efficient breeding plans for propagating captive pythons. In addition, some specific information presented here can be of immediate use for python propagation. Results from this study suggest that female ball pythons in captivity ovulate in all months of the year. Also, during this study the female reproductive frequency was every other year. Our results also show that desiccation, even for periods of time as short as only a few days, at the beginning of incubation may significantly decrease hatching success. Taking these findings into account, those attempting to propagate pythons in captivity should do the following: 1) Become proficient in techniques such as follicle palpation and ultrasound in order to assess the reproductive stages of females throughout the year; 2) Understand that the reproductive frequency of python females in captivity may be every other year, or even every third year and not push females to reproduce every year; 3) Make provisions in breeding procedures to decrease the risk of subjecting eggs to desiccation at any time during incubation. With further study of some of the correlations presented in this study (e.g. EW correlations), additional information regarding selection parameters to increase breeding efficiencies may be derived as well. Such knowledge will likely lead to increased success in breeding endangered and otherwise rare and difficult to breed python species in captivity.

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HERPETOCULTURE NOTES

CROCODYLIA — CROCODILIANS

***CROCODYLUS RHOMBIFER* (Cuban Crocodile). MATING BEHAVIOR.** Courtship and mating of captive 2.2 m long male and 1.7 m long female *Crocodylus rhombifer* were observed in Zoo Miami (Miami, Florida, USA, 25.60ºN, 80.40ºW) in 2010. The animals were kept in a 20 m^2 concrete pool within a grassy enclosure.

The animals were observed almost daily from 20 March to 15 April, 2010, between 0700–1100 h, from outside the enclosure. All courtship and mating activity was observed between 0830–1000 h from 23–30 March. During seven days of observation with no rain, the male produced six roars (no more than one per day). The roars were produced at the edge of the pool in arched-back posture, and accompanied by body vibrations and "water dance" effect indicative of brief infrasound pulse, as described for Nile (*C. niloticus*) and American (*C. acutus*) Crocodiles (Garrick et al. 1978. Bull. Am. Mus. Nat. Hist. 160:153–192). One of these six roars was followed by a headslap. On one rainy day (when the water temperature was probably lower than usual) the male produced four roars on land. All roars produced in the water were immediately followed by approaches and courtship behavior by the female. In five such cases the male eventually responded with courtship behavior and then mating. The courtship behavior included not only snout- and chin-touching, but also rides around the pool by the female on the back of the male, which were observed on four occasions, and lasted for up to one minute (Fig. 1). Such rides have never been reported for any crocodilian species.

I thank Steven Conners (Zoo Miami) for assistance and the observation permit.

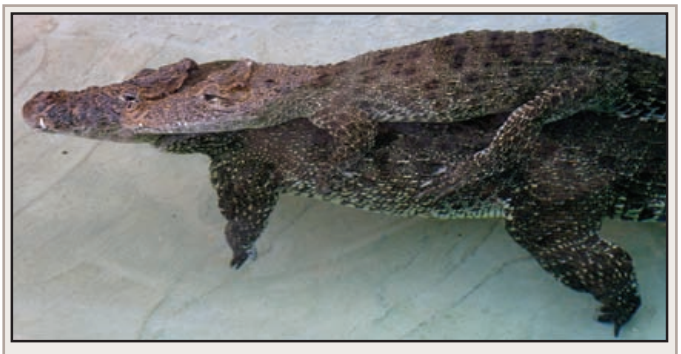


FIG. 1. Female *Crocodylus rhombifer* riding on the male's back during courtship.

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TESTUDINES — TURTLES

***INDOTESTUDO FORSTENII* (Forsten's Tortoise). REPRODUCTION.** *Indotestudo forstenii*, a crepuscular tortoise found only on the islands of Sulawesi and Halmahera, is officially listed by the Convention on International Trade of Endangered Species (CITES) Appendix II and by the International Union for Conservation of Nature (IUCN) as an endangered species (Halvorsen 2009. The North American Regional Studbook for the Sulawesi Tortoise, *Indotestudo forstenii*. 2nd ed. West Palm Beach Zoo, West Palm Beach, Florida. 23 pp.). Most of the captive population in zoos consists of wild caught individuals, but a few successful captive breedings have occurred. On 19 March 2010 a wild-caught female housed at the Memphis Zoo with a wild-caught male laid two eggs. Although one of the eggs died, one pipped on 14 August 2010. Six days prior to pipping, a translucent white circle appeared on the egg. Similar translucent patches were observed five, six, and eleven days prior to pipping on three *Gopherus polyphemus* (Gopher Tortoise) eggs that were incubated at the University of Southern Mississippi (pers. obs.). These observations suggest that the appearance of these translucent circles are related to the hatching process and could be used as a way to predict when an egg will hatch. Because zoos attempt to breed tortoise species whose incubation parameters—including incubation duration—are relatively unknown or are widely variable, an indicator of impending pipping would be a useful husbandry tool.



PHOTO BY CHRIS BAKER

FIG 1. Arrows indicate lower margin of clear circle on egg.

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***KINOSTERNIDAE* (Mud and Musk Turtles). GROOMING BEHAVIOR.** Herein, I report multiple instances of self-performed grooming behaviors in captive individuals of at least eight kinosternid taxa in the genera *Sternotherus*, *Kinosternon*, and *Staurotypus*. Behaviors consisted of biting at fore- and hindlimbs, carapacial margins, and areas of reachable skin (all underwater). These taxa have long slender necks with thin loose skin (providing flexibility), and kinetic plastral forelobes that likely facilitate the behaviors described here.

Two adult *Sternotherus minor minor* (1 male, 1 female) were observed on seven occasions (within a month after capture) attempting to remove small turtle leeches (*cf. Placobdella* sp.) from the underside of the nuchal along the ventral scale margin.



FIG. 1. Self-performed grooming session in an adult male *Sternotherus carinatus*. Top) gentle forelimb biting; Center and bottom) biting at skin between the neck and forelimb. This individual has been observed biting at its own nuchal margin and achieving over 180 degrees of head rotation in the process.



FIG. 2. Gentle forelimb biting in an adult male *Kinosternon subrubrum steindachneri*. This individual has been observed removing and eating shedding skin from anterior portions of the body.

Leeches can accumulate in large numbers in this region of the body on *S. m. minor*. Turtles demonstrated the capability of orienting the head 180° laterally through hyperextension and rotation of the neck, so that the nostrils were directed towards the posterior of the body. This enabled the turtles to position their head and jaws under the nuchal margin, and bite, scrape, and even remove leeches from themselves with their jaws. It is unknown if leeches were subsequently consumed, however leeches were observed attached on the inside of the turtles' mouths on the palate and lingual portions of the mandible.

Five adult male *Sternotherus carinatus* were also observed performing similar grooming behaviors, but in the absence of leeches on their bodies. For example, on more than sixteen occasions a large (140 mm CL) individual was observed grooming all reachable portions of its body, including achieving ≥180º head orientation as described above for *S. m. minor*. In such instances, the turtle would repeatedly bite at the anterior margin of its carapace including the outer rim of the nuchal, and gently scrape its lower jaw along the underside of the carapacial rim. During one observation, this turtle began by rotating its head to the left, gently biting at the skin between the neck and forelimb (as seen in Fig. 1), and then biting the margin of the carapace at left marginal scales 1 and 2. It then proceeded to rotate its head even further, biting at the cervical and anterior-most portion of Vertebral Scale 1. This turtle eventually accomplished >180º head orientation, having turned its head to the left side and bitten at right marginal scale 1. Forelimb and hindlimb grooming were most commonly observed in male *S. carinatus*, and pieces of thin sloughing skin were removed and consumed through gentle biting. Hindlimb biting was observed in three individuals and accomplished through hyperextension of the neck either laterally or directly under the body. Standing on the bottom of the enclosure, turtles would straighten out their limbs to position the body off of the substrate. The head and neck were then extended to bite at a hindlimb, often lifting the hindlimb off the substrate in concert to reach the foot. Grooming behaviors lasted between 7–120 seconds.

Six (4 males, 2 females) captive adult *Kinosternon s. steindachneri* were observed briefly self-biting at marginals 1–3 as well as removing shedding skin from forelimbs, the latter being

more commonly observed (Fig. 2). Shedding skin was consumed in forelimb biting. This species frequents xeric wetland habitats that are prone to periods of drought, and it is possible that skin consumption is a resourceful response to this situation. Leeches (cf. *Placobdella* sp.) have also been observed on *K. s. steindachneri* (pers. observ.).

Short bouts of forelimb biting was seen in multiple captive adult individuals of *S. odoratus, Staurotypus salvinii,* and *S. triporcatus*, a male and two female *K. l. leucostomum*, and at least three instances in a young male *K. flavescens*. Grooming intervals for these specimens tended to be relatively short (less than 15 seconds).

Intentional rubbing of the carapace against limestone rocks and cypress wood placed within enclosures was exhibited by four *S. carinatus* on at least six occasions, however these instances lasted for only a few seconds. More passive scraping was also noted when turtles would repeatedly burrow or try to retreat under or adjacent to those objects.

In addition to the taxa reported here, self-performed grooming behavior has been documented for the side-necked turtle *Hydromedusa* (Novelli et al. 2009. Herpetol. Rev. 40:435–436) and it is likely that grooming is (at least in part) a response to heavy ectoparasite loads often borne by many turtle species in the wild. Bottom-dwelling species such as Wood Turtles (*Glyptemys insculpta*), Snapping Turtles (*Chelydra serpentina*), Flattened Musk Turtles (*Sternotherus depressus*), and *S. minor* (Ernst and Lovich 2009. Turtles of the United States and Canada, 2nd ed., Johns Hopkins University Press, Baltimore, Maryland; pers. observ.) often are hosts to dense concentrations of leeches, and *Sternotherus odoratus* has been reported to carry over 20 times the number of leeches as (more commonly) aerial basking species such as the Northern Map Turtle (*Graptemys geographica*) (Ryan and Lambert 2005. J. Herpetol. 39:284–287). The presence of leeches on *Sternotherus* species could be presumed to be energetically costly for such relatively small-sized turtles given that these parasites have been found to consume blood and bone tissues of the host (Siddall and Gaffney 2004. J. Parasitol. 90[5]:1186–1188).

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SQUAMATA — LIZARDS

***SCINCUS SCINCUS* (North African Sand Skink). LONGEVITY.** *Scincus scincus* is a common lizard of Egypt, Libya, and Morocco. The natural life span of this species is currently unknown, but Hughes (1988. J. Herpetol. Assoc. Africa 34:20–24) reported a captive longevity of 5 years, 3 months for this species. Schleich et al. (1996. Amphibians and Reptiles of North Africa. Koeltz Scientific Books, Koenigstein, Germany. 630 pp.) reported a captive life span of 10 years for this species, but gave no specific information to support this.

At the North Carolina Zoological Park, we maintained a female *Scincus scincus* from 27 May 1993 to 5 May 2010. This specimen was obtained from an animal dealer on 27 May 1993 as an adult and was euthanized on 5 May 2010 due to deteriorating health related to old age. At the time of euthanasia the individual had lived at the North Carolina Zoological Park for a period of 16 years, 11 months, and 8 days. This specimen was housed in a 75.6 L. aquarium filled to a depth of 102 mm with loose sand. A heat pad was provided under its off-exhibit enclosure and a 100W incandescent bulb was above the enclosure to provide a basking area. No UV lighting was provided to this animal given its fossorial nature. Water was provided in a shallow dish at all times and the enclosure was misted twice daily to maintain moisture in the sand. Prey items were offered three times/week and consisted of adult crickets, meal worms, and wax worms. All prey items were dusted with several vitamin and mineral supplements (Walkabout Farm's dietary products and Reptivite®) at different times during this period. Because age at time of acquisition was unknown, we cannot estimate age at death although it may have been in the range of 18–20 years.

Three other lizards of the same species that were obtained at the same time from the same source lived for periods of 3 years, 3 months, and 24 days; 5 years, 7 months and 17 days; and 8 years, 8 months, and 9 days. Based on these longevity records, this species may have a natural average life of 10 years as reported by Schleich et al. (1996, *op. cit.*).

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GEOGRAPHIC DISTRIBUTION

CAUDATA — SALAMANDERS

AMBYSTOMA TIGRINUM (Tiger Salamander). USA: MINNESOTA: Le Sueur Co.: In private pasture 600 m E of 367th Avenue ca. 6.00 km SW of Kasota, MN. (44.24266667°N, 93.99916667°W; WGS 84). 02 July 2010. James Ford Bell Museum (JFBM P379a–b; photographic records). Verified by Kenneth H. Kozak and Christopher E. Smith. Observed by Andrés F Morantes, Otto T Gockman, and Scott A Milburn. First county record updating a pre-1960 voucher from Le Sueur Co. (Oldfield and Moriarty 1994. Amphibians & Reptiles Native to Minnesota. University of Minnesota Press. Minneapolis. 237 pp.). Found under cover board.

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ECHINOTRITON ANDERSONI (Anderson's Crocodile Newt). JAPAN: RYUKYU ARCHIPELAGO: Amami Island Group: Ukejima Island (28.0333°N, 129.2166°E, ca. 250 m elev.). 5 and 29 March 2010. M. Honda. Graduate School of Human and Environmental Studies, Kyoto University (KUHE) 50691–50693. First island record with voucher. Individuals found inactive underneath pile of withered weeds. Species previously known from Amamioshima and Tokunoshima Islands of the Amami Group, and Okinawajima, Sesokojima and Tokashikijima Islands of the Okinawa Group (Hayashi et al. 1992. Herpetologica 48:178–184), and from Taiwan on the basis of three skeletal specimens deposited in MCZ (Zhao and Adler 1993. Herpetology of China. Contributions to Herpetology [10]. SSAR, Oxford, Ohio. 522 pp. + 48 pl. + 1 folding map). However, this latter record needs verification (Matsui and Ota 1995. Herpetologica 51:234–250). Ukejima Island (13.3 km^2 in area, 398 m elev.) was referred to as another island inhabited by *E. andersoni* but on basis of single photograph, lacking date and locality (Ota and Okada 2003. Reptiles and amphibians. *In* Kagoshima Red Data Book for Animals, pp. 82–116. Kagoshima Environmental Research and Service, Kagoshima, Japan [in Japanese]).

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NOTOPHTHALMUS VIRIDESCENS (Eastern Newt). USA: MICHIGAN: Charlevoix Co.: South end of Hog Island, Eastern Lake Michigan Archipelago (45.76667°N, 85.366667°W; WGS 84). 24 May 2008. Kenneth D. Bowen. Verified by Fred Janzen. Iowa State University Research Collection (ISUA201101; digital image). New record for Hog Island (Bowen and Gillingham 2004. Michigan Acad. 35:213–223).

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NOTOTRITON BRODIEI (NCN). GUATEMALA: IZABAL: Sierra Caral: near Cerro Pozo de Agua (15.39367°N, 88.69183°W; WGS84), 850 m elev. 1 October 2010. Carlos R. Vásquez-Almazán and Jeffrey W. Streicher. Verified by David Wake. Museo de Historia Natural de la Universidad de San Carlos (USAC 2737). This is only the sixth known individual of the species and the locality has the lowest recorded elevation to date; previous low was 1125 m (Campbell and Smith 1998. Sci. Pap. Nat. Hist. Mus., Univ. Kansas 6:1–8). Thus, the elevational distribution of *N. brodiei* is now known to range from 850 m through 1590 m (Kolby et al. 2009. Herpetol. Rev. 40:444), so preserving natural habitats in that range zone is a necessity for its conservation and continued survival. The salamander was caught at ca. 2100 hrs while it was walking across low-lying vegetation in secondary growth forest that was previously covered with tropical deciduous forest.

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OEDIPINA LEPTOPODA (Narrow-footed Worm Salamander). HONDURAS: CORTES: 1.5 km N of Los Pinos (14.866861°N, 87.900197°W; WGS84). 710 m elev. January 2010. José Mario Solis. Verified by David Wake. MVZ 263988. First record for Cortés, extending its range ca. 75 km SW of nearest known locality, ca. 32 km W of Yoro, Yoro (McCranie et al. 2008. Zootaxa 1930:1–17). The salamander was found during the late rainy season in dry leaf litter of early secondary growth forest in an area originally a mixture of pine and broadleaf forest.

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ANURA — FROGS

ANAXYRUS AMERICANUS (American Toad). USA: INDIANA: Jennings Co.: Calli Nature Preserve: (39.0031°N, 85.60918°W; NAD 83). 13 July 2010. Sarabeth Klueh, Jason Mirtl, and Tim Shier. Verified by Chris Phillips, Illinois Natural History Survey (INHS 2010k). New county record for Indiana (Minton 2001. Amphibians and Reptiles of Indiana. 2nd ed., revised. Indiana Academy of Science. vii+404 pp.)

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ANAXYRUS FOWLERI (Fowler's Toad). USA: INDIANA: Jennings Co.: Calli Nature Preserve: (38.99789°N, 85.60726°W; NAD 83). 13 July 2010. Sarabeth Klueh, Jason Mirtl, and Tim Shier. Verified by Chris Phillips, Illinois Natural History Survey (INHS 20101). New county record for Indiana (Minton 2001. Amphibians and Reptiles of Indiana. 2nd ed., revised. Indiana Academy of Science. vii + 404 pp.)

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ATELOGNATHUS REVERBERII. ARGENTINA: RIO NEGRO: Departamento 25 de Mayo: El Caín: Meseta de Somuncurá (41.68461°S, 68.19228°W; WGS 84; elev. 1050 m). 02 February 1999. J. Muzón and P. Marino. Herpetological collection, Centro Nacional Patagónico, Puerto Madryn, Chubut, Argentina (CNP-L 201–202); CHUBUT: Departamento Telsen: Gan Gan (42.51042°S, 67.97728°W; WGS 84; elev. 920 m). 09 March 2000. N. G. Basso and L. Alcalde (CNP-L 204–208). All verified by Jorge D. Williams. Previously known only from the type locality, Laguna Minuelo, Meseta de Somuncurá, Río Negro Province (Cei 1969. J. Herpetol. 3:1–18) and closely surrounding lagoons. Verification supported with mitochondrial data from control region (D-loop), cytochrome b (CytB) and cytochome oxidase subunit one (COI) genes (Basso, Martinazzo, and Úbeda, unpubl. data). Specimens collected were found under stones surrounding small lagoons in the arid Patagonian steppe, in sympatry and syntopy with the frog *Pleurodema bufoninum*. These vouchers extend the range 130 km airline W in the province of Rio Negro and 150 km airline SW from the type locality, being the first record for the province of Chubut.

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CRAUGASTOR CHARADRA (Ranita de Arroyo de la Montaña Noroeste). HONDURAS: SANTA BÁRBARA: tributary of Río Listón (15.533336°N, 88.35014°W; WGS84), 405 m elev. 12 November 2008. James R. McCranie and Leonardo Valdés Orellana. Verified by Steve W. Gotte. USNM 573827–573829. First records for Santa Bárbara (McCranie 2007. Herpetol. Rev. 38:35–39), with the closest known locality being ca. 10 km NE at El Cusuco, Cortés (McCranie 2006. Smithson. Herpetol. Inform. Serv. [137]:ii + 39). The specimens were active at night along a stream surrounded by relatively undisturbed broadleaf forest.

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CRAUGASTOR RANOIDES (NCN). COSTA RICA: GUANACASTE: Municipality of La Cruz: Península de Santa Elena; Area de Conservación Guanacaste, Quebrada Pedregal 1 (10.9025°N, 85.741667°W; WGS84), 100 m elev. 25 March 2006. H Zumbado-Ulate and F. Soley. UCR 18208. Quebrada Pedregal 2 (10.905278°N, 85.747778°W; WGS84), 80 m. elev. 25 March 2006. H. Zumbado-Ulate and F. Soley. UCR18209. Quebrada Cachimbo (10.908333°N, 85.748333°W; WGS 84), 30 m elev. 19 January 2009. H. Zumbado-Ulate and B. Willink. UCR20555. Quebrada La Amanda (10.532211°N, 85.726111°W; WGS84), 90 m elev. 19 January 2009. H. Zumbado-Ulate and B. Wilink. UCR 20556. Río Canelo (10.912222°N, 85.749167°W; WGS84), 30 m elev. 19 January 2009. H. Zumbado-Ulate and B.Willink. UCR20554. Quebrada Casa de Zinc (10.8375°N, 85.697222°W; WGS84), 150 m elev. 1 May 2009. H. Zumbado-Ulate and B. Willink. UCR20681. All verified by F. Bolaños. First records for the municipality, located ca. 5 km W of the closest known localities in the Municipality of Liberia within the Río Murciélago region (Zumbado-Ulate et al. 2007. Herpetol. Rev. 38:184–185; Zumbado-Ulate et al. 2009. Herpetol. Rev. 40:201). This previously common species throughout Costa Rica has had its populations decimated in recent years due to unknown factors (Puschendorf et al. 2005. Herpetol. Rev. 36:53), so its presence along several rivers and streams within the Península de Santa Elena provides hope that it can be adequately protected; it is considered an endangered species by IUCN. All frogs were found on boulders along slow flowing rocky streams in tropical dry forest.

HÉCTOR ZUMBADO-ULATE (e-mail: hugozu1@yahoo.com) and **BEATRIZ WILLINK** (e-mail: bwillink@gmail.com), Escuela de Biología, Universidad de Costa Rica, Sede Rodrigo Facio, Costa Rica.

HADDADUS BINOTATUS (Clay Robber Frog). BRAZIL: MATO GROSSO DO SUL: Corumbá, Capim Gordura port (18.806871°S, 57.578821°W, datum WGS84), in forested area on the banks of the Paraguay River, about 45 km upstream from the urban area of Corumbá. 27 November 1993. Collected by J. C. Louzan. Coleção Zoológica de Referência da Universidade Federal de Mato Grosso do Sul, Campo Grande, Mato Grosso do Sul, Brazil (ZUFMS AMP0628). Verified by C. F. B. Haddad. *Haddadus binotatus* occurs in eastern and southern Brazil, from southern Bahia state to Rio Grande do Sul state (Brassaloti et al. 2010. Biota Neotrop. 10[1]:275–291; Feio and Caramaschii 2002. Phyllomedusa 1[2]:105–111; Machado and Maltchik 2007. Neotrop. Biol. Cons. 2[2]:101–116; Machado et al. 1999. Rev. Bras. Zool. 16[4]:997–1004; Van Sluys and Rocha 2008. IUCN Red List of Threatened Species, ver. 2010.4. http://iucnredlist.org/). First state record, extends the distribution ca. 840 km W of the Parque Estadual Mata dos Godoy, municipality of Londrina, state of Paraná

(Machado et al. 1999, *op. cit.*) and ca. 920 km W of the Estação Ecológica dos Caetetus, between the municipalities of Gália and Alvilândia, state of São Paulo (Brassaloti et al. 2010, *op. cit.*).

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***HYLA CINEREA* (Green Treefrog)**. USA: GEORGIA: Dekalb Co.: approximately 0.8 km from intersection of SR 29 and Leeshire Rd. (33.86352°N, 84.18267°W; WGS 84; elev. 289 m). 08 May 2009. Deborah Ashley. Verified by John Jensen. Photographic vouchers UTADC 6846–6847. New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.); previously documented from neighboring Gwinnett, Rockdale, Clayton, and Henry counties. Specimen was found in a residential garden resting on a lily leaf (*Lilium* sp.) along the edge of a storm water retention pond.

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***HYLA GRATIOSA* (Barking Treefrog)**. USA: GEORGIA: Baldwin Co.: Browns Crossing Road NW (33.074277°N, 83.377750°W; WGS84). 28 September 2010. Dennis Parmley. Florida Museum of Natural History photo voucher (UF 162272). Verified by John B. Jensen. New county record but within expected range (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). Single adult found on road during heavy rain. Road passed though mixed pine-deciduous forest.

HOUSTON C. CHANDLER and **DENNIS PARMLEY** (e-mail: dennis.parmley@gcsu.edu), Department of Biological and Environmental Sciences, Georgia College and State University, Milledgeville, Georgia 31061, USA.

***HYLORINA SYLVATICA* (Emerald Forest Frog)**. CHILE: XI REGION DE AYSÉN: 10 km NE of Villa O'Higgins (48.37153°S, 7249727°W, datum WGS 84; 426 m elev.). Adult male 43.25 mm SVL, collected under logs in Chilean temperate rain forest dominated by *Nothofagus* at the border of Mayer River. 28 January 2010. H. Díaz-Páez. Collection of the Museum of Zoology of the University of Concepción, Concepción, Chile (MZUC-UCCC 36285). Verified by M. Vidal. Species is distributed in Chile from Golfo de Arauco (40.00°S, 72.00°W; Veloso and Navarro 1988. Bull. Mus. Reg. Nat. Torino 6:481–539) to Laguna San Rafael (46.73°S, 73.93°W; Díaz-Páez et al. 2002. Bol. Mus. Nac. Hist. Nat., Chile 51:135–145), and is also reported from the Pacific border of Chiloé Archipielage to Wellington Island (Rabanal and Nuñez 2009. Anfibios de los Bosques Templados de Chile. Universidad Austral de Chile, Valdivia. 206 pp.). This new continental record in the Aysen Region extends the range of the species ca. 220 km SE from Laguna San Rafael and places it on the eastern side of the Patagonian Icefields.

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***INCILIUS CAMPBELLI* (Sapo del Bosque Noroeste)**. HONDURAS: SANTA BÁRBARA: trubutary of Río Listón (15.51689°N, 88.350086°W; WGS84), 560 m elev. 12 November 2008. James R. McCranie and Leonardo Valdés Orellana. Verified by Steve W. Gotte. USNM 573736. First record for Santa Bárbara (McCranie 2007. Herpetol. Rev. 38:35–39) and helps bridge a distributional gap between localities in the departments of Cortés and Copán (McCranie 2006. Smithson. Herpetol. Inform. Serv. [137]:ii + 39). The specimen was active mid morning on the ground in relatively undisturbed broadleaf forest.

LEONARDO VALDÉS ORELLANA, Gerente General de "Hondufauna," Investigador Privado, Colonia América, Bloque 9, Casa 1806, Comayagüela, MDC, Honduras (e-mail: leovalor@hotmail.com); **JAMES R. McCRANIE**, 10770 SW 164th Street, Miami, Florida 33157–2933, USA (e-mail: jmccranie@bellsouth.net).

***LITHOBATES CLAMITANS* (Green Frog)**. USA: INDIANA: Gibson Co.: Patoka River National Wildlife Refuge and Management Area (38.37256°N, 87.33124°W; NAD 83; Zone 16N). 27 March 2009. Alisha Maves and Randall Haken. Verified by Chris Phillips, Illinois Natural History Survey (INHS 2009ag). New county record (Minton 2001. Amphibians and Reptiles of Indiana. 2nd ed., revised. Indiana Academy of Science. vii + 404 pp.). Single individual caught in a small inundated depression created by a fallen tree.

ALISHA MAVES, **RANDALL HAKEN**, and **LINDSEY LANDOWSKI**, US Fish and Wildlife Service, Patoka River National Wildlife Refuge, 510 1/2 West Morton Street, PO Box 217, Oakland City, Indiana 47660, USA (e-mail: Lindsey_Landowski@fws.gov).

***LITHOBATES CLAMITANS* (Green Frog)**. USA: TENNESSEE: Smith Co.: Hurricane Creek adjacent to Maggarte Road ca. 2.5 km N of Hwy US 70N (36.227797°N, 85.841232°W; WGS 84). 21 March 2011. M. Anderson and A. Carey. Verified by Brian T. Miller. Herpetology Collection at Middle Tennessee State University (MTSU 352A). New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Internet version [http://www.apsu.edu/amatlas] contains links to information regarding Tennessee distribution of amphibians recorded since 1996; accessed 28 March 2010). Adult found in creek.

MICHAEL A. ANDERSON (e-mail: maa3t@mtmail.mtsu.edu) and **ALISON N. CAREY** (e-mail: anc3i@mtmail.mtsu.edu), Department of Biology, Middle Tennessee State University, Murfreesboro, Tennessee 37132, USA.

***LITHOBATES SYLVATICUS* (Wood Frog)**. USA: INDIANA: Pike Co. (38.37114°N, 87.15238°W; NAD83). 22 June 2010. Sarabeth Klueh, Jason Mirtl, Tim Shier, and Lindsey Landowski. Verified by Chris Phillips. Illinois Natural History Survey (INHS 2010o). New county record (Minton 2001. Amphibians and Reptiles of Indiana. 2nd ed., revised. Indiana Academy of Science. vii + 404 pp.). A juvenile was found in a wooded upland area.

SARABETH KLUEH (e-mail: sklueh@dnr.IN.gov), **JASON MIRTL**, **TIM SHIER**, Wildlife Diversity Section, Indiana Department of Natural Resources Division of Fish and Wildlife, 553 E. Miller Drive, Bloomington, Indiana 47401, USA; **LINDSEY LANDOWSKI** (e-mail: Lindsey_Landowski@fws.gov), US Fish and Wildlife Service, Patoka River National Wildlife Refuge, 510 1/2 West Morton Street, PO Box 217, Oakland City, Indiana 47660, USA.

***OSTEOPILUS SEPTENTRIONALIS* (Cuban Treefrog)**. TURKS AND CAICOS ISLANDS: North Caicos: east of Kew Town (21.919°N, 72.012°W; WGS84), 25 m elev. 10 August 2008. R.

Graham Reynolds and Matthew L. Niemiller. Color photo voucher (APSU 19024). Providenciales, National Environmental Centre (21.7819°N, 72.212°W; WGS84), 12 m elev. 17 March 2010. Brian M. Riggs. Color photo voucher (APSU 19027). Both verified by A. C. Echternacht. First records for Turks and Caicos Islands. The closest known locality is on Great Inagua Island (Schwartz and Henderson 1991. Amphibians and Reptiles of the West Indies: Descriptions, Distributions, and Natural History. Univ. Florida Press, Gainesville. xvi + 720 pp.).

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***TLALOCOHYLA LOQUAX* (Rana Trepadora Sonorense; Mahogany Treefrog)**. HONDURAS: EL PARAÍSO: Mapachín (13.9830°N, 86.4910°W, WGS84), 830 m elev. 8 July 2010. Alexander Gutsche, James R. McCranie, and Leonardo Valdés Orellana. Verified by Steve W. Gotte. USNM 565832–33. First record for El Paraíso (McCranie 2007. Herpetol. Rev. 38:35–39). The closest known locality in Honduras is ca. 55 km W at Cerro Uyuca, Francisco Morazán (McCranie 2006. Smithson. Herpetol. Inform. Serv. 137:1–38). The frogs were calling at night from small trees next to a pond surrounded by pastures. Fieldwork of A. Gutsche was supported by the Adolf and Hildegard Isler Foundation.

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TESTUDINES — TURTLES

***APALONE SPINIFERA SPINIFERA* (Eastern Spiny Softshell)**. USA: OHIO: Allen Co.: Amanda Township: Auglaize River 100 m S of State Route 117 (40.707233°N, 84.272914°W; WGS84). 12 September 2010. Cincinnati Museum Center (CMC 12094). Harrison Co.: North Township: Conotton Creek (40.41768°N, 81.14656°W; WGS84). 04 September 2010. CMC 12115. Jefferson Co.: Saline Township: Brush Creek along Pine Grove Road (40.54996°N, 80.71447°W; WGS84). 04 September 2010. CMC 12118. Shelby Co.: Clinton Township: Tawawa Creek 200 m upstream from its confluence with the Great Miami River (40.24918°N, 81.14499°W; WGS84). 12 July 2010. CMC 12095. All specimens were collected by Jeffrey G. Davis and Paul J. Krusling and verified by John W. Ferner. New county records (Wynn and Moody 2006. Ohio Turtle, Lizard and Snake Atlas. Ohio Biol. Surv. Misc. Contr. No. 10. iv + 81 pp.).

JEFFREY G. DAVIS (e-mail: anura@fuse.net) and **PAUL J. KRUSLING** (e-mail:pkrusling@gmail.com) Geier Research and Collections Center, Cincinnati Museum Center, 1301 Western Avenue, Cincinnati, Ohio 45203, USA.

***CHELUS FIMBRIATUS* (Matamata Turtle)**. BRAZIL: MARANHÃO: Tocantins River Basin, Municipality of Estreito (ca. 6.51°S, 47.38°W; datum: SAD 69; 150 m elev.). November 2009. G. Nunan. Museu Nacional, Rio de Janeiro, RJ, Brazil (MNRJ 19411). Verified by U. Caramaschi. This new record is within the Cerrado biome. Species was previously known from the states of Amapá, Amazonas, Pará, Rondônia (on frontier with Bolivia), Mato Grosso, Tocantins e Goiás in Brazil, along the Amazon and north of the Cerrado, and also in Venezuela, Guiana, French Guiana, Colombia, Ecuador, Peru, and Bolivia (Iverson 1992. A Revised Checklist with Distribution Maps of the Turtles of the World. Privately printed, Richmond, Indiana xiii + 363 pp.; Pritchard 2008. *In* Rhodin et al. Chelonian Research Monographs 5:020.1–020.10; Pritchard and Trebbau 1984. The Turtles of Venezuela. SSAR, Oxford, Ohio. vii + 403 pp.). First record for the state of Maranhão in Brazil and the easternmost record, filling a gap along the Tocantins River Basin ca. 570 km S from Belém region (Pará state) and 570 km NE from Luciária / Santa Terezinha region (Mato Grosso state) (Iverson, *op. cit.*; Pritchard, *op. cit.*).

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***CHRYSEMYS PICTA MARGINATA* (Midland Painted Turtle)**. USA: OHIO: Allen Co.: Amanda Township: Auglaize River at Bice Road bridge (40.70035°N, 84.25469°W; WGS84). 13 July 2010. Cincinnati Museum Center Herpetological Photodocumentation Collection (CMC HP 5249). Jefferson Co.: Brush Creek Township: farm pond on State Park Mooretown Rd. (40.59604°N, 80.83760°W; WGS84). 05 September 2010. CMC HP 5247–5248. Both specimens collected by Jeffrey G. Davis and Paul J. Krusling, and verified by John W. Ferner. New county records (Wynn and Moody 2006. Ohio Turtle, Lizard and Snake Atlas. Ohio Biol. Surv. Misc. Contr. No. 10. iv + 81 pp.).

JEFFREY G. DAVIS (e-mail: anura@fuse.net) and **PAUL J. KRUSLING** (e-mail: pkrusling@gmail.com) Geier Research and Collections Center, Cincinnati Museum Center, 1301 Western Avenue, Cincinnati, Ohio 45203, USA.

***DERMATEMYS MAWII* (Central American River Turtle)**. MÉXICO: YUCATÁN: Municipality of Progreso: El Corchito, ca. 31 km N of Mérida (21.281111°N, 89.643056°W; WGS84), ca. sea level. 30 April 2010. Juan Chablé-Santos. Verified by David Lazcano. Photo vouchers, Universidad Autónoma de Yucatán Herpetological Collection (FMVZ-UADY-CH 00001–000028). First record for Yucatán and a 239 km range extension NE of the nearest record at Champotón, Campeche (Lee 1996. The Amphibians and Reptiles of the Yucatán Peninsula. Comstock Publ. Assoc., Cornell University Press. New York. xii + 500 pp.). The turtle was live-captured by hand, photographed, and then released back into a freshwater spring located within a mangrove swamp system.

JUAN B. CHABLÉ-SANTOS (e-mail: jcsantos@uady.mx), **LIZBETH CHUMBA-SEGURA**, and **CELIA SELEM-SALAS**, Universidad Autónoma de Yucatán, Facultad de Medicina Veterinaria y Zootecnia, Campus de Ciencias Biológicas y Agropecuarias, Departamento de Zoología., Km 15.5, Carretera Mérida-Xmatkuil, Yucatán, México.

***GRAPTEMYS GEOGRAPHICA* (Northern Map Turtle)**. USA: OHIO: Van Wert Co.: Washington Township: Little Auglaize River at Township Road 199 bridge (40.858133°N, 84.3975750°W;

WGS84). 13 July 2010. Jeffrey G. Davis and Paul J. Krusling. Verified by John W. Ferner. Cincinnati Museum Center Herpetological Photodocumentation Collection (CMC HP 5259). New county record (Wynn and Moody 2006. Ohio Turtle, Lizard and Snake Atlas. Ohio Biol. Surv. Misc. Contr. No. 10. iv + 81 pp.). Adult and sub-adult basking on emergent log.

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MESOCLEMMYS GIBBA. BRAZIL: PARÁ: Municipality of Parauapebas: Alto dos Carajás (ca. 6.03°S, 50.29°W; datum SAD 69). 16 March 2009. D. F. M. Victor. Museu Nacional / UFRJ, Rio de Janeiro, RJ, Brazil (MNRJ 18105–18108). Verified by U. Caramaschi. This new record is located with the Amazonia biome. The species was previously recorded in Venezuela, Guiana, Suriname, French Guiana, Colombia, Ecuador, and Peru, and in a few localities in the states of Roraima, Amazonas, Acre, and Pará in Brazil (Bour and Pauler 1987. Mesogee 47:3–23; Mittermeier et al. 1978. Herpetologica 34:93–100; Schneider et al. 2009. Herpetol. Rev. 40:236). This new record extends the known geographic distribution of the species about 480 km S of Corcovado, Breves, Pará, the nearest previously reported population (Mittermeier et al., *op. cit.*).

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PSEUDEMYS CONCINNA CONCINNA (Eastern River Cooter). USA: ALABAMA: Crenshaw Co.: Patsaliga Creek at U.S. Hwy 331 N of Luverne (31.72469°N, 86.27813°W). 12 September 2010. Collected by Sean Graham, David W. Hunt, Lindsay V. Adams, and Nicholas C. Craig. Verified by Craig Guyer. AHAP-D 272–273. New county record (Mount 1975. The Reptiles and Amphibians of Alabama. Univ. Alabama Press, Tuscaloosa. 287 pp.). We thank Sean Graham for helping us collect the specimen on our field trip.

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TERRAPENE CAROLINA (Eastern Box Turtle). USA: GEORGIA: Baldwin Co.: approximately 0.5 km W of Oconee River (33.046236°N, 83.203739°W; WGS84). 01 September 2010. Houston C. Chandler and Dennis Parmley. Florida Museum of Natural History photo voucher (UF 162271). Verified by John B. Jensen. New county record, but within expected range (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). Single adult male found on forest floor of mixed pine-deciduous forest along Oconee River floodplain.

HOUSTON C. CHANDLER and **DENNIS PARMLEY** (e-mail: dennis.parmley@gcsu.edu), Department of Biological and Environmental Sciences, Georgia College and State University, Milledgeville, Georgia 31061, USA.

TERRAPENE CAROLINA (Eastern Box Turtle). USA: INDIANA: Dearborn Co.: Lubbe Nature Preserve (38.99411°N, 85.11732°W; NAD 83). 12 June 2010. Illinois Natural History Survey (INHS 2010n). Jennings Co.: Calli Nature Preserve (39.00311°N, 85.60933°W; NAD 83). 13 July 2010. (INHS 2010m). Both specimens collected by Sarabeth Klueh, Jason Mirtl, and Tim Shier, and verified by Chris Phillips. New county records (Minton 2001. Amphibians and Reptiles of Indiana. 2nd ed., revised. Indiana Academy of Science. vii + 404 pp.).

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TRACHEMYS SCRIPTA ELEGANS (Red-eared Slider). TURKS AND CAICOS ISLANDS: Providenciales: leeward highway near golf course (21.798°N, 72.160°W; WGS84), 10 m elev. 1 October 2009. Brian M. Riggs. Verified by Brian T. Miller. Color photo voucher (APSU 19021). First record from Turks and Caicos Islands (Henderson and Powell. 2009. Natural History of West Indian Reptiles and Amphibians. Univ. Florida Press Florida, Gainesville. xvii + 495 pp.; Schwartz and Henderson 1991. Amphibians and Reptiles of the West Indies: Descriptions, Distributions, and Natural History, Univ. Florida Press, Gainesville. xvi + 720 pp.).

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SQUAMATA — LIZARDS

ANOLIS EQUESTRIS (Knight Anole). Turks and Caicos Islands: Providenciales: Grace Bay (21.7874°N, 72.1965°W; WGS84), 7 m elev. 29 April 2009. Brian M. Riggs. Verified by A.C. Echternacht. Color photo vouchers (APSU 19025, 19026). First record from the Turks and Caicos Islands (Schwartz and Henderson, 1991, Amphibians and Reptiles of the West Indies: Descriptions, Distributions, and Natural History. Univ. Florida Press, Gainesville. xvi + 720 pp.; Henderson and Powell. 2009. Natural History of West Indian Reptiles and Amphibians. Univ. Florida Press, Gainesville. xvii + 495 pp.).

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ANOLIS (*NOROPS*) *SAGREI* (Brown Anole). USA: LOUISIANA: St. Tammany Parish: Slidell, Garden Spot Nursery, 770 Robert Boulevard (30.29543°N, 89.76388°W; WGS84). 11 August 2010. C. Thawley. Verified by Kenneth L. Krysko. AUM AHAP-D 297 (digital photograph). New parish record (Dundee and Rossman 1989. The Amphibians and Reptiles of Louisiana. Louisiana State University Press, Baton Rouge. 300 pp.). Adult, captured by hand. Observed in a plant nursery with other adults and juveniles, suggesting presence of breeding population. Corroborates earlier reports that nursery transport is an important vector for invasive *A. sagrei* in Louisiana and elsewhere (Steffen and Birkhead 2007. Herpetol. Rev. 38:353; Williams and Comeaux 2008. Herpetol Rev. 39:366). *Anolis sagrei* has been recorded from six other parishes across southern Louisiana (Meshaka et al. 2009. J. Kansas Herpetol. 32:13–16); the nearest locality is 47 km SW in Orleans Parish (Boundy et al. 2004. Herpetol. Rev. 35:194–196). This new record

is only 11 km W of the Mississippi state line, but 304 km W of the nearest easterly locality in Fort Walton Beach, Florida (Bishop 2005. Herpetol. Rev. 36:336).

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CELESTUS BIVITATUS (NCN). HONDURAS: OCOTEPEQUE: El Portillo de Cerro Negro (15.350114°N, 88.633603°W; WGS84), 2100 m elev. 19 August 2008. James R. McCranie and Leonardo Valdés Orellana. Verified by Steve W. Gotte. USNM 573885–86). First records for Ocotepeque. The closest reported locality in Honduras is from ca. 70 km ESE at 18.1 km NW of La Esperanza, Intibucá (see map in McCranie and Wilson 1996. Rev. Biol. Trop. 44:259–264) and ca. 100 km W in Guatemala from near Potrero Carillo, Jalapa (Campbell and Camarillo 1994. Herpetologica 50:193–209). The lizards were active midday in rock crevices on a steep embankment above a trail in cutover broadleaf cloud forest.

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ENYALIUS BIBRONII (NCN). BRAZIL: MINAS GERAIS: Taiobeiras: 15.867°S, 42.132°W, SAD 69). 6 August 2003. R. N. Feio. Museu de Zoologia João Moojen, Universidade Federal de Viçosa, Viçosa, Minas Gerais, Brazil (MZUFV 409). Joaíma, Fazenda Ramaiana: 16.708°S, 40.816°W. 26 April 2001. R. N. Feio. MZUFV 307. Cristália: 16.749°S, 42.834°W. 1 December 1989. MZUFV 251. Berilo: 16.951°S, 42.463°W. 9 January 1989. MZUFV 249. All verified by M. Trefaut Rodrigues. This species is known to occur in relictual forests of northeastern Brazil, from Ubajara (3.854°S, 40.921°W), state of Ceará to the north, southward to Montezuma, state of Minas Gerais (15.172°S, 42.4973°W) (Jackson 1978. Arq. Zool. 30[1]:1–79; Gogliath et al. 2010. Check List 6[4]:652–654). All new localities are farther south than the previous southernmost records, now updated to Berilo municipality, ca. 195 km straight-line S from Montezuma. Specimens reported here were collected inside forested areas in the Atlantic Forest (MZUFV 307) and ecotonal zones between the Atlantic Forest and the Cerrado morphoclimatic domains (MZUFV 251, 249, and 409).

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HEMIDACTYLUS BROOKII (NCN). HONDURAS: ISLA DEL CISNE: Isla Grande (17.4059°N, 83.9421°W; WGS 84), 12 m elev. 28 April, 5 May 2007, respectively. Jorge A. Ferrari. Verified by Konrad Klemmer. Forschungsinstitut Senckenberg (SMF 90456–57). First records for Isla del Cisne (Powell and Maxey 1990. Cat. Amer. Amphib. Rept. 493.1–493.2). SMF 90456 was caught at night on the walls of a house; SMF 90457 was encountered on a stack of old wood panels.

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HEMIDACTYLUS FLAVIVIRIDIS (Yellow-green House Gecko). INDIA: NAGALAND: Kohima (25.6685°N, 94.1056°E, 1432 m elev.). Arya Vidyapeeth Collage Zoological Museum (AVC A1047). 24 September 2010. Verified by S. Sengupta. First record for Nagaland. In India, distributed throughout northern India and westwards but not extending to east of Bengal (Smith 1935. The Fauna of British India, Ceylon and Burma, Including the Whole of the Indo-Chinese Region. Vol. III. Sauria. Taylor & Francis, London. xiii + 440 pp. + 1 pl.). Recent record from Manipur (Harit 2007. Cobra 1[4]:30–32) and Assam (Purkayastha and Das 2009. Herpetol. Rev. 40:451–452), with an assumption of anthropogenic introduction. Observed in a market place, again pointing to a probable human-mediated introduction. Not included in Dasgupta and Raha (2006. Reptilia. *In* J. R. B. Alfred [ed.], Fauna of Nagaland, pp. 433–460. State Fauna Series 12. Zoological Survey of India, Kolkata) indicates a recent introduction. Thanks are due to Kaushik Deuti, ZSI, Kolkata, and Arunabha Bhattacharjee, ZSI, Shillong, for literature support

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HEMIDACTYLUS FRENATUS (Common House Gecko). MÉXICO: BAJA CALIFORNIA SUR: Municipality of Mulegé: Santa Rosalía, Hotel El Morro (27.19580°N, 112.14994°W; WGS84), 15 m elev. 25 May 2010. J. B. Granados. Verified by Patricia Galina. Herpetological collection, Centro de Investigaciones Biológicas del Noroeste, La Paz, Baja California Sur, México (CIBNOR 1306–1307). First records for the municipality, extending the known range of this exotic species 197 km N of Loreto (Grismer 2002. Amphibians and Reptiles of Baja California: Including Its Pacific Islands and the Islands in the Sea of Cortez. Univ. of California Press, Berkeley, California. xiv + 399 pp.). Both lizards were collected at night on the hotel wall, along with observing more than 20 other adults, thus indicating a well-established population.

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HEMIDACTYLUS FRENATUS (Common House Gecko). HONDURAS: VALLE: Amapala, Isla del Tigre (13.2928°N, 87.6520°W; WGS84), 10 m elev. 14 July 2010. USNM 565827. Isla Exposición (13.3150°N, 87.6741°W; WGS84), 7 m elev. 15 July 2010. USNM 565828–29. Alexander Gutsche, James R. McCranie, and Leonardo Valdés Orellana. All verified by George Zug. First records for Valle. The closest known locality is ca. 50 km E at Choluteca, Choluteca (USNM 570129). USNM 565828–29 were collected midmorning under discarded roof tiles in beach area vegetation, and USNM 565827 was active at night on a hotel wall; many others were observed at both localities. Fieldwork of A. Gutsche was supported by the Adolf and Hildegard Isler Foundation.

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HEMIDACTYLUS FRENATUS (Common House Gecko). HONDURAS: ISLA DE LA BAHÍA: Isla de Roatán, Lawson Rock housing development, 6.6 km E of West End (16.33841°N, 86.55511°W; WGS84), 9 m elev. 12 January 2008. Sean M. Rovito. Verified by Theodore Papenfuss. MVZ 263826. First record for Isla de Roatán (McCranie et al. 2005. The Amphibians & Reptiles of the Bay Islands and Cayos Cochinos, Honduras. Bibliomania!, Salt Lake City, Utah. xiii + 210 pp.). The gecko was found at night along with *Phyllodactylus palmeus* and *Sphaerodactylus rosaurae* on a rock wall along the edge of the housing development.

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HEMIDACTYLUS PARVIMACULATUS (Sri Lankan House Gecko). THAILAND: Bangkok, Suan Luang District (13.711778°N, 100.603986°E, 3 m elev.). Two females (THNHM 17952, 31 January 2011; THNHM 17953, 1 February 2011). Found under cover of a pile of concrete blocks on ground in open lot of urban area. Bangkok, Panthum Wan District, Lumpini Park (13.729047°N, 100.538439°E, 3 m elev.). THNHM 17954, male. 17 February 2010. Under concrete ground cover. Bangkok, Khlong Toei District (13.727208°N, 100.574161°E, 3 m elev.). THNHM 17955, female. 28 February 2011. Found among hedges along walkway of Sukhumwit Road. All specimens collected by Jonathan Hakim. Verified by Tanya Chan-ard. Previously considered a subspecies of *H. brookii,* and separated on basis of molecular (Bauer et al. 2010. Mol. Phylogen. Evol. 57:343–352) and morphological (Rösler and Glaw 2010. Spixiana 33:139–160) evidence. *H. brookii* was recorded from Thailand (Bauer et al. 2002. Herpetol. Rev. 33:322). Separation from *H. brookii* made on basis of number of nasals and of postanal tubercles. THNHM 17953 is gravid, with one developed egg; this along with the number of localities, previous sightings of adults, subadults, and hatchlings, constitute evidence of established population at first location. Other individuals were seen within ca. 150 m radius of first location. Populations in Bangkok likely inadvertently introduced, probably entering via major sea cargo port/sea cargo storage facilities in Khlong Toei District, within 3 km, 4 km, and 2 km of the populations, respectively. First record for Thailand and Southeast Asia. Other recorded localities are in Sri Lanka, southern India (Bauer et al. 2010. Herpetol. J. 20:129:138), and an introduced population in Mascarene Islands, Seychelles (Bauer et al. 2010, *op. cit.*).

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HEMIDACTYLUS TURCICUS (Mediterranean Gecko). USA: CALIFORNIA: Inyo Co.: Death Valley National Park, Furnace Creek Ranch Hotel, 0.5 km W of Hwy 190 (36.45604°N, 116.87041°W; WGS83; elev. -56 m). 21 April 2007. Ian W. Murray. Verified by Neftali Camacho. Natural History Museum of Los Angeles Co. (LACM PC 1545–1546). New county record (Stebbins 2003. A Field Guide to Western Reptiles and Amphibians. 3rd ed. Houghton Mifflin, Boston, Massachusetts. 533 pp.). Between 2006 and 2008 multiple *H. turcicus* were seen nocturnally active on building walls here. The aforementioned specimen was found while actively foraging on the illuminated wall of a hotel building. In their detailed survey of Death Valley National Park amphibians and reptiles, Persons and Nowak (2006. Inventory of Amphibians and Reptiles at Death Valley National Park. Report to National Park Service. USGS Colorado Plateau Research Station, Flagstaff, Arizona) list *H. turcicus* as being a species of possible occurrence, and discuss a third party sighting of an unidentified gecko climbing a wall at Scotty's Castle, Death Valley as probably being a *Coleonyx variegatus* after repeated searches failed to document *H. turcicus* .

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IGUANA IGUANA (Common Green Iguana). TURKS AND CAICOS ISLANDS: Providenciales: east side of island, near Long Bay (21.780°N, 72.166°W; WGS84), 11 m elev. 1 October 2009. Brian M. Riggs. Verified by A. C. Echternacht. Color photo voucher (APSU 19019). First record for Turks and Caicos Islands. The closest reported localities in the West Indies are from the Cayman Islands and Puerto Rico (Schwartz and Henderson 1991. Amphibians and Reptiles of the West Indies: Descriptions, Distributions, and Natural History. University of Florida Press, Gainesville. xvi + 720 pp.)

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LEPIDOPHYMA MAYAE (Maya Night Lizard). HONDURAS: SANTA BÁRBARA: tributary of Río Listón (15.533336°N, 88.350144°W; WGS84), 405 m elev. 12 November 2008. James R. McCranie and Leonardo Valdés Orellana. Verified by Steve W. Gotte. USNM 573973. First record for Santa Bárbara and only the second record from Honduras; the other locality is from ca. 95 km SSW at San Isidro, Copán (McCranie 2004. Herpetol. Bull. 90:10–21). The lizard was inside a rotten log overhanging a stream surrounded by relatively undisturbed broadleaf forest.

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LIOLAEMUS XANTHOVIRIDIS (Rawson Lizard). ARGENTINA: CHUBUT: Escalante Department: Provincial Route 27, 33.1 km N junction with Provincial Route 25, 55.1 km N Nollman Bridge over Río Chico (44.93433°S, 68.02661°W; WGS84; elev. 381 m.). 4 November 2008. L. J. Avila and M. Nicola. Herpetological collection of Centro Nacional Patagónico, Puerto Madryn, Chubut, Argentina (LJAMM-CNP 11078–11080). Escalante Department: Provincial Route 27, 60 km N junction with Provincial Route 25 (44.72872°S, 67.90667°W; WGS84; elev. 349 m.). 10 February 2008. L. J. Avila, C. H. F. Pérez, M. F. Breitman, and N. Feltrin. LJAMM-CNP 10296–10303. All verified by C. H. F. Pérez. The type locality is 18 km SW from Dos Pozos (Chubut Province) and the species occurs on the xerophytic coast between northern Río Chubut

and southern Bahía Santa Cruz, extending inland to the Gran Laguna Salada (Mártires Department) basin through the flat embossment of Meseta de Montemayor and extends to about 44°S near Cabo Raso (Florentino Ameghino Department), on the Atlantic shore (Cei and Scolaro 1980. Herpetology 14[1]:37–43). Although the geographic range of this species is poorly known, present confirmed distribution includes Rawson, Gaiman, and Florentino Ameghino departments (Abdala 2007. Zootaxa 1538:1–84). Vouchered specimens from inland localities for this species are scarce. The present records are the first for Escalante Department, extending the known distribution about 235 airline km SW from the nearest vouchered record (FML 17033; Abdala 2007, *op. cit.*), and are the southwestern most localities for Chubut Province and for Argentina.

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MESOSCINCUS MANAGUAE (NCN). HONDURAS: VALLE: Isla Exposición (13.3150°N, 87.6741°W, WGS84), 7 m elev. 15 July 2010. Alexander Gutsche, James R. McCranie, and Leonardo Valdés Orellana. Verified by Steve W. Gotte. USNM 565830–31). First records for Valle. The closest known locality in Honduras is about 19 km E at Punta Ratón, Cortés (Cruz et al. 1979. Herpetol. Rev. 10:26). The lizards were collected midday in heavily disturbed deciduous forest; one was under a log and the other was sunning on a tree stump. Fieldwork of A. Gutsche was supported by the Adolf and Hildegard Isler Foundation.

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PLESTIODON FASCIATUS (Common Five-lined Skink). USA: ILLINOIS: Calhoun Co.: McCully Heritage Project, 70 m N of Crawford Creek Hollow Rd., 1.15 km W of Hwy 100 (39.282653°N; 90.622480°W; WGS84 datum). 11 April 2009. C. E. Montgomery and P. J. Muelleman. Verified by Chris Phillips. Illinois Natural History Survey collection (INHS 2009.08 photo voucher). First county record since 1954, re-establishing the presence of the species in Calhoun Co. (Philips et al. 1999. Field Guide to Amphibians and Reptiles of Illinois. Illinois Natural History Survey, Champagne, Illinois. 282 pp.). One individual was captured under a board, adjacent to an equipment shed. Permits issued by the Illinois Department of Natural Resources (NH08.5174; NH08.5173). We thank the McCully Heritage Project.

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SQUAMATA — SNAKES

AGKISTRODON CONTORTRIX (Copperhead). USA: MISSOURI: Grundy Co.: 200m S of NW 15th St., 1 km W of Hwy 190 (40.083292°N, 93.742302°W; WGS84). 24 May 2010. P. J. Muelleman. Verified by Chad Montgomery. Photo voucher deposited in the Dean E. Metter Memorial Collection, University of Missouri, Columbia (UMC 1843P). First county record. Partially fills a distributional gap in northern Missouri (Daniel and Edmond 2010. Atlas of Missouri Amphibians and Reptiles for 2009. <http://atlas.moherp.org/pubs/atlas09.pdf>). A 67.0 cm (SVL) adult male was captured, photographed, and released on a forested rocky hillside. A copulating pair was captured and released at this site on 29 April 2010 but no photo was taken. Collected under Missouri Department of Conservation wildlife collector's permit #14509.

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AGKISTRODON CONTORTRIX (Copperhead). USA: TENNESSEE: Robertson Co.: South of Shiloh Road, 0.2 mi SSW of junction TN 76E and Distillery Road (36.469600°N, 086.763233°W, NAD 83). 25 April 2009. Gregory T. Barrass. David H. Snyder Museum of Zoology, Austin Peay State University (APSU 18990). Verified by A. Floyd Scott. New county record (Scott and Redmond 2008. Atlas of Reptiles in Tennessee. The Center of Excellence for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available from http://apsu.edu/reptatlas/ [updated 1 February 2011, accessed 20 March 2011]). Found lethargic, beneath a log pile, approximately 23m N and 15m above Sulphur Fork Creek.

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CARPHOPHIS AMOENUS AMOENUS (Eastern Wormsnake). USA: GEORGIA: Dekalb Co.: Henderson Park: ~ 0.25 km from parking lot at end of Henderson Park Rd. (33.86667°N, 84.23106°W; WGS 84), elev. 306 m. 03 November 2010. Robert L. Hill. Verified by Joseph R. Mendelson. AUM AHAP-D 299–300. New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. Univ. of Georgia Press, Athens. 575 pp.); documented previously in all counties adjacent to Dekalb. Specimen found under log at junction of two foot paths ~52 m SW of the north end of Lake Erin.

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CONIOPHANES MELANOCEPHALUS (Black-headed Stripeless Snake). MÉXICO: MICHOACÁN: Municipality of Taretan: Hoyo del Aire (19.266667°N, 101.866667°W; WGS84), 887 m elev. 15 July 2006. Marco Antonio Domínguez de la Riva, Rubén Alonso Carbajal Márquez, and Eric Rivas Mercado. Verified by Luis Canseco-Márquez. Herpetological Collection, Universidad Autónoma de Aguascalientes (UAA-CV-0323). First record for Michoacán, extending its range ca. 268.54 km (air) northwest of closest known locality at Huajintlán, Morelos (Ponce-Campos and Smith 2001. Bull. Maryland Herpetol. Soc. 37:10–17). The snake was found at 2230 h crawling next to a stone wall near a small stream in subtropical dry forest.

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LAMPROPELTIS GETULA (Common Kingsnake). USA: MISSOURI: Adair Co.: approximately 200 m E of Big Creek

Conservation Area north parking lot on W. Michigan St. (40.184028°N, 92.618975°W). 6 April 2010. Anthony J. Wilmes. Verified by Richard Daniel. Voucher specimen deposited in the University of Missouri Columbia Museum (UMC 8750). A single sub-adult male DOR (64 cm SVL, 10 cm TL, 135 g). First vouchered specimen from Adair Co. (Daniel and Edmond. 2010. Atlas of Missouri Amphibians and Reptiles for 2009. <http://atlas.moherp.org/pubs/atlas09.pdf>). Collected under Missouri Department of Conservation wildlife collector's permit #14509 issued to PJM.

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LAMPROPELTIS MEXICANA (Mexican Kingsnake). MEXICO: NAYARIT: Mesa de Nayar (22.4283861°N, 104.8460944°W; WGS84), 2220 m elev. 23 August 2010. C. Rodriquez and C. Grünwald. Verified by Robert W. Bryson, Jr. University of Texas Arlington Digital Collection (UTADC 6833–6835, photo vouchers). New state records, extending the range 110 km S from southern Durango (42 mi. S of Cd. Durango [UCM 21061]; Gehlbach and McCoy 1965. Herpetologica 21:35–38), which represents the southernmost locality for the western portion of the Sierra Madre Occidental. The three snakes, phenotypically similar to populations of *L. m. "greeri"* from Durango, along with several shed skins, were located under rocks within pine-oak forest.

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MICRURUS LATICOLLARIS (Balsan Coralsnake). MEXICO: JALISCO: Municipality of Tecolotlán: 1 km N Tecolotlán (20.23289°N, 104.06000°W; WGS84) , 1300 m elev. 30 June 2009. Iván T. Ahumada-Carrillo. Verified by Eric N. Smith. UTADC 6253. First record for municipality and northernmost record for the species, extending the range ca. 85 km (airline) N from the closest known localities in southern Jalisco (Campbell and Lamar 2004. The Venomous Reptiles of the Western Hemisphere, Vol. I. Comstock Publ. Assoc., Cornell Univ. Press, Ithaca, New York. 475 pp.). The snake was found in tropical deciduous forest.

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NERODIA ERYTHROGASTER (Plain-bellied Watersnake). USA: ALABAMA: Crenshaw Co.: 8.69 km E of US 331 on CR 6 (31.6722°N, 86.18972°W; WGS84; elev. 97 m). 22 April 2006. Michael E. Welker. Verified by Craig Guyer and Robert Makowsky. University of Alabama Herpetological Collection (UAHC 15643). New county record and range extension (Mount 1975. The Reptiles and Amphibians of Alabama. University of Alabama Press, Tuscaloosa. 347 pp.). This DOR adult male specimen weighing 209 g helps fill a distributional gap in south-central Alabama. The closest documented locality for this species occurs southeast of this specimen in extreme northwestern Coffee Co.

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NERODIA ERYTHROGASTER FLAVIGASTER (Yellow-bellied Watersnake). USA: ALABAMA: Pickens Co.: 5.15 km N of CR 2 on CR 63 (33.13613°N, 87.92922°W; WGS84; elev. 68 m). 04 July 2006. Michael E. Welker. Verified by Craig Guyer and Robert Makowsky. University of Alabama Herpetological Collection (UAHC 15644). New county record and range extension (Mount 1975. The Reptiles and Amphibians of Alabama. University of Alabama Press, Tuscaloosa. 347 pp.). This DOR adult male specimen weighing 230 g helps fill a distributional gap in western Alabama along the Mississippi border. The closest records for this species are unpublished specimen records from the UAHC database that occur in Greene, Tuscaloosa, and Fayette counties (R. Makowsky, pers. comm.).

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OPHEODRYS AESTIVUS AESTIVUS (Northern Rough Greensnake). USA: ALABAMA: Hale Co.: 12.87 km E of CR 708 on NFR 708A (32.950889°N, 87.450389°W; WGS84; elev.115 m). 15 July 2006. Michael E. Welker and Scott Altnether. Verified by Craig Guyer and Robert Makowsky. University of Texas Arlington (UTA R 55651). New county record and range extension (Mount 1975. The Reptiles and Amphibians of Alabama. University of Alabama Press, Tuscaloosa. 347 pp.). The closest documented locality record to this DOR adult specimen occurs in adjacent Perry Co.

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PANTHEROPHIS GUTTATUS (Red Cornsnake). TURKS AND CAICOS ISLANDS: Grand Turk: south of Cockburn Town, near cruise ship terminal (21.430°N, 71.145°W; WGS84), 5 m elev. 1 October 2009. Brian M. Riggs. Verified by A. C. Echternacht. Color photo voucher (APSU 19020). First record from the Turks and Caicos Islands, but was also introduced to the Cayman Islands (Henderson and Powell 2009. Natural History of West Indian Reptiles and Amphibians. Univ. Florida Press, Gainesville. xvii + 495 pp.; Schwartz and Henderson 1991. Amphibians and Reptiles of the West Indies: Descriptions, Distributions, and Natural History, Univ. Florida Press, Gainesville. xvi + 720 pp.).

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PANTHEROPHIS GUTTATUS (Red Cornsnake). USA: TENNESSEE: Chester Co.: Rabbit Ranch Rd. ca 1.4 km W of Glendale Rd. 35.2817°N, 88.3340°W; WGS 84). 03 May 2009. Jonathan W. Stanley. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19064). First county record (Scott and Redmond 2008. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. http://www.apsu.edu/reptatlas [updated 13 October 2010; accessed 03 January 2011]).

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PITUOPHIS MELANOLEUCUS MELANOLEUCUS (Northern Pinesnake). USA: ALABAMA: Hale Co.: 2.7 km E of CR 53 on CR 50 (32.954944°N, 87.482222°W; WGS84; elev. 85 m). 08 July 2006. Michael E. Welker and Scott Altnether. Verified by Craig Guyer and Robert Makowsky. University of Texas Arlington (UTA R 55651). New county record and range extension (Mount 1975. The Reptiles and Amphibians of Alabama. University of Alabama Press, Tuscaloosa. 347 pp.). DOR adult female (474 g; 134.5 cm TL) extends the known range of this species 12 km SW from the closest documented locality (AUM 23790)and brings the known range of *Pituophis m. melanoleucus* to within one county of *P. m. lodingi*.

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REGINA GRAHAMII (Graham's Crayfish Snake). USA: MISSOURI: Grundy Co.: DOR, Hwy 6, 0.3 mi. W of Trenton (40.07013°N, 93.627236°W; WGS84). 24 May 2010. Chad E. Montgomery. Verified by Richard Daniel. University of Missouri-Columbia (UCM 1846P). First county record (Daniel and Edmond 2010. Atlas of Missouri Amphibians for 2009. <http://atlas.moherp.org/pubs/atlas09.pdf>). Single adult collected DOR surrounded by agricultural fields in the Thompson River floodplain. Collected under Missouri Department of Conservation wildlife collector's permit #14509 issued to PJM.

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RENA (= *LEPTOTYPHLOPS*) *DULCIS* (Texas Threadsnake). MÉXICO: HIDALGO: Municipality of Tasquillo: Dangu (20.50014°N, 99.25008°W; WGS84), 2230 m elev. 22 September 2008. Luis Alberto Trejo-Corona. Verified by Aurelio Ramírez-Bautista. Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo (CIB 2185). New municipality record that reaffirms the occurrence of *R. dulcis* in Hidalgo, whose taxonomic allocation within the state had been questioned by Lemos Espinal and Smith (2007. Anfibios y Reptiles del Estado de Coahuila, México. CONABIO, México, D.F. xii + 550 pp.) and Dixon and Vaughn (2003. Texas J. Sci. 55:3–24). Most recently, Ramírez-Bautista et al. (2010. Lista Anotada de los Anfibios y Reptiles del Estado de Hidalgo, México. Universidad Autónoma del Estado de Hidalgo, y CONABIO, México, D.F. x + 104 pp.), without taxonomic comment, listed the species as occurring in two municipalities within the state (Huautla [Tamoyón] and Metztitlán [Las Casita; Presa de Apanco]). All known records to date from Hidalgo indicate that *R. dulcis* occurs in xeric to moist lowland and highland habitats ranging in elevation from about 500 to 2300 m.

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RHAMPHOTYPHLOPS BRAMINUS (Brahminy Blindsnake). TURKS AND CAICOS ISLANDS: Grand Turk: south end of island (21.439°N, 71.137°W; WGS84), 5 m elev. 16 June 2009. Jewel Batchasingh. Verified by A. C. Echternacht. Color photo voucher (APSU 19022). First record from Turks and Caicos Islands (Henderson and Powell 2009. Natural History of West Indian Reptiles and Amphibians. Univ. Florida Press, Gainesville. xvii + 495 pp.; Schwartz and Henderson 1991. Amphibians and Reptiles of the West Indies: Descriptions, Distributions, and Natural History. Univ. Florida Press, Gainesville. xvi + 720 pp.).

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RHINOCHEILUS LECONTEI (Long-nosed Snake). MÉXICO: AGUASCALIENTES: Municipality of Calvillo: 930 m NE La Rinconada (21.795083°N, 102.790889°W; WGS84), 1587 m elev. 5 July 2010. Rubén Alonso Carbajal Márquez, Zaira Yaneth González Saucedo, and José A. de Jesús González Barajas. Verified by Luis Canseco Márquez. Herpetological Collection, Universidad Autónoma de Aguascalientes (UAA-CV 0321). First official record for Aguascalientes, extending the known range ca. 8.3 km NE from the closest known locality in southwestern Zacatecas; its occurrence in Aguascalientes was expected by both Frost and Aird (1978. Herpetol. Rev. 9:62) and McCranie and Wilson (2001. Cour. Forsch.-Inst. Senckenberg 230:1–57). The specimen was found in an area covered by tropical deciduous forest.

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SENTICOLIS TRIASPIS (Green Rat Snake). MÉXICO: VERACRUZ: Municipality of Córdoba: Finca Biozoo (18.8837°N, 96.9455°W, WGS84), 875 m elev. 12 November 2004. Edith Batista. Verified by Julio Lemos Espinal. Colección de Anfibios y Reptiles, Facultad de Ciencias Biologicas y Agropecuarias, Universidad Veracruzana (HFBUV-0473). First record for the Municipality of Córdoba. The closest reported localities are in Veracruz from near San Andrés Tuxtla, ca. 190.5 km to the east (Pérez-Higareda and Smith 1991. Publ. Espec. 7, Instit. Biol. UNAM) and Alto Lucero, 84.6 km to the north (Colección Nacional de Anfibios y Reptiles de México [CNAR 3414-A]). The snake was found in a coffee plantation.

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SISTRURUS CATENATUS (Massasauga). USA: NEW MEXICO: De Baca Co.: 5.31 rd km S jct. NM 294 and Roosevelt Co. Rd 3

on Gunsmoke Rd (34.1670151°N, 103.9969887°W, NAD 83; elev. 1295 m). 11 May 2010. M. T. Hill. Verified by J. T. Giermakowski. Museum of Southwestern Biology (MSB 78054). New county record (Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. University of New Mexico Press, Albuquerque. 431 pp.). The closest known specimen of *S. catenatus* (MSB 74669) is from Chaves Co., 31.74 km S of the new locality.

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***TANTILLITA LINTONI* (Linton's Dwarf Short-tailed Snake, Culebrita Enana de Linton)**. HONDURAS: ISLAS DE LA BAHÍA: Isla de Utila, Utila, Iguana Station (16.10056°N, 86.885833°W; WGS84), elev. 40 m. 24 February 2010. Andrea Martinez. Verified by James R. McCranie. UNAH 5571. First record for Isla de Utila, Islas de la Bahía (McCranie et al. 2006. Amphibians and Reptiles of the Bay Islands and Cayos Cochinos, Honduras. Bibliomania, Salt Lake City, Utah. xii + 210 pp.). The snake was found under a rock.

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***THAMNOPHIS MELANOGASTER* (Mexican Black-bellied Gartersnake)**. MÉXICO: MORELOS: Municipality of Huitzilac: Parque Nacional Lagunas de Zempoala (19.051139°N, 99.31325°W; WGS84), 2832 m elev. 24 September 2010. Adriana J. González Hernández. Verified by Víctor Hugo Reynoso. Colección Nacional de Anfibios y Reptiles, Instituto de Biología, UNAM (CNAR-IBH 24541). First record from Morelos, extending its known range 30 km S of Tlalpan, Distrito Federal, and an upward elevation extension of 287 m (Ramírez-Bautista et al. 2009. Herpetofauna del Valle de México. UAEH-CONABIO, México, D.F. xxiv + 213 pp.; Rossman et al. 1996. The Garter Snakes: Evolution and Ecology. Univ. Oklahoma Press, Norman, Oklahoma. xx + 332 pp.). The snake was basking on tree branches adjacent to a lagoon.

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***THAMNOPHIS SIRTALIS* (Common Gartersnake)**. USA: MICHIGAN: Charlevoix Co.: South end of Hog Island, Eastern Lake Michigan Archipelago (45.76667°N, 85.383333°W; WGS84). 24 May 2008. James C. Gillingham. Verified by Fred Janzen. Iowa State University Research Collection (ISUA 201102; digital image). New record for Hog Island (Bowen and Gillingham 2004. Michigan Acad. 35:213–223).

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Noteworthy Records of Amphibians from Western Panama

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In view of its relatively small size, Panama supports one of the most diverse amphibian faunas in Central America (Jaramillo et al. 2010; Ibáñez et al. 2001; Myers and Duellman 1982). The global amphibian crisis has lead to serious population declines throughout the world, with almost all amphibian families being affected (Stuart 2004). This has been especially the case in Panama (Jaramillo et al. 2010). The major threat to amphibians is habitat loss as measured by high deforestation rates in all of Central America and other hotspots of biodiversity (Wilson and Johnson 2010; Wilson and Townsend 2010; Brooks et al. 2002). Another cause for concern is the chytrid fungal pathogen, *Batrachochytrium dendrobatidis*, which has caused mass mortalities and amphibian diversity loss in most highland amphibian populations in western Panama (Brem and Lips 2008; Crawford et al. 2010a; Lips 1999; Lips et al. 2006). However, recent amphibian species descriptions (e.g., Bolaños and Wake 2009; Crawford et al. 2010b; Köhler et al. 2007; Mendelson et al. 2008; Mendelson and Mulcahy 2010; Ryan et al. 2010; Wake et al. 2005, 2007) and continual reports on range extensions (e.g., Köhler et al. 2008) demonstrate that the amphibian inventory for Panama is still far from complete. A checklist and bibliography on the Panamanian

herpetofauna prepared by Auth (1994) listed 170 species of amphibians. Later, Young et al. (1999) published a list that contained 171 species of amphibians and additional information on provincial records and conservation status. Ibañez et al. (2001) updated the list to 176 species, and most recently Jaramillo et al. (2010) registered 199 species from Panama, including two introduced forms.

During field work from May through August 2008, we visited different sites in the Cordillera Central of western Panama in the provinces of Chiriquí, Bocas del Toro, Veraguas and the Comarca Ngöbe-Buglé, an indigenous, autonomous territory that was established in 1997 (Fig. 1). During that period, we collected 233 specimens of amphibians representing 51 species. The purpose of this paper is to report noteworthy findings among the collected material. For frogs, we present a first country record and four distributional range extensions, all of which represent first province records. We also provide new morphological and ecological information on two rarely observed salamanders.

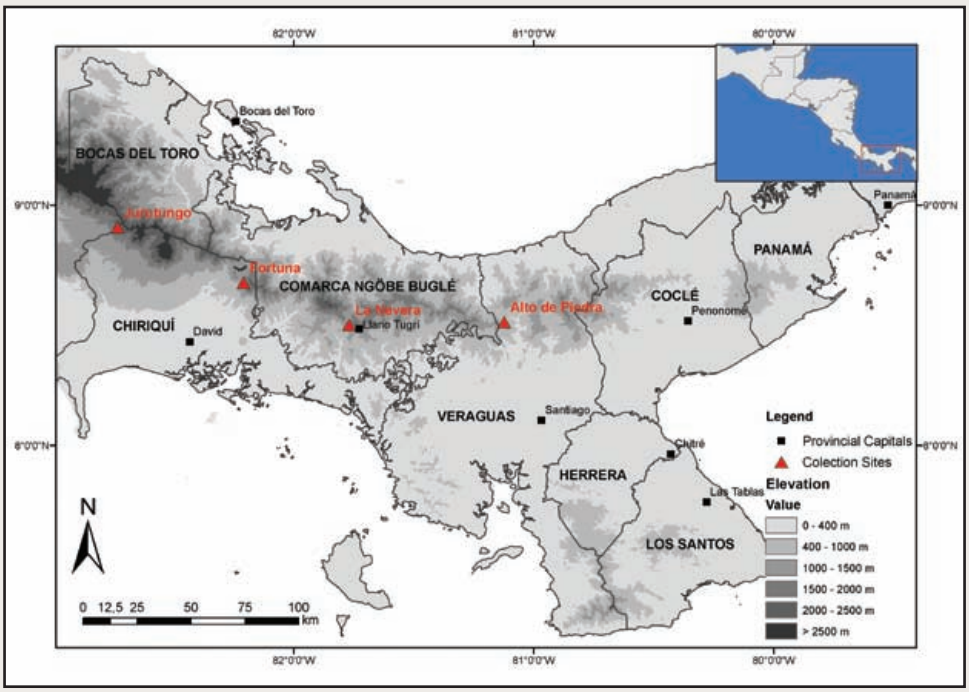


FIG. 1 Map of collection localities in western Panama denoted by red triangles, from west to east: Jurutungo, Chiriquí; Reserva Forestal La Fortuna, Chiriquí; La Nevera, Comarca Ngöbe-Buglé; Alto de Piedra, Veraguas.

All vouchers were verified by Javier Sunyer. Locality and elevational data were recorded using a GPS receiver with an integrated barometric altimeter, Garmin Etrex Summit; map datum used was WGS84. The map (Fig. 1) was created using ArcMap 10 and the shapefiles provided by the Smithonian map server at http://mapserver.stri.si.edu/. All voucher specimens are deposited in the collection of Senckenberg Forschungsinstitut und Naturmuseum (SMF). Common names were generated consulting the online database of Frost (2010), except for *Oedipina fortunensis*, which was named by translating the scientific name.

ANURA — FROGS

Hylidae

AGALYCHNIS ANNAE (Blue-Sided Leaf Frog) (Fig. 2). COMARCA NGÖBE-BUGLÉ: ca. 6.3 km W of La Nevera and 10.5 km NNW of Hato Chamí (8.5353°N, 81.8081°W), 1600 m elev. 10 May 2008. Andreas Hertz and Gunther Köhler. SMF 89791. First record for Panama, extending the known distribution ca. 230 km SE from the nearest collection site at Moravia de Chirripó, Costa Rica (Duellman 2001, who also assumed it would be found on the Caribbean slopes of western Panama). *Agalychnis annae* has suffered serious population declines and has disappeared from most of its known geographic range; it is now listed as endangered by the IUCN (Pounds et al. 2008). The only population in Costa Rica that seems to persist is found around San José (Pounds et al. 2008), thus this new record from Panama should play an important role in shaping future conservation actions.

HYLOSCIRTUS COLYMBA (La Loma Treefrog) (Fig. 3). VERAGUAS: Alto de Piedra, ca. 4 km W of Santa Fé (8.5129°N, 81.1220°W), 880 m elev. 11 July 2008. Leonard Stadler and Nadim Hamad. SMF 89794. First record for Veraguas that fills the gap between the species' nearest collection sites; Reserva Forestal Fortuna, Chiriquí; 120 km W (Lips 1999) and El Copé, Coclé; ca. 45 km E (Crawford et al. 2010). However, at both of those neighboring sites it has become extremely rare after serious declines and is listed as critically endangered by IUCN (Solis et al. 2008). Martínez and Rodríguez (1992) and Martínez et al. (1994) were the first to present inventories of the herpetofauna of the Santa Fé, Veraguas region, and mentioned finding various unidentified hylid frogs. We cannot rule out that they discovered *H. colymba* around Santa Fé, but that has become an irresolvable point because the voucher specimens were lost before they could be identified (V. Martínez, pers. com.).

Craugastoridae

CRAUGASTOR MONNICHORUM (Dunn's Robber Frog) (Fig. 4). COMARCA NGÖBE-BUGLÉ: La Nevera, Caribbean slopes, ca. 6 km NNW of Hato Chamí (8.4953°N, 81.7672°W), 1800 m elev. 14 August 2008. Andreas Hertz and Sebastian Lotzkat. SMF 89801.

COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND



PHOTO BY AH

FIG. 2. *Agalychnis annae*, La Nevera, Comarca Ngöbe-Buglé.



PHOTO BY AH

FIG. 3. *Hyloscirtus colymba*, Alto de Piedra, Veraguas.



PHOTO BY SL

FIG. 4. *Craugastor monnichorum*, La Nevera, Comarca Ngöbe-Buglé.



PHOTO BY AH

FIG. 5. *Hyalinobatrachium talamancae*, La Nevera, Comarca Ngöbe-Buglé.

First record for Comarca Ngöbe-Buglé, extending the known distribution in Panama, ca. 60 km E of the formerly easternmost collecting site at Quebrada Frank, Reserva Forestal Fortuna (Tejera and Dupuy 2003). The large female was situated ca. 30 cm above ground on a mossy liana situated in elfin woodland on the crest of a mountain ridge.

Centrolenidae

***HYALINOBATRACHIUM TALAMANCAE* (Talamanca Glass Frog)** (Fig. 5). COMARCA NGÖBE-BUGLÉ: La Nevera, Caribbean slope, ca. 6 km NNW of Hato Chamí, (8.4987°N, 81.1195°W), 1550–1600 m elev. 16 August 2008. Andreas Hertz and Sebastian Lotzkat. SMF 89798–89800. First record for Comarca Ngöbe-Buglé that fills the gap between the species' nearest collection sites at Reserva Forestal Fortuna, Chiriquí; ca. 53 km W (Kubicki et al. 2008) and Parque Nacional Altos de Campana, Panama province; ca. 195 km SE (Ibañez et al. 1996). Furthermore, this record exceeds the known elevational limit known for this species by about 484 m (Taylor 1952).

Hyalinobatrachium talamancae is often confused with *H. vireovittatum*, as both show a characteristic green mid-dorsal line and are similar in respect to their morphology, ecology, and mating calls (Kubicki 2007). However, in the latter species the mid-dorsal green line is bordered by two clearly distinguishable yellow stripes that are lacking on specimens from La Nevera. Kubicki (2007) reviewed specimens referred to as *H. vireovittatum* in the collection of the Círculo Herpetológico de Panama in 2004 and considered all to be *H. talamancae*. Moreover, in 2005 he found a population in El Valle, Coclé, that apparently is the only record of *H. vireovittatum* currently known from Panama. Nevertheless, the possibility exists that *H. vireovittatum* is a synonym of *H. talamancae* (Kubicki 2007).

Strabomantidae

***PRISTIMANTIS MORO* (La Hondura Robber Frog)** (Fig. 6). VERAGUAS: Alto de Piedra, ca. 4 km W of Santa Fé (8.5142°N, 81.1195°W), 1060 m elev. 1 August 2008. Leonard Stadler and Nadim Hamad. SMF 89796. First record for Veraguas that fills the gap between the two nearest published localities, about 360 km NW to La Hondura, San José, Costa Rica and ca.110 km SE to Valle de Antón, Coclé, Panama (Crawford et al. 2010). This

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PHOTO BY NH

FIG. 6. *Pristimantis moro,* amplectant pair,Veraguas.



PHOTO BY AH

FIG. 7. *Bolitoglossa sombra,* Jurutungo, Chiriquí.



PHOTO BY SL

FIG. 8. *Oedipina fortunensis* with automized tail, La Fortuna, Chiriquí.

rarely observed species uses epiphytic bromeliads during daylight hours (Savage 1965, 2002). We found an amplecting pair at night on a leaf about 1.2 m above the ground in premontane wet forest. Unfortunately, the female escaped the next day, but left nine eggs inside the collection bag.

CAUDATA — SALAMANDERS

Plethodontidae

***BOLITOGLOSSA SOMBRA* (Shadowy Web-footed Salamander)** (Fig. 7). CHIRIQUÍ: Jurutungo, on the Pacific slopes of Cerro Pando, near the Costa Rican border (8.9075°N, 82.7336°W), 1850–1965 m elev. 12–13 July 2008. Andreas Hertz and Sebastian Lotzkat. SMF 89792–89793. The locality is within the known range of this recently described species (Hanken et al. 2005), but because of its rarity in collections, we here add information on morphological characteristics and ecology.

On two rainy nights, we found several of these large black salamanders, but only collected one large male and one large female. Some were found in pristine lower montane wet forest while they were walking on tree trunks; a single juvenile was inside a rotten log on the forest floor; and others were located inside a cow paddock while positioned on top of rocks. When disturbed, the salamanders were able to move astonishingly fast. Most morphometric data and tooth counts are within the documented range of variation of this species (Hanken et al. 2005). However, the two secured specimens represent the largest individuals so far reported for this species; SMF 89792, a male, has a standard length of 70 mm and SMF 89793, a female, has a standard length of 84.5 mm. The largest individuals reported before were 61.5 mm (males) and 82.7 mm (females), respectively.

***OEDIPINA FORTUNENSIS* (Fortuna Worm Salamander)** (Fig. 8). CHIRIQUÍ: Reserva Forestal Fortuna, near Río Hornito (8.677°N, 82.209°W), 1300 m elev. 18 June 2008. Andreas Hertz and Sebastian Lotzkat. SMF 89795. Our record is only the second known individual of this species reported since its description by Köhler et al. (2007), and the site is located near the type locality. The male specimen was found near the riverbank of the Río Hornito on a trail through a former citrus plantation. The salamander was on the ground and had shed its tail, probably due to our disruptive pursuit, but the extremity was retrieved for inclusion with morphological comparison to the holotype. Because of the lack of comparative statistics with the male holotype, we herein present morphometric data and tooth counts from the additional specimen; holotype values are in parentheses and abbreviations for standard measurements are those of Köhler et al. (2007): SVL 32.5 mm (33.5 mm); TL 39.0 mm, incomplete (46.5 mm); SVL/TL 0.80 (0.72); HL 5.4 mm (6.5 mm); SVL/HL 6.0 (5.2); HW 4.1 mm (3.9 mm); SVL/HW 7.9 (8.6); HHL 5.6 mm (4.3 mm); SVL/HHL 5.8 (7.8); HAW 0.9 mm (1.2 mm); SVL/HAW 36.1 (27.9); HFW 1.2 mm (1.7 mm); SVL/HFW 27.1 (19.7). A single large premaxillary tooth is distinctly offset, almost piercing the lip (same in holotype); maxillary teeth 16 (right) - 18 (left) (13-14); vomerine teeth 7 (right) - 6 (left) (7-7). The above values reasonably favor the contention that SMF 89795 is conspecific with the holotype of *O. fortunensis*.

Based on information presented by Brame (1968), the high total number of maxillary teeth (27–34) distinguishes *O. fortunensis* from other members of the subgenus *Oedopinola* in lower Central America, except *O. complex* (16–40 in males). Generally

however, adult males of *O. complex* are larger (SVL: 36.6–39 mm versus 32.5–33.5 mm in *O. fortunensis*), have a slightly broader head (SVL/HW: 8.5–9.6 versus 7.9–8.6), and more vomerine teeth (17–28 versus 13–14). Nevertheless, since both species overlap in some morphometric characters, tooth counts, geographical range, and that *O. fortunensis* presently contains only two specimens for comparison, it cannot be ruled out that *O. fortunensis* is a junior synonym of *O. complex*.

Coloration in life of SMF 89795, interpreted from Smithe (1975, 1981) (color code numbers in parentheses), was recorded as follows: Dorsal ground color of body, head, and tail Russet (34) with Warm Buff (118) mottling; dorsal surface of head and upper legs with Buff (124) blotches; lower legs and lateral surfaces of body and head Fuscous (21), merging into Sepia (119) ventrally; venter with dirty white mottling.

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Additional Distributional Records of Amphibians and Reptiles in Georgia, USA

Since the publication of *Amphibians and Reptiles of Georgia* (Jensen et al. 2008), numerous records of amphibians and reptiles from counties not represented in the book's species-distribution maps have been submitted to the Georgia Department of Natural Resources. These new records, as well as recent records obtained by the authors, are provided herein. Unless otherwise indicated, geo-coordinates are based on datum NAD 83. Vouchers indicated as "AHAP-D" are digital photos housed in the Auburn University Herpetological collections. Identifications were verified by Lance D. McBrayer unless indicated otherwise.

CAUDATA — SALAMANDERS

***AMBYSTOMA MACULATUM* (Spotted Salamander).** APPLING CO.: 4.5 km NW of Davis on Moody Forest Natural Area Preserve (31.930833°N, 82.283333°W). 14 March 2009. D. Stevenson and E.

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Grunwald. GSU 2252. First museum voucher specimen for county. Adult found under debris in Altamaha River floodplain bottomland forest, further demonstrating that this species extends its range into the lower Coastal Plain of southeastern Georgia along this prominent hardwood corridor adjacent to the river. Coffee Co.: Flat Tub Wildlife Management Area, 10.2 km NE of Relee (31.802465°N, 82.837232°W). 07 January 2008. D. Stevenson. GSU 2249. Adult under log in hardwood forest along Ocmulgee River. First museum record for county. MONTGOMERY Co.: State Hwy. 280/30 at Oconee River, 1.3 km W of Mt. Vernon city limits (32.192261°N, 82.625411°W). 23 March 2009. D. Stevenson. GSU 2250. One of five specimens found beneath logs in hardwood forest along Oconee River. Treutlen Co.: State Hwy. 46 at Oconee River, ca. 4.0 km SSW of Barnhill (32.301508°N, 82.694247°W). 28 March 2009. D. Stevenson. GSU 2251.One of three specimens found beneath logs in hardwood forest along Oconee River.

***AMBYSTOMA OPACUM* (Marbled Salamander).** Montgomery Co.: State Hwy. 280/30 at Oconee River, 1.3 km W of Mt. Vernon city limits (32.195089°N, 82.628717°W). 23 March 2009. D. Stevenson. GSU 2253. Adult found beneath log in hardwood forest along Oconee River. Treutlen Co.: State Hwy. 46 at Oconee River, ca. 4.0 km SSW of Barnhill (32.301508°N, 82.694247°W). 28 March 2009. D. Stevenson. GSU 2254. Adult found beneath log in hardwood forest along Oconee River. Wheeler Co.: State Hwy. 46 at Oconee River, ca. 5.5 km SSW of Barnhill (32.295222°N, 82.699933°W). 28 March 2009. D. Stevenson. GSU 2255. Adult found beneath log in hardwood forest along Oconee River.

***AMBYSTOMA TIGRINUM* (Tiger Salamander).** Thomas Co.: AOR Whitney Camp Road 3.2 km S of Boston (30.762314°N, 83.785417°W). 21 December 2006. J. Young. Verified by Kenneth L. Krysko. UF 156845. Turner Co.: South side of State Hwy.107, 10.0 km E of jct. of State Hwys.107/112 (31.720478°N, 83.480383°W). 06 March 2009. D. Stevenson. GSU 2256. Larva dip-netted from borrow pit wetland adjacent to State Hwy. 107.

***AMPHIUMA MEANS* (Two-toed Amphiuma).** Wheeler Co.: 2.3 km SW of Jordan, seepage area in xeric sandhills E of Alligator Creek. (32.018342°N, 82.683306°W). 06 May 2009. D. Stevenson. GSU 2257.

***EURYCEA GUTTOLINEATA* (Three-lined Salamander).** Candler Co.: Canoochee River E of Stillmore on Stillmore-Metter Road (32.425661°N, 82.160944°W). 08 July 1976. J. Cadle. Verified by Ned Gilmore. ANSP 30811. Treutlen Co.: 6.6 km SW of Nunez, State Hwy. 297 at Ohoopee River (32.439522°N, 82.384017°W). 26 August 2009. D. Stevenson. GSU 2277. Two adults found in hardwood swamp adjacent to Ohoopee River. Twiggs Co.: Stone Creek access trail at Bond Swamp National Wildlife Refuge (32.739264°N, 83.567042°W). 27 March 2008. J. Jensen. Verified by Elizabeth McGhee. GMNH 50103. Several individuals found under logs in floodplain forest.

***EURYCEA LONGICAUDA* (Long-tailed Salamander).** Catoosa Co.: Chickamauga and Chattanooga National Military Park (34.91267°N, 85.23374°W). 26 May 2009. S. Graham and J. Jensen. Verified by Craig Guyer. AHAP-D 229. Two individuals found under logs adjacent to small stream.

***EURYCEA QUADRIDIGITATA* (Dwarf Salamander).** MONTGOMERY Co.: US Hwy. 280/State Hwy. 30 at Oconee River, 1.3 km W of Mt. Vernon city limits (32.192261°N, 82.625411°W). 23 March 2009. D. Stevenson. GSU 2279. Adult found beneath log in hardwood forest along Oconee River.

***GYRINOPHILUS PORPHYRITICUS* (Spring Salamander).** Polk Co.: Thompson Creek Gorge (33.956592°N, 85.024212°W). 03 April 2008. M. Elliott and C. Camp. Verified by Elizabeth McGhee. GMNH 50101.

***NOTOPHTHALMUS VIRIDESCENS* (Eastern Newt).** Lamar Co.: St. George's Episcopal School Campus, Milner (33.117475°N, 84.198389°W). 16 May 2007. C. Muise and T. Muise. Verified by Kenneth L. Krysko. UF 156846. MONTGOMERY Co.: US Hwy. 280/State Hwy. 30 at Oconee River, 1.3 km W of Mt. Vernon city limits (32.195089°N, 82.628717°W). 23 March 2009. D. Stevenson. GSU 2295. Adult dipnetted from pool in hardwood forest along Oconee River. Rockdale Co.: Panola Mountain State Park (33.634103°N, 84.173528°W). 12 June 2009. H. Davis. Verified by Kenneth L. Krysko. UF 156847. Treutlen Co.: State Hwy. 46 at Oconee River, ca. 4.0 km SSW of Barnhill (32.301508°N, 82.694247°W). 28 March 2009. D. Stevenson. GSU 2293. Adult dipnetted from pool in hardwood forest along Oconee River. Wayne Co.: 4.5 km NNE of Mt. Pleasant, Sansavilla Wildlife Management Area (31.456181°N, 81.656503°W). Beaver (*Castor canadensis*) wetland adjacent to NW side of Howard Road. 15 March 2009. D. Stevenson and B. Willis-Stevenson. GSU 2294.

***PSEUDOTRITON RUBER* (Red Salamander).** Telfair Co.: 1.1 km N of State Hwy. 117 at Fishing Creek (31.899402°N, 82.758076°W). 13 June 2009. D. Stevenson, W. Dopson and F. Snow. GSU 2304. Adult found in seepage area on N side of Fishing Creek.

***SIREN INTERMEDIA* (Lesser Siren).** Bacon Co.: State Hwy. 32 at Hurricane Creek, 2.0 km E of Alma (31.540425°N, 82.445125°W). 19 June 2009. D. Stevenson. GSU 2308. Adult from seepage wetland on E side of Hurricane Creek. Telfair Co.: 3.3 km ENE of Jacksonville, State Hwy. 117 at Lampkin Branch (31.816883°N, 82.944207°W). 13 July 2009. D. Stevenson. GSU 2307. Juvenile found in seepage area.

***SIREN LACERTINA* (Greater Siren).** Coffee Co.: Bay Meadows subdivision 7.7 km SW of Douglas (31.468833°N, 82.920620°W). 10 April 2009. R. Preston, Jr. GSU 2309. Found in ditch.

***URSPELERPES BRUCEI* (Patch-nosed Salamander).** Habersham Co.: Just W of Stephens county line in a tributary of Panther Creek (exact locality withheld due to rarity of species and vulnerability to over-collection). 13 August 2009. C. Camp. Verified by Elizabeth McGhee. GMNH 50121. Represents only the second county from which this recently described species has been found in Georgia.

ANURA — FROGS

***ACRIS CREPITANS* (Northern Cricket Frog).** Telfair Co.: Mopani Preserve at Ocmulgee River (31.846856°N, 82.792507°W). 28 September 2009. D. Stevenson, J. Bauder, and W. Taylor. GSU 2244. Toombs Co.: 10.7 km SE of Uvalda; Gray's Landing at Altamaha

River (31.966389°N, 82.428889°W). 10 July 2009. D. Stevenson. GSU 2243. This record further demonstrates that this species extends its range into the lower Coastal Plain of southeastern Georgia along a prominent bottomland hardwood corridor adjacent to the Altamaha River.

ANAXYRUS AMERICANUS (American Toad). Talbot Co.: AOR River Road in Big Lazar Creek Wildlife Management Area, 100 m from confluence of Lazar Creek and Flint River (32.809287°N, 84.401516°W; WGS 84). 11 June 2009. S. Graham. Verified by Craig Guyer. AHAP-D 219.

GASTROPHRYNE CAROLINENSIS (Eastern Narrow-mouthed Toad). Lamar Co.: Private residence on Eady Creek Road, Barnesville (33.126083°N, 84.138528°W). 28 August 2008. C. Muise and T. Muise. Verified by Kenneth L. Krysko. UF 156848.

HYLA CINEREA (Green Treefrog). Catoosa Co.: Small spring pond along Graysville Road (34.97809°N, 85.14338°W). 26 May 2009. J. Jensen and S. Graham. Verified by Craig Guyer. AUM 34834. Forsyth Co.: Private residence on Lillie Lane, Cumming (34.292669°N, 84.150822°W). 26 May 2009. J. Flynn. Verified by Kenneth L. Krysko. UF 156849. Murray Co.: Marsh on east side of Fox Bridge Road ca. 3.0 km N of State Hwy 225, near Holley (34.677108°N, 84.838894°W). 18 September 2007. J. Spence. Verified by Elizabeth McGhee. GMNH 50094. This species is apparently expanding its range northward, and all three county records likely represent new occurrences rather than cryptic, long-established populations.

LITHOBATES CLAMITANS (Green Frog). Catoosa Co.: Small spring pond along Graysville Road. (34.97809°N, 85.14338°W). 26 May 2009. J. Jensen and S. Graham. Verified by Craig Guyer. AUM 34835.

LITHOBATES HECKSCHERI (River Frog). McIntosh Co.: 11.1 km SW of Townsend; boat ramp at Old Fort Barrington Landing (31.470588°N, 81.605802°W). 02 August 2009. D. Stevenson and B. Willis-Stevenson. GSU 2286. Larvae found in backwater river slough.

LITHOBATES SPHENOCEPHALUS (Southern Leopard Frog). Catoosa Co.: Floodplain of Chickamauga Creek. (34.95374°N, 85.12226°W). 26 May 2009. S. Graham and J. Jensen. Verified by Craig Guyer. AHAP-D 224. Lamar Co.: St. George's Episcopal School Campus, Milner (33.117475°N, 84.198389°W). Spring 2008. C. Muise and T. Muise. Verified by Kenneth L. Krysko. UF 156850. MONTGOMERY Co.: US Hwy. 280/State Hwy. 30 at Oconee River, 1.3 km W of Mt. Vernon city limits (32.195089°N, 82.628717°W). 23 March 2009. D. Stevenson. GSU 2287.

PSEUDACRIS ORNATA (Ornate Chorus Frog). Telfair Co.: 15.8 km SW of Lumber City on State Hwy. 117 (31.861181°N, 82.8121°W). 01 March 2009. D. Stevenson and C. Jenkins. GSU 2300. Adult male captured while calling from roadside ditch. Turner Co.: South side of State Hwy.107, 10.0 km E of jct. State Hwys.107/112 (31.720478°N, 83.480383°W). 09 April 2009. D. Stevenson. GSU 2301. Larvae dip-netted from borrow pit wetland adjacent to State Hwy. 107.

SCAPHIOPUS HOLBROOKII (Eastern Spadefoot). Wheeler Co.: 3.7 air km N of Lumber City; xeric sandhills on E side of Little Ocmulgee River and N of State Hwy. 19 (31.96585°N, 82.684811°W). 02 May 2009. D. Stevenson and M. Wallace. GSU 2305. Larvae found in ephemeral, depressional wetland.

TESTUDINES — TURTLES

APALONE FEROX (Florida Softshell). Brantley Co.: DOR 3.5 km NNE Hoboken on Raybon Rock Road (31.211078°N, 82.119353°W). 12 September 2009. D. Stevenson. GSU 2259. TOOMBS Co.: Cedar Crossing Road, 0.2 km W of US Hwy. 1/State Hwy. 15/4 (31.970331°N, 82.360319°W). 06 May 2009. D. Stevenson. GSU 2261.

APALONE SPINIFERA (Spiny Softshell). Camden Co.: Satilla River opposite Big Oak (31.061694°N, 81.930829°W). 04 September 2009. D. Stevenson and G. Rogers. GSU 2268. Evans Co.: 3.3 km SW of Groveland; Canoochee River S of State Hwy. 280 (32.131444°N, 81.777190°W). 06 September 2009. D. Stevenson and B. Willis-Stevenson. GSU 2262. Jeff Davis Co.: 12.3 km NE of Hazlehurst; Altamaha River at Bullard Creek Wildlife Management Area (31.952807°N, 82.511408°W). 10 June 2009. D. Stevenson. GSU 2264. MONTGOMERY Co.: County Rte. 95 at Oconee River; Public boat launch area on Dead River Road (31.981825°N, 82.551294°W). 06 May 2009. D. Stevenson. GSU 2266. Pierce Co.: 5.3 km N of Blackshear. Alabaha River at State Hwy. 121/15 (31.350986°N, 82.237467°W). 19 June 2009. D. Stevenson. GSU 2263. Stewart Co.: Singers Pond on private plantation near Lumpkin. 19 October 2008 (31.970781°N, 84.748481°W). J. Young. Verified by Kenneth L. Krysko. UF 156852. Wheeler Co.: 2.7 km WSW of Jordan; County Rte. 197 at Alligator Creek (32.626014°N, 82.695625°W). 09 May 2009. D. Stevenson. GSU 2265.

CHELYDRA SERPENTINA (Snapping Turtle). Catoosa Co.: DOR State Hwy 2 (34.93364°N, 85.19046°W). 26 May 2009. S. Graham and J. Jensen. Verified by Craig Guyer. AHAP-D 230. Haralson Co.: Tallapoosa River, approximately 225 m S of US Hwy 78 (33.73946°N, 85.33691°W). 28 August 2009. Greg Greer and Gregory B. Pauly. Verified by Kenneth L. Krysko. UF 156853. Upson Co.: AOR Logtown Road, Yatesville (32.905661°N, 84.143372°W). 07 June 2009. C. Muise. Verified by Kenneth L. Krysko. UF 156854.

CLEMMYS GUTTATA (Spotted Turtle). Wheeler Co.: 4.1 km E of State Hwy. 19 on County Rte. 95; 0.8 km E of Mill Creek Rd. (31.959206°N, 82.612831°W). 02 May 2009. D. Stevenson and M. Wallace. GSU 2272. Adult female found DOR.

DEIROCHELYS RETICULARIA (Chicken Turtle). Wheeler Co.: 5.6 km E of State Hwy. 19 on County Rte. 95 (31.972947°N, 82.578653°W). 12 February 2009. D. Stevenson. GSU 20064. Adult female found AOR.

KINOSTERNON BAURII (Striped Mud Turtle). Laurens Co.: 10.7 km SE of Dublin; Riverbend Wildlife Management Area (32.460269°N, 82.840839°W). 26 August 2009. D. Stevenson. GSU 2282. Adult found in backwater river slough.

KINOSTERNON SUBRUBRUM (Eastern Mud Turtle). Lamar Co.: DOR US Hwy. 341, ca. 1.5 km N of Monroe County line

(32.860906°N, 84.082608°W). 14 June 2009. C. Muise. Verified by Kenneth L. Krysko. UF 156855. MONTGOMERY Co.: US Hwy. 280/State Hwy. 30 at Oconee River, 1.3 km W of Mt. Vernon city limits (32.192261°N, 82.625411°W). 23 March 2009. D. Stevenson. GSU 2283. Adult dip-netted from pool in hardwood forest along Oconee River. Taylor Co.: AOR jct. of State Hwy. 137 and State Hwy. 128 (32.666017°N, 84.104081°W). 05 May 2009. J. Jensen and S. Castleberry. Verified by Kenneth L. Krysko. UF 156856.

***PSEUDEMYS CONCINNA CONCINNA* (Eastern River Cooter)**. Jones Co.: Ocmulgee River just downstream of State Hwy. 18 bridge (32.015839°N, 83.728194°W). 26 August 2009. J. Jensen and D. Stevenson. Verified by Kenneth L. Krysko. UF 156857. Laurens Co.: Oconee River 11.3 km SE of Dublin, Riverbend Wildlife Management Area (32.454620°N, 82.837125°W). 26 August 2009. D. Stevenson. GSU 2302.

***STERNOTHERUS MINOR* (Loggerhead Musk Turtle)**. Catoosa Co.: Found on bank of Chickamauga Creek (34.95374°N, 85.12226°W). 26 May 2009. S. Graham and J. Jensen. Verified by Craig Guyer. AHAP-D 225-226.

***STERNOTHERUS ODORATUS* (Eastern Musk Turtle)**. MONTGOMERY Co.: US Hwy. 280/State Hwy. 30 at Oconee River, 1.3 km W of Mt. Vernon city limits (32.195089°N, 82.628717°W). 23 March 2009. D. Stevenson. GSU 2313. Juvenile dip-netted from pool in hardwood forest along Oconee River. Wheeler Co.: County Rte. 95 at Oconee River (31.980000°N, 82.547814°W). 04 June 2009. D. Stevenson. GSU 2312. Adult male AOR adjacent to swampy river floodplain.

***TERRAPENE CAROLINA* (Eastern Box Turtle)**. TOOMBS Co.: State Hwy. 147 at Cobb Creek (31.971648°N, 82.322175°W). 13 June 2009. D. Stevenson and B. Willis-Stevenson. GSU 2315.

***TRACHEMYS SCRIPTA* (Pond Slider)**. Lamar Co.: City Pond reservoir (33.120703°N, 84.119397°W). 06 September 2009. C. Muise, T. Muise, and A. Muise. Verified by Kenneth L. Krysko. UF 156858.

SQUAMATA — LIZARDS

***ANOLIS CAROLINENSIS* (Green Anole)**. Twiggs Co.: Stone Creek access trail at Bond Swamp National Wildlife Refuge (32.739264°N, 83.567042°W). 27 March 2008. J. Jensen. Verified by Elizabeth McGhee. GMNH 50100. Adult found in floodplain forest.

***ANOLIS SAGREI* (Brown Anole)**. Ware Co.: Laura Walker State Park (31.143475°N, 82.214586°W). 25 March 2009. J. Carter. Verified by Kenneth L. Krysko. UF 156859. Numerous individuals of this non-native species observed.

***HEMIDACTYLUS GARNOTII* (Indo-Pacific House Gecko)**. Glynn Co.: Private residence on Sunset Boulevard, Brunswick (31.216342°N, 81.471456°W). 10 September 2006. M. Butler and B. Winn. Verified by Elizabeth McGhee. GMNH 50088. First confirmed, established population of this non-native species in the state. Multiple individuals observed on house, and population has survived at least two winters (B. Winn, pers. comm.).

***HEMIDACTYLUS TURCICUS* (Mediterranean House Gecko)**. Clarke Co.: Fowler Products Company warehouse building on Collins Industrial Boulevard (33.979067°N, 83.359700°W). 14 August 1975. J. Cadle. Verified by Ned Gilmore. ANSP 30881. Evans Co.: Private residence on West Railroad Street, Claxton (32.159781°N, 81.915339°W). 09 September 2009. P. McDonald. Verified by Kenneth L. Krysko. UF 156860. Species first observed at residence approximately 15 years prior, and multiple individuals of various sizes have been seen annually since then (P. McDonald, pers. comm.). Telfair Co.: Private residence on S 2nd Avenue, McRae (32.067660°N, 82.899615°W). 12 June 2009. W. Dopson. GSU 2280. Adult female found on dwelling; five additional adult specimens observed in the vicinity.

***PLESTIODON FASCIATUS* (Common Five-lined Skink)**. Twiggs Co.: Stone Creek access trail at Bond Swamp National Wildlife Refuge (32.739264°N, 83.567042°W). 27 March 2008. J. Jensen. Verified by Elizabeth McGhee. GMNH 50099.

***PLESTIODON INEXPECTATUS* (Southeastern Five-lined Skink)**. Turner Co.: South side of State Hwy.107, 10.0 km E of jct. State Hwys.107 and 112 (31.720478°N, 83.480383°W). 09 April 2009. D. Stevenson. GSU 2298.

***SCELOPORUS UNDULATUS* (Eastern Fence Lizard)**. Lamar Co.: Private residence on Eady Creek Road, Barnesville (33.126083°N, 84.138389°W). 21 September 2008. C. Muise. Verified by Kenneth L. Krysko. UF 156861.

***SCINCELLA LATERALIS* (Little Brown Skink)**. Coffee Co.: Private residence 11.3 km WSW of Douglas (31.482556°N, 82.965020°W). 11 April 2009. F. Snow. GSU 2306. Captured in yard beneath pine straw. Lamar Co.: St. George's Episcopal School Campus, Milner (33.117475°N, 84.198389°W). 05 September 2008. C. Muise and T. Muise. Verified by Kenneth L. Krysko. UF 156903.

SQUAMATA — SNAKES

***AGKISTRODON CONTORTRIX* (Copperhead)**. Coffee Co.: New Hope Baptist Church, 1.44 km NW of Ambrose, GA (31.602934°N, 83.025112°W). 08 June 2001. D. Paulk. GSU 2248. Lamar Co.: Private residence on Eady Creek Road, Barnesville (33.126083°N, 84.138389°W). 17 May 2009. C. Muise. Verified by Kenneth L. Krysko. UF 156862. Rockdale Co.: Panola Mountain State Park (33.640667°N, 84.156194°W). 28 August 2009. C. Muise and V. Lane. Verified by Kenneth L. Krysko. UF 156935. Telfair Co.: State Hwy 117 at State Hwy 132 near Temperance (31.881148°N, 83.139010°W). 25 October 2009. Billy Kellner. GSU 2321. AOR adult. Treutlen Co.: 2.3 km SW of Barnhill; State Hwy. 46 at Oconee River Road (32.312883°N, 82.687419°W). 09 May 2009. D. Stevenson. GSU 2247.

***AGKISTRODON PISCIVORUS* (Cottonmouth)**. Bartow Co.: Green Pond at Henderson Mountain (34.269241°N, 84.918324°W). 27 July 2009. T. Morris, M. Moffett, S. Raper, and T. McCuean. Verified by Kenneth L. Krysko. UF 156863. Coffee Co.: 100 m from jct. Hwy 441 and Hwy 221, Douglas (31.490907°N, 82.851215°W). 13 May 2009. R. Preston, Jr. GSU 2245. Coweta Co.: Hutchinson Lake, Senoia (33.320069°N, 84.549319°W). July 2001. R. McCarthy.

Verified by Kenneth L. Krysko. UF 156864. McDuffie Co.: State Hwy. 17 0.8 km N of Little Brier

Creek/Warren Co. line (33.347324°N, 82.460063°W). 8 October 2009. D. Stevenson and B. Willis-Stevenson. GSU 2325. Telfair Co.: 3.3 km ENE of Jacksonville; State Hwy. 117 at Lampkin Branch (31.816883°N, 82.944207°W). 13 July 2009. D. Stevenson. GSU 2246.

CARPHOPHIS AMOENUS (Eastern Wormsnake). Catoosa Co.: Found under bark of rotten stump near Chickamauga Creek (34.95374°N, 85.12226°W). J. Jensen and S. Graham. 26 May 2009. Verified by Craig Guyer. AHAP-D 227-228.

CEMOPHORA COCCINEA (Scarlet Snake). Coffee Co.: DOR Entrance to Westwood Heights subdivision at State Hwy. 158; 3.9 km WSW of Douglas, GA (31.493121°N, 82.889002°W). 24 August 2009. R. Preston, Jr. GSU 2269. Heard Co.: Private residence in Centralhatchee (33.35333°N, 85.11000°W). 25 August 2009. M. Terry and R. McCarthy. Verified by Kenneth L. Krysko. UF 156865. Lamar Co.: Private residence on Oliver Road, Barnesville (33.050092°N, 84.099083°W). August 2009. B. Cherry. Verified by Kenneth L. Krysko. UF 156866. Pulaski Co.: Found at Sandy Hammock on bank of Ocmulgee River. (31.140401°N, 83.366332°W). 09 February 1991. F. Snow. GSU 2271. Taylor Co.: Black Creek Natural Area, ca. 1.5 km SSW of Howard (32.571356°N, 84.406653°W). 14 June 2008. N. Klaus. Verified by Kenneth L. Krysko. UF 156867. Telfair Co.: 5.2 km NW of Lumber City on State Hwy. 341/27 (31.959519°N, 82.720458°W). 2 May 2009. D. Stevenson and M. Wallace. GSU 2270.

COLUBER (= *MASTICOPHIS*) *FLAGELLUM* (Coachwhip). Bacon Co.: State Hwy. 203 N at Brown Thrasher Drive, 2.7 km SW of Appling County line (31.571311°N, 82.331094°W). 09 August 2009. D. Stevenson. GSU 2289.

CROTALUS ADAMANTEUS (Eastern Diamond-backed Rattlesnake). Cook Co.: 2.0 km SW of New Lois, W of Withlacoochee River (31.057744°N, 83.290406°W). 10 December 2008. D. Stevenson, C. Powell, M. Ravenscroft, and K. Ravenscroft. GSU 20065. MONTGOMERY Co.: Adult DOR South Old River Road at State Hwy. 221/135 (31.987425°N, 82.510467°W). 14 May 2009. D. Stevenson. GSU 2275.

CROTALUS HORRIDUS (Timber Rattlesnake). Coffee Co.: DOR jct. of Mora Road and Tractor Trail (31.420710°N, 83.007422°W). 25 August 2009. A. Safer and F. Snow. GSU 2276.

DRYMARCHON COUPERI (Eastern Indigo Snake). Cook Co.: Turkey Oak Trail at Reed Bingham State Park (31.169633°N, 83.535297°W). February 2007. C. Powell. Verified by Elizabeth McGhee. GMNH 50097.

FARANCIA ABACURA (Red-bellied Mudsnake). Jenkins Co.: State Hwy. 17 0.3 km S of Buckhead Creek, just outside Millen (32.800772°N, 81.958425°W). 21 April 1974. J. Cadle. Verified by Ned Gilmore. ANSP 30904.

HETERODON PLATIRHINOS (Eastern Hog-nosed Snake). Echols Co.: US 129/Hwy 11 E between County Rte. 10 and County Rte. 12 (30.763517°N, 83.004248°W). 15 March 2009. A. Safer and J. Safer. GSU 2281. Habersham Co.: Downtown Demorest (34.56609°N, 83.54460°W). 22 September 2008. C. Camp. Verified by Kenneth L. Krysko. UF 156868.

LAMPROPELTIS GETULA (Common Kingsnake). Jeff Davis Co.: AOR 0.4 km S of Carvers Chapel (31.689806°N, 82.804209°W). December 1991. F. Snow. GSU 2284. Wheeler Co.: 5.0 km S of Jordan on State Hwy. 19 (31.992642°N, 82.64215°W). 02 May 2009. D. Stevenson and M. Wallace. GSU 2285.

NERODIA ERYTHROGASTER (Plain-bellied Watersnake). Long Co.: 16.0 km W of Townsend (31.554132°N, 81.687387°W). 29 July 2009. D. Stevenson and K. Morris. GSU 2291. Adult found in Altamaha River floodplain swamp. Taylor Co.: Slough of Little Whitewater Creek just upstream from State Hwy. 137 bridge (32.525128°N, 84.311064°W). 25 August 2009. D. Stevenson and J. Jensen. Verified by Kenneth L. Krysko. UF 156869. Walker Co.: DOR just outside Chattanooga and Chickamauga National Military Park (34.90556°N, 85.27080°W). 26 May 2009. J. Jensen and S. Graham. Verified by Craig Guyer. AUM 34916.

NERODIA TAXISPILOTA (Brown Watersnake). Evans Co.: 3.3 km SW of Groveland; Canoochee River S of State Hwy. 280 (32.131444°N, 81.777190°W). 06 September 2009. D. Stevenson and B. Willis-Stevenson. GSU 2292.

OPHEODRYS AESTIVUS (Rough Greensnake). Telfair Co.: Adult DOR 7.9 km ENE of Jacksonville on State Hwy. 117 (31.826197°N, 82.896742°W). 04 June 2009. D. Stevenson. GSU 2297.

PANTHEROPHIS ALLEGHANIENSIS (Eastern Ratsnake). Meriwether Co.: DOR State Hwy. 109 at jct. with Jones Mill Road (33.076059°N, 84.614137°W; WGS 84). 26 November 2007. S. Graham and S. Hoss. Verified by Craig Guyer. AUM 37596.

PANTHEROPHIS GUTTATUS (Red Cornsnake). Chattooga Co.: DOR State Hwy. 157 2.7 km S of Walker Co. line (34.580504°N, 85.443711°W; WGS 84). 22 May 2009. S. Graham. Verified by Craig Guyer. AHAP-D 220.

PITUOPHIS MELANOLEUCUS (Pinesnake). Jenkins Co.: State Hwy. 121 near Burke Co. line (32.916356°N, 81.964642°W). 11 April 1976. J. Cadle. Verified by Ned Gilmore. ANSP 30934. Pickens Co.: State Hwy. 53 ca. 1.5 km SW of Ludville (34.470814°N, 84.618497°W). 04 June 2007. S. Gravette. GMNH 50098.

SISTRURUS MILIARIUS (Pygmy Rattlesnake). Atkinson Co.: Guest Mill Pond in East Flatwoods Swamp, 11.7 km SSE of Pearson (31.193483°N, 82.832963°W). 09 September 2000. D. Edwards. GSU 2311. McIntosh Co.: DOR 7.3 km SW of Townsend, Old Barrington Road at Cox Road (31.504396°N, 81.58680°W). 30 August 2009. D. Stevenson and B. Willis-Stevenson. GSU 2310.

STORERIA DEKAYI (DeKay's Brownsnake). Appling Co.: 4.5 km NW of Davis on Moody Forest Natural Area Preserve (31.930833°N, 82.283333°W). 02 March 2009. D. Stevenson and C. Jenkins. GSU 2314. Adult found under debris in Altamaha River floodplain bottomland forest. Lamar Co.: St. George's Episcopal School Campus, Milner (33.117475°N, 84.198389°W). 05 September 2008. C. Muise and T. Muise. Verified by Kenneth L.

Krysko. UF 156871. Twiggs Co.: Stone Creek access trail at Bond Swamp National Wildlife Refuge (32.739264°N, 83.567042°W). 27 March 2008. J. Jensen. GMNH 50095. Adult found under log in floodplain forest.

STORERIA OCCIPITOMACULATA (Red-bellied Snake). Jasper Co.: Private residence on State Hwy. 16 E, Monticello (33.298805°N, 83.662808°W). 09 May 2009. John B. Jensen. Verified by Kenneth L. Krysko. UF 155361. Meriwether Co.: Joe Kurz Wildlife Management Area (33.099433°N, 84.535967°W). 04 October 2008. H. Davis. Verified by Kenneth L. Krysko. UF 156872.

TANTILLA CORONATA (Southeastern Crowned Snake). Taylor Co.: Black Creek Natural Area, ca. 1.5 km SSW of Howard (32.571356°N, 84.406653°W). 13 June 2008. N. Klaus. Verified by Kenneth L. Krysko. UF 156873.

THAMNOPHIS SIRTALIS (Common Gartersnake). Coffee Co.: Old River Road (31.67977° N, 82.877807°W). 18 April 2009. A. Safer and F. Snow. GSU 2318. Tattnall Co.: Baxter Durrence Road at Mushmelon Creek, 9.2 km SSW of Glennville, by air (31.864556°N, 81.965542°W). 28 September 2009. D. Stevenson. GSU 2316. Telfair Co.: 3.7 km ESE of Jacksonville in Ocmulgee River swamp (31.800094°N, 82.942388°W). 10 June 2009. D. Blanton. GSU 2317.

VIRGINIA STRIATULA (Rough Earthsnake). Ben Hill Co.: Mobley Bluff Road boat landing on Ocmulgee River (31.775100°N, 83.007956°W). 09 June 2009. B. Hudson, C. Camp, and D. Stevenson. GSU 2319. Adult found under debris in floodplain bottomland forest.

VIRGINIA VALERIAE (Smooth Earthsnake). Coffee Co.: Walking trail 2.4 km N of South Georgia College campus between Gordon Street and Franklin Street, Douglas (31.513653°N, 82.852946°W). 30 September 2009. R. Preston, Jr. GSU 2320. Forsyth Co.: Private residence on Ivey Wood Court (34.199514°N, 84.240542°W). 24 June 2009. G. McCreary. Verified by Kenneth L. Krysko. UF 156874. White Co.: Rocky Mountain, near summit (~1200 m), E of Hwy 17 (Unicoi Gap), ca. 8.4 km N of Helen (34.798086°N, 83.729514°W). 20 September 2008. B. Hudson and C. Camp. Verified by Kenneth L. Krysko. UF 156875.

Acknowledgments.— We thank all individuals who sent us verifiable county records to further our understanding of herpetofaunal distributions in the state. Special thanks are given to the students of St. George's Episcopal School who were responsible for discovering many of the Lamar County records. We appreciate museum curators Lance McBrayer, Kenneth Krysko, and Elizabeth McGhee for verifying and accessioning specimens and photographs in a very timely manner.

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Additional Geographic Distribution Records for Amphibians and Reptiles from Georgia, USA

Since the publication of *Amphibians and Reptiles of Georgia* (Jensen et al. 2008), a number of new geographic distribution records have been documented for the state, including those reported by Stevenson et al. (2009) and Jensen et al. (2011). Herein, we report 34 additional distribution records based on field collections made during 2009–2010. Geo-coordinates are based on datum NAD 83. All identifications were verified by Lance D. McBrayer.

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CAUDATA — SALAMANDERS

AMBYSTOMA TALPOIDEUM (Mole Salamander). Atkinson Co.: County Rd. 38, 15.8 km SSE Willacoochee (31.203401°N, 82.999898°W). 16 March 2010. D. Stevenson and K. Stohlgren. GSU 11881. Larvae dipnetted from roadside ditch.

AMPHIUMA MEANS (Two-toed Amphiuma). Coffee Co.: Flat Tub Wildlife Management Area at Flat Tub Landing Road (31.793549°N, 82.843021°W). 14 August 2010. D. Stevenson, R. Kazmaier, and D. Riedle. GSU 11882; Jeff Davis Co.: Bullard Creek Wildlife Management Area at State Hwy. 221(31.968274°N, 82.477741°W). 3 September 2010. D. Stevenson and J. Bauder. GSU 11883; Telfair Co.: 3.3 km ENE Jacksonville. State Hwy. 117 at Lampkin Branch (31.816883°N, 82.944207°W). 22 July 2010. K.

Stohlgren and D. Stevenson. GSU 11884. Juvenile found in seepage area. Toombs Co.: State Hwy 147 at Cobb's Creek (31.974867°N, 82.323675°W). 19 August July 2010. D. Stevenson. GSU 11885.

SIREN INTERMEDIA (Lesser Siren). Ben Hill Co.: State Hwy 107/319 at Sturgeon Creek (31.773471°N, 83.054068°W). 28 July 2010. K. Stohlgren and D. Stevenson. GSU 11886.

ANURA — FROGS

ACRIS CREPITANS (Northern Cricket Frog) Jeff Davis Co.: Bullard Creek Wildlife Management Area at State Hwy. 221(31.965610°N, 82.482357°W). 3 September 2010. D. Stevenson and J. Bauder. GSU 11887

HYLA AVIVOCA (Bird-voiced Treefrog). Telfair Co.: Orianne Indigo Snake Preserve at Ocmulgee River floodplain (31.846856°N, 82.792507°W). 2 June 2010. K. Stohlgren. GSU 11888. Adult male captured while calling from bottomland forest.

LITHOBATES CLAMITANS (Green Frog). Telfair Co.: Orianne Indigo Snake Preserve at Ocmulgee River (31.846856°N, 82.792507°W). 2 May 2010. J. Bauder and K. Stohlgren. GSU 11889.

LITHOBATES HECKSCHERI (River Frog) Jeff Davis Co.: Bullard Creek Wildlife Management Area at State Hwy 221(31.965610°N, 82.482357°W). 5 September 2010. D. Stevenson and M. P.. Wallace. GSU 11890; Montgomery Co.: State Hwy 221 at the Altamaha River (31.958062°N, 82.516793°W). 10 September 2010. D. Stevenson. GSU 11891.

PSEUDACRIS FERIARUM (Upland Chorus Frog). Telfair Co.: Orianne Indigo Snake Preserve at Ocmulgee River floodplain (31.846856°N, 82.792507°W). 27 November 2009. K. Stohlgren, M. Ravenscroft and K. Ravenscroft. GSU 11892. Adult male captured while calling from bottomland forest

PSEUDACRIS ORNATA (Ornate Chorus Frog). Wheeler Co.: 5.4 km NE McRae, State Hwy 280/30 at Co. Rte. 126 (32.085298°N, 82.847111°W). 30 March 2010. W. Taylor, K. Stohlgren, and D. Stevenson. GSU 11893. Larvae dipnetted from depressional wetland.

TESTUDINES — TURTLES

APALONE FEROX (Florida Softshell). Coffee Co.: 11.7 km SW Douglas on State Hwy 135 (31.414629°N, 82.906530°W). 24 April 2010. E. Schlimm and K. Stohlgren. GSU 11894. Adult DOR, cypress wetland nearby; Tattnall Co.: State Hwy 144 at Watermelon Creek (31.928053°N, 82.003155°W). 28 September 2010. D. Stevenson. GSU 11914.

APALONE SPINIFERA (Spiny Softshell). Coffee Co.: 7.4 air km NE Relee; Flat Tub Wildlife Management Area at the Ocmulgee River (31.787834°N, 82.861011°W). 28 July 2010. D. Stevenson and K. Stohlgren. GSU 11895; Laurens Co.: 17.8 km SSE Dublin; Oconee River at Rock Springs Road boat landing (32.399131°N, 82.798492°W. 28 June 2010. D. Stevenson. GSU 11896; Ware Co.: Waycross. State Hwy 84 at the Satilla River (31.238512°N, 82.323216°W). 17 June 2010. D. Stevenson. GSU 11897.

DEIROCHELYS RETICULARIA (Chicken Turtle). Atkinson Co.: County Road 38 at Cty. Rd. 36, 14.5 km SSE of Willacoochee (31.214153°N, 83.007461°W). 16 March 2010. D. Stevenson and K. Stohlgren GSU 11898.

KINOSTERNON BAURII (Striped Mud Turtle) Jeff Davis Co.: Bullard Creek Wildlife Management Area at State Hwy 221(31.965610°N, 82.482357°W). 5 September 2010. D. Stevenson and M. P. Wallace. GSU 11899.

PSEUDEMYS CONCINNA FLORIDANA (Coastal Plain Cooter). Telfair Co.: 2.5 km SW Lumber City on State Hwy 117 (31.912864°N, 82.697977°W). 2 June 2010. K. Stohlgren. GSU 11900. Adult female AOR, man-made impoundment nearby.

STERNOTHERUS MINOR (Loggerhead Musk Turtle). Montgomery Co.: Bell's Ferry Rd. at the Oconee River (31.980202°N, 82.553902°W). 20 May 2010. D. Stevenson. GSU 11901. Toombs Co.: Gray's Landing at the Altamaha River (31.96613°N, 82.428422°W). 27 July 2010. D. Stevenson. GSU 11902.

STERNOTHERUS ODORATUS (Eastern Musk Turtle). Jeff Davis Co.: Bullard Creek Wildlife Management Area at State Hwy 221(31.968274°N, 82.477741°W). 5 September 2010. D. Stevenson and M. P. Wallace. GSU 11915–16.

SQUAMATA — LIZARDS

PLESTIODON FASCIATUS (Common Five-lined Skink). Jeff Davis Co.: Bullard Creek Wildlife Management Area at State Hwy 221(31.965610°N, 82.482357°W). 10 September 2010. D. Stevenson. GSU 11903.

SQUAMATA — SNAKES

AGKISTRODON PISCIVORUS (Cottonmouth). Toombs Co.: Providence Church Rd. at Bell's Mill Creek (31.954659°N, 82.244034°W). 24 September 2010. D. Stevenson. GSU 11904.

CROTALUS ADAMANTEUS (Eastern Diamond-backed Rattlesnake). Atkinson Co.: County Rd. 38, 7.0 km S Willacoochee (31.279601°N, 83.026359°W). 16 March 2010. D. Stevenson and K. Stohlgren. GSU 11905. Adult found at Gopher Tortoise (*Gopherus polyphemus*) burrow in xeric sandhill.

CROTALUS HORRIDUS (Timber Rattlesnake). Decatur Co: State Hwy 253, 16.8 km NNE Bainbridge (31.04973°N, 84.52710°W). 25 July 2010. Juvenile found DOR. E. Schlimm and K. Stohlgren. GSU 11906.

FARANCIA ERYTROGRAMMA (Rainbow Snake). Tattnall Co.: State Hwy 178 at the Ohoopee River, 18.0 air km W Glennville (31.922805°N, 82.118758°W).1 June 2010. D. Stevenson. GSU 11907. Adult female found in shallow water of the Ohoopee River at 1330 h. It was attempting to eat an American Eel (*Anguilla rostrata*).

NERODIA ERYTHROGASTER (Plain-bellied Watersnake). Montgomery Co.: Bell's Ferry Rd. at the Oconee River (31.980202°N, 82.553902°W). 14 July 2010. D. Stevenson. GSU 11908; Telfair

Co.: Orianne Indigo Snake Preserve at Ocmulgee River floodplain (31.846856°N, 82.792507°W). 20 July 2010. K. Stohlgren. GSU 11909.

***NERODIA TAXISPILOTA* (Brown Watersnake)**. Jeff Davis Co.: Bullard Creek Wildlife Management Area at State Hwy 221 (31.956723°N, 82.479082°W). 24 September 2010. D. Stevenson. GSU 11911; Toombs Co.: Gray's Landing at the Altamaha River (31.96613°N, 82.428422°W). 27 July 2010. D. Stevenson. GSU 11910.

***THAMNOPHIS SAURITUS* (Eastern Ribbonsnake)**. Telfair Co.: 5.6 km ENE Jacksonville; DOR on Hwy 117 (31.820534°N, 82.919978°W). 24 July 2010. K. Stohlgren. GSU 11913.

Acknowledgments. —We thank Christopher L. Jenkins, John B. Jensen and Lance D. McBrayer for their assistance and support.

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ART IN HERPETOLOGY



SUBJECT: California red-legged frog (*Rana draytonii*) SIZE: Painted area is approx. 8" x 9" on 11" x 14" paper

Cindy Hitchcock earned a BA in Fine Arts emphasizing in drawing and painting and a MS in Biology, emphasizing herpetology and amphibian decline. Cindy was formerly a graphic designer for Pepsi Cola Company and Lennox China, but later worked as a biologist for US Geological Survey and Aspen Environmental Group in Southern California. She now resides in Reseda, California with her husband (herpetologist Robert Espinoza) and two children (Max and Olivia). For archival prints of the featured paintings or for biological illustration services please contact cindyhitchcock@yahoo.com.

NATURAL HISTORY NOTES

CAUDATA — SALAMANDERS

***BOLITOGLOSSA PLATYDACTYLA* (Broad-footed Mushroom-tongued Salamander). MAXIMUM ELEVATION.** *Bolitoglossa platydactyla* is known to inhabit an elevational distribution of 0–1300 m (Duellman 1999. Patterns of Distribution of Amphibians. A Global Perspective. The Johns Hopkins University Press. Baltimore and London. 633 pp.). Within the state of Hidalgo, México, the maximum elevation previously known for *B. platydactyla* was 148 m in rainforest (Hernández-Salinas et al. 2008. Herpetol. Rev. 39:231). On 12 February 2010, an adult *B. platydactyla* was captured under a stone in the cloud forest in the municipality of San Bartolo Tutotepec (20.40442°N, 98.22689°W; WGS 84) at an elevation of 1510 m. This record provides information on the potential elevation of this species, and is the first record of *B. platydactyla* for cloud-forest habitat in Mexico.

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***NOTOPHTHALMUS VIRIDESCENS* (Eastern Newt). NECROPHILIA AND CANNIBALISM.** On 22 March 2010, in a wetland located in Pickens Co., South Carolina, USA, we observed a pair of adult *Notophthalmus viridescens* engaged in what appeared to be amplexus and a third adult *N. viridescens* attempting interference of the mating pair. Upon closer examination, we saw that a male *N. viridescens* was mounting a decapitated female *N. viridescens*. The third *N. viridescens* was feeding on the exposed soft tissue of the decapitated female *N. viridescens*. We do not know if the decapitation occurred prior to amplexus or after. *Notophthalmus viridescens* are opportunistic feeders and the cannibalism of larvae by adults has been documented (Burton 1977. Copeia 1977:139–143). This coincidence of necrophilia and cannibalism of an adult *N. viridescens* appears to be unique.

Notophthalmus viridescens amplexus can last for up to three hours, and thus represents a substantial energetic investment in reproduction (Verrell 1985. Behaviour 94:244–253). Trauth et al. (2000. J. Arkansas Acad. Sci. 54:154–156) posited that by engaging in or continuing amplexus with a dead female, a male amphibian may diminish his reproductive output due to increased energetic costs and wasting gametes.

Amplexus between live male and dead female anurans has been documented for several species (Mollov et al. 2010. Biharean Biol. 4:121–125; Trauth et al. 2000, *op. cit.*) and death of female anurans as a result of mating activities has been observed for Wood Frogs, *Lithobates sylvaticus* (Trauth et al. 2000, *op. cit.*). Amplexus may represent a time of increased female vulnerability that can lead to mortality.

We extend our gratitude to the South Carolina State Parks, Upstate Forever, South Carolina Department of Natural Resources, and John Garten for assistance in locating wetlands. We thank the Clemson students who participated in field work. Funding was provided by the Environmental Protection Agency Region 4 WPDG. Research was approved by Clemson University IACUC (AUP2009-103).

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***PLETHODON CINEREUS* (Eastern Red-backed Salamander). WILDFIRE SURVIVAL.** *Plethodon cinereus* is an entirely terrestrial plethodontid salamander at the northeastern extreme of its natural distribution in Nova Scotia, Canada (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, D.C. 587 pp.). On 30 April 2009, a wildfire of anthropogenic origin was ignited on the periphery of Halifax, Nova Scotia, Canada (44.60147°N, 63.59264°W), fueled by downed trees remaining from a 2003 hurricane. This stand-replacing fire ultimately consumed 800 ha of Acadian forest including above-ground vegetation, woody debris, and the organic soil layer, removing critical salamander habitat. *Plethodon cinereus* was the most commonly observed terrestrial amphibian in the study area before the fire (pers. obs.). Most studies of fire effects on herpetofauna address low-severity burns (Dechant 2007. Low-Intensity Prescribed Fire does not Affect Salamanders in an Oak-Hickory Woodland. M.Sc. Thesis, Univ. Michigan, Ann Arbor. 29 pp.), and few address the effects of stand-replacement wildfire (Bury 2004. Cons. Biol. 18:968–975) due to difficulties in measurement, frequency, and experimental manipulation. A single *P. cinereus* was observed under rocky debris on an unburned rock outcrop (44.58486°N, 63.55519°W) on 9 May 2009, 302 m from the nearest unburned area. Based on their small territories (0.16–0.33 m^2) (Petranka 1998, *op. cit.*) and dispersal distances of less than 2 m per year (Ousterhout and Liebgold 2010. Herpetologica 66:269–275), it is unlikely that *P. cinereus* migrated across the burned zone in the nine days following the fire. Taub (1961. Ecology 42:681–698) demonstrated a large reservoir of *P. cinereus* in the soil and some individuals never moved to the surface. *Plethodon cinereus* have limited burrowing abilities, restricting them to soft substrates such as leaf litter (Heatwole 1960. Ecology 41:661–668). *Plethodon cinereus* residing in the leaf litter and organic soil layer or under woody debris at this location probably perished in the fire, but individuals could potentially have

survived in unburned rock piles which provided refuge from combustion and extreme temperatures. Multiple searches of the surrounding area and monitoring of artificial cover objects over the next four months did not result in any further observations of *P. cinereus* on burned soils. This observation indicates that 1) wildfire adversely affects *P. cinereus* populations immediately following the fire; and 2) amphibian recolonization of extensively burned landscapes may occur from unburned refugia within the fire zone.

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***SIREN LACERTINA* (Greater Siren). DIET.** On 20 Oct 2010 a dead *Siren lacertina* was found in a minnow trap in Southern Landing, a 1.4-acre constructed wetland on the Florida Southern College campus in Lakeland, Florida, USA. Once collected from the trap, the siren was placed in tap water and kept overnight in the laboratory at 10° C until it was dissected on 21 Oct 2010. Upon dissection, a *Nerodia taxispilota* (Brown Water Snake), in the later stages of digestion, was recovered from the siren's small intestine. The *N. taxispilota* was partially intact (i.e., the bones and scales were poorly digested) and had a TL of ca. 17 cm. In addition to the snake, the siren had consumed large amounts of muddy vegetation that contained snails, fingernail clams, amphipods, and chironomid larvae. The siren was 483 mm SVL, 650 mm TL, and its mouth had a vertical gape of ca. 12 mm with a horizontal opening of ca. 17 mm. The Greater Siren has been known to consume small fish (Hanlin 1978. Copeia 1978:358–360) and salamanders (Luhring 2007. Herpetol. Rev. 38:317), however this is the first account of consumption of a reptile by *S. lacertina*.

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ANURA — FROGS

***HYLA ARENICOLOR* (Canyon Tree Frog). MISSING LIMBS.** Severe deformities have been reported in several species of amphibians, in which supernumerary and ectromelia are the most common (Blaustein and Johnson 2003. Front. Ecol. Environ. 1:87–94). Here, I report an apparently high occurrence of *Hyla arenicolor* with completely missing hindlimbs.

On two field trips (9 and 22 Oct 2004) to the Sierra de Nanchititla, State of Mexico, Mexico (18.8241944°N, 100.42772°W; elev. 1435 m), I sampled a total of 12 adult and 40 tadpole *H. arenicolor*. Individuals were collected next to Nanchititla Falls in two different temporary ponds. Three adults had completely missing hindlimbs (ectromelia). Tadpoles did not show any sign of deformity.

Potential sources of missing limbs include both abiotic and biotic factors (Blaustein and Johnson 2003. Sci. Amer. 288(2):60–65). A detailed study, including frequencies of deformities in this and other species, and the sources of such deformities in this relatively isolated and protected area are needed.

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***HYLARANA MALABARICA* (Fungoid Frog). PREDATION.** On 7 August 2009 at 0030 h, we located a breeding congregation of *Hylarana malabarica* in a temporary water pool surrounded by *Ipomoea carnea* in Judia Farm, Keonjhar district, Odisha, India (21.949475°N, 84.3600861°E; 400 m elev.; WGS 84). As we photographed a calling male sitting on a stump, the frog jumped into water and was immediately caught by a giant water bug (*Belostoma indicum*) (Fig. 1). The frog was grasped laterally near the groin with a tight grip of its legs, uttered a distress, and died within 15 minutes of capture. *Belostoma indicum* in its nymphal stage is known to kill subadult *Hoplobatrachus tigerinus* by strangulation (Mitra 1975. J. Bombay. Nat. Hist Soc. 72[2]:599–600). However, during our observation the frog was killed while the *B. indicum* had a tight grip on its groin region. *Hylarana malabarica* is distributed in Western Ghats, Eastern Ghats, and Peninsular India and it lives in tree holes, below leaf litter, under boulders, and in caves (Dutta et al. 2009. Amphibians and Reptiles of Similipal Biosphere Reserve. Regional Plant Resource Centre, Bhubaneswar, Orissa, India. 174 pp.). During the monsoon season, breeding congregations are found near ponds and temporary water pools syntopic with B. indicum.

Although predation of amphibians by arthropods has been reported by many workers (e.g., Barej et al. 2009. Herpetol. Notes 2:137–139; Forti et al. 2007. Braz. J. Biol. 67:583–584; Figueiredo-de-Andrade et al. 2010. Herpetol. Notes 3:53–54), this is the first record of predation of *H. malabarica* by *B. indicum* in nature.

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FIG. 1. *Hylarana malabarica* being attacked by a giant water bug (*Belostoma indicum*).

COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND

***LEPTOBRACHIUM HASSELTII* (Hasselt's Litter Toad). ANTIPREDATOR BEHAVIOR.** *Leptobrachium hasseltii* is a megophryid toad occurring in the southern part of Sumatra, Java, Bali, and

COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND



FIG. 1. Antipredator behavior exhibited by *Leptobrachium hasseltii*—posterior body elevation, hind limbs outstretched, and head flexed downward.

several adjacent islands of Indonesia (Hamidy and Matsui 2010. Zootaxa 2395:24–44; Iskandar 1998. The Amphibians of Java and Bali. Research and Development Centre for Biology-LIPI, Bogor. xix + 117 pp.). The antipredator behavior of *Leptobrachium* has been reported for *L. smithi* from Thailand (Chuaynkern et al. 2007. Herpetol. Rev. 38:323–324). The behavior in that species includes arching of the back with its head elevating ca. 90°, and the bulging of eyes with prominent display of the contrasting orange and black eye colors (Chuaynkern et al. 2007, *op. cit.*). Here, we observed a different pattern of antipredator behavior of *Leptobrachium*. We collected a female *L. hasseltii* from Banyuwindu, Ungaran, Central Java (2.442°N, 103.242°E, 111 m elev.) on 29 July 2010. As we photographed the specimen, it performed an antipredator behavior by elevating the posterior part of the body, outstretching the hind limbs, and flexing its head downward (Fig. 1). This type of antipredator behavior has been reported for several bufonids including *Bufo bufo* (Beebee 1985. Frogs and Toads. Whittet Books, London. 121 pp.), *Epidalea clamaita* (Noble 1931. The Biology of the Amphibia. Dover Publications Inc., New York. 577 pp.), and *Rhinella marina* (Tyler 1976. Frogs. William Collins Ltd., Sydney. 256 pp.), as well as a microhylid *Phrynomantis bifasciatus* (Duellman and Trueb 1986. Biology of Amphibians. The John Hopkins Univ. Press, Baltimore. 670 pp.), and is thought to increase apparent body size. The different antipredator behaviors exhibited by *L. smithi* and *L. hasseltii* might be related to different predator pressures, although similar predators are present in their respective ranges. Because species of this genus are characterized by their disproportionately large head (Inger and Stuebing 1997. A Field Guide to the Frogs of Borneo. Natural History Publications Sdn. Bhd., Kota Kinabalu. ix + 205 pp.), behavior seen in *L. hasseltii* seems to be effective, while the "Unken-reflex" (Noble 1931, *op. cit.*) displayed by *L. smithi* is otherwise uncommon in species of this genus. Bright ventral coloration and potent skin secretions are unknown in this group.

The specimen reported here is deposited in the Graduate School of Human and Environmental Studies, Kyoto University (KUHE 44305). Field work was financed by Monbukagakusho to AH for his doctoral scholarship.

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***LEPTODACTYLUS BUFONIUS* (Vizcacheras' White-lipped Frog). SPAWNING BEHAVIOR.** *Leptodactylus bufonius* is a typical frog from the arid Chaco, and is included in the *L. fuscus* group (Heyer 1978. Bull. Los Angeles Co. Mus. Nat. Hist. 29:1–85). It occurs in southern Bolivia, northern Argentina, Paraguay, and Central Brazil (Mato Grosso do Sul state) (Frost 2010. Amphibian Species of the World. Electronic database accessible at <http://research.amnh.org/vz/herpetology/amphibia/>, American Museum of Natural History, New York). Species in this group exhibit an intermediate reproductive mode, from the aquatic to terrestrial, with terrestrial clutches and aquatic tadpoles. Males construct subterranean chambers close to streams or ponds, and eggs embedded in foam nests are deposited inside the chambers. Subsequent to rains or floods, tadpoles complete development in the water (Heyer 1969. Evolution 23:421–428). Studies on the reproductive biology of *L. bufonius* throughout its geographic distribution are scarce (Crump 1995. Herpetol. Rev. 26:97–98; Reading and Jofré 2003. Amphibia-Reptilia 24:415–427) and nonexistent for Brazilian populations. Herein, we describe some aspects of the spawning behavior of *L. bufonius* in a temporary pond (21.7°S, 57.717°W), in the municipality of Porto Murtinho, Mato Grosso do Sul state, western Brazil. The study site is located in the southern Pantanal, the only Brazilian region under the influence of the Chaco biome, where annual floods are common in the summer (Prado et al. 1992. *In* Furley et al. [eds.], Nature and Dynamics of Forest-Savanna Boundaries, pp. 451–470. Chapman and Hall, London; Silva and Abdon 1998. Pesq. Agropec. Bras. 33:1703–1711). Climate is "Aw" type, according to Köppen's classification, with a hot and wet summer (Oct–Apr) and a dry and cold winter (May–Sep).

On 3 Dec 2009, 2230 h, we observed a pair of *L. bufonius* in amplexus inside a chamber, but spawning had not started. At 2232 h, another male entered the same chamber and immediately they started spawning. At 2300 h, with the foam nest already formed, the female (Coleção Zoológica de Referência da Universidade Federal de Mato Grosso do Sul – ZUFMS -CH593) left the chamber. Both males remained inside the chamber until 2344 h, when one of the males left the chamber (ZUFMS-CH594), followed by the other male at 2355 h (ZUFMS-CH595). On 6 Dec 2009 we observed another male being followed by a female and both entered the chamber at 2120 h. After five minutes, the male left the chamber and remained motionless for 35 minutes, ca. 10 cm from the chamber entrance. During this period, the female remained with her head out of the chamber. At 2205 h, both returned to the chamber and amplexed. After 20 minutes they started spawning. At 2245 h, another female (ZUFMS-CH598) approached the chamber and, at 2307 h joined the pair that was spawning. After seven minutes, this second female left. Thirty minutes later, another male approached and entered in the chamber. The three individuals (two males and one female) remained inside the chamber for almost 40 minutes (until 0028 h), when the female left. At 0047 h one male (ZUFMS-CH599) left and at 0100 h the other male (ZUFMS-CH600) also left the chamber. We were able to recognize males and females because of the presence/absence of vocal sacs; behavioral observation was possible through the chamber entrance. Observations of chambers

containing more than a male and female have been reported for *L. bufonius* (Philibosian et al. 1974. Herpetologica 30:381–386; Pisanó et al. 1993. Rev. Fr. Aquariol. 19:125–126; Reading and Jofré 2003, *op. cit.*). Philibosian et al. (1974, *op. cit.*) suggested that *L. bufonius* may exhibit polyandrous behavior or males may use chambers of other males. The second scenario seems more plausible for the population studied in Argentina by Reading and Jofré (2003, *op. cit.*). These authors stated that the available evidence did not support polyandry. Given that *L. bufonius* individuals occur in high densities at our study site, and that the region is subjected to floods which may shorten the reproductive period because of lack of suitable sites to construct the chambers, we suggest that the occurrence of multimale and perhaps multifemale spawning behavior seems plausible for this population. Polyandry has rarely been reported for South American frogs (Prado and Haddad 2003. J. Herpetol. 37:354–362; Prado et al. 2006. Herpetol. Rev. 37:206–207). In species with external fertilization, as most anurans, one of the ways to increase fertilization success is increasing quantity of sperm released (Gross 1985. Nature 313:47–48). Thus, selection may favor males with larger testes (Prado and Haddad 2003, *op. cit.*). Studies on the reproductive effort (gonad mass relative to body mass) of *L. bufonius* males, as well as studies addressing offspring paternity, are needed to help understand the behaviors described herein.

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***LIMNONECTES PALAVANENSIS* (Smooth Guardian Frog). ALTITUDE.** *Limnonectes palavanensis* is a small (to 40 mm SVL) raniform anuran with conspicuous tympanum and supratympanic folds, smooth reddish to chocolate brown on top of the head and dorsum except for a distinctive inverted V-shaped ridge between the shoulders and two unbroken folds from behind the eyes to the lower back, several posterior dorsolateral dark spots, immaculate orange yellow venter, and half-webbed toes with faintly dilated tips (Inger 2005. The Systematics and Zoogeography of the Amphibia of Borneo. Natural History Publications [Borneo] Sdn. Bhd. Kota Kinabalu. 402 pp.; Malkmus et al. 2002. Amphibians and Reptiles of Mount Kinabalu [North Borneo]. A.R.G. Gantner Verlag K.G. Ruggell. 424 pp.). *Limnonectes palavanensis* occurs in Palawan of the Philippines, and Borneo (Sabah and Sarawak of Malaysia, Brunei Darussalam, and Kalimantan of Indonesia) (Das 2007. A Pocket Guide: Amphibians and Reptiles of Brunei. Natural History Publications [Borneo] Sdn. Bhd. Kota Kinabalu. viii + 200 pp.; Inger 2005, *op. cit.*; Inger 2007. Systematics and Zoogeography of Philippine Amphibia. Natural History Publications [Borneo] Sdn. Bhd. Kota Kinabalu. vi + 370 pp.). Previous publications reported the altitudinal range for the species to be from near sea level to 1300 m elev. (Inger and Stuebing 2005. A Field Guide to the Frogs of Borneo, 2nd ed. Natural History Publications [Borneo] Sdn. Bhd. Kota Kinabalu. viii + 201 pp.; Malkmus et al. 2002, *op. cit.*). Herein we report a new altitude limit for *L. palavanensis*.

On 11 Dec 2008, between 1900 and 2200 h, an adult *L. palavanensis* (26 mm SVL, 1.7 g) was sampled via opportunistic examination at Geludu Trail on Geludu Hill (6°N, 116.5375°E; 1502 m elev.), Bundu Tuhan, Ranau District, West Coast Division, Sabah, Bornean Malaysia. The male anuran was found on the forest floor among dead leaves, and was not guarding eggs or carrying tadpoles. Air temperature was 16.2°C, and relative humidity was 88.1%. Geludu Hill is densely forested with elevation of 1200–1550 m. The hill houses other anuran species associated with forest floor such as *Ansonia longidigita*, *Leptobrachella baluensis*, *Leptobrachium montanum*, *Leptolalax dringi*, and *Chaperina fusca*, as well as with primary forest: *Philautus aurantium*, *P. bunitus*, *P. petersi*, and *Rhacophorus angulirostris*. The locality represents an extension of habitat for *L. palavanensis* from submontane to the montane zone. The specimen (HEP00913) was deposited in BORNEENSIS, the Bornean reference collection of the Institute for Tropical Biology and Conservation, Universiti Malaysia Sabah. On the same night, an additional *L. palavanensis* was sampled at Geludu Hill at 1478 m elev. (HEP00912: SVL 37 mm, mass 5.1 g).

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***LITHOBATES AREOLATUS CIRCULOSUS* (Northern Crawfish Frog). WINTERKILL.** Herein we report the first documented instance of winterkill in *Lithobates areolatus*, a state endangered species in Indiana and a species thought to be threatened throughout its range (Parris and Redmer 2005. *In* Lannoo [ed.] Amphibian Declines: Conservation Status of United States Species, pp. 526–528. Univ. California Press, Berkeley, California.). Our study population is located at the Hillenbrand Fish and Wildlife Area, in Greene Co. in southwestern Indiana (Lannoo et al. 2009. Diversity 1:118–132). This population is about 40 km SSE of the northernmost known extant population in Indiana, and probably at this point in time, the species. At this latitude, Crawfish Frogs overwinter obligately in burrows—one frog per burrow—excavated by crayfish (*Cambarus diogenes*, *C. polychromatus*, or *Fallicambarus fodiens*; Heemeyer and Lannoo 2010. Herpetol. Rev. 41:168–179). These burrows are small-bore—about the width of the frog—and long, extending a meter, perhaps more, down into the water table (Thompson 1915. Occ. Pap. Mus. Zool. Univ. Michigan 9:1–7). Crawfish Frogs spend the



FIG. 1. Flooded Crawfish Frog burrow; feeding platform is the muddy area immediately to the left and below the entrance in this photograph. Photo taken on 14 October 2009, after several days of heavy rains. Burrow entrance is about 8 cm in diameter.



FIG. 2. A) A thin incomplete ice cap covering the burrow of Crawfish Frog 9. Burrow entrance about 14 cm across. B) A magnified view of Frog 538 (headwidth 40 mm) partially submerged sitting in the water of her burrow after the ice cap had been broken and cleared. Distance from ice cap to the water was approximately 10 cm. Photos taken on 10 Dec 2009.

winter in or near the water at the bottom of their burrow, either partially submerged with their nostrils above the water or completely submerged with occasional emergence (especially under warm conditions). Crawfish Frogs will drown if submerged for extended periods of time (Heemeyer and Lannoo 2010, *op. cit.*).

During the winter of 2009–2010 we monitored 14 Crawfish Frogs on a weekly basis until 1 March, when we resumed daily monitoring. We observed frogs at the entrance or out of their burrows during every month of the winter. Temperature and precipitation data were recorded every 10 min throughout the winter using a HoboWare weather station located at a secure site 4.4 km NW of our study area. October 2009 was unusually wet (114 mm of rain, 28.7 mm above the 10-yr monthly average), with heavy rains coming on the 8th, 9th, and 14th. These rains raised the water table to the soil surface and inundated Crawfish Frog burrows (Fig. 1). For much of the winter (December was also wet) the water table remained near the soil surface. Throughout the winter we noticed a general pattern of rain leading a cold front, which led to burrow inundation with ice formation over the burrow entrance, followed by a fast or slow percolation of water out of burrows. This drainage created an air pocket between the ice and the water surface (Fig. 2). Burrows did not drain evenly in the clay-capped mine spoil soils of our study site (Lannoo et al. 2009, *op. cit.*). Later warming produced thawing and open burrow entrances. At no time during the winter was there enough persistent snow to provide insulation to retain ground heat.

January and February were cold, with a minimum recorded temperature of –20.4°C. On 21–22 February it rained 2.6 cm, and from 23–25 February a cold snap froze the entrances to many burrows, and in particular the burrow of Crawfish Frog number 9. Frog 9 was a large male (119 mm SUL, 152 g minus the transmitter [3.8 g]) whose burrow was situated on a south-facing hillside, in deep clay, in a pocket shaded by several large clusters of Big Bluestem (*Andropogon gerardii*). As a consequence of being sheltered and in thick clay, the ice at the entrance to this burrow was thick (centimeters), the water in the burrow did not drain to form an air pocket, and the ice over the burrow did not thaw quickly. When it did, on 7 March, we saw Frog 9 below the water level, something that is not unusual and typically not cause for alarm. On 9 March we realized Frog 9 had not moved and JLH extracted him. The carcass was fresh, and necropsy followed by consultation with Alan Pessier, D.V.M., suggested death by either drowning or asphyxiation. Among all (14) burrows surveyed, Frog 9's burrow had the thickest ice, was the last to thaw, and had the highest water table relative to the ground surface.

Frog 9 was the only monitored frog to die over the winter, and over the course of this study (16 months to date) has been only the second Crawfish Frog in a burrow to die (Engbrecht and Heemeyer 2010. Herpetol. Rev. 41:197). In the absence of heavy fall rains, we expect the winter water table to be close to or below the frost line (76 cm), and for Crawfish Frogs sheltered (water has a higher thermal inertia than air) in the water at the bottom of crayfish burrows to be relatively protected from the several potential consequences of freezing temperatures.

We thank Alan Pessier for the consultation following our necropsy.

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***LITHOBATES SYLVATICUS* (Wood Frog). PREDATION.** *Lithobates sylvaticus* are prey to mammals, large birds, snakes, fish, leeches, and salamander larvae (Baldwin et al. 2007. Herpetol. Rev. 38:194–195; Dorcas and Gibbons 2008. Frogs and Toads of the Southeast. Univ. Georgia Press, Athens, Georgia. 238 pp.). *Lithobates sylvaticus* eggs and tadpoles may also be an important seasonal prey item for *Notophthalmus viridescens*. During March–April 2010, *N. viridescens* was observed actively feeding on *L. sylvaticus* eggs and tadpoles at five separate temporary wetlands located within Oconee and Pickens counties in South Carolina. *Notophthalmus viridescens* would either approach egg masses from the sides or from underneath and consume eggs from these areas. In all cases, a minimum of three *N. viridescens* at a time were observed actively feeding on *L. sylvaticus* eggs. We also observed the consumption of *L. sylvaticus* tadpoles by *N. viridescens*. However, *L. sylvaticus* tadpoles appeared to avoid predation by purposefully positioning themselves on top of the remaining egg masses (i.e., tadpoles were observed swimming from other areas of the wetland to the top of the egg masses then remained there with minimal body movement for at least the duration of our observations). This observation may represent an example of active predator avoidance behavior by *L. sylvaticus* tadpoles. *Notophthalmus viridescens* were not observed in these wetlands prior to the *L. sylvaticus* breeding season and few were observed in these wetlands after *L. sylvaticus* eggs and tadpoles were no longer present. This pattern suggests that *N. viridescens* may seasonally occupy temporary wetlands following *L. sylvaticus* reproduction.

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***RHINELLA POMBALI* (Pombal's Toad). PREDATION.** The capture of animals by drift fences with pitfall and funnel traps can be a source of artificial aggregation of individuals and thus may attract potential predators. Spiders have been recorded preying on lizards of the genus *Enyalius* inside traps (Gomides et al. 2010. Herpetol. Rev. 41:221–222).

Rhinella pombali is distributed throughout the Atlantic Rainforest and its transitional areas with the cerrado, in the State of Minas Gerais and part of State of Rio de Janeiro (Baldissera et al. 2004. Arq. Mus. Nac. Rio J. 62[3]:255–282; Silveira et al. 2009. Biotemas 22[4]:231–235).

In this note we report the predation of *R. pombali* by army ants, *Labidus* sp. (Ecitoninae), within a funnel trap installed in the Reserva Biológica Municipal Santa Cândida (21.754917°S, 43.396833°W, WGS 84; 783 m elev.), an Atlantic Rainforest patch, in the municipality of Juiz de Fora, State of Minas Gerais, southeastern Brazil. The predation was observed by SCG and CHVR on 21 Jan 2009, at about 1600 h, who saw the column of ants (about 10 m long and 3 m wide) walk across the leaf litter and on vegetation along the drift fence. In one of the funnel traps a *R. pombali* was eaten by ants. When first observed, the individual was already dead, and consumption was complete in less than one hour. In Lajinha Municipal Park in the municipality of Juiz de Fora (21.792417°S, 43.380889°W; WGS84, 893 m elev.) on 28 Jan 2009, there was also a colony of *Labidus* observed to walk along the drift fences, but these ants encountered no amphibians or reptiles.

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***SCAPHIOPUS HOLBROOKII* (Eastern Spadefoot). LOCOMOTION.** Alternate-leg swimming patterns are considered to be a unique behavioral characteristic of the primitive frog families Leiopelmatidae and Ascaphidae, with more advanced families of frogs using a synchronous-leg swimming pattern (Abourachid and Green 1999. J. Herpetol. 33:663–674). All of the more advanced anuran species reported by Abourachid and Green (1999, *op. cit.*) exhibited the typical, and more efficient, synchronous-leg swimming. In this familiar form of aquatic locomotion, both hind legs simultaneously move through a rapid extension propulsion stroke, which is then followed by a synchronized recovery stroke where both hind legs are simultaneously pulled back up to the body. Similar to the more advanced anurans (suborder Neobatrachia) used in the study, the primitive species *Bombina variegata* (suborder Archeobatrachia, family Bombinatoridae) also exhibits a synchronized swim kick pattern.

Here we report that *Scaphophus holbrookii* swims with the alternate-leg kick pattern exhibited by the most morphologically archaic extant species of frogs (Green and Cannetella 1994. Ethol. Ecol. Evol. 5:233–245). Field observations of *S. holbrookii* swimming in vernal pools in Cape May Co., New Jersey, USA, on the evening of 20 March 2010 (by DMG) and in Charles City Co., Virginia, USA, on the evening of 29 March 2010 (by JDK) confirm that this species swims with the same alternate-leg swimming pattern described by Abourachid and Green (1999, *op. cit.*). *Scaphiopus holbrookii* alternates the movements of its hind limbs and extends its forelimbs out in front of its body when swimming. Because *S. holbrookii* is in the suborder Mesobatrachia, this observation raises questions about the evolutionary point at which a synchronized pattern of aquatic locomotion became prominent in anurans.

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TESTUDINES — TURTLES

***CHELONIA MYDAS AGASSIZII* (East Pacific Green Seaturtle). DIET.** The East Pacific Green Turtle is considered the most carnivorous of all Green Turtle subpopulations worldwide (Bjorndal 1997. *In* Lutz and Musick [eds.], The Biology of Sea Turtles, pp. 199–231. CRC press, Boca Raton, Florida). Novel green turtle diet items have been reported, including consumption of the sea pen, *Ptilosarcus undulatus* (Seminoff et al. 2002. Copeia 2002:266–268), pelagic red crabs, *Pleuroncodes planipes* (Lopez-Mendilaharsu et al. 2005. Aquatic Conserv: Mar. Freshwater Ecosyst. 15:259–269), tunicates and crustaceans (Amorocho and Reina 2007. Endang. Species Res. 3:43–51), hydrozoans, scyphozoans, nematodes, annelids, molluscs (Carrion-Cortez et al. 2010. J. Mar. Biol. Assoc. U.K. 1–9), and sponges, *Craniella* sp. and *Suberites aurantica* (Rodriguez-Baron 2010. MS thesis. Centro Interdisciplinario de Ciencias Marinas [CICIMAR-IPN]. 98 pp.). It has been suggested that such dietary diversity is a response to the energy requirements of these animals in the early life stages, facilitating nutritional (e.g., protein) gains for development and maturation (Bjorndal 1985. Copeia 1985:736–751) and optimizing digestion time (Amorocho and Reina 2008. J. Exp. Mar. Biol. Ecol. 360:117–124). It has also been noted that *C. mydas* diet is influenced by resource availability (Balazs 1980. NOAA Tech. Memo. NOAA-TM-NMFS-SWFS-7; Garnett et al. 1985. Wildl. Res. 12:103–112) and that diet selection is linked to the composition and capacity of the hind-gut microflora, which may change as turtles grow and/or occupy different habitats (Bjorndal 1980. Mar. Biol. 56:147–154).

During two field trips in 2009 we collected food samples from the esophagi of 21 Green Turtles (body mass 14–65 kg, and straight carapace length [SCL ± 0.1 cm] from 40.3–73.4 cm; mean SCL = 54.83 ± 83.6 cm) captured at Laguna Ojo de Liebre (LOL; 27.5908333–27.9166667°N and 113.9983333–114.1666667°W) located in the El Vizcaino Biosphere Reserve, Baja California Sur, Mexico. The anemone *Palythoa ignota* was present in 18 of the total samples, and it comprised 68.76% of the total volume. Turtle mean body condition index (BCI) was 1.48 (range = 1.25–2.06), similar to the values reported in previous studies (Seminoff et al. 2003. J. Mar. Biol. Assoc. U.K. 83:1355–1362; Koch et al. 2007. Mar. Biol. 153[1]:35–46) and indicative of good health of the animals (Bjorndal et al. 2000. Ecol. Appl. 10:269–282).

To our knowledge this is the first report of targeted anenome consumption by Green Turtles. The fact that *P. ignota* occurred in such high proportion among a substantial number (85.7%) of turtles suggests that this colonial cnidarian is a major food resource for Green Turtles at LOL, and that these turtles have the capacity to assimilate nutrients from this invertebrate species (Bjorndal 1990. Bull. Mar. Sci. 47[2]:567–570).

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***CHELONIA MYDAS AGASSIZII* (Black [Pacific] Seaturtle). EPIBIONT BARNACLES.** The taxonomy of *Chelonia mydas* is controversial; some authors reject the designation of subspecies (e.g., Ernst and Lovich 2009. Turtles of the United States and Canada, 2nd ed., Johns Hopkins Univ. Press) but traditionally *Chelonia m. agassizii* Bocourt 1868 is the form recognized in the Pacific and Indian Oceans. A melanistic (black) form, *C. mydas carrinegra*, was described from the coast of Baja California (Caldwell 1962. Los Angeles Co. Mus. Contrib. Sci. 50:1–8) but black turtles are now known from other regions of the Pacific, including Japanese waters (Abe and Minami 2008. Nippon Suisan Gakkaishi 74:230–233). Three species of sea turtles are known to nest on the Japanese coast: *Caretta caretta*, *Chelonia mydas* (non-melanistic), and *Eretmochelys imbricata*, and the commensal barnacles of those sea turtles were listed by Hayashi (2009. Umigame Newsletter of Japan 81:2–17). There are apparently no previous records of the barnacles attached to black *C. mydas* from Japan. Additionally, few records exist for epibionts on Black Seaturtles anywhere (Green 1998. NOAA Tech. Mem. NMFS-SEFSC-412. p. 63; Lazo-Wasem et al. 2007. Bull. Peabody Mus. Nat. Hist. 48:153–156; Nichols 2003. Biology and Conservation of Sea Turtles in



FIG. 1. The barnacle *Platylepas hexastylos* on carapace and plastron of *Chelonia mydas agassizii*.

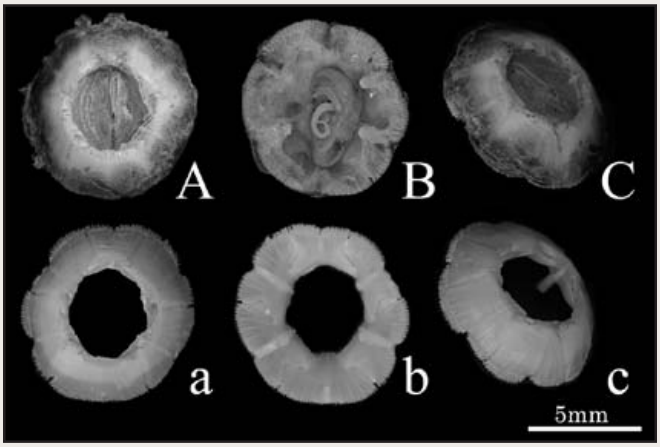


FIG. 2. Close-up of the barnacles *Platylepas hexastylos* found on *Chelonia mydas agassizii*.

Baja California, Mexico. PhD dissertation, University of Arizona, Tucson. 474 pp.; Zullo 1991. *In* M. J. James [eds.], Galápagos Marine Invertebrates: Taxonomy, Biogeography, and Evolution in Darwin's Islands, pp. 173–192. Plenum Press, New York). In this note, we report the epibiont barnacles found on a Black Seaturtle from Japanese waters. This report also represents the northernmost record of a Black Seaturtle and the first record of barnacles attached on a Black Seaturtle in the western Pacific.

On 7 September 2009, a black *C. mydas* was caught in a fishing net at Miyako, Iwate, Japan (39.40°N, 141.58°E). This turtle was measured (standard carapace length, 53.8 cm; standard carapace width, 43.8 cm) and tagged (Sea Turtle Association of Japan [STAJ] plastic tags, No. 64800 on the right hind flipper and No. 64801 on the left hind flipper), and a sample of barnacles were collected and preserved in 99% ethanol solution, and identified in the laboratory. Materials examined were deposited in Fujukan, the Museum of the University of Ryukyus, under accession numbers RUMF-ZC 02009–02011. After investigation, the animal was released but unfortunately it was stranded the next day (fishermen in Kyofuku-Maru, Fisheries Cooperative Association of Funakoshi Bay, pers. comm.). This turtle had many barnacles (>100 individuals) attached on the carapace, plastron, and flippers. All of these barnacles were identified as *Platylepas hexastylos* (Fabricious, 1798) (Fig. 1). Previous studies reported the occurrences of *Platylepas decorata* Darwin 1854, *Stomatolepas praegustator* Pilsbry 1910, *Cylindrolepas darwiniana* Pilsbry 1916, and *Platylepas hexastylos* on Black Seaturtles in the eastern Pacific. *Platylepas hexastylos* is cosmopolitan and known to attach to various species of sea turtles; phylogeography and population genetics of this species might provide information on the macro scale distribution and migration of sea turtles.

The field study was assisted by STAJ, and supported by grants from National Geographic, the Japan Society for the Promotion of Science (19255001), and JSPS Research Fellowship for Young Scientists (21-7432). We gratefully acknowledge the Hidejima set net fishermen in the Fisheries Cooperative Association of Miyako for providing the living Black Seaturtle specimen.

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***CHELYDRA SERPENTINA* (Common Snapping Turtle). BIFID TAIL.** Regeneration can be defined as the ability to reproduce relatively complicated organs or structures after they have been lost through injury (Kuchling 2005. Chelon. Cons. Biol. 4[4]:935–937). The best examples of tail regeneration are found in extant reptiles that exhibit caudal autotomy, for example, lizards (with the exception of most agamids, a few iguanids, and the varanids) and tuataras (*Sphenodon*). Turtles do not exhibit caudal autotomy and very little is known about their tail regeneration. Kuchling (2005, *op. cit.*) reports the occurrence of bifid tail regeneration in an individual adult male *Emydura* sp. in Western Australia, which indicates that the tails of chelonians may have some regenerative capacity. Herein, I report a bifid tail, and possible tail regeneration, in an individual *Chelydra serpentina* found in a pond in New York City. This is apparently the first published report of a bifid-tailed turtle in North America.

I captured an adult male *Chelydra serpentina* (straight-line carapace length = 414 mm, plastron length = 330 mm, carapace width = 376 mm) with a bifid tail in a baited hoop trap in a 0.4-ha pond in Alley Pond Environmental Center, Queens, New York, USA, on 25 September 2007. The tail of the turtle was much shorter than is typical. The tip of the tail was bifurcated in the horizontal plane with mirror duplication and the bifurcation point was positioned 55 mm posterior from the cloaca. The same individual was recaptured several times in 2008 and 2009 as a part of a long term mark-recapture study.

Turtles have demonstrated the capacity to regenerate their shells but the regenerative capability of the turtle tail is poorly known. Etheridge (1967. Copeia 1967:699–721) suggested that in non-autotomous lizards, extensive tail regeneration only occurs after tail loss involving damage to vertebrae (*in* Kuchling 2005, *op. cit.*). Previous research suggests that the bifid or multiple regeneration of a tail most likely results from damage to a vertebra. Records of bifid tail regeneration have been published for several lizards (*in* Mata-Silva 2010. Herpetol. Rev. 41:352–353). However, not all cases of multiple tail occurrences can attributed to regeneration; cases of developmental axial bifurcation have also been reported (Kuchling 2005, *op. cit.*). Kuchling (2005, *op. cit.*) demonstrated that the bifid tail of the *Emydura* sp. was a case of regeneration, based on a radiograph. Because there was no radiographic or histological examination on the bifid-tailed *Chelydra serpentina* reported here, it cannot be determined whether this specimen was an example of a regeneration phenomenon or represents a case of axial bifurcation. Further investigations are needed to better understand tail regeneration in turtles.

I acknowledge the staff of Alley Pond Environmental Center and Peter Warny, who provided valuable support and logistics in the field. I thank Anders Rhodin who kindly provided literature sources and Gerard Kuchling for providing valuable comments on the manuscript.

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***CHELYDRA SERPENTINA* (Snapping Turtle). OVERWINTER TISSUE NECROSIS.** On 15 April 2007, an unusually warm spring day (24°C), several large Snapping Turtles were surface basking in shallow water in the northwest corner of Gimlet Lake, Crescent Lake National Wildlife Refuge, Garden County, Nebraska, USA. The site was a flooded pool ca. 10 m × 20 m, fed by small artesian springs along the shore, and was the probable overwintering site for these turtles. I was able to hand-capture one individual, a male of 36 cm carapace length. Subsequent cold weather and dispersal of the snappers from the pool prevented capture of other individuals in the area. Closer inspection of the turtle revealed considerable tissue damage and necrosis only to the tongue, roof of the mouth, and the extremities (Figs. 1A–C), and was consistent with severe frostbite. This was my first observation of this condition among >2000 captures of snappers on the Refuge over thirty years. Following processing, this turtle was released at the capture site, and has not been recaptured, but it is not known whether the turtle survived this condition. It is also not clear how this damage was incurred, but it was consistent with terrestrial activity during sub-freezing activity. Winter temperatures had been erratic (December, 3.2°C above normal; January, 0.9°C below; February, 1.6°C below; March, 5.2°C above; and April, 0.3°C below), and perhaps this turtle had been active during March (the warmest March in at least 40 years), and

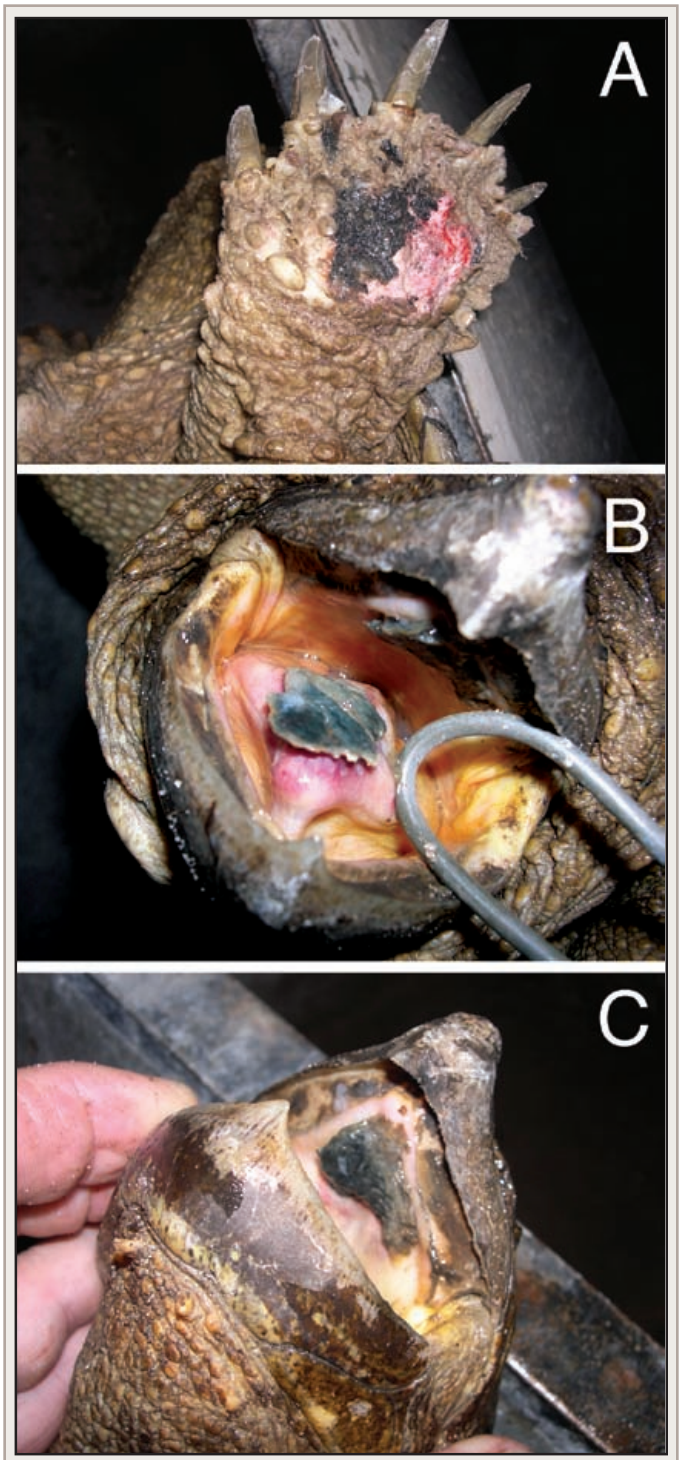


FIG. 1. Severe necrosis of ventral surface of right rear foot (A, top), dorsal surface of tongue (B, middle), and ventral surface of the palate (C, bottom) on a Nebraska Snapping Turtle captured 15 April 2007.

subsequent cold weather forced its terrestrial (or over-ice) migration to warmer water.

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***GOPHERUS AGASSIZII* (Desert Tortoise). NON-NATIVE SEED DISPERSAL.** Sahara Mustard (*Brassica tournefortii*) is a non-native, highly invasive weed species of southwestern U.S. deserts. Sahara Mustard is a hardy species, which flourishes under many conditions including drought and in both disturbed and undisturbed habitats (West and Nabhan 2002. *In* B. Tellman [ed.], Invasive Plants: Their Occurrence and Possible Impact on the Central Gulf Coast of Sonora and the Midriff Islands in the Sea of Cortes, pp. 91–111. University of Arizona Press, Tucson). Because of this species' ability to thrive in these habitats, *B. tournefortii* has been able to propagate throughout the southwestern United States establishing itself in the Mojave and Sonoran Deserts in Arizona, California, Nevada, and Utah. Unfortunately, naturally disturbed areas created by native species, such as the Desert Tortoise (*Gopherus agassizii*), within these deserts could have facilitated the propagation of *B. tournefortii*. (Lovich 1998. *In* R. G. Westbrooks [ed.], Invasive Plants, Changing the Landscape of America: Fact Book, p. 77. Federal Interagency Committee for the Management of Noxious and Exotic Weeds [FICMNEW], Washington, DC). However, Desert Tortoises have never been directly observed dispersing Sahara Mustard seeds. Here we present observations of two Desert Tortoises dispersing Sahara Mustard seeds at the interface between the Mojave and Sonoran deserts in California.

On 24 May 2010, we observed several Sahara Mustard seeds on the carapace of two male Desert Tortoises at our study site, a utility-scaled renewable energy wind park (33.95168°N, 116.667295°W, WGS84) in southern Riverside County, California. One tortoise had six *B. tournefortii* seeds adhered to the cervical scute and first vertebral scute, the seam between the first right marginal and the cervical scute, and on the dried epoxy holding the radio antenna to the carapace (Fig. 1). Another tortoise had a single Sahara Mustard seed on the second vertebral scute. Interestingly, Sahara Mustard has several modes of seed dispersal including, when moist, adhering to mobile organisms by a sticky substance (Minnich and Sanders 2000. *In* Bossard et al. [eds.], Invasive Plants of California's Wildlands, pp. 68–72. University of California Press, Berkeley, California), which explains our observations. Sahara Mustard seed's primary dispersal mechanism



FIG. 1. A male *Gopherus agassizii* with five visible red seeds of *Brassica tournefortii* adhered to its carapace.

includes wind (i.e., tumbleweed action) and rodents that collect, cache, and consume them (Bangle et al. 2008. West. N. Amer. Nat. 68:334–342). Although the observations reported here provide evidence that Desert Tortoises can also disperse seeds of Sahara Mustard, this mechanism, unlike wind and similar to rodent dispersal, has the potential for specifically introducing the non-native species in disturbed habitats, such as burrow aprons. Others have also reported the potential for Desert Tortoises to disperse other non-native species, such as Red Brome (*Bromus madritensis rubens*; Medica and Eckert 2007. Herpetol. Rev. 38:446–448).

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***MAUREMYS RIVULATA* (Balkan Terrapin). ANOPHTHALMIA.** Congenital defects of the eye, such as anophthalmia, microophthalmia, and cyclopia have been reported in many species of mammals (e.g., Fantes et al. 2003. Nat. Gen. 33:462–462), birds (Berger and Howard 1968. Condor 70:386–387), reptiles (Frye 1991. Biomedical and Surgical Aspects of Captive Reptile Husbandry, Volume II. Krieger Publ. Co., Malabar, Florida; Hindebrand 1930. J. Elisha Mitchell Sci. Soc. 46:41–53; Millichamp 1990. Proc. Amer. Assoc. Zoo Vet., American Association of Zoo Veterinarians, South Padre Island, Texas, pp. 297–301) and amphibians (e.g., Cheong et al. 2000. J. Comp. Pathol. 123:110–118; Millichamp 1990, *op. cit.*; Schoff et al. 2003. J. Wildl. Dis. 39:510–521), but reports of these conditions are uncommon, especially in the wild.

During a recent fieldtrip in the Southern Cyclades (Greece) in 2009, we examined 814 *Mauremys rivulata* specimens and found one (0.00123%) juvenile specimen near the barrage of Steno, in Livadi on Serifos Island, expressing this deficiency. This specimen clearly lacked eyes (Figs. 1, 2) and also possessed a reduced dental bone. We analyzed the skull dimensions with a portable RX-apparatus (AJEX 9020H, X-ray equipment Verachtert, Antwerp, Belgium). Comparison with a normal turtle (Figs. 1–2) of similar size clearly showed overall skull malformations of the examined specimen. The specimen with bilateral anophthalmia clearly has an enlarged os dentale, reduced maxilla and premaxilla. Additionally, the os nasale, os frontale, and the parietal bones do not appear to be ossified.

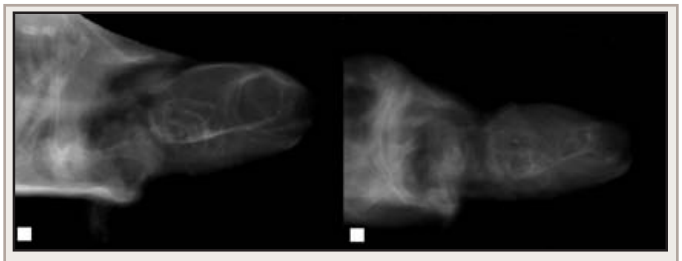


FIG. 1. Radiographic pictures of *Mauremys rivulata* with normal head (left) and with bilateral anophthalmia (right). The white square on the bottom left of each picture represents 1 mm.



FIG. 2. Photographic pictures of specimen with normal head (left) and with bilateral anophthalmia (right). The black and white bars on the scale represent 1 mm each, for a total bar length of 5 mm.

Bilateral anophthalmia is the most rare and severe form of structural eye malformation. Causes of this anomaly can both be induced by genetic mutations (e.g., Fantes et al. 2003, *op. cit.*) or by physical conditions during development (e.g., pathological shortening of the embryonic axis; Ewert 1985. Biology of the Reptilia, Vol. 14, Development A, pp. 75–267. Wiley, New York), but is usually undetermined (e.g., Millichamp 1990, *op. cit.*). All research was conducted under permits provided by the Greek Herpetological Society and the Greek Ministry of Agriculture. All procedures followed were approved by the University of Antwerp Animal Care and Use Committee. Jonathan Brecko is funded by a PhD. grant of the Instituut voor de Aanmoediging van Innovatie door Wetenschap en Technologie in Vlaanderen (Institute for the Promotion of Innovation by Science and Technology in Flanders).

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***PELODISCUS SINENSIS* (Chinese Softshell Turtle). EXTRALIMITAL WINTER SURVIVAL.** *Pelodiscus sinesis* is a medium-sized softshell turtle that ranges from from extreme southeastern Siberia (between the Ussuri and the Amur River drainages) and adjacent Korea through central and southern China, Vietnam, and the islands of Hainan and Taiwan. It has been introduced into the Hawaiian Islands, Guam, one of the Mariana Islands, one of the Bonin Islands, Timor, and California (Lever 2003. Naturalized Amphibians and Reptiles of the World. Oxford University Press, New York; Ernst and Barbour 1989. Turtles of the World. Smithsonian Press, D.C.). *Pelodiscus sinensis* is the most common turtle species bred in turtle farms in Asia (Haitao et al. 2008. Oryx 42[1]:147–150. They are exported to United States and are often sold in Asian food markets of New York City. Here, we report winter survivorship of an individual *Pelodiscus sinensis* in New York City.

We captured an adult male *Pelodiscus sinensis* at Windmill Pond, Alley Pond Environmental Center, Queens, New York (40.4542°N, 73.4516°W) (Fig. 1). Photographs were verified by Balazs Farkas, Hungarian Natural History Museum, Budapest, Hungary. Windmill pond is approximately 0.4 ha, 1.5 m deep, muddy-bottomed, and has abundant aquatic vegetation. Non-native *Trachemys scripta elegans* are the most common turtles in this pond, followed in abundance by native *Chelydra serpentina* and *Chrysemys picta*. Turtle trapping was conducted in this pond starting in 2007 for a long term study. The *P. sinensis* was captured on 24 July 2009 (carapace length = 238 mm; plastron length = 172 mm; weight = 1620 g) and recaptured on 27 July 2010, essentially unchanged. The turtle was captured in a baited hoop net on both occasions. The recapture site was less than 10 m from the original capture site. The turtle was photographed on each capture and we confirmed it as the same individual based

on scar marks on carapace, injury mark on lower jaw, and unique pattern of dark blotches on plastron. The turtle was missing part of its lower jaw, in both 2009 and 2010, but otherwise appeared healthy and in good condition. The turtle had plastral blotches, which suggest that it is probably originated from central Vietnam or a turtle farm anywhere in Vietnam or China (B. Farkas, pers. comm.,13 August 2010) The northernmost population of *P. sinensis* in northern China and Russian Far East hibernate over winter, where the summer temperatures in the hottest month barely exceed 20°C. There are reports of *P. sinesis* in Central and Prospect Parks in New York City but this is the first known report of overwinter survivorship in New York, indicating that they are capable of surviving the local climatic conditions of that area.



FIG. 1. Lateral (top) and ventral (bottom) view of *Pelodiscus sinensis* found in Windmill Pond, Queens, New York.

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***STERNOTHERUS MINOR MINOR* (Loggerhead Musk Turtle). DIET.** The diet of *Sternotherus minor minor* has been well-documented in the literature and includes crayfish, snails, plant material, insects, millipedes, clams, fish, aquatic invertebrates, carrion, small vertebrates, algae and other aquatic plants, small turtles, and *Goniobasis* snails (Ernst and Lovich 2009. Turtles of the United States and Canada, 2nd ed. Johns Hopkins University Press, Baltimore, Maryland). *Sternotherus minor peltifer* has been reported to consume insects, snails, filamentous algae, vascular plants, riverweed (*Podostemum*), clams, crayfish, spiders, fish, bits of rock, and detritus (Ernst and Lovich 2009, *op. cit.*). Herein I report evidence of *S. m. minor* consuming fruits of the Sugarberry Tree, *Celtis* cf. *laevigata*.

On 2 January 2006 an adult male *S. m. minor* (11–12 cm carapace length) was captured along the Itchetucknee River in north-central Florida. The turtle was placed in a 5-gallon bucket of shallow water until it could be photographed. Shortly after capture, the turtle defecated in the bucket. The fecal sample consisted almost exclusively of the crushed remains of endocarps of *C.* cf. *laevigata*. Only crushed (no whole) fruits were found in this sample.

Subsequent investigation of preserved (pre-dissected only) *Sternotherus m. minor* housed in the FLMNH Division of Herpetology collection also yielded small amounts of *Celtis* endocarps within their digestive tracts. Most endocarps found had been crushed (e.g., UF 71608 and UF 71604), but a whole seed was also found in the intestine of one turtle (UF 71604).

As a result of these findings, ca. 14 *C. leavigata* fruits were added to the enclosure of two captive *S. m. minor*. Both floating and sunken fruits were readily consumed by the captive turtles within minutes of deposition. The fruits were manipulated in the turtles' jaws until the hard endocarps were broken, indicated by a loud popping sound, after which the turtles would swallow. Any fragments of exocarps and/or endocarps inadvertently expelled during intake were pursued and eaten.

Questions arise as to what frequency *Celtis* fruits are consumed by *Sternotherus m. minor*, what role *Celtis* seeds might play with regards to nutritional value, morphology, and habitat preferences of *S. m. minor*, as well as the role of *S. m. minor* acting as a potential seed disperser through the riparian systems it occupies. The expanded alveolar surfaces in *S. m. minor* are a presumed adaptation for durophagy—a diet comprised primarily of mollusks such as snails and clams (Ernst and Lovich 2009, *op. cit.*). This adaptation also allows *S. m. minor* to completely crush the rigid seeds of *Celtis*. Crushed *Celtis* endocarps do resemble crushed gastropod shells, and for this reason it is plausible that *Celtis* remains might have been overlooked or misidentified by investigators in previous dietary studies of *S. minor*, particularly if mixed with crushed gastropod shells. Because *Celtis*

sp. endocarps contain high concentrations of calcium carbonate (Yanovsky et al. 1932. Science 75[1952]:565–566), future studies could explore the nutritional of these fruits in *S. minor*. Additionally, the range and associated riparian habitats of *C. laevigata* are strikingly similar to those of which were once referred to as the *Sternotherus carinatus* complex, which is currently recognized as *Sternotherus carinatus*, *Sternotherus depressus*, *S. m. peltifer*, and *S. m. minor*. Further work might explore the extent of any dependency or even interdependency between this group and *C. laevigata*.

I thank Donna Ruhl for help in identifying *Celtis* remains, K. Krysko for allowing me to examine preserved specimens in the FLMNH Division of Herpetology collection. K. Krysko, D. Ehret, A. Hastings, M. Nickerson, and J. Harding provided helpful comments on this manuscript.

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CROCODYLIA — CROCODILIANS

***ALLIGATOR MISSISSIPPIENSIS* (American Alligator). DIET.** *Alligator mississippiensis* inhabits swamps, marshes, and other freshwater bodies of water in the southeastern United States (Ambercrombie and Delaney 1986. J. Wildl. Manag. 50:348–353). It is an apex predator, an opportunistic eater, and it is considered a keystone species (Abercrombie and Delaney 1986, *op. cit.*). *Alligator mississippiensis* is known to prey upon crustaceans, such as Blue Crab (*Callinectes sapidus*), fish, snakes, turtles, birds, and mammals, such as Nutria (Valentine 1972. J. Wildl. Manag. 36:809–815). Cannibalism has also been observed in this species (Giles and Childs 1949. J. Wild. Manag. 13:16–28).

We collected and dissected 20 stomachs of *A. mississippiensis* to investigate stomach parasitism. Specimens had been captured and killed by hunters during the alligator harvesting and hunting season up to 24 h prior at a processing center from 26–29 August 2010. Alligators were caught in the East Zone, a geographic zone designated by the Louisiana Fisheries and Wildlife Department. Dissection of one of the stomachs yielded an intact specimen that was later identified as a Gulf Crayfish Snake (*Regina rigida sinicola*). Research has shown that crocodilians can digest prey items within 12 h if the prey is not large and does not contain bony plates or an exoskeleton (Diefenbach 1975. Comp. Biochem. Physiol. 51:259–265). Therefore, it may be inferred that the snake was ingested shortly before the capture of the alligator.

The snake was identified based upon scalation, morphology, and coloration (Fig. 1). This is the first report of *R. r. sinicola* as a prey item of *A. mississippiensis*, although the congeneric *Regina alleni* has been previously documented (Delany and Abercrombie 1986, *op. cit.*).

We thank Chris Plott and the American Tanning and Leather Company for allowing us to conduct our research, and their help in obtaining samples. We also thank Ruth Elsey and the Louisiana Department of Wildlife and Fisheries for all their assistance in this project.

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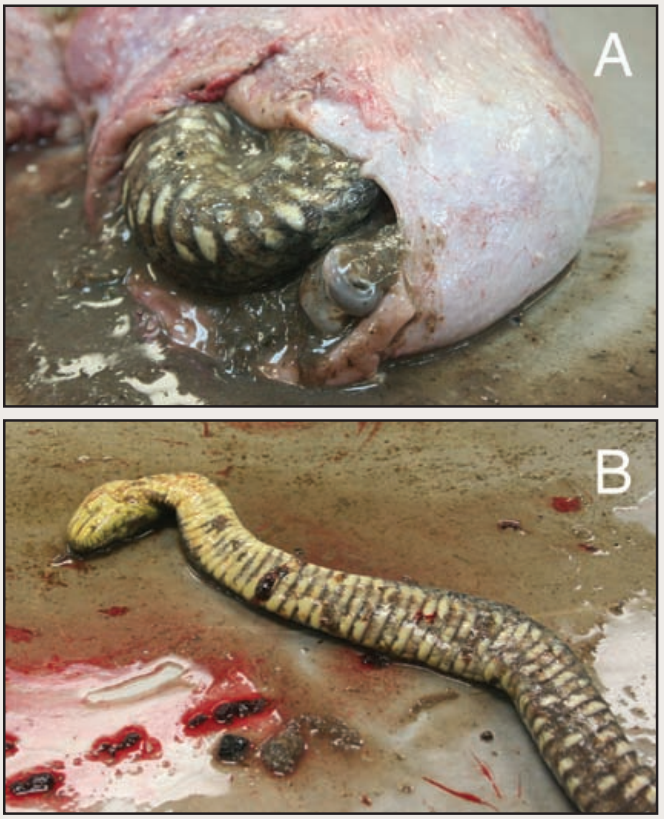


FIG. 1A. *Regina rigida sinicola* in the stomach of *Alligator mississippiensis*. 1B. Underside of *Regina rigida sinicola* after removal from stomach.

***CAIMAN CROCODILUS* (Spectacled Caiman). PREY.** Crocodilians are top predators adapted to aquatic habitats (Shyrley et al. 2009. Oryx 43:136–145). The diet of *Caiman crocodilus* has been reported to consist of terrestrial invertebrates, such as freshwater crabs and coleopterans, more so than terrestrial vertebrates, such as mammals, reptiles, and anurans (Magnusson et al. 1987. J. Herpetol. 21:85–95; Thorbjarnarson. 1993. Herpetologica 49:108–117).

We conducted spotlight surveys from a boat to evaluate crocodilian populations at Sapucuá Lake (between 1.75°N, 56.31°W and 1.86°N, 55.98°W) in the municipality of Oriximiná, in the northern part of the state of Pará, Brazil. On 26 May 2010 at 1900 h, one *Caiman crocodilus* (estimated SVL 39.5 cm) was observed with a Marine Toad (*Rhinella marina*; SVL = 95 mm; mass = 80 g) in its mouth biting down on the toad's parotoid glands. The caiman escaped before it could be captured for data collection, leaving the dead toad behind. The amphibian was collected and deposited at the herpetological collection of Museu de História Natural Capão da Imbuia at Curitiba, Paraná state, Brazil (MHNCI 7186).

Parotoid glands contribute to anuran protection against predators and parasites (Almeida et al. 2007. Contrib. Zool. 76:145–152; Sakate and Lucas de Oliveira. 2000. J. Venom. Anim. Toxins 6:46–58), due to pharmacological activity. Indolealkylamine is the main compound found in the skins of bufonids (Cei et al. 1972. *In* W. F. Blair [ed.], Evolution in the Genus *Bufo*, pp. 233–243. University of Texas Press, Austin, Texas), acting as a vasoconstrictor, convulsant, hallucinogen, and cholinergic agent

(Maciel et al. 2003. Comp. Biochem. Physiol. B 134:641–649). In Australia, where *R. marina* was introduced, *Crocodylus johnstoni* individuals of intermediate size class died after the ingestion of the toads due to the absence of physiological adaptations against its highly toxic secretions (Letnic et al. 2008. Biol. Conserv. 141:1773–1782). However, *Crocodylus porosus*, which naturally coexist with *R. marina*, presented a better performance against the bufotoxin when compared to *C. johnstoni* during physiological tests (Smith and Phillips 2008. Pac. Conserv. Biol. 12:40–49). Predation behavior on *Rhinella marina* by Schneider's Dwarf Caiman (*Paleosuchus trigonatus*) was described in the state of Pará, Brazil (Assis and Santos 2007. Herpetol. Rev. 38:45); however, there are no data available regarding the interaction between *R. marina* and *C. crocodilus*. Among terrestrial vertebrates reported in the diet of *C. crocodilus*, anurans are few (Magnusson et al. 1987. J. Herpetol. 21:85–95; Thorbjarnarson 1993, *op. cit.*; Da Silveira and Magnusson 1999. J. Herpetol. 33:181–192). Percentage of prey occurrence analysis and relative digestibility can bias the presence of vertebrate prey items in the diet of *C. crocodilus* (Thorbjarnarson 1993, *op. cit.*). We believe that field observations on crocodilian foraging behavior can provide relevant data about predator-prey interactions. Meanwhile, captive experiments can help in understanding feeding habits and preferences as well as in investigating resistance to bufotoxins.

We thank MRN (Mineração Rio do Norte S.A.) for the financial support of the studies conducted on the herpetofauna of FLONA Saracá-Taquera, Pará State, and Instituto Chico Mendes de Conservação da Biodiversidade, Porto Trombetas (ICMBio), PA unit, for permits.

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***CROCODYLUS MORELETII* (Morelet's Crocodile). SMALL POND USE.** At 0047 h on 14 June 2008, during rainy conditions, we encountered a juvenile (571 mm SVL) female *Crocodylus moreletii* in a small pond (3.0 m × 4.3 m, 70 mm deep) in the middle of a small road surrounded by a brackish water wetland in Reserva de la Biosfera Los Petenes, Campeche, México (20.087032°N, 90.401258°W). At 0139 h, we observed another juvenile female *C. moreletii* (700 mm SVL) in a second small pond (1.4 × 3.0 m, 90 mm deep at 20.089948°N, 90.433983°W).

These observations are of interest since both ponds were in the middle of a small road surrounded by brackish water wetlands that are more indicative habitat for this species. We encountered another three *C. moreletti* (one adult, two juveniles) in open waters within the actual wetlands the same night. No previous reports exist of this behavior (Alvarez del Toro and Sigler 2001. Los Crocodylia de México. IMERNAR, PROFEPA, México 134 pp.). It is possible that the animals utilizing these smaller sites may take advantage of the low salinity in the rainwater filled ponds or the small ponds may provide food resources based on the potential prey we observed in similar ponds on this area (*Lithobates brownorum, Leptodactylus melanonotus, Ollotis valliceps, Smilisca baudinii*).

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SQUAMATA — LIZARDS

***AMEIVA CORAX* (Little Scrub Island Ground Lizard). FEEDING BEHAVIOR.** *Ameiva corax* is endemic to Little Scrub Island, off the northeast coast of Anguilla in the British West Indies (18.308°N, 62.967°W). It is reported to consume the eggs of seabirds that nest on the island (Hodge et al. 2003. The Reptiles and Amphibians of Anguilla, British West Indies. Anguilla National Trust, Anguilla. 72 pp.). Herein we report on an individual lizard of this species opening, partially consuming, and ultimately killing the chick of a Laughing Gull (*Larus atricilla*) nesting on the island (Fig. 1).

At 0904 h on 12 June 2009 we noticed a lizard in a gull nest attempting to open one of three eggs present. The egg was opened in less than one minute; it is unclear whether the lizard cracked the egg or whether it had already been cracked by an emerging chick. We have observed other lizards cracking and consuming the contents of gull eggs in earlier stages of development, but since it appeared to be near hatching, the chick may have cracked the egg itself. Nevertheless, the lizard successfully opened the egg and we monitored its activity from ca. 5 m away. Once the egg was opened, the lizard first consumed the yolk sac, then began to claw and bite at the lower abdomen of the chick, eventually opening a hole in the chick's skin, pulling out and consuming part of its intestinal tract. Although the lizard bit and clawed at other parts of the chick, particularly the legs and wings, it did not pierce the skin elsewhere. The lizard (individually identifiable by



FIG. 1. *Ameiva corax* consuming the intestinal tract of a Laughing Gull (*Larus atricilla*) chick.

its shedding skin pattern) left the nest and returned three times between 0910 and 0930 h. When the lizard left the nest at 0930 h, the chick was still alive and moving. An adult gull returned to the nest at 0930h and incubated the remaining eggs. We monitored the nest until 1000 h, at which point the chick was still alive and an adult gull was on the nest. The chick was dead at 1230 h when we next checked on it.

We thank the Government of Anguilla for allowing us to work on Little Scrub Island. We are particularly grateful to Karim Hodge and Rhon Conner in the Department of the Environment for their support, encouragement, and advice. We also thank Captain Nature Boy Webster for transporting us to and from the island every day.

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***AMEIVA LEPTOPHRYS* (Delicate Ameiva). ENDOPARASITES.** *Ameiva leptophrys* frequents lowland humid forests of southwestern Costa Rica and Panama to western Colombia (Savage 2002. The Amphibians and Reptiles of Costa Rica. A Herpetofauna Between Two Continents, Between Two Seas. Univ. Chicago Press, Chicago, Illinois. 934 pp.). There are, to our knowledge, no reports of helminths from *A. leptophrys*. The purpose of this note is to establish the initial helminth list for *A. leptophrys* as part of an ongoing survey of lizard helminths from Central America.

Six *A. leptophrys* (mean SVL = 112.3 mm ± 17.4 SD, range: 85–130 mm) from Costa Rica were examined from the herpetology collection of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California: Limón Province (LACM 174920); Puntarenas Province (LACM 174922–174924, 174927, 174928). Lizards were collected 1963–1967. The digestive tract was removed and the esophagus, stomach, small and large intestines were examined for helminths using a dissecting microscope. Nematodes and cystacanths were cleared in a drop of glycerol on a microscope slide, cover-slipped and studied using a compound microscope. Three species of Nematoda were found: *Physaloptera retusa* (stomach) prevalence, number infected/number examined × 100 = 83%, mean intensity, mean number helminths ± 1 SD = 49.8 ± 33.6 SD, range = 2–85; *Spinicauda spinicauda* (large intestine) prevalence = 67%, mean intensity = 3.8 ± 2.2 SD, range = 1–6 and two ascarid larvae (Angusticaecinae) (body cavity) prevalence = 17% and one species of Acanthocephala as 11 cystacanths (body cavity) prevalence = 17%. Helminths were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland: *Physaloptera retusa* (USNPC 103860); *Spinicaud spinicauda* (USNPC 103861); Ascarid larvae (USNPC 103862); Oligacanthorhynchid cystacanths (USNPC 103863).

Physaloptera retusa is widely distributed in the Western Hemisphere. Records are summarized in McAllister et al. (2010. Comp. Parasitol. 77:184–201). Physalopterid nematodes utilize insect intermediate hosts (Anderson 2000. Nematode Parasites of Vertebrates. Their Development and Transmission. CABI Publishing, Oxon, UK, 650 pp.). Lizards are infected through their diet. *Spinicauda spinicauda* is known from a variety of South American lizards (Baker 1987. Mem. Univ. Newfoundland, Misc. Pap. 11:1–325; Ramallo et al. 2009. J. Parasitol. 95:1026–1028). Lizards become infected when they ingest eggs; no intermediate host is utilized (Anderson 2000, *op. cit.*). Eggs of various species assigned to the order Ascaridida, Angusticaecinae will hatch in a variety of vertebrate intermediate hosts and develop into third-stage infective larvae (Anderson 2000, *op. cit.*). Because these larvae were in cysts, the possibility that *A. leptophrys* was serving as a transport (= paratenic host) must be considered. Cystacanths are larval forms infective to the definitive host (Kennedy 2006. Ecology of the Acanthocephala. Cambridge Univ. Press, Cambridge, UK. 249 pp.) and reach the lizard when it ingests an infected insect. No further development occurs in the lizard which serves as a paratenic transport host. *Physaloptera retusa*, *Spinicauda spinicauda*, ascarid larvae and oligacanthorhynchid cystacanths in *A. leptophrys* are new host records. Costa Rica is a new locality record for *S. spinicauda*.

We thank Christine Thacker (LACM) for permission to examine individuals of *A. leptophrys*, which are part of the Costa Rica Expeditions Collection donated to LACM in 1998 by Jay M. Savage. Cecilia Nava and Daisy Salguero (Whittier College) assisted with dissections.

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***ANOLIS ALTAE* (High Anole). ENDOPARASITES.** *Anolis altae* occurs in premontane and lower montane zones of the Cordillera de Tilarán, Cordillera Central and Cordillera de Talamanca of Costa Rica at elevations of 1220 to 2000 m (Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna Between Two Continents, Between Two Seas. Univ. Chicago Press, Chicago, Illinois. 934 pp.). Five *A. altae* (mean SVL = 45.2 mm ± 1.6 SD, range: 44–48 mm) collected November 1963 and deposited in the herpetology collection of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California, USA were examined for helminths (Costa Rica: Cartago Province, LACM 149056, 149063–149065, 169075).

The digestive tract was removed through a mid-ventral incision, and the esophagus, stomach and small and large intestines were examined for helminths under a dissecting microscope. Cestodes were found in the small intestine, nematodes were found in the small and large intestines. Cestodes were regressively stained in hematoxylin, dehydrated in ethanol and mounted in Canada balsam; nematodes were cleared in glycerol and cover-slipped on a microscope slide. Both preparations were studied under a compound microscope. The cestodes were identified as *Mathevotaenia panamaensis* (prevalence [number infected lizards/number lizards examined × 100] = 40%, mean intensity [mean number helminths per infected lizard ± 1 SD] = 36.0 ± 39.6, range: 8–64). The nematodes were identified as *Falcaustra costaricae* (prevalence = 40%, mean = 1.0). Helminths were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland: *Mathevotaenia panamaensis* (USNPC 103944); *Falcaustra costaricae* (USNPC 103945).

Mathevotaenia panamaensis was recently described from *Sceloporus malachiticus* from Panama by Bursey et al. (2010. Acta Parasitol. 55:53–57). *Anolis altae* is the second host to harbor this parasite although an unidentified species of *Mathevotaenia* was found in *Anolis humilis* from Nicaragua (Goldberg et al. 2010. Comp. Parasitol. 77:242–246). *Mathevotaenia panamaensis*, a member of the Anoplocephalidae, utilizes an arthropod as an intermediate host (Roberts and Janovy 2005. Gerald D. Schmidt

& Larry S. Roberts' Foundations of Parasitology, McGraw Hill Higher Education, Boston, Massachusetts. 702 pp.). *Falcaustra costaricae* was described from *Anolis* (as *Norops*) *tropidolepis* from Costa Rica (Bursey et al. 2004. J. Parasitol. 90:598–603). It has been reported from anurans (Goldberg and Bursey 2010. J. Nat. Hist. 44:1755–1787) and *Anolis lionotus* from Costa Rica (Bursey and Brooks 2010. Comp. Parasitol. 77:232–235). The life cycle of *Falcaustra costaricae* is unknown, but it is thought that larvae may utilize invertebrates as paratenic (= transport) hosts which are infective upon ingestion by lizards (Anderson 2000. Nematode Parasites of Vertebrates: Their Development and Transmission. CABI Publishing, Oxon, UK. 650 pp.). *Anolis altae* represents a new host record for *M. panamaensis* and *F. costaricae*. Costa Rica is a new locality record for *M. panamaensis*.

We thank C. Thacker (LACM) for permission to examine *A. altae* which are part of the Costa Rica Expeditions Collection donated to LACM by J. M. Savage in 1998.

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***ANOLIS CYBOTES CYBOTES* (Hispaniolan Stout Anole) and *ANOLIS MARRON* (Jacmel Gracile Anole). PREDATION/PREY.** On 18 August 2009, at approximately 1400 h, while sampling anoles at a coastal locality near Marigot, Haiti (approximately 20 km E of Jacmel), we encountered a large adult male *Anolis c. cybotes* vertically perched with its head pointing upwards on the trunk of a coconut palm with the hindquarters of an adult female *A. marron* protruding from its mouth (Fig. 1). The *A. c. cybotes* held its ground as we moved around it and photographed it *in situ*, at one point partially extending its dewlap and doing a pushup. After photographing the *A. c. cybotes* with its prey we captured it using a noose and placed it in a cloth bag, which we subsequently stored in an empty plastic cooler inside an air-conditioned car for the remainder of the day. At some point during capture of the *A. c. cybotes*, the *A. marron* autotomized its tail, which we were not able to locate. At 2230 h (8.5 h after discovery and capture), the *A. c. cybotes* still had not fully swallowed the *A. marron* and the feet of the prey continued to protrude from its mouth. At this time, we euthanized the *A. c. cybotes*, extracted the *A. marron*, and measured, photographed, and preserved both specimens (Fig. 2). The *A. c. cybotes* measured 70 mm SVL and weighed 9.0 g. The *A. marron* measured 45 mm SVL and weighed 2.4 g. The predated anole was intact, but partially digested externally when removed from the stomach of its predator. The skin on the anterior half of the anole had been largely digested, and the skull and forelimbs of the anole showed considerable loss of structural integrity.

Although the conditions of its captivity were artificial, the fact that this large male *A. c. cybotes* failed to fully ingest the *A. marron* prey item over an 8.5 h period, and the fact that considerable digestion of the anterior portion of the *A. marron* took place over this period suggests that (1) this prey item was close to the maximum size possible for this anole, and (2) that *A. c. cybotes* may occasionally capture and eventually consume prey items that it may not fully ingest upon capture. It is possible that the progress of ingestion was correlated with the progress of digestion of the prey's anterior portion. However, it is also possible



FIG. 1. Male *Anolis cybotes cybotes* with female *A. marron* protruding from its mouth, photographed *in situ* immediately after discovery.

COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND

that these observations largely reflect the influence of the capture and containment of the predator. The *A. c. cybotes* was kept inactive at a slightly lower temperature than it was captured at, so we urge caution in interpreting its rate of digestion following capture.

Although intraguild predation events have been reported several times in *Anolis*, the sizes of the anoles involved have rarely been measured quantitatively (Gerber 1999. *Anolis* Newsletter V:28–39). This event is noteworthy in that the predator consumed a congener measuring 64.3% of its own SVL and approximately26.7% of its own body weight (possibly more, given the lost tail and partial digestion of the *A. marron* specimen at the time of measurement). To our knowledge, this is the highest

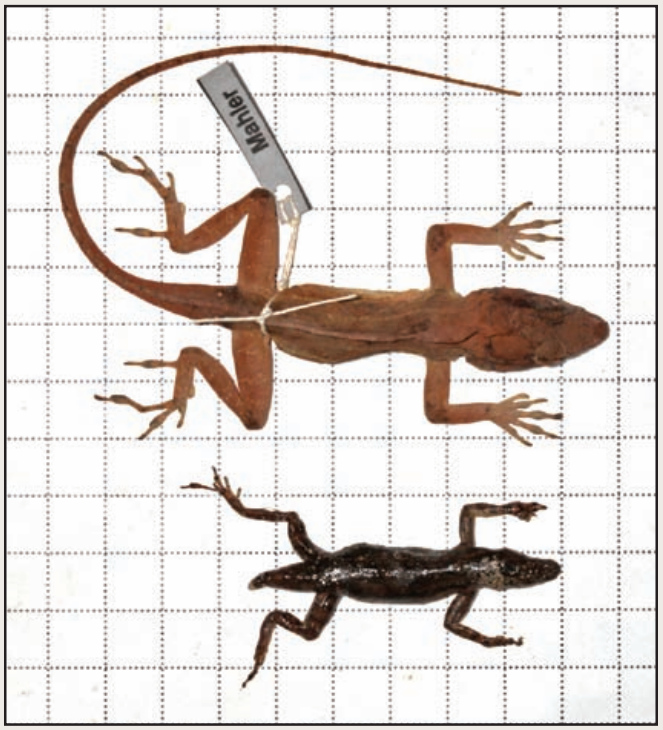


FIG. 2. Male *Anolis cybotes cybotes* (top) and female *A. marron* (bottom), immediately after the latter was extracted from the stomach and mouth of the former, but after at least 8.5 h of digestion. Grid unit = 1 cm.

prey:predator ratio quantified for anoles (Gerber 1999, *op. cit.*; Losos 2009. Lizards in an Evolutionary Tree. Univ. of California Press, California. 507 pp.). In experiments, *A. cybotes* is known to feed on juveniles of other anole species (e.g., *A. bahorucoensis*, *A. coelestinus*, and *A. distichus*), as well as juvenile *A. cybotes* (Fitch and Henderson 1987. Amphibia-Reptilia 8:69–80). Although previous natural predation of *A. cybotes* on *A. marron* has not been reported, *A. cybotes* has been documented to predate on a species closely related to *A. marron*, *A. distichus*. *Anolis marron* coexists with *A. cybotes* throughout the former species' entire range, and these two species clearly compete, often using the same food resources on a single tree (pers. obs.). This observation demonstrates that these two species interact as predator and prey as well as resource competitors.

These specimens are deposited in the Museum of Comparative Zoology at Harvard University (*A. c. cybotes* = MCZ R-188077; *A. marron* = MCZ R-188078).

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***ANOLIS EQUESTRIS* (Knight Anole). REPRODUCTION.** *Anolis equestris* is native to Cuba and has been introduced to Florida and Oahu, Hawaii (Henderson and Powell 2009. Natural History of West Indian Reptiles and Amphibians. Univ. Press Florida, Gainesville. 495 pp.). Anecdotal information on reproduction is in Henderson and Powell (*op. cit.*), from Florida (Meshaka et al. 2004. The Exotic Amphibians and Reptiles of Florida. Krieger Publ. Co., Malabar, Florida. 155 pp.; Meshaka and Rice 2005. *In* Meshaka and Babbitt [eds.], Amphibians and Reptiles Status and Conservation in Florida, pp. 225–230. Krieger Publ. Co., Malabar, Florida) and Hawaii (McKeown 1996. A Field Guide to Reptiles and Amphibians in the Hawaiian Islands. Diamond Head Publishing, Los Osos, California. 172 pp.). *Anolis equestris* was first noted in Oahu in 1981 (McKeown, *op. cit.*). The purpose of this note is to add to the knowledge on *A. equestris* reproduction from a histological examination of gonadal material from Hawaii.

A sample of 17 *A. equestris* from Oahu, Hawaii consisting of 10 adult males (mean SVL = 148.4 mm ± 4.1 SD, range: 115–157 mm), five adult females (mean SVL = 143.4 mm ± 3.9 SD, range: 140–148 mm), and two subadult females (mean SVL = 108.0 mm ± 31.8 SD, range: 85–130 mm) from Oahu, Hawaii was examined from the Bishop Museum (BPBM), Honolulu, Hawaii, USA: BPBM:11805, 12200, 12201, 12209, 13718, 14163, 14821, 14822, 14998, 16960, 16961, 20982, 20983, 25352, 31892, 31893, 33835. *Anolis equestris* were collected 1993 to 2009.

An incision was made on the lower left lateral side of the abdomen to expose the gonads. The left testis was removed from males and the left ovary was removed from females for histological examination. Oviductal eggs and enlarged follicles (> 4 mm) were counted. Tissues were embedded in paraffin; sections were cut at 5 µm and stained with hematoxylin followed by eosin counterstain. Histology slides are deposited in BPBM.

The only stage observed in the testicular cycle was spermiogenesis in which the lumina of the seminiferous tubules were lined by sperm or clusters of metamorphosing spermatids. Males undergoing spermiogenesis were found in the following months (sample size in parentheses): February (N = 2); April (N = 2); May (N = 4); July (N = 1); August (N = 1), indicating a prolonged period of spermiogenesis. The smallest reproductively active male (BPBM 14163) measured 115 mm SVL and was from May. The smallest reproductively active female (BPBM 16961) measured 140 mm SVL and was from April. Three adult females from April each contained oviductal eggs. In one, (BPBM 12200) the eggs were fused and could not be counted. The other two females contained evidence that consecutive clutches are produced as one of them (BPBM 11805) contained one oviductal egg and two follicles (> 4 mm) in both the right and left ovaries and the other (BPBM 16961) contained both one oviductal egg and one enlarging follicle (> 4 mm). *Anolis equestris* produces clutches of one to two eggs (Haselhaus and Schmidt 1995. Caribbean Anoles. T.F.H. Publ., Neptune City, New Jersey. 64 pp.). Two females (BPBM 20982, 20983) from December contained quiescent ovaries (no yolk deposition) suggesting some seasonality in the ovarian cycle of *A. equestris* in Hawaii.

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***CTENOSAURA OEDIRHINA* (Roatán Spiny-tailed Iguana). SAUROPHAGY.** Here we report an instance of saurophagy by *Ctenosaura oedirhina* at Arch's Iguana Farm, French Harbour, Roatán, Honduras (16.3575°N, 86.441111°W). The farm is a rehabilitation center for *Iguana iguana* (Green Iguana). The *Iguana iguana* are free roaming but at an artificially high density. Wild *C. oedirhina* also occur at this site as it falls within their natural distribution, however this species is present in much lower numbers.

At ~1125 h on 17 August 2008 we observed an adult *Ctenosaura oedirhina* actively pursue and consume a juvenile *Iguana iguana*. The *I. iguana* was caught by the posterior region of its torso after a short chase, and after some maneuvering the *Ctenosaura* proceeded to swallow the *Iguana* whole from the rear. The entire predation event was very rapid, lasting only approximately three minutes from the initiation of the chase to complete ingestion.

To our knowledge this is the first account of saurophagy in *Ctenosaura oedirhina*. This is a relatively under-studied iguanid species, with very few reports concerning its dietary preferences. The most reliable of available accounts is found in the proposal for the inclusion of this species into CITES Appendix II (reference number CoP15 Prop. 11), where *Ctenosaura oedirhina* was "assumed to be mainly herbivorous and to feed opportunistically on small invertebrates."

It is possible that this predation was a unique event triggered by the artificially high density of *Iguana iguana* at this site. However, given that other closely related species of *Ctenosaura* have been documented to include saurian prey in their diet, with saurophagy observed in both *C. bakeri* (Dirksen and Gutsche 2006. Elaphe 14:51–52) and in *C. similis* (Henderson 1973. J.Herpetol. 7:27–33), it seems likely that this type of predation event might be more commonplace than is currently accredited to this genus.

Further study would be required to elucidate whether this observation represents an isolated opportunistic predation event or whether saurian prey comprise a regular part of the natural diet of *C. oedirhina*.

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***CYCLURA CYCHLURA INORNATA* (Allen Cays Rock Iguana). MORTALITY.** Ingestion of unnatural or atypical food items (especially human-produced refuse) by reptiles in nature can have significant negative consequences (Mrosovsky et al. 2010. Mar. Pollution Bull. 58:287–289). Here we report the apparent death of a *Cyclura cychlura inornata* following the ingestion of a marine sponge (Porifera). On 18 May 2009, a marked female (15.7 years old; SVL ca. 28 cm) in a long-term study (Iverson et al. 2006. Biol. Cons. 132:300–310) was found dead and nearly mummified along the southwest coastline of Leaf Cay in the Allen Cays in the northern Exuma Islands (site detailed in Iverson et al. 2004. Herpetol. Monogr. 18:1–36). Although the carcass was nearly completely intact, detritivores had partially opened the ventral body wall, exposing the contents of her abdomen. The internal organs were mostly gone, but the space was completely filled with a large piece of dried marine sponge (ca. 4 cm × 2 cm × 1.5 cm; Fig. 1). It appeared that she had ingested the large sponge, but that it had obstructed her gastrointestinal tract, causing her death. Whether she ingested the sponge during natural foraging, or during a tourist feeding event on the nearby landing beach is unknown. For example, on 25 May 2009 one of us (CRK) observed an Exuma Islands Iguana (*Cyclura cychlura figginsi*) on Bitter Guana Cay in the central Exuma Islands foraging at the high tide line, and ingesting a small piece of marine sponge by its own choice (Fig. 2). In addition, we regularly observe both subspecies of iguana in the Exumas foraging among the wrack at the high tide line. However, we have also observed tourists throwing litter and beach wrack (from seaweed to sticks to dead sponges) toward iguanas almost daily on the Leaf Cay beach to induce them to come to feed. More specifically, we have occasionally observed the ingestion of sponges by Allen Cays Iguanas under these conditions. Our observations suggest that although dead sponges may occasionally be part of the natural diet of these iguanas, they may sometimes be hazardous to the iguana's health.



FIG. 1. Mummified carcass of Allen Cays Iguana that apparently died because of ingestion of a marine sponge.



FIG. 2. Exuma Island Iguana foraging on a marine sponge at high tide line.

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***HEMIDACTYLUS AGRIUS* (Country Leaf-toed Gecko). REPRODUCTION.** Communal nesting has been recorded in several species of lizards, including the families Teiidae (Magnusson and Lima 1984. J. Herpetol. 18:73–75), Polychrotidae (Rand 1967. Herpetologica 23:227–230; Estrada 1987. Poeyana 353:1–9), and,

in particular, Gekkonidae (Rand, *op. cit.*; Greer 1967. Breviora 268:1–19; Vitt et al. 1997. Copeia 1997:32–43). Rand (1967, *op. cit.*) suggested two possible explanations for communal egg laying: the attractiveness of sites suitable for oviposition and the relative scarcity of suitable places to spawn.

Communal nests have been found in litter, logs and fallen branches on the ground, holes in logs, termite mounds, rocky pools, anthropogenic debris and buildings, among others (Greer, *op. cit.*; Rand, *op. cit.*; Krysko et al. 2003. Amphibia-Reptilia 24:390–396). The genus *Hemidactylus* is characterized by oviposition of one or two eggs (Krysko et al., *op. cit.*). Herein we present a new record of communal nesting by *Hemidactylus agrius*. Little is known about this gecko's ecology and the data presented here contribute to the knowledge of the reproductive biology of this species.

On 26 September 2009, during field research in a semiarid area at the Fazenda Experimental Vale do Curu, near Pentecoste municipality, State of Ceará, Brazil (3.82145°S, 39.33824°W; datum WGS 84), we found a nest with five eggs of *Hemidactylus agrius*. The eggs were found aggregated and juxtaposed to one another, oviposited at ground level in a small brick house.

The eggs were handled carefully and taken to the laboratory of herpetology at the Núcleo Regional de Ofiologia da UFC (NUROF – UFC), where they were monitored until hatching so the identification of the species could be determined. Hatching occurred from 11–16 November 2009. Hatchling voucher specimens were placed in the Coleção Herpetológica da UFC – CHUFC (L 4105, L 4106, L 4107, L 4108 and L 4109).

Based on the number of eggs and hatching dates, we believe at least three females participated in oviposition at the nest. To our knowledge, this is the first known occurrence of communal egg laying in *H. agrius*.

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***HEMIDACTYLUS BROOKII* (Brook's Gecko). AVIAN PREDATION.** *Hemidactylus brookii* is one of the most common gekkonids in the Indian subcontinent (Smith 1943. The Fauna of British India, including Ceylon and Burma. Reptilia and Amphibia. Vol. III. Serpentes. Taylor and Francis, London. xii + 583 pp.; Daniel 2002. The Book of Indian Reptiles and Amphibians. Bombay Natural History Society. Oxford University Press; Sharma 2002. The Fauna of India and the Adjacent Countries–Reptilia (Sauria) Volume II, pp. 107–108. Director, Zoological Survey of India, Kolkata). *Hemidactylus brookii* is a crepuscular and nocturnal species. It occurs in many different habitats such as rocky areas and grassy plains. Despite its abundance and wide distribution, little is known about the ecology of this species or its natural predators. Here we report on the predation of this gecko by the Oriental Magpie Robin (*Copsychus saularis*), a typically insectivorous and diurnal forest bird.

On 31 July 2010 at 1715 h, we photographed an adult male *C. saularis* in Jiwaji University campus, Gwalior, Madhya Pradesh, India (26.63278°N, 77.864167°E; 119 m elev.) consuming an adult *H. brookii* after killing it by beating it several times on the forest floor (Fig. 1). The bird then consumed the lizard in small pieces.

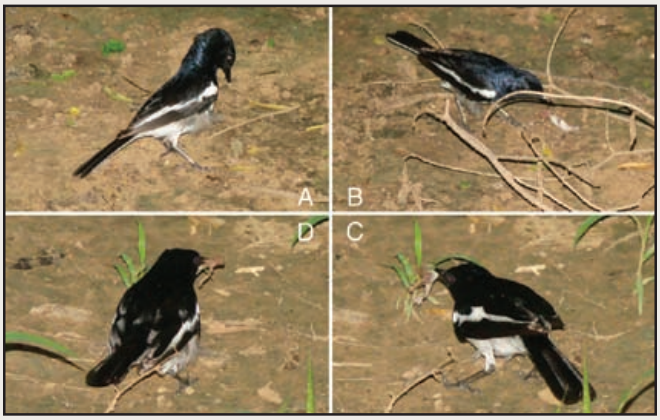


PHOTO BY VIVEK SHARMA

FIG. 1. The progressive steps (A, B, C, and D) of predation on *Hemidactylus brookii* by *Copsychus saularis*.

The Oriental Magpie Robin typically feeds on insects (Kazmierczak and Perlo 2006. A Field Guide to the Birds of India. Om Book Services, New Delhi, India. pp. 264). Our observations are the first photographic evidence of predation by this bird on a lizard. This note is of further interest as it reports a diurnal predator consuming a nocturnal prey species.

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***LYGODACTYLUS KLUGEI* (NCN). SEXUAL DIMORPHISM, HABITAT, DIET.** *Lygodactylus klugei* is a small-bodied, diurnal and arboreal gecko from the caatinga of northern South America. Here we provide data on sexual dimorphism, habitat use, and diet of *L. klugei* from the northernmost caatinga of Brazil. We captured 22 adults (11 males and 11 females) from 16 February to 3 March, 2010 at the Fazenda Experimental do Vale do Curu (FEVC), Pentecoste Municipality, Ceará State, Brazil (03.42°S, 39.33°W). We recorded perch height (PH) and perch circumference (PC) from the place each lizard was first sighted. In the lab, lizards were euthanized with an injection of sodium thiopental (Tiopental®) and fixed with 10% formalin. Next, we measured snout–vent length (SVL) and determined sex via inspection of gonads. Diet was determined by inspection of stomach contents (to taxonomic order for insects), and the volume of prey estimated by using the formula for a prolate spheroid. Diet niche breadth was calculated following Pianka (1973. Ann. Rev. Ecol. Syst. 4:53–74). We also calculated the standardized diet niche breadth by dividing the niche breadth value by the total number of prey categories, which allows for comparisons with other studies.

Males were smaller than females in SVL: males = 26.4 ± 1.6 mm, females = 28.4 ± 0.9 mm (*t*-test: $t = 3.51$, $P = 0.002$), as was found for *L. klugei* from Exu, Pernambuco, Brazil (Vitt 1986. Copeia 1986:773–786). All lizards were found on tree trunks. Neither PH nor PC differed between the sexes: PH males = 30 cm, females = 37.5 cm (Mann–Whitney *U*: 11, $P = 0.46$); PC males = 34.3 ± 13.9, females = 29.7 ± 7.8 cm (*t*-test: –0.91 P 0.37). At FEVC, stomach contents included six types of prey (Araneae, Coleoptera,

Diptera, Hemiptera, Hymenoptera, and insect larvae). Coleopterans were the most prevalent prey item found in stomachs (89%), representing 55% of the total numerical prey frequency, followed by dipterans (22%). Volumetrically, coleopterans represented 48% and hymenopterans 28% of the prey eaten. Food niche breadth was 2.94 and standardized niche breadth was 0.49. Prey volume was not related to lizard SVL or to head width (all variables $\log_{10}$ transformed).

Lygodactylus klugei from FEVC seem to eat a relatively narrow range of prey with coleopterans and hemipterans accounting for the majority of the total prey volume. Vitt (1995. Occas. Pap. Oklahoma Mus. Nat. Hist. 1:1–29) found that *L. klugei* from Exu, Pernambuco, Brazil ate 25 prey types, but mainly termites and spiders. Diet niche breadth for *L. klugei* from Vitt's (1995, *op. cit.*) study was 8.33 (standardize niche breadth = 0.24). Thus, *L. klugei* from FEVC, despite the inclusion of fewer prey types, seems to exploit food resources more equitably compared to the population from Exu.

We are grateful to the administrative staff of the Fazenda Experimental do Vale do Curu for logistical support. We also thank R. Espinoza for reviewing this note. CABG benefitted from a grant from Conselho Nacional de Desenvolvimento Científico e Tecnológico proc. 35.0241/2008-2 and DZ received a grant from Fundação Cearense de Apoio ao Desenvlvimento Científico e Tecnológico BMD-0008-00060.01.14/10. The study was conducted under Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio) permit 21551-1.

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***MABUYA DORSIVITTATA* (NCN). REPRODUCTION.** *Mabuya dorsivittata* is a viviparous scincid with a relatively wide geographical distribution in South America. The only available data on reproduction were based on a few specimens from a population in southeastern Brazil (Vrcibradic et al. 2004. Herpetol. J. 14:109–112). Here we expand upon the knowledge of the reproductive biology of this species.

A mark-recapture study was conducted from February 2001 to January 2004 using pitfall traps with drift-fencing in Santa Maria, Rio Grande do Sul, Brazil. In February 2001, a gravid female *Mabuya dorsivittata* was captured, measuring 65.21 mm snout–vent length (SVL); 129.31 mm tail length (TL), and weighed 4 g. Five young were born the same day of capture; two females and three males, all with the same weight (0.75 g). Measurements ranged from 29.07–32.26 mm SVL (mean = 31.8 ± 1.4) and 40.45 to 55.27 mm (TL) (mean = 46.6 ± 5.6). The neonate skinks were released three days after birth near the capture location of the mother, but none was recaptured until January 2004. The mother was recaptured only once, 10 months later, non-gravid. The brood size we report here differs from that recorded from southeast Brazil: 3.2 ± 0.45 embryos (Vrcibradic et al. 2004, *op. cit.*). This report is important for future studies on the reproductive aspects of *M. dorsivittata*, as only limited data on this species are available.

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***PLESTIODON OBSOLETUS* (Great Plains Skink). LIFE HISTORY.** Herein we report information on habitat, morphology, and activity from 813 captures of 505 individual *Plestiodon obsoletus* from riparian forest habitat along the middle Rio Grande in central New Mexico. We used toe-clipping during a mark-recapture study conducted from late May to mid-September each year from 2000 to 2006 to evaluate the effects of non-native plant and fuels removal on herpetofauna (Bateman et al. 2008. Restoration Ecol. 16:180–190). We monitored herpetofauna at 12 sites spanning 140 km of river from Albuquerque (35.008380°N, 106.681805°W) to Bosque del Apache National Wildlife Refuge (33.805122°N, 106.859980°W). The climate is semiarid to arid (Tuan 1962. Annals Assoc. Amer. Geograph. 52:51–68). Trapping arrays were located in riparian forests containing a mixture of native Rio Grande Cottonwood (*Populus deltoides wislizenii*) and willow (*Salix* spp.), and non-native plants, including saltcedar (*Tamarix chinensis* and *T. ramosissima*) and Russian Olive (*Elaeagnus angustifolia*).

Plestiodon obsoletus were captured by means of pitfall (5-gallon, 18.9 liter buckets) and funnel traps, 55% and 45%, respectively. Snout–vent length (SVL), vent–tail length (VTL), and mass were measured (Table 1). Sex was often difficult to determine and was confirmed only when experienced technicians were available. Skink hatchlings became active in July and captures peaked during the first half of August. For example, of the number of hatchlings captured for the first time, 3.2% (mean SVL = 38.4 mm, range = 36–41 mm, N = 7) occurred from 1–15 July, 32.7% (mean SVL = 37.9 mm, range = 31–64 mm, N = 72) from 16–31 July, 36.4% (mean SVL = 38.0 mm, range = 34–45 mm, N = 80) from 1–15 August, 23.2% (mean SVL = 40.8 mm, range = 36–58 mm, N = 51) from 16–31 August, and 4.5% (mean SVL = 48.2 mm, range = 38–58 mm, N = 10) from 1–15 September. Adult activity, in terms of total captures, peaked in the latter half of July. For example, of total number of adult captures, 7.5% (mean SVL = 91.7 mm, range = 63–111 mm, N = 39) occurred from 1–15 June, 20.0% (mean SVL = 93.7 mm, range = 61–115 mm, N = 104) from 16–30 June, 19.0% (mean SVL = 88.8 mm, range = 60–113 mm, N = 99) from 1–15 July, 23.5% (mean SVL = 89.1 mm, range = 63–124 mm, N = 122) from 16–31 July, 16.5% (mean SVL = 91.0 mm, range = 68–120 mm, N = 86) from 1–15 August, 10.4% (mean SVL = 87.6 mm, range = 67–120 mm, N = 54) from 16–31 August, and 3.1% (mean SVL = 88.6 mm, range = 71–117 mm, N = 16) from 1–15 September. Only 22% (114 of 505) of marked skinks were recaptured and most sightings occurred during the summer of marking, although some skinks were seen up to three summers later. For example, 25 skinks were recaptured the summer following first capture, 9 were recaptured two summers later, and 5 were recaptured three summers later. From these data, we documented that skinks grew the fastest in their first year and that growth slowed as skinks reached adult size. For example, skinks first encountered as hatchlings and recaptured the following summer grew by 60% in SVL (mean first summer SVL =

TABLE 1. Morphological characteristics of *Plestiodon obsoletus* captured during 2000–2006 from the riparian forest along the middle Rio Grande in central New Mexico. Data are summarized by captures of individuals < 5 g mass (hatchlings) and > 5 g mass (juveniles and adults). Data represent captures and individuals occur more than once in table.

	Hatchling (< 5 g)				Juvenile, Adult (> 5g)			
Sex	Number of captures	Mean SVL (mm)	Mean VTL (mm)	Mean Mass (g)	Number of captures	Mean SVL (mm)	Mean VTL (mm)	Mean Mass (g)
Female	6	44.3 (± 3.70)	53.8 (± 2.09)	2.2 (± 0.56)	129	88.2 (± 1.08)	120.2 (± 3.01)	16.8 (± 0.63)
Male	5	42.6 (± 2.82)	56.4 (± 5.78)	1.3 (± 0.34)	52	92.5 (± 1.89)	123.9(± 4.53)	19.5 (± 1.22)
Unknown	236	39.5 (± 0.32)	49.8 (± 0.93)	1.2 (± 0.05)	340	90.7 (± 0.60)	123.3 (± 1.68)	16.9 (± 0.36)

44.2 mm, range = 41–48 and one year SVL = 70.8 mm, range = 51–83, N = 10). Whereas skinks first encountered as adults and recaptured the following summer grew only 10% in SVL (mean first summer SVL = 88.6 mm, range = 63–113, and the following year SVL = 97.4 mm, range = 80–109, N = 19). We documented similar hatchling period and SVL compared to other locations in New Mexico (Belfit and Belfit 1985. Southwest. Nat. 30:612–614) and in Kansas (Hall and Fitch 1971. Kansas Acad. Sci. 74:93–98). However, this report summarizes lesser known growth rates for *Plestiodon obsoletus* tracked over time in a field setting.

The Middle Rio Grande Conservancy District, Bosque del Apache National Wildlife Refuge, and Albuquerque Open Space permitted access to study sites. The University of New Mexico Animal Care and Use Committee approved field techniques (protocol #20415). This study was funded by the USDA Forest Service – RMRS Middle Rio Grande Ecosystem Management Unit, Joint Fire Sciences Program, National Fire Plan, US FWS Bosque Improvement Initiative, and USFS S&PF NM Collaborative Forest Restoration Program. This note was improved by helpful suggestions by James M. Walker.

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***POLYCHRUS GUTTEROSUS* (Berthold's Bush Anole). ENDOPARASITES.** *Polychrus gutterosus* occurs in lowland and lower premontane evergreen forests from northwestern Honduras and western Costa Rica to northwestern Ecuador at 6–700 m elevation (Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna Between Two Continents, Between Two Seas. University of Chicago Press, Chicago, Illinois. 934 pp.). To our knowledge there is one report of helminths from *P. gutterosus*; Bursey et al. (2007. Comp. Parasitol. 74:108–140) reported one species of trematode, *Parallopharynx arctus*, and two species of nematodes, adults of *Physaloptera retusa* and larvae of *Ophidascaris* sp., from *P. gutterosus* collected in Panama. The purpose of this note is to add new records to the helminth list for *P. gutterosus* collected in Costa Rica as part of an ongoing study of the biodiversity of helminths of amphibians and reptiles from Central America.

Three *P. gutterosus* (mean SVL = 141.7 mm ± 49.1 SD, range: 85–170 mm) deposited in the herpetology collection of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California from Costa Rica were examined: LACM 166772, from Heredia Province, collected December 1973; LACM 166773, from Alajuela Province, collected March 1966; LACM 166776, from Puntarenas Province, collected October 1974.

The body cavity was opened by a mid-ventral incision and the digestive tract was removed and opened. The esophagus, stomach and small and large intestines were examined for helminths. Only LACM 166772 contained helminths. Five digeneans were found in the small intestines (prevalence = number infected lizards/all lizards examined × 100 = 33%); mean = 5.0. One nematode (prevalence = 33%; mean = 1.0) was found in the large intestines. The digeneans were regressively stained in hematoxylin, mounted in Canada balsam, studied as whole mounts under a compound microscope and identified as *Mesocoelium monas*. The nematode was cleared in a drop of glycerol on a microscope slide, cover-slipped, studied under a compound microscope and identified as *Strongyluris panamaensis*. Voucher helminths were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland, USA as *Mesocoelium monas* (USNPC 104037); *Strongyluris panamaensis* (USNPC 104038).

Mesocoelium monas is cosmopolitan in distribution and is known from a large number of hosts (Goldberg et al. 2009. Comp. Parasitol. 76:58–83). Infection occurs with the ingestion of an infected snail or vegetation supporting cysts (Thomas 1965. J. Zool. 146:413–446). *Strongyluris panamaensis* was described from *Anolis biporcatus* from Panama (Bursey et al. 2003. J. Parasitol. 89:118–123). It has also been reported in *Anolis* (as *Norops*) *limifrons* (Bursey and Goldberg 2003. J. Parasitol. 89:573–576), *Ctenosaura quinquecarinata*, and *Sceloporus variabilis* from Costa Rica (Bursey and Brooks 2010. Comp. Parasitol. 77:232–235). *Strongyluris panamaensis* is a member of the Heterakidae which do not utilize intermediate hosts in their life cycle (Anderson 2000. Nematode Parasites of Vertebrates. Their Development and Transmission. CABI Publ. Oxon, UK. 650 pp.). Lizards likely become infected when they ingest contaminated substrate while feeding. *Polychrus gutterosus* represents a new host record for *Mesocoelium monas* as well as *Strongyluris panamaensis*.

We thank C. Thacker (LACM) for permission to examine *P. gutterosus*, part of the Costa Rica Expeditions Collection donated to LACM in 1998 by J. M. Savage. Daisy Salguero (Whittier College) assisted with dissections.

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***RIAMA OCULATA* (NCN). PREHENSILE TAIL and NEW HABITAT TYPE.** The presence of prehensile tails or other arboreal



FIG. 1. *Riama oculata* demonstrating use of prehensile tail on first author's finger.

characteristics have not previously been documented in the semi-fossorial gymnophthalmnid genus *Riama* (Reyes-Puig 2008. Check List 4:366–372) and although there is no specific information on habitat preferences, all reports indicate capture in forested environments. *Riama oculata* is commonly encountered in the Santa Lucía Cloud Forest Reserve, Nanegal, Pichincha, Ecuador, with primary capture through the use of pitfall traps with drift fences (Maddock et al., unpubl. data). Here we present evidence of a prehensile tail in an individual *R. oculata* upon capture.

At 1550 h on 19 July 2010 an adult *R. oculata* was captured by hand as it moved along the ground inside the sugarcane plantation at the Santa Lucía Cloud Forest Reserve (00.11819°N, 078.60915°W; WGS 84). Upon capture the specimen wrapped its tail securely around the left index finger of its captor; the other hand was slowly moved away and the *R. oculata* remained attached hanging by its tail (Fig. 1). After examination in the field, the specimen was released back to the original location of capture.

These observations, including the presence of this species in a novel agricultural habitat and a prehensile tail, are new records for this poorly studied species and therefore increase knowledge of its natural history and behavior.

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FIG. 1. *Riama unicolor* with autotomized tail emerging from stomach following specimen examination.

***RIAMA UNICOLOR* (NCN). FEEDING and NEW ALTITUDINAL RANGE.** *Riama unicolor* is a small, semi-fossorial gymnophthalmnid found on the Pacific versant cloud forests of northwestern Ecuador between 2390–3300 m (Copping 1957. Brit. J. Herpetol. 2:54–56; Kizirian 1996. Herpetol. Monogr. 10:85–155). This species is known to prey on small invertebrates and maggots, although this information is based only on captive observations (Kizirian 1996, *op. cit.*). Here we report on an observation of *R. unicolor* consuming its recently autotomized tail and provide new data on the altitudinal range for the species.

At 1346 h on 1 July 2010 a *Riama unicolor* (SVL = 8.8 mm; weight = 1 g) was captured just below the surface of the ground by excavation at the Santa Lucia Community Reserve, Nanegal, Pichincha, Ecuador (0.11266°N, 78.61143°W; 1775 m elev.). Upon capture the specimen autotomized part of its tail (5.3 mm in length). Both the lizard and its tail were stored in a field container together until the following day. On the morning of 2 July 2010 the specimen was found dead in the container. Tissue was taken from the liver for future DNA analyses and upon inspection the tail was discovered inside the lizard's stomach (Fig. 1). The specimen was deposited at the Museo de Zoología QCAZ, Pontificia Universidad Católica del Ecuador (SC 32463).

This report increases our knowledge of this poorly understood species, extending its range down to altitudes as low as 1775 m and documenting a novel observation on its feeding behavior.

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***SCELOPORUS ORCUTTI* (Granite Spiny Lizard). MINIMUM SIZE AT REPRODUCTION.** *Sceloporus orcutti* ranges from the lower slopes of the Peninsular Range of southern California south to just north of the Cape of Baja California (Stebbins 2003. A Field Guide to Western Reptiles and Amphibians. Houghton Mifflin Co., Boston, Massachusetts. 533 pp.). Reproduction of *S. orcutti* in California is known from a study by Mayhew (1963.

Copeia 1963:144–152) on a population in Riverside Co. The purpose of this note is to report *S. orcutti* reaches reproductive maturity at smaller sizes in Baja California Sur, Mexico, when compared to the southern California population.

Twenty males (mean SVL = 82.8 mm ± 10.4 SD, range = 67–96 mm) and four females (mean = 71.2 mm ± 9.0 SD, range = 63–84 mm) from Baja California Sur were examined from the herpetology collection of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California: LACM 97335, 97336, 128068–128089. Lizards were collected in 1967, 1975, and 1978. A small slit was made in the lower part of the abdomen and the left gonad was removed for histological examination. Gonads were embedded in paraffin and histology slides were cut at 5µm and stained by hematoxylin followed by eosin counterstain. Enlarged follicles (> 4 mm) or oviductal eggs were counted. Histology slides were deposited in LACM.

Mayhew (*op. cit.*) reported females and males of *S. orcutti* reached maturity at 85 and 90 mm SVL, respectively, in southern California. In Baja California Sur, the smallest mature *S. orcutti* female (LACM 128083) measured 70 mm SVL and contained five enlarged ovarian follicles (> 8 mm diameter); the smallest mature male (LACM 128070) measured 68 mm SVL (spermiogenesis in progress, seminiferous tubules lined by clusters of sperm or metamorphosing spermatids). Both *S. orcutti* were collected in May which is within the height of reproductive activity for this species (Mayhew, *op. cit.*) and are from San José de Comondú (26.0625°N, 56.6900°W; datum WGS 84), which is north of the range of the congeners *S. hunsakeri* and *S. licki* (Grismer 2002. Amphibians and Reptiles of Baja California, Including its Pacific Islands and the Islands in the Sea of Cortés. University of California Press, Berkeley. 399 pp.).

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***SPHAERODACTYLUS PACIFICUS* (Pacific Least Gecko). ENDOPARASITES.** *Sphaerodactylus pacificus* is endemic to Cocos Island (Isla de Cocos), Costa Rica (Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna Between Two Continents, Between Two Seas. University of Chicago Press, Chicago, Illinois. 934 pp.). There are, to our knowledge, no reports of helminths from *S. pacificus*. The purpose of this note is to establish the helminth lists for *S. pacificus* as part of ongoing studies of helminths in lizards from Central America.

Three *S. pacificus* (mean SVL = 40.0 ± 1.5 SD, range: 37–42 mm) deposited in the herpetology collection of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California: (LACM 147972, 147976, 147977), collected April 1965, from Cocos Island (5.533°N, 87.067°W; WGS 84, elev. 610 m), Puntarenas Province, Costa Rica were examined for helminths.

The digestive tract was removed through a mid-ventral incision and the digestive contents from the esophagus, stomach, small and large intestines were examined under a dissecting scope. Nematodes found in the large intestine were cleared in a drop of glycerol, studied under a compound microscope and identified as *Parapharyngodon cubensis*; prevalence (number lizards infected/number lizards examined × 100) = 67%, intensity (number helminths per infected lizard) = 1.0. The *Parapharyngodon cubensis* was deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland, USA as (USNPC 103947).

Selected morphological characters of species within the genus *Parapharyngodon* were presented by Bursey and Goldberg (2005. J. Parasitol. 91:591–599) and we have assigned our specimens to *P. cubensis* based on those characters (i.e., spicule of 70 µm, 7 caudal papillae, smooth cloacal lip in the male, prebulbar ovary and stout tail spike in the female). *Parapharyngodon cubensis* has been found in a wide spectrum of reptiles throughout the West Indies (Dyer et al. 2001. Trans. Illinois State Acad. Sci. 94:161–165) and as a member of the Oxyuroidea, does not utilize an intermediate host (Anderson 2000. Nematode Parasites of Vertebrates. Their Development and Transmission. 2nd ed. CABI Publishing, Oxon, UK. 650 pp.). Transmission likely occurs by ingesting eggs from substrate while feeding. *Sphaerodactylus pacificus* represents a new host record. *Parapharyngodon cubensis* in Costa Rica is a new locality record.

We thank C. Thacker (LACM) for permission to examine *S. pacificus* which are part of the Costa Rica Expeditions Collection donated to LACM in 1998 by J. M. Savage.

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***TROPIDURUS ITAMBERE* (NCN). TONIC IMMOBILITY.** Tonic immobility, also known as "death feigning" or "thanatosis," is exhibited by a great variety of animals (Hoagland 1928. J. Gen. Physiol. 11:715–741). By simulating death, potential prey may inhibit the attack response of a potential predator. Locomotor escape, caudal autotomy, tail waving, and threat displays that may follow tonic immobility are considered secondary mechanisms of defense (Edmunds 1974. Defense in Animals. Longman Group, New York. 357 pp.). A widespread antipredator strategy, tonic immobility has been reported for virtually all vertebrate groups, including fishes (Wells et al. 2005. Mar. Freshwater Behav. Physiol. 38:71–78), snakes (Griffiths et al. 2007. J. Comp. Psychol. 121:123–129), birds (Hohtola 1981. Phys. Behav. 27:475–480) and mammals (Fraser 1960. Can. J. Comp. Vet. Sci. 24:330–334) In lizards, tonic immobility has been reported for species such as *Iguana iguana* (Prestrude and Crawford 1970. Anim. Behav. 18:391–395), *Anolis carolinensis* (Henning and Dunlap 1978. Behav. Ecol. 23:75–86), and *Carlia jarnoldae* (Langkilde et al. 2003. Herpetol. J. 13:141–148). Here, we provide for the first time a brief description of this behavior in *Tropidurus itambere*.

On 9 July 2010, we observed an adult male *T. itambere* (4.99 cm SVL) in a rocky field in the Cerrado bioregion, in the Reserva Biológica Unilavras – Boqueirão, municipality of Ingaí (21.34638°S, 44.99083°W, 1250 m elev.) in the state of Minas Gerais, Brazil. Upon capture, it exhibited tonic immobility for ca. 45 seconds. The behavior persisted after the animal was placed carefully on the ground. After ca. 1 min. the lizard righted itself and fled. During this observation of tonic immobility, the lizard kept its eyes closed and showed no external response to stimulation. The duration of this behavior varies among species and to a lesser degree for individuals within species (Hoagland 1928, *op. cit.*). Among Brazilian lizards, this behavior has been observed in the congeners *Tropidurus torquatus, T. hispidus, T. divaricatus, T. nanuzae* (Bertoluci et al. 2006. Herpetol. Rev. 37:472–473; Frost et al. 2001. Mol. Phylog. Evol. 21:352–371), as well as in *Liolaemus lutzae* (Rocha 1993. Cienc. Cult. 45:116–122), *Eurolophosaurus nanuzae* (Galdino and Pereira 2002. Herpetol. Rev. 33:54), and

E. divaricatus (Kohlsdorf et al. 2004. Herpetol. Rev. 35: 309–391), but has not been reported in *T. itambere* to our knowledge.

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SQUAMATA — SNAKES

***ACROCHORDUS GRANULATUS* (Marine File Snake). ABERRANT COLORATION.** *Acrochordus granulatus* is a coastal marine snake and one of three species in the family Acrochordidae. On 28 October 2009, while conducting research in collaboration with the Philippine National Museum, we observed a collection of twelve specimens in the pet trade that showed variation in color patterns and degree of pigmentation. The specimens were reported to have been collected from a single population in Quezon Province, Luzon Island, Philippines. Seven of the specimens possessed the normal color pattern observed for *A. granulatus* consisting of dark gray to black ground coloration with alternating lateral white bands that are discontinuous on the dorsal surface (Fig. 1C). Two specimens were observed to possess a leucistic color pattern, completely lacking pigmentation on the body, but still possessing dark eye pigmentation (Fig. 1A). The three remaining specimens possessed an intermediate color pattern of predominately white ground coloration and irregular dark gray to black dorsal blotches (Fig. 1B). This intermediate color pattern resulted in a "piebald" appearance, and was likely the result of partial leucism. To our knowledge, this is the first observation of full and partial leucism in *A. granulatus*.



FIG. 1. Two adult females and one adult male *Acrochordus granulatus* showing A) complete leucistic, B) partial ("piebald") leucistic, and C) normal color and pigmentation patterns.

Three specimens were donated to the Philippine National Museum, preserved, and deposited in the herpetological collections (CDS 5521 [female; total length = 550.6 mm; 48.0 g]: Fig. 1A; CDS 5539 [male; total length = 508.6 mm, 40.2 g]: Fig. 1B; CDS 5520 [female; total length = 536.7 mm; 40.0 g]: Fig. 1C).

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***BITIS GABONICA* (Gaboon Viper). DIET AND PREY SIZE.** *Bitis gabonica*, a large terrestrial African viperid, is a strict sit-and-wait predator that frequently remains motionless for days or weeks at ambush sites (Warner 2009. Conservation Biology of the Gaboon Adder [*Bitis gabonica*] in South Africa. Unpubl. MSc thesis. Univ. Witwatersrand, South Africa. 121 pp.). During a radiotelemetry study of *B. gabonica* in northeastern South Africa, on 5 March 2007, a female (SVL = 899 mm; total length = 959 mm; mass = 1242 g) was observed in ambush posture next to a thicket in open woodland habitat (28.27598°S, 32.47460°E, datum: WGS84). On 13 March 2007, 83 m (linear distance) from the previous location, we found the snake with a very large meal in its stomach. Because the study was near its end and the prey record



FIG. 1. Female *Bitis gabonica* with antelope prey (*Cephalophus natalensis*).

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was potentially valuable, the individual was carefully removed from the field and transported to the lab to induce regurgitation. Approximately 15 minutes after removal, the snake was discovered dead. Although *Bitis* in captivity have died after consuming meals close to their own body mass (Haagner 1988. Koedoe 31:246), we attribute the snake's death to stress from transport. A post-mortem (Fig. 1) revealed that the snake had consumed a *Cephalophus natalensis* (Red Duiker). The antelope had been bitten in the lower abdomen, and a single fang was found entangled in its fur. The *C. natalensis* was 104% of the snake's body mass, which is the highest relative prey mass (RPM) recorded for *B. gabonica* and also the first record of ungulate predation by the species in South Africa.

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***BOA CONSTRICTOR* (Boa Constrictor). FORAGING BEHAVIOR.** *Boa constrictor* is often referred to as a sit-and-wait or ambush forager that chooses locations to maximize the likelihood of prey encounters (Greene 1983. *In* Janzen [ed.], Costa Rica Natural History, pp. 380–382. Univ. Chicago Press, Illinois). However, as more is learned about the natural history of snakes in general, the dichotomy between active versus ambush foraging is becoming blurred. Herein, we describe an instance of diurnal active foraging by a *B. constrictor,* illustrating that this species exhibits a range of foraging behaviors.

At 1120 h on 25 May 2007, on Cayo Cochino Grande, Cayos Cachinos, Honduras (15.9711928037812°N, 86.4739467195224°W, NAD 83/WGS 84), we saw several *Artibeus jamaicensis* (Jamaican Fruit Bat) fly from a living Cohune Oil Palm (*Attalea cohune,* Arecaceae) approximately 8 m above the ground. We noticed that the bats were disturbed from their daytime roost (likely beneath a frond of the *A. cohune*) by a *B. constrictor* (male; SVL = 760 mm; total length = 118 mm; 268 g including prey). The snake fell to the ground while simultaneously constricting four bats and continued to constrict and kill all four bats on the ground. Over approximately 1.5 h we observed the snake consume two of the four individuals (one adult male and one adult female) headfirst and then take refuge under nearby palm fronds on the forest floor. The two bats that were abandoned by the snake were a female (42 g) and a male (29 g). After measuring, we released the *B. constrictor* at the point of capture without palpating the two bats it had consumed.

Boa constrictor is known to prey upon at least four species of bats (including *A. jamaicensis*; Esbérard and Vrcibradic 2007. Rev. Brasil. Zool. 24:848–853). Previous observations of bat predation by *B. constrictor* describe snakes entering caves or tree cavities to capture roosting bats during the day (Arendt and Anthony 1986. Carib. J. Sci. 22:219–220; Thomas 1974. J. Herpetol. 8:188). Bats roosting in caves and tree cavities would be a predictable prey source for *B. constrictor*. In contrast, although female *A. jamaicensis* nested in tree hollows and moved day roosts infrequently on Barro Colorado Island, males roosted in foliage and changed day roost sites frequently (every 3–13 days; Morrison 1978. Ecology 59:716–723). We observed this mixed-sex group of *A. jamaicensis* roosting in foliage suggesting a relatively ephemeral roost site. Thus our observations suggest that *B. constrictor* uses active, sometimes diurnal foraging to locate prey such as roosting bats. Additionally, this observation is the first to document a *B. constrictor* apprehending and constricting multiple bats simultaneously.

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***BOIGA DENDROPHILA* (Mangrove Cat Snake). DIET.** *Boiga dendrophila* is a large (to 250 cm total length) colubrid snake, known from both primary and disturbed lowland forests and mangrove swamps of Southeast Asia (Das 2006. A Photographic Guide to the Snakes and Other Reptiles of Borneo. New Holland Publishers, Ltd., London. 144 pp.; David and Vogel 1996. The Snakes of Sumatra: An Annotated Checklist and Key with Natural History Notes. Edition Chimaira, Frankfurt am Main. 260 pp.). Its diet is known to include vertebrates such as frogs, lizards, birds, and rodents; one snake species (*Ahaetulla prasina*) has also been documented (Stuebing and Inger 1999. A Field Guide to the Snakes of Borneo, Natural History Publications, Sdn. Bhd. Kota Kinabalu. 235 pp.).

At 2000 h on 13 September 2009, an adult *B. dendrophila* (total length ca. 1 m) was encountered in tree branches on the bank of Sungei Bawang (01.0613°N, 110.1976°E, datum WGS84), a perennial stream flowing over granite-sandstone substrate at Kubah National Park at the Matang Range, Sarawak, East



FIG. 1. *Boiga dendrophila* consuming a *Parias sumatranus* in Kubah National Park, East Malaysia.

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Malaysia (western Borneo). This individual was observed to attack, subdue, and swallow a juvenile (total length < 1 m) *Parias sumatranus,* a large (to 1.6 m) and dangerously venomous viper. The prey was approached while it was resting on a horizontal branch of a tree overhanging the stream, ca. 3 m from ground. It was then seized by the head, rapidly followed by the tail, which arched forward to grab the neck region of the prey, which was then swallowed in ca. 30 min (Fig. 1). This observation represents the first reports of foraging behavior in *B. dendrophila*, as well as the first record of a venomous snake in its diet.

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***BOIGA IRREGULARIS* (Brown Treesnake). PREDATION AND DIET.** Introduced *Boiga irregularis* on the Western Pacific island of Guam feed on a wide variety of vertebrate prey. Stomach contents of juvenile *B. irregularis* specimens include a large proportion of lizards, especially geckos and skinks (Savidge 1988. J. Herpetol. 22:275–282). Guam is also home to *Varanus indicus* (Mangrove Monitor), which reach an adult size of ca. 560 mm SVL (Wikramanayake and Dryden 1988. Herpetologica 44:338–344). *Varanus indicus* are opportunists that feed primarily on arthropods (Dryden 1965. Micronesica 2:72–76), but they may prey on *B. irregularis* (Fritts and Rodda 1998. Annu. Rev. Ecol. Sys. 29:113–140; McCoid and Witteman 1993. Herpetol. Rev. 24:105). Occasionally the roles are reversed and the snakes prey on monitor eggs (Savidge 1988, *op. cit.*), but in general, interactions between *V. indicus* and *B. irregularis* remain poorly documented.

While working at our main study site in northwestern Guam in the late morning of 12 May 2010, the first two authors observed a large (ca. 500 mm SVL) adult *V. indicus* perched ca. 4 m above ground in a large Fagot Tree (*Neisosperma oppositifolia*). On the ground was a fresh bolus containing the regurgitated remains of a large *B. irregularis*. We scanned the bolus for a PIT tag since virtually all adult snakes in our study population have been previously tagged. The bolus contained the PIT tag from a large male snake that had been captured 22 days previous to this observation. On that date of capture, it measured 1305 mm SVL, 1645 mm total length, and weighed 307 g. At that time, it was in good health and had an above-average condition index of 1.35 (1.00 is the long-term average for snakes across Guam), so we have no reason to suspect the monitor had scavenged a snake that was already dead. Assuming the monitor measured 500 mm SVL, its weight should have been ca. 2 kg (Wikramanayake and Dryden 1988, *op. cit.*). Hence, the snake's mass was approximately 15% of the monitor's mass.

We found evidence for predator-prey role reversal while searching for snakes in the same part of Guam on the evening of 17 May 2010. The third author captured a male *B. irregularis* that was 865 mm SVL and had a gross weight of 71 g, which included an obvious food bulge in its stomach. As part of a study on stomach contents and reproductive characteristics, it was brought to the lab for euthanasia and necropsy the following day. The prey item was found to be a juvenile *V. indicus* (head and neck partially digested, weight of remains 7.8 g, tail length 134 mm).

Predation on *B. irregularis* by *V. indicus* may be uncommon, as the former normally seeks diurnal shelter in arboreal vine tangles, tree hollows, or even underground refugia (unpubl. data); all of which may be difficult for an adult monitor to access. However, the snakes can probably access virtually any nocturnal refugium used by a juvenile monitor, and we suspect that predation pressure may affect recruitment of monitors.

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***BOTHRIECHIS SCHLEGELII* (Eyelash Palm-Pitviper). DIET.** *Bothriechis schlegelii* has been recorded feeding on a variety of small vertebrates including frogs, lizards, birds, and small mammals (Campbell and Lamar 2004. The Venomous Reptiles of the Western Hemisphere. Comstock Publishing Associates, Ithaca, New York. 898 pp.). Given the nocturnal and arboreal habits of *B. schlegelii* it is not surprising that bats have been documented in their diet, yet records of chiropterophagy in this species are limited to only two accounts. In one case, a *B. schlegelii*, found in a shipment of bananas that was believed to have originated in Honduras, regurgitated the nectar-feeding bat, *Glossophaga soricina* (Groves 1961. Herpetologica 17:277). The other, a case from Costa Rica, involved a *B. schlegelii* that contained an unidentified bat in its stomach (Hardy 1994. Sonoran Herpetol. 7:108–113). Here we report the fist record of *B. schlegelii* consuming a *Myotis riparius*.

On 16 August 2008 at 1920 h, a subadult *B. schlegelii* (UF 155962; SVL = 40.6 cm; tail length = 6.8 cm) was found in the process of consuming a *M. riparius* (UF 31760; SVL = 3.6 cm). The incident was recorded by SLT and Juan Francisco López while walking a nocturnal transect, Pamka Buhna, in the Kipla Sait Tasbaika indigenous territory of Reserva de la Biósfera Bosawas, Departamento Atlántico Norte, Nicaragua (14.3653°N, 84.9349°W, datum: WGS84; elev. 186 m). The snake was encountered ca. 3 m above ground holding onto an epiphyte on the truck of a large tree, and was in the latter stages of consuming the bat. It took ca. 5 min for the snake to finish consuming the bat, after which, the snake was collected and later preserved. Both specimens were deposited in the Florida Museum of Natural History.

Approximately 20 species of snakes have been documented feeding on bats in the Neotropics, the majority being boiids and colubrids, with only four representatives of Viperidae (Esbérard and Vrcibradic 2007. Rev. Bras. Zool. 24:848–853). Esbérard and Vrcibradic (*op. cit.*) conclude that most documented cases of bat predation by snakes in the Neotropics are within or around the entrance of bat refuges, indicating the possibility that snakes are drawn to these areas due to the abundant concentration of prey. Hardy (*op. cit.*) stated that the *B. schlegelii* found with a bat in its stomach was encountered sitting near the opening of a tree trunk that led to a bat roost, which may suggest that this feeding strategy is also employed by this species. Although we did not witness the snake capture the bat in the predation event documented here, there was no evidence of a bat roost in the vicinity. Therefore, we suspect this event was an opportunistic prey capture.

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***BOTHROPOIDES* (= *BOTHROPS*) *JARARACA* (Jararaca). DIET.** Predation on anurans by juvenile *Bothropoides jararaca* has frequently been reported (e.g., Sazima 1991. Copeia 1991:245–248; Sazima 1992. *In* J. Campbell and E. Brodie, Jr. [eds.], Biology of Pitvipers, pp. 199–216. Univ. Texas Press, Arlington; Sazima and Haddad 1992. *In* Morellato [ed.], História Natural da Serra do Japi, pp. 212–237. UNICAMP, Campinas; Hartmann et al. 2003. Phyllomedusa 2:35–41). Although records of lizards as prey are scarce, Sazima (1992, *op. cit.*), reported *Hemidactylus mabouia* as a prey item of two juvenile snakes and Sazima (1991, *op. cit.*) and Sazima and Haddad (1992, *op. cit.*) noted that lizards must be included in the diet of the species.

On 23 March 2003, during an expedition to the southern portion of the Atlantic Forest of Paraná State, Brazil, I collected a juvenile *B. jararaca* (SVL = 248 mm; 8.6 g) actively crawling along a forest edge at 1630 h. Examination of the specimen revealed the remains of an adult gymnophthalmid lizard, *Placosoma glabellum*, in the snake's stomach. The lizard had been swallowed head first and was partially digested, but comparisions with other specimens from the herpetological collection of Museu de História Natural Capão da Imbuia at Curitiba (MHNCI) suggested that it was larger than 40 mm SVL. Juvenile *B. jararaca* exhibit criptic coloration and are known to use caudal luring behavior to lure amphibians, but it is possible that they may also lure lizards and other arthropod predators, such as birds (Sazima 1991, *op. cit.*). This is the first record of an interaction between *B. jararaca* and a gymnophthalmid lizard, and confirms the suspicions that juvenile *B. jararaca* consume lizards. The snake and lizard were deposited at the herpetological collection of MHNCI (MHNCI 11117).

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***BOTHROPS* (= *RHINOCEROPHIS*) *ALTERNATUS* (Urutu Pitviper). MICROHABITAT.** *Bothrops alternatus* is a widespread species that occurs primarily in humid habitats across Brazil, Paraguay, Uruguay, and Argentina (Campbell and Lamar 1989. The Venomous Reptiles of Latin America, Cornell Univ. Press, Ithaca, New York. 425 pp.). Although it is usually indicated to occur near wetlands, no precise information has been presented on specific microhabitats occupied in these particular situations. While conducting research at the Iberá wetlands, Corrientes province, Argentina, on 7 May 2000, we collected a specimen of *B. alternatus* 10 km inside the swamp, occupying a floating substrate locally known as "embalsado" (Fig. 1; Laguna Luna, 28.13778°S, 56.82222°W, datum: WGS 84). The "embalsado" is essentially a vegetated Histosol (organic soil type), of up to 2 m depth, consisting primarily of dead plant material that, depending on the water level, floats or rests on the bottom. At Iberá, these soils support sophisticated plant communities, mainly grasslands, but that in some locations can even include shrubs and trees. The *B. alternatus* was found basking at the base of a mat, in a small open spot (ca. 20 m wide) near the edge of a lagoon, in an area otherwise dominated by the tall and dense grass, *Rhynchospora corymbosa* (Ciperaceae). The open spot resembled a peat, characterized by the presence of puddles, open soil (mainly vegetation debris) and *Sphagnum* (Sphagnaceae) patches. The area was scattered with feces of *Cavia aperea* (Rodentia: Cavidae). The snake was a 109.5 cm SVL, severely emaciated, adult female. Dissection revealed that it had given birth recently, exhibiting a total of 18 elliptic oviducal scars. The specimen was deposited at the collection of the Museo Argentino de Ciencias Naturales "Bernardino Rivadavia" (MACN 39628).



FIG. 1. *Bothrops alternatus* basking at the base of a mat of grass, upon a carpet of peat-mosses (*Sphagnum*), Iberá wetland, Argentina.

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Although *B. alternatus* has been found in the vicinity of several types of wetlands in the Iberá area (Alvarez et al. 2003. *In* Alvarez [ed.], Fauna del Iberá, pp. 99–178. Editorial Universitaria de la Univ. Nacional del Nordeste, Corrientes, Argentina), it was not known to occur inside the swamp in the microhabitat described here. The significant distance from the shore and the evidence of reproduction suggests that some floating habitats at the Iberá wetland can harbor populations of this species, presumably sustained by locally dense rodent populations.

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***BOTHROPS MOOJENI* (Brazilian Lancehead). DIET.** *Bothrops moojeni* is a large pitviper that inhabits riparian areas in central and southeastern Brazil throughout the Cerrado physiogeographic region (Borges and Araújo 1998. Rev. Bras. Biol. 58:591–601). The diet of *B. moojeni* consists of centipedes, frogs, lizards, snakes, birds, and mammals (Nogueira et al. 2003. J. Herpetol. 37:653–659). Here we report predation on an adult treefrog, *Scinax fuscovarius*, by a juvenile *B. moojeni*.

At 1100 h on 10 Jan 2008, at the edge of the Sucuriú River, Três Lagoas municipality, State of Mato Grosso do Sul, Brazil, a

juvenile *B. moojeni* was observed grasping an adult *S. fuscovarius* by the rear legs. When disturbed by our presence, the snake retreated into vegetation.

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***CEMOPHORA COCCINEA COPEI* (Northern Scarletsnake). DIET.** *Cemophora coccinea* is a small fossorial snake thought to feed largely on the eggs of other reptiles (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Institution Press, Washington D.C. 680 pp.). On 17 August 2007, while surveying a study site in Chesterfield Co., South Carolina, USA, I captured a female *C. coccinea* (349.25 mm total length; 8 g) crossing the road at night. Shortly after, I found a juvenile *Pantherophis guttatus* (total length = 279.4 mm; 5 g) that had recently been hit by a vehicle. Due to a lack of collection bags, I placed the dead *P. guttatus* in the same bag as the *C. coccinea*. Approximately 45 min later, I opened the bag and only found the *C. coccinea*; the *Cemophora* had eaten the *P. guttatus*. To our knowledge *P. guttatus* has not been documented in the diet of *C. coccinea* (Ernst and Ernst, *op. cit.*). Though ophiophagy has been reported in *C. coccinea* (Conant and Collins 1998. A Field Guide to Reptiles and Amphibians of Eastern and Central North America. Houghton Mifflin Co., New York. 616 pp.), it is very uncommon and has not been documented in any accounts from North or South Carolina (Palmer and Braswell 1995. Reptiles of North Carolina. Univ. North Carolina Press, Chapel Hill. 412 pp.; S. Bennett, pers. comm.). The prey item comprised 62.5% of the *C. coccinea*'s body weight.



PHOTO BY NATHAN SHEPARD

FIG.1. *Cemophora coccinea* regurgitating a juvenile *Pantherophis guttatus*.

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***CHIRONIUS EXOLETUS* (Vine Snake). REPRODUCTIVE BEHAVIOR.** Few data are available on the mating behavior of neotropical snakes in the wild (Greene 1997. Snakes: the Evolution of Mystery in Nature. University of California Press, Los Angeles. 351 pp.). In the Brazilian state of Rondônia, newborn *Chironius exoletus* have been found in November and February, and females with eggs and enlarged follicles have been observed from November through March (Bernarde and Abe 2006. S. Amer. J. Herpetol. 1:102–113).

On 6 September 2009 at 1730 h, in forest along the São Miguel River, Municipality of Seringueiras, Rondônia state, Brazil (12.0039722°S, 63.0351389°W; datum WGS84; elev. ca. 160 m), we observed a pair of *C. exoletus* on the ground engaged in courtship and mating (tactile-alignment, intromission, and coitus; Gillingham 1986. *In* Seigel et al. [eds.], Snakes: Ecology and Evolutionary Biology, pp. 184–209. McGraw Hill, New York). The duration of copulation was 27 min. Another unsexed adult *C. exoletus* was observed approximately 1 m away, resting about vegetation. The snakes were not captured.

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***COLUBER CONSTRICTOR* (North American Racer). CANNIBALISM AND DEFENSIVE BEHAVIOR.** Cannibalism by racers has been described in both field and laboratory conditions (Mitchell 1986. SSAR Herpetol. Circ. 15:1–37). Most reports are from stomach contents and lack behavioral observations. Cannibalism might occur as a byproduct of captive feeding, from a competitive interaction, or as direct consumptive behavior; therefore information describing these interactions is valuable. This observation is also the first documentation of an anchoring behavior used by *C. constrictor* as an attempt to avoid predation.

On 6 June 2008 at approximately 1030 h, I documented cannibalism between male *C. constrictor* at the Department of Energy's Savannah River Site, Aiken Co., South Carolina, USA. While driving on a gravel road, I observed a *C. constrictor* (SVL = 107 cm, total length = 143 cm) enter perpendicular to the road from the grassy edge in front of me. As I quickly halted the vehicle, the racer increased speed away from me parallel to the road's edge. The snake moved approximately 6 m and came to an abrupt stop at the road's edge where it attacked another smaller *C. constrictor* (SVL = 70 cm, total length = 98 cm). Following the attack and a short struggle, the larger snake and aggressor (hereafter Snake A) raised above the grass with the smaller snake (hereafter Snake B) in its grasp (~3 cm posterior to head). With raised anterior portions of body and Snake B in mouth, Snake A moved

perpendicular and away from the road (~6 m away) into dense brush. Occasionally the snakes' bodies were entwined, biting one another. There were long periods of what appeared to be rest with slow biting movements followed by the occasional quick and aggressive struggles that lasted only seconds at a time. In defending itself, Snake B bit and coiled around Snake A and at one point it anchored to surrounding vegetation by biting itself. The anchoring was performed by extending the anterior region of its body over a vine and then biting itself. Snake B was thus secured to the vine and Snake A had difficulty pulling it free (with a "tugging" motion). While anchoring, Snake B worked its way down its own body and bit the bottom jaw of Snake A allowing brief freedom from the grasp of Snake A. After a nearly 60 min struggle, Snake A was able to overcome Snake B and consumed it within 10 min. During consumption, Snake A vigorously vibrated its tail, possibly in response to my presence. After consumption, I captured Snake A whereupon it regurgitated Snake B, which was still alive. Snake A was starting to shed within one day following capture and Snake B was close to shedding having nearly opaque eyes at the time of capture.

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COLUBER CONSTRICTOR **(North American Racer). PREY SIZE.** *Coluber constrictor* is a large (to 191.1 cm total length) colubrid snake native to a variety of open habitats in North America (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Institution Press, Washington, DC. 668 pp.). It is a nonvenomous, nonconstricting dietary generalist that is known to consume a wide range of vertebrate and invertebrate prey items, including other snakes. Here we report a juvenile *C. constrictor* feeding on a relatively very large ophidian prey item, to our knowledge the largest relative prey mass reported for this species.

At 1300 h on 20 April 2010, a juvenile *C. constrictor* (female, SVL = 289 mm, 12.58 g) was found by a terrier among dry leaves in a grassy roadside at Rocky Branch Nature Preserve, Clark Co., Illinois, USA (39.46282°N, 87.77423°W, datum WGS 84). We noticed that the snake's body had a lumpy, kinked quality, and so returned it to the laboratory where it regurgitated an adult male *Diadophis punctatus* (Ring-necked Snake) measuring 265 mm SVL with a mass of 4.38 g, which had been swallowed headfirst. The mass of the racer without the prey item was 8.20 g, so the prey represented 53.4% of the predator's body mass and measured 91.7% of the body length.

Coluber constrictor is known to feed on other snakes, including *D. punctatus*, but generally consumes relatively small prey. Halstead et al. (2008. Copeia 2008:897–908) found a significant positive relationship between snake mass and prey mass for *C. constrictor* in Florida, with a mean relative prey mass of 6.8 ± 1.4%, although racers in their study had consumed no other snakes. Fitch (1982. *In* N. J. Scott, Jr. [ed.], Herpetological Communities: A Symposium of the SSAR and HL, August 1977. USFWS, Wildl. Res. Rep. 13. 239 pp.) found *D. punctatus* to be the fifth most common vertebrate prey item consumed by racers in Kansas and estimated that *C. constrictor* consumed on average 23 g/ha of *D. punctatus* annually, compared to >1500 g/ha of small mammals and almost 300 g/ha of insects. About 12% of racer stomach contents from Illinois contained reptiles, with a larger proportion containing insects (48%) and mammals (43.5%; Klimstra 1959. Copeia 1959:210–214).

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COLUBER CONSTRICTOR MORMON **(Western Yellow-bellied Racer) and** ***PITUOPHIS CATENIFER DESERTICOLA*** **(Great Basin Gopher Snake). DIET.** Although some aspects of *Coluber constrictor mormon* and *Pituophis catenifer deserticola* ecology

TABLE 1. Diet items collected from *Coluber constrictor mormon* and *Pituophis catenifer deserticola* from Antelope Island State Park, Utah, USA, in 2005. (U) denotes an individual of unknown sex and (*) indicates a gravid female.

Species	Capture Method	Sex	SVL (cm)	Mass (g)	Stomach Contents
Coluber constrictor mormon	Trapped	F	68	162	*Microtus* sp.
		F*	73	160	*Microtus* sp.
		F	67	163	*Peromyscus* sp.
		F	71	162	*Peromyscus* sp.
	Road-Killed	M	41	—	three grasshoppers (Acridae)
		M	64	100	*Peromyscus* sp.
		U	—	—	cricket (Gryllidae)
		U	50	—	*Stenopelmatus* sp.
		F	56	—	*Sceloporus graciosus*
		F	55	65	two grasshoppers (Acrididae)
		M	44	42	two grasshoppers (Acrididae)
		F	42	40	cricket (Gryllidae), beetle (Coloeptera)
Pituophis catenifer deserticola	Hand captured	M	84	—	*Microtus* sp.
	Road Killed	M	—	—	*Microtus* sp.

have been studied within the Great Basin (Brown 1973. Ph.D. Diss., Univ. Utah, Salt Lake City; Parker and Brown 1980. Milwaukee Public Mus. Publ. Biol. Geol. 7:1–104), few studies have examined their feeding habits and there are no published records from any islands within the Great Salt Lake. This lack of basic natural history information is a major impediment to the conservation of these species, particularly in light of degradation of local island landscapes by exotic and invasive species. While conducting research to examine the effects of Cheatgrass (*Bromus tectorum*) on snake populations at Antelope Island (Hall et al. 2009. West. N. Am. Nat. 69:88–95) we gathered information on the diets of *C. c. mormon* and *P. c. deserticola*.

Data were collected from June through September 2005 at Antelope Island State Park in Davis Co., Utah, USA. Antelope Island is the largest of the ten islands found within the Great Salt Lake and covers over 113 km^2. Live snakes were captured using hardware cloth drift fences with funnel traps or by hand and freshly killed snakes were recovered from the island's roads. Live snakes were palpated to regurgitate recently ingested prey items and all dead snakes were dissected and their stomach contents were examined.

Diet information was obtained from 12 *C. c. mormon* and two *P. c. deserticola* (Table 1). Despite the large geographic ranges of *C. c. mormon* and *P. c. deserticola* we found that stomach contents were similar to those previously reported for these species (Fitch 1963. Univ. of Kansas Publ. Mus. Nat. Hist. 15:351–468; Rodriguez-Robles 2002. Biol. J. Linn. Soc. 77:165–183). The majority of prey items recovered from *C. c. mormon* were invertebrates, representing 65% of the total diet, whereas rodents represented 29% and a lizard was recovered from a single female. Although similar diet items have been recorded for *C. c. mormon*, the proportion of snakes with rodents was much higher than previously reported for the region (Brown 1973, *op. cit.*). This may be a consequence of the different methods used to acquire samples; diet of road-killed snakes included a larger proportion of invertebrates than diet of trapped snakes. Our data support previous findings that *C. c. mormon* prefer orthopterans among invertebrate prey and that larger females incorporate vertebrates into their diet (Shewchuk and Austin 2001. Herpetol. J. 11:151–155). The two *P. c. deserticola* examined both contained *Microtus* sp., as has been reported for this species in the Great Basin (Rodriguez-Robles, *op. cit.*).

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***COLUBER* (= *MASTICOPHIS*) *FLAGELLUM* (Coachwhip). UNUSUAL FEEDING BEHAVIOR.** Two of us (DK and DK) observed and photographed an unusual feeding event of an adult *Coluber flagellum piceus* (Red Racer), 5 km W of Wickenburg, Arizona, USA at 1145 h, 28 April 2007, elev. 670 m, air temperature 27–32°C. The snake, which seemed undisturbed by observers, started biting a dead branch of a tree. It then moved a few cm away from the branch for about 10 sec, returned and broke off a 2.5 × 1.3 cm piece of the branch and swallowed it (Fig. 1).



PHOTO BY DEBBIE KEISER

FIG. 1. *Coluber flagellum piceus* consuming small portion of stick after breaking it off the branch.

The piece of the stick eaten looks like a scaly lizard. Fenner et al. (2008. Herpetofauna 38:105–109) showed that *Pseudonaja textilis* (Australian Eastern Brown Snake) are attracted to motionless unscented models of *Tiliqua adelaidensis* (Pigmy Bluetounge Lizards), as well as live lizards, and suggested that the shape of the lizard is sufficient to elicit an attack. The stick in these observations of *C. flagellum* likely looked enough like a lizard for a snake to eat it. Alternately, it is possible that residual scent on the branch from a potential prey item could have elicited attack by the snake.

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***COLUBER* (= *MASTICOPHIS*) *LATERALIS EURYXANTHUS* (Alameda Striped Racer) and *LAMPROPELTIS GETULA CALIFORNIAE* (California Kingsnake). PREDATION AND MAXIMUM PREY LENGTH RATIO.** While most recent research on the federally threatened *Coluber lateralis euryxanthus* has focused on habitat use and demography, other ecological aspects such as causes of mortality in this subspecies remain poorly understood. Natural predation on the related *C. l. lateralis* was recorded by Fitch (1949. Am. Midl. Nat. 41:513–579) and included 50 occurrences by Red-tailed Hawks (*Buteo jamaicensis*), seven by Great Horned Owls (*Bubo virginianus*), and seven by Coyotes (*Canis latrans*). In addition, Jennings (1997. Herpetol. Rev. 28:205–206) observed a *C. l. lateralis* being carried away in the talons of an American Kestrel (*Falco sparverius*). All of these documented predators are found in the same habitats as *C. l. euryxanthus* and likely prey upon this threatened taxon as well. Herein, we describe two separate instances of predation on *C. l. euryxanthus* by a well-known ophiophage, *Lampropeltis getula californiae*, and discuss associated predator-prey length ratios.

On 26 May 2009, at 1230 h, M. Yacelga discovered an adult female *L. g. californiae* (SVL = 950 mm; total length = 1018 mm)



PHOTO BY M. YACELGA

FIG. 1. An adult *Lampropeltis getula californiae* consuming a *Coluber lateralis euryxanthus* from Contra Costa Co., California, USA.

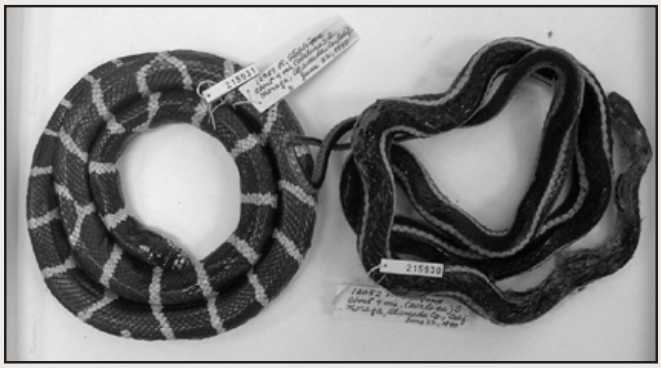


PHOTO BY K.D. WISEMAN

FIG. 2. An adult *Lampropeltis getula californiae* (MVZ 215931, left) that consumed a *Coluber lateralis euryxanthus* (MVZ 215930) from Alameda Co., California, USA.

in a drift fence funnel trap at the edge of coastal scrub/chaparral and grassland habitats approximately 2.3 km NW of Briones Reservoir, Contra Costa Co,, California, USA (37.950135°N, 122.217778°W, datum: WGS 84). When initially discovered, the kingsnake had already swallowed the anterior third of the body of an adult male *C. l. euryxanthus* (SVL = 832 mm; total length = 1157 mm; 134 g; Fig. 1). The racer had been initially captured and pit-tagged in September 2005 and was last recaptured on 8 May 2009. The kingsnake was removed from the trap for photographic documentation and left undisturbed while it continued to consume the racer. After approximately 30 min, the kingsnake had disappeared and the racer was not observed in the vicinity and had presumably been consumed by the kingsnake.

On 22 June 1990, an adult *L. g. californiae* (MVZ 215931; SVL = 839 mm; total length = 962 mm; 180 g [live]) was collected 1.1 km W of the corner of Brown Ranch Road on Old Airstrip Road (37.79259°N, 122.10416°W, datum: WGS 84), approximately 6.4 km S of Moraga, Alameda Co,, California, USA. The kingsnake had recently consumed an adult female *C. l. euryxanthus* (MVZ 215930; SVL = 838 mm, total length = 1150 mm; 129.2 g [preserved]) head-first (R.C. Stebbins, unpubl. field notes; Fig. 2).

Although the first instance of predation is complicated by the fact that the racer was confined within a funnel trap and could not have escaped the predator (or may have even attracted it), our second observation clearly demonstrates that *L. g. californiae* preys upon *C. l. euryxanthus* under natural conditions. Whipsnakes and racers (including *C. constrictor*, *C. lateralis*, *C. flagellum*, and *C. taeniatus*) are relatively common prey of *L. g. californiae* and account for approximately 5% of their overall diet, and 17% of the snake diversity consumed based upon the examination of 2,660 museum specimens, published literature, unpublished field notes, and personal communications (K. D. Wiseman, H. W. Greene, D. J. Long, and M. S. Koo, unpubl. data).

Jackson et al. (2004. Zoology 107:191–200) demonstrated that under captive conditions, *L. g. californiae* were capable of ingesting *Pantherophis guttatus* (Red Cornsnakes) with total lengths much greater than their own SVL. They accomplished this feat through several mechanisms: 1) anterior stretching of the stomach and esophagus, 2) bending the prey snake into longitudinal waves, and 3) folding of the tail tip (Fig. 2). A maximum length ratio (LR = prey total length/predator SVL) of 1.29 was accomplished by one kingsnake which completely digested its prey (Jackson et al., *op. cit.*). Three other kingsnakes completely ingested snakes with LR values of 1.07 to 1.21, however each regurgitated them after 4–7 days. Another kingsnake attempted to ingest a snake with an LR of 1.39, but regurgitated it before ingestion was complete. The kingsnake reported in our first observation (Fig. 1) had a LR of 1.22 and the second (MVZ 215931) had an LR of 1.37 (Fig. 2).

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***CROTALUS MITCHELLII* (Speckled Rattlesnake) and *CROTALUS RUBER* (Red Diamond Rattlesnake). ECTOPARASITES.** *Crotalus mitchellii* and *C. ruber* occur in a wide variety of predominantly dry habitats in the southwestern United States and México (Campbell and Lamar 2004. The Venomous Reptiles of the Western Hemisphere. Cornell Univ. Press, Ithaca, New York. 898 pp.). *Crotalus* spp. are known to be parasitized by several tick species including *Amblyomma dissimile*, and *Dermacentor* spp. (Klauber 1997. Rattlesnakes: Their Habits, Life Histories, and Influence on Mankind. Univ. California Press, Berkeley. 1533 pp.; Campbell and Lamar, *op. cit.*). Here we report novel tick-host relationships involving two species of rattlesnakes.

Rattlesnakes were captured at night, examined for ectoparasites and released at the site of capture. All visible ectoparasites were removed using forceps, preserved, and identified under a compound light microscope in the laboratory. On 6 November 2004, at 2150 h, an adult female *C. mitchellii* (total length [TL] ca. 700 mm) was collected along the road from La Paz to San Juan de la Costa, Baja California Sur, México (24.194733°N, 110.556789°W, WGS84). The female snake had two tick larvae (ZMB 48383, one larva was destroyed during identification), both swollen with blood meals, between the scales on the body. On 10 November 2004, at 2120 h, an adult female *C. ruber* (TL

ca. 800 mm) was found on the road from Insurgentes to Puerto López Mateos, Baja California Sur, México (25.761458°N, 112.010964°W, WGS84). The snake had five larvae and nymph ticks (ZMB 48380), all filled with host blood, between the scales on the body. A juvenile *C. ruber* (TL ca. 300 mm) was collected on 25 November at around 2100 h on the highway Mex 1, Baja California Norte, México (29.983342°N, 115.206078°W, WGS84). The juvenile had six larvae and nymph ticks (ZMB 48381), filled with blood, on the body sides. On 28 November 2004 at 2020 h, an adult male *C. ruber* (TL ca. 700 mm) was found on the highway Mex 12 from Bahía de los Ángeles to the highway Mex 1, Baja California Norte, México (29.052358°N, 114.121942°W, WGS84). The snake had 10 larvae and nymph ticks (ZMB 48382), one was on the neck, and the others were on the snake's back and body side engorged with blood.

All ticks were identified as the soft tick *Ornithodoros turicata* (Acari: Ixodida: Argasidae) (*fide* Wenzel and Tipton 1966. Ectoparasites of Panama. Field Mus. Nat. Hist. Chicago, Illinois. 861 pp.). Voucher specimens of *O. turicata* were deposited in the arachnid collection of the Museum für Natukunde Berlin (ZMB), Germany. *Ornithodoros turicata* is a burrow-dweller known to inhabit burrows of the Gopher Tortoise, *Gopherus polyphemus* (e.g., Beck et al. 1986. J. Med. Entomol. 23:313–319). Additionally, *O. turicata* is reported as a vector of the relapsing or tick-born fever (TBRF), which is caused by several *Borrelia* species that are transmitted to humans by bites of this soft tick species (e.g., Dworkin et al. 2008. Infect. Dis. Clin. North Am. 22:449–68). The fact that *O. turicata* was found over a linear distance of about 780 km from north to south, on the Pacific as well as on the Gulf side, indicates that this tick species occurs throughout the Baja California peninsula.

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***CROTALUS MITCHELLII* (Speckled Rattlesnake). ARBOREAL BEHAVIOR.** At 1654 h on 14 May 2004, we observed an adult *Crotalus mitchellii* (sex undetermined) approximately 1 m above the ground in *Opuntia ramosissima* (Diamond or Pencil Cholla) in Granite Cove, Granite Mountains, San Bernardino Co., California, USA (34.7814°N, 115.6537°W, datum WGS 84; elev. 1276 m). Air temperature at the time of observation was 26.2°C. At first observation, the snake was in a coiled position in the cactus, rattling loudly. Upon being photographed, it uncoiled and began to move (Fig. 1). The snake was not collected, and within one hour, the snake had left the cactus.

To our knowledge, few records of arboreal behavior exist for this species, at heights of 0.46 m, 0.76 m, and 0.91 m (Klauber 1997. Rattlesnakes: their habits, life histories, and influence on mankind. Univ. California Press, Berkeley. 1580 pp.). Klauber (*op. cit.*) suggested that rattlesnakes climb more often in pursuit of prey than for refuge from predators or heat. Moore (1978. Copeia 1978:439–442.) showed that *C. m. pyrrhus* in the West Mojave Desert of California exhibit diurnal activity from April–May and October–November, feeding on the only diurnal mammalian prey available at the study site: *Ammospermophilus* (*Citellus*) *leucurus* (Antelope Ground Squirrel). *Ammospermophilus leucurus* are known to climb Pencil Cholla and other cacti and are found at the site of our *C. mitchellii* observation. Given the time of day and time of year, the subject of our observation likely climbed the cactus in pursuit of prey.



FIG. 1. *Crotalus mitchellii* in *Opuntia ramosissima* in the east Mojave Desert of California.

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***CROTALUS OREGANUS HELLERI* (Southern Pacific Rattlesnake). DIET.** On 24 April 2010, at 1530 h, we collected an adult *Crotalus oreganus helleri* (total length = 127cm; 552.7 g), in Los Angeles Co., California, USA (34.478°N, 118.510°W; datum: NAD27). Upon capture, we noticed that the snake had consumed a large prey item. Once dissected, an adult California Thrasher (*Toxostoma redivivum*; 86.5 g) was removed from the snake. Positive identification of the prey item was made by L. Comrack. Because the prey item displayed no signs of digestion, we concluded that the bird had been recently consumed and was probably captured alive.

Snakes frequently prey upon eggs and nestlings of various bird species (Stake et al. 2005. J. Herpetol. 39:215–222; Tweit 1996. The Birds of North America. Cornell Lab of Ornithology, Ithaca. 20 pp.; Tyler 1986. Bull. Okla. Ornithol. Soc. 19:14–15); predation upon adult birds is less well-documented. Although snakes are listed as possible predators of juvenile *T. redivivum* (Cody 1998. *In* Poole [ed.], The Birds of North America Online. Cornell Lab of Ornithology, Ithaca), species-specific accounts have not been previously documented. To our knowledge, this is the first documentation of predation on *T. redivivum* by *C. o. helleri*. A digital photograph of the prey item and the specific account data is deposited in the Natural History Museum of Los Angeles County Ornithology Department.

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***DIADOPHIS PUNCTATUS PUNCTATUS* (Southern Ring-necked Snake). MAXIMUM SIZE.** On 19 May 2008, a female *Diadophis punctatus* was captured crossing the upper loop of the Carrick

Creek nature trail at Table Rock State Park, Pickens, Pickens Co., South Carolina, USA. The snake weighed 27 g and had an SVL of 47 cm. The total length (TL) was 52 cm but it should be noted the snake was missing part of its tail. Nevertheless, this TL exceeds the maximum recorded TL of 48.2 cm for *D. p. punctatus* (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Institution Press, Washington D.C. 680 pp.). The specimen showed characteristics of *D. p. punctatus*, including uniform mid-ventral spots, but had an unbroken neck ring, suggesting some intergradation with *D. p. edwardsii*. The snake was photographed and released at site of capture.

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***DIPSADOBOA AULICA* (Marbled Tree Snake). DIET.** *Dipsadoboa aulica* is a small arboreal snake found in southeast Africa. It feeds nocturnally on anurans, geckos, and occasionally skinks and small rodents (Branch 1998. Field Guide to Snakes and Other Reptiles of Southern Africa. Struik, Cape Town. 400 pp.) but has not been documented to prey upon chameleons. At 1130 h on 10 January 2006, we collected a dead adult male *D. aulica* (SVL = 45.9 cm; total length = 58.4 cm) on a tar road (28.11889°S, 32.54667°E, datum: WGS84) near the village of St. Lucia in KwaZulu-Natal, South Africa. The snake had been run over at midbody and two undigested female *Bradypodion setaroi* (Setaro's Dwarf Chameleon) were partly visible extruding from the digestive tract (Fig. 1). Dissection revealed the head of the smaller chameleon (SVL = 5.1 cm; total length = 9.2 cm) in the hindgut of the snake. The larger *B. setaroi* (SVL = 6.6 cm; total length = 11.8 cm) was swallowed tail-first. *Bradypodion* is a South African endemic composed of at least 15 species generally restricted to small, allopatric distributions. *Bradypodion setaroi* is limited to subtropical coastal forests in the northeastern part of the country (Tolley and Burger 2007. Chameleons of Southern Africa. Struik, Cape Town. 400 pp.) and is currently listed as Endangered (EN B1+2c, 2006 IUCN Red List of Threatened Species); however, the species is to be down-listed to Least Concern in 2010 (W. Branch, pers. comm.).



FIG. 1. Road-killed *Dipsadoboa aulica* with two *Bradypodion setaroi* protruding from the digestive tract.

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FIG. 1. *Drymarchon melanurus erebennus* feeding on an Evening Bat (*Nycticeius humeralis*).

***DRYMARCHON MELANURUS EREBENNUS* (Texas Indigo Snake). DIET.** *Drymarchon melanurus erebennus* is a large, diurnal colubrid distributed across southern Texas in the United States southward throughout eastern Mexico to the state of Veracruz (McCranie 1981. Cat. Amer. Amphib. Rept. 267:1–4). While mostly terrestrial, it will occasionally climb into bushes and low branches of trees. An active forager, it preys on a wide variety of vertebrates including frogs, fishes, turtles, snakes (including venomous species), birds, and rodents (Wright and Wright 1957. Handbook of Snakes of the United States and Canada. Cornell Univ. Press, Ithaca, New York. 564 pp.; Werler and Dixon 2000. Texas Snakes: Identification, Distribution, and Natural History. Univ. Texas Press, Austin. 519 pp.). Herein we report the first record of predation by *D. m. erebennus* on a bat.

At 1708 h on 25 October 2008, at Southmost Preserve, Cameron Co., Texas, USA, we captured an adult *D. m. erebennus* (total length = 90.5 cm) in a ditch alongside a path adjacent to a large lagoon. The snake was in an area of abundant plant litter and in low light, so it was not immediately evident that the snake had a prey item in its mouth. However, upon closer examination we discovered the snake was attempting to ingest a bat. The bat's body was entirely within the snake's mouth with only the wings protruding (Fig. 1). Unfortunately, during the process of photographing the snake, it regurgitated the bat (which was still alive, albeit mortally injured). The bat was identified as an Evening Bat (*Nycticeius humeralis*; verified by Maxwell Pons, Jr.). *Nycticeius humeralis* roost in tree hollows and behind loose bark and forage in the early evening (Schmidly 2004. The Mammals of Texas. Univ. Texas Press, Austin. 501 pp.). It is likely the snake encountered the bat in a low level roosting area or emerging from it.

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***EPICRATES CENCHRIA* (Rainbow Boa). DIET.** *Epicrates cenchria* occurs in the Atlantic rainforest biome of Brazil from Rio de Janeiro to Pernanbuco. The diet of *E. cenchria* includes small mammals, lizards, bird and their eggs, amphibians, and bats (Freitas 2003. Serpentes Brasileiras. Editoria DALL, Bahia, Brazil. 78 pp.). On 19 January 2009, an adult *E. cenchria* (178 mm total

length) was captured alive by a rural worker in Aparecidinha, Santa Teresa, Espirito Santo, Brazil, and brought to the Museu de Biologia Prof. "Mello Leitão," located in the same city. According to the worker, the snake was found in a hen house and had ingested seven domestic chicken (*Gallus gallus*) chicks. The snake was released several days later. This new diet record for *E. cenchria* represents an additional example of conflict between native and domestic wildlife. *Epicrates cenchria* is widely feared and frequently killed in rural areas of Brazil because of a misconception that it is venomous. In some cases the presence of domestic animals may attract native predators, putting them at risk from human persecution.

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***EPICRATES CHRYSOGASTER CHRYSOGASTER* (Turks Island Boa). DIET.** *Epicrates chryogaster chrysogaster* has been reported to feed on small introduced rodents such as rats and mice (*Rattus*, *Mus*), as well as the chicks and eggs of introduced birds such as chickens (*Gallus*; Schwartz and Henderson 1991. Amphibians and Reptiles of the West Indies: Descriptions, Distributions, and Natural History, Univ. Florida Press, Gainesville. 720 pp.; Tolson and Henderson 1993. The Natural History of West Indian Boas, R&A Publishing, Taunton, Somerset, England. 68 pp.), though native lizards probably also factor heavily in the diet. The previous authors report that juvenile *E. c. chrysogaster* are probably saurophagous, but here we report that adults may be entirely saurophagous on small islands without *Rattus*, *Mus*, or *Gallus*. In addition, no previous studies have identified the species of lizards that are preyed upon by *E. chrysogaster*.

AT 0935 h on 8 August 2008, we found an adult male *E. c. chrysogaster* which had recently consumed a medium sized (SVL ca. 65 mm) *Leiocephalus psammodromus* (Turks and Caicos Curly-tailed Lizard). The snake was found on a small island on the Turks Bank, Turks and Caicos Islands. While the food item was not extracted entirely in order to prevent harm to the snake, we were able to determine the species of lizard that had been consumed. Additionally, herpetological surveys have determined that only three species of lizards inhabit the island: the *Anolis scriptus scriptus* (Southern Bahamas Anole), *Leiocephalus psammodromus* (Turks and Caicos Curly-tailed Lizard), and *Sphaerodactylus underwoodi* (Turks Dwarf Gecko). Of these, only *L. psammodromus* reaches sufficient size to have been the size of the food item. As no known record of *Mus*, *Rattus*, or *Gallus* exists for this island, it is expected that lizards are a major, if not the sole, component of the diet of this small population of *E. chrysogaster*.

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***EPICRATES CHRYSOGASTER CHRYSOGASTER* (Turks Island Boa). MAXIMUM SIZE.** To our knowledge, the previously reported maximum size for *Epicrates chrysogaster chrysogaster* is 1310 mm SVL (Schwartz and Henderson 1991. Amphibians and Reptiles of the West Indies: Descriptions, Distributions, and Natural History, Univ. Florida Press, Gainesville. 720 pp.; Tolson and Henderson 1993. The Natural History of West Indian Boas, R&A Publishing, Taunton, Somerset, England. 68 pp.). At 1852 h on 12 August 2008, we found an adult female *E. chrysogaster* which we determined to be 1321 mm SVL by measuring the body with a length of string strung along the spine. The snake was found on North Caicos, Turks and Caicos Islands, about 2.25 km WNW of the town of Kew. The individual weighed 525 g and had a tail length of 228 mm.

In addition, an unusually large captive *E. chrysogaster*, maintained for educational purposes by the Turks and Caicos National Trust, was measured and is reported here to illustrate even larger size that may be reached by this species in captivity. The individual, a female, measured 1540 mm SVL, with a mass of 1100 g, and a tail length of 228 mm. The boa was excavated in the town of Kew, North Caicos, Turks and Caicos Islands during home remodeling and was brought to BNM by the property owner. It had been in captivity for approximately three years prior to our examination, which was performed on 12 August 2008.

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***EUNECTES NOTAEUS* (Yellow Anaconda). DIET / CANNIBALISM.** *Eunectes notaeus* is a marsh dwelling boid that preys upon a variety of vertebrates (Strüssmann 1997. Biociencias 5:35–52; Waller et al. 2001. Herpetol. Rev. 32:47). The implementation of a harvest program for this species in the Province of Formosa (Argentina), allowed us to evaluate the stomach contents of large numbers of specimens harvested each year from the highly productive floodplain that is seasonally inundated by the Pilcomayo River, Fortín Soledad, Bañado La Estrella, (24.1453°S, 60.6932°W, datum: WGS84). At this location *E. notaeus* is abundant and mainly feeds on waterfowl, bird eggs, aquatic rats, and the common and large *Hydrodynastes gigas* (False Water Cobra; Waller et al. 2007. *In* Henderson and Powell [eds.], Biology of the Boas and Pythons, pp. 340–362. Eagle Mountain Publishing, Utah).

On 3 June 2009, a hunter caught a female *E. notaeus* (SVL = 253 cm; 15 kg). The snake was in excellent body condition showing ovarian follicles in secondary vitellogenesis. In its stomach we found a freshly caught female conspecific (Fig. 1), as well as feathers of a Cormorant (*Phalacrocorax brasilianum*) and the digested remnants of a medium-sized but unidentified bird. This finding represents the first record of cannibalism in *E. notaeus*. The ingested anaconda was immature, 125 cm SVL and though it was not weighted, its size corresponds to an average 1.6 kg specimen (T. Waller, unpubl. data). Moreover, its subsequent dissection revealed a recently ingested juvenile aquatic rat (*Holochilus chacarius*; total length = 205 cm; ca. 35 g), showing that both snakes, predator and prey, were actively feeding.

Rivas and Owens (Herpetol. Rev. 31:45–46) found that large female *E. murinus* from the Venezuelan Llanos often prey upon smaller conspecifics, especially males, during the dry season. He suggested that this behavior could be a strategy to improve their survival during the long fasting periods of pregnancy. However, it is unlikely that such a behavior would be necessary at our highly productive study site, where prey availability does not seem to be a limiting factor for *E. notaeus* and reproductive females are generally in good condition year after year (Waller et al. 2007, *op. cit.*). Instead, this event may have been instigated by both snakes



FIG. 1. Dissection of an adult female *Eunectes notaeus* revealed ingestion of an immature conspecific female (shown here).

attempting to swallow the same prey. This also seems unlikely because the disparity in size between snakes would likely result in differences in prey size selection. Moreover, the absence of another fresh prey item in the stomach if the larger individual, as would be expected in such a situation, argues against accidental ingestion. Another explanation could be that the larger snake was attracted and confused by the scents left on the body of the smaller individual by the recently eaten rat; but again, it is hard to imagine that a large female anaconda would pursue the scent of such a small rodent (35 g) as prey. Regardless of the circumstances, this is the first time in nine years of work that we have received a reliable record of cannibalism by *E. notaeus*, suggesting that the phenomenon is unusual at this location.

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***HELICOPS ANGULATUS* (South American Watersnake). DIET.** *Helicops angulatus* is a semi-aquatic and primarily nocturnal dipsadid snake that is widely distributed in northern South America. This species inhabits ponds, streams and rivers (Ford and Ford 2002. Carib. J. Sci. 38:129–132), where it is known to feed on amphibian eggs, adult frogs, and aquatic lizards, but primarily on fish and tadpoles of the genera "*Hyla*" and *Osteocephalus* (Martins and Oliveira 1998. Herpetol. Nat. Hist. 6:78–150).

On 16 May 2009, at ca. 1600 h, an adult female *H. angulatus* (SVL = 490 mm; tail length = 215 mm) was collected near the Unini river's south margin (01.7116°S, 62.8220°W; datum: WGS 84), Barcelos, Amazonas, Brazil. Upon capture, a Cane Toad (*Rhinella marina* = *Bufo marinus*) tadpole was removed from the mouth of the snake. The *H. angulatus* was deposited in the herpetological collection of Instituto Nacional de Pesquisas da Amazônia (INPA-H 25379). Upon dissection, we found another seven *R. marina* tadpoles inside the snake's stomach. All tadpoles collected were below the developmental stage 25 (Gosner 1960. Herpetologica 16:183–190).

Rhinella marina is known to be toxic and unpalatable to a wide range of predators, but a recent study showed a decrease of both toxin diversity and concentration during its tadpole stage (Hayes et al. 2009. J. Chem. Ecol. 35:391–399). Moreover, several other snake species within the subfamily Xenodontinae prey on adult toads and are able to tolerate bufonid toxins (Duellman and Trueb 1986. The Biology of Amphibians. McGraw-Hill Inc., New York. 670 pp.). Future research should investigate whether *H. angulatus* is also able to tolerate bufonid toxins found in adults, or if consumption of *R. marina* by this snake is restricted to the more palatable tadpole stage.

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***HETERODON NASICUS* (Western Hog-nosed Snake). DIET AND ARBOREAL FORAGING BEHAVIOR.** *Heterodon nasicus* is a fossorial snake that primarily inhabits well drained, sandy grasslands of the Great Plains in the United States (Conant and Collins 1991. Reptiles and Amphibians Eastern/Central North America. Houghton Mifflin, Boston, Massachusetts. 450 pp.) *Heterodon nasicus* are known to burrow and forage along the ground for amphibians, reptiles, mammals, and birds, and their offspring, including eggs (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Press, Washington DC. 680 pp.). Herein, we describe arboreal foraging behavior of *H. nasicus*, including predation upon eggs of *Chondestes grammacus* (Lark Sparrow).

On 7 July 2008 at 2130 h, a pair of *C. grammacus* was discovered jumping and screeching around their nest. The nest was located 1.5 m high in a Chokecherry (*Prunus virginiana*) bush near Keystone Lake on Cedar Point Biological Station, Keith Co, Nebraska, USA (41.2110°N, 101.6574°W, datum: WGS84). Upon approaching the nest, an *H. nasicus* was discovered consuming eggs inside the nest, while being harassed by the sparrows. The birds appeared not to harm the snake, despite making physical contact with the snake's posterior end. After 3–5 min of harassment, the sparrows drove the snake away, but not before the snake grabbed another egg in its mouth. The snake awkwardly, but quickly (i.e., almost a controlled fall), undulated down the dense vegetation and moved 5 m away from the nest, underneath the bark of a fallen Eastern Cottonwood (*Populus deltoides*). The snake finished consuming the second egg under this cover. After 10 min, the snake (female; total length = 67 cm) was captured and when palpated, two eggs were found in her stomach. Upon discovery the snake performed a typical defensive display (Ernst and Ernst, *op. cit.*), but did not regurgitate the eggs. The snake was subsequently released under the same Eastern Cottonwood bark refugia. To our knowledge, this is the first record of arboreal foraging in *H. nasicus* and the first record of *C. grammacus* eggs in this species' diet.

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***HETERODON PLATIRHINOS* (Eastern Hog-nosed Snake). MAXIMUM SIZE.** On 8 April 2010 a melanistic adult female *Heterodon*

platirhinos was captured alive on Fort Stewart Rd. 70B, Fort Stewart, Bryan Co., Georgia, USA (32.0681°N, 81.5569°W, datum: WGS 1984). The snake was measured independently by two teams of experienced herpetologists, who differed in their total length measurements by ca. 2 cm; the mean of these measurements was SVL = 105.9 cm; tail length (tail was intact) = 20.9 cm; total length = 126.8 cm. Mass of the snake was 900 g (no apparent food boli).

The length of this snake exceeds the previously published maximum size (total length = 115.6 cm) for the species (Conant and Collins 1998. A Field Guide to Reptiles and Amphibians of Eastern and Central North America. Houghton Mifflin Co., Boston, Massachusetts. 616 pp.), based on a specimen from Beaver Co., Oklahoma reported by Platt (1969. Univ. Kansas Publ. Mus. Nat. Hist. 18:253–420). We deposited a voucher photograph of the specimen in the University of Florida Museum of Natural History Herpetology Collection (UF 157500).

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***HETERODON SIMUS* (Southern Hog-nosed Snake). DIET.** *Heterodon simus* is commonly reported to feed "almost exclusively" on anurans (Mount 1975. The Reptiles and Amphibians of Alabama. Agriculture Experiment Station, Auburn University. 345 pp.; Tuberville and Jensen 2008. *In* Jensen et al. [eds.], Amphibians and Reptiles of Georgia, Univ. Georgia Press, Athens. 575 pp.). Beane et al. (1998. Herpetol. Rev. 29:44–45) also reported two lizard species as prey. Here we report predation by *H. simus* on a large invertebrate.

An adult male *H. simus* (SVL = 330 mm; total length = 408 mm) was found road-killed ca. 9.7 km WNW of Wagram, Scotland Co., North Carolina, USA (34.904579°N, 79.470070°W, datum: WGS 84) on 4 October 2008. The stomach contained a third (final) instar Ox Beetle (*Strategus antaeus*) larva. The larva was too badly fragmented to measure accurately, but was estimated to be ca. 60 mm total length. Insect fragments are occasionally found in the digestive tracts and in the feces of *H. simus* (pers. obs.), but virtually all these almost certainly represent items secondarily ingested along with typical food items (e.g., *Scaphiopus*, *Bufo*). The large size of this grub, its only partially digested condition and lack of association with any recently ingested vertebrate prey, and its presence in the stomach rather than farther down the digestive tract indicate that it was almost certainly taken directly as prey and not secondarily ingested. A few tarsal bone fragments from an anuran of undetermined species were also present in the stomach, but they were obviously from a prey item that had been eaten much earlier. To our knowledge, this represents the first documentation of an invertebrate taken as primary prey by *H. simus*. The *H. simus* specimen is deposited in the herpetological research collections of the North Carolina State Museum of Natural Sciences (NCSM 74482). The *S. antaeus* remains are deposited in the entomological collections of North Carolina State University.

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***LAMPROPELTIS GETULA HOLBROOKI* (Speckled Kingsnake). DIET.** *Lampropeltis getula* eat a variety of prey, including small mammals, birds, eggs, and other reptiles. Many species of snakes are eaten by *L. getula*, but the only species of watersnakes noted are *Nerodia erythrogaster*, *N. fasciata*, *N. floridana*, and *N. rhombifer* (Clark 1949. J. Tennessee Acad. Sci. 24:244–261; Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Institution Press, Washington D.C. 668 pp.; Winne et al. 2007. Copeia 2007:507–519). No previous reports include *L. g. holbrooki* preying on *Nerodia cyclopion*.

On 23 March 2007, a *L. getula* (female; SVL = 89.1 cm; tail length = 12.8 cm; 288 g) was found constricting a *N. cyclopion* (male; SVL = 63.2 cm; tail length = 14.0 cm; 150 g) at Spanish Lake, Cade, Iberia Parish, Louisiana, USA. The *L. getula* had approximately 3½ loops wrapped around the anterior half of the prey, but released the watersnake when disturbed. The watersnake had been constricted tightly, but was still capable of slight movement. When the watersnake became responsive and alert, it was released at the site of capture. If ingestion had been allowed, this would have been a 52.1% prey mass/predator mass ratio.

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***LEPTOPHIS DIPLOTROPIS* (Pacific Coast Parrot Snake). DIET.** *Leptophis diplotropis* is a colubrid endemic to México that feeds on a variety of frogs (Hardy and McDiarmid 1969. Univ. Kansas Publ. Mus. Nat. Hist. 18:182; Oliver 1948. Bull. Amer. Mus. Nat. Hist. 92:255). Although lizards are included in the diet of other species within the genus (Henderson 1982. Amphibia-Reptilia 3:71–80; Henderson et al. 1977. J. Herpetol. 11:231–232), to our knowledge no lizards have been reported in the diet of *L. diplotropis*. Here we present the first record of a lizard in the diet of this species.

On 13 November 2009, at 1344 h, an adult *L. diplotropis* was observed in the process of feeding on a *Phyllodactylus tuberculosus* at Campamento Aserradero, María Madre Island, Nayarit, México (21.6801°N, 106.6054°W, WGS84; elev. 41 m). The snake and prey were found on the ground near a wooden table used for remodeling buildings. At this site, geckos often seek shelter between the construction materials, where they are hunted by snakes. When encountered, the snake was holding its prey by the posterior body portion. It proceeded to swallow the lizard over the next 13 min. The event was photographed and a color slide (MFSI-REPT-859) was deposited in the amphibian and reptile collection of Museo de las Ciencias Biológicas "Enrique Beltrán," FES-Iztacala, Universidad Nacional Autónoma de México, México.

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***MASTICOPHIS* (= *COLUBER*) *MENTOVARIUS* (Neotropical Whipsnake). DIET.** Species in the genus *Masticophis* are known to prey on a diversity of vertebrates, including young birds, lizards, frogs, rodents, eggs, snakes, and small turtles (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Institution Press, Washington D.C. 668 pp.; Werler and Dixon 2000. Texas Snakes: Identification, Distribution, and Natural History. Univ. Texas Press. Austin. 437 pp.). *Masticophis mentovarius*, like all members of the genus, is considered a generalist forager. On 1 December 2008, in tropical dry forest at Las Mojarras, Municipality of Oaxaca de Juárez, Oaxaca, México (17.11186°N, 96.72225°W; datum: WGS84; elev. 1683 m), we observed a male *M. mentovarius* feeding on a Grayish Mouse Opossum (*Tlacuatzin canescens*; Fig. 1). This is the first record of a marsupial in the diet of *M. mentovarius*.

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FIG. 1. Adult male *Masticophis mentovarius* feeding on an adult Grayish Mouse Opossum (*Tlacuatzin canescens*), Las Mojarras, Municipality of Oaxaca de Juárez, Oaxaca, México.

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***MASTIGODRYAS BRUESI* (Windward Tree Racer, White Snake). BEHAVIOR.** *Mastigodryas bruesi* is native to the Grenada and St. Vincent island banks and has been introduced on Barbados (Greene et al. 2003. Cat. Amer. Amphib. Rept. 777:1–3). Very little is known about the biology of the species (Henderson and Powell 2009. Natural History of West Indian Reptiles and Amphibians. Univ. Press Florida, Gainesville. xxiv + 495 pp.). From 3–22 June 2010, we had 32 encounters with *M. bruesi* on Union Island (St. Vincent and the Grenadines). These snakes were abundant at elevations ranging from sea level to nearly 300 m (just below the highest point on the island) and in a variety of habitats. The number of encounters and the broad distribution of *M. bruesi* on Union might be attributable to the absence of the Small Indian Mongoose (*Urva auropunctata*), which has been implicated in the extirpation or extinction of several species of ground-dwelling lizards and snakes in the West Indies (e.g., Powell and Henderson 2005. Iguana 12:62–77). Encounters with *M. bruesi* on St. Vincent and Grenada are comparatively rare and mongooses are common. On the larger mongoose-infested islands, arboreal, nocturnally active boids (*Corallus grenadensis* and *C. cookii*) have broad distributions at elevations under 500 m and can be encountered in a variety of habitats (Henderson 2002. Neotropical Treeboas: Natural History of the *Corallus hortulanus* Complex. Krieger Publ. Co., Malabar, Florida. xiv + 197 pp.; Powell et al. 2007. *In* Henderson and Powell [eds.], Biology of the Boas and Pythons, pp. 374–387. Eagle Mountain Publ., Eagle Mountain, Utah). In contrast, diurnally active and largely ground-dwelling *M. bruesi* is rarely encountered outside of disturbed areas where human activity is common and mongooses rare or absent. On mongoose-free Union, the frequencies of encounters with *C. grenadensis* and *M. bruesi* encounters were comparable.

Although 26 of 28 diurnal encounters were with individuals on the ground and two with snakes in rock crevices, *M. bruesi* is an excellent climber. Of 14 escapes we observed, 10 individuals fled downhill before ascending into shrubs or vines that they then used to gain access to the lower branches of larger trees. Arboreality might provide some protection from terrestrial predators (e.g., mongooses; Sajdak and Henderson 1991. Oryx 25:33–38). The other four snakes escaped by continuing downhill until out of sight or by entering rock crevices. When captured, snakes were not aggressive and seldom attempted to bite. In all instances, they released musk in an apparent effort to deter handling. Four snakes vibrated their tails when cornered or captured.

Three *M. bruesi* were encountered while actively foraging, probing and tongue-flicking in leaf litter and rock crevices where geckos (e.g., *Gonatodes daudini* and *Sphaerodactylus kirbyi*) occurred. They also responded actively to movements. Three individuals followed and struck at small rocks rolling downhill. We observed four snakes sleeping in trees at night while coiled on branches at heights of 2–8 m. Schwartz and Henderson (1991. Amphibians and Reptiles of the West Indies: Descriptions, Distributions, and Natural History. Univ. Florida Press, Gainesville. xvi + 720 pp.) noted that *M. bruesi* sleeps at heights of at least 5 m.

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***MICRURUS DISTANS* (Sinaloan Coralsnake). DIET.** *Micrurus distans* is an elapid snake distributed from southern Chihuahua and Sonora to central Guerrero, México (Lemos-Espinal and Smith 2007. Amphibians and Reptiles of the State of Chihuahua, México. Universidad Nacional Autónoma de México (UNAM) and Comisión Nacional para el conocimiento y uso de la Biodiversidad (CONABIO), México, D.F. 418 pp.). This species feeds on small snakes, lizards, and frogs (Ramirez-Bautista 1994. Manual y Clave Ilustrada de los Anfibios y Reptiles de la Región de Chamela, Jalisco, México. Instituto de Biología, UNAM, México D.F. 87 pp.), but few specific diet records are known. Here we report evidence of predator-prey interaction between *M. distans* and its presumptive Batesian mimic *Lampropeltis triangulum*.

On the morning of 25 March 2008, in tropical deciduous forest at Chamela UNAM Biological Station, Jalisco, México, we observed an *M. distans* preying on an *L. triangulum* in the leaf litter (Fig. 1). The snakes were of similar size (ca. 700 mm total length) and were observed wrestling, with the *L. triangulum* apparently using constriction as a defensive tactic against its predator. After about 10 min, the *M. distans* immobilized its prey by envenomation and later ingested it headfirst. After approximately 20 min, the *L. triangulum* had been fully ingested and the *M. distans* was hidden among leaf litter.

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FIG. 1. *Micrurus distans* preying on *Lampropeltis triangulum* in Jalisco, México.

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***MICRURUS FULVIUS* (Harlequin Coralsnake). DIET.** The diet of *Micrurus fulvius* consists primarily of elongate reptiles including other snakes (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Institution Press, Washington D.C. 668 pp.). Previously, only one viperid has been documented as a prey item of *M. fulvius*. A *Sistrurus miliarius* (Pigmy Rattlesnake) was removed by dissection from a *M. fulvius* from the University of Texas at Tyler teaching collection. Locality data for the specimen was not available. The coral snake measured 551 mm SVL with a head width of 10.42 mm. The partially digested prey measured 138 mm in total length and 5.5 mm in diameter at its maximum point. After the prey was removed, the coral snake weighed 37.33 g and the prey weighed 1.88 g. From the remains, the prey generated the conservative estimates of the following prey-to-predator ratios: a weight ratio of 0.05, an ingestion ratio of 0.52, and a length ratio (= total length of prey/snout–vent length of predator) of 0.25. To my knowledge, this is the first report of a *S. miliarius* as a prey item of *M. fulvius*.

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***MICRURUS NIGROCINCTUS NIGROCINCTUS* (Central American Coral Snake). DIET.** Caecilians are known from the diets of at least nine species of coral snake (Burger 1997. Bull. Chicago Herpetol. Soc. 32:145; Freile and Fletcher-Lazo 2009. Herpetol. Rev. 40:99; Roze 1996. Coral Snakes of the Americas: Biology, Identification and Venoms. Krieger Publ. Co., Malabar, Florida. 340 pp.), with the earliest record dating back to Boulenger (1913. Proc. Zool. Soc. London 1913:1019–1038). Although multiple early authorities recognized interactions between coral snakes and caecilians, the exact species relationships were not always reported; prey were often reported only as "caecilian." *Micrurus nigrocinctus nigrocinctus* is a common member of the genus within its range (Greene and Seib 1983. *In* D. H. Janzen [ed.], Costa Rican Natural History, pp. 406–408. Univ. Chicago Press, Illinois) and has been reported to consume caecilians but until now specific species of caecilians have not been reported. Here we present three independent accounts of *M. n. nigrocinctus* feeding on the caecilian *Oscaecilia ochrocephala*.

On 27 July 2003, at ca. ca. 1700 h, RVH observed a recently killed female coral snake (SVL = 419 mm; total length = 466 mm; 15.8 g after prey removal) in a private lawn in Gamboa, Colon Province, Panama. Closer inspection of the specimen revealed a blow to the upper body caused its death. The specimen appeared to contain a large food item and upon dissection was found to contain an *O. ochrocephala* that had been consumed headfirst (total length = 281 mm; 4.9 g). Both specimens were deposited at the Círculo Herpetológico de Panamá (Fig. 1; CH5730 and CH5732).

On 17 September 2009, at ca. 1130 h, AH collected a coral snake in the Río Agua Salud watershed, El Giral, Colon Province, Panama. After being placed in a bag, the snake regurgitated a partly digested *O. ochrocephala* that had been consumed headfirst. The snake was subsequently released and the caecilian left on site.

On 21 September 2009, at ca. 1330 h, RID observed a *M. n. nigrocinctus* biting an *O. ochrocephala* on a lawn in Parque Municipal Summit, Panama Province, Panama. Upon approach, the coral snake released the caecilian and fled to nearby cover. The caecilian appeared dead, and was moved 2–3 m away from the capture site. Some minutes later, the coral snake returned, appearing to be seeking the dead prey. The coral snake bit the caecilian and started eating it headfirst. At ca. 1400 h, the coral snake was observed swallowing its prey, from a concealed position (Fig. 2). The caecilian was somewhat longer than the snake



PHOTO BY R. V. HORAN III

FIG. 1. Preserved specimen of *Micrurus nigrocinctus nigrocinctus* and its prey *Oscaecilia ochrocephala,* collected in Gamboa, Colon Province, Panama, 27 July 2003.



PHOTO BY R. IBÁÑEZ-D

FIG. 2. *Micrurus n. nigrocinctus* feeding on an *O. ochrocephala* on a lawn in Parque Municipal Summit, Panama Province, Panama, 21 September 2009.

and consumption took approximately 50 min. No attempt was made to interrupt the feeding event or to collect the snake. Photos from all three observations are available on the Smithsonian Tropical Research Institute's Digital File Manager website at http://biogeodb.stri.si.edu/bioinformatics/dfm/.

Micrurus nigrocinctus nigrocinctus has previously been considered a generalist, consuming a wide range of small amphibian and reptile species. Based on the observations reported here, we think that caecilians might be a more important diet item for this species than previously considered.

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***NAJA MELANOLEUCA* (Forest Cobra). DIET AND FORAGING BEHAVIOR.** Primarily an arboreal snake restricted to tropical and subtropical African forests, *Naja melanoleuca* is a dietary generalist that preys on small mammals, anurans, birds, other squamates, and fish (Alexander and Marais 2007. A Guide to the Reptiles of Southern Africa. Struik, Cape Town. 408 pp.). The species is locally abundant in the coastal village of St. Lucia in northeastern South Africa, and is frequently encountered



FIG. 1. *Naja melanoleuca* with regurgitated *Stactolaema leucotis.*

around human residences. The presence of *N. melanoleuca* in trees is often betrayed by the shrieking alarm calls of gregarious birds like the Dark-capped Bulbul (*Pycnonotus tricolor*), White-eared Barbet (*Stactolaema leucotis*), and Weavers (*Ploceus* spp.). Additionally, these birds sometimes engage in a series of mock attacks by making short, diving flights directly at the snake before quickly turning away to avoid contact. On three occasions, I have also observed *N. melanoleuca* coiled on or around small branches make reciprocal lunges with open mouths at birds as they fly past. On the morning of 10 February 2009, after observing part of one such encounter in a residential garden in St. Lucia (28.38293°S, 32.40816°E, datum: WGS84), I captured the snake (branch height = 2.5 m) and examined its stomach contents. The individual (SVL = 144 cm; mass = 984 g) regurgitated six adult *S. leucotis* (Fig. 1) that collectively weighed 361 g (36.7% of snake body mass). Although I did not witness the snake feeding, based on the presence of perturbed *S. leucotis* at the capture scene and the relatively undigested condition of the prey (all ingested head-first), the birds presumably had been eaten immediately before my arrival. *Stactolaema leucotis* sometimes roost communally in tree cavities (Hockey et al. 2005. Birds of Southern Africa, 7th ed. The Trustees of the John Voelcker Bird Book Fund, Cape Town. 1296 pp.), so it is possible the snake trapped the six barbets in a nest prior to feeding. Alternately, *N. melanoleuca* might intentionally expose themselves to some avian prey because the resulting response behavior (mock attacks) by groups of birds puts the snakes in close proximity to multiple meals. *Stactolaema leucotis* has not been previously recorded in the diet of *N. melanoleuca.* Regurgitated stomach contents of other *N. melanoleuca* captured at St. Lucia during 2007–2009 also include an *Acontias plumbeus* (Giant Legless Skink), *Amietophrynus gutturalis* (Guttural Toad), and unidentified small mammals.

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***NATRIX MAURA* (Viperine Snake). NON-ACCIDENTAL SALT WATER ACTIVITY.** Snakes in the genus *Natrix* are occasionally found in marine environments but few records substantiate voluntary entry. The earliest record appears to be that of Böse (1897. Zoologischer Anzeiger 20[521]:255), a naval physician aboard the warship S.M.S. Blücher, who reported a *N. natrix* 1 km from the coast of the Second German Empire (1871–1918)

in an unspecified (either the North Sea or Baltic Sea) location. *Natrix natrix* subsequently has been reported in the Atlantic Ocean 46.3 km off the coast of Norway (Hecht 1930. Mitt. Zool. Mus. Berlin 16:345–346), approximately 11 km from the coast of France between Île de Penfret in the Îles de Glénan and the coast (Guérin-Ganivet 1909. Bull. Inst. Oceanographie 132:1–2), and in the Bay of Biscay (p. 227 *in* Smith 1951. The British Amphibians and Reptiles. Collins, London. 318 pp.). Additional records include the North Sea (9.7 km from the coast of Bretagne, France; Hecht 1930. Mitt. Zool. Mus. Berlin 16:345–346) and the English Channel (p. 126 *in* Loveridge 1945. Reptiles of the Pacific World. Macmillan Co., New York. 259 pp.) but it is unclear whether these records reflect accidental or voluntary entry into saline waters.

Natrix tessellata, on the other hand, has been observed chasing small gobies in the Black Sea along the shore near Odessa (Ukraine; p. 164 *in* Boulenger 1913. The Snakes of Europe. Methuen and Company, London. 269 pp.) and a single specimen of *N. maura* was observed in a 0.2 m deep pool on the beach between Tarifa and Algeciras (Cádiz Province, Spain) that is inhabited by small fish and that, at high tide, is flooded with seawater (Cabot and Olea 1978. Doñana, Acta Vertebrata 5:107).

In August, when freshwater streams in southeastern Cádiz Province, Spain, are completely dry, *N. maura* is frequently seen fishing in small "pools" formed by sand and stones in the tidal zone by Piedra de las Morenas (36.07095°N, 5.7500889°W; datum WGS84). Many small fish remain trapped in these pools between low tide and high tide and, on one occasion, an individual that had captured a "cabozo" (*Gobius paganellus*) was seen. During August 1986–1987, while spear fishing in the area of Galerilla (Ensenada de Bolonia, Cádiz Province, Spain; 36.0737083°N, 5.7597778°W; datum WGS84) one of us (RC) observed a *N. maura* actively swimming on the surface of the Atlantic Ocean where water depth was 5 m. These observations confirm that *Natrix maura* engages in limited, non-accidental, activity in salt water.

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***NERODIA RHOMBIFER* (Diamond-backed Watersnake). INTERSEXUALITY.** Intersexuality is rare among adult snakes (Cole 1975. *In* Reinboth [ed.], Intersexuality in the Animal Kingdom, pp. 340–355. Springer-Verlag, New York). Adult female *Pseudoficimia frontalis* universally possess hemipenes, though they are smaller than those of males (Hardy 1970. Herpetologica 26:336–343). Adult female *Bothrops insularis* may be either normal or intersexual with most being intersexual. Normal females of this species appear to be sterile while intersexuals are fertile but are capable of carrying fewer embryos than sister taxa (Hoge et al. 1959. Mem. Inst. Butantan 29:17–88). Wilson and Robinson (1971. Bull. So. California Acad. Sci. 70:53–54) described an intersexual *Amastridium veliferum* that apparently functioned as a female though it possessed hemipenes. The hemipenes, however, were reduced in size and were not fully ornamented. An intersexual *Thamnophis sirtalis* was described by Krohmer (1989. Copeia 1989:1064–1068). Upon dissection, this individual possessed male sex characters on the left side and female sex characters on the right, though it was behaviorally only a male.

On 31 August 2007, 19 *Nerodia rhombifer* were collected from a private fish farm in Desha Co., Arkansas, USA (33.67992°N, 91.26831°W, datum: WGS 84). Of these, six were normal males, 12 were normal females, and 1 was an intersexual. The intersexual (SVL = 802 mm, tail length = 223 mm; ASUMZ 30809) lacked the papillae on the chin indicative of male *N. rhombifer*, but possessed hemipenes with full ornamentation (Fig. 1). Dissection showed oviducts and ovaries with pre-vitellogenic follicles and undeveloped Wolffian ducts, thus signifying a female. The right ovary (75 mm × 6 mm) was removed and follicles were measured (N = 6; mean length ± SD = 6.833 ± 1.722 mm; mean diameter ± SD = 3.833 ± 0.983 mm). Because the Wolffian ducts were not developed into ductus deferentia, it appears that this individual could only function as a female, and the abnormality was the possession of hemipenes. This individual is, therefore, considered a pseudohermaphrodite as opposed to a true hermaphrodite.

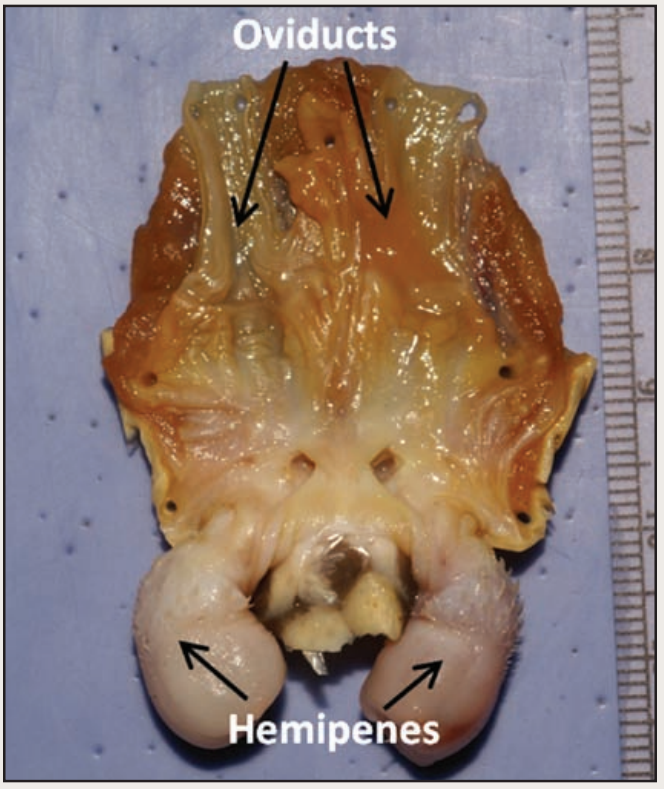


FIG. 1. Dissected cloaca of intersexual *Nerodia rhombifer* showing both male and female reproductive organs.

The cause of sexual abnormalities is not fully understood and both genetic and hormonal factors have been proposed (Hoge et al. 1959, *op. cit.*, Fox 1977. *In* Gans and Parsons [eds.], Biology of the Reptilia, Vol. 6, Morphology E, pp. 1–157. Academic Press, New York). Because our *N. rhombifer* represents a single instance of intersexuality in this species, aberrant hormonal or genetic factors are likely the cause.

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***NERODIA SIPEDON* (Northern Watersnake). DEFENSIVE BEHAVIOR.** Many reptiles have the ability to detach their tails when threatened or attacked. This antipredator behavior, called tail autotomy, has been reported for various species of lizards,

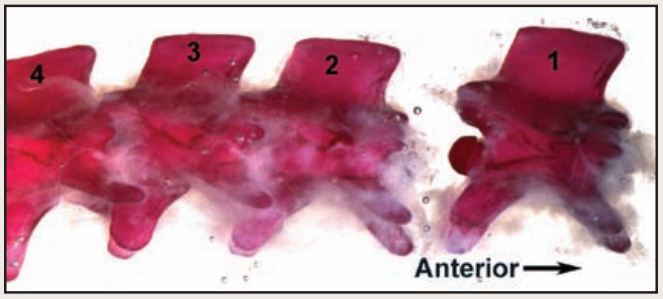


FIG. 1. *Nerodia sipedon* vertebrae caudal to the tail detachment site. Vertebra 1 has been isolated to show it is complete.

sphenodonts, amphisbaenids, and snakes. Among these taxa, an array of tail autotomy strategies exists (Arnold 1984. J. Nat. Hist. 18:127–169). True autotomy occurs when the tail is lost spontaneously and is later regenerated, as is the case with many lizards and *Sphenodon*. Often the tail breaks intravertebrally, along a pre-existing fissure. Pseudoautotomy occurs when a mechanical force is required to separate the tail from the body and the tail does not grow back; this is common in natricine snakes in North America (Cooper 1993. Amphibia-Reptilia 14:86–89; Fitch 1965. Univ. Kansas Publ. Mus. Nat. Hist. 15:493–564; Todd 2010. Amphibia-Reptilia 31:213–215). Pseudoautotomy is further divided into specialized pseudoautotomy where the tail anatomy facilitates breakage, and non-specialized pseudoautotomy where the tail is lost because it is long and fragile with no clear mechanisms to facilitate detachment (Slowinski and Savage 1995. Herpetologica 51:338–341).

At approximately 1130 h on 27 August 2009, we captured an adult *Nerodia sipedon* in Killarney Provincial Park, Ontario, Canada (46.08333°N, 81.33333°W, datum NAD 83). The snake was basking on a granite ledge, roughly 10 m from water's edge. The snake was caught by the tail and it immediately performed a lateral roll, causing its tail to detach. We dropped the tail and caught the snake before it could escape. Very little blood was lost through the wound, where the tail detached. The isolated tail continued to move in response to touch for almost 30 min. The tail was frozen and shipped to Dalhousie University, Nova Scotia, Canada for clearing and staining after fixation in neutral buffered formalin.

The wriggling of the tail immediately after detachment and prolonged response of the tail to touch suggests that these snakes may have anatomical features that facilitate tail detachment for predator evasion. This would fall into the category of specialized tail pseudoautotomy. To determine whether the tail had broken intra- or intervertebrally, the tail tissue was cleared using trypsin powder in sodium tetraborate and potassium hydroxide. The bone was stained with aliziran red. Fig. 1 shows the first four vertebrae after the break site. The first vertebra caudal to the break site is separated to show that it is complete, confirming that the tail broke intervertebrally and that *N. sipedon* displays tail pseudoautotomy in response to a sheer force sufficient to detach the tail. There are no distinctive osteological features before or after the break site, suggesting that anatomically, pseudoautotomy in *N. sipedon* is of a non-specialized nature.

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OPHIOPHAGUS HANNAH **(King Cobra). DIET.** *Ophiophagus hannah* is a front-fanged elapid snake found throughout much of Southeast Asia. *Ophiophagus hannah* is known to primarily consume other snakes, but has also been documented to consume lizards, including varanids (Evans 1902. J. Bombay Nat. Hist. Soc. 14:409–418; Hesed 2006. Herpetol. Rev. 37:480; Smith 1943. Fauna of British India: Reptilia and Amphibia, Vol. III, Serpentes. Taylor & Francis, London). However, a review of published dietary observations in this species showed all records to be restricted to India, Malaysia, and Thailand (Hesed, *op. cit.*). To our knowledge, this is the first record of a varanid in the diet of *O. hannah* in the Philippines.

During fieldwork in the Philippines, we observed a male *Ophiophagus hannah* (total length = 327.5 cm; 3.75 kg) consuming, head-first, a 1.5 kg *Varanus cumingi* (Fig. 1.). The event occurred on 12 April 2009, in mixed primary and secondary growth forest, on a trail near a water intake system, in Pasonanca Natural Park, Barangay Pasonanca, Zamboanga City Province, Mindanao Island, Philippines (6.9922333°N, 122.0604333°E, datum: WGS-84; elev. 90 m). Both specimens were collected, preserved, and deposited at the Biodiversity Institute, University of Kansas (KU 321813: *Ophiophagus hannah*, KU 321814: *Varanus cumingi*).

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FIG. 1. An adult *Ophiophagus hannah* preying upon an subadult *Varanus cumingi* in Pasonanca Natural Park, Mindanao Island, Philippines.

COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND

***OPISTHOTROPIS KUATUNENSIS* (Striped Stream Snake). DIET.** *Opisthotropis kuatunensis* is a small- to medium-sized aquatic snake which is widely distributed in southern China, including Fujian, Guangxi, Jiangxi, Zhejiang, Guangdong provinces and Hong Kong Special Administrative Region (Karsen et al. 1998. Hong Kong Amphibians and Reptiles. Provisional Urban Council. Hong Kong SAR. 186 pp.). This snake inhabits moderate- to high-gradient rocky streams on hillslopes with intact forest. It can be observed at night foraging in stream pools and riffles, probing crevices in the substrate for prey. Very limited information is available about its diet except that it consumes fish and tadpoles in captivity (Karsen et al., *op. cit.*). Here we report the first documented observation of *O. kuatunensis* consuming frog eggs and tadpoles in the wild, which also represents the first report of frog egg consumption by any snake in the genus *Opisthotropis*.

At 2105 h on 18 September 2009, at Kadoorie Farm and Botanic Garden (22.43386°N, 114.12736°E, datum: WGS84; elev. 415 m), New Territories, Hong Kong, we observed a female *O. kuatunensis* (SVL = 46 cm; total length = 55 cm) attempting to swallow an egg of *Paa exilispinosa* (Lesser Spiny Frog) in an artificial pond (length × width × depth = 50 × 30 × 18 cm) that was located in secondary forest and was connected to a 2 m wide stream nearby. When the egg was ingested halfway, the snake detected our presence, released the egg, and fled. We caught the snake for measurement and photographic record. A total of 19 eggs of *P. exilispinosa* at early tail-bud stage (Gosner 1960. Herpetologica 16:183–190) were found in the pond. Clutches of *P. exilispinosa* generally contain approximately 50–150 eggs and the entire clutch is typically deposited together in a small pool (N. Karraker, unpubl. data). The few eggs observed at this site suggest that the snake, or possibly some other predator, had consumed other eggs. Eggs of *P. exilispinosa* are approximately 12–23 mm in diameter, with embryos ranging from 9 to 11 mm, depending upon developmental stage (N. Karraker, unpubl. data). These are the second largest embryos of any stream-breeding frog in Hong Kong, aside from those of the Giant Spiny Frog (*P. spinosa*), and their size and oviposition as a group potentially represents a substantial food source for *O. kuatenensis*.

At 2040 h on 11 January 2010, at Tai Mo Shan (22.54278°N, 114.28917°E, datum: WGS84; elev. 878 m), New Territories, Hong Kong, a male *O. kuatunensis* (SVL = 32 cm; total length = 38.5 cm) was observed biting the head of a *Leptolalax liui* (Leaf Litter Toad) tadpole (total length ca. 3 cm) in a pool (length × width × depth = 62 × 30 × 8 cm) along a natural stream in secondary forest. The tadpole struggled and escaped after being held for 30 seconds, and we were unable to capture it. This sighting confirms that *O. kuatunensis* eats tadpoles in the wild. These two species are commonly sympatric in streams in Hong Kong, and it is likely that *L. liui* tadpoles are regular prey for *O. kuatunensis*. Although the natural diets of stream snakes in southern China are largely unknown, amphibians may be important prey here, as they are for stream-associated snakes in other regions of the world.

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***OXYBELIS AENEUS* (Brown Vinesnake). MOVEMENTS AND FORAGING BEHAVIOR.** Monitoring movement patterns in vertebrates is a complex task, especially in secretive species such as snakes (Shine et al. 2006. Copeia 2006:103–115). Radiotelemetry has been used to better understand the ecology of snakes, but has seldom been applied to arboreal slender species or small terrestrial or fossorial species and many ecological aspects of these species are unknown (Madrid Sotelo and Balderas Valdivia 2008. Bol. Soc. Herpetol. Mex. 16:5–12). Here we use radiotelemetry to investigate movement patterns of seven female *O. aeneus* during the dry season in the tropical dry forest of Chamela, Jalisco, México. Additionally, we report observations of foraging behavior in the telemetered snakes.

Seven adult female *Oxybelis aeneus* were captured by hand in the first two weeks of April 2007 in the tropical dry forest around the Chamela Field Station. One radiotransmitter (< 5% of snake mass) model TXA-0061 (Telenax®, Mexico) was attached externally to the back of each individual (Madrid-Sotelo and García 2008. North-West J. Zool. 2:335–338) and the snakes were released at their capture location within 24 h. Between April and June snakes were relocated daily on an alternating morning (1000–1400 h) or afternoon (1600–1900 h) schedule and each snake's location was recorded using a handheld GPS (model Etrex, Garmin). Whenever possible, snake locations were verified visually and the habitat (tree, shrub, or soil) and approximate perch height was recorded. Activity area was estimated using the Movement Animal Extension in Arc View 3.2 (ESRI 1996). We also determined number of significant movements (those >10 m) and the mean movement distance travelled by each snake.

Activity areas were smaller than one hectare in most of the cases (Table 1) and movements were generally small; less than 20% were greater than 10 m. Similarly, the mean distance traveled was less than 30 m (Table 1). Most (88.2%) of all visualized snakes were in trees or shrubs 60 to 130 cm above the ground, whereas 5.9% were higher than 2 m and only 5.9% were located on the ground. On two occasions we observed snakes in their nocturnal perches in the typical rest, loose-coiled, head down

TABLE 1. Activity areas and movement characteristics of female *Oxybelis aeneus* in tropical dry forest of Chamela, Jalisco, México.

Individual identification	SVL (mm)	Number of relocations minimum convex polygon(ha)	Activity area — movements (>10 m)	Percentage of significant traveled (m)	Mean distance
Oa I	730	23	2.9	17.39	29.03
Oa II	900	26	1.47	12.5	7.22
Oa III	630	10	0.004	0	1.19
Oa IV	940	22	0.05	9.09	6.2
Oa V	790	21	0.49	14.28	9.69
Oa VI	800	26	0.2	11.53	9.32
Oa VII	860	22	0.05	9.09	6.94

position (Henderson 1974. Herpetologica 30:19–24). These snakes were located 85 and 178 cm above the ground within dense vegetation, which made observation difficult.

During this study there were several opportunities when it was possible to observe the foraging behavior of *O. aeneus*. A total of 20 foraging events was recorded, 17 (85%) towards *Aspidoscelis* spp., 2 (10%) towards *Anolis* spp. and 1 (5%) towards *Plestiodon parvulus*: only 3 (15%) all of these foraging events were successful, two for *Aspidoscelis* and one for *Plestiodon parvulus*. In all the observations the snakes used ambush foraging behaviors and active pursuit of prey was never observed.

Our results suggest that female *O. aeneus* have small, defined activity areas and move short distances; several times snakes were relocated in their previous relocation site. On the other hand, two individuals exhibited relatively larger activity areas (1.4 and 2.9 ha). This may be due to some unusual larger movements in which a snake moved outside of its habitual home range and soon returned. Such movements have been observed in female *Stegonotus cucullatus* which move outside of their habitual home range, apparently to oviposit in nesting sites, and then return to the areas usually occupied (Brown et al. 2005. J. Trop. Ecol. 21:605–612). In our case, however, we did not detect that any of the monitored females were gravid. Restricted movement by female *O. aeneus* during the dry season apparently minimizes wasted energy and may diminish risk of desiccation. In seasonal environments some snakes drastically increase movement patterns and home range during wet seasons, whereas others maintain similar patterns at both times of the year (Brown et al. 2002. J. Trop. Ecol. 18:549–568). It would be important to know if activity patterns of *O. aeneus* during the dry season are maintained during the rainy season.

The movement patterns and behavior that we observed suggest that *O. aeneus* is primarily a sit and wait predator. Similar patterns have been observed in other arboreal colubrids such as *Uromacer catesbyi* and *U. oxyrhynchus*, which spend about 95% of daylight hours relatively motionless, looking for active prey, and only descend to the ground to look for a new ambush site (Lillywhite and Henderson 1993. *In* Seigel and Collins [eds], Snakes: Ecology and Behavior, pp. 1–48. McGraw-Hill, Inc. New York). A similar pattern was also reported in vipers such as the Asian viper *Gloydius shedaoensis*, which is an extremely sedentary hunter. The home range in this species is 0.3 ha with daily movements of less than two meters (Shine et al. 2003. Oikos 2:342–352). Snakes using these foraging strategies have been defined by Greene (1997. Snakes: The Evolution of Mystery in Nature. University of California Press, Berkeley. 317 pp.) as mobile ambushers, that is to say, serpents that remain from days to months in the same site before moving to another place.

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***OXYRHOPUS PETOLA DIGITALIS* (False Coral Snake). PREY.** Snakes of the genus *Oxyrhopus* feed on a wide variety of prey, but seem to be primarily predators of lizards and small mammals (e.g., Duellman 1978. Misc. Publ. Mus. Nat. Hist. Univ. Kansas 65:1–352; França et al. 2008. Copeia 2008:23–38; Vitt and Vangilder 1983. Amphibia-Reptilia 4:273–296). On 3 August 2007, at 1935 h, three of us (DV, MAG, CCS) found an adult female *Oxyrhopus petola digitalis* (SVL = 855 mm; tail length = 235 mm; 178 g) at the border of a forest fragment (22.445694°S, 42.764056°W, datum: SAD 69) near the Reserva Ecológica de Guapiaçu (REGUA) in the district of Guapiaçu, municipality of Cachoeiras de Macacu, state of Rio de Janeiro, Brazil. The snake was promptly captured and placed in a cloth bag. The next day, it had regurgitated a rodent (*Oligoryzomys nigripes*; 28.5 g) inside the bag (Fig. 1). The snake is currently housed at the reptile collection of the Museu Nacional, Rio de Janeiro (MNRJ 15370). The skin and skeleton of the rodent were deposited at the mammal collection of the same museum (MN 72716). Previous prey records for *O. p. digitalis* have included small mammals, lizards, and birds (Bernarde and Machado 2000. Herpetol. Rev. 31:247–248; Duellman, *op. cit.*; Palmuti et al. 2009. Biota Neotrop. 9:263–269; Rocha and Vrcibradic 1998. Cienc. Cult. 50:364–368). In most cases, mammalian prey have not been identified to species or genus, with the exception of Rocha and Vrcibradic (*op. cit.*) who provided the identity of the snake's prey as the rodent *Akodon cursor*. The present record adds another case of predation on mammals by *O. p. digitalis* and is the second in which the mammal prey was identified to species.

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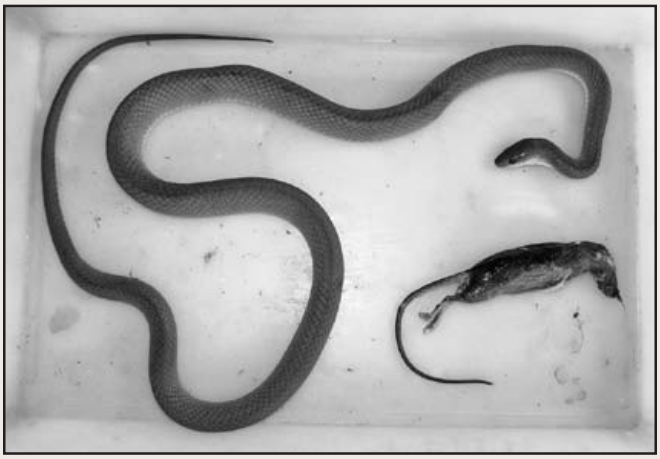


FIG. 1. Adult female *Oxyrhopus petola digitalis* and its recently regurgitated rodent prey (*Oligoryzomys nigripes*).

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***PANTHEROPHIS BAIRDI* (Baird's Ratsnake). DIET AND FORAGING BEHAVIOR.** A *Pantherophis bairdi* was found inside a cave (La Sepultura) in the municipality of Cd. Victoria, Tamaulipas, México (23.7756667°N, 99.2288056°W, datum WGS84; elev. 597 m). The snake was found coiled 2 m above the ground along one of the walls of the cave attempting to catch bats of the species *Leptonycteris curasoae* (Fig. 1). Other species of bats found and identified in this cave included *Desmodus rotundus, Diphylla ecaudata,* and *Pteronotus parnelli*. Previous reports mention that *P. bairdi* preys on rats, mice, bats, birds, bird eggs, and lizards, without reference to specific species or families of each group (Schulz 1996. A Monograph of the Colubrid Snakes of the Genus *Elaphe* Fitzinger. Koeltz Scientific Books, Czech Republic. 439 pp.). Schulz (1996, *op. cit.*) mentions that caves are inhabited by several species of rat snakes at least temporarily. For example, *Pantherophis guttata, P. obsoleta,* and *Senticolis triaspis* were recorded from caves occupied by bats, which served as prey. Moreover, the only known *P. bairdi* record in this municipality was published in 2009, but referred to a specimen found by T. W. Walker in 1969 (Farr et al. 2009. Herpetol. Rev. 40:459–467). Thus, this record represents the second municipality record in a span of over 40 years. The snake and bats were not caught or collected and were identified photographically and with the help of Luis Canseco-Márquez and Arnulfo Moreno-Valdez, respectively. We also thank David Lazcano-Villarreal for revising the manuscript.

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PHOTO BY JOSÉ IVÁN CUMPIÁN-MEDELLÍN

FIG. 1. *Pantherophis bairdi* attempting to catch *Leptonycteris curasoae* in the cave La Sepultura, Tamaulipas, México.

***PANTHEROPHIS SPILOIDES* (Gray Ratsnake). REPRODUCTIVE BEHAVIOR / ARBOREAL MALE COMBAT.** The goal of male combat in snakes is to establish dominance over an opponent through physical superiority (Gillingham 1987. *In* Seigel et al. [eds.], Snakes: Ecology and Evolutionary Biology, pp. 184–209. McGraw-Hill Publishing Co., New York). Male ratsnakes compete for mates by participating in dominance "combat dances" (Rigley 1971. J. Herpetol. 5:65–66; Stickel et al. 1980. Amer. Midl. Nat. 103:1–14); although the role of this behavior is not fully understood (Rigley, *op. cit.*). The arboreal habits of species in the *Pantherophis obsoleta* complex are also well documented (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Institution Press., Washington, D.C., 681 pp.), and arboreal mating has been noted in *P. o. obsoleta* (Padgett 1987. Catesbeiana 7:27–28), but to our knowledge, arboreal male combat has not been reported.

On 24 May 2006 at 1200 h, we observed a pair of free-ranging male *Pantherophis spiloides* engaged in arboreal combat on the Camp Shelby Joint Forces Training Center, Forrest Co., Mississippi, USA. The snakes were found entwined approximately 5 m above ground, hanging from a broken limb in a *Quercus marilandica* (Fig. 1). The smaller male (SVL = 141 cm, 612 g) continued to break contact and move up the tree, and was followed by



PHOTO BY T. M. DICKINSON

FIG. 1. Two adult male *Pantherophis spiloides* engaged in arboreal combat in Forrest Co., Mississippi, USA.

the larger male (SVL = 148.5 cm, 814 g). The larger male would continuously initiate contact and entwine with the smaller male along the tree branches attempting to press down the smaller male's head. At approximately 1235 h, the two snakes entered a decaying cavity of a limb and were unobservable. At 1239 h, the two snakes emerged from the cavity and began to move, entwined, towards the ground.

At approximately 1245 h, the two snakes reached the ground and continued in combat for 5 minutes until the smaller male retreated into nearby shrubbery without the larger male following. At this time, the snakes were collected for measurements and released at the point of capture the following day. A female *P. spiloides* was never observed to be present during this display or combat ritual. The behavior exhibited by both snakes was similar to the combat sequences described by Gillingham (1980. Herpetologica 36:120–127) for captive snakes.

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***PITUOPHIS MELANOLEUCUS LODINGI* (Black Pinesnake). REPRODUCTION and NEST LOCATION.** Our knowledge of *Pituophis melanoleucus* nesting ecology is primarily a result of intensive research conducted on a disjunct population of the nominate race, located at the northern limit of the species range (i.e., New Jersey Pine Barrens; Burger and Zappalorti 1986. Copeia 1986:116–121; Burger and Zappalorti 1991. J. Herpetol. 25:152–160). Although the first natural nest of *P. m. melanoleucus* outside of the Pine Barrens has recently been described (Beane and Pusser 2007. Herpetol. Rev. 38:469), information on nesting locations of the two more southerly distributed races remains anecdotal (i.e., *P. m. mugitus*: Franz 2005. *In* Meshaka, Jr. and Babbitt [eds.], Amphibians and Reptiles: Status and Conservation in Florida, pp. 120–131. Krieger Publ. Co., Malabar, Florida; Miller 2008. M.S. thesis, Univ. of Florida), or unknown (i.e., *P. m. lodingi*). In a note on *P. catenifer sayi* nesting, Iverson et al. (2007. Herpetol. Rev. 38:92) stated, "These data suggest that *P. melanoleucus* excavates its nest burrows, whereas *P. catenifer* uses natural cavities or burrows for oviposition; however, further data are needed for both species to determine the universality of this pattern." Herein we report a novel nesting location for *P. melanoleucus*, and provide, to our knowledge, the first published description of a natural nest of *P. m. lodingi*. The following observation took place in the southwestern portion of the Camp Shelby Joint Forces Training Center, Perry Co., Mississippi, USA.

On 3 September 2009, while searching the area around the last known location (i.e., burrow) of a telemetered *Gopherus polyphemus* (Gopher Tortoise), whose radio transmitter prematurely failed a month earlier, one of us (MGH) captured two hatchling *P. m. lodingi* which were basking on, or adjacent to, the apron of the tortoise burrow. On 4 September 2009, we revisited the site to excavate the burrow and immediately found a third hatchling *P. m. lodingi* tightly coiled and basking in the open, 6 m from the burrow's entrance. After taking some basic burrow measurements (i.e., width = 6.4 cm, height = 3.5 cm, angle of declination from the soil surface = 27°) following the methods of Doonan and Stout (1994. Am. Midl. Nat. 131:273–280), we excavated the burrow and located a clutch of six recently hatched eggs (cemented together in a single cluster) and two hatchling sheds at the burrows terminus (74 cm below the soil surface; measured to the bottom of the nest chamber). The straight line distance from the burrow's entrance to the terminus measured 161.9 cm; however, the total length of the burrow including turns (Doonan and Stout 1994, *op. cit.*) measured 188 cm. The chamber at the end of the burrow had a width of 14.5 cm and a height of 9 cm. The entire chamber and the last ~1/3 of the burrow were loosely packed with soil; however, a small tunnel (1.5 cm in diameter) extending from the chamber, presumably the route made by the exiting hatchling snakes, was observed. The tortoise was not found during the excavation, but was discovered 13 d later on the apron of a burrow that it had constructed previously.

The nest/burrow was located in a sandy area (McLaurin-Bendale soil series), with an open *Pinus palusrtis* (Longleaf Pine) canopy (canopy closure = 8%; estimated with a convex spherical crown densiometer), sparse mid-story (10%; visual estimate within 10 m^2), moderate *Andropogon* sp. (bluestem) dominated understory (60%; visual estimate within 10 m^2), and was in close proximity to a road (45 m); which are similar habitat characteristics reported for *P. m. melanoleucus* nests elsewhere (Burger and Zappalorti 1986, *op. cit.*; Burger and Zappalorti 1991, *op. cit.*; Beane and Pusser 2007, *op. cit.*). Interestingly, the depth of the nest reported here (74 cm), is nearly twice as deep as the nest found in North Carolina (41 cm; Beane and Pusser 2007, *op. cit.*), and three times deeper than those found in New Jersey (≤ 25 cm; N = 93; Burger and Zappalorti 1991, *op. cit.*). Although researchers have noted that *P. m. lodingi* infrequently utilize tortoise burrows as retreat sites (Baxley and Qualls 2009. J. Herpetol. 43:284–293; J. Lee, unpubl. data), this microhabitat likely plays an important role in the reproductive ecology of the Black Pinesnake, and may provide a suitable microclimate for the incubation of *Pituophis* eggs in warm climate areas (e.g., the southeastern portion of the species range).

We thank the Mississippi Army National Guard and the U.S. Forest Service for allowing us to conduct research on their properties, and M. Lyman and A. Schneider for assisting with burrow excavation. All work was conducted in accordance with Mississippi Department of Wildlife, Fisheries, and Parks Administrative Scientific Collecting Permit Number 0502091.

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***PITUOPHIS MELANOLEUCUS MUGITIS* (Florida Pinesnake). PREDATION.** On 22 June 2007, at ca. 1130 h, one of us (TWT) observed a *Pituophis melanoleucus* (ca. 1.2 m total length) crossing a dirt road bisecting a tract of mature Longleaf Pine (*Pinus palustris*) forest on the Joseph W. Jones Ecological Research Center at Ichauway Plantation, Baker Co., Georgia, USA (31.210946°N, 84.445900°W; datum WGS84). The snake moved from the road into a briar thicket. Approximately 90 min later a bird-of-prey believed to be either a *Buteo jamaicensis* (Red-tailed Hawk) or *B. lineatus* (Red-shouldered Hawk) was startled from the brush and was seen carrying what appeared to be a dead *P. melanoleucus* (ca. 1.2 m total length) in its talons as it crossed the road approximately 50 m west of where the snake was sighted previously. Both

Red-shouldered and Red-tailed Hawks are present on Ichauway and are known to include snakes in their diet (Crocoll 1994. *In* A. Poole [ed.], The Birds of North America Online. Cornell Laboratory of Ornithology, New York; Preston and Beane 1993. *In* A. Poole and F. Gill [eds.], The Birds of North America.The American Ornithologists' Union, Washington, DC). Although Red-tailed Hawks prey heavily on *P. catenifer* (Gophersnake) in the western United States (Fitch et al. 1946. Condor 48:205–237; Grothe 1992. Red-tailed Hawk Predation on Snakes: The Effects of Weather and Snake Activity. M.S. thesis. Idaho State University. 103 pp.), birds of prey are not listed among predators of *P. melanoleucus* (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Books, Washington D.C. 668 pp.; Gibbons and Dorcas 2005. Snakes of the Southeast. Univ. Georgia Press, Athens. 253 pp.). To the best of our knowledge, this observation represents the first documentation of *P. melanoleucus* being depredated by a hawk.

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***PSOMOPHIS JOBERTI* (NCN). REPRODUCTION.** *Psomophis joberti* is a small species distributed in Brazil, Paraguay, and Bolivia. Despite its wide geographic distribution in South America, information on the ecology of this secretive species is limited to anecdotal reports on diet (Strüssman and Sazima 1993. Stud. Neotrop. Fauna Environ. 28:157–168) and behavior (Lima et al. 2010. Herpetol. Rev. 41:96–97). Herein, we present information on clutch size and reproductive investment for this species.

On 13 November 2009, we collected an adult female *P. joberti* (SVL = 388 mm; 11.0 g after egg removal) road-killed near Pentecoste Municipality, Ceará, Brazil (3.82145°S, 39.33824°W, datum: WGS84). Upon dissection, we found seven oviductal eggs (largest egg length = 14.2 mm; total eggs mass = 6.2 g). The relative clutch mass (total clutch mass / female mass without eggs) was high (approximately 0.56) representing an exceptionally high reproductive investment, especially considering that the eggs were not fully developed. To our knowledge, this is the first report on reproduction and clutch size for *P. joberti*. The snake is deposited in the herpetological collection of Universidade Federal do Ceará (CHUFC 3421).

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***PYTHON MOLURUS BIVITTATUS* (Burmese Python). REPRODUCING POPULATION.** The population of introduced *P. m. bivittatus* in Everglades National Park (ENP), Florida, USA is growing rapidly (Snow et al. 2007. *In* Henderson and Powell [eds.], Biology of the Boas and Pythons, pp. 416–438. Eagle Mountain Publishing, Utah). This growth has raised concerns about geographic expansion and the establishment of new populations. In areas of southern Florida outside of the core of the introduced range, large individuals are increasingly being noted in the popular news media. However, smaller individuals seem to be encountered much less frequently in the invasion periphery. Because the probability is arguably low that very young pythons found in wild areas are released/escaped from captivity, any such observations would suggest that reproduction was taking place at those locations.

At 0420 h local time on 26 July 2009, I discovered a male hatchling *P. m. bivittatus* (total length = 599 mm; tail length = 90 mm; 122 g, conspicuous umbilical scar, no gastric or cloacal contents externally palpable) dead on the road surface of Tamiami Trail (U.S. Highway 41) in Collier Co., Florida, USA. At this location (25.98723°N, 81.57438°W, datum: WGS84), the road is within the boundaries of Collier-Seminole State Park (CSSP). The snake had been hit once on the head while crossing from north to south. Based on the low level of traffic at that hour, I estimate it was killed no more than 1 h earlier. The roadside vegetation included palms, dense shrubs, and grasses. The habitat to the south was estuarine tidal marsh. A small brackish canal with mangroves runs along the north side of the road. Beyond the canal was freshwater marl prairie, with wet flatwoods 200 m further north. With regard to possible egg incubation sites, the nearest microhabitats not permanently or seasonally inundated were the road embankment itself, and a patch of scrubby flatwoods about 500 m to the NW. Night drives through this area over the following three nights yielded no additional specimens. The whole specimen, a tissue sample, and a photo voucher (image provided by R. W. Snow) are deposited in the Florida Museum of Natural History (UF 155674; species identity verified by K. E. Krysko).

This record represents the first direct evidence of *P. m. bivittatus* reproduction in Collier Co., Florida; previous Florida records of reproductive females, eggs, or hatchlings are from either Miami-Dade or Monroe counties (Snow et al. 2007. Herpetol Rev 38:93; Brien et al. 2007. Herpetol Rev 38:342–343; Krysko et al. 2008. Applied Herpetol. 5:93–95). If, as seems likely, this snake hatched in the wild, there are at least three possible interpretations of the population status of *P. m. bivittatus* in Collier Co.: 1) this record represents the first instance of successful reproduction; 2) reproduction is irregular (e.g., only in years with particular weather conditions), only in scattered locations, or occurs at very low frequency; or 3) reproduction is occurring frequently, but small pythons have an extremely low detectability. Interpretation 1 is unlikely, but cannot be discounted; if this is indeed the first instance, then land managers may start encountering juvenile pythons in Collier Co. As for interpretation 2, I independently queried two staff members at CSSP in 2008 about python sightings in that park; both agreed that between six and ten large (> 2.5 m total length) pythons had been seen in CSSP in the preceding 5–6 years, but no smaller pythons had been found. Even if the previous apparent absence of hatchlings was attributable to lack of road surveys, the lack of larger juveniles (1.0–2.4 m) suggests that pythons have not been regularly reproducing in CSSP heretofore. Regarding interpretation 3, *P. m. bivittatus* hatchlings are the same size as many native snakes. In 11 nights of driving the roads (1995 miles, 55.5 h) of Collier Co. from 02–09 August 2008 and 21–29 July 2009, I encountered the single hatchling python and at least 59 native snakes on the road. For comparison, I was systematically roadcruising in ENP during these same two time periods and observed five hatchling pythons and 102 native snakes in six nights of driving (1820 miles, 49.5 h). These comparative observations suggest that small pythons on roads are detectable, and further, indicate that the frequency of reproduction in Collier Co. is much lower than in ENP. Although future

work is needed to determine factors that influence detectability of hatchling pythons, systematic road cruising on summer nights might be a useful method for assessing the reproductive status of *P. m. bivittatus* populations.

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***PYTHON SEBAE* (Northern African Python or African Rock Python). SIZE.** *Python sebae* is the largest snake in Africa, and one of the largest in the world. As with most giant snakes, *P. sebae* exhibits female-biased sexual size dimorphism. Although there are numerous claims about overall maximum size for this species (Murphy and Henderson 1997. Tales of Giant Snakes. Krieger Publ. Co., Malabar, Florida. 221 pp.), the largest individuals are likely females. Literature reviews suggest males attain maximum sizes of about 4 m total length and 30–40 kg (Reed and Rodda 2009. Giant Constrictors: Biological and Management Profiles and an Establishment Risk Assessment for Nine Large Species of Pythons, Anacondas, and the Boa Constrictor. U.S. Geological Survey Open-File Report 2009-1202, and references therein). Herein, we report on the largest known male *P. sebae* from an introduced population in Florida, possibly representing a new male size record for the entire species.

In response to a series of observations of *Python sebae* in the Bird Drive Basin area of western Miami (Miami-Dade Co., Florida, USA; Reed et al. 2010. IRCF Reptiles and Amphibians 17:52–54), an organized search for pythons was conducted during 12–14 January 2010; coincidentally, the search occurred just after a record prolonged cold snap in southern Florida during the first 11 days of January 2010. On 12 January 2010 at 1428 h (approx. 15°C ambient air temperature, with NNW winds at 15 kph), a male python was captured on a canal bank (25.7551°N, 80.4708°W, datum WGS84) by J. Dozier, D. Hazelton, and J. Prieto. The python was sluggish after a night during which temperatures in Miami dropped to 4.9°C, but later became active enough to partially escape from a bag that was not sufficient to fully contain it. The python exhibited no evidence of respiratory infection or other illness during initial examination, and was then euthanized. Body size was as follows: total length = 440 cm, SVL = 405 cm, maximal girth = 59 cm, 62.96 kg. The python was male, confirmed by voluntary eversion of hemipenes during capture, enlarged pelvic spurs, and observation of testes during necropsy. The skeleton, skin, and tissues from this specimen were accessioned into the Florida Museum of Natural History (UF 157217). Another large (total length = 376 cm, SVL = 336 cm, 32.9 kg) male was captured nearby during 12–14 January 2010, as were three adult females (total lengths 297–400 cm).

The larger male *Python sebae* is notable not only for its length, but also for its mass; despite being captured during winter when feeding is likely uncommon, the python was in excellent body condition (9.25 kg of fat bodies were recovered from the carcass), as were most of the four other pythons. Although larger individual *P. sebae* are known from the native range, most are confirmed or suspected to be female. Observations in Florida lend support to the proposal that sexual size dimorphism might be reduced in *P. sebae* as compared to *P. molurus* and other giant constrictors (Reed and Rodda 2009, *op. cit.*).

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***RINECHIS SCALARIS* (Ladder Snake). MAXIMUM SIZE.** *Rinechis scalaris* is a large colubrid that inhabits most of the Iberian Peninsula, southeastern France, and areas of northwestern Italy (Arnold and Ovenden 2002. Field Guide to the Reptiles and Amphibians of Britain and Europe. Collins, London. 288 pp.). The maximum size previously recorded for the species was a 1570 mm total length (TL) female (Cheylan and Guillaume 1993. *In* Böhme [ed.], Handbuch der Reptilien und Amphibien Europas. Band 3/I: Schlangen [Serpentes] I [Typhlopidae, Boidae, Colubridae 1: Colubrinae], pp. 397–429. Aula-Verlag, Wiesbaden). However, that record was from an insular population that is known to contain an unusually high proportion of large individuals, reflecting a lack of large predators. In southwestern Spain, maximum SVL recorded was 1385 mm, with a mean tail length of 15.5% (Pleguezuelos 2006. *In* Carrascal and Salvador [eds.], Enciclopedia Virtual de los Vertebrados Españoles. Museo Nacional de Ciencias Naturales. Madrid). Generally, specimens greater than 1200 mm TL are rare (Arnold and Ovenden, *op. cit.*) and sexual size dimorphism has not been reported (Pleguezuelos, *op. cit.*).

On 20 September 2007, a male *R. scalaris* was received at the Centro de Rescate de Anfibios y Reptiles (Alcalá la Real, Spain). Measurements were: TL = 1650 mm (tail slightly incomplete); SVL = 1410 mm (measured using ImageJ images analysis software). The specimen was found in a building site on the outskirts of a medium-size village (37.46°N, 3.93°W, datum: ED50; elev. 1000 m), surrounded both by forest and agricultural landscape. High densities of large prey favored by male *R. scalaris* (e.g., *Rattus* sp.) can be found in this habitat (Palomo and Gisbert 2002. Atlas de los Mamíferos Terrestres de España. Dirección General de Conservación de la Naturaleza-SECEM-SECEMU, Madrid. 564 pp.), even though this species seldom uses urban areas (Pleguezuelos, *op. cit.*).

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***SALVADORA HEXALEPIS DESERTICOLA* (Big Bend Patch-nosed Snake). DIET AND PREDATION.** Witnessing tritrophic interactions among vertebrates is rare. One mechanism for such an event is that a predator is vulnerable while ingesting a prey item, presenting an opportunity for a second predator. Because snakes must swallow prey whole, they are especially vulnerable to predation while subduing and ingesting prey. For example, anacondas are vulnerable to predators during and after ingesting prey and often tighten their hold on prey when approached while feeding (Murphy and Henderson 1997. Tales of Giant Snakes: A Historical Natural History of Anacondas and Pythons. Krieger Publ. Co., Malabar, Florida. 221 pp.). Here we report a tritrophic interaction involving a *Geococcyx californianus* (Greater Roadrunner), a *Salvadora hexalepis deserticola*, and an *Aspidoscelis tesselata* (Common Checkered Whiptail).

Lizards are the primary prey of *Salvadora*, but few dietary data exist. Painter (1985. Herpetology of the Gila and San Francisco River Drainages of Southwestern New Mexico. Unpubl. report, New Mexico Game and Fish, Santa Fe. 333 pp.) and Degenhardt et al. (1996. Amphibians and Reptiles of New Mexico. Univ. New Mexico Press, Albuquerque, New Mexico, 431 pp.) reported that *S. h. deserticola* feeds on lizards, reptile eggs, small mammals, and grasshoppers. Greater Roadrunners are known to prey on snakes such as *Micruroides euryxanthus, Crotalus atrox*, and *Pituophis catenifer* (Sherbrooke and Westphal 2006. Southwest. Nat. 51:41–47). To our knowledge, this is the first report of *S. hexalepis* preying on *A. tesselata*, and the first report of a Greater Roadrunner preying on *S. hexalepis*.

On 3 May 2009 at ca. 0930 h, we were driving along Aguirre Springs Road in the Organ Mountains, Doña Ana Co., New Mexico, USA (32.411924°N, 106.547928°W, datum: WGS84; elev. 1524 m) when we observed a Greater Roadrunner that had captured a *S. h. deserticola*. The roadrunner was startled by our vehicles, dropped the snake on the road, and ran away before it could be photographed. The abandoned snake appeared uninjured and had an adult *A. tesselata* in its mouth. The snake was gripping the whiptail laterally by the torso and immediately dropped the lizard when we picked it up. Although neither predatory attack was observed, we presume that the roadrunner attacked the snake after the snake had captured the lizard. The released *A. tesselata* was sluggish, did not attempt to escape from our hands when picked up, and died within 5 min. Although its behavior suggested injury, there were no visible puncture wounds, but a small amount of blood was present on the torso; thus, we were unable to ascertain if the blood came from the lizard or the snake. Prey is seized and chewed by *S. h. deserticola* (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Institution Press, Washington, D.C. 680 pp.).

This event occurred during an educational field trip sponsored by the National Science Foundation GK-12 Ecohydrology of the Middle Rio Grande Environment (E-MRGE) fellowship program at the University of New Mexico. Eight 7th grade students from Belen Middle School witnessed this real-life example of complex foodweb interactions in a desert ecosystem. We thank GK-12 fellows J. Snider and T. Salem and PIs S. Collins and L. Crossey for encouraging the development of the Belen Outdoor Education Program. We thank M. Ryan for his valuable comments on the manuscript and I. Latella for providing relevant literature resources.

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***SINONATRIX PERCARINATA SURIKI* (White-bellied Watersnake). DIET.** In Taiwan, *Sinonatrix percarinata suriki* primarily preys on frogs (e.g., *Fejervarya limnocharis* and *Rana longicrus*), and fishes (e.g., *Channa asiatic*, *Misgurnus anguillicaudatus*; Mao 2003. Population Ecology of Genus *Sinonatrix* in Taiwan. Doctoral dissertation, Trier University, Germany. 157 pp.). At 2245 h on 1 September 2007, during a routine survey of a *S. p. suriki* population in a hydrophytic pond of Fushan Botanical Garden, Ilan County, northern Taiwan (24.75975°N, 121.58367°E, datum: TWD97; elev. 665 m), a female *S. p. suriki* (total length = 489 mm; tail length = 115 mm) was observed moving among the leaves of a Taiwanese Yellow Pond Lily (*Nuphar shimadai*). The snake had an obviously enlarged mid-body and was forced to regurgitate a partially digested *Babina adenopleura* (Olive Frog; SVL = 47 mm; 6.6 g), which had been ingested vent-first. The snake was then released at its capture location.

Babina adenopleura is a fairly common anuran in mountainous wetlands (e.g., lakes, ponds, and pools) of northeast Taiwan from 300–2000 m elevation. Its tadpoles are the largest of the 31 native anuran species of Taiwan and have been observed to coexist with some *S. p. suriki* populations in Ilan County. Previously, a male *S. p. suriki* was observed preying on a tadpole of *B. adenopleura* in Mystries Lake, Ilan County, Tiawan (Mao, unpubl. data). However, to our knowledge, this is the first published report of *S. p. suriki* utilizing the adult frogs or tadpoles of *B. adenopleura* as food resources.

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***TAENIOPHALLUS AFFINIS* (NCN). DEFENSIVE BEHAVIOR.** *Taeniophallus affinis* is a snake in the family Dipsadidae that is found in leaf litter in forested areas of southeastern and southern Brazil. Studies of the natural history of this species are lacking, and its defensive behavior is poorly documented. There are several defensive tactics used by snakes (Greene 1988. *In* Gans and Huey [eds.], Biology of the Reptilia, 16, pp. 1–152. Alan R. Liss, New York), and eversion of hemipenes has been observed in many species. Sazima and Abe (1991. Stud. Neotr. Fauna Environ. 26:159–164) observed this tactic in *Micrurus frontalis* from Minas Gerais, Brazil, and Martins (1996. *In* K. Del Claro [ed.], Anais XIV Encontro Anual de Etologia, pp. 185–199. Sociedade Brasileira de Etologia, Uberlândia, Brazil) reported it in *Erythrolamprus aesculapii* and *Imantodes cenchoa* from the Central Amazon. We observed an everted hemipenis in a specimen of *T. affinis* (SVL = 502 mm; tail length = 141 mm; 48.0 g) collected from a pitfall trap in the Parque Natural Municipal de Sertão (28.0456°S, 52.2141°W, datum: WGS84; elev. 670 m), Rio Grande do Sul, Brazil. The individual everted its hemipenis after being manipulated for photographs. This specimen was deposited in the Coleção de Répteis da Universidade de Passo Fundo (CRUPF 1698).

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***THAMNOPHIS CYRTOPSIS* (Black-necked Gartersnake). REPRODUCTION / AUTUMN COURTSHIP.** Male *Thamnophis cyrtopsis* are thought to follow a postnuptial pattern of reproduction, with males reaching maximum testicular weight and peak rate of spermiogenesis in autumn, prior to winter brumation (Goldberg 1998. Texas J. Sci. 50:229–234). However, females enter winter brumation with small, previtellogenic follicles and undergo secondary vitellogenesis and ovulation in spring, following emergence (Goldberg 1998, *op. cit.*). It is assumed that most breeding takes place in spring, but based on the male spermiogenic cycle in Arizona there is a possibility that some autumn breeding may occur (Goldberg 1998, *op. cit.*). The purpose of this note is to report an instance of courtship and suspected autumn copulation in *T. cyrtopsis*.

At Chimenea Canyon, Saguaro National Park (Pima Co., Arizona, USA; 32.15285°N, 110.60906°W; datum: NAD83; elev. 1033 m) on 19 November 2005, at 1124 h, one of us (EWS) encountered a pair of adult *T. cyrtopsis* engaged in courtship (Fig. 1). Both snakes were of similar size, estimated to be between 55–70 cm total length. The snakes were loosely intertwined in a circle on a substrate of coarse sand and leaf litter, ca. 2 m from a small (1 m^2), shallow (< 30 cm) pool in partial shade. One snake's tail was held to the side, with the other's wrapped alongside and around it in classic copulatory posture. The anterior 75% of each snake's body was still, while the posterior of one snake's tail made several quivering motions over 5–10 sec., leading us to suspect that copulation was occurring. However, no postcloaca bulge was observed so we cannot conclude that intromission occurred. The snakes were aware of the observer's presence, who watched for 8–10 min. When an attempt was made to capture the snakes for measuring and to confirm sex, they quickly escaped under a large boulder < 0.5 m away. The shaded ambient temperature was 22.5°C, substrate temperature was 27.0°C, and overnight low temperature the previous night was ca. 10°C.

Our observation appears to be the first evidence that *T. cyrtopsis* in southeastern Arizona engages in courtship behaviors in the fall, which may place it among *T. atratus*, *T. ordinoides*, and *T. sirtalis* for which autumn breeding has been reported (Rossman et al. 1996. The Garter Snakes: Evolution and Ecology. Univ. Oklahoma Press, Norman. 332 pp.).



FIG 1. Two *Thamnophis cyrtopsis* engaged in suspected copulation at Saguaro National Park, Arizona, USA, on 19 November 2005.

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***THAMNOPHIS SIRTALIS PARIETALIS* (Red-sided Gartersnake). GIGANTIC SIZE.** *Thamnophis sirtalis parietalis* is a wide-ranging snake that provides a good model for understanding how growth rates and biological variables are expressed in reptiles across a range of geographic conditions (Aleksiuk and Stewart 1971. Ecology 52:485–490; O'Donnell et al. 2004. Behav. Ecol. Sociobiol. 56:413–419). Here we describe the presence of gigantic *T. s. parietalis* at the northern limit of their range in Manitoba, Canada. Of the 514 snakes captured between April 2005 and October 2006 near Jenpeg, Manitoba (54.3321°N, 98.3161°W; datum WGS 84), three individuals exceeded the previous length record of 1241 mm (Conant and Collins 1998. A Field Guide to Reptiles and Amphibians of Eastern and Central North America, 3rd ed. Houghton Mifflin Co., Boston, Massachusetts. 616 pp.). The length of the longest individual was 1340 mm total length (SVL = 1060 mm, 435 g). To determine the approximate age of one large female (total length = 1275 mm, SVL = 1020 mm), a tail tip was analyzed using skeletochronology (Waye and Gregory 1998. Can J. Zool. 76:288–294). Although the analysis was not conclusive, it appeared that this individual was approximately 11 ± 1 years old.

Recent research on latitudinal body size variation in snakes has pointed to a number of factors that might influence growth rates and total length (Olalla-Tárragal et al. 2006. J. Biogeog. 33:781–793). Although latitudinal body size trends in snakes are still poorly understood, hibernation survival has been implicated as a strong selective pressure driving gigantism in northern snakes (Ashton 2001. Evolution 52:2523–2533). Snakes that can attain larger sizes have a higher likelihood of surviving the extended periods of hibernation required in northern Manitoba (Gregory 1982. *In* Gans and Pough [eds.], Biology of Reptilia, Vol. 13, pp. 53–154. Academic Press, New York).

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***XENODON HISTRICUS* (Rayed or Jan's Hog-nosed Snake). REPRODUCTION.** On 3 November 1962, R. Praderi collected a female *Xenodon histricus* (MNHN 1044; SVL = 310 mm; tail length = 40 mm) at Estancia de Patrón, near Salto Penitente, Dpto. Lavalleja, Uruguay (34.3333°S, 55.1166°W, datum Yacare). We found five eggs in the left oviduct. Mean egg length was 10.17 mm (range: 9.58–11.82 mm). These are the first reproductive data for *X. histricus*, which is seldom encountered throughout its range. The collection date suggests that this species has similar reproductive phenology as other reptile species in the region.

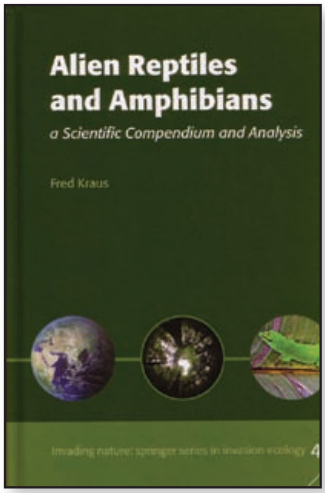
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BOOK REVIEWS

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Alien Reptiles and Amphibians: A Scientific Compendium and Analysis

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Invasive species are increasingly recognized as one of the leading threats to global biodiversity. The field has grown complex enough to deserve its own journal (*Biological Invasions*) and encyclopedia (Simberloff and Rejmánek 2011), but the lion's share of attention has been paid to a few groups of organisms, such as rodents, plants, and ballast-water contaminants. While a few species of introduced reptiles and amphibians and certain geographic areas (Florida, Hawaii) have received research attention, most herp introductions have been largely ignored by the herpetological community. Instead, available knowledge of the great majority of herp introductions is scattered throughout a vast body of literature, often as short notes or as minor addenda to papers on tangentially related topics. In this volume, Fred Kraus offers the definitive literature-based treatment of the subject. Lever (2003) was the first to attempt a summary of herpetofaunal introductions, but Kraus goes far beyond Lever on both conceptual and taxonomic grounds, while correcting a number of errors in Lever's summary. For those desiring a general overview of his conclusions but not willing to suffer through this review, Kraus (2010) is brief and accessible.

A prodigious amount of data is shoehorned into the book, and is summarized with prose that is clear and readable. In fact, my overall impression is that this is a great book to read if one has a perverse desire to feel that, comparatively speaking, one's own scholarship is mediocre. I will present relevant statistics first, because an understanding of the volume of literature-based support behind the text will be an important factor for those deciding whether to purchase the book. The five written chapters sum to only 131 pages, but as noted below these five chapters are meaty and deserving of careful reading—they are also profusely illustrated with pertinent figures and graphs (Chapter 2, Introduction Patterns, alone includes 36 figures). These chapters are followed by two appendices of herpetofaunal introductions, with records dating back to 1850. If there's a bigger table than Kraus' Database of Introduction Records (Table A.1) in the herpetological literature, I'd like to see it—the table spans 220 pages. It is followed by a shorter table of erroneous and uncertain introduction claims. The Literature Cited is also massive, covering 167 pages despite a small font size. The sheer size of the tables would make data extraction by the reader a plodding exercise were not an accompanying CD included with the volume, containing a MS Excel file version of the database of 5,745 introductions. The file can be sorted, allowing readers to quickly extract data corresponding to their taxonomic or geographic interests.

Editorial oversight of the book was very good; I noticed only a few minor errors (e.g., p. 3, l. 22, 'than' should be 'that'; p. 60, l. 26, 'on' should be 'of', p. 87, l. 17, 'It's' should be 'Its', p. 32, Table 2.2, 'Teidae' should be 'Teiidae'). The binding has held up to repeated consultations of the text and tables over the last few months, although I did not subject it to the more rigorous Crombie Binding Test (Crombie 1992). I found an important indexing error on p. 557 of the Geographic Index—no entries past p. 217 of the text are indexed for the state of Florida, despite the fact that >80% of the entries for that state are found past this page. Spot-checks for other geographic areas did not reveal this error to be systemic, and the ability to sort the electronic database on the CD should obviate this issue.

Chapter 1 (*Background to invasive reptiles and amphibians*) is a concise introduction to invasive species concepts, including the gamut of processes from transportation and establishment through spread and impacts, as well as a concise history of research on invasive herps. This chapter would serve admirably as part of the introductory readings

for a course on invasion biology, regardless of the conceptual or taxonomic interest of the reader. By page 5, Kraus has already considered and dispensed with the notions that invasive species are beneficial because they increase biodiversity, and that human-caused movement of animals is a 'natural' process. I found Kraus' argument that loss of beauty is an underappreciated but vital aspect of exotic species introductions to be the most riveting part of the chapter. Policy-makers often stress economic or ecological impacts; while Kraus discusses these in depth, he also offers the following: "I suggest that the distinctive co-evolved, unique beauty of (natural ecological) systems is besmirched by the introduction of alien species—much as a beautiful beach or coastline may be impaired by an oil spill. Or perhaps more aptly, the facile pollution of these self-generated biotas by human introductions is equivalent to splattering the canvases in the Louvre with day-glo paint; the structural integrity of the canvases may not be marred, the added colors may be beautiful, but the aesthetic integrity of the artworks is thoroughly violated. The difference, of course is that the impact of an oil spill lasts for mere years, vandalization of a painting may be rectified by careful restoration, but alien invasions are most usually irreversible and irreparable."

Chapter 2 presents introduction patterns for herps. Before 1950, introductions were largely intentional and associated with food and biocontrol pathways, but in later decades the primary pathway switched to the pet trade and the rate of introductions increased exponentially. Kraus calculated this exponential equation and concluded that the number of introductions via the pet trade pathway has been doubling every 15.3 years for the last 10 decades. In terms of established species, the pet trade again leads the way, but release pathways including cargo, intentional releases, the nursery trade, human food source, and biocontrol have been important contributors to the sum total. It is unsurprising that Europe and North America have been the recipients of the most introductions since these regions are the primary consumers of wildlife as pets, but some readers will be discomfited by the U.S. contribution to introductions elsewhere—for example, Kraus reports >1400 records of Red-eared Slider (*Trachemys scripta*) introductions worldwide. Kraus considers the pet trade pathway as intentional introductions, because, "…the importation was intentional and because the consequence of irresponsible ownership of animals will be the frequent and predictable escape of the deliberately imported pets." Researchers do not escape scot-free in this analysis; Kraus presents multiple examples of intentional introductions for scientific purposes, with varying levels of justification for conducting the release. This pathway is important for some taxa, as nearly 40% of all salamander releases were deliberate in nature and associated with research (and >80% of these releases were done by a single researcher!).

While Kraus does a good job of discussing regional (availability of knowledgeable reporters) and climatic (e.g., rates of establishment are lower in Europe than in the U.S.) contributions to reporting bias in herp introductions in Chapter 2, I would have preferred a more direct discussion of taxonomic and perceptual biases. Large (e.g., pythons, crocodilians) or otherwise distinctive (e.g., chameleons) species are much more likely to be noticed and reported than are small, drab, or highly secretive species. This undoubtedly leads to biased interpretations of establishment success—because introductions of small species are less frequently observed, their perceived rate of establishment (no. established populations/ no. introductions) is often high, but in reality the disparity in establishment success between obvious and less-obvious taxa may not be particularly striking. Failure to recognize the potential of taxonomic bias can have policy implications: representatives of the pet trade have used Kraus' calculation of low establishment success for the families Boidae and Pythonidae (they rank second to last and last, respectively, in his tabulation across herpetofaunal families) as 'proof' that large-bodied snakes represent low risk as invaders and therefore that regulatory efforts to reduce the odds of establishment are unnecessary.

Chapter 3 reviews impacts of introduced herps. Some authors have stated that herps tend to pose little threat as introduced species, which has tended to dampen researcher interest in documenting impacts that are assumed *a priori* to be minimal. Based on the few studies that have specifically examined deleterious impacts of introduced herps, Kraus reports that impacts have actually been recorded for a wide range of species. In Florida, for example, negative impacts of introduced herps have been demonstrated for virtually every species that has received research attention, although admittedly this conclusion is influenced by the fact that species that first receive research attention tend to be those that are most feared to have negative impacts. Looking farther abroad, most ecologists are familiar with the avifaunal devastation wrought by the Brown Treesnake (*Boiga irregularis*) on Guam, but may not be aware that, for example, Green Anoles (*Anolis carolinensis*) have caused the decline or extirpation of large numbers of insect species on Japanese islands or that Bullfrogs (*Lithobates catesbeiana*) have been implicated in the decline of a variety of vertebrate taxa at sites all over the globe. These are examples found under only one header (Removal of Native Prey Species) in the chapter; Kraus subsequently reviews ecological impacts including loss of native predators, changes in ecosystem dynamics, competition with natives, vectoring novel pathogens (e.g., chytridiomycosis), and community homogenization. He also examines evolutionary and social impacts, including scientific loss of knowledge based on confusion about native ranges, evolutionary status, or ecological relationships. Kraus ends by saying that 26 herp species can be credibly implicated in impacts

on native wildlife or humans, but that such a relatively low number can likely be ascribed to inattention to impacts and the difficulty of demonstrating such impacts.

It is telling that Chapter 4 (*Management Responses*) is the shortest chapter in the book, as delays in recognizing the potential impacts and scale of herp introductions has curtailed interest in developing such responses among stakeholders, and availability of funding for such endeavors remains anemic as compared to better-known invaders such as mammals, plants, and ballast-water contaminants. Kraus reviews the three legs of the management tripod for exotic species—prevention, early detection, and rapid response, and management of well-established pests. In most countries, prevention of new introductions via regulatory or incentivized means is uncommon, and typically reactive rather than proactive; in other words, importation or ownership bans are enacted only after a species proves pestiferous, thus closing the barn door after the horses have fled. This tendency to consider only some members of taxonomic groups for regulatory action allows the live-animal industry to make compensatory switches after taxon-specific bans, such as was seen when turtle exporters in the United States switched from Red-eared Sliders to Painted Turtles (*Chrysemys picta*) after importation of sliders was prohibited by the European Union (ironically, the painted turtle has a climate match with larger portions of the E.U. than does the slider).

Kraus summarizes the few successes in eradicating invasive amphibians at a local scale (usually single ponds or drainages), but he could find no examples of a successful eradication of an established reptile population anywhere in the world. While Chapter 4 gives the specific details to back up this depressing statistic, the issue is most lyrically summarized in Chapter 1: "A second generality of extremely practical importance is that alien-species naturalizations are usually irreversible. In most instances, once introductions have been allowed to establish, no amount of money or effort can change the situation—much as is widely recognized for other lamentable and irreversible developments such as death, amputation, or the invention of disco music."

Because eradication of well-established populations has such a dismal record of success, Kraus next discusses long-term control. He largely focuses on the interdiction program for Brown Treesnakes (*Boiga irregularis*) on Guam, which aims to prevent the snake from reaching other areas, such as Hawaii, that are at risk of colonization by unintentional human transport of snakes. While this program has been successful in achieving its goals, it illustrates uncomfortable truths about the financial cost of long-term control and long timelines for research needed to develop effective control tools. The chapter ends with a discussion of limitations on our ability to manage introduced herps, focusing first on biology-related drivers (crypsis, high reproductive rates, and high population densities), then moving to social obstacles (disbelief in the magnitude of the problem, widespread intentional releases, etc.) and a general lack of commitment to developing adequate tools for the job. Taking the chapter as a whole, the take-home message is that reducing the rate of future invasions must be heavily reliant on prevention programs.

The final chapter (*Implications for Policy and Research*) offers a concise roadmap for those interested in developing solutions from a regulatory standpoint as well as researchers interested in fleshing out our limited scientific understanding of an increasing problem. Kraus presents a scathing indictment of regulatory structures and regulatory timidity in the United States and the European Union (the primary consumers of imported reptiles). Especially striking is the comparison of New Zealand with the U.S.; the former country has a single agency charged with preventing and managing exotic species, and this agency employs the precautionary principle when screening potential imports. Meanwhile, 36 to 40 federal agencies (and orders of magnitude more at the state level) have some role with invasive species in the U.S., and collectively they exhibit a history of regulating species only after they have become problematic invaders. The U.S. has a regulatory patchwork quilt with more holes than patches, and the result is sadly predictable—New Zealand has had zero exotic herpetofaunal establishments since the 1960s, while the U.S. has experienced at least 110 establishments during the same period.

Kraus also bemoans the 'dishonest market costing' in pet-trade-related herp introductions. He notes that in much of the world, animal importers and dealers are able to market herps at extremely low prices, allowing them to maintain high trade volumes including species that are poorly suited to captivity but which are abundant in source countries. Release or escape of animals by poorly informed, overwhelmed, or negligent owners is the near-inevitable consequence, and taxpayers end up picking up the tab for management of established populations. Kraus opines that costs of screening potential imports, educating purchasers, and controlling established populations should be internalized in the live animal trade, instead of being externalized by denying culpability and dumping the problem on others. Among other benefits, this raises the price of potential pets, promoting responsible care by owners and reducing the number of 'impulse buys' by those lacking the knowledge or resources to properly care for an animal.

The chapter concludes with a list of vital research questions that are needed to better understand the drivers of, and results of, herp introductions. This section could be a wellspring of ideas for new graduate students looking for thesis projects in applied herpetology. Kraus' recommendations on information that should be included in reports of new introductions or naturalizations should be of particular interest for readers of *Herpetological Review*, as this journal publishes

many Geographic Distribution notes for introduced herps. He recommends including information on when the introduction occurred, how many introductions were involved (and numbers of individual organisms when these data are available), identification of relevant pathways and motivations for release, and the status of the current population. With the recent demise of the journal *Applied Herpetology*, the importance of *Herpetological Review* and *IRCF Reptiles and Amphibians Conservation and Natural History* (which has taken over the peer-reviewed section on exotic herps from *Applied Herpetology*) as outlets for such reports will likely increase.

In a recent conversation, Kraus indicated no desire to continue the Sisyphean task of compiling literature records on this subject. Where will be found the sucker who will take up the mantle of Assembler of Arcane Introduction Records? While there are myriad, and often competing, databases that attempt to track introduced organisms, most of these rely on volunteers posting new finds to the site or a few flustered agency employees attempting to compile records across all organismal taxa. This approach lends itself to fragmentary and taxonomically or regionally biased perceptions of introductions. It is also worth noting that while Kraus has assembled a monumental dataset, this is likely an *under*estimate of the numbers and taxonomic diversity of introduced herps. By including only those records reported in the peer-reviewed literature, Kraus ignored media accounts, unpublished observations, and unpublished museum records. Accurate and complete introduction databases will be vital to answering some of the most basic questions that are of interest to preventing and managing future herp invasions, but the task is large and the payoff often small (Kraus notes that, "To put it bluntly, applied herpetologists don't get tenure").

Kraus' opus will be of great interest to a wide range of scientists, land managers, and policy makers, and its distribution would help dispel many of the common myths and laissez-faire attitudes about introduced herps. Unfortunately, the book's price will reduce its penetration in the groups that would most benefit from reading it (in fact, certain cheapskate herpetologists might accept an invitation to write a book review in order to get a free copy). The book is currently available online for about 20% less than the suggested price. It is really a steal at this price when considering its scholarly treatment of the subject matter, lively prose, and a trove of easily mined data.

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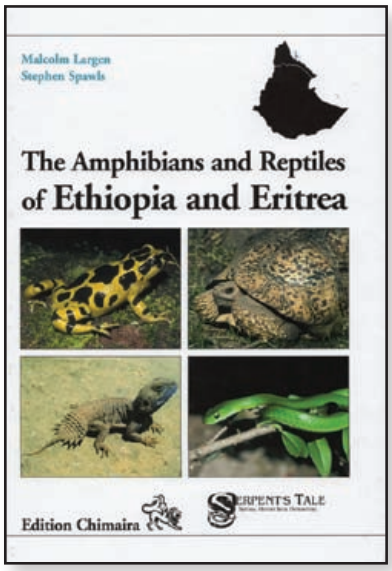
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The Amphibians and Reptiles of Ethiopia and Eritrea

By Malcolm Largen and Stephen Spawls. 2010. Edition Chimaira (www.chimaira.de). Hardcover. 693 pp. 98,00 Euros (approximately US $140.00). ISBN 978-3-89973-466-9.

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Ethiopia is a special place, not only because of its history but also because of its stunning geographical and biological diversity, and the amphibians and reptiles of the area are no exception. Ethiopia and Eritrea are home to some 285 species of amphibians and reptiles and especially among amphibians, the level of endemism is high, with over 40% of all anuran species being endemic to Ethiopia. At the same time, the highlands of Ethiopia are among the most densely settled areas in Africa and the human pressure on the environment is immense, which makes this area one of the most threatened global biodiversity hotspots. It is, therefore, all the more laudable that the two foremost experts on the amphibians and reptiles of Ethiopia and Eritrea have teamed up to produce a guide book that will serve as a concise introduction to the herpetofauna of the area. As the authors state in the introduction, the targeted audience is less the seasoned herpetologist but more the interested novice and especially young, local herpetologists who are sorely needed to help preserve this unique place.

The book is lavishly illustrated with over 380 color and 25 black and white photographs, in addition to some 23 black and white drawings and 282 distribution maps. The photographs are usually arranged two to a page but a fair number

occupy a full page. With a few exceptions, the photographs are of very good quality although the colors seem a little off (a little faded or slightly too saturated) in quite a few images.

Following the table of contents, the preface, and acknowledgments, the book begins with a chapter on the zoogeography of North East Africa. This chapter introduces the various ecosystems of the area, their main characteristics and dominant plant species, and briefly describes the geological history as well as more recent changes. The chapter contains 23 color pictures illustrating a number of different habitats and a simple black and white map of the physical geography of Ethiopia and Eritrea. The color photographs are very instructive and give the reader a good idea of the various habitats but the map is too small and pretty dull and does not stand up to the quality of the rest of the illustrations in this book. It would have also been nice to include a map of the different vegetation zones and perhaps another map with rainfall data. The next, short chapter highlights conservation issues that pertain to the Ethiopian and Eritrean herpetofauna.

The following four chapters deal more specifically with amphibians and reptiles. The first of these provides a very general introduction to the two groups, their evolutionary history and some very brief information on their ecology, physiology, reproduction, etc., and the information provided here indeed only serves as a first introduction for someone who really does not know much about amphibians and reptiles. The second chapter gives advice on observing and collecting amphibians and reptiles. This chapter is more detailed than the previous and gives useful advice for collecting and handling amphibians and reptiles. This chapter appears to have been written with the beginner in mind and it would have been good to point out how important it is to preserve tissue samples in ethanol, particularly for specimens from some seldom visited places within Ethiopia and especially Eritrea. The third chapter briefly explains the rationale behind scientific nomenclature and the following short chapter provides some general advice on identifying amphibians and reptiles and how to use the identification keys provided in the book.

The more than 600 pages that follow are dedicated to the familial, generic and species accounts. The familial and generic accounts are quite short. The species accounts differ in length but comprise on average two thirds of a page to a full page. Species accounts are subdivided into a section describing the species and another section that provides information on its distribution and ecology. Almost all species accounts are accompanied by a small distribution map with point distributions mapped onto it and at least one color photograph. The species accounts are necessarily rather concise but contain enough information to help identify specimens and also provide a good summary of what is known about the distribution and some information on ecology. In the amphibian accounts, information on the conservation status is listed as a separate section whereas in the reptile accounts this information, where available, is integrated into the "distribution and ecology" section. Some recent taxonomic changes have not been implemented here and the taxonomy applied is best described as conservative. This is particularly apparent in gekkotan (Han et al. 2004) and amphibian (Frost et al. 2006) taxonomy, where recent changes have not been incorporated even though these are widely accepted now.

Following the species accounts are a gazetteer, a glossary, a bibliography with a "selection from the most relevant work published in or after 1970" as well as a taxonomic index and an alphabetic list of the amphibian and reptile species of Ethiopia and Eritrea with taxonomic authors.

In addition to the taxonomic accounts, the book contains keys to all genera of frogs, lizards, snakes, and turtles found in the area. Each key is accompanied by a schematic drawing illustrating the main diagnostic features used in the keys, which should help the novice navigate her or his way through the keys. Additional keys are provided for speciose genera although there seems to be no consistent pattern as for when a key is provided or not. The general rule seems to be to have keys for genera with seven or more species although for some, like *Agama* with seven species no key is provided whereas a key to the six species of *Platyceps* is included. I found that slightly puzzling, but I am sure that there are good reasons for this. Somewhat more puzzling is the pattern by which taxa are arranged in the book. Orders and families are arranged alphabetically (with one exception) whereas there is no consistent pattern for listing genera or the species within a genus. This might not seem to be much of an issue but it quickly becomes a nuisance if one has to go back and forth between species accounts within a species-rich genus, which either means frantically leafing through the book or constantly referring back to the table of contents. This is definitely something that should be rectified in any future edition.

Edition Chimaira publishes a number of different series, the most prominent of which are the "white" (also known as the Frankfurt Contributions to Natural History), and the "black" series. The present book is published in the white series, which is smaller in format than the black series. Given the substantial page count, it might have been better to publish this as part of the slightly larger black series, because the current size and especially weight of the book means it is actually not too dissimilar from a brick. I personally would not want to have to carry it into the field but it definitely seems to be sturdy enough to survive more than one field exposure, if you keep it dry of course.

The verdict? There are many small things to fret about but at the end of the day I found myself picking up this book far more often than I initially expected. This book is an excellent contribution to literature on African herpetology and every person with a remote interest in the herpetofauna of Ethiopia and Eritrea, and Africa more generally, would want to have this book in her or his library. It is admittedly not cheap but

the print quality just about justifies the price. Sadly, I fear that the asking price will very likely prevent this book from reaching a circulation in Ethiopia or Eritrea that will exceed single digit figures. On the other hand, for people from overseas working in the area, it would make a great and surely much appreciated gift for a local collaborator.

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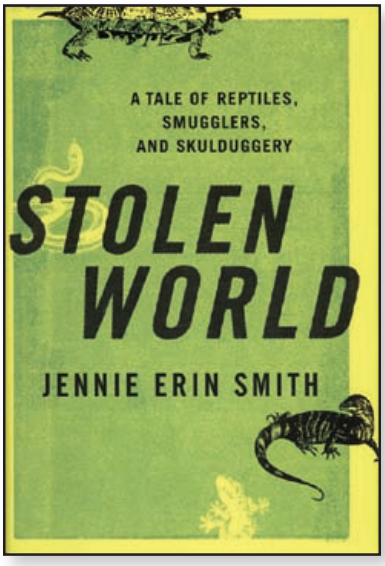
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Stolen World: A Tale of Reptiles, Smugglers, and Skullduggery

By Jennie Erin Smith. 2011. Crown Publishers, New York (www.crownpublishing.com). Hardcover. 322 pp. U.S. $25.00. ISBN 978-0-307-38147-7



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By any measure, the last decade has been a challenging one for those involved with either the private reptile hobby (or, if one prefers the more grandiose term, industry), or the professional worlds of zoo and academic herpetology. For amateur enthusiasts and "herpetoculturists," flush with the optimism born of the explosion of these fields in the 1990s, the last decade has been a sobering wake-up call. With the rising popularity of keeping, breeding, and observing/photographing reptiles and amphibians in the wild has come push-back, in the form of legislative restrictions at the local, state, and national levels in the United States. Concurrently, zoological institutions have found that they are far from immune to these same regulations, and in many cases both the acquisition of new specimens and disposal of surplus animals have become equally problematic.

These regulations, justified or not, have been fueled, to a great extent, not only by lobbying from animal rights groups such as the Humane Society of the United States and People for the Ethical Treatment of Animals, but by sensationalized, unflattering, and (at times) dubiously factual depictions of reptile professionals and enthusiasts in the popular media. So it was with some trepidation that I approached Jennie Erin Smith's new book, an exhaustive account of the careers of three of the reptile world's most well known (and, truth be told, notorious) characters: Hank Molt, Tom Crutchfield, and Anson Wong. Although certainly of interest to herpetologists and reptile enthusiasts of all stripes, this book is aimed at a mass audience, and I worried that here I would find more of the same, the literary equivalent of those Animal Planet documentaries—heroes and villains portrayed in black and white terms, leaving the reader with little choice but to be led, cheering, to the author's inevitable and foregone conclusion.

I also expected the kind of ludicrous errors of scientific fact one commonly finds when a journalist writes on a herpetological subject. This passage on the very first page, in which Smith introduces (and attempts to define, in a lighthearted yet dismissive manner), the term "herpetoculture," did little to ease my discomfort:

> "...it [herpetoculture] sounded like "herpetology", but you needed a Ph.D. to be a herpetologist. If you woke up to find your pet snake had laid eggs, you were a 'herpetoculturist'."

Not exactly accurate on either count and guaranteed to annoy herpetologists and herpetoculturists alike.

However, as my reading progressed, I am pleased to report that I found quite the opposite of that which I feared. Over a decade's time, Smith immersed herself in the lives of her three protagonists, as well as those of a host of supporting characters from all sides of the law. What she found, unsurprisingly, were big plans, big egos, big mistakes, quite a lot of villainy, and a notable lack of heroes. In a disarmingly transparent style, she is content to lay out the facts and allow a truly fascinating story to speak for itself. I could detect very little personal bias in her prose, and, even better, factual errors were all but nonexistent. Smith is obviously either a bit of an enthusiast herself, ran her manuscript past some experts, or, more likely, both.

Despite the tawdry, unflattering, often illegal nature of many aspects of these stories, surprisingly few facts are seemingly in dispute. For those that are, Smith is careful to give the accounts of all protagonists equal weight, and generally refrains from editorializing, leaving the reader to reach his or her own conclusion. Given the information available, that conclusion is often pretty clear.

Most of the book is devoted to Molt and Crutchfield, and from the mid-1960s to the present, their careers evolve against a background of the great change that swept across the face of herpetology and reptile-keeping ("herpetoculture" had not yet been coined) in those decades—not incidentally including the ever-widening gap between academic herpetologists on the one hand, and those from the zoos and the private sector on the other. Two more fascinating personages could hardly be imagined.

The section on Anson Wong, the successful and wealthy Asian animal dealer, almost seems an afterthought, and almost pasted-on, leaving one curious to hear more about his exploits earlier in life. Interestingly, Wong is the only one of the three currently still imprisoned, in Malaysia, for his illegal activities.

Tom Crutchfield comes off as the most sympathetic character, a charming, brash, overbearing, somewhat volatile rogue, seemingly dismissive of authority yet, on another level, longing for acceptance and success in the mainstream of herpetology. In this respect, there are many like him out there, frustrated herpetologists who, in one way or another, lack the patience, focus, or other scholarly character traits that lead to success in the academic arena. Yet they certainly do not tend to channel that kind of frustration into illegal activities such as wildlife smuggling. Despite his illegal activities involving smuggled wildlife, one gets the impression that Crutchfield harbors a deep love and respect for reptiles, and would draw the line at doing anything that would have negative conservation consequences.

Hank Molt is more difficult to understand, as his passion for rare and unusual reptiles quickly combines with a seemingly congenital need for adventure and stimulation to push him far beyond the boundaries of the law, and even morality. Though obviously a man of considerable intelligence, he repeatedly makes fatal (and avoidable) errors that deliver him into the hands of the authorities. And yet soon he is back at it, seemingly addicted to the thrill of pulling scams, uncaringly ripping off friend and foe alike (and his treatment of his "friends" is profoundly base and deceitful—the term "sociopath" comes to mind here). As can be imagined, Molt's tale is a roller coaster ride, but certainly not boring!

The authorities, United States Fish and Wildlife Service agents most notably, but also federal prosecutors and the wildlife departments of various countries, are not exactly heroes here either. Personal vendettas, selective prosecutions, amateurish mistakes, sweetheart deals, bribery, and kickbacks are portrayed as commonplace. Reptile dealers are sent to prison while the famous zoos and museums, which actively encouraged "acquisition" (read smuggling) of protected species, are shielded by political connections. If personnel from these institutions were not fully aware of the illicit activities, they certainly turned a blind eye as long as they obtained their sought-after species.

And then there was the blatant hyperbole and self-promotion by U.S. officials, as Smith notes:

> "The Time Magazine story, which relied heavily on Agency sources, estimated the global illegal reptile trade as worth between $10 billion and $20 billion annually."

The above figures would have placed international reptile smuggling on a par with the global arms trade, at a time when TRAFFIC estimated the total LEGAL live animal trade (including ornamental fish, birds, reptiles and amphibians, and mammals at about US $826 million a year (with smuggling considered the barest fraction of that) (Roe et al. 2002). An agency official later concedes that their figures were made up out of whole cloth.

Caught in the middle were the zoos, increasingly desperate for rare specimens to attract visitors. At times they bankrolled and even explicitly supported the smugglers in private, with paperwork and "letters of introduction" on zoo letterhead. But in public they were very careful to appear spotless, and voiced nominal support for conservation organizations and NGOs bent on curtailing smugglers and even the wildlife trade itself. Of course this path was doomed to failure from the beginning, and good zookeepers and curators eventually lost their careers when the house of cards finally tumbled.

The big losers in this story are, of course, the thousands of individual reptiles and amphibians swept up in the illicit wildlife trade. With rare exceptions (the brazen theft of over 70 Ploughshare Tortoises from the Jersey Wildlife Preservation Trust compound in Madagascar, for example), the numbers involved apparently had scant effect on wild populations or species. But the carnage among the individual animals is difficult at times to comprehend. Entire shipments of Fiji Iguanas, Boelen's Pythons, Gray's Monitors, and countless other reptiles perished in a variety of nasty ways: in the country of origin due to brutal capture techniques, through being smuggled in horribly cramped and unsuitable containers, or from incompetent husbandry at the hands of government authorities and even zoos after confiscation.

Noteworthy is the fact that nearly all the fabulously valuable reptiles that were the object of smugglers in the 1970s and 1980s—Bismarck Ringed Pythons, Ridgetail Monitors, *Rhacodactylus* geckos, Green Tree Pythons, Blue-tongued Skinks—are now captive bred so frequently and in such quantity that their value no longer justifies the risks associated with smuggling, or, in many cases, even the cost and hassle of legal importation.

Stolen World is a sad, yet fascinating, look at all sides of illegal reptile trafficking. It is that rare book that will appeal to the masses as a good read, and yet simultaneously can be regarded as an important one as well. It should be read by anyone interested in truly effective conservation of reptiles and amphibians.

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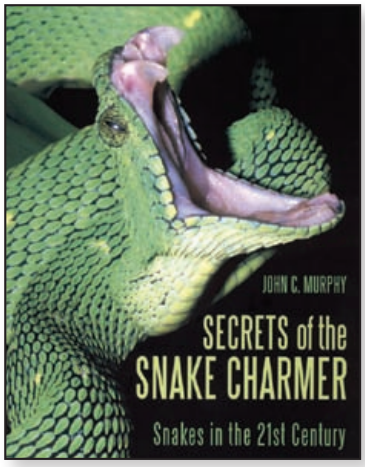
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Secrets of the Snake Charmer: Snakes in the 21st Century

By John C. Murphy. 2010. iUniverse (www.iuniverse.com). xv + 400 pp. Softcover. US$ 36.95. ISBN 978-1-4502-2126-9.

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Catching up with all the new knowledge being accumulated on snakes, published in diverse journals all over the world and in many languages, is a time- and energy-consuming exercise. This is particularly true for the first decade of this century, which has already seen impressive progress on a number of aspects of snake biology and evolution. Fortunately for all naturalists and herpetologists, every few years one or more researchers seem to tackle this arduous task, for the benefit of the entire community. This is especially valuable when it is done by a skilled herpetologist such as John C. Murphy, who is an active field researcher and has an extensive experience in making scientific knowledge accessible to the public, as evidenced by his recent comprehensive volume on homalopsid snakes (Murphy 2007).

The new book is illustrated by 84 snake photos, plus two dozen others, mainly of other reptiles, as well as diverse drawings and figures. All are in black and white. It is thus definitely not a coffee table book, but rather a book to learn from. *Secrets of the Snake Charmer* focuses on snake research done during the first decade of the 21st century. Although released in April 2010, the book deals with literature through the beginning of the same year. Literature references are not indicated in the main text, but the commented bibliography (pp. 321–380) is organized by chapter and thus easily allows the identification of sources of the information presented.

As noted by the author (p. xii) "snakes can serve as a window to open the ideas of ecology and evolution to people otherwise distracted by religion, junk TV, technological gadgets, and sporting events." Although packed with information the book is written in an accessible style and makes a pleasant read for both professional herpetologists and amateurs. The selection of subjects dealt with in the main text (pp. 1–320) is wide: snake evolution, fangs and venom apparatus, predation, defense mechanisms, etc. The 14 chapters are themselves divided into numerous focal subtopics. Many topics are enlivened by the author's anecdotes based on personal experiences in the field.

A weak point of the book is the 'Index to Scientific Names and Authors' (pp. 389–400). The text uses snake common names (e.g., Burmese Python, European Cat Snake, King Cobra, Little File Snakes, Vine Snakes) extensively, and it would thus have been useful to include them in the index as well. In many cases the common name is not associated in the main text with the corresponding scientific name, and the exact identity of the snake is thus not always easy to determine. Further, many scientific names cited in the main text are not included in the index (e.g., *Coelognathus radiatus*, *Colubroelaps nguyenvansangi*, Crotalidae, *Enhydrina schistosa*, *Enhydris polylepis*, *E. subtaeniata*, *Oxyuranus microlepidotus*, *Pseudonaja textilis*, *Vipera aspis*), or only at the generic level, or not for all pages where they are cited in the main text. Among the non-reptilian scientific names mentioned in the main text, some are listed in the index (e.g., *Felis catus*), some not (e.g., *Rattus villosissimus*). As for the scientific names, authors listed in the main text are not all listed in the index either, and in any case the utility of an author index in such a work seems limited to us. There are some mistypings, mainly in scientific names and proper nouns, but not to the extent that they detract appreciably from the book.

Despite the few negative points noted, we generally had an excellent opinion of this new book. It makes a very good read for anybody seriously interested in snakes and who wants to know more about them and we recommend it to both interested novices as well as seasoned herpetologists.

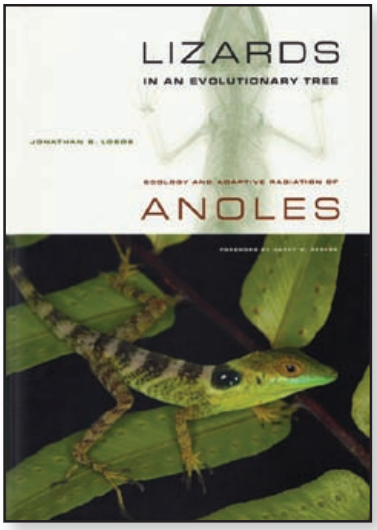
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Lizards in an Evolutionary Tree: Ecology and Adaptive Radiation of Anoles

By Jonathan B. Losos. 2009. University of California Press (www.ucpress.edu). xx + 527 pp. Hardcover. US $95.00. ISBN 978-0-520-25591-3 (Paperback US $49.95. ISBN 978-0-520-26984-2).



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The history of evolutionary theory is tightly linked to vertebrates and islands. The year of evolution (2009) has reminded biologists and non-biologists that finches in the Galapagos Archipelago inspired some of the most provocative thoughts in Charles Darwin's mind. Since then, these ecologically diverse birds have gained a privileged place as promoters of one of the deepest revolutions in human thought. Far away from the Galapagos and from Darwin's itinerary, another group of vertebrates on another group of islands quietly awaited their own opportunity to gain a privileged place in the history of science. In *Lizards in an Evolutionary Tree*, Jonathan Losos tells the story of Caribbean anoles and their contributions to evolutionary biology. For over five decades anoles, particularly the genus *Anolis*, have been the subject of an extraordinary wealth of research dealing with most aspects of the fields of ecology and evolutionary biology. These lizards have not only been useful model systems, anoles are special because they have been instrumental in the development and refinement of theories that have shaped our view of ecological and evolutionary dynamics, contributing greatly to our understanding of major theories such as adaptive radiation and speciation. Anoles, therefore, deserve a great deal of attention from those interested in ecological and evolutionary processes as they occur in nature. However, to read and assimilate the monumental amount of literature on anole evolutionary ecology would require a large part of one's career. The good news is that Losos has done just this, achieving an extraordinary synthesis in a single, solid, entertaining, and comprehensive volume.

The book is impeccably well-organized and its 17 chapters cover the entire diversity of primary theoretical and technical fields relevant to understanding the evolution of adaptations and the origin of new species. While the many footnotes (477 on 409 pages)can be somewhat distracting , they typically contain important relevant information and are worth the pause from the main text. After a couple of pages these footnotes become pleasing distractions because they often also contain entertaining stories that tend to be absent from scientific books of this quality.

In the first three review chapters (2–4, Chapter 1 is a general introduction to the problem of evolution), Losos provides a fine account of the most important aspects of anole diversity. Information in these chapters covers themes as varied as species concepts, competition, key traits involved in sexual and ecological performance, biogeography, reproductive isolation, and arguably one the most comprehensive treatments about anole ecomorphs (and non-ecomorphs) available in the literature. In these chapters, the reasons why these lizards are excellent model organisms for evolutionary and ecological research become apparent. Losos also makes the case for how critical species-specific natural history information is for understanding evolutionary processes. Clear maps and astonishing color pictures contribute to making these chapters accessible and enjoyable to read.

In chapters 5–7, the book turns to phylogeny. Of particular interest for all comparative biologists are timely discussions of the application of phylogenetic approaches to evolutionary questions (Chapter 5), a field in which the author himself has made important contributions. From this chapter, it becomes clear that not all phylogenetically based analyses can be taken at face value. For example, Losos shows why ancestral reconstructions (widely used in the mainstream scientific literature) under several circumstances should be interpreted with caution. Chapter 6 discusses the phylogeny of anoles, and explains how this information has unravelled the biogeographic history of the group. In this phylogenetic framework, evolutionary changes that accompany the selective challenges encountered in newly colonized areas can be appropriately interpreted. This information is used to discuss the roles of divergent and convergent adaptation that have shaped anole morphologies, and remarkable historical scenarios emerge. For example, a well-established observation in biogeography is that colonization between mainland and islands is typically unidirectional, from the former to the later. Colonization in the other direction is thought to be less likely because island species are regarded as weak competitors if placed in continental ecological arenas. However, phylogenetic evidence suggests that anoles have not only recolonized the continent from the Caribbean islands several times, but also that these adventurous colonizers have been remarkably successful establishing an extraordinary lineage of almost 130 species. Patterns of dispersal and speciation

emerge, and Chapter 7 covers the exciting topic of ecomorphological evolution in great detail. The predictability of body size and shape evolution are explored, with interesting accounts of phylogenetic patterns of ecomorphs and the debated, but intriguing, idea of evolution by character displacement. These chapters make a strong case for how autonomous the process of adaptation can be, and how crucial the effect of selection is to shaping the functional, causal, and dependent linkages between environmental pressures and phenotypes (see Hurst, 2009, for a discussion of the genetics of selection effects). As Williams (1966) vividly argued in his famous book, adaptation should be accepted as an explanation when other alternatives have failed. This imposes a difficult challenge as alternative hypotheses often offer appropriate mechanistic pathways to explain organismal features. However, as Losos shows in his book, the adaptive explanation for Caribbean *Anolis* evolution is strongly supported from a number of empirical angles, including replicated associations between ecological demands and morphological traits and functional capabilities. Losos also emphasizes that not all *Anolis* are the same, and that this idealized evolutionary story is much more complex on other islands and on the mainland. The field of ecomorphology is, in summary, richly presented in this section.

Losos broadly reviews the biology of anoles in the next section of the book (chapters 8–13), covering all aspects of anole interactions, from causes to consequences, and from ecology to sexuality. These broad discussions even touch on topics that lizard biologists rarely mention, including potential intelligence and sleeping habits. Chapter 8 includes a diversity of topics that are rarely known in such detail in any single genus, such as reproduction, growth, lifespan, parasites, predators, diet and other forms of ecological interactions. Chapter 9 focuses on one of the most exciting fields in evolutionary biology, the origin and impact of intraspecific interactions to determine social and sexual dynamics, with a clear review of the main principles of sexual selection theory. The discussion includes the unavoidable phenomenon of sexual dimorphism, a remarkable and debated outcome of evolutionary diversification within species. Losos presents a clear, unbiased and comprehensive review of the problem of phenotypic differences between the sexes. The chapter gives deserved weight to the two main explanations proposed by Darwin (1874), natural selection on ecological preferences or sex roles, and sexual selection. The focus of the analysis is primarily on the evolutionary forces that determine the direction of patterns of sexual dimorphism and the outcome. However, no particular detail is given to the complex genetic factors that allow or constrain divergence in alternative, sex-specific directions in the first place, once selection has provided the evolutionary impetus for the expression of this phenotypic divergence (Fairbairn et al. 2007). Chapter 10 presents a particularly informative review on how temperature, humidity, light and other factors govern the ways anoles exploit common areas by means of micro- and macro-environmental segregations. Once again, the pivotal role of anoles in the establishment of current theories and models is highlighted, as Losos reminds us how these lizards have been instrumental in the development of the field of thermal biology.

From Chapter 11, the book turns into a fascinating and dynamic synthesis of information from previous chapters and the focus shifts to the broad fields of adaptive radiation and speciation, which represent the real essence of evolution. In chapters 11–13, the theory of adaptive radiation is introduced from the multiple angles required to understand how evolutionary mechanisms (essentially, natural selection) ultimately drive evolution. A brief but clear theoretical background to adaptive radiation is presented, in which Losos emphasizes that this process is important because it results in the evolution of disparate ecological and phylogenetic diversity from single ancestors, whereas the timing of diversification (the well known "early burst") is simply one of the features of the process, rather than a crucial concept involved in its definition. These three chapters offer a complete review of the anole adaptive radiation, where studies of community ecology (from predators to parasites), field manipulation of free-ranging lizards, and phylogenetics provide evidence of the effects of divergent natural selection on adaption and cladogenesis. Interesting syntheses of field evolutionary genetic experiments across generations and of geographic variation as an encouraging avenue to investigate adaptive radiations are presented.

The integration becomes still stronger in chapters 14–16, where the evolutionary diversification of anoles is reviewed in great detail. In these chapters, as in the rest of the book, no theoretical biases or biased speculations are found. All major theories of diversification are incorporated into the discussion, including the largely demonstrated fact that natural selection is a prominent driver of speciation. However, several controversial views, such as founder effect speciation (Coyne and Orr 2004), are also included in the discussion. As can be expected for an island adaptive radiation, due weight is also given to geographical models of speciation (allopatry, sympatry, parapatry). Some fascinating explanations of selection-based speciation are presented, such as the potential impact of head-bobbing and variation of dewlaps on the breakdown of gene exchange between diverging species. Phylogeny, rates of evolution, sexual dimorphism and niche expansion as agents of diversification, key innovations, island biogeography theory, ecomorphs, and the adaptive landscape approach, among others, are dynamically recalled in these final chapters. The book concludes with Chapter 17, in which an overview touching on other adaptive radiations elegantly summarizes the extensive information presented in the preceding chapters.

Throughout the book, Losos provides responsible and unbiased discussions and interpretations of the available evidence, and still better, maintains the tendency to complement certain ideas with novel speculations about the factors involved in anole lizard evolution. Although many scientists often feel reluctant to take intuitive speculations into account, it cannot be denied that scientific progress relies importantly on the freedom of imagination to suggest alternative explanations for phenomena. Some of these speculations may be proven incorrect, but they inspire the reader to think freely about possible explanations for evolutionary questions.

Finally, an important question that many potential readers of Losos's book may be asking is whether this is primarily about anole lizards or about evolutionary ecology. Many might immediately argue that this book is about evolutionary ecology. However, I believe one of the greatest achievements of Losos is the integration of fields he provides in this book. Losos, more than most evolutionary biologists, makes a strong case that species-level natural history is critically important to fully understand a complex multi-phenomena process like evolution. Hence, Losos has managed to write a book that will serve a broad audience. It represents one of the best and most comprehensive synthetic treatments of the theories of adaptive radiation and speciation based on the empirical context of a specific model system, but it also provides a thorough review of the diversity and natural history of anoles. It has to be said, however, that this is a decidedly scientific book, and clear understanding of theoretical concepts is paramount to the story it tells. For example, despite the enormous diversity of theories encompassed by Losos in this book, the introductory text for each of these ideas is generally brief. Hence, the author implicitly assumes that readers are familiar with the main concepts. However, in this book jargon and simple language are balanced, making it accessible to a broad audience, while maintaining a consistently high level of scholarship. This book is, therefore, a true representation of Einstein's quote "everything should be made as simple as possible, but not simpler."

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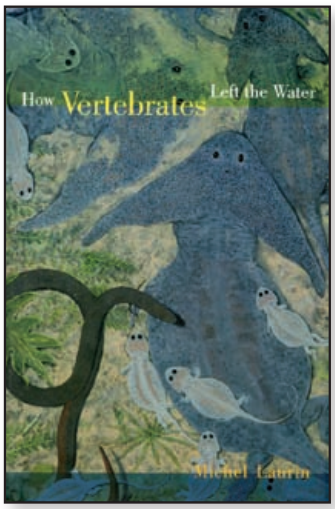
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PUBLICATIONS RECEIVED

How Vertebrates Left the Water

By Michel Laurin. 2010. University of California Press (www.ucpress.edu). Hardcover. xv + 199 pp. US $34.95. ISBN 978-0-520-26647-6.



This is an English translation, with minor updates, of Laurin's original French book of 2008. It is concise, clear, and well written. The book serves both as a summary of the important changes that took place in this most important of vertebrate transitions and as an argument for parsimony and phylogenetic nomenclature. It begins with a critique of rank-based nomenclature and offers phylogenetic nomenclature as a solution to aspects of instability in the prevailing system. This is followed by an explanation of parsimony-based methods of phylogenetic reconstruction and a discussion of molecular and paleontological dating. The introductory chapter is rounded out by brief treatments of homology, the geological time scale, and paleogeography. Laurin then considers what living taxa can tell us about the conquest of the land before addressing such topics as the evolution of limbs, the diversity of Paleozoic stegocephalians, and the adaptation of the skeleton, respiratory system, skin, and sensory organs to life on land. The slender volume closes with a glossary of more than 50 terms, a bibliography of more than 150 entries, and a combined subject/taxon index. The book draws heavily on the author's works from the early 1990s onwards and unabashedly promotes his views on a number of topics. At the same time, it does a remarkable job of distilling down each of the subjects addressed to just a few clear, concise, information-packed pages. The book ably succeeds in the author's desire to make the material accessible to those with little prior knowledge in the field and, indeed, offers even novices a succinct view of how modern vertebrate paleontologists test hypotheses about the evolution and biology of extinct organisms. It may be especially useful for herpetologists, systematists, and anatomists whose work

is chiefly or exclusively neontological and who would like an up-to-date primer of the events of the Paleozoic that set the stage for the modern world of terrestrial vertebrates.

L'Interprétation des Nomes Grecs er Latins d'Animaux Illustrée par le Cas du Zoonyme Sēps-Seps

By Liliane Bodson. 2009. Académie Royale de Belgique, Mémoire de la Classe des Lettres, Collection in-8°, 3° série, Tome XLIX, n°2062 (www.academieroyale.be). Softcover. 368 pp. 30,00 Euro (approximately US $42.00). ISBN 978-2-8031-02631.



This French language memoir explores the interface between classical studies and zoology and has a significant herpetological component. The ancient Greek word "sps," originally meaning "putrifying sore" (hence the word sepsis), was subsequently Latinized and applied to certain types of venomous animals known in the ancient world. The author examines both written and iconographic sources in order to determine the identity of the animals to which the term "seps" has been applied and the anthropological and toxicological criteria met by these disparate taxa that resulted in their inclusion under this term. This specific example is used to investigate the Greek and later the Roman approach to knowledge about the animal kingdom and is further used as an example that illustrates the way in which ancient sources can provide information about the ecology and zoogeography of animals in the ancient Mediterranean. Based on its usage by 31 authors over nearly two millennia, the term "seps" is shown to have been applicable to snakes, lizards, centipedes and caterpillars, with the majority of uses, and virtually all before the 6th century A.D., being herpetological. Additional iconographic sources, as well as modern interpretations of early uses of the term are also considered and the identities of the animals intended by ancient authors are carefully deduced through the comparison of the characteristics of the "seps" and modern knowledge about the distribution and biology of candidate species. Viperid snakes and scincid lizards are most consistent with the ancient data which, in many cases, are detailed enough to allow specific identification. All Greek and Latin sources have been translated into French and much of the data are summarized in convenient tables. The work is supported by a thorough bibliography of 40 pages and six indices (ancient sources, modern authors, Greek and Latin vocabulary, scientific names, French scientific and vernacular names of animals, and a general index) and is accompanied by four color plates and several black and white illustrations. Although highly specialized, this work will be of interest to herpetologists, and zoologists in general, who have an interest in history, as well as to ethnozoologists, anthropologists, and classicists.

Lista Anotada de los Anfibios y Reptiles del Estado de Hidalgo, México

By Aurelio Ramírez-Bautista, Uriel Hernández-Salinas, Fernando Mendoza-Quijano, Raciel Cruz-Elizalde, Barry P. Stephenson, Victor D. Vite-Silva, and Adrian Leyte-Manrique. 2010. Universidad Autónoma del Estado de Hidalgo and CONABIO, Pachuca, Hidalgo. 104 pp. Softcover. US $25.00 (available from Bibliomania! www. Herplitsales.com). ISBN 978-607-7607-39-7. [In Spanish]



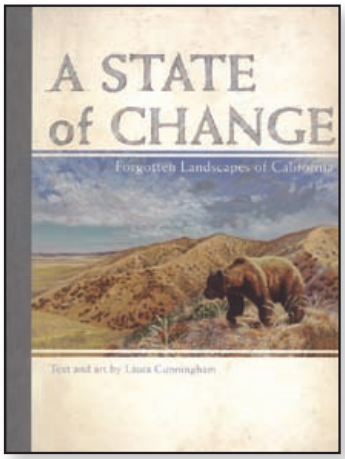
Here is another addition to the rapidly expanding list of state or other regional works concerning Mexican herpetofauna. This volume is the first treatment for the Mexican state of Hidalgo, which straddles the Sierra Madre Oriental of eastern-central Mexico, a region of substantial topographic and habitat diversity. This is an introductory work, offering an annotated list of species along with known localities, as well as preliminary analyses of the herpetofauna based on levels of endemism and association with specifc biotic communities. The authors include an overview and color photograph of each the 12 major vegetation types. There are four principal biogeographic regions within Hidalgo: Sierra Madre Oriental, Altiplano Mexicano (Central Plateau), La Faja Volcánica Transmexicana (Transvolcanic Belt), and Golfo de Mexico (Gulf of Mexico). Despite its small size (20,500 km^2, equivalent to the US state of New Jersey), Hidalgo boasts 173 species of amphibians and reptiles, emphasizing Mexico's status as a biodiversity hotspot. Taxonomically, the herpetofauna consists of 14 salamanders (all but 3 are plethodontids), 40 anurans (including the introduced *Lithobates catesbeianus*), 3 turtles (all *Kinosternon*), 37 lizards (including an undescribed species of *Xenosaurus*), and 78 snakes (including an undescribed species of *Rhadinaea*). Another five species (one anuran, four lizards) are listed as potentially occurring within the state. Of the 173 confirmed species, four are new state records: *Hyla euphorbiacea, Epicta goudotii, Thamnophis scaliger*, and *Rhamphotyphlops braminus* (introduced). Color photographs are provided for 90

species, in addition to 32 black-and-white images that depict an additional 12 species. A detailed map of Hidalgo with key reference points, as well as a vegetation map, would be helpful additions for readers not intimately familiar with the regional geography. The authors have produced an important foundational work that sets the stage for further research.

A State of Change: Forgotten Landscapes of California

By Laura Cunningham. 2010. Heyday Books, Berkeley, California (www.heydaybooks.com). 350 pp. Hardcover. US $50.00. ISBN 978-1-59714-136-9.

Biologist / illustrator Laura Cunningham has combined her artistic talent with a keen knowledge of contemporary and ancient communities to produce a masterpiece of historical ecology, accessible to a broad range of readers. Cunningham draws on the works of various researchers across diverse disciplines (archaeology, paleontology, geology, ecology) to describe what these same communities looked like prior to the arrival of European colonizers—before rivers were dammed for hydroelectricity, before vast swaths of land were converted for agriculture or cities, before wetlands were drained—and in some cases, much earlier (40,000 ybp). The illustrations range from beautiful oil paintings to pencil sketches. Particularly fascinating are the pairing of ancient and modern views of the same place. Thus, we are treated to a biologically informed rendering ("paleo art") of Santa Barbara 500 yrs ago alongside a contemporary photo of the same scene. Historical information is footnoted throughout the text, permitting readers to track down primary sources. Although this is not a herpetological work, per se, a few amphibians and reptiles receive featured treatment: Panamint Alligator Lizards (*Elgaria panamintina*), Amargosa Toads (*Bufo nelsoni*), and Foothill Yellow-legged Frogs (*Rana boylii*). Species are indexed by common name, although an appendix lists both common and scientific names.



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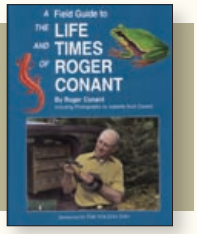
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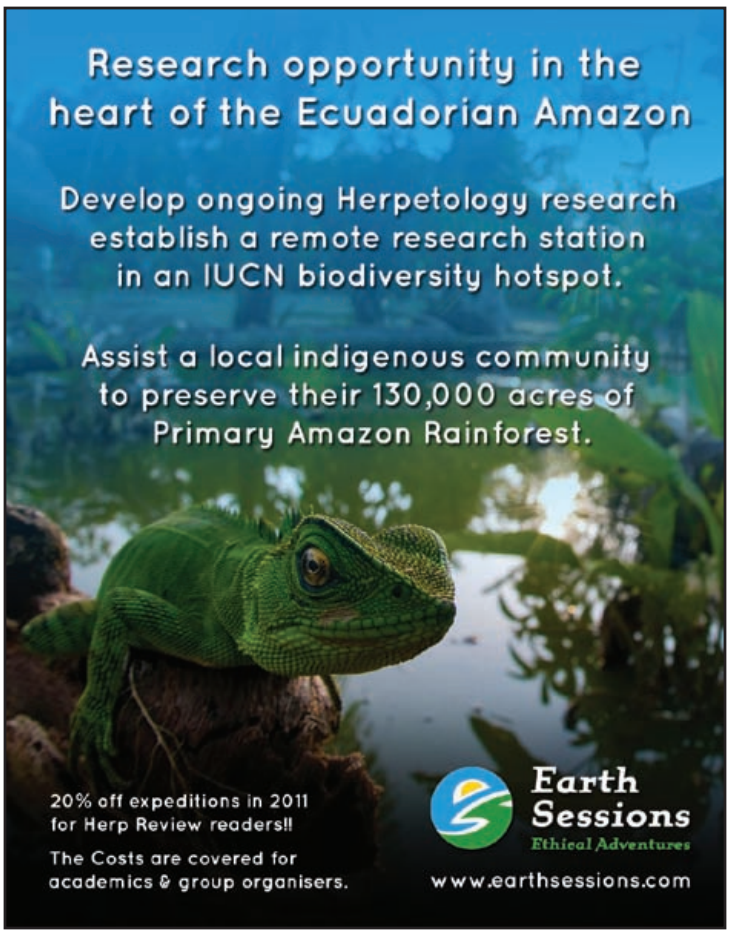
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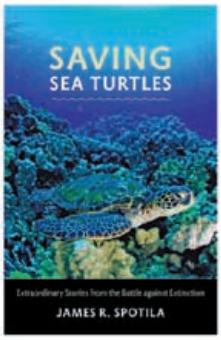
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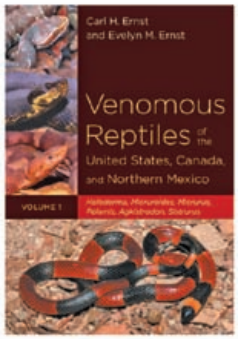
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Herpetological Review

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HERPETOLOGICAL REVIEW

THE QUARTERLY NEWS-JOURNAL OF THE

SOCIETY FOR THE STUDY OF AMPHIBIANS AND REPTILES

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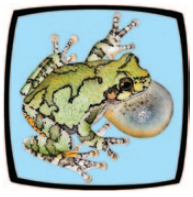
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SOCIETY FOR THE STUDY OF AMPHIBIANS AND REPTILES

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The Society for the Study of Amphibians and Reptiles, the largest international herpetological society, is a not-for-profit organization established to advance research, conservation, and education concerning amphibians and reptiles. Founded in 1958, SSAR is widely recognized today as having the most diverse society-sponsored program of services and publications for herpetologists. Membership is open to anyone with an interest in herpetology—professionals and serious amateurs alike—who wish to join with us to advance the goals of the Society.

All members of the SSAR are entitled to vote by mail ballot for Society officers, which allows overseas members to participate in determining the Society's activities; also, many international members attend the annual meetings and serve on editorial boards and committees.

All members and institutions receive the Society's primary technical publication, the *Journal of Herpetology*, and its news-journal, *Herpetological Review*, both are published four times per year. Members also receive pre-publication discounts on other Society publications, which are advertised in *Herpetological Review*.

To join SSAR or to renew your membership, please visit the secure online ZenScientist website via this link:

http://www.ssarherps.org/pages/membership.php

Future Annual Meetings
2011 — Minneapolis, Minnesota, 6–11 July (with ASIH, HL)
2012 — Vancouver, British Columbia, 8–14 August (with ASIH, HL)
2013 — Albuquerque, New Mexico, dates to be determined

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A VISION FOR SSAR'S FUTURE



PHOTO BY D. G. MULCAHY

Our society was founded on the ethic of inclusivity and a broad vision for what it means to study and appreciate amphibians and reptiles. These important values are evident in our diverse activities, publications, grants, and awards. Professional societies generally are experiencing declining memberships, but SSAR impressively is holding steady. Although our membership number is a bit lower than at our peak in the mid 1990s, we do remain the largest academic herpetological society in the world.

But this is no time for complacency in our mission or our purpose. The world has changed significantly since our beginnings in 1958, and SSAR must adapt accordingly. The internet has changed the playing field of every aspect of society; amphibians and reptiles, quite incredibly, have became popular as pets; and their global conservation needs have never been more imperative. SSAR must keep pace if we are to continue to advance our constitutionally-prescribed missions of research, education, and conservation. **A timely upgrade of SSAR is in order and is well underway.**

The brainstorms for our new programs took place, like many great ideas do, in the lunchrooms, barrooms, and hallways at the times of our annual meetings. Members suggested that an upgrade was in order and Immediate Past-President Brian Crother directed the energy of an enthusiastic group of members to form a new **Long Range Planning Committee (LRPC)**. SSAR cofounder Kraig Adler chairs the committee, which includes Breck Bartholomew, Rafe Brown, Indraneil Das, Tim Halliday, Robert Hansen, Kristine Kaiser, Roy McDiarmid, James Murphy, Erin Muths, Ann Paterson, and Marion Preest. This group includes three former society presidents, key officers and editors, overseas members, and it represents the great diversity of our membership. In concert with the efforts of the LPRC is a newly launched **Membership Committee (MC)**, chaired by Ann Paterson and including David Bradford, Jason Brock, Marina Gerson, Kristine Kaiser, Wulf Schleip, and Andy Snider. These teams already have invested considerable time toward re-inventing SSAR and it will be rewarding to implement their visions.

Together, the LRPC and MC are directed to modernize SSAR and make it known and attractive to the broadest diversity of future members worldwide. Everything for which SSAR is already known will remain but be improved and new programs and products will be added to benefit our members. Chief among these will be significant updates to our two quarterly serials, with full color becoming standard. **We will also be generally expanding the internet presence of the society.** Expansion requires resources, and the Board of Directors is committed to careful financial stewardship.

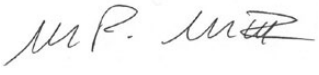
The first noticeable change for SSAR is in your hands now—**a wonderful facelift for our workhorse news-journal, *Herpetological Review*.** Recommended by the LRPC and approved by the Board of Directors, our new look follows conceptually the vision that Editor Robert Hansen has brought to *HR* since 1991. Bob's dramatic transformation of *HR* has been astounding, and he further details more upgrades in an accompanying article. Spectacular color images were brought to the cover of the journal in 1995, and more recently to the internal pages thanks to generous financial support from The Thomas Beauvais Fund. The addition of color improved *HR*, and we are now committed to it. Color imagery makes publication more attractive to a broader membership, but this is much more than mere cosmetics. Coloration is an important feature in the lives of our study animals and we can best advance our understanding of their biology—for example, in the section "Natural History Notes"—if we illustrate their full colors.

As SSAR modernizes, our initial focus on *HR* is appropriate because it really represents our core value of inclusivity. Our news-journal is unique among all herpetological publications and really does offer "something for everyone" with an interest in amphibians and reptiles. New additions to *HR* will aim to make it more international in scope and coverage; to make it more attractive to a broader array of herpetological enthusiasts; and to more closely link the increasingly intertwined fields of research and conservation. **A new membership category—Associate Member—**which will receive *HR* only, is being introduced at an attractive price, to entice new members, especially younger ones, to see what SSAR is all about. Watch for the formal announcement to appear in a future issue of *HR*.

SSAR is a broad-based organization with traditions of excellence in research, conservation, and education. Our primary research publication, *Journal of Herpetology*, was named last year as one of the "100 Most Influential Journals in the Past 100 Years in Biology and Medicine" by the Special Libraries Association. **Our *Journal* is now introducing a new "Perspectives" department**, featuring invited papers by leading senior authorities on special topics of interest to herpetologists. The *Journal* will also be including a larger number of color images on its pages. SSAR publishes a remarkable array of top-tier publications that appeal to every level of interest in herpetology. Our 700-page, color-illustrated book, **"Snakes of Honduras" by James R. McCranie, was issued just last month.** (To purchase, see the ad on last page of the December 2010 issue of *HR*.)

Most importantly, SSAR remains true to its founding goals: an inclusive organization that welcomes and encourages persons at all levels to join our society; attend our annual meetings; publish in our journals and series; and generally network to promote the study and appreciation of amphibians and reptiles. As these creatures become increasingly popular in the public's perception, and more frequently featured in the major media, we need to expand our society to do the research, educate the public and schoolchildren, and ensure their conservation. SSAR exists to lead research and conservation, bring herpetology to the people, and open its doors to a diverse membership.

We earnestly solicit your advice on ways that we can better serve the membership and advance the goals of the society and of herpetology as a discipline. You may contact any of the relevant officers and editors (see the inside front cover of this issue) or by writing to me directly at jmendelson@zooatlanta.org.



Joseph R. Mendelson III, President

CHANGES FOR *HERPETOLOGICAL REVIEW*

With this issue, we unveil a new look for *Herpetological Review*, featuring full color throughout and a new layout. Additionally, during 2011 we will introduce several content changes.



PHOTO BY BRAD ALEXANDER

- A new section, "**Conservation**," will debut later this year, managed by Section Editor Priya Nanjappa. The goal is to showcase innovative conservation projects, partnerships, and success stories to better bridge the gaps among science, management, and policy.
- A new "**National & Regional Organizations**" section will highlight the activities of national, regional, and taxon-focused organizations and societies, whether amateur or professional. This section will be international in scope.
- An "**Institutional Profiles**" section will feature articles about people and programs associated with herpetology and herpetological research at a variety of types of institutions. As these are published, individual articles will be archived on the SSAR website to serve as a reference for prospective students, or persons planning research travels.
- Our "**Herpetoculture**" section (renamed from "Herpetological Husbandry") will broaden its coverage to include publication of short notes based on captive observations, somewhat analogous to our Natural History Notes (the latter section generally excludes observations based on captive animals). This expansion is made in recognition of the volume of valuable observational data and husbandry knowledge—often developed by amateur herpetologists and herpetoculturists—derived from work with captive amphibians and reptiles. Refer to the note immediately following for details.

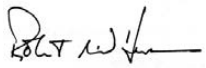
Additional information about these new content areas, including how to submit manuscripts, can be found on the SSAR website: http://www.ssarherps.org/pages/HRinfo.php

Other initiatives are in the developmental stages. One of these—"**For Students**"— will focus on gathering information resources of particular interest to students. These will include an up-to-date list of universities that teach herpetology courses, as well as those offering Masters and PhD programs. Job openings, grant opportunities, research requests, internships, news bulletins, and more will be posted in a special section on the SSAR website. We welcome the active participation of student members in the formulation of this project.

To encourage SSAR membership for those who publish in *HR*, each primary or corresponding author who is a current SSAR member will receive a **pdf free of charge** of his/her article, note, or review. Authors who are not SSAR members will still have an opportunity to order reprints (paper or pdf) as before.

We hope our readers enjoy these changes. To offer feedback, please contact us by email (HerpReview@gmail.com) or find us on Facebook ("Herp Review").

Finally, a new year brings changes to our editorial team. **Priya Nanjappa** (USA), **Félix Cruz** (Argentina), **Wulf Schleip** (Germany), and **Jodi Rowley** (Australia) are coming aboard as Section or Associate Editors. **Margaret Gunzburger**, **Meredith Mahoney**, and **Robert Reed** are stepping down as Associate Editors; their service to the herpetological community is greatly appreciated.



Robert W. Hansen, Editor

"HERPETOCULTURE" SECTION TO EXPAND

Along with a new name, our "**Herpetoculture**" section is being redefined and expanded to accommodate a broader range of topical content. This section offers a publication outlet for manuscripts involving amphibians and reptiles in a captive environment—**public or private**. Subjects appropriate for this section include, but are not restricted to, the following:

- *Novel techniques for maintenance and reproduction of live herpetofauna*
- *Genetic management of captive populations*
- *Legal issues in herpetoculture and animal trade: laws, regulations, permits*
- *Reviews of tools, equipment, technology, enclosures, etc.*
- *Safety protocols for working with dangerous species*
- *Policies and procedures related to preventing transmission of pathogens*

Manuscripts that deal exclusively with veterinary medical subjects generally are not appropriate for this section, but consult with Section Editor if in doubt.

Manuscripts, ideas, or questions should be directed to the Herpetological Husbandry Section Editors: **Brad Lock** (block@zooatlanta.org) or **Wulf Schleip** (wschleip@leiopython.de). All manuscripts will undergo external peer review. For detailed instructions on manuscript preparation, please consult the SSAR web page at: http://www.ssarherps.org/pages/HRinfo.php. When reporting on captive held animals, please also consider the Guidelines for Use of Live Amphibians and Reptiles in Field Research, accessible at: http://www.ssarherps.org/pages/HRinfo.php

For authors whose native language is not English and who might require assistance with manuscript preparation, we invite you to consult SSAR's Presubmission Manuscript Review service: http://www.ssarherps.org/page/presub.php

In addition to conventional manuscripts, we will also publish **brief notes based on limited observations of captive animals**. These can be considered analogous to Natural History Notes and should be formatted the same way. Color figures should be supplied as separate files. Subject matter examples include:

- *Courtship and breeding*
- *Behavior (activity patterns, agonistic behavior, etc.)*
- *Clutch / litter size*
- *Gestation / incubation*
- *Growth*
- *Age at first reproduction*
- *Fertility*
- *Longevity*
- *Feeding preferences / techniques*
- *Thermal biology*

Contributions are welcome from all persons who work with captive amphibians and reptiles, including zoo biologists, private herpetoculturists, and institutional professionals.

ABOUT OUR COVER: *ECNOMIOHYLA RABBORUM*



This large species of fringe-limbed treefrog was first discovered near El Valle de Antón, Coclé, Panama in 2005, as collections were being made ahead of the predicted arrival of the pathogenic amphibian chytrid fungus *Batrachochytrium dendrobatidis*; that prediction was based on the arrival and epidemic in the environs of El Copé just to the east (Lips et al. 2006. PNAS 103:3165–3170). The species was described in 2008 by Mendelson et al. (Journal of Herpetology 42:750–759), being named in honor of herpetologists and conservationists George and Mary Rabb. The species is characterized by substantial webbing on the feet, large discs at the ends of the digits, and scalloped fringes of skin on the outer margins of the forearms and the feet. There are conspicuous humeral spines in the males overlain by keratinized cutaneous spicules. Presumably these play a role during amplexus.

As in the other species of *Ecnomiohyla* that have been observed, this species lives in the forest canopy, and, when threatened, shows a remarkable behavior of leaping from the treetops and using its outstretched limbs and large, webbed hands and feet to glide and orient during its descent. Individuals have been seen to leap from heights of up to nine meters and land safely on the ground. Eggs numbering 60–200 are deposited in water-filled tree holes of various sorts. The tadpoles are large and it may appear that there is more biomass of larvae than actual water in the tree hole. Males appear to defend territories, including a particular tree hole, including production of vocal calls seemingly unrelated to breeding which takes place in the summer rainy season. After laying eggs, the female departs, but the male remains to attend eggs and tadpoles. Attendant males proceed to show a behavior that we interpreted to represent direct paternal nutrition of the larvae (which is otherwise undocumented in amphibians). The male backs his body into the water and writhing mass of tadpoles, which then proceed to forage vigorously on his skin—presumably rasping epidermal cells as a form of nutrition, as is known to occur in some female caecilians (Kupfer et al. 2006. Nature 440:926–929).

Ecnomiohyla rabborum is listed as Critically Endangered on the IUCN Red List, with that designation being based on its small range (known only from the immediate vicinity of the type locality) and its presumed susceptibility to chytridiomycosis. The predicted epidemic of chytridiomycosis in this area took place in 2006. This frog was last heard (but not seen) in the wild in 2007 and is now known from only two living specimens (both males) located at two facilities in Atlanta. This scenario is recounted in an essay by Joe Mendelson elsewhere in this issue.

Brad Wilson recorded our cover image using a Canon 1ds Mark iii DSLR with a Canon 100mm f2.8 macro lens, mounted on a Gitzo Explorer tripod with G1376 off-center ball head. Lighting was accomplished using two off-camera 580EX flash units and a Photoflex light dome. The image was shot at ISO 400, f10, at 1/20 sec, and recorded in RAW, with post-processing in Adobe Photoshop CS4. Wilson is a veterinarian in Atlanta, Georgia and a graduate of The University of Georgia College of Veterinary Medicine 1994. Brad became the consulting veterinarian for the Atlanta Botanical Garden in 1995 and together with Ron Gagliardo instituted the ABG amphibian collections. Brad has provided many volunteer hours as a consultant on amphibian conservation projects in Costa Rica, Panama, Ecuador, Peru, and Malaysia since 2005. He is currently the co-owner of two private small animal practices in north metro Atlanta. He also serves as a principal consulting veterinarian with Amphibian Ark, http://www.amphibianark.org/.


PHOTO BY RICK MCCARTHY

Brad's photographic interests include all things natural history and his amphibian photographs have been published internationally for numerous conservation organizations. His most current photography project is assisting with the cataloguing and field photography of all native orchid species in Georgia. His photographs may be viewed at:

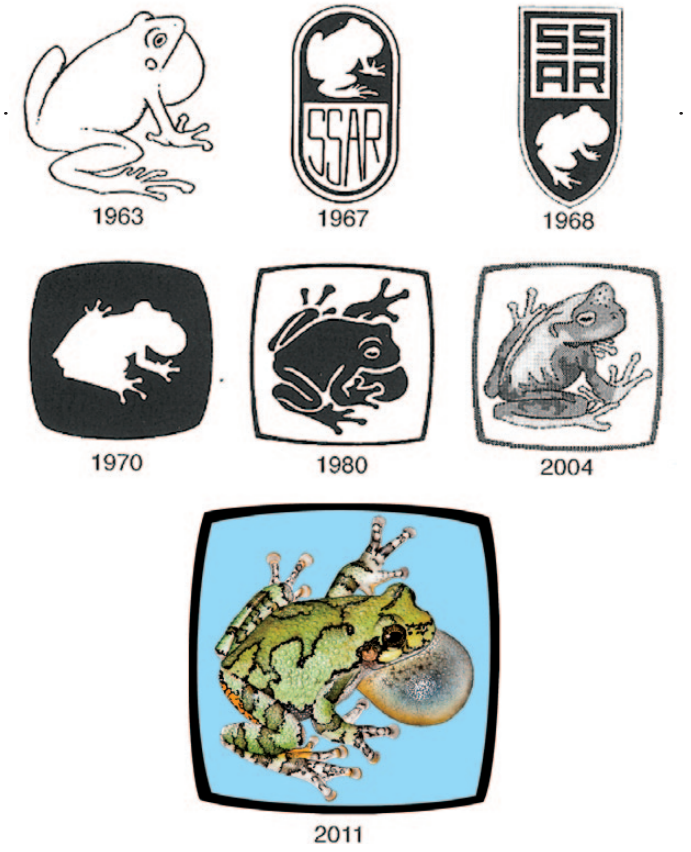
http://www.flickr.com/photos/frogdr/collections/

SSAR BUSINESS

Colorized SSAR Logo

With the inauguration of an all-color *Herpetological Review*, it is appropriate to introduce a colored version of the society's official logo. The current logo, which has become known internationally as the most recognizable symbol of SSAR, has now been rendered in watercolors by David M. Dennis, the noted wildlife artist and nature photographer. He was one of the society's founders in 1958. The new image is based on a specimen of the Gray Treefrog (*Hyla versicolor*) collected by Mr. Dennis just east of Columbus, Ohio, in 1978.

The first version of the society's logo appeared in 1963 on the cover of the *Journal of The Ohio Herpetological Society*, the predecessor serial to today's award-winning *Journal of Herpetology*, which began in 1968. The logo depicts a frog in the act of communicating, a function that is the primary role of any scientific society. The original logo underwent many modifications in the 1960s and 1970s, most of them drafted by Mr. Dennis. The current, simpler version by Mr. Dennis was introduced in 1980. It has generally been printed in black, white, or light blue, the society's official colors. (The 2004 color version has been used on the SSAR website.)



SSAR Election Results

Results of the 2010 SSAR election are as follows:

President-Elect: ..... Robert Aldridge
Treasurer: .....Kirsten Nicholson
Secretary: ..... Marion Preest
Board Members (Regular): ..... Tiffany Doan, Carol Spencer
Board Member (Conservation): ..... Jennifer Pramuk
Board Member (Regional Society): ..... Travis LaDuc

Thank you to all of the nominees who agreed to stand for positions and to Dan Noble (Elector Officer).

—Marion Preest, SSAR Secretary

SSAR Henri Seibert Awards for 2011

The Henri Seibert Awards were initiated in 1992 to provide recognition for the best student papers presented at the annual meeting of the SSAR. To be eligible, the presented paper must be the result of research by the individual making the presentation. The research must have been conducted while the student was enrolled in either an undergraduate or graduate degree program. Please refer to *Herpetological Review* 28(4):175 and the SSAR website (http://www.ssarherps.org/pages/seibert.php) for recommendations to students entering the Henri Seibert Competition. Students entering the competition must be members of SSAR. The presentations will be judged by the SSAR student prize committee. One Henri Seibert Award of US $200 may be given in each of the following four categories: **Systematics/Evolution, Ecology, Physiology/Morphology**, and **Conservation**. Students may win a Henri Seibert award only one time. Please indicate the appropriate category for which you are applying on the abstract submission form. Announcement of winners will be made at the SSAR Business Meeting. All participants should be present at the business meeting. Contact Rafe Brown (e-mail: rafe@ku.edu) for further information.

SSAR Poster Awards for 2011

This is the inaugural year for the SSAR Poster Award. The SSAR Poster Awards will provide recognition for the best student posters presented at the annual meeting of the SSAR. To be eligible, the presented poster must be the result of research conducted by the individual making the presentation. The research must have been conducted while the student was enrolled in either an undergraduate or graduate degree program. Students entering the competition must be members of SSAR. The presentations will be judged by the SSAR student prize

committee. One SSAR Poster Award of US $100 (plus a book gift from the University of California Press) may be given in each of the following four categories:

- Evolution, Genetics, & Systematics
- Ecology, Natural History, Distribution, & Behavior;
- Physiology & Morphology
- Conservation & Management

The SSAR Poster Award will be judged by the following criteria:

- Quality of Research
- Quality of the Visual Display of the Research
- Professionalism and Confidence of the Presenter

Recommendations to Students Entering the SSAR Poster Competition

The SSAR Poster Award will be presented for the first time in Minneapolis at the 2011 Joint Meeting. The SSAR Board of Directors wishes to recognize that poster presentations are an important part of the annual Joint Meeting event and that they are an important component of the graduate and undergraduate experience. The presentation of some research projects is better suited to a poster session, which allows much greater communication between the presenter and the audience. The following recommendations are intended to aid students in improving the quality of their poster presentations. The criteria presented below are applicable to any poster given at a scientific meeting.

Preparing the Presentation

A. The Poster

- More so than an oral presentation, a poster needs to visually draw in the audience. When hundreds of posters are up at the same time, one's poster needs to stand out to be noticed.
- Organization is key—a cluttered poster that is hard to read will not keep the attention of the audience.
- Use large fonts: at least 28–36 size font for the smallest words; approximately 90 size for the title.
- Use *sans serif* fonts such as Arial, Helvetica, and Calibri, which are easy to read from a distance.
- Use as many figures as possible, including graphs and photographs, to display your data.
- Use color to your advantage, but do not make it overwhelming. No one wants to look at a black-and-white poster, but too much color can be distracting.
- Do not include paragraphs on your poster (no one wants to stand there and read them). Bullet points or short sentences are much easier to read.

B. Oral Presentation

- Prepare a short explanation to your poster so that viewers do not have to read everything.
- Anticipate questions that your audience might have.
- Be prepared to discuss further research that you may later perform based on the results from the project about which you are presenting.
- Remember that other scientists have stopped at your poster because they are interested in your research. Relax and enjoy the experience of "talking shop" with other scientists who share similar interests.

Describing your Research

A. Design

- Present your research in a larger context by addressing previous studies (choose 1 or 2 to make your point). Relate your data to the knowledge of your field.
- Clearly state your hypothesis(es) and/or objectives up front.
- Flag techniques that are original to your study (i.e., this study is the first to address this question or to use this technique).

B. Summary of Results

- Present your results clearly. Tables with N and P values are fine (but not necessary) if they are readable. Always indicate your sample sizes.
- Indicate the importance of your results. How do they relate to previous studies? Biology in general?

C. Importance of Study

- An abstract, summary, or conclusions section of your poster is helpful in tying together many results.
- State the importance of your study and how your research has added to knowledge of the subject presented. Are your results generally applicable to larger biological questions?

Students may only win the award one time. Please indicate the appropriate category for which you are applying on the abstract submission form. Announcement of winners will be made at the SSAR Business Meeting. All participants should be present at the business meeting. Contact Tiffany Doan (e-mail: DoanTiM@ccsu.edu) for further information.

NEWSNOTES

Kansas Herpetological Society Annual Meeting

The Kansas Herpetological Society held its 37th Annual Meeting at the Topeka Zoo in Topeka, Kansas, on 6–7 November 2010. Over 100 participants attended scientific paper sessions presented by scientists and students from across the nation.

Jodie Hearlson, student at Emporia State University, received the 2010 Howard K. Gloyd/Edward H. Taylor Scholarship, honoring the memory of two great biologists with strong ties to Kansas.The 2010 Alan H. Kamb Grant for Research on Kansas Snakes was made to Prashant Deshmukh, Emporia State University. George Pisani, Kansas Biological Survey, was

the 13th recipient of "The Suzanne L. & Joseph T. Collins Award for Excellence in Kansas Herpetology." Katie Talbott, Fort Hays State University, was presented with the George Toland Award for the best student paper given at the meeting. Travis Taggart, Sternberg Museum of Natural History, received the Bronze Salamander Award for his years of service to KHS. The inaugural "Henry S. Fitch-Dwight R. Platt Award for Excellence in Field Herpetology" was made to Stanley Roth, Kansas Biological Survey.

The J. Larry Landers Student Research Grant

The J. Larry Landers Student Research Grant is a Gopher Tortoise Council competitive grant program for undergraduate and graduate college students. Proposals can address research concerning Gopher Tortoise biology or any other relevant aspect of upland habitat conservation and management. The amount of the award is variable, but projects up to US $2,000 have been awarded.

The proposal should be limited to four pages in length and should include a description of the project, a concise budget, and a brief resume of the student. Submissions via e-mail as text files are preferred.

This is an excellent opportunity for undergraduate and graduate students to access funding for their projects. The deadline for grant proposals is 15 September 2011. Please send submissions to: Bob Herrington, Chairperson, Research Advisory Committee, Department of Biology, Georgia Southwestern State University, Americus, Georgia 31709, USA; e-mail: bherring@canes.gsw.edu.

MEETINGS

Meetings Calendar

Meeting announcement information should be sent directly to the Editor (HerpReview@gmail.com) well in advance of the event.

23–27 May 2011—Second Mediterranean Congress of Herpetology, Marrakech, Morocco. Information: http://www.ucam.ac.ma/cm2

19–22 June 2011—Sixth Hellbender Symposium, Ligoneer, Pennsylvania, USA. Information: mcmillan@buffalostate.edu

6–11 July 2011—Joint Meeting of Ichthyologists and Herpetologists (ASIH / HL / SSAR), Minneapolis, Minnesota, USA. Information: http://www.dce.k-state.edu/conf/jointmeeting/

17–22 July 2011—IX Congresso Latinoamericano de Herpetologia, Curitiba, Brazil. Information: http://clah2011esp.blogspot.com/

20–23 July 2011—Biology of the Rattlesnakes Symposium, Tucson, Arizona, USA. Information: http://www.williamkhayes.com/rattlesnakes/

27–30 July 2011—34th International Herpetological Symposium, Fort Worth, Texas, USA. Information: http://www.kingsnake.com/ihs/

8–14 August 2012—World Congress of Herpetology 7, Vancouver, British Columbia, Canada (together with SSAR, HL, ASIH). Information: http://www.worldcongressofherpetology.org/

2–7 September 2012—4th International Zoological Congress (IZC), Mount Carmel Campus, University of Haifa, Haifa, Israel. To receive the first and subsequent meeting announcements, contact the organizers at: izc2012@sci.haifa.ac.il.

CURRENT RESEARCH

The purpose of Current Research is to present brief summaries and citations for selected papers from journals other than those published by the American Society of Ichthyologists and Herpetologists, The Herpetologists' League, and the Society for the Study of Amphibians and Reptiles. Limited space prohibits comprehensive coverage of the literature, but an effort will be made to cover a variety of taxa and topics. To ensure that the coverage is as broad and current as possible, authors are invited to send reprints to the Current Research section editors, Joshua Hale or Ben Lowe; e-mail addresses may be found on the inside front cover.

A listing of current contents of various herpetological journals and other publications is available online. Go to: http://www.herplit.com and click on "Current Herpetological Contents."

Enigmatic New World Snake Found to Represent Ancient Lineage

A number of studies conducted in the first decade of the 21st century have helped shed light on the evolutionary relationships

of snakes and alleviate the taxonomic confusion that reigned through the 20th century. The authors of this paper present the results from the most inclusive molecular phylogenetic analysis to date focusing on advanced snakes (Colubroidea), featuring 299 genera and 761 species. An attempt was made to acquire data for five genes (two nuclear and three mitochondrial) for all taxa; however a "supermatrix" approach was employed, whereby new and previously published sequence data is combined into a single dataset and analyzed together, despite many taxa missing data for some or even most of the genes. The authors posit that previous studies have supported the use of this method. The recovered phylogeny largely corroborates other recent studies. In particular, a number of lineages once regarded as members of the family Colubridae are either more closely related to Elapidae (Lamprophiidae, Homalopsidae) or occupy a basal position within Colubroidea (Pareatidae, Xenodermatidae). The most exciting novel discovery of this analysis is the finding that the Skinkeater (*Scaphiodontophis annulatus*), a little-known snake of the New World tropics, is the sole living member (at least of sampled species) of an ancient, heretofore unknown lineage in the family Colubridae (comparable in divergence to colubrid lineages given the rank of subfamily). Long thought to belong to the subfamily Colubrinae, the phylogenetic distinctiveness of this taxon with respect to other colubrine snakes is consistent with early immunological data and its suite of unique, derived characters such as hinged teeth and advanced intervertebral tail autotomy. In order to maintain the monophyly of Colubrinae, the authors propose the erection of the subfamily Scaphiodontophiinae to accommodate *S. annulatus*, rather than placing Grayiinae and Calamariinae in synonymy with Colubrinae. Future studies should include representatives of other enigmatic taxa such as *Sibynophis, Enulius*, and *Urotheca* (all of which have been hypothesized to be allied with *Scaphiodontophis*).

Pyron, R. A., F. T. Burbrink, G. R. Colli, A. N. Montes de Oca, L. J. Vitt, C. A. Kuczynski, and J. J. Wiens. 2010. The phylogeny of advanced snakes (Colubroidea), with discovery of a new subfamily and comparison of support methods for likelihood trees. Molecular Phylogenetics and Evolution (in press). doi:10.1016/j.ympev.2010.11.006.

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Caribbean Lizards Solve the Problem of Signaling Amid Noise in Different Ways

Successful intraspecific communication amid distracting background noise (be it auditory, visual, or chemical) is a problem experienced by many organisms. Interestingly, different lineages have sometimes arrived at different solutions to the same problem; these situations are valuable in that they shed light on basic evolutionary processes. The authors of this paper examined communication in *Anolis* communities occurring on the Caribbean islands of Jamaica and Puerto Rico. This system provides an opportunity to study the evolution of signaling strategy, as both islands have species specializing on the same habitats (edge, open woodland, closed-canopy woodland) despite each island's *Anolis* species assemblage being monophyletic. Representatives of eight *Anolis* species (four on each island) were video recorded while engaged in headbob and dewlap-extension displays. Furthermore, background "noise" (wind-blown vegetation) level was simultaneously evaluated. The findings of previous studies were corroborated in that Jamaican *Anolis* engage in significantly more rapid displays (relative to their Puerto Rican counterparts), which have been hypothesized to be effective in noisy situations. Furthermore, multilevel regression analyses simultaneously examining timing of display (relative to timing of noise), lizard species, and island species group revealed Puerto Rican *Anolis* were significantly more likely to display during periods of reduced noise than Jamaican *Anolis*. As the variation in display strategy was principally between islands and not between ecological niches, this study finds strong evidence for the divergent signaling strategies being a consequence of the two communities having different evolutionary starting points.

Ord, T. J., G. K. Charles, and R. K. Hofer. 2011. The evolution of alternative adaptive strategies for effective communication in noisy environments. American Naturalist 177:54-64.

Correspondence to: **TERRY ORD**, Museum of Comparative Zoology and Department of Organismic and Evolutionary Biology, Harvard University, Cambridge, Massachusetts 02138, USA; e-mail: t.ord@unsw.edu.au

Unisexual *Ambystoma* of Ancient Origin

Because of a limited ability to evolve stemming from the lack of genetic recombination, evolutionary theory predicts asexual lineages should be short lived. However, it has been hypothesized that unisexual *Ambystoma* (Ambystomatidae) salamanders of eastern North America may be an exception to the rule. Unisexual *Ambystoma* constitute a genetically and reproductively complex group featuring nuclear genetic material from five sexual species but comprise a monophyletic mitochondrial group nested within the sexual species *Ambystoma barbouri*. Despite early studies concluding that the unisexual *Ambystoma* lineage originated as the result of an ancient hybridization event (with *A. barbouri* as the maternal species), a recent study using the mitochondrial (mt) gene cytochrome b (cyt-b) deduced that unisexual *Ambystoma* are genetically indistinguishable from some *A. barbouri*, implying that they are instead of recent origin. To resolve this conflict, the authors of this study generated complete mt genome sequences for two *A. barbouri* (one of which was found to be indistinguishable from unisexual *Ambystoma* in the previous study), and one unisexual *Ambystoma* (only one was necessary as previous studies have found unisexual *Ambystoma* to lack mt variation). Additionally, cyt-b sequences were produced using the protocol employed

in the previous study. The mt genome of the unisexual *Ambystoma* was found to be genetically distinct from both *A. barbouri*. An analysis resulting in a time-calibrated phylogeny reveals the asexual *Ambystoma-A. barbouri* split occurred roughly five million years ago. Interestingly, close inspection of the *A. barbouri* cyt-b gene recovered using the protocol of the previous study revealed that the sequence had several heterozygous sites; as organisms possess only a single copy of mt genes, this suggests that what is actually being amplified and sequenced is a nuclear "pseudogene" (a gene fragment that has found its way into the nuclear genome and is presumably functionless, "junk DNA"). These findings strongly support the ancient origin of unisexual *Ambystoma*; indeed, they may be the oldest unisexual vertebrate lineage known to science.

Bi, K., and J. P. Bogart. 2010. Time and time again: unisexual salamanders (genus *Ambystoma*) are the oldest unisexual vertebrates. BMC Evolutionary Biology 10:238.

Correspondence to: **JAMES BOGART**, Department of Integrative Biology, University of Guelph, Guelph, Ontario, N1G 2W1, Canada; e-mail: jbogart@uoguelph.ca

Frogs Can Excrete Body Cavity Objects Via Their Bladders

Despite being the model organism for classroom anatomical study for nearly a century, we are still learning new aspects of anuran anatomy. The authors of this paper describe a heretofore unknown ability of frogs—the capacity to pass objects in their body cavity through the wall of their bladder, allowing them to be excreted with their urine. This ability was serendipitously discovered as the researchers attempted to remove radio transmitters from several frogs at the terminus of a study, only to find many of the transmitters had moved into the frog's bladders. Finding evidence of this phenomenon in three species of Australian treefrogs (Hylidae: Pelodryadinae) led them to ask if this ability was more widespread among anurans. To answer this question, and to better document this ability, they surgically implanted small beads into the body cavities of 36 toads (Bufonidae: *Bufo* [*Rhinella*] *marinus*) and five treefrogs (Hylidae: *Litoria caerulea*). Thirty-one of the *B. marinus* were dissected over the course of several days to document the progression of bead sequestration; the remaining frogs were maintained alive until the end of the study (45 days). At the end of the study, all *L. caerulea* had expelled their beads (average = 19 days) while only one of the five *B. marinus* had done so. However, upon dissection, it was revealed that the remaining four *B. marinus* possessed the beads within their bladders. Investigation of the *B. marinus* dissected through the course of the studied that envelopment of the beads by the bladder began as early as day two and all beads were enveloped by day seven. While other vertebrates have shown the ability to expel body cavity objects through either the intestines or the skin, this finding marks the first documentation the use of the bladder in expelling objects. Finally, the authors posit that this ability may be an adaptation aiding the removal of objects forced into the body cavity by the force frequently exerted upon the frog's ventrum when landing following a jump.

Tracy, C. R., K. A. Christian, L. J. McArthur, and C. M. Gienger. 2010. Removing the rubbish: frogs eliminate foreign objects from the body cavity through the bladder. Biology Letters (*in press*). doi: 10.1098/rsbl.2010.0877.

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Fossil Reptiles Reveal Insights into Venom Delivery Evolution

Several dental morphologies aiding in venom delivery exist among extant reptiles, from the open grooves of Helodermatidae and some Colubroidea (opisthoglyphous condition) to the enclosed canals of Elapidae and Viperidae (proteroglyphous and solenoglyphous conditions, respectively). Studies of the development of replacement fangs in extant snakes have revealed the venom tube begins as a basal groove which elongates, narrows, and finally folds over, forming an enclosed tube. Whether this represents a viable hypothesis for the evolution of hollow fangs has remained unknown. The authors of this study describe *Uatchitodon schneideri*, a new species of Triassic archosauriform (crocodile-looking and early diverging members of the clade containing crocodilians, dinosaurs, and birds) from North Carolina, USA bearing twin (medial and lateral) tubes along the length of each tooth. This species appears to be derived from a previously-described species, *Uatchitodon kroehleri*, also known from deposits in eastern USA. As *U. kroehleri* exhibits opistoglyphous teeth with paired grooves either on the proximal end or along the whole length, the tooth of *U. schneideri* represents the culmination of the evolution of the proteroglyphous condition. Indeed, close scrutiny of some *U. schneideri* teeth reveal a faint seam, signifying where the tube was ultimately closed. The authors consider other potential uses for the grooves and tubes and systematically rule out any use other than venom delivery. They also highlight the uncanny similarity of this progression to the development of replacement teeth in snakes. These findings demonstrate one potential pathway for the evolution of hollow fangs in reptiles.

Mitchell, J. S., A. B. Heckert, and H.-D. Sues. 2010. Grooves to tubes: evolution of the venom delivery system in a Late Triassic "reptile." Naturwissenschaften 97:1117–1121.

Correspondence to: **JONATHAN MITCHELL**, Committee on Evolutionary Biology, The University of Chicago, 1025 57th Culver 402, Chicago, Illinois 60637, USA; e-mail: mitchelljs@uchicago.edu

Terrestrial Chameleon Locomotion Assisted by Tail

Aided by prehensile tails and zygodactyly, arboreal members of the family Chamaeleonidae are the masters of their environment. Do diminutive, terrestrial chameleons (which represent as much as 30% of chameleon species) also possess distinctive locomotor adaptations? The use of the tail during locomotion has been documented in species of *Brookesia*; however, whether the tail is being used for balance or propulsion has remained unknown. To shed light on this behavior, the authors of this study recorded video of two species of *Brookesia* (*B. thieli* and *B. superciliaris*) moving across narrow (1.38 mm diameter wire) and flat surfaces. Furthermore, they generated x-ray microtomographic images of *B. thieli* and two arboreal iguanians, *Calumma tigris* and *Anolis carolinensis*, paying particular attention to tail and inner ear morphology. Video footage confirmed the use of the tail in locomotion. Specifically, the dorsal surface of the tip of the tail is placed in the substrate when walking on flat surfaces (twice every four foot movements); very narrow surfaces elicit the same tail movements, yet the tip does not make contact with the surface. A comparison of body position when the tail is, and is not, in contact with substrate suggests the tail is only serving as a balance and not propulsion. In support of this hypothesis, most of the tail musculature is primarily devoted to flexion, with much less muscle tissue that would provide extension. Additionally, unlike arboreal chameleons, only the distal caudal vertebrae are adapted for movement, with the proximal vertebrae possessing movement-suppressing dorsal shields. Finally, the inner ear of *B. thieli* appears to be an adaptation to terrestrial movement, as the horizontal canal is flattened vertically (and therefore function optimally when the animal is on a flat surface) relative to the condition seen in *A. carolinensis* and *C. tigris*. This study reveals that the lesser-known terrestrial chameleons also exhibit interesting locomotory adaptations.

Boistel, R., A. Herrel, G. Daghfous, P.-A. Libourel, E. Boller, P. Tafforeau, and V. Bels. 2010. Assisted walking in Malagasy dwarf chamaeleons. Biology Letters 6:740–743.

Correspondence to: **RENAUD BOISTEL**, CNRS UMR 7179 'Mécanismes adaptatifs: des organismes aux communautés,' Départ. EGB, Muséum National d'Histoire Naturelle, 57 rue Cuvier, case postale 55, 75231 Paris cedex 5, France; e-mail: boistel@mnhn.fr

The Nuclear Gene "POMC" Fails to Resolve Turtle Placement in Tetrapod Tree

Uncertainty regarding the phylogenetic placement of Testudines persists, as studies continue to emerge presenting evidence for alternative topologies. The most tenable hypotheses are: a) turtles are sister to diapsids, b) turtles are diapsids and sister to archosaurs, and c) turtles are diapsids and sister to lepidosaurs. The authors of this paper conducted a study aiming to help solve this fundamental mystery in the field of herpetology. Hoping to capitalize on this marker's usefulness in resolving other deep nodes in the vertebrate tree of life, they generated POMC (the nuclear gene coding for proopiomelanocortin) sequences for a turtle and a snake, and along with ~35 previously-published vertebrate sequences, conducted several phylogenetic analyses (each using different algorithms, indices of support, partitioning schemes, and/or parameter values). Unfortunately, these analyses failed to recover a well-supported position for Testudines. Despite good indices of clade support throughout the rest of the tree, no analysis confidently resolved the turtle-archosaur-lepidosaur clade. Perhaps the two divergence events leading to these three lineages occurred in quick succession, without the time needed for phylogenetically-informative synapomorphies to accumulate.

Becker, R. E., R. A. Valverde, and B. I. Crother. 2010. Proopiomelanocortin (POMC) and testing the phylogenetic position of turtles (Testudines). Journal of Zoological Systematics and Evolutionary Research (*in press*). doi: 10.1111/j.1439-0469.2010.00589.x

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Species and Life-stage Differences in Susceptibility to Chytrid in Two Australian Anurans

How frog species vary in susceptibility to the chytrid fungus, and whether larval and recently metamorphosed anurans also exhibit different vulnerabilities to this pathogen are questions important to the effort to avert a global amphibian extinction event. To explore these questions, the authors of this paper exposed both age classes of two species to chytrid fungus and documented their response. They chose to use two sympatric Australian species, a myobatrachid, *Limnodynastes peronii*, and a hylid, *Litoria aurea*. As the latter has undergone recent precipitous population declines (while the former has not) and chytrid is the suspected culprit, the results of this study have conservation implications as well. Captive bred representatives of both species were raised to the tadpole or juvenile stage and exposed to chytrid fungus (except for controls). The condition of the animals was assessed visually daily and the degree of chytrid infection was determined via quantitative PCR two weeks after inoculation and three and six months after metamorphosis. The two species were found to show very different susceptibilities to chytrid, with no infected *L. aurea* surviving to 100 days while *L. peronii* and uninfected *L. aurea* displayed greater than 80% survivorship over the same period. Indeed, pathogen loads significantly decreased in both larval and juvenile *L. peronii* over the experiment. Furthermore, survivorship did not decrease linearly with respect to pathogen load; instead, there appeared to be a threshold concentration, below which survivorship was unaffected and above which survivorship precipitously

declined. Taken together these results suggest a threshold level of chytrid load, above which chytridiomycosis sets in and survivorship plummets; the apparent chytrid immunity exhibited *L. peronii* may be due to its ability to keep chytrid infection levels below this threshold. Despite these considerable species differences, no within-species age-class differences in survivorship where detected, although the threshold level of pathogen concentration was lower for tadpoles. This study presents strong evidence for chytrid being the causal agent responsible for *L. aurea* declines and sheds more light on the relationship between chytrid infection and chytridiomycosis and how susceptibility varies across species and life stages.

Stockwell, M. P., J. Clulow and M. J. Mahony. 2010. Host species determines whether infection load increases beyond disease-causing thresholds following exposure to the amphibian chytrid fungus. Animal Conservation 13 (issue supplement s1): 62–71.

Correspondence to: **MICHELLE STOCKWELL**, Environmental Biology and Biotechnology Group, School of Environmental and Life Sciences, The University of Newcastle, Callaghan Drive, Callaghan, NSW 2308, Australia; e-mail: michelle.stockwell@newcastle.edu.au

Method of Securing Transmitters in Snakes Prevents Expulsion

Radio telemetry has proven to be a valuable method of collecting data on reptile movements. However, with some organisms (particularly snake species) expulsion of devices placed within the coelomic cavity has been a problem. The authors of this study present some results from a study wherein one possible solution to this problem was employed. For an ecological study of Australian Carpet Pythons (*Morelia spilota*), 46 pythons were implanted with radio transmitters using standard procedures. Of those, half of the snakes received an additional treatment: the attachment of the transmitter to a rib via sutures. The snakes were then released and followed for the remainder of the three year study. Twelve of the 23 animals with unsecured transmitters voided their transmitters while none of the animals with secured transmitters did so. Contrary to what previous investigators have hypothesized, as only three of the expelled transmitters were associated with feces, transmitter expulsions appear to not be solely associated with the passage of food through the intestinal tract. The discovery that this simple technique can prevent the voiding of radio transmitters represents an important innovation for future telemetry studies.

Bryant, G. L., P. Eden, P. de Tores, and K. Warren. 2010. Improved procedure for implanting radiotransmitters in the coelomic cavity of snakes. Australian Veterinary Journal 88:443–448.

Correspondence to: **GILLIAN BRYANT**, School of Veterinary and Biomedical Science, Murdoch University, Murdoch, Wester Australia, Australia; e-mail: g.bryant@murdoch.edu.au

Tortoises Learn from Watching Other Tortoises

Although tortoises are solitary animals; it is possible that they learn from watching the actions of other tortoises. To investigate this question, the authors of this study subjected Red-footed Tortoises (*Geochelone carbonaria*) to a simple obstacle course under different conditions. In the control group, four tortoises were allowed repeated opportunities to complete the course and their success rate was documented. Subsequently, these tortoises were subjected to the trial repeatedly until they had learned the lay of the course. In the experimental treatment, four naive tortoises were subjected to several trials wherein they were allowed to observe the trained tortoises complete the course before attempting themselves. Fresh substrate was laid on the course between observation and attempt, eliminating the scent of the trained tortoise. The success rate of the tortoises in both of the treatments was then compared. In twelve trials each, none of tortoises in the control group completed the course; conversely, all tortoises in the experimental group completed the course at lead twice, with two of them completing more than 90% of the time. As this represents a statistically significant difference between the two groups, this finding suggests that tortoises do indeed possess the capacity to learn from observing conspecifics. Perhaps social learning in non-social animals is a more widespread phenomenon than is currently appreciated.

Wilkinson, A., K. Kuenstner, J. Mueller, and L. Huber. 2010. Social learning in a non-social reptile (*Geochelone carbonaria*). Biology Letters 6:614–616.

Correspondence to: **ANNA WILKINSON**, Department of Cognitive Biology, University of Vienna, Althanstrasse 14, Vienna 1090, Austria; e-mail: anna.wilkinson@univie.ac.at

Amphibian Species Shifting Breeding Time in Response to Climate Change

Pond-breeding amphibian communities frequently exhibit partitioned use of aquatic sites temporally, with only a subset of the species breeding at any one time. However, changes in regional climate could disrupt reproductive patterns and potentially intensify competition between certain species. To determine if changes in amphibian phenology are a concern, the authors of this paper analyzed data collected over thirty years for ten amphibian species. Data was collected from a wetland site on the property of the Savannah River Ecological Laboratory in South Carolina, USA. The site was sampled for reproductive amphibians throughout the year and for each year a median arrival date was calculated. Annual variation in breeding time was tested for correlations with variation in moisture and temperature observed over the course of the study. They found several species for which the timing of reproduction had sig-

nificantly changed over the course of the sampled period. Both autumn breeding amphibians (two salamander species) were breeding later. Additionally, two of the five winter breeding amphibians, an anuran and a salamander were breeding sooner. Finally, six of the ten species were found to have a statistically significant correlation between timing of breeding and at least one of the two climactic variables. Together, these results reveal a significant shift in phenology (15–76 days) for about half of the members of a community in a relatively short period. Pond-breeding amphibians exhibit complex interactions of predation and resource competition and the impact of these changes could be large. As this study also documented significant population declines in six of the species, changes in phenology represent a potential culprit. This work demonstrates that climate-change-induced changes in phenology may bring about cascading effects on amphibian communities.

Todd, B. D., D. E. Scott, J. H. K. Pechmann, and J. W. Gibbons. 2010. Climate change correlates with rapid delays and advancements in reproductive timing in an amphibian community. Proceedings of the Royal Society B (*in press*) doi: 10.1098/rspb.2010.1768.

Correspondence to: **BRIAN TODD**, Department of Wildlife, Fish and Conservation Biology, University of California, Davis, One Shields Avenue, Davis, California 95616, USA; e-mail: btodd@ucdavis.edu

Male Banded Geckos Successfully Court Females Despite Removal of Testosterone

Males of most vertebrate species rely on testosterone (T) for the development of male sexual characteristics and the coordination of reproductive behaviors. For instance, in the Leopard Gecko (Eublepharidae: *Eublepharis*), it has been shown that the characteristic courtship routine (tail twitching and pheromone deposition) is inhibited in the absence of T. In this study, the authors investigated the role of testosterone in another eublepharid gecko, the Yucatan Banded Gecko, *Coleonyx elegans*. As the *Coleonyx* lineage has lost the courtship routine exhibited by other eublepharids, the authors aimed to determine the effects of T removal on reproductive behavior in non-courting species. Upon sexual maturity, lizards reared from eggs were placed into one of three treatments: castration (male), castration with T supplement (male), female with T supplement, and control (male and female). Animals not receiving T supplement were administered placebo implants. Five weeks following surgery males were subjected to reproductive trials, wherein they were presented with a female (from the control group) and observed for reproductive behavior. Activities were conducted under a red light, observed via closed-circuit television from another room, and were interrupted prior to copulation so the females would remain receptive for subsequent trials. Seven weeks after surgery, females of both treatments were subjected to trials of the same design. At ten weeks post-surgery, two of the castrated males were subjected to another round of trials. Males of all treatments exhibited no difference in reproductive response when presented with receptive females (even ten weeks post-surgery), signifying elevated T levels are not needed for reproductive behavior in *Coleonyx*. Interestingly, this is contrary to what has been determined in studies of other squamates. Additionally, females administered supplementary T exhibited the same response as males when presented with females. The authors argue that these seemingly opposing findings suggest that T is important in the development of normally-functioning males (but not at the moment of reproduction) and that females retain sensitivity to T, causing them to masculinize when it is administered.

Golinski, A., H. John-Alder, and L. Kratochvíl. 2010. Male sexual behavior does not require elevated testosterone in a lizard (*Coleonyx elegans*, Eublepharidae). Hormones and Behavior (*in press*) doi:10.1016/j.yhbeh.2010.11.007.

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Art in Herpetology

As space and available material permit, we will occasionally publish examples of historical as well as contemporary herpetological art. An example of this can be seen on page 42 in this issue. We welcome the submission of historical material under the following conditions:

- The work should be copyright-free and be provided as a high-resolution digitized file (consult Editor for specifications).
- Accompanying text should provide information on the subject matter, artist/illustrator, and publication source. Include references as needed to appropriately attribute information from other sources.

Contemporary artists are invited to submit their own work for publication:

- Artist will retain copyright of all submitted material.
- Accompanying text should provide information about technique, media, or other information likely to be of interest, especially to other artists. Source of illustration subject (e.g., scientific name, geographic origin, etc.) should be included.
- Artists are welcome to include contact information (e.g., email address, website location), as well as indicating whether original art or prints are available for sale or if the artist is available for commissioned work.

OBITUARIES

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Ernest Anthony Liner 1925–2010

Ernest Anthony Liner was born on 11 February 1925 to Remie Antoine Liner and Leonise Marguerite Arceneaux Liner, who both preceded him in death, and died on 22 September 2010. Both his birth and death took place in Houma, Terrebonne Parish, Louisiana. He was surrounded by family as he peacefully passed at about 10:34 pm in bed at Terrebonne General Hospital. He is survived by one sister, Jeannette Liner Gomez, and by12 nieces and nephews. He was preceded in death by his other sister, Mary Ann Fayette.

It is interesting that Ernie (as he was known to his friends and colleagues) was born and died in the same bayou town in southern Louisiana, because that belies his life. The humble, extremely affable Ernie lived an expansive life and saw much of the world. He was a Pacific theater WWII hero and received two Purple Hearts, two Presidential Unit Citations, and the Asian-Pacific Combat Medal. He attended Southwestern Louisiana Institute (now the University of Louisiana at Lafayette) and Louisiana State University and earned his B.S. degree in Biology in 1951. He worked for a while as a sixth grade teacher and then was hired by Fred Cagle for the Zoology Department at Tulane University in 1952. After three years there he took a pharmaceutical salesman position with E.R. Squibb and Sons, with whom he worked until his retirement in 1987. Ernie was an active member of SSAR, ASIH, HL and the Southwestern Association of Naturalists (who recognized him for his service in 1993) and was a member of 14 societies. He published over 150 papers (including species and subspecies descriptions) and books, including arguably his *pièce de résistance*, the final volume in the acclaimed Biology of the Reptilia series, the 1366 page *Comprehensive Literature of the Reptilia* (Liner 2010). He was in the Marquis Who's Who of America and received an honorary doctorate from the University of Colorado, which impressively was supported by over 125 letters from colleagues around the world. He was of course also famous for his amazing herpetofauna cookbooks, which culminated in his summary volume, *The Culinary Herpetologist*, which has almost 1000 recipes (Liner 2005). Remarkably, Ernie accomplished almost of this while working as a full-time pharmaceutical salesman! As David Chiszar noted about Ernie in Mitchell (2006), "It is possible to have a fairly distinguished career as a hobby." Besides being a world-renowned herpetologist, he was also something of a local celebrity and was often the subject of articles in the local press, most recently in 2009 (Lizards and Frogs and Snakes, Oh My!, Point of Vue, Dec. 2009) and in 2010 (Dangerous Creatures, The Courier, Feb. 28, 2010).

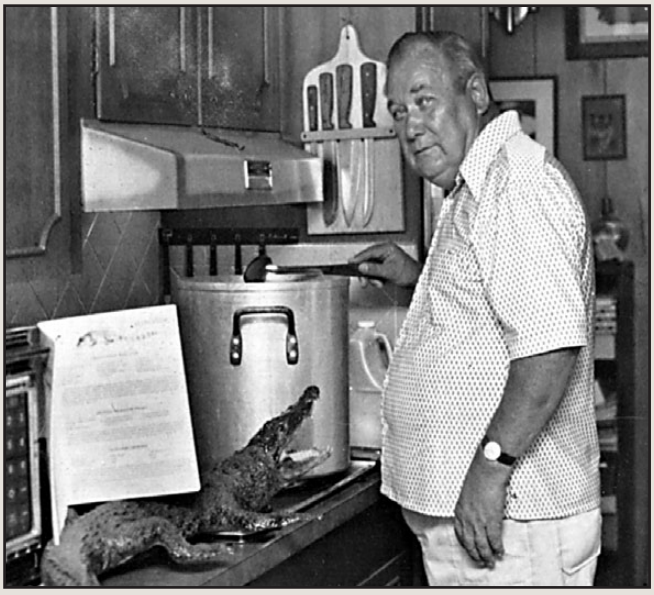


FIG. 1. Ernie is trying out recipes for alligator stew at his home. September 1985. Photo courtesy of *Terrebonne Magazine*.

Right up to his passing, Ernie remained active locally as one of the organizers of a biennial herpetology conference held south of Houma at LUMCON (the Louisiana Universities Marine Consortium) in November. Before each meeting, Ernie preferred to visit LUMCON, rather than just email or telephone, where he would work with the staff to organize the conference details; after the meeting, he would take a gift to the staff members to indicate his appreciation for their friendliness and help. Ernie also took responsibility for updating the conference mailing list; he always managed to know when herpetologists moved into or out of Louisiana--including many of the students throughout the state. For many of the meetings, he cooked a fantastic seafood gumbo for the Saturday night meal. At every conference, he would give each attendee a "ditty bag" of items such as promotional materials about Houma and south Louisiana, and the Mardi Gras beads and cups that many people fondly remember receiving from him at that meeting and others. After each meeting, he would welcome the attendees to visit his house on the way home, where he would share stories, reprints, and occasionally some books from his impressive library. As always, Ernie was fond of sharing items and ideas, and of meeting and renewing friendships with students and more senior herpetologists.

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To detail these parts of Ernie's life would require essentially copying an excellent biography written by Joseph Mitchell in 2006 as part of the Historical Perspectives series in *Copeia*. We refer all readers to that work for learning about the details of Ernie's life, from catching a copperhead as a Cub Scout to his various professional activities and passions. Because Mitchell (2006) is so complete, we decided instead to fill in the lines between his many accomplishments with remembrances of Ernie from some of his colleagues and from his own stories of his collecting trips in Mexico. From 1991 to 1996, Ernie published nine essays (50 pages) of his collecting trips to Mexico, spanning 1951–1964. These were published in the newsletter of the Louisiana Gulf Coast Herpetological Society. They are a treasure. Think about the Ernie you knew as you enjoy the excerpts from his collecting trips in Mexico and a few of the memories from his colleagues.

"As I sit on my porch to write this segment of my Mexican adventures I am distracted watching the antics of a pair of Carolina Wrens, *Thryothorus ludovicianus*, which have a nest above my head with five young hatched 2 and 3 days ago. The parents keep coming and going to get food for the young. They flit around the shrubbery and my Ginko tree, *Ginkgo biloba*, getting ever closer before they enter the nest. While they are fulfilling their household duties 2 Green Anoles, *Anolis carolinensis*, are displaying their dewlaps in the Ginko Tree near me, and Boat-tailed Grackles, *Cassidix major*, are on the ground and in my American Elm, *Ulmus americanus*. An idyllic way to write." —*Liner, 1995*, Mexico 1962.

"When I heard all this [the imminent passing of Ernie] on Monday, I wanted to reach out to his other family—his herpetology friends. I knew how important the herpetology world was to him and all the people that he had met along the way. I honestly can say, I didn't really know how important that he was to all of you. I knew that he was pretty important (after all not many people get a reptile named after them), but I did not know how important he was. I had a suspicion that he was more important than I knew. This was proven true via all the emails I received that I passed on to my mom to tell Ernie." —*Derek Prosperie, great nephew, in reaction to the impromptu listserve that developed as news of Ernie's imminent passing spread.*

"In the morning I again ventured out on this lovely road to Linares. At 24 miles west of Linares near San Jose de Iturbide I spotted an AOR black-tailed rattlesnake, *Crotalus molossus nigrescens*. It was a beauty and I figured my luck had taken a turn for the better. However, shortly after this my luck really turned bad. Just after leaving Santa Rosa Canyon (and the uneven rock road bed) I started hearing funny noises from my car. I looked under it and found oil leaking out. I had put a hole in the crankcase. What lousy luck. The closest place for repairs was Linares about 20 miles east. I decided to ride it in. Six miles west of Linares I spotted a DOR *Masticophis taeniatus ruthveni* in very good condition, so I collected it. After all, specimens were hard to come by and I could not let a little trifle like a hole in the crankcase keep me from adding another specimen to the collection. Upon getting near to Linares I believe everybody in town heard me coming. The car was really making loud noises, but it was still rolling. The mechanic shook his head. I really began to worry. He repaired the crankcase. Then he had to do a ring job on the valves. Next he found parts in his junkyard to repair the drive shaft. He worked from mid-afternoon until close to midnight before it was almost good as new. I spent the rest of the night in the car in his shop yard. At least my mind was more at ease. When it comes to fixing anything mechanical, especially cars, the only thing I know is how to find someone else to do it." —*Liner 1991*, Mexico 1951.



FIG. 2. Chili cook-off at SSAR-HL Meeting, Veracruz, Mexico, August 1987. Sherman Minton gets a sample of Ernie's chili while David Hillis and Mike Ryan (among many others) wait their turn. Photo by Kraig Adler.

"Thank you for your call early this morning and for sending out this very warm and touching tribute to your Uncle Paran. He was truly a unique individual and we will not see his likes again. It was a privilege to have known him and to be his friend. I know he had hundreds of herpetological friends around the world who will mourn his passing, but at the same time we will reflect on all the joy and pleasure he brought into our lives. "Ernie Stories" abound in the herpetological world and will be passed by word of mouth for many years to come to the younger generations. I will miss my nearly monthly chats with him, just talking about what's going on in the herpetological world. Ernie never had any hidden agenda. He liked everybody and let them know it. This generosity of spirit was therefore returned to him by all of us. In many ways, he was our Uncle Paran, too, our godfather who was looking after all of us in his kindly, generous ways." —*Kraig Adler, in an email to Derek Prosperie*

"At 3 miles south of Cortulla and Dilley, DOR *Crotalus atrox* were collected. These were just placed on the floor of the passenger side of the car until a roadside park showed up where I could pickle them. While driving along I felt something crawl across my feet. I looked down to see a rattlesnake crawling across them. Needless to say I almost had a heart attack. I very [slowly] slowed the car down and by the time I was able to stop the snake had moved back over to the other side of the car. I got my rake, moved out of the car to the other side, pinned it and sacked it. Apparently the snake had just been stunned with injuries because it died in the sack. This could have been serious due to a bit of carelessness on my part. Needless to say, I never made this particular mistake again." —*Liner, 1991a*, Mexico 1951.

"I first met Ernie at JMIH 2005 in Tampa while he was signing copies of his book (*The Culinary Herpetologist*). Dave [Sever] introduced me. I didn't see him again until LUMCON [the Louisiana herpetology meeting] 2007. He was taking down names for registration. I was quite surprised that he called me by my first name when I reached the front of the line for registration. My own grandparents don't even recognize me, let alone know my name, yet Ernie remembered me from one meeting two years previous. He was amazingly sharp, and obviously that carried over to his herpetological work." —*Dustin Siegel, graduate student*

"Whenever I think of Ernie, I think of the herp meetings in Lawrence KS in the 70's…Ernie had the most amazing footlocker! Some others may remember it as well; he was definitely one of the best at meeting preparation among all of us. He will be missed. Still have his cook book, too." —*Bob Drewes*

"I first met Ernie about 25 years ago and have been lucky enough to visit him many times in Houma. I can safely say that Ernie was the kindest, most considerate person I have ever known. On several occasions I took vanloads of students from Pennsylvania down to Houma to visit Ernie and sample his hospitality and fine cooking. Somehow, despite there being no room for anything more in his home, Ernie always managed to find a place to fit us all in and wouldn't think of having us stay at a motel. On one trip I brought Wolfgang Boehme from Germany on his first and only trip to America. The visit to Ernie's place was a highlight and Wolfgang wrote about it in summary of his trip that he published after his return.



Fig. 3. Ernie Liner on a field trip during the 1998 JMIH in Seattle. The expression on his face pretty much sums up Ernie's outlook—life was pretty good. Armed with snake hook and camera, of course he is collecting plants to take back home! Photo by Robert Hansen.

Like many people, I received a King Cake from Ernie every Mardis Gras. However, most of the mail that arrived at my house from Ernie was not addressed to me. Once Ernie learned that my wife Monica's family was from Louisiana she regularly received care packages of food, including jambalaya and beignets, and once red boudin, which he brought to a herp meeting in a cooler for me to bring home. After visiting our house and seeing that Monica collected antique glass insulators, boxes of insulators started showing up periodically too. I don't know how many people were recipients of Ernie's generosity, but it must have been hundreds. Ernie loved herping and he loved cooking, but most of all he loved people. His passing marks not only the loss of a dear friend but the end of an era, as he was among the last of the great 'amateurs' who, in his spare time, made contributions to herpetology that rivaled those of any 'professional.'" —*Aaron M. Bauer*

"After collecting Crystal Cave we went to another cave which had a large population of vampire bats and some frogs. While collecting frogs from the roof, I was clinging on to the sides of the cave on sky hooks and whatever grips I could find. I must have been about eight to ten feet up when I reached out for a frog on a stalactite and it broke. Down I came. It seemed like an eternity before I hit bottom. I landed on the back of my head in a big pile of bat…guano. Fortunately I had on an old straw hat. I had bruises all over, hurt all over, and had a hole in my right shin. I was covered with old and new bat guano and vampire bats were flying all over. I stunk. In my field notes I commented that I would probably have a scar on my leg for the rest of my life. I do, but it also took six months to heal thoroughly." —*Liner, 1991b*, Mexico 1952.

"Just got in from the Rio Negro to hear the dismal news of the passing of Uncle Ernie, as he was known to us youngsters at the herp meetings, I never had the opportunity to be in the field with Ernie, but he relived his field experiences with Fred Cagle, Chaney, and others with such vivid detail and enthusiasm at the meetings that you went away thinking you had been there too. I met Ernie in 1972 at the SSAR meeting in Albuquerque, his stories of Mexico may have helped wet my interest to spend over 25 years collecting in Mexico as well. He will stay alive with me forever." —*Dick Vogt*

"I met Ernie in the herp range at the University of Southwestern Louisiana (now the University of Louisiana Lafayette) in 1964. As all the testimonials attest, Ernie never met a stranger and conversation was always easy. Ernie sent me his papers, and either accompanied me or gave explicit directions to all the local collecting sites on which he published, such as the almost mythical (to me) Bayou Tortue.

It has been adequately said that Ernie was nurturing. He was certainly an inspiration to this 18-year old budding herpetologist.

Fast forward to my last visit with Ernie. He had fallen in his driveway, hit his head, and landed in intensive care at East Jefferson Hospital near my home. True to form, he complained about the work he should be doing. The next time I entered his room, Ernie was propped up with a tablet and copies of Lemos-Espinal and Smith's *Anfibios y Reptiles del Estado de Coahuila, Mexico* and the same for Chihuahua on the bed. Ernie was writing reviews of these massive books, and his comments on the content of the texts ended with his regaling me with more stories of his exploits in his beloved Nuevo Leon, Mexico.

A few excited phone calls about news of fellow herpetologists later, the phone rang and I was told Ernie was gone. Although I didn't spend enough time with him during our 46-year friendship (there is never *enough* time with Ernie), the fact that he was nearby—and active—was comforting. Now there is a void." —*Robert Thomas*

"After negotiating and sightseeing through Monterrey, I stopped at Horsetail Falls, 25 miles south of Monterrey for collecting and sightseeing. Collecting was lousy: I only collected 1 *Rana pipiens* and saw 1 *Cnemidophorus gularis*. No way to collect the lizard because at the time I was riding a burro. For some reason I could not make the beast understand English, and besides, it had a mind of its own. I decided then that I was not meant to ride burros and never have since." —*Liner 1991a*, Mexico 1951.

"On this sad day, hello to all. I am greatly saddened to hear of Ernie's passing. I am sure that some of you know that I met Ernie while I was a grad student at LSU sometime back in the Pleistocene. It was Ernie who, in fact, introduced me to the world 'south of the border.' He invited me to go with him to his beloved Mexico. That trip took us from one end of the country to the other. Quite a few states in Mexico went on my 'life list' on that trip. There was even a paper that came out of it.

Ernie was one of those people in our field of herpetology that help to keep it grounded in what is important to all of us... our animals...that is, the whole animal in its habitat that we are privileged to see if we wish to join them where they live. This is what Ernie did for me on that first trip to Mexico all those many years ago (now amounting to about 45 of them) and I will be forever grateful to him for offering me that experience.

Ernie was a unique presence in herpetology who gathered friends far and wide in our field. With my sincere condolences to all those who knew, appreciated, and loved Ernie Liner. It will be a long while until we see the likes of him again, if ever." —*Larry D. Wilson*

"While we were admiring our catch a rabbit hunter came by carrying an old blunderbuss. He saw our .22 pistols and became interested. We were using rat shot and we showed him our shells. He had us shoot at an *Opuntia* (cactus) leaf to see our pattern. We did so and he was not too impressed. He then loaded his piece by placing powder, and packing it with some dried cow dung, placing some shot, and then more dung. He fired at the leaf and blew it all apart. Both of us commented that we would not want to eat the rabbits that he brought home." —*Liner 1996*, Mexico 1964.

"I met Ernie during my four years at what was then USL, in Lafayette. He was nearly always on the road for the drug company he worked for as his 'real job.' But he did stop by a couple of times. Usually I would see him at meetings though, like everyone else. As Dick Vogt noted, his enthusiasm for collecting was unmatched. Whenever we did have a chance to visit, the conversation was always about herping in Mexico, not about Louisiana. At one meeting I told him about collecting several populations of *Hyla* [=*Tlalocohyla*] *smithi* and *Hyla* [=*Tlalocohyla*] *picta*, on opposite sides of Mexico, and that I was analyzing the calls and would probably do a paper on them. The next week I received his entire collection of those species in the mail, for me to use in that study—he was also very generous. Since I left Louisiana for Arizona, we lost touch, but I will always cherish my memories of that man. He made meaningful contributions to herpetology, and brought joy to most anyone in his presence. I will certainly miss him, like the rest of you." —*Jack Fouquette*

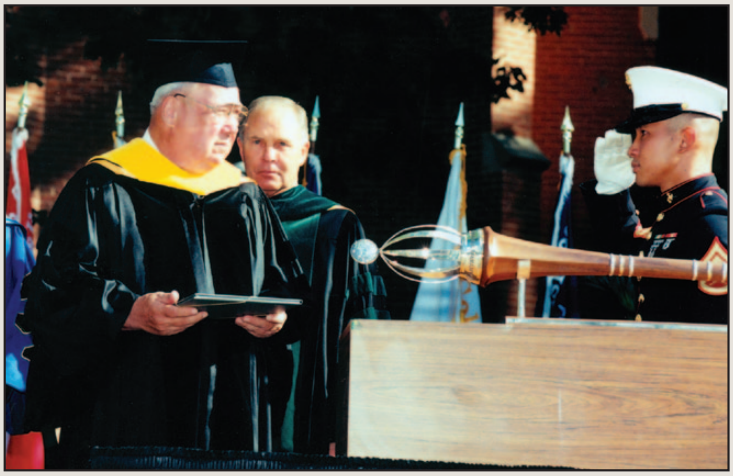


FIG. 4. Hooding ceremony, 8 August 1998. Ernie receives honorary Doctorate from the University of Colorado. Marine honor guard provided because of Ernie's WWII service in the Marines, Pacific Theater. Photo courtesy of University of Colorado.

"As is typical of collecting in Mexico (especially near villages) you soon pick up a retinue of followers, not always children. They were really excited when I just grabbed the coachwhips by hand and got bitten, as usual with them. I had an enjoyable day and pleasant dinner with the people of the village…as well as getting a nice assortment of herps from a remote area." —*Liner 1992a*, Mexico 1954.

"Some of my fondest memories of the joint meetings are the time I was able to spend with Ernie. Very often, I seemed to serendipitously come upon him at the airport on the way there (he usually looked like he was lost) and also have the opportunity to share a taxi ride on the return trip. I can't even put into words the pleasure those times brought me—and just when you were positive that he was the prototypical absentminded professor, he said something so astounding that it brought you back with a jolt. When we had differing opinions on details (and I was always wrong), he never argued, just smiled—reminiscent of the Grinch.

The incredible amount of knowledge I brought away from these encounters will always stay with me. I have always been amazed at his insightful approach, attention to detail, and sheer depth of knowledge, to say nothing of his dogged persistence and determination to complete seemingly insurmountable projects. He got that glow about him when he discussed his bibliographies and new projects. When he inscribed my copy of his first cookbook, I remember him telling me that there would be a second, even larger and better edition. It didn't seem like that would ever come to pass—who knew. But I'm very glad it did. I especially enjoyed our discussions about cooking and old dusty herp books.

He always had a ready smile, an amazing positive attitude, and never a harsh word for or about anyone. And I'm quite

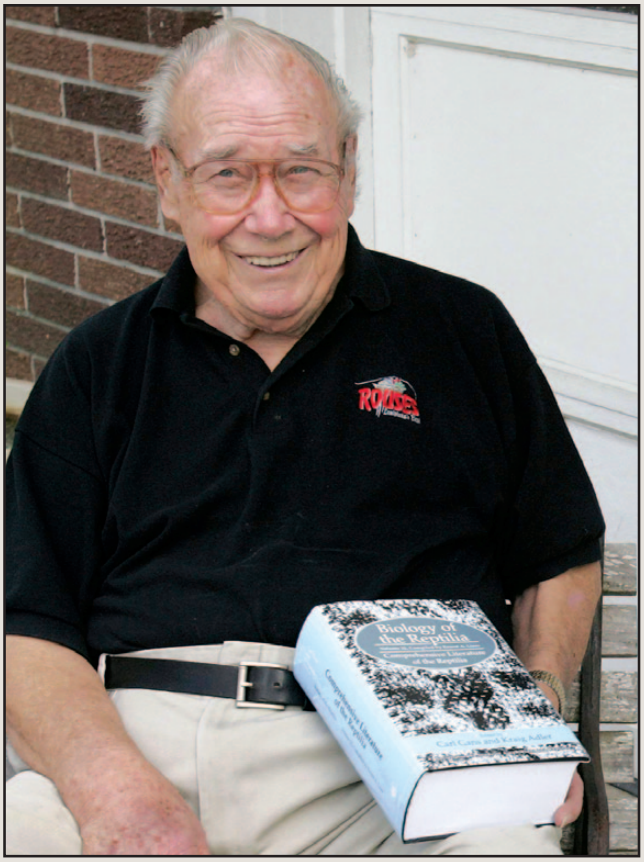


FIG. 5. Ernie with his big new book, *Comprehensive Literature of the Reptilia*, February 2010. Photo courtesy of *The Courier*, Houma, Louisiana.

sure that I never heard ill spoken of him. But that is just the kind of person he was. And you knew he was about to say something of great import when he preceded it with that Ernie grin. Both editions of his cookbooks sit at the entrance to my library separate from my other books and always will. Where else could you put them? They fit into no other classification or convenient niche—just like Ernie. I was honored to call him my friend and like so many others, will miss him immensely." —*Chuck Schaffer*

"At this location I received a great fright. While moving around trying to find more lizards I became aware of what I considered to be a mess of rattlers. They seemed to be all around me but I couldn't spot a single one. After awhile it dawned on me (I'm pretty dense sometimes) what was making the rattling sounds. It was locusts (grasshoppers) moving around in the dry vegetation and giving the impression of rattling sounds. For a while I was scared to move." —*Liner 1992b,* Mexico 1958

"I met Ernie shortly after arriving at LSU as a graduate student in 1966. A bunch of us were invited to one of Ernie's parties in Houma. The variety and amount of food was amazing, not to mention the iced beer. One of the memorable things in visiting Ernie was roaming his house looking at his books, journals, and various art works. However, the best was being in the company of an intelligent and always friendly person. Although I have not seen him often in recent years I will miss him." —*Ken L. Williams*

"I can hardly see through my tears to write this. I had read on a US Marine Corps web page something about the book *Flags of Our Fathers* written by James Brady and published in 2000. It covers in great detail the lives of the five Marines who raised the American flag on Iwo Jima in 1945. I had a copy on my shelf so I read the first part and then later, well into the night, got to reading to the end of the book. I don't usually do that but got caught up in reading a passage near the end and kept on going. Once I finished, I closed the book, feeling sadness over what happened to those boys and how it all affected their lives afterwards; those who were not killed on Iwo that is. I leafed through it and found a signature on the Library of Congress page – *Ernest A. Liner*. I could not believe it. I burst into tears and cried for a long time. Ernie was there. There in the book. There on Iwo Jima when the flag was raised. That immortal shot by Joe Rosenthal of the flag raising that captured American hearts and imagination, the photo that captured the essence of the US Marine Corps, that icon of the Marines. Ernie was there. He saw that flag fluttering in the South Pacific wind. Ernie died a few weeks ago. He did his duty on Iwo like everyone else. As a trained demolitions expert, he killed the enemy with satchel bombs by crawling to the top of concrete machine gun pill boxes and heaving the satchels inside through the small openings over the edge below. He was wounded there, but he came back alive and healed. He healed so well that, unlike most other men, he did not have nightmares about the ordeal and experience. I interviewed him about his life as a herpetologist for the Historical Perspectives section in *Copeia* and included a paragraph on his contributions as a combat Marine. I described his actions on Iwo Jima and how he was wounded. I felt great sadness upon learning of his death. But I never cried, at least until now. I clutched the book, ran my fingers gently over the signature and cried hard. Ernie was a Marine, a fellow Marine, a brother warrior Marine. How could I not cry over losing him, over the loss of yet another Iwo Jima Marine to time and history? Ernie was a hero in my book and a hero by any definition. He loved life, loved herpetology, loved Cajun cooking, and loved people. All of my colleagues who knew him respected and loved him for the kind of person he was, in part a herpetologist who made substantial contributions to that field. I loved him for being a fellow Marine. We shared a common bond, the bond forged by being a part of a brotherhood within a highly respected organization. We both paid the same dues to become part of that organization. We shared the common history of all the Marines that came before and those who will come after. We were connected in ways most will never understand. I miss Ernie. I want to talk to him more about his Marine Corps and war experiences. Unfortunately, that will never be. I can only cherish the memories I have of my brief times with him at meetings, of my interview with him for the article in *Copeia* that covered three days in his home in Houma, Louisiana, and of his thoughtfulness and kindness to others, myself included. I do not know where I got that copy of Brady's book. I still cannot remember getting it from Ernie, tho' I am sure I did. But there, on that page, was his signature. How did I come to get

this, I pondered? It haunted me as if it was somehow destined for me to find out this way, after reading the end of the book. And then I saw an odd piece of paper sticking out from inside the back cover. I turned to the back and found a white circular paper. Turning it over I saw the following words on the sticker: "RCA, Registered Coonass, 'Ain't Worried bout Nothin' " with a raccoon on the front. Well, it was Ernie's Cajun way of telling me to lighten up, to stop being mournful. Life goes on, as did his after Iwo Jima. He did his time. Now it is time for me to get on with what is left of mine. Thanks, Ernie. *Semper fi*. Always." —*Joseph C. Mitchell*

"At 0.6 mi. NW Guasave, I stopped at a pond alongside the highway which had a turtle swimming in it. I collected a few tadpoles, and saw an algae in it that I believed to be *Elodea*. Started in after the turtle with a dip net and a rake. I soon realized my mistake, as I began to sink rapidly in a quicksand-like substance. I anchored my tools into the solid ground and used them as leverage to pull myself out, losing my shoes in the effort. It was a frightening experience, but after replacing my shoes, I again headed north, though by then I lost all interest in the turtle!" —*Liner 1993*, Mexico 1960.

"I too share the warm feelings and sentiments expressed in all the emails I've seen. Ernie was a true prince. We first met in 1972 when Ray Ashton and I were on a toad collecting trip to supply Shelly Guttman with specimens for his systematics studies. Ernie had never met us before, but we were as warmly received into his home as if we were long time friends.

After a splendid meal of shrimp and crawfish boil, he offered to show us some local collecting areas. I offered my Dodge Power Wagon as transport—the go-[almost]anywhere vehicle of the trip. 'Naw... Let's take my company car.' So we piled into this plush Buick, me thinking we'd collect off some paved road. HAH! Ernie skillfully piloted that land-yacht out of town, OFF the road, and through sand, mud, and standing water that I'd have hesitated to drive the Dodge into! But Ernie of course knew the terrain and how deep the gunk was, so we just pushed on in to his spots and collected!

Well, afterward of course we were, ummmmm..., a MESS. But Ernie just said to pile in (we did set down some towels) and back through the goo we went to his house where there were more crawfish and shrimp to eat up, washed down as before with an appropriate libation.

Over the years since, we met at meetings and always spent time just yakking about all manner of things. And of course I have his cookbook! Not long ago, he mailed me a copy of a Houma magazine that had done a very nice profile article about him. I emailed him to thank him, assuming he got the email (Ernie never replied via email, but whenever I emailed asking for this-that info, it always arrived so I'm sure he read email).

Fond memories of a truly wonderful man. I'm having trouble typing through increasingly misty eyes, so I'll stop after saying to Derek and the other family that it's obvious Ernie touched so very MANY lives in diverse positive ways. Peace and good memories." —*George Pisani*

"Upon arriving near Galeana I saw Mexican vaqueros (cowboys) riding horses into the town. It seems they were going to a dance this Sunday night. I stopped at a local store in town near the plaza which had a lot of people milling around. I became an attraction and was told that cars could not make the trip—only busses and trucks. New ones became old very quickly. I was warned by the locals that since I was camping out I must be on the look out for banditos. They still had them around.

I made camp off of the road to the west of town for the night. Around eleven that night I suddenly had my camp surrounded by the vaqueros I saw earlier. They insisted that instead of my staying at my camp I must come to their rancho (which I now believe to be Rancho de la Montana). Upon arriving at the rancho one of the guys disappeared into a building emerging with a case of cerveza (beer). I was expected to pay for it, which I did. After we drank the beer we went to a tanque (pond) to look for sapos (toads) and ranas (frogs). We didn't find any so they went to bed and I slept in my car. The next morning they brought me fresh milk and cookies for breakfast. A little later in the morning they started chasing lizards for me on horseback. It was really hilarious watching them try to catch them. They did succeed in collecting 5 specimens of *Sceloporus parvus parvus*. After fooling around with them most of the day, and not collecting much, I decided to leave them to head back to Linares. After finding my way back to Galeana I again camped out just west of town, but this time I had no nocturnal visitors to interfere with my sleep."—*Liner, 1991a*, Mexico 1951

"As one ages one of the saddest things is the increasing loss of friends. No loss to me has been sadder than that of Ernie Liner.

I first met Ernie in the 1960s when he led a field trip at a herp meeting in New Orleans. He took us to an incredible spot where the bus load got a huge number of herps, mostly some fine snakes. One of my students needed copperheads, under one sheet of roofing tin we got four.

My greatest respect for Ernie was his empathy and kindness shown me and my family over the years, having little to do with herpetology. When one of my sons died, I was in deep depression. Ernie invited me to come visit him. With a geologist friend we drove through a severe ice storm to Houma, where Ernie's kindness was a big help. It was on this visit that he took us through the Mississippi delta—Chauvin, Boudreaux, Dulac, Cocodrie, etc. Of course, he fed us well!

When my granddaughter was five and after her father died, we had to go through a lot to get her out of a dangerous environment and become her legal guardians. When Ernie heard of this, here came an 'Ernie care package' full of very appropriate items for a five year old. He later sent her dozens of Mardi Gras beads and trinkets, which she still cherishes. Similarly, several times Ernie sent my wife care packages with spices and food items available only in Louisiana.

Several trips with Ernie were also memorable. In the 1980s he drove to the herp meetings in San Francisco, collecting along the way, including some rattlers. He drove us and Meg Stewart and her spouse to Point Reyes and surrounding areas, along with the menagerie he had assembled in his Dodge Ram. He and I drove from Norman to a SWAN meeting in Kansas, birding along the way at the Great Salt Plains, Cheyenne Bottoms,

and other refuges where we saw huge flocks of migrating sand hill cranes, white pelicans, and numerous shore birds.

Ernie shared his many joys with me (as he apparently did with his many other friends), especially his honorary doctorate from Colorado. After he was selected to receive the research award from SWAN a few years ago, I had the privilege of calling him to give him the news. I could hear the tears of joy and humility in his voice. He was truly a humble man." —*Vic Hutchison*

"I pulled into El Naranja into a small hotel along the Rio El Salto. I was one beat gringo not having been to sleep in two days but before retiring collected 8 Gulf Coast toads, *Bufo valliceps*, and 2 common Mexican treefrogs on the highway and along side it at the river.

With the roar of the river singing a lullaby I had a good, sound sleep. Upon arising in the morning and while I was in the bathroom I found my first herp of the day. Under the lip of the toilet bowl a veined treefrog, *Phrynohyas venulosa* [=*Trachycephalus venulosus*], was collected." —*Liner 1994*, Mexico 1961

"I knew Ernie a bit from the SSAR meetings, but after I moved to Louisiana in 1991, I had the pleasure of really getting to know him. We spent time on the phone and at the biannual Louisiana herpetology meeting down in Cocodrie, talking about this and that in herpetology, but that's not how I really got to know him. Ernie had a habit of just getting into his car and visiting unannounced. It was always a great pleasure to see him so I would drop everything and do work if we needed but invariably we would go eat, usually with herp grad students in tow, and all the while talking about herpetology. As he got more involved in the second edition of his Standard Spanish and English names list of Mexican reptiles and amphibians, we spent more and more time talking about names. We did not always agree, but that was fine with both of us and the differences are evident in his publication (Liner and Casas-Andreu 2008). The amazing thing about these visits, was that sometimes I would be in class or in a meeting so Ernie would just find a bench near my office and sit. He always had something to read, but I know that sometimes he sat for over an hour! I always felt bad about him waiting around, but Ernie would have none of that and give his broad smile accompanied by an offhand comment saying he was perfectly content. I finally got to give all those visits back to Ernie. Just before he passed I (along with Cliff Fontenot) raced down to Houma to see him in the hospital. He could not speak much, but at the end of the visit I said I would see him at Cocodrie in November and very audibly he said, 'I hope so.' Ernie, thanks for everything."—*Brian Crother*

"This ad hoc list-serve has brought to attention stories of kindness and generosity stemming from Ernie that are beyond comparison. I knew he was a nice guy, but I was unaware of the depth of his devotion to giving and support.....truly humbling to read of this great person. I will say that I never knew Ernie particularly closely, so these stories we've been relating are especially eye-opening. I met him first soon upon arriving at my first-ever annual Herp Meeting (hosted by Tulane, in 1990 I believe). I was a first-year Master's student, I was nervous, and I was awed to see names I knew from the literature and specimen tags on name tags! Ernie spotted me early in the conference, introduced himself, and made me feel extraordinarily welcome and at ease through the entire week; he checked up on me at least once every day. Ever since, at every conference, he would always make a point of asking me something friendly and implicitly supportive like "Hi Joe, are you still chasing those *valliceps* toads?" That meant a lot to me, to simply be recognized and remembered from year to year at the meetings."—*Joseph Mendelson*

"I can simply say that my coonass friend Ernie, like only a chosen few, was one of those special guys who should be allowed to live forever." —*Charlie Painter*

"As all good things must come to an end, I then had to go home…." —*Liner 1993*, Mexico 1960

Acknowledgments.—We are extremely grateful to everyone who allowed us to use their personal comments about Ernie: K. Adler, A. Bauer, B. Drewes, J. Fouquette, V. Hutchison, C. Painter, G. Pisani, D. Prosperie, C. Schaffer, D. Siegel, D. Vogt, K. Williams, and L. Wilson. Bob Hansen kindly sent a digitized copy of Ernie's *Mexico Bound* essays. Kraig Adler generously shared a number of articles about Ernie as well as the photos. Mary White is thanked for reading and editing drafts.

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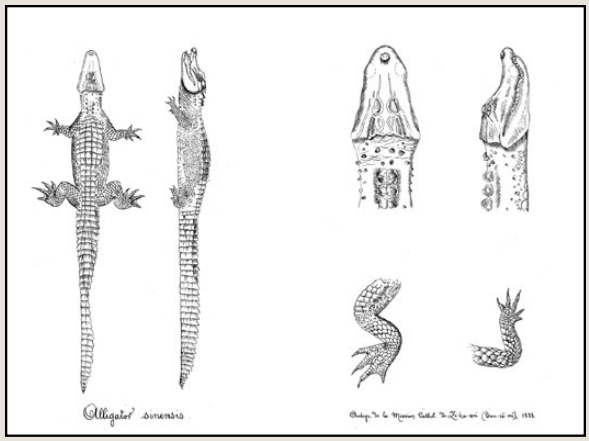
ZOO VIEW

Herpetological Review, 2011, 42(1), 19–20.
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"The Chinese have an idea that the Alligator is wonderfully tenacious of life. The Canton annals say that the head can be cut and dried, before the animal dies, the muzzle can be broken into pieces and all the teeth pulled out and it still lives."

—Albert-Auguste Fauvel, *Alligators in China: Their History, Description and Identification*, 1879:12

Chinese Alligators (*Alligator sinensis*) have been an integral part of zoo collections for many decades because they are hardy in captivity and not subjected to the assaults described above by Fauvel. One lived at the Bronx Zoo (Wildlife Conservation Society) in New York for over 46 years (Snider and Bowler1992). In an early account, Lederer (1941) described care of the Chinese alligator at the Frankfurt Zoo. There is an interesting photograph of a London Zoo keeper holding a tame alligator in the book Marvels of Animal Life by W. S. Berridge in 1926. Müller (1970) mentioned reproduction at the Leipzig Zoo. Behler (1977) described the excellent propagation program for Chinese alligators which involved a number of zoos and the Rockefeller Wildlife Refuge in Grand Chenier, Louisiana where the alligators were maintained in a semi-captive environment. For example, a pair was acquired by the Smithsonian National Zoological Park in 1937 and the female never reproduced for forty-three years until transferred to the Refuge when 8 young hatched there from 21 eggs. Behler et al. (1982) and Brazaitis and Joanen (1984) documented the status of the species and propagation in captivity. Davenport (1982) discussed reproduction and aging and Watanabe (1986) felt hopeful about its future.



In 1879, Albert-Auguste Fauvel published the first scientific description of the Chinese Alligator (Alligator sinensis) in Alligators in China: Their History, Description and Identification. Shown here are plates from his original monograph. It is a pre-print of an article published in the 1879 volume of the Journal of the North-China Branch of the Royal Asiatic Society. Credit: courtesy of Tim Perry and Kraig Adler.

Although there are thousands in captive breeding facilities, fewer than 300 individuals exist in the wild. This taxon is considered to be the most endangered crocodilian in the world. The late John Thorbjarnarson from the Wildlife Conservation Society in New York and Xiaoming Wang from East China Normal University have published a book with up-to-date information on this imperiled crocodilian (2010, The Chinese Alligator: Ecology, Behavior, Conservation, and Culture, Johns Hopkins University Press, Baltimore, Maryland; ISBN-13:978-0-8018-9348-3; 10:0-8018-9348-8; 265 pp.). In their book, the authors cover many topics: crocodilians of the world, ecology and behavior, habitat and population status, and its future.

There are captive management plans in place by the Association of Zoos and Aquariums (AZA) in the United States, The World Association of Zoos and Aquariums (WAZA), and the European Association of Zoos and Aquariums (EAZA) which include population analysis, studbooks and recommendations on breeding and transfers to prevent inbreeding depression.

Snakes in Trees

For twenty years, Richard A. Sajdak was Curator of Herpetology at the Milwaukee County Zoo in Wisconsin until retirement. He has a fascination with arboreal snakes and has written an interesting book about them. In fact, virtually everything yo-would ever want to know about tree-dwelling serpents is contained in this book. The title is *Hunters in the Trees. A Natural History of Arboreal Snakes* (2010, Krieger Publishing Company, Malabar, Florida, ISBN-13:978-1-57524-303-0; 10:1-57524-303-2). Sajdak coordinated an admirable research program at the Zoo, publishing over 40 articles and book chapters. Selected Sajdak publications and descriptions of the Zoo's herpetological history are listed below:

Historical Overview

Card, W., and J. B. Murphy. 2000. Lineages and histories of zoo herpetologists in the United States. Herpetol. Circ. 27:1–45. [portrait of Richard Sajdak]

Speidel, G. 1969. Aquarium and reptile building at Milwaukee Zoo. Inter. Zoo Yearb. 9:71–72.

Zucconi, D. 1967. Impressive new aquarium and reptile building for Milwaukee County Zoological Park. Herpetol. Rev. 1(1):9.

Zucconi, D. G. 1968. Reptile & amphibian exhibits in the Milwaukee Zoo's new Reptile/ Aquarium Building. Bull. Philadelphia Herpetol. Soc. 16:21–30. [Contribution was the last on reptile buildings in the United States. Photographs of the building, public areas, rear section, a very young David Zucconi, who was Sajdak's curatorial predecessor and a few alligators were included.]

Conservation

Sajdak, R. A. 2001. Patriarchs of the bluffs. Fauna May/June:8–21. [description of long-term monitoring study on Timber Rattlesnakes in Wisconsin]

General

Henderson, R. W., M. H. Binder, and R. A. Sajdak. 1982. Ecological relationships of the tree snakes *Uromacer catesbyi* and *U. oxyrhynchus* (Colubridae) on Isla Saona, República Dominicana. Amphibia-Reptilia 2:153–163.

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———, and R. W. Henderson. 1991. Status of West Indian racers in the Lesser Antilles. Oryx 25:33–38.

———, M. A. Nickerson, R. W. Henderson, and M. W. Moffett. 1980. Notes on the movements of Basiliscus plumifrons (Sauria: Iguanidae) in Costa Rica. Milwaukee Public Mus. Contrib. Biol. Geol. No. 36.



There are beautiful plates in Alfred E. Brehm's *Les Merveilles de la Nature. Les Reptiles et les Batraciens* (Librairie J.-B. Baillière et Fils, Paris, 1883). Brehm was Director of the Hamburg Zoo in Germany from 1863 onward and founder of the Aquarium Unter den Linden (Berlin's main street) in 1869. This Long-Nosed Tree Snake (*Ahaetulla nasuta*) is found throughout India, Sri Lanka, Burma, Thailand, Cambodia, and Vietnam.

Important Article for Zoo Ecologists

Sillero, N., and P. Tarroso. 2010. Free GIS for herpetologists: free data sources on Internet and comparison analysis of proprietary and free/open source software. Acta Herpetologica 5(1): 63–85.

Box(ed) Turtles

Dave Fogel provided this cardboard shipping box used to send baby painted Red-Eared Sliders through the mail. It was used ca. the late 1950s or early 1960s. Imagine the trauma, dehydration and temperature variation encountered by these entombed chelonians.



Cardboard shipping box used to send baby turtles through the mail. "Neither snow, nor rain, nor heat, nor gloom of night stays these couriers from the swift completion of their appointed rounds "— unofficial motto of United States Postal Service.

Hopelessness

In recent years we have noticed a worrisome trend among our colleagues in conservation biology: a continuing culture of despair. This culture manifests particularly in conference presentations, most recently at the 2009 annual conference of the Society for Conservation Biology in Beijing. Many young, emerging conservation biologists could be heard questioning, "Where's the hope?" and expressing despair at the gloominess of many presentations and discussions.

"The Culture of Conservation Biologists: Show Me the Hope!" by Ronald R. Swaisgood and James K. Sheppard
—*BioScience* September 2010 / Vol. 60 No. 8:626–630.

Ronald R. Swaisgood <*rswaisgood@sandiegozoo.org*> is the director of the Applied Animal Ecology Division, and James K. Sheppard <*jsheppard@sandiegozoo.org*> is a postdoctoral fellow at the San Diego Zoo's Institute for Conservation Research.

Shifting Baselines for Herpetologists

Virtually all of the papers I read about amphibian decline are impersonal and this is appropriate because these are technical papers. Joe Mendelson's essay that follows is unique because it tells the reader what it FEELS like to watch the loss of amphibians and how this event changed his life. I sent this essay out for review and got back some interesting reminiscences and thoughts; I will share some of them in my next column.

JAMES B. MURPHY, *Section Editor*

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Shifted Baselines, Forensic Taxonomy, and Rabbs' Fringe-limbed Treefrog: The Changing Role of Biologists in an Era of Amphibian Declines and Extinctions

My initial foray in tropical herpetology yielded less than spectacular results. In 1989, I was a new graduate student at the University of Texas at Arlington, where my mentors, J. A. Campbell and E. D. Brodie Jr., arranged for me to spend a field season in Guatemala. My task was to make collections on the wet northern slope of the Sierra de las Minas, based out of Finca Pueblo Viejo, a coffee/cardamom/rubber plantation at the edge of the Polochic Valley in Alta Verapaz (Mendelson 1990). This region of the sierra had never been surveyed herpetologically, so I was very excited to conduct an expedition.

As this was to be my first experience in the tropics, I "did my homework" in terms of relevant literature, available field notes, and especially reviewing the collections at UT Arlington. Consequently, when I arrived at the site and despite my inexperience, I was fairly knowledgeable of the animals I might encounter. I knew to look on the underside of leaves for centrolenid frogs, and to dig in piles of rotting coffee-bean husks for caecilians. I knew to look for species of frogs in the *Craugastor rugulosus* group on the ground and rocks along montane streams. That summer, I assembled a good collection of reptiles from Pueblo Viejo, but a poor collection of amphibians.

Late summer and fall, I sorted and identified my specimens. I was pleased to realize that I had, for the first time in my career, discovered a species new to science: *Incilius campbelli* (Mendelson 1994), a toad previously confused with the ubiquitous *Incilius valliceps*. One day, while I had some frogs out in a tray, Jon Campbell pointed to a specimen of the *Craugastor rugulosus* group (later described as *C. sabrinus* by Campbell and Savage 2000) and asked why I had collected only one of those. I responded "*Because that's the only one I found*." It seemed clear to all concerned that Mendelson's inexperience explained the paucity in the collection of these typically common streamside frogs. Meanwhile, down the hall in his lab, Campbell was frustrated in his attempts to describe the tadpole of a new species of *Ptychohyla* from Guatemala (Campbell and Smith 1992) because—for some reason—none of the specimens collected by Eric Smith (then an undergraduate in Guatemala) had complete mouthparts.

That same month, September, hallway conversations at the First World Congress of Herpetology, held in Canterbury, UK, were considering that amphibians might possibly be in decline (Wake 1991). It would be several years yet until Joyce Longcore and colleagues described the insidious chytrid fungus that destroys the mouthparts of tadpoles as it proceeds to decimate amphibian populations (Longcore et al. 1999). But it would be a long time before I realized that the paucity of specimens of *C. sabrinus* in my collection was not the result of my tropical inexperience.

In 1992, my friend Adrian Nieto-Montes de Oca and I spent the summer in southern Mexico, looking for anoles and toads for our dissertations at the University of Kansas. I took along photocopies of field notes by Bill Duellman, Jan Caldwell, John Lynch, and others made in the 1960s and 1970s to help guide our efforts at certain sites. That trip was frustrating because, despite our best attempts, Adrian and I could not come close to duplicating the successes of the earlier collectors. For example, field notes indicated that salamanders of the genus *Thorius* could easily be found by the dozens or even hundreds in Oaxaca. We found one *Thorius* that summer, and it was a new species (*T. smithi* Hanken and Wake, 1994).

Around this time I became friends with Karen Lips, a graduate student from a "competing lab" (Jay Savage's group at the University of Miami), who had interests similar to mine but with field sites that were further south, mostly in Costa Rica. She and I often discussed our experiences and compared notes from our respective field adventures. She told me of working cloudforest streams at night and finding dozens and dozens of frogs, whereas I was hard-pressed to find dozens of upland frogs in Mexico during an entire season, much less a single night. We didn't think much of the disparity at the time, but I will be honest in admitting that I was worried that my life-long southern California field skills were not serving me well in the tropics. In the mid-90s I travelled extensively with Jonathan Campbell and Eric Smith, mostly in Guatemala, and it became obvious that they too could not find appreciable numbers of amphibians including the "common" species of the *Craugastor rugulosus* group or upland hylid frogs. I clearly remember a day in 1996, when I stood with Campbell at the type locality for *Plectrohyla cyanomma* (Caldwell, 1974) in the Sierra de Juárez, Oaxaca, and he pointed to a particular rock in the stream and commented that he inevitably found individuals basking on that rock, and the stream was always replete with their large tadpoles. There were none.

During those times in the late 80s and the 90s, it never occurred to me that I found few amphibians on my trips because they simply were no longer there. It is clear now that I began my career in tropical herpetology in a geographic arena (Mexico

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FIG. 1. JRM in Sierra de Juárez, Oaxaca, Mexico, July 1992. Photo by A. Nieto-Montes de Oca.

and Guatemala) that had experienced a dramatic baseline shift in amphibian diversity and abundance before I ever arrived. As we were to discover, Karen Lips began her career in a geographic arena (Costa Rica and Panama) that was just on the verge of having its baseline shifted. When it did so, I am glad at least that she and her collaborators were able to describe that shift in great detail. They were there to document one of the great stories unfolding in natural history during our times (e.g., Lips 1999; Lips et al. 2006; see also Collins and Crump 2009). As for me, I got but a single glimpse at an intact Mesoamerican amphibian community in central Panama in 2005, just months before it crashed. All told, I personally feel like I was cheated of a natural history experience that I deserved and I am angry about it. I also am sad that current and future cohorts of graduate students and naturalists will share this loss. There no longer exists a natural upland ecosystem in Mesoamerica.

Nobody noticed the declines taking place in Mexico and Guatemala. In 2000 Karen Lips and I led resurveys of historical collecting sites in southern Mexico that had not been visited in years, and concluded that a subset of the amphibian fauna was simply missing and what species did remain in the higher elevations were far less abundant than they had been historically (Lips et al. 2004). Our reasonable estimate was that the declines there took place in the mid-1980s. That summer we found exactly one individual representing the entire *Craugastor rugulosus* group. Similarly, in Guatemala, the remnant amphibian fauna of a cloudforest reserve, Biotopo Mario Dary in the Sierra de las Minas, Baja Verapaz, bears little resemblance to its historical assemblage and abundance, based on Campbell's field work there ca. 1980 (Mendelson et al. 2005). If you wish to know the details of how a decline like these comes about, then do read the important paper by Ryan et al. (2008) wherein they describe the final days of a population of *Craugastor* cf. *punctariolus*. We now believe that species to be extinct in the wild (Griffiths, Ross, and Mendelson, unpublished data), but taxonomists are not entirely sure as to what species it was.

It is reasonable to conclude that the chytrid fungal pathogen *Batrachochytrium dendrobatidis* Longcore, Pessier, and Nichols, 1999, played a major role in eliminating amphibian species and reducing their populations in Mexico and Guatemala (Lips et al. 2004; Mendelson et al. 2005) in the 1980s, but of course this is difficult to demonstrate directly in retrospect. Although histological examination of museum specimens (where sufficient series of specimens exist, which is unusual) might identify synchronous appearance of the fungus and subsequent population declines, correlation is not causation. Quite frankly, such studies are psychologically depressing, and I have noticed that few students delve into them. It is not very rewarding to study a population or species so recently vanished.

Herpetologists spent the better part of the 1990s aggressively debating the reality of amphibian declines and potential causes (reviewed by Collins and Crump 2009) and, meanwhile, the situation became worse. The baseline shift that I missed means that, despite my 20 years of field work and research in northern Mesoamerica, I have never experienced a natural amphibian community there. The baseline shift that Karen Lips and colleagues are documenting in southern Mesoamerica means that no herpetologist visiting the area in the future can ever possibly know the historical reality of those ecosystems.

When an epidemic of chytridiomycosis decimates a regional amphibian assemblage, the ecosystem there is fundamentally changed (Lips et al. 2006; Smith et al. 2009; Crawford et al. 2010) and those changes have ecosystem-level effects (Whiles et al. 2006; Connelly et al. 2008). A national park near El Copé, Panama, lost at least 30 species of amphibians (41% of the assemblage; Crawford et al. 2010). The fully-protected Biotopo Mario Dary in Guatemala appears to have lost about 70% of its amphibian fauna (J. A. Campbell, pers. comm.). When you consider losses of this magnitude together with the phenomenal biomass that amphibians may attain (Burton and Likens 1975), it is impossible to assume that the affected ecosystem will function in any manner similar to pre-epidemic conditions. The implications of these faunal upheavals are considerable, and they are generally ignored outside the research community that is directly related to amphibian declines. Biologists of all sorts should acknowledge if their research is taking place in the context of an intact, or an altered, amphibian community. Would not a cardiologist also consider the fact that their patient has emphysema? The reality of amphibian declines and extinctions has shifted the ecological baseline in so many ecosystems, that an entire generation of biologists is conducting their research in a framework that has been very recently remodeled. And I feel like we—herpetologists, ecologists, biogeographers,

systematists, and more—are not really talking about it; this reality compromises our research, and this is a problem.

I am a taxonomist and I have seen my career vacillate between the thrill of discovering new species and the chill of tracking extinction events—including species that I described. Taxonomists are not the warmest lot of people, but I will opine that one feels a personal connection with a species that you yourself have named. In a recent species description (Mendelson and Mulcahy 2010) we put forward the term "Forensic Taxonomy" to try to communicate the frustrating reality of what it means to be an amphibian taxonomist in this era. In the last 20 years, I have contributed to naming (or resurrecting) 32 amphibian species. Of these, I believe at least four of them are extinct, and several others are hanging on in very low numbers. I have never seen several of them in life, having described them based on specimens on the shelves of museums. I sought a career in herpetology because I enjoy working with animals. I did not anticipate that it would come to resemble paleontology. I am not alone in this cutting-edge new field of Forensic Taxonomy, as I note that my friend Luis Coloma (Coloma et al. 2007, and especially Coloma et al. 2010) has independently discovered the field as he works his way taxonomically through the ashes of what once was the wonderful radiation of *Atelopus* (LaMarca et al. 2005). I focus most of my attentions on frogs, but the salamanders are in no better shape (Parra-Olea et al. 1999; Rovito et al. 2009), and the poor caecilians perpetually languish in the cloud of our ignorance of their fascinating habits.

The US National Science Foundation has an entire program devoted to Biotic Surveys, and I endorse that program entirely. However, I must pose the question "*What does it mean to conduct biotic surveys in an era of shifted, shifting, or soon-to-be shifted baselines of amphibian diversity*?" Crawford et al. (2010) discovered that even seven years of systematic collections of tissues, specimens, and ecological notes failed to discover a good proportion of the actual amphibian species-level diversity that existed near El Copé, Panama, prior to the epidemic of chytridiomycosis documented by Lips et al. (2006). Our discovery and description of *Incilius karenlipsae* Mendelson and Mulcahy, 2010, based on a single specimen found at that site in the wake of the disease, was an experience I can classify only as bittersweet because the effects of chytridiomycosis there suggest that it likely no longer exists. I hope I am wrong about that.

I can tell you what it feels like to conduct biotic surveys for amphibians in this era. In 2004, I joined Martín Bustamante to survey a site in southern Ecuador. That general region of the Amazonian slope of the Andes had never been surveyed herpetologically, so the project qualified as an expedition into an area undocumented by herpetologists—the kind of excursion that made H. M. Smith, E. H. Taylor, L. C. Stuart, and our other heroes legendary. We were on site for about a month, with a team of eager students, in what we thought was a pristine ecosystem along a cloudforest–paramo transition zone. In that month we found only seven species of amphibians—five *Pristimantis* spp., one *Gastrotheca* sp., and one dendrobatid; at least three of the *Pristimanis* spp. are new to science. Biannual surveys of the site in the last six years have not increased the numbers. Bustamante and I are working on describing these new species (e.g., Bustamante and Mendelson 2008), but it is apparent that our attempt to conduct a modern biotic survey came too late. Where were the hylids, the centrolenids, the bufonids, or the *Telmatobius*? What we surveyed was in no way a typical Andean amphibian fauna (see Duellman 1979), which should have harbored many more species. Local ranchers told us that the site used to include *jambatos* (= *Atelopus* spp.). They also provided perfect descriptions of a local *Telmatobius* sp. but they had not seen either frog in many years. The *Telmatobius* sp. likely was *T. cirrhacelis* Trueb, 1979, a species described as "possibly extinct" on the IUCN Red List (www.iucnredlist.org). We cannot hazard a guess as to the identity of the *Atelopus* spp. that had once existed at the site. Bustamante and I had gone into the area too late even to conduct a proper Forensic Taxonomy of the life that once existed there.

In late 2004, Karen Lips determined that the chytrid pathogen had finally arrived at her long-term study site near El Copé, Panama, and the expected massive die-off was in progress. This reality created a terrifying reality of predictiveness—we knew where it was going next, but we had no idea of what to do about it. In response to this important finding, an emergency meeting in Atlanta brought together a small group of key stakeholders to try to determine what, if anything, could be done about the situation there, as all precedents indicated that the amphibian fauna of the adjacent highlands of Panama were about to be



FIG. 2. JRM in Sierra de Huautla, Oaxca, Mexico, July 1992. No individuals of *Craugastor* nor *Plectrohyla* were found along this cloudforest stream. Photo by A. Nieto-Montes de Oca.

decimated by the disease (Collins and Crump 2009, provided more details about this meeting). Among the projects that resulted from that meeting was a pilot-study for the development of a rapid-response multi-species "extraction" of amphibians into captive safekeeping. This was to be launched near El Valle de Antón, just east of Lips' site at El Copé. This pilot project took place in 2005, and was described by Gagliardo et al. (2008).

Among the frogs collected at the El Valle site for safekeeping was a large fringe-limbed treefrog of the genus *Ecnomiohyla*. We assumed it to be *E. fimbrimembra* (Taylor, 1948), but our colleague Brian Kubicki (Costa Rican Amphibian Research Center) immediately recognized it as a new species. Eventually, we collaborated and described the species *Ecnomiohyla rabborum* Mendelson, Savage, Griffith, Ross, Kubicki, and Gagliardo, 2008. The name honors George and Mary Rabb, as lifelong stalwarts for conservation—especially for amphibians. It meant a lot to us to honor them with this spectacular new species. Edgardo Griffith and Heidi Ross (El Valle Amphibian Conservation Center [EVACC]) led the field work that discovered the frog and were able to document some of its amazing natural history (detailed in Mendelson et al. 2008). As is known in other species of *Ecnomiohyla*, the frog does leap from upper tree limbs and glide to the forest floor, using its massive fully webbed hands and feet to orient, and the eggs are deposited in tree holes. Edgardo and Heidi observed that the males remain with the developing eggs and immerse their body into the writhing mass of tadpoles on occasion, allowing the tadpoles to rasp their epidermis for nutrition. We believe this is the first example of direct paternal nutrition of offspring in an amphibian, but it appears that we will not have the opportunity to directly demonstrate such. In any case, this is an impressively large treefrog (up to 100 mm SVL) with a remarkable natural history. *Ecnomiohyla rabborum* was discovered afield in 2005 and formally named in 2008. In 2006, the chytrid fungus arrived at El Valle, having moved eastward from El Copé, in an advancing wave, exactly as predicted by Lips et al. (2006) and further characterized by Lips et al. (2008). Just as predictable was the utter decimation of the amphibian fauna there during 2006–2007, and our lack of any means of preventing it.

In 2006, crews at the nascent protection facility, EVACC (still under construction at the time!), scrambled to triage and treat infected frogs of many species, hoping to use them to establish captive survival-assurance colonies. Individuals of *E. rabborum* were distributed, for safekeeping, to facilities at EVACC, Zoo Atlanta, and Atlanta Botanical Garden. Captive programs for endangered species sometimes are successful (e.g., *Atelopus zeteki*, www.ranadorada.org) and sometimes they are not (e.g., Passenger Pigeon, as a singularly famous example). The end-story is that these individuals of Rabbs' Fringe-limbed Treefrog thrived for years but never bred under captive conditions. The last wild individual noted was a calling male heard (but not seen) in 2007. Edgardo and Heidi still lead field work in the area, but the species has not been found. The last female known died in captivity at Atlanta Botanical Garden in 2009. At this time of writing, a single adult male lives at the Atlanta Botanical Garden and another is at Zoo Atlanta (see cover image). It appears that nature has run its course before three teams of dedicated people were able to determine the needs of these frogs in order for them to reproduce. To have been a part of one of those teams has been a frustrating and sad experience.

Our esteemed colleague Tim Halliday—a longtime leader in the field of amphibian declines—has taken to calling himself "an extinction biologist." His sense is accurate, if morbid, and I posit that most of us working on amphibians in this era may consider adopting the term. As for me, I'm still adjusting to my new title of "Forensic Taxonomist." I have re-surveyed field sites and experienced the emptiness of not finding as many frogs as Bill Duellman did in the 1960s. I have co-led biotic surveys to places that are too ravaged to consider. I have named species from museum jars, lamenting all the while that I would never see them alive. But none of those feelings resonate like coming to my zoo everyday and seeing what is essentially the end of a spectacular species like Rabbs' Fringe-limbed Treefrog. There is no female that we know of, and one morning I will find the male at Zoo Atlanta dead of natural causes. I will collect tissue samples for phylogenetic studies, I will collect cells for San Diego Zoo's Frozen Zoo initiative (perhaps one day it can be cloned?), and then I will preserve the specimen for the museum shelf. Shall I post a video clip on YouTube so people can watch the frog move about, like the famous film clip of the last thylacine? Then I will return to my lab, take a jar off the shelf and proceed to describe another new species of frog that used to exist somewhere in the world. I am, after all, a Forensic Taxonomist.

It turns out that extinction is a difficult thing to demonstrate unequivocally, as it is founded largely on negative evidence. In my career, I never suspected that I would end up hoping to be wrong in so many of my academic endeavors. I am glad that we all were wrong about the extinction of Holdridge's Toad (*Incilius holdridgei* Taylor, 1952) in Costa Rica (Abarca et al. 2010). I hope we are wrong about the iconic Golden Toad (*Incilius periglenes* Savage, 1967) and that really it is simply underground (Crump et al. 1992), waiting out this entire ordeal.

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ARTICLES

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One Day to Hatch: Calcium-poor Eggshells and Maternal Care in *Ovophis okinavensis* (Squamata: Viperidae)

Reptile reproductive modes are defined on the basis of whether the females lay eggs (oviparity) or produce live young (viviparity) (Vitt and Caldwell 2009). Oviparous species have incubation periods ranging from more than six months to a few days (Köhler 2005). It is known that a Japanese pitviper *Ovophis okinavensis* lays eggs that hatch in an extremely short period (1–5 days, Koba 1959; Fukada 1964; Koba et al. 1970: 1–10 days (estimated), Nishimura and Kamura 2000) compared to other species of snakes (Köhler 2005). Eggs of *O. okinavensis* are characterized by partially transparent, thin eggshells through which the embryos are visible (Fukada 1964; Koba et al 1970). Nonetheless, no detailed structural examination of the eggshells has been conducted. In this study, we quantify the area of calcium covering the eggshell surface and the amount of calcium contained in an eggshell. In addition, because an evolutionary association between short incubation period and the occurrence of parental egg-guarding has been suggested (Tinkle and Gibbons 1977; Shine 1988), we present the first evidence of maternal attendance of eggs and neonates by *O. okinavensis* based on a field observation and a laboratory experiment.

Methods.—We collected six gravid female *O. okinavensis* in 2007 from three islands (Okinawajima, N = 3; Yanahajima, N = 2; Amamioshima, N = 1) in the Ryukyu Archipelago, Japan. The snakes were individually housed in plastic cages until oviposition.

The area of the eggshell surface covered by deposited calcium was measured for 6 eggs (clutches A (3 eggs) and B (1 egg) from Yanahajima and clutch C (2 eggs) from Okinawajima). We cut each eggshell and spread it out on a board to take a photograph of its surface. The photographs were imported into Adobe Photoshop CS 8.0, and calcium deposited and non-deposited areas were painted to white and black, respectively, by eye. The painted photographs were then captured to NIH Image 1.63 (available online from the US National Institutes of Health; http://www.nih.gov/), and the percentage of white area was calculated. The amount of calcium contained in each eggshell was measured using 4 eggs (a clutch from Amamioshima). For comparison, the amount of calcium was also measured for 3, 3, and 2 eggs of *Elaphe quadrivirgata*, *Rhabdophis tigrinus*, and *Protobothrops flavoviridis*, respectively. These eggshells were dried at 105°C for 1 h and then weighed. The dried samples were dissolved in NHO_3, and dilutions were made using 5% lanthanum chloride solution and distilled water. Calcium determinations were performed using an atomic absorption spectrometer. We used eggshells after hatching for the above two analyses.

Maternal attendance of eggs and neonates by a telemetered female was observed in a deciduous forest on Amamioshima Island. The female was surgically implanted with a radio-transmitter on 22 February 2007 (for methods see Reinert and Cundall 1982 and Nishimura et al. 1995) and was radio-tracked every month for one year.



FIG. 1. A clutch of eggs of *Ovophis okinavensis* immediately after deposition.

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TABLE 1. Overview of eggshell composition. Mass values are expressed as mg dry mass.

	Ovophis okinavensis				*Elaphe quadrivirgata*			*Rhabdophis tigrinus*			*Protobothrops flavoviridis*	
Egg ID number	1	2	3	4	1	2	3	1	2	3	1	2
Total shell mass	18.95	21.71	18.15	20.62	387	388	492	118	118	113	421	401
Calcium mass	0.22	0.40	0.15	0.27	42.56	50.89	63.85	10.55	11.16	10.92	34.06	29.34
Ca as % total	1.16	1.84	0.83	1.31	11.00	13.12	12.98	8.94	9.46	9.66	8.09	7.32

For the laboratory experiment, one of the three gravid females from Okinawajima was housed in a glass cage (600 × 300 × 350 mm) with shelter, water bowl, and artificial turf as substratum. Food (euthanized mice) was offered at 7–14 day intervals. On 23 August 2007 the female laid five eggs, two of which were infertile. The next day, we gently took out the eggs, using forceps, to measure their size, and immediately returned them to their original position. We then left the eggs undisturbed while recording maternal attendance of the eggs using a video camera (SONY DCR-TRV30, interval mode, 1.5 second / min), until the three live eggs hatched (26 August).

After hatching we conducted a experiment in which we moved neonates and mothers to observe whether they would re-aggregate every day from 1 to 11 days, except for days 4, 7, 9, and 10. Prior to the experiment, the shelter was removed, and the neonates were measured and painted on their dorsal parts for individual identification. Each day we moved the three neonates to one side of the cage and moved their mother to the other side. One hour after this manipulation, we recorded whether each neonate was in contact with the mother. It should be noted that we did not determine which individual(s) moved to re-establish proximity.

Results.—We observed hatching of a total of 22 eggs (from 7 clutches). Seven of the 22 eggs hatched on the day they were deposited. The longest incubation period was 4 days. The stage of embryos immediately after oviposition was 43 (last stage; Hubert and Dufaure 1968) in all eggs (Fig. 1). The proportion of the eggshells' area covered with calcium varied greatly both among and within clutches (proportion of calcium on each eggshell; clutch A: 0.80, 0.56, 0.17; clutch B: 0.46; clutch C: 0.98, 0.93). The percentage of calcium contained in an eggshell, by mass, was considerably lower in *O. okinavensis* than in the other three species (Table 1).



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FIG. 2. A wild female *Ovophis okinavensis* attending eggs.

At 1102 h on 6 September 2007 we located the telemetered female coiled along a log on a forest floor, with its body partially concealed under the log. We initially detected the position of the snake from approximately 2 m away by the conspicuous movement of the snake, apparently in response to our approach. The female extended and raised its head and the anterior part of its body nearly vertically above the ground with frequent tongue flicking (> 1 / sec). After measuring several environmental variables, we left the site to avoid further disturbance. We visited the site again at 0030 h on 7 September and found the snake at the same spot. We slowly approached the snake and noticed a clutch of eggs under her body. A single loop of the posterior part of her body encircled the eggs, and her head and S-shaped body lay over the clutch (Fig. 2). As we approached more closely, she raised her head by extending the anterior part of the body and twitched the raised body repeatedly and intermittently in a peculiar manner while directing the head toward us, with frequent tongue flicking. We observed embryos inside two eggs through the partially transparent eggshells, and a third egg appeared to be infertile. When we returned to the site at 1500 h on the same day, we found the female at exactly the same spot, with three neonates (Fig. 3). Two of them were intertwined beside the female (at ca. 5 cm), and the other was concealed behind her body and under the log. The female showed the above-mentioned conspicuous twitching movement in response to our approach. After several minutes one of the exposed neonates slowly crawled behind the female. At 1532 h on 8 September we again confirmed her attendance of the neonates. For logistic reasons we did not have an opportunity to track the female again until 28 October, when the female was located alone approximately 85 m from the oviposition site.

Maternal attendance of eggs by the experimental female was observed at ovipostion. The video analysis demonstrated that the mother never left the eggs until all live eggs hatched. Her posture, however, changed several times. Incubation periods of the eggs varied from 1–3 days. Neonates that hatched earlier occasionally crawled around in the cage. While attending the unhatched eggs, the female often moved her head close to the neonates as they approached her. When we attempted to remove the eggs or neonates from the attending mother, we frequently observed that the mother elevated her head and followed the movement of the forceps with frequent tongue flicking, but she never struck them.


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FIG. 3. A wild female *Ovophis okinavensis* (same individual as in Fig. 2) attending neonates. This photo was taken approximately 15 h later than Fig. 2.

In the relocation experiment, all three neonates and their mother re-aggregated at one and two days after hatching. Three and five days after hatching, two neonates and the female re-established their association. Six days after hatching, only one neonate re-associated with the mother, and the other neonates coiled side by side, away from their mother. Only the latter two neonates had opaque eyes. The neonatal ecdysis occurred seven and eight days after hatching. No maternal attendance was observed eight and eleven days after hatching.

Discussion.—This study confirms the short incubation period of *O. okinavensis* reported in previous studies (Koba 1959; Fukada 1964; Koba et al. 1970; Nishimura and Kamura 2000). Short incubation periods in snakes have been reported in *Liochlorophis vernalis* (4 to 23 days; Blanchard 1933), but the proportion of calcium contained in its eggshells (21.43% of total eggshell mass; Cox et al. 1984) is more than ten times higher than that of *O. okinavensis* (0.83–1.84%). Although our study is preliminary, considering the calcium-poor eggshells with variable quantities of calcium, it is possible that the eggshell of *O. okinavensis* is not as functional, in terms of providing protection, gas exchange, or water balance, as the eggshells of other animals. Moreover, because a short incubation period has often been interpreted as a stage in the transition from oviparity to viviparity (Packard 1966), the remarkably short incubation period and calcium-poor eggshells of *O. okinavensis* may be viewed as such an intermediate step. The phylogenetic position of *O. okinavensis* supports this interpretation because the most closely related species, *Trimeresurus gracilis*, as well as genera in their sister group including *Bothrops*, *Porthidium*, *Agkistrodon*, *Sistrurus*, and *Gloydius* are all viviparous (Malhotra et al. 2010). *Ovophis okinavensis* is thus a useful species from which to gain insights into the evolution of viviparity, or the possible reversal to oviparity (Lynch and Wagner 2010), among reptiles.

Our observations in the field and laboratory provide evidence of maternal attendance of neonates in an oviparous snake. Our laboratory experiment suggests that attendance of neonates may not be limited to immediately after hatching but may last until the first neonatal ecdysis, a typical phenomenon in pitvipers (Greene et al. 2002). Considering the incubation period and the fact that neonates and the mother re-aggregated after being moved, it is unlikely that the attendance of neonates in *O. okinavensis* simply reflects physiological stress of the mother immediately after oviposition or coincidental aggregation of adults and neonates. Instead, we suggest that the behavior represents active maternal care as also suggested by Fukada (1964) and Koba et al. (1970). The observed wariness of the females, which contrasts with the usual docile behavior of *O. okinavensis* (Takara 1962; Mori unpublished data), may suggest a guarding function of maternal attendance that increases survivorship of neonates. Ecological consequences of the short incubation period, calcium-poor eggshells, and maternal care in *O. okinavensis* deserve future investigation, which may enhance our understanding of the evolution of viviparity.

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Breeding Phenology of *Leiopelma pakeka*: a Threatened Frog Never Found Breeding in the Wild

The timing of breeding is a relevant aspect of a species' biology (Blaustein et al. 2001; Gibbs and Breisch 2001), and may be particularly important information for those involved with conservation (Hocking et al. 2008; Jakob et al. 2003; Paton and Crouch 2002). Yet in two threatened species of leiopelmatid frogs from New Zealand, *Leiopelma hamiltoni* and *L. pakeka*, breeding has never been recorded in the wild (Bell 1996, 2008; Germano and Bishop 2007). However, the timing of breeding can be inferred from other information, such as sexual behavior and appearance of progeny in the wild or breeding events in captive frogs. Here, information on the breeding phenology of the Maud Island Frog, *Leiopelma pakeka*, is discussed (Fig. 1). This frog is nocturnal, terrestrial, independent of open water, and occupies retreat sites by day under rocks, logs and vegetative cover where breeding is likely to occur (Bell 1985; Fig. 2). It ranks among the top 100 amphibians on the EDGE list, being both evolutionarily distinct and threatened (Hitchmough et al. 2007; IUCN 2010; Newman et al. 2010; Zoological Society of London 2010). *Leiopelma pakeka* was initially regarded as *L. hamiltoni*, but was then described as a cryptic phylogenetic species based on comparison of allozyme and morphometric data (Bell et al. 1998). Studies of captive frogs have revealed the mode and timing of reproduction, with oviposition occurring in the late austral spring or early summer (Bell 1985,

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Fig. 1. Adult *Leiopelma pakeka*, Maud Island. Photo by Andrew Digby.



Fig. 2. Habitat of *Leiopelma pakeka* on Maud Island. Photo by Ben Bell.

2010), however this may not represent the situation in the wild.

This study draws on information from captive breeding studies near Wellington, New Zealand, and from long-term demographic research on Maud Island (41.0167°S, 173.8833°E), central New Zealand (Bell et al. 2004; Bell and Pledger 2010; Newman 1990). First characterized by Stephenson (1961), *L. pakeka* survived only on Maud Island, probably because no invasive mammalian predators, such as rats or mice, have established there (Bell 1978). Demographic studies of *L. pakeka* on Maud Island over the past 35 years represent some of the longest population research on any wild anuran, revealing K-selected traits with some frogs living for up to 37+ years (Bell and Pledger 2010).

The only direct information on breeding in *L. pakeka* comes from captive frogs held in secure enclosures in mainland forest sites near Wellington in conditions resembling as closely as possible those in the wild (Bell 1978, 1985, 2008; Bell and Wassersug 2003; Lukis 2009). Here, *L. pakeka* (also *L. hamiltoni*) successfully bred in the austral spring/summer and individual females laid up to 19 eggs under rocks and logs in a terrestrial nest. Tadpoles are endotrophic (non-feeding) (Wells 2007) and exoviviparous, (following terminology of Altig and Johnston 1989), with the male undertaking care of the terrestrial eggs and hatchlings (Bell 1985, 2008; Bell and Wassersug 2003) (Fig. 3). Laying dates for captive *L. pakeka* were over October–December (Bell 1978, 1985). Eighty-seven *L. pakeka* progeny (from 19 broods) were reared to the end of metamorphosis, which occurred in late summer/fall (Figs. 4, 5). The mean ± SE snout–vent length (hereafter SVL) at the end of metamorphosis was 11.9 ± 0.1 mm (N = 87; range 10.0–13.2 mm).

After one year's growth in outdoor enclosures, the mean SVL ± SE of juvenile frogs was 18.1 ± 0.4 mm (N =16; range 15.5–20.2 mm). On average the SVL of captive juveniles increased from 11.9 to 18.1 mm in their first year. Assuming equivalent development, this information can be used to identify juvenile frogs of equivalent size in the wild on Maud Island. Over the period of long-term population study (1976–2010), 155 young frogs measuring 18 mm SVL or less were caught on the island, the smallest of them being 11.6 mm SVL (Table 1).

Most of the smallest frogs were found on Maud Island in the austral fall from March onwards, although a few small juveniles were caught as late as September (Table 1). The monthly mean SVL ± SE for the year commencing March shows a significant linear trend ($r^2 = 0.9517$, $p < 0.001$), indicating first emergence



FIG. 3. Captive adult male *Leiopelma pakeka* with hatchlings under log in outdoor enclosure. Photo by Ben Bell.

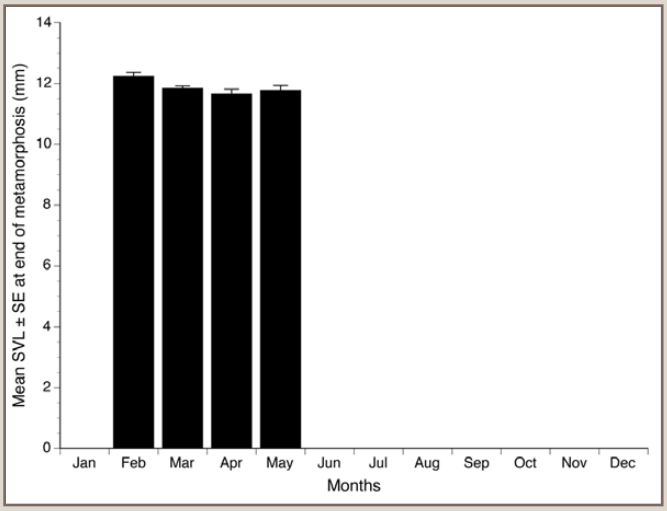


FIG. 4. The monthly distribution and mean SVL ± SE of 87 captive *Leiopelma pakeka,* at the end of metamorphosis. The frogs were bred and reared in outdoor enclosures sited under forest near Wellington. Sample sizes were February (N = 13), March (N = 49), April (N = 18) and May (N = 7).



FIG. 5. Captive-reared *Leiopelma pakeka* on 28 March 2008 at approximately 3.5 months of age, SVL 12.0–12.1. Metamorphosis is almost complete, with only small tail remnant present. Photo by Ben Bell.

TABLE 1. Monthly size distribution of 155 juvenile *Leiopelma pakeka* up to 18 mm SVL caught during a series of sampling sessions on Maud Island over the period 1976–2010.

SVL (mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
18	4	4							2		3	4	17
17	1										3	1	5
16	1							2	11		3	3	20
15						1		10	8		6	1	26
14				2	2	5		13	24		2		48
13			3	7	3	4		7	9				33
12			3	1					2				6
11													0
Total	6	4	6	10	5	10	0	32	56	0	17	9	155
Mean SVL ± SE (mm)	17.5 ± 0.3	17.8 ± 0.1	12.5 ± 0.2	13.3 ± 0.1	13.2 ± 0.3	13.6 ± 0.2		14.1 ± 0.1	14.4 ± 0.2		15.9 ± 0.3	16.9 ± 0.5	

of young juvenile frogs in the late summer or early fall (Table 1). The resulting regression (y = 0.483x + 11.780) over their first year predicts them growing to 17.6 mm by February. Percent seasonal mean SVL increases were: fall 10.9% (March–May); winter 6.6% (June–August); spring 12.5% (September–November); and summer 11.2% (December–February).

Direct evidence from captive breeding enclosures showed that *L. pakeka* breeds in the austral spring/summer (November–December), with offspring completing metamorphosis by late-summer or fall (February–May; Figs. 4, 5). The evidence from Maud Island presented here suggests little difference between the timing of breeding on the island and under the relatively natural regimes maintained for captive frogs (Bell 1978, 1985, 2008). The earliest reported juvenile *L. pakeka* on Maud Island was on 19 January 2010 (N. Mana, pers. comm.). Other terrestrial *Leiopelma* are also spring or summer breeders, captive *L. hamiltoni* breeding at about the same time as *L. pakeka* (Bell 1985), while Archey's Frog (*L. archeyi*) from warmer latitudes breeds a little earlier (October–November) both in the wild and in outdoor enclosures (Bell 1985; Thurley and Bell 1994). Terrestrial *Leiopelma* take at least 3.5 months to reach the end of metamorphosis (Bell 1978, 1985), so emergence of *L. pakeka* juveniles in the early fall (March–April) suggests breeding occurs there in late spring to early summer (November–December). They are K-selected species, like other terrestrial *Leiopelma*, with marked longevity, delayed maturity, small clutch size, and relatively infrequent breeding as compared to r-selected frogs (Bell et al. 2004; King et al. 2009). Breeding, growth and development depend on a range of abiotic and biotic factors, such as ambient temperature, phenotype, parental condition, and clutch size, so variation in their timing is to be expected, and this was the case (Fig. 4, Table 1). Despite the frogs being active throughout the year on Maud Island (pers. obs.), the juvenile growth rate was less (6.6%) in the cooler winter months (June–August) compared with other seasons (10.9–12.5%).

Germano and Bishop (2007) reported amplectic behavior in *L. pakeka* on Maud Island in December and January, while Lukis (2009) also reports summer amplexus of *L. pakeka* in captive enclosures in Zealandia (Karori sanctuary, Wellington) at about the time they bred there. These observations of amplexus suggest enhanced summer sexual activity in wild and captive populations, and lend support to summer breeding on Maud Island. In contrast, Germano et al. (2010) and Germano (2010) report that testosterone metabolites in male *L. pakeka* and estrone and progesterone metabolites in females were at their peak during winter for both wild and captive frogs, while the greatest proportion of females with large ovarian follicles also occurred in the winter. The reason for urinary hormonal levels in the population peaking well before likely summer breeding remains unclear, and is an unexpected but interesting issue that needs resolution. While much has been learned about the breeding biology of these threatened and evolutionarily distinct frogs, there is still more to discover, including unraveling this apparent paradox.

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Taxonomic Implications of Color Pattern and Meristic Variation in *Aspidoscelis burti burti*, a Mexican Whiptail Lizard

The gonochoristic whiptail lizard *Aspidoscelis burti burti* is restricted to the vicinity of Guaymas on the coast of Sonora, México (Duellman and Zweifel 1962), near the southern limits of the Sonoran Desert (Brown and Wright 1994:70, map). Color-pattern characters, the diagnostic basis for taxonomic recognition of this form, were summarized by Duellman and Zweifel (1962:174) as follows: "Typically a five- or six-lined lizard with relatively indistinct spotting developing in the dark fields only of largest individuals." This brief description of the only member of the *A. sexlineata* species group in the Guaymas vicinity, coupled with Duellman and Zweifel's (1962:175) opinions on the significance of color pattern variation in four individuals of *Aspidoscelis* from the Sierra Tetalejo about 48 km south of Hermosillo, Sonora, and one from about 8.0 km north of Hermosillo, have constituted the only documentation for decisions on the taxonomic status of the *A. burti* complex in Sonora and the United States for nearly half a century. Specifically, we refer to treatment of *Cnemidophorus burti* Taylor ("1936" [1938]), maximum SVL about 98 mm, and *C. sackii stictogrammus* Burger (1950), maximum SVL about 130 mm, as the subspecies *A. b. burti* and *A. b. stictogramma* (Duellman and Zweifel 1962; Reeder et al. 2002; Wright 1993, 1994). This taxonomic arrangement has persisted though Duellman and Zweifel (1962:176) in reference to the aforementioned specimens also stated "Although we are calling these intermediate lizards intergrades, it is probable that they represent a population of sufficient constancy to deserve taxonomic recognition." Herein, we provide analyses and expanded descriptions of color pattern variation in what is presently known as *A. b. burti* (Tables 1–2) and *A. b. stictogramma*, complemented with meristic comparisons (Table 3). We also discuss the implications of these findings, supplemented with reassessment of variation in specimens treated as intergrades by Duellman and Zweifel (1962) and those misidentified by Good and Wright (1984), on the taxonomy of the *A. burti* complex in Sonora and the United States.

In addition to specimens in the University of Arkansas Department of Zoology (UADZ) collection maintained by JMW, we used online and curator-assisted searches of museum databases with large holdings of whiptail lizards from Sonora and Arizona to secure loans of specimens relevant to an ongoing assessment of the taxonomic relationships of the *Aspidoscelis burti–stictogramma–costata* complex. For this study, we selected a total of 156 specimens from seven institutions (Appendix I), including taxa and putative intergrades in the *A. burti* complex (sensu Duellman and Zweifel 1962).

Meristic characters analyzed (terminology after Burt 1931; Smith 1946; Walker 1981a,b; Table 1) included counts of (1) granules (= scales) at midbody from the right outer row of ventral scales over the body to the left outer row of ventral scales (GAB), (2) dorsal granules longitudinally from the occipital scales to the first row of caudals (OR), (3) granules between the

Table 1. Color pattern characters related to body size (SVL in mm) and sex in samples of *Aspidoscelis burti* collected from Sonora, México, in 1964 (UCM 27051–73, N = 23) and 1967 (UCM 35401–22, N = 22). Data are N (Range), mean ± SE.

Year / Sex	5 Stripes	6 Stripes	No Spots	Spots Present
1964 / female	4 (65–71) 68.0 ± 1.5	3 (57–72) 63.0 ± 4.6	4 (57–72) 65.0 ± 3.8	3 (65–70) 67.0 ± 1.5
1964 / male	7 (64–84) 77.2 ± 2.5	9 (68–89) 76.6 ± 2.5	13 (64–89) 76.7 ± 2.1	3 (73–81) 77.6 ± 4.8
1967 / female	4 (67–83) 76.5 ± 3.4	3 (70–71) 70.3 ± 0.3	3 (70–83) 77.0 ± 3.8	4 (67–78) 71.5 ± 2.3
1967 / male	6 (73–90) 84.6 ± 2.6	9 (69–92) 81.7 ± 2.5	4 (69–86) 81.5 ± 4.2	11 (73–92) 83.4 ± 2.1

Table 2. Four combinations of color-pattern characters related to body size (SVL in mm) and sex represented in the Sonora sample of *Aspidoscelis burti* (UCM 27051–73, 35401–22, N = 45). Data are N (Range), mean ± SE.

A. burti	5 Striped with Spots	5 Striped no Spots	6 Striped with Spots	6 Striped no Spots
♀	5 (65–78) 69.2 ± 2.4	3 (71–83) 77.3 ± 3.5	2 (70–71) 70.5 ± 0.5	4 (57–72) 64.8 ± 3.7
♂	8 (73–90) 81.9 ± 2.4	5 (64–86) 78.8 ± 3.9	6 (75–93) 82.7 ± 3.1	12 (68–89) 77.4 ± 2.3

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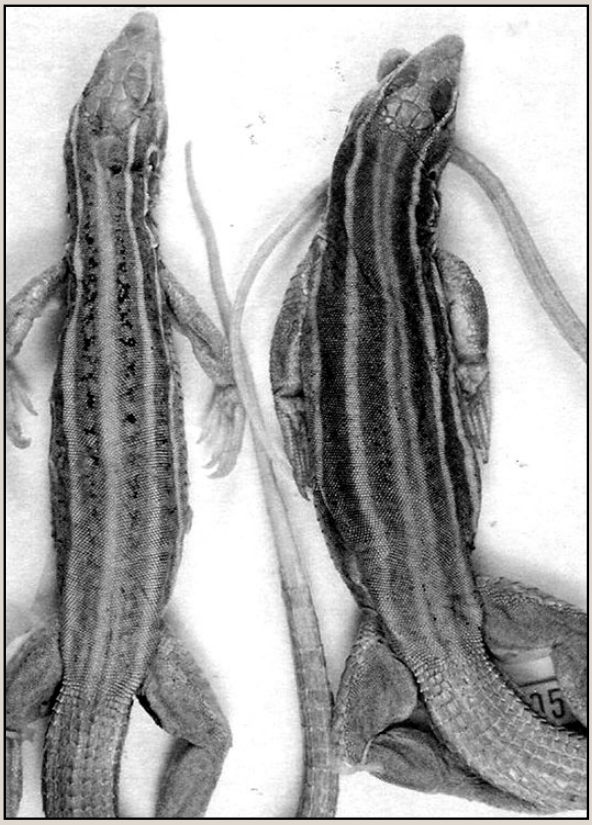


FIG. 1. Mature adult dorsal patterns in spotted five- and unspotted six-striped males of *Aspidoscelis burti* from 1.6 km W San Carlos Bay, Guaymas, Sonora, México (L: UADZ 453, 89 mm SVL; R: UCM 27055, 87 mm).

paravertebral stripes at midbody (PV; only possible for lizards with six stripes at midbody), (4) percent of granules around midbody between paravertebral stripes (PV/GAB × 100; only possible for lizards with six stripes at midbody), and (5) femoral pores (FP, summed from both sides). Scutellation characters qualitatively referenced included (1) anterior extent of the circumorbital scale series between the supraocular and median head scales, (2) size of the postantebrachial scales on the posterior part of each lower arm, and (3) size of the mesoptychial scales bordering the edge of the gular fold. Each specimen of the *Aspidoscelis burti* complex was sexed (via inspection of femoral pores, cloacal region, and/or internal organs), and its snout–vent length (SVL) measured to the nearest mm.

We used JMP v. 8 (SAS Institute, Cary, NC) to generate a mean ± 1 SE for each univariate meristic character, SVL for each sex, and population sample (Tables 1–3). For overall models that were statistically significant, we used Tukey-Kramer post-hoc comparisons to determine which means differed from the others. This procedure preserves alpha in statistical comparisons of multiple means (Sokal and Rohlf 1981).

Based on the smallest specimens examined (e.g., CAS-SU 16609 ♀, 53 mm SVL; UCM 27059 ♀, 57 mm SVL), we infer that juveniles of *Aspidoscelis b. burti* have a black to black–brown dorsal background color (paler near the ventral scales) that is divided into fields by either five or six light-colored longitudinal stripes. All specimens from CAS (N = 10), UADZ (N = 3), and UCM (N = 45) have pairs of white, cream, or buff-colored lateral stripes (one on each side from below the eye to the hind limb) and dorsolateral stripes (one on each side from above the eye to the base of the tail). A lizard becomes six-striped only when deposition of dark background color longitudinally separates a pale-tan middorsal band into two narrowly spaced paravertebral stripes from the parietal scales to the base of the tail. The five-striped pattern obtains when the paravertebral separation process does not occur; it is not a result of fusion of pre-existing stripes as stated by Duellman and Zweifel (1962:174). We recorded dorsal patterns in *A. b. burti* as six-striped (1) if the paravertebrals were visibly separated, even if by only one or two dark-colored scales (e.g., UCM 35410 ♂, 90 mm SVL), and (2) if the paravertebrals were only intermittently separated (e.g., Brown and Wright 1994: plate X–A; UCM 27072 ♀, 60 mm SVL). A hint of six incipient stripes was detected within a 2–5-mm area near the base of the tail in some five-striped *A. b. burti* (e.g., Fig. 1).

Whether five- and six-striped dorsal patterns in *Aspidoscelis b. burti* are examples of sexual, ontogenetic, or individual variation has not been assessed. The UCM sample of 45 specimens (14 female, 31 male) of this form from near Guaymas comprises these relative numbers of five- and six-striped phenotypes: 8:6 for females, 13:18 for males, or 21:24 for both sexes. None of these combinations deviates significantly from a 1:1 ratio, indicating that stripe number in *A. b. burti* is not sexually dimorphic. Moreover, stripe number is not an example of age/body-size dependent variation in *A. b. burti* (Tables 1–2). Sexual dimorphism in SVL is apparent for both five- and six-striped specimens in the 1964 and 1967 UCM samples of *A. b. burti* (N = 23 and 22, respectively; the latter with significantly larger SVL); however, the ratios of stripe numbers do not differ significantly (Table 2). Although stripe number in *A. b. burti* does not change ontogenetically, stripe appearance can change. A "faded" dorsal pattern is observed in large/old adults as increasing paleness of the lateral and dorsolateral fields, loss of contrast between stripes and fields, progressive loss of definition of spots (if present) in the dark fields, and blending of the background color of the hind limbs and tail to uniform gray–tan (Fig. 1). Unbroken stripes persist even in the largest adults of both sexes of *A. b. burti* (e.g., CAS 53425 ♂, 98 mm SVL; CAS-SU 15498 ♀, 86 mm SVL); however, stripe replacement by fragmentation/spot formation occurs during ontogeny in *A. b. stictogramma* in Sonora, México, and Arizona and New Mexico, USA (e.g., Brown and Wright 1994; color plate X–B; Zweifel 1959; plate 46–3; Fig. 2).

We sought to determine the extent to which spotted and unspotted dorsal patterns in *Aspidoscelis b. burti* vary sexually, ontogenetically, and individually. The 1964 UCM sample (N = 23) comprises seven gravid females (57–72 mm SVL) and 16 adult males (64–89 mm). Three of four of the five-striped females (65–70 mm) have distinct spots in the upper lateral and dorsolateral fields (= the fields) and one (71 mm) is unspotted; the three six-striped females (57–72 mm) are unspotted. Among the seven five-striped males (64–84 mm) from 1964, only three (73–81

mm SVL) have spots (all indistinct) in the fields; all nine six-striped males (68–89 mm) are unspotted. The 1967 UCM sample (N = 22) of *A. b. burti* comprises seven gravid females (67–83 mm) and 15 adult males (69–92 mm). Two of four of the five-striped females (67–78 mm) have distinct spots in the fields and two (78–83 mm) are unspotted. Two of three of the six-striped females (70–71 mm) in the sample have spots and one (70 mm) does not. Three of six of the five-striped males (73–90 mm) from 1967 have indistinct spots in the fields and two (84–90 mm SVL) have distinct spots. Four of nine of the six-striped males (75–83 mm) have distinct spots in the fields (e.g., Duellman and Zweifel 1962; plate 29 [1]; Fig. 1, this study), two (90–92 mm SVL) have indistinct spots, and three (69–86 mm) are unspotted (e.g., see Wright 1993:41; *A. b. burti* Fig. 7F). Although the mean SVL of 15 males (82.9 ± 1.8, 69–92 mm) from the 1967 UCM sample of *A. b. burti* is significantly larger ($P = 0.05$) than that of 16 males (76.9 ± 1.7, 64–89 mm) from the 1964 sample, development and definition of spots are not unambiguously age/size dependent (Table 1). Among eight of the 1964 males (79–89 mm), only two (25.0%) have spots, whereas among 11 of the 1967 males (80–92 mm), eight (72.7%) have spots. Our data support the following assertion by Duellman and Zweifel (1962:174) "…relatively indistinct spotting developing in the dark fields only of largest individuals" for *A. b. burti* (Table 1). However, the occurrence of similarly sized large lizards with and without spots indicates that spot development is not entirely deterministic. The small number of females available for study prevented us from testing whether the occurrence of spots was a form of sexual dimorphism in *A. b. burti*.

To identify diagnostic characters for *Aspidoscelis b. stictogramma*, we analyzed color pattern, meristic characters, and scutellation in 16 females (SVL = 88.9 ± 4.0, 66–115 mm) and 17 males (SVL = 107.1 ± 5.1, 62–130 mm) from the Santa Catalina Mountains, Pinal County, Arizona, from OMNH (Appendix 1). We selected specimens from this population because it is well removed from other closely related congeners: at least 150 km east of *A. xanthanotha* in the Ajo Mountains, Organ Pipe Cactus National Monument, Pima County, Arizona, and 400 km north of *A. b. burti* and *A. costata griseocephala* in Sonora. We also examined 32 specimens of *A. b. stictogramma* from Cochise Stronghold Campground, Coronado National Forest, Cochise County, Arizona, from UADZ (Appendix 1). Variation in UADZ sample was similar to that observed in the OMNH Pinal County sample. The largest males and females of *A. b. stictogramma* among the 33 OMNH specimens from Arizona and the 14 UCM specimens from central Sonora are more than twice the body size of those of *A. b. burti* from southern Sonora (Fig. 2). Each of the OMNH specimens has either six primary stripes (= pairs of laterals, dorsolaterals, and paravertebrals) or the ontogenetically derived remnants thereof; most of these specimens also have a very faint vertebral stripe. Among the 16 females, four have no vertebral stripe (66–105 mm SVL), three have an incomplete faint vertebral stripe (68–75 mm), and nine have a complete indistinct vertebral stripe (75–115 mm). All of the 17 males (62–130 mm) in the OMNH sample either have an indistinct vertebral stripe or its ontogenetic remnants. Among the females of *A. b. stictogramma*, five have stripes and developing spots in the fields (66–87 mm), five have stripes with distinct spots (73–95 mm), and six have partially fragmented stripes along with extensive spotting middorsally and vertical bars laterally (100–115 mm). Among the males of *A. b. stictogramma*, three have stripes with developing spots in the fields (62–68 mm), three have stripes and distinct spots (105–116 mm), and 11 (105–130 mm) have either partially (N = 4) or completely (N = 7) fragmented stripes, extensive spots middorsally and laterally, and bars laterally. Male-biased sexual dimorphism in SVL and in ontogeny of color pattern (males have complete replacement of stripes by spots and bars) is evident in the OMNH and UADZ samples of *A. b. stictogramma*, as is individual variation in color pattern in specimens of similar size in both sexes. Large adults of *A. b. stictogramma* in the UCM sample from central Sonora also have dorsal patterns of spots and stripe fragments (Fig. 2A and B).

Aside from the distinctive color patterns described (as well as significant differences in PV and PV/GAB; Table 3), there are no meristic or scutellation characters that distinguish *Aspidoscelis b. burti* and *A. b. stictogramma* in the context of variation in their clade within the *A. sexlineata* species group (Reeder et al. 2002). We detected a significant difference between these forms in the GAB; however, broadly overlapping ranges render assignment of a given specimen to one of the two subspecies on this basis unreliable. Similarly, only characters of color pattern separate all populations of *A. costata* and *A. gularis* (including *A. septemvittata*) from these taxa. Furthermore, Dessauer and Cole (1989) showed strong similarities in allozymes of *A. b. stictogramma* and *A. costata griseocephala* (i.e., genetic distance; 0.133 [Rogers 1972] and 0.110 [Nei 1972]).

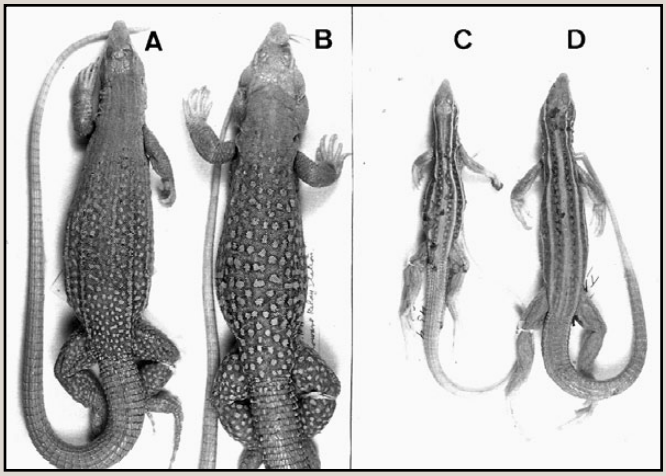


Fig. 2. Comparisons (photographed at same settings) of size and adult dorsal color pattern in specimens of *Aspidoscelis stictogramma* from 80 km N of Hermosillo on México Hwy 15, Sonora, México (A: UCM 35428 ♀, 118 mm SVL; B: UCM 35424 ♂, 124 mm) and *A. burti* from 1.6 km W San Carlos Bay, Guaymas, Sonora, México (C: UADZ 454 ♀, 84 mm; D: UADZ 453 ♂, 89 mm).

TABLE 3. Data for meristic characters (see text for definitions of abbreviations) for *Aspidoscelis burti* from Sonora, México (data except for OR are from Duellman and Zweifel 1962), *A. stictogramma* from Arizona, USA, and Sonora, and *A. stictogramma* ssp. from Sonora. Data are mean ± SE (first row) and N and (range) (second row); means for a character with one or more superscript letters in common are not significantly different.

Character	GAB	OR	PV	PV/GAB	FP
A. burti					
Guaymas Vicinity	93.3 ± 1.4[b]	198.3 ± 3.7[b]	1.5 ± 0.4[b]	1.6 ± 0.06	34.0 ± 0.7[b]
AMNH, SNHM, UADZ, UCM	15 (85–101)	4 (190–207)	15 (0–7)	15 (0–8.0)	15 (30–38)
A. stictogramma					
Pinal County, AZ	105.9 ± 1.0[a]	212.3 ± 1.7[ab]	7.5 ± 0.3[a]	6.9 ± 0.3[a]	38.3 ± 0.4[a]
OMNH	33 (92–117)	33 (189–238)	26 (5–10)	26 (4.8–9.8)	33 (34–42)
Central Sonora	100.0 ± 2.7[ab]	219.2 ± 6.7[a]	6.0 ± 1.0[a]	6.1 ± 0.9[a]	34.8 ± 0.2[b]
UCM	5 (91–108)	5 (207–237)	4 (5–9)	4 (5.0–8.8)	5 (32–39)
A. stictogramma ssp.					
N Hermosillo, Sonora	100.8 ± 2.0[ab]	210.2 ± 5.3[ab]	6.2 ± 1.0[a]	6.0 ± 0.9[a]	35.7 ± 0.2[b]
UAZ	6 (94–106)	6 (194–233)	5 (4–9)	5 (4.0–8.7)	6 (35–36)
Cerro de la Agualurca, Sonora	96.5 ± 1.7[b]	200.5 ± 2.5[ab]	5.5 ± 0.5[ab]	5.7 ± 0.4[ab]	34.3 ± 0.4[b]
LACM	6 (91–102)	6 (191–208)	2 (5–6)	2 (5.3–6.0)	6 (33–36)
Sierra Tetalejo 1, Sonora	95.3 ± 3.2[b]	197.3 ± 3.4[b]	1.5 ± 0.9[b]	1.6 ± 0.9[b]	34.0 ± 1.4[b]
AMNH	4 (90–103)	4 (192–206)	4 (0–3)	4 (0–3.3)	4 (32–38)
Sierra Tetalejo 2, Sonora	93.7 ± 2.7[b]	200.3 ± 8.1[ab]	4.0 ± 0.0[ab]	4.3 ± 0.0[ab]	34.0 ± 1.0[b]
UAZ	3 (90–99)	3 (187–215)	1 (4)	1 (4.3)	3 (32–35)

We provide the first reassessment of color-pattern variation and its significance in the four AMNH specimens discussed by Duellman and Zweifel (1962) bearing on the taxonomic status of *Aspidoscelis b. burti*. Included are two lizards that either have six stripes (AMNH 80599 ♀, 78 mm SVL) and spot/fragment remnants thereof (AMNH 80601 ♂, 104 mm) or five stripes (AMNH 80602 ♂, 101 mm) and spot/fragment remnants thereof (AMNH 80600 ♂, 82 mm SVL). Duellman and Zweifel (1962) regarded the five-striped condition in AMNH 80600 and 80602 to be indicative of intergradation between *A. b. burti* and *A. b. stictogramma*, notwithstanding the fact that the specimens are very similar to *A. b. stictogramma* in all other aspects, including ontogenesis of dorsal color pattern from stripe dominated to total disruption of stripes. The intergradation hypothesis is problematic for these specimens because no population of the "nominal form" has been discovered within the nearly 50-km hiatus between the vicinity of Guaymas and the source population of the specimens, despite repeated efforts to identify one by T. P. Maslin (UCM), C. H. Lowe (UAZ), and J. W. Wright (UAZ, LACM). Thus, determination of past secondary intergradation between these forms must await formal tests using molecular techniques on samples from the relevant areas of Sonora.

We provide a description and discussion of six lizards (LACM 121421–26) with distinctive color patterns from 8.0 km south of Hermosillo, an intermediate area between the localities for the AMNH and UCM specimens, which were designated as possible intergrades between *A. b. burti* and *A. b. stictogramma* by Duellman and Zweifel (1962). If these specimens were in fact intergrades, the LACM specimens would be expected to have the unusual pattern variability seen among hybrids (e.g., Dessauer et al. 2000 [*Aspidoscelis tigris* complex]; Walker 1981a,b [*A. gularis* complex]), based on their provenance (Duellman and Zweifel 1962). However, they exhibit the uniformity typical of a single taxon, which they may well represent. Four of these lizards (LACM 121421–23, 121426) were misidentified as *A. b. burti* and used in allozyme analyses to identify the gonochoristic species involved in the hybrid origin of triploid parthenogenetic *A. exsanguis* (Good and Wright 1984). In fact, the LACM sample is at the opposite end of the spectrum from *A. b. burti* in color-pattern variation in the context of variation within the *A. burti* complex (compare Figs. 1 and 2 with 3). One lizard (Fig. 3A, LACM 121421 ♀, 74 mm SVL) has six stripes running most of the length of the body; however, the paravertebral stripes are in contact on the neck and indistinct spots are present in the dark fields. Another specimen (Fig. 3B, LACM 121423 ♂, 78 mm) has six completely separated stripes and a profusion of sharply defined spots/bars, some of which contact the stripes. In the other four male LACM specimens, the stripes have been replaced by distinct gray–white spots middorsally and spots and bars laterally. Among these, the positions of spots/fragments in the former positions of the paravertebral stripes indicate that the stripes were completely separated (i.e., six striped) as juveniles in two specimens (Fig. 3D and F, LACM 121425, 102 mm and LACM 121422, 102 mm, respectively), whereas two had incompletely separated paravertebral stripes on the neck as juveniles (Fig. 3C and E, LACM 121426, 82 mm and LACM 121424, 100 mm, respectively). We did not find evidence of intergradation in color pattern between specimens of *A. b. burti* and *A. b. stictogramma* from Sonora, as had been asserted without supporting data by Wright (1994:260).

Treatment of *Aspidoscelis b. burti* and *A. b. stictogramma* as subspecies for the past 47 years was based on fragmentary data and the tentative identification of five specimens from north (UCM 8605) and south (AMNH 80599–602) of Hermosillo

TABLE 4. Comparison of taxonomic arrangements of the *Aspidoscelis burti* (formerly *Cnemidophorus burti*) complex.

Author(s) Taxa Recognized	Based on Original Data
Duellman and Zweifel (1962); Reeder et al. (2002)	Yes
Aspidoscelis burti burti	
Aspidoscelis burti stictogramma	
Aspidoscelis burti xanthanota	
Wright (1993, 1994)	No
Aspidoscelis burti burti	
Aspidoscelis burti griseocephala	
Aspidoscelis burti stictogramma	
Aspidoscelis burti xanthanota	
Collins and Taggart (2009); Crother (2008)	No
Aspidoscelis burti burti	
Aspidoscelis burti stictogramma	
Aspidoscelis xanthanota	
This Study	Yes
Aspidoscelis burti	
Aspidoscelis stictogramma	
Aspidoscelis xanthanota	

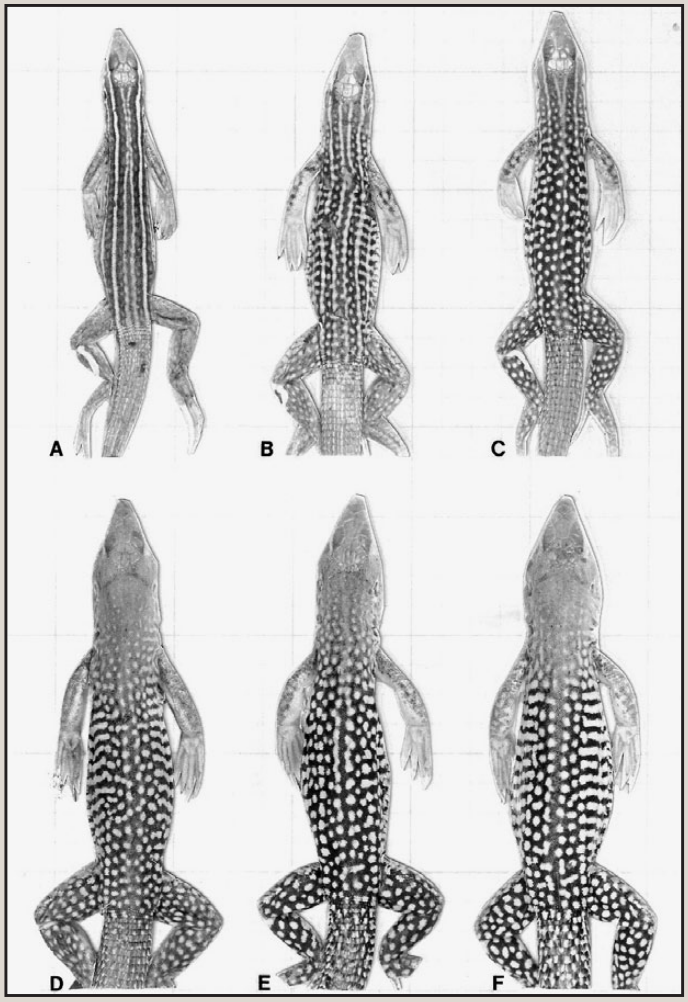


FIG. 3. Variation in dorsal color pattern of a sample (all males except LACM 121421) provisionally allocated to *Aspidoscelis stictogramma* from Cerro de la Agualurca, 8.0 km S of Hermosillo, Sonora, México (A: LACM 121421, 74 mm SVL; B: LACM 121423, 78 mm; C: LACM 121426, 82 mm; D: LACM 121425, 102 mm; E: LACM 121424, 100 mm; F: LACM 121422, 102 mm).

as intergrades (Duellman and Zweifel 1962). The assertions of Wright (1993, 1994), who supported recognition of these forms as subspecies reportedly based on new information on intergradation, were not documented by localities, voucher specimens, or data on variation. We requested this information and offered this manuscript to Wright, but received no response to our queries. Consequently, we are compelled to dismiss his statements concerning the taxonomic status of these subspecies given the absence of supporting data.

We regard *Aspidoscelis burti*, *A. stictogramma*, and *A. xanthanota* as the northwestern-most cluster (see Moritz et al. 1989; Fig. 1) of derivatives from a prototype from which some southern Sonoran populations acquired the potential for development of five-striped dorsal patterns. Of these, *A. burti* (restricted to a small area of coastal Sonora) and *A. xanthanota* (sensu Collins 1991; see Wright 1994; color plate X–C) (restricted to a small area in Arizona and possibly adjacent Sonora) represent peripheral isolates. A reviewer of this report opined that *A. burti* and *A. xanthanota* could be smaller-bodied populations derived from *A. stictogramma* as an alternative hypothesis for their origins. *Aspidoscelis burti* is an unusual member of the complex in having four identifiable variants: five stripes with and without spots and six stripes with and without spots. Nevertheless, *A. b. stictogramma* is at once the most divergent and widely distributed member of the complex, based on the combination of giant size (maximum SVL ca. 130 mm) and complete ontogenetic loss of stripes in males.

The search for an appropriate taxonomic treatment of the *Aspidoscelis burti* complex has resulted in several sets of answers (Table 4). Wright (1994) mentioned that extensive intergradation between *A. b. stictogramma* and *A. costata griseocephala* (sensu Zweifel 1959) occurs in southern Sonora; however, he did not present precise localities, specimens examined, and/or morphological data in support of his use of the name *A. burti griseocephala*. Pending publication of such information, there is no basis for altering the name combination *A. costata griseocephala* (see Reeder et al. 2002). The first departure from Duellman and Zweifel's (1962) taxonomic arrangement for the *A. burti* complex was proposed by Collins (1991), who justified his nomenclatural changes primarily on philosophical grounds. He invoked the evolutionary species concept, emphasizing apparent allopatry from other members of the complex and presumed diagnosability, to elevate *A. b. xanthanota* Duellman and Lowe (1953), as well as numerous other subspecies of amphibians and reptiles, to species rank. Many of Collins's (1991) recommendations have been adopted in checklists of North American amphibians and reptiles by Collins and Taggart (2009) and Crother (2008). By listing the combination *A. b. stictogramma*, these authors tacitly accept

Duellman and Zweifel's (1962) recommendations on the status of *A. b. burti* in Sonora. If zones of secondary intergradation (or hybridization) do exist between members of the *A. burti* complex, as reported for *A. tigris aethiops* and *A. tigris punctilinealis* (= *Cnemidophorus tigris gracilis*) in north–central Sonora by Taylor and Walker (1991), they have yet to be located/reported. At present, those applying either the biological or evolutionary species concept would be justified in recognizing three species: *A. burti* (monotypic), *A. stictogramma* (potentially polytypic), and *A. xanthanota* (monotypic) based on the data presented herein.

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Appendix 1

Specimens examined for Tables 1–3 and text descriptions (N = 156)

Aspidoscelis burti (N = 58). MEXICO. Sonora: CAS-SU 15496–98: S slope of Cerro Bocochibampo, N side of Bahia Bocochibampo; CAS-SU CAS-SU 16606–09: E shore of Bahia San Pedro; CAS 53425: San Pedro Bay; CAS 104814: San Carlos Bay; UADZ 453–54, 458: 1.6 km W of San Carlos Bay, Guaymas; UCM 27051–73, 35401–22, CAS 100224: La Posa, San Carlos Bay, 16 km NW of Guaymas.

Aspidoscelis stictogramma (N = 79). ARIZONA. Cochise County: UADZ 7212, 7264, 7268, 7271, 7300–04, 7874–78, 7996–006, 8083–84, 8143–44, 8453–54, 8511: Cochise Stronghold Campground, Coronado National Forest. Pinal County: OMNH 38806–38: Bonita Wash, Windmill Camp, bajada of Santa Catalina Mountains (32º 33.68' N, 110º 40.453' W, 1333 m). MEXICO. Sonora: UCM 35423–33: 80 km N of Hermosillo on México Hwy 15; UCM 42047–49: 45 km W of Santa Ana.

Aspidoscelis stictogramma subsp. (N = 19; includes AMNH and UCM specimens identified as *A. burti burti* x *A. burti stictogramma* by Duellman and Zweifel 1962; LACM specimens identified as *A. b. burti* by

Good and Wright [1984], and newly reported UAZ specimens). MEXICO. Sonora: AMNH 80599–602: 8.0 km SE of La Pintada about 48 km S of Hermosillo; UAZ 6657–58: Sierra Tetalejo (ca. 8.0 km S of La Pintada); LACM 121421–26: Cerro de la Agualurca, 8.0 km S of Hermosillo; UCM 8605: 8.0 km N of Hermosillo; UAZ 6681–82: Tetavejo (archeological cave site); UAZ 6684, 6686, 6688: 22.1 km S of El Oasis (49.6 km N of Hermosillo); UAZ 6687: 49.9 km N of Hermosillo.

APPENDIX 2
Distinguishing characters of *Aspidoscelis burti* prepared from UCM 27051–73, 35401–22 (N = 45)

Black to black–brown dorsal ground color, five (N = 8 ♀ and 13 ♂, 46.6%) or six (N = 6 ♀ and 18 ♂, 53.3%) pale colored dorsal stripes, spots present (N = 7 ♀ and 14 ♂ , 46.6%) or absent (N = 7 ♀ and 17 ♂, 53.3%) in the upper lateral and dorsolateral fields, stripes persistent throughout life (N = 45, 100%), contrast between fields, stripes, and spots (if present) diminishing with age to produce a faded appearance, venter without a dark suffusion, circumorbital scale series ending posterior to frontal scale, enlarged postantebrachial scales, enlarged mesoptychial scales, 93.3 ± 1.4 granules around midbody, 198.3 ± 3.7 granules from occiput to first row of caudals, 1.5 ± 0.4, granules between the paravertebral stripes at midbody, 34.0 ± 0.7 femoral pores (summed), and 98 mm maximum SVL in males.

APPENDIX 3
Distinguishing characters of *Aspidoscelis stictogramma stictogramma* prepared from OMNH 38806–38 (N = 33)

Black to brown dorsal ground color, six (9.0%) or 7 (91.0%, including an indistinct partial or complete vertebral) stripes, spots developing on stripes and in intervening dark fields early in life, females infrequently develop a dorsal pattern of stripe fragments and spots, males frequently develop a dorsal pattern of stripe-fragments, spots, and lateral bars, venter without a dark suffusion, 105.9 ± 1.0 granules around midbody, 212.3 ± 1.7 granules from occiput to first row of caudals, 7.5 ± 0.3 granules between the paravertebral stripes at midbody, 38.3 ± 0.4 femoral pores (summed), and 130 mm maximum SVL in males.

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Microhabitat Use and Choice of Refuge in *Sceloporus magister*

Individual lizards often occupy multiple microhabitats during the course of a day, and thecurrent microhabitat may affect decisions regarding refuge selection (e.g., Cooper 1998; Cooper and Wilson 2007). The montane phrynosomatid lizards *Sceloporus virgatus* and *S. jarrovii* occupy rocks, ground, logs, and trees (Smith 1996) and vary aspects of their escape behavior and refuge selection among these microhabitats (Cooper and Wilson 2007). Here, I report variation in occupation of microhabitats and the effect of types of microhabitats on selection of refuges in a population of the Desert Spiny Lizard, *S. magister*.

Methods.—The abundance and ease of observation of *S. magister* in Rillito River Park in Tucson, Arizona provided an opportunity to make preliminary observations on substrates where they occur, microhabitats used as destinations or refuges after escape, and the effect of tree diameter on escape behavior by lizards perched low on trees. All observations were conducted on warm (30–36°C), sunny days in early June of 2009. Because lizards off paths in Rillito River Park are frequently exposed to people walking, running and bicycling on the paths, they often do not flee when people pass. However, they flee if approached directly. After sighting an adult lizard, I recorded its initial substrate and approached it directly at approximately 1 m/s until it fled. Sex was not ascertained. When lizards were on rocks or ground, I continued to approach until a lizard entered a refuge. For lizards initially on trees, I approached until the lizard climbed out of reach or moved off the tree onto ground. I also recorded the perch height and diameter of the tree at its ground level. Finally, I recorded the type of refuge used.

I used a chi-square test to examine differences in frequencies of occupation among the microhabitat types. For lizards initially on trees, I statistically examined relationships among perch height, tree diameter, and escape by climbing versus descending to ground. I conducted a regression of perch height on tree diameter, an analysis of variance of perch heights in lizards that fled up the tree or fled down and onto the ground, and an analysis of variance to assess the effect of tree diameter on climbing upward versus fleeing to the ground. Statistical tests were two-tailed with $\alpha = 0.05$. Effect sizes are given as n^2 for analysis of variance (Cohen 1992) and Cramer's V for chi-square (Gliner et al. 2002).

Results.—When initially sighted, 53 individuals were on the ground, 13 were on rocks, and 17 were on trees. Frequency of use varied significantly among these microhabitats ($\chi^2_2 = 35.77$, $P < 0.001$; $V = 0.46$). Lizards occupied ground significantly more frequently than rocks ($\chi^2_1 = 24.24$, $P < 0.001$; $V = 0.61$) or trees ($\chi^2_1 = 18.52$, $P < 0.001$; $V = 0.52$), but frequency did not differ significantly between rocks and trees ($\chi^2_2 = 0.54$, $P > 0.10$).

Refuges used by the lizards differed among initial microhabitats (Table 1). The proportions of the refuge types used for all lizards initially on ground or rocks pooled were 0.15 for trees, 0.27 for ground squirrel burrows, 0.55 for yucca, *Opuntia*, and bushes, and 0.03 for others. Among lizards not initially on trees, only 0.15 fled to trees, a much smaller proportion than remained on trees (Table 1). Lizards initially on trees were significantly more likely to flee up and around trees than were lizards initially in other microhabitats (pooled; $\chi^2_1 = 8.10$, $P = 0.0044$; $V = 0.31$).

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TABLE 1. Types of refuges used by *Sceloporus magister* differed among initial microhabitats.

Initial substrate	Refuge	Proportion (N)
Ground		
	Tree	0.19 (10)
	Burrow	0.30 (16)
	Bush, Yucca, or *Opuntia*	0.49 (26)
	Rock (far side)	0.02 (1)
Rock		
	Bush, Yucca, or *Opuntia*	0.77 (10)
	Burrow	0.15 (2)
	Log	0.08 (1)
Tree		
	Ground	0.53 (9)
	Tree	0.47 (8)

For lizards on trees, the decision to escape by climbing upward versus fleeing to the ground was strongly affected by the diameter of the tree at its base ($F_{1,15}$ = 14.63, P < 0.0017; effect size: n^2 = 0.49). Variances of tree diameter did not differ significantly between refuge types (Levene's $F_{1,15}$ = 4.39, P > 0.05). The diameters of trees occupied by lizards that fled up and around trees were larger (0.30 ± 0.05 m, N = 9) than those of trees occupied by lizards that fled to the ground (0.11 ± 0.02 m, N = 8). Decisions by lizards on trees to flee to ground or climb higher were unaffected by initial perch height on the tree ($F_{1,15}$ = 0.22, P > 0.10), presumably because all lizards were initially low on trees (0–1.4 m). Variances were homogeneous (Levene's $F_{1,15}$ = 0.45, P > 0.10). Initial perch height and tree diameter were not significantly correlated ($F_{1,15}$ = 0.39, P > 0.10).

Discussion.—The more frequent occupation of ground than the other microhabitats by *S. magister* is likely a consequence of several factors., including the fact that that lizards engage in social activity and forage there, the lesser availability of the other substrates, and the availability of effective refuges, such as spiny plants and ground squirrel burrows, on the ground. The proportion of lizards on the ground (0.64) was much higher in *S. magister* than in *S. virgatus* or *S. jarrovii* (Cooper and Wilson 2007; Smith 1996). Surprisingly for a desert lizard, the proportion of individuals initially sighted on trees (0.20) in *S. magister* was similar to that reported for trees and logs in *S. virgatus* although it was lower than the proportion for *S. jarrovii* (Cooper and Wilson 2007; Smith 1996). Rocks were used by *S. magister* less frequently (0.16) than by the other species, at least in part because rocks are much less abundant at Rillito River Park than in the study sites in the Chiricahua Mountains.

I quantified only microhabitats used by *S. magister*. Because I did not record microhabitat availability, the findings do not bear directly on microhabitat choice. Microhabitat use varies geographically in *S. magister*, which is arboreal, saxicolous, or terrestrial (Johnson et al. 1948; Parker and Pianka 1973; Vitt and Ohmart 1974). Presumably, this variation is related to availability of the microhabitats themselves and of refuges therein.

Some of the differences in selection of refuges presumably were consequences of differences in availability of microhabitats among sites. For example, few rocks or bushes were near many of the trees, and rocks tended to be close to ground squirrel burrows, yuccas, and *Opuntia*. *Sceloporus magister* has a strong tendency to be arboreal, but is saxicolous or terrestrial where trees are scarce (Parker and Pianka 1973). Climbing out of reach in trees is a widespread trait in *Sceloporus* (Blair 1960; Cooper and Avalos, *in press*; Cooper and Wilson 2007), and may be expressed frequently by *S. magister* where trees are present. In the single population I studied, the lizards flexibly used whichever types of refuge were nearby.

All trees occupied by lizards were much taller than necessary for lizards to climb well above my reach, yet lizards selectively left smaller trees to seek refuge elsewhere, and climbed higher in larger trees. Because branch diameter decreases as height increases within trees, trees of smaller diameter may not have large enough branches to provide concealment when lizards climb out of immediate reach. When escaping up trees, lizards moved to the far side and stayed out of sight. Staying hidden on the far side may have been less feasible in smaller trees. If some terrestrial snakes and perhaps mammals climb trees to pursue lizards that can be seen when out of reach from the ground, escape to refuges off small trees might be safer than climbing. Another possible factor is that lizards high in smaller trees may be more detectible by and less able to escape from avian predators.

Acknowledgments.—Field work was conducted according to approved research protocol 00-037-06 of the Purdue Animal Care and Use Committee.

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Plectrohyla hazelae (Taylor, 1940) Not Extinct

Plectrohyla hazelae, a stream-breeding tree frog from southern Mexico, has been reported in the past from several localities in the states of Oaxaca and Guerrero (Duellman 2001). Mendelson and Kabay (2009), however, demonstrated that all records of this species were in error or at least doubtful except for those from the area of the type locality. The type locality is on Cerro San Felipe in central Oaxaca a few kilometers north of the city of Oaxaca. This area is also known as the Sierra Aloapaneca. Mendelson and Kabay (2009) further stated that this species was last seen alive in 1975 and probably became extinct not very long after that year. The extinction of *P. hazelae* was earlier proposed by Lips et al. (2004).

Herein, we report recent sightings of this species at two different localities, both not far from the type locality. On 23 June 2003, we found two individuals in a dry streambed near the village of El Punto. The two males were calling at night from low bushes within pine-oak forest (Fig. 1). El Punto (17°20'N, 96°36'W) is located at 2000 m elevation on the eastern slope of Cerro San Felipe and was listed as a locality of *P. hazelae* by Duellman (1970).

On 7 May 2004, Moises Kaplan and the two authors collected tadpoles in a small creek near Ixtlán de Juárez; these were later described as those of *Plectrohyla hazelae* (Kaplan et al. 2006). Ixtlán de Juárez (17°20'N, 96°29'W) is located at about 1900 m elevation and 30 km N of El Punto. On 8 July 2004 we (PH and RA) returned to the same creek and found a small breeding colony of at least a dozen adults. Several males were calling at night from a patch of small broadleaf trees within pine-oak forest. Our observations suggest that *P. hazelae* reproduces at the beginning of the rainy season and that the metamorphosis of the young occurs also at this time of the year, which implies that the tadpole stage may last for about one year.

A female we found at the locality near Ixtlán is the first known female of this species (Fig. 2; Duellman 2001). It had a snout–vent length of 38.2 mm (largest known male 38.6 mm SVL; Duellman 2001). We did not observe any obvious differences in



FIG. 1. Adult male *Plectrohyla hazelae*, El Punto, Oaxaca, Mexico.



FIG. 2. Adult pair (female on left, male on right) of *Plectohyla hazelae* from Ixtlán de Juárez, Oaxaca, México. The female is the first example known for this species. The differences in coloration are not gender-based, instead reflecting individual variation. Individual frogs have the ability to change from light to dark green.



FIG. 3. Adult male *Plectrohyla hazelae* from El Punto, Oaxaca, showing dark ground color and light green spotting.

COLOR REPRODUCTIONS SUPPORTED BY THE THOMAS BEAUVAIS FUND

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coloration between the genders except that the female's throat is heavily mottled with dark brown whereas in males the throat is pale yellow and immaculate. Males and females possess the ability to change their dorsal coloration between bright green and very dark green. The pale dorsal spots, which are characteristic of this species, are more pronounced when the frogs exhibit a dark ground color (Fig. 3).

Acknowledgments.—We thank Moises Kaplan for confirming the identification of frogs. Photo vouchers are deposited at the Amphibian and Reptile Diversity Research Center, University of Texas at Arlington: UTADC 6714 (Ixtlán de Juárez record), UTADC 6715, 6716 (El Punto record).

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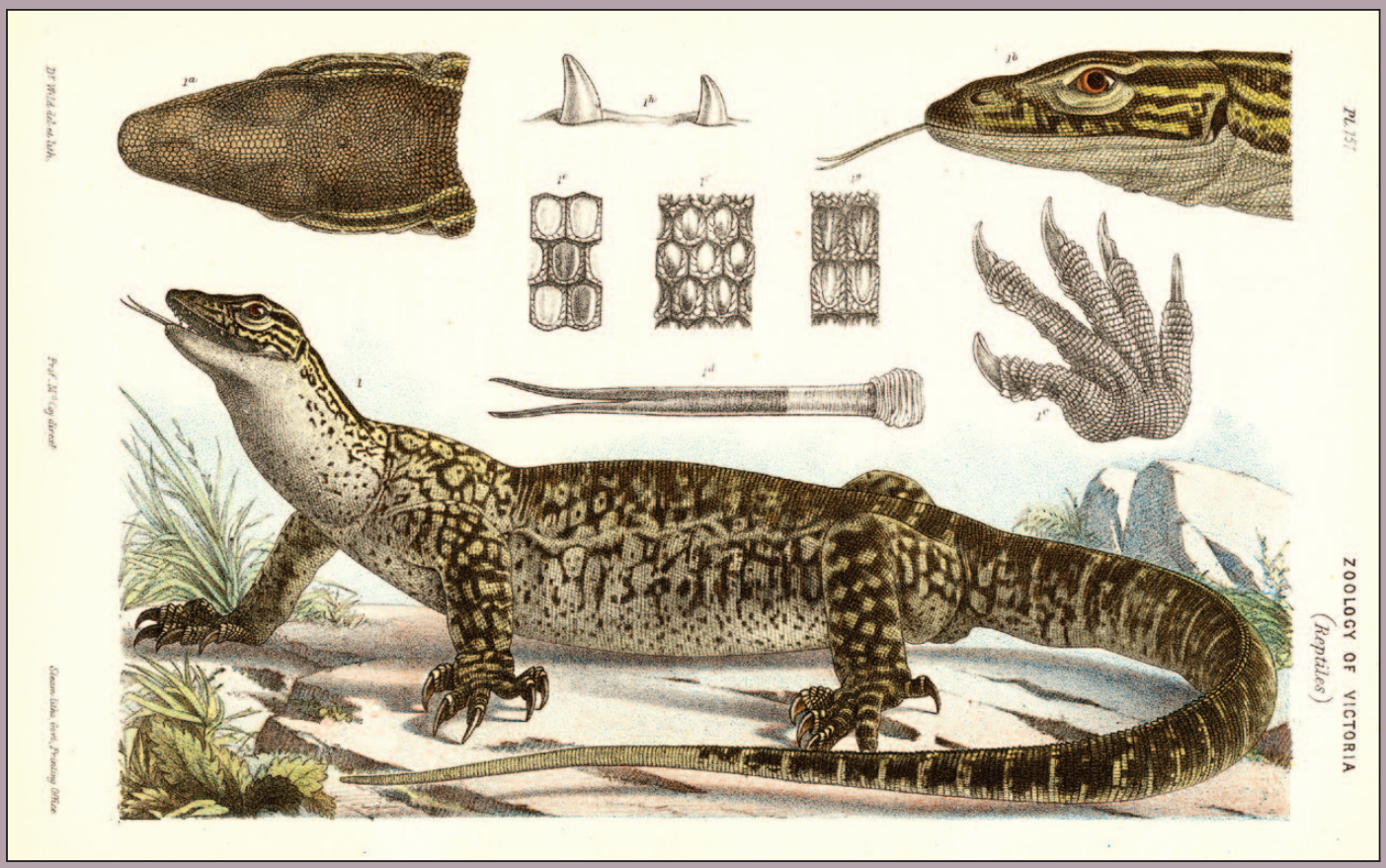
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ART IN HERPETOLOGY



The illustration above originally accompanied an article titled "Monitor gouldi, Gould's Monitor Lizard," published in 1888 within the pages of *Prodromus of the Zoology of Victoria; or Figures and Descriptions of the Living Species of All Classes of the Victorian Indigenous Animals.* This periodical, published in twenty parts from 1878 to 1890 by the National Museum of Melbourne, was met with critical acclaim and wide popular support. John McCoy (1823–1899), director of the National Museum of Melbourne, wrote the text and employed a number of artists to illustrate his work, including John James Wild, the illustrator of this piece. Born in Switzerland in 1824, Wild traveled to Australia in 1881 where he was employed by McCoy to illustrate terrestrial and marine mammals for the *Prodromus.* Wild was noted for the clarity of his illustrations, his desire to depict his subjects in naturalistic environments, and his ability to fit an impressive amount of information onto a single page. All three of these characteristics are evident in this piece. Additional information can be found at: http://museumvictoria.com.au/caughtandcoloured/

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TECHNIQUES

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Use of Fluorescent Visible Implant Alphanumeric Tags to Individually Mark Juvenile Ambystomatid Salamanders

Identification of individuals over time is essential for measuring growth, fecundity, survival, movement, and dispersal of amphibians. Such individual measures usually result in more robust estimates of processes affecting population growth and declines, and likely yield more effective management recommendations. There are a variety of marking and identification techniques that have been evaluated for use with amphibians including toe-clipping (McCarthy and Parris 2004; Otto and Scott 1999; Phillott et al. 2007; Waddle et al. 2008), passive integrated transponder (PIT) tags (Brown 1997; Gibbons and Andrews 2004; Otto and Scott 1999), coded wire tags (Sinsch 1997), radio-transmitters (Richards et al. 1994; Weick et al. 2005), pattern recognition (Gamble et al. 2008; Grant and Nanjappa 2006), various tattooing and branding techniques (Donnelly et al. 1994; Measey et al. 2001; Schlaepfer 1998), visible implant elastomer (VIE) marks (Grant 2008; Kinkead et al. 2006; Measey et al. 2001; Nauwelaerts et al. 2000; Ralston Marold 2001), and visible implant alphanumeric (VIAlpha) tags (Buchan et al. 2005; Gower et al. 2006; Heard et al. 2008; Measey et al. 2001). When selecting the most appropriate method, a researcher should consider impact on health and behavior of study animals, degree of invasiveness, ease and speed of use, handling time, mark longevity, expense, and number of unique marks necessary. Researchers should select tags or marking procedures with the least possible effect on behavior, growth, and survival.

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Ambystomatid salamanders at metamorphosis are typically less than 40 mm SVL and weigh < 2 g (Petranka 1998). Their small size limits the practical options for individual identification of juveniles. Most individuals are too small for currently available internal radio-transmitters. Although Otto and Scott (1999) demonstrated that PIT tags could be surgically implanted in juvenile Marbled Salamanders (*Ambystoma opacum*) weighing from 2 to 4 g, ambystomatid salamanders in Missouri are typically closer to 1 g at metamorphosis (Osbourn, unpubl. data). In addition to the body size constraints of PIT tagging, the necessary surgical procedure requires extra time and precautions, limiting the ability to mark a large number of individuals. Recent advancements in pattern recognition technology are very promising (e.g., Gamble et al. 2008), however Marbled Salamanders, Spotted Salamanders (*A. maculatum*), and Ringed Salamanders (*A. annulatum*) lack their characteristic patterns at metamorphosis, limiting its effectiveness. Toe-clipping is limited by the number of possible combinations, regeneration, and potential harmful effects (Brown 1997; May 2004; McCarthy and Parris 2004). Though there is considerable debate about the potential harmful effects of toe-clipping versus the effects of other marking techniques (e.g., Funk et al. 2005; Phillott et al. 2007), it is likely that stress associated with increased handling time impacts animal health regardless of marking technique (Kinkead et al. 2006). Visible implant elastomers are very effective with most species. Although often sufficient for marking individuals, VIEs are limited by the number of possible combinations of mark colors and lightly pigmented marking locations (Heemeyer et al. 2007). Visible implant elastomers can also be inconvenient for fieldwork because of their tendency to become solidified and inoperative when inadequately refrigerated. Perhaps the greatest limitation of VIEs is their potential for misidentification due to tag migration. Misidentifications of VIE markings were reported for 19% of Western Red-backed Salamanders (Davis and Ovaska 2001), 17% of Eastern Red-backed Salamanders (Heemeyer et al. 2007), and 31% of Wood Frogs (Moosman and Moosman 2006). Ralston Marold (2001) did not observe VIE mark migration in stream

salamanders, however Bailey (2004) reported a misidentification rate of 13% in Blue Ridge Two-lined Salamanders which she attributed to color misidentifications, overlooking of small marks, and incorrect mark location.

Soft VIAlpha tags, manufactured by Northwest Marine Technology, Inc., are individually coded, biocompatible tags measuring 1.0 × 2.5 mm. They are imprinted with one letter (A–Z) and two numerals (00–99) on a fluorescent red, orange, or yellow background (also available as fluorescent lettering on black background or larger 1.5 × 3.5 mm tags, although these were not tested here). The combinations of colors and alphanumeric codes yield 7800 possible individual fluorescent tags. VIAlpha tags have been used extensively in fish (e.g., Frenette and Bryant 1996) and are increasingly being used for individual identification in a range of amphibian species (e.g., Measey et al. 2001; Pittman et al. 2008; Spickler et al. 2006). In contrast to PIT tags and similar to VIE marks, VIAlpha tags are inserted just below the surface of the skin and do not require deep insertion into the abdominal cavity. This comparably less invasive tagging procedure could translate into decreased handling and recovery times for small salamanders. For VIAlpha tags the problem of tag migration often reported for VIEs seems only to be a problem in amphibians with loose skin. Some studies examining VIAlpha tags effectiveness with frogs reported tag migration (Kaiser et al. 2009) or having to manipulate inverted tags through the skin with forceps so that they could be read (Heard et al. 2008; Kaiser et al. 2009). These problems have not been reported in species with tight connective tissue between skin and muscle such as salamanders and caecilians (Gower et al. 2006; Measey et al. 2001). We conducted an experiment to assess the effectiveness of VIAlpha tags for individual identification of juvenile ambystomatid salamanders by evaluating ease of application, readability, tag retention, and effect on body mass gained by individuals.

Materials and Methods.—We collected Marbled Salamander larvae (*Ambystoma opacum*) from the Daniel Boone Conservation Area, Warren County, Missouri, and raised them in 1000 L cattle watering tanks until metamorphosis. Juvenile salamanders were placed in individual 17 × 12 × 9 cm plastic containers with moist sphagnum moss and fed 4–5 crickets weekly. Prior to and during the experiment, salamanders were housed in a temperature controlled (24°C) animal care facility at the University of Missouri. A total of 59 individuals were randomly assigned to one of four treatments. Fourteen untagged and non-anesthetized salamanders served as the control, 15 were anesthetized without a tag, 15 were tagged without anesthetization, and 15 were tagged with anesthetization. Of the salamanders receiving tags, three colors (red, orange, and yellow) were used.

Tricaine methanesulfonate (MS-222) is an effective and commonly used anesthetic for sedating and immobilizing fish and amphibians (Lowe 2004). We chose a concentration of 500 mg/L of MS-222 based on the mass of our juvenile salamanders (Peterman and Semlitsch 2006). To achieve a neutral pH, we buffered the solution with 800 mg of $NaHCO_3$ (sodium bicarbonate) (Cooper 2003). Salamanders were placed in the MS-222 bath until anesthetized (unresponsive to prodding and unable to right themselves) and for no more than 5 minutes. Once anesthetized, individuals were rinsed of MS-222 by dipping them in a shallow dish of dechlorinated tap water.

We individually marked juvenile salamanders with Northwest Marine Technology (NMT), Inc., (Shaw Island, Washington, USA) VIAlpha tags. During the marking procedure, one investigator (MSO) inserted all VIAlpha tags to insure consistency, while three others monitored anesthetization, weighed and measured, and monitored recovery of individuals. Tags were placed subcutaneously under translucent epidermis near the lateral base of the tail (Fig. 1). We administered VIAlpha tags by first making a 1 to 2 mm incision with a sterile pointed scalpel blade and then used the injector provided by NMT to insert the tag approximately 3 mm inward from the entry wound. Non-anesthetized individuals were restrained by hand during tag injection. To minimize infection, we wore nitrile gloves and sterilized all equipment with alcohol before each injection. During the four weeks of monitoring, each salamander was removed from its container at weekly intervals, weighed with an electronic balance, and fed. The same observer (MSO) examined tags weekly for retention and assigned a ranking according to the following readability index: 0, tag not visible or not present; 1, tag visible but only color discernable; 2, tag color and partial code visible or incorrect code read; 3, correct code only read with use of blue LED light and amber filter glasses; and 4, correct code visible without aid of amber filter glasses. This index was a useful tool for determining whether readability and accuracy decreased over time. Tags were initially read without the use of aids and then read while using a blue LED light and amber filter glasses to examine the usefulness of the light and glasses.

We used two-way analysis of variance (ANOVA, SAS version 9.1) to test for significant differences between our treatment groups in proportion increase of body mass after four weeks.

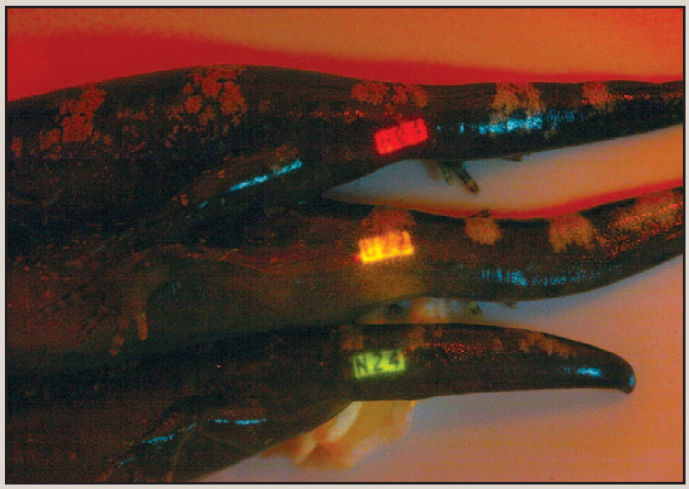


FIG. 1. *Ambystoma opacum* juveniles marked near the lateral base of the tail with VIAlpha tags as viewed with blue LED light and amber filter glasses.

TABLE 1. Mean initial body mass, mean final body mass, and mean proportion body mass increase (± SE) of Marbled Salamanders reared in the laboratory after being marked with VIAlpha tags and/or anesthetized with MS-222.

Treatment	N	Initial Mass (g)	Final Mass (g)	Proportion Mass Increase
Anesthetized	29	1.17	1.74	0.49 (± 0.15)
Non-anesthetized	29	1.25	1.80	0.46 (± 0.17)
Tagged	28	1.29	1.90	0.48 (± 0.14)
Non-tagged	30	1.13	1.63	0.47 (± 0.18)

To adjust for differences in mean initial body mass among our treatments, we used arcsine square-root transformed proportions. Anesthetization (anesthetized and non-anesthetized) and tag (tagged and non-tagged) treatments and their interaction (tag x anesthetization) were fixed effects in our model. We then used two-way ANOVA to test these same effects for significant differences in tag readability index scores after four weeks. Finally, we tested for random effects in tag retention and reading accuracy between anesthetized and non-anesthetized salamanders with a goodness of fit G-test (Zar 1999).

To supplement our laboratory experiment, we recorded additional observations on 122 Spotted Salamanders marked as recent metamorphs for ongoing mark-recapture experiments. Anesthetization, VIAlpha tagging procedures, housing, and care of these juveniles followed similar methods as in the laboratory experiment. After twelve weeks, our observer (MSO) assigned each salamander's tag a readability score and recorded tag retention. These additional observations were useful for examining tag retention over a longer time scale and comparing readability between species.

Results and Discussion.—The use of VIAlpha tags on small juvenile salamanders was successful. All tagged salamanders survived and grew during the four weeks of the experiment, although one small anesthetized untagged individual died after the first week. Our 100% survival of tagged individuals was comparable to the 96% survival of VIAlpha-tagged Pacific Treefrogs (*Pseudacris regilla*) reported by Buchan et al. (2005). Entry wounds created during tag insertion closed rapidly, lacked discoloration or swelling, and were typically considered healed within 24 hours. Our selected MS-222 concentration of 500 mg/L buffered with 800 mg of sodium bicarbonate was very effective, causing anesthetization in ~5 minutes with no detectable decline in health or behavior over four weeks. All surviving salamanders (N = 58) consistently fed and grew during the four-week period, increasing their mass by an average of 48%. There were no significant differences in the proportion of mass increase between tagged and untagged individuals ($F_{1,54} = 0.03$, $P = 0.869$), anesthetized and non-anesthetized individuals ($F_{1,54} = 0.009$, $P = 0.621$), nor was there an anesthetization by tag interaction ($F_{1,54} = 0.030$, $P = 0.3681$; Table 1).

Through experience tagging over 2000 juvenile Spotted Salamanders (*Ambystoma maculatum*) and Ringed Salamanders (*A. annulatum*) in the field, we have observed the advantages of VIAlpha tags and potential problems which can arise during tag injection. The effectiveness of VIAlpha tags appears to be primarily limited by the skill and experience of the operator. Although tedious and requiring some initial practice to use efficiently, VIAlpha tags can be individually loaded in approximately 10 sec and injected into properly immobilized salamanders in less than 15 sec by a lone operator in the field. After a 5 min anesthetization period, handling time is often no more than 20 sec for immobilized salamanders. A recovery period of 10 to 20 min is also needed for anesthetized individuals. Our VIAlpha marking procedure time for juvenile salamanders is very similar to caecilians (< 1 min plus anesthetization and recovery; Measey et al. 2001) and Pacific Treefrogs (< 15 sec with no anesthetization; Buchan et al. 2005). Marking procedure times for VIAlpha tags are very similar to VIEs. Ralston Marold (2001) reported that it took 30 sec to inject four VIE marks and the entire procedure, including anesthetization and recovery, took about 20 min per individual. The VIAlpha tagging procedure can be streamlined with one technician loading tags and anesthetizing batches of five or more individuals while a second technician simultaneously injects and measures others.

Attempting to inject tags into improperly restrained individuals can result in agitation and tearing in the entry wound, potentially affecting tag readability by tags being placed too deep, too shallow, or folded. Despite difficulties encountered while trying to administer VIAlpha tags to non-anesthetized juvenile salamanders, we observed no significant differences in tag readability between anesthetized and non-anesthetized individuals ($F_{1,22} = 0.30$, $P = 0.591$). If anesthesia is not preferred, restraining the salamander in a plastic bag and injecting the tag through the side of bag directly into the tail of the salamander is an effective technique with practice. The tradeoff of attempting to insert VIAlpha tags into non-anesthetized individuals is the potential for increased stress from prolonged handling time (however, no one has yet measured the level stress induced by exposure to MS-222 solution).

The mean readability score for Marbled Salamander juveniles after four weeks was 3.33 ± 0.16 (± SE; N = 24), indicating that a typical alphanumeric code could be read clearly by employing both the blue LED light and amber filter glasses. Marbled Salamanders are particularly darkly pigmented compared to other ambystomatids and we would expect their readability scores to be lower than more lightly pigmented species. For example, the comparably paler Spotted Salamander juveniles we monitored for twelve weeks had a mean readability score of 3.91 ± 0.03 (N = 103). A typical Spotted Salamander alphanumeric code could be clearly read without amber filter glasses. To ensure optimal readability, tags should be positioned just below translucent epidermis and inserted far enough away from the entry wound to allow it to heal and to prevent scar tissue from obscuring the alphanumeric code. Although we found that shining a blue LED or UV light and wearing amber filter glasses provided by NMT greatly improved tag detection in more heavily pigmented salamanders, for individuals with little

translucent skin or abundant patterning, VIAlpha tags may not be a viable marking technique.

Tag reading accuracy is a potential problem when reading 1 mm alphanumeric codes. Our observer incorrectly read 4% of 227 total tag reading attempts and 10% of 30 VIAlpha tags were misread at least once. Our results are similar to those of Heard et al. (2008) who reported a VIAlpha tag misidentification rate by naïve observers in 3% of attempts. By comparison, Bailey (2004) reported a lower reading accuracy of 13% for VIEs due difficulty finding marks or color misidentifications. PIT tags probably have the lowest rate of inaccurate readings, although Pyke (2005) attributed a 1.8% error rate to human recording error.

Placement of tags too close to the entry wound was the primary cause for tags being dropped. For the first two weeks we recorded 100% tag retention, but by the end of week four 20% of 30 tags were dropped. Though not significant ($P = 0.218$), all six dropped tags were from non-anesthetized salamanders and could be the result of less than optimal tag placement while attempting to restrain them by hand. We found similar results in tag retention over twelve weeks for anesthetized Spotted Salamander juveniles (16% of 122 were dropped), suggesting that the problem of tag retention may be independent from the use of anesthesia. Tag loss may be the greatest potential limitation of VIAlpha tags. Heard et al. (2008) observed rates of tag loss of ~8% in frogs, which they attributed to expulsion of tags from slow-healing entry wounds. Tag loss has also been reported in PIT tags (Gibbons and Andrews 2004) however it has not been observed for VIEs (Bailey 2004; Moosman and Moosman 2006; Nauwelaerts et al. 2000) except when individuals are marked prior to metamorphosis (Grant 2008). Heard et al. (2008) suggest mark duplication as possible insurance against tag loss. Adding a cohort toe clip or a VIE mark in conjunction with a VIAlpha tag could be helpful, however at a potential cost in handing time and stress. During the twelve weeks we made observations, a small scar was almost always detectable upon close inspection, allowing us to identify individuals with lost tags in the field.

For individually identifying large numbers of small juvenile salamanders, VIAlpha tags are a reliable and effective marking system. They have both advantages and disadvantages when compared to VIE marks and PIT tags. While PIT tags are very effective for individual identification of larger individuals, they are not yet available in small enough sizes to be practical for most recently-metamorphosed salamanders and require a more invasive surgical procedure. VIAlpha tags and VIE marks are both effective marking systems for small amphibians and each has trade-offs. One key advantage of using VIAlpha tags in salamanders, however, is that they do not appear prone to migrate to other regions of the body as reported with VIE marks. While VIEs do not appear to be as prone to tag loss as VIAlpha tags (8–20%), the reported misidentification rates for VIEs (13–31%) appear to neutralize this advantage. According to the estimation of Nauwelaerts et al. (2000), VIEs cost about $0.06 per mark which is much less expensive than ~$1.00 per VIAlpha tag or ~$6.00 per PIT tag. The price advantages of VIEs may be somewhat diminished when multiple colors and locations are used to create individual marks, plus a proportion of a VIE batch is often wasted due to premature hardening in the field. Ralston Marold (2001) reported material costs for her project increased substantially because of the need to mix multiple batches per day despite keeping VIEs on ice. VIAlpha tags are very practical for fieldwork because they are extremely compact, lightweight, and are as visible as VIEs without requiring refrigeration.

Ultimately, which marking technique is the most appropriate depends on the question being asked. Here, we were concerned with individual identification of thousands of small, recently metamorphosed salamanders. Our field experiments required identification of recaptures over relatively short time periods (1–12 weeks). For our short-term projects, VIAlpha tags worked well, however long-term retention and readability has yet to be tested and is of concern. Marking juvenile salamanders with any method can be problematic because of their high rate of growth and development of pigmentation and patterning. We recaptured several Ringed Salamander juveniles the following field season with their tag color still discernable but their alphanumeric code mostly obscured. Although often tedious and slow when first used, an experienced operator can load and accurately inject tags swiftly with progressively decreasing handling time. When compared to other available marking techniques, the speed of use, cost, detection and readability, number of individual combinations, and lack of observed negative effects on survival or behavior, suggests that VIAlpha tags are highly effective for individual identification of small juvenile salamanders.

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Efficacy of Small Diameter Pipe-trap Refugia for Capturing Metamorph Treefrogs

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Pipe-trap refugia are currently the most widely used method for sampling hylid frogs in their terrestrial habitats (Johnson et al. 2008; Myers et al. 2007; Pittman et al. 2008). Several studies have validated the technique for a variety of species and highlighted the potential for modifications of pipe-traps targeting specific species or age classes (Bartareau 2004; Moulton et al. 1996; Zacharow et al. 2003). In a study of Gray Treefrog (*Hyla versicolor*) habitat use in mature oak-hickory forest within Daniel Boone Conservation Area, Warren County, central Missouri,

I tested a scaled-down variant of the artificial pipe-trap refugia design used by Johnson (2005). I modified the pipe-trap in an attempt to enhance capture rates of metamorph Gray Treefrogs, a crucial life stage for which the ecology remains poorly understood. Metamorph-specific pipe refugia were constructed in the same manner as the larger pipe-traps after Johnson (2005), but with a gray 18 mm (pipe interior diameter) polyvinyl chloride (PVC) pipe rather than the black 40 mm acrylonitrile butadiene styrene (ABS) pipe used for the larger pipe-traps. The reduced pipe diameter maintains accessibility for metamorph treefrogs while effectively excluding adult treefrogs. The restricted pipe diameter also limits access for several other bycatch species that may influence treefrog occupancy (e.g. skinks, spiders, katydids; pers. obs.) and reduces risks of mortality for bycatch species who are themselves in danger of entrapment (e.g. skinks, pers. obs.; flying squirrels, Borg et al. 2004). Finally, the pipe diameter excludes potential predators that have been found in larger pipe-traps such as the Black Rat Snake (*Elaphe obsoleta*, pers. obs.).

I distributed 96 large and 96 small pipe-traps evenly throughout three experimentally treated forest plots surrounding permanent forest ponds. Each of the three sites was comprised of four treatment areas: 4–5 year old clearcuts (with one treatment area having coarse woody debris from logging retained and one treatment area with coarse woody debris reduced), partially-thinned forest stands, and unmodified control forests (32 pairs of pipes at each site, 24 pairs of pipes in each habitat type). Pipes were placed on a wide variety of trees representative of the range of species occurring in the area, including White Oak (*Quercus alba*), Black Oak (*Q. velutina*), Red Oak (*Q. rubra*), Shagbark Hickory (*Carya ovata*), Flowering Dogwood (*Cornus florida*), Black Cherry (*Prunus serotina*), and Black Maple (*Acer nigrum*). Pipe-traps were placed in pairs on trees with the open upper end of the pipes approximately two meters above the ground. Within pairs, one large and one small pipe were placed side-by-side on a single tree to allow direct comparison of the effectiveness of the smaller refugia for sampling metamorphs. In clearcuts where some trees were too small to place both pipes on a single tree, pipes were placed on trees of the same species and approximate diameter within 5 meters of one another.

I monitored all pipe-traps 3 times weekly over two seasons of monitoring from May through October in 2007 and 2008, and assigned each individual a unique mark using toe clips. I recorded 55 captures of 32 individual Gray Treefrog metamorphs in pipe-traps. Comparison of metamorph captures between large and small pipe-traps showed gross capture rates of 83% (46 captures) in large pipes and 17% (9 captures) in small pipes. Of the 32 individuals captured, 4 were recaptured in adjacent pipes of different diameters showing repeated use of adjacent refuges of both sizes. Spring Peepers (*Pseudacris crucifer*), the only other hylid species occurring in the study area, were only rarely found occupying the larger pipe-traps and were never found in the small diameter traps. While adult treefrogs, large spiders, skinks, and katydids would occupy the large pipes, only metamorph treefrogs were found occupying the small diameter pipes. However, spiders would frequently deposit an egg sac near the mouth of the pipe temporarily obstructing access and potentially precluding occupancy by metamorph treefrogs.

Previous studies comparing the effects of different pipe diameters on capture rates of hylid frogs have shown differential capture rates among multiple species as well as among age-classes within species. Bartareau (2004), in a study of ground-placed pipe-traps of three different diameters (13, 25, and 38 mm), reported a significant positive relationship between pipe diameter and treefrog size across species. The design that I tested for a reduced diameter (18 mm as compared to 40 mm) tree-based pipe-trap targeting Gray Teefrog metamorphs was partially unsuccessful in that it did not show improved capture rates of metamorph Gray Treefrogs compared to traps of a larger pipe diameter. However, the small diameter pipe did effectively exclude adult treefrogs and the bycatch species commonly found in the large pipe-traps. Further testing of pipe-traps of intermediate diameters will help determine the suitability of such modifications for targeting Gray Treefrogs of different age classes. Pipe-traps remain one of the best techniques currently available for studying Gray Treefrogs and many other hylids in their terrestrial environments. I strongly encourage further testing of new pipe-trap designs utilizing intermediate pipe diameters or other modifications to further refine the technique and its applications. Such modifications could lead to the development of age-class or species-specific pipe-traps for hylid frogs, ultimately facilitating studies that examine the ecology and conservation of these species.

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Venom Canal Occlusion as an Experimental Alternative to Surgically-rendered Venomoid Snakes in the Copperhead, *Agkistrodon contortrix*

In a study of the time of passage of prey through the digestive tract of a Copperhead (*Agkistrodon contortrix*) to compare the efficiency of digestion between envenomated and non-envenomated prey, it was planned to employ an intact snake as its own control and then surgically remove its venom glands and use it as an experimental subject. Much of the literature about this topic is found in relatively obscure sources (Alpi et al. 2009). Although Tait (1938) established a procedure for excising the venom gland of pit vipers, later refined by Langlada and Belluomini (1972), it is invasive and can result in formation of hematomas and other complications. With that technique, healing requires an extended convalescence but is not always complete. An alternate technique developed in an effort to establish a less drastic method is the occlusion of venom ducts using electrocautery (Jaros 1940). This technique has been reported to be superior to extirpation of the venom gland, but would require highly specialized microsurgical techniques to achieve a theoretically possible reversal of the ablation. This technique also requires an extended convalescence and healing is not always complete. The present study attempted to create an easily reversible alternative to these invasive techniques by testing whether dental composites would effectively block flow of venom through the fangs of the Copperhead.

Table 1. Shedding of fangs by Copperheads (*Agkistrodon contortrix*) following occlusion.

Dental Composite	Snake No.	Successfully Occluded	Time to Shedding (post-treatment)
Visible-light-cured glass ionomer restorative	12 (first attempt)	Yes	Before day 6
	12 (second attempt)	Yes	Before day 15
	7	Yes	Before day 15
Light-cured, radiopaque, flowable composite	3	Yes*	Before day 24
	4	Yes	Before day 10
	9	Yes	Before Day 6
	10	Yes *	Before day 6

* The dentist indicated at the time of the procedure that he was not confident he had completely occluded these two fangs. When an attempt was made subsequently to milk the snake there was minor leakage that was barely perceptible.

Methods.—Prior to the surgical studies, fangs of Copperheads dissected from deceased specimens were examined by scanning electron microscopy to ascertain the general characteristics of the interior surface of the fang and to assess the potential for direct filling without amputation of the tooth. The structure of the fang's opening was considered incompatible with a pressurized fill technique and the smooth featureless surface of the fang's interior suggested that a glass ionomer fill might have the best chance of full adherence using a pressurized fill on a partially coronectomized tooth.

Six Copperheads were housed at North Carolina State University's A.E. Finley Research and Education Center located at Historic Yates Mill County Park near Raleigh, North Carolina. Snakes were subjected to treatment on separate days. Prior to treatment each snake was milked and the venom collected into a 150-ml glass beaker covered by Parafilm. Then, the snake was placed into an individual reinforced rubberized container and transported by automobile to the North Carolina State University

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College of Veterinary Medicine where it was placed into a clear Perspex tube appropriate to its girth and anesthetized.

Following induction with 5% isofluorane, the snake was intubated with an appropriately sized endotracheal tube and dosage was adjusted according to the snake's physiologic parameters and plane of anesthesia. Heart and respiratory rates were monitored every five minutes for each snake; the snake was then carefully observed for muscle tone and any voluntary movement during treatment. The crown of each fang was amputated approximately halfway down its length using a tapered diamond burr on a high-speed handpiece with water cooling and the fang filled with a dental restorative (Fig. 1). A visible-light-cured glass ionomer (GC Fuji II LC distributed by GC Corporation, Tokyo, Japan) was used for snakes #12 and #7. A radiopaque, flowable composite (PermaFlo Purple distributed by Ultradent Products, Inc, Utah, USA) was employed for the remaining four.

Following the procedure the snakes were returned to the housing facility at Yates Mill Park and monitored daily for any aberrations in behavior. The fangs of the treated snakes were visually examined six to eight days post-operatively to ascertain whether or not they were intact. An attempt was also made to milk the snake to discover whether occlusion of the fang had been successful. If the fangs were not shed by eight days, they were checked intermittently thereafter.

Results and Discussion.—Table 1 demonstrates that both composites successfully occluded the snakes' fangs but because snakes shed their fangs within a short time post-treatment, sometimes within six days, the occlusion was not long-lasting. The times in Table 1 indicate when the new fang was first observed, but in some cases replacement could have occurred earlier.

It is not clear whether the occlusion of the venom canal induced exfoliation or whether fang shedding naturally occurs at this interval. A study is now in progress to ascertain the normal rate of fang replacement.

Once the natural rate of shedding is known, experiments of short duration could be planned to begin at the inception of the new shedding cycle. Occlusion of the venom canal in the fang, however, does not seem a viable alternative for long-term experiments. Following the use of the dental composites, shedding of the occluded fangs took place with the replacement fang being operative.

Although the procedure is unsuccessful for long-term experiments, it is a valid technique for the blockage of venom over short periods. There were only two instances in which the technique was not completely successful in blocking the flow of venom, causing slight leakage to occur. In both these cases immediately after the procedure the surgeon indicated he had experienced difficulty and was not positive he had blocked the fang completely.

Acknowledgments.—This research was carried out with approval by the North Carolina State University Institutional Animal Care and Use Committee under protocol 08-151-O

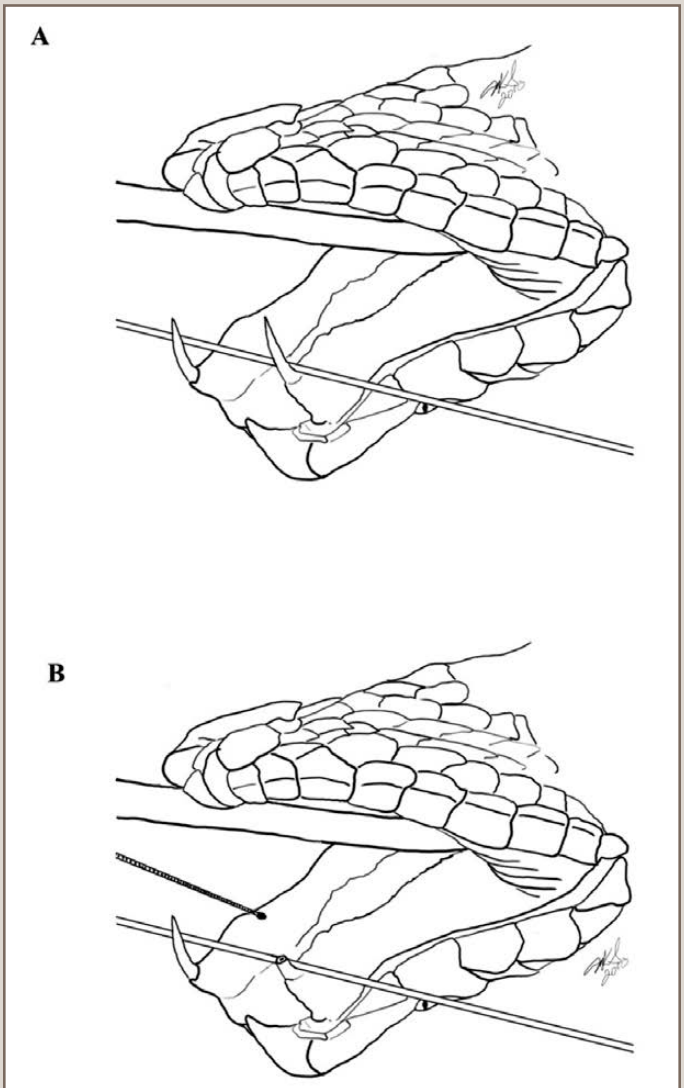


FIG. 1. A. Endotracheally intubated snake with steel tooth retention rod holding fang to be operated forward from the sheath. B. After amputation of the fang proximal to the venom slit, showing the use of a small dental file to deliver the filling material to the tooth canal.

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HERPETOCULTURE

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Using Livestock Markers to Individually Identify Communally-housed Chuckwallas (*Sauromalus ater*) at the Bronx Zoo

The ability to individually identify animals is important in many types of biological studies. Mark-recapture studies are often utilized in the investigation of numerous natural history parameters of wild populations of animals including lifespan, habitat use, home range and behavior. Individual recognition is important to *ex-situ* managed populations as well. In zoos, accurate animal identification is essential to animal health, record keeping, breeding programs and collection management. This information is vital for the implementation and coordination of the Association of Zoos and Aquariums Species Survival Plans.

Various techniques have been developed and employed for individual recognition in reptiles (see Ferner 2007). The most appropriate should be minimally invasive, allow for easy recognition (ideally from a distance), and persist or be easily maintained. Both scale- and toe-clipping (Waichman 1992; Woodbury 1956) have been performed in the field and on captive animals, but both require the handling of individual animals for subsequent identifications. Scale-clipping can be unreliable as scales might re-grow. Toe-clipping can negatively impact locomotion (Bloch and Irschick 2004) and might affect survivorship as has been suggested by some amphibian studies (Clarke 1972; McCarthy and Parris 2004). Branding has been described (Clark 1971), but also requires handling of the animal for recognition. The attachment of colored beads to lizard species using various techniques has been reported. Because beads are not shed, this technique could be effective long-term. However, the invasive methods utilized by Fisher and Muth (1989) and Rodda et al. (1988) are not appropriate in a zoo setting as they might prove distasteful to the public. All of these techniques probably involve some discomfort to the animal as well as possible infection at the site. Implantation of passive integrative transponders (PIT tags) is one of the most commonly employed recognition techniques utilized for all taxonomic groups (Gibbons and Andrews 2004) and has the benefit of potentially persisting throughout the life of the animal. Unfortunately, animals must reach a certain size before PIT tags become practical. And although PIT tags offer a reliable source of identification, individual recognition still requires some handling of the animal. Painting has been employed on various squamates (Brown et al. 1984; Jones and Ferguson 1980; Rodda et al. 1988; Simon and Bissinger 1983; Vinegar 1975). This technique might make individuals more visible and vulnerable to potential predators, although Jones and Ferguson (1980) and Simon and Bissinger (1983) reported no effect on survivorship in *Sceloporus undulatus* and *S. jarrovii*, respectively. Further study is needed to determine effect of painting on survivorship and social significance (Ferner 2007), the latter of which could affect adult zoo animals while predation pressure does not. In hopes of safely and effectively identifying Common Chuckwalla (*Sauromalus ater*) hatchlings at the Bronx Zoo without handling, we employed painting tail bands using livestock markers.

Nine Common Chuckwallas hatched between 24 September and 26 September 2010 at a mean (± 1 Standard Error) mass of 5.27g (± 0.141). All hatched with the expected alternating black and white banded tails. On 30 September, linseed oil-based All-Weather Paintstick® livestock markers (LA-CO®, Elk Grove, Illinois, USA) in red, blue or green colors were used to mark them. The distinct white bands were numbered in ascending order from the cloaca to the tail tip. A strip of color was applied to one of these three bands in each animal, in one of the three colors. Animals were then referred to by color and band number (e.g., Red-1 referred to the animal marked red on the first white band). The livestock marker was applied using a fine tipped file and gently applied to the skin. Although several tools could be used for marking, the texture of the file allowed the livestock marker to adhere easily to its surface during application. Excess marker was removed with the edge of the file. Animals displayed no signs of discomfort and behavior was not obviously altered by the markers. All the marks remained easily

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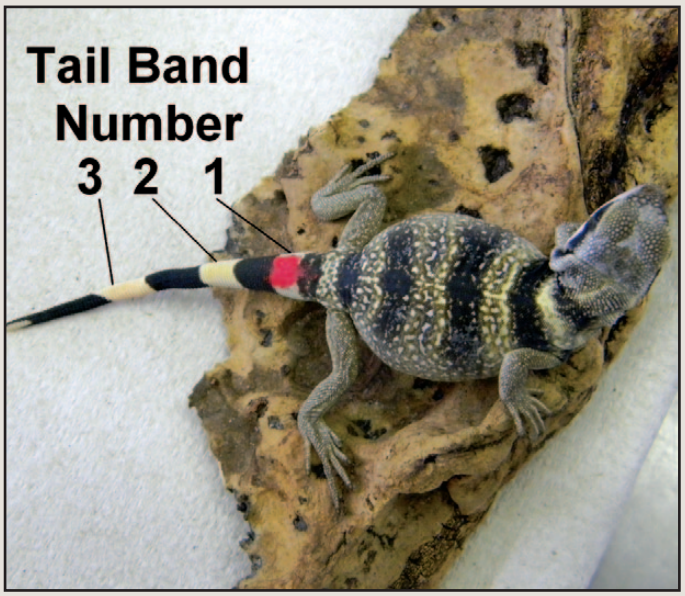


FIG. 1. Tail band numbers of a hatchling Common Chuckwalla (*Sauromalus ater*) Red-1 (i.e., marked with red Paintstik on the anterior-most white tail band [tail band #1]).

distinguishable when they were proactively touched up on 22 October. The red and green colors were the easiest to discern; the blue marker attracted or held substrate more readily making the mark appear a dull brown color, a disparity likely due to a slight difference in ingredients used to manufacture the color (Bachleda, LA-CO, pers. comm.). When the blue mark was wiped free of debris, however, the color was obvious. Because the red and green marks were so vibrant, the blue marks were still easily distinguishable from the other two colors. No marks disappeared until animals began shedding on 20 November at which point colors were reapplied as each animal shed.

Some of the benefits of this technique were realized immediately. The marks took little time to apply and required only minimal maintenance. Animals could be individually identified to monitor behavior (e.g., food consumption) with negligible or no disturbance to them. The markers are ideal for use with communally-housed animals in captive situations where some of the more invasive techniques would stress the animals and potentially alter behaviors. It is a viable, noninvasive alternative to marking animals too small to receive PIT tags. Paintstik markings could also be useful in short-term field studies, allowing individuals to be distinguished from a distance so that an observer would not alter the animals' behavior. Location of marks on the body can be easily adapted to each species.

Paintstiks are readily available, inexpensive (costing around US $1.00 each), and come in nine colors, with an additional four colors available in fluorescent, allowing for a significant number of possible combinations. With each stick useful for hundreds of applications, this technique is optimal for short-term use where PIT tagging is cost prohibitive. Additionally, it is much less invasive than PIT tagging, and animals can be identified from a distance. With longer intervals between sheds, adult animals might display Paintstik marks for much longer than the juveniles discussed here. Similarly, body location might affect longevity of the mark with Brown et al. (1984) reporting acrylic paint marks lasting four years when applied to the basal segments of the rattles of *Crotalus viridis*.

Acknowledgments.—We thank the Bronx Zoo Herpetology Staff for their assistance, particularly Brandon Casey and Alyssa Borek. We are also grateful to Pat Thomas and Valorie Titus for reviewing an earlier version of this manuscript.

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AMPHIBIAN DISEASES

This section offers a timely outlet for streamlined presentation of research exploring the geographic distribution, host range, and impact of emerging amphibian pathogens, especially the amphibian chytrid fungus *Batrachochytrium dendrobatidis* (*Bd*) and ranaviruses. *Bd* is an emerging pathogen linked to mass mortality and declines of amphibians worldwide, yet *Bd* has also been detected in amphibians without disease. Ranaviruses also cause mass mortality, but have not yet been linked to large-scale declines. We know relatively little about their global distribution, host range, or impacts on host populations. To improve our understanding of the scope of this issue, we encourage submission of studies that illuminate the geographic distribution, host ranges, and impact of these pathogens on amphibian populations, including research on individual species or groups of species, wild or captive animals, native or non-native species, live animals or museum specimens, environmental samples, and, provided there is sufficient sampling[1], reports of non-detections.

We ask authors to: 1) restrict the Introduction of their paper to a maximum of two paragraphs to highlight the context of their study; 2) briefly include both field and laboratory Methods; 3) present Results in a Table, although a map might also be useful, and limited text; and 4) have a short discussion of a maximum of three paragraphs to touch upon key findings. Please include the following information in submissions as appropriate: coordinates and description of sampling areas (or please note if locations are extremely sensitive to reveal, and provide general area instead); species name(s) and life history stages examined, as well as other species present; whether samples were collected randomly or just from dead or moribund animals; date of specimen collection; evidence of unusual mortality; numbers of positive and negative samples; disposition of voucher specimens; name of collaborative laboratory or researcher conducting histological sections or PCR analyses; and names of cooperative land owners or land management agencies. We encourage researchers to conduct post-mortem examinations when possible to identify the cause of death when reporting mortalities. We aim to expedite the review and publication process! Please e-mail submissions directly to Associate Editor, Dr. Dede Olson: dedeolson@fs.fed.us.

[1]If a sample of 30 individuals of a particular life history stage of a particular species yields no positive results, and the diagnostic test is highly sensitive, one can conclude that the prevalence of infection is less than 10% with 95% confidence. With a sample of 10 an infection in one of four individuals could go undetected. We encourage researchers to collect sufficient samples that negative results are meaningful.

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Dynamics of Chytridiomycosis in a Tasmanian Frog Community

Most previous studies of the prevalence of chytridiomycosis (*Batrachochytrium dendrobatidis*, *Bd*) in wild frog populations in Australia have been in tropical or subtropical environments, in areas with predominantly summer rainfall (Kriger and Hero 2007; Kriger et al. 2007; McDonald et al. 2005). As Tasmania is both more temperate and does not have a summer-dominated rainfall pattern, seasonal patterns in prevalence in Tasmania may not be the same as in other parts of Australia. In tropical and subtropical areas of Australia, *Bd* prevalence and clinical disease are both higher in the colder and drier winter months (Berger et al. 2004; Kriger and Hero 2006; Retallick et al. 2004). In a broad-scale latitudinal study of chytridiomycosis in the *Litoria lesueuri* complex in eastern Australia, Kriger et al. (2007) found that prevalence and intensity of *Bd* infection increased with latitude, with an order of magnitude increase in the intensity of infection (as measured by zoospore equivalents) from 17° to 37°S. This latitudinal variation appeared to be related to a negative association between infection intensity

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and temperature in the warmest quarter of the year and a positive association between infection intensity and rainfall in the driest quarter. They suggested that temperate frog populations might therefore be particularly susceptible to chytridiomycosis, especially as substantial population declines have occurred in at least 11 frog species in south-east Australia (Hero et al. 2006). However, the highest latitude they examined was 37.26°S, close to the Victoria-New South Wales border, which is still in a region of predominantly summer rainfall.

Chytridiomycosis has only recently been reported from Tasmania (Obendorf 2005; Obendorf and Dalton 2006; Pauza and Driessen 2008). It has been detected in samples from a number of sites surrounding the World Heritage Area in south-west Tasmania, in tadpoles of all four frog species surveyed (*Litoria burrowsae, L. ewingii, Crinia signifera*, and *C. tasmaniensis*; Pauza and Driessen 2008). There are concerns that it may threaten Tasmania's three endemic anurans (*Litoria burrowsae, Bryobatrachus nimbus* and *Crinia tasmaniensis*; Pauza and Driessen 2008) and also the threatened green and gold frog, *Litoria raniformis* (Obendorf and Dalton 2006). There has not, however, been any quantitative examination of prevalence or intensity of infection in adult frogs, as distinct from tadpoles, in Tasmania. Our objective in this brief study was to address this gap in knowledge by estimating prevalence and intensity of *Bd* infection, and possible effects of *Bd* infection on survival and capture probability in two Tasmanian frog species.

Our study site was in Knocklofty Reserve, Hobart, Tasmania. The reserve usually has several small ponds with the Brown Tree Frog *Litoria ewingii*, the Spotted Marsh Frog *Limnodynastes tasmaniensis*, and the Common Froglet, *Crinia signifera* (http://www.friendsofknocklofty.org/fauna.html; accessed 5 July 2010). These species are common in Tasmania and also are found in southern mainland Australia (Barker et al. 1995). At the time of the study, southern Tasmania was in severe drought, with 24-month cumulative rainfall to 1 March 2008 in the lowest 5% of historical totals (http://www.bom.gov.au/climate/drought/archive/20080304.shtml; accessed 5 July 2010). Only one water body, a small flooded quarry at 42.881°S, 147.303°E, still held water at the time of the study in Knocklofty Reserve. All data collection was therefore concentrated at that site.

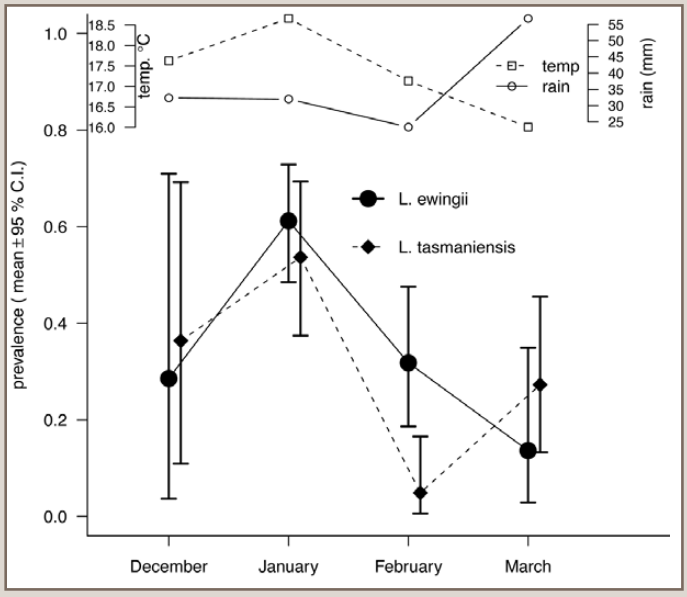


FIG. 1. Prevalence of *Batrachochytrium dendrobatidis* infection in *Litoria ewingii* (solid circles) and *Limnodynastes tasmaniensis* (diamonds) per monthly survey period, December 2007 to March 2008, from Knocklofty Reserve, Tasmania, Australia. Rainfall (circles) and mean temperature (squares) in the 30 days preceding each sampling period are shown.

We conducted fieldwork from December 2007 to March 2008, with monthly field surveys of 4–5 days, conducted in late afternoon and early evening. Frogs were captured by hand after searching under rocks and logs around the edge of the pond. On first capture, adult frogs were measured using calipers and individually marked using toe "tipping." No more than 2 mm of the toe tip was removed and a maximum of one toe tip per foot or 4 toe tips per individual were removed. To minimize spread of disease between individuals, all frogs were placed into individual plastic bags immediately after capture and field gear such as scissors and callipers were disinfected in 70% ethanol between uses on individual frogs. Individual frogs were handled with a new pair of latex disposable gloves. The first time an individual frog was captured during one of the monthly survey periods, it was swabbed for *Bd* detection using a standardized technique as described by Kriger et al. (2006), using individually packed sterile dry swabs (MW100-100, Medical Wire and Equipment Company, Bath, UK). Frogs were swabbed 10 times on their ventral and dorsal surfaces, 10 times on each side from the fore to hind limbs and five times on each foot.

Swabs were processed using real-time quantitative TaqMan PCR (qPCR) as described by Boyle et al. (2004) and Hyatt et al. (2007) with modifications as described by Garland et al. (2009). DNA extracts from swabs were diluted and added to PCR reactions and analyzed in groups of 22 swabs, and in each group, a negative control swab (negative extraction control - NEC) and a positive extraction control swab (PEC) were processed. The TaqMan analyses were performed in triplicate for the sample extracts, NEC, no template controls (NTC) and PEC. Standards (100, 10, 1, 0.1 zoospore equivalents) were analyzed in quadruplicate. Analyses were performed on the Rotor-GeneT 6000 (Corbett Research) using Gene-Disc 100 tubes and a set threshold of 0.01 to determine the PCR cycle at point of detection (Cycle threshold (Ct)). PCR master mix and diluted sample extract, diluted NEC, PEC, water (NTC), or standard, were added to the tubes with a CAS-1200T pipetting robot (Corbett Robotics). NEC, PEC, NTC and standards were analyzed together by qPCR for each group of 22 swabs.

Sample extracts obtaining a negative result for the TaqMan assay were reanalyzed for inhibition by assessing amplification of the TaqMan exogenous internal positive control. Single analyses were performed. If the Ct value of the IPC was above 32 then the extract was diluted to 1 in 100 and a second TaqMan

TABLE 1. Recapture rates and *Batrachochytrium dendrobatidis* (*Bd*) infection status at time of first capture for *Litoria ewingii* and *Limnodynastes tasmanienisis* at Knocklofty Reserve, Tasmania, Australia. Frogs caught in the last of the four sampling periods could not have been recaptured in a subsequent sampling period, hence the percentage of frogs recaptured in the final column is based on frogs captured in the first three sampling periods only. Frogs with uncertain infection status on first capture have been omitted (*L. ewingii*: N = 11; *L. tasmaniensis*: N = 17).

Species	*Bd* infection status at first capture	N	*Bd* prevalence	No. frogs captured in first three sampling periods	No. (%) recaptured in a subsequent sampling period
Litoria ewingii	Negative	77		62	1 (2)
	Positive	56	42%	56	6 (11)
	TOTAL	133		188	7 (6)
Limnodynastes tasmaniensis	Negative	59		50	21 (42)
	Positive	27	31%	23	7 (30)
	TOTAL	88			
Crinia tasmaniensis	Negative	0		0	0
	Positive	1	100%	1	1 (100)

assay (in triplicate) was performed on the inhibited sample. Samples where 1 or 2 only of the triplicate qPCR reactions were positive were regarded as inconclusive and not included in any analyses.

Program MARK (Cooch and White 2010) was used to model capture-mark- recapture data, examining whether *Bd* infection affected frog survival or capture probability. Initially, capture probability models were constructed with fully saturated survival models. Secondly, survival and transition rates were modelled using the best supported capture models from the first step and evaluated using AICc weight. Model selection uncertainty was accounted for by model averaging (Burnham 2002; Burnham and Anderson 2004). Prevalence was analyzed using logistic models implemented in R (R Development Core Team 2007). When the same individual was captured on multiple occasions in the same survey period, it was treated as a single observation and was scored as positive if it was clearly positive (3 of the 3 replicate qPCR reactions) on any of the capture occasions and negative if it was clearly negative (0 of 3 qPCR reactions) on at least one of the capture occasions, even if inconclusive (see above) on some of the others. For analysis of infection intensity (zoospore counts), the maximum count per individual per sampling period was used in the analysis.

At the time of first capture, 42% of *L. ewingii* (N = 133) tested positive for *Bd*, whereas 31% of *L. tasmaniensis* (N = 88) tested positive (Table 1). However, a Fisher's exact test did not reject the null hypothesis of equal prevalence in the two populations (P = 0.09, 95% CI for odds ratio 0.33, 1.11). The one *C. signifera* individual captured was infected with *Bd*.

Overall, *L. tasmaniensis* had a much higher recapture rate (38%) than *L. ewingii* (6%). A logistic model of recapture probability in subsequent sampling intervals as a function of species and infection status at the time of first capture showed that there was a significant interaction term (χ^2 = 5.52, 1 df, P = 0.019). A borderline significantly higher (P = 0.052 ; Fisher's exact test) proportion of infected *L. ewingii* were recaptured (10.7%) as compared to noninfected individuals (1.6%). In *L. tasmaniensis*, there were more recaptures of noninfected individuals (42%) as compared to infected frogs (30%), although a Fisher's exact test did not reject the null hypothesis of equal recapture probability between these species (P = 0.44).

Although the prevalence of infection differed between *L. tasmaniensis* and *L. ewingii* captured in each of the four monthly survey periods (Figure 1; logistic model of prevalence as a function of species and collection month had a significant interaction term; χ^2 = 11.2, 3 df, P = 0.01), inspection of the data suggested that prevalence was similar for both species in December, January, and March, but was significantly lower in *L tasmaniensis* than in *L. ewingii* in February. Whereas the mean temperature in the 30 days preceding the sampling period appeared to be positively associated with prevalence (χ^2 = 29.8, 1 df, P = 0.00001; see Fig. 1), a model including month, species and their interaction fitted the data significantly better than a model including species, temperature and an interaction (χ^2 = 17.3, 4 df, P = 0.002), indicating that temperature was not a sufficient explanation for the observed differences in prevalence between months and species. Similarly, although the interaction between species and the total rainfall in the 30 days preceding the sampling period was associated with prevalence (χ^2 = 4.35, 1 df, P = 0.03), it was not sufficient to explain the observed differences in prevalence (χ^2 = 43.0, 4 df, P ≈ 0).

Capture-Mark-Recapture modelling was only possible for *L. tasmaniensis* because the recapture rate for *L. ewingii* was too low to provide sufficient data. Models with constant capture probability and models with capture probability dependent on infection status were almost equally well supported (AICc weights 0.33 and 0.36, respectively). Models with survival dependent on disease status were more weakly supported (total AICc weight 0.19) than those in which survival was independent of disease status (Total AICc weight 0.44). Model-averaged estimates of *L. tasmanienisis* monthly survival were

therefore almost identical for diseased individuals (0.60, SE = 0.16) and non-diseased individuals (0.59, SE = 0.13), whereas the model-averaged capture probability for diseased individuals was 0.41 (SE = 0.13), in comparison with 0.55 (SE = 0.16) for non-diseased individuals. Models including an effect of temperature on either recapture (Total AICc weight 0.18) or survival (Total AICc weight 0.25) were not well supported.

Geometric mean infection intensity (as measured by zoospore counts) in infected frogs was 24.0. There was no evidence that the monthly variation in this intensity differed between the species ($F = 1.50$, $df = 3, 87$; $P = 0.22$) or that the intensity of infection differed between the species overall ($F = 0.77$, $df = 1, 7$; $P = 0.38$). However, the difference in infection intensity between months was of borderline significance ($F = 2.70$, $df = 3, 87$, $P = 0.051$).

We found evidence that the proportion of infected frogs that were recaptured, relative to the proportion of uninfected frogs that were not recaptured, differed significantly between *L. ewingii* and *L. tasmaniensis*. Several previous studies have used the proportion of frogs recaptured as a proxy for survival but such an effect can be due to differences in survival or catchability. In this case, the difference in recapture rates appeared primarily to be due to higher recapture rates of infected *L. ewingii* compared to uninfected *L. ewingii,* which suggests that there may be behavioral differences between infected and uninfected frogs rather than reduced survival of infected frogs. Whether it is infection status, perhaps by making frogs less active, which increases their probability of recapture, or whether frogs with certain behaviors (perhaps those which are most closely associated with the water body) are more likely to be both infected and recaptured cannot be determined from our results. Overall, the recapture rate of *L. ewingii* was much lower than that of *L. tasmanienisis*. We can only speculate on why this should have been the case, but it is likely to be the result of behavioral differences between the two species.

Using mark-recapture methods, we were unable to detect any effect of *Bd* on the survival of *Limnodynastes tasmaniensis*, despite a relatively high prevalence of *Bd* infection. However, we conducted our study in summer only and there may be mortality due to *Bd* in other seasons. Mortality mainly occurs in winter and spring in northern Australia (Berger et al. 2004; Murray et al. 2009). Akaike weights for models with constant recapture probability and recapture probability depending on disease status were approximately equal and there is insufficient evidence to reject a null hypothesis that catchability is equal between infected and uninfected *L. tasmaniensis*. However, the significant difference between the two species in the effect of infection on recapture probability cautions that infection may influence the probability of capture. Not only does this mean that differences between species in the proportion of frogs recaptured as a function of infection status may not be indicative of differences in mortality induced by the pathogen, but it also means that prevalence in any sample may not be an unbiased estimate of prevalence in the frog population as a whole (Jennelle et al. 2007). This has potential implications beyond our study. With the exception of Retallick et al. (2004) and Murray et al. (2009), neither of which found any indication that infection by *Bd* affected catchability, we know of no other study that has explicitly investigated possible differences in catchability between infected and uninfected frogs. This means that all conclusions drawn about prevalence in populations based on prevalence in samples of adult frogs where catchability of infected frogs has not been assessed need to be treated with caution.

Interestingly, we found that the monthly changes in apparent prevalence differed between our two study species. Although prevalence peaked in both species in January and declined by February, in *L. ewingii* it continued to decline in March, whereas in *L. tasmaniensis* it rose again. This may be a result of behavioral differences between the two species, but it does suggest that the dynamics of infection in these two species, although they were captured around the same water body, are not tightly linked. Little is known about how *Bd* is transmitted in the field. In experimental situations, transmission through water containing zoospores has been demonstrated several times (Berger et al. 1998; Rachowicz and Briggs 2007; Rachowicz and Vredenburg 2004). If this were the predominant means of transmission in the field and species were similar in their contact rate with water, susceptibility to infection and mortality and recovery rates, one might expect that temporal patterns in prevalence would be synchronous in all species sharing the water body in which transmission occurred. Another possibility is that transmission may occur through direct contact between individual frogs, particularly through shared use of shelter sites (Rowley and Alford 2007). If this is the predominant route of infection and there are differences in habitat use between species, then disease dynamics in different species would be less tightly coupled than if transmission occurred predominantly through a shared water body. Our results are consistent with either infection occurring predominantly through a frog-to-frog contact or differences in contact rate with water, susceptibility to infection, mortality and recovery rates.

We detected substantial levels of *Bd* infection in post-metamorphic *L. tasmaniensis.* In a broadscale survey of clinically ill frogs, Berger et al (2004) found six adult *L. tasmaniensis* to have died from chytridiomycosis. Obendorf and Dalton (2006) also reported *Bd* infection in *L. tasmaniensis* but their study investigated only tadpoles. In contrast, Woodhams et al. (2007) attempted to experimentally infect four Australian frog species (*Litoria caerulea, Mixophyes fasciolatus, Litoria chloris* and *L. tasmaniensis*) with *Bd* spores. Only *L. tasmaniensis* failed to become infected and had 100% survival over the course of the experiment. Furthermore, they found evidence that peptide skin secretions of *L. tasmaniensis* inhibited growth of *Bd* in vitro. These conflicting results highlight the importance of using caution when extrapolating laboratory experimental results to the field.

Comparison of infection levels, both in terms of intensity and prevalence, is problematical between sites, species and

seasons, even if a standardized swabbing protocol has been applied in each case. However, it is worth noting that the intensity of infection in our study in both species (approximately 30 zoospore equivalents) was relatively low in comparison with the mean intensity of about 1000 zoospore equivalents reported by Kriger et al (2007) and Kriger and Hero (2006) in *L. wilcoxii* at a similar mean temperature. Pathogenesis of *Bd* is dependent on intensity of infection and may explain the lack of mortality observed in this study (Voyles et al 2009).

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A Preliminary Survey of *Batrachochytrium dendrobatidis* Exposure in Hellbenders from a Stream in Georgia, USA

Hellbenders (*Cryptobranchus alleganiensis*) are among the largest salamanders in the world. Hellbenders are thought to live over 25 years (Wheeler et al. 2003) and successful breeding populations are generally limited to relatively pristine stream systems. Hellbender populations appear to be declining due to a number of reasons, with habitat degradation such as siltation being a major factor (Briggler et al. 2007a). However, few studies have looked at pathogens as a potential cause of decline.

Batrachochytrium dendrobatidis (*Bd*) has been in the forefront of amphibian disease research in recent years (Duffus 2009). New reports of *Bd* range expansion and host diversity are now common in the literature (e.g., papers in *Herpetological Review*), but studies on the effect of *Bd* on salamander populations is limited, largely because of a lack of knowledge on the status of the populations prior to the introduction of *Bd*. In particular, there is a paucity of information regarding *Bd* in Georgia, USA (Rothermel et al. 2008; Timpe 2008), and few reports of *Bd* in Hellbenders are available: in Missouri and Arkansas, USA (Briggler et al. 2008); in Kentucky, USA (G. Lipps: data available at: www.spatialepidemiology.net/*Bd*-maps). The goal of our study was to obtain baseline data on *Bd* occurrence in a Hellbender population in Georgia.

Hellbenders were collected from Cooper Creek, Union County, Georgia, using a dip-net placed downstream of flipped rocks, as part of another study. Cooper Creek is a fairly swift, medium-sized, rocky-bottomed stream nestled within the Blue Ridge Mountains. Samples were collected opportunistically in March 2009, and in May 2009, additional samples were collected from a site upstream of the March samples. Each salamander was systematically swabbed 20 times along the ventral skin surface and feet with a sterile cotton swab. Samples were stored in individual cryovials, and frozen at -80° C until testing. Genomic DNA was extracted from each swab using the Qiagen DNA Purification Kit (Germantown, MD, USA) following the manufacturer's protocol and each sample was tested in duplicate for *Bd* by polymerase chain reaction (PCR) testing as described (Annis et al. 2004). A sample was only considered positive if both independent PCR reactions were positive; a single *Bd*-positive result was interpreted as being equivocal.

TABLE 1. *Batrachochytrium dendrobatidis* (*Bd*) occurrence in Hellbenders (*Cryptobranchus alleganiensis*) from Georgia, USA.

Age Class	N	No. *Bd*-positive (%)	No. *Bd*-negative (%)	No. equivocal (%)
March 2009				
Adults	17	9	3	5
Juveniles	4	0	3	1
Total	21	9 (43)	6 (28)	6 (28)
May 2009				
Adults	1	0	1	0
Juveniles	5	0	5	0
Total	6	0 (0)	6 (100)	0 (0)
Overall Total	27	9 (33)	12 (44)	6 (22)

In total, 21 of 27 samples had unequivocal results, and 10 of 21 (48%) samples were *Bd*-positive (Table 1). More salamanders were *Bd*-positive during the March sampling period compared with May (Fisher's exact test, $p = 0.0152$); however, the low number of salamanders in the later sample ($N = 6$) may have been insufficient for determining an accurate *Bd* prevalence at that time. Skerratt et al. (2008) recommended sample sizes > 59 when *Bd* prevalence is expected to be low. During the March sampling period, more adults were positive compared with juveniles (Fisher's exact test, $p = 0.0357$), but again low sample sizes may have affected results (Table 1). Unfortunately, due to a freezer failure, the integrity of the 6 equivocal samples was compromised and they could not be retested.

Despite the small sample size of this study, we documented a high prevalence (48%) of *Bd*-positive Hellbenders. To our knowledge this is the first report of *Bd* in Hellbenders from Georgia, although *Bd* has been documented in captive Hellbenders (Briggler et al. 2007b) and in wild Hellbenders from five rivers in Missouri and Arkansas (Briggler et al. 2008), and in wild Hellbenders in Kentucky (G. Lipps, www.spatialepidemiology.net/Bd-maps). Further investigation is needed to determine the effects of *Bd* infection in Hellbenders. However, none of the salamanders that were sampled in our study exhibited clinical signs or had gross lesions suggestive of chytridiomycosis.

It is interesting to note that the samples obtained in March were collected in an area of the stream that is utilized heavily by humans for camping, fishing, and other recreational pursuits. In contrast, the May samples, which were all negative,

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were from a relatively isolated site upstream. Additional studies along a gradient in the creek are needed to determine if the difference in *Bd* prevalence may be related to anthropogenic factors. Some species of ranids are common hosts for *Bd* and can serve as reservoirs (Sánchez et al. 2008; Daszak et al. 2004), so differences in amphibian communities between sites may affect prevalence. Additionally, there may be seasonal variation in the detection of *Bd* (Rothermel et al. 2008).

Recent studies on the morbidity and mortality of amphibians due to emerging infectious diseases, such as chytridiomycosis and *Ranavirus*, has highlighted the need to conduct surveillance for these pathogens in an effort to determine possible population effects (Duffus 2009). Although reports of these diseases in various species of salamanders are limited, they are increasing in number and geographic scope. The samples utilized for our study were collected by researchers who were conducting non-disease related research on these salamanders. We encourage others to take advantage of opportunities to collaborate with other researchers in order to carry out pathogen surveillance, particularly in at-risk or cryptic species.

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Chytrid Fungus Not Found in Preliminary Survey of Lowland Amphibian Populations Across Northwestern Borneo

The emerging pathogen *Batrachochytrium dendrobatidis* (*Bd*) has been implicated in amphibian declines in temperate (Rachowicz et al. 2006) and tropical regions (Lips et al. 2006), but sampling for the fungus has been heavily focused on regions such as North America, Australia, and Europe. Southeast Asia has been comparatively underrepresented in sampling efforts, although *Bd* has been found in the region (Kusrini et

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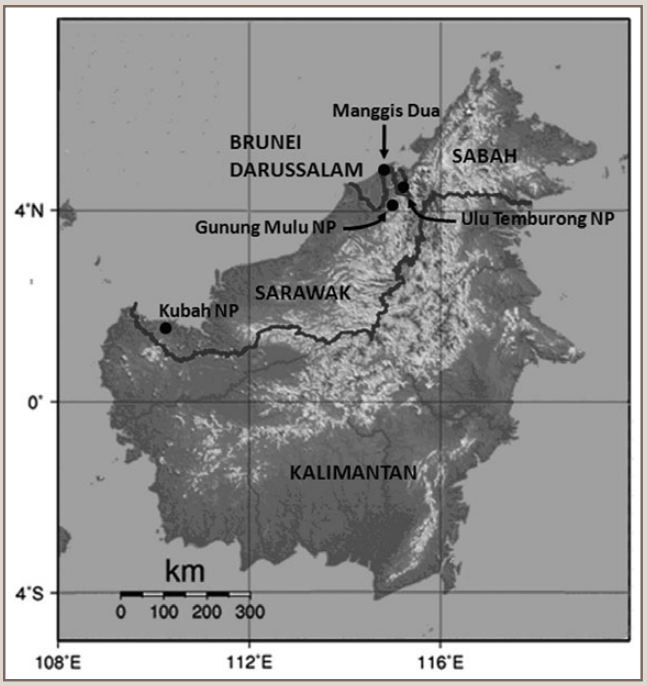


FIG. 1. Sites on the island of Borneo where amphibians were sampled for *Batrachochytrium dendrobatidis*. Gunung Mulu and Kubah National Parks (NP) are located within the state of Sarawak, Malaysia. Ulu Temburong National Park and Manggis Dua are located within Brunei Darussalam.

al. 2008; Neang and Eastoe 2010). The island of Borneo, home to more than 160 amphibian species of which two thirds are endemic (Inger and Stuebing 2005), has remained untested for *Bd*. We tested for *Bd* in northwestern Borneo both in the Malaysian state of Sarawak and in Brunei Darussalam across a variety of habitat types to determine if *Bd* is currently present in the region.

We sampled 16 species of frogs from five different families (Table 1). Animals were sampled opportunistically at five sites across Sarawak, Malaysia and Brunei Darussalam from July through November 2009 (Fig. 1). Sites included urban habitat, national park buffer zone, and core national park areas. All frogs were inhabitants of lowland mixed dipterocarp rainforests except for two individuals sampled from a lowland urban ditch.

Only adults were sampled. Frogs were captured by hand. Skin swabs were taken from pelvic patch, legs, and toes using sterile swabs and stored in 70% ethanol. Clean gloves were used for each individual. Swabs were stored at 20–25°C for 2–4 months and shipped to the United States where they were frozen until extraction. DNA was extracted using a Qiagen QIAamp DNA Minikit. The standard extraction protocol was used. Sample DNA was analyzed using a high resolution melt (HRM) rt-PCR protocol (Boyle et al. 2004; Hyatt et al. 2007) to test for the presence of *Bd* on swabs. Rt-PCR has been shown to be the most sensitive detection method for *Bd* (Boyle et al. 2004; Hyatt et al. 2007). Positive and negative controls were run on the same plate. Samples were run in triplicate.

TABLE 1. Amphibian species and locations sampled for *Batrachochytrium dendrobatidis* in Borneo. Numbers in parentheses indicate total individuals of that species surveyed at that GPS point.

Location	Species	Family
Sarawak, Malaysia		
Gunung Mulu National Park	*Ansonia longidigita*	Bufonidae
	Staurois guttatus	Ranidae
Kubah National Park	*Limnonectes kuhlii* (2)	Dicroglossidae
	Limnonectes paramacrodon	Dicroglossidae
Brunei Darussalam		
Manggis Dua	*Duttaphrynus melanostictus* (2)	Bufonidae
Ulu Temburong National Park buffer zone	*Bufo divergens*	Bufonidae
	Hylarana glandulosa	Ranidae
	Hylarana megalonesa	Ranidae
	Hylarana signata (2)	Ranidae
	Leptolalax gracilis	Megophryidae
	Limnonectes leporinus	Dicroglossidae
	Megophrys nasuta	Megophryidae
	Phrynoidis juxtaspera	Bufonidae
	Rhacophorus pardalis	Rhacophoridae
	Staurois guttatus (2)	Ranidae
Ulu Temburong National Park core	*Ansonia albomaculata*	Bufonidae
	Ansonia longidigita	Bufonidae
	Limnonectes kuhlii	Dicroglossidae
	Meristogenys poecilus	Ranidae

We collected swabs from 23 individuals, and no swabs tested positive for *Bd*. No swab tested positive in triplicate. Furthermore, no single well tested positive, indicating not even weak infection.

We found no evidence of *Bd* in lowland Sarawak, Malaysia or in Brunei Darussalam in this preliminary survey. Our results could be indicative of a small sample size (e.g., Skerratt et al. 2008); *Bd* may currently be present in northwestern Borneo, but we simply failed to detect it. It is also possible that the pathogen has not yet reached the region. Despite substantial fieldwork, we have never observed animals showing symptoms of *Bd*, even at higher elevation sites. *Bd* is thought to grow fastest and be most infectious at lower temperatures (Berger et al. 2004; Piotrowski et al. 2004). The lowland tropical sites we sampled are thus not the ideal habitat for *Bd*, although the fungus does survive in other lowland tropical sites (e.g., Whitfield et al. 2007); *Bd* may however be present or more prevalent at cooler upland sites within this region. We hope to collect samples from these regions in the future for further diagnosis of *Bd*.

We submit that monitoring should continue, however, because if *Bd* is present but was not detected, or if it is introduced in the future, these lowland populations may act as a reservoir (Carnaval et al. 2006; Puschendorf et al. 2006), allowing *Bd* to spread across the island, through amphibians or through humans as tourists or researchers inadvertently carrying *Bd* on boots or on cars. Moreover, several of these lowland species also can be found at higher elevations. For example, Das (2006) found several of the species sampled here within the Crocker Range National Park in Sabah, Malaysia; such wide-ranging species have the potential to carry *Bd* into pristine highland sites where temperature and humidity regimes are more likely to foster chytridiomycosis (Bickford et al. 2010). A *Bd* outbreak could decimate the amphibian fauna of the region, including many poorly-known species and many species of conservation concern. We therefore recommend continued monitoring of the amphibians of Borneo for the presence of *Bd*, with larger samples and inclusion of samples from elevations which would be likely to be conducive to *Bd* outbreaks.

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Erratum

In the most recent issue (Vol 41, no. 4, p. 402), the caption for the group photo (Fig. 1) of turtle symposium participants has two misidentifications: "Tom Herman" is actually Steve Mockford, and "unknown" beside him is Jose Lefebvre, both from Acadia University, Wolfville, NS, Canada.

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Detection of *Batrachochytrium dendrobatidis* in Anurans of Cape Cod National Seashore, Barnstable County, Massachusetts, USA

Evidence indicates that the pathogenic fungus *Batrachochytrium dendrobatidis* (*Bd;* Phylum Chytridiomycota; Longcore et al. 1999) has contributed to global declines of amphibian populations (Young et al. 2007) and may be anthropogenically introduced (Weldon et al. 2004). Because of its life history (Longcore et al. 1999), *Bd* is typically more prevalent in amphibians that are intimately tied to permanent water bodies (Kriger and Hero 2007). *Bd* appears particularly lethal to amphibians inhabiting relatively mild and stable climates (Longcore et al. 2007) and it is hypothesized that a range of environmental stressors may increase amphibian susceptibility to this disease (see Davidson et al. 2003). Additionally, it is hypothesized that global climate change may be contributing to *Bd* persistence in environments previously unsuitable for this fungus (Pounds et al. 2006). While *Bd* has been identified in amphibian populations globally (see Young et al. 2007), including parts of the northeastern United States (Longcore et al. 2007), data describing its presence in anurans of Cape Cod National Seashore (CACO; Fig. 1), Barnstable County, Massachusetts, USA are non-existent.

CACO is a ca. 17,000 ha national park that is dominated by early-successional landscapes with a multitude of permanent and temporary wetlands that support large populations of several anuran species (Paton et al. 2003), two of which are less common or extirpated (*Anaxyrus fowleri* and *Scaphiopus holbrookii*) elsewhere in New England (see Klemens 1993). CACO is a regional refuge for certain anuran species, but populations are not entirely sheltered from anthropogenic perturbations. Road mortality (U.S. National Park Service, unpubl. data), habitat changes associated with development of adjacent unprotected habitats (Tupper and Cook 2008), recreational use of breeding ponds by park visitors (Tupper et al. 2009), successional changes associated with invasive plants (Smith and Hanley 2005; Tupper and Cook 2008), and extensive predation by large populations of urban-tolerant predators (see MacIvor et al. 1990; O'Connell et al. 2006) are local stressors that contribute to anuran mortality. These stressors, coupled with the implicated effects of climate change and the potential for *Bd* transmission between wetlands by CACO visitors and employees, have the potential to act synergistically (see Alford et al. 2007; Daszak et al. 2005; Di Rosa et al. 2007; Pounds et al. 2006, 2007) to cause declines of anuran populations at CACO.

Here, our goal is to inform anuran management and conservation at CACO by determining if *Bd* is present at CACO and if *Bd* infection rates are significantly different between ecological guilds of anurans. We broadly hypothesized that *Bd* would be present at CACO and that its distributions would be dissimilar among ecological guilds, thus conforming to previously documented distributions (e.g., Longcore et al. 2007; Kriger and Hero 2007).

We opportunistically collected road-killed anurans throughout CACO (for a detailed description of the study area, see Tupper et al. [2007]; Fig. 1) in June, July and August, 2009. All anurans were handled with new latex gloves and placed in individual plastic bags prior to storage at -20°C. To assay for *Bd* presence, animals were thawed and available skin surfaces were thoroughly sampled with sterile dry swabs in March 2010 (no. MW113, Medical Wire and Equipment Company, Durham, North Carolina, USA). Sampling techniques are described by Hyatt et al. (2007). Skin swabs were placed in 1.5 mL microcentrifuge tubes containing 20 µL of proteinase K and 180 µL of digestion buffer. Samples were stored at 56°C and continuously agitated at 550 rpm on a thermomixer (Thermomixer compact, Eppendorf, Hamburg, Germany) for 24 hours. After digestion, we followed protocols from the Qiagen DNeasy kit (Qiagen ®, Valencia, California, USA) to isolate DNA in 30 µL of TE storage buffer (reduced from the protocol volume of 200 µL).

To detect *Bd*, we followed the PCR protocols of Annis et al. (2004) and employed a nested design using modifications similar to those described by Beard and O'Neill (2005) and Goka et al. (2009). Each PCR reaction had a total volume of 25 µL, which included 2 µL of template DNA, 2 µL of primers (Bd1a and Bd2a [Annis et al., 2004] in 10 µM concentrations), 12.5 µL of GreenTaq Master Mix (Promega, Madison, Wisconsin, USA), and 8.5 µL of DEPC water. We modified the thermal cycling protocol used by Annis et al. (2004) to include a +5 sec/cycle time increase to the 1-min elongation step of each cycle. All PCR reactions were visualized on 1–2% TBE or TAE agarose gels. After confirming positive test results (positive control = *Bd* type strain JEL 197) we *ad libitum* sequenced several positive samples to confirm the identity of bands in our gel assay. Resulting

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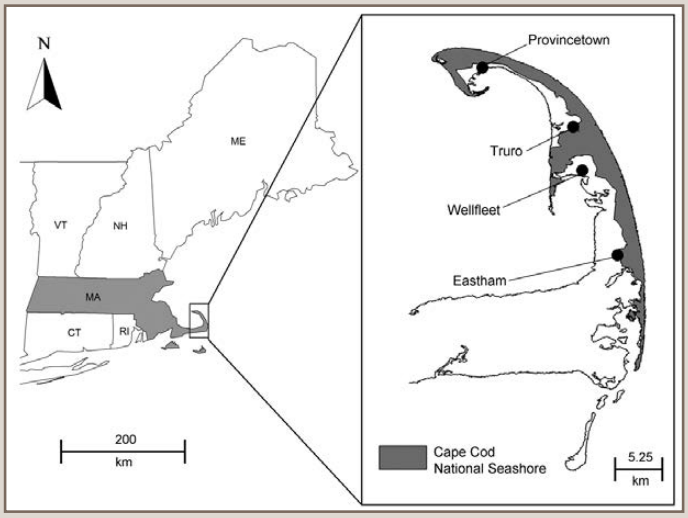


FIG. 1. *Batrachochytrium dendrobatidis* sampling locations at Cape Cod National Seashore, Massachusetts, USA. Localities (towns mentioned in text) near specimen collection sites are indicated on the Outer Cape.

DNA sequences were submitted to GenBank (HQ176488–92). DNA sequence identity was confirmed via BLAST searches in Genbank. Sequence alignments were made using the program Sequencher 4.1 (GeneCodes, Ann Arbor, Michigan, USA). We used a Fisher's exact test (Zar 1999) to assess differences in *Bd* detection rates across two broad ecological guilds (aquatic [*Lithobates* sp.] and terrestrial/arboreal [*Scaphiopus holbrookii, Pseudacris crucifer*, *Anaxyrus fowleri*]). We analyzed data with SPSS version 16 (www.spss.com).

We collected 118 road-killed specimens throughout CACO. Our sampling was distributed across the towns of Eastham, Wellfleet, Truro and Provincetown where we collected 8 (7% of total), 34 (29% of total), 11(9% of total) and 65 (55% of total) samples, respectively. The majority of specimens (N = 114) were collected between 12 July and 1 August 2009. We also used some previously collected material from 5 June 2009 (N = 1) and 2 July 2008 (N = 3). Specimens included representatives of the following species: *Anaxyrus fowleri* (N = 50; 42% of total), *Lithobates catesbeianus* (N = 18; 15% of total), *Lithobates clamitans* (N = 19; 16% of total), *Scaphiopus holbrookii* (N = 17; 14% of total), and *Pseudacris crucifer* (N = 5; 4% of total). We collected several *Lithobates* specimens (*L. catesbeianus* or *L. clamitans*; N = 9; 8% of total) that were not assignable to species because of their disfigurement. Of these specimens, 117 were used in molecular analyses. Twenty one (18%) were *Bd* positive. With the exception of a single *S. holbrookii*, all *Bd*-positive amphibians were *Lithobates* spp. (Table 1), yielding significantly more *Bd*-positive samples from anurans in the aquatic ecological guild (Fisher's exact test; $P < 0.0001$). Of the 21 samples that tested positive for *Bd*, we sequenced 5 and the positive control (SCHO-11, LICA-10, LICL-2, LICL-18, LISP-2, and JEL-197). The resulting DNA sequence for each was ca. 290 base pairs after trimming chromatogram ambiguities. We recovered 3 haplotypes among these fragments each differing by one or two single site polymorphisms.

To our knowledge, this is the first account of *Bd*-infected anurans at Cape Cod, Massachusetts. This study, therefore, provides new distributional data for *Bd* in North America and contributes to the growing pool of evidence indicating that this pathogen is generally widespread. We also document the first reported case of *Bd* detection in *S. holbrookii*. The prevalence of *Bd* infection in our study (18%) was similar to that reported in other parts of New England, USA (13.6%; Longcore et al. 2007). *Bd* detection differed by species, with detections in *L. catesbeianus* and *L. clamitans* and non-detections in *A. fowleri* corresponding to previous surveys in the northeastern United States (Longcore et al. 2007) and other parts of North America (e.g., Ouellet et al. 2005; Rodriguez et al. 2009; Rothermel et al. 2008). Infected individuals of *P. crucifer* have been documented in the southeastern United States (Rothermel et al. 2008) but, as reported here, have not been documented farther north (Ouellet et al. 2005; Longcore et al. 2007). Given our modest sample sizes, however, we cannot conclude that *Bd* is absent from any species in our study area. Our finding that most *Bd* detections were from highly aquatic species is also consistent with other studies (e.g., Longcore et al. 2007; Pearl et al. 2007; Rodriguez et al. 2009), but it is important to note that the presence of *Bd* in *S. holbrookii*, a fossorial species, demonstrates that *Bd* infection is not confined to fully aquatic anurans and, in some cases, spans ecological guilds.

Large-scale morbidity and mortality due to chytridiomycosis have not been observed in anuran species that have tested positive for *Bd* in the northeastern United States. The potential biotic and abiotic factors contributing to this trend are, however, undetermined (but see Longcore et al. 2007 for hypotheses). Also poorly understood are the long-term, sublethal effects of *Bd* in these populations and the possible synergy between *Bd* and other anuran stressors that could alter the virulence of *Bd* in the study region. Our results therefore underscore the importance of long-term monitoring of anuran populations at CACO to detect negative effects of this potentially lethal pathogen. Effective long-term monitoring is especially important for *S. holbrookii* because it is a state-listed threatened species in Massachusetts (http://www.mass.gov/dfwele/dfw/). This species is locally abundant at CACO but uncommon elsewhere in New England (Timm and McGarigal 2010) and difficult to monitor with standardized techniques (R.P. Cook unpublished). Thus, rapid declines associated with

TABLE 1. Amphibian species sampled for *Batrachochytrium dendrobatidis* (*Bd*) at Cape Code National Seashore, Massachusetts, USA.

Species	No. Sampled	No. *Bd* positive (%)
Anaxyrus fowleri	49	0
Scaphiopus holbrookii	17	1 (0.06)
Pseudacris crucifer	5	0
Lithobates catesbeianus	18	7 (0.39)
Lithobates clamitans	19	8 (0.42)
Lithobates spp.	9	5 (0.56)
Total	117	21 (0.18)

chytrid infection at CACO could go undetected and negatively impact New England populations. *Bd* detection in *L. catesbeianus* is also of particular interest because this species is considered a potential *Bd* vector (Daszak et al. 2004). Therefore, we discourage translocation of CACO anurans, particularly *Lithobates* spp., and recommend that equipment and waders be disinfected (Johnson et al. 2003) after visiting wetlands. We also encourage further quantification of *Bd* in *S. holbrookii* populations at CACO.

Unlike in studies that use living or freshly sacrificed frogs, the amount of skin surface available for swabbing in our sample was variable (based on the level of vehicular injury sustained). Inferring *Bd* zoospore load using quantitative PCR (qPCR) could have provided misleading results under these circumstances, so we chose to use the Annis et al. (2004) protocol over qPCR methods. A useful focus for future research at CACO would be *Bd* screening of live anurans from known wetlands in multiple seasons using qPCR, which would allow managers to gain an understanding of the spatial distribution of *Bd* at CACO and zoospore load across seasons.

Acknowledgments.—We are indebted to Joyce Longcore for the donation of several positive controls for this study. Laboratory access at University of Texas at Arlington was generously provided by Eric Smith. We thank Megan Tyrrell of the Cape Cod National Seashore Atlantic Research Center for helping to facilitate this project. Linda Taylor, Scott Buchanan, Megan McLean, Mary Hake, Taylor Harvey, and Kimberly Corwin provided laboratory and field assistance. Molecular aspects of this project were financially supported by a University of Texas at Arlington Phi Sigma honor society grant to JWS.

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First Case of Chytridiomycosis in an Adult Specimen of a Native Anuran from Uruguay

In Uruguay, the amphibian chytrid fungus *Batrachochytrium dendrobatidis* (*Bd*) was first detected by Mazzoni et al. (2003). They reported chytridiomycosis in a captive population of *Lithobates catesbeianus* (Anura, Ranidae) which suffered a massive death of metamorphs at a commercial farm. Later, Garner et al. (2006) also confirmed the presence of *Bd* at the same farm and in a new one. Subsequently, Borteiro et al. (2009) found *Bd* by histological analysis in the oral epithelium of native wild species larvae: *Odontophrynus maisuma* (Anura, Cycloramphidae), *Physalaemus henselii* (Anura, Leiuperidae), *Hypsiboas pulchellus* and *Scinax squalirostris* (Anura, Hylidae).

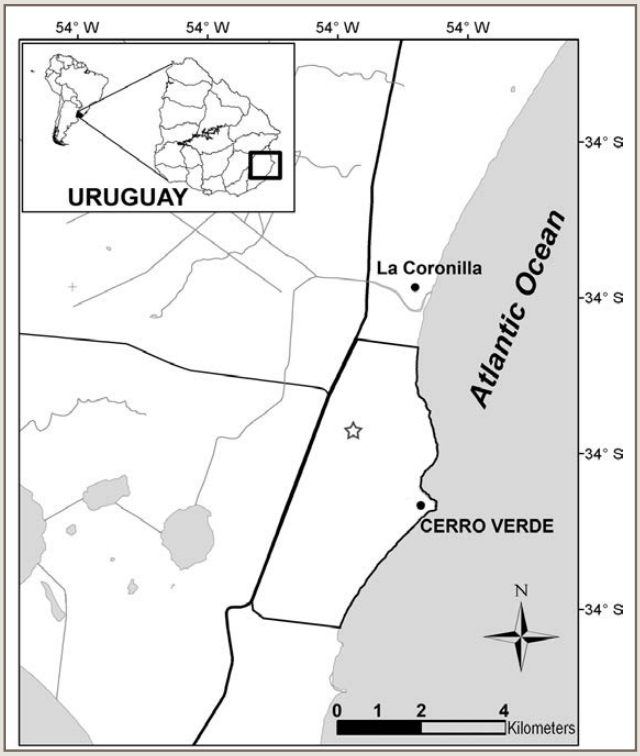


Fig. 1. Location of the Cerro Verde Protected Area, Rocha Department, Uruguay, where *Batrachochytrium dendrobatidis* was detected on *Pleurodema bibroni* (star).

We sampled native, wild amphibians for *Bd* in June 2009 at the Cerro Verde Protected Area, Rocha Department, Uruguay (33.945833°S, 53.508611°W) (Fig. 1). This area is characterized by humid subtropical climate (average temperature 16°C, annual rainfall 950 mm) and an ocean coastline with dunes (20–30 m elevation) and plains (Alonso and Bassagoda 2003). During nighttime sampling, *Pleurodema bibroni* were heard calling at a temporary pond of a coastal meadow. One frog was collected as a voucher specimen of the survey and another individual was collected under suspicion of being infected by *Bd* because it possessed some lesions on the skin (two ulcerations: on right side and dorsum, as described by Berger et al. 2005). Both specimens were taken to the laboratory and the injured frog died a few days later. Both were deposited at Vertebrate Zoology Collection, Facultad de Ciencias, Universidad de la República (ZVC-B 19776, ZVC-B 19775).

To assess the presence of *Bd* in both frogs, skin of the underside of the legs, interdigital membrane of feet, and drink patch was comprehensively swabbed (10 times ea.). Each swab was broken off into an empty Eppendorf tube, and then analyzed

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FIG. 2. Skin section of *Pleurodema bibroni* (ZVC-B 19775), collected from Cerro Verde Protected Area, Rocha Department, Uruguay, showing empty *Batrachochytridum dendrobatidis* zoosporangium (EZ) and zoosporangium containing zoospores (Z), one with a discharge tube (DT). Scale bar: 20µm.

for the presence of *Bd* DNA using qPCR (Boyle et al. 2004). *Bd* infection was also analyzed histologically. Abdominal and hind limb ventral skin patches (~5 × 10 mm) and two toe tips were excised from the anurans and routinely processed for histological examination following Berger et al. (1999).

Both analyses (qPCR and histology) were *Bd*-positive only for the apparently healthy specimen. Zoospores and zoosporangia at different stages were found at multiple sections of toe tips and hind limb of the infected individual, and some degree of hyperkeratosis at the sections from hind limbs of the specimen was found (Fig. 2).

This is the first record of *Bd* in an adult native wild-caught amphibian in Uruguay, and the first report of *Bd* infection for *Pleurodema bibroni*. This frog is considered Near Threatened by the IUCN Red List (IUCN 2006) and is Threatened at a country level for Uruguay (Maneyro and Langone 2001; Canavero et al. 2010). The pathogen was detected 100 km northeast of the nearest record in Uruguay (Borteiro et al. 2009) inside a Protected Area, which is both alarming and suggests that measures for control and prevention of human-mediated *Bd* dispersal warrant consideration. This is particularly important because populations of other native species in the area, such as *Melanophryniscus montevidensis* (Núñez et al. 2004), may be at risk (IUCN RED LIST: Vulnerable; IUCN 2006).

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Resumen.—En Uruguay la infección causada por *Batrachochytrium dendrobatidis* (*Bd*) había sido detectada en *Lithobates catesbeianus* de criaderos comerciales y en larvas silvestres de especies autóctonas, pero no había sido confirmada aún en ejemplares adultos de ninguna especie nativa. En junio de 2009 se colectaron dos machos adultos silvestres de *Pleurodema bibroni* en el Cerro Verde (33.935°S, 53.5070556°W, Rocha, Uruguay), se les tomaron muestras para análisis de ADN (qPCR) para detectar *Bd*. Uno de ellos resultó positivo y el análisis histológico de la piel del ejemplar también confirmó la infección. Por tanto se diagnostica por primera vez la infección por *Bd* en adultos silvestres de esta especie en Uruguay, que además está considerada como *Amenazada* a nivel nacional y *Near Threatened* para la IUCN.

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First Survey of the Chytrid Fungus, *Batrachochytrium dendrobatidis*, in Amphibian Populations of Gabon, Africa

First associated with amphibian declines in 1998 from amphibian populations in Australia and Panama, the amphibian chytrid fungus *Batrachochytrium dendrobatidis (Bd)* has since been detected in amphibian populations in all continents except Antarctica, and additional mass-mortalities thought to be caused by *Bd* are continually being observed (Berger et. al. 1998, 2004; Bosch et. al 2001; Lips 1998; Lips et al. 2003, 2006). Weldon et al. (2004) found *Bd* on amphibian specimens collected from South Africa in the 1930s, the earliest date of a *Bd* record, and suggested that *Bd* originated in the continent of Africa. Analyses of museum specimens by Soto-Azat (2010) corroborated this hypothesis. Yet to date, *Bd* surveillance in Africa has been limited. The few studies that have been carried out have confirmed the presence of *Bd* in Africa, including: 1) in Uganda, six amphibian species tested positive for *Bd* (Goldberg et. al. 2007); 2) in Kenya, *Bd* was found in all of amphibian populations sampled in several habitat types (Kielgast et. al. 2010); 3) in eastern Democratic Republic of Congo, *Bd* was detected in two species (Greenbaum et al. 2008); and 4) evidence of *Bd* was found in amphibians in Okomu National Park, Nigeria (Imasuen 2009; Reeder et al., *in press*). In light of the confirmed existence of *Bd* in Africa, regions where data are lacking warrant surveys for this pathogen.

Gabon is located in the equatorial region of the Atlantic coast of Central Africa (Fig. 1), contains an exceptionally high diversity of amphibian species (IUCN 2004), and is in close proximity to the West African forests that have been denoted a global biodiversity "hotspot" (Myers et al. 2000). Yet to date, no *Bd* sampling has been conducted in Gabon. In fact, there are remarkably few published reports of *Bd* surveys from the tropical forests of Central and West Africa (www.Bd-maps.net): two studies in Cameroon (Blackburn et al. 2010; Dougherty-Bone et al. 2008) and one study in the Democratic Republic of Congo (DRC) (Greenbaum et al. 2008). Our aim was to determine the incidence of *Bd* in amphibian populations in Gabon. The results of our study contribute to the expanding body of literature on the global distribution of *Bd* and aid the determination of priority areas for amphibian conservation in equatorial Africa.

Surveys were conducted from July through September 2008, months coinciding with the dry season, in three regions of Gabon: Lastoursville (-0.816815°S, 12.708026°E), located on the banks of the Ogooué River in eastern Gabon; Lebamba (-2.210605°S, 11.476516°E); and the Station d'Etudes des Gorilles et Chimpanzés (SEGC), located within the 4970 km^2 Lopé National Park (0.166667°S, -0.266667°E) (Fig. 1). The Lastoursville and Lebamba region contain extensive Guineo-Congolian tropical forest (Plana 2004), though much of our sampling occurred in villages and agricultural areas that have been cleared of forest. SEGC lies in a lowland area featuring savannah patches that are interspersed with gallery forests and small forest fragments, referred to locally as "bosquets." Flanking the savannahs is a block of continuous forest in various stages of succession but typically Marantaceae and mature forest (Dowsett and Dowsett-Lemai 1991; White and Abernethy 1997; Christy and Wilmé 2003). Surveys were performed in conjunction with a survey of caves in this country, and thus, surveys focused on cave-dwelling species. With the exception of the Grotte de Lastoursville, the caves that were surveyed were located within the vicinity of Lebamba, including: the Grotte de Lebamba, the Dilime de Mutsobulu, the Grotte de Bangouéguelé, the Grotte de Munganga, the Grotte de Diengu, and the Grotte de Mbenaltembe (for detailed account of each cave, see Frost and Testa 2009). In general, the caves were moist and had flowing water. During the wet season, many of these caves flood entirely. Local villagers and bat hunters occasionally frequent the caves, but none were developed for tourism. Caves were typically surrounded by forestland, except the Grotte de Diengu, which was located in an agricultural field.

Sampling for amphibians was performed in an opportunistic manner along roads and trails, around cave entrances, and inside cave chambers. A tissue sample was collected from each captured individual by rubbing a sterile cotton swab over the ventral side of the body and thighs (20 strokes) and the webbing of the hind feet (10 strokes). Swabs were placed into microcentrifuge tubes, stored in freezers at SEGC and later exported to the Museo Nacional de Ciencias Naturales in Madrid (CSIC), Spain. Here, swabs were analyzed for the presence of *Bd* following Boyle et al. (2004). Positive controls were not used, but samples that tested positive for *Bd* from other surveys were included in the same analysis. That samples in the same plate tested positive confirms the functionality of the analysis. Geographic coordinates were recorded for each capture location using a Global Positioning System (GPS). When animals were captured inside a cave, coordinate locations of the cave entrance were used. Photographs of each morphotype were taken for subsequent species identification.

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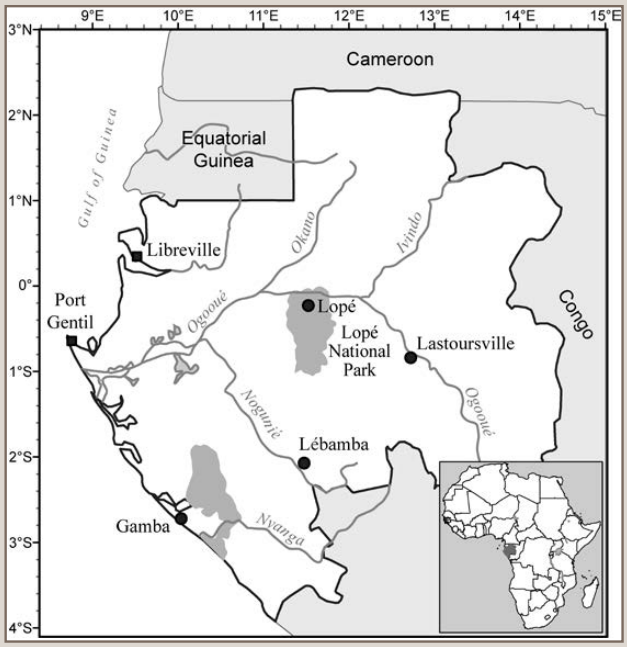


FIG. 1. Locations of Lastoursville, Lebamba, and Lopé National Park, Gabon, where amphibians were sampled for *Batrachochytrium dendrobatidis*.

Fifty adult frogs were captured throughout the study period, 29 of which were cave-dwelling species. Five individuals were captured in the area of Lastoursville. Of these five individuals, two *Amietophrynus* cf. *camerunensis* and one *Arthroleptis poecilonotus* were encountered along dirt roads and walking paths surrounding the town. One *Ptychadena aequiplicata* was found approximately 150 m inside the Grotte de Lastoursville.

In the Lebamba region, 35 amphibians were captured. Seven *Petropedetes* cf. *vulpiae* were found at the entrance of the Grotte de Lebamba. Three *Phrynobatrachus* cf. *auritus* were captured along a logging road that led to the cave entrance. Four amphibians were found in open grassy areas: two *Amietophrynus maculates* and two *Arthroleptis poecilonotus*. Six *Petropedetes* cf. *vulpiae* were found at the entrance of the Grotte de Bangouéguelé. One *Petropedetes* cf. *vulpiae* was found at the Dilme de Mutsobulu. Six *Petropedetes* cf. *vulpiae* were captured in the Grotte de Munganga/Iduku. When sampling in the Grotte de Diengu, seven *Phrynobatrachus* cf. *auritus* were captured. One *Petropedetes* cf. *vulpiae* was captured at the Grotte de Mbenaltembe under a rock pile at the entrance of the cave. In this region, all cave-dwelling frogs were found within the first 15 m of the cave entrance under rock piles or inside nooks in the cave walls.

In Lopé National Park, 10 *Cardioglossa leucomystax* were captured. Except for one individual, which was captured along a dirt road leading to the SEGC biological station, these frogs were found along sandy streambanks in maratanacae forest.

Bd was not detected in any of the 50 samples collected from these animals. Comparing these results to surveys done in other Central African countries, our findings mirror those from surveys in the neighboring country of Cameroon, where *Bd* was absent as well (Blackburn et al. 2010; Doherty-Bone et al. 2008), but differ from the surveys done in eastern DRC, where *Bd* was detected (Imausen 2009; Reeder et al., *in press*). Despite our findings, continued surveillance of *Bd* in Gabon and the Central African region is warranted. Skerratt et al. (2008) reported that 59 animals should be sampled to detect *Bd* when prevalence is low, hence we cannot rule out the possibility that *Bd* occurs on our sampled species at our sampled sites in Gabon at a low prevalence rate. Furthermore, in an extinction-risk assessment for *Bd*, Gabon occurred in an area of both high susceptibility to *Bd* and high amphibian richness (see Figure 2B in Rödder et al. 2009). Thus, our report should not discourage future surveys of *Bd* prevalence in Gabon but rather act as a reference by which to plan and execute more focused and expansive *Bd* monitoring activities in this region.

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Batrachochytrium dendrobatidis Not Detected on Amphibians from Two Lowland Sites in Gabon, Africa

Batrachochytrium dendrobatidis (*Bd*) is behaving as an invasive pathogen in many parts of the new world where it has been associated with massive amphibian declines in native populations (Berger et al. 1998; Lips et al. 2006; Lips et al. 2008; Soto-Azat et al. 2010). *Bd* has also been found on various Pipidae species in South Africa, Uganda, Malawi and Cameroon from as early as the 1930s, suggesting a widespread historical prevalence on the continent (Soto-Azat et al. 2010; Weldon et al. 2004). Despite these observations, many areas in Africa have not been systematically surveyed for *Bd*. Contemporary *Bd* distribution data are sorely lacking in West and Central Africa, including for Gabon (http://www.bd-maps.net). Yet, such data may prove critical in assessing the risk of *Bd* infection to amphibians on the continent, and identifying its ultimate origin.

In November to December 2009, we surveyed amphibians for *Bd* at two lowland areas in Gabon (Fig. 1). The first site was located in the SW region of the country around the town of Gamba (2.78676°S, 0.04551°E; elevation 0–100 m). The area is a coastal plain covered by a mosaic of rainforest patches interspersed with open, seasonally inundated grasslands (Alonso et al. 2006). The second site was at the Libreville campus and surrounding areas of L'Ecole Nationale des Eaux et Forêts training center in the NW region of the country (0.6030167°N, 9.3372667°E; elevation 0–100 m). It is covered by primary and secondary rainforest with many streams, but most amphibians at this site were found in temporary wetlands formed in open grassy areas adjacent to the forest. At each site we opportunistically searched for amphibians in forests, streams, wetlands and ditches. Amphibians were captured with a gloved hand and were brought indoors for processing where they were swabbed with a sterile cotton swab (10 strokes on the belly and thigh,

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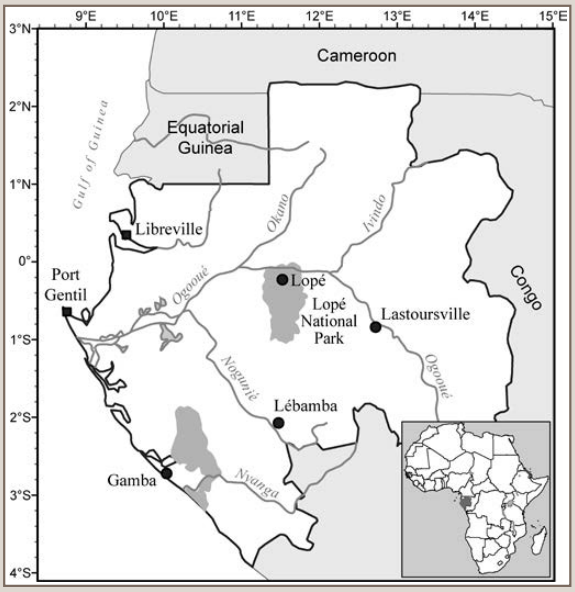


FIG. 1. Locations of Libreville and Gamba, Gabon, where amphibians were sampled for *Batrachochytrium dendrobatidis*.

TABLE 1. Amphibian species tested for *Batrachochytrium dendrobatidis* (*Bd*) at two sites (Gamba and Libreville) in Gabon.

Species	Gamba	Libreville	*Bd* positive
Afrixalus dorsalis	3	7	0
Amietophrynus regularis	4	0	0
Chiromantis rufescens	0	5	0
Hoplobatrachus occipitalis	6	0	0
Hyperolius spp.	10	32	0
Hyperolius tuberculatus	2	9	0
Hyperolius cf. *cinnamomeoventris*	3	1	0
Hyperolius nasutus	25	2	0
Hyperolius phantasticus	15	0	0
Hyperolius platyceps	1	0	0
Leptopelis aubryi	1	1	0
Leptopelis sp. (juvenile)	2	0	0
Phlyctimantis leonardi	6	2	0
Phrynobatrachus auritus	1	0	0
Ptychadena sp.	1	5	0
Xenopus epitropicalis	6	2	0
Totals	86	66	0

and five strokes on each foot). Swabs were stored in tissue buffer prior to DNA extraction. Specimens were identified to the extent possible in the field using a small reference collection of specimens housed on site at Gamba. We retained 129 specimens for the Smithsonian's National Museum of Natural History (USNM 578099 – 578232) Washington, DC, USA. We swabbed and released an additional 24 *Hyperolius* spp. at Libreville.

Each swab was incubated in an oscillating thermal incubator at 56°C and 350 rpm in 400 µl of buffer ATL (Qiagen) and proteinase K (Qiagen) for 24 h. After incubation, DNA was extracted from the lysate solutions using a Qiagen Biosprint 96 DNA Blood Kit according to the manufacturer's instructions for "extraction from buccal swabs." Extracted DNA was eluted in 200 µl of AE buffer (Qiagen) and stored at 4°C prior to further analysis. To ensure successful DNA extraction, a fragment of 16s mRNA was amplified for each sample, including negative controls (N = 10), and visualized on 2% agarose gels. Testing for the presence of *Bd* was performed using a Qiagen QuantiTect SYBR Green PCR Kit using the primers ITS1-3 Chytr and 5.8s Chytr, developed by Boyle et al. (2004). To identify potential false positive and false negative results, two positive and two negative controls were included in every PCR reaction; false positive/negative results were not obtained.

A total of 86 frogs from Gamba and 66 frogs from Libreville were sampled, represented by five families (Table 1); all were *Bd*- negative. We used a binomial distribution to calculate the maximum potential prevalence rate using a 95% confidence limit with our sample of 0 infected swabs (successes) from 152 frogs (trials). Assuming 100% *Bd* detectability on all animals swabbed, we can be 95% confident that—if *Bd* is present in wild frogs at these two sites—prevalence rates are lower than 2%. While we cannot rule out non-detection as a reason for its supposed absence, we can say that if *Bd* is present, its prevalence in this region is extremely low and thus unlikely to be having any significant ecological impact on the sampled populations. These data as well as those of Daversa et al. (2011, this issue) therefore lend support to climate models which predict *Bd* has a low probability of affecting amphibian populations in lowland areas (Rödder et al. 2009).

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First Record of the Chytrid Fungus *Batrachochytrium dendrobatidis* in North Africa

An important driver of amphibian declines is chytridiomycosis, a disease caused by the pathogen *Batrachochytrium dendrobatidis* (*Bd*; Berger et al. 1998; Bosch et al. 2001; Collins and Storfer 2003; Daszak et al. 1999, 2003; La Marca et al. 2005; Ron and Merino-Viteri 2000; Ron et al. 2003; Wake and Vredenburg 2008; Walker et al. 2010). *Bd* is now known to be an emerging pathogen that is rapidly expanding its global range (Fisher et al. 2009) and now has attained a global distribution on all continents that contain amphibians (www.bd-maps.net). Research by Weldon et al. (2004) on the potential origin of *Bd* suggests that the panzootic originated in South Africa and has perhaps been dispersed by international trade in amphibians, becoming established around the world (Rödder et al. 2009). To date, the rapid and widespread distribution of *Bd* infection across hundreds of amphibian species is alarming.

In Spain, outbreaks of chytridiomycosis and mass mortalities has been reported in many species and in different regions of the country (Bosch et al. 2001; Bosch and Martínez-Solano 2006; Walker et al. 2008, 2010). In the south of Spain, *Bd* is widely distributed (www.bd-maps.net); Bosch et al., unpubl. data), suggesting that its occurrence in northern Morocco is plausible. The two regions are spatially proximate with similar Mediterranean ecologies, however, they are separated by the Straits of Gibraltar. In addition, ecological niche modelling has shown that the environmental envelope in northern Morocco is suitable for the establishment of *Bd* where susceptible amphibians occur (Rödder et al. 2009; Ron 2005). The legal and illegal increase in the transport of animals for pet trade (Fisher and Garner 2007), and the possibility that the fungus could be vectored into Morocco on the feathers of water birds, are potential modes of transmission between Spain and Morocco. However, no systematic surveillance for *Bd* has been undertaken across this region, where several endemic species occur with a high ecological value. The aim of the present study is to conduct the first survey for *Bd* in northern Morocco to determine the presence, prevalence, and intensity of infection in the amphibian populations that occur within the region. These data will allow us to understand the distributional patterns of *Bd*, providing essential data for the effective management and control of this emergent pathogen.

Surveys for *Bd* were conducted between October 2005 and April 2009. During this period, we prospected the north of Morocco which is primarily a mountainous area (central-western Rif and north part of middle Atlas). Samples from the plain of Gharb and the Mammora regions were provided by P. de Pous (University of Applied Science van Hall-Larenstein, the Netherlands). The Rif region forms a mountainous barrier that is relatively low in elevation (less than 2500 m) with approximately half of the surface occurring above 500 m. It is an extension of the Baetic Cordillera, which includes the Sierra Nevada in the south of Spain. The area is a sub-wet zone with an average annual rainfall between 800 and 1400 mm (Bab Taza: 1361 mm/year), and probably reaches 2000 mm on the highest summits, and wetlands are common. In comparison, the coastal fringe is dry, where rainfall does not reach 500 mm (Oued Laou, 473 mm). Across the coast, the summer is moderate in temperature (Oued Laou, mean maximum temperature of the hottest month: 28.6°C), however weather stations located inland record

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much higher temperatures (Chefchaouen, mean maximum temperature of the hottest month: 33.8°C). In general, winter is the season when thermal contrasts are most variable, according to the altitude and of the distance of the sea. The coastal fringe has a mild winter (Oued Laou, mean minimum temperature of the coldest month: 7.2°C), with high-altitude areas recording harsher winters (Bab Taza, mean minimum temperature of the coldest month: 2.3°C). Separated from the Rif region by the corridor of Taza, the middle Atlas is the westernmost of three Atlas Mountains chains existing in Morocco. Its geomorphologic structure is primarily constituted by limestone (with an altitude more than 3000 m) and volcanic plates. The western façade, with the oceanic influence, is the most humid part (approximately 1000 mm/year). More continental than Rif, the middle Atlas experiences harsh winters, with snow occurring above 2000–2500 m elevation. The Riffian and the middle Atlas forests are rich and are characterized by a gradient of elevation on which are overlaid continental, oceanic, and Mediterranean influences. The plain of Gharb and the forest of Mammora are located at the northwest of Morocco. The first is a basin characterized by a Mediterranean-type climate with an oceanic influence. The east-west rainfall gradient varies between 450 and 530 mm, with 80% of the total rainfall occurring during the winter. In its south, the forest of Mammora is located in the semi arid bioclimatic zone. It is in extreme limit of the natural distribution surface of the Mediterranean cork oak. This marginal geographical location makes this ecosystem particularly fragile. All of these prospected ecosystems are indispensable for animal species, particularly amphibians, and are experiencing increasing deterioration under the effect of sustained anthropogenic pressures.

Amphibian specimens were collected opportunistically from 28 sites on the Rif region, 11 sites on the middle Atlas and 12 sites on the Gharb plain and Mammora forest (Table 1; Fig. 1). During nocturnal and occasional diurnal surveys, we extensively searched all water bodies that exist in the survey areas for amphibian larvae. We also searched for adults in the areas surrounding ponds. Immediately after capture, we took samples including toe clippings from adults and swabs from the mouthparts from tadpoles (MW100-100; Medical Wire & Equipment Co, Corsham, UK). Toe clippings were preserved in 70% ethanol for laboratory analysis. After sampling, animals were returned to their place of capture. The intensity of infection was subsequently assessed in the laboratory using the quantitative PCR (qPCR) protocol described by Boyle et al. (2004).

We sampled 203 amphibian specimens representing six families and nine species captured from 51 sites (Table 1). Of these, 96 specimens were collected in the Rif mountains, 42 in the Middle Atlas and 64 in the Gharb plain. *Bd* was confirmed in just four amphibians collected from three sites (Table 1, Fig. 1); *Bd* was found in *Discoglossus scovazzi* in the Tetouan region and in *Hyla meridionalis* and *Pelobates varaldii* in the Larache-Lakser Lakbir region (total prevalence 6%). Rare detection of the fungus occurred, with 1/1 in Agnane (intensity of infection: 29.9 genome equivalents, GE), 2/5 in Larach-Lakser lakbir (intensity of infection: 60.3 and 395.9 GE) and 1/10 in Larach (intensity of infection: 0.4 GE), demonstrating a low prevalence of infection for the fungus across these three sites.

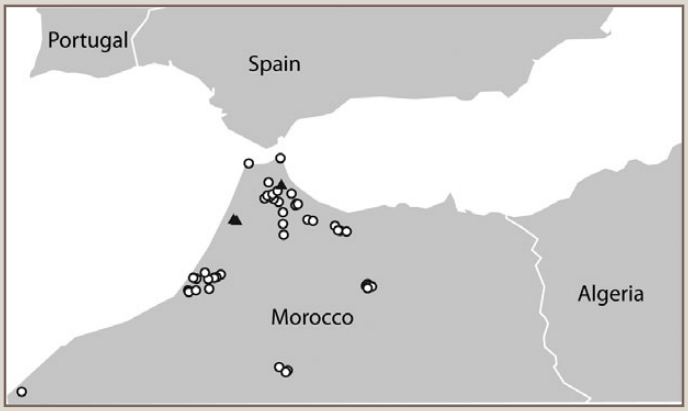


FIG. 1. Map of northern Morocco showing *Batrachochytrium dendrobatidis* (*Bd*) sampling locations that were *Bd*-positive (closed triangle) and *Bd*-negative (open circles).

In Morocco, many populations of amphibian species are endangered and local declines of several species have been principally attributed to two threats: habitat destruction and pollution. However, no work has been conducted previously to assess the presence of *Bd* on the amphibians living in the country. In our study, we confirm the presence of *Bd* in Morocco and consequently in North Africa. This region of the world is not free of *Bd*, a finding that is in accordance with the models of Ron (2005) and Rödder et al. (2009), which predicted suitable habitats for *Bd* in north Morocco. The niche distribution models of Ron (2005) assigned a maximum overlap index of 1 to this region, which means that 10 of 10 models predicted the survival of *Bd*, should susceptible amphibian species exist.

The presence of *Bd* in Morocco and particularly in the north part of the country can be explained by several mechanisms. The presence of chytrid fungus in peninsular Iberia, especially in the south of Spain where it is broadly distributed, may have been vectored to the northern part of Morocco by anthropogenic or natural processes. For example, during a survey in southern Spain performed in 2004, 31% of 86 collected samples and 29% of 17 sampled localities were *Bd*-positive (Bosch et al., unpubl. data). The border between the two countries experiences the extensive transport of industrial and agricultural products and animals across the straits of Gibraltar. Moreover, the presence of two Spanish enclaves at the north of Africa without customs and borders with the remainder of continental Spain makes the possible contamination of North Africa by *Bd* more real. However, natural vectors may also transport *Bd*. The fungus is able to survive and remain infectious for 3–6 weeks in the environment in the absence of an amphibian host (Johnson and Speare 2003), may attach to plant debris and microorganisms within sterile environments, and can perhaps persist in soil as do some other members of the phylum Chytridiomycota (Johnson and Speare 2005). These life-history characteristics of chytrid fungi allow prediction (and possible prevention) of its potential accidental transport via the movement of soil such

TABLE 1. Localities in northern Morocco where amphibians were sampled for *Batrachochytrium dendrobatidis* (*Bd*). Species: Am- *Alytes maurus*, Ds- *Discoglossus scovazzi*, Bm- *Bufo mauritanicus*, Sa- *Salamandra algira*, Hm- *Hyla meridionalis*, Ps- *Pelophylax saharicus*, Bb- *Bufo bufo*, Pb- *Pseudepidalea boulengeri* (= North African populations of *Bufo viridis* s.l.), Pv- *Pelobates varaldii*, Pw- *Pleurodeles waltl*. Life history stage (LHS): A- adult, L- larvae, J- juvenile, M- metamorph. N = sample size, IA = number of infected animals, range of *Bd* infection loads (*Bd* IL) in genomic equivalents detected using quantitative PCR.

Date	Coordinates (UTM format)	Species	LHS	N	IA	*Bd* IL
Nov 2006	Near Talambote (30S 301325, 3901676)	*Ds*	A	3	0	-
Nov 2006	Near Talambote (30S 296364, 3918812)	*Am*	PM	1	0	-
		Ds	A	1	0	-
Nov 2006	Remilate, Tanger (30S 243011, 3968202)	*Bm*	A	1	0	-
Nov 2006	Lahcen, between Tanger and Tetouan (30S 267670, 3937240)	*Sa*	A	4	0	-
			PM	2	0	-
Nov 2006	Agnane, near Tetouan (30S 283666, 3935092)	*Ds*	PM	1	1	10–50
Nov 2006	Koudiate Drup (30S 267908, 3914926)	*Hm*	A	1	0	-
Nov 2006	Moulay Abdesalam (30S 273019, 3911252)	*Sa*	A	5	0	-
		Ds	A	1	0	-
Nov 2006	Koudiate Sbaa (30S 316198, 3877741)	*Ds*	A	4	0	-
			J	2	0	-
		Sa	A	5	0	-
Nov 2006	West Ketama (30S 351185, 3867558)	*Ds*	A	1	0	-
Nov 2006	West Ketama (30S 358428, 3859824)	*Ds*	A	1	0	-
Nov 2006	West Ketama (30S 351309, 3867347)	*Sa*	A	1	0	-
Nov 2006	West Ketama (30S 357507, 3860272)	*Am*	A	1	0	-
Nov 2006	Akchour, Talambote NP (30S 301325, 3901676)	*Ps*	PM	12	0	-
Nov 2006	Akchour, Talambote NP (30S 302760, 3903012)	*Am*	PM	2	0	-
Nov 2006	Jbel Moussa, Near Ceuta (30S 283414, 3974434)	*Ds*	A	3	0	-
		Sa	A	1	0	-
Feb 2007	20k from Larache-Lakslakbir (29S 76944, 3881906)	*Ds*	A	1	1	50–100
		Hm	A	4	1	100–500
Feb 2007	Between Zinate and Larache (30S 278118, 3923873)	*Bm*	A	2	0	-
Feb 2007	Between Zinate and Larache (30S 271385, 3918656)	*Bm*	A	2	0	-
Feb 2007	Between Zinate and Larache (30S 265300, 3916882)	*Bm*	A	4	0	-
Feb 2007	Between Zinate and Larache (30S 261159, 3912327)	*Bm*	A	1	0	-
Feb 2007	Mokrissat (30S 284012, 3871774)	*Am*	PM	1	0	-
Feb 2007	Jebel Sunna, near Chefchaouén (30S 284719, 3890398)	*Sa*	PM	1	0	-
Feb 2007	near Bab Bouidir (30S 395460, 3770906)	*Am*	L	21	0	-
Aug 2007	Bab Bouidir (30S 397165, 3770577)	*Hm*	A	1	0	-
Feb 2007	Tazekka NP (30S 392482, 3769065)	*Sa*	A	1	0	-

TABLE 1. Continued.

Date	Coordinates (UTM format)	Species	LHS	N	IA	*Bd* IL
Aug 2007	Tazekka NP (30S 394293, 3771325)	*Ps*	A	1	0	-
		Bb	A	1	0	-
Aug 2007	Tazekka NP (30S 394480, 3772051)	*Ps*	A	1	0	-
			J	2	0	-
		Ds	J	1	0	-
Aug 2007	Tazekka NP (30S 393337, 3771961)	*Bb*	A	1	0	-
Aug 2007	Tazekka NP (30S 392652, 3774512)	*Am*	L	4	0	-
Aug 2007	Tazekka NP (30S 390033, 3772458)	*Sa*	L	3	0	-
		Ds	J	1	0	-
Sep 2007	Between Tlet and Zerkat (30S 366709, 3858627)	*Ds*	J	1	0	-
Sep 2007	Between BabTaza and Chefchaouén (30S 323068, 3875857)	*Ps*	L	13	0	-
		Ds	J	1	0	-
Sep 2007	Near Talambote (30S 302161, 3901983)	*Am*	L	1	0	-
Sep 2007	Way to Souk Khemis-des-Beni-Arouss (30S 279104, 3905682)	*Ds*	J	10	0	-
Dec 2008	Between Khenifra and Itzer (30S 274115, 3647848)	*Bv*	A	1	0	-
Dec 2008	Between Khenifra and Itzer (30S 284069, 3642310)	*Ds*	J	2	0	-
Dec 2008	Between Khenifra and Itzer (30S 284992, 3642900)	*Ds*	J	2	0	-
Jan 2009	South Sidi Yahya al Rharb (29S 747855, 3788587)	*Pv*	L	1	0	-
Jan 2009	East Salé (29S 712135, 3765885)	*Pv*	L	2	0	-
Jan 2009	East Salé (29S 712108, 3767089)	*Hm*	L	1	0	-
		Pw	A	1	0	-
Feb 2009	South Oualidia (29S 493990, 3607337)	*Pb*	L	1	0	-
Mar 2009	Mamora forest (29S 721979, 3786336)	*Pv*	L	5	0	-
Mar 2009	Mamora forest (29S 732621, 3796472)	*Pv*	L	5	0	-
Apr 2009	Mamora forest (29S 732621, 3796472)	*Pv*	L	5	0	-
Apr 2009	Mamora forest (29S 739204, 3771390)	*Pv*	L	5	0	-
Apr 2009	Larache (29S 771002, 3881305)	*Pv*	L	10	1	0–10
Apr 2009	South Sidi Yahya du Rharb (29S 753741, 3793514)	*Pv*	L	5	0	-
Apr 2009	South Sidi Yahya du Rharb (29S 745156, 3787886)	*Pv*	L	2	0	-
		Ps	A	3	0	-
Apr 2009	West Sidi Allal el Bahraoui (29S 722308, 3768165)	*Hm*	L	4	0	-
		Pv	L	4	0	-
Apr 2009	East Kénitra (29S 737246, 3785471)	*Pv*	L	5	0	-
Apr 2009	South Kénitra (29S 718310, 3787768)	*Pv*	L	6	0	-
Apr 2009	South Taza (30S 397532, 3772137)	*Sa*	A	1	0	-

as in extraction industries, in contaminated soil on vehicles or footwear of hikers, or in plant nursery products (Johnson et al. 2003; Johnson and Speare 2005; Laurance et al. 1997). However, the dissemination by water birds through the migration routes between Europe and Africa via the Gibraltar strait may be responsible for facilitating the spread of the pathogen across this region, and this process is largely uncontrollable, rendering effective biosecurity of northern Africa unlikely.

Our surveys were by no means exhaustive and further research on both the distribution and effect of the pathogen across this region is needed. Our data show: 1) three *Bd*-positive sites (1/1 in Agnane, 2/5 in Larach-Laks lakbir, and 1/10 in Larach); and 2) a clustering of *Bd* in the western part of northern Morocco, just in the south of Tangitana peninsula (Fig. 1). This distribution supports the hypothesis of a dissemination of *Bd* from the Iberian Peninsula to northern Morocco. However, confirmation of this hypothesis awaits molecular typing of isolates of *Bd* that have been recovered from these infected Moroccan populations.

Our results suggest a systematic survey of the area is warranted in order to determine the exact situation in the region. Furthermore, biosecurity and population management measures warrant consideration to prevent further amphibian species loss owing to this emergent pathogen.

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Ranavirus Infection in Die-offs of Vernal Pool Amphibians in New York, USA

Amphibian ranaviruses have an apparently wide distribution in North America. The type virus in the genus *Ranavirus*, frog virus 3 (FV3), was isolated from aclinically infected leopard frogs (*Lithobates pipiens*) collected in Wisconsin and Minnesota in 1962 (Granoff et al. 1965). Since then, FV3-like viruses have been identified in California (Mao et al. 1999), Saskatchewan (Schock et al. 2008), Tennessee (Gray et al. 2007), North Carolina (Petranka et al. 2003), Alabama and Arkansas (Wolf et al. 1969), Ontario (Greer et al. 2005), Vermont (Clark et al. 1968), and Maine (Bank et al. 2007). To date, however, ranaviruses have not been reported from amphibians in New York State, although they have been isolated from Eastern Box Turtles (*Terrapene carolina carolina*) on Long Island, New York (Johnson et al. 2008). Here we report that FV3-like ranaviruses are widespread in New York State and associated with recurrent die-offs of larval Spotted and Jefferson Salamanders (*Ambystoma maculatum* and *A. jeffersonianum*) and Wood Frog tadpoles (*Lithobates sylvaticus*) in vernal pools.

During routine monitoring of vernal pools for amphibian breeding from May through early July in 2008 and 2009, we noted die-offs in several vernal pools in four locations in New York: the Albany Pine Bush, the Huntington Wildlife Forest in the Adirondack Mountains, the Teatown Lake Reservation in the lower Hudson Valley, and the Mohonk Preserve in the Shawangunk Mountains.

In each case, live larvae or tadpoles were haphazardly collected by hand or with a dip net, sent to the laboratory of JLB in pond water on ice, and frozen at -80°C until they could be screened for ranavirus infection. Samples were collected opportunistically and so sample sizes varied and were generally small. Samples from the Albany Pine Bush and Teatown Lake Reservation were bagged by pond rather than individually such that their independence cannot be guaranteed. Care was taken, however, to prevent contamination between ponds by disinfecting sampling equipment between ponds with a 10% bleach solution.

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In early to mid-May 2008, KEB and CG visited a pond and vernal pool (ca. 150 m apart) located in the Albany Pine Bush where essentially every tadpole (apparently all *L. sylvaticus*) visible from shore or caught with a dip net was moribund or dead. The tadpoles had edema, diffuse petechial lesions along the ventral surface, especially near the cloaca and base of the tailfin, and about a third had a torn peritoneum, apparently because their abdomens were severely bloated. Similar mortality events were not observed in these two ponds during the two or three visits per breeding season in the previous several years. In 2009, both ponds dried by mid June, earlier than usual, and no apparent disease-associated mortality was noted.

In mid-June 2008, SAM observed dying *L. sylvaticus* tadpoles in three of eight vernal pools that have been regularly monitored for amphibian breeding in the Huntington Wildlife Forest (HWF), Essex County, New York, in the Adirondack Mountains. Moribund (listless, occasionally edematous, with petechial lesions) and apparently healthy *A. maculatum* larvae as well as *L. sylvaticus* tadpoles were collected from four vernal pools, one of which had obvious signs of mortality (pond VP65-2; named according to a grid at the HWF) and three of which did not (VP43-2, VP73-3, and VP70-1). In VP65-2, an apparently healthy adult, female Green Frog (*L. clamitans*) was captured by hand and a toe-clip was taken with a sterile razor blade. On 10 June 2009, moribund and dead *L. sylvaticus* tadpoles were found in two ponds that were sampled the previous year (VP43-2 and VP65-2) and one that had not (VP42-1). Five live tadpoles were collected across all three ponds.

On 19 June 2008, MJR noticed dead wood frog tadpoles in a vernal pool (HV2) at the Teatown Lake Reservation, in Westchester County, New York in the lower Hudson Valley; many more dead tadpoles were observed 26 June. On 30 June 2008 one to two live individuals per species were collected from each of five ponds: three (HV2, HV3, and HV4) where dead and dying *Ambystoma* larvae, probably *A. maculatum*, were noted, along with apparently healthy Grey Tree Frog tadpoles (*Hyla versicolor*), and two (CL1, and DH2) where dead *L. sylvaticus* tadpoles were found. One other vernal pool observed on that day did not have signs of mortality and no samples were collected from it. Five of seven vernal pools at Teatown Lake Reservation had die-offs of amphibian larvae in early July 2009 as well, but samples were not collected.

On 15 June 2009, MBK found a die-off in the James Stokes vernal pool in the Mohonk Preserve, Ulster County. Many dead *L. sylvaticus* tadpoles were found as well as apparently healthy and moribund *A. maculatum* and *A. jeffersonianum* larvae. Two

TABLE 1. *Ranavirus* infection status, no. positive samples/no. tested, of amphibian samples from New York, USA examined using both PCR of the MCP gene and virus isolation with cell culture. Parentheses represent animals that were transported in the same container; cross contamination cannot be ruled out. # indicates MCP gene was sequenced. * indicates lateral halves of the same individuals were tested by PCR.

Site	Date	Pond	Coordinates	Species	PCR	Cell culture
Albany Pine Bush						
	11 May 2008	Pond1	42.7016°N, 73.8615°W	*Lithobates sylvaticus*	(9/10)#	—
		Pond2	42.7012°N, 73.8683°W	*L. sylvaticus*	(1/10)# & (0/4)	(6/6)
Huntington Wildlife Forest						
	24 June – 3 July 2008	VP43-2	43.9838°N, 74.2048°W	*Ambystoma maculatum*	0/1	—
				L. sylvaticus	0/5	—
		VP65-2	43.9825°N, 74.2330°W	*A. maculatum*	3/3#	—
				L. sylvaticus	0/5	—
				L. clamitans adult	1/1	—
		VP73-3	44.0091°N, 74.2226°W	*L. sylvaticus*	0/1	—
		VP70-1	43.9842°N, 74.2230°W	*A. maculatum*	1/3#	—
	10 June 2009	VP42-1	43.9831°N, 74.2070°W	*L. sylvaticus*	—	2/2
		VP43-2	43.9838°N, 74.2048°W	*L. sylvaticus*	—	0/1
		VP65-2	43.9825°N, 74.2330°W	*L. sylvaticus*	—	2/2
Teatown Lake Reservation						
	30 June 2008	CL1	41.2076°N, 73.8562°W	*L. sylvaticus*	(0/2)	(2/2)*
		HV2	41.2148°N, 73.8220°W	*L. sylvaticus*	0/1	—
		HV3	41.2154°N, 73.8218°W	*Ambystoma* spp.	(2/2)#	(2/2)*
		HV4	41.2144°N, 73.8217°W	*Ambystoma* spp.	(2/2)#	(1/1)*
				H. versicolor	(0/2)	—
		DH2	41.2024°N, 73.8263°W	*Ambystoma* spp.	(1/2)#	—
Mohonk Preserve						
	17 June 2008	James Stokes	41.8038°N, 74.1120°W	*A. maculatum*	—	2/2
				A. jeffersonianum	—	2/2

of each ambystomatid species were collected alive, all with lesions and two with slight edema by the following day. Apparently healthy *H. versicolor* tadpoles and later metamorphs, and *L. clamitans* tadpoles were observed in this pond during periodic sampling at James Stokes vernal pool throughout the rest of the summer. No morbidity or mortality was noted during a visit two weeks earlier, or at another study site, North Mud pond. These two ponds had been studied extensively in the previous two years, but this was the first time a die-off was observed.

The carcasses or, for larger animals, one lateral half of a carcass was ground in cell lysis buffer with ca. 1 ml silicone-carbide sharp particles (1 mm diameter) using a Bead Beater 96 (Biospec Products, Bartlesville, Oklahoma, USA) and digested with 10 µl Proteinase K. DNA was then extracted using a standard salt extraction protocol (Sambrook and Russell 2001). In order to minimize surface contamination, the samples from Teatown and the Albany Pine Bush, which were bagged and transported in groups, were surface sterilized with a 10% solution of commercial bleach in water and then rinsed with distilled water before being placed in an individual tube and extracted. It is impossible, however, to guarantee independence among these samples. Animals from the Adirondacks and Mohonk Preserve were individually bagged.

Samples were screened with PCR using primers MCP4 and MCP5 (Mao et al. 1997), which target a ca. 500 bp region of the 5' end of the major capsid protein (MCP) gene. PCR products were separated by gel electrophoresis on 1.5% agarose gels and visualized with ethidium bromide staining. Samples were tested at least twice, but up to four times to resolve ambiguous or contradictory results, and scored by majority rules.

PCR products from two *L. sylvaticus* from the Albany Pine Bush, two *A. maculatum* from the Huntington Wildlife Forest, and three *Ambystoma* sp. from the Teatown Lake Reservation (Table 1) were purified using the QIAEX II gel extraction kit (Qiagen, Valencia, California, USA) and submitted to the Nevada Genomics Laboratory for sequencing in the forward direction. Sequences were aligned using Geneious 4.0.2 (Biomatters Ltd.) resulting in a common 471 bp of sequence.

Virus isolation was attempted in the laboratory of JLB on six dead *L. sylvaticus* tadpoles from the Albany Pine Bush; five moribund *L. sylvaticus* tadpoles from the Huntington Wildlife Forest; one moribund and one dead *A. maculatum* and two moribund *A. jeffersonianum* larvae from the Mohonk Preserve; and the un-extracted lateral halves of two *L. sylvaticus* tadpoles and three *Ambystoma* larvae from the Teatown Lake Reservation (Table 1). Samples were homogenized in 5% fetal bovine serum in minimum essential medium with Hanks salts (HyClone, Ottawa, ON, Canada) in tubes filled with silicone-carbide sharp particles (Biospec Products) using a Mini-Beadbeater-96 (Biospec Products). The homogenates were then filtered

through a 0.45-µm filter and inoculated onto *epithelioma papulosum cyprini* (EPC) cells. Samples were passed twice, except for the sample from VP43-2 in which bacterial contamination prevented a second pass, and observed for signs of cytopathic effects using an inverted light microscope at 100× magnification. Isolation of ranavirus was verified using PCR, as above.

Twenty-two of 57 animals tested positive for ranavirus with PCR and ranavirus was isolated from 19 of 20 animals, including the lateral halves of two tadpoles that were negative by PCR (Table 1). Animals from all three regions tested positive, including *Ambystoma* larvae and *L. sylvaticus* tadpoles, as well as the toe of one adult *L. clamitans*, which consistently produced weakly visible bands. Given our small samples sizes, imperfect diagnostic tests (Greer and Collins 2007), and because these samples were collected opportunistically from die-offs, which can occur very rapidly and last for only two or three weeks (Gray et al. 2009), it seems likely that our data underestimate the prevalence, geographic range, and host range of these ranaviruses. Indeed, ranaviruses have been identified in all of the species we tested (Duffus et al. 2008; Gray et al. 2009), even though we never detected ranavirus in *H. versicolor*.

The major capsid protein (MCP) gene sequences of all eight sequenced samples were identical to each other and to the published sequence of Frog Virus 3 (GenBank accession # AY548484) across all 471 bases. It is not clear whether these virus isolates are in fact a single, widespread virus. The MCP is highly conserved among ranavirus species, and so sequence data from the MCP gene alone is not sufficient to differentiate species (Chinchar et al. 2009). Moreover, Schock et al. (2008) have shown that ranavirus isolates with identical MCP sequences can have distinct restriction profiles and perhaps different ecology interactions. Isolates from *L. sylvaticus* and *A. maculatum* collected from two vernal pools in the Teatown Lake Reservation, however, were statistically indistinguishable in terms of the rate and timing of mortality that they caused in an LD_{50} study in *L. sylvaticus* (Warne et al. 2010) and *A. maculatum* (JLB, unpubl. data). Further study is required to determine whether there is one widespread or many, somewhat distinct ranaviruses in New York State.

We must emphasize that while ranaviruses are known to cause catastrophic mortality in larval amphibians (Gray et al. 2009) and several of the virus isolates we collected are highly lethal (Warne et al. 2010) we did not screen for other agents or complete a post mortem exam on these larvae and so we cannot conclude that ranavirus was the cause of these vernal pool die-offs, but merely that amphibians were infected with ranavirus during these die-offs. Whatever the cause, these were not the first die-offs noted in the Huntington Wildlife Forest, which has been systematically monitored for breeding activity every year since the mid 1990s. There was a report of "red-leg," which can be associated with ranaviral disease (Green et al. 2002), in *L. sylvaticus* tadpoles during mortality events in 1999 and 2000 (Quail 2001). Similarly, a die-off of *L. sylvaticus* tadpoles and *A. maculatum* larvae was observed in 2006, with moribund animals showing similar signs of infection as seen in the 2008 and 2009 die-offs. It is worth noting that there is no obvious sign of declines in breeding output in the vernal pools of the Huntington Wildlife Forest (SAM, unpubl. data). Moreover, die-offs may not be completely catastrophic to recruitment. Pond VP65-2, which had a die-off in mid-June of 2008, produced *L. sylvaticus* metamorphs by mid-July.

In summary, FV3-like ranaviruses were identified in live and dead *Ambystoma* larvae and *L. sylvaticus* tadpoles during mortality events in vernal pools across New York State. These epidemics and the occurrence of ranavirus recurred in the same ponds over two years, as has been observed elsewhere (e.g., Petranka et al. 2007). It remains to be determined whether these virus isolates represent a single widespread virus or whether there are several closely related strains of ranavirus with different ecologies. It is clear, however, that these virus isolates are capable of infecting multiple hosts. Whether they were the cause of the die-offs we observed or have long-term impacts on their host populations is not known, but the potential for ranaviruses to cause catastrophic mortality has been established (Gray et al. 2009; Green et al. 2002; Teacher et al. 2010). We urge amateur and professional biologists working in vernal pools in New York State to take basic steps to prevent the spread of these highly lethal viruses including washing and disinfecting boots and equipment between sites and taking care not to move water, sediment, or organic materials between ponds (Bryan et al. 2009; Green et al. 2009).

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NATURAL HISTORY NOTES

The Natural History Notes section is analogous to Geographic Distribution. Preferred notes should 1) focus on observations in the field, with little human intrusion; 2) represent more than the isolated documentation of developmental aberrations; and 3) possess a natural history perspective. Individual notes should, with few exceptions, concern only one species, and authors are requested to choose a keyword or short phrase which best describes the nature of their note (e.g., Reproduction, Morphology, Habitat, etc.). Use of figures to illustrate any data is encouraged, but should replace words rather than embellish them. The section's intent is to convey information rather than demonstrate prose. Articles submitted to this section will be reviewed and edited prior to acceptance. Notes concerning captive animals should be directed to our Herpetoculture section (see inside front cover for section editor contact information).

Electronic submission of manuscripts is requested (as Microsoft Word or Rich Text format [rtf] files, as e-mail attachments). Color figures can be submitted electronically as JPG files, although higher resolution TIFF or PDF files will be requested for publication. Please DO NOT send graphic files as imbedded figures within a text file. Additional information concerning preparation and submission of graphics files is available on the SSAR web site at: http://www.ssarherps.org/HRinfo.html. Manuscripts should be sent to the appropriate section editor: **Jackson Shedd** (crocodilians, lizards, and *Sphenodon*; jackson.shedd@gmail.com); **Charles Painter** (amphibians; charles.painter@state.nm.us); **J. D. Willson** (snakes; hr.snake.nhn@gmail.com); and **James Harding** (turtles; hardingj@msu.edu).

Standard format for this section is as follows: SCIENTIFIC NAME, COMMON NAME (for the United States and Canada as it appears in Crother [ed.] 2008. *Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico*. SSAR Herpetol. Circ. 37:1–84, available from SSAR Publications Secretary, ssar@herplit.com; for Mexico as it appears in Liner and Casas-Andreu 2008, *Standard Spanish, English and Scientific Names of the Amphibians and Reptiles of Mexico*. Herpetol. Circ. 38:1–162), KEYWORD. DATA on the animal. Place of deposition or intended deposition of specimen(s), and catalog number(s), if relevant to your report. Then skip a line and close with name and address in full—spell out state or province names—no abbreviations. References may be briefly cited in text (refer to this issue for citation format).

Recommended citation for notes appearing in this section is: Medina, P., and R. L. Joglar. 2008. *Eleutherodactylus richmondi*: reproduction. Herpetol. Rev. 39:460.

CAUDATA — SALAMANDERS

***AMBYSTOMA OPACUM* (Marbled Salamander). ALBINISM.** On 27 Sept 2009, I captured a gravid adult female (ca. 9.5 g) *Ambystoma opacum* in a wetland located at Bear Hollow Wildlife Management Area in Franklin Co., Tennessee, USA that was completely void of any pigmentation (Fig. 1) and is, therefore, a complete albino (e.g., complete lack of melanin, red eyes: Hensley 1959. Publ. Mus., Michigan State Univ. 1[4]:133–159). The albino, and 17 other gravid females displaying typical pigmentation, was captured in a pitfall trap as they migrated to a wetland (35.02035°N, 86.01425°W).

Various forms of albinism in *A. opacum* have been documented in both the larvae and adults, in populations from six states. Dyrkacz (1981. Recent instances of albinism in North American amphibians and reptiles. Society for the Study of Amphibians and Reptiles. 31 pp.) reported three larvae in Maryland and eight larvae in Mississippi.



FIG. 1. A) Albino gravid female *Ambystoma opacum* found in Franklin County, Tennessee. Note the complete lack of body pigmentation. B)Closeup of head showing red eyes.

Partial albinism in larvae has been documented in Rhode Island and Connecticut (Deegan et al. 1998. Herpetol. Rev. 29:229). Mitchell and Church (2002. Banisteria 20:67–69) collected two larval leucistic *A. opacum* in Virginia and stated this form of albinism rarely occurs in nature. Walston and Regester (2004. Herpetol. Rev. 35:365) reported partial albinism in larvae and a gravid female from a population in Illinois. A frequency of 0.24 for the occurrence of an albino phenotype was reported for the Illinois population (Walston and Regester 2004, *op. cit.*). I examined 9387 Marbled Salamanders at this wetland (5031 adults, 4356 metamorphs) between December 2007 and May 2010 and this was the only individual exhibiting any form of albinism, further illustrating the rarity in which albinism occurs in this species. To my knowledge, this is not only the first report of albinism in *A. opacum* for Tennessee, but also the first report range-wide of a complete albino gravid female.

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***EURYCEA BISLINEATA BISLINEATA* (Northern Two-lined Salamander). LARVAL PREDATION.** *Eurycea bislineata* is a semi-aquatic plethodontid salamander at the northeastern extreme of its geographic distribution in Québec and New Brunswick, Canada (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, D.C. 587 pp.). Terrestrial predators of both larval and adult *E. bislineata* include Common Garter Snakes (*Thamnophis sirtalis*) (Uhler et al. 1939. Trans. Fourth North American Wildlife Conference. Washington, D.C.). Spring salamanders (*Gyrinophilus porphyriticus*) are known to prey on larval *E. bislineata* (Wright and Haber 1922. Copeia 105:31–32; Bishop 1941. The Salamanders of New York. New York State Mus. Bull. 324), and Rainbow Trout have been observed feeding on *E. bislineata* (Mathews 1982. J. Tennessee Acad. Sci. 57:82–83).

American Eels (*Anguilla rostrata*) are known to be generalist predators, consuming a variety of aquatic invertebrates, insects, and small fish (Lookabaugh and Angermeier 1992. J. Freshwater Ecol. 7:425–431; Denoncourt and Stauffer. 1993 Am. Midl. Nat. 129:301–308; Daniels 1999. Diet of American Eels [*Anguilla rostrata* LeSueur] in Five Freshwater Lakes, Maine, USA. Ph.D. dissertation, Univ. Maine, Orono. 61 pp.); however, amphibians have not been observed in eel diets. Here we document the first reported incidence of eel predation on amphibians. One *E. bislineata* larva (32.5 mm TL, 17.1 mm SVL) was recovered undigested from the stomach of an American Eel (354 mm TL, 61.8 g) captured as bycatch from a Fisheries and Oceans Canada juvenile salmonid assessment on 20 Aug 2009 in the Nashwaaksis River, York County, New Brunswick, Canada (46.08059°N, 66.76832°W). The stomach of this eel contained only the *E. bislineata* larva. Identification was based on comparisons with collections in the New Brunswick Museum. The *E. bislineata* larva was deposited in the New Brunswick Museum (NBM 9142).

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***TYLOTOTRITON ASPERRIMUS* (Black Knobby Newt). REPRODUCTION.** *Tylototriton asperrimus* is distributed in Central and South China, reaching the southwestern limit of its range in the northernmost provinces of Vietnam (Nguyen et al. 2009. Herpetofauna of Vietnam, Edition Chimaira, 768 pp.). Chinese literature (Fei [ed.] 1999. Atlas of Amphibians of China. Henan Science and Technology Press, Zhengzhou, China) reports clutches of 30–50 eggs, 3–4 mm in diameter, with light brown animal pole and creamy white vegetable pole, laid under fallen leaves on pond embankments some distance away from the water. The same literature refers to an aquatic phase of the adult salamanders, but reproductive activity has not been observed.

On 12 May 2010 we found an adult *T. asperrimus* (Fig. 1) 75 mm SVL, 145 mm total length, under a large rock in a marshy area where part of the forest was cleared at Pia Oac, SW of Tinh Tuc at 1596 m altitude, in the province of Cao Bang (22°60.556N, 105°87.530E) in northern Vietnam. Air temperature was 22–24°C, humidity 70–75%. Some 30 m further, by turning stones we discovered two assemblages of 123 total eggs, possibly representing two clutches. One assemblage was found in moist soil under a stone sticking out from the side of a forested slope (Fig. 2); the other was situated above the same stone, between the stone and adjacent undergrowth. The diameter of the egg capsule was 10–11 mm. Judging by the shape of the creamy white embryos in the transparent jelly capsules, we estimated the eggs were about one week old. The closest water body was a shallow (5–10 cm deep) puddle formed by rain water in a car track on a path, measuring 200 × 60 cm, water temperature was 17°C, pH 6.4, KH 0–3, GH <3. The stone was situated beside, and not directly above the puddle, on a slope overgrown with ferns and bamboo. On a vertical plane, one egg assemblage was some 20 cm removed from the level of the puddle, the other 50 cm. With the ensuing rainy season, the volume of the puddle would probably increase and rains would flush the emerging larvae from their capsules. NTT found 12 adult males, one female, and 24 larvae in the same puddle in early June



FIG. 1. Adult *Tylototriton asperrimus* found under a stone at Pia Oac, Cao Bang, Vietnam.



FIG. 2. Egg clutch of *Tylototriton asperrimus* found under a stone at Pia Oac, Cao Bang, Vietnam.

COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND



FIG. 3. Larvae of *Tylototriton asperrimus* in a car track puddle at Pia Oac, Cao Bang, Vietnam, 2009. Photo by Nguyen Thien Tao.



FIG. 4. Eggs and recently hatched larva of *Tylototriton asperrimus* from Pia Oac, Cao Bang, Vietnam.

2009, when the water level was higher (Fig. 3). Approximately 10 m further down there was a marshy area ca. 30 × 30 m with a small stream and several small pools with submerged and bordering vegetation. We did not find eggs, larvae, or adults there.

This discovery of eggs on land is comparable to an earlier find of *T. asperrimus* eggs on Mt. Tay Con Linh in Vi Xuyen district, Ha Giang province, Vietnam. Those eggs, believed to represent five clutches, were found 5 cm underground, adjacent to a small, temporary forest pool at 1700 m elev. (Bain and Nguyen 2004. Am. Mus. Novit. 3453:1–42).

We collected some of the eggs from the assemblage to study further development. On hatching the larvae measured 21–22 mm, had a long pigmented tail, no remains of yolk, no balancers, and four well-developed legs (Fig. 4). They were very agile and strong enough to actively flip from the spoon by which they were handled.

On the basis of a number of physiological and ecological similarities some authors have included *T. asperrimus* in the genus *Echinotriton* (Zhao and Hu 1988. Studies on Chinese Salamanders 12–26; Zhao and Adler 1993. Herpetology of China. Society for the Study of Amphibians and Reptiles, 522 pp.; Yu and Zhao 2005. Sichuan J. Zool. 24:646–650). One of these similarities is the laying of large eggs in one clutch on land, under a surface of fallen leaves. Larvae of *T. asperrimus* hatch at an advanced stage of development, and have resorbed the balancers, just like larvae of *E. chinhaiensis* (Cai and Fei 1984. Acta Herpetol. Sinica 3:71–78). Hatchling larvae of both *Echinotriton* species are known to migrate to the water body by making active leaping or wriggling movements (Utsunomiya et al. 1979. Proc. Japan Acad. 54[1978]:341–346; Xie et al. 2000. Herpetol. J. 10:111–118). We believe that hatchlings of *T. asperrimus* are capable of doing the same.

If adult *T. asperrimus* enter the water, it is difficult to imagine what else they would do there apart from breeding and/or foraging. *Echinotriton* species never enter the water. So in this respect *T. asperrimus* is more similar to other species of *Tylototriton*, which typically enter water for breeding. It looks like the reproductive mode of *T. asperrimus* is situated somewhere between that of other *Tylototriton* and *Echinotriton*. We anticipate that future observations will provide additional information.

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ANURA — FROGS

***BUFO PUNCTATUS* (Red-spotted Toad) and *THAMNOPHIS CYRTOPSIS* (Black-necked Garter Snake). PREY-PREDATOR.** Several species of anurans breed in ephemeral rock pools in the American Southwest (Dayton and Fitzgerald 2001. Oecologia 129:430–435). These species breed explosively when ephemeral habitats fill and then rapidly complete development prior to pool drying. The advantage of breeding in ephemeral pools is that most aquatic predators require permanent water to complete their life cycle. However, predators that can effectively forage in ephemeral pools can potentially take advantage of an abundant food source.

On 3 July 1999, rock pools in Blackwater Canyon, Peloncillo Mountains, New Mexico, USA (31°30.465'N, 109°00.615'W, WGS84) filled overnight after a storm delivered 1.2 cm of rain. On 3 and 5 July we collected adult *Bufo punctatus* that had been preyed upon (or scavenged) by adult Sonoran Mud Turtles (Ligon and Stone 2003. Herpetol. Rev. 34:241–242), suggesting that breeding for this species began immediately after the pools filled. On 8 July 1999, we captured a juvenile *Thamnophis cyrtopsis* (165 mm SVL; 49 mm tail length; 3.0 g) in a rock pool. While we were examining the snake, it regurgitated 35 *B. punctatus* tadpoles, six of which were still alive. We collected 24 tadpoles, and assigned Gosner stages to 21 of these. The other tadpoles were too badly decomposed to collect or stage. Gosner stages ranged from 26–29 with a mode of 28 (N = 10 tadpoles), indicating that tadpoles were midway through development. The snake was measured and released, and the 24 tadpoles were deposited in the Herpetology Division of the University of Central Oklahoma Natural History Museum (UCO 803).

Thamnophis cyrtopsis is a well-known tadpole predator, and there are several observations of it preying on *B. punctatus* tadpoles (Rossman et al. 1996. The Garter Snakes: Evolution and Ecology. University of Oklahoma Press, Norman, Oklahoma. 332 pp.). Our observation adds to this database and provides a time frame

for the latency to response to the environmental cue (rainfall) that made the interaction possible.

We thank Mike O'Brien for field assistance and Erica Becker for assigning Gosner stages to the tadpoles. Fieldwork was conducted under permits issued by the New Mexico Department of Game and Fish and the U.S. Forest Service. The Office of Research and Grants at the University of Central Oklahoma provided financial support for fieldwork.

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***CRAUGASTOR ALFREDI ALFREDI* (Northern Alfred's Rainfrog). PREDATION.** Because anurans often are locally abundant, small to moderate in size, and have soft skin, they are common prey for a variety of predators of all classes of vertebrates, as well as some arthropods. Various species of predaceous spiders feed on anurans (Menin et al. 2005. Phyllomedusa 4[1]:39–47). In some cases the frogs are caught in webs and subsequently killed and eaten, but crab spiders, tarantulas, and other hunting spiders spring on anuran prey, grasp them, and kill by injection.

On 11 Nov 2009, I found a partly-eaten *Craugastor alfredi alfredi* in Cañón del Metlac (18.9029°N, 97.0062°W, 800 m elev.), Ixtaczoquitlán, Veracruz, México. The frog was found on a banana tree leaf, and nearby was a female hunting spider, *Cupiennius salei* (species identification based on Benítez and Castañeda 1994. La Ciencia y El Hombre 16:37–48), which had partially consumed the frog. Because of the posture of the frog and the removed skin on the posterior part of the body, I suspect that it was attacked from behind. Photographs of the frog and the spider were deposited in the Colección de Anfibios y Reptiles, Facultad de Biología, Campus Peñuela, Universidad Veracruzana. The frog measured 46 mm SVL; cephalothorax to abdomen length of the spider was 44 mm. Identification of the frog was verified by Uri Omar García Vázquez.

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***DUTTAPHRYNUS SCABER* (Ferguson's Toad). PREDATION BY BEETLES.** Invertebrate predation of vertebrates is widely known (Duellman and Trueb 1986. Biology of Amphibians. John Hopkins Univ. Press, Baltimore, 670 pp.). Beetle predators that specialize on vertebrates are uncommon (McCormick and Polis 1982. Biol. Rev. 57:29–58). Even rarer and little known are the beetle parasitoids of vertebrate hosts (Eggleton and Belshaw 1993. Biol. J. Linn. Soc. 48:213–226). Both adult and larval carabid beetles have been documented eating frogs (Littlejohn and Wainer 1978. Vict. Nat. 95:251–252; Ovaska and Smith 1988. Can. J. Zool. 66:599–604), but larvae in the carabid tribes Brachinini, Chlaeniini, Lebiini, and Peleciini exhibit more specialized predatory and parasitoid life cycles (Brandmayr et al. 2010. Zootaxa 2388:49–58; Erwin and Erwin 1976. Biotropica 8[4]:215–224; Frank et al. 2009. ZooKeys 14:1–36; Saska and Honek 2008. Ann. Entomol. Soc. Amer. 101[3]:533–538). The documented larvae of Peleciini and Lebiini are primarily ectoparasitic on chrysomelid beetle larvae and pupae, but a few non-chrysomelid hosts are known—other beetles (Dytiscidae, Endomychidae, and Hydrophilidae), mole crickets (Gryllotalpidae), and a millipede.

The documented chlaeniine larvae consume frogs and toads. Two blood-feeding carabid larvae were reported parasitizing a toad in South Africa (Moore 1971. Ann. Nat. Mus. 20:479–482). *Chlaenius darlingensis* Castelnau was reported as consuming *Crinia signifera* (Eastern Common Froglet) and *Uperoleia laevigata* (Smooth Toadlet) (Robertson 1989. Herpetol. Rev. 20:7–8; Toledo 2005. Herpetol. Rev. 36:395–400). Another chlaeniine, larvae of *Epomis nigricans* Wiedemann, was reported eating frogs: *Hyla* sp. and *Rhacophorus schlegelii* (Schlegel's Green Tree Frog) (Shiina and Tachikawa 1998. Abstracts 48th Ann. Meet. Entomol. Soc. Japan; Tachikawa 1994. Atlas 48th Spec. Exhib. Otaru Museum, Otaru), and both tadpoles and adults of *Pelophylax nigromaculatus* (= *Rana nigromaculata*; Toledo 2005. J. Zool. 271:170–177; Toshiaki 2006. Bull. Herpetol. Soc. Japan 2:99–100) in Japan. Elron et al. (2007. Herpetol. Rev. 38[1]:30–33) reported the biology of *Epomis dejeani* Dejean and *Epomis conscriptus* (Duftschmid) whose larvae attack adult frogs, *Pseudepidalea viridis* (= *Bufo viridis*; Green Toad) and *Hyla savignyi* (Yellow Lemon Tree frog), in Israel. Here we report another specialized carabid larval predator of an adult toad from India (Fig. 1).

The observation and photograph were made around 1000 h, 1 April 2008, near Karanji Lake, campus of the Regional Museum of Natural History, Mysore, Karnataka, India, 12°18.333'N, 76°40.45'E. The lawn was not well-maintained, and grasses and bushes along with scattered puddles provided good habitat for many insects. VB startled the toad, which appeared lean and jumped sluggishly; then he noticed the larva protruding from the abdomen. The photograph was taken but no specimens were collected. Kotambylu Vasudeva Gururaja, an expert on the regional herpetology at the Indian Institute of Science, Bangalore, identified the toad as *Duttaphrynus scaber*. *Duttaphrynus scaber* is found in India (Orissa State and southwards) and at lower elevations of Sri Lanka (view distribution at http://berkeleymapper.berkeley.edu/). CSC identified the larva as Carabidae based on her work with other carabid parasitoids of Chrysomelidae; given that only chlaeniines have been documented consuming frogs in this way, our larva is likely a chlaeniine but we cannot go further with an identification.

Elron et al. (2007, *op. cit.*) revealed that an individual *E. dejeani* larva may use up to four frogs to complete the life cycle; the 1st instar is ectoparasitic, feeding on body fluids, while the 2nd and 3rd instars chew body tissues. Toledo et al. (2005, *op. cit.*) termed this behavior "temporary specialized predators." It is a challenging question whether such specialized feeding represents an evolutionary step towards parasitoidism, in which one individual completes its life



FIG. 1. *Duttaphrynus scaber* from southern India with a carabid larva parasitoid embedded in the abdomen. Photo by V. Barve.

cycle on one host (Eggleton and Belshaw 1992. Phil. Trans. R. Soc. B 337:1–20).

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***ECNOMIOHYLA MIOTYMPANUM* (Small-eared Treefrog) and *CHARADRAHYLA TAENIOPUS* (Porthole Treefrog). REPRODUCTIVE BEHAVIOR.** *Ecnomiohyla miotympanum* and *Charadrahyla taeniopus* are endemic to the Atlantic Versant in the Sierra Madre Oriental of México (Duellman 2001. The Hylid Frogs of Middle America. Society for the Study of Amphibians and Reptiles, in cooperation with the Natural History Museum of the University of Kansas. 1170 pp.). Male *E. miotympanum* reach 38.4 mm SVL, and attract females by means of an advertisement call, whereas acoustic communication for mate acquisition in *C. taeniopus* (whose females are 70 mm SVL) does not seem to be important (Duellman 2001, *op. cit.*). Despite these differences in size and presumably in reproductive behavior, here we report an observation of amplexus between these two hylid frogs.

On 30 Oct 2009, we surveyed anurans along the Apulco River (19°57'N, 97°32'W; 1041 m elev.), located in the Sierra Norte of Puebla, México. At 0008 h, one of us (FGVC) found a male *E. miotympanum* in amplexus with a female *C. taeniopus*, on a stone at the river's edge (Fig. 1). Although the couple was manipulated, they remained in amplexus during the observation period which lasted for at least 23 min. We cannot be certain how long the frogs remained in amplexus after our observations. This kind of interspecies interaction may increase the risk of predation, and implies an unsuccessful time investment that otherwise could be utilized for mating with conspecific individuals (Butler 2007. Herpetol. Rev. 38:444; Höbel 2005. Herpetol. Rev. 36:55–56). Indeed, if gamete release occurred, it would mean a considerable loss of energy, at least for the female.

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FIG. 1. Male *Ecnomiohyla miotympanum* in amplexus with a female *Charadrahyla taeniopus* found in the Sierra Norte of Puebla, México.

***ENGYSTOMOPS PUSTULOSUS* (Tungara Frog). PREDATION.** On 1 Aug 2010 at 2000 h local time, at Parque Nacional Palo Verde, Provincia Guanacaste, Costa Rica (10.34459°N 85.34080°W), we observed a large belostomatid (giant water bug) predating an adult male *Engystomops pustulosus* (Fig. 1). This took place in a flooded roadside ditch, in close proximity to several calling male *E. pustulosus*. We did not observe the bug seize the frog, but the frog appeared fresh and alive (though not moving), and was presumed to have been recently captured. As we photographed the bug, it swam away with the frog still in its grasp, and we presume that it consumed the frog. Belostomatids are among the most common invertebrate predators of frogs, and the ecologically similar *Physalaemus cuvieri* has been observed to fall prey to these insects (Toledo 2005. Herpetol. Rev. 36:395–400). However, this is the first observation of predation of *E. pustulosus* by a belostomatid. Two species of *Lethocerus* are reported from Costa Rica: *L. medius* (Guérin-Méneville) and *L. collosicus* (Stål) (Perez-Goodwyn 2006. Stutt. Beiträge zur Natur. 695:1–71). The belostomatid reported here was large (> 8 cm), and well outside the reported geographic range of *L. medius*. Because of its size and the geographic region, the tentative identification of this insect is *L. collosicus*.



FIG. 1. Belostomatid (likely *Lethocerus collosicus*) predating *Engystomops pustulosus*.

We thank Christiane Weirauch (University of California, Riverside) for additional bug identification consultation for this note. This observation was made under RESOLUCIÓN No 018-2009-ACAT (MINAET, Ministry of Environment, Energy, and Telecomunications) while conducting research funded by the NSF IRES grant to the Organization for Tropical Studies.

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***HYLA CINEREA* (Green Treefrog). WINTER AGGREGATION.** Hibernation site selection is poorly known for adult North American treefrogs, and true winter aggregation has not been reported. Here, I report a winter aggregation of *Hyla cinerea* in southern Louisiana, USA.

At 1230 h on 28 Dec 2009, I discovered 31 adult-sized *H. cinerea* between two 0.5 × 61 × 244 cm plywood boards (air temperature

TABLE 1. Hibernation sites for adult North American treefrogs (*Hyla* and *Pseudacris*). In the "N" column, groups of individuals found together are separated by a comma.

Species	Locality	Month/ season	°C	N	Habitat	Reference
H. andersonii	Georgia	winter	—	1	under bark	Neill 1948. Herpetologica 4:107
H. chrysoscelis	Ohio	Dec	4	1, 1, 1, 1, 1	leaf litter at base of tree	Burkholder 1998. Herpetol. Rev. 29:231
H. chrysoscelis	Tennessee	Oct	15–30	1, 1, 1, 1	treehole	Ritke and Babb 1991. Herpetol. Rev. 22:5
H. cinerea	Louisiana	Dec	5	31	elevated wood pile	This study
H. cinerea	Illinois	Nov Feb Jan	20 — 16	2 1 1–5	cliff face crevices, under talus in holes	Garton and Brandon 1975. Herpetologica 31: 150
H. cinerea	Georgia	winter	—	2–3	decaying tree under bark	Neill 1948, *op. cit.*
H. femoralis	Georgia	Dec	—	1	decaying log	Neill 1948, *op. cit.*
H. gratiosa	Florida	Dec	14	1	ground, under bark	Franz 2005. Herpetol. Rev. 36:434
H. squirella	Georgia	winter	—	1	decaying log	Neill 1948, *op. cit.*
H. versicolor	Louisiana	Jan	16	3, 4	treehole	Fontenot 2003. Herpetol. Rev. 34:358
P. cadaverina	California	fall–winter	4–19	40, each	rock crevices	Harris 1975. Herpetologica 31:236
P. regilla	California	Feb	9	1	under weeds, in water	Brattstrom and Warren 1953. Copeia 1955:181

5.3°C). The boards were among ~20 others in a pile stored ~1 m above the ground, under the west side a house that was elevated 4 m on pilings. Natural ground elevation was ~0.5 m, thus the frogs' refuge was ~1.5 m above sea level, in an area largely surrounded by brackish marsh and open waterways. The pile of boards had been in the weather for at least 6 months, and had warped to form ~1 cm crevices between them. The frogs were initially clustered next to each other in a roughly oval shape between the boards. Within three minutes of removing the board hiding them, all of the frogs had crawled slowly until each fell off the edge onto the ground, and continued to disperse into vegetation. The site was located at 30.303427°N, 90.330054°W, just south of the Joyce Wildlife Management area, ca. 8 air km E of the village of Manchac, Louisiana, USA.

Table 1 summarizes reported hibernation sites, most of which represent only one locality within each species' geographic range. Note that each account includes <5 individuals. Habitat descriptions in the Table 1 references suggest that many species move to different habitat for winter hibernation sites. Some of these sites were at higher elevation and may be above flood level, particularly in canyon habitat that may be prone to seasonal flooding. The present report is of a remote location in brackish marsh that potentially experiences flooding and increased salinity by wind-driven tides through Lake Pontchartrain. Variation in elevation in most of this marsh is less than 1m, such that sustained light east wind for 2–3 days would likely flood most of the area. Historical floods levels in the local area suggest that the frogs would have been above most flooding associated with normal weather patterns, but not catastrophic floods like those produced by organized storms (i.e., tropical depressions, tropical storms, hurricanes), which do not normally occur there during winter. Thus, a potential explanation for the unusually large aggregation of frogs reported here is that suitable hibernation sites above flood level are rare in the area. Alternatively, and perhaps in addition, a frog aggregation may reduce evaporative water loss by reducing the amount of exposed body surface area.

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***HYLA CINEREA* (Green Treefrog). CANNIBALISM AND DEFENSIVE POSTURE.** Cannibalism among larval amphibians is not unusual (Pfennig et al. 1993. Anim. Behav. 46:87–94; Poelman and Dicke 2007. Evol. Ecol. 21[2]:215–227), and adults of large anuran species like Cane Toads (*Rhinella marina*) are also known to prey on smaller anuran species or smaller conspecifics (Pizzatto and Shine 2008. Behav. Ecol. Sociobiol. 63[1]:123–133). However, reports of adult treefrogs cannibalizing smaller conspecifics are rare (McCallum et al. 2001. Herpetol. Rev. 32[2]:99–100), and to my knowledge there has never been a report of a Green Treefrog consuming a smaller conspecific.

Here I report an incident of cannibalism of a recently metamorphosed *Hyla cinerea* (20.7 mm SVL) by an adult, male *H. cinerea* (41.6 mm SVL) (Fig. 1), which occurred on 23 June 2009 at a pond

COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND



FIG. 1. Adult male Green Tree Frog (*Hyla cinerea*) consuming a recently metamorphosed conspecific. Inset: Semicircular scars left on back of juvenile.

at Bowens Mill Fish Hatchery in Georgia, USA. I observed the frogs from when the male had apparently just captured the juvenile (only the juvenile's head was inside the male's mouth), until he had largely swallowed it (only one hind leg protruded out of the mouth). *Hyla cinerea* consume a variety of invertebrate prey, including insects and spiders of similar size to those of recently metamorphosed conspecifics. At the time the cannibalistic behavior occurred, recently metamorphosed frogs were relatively abundant at the site, and could thus provide a readily available food source for appropriately sized adults.

During the process of being preyed on, the juvenile struggled and showed defensive posturing which included spreading and locking of arms and legs. Although these defensive postures did not deter further ingestion, they seemed to interfere with the predator's ability to swallow its prey. It took the male more than 15 minutes to proceed beyond the outstretched arms of the juvenile, and another15 min to swallow it to the point where only one leg protruded from its mouth. After more than 30 min of observation I captured the male to document its size, at which point he regurgitated its prey. Without this intervention, it is certain the juvenile would have been fully consumed. The juvenile was still alive, but showed a series of semicircular scars across its back (Fig. 1-inset). Both frogs were released at the site of capture immediately after size measurements were taken.

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***HYLA INTERMEDIA* (Italian Treefrog). CANNIBALISM.** Cannibalism often occurs in crowded conditions where resources are limited (Crump 1983. Amer. Nat. 121[2]:281–289) and the predator benefits from a gain in nutrients, a reduction in competition for food, and consequently increased fitness. Amphibians breeding in ephemeral pools are especially likely to experience crowding and food limitation as the pond dries, leading to intraspecific predation (Crump 1983, *op. cit.*; Crump 1990. Copeia 1990:560–564; Jordan et al. 2004. Western N. Amer. Nat. 64[3]:403–405). As a temporary pond dries, larvae are subject to intensifying pressure for oxygen, food, space, and there is also a build-up of waste products, which can lead to intra-larval competition and inhibition of growth of some larvae (Kovaks and Sas 2009. North-West. J. Zool. 5[1]:206–208). In such pond drying situations, larger larvae may prey on smaller conspecifics (Kovaks and Sas 2009, *op. cit.*).

We observed the larvae of the prolonged breeding anuran, *Hyla intermedia*, in an ephemeral pool formed by rainwater collecting in the tire tracks of agricultural vehicles. The pool was located near San Ruffino Lake, Le Marche, Italy (43.0011°N, 13.3844°C). Observations at the breeding pool were made daily from 16 May to 13 June 2010 but the time of day at which observations were made varied. Two cohorts of larvae hatched in the pool during the study period. Spawn was laid on 17 May and 24 May. The first cohort hatched on 24 May and the second on 30 May. This indicates a developmental time to hatching of 7 and 5 days, with the increased developmental time of the second cohort probably reflecting the increasing temperature of the pool. This agrees with the observations of Sayim and Kaya (2008. Biologia 63[4]:588–593) who observed hatching after 5 or 6 days in the laboratory at 20°C in the closely related species *Hyla arborea*. The different cohorts were easily distinguished by their size and development stage. Early developmental stages were determined by comparing to those shown in Sayim and Kaya (2008, *op. cit.*).

The pond dried steadily over the course of the study and by 13 June there was <1 cm of water left and between 12 June and 13 June the younger larvae were no longer visible in the pool. There are several possible reasons for this. Small larvae may have burrowed into the mud at the bottom of the pool, but this is unlikely due to the probable low O_2 levels as the pond dried. Alternatively, larvae may have died due to a build-up of waste products, low O_2 levels, or lack of food. However no remains were seen and we think that this would have been unlikely to affect all larvae simultaneously.

The most likely explanation is that the smaller larvae were consumed by their larger conspecifics as an response to the drying up of a small, ephemeral pool, a condition in which cannibalism is likely to be common (Hoff et al. 1999. *In* R. W. McDiarmid and R. Altig [eds.], Tadpoles. The Biology of Anuran Larvae, pp. 215–239. Univ. Chicago Press, Chicago, Illinois). Unfortunately, we were not able to compare the responses of larvae in a non-ephemeral pool. To our knowledge this is the first time that cannibalism has been reported in *Hyla intermedia* tadpoles.

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***HYPSIBOAS RANICEPS* (Chaco Treefrog). PREDATION.** Anurans are potential prey to all classes of vertebrates, many invertebrates, and even carnivorous plants (Andrade-de-Figueiredo et al. 2010. Herpetol. Notes 3:053–054; Ghizoni-Jr et al. 2000. Melopsittacus 3[3]:137–139; Morais et al. 2010. Herpetol. Rev. 41[3]:336; Pombal 2007. Rev. Bras. Zool. 24[3]:841–843). Studies on the predation of amphibians are sparse and are based mostly on fortuitous observations. This is due to the difficulty of observation and quantification of predation events, but it has been estimated that such events occur frequently (Pombal 2007, *op. cit.*).

Hypsiboas raniceps is a medium-sized hylid commonly found in Brazilian Cerrado, Atlantic Rainforest, and Caatinga biomes (Arzabe 1999. Ver. Bras. Zool. 16[3]:851–864; Guimarães et al. 2003. Iheringia 93[2]:149–158). They occur in Amazonian Colombia, Venezuela (Amazonas), French Guiana, eastern Brazil, Paraguay, northern Argentina, and eastern Bolivia (Frost 2010. Amphibian Species of the World: an Online Reference. Version 5.4 [8 April 2010]. Electronic database accessible at http://research.amnh.org/vz/herpetology/amphibia/. American Museum of Natural History, New York. Accessed 14 Sept 2010).



FIG. 1. Adult male *Leptodactylus latrans* predating an adult male *Hypsiboas raniceps*.

Leptodactylus latrans is also a medium-sized anuran with a wide distribution in South America, occurring in Paraguay, Argentina, Uruguay, and practically all of the Brazilian territory (Oliveira et al. 2009. Biodivers. Pampeana 7[1]:44–46).

On 29 Aug 2010 at 1930 h an adult male *L. latrans* (81.6 mm SVL) was observed predating an adult male *H. raniceps* (72.3 mm SVL) (Fig. 1). The observation occurred 6 m from the margin of a temporary pond at the U.C. Refuge for Wildlife Mata do Junco (10.291037°S, 36.583701°W, 120 m elev.), in the city of Capela, Sergipe, Brazil. The anurans are deposited in the Herpetological Collection of the Federal University of Sergipe (CHUFS C0607, C0608). *Leptodactylus* spp. are well known predators of small anurans (Haddad and Sazima 1992. Unicamp. FAPESP. 321 pp.), and may contribute significantly to the anuran community structure in this region.

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***INDIRANA SEMIPALMATA* (Brown Leaping Frog). REPRODUCTION.** The ranid frog genus *Indirana* contains 11 species, all of which are endemic to the Western Ghats Mountains of southern India. Limited information is available regarding the breeding biology of this genus other than anecdotal notes, mostly about the most widespread species, *I. beddomii* (Daniels 2002. The Book on Indian Reptiles and Amphibians. Bombay Nat. Hist. Soc., Oxford Press, Mumbai, India. 238 pp.; Daniels 2005. Amphibians of Peninsular India. Universities Press India: Hyderabad 268 pp.; Das and Dutta 2007. Hamadryad 31:152; Inger et al. 1984. J Bombay Nat. Hist. Soc. 81[2]:406; Roelants et al. 2004. Mol. Phyl. Evol. 31:730), all of which remark that *Indirana* breed on rock faces in the immediate surroundings of splashing water. The semi-terrestrial tadpoles of *I. beddomii* are morphologically specialized with strongly hooked beaks and a long, strongly developed tail with reduced fin membranes which allow the tadpoles to skip across the rock surfaces on which they feed (Bossuyt and Milinkovitch 2000. PNAS 97:6585; Kuramoto and Joshy 2002. Hamadryad 27:71). *Indirana semipalmata* is a rarely encountered species, the life history of which is unknown, except for a study on its tadpoles by Kuromoto and Joshy (2002, *op. cit.*). Herein we report observations of egg laying sites of *I. semipalmata*.

Observations were made during the southwest monsoons, in the month of July at the Agumbe Rainforest Research Station (ARRS),

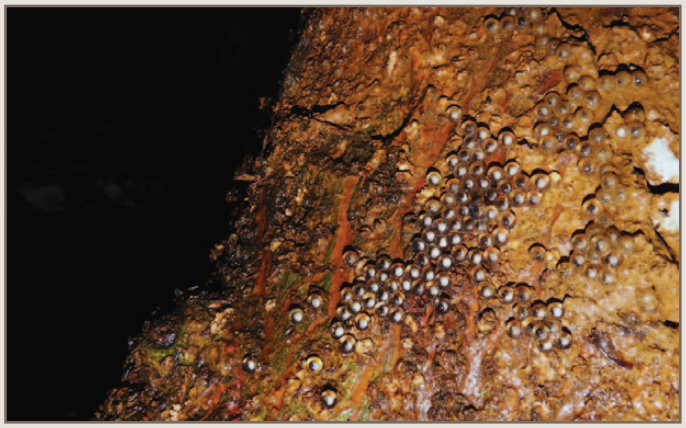


FIG. 1. Egg clutch of *Indirana semipalmata* on the bark of *Erythrina variegata*.



FIG. 2. Tadpole of *Indirana semipalmata* feeding on the bark of *Erythrina variegata*.

Agumbe, Shivamogga District, Karnataka, India (13°N, 75°E, 600–700 m elev). ARRS is a 3.2-ha area consisting of a Betel Nut (*Areca catechu*) plantation and fallow paddy fields bordered by secondary tropical rainforest. Temperature ranges between 10–35°C and average annual rainfall is ca. 7000 mm/yr. Three egg clutches were observed. The eggs were attributed to *I. semipalmata* because adult male frogs were observed sitting alongside possibly guarding the eggs. When the eggs hatched the tadpoles were similar to those of *I. beddomii* "with strongly hooked beaks and a long strongly developed tail with reduced fin membranes" (Kuramoto and Joshy 2002, *op. cit.*). The first egg clutch was observed on 7 July 2010 on the concrete steps of a bungalow located in a Betel Nut plantation. The eggs were laid 68 cm above the ground in a film of water that accumulated from water splashing as it ran from the roof tiles onto the concrete area below the steps. Clutch size was 343 eggs and average egg diameter 2.7 mm. The eggs hatched on 11 July 2010. Tadpoles remained on the concrete surface feeding post hatching.

The second egg clutch was observed on 15 July in a metal dish that had been left on a granite slab which formed the seat of a bench 47 cm off the ground. This granite bench was also situated in the Betel Nut plantation. Clutch size was not determined as the eggs were at different stages of development and inferred to represent multiple clutches. Tadpoles remained on the granite surface post hatching and were observed feeding. The third egg clutch was first observed on 15 July under a piece of wood propped up against the bark of an Indian Coral Tree (*Erythrina variegata)* at the edge of the Betel Nut plantation (Fig. 1). The eggs were laid 75 cm above the ground and the clutch size was 143 eggs with an average egg diameter of 2.9 mm. Eggs began hatching on 19 July. During the day one tadpole with hind limbs (therefore from an earlier clutch) was observed feeding on the bark surface of this tree, indicating that tadpoles remain on the tree once they have hatched (Fig. 2). It was notable that there were no pools of standing water within 3 m of any of the egg deposition sites mentioned.

These observations indicate that the eggs of *I. semipalmata* are laid, develop, and hatch outside of standing water. This differs from previously published accounts (Daniel 2002, *op. cit.*; Daniels 2005, *op. cit.*; Inger et al. 1984, *op. cit.*; Kuramoto and Joshy 2002, *op. cit.*) for other species of this genus. In each of the cases the eggs were hydrated when water was splashed upon them, when it dripped from the leaves or roof tiles above or ran down the branch upon which the eggs were laid. As far as we are aware, this is the first known case where tadpoles have been observed feeding on a bark substrate and subsequently metamorphosing on the bark of a tree. Given that there is such high rainfall in Agumbe, an adaptation where eggs are able to develop out of water may be a localized phenomenon. To determine if this is a viable life history strategy elsewhere would require further study in the Western Ghats.

The highly specialized, semi-terrestrial tadpole of *Indirana* is restricted to the Western Ghats by ecogeographical barriers (Roelants et al. 2004, *op. cit.*). The specialized life history of *I. semipalmata* described here makes them vulnerable to changes in rainfall pattern/climate and at the mercy of the monsoon.

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***LEPTODACTYLUS FUSCUS* (Whistling Frog). HABITAT AND DIET.** *Leptodactylus fuscus* is widely distributed in South America east of the Andes, between Panama and northern Argentina, and is found in open fields, pastures, marshes, degraded forests, and urban habitats (Reynolds et al. 2004. *In* IUCN Red List of Threatened Species. Version 2010.1. <www.iucnredlist.org>. Downloaded 01 June 2010). Here we report on the occurrence of the species in mangrove forests, where the abundant invertebrate fauna is likely an important alimentary resource.

Leptodactylus fuscus is a "sit-and-wait" forager (Perry and Pianka 1997. Trends Ecol. Evol. 12:360–384), which typically feeds on small arthropods, principally Isoptera and Coleoptera, as well as insect larvae (De-Carvalho et al. 2008. Biota Neotropical 18:105–115). Between April 2008 and May 2009, 30 *L. fuscus* (7 males, 10 females, and 13 juveniles) were recorded on the Bragança Peninsula in the Brazilian state of Pará. The local mangrove forests cover a total area of ca. 467 km² of mudflats, and are dominated by tree species of the genera *Avicennia* and *Rhizophora* (Souza-Filho and El-Robrini 1996. Geonomos 4:1–16).



FIG. 1. Capture of a crab of the genus *Uca* by *Leptodactylus fuscus* in the mangrove forest on the Bragança Peninsula, Pará, Brazil. Photo by R. P. Silva.

The analysis of stomach contents (males: 52.1 mm SVL, females: 47.3 mm SVL, and juveniles: 39.4 mm SVL) revealed a predominance of arthropods in the diet (Formicidae – 35.2%, Acari – 16.0%, insect larvae – 10.3%, and Coleoptera – 9.8%), as well as a crab of the species *Pachygrapsus gracilis* (Crustacea: Decapoda). The observation of the capture of a crab of the genus *Uca* by a Whistling Frog (Fig. 1) further reinforces the ability of the species to adapt to the diversity of habitats and resources available within its broad geographic distribution. The exploitation of a wide range of invertebrate prey and the occupation of the mangrove ecosystem, which is relatively inhospitable for the majority of ectothermic vertebrates, appears to represent an advantageous adaptive strategy for *L. fuscus*, in particular by reducing competition with other organisms, including anurans, that compete for more typical resources in shared habitats.

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***LEPTODACTYLUS LATRANS* (Butter Frog). DIET.** *Leptodactylus latrans* is a large nocturnal frog that is widely distributed throughout South America east of the Andes (Frost 2010. Amphibian Species of the World: an Online Reference. Version 5.4 [8 April 2010]. Electronic database accessible at http://research.amnh.org/vz/herpetology/amphibia/). The species inhabits natural environments such as ponds, rivers, and lakes as well as urban areas. Ferreira and Tonini (2010. Herpetol. Notes 3:237–238) reported *L. latrans* occupying crab burrows in a mangrove ecosystem, which was the first report of a frog living in this type of habitat. The generalist diet of *L. latrans* is well known (França et al. 2004. Stud. Neotrop. Fauna Environ. 39:243–248; Sanabria et al. 2005. Rev. Peruana Biol. 12:472–477; Solé et al. 2009. Herpetol. Notes 2:9–15; Strussman et al. 1984. J. Herpetol. 18:138–146; Teixeira and Vrcibradic 2003. Cuad. Herpetol. 17:113–120). *Leptodactylus latrans* feeds on a variety of

invertebrates and small vertebrates, including anurans and fish (Teixeira and Vrcibradic, *op. cit.*; Teixeira et al. 2010. Herpetol. Bull. 112:41–42). Solé et al. (2009, *op. cit.*), studying a population of *L. latrans* at a Cacao plantation, reported the first decapod crustacean in the diet of *L. latrans*. In March 2005, in the mangrove ecosystem of the Federal University of Espirito Santo (20.2667°S, 40.3°W), an urban area of the municipality of Vitoria, southeastern Brazil, RBF observed a female (8.42 cm SVL; 92.6 g) *L. latrans* eating a juvenile Mangrove Crab. This frog was captured and brought to the laboratory for further examination. An examination of the stomach contents revealed two coleopteran larvae, one lepidopteran larva, one orthopteran, and one Araneae in addition to the crab. This is the first published report of *L. latrans* eating a mangrove crab.

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***LITHOBATES CATESBEIANUS* (American Bullfrog). PREDATION.** Great Blue Herons (*Ardea herodias*) commonly prey on anurans (Butler 1997. The Great Blue Heron: A Natural History and Ecology of a Seashore Sentinel. UBC Press, Vancouver, British Columbia) and frequently have been photographed eating bullfrogs (e.g., http://www.whatbird.com/forums/forums/thread/114157.aspx). On several occasions between April and June 2010, in a newly mitigated (100 m^2) wetland in Hancock County, northwest Ohio, USA (40.9905°N, 83.7596°W), we observed *A. herodias* stalking and eating frogs, many of which we tagged with transponders (Biomark Inc., TXP148511B**,** 8.5 mm × 2.12 mm, 134.2kHz ISO, 0.067 g). On 27 Aug 2010, we located a patch of forested land with heron nests in three ca. 30 m tall sycamore trees (40.9849°N, 83.6904°W), the tallest trees in the woodlot, 5.87 km from the aforementioned wetland. Although the birds vacated the site at the end of July 2010, patches of heron droppings were visible on the ground around some trees. A search directly under the nests with a Pocket Reader (Biomark Inc.) revealed a transponder that was placed in an American Bullfrog tadpole (95 mm total length) on 11 April 2010. The transponder was located about 1 cm below a ground litter of fragmented tree bark, twigs, and dried leaves. A frog clavicle was found 10 cm from the transponder. To our knowledge this is the first reported incidence of predation on frogs by herons in which the feeding habitat and the nesting site were determined by recovering a transponder from the remains of a defecated (or regurgitated) bullfrog.

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***ODONTOPHRYNUS MAISUMA* (NCN). CANNIBALISM.** *Odontophrynus maisuma*, Cycloramphidae, is a fossorial frog that was recently described as a new species distinct from populations of *O. americanus* (Rosset 2008. J. Herpetol. 42:135). This species occurs on the coast of southern Brazil and Uruguay and is associated with wet environments and open grasslands (Achaval and Olmos 2003. Anfíbios y Reptiles del Uruguay. Graphis Impresora, Montevideo, Uruguay. 136 pp.). On 14 May 2009 at 0900 h, we collected a female *O. maisuma* (35 mm SVL; 7.0 g) in a pitfall trap that contained a juvenile *O. maisuma* (23 mm SVL; 0.3 g) in her stomach. The capture was made in wetland habitat associated with coastal sand dunes (32.1654°S, 52.1523°W, datum Corrego Alegre, sea level) in municipality of Rio Grande, RS, southern Brazil. The bucket in which the individual was captured was relatively large (40 cm diameter) and the individual remained in the trap for no more than 12 h, which perhaps reduced the possibility that the cannibalism occurred due to stress. Moreover, the bucket contained numerous arthropods that could be utilized as a food source. Records of cannibalism are rare among post-metamorphosed anurans, and this is the first report for the family Cycloramphidae. The lack of dietary studies of *O. maisuma* increases the importance of this information for understanding the feeding habits of the species. The anurans collected were deposited in the Collection of the Laboratório de Ecologia de Vertebrados Terrestres of FURG (AMRG48; AMRG49). We thank CNPq and Fapergs for financial support and ICMBio for collecting permits.

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***OLLOTIS ALVARIA* (Sonoran Desert Toad). REPRODUCTION.** Adult male anurans have been known to attempt amplexus with conspecific females and males, both sexes of other species of anurans and even inanimate objects. Streicher (2008. Herpetol. Rev. 39:75) provided a photograph of an adult male American Toad (*Anaxyrus americanus*) in amplexus with a tennis ball for ca. 2 min. in Fairfax County, Virginia. We provide observations and a photograph of an adult male Sonoran Desert Toad (*Ollotis alvaria*) discovered in amplexus with a non-native adult male American Bullfrog (*Lithobates catesbeianus*).

At 2200 h on 19 July 2008, CBG and M. Davis discovered a large adult male *O. alvaria* in amplexus with a similar-sized adult male *L. catesbeianus* (Fig. 1) on the sandy margin of the Santa Maria River, ca. 12 km SE of Bagdad, Yavapai County, Arizona (USA) (34.484722°N, 113.055125°W; 712 m elev.). These male anurans remained in amplexus and did not move from their position during the ca. 5 min they were observed and photographed. The surrounding soil was very damp due to heavy rain during the previous night.



FIG. 1. Adult male *Ollotis alvaria* in amplexus with an adult male *Lithobates catesbeianus*. Photo by Charles Grogan.

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***OOPHAGA PUMILIO* (Strawberry Dart Frog). HABITAT USE.** *Oophaga pumilio* occurs in lowland rainforests from Nicaragua to Panama. In these habitats, they typically will utilize the forest floor for foraging as well as defending territories. After eggs hatch in the leaf litter, the female will transport the larvae to arboreal water sources such as bromeliads (Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna between Two Continents, between Two Seas. Univ. Chicago Press, Chicago, Illinois. 934 pp.). Previous research has shown that *O. pumilio* will travel up to 12 m into a tree to deposit tadpoles (Young 1979. Biotropica 11:238–239). Here, I report the distance frogs will travel is far greater and that frogs are likely establishing territories in the canopy as well as on the forest floor.

In June 2010 on Isla Colon, Bocas del Toro, Panama, I ascended into the canopy of a *Ficus* sp. to 30 m and observed an *O. pumilio* on a branch next to the climbing line. This frog examined a small bromeliad before continuing to climb up the branch higher into the canopy. In August 2009, I ascended a different tree to 40 m and heard the advertisement call of a male in the tree next to the one I was climbing which was approximately at my level. Further, on both excursions, males could be heard through the entire ascent although height of males could not be determined. Other individuals have been seen as high as 46 m into the canopy (J. Maher, pers. comm.). As advertisement calls vary significantly from aggressive calls in this species (Bunnell 1973. Copeia 1973:277–284), frogs heard calling in the canopy presumably were calling to establish a territory and attract mates.

Utilization of canopy resources may be more important to *O. pumilio* than previously thought. Virtually all previous research on this species has taken place at ground level; thus future studies on populations and ecology of *O. pumilio* should include a canopy component to better understand habitat use of this species.

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***OSTEOPILUS SEPTENTRIONALIS* (Cuban Treefrog). PREY.** *Osteopilus septentrionalis* is native to Cuba, Cayman Islands, and Bahamas (Meshaka et al. 2004. The Exotic Amphibians and Reptiles of Florida. Krieger Publ. Co., Malabar, Florida. 155 pp.), and has been introduced into five states in the USA, but is established only in Florida (Barbour 1931. Copeia 1931:140; Crother 2008. Scientific and Standard English Names of Amphibians and Reptiles of North America. SSAR Herpetol. Circ. 37, 84 pp.). In Florida, *O. septentrionalis* is known to prey primarily on roaches (Dictyoptera), but has also been documented consuming lizards (anoles and geckos), frogs (including its own species) (Meshaka et al. 2004, *op. cit.*), native Florida Brown Snake (*Storeria victa*) (Maskell et al. 2003. Herpetol. Rev. 34:137) and Ring-necked Snake (*Diadophis punctatus*) (Krysko and Halvorson 2010. Herpetol. Rev. 41:339–340) in Florida. Herein, we report *O. septentrionalis* preying upon a native Florida Striped Scorpion (*Centruroides hentzi*) in Florida.

On 2 Oct 2010 at 945 h, an *Osteopilus septentrionalis* (ca. 49.5 mm SVL) was collected at the Natural Area Teaching Laboratory, Univ. Florida campus, Gainesville, Alachua Co. (29.63384°N, 82.36851°W, WGS84; elev. 26 m) inside a vertical PVC pipe set up to sample treefrogs. This nonindigenous *O. septentrionalis* was deposited in the Florida Museum of Natural History (UF 160926), dissected and found to contain a native Florida Striped Scorpion (*C. hentzi*) (34.5 mm total length) in its stomach. This is the first known record of this nonindigenous frog preying upon a native scorpion in Florida.

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***PSEUDIS PLATENSIS* (Paradox Frog). PREDATION.** Amphibians are common prey for a great variety of vertebrates, arthropods, and even carnivorous plants (Duellman and Trueb 1986. Biology of Amphibians. McGraw-Hill, New York. 670 pp.; Pough et al. 1998. Herpetology. Prentice-Hall, New Jersey. 577 pp.). *Pseudis platensis* is reported to be preyed upon by *Caiman yacare* (Santos et al. 1996. Herpetol. J. 6:111–117) and the Rufescent Tiger Heron (*Tigrisoma lineatum*) (Prado 2003. Herpetol. Rev. 34:231–232). Predation of anurans by birds is considered to be occasional and opportunistic (Toledo et al. 2007. J. Zool. 271:170–177). Predation of anurans by the Guira Cuckoo (*Guira guira*) is rare and limited to three reports; *Physalaemus* cf. *fuscomaculatus* (Kokubum and Zacca 2003. Herpetol. Rev. 34:232–233), *Leptodactylus ocellatus* (Repenning et al. 2009. Zoologia 26:443–453), and *Rhinella granulosa* (Mesquita 2009. Rev. Bras. Ornit. 17:84–85). Herein we report the predation of adult *Pseudis platensis* by a group of Guira Cuckoos.

On 17 Sept 2010 at 0900 h, on the margin of a pond in the municipality of Bataiporã, Mato Grosso do Sul State, Brazil (22.51645°S, 53.28405°W, SAD 69), four events of *P. platensis* predation by *G. guira* were observed (Fig. 1). This is the first record of an aquatic anuran being preyed upon by the Guira Cuckoo; individuals captured were swallowed whole. The diet of the Guira Cuckoo is made up mostly of arthropods (Schubart et al. 1965. Arq. Zool. 12:95–249), especially Orthoptera (Repenning et al. 2009, *op. cit.*). The abundance of *P. platensis* in the study area is high, so predation by the Guira Cuckoo can be considered opportunistic.



FIG. 1. *Pseudis platensis* being preyed on by *Guira guira* in Bataiporã, Mato Grosso do Sul State, Brazil.

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***RHACOPHORUS GAUNI* (Short-nosed Tree Frog). HIGH ELEVATION RECORD.** *Rhacophorus gauni* is a small, slender anuran (to 38 mm SVL) recognized by its short rounded snout, upright pointed dermal spikes on the upper eyelids, noticeable white spots below the eyes, light brown dorsum with indistinct dark spots, and reddish orange inner thighs (Inger 2005. The Systematics and Zoogeography of the Amphibia of Borneo. Natural History Publications [Borneo] Sdn. Bhd. Kota Kinabalu. 402 pp.; Inger and Stuebing 2005. A Field Guide to the Frogs of Borneo. 2nd ed. Natural History Publications [Borneo] Sdn. Bhd. Kota Kinabalu. 201 pp.). *Rhacophorus gauni* is endemic to Borneo, Sabah and central Sarawak of Malaysia, Brunei Darussalam, and western and northeastern Kalimantan of Indonesia (Inger et al. 2004. *Rhacophorus gauni*. *In* IUCN 2010. IUCN Red List of Threatened Species. Version 2010.3. <www.iucnredlist.org>. Accessed 24 Sept 2010; Das 2007. A Pocket Guide: Amphibians and Reptiles of Brunei. Natural History Publications [Borneo] Sdn. Bhd. Kota Kinabalu. 200 pp.). The species lives in primary forests (Malkmus et al. 2002. Amphibians and Reptiles of Mount Kinabalu [North Borneo]. A.R.G. Gantner Verlag K.G. Ruggell. 424 pp.; Inger 2005, *op. cit.*). Due to dwindling primary forest, *R. gauni* is listed as Near Threatened in the 2010 IUCN Red List of Threatened Species (Inger et al. 2004, *op. cit.*). Previous publications reported the altitudinal range for the species to be from near sea level to 980 m (Inger and Stuebing 2005, *op. cit.*; Frost 2010. Amphibian Species of the World: an Online Reference. Version 5.4 [8 April 2010]. Electronic database accessible at http://research.amnh.org/vz/herpetology/amphibia. Amer. Mus. Nat. Hist., New York. Accessed 24 Sept 2010). Herein we report a new elevational limit for *R. gauni*.

On 1 Oct 2008, between 1900 and 2200 h, an adult *R. gauni* (29 mm SVL, 1.2 g) was collected at Sungai Lidan (5.9839°N 116.5261°E; 1215 m elev.), Bundu Tuhan, Ranau District, West Coast Division, Sabah, Bornean Malaysia. The individual was found perched on a 2.5 m high rattan leaf overhanging the clear and moderately flowing Sungai Lidan with a rocky bottom—a preferred habitat type for *R. gauni* (Malkmus et al. 2002, *op. cit.*; Inger 2005, *op. cit.*). Air temperature was 16°C; relative humidity was 86.5%. Sungai Lidan is one of the main streams in Bundu Tuhan with rattan, bamboo, and ginger on the banks. Other anurans, including *Ansonia hanitschi, A. longidigita, Leptolalax pictus, Meristogenys orphnocnemis, Staurois latopalmatus, S. tuberilinguis,* and *Rhacophorus rufipes* occur in this rocky stream habitat. This locality represents an extension of habitat for *R. gauni* from lowlands and hilly terrain to the submontane zone. The specimen (HEP00674) was deposited in BORNEENSIS, the Bornean reference collection of the Institute for Tropical Biology and Conservation, Universiti Malaysia Sabah.

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***SMILISCA BAUDINII* (Mexican Treefrog). PREDATION.** On 24 Aug 2010, 1600 h local time, at the Organization for Tropical Studies field station at Parque Nacional Palo Verde, Provincia Guanacaste, Costa Rica (10.34547°N, 85.33889°W), we observed a male *Crax rubra* (Great Curassow) seize an adult *Smilisca baudinii* with its beak during a predatory attack. The frog emitted its characteristic alarm call as the Great Curassow quickly walked away with it. It is presumed that the bird consumed the frog, although it is possible that the frog eventually escaped; in any event, it is assumed the intention of the bird was to eat the frog. Although up to 5% of their diet is composed of small vertebrates, this is the first known instance of a Great Curassow feeding upon an amphibian (Muoz and Kattan 2007. Ornithologica Neotropical 18:21–36), and to our knowledge the first reported instance of a bird feeding upon *S. baudinii* (Malone 2005. *In* M. Lannoo [ed.], Amphibian Declines: The Conservation Status of United States Species, pp. 489–491. Univ. California Press, Berkeley).

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***SPEA HAMMONDII* (Western Spadefoot). PREDATION.** Invertebrates are a major predator of amphibians in many freshwater settings. Indeed, predatory pressure on eggs by dytiscid larvae is one reason suggested for the diversification of oviposition strategies in South American anurans (Magnusson and Hero 1991. Oecologia 86:310–318). Breeding adult amphibians have been documented as prey for dytiscid beetle larvae (Hinshaw and Sullivan 1990. J. Herpetol. 24:196–197), and dytiscid beetle larvae were found to be effective predators of *Rana sylvatica* larvae in a naturalistic predation experiment (Rubbo et al. 2006. J. Zool. 269:1–5). In the latter experiment, researchers found that *R. sylvatica* tadpoles recognized chemical cues and avoided areas inhabited by dytiscid beetle larvae, indicating a shared evolutionary relationship. In short-duration or ephemeral pools, amphibians face trade-offs between maximizing tadpole age and body mass, ostensibly by inhabiting pools with longer hydroperiods, and minimizing predation risk through earlier metamorphosis driven by pools with shorter hydroperiod

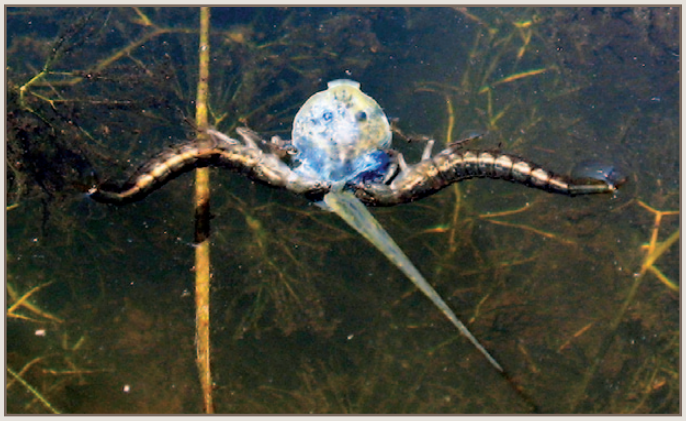


FIG. 1. Larval *Spea hammondii* succumbing to predation by two dytiscid beetle larvae.

(Morey 1996. *In* Witham et al. [eds.], Ecology, Conservation, and Management of Vernal Pool Ecosystems, pp. 86–91. Proceedings from a 1996 Conference. California Native Plant Society, Sacramento, California). Here, we document an isolated instance of predation on *Spea hammondii* by larval dytiscid beetles, which, although previously unreported in a vernal pool ecosystem, may be a common predator-prey relationship in intact vernal pool landscapes.

On 8 April 2010, at 1530 h, in an unincorporated area south of Rancho Murieta in northern California, we observed two large (± 60 mm) larval dytiscid beetles (*Dytiscus* sp.) preying upon a larval *S. hammondii* within the upper column of an ephemeral pool (Fig. 1). It appeared the tadpole was very recently killed, we assume by the beetle larvae, and at the start of our observation the tadpole still exhibited a righting response. Water clarity was very good, and no other dead tadpoles or other aquatic organisms were observed. The two beetle larvae had grasped the tadpole on either side of the body, basal to the tail. We watched for 9–10 min as the beetle larvae appeared to feed and wrestle the *Spea* larva into different positions. In the same pool within a slowly flowing ephemeral drainage were an additional 150–200 *Spea* tadpoles, all apparently healthy and mostly aggregated into shallow water with relatively thick submerged and emergent herbaceous vegetation (*Deschampsia danthanoides, Glyceria declinata, Ranunculus aquatilis, R. bonariensis, Trifolium variegatum*). Areas of deeper (ca. 60 cm) open water were present and water did not appear to be limiting, but tadpoles were not observed in these. Most tadpoles, including the prey item, were of large size (50–60 mm total length) and Gosner stages 26–34 (Gosner 1960. Herpetologica 16:183–190). At least two cohorts were apparent. One additional dytiscid larva of the same approximate size as the predators was observed swimming and floating 0.5 m from the presumed predation event within the water column. The ambient temperature at the time of observation was ca. 25°C, water temperature was 23.5°C.

Like many vernal pool organisms, *S. hammondii* have developed adaptations for dealing with short hydroperiod and severe water chemistry attributes (Burgess 1950. Copeia 1950:49–50; Morey, *op. cit.*). Along with the abiotic criteria, predation surely plays a large role in regulating population processes. However, to our knowledge, predation by aquatic invertebrates has not been reported for *Spea hammondii*.

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SQUAMATA — LIZARDS

***BACHIA HETEROPA ALLENI* (Earless Worm Lizard). ESCAPE AND DIGGING BEHAVIORS.** From 3 to 22 June 2010 on Union Island, St. Vincent the Grenadines, we had 43 encounters with *Bachia heteropa alleni*. Lizards typically were under rocks surrounded by leaf litter. Escape behaviors entailed quick retreats into leaf litter or cracks and crevices in hard substrates, burrowing rapidly in loose soil, or using their disproportionately long tails to "tail-slap" the surface, launching themselves into the air. We recorded examples of the latter two behaviors with a high-speed Casio Exilim FX-1 camera (Casio Computer Co., Ltd., Tokyo).

While burrowing, the lizard employed a serpentine posture to provide traction while using its head as a wedge, which was jammed repeatedly into the soil and moved laterally to enlarge the opening (Fig. 1). Limbs were loosely suspended and not held tightly against the body, nor were they used for either traction or removing debris.

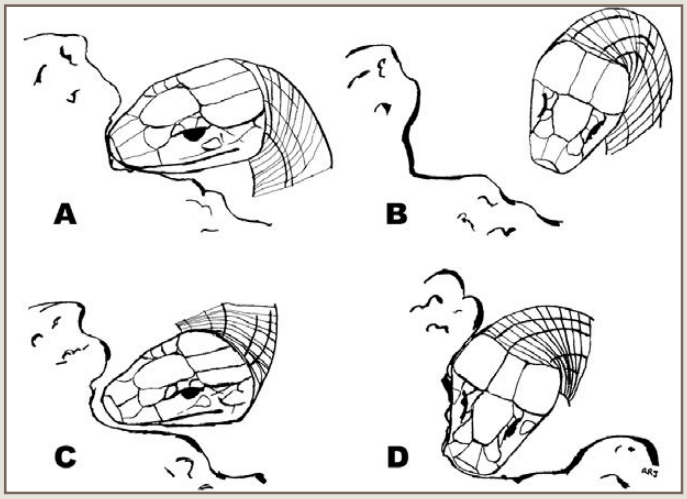


FIG. 1. Burrowing behavior of *Bachia heteropa alleni* (drawn from a high-speed video recording by RRJ). The head is wedged into the soil with traction provided by a serpentine posture primarily involving the tail (A), the head and body are retracted (B), the head is jammed repeatedly into the soil and moved laterally to enlarge the opening (C & D), with actions repeated until the body is covered.

Once initiated, the process was completed (body entirely underground) in 24 sec. The tail tip protruded when efforts ceased.

Undisturbed movement on the surface was serpentine, but lizards would quickly revert to "tail-slapping" when threatened. Tail-slapping consisted of forcefully depressing the entire tail, beginning at the base, against the substrate, in the process elevating the body and ultimately the tail into the air. In the recorded episode, the lizard sporadically threw itself into the air with limbs loosely suspended, often losing all contact with the substrate. It frequently landed on its side or back, quickly rotating back to an upright position before repeating the maneuver.

If captured, individuals would attempt to escape by rolling their bodies, like turning a screw or somewhat similar to an alligator "death roll." As in digging and tail-slapping, limbs were not used and were held loosely by the body.

Permits to conduct research on Union Island were issued by Mr. Brian Johnson, Director, Department of Forestry, St. Vincent and the Grenadines. Protocols were approved by the Avila University Animal Care and Use Committee. Fieldwork was funded by a grant from the National Science Foundation (USA) to Robert Powell (DBI-0851610).

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***CARLIA AILANPALAI* (NCN). HERMAPHRODITISM.** *Carlia ailanpalai* occurs in Manus Province, Papua New Guinea and also on Guam, Mariana Islands, Yap and Korae (Zug 2004. Bishop Mus. Bull. Zool.5:1–83). In this note I report a hermaphroditic *C. ailanpalai* (SVL = 51 mm), collected June 1996 from Saipan Island,



FIG. 1. Hermaphroditic gonad of *Carlia ailanpalai*. A = seminiferous tubules; B = atretic follicle with enlarged granulosa cells; c = normal ovarian follicle. Bar represents 1000 µm.

Commonwealth of the Northern Mariana Islands, (15.215391°N, 145.722695°E, datum WGS84; elev. 0–10 m). It was deposited in the Bishop Museum (BPBM), Natural Sciences Department, Vertebrate Zoology, Honolulu, HI as BPBM 26936.

A lateral incision was made on the lower left side and the left gonad was removed for histological examination. It was embedded in paraffin and histological sections were cut at 5 µm and stained with Harris' hematoxylin followed by eosin counterstain. A voucher histology slide was deposited at BPBM.

In the testis portion (Fig. 1A) seminiferous tubules contained mainly primary spermatocytes and occasional secondary spermatocytes. In the female portion, two follicles were present, one of which was a degenerating atretic follicle (Fig. 1B) in which the granulosa cells had markedly enlarged and projected into the interior of the follicle. The other appeared normal (Fig. 1C) and was not undergoing yolk deposition. It was not possible to ascertain if either the female or male portion of the gonad would have produced mature gametes. Hermaphroditism is rare in lizards (Brown 2008. Biawak 2:87–88; Goldberg 1989. Copeia 1989:486–488). This is the first report of hermaphroditism in *C. ailanpalai*.

I thank Christine Thacker (Natural History Museum of Los Angeles County) for the photomicrograph and Pumehana Imada (BPBM) for facilitating my examination of *C. ailanpalai*.

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***CNEMASPIS ASSAMENSIS* (Assamese Day Gecko). HABITAT.** *Cnemaspis assamensis* was described from Mayeng Reserve Forest within the Kamrup District of Assam. The species was recorded from within a subtropical evergreen forest on a tree trunk, 35–148 cm from the ground (Das and Sengupta 2000. J. S. Asian Nat. Hist. 5:17–23). The species was also recorded from a tree trunk in Garbhanga Reserve Forest, Kamrup District of Assam (Sengupta et al. 2000. J. Assam Sci. Soc. 41:372–378). Das and Ahmed 2007 (Zoos' Print J. 22:2720) reported the species from tropical semi-evergreen forest of Diffolu Camp, in the Ghorakhati Range of Kaziranga National Park. They observed the species on the trunk of a tree (*Ficus bengalensis*), 1 m above the ground and on a rock in the ground beside a small tree in Kukurakata Reserve Forest. In all the aforementioned records, the lizard was reported from within naturally forested areas. Here we report on the occurrence of this species from an anthropogenic habitat.

On 24 September 2009, we found six individual *C. assamensis* on the outer wall of a two-storied concrete building in the residential area of Kamakhya Temple (26.1642713°N, 91.7076637°E; 171 m elev.) during a herpetological investigation of Guwahati City, Kamrup District of Assam. Although commonly regarded as a diurnal gecko species, we encountered them at around 1930 h. Two of the individuals were captured and photographed. The lizards were found at a height of about 2.5 m from the ground and were observed coexisting on the wall with *Hemidactylus frenatus*.

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***COLEONYX BREVIS* (Texas Banded Gecko). INVERTEBRATE INTERACTIONS.** *Coleonyx brevis* is a secretive and nocturnal lizard that often spend a considerable amount of time in dark microhabitats including, but not limited to, underneath rocks, under other objects, and within crevices (Stebbins 2003. A Field Guide to Western Reptiles and Amphibians, 3rd ed. Houghton Mifflin Co., New York, New York. 533 pp.). Throughout the range of *C. brevis* these same microhabitats are often cohabited by various invertebrates including Striped Bark Scorpions (*Centruroides vittatus*) (pers. obs.). Herein we report three instances involving hatchling *Coleonyx brevis* running towards, and stopping next to, adult *Centruroides vittatus* after their cover had been lifted.

On 20 June 2002 at Amistad National Recreation Area, Pandale, Val Verde Co., Texas, USA (30.13026°N, 101.57430°W; 482 m elev.) between 2420–2425 h, a juvenile *Coleonyx brevis* was found beneath a wooden board. Upon the initial attempt to capture the specimen, the gecko raised its tail in the air and ran directly to an adult *Centruroides vittatus* whereupon it aligned its body parallel to that of the scorpion and became motionless. A pair of forceps was used to move the scorpion in an attempt to facilitate capturing the gecko. This elicited a flee response by the gecko and it ran towards and aligned itself alongside another resting *Centruroides vittatus* in the previously described manner. In both instances the gecko made physical contact with the scorpions and no reaction was elicited on their behalf.

During a second observation the next day on 21 June 2002 at 1215 h in Pandale, Texas (30.075982°N, 101.574196°W), a hatchling *Coleonyx brevis* was found beneath a flat rock. When a capture attempt was made the lizard ran and stopped between two resting *Centruroides vittatus*. While between the scorpions, the gecko assumed a submissive posture with the head lowered and body and tail pressed against the ground. A flight response was elicited after one of the scorpions was moved with a pair of forceps.

During a third observation on 1 August 2007 in close proximity of Minerales de Monclova (27.87646°N, 101.30571°W), Coahuila, Mexico at 1356 h, a hatchling *Coleonyx brevis* was discovered after lifting a rock. During an attempt to capture the specimen it ran towards and paused alongside a resting *Centruroides vittatus*. However, continued capture attempts caused the scorpion to leave the area and no additional observations pertaining to the gecko and scorpion were made.

To date we have not noticed any of the aforementioned behavior among adult *Coleonyx brevis*. Based upon our accounts it seems that

the geckos are benefiting from the presence of the scorpions without any consequence or cost for the scorpions. Although these behaviors by juvenile geckos are suggestive of commensalism, a quantitative analysis is required to better understand the significance of these observations.

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***DIPOGLOSSUS LESSONAE* (Brazilian Galliwasp) DIET.** The anguid *Diploglossus lessonae* is a diurnal and active forager, widely distributed in northeastern Brazil (Atlantic Forest and Caatinga). It is a terrestrial and semi-fossorial species usually associated with leaf litter, fallen logs, and crevices in rocks.

Although described over a century ago, the ecology of this species is poorly known. Some data regarding its diet based on a population from Exu (Pernambuco State, Brazil) have been provided (Vitt 1985. Pap. Avul. Zool. 36:69–76; Vitt 1995. Occas. Pap. Oklahoma Mus. Nat. Hist. 1:1–29). However, the diet of *D. lessonae* remains poorly studied. According to these previous dietary studies, prey includes invertebrates of the orders Araneae, Coleoptera, Dermaptera, Hemiptera, Opiliones, Orthoptera, Scorpiones, and insect larvae (Vitt 1985, *op. cit.*; Vitt 1995, *op. cit.*). Herein, we expand the knowledge regarding the feeding ecology of *D. lessonae* through the first record of two new orders of invertebrates included in its diet.

We examined 10 individuals—four males and six females—deposited in the scientific collection Coleção de Herpetologia da Universidade Federal do Ceará (CHUFC). Lizards were dissected and diet was assessed by stomach content analysis. Prey items present in the stomachs were identified as the following arthropod orders: Araneae, Blattodea, Coleoptera (elytra and Elateriform larvae), Hymenoptera, Orthoptera, and Scorpiones. Therefore, this is the first record of the orders Hymenoptera and Blattodea included in the diet of *D. lessonae*.

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***HEMIDACTYLUS FLAVIVIRIDIS* (House Gecko). BIFURCATION.** *Hemidactylus flaviviridis* is the most common gecko of the genus *Hemidactylus* occurring throughout the Indian sub-continent. It occupies a variety of habitats including tree trunks, rocks, and on walls of buildings (Daniel 1983. The Book of Indian Reptiles. Bombay Nat. Hist. Soc. Oxford University Press, Bombay. 141 pp.). On 30 March 2010 at 1942 h we observed an adult male *H. flaviviridis* with a bifurcated (or bifid) tail in a residential house in Palus, District, Sangli, Maharashtra, India (16.75°N, 73.70°E). The tail of the lizard was bifurcated in the posterior region. The right bifurcation of the tail was longer than the left. There are many reports of natural occurrences and experimental manipulation of bifid and trifid tails in lizards (Brindley 1894. J. Bombay Nat. Hist. Soc. 9:30–33; Das 1932. J. Bombay Nat. Hist. Soc. 35:657–662).

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FIG. 1. Photograph depicting the adult male *Hemidactylus flaviviridis* with bifurcated tail (right) compared with a normal-tailed female (left).

***PHRYNOSOMA BLAINVILLII* (Coast Horned Lizard). COMMENSALISM.** The use of burrows as refugia by herpetofauna that have been constructed by other animals (mainly rodents) has been observed for a wide range of species. For some of these relationships, commensalism has been suggested, with the ectothermic amphibian or reptile species benefiting from the microhabitat created by the rodent. Examples, which may be locality and temporally dependent, include Oldfield Mouse (*Peromyscus polionotus*) burrow use by the Six-lined Racerunner (*Aspidoscelis sexlineatus*) (Pearson and Nelson 1952. Copeia 1952:188–189), Southeastern Pocket Gopher (*Geomys pinetis*) burrow use by the Mole Skink (*Plestiodon egregarius*) and Southeastern Crowned Snake (*Tantilla coronata*) (Funderburg and Lee 1968. J. Herpetol. 1:99–100), California Ground Squirrel (*Spermophilus beecheyi*) burrow use by the California Tiger Salamander (*Ambystoma californiense*) (Laredo et al. 1996. J. Herpetol. 30:282–285), and Gunnison's Prairie Dog (*Cynomys gunnisoni*) burrow use by the Lesser Earless Lizard (*Holbrookia maculata*) (Davis and Theimer 2003. Amer. Midl. Nat. 150:282–290).

The use of rodent burrows by horned lizards (*Phrynosoma* spp.) is well documented (Hagar and Brattstrom 1997. Southwest. Nat. 42:339–344; Milne and Milne 1950. Amer. Midl. Nat. 44:721–741; Tappe 1941. J. Mammal. 22:117–148; Wone and Beauchamp 2003. J. Herpetol. 37:679–686), but obligate dependency on such burrows for their survival is not. Here we report on the first observed commensal relationship between the Coast Horned Lizard (*Phrynosoma blainvillii*) and the California Kangaroo Rat (*Dipodomys californicus*).

Throughout its diminishing range in California, *P. blainvillii* occurs in an array of habitats including chaparral, coastal sage scrub, open coniferous forest, broadleaf woodland, pinyon-juniper woodland, Joshua Tree woodland, and grassland (Lemm 2006. Field Guide to Amphibians and Reptiles of the San Diego Region. Univ. California Press, Berkeley, 326 pp.; Stebbins 2003. A Field Guide to Western Reptiles and Amphibians, 3rd ed. Houghton Mifflin Co., Boston, Massachusetts, 533 pp.; pers. obs.). Shrubs and other low-growing woody vegetation are typically significant components within such

habitats, which horned lizards use to escape predation and for thermoregulation in the shade provided as the position of the sun shifts throughout the day (Heath 1965. Univ. California Misc. Publ. Zool. 64:97–129; Sherbrooke 2003. Introduction to Horned Lizards of North America. Univ. California Press, Berkeley, 178 pp.; Tanner and Krogh 1973. Herpetologica 29:327–342; pers. obs.).

In a grassland community in the northern Sierra Nevada at Table Mountain, Butte Co., California, shrubs do not exist on the open plateau where a population of *P. blainvillii* occurs. Other shade-providing woody vegetation (e.g., Blue Oak, *Quercus douglasii*, and Foothill Pine, *Pinus sabiniana*) are present only in localized areas on the plateau that are not inhabited by horned lizards. However, the open burrows of *Dipodomys californicus* are ubiquitous. *Phrynosoma blainvillii* occurs on expanses of exposed basalt bedrock on the open plateau, which lacks the loose soil characteristic of its habitats in other parts of California. A community of low-growing grasses and forbs occurs throughout the Table Mountain plateau between areas of exposed basalt, but the landscape is entirely devoid of shrubs, large rocks, or any other cover that would provide sufficient shade for the lizards. Small basaltic rocks lie flat on the ground, often embedded in Hansen's Spike-moss (*Selaginella hansenii*), and are not large enough to provide suitable cover. Burrows of *D. californicus* are typically found along the edges of the exposed basalt. The mounds created by Botta's Pocket Gopher (*Thomomys bottae*) activity are also present; however, the entrances to burrow chambers are inaccessible to retreating horned lizards as they are covered by soil. Burial into these exposed mounds during peak spring and summer temperatures is unlikely to bring sufficient protection from overheating due to lack of shade over the mound. Given this open habitat, we suggest that this population of *P. blainvillii* would likely not exist in the absence of *D. californicus*. This presumptive dependence on rodent burrows for shelter is supported by the following observations.

At 1045 h on 20 May 2007, a sub-adult male *P. blainvillii* was found emerging from a *Dipodomys* burrow, suggesting its likely use as an overnight refuge. Later the same day at 1300 h an adult (not sexed) *P. blainvillii* was observed sleeping in the mouth of a *Dipodomys* burrow, head facing outward. The lizard was just out of reach of sunlight in the shade of the burrow. On 18 May 2008, an adult female *P. blainvillii* was discovered at 1130 h just outside the entrance of a *Dipodomys* burrow and then retreated into it. At 1145 h that same day, a large adult male was observed sleeping inside a *Dipodomys* burrow, tail facing outward. As 37.8°C was the recorded high for this date, air and ground temperatures were very warm by this time (no temperature data available at time of observation). On 8 June 2008, a juvenile (not sexed) was observed at 1140 h with tail facing outward in the mouth of a *Dipodomys* burrow, again during warming temperatures (recorded high for this date was 32.2°C). On 24 May 2009 a juvenile female was observed in a *Dipodomys* burrow at 1129 h; air temperature was 23°C at the time the lizard was observed. Because this recorded temperature is relatively cool for activity at this locality (pers. obs.) and the observed temperature high for this date was 26.1°C, it is possible that this individual might have used the burrow for an overnight refuge and had not yet initiated activity for the day. On 29 May 2010 a juvenile female was observed in a *Dipodomys* burrow at 1410 h, with head facing outward, but entirely within the burrow. Ground temperature outside the mouth of the burrow was 53.05°C; temperature where the horned lizard was located within the burrow was 21.1°C. Other, active horned lizard individuals observed at this locality during optimal conditions for surface activity were also always found on relatively flat, exposed basalt bedrock with kangaroo rat burrows in the vicinity.

Because of the habitat characteristics of this unique community, other questions arise regarding the ecology of *P. blainvillii* and its relationships with these rodents: Does this population of *P. blainvilli* use the *D. californicus* burrows and/or the pocket gopher mounds for brumation sites or for oviposition sites? Was this commensal relationship between *P. blainvillii* and rodents such as *D. californicus* a more widespread phenomenon throughout historical grassland communities of the Central Valley and its adjacent foothills prior to the lizard's extirpation from much of the region due to extensive cultivation, urbanization, and introduction of invasive annuals (Germano et al. 2001. Wildl. Soc. Bull. 29:551–559; Leaché et al. 2009. PNAS 106:12418–12423)?

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***PHRYNOSOMA MODESTUM* (Round-tailed Horned Lizard). PREDATION.** Predation on *Phrynosoma modestum* has been documented for lizards (*Gambelia wislizenii*, *Crotaphytus collaris*), birds (*Geococcyx californianus*, *Lanius ludovicianus*), and rodents (*Onychomys* spp.) (Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. Univ. of New Mexico Press. Albuquerque. 431 pp.; Hodges 2009. *In* Jones and Lovich [eds.], Lizards of the American Southwest, pp.186–189. Rio Nuevo Publ., Tucson, Arizona; Sherbrooke 2003. Introduction to Horned Lizards of North America. Univ. of California Press, Berkeley. 177 pp.). Herein we report the first record of predation on *P. modestum* by the Pallid Bat (*Antrozous pallidus*).

On 11 October 2007 at 2230 h, a freshly killed female hatchling *P. modestum* (SVL 39 mm) was found under an *Antrozous pallidus* night roost, along with various arthropod remains, at the entrance to the bathroom facility on Indio Mountains Research Station (IMRS), located in the Trans-Pecos area of the Chihuahuan Desert, ca. 40 km SW of Van Horn, Hudspeth Co., Texas, USA (30.782778°N, 105.015278°W, WGS84; 1233 m elev.). The hatchling had been partially consumed, thereby missing its tail and the right hind limb. Nocturnal predation on *P. modestum* and other normally diurnal lizards by *A. pallidus* on IMRS (Lenhart et al. 2010. Southwest. Nat. 55:110–115) is not entirely surprising given their frequently observed movements at night during the warm months of the year (Degenhardt et al., *op. cit.*; pers. obs.). Unlike most bats on IMRS, *A. pallidus* gleans most of its food from the ground and low vegetation (Lenhart et al., *op. cit.*). The lizard is deposited in the Herpetology Collection, Laboratory for Environmental Biology, Centennial Museum, The University of Texas at El Paso (UTEP 20007).

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***PHRYNOSOMA ORBICULARE* (Mexican Plateau Horned Lizard). ENDOPARASITES.** *Phrynosoma orbiculare* is restricted to Mexico and occurs in the Sierra Madre Occidental of central western Chihuahua southward into Puebla and northward in the Sierra Madre Oriental to southern Nuevo León and Coahuila (Lemos Espinal

and Smith 2007. Amphibians and Reptiles of the State of Coahuila, México. Univ. Nac. Autón. México, México, D.F. 550 pp.). To our knowledge, there are no reports of helminths from this species. The purpose of this note is to establish the initial helminth list for *P. orbiculare*.

One female *P. orbiculare* (SVL = 66 mm) collected 29 April 1966 at Xochimilco Districto Federal (19.5°N, 99.20166°W, datum WGS84; elev. 2255 m) was borrowed from the herpetology collection of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California, USA. The body cavity (LACM 36699) was opened and the digestive tract removed. Contents were examined under a dissecting microscope. In the large intestine were 185 nematodes. They were cleared in a drop of glycerol, placed on a microscope slide, cover slipped, studied under a compound microscope and identified as *Cyrtosomum penneri*. Voucher helminths were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland as USNPC (103548).

Cyrtosomum penneri is a common nematode in horned lizards and has been reported in *P. asio*, *P. mcallii* (Gambino and Heyneman 1960. Amer. Midl. Nat. 63:365–382), *P. blainvillii* (as *P. coronatum*) (Telford 1970. Amer. Midl. Nat. 83:516–564), *P. cornutum*, *P. hernandesi* (as *P. douglassi*), *P. platyrhinos*, *P. solare* (Goldberg et al. 1993. J. Helminthol. Soc. Washington 60:234–238) as well as some 26 additional lizard species (see McAllister and Bursey 2007. Comp. Parasitol. 74:179–184). Three species of *Cyrtosomum* have been reported from Mexican hosts: *C. longicaudatum*, *C. penneri*, and *C. scelopori* (Gambino and Heyneman 1960, *op. cit.*; Caballero Deloya 1971. Ann. Inst. Biol. Univ. Nac. Autón. México 42:29–34). These species are separated based on the morphology of spicules and number of caudal papillae: *C. longicaudatum*, unequal spicules, 16 papillae; *C. penneri*, unequal spicules, 12 papillae; *C. scelopori*, equal spicules, 12 papillae (Bursey and Flanagan 2002. J. Parasitol. 88:320–324). Our specimens fit the description of *C. penneri*. *Cyrtosomum* belongs to the Atractidae; transmission between hosts is not understood (Anderson 2000. Nematode Parasites of Vertebrates, Their Development and Transmission. CABI Publ. Oxfordshire, U.K. 650 pp.), although Petter (1966. Mem. Mus. Nat. d'Hist. Natur. 39:1–252) speculated that infection in tortoises might occur during copulation. *Phrynsoma orbiculare* represents a new host record for *C. penneri*.

We thank Christine Thacker (LACM) for permission to examine *P. orbiculare* and Daniel Covarrubias (Whittier College) for assistance with dissection.

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SCELOPORUS MUCRONATUS **(Cleft Lizard). SAUROPHAGY.** Studies regarding the feeding habits of *Sceloporus mucronatus* have documented an omnivorous diet in which the staple prey are insects (Méndez-de la Cruz et al. 1992. Southwest. Nat. 37:349–355; Vega-López and Alvarez 1992. Acta Zool. Mex. 51:1–128). Vega-López and Alvarez (1992, *op. cit.*) mentioned the presence of scales in the stomachs they analyzed, however, the identity of the species to which these belonged was not provided. Here we report a case of predation by *S. mucronatus* on a phrynosomatid lizard of the same genus.

On March 2010, we captured five specimens of *S. mucronatus* (one of which was found dead; deposited in the herpetological collection of the Benemérita Universidad Autónoma de Puebla as EBUAP 2115), in an oak forest (19.033°N, 98.115°W; 2240 m elev.) from Parque Estatal Flor del Bosque, located in the municipality of Amozoc, state of Puebla, México. To examine stomach contents, live specimens were stomach-flushed (Legler and Sullivan 1979. Herpetologica 35:107–110) and subsequently released. The dead specimen was dissected. Analysis of stomach contents revealed the presence of a partly digested neonate *S. grammicus* (ca. 25 mm SVL), ingested by an adult male *S. mucronatus* (74 mm SVL). Other contents observed were plant remains in four of the five specimens examined, and arthropods of the following orders: Araneae, Coleoptera, Diptera, Hemiptera, Hymenoptera (ants and others), and Lepidoptera (larvae). These observations confirm that at least one species of lizard is part of the diet of *S. mucronatus*, in addition to arthropods of several orders and plant material.

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TIMON LEPIDUS **(Ocellated Lizard). PREDATION.** *Timon lepidus* is a widely distributed species in southern Europe (Gasc et al. 1997. Atlas of Amphibians and Reptiles in Europe. Collection Patrimoines Naturels, 29. SPN-IEGB-MNHN, Paris. 496 pp.), being the commonest large lizard in the Iberian Peninsula (Pérez-Mellado 1997. *In* A. Salvador [ed.], Reptiles, Fauna Ibérica Vol. 10, pp. 198–207. MNCN-CSIC, Madrid; Pleguezuelos et al. 2002. Atlas y Libro Rojo de los Anfibios y Reptiles de España. DGB-AHE. Madrid. 587 pp.). It forms the bulk, in terms of biomass, of the lacertid communities in Mediterranean environments (Pérez-Mellado 1997, *op. cit.*). Such a life history trait has driven its keystone position in the trophic webs of various habitats, where it forms an important part of the diet of a large number of predators (Martín and López 1996. Copeia 1996:722–726; Pérez-Mellado 1997, *op. cit.*).

Although this species is commonly consumed by terrestrial predators, its occurrence in the diet of freshwater-associated predators is anecdotal (Ruiz-Olmo 1995. *In* Llorente et al [eds.], Scientia Herpetologica, pp. 259–264. SHE-AHE. Barcelona; Clavero et al. 2005. Herpetol. J. 15:125–131.). In fact, there are no data on predation upon *T. lepidus*, despite its relative high abundance (Pérez-Mellado 1997, *op. cit.*).

We examined the feces (spraints) of a freshwater predator, the Eurasian Otter (*Lutra lutra*), for evidence of Ocellated Lizard remains. Spraints were stored and analyzed following standard procedures (Conroy et al. 1993. A Guide to the Identification of Prey Remains in Otter Spraints. Occas. Publ. Mammal Soc. 16, London. 52 pp.). The scat sample analyzed comes from the winters of 2007–2008 (21 spraints) and 2008–2009 (32 spraints). In one out of 53 spraints we found the skeletal remains of an adult *T. lepidus* (identified using the key of Barahona and Barbadillo 1997. Rev. Esp. Herpetol. 11:47–62). Expressed in percent biomass in the diet of the otter (applying the correction factors by Jedrzejewska and Jedrzejewski 1998. Predation in Vertebrate Communities. The Bialowieza Primeval Forest as a Case Study. Ecological Studies 135. Springer-Verlag, Heidelberg. 450 pp.), *T. lepidus* comprised 0.85%, a very low proportion.

This observation, although interesting because otters are almost entirely aquatic predators (Jedrzejewska et al. 2001. Ecography 24:165–180), most likely reflects an opportunistic feeding event because *T. lepidus* rest under rocks at night while otters are foraging during this time period (Pérez-Mellado 1997, *op. cit.*).

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***XANTUSIA GILBERTI* (Gilbert's Night Lizard). REPRODUCTION.** *Xantusia gilberti* is a Baja peninsular endemic restricted to the oak and pine-oak woodlands of the upper elevations of Sierra la Laguna, Baja California Sur, México, where it is common above 1200 m (Alvarez et al. 1988. *In* L. Arriaga and A. Ortega [eds.], La Sierra de la Laguna de Baja California Sur, pp. 167–184. Centro de Investigaciones Biológicas de Baja California Sur A.C., La Paz). Anecdotal observations on microhabitat use of this species have been reported (Grismer 2002. Amphibians and Reptiles of Baja California Including its Pacific Islands and the Islands in the Sea of Cortez. Univ. California Press, Berkeley, California. 399 pp.), but virtually nothing is known of its reproductive habits. Here we report an observation that contributes to the timing of reproduction in this species.

On 26 August 2010, we captured an adult female (40 mm SVL, 47 mm tail, 1.5 g) *X. gilberti* beneath a pine tree log in pine-oak woodland, ca. 1 km NW of the Segundo Valle in the uplands of the Sierra la Laguna, Baja California Sur, México (23.5575°N, 109.9844°W; NAD 27; elev. 1745 m). Less than 10 cm from the female we observed two neonates (20 and 22 mm SVL; 15 and 20 mm tail; 0.3 and 0.5 g). We assume that these newborns were produced by the adult female found with them. Therefore, this is also an observation of young staying near the parent after birth. Based on the size of the young, we estimate that the birth happened during the first part of August.

Patricia Galina verified the species identification. One of the young lizards was deposited in the herpetological collection of the Centro de Investigaciones Biológicas del Noroeste (CIBNOR), La Paz, Baja California Sur, México (CIBNOR 1308).

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SQUAMATA — SNAKES

***BOA CONSTRICTOR* (Boa Constrictor). DIET.** *Boa constrictor* is a large tropical non-venomous snake that ranges from Mexico to northern Argentina and inhabits a variety of habitats including wet tropical forests, deserts, open savannahs, and cultivated fields. Prey include a wide variety of mammals, birds, and lizards (Reed and Rodda 2009. U.S. Geological Survey Open-File Report 2009–1202. 302 pp.). Here we describe a *B. constrictor* preying upon a domestic animal.



FIG. 1. Adult *Boa constrictor* consuming an adult Domestic Cat (*Felis silvestris catus*) in Nova Guarapari, Guarapari, Espirito Santo, Brazil.

On 29 August of 2005, at ca. 1400 h, an adult *B. constrictor* (total length > 1.5 m) was observed in the process of constricting a Domestic Cat (*Felis silvestris catus*) in Nova Guarapari, Guarapari City, Espirito Santo State, Brazil (20.7227778°S, 40.5383333°W; datum WGS84), within the yard of a local home (Fig. 1). The snake continued to consume the prey headfirst and soon attracted a crowd of several people. After the snake finished consuming its prey, it was removed from the site and released elsewhere.

Anthropogenic alteration or destruction of natural environments (e.g., deforestation and urbanization) can alter predator-prey relationships (Leme 1985. Boletim da Fundação Brasileira de Conservação da Natureza 20:57–67), force species into novel habitats, and result in the introduction of non-native taxa (Flinte et al. 2006. Rev. Bras. Entomol. 50:512–523; Schineider and Teixeira 2001. Iheringia, Sér. Zool. 91). This observation represents an additional record in the escalating list of conflicts between native and domestic wildlife (Bellati and Thungen 1990. *In* L. R. Davis and R. E. Marsh [eds.], Proceedings of the 14th Vertebrate Pest Conference, pp. 262–268. University of California, Davis). Importantly, *B. constrictor* may be one of the few native snakes capable of preying upon domestic or feral *F. s. catus*, which are widely recognized for their devastating impacts on populations of small native vertebrates (Burbidge and McKenzie 1989. Biol. Coserv. 50:143–198).

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***BOTHROPS JARARACUSSU* (Jararacussu). DIET.** *Bothrops jararacussu* is a venomous pitviper (to 2 m total length) with a diet that includes mammals, birds, amphibians, and insects (Freitas 2003. Serpentes Brasileiras. Bahia, Brazil. 160 pp.; Marques 2001. Serpentes da Mata Atlântica: Guia Ilustrado Para a Serra do Mar. 184 pp.). On 1 January 1998, an adult *B. jarracussu* (female; SVL = 1168 mm; tail length = 121 mm) was killed by a rural worker in Rio Nove, Santa Maria de Jetibá, Brazil (20.002087°N, 40.719045°E; datum WGS84). Upon dissection, we discovered three rodents, *Nectomys squamipes* (one adult and two juveniles), that had been swallowed head first. The lack of digestive activity indicates that the prey items had been swallowed recently and the presence of the adult female and two young rodents suggests that the snake may have raided the rodents' nest. The snake was deposited in the herpetological collection of Museu de Biologia Prof Mello Leitão (MBML 515), Santa Teresa, State of Espirito Santo, Brazil.

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***COLUBER CONSTRICTOR PRIAPUS* (Southern Black Racer). SCAVENGING AND DIET.** *Coluber constrictor* is an opportunistic predator that feeds on a wide variety of prey items including rodents, lizards, birds, amphibians, insects, snakes, and even small turtles (Ernst and Ernst 2002. Snakes of the United States and Canada. Smithsonian Institution Press, Washington D.C. 661 pp.). Here we describe two incidences of *C. constrictor* scavenging on road-killed *Opheodrys aestivus* (Rough Greensnakes).

On 19 June 2009, on Bald Head Island, Brunswick Co., North Carolina, USA, we observed an adult *C. constrictor* traversing the yard of our residence. The animal paused when it encountered the desiccated

remains of an *O. aestivus* that had been collected for measurement. After several tongue flicks the prey item was lifted, carried off, and consumed. During a snake road survey on 22 August 2009 we observed another adult *C. constrictor* carrying the remains of a freshly hit *O. aestivus* off the road. To our knowledge these records represent the first observations of scavenging by *C. constrictor* (Devault and Krochmal 2002. Herpetologica 58:429–436; Ernst and Ernst, *op. cit.*). Carrion foraging by snakes may be more prevalent than has traditionally been accepted (reviewed in Devault and Krochmal, *op. cit.*).

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***COLUBER* (= *MASTICOPHIS*) *FULIGINOSUS* (Baja California Coachwhip). DIET.** *Coluber fuliginosus* preys on a variety of species but most commonly feeds on lizards, small snakes, birds, and small mammals (Grismer 2002. Amphibians and Reptiles of Baja California including its Pacific Islands and the Islands in the Sea of Cortez. Univ. California Press, Berkeley, California. 399 pp.). Specifically, the following prey have been reported for *C. fuliginosus* from the Baja California Peninsula or its associated islands: *Sceloporus grandaevus, Dipsosaurus dorsalis, Aspidoscelis hyperythra, Sonora semiannulata,* and *Aspidoscelis tigris rubida* (Cliff 1954. Trans. San Diego Soc. Nat. Hist. 12:67–98; Grismer, *op. cit.*; Rodriguez-Robles and Galina-Tessaro 2005. Herpetol. Rev. 36:195). Here we report an attempted predation event, representing new diet item for *C. fuliginosus*. At 1200 h on 31 August 2007 near the Sierra del Mechudo, municipality of La Paz, Baja California Sur, México (24.8716667°N, 111.2527778°W; datum WGS84; elev. 156 m) in a rocky dry arroyo, we saw a *C. fuliginosus* that was biting the neck of a *Crotalus enyo* (Baja California Rattlesnake; Fig. 1). After about four minutes, the *C. fuliginosus* noticed our presence and moved away, leaving the potential prey dead and with bite marks on the tail, at midbody, and on the neck. We believe that the coachwhip was attempting to feed on the rattlesnake. Although this represents the first report of *C. enyo* in the diet of *C. fuliginosus,* the record is not unexpected; the closely related *Coluber flagellum* is known to feed on a variety of snakes species, including several species of rattlesnakes (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Institution Press, Washington DC. 668 pp.).

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FIG. 1. *Coluber fuliginosus* attempting to consume a *Crotalus enyo*. Photo by Sergio Álvarez.

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***CROTALUS HORRIDUS* (Timber Rattlesnake). NEONATE GROWTH.** Little information has been published regarding the ecology of neonate *Crotalus horridus*. Gibbons (1972. Copeia 1972:222–226) used size class data to examine the growth rate of juvenile *C. horridus* in spring and early summer over a three-year period. However, neonate growth has not been measured during the period between dispersal from parturition sites and the critical months leading up to hibernation.

We found an adult female *C. horridus* (SVL = 1126 mm) with a litter of 23 neonates (11 male, 12 female) in a shallow depression beneath a large log on 6 August 2009 in Baker Co., Georgia, USA. Snakes were held until their initial shed (5 days), after which they were measured and marked with either scale brands or passive integrated transponders (PIT tags). We attached 0.68 g radio transmitters to the tails of 15 neonates using Superglue® gel and released them at the natal site on 11 August 2009. We were able to relocate a portion of the telemetered snakes at regular intervals to collect growth data. Initial SVL of males ranged from 292.0–327.0 mm (mean = 314.1, N = 11) and masses ranged from 23.0–29.0 g (mean = 26.1, N = 11). SVL of females ranged from 302.5–330.0 mm (mean = 325.0, N = 12), and masses ranged from 21.0–28.0 g (mean = 28.0, N = 12).

Seven snakes were recaptured and measured 14 days after initial capture (Table 1). Neonates grew an average of 18.0 mm in SVL and lost 0.6 g in mass. The four snakes that were recaptured 41 days after initial capture had grown an average of 49.9 mm in SVL and gained 8.0 g. Morphological measurements were collected for one snake captured 74 days after initial capture; this individual grew 78.5 mm in SVL and gained 28.0 g.

TABLE 1. Growth data for juvenile *Crotalus horridus* in Baker Co., Georgia, USA. Data presented reflect the change in snout–vent length and mass from the date of the initial shed up to 74 d for one individual.

Snake ID	Sex	SVL (mm)			Mass (g)		
		14 d	41 d	74 d	14 d	41 d	74 d
1312	M	28.0	—	—	2.0	—	—
7231	M	3.5	—	—	-5.0	—	—
1319	M	—	82.5	—	—	26.0	—
1B5E	F	22.0	41.5	78.5	0.0	4.0	28.0
6C57	F	11.5	—	—	-1.0	—	—
1308	F	24.5	49.5	—	1.0	9.0	—
1310	F	25.5	26.0	—	-3.0	-7.0	—
1315	F	12.0	—	—	2.0	—	—
Mean		18.1	49.9	—	-0.6	8.0	—

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CROTALUS TORTUGENSIS (Tortuga Island Rattlesnake). **DIET.** At 1035 h on 22 September 2009, an adult female *Crotalus tortugensis* (SVL = 656 mm; tail length = 40 mm) was detected on Tortuga

COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND



FIG. 1. *Crotalus tortugensis* feeding on an adult male *Sceloporus orcutti*.

Island, Gulf of California, México (27.4333°N, 111.8667°W, datum WGS 84), as it rattled under rocks in a lava flow. When we located the snake we found it accompanied by a recently killed adult male *Sceloporus orcutti* (Granite Spiny Lizard; total length ca. 150 mm, Fig. 1). The snake proceeded to ingest the lizard over the next 25 min. Reports of the diet of this endemic rattlesnake mention only deer mice (*Peromyscus*) found in the stomachs of many specimens examined (Klauber 1972. Rattlesnakes: Their Habits, Life Histories, and Influence on Mankind. Univ. California Press, Berkeley. 1533 pp.; Van Denburgh 1922. The Reptiles of Western North America. Proc. California Acad. Sci., Vols. 1–2:1–1028). This observation represents a new diet record for *C. tortugensis*.

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***CROTALUS VIRIDIS* (Prairie Rattlesnake). DIET.** Adult *Crotalus viridis* are generalist predators known to feed on a variety of vertebrates, including a wide range of mammals and many ground-nesting birds, whereas juveniles feed primarily on small lizards (*Sceloporus* and *Holbrookia*; Werler and Dixon 2000. Texas Snakes. Univ. Texas Press, Austin. 437 pp.). Hamilton (1950. Herpetologica 6:34) noted the remains of several *Phrynosoma* sp. (surmised to be *P. douglasii* based on geographic proximity) in adult *C. viridis* specimens collected in the Black Hills of South Dakota, USA. This had been the only report of *C. viridis* preying upon lizards of the genus *Phrynosoma*; the following report adds *P. cornutum* to the diet of *C. viridis*.

On the morning of 4 June 2009, a live female *C. viridis* (TNHC 76278; SVL = 574 mm; tail length = 32 mm; 121.1 g) was collected by Albert Miller and Glen Nix roughly 5 km W of Valentine, Jeff Davis Co., Texas, USA (30.5607°N, 104.5928°W, datum WGS 84). Upon preserving the snake that afternoon, we found a recently ingested adult male *P. cornutum* (TNHC 76279; SVL = 102 mm; tail length = 45 mm; 32.6 g; swallowed headfirst) in the stomach of the snake.

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***EUNECTES MURINUS* (Green Anaconda). DIET.** *Eunectes murinus* is an aquatic, nocturnal, and euryphagic snake species, feeding on several vertebrate types (fishes, frogs, turtles, lizards, snakes, caimans, birds, and mammals; Martins and Oliveira 1998. Herpetol. Nat. Hist. 6:78–150; Strimple 1993. Herpetol. Nat. Hist. 1:25–35). Here we report the predation of an adult Tegu Lizard, *Tupinambis duseni*, by *E. murinus*.

On 17 September 2007, at 1125 h, at the edge of a stream in the area at Small Hydroelectric Power Plant - PCH Foz do Cedro, municipality of Lucas do Rio Verde (14.2083°S, 56.7766°W, datum: SAD 69), Mato Grosso State, Brazil, we observed a large adult *E. murinus* (total length > 2500 mm) in the process of constricting a *T. duseni*. When disturbed by our presence the snake dove into the water, allowing the lizard to escape.

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***IMANTODES CENCHOA* (Blunt-headed Treesnake). DIET.** Various species are reported in the diet of *Imantodes cenchoa* from Manaus, Brazil; these include *Eleutherodactylus fenestratus*, *Anolis punctatus*, and *A. fuscoauratus* (Martins and Oliveira 1998. Herpetol. Nat. Hist. 6:110–111). *Imantodes cenchoa* from the region of Los Tuxtlas, Veracruz, México feeds mainly on lizards of the genus *Anolis* (Higareda et al. 2007. Serpientes de la Región de los Tuxtlas, Veracruz, México. Guía de Identificación Ilustrada. Instituto de Biología, Universidad Nacional Autónoma de México, México D.F. 88 pp.). Here we report a new diet record for *I. cenchoa*.



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FIG. 1. *Imantodes cenchoa* feeding on a specimen of *Anolis petersii*. Photo by Elí García-Padilla.

At 0030 on 21 July 2008, during a field expedition to the Los Tuxtlas region, Rancho los Ramos, municipality of San Andrés Tuxtla, Veracruz, Mexico (18.5861°N, 95.1172°W, datum: WGS84; elev. 431 m.) we found an adult *I. cenchoa* feeding on an *Anolis petersii* (Peters' Anole; Fig. 1). After we photographed the snake, it finished swallowing the lizard and moved away.

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***IMANTODES CENCHOA* (Blunt-headed Treesnake). DIET.** *Imantodes cenchoa* is a common Neotropical arboreal snake that ranges from southern Mexico to Argentina. It is recognized for its long slender body and extremely thin neck. Solorzano (2004. Snakes of Costa Rica. Instituto Nacional de Biodiversidad, Santo Domingo de Heredia, Costa Rica. 791 pp.) states that small lizards (e.g., *Norops* and *Dactyloa*) and small frogs are common prey items. Additionally, Henderson and Nickerson (1976. J. Herpetol. 10:205–210) and Landry et al. (1966. J. Ohio Herpetol. Soc. 5:93–101) suggested that *I. cenchoa* may feed on the eggs of lizards but did not provide confirmation of this phenomenon. Here we report two instances of lizard egg predation by *I. cenchoa*.

On 13 November 2006 at 1901 h, in Parque Nacional G. D. Omar Torrijos Herrera, Coclé Province, Panamá, we found a juvenile *I. cenchoa* (SVL = 326 mm, total length = 466 mm, 3.3 g) that contained a small frog of the genus *Craugaster* (0.2 g) and a lizard egg (Polycrotidae; 0.4 g). The prey items totaled 18.2% of the snake's body mass. The prey items and snake were photographed (UTADC 6524–25) and the snake was released. On 8 March 2007 at 2236 h, in Parque Nacional G. D. Omar Torrijos Herrera, we found a female *I. cenchoa* (SVL = 986 mm, total length = 1439 mm, 56.4 g). This snake contained a *Dactyloa frenata* (19.1 g) and a large anole egg (1.3 g). The prey items totaled 36.2% of the snake's body mass. This snake was weak, but crawling along a branch next to the stream. It died soon after capture and when cut open to identify the prey item, the stomach was found to be perforated, presumably by a claw of the *D. frenata*. Photographs of the specimens were deposited at the Amphibian and Reptile Diversity Research Center, University of Texas at Arlington (UTADC 6526–27).

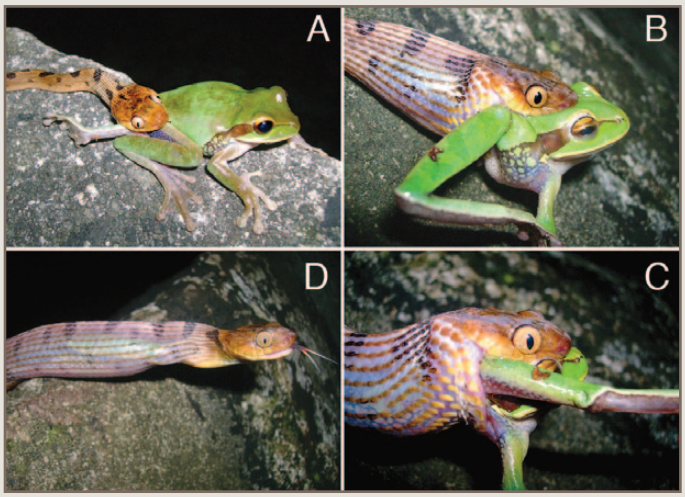
Sources to date have not confirmed the consumption of lizard eggs by *I. cenchoa*. The second snake reported here also contained a lizard in the gut, but the lizard was fully intact, implying that the egg was ingested on a separate occasion. The first snake did not contain any other lizard parts in the stomach, but contained an intact lizard egg. These records suggest that *I. cenchoa* does in fact feed on lizard eggs independent from consumption of lizards.

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***LEPTODEIRA SEPTENTRIONALIS POLYSTICTA* (Central American Cat-eyed Snake). DIET.** *Leptodeira septentrionalis polysticta* is a nocturnal colubrid that inhabits lowlands up to elevations slightly in excess of 2000 m from Nayarit and southern Veracruz, México, southward to central Costa Rica (Duellman 1958. Bull. Amer. Mus. Nat. Hist. 114:72). This species is known to feed on a wide variety of frogs (adults and eggs), lizards, and small mammals (Cabrera-Guzman et al. 2009. Herpetol. Rev. 40:99; Dehling 2009. Herpetol. Rev. 40:356; Duellman, *op. cit.*).

On 8 July 2008, at 2345 h, we encountered a breeding congregation of several adult *Smilisca cyanosticta* at the edge of an artificial reservoir (3 m × 1 m × 1 m) used for watering cattle along a dirt road near La Perla at Los Tuxtlas, Veracruz, México (18.5634°N, 95.1271°W, datum WGS84; elev. 600 m). We also observed two adult *L. s. polysticta*, one of which was in the process of feeding on a female *S. cyanosticta* (Fig. 1A–D). The snake held the hind leg of the frog and chewed it until the rear fangs were engaged. After three minutes, the frog's movement stopped and the snake swallowed it, starting at the posterior body portion, over the next ten minutes. Another predation event involving these species was observed several days later at the same location. This is the first record of *S. cyanosticta* in the diet of *L. septentrionalis*.



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FIG. 1. *Leptodeira septentrionalis polysticta* feeding sequence on a female *Smilisca cyanosticta*, Los Tuxtlas, Veracruz, México. Photos by Alfonso Hernández Ríos.

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***NERODIA FASCIATA FASCIATA* (Banded Watersnake). INTERWETLAND MOVEMENT.** Although many animals regularly display seasonal migrations or periodic long-distance dispersal, few instances of long-distance movements by snakes have been

reported (Browne and Bowers 2004. Landscape Ecol. 19:1–20; Roe and Georges 2007. Biol. Conserv. 135:67–76). Notable exceptions to this generalization are Australian Water Pythons (*Liasis fuscus*), which undertake up to 12 km seasonal migrations between floodplain and high-ground habitats (Madsen and Shine 1996. Ecology 77:149–156) and long-distance "wandering" of snakes displaced by humans (e.g., Plummer and Mills 2000. J. Herpetol. 34:565–575; Reinert and Rupert Jr. 1999. J. Herpetol. 33:45–61). *Nerodia fasciata* is a mid-sized natricine snake that is ubiquitous in the southeastern USA, occurring in virtually all aquatic habitats (Gibbons and Dorcas 2004. North American Watersnakes: a Natural History. Univ. Oklahoma Press, Norman. 438 pp.). Although this species is often abundant in isolated wetlands, these habitats may become unsuitable for aquatic snakes when severe droughts render them dry, sometimes for years at a time (Willson et al. 2006. Wetlands 26:1071–1078). Large numbers of *N. fasciata* captured leaving wetlands at the onset of droughts (Seigel et al. 1995. Herpetologica 51:424–434) have suggested that these snakes may emigrate overland to more permanent wetlands to escape drought conditions, but how far snakes travel and whether or not they successfully reach other aquatic habitats has not been confirmed. Here we report two *N. fasciata* that successfully moved long distances (> 3 km) between wetlands in response to drought.

Between February 2003 and June 2007, two of us (JDW and CTW) captured and marked over 900 individual *N. fasciata* at Ellenton Bay, a large Carolina bay wetland located on the Department of Energy's Savannah River Site in Aiken Co., South Carolina, USA. Ellenton Bay dried partially in the summer of 2006 and fully in June 2007. In 2007, one of us (TML) captured two marked *N. fasciata* in trashcan traps (Luhring and Jennison 2008. J. Fresh. Ecol. 23:445–450) at Dry Bay, a Carolina bay with a longer hydroperiod, located approximately 3.1 km N of Ellenton Bay. Both animals had been originally captured and marked with medical cautery units (Winne et al. 2006. Herpetol. Rev. 37:52–54) at Ellenton Bay. The first *N. fasciata* was a male (SVL = 449 mm; 94 g), originally captured on 20 September 2005 in a plastic minnow trap within Ellenton Bay. It was captured three more times between 22 and 28 September 2005 at Ellenton Bay, prior to being captured 22 months later on 21 July 2007, at Dry Bay (SVL = 488 mm; 102 g). The second snake was a female (SVL = 603 mm; 170 g), originally captured on 1 April 2003 in a box trap along a terrestrial drift fence surrounding Ellenton Bay as it attempted to enter the wetland following a previous extreme drought that lasted from 2000–2003 (Willson et al. 2006. Wetlands 26:1071–1078). This snake was recaptured at Dry Bay on 13 September 2007 (SVL = 802 mm; 486 g), 4 years and 5 months after its initial capture. These two snakes represented 4% (2 out of 56) individual *N. fasciata* captured at Dry Bay in 2007 by TML.

These observations provide the first unambiguous evidence that *N. fasciata* move long distances between wetlands in response to drought conditions. Whether this is a case of directed migration between known habitats or the chance outcome of undirected dispersal, remains unknown. The majority of the intervening habitat between Ellenton Bay and Dry Bay is forested and relatively undisturbed by development, and includes some (mostly temporary and dry during the 2006–2007 period) wetlands that could have been used during transit. However, in addition to > 3 km of distance, the route between Ellenton Bay and Dry Bay is bisected by a well-traveled two-lane highway (SC Hwy 125) and a large (> 5 m across, > 1 m deep) creek (Upper Three Runs Creek). The motivation required to traverse these obstacles (roads) and potential refuges (creek) suggests that these snakes may have been purposefully seeking refuge at Dry Bay. This interpretation is supported by the fact that other *Nerodia* use wetland complexes on a landscape scale; Copperbelly Watersnakes (*N. erythrogaster neglecta*) regularly move between ephemeral wetlands under normal environmental conditions (Roe et al. 2004. Biol. Conserv. 118:79–89). Additionally, at least three species of freshwater turtles have been documented moving between Ellenton Bay and Dry Bay in the past (Buhlmann and Gibbons 2001. Chelon. Conserv. Biol. 4:115–127). Neither snake has been recaptured at either location since 2007, leaving unresolved the question of whether the snakes attempted to return to Ellenton Bay when normal water levels resumed.

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***PSEUDOLEPTODEIRA URIBEI* (Uribe's False Cat-eyed Snake). REPRODUCTION.** The genus *Pseudoleptodeira* is endemic to Mexico and presently includes two species. The more recently described species, *P. uribei*, is known from a small series of individuals collected in the state of Jalisco (Ramirez-Bautista and Smith 1992. Bull. Maryland Herpetol. Soc. 28:83–98) and subsequent reports on individuals from the states of Guerrero (García and Ceballos 1994. Field Guide to the Reptiles and Amphibians of the Jalisco Coast, Mexico. Fund. Ecol. Cuixmala, A.C., Inst. Biol. U.N.A.M., Mexico City, 184 pp.), Michoacán (Mijangos et al. 2007. Herpetol. Rev. 37:500), and Colima (Reyes-Velasco et al. 2009. Herpetol. Rev. 40:117–120). Many aspects of natural history remain enigmatic for this species. Herein we present, to the best of our knowledge, the first formal report of clutch size in a *P. uribei*.

On 6 July 2009 at 2308 h, we found a gravid female *P. uribei* dead on a road near the city of Ixlahuacán, municipality of Ixtlahuacán, Colima, Mexico (19.02558°N, 103.78031°W, datum WGS 84; elev. 309 m). Because of vehicular injuries we were unable to obtain a precise measurement of body size, but conservatively estimate that the animal was over 60 cm total length. The adult female *P. uribei* contained six undamaged eggs which when measured with a digital caliper following preservation in 10% formalin had a mean length of 28.05 mm (± 2.09 SD) and a mean width of 11.32 mm (± 1.67 SS). Our identification was verified by Jacobo Reyes-Velasco and the specimen and its eggs are deposited in the herpetological collection of the University of Texas at Arlington (UTA R-57503; Field ID, JAC 30668).

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***REGINA RIGIDA* (Glossy Crayfish Snake). TERRESTRIAL MOVEMENT.** The overland movements and upland habitat use of wetland-associated reptiles has important conservation implications (Semlitsch and Bodie 2003. Conserv. Biol. 17:1219–1228). However, for many species, particularly snakes, we lack a basic understanding of spatial ecology and habitat use. *Regina rigida* is a poorly known species for which "observations of any kind would be of considerable value in understanding its biology" (Gibbons and Dorcas 2004. North American Watersnakes: A Natural History. Univ. Oklahoma Press, Norman. 438 pp.). *Regina rigida* is a highly aquatic species and although sporadic reports exist of the snake found in habitats considered uplands, specific reports regarding distance to the nearest body of water are lacking.

Herein we report five captures of *R. rigida* in pitfall or box traps associated with drift fences in areas relatively distant from aquatic habitats. On 12 June 2005, we captured a *R. rigida* (SVL = 224 mm) in Conecuh National Forest, Covington Co., Alabama, USA in a trap approximately 10 m from the nearest pond margin. On 19 June 2005, also in Conecuh National Forest, we captured a specimen (SVL = 236 mm) 135 m from the nearest seepage creek and 1180 m from the nearest pond margin. Based on the position of its capture, the snake was moving away from the seepage toward the pond. On 13 June 2009, we captured a specimen (SVL = 190 mm; AUM 34944) on Eglin Air Force Base, Okaloosa Co., Florida, USA. This site was 470 m from the nearest aquatic habitat, a small creek. However, as the snake was captured in a bucket on the opposite side of the drift fence from this creek, the snake was either returning to the creek from a more distant location or originally inhabited a different water body. On 14 Sept 1996, we captured a *R. rigida* on private land in Bienville Parish, Louisiana, USA. The nearest water source was an intermittent stream 460 m from the trap. The nearest permanent water source was Kepler Lake, 860 m from the trap. On 3 May 2006, we captured a specimen on Ft. Polk Army Base, Vernon Parish, Louisiana, USA. The box trap that captured this snake was 70 m from an intermittent stream. Together, these observations indicate that *R. rigida* occasionally undertake significant terrestrial movements, although the impetus for these movements remains unknown.

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***RHABDOPHIS CHRYSARGOIDES* (Gunther's Keelback Snake). MATING BEHAVIOR.** Mating behavior in snakes can be conspicuous but the secretive nature of snakes in general renders mating observations infrequent. Publishing mating observations contributes to our understanding of timing and location of reproduction, reproductive behaviors such as mating aggregations, and possible correlates of mating behavior such as sexual size dimorphism (Rivas and Burghardt 2001. Anim. Behav. 62:F1–F6; Shuster and Wade 2003. Mating Systems and Strategies. Princeton Univ. Press. Princeton. 520 pp.).

On 5 July 2009 at ca. 1900 h, we found a pair of *Rhabdophis chrysargoides* copulating along a stream in the Lambusango Reserve on Buton Island, southeast Sulawesi, Indonesia (5.2125°N, 122.8764°E, datum WGS84; elev. 238 m). The pair was draped along branches ca.1.2 m above water over the streambank in rainforest with ca. 90% canopy cover. The snakes were intertwined only near the tail and cloaca and were facing away from one another. Sperm was abundantly visible at the cloacae. At ca. 2200 h the snakes were still copulating in the same position, at which time they were collected for measurements and photographed; they separated shortly thereafter. The weather that night was ca. 24°C and partly cloudy after a rainless day. At ca. 0630 h the following morning the snakes were found copulating in the bag. The snakes were sexed, measured, and released that morning at their point of capture. The female was much larger than the male (female: SVL = 545 mm; tail length = 145 mm; male: SVL = 392 mm; tail length = 126 mm).

Rhabdophis chrysargoides is frequently encountered along streams on Buton Island (Gillespie et al. 2005. Biotropica 37:279–290). Recently hatched juveniles have been encountered in this area between July and September (G. Gillespie, unpubl. data). To our knowledge, mating has not been observed in this species. July coincides with the cessation of the wet season in southeast Sulawesi (Fontanel and Chantefort 1978. Bioclimates of the Indonesian Archipelago. Institut Francaise de Pondicherry).

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***SIBON ARGUS* (Blotched Snail Sucker). DIET.** The diet of *Sibon* spp. is reported to include mollusks (Solórzano 2004. Snakes of Costa Rica. Instituto Nacional de Biodiversidad, Santo Domingo de Heredia, Costa Rica. 791 pp.) and soft-bodied invertebrates (Greene 1997. Snakes: The Evolution of Mystery in Nature. Univ. California Press. Berkeley. 351 pp.). However, Solórzano (2002. Rev. Biol. Trop. 49:1111–1120) and Ryan and Lips (2004. Herpetol. Rev. 35:278) mention the consumption of centrolenid eggs by *S. argus* and Montgomery et al. (2007. Herpetol. Rev. 38:343) documented the consumption of *Cochranella albomaculata* for the closely related and sympatric *S. longifrenis*.

On 12 June 2006 at 2245 h, a male *S. argus* (SVL = 33.6 cm; 6.6 g) was found eating a clutch of *Agalychnis callidryas* eggs in vegetation overhanging a small temporary pond in El Valle de Antón, Coclé Province, Republic of Panamá (Fig. 1). Eight eggs were manually palped from the snake. Three adult male *A. callidryas* were seen within 3 m of the snake but no other egg masses were found. This pond only



FIG. 1. *Sibon argus* consuming an *Agalychnis callidryas* egg (UTADC 6246), El Valle de Antón, Coclé Province, Republic of Panamá.

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maintains water after significant rain events and dries completely during the dry season. Two digital photographs were taken and were deposited at the Amphibian and Reptile Diversity Research Center, University of Texas at Arlington (UTADC 6246–47). This is the first confirmation that *Sibon* spp. feeds on *A. callidryas* eggs (Ryan and Lips [*op. cit.*] suggested that this might be the case for *S. nebulatus*) and expands the species of frog eggs that are preyed upon by *S. argus*. This further suggests that amphibian eggs might provide an important component of the diet of *Sibon* spp.

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***THAMNOPHIS ELEGANS* (Terrestrial Gartersnake). FEEDING BEHAVIOR, PREY SUBJUGATION BY DROWNING.** *Thamnophis elegans* has been reported to feed on a wide variety of invertebrate and vertebrate species including slugs, earthworms, fish, amphibians, birds, and small mammals (Stebbins 2003. A Field Guide to Western Reptiles and Amphibians. Houghton Mifflin Co., New York, New York. 533 pp.). Compared to other prey taxa, predation on mammals poses serious risks to this species because of mammals' high activity levels and the presence of sharp claws and teeth. Although some populations of *T. elegans* regularly prey on small mammals, they are poor constrictors, using coiling to "pin" their prey, at which time ingestion of the struggling victim occurs (Gregory 1978. Can. J. Zool. 56:1967–1974). Because *T. elegans* lack any strong immobilization mechanisms (i.e., venom or efficient constriction) and are inefficient predators of mammals, selection may favor novel techniques for subjugating these potentially dangerous prey.

On 17 September 2009 at 1645 h, near the bank of a man-made pond in Logan, Utah, USA (41.720309°N, 111.845749°W, datum WGS84; elev. 1369 m), we observed an adult *T. elegans* (total length ca. 50 cm) attack a mouse (body length ca. 6–9 cm). The snake struck the mouse at the posterior end, just above the tail. The snake attempted to subdue the mouse by coiling. Although this behavior looks similar to the constricting behaviors exhibited by other snakes, *T. elegans* rarely kills its prey in these attacks and uses this behavior to subdue the prey long enough to ingest it live (Gregory et al. 1980. Herpetologica 36:87–93).

The snake continued this coiling behavior on the shore of the pond for approximately 1 min at which time it rolled into the pond with its prey. While in the water the mouse continued to struggle, often temporarily freeing itself from the snake's coils long enough to come to the surface for air. The snake, however, still retained the mouse at its hind end and the mouse was quickly re-submerged and wrapped up. The snake and its prey continued in this manner for 7 min, and after 2 min of complete submersion the mouse appeared to have drowned. During the entire predation event, the snake's head remained submerged under water. At the time the mouse stopped moving, we were able to see that the snake had at least two coils wrapped loosely around the mouse.

The snake remained wrapped around the mouse, with its head still submerged, for another 3 min as the current caused the pair to drift to the center of the pond. We then observed the snake swim towards shore pushing the dead mouse in front of it for 10 m. We were unable to continue the observations and it is unknown if the snake consumed the mouse.

Although it is not uncommon for *T. elegans* to prey upon mice and other small rodents, this is the first record of *T. elegans* killing its prey by drowning. Because *T. elegans* is often found near water (Stebbins, *op. cit.*), it is possible that this type of predatory behavior is more common than has previously been thought.

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***THAMNOPHIS FULVUS* (Central American Highland Gartersnake). DIET.** *Thamnophis fulvus* is a terrestrial and semi-aquatic highland snake that is restricted to Nuclear Central America (Köhler 2003. The Reptiles of Central America. Herpeton, Offenbach, Germany. 368 pp.). Almost no information has been reported regarding the diet or foraging ecology of *T. fulvus*, as is the case with a number of Mesoamerican congeners (Rossman et al. 1996. The Garter Snakes: Evolution and Ecology. Univ. Oklahoma Press, Norman. 332 pp.). Brodie et al. (1991. Biotropica 23:58–62) stated that *T. fulvus* was known to feed on *Bolitoglossa* (Caudata: Plethodontidae), and in feeding trials *T. fulvus* accepted both *B. rostrata* and *B. subpalmata*. In Honduras, this species is found in the vicinity of streams, as well as temporary and permanent ponds in highland areas in the southwestern portion of the country. McCranie and Wilson (2002. SSAR Contrib. Herpetol. 19:i–x, 1–625) indicated that an adult specimen from Zacate Blanco (erroneously cited as "Zacate Grande"), Depto. Intibucá, Honduras, regurgitated a single *Hypopachus barberi* (Anura: Microhylidae). In addition, they reported *T. fulvus* as abundant in a stream at the type locality (Depto. de Ocotepeque: El Chagüitón) of *Craugastor anciano* (Anura: Craugastoridae) where it "was probably preying on these frogs."

On 24 May 2008, we collected two specimens (UF 152960–61) of *T. fulvus* in a cattle pond (14.146537°N, 87.844239°W, datum WGS84; elev. 2160 m) about 5 × 12 m in size, located about 3.4 airline km NNW Guajiquiro, Depto. La Paz, Honduras. The adult male *T. fulvus* (UF 152960) contained two adult *Exerodonta catracha* (Anura: Hylidae; UF 152962–63), a small hylid endemic to the highlands of southwestern Honduras. The adult female *T. fulvus* (UF 152961) contained one *Hypopachus barberi* (UF 152967), three *E. catracha* (UF 152964–66), and some frog eggs attached to the latter specimens. At this location, *H. barberi* were observed either floating on the surface of the pond or, in the case of calling males, sitting in concealed positions along the pond's edge. *Exerodonta catracha* were found floating in the pond as well, and were also extremely abundant in the grass and trees around the pond. Both anuran species were remarkably plentiful at this site, apparently due to fact that the first heavy rain of the season fell the night prior to our visit.

LORRAINE P. KETZLER, Voluntaria de Cuerpo de Paz, San Isidro, Santa Cruz de la Yojoa, Departamento de Cortés, Honduras; **ILEANA R. LUQUE-MONTES** and **CÉSAR A. CERRATO-MENDOZA**, Departamento de Biologia, Universidad Nacional Autónoma de Honduras, Tegucigalpa, Departamento de Francisco Morazán, Honduras; **LARRY DAVID WILSON**, Centro Zamorano de Biodiversidad, Escuela Agrícola Panamericana Zamorano, Departamento de Francisco Morazán, Honduras; and **JOSIAH H. TOWNSEND**, School of Natural Resources and Environment, University of Florida, Gainesville, Florida 32611-7800, USA, Centro Zamorano de Biodiversidad, Escuela Agrícola Panamericana Zamorano, Departamento de Francisco Morazán, Honduras (e-mail: jtwnsnd@ufl.edu).

GEOGRAPHIC DISTRIBUTION

Herpetological Review publishes brief notices of new geographic distribution records in order to make them available to the herpetological community in published form. Geographic distribution records are important to biologists in that they allow for a more precise determination of a species' range, and thereby permit a more significant interpretation of its biology.

These geographic distribution records will be accepted in a **standard format** only, and all authors *must* adhere to that format, as follows: SCIENTIFIC NAME, COMMON NAME (for the United States and Canada as it appears in Crother [ed.] 2008. *Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico*. SSAR Herpetol. Circ. 37:1–84, gratis PDF available (http://www.ssarherps.org/pages/HerpCommNames.php); for Mexico as it appears in Liner and Casas-Andreu 2008, *Standard Spanish, English and Scientific Names of the Amphibians and Reptiles of Mexico*. Herpetol. Circ. 38:1–162), LOCALITY (use metric for distances and give precise locality data, including lat/long coordinates in **decimal degrees** and cite the map datum used), DATE (day-month-year), COLLECTOR, VERIFIED BY (*cannot* be verified by an author; curator at an institutional collection is preferred), PLACE OF DEPOSITION (where applicable, use standardized collection designations as they appear in Sabaj Pérez [ed.], 2010. *Standard Symbolic Codes for Institutional Resource Collections in Herpetology and Ichthyology, an Online Reference*. Version 2.0 [8 November 2010]. Electronically accessible at http:///www.asih.org/node/204) and CATALOG NUMBER (required), COMMENTS (brief), CITATIONS (brief and must adhere to format used in this section; these should provide a geographic context for the new record). Skip a line and give name and address in full—spell out state or province names—no abbreviations. Please include distance from nearest previously known record (provide a citation or refer to existing vouchered material to substantiate your report). If publishing specific locality information for a rare or endangered species has the potential to jeopardize that population, please consult with the Section Editor at time of record submission. If field work and/or specimen collection occurred where permits were required, please include permit number(s) and authorizing governmental authority in the text of the note.

Some further comments. The role of the "Standard Names" lists (noted above) is to standardize English names and comment on the current scientific names. Scientific names are hypotheses (or at least represent them) and as such their usage should not be dictated by a list, society, or journal.

Additionally, this geographic distribution section does not publish "observation" records. Records submitted should be based on preserved specimens that have been placed in a university or museum collection (private collection depository records are discouraged; institutional collection records will receive precedence in case of conflict). A good quality photograph (print, slide, or digital file) may substitute for a preserved specimen *only* when the live specimen could not be collected for the following reasons: it was a protected species, it was found in a protected area, or the logistics of preservation were prohibitive (such as large turtles or crocodilians). Photographic vouchers *must* be deposited in a university or museum collection along with complete locality data, and the photographic catalog number(s) must be included in the same manner as a preserved record. Before you submit a manuscript to us, check Censky (1988, *Index to Geographic Distribution Records in Herpetological Review: 1967–1986*; available from the SSAR Publications Secretary), subsequent issues of *Herpetological Review*, and other sources to make sure you are not duplicating a previously published record. The responsibility for checking literature for previously documented range extensions lies with authors. **Do not submit range extensions unless a thorough literature review has been completed.**

Please submit any geographic distribution records in the **standard format only** to one of the Section Co-editors: **Alan M. Richmond** (USA & Canada records only); **Jerry D. Johnson** (Mexico and Central America, including the Caribbean Basin); **Indraneil Das** (all Old World records); or **Gustavo J. Scrocchi** (South American records). Short manuscripts are discouraged, and are only acceptable when data cannot be presented adequately in the standard format. **Electronic submission of manuscripts is required** (as Microsoft Word or Rich Text format [rtf] files, as e-mail attachments). Refer to inside front cover for e-mail addresses of section editors.

Recommended citation for new distribution records appearing in this section is: Schmitz, A., and T. Ziegler. 2003. Geographic distribution: *Sphenomorphus rufocaudatus*. Herpetol. Rev. 34:385.

CAUDATA — SALAMANDERS

***AMBYSTOMA MACULATUM* (Spotted Salamander)**. CANADA: QUÉBEC: Manicouagan Regional County Municipality: Uapishka (Monts Groulx) region, in roadside ponds along Route 389, the Québec-Labrador Highway. "Pond 1" is located 5.3 km W of Mont Provencher near highway km 336 (51.480°N, 68.224°W, NAD1983; elev. 414 m). "Pond 2" is located 4.2 km N of Relais Gabriel, near highway km 324 (51.359°N, 68.148°W, NAD1983; elev. 446 m). 19 May 2010. M. T. Jones and L. L. Willey. Verified by J. Martinez. Harvard University, Museum of Comparative Zoology (MCZ A-140250, A-140251 digital images). This site represents a northeasterly range extension of approximately 160 km NW of an observation near Godbout (also in Manicouagan RCM), and 430 km ENE of an observation near Lake Mistassini (Bider and Matte 1996. The Atlas of Amphibians and Reptiles of Québec. St. Lawrence Valley Natural

History Society, Ste-Anne-de-Bellevue, Québec), and well outside of several published range maps (e.g., NatureServe, http://natureserve.org; IUCN, http://www.iucnredlist.org/apps/-redlist/details/59064/0/rangemap). Considered with the above-mentioned Lake Mistassini and a report from the James Bay region (Ouellet et al. 2009. Herpetol. Cons. Biol. 4[2]:277–284), our observation provides additional evidence that *A. maculatum* may be widespread, but undersampled, in Québec north of 50°N. Twelve egg masses were observed in Pond 1 and eight egg masses were observed in Pond 2. *Lithobates sylvaticus* egg masses were abundant in both locations.

Permission to initiate amphibian research in the Monts Groulx was coordinated by Dominic Boisjoly of the Québec Ministère du Développement durable, de l'Environnement et des Parcs. Funding for travel to the Monts Groulx was provided by the Guy Waterman Alpine Stewardship Fund.

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***AMBYSTOMA JEFFERSONIANUM* (Jefferson Salamander)**. USA: PENNSYLVANIA: Warren Co.: Spring Creek Township, 0.6 km W of junction of Route 426 and Cemetery Rd. (41.86730°N, 79.52540°W; WGS 84). 31 March 2006. Mark Lethaby. Verified by Stephen Rogers. Carnegie Museum of Natural History (CM 130415, 155785). First county record (Hulse et al. 2001. Amphibians and Reptiles in Pennsylvania and the Northeast. Cornell Univ. Press, Ithaca. xii + 419 pp.).

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***AMBYSTOMA OPACUM* (Marbled Salamander)**. USA: GEORGIA: Bartow Co.: Pine Log Mountain Wildlife Management Area, 5.86 km ENE of intersection of Stamp Creek Rd. and State Rt. 411 (34.256697°N, 84.688281°W; WGS 84). 5 May 2010. Z. Felix. AUM AHAP-D 274, digital image. Verified by Craig Guyer. New county record (Jensen et al. [eds.] 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). One adult found under log in floodplain of Stamp Creek.

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***AMBYSTOMA TEXANUM* (Smallmouth Salamander)**. USA: ARKANSAS: Sevier Co.: 2.1 km W Lockesburg off St. Hwy 24 at roadside ditch (33.966712ºN, 94.202957ºW; WGS 84). 26 May 2002. H. W. Robison. Verified by S. E. Trauth. Arkansas State University Museum of Zoology, Herpetological Collection (ASUMZ 31568). New county record that fills a distributional gap in southwestern Arkansas among Howard (Robison and McAllister. 2007. Herpetol. Rev. 38:212), Little River, and Polk counties (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.).

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***BOLITOGLOSSA MEXICANA* (Mexican Mushroom-tongued Salamander; Salamandra de Vientre Oscuro)**. HONDURAS: OCOTEPEQUE: El Mojonal (14.483333°N, 89.283333°W; WGS84, elev. 1350 m). 13 August 2008. James R. McCranie and Leonardo Valdés Orellana. Verified by Sean M. Rovito. USNM 573703. First record for Ocotepeque (McCranie 2007. Herpetol. Rev. 38:36) and first Pacific versant record for the species (McCranie and Wilson 2002. The Amphibians of Honduras. SSAR Contr. Herpetol. 19, x + 625 pp.). Closest known Honduran record is 2 km N of Santa Rosa de Copán, Copán (McCranie 2006. Smithson. Herpetol. Inform. Serv. 137:4), located about 65 km NNE of El Mojonal. The salamander was found at night on low vegetation within a coffee farm, originally in broadleaf forest.

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***DESMOGNATHUS QUADRAMACULATUS* (Black-bellied Salamander)**. USA: VIRGINIA: Russell Co.: Clinch Mountain Wildlife Management Area, 6.4 km NW of intersection of Russell County Routes 733 and 613 (36.931505°N, 81.831927°W; WGS 84). 16 June 2010. Z. Felix. AUM AHAP-D 280, digital image. Verified by Carlos Camp. New county record (Mitchell and Reay 1999. Atlas of Amphibians and Reptiles in Virginia. Virginia Dept. of Game and Inland Fisheries, Richmond. 122 pp.). One adult found under rock at Twin Springs, northwest of Tumbling Creek. The presence of *D. quadramaculatus* at this site extends the species' range 20 km NW in Virginia, and apparently represents a rare case of sympatry with *Desmognathus welteri*, the Black Mountain Salamander (Mitchell and Reay, *op. cit.*).

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***EURYCEA GUTTOLINEATA* (Three-lined Salamander)**. USA: GEORGIA: Banks Co.: Wilson Shoals Wildlife Management Area, close to Grant Mill Rd 0.9 km NE of junction with Yonah Homer Road (34.40291°N, 83.58813ºW, WGS 84; elev. 289 m). 02 April 2009. Robert L. Hill. Verified by Graig Guyer. AUM AHAP-D 286. New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. Univ. of Georgia Press, Athens. 575 pp.). Previously documented in adjacent Habersham, Hall, Jackson, and Stephens counties. One adult female (49 mm SVL) and one adult male (41 mm SVL) retrieved from inside shallow crevices in a man-made rock structure near edge of stream along Grant Mill Road. Male specimen photographed and both released.

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***NECTURUS MACULOSUS LOUISIANENSIS* (Red River Mudpuppy)**. USA: ARKANSAS: Grant Co.: 19.3 km SW Sheridan along Saline River backwater area (34.195901°N, 92.539814°W; WGS 84). 8 May 2003. H. W. Robison. Verified by S. E. Trauth. Arkansas State University Museum of Zoology, Herpetological Collection (ASUMZ 31566). New county record; helps fill a distributional hiatus between Dallas and Hot Spring counties (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.).

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***PSEUDOTRITON RUBER VIOSCAI* (Southern Red Salamander)**. USA: ALABAMA: Escambia Co.: along County Road 4, 0.2 mi. E. of County Road 11 (31.067574°N, 86.807876°W; WGS84/NAD83). 06 March 1999. R. Birkhead and S. M. Boback. Verified by Craig Guyer. AUM 35176. New county record. Fills the distribution gap between populations of *P. r. vioscai* to the south in Santa Rosa and Okaloosa counties, Florida (Ashton and Ashton 1988. Handbook of the Reptiles and Amphibians of Florida, Part III. The Amphibians. Windward Publishing. 191 pp.), and the putative zone of *P. r. ruber* × *P. r. vioscai* intergradation to the north in Monroe and Conecuh counties, Alabama (Mount 1996. The Reptiles and Amphibians of Alabama. University of Alabama Press. xi + 347 pp.). Collected in roadside ditch.

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***SIREN INTERMEDIA NETTINGI* (Western Lesser Siren)**. USA: ARKANSAS: Perry Co.: 3.2 km SE Hollis at roadside ditch along Bear Creek (34.874444°N, 93.110278°W; WGS 84). 2 June 2005. H. W. Robison. Verified by S. E. Trauth. Arkansas State University Museum of Zoology, Herpetological Collection (ASUMZ 31569). New county record; fills a distributional gap in the Ouachitas south of the Arkansas River between Conway and Yell counties (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.).

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ANURA — FROGS

***ACRIS CREPITANS* (Northern Cricket Frog)**. USA: ARKANSAS: Grant Co.: 1.6 km E Poyen off St. Hwy 270 (34.320614°N, 92.624016°W; WGS 84). 16 September 2010. H. W. Robison. Verified by S. E. Trauth. Arkansas State University Museum of Zoology, Herpetological Collection (ASUMZ 31567). A new county record that completely fills small hiatus in central Arkansas (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.). This frog has now been documented from every county of the state.

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***ACRIS CREPITANS* (Northern Cricket Frog)**. USA: GEORGIA: Gwinnett Co.: George Pierce Park: ca. 0.87 km from junction of SR 13/US 23 and George Pierce Park (34.05667°N, 84.05481°W; WGS 84; elev. 280 m). 18 April 2008. Robert L. Hill. Verified by John B. Jensen and Joseph R. Mendelson. AUM AHAP-D 285. New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. Univ. of Georgia Press, Athens. 575 pp.). Previously documented in all surrounding counties. Three specimens of undetermined sex observed in leaf litter along edge of small stream parallel to gravel hiking trail ca.70 m from trail entrance closest to George Pierce Park at end of parking lot. Specimens photographed and released.

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***ACRIS CREPITANS* (Northern Cricket Frog)**. USA: INDIANA: Vermillion Co.: Highland Township: (40.09627°N, 87.43305°W; WGS 84). 02 April 2010. Nathan Engbrecht. Verified by Chris Phillips. Illinois Natural History Survey (INHS 2010j). New county record. Fills a distribution gap in western Indiana (Minton 2001. Amphibians and Reptiles of Indiana, 2nd ed., revised. Indiana Academy of Science. vii + 404 pp.). Two adults were observed in the vicinity of a small farm pond.

NATHAN ENGBRECHT, 135 Holmstedt Hall, Indiana University School of Medicine-Terre Haute, Indiana State University, Terre Haute, Indiana 47809, USA (e-mail: nengbrecht@indstate.edu); **SARABETH KLUEH** and **JASON MIRTL**, Wildlife Diversity Section, Indiana Department of Natural Resources Division of Fish and Wildlife, 553 East Miller Drive, Bloomington, Indiana 47401, USA (e-mail: sklueh@dnr.in.gov).

***CARDIOGLOSSA ALSCO* (NCN)**. CAMEROON: ADAMAWA PROVINCE: Gotel Mts., Tchabal Wadi (alternative names: Tchabel Ouade, Tchabal Gangroua, Chappal Waddi, Gangirwal – latter two in Nigeria), Cameroon – Nigeria border: 7.02921°N, 11.70576°E, 2010 m elev. 5 November 2009. Václav Gvozdík. National Museum, Prague, Czech Republic. NMP6V 74162. Verified by David C. Blackburn. Previously known from type locality on southern slopes of Tchabal Mbabo Mts. (Herrmann et al. 2004. Herpetozoa 17:119–125; Herrmann 2006. *In* IUCN 2010. IUCN Red List of Threatened Species. Version 2010.4. <www.iucnredlist.org>). Subadult, probably male (SVL 23.6 mm) collected from side of small stream fringing forest within montane grassland-pasture in early dry season, with occasional rain. Active on wet rock-ground close to small pool at 1930 h, shortly after dusk. Locality is ca. 50 km by air from type locality, but in different mountain system. Present locality on border between Cameroon and Nigeria, and occurrence in Nigeria, on western slopes of Gotel Mountains, where Gashaka Gumti National Park extends, assumed.

Specimen collected under permit issued by Cameroonian Ministry of Forestry and Wildlife and Ministry of Scientific Research and Innovation Nos. 1010/PRBS/MINFOF/SG/DFAP/SDVEF/SC and 0132/MINRESI/B00/C00/C10/C13.

VÁCLAV GVOŽDÍK, Institute of Animal Physiology and Genetics, Academy of Sciences of the Czech Republic, Rumburska 89, CZ 277 21 Libechov & National Museum, Department of Zoology, Cirkusova 1740, CZ 193 00 Prague, Czech Republic; e-mail: vgvozdik@email.cz.

***CARDIOGLOSSA SCHIOETZI* (Acha Tugi Long-fingered Frog)**. CAMEROON: ADAMAWA PROVINCE: Gotel Mts., Tchabal Wadi (alternative names: Tchabel Ouade, Tchabal Gangroua, Chappal Waddi, Gangirwal – latter two in Nigeria), Cameroon – Nigeria border (07.02921°N, 11.70576°E, 2010 m elev.). 5 November 2009. Václav Gvozdík. National Museum, Prague, Czech Republic. NMP6V 74164/1–4. Verified by David C. Blackburn. Previously known from several localities in the mountains of Cameroon and eastern Nigeria: Oshie-Obudu Ridge, Mount Mbam, Mount Oku (Amiet 1981. Ann. Fac. Sci. Yaoundé 28:117–131; Amiet and Schiøtz 2008. *In* Stuart et al. [eds.], Threatened Amphibians of the World. Lynx Ediciones, Barcelona/IUCN- The World Conservation Union, Conservation International and NaturServe, Washington, D.C. 148 pp.; Blackburn 2006. Herpetol. Rev. 37:486). Four adult males (SVL 23.7–24.9 mm) collected from side of small stream fringing forest within montane grassland-pastures in early dry season when

occasional rains occurred. Males calling from leaf litter on banks close to stream from dusk until at least 2200 h. New record extends known range by ca. 170 km NE from nearest locality on Mount Oku.

Specimens collected under permits issued by Cameroonian Ministry of Forestry and Wildlife and Ministry of Scientific Research and Innovation Nos. 1010/PRBS/MINFOF/SG/DFAP/SDVEF/SC and 0132/MINRESI/B00/C00/C10/C13.

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***EUPHLYCTIS HEXADACTYLUS* (Indian Five-fingered Frog)**. BANGLADESH: DHAKA: Gazipur District: Demurpara village, Pubail (23.9559°N, 90.4548°E, 70 m elev.). Digital image deposited at Raffles Museum of Biodiversity Research ZRC(IMG) 1.33. First record from Gazipur District. 28 May 2010 at ca. 1900 h near residential area. Verified by Monirul H. Khan. In Bangladesh, reported from western parts of Padma River as well as southeast, including Barisal and Khulna. Confirmed report from Jahangirnagar University Campus, Savar, Dhaka (Kabir et al. 2009. Encyclopedia of Flora and Fauna of Bangladesh. Volume 25. Amphibians and Reptiles. Asiatic Society of Bangladesh, Dhaka. 204 pp.). Reported from Sundarban Reserve Forest (Reza et al. 2000. Froglog 4[2]:1–2). First locality record from Gazipur District and northernmost record for Bangladesh.

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***HYLA CHRYSOSCELIS* (Cope's Gray Treefrog)**. USA: ALABAMA: Lauderdale Co.: Butler Creek off Co Rd 61 (34.98659°N, 87.61431°W, WGS 84). 28 October 2010. Christina M. Schmidt and Sean P. Graham. Verified by Craig Guyer. Photo voucher AUM AHAP-D 295. New county record (Mount 1975. The Reptiles and Amphibians of Alabama. University Alabama Press, Auburn. 345 pp.).

CHRISTINA M. SCHMIDT, 101 Life Sciences Building, Auburn University, Alabama 35849, USA.

***LEPTODACTYLUS SAVAGEI* (Rana Grande de la Selva)**. HONDURAS: ATLÁNTIDA: Pico Bonito Lodge, ca. 15 km WSW of La Cieba (15.70°N, 86.90°W, WGS84; elev. 100 m). 14 August 2009. James R. McCranie and Leonardo Valdés Orellana. Verified by W. R. Heyer. USNM 573361. First record for Atlántida (McCranie 2006. Smithsonian Herpetol. Inform. Serv. 137:33). Extends the range ca. 65 km W of the closest previously known locality at Balfate, Colón. The adult female was collected at night in the water at the edge of a small man-made pond surrounded by secondary lowland rainforest, during a light rain about 1 h after dark.

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***LITHOBATES CATESBEIANUS* (American Bullfrog)**. USA: NEBRASKA: Rock Co.: approx. 5.9 mi. NNW Newport in sandhill habitat (42.68011667°N, 99.37136111°W, WGS 84; elev. 679 m). 15 June 2004. Brian Hubbs. Verified by Travis Taggart. Los Angeles County Museum photo voucher LACM PC 1534. First county record (Ballinger et al. 2010. Amphibians and Reptiles of Nebraska. Rusty Lizard Press, Oro Valley, Arizona. 400 pp.; Fogell 2010. A Field Guide to the Amphibians and Reptiles of Nebraska. University of Nebraska, Lincoln. 158 pp.) Frog found in man-made farm pond.

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***LITHOBATES PALUSTRIS* (Pickerel Frog)**. USA: ILLINOIS: Edgar Co.: Brouilletts Creek, 0.76 km SE of intersection of County Road 2225 E and County Road 1650 N (39.702885°N, 87.550654°W; WGS 84). 29 August 2010. Collected by NMK and AMD. Verified by C. A. Phillips. INHS 2010–12. New county record (Phillips et al. 1999. Field Guide to Amphibians and Reptiles of Illinois. Illinois Natural History Survey Manual 8. 300 pp.). A subadult *L. palustris* was found under a log on a sandy streambank at approximately 1700 h.

NICHOLAS M. KIRIAZIS (e-mail: nmkiriazis@eiu.edu) and **ANDREW M. DURSO**, Eastern Illinois University, Department of Biological Sciences, Charleston, Illinois 61920, USA (e-mail: amdurso@gmail.com).

***MELANOPHRYNISCUS DEVINCENZII*.** PARAGUAY: ITAPÚA DEPARTMENT: District of Alto Vera: Kanguery, privately-owned reserve by Guyra Paraguay within the area delimited for the implantation of the San Rafael National Park (26.50833°S, 55.7825°W; WGS 84). 18 February 2009 and 22 April 2009. K. Núñez. Verified by D. Baldo. Museo Nacional de Historia Natural del Paraguay, San Lorenzo, Paraguay (MNHNP 11392, 11400). First record of *M. devincenzii* for Itapúa Department and second record for Paraguay. *Melanophryniscus devincenzii* is known in the departments of Rivera and Tacuarembó, northeastern Uruguay (Achaval and Olmos 2003. Anfíbios y Reptiles del Uruguay, 2nd ed. Graphis Impresora, Montevideo. 136 pp.; Langone 1995 "1994." Mus. Damaso Antonio Larrañaga Ser. Divulg. 5); Misiones and Corrientes provinces, northern Argentina (Baldo and Krauczuk 1999. Cuad. Herpetol. 13:101; Baldo and Basso 2004. J. Herpetol 38:393–403; Boeris et al. 2010. Check List 6:395–396); the Municipality of Sertão, Rio Grande do Sul, Brazil (Zanella et al. 2007. Check List 3:104); Guairá Department, south-central Paraguay (Airaldi et al. 2009. Check List 5:377–379).

This new locality is situated between the known sites of the Department of Guaira (75 km SE) and the Provinces of Misiones and Corrientes (123 km NE and 148 km NE, respectively).

The collecting license was granted by Secretaría del Ambiente (13/2008).

KARINA NÚÑEZ, Universidad Nacional de Asunción, Facultad de Ciencias Exactas y Naturales, Departamento de Biología, Ruta Mariscal Estigarribia km 11 (Campus Universitario), San Lorenzo, Paraguay; e-mail: ranitapy@hotmail.com.

***OSTEOPILUS SEPTENTRIONALIS* (Cuban Treefrog)**. USA: FLORIDA: Bradford Co.: Starke, 703 South Orange Street (29.94015°N, 82.115328°W; WGS84). 12 December 2009. Linda S. Stevenson. Verified by Melvin P. Gramke. Florida Museum of Natural History, University of Florida. UF 162973. First county record (Meshaka et al. 2004. The Exotic Amphibians and Reptiles of Florida. Krieger Publ. Co., Malabar, Florida; Somma 2009. *In* Nonindigenous Aquatic Species. USGS: http://nas.er.usgs.gov/queries/FactSheet.asp?speciesID=57). One adult collected from inside a mailbox on wall of a residence. Individual *O. septentrionalis* have been sighted at this locality from early 2009 through early 2010. This established population is adjacent to populations of *O. septentrionalis* in Alachua, Clay, and Duval (Jacksonville) counties, Florida, forming part of a northern invasion front in Florida, from Levy Co. on the Gulf Coast extending northeastward to Nassau Co. (Krysko et al. 2005. Herpetol. Rev. 36:85–87; Somma 2009, *op. cit.*; Wilson and Bechler

2010. Herpetol. Rev. 41:376). This is Entomology Contribution No. 1186, DPI, FDACS.

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***PELOBATES VARALDII* (Moroccan Spadefoot Toad).** MOROCCO: temporary ponds next to road N1 between Asilah and Tanger (35.621983°N, 5.979220°W; WGS84). 4 April 2009. Marta Lapeña and Luis Javier Barbadillo. Verified by mt-DNA barcoding (IMS, unpubl. data). Tissue vouchers of five tadpoles deposited at Instituto de Investigación en Recursos Cinegéticos (IMS personal collection, voucher numbers: IMS 1148–1152). Hundreds of tadpoles in three ponds < 100 m of each other, in all cases co-occurring with larvae of *Pleurodeles waltl*. Extends range 50 km N (town of Larache; see Bons and Geniez 1996. Anfibios y Reptiles de Marruecos [incluido Sáhara Occidental]. Atlas Biogeográfico. Asociación Herpetológica Española, Barcelona. 320 pp.).

MARTA LAPEÑA, Avenida del Ejército Español, 1, Bloque 1, 6º D, 51002 Ceuta, Spain (e-mail: martalape@yahoo.es); **LUIS JAVIER BARBADILLO**, Avenida Hassan II, 2, 93000 Tetouan, Morocco (e-mail: ljbarbadillo@yahoo.es); **IÑIGO MARTÍNEZ-SOLANO**, Instituto de Investigación en Recursos Cinegéticos, Ronda de Toledo, s/n, 13005 Ciudad Real, Spain (e-mail: inigomsolano@irec.csic.es).

***PROCERATOPHRYS PAVIOTII*.** BRAZIL: ESPÍRITO SANTO: Pinheiros, Fazenda Santa Rita (18.30ºS, 40.15ºW; WGS 84; 105 m elev.). 25 August 2008. J. Peres and J. E. Simon. Museu de Biologia Professor Mello Leitão, Santa Teresa, Espírito Santo, Brazil (MBML 7237–7243).Verified by G. Machado Prado. The species was previously known only from its type locality: Estação Biológica de Santa Lúcia (ca. 19.96°S, 40.53°W, elev. 560 m), Municipality of Santa Teresa, mountainous region of the State of Espírito Santo, southeastern Brazil (Cruz et al. 2005. Arq. Mus. Nac. 63[2]:289–295). This record extends the species distribution ca. 190 km N from type locality.

JULIANA PERES and **JOSÉ EDUARDO SIMON**, Museu de Biologia Prof. Mello Leitão, Rua José Ruschi, 4, Santa Teresa, ES, Brazil, CEP: 29650-000 (e-mail: simon@ebr.com.br)

***PSEUDACRIS CRUCIFER* (Spring Peeper).** USA: GEORGIA: Meriwether Co.: Joe Kurz Wildlife Management Area, 0.64 km S of Damascus Church Rd (33.12956°N, 84.53502°W, WGS 84; elev. 237 m). 11 November 2009. Robert L. Hill. Verified by Craig Guyer. AUM AHAP-D 284. New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. Univ. of Georgia Press, Athens. 575 pp.); previously documented in all surrounding counties. Specimen found under decaying log, photographed, and released.

ROBERT L. HILL, Department of Conservation and Research, Atlanta Botanical Garden, Atlanta, Georgia 30309, USA; e-mail: rhill@atlantabotanicalgarden.org.

***PSEUDACRIS CRUCIFER* (Spring Peeper).** USA: TENNESSEE: Union Co.: Maynardville (36.219444°N, 83.828889°W; WGS84). 27 September 2010. Stephen K. Nelson. Verified by A. Floyd Scott. David H. Snyder Museum of Zoology, Austin Peay State University (APSU 19063, color photo). First county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, Center for Field Biology, Austin Peay State University, 24 pp. Internet version, available at http://www1.apsu.edu/amatlas/index.html. Accessed 25 October 2010). On road at night in rain, at an air temperature of 15°C.

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***PSEUDACRIS FERIARUM* (Upland Chorus Frog).** USA: TENNESSEE: Marshall Co.: (35.6700°N, 86.7856°W; NAD83). 21 April 2009. Michael Anderson and Daniel Estabrooks. Verified by A. Floyd Scott. Austin Peay State University's David H. Snyder Museum of Zoology (APSU 19059, photographic voucher). First record for county, ca. 38 km from previous site in Giles Co. (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Internet version [http://www.apsu.edu/amatlas] contains links to information regarding Tennessee distribution of amphibians recorded since 1996; accessed 07 October 2010). Male and female in amplexus.

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***RHINELLA BERNARDOI*.** ARGENTINA: SAN JUAN: Departmento Caucete: Quebrada de Las Flores (31.70083°S, 68.09500°W, WGS 84; elev. 743.5 m). February 2009. L. Quiroga, E. Sanabria, F. Cano, R. Cortez, and V. Marinero. Herpetological Collection, Fundación Miguel Lillo, Tucumán, Argentina (FML 23921, male, SVL 70 mm, body mass 40 g, and body temperature 18°C). Verified by F. Arias.

Previously known only from the type locality, this record extends known distribution about 170 km S from Parque Provincial Ischigualasto, Departamento Valle Fértil, San Juan, Argentina (Sanabria et al. 2010. Zootaxa 2396:50–60).

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***RHINELLA RUBESCENS* (Rufous Toad).** BRAZIL: MATO GROSSO DO SUL: Municipality of Dourados: (22.09613°S, 55.37456°W; SAD 69).16 June 2007. C. Aoki and P. Landgref Filho. Coleção Zoológica de Referência da Universidade Federal de Mato Grosso do Sul, Mato Grosso do Sul, Brazil (ZUFMS-AMP 1213). Verified by R. A. Brandão. First record for Mato Grosso do Sul State (Frost 2010. Amphibian Species of the World: an Online Reference. Version 5.4). The geographic distribution of *Rhinella rubescens* encompasses the Brazilian states of Pará, Piauí, Goiás, Minas Gerais, São Paulo, and Bahia. Extends the known distribution of *R. rubescens* ca. 520 km SW from the closest known locality (Goiás).

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***SCINAX AURATUS* (Golden Tree Frog).** BRAZIL: PARAÍBA: Mamanguape, Reserva Biológica Guaribas (06.74339°S, 035.14711°W, WGS84; elev.182 m). 5 June 2010. Collected by A. Santos Protázio,

L. B. Q. Cavalcanti. Verified by G. H. Calazans Vieira. Departamento de Sistemática e Ecologia, Coleção Herpetológica, Universidade Federal da Paraíba (SVL 22.38 mm; UFPB 4884; collecting license ICMBIO 15806-2). First state record. *Scinax auratus* was previously known from the states of Bahia, Sergipe, and Alagoas (Alves et al. 2004. Rev. Brasil. Zool. 21[2]:315–317; Bokermann 1969. Rev. Brasil. Biol. 29[2]:159–162; Juncá 2005. *In* Juncá et al. [org.], Biodiversidade e Conservação da Chapada Diamantina, pp. 337–356. Ministério do Meio Ambiente; Nunes and Pombal Jr. 2010. Amphibia-Reptilia 31:347–353; Santana et al. 2009. Check List 5[2]:246–248). Extends the species distribution ca. 406 km NE from the municipality of Quebrângulo, Alagoas state.

ARIELSON DOS SANTOS PROTÁZIO, **LUCAS BARBOSA DE QUEIROGA CAVALCANTI**, **DANIEL OLIVEIRA MESQUITA**, Universidade Federal da Paraíba, Departamento de Sistemática e Ecologia, Cidade Universitária, Cep: 58059-900, João Pessoa, Paraíba, Brazil; **AIRAN DOS SANTOS PROTÁZIO**, Universidade Estadual de Feira de Santana, Laboratório de Animais Peçonhentos e Herpetologia, Av. Transnordestina, S/N, Novo Horizonte, Cep: 44036-900, Feira de Santana, Bahia, Brazil (e-mail: neu_ptz@hotmail.com).

SCINAX GRANULATUS **(NCN)**. ARGENTINA: BUENOS AIRES: Partido de General Pueyrredon: Sierra de Los Padres (37.94028°S, 57.79472°W; WGS 84). 24 July 2010. L. E. Vega and P. J. Bellagamba. Verified by J. Faivovich. Herpetological Collection of Laboratorio Vertebrados, Departamento de Biología, Universidad Nacional de Mar del Plata, Mar del Plata, Buenos Aires, Argentina (UNMdP 1809–1810). First citation for the county and the southernmost record known for this species. This is the first documentation of this frog inhabiting mountain environments at 170 m elev. Present record extends the distribution of this frog 120 km to the SW from nearest known locality in Partido de General Madariaga in the Buenos Aires province (Barrasso and Cajade 2007. Herpetol. Rev. 38:99). The species was previously known from northeastern Argentina, south to Buenos Aires Province; Uruguay and Paraná, Santa Catarina, and Rio Grande do Sul, Brazil; expected in southern Paraguay (Frost 2010. Amphibian Species of the World: an Online Reference. Version 5.4 [8 April 2010]. Electronic database accessible at http://research.amnh.org/vz/herpetology/amphibia. American Museum of Natural History, New York). Barrasso and Cajade (2007, *op. cit.*) pointed out that Gallardo mentioned two specimens from Sierra de la Ventana, but the citation is not supported by voucher specimens. Two adults were captured under rocks. Another five individuals were found inactive under rocks.

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SCINAX TRAPICHEIROI. BRAZIL: RIO DE JANEIRO: Municipality of Bom Jesus do Itabapoana: River Itabapoana bank (21.106424°S, 41.725598°W; SAD 69, elev. 139 m). 18 August 2006. Collected by A. L. Silveira. Museu Nacional / UFRJ, Rio de Janeiro, RJ, Brazil (MNRJ 42510). Verified by U. Caramaschi. The new record extends the known geographic distribution of species about 205 km NE from the closest previous record (Saquarema, ZUFRJ 6720–6723, Luna-Dias et al. 2009. Check List 5[2]:251–253), and constitutes the northern and western boundaries of this distribution. First record of *Scinax trapicheiroi* in the Atlantic Forest biome, a semideciduous seasonal forest. Species was previously known from municipalities of Rio de Janeiro, Maricá, Angra dos Reis (Ilha Grande), Mangaratiba (Ilha da Marambaia), Piraí and Saquarema, in Rio de Janeiro state, Brazil (Luna-Dias et al., *op. cit.*; Lutz 1954. Mem. Inst. Oswaldo Cruz 52[1]:155–197); all localities occur in area of dense ombrophile forest.

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CROCODYLIA — CROCODILIANS

PALEOSUCHUS PALPEBROSUS **(Cuvier's Dwarf Caiman, Jacaré-paguá)**. BRAZIL: CEARÁ: Itapipoca Municipality: Sítio São José (03.1825°S, 39.4369444°W; WGS84). January–February 2005. F. H. C. de Lima. Collection of Herpetology of Núcleo Regional de Ofiologia (NUROF) - Universidade Federal do Ceará, Fortaleza, Brazil (CHUFC C045–C046). Verified by L. M. Verdade. First state record. The species was also photographed and registered by visual survey on Serra das Almas, Crateús Municipalty (03.345°S, 40.8861111°W; datum WGS84), located 260 km airline SW from Itapipoca, during January 2003. The species was previously known from basins of Amazonian (Colombia, Venezuela, Guianas, Bolívia, Paraguay and Brazil), Pantanal, Caatinga, and Atlantic Forest (Brazil) biomes (Carvalho 1951. Os Jacarés do Brasil. Arquivos do Museu Nacional, XLII:127–152; King and Burke 1989. Crocodilian, Tuatara, and Turtle Species of the World. Association of Systematics Collections, Washington, DC. 216 pp). In northeastern Brazil, the species was known from Grande River in the São Francisco River basin, state of Bahia (Carvalho, *op. cit.*), and recently from Atlantic Forest on João Pessoa Municipality, state of Paraíba (Santana et al. 2008. Biotemas 21[1]:75–84). Extends known distribution ca. 660 km airline NW from João Pessoa, and ca. 900 km airline SW of previously known range to the Rio Grande/Rio São Francisco. This is the first record of the species from streams in dune forests (Complexo Litorâneo), ca. 3 km from the seacoast, and is the northernmost distribution point in northeastern Brazil.

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TESTUDINES — TURTLES

APALONE SPINIFERA **(Spiny Softshell)**. USA: OHIO: Union Co.: Paris Township: Mill Creek at Swartzkopf Park in Marysville (40.24449°N, 83.37324°W; WGS 84). 16 July 2008. Jeffrey E. Dawson. Verified by Jeffrey G. Davis. Photo voucher in Cincinnati Museum Center, Geier Collections and Research Center (CMC HP 480). First vouchered record for the county (Wynn and Moody 2006. Ohio Turtle, Lizard, and Snake Atlas. Ohio Biol. Surv. Misc. Contr. No. 10, Columbus. iv + 81 pp.). Several specimens photographed as they basked on large woody debris within the stream. Rausch (1947. Am. Midl. Nat. 38:434–442) reported obtaining one *A. spinifera*

from Union Co. for a survey of chelonian helminths. The turtle was collected while basking on a rock in the Big Darby Creek immediately upstream of U.S. Rte. 36/State Rte. 4 within the village of Milford Center (R. L. Rausch, pers. comm.). This specimen was not deposited as a voucher and subsequently was not included in later atlases of Ohio reptile distributions by Conant (1951. The Reptiles of Ohio. 2nd ed. Univ. Notre Dame Press, Notre Dame. 284 pp.) and Wynn and Moody (2006, *op. cit.*). Recent sightings of *A. spinifera* in the Union Co. section of Big Darby Creek indicate that the species continues to inhabit the area (J. G. Davis, pers. comm.). Both Mill Creek and Big Darby Creek are tributaries of the Scioto River, with the current record ca. 8.8 km NE (straight-line distance) of Rausch's collection site. I thank Robert L. Rausch and Jeffrey G. Davis for their insights and comments on this note.

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***CHELYDRA SERPENTINA* (Common Snapping Turtle)**. USA: GEORGIA: Cherokee Co.: Reinhardt University campus, 0.42 km NNW of intersection of State Routes 108 and 140 (34.321556°N, 84.555367°W; WGS 84). 17 April 2010. B. Hudson. AUM AHAP-D 275, digital image. Verified by Craig Guyer. New county record (Jensen et al. [eds.], 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). One adult found dead in pond.

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***CHELYDRA SERPENTINA* (Snapping Turtle)**. USA: ILLINOIS: Whiteside Co.: IL-84, 0.21 km S Carroll-Whiteside county line (41.927920°N, 90.104456°W; WGS84). 24 May 2010. A. M. Durso. Verified by C. A. Phillips. Photographic voucher INHS 2010-8. New county record (Phillips et al. 1999. Field Guide to Amphibians and Reptiles of Illinois. Illinois Natural History Survey Manual 8. 300 pp.). A live adult female *C. serpentina* was moved from the highway at 2000 h.

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***CHRYSEMYS DORSALIS* (Southern Painted Turtle)**. USA: LOUISIANA: Union Parish: Upper Ouachita National Wildlife Refuge (32.89062°N, 92.09124°W; NAD83). 12 June 2010. John L. Carr and Lisa D. Brown. Verified by John L. Carr. University of Louisiana at Monroe Museum of Natural History (NLU 70659, 70660). New parish record (Dundee and Rossman 1989. The Amphibians and Reptiles of Louisiana. Louisiana State University Press. 300 pp.). A gravid female *C. dorsalis* was captured on 08 June 2010. The two hatchling vouchers were obtained from a clutch of seven eggs laid on 12 June 2010 when oviposition was induced with oxytocin administered to the female. Collecting was done with U.S. Fish and Wildlife Service special use permit 42651-10-07 and Louisiana Department of Wildlife and Fisheries collecting permit LNHP-10-048.

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***GRAPTEMYS GEOGRAPHICA* (Northern Map Turtle)**. USA: OHIO: Fairfield Co.: Berne Township, Logan-Lancaster Rd. (U.S. Rte. 33 Business) ca. 50 m E of the Hocking River and ca. 5.8 km SE of Lancaster (39.67103°N, 82.56126°W; WGS 84). 1 June 2010. Jeffrey E. Dawson and Cheri L. Dawson. Verified by Jeffrey G. Davis. Photo voucher in Cincinnati Museum Center, Geier Collections and Research Center (CMC HP 5266). New county record (Wynn and Moody 2006. Ohio Turtle, Lizard, and Snake Atlas. Ohio Biol. Surv. Misc. Contr. No. 10, Columbus. iv + 81 pp.) and the second record of this species from the Hocking River system, extending the range in this drainage ca. 90 river km from a historical record in Athens Co. (Conant 1951. Reptiles of Ohio. 2nd ed. Univ. Notre Dame Press, Notre Dame. vi + 284 pp.). This species has also been collected from neighboring Franklin, Licking, and Pickaway counties in central Ohio. Adult female found DOR.

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***GRAPTEMYS GEOGRAPHICA* (Northern Map Turtle)**. USA: ILLINOIS: Whiteside Co.: Mississippi River, 1.64 km SW jct. Riverfront Dr. and Great River Trail (41.925796°N, 90.127778°W; WGS84). 12 June 2010. L. A. Neuman-Lee. Verified by C. A. Phillips. Photographic voucher INHS 2010-9. New county record (Phillips et al. 1999. Field Guide to Amphibians and Reptiles of Illinois. Illinois Natural History Survey Manual 8. 300 pp.). An adult female *G. geographica* was observed basking on debris in the river.

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***GRAPTEMYS PSEUDOGEOGRAPHICA* (False Map Turtle)**. USA: ILLINOIS: Carroll Co.: Thomson, Main St., 0.22 km E jct. Lewis Ave. (41.958503°N, 90.109141°W; WGS84). 18 September 2010. A. M. Durso. Photographic voucher INHS 2010-10. An adult female crossing the road at 1600 h. Whiteside Co.: Mickelson's Landing sand prairie, 0.69 km NW jct. Covell Rd. and IL-84 (41.918912°N, 90.117005°W; WGS84). 9 June 2008. L. A. Neuman-Lee. Photographic voucher INHS 2010-11. New county record. An adult female was observed nesting on a sand prairie. Both vouchers verified by C. A. Phillips.

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***MACROCHELYS TEMMINCKII* (Alligator Snapping Turtle)**. USA: TENNESSEE: Tipton Co.: Densford Bar Mississippi River Mile 757 Pecan Point Quad (35.410308°N, 90.026275°W, NAD 83). 15 June 2004. Robert Colvin. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19066). New county record (Scott and Redmond 2008. Atlas of Reptiles in Tennessee, Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available from http://www.apsu.edu/reptatlas/frames_file.htm, accessed 4 October 2010). One individual found by a fisherman. Air temperature at collection was 35°C.

Voucher image made under the authority of the Tennessee Wildlife Resources Agency; field work supported by State Wildlife Grant (SWG) funding under the authority of the U.S. Fish and Wildlife Service.

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***MELANOCHELYS TRICARINATA* (Tricarinate Hill Turtle)**. INDIA: MADHYA PRADESH: Kanha National Park: Phuta Tal (22.2777°N, 80.6425°E, ca. 600 m elev., WGS84) 28 June 2009. Digital image voucher, ZRC (IMG) 2.128. Photographed by Durgesh Kumar Singh. Verified by Indraneil Das. Species known from relatively narrow sub-Himalayan band across NE India, Nepal, and Bangladesh. Nearest population in Chaibassa, in Jharkhand State, ca. 550 km to northeast (Das 2009. Chelonian Res. Monogr. 5:025.1–0.25.5). Individual observed crossing dirt road opposite Phuta Tal at 0740 h, and went under dry leaf litter on forest floor.

DURGESH KUMAR SINGH, Taj Safaris, Banjaar Tola, Mukki, Post Baihar, Balaghat District, Madhya Pradesh, India; e-mail: durgesh.singh@gmail.com.

***PSEUDEMYS CONCINNA* (River Cooter)**. USA: GEORGIA: Baldwin Co.: ca. 3 km E and 4 km N of Milledgeville (33.120173°N, 83.182872°W; WGS84). 14 October 2010. Sergio Paiitucci Saieh. GCH 5345. Verified by John B. Jensen. New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). Single sub-adult collected in pitfall trap on forest floor in mixed pine-deciduous forest near Lake Laurel.

SERGIO PAIITUCCI SAIEH (e-mail: sergio_patituccisaieh@ecats.gcsu.edu) and **DENNIS PARMLEY**, Department of Biological and Environmental Sciences, Georgia College & State University, Milledgeville, Georgia 31061, USA.

***STERNOTHERUS MINOR PELTIFER* (Stripe-necked Musk Turtle)**. USA: MISSISSIPPI: Perry Co.: De Soto National Forest (31.194439°N, 89.129217°W; NAD83). 24 November 2010. Donald J. Newman III and James R. Lee. Verified by Robert L. Jones. Mississippi Museum of Natural Science (MMNS 17439). New county record. Although the species is known from eleven other counties statewide, its distribution within the Pascagoula River system appears to be limited (Iverson 1977. Cat. Am. Amphib. Rept. 195:1–2; McCoy et al. 1978. Herpetol. Rev. 9:109). We also searched *Herpetological Review* records from 1967–September 2010, Mississippi Department of Wildlife, Fisheries, and Parks collection records, and all museums on www.herpnet.org).

DONALD J. NEWMAN III (e-mail: dnewman@tnc.org.) and **JAMES R. LEE**, The Nature Conservancy, Camp Shelby Joint Forces Training Center, CSJFTC-ENV Building 622, Camp Shelby, Mississippi 39407, USA.

***STERNOTHERUS ODORATUS* (Eastern Musk Turtle)**. USA: GEORGIA: Cherokee Co.: Reinhardt University campus, 0.42 km NNW of intersection of State Routes 108 and 140 (34.321556°N, 84.555367°W; WGS 84). 21 April 2010. Z. Felix. AUM AHAP-D 278, digital image. Verified by Craig Guyer. New county record (Jensen et al. [eds.] 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). One adult found in pond.

ZACH I. FELIX, Biology Department, Reinhardt University, Waleska, Georgia 30183, USA; e-mail: zif@reinhardt.edu.

***TERRAPENE CAROLINA* (Eastern Box Turtle)**. USA: ALABAMA: Autauga Co.: Found dead on road, along Hwy 82 near the town of Prattville (32.441850°N, 86.413117°W; WGS84/NAD83). 19 May 2010. R. Birkhead. AHAP-D-265 –266, digital images. Chambers Co.: I-85 near the town of Valley (32.832150°N, 85.204133°W; WGS84/NAD83). 8 October 2009. R. Birkhead. AUM 33164, DOR. Madison Co.: Caught live across from the intersection of Slatemill Rd and Bell Rd in southwest Huntsville (34.610871°N, 86.577766°W; WGS84/NAD83). 13 July 2010. D. O'Halloran and S. Dery. AHAP-D-262–264, digital images. All verified by Craig Guyer. New county records (Mount 1996. The Amphibians and Reptiles of Alabama. University of Alabama Press. xi + 347 pp.). *Terrapene carolina* is assumed to occur statewide; however, verified records are lacking for many Alabama counties.

ROGER D. BIRKHEAD, Alabama Science In Motion, Auburn University, Alabama 36849-5414, USA (e-mail: birkhrd@auburn.edu); **DAN O'HALLORAN**, Alabama Science In Motion, University of Alabama Huntsville, Alabama 35899, USA (e-mail: do0001@uah.edu); **SAMUAL G. DERY,** 14000 Hermosa Drive, Huntsville, Alabama 35803, USA (e-mail: atlpunkrocker@yahoo.com).

***TRACHEMYS SCRIPTA* (Pond Slider)**. USA: GEORGIA: Cherokee Co.: Reinhardt University campus, 0.42 km NNW of intersection of State Rts. 108 and 140 (34.321556°N, 84.555367°W; WGS 84). 21 April 2010. R. Mansfield. AUM AHAP-D 279, digital image. Verified by Craig Guyer. New county record (Jensen et al. [eds.] 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). Three juveniles dip-netted from pond.

ZACH I. FELIX (e-mail: zif@reinhardt.edu)**, RACHEL MANSFIELD,** and **DANIELLE GLANZER**, Biology Department, Reinhardt University, Waleska, Georgia 30183, USA.

SQUAMATA — LIZARDS

ANOLIS EUSKALERRIARI. COLOMBIA: LA GUAJIRA: Urumita Municipality: Tres Picos farm, Serranía del Perijá (10.459083°N, 72.95725°W; datum Bogotá WGS 84). 12 November 2009. J. E. Carvajal-Cogollo and V. A. Bernal-González. Colección de Reptiles. Instituto de Ciencias Naturales, Universidad Nacional de Colombia, Bogotá, Colombia (ICN 12075). Verified by R. A. Moreno-Arias and O. V. Castaño-Mora. First country record. This species was known only from Mesa Turik in Venezuela (Barros et al. 1996. Breviora [504]:1–30). Extends species range 28.5 linear km W of type locality "Serranía del Perijá" (Barros et al. 1996, *op. cit.*; Poe 1998. Herpetol. Monogr. 12:192–236).

Submitted by: **JUAN E. CARVAJAL-COGOLLO** (e-mail: juancarvajalc@gmail.com), and **VLADIMIR A. BERNAL-GONZÁLEZ,** Instituto de Ciencias Naturales, Universidad Nacional de Colombia, Apartado Aéreo 7495, Bogotá D.C., Colombia (e-mail: vlacho83@gmail.com).

***HELODERMA HORRIDUM* (Mexican Beaded Lizard)**. MÉXICO: DURANGO: Municipality of Tamazula: 3 km N Jala (24.9333°N, 106.9500°W; WGS84), elev. 650 m. 14 September 2007. Iván T. Ahumada. Verified by Héctor Eliosa León. Colección Herpetológica de la Escuela de Biología, Benemérita, Universidad Autónoma de Puebla (EBUAP 2103). First record for the state and extends the known range ca. 60 km NNE from the closest known locality at Costa Rica, 16 mi. S of Culiacan (UIMNH 36201). The lizard was found in tropical deciduous forest. We thank Chris Phillips for providing information from the UIMNH collection.

IVÁN T. AHUMADA-CARRILLO, Centro Universitario de Ciencias Biológicas y Agropecuarias, Universidad de Guadalajara, Zapopan, Jalisco, México (e-mail: lepidus320@hotmail.com); **CARLOS A. HERNÁNDEZ-JIMÉNEZ**, Laboratorio de Sistemática y Recursos Naturales, Escuela de Biología, Universidad Autónoma de Puebla, Edificio 112 A Ciudad Universitaria C.P. 72570 Puebla, México (e-mail: acaltetepon22@gmail.com); **URI OMAR GARCÍA-VÁZQUEZ**, Laboratorio de Herpetología, Museo de Zoología, Facultad de Ciencias, Universidad Nacional Autónoma de México, A.P. 70-399, México, D.F. 04510, México (e-mail: urigarcia@gmail.com).

***HEMIDACTYLUS FRENATUS* (Asian House Gecko)**. SOUTHWEST PACIFIC: COOK ISLANDS: AITUTAKI: Arutanga Wharf (18.83°S, 159.75°W). First island record and approximate year of establishment. 5 October 1995. B. J. Gill, Auckland Museum (AIM

LH1855–7). Verified by Tom Trnski, Auckland Museum. Aitutaki is the second-most visited island in Cook Group, located 260 km N of main island of Rarotonga. No previous records on Aitutaki; known in Rarotonga since 1987 (Gill 1998. Tuhinga 10:151–157). BJG spent a week on Aitutaki (4–10 October 1995) and searched at many sites across main island (including jetties at Vaipae and Tautu) and on some of its lagoon islets, and found none other than three caught at wharf buildings in main town (Arutanga) on west coast. AHW visited Aitutaki in July 2000 and found species widespread along western side of island. Scarcity of species in 1995, their presence then at island's main wharf, and abundance in 2000 at many sites, seem to fix 1995 as approximate year of arrival at Aitutaki, presumably in cargo.

B. J. GILL, Auckland Museum, Private Bag 92018, Auckland, New Zealand (e-mail: bgill@aucklandmuseum.com); **A. H. WHITAKER**, 270 Thorpe-Orinoco Road, R.D. 1, Motueka, New Zealand (e-mail: whitaker@ts.co.nz).

***HEMIDACTYLUS TURCICUS* (Mediterranean House Gecko)**. PORTUGAL: MOURÃO: ca. 38.3847°N, 07.3444°W. 26 July 2010. Collected by Luis Ceríaco, Centro de Estudos de História e Filosofia da Ciência, Universidade de Évora. Specimen and photographic vouchers deposited at Colecção de Animais em formol of the Museu de Ciências Naturais da Escola Secundária André de Gouveia (MCN/MB/AC/V/39). Verified by Ana Pires. Species known from several localities, nearest population at western margin of Guadiana (Mateus and Jacinto 2010. *In* Loureiro et al. [coord.], Atlas dos Anfíbios e Répteis de Portugal, pp. 130–131. Esfera do Caos Editores, Lisboa). Collected and photographed on village wall, at ca. 2230 h. Individuals abundant on village walls, where groups of 2–3 seen at a time, especially after 2100 h.

LUIS MIGUEL PIRES CERÍACO, Projecto "Salvem as Osgas!" and Centro de Estudos de História e Filosofia da Ciência, Universidade de Évora; Bairro do Bacelo, Rua do Viveiro nº 5D, 7005-638 Évora, Portugal (e-mail: luisceriaco@netcabo.pt); **MARIANA PIMENTEL MARQUES**, Projecto "Salvem as Osgas!" and Escola de Ciências e Tecnologias, Universidade de Évora.

***HEMIDACTYLUS TURCICUS* (Mediterranean Gecko)**. USA: ARKANSAS: Jefferson Co.: Jefferson (Sec. 11, T4S, R11W; 34.380556°N, 92.163889°W; WGS84). 6 October 2010. Joe M. Fowler. Verified by S. Trauth. Arkansas State University Museum of Zoology (ASUMZ 31565). New county record partially filling a distributional gap in southeastern Arkansas (Trauth et al. 2004. Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.). This specimen was from a reproducing population as it was a hatchling or very young juvenile.

JOE MIKE FOWLER, 2525 Whitewood Drive, Sherwood, Arkansas 72120, USA; e-mail: jfowle98@yahoo.com.

***HEMIDACTYLUS TURCICUS* (Mediterranean Gecko)**. USA: TEXAS: Ward Co.: 900 block Franklin Ave., 0.6 km E St. Hwy 18 (31.593345°N, 102.892995°W; NAD83). 23 April 2008. Matthew Anderson. Oklahoma State University Stillwater (OSUS R6137). Winkler Co.: 2100 block East Ave., 0.5 km N St. Hwy 302 (31.88346°N, 103.01183°W; NAD 83). 5 May 2009. Matthew Anderson. OSUS R6144. Both specimens verified by Stanley Fox. New county records (Dixon 2000. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 421 pp.). The presence of juveniles and adults at the former residence indicates a breeding population. At the latter site (apartment complex), a single adult was located on a brick wall; the only sighting made by MLA during three months living at this locale. These records represent a further expansion of this species' range immediately north of the Pecos River into more arid and sparsely populated counties of west Texas; the closest proximate locality is southward across the Pecos River in Pecos Co. (Dixon 2000, *op. cit.*).

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***MANTHEYUS PHUWUANENSIS* (Phu Wua Rock Agama)**. LAOS: BOLIKHAMXAY PROVINCE: Pakkading District: Nam Kading National Protected Area (18.3717°N, 104.1625°E, WGS 84; 450 m elev.). 27 May 2009. Kiangsack Bouakhasith and Chris D. Hallam. Verified by James A. Schulte II. North Carolina State Museum of Natural Sciences (NCSM 77720). Adult male in crag of rock overhang in large boulder pile ca. 15 m from small, permanent, flowing stream in hill evergreen forest, at dusk. Female observed in syntopy but not captured. Third known locality for species with small range and district record. Originally described from Phu Wua Wildlife Sanctuary in Nong Khai Province, Thailand (Manthey and Nabhitabhata 1991. Sauria 13:3–6) and reported from Phou Khao Khouay National Protected Area (= National Biodiversity Conservation Area) in Bolikhamxay Province, Thaphabat District, Laos (Ananjeva and Stuart 2001. Russ. J. Herpetol. 8:165–170; Manthey and Manthey 2005. Reptilia 10:26–31). New record ca. (straight-line) 25 km from type locality in Thailand and 100 km from Laos locality. The species is geographically restricted to a small area near the Mekong River in these two countries, where it occurs on rock ledges, boulder piles, and caves in evergreen forest.

CHRIS D. HALLAM, Wildlife Conservation Society, Vientiane, Laos (e-mail: challam@wcs.org); **BRYAN L. STUART**, North Carolina State Museum of Natural Sciences, Raleigh, North Carolina 27601, USA (e-mail: bryan.stuart@ncdenr.gov); **SOMPHOUTHONE PHIMMACHAK** and **NIANE SIVONGXAY**, Department of Biology, Faculty of Sciences, National University of Laos, Vientiane, Laos.

***PLESTIODON ANTHRACINUS* (Coal Skink)**. USA: PENNSYLVANIA: Venango Co.: Cranberry Township, State Game Land 45 (41.33046°N, 79.61633°W; WGS 84). 24 June 2007. Natural History Museum at the Tom Ridge Environmental Center (TREC R- 00020). Vouchers collected at two additional Venango Co. (TREC R- 00046, 00047). All specimens collected by Mark Lethaby and verified by Peter Lindeman. First vouchered county records. Extends the species range in Pennsylvania 25 km W from the nearest record in Forest Co. (Hulse et al. 2001. Amphibians and Reptiles in Pennsylvania and the Northeast. Cornell Univ. Press, Ithaca, New York. xii + 419 pp.). Collections made under Pennsylvania Fish and Boat Commission Scientific Collector Permit 184.

MARK LETHABY, Natural History Museum at the Tom Ridge Environmental Center, 301 Peninsula Drive, Erie, Pennsylvania 16505, USA; e-mail: mlethaby@verizon.net

***PLESTIODON FASCIATUS* (Common Five-lined Skink)**. USA: GEORGIA: Cherokee Co.: Reinhardt University campus, 0.62 km NE of intersection of State Rts. 108 and 140 (34.319640°N, 84.547130°W; WGS 84). 17 April 2010. K. Thompson. AUM AHAP-D 276, digital image. Verified by Craig Guyer. New county record (Jensen et al. [eds.] 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). One juvenile under cover in field.

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***PLESTIODON SKILTONIANUS UTAHENSIS* (Great Basin Skink)**. USA: WYOMING: Lincoln Co.: on west bank of Bear River, 6.0 km N of Cokeville (42.13769ºN, 110.97446ºW; NAD27). 6 May 2010. Henry J. Vogel, Charlotte E. Matthews, and Leslie A. Schreiber. Verified by Christopher Phillips. Illinois Natural History Survey (INHS 2010d). New state record (Baxter and Stone 1985. Amphibians and Reptiles of Wyoming, 2nd ed. Wyoming Game and Fish Department, Cheyenne, Wyoming. 137 pp.). One juvenile was found 10 m from a former dammed area on the Bear River, underneath a piece of tin. Temperature was 2.2°C when found, though had been sunny earlier in the day. Another juvenile was found on 7 May 2010, 6.4 km NE of first specimen under a rock on a ridge, 275 m from water. A genetic sample was obtained from this individual.

CHARLOTTE E. MATTHEWS (e-mail: charlotte.matthews@wgf.state.wy.us), **HENRY J. VOGEL**, and **LESLIE A. SCHREIBER**, Wyoming Game and Fish Department, 3030 Energy Lane, Casper, Wyoming 82604, USA.

***SPHAERODACTYLUS DUNNI* (NCN)**. HONDURAS: GRACIAS A DIOS: Región La Mosquitia, Reserva de Biósfera Río Platano, Raudal Kiplatara (15.583472°N, 84.933589°W; WGS84), 230 m elev. 20 July 2003. Jorge A. Ferrari. Verified by Konrad Klemmer. SMF 86283. First record for Gracias A Dios, with the closest reported locality being near Trujillo, ca. 115 km to the WNW (Harris and Kluge 1984. Occas. Pap. Mus. Zool. Univ. Michigan 706:1–59). The lizard was found during daytime inside a rotten tree trunk in rainforest.

GUNTHER KÖHLER, Forschungsinstitut und Naturmuseum Senckenberg, Senckenberganlage 25, 60325 Frankfurt a.M., Germany (e-mail: gkoehler@senckenberg.de); **JORGE A. FERRARI**, Organización de Rescate y Protección de Reptiles y Anfibios de Honduras, Tegucigalpa, Honduras (e-mail: herpetoking@yahoo.com).

SQUAMATA — SNAKES

***AGKISTRODON CONTORTRIX* (Copperhead)**. USA: TEXAS: Rockwall Co.: 32.823360°N, 96.490687°W; WGS84) 10 September 2005. Matthew D. Broxson. Verified by Carl J. Franklin, The University of Texas at Arlington Reptile and Amphibian Diversity Research Center (UTA DV1001). New county record (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. Texas A&M University Press, College Station, Texas. 421 pp.) Copperheads have been documented in all adjacent counties but not from Rockwall Co. (Dixon 2000, *op. cit.*). This may reflect the small size of the county, the prevalence of urbanization throughout most of the county, and the fact that a large portion of the county is open water.

MATTHEW D. BROXSON, Department of Life, Earth and Environmental Sciences, West Texas A&M University, Box 60808, Canyon, Texas 79016, USA.

***AGKISTRODON PISCIVORUS* (Cottonmouth)**. USA: TENNESSEE: Tipton Co.: Hwy 54 approximately 1 mile W of the Hatchie River in the Turnpike 7.5-minute USGS quad (35.3357°N, 89.2922°W; NAD 83). 17 June 2009. Collected by Robert Colvin. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19067). New county record (Scott and Redmond 2008. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available from http://www.apsu.edu/reptatlas/frames_file.htm, accessed 4 October 2010).

Voucher image made under the authority of the Tennessee Wildlife Resources Agency; field work supported by State Wildlife Grant (SWG) funding under the authority of the U.S. Fish and Wildlife Service.

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***CHARINA BOTTAE* (Rubber Boa)**. USA: CALIFORNIA: San Luis Obispo Co.: Montaña de Oro State Park: Valencia Peak Trail (35.2636417°N, 120.87425°W; Google Earth; elev. 326 m). 02 June 2010, 1045 h, ~16°C air, total length ca. 46 cm, in an area of rocky shale outcrops and coastal scrub vegetation. Steve C. Schubert. Verified by Richard F. Hoyer. Natural History Museum of Los Angeles County voucher photographs (LACM-PC 1515–1517).

This appears to be the first documented report of *Charina bottae* within San Luis Obispo Co. There are a few earlier sight reports during the past several decades within or near Montaña de Oro State Park; the most recent of these was in 2006, when a boa was found on the Coon Creek Trail in the riparian zone, but the observer lacked a camera to document the find and the snake was not collected (B. Stafford, California Department of Fish and Game, pers. comm.).

STEVEN C. SCHUBERT, P.O. Box 6002, Los Osos, California 93412, USA; e-mail: s_schub1@msn.com.

***COLUBER* (=*MASTICOPHIS*) *TAENIATUS* (Striped Whipsnake)**. USA: WYOMING: Sweetwater Co.: Flaming Gorge National Recreation Area, less than 1 km W of US Highway 191, 2–3 km N of the Utah border (41.020028°N, 109.431500°W; WGS84). 5 July 2010. Deborah Ambrose and Zachary Pohlen. Verified by Chris Phillips. Illinois Natural History Survey (INHS 2010s [digital photographs]). First verified record for this species in Wyoming (Baxter and Stone 1985. Amphibians and Reptiles of Wyoming, 2nd ed. Wyoming Game and Fish Department, Cheyenne, Wyoming. 137 pp.). The Striped Whipsnake is known to occur in Utah, just south of the Wyoming border. Although the species has been observed previously in the state by Jan Roth, it was not formally verified or considered a native Wyoming species (Zack Walker, Wyoming Game and Fish Department, pers. comm.). This observation formalizes the previous sighting and provides reason for the state of Wyoming to assign it a native species status. Two living individuals were observed on the same day within 1–2 km of each other, both on unpaved roads. One large adult specimen was observed on the side of Canyon Road/Forest Service Road 26. The second specimen (INHS 2010s) was observed shortly thereafter sunning on Flaming Gorge Road/County Road 33 and was captured for photographs and released.

KAYLAN A. HUBBARD, Wyoming Cooperative Fish & Wildlife Research Unit, Department of Zoology and Physiology, University of Wyoming, Laramie, Wyoming 82071, USA; e-mail: khubbar4@uwyo.edu.

***CROTALUS HORRIDUS* (Timber Rattlesnake)**. USA: TENNESSEE: Haywood Co.: approximately 2.1 km S of Highway 54 off of Herbert Willis Road and located in the Turnpike 7.5-minute USGS quad (35.562810°N, 89.428480°W; NAD 83). 2 June 2010. Robert Colvin. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19070). New county record (Scott and Redmond 2008. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available from http://www.apsu.edu/reptatlas/frames_file.htm, accessed 4 October 2010).). One individual found by a farmer on the John Willis farm. Temperature at collection was 26.1°C.

Collection made under the authority of the Tennessee Wildlife Resources Agency; field work supported by State Wildlife Grant (SWG) funding under the authority of the U.S. Fish and Wildlife Service.

ROBERT COLVIN, Tennessee Wildlife Resources Agency Region I, 200 Lowell Thomas Drive, Jackson, Tennessee 38301, USA; e-mail: Rob.Colvin@tn.gov.

***DRYMARCHON COUPERI* (Eastern Indigo Snake)**. USA: GEORGIA: Dodge Co.: SR 117, 0.85 km S George S Walker Road (31.937967°N, 83.178675°W; WGS84, elev. 60 m). 23 October 2010. W. Kellner. Verified by Kenneth L. Krysko. Photographic voucher UF 163246. First record for county (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens, Georgia. 575 pp.).

WILLIAM S. KELLNER, 4851 West Blue Indigo Lane, Beverly Hills, Florida 34465, USA; **KILEY V. BRIGGS, JAVAN M. BAUDER,** and **DIRK J. STEVENSON,** The Orianne Society, Indigo Snake Initiative, 579 Hwy 441 South, Clayton, Georgia 30525, USA.

***DRYMARCHON MELANURUS* (Central American Indigo Snake)**. HONDURAS: VALLE: Isla del Tigre, close to Amapala (13.2898°N, 87.6555°W, WGS84; elev. 10 m). 14 July 2010. Alexander Gutsche, James R. McCranie, and Leonardo Valdés Orellana. Verified by James R. McCranie. USNM 565805. First record for Valle, ca. 35 km SW of the closest known locality, 20 km WNW of Choluteca, Choluteca (UNAH 4232)). The snake was killed by a local in a residential neighborhood.

Field work of A. Gutsche was supported by the Adolf and Hildegard Isler Foundation.

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***DRYMOBIUS CHLOROTICUS* (Green Highland Racer)**. MÉXICO: GUERRERO: Municipality of Leonardo Bravo: 10 km S of Yextla (17.52007°N, 99.96379°W, WGS84; elev. 2000 m). 16 June 2002. Jonathan A. Campbell. Verified by Luis Canseco Márquez. Museo de Zoología "Alfonso L. Herrera" Fac. Ciencias UNAM (MZFC 17051). First record for Guerrero, extending its known range 328 km (airline) NW of Dist. de Juquila Lachao Nuevo, ca. 10 mi N San Juan Lachao, Oaxaca (Wilson 1975. Cat. Amer. Amphib. Rept. 171:1). The snake was found DOR surrounded by pine forest.

Field work was funded by NSF DEB-0613802 to Jonathan A. Campbell.

ANDRÉS ALBERTO MENDOZA-HERNÁNDEZ (e-mail: andreasmeher@gmail.com)**, EDMUNDO PÉREZ-RAMOS,** and **URI OMAR GARCÍA-VÁZQUEZ,** Laboratorio de Herpetología, Museo de Zoología, Facultad de Ciencias, UNAM, A.P. 70-399, México D.F. 04510

***ENULIUS FLAVITORQUES* (Pacific Long-tailed Snake, Coluda del Pacifico)**. HONDURAS: INTIBUCA: San Isidro (14.550274°N, 88.1000208°W, WGS84; elev. 1162 m). 23 March 2010. Leonardo Valdés Orellana. Verified by James R. McCranie. USNM 252303. First record for Intibuca. The closest known locality is ca. 30 km ENE of San Isidro at Siguatepeque, Comoagua (UNAH 2743). The snake was killed at 1000 h by a local resident on a road surrounded by pastures formerly in subhumid forest.

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***FARANCIA ABACURA REINWARDTII* (Western Mudsnake)**. USA: TENNESSEE: Tipton Co.: Adult found dead on Hwy 59 in the Baxter Bottoms and located in the Mason 7.5-minute USGS quad (35.2705°N, 89.3349°W; NAD 83). 25 April 2009. Robert Colvin. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19068). New county record (Scott and Redmond 2008. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available from http://www.apsu.edu/reptatlas/frames_file.htm, accessed 4 October 2010).

Voucher image made under the authority of the Tennessee Wildlife Resources Agency; field work supported by State Wildlife Grant (SWG) funding under the authority of the U.S. Fish and Wildlife Service.

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***LAMPROPELTIS GETULA* (Common Kingsnake)**. USA: GEORGIA: Cherokee Co.: Reinhardt University campus, 0.67 km NNW of intersection of State Routes 108 and 140 (34.316791°N, 84.552819°W; WGS 84). 17 April 2010. B. Hudson. AUM AHAP-D 283, digital image. Verified by Craig Guyer. New county record (Jensen et al. [eds.] 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). One adult found active in field.

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***LAMPROPELTIS TRIANGULUM ELAPSOIDES* (Scarlet Kingsnake)**. USA: GEORGIA: Baldwin Co.: ca. 3 km E and 4 km N of Milledgeville (33.117474°N, 83.187023°W, WGS84; elev. 89.6 m). 06 June 2001. Dennis Parmley. GCH 5346. Verified by John Jensen. First county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). Single adult collected DOR on asphalt GCSU road that runs parallel with Champion Creek through a pine-deciduous woodlot.

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***LAMPROPELTIS TRIANGULUM SYSPILA* (Red Milksnake)**. USA: MISSOURI: Livingston Co.: Approx. 5.3 mi. NW Chillicothe (39.85907222°N, 93.60844444°W; WGS84, elev. 227 m). 5 June 1983. Brian Hubbs. Verified by Travis Taggart. Natural History Museum of Los Angeles County photo voucher (LACM PC 1523). New county record (Johnson 1997. The Amphibians and Reptiles of Missouri. Missouri Dept. of Conservation, Jefferson City, Missouri. 400 pp.; Missouri Herpetological Atlas Project. <http://atlas.moherp.org>). Snake found under piece of sandstone.

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***LEPTODEIRA URIBEI* (Uribe's Cat-eyed Snake)**. MEXICO: GUERRERO: Municipality of Zihuatanejo: 30.9 km SW Vallecitos de Zaragoza on Mexico Hwy 134 (17.7728°N, 101.505°W, WGS84; elev. 180 m). 27 September 2008. William H. Mertz. Verified by Daniel G. Mulcahy. UTA digital collection (UTADC 3700). First verified record for Guerrero. Fills a gap of ca. 830 km from the closest known localities in southwestern Michoacán (230 km NW; Mijangos, Huacuz, and Quijada-Mascareñas 2006. Herpetol. Rev. 37:500) and southern Oaxaca (600 km SE; Siria-Hernandez et al. 2006. Bol. Soc. Herpetol. Mex. 14:25–26). The snake was found AOR at night in tropical deciduous forest. This species was removed from the genus *Pseudoleptodeira* by Reyes-Velasco and Mulcahy (2010. Herpetologica 66:99–110).

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***LICHANURA TRIVIRGATA GRACIA* (Desert Rosy Boa)**. USA: NEVADA: Clark Co.: Newberry Mountains, Christmas Tree Pass (35.261667°N, 114.746944°W; WGS 84). 30 May 2010. Paul Lynum and Tony Boudreau. Verified by Carol L. Spencer. Museum of Vertebrate Zoology (MVZ 263987). First state record. Adult female found on the road at 1118 h. This is the sixth specimen found in the Newberry Mountains by Paul Lynum—none of the previous animals were deposited as voucher specimens. Closest known localities for *L. trivirgata* are in the Cerbat and Hualapai Mountains of Mohave Co., Arizona (Stebbins 2003. A Field Guide to Western Reptiles and Amphibians, 3rd ed. Houghton Mifflin Co., Boston, Massachusetts. 533 pp.; UAZ 42143, 47322, 55611). Using pattern as an indicator of relationships, this population is most similar to those in western Arizona rather than geographically proximate populations of *L. t. gracia* in southeastern California. Although the Colorado River serves as a formidable barrier to gene flow between California/Nevada and Arizona populations of some reptiles (Lamb et al. 1989. Evolution 43:76–87; Mulcahy et al. 2006. Mol. Ecol. doi: 10.1111/j.1365-294X.2006.02892.x), it may not be insurmountable; snakes from the southeasternmost population of *L. t. gracia* in the Black Mountains, Imperial Co., California, phenotypically resemble those from Arizona more closely than they do those occurring elsewhere in California.

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***OPHEODRYS VERNALIS* (Smooth Greensnake)**. USA: PENNSYLVANIA: Erie Co.: Amity Township, State Game Land 162 (41.9739°N, 79.8421°W; WGS 84). 05 October 2005. Mark Lethaby. Verified by Peter Lindeman. Natural History Museum of the Tom Ridge Environmental Center (TREC R- 00003). First vouchered county record (Hulse et al. 2001. Amphibians and Reptiles in Pennsylvania and the Northeast. Cornell Univ. Press, Ithaca, New York. xii + 419 pp.).

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***PANTHEROPHIS ALLEGHANIENSIS* (Eastern Ratsnake)**. USA: GEORGIA: Dawson Co.: Amicalola Falls State Park: approximately 2.5 km from junction of Top of the Falls Rd. and Amicalola Park Rd (34.56138°N, 84.24833°W; WGS 84, elev. 595 m). 30 September 2009. Robert L. Hill and Alicia Kaylock. Verified by Joseph R. Mendelson, III. AUM AHAP-D 287–288. New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. Univ. of Georgia Press, Athens. 575 pp.); previously documented in surrounding Cherokee, Fannin, Forsyth, Gilmer, Lumpkin, and Pickens counties. Specimen observed along edge of Creek Trail at southernmost junction with Mountain Laurel Trail.

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***PANTHEROPHIS EMORYI* (Great Plains Rat Snake)**. USA: ARKANSAS: Logan Co.: 4.0 km W Midway off St. Hwy 22 (35.290469°N, 93.554420°W; WGS 84). 19 June 1998. J. Denny. Verified by S. E. Trauth. Arkansas State University Museum of Zoology, Herpetological Collection (ASUMZ 31570). New county record. Helps fill a distributional hiatus among Sebastian, Scott and Yell counties (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.).

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***PANTHEROPHIS SPILOIDES* (Gray Ratsnake)**. USA: PENNSYLVANIA: Erie Co.: McKean Township, Whispering Woods Golf Club, 7214 Grubb Road, Erie, Pennsylvania 16506 (42.03535°N, 80.14481°W; WGS 84). 24 May 2010. TREC R- 00074. Aimee Colaizzo. Verified by Peter Lindeman. First vouchered county record (Hulse et al. 2001. Amphibians and Reptiles in Pennsylvania and the Northeast. Cornell Univ. Press, Ithaca. xii + 419 pp.)

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***PITUOPHIS CATENIFER SAYI* (Bullsnake)**. USA: NEBRASKA: Rock Co.: approx. 0.3 mi. N Rose on U.S. Hwy 183 in sand hill habitat (42.18500833°N, 99.52629722°W, WGS 84; elev. 771 m). 2 May 2010. DOR. Brian Hubbs. Verified by Travis Taggart. Natural History Museum of Los Angeles County photo voucher LACM PC 1535. First county record (Ballinger et al. 2010. Amphibians and Reptiles of Nebraska. Rusty Lizard Press, Oro Valley, Arizona. 400 pp.; Fogell 2010. A Field Guide to the Amphibians and Reptiles of Nebraska. University of Nebraska, Lincoln. 158 pp.).

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***PITUOPHIS MELANOLEUCUS MELANOLEUCUS* (Northern Pinesnake)**. USA: TENNESSEE: Decatur Co.: Lick Creek boat dock loop approximately 5 km SW of junction with Little Jackson Road. Located in the Jeanette 7.5-minute USGS quad (35.43370°N, 88.04220°W; NAD 83). 20 April 2009. Keith Byrd. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19071). New county record (Scott and Redmond 2008. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available from http://www.apsu.edu/reptatlas/frames_file.htm, accessed 4 October 2010). Specimen was DOR.

Collection made under the authority of the Tennessee Wildlife Resources Agency; field work supported by State Wildlife Grant (SWG) funding under the authority of the U.S. Fish and Wildlife Service.

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***RAMPHOTYPHLOPS BRAMINUS* (Brahminy Blind Snake)**. GABON: OGOOUÉ-MARITIME PROVINCE: Bendjé Department: Port-Gentil, Quartier SEEG. April 2008. P. Sarrazin. Institut Royal des Sciences naturelles de Belgique, Brussels (IRSNB 17969). Smithsonian Institution's Gabon Biodiversity Center, Gamba (Gamba 244). Verified by G. L. Lenglet (IRSNB). Both individuals found in cultivated house garden, where species reportedly is common according to local gardeners. First provincial record. This introduced species is presently known in Gabon from the capital city, Libreville, Estuaire Province and Port-Gentil (Pauwels et al. 2004. Hamadryad 29:138–139; Pauwels and Vande weghe. 2008. Les reptiles du Gabon. Smithsonian Institution, Washington, D.C. 272 pp.). We thank G. L. Lenglet (IRSNB) for providing working facilities.

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***SISTRURUS CATENATUS* (Massasauga)**. MÉXICO: COAHUILA: Municipality of Guerrero: 6 km S of La Piedra Parada (28.280000°N, 100.582500°W; WGS84), 297 m elev. 18 July 2010. Manuel Nevárez de los Reyes. Verified by David Lazcano Villarreal. UANL 7145. First record for the municipality, third municipality documented for Coahuila, and only the third area in México where this species is known to occur. The other records in Coahuila are concentrated in the Cuatro Ciénegas region, ca. 205 km to the SW in the municipalities of Cuatro Ciénegas and Sacramento (Lemos Espinal and Smith 2007. Anfibios y Reptiles del Estado de Coahuila, México. UNAM, CONABIO, México, D.F. xii + 550 pp.; McCoy and Minckley 1969. Herpetologica 25:152–153; Minckley and Rinne 1972. Texas J. Sci. 23:432–433). The only other record for northeastern Mexico is from Aramberri, Nuevo Leon, located 470 km to the S (Minton 1983. Cat. Amer. Amphib. Rept. 332:1–2). Vegetation at the site was a form of Tamaulipan thornscrub, with Cenizo (*Leucophyllum texanum*) being the dominant species, alongside Honey Mesquite (*Prosopis glandulosa*), Don Quixote's Lace (*Yucca treculaena*), Coahuila Yucca (*Yucca coahuilensis*), Cortadillo (*Nolina cespitifera*), and scattered grasses; no cacti were evident. The topography was flat landscape without rocks.

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***STORERIA OCCIPITOMACULATA* (Red-bellied Snake)**. USA: GEORGIA: Baldwin Co.: ca. 3 km E and 4 km N of Milledgeville (33.120173°N, 83.182872°W; WGS84). 15 August 2010. Sergio Paiitucci Saieh. GCH 5341. Verified by John Jensen. New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). Single subadult collected on forest floor (pitfall trap) of a mixed pine-deciduous forest.

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***TANTILLITA LINTONI* (Linton's Dwarf Short-tailed Snake, Culebrita Enana de Linton)**. HONDURAS: ISLAS DE LA BAHÍA: Isla de Utila, Utila, Iguana Station (16.10056°N, 86.885833°W; WGS84, elev. 40 m). 24 February 2010. Andrea Martinez. Verified by James R. McCranie. UNAH 5571. First record for Isla de Utila, Islas de la Bahía (McCranie et al. 2006. Amphibians and Reptiles of the Bay Islands and Cayos Cochinos, Honduras. Bibliomania, Salt Lake City, Utah. xii + 210 pp.). The snake was found under a rock.

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***THAMNOPHIS SIRTALIS FITCHI* (Valley Gartersnake)**. USA: WYOMING: Lincoln Co.: Cokeville Meadows National Wildlife Refuge, 1.3 km E of County Road 207 (41.97799°N, 110.97260°W; NAD27). 25 June 2009. Charlotte E. Matthews, Leslie A. Schreiber, and Julia M. Sonn. Verified by Christopher Phillips. Illinois Natural History Survey (INHS 2010e). First record for Lincoln Co. and extends the range 110 km S of nearest known location in Wyoming (Baxter and Stone 1985. Amphibians and Reptiles of Wyoming, 2nd ed. Wyoming Game and Fish Department, Cheyenne, Wyoming. 137 pp.) and extends the range to 6.1 km E from Utah border (Stebbins 2003. A Field Guide to Western Reptiles and Amphibians, 3rd ed. Houghton Mifflin Co., Boston, Massachusetts. 533 pp.). Seven adult females were observed.

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***XENOPHOLIS UNDULATUS* (Jensen's Ground Snake)**. BRAZIL: PERNAMBUCO: Camaragibe (07.976044°S, 35.001488°W, WGS84; elev 114 m). Neighborhood Aldeia, 12 July 2008. M. J. Freitas. Collection of the Laboratory of Zoology, Universidade Regional do Cariri, Crato, Ceará, Brazil (LAZ-URCA-952). Verified by I. J. Roberto and D. Loebmann. First state record. Female: SVL 24.6 cm; TL 4.0 cm collected at 2300 h, next to a fragment of Atlantic Forest. The species was previously recorded from Paraguay and the Brazilian states of Ceará, Goiás, Maranhão, Mato Grosso do Sul, Minas Gerais, Pará, Paraná, São Paulo, and Tocantins (Cunha and Nascimento 1993. Bol. Mus. Para. Emílio Goeldi, sér. Zool. 9[1]:1–191; França et al. 2006. SNOMNH Occas. Pap. [17]:1–13; Loebmann 2009. Herpetol. Rev 40:117). Our record suggests that the species inhabits a fragment of the Northeast Atlantic Forest (Silva and Casteletti 2003. *In* Galindo-Leal and Câmara [eds.], The Atlantic Forest of South America: Biodiversity Status, Threats, and Outlook, pp. 43–59. Island Press, Washington, DC). Extends distribution ca. 800 km SE from Ubajara, Ceará, Brazil (Loebmann 2009, *op. cit.*) and approximately 1040 km NNE from Minas Gerais, Brazil (Freitas 2003. Serpentes Brasileiras. Lauro de Freitas, Malha-de-Sapo Publicações.120 pp.).

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Snakes and Lizards from the Bumdeling Wildlife Sanctuary Region of Bhutan: Review of Herpetofaunal Information and New Country Records

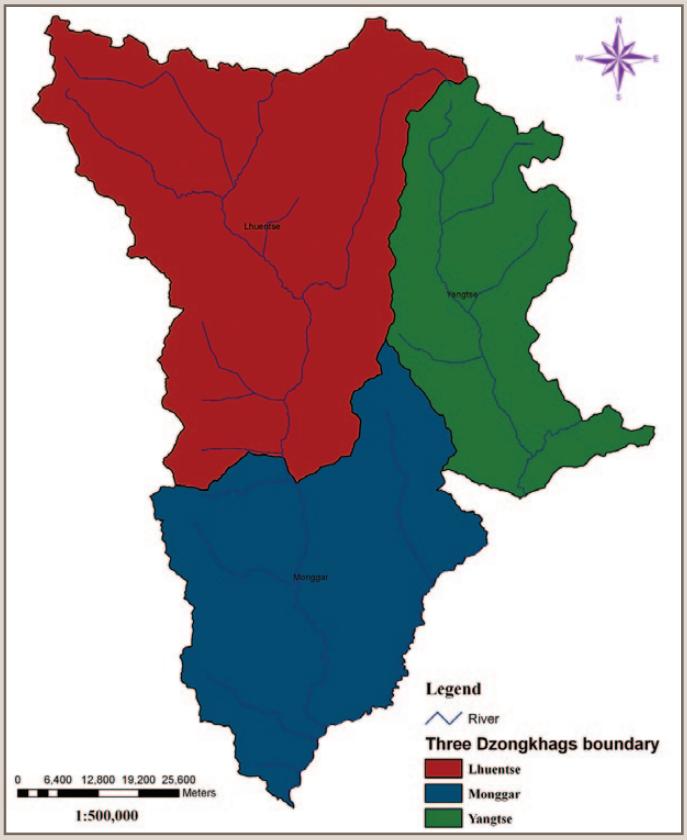


FIG. 1. Map showing study area located in northeastern Bhutan. Map source: Dzongkhag Statistics Office, Trashiyangtse.

Bumdeling Wildlife Sanctuary is one of 10 protected areas in Bhutan and is located to the northeast. It is bordered by the Tawang District of Arunachal Pradesh, India, in the east, and by China to the north. The Sanctuary covers developmental blocks, locally called Gewogs, on the districts of Lhuentse, Mongar, and Trashiyangtse, and is spread over an area of 1965 km^2 and has an altitudinal range from 1500 m in the south to 6400 m in the north (Fig. 1). Three main rivers cross the Sanctuary including the Kulong Chhu in the east, the Khoma Chhu in the west, and the Sheri Chhu in the south. These originate in the alpine and snow-capped mountains of the Sanctuary and ultimately drain into the Brahmaputra, in Assam State, India.

This mountainous sanctuary is dissected by steep-sided valleys and is subject to erosion and flooding during the summer. In some cases, land use practices exacerbate the process of land transformation. The Kulong Chhu River system, which meanders through the eastern stretch of the Sanctuary, erodes land and deposits sand, gravel, and cobbles at the base of the flood plain of the Bumdeling Valley. Further up, the alpine landscape is replete with signs of glacial activity, such as cirques, moraines, and glacial lakes.

The Bumdeling Wildlife Sanctuary was established in 1994, and started functioning in 1998 with the establishment of a Sanctuary Head Office for human resources and other infrastructure. However, in the last 10 years of management, there has been no mention of reptile conservation programs or diversity study records within the management plan. With the exception of the Royal Manas National Park, none of the protected areas of Bhutan has reports of their reptile diversity.

The lack of herpetological studies for the Sanctuary is not surprising, as the herpetological information for Bhutan as a whole is scanty. Biswas (1976) reported on three agamas, one of which was new—*Calotes bhutanensis*. The next two reports were published by Bustard (1979, 1980), explicitly on crocodilians. Bauer and Günther (1992) prepared a preliminary list of the herpetofauna of the Kingdom of Bhutan. They based their list on specimens collected by a 1972 expedition of the Basel Natural History Museum (Switzerland) to Bhutan. These authors reported seven families and 18 species, including a new scincid lizard. Das and Palden (1999) reported on a herpetofaunal collection assembled while conducting Bhutan's first workshop on herpetological techniques for staff of the protected areas of Bhutan, at the Royal Manas National Park. They reported seven amphibians (all new records for Bhutan) of three families (one megophryid, one bufonid, and five ranids), three geckos, one agamid, two scincids, one typhlopid, three colubrids, and two elapids. The current literature records bring the total herpetofauna of Bhutan to 39 species (Table 1).

To this list we can add 10 more species records from new specimens at the collection of Royal Manas National Park laboratory. The list is presented below (Table 1).

Considering the unpublished records, the total number of species of herpetofauna known from Bhutan is 49. With this report, several more species are added to this list.

With the financial support from the Bhutan Trust Fund for Environmental Conservation (based in Thimphu), Bumdeling Wildlife Sanctuary conducted a rapid survey of its reptiles between April and December 2008. Testudines and Crocodilia are absent in the area, but snakes and lizards were collected from

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TABLE 1. Known herpetofaunal records for Bhutan.

Class	Order/Suborder	Family	Species	Previous published records	Royal Manas N.P. records (unpubl.)	Bundeling W. S. Area (this paper)	New for Bhutan (this paper)
Amphibia	Anura	Bufonidae	*Duttaphrynus melanostictus*	+			
		Dicroglossidae	*Amolops marmoratus*	+			
			Euphlyctis cyanophlyctis	+			
			Fejervarya cf. *limnocharis*	+			
			Hoplobatrachus tigerinus	+			
		Hylidae	*Hyla* cf. *annectans*		+		+
		Megophryidae	*Megophrys parva*	+			
		Ranidae	*Hylarana* sp.	+			
			Lithobates catesbeianus		+		+
Reptilia	Crocodylia	Gavialidae	*Gavialis gangeticus*	+			
	Squamata/Sauria	Agamidae	*Calotes bhutanensis*	+			
			Calotes versicolor	+		+	
			Calotes jerdonii			+	+
			Japalura variegata	+		+	
		Gekkonidae	*Cyrtodactylus khasiensis*	+			
			Hemidactylus brookii	+			
			Hemidactylus frenatus	+			
			Hemidactylus garnotii	+			
			Hemidactylus platyurus	+		+	
		Scincidae	*Asymblepharus sikimmensis*	+			
			Asymblepharus cf. *sikkimensis*			+	+
			Eutropis carinata		+		+
			Eutropis macularia	+			
			Eutropis quadratilobus	+			
			Riopa punctata		+		+
			Sphenomorphus maculatus	+			
			Sphenomorphus indicus	+			
			Sphenomorphus sp.		+		+
		Varanidae	*Varanus bengalensis*	+			
			Varanus flavescens		+		+
	Squamata/Serpentes	Colubridae	*Ahaetulla nasuta*		+		+
			Ahaetulla prasina			+	+
			Amphiesma platyceps	+			
			Amphiesma sieboldii			+	+
			Amphiesma stolatum	+			
			Amphiesma sp.			+	+
			Boiga cyanea			+	+
			Boiga multifasciata			+	+
			Boiga ochracea	+		+	
			Coelognathus radiatus			+	+
			Dendrelaphis cyanochloris			+	+
			Dinodon septentrionalis			+	+
			Dryocalamus cf. *davisonii*			+	+
			Enhydris enhydris		+		+
			Oligodon albocinctus			+	+
			Oligodon cinereus			+	+
			Oligodon dorsalis	+		+	
			Oligodon sp.			+	+
			Oreocryptophis porphyracea			+	+
			Orthriophis cantoris			+	+
			Orthriophis taeniurus			+	+
			Psammodynastes pulverulentus	+			
			Pseudoxenodon macrops	+		+	
			Ptyas korros			+	+
			Ptyas nigromarginatus	+		+	
			Rhabdophis himalayanus			+	+

TABLE 1. Continued.

Class	Order/Suborder	Family	Species	Previous published records	Royal Manas N.P. records (unpubl.)	Bundeling W. S. Area (this paper)	New for Bhutan (this paper)
			Sibynophis collaris			+	+
			Sibynophis sagittarius	+			
			Trachischium guentheri	+			
			Trachischium cf. *laeve*			+	+
			Trachischium sp.			+	+
			Xenochrophis piscator	+			
		Elapidae	*Bungarus bungaroides*			+	+
			Bungarus niger	+			
			Bungarus fasciatus	+			
			Naja kaouthia			+	+
			Naja naja	+			
			Ophiophagus hannah	+		+	
			Sinomicrurus macclellandii			+	+
		Pythonidae	*Python molurus*	+			
		Typhlopidae	*Ramphotyphlops braminus*	+			
			Typhlops jerdonii	+			
		Viperidae	*Gloydius himalayanus*		+		+
			Ovophis monticola			+	+
			Protobothrops jerdonii			+	+
			Trimeresurus erythrurus		+		+
	Testudines	Testudinidae	*Indotestudo elongata*		+		+

the Sanctuary. Collections were made mostly from the southern belt of the Sanctuary, an area classified as sub-tropical to warm broadleaved forest (Grierson and Long 1983). The altitudinal range of the current work ranged from 614 m, at Sheripam, Mongar to 2143 m at Barigang, Trashiyangtse.

Collections were opportunistic, by me and colleagues, sometimes supplemented by people encountering animals and reporting to us. Hand searching, turning over of logs and boulders, looking inside crevices and tree holes, and searching along creeks were some other methods employed. Occasional interviews of local residents, as to where these animals could be located, were also done. A monetary reward for locals who captured live specimens was another important way of obtaining specimens. To avoid the loss of dead animals, people were informed that they would be compensated even if they preserved dead animals. Many specimens were collected encountered on roads.

Due to restrictions on killing of animals, most specimens were released after photography, with only important ones retained and preserved. For several species (e.g., *Bungarus bungaroides*), only photographs could be taken. Species determinations were made using standard identification guides. Features of scalation and morphometric measurements were recorded. For specimens recorded only through photo vouchers, these have been given an accession number and are labeled 'photographic specimen' throughout this report. Preserved specimens are housed at the collection of the Bumdeling Wildlife Sanctuary Museum, Trashiyangtse, Bhutan, using a numbered system. For each preserved specimen, locality and microhabitat data, date and time (Bhutan Standard Time) of collection, altitude, and measurements are presented. Data on pholidosis for ventrals using the Dowling system and midbody scale at the half of the ventrals and subcaudals, excluding the final spine (for those juvenile specimens) is also given for snake specimens. Measurements were taken with a steel tape measured to the nearest 1 mm. A Garmin Etrek GPS was used to record locations of all specimens. Abundant species such as *Calotes versicolor* were closely observed only for the first 2–3 animals, while subsequent individuals were visually identified without capture. The identification references used in the field include Das (2002), Smith (1935, 1943), and Whitaker and Captain (2004).

SPECIES ACCOUNTS

LIZARDS

Family Agamidae

Calotes versicolor, Daudin, 1802. Photographic specimen BWS SPRO-L1. Sheripam, Mongar District, 869 m. 1100 h. 15 April 2008. Photographed on fallow land near Sherichu River. Most abundant lizard encountered. Multiple specimens photographed at several locations. Photos show color variation. *Remarks:* Reported by Günther and Bauer (1992) from Wangdiphodrang, and by Biswas from Samdrup Jongkhar (eastern Bhutan). Also reported from Gelephu town, Sarpang District by Das and Palden (1999). Common in southern Bumdeling Wildlife Sanctuary.

Calotes jerdonii, Günther, 1870. BWS KPRO-L4. Khoma, Lhuentse District, 1200 m. 1130 h. 29 May 2008. From trail 3 m from stream, trying to cross trail facing hill side. *Measurements*: SVL

90 mm; tail length 215 mm. *Remarks:* New record for Bhutan. Second specimen found at Wanglawa, Trashiyangtse District on 10 June 2008, at 1125 h.

Japalura variegata, Gray, 1853. BWS CKHQ-L2. BWS head office, Trashiyangtse District, 1761 m. 1214 h. 30 September 2008. From parking lot of Bumdeling Wildlife Sanctuary Head Office. Found hunting insects. *Measurements*: SVL 67 mm; tail length 160 mm. Second specimen obtained at Serzhong Range Office, Serzhong, Mongar District. Photographed (BWS SPRO-L5) on 24 July 2008 at 1213 h. *Remarks*: Common in southern part of sanctuary.

Family Gekkonidae

Hemidactylus platyurus, Schneider, 1792. Photographic specimen BWS SPRO-L9. from Serzhong, Mongar District, 1,540 m. 2133 h. 3 August 2008. Photographed at night on side of footpath. Photographic specimen BWS SPRO-L12, from Serzhong, Mongar District, 1500 m. 1913 h. 17 May 2008. Photographed on wall of agriculture extension agent of Gewog. *Remarks:* Reported by Günther and Bauer (1992) from Wangdiphodrang District, western Bhutan. Common.

Family Scincidae

Asymblepharus cf. ***sikkimensis,*** Blyth, 1854. Photographic specimen BWS SPRO-L7. Serzhong, Mongar District, 1,500 m. 1140 h. 2 August 2008. Found on edge of farm, over rock. Photographic specimen BWS SPRO-L8. Serzhong, Mongar District, 1545 m. 1211 h. 13 August 2008. Found entering quarter of Range Officer. *Remarks*: Common.

Sphenomorphus sp. Photographic specimen BWS KPRO-L1. Khoma, Lhuentse District, 1170 m. 1613 h. 24 April 2008. At edge of playground of Khoma Lower Secondary School.

SNAKES

Family Colubridae

Ahaetulla prasina, Boie, 1827. BWS OPA-S5. Pakadrang (below Yadi), Mongar District, 973 m. 1530 h. 21 September 2008. One of two road-killed specimens found at this locality. *Measurements*: SVL 930 mm; tail length 520 mm. *Pholidosis*: Ventrals 197; subcaudals 167; midbody scale rows 15; anal plate single. *Remarks*: New record for Bhutan.

Amphiesma sieboldii, Günther, 1860. Photographic specimen BWS DPRO-S14. Dungzam, Bumdeling, Trashiyangtse, District, 1903 m. 1000 h. 15 July 2008. Found by a heath worker in his garden, 30 m from Kulongchu River. Individual with broken tail kept in laboratory for one week, where it laid three eggs. Released at office complex. *Remarks*: New record for Bhutan. Second individual caught in kitchen garden of nearby house on 19 July 2008, at ca. 0830 h.

Amphiesma sp. BWS DPRO-S8. Kwankang (Cheng), Bumdeling, Trashiyangtse District, 1990 m. 1330 h. 24 June 2008. Collected 10 m from Kulongchu River while crossing footpath towards river. *Measurements*: SVL 765 mm; tail length 200 mm. *Pholidosis*: Ventrals 168; subcaudals 67; midbody scale rows 15; anal plate single. *Remarks*: Probably new record for Bhutan and possibly an undescribed species.

Boiga cyanea, Duméril, Bibron & Duméril, 1854. Photographic specimen BWS SPRO-S4. Shingdogor (above Yarab), Sherimung, Mongar District, 1929 m. 1529 h.15 April 2008. Video clip (7.2. megapixels digital camera) confirms identity of species. Found in high, cool, broad-leaved forest, close to a small stream. *Remarks*: New record for Bhutan.

Boiga multifasciata, Blyth, 1861. BWS CKHQ-S11. Choetenkora town, Trashiyangtse District, 1761 m. 1159 h. 27 September 2008. Caught by municipal staff while entering housing colony. Preserved after photography. *Measurements*: SVL 529 mm; tail length 115 mm. *Pholidosis*: Ventrals 230; subcaudals 117; midbody scale rows 21; anal plate single. *Remarks*: New record for Bhutan. Species recorded from several locations. BWS KPRO-S8, photo taken by Chief Forest Officer of Bumdeling Wildlife Sanctuary, from Khoma Zam, Lhuentse District, on 13 June 2007, at 0617 h. On 7 July 2008, at 1800 h, a laboratory technician in Trashiyangtse hospital collected a specimen (BWS CKHQ-S9) from Bimkhar, Trashiyangtse. On 28 November 2008, at 1330 h, a photographic specimen (BWS KPRO-S12) found near Range Office of Khoma, Lhuentse. Another photographic specimen (BWS SPRO-S10) brought by school teacher from near house at Bimkhar, Trashiyangtse. Snake caught on evening of 15 August 2008.

Boiga ochracea, Günther, 1868. BWS SPRO-S11. Serzhong (Mangzhing), Mongar District, 1766 m. 1030 h. 9 June 2008. Specimen found in maize field. *Measurements*: SVL 860 mm; tail length 238 mm *Pholidosis*: Ventrals 238; subcaudals 100; midbody scale rows 21; anal plate single. *Remarks*: Reported by Bauer and Günther (1992), from Phuntsholing.

Coelognathus radiatus, Boie, 1827. BWS OPA-S12. Rollong, Trashigang District, 694 m. 1500 h. 11 November 2008. Juvenile on roadside, ca. 150 m from perennial stream and close to road construction labor office. *Measurements*: SVL 320 mm; tail length 30 mm. *Pholidosis*: Ventrals 244; subcaudals 91; midbody scale rows 19; anal plate single. *Remarks*: New record for Bhutan.

Dendrelaphis cyanochloris, Wall, 1921. Photographic specimen BWS OPA-S3. Palangphu, Mongar District, 763 m. 1030 h. 4 October 2008. Found dead on road. *Remarks*: New record for Bhutan.

Dinodon septentrionalis, Günther, 1864. BWS DPRO-S6. Trammar, Bumdeling, Trashiyangtse District, 1809 m. 1030 h. 10 June

2008. Specimen found under bark of fallen *Alnus nepalensis* tree, above farm road. *Measurements:* SVL 965 mm; tail length 225 mm. *Pholidosis*: Ventrals 210; subcaudals 72; midbody scale rows 17; anal plate single. *Remarks*: New record for Bhutan.

Dryocalamus cf. ***davisonii,*** Smith, 1943. Photographic specimen BWS DPRO-S12. Betsamang, Bumdeling, Trashiyangtse District, 1903 m. 0800 h. 29 June 2008. Found in litter compost in farm. Photographed alive and released. *Remarks*: New record for Bhutan. Another photographic specimen (BWS DPRO-S13) collected on 1 July 2008 by villager from Trammar, Bumdeling, Trashiyangtse District, from farm road, at ca. 0830 h.

Oligodon albocinctus, Cantor, 1839. BWS CKHQ-S11. Choetenkora, Trashiyangtse District, 1760 m. Collected in 2003 by management staff, and preserved in Visitor Center. *Measurements*: SVL 665 mm; tail length 185 mm. *Pholidosis*: Ventrals 196; subcaudals 63; midbody scale rows 19; anal plate single. *Remarks*: New record for Bhutan. A second specimen (photo specimen BWS SPRO-S10) provided by staff of Serzhong Park Range, Mongar. According to collectors individual was found eating eggs, behind Basic Health Unit office of Serzhong developmental block, on 25 May 2008, at 1400 h. A third specimen photographed by Park Range Officer of Khoma. Individual found at Serphu, Khoma Village, Lhuentse district, on footpath at ca. 1000 h on 1 December 2008.

Oligodon cinereus, Günther, 1864. Photographic specimen BWS SPRO-S15. Serzhong, Mongar District, 1541 m. Found on footpath leading to village, where it was killed by farmer and brought to Range Office in Serzhong. Photograph taken by staff of Range Office on 25 June 2008, at 1643 h. *Remarks*: New record for Bhutan.

Oligodon dorsalis, Gray, 1834. Photographic specimen BWS SPRO-S19. Serzhong, Mongar District, 1541 m. 1831 h. 24 August 2008. Photo taken by staff of Range Office; found in roadside meadow. *Remarks*: Reported by Das and Palden (1999) from Royal Manas National Park, Sarpang.

Oligodon sp. BWS CKHQ-S7. Choetenkora, Trashiyangtse District, 1,818 m. 1135 h. 27 June 2008. Specimen found on grassy lawn. *Measurements*: SVL 653 mm; tail length 150 mm. *Pholidosis*: Ventrals 191; subcaudals 66; midbody scale rows 19; anal plate single. *Remarks*: New record for Bhutan. Two other photographic specimens (BWS DPRO-S1 and S5) from Tshaling, Trashiyangtse. First killed by farmer on 4 June 2008, second in a paddy field on 9 June 2008.

Oreocryptophis porphyracea, Cantor, 1839. BWS CKHQ-S2. Bumdeling Wildlife Sanctuary Headquarters, Trashiyangtse District, 1761 m. 1530 h. 15 April 2008. At door of residence of Chief Forest Officer of Sanctuary, ca. 100 m from Kulongchu River. *Measurements*: SVL 625 mm; tail length 125 mm. *Pholidosis*: Ventrals 199; subcaudals 62; midbody scale rows 19; anal plate divided. *Remarks*: New record for Bhutan. Another road kill of about the same size (BWS CKHQ-S1) collected from entry gate to town of Trashiyangtse, in early morning (0600 h) of 16 May 2008. Staff of Serzhong Park Range, Mongar provided photo of another specimen on 21 October 2008, from Muhoong, Mongar District, found on trail near village, at 1530 h.

Orthriophis cantoris, Cantor, 1839. BWS SPRO-S12. Pangtala, Mongar District, 1790 m. 1230 h. 10 June 2008. In cultivated maize field. *Measurements*: SVL 995 mm; tail length 235 mm. *Pholidosis*: Ventrals 209; subcaudals 76; midbody scale rows 19; anal plate single. *Remarks*: New record for Bhutan. Small specimen (photographic specimen BWS SPRO-S12) also collected from maize field at Jabgang, same District and developmental block, on 18 May 2008.

Orthriophis taeniurus, Cope, 1861. BWS KPRO-S1. Khoma, Lhuentse District, 1200 m. 1300 h. 19 April 2008. Near Range Office wall. Measurements: SVL 1300 mm; tail length 300 mm. Pholidosis: Ventrals 238; subcaudals 93; midbody scale rows 23; anal plate divided. Remarks: New record for Bhutan. Another specimen (photographic specimen BWS KPRO-S3) found in Lhuentse town, Lhuentse District, moving towards cave on road. A picture of third specimen taken by Land Survey officials at 1200 h on 30 August 2008, at Baptong in same district and block.

Pseudoxenodon macrops, Blyth, 1854. BWS DPRO-S9. Sisikang, Bumdeling, Trashiyangtse District, 1959 m. 1400 h. 24 June 2008. On edge of Sisikang Stream, tributary of Kulongchu River, specimen was heading towards river. Flattened neck several times. *Measurements*: SVL 740 mm; tail length 195 mm. *Pholidosis*: Ventrals 165; subcaudals 64; midbody scale rows 17; anal plate divided. *Remarks*: Reported by Bauer and Günther (1992), from Phuntsholing. A few days later, second specimen brought by farmer from Bumdeling, Trashiyangtse. On 2 November 2008, juvenile entered our campsite at Bumdeling, Trashiyangtse at 1411 h. Specimen preserved and kept in the laboratory.

Ptyas korros, Schlegel, 1837. BWS OPA-S11. Rollong, Trashigang District, 694 m. 1100 h. 4 November 2008. Juvenile crossing road ca. 8 m away from perennial stream and 100 m from a settlement. *Measurements*: SVL 330 mm; tail length 142 mm. *Pholidosis*: Ventrals 181; subcaudals 140; midbody scale rows 17; anal plate divided. *Remarks*: New record for Bhutan.

Ptyas nigromarginatus, Blyth, 1854. Photographic specimen BWS DPRO-S2. Bumdeling, Trashiyangtse District, 1885 m. 1130 h. 4 June 2008. Found slithering over *Cyathea* fern, below farm road, ca. 500 m from Kulongchu River. *Remarks*: Reported by Bauer and Günther (1992). First specimen recorded as roadkill between Trashiyangtse to Mongar on 7 November 2007, at Yadi, Mongar. Third specimen recorded from Bimkhar, Trashiyangtse, on 15 June 2008, at 1130 h, killed by Bhutan Power Corporation staff when on power line at Trashiyangtse. Fourth

specimen found dead at 7 km point from Yongkola on road from Thimphu, Mongar, on 21 September.

Rhabdophis himalayanus, Günther, 1864. Photographic specimen BWS SPRO-S13. Tingtibi, Zhemgang District (not recorded in BWS), 1945 m. Coordinates 27°15'10"N, 91°16'24"E. Information and photograph courtesy of D. B. Gurung, College of Natural Resources, Lobesa, Punakha. Not found in the project area. *Remarks:* New record for Bhutan.

Sibynophis collaris, Gray, 1853. BWS CKHQ-S13. Baychen, Trashiyangtse District, 1799 m. 1800 h. 30 September 2008. Collected between school and footpath leading to Baychen village, at 200 m from Berzing Stream. *Measurements*: SVL 450 mm; tail length 225 mm. *Pholidosis*: Ventrals 181; subcaudals 115; midbody scale rows 17; anal plate single. *Remarks*: New record for Bhutan. Photographic specimen (BWS SPRO-S2) found at Kilikhar, near Mongar, on 29 April 2008 at 1614 h, on road, ca. 300 m from stream. Third specimen found at Muroongdrang, Serzhong, Mongar, on 15 May 2008. Individual dead on road to Serzhong, probably killed by locals. In yet another incident, three individuals (photographic specimen BWS SPRO-S12) killed by farmer behind the Matron's Quarter (near girls' dormitory) at Trashiyangtse Lower Secondary School. Five juveniles found under weed heaped around base of gourd plant, in a garden.

Trachischium cf. ***laeve,*** Peracca, 1904. Photographic specimen BWS SPRO-S3. Serzhong, Mongar District, 1540 m. 1641 h. 4 February 2008. Accidentally killed by a resident while gardening. *Remarks*: New record for Bhutan.

Trachischium sp. BWS CKHQ-S6. Choetenkora, Trashiyangtse District, 1758 m. 1000 h. 15 June 2008. Specimen found in lawn of Bumdeling Wildlife Sanctuary Head Office complex. *Measurements*: SVL 325 mm; tail length 50 mm. *Pholidosis*: Ventrals 134; subcaudals 36; midbody scale rows 13; anal plate single. *Remarks*: Not referrable to *T. guentheri* or *laeve*. New record for Bhutan.

Family Elapidae

Bungarus bungaroides, Cantor, 1839. Photographic specimen BWS SPRO-S11. Serzhong, Mongar District, 1541 m. 0900 h. 5 August 2008. Collected by farmer, photographed and released. *Remarks*: New record for Bhutan. Another specimen (Photographic specimen BWS OPA-S7) found dead on road, near Korila Forest Management Unit Office, Mongar, on 21 September 2008, at 1400 h.

Naja kaouthia, Lesson, 1831. BWS SPRO-S5. Sheripam, Mongar District, 869 m. 1705 h. 15 May 2008. Killed by farmer when trying to enter hen coop. *Measurements*: SVL 828 mm; tail length 242 mm. *Pholidosis*: Ventrals 184; subcaudals 57; midbody scale rows 21; anal plate single. *Remarks*: New record for Bhutan. Another specimen (BWS SPRO-S8) found along Yadi-Serzhong Road, Mongar on 22 May 2008. Found struggling to escape crow attack near dry causeway of road and seen entering basement of causeway. In yet another incident, road-killed specimen (BWS SPRO-S16) was found at Sherichu, on 8 July 2008.

Ophiophagus hannah, Cantor, 1836. Photographic specimen BWS OPA-S5. Gomkora, Trashiyangtse District, 822 m. 1700 h. 5 November 2007. Specimen killed by farmer. Second specimen, a dead juvenile (BWS KPRO-S13), collected at Khoma School, Lhuentse District, September 2008. Students killed the animal. Measurements and scales count could not be taken due to poor condition of specimen. Third specimen, a juvenile (BWS OPA-S13), from Chumdu area, Trashiyangtse, 1703 m. 1200 h. 23 October 2008. Specimen obtained by Mr. Sherub (an ornithologist). *Measurements*: SVL 480 mm; tail length 87 mm. *Pholidosis*: Ventrals 254; subcaudals 30+ (could be counted only up to 30); midbody scale rows 17; anal plate single. *Remarks*: Reported at Manas Valley by Biswas (1975).

Sinomicrurus macclellandii, Reinhardt, 1844. BWS OPA-S8. Ngatshang, Mongar District, 1755 m. 1500 h. 21 September 2008. Cross the road near the Ngatshang Basic Health Unit Office. *Measurements*: SVL 460 mm; tail length 50 mm. *Pholidosis*: Ventrals 460; subcaudals 50; midbody scale rows 13; anal plate divided. *Remarks*: New record for Bhutan.

Family Viperidae

Ovophis monticola, Günther, 1864. BWS CKHQ-S4. Choetenkora, Trashiyangtse District, 1807 m. 1200 h. 7 June 2008. Most abundant species in Trashiyangtse and Mongar Districts, being reported not less than 21 times at Trashiyangtse alone. One specimen preserved. *Measurements*: SVL 510 mm; tail length 100 mm. *Pholidosis*: Ventrals 147; subcaudals 43; midbody scale rows 21; anal plate single. *Remarks*: New record for Bhutan.

Protobothrops jerdonii, Günther, 1875. BWS DPRO-S11. Barigang, Trashiyangtse District, 2143 m. 1450 h. 25 June 2008. Two individuals collected in same locality at a distance of ca. 30-minute walk from each other. First released and second retained in laboratory. *Measurements*: SVL 640 mm; tail length 112 mm. *Pholidosis*: Ventrals 177; subcaudals 51; midbody scale rows 21; anal plate single. *Remarks*: New record for Bhutan. A third specimen reported from Phanteng, Bumdeling, Trashiyangtse. 1130 h. 5 June 2008. After photography (BWS SPRO-S3) specimen released.

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BOOK REVIEWS

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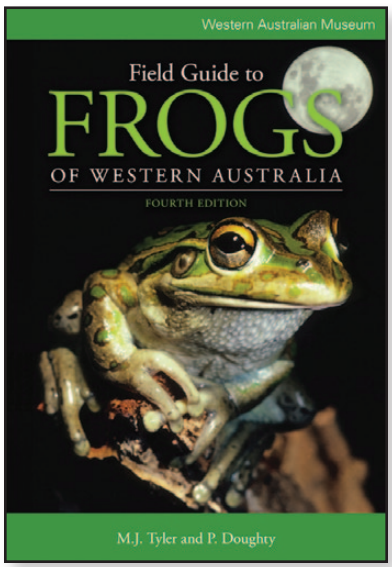
Field Guide to Frogs of Western Australia (4th edition)

By Michael J. Tyler and Paul Doughty. 2009. Western Australian Museum (www.museum.wa.gov.au). 160 pp. Paperback. AU $35.00 (approximately US $35.00). ISBN 978-1-920843-40-3.

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The fourth edition of the *Field Guide to Frogs of Western Australia* by Michael Tyler and Paul Doughty provides an excellent up-to-date (as of 2009) version of the guide first published more than 25 years ago by Tyler, Smith, and Johnstone. Updates to the previous version include concentrating information for a given species on a single page (or two), three helpful color maps in the inside back cover, and the inclusion of recently described species from the Kimberley (Doughty and Anstis 2007; Doughty and Roberts 2008; Doughty et al. 2009). To me, the book has all the hallmarks of an excellent guide regardless of your range of experience identifying frogs. This book is well produced and I would not hesitate to throw this book into my pack on my way out to go herping in Western Australia.

The organization of the book is smart and straightforward. First, as introduced in the third edition, the front inside cover contains four well-labeled diagrams highlighting major morphological features used in the guide for identification. In turn, and new to this edition, the inside of the back cover contains a map of Western Australia with close-up maps of the Kimberley and the Southwest. Following a short index, the book begins with a general overview of the four families of frogs found there (including Bufonidae for *Bufo* [*Rhinella*] *marinus*), followed by ten pages of basic information on frog biology and anatomy (including for tadpoles), and a page or so dealing with legislation related to frogs and regional comparisons within Western Australia. First introduced in the original edition of this book (accompanied by excellent line drawings by Linda Trueb and others), these concise descriptions of frog anatomy are well done and very accessible.



The book then proceeds alphabetically by genus. Each genus is provided a concise summary page, which is followed by

separate pages for each species in the genus. The genus-level summaries provide an informative entry into each genus with details on species diversity and phylogenetic relationships, morphological features, reproductive mode, and etymology (including my favorite explanation for *Litoria*: "the name may have been coined merely for the way it sounds").

Each species page has at least one color picture of the frog and a map showing point localities on a map of Western Australia. Collecting all of the information for each species all in one place (rather than a separate section of color plates) is one of the significant changes to the organization introduced in this edition. Scattered throughout the book are extra images that are either other color photographs of the species (sometimes in ventral view), line drawings depicting tadpoles or specific morphological features, and even a few sonograms. As a taxonomist, I appreciate that the authors used a color image of the holotype (and only) specimen of *Uperoleia marmorata* rather than excluding an image of it since there was no color image in life. The text for each species account contains sections providing a general morphological description and short summaries of its distribution, typical habitat, advertisement call, and breeding biology. The etymology for each species name is also provided. Many species also have a short section of remarks; these are among the most interesting bits in the book. Each species also has a few references for recommended reading, which are helpfully annotated so one knows whether the reference pertains to evolutionary relationships, reproduction, population biology, tadpoles, calls, etc.

The book concludes with other sections that are quite useful; several of these were added to the book in previous editions. First, it has a helpful collection of references that are more than sufficient for enabling the amateur and specialist alike to dive into the literature dealing with this frog fauna. There is also a two-page glossary section that nicely compliments the morphological descriptions in the beginning of the book and the labeled diagrams on the inside front cover. Following the glossary, the authors have included keys by region (Kimberley, Southwest, and the intervening Arid Zone) as well as "checklists of frogs for urban centres" organized by region. The latter is among my favorite parts of the book and was originally introduced in the second edition.

I found no problems with this book. There are only a few things to note for the more interested reader. The authors prefer to recognize *Cyclorana* as a genus rather than subgenus of *Litoria* (contra Frost et al. 2006). At the same time, the authors have opted to utilize the Limnodynastidae as a distinct family rather than as a subfamily within Myobatrachidae. Not included among the species in this book is *Litoria aurifera* (Anstis et al. 2010), which was, of course, described after the publication of this book.

If and when I ever write a field guide, I would happily follow the model set forth in this book. I have always had a fascination with Australian frogs and this only fueled my desire to visit and see some of these remarkable species. The authors make brief reference to "overseas froggers" in their preface, probably without considering that such a nice field guide may serve to attract a good number of overseas froggers to visit them in Western Australia, myself included.

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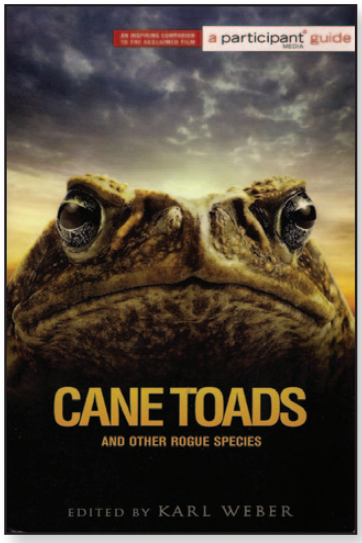
Herpetological Review, 2011, 42(1), 124–125.
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Cane Toads and Other Rogue Species

Edited by Karl Weber. 2010. Participant Media, New York. Softcover. x + 243 pp. US $14.95. ISBN 978-1-58648-706-5.

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One presumes that most herpetologists are by now familiar with, if not enraptured by, the 47-minute documentary "Cane



Toads: an Unnatural History," released in 1988 and directed by Mark Lewis. The film is famous for its hilarious depiction of the varied human responses to the invasion of *Rhinella* (formerly *Chaunus*, formerly *Bufo*, *nee Rana*) *marina* across northern Australia. The director has now followed up on his early success with the 90-minute sequel "Cane Toads: the Conquest" (2010). And, in the now-common trend of multimedia packaging, released

the same year is this companion book whose stated purpose is "to serve as a guide to the important, intriguing, and disturbing issue of rogue species." Alas, the book seems nothing but a quickly patched-together marketing ploy reeking of commercial cynicism.

The book has a four-page preface by the editor and is followed by 12 chapters treating (or at least touching on) varied aspects of the problem of invasive alien species. These are divided into three sections: "The Cane Toad Saga" (two chapters), "Rogue Species and the Future of the Planet" (seven chapters), and "What We Can Do" (three chapters). At the end is an appendix listing relevant books, websites, and organizations treating this issue so that the interested reader can explore the topic in greater depth. This is useful—and, indeed, necessary—because the book under consideration does such a poor job of meeting its stated goal. Despite the book's title, with the exception of the first chapter, there is nothing of interest herein for the average herpetologist.

Let's focus on the positive aspects of the book. As the reader familiar with the literature on this topic might expect, Dan Simberloff and James Carlton provide excellent summaries of their chosen (or assigned) topics. The former delivers a lucid and erudite case study of the invasives problem in Hawaii, one of the most invaded areas on earth. It provides a useful contrast to most of the other chapters in the book because it not only describes the ecological havoc caused by invasives in Hawaii but provides sufficient explantory detail of the underlying reasons for these impacts that the reader can understand why the damage occurs. This chapter serves as a compelling examination of a worst-case situation. Similarly, Carlton contributes a detailed explanation of how and why invasives are a problem in the oceans, giving a historical overview of the development and scale of the phenomenon, with development in this case being the addition through time of new dispersal vectors. He then gives several examples of the consequences of these invasions and finishes with a brief discussion of management options, including the rarely discussed need for early education (read: toward children) about the problem to instill more responsible attitudes toward biotic mixing.

In a very different vein, Nigel Turvey contributes a chapter replete with much new information on the history of the release of Cane Toads into Australia. The major events in the prerelease history are already available in the literature, but Turvey, using memos from the historical files of the Queensland Bureau of Sugar Experiment Stations and Queensland State Archives, fills in useful details and continues the history of political maneuvering past the release date in August, 1935. He provides a detailed case study of the contrasting political interests, human foibles, and mediocre judgement that continue to be replayed repeatedly around the world in the deliberate release of alien invasives. Turvey provides the best illustration of the profound banality of invasive-species release of which I am aware. It is also one of only two chapters with a specific focus on herps.

These are the chapters that shine. So does Chapter 9, which is a reprint of David Quammen's seminal 1998 essay "Planet of Weeds," originally published in *Harper's*. This essay is an eloquent exposition of the biotic extinction crisis and why it matters, with approximately 25–30% of the space devoted to discussing invasives, which was one of the first attempts to educate the general public about the problem. However, this chapter is clearly dated, and its inclusion contributes nothing particularly important toward a current understanding of the invasives problem or its solution.

Chapter 5, "The Fungus Amongus – Toad as Victim" by Chad Peeling, is a concise and well-written summary of the problem of chytridomycosis in amphibians (the second of two chapters with a herpetological focus). However, there are two caveats: (1) the title is a misnomer, since *R. marina* is not threatened by the chytrid fungus, and (2) the last paragraph asks how anyone could want to kill a toad (even if it is invasive), thereby missing the point that invasives are an issue of ecological and evolutionary context, not of the species per se. This is an odd remark to include in a book purporting to educate the public about the problem of invasive species.

The remainder of the book is a wash; indeed much of it is downright awful. I could bore the reader with the details, but it would take too long and is not particularly relevant for a review in a specifically herpetologically focused journal. To summarize, the book is a poorly edited, incoherent mishmash of chapters revolving around the general issue of invasive alien species. With the exception of the chapters mentioned above, most do not serve to educate; some are absolutely misleading. Nor is the situation improved by the attempt to coin yet another term ("rogue species") for a phenomenon already burdened with a history of competing descriptors. There is nothing of specifically herpetological interest in this book, with the exception that Turvey's chapter will be useful for the specialist in herpetological invasions. For lay readers wanting a general introduction to the problem of alien invasions, the works by Bright (1998), Devine (1998), Baskin (2003), and van Driesche and van Driesche (2004) are infinitely better written, coherent treatments, and I can recommend any of them as far more deserving of attention than the present title.

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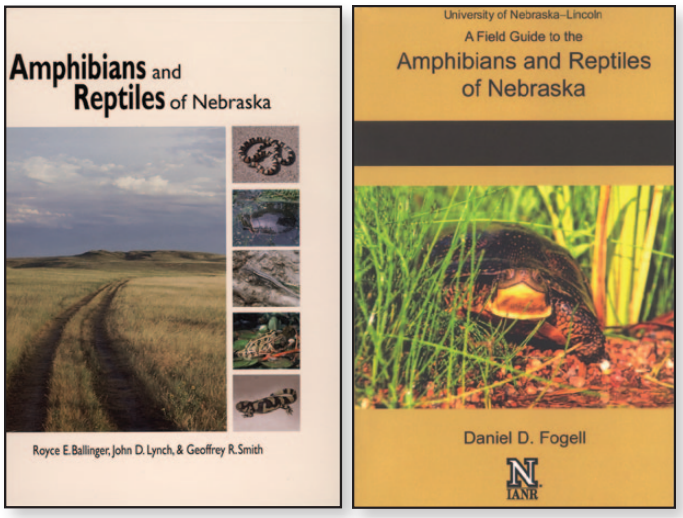
Amphibians and Reptiles of Nebraska

By Royce E. Ballinger, John D. Lynch, and Geoffrey R. Smith. 2010. Rusty Lizard Press, P.O. Box 68058, Oro Valley, Arizona 85737. 400 pp. Hardcover. US $45.00. ISBN 978-1-61658-495-5.

A Field Guide to the Amphibians and Reptiles of Nebraska

By Daniel D. Fogell. 2010. Conservation and Survey Division, School of Natural Resources, University of Nebraska, 3310 Holdrege Street, Lincoln, Nebraska 68583-0961. vi + 158 pp. Softcover. US $17.99. ISBN 978-1-56161-013-6.

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Nebraska had gone over 65 years since Hudson's (1942) treatment of the state's amphibians and reptiles then, within weeks of one another, two new books on the topic were published. The two new books, *Amphibians and Reptiles of Nebraska* and *A Field Guide to the Amphibians and Reptiles of Nebraska*, despite their similar subject matter, are very different. The former is larger (18.4 × 15.4 cm and 400 pp. vs 12.1 × 19.1 cm and 161 pp.), with more in-depth coverage and referencing (4.5 pages per species with 970 references cited compared to two pages per species and no literature cited), and a heftier price tag (US $45.00 vs. $17.99). They also differ in the number of species treated; Fogell has 62, one more than Ballinger et al., as he treats Tiger Salamanders as two species (*Ambystoma tigrinum* and *A. mavortium*).

A Field Guide to the Amphibians and Reptiles of Nebraska (Fogell) is a nicely laid out and designed guide that has a short introduction and a two-page section on habitats. This is followed by a well done key for all amphibians and reptiles found in the state. The species names follow Crother (2008) with the exception of ratsnakes and foxsnakes for which *Scotophis* and *Mintonius* are used, as well as *Pantherophis*, without explanation. The accounts are standardized to two pages per species and include four text sections on one page—description, habitat, natural history, and distribution— and photos and a distribution map on the facing page. There are no citations in the text of the accounts. The maps show distribution by county, but do not provide information on the origin or age of the records. The last portion of the book includes short descriptions of species of possible occurrence, a glossary of terms, and a checklist of amphibians and reptiles of Nebraska.

This is a handy guide that fits nicely in one's pocket and is appropriate for persons with a general interest in the wildlife of Nebraska. It falls short for the serious student of herpetology, however, because of the lack of references and relatively cursory treatment of each species.

Amphibians and Reptiles of Nebraska (Ballinger et al.) is a major treatise on the herpetology of Nebraska. The three authors have over 60 combined years of experience with Nebraska reptiles and amphibians and over 30 collective years of work invested in this book. The book has extensive introductory chapters. "A Brief History of Herpetology in Nebraska," which covers works from prior to Hudson (1942) to the present, including a mention of the (then forthcoming) field guide by Fogell, gives a good overview of the research that has been carried out on the amphibians and reptiles of the state. The "Environments for Amphibians and Reptiles in Nebraska" chapter is over 20 pages long and covers the physiographic regions and vegetation types found in the state. There is also a section on conservation and a checklist to the species found in the state.

Ballinger et al. break up their key so the portion for each order is at the beginning of the sections for those species. The species accounts are laid out with sections on recognition, description, size, distribution, habitat, habits, variation, and remarks. There are multiple photos for each species showing different life stages, colorations, and habitats. The state maps show point localities with different dots that distinguish the records by age and smaller American maps show the broader distribution of each species. Unfortunately, the state maps all show gray speckling or smudging, probably due to low quality scans. The same problem is found in the line drawings used in the book.

The species accounts vary in length from three pages to over 10 pages. The authors mainly follow Crother (2008) for standard English and scientific names, except that they retain the use of the genera *Bufo* and *Rana*, explaining their rationale in the text. A single page of species of potential occurrence in Nebraska is presented. There is an extensive glossary and a 51-page Literature Cited section, with 970 references.

This book is a major treatise that will stand the test of time. Unfortunately, numerous typos, the use of informal terms like "herpetile," and the low quality maps and line drawings take off a little of the luster. It is too bad this book did not get the copyediting and design support that went into Fogell's *Field*

Guide. It would have been nice for the users of both books if the authors had collaborated to use one standard names list for Nebraska.

I will keep both of these books on my bookshelf. I will refer to Ballinger et al. when I need information about Nebraska amphibians and reptiles. When I am in the field in Nebraska I will have Fogell in my back pocket. It is too bad that these two projects could not have been merged, particularly considering the authors were all associated in some way with the University of Nebraska – Lincoln.

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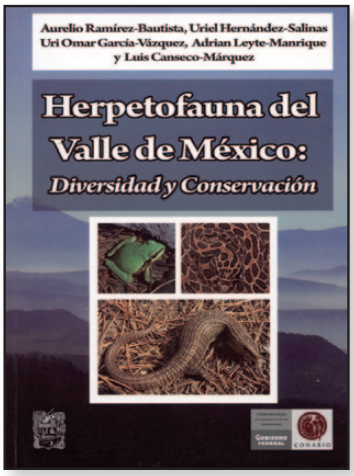
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PUBLICATIONS RECEIVED

Herpetofauna del Valle de México: Diversidad y Conservación

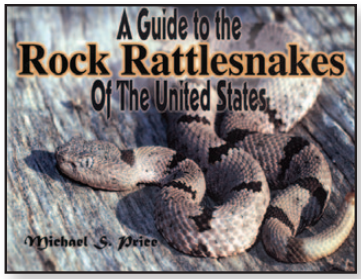
By Aurelio Ramírez-Bautista, Uriel Hernández-Salinas, Uri Omar García-Vázquez, Adrian Leyte-Manrique, and Luis Canseco-Márquez. Prologue by Jerry D. Johnson. 2009. Universidad Autónoma del Estado de Hidalgo and CONABIO, Mexico, D.F. 213 pp. Softcover. US $40.00 (available from Bibliomania! www.herplitsales.com). ISBN 978-607-7607-18-2. [In Spanish]



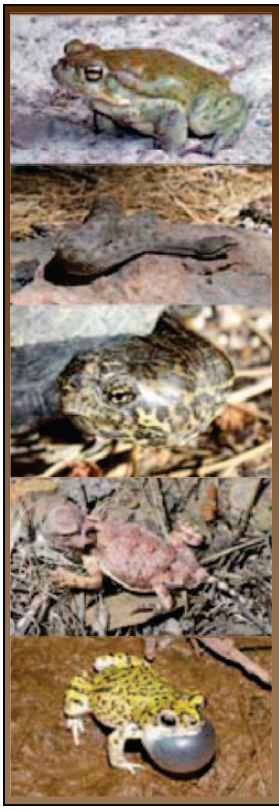
This volume joins a growing list of regional treatments of Mexico's wonderfully diverse herpetofauna, and like most of these other recent publications is the work of native Mexican herpetologists. This publishing wave reflects a movement to document Mexico's herpetological diversity in the face of growing conservation challenges. The Valley of Mexico, in particular, because of its long period of high-density human habitation, is a region of heavily compromised ecosystems, with some species already extirpated and others marginalized to vestiges of native habitats. Individual accounts for 69 species of amphibians and reptiles include descriptions, natural history, and distribution (with dot maps). Small color photographs are included for each species; where possible, specimens illustrated are from within the book's coverage area. Separate sections review distribution—from ecological and biogeographic perspectives—including levels of endemism, as well as diet, habits, and reproduction (noting the high percentage of viviparous squamates). The book concludes with a discussion of the conservation status of the region's herpetofauna as a group, as well as individual species that have disappeared already or are in imminent danger of regional extirpation. Herpetologists and conservation biologists with interests in Latin America will want to acquire this book.

A Guide to the Rock Rattlesnakes of the United States

By Michael S. Price. Foreword by Travis J. LaDuc. 2009. ECO Herpetological Publishing, Rodeo, New Mexico (www.ecouniverse.com). 160 pp. Softcover. US $24.95. ISBN 978-0-9788979-9-4.



This book is a photographic atlas documenting the extensive phenotypic variation in *Crotalus lepidus* within the United States. This species has been Michael Price's passion for a number of years, and he has traveled widely throughout the American Southwest to observe and record Rock Rattlesnakes from the mountains of southeastern Arizona and adjacent New Mexico eastward into the desert and near-desert environments of West Texas. Within this region, *C. lepidus* occupies a broad range of elevations and habitats (nearly always rocky), and populations of snakes display differences in adult size and color pattern. The geographic range and morphological variation is even more extensive south of the U.S.–Mexico border and will be the subject of a future book by Price. The present volume contains hundreds of high-quality color photographs depicting 240 individual snakes from 52 discrete localities (many also illustrated by color photographs). Price recognizes five "phenotypes"—but in reality these are not diagnosed morphologically but simply allocated to ecoregions (e.g., "Edwards Plateau / Eastern Phenotype," etc.). Although this book would have benefited from a stronger editorial presence, its value lies in the voluminous compilation of images that record the variation in this diverse group of snakes.

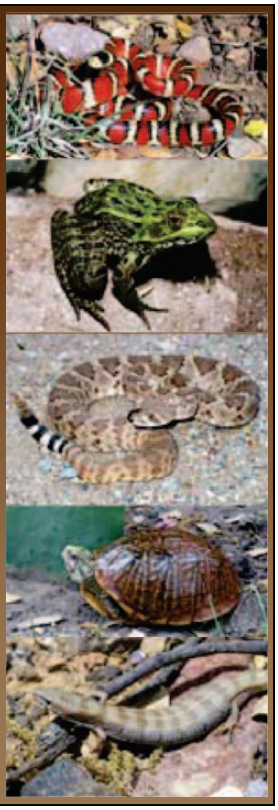


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For more information about the course contact Dawn Wilson
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SOCIETY FOR THE STUDY OF AMPHIBIANS AND REPTILES

www.ssarherps.org



The Society for the Study of Amphibians and Reptiles, the largest international herpetological society, is a not-for-profit organization established to advance research, conservation, and education concerning amphibians and reptiles. Founded in 1958, SSAR is widely recognized today as having the most diverse society-sponsored program of services and publications for herpetologists. Membership is open to anyone with an interest in herpetology—professionals and serious amateurs alike—who wish to join with us to advance the goals of the Society.

All members of the SSAR are entitled to vote by mail ballot for Society officers, which allows overseas members to participate in determining the Society's activities; also, many international members attend the annual meetings and serve on editorial boards and committees.

All members and institutions receive the Society's primary technical publication, the *Journal of Herpetology,* and its news-journal, *Herpetological Review*; both are published four times per year. Members also receive pre-publication discounts on other Society publications, which are advertised in *Herpetological Review*.

To join SSAR or to renew your membership, please visit the secure online ZenScientist website via this link:

http://www.ssarherps.org/pages/membership.php

Future Annual Meetings

2011 — Minneapolis, Minnesota, 6–11 July (with ASIH, HL)
2012 — Vancouver, British Columbia, 8–14 August (7th World Congress; also SSAR, HL, and ASIH)
2013 — Albuquerque, New Mexico, dates TBA (with ASIH, HL)

About Our Cover: *Drymarchon couperi*



Among the largest of colubrid snakes—reaching adult lengths of 1.6–2.95 m—are members of the genus *Drymarchon*, the indigo snakes. Collectively, their range spans some 55° degrees of latitude, extending from the southeastern United States to northern Argentina. Herpetologists have long considered *Drymarchon* as monotypic (*D. corais*) with up to eight subspecies. Currently, four species are recognized based on morphology and color patterns (Wüster et al. 2001. Herpetological Journal 11:157–165).

In sandy pineland habitats in Georgia/Florida, the Eastern Indigo Snake (*Drymarchon couperi*) has an intimate association with the Gopher Tortoise (*Gopherus polyphemus*), using the long, deep burrows of this turtle for winter dens, foraging, and nesting. Many landowners and outdoorsman revere Eastern Indigos because of their docile temperament and beauty. The colloquialisms "blue gopher" and "gopher snake" capture the species' predilection for tortoise burrows and the violet iridescence of the dorsal scales in sunlight. This North American icon was federally listed in 1978 as "Threatened" due to population declines attributable to habitat loss and overcollection for the pet trade. The practice of introducing gasoline into Gopher Tortoise burrows to evict Eastern Diamondback Rattlesnakes (*Crotalus adamanteus*) may still be employed by some snake hunters; doing so has been shown to be lethal to any Indigo Snake residing in a "gassed" burrow; currently, three rattlesnake roundups are held annually (two in Georgia, one in Alabama) at sites within or near the range of *D. couperi*.

Like other members of the genus, *D. couperi* are diurnal, active foragers that feed on a wide array of vertebrates, particularly snakes, including venomous species. Formidable and indiscriminate predators, they prowl wetland margins and probe their heads into burrows when searching for prey; snake prey are typically seized by the head, chewed until immobilized, then swallowed head-first. Interestingly, a number of the forms of *Drymarchon* commonly consume small turtles (H. W. Greene, Cornell University, pers. comm.). (And, somewhat ironically, Eastern Indigos frequently eat hatchling Gopher Tortoises [Stevenson et al 2010. Southeastern Naturalist 9:1–18]). Mark-recapture field studies in southern Georgia have documented that adult Eastern Indigo Snakes exhibit male-biased sexual size dimorphism, require 3–4 years to reach sexual maturity, display winter den site fidelity by returning to the same tortoise colonies in successive years, and commonly live to be 8–12 years of age on vast protected landscapes (Stevenson et al. 2009. Herpetological Conservation and Biology 4:30–42).

Our cover features a female *Drymarchon couperi* found basking in January 2009 near a Gopher Tortoise burrow in Longleaf Pine-Wiregrass sandhill habitat along the Canoochee River, Georgia. **Dirk J. Stevenson** recorded this image with a Sony MVC–CD500, equipped with a Zeiss macro lens at f22, ISO 400, 1/30 sec exposure, and auto fill flash. Stevenson is Director of Inventory and Monitoring with The Orianne Society (www.projectorianne.org), a nonprofit organization dedicated to the conservation of imperiled amphibians and reptiles. Elsewhere in this issue (pp. 437–442), Stevenson and colleagues investigate the effectiveness of using wildlife detector dogs to locate Eastern Indigo Snakes.



PHOTO BY STELLA OSBORN

SSAR BUSINESS

2010 Annual Meeting, Providence, Rhode Island

The 53rd Annual Meeting of SSAR took place from 7–12 July 2010 at the Weston Providence Hotel, Providence, Rhode Island, USA. The Organizing Societies were Society for the Study of Amphibians and Reptiles (in conjunction with the International Society for the History and Bibliography of Herpetology), American Elasmobranch Society (celebrating its 26th annual meeting), American Society of Ichthyologists and Herpetologists (celebrating its 90th annual meeting), and The Herpetologists' League (celebrating its 68th annual meeting). The meeting was hosted by University of Rhode Island, Brown University, and University of Connecticut. The local hosts were Jacki Webb (Chair), Beth Brainerd, Eric Shultz, Kurt Schwenk, Cheryl Wilga, and Brad Wetherbee. Once again, the local hosts were ably assisted by the staff of KState University Division of Continuing Education and by many student volunteers (from University of Rhode Island, Brown University, and University of Connecticut).

There were 1031 herpetologists and ichthyologists from around the world at the 2010 JMIH. This number was down slightly compared with that in the previous year (1170). Attendees hailed from 25 different countries (e.g., Argentina, Australia, Austria, Belgium, Canada, Germany, Italy, Korea, Malawi, Malaysia, The Netherlands, Poland, New Zealand, Saudi Arabia, United Kingdom, United States, Venezuela). Approximately 45% of attendees were students, and around 520 papers and 260 posters were presented. Twenty-eight exhibit booths were staffed. Seven symposia, including one sponsored by SSAR and ASIH "Head-Starting Turtles—Learning from Experience" (Fig. 1), and three student workshops were scheduled. A workshop on grant writing was organized by Dawn Wilson and other members of the SSAR Graduate Student Participation Committee. The Henri Seibert Competition attracted 28 students in four categories this year.

The Annual Meeting began officially at 0900 h on Thursday, July 8th with welcomes from the Chair of the Local Host Committee, Jaqueline Webb (University of Rhode Island) and Nancy Fey-Yensen (Interim Dean, College of the Environment and Life Sciences, University of Rhode Island). Kentwood Wells, this year's ASIH speaker, gave a presentation on "The Social Behavior of Anuran Amphibians: What Have We Learned in the Last 35 years?" This was followed by the presentation of three ASIH Awards (Gibbs, Fitch, and Johnson awards) to John Lundberg, Tom Schoener, and Joe Nelson, respectively. The first winner of the new SSAR/ASIH/HL Meritorious Teaching Award in Herpetology, Whitfield Gibbons, was then announced by President Crother. ASIH Past-President John Lundberg spoke on "Authentic American Cryptoichthyology," followed by The Herpetologists' League's distinguished herpetologist for 2010, Indraneil Das from University Malaysia, Sarawak, who spoke on "Perceptions, Use and Conservation of Amphibians by Indigenous People Worldwide." The AES speaker, Gregor Cailliett gave an address on "Ageing, Age Validation, Growth and Aging: The Life Histories of Chondrichthyan and Deep-Sea Fishes" and the Plenary Session was closed by Jacqueline Webb.

Social and Professional Events

Robert Espinoza (California State University, Northridge) was this year's President's Travelogue speaker and gave his presentation ("The Herpetofauna of South America's Southern Cone: New Discoveries from the Andean Peaks to the Peruvian Steppe") on July 7th (Fig. 2). He spoke about the extremes of temperature and water availability and the great diversity of reptiles and amphibians in this area. Bobby acknowledged Richard Etheridge who introduced him to Argentina and Argen-



FIG. 1. Participants in this year's highly successful symposium, "Head-starting Turtles. Learning from Experience," organized by Russell Burke and co-sponsored by SSAR and ASIH. Standing (from left to right): Willem Roosenburg, Roger Wood, Slawomir Mitrus, Tom Herman, unknown, Tom French, David Taylor, Lisa Hazard, Ken Nagy, Russ Burke, Tracey Tuberville, Brian Windmiller, Stephanie Koch, Charles Innis, Matt Hinderliter, Maria Wojakowski, Peter Warny, unknown. Seated (from left to right): Thane Wibbels, unknown, unknown, unknown, Kurt Buhlmann. (Photo M. Preest)



FIG. 2. Beck Wehrle, Denita Weeks and Navasha Singh (L to R) students of this year's President's Travelogue Speaker Robert Espinoza (second from right). Denita was the 2010 Seibert Award winner in the Morphology/Physiology section. (Photo M. Preest)

tinian herpetofauna, as well as the many friends and contacts he and his students have developed over the years. Every year SSAR manages to find a great Travelogue speaker and this year was no exception.

On the evening of July 8th, SSAR joined with HL to host another very successful reception for student members of both Societies and invited professionals (Fig. 3). The Joint Meeting Reception was held immediately after the Student Reception at the Roger Williams Park Zoo. After a long wait for buses by most (Fig. 4a) and a detour to a casino for some, good barbeque and interesting exhibits were enjoyed by those who finally made it (Fig. 4b).

In addition to the planned gatherings, many meeting attendees felt the need for some "field work" and explored local dining establishments and pubs (Fig. 5).

Twenty two students attended a pizza lunch and student workshop on grant writing organized by the Student Participation Committee on July 9th. The workshop included a panel of professional herpetologists (Robert Espinoza, Al Savitzky, Rafael de Sá, Henry Mushinsky, Karen Warkentin, and Dawn Wilson) from a variety of types of institutions offering valuable advice, including how to set a proposal in a broader context, how important it is to stress the relevance and novelty of the proposed research, and how to include preliminary data. Al and Rafael spoke of their work at NSF, as well as their own experiences writing grant proposals.

The SSAR/HL Live Auction occurred on July 11th and raised $3759.50 to support graduate student travel ($1706 of this was the result of items from the Roger Conant library). Frank Burbrink served as auctioneer and was assisted by Greg Watkins-Colwell, Samantha Wisniewski (who has helped with several of the past few auctions), Ben Jellen, Phillip Skipwith, Heather Heinz, and Taryn Cazzolli among others (Fig. 6). Greg also served as onsite coordinator before the meeting began.

Matt Venesky and Cari Hickerson (co-Chairs, Student Travel Award Committee) again worked hard to pull together a successful Silent Auction. $727 was raised to support the SSAR Student Travel Fund. Thanks to this year's winners of SSAR Student Travel Awards who helped staff the exhibit desk.

A rather hastily organized evening session dealing with the ichthyological and herpetological implications of the oil spill in the Gulf of Mexico was held on July 10th. Close to standing-room-only in a large ballroom was an indication of the level of interest in this topic.

The Joint Meeting Banquet was held on the last evening of the meeting, with Lynn Parenti serving as Master of Ceremonies. SSAR was represented at the head table by Brian Crother (President), Kirsten Nicholson (Treasurer), Marion Preest (Secretary), and SSAR member Mary White. Five past-Presidents of SSAR were in attendance. At the end of the Banquet, an invitation was issued to attend the 2011 JMIH in Minneapolis, Minnesota, July 6–11. Pat Gregory (Chair, Local Committee) invited all the world's herpetologists as well as our ichthyological colleagues from ASIH and AES to the 2012 JMIH/World Congress of Herpetology meeting in Vancouver (August 8–14). A meeting website is already up and a call by WCH for symposia has been issued.

BOARD MEETING AND BUSINESS MEETING SUMMARIES

Society President Brian Crother called the Board Meeting to order at 0803 h on July 7th, 2010 in the Westin Providence Hotel, Providence, Rhode Island. In attendance were the following members of the Board of Directors, Editors, and Committee Chairs: Kraig Adler (Editor, *Contributions in Herpetology*), Aaron Bauer (Editor, *Facsimile Reprints in Herpetology*), Brian Crother (President; SSAR Rep MMPC; Chair, Standard English and Scientific Names Committee), David Cundall (Board Member, Reg. 2012), Kevin de Queiroz (Board Member, Reg. 2012),



FIG. 3. Jay Savage, Villanova student Alicia Kennedy, Mary White, and Treasurer Kirsten Nicholson enjoying the SSAR Student Reception. (Photo M. Preest)





Fig. 4a (top). A long wait for buses to the JMIH Picnic at the Roger Williams Park Zoo; 4b (lower) but worth it when we got there. (Photo M. Preest)

Tiffany Doan (Board Member, Reg. 2010), Pat Gregory (Board Member, non-US 2012), Roy McDiarmid (Past-President), Joe Mendelson, III (President-Elect), John Moriarty (Editor, *Herpetological Circulars*), Erin Muths (co-Editor, *Journal of Herpetology*), Kirsten Nicholson (Treasurer), Pat Owen (Chair, Seibert Award Committee), Ann Paterson (Board Member, Reg. 2012), Marion Preest (Secretary), Stephen Richter (Board Member, Cons. 2010), Betsie Rothermel (Chair, Conservation Committee), Al Savitzky (SSAR Rep to AIBS and BioOne), Greg Watkins-Colwell (Chair, Nominations Committee; Chair, SSAR/HL



Fig. 5. Matthew Morrill, Alex Pyron, Greg Watkins-Colwell, Meredith Mahoney, and Frank Burbrink (L to R) enjoying the "best beer in Rhode Island" at one of the many local pubs. (Photo M. Preest)

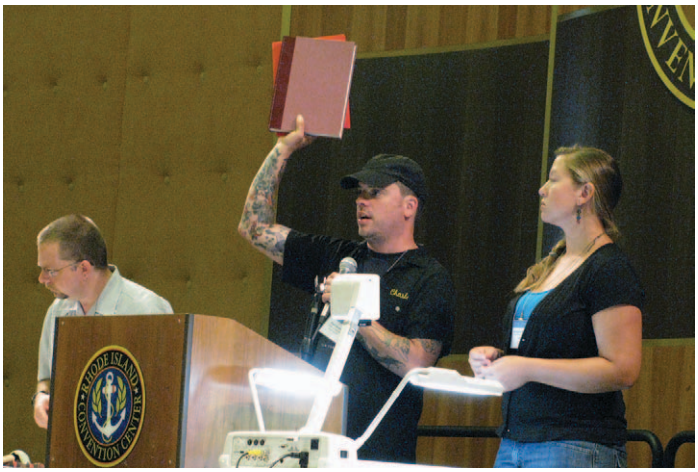


Fig. 6. Greg Watkins-Colwell (far left, the new Chair of the Live Auction Committee) was energetically and persuasively assisted by Frank Burbrink and Samantha Wisniewski at the auction. (Photo M. Mahoney)

Live Auction Committee), and Dawn Wilson (Chair, Student Participation Committee). Additional society members present included Robin Andrews and Henry Mushinsky. Minutes of the 2009 Board of Directors Meeting (Portland, Oregon) were approved.

Annual reports for 2009/2010 were submitted by all Officers, Editors, and Committee Chairs. President Brian Crother reported that SSAR became involved as a Festival Partner with the USA Science & Engineering Festival to be held in Washington D.C. in October, 2010. SSAR will have a booth at the festival and Joe Mendelson, III is in charge of our participation in this national event (see event report elsewhere in this issue). The editor of the *Journal of Herpetology*, Matthew Parris, unexpectedly stepped down in early 2010, but Brian noted that the Society was fortunate to find new editors, Gad Perry and Erin Muths, fairly quickly. It is anticipated that a two-editor system will improve our manuscript turnaround time. Welcome aboard to Gad and Erin and many thanks to them for stepping up to take this key position. Thanks also to Geoff Smith, a previous editor, for stepping in and helping smooth the transition.

President Crother reported writing or signing a number of letters pertaining to SSAR business over the past year, including various letters submitted by the Conservation Committee, letters of congratulations to national and international herpetological societies acknowledging significant landmarks, and letters of thanks to Maureen Donnelly (President's Travelogue speaker, 2009) and to the participants in the 2009 JMIH SSAR Student Workshop.

Treasurer Kirsten Nicholson reported that, overall, the finances of SSAR are fairly sound and doing well. The approved 2009 budget was balanced and the Society came in under budget by around $7,000. Costs for production of our journals are increasing and we may need to review the manner in which we produce them and develop our presence online. Membership management fees assessed by Allen Press have been much higher than anticipated. Membership management was taken over by Breck Barthlomew in October 2009 and our costs are expected to be half of those charged by Allen Press. Our membership is holding steady overall. Institutional subscriptions have fallen, however individual memberships have increased. Although growth in membership levels would be better, holding steady is very good, given the decrease in memberships experienced by most societies. It is not clear if institutions are dropping memberships to remove duplication of effort or to reduce costs by having a BioOne (or other similar) contract which would provide *Journal of Herpetology* to them without having a subscription directly with us. This would explain the huge increase in royalties we are enjoying, which is expected to continue to rise. A comment was made that SSAR needs to offer an electronic-only membership option. The Society's investments made a substantial rebound during 2009. Total market value increased

28% (from $383,743 to $496,004). Kirsten had considered a review and possible revamp of our investment portfolio, but considers it prudent to stay the course at present until conditions change.

Secretary Marion Preest provided Officers, Editors, and Committee Chairs with minutes of the 2009 Board Meeting and summarized the 2009 Annual Meeting for publication in *Herpetological Review*. She keeps track of changes in personnel and regularly updates SSAR letterhead, informs the Editors of *Journal of Herpetology* and *Herpetological Review* of these changes and provides various updates to Raul Diaz (webmaster). She routinely writes letters to student winners of various awards (e.g., Kennedy, GIH, etc.) and prepares announcements for publication in *Herpetological Review*.

The Secretary compiled the 2010 Annual Report and prepared agendas for the Board and Business Meetings for the 2010 JMIH. She was again involved in helping to organize a reception for student members of SSAR and The Herpetologists' League to be held at the JMIH.

A major task in 2009 was to contact all members who are entitled to *CAAR* as part of their membership and inform them of changes to the publication schedule and how we would deal with this. She corresponded with the Board regarding various issues that needed a vote, e.g., a proposal to accept a donation to fund increased use of color photos in *Herpetological Review* and *Journal of Herpetology*, a letter regarding the Natural Science Collections Alliance, a change in editorship for *Journal of Herpetology*, approval of JMIH symposia, etc. Marion framed the Special Libraries Association certificate that SSAR received last year and sent it to Matt Parris. Gad Perry has it currently and it will be passed on to new Editors as necessary. As an *ex officio* member of the Nominations Committee, the Secretary helped to identify and contact potential candidates for the four positions we need to fill in 2010.

Breck Bartholomew reported that total income from the Publications Office in 2009 was $64,651.90.

Editor of *Catalogue of American Amphibians and Reptiles* Andy Price, reported that accounts 861–880 (2 salamanders, 7 frogs, 2 turtles, 7 lizards, 2 snakes, 113 total pages) were published in January 2010 and mailed to subscribers in March. Every account in this issue had at least one color illustration. Andy has 12 accounts on hand in various stages of completeness but is unlikely to have an issue ready by the end of 2010. The frog section editorship is vacant, and the snake editorship will change soon. Andy considers the following as minimal qualifications for a section editor: 1) the ability to recruit authors for accounts, 2) a comprehensive knowledge of the literature not limited to systematics and taxonomy, 3) the ability to pay attention to detail including spelling, syntax, and punctuation, and 4) the ability to check bibliographic entries for accuracy and completeness, and to cross-match these with text citations. If anyone knows of a suitable candidate for either position, please contact Editor Price.

Editor of *Contributions to Herpetology* Kraig Adler reported that "Biology of the Reptilia, Volume 22, Comprehensive Literature of the Reptilia," by Ernest A. Liner was published in March 2010. "Snakes of Honduras" by James McCranie will be published in 2010/2011. A $5,000 donation has been received to support publication.

A "Guide to the Snakes of the Philippines" by Rafe Brown, Alan Leviton, Maren Gaulke, and Arvin Diesmos, "Field Guide to Amphibians and Reptiles of the West Indies" by S. Blair Hedges, and "Lizards of Southern Africa," edited by William R. Branch and Aaron Bauer are planned beyond 2010.

Editor of *Facsimile Reprints in Herpetology* Aaron Bauer reported that no new titles were published in the past year. "Gray's Catalogue of the Specimens of Amphibians and Reptiles in the Collection of the British Museum" is planned for late 2010. Duméril and Bibron's "Erpétologie Générale ou Histoire Naturelle Complète des Reptiles" (1834–1854) is planned for publication in late 2011. This is one of the most important of all herpetological works and a truly comprehensive summary of all amphibian and reptiles species known at the time. The original was nine volumes in 10, totaling over 7000 pages with a separate Atlas of 120 plates. The facsimile will be produced in the same format, with colored plates in the Atlas and black and white versions of the plates also bound into the volumes with which they are associated. The cost of the original work today is in the neighborhood of $20,000. Funding permitting, it is hoped that SSAR will be able to sell the full set at less than $300.

Editor of *Herpetological Circulars* John Moriarty reported that "Reptile Dealers and their Price Lists" was withdrawn by the authors. *Herpetological Circulars* 39 ("A Guide to Tissue Collection, Preservation, and Management for Reptiles and Amphibians" is in preparation and publication is planned for late 2010. Because *Herpetological Circulars* are print on demand, reprint costs are now a factor in the budget for this publication.

Joe Mitchell (Editor) reported that *Herpetological Conservation*, Volume 3 ("Urban Herpetology") has sold well. It was nominated for an award from The Wildlife Society.

Herpetological Review continues to operate smoothly according to Editor Robert Hansen. Volume 40 was slightly smaller (reflecting budget constraints) and the same is likely to be true for Volume 41. Personnel changes include Margaret Gunzberger, Marc Hayes, and Andy Holycross stepping down and Peter Lindeman, Jesse Brunner, Kerry Griffis-Kyle, Michael Benard, Jackson Shedd, and J.D. Wilson joining the staff.

As of late 2009, issues of *Herpetological Review* from 2007 onwards are available to SSAR members as PDF downloads from the ZenScientist website. The Board discussed electronic publishing of *Herpetological Review* again this year. It was felt unanimously that electronic publishing is essential for the future of this publication and for the Society, and must therefore happen sooner rather than later. The issue of indexing of past issues must be resolved. Increased use of color was also considered again. Hansen has obtained reduced color charges from Allen Press and has accessed the Beauvais Fund in support of color printing (evident in the first issue of 2010).

Matthew Parris stepped down as Editor of *Journal of Herpetology* in early 2010 and was replaced by Gad Perry and Erin Muths. Geoff Smith is serving as "Interim Editor" and processing all manuscripts submitted before 2010. There have also been some changes in the roster of Associate Editors. The current list partially reflects an interest in expanding the global reach of *Journal of Herpetology*.

Submission rates were markedly reduced in 2009 (down ~ 30%), but submissions to date for 2010 are higher than for comparable periods in 2009 and 2008. Rejection rate continues at around 60% and there is approximately a nine-month wait between acceptance and publication (down somewhat relative to the previous year). The change in journal leadership has resulted in longer than desired handling times for some manuscripts, however, the Editors have reduced the backlog drastically thanks to the work of Geoff Smith. They are hopeful that the entire process will be back to desired levels by the end of 2010.

The co-editors brought five issues to the attention of the Board.

1) Journal Format — There was discussion of a recommendation to convert *Journal of Herpetology* to an 8.5" x 11" trim size at the 2009 Board Meeting. Editors Muths and Perry are still waiting to receive relevant numbers and mockups from Allen Press. Once they receive them, this issue will be submitted to the Board for an electronic vote.
2) Electronic Publishing — They recommended that the Board continue consideration of electronic publishing of *Journal of Herpetology* with the expectation that this would happen by 2012. It is not obvious whether this would affect SSAR membership levels. The Editors are awaiting information from Allen Press on the financial implications of electronic publishing.
3) Rewarding Associate Editors — There was discussion of a suggestion that Associate Editors receive free membership as a token of appreciation for their efforts. There was also discussion of the fact that some Associate Editors are not members of SSAR. The sense of the Board was that membership should be an expectation, but not a requirement. The President could contact new Associate Editors

who are not members of the Society, and encourage them to join. Editor Muths will write a draft of this letter and send it to President Crother and President-Elect Mendelson.

4) Editorial Board — The Editors questioned the role of the Editorial Board. Their function is to serve as guaranteed reviewers and the Board recommended that they be used more in this manner.
5) Page Charges — Whether a strong policy regarding page charges should be developed and enforced was again discussed. In 2009, the Board asked Editor Parris to develop such a policy. As this was not done, the Board asked the current editors to develop a policy for its consideration. This policy needs to address the issue of charges for both black and white and color pages.

When *Journal of Herpetology* is published electronically, increased use of color plates will be possible. Some reservations were expressed about having two versions of each issue (electronic and hard copies). One version (likely the hard copy) will need to be designated as the official version.

Three new members were added to the Conservation Committee this past year. The Committee took action on a number of items: a) they supported a petition to list western U.S. populations of the Northern Leopard Frog as threatened, b) they sent a letter to U.S. Fish and Wildlife Service (USFWS) requesting re-initiation of an incidental take permit for a wind farm project which may affect the federally threatened Puerto Rican crested toad and contacted Puerto Rican authorities encouraging greater protection of remaining habitat for this species, c) they submitted a letter to USFWS urging federal listing and habitat designation for the coquí llanero, d) they expressed support for proactive strategies for curbing introduction and spread of invasive species (e.g., large constrictors) and stated their position that removal of these organisms (e.g., through controlled hunting) is unlikely to be effective, e) they wrote to the Florida Fish and Wildlife Conservation Commission (FFWCC) to encourage adoption of new rules regarding take and possession of native freshwater turtles.

Actions of the Committee contributed to several positive developments in the past year. For example, the local Planning Board in Puerto Rico temporarily suspended their decision to approve a wind farm project and allowed time for reconsideration, and the FFWCC approved new rules that prohibit commercial harvest and impose strict daily limits on the take of wild turtles in Florida. President Crother remarked on what 10 people can accomplish and congratulated the Committee on its efforts.

Betsie expressed some reservations about a small Committee representing the views of the entire Society and there was some discussion of soliciting greater input from the membership (e.g., via email, a web forum, or an online survey). The view of the Board was that this could be unwieldy and slow down the process and commended the Committee on its activities.

Joe Beatty (Chair, Dean Metter Award Committee) received 24 proposals this year and it was decided to choose two winners. They are: Matthew Niemiller (University of Tennessee, Knoxville) who is working on the maintenance of distinct cave and surface forms in the salamander genus *Gyrinophilus*, and Michael Reichert (University of Missouri, Columbia) who is studying acoustic communication in *Hyla versicolor*. Michael is the first student from University of Missouri in Columbia (which is where Dean Metter was a long time faculty member) to win this award. The Board encouraged Joe to advertise the Award via the SSAR website and an emailing to student members of the Society.

Erik Wild and Josh Kapfer (co-chairs, Grants-in-Herpetology Committee) received 55 proposals in 2010. Applications were sent from 19 states in the US and nine countries (including the U.S.). Most applications were received in the "Field Research" category. The winners each receive $500 and they are:

Conservation: James C. Cureton II, Sam Houston State University
Field Research: Karla Moeller, Arizona State University
Laboratory Research: Tara A. Pelletier, Louisiana State University
Travel: Lindsey Noel Swierk, Penn. State University
International: Paulo Fernando Guedes Pereira Montenegro, Universidade Federal da Paraíba (Brazil)

Eric is stepping down as co-chair of the committee.

The 18th annual Seibert Awards Competition was run at the 52nd Annual Meeting of SSAR in Portland, Oregon. There were 35 eligible presentations. The Seibert Award winners for 2009 were: **Systematics/Evolution**: *Jamie Oaks*, University of Kansas, "Objective partition choice and the phylogenetic systematics and biogeography of the true crocodiles." **Ecology**: *John Wilson*, Brian Todd, and Christopher Winne, University of Georgia, Savannah River Ecology Lab, Virginia Polytechnic Institute and State University, "Trap-happiness, temporary emigration and other factors affecting detectability and population estimation in aquatic snakes." **Physiology/Morphology**: *Victoria Arch*, T. Ulmar Grafe, Marcos Gridi-Papp, and Peter Narins, University of California, Los Angeles, University Brunei Darussalam, "An Old World frog communicates in pure ultrasound." **Conservation**: *Kristine Kaiser*, Menemsha Alloush, Robin Jones, Susanne Marczak, Katherine Marineau, Mark Oliva, and Peter Narins, University of California, Los Angeles, "When sounds collide: effects of anthropogenic noise on frog calling behavior."

Honorable mentions were: **Ecology**: *Javan Bauder*, Holly Akenson, and Charles Peterson, Idaho State University, University of Idaho, "Over the hills and far away: movements of prairie rattlesnakes across a mountainous landscape in a designated wilderness." **Conservation**: *Anna Savage*, Cornell University, "Experimental infection with *Batrachochytrium dendrobatidis* demonstrates genetic resistance to chytridiomycosis in *Lithobates yavapiensis*."

All winners received a check for US $200 from SSAR and a book from University of California Press, the latter compliments of UCP Editor Chuck Crumly.

The Herpetological Education Committee website has been active for a year and members respond to various enquiries submitted to the Herp Hotline. Members have also been active in developing and encouraging educational activities in herpetology. The Committee received support in 2009 from SSAR, HL, and ASIH for a proposal for a Meritorious Teaching Award in Herpetology. Ten nominations were received and considered by a Committee consisting of professional and student members of the three participating societies.

Lynnette Sievert (Chair, Kennedy Award Committee) announced that the winning paper for 2009 is by Ermin Schadich, "Skin peptide activities against opportunistic bacterial pathogens of the African clawed frog (*Xenopus laevis*) and three *Litoria* frogs. *Journal of Herpetology* 43:173–183." Ermin will receive a check for $200 or $400 equivalent in SSAR publications.

The Meeting Management and Planning Committee (MMPC) met in Providence in March 2010 to develop a meeting schedule and review conference facilities. President Crother and President-Elect Mendelson, who will replace Brian on the MMPC, attended the meeting as SSAR representatives. Almost 800 presentations (papers and posters) will be made at the 2010 meeting. Future meetings are to be held as follows:

- Minneapolis (2011)
- Vancouver (2012; with the WCH)
- Albuquerque (2013)

A survey conducted by the MMPC last year confirmed that many members thought the meetings were too expensive. Consequently, the MMPC invited two meeting management companies (KState and Experient, Inc.) to submit competitive bids for the 2013 meeting in Albuquerque. Experient's bids failed twice to provide costs for a number of services (e.g., web design and maintenance for registration and abstract submission, meeting announcement postcards, program book, abstract CD and book, reimbursements for MMPC, etc.). This process had two outcomes. It opened the eyes of the MMPC to the quality of service we receive from KState and it made KState aware of how serious the MMPC is in reducing meeting costs. Subsequently, KState joined with

another meeting management company to reduce costs of site selection and hotel negotiations (e.g., reduced or eliminated room rental fees, eliminated the need for a food and beverage minimum required for free or reduced room rental fees, eliminated fees associated with not filling a certain percentage of our room block).

The MMPC presented a proposal to make the MMPC a JMIH, rather than an ASIH, Committee and a proposal to reduce expenses at future meetings. These proposals were discussed by the Board later under New Business.

The MMPC also considered, but took no action on, the issue of reduced registration rates for accompanying and retired persons. Lightning round talks and the future and format of the banquet were discussed. A competition for a JMIH logo, separate from the individual society logos and the local meeting logo is being run. It will reflect combined interests in cartilagenous and bony fishes, amphibians, and reptiles and act as a banner for the JMIH meeting websites.

Five symposia were approved for the 2011 meetings.

ASIH — Turtle Ecology on the Upper Mississippi River System, Then and Now: A Zeitschrift in Honor of the Career in Turtle Biology of Dr. John M. Legler

ASIH — Drawing Lines in the Sand: Comparative Phylogeography of the Gulf-Atlantic Coastal Plain

ASIH — Ranaviruses: An Emerging Threat to Ectothermic Vertebrates

SSAR — Assisted Reproductive Technologies and Genetic Resource Banking: Tools for Conserving Declining Amphibians

AES — Elasmobranch Telemetry

Greg Watkins-Colwell reported that no elections were held in 2009. In 2010, SSAR needs to elect a President-Elect, Secretary, Treasurer, and three Board Members (Regular, Conservation, Regional Herpetological Societies). The committee plans to submit suggestions to the Board on how to define (or re-define) some of the specialty Board positions such as "Regional Herpetological Societies."

Stu Nielsen presented resolutions at the SSAR Business Meeting in Portland in 2009. Stu stepped down as Resolutions Chair and was replaced by Rob Denton.

The 6th Edition of the Scientific and Standard English Names List was published two years ago and the web version is close to posting. Brian Crother, Chair of the Standard English and Scientific Names Committee, thanked Raul Diaz for his help in getting this accomplished. Kevin de Queiroz donated many photographs and has worked closely with Raul on the website version.

Dawn Wilson reported that SSAR held a pizza lunch and workshop ("How to Get a Job After Graduation: Advice from Experts") for students at the 2009 JMIH. A workshop will be offered in 2010 on a topic decided on the basis of an exit survey given to students at the 2009 workshop. For improvements, students suggested more specific workshops, longer workshops, holding different workshops for undergraduates and graduates, and not overlapping the workshop with other meeting activities. Dawn will contact students attending the 2010 JMIH and ask for ideas for future workshops. Roy McDiarmid suggested a workshop focusing on nomenclature.

New co-chairs of the Student Travel Awards Committee, Matt Venesky and Cari Hickerson, reported that the Silent Auction raised $733 at the JMIH in 2009. They hope to double this amount within two years. Proposed changes to the operation of the Auction include:

1) Placing auction items on tables in the registration lobby of the JMIH to increase visibility and bidding activity.
2) Requiring Travel Award winners to monitor the Auction table.
3) Actively soliciting donations from distinguished herpetologists.
4) Creating a Facebook page to promote donations and bidding and providing information regarding applications for Student Travel Awards.

A comment was made that although the Silent Auction has traditionally focused on objects of art, last year items in the Live and Silent Auctions were very similar. This reflected a decision made by the co-chairs to expand the types of items they would accept. Matt and Cari were encouraged to think creatively about new ways to raise funds for the Student Travel Awards, e.g., games, quizzes, photo competitions.

Anne Maglia stepped down as chair of the Web Oversight Committee in March 2010. Consequently, Raul Diaz (webmaster) summarized activity relating to the SSAR webpage.

1) Homepage updated with news.
2) ZenScientist has been added where needed as the link to the page for accessing membership information.
3) Constitution, Contacts/Committees, Chairs/Officers/Editors, award winners, and Annual Meetings information updated.
4) Publications list drop menu updated with addition of: *Catalogue of American Amphibians and Reptiles, Contributions to Herpetology, Facsimile Reprints in Herpetology, Herpetological Conservation, Herpetological Circulars*.
5) Scientific and Standard English Names List Circular added as a *gratis* PDF under RESOURCES drop down tab and online version is in preparation.
6) Working with Andy Mansker (Mansker Consultation, host of the ssarherps.org page) to control access to files on the SSAR Forum.
7) We received a free upgrade in server storage from 300 to 600MB and our bandwidth also increased from 8 to 24GB. This is necessary to host the photos that will accompany the Scientific and Standard English Names page.

Elections Officer Dan Noble reported that no elections were held in 2009.

In 2009, Henry Mushinsky stepped down after many years as Coordinator of the SSAR/HL Live Auction. After some discussion, a Live Auction Committee was formed and Greg Watkins-Colwell was appointed as chair. The Live Auction raised $4048 (split 50:50 with The Herpetologists' League) in 2009. A new bidding form was used which makes receipts available for donors. A high value item was stolen from the viewing room in 2009. The Auction Committee responded with increased security and will no longer leave high-end items out for viewing (but will provide photocopies of packaging, etc.).

Al Savitzky attended the AIBS Board of Directors Meeting and the BioOne Publishers and Partners Meeting. AIBS changed its meeting model and elected to forego a general annual meeting, although it retained the annual meeting of the Council and held an annual awards ceremony.

As with many of its member organizations, AIBS has experienced decreases in both individual memberships and investment revenues, and it has consequently downsized its staff. Despite the decline in individual members, however, AIBS has retained a large number of member societies and continues to provide a strong voice for organismal and environmental biology at the national level.

The AIBS Public Policy Office launched the AIBS Legislative Action Center (www.capwiz.com/aibs) in 2009, through which the society can alert registered individuals of important issues and facilitate their responses to legislators. AIBS also maintains an active Education Office, which was heavily involved in the 2009 Year of Science and the ongoing COPUS activities. In January, 2010 AIBS initiated intensive strategic planning, to determine the most important elements of its mission, to decide how to focus its activities for the furtherance of that mission, and to examine its business model.

This year's annual BioOne Publishers and Partners Meeting included presentations by David Remsen (Global Biodiversity Information Facility) on biodiversity informatics, by Amy Brand (Harvard University) on self-archiving mandates, and by Chuck Koscher (CrossRef) on accessing an electronic publication through several alternative websites and checking manuscripts for plagiarism.

SSAR received two symposium proposals in 2010 ("Assisted Reproductive Technologies and Genetic Resource Banking: Tools for Conserving Declining Amphibians" and "Herpetology and Ichthyology Collections—the Curation of Earth's Natural History"). Based on reviews,

the SSAR Board's decision was to sponsor the first proposal by Jennifer Germano and Andy Kouba for the 2011 JMIH meetings in Minneapolis.

This concluded discussion of reports submitted, and the Board then turned to new business. The Meeting Management and Planning Committee (MMPC) made the following recommendations to convert the (ASIH) MMPC into a JMIH MMPC and to reduce expenses for future Joint Meetings:

1. Reconstruct the ASIH MMPC to be a JMIH Committee to make the committee equally responsible and responsive to the four sponsoring societies.
2. The reconstructed JMIH MMPC shall have equal representation of ichthyologists and herpetologists to ensure that we have the necessary expertise to schedule oral presentations, posters, and symposia sessions efficiently.
3. The JMIH MMPC will be composed of six voting members and one non-voting member; one voting member each appointed by the AES, HL and SSAR, and three voting members appointed by the ASIH (two ichthyologists and one herpetologist) and the non-voting Secretary of the ASIH. Other than the ASIH Secretary, each member serves a four-year term and may be reappointed as determined by the appropriate society. The Chair of the MMPC is elected from within the committee and serves a two-year term. The ASIH secretary is an *ex officio*, non-voting member and serves on the committee for the duration of the Office. Individuals serving on the ASIH MMPC shall assume their same role on the JMIH MMPC.
4. The JMIH MMPC reports directly to the four JMIH sponsoring societies.
5. All votes of the JMIH MMPC must be unanimous.
6. The reconstructed JMIH MMPC must be ratified by the four JMIH sponsoring societies.
7. Assuming that the four sponsoring societies ratify the proposed change to the MMPC, it shall become a recognized JMIH Committee.
8. Reduce the number of days of the meeting from five to four.
9. Limit the number of oral presentations to fit into the new meeting format.
10. Run seven (or at most eight) concurrent sessions (most recent past meetings have had six). Seven concurrent sessions will accommodate 630 oral presentations (eight concurrent sessions will accommodate 714 presentations).
11. Oral presentations are accepted on a first-come, first-served basis.
12. Invited presentations for approved symposia are protected (they will be included in the appropriate symposium).
13. The number of symposia will be limited to four (one per society). If a society fails to support a symposium, a replacement symposium can be offered by another society, if approved by the MMPC.
14. Oral presentations by students in award competitions are scheduled during meeting days one and two.
15. Winners of student awards are announced at the business meetings of each sponsoring society or another occasion as determined by each society. If the JMIH Banquet is retained, then each society should have the opportunity to work with the local committee and have input into the program.
16. Increase the number of poster presentations on meeting days two and three to accommodate approximately 300 poster presentations (150 per day).
17. Eliminate the end of meeting banquet (elimination of the banquet was supported strongly by the membership when polled about reducing meeting length and costs).
18. Authorize the Kansas State Division of Continuing Education to enter into a long-term agreement with a major hotel chain (e.g., Marriott, Sheraton, or Hilton) to reduce meeting costs.
19. Some proposed changes cannot take effect until 2014, because we are under contract to hold five-day meetings, others may be implemented as they become ratified by the four societies.

There was discussion of unequal representation of the participating Societies and of disciplines (i.e., three representatives from ASIH—two ichthyologists and one herpetologist) and the requirement that votes be unanimous. The argument for three ichthyologists centers around the need to have the expertise to schedule ichthyological presentations. Suggestions were made that ASIH could have three members on the Committee, but that only one would have voting privileges or that ASIH could have two voting members (an ichthyologist and a herpetologist) on the Committee. The Committee as it is currently comprised works well according to President Crother. However, concern was expressed that there was no guarantee this would continue as the committee composition changes. There was discussion of whether any decisions made by this committee could actually harm SSAR. The Board agreed that the Chair of the Committee should be an experienced member of the Committee and the position of Chair should rotate among disciplines and participating Societies. A motion to modify item 3 above such that the Committee would have five voting members (two from ASIH) was made and seconded. A vote was taken on items 1–8 above, with item 3 modified as noted (9 supported, 1 opposed). There was little discussion of most of the remaining items. Items 8, 9, 13, 14, 15, and 17 were supported unanimously (10 supported, 0 opposed). Item 16 received majority support (9 supported, 1 opposed). The Board decided that items 10, 11, and 12 did not require a vote. There was some discussion of the proposal to enter into a long-term agreement with a particular hotel chain. Questions were raised regarding the duration of such an agreement and whether the costs savings would be worthwhile. Concern was expressed that this would preclude having a university-based meeting. The Board did not support item 18 (0 supported, 10 opposed).

Discussion via email regarding the composition of the JMIH MMPC (item 3) and entering into a long-term agreement with a major hotel chain (item 18) ensued after the Annual Meeting. President Crother reported that the other three JMIH Societies (ASIH, HL and AES) approved the proposal regarding the composition of the JMIH MMPC and he recommended that SSAR should not oppose the proposal as written. He quoted from the memorandum of understanding that SSAR has previously approved: "To affirm willingness to cooperate with each other to every extent possible." President Crother also addressed the concern regarding item 18 that a long-term agreement could prevent SSAR from having a future meeting at a university. He reminded the Board that any society may meet separately with a three-year notice of its intention to do so. KState estimated that entering into an agreement with a hotel chain could result in savings of up to approximately $30,000/yr. A vote was held electronically. Eleven yes votes were received for item 3 (two votes were not received). Nine yes votes, one no vote, and one abstention were received for item 18 (two votes were not received).

The Board received a proposal for a Student Poster Award from Joe Mendelson, III and Pat Owen. Four awards each of $100 would be awarded to student members of SSAR in the following categories: Evolution, Genetics, and Systematics; Ecology, Natural History, Distribution, and Behavior; Conservation and Management; Physiology and Morphology. There was discussion of whether this award should target junior students (e.g., undergrads and Masters students), whether the Award should be money or SSAR publications, whether there should be a fifth category specifically for undergraduates, and what the grading criteria should be. A suggestion was made that the judges should factor in the status of the student (i.e., whether an undergrad or a finishing graduate student) when evaluating the poster. The Board voted to support the proposal (10 supported, 0 opposed).

Treasurer Nicholson presented a "Conflict of Interest" policy as required by the IRS. This policy was approved by the Board (10 supported, 0 opposed). Secretary Preest has since emailed this to the Board and to Editors for their signatures.

Treasurer Nicholson presented "Whistleblower," "Ethics," and "Document Destruction and Retention" policies as required by the IRS. A statement regarding timeliness in the "Ethics" policy will be modified

to read "Editors and reviewers will not intentionally delay reviewing of manuscripts for their own benefit." These policies were approved by the Board (10 supported, 0 opposed) and the "Whistleblower" and "Ethics" policies will be made available on the SSAR website.

In response to several recent requests from outside parties to pay for access to our membership lists, there was discussion of whether SSAR wishes to continue to restrict access to this list. A suggestion was made that, when members join or renew subscriptions, they could indicate the level of access that they wish other members of SSAR or outside parties to have to their personal information. Breck Bartholomew will be queried as to how difficult this would be. The consensus was that the Board wished to continue restricting access to our membership list.

Subscription agencies are currently offered a small discount if they pay renewals without being invoiced. Breck Bartholomew recommended that we discontinue this practice. The Board approved this recommendation (10 supported, 0 opposed).

There was continued discussion of an issue raised at the 2009 Board Meeting, i.e., acceptance of donations by individuals who are not members of the Society or are unknown to the Society. Concern had been expressed regarding the credentials of these potential donors, whether there are any strings attached, etc. The Board decided that donations above $500 would need to be accompanied by a statement from the donor regarding why the donation is being made, would be evaluated on a case by case basis, and must be approved by the Board before being accepted. The President would act as an intermediary between the donor and the Board should the donor wish to remain anonymous.

There was brief discussion of how the Society should handle requests to provide financial support for meetings other than JMIH and WCH. The consensus was that we did not have the financial wherewithal to provide this support.

A proposal was received to establish "The Thomas Beauvais Fund" within SSAR. The purpose of this fund would be to increase the use of color photographs, primarily of living animals and unusual and especially new species, on the interior pages of *Journal of Herpetology* and *Herpetological Review*. The proposal came with some stipulations regarding how the fund would be used, e.g., the Fund may be used *only* as a supplement or add-on to the budgets, not as a substitute for funds allocated from the Society's regular budget. The Fund may *not* be used to increase the length of issues, but only to increase their quality and attractiveness. The Board voted unanimously to accept the proposal (10 supported, 0 opposed).

A proposal was received from EBSCO Publishing to include articles from *Journal of Herpetology* on their research databases. The Board voted to sign the License Agreement (10 supported, 0 opposed) which states that the copyright of the publication remains the Society's and that EBSCO are licensing the content for inclusion on their databases.

Complimentary subscriptions and receipt of *gratis* copies of SSAR publications were discussed. This was raised in part because of a request from the co-Editors of *Journal of Herpetology* that we consider offering complimentary memberships to Associate Editors. President Crother will draft a policy regarding complimentary memberships and publications and will email this to the Board and to the Editors for their consideration.

Three SSAR Board positions are reserved for representatives of special constituencies: 1) Regional Herpetological Societies, 2) Conservation, and, 3) Non-U.S. Members. There has been some difficulty of late filling the Regional Societies position and a request was received from the Nominations Committee early in 2009 that the Board redefine this position. At the time, the Board voted electronically to retain the Regional Societies position for the 2010 election, but agreed to consider the request at the 2010 Board Meeting. After some discussion, the Board voted (10 supported, 0 opposed) to reword the Regional Herpetological Societies position. It will now be referred to as "Member at Large" and could include, for example, representatives of regional herpetological societies, members of non-governmental organizations, governmental agencies, etc.

Formation of a Membership Committee and launching of a membership campaign has been discussed at the last several Board Meetings. In the past year, informal discussions among some Editors and Officers regarding an initiative have occurred and some ideas have been generated. President Crother asked Board member Ann Paterson if she would consider chairing and forming a Membership Committee, and she agreed to do so.

There has been some turnover in the Resolutions Chair position in recent years and there was discussion of whether such a chair is necessary. The chair presents resolutions written by the Secretary at the Business Meeting. It was decided that, because this is an easy way of getting students more involved in the Society, we would retain a Resolutions Chair.

SSAR still lacks copyright agreements with authors who have published recently in our journals. Treasurer Nicholson will develop a policy and distribute it to the Board for their consideration.

A request was received by the co-Editors of *Journal of Herpetology* from the SHERPA Services Development Officer at Centre for Research Communications to encourage authors to deposit research material into open-access repositories of "e-prints." Because of concern that this would cut into royalties that we already receive (e.g. from BioOne), the Board decided to deny this request.

A balanced budget for 2011 of $263,150 was approved, and the meeting was adjourned by President Crother at 1440 h.

An informal lunchtime meeting for a number of officers, editors, and interested SSAR members was held a few days later. The main topic for discussion was the future of SSAR and the important roles that *Journal of Herpetology* and *Herpetological Review* would play in that future. Additionally, time was spent considering the possible activities of the newly reformed Membership Committee.

The Annual SSAR Business Meeting was called to order by President Crother at 1802 h on July 10th. Approximately 70 members of SSAR were in attendance. Officers, Editors, and Committee Chairs who were at the Business Meeting introduced themselves to the other attendees and gave brief summaries of their annual reports and relevant information from the Board Meeting. Chuck Crumly generously volunteered to support the soon-to-be-established Student Poster Competition.

Winners of the 2010 Dean Metter Award, Kennedy Award, Henri Seibert Student Awards, Grants in Herpetology Awards, and Student Travel Awards were announced (Fig. 7).

Rob Denton (Resolutions Chair) read the following 2010 resolutions: "SSAR wishes to thank individuals who have resigned from positions of service to the Society in the past year. At *Herpetological Review*, Margaret Gunzburger (Associate Editor) stepped down at the end of 2009. Natural History Notes Section Editors Marc Hayes and Andy Holycross also stepped down in 2009 and Barb Banbury (Copy Editor) completed her service as of late 2009. There have also been some changes for *Journal of Herpetology*. Matt Parris stepped down as Editor in late 2009. We thank him for the service he provided to the Society. SSAR thanks Erin Muths and Gad Perry who are now co-Editors of the journal. Geoff Smith, who had been the Editor before Matt Parris, is serving as interim editor to help with the transition to the two new Editors. Erik Wild who was Chair, and then co-Chair, of the Grants in Herpetology Committee for 9 years is turning over the reins to his co-chair Josh Kapfer. Pat Owen who was chair of the Seibert Award Committee is stepping down after 3 years. Anne Maglia has finished several years of service as chair of the Web Oversight Committee. Raul Diaz continues as our very hard-working webmaster. Thanks to Stu Nielsen who served as Resolutions chair for 1 year. SSAR President's Travelogues are always something to look forward to at the JMIH, and this year was no exception. Thanks to Robert Espinoza for a great presentation on "The Herpetofauna of South America's Southern Cone: New Discoveries from the Andean Peaks to the Peruvian Steppe." SSAR received a proposal for a generous donation from Thomas Beauvais in the past year. At the Board Meeting, we accepted this proposal and are establishing "The Thomas Beauvais Fund."



FIG. 7. Some of the 2010 winners of the Henri Seibert Awards with President Brian Crother. Clockwise from top L. Scott Farnsworth (Honorable Mention, Conservation section), Dan Leavitt (Winner, Conservation section), Cameron Siler (Winner, Systematics/Evolution section), Brian Crother, Jennifer Stynoski (Winner, Ecology section), and Oliver Hyman (Honorable Mention, Ecology section). Denita Weeks was the winner in the Morphology/Physiology section (see Fig. 2)

The purpose of this fund is to increase the use of color photographs, primarily of living animals and of unusual and especially new species, on the interior pages of issues of *Journal of Herpetology* and *Herpetological Review*. The herpetological community is most grateful for this generosity, which will lead to greater appreciation of the scientific and esthetic qualities of the animals we study. We also received a donation this past year from Tim Criswell towards the Grants in Herpetology Award. Thanks to Chuck Crumly of University of California Press for his continued support of Seibert Award winners. Congratulations to Whit Gibbons who is this year's winner of the new multi-Society Meritorious Teaching Award in Herpetology. SSAR reached the end of an era this year with the publication of Vol. 22 of *Biology of the Reptilia*. Carl Gans was the originator and senior editor of this series, that he envisioned as facilitating "future work" and proving "germinal in inducing additional study." One hundred sixty-nine authors from 21 countries contributed chapters on morphology, behavior, ecology, development, neurology, and physiology beginning in 1969 with the publication of Volume 1. SSAR was immensely proud to assume publication of this series in 1998 with Volume 19 (Morphology G: Visceral Organs). Since then, we have published Volume 20 (Morphology H: The Skull of Lepidosauria), Volume 21 (Morphology I: The Skull and Appendicular Locomotor Apparatus of Lepidoasuria), and then, in March of this year Volume 22 by Ernest A. Liner (Comprehensive Literature of the Reptilia). Kraig Adler was co-Editor (with Carl Gans and Abbot Gaunt) of several of the last volumes of *Biology of the Reptilia* and SSAR extends its gratitude to Kraig for seeing this series through to completion. Finally, SSAR thanks the many members who serve in various capacities—continuing officers, editors, and members of committees, judges of student competitions, reviewers of manuscripts submitted to our journals, contributors to the Live and Silent Auctions, as well as those who attend these Joint Meetings."



FIG. 8. The traditional passing of the gavel from President Brian Crother to President-Elect Joe Mendelson, III occurred at the end of the SSAR Business Meeting. (Photo M. Preest)

President Brian Crother, who comes to the end of his term in December, then turned over the SSAR gavel to President-Elect Joe Mendelson, III (Fig. 8), and the 2010 Business Meeting was adjourned at 1915 h.

—Respectfully submitted by Marion Preest, SSAR Secretary

Seibert Award Winners for 2010 Announced

The 19th annual Seibert Awards were presented at the 53rd Annual Meeting of the SSAR in Providence, Rhode Island, 7–12 July 2010. These awards are named in honor of Henri C. Seibert, an early and tireless supporter of SSAR (having served as an officer for over 20 years). In recognition of outstanding student presentations at the annual meeting, a single award was given in each of the following categories: Evolution/Systematics (9 presentations), Ecology (12 presentations), Physiology/Morphology (6 presentations) and Conservation (8 presentations). All awardees will receive a check for US $200 and a book from Chuck Crumly at University of California Press.

The Winners—Systematics/Evolution: **Cameron Siler** and Rafe Brown, University of Kansas, "Historical processes behind patterns of limb reduction and loss in an island radiation of fossorial lizards." Ecology: **Jennifer Stynoski**, Virginia Noble, Meredith Strider, University of Miami, Organization for Tropical Studies, University of Maryland, "To eat but not to be eaten: honest begging signals and visual detection of predators and mothers by tadpoles of the Strawberry Poison Frog (*Oophaga pumilio*)." Physiology/Morphology: **Denita M. Weeks** and Robert E. Espinoza, California State University, Northridge, "Geckos on ice: unexpected thermal tolerances and temperature-dependent performance of the world's southernmost gecko." Conservation: **Daniel Leavitt**, Texas A&M University, "*Sceloporus arenicolus*, an endemic lizard in an endangered ecosystem."

Honorable Mention—Systematics/Evolution: **Philip L. Skipwith**, Aaron M. Bauer, and Todd R. Jackman, Villanova Univer-

sity, "Molecular phylogenetics of New Caledonian diplodactylid geckos." Ecology: **Oliver Hyman** and James P. Collins, University of Arizona, "Negative influence of phosphorus on prevalence of the frog killing pathogen, *Batrachochytrium dendrobatidis*." **James Paterson**, Brad Steinberg, and Jacqueline Litzgus, Laurentian University, Algonquin Park, "Comparisons of hatchling survivorship and spatial ecology between two sympatric turtle species." Physiology/Morphology: **Travis Hagey**, Luke Harmon, and Kellar Autumn, University of Idaho, Lewis and Clark College, "Predicting adhesive capabilities in *Anolis* and *Phelsuma* lizards via the frictional adhesion model and critical detachment angle." Conservation: **Scott Farnsworth** and Richard Seigel, Towson University, "Short and long distance translocations of Eastern Box Turtles: Do fences make good neighbors or conservation practices?"

The judges were Cathy Bevier (Colby College), Rafe Brown (University of Kansas), Tiffany Doane (Central Connecticut State University), Nirvana Filoramo (Wesleyan University), Mac Given (Neumann College), Noah Gordon (University of Evansville), Eric Juterbock (The Ohio State University), and Patrick Owen (University of Cincinnati).

Metter Award Application Period Open

Dean E. (Doc) Metter (1932–2001) was a long-time member of the biology faculty at the University of Missouri-Columbia, where he taught zoology, comparative anatomy, evolution, and herpetology. A believer in putting knowledge to the test in the field, Doc provided frequent opportunities for students to engage in fieldwork. In addition, he frequently assisted his graduate students as they ventured out to collect data. Doc was a co-founder of the Bobby Witcher Society, the legacy of which is a scholarship fund. For many years, the interest earned served to reward outstanding herpetology students who intended to continue their education and seek a career in vertebrate biology. That fund now serves a similar purpose by honoring Doc's memory while helping to fund the SSAR-administered Dean E. Metter Memorial Award.

The deadline for receipt of applications for the 2011 Metter Awards is 30 March 2011. Successful applicants must be current members of SSAR as of 31 December 2010. For details of eligibility and application requirements, please check the SSAR web page: http://www.ssarherps.org/pages/metter.php

SSAR Participation at the USA Science & Engineering Festival, Washington, DC 23–24 October 2010

The Society for the Study of Amphibians and Reptiles participated in the recent inaugural USA Science & Engineering Festival by hosting an interactive booth highlighting SSAR and the animals we study. The event was massive, with many hundreds of booths and several stages stretching down the National Mall and occupying several other nearby sites. The 10 ft x 10 ft SSAR booth was outdoors in Woodrow Wilson Plaza next to the Ronald Reagan Building on Pennsylvania Avenue. Our booth was situated between booths sponsored by *Scientific American* and NASA, and just opposite a very large booth sponsored by Lockheed Martin. These booths were directly behind the main stage for the plaza, that featured everything from science-themed musical acts, scientific cuisine demonstrations, an Albert Einstein impersonator, and the Science Cheerleaders (science majors drawn from cheerleading squads of regional universities). So, we were ideally located in a very high traffic location.



FIG. 1. Novel SSAR logo created for souvenir stamp for the USA Science and Engineering Festival. Actual size of imprint is ½" x ½".

The booth displayed a representative selection of SSAR publications including *Journal of Herpetology, Herpetological Review, Urban Herpetology, Biology of the Reptilia* series, the standard names checklist, books from the facsimile series, and others. Distribution of brochures or other handouts was greatly discouraged by the organizers of the event (for reasons of litter control), so the newly printed SSAR Membership brochures were held back and handed individually only to persons who appeared genuinely interested in the society. The booth displayed a variety of real and replica skulls, shells, and fangs of reptiles. We also had a live American Toad, Corn Snake, and Eastern Box Turtle. As expected, the live animals and impressive skeletal specimens were a huge draw and we regularly had visitors lined up five-deep at the booth awaiting their turn to examine and touch them—and to discuss them with the SSAR members and officers in the booth. The publications received a bit less attention—it is hard for a book to compete with real, live animals!—but were of sufficient interest to some that a few copies "went missing" over the course of the weekend. However, the impressive cover images on *Herpetological Review* engendered considerable discussion, especially those of *Crotalus lannomi* (by Ginny Weatherman et al.) and the tadpoles of *Anotheca spinosa* filled with nutritive eggs (by Danté Fenolio).

The attendees were primarily families and, typical of the DC metropolitan area, represented many nations worldwide. Kids and parents interacted with our staff and exchanged questions and stories and generally marveled at the materials on display. A number of people marveled at the fact that it was possible to make a career out of the study of amphibians and reptiles; more than a few young people seemed truly inspired by that real possibility. The booth staff seemed proud to relate that they had the most exciting careers and hobbies imaginable; we truly held our own



FIG. 2. Kyle Miller Hesed and Steve Gorzula braving the mass attendance at the SSAR booth at the USA Science and Engineering Festival.

with the "competing" astronauts in the adjacent booth! Most of the attendees had festival-sponsored folios or "science passports" and were rabid in their efforts to collect stamps from as many booths as possible. We prepared a novel SSAR stamp for the occasion (Fig. 1), and many kids were thrilled to have the SSAR frog also applied to their hand (or even forehead!) as a "tattoo." Next year we need special SSAR T-shirts for the booth staffers, and stickers or buttons to decorate the young people!



FIG. 3. George Zug interpreting a live Corn Snake for a young woman attending the SSAR booth.

Given the contemporary popularity of herps as pets, and their ubiquity in classrooms and education programs at museums, nature centers, and zoos, it was surprising to see how many of the attendees had never touched or held a live reptile before. A great number of people touched their first snake or turtle at the SSAR booth at the Science Festival in 2010, an experience they are not likely to forget. At the other extreme, it was rewarding to meet so many people—especially young people—who were remarkably learned and respectful towards amphibians and reptiles. We met 12-year olds who knew the difference between elapids and vipers, or who knew about the amphibian chytrid fungus.

The evident success of the weekend event was bolstered by spectacularly beautiful Fall weather and extraordinarily smooth logistics and planning on the part of the organizers. The event was promoted by President Obama and covered by major media. The National Park Service has conservatively estimated an astounding attendance between 750,000–1,000,000 persons. We can be proud to truthfully say that SSAR, in keeping with its mission, reached out and "brought herpetology to the people" in a booth staffed by members including hobbyists, career academics, and students (Figs. 2, 3).

Credits: Brian Crother suggested and initiated SSAR participation in the event; Joe Mendelson handled pre-festival arrangements; Karen Lips led intra-DC logistics and volunteers for the booth; Joe Mendelson and Karen Lips managed daily set-up and break-down of the booth and staffed it for both days; use of live animals was facilitated by Jim Murphy and Robin Saunders, with animals courtesy of Long Branch Nature Center; viper fang displays were prepared and loaned by Jason Brock; skeletal specimens were loaned by Education Department at Zoo Atlanta; Breck Bartholomew selected and shipped representative SSAR publications. Volunteer staff at the booth were Anne Maglia, George Zug, Roy McDiarmid, Ted Kahn, Jake Li, Kyle Miller Hesed, Peter Uetz, Brian Gratwicke, Steve Gorzula, and Jim Murphy.

—Submitted by Joseph R. Mendelson, SSAR President-Elect

2011 Year of the Turtle

Partners in Amphibian and Reptile Conservation (PARC), along with many partners (IUCN Tortoise and Freshwater Turtle Specialist Group, Turtle Survival Alliance, Chelonian Taxonomic Advisory Group, The Turtle Conservancy, and a growing list of others) are designating 2011 as "Year of the Turtle." We invite SSAR members to join our efforts! This is an opportunity to raise awareness of efforts in research, conservation, and education to benefit these animals. Throughout the year there will be a number of activities including monthly newsletters featuring conservation or research efforts, local events and presentations, official reports and meeting highlights, a photo contest and release of monthly calendar pages with selected photos, and educational materials for teachers and children, including arts, humanities, and cultural values relating to turtles. Please contact Dede Olson (dedeolson@fs.fed.us) or Priya Nanjappa (pnanjappa@fishwildlife.org) if you'd like to assist or to contribute information toward the newsletter or related resources.

NEWSNOTES

2010 IUCN Crocodile Action Plan

The IUCN-SSC Crocodile Specialist Group recently released the 2010 Action Plan for Crocodiles, which includes summary accounts for the world's 23 crocodile species. Accounts for all species can be downloaded here:

http://www.iucncsg.org/ph1/modules/Publications/ActionPlan3/ap2010_index.html

The current IUCN Red List (http://www.iucnredlist.org/) descriptions for threatened crocodilians will eventually be updated with these accounts. Please note that the distribution maps for Tomistoma and Siamese Crocodile contain some errors which escaped the editing process, and the maps will be corrected and re-uploaded to the CSG website within the next few months.

Retirement of Wolfgang Böhme

Prof. Dr. Wolfgang Böhme, for 40 years head of the herpetology department at Museum A. Koenig in Bonn, Germany will retire on December 1, 2010. During his long tenure as curator, he advanced the Koenig to the first rank of herpetological collections in Germany and it became one of the most active herpetological research centers in the world. In addition to his curatorial duties, he supervised a large number of masters and doctoral students at the University of Bonn.

SSAR members will recall Prof. Böhme's outstanding keynote lecture on West African herpetology delivered at its 2002 meeting in Kansas City. This was his first visit to the United States. SSAR salutes Prof. Böhme on his retirement.

MEETINGS

Meetings Calendar

Meeting announcement information should be sent directly to the Editor (HerpReview@gmail.com) well in advance of the event.

11–14 January 2011—10th Conference of the Herpetological Association of Africa, Cape Town, South Africa. Information: https://sites.google.com/site/10haacapetown/

18–20 February 2011—36th Annual Symposium of the Desert Tortoise Council, Las Vegas, Nevada, USA. Information: www.deserttortoise.org

23–27 May 2011—Second Mediterranean Congress of Herpetology, Marrakech, Morocco. Information: http://www.ucam.ac.ma/cm2

19–22 June 2011—Sixth Hellbender Symposium, Ligoneer, Pennsylvania, USA. Information: mcmillan@buffalostate.edu

6–11 July 2011—Joint Meeting of Ichthyologists and Herpetologists (ASIH / HL / SSAR), Minneapolis, Minnesota, USA. Information: http://www.dce.k-state.edu/conf/jointmeeting/

2–7 September 2012—4th International Zoological Congress (IZC), Mount Carmel Campus, University of Haifa, Haifa, Israel. To receive the first and subsequent meeting announcements, contact the organizers at: izc2012@sci.haifa.ac.il.

CURRENT RESEARCH

The purpose of Current Research is to present brief summaries and citations for selected papers from journals other than those published by the American Society of Ichthyologists and Herpetologists, The Herpetologists' League, and the Society for the Study of Amphibians and Reptiles. Limited space prohibits comprehensive coverage of the literature, but an effort will be made to cover a variety of taxa and topics. To ensure that the coverage is as broad and current as possible, authors are invited to send reprints to the Current Research section editors, Joshua Hale or Ben Lowe; postal and e-mail addresses may be found on the inside front cover.

A listing of current contents of various herpetological journals and other publications is available online. Go to: http://www.herplit.com and click on "Current Herpetological Contents."

Surface Currents Assist Estuarine Crocodiles in Completing Long Distance Movements

The Estuarine Crocodile, *Crocodylus porosus*, is the largest living reptile and its wide geographic distribution throughout the southwestern Pacific and eastern Indian Oceans (including far-flung oceanic islands) suggests that it is capable of extended ocean travel. Further, no island speciation has occurred, suggesting that this type of movement is relatively common. *C. porosus* have been known to travel up to 30 km across the ocean in a single day, and are capable of consecutive days of more than 20 km, which is remarkable for an animal that is believed to have modest aerobic capacity. In this study, the authors have investigated long-distance movement in *C. porosus*. Acoustic telemetry was used to measure movement along the North Kennedy River, North Queensland, Australia. Results showed that long distance (greater than 10 km), single direction travel was restricted to when tidal currents were moving in the same direction. Further, when surface current direction became unfavorable, individuals would dive, or retire to the river bank. Satellite tracking of tagged crocodiles on ocean travel resulted similar findings, with a strong correlation between the direction of travel and the residual surface current. Using this strategy, one crocodile was able to complete a 560 km journey along the west coast of the Cape York Peninsula in only 25 days. Another satellite tracked individual made a significant ocean movement, only to return to its original home range. The discovery that these crocodiles use of surface currents for long distance movement has management consequences, particularly if changes in ocean currents result in them traveling to areas where there is no recent history of their presence and putting them into contact with humans, to which they pose a significant risk.

Furthermore, translocations of problem crocodiles, a common management strategy, need to take place where prevailing currents do not allow a rapid passage back to their original location.

Campbell, H. A., M. E. Watts, S. Sullivan, M. A. Read, S. Choukroun, S. R. Irwin and C. E. Franklin. 2010. Estuarine crocodiles ride surface currents to facilitate long-distance travel. Journal of Animal Ecology 79:955–964.

Correspondence to: Hamish Campbell, School of Biological Sciences, The University of Queensland, Brisbane, Qld 4072, Australia; e-mail: dr.hamish.campbell@gmail.com.

Extreme Longevity in the Human Fish

The human fish or olm, *Proteus anguinus* (Proteidae), is an aquatic, paedomorphic, cave-dwelling salamander native to the European countries Slovenia and Croatia. As captive specimens have been known to live for over 70 years, this species has long been of interest to biologists studying aging and senescence. Extreme lifespan has been demonstrated in a number of taxa, including mammals, birds and reptiles, and is usually positively correlated with size. However, the Human Fish is small, generally less than 20 g. Longevity has also been associated with living in environments that are stable and/or free from predators, the possession of mechanisms that mitigate damage caused by free radicals, and slow metabolisms. It is cave dwelling and therefore lives in a stable environment, and is thought to not suffer from predation. Additionally, it has been shown not to possess advanced cellular oxidation defences; the metabolic rate of *Proteus* is unknown. A breeding colony, established in a cave in Saint-Girons, France in 1952, now has over 400 individuals of various age classes, allowing the authors of this paper to conduct a detailed investigation of the demographic and physiological characteristics of this species. Data on physical condition and instances of birth and death (collected weekly) reveal that the population is growing at a rate of 1.05, olms reach sexual maturity at roughly age 15, reproduce once every 12 years, and average adult lifespan is roughly 70 years. From these data, the researchers determined that the maximum lifespan for this species is 102 years. Furthermore, while salamanders exhibit reduced metabolic rates relative to other vertebrates, laboratory experiments found the metabolism of the human fish to not be markedly different from other salamanders. While the proximate mechanisms leading to longevity in the human fish remain elusive, it does represent an excellent model organism for studying longevity and senescence in vertebrates.

Voituron, Y., M. de Fraipont, J. Issartel, O. Guillaume and J. Clobert. 2010. Extreme lifespan of the human fish (*Proteus anguinus*): a challenge for ageing mechanisms. Biology Letters doi:10.1098/rsbl.2010.0539.

Correspondence to: Yann Voituron, Ecologie des Hydrostèmes Fluviaux, UMR CNRS 5023, Université Claude Bernard Lyon 1, Université de Lyon, 69622 Villeurbanne cedex, France; e-mail: voituron@univ-lyonl.fr.

Tadpoles Recognize Native but not Introduced Turtle Predators

The impact of introduced predators on prey populations is well known, but less research has been conducted on the negative effects on native species of having to compete with these alien species. On the Iberian Peninsula, the native freshwater turtles (the European pond turtle, *Emys orbicularis* and the Spanish terrapin, *Mauremys leprosa*), are being displaced by exotic species (principally the red-eared slider, *Trachemys scripta elegans* and the false map turtle, *Graptemys pseudogeographica*). Both native and introduced species feed on anuran tadpoles, which are able to recognize local predators and alter their behavior. In this study the authors have examined tadpole responses to both native and introduced species in order to determine whether they can recognize introduced species as well. Chemical cues of the four turtle species mentioned above were presented to tadpoles of four species of European anurans: Iberian green frog (*Pelophylax perezi*), western spadefoot (*Pelobates cultripes*), natterjack toad (*Bufo calamita*), and common gree frog (*Hyla arborea*). Three species (*P. perezi*, *P. cultripes* and *H. arborea*) reduced their swimming behavior in response to native, but not introduced species. The authors suggest that a lack of evolutionary experience with the introduced predators explains the inability of the tadpoles of these species to detect them and may confer a competitive advantage to the introduced turtle species.

Polo-Cavia, N., A. Gonzalo, P. López and J. Martín. 2010. Predator recognition of native but not invasive turtle predators by naïve anuran tadpoles. Animal Behaviour 80:461–466.

Correspondence to: Nuria Polo-Cavia, Departamento de Biología, Universidad Autónoma de Madrid, Ciudad Universitaria de Cantoblanco, 28049 Madrid, Spain; e-mail: nuria.polo@uam.es

Cane Toad Eggs Toxic to Tadpoles of Native Australian Anurans

The introduced Cane Toad, *Bufo* (= *Rhinella*) *marninus*, is inflicting a number of profound impacts on native species as it expands across Australia. Previous studies have shown cane toad eggs to be extremely toxic to the tadpoles of native Australian anurans and in this study, the authors have conducted a number of laboratory trials to determine if there is variation among tadpoles of Australian species in propensity to consume cane toad eggs or susceptibility to toad egg toxins. In each trial, individual tadpoles were presented ten cane toad eggs either with or without an additional food source (lettuce). At least some individuals of each of the 15 anuran species studied ingested toad eggs, with mortality following rapidly in most cases. While no interspecific difference in propensity to ingest eggs was observed, the high interspecific variance in survival rate (0 > 70%) was driven by a difference in feeding behavior (e.g., small size preventing efficient consumption of toad eggs) rather than physiological tolerance. Furthermore, alternative food sources did not reduce mortality from egg ingestion as most tadpoles foraged on both the eggs and the lettuce. The influence of overall body size on

survival was also examined in four species. While three of the species did show an effect of body size on mortality, this was not in a consistent direction, and instead was a complex interaction related to alternate food availability. Interclutch affects were examined in one species, but none were observed. This study highlights the toxicity of toad eggs to native frogs and that frequency of mortality relates to a complex interaction between body size, species and other ecological factors.

Crossland, M. R. and R. Shine. 2010. Vulnerability of an Australian anuran tadpole assemblage to the toxic eggs of the invasive cane toad (*Bufo marinus*). Austral Ecology 35:197–203.

Correspondence to: Richard Shine, School of Biological Sciences A08, University of Sydney, New South Wales 2006, Australia; e-mail: rics@bio.usyd.edu.au.

How Much UV-B Should a Captive Reptile be Exposed to?

Ultraviolet-B (UV-B) exposure is important to the production of Vitamin D in many vertebrate species, including reptiles, and plays a part in calcium-phosphorous balance and immune function. The amount of UV-B to provide is therefore an important consideration to ensure the good health of captive reptiles. In this study, the authors have investigated voluntary UV-B exposure of a number of squamate species in the wild, in the US and Jamaica. In Jamaica, three species of *Anolis* (*A. lineotopus, A. grahami,* and *A. sagrei*) were investigated. In the US, *Agkistrodon piscivorous, Pantherophis obsoletus, Thamnophis proximus, Nerodia fasciata, N. erythrogaster, Uta stansburiana, Holbrookia maculata, Sceloporus olivaceus, S. consobrinus, S. undulatus, S. graciosus,* and *Anolis carolinensis* were studied. Animals encountered in the field were subjected to cloacal temperature readings and UV-B readers were employed to ascertain the level of UV-B exposure the animals were experiencing. The authors found significant variation among species in UV-B exposure; more extensive observations of two species of *Sceloporus* (*S. olivaceus* and *S. graciosus*) revealed seasonal and diel variation as well. The authors provide a number of guidelines for providing UV-B to these species in captivity. They also highlight the importance of providing a UV-B refuge in enclosures to allow behavioral regulation of UV-B exposure.

Ferguson, G. W., A. M. Brinker, W. H. Gehrmann, S. E. Bucklin, F. M. Baines and S. J. Mackin. 2010. Voluntary exposure of some Western-Hemisphere snakes and lizard species to ultraviolet-B radiation in the field: How much ultraviolet-B should a lizard or snake receive in captivity? Zoo Biology 29:317–334.

Correspondence to: Gary Ferguson, Department of Biology, Texas Christian University, Box 298930, Fort Worth, Texas 76129, USA; e-mail: g.ferguson@tcu.edu.

Behavioral Syndromes, or "Personalities" Investigated in a Lizard

Behavioral syndromes ("personalities") are increasingly being recognized as an important component of natural systems, having been observed in fish, invertebrates, mammals, and reptiles. In this paper, the authors have examined behavioral syndromes in the Namibian Rock Agama, *Agama planiceps*. To determine if individuals displayed consistent magnitudes of boldness or shyness, investigators measured flight initiation distance (the distance away a perceived threat, in this case an advancing experimenter, was from the lizard before it fled) for a number of individuals several times over a period of time. Next, male lizards were observed and their behavior (instances of head bobbing and push ups; collectively defined as "signaling") was documented. Finally, possible fitness consequences of boldness or shyness was investigated by measuring the home ranges, rates of tail loss, and feeding rates of several males. Individuals were found to exhibit consistent degrees of boldness. Bold males spent more time basking and moving and had larger home ranges and higher feeding rates than shy males. The rate of signaling behavior however, did not differ between bold and shy individuals. Males that had a third or more of their tale missing were more likely to be bold, suggesting that there may be an increased predation risk associated with being bold. The authors suggest that long term studies are required to fully understand the fitness consequences of animal personalities such as boldness.

Carter, A. J., A. W. Goldizen, and S. A. Tromp. 2010. Agamas exhibit behavioral syndromes: Bolder males bask and feed more but may suffer higher predation. Behavioral Ecology doi: 10.1093/beheco/arq036.

Correspondence to: Alecia Carter, The Fenner School of Environment and Society, The Australian National University, Acton, Canberra, ACT 0200, Australia; e-mail: alecia.carter@anu.edu.au.

Roads Act as Barriers to Seasonal Migration in Timber Rattlesnakes

Anthropogenic landscape modification, especially roads, can fragment habitats and act as dispersal barriers to wildlife. However, the degree to which a road acts as a barrier to dispersal is related to characteristics both of the road itself and the animal in question. In this study, the authors have examined the impact of recently constructed roads separating hibernacula (communal dens) of timber rattlesnakes, *Crotalus horridus* in four regions in New York State, USA. Microsatellites were used to examine population subdivision and gene flow across roads. It was found that hibernacula separated by roads had a higher degree genetic differentiation than hibernacula in contiguous habitat and also were less genetically diverse. This was further examined by completing genetic assignment analyses, which showed that disruption of seasonal migration was the cause of these patterns, with matings less likely to occur between snakes from hibernacula separated by roads. This study highlights the fragmenting nature of roads, even those that are relatively small, or recent in origin.

Clark, R. W., W. S. Brown, R. Stechert and K. R. Zamudio. 2010. Roads, interrupted dispersal, and genetic diversity in timber rattlesnakes. Conservation Biology 24:1059–1069.

Correspondence to: Rulon Clark, Department of Biology, San Diego State University, 5500 Campanile Drive, San Diego, California 92182, USA; e-mail: rclark@sciences.sdsu.edu.

The Island of Bermuda Preserves an Ancient Skink Lineage

Paleoendemism is the preservation of ancient, formerly widespread lineages in a restricted geographic area. Islands can be good sources of paleoendemism, with the most well known example being that of the Tuatara, which was once widely-distributed, but is now restricted to islands off the shores of New Zealand. The native fauna of the island of Bermuda includes only a single extant flightless terrestrial vertebrate: the endemic scinid lizard, *Plestiodon longirostris*. In this study, the authors have assembled a multi-locus molecular dataset which they used to reconstruct a phylogeny and estimate divergence times, which were in turn used to determine if colonization of Bermuda was recent or ancient. They found that the lineage occuring on Bermuda is indeed ancient, having split from the lineage containing its closest extant relatives before the bulk of the diversification events that led to the divirsity of skink species occurring in North America today (about 16 million years ago). Furthermore, the extant members of the clade from which the Bermuda Skink split occur in western North America (*P. skiltonianus* complex), with no extant eastern North American representatives. Even more interestingly, it is found only on Bermuda currently, which is itself only 2 million years old. Fossil evidence of *P. longirostris* on Bermuda from 400,000 years ago suggests that colonization occurred between 2 million and 400,000 years ago, possibly by rafting the 1000 km that separates Bermuda from the North American mainland (where they once existed). Following colonization, the lineage then disappeared from the mainland. Bermuda therefore, represents a unique 'life raft,' preserving one of the most ancient lineages of North American *Plestiodon.* Currently however, habitat destruction and degradation and pressure from non-native species has severely lowered population size, resulting in this unique lizard being highly endangered.

Brandley, M. C., Y. Wang, X. Guo, A. N. Montes de Oca, M. F. Ortíz, T. Hikida and H. Ota. 2010. Bermuda as an evolutionary life raft for an ancient lineage of endangered lizards. PLoS ONE 5: e11375.

Correspondence to: Matthew Brandley, Department of Ecology and Evolutionary Biology, Yale University, New Haven, Connecticut, USA; e-mail: matthew.brandley@yale.edu.

Newly Discovered Chameleon Species Highlights Importance of Preserving Biodiversity Hotspots

Madagascar has the dubious distinction of being among the most imperiled biodiversity hotspots on earth. However, despite a mere 17% of its original vegetation remaining, Madagascar continues to divulge species new to science. The authors of this paper describe a distinctive new species of chameleon, *Calumma tarzan*, from three localities on the eastern slope of the island (Anosibe An'Ala region). This species exhibits morphological traits consistent with the *Calumma furcifer* species group. However, it possesses a unique rostral spade, and males have a distinctive dorsal brown blotch on the head and neck. A molecular analysis confirms the phylogenetic placement of this new taxon, follows previous analyses in failing to resolve relationships within the *C. furcifer* species group, corroborates the evolutionary distinctiveness of these lizards, and suggests two genetically differentiated populations (north and south). The specific epithet is derived both from the former name of a nearby village, Tarzanville (now Ambatofotsy), and the fictional forest denizen, Tarzan. As *C. tarzan* is known to occupy less that 10 km^2, the authors posit that it should receive the IUCN's Critically Endangered listing. They also point out the lack of protected land in this region (amounting to a "reserve gap") and hope the patronym brings attention to this overlooked region and compels conservation efforts.

Gehring, P. S., M. Pabijan, F. M. Ratsoavina, J. Köhler, M. Vences, and F. Glaw. 2010. A Tarzan yell for conservation: A new chameleon, *Calumma tarzan* sp. n., proposed as a flagship species for the creation of new nature reserves in Madagascar. Salamandra 46:167–179.

Correspondence to: Philip-Sebastian Gehring, Division of Evolutionary Biology, Zoological Institute, Technical University of Braunschweig, Spielmannstr. 8, 38106 Braunschweig, Germany; e-mail: sebastiangehring@web.de.

Habitat Preferences and Home Range Size in a Colubrid Snake

Effective wildlife conservation plans should consider both the habitat needs and spatial requirements of the species in question. Studies that focus on the correlation between the habitat preferences and movement patterns of wildlife, particularly snakes, are uncommon. In this study, the authors attempted to determine how habitat preferences or quality influenced movement patterns of snakes. To answer this question, they used habitat preference or avoidance information obtained for Bullsnakes (*Pituophis catenifer sayi*) from 2003–2005 at a site in the upper-midwestern United States and compared it to minimum convex polygon estimates of home range size derived from data on radio-tracked snakes. They employed Geographical Information Systems to model the amount of preferred (open bluff faces) and avoided (agricultural fields and closed canopy forests) habitats within each estimated home range and compared them via multiple linear regression. They also tested the influence of gender, length and weight on home range size. The results of this study indicated that, among the investigated potential correlates, amount of avoided habitat was the most significant indicator of home range size. More specifically, home range size increased with amount of avoided habitat within the home range. As bullsnakes are large snakes**,** they ar**e** particularly susceptible to road mortality; therefore, fragmentation of suitable habitat forces snakes to wander further in the search for suitable habitat, exposing them to greater risk. In a broader context, this finding supports the hypothesis that habitat quality has an impact on wildlife movement patterns, and the relationship between habitat needs and spatial requirements should be considered when conserving or managing species.

Kapfer, J. M., C. W. Pekar, D. M. Reineke, J. R. Coggins, and R. Hay. 2010. Modeling the relationship between habitat preferences and

home-range size: A case study on a large mobile colubrid snake from North America. Journal of Zoology 282:13–20.

Correspondence to: Joshua M. Kapfer, Departments of Environmental Studies and Biology, Campus Box 2015, Elon University, Elon, North Carolina 27244, USA; e-mail: jkapfer@elon.edu.

Multi-year Study of Toad Populations Reveals Demographic Implications of Chitrid Fungus

While many studies have implicated *Batrachochytrium dendrobatidis* (Bd) infection in population declines, few have studied natural populations for multiple years to elucidate the specific demographic impact of the disease. The authors of this study conducted a six-year capture-recapture study on three populations of western toad (*Bufo* [= *Anaxyrus*] *boreas*) in the Rocky Mountains of western US. Of these populations, two were infected with Bd and one was not. Captured animals were individually marked (if first capture), measured, swabbed to determine if the animal was infected with Bd, and released. From these data, population growth rates were obtained and analyses were conducted to determine if growth rates were correlated with various factors such as the presence or absence of Bd and climactic conditions (e.g., breading season temperature). Roughly 58% of individuals in the two Bd-infected populations were found to be infected with the disease. These infected animals were found to have an annual survival coefficient of about 0.47 (about 0.75 for uninfected individuals). Bd-infected populations were found to be declining by roughly 6% per year over the duration of the study while the Bd-free population exhibited stable population growth. Furthermore, population growth rates were not correlated with temperature. These findings reveal that in addition to causing rapid local extirpations, in some instances, Bd can also exhibit long-term persistence as a chronic disease (and that some species can persist with Bd). Furthermore, this study highlights the need for long-term monitoring of amphibian populations to determine the species-specific demographic impacts of pathogens.

Pilliod, D. S., and Colleagues. 2010. Effects of amphibian chytrid fungus on individual survival probability in wild boreal toads. Conservation Biology 24:1259–1267.

Correspondence to: David Pilliod. U.S. Geological Survey, Forest and Rangeland Ecosystem Science Center, Snake River Field Station, 970 Lusk Street, Boise, Idaho 83706, USA; e-mail: dpilliod@usgs.gov.

ZOO VIEW

Snake Versus Rabbit

This colorful excerpt was sent by Jon Coote about the Tower of London and the last director, Alfred Cops, who took over the operation in 1822.

Mr. Broderip, in the second volume of the *Zoological Journal*,

"Mr. Cops of the Lion Office in the Tower," writes Broderip, "sent to inform me that one of these reptiles had just cast his skin, at which period they, in common with other serpents, are most active and eager for prey. Accordingly I repaired with some friends to the Tower, where we found a spacious cage, the floor of which consisted of a tin case covered with red baize and filled with warm water, so as to produce a proper temperature. There was the snake, " positis novus exuviis," gracefully examining the height and extent of his prison as he raised, without any apparent effort, his towering head to the roof and upper parts of it, full of life, and brandishing his tongue.

A large buck rabbit was introduced into the cage. The snake was down and motionless in a moment. There he lay like a log without one symptom of life, save that which glared in the small bright eye twinkling in his depressed head. The rabbit appeared to take no notice of him, but presently began to walk about the cage. The snake suddenly, but almost imperceptibly, turned his head according to the rabbit's movements, as if to keep the object within the range of his eye. At length the rabbit, totally unconscious of his situation, approached the ambushed head. The snake dashed at him like lightning. There was a blow—a scream—and instantly the victim was locked in the coils of the serpent. This was done almost too rapidly for the eye to follow: at one instant the snake was motionless : in the next he was one congeries of coils round his prey. He had seized the rabbit by the neck just under the ear, and was evidently exerting the strongest pressure round the thorax of the quadruped ; thereby preventing the expansion of the chest, and at the same time depriving the anterior extremities of motion. The rabbit never cried after the first seizure:—he lay with his hind legs stretched out, still breathing with difficulty, as could be seen by the motion of his flanks. Presently he made one desperate struggle with his hind legs; but the snake cautiously applied another coil with such dexterity as completely to manacle the lower extremities, and, in about eight minutes, the rabbit was quite dead. The snake then gradually and carefully uncoiled himself, and, finding that his victim moved not, opened his mouth, let go his hold, and placed his head opposite to the fore part of the rabbit. The boa generally, I have observed, begins with the head ; but in this instance the serpent, having begun with the fore-legs, was longer in gorging his prey than usual, and in consequence of the difficulty-presented by the awkward position of the rabbit, the dilatation and secretion of lubricating mucus were excessive. The serpent first got the fore-legs into his mouth; he then coiled himself round the rabbit, and appeared to draw out the dead body through his folds; he then began to dilate his jaws, and holding the rabbit firmly in a coil as a point of resistance, appeared to exercise at intervals the whole of his anterior muscles in protruding his stretched jaws and lubricated mouth and throat at first against, and soon after gradually upon, and over his prey. The curious mechanism in the jaws of serpents which enables them to swallow bodies so disproportioned to their apparent bulk is too well known to need description; but it may be as well to state that the symphysis of the under jaw was separated in this case, and in others which I have had an opportunity of observing. When the prey was completely ingulphed, the serpent lay for a few moments with his dislocated jaws still dropping with the mucus which had lubricated the parts, and at this time he looked quite sufficiently disgusting. He then stretched out his neck, and at the same moment the muscles seemed to push the prey further downwards. After a few efforts to replace the parts,

the jaws appeared much the same as they did previous to the monstrous repast."

Headline from *New York Times*:
Raymond L. Ditmars Urges "Suppression" of Immoral "Ragtime"

Raymond J. Novotny sent this letter written by Raymond L. Ditmars to the editor of the *New York Times*, published on 13 October 1912. I wonder which song he was referring to as the term "Ragtime" was used for many songs, especially those by Scott Joplin. If Ragtime tunes were unsettling to Ditmars, I wonder what his response would be watching and listening to today's rock bands. This letter offers a glimpse into the character of the man.

To the Editor of the New York Times:

Coming into town in a smoking car a few nights ago, I listened to a very suggestive song rendered by a crowd of young rowdies. I thought little of the matter at the time, as the song appeared to be their own composition. Yesterday morning I was startled to hear two little girls on their way to school singing the chorus of this song. Inquiry at a cheap music store brought me the information that this composition was one of the latest "popular" songs. It follows in the wake of objectionable portrayals of marital infidelity, risque situations, and crude twistings of coarse phrases.

It seems remarkable to me that nothing is being done to stamp out the epidemic of these positively dangerous songs, the titles of which are now stock phrases around town, and all too common from the lips of children. There has been much ado about suppressing objectionable literature, cleansing the stage, even subjecting the motion picture playlets to a board of censorship. Yet songs that are clearly immoral are being issued with unabated energy—even sung by little girls on their way to school.

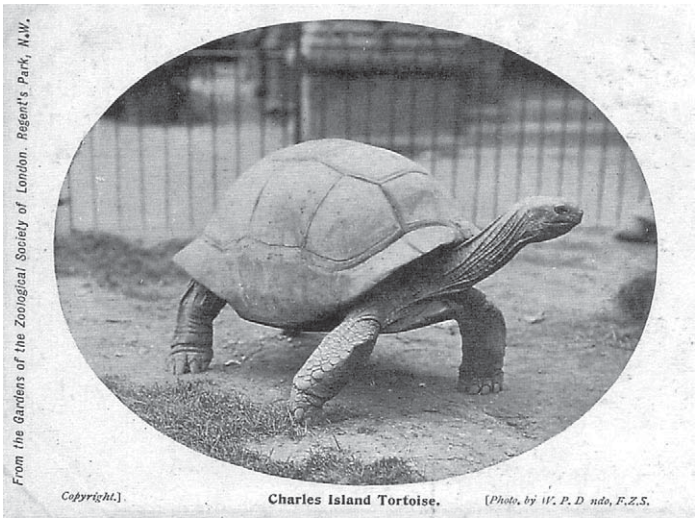
—RAYMOND L. DITMARS
New York, October 9, 1912

And Then There Was One

Whenever a book appears on the scene with a title like *The Last Tortoise: A Tale of Extinction in Our Lifetime* (2010, The Belknap Press of Harvard University Press, Cambridge, Massachusetts & London, England ISBN 978-0-674-04992-5) by Craig B. Stanford, it is clear that this will not be an uplifting read. In fact, tortoises are under siege worldwide, caused by a number of human-induced pressures, and Stanford covers all of these usual factors in depth: habitat alteration, collection for exotic animal pet trade, human food and medicine, climate change and so on. In Chapter 6 of the book called "Beloved Captives," he paints a grim picture of the future of these pet tortoises. One of the examples he gives is the discovery of several dozen Radiated Tortoises from Madagascar in a pet market in Thailand, probably illegally sent from the range country. A full review of this book appears elsewhere in this issue, prepared by John Moriarty.



Undated postcard of child riding a Galápagos Tortoise named "Grandpa" at New York Zoological Society. Zoos no longer offer tortoise "rides." Credit: provided by Brint Spencer.



Official postcard of Zoological Society of London depicting Charles Island [Santa María or Floreana] Tortoise (*Geochelone elephantopus*, now *Geochelone n. nigra*) at London Zoo from series of postcards available to the public in October 1904. This species is now extinct. Author Craig Stanford in his book *The Last Tortoise* describes how vulnerable tortoises are today, facing the real danger of disappearing from the planet for all time. Credit: photographed by W. P. Dando, provided by John Edwards.

Some years ago, the late John Behler from the Wildlife Conservation Society in New York called me after resurveying tortoise populations in Madagascar and discovering that hundreds, perhaps thousands, of Radiated Tortoises had been killed for their livers to make pâté for the Asian food market. Dead tortoises and empty shells were scattered throughout the habitat; virtually no living individuals were located and he characterized the locale as "The Tortoise Killing Fields." Poaching of the tortoises occurs throughout the year but predominantly in March. Populations of the other three indigenous tortoise species were near collapse as well. I asked Behler what the likely fate for these taxa would be in a decade or two in the wild and he said "They are doomed!" It seems as though he was right.

Endangered Iguanas

The Grand Cayman Blue Iguana (*Cyclura nubila lewisi*) was described in 1940 by Chapman Grant in *The Herpetology of the Cayman Islands* and was nearly extinct at that time. The lizard formerly was widely distributed in dry habitats over most of the island but is now restricted to a few remnant populations, a consequence of the introduction of feral animals, combined with habitat destruction and development. In 2002, the population



Green Iguanas (*Iguana iguana*) have been established on Cayman Island, posing a threat to the Blue Iguana. Illustration (top left) from Seba, Albertus. 1734–1765. *Locupletissimi rerum naturalium thesauri accurata descriptio, et iconibus artificiosissimis expressio, per universam physices historiam : Opus, cui, in hoc rerum genere, nullum par exstitit / / Ex toto terrarum orbe collegit, digessit, descripsit, et depingendum curavit Albertus Seba ...*

Imprint: Amstelaedami : Apud J. Wetstenium, & Gul. Smith, & Janssonio-Waesbergios.

crashed alarmingly, dropping to only 15–25 individuals.

Frederic J. Burton, a botanist formerly with the Caymans National Trust, began developing a captive population of iguanas in the Queen Elizabeth II Botanical Gardens on Grand Cayman in the early 1990s and expanded the program dramatically since that time. In those early days, Smithsonian National Zoological Park herpetological curator Dale Marcellini was instrumental in developing the program for radio-tracking these remarkable lizards and initiating a captive management program for reintroduction. In his lively and well-written book *The Little Blue Book. A Short History of the Grand Cayman Blue Iguana* (2010, The International Reptile Conservation Foundation, San Jose, California, ISBN 087-0-578-04308-1), Burton describes the massive challenges in radio-tracking the iguanas in the dry forest habitat favored by the lizards. To evaluate the eastern site, Burton and Quentin Bloxam from the Durrell Wildlife Conservation Trust arranged a field trip, hoping that iguanas would still be found; Bloxam nearly died in the effort (see Murphy, J. B. 2007. *Herpetological History of the Zoo and Aquarium World*. Krieger Publishing Co., Malabar, Florida). Burton and many dedicated colleagues have built a breeding and head-starting facility where iguanas have been bred and returned to the wild. This book chronicles the daunting obstacles and incredible flexibility needed to design and implement an *in situ* conservation project; every zoo person should read it before starting another one.

A zoo management plan has been formulated by Tandora Grant (Studbook Keeper & Population Manager, San Diego Zoo), Rick Hudson (Species Coordinator, Fort Worth Zoo), and Jamie Ivy (Advisor, San Diego Zoo); recommendations have been outlined in the recently published *Population and Breeding Plan. Grand Cayman Blue Iguana* Cyclura lewisi—*Rock Iguana* (Cyclura) *Species Survival Plan* on 30 October 2009.

The following article by Cathy Eser (Supervisor of Menagerie) and Ken Kawata (retired General Curator) describes the major renovation of the reptile and amphibian wing of the Staten Island Zoo in New York.

—James B. Murphy, Section Editor

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Renovation of the Reptile Wing at the Staten Island Zoo, New York

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At the bottom of the Great Depression in 1936, a small zoo opened in Staten Island, New York City (hereafter SIZ). Operated by the Staten Island Zoological Society on an eight-acre (3.2 hectare) Barrett Park, it presented a unique design of a one-building zoo in the shape of a large "T," consisting of an aquarium section behind the entrance and three "wings" exhibiting mammals, birds, and reptiles, respectively. The zoo established itself as a pioneer in education and in herpetology. The zoo was intimately tied to snakes from the beginning (Kawata 2003). In particular, thanks to the vision of legendary Carl Kauffeld (1911–1974; SIZ curator of reptiles 1936–1973, director 1963–1973) the zoo was globally known for its large rattlesnake collection, exhibiting several species for the first time in the United States and internationally (Kawata 2004). In addition to the large number of articles in popular journals, Kauffeld wrote two popular books, *Snakes: The Keeper and the Kept* (Doubleday & Company, 1969), *Snakes and Snake Hunting* (Hanover House, 1957), and co-authored a third with C. H. Curran, *Snakes and Their Ways* (Harper & Brothers, 1937); together, these books inspired a generation of young herpetologists. In 1977, the wing was officially dedicated to the memory of Kauffeld. By that time the focus and emphasis of the zoo world had changed fundamentally, and the zoo's exhibit style, consisting of rows of sterile cages, had become antiquated.

It was necessary to upgrade the entire structure to meet the challenges of our time. The massive renovation began first in 1986 to face-lift the aquarium area, followed by two of the wings, ending in 1997. The City of New York furnished the funds for the project through the Department of Design and Construction (DDC). That left the reptile wing the last of the wings to be renovated. Unlike the old mammal and bird wings that gave the impression of "naked cages" of metal and concrete, the reptile exhibits had still presented an amicable atmosphere. Yet, it could not erase the appearance of the aging glass-fronted boxes. As the news of the renovation plan spread, those who "cut their teeth" in zoo herpetology in the wing expressed their fond memories of the happy, bygone days; it was not merely an exhibit facility but also a classroom that nurtured many young enthusiasts. Robert

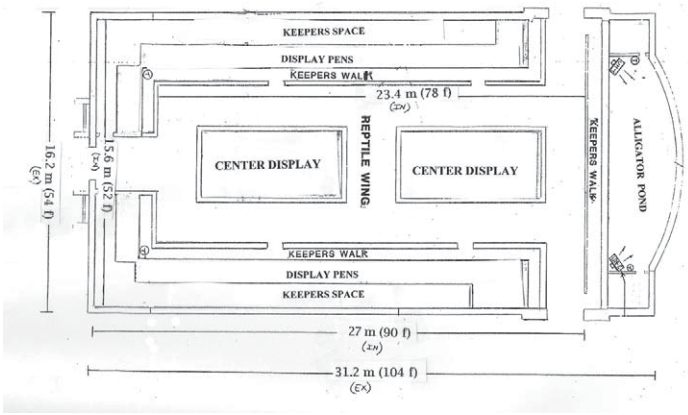
Zappalorti, a former SIZ staff member (currently the president of Herpetological Associates, Inc., in New Jersey), was one of them.

"I guess modernizing the reptile wing means progress, which is a good thing, but on the other hand, there is so much history within the walls and cages of the old reptile wing," he noted, and wished that there were a recording device in the walls "that would have documented all the stories and conversations that were spoken over the years." (Zappalorti, pers. comm. 2005)

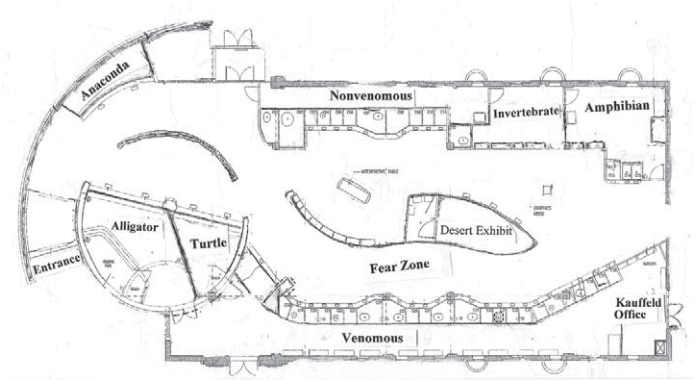
Early Planning Stage

A preliminary in-house review was made in 1999 to address the needs of SIZ with its unique history in education and reptiles. It was decided that, during the planning process, we should fully utilize expertise of the zoo staff who are intimately familiar with the needs of the visiting public, animal inhabitants, and daily husbandry procedures. At this juncture, an in-house committee was organized with representatives of administration, animal care, education, arts, as well as maintenance and grounds. It was the consensus of the group to invite well-experienced professionals from a prominent zoo to assist us in formulating an innovative plan. In the fall of 1999 David Jenkins and James Murphy of the Smithsonian National Zoo, Washington, D.C., were invited as consultants for concept development. The two men submitted a ten-page document in September, which established the foundation for the renovation project.

The document reminded the staff of the international recognition of SIZ generated by Carl Kauffeld. "It was certainly due to his writing skills that the reputation of the Staten Island Zoo was global," Jenkins and Murphy (1999) noted: "This history and positive reputation should be continued," and they recommended to develop Carl Kauffeld's memorial office in the new wing. Over the decades, education and exhibitry in zoos have improved markedly, they stated, but exhibitry involving reptiles and amphibians has not kept pace; it was time to develop an innovative design. As a central theme, "Use common fears as a psychological 'hook' as introduction: Confront fears and misconceptions and dispel them through science, beauty and art. Call the exhibit FEAR ZONE: A SNAKE ENCOUNTER. …An open and inviting atmosphere in the rest of the building should be light and airy." Also, "Create an exhibit of great expectations,



Floor plan of the Reptile Wing prior to the renovation as of 2005 (518 sq.m; 5.573 sq.f)



Floor plan of the Reptile Wing after the renovation as of 2007 (1,255 sq.m; 13,000 sq.f)

interaction, herpetological science," and "Develop a comfortable learning environment for both adults and children," they emphasized. In the process, they added, "Minimize excessive artificial structures and high maintenance equipment."

Once the course was established, the next step for SIZ was to select a general architectural firm. The senior staff decided to hire a local company instead of one of the out-of-state firms that specialize in zoo design; in our experience, the "specialist" designers do not necessarily meet the unique institutional needs. The zoo director was able to do this and hired the Manhattan-based architectural firm of Curtis + Ginsberg.

Design and Construction Process

Frequent progress meetings were held throughout the design and construction process with the DDC staff, architectural firm, general contractors, and members of the zoo's herpetology, maintenance, curatorial, and administrative staff. Internal meetings of the zoo staff included the graphics, education, curatorial, and herpetology departments.

The exhibit design was only one of the major aspects of the wing renovation project. There existed problems with the wear and tear of the seven-decade old facility such as a leaky ceiling, and compounding structural issues of the large auditorium located directly underneath the reptile wing. In that regard what started out as a renovation project became, in effect, a reconstruction project and general facility upgrade. The entire structure excluding the two original side walls was removed. All new HVAC, plumbing, and electrical network were installed along with a new electrical vault and generator.

General Layout

Because the location of the two side walls could not change, the remodeled wing had to retain the dimensions of the original along with an addition of a rotunda. This restriction involved creating a general layout of exhibits lining the two sides of the wing with only a portion of the center for exhibit space. (Yet, due to the added overall space we were able to increase the number of species and specimens of animals, and maintain a similar number of enclosures that we had prior to the renovation project, in addition to the new interpretive devices and exhibits.) It was decided to place inanimate interpretives on the opposite side of

live animals to avoid competing exhibits, such as live animal cages facing each other. Due to the flexibility of "jewel box" type exhibits, "It's going to be the kind of exhibit where people will notice something new every time they come," said reptile keeper Cathy Eser (Platt 2007). An additional principle was to have the front lines of the exhibits and dividing walls form a gentle curve, where possible, to counteract the rigid and artificial appearance of a straight line and boxiness of the original structure.

The Rotunda

Another change is the traffic flow of visitors. It works better now that the formal entrance starts at the opposite end of the building from where it had been originally. The beginning of the exhibit would be excavated to include a rotunda that has a prominent introduction to the new wing. The same brick types that are on the surface of the other buildings help to blend the structure with the rest of the park. All construction projects by the City of New York require a portion of the funding to be designated for the Percent for Art Program. The result is a stylized bronze sculpture of a 9.6-m (32 ft) long Reticulated Python on the wall of the rotunda, coming in and out of the brick on the exterior of the building, designed by Steve Foust, a Staten Island artist.

The entrance to the wing has glass doors hung with a "Carl F. Kauffeld Hall of Reptiles" sign. Once inside the glass doors, a visitor is greeted with the following quote from Baba Dioum: "In the end, we will conserve only what we love, we will love only what we understand, we will understand only what we are taught." Next to the quote, a mural of a vernal pool was painted with native Staten Island species. Handouts are available with a key to the wildlife within the painting. A second painting by the same muralist depicting a cladogram may be found farther in the rotunda. An illuminated wooden ceiling with etched glass panels crowns the rotunda, adding to its beauty.

This area contains three large aquatic exhibits. Here, the animals can be viewed swimming in their naturalistic environments from above and below the water's surface. A 6-m (20 ft) high pane of glass is the only barrier separating the viewer from the animal. Each exhibit has its own in-line filtration and water heating elements. Because of the massive size of the rotunda, additional heaters are used to keep the ambient temperature warm enough for the animals and visitors during the cooler months. Water features in the two largest exhibits add to the serene ambiance of the rotunda. Alligators had been an all time favorite in the old wing, and were therefore chosen as one of the species for a larger exhibit. More specifically, the Chinese Alligator, *Alligator sinensis,* is featured and is part of a cooperative captive breeding program. A sandy beach area provides a nesting ground, and a holding area separated by a planter allows animals to be separated if aggression is observed. The other large exhibit was designed for aquatic turtles, so appropriate sand depths were chosen for that beach as well. The last exhibit houses anacondas but due to the live-bearing nature of the species, does not require a sandy beach area.



The large rotunda includes three of the largest exhibits, all of which are aquatic. Note the Chinese Alligator, *Alligator sinensis* exhibit that allows the visitor to view the animals from above and below the water or when basking on the beach area. (Photo by Cathy Eser)

The Fear Zone

The theme of the exhibits on the south side is the Fear Zone. While increased knowledge might prevent some people from being fearful of and indifferent to the fate of snakes, there is little evidence that instruction can help the truly phobic individual overcome their animal phobias (Burghardt et al. 2007). As discussed earlier, this novel approach was incorporated in the renovation plan (see Murphy and Chiszar 1989; Burghardt et al. 2007) to dispel the public's fear of snakes through a better understanding of the animals. The exhibits contain rows of mostly small "jewel box" cages consistent with the Kauffeld tradition. The majority of the exhibits contain venomous snakes and lizards with the exception of the large python exhibit in the beginning. It was believed by management that if the majority of venomous animals were housed in the same area, it would create a safer work environment for the keepers. In addition, the antivenom refrigerator could be kept in close proximity to the emergency snakebite station. Other safety features, such as alternating shift exhibits, allow keepers to move fast-moving elapids from one exhibit to another without having to be removed from the exhibit. The total number of "jewel box" exhibits is 22.

In the original wing the lights had to be accessed from within the cage, which meant the snake had to be removed whenever a light bulb needed to be changed. In the new design, the keeper has a separate access panel that opens for safe access to electrical units. An increased number of electrical outlets has led to improved husbandry practices. We are able to create more temperature gradients between exhibits by adding more basking lights, or to increase humidity by installing humidifiers and misting systems. The service areas behind the south side have also been considerably increased in size, giving the keeper more room to handle the dangerous animals housed in this section. This was a subject that former SIZ keeper Zappalorti (pers. comm., 2005) commented on: "I'm sure that the husbandry design will be more efficient and safe in the new wing, as the old keeper's alleys were much too narrow. I can't tell you how many times I was pinned against the wall, while a large hungry python, cobra, or rattlesnake struck at me." Each exhibit was installed with an alarm system including an intercom to reach the receptionist office, and would sound over the general PA system when activated. Other husbandry conveniences are permanent fiberglass pools and



The Fear Zone area begins with a giant snakes exhibit and continues with 22 "jewel box" exhibits containing venomous snakes and lizards. The push button interactive snake skull may also be seen in this photograph. (Photo by Cathy Eser)

radiant heat pads in alternating exhibits.

At the end of the Fear Zone a Carl Kauffeld memorial office was built. Historical artifacts such as hand-made tools including snake hooks, rippers, and scoops are displayed. His original desk, letter opener, documents, and art work were donated by various SIZ alumni or retrieved from other parts in the zoo and placed in the office. This is also an area to exhibit some of the smaller captive-bred animals in small tanks that would not be seen in a large exhibit. This office can be seen from inside of the wing as well as from the hallway that leads to other wings of the zoo.

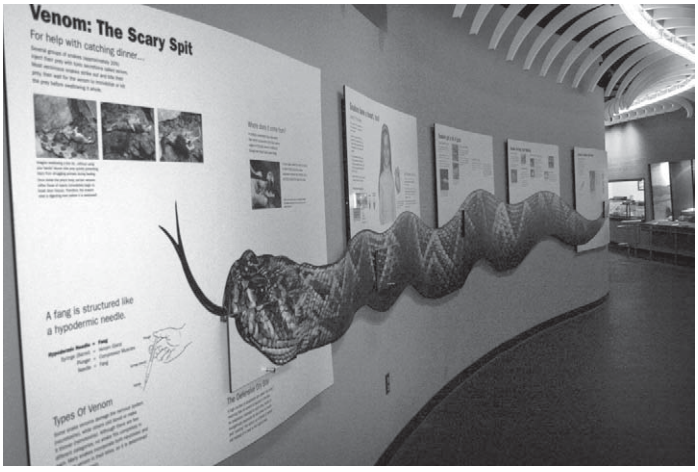
The graphics and interactive displays for the Fear Zone are numerous. To alert visitors that they are entering the area, there is a floor pad that activates the sound of a hissing snake when stepped on. Visitors are greeted with an illuminated snake skeleton that is suspended from the ceiling and runs the entire length of the Fear Zone. There is also a beautiful mosaic and panel showing cultural artwork of snakes. Next to the large snake exhibit, there is a functional replica of a viperid snake skull, activated by a push button. The exhibit was built by Peeling's Productions Inc. in Pennsylvania. There is also an informative panel that describes the methods by which snakes feed.

Across from the animal exhibits is a 7.5-m (25-ft) long Eastern Diamondback Rattlesnake graphic that contains various flip-up panels to allow the visitor to see inside of the snake. Some of these panels are activated when opened to make sounds, such as a snake's heartbeat and a rattlesnake rattle. Other flip-up panels show diagrams of the venom gland, heart, and a radiograph of a food item in the stomach. Many of the photographs were donated by SIZ alumni or taken by SIZ staff. Other flip-up panels include graphics located along the railing in front of the exhibits. Some of the topics covered are how many humans are harmed by automobiles or by non-reptilian venomous animals than are harmed by snakes. For example, one flip-up asks, "Still think snakes are the most dangerous animals around? Out of these, what is your guess?" There is a picture of a cobra, conesnail, and platypus. The answer is the conesnail.

Amphibian Area

Along the north side of the wing, an attempt was made to bring a more modern approach to the exhibits and types of species exhibited. Many people know of the global amphibian crisis, yet amphibians have historically been poorly represented in zoos. This is partly because they generally require more controlled environmental conditions than was made available in the old-styled exhibits. For this reason, a large area was allocated for an air-conditioned room with sufficient space for aquatic life support systems, water purification systems, food cultures and various other products needed for their care.

Two of the exhibits are large fish tanks that can house aquatic amphibians. The two species exhibited are Mexican Axolotls (*Ambystoma mexicanum*) and Mudpuppies (*Necturus maculosus*). The background of the tanks is covered to create a naturalistic appearance, and because of the delicate nature of amphibians we hired Petra Works, Inc. (New Jersey), a company that specializes in rockwork of amphibian exhibits. The filters in the tanks are polybead filters and a chiller cools the mudpuppy tank. A reverse osmosis unit feeds into a large reservoir and is hooked to a



A 7.5 m (25-foot) long Eastern Diamondback Rattlesnake graphic runs the entire length of the Fear Zone educating the visitor about snake anatomy, physiology and behavior. (Photo by Cathy Eser)



The amphibian and invertebrate exhibits add a diversity of new taxa that were not previously represented by the SIZ. The exhibits are modern in design and style. (Photo by Cathy Eser)

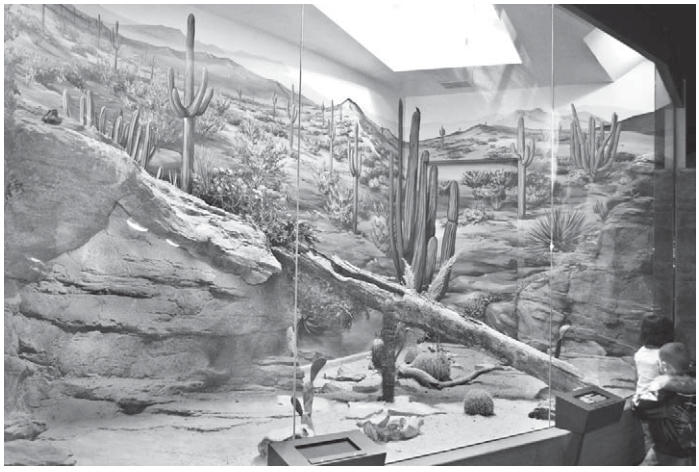
pump and hose for water changes. Also, the water can be easily reconstituted with commercial products.

Two other exhibits are tall "jewel box" style that house various frog species. They are retrofitted with artificial rockwork that contains planters, so the exhibit could be lushly planted and the animals could be seen utilizing the various heights of the exhibit. They also have acrylic inserts with murals painted on them. The temperature and humidity can be adjusted by addition of lighting or humidifiers.

The last two exhibits in the amphibian room are custom-made modular units that were ordered from Waterdog Inc. (California). They were built with various ports so that water features could be added and with side and top access panels. In one of the exhibits is a Ridge-nosed Rattlesnake, *Crotalus willardi*, a mountain species that fares better in a cooler exhibit. This exhibit has a carved desert rockwork background done by Petraworks Inc. The second modular exhibit has a vernal pool background and holds Gray Tree-Frogs, *Hyla versicolor,* and Jefferson Salamanders, *Ambystoma jeffersonianum*. The design of the amphibian area and the adjacent invertebrate area was basically redone in the middle of the construction process due to the relative small size of the originally planned exhibits and the lack of graphics. The new plan incorporates a habitat and adaptations theme to coincide with the exhibit next to it. The topics that are covered are animals that live on mountains, in vernal pools, in trees, or underground. There is also a panel describing how invertebrates are responsible for creating certain types of habitat. Each panel also contains a conservation message called "Conservation Connection."

Invertebrate and Desert Exhibits

One of the objectives of the new exhibit was to have the potential to exhibit a broad range of species. That meant an area that adhered to containment specifications by the U.S. Department of Agriculture so that invertebrates could also be exhibited. The specifications included a second set of doors, separate air handlers, and responsible ways to decontaminate waste from the exhibits. Habitat graphics are matched with the animals on exhibit. Next to the graphic about fossorial animals, there are two exhibits that are 151-liter (40-gallon) fish tanks with plumbing hooked up to filters and chillers to house salamanders. These animals spend a majority of their lives underground near fresh springs. The exhibit that accompanies the graphic about arboreal animals houses Australian Walking Sticks, *Extatasoma tiaratum*.



There is a large center exhibit representing the Sonoran Desert fauna with naturalistic rockwork containing radiant heat and ultraviolet basking light bulbs. (Photo by Cathy Eser)

The keepers wanted to exhibit some species of social insects, which are generally very active and therefore visually interesting. We chose the Honey-Pot Ant, *Myrmecocystus mimicus*. This exhibit was designed and built by Work As Play Inc. (Arizona). The transport of the unit and the animals was a fun adventure for the keepers who drove them across the country from Arizona. The animals were the most delicate among the species housed in the wing, and eventually succumbed due to an infestation of mites that attacked the colony. They were not replaced and the exhibit now contains a Texas Patch-nosed Snake, *Salvadora grahamiae.*

The last exhibit in the invertebrate area housed another species of social insect, Pacific Dampwood Termites, *Zootermopsis angusticollis*. They also proved to be challenging to exhibit due to their fossorial nature.

A large, terrestrial exhibit features the Sonoran Desert, an arid region unfamiliar to the public in the eastern seaboard states. Due to the high ultraviolet light requirement of diurnal desert lizards, specific light bulbs are used in an outcropping of artificial rockwork that enables the animals to bask. Radiant heat is run under specific parts of the exhibit. The mural of the exhibit, depicting the arid habitat, was painted by the artist Amy Bartlett, and it represents the largest of her four mural projects in the wing.

Non-venomous Animals and Interpretive Area

There are still more reptile taxa on exhibit in addition to the snake-themed Fear Zone and the amphibian area. The turtles and lizards are represented in the remaining 12 exhibits of the north side of the wing. Some of the species on exhibit are Blue Tree Monitors, *Varanus macraei,* Wood Turtles *Glyptemys insculpta*, New Caledonia Gecko, *Rhacodactylus leachianus* and a Rhinoceros Iguana, *Cyclura cornuta.*

Across from those exhibits is an interpretive area where zoo volunteers can show live animals to the public. In part, this is a continuation of the Fear Zone where a visitor may encounter a volunteer holding a live snake. There is a table that volunteers use to set animals on that has a tabletop that is an educational tool and has footprints of different reptiles embedded in the resin. Inside of the table lies the shell of a Galapagos tortoise by the name of "Jalopy," who was well known in the 1980s for having the first recorded case of a malignant fibro-sarcoma in a reptile. Four display cases line the back of the interpretive area. The topics covered are shell differences, reptile and amphibian skulls and bones, radiotelemetry devices, and an archaeological dig about when early reptiles and amphibians began to evolve. A video monitor is also hung in this area.

A Timeline

SIZ has enjoyed a strong community support from its very beginning. Reflecting this tradition, what made the renovation project possible was the continuous efforts by elected officials, such as City Councilman (currently U.S. Congressman) Michael McMahon, for the allocation of city funds. However, due to

the unforeseen financial situation of the city, the availability of the funds materialized later than expected. In order to mark the beginning of the project, a groundbreaking ceremony was held on 11 March 2005. At that time there were 45 exhibits in the original wing with 83 species of reptiles and 16 species of amphibians on the inventory, yet only four amphibian species were on exhibit. The large American alligators had been moved out by that time. The non-venomous reptiles were moved out of the wing on 14 March 2005 into holdings in the Animal Hospital, and the venomous reptiles were moved out of the wing on 23 March 2005 into the Animal Hospital as well. This left the Animal Hospital holding space filled to maximum capacity, with little space to quarantine new animals. Thus the acquisition and quarantine of new specimens had to be a carefully coordinated procedure over the next two years for the new exhibit opening. The last day that the wing was opened to the public was 27 March 2005. Demolition of the wing was started three days later.

The Carl F. Kauffeld House of Reptiles was opened by Michael Bloomberg, the Mayor of New York on 18 April 2007. At that date there were 127 reptile specimens in 66 species, and 97 amphibian specimens in 22 species with 12 of those species on exhibit. The $15 million project expanded the size of the wing to 1,255 square meters (13,000 square feet) which enabled us to increase the number of animals in the new wing.

After a "sneak preview" of the renovated wing, a local reporter observed that the refurbished wing "represents a renewal of Kauffeld's project and the institution's larger missions" and "Each section of the wing represents a feat of architecture and design -- a collaborative effort on the part of engineers, builders, artists, keepers and administrators—to create functional, educational and aesthetic exhibits that balance the needs of animals, Zoo workers and visitors." (Platt 2007) Likewise, zoo director John Caltabiano attributed the reconstruction to teamwork among city agencies, designers and zoo staff (Caltabiano et al. 2007). In terms of husbandry, 85% to 90% of the requirements suggested by the animal care staff, such as size of the service area, the microclimate control system, staff safety measures and utility needs materialized in the behind-the-scenes area.

Acknowledgments.—Without the concerted efforts by many individuals the Reptile Wing renovation project would not have been a successful endeavor. We would like to express our appreciation to Vincent Gattullo and John Caltabiano, the former directors of the Staten Island Zoo, for their support. Special thanks go to Amar Malla and Charles Orlando of the City of New York Department of Design and Construction; Darby Curtis, Partner, Curtis + Ginsberg LLP, Karen Mohlenbrok from Hill International, and former and current SIZ staff members (in alphabetical order) Frank Indiviglio, Bob Kurtz, Peter Laline, Matt Lanier, Jim McNiesh, Ellen Palm, Lisa Salmose, and Harry Strano.

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A Comparison of Carapace-Mounted and Body Cavity Implanted, Thermally-Sensitive Radio Transmitters with Implications for Thermoregulation in Free-Ranging Midland Painted Turtles (*Chrysemys picta marginata*)

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In ectotherms, the influence of environmental temperature (T_e) on body temperature (T_b), and resulting physiological processes (Peterson et al. 1993), makes thermal ecology essential to understanding energy acquisition and life histories (Congdon 1989). Investment in behavioral and physiological thermoregulation ranges from little or none (thermoconformity) to precise thermoregulation around a thermoregulatory set point (Christian et al. 2006; Hertz et al. 1993). Ultimately, the investment in thermoregulation is determined by the benefits of attaining T_b that is optimal for various physiological processes weighed against the costs of failing to invest in activities such as foraging or mate location (Blouin-Demers and Weatherhead 2001; Huey and Slatkin 1976). Freshwater turtles are ectotherms that thermoregulate within limits set by temporal variations in aquatic and atmospheric thermal environments (Spotila et al. 1990). In Painted Turtles (*Chrysemys picta*), for example, daily T_b cycling apparently results from behavioral and physiological modifications (Rowe and Dalgarn 2009). Edwards and Blouin-Demers (2007) concluded that field active *C. picta* are capable of at least moderate thermoregulation.

Because of the dynamic, cyclic nature of T_b in ectotherms, the study of T_b variation requires fairly constant acquisition of data points. In freshwater turtles, T_b variation is studied by surgical implantation of thermally-sensitive radio transmitters, or surface-mounted radio transmitters with thermal probes, coupled with remote data logging (Brown et al. 1990; Manning and Grigg 1997; Rowe and Dalgarn 2009), or by the surgical implantation of thermally-sensitive data loggers (Edwards and Blouin-Demers

2007; Plummer et al. 2005; Sajwaj and Lang 2000). However, surgical implantation of thermally-sensitive devices can require extended post-surgical recovery periods and runs the risk of adverse effects, particularly when individuals are relatively small. Alternatively, thermally-sensitive radio transmitters or data loggers can be mounted on the carapace and shell temperature (T_s) used as a proxy for T_b (Grayson and Dorcas 2004; Litzgus and Brooks 2000). However, T_s values presumably reflect not only thermal conduction from the shell, but also the influences of thermal radiation and water temperature directly on the radio transmitter. Therefore, T_s should reflect the temperatures of thermal patches selected by the turtle, including basking events (Grayson and Dorcas 2004; Plummer et al. 2005; Sajwaj and Lang 2000). Under variable controlled conditions, Grayson and Dorcas (2004) found that cloacal temperature of the relatively small-bodied Painted Turtle (*Chrysemys picta*) deviated from T_s by less than 1ºC and so T_s may be an acceptable estimator of T_b. In *C. picta* under field conditions, Edwards and Blouin-Demers (2007) found significant deviations of midday T_b from T_s under variable environmental temperatures. Similarly, Dubois et al. (2009) reported correlated midday T_b and T_s of free-ranging Wood Turtles (*Glyptemys insculpta*) but with T_s distributions that deviated from, and generally exceeded, T_b distributions. Apparently, thermal inertia associated with body mass buffers temperature changes of body cavity-implanted radio transmitters relative to carapace-mounted radio transmitters that are directly exposed to solar radiation and water and air temperatures. It could then be predicted that T_s values would be more extreme and variable than T_b values and, depending on the size of the turtle, the apparent initiation and duration of a thermoregulatory event (e.g. basking) could vary between T_b and T_s data sets.

We studied T_b and T_s variation in six free-ranging *Chrysemys picta marginata* at Miller's Marsh on Beaver Island, Michigan, using both body cavity-implanted and carapace-mounted radio transmitters. Miller's Marsh is a small north-temperate marsh system in northern Michigan that is subject to daily and seasonal fluctuations in water temperatures (Rowe 2003; Rowe and Dalgarn 2009). The two main goals of our study were the determination of: 1) how closely diurnal thermal events (e.g. basking) of the thermal profile are coupled temporally as measured as T_b vs. T_s, and 2) how, or if, T_b and T_s depart in value over time. To determine if the timing and durations of readily identifiable thermal events coincided over time as measured as T_b vs. T_s, we compared the initiation, termination, and duration of the pre-midday temperature decline and the midday temperature spike for T_b and T_s data. The pre-midday spike decline may represent movement through cool water, some physiological adjustment (Rowe and Dalgarn 2009), or evaporative cooling (Case 1972) at the initiation of some basking event. The midday spike may be a very important thermoregulatory event as it presumably represents aerial or aquatic basking (Grayson and Dorcas 2004; Plummer et al. 2005; Rowe and Dalgarn 2009). We expected that during the early morning hours, when solar energy would be minimal, mean hourly T_b and T_s values would closely coincide. During the late morning and afternoon, when available solar energy would be maximal, we expected that the initiations of the pre-midday spike temperature decline and the midday temperature spike would occur earlier in T_s data than in the T_b data. We had no *a priori* expectation for the durations of the pre-midday spike decline and midday spike. Due to thermal inertia associated with body mass, we anticipated that midday T_s values would exceed T_b values (Dubois et al. 2009; Edwards and Blouin-Demers 2007) and that T_s values would be more variable and extreme than T_b values.

Materials and methods.—We collected turtles in baited funnel traps or by hand beginning in early May 2006. We obtained carapace length (CL) and body mass (BM) and uniquely marked each individual. Eight individual turtles (4 F and 4 M) received both carapace-mounted and surgically implanted thermally sensitive radio transmitters (Advanced Telemetry Systems) that were calibrated together in a water bath (1–45°C). Radio transmitters (2.5 g) with whip antennae were adhered to the dorsal margins of the carapace using epoxy. Radio transmitters (2.8 g) with a coiled antenna were surgically implanted in the body cavities anterior to the left hind limb (Rowe and Dalgarn 2009). Turtles were allowed to recover for 4–5 days before returning them to the marsh. Of the original eight radio-tagged turtles, four females (mean CL ± SE = 151.5 ± 2.53 mm, min.–max. = 144–155 mm; mean BM = 411.3 ± 19.19 g, 355–440 g) and two males (mean CL = 136.5 ± 6.50 mm, 130–140 mm; mean BM = 276.0 ± 36.00 g, 310–240 g) were monitored throughout the summer months. One male moved beyond detection of our data-logging radio receiver early in the summer and the internal transmitter of another male failed soon after its release.

At a central location in the marsh, we placed a radio receiver (TR5, Telonics. Inc.) that was equipped with an omnidirectional antenna. We programmed the radio receiver to record pulse intervals (duration of time between pulses; mSec) for each turtle's radio transmitter every 15 min for a maximum of 96 observations per individual per day. Turtles were monitored between 10 May and 14 August for a total of 294 individual turtle observation days. We converted pulse interval values to T_b or T_s values for each individual using polynomial regression equations ($R^2 > 0.99$).

To determine whether T_b and T_s values obtained during readily identifiable thermal events coincided temporally, we manually recorded times (to the nearest 15 min, 0000 h = 0 min to 2345 h = 1425 min) at the initiation of the pre-midday spike temperature decline and of the midday temperature spike for each individual on each day. The average differences in time (min) between the initiation of basking for T_b and T_s and between the termination of basking for T_b and T_s were determined per individual and differences tested by Wilcoxon signed-rank tests.

We tested for differences in value between T_b and T_s overall and temporally in two ways. First, we examined residuals of T_b on T_s as plotted on T_s, as a predictor of T_b, and on each 15 min interval throughout the day. For the regression analysis, we determined mean values for each 15 min interval and then averaged them across individuals for both T_b and T_s. If T_s is a reasonable predictor of T_b, then residual plots should show an even distribution over values of T_s and over the course of the day. Second, we analyzed the difference between hourly T_b and T_s (T_b-T_s) by ANOVA with transmitter type (body cavity-implanted or carapace-mounted), hour-of-day (0000–2300 h), radio transmitter type x hour-of-day terms included as fixed effects. Hourly T_b-T_s values were averaged across 15 min intervals per hour (0000–0045 h, 0100–

0145 h, etc,) per individual, and then hourly values were averaged per individual over the entire study period. To assess relative variability of T_b vs. T_s, we calculated mean hourly coefficients of variation (CV x 100) for each variable (CV T_b and CV T_s) and for each individual over the summer and used ANOVA as described previously for analysis of T_b-T_s. Small sample size for males precluded the use of sex as a main effect. In both ANOVA models, we included turtle identification (ID) number and sex as random variables to account for autocorrelation and potential inter-sexual differences respectively. *Post-hoc* comparisons were made using least square means (LS means) multiple t-tests. Test statistics were considered significant at or below alpha = 0.05 unless otherwise specified.

Results.—For individual turtles, both T_s and T_b recorded at 15 min intervals showed diel cycling that included monotonic declines, pre-midday spike declines, midday spikes and oscillations, and late evening and early morning monotonic declines (Fig. 1A). Of the 190 total turtle observation days for which 96 observations per individual per day were obtained, well-defined midday spikes were observed on 70.0%, pre-midday spike declines occurred on 24.7%, and no discernable temperature cycling was observed on 5.3%.

The timing and durations of the pre-midday temperature spike decline and the midday temperature spike did not vary between data recorded by body cavity-implanted and carapace-mounted radio transmitters. For both T_b and T_s, pre-midday spike declines were initiated between 0500 and 1000 h (middle 50%: 0615–0815 h) and had durations of 118 ± 14.4 min (75–165 min, N = 6) and 122.2 ± 17.34 min (90–178 min, N = 6) respectively. Midday

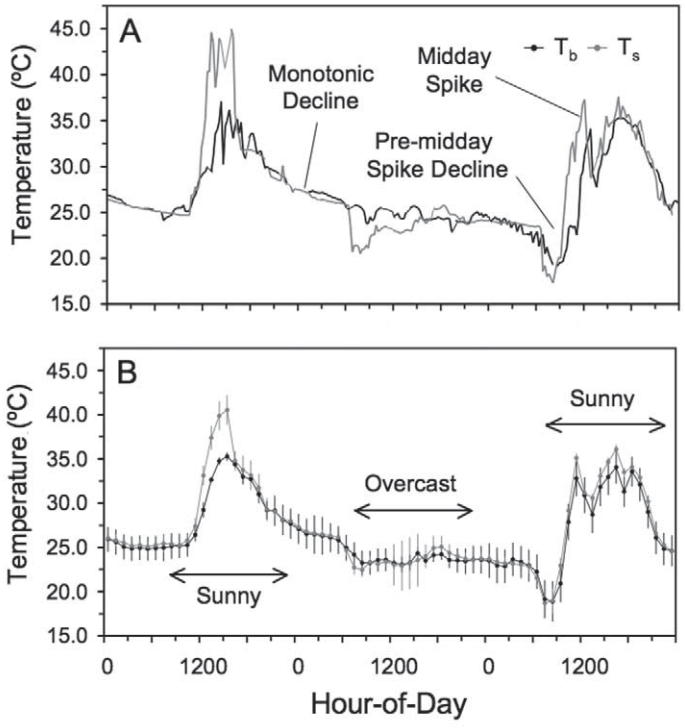


FIG. 1. A) Body temperature (T_b) and carapace surface temperature (T_s) measured in a single *Chrysemys picta marginata*, and B) mean T_b and T_s ± 1SE (vertical lines) measured at 15 min intervals in six individual *C. picta marginata* at Miller's Marsh, under variable weather conditions between 1 and 3 August, 2006.

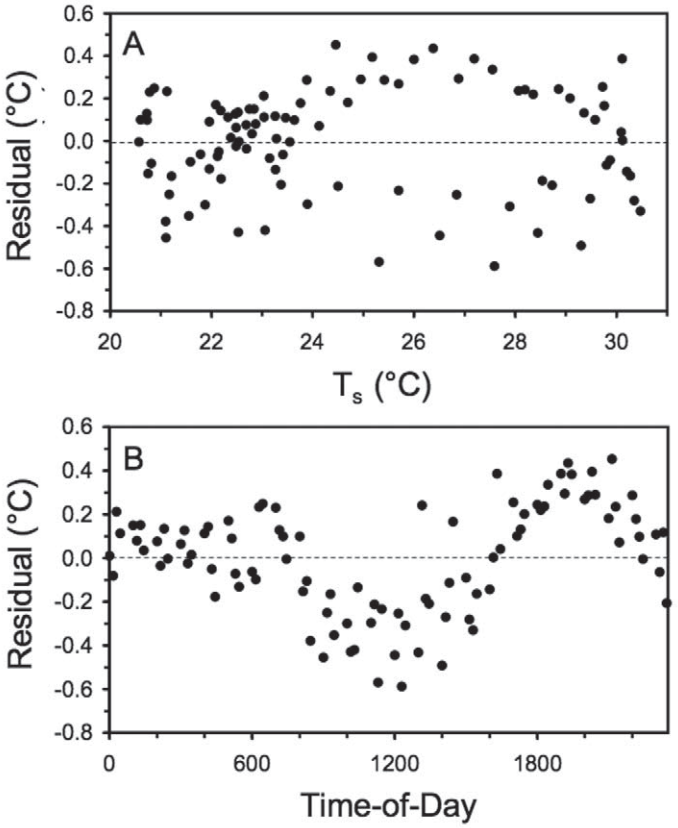


FIG. 2. Residual values from the regression of mean T_b on T_s (averaged per individual) plotted on A) T_s, and B) time-of-day at 15 min intervals in six *Chrysemys picta marginata*.

spikes were initiated between 0745 and 1530 h (middle 50%: 0945–1130 h for T_s and 1000–1145 h for T_b) and maximum values occurred between 0930 and 1815 h (middle 50% 1215–1430 h for T_s and 1230–1430 h for T_b). Mean durations of basking (time between initiation and peak of the mid-day spike) were 152.7 ± 9.50 min (118–181 min, N = 6) for T_b and 149.8 ± 9.30 min (124–178 min) for T_s. The initiations of the pre-midday spike decline and midday spike of T_s occurred slightly before those of T_b (8.3 ± 6.80 min, 0–16.4 min, N = 6, and 5.1 ± 4.11 in, 1.0–10.4 min, N = 6, respectively). However, Wilcoxon signed-rank tests of the timing of initiation and termination and of the durations of the pre-midday spike decline and midday spikes were not significant ($P > 0.05$ in all comparisons).

On sunny days, T_s increased more rapidly and attained higher maximal values, by as much as 10°C, than did T_b but such differences were not as pronounced on overcast and cool days (Fig. 1A). Averaged per individual, T_s and T_b values appeared largely concordant during most of the day but T_s exceeded T_b during the afternoon hours on sunny days (Fig. 1B). Mean minimum T_s and T_b values, averaged across individuals throughout the summer (N = 6), were roughly similar (mean minimum T_s = 11.8 ± 1.67°C versus mean minimum T_b = 12.5 ± 1.05°C) but mean maximum values were more dissimilar (mean maximum T_s = 44.6 ± 1.87°C vs. mean maximum T_b = 37.8 ± 0.24°C).

Overall, and on a diel basis, mean hourly T_s tended to exceed, and was more variable than, mean hourly T_b and the magnitude of difference was greatest during the afternoon. Averaged across all

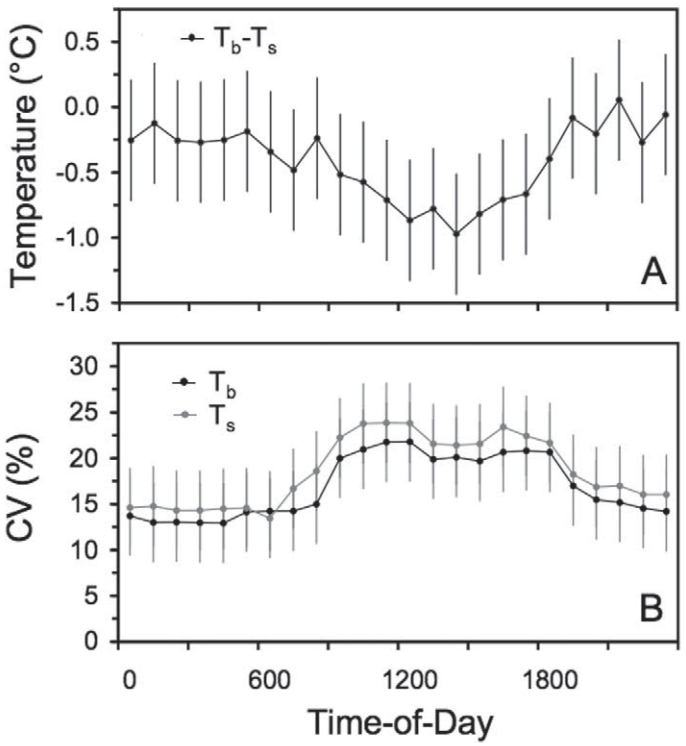


FIG. 3. A) LS mean (± 1 SE) hourly difference between T_s and T_b (T_s-T_b), and B) mean hourly coefficients of variation (CV) in six *Chrysemys picta marginata* at Miller's Marsh, 2006.

individuals at 15 min intervals, T_b regressed on T_s was significant and linear ($T_b = 1.60 + 0.94T_s$, $F_{1,94} = 13{,}687.7$, $P < 0.00001$, $R^2 = 0.99$). A residual plot indicated that observed T_b values tended to deviate from predicted T_b values as T_s values increased (Fig. 2A). Residuals plotted over the course of the day indicated that T_b values tended to be lower than predicted T_b values during the afternoon and exceeded predicted T_b values during early morning and late evening (Fig. 2B). In the ANOVA of the difference between T_b and T_s (T_b-T_s), hour-of-day as the main effect was significant ($F_{23,120} = 2.5$, $P = 0.0007$, $R^2 = 0.87$). The magnitude of difference was greatest between 1000–1700 h, lowest and near 0°C between 1900–2100 h, and intermediate during the early morning and late evening hours (Fig. 3A). Temperature variability, as measured by CV T_b and CV T_s, varied as a function of radio transmitter type ($F_{1,240} = 15.6$, $P = 0.0001$, $R^2 = 0.97$) and hour-of-day ($F_{23,240} = 157.7$, $P < 0.0001$), but the radio transmitter type x hour-of-day term was not significant ($F_{23,240} = 0.3$, $P > 0.05$). Overall, LS mean CV T_s (16.9 ± 5.67) was significantly more variable than LS mean CV T_b (15.3 ± 5.67). *Post hoc* comparisons indicated that, for both CV T_b and CV T_s, variability was relatively low between 0000–0600 h, increased sharply after 0600 h, attained maximal values between 1000–1800 h, and declined gradually during the late evening hours (Fig. 3B). Nonsignificant interaction terms in both ANOVA models indicated that the magnitude of differences between, and variability in, T_b and T_s remained approximately constant throughout the day (Fig 3A–B).

Discussion.—We tested whether T_s values, as recorded by carapace-mounted radio transmitters, accurately estimated T_b values that were recorded using body-cavity implanted radio transmitters in *Chrysemys picta*. On a daily basis, data from both types of transmitters oscillated in a similar way. As we expected, T_b and T_s values were similar during the early morning hours, when aquatic activity is reduced and when turtles were presumably submerged (Rowe 2003). That we detected pre-midday spike declines on the surface of the carapace in T_s data, which averaged over 2.5 h in duration, indicates either movement through cool water before basking or perhaps evaporative cooling at the initiation of aerial basking (Case 1972). Since evaporative cooling would be expected to occur each time that aerial basking was initiated, we suspect that the former explanation accounts for the pre-midday spike T_b decline. If, indeed, the midday spike represents an aerial basking event (Edwards and Blouin-Demers 2007; Plummer et al. 2005; Sajwaj and Lang 2000), the use of T_s as a proxy for T_b might be valid for determining the frequency, timing, and duration of basking events that occur during a specified time period (Grayson and Dorcas 2004). However, we suspect that with relatively large sample size and shorter time intervals between the acquisition of successive data points (<15 min), differences between T_b and T_s in the initiation of basking events could be detected.

We conclude that body cavity-implanted thermal data recording devices would be preferred for the estimation of T_b and the study of thermoregulatory precision in most species. Our T_s values were higher and more variable than T_b values, particularly when solar radiation levels were relatively high. Similarly, Edwards and Blouin-Demers (2007) found that when T_b values were relatively high, and exceeded instantaneously recorded T_s values, with the converse occurring when T_b values were relatively low. Because we detected T_s values greater than the thermal critical maximum for *Chrysemys picta* (41.5–42.3°C, Brattstrom 1965; Ernst 1972), carapace-mounted thermal data recording devices would not accurately estimate T_b at relatively high T_e. Yet, we found that mean T_b-T_s was maximal and less than 1°C during the afternoon hours and T_b and T_s values in *C. picta marginata* were far more concordant than in the relatively large-bodied *Emydoidea blandingii* (Sajwaj and Lang 2000). Therefore, T_s values might adequately estimate T_b in relatively small-bodied freshwater turtles or in juveniles whose relatively small bodies would respond more quickly to changes T_e than would those of adults.

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Geographic Variation in Philippine Mimicry System: Hypothesized Widespread Coral Snake (*Hemibungarus calligaster*) Mimicry by Lepidopteran Larvae (*Bracca* sp.) on Luzon Island, Philippines

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Aposematic Batesian mimicry of elapine coral snakes has been widely documented, with the most well-known and highly referenced phenomena occurring between the highly venomous coral snakes of the New World (*Leptomicrurus*, *Micruroides*, and *Micrurus*) and a number of relatively harmless colubrine snakes (e.g., *Lampropeltis triangulum* ssp.; Brodie 1993; Greene and McDiarmid 1981; Greene and McDiarmid 2005). Less common are similar cases of mimicry of the Old World coral snakes (*Hemibungarus*, *Calliophis*). A number of experimental studies have documented apparent increased fitness of relatively harmless species that, even to varying degrees, mimic the aposematic coloration of the highly venomous model species (Brodie 1993; Brodie and Janzen 1995). In such studies, correlations between the model species' abundance and the quality of mimicry indicate an underlying geographic variation in a given mimic's level of similarity to the model species (Harper and Pfennig 2007). Although this system of mimicry has been documented and studied with colubrine mimics, general Aposematic Batesian mimicry systems involving arthropods are much more common (Greene and McDiarmid 1981; Brodie and Moore 1995).

Brown (2006) reported a potential case of mimicry involving the larvae of a species of lepidopteran in the genus *Bracca* and the Philippine coral snake *Hemibungarus calligaster calligaster*. The larva possessed banding and color patterns highly similar to the coral snake where they are sympatric on two distinct mountain ranges of the Bicol Peninsula of southeast Luzon Island, Philippines (Fig. 1). Upon closer inspection of the *Hemibungarus* from the collection of Brown (2006), it is clear that the Bicol Peninsula subspecies is morphologically most similar to *H. c. mcclungi*, formerly believed to be endemic to Polillo Island (Leviton 1963). Brown (2006) questioned whether this example of mimicry was widespread across the Philippines, and whether morphological differences in banding patterns among subspecies of Philippine *H. calligaster* were mirrored in changes in banding pattern of sympatric lepidopteran larvae. In this note, we question the hypothesis of a widespread case of mimicry, report on additional observations of the sympatric association of *Bracca* and *Hemibungarus*, and compare banding and color patterns between two subspecies of *Hemibungarus* and the sympatric lepidopteran from Luzon Island, Philippines.

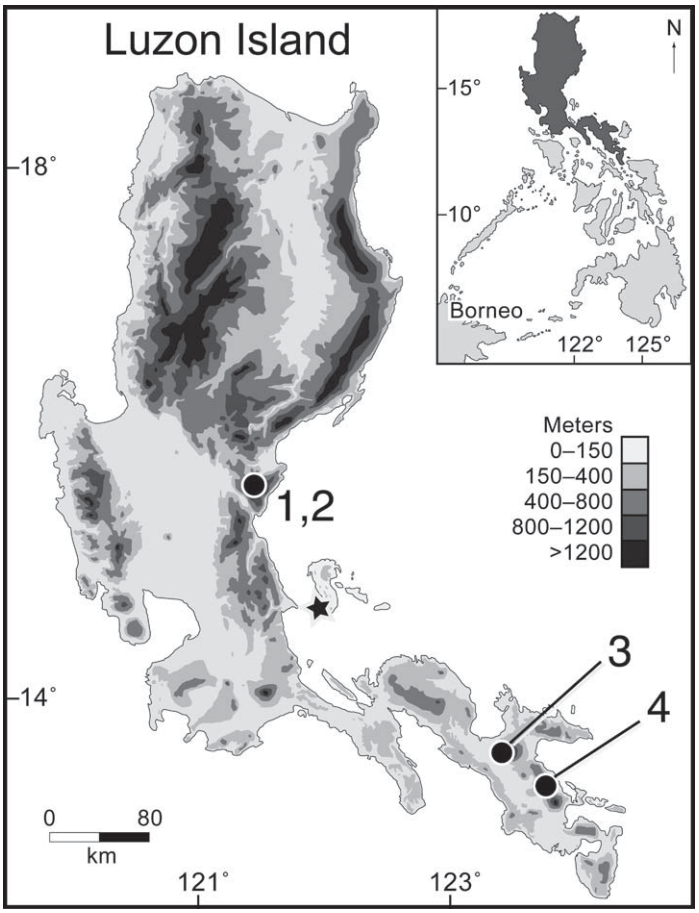


FIG. 1. Localities of observed occurrences of *Hemibungarus calligaster* cf. *mcclungi*, *H. c. calligaster*, *H. c. mcclungi*, and the lepidopteran larvae (genus *Bracca*) on Luzon Island, Philippines. Localities 1 and 2 represent sampling localities from this study, 3 and 4 represent sampling localities from Brown (2006), and the type locality of *H. c. mcclungi* marked with a star. The inset shows the location of Luzon Island (colored black) within the Philippines.

Methods.—In June 2009 we conducted herpetological field surveys at two sites in Aurora Province, Luzon Island: Site 1, mid-elevation forest of Barangay Lipimiental, Municipality of San Luis (15.65366°N, 121.50734°E; WGS 84; Fig. 1); Site 2, mid-elevation forest of Mt. Dayap, Aurora Memorial National Park, local area "Siete," Barangay Villa Aurora, Municipality of Maria Aurora (15.680°N, 121.336°E; WGS 84; Fig. 1). Specimens were deposited in the Philippine National Museum and the University of Kansas Natural History Museum. We measured relative lengths of the color bands of *Bracca* larvae and *Hemibungarus* coral snakes from alcohol-preserved specimens using digital calipers to the nearest 0.1 mm and follow Brown (2006). Bands were measured from their anterior to posterior edges, with all measurements scored by LJW. The coral snake was keyed to species with reference to Leviton (1963), and genus-level identification of the lepidopteran larvae was provided by Brown (2006) and Holloway (1991, 1993).

Results and Discussion.—At Site 1, one individual of the coral snake, *H. c. calligaster* (KU 323337), and two *Bracca* sp. larvae were observed (one collected, deposited in the KU teaching collection). Both *Bracca* sp. larvae were observed suspended 0.5 meter above the ground from a thread of silk. The coral snake



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FIG. 2. (A) *Hemibungarus calligaster calligaster* (KU 323337) in life and unidentified species of *Bracca* moth larvae (RMB 10649, deposited in the KU teaching collection) in life. (B) *Hemibungarus calligaster* cf. *mcclungi* (TNHC 62483; Brown 2006) in life and unidentified species of *Bracca* moth larvae (not collected; Brown, 2006) in life. Arrows highlighting ventral banding differences between specimens collected by Brown (2006) and those from this study. Photographs by CDS and R. M. Brown.

TABLE 1. Summary of body and banding pattern measurements in *Hemibungarus calligaster calligaster* and *H. c.* cf. *mcclungi*, and the associated *Bracca* sp. from this study and Brown (2006). Sample size for each species and study are included for reference, and all measurements given as the range followed by mean ± standard deviation.

	Hemibungarus c. cf. *mcclungi* (N = 4; Brown 2006)	*Hemibungarus c. calligaster* (N = 2; this study)	*Bracca* sp. (N = 5; Brown 2006)	*Bracca* sp. (N = 1; this study)
Total body length	479–510 (498.5 ± 14.5)	525, 554	71–92 (78.8 ± 8.1)	56.2
Body width at midbody	9.0–17.0 (14.0 ± 0.2)	9.0, 9.1	7.0–11.0 (9.0 ± 0.2)	6
White annuli width	9.0–13.0 (11.0 ± 0.2)	2.8, 2.9	7.0–11.0 (9.0 ± 0.2)	1.5
Black band width	13.1–18.2 (15.8 ± 0.9)	6.6, 6.9	6.0–10.3 (7.5 ± 0.2)	5.9
Red band width	13.8–17.0 (15.8 ± 1.7)	10.7, 10.8	7.4–11.5 (9.2 ± 1.3)	5.1

was found under rocks near a stream. A second coral snake (KU 323337) was collected at Site 2 under rocks near a stream. No *Bracca* sp. larvae were observed at Site 2. When disturbed, both snake and caterpillar exhibited jerky movements, including body twisting and flipping, similar to the observations of Brown (2006).

Both subspecies of coral snake and the lepidopteran larvae possess brightly colored banding patterns (Fig. 2), as observed by Brown (2006). However, the order of colored bands and location of white annuli in the *Bracca* specimens most closely matches those of *H. c.* cf. *mcclungi* in the Bicol Peninsula of Luzon Island (Fig. 2B). In *H. c.* cf. *mcclungi*, the white annuli are clearly defined and divide the black bands into a pattern of black band-white annuli-black band. This pattern is bordered by red bands, and closely resembles the color and banding pattern of the lepidopteran larvae in the Bicol Peninsula as well as those observed in this study. In contrast, white annuli are absent or broken and indistinct ventrally with no division of black bands across the ventral surface in *H. c. calligaster* specimens from mainland Luzon (Fig. 2A). This results in the pattern of red and black bands separated by narrow or indistinct white annuli, dissimilar to the *Bracca* larvae and the Bicol Peninsula coral snake.

Other color patterns differences are also observed in *H. c. calligaster*, *H. c.* cf. *mcclungi*, and the *Bracca* sp. The lepidopteran larvae possess a greater number of black bands between red bands than either coral snake subspecies. Additionally, the red bands of the caterpillar encircle the entire body, whereas they are restricted to the ventral surface of the coral snakes. However, observed defensive movements of both snakes and caterpillars resulted in the flashing of the brightly colored red bands (Brown 2006; this study).

These observations suggest that a mismatch in color and pattern exists between the model (snake) and potential mimic (lepidopteran larvae) across their range of sympatry in the northern Philippines. While the lepidopteran larvae shares a general resemblance to both subspecies of *H. calligaster* on Luzon Island, its banding pattern is more similar to *H. c. mcclungi* than it is to *H. c. calligaster*. This may indicate that the model/mimic system evolved between a single subspecies of Philippine coral snake (*H. c. mcclungi*) and that the lepidopteran does not vary geographically in correspondence with separate subspecies of coral snake as was proposed as a possibility in Brown (2006). Despite the observed differences, the caterpillar's aposematic coloration may be similar enough to coral snakes on Luzon Island to reduce avian predation pressures. An innate prey avoidance behavior in the Bicol Peninsula may extend well past the range of close correspondence between the model and the mimic banding patterns.

Although experimental studies of coral snake mimicry have been successfully conducted (e.g., Brodie 1993; Brodie and Janzen 1995; Brodie and Moore 1995), no experimental confirmation of a model/mimic system has been made for these two species. The sympatric occurrence and striking morphological similarity between snakes and caterpillars seems to be restricted to the Bicol Peninsula of Luzon Island (Fig. 1). If the color pattern is in fact reducing avian predation on the caterpillar, it would be interesting to experimentally determine how quickly the learned avoidance behavior dissipates as geographic distance increases from regions of sympatry. Assuming the close resemblance of caterpillar to *H. c. mcclungi* is a case of mimicry, toxicity analysis should be conducted to determine whether *Bracca* sp. larvae are toxic, or if the caterpillar is a palatable mimic. It remains unknown whether a species of *Bracca* sharing similar color patterns co-occurs with the other Philippine coral snake subspecies, *H. c. gemiannulis* from Cebu, Negros, and Panay Island (Brown 2006; Leviton 1963).

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Australian Freshwater Crocodile (*Crocodylus johnstoni*) Attacks on Humans

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Both *Crocodylus johnstoni* (Australian Freshwater Crocodile) and *C. porosus* (Australian Saltwater or Estuarine Crocodile) occur in northern Australia. *Crocodylus porosus* is accepted as being dangerous, known to attack humans and responsible for at least 25 fatalities in Australia between 1971 and 2009 (Caldicott et al. 2005; C. Manolis, pers. comm.). *Crocodylus johnstoni*, on the other hand, is widely considered harmless to humans (e.g., Crocodile Specialist Group 2008; Webb and Manolis 2007). There are no recorded human fatalities from *C. johnstoni* (C. Manolis, pers. comm.) and locals frequently swim with this species, believing that it does not bite people (pers. obs.). Although it is acknowledged that *C. johnstoni* is capable of inflicting injury, both local people and experts are reluctant to believe they attack humans (Anonymous 2006; Caldicott et al. 2005; Crocodile Specialist Group 2008).

In September 2008, two *Crocodylus johnstoni* attacked one of the authors (KNH) in the Throssell River of the Kimberley Region of Western Australia in the presence of the second author (AS). This experience provides evidence contrary to the prevailing opinion that this species is harmless to humans. We have found additional accounts of *C. johnstoni* attacks on humans in northern Australia, but the difficulty we had in acquiring this information suggests that the widespread belief that *C. johnstoni* is harmless may in part be perpetuated by a lack of reporting, reluctance to lend credence to such accounts, and consequently a lack of media attention. These factors impede a full understanding of this species' behavior and jeopardize public safety. We discuss these issues further using our case study and compiled accounts of additional *C. johnstoni* attacks on humans in northern Australia.

Methods.—We compiled accounts of *C. johnstoni* attacks that were reported in northern Australia. Accounts were gathered between September 2008 and June 2010 from personal narratives brought to our attention, scientific literature, the internet (primarily online newspapers), and the Crocodile Attack Database (CAD) that was begun in 1971 and is maintained by Wildlife Management International in Darwin, Northern Territory of Australia (C. Manolis, pers. comm.). We included accounts where the attacking species was clearly identified as *C. johnstoni* and where there was no obvious human harassment of the animal prior to attack.

Results.—In addition to our encounter involving two *C. johnstoni*, we recorded ten other accounts of *C. johnstoni* attacks on humans in northern Australia between 1971 and 2009 (Table 1). This total is likely an underestimate given that three of the attack accounts were collected through chance personal communications (two relayed to the authors and one acquired by C. Manolis second hand [C. Manolis, pers. comm.]) and another two through personal experience, meaning that nearly half of the accounts were collected opportunistically rather than being available in the scientific literature or from news sources.

There was an average of 0.3 *C. johnstoni* attacks on humans reported annually in northern Australia between 1971 and 2009 (Table 1). The first reported attack was in 1988 and the annual number of reported attacks increased to 0.9 between 2000 and 2009. In all cases, the victims were engaged in water activities—swimming, treading water, or floating in an inner tube or on an inflatable mat—at the time of attack. Where gender of the victims was known, numbers were evenly divided between males and females. Crocodile size was estimated in five of the accounts and attacking crocodiles were reported as 1–2 m total length, with 2 m crocodiles being reported as responsible for three of those attacks. Attacks ranged from a quick bite and release to varying degrees of biting persistence until the victim escaped or resisted further bites. Most injuries were restricted to puncture wounds or cuts made directly by the teeth.

Case Study

The authors' *C. johnstoni* attacks occurred on 17 September 2008, along a remote section of the Throssell River in the Kimberley Region of Western Australia (17.43°S, 126.05°E). September is the dry season and the river was divided into a series of water holes. There was a high density of *C. johnstoni* along the river, but the water hole where the attack occurred had no visible individuals on the bank or at the surface of the water. The water hole was ca. 100 m x 20 m and contained deep, murky water. The bank was steep on both sides with boulders on one end of the river bed and a shallow bank adjoining the river bed on the other end. There was dense vegetation and a steep bank along the side of the hole where the authors entered the water.

Around noon KNH entered the water with a splash and was



FIG. 1. Hand and arm wounds from *Crocodylus johnstoni* less than an hour after attack.

followed about a minute later by AS. Moments after the second splash, KNH headed toward the bank along her previously clear path. She swam into the broadside of a crocodile. She stopped momentarily, then proceeded slightly to the left of her previous path. The crocodile circled and approached KNH from her right side, attacking at a sideways angle from the front and biting her left knee. KNH tried unsuccessfully to pull the jaws off her knee with both of her hands. KNH released the jaw to reach for an assisting hand offered by AS and the crocodile attempted a death roll. KNH successfully resisted and kept her head above water. KNH returned to the bank with the crocodile where both authors identified the species as *C. johnstoni* when the head was lifted out of the water and as being 2 m long (total length). AS gouged one of the *C. johnstoni*'s eyes until it released the knee.

Before KNH exited the water, a second crocodile bit her right arm. KNH freed herself by thrusting her arm down forcefully while twisting it to one side. This crocodile was ~1 m long and was identified as *C. johnstoni* based on shape and size of the teeth puncture wounds. Identification of the second crocodile was further supported by the abundance of this species along the river and no evidence suggesting the presence of *C. porosus*, which local people (pers. comm.) insisted do not occur in the area.

Combined injuries from the two attacks included puncture wounds on both hands and the right arm (Fig. 1), and around the left knee (Fig. 2). The left knee also sustained soft tissue damage including a small meniscus tear, sprains, and strains.

Discussion.—For many years, much attention has been focused on understanding and preventing *C. porosus* attacks on humans (e.g., Caldicott et al. 2005, Crocodile Specialist Group 2008, Gruen 2009). Little attention has been paid to the dangers of *C. johnstoni*, no doubt because of the prevailing notion that this species is harmless (e.g., Crocodile Specialist Group 2008; Webb and Manolis 2007). To the contrary, our case study, backed up by other reports we have gathered, indicates that *C. johnstoni* are capable of attack resulting in serious injury.



FIG. 2. Leg wounds from *Crocodylus johnstoni* five days after attack.

TABLE 1. Compiled accounts of *Crocodylus johnstoni* attacks on humans in northern Australia, 1971–2009.

Year	Month	Location	Estimated Crocodile Size	Victim Activity Prior to Attack	Resulting Injury	Victim Gender	Source
1988	N/A	Twin Falls, Kakadu National Park, Northern Territory	N/A	Floating on inflatable mat	N/A	N/A	CAD[1, 2]
1990	N/A	Twin Falls, Kakadu National Park, Northern Territory	N/A	Floating on inflatable mat	N/A	N/A	CAD[1, 2]
2003	September	Barramundi Gorge, Kakadu National Park, Northern Territory	1.5 m	Swimming	Puncture wounds on chest; cuts on hand	Male	ABC 2003
2006	April	Katherine River, Northern Territory	2.0 m	Swimming	Puncture wounds on back and arm	Male	Anon., 2006; CAD[1]
2007	January	Ivanhoe Crossing, Kimberley, Western Australia	2.0 m	Swimming	11 stitches on arm; four stitches on neck	Male	ABC 2007
2008	N/A	Kununurra, Western Australia	N/A	Swimming	Punctures wounds on arms	Female	CAD[1]
2008	September	Throssell River, Mt House, Western Australia	2.0 m	Treading water See case study.	Puncture wounds and soft tissue damage to knee. See case study.	Female	Authors, pers. obs.
2008	September	Throssell River, Mt House, Western Australia	1.0 m	Treading water See case study.	Puncture wounds on hand and arm. See case study.	Female	Authors, pers. obs.
2009	April	Adcock River, Mornington Wildlife Sanctuary, Western Australia	N/A	Floating in rubber tube with legs in water	Puncture wounds on leg	Male	Victim, pers. comm.
2009	April	Lake Argyle, Western Australia	N/A	Swimming	40 stitches on left arm and chest	Male	Australian Reptile Forum 2009
N/A	N/A	Adcock River, Mt House, Western Australia	N/A	Swimming	Puncture wounds on forearm	Female	Victim, pers. comm.
N/A	N/A	Edith Falls, Northern Territory	N/A	Floating on air mattress	Puncture wounds	Female	Amazing Australia 2009

[1]CAD = Crocodile Attack Database.

[2]We incorporate these accounts of *C. johnstoni* attacks into our analysis because they are included in the CAD and are cited by Anonymous (2006), Caldicott et al. (2005), and Crocodile Specialist Group (2008). The original source for these accounts is Lindner (2004), but this reference does not explicitly state that attacks occurred but rather that nuisance *C. johnstoni* were removed from this site.

Available data indicate that *C. johnstoni* attacks are not as common, nor usually as severe, as *C. porosus* attacks. From 1971 to 2009 there has been an average of 0.3 reported accounts of *C. johnstoni* attacks on humans per year compared to 1.95 average accounts reported per year for *C. porosus* (C. Manolis, pers. comm.). There are no known cases of human fatality from *C. johnstoni* compared to 25 recorded cases from *C. porosus* between 1971 and 2009 (C. Manolis, pers. comm.). Nevertheless, given the apparently limited reportage, acceptance, and recording of *C. johnstoni* attack accounts, one must wonder how many other attacks have occurred and are not known. In our data set there is a suggestion of an increase in the number of *C. johnstoni* attacks on humans in the last decade. This may indicate an actual rise in the number of attacks, but may also reflect easier access to more recent attack accounts.

Our analysis of available information suggests that improved data collection and access to that data is needed if information on *C. johnstoni* attacks are to be available and useful for both understanding this species' biology and for informing public safety. The IUCN Crocodile Specialist Group's recommended repository for crocodile attack information in Australia is Wildlife Management International's Crocodile Attack Database (CAD). Given that only a third of the attacks compiled here were also in the CAD, this resource appears to be severely underutilized with respect to *C. johnstoni*. While not an unusual situation for data bases of this sort (Fergusson 2002), it remains troubling. One problem is that the data base is not easy to find. Google searches using reasonable search criteria are unable to find a match within the first ten pages of search results. In addition, there is no online data sheet for easy submission and data contained within the CAD are not readily available online.

Equally critical is the encouragement of reporting in the first place. Our experience and findings suggest that *C. johnstoni* attacks deserve more initial credibility and reportage of their details needs to be encouraged. Whether there has been an actual increase in the number of *C. johnstoni* attacks in the last decade or not, the threat of more attacks in the future is real. The numbers of people visiting remote areas continues to rise as improved technology and infrastructure make more challenging locations increasingly accessible. Since *C. johnstoni* have been observed to be less wary of humans and more prone to aggressive displays in areas where they are not regularly exposed to humans (Webb 1985), increased visitation to remote areas could increase the number of attacks. Attacks may become more frequent across this species' range regardless of remoteness as human populations rise, increasing the probability of negative encounters. Clearly outlined safety guidelines exist for *C. porosus* (e.g., Queensland Government 2008). Similar guidelines should be developed and publicized for *C. johnstoni.* However, little is definitively understood in order to undertake such a task. Improved data will be needed to assess the triggers for *C. johnstoni* attack. The only clear evaluations from the data set compiled here is that all victims were in the water at the time of attack and there is no apparent gender bias. It appears that larger *C. johnstoni* are more prone to attack and that attacks are more likely to occur in April or September, but these conclusions are not much more than indicative. Standardized data collection is necessary to limit gaps in the data set and to ensure that the data being collected are useful for understanding *C. johnstoni* attack triggers.

We emphasize the importance of documenting all *C. johnstoni* attacks in a standardized, easily accessible format. Acquiring such data will require an educational campaign to alter the perception that *C. johnstoni* are harmless, to one of recognizing their potential to attack and the need to report such incidents. Future research should pay discerning attention to the details of each recorded attack to increase our understanding of *C. johnstoni* attack triggers. This information is essential to understanding the biology of *C. johnstoni*, improving its conservation and management and, as we have shown in this paper, human safety.

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Kälin's 12-12 as an Indicator of Size in Crocodylia

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The search for the biggest crocodile is a frequent endeavor not only for spectacle but also for the sake of science and evolutionary studies (Whitaker and Whitaker 2008). Crocodile skulls are more often than not the only preserved element of the skeleton. Since crocodile skulls grow in allometry with body size, they are frequently used as a proxy for physical size of a specimen (Greer 1974; Woodward et al. 1995). However, there is often confusion over the best location for determining size (Ross and Pearcy 2009). This article reexamines and suggests Kälin's 12-12 (Kälin 1933) as a best predictor of skull size in crocodilians and possibly an accurate and easily identifiable proxy for body size in crocodilians.

Previously, total skull length has been considered the independent variable indicating size (Radinsky 1981; Simpson et al. 1960). There has been debate on this assumption as width at the back of the jaw has also proven to vary considerably (Monteiro and Soares 1997). Most commonly used has been the ratio between the two aforementioned measurements (Busbey 1995; Verdade 2000).

These commonly used measurements, however, are often susceptible to notable variation within the ontogenetic process and change outside of this process. For example, hatchling skull shape, specifically in the rostrum, is different from that of the adult of the same species (Dodson 1975; Hall and Portier 1994; Verdade 2000). Outside of the ontogenetic process more problems tend to occur. Depending on physical environmental conditions and stress factors, skull shape as described by total length and total width can vary dramatically, as commonly seen in captive populations (Hutton 1987). Growth can be extremely variable within species (Hall and Portier 1994; Hutton 1987). This variability can be especially noted when comparing healthy vs. unhealthy and captive vs. wild specimens (Black and Loveridge 1975; Coulson et al. 1973; Joanen and McNease 1974; Whitaker and Whitaker 1977). While traditional measurements of total length and total width can be informative of how large an individual is, the disparity between size of individuals, caused by ontogenetic factors, and average size of the species can reduce application among comparative morphometric studies.

Based on a large dataset, I identify the most applicable and least variable indicator of skull size within and across species. Furthermore, I discuss this measurement as an applicable indicator of body size based on the criteria derived from a number of sources (Hall and Portier 1994; McIntosh 1955; Pierce et al. 2008; Verdade 2000): 1) low variability within species; 2) correlation with body size; 3) functional importance; and 4) repeatability.

Methods

Measurements were made from the jaw line at the center of the post-orbital bar across the head to the opposite jaw line at the same point (Fig. 1c,d; Kälin 12-12). On skin-covered specimens this area is identified as the space between the earflap and the back of the eye. The distance from midline at this width (Fig. 1g) to the tip of the snout (Fig. 1a) is Kälin's 12-3.

Only one traditional width measurement, cranial width (CW), was examined. That is the width of the jaw at Kälin 1 (1933) as defined by the widest point on the quadrojugal bone (Fig. 1:e,f). Total length of skull (TSL) is from the back of the cranial ridge (Fig. 1b) along the midline to the tip of the snout (Kälin's 6-3) (Fig. 1a). All measurements were taken in centimeters.

Data were collected from museum specimens (N = 152) of all 23 species of extant crocodilians. From these specimens, the four aforementioned measurements were taken. Juveniles and noticeably deformed specimens were not used if possible. A separate data set was used, where whole specimens, not only skulls, were examined for comparison of measurements to the total body. These measurements of total body length (TBL) and snout-vent length (SVL) were collected on 21 wild *Osteolaemus tetraspis* by a crocodile expedition throughout central Africa (Zoer 2010). A rope was used to take the measurement on the crocodile and then measured along a tape measure. TBL was taken on the dorsal surface, while SVL was measured along the ventral surface.

By using Pearson correlation analyses the Kälin 12 measurements were compared to traditional measurements using SPSS 16.0. One-way ANOVA's were run to test for the difference between ratios. Standard deviations and t-tests (Dinov 2005) were then calculated within each measurement type for each species in Microsoft Excel 2008. A principal components analysis was used to better define the difference between the Kälin 12 ratio and the

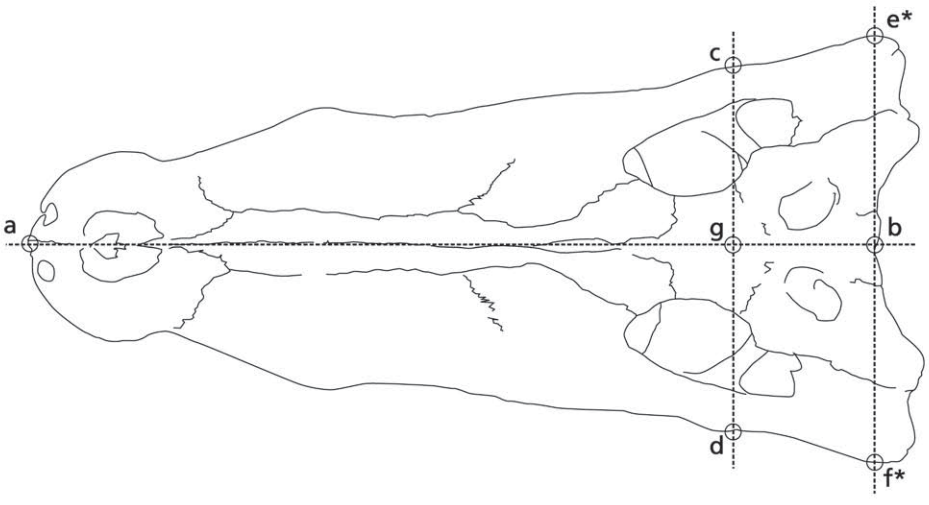


Fig. 1. Measurements taken from crocodilian skulls; a–b: total skull length, c–d: Kälin 12-12, e–f: total width of skull, a–g: Kälin 12-3. Asterisks mark traditional measurement.

traditional ratio as they relate to species differentiation.

Results

Correlation analyses of total length (TSL) and total width (CW), and TSL and Kälin 12-12 for all species show positive correlations between the Kälin 12 measurement ratio (R = 0.875) and the traditional measurement ratio (R = 0.908). The ratio of CW to TSL did not differ significantly from the ratio of Kälin 12-12 to Kälin 12-3 (ANOVA: F = 0.54, df = 1, p = 0.46).

Standard deviations for each measurement within each species (Table 1) were lower for Kälin 12 measurements than for traditional measurements. Kälin12-12 was significantly less than CW ($t = -5.1$, $df = 20$, $p < 0.001$) and Kälin 12-3 was significantly less than TSL ($t = -4.320$, $df = 20$, $p < 0.001$).

A principal components analysis of the Kälin 12 ratio and the traditional ratio found that 97.34% of the variation was accounted for in principal component 1. Case loadings show that PC1 was driven by the Kälin 12 ratio (0.82) rather than the traditional ratio (0.58) to separate by species.

Data from 21 *Osteolaemus tetraspis* revealed the standard deviation of the ratio of Kälin 12-12 to total body length (0.175) was lower than the standard deviation of the ratio of CW to body length (0.192). Within the same dataset, the standard deviation of width at Kälin 12 to snout-to-vent length (SVL) to (0.0138) was lower than that of cranial width to SVL (0.282). A correlation analysis showed slightly higher correlation between SVL and Kälin 12-12 (R = 0.977) than between SVL and CW (R = 0.958).

Discussion

The Kälin 12-12 and 12-3 measurements are a better indicator of skull size than cranial width and total skull length measurements. Through the PCA, the Kälin 12 measurement ratio is noted as a stronger driving force than the traditional ratio for species division. Four criteria were used to further investigate the usability of the Kälin 12 measurements as a measurement of skull and body size, finding it to be of value over the other measurements.

Low variability.—The best size measurement is the least variable one (McIntosh 1955). The Kälin 12-12 measurements had a lower standard deviation within species than did the measurements of total width and total length. The lower deviations within species support the hypothesis that the Kälin 12-12 and Kälin 12-3 measurements are less susceptible to growth outside of the ontogenetic process and exhibit less variation than other methods.

Kälin 12-12 also occurs in an area, near the orbits, of reduced allometric growth coefficient (Verdade 2000; Wu et al. 2006), which means that the growth rate of this area is reduced compared to snout length and width at the back of the jaw, which accounts for the lower deviation. The reduced growth of this portion of the

Table 1. Sample size, size range, and standard deviations within measurements by species.

			Standard deviations			
Species	N	Range CW (cm)	Kälin 12-12	CW	Kälin 12-3	TSL
Alligator mississippiensis	13	16.10–30.28	3.67	5.04	6.48	7.31
Alligator sinensis	4	9.60–15.10	2.24	2.33	3.02	3.61
Caiman crocodilus	12	12.37–16.55	0.99	1.21	2.03	2.19
Caiman latirostris	9	12.30–23.65	3.47	4.57	3.22	3.85
Caiman yacare	6	13.50–19.70	2.14	2.56	2.46	3.21
Crocodylus acutus	3	19.90–35.72	5.93	8.26	14.16	15.63
Crocodylus cataphractus	8	20.07–26.86	2.05	2.31	4.36	4.76
Crocodylus intermedius	9	20.00–35.50	4.44	5.75	8.73	10.08
Crocodylus johnsoni	2	12.20–14.10	0.99	1.34	2.26	2.69
Crocodylus mindorensis	1	–	–	–	–	–
Crocodylus moreletii	2	13.08–27.40	–	–	–	–
Crocodylus niloticus	17	20.90–37.40	5.15	6.41	9.11	10.47
Crocodylus novaeguineae	3	14.00–22.10	3.08	4.06	4.85	5.78
Crocodylus palustris	7	15.60–34.84	5.09	6.99	8.39	14.4
Crocodylus porosus	12	28.50–43.94	5.08	5.98	5.63	6.27
Crocodylus rhombifer	3	10.69–23.70	5.50	6.87	4.97	7.52
Crocodylus siamensis	2	15.22–23.10	4.26	5.57	7.89	9.89
Gavialis gangeticus	7	20.35–29.55	3.69	3.66	7.54	7.57
Melanosuchus niger	8	18.80–33.91	4.23	5.56	6.46	7.56
Osteolaemis tetraspis	10	8.50–11.28	0.75	0.92	0.92	1.23
Paleosuchus palpebrosus	3	9.70–15.49	2.25	3.00	3.65	4.69
Paleosuchus trigonatus	5	8.20–15.75	2.84	3.51	5.17	6.20
Tomistoma schlegelii	6	19.60–41.97	7.95	12.02	12.77	14.08

skull at later stages of crocodile development is visible through a study of *Crocodylus novaeguineae* (Hall and Portier 1994). These studies do not specify the exact position of Kälin 12-12, thus inferences are made from the orbital width and postorbital cranial ridge width to snout-vent length. One study on *C. niloticus* used a measurement from the point anterior to the orbits to the tip of the snout, finding that it grows isometrically relative to head width (Hutton 1987). This is the closest measurement comparable to Kälin 12-3. As the area around the orbits is less prone to growth extremes, it represents a more accurate figure for skeletal size. This can be especially important in captive populations where growth responds to temperature, population density, and food (Blake and Loveridge 1975; Coulson et al. 1973; Joanen and McNease 1974; Whitaker and Whitaker 1977), thereby creating a comparable database. For skin-covered specimens, the location of Kälin 12-12 is also an area of reduced soft tissue, which could prevent discrepancies in measurements based on the thickness of soft tissue.

Correlation with body size.—When compared to body length and snout-vent length, Kälin 12-12 has a lower standard deviation than CW. This shows that Kälin 12-12 is a viable measurement of size even for total body length in *O. tetraspis*. As *O. tetraspis* is the smallest crocodile, the lower standard deviation of Kälin 12-12 may be due in part to the crocodile's small size. However, the previous analysis shows the same positivity for Kälin 12 in skull size for all species. The direct proportions between the skull and body of crocodilians (Chentanez et al. 1983; Hutton 1987; Verdade 2000) supports the conclusion that Kälin 12-12 is a viable measurement relatable to total body size in species other than *O. tetraspis.*

There is a high level of integration of the differing parts of the skull meaning change in one part will result in the restructuring of the entire skull (Monteiro et al. 1997). We would, therefore, expect a similarity between the Kälin 12 measurements and CW and TSL and their respective ratios, as they are related measurements of length and width, which is a verifiable proportion within crocodilians (Chentanez et al. 1983; Hall and Portier 1994).

Functional importance.—Although functional importance is not always a necessity for determining a measurement point, it can be beneficial for application to ecology and functional morphology. The area of the skull surrounding the orbits has a reduced susceptibility to growth caused by environmental factors and it is a physically strong point on the skull. In battle, crocodilians have been known to bash heads (Webb and Manolis 1989) with the point of contact often near Kälin 12. In spite of the dangers to either side of the focal point such battles rarely seem to cause damage. Due to the closing of the secondary palate, the crocodilian rostrum is much stronger near the orbits. According to Busbey (1995) this leads to less tension from torsional loads associated with feeding behaviors.

Repeatability.—The post-orbital bar offers an area easily identifiable on skulls. On skin-covered specimens there is a minimum margin of error as the distance between the earflap and the eye is small. Although the widest part of the skull seems easier to identify than Kälin 12, in many skulls from collections, the bone is chipped or broken at the widest part. The widest part of the skull can also be open to interpretation ranging from anywhere between the back of the quadrojugal bone to the widest part of the quadrojugal.

Conclusion

Based on the aforementioned criteria, the Kälin 12 measurements prove to be slightly better than the traditional width measurement at the widest part of the skull for determining size of both skull and body. It offers an easily identifiable area which is less susceptible to growth due to environmental factors and the low amount of soft tissue in this area also reduces the bias already found in skin-covered vs. clean specimens. Kälin 12 measurements may also be better measurements within captive populations, where malnourishment and stressful conditions can lead to abnormal growth. Kälin 12-12 is also of physiological importance being one of the stronger areas of the crocodilian skull. The use of Kälin 12 could benefit comparative anatomical, evolutionary, and ecological studies of crocodilians by presenting a measurement meeting proven criteria for usability.

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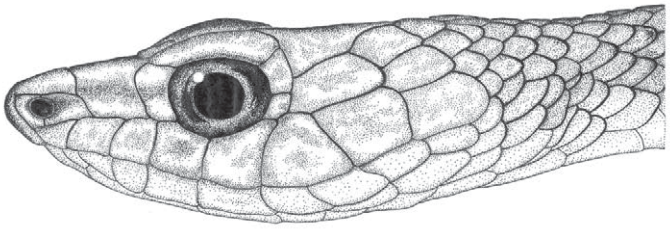
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Leptophis ahaetulla (UMRC 85-25). Mexico: Quintana Roo: 35 km NE Felipe Carrillo Puerto. Illustration by Julian C. Lee.

TECHNIQUES

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Using a Wildlife Detector Dog for Locating Eastern Indigo Snakes (*Drymarchon couperi*)

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The Eastern Indigo Snake (*Drymarchon couperi*), a large (adults from 1.5–2.6 m total length [Stevenson et al. 2009]) diurnal species, is imperiled and federally listed as "Threatened" due to population declines attributable to habitat loss/fragmentation and declining Gopher Tortoise (*Gopherus polyphemus*) populations (United State Fish and Wildlife Service [USFWS] 2008). In southern Georgia and portions of its Florida range, *D. couperi* is closely associated with xeric sandhill habitats and Gopher Tortoise burrows, and adults often use tortoise burrows for overwintering sites (Diemer and Speake 1983; Hyslop et al. 2009a; Stevenson et al. 2003). The burrows of adult tortoises average 4.5 m long and 2 m deep (Diemer 1992), but in aeolian sand ridge habitats (see Ivester and Leigh 2003) adjacent to blackwater streams in southeastern Georgia, burrows are commonly 6.1–9.1 m in length (D. Stevenson, unpubl. data). Adult *D. couperi* are frequently surface-active during the winter and may bask or shed their skins near burrows, or move between burrows, during periods of mild (10.0–16.7°C) temperatures (Speake et al. 1978; Stevenson et al. 2009). Although habitat use is varied and less associated with sandy habitats in peninsular Florida, *D. couperi* occur in xeric uplands and regularly use tortoise burrows as far south as south central Florida (Layne and Steiner 1996). Because of the extensive time they spend in tortoise burrows and other below-ground refugia, adult *D. couperi* are difficult to locate during field surveys. Developing reliable survey methods for this species is an important priority for *D. couperi* research and monitoring efforts (USFWS 2008).

Recent studies demonstrate that detector dogs have potential

as a non-invasive method for locating target wildlife species in their natural habitats (Nussear et al. 2008; Reindl-Thompson et al. 2006; Smith et al. 2003). However, few studies have used detector dogs to survey for snakes. Klauber (1956) mentions a "hound" from Florida that was trained to trail rattlesnakes (*Crotalus adamanteus*) and "bay" them when found; this dog located ca. 500 rattlesnakes in two years. Detector dogs located Brown Tree Snakes (*Boiga irregularis*) in cargo (Engemann et al. 1998, 2002), and, recently, the New Jersey Division of Fish and Game, Endangered Species Program used a trained dog to locate Northern Pine Snakes (*Pituophis m. melanoleucus*) adults and eggs (Dave Golden, pers. comm., 2007).

In an effort to develop an efficient and accurate survey method for locating *D. couperi* in the wild, we conducted a pilot study to test the effectiveness of a trained detector dog at locating Eastern Indigo Snakes. We conducted: 1) experimental field trials to evaluate a trained detector dog's ability to find live *D. couperi* and shed skins of *D. couperi* in the species' natural habitat; 2) actual field surveys, using a trained dog, to survey sites known to support *D. couperi*.

Methods

Dog Selection and Training.—We trained a dog (male, Labrador-mix, 5 years old, 30 kg) on loan from PackLeader Conservation Detector Dogs, Gig Harbor, Washington, USA 98329 to locate *D. couperi* using a combination of detection training techniques. We first introduced the dog to the odor of *D. couperi* at PackLeader in Washington State in October 2008. We randomly placed sections of shed skins (from multiple *D. couperi* collected from the wild in southern Georgia and central Florida) in a large field and allowed them to sit for up to 0.5 h. We then allowed the dog to roam the field, and when the dog showed interest in a shed skin the dog was commanded to sit and was rewarded with its play object (tennis ball). We continued similar shed-skin exercises with the dog over the next two weeks until the dog reliably located the samples.

Next, we trained a handler on the fundamentals of working the dog in the natural habitat of *D. couperi*. We conducted this training at the Orianne Indigo Snake Preserve, Telfair County, Georgia on 17 dates in November, 2008. Well-drained xeric sandhills on-site support resident populations of Gopher Tortoises and *D. couperi*. During this phase of training, we continued field exercises with shed skins and also introduced the dog to the scent of live *D. couperi*.

To train the handler, we set up area-search exercises wherein we hid varying numbers (7–14) of *D. couperi* shed skin sections. The trainer accompanied the handler to point out the dog's working style and to explain the effects of environmental factors on scent. In the first series of exercises, the handler and observer knew the location of the hidden shed skins. Gradually, sheds at undisclosed locations were added to the search area, and the size of the search area was increased (to add time and distance to the search).

When the handler had learned the various changes of behavior exhibited by the dog and could accurately determine when the dog was appropriately "indicating" the location of shed skin from a *D. couperi*, shed skins from several other snake species that are sympatric with *D. couperi* (Eastern Coachwhip [*Coluber f. flagellum*], Florida Pine Snake [*Pituophis melanoleucus mugitus*], and Eastern Diamondback Rattlesnake [*C. adamanteus*]) were added to the exercises. When the dog showed interest in the non-target odors (other than rattlesnake), the handler verbally corrected him off the non-target odor and reinforced on the target odor. When the dog showed interest in rattlesnake odor, the handler administered a physical correction and reinforced on the target odor. The dog quickly learned to avoid rattlesnake odor and to ignore non-target species odors. The dog's avoidance behavior (a "sideways look" at the rattlesnake [or rattlesnake shed] followed by a movement away from the area prior to returning to search mode) was clearly distinctive from the change of behavior it exhibited when expecting a reward for finding the target species. Upon locating the target (i.e., *D. couperi* shed skin), the dog "indicated" by expressing a suite of behaviors including sitting and/or remaining stationary, vigorous tail-wagging, and crouching. We continued training in this fashion until the handler was capable of working exercises independently. The handler and dog found more than 90% of the hidden shed skins during these training exercises.

We conducted several exercises near the end of the training period to introduce the dog to the odor of live *D. couperi* and to the holding cages that we used in the Phase 1 field trials (*see below*). As part of this training, we used both empty cages that never held snakes and occupied cages which held live *D. couperi*. We conducted this training so that the handler would have confidence in the dog's ability to separate these odors. In successful exercises, the dog positively "indicated" on the live *D. couperi* as he did above for shed skins of the species.

Phase 1 Trials.—To assess the dog's ability to recognize *D. couperi* scent, we conducted controlled field tests at one site each in Georgia (Joseph W. Jones Ecological Research Center [JERC], Baker Co., Georgia, USA) and in Florida (Apalachicola Bluffs and Ravines Preserve [ABR], Liberty Co., Florida, USA). To control for the possible effects of wild *D. couperi* present on-site, we selected sites not inhabited by *D. couperi* (Gunzberger and Aresco 2007; Smith et al. 2006; D. Printiss, pers. comm., 2008).

We conducted a total of 108 Phase 1 trials (52 at JERC on 23–25 November 2008; 56 at ABR on 3–5 December 2008). At each site, we evenly distributed trials among a total of four treatments for live *D. couperi* and *D. couperi* shed skins, as follows: 1) Above-ground: A live caged snake was placed on the ground surface within 10 meters of a tortoise burrow; 2) Above-ground: A shed skin (free, not caged) was placed on the ground surface within 10 meters of a tortoise burrow; 3) Below-ground: A live caged snake was placed flush with the entrance of a tortoise burrow, or situated a short distance (≤ 0.5 m or less) inside the burrow tunnel; 4) Below-ground: A shed skin (free, not caged) was placed flush with the entrance of a tortoise burrow, or a situated a short distance (≤ 0.5 m or less) inside the burrow tunnel.

For live snake trials, we used adult *D. couperi* (Total length: 140–200 cm) that we captured by hand from sites in Georgia (N = 3 ♂, 1 ♀) or in Florida (N = 2 ♂, 1 ♀). At our Georgia study site (JERC), we used snakes found in Georgia; similarly, we conducted trials at our Florida study site (ABR) using snakes found in Florida. For shed skin trials, we used recent (< 3 months old) shed skins from adult *D. couperi* found in the wild.

When conducting live-snake trials, we placed one *D. couperi* in a specially-designed, escape-proof holding cage (Herpetological Associates, Inc., Dunnellon, Florida, USA). We constructed two different sizes of holding cages so they would fit into tortoise burrows of varying widths. The smaller cages we made measured 18.3 cm wide, 11.2 cm high, by 61.5 cm in length, whereas the larger cage measured 21.0 cm, 13.0 cm, by 101.5 cm in length. We built holding cages with 15 cm plywood ends, and on one end of the cage we installed a small locking door. We made the walls of the cage of rubber-coated hardware cloth with 1.8 cm square openings. So they would fit into tortoise burrows, we constructed the cages so that the top was arched and the bottom was flat, thus approximating the shape of a tortoise burrow in cross-section.

We placed the cage holding the live snake (or the *D. couperi* shed skin) in the selected test location (i.e., on the ground within 10 m of a tortoise burrow, or just inside the entrance of a tortoise burrow). On field trial dates, we dedicated one individual of our study team to the handling and placement of cages holding live snakes and shed skins to minimize transfer of scent odors; forceps were used to position and retrieve shed skins between trials. We concealed our live-snake-in-cage sets by wrapping camouflage netting around the exposed portions of the cage. On above-ground trials, we positioned cages holding live snakes and shed skins so that they were partially or mostly concealed by ground cover vegetation and not readily visible to the dog survey team/handler.

On each individual trial, we had the dog handler, the handler's field assistant, and the dog visit three tortoise burrows: 1) one burrow with a hidden target (i.e., either a live snake above-ground, a live snake below-ground, a shed skin above-ground, or a shed skin below-ground); 2) one burrow that was empty (i.e., no hidden targets), and; 3) one burrow that was either empty (all shed skin trials) or, for all live snake trials, one burrow with a control (i.e., an empty cage hidden above or below-ground—to verify that the dog was not indicating on the cages). We conducted trials in sets of four, in varying order: snake above-ground; snake below-ground; shed skin above-ground; shed skin below-ground. To ensure that the dog was not following human scent or keying on flags, we marked all tortoise burrows used in these field trials with similar-colored flagging tape tied to nearby vegetation, and we had a supporting biologist introduce human scent at all burrows (by rubbing his hand over the sand inside the burrow and on the apron) while setting up trials. We removed the dog and handler from the immediate area (i.e., minimum 100 m distant) when preparing trial sets. We allowed our live snake and shed skin sets to sit for ca. 10–20 minutes to allow some airborne scent dispersal before bringing the dog and handler to the area.

Next, we had the handler lead the dog to each of the three burrows that constituted an individual trial. We classified a particular trial as successful if the dog correctly indicated the presence of an indigo snake or shed; those trials where the dog did not indicate at/near burrows where we had hidden a snake or shed skin we classified as errors of omission; trials where the dog indicated at/near burrows where we had not hidden a snake or shed skin we classified as commission errors. On all Phase 1 trials, the dog handler was accompanied by a field assistant who helped orient her and lead the dog to trial burrow locations.

We used data from these trials to calculate the proportion of trials where the dog successfully signaled on live *D. couperi* or shed skins. We used a Chi-square goodness of fit test to compare dog success among the four treatments (Above Ground-Live Snake, Above Ground-Shed Skin, Below Ground-Live Snake, Below Ground-Shed Skin). We further classified unsuccessful trials by calculating the proportions that were omission versus commission errors.

Phase 2 Trials.—For the second part of our study, the dog and handler conducted 1-h long field surveys for *D. couperi*. We surveyed non-overlapping xeric sandhill sites that supported numerous active/inactive tortoise burrows and resident, overwintering *D. couperi*. We conducted a total of 26 1–h long trials (2–4 trials per survey date) on nine dates from 8–23 January 2009 at a total of seven sites: Fort Stewart Military Installation (FSMI), Bryan Co., Georgia (N = 3); FSMI, Evans Co., Georgia (N = 3); Broxton Rocks Preserve, Coffee Co., Georgia (N = 5); General Coffee State Park, Coffee Co., Georgia (N = 3); Orianne Indigo Snake Preserve, Telfair Co., Georgia (N = 3); Withlacoochee State Forest, Citrus/Hernando counties, Florida (N = 7); Chassahowitzka Wildlife Management Area, Hernando Co., Florida (N = 2).

Prior to beginning the surveys, we presented the dog survey team (comprised of the dog, the dog handler and her field assistant) with an aerial photograph of the survey site, oriented them with respect to nearby primitive roads, wetlands, and other landmarks, and defined the area of potential habitat to be surveyed. We did not flag tortoise burrows. We then directed the dog survey team to search for one full hour; the dog team made a single pass through each survey area, attempting to visit and search all tortoise burrows they could locate. The field assistant used a compass and aerial photo to orient the dog and the dog handler and keep them on a steady compass bearing. The dog team began the survey at the downwind end of the survey area and progressed upwind, maximizing the dog's exposure to possible *D. couperi* scent. We conducted these surveys from mid-morning through mid-late afternoon on clear or rain-free days (i.e., weather conditions that would prove suitable for *D. couperi* surface activity).

If the dog indicated at the entrance of an individual tortoise burrow (suggesting the presence of a live *D. couperi* or recent shed skin within the burrow), we immediately scoped the burrow with a remote video camera attached to a 9 m section of tubing (Gopher Tortoise Burrow Camera, Southern Ecosystems Research, Auburn, Alabama, USA) in an effort to determine the presence of a live *D. couperi* or shed skin. If *D. couperi* were not documented, we placed a large single-opening funnel trap at the mouth of the burrow in an effort to capture any resident *D. couperi* as they exited the burrow. We shaded funnel traps and checked them 2–3 times per day during daylight hours.

Results

Phase 1 Trials.—The detector dog was correct on 91% (98 of 108) of the Phase 1 trials. Overall, the dog was more successful during shed skin trials than during live snake below-ground trials ($\chi^2 = 13.928$, Df = 3, P = 0.003). The dog was correct in all (100%) of 54 shed skin trials—both above-ground and below-ground. Of the live snake trials, the dog was correct 81% of the time (44 of 54 trials), with 88% success (23 of 26 trials) on above-ground trials,

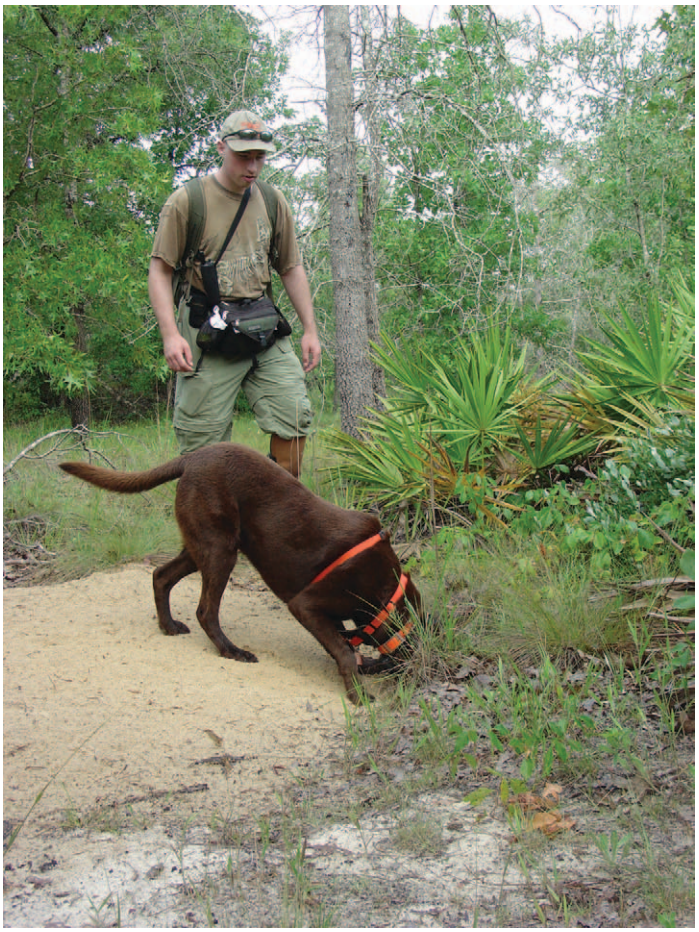


FIG. 1. A specially trained wildlife detector dog ("C.J.") surveys a Gopher Tortoise (*Gopherus polyphemus*) burrow for Eastern Indigo Snakes (*Drymarchon couperi*), Wheeler County, Georgia, USA. Photo by Dirk J. Stevenson.

and 75% success (21 of 28 trials) on below-ground trials. Thirty percent (3 of 10) of the unsuccessful trials were commission errors, all of which occurred on below-ground trials, while 70% (7 of 10) of the unsuccessful trials were omission errors, four of these were below-ground trials.

Phase 2 Trials.—On 26 1-h long Phase 2 trials, the dog team surveyed a total of 496 active/inactive Gopher Tortoise burrows at seven sites. During these surveys, the dog located 11 individual *D. couperi* shed skins and indicated at another 18 tortoise burrows. Seventeen of these 18 burrows were examined with the tortoise burrow camera; *D. couperi* were observed in three separate burrows at distances of 3.7, 6.7, and 7.0 m. All of the remaining burrows were trapped from 2–10 days; no *D. couperi*, or any other snakes, were captured by these efforts.

DISCUSSION

Our study suggests that wildlife detector dogs have value as a field survey method for the Eastern Indigo Snake (*D. couperi*). During controlled field tests (Phase 1 Trials), the detector dog used in this study successful located 81% of live *D. couperi* and 100% of *D. couperi* shed skins.

The dog had very little field training with live *D. couperi* prior to Phase 1 trials, and we strongly suspect that the dog would have performed better with additional training with live snakes prior to these trials. During informal training exercises and field surveys conducted 10 December 2008–27 January 2009 at the Orianne Indigo Snake Preserve (Georgia), the dog found seven individual *D. couperi* (a total of 11 times) on the surface near tortoise burrows, and four *D. couperi* below-ground in tortoise burrows. Additionally, the dog indicated at the entrances of 12 tortoise burrows, four of which were confirmed (by scoping with the tortoise burrow camera) to contain *D. couperi*.

On Phase 2 Trials, the dog confirmed the presence of *D. couperi* at 6/7 sites surveyed, finding three *D. couperi* below-ground inside tortoise burrows and 11 *D. couperi* shed skins above-ground. However, the dog may have falsely indicated snake presence at some of those Phase 2 tortoise burrows where he signaled the presence of a snake below-ground inside the burrow (N = 15). Despite our lack of success in documenting *D. couperi* via burrow camera and trapping surveys, we cannot say conclusively that *D. couperi* were not present in these burrows. Although *D. couperi* are occasionally observed by tortoise burrow camera surveys, scoping burrows is unreliable at detecting the presence of *D. couperi* because the terminus of many burrows cannot be reached with a burrow camera due to burrow length, burrow curvature, inanimate obstacles (e.g., plugs of pine straw, tree roots), or the presence of the resident tortoise partway down the tunnel shaft blocking progress of the camera (Smith and Dyer 2003; Stevenson et al. 2003).

Eastern Indigo Snakes have been documented by the following field methods: 1) visual encounter surveys at or near tortoise burrows in sandhill habitats (Diemer and Speake 1983; Stevenson et al. 2009); 2) single-opening funnel traps placed at the entrances to tortoise burrows (Lips 1991); 3) motion-activated cameras placed at tortoise burrows (Alexy et al. 2003); 4) remote video cameras ("tortoise burrow cameras") to examine the interiors of tortoise burrows (Hipes and Jackson 1996; Stevenson et al. 2003); and 5) drift fence arrays using large "box" traps (Hyslop et al. 2009b). Except for visual encounter surveys, most of the survey methods listed above are either not particularly effective and/or are extremely labor-and-time-intensive (Hyslop et al. 2009b; Smith and Dyer 2003). In southern Georgia, visual encounter surveys at tortoise burrows conducted by experienced herpetologists are often effective in locating *D. couperi* (and *D. couperi* sheds) during the cooler seasons (Hyslop et al. 2009b; Stevenson et al. 2003, 2009). However, human searchers vary in the speed at which they visit burrows, their ability to accurately discern snake tracks, and their ability to spot snakes on the surface (Hyslop et al. 2009b).

Both canine surveys and visual encounter surveys may locate live *D. couperi* or shed skins on the ground near tortoise burrows. During field training, the dog found several live *D. couperi* under natural conditions on the surface that were basking cryptically (e.g., under branches or vegetation) near tortoise burrows. And, in both training and during trials the dog often located small fragments of old *D. couperi* shed skins (hidden under debris or vegetation) that went unnoticed by human surveyors. Our study also indicates that a trained detector dog may locate *D. couperi* deep inside tortoise burrows via olfaction. Our dog was able to survey for snakes ca. 4 hours/day; frequent hydration and rest breaks were needed, and the dog did not perform well in hot

weather (i.e., > 23°C). Excessive panting during hot weather affects olfactory abilities and may lower detection rates (Smith et al. 2003). In some disturbed sandhill landscapes where native prickly pear cactus (*Opuntia* sp.) and blackberries (*Rubus* sp.) were especially abundant, the dog experienced difficulties due to abrasions to his paws from thorns. Experienced human searchers (i.e., visual encounter surveyors) often discern indigo snake tracks in the sand of tortoise burrow aprons (Stevenson et al. 2009), and visit and survey tortoise burrows at ca. twice the rate of a dog escorted by its handler and one field assistant (this study).

Possible explanations for dog errors in the field include insufficient training, mistakes due to handler errors (e.g., inadequate search), fatigue, and distractions due to encountering novel scents or wildlife species. Inappropriate weather (e.g., windless days and days following heavy rains) may also have influenced the dog's success.

Detector dog surveys were 61% and 64% successful in detecting the presence of Brown Tree Snakes planted in outbound cargo during 1998 and 1999, respectively (Engemann et al. 2002). In cases where the snakes were not located by dogs, twice as many were missed because the dog did not change its behavior in response to the snake rather than because the handler did not conduct an adequate search pattern (Engemann et al. 2002).

This study, a pilot effort, suggests that specially trained wildlife detector dogs are sometimes able to locate *D. couperi* in the wild, and the effectiveness of these "canine surveys" may be enhanced if conducted in concert with other techniques (e.g., visual encounter surveys of Gopher Tortoise burrows). Additional study will reveal whether canine surveys have value at sites where *D. couperi* is present in very low numbers, during periods when the species is not surface-active, or in habitats lacking Gopher Tortoise burrows. The detector dog used in this study located (under natural conditions) live *D. couperi* on the surface and below ground in Gopher Tortoise burrows, and frequently found shed skins that were overlooked by human searchers. Improved survey methods will enable researchers to better determine the distribution of this imperiled species, especially in regions where the species is now seemingly extremely rare or locally distributed (Florida panhandle [Gunzberger and Aresco 2007]), and may assist in developing a defensible presence/absence survey method for development projects.

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Visible Implant Elastomer: A Simple, Non-Harmful Method for Marking Hatchling Turtles

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Effectively marking hatchling freshwater turtles is challenging because hatchling turtles are typically small, but increase significantly in size by maturity (Plummer 1979). Ideal marks are minimally invasive, with zero or low impact on survival, are correctly identifiable upon recapture, do not affect recapture probability, remain recognizable for the length of the proposed study, and are reasonably affordable (Gibbons 1968; Plummer 1979). Marks must also remain detectable through significant growth, given turtles' dramatic increase in size between hatching and maturity. In reality, very few marking methods meet all of these criteria. Here, we discuss the merits and pitfalls of various marking methods for use in hatchling turtles. Also, we describe the use of visible implant elastomer (VIE) to mark hatchling turtles and summarize potential areas of concern regarding the use of VIE for hatchling turtles.

Why mark hatchling turtles?—Marking is useful for studying population dynamics and ecology of hatchling turtles. It is essential for monitoring "head-start" programs and related conservation endeavors. Turtle head-starting programs include *ex situ* incubation of eggs and may also involve maintenance of hatchlings in captivity until they reach a pre-determined size or age. Well-planned and carefully managed head-start programs mitigate nest predation and are potentially powerful tools for turtle conservation in populations threatened by limited recruitment (e.g., Moll and Moll 2000). Nonetheless, *ex situ* incubation and head-starting programs do not always include a post-release evaluation of their efficacy (Seigel and Dodd 2000). In the absence of post-release monitoring it is difficult or impossible to determine the effect of the program on the population(s) in question. Evaluating the success (or shortcomings) of such programs requires marking turtles to compare survivorship between nests incubated *in situ* and *ex situ.*

Consistent evaluation of the success of head-starting and other applied conservation programs (e.g., translocations, predation mitigation, and habitat restoration) allows researchers to adjust their methods to maximize success and address shortcomings as they are identified. In cases where a project is not having the desired effect, ongoing evaluation allows researchers to identify factors which merit further investigation. If a program is truly ineffective (for example, due to high mortality of released animals, or failure of head-started animals to function successfully in the wild), cancelling the program in a timely fashion minimizes the waste of precious resources. Program evaluation requires marking head-started hatchlings for post-release monitoring.

How should hatchling turtles be marked?—Several marking methods are used for adult turtles, including branding (Woodbury and Hardy 1948), paint-marking (Tinkle 1958), shell-notching (Cagle 1939), wiring metal identification plates through holes drilled in the marginal scutes (Carr 1967), tattooing (Breckenridge 1955; Woodbury 1948), flipper-tagging with plastic or metal livestock tags (e.g., Carr 1967), or passive integrated transponder (PIT) tags (e.g., Camper and Dixon 1988; McDonald and Dutton 1996). None of these methods are ideal for use with hatchling turtles.

Branding is not a reliable method, because if the brand penetrates the dermal layer, the shell may regenerate so efficiently that the brand is no longer clearly visible (Clark 1971; Woodbury and Hardy 1948). The rapid growth of hatchlings might enable them to heal over branding scars more quickly than adult individuals, further obscuring marks. Paint-marking is a useful short-term method, but the marks typically do not last longer than a few months and thus are not useful for long-term monitoring programs (Plummer 1979). Shell notching can be used on hatchlings, but their rapid growth may obscure the notch before they are re-encountered, and shell injuries sustained during growth may mimic a grown-out notch, thereby confounding individual identification (Plummer 1979). Hatchlings are too small to wire metal plates to the carapace. Thin wire tags with beads which were threaded through the marginal scutes of hatchling *Chelydra serpentina* were lost at a rate of 2.5% per week in the laboratory (Galbraith and Brooks 1984). Tattooing is useful with some adult turtles, but in hatchlings, the dye granules may spread as they grow, rendering the tattoo illegible (Plummer 1979). Flipper tags are widely used in adult marine turtles (e.g. Carr 1967), but they are of no use in species which do not have flippers, and they are too large and heavy for hatchling turtles. Finally, PIT tags have great potential for juvenile and adult turtles. However, it is debatable whether PIT tags are small enough to use safely in hatchlings of most species (Buhlmann and Tuberville 1998; Gibbons and Andrews 2004). Some studies have successfully applied PIT tags to small turtle hatchlings (e.g., Rowe and Kelly 2005), but regardless of researchers' opinion regarding their size, PIT tags are expensive. The very real possibility of low recapture rates make the financial investment required to obtain PIT tagging

equipment difficult to justify when large numbers of hatchlings must be marked for release into the wild. Thus, the methods listed here have major drawbacks when used to mark hatchlings and as a result it can be difficult to accurately determine survivorship and recapture rates for hatchling and juvenile turtles.

We tested marking hatchling turtles using VIE (Northwest Marine Technology Inc., Shaw Is., Washington, USA), a biocompatible, flexible plastic originally developed for use in the fisheries industry. Marks made with VIE have been successfully used to study frogs, salamanders, snakes, and lizards (e.g., Bailey 2004; Daniel et al. 2006; Davis and Ovaska 2001; Hutchens et al. 2008; Moosman and Moosman 2006; Regester and Woosley 2005). No adverse effects have been recorded on these species and tag loss was generally low (Ferner 2007). Park et al. (2007) evaluated the use of VIE for marking adult Chinese Softshell Turtles (*Pelodiscus sinensis*) on a turtle farm in Korea. Marks placed in the webbing between the digits of adult *P. sinensis* were retained well and were clearly visible several months after application, although marks placed in the adipose tissue of the eyelid were either lost or obscured at a high rate. They observed no adverse effects from the marks.

The elastomer is prepared by mixing a curing agent with a brightly colored liquid polymer directly before application. A small amount of the mixture is injected under the skin, leaving a visible colored dot or short line. While visibility to the naked eye is highly dependent on the coloration of the study organism and the color and placement of the elastomer, the marks fluoresce under ultraviolet (UV) light and are easily visible.

A VIE mark is non-toxic, light-weight, and based on the studies listed above, it is unlikely to impact survivorship. Because a single color kit can mark at least 700 turtle hatchlings and currently costs US $252, the cost is less than US $0.40 per mark. Placing multiple VIE marks in the front and hind legs, plastron, tail or toe webbing and using a combination of differently colored marks allows for marking schemes that identify the clutch of origin, year of hatching, or even individual hatchlings. The availability of several different colors of fluorescent elastomer is also useful for marking multiple clutches uniquely for future identification: Northwest Marine Technologies currently offers ten colors, six of which fluoresce under UV light. Below, we evaluate the use of VIE as a marking method for hatchling turtles. To our knowledge, VIE has not been previously used to mark hatchling turtles.

Methods

Before applying VIE to hatchling turtles, the method was tried on two captive adult turtles at Reptilia (a reptile zoo in Vaughan, Ontario). We marked one adult female Loggerhead Musk Turtle (*Sternotherus minor*) and one adult female Red-bellied Short-necked Turtle (*Emydura subglobosa*) with red VIE. Marks were injected subcutaneously on the ventral surface of the left hind leg using a sterile 0.3 cc syringe with a 29-gauge needle. Both animals were monitored on a daily basis by zoo staff and no ill effects were reported. The *E. subglobosa* was moved out of the zoo nine months after the mark was injected, at which time the mark was still clearly visible. The mark on the hind leg of the *S. minor* was clearly visible to the naked eye 18 months after injection. Under fluorescent light it was extremely bright and could not be mistaken for anything else (Fig. 1).

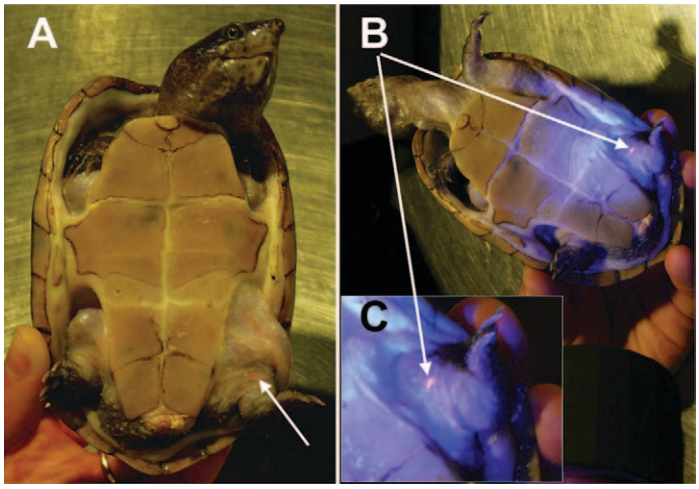


Fig. 1. Adult female Loggerhead Musk Turtle (*Sternotherus minor*) showing red visible implant elastomer mark in left hind leg (arrows). A) Mark is visible under standard room lighting or sunlight as a red dot. B) The mark fluoresces and is clearly visible under a hand-held ultraviolet light. C) Close-up of B.

We applied VIE marks to hatchling Snapping Turtles (*Chelydra serpentina*) during a research program conducted in part at the Pinery Provincial Park (Ontario, Canada) which involved *ex situ* incubation. After hatching, neonates were maintained in clean, humid tubs until they had completely absorbed their yolk sacs. They were then kept in shallow water with aquatic plants (*Elodea canadensis*) for shelter. Neonates (N = 301) were marked with red VIE within two days of hatching using a 0.3-cc syringe with a 29 or 30-gauge needle. Needles were cleaned with ethanol between applications. Enough elastomer was injected to leave a short line (approx. 2 mm long) or a small dot (approx. 1 mm diameter) beneath the skin in the underside of the hind leg or on the plastron.

Marked individuals were kept for a minimum of 24 h observation

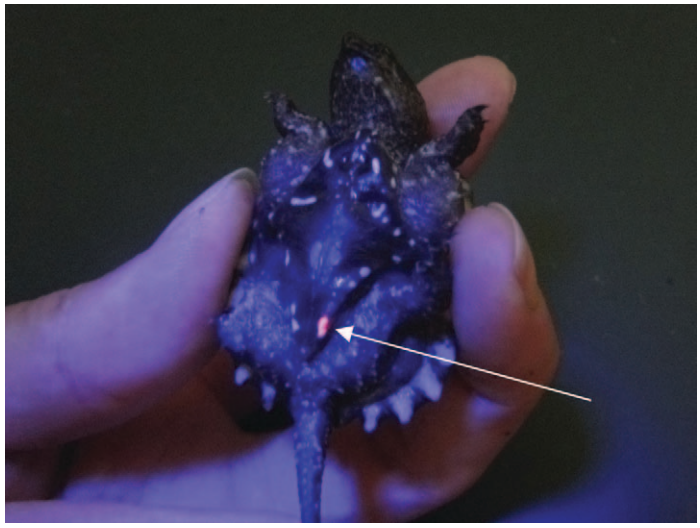


Fig. 2. Ventral view of a juvenile Snapping Turtle (*Chelydra serpentina*) found 11 months after hatching, marking and release. The red visible implant elastomer mark in the plastron (arrow) fluoresces under a handheld UV light.

(24–120 h; mean = 72 h) to monitor possible reactions to VIE marks. VIE marks may break apart, spread, move around under the skin, or be expelled (Heemeyer et al. 2007; Hutchens et al. 2008), so this period was also used to monitor for mark loss or changes in mark visibility or placement in the first few days post-marking. Hatchlings were released at the site of their original nest chamber within 24–72 h post-marking and allowed to enter the water themselves. In 2009, 301 hatchlings were marked and released. Eighty-four of these were released into the Pinery Provincial Park, where subsequent hatchling surveys were carried out, while the others were released at their original nest sites. The location of these releases varied, but all were sufficiently distant from the park (10–120 km) that dispersal back into the park was unlikely.

In 2009, two live embryos were found while opening unhatched eggs at the end of the season (unhatched eggs were opened a minimum of 30 days after the last successful hatch from the clutch). These embryos were kept in the same conditions as normally pipping hatchlings until they had absorbed their yolk sacs and both survived. By this point it was too late in the year to release them as frost had already set in. The hatchlings were marked and overwintered in a paludarium at the Pinery Provincial Park and both were released the following spring.

Results

No mortality or adverse reactions were observed following marking of hatchlings. No inflammation or tissue discoloration was observed around the marks. No evidence of mark breakdown, spread of VIE during curing, or mark expulsion was observed between marking and release and marks were clearly visible when fluoresced with a hand-held UV light (Northwest Marine Technology Inc., Shaw Is., Washington, USA) at the time of release. All hatchlings displayed normal behaviors when released. The two hatchlings which had overwintered in captivity grew quickly (as expected in captive turtles provided with high-quality food) and had doubled in straight-line carapace length by the time they were released in early May. The VIE marks in their hind legs were clearly visible under UV light at this time, despite their rapid growth.

During surveys for juvenile Snapping Turtles in Pinery Provincial Park from 23 June to 3 July 2010 (69.9 survey hours), we found 17 juveniles within the size range expected for hatchlings released in 2009. Four had VIE marks clearly visible in the left hind leg and two had been marked on the plastron (Fig. 2). None of the marks in the leg had broken down, but one of the plastral marks appeared to have split into several pieces, possibly due to the turtle's growth. Despite changing in shape, the plastral mark was still clearly visible.

It is possible that juveniles found in 2010 that did not have visible VIE marks were in fact released turtles which had lost their marks. We are currently incorporating Decimal Coded Wire Tags (Northwest Marine Technology Inc.) into our mark-recapture study to allow for more accurate estimations of the rate of VIE mark loss in turtles and we are not able to estimate exact rates of mark loss at this time. However, in our experience it would be unlikely to find only released juveniles during our surveys.

Fluorescent food for thought.—Researchers who plan to use VIE to mark hatchling turtles should consider the following in their experimental design. First, the rate of VIE mark loss in turtle hatchlings must be more accurately quantified and may differ among species. Second, it is possible that the rapid growth rate of juvenile turtles will cause the marks to be overgrown and obscured. Although the marks remained visible in both the two hatchlings that overwintered in captivity (which doubled in size), and although they were visible after ten months in recaptured hatchlings which had overwintered naturally, we have no way to accurately gauge the rate of mark loss at this time. Both of these concerns can be addressed by applying multiple marks to each hatchling (study in progress).

If mark loss were high in the first few days post-marking, application of Liquid Bandaid over the injection site might increase mark retention. Liquid Bandaid or cyanoacrylate glues are commonly used to increase PIT tag retention in snakes (e.g., Koons et al. 2009) and Liquid Bandaid has been suggested as a method of increasing VIE retention in snakes (Hutchens et al. 2008). However, we did not experience any mark loss during the first few days after marking. Therefore, we chose not to apply Liquid Bandaid to the injection site in order to avoid introducing further chemicals onto the hatchlings' skin and to avoid sealing potential pathogens into the healing injection sites.

In summary, VIE marks provide a simple, cost-effective way to quickly and non-harmfully mark large numbers of turtle hatchlings for mark-recapture studies, including evaluation of head-starting methods. Marks made with VIE are completely unambiguous; however, quantitative analyses of the rate of mark loss are still required. Marked turtles should be easily identifiable for at least the first year and if recapture rates are very low (or nonexistent), the VIE marks do not represent a significant loss of resources.

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Suggestions on Photographing Crocodile Skulls for Scientific Purposes

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In cranial morphometrics, an effective way of obtaining data for analyses is by using photographs or drawings. With an average digital camera, computer and software it is now possible to extract extensive information on size, shape, location, surface area, and color. Existing photographs or drawings, however, may not always be suitable for metric comparisons because of optical distortion, light conditions, the background used, or inconsistency in type and position of the camera or skull (Friess 2003). Ideally an applicable standardized method would be used in all photo-documentation and photographic research. For practical purposes, however, a proper and complete documentation of exact methods used would allow other authors to use the information or convert the acquired data to match theirs.

We describe and discuss a method, used successfully in previous morphological research on crocodile skulls (Pearcy, unpubl. data), with regard to applicability and effectiveness. Crocodilian skull morphometric studies are becoming more frequent (e.g., Pierce et al. 2008; Piras et al. 2009; Sadleir and Makovicky 2008), and therefore there is need for such methods' description. Object orientation with respect to the camera, optical distortion, and materials used are discussed.

General Setup and Materials

Skulls were placed on a floor using a black towel as background. We used a Panasonic Lumix DMC-FX107 digital camera set to intelligent AUTO mode, 3072 x 2304 pixels, JPEG/Exif format. The camera was screwed on an adjustable aluminum tripod placed on the floor positioned directly over the skull. For each picture the camera was set to automatic-mode with a two-second timer to prevent movement blur from pressing the shutter button. The lens range was 28–102 mm and aperture range F2.8–F5.6. The grid in display option enabled a non-essential but convenient way of lining up specimens within the field of view.

The tripod's center column and head were inverted, so the camera on the saddle plate was centered between the legs of the tripod directly perpendicular to and facing the skull. Because crocodile skulls have a wide range of height, distance from specimens had to vary arbitrarily from 40–120 cm for convenience.

Orientation of Subject and Camera

Dorsal view cranium.—This view is most commonly used for comparative studies between crocodilian species (Fig. 1).

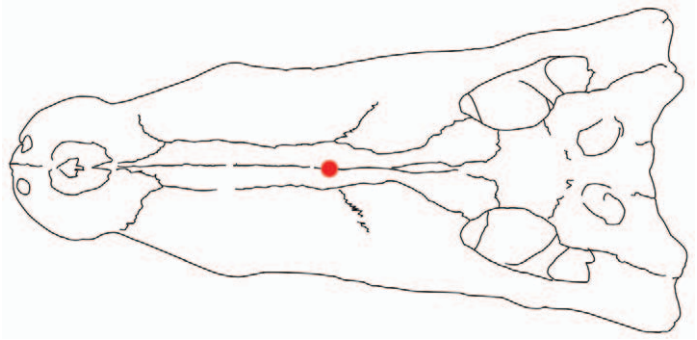


FIG. 1. Dorsal view of the cranium. The red dot shows the center point along the midline of the skull and the focus point of the camera.

The cranium rests upon its pterygoid flanges and front teeth or alveolus and is leveled along the midline from cranial table to tip of snout. Where necessary, the skulls were also leveled along the cranial table width-wise. Black towels were rolled up into appropriate thicknesses and placed under skulls to raise them to the desired height. The focus point (red dot) was on the center of the midline.

Ventral view cranium.—For this view of the skull, the tip of the snout posterior to the premaxillary tooth row is made level to the back of the skull along its midline (Fig. 2). Focus point remains the same as that of the dorsal view of the cranium.

Occipital view.—For this shot, the skull is leveled along its midline as it was for the dorsal view (Fig. 3 a–b). The lens focus point is the tip of the vertebral condyle.

Lateral view cranium.—The skull is laid flat without leveling, with its lateral axis perpendicular to the view of the camera (Fig. 4a). In this way, the snout and posterior portion of the skull can be compared. The focus point is halfway between the tip of snout and the back of cranium (Fig. 4b).

Dorsal/Ventral view lower jaw.—This view can be used for the study of the mandibular symphysis and other basic jaw studies (Fig. 5). For the dorsal view, the lower jaw is leveled from the inside of the front teeth to the inside of the back of the jaw, resting on the mandibular ramus indentions. For the ventral view, the leveling remains from the tip of snout to the back of jaw. Again, the focus point is the center of a virtual midline along the length between the mandibular symphysis and the back of the jaw.

DISCUSSION

In this discussion we will elaborate on the methods used and where applicable consider other options and improvement.

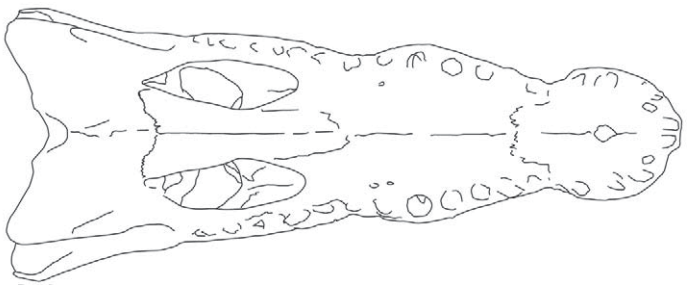


FIG. 2. Ventral view of the crocodile skull.

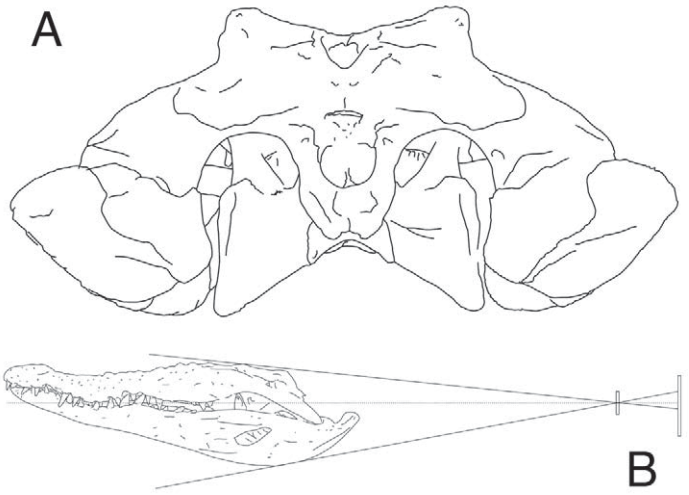


FIG. 3. Occipital view of the cranium (a) and the leveling of the skull for the focus point (b).

Generally, methods chosen are based on the intended measurements of study. We state, however, that in many situations using a general standardized method when photographing crocodile skulls would optimize the use of a photograph and thus be preferable. The methods can, of course, be adapted for photographing dorsoventral topography of other large tetrapods.

Leveling a skull in general makes for a repeatable method. The lifting of the skull in dorsal perspective allows for the view of the front end of the tip of the snout instead of just the top end of the snout. Error from not leveling the skull is dependent upon a skull's size. A *Crocodylus acutus* with a real maximum cranial length of 80 cm will appear to be about 2.5 cm shorter in any picture when not leveled; the same measurement on a *Crocodylus johnstoni* would only be off by about 1 cm. Not leveling the skull in ventral view, a technique applied often, is obviously more convenient and would show more of the skull; however, this makes extracting measurements from pictures nearly impossible due to depth differences. Positioning of the skull in occipital view is, as far as we are concerned, a matter of individual choice. Depth differences are relatively large, thus this view is not normally used. We chose to level the skull to have a better view of the tip of the vertebral condyle as a reference point. Artificially adapting the position of the skull when resting on a horizontal surface in side

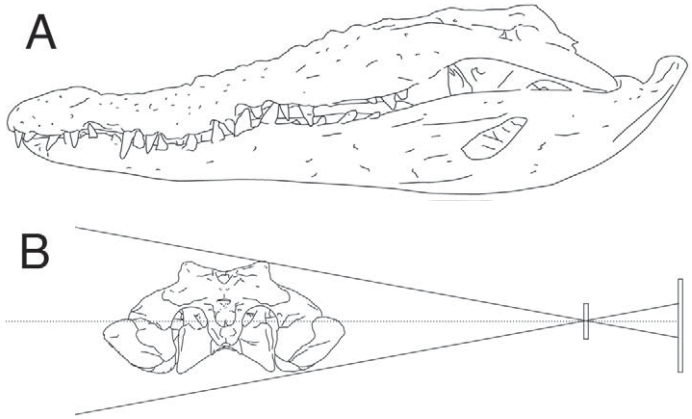


FIG. 4. Lateral view of the skull (a) and the aim of the camera (b).

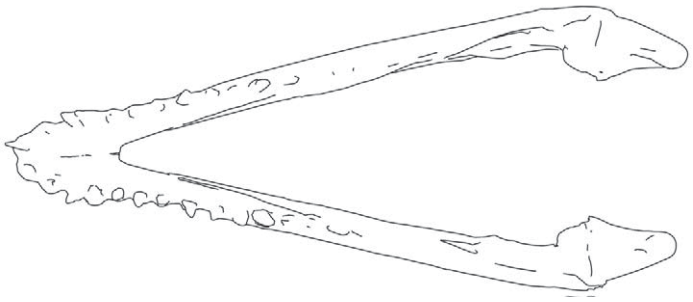


FIG. 5. The lower jaws of a crocodile skull. While this diagram is from the dorsal view, the ventral view is similar.

view would expose more of the lower jaw and less of the upper, although the effect is very minimal due to the flattened skull of a crocodile, rendering such actions virtually useless. In dorsal view of the lower jaw, we leveled the jaw in a repeatable way. Apart from enhancing accuracy of later distance measurements, this action also exposes an often researched subject—the teeth and their sockets—more evenly.

Any optical lens leads to distortion of the absolute and relative dimensions of an object like a skull. The outer edge of the skull will be invisible in a central projection, affecting absolute dimensions. Furthermore, objects that are closer to the focal point will appear relatively bigger than they are compared to portions that are further away, thereby affecting the proportions of the object. Practically speaking, taking a picture of a cranium with a distance of one meter results in a distortion of a maximum of 7.5% (Jacobshagen et al. 1988) and so-called barrel or pincushion distortion is negligible using everyday lenses. Most distortions can be avoided by applying stereophotographic techniques. Another commonly used technique relies on resorting to reference objects–a ruler for instance–from which sizes can be related to later, but the reference object must be at the same height as the surface being photographed in order to minimize error. We believe, however, that in the interest of applicability, increasing the distance between the camera and the object, which significantly reduces the photographic error, or resorting to mathematical solutions like a Generalized Procrustes Analysis (Bookstein 1996; Rohlf 1999) as we did, is a more preferable solution. Also, in many situations, adapting one's methods to render optical error irrelevant is the best solution.

Backgrounds, for most purposes, must be in contrast to the subject as much as possible. For the generally white skulls, we used a black towel. Contrast decreases ambiguity between skull and background, and darker backgrounds will reduce the number of artifacts caused by shadows or reflection. Both lead to more precise definition. However, in some situations using a background color that is unlikely to be present in the subject might be worth considering, as software would then be able to filter this color independent of the subject color.

With the accuracy of distance measurements roughly increasing with the square root of pixel depth, we consider a 7 Megapixel camera, giving an estimated error of 0.05 cm on an 80 cm specimen, about the minimum for most applications with crocodile skulls. The tripod may not always be a necessity. It does, however, lend stabilization to the camera, especially important in self-timed shots.

Not all studies have the funding to use stereographic techniques or even CT-scans, which would reduce distortion completely, and allow for a comprehensive assessment of measurements. The methods presented here are cost-effective, while reducing distortion. Museums and conservation groups can follow these methods for their databases in order to have a comparable method, repeatable by anyone with a digital camera and material for a background. If not applied, at least the description presented herein should serve as an example to the extent required to allow other researchers to convert their data into comparable material.

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PIT Tag Migration in Seaturtle Flippers

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Marking individual animals in wildlife studies is essential and plays a vital role in furthering our knowledge of animal populations. Mark and recapture studies delineate ranges and migratory movement patterns, help identify which populations use feeding and breeding grounds, and can contribute to vital rates where animals can be encountered across time during breeding events. Marine turtle studies also have benefited from marking of animals. External tags have long been used to mark individual nesting turtles, juvenile and adult turtles in benthic, oceanic and neritic foraging habitats (Godley et al 2003; Limpus et al. 2009; Mortimer and Carr 1987; Schmid 1998). However, some external tags have been found to cause harm or reduce the survival of an individual (Nichols et al. 1998). In addition, external tag loss is common and decreases the rate at which previously tagged individuals are identified (Balazs 1982; Bjorndal et al. 1996; Henwood 1986; Limpus 1992). Consequently, in recent years, use of Passive Integrated Transponder (PIT) tags, also termed Radio Frequency Identification tags, has increased (Balazs 1999; Broderick and Godley 1999). A PIT tag is a tiny electronic microchip encased in a glass capsule that is inserted under the skin or into muscle. It is passive until interrogated with an external tag reader, and then it briefly transmits a unique identification number to a receiver. Studies examining the feasibility and ease of PIT tag use determined that PIT tags have a much greater retention rate than external tags and increase the reliability of re-identifying tagged animals (Balazs 1999; Braun-McNeill et al. 2003; Dutton and McDonald 1994) when tag readers are on hand. Due to the subcutaneous placement of PIT tags, internal complications that result after insertion may occur. To date, surprisingly few studies have examined this aspect of PIT tag use in seaturtles (van Dam and Diez 1999).

The negative effects of PIT tags on wild animals are often difficult to determine. Once seaturtles have been tagged, they are released (usually immediately) back into the environment where they spend most of their lives beyond the reach of researchers. PIT tags are designed to minimize internal complications through the use of a glass protective coating. Although this glass casing serves to both protect the electronic components and prevent tissue irritation (Gibbons and Andrews 2004), there are some reports of visible infection and irritation at the PIT tag injection site despite proper use of disinfecting techniques during insertion in marine turtles (Dutton and McDonald 1994), manatees (Wright et al. 1998), and fish (McKenzie et al. 2006). Along the Atlantic Coast of the U.S., reports of tag-related infection and joint injuries appear in stranding data (New England Aquarium [NEAq], unpubl. data). While there are many advantages to using PIT tags (Balazs 1999; Gibbons and Andrews 2004), recognizing risks and advantages associated with different tagging sites will enhance the quality of studies relying on this marking method. As all seaturtle species are considered imperiled (IUCN listing varies with population), there remains a need to recognize impacts on the health, physiology, and ultimately the survival of PIT-tagged turtles.

The use of PIT tags is usually benign. When tags are placed into muscle, the cutting edge of the applicator needle makes a small circular cut that extends to the depth of the injection. The tags induce encapsulation by fibrous connective tissue, which stabilizes their placement. Encapsulation is most rapid and effective in highly vascular, resilient tissue such as muscle. While the injection causes a small cut in the muscle, it is the responses by fibroblasts and muscle cells to this minor damage that result in largely stable tags. When the tags do not stay where placed, they can be expelled from the body or migrate internally causing inflammation and damage and opening a route to infection. PIT tag movement has been documented in bats (Barnard 1989), young birds (turkey poults; Jackson and Bunger 1993), reptiles and amphibians (Camper and Dixon 1988; Keck 1994), and fish (Baras et al. 2000, Gheorghiu et al. 2010). Baras et al. (2000) found that PIT tags injected into perch migrated ventrally over time. PIT tag movement also has been reported in Hawksbill (*Eretmochelys imbricata*) seaturtles (van Dam and Diez 1999). Not only can the migration of the tag reduce the re-identification accuracy, it may cause injury. The risk of complications can be minimized by the location and method of tag placement (Germano and Williams 1993; Gibbons and Andrews 2004; Jackson and Bunger 1993). In cheloniids, PIT tags usually are inserted via injection using an applicator fitted with a sterile 12-gauge needle. The most common PIT tagging sites used in the U.S. Atlantic and Gulf of Mexico coasts are subcutaneously along the trailing side of the flipper blade (adjacent to the radius and ulna, wrist, and/or metacarpals; Fig. 1) or, for large species (*Dermochelys* and some cheloniids), in anterior shoulder muscles medial to the arm. Additionally, more than 9000 Kemp's Ridley (*Lepidochelys kempii*), Loggerhead (*Caretta caretta*), Green (*Chelonia mydas*) and Hawksbill turtles were released with PIT tags inserted into the ventrally located pectoral muscles (Fontaine et al. 1987). To date,

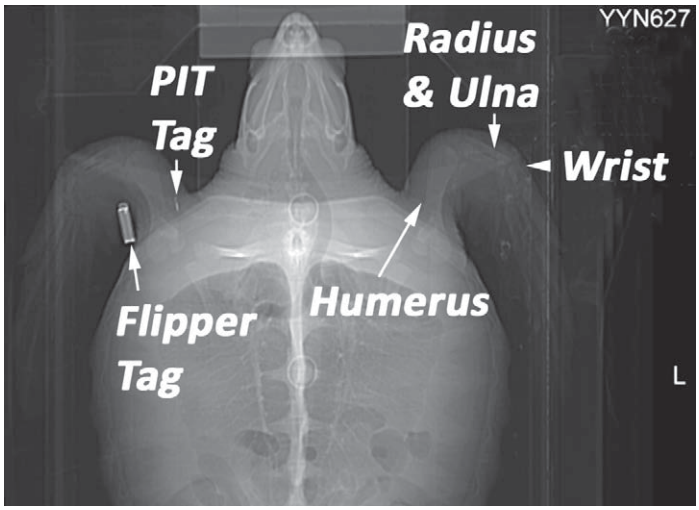


FIG. 1. The overall skeletal anatomy of the marine turtle forelimb and shoulder and several tags are shown in this two-dimensional dorsoventral view CT scan. The forelimb skeletal elements of relevance to this study are labeled. The small PIT tag is in the triceps muscle, an external flipper tag in attached to the trailing edge of the flipper. The light circles at mid-body and the base of the neck, as well as the lighter rectangle at the anterior head, are parts of the scanner's table.

studies of PIT tag placement in seaturtles focus on locations that maximize tag reader reception (Epperly et al. 2008).

In this study, we tested the null hypotheses that PIT tag movement does not differ between species or between two locations in the forelimb: the trailing side of the flipper blade (defined as the proximal manus and antebrachium) and the triceps muscle complex of the upper arm (the brachium). We assess whether PIT tags migrated once placed at the two locations in clinically healthy juvenile Loggerhead and Kemp's Ridley turtles. We report PIT tag movement in both species at the two tagging sites and recommend adoption of the triceps muscle site in seaturtle studies to reduce tag migration and potential complications.

Turtles and Maintenance.—The Loggerhead turtles for this study were wild-caught as hatchlings from marked nests in Clearwater, Florida, USA (emerged from nests 27 August 2000); Kemp's Ridley turtles originated as hatchlings from relocated nests incubated on the beach at Rancho Nuevo, Mexico (emerged 16 August 2000). The turtles were reared in captivity at the National Marine Fisheries Science (NMFS) Sea Turtle Facility in Galveston, Texas, USA. All turtles were juveniles and were similar in size (Loggerhead turtles, N = 21, 31.4–33.6 cm straight carapace length (SCL), mean ± SD = 32.6 ± 0.6 cm; 3.3–4.8 kg, mean = 4.0 ± 0.4 kg; Kemp's Ridley turtles, N = 24, 27.0–30.2 cm SCL, mean = 29.1 ± 0.7 cm; mean = 3.4 ± 2.0 kg). Turtles were held in individual rearing containers in a common raceway tank filled with seawater. Raceways were drained and re-filled with fresh seawater three times/week (described in detail elsewhere, Higgins 2003). Kemp's Ridley turtles were maintained in the Galveston facility prior to and for the duration of the study. Loggerhead turtles were maintained at the Galveston facility for two months, taken to Panama City, Florida and placed under semi-wild conditions for 30 days in communal, large open seawater pens. There they were used for fishing equipment research unrelated to this study, then returned to Galveston. In the Panama City pens, turtles were able to swim more vigorously and interact, potentially challenging the tags and the tag sites beyond what they might experience at the Galveston facility.

PIT Tag Placement and Tag Migration Assessment.—All turtles were tagged in the same forelimb, at both tagging locations, on the same day. Tagging sites were cleaned with 70% isopropyl alcohol and povidone iodine swabs, and then one PIT Tag (Model TX1406L, Destron-Fearing, 12.50 mm L x 2.07 mm diam) was inserted at each site via a pre-loaded sterile 12-gauge needle. One tag was placed deep to the dorsal skin adjacent to the fifth metacarpal and carpal bones on the caudal (postaxial) side of the flipper (Fig. 2a), while the other was placed within the cranial part of the triceps muscle complex in the upper arm on the same side of the turtle (Figs. 2b). Each tag site was sealed with a drop of surgical cement (VetBond™; 3M™, St. Paul, Minnesota) to minimize the chances of tag loss and infection.

Initial MRI scans of the entire flipper were taken shortly after insertion (1 April 2002 for Kemp's Ridley turtles; 2 April 2002 for Loggerheads). Second MRI scans were taken at 104–106

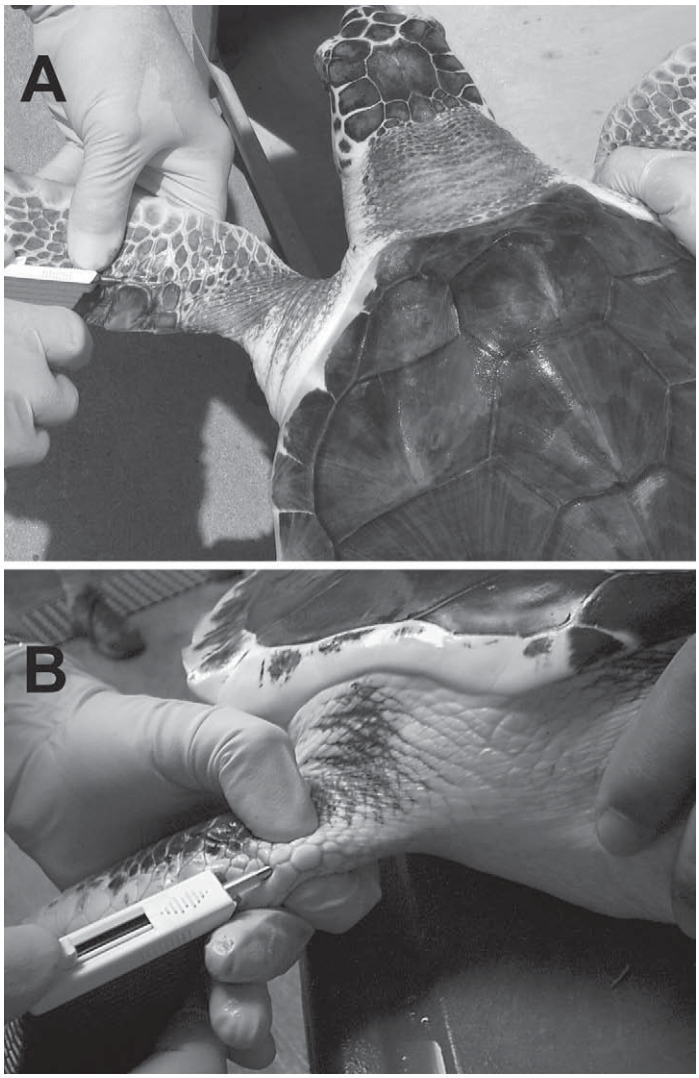


FIG. 2. (A) PIT tag insertion into trailing edge of flipper blade parallel to the fifth metacarpal and postaxial carpal bones. (B) PIT tag insertion in triceps muscle complex of the upper arm showing the method of manipulating the muscle and allowing the tagger to palpate the insertion of the tagging needle and tag.

days (16 July 2002 for Loggerheads, and 17 July 2002 for Kemp's Ridleys). Each turtle was anesthetized (0.15 mg/kg meditomidine, 5 mg/kg ketamine) administered IV in a cervical sinus (external jugular vein). Turtles were placed in ventral recumbency with the flipper positioned alongside the body in a standardized position, flippers were flexed so they rested along the lateral carapace with the blade's long-axis aligned with the scanner table axis, and flippers were held in place with Vet Wrap™ Bandaging Tape (3M™, St. Paul, Minnesota). Scans were taken in dorsoventral and axial planes so that the three-dimensional positions of the skin, muscles, tag, and bones could be visualized. After the scans, the anesthesia was reversed with 0.75 mg atipamezole administered IV in the external jugular vein.

TABLE 1. The fate of PIT tags in (A) Loggerhead (N = 21) and (B) Kemp's Ridley (N = 24) seaturtles over 104–106 days, showing the contingency tables for each species.

A. Loggerhead		Flipper blade		
		No movement	Movement	Row totals
Triceps muscle	No movement	11	7	18
	Movement	1	2	3
	Column totals	12	9	21
B. Kemp's Ridley		**Flipper blade**		
		No movement	Movement	Row totals
Triceps muscle	No movement	15	9	24
	Movement	0	0	0
	Column totals	15	9	24

The metal in each PIT tag produced a signal-void of characteristic size and shape. The maximum size of each signal-void (hereafter referred to as the PIT tag) was used to determine tag position. Each scan was evaluated to determine the distance of the PIT tag's longest axis end to nearest joint and/or bone (Fig. 3); the structure used as the landmark varied among individuals, but was consistent within an individual. Distances were measured using eFilm Lite v.2.1 (Merge Technologies Inc. 2005) and compared. Humerus length (from midpoint of the head to distal-most point, the radial facet) was also measured and compared between first and second scans to account for growth during the study. PIT tags were categorized as having moved or not moved. If the distance of the PIT tag void to the nearest joint and/or bone was greater than the increase in humerus length ± resolution error (defined as > 0.2 cm), the tag was considered to have moved. If the distance was not greater, the tag was assumed to have not moved. In the absence of three-dimensional reconstructions and scan intervals greater than the one we used, we could not measure actual paths traveled for each tag.

Statistical Analysis.—A 2 x 2 contingency table and McNemar's test for significance of changes, adjusted with Williams' correction, was used to assess whether PIT tag movement in one location was independent of movement in the second location. SAS v.9.2 was used to generate all statistics (SAS Institute, Inc. 2009).

Results.—In Loggerheads, three of the 21 tags (14%) placed in the triceps muscle complex migrated, while 9 tags (43%) placed in flipper blades displayed movement (Table 1). However, in the

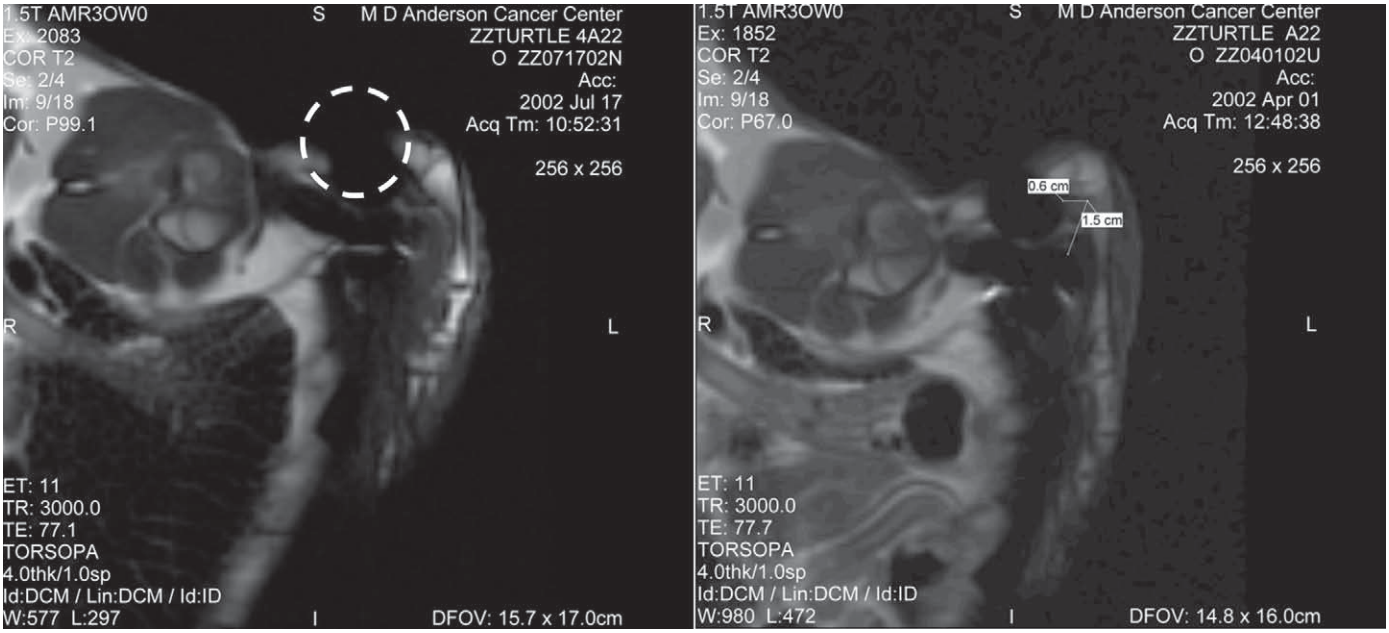


FIG. 3. (A) A dorsoventral plane MRI scan of the left turtle flipper and shoulder. The white dashed circle indicates a signal-void produced from PIT tag in the triceps during the MRI scans. The bone and fat are light colored, muscle is gray, and air in the lung is black. (B) MRI scan of a left turtle flipper with measurements taken from the long axes of the two signal-voids to the nearest joint. Humerus length (from midpoint of the head to the distal-most point, the radial facet) was also measured and compared between first and second scans to account for growth during the study.

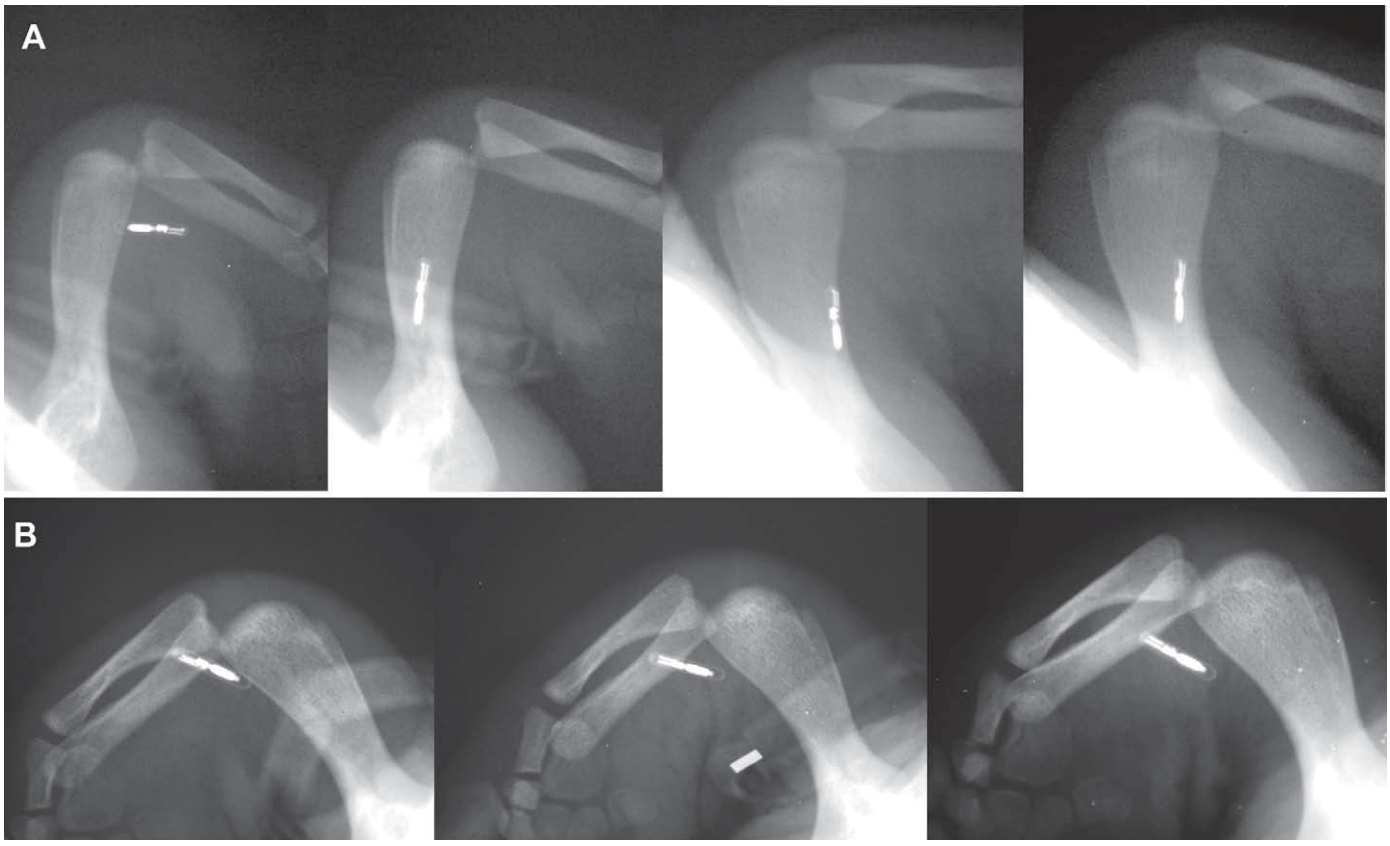


FIG. 4. (A). Migration of a PIT Tag in the right flipper of a cold-stunned Kemp's Ridley (ID No. 99-831). The top four images span 253 days. The greatest proximal movement occurred between the initial radiograph (28 days after the tag was inserted) and the second, a period of 58 days. Subsequent movement was more circumferential from the second to last images (from 58 days to 168 days to 253 days). While the tag migration was quite obvious, the site did not become infected, most likely due to several courses of systemic antibiotics administered to treat other health issues. (B) Botton row: radiographs taken of a second Kemp's Ridley (ID No. 99-842), also show PIT tag migration, however with less drastic movement than in 4A. While the migration of the tag appears shorter in distance, the impact to the animal's health was more significant. The PIT tag was initially placed in the anterior dorsal part of the left front flipper blade on 21 November 1999. The radiographs (left to right) were after two days, 73 days, and 89 days. The tag site became severely infected requiring surgical removal of the tag. The animal was treated topically at the wound site and with systemic antibiotics for several months following tag removal.

majority of cases (62%), both of an animal's tags performed similarly. We rejected the hypothesis that movement at the two sites was the same in Loggerheads ($S_{adj} = 4.2353$, $p < 0.05$). The maximum net tag migration that we could measure, in Loggerheads, was 5.2 cm in the flipper blade and 1.3 cm in the triceps muscle complex. In Kemp's Ridley turtles, none of the 24 tags placed in the triceps muscle complex migrated, whereas 9 of the tags (38%) placed in the flipper blade had moved (Table 1); the maximum net distance moved in the flipper blade of Kemp's Ridleys was 2.2 cm. The marginal proportions (e.g., the cases where both tags in a turtle did not have the same result) were identical (38%) in the two species (Table 1). In no case was infection noted.

Discussion.—We determined that the forelimb tagging locations used in two species of marine turtles differ in their tendency for PIT tags to migrate. Tag migration is an important factor to consider in minimizing risks to the turtles. Movement occurred more often in PIT tags that were inserted subcutaneously in the flipper blade, suggesting that this location can be problematic. The tag stability at one site was not related to tag performance at the other site. Our results are consistent with the tag loss results that vanDam and Diez (1999) found when tags were placed subcutaneously in Hawksbill turtles. Despite the short time frame of this project and the lack of three-dimensional reconstructions, we were able to detect migration by PIT tags in the subcutaneous hypodermal layer, which is rich in collagenous and elastic connective tissues. This site, adjacent to the ulnare, pisiform (carpals), and fifth digit metacarpal, has relatively thick, keratinous skin overlying a connective tissue network with little or no muscle tissue. The muscles of the manus are very reduced in this part of the flipper and may be missed entirely during PIT tag application. In contrast, PIT tags inserted into the triceps muscle complex with the muscle pinched outward (cranially or dorsally) during tag placement (Fig. 2b) clearly are embedded in muscle tissue. Muscle, a metabolically more active tissue, is more likely to encapsulate the tag quickly. While PIT tags may become encapsulated and stabilized in connective tissue, they appear to be more stable when placed in muscle. We presume that the tags placed in the shoulder muscles of large turtles as well as those placed in the hind flipper muscle (Balazs, unpubl. data), a tagging site used in some Pacific studies, are probably stable, however, direct comparisons with the hind flipper site were beyond the scope of this study.

The possibility exists that movement of the tag may occur well beyond the time frame of this study (104–106 days). It is possible

that tag movement or loss may be greater in wild animals than those in captivity (Thomas 2006) associated with their potential exposure to more varied physical stressors, although we did not observe such in Loggerheads that were allowed 30 days of swimming in open pens (compared with Kemp's Ridleys that were maintained in tanks). PIT tag movement may also increase with the size of an animal (Gibbons and Andrews 2004), indicating that the tag movement measured in this study may be less than what might occur in larger juvenile or adult turtles.

In some cases, movement of a PIT tag may be detrimental to seaturtle health and survival. Several cases of PIT tag migration in the flippers of cold-stunned Kemp's Ridley turtles were documented by the NEAq while the animals were undergoing rehabilitation. In November 1999, more than 277 seaturtles stranded along the shores of Cape Cod Bay (Massachusetts, USA) during a large cold-stunning event. A total of 156 were recovered alive (Still et al. 2002) and transported to the NEAq for rehabilitation. Due to the overwhelming volume of cases admitted into the NEAq seaturtle clinic, turtles were rapidly transported to secondary facilities for rehabilitation. Many turtles were PIT tagged in the dorsal and cranial flipper blades prior to transport (N = 103 Kemp's Ridleys), while others were tagged prior to release. Tag migration was noted via radiographs of several turtles (Fig. 4). At least eight of those 103 turtles developed localized infection associated with the PIT tag, and surgical removal of the tag was required. It is likely that this number under-represents the true number of infections, due to the difficulty in following the clinical outcome of large numbers of turtles after relocation to multiple institutions. At least one of these turtles developed significant osteomyelitis of the humerus, radium, and ulna. While osteomyelitis and joint mobility issues are common in cold-stunned turtles (Wyneken et al. 2006), the proximity of the PIT tag to the sites of infections suggested further assessment of PIT tagging location was warranted. Infections of the skeleton and primary locomotor structures are likely to decrease survival probability.

Because our study tested the tendency of PIT tags to migrate in clinically normal turtles (both Kemp's Ridley and Loggerhead turtles) we were able to confirm that tags placed in the flipper blade may migrate even in the absence of infection or cold stress. Similarly, tag migration was observed in penguins both in the presence and absence of microbial growth around the tag and infection (Clarke and Kerry 1998).

It is likely that when physiologically stressed, such as by hypothermia, immune function decreases (reviewed by Jacobson 2007). Thus cold-stunned or otherwise stressed turtles may be at increased risk of infection in the PIT tag site (Baras et al. 2000). Infection and irritation have been reported in PIT tagged leatherback turtles as well (Dutton and McDonald 1994).

Studies of PIT tag placement in the skin of manatees (*Trichechus manatus latirostris*) showed that when the skin is thick, a plug of skin can be driven internally in front of the tag during the injection, increasing the risk of infection. This may, in turn, increase tag movement or rejection (Lambooij et al. 1995; Wright et al.1998).

PIT tags can also be expelled from animals, depending on where the tag is placed (Elbin and Burger 1994; Fontaine et al. 1987; Gibbons and Andrews 2004). Zimmerman and Welsh (2008) studied the placement of PIT tags in American Eels (*Anguilla rostrata*) and found that tag retention varied according to tag location, with the highest retention rates in tags placed into musculature. PIT tags placed in penguins and monitored over several years showed that tag movement can be substantial (> 5 cm; Clarke and Kerry 1998). We observed less movement in PIT tags placed into seaturtle triceps muscle than the trailing aspect of the flipper blade, thus its use may minimize the potential for tag migration, infection and loss. Risk of PIT tag movement and/or infection caused by PIT tags in seaturtles can be mitigated by combining standard skin cleaning with an antiseptic solution prior to application, the use of a sterile applicator and tag, and placement of the tag in a stable location where the keratinous skin layer is thin and the tag is most likely to be placed in muscle. In addition, the accuracy of seaturtle mark-recapture studies will increase because once placed in the triceps muscle, the tag is less likely to move; it remains within readable distance because of the location and size of the muscle, and should increase recognized recaptures.

There may be other advantages to placing the PIT tags into the triceps muscle over the flipper blade. The triceps muscle complex provides some soft tissue protection and so may decrease the likelihood of a tag failure due to shattering of the glass casing. When the glass encasing a PIT tag's electronics is broken, the transponder fails (Camper and Dixon 1988; Lambooij et al. 1995) and tags can migrate, breaking through skin (Germano and Williams 1993). Camper and Dixon (1988) report tag breakage and malfunction due to aggressive encounters between lizards. While we found no incidence of PIT tag failure in seaturtle flipper blades during this study, lack of "padding" in the flipper blade does little to minimize the risk of tag breakage.

While PIT tag location, consistency, and reliability are important aspects of any mark-recapture study, there has been relatively limited consideration of the efficacy of tag placement in seaturtles except for turtle size (Fontaine et al. 1987) and accommodating the limits of tag readers (Epperly et al. 2008). Consideration of tag migration risk in seaturtles is examined for the first time here.

The use of PIT tags is an integral part of much herpetological research. PIT tag use is clearly essential in understanding vertebrate populations worldwide and has greatly increased the reliability and ease of re-identification of individuals. PIT tag use is bolstering our knowledge of seaturtle populations, at sea and on land. Their use in seaturtles has increased recapture rates, which has improved understanding of turtle movements, growth rates, habitat use, nesting success, internesting intervals, migration and numerous other life-history attributes. In addition, the use of PIT tags has eliminated the need to mark turtles using tattooing, drilling or carapace scarring (Affronte and Scaravelli 2002; Hendrickson and Henrickson 1981). Our results support avoiding the flipper blade and applying tags in the triceps to minimize risks of compromising the well-being of the tagged animal.

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vice Endangered Species Act Section 10a(1)a Scientific Research Permit #TE-676379-4 and complied with all institutional animal care guidelines. The Florida Atlantic University (FAU) IACUC determined that the study is in compliance with IACUC guidelines; administratively it does not receive an approval number because FAU personnel worked with the data files alone, not the animals. The methods used were consistent with those the IACUC would approve had the animal part of the study been done by FAU personnel. At the time, the NMFS did not issue IACUC approvals, but always complied with USFWS and State of Florida requirements for holding seaturtles. J. Flanagan, DVM ensured that best practices were followed. All authors participated in one or more aspects of this study and edited the manuscript.

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AMPHIBIAN DISEASES

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Detecting the Western Limits for *Batrachochytrium dendrobatidis* in Southeastern Queensland, Australia

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The fungal pathogen *Batrachochytrium dendrobatidis* (*Bd*) is implicated in the decline of worldwide amphibian populations (Berger et al. 1999), with new occurrences of the fungus being constantly reported (e.g., recent issues of *Herpetological Review*). Whereas the fungus has been detected in numerous locations, it is considered an invasive species (Weldon et al. 2004) and an emerging infectious disease (Daszak et al. 1999; Rosenblum et al. 2010), and hence its distribution is not at equilibrium. Niche modeling has predicted the potential of *Bd* to invade southern and central Africa, parts of south-east Asia, southern and central North America, Europe, and South America (Ron 2005). Within Australia the impact of the fungus is expected to be highest in the eastern and southeastern mountainous regions along the eastern seaboard (Rödder et al. 2008), however it is expected to reach its physiological limits approximately 300–400 km from the coastline (Rödder et al. 2008).

Although numerous studies within Australia have detected *Bd* along the eastern coastline (Kriger et al. 2007a; see Ron 2005 appendix) there have been no studies aimed at detecting *Bd* west of the mountain range known as the Great Dividing Range in southeastern Queensland. Considering the impacts that *Bd* has had on amphibian populations worldwide it is essential to determine the presence of this fungus in untested areas. The aim of our study was to sample for *Bd* in the unsampled western plains of southeastern Queensland, Australia.

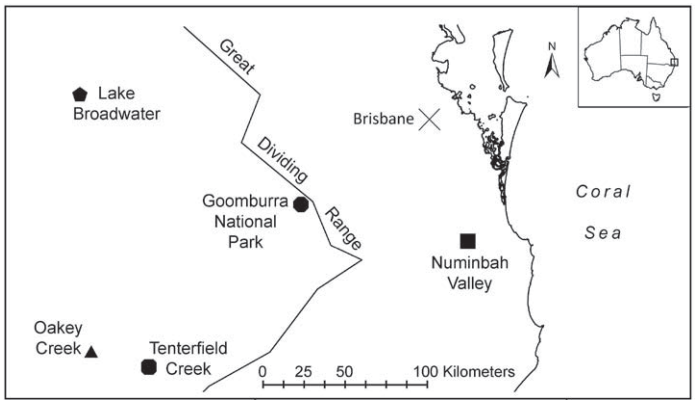


FIG. 1. Location of sites sampled for *Batrachochytrium dendrobatidis* east and west of the Great Dividing Range (approximate location represented by the left line), Queensland, Australia. The coastline (right line) and Queensland's capital city, Brisbane (X) are shown.

We sampled for *Bd* in early September 2007 at four sites west of the Great Dividing Range (GDR) in southeast Queensland, including a previously known site of *Bd* on the GDR in Goomburra National Park (Ron 2005) (Fig. 1). We also sampled a well-studied site in Numinbah Valley (east of the GDR) as a reference site to address annual variation in prevalence (Kriger and Hero 2006; Kriger et al. 2007a) (Fig. 1). Sampling was carried out in spring (26 September 2007 to 10 October 2007) to maximize the probability of detecting *Bd* (Kriger and Hero 2007). We swabbed 212 adult frogs, with 145 sampled west of the Great Dividing Range and 67 sampled at Numinbah Valley (Table 1).

A standardized swabbing method was used (Kriger et al. 2007a), modified slightly as we did not swab the dorsal surface. Swabs were stored on ice and kept in a refrigerator until analysis (Van Sluys et al. 2008). Frogs were individually handled with clean 250 mm x 200 mm plastic bags, which were discarded after use to avoid the transfer of *Bd* and to minimize the chances of sample contamination. All frogs were swabbed by the same individual (JMH) to avoid swabber bias. To circumvent sampling the same frog twice, individuals were not released until all frogs had been swabbed at each site.

Quantitative polymerase chain reaction techniques (qPCR), as described by Boyle et al. (2004) with modifications described by Kriger et al. (2006), were used to determine *Bd* presence. A positive infection was considered any frog which produced a result of one or more zoospores in the triplicate PCR analysis procedure (Kriger et al. 2007b). Prevalence for each species per site was calculated.

The site with the highest prevalence (25.4%) was Numinbah Valley, located east of the GDR. This was followed by Goomburra National Park (12.5%), located just west of the GDR, Lake Broadwater (7.1%), and Tenterfield Creek (2.2%; Table 1). We detected *Bd* at only one site sampled at Lake Broadwater. This site consisted of 19 of the 28 individuals surveyed for the Lake Broadwater Conservation Park. All frogs detected with *Bd* were from water bodies that are either permanent or temporary riverine systems (Table 1).

Our study has extended the known range of *Bd* west of the GDR, in southeast Queensland, Australia, by approximately

TABLE 1. Sites where frogs were sampled for *Batrachochytrium dendrobatidis* (*Bd*), both west and east of the Great Dividing Range (GDR) in southeast Queensland, Australia. *Bd* prevalence per site and per frog species sampled is shown. Habitat types of sampling locations were either permanent or ephemeral water bodies (streams or ponds).

Location (habitat type)	Lat / Long ° (approx. distance west (+) or east (-) of GDR (km)	Species	No. *Bd*-positive / No. frogs swabbed	Prevalence (%)
Tenterfield Creek (permanent)	-28.8600 151.4852 (+52)	*L. wilcoxii*	1/43	2.2
		L. latopalmata	0/3	0
	Tenterfield Creek Total		**1/46**	**2.2**
Oakey Creek (permanent)	-28.7753 151.1705 (+80)	*L. wilcoxii*	0/17	0
		L. latopalmata	0/6	0
	Oakey Creek Total		**0/23**	**0**
Lake Broadwater Surveyor's Gully Site 1 (ephemeral) 100	-27.3765 151.1088 (+85)	*C. alboguttata*	0/1	0
		L. tasmaniensis	1/1	
		L. fletcheri	0/3	0
		L. latopalmata	1/14	7
	Surveyor's Gully Site 1 Total		**2/19**	**10.5**
Lake Broadwater Surveyor's Gully Site 2 (ephermal)	-27.3765 151.1088 (+85)	*C. alboguttata*	0/2	0
		L. tasmaniensis	0/1	0
Lake Broadwater Quarry Dam Site 3 (permanent)	-27.3765 151.1088 (+85)	*L. tasmaniensis*	0/5	0
Lake Broadwater Historical Farm Dam Site 4 (permanent)	-27.3765 151.1088 (+85)	*L. tasmaniensis*	0/1	0
	Lake Broadwater Total (all sites combined)		**2/28**	**7.1**
Goomburra N.P. Dalrymple Creek (permanent)	-27.9754 152.3153 (+6)	*L. wilcoxii*	6/48	12.5
Numinbah Valley Nerang River (permanent)	-28.1752 153.2258 (-60)	*L. wilcoxii*	17/67	25.4

85 km (Ron 2005). This range extension falls within the area predicted by the Rödder et al. (2008) model.

All *Bd*-positive samples were taken from frogs captured in riverine systems that have flowing water for at least some time of the year. The absence of detection of *Bd* from ponds/dams at Lake Broadwater may be due to low sample size (Table 1). However Kriger and Hero (2007) found low prevalence of *Bd* in anuran pond/dam breeders when compared with stream breeders. The low prevalence and lack of *Bd* within the other permanent river systems sampled in this study (Tenterfield and Oakey Creek) suggest the distribution of *Bd* in the drier inland parts of Australia may be patchy or absent.

Our results suggest that prevalence is lower at sites west of the GDR when compared with sites east or on the GDR, thus suggesting that prevalence decreases within populations of frogs with increasing distance west of the GDR in south-eastern Queensland. Prevalence was low west of the GDR when compared with our samples both east of (Nerang River, Numinbah) and on the GDR itself (Darlymple Creek, Goomburra). This is not surprising because *Bd* has been readily detected in areas with high rainfall and cooler temperatures (Kriger and Hero 2006; Kriger and Hero 2008, Kriger et al. 2007a), and the rainfall gradient decreases and average temperatures increase with increasing distance west of the GDR (Hijmans et al. 2005).

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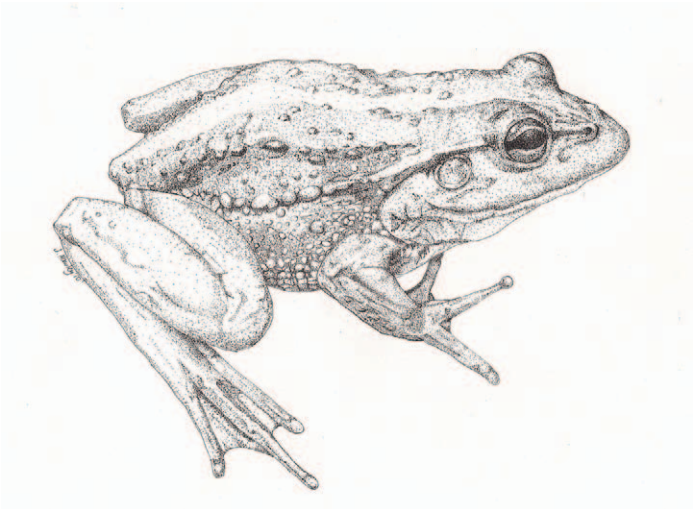
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Litoria raniformis. Australia: South Australia, River Murry. Illustration by Jesse Hawley (Jess_H_91@hotmail.com), based on a photograph by Michael B. Thompson.

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Annual Variation of *Batrachochytrium dendrobatidis* in the Houston Toad (*Bufo houstonensis*) and a Sympatric Congener (*Bufo nebulifer*)

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The Houston Toad (*Bufo* [= *Anaxyrus*] *houstonensis*) is endemic to south-central Texas, USA, currently occupying suitable habitat in seven counties (Forstner and Dixon 2010). Population sizes are in steady decline, and the populations in Bastrop County are considered the most robust and sustainable of the remaining populations (Seal 1994), with current estimates of less than 500 adult individuals (M.R.J. Forstner, unpubl.). The Houston Toad was listed as endangered in 1970, and has been referred to as "probably the rarest and most endangered amphibian in the United States" (USFWS 1978). The factors linked to global amphibian decline (e.g., habitat alteration, global environmental change, environmental contaminants, introduced species, emerging infectious diseases) or combinations thereof are likely primary threats to the Houston Toad as well (Seal 1994; Peterson et al 2004). Yet, published information on infectious diseases of this endangered taxon is still lacking.

Chytridiomycosis is a recently emerged infectious disease caused by the fungus *Batrachochytrium dendrobatidis* (*Bd*). It has been implicated as a significant contributor to amphibian population declines worldwide (Berger et al. 1998; Garner et al. 2005; Ouellet et al. 2005). The presence of *Bd* has been confirmed in many states of the USA (Davidson et al. 2003; Ouellet et al. 2005; Rothermel et al. 2008) including south-central Texas near Bastrop County where it was detected in several endemic salamander species (*Eurycea nana*, *E. neotenes*, *E. pterophila*, *E. sosorum*, and *E. tonkawae*) and in Blanchard's Cricket Frogs (*Acris crepitans blanchardi*) (Gaertner et al. 2009a; Gaertner et al. 2009b).

The aim of this study was to expand the previous research on *Bd* in south-central Texas in order to assess the potential threat that the presence of *Bd* might pose to Houston Toads. These studies took advantage of existing DNA from toes of *B. houstonensis* and a sympatric toad, *Bufo* [*Anaxyrus*] *nebulifer* (Coastal Plain Toad) originally sampled for a long-term conservation study on *B. houstonensis* in Bastrop County and available from the M.R.J. Forstner Frozen Tissue Catalogue held at Texas State University-

San Marcos. Toads were sampled opportunistically and via drift fences around small ephemeral and semi-permanent reservoirs on the Griffith League Ranch (30.215390°N, 97.255320°W), Bastrop State Park (30.110745°N, 97.292980°W), and several other sites within federal designated Houston toad Critical Habitat in Bastrop County, Texas.

Toes were collected between 2001 and 2007 from January to May, a period prior to the average monthly temperature rising above 25°C. All samples were stored in 95% ethanol at –80°C: 105 *B. houstonensis* (2001, N = 8; 2002, N = 24; 2003, N = 16; 2004, N = 2; 2005, N = 7; 2006, N = 24; 2007, N = 24) and of 96 *B. nebulifer* (2001, N = 21; 2002, N = 3; 2003, N = 6; 2004, N = 18; 2006, N = 24; 2007, N = 24) (Table 1). DNA was isolated using a Wizard® SV 96 Genomic DNA Purification System (Promega) on a Biomek® 3000 Laboratory Automation Workstation (Beckman Coulter), a DNeasy™ Tissue Kit (QIAGEN Inc.), or a standard phenol-chloroform method (Sambrook et al. 1989). We tested for *Bd* using a nested PCR approach (Gaertner et al. 2009a). The nested PCR used primers ITS1f and ITS4 targeting conserved regions of the 28S and 18S rRNA to amplify the 5.8S rRNA gene and the flanking internal transcribed spacer (ITS) of all fungi (White et al. 1990). Purified PCR products were then used as a template for the second PCR reaction using the primer set Bd1a and Bd2a which is specific for *Bd* (Annis et al. 2004). Reactions were then examined for the presence of a 300-bp fragment (Annis et al. 2004) using gel electrophoresis (2% agarose in TAE buffer) (Sambrook et al. 1989).

Overall, 29 of 201 (14.4%) toads tested were positive for the 300-bp fragment, indicating *Bd* presence, including 6 of 105 *B. houstonensis* and 23 of 96 *B. nebulifer* (Table 1). More than 80% (24 of 29) of *Bd*-positive samples were obtained in year 2006. Samples obtained in 2003 (23 tested) and 2005 (7 tested) were all *Bd*-negative, whereas years 2001 (2/29 or 6.9%), 2002 (1/28 or 3.6%), 2004 (1/20 or 5.0%), 2006 (24/48 or 50%) and 2007 (1/48 or 2.1%) had positive samples though mostly at low percentages (Table 1). All amplicons of the appropriate size were purified, and then sequenced at the DNA Sequencing Facility of the Institute for Cellular and Molecular Biology at the University of Texas at Austin, TX. Sequences were compared to GenBank/EMBL databases and aligned using BLAST (Pearson and Lipman 1988) and alignment functions in Geneious 4.8.3 (Drummond et al. 2009). Sequence diversity was limited. Two haplotypes were discovered that shared more than 99% similarity to sequences in the databases representing *Bd*. Haplotype A (GenBank Accession HM153084) was detected in toads sampled in 2001, 2002, 2004 and 2006 and in both *B. houstonensis* and *B. nebulifer*. Haplotype B (HM153085) was not detected in samples collected prior to 2006 and was detected only in *B. nebulifer* (Table 1). These results demonstrate the presence of *Bd* in populations of *B. houstonensis* and *B. nebulifer* as early as 2001 and within federally designated Critical Habitat of the Houston Toad. Any further statements about the significance of this observation and consequences for current and future conservation efforts for *B. houstonensis* specifically remain speculative, and require additional studies.

Detection of *Bd* in zero or only a few individuals during most years may depend on seasonal and environmental conditions as is the case in other wild amphibians (Gaertner et al. 2009b; Kriger and Hero 2006; Voordouw et al. 2010). Although this situation does not correspond with the commonly viewed perception of disease dynamics, populations of frogs with low numbers of infected individuals have been reported (Voordouw et al. 2010). Populations of *Xenopus* frogs in South Africa, for example, have carried the fungus with a relatively low prevalence (about 2.7%) for as long as 65 years (Weldon et al. 2004). Alternatively, these results could underestimate the presence of *Bd* due to sampling bias as a consequence of low numbers or of preferential predation on infected toads in nature. Assuming a low prevalence of infection, approximately 60 individuals would need to be tested to provide a 95% certainty of detecting *Bd* on at least one animal (Skerratt et al. 2008).

Of particular interest are the results from year 2006. Despite populations from all other years lacking detections or with relatively low numbers of positive samples, 50% of the samples collected in 2006 (N = 48) were *Bd*-positive. Differences in the prevalence of *Bd* in anuran populations have been seen frequently but were attributed to seasonal differences in temperature (Kriger and Hero 2007; McDonald et al. 2005; Ouellet et al. 2005; Retallick et al. 2004) or precipitation (Gaertner et al. 2009b; Ron 2005). Weather data retrieved for 2001–2007 breeding seasons (January to June) from the National Climatic Data Center using the average for three sites surrounding Bastrop (Smithville, Station ID 20024578; Cedar Creek, Station ID 20024579 and Elgin, Station ID 20024696) reveal that 2006 was notably hotter and dryer for the period, with an increase in temperature by 1.5°C and a decrease in precipitation by 256 mm from the average for the period. The conditions were the inverse necessary for optimal growth of *Bd* (Berger et al. 2004; Lamirande and Nichols 2002), even though a significant negative relationship between the occurrence of *Bd* and precipitation has been reported (Kriger and Hero 2007). That relationship, however, was suggested to be affected more by low temperature conditions than by the concomitant dry conditions. The increase in occurrence of *Bd* during 2006 in our study might therefore not be a consequence of the environmental conditions in this year alone, but may be significantly affected by the environmental conditions in the preceding drought in 2005 with 204 mm below average precipitation. Environmentally stressed toads could be more susceptible to *Bd* which may consequently result in an increase in occurrence of *Bd* the following year. A similar scenario was discussed in one of our previous studies that suggested high occurrence of *Bd* on salamanders at specific sites was caused by environmental stress from pollution originating from urban runoff (Gaertner et al. 2009a). Relief from the drought with precipitation 91 mm above average during year 2007 and thus reduction in environmental stress could then have resulted in a reduction in occurrence of *Bd*. The fluctuation in occurrence of *Bd* on toads, however, could also be a function of sample size and sampling strategy that were originally designed to retrieve information on the genetic diversity of toads. Low sample numbers, but also the inability to conduct repetitive sampling of sites with high numbers of infected toads in consecutive years might therefore have influenced the detection of *Bd* through time.

Data obtained for 2006 showed not only much higher occurrence of *Bd* on toads, but also species-specific differences in occurrence, with a much higher detection in *B. nebulifer* (83%, 20 of 24 toads) than in *B. houstonensis* (17%, 4 of 24 toads). Differences in occurrence of *Bd* in sympatric amphibian species

TABLE 1. Prevalence of *Batrachochytrium dendrobatidis* in *Bufo houstonensis* and *Bufo nebulifer* at localities in Bastrop County, Texas, USA, from January to May 2001 to 2007.

Species by year	Locality[1]	Prevalence (No. infected / total)	Fungal haplotype (no. infected)
2001			
B. houstonensis	BAN02p	1/5	A (1)
	BAN04p	0/1	
	BAN15t	0/1	
	BAN18t	0/1	
B. nebulifer	BAN02p	0/7	
	BAN12t	1/8	A (1)
	BAN15t	0/2	
	BAN19t	0/2	
	BAN34t	0/1	
	BAN35t	0/1	
	GLR	0/1	
2002			
B. houstonensis	BAN02p	1/17	A (1)
	BAN12t	0/1	
	BAN14t	0/1	
	BAN19t	0/2	
	GLR	0/3	
B. nebulifer	BAN02p	0/2	
	GLR	0/1	
2003			
B. houstonensis	BAN01p	0/1	
	BAN12t	0/1	
	BAN13t	0/1	
	BAN21t	0/1	
	BAN23t	0/1	
	BAN24t	0/1	
	BAN26t	0/1	
	BAS06p	0/3	
	GLR	0/6	
B. nebulifer	BAN40s	0/6	
2004			
B. houstonensis	BAN13t	0/1	
	BAS15p	0/1	
B. nebulifer	BAN02p	0/7	
	BAN04p	0/2	
	BAN14t	1/4	A (1)
	BAN17t	0/1	
	BAN23t	0/1	
	BAN24t	0/1	
	BAN36t	0/1	
	GLR	0/1	
2005			
B. houstonensis	BAS10t	0/1	
	BAS11t	0/3	
	BAS12t	0/2	
	BAS13t	0/1	
B. nebulifer	n/a	0/0	
2006			
B. houstonensis	BAS01p	1/4	A (1)
	BAS07p	1/4	A (1)
	BAS09p	1/8	A (1)
	BAS15p	0/1	
	BAS17p	0/6	
	BAS18p	1/1	A (1)
B. nebulifer	BAN02p	5/5	A (3), B(2)
	BAN09p	2/4	B (2)
	BAPp	3/3	A (1), B (2)
	BAS01p	1/1	B (1)
	BAS09p	9/11	B (9)
2007			
B. houstonensis	BAN29s	0/3	
	BAS04p	0/6	
	BAS07p	0/6	
	BAS08p	0/6	
	BAS18p	0/3	
B. nebulifer	BAN09p	1/3	B (1)
	BAN11p	0/2	
	BAN28p	0/4	
	BAN38p	0/2	
	BAS01p	0/1	
	BAS14p	0/4	
	BAS15p	0/4	
	BAS18p	0/4	

[1]Sites with the prefix BAN (Bastrop Co. 'north,' see Forstner and Dixon [2010]) are located 8–11 km W and WSW of the TX21/US290 junction. Site BAPp (Bastrop County 'p12') is about 10 km WSW of TX21/US290 junction. Sites with the prefix BAS (Bastrop Co. 'south') are within a 9 km radius E of TX21/TX95 junction, mostly between TX21 and TX71, with few sites W of TX21. All locations are within federally designated Critical Habitat for the species.

have been observed (Goka et al. 2009; Peterson et al. 2007; Retallick et al. 2004), with few studies linking the occurrence of *Bd* to the disease (Retallick et al. 2004). The increase in occurrence of *Bd* in 2006 was coincident with the identification of a new haplotype (haplotype B) that differed from the previously identified one (haplotype A) by a 10 bp insertion after base number 64. Haplotype B was identical to the most prominent *Bd* haplotype found in *Eurycea* salamanders from central Texas (GenBank Accession numbers EU779859, EU779862, EU779864, and EU779867) (Gaertner et al. 2009a) suggesting strain-specific differences affect occurrence and potential virulence as demonstrated in other studies (Berger et al. 2005; Goka et al. 2009; Retallick and Miera 2007). Because haplotype B was not found in *B. houstonensis*, but only in *B. nebulifer* so far, differences in host specificity might be present. This may also be evidence of *B. nebulifer* acting as a vector for *Bd* similar to assumptions for the American Bullfrog (*Lithobates catesbeianus* [*Rana catesbeiana*]; Daszak et al. 2004; Hanselmann et al. 2004) as *B. nebulifer* dispersed into Houston Toad habitats during the spring of 2006 as the drought left no breeding ponds in the grassland patches.

In any case, these speculations need additional studies with more samples and a sampling strategy directed towards repeated and seasonal analyses of *Bd* at a site with high occurrence of *Bd*. These studies should include comparative analyses of water and sediment samples for presence and abundance of *Bd* and the respective haplotypes as a function of environmental characteristics during the season.

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Comparison of PCR and RT-PCR in the First Report of *Batrachochytrium dendrobatidis* in Amphibians in New Jersey, USA

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Batrachochytrium dendrobatidis fungus (*Bd*) has recently been implicated as a cause of massive amphibian declines and extinctions globally (Berger et al. 1998; Daszak et al. 1999; Bosch et al. 2001). *Bd* surveillance typically relies on direct sampling of amphibians using non-invasive molecular techniques to screen for the presence of *Bd* DNA on their skin. Histological exams are also used to microscopically examine amphibian skin, identify zoospores, and diagnose the extent of *Bd* infection (clinically known as chytridiomycosis). However, histological examination is invasive and may not show *Bd* infection if zoospores are not actively being shed by an infected animal (Annis et al. 2004). *Bd* is a water-borne pathogen, so it is also important to test environmental water samples for this fungus, but this has proven difficult using microscopy (Annis et al. 2004). However, several recent studies have used molecular methods to successfully screen for the presence of *Bd* DNA in water and soil samples (Lips et al. 2006; Kirshtein et al. 2007; Walker et al. 2007).

Molecular detection of *Bd* DNA typically involves traditional polymerase chain reaction (PCR) with *Bd*-specific primers followed by visualization using agarose gel electrophoresis (Beard and O'Neill 2005; Lips et al. 2006). Although this technique has been successfully used to detect the presence of *Bd* DNA, it may be ineffective at detecting *Bd* DNA if the DNA concentration is low (early stage of infection and/or diluted environmental samples) since low concentration of template DNA may lead to PCR failure. To address this lack of sensitivity, some researchers have turned to real time fluorescently-based PCR (RT-PCR) for detection of *Bd* DNA (Boyle et al. 2004; Knapp and Morgan 2006). RT-PCR has been shown in some studies to be significantly more sensitive to dilute concentrations of DNA than conventional PCR (Helps et al. 2001; Balamurugan et al. 2009), however this is not always the case (Bastien et al. 2008).

There are currently few data available regarding the distribution of *Bd* in amphibians in the state of New Jersey, USA, making the threat of this pathogen to local amphibians unknown. A recent study of the Pinelands of southern New Jersey did not detect *Bd* in animals or environmental samples (Di Leo 2010). In this study we tested 43 samples (27 animals and 16 water) from the New Jersey School of Conservation in Northern New Jersey for the presence of *Bd* DNA using a traditional PCR-based approach and species-specific primers designed by Annis et al. (2004). We then re-screened these samples using the same primers in an RT-PCR assay to compare the two methods and screen for the presence of *Bd* in New Jersey.

Sampling was carried out at the 97-ha (240-acre) New Jersey School of Conservation (NJSOC, Branchville, Sussex County, New Jersey, 41.22690°N, 74.74975°W), the environmental field campus of Montclair State University, which is surrounded by undeveloped land including Stokes State Forest, High Point State Park, the Delaware Water Gap National Recreation Area, and other properties held by nonprofit conservation organizations. The property is primarily mixed deciduous forest with streams, vernal pools, and a small (6 ha) artificial lake, Lake Wapalanne. The NJSOC is located within the Flat Brook watershed of the Delaware River basin, an area with relatively high water quality (Delaware River Basin Commission 2008). However, the region is heavily used for recreation (e.g., trout fishing and hiking), raising the possibility that disease could be introduced through movement of fishing gear or introduction of live amphibians used as bait, as reported elsewhere (Picco and Collins 2008). This potential connection, however, is speculative since there are currently no empirical data available. We sampled water and animals at Lake Wapalanne and several vernal pools located within 1 km of the lake, and opportunistically sampled animals elsewhere on NJSOC property.

Sampling was conducted between 26 June and 18 August 2009. Animals were caught by net or hand and swabbed with a sterile cotton swab over all body surfaces with additional attention paid to the ventral surface. Swabs were stored in sterile 1.5 ml Eppendorf tubes for 2 to 6 h until transported to the laboratory where they were frozen at -20°C. Tadpoles were put in a 1.5 ml Eppendorf tube with approximately 500 µl water that was collected from the tadpole's environment. The tadpoles were allowed to "swim" in the tube of water for 30 sec to 1 min. Tadpoles were removed from the tube and returned to the environment. Samples were stored at room temperature for 2 to 6 h until transported to the laboratory where they were frozen at -20°C. We collected samples from the following species and life stages: *Lithobates clamitans* (8 tadpoles, 3 juveniles, and 9 adults), *L. palustris* (2 adults), *L. sylvatica* (1 adult), *Notophthalmus viridescens* (2 adults), and *Ambystoma maculatum* (2 larvae) for a total of 27 animals. We considered these animals to belong to the same geographic site given the close proximity of their habitat, so we did not sterilize nets during sampling.

Environmental samples consisted of water from the same aquatic habitats where animals were caught. Approximately 500 µl water were collected from each of 11 ephemeral ponds and one small stream, and four locations from Lake Wapalanne (16 samples total). Water samples were stored separately in sterile 1.5 ml Eppendorf tubes as described above.

We added 200 µl deionized water to the tubes with swabs and vortexed the tubes for approximately 30 sec. No additional water was added to the water or tadpole samples. We thawed water and tadpole samples, then vortexed them for approximately 30 sec. All samples were boiled in a boiling water bath for 10 minutes to lyse open zoospores if present.

A sample of *Bd* preserved in ethanol provided by J. Longcore (University of Maine) was used to isolate positive control DNA. We centrifuged 100 µl of the culture at 13,000 RPM for one min, and resuspended it in 500 µl of deionized water twice to remove ethanol and dilute cells. The positive control was then boiled for

10 min to lyse open zoospores.

Traditional PCR.—Bd-specific primers (Bd1a and Bd2a) designed by Annis et al. (2004) were used to amplify an approximately 300-bp fragment of the 5.8S rRNA gene. Ten microliters of each test sample and 2 µ1 of positive control DNA were used in 25-µ1 PCR reactions that included the following components: 0.4 µM forward and reverse primers, 1.5 mM $MgCl_2$, 0.2 mM dNTPs, and 0.1 U/µl taq polymerase. PCR reactions were subjected to one cycle of 95°C for 5 min followed by 30 cycles of 95°C for 30 sec, 60°C for 30 sec, and 72°C for 30 sec, followed by a final 7-min extension at 72°C. All reactions were run in a GeneAmp 9700 Thermalcycler (Applied Biosystems). Appropriate negative controls using water in place of DNA were included with each PCR run. PCR products were checked for the presence of the *Bd*-specific 5.8S fragment on 2% 1XTAE gels followed by SYBR Safe (Invitrogen) staining and UV illumination.

RT- PCR.—We used 11.5 µl of each test sample in 25-µl PCR reactions that included the following components: 0.4 µM Bd1a and Bd2a primers (Annis et al. 2004) and 12.5 µl of Brilliant II SYBR Green qPCR Master Mix (Agilent Technologies). We used 11.5 µl of test sample to maximize the amount of *Bd* DNA used in the reaction if it was present in the test sample. We ran positive control reactions using 0.5 ng/µl *Bd* DNA and negative control reactions using water in place of DNA under the same conditions. PCR reactions were subjected to 1 cycle of 95°C for 10 min followed by 40 cycles of 95°C for 45 sec, 60°C for 30 sec, and 72°C for 30 sec. All RT-PCR reactions were run on a Stratagene Model Mx 3000 P Thermalcycler (Stratagene Technologies). We rescreened all positive samples in triplicate using RT-PCR to verify the results.

All animals used in this study were alive at the point of capture and none appeared to show obvious symptoms of chytridiomycosis. None of the 43 samples tested positive for *Bd* DNA using traditional PCR (Table 1). When these samples were retested using RT-PCR however, three tested positive for *Bd* DNA: two *L. clamitans* juveniles from separate sites and one water sample from Lake Wapalanne (Table 1). Results were repeatable for all three trials of the RT-PCR. Indeed, both of the *L. clamitans* juveniles that tested positive produced a fluorescence intensity that was comparable to the positive control (Table 2). All positive and negative controls yielded expected results for both traditional and RT-PCR.

To our knowledge, this is the first published account of the presence of *Bd* in New Jersey amphibians or environmental samples. It is not surprising that *Bd* is present in New Jersey given that it has been documented in New York and Connecticut (Longcore et al. 2007). If we had only used the traditional PCR-based method we would have erroneously determined that *Bd* might not be present at the New Jersey School of Conservation (although sample sizes were low), potentially missing an important opportunity to study the distribution and effects of this pathogen in native amphibians. Given that *Bd* was detected in two animals and one water source, all from different locations within the NJSOC, it is possible this pathogen is widespread at NJSOC. We are currently focusing our efforts on increasing sample sizes for all species and life stages present at the NJSOC to quantify infection loads and determine species-specific effects of infection.

Because we had negative results from all of the tadpole samples we cannot be sure that our protocol is sensitive enough to detect *Bd* in this life stage. Future studies will focus on substantially increasing tadpole sample size and verifying the efficacy of this screening method by comparing it with an established method of detection in tadpoles. Additionally, given the small sample size (<60) of all species and life stages it will be necessary to increase sample sizes to more accurately assess the prevalence of *Bd* at NJSOC (Skerratt et al. 2008).

We were able to detect the presence of *Bd* DNA without the use of a traditional DNA extraction protocol, even in an environmental sample. Simply boiling skin swab and water samples to lyse zoospores without the use of a costly and time-consuming DNA extraction method was sufficient. This was especially surprising given that environmental water samples may contain PCR-inhibitors. For a rapid presence/absence screen, this method is a viable

TABLE 1. Results of traditional and RT-PCR for the presence (+/-) of *Batrachochytrium dendrobatidis* DNA from animals (A) and environmental samples (B) collected from the New Jersey School of Conservation, Branchville, Sussex County, New Jersey, USA.

Sample	N	Traditional PCR	RT-PCR
A. Animal Samples (Species/Life Stage)			
L. clamitans/tadpole	8	-	-
L. clamitans/juvenile	3	-	- (N = 1), + (N = 2)
L. clamitans/adult	9	-	-
L. palustris/adult	2	-	-
L. sylvatica/adult	1	-	-
N. viridescens/adult	2	-	-
A. maculatum/larvae	2	-	-
B. Environmental Samples			
Water	16	-	- (N = 15), + (N = 1)
C. Total	43		- (N = 40), + (N = 3)

TABLE 2. Mean threshold cycle (Ct) and fluorescence (dR) values for samples testing positive for *Batrachochytrium dendrobatidis* DNA from samples collected from the New Jersey School of Conservation, Branchville, Sussex County, New Jersey, USA.

Sample	Ct	dR
Positive *Bd* DNA Control (1 ng DNA)	19.9	7304.3
L. clamitans juvenile 1	22.4	8160.6
L. clamitans juvenile 2	24.5	7844.1
Positive Water Sample	32.1	4572
Negative Control	>40	202.7

alternative to current methods, making it potentially important for rapid assessment or in situations where funds are very limited.

Perhaps more important however, are the results of our PCR technique comparison, which could have a potential impact on future molecular screening procedures throughout the *Bd* research community. In this study, we detected *Bd* in 3 of 43 samples using RT-PCR, but none using traditional PCR. Our results strongly support the need to use the more sensitive RT-PCR screening method when using a non-invasive PCR-based detection technique for *Bd* DNA.

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Batrachochytrium dendrobatidis is Present in Northwest Pennsylvania, USA, with High Prevalence in *Notophthalmus viridescens*

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Batrachochytrium dendrobatidis (*Bd*) has been found with varying prevalence on amphibians in the northeast, midwest, and southeast United States (Longcore et al. 2007; Zellmer et al. 2008; Green and Dodd 2007; Rothermel 2008), but surveys in Pennsylvania have failed to find infected individuals (Glenney et al. 2010). We studied between-pond variation in *Bd* infection levels in amphibians of northwestern Pennsylvania, USA. In doing so, we focused our sampling efforts on three species, Green Frogs (*Rana clamitans*), Red-spotted Newts (*Notophthalmus viridescens*) and Wood Frogs (*Rana sylvatica*). These species are locally abundant and, if commonly infected, could serve as an indicator species for assessing *Bd* presence in ponds.

Our surveys were designed to maximize the number of ponds sampled for *Bd* occurrence. We swabbed up to 12 individuals per species for *Bd* at 10 ponds containing Green Frog tadpoles, 8 ponds containing Red-spotted Newts and 2 ponds containing Wood Frog adults between 1 April and 28 May 2008 (Table 1). This sampling scheme has low statistical power to detect true negative results within a pond (e.g., Skerratt et al. 2008), but it is sufficient for *Bd* detection at ponds with moderate to high infection prevalence. For sampling efficiency, we visited each pond only once and limited the life stages that we sampled to larval Green Frogs, adult Red-spotted Newts and adult Wood Frogs. While adult frogs are more commonly sampled, we focused on larval

TABLE 1. Prevalence and infection levels of *Batrachochytrium dendrobatidis* in several species of amphibians sampled in northwestern Pennsylvania, USA. "-" indicates the species was not sampled at that site.

Site name and coordinates	Red-Spotted Newt (*Notophthalmus viridescens*)		Green Frogs (*Rana clamitans*)		Wood Frogs (*Rana sylvatica*)
	Sample size (No. *Bd*-positive), %	Infection level (zoospore equivalents, mean ± SE)	Sample size (No. *Bd*-positive), %	Infection level (zoospore equivalents, mean ± SE)	Sample size (No. *Bd*-positive), %
Dodds Road Beaver Pond 41.4760°N, 80.3193°W	1 (1) 100%	1639 ± 131	10 (0) 0%	-	-
Geneva Pond 41.5872 °N, 80.2432 °W	10 (6) 60%	259 ± 205	-	-	-
Housing Site 41.6229°N, 80.4551°W	-	-	-	-	9 (0) 0%
Mark's Pond 41.4607°N, 80.3059°W	7 (2) 28%	2.9 ± 2.6	9 (1) 11%	44.3 ± 24.9	- -
Mosquito Coast 41.6798°N, 80.4976°W	2 (0) **0%**	-	10 (1) 10%	27.8 ± 14.5	-
Mud Lake 41.5594°N, 80.3688°W	-	-	9 (0) 0%	-	- -
Oberdick Pond 41.6875°N, 80.4273°W	-	-	6 (0) 0%	-	-
Oxbow Lake, Shenango River 41.3161°N, 80.3209°W	7 (3) 42.9%	158.7 ± 130.7	8 (1) 13%	69.0 ± 19.1	-
Ravine by Shenango Oxbow 41.3214°N, 80.3228°W	-	-	-	-	-
State Game Land 69 41.6260°N, 79.1180°W	1 (1) 100%	66.2 ± 7.6	8 (1) 13%	3.8 ± 1.6	-
State Game Land 144 41.8419°N, 79.7169°W	9 (0) 0%	-	-	-	-
State Game Land 269 41.7969°N, 80.2114°W	-	-	5 (0) 0%	-	-
State Game Land 277 41.8166°N, 80.0250°W	9 (3) 33%	27.5 ± 22.2	9 (1) 11%	10.0 ± 2.4	-
Trailer Park Pond 41.5687°N, 80.4545°W	-	-	-	-	12 (0) 0%

Green Frogs because they often overwinter as tadpoles, which increases the opportunity for infection to occur, and because high sample sizes can be obtained. In addition to the three focal species, we also opportunistically sampled adult Northern Two-lined Salamanders (*Eurycea bilineata*), Northern Dusky Salamanders (*Desmognathus fuscus*), and adult Spring Peepers (*Psuedacris crucifer*) for *Bd*. All Red-spotted Newts and Green Frogs were collected in permanent ponds, whereas Wood Frogs and Spring Peepers were sampled in ephemeral ponds. Salamanders were sampled in an ephemeral stream. Sites were surveyed until 10 individuals of a species were collected or no more animals could be found in a reasonable time frame.

To sample *Bd*, animals were swabbed thirty times along keratinized tissues where *Bd* zoospores are highly concentrated (Marantelli et al. 2004). Tadpoles were swabbed (Medical Wire Company MW113) across mouthparts, adult frogs were swabbed along the drink patch, inside lower thighs and foot webbing, and newts were swabbed on the ventral side, back legs, and feet. Swabs were stored in 95% ethanol and DNA was extracted and analyzed for *Bd* presence and quantity using quantitative PCR

(Boyle et al. 2004). This method is highly sensitive and can detect very low-level infections that might be missed with other methods (Hyatt et al. 2007). Samples were run in triplicate and were re-run from the same extraction in cases where results yielded only one or two positive results. A re-run sample was considered positive if at least 3 of 6 wells tested were positive. Such variability between wells is common in samples with low infection levels (personal observation). Quantitative estimates of infection levels were made by averaging positive results within a sample.

To minimize cross-contaminating animals, gloves and equipment that contacted frogs were sterilized with 70% ethanol and dried between handling of individuals and all other equipment was sterilized with a 10% bleach solution or discarded after leaving a pond (Johnson et al. 2003).

Our results suggest that *Bd* is widespread throughout northwestern Pennsylvania, USA, yet infection prevalence and intensity varies among species (Table 1). Red-spotted Newts had the highest prevalence of the three species that could be surveyed with sufficient sample sizes. We did not find infected newts in 2 of the 9 ponds, however, the sample size was not sufficient to confidently demonstrate that these ponds were infection-free. Among tested individuals, infection loads (measured in terms of zoospore equivalents) varied over three orders of magnitude among sites. There are few other data examining *Bd* infection loads in Red-spotted Newts, but infection has been reported for museum specimens in eastern North America and more recently in field-collected Red-spotted Newts from the southeastern USA (Ouellet et al. 2005; Rothermel et al. 2008). This suggests that *Bd* infection in Red-spotted Newts is not uncommon. Interestingly, the closest area to our study site that has been surveyed for *Bd* (Delaware Water Gap National Recreation Area) did not find infections in Red-spotted Newts or any other tested species (e.g., *Rana sylvatica*, *Pseudacris crucifer, Hyla versicolor*; Glenney et al. 2010). Many of the newts collected in our study also exhibited cysts indicating infection by the mesomycetozoan *Amphibiocystidium viridescens* (pers. obs.), and newts in the surrounding area have been shown to carry infections of other parasites, including trematodes, nematodes, trypanosomes, acanthocephelans, helminths and bacteria (Raffel et al. 2009). This raises the question as to whether co-infection with other pathogens alters *Bd* infection rates in Red-Spotted Newts.

Bd infection also was found in Green Frog tadpoles (Table 1). Although infection prevalence was lower than that found in Red-spotted Newts, infection was detected in more than 50% of ponds and sample sizes were not large enough to confidently detect low-level infections in the other ponds. On average, infection loads of Green Frog tadpoles were lower than that found in newts. This may reflect the fact that tadpoles possess less keratinized tissue than newts (Marantelli et al. 2004). Other surveys examining *Bd* infection in Green Frog adults and metamorphs with qPCR and histology have found higher infection levels (18–36% in Maine from 2000–2002; Longcore et al. 2007), which also may reflect less keratinized tissue in tadpoles (Marantelli et al. 2004). It is likely that *Bd* has been prevalent in Green Frogs for some time; the earliest evidence for *Bd* in North America came from a museum specimen collected in 1961 in Quebec (Ouellet et al. 2005). The tadpoles sampled in our study were in their second larval year, allowing ample time for animals to be infected. Since newts co-occur in ponds with Green Frogs, *Bd* may have been transmitted across species.

No individuals of the four other species sampled were *Bd*-positive: Northern Two-lined Salamanders (N = 2, ravine by Shenango Oxbow); Northern Dusky Salamanders (N = 4, ravine by Shenango Oxbow); Spring Peepers (N = 2, Trailer Park Pond); and Wood Frogs (Table 1). However, our sample sizes were small and sample sizes >59 are recommended to detect *Bd* when prevalence is low (Skerratt et al. 2008). Past studies of Wood Frogs in New England and Michigan, USA show low to moderate prevalence of *Bd* (>1 % to 16.7% with qPCR and histology; Longcore et al. 2007; Zellmer et al. 2008), but previous studies of Wood Frogs in eastern Pennsylvania (N = 28) did not find infected individuals, despite using sensitive testing techniques (i.e., qPCR, Glenney et al. 2010). *Bd* also has been found in the Northern Two-Lined Salamander and the Dusky Salamander, suggesting that these species are susceptible to infection (Byrne et al. 2008; Grant et al. 2008). We failed to find any records of infected Spring Peepers, although they have been previously surveyed for *Bd* infections (Byrne et al. 2008; Longcore et al. 2007; Ouellet et al. 2005; Rothermel et al. 2008; Glenney et al. 2010).

Overall, our results correspond with other studies showing that *Bd* is present in areas where amphibian population declines have not been documented (Green and Dodd 2007; Longcore et al. 2007; Rothermel 2008; Zellmer et al. 2008). Though we only sampled at a single point in time, high prevalence of infection and relatively low infection intensities in both Green Frogs and Red-spotted Newts suggest that *Bd* is not uncommon in northwest Pennsylvania and both species might be good indicators for *Bd* presence in this region. Although no pathology was observed in infected individuals we suggest that further monitoring is necessary to test whether this observation is consistent.

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HERPETOLOGICAL HUSBANDRY

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Observations on the Captive Reproduction of Gaige's Rain Frog *Pristimantis gaigeae* (Dunn 1931)

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Gaige's Rain Frog, *Pristimantis gaigeae* (Strabomantidae) is a direct-developing anuran species ranging from the Atlantic lowlands in extreme southeastern Costa Rica through eastern Panama and on the Pacific versant in central Colombia (Savage 2002). The species is considered a mimic of dendrobatid species, exhibiting a pair of red, orange, or golden dorsolateral stripes on a black body, similar to the two toxic species *Phyllobates aurotaenia* and *P. lugubris* (family Dendrobatidae) with which some populations of *Pristimantis gaigeae* are sympatric (Fig. 1).

It is the intent of the authors to present methods that have been utilized to successfully maintain and reproduce *Pristimantis gaigeae* in captivity. As little information is currently available on the captive husbandry and reproduction in species of *Pristimantis*, we believe the information provided herein may prove useful in future attempts to maintain *ex situ* populations of this and other species of the genus.

SPECIMEN ACQUISITION AND HUSBANDRY METHODS

The group of *P. gaigeae* at the Atlanta Botanical Garden (ABG) consisted of one male and two females collected in 2005 from the vicinity of El Valle de Antón and one male collected from the vicinity of El Copé, both in Provincia de Coclé, Panamá. The specimens were collected and exported as a part of the Amphibian

Recovery and Conservation Coalition (ARCC) project. This was a collaborative effort between ABG and Zoo Atlanta aimed at learning the logistics of an ex situ response to the rapid spread of chytridiomycosis through amphibian populations in Panama (Lips et al. 2006; Gagliardo et al. 2008).

After importation, specimens were put through a quarantine period of thirty days during which all were prophylactically treated for *Batrachochytrium dendrobatidis* infection following the protocol suggested by Dr. Brad Lock (Zoo Atlanta) and Dr. Brad Wilson (The Veterinary Clinic West, Marietta, Georgia). Post-quarantine and treatment, the three specimens from El Valle were housed in an enclosure measuring 60 x 30 x 90 cm with live plants (*Philodendron* and *Calathea*), substrate consisting of moistened sphagnum moss, and pieces of cork bark for cover. The single male from El Copé was housed in an enclosure measuring 25 x 30 x 50 cm and furnished as for the El Valle group. Light was provided by one 55-watt power compact fluorescent fixture over each enclosure and temperatures were maintained between 18–28°C. A 12-hour on and 12-hour off light cycle was maintained throughout the year. Humidity and moisture were maintained through use of an automated misting system. The diet of the adults consisted almost exclusively of domestic crickets (*Acheta domestica*) that were gut loaded with a varied fresh vegetable diet and dusted at alternate feedings with Rep Cal D3® and finely powdered Men's Health® vitamins. Occasionally, nymphs of the Turkistan Roach (*Blatta lateralis*) and Lobster Roach (*Nauphoeta cinerea*) were offered.



COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND

FIG. 1. Adult male *Pristimantis gaigeae* collected from El Valle De Anton, Provincia De Coclé, Panama. Photo by Robert Hill.

In May 2006, the three El Valle specimens were transferred to the private collection of Paul Crump in Houston, Texas, USA. The specimens were housed together in an enclosure measuring 60 x 30 x 90 cm. Furnishings consisted of moistened sphagnum moss substrate, live plants, and pieces of cork bark as refugia. Misting occurred four times daily, with the longest misting event taking place for five minutes each day at 00:00 then gradually decreasing to one minute by 12:00 and increasing gradually back to five minutes. Temperatures were maintained from 21–24°C. Light was provided by two 1.2 m fluorescent full spectrum bulbs on a 12-hour on and 12-hour off cycle. Specimens were fed a diet of domestic crickets and fruit flies (*Drosophila hydei*) that were dusted at each feeding with Miner-All I®.

In April 2008, the three adult El Valle specimens and one captive offspring were returned to ABG. Upon return, specimens were put through quarantine procedures as described above. They were then transferred to a temporary enclosure measuring 50 x 25 x 30 cm that was furnished with a moistened sphagnum moss substrate, live plants, and plastic refugia. This enclosure was misted once daily by use of a spray bottle.

In 2008, a modified shipping container was acquired by ABG and outfitted for use as a holding and breeding facility for amphibians (Fenolio et al. 2009). This included the group of four adult *P. gaigeae*. The El Valle group was split, with the male and one female kept together, and the additional female placed with the El Copé male. Each pair of frogs was housed in a Zoo Med® terrarium measuring 30 x 30 x 45 centimeters. Each was furnished with lighting, live plants, substrate, and refugia as above. Humidity and moisture were regulated through the use of an automated misting system operating six times daily during a simulated wet season from November–April and two times daily during a simulated dry season from May–October. Individual misting events ranged from three to 10 minutes each with the shortest misting events taking place during the simulated dry season.



FIG. 2. Late stage eggs of *Pristimantis gaigeae*. Photo by Brad Wilson.

Breeding

Axillary amplexus has been observed in *P. gaigeae*, though further observations are necessary to determine duration before oviposition and fertilization. No calls have been noted or recorded and, according to Savage (2002), this species does not have an advertisement call. Egg attendance behavior has been observed in both sexes and occurs in other members of the Strabomantidae (Ryan 2005).

Multiple breeding events have occurred at ABG; the first being in May 2006 with 36 eggs deposited on a piece of cork bark. The male was observed in attendance of the egg clutch. Viability was low and none of the resultant offspring survived. Several breeding events were observed in 2009 with clutch sizes ranging from 22–37 eggs. Eggs measured approximately 5 mm in diameter and typically were buried in the substrate under one of the plastic cover objects or within the root systems of the plants; typically, one or more eggs did not get covered with the rest of the clutch and in more than one instance, were observed up to several centimeters from the main egg mass. These scattered, isolated eggs typically failed to hatch. However, eggs were deposited on top of a plastic cover object on more than one occasion by each female. Both sexes have been observed attending clutches, however never together or at the same time. In instances where egg clutches have been observed in the open and uncovered, viability appeared to be lower in comparison to the typically covered clutches. However, even under these exposed circumstances, an adult was observed in attendance. The time period between clutches during peak breeding activity was from six to eight weeks.

Handling of Eggs and Hatchlings

Eggs were carefully removed from the adult enclosure and incubated on a 5–10 cm layer of moistened sphagnum moss in plastic quart-size deli cups until hatching, which occurred from 28–39 days post-oviposition (Fig. 2). The incubation cups are maintained at 21–26°C with all eggs completely covered with moss so that they were not exposed to light. Interestingly, in a recent manipulation, a portion of an egg mass was left completely exposed to light and development continued normally and unimpeded (R. Hill, pers. obs.). Newly hatched *P. gaigeae* measured approximately 5 mm in length. Because of this small size, and the propensity of injury during movement, eggs were separated and placed two each into rearing containers late in development. Rearing containers consisted of quart-size plastic deli cups containing a layer of moistened sphagnum moss and a vented lid. To prevent desiccation of the tiny young, roughly 50% of the lid was covered with plastic wrap to maintain high humidity.

Hatchlings proved difficult to rear successfully and often began showing what appeared to be signs of calcium deficiency within the first several weeks. The diet at this stage consisted nearly exclusively of springtails (*Collembola* sp.). Anecdotal observation suggests that the use of liquid and powdered vitamin supplementation added to the diet of the springtails may potentially increase hatchling survivorship (J. Kaylock, pers. obs.). Desiccation proved to be a major concern. Some specimens were observed to dry out on the sides of their enclosures. The covering of at least 50% of the vented lid of the rearing container combined with daily misting mitigated this issue. Another method utilized was to maintain the hatchlings as stated above, but without the plastic wrap and placed inside a larger enclosure with automated misting. In this arrangement, we found that the mist soaks and penetrates the vented lid to provide additional moisture and ambient humidity. Both rearing methods have proven successful thus far. Once the young frogs moved onto larger food items such as flightless fruit flies (*Drosophila melanogaster* and *D. hydei*) and newly hatched domestic crickets, growth was rapid.

Conclusions

Pristimantis gaigeae is listed as a species of Least Concern by the World Conservation Union (IUCN Red List, 2009). Of the 426 currently recognized species of *Pristimantis* considered by the IUCN Red List, 67 are listed as Endangered, Critically Endangered, or Vulnerable with 38 listed as Data Deficient. Very few species of *Pristimantis* are currently held in managed collections and even fewer have been routinely reproduced. While *P. gaigeae* may not be a species of particular conservation concern at this point in time, the methods and techniques used in the successful husbandry and reproduction of this species may prove useful for other members of the genus for which *ex situ* management programs may eventually be deemed necessary.

Acknowledgments.—This manuscript is dedicated in gratitude and to the memory of Julia Beth Kaylock (1980–2009), whose dedication to and passion for amphibian conservation and husbandry helped bring about the current successes with *P. gaigeae* and other Panamanian amphibians. Special thanks to the personnel and government of the Republic of Panama. Permits were granted by the Autoridad National del Ambiente (permit SEX/A-81-05). Acknowledgments also to Joseph R. Mendelson, III and Jennifer Cruse-Sanders for assistance during the editorial process and to Brad Wilson for providing images. Further gratitude goes to George Rabb, Cynthia Jeness, and Bill and Claire Simmons for their support of *ex situ* conservation efforts for Panamanian amphibians.

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NATURAL HISTORY NOTES

The Natural History Notes section is analogous to Geographic Distribution. Preferred notes should 1) focus on observations in the field, with little human intrusion; 2) represent more than the isolated documentation of developmental aberrations; and 3) possess a natural history perspective. Individual notes should, with few exceptions, concern only one species, and authors are requested to choose a keyword or short phrase which best describes the nature of their note (e.g., Reproduction, Morphology, Habitat, etc.). Use of figures to illustrate any data is encouraged, but should replace words rather than embellish them. The section's intent is to convey information rather than demonstrate prose. Articles submitted to this section will be reviewed and edited prior to acceptance.

Electronic submission of manuscripts is requested (as Microsoft Word or Rich Text format [rtf] files, as e-mail attachments). Figures can be submitted electronically as JPG files, although higher resolution TIFF or PDF files will be requested for publication. Please DO NOT send graphic files as imbedded figures within a text file. Additional information concerning preparation and submission of graphics files is available on the SSAR web site at: http://www.ssarherps.org/HRinfo.html. Manuscripts should be sent to the appropriate section editor: **Jackson D. Shedd** (crocodilians, lizards, and *Sphenodon*; jackson.shedd@gmail.com); **Charles W. Painter** (amphibians; charles.painter@state.nm.us); **John D. Willson** (snakes; hr.snake.nhn@gmail.com); and **James Harding** (turtles; hardingj@msu.edu).

Standard format for this section is as follows: SCIENTIFIC NAME, COMMON NAME (for the United States and Canada as it appears in Crother [ed.] 2008. *Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico*. SSAR Herpetol. Circ. 37:1–84, available from SSAR Publications Secretary, ssar@herplit.com; for Mexico as it appears in Liner and Casas-Andreu 2008, *Standard Spanish, English and Scientific Names of the Amphibians and Reptiles of Mexico.* Herpetol. Circ. 38:1–162), KEYWORD. DATA on the animal. Place of deposition or intended deposition of specimen(s), and catalog number(s). Then skip a line and close with SUBMITTED BY (give name and address in full—spell out state names—no abbreviations). (NCN) should be used for common name where none is recognized. References may be briefly cited in text (refer to this issue for citation format).

Some further comments. The role of the "Standard Names" lists (noted above) is to standardize English names and comment on the current scientific names. Scientific names are hypotheses (or at least represent them) and as such their usage should not be dictated by a list, society, or journal.

Recommended citation for notes appearing in this section is: Medina, P., and R. L. Joglar. 2008. *Eleutherodactylus richmondi*: reproduction. Herpetol. Rev. 39:460.

CAUDATA — SALAMANDERS

PLETHODON CINEREUS (Eastern Red-backed Salamander). **WETLAND HABITAT.** *Plethodon cinereus* are noted for their ability to live and breed in terrestrial "forest litter habitats in deciduous, northern conifer, and mixed deciduous-conifer forests" (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, D.C. 587 pp.). However, although "many individuals are found far from any visible water supply and the species is less dependent on water than many others, [*P. cinereus* can be found] in greatest numbers in fairly damp situations" (Bishop 1941. The Salamanders of New York. New York State Mus. Bull. 324). Scattered reports in the literature confirm the species' use of moist habitats, for example, two dead *P. cinereus* were observed in leaves of the bog-dwelling Purple Pitcher Plant (*Sarracenia purpurea*; Hughes et al. 1999. Herpetol. Rev. 30:160). We observed *P. cinereus* in moss along shorelines of wetlands and also observed the species under rocks and leaf litter in stream channels in Maine. We are aware of no previous literature documenting the occurrence and breeding of *P. cinereus* in wetland shoreline. Two publications document *P. cinereus* presence in stream channel habitat: 25 *P. cinereus* were detected under rocks (18–30 cm in diameter, 30% embedded in substrate) in ≥ 6 streams in Maine (Perkins and Hunter 2006. J Wildl. Manag. 70[3]:657–670) and the species was observed beneath stones in small streams in Maryland (Cooper 1956. Herpetologica 1956:165–166). Our observations further describe the stream channel habitat used by *P. cinereus*. The occurrence of *P. cinereus* in wetland and stream habitat has relevance to managers and biologists surveying for the species.

We thoroughly searched the vegetation growing in wetlands and on the shoreline of palustrine wetlands (N = 67) in Maine, USA (Acadia National Park, Massabessic Experimental Forest, U.S. Fish and Wildlife Service Sunkhaze Meadows National Wildlife Refuge, University of Maine Foundation Penobscot Experimental Forest, University of Maine Demeritt Forest) during 2001–2003. We searched by parting vegetation growing <30 cm from water with methods described by Chalmers and Loftin (2006. J. Herpetol. 40:479–486). We detected 49 *P. cinereus* (of which at least 12 were gravid) and one clutch of eggs in vegetation in wetlands (N = 26; 39% of wetlands surveyed). We typically observed the *P. cinereus* located directly above water and in *Sphagnum* or *Thuidium* (feather moss). Twice we observed *P. cinereus* with Four-toed Salamanders (*Hemidactylium scutatum*). We observed an adult of each species entwined at one wetland. We found eggs of *P. cinereus* and *H. scutatum* within <8 cm of each other at another wetland. The *P. cinereus* clutch was located in *Sphagnum* along the shoreline of a slow moving stream in a palustrine wetland with a Red Maple (A*cer rubrum*) canopy, alder (*Alnus incana*) understory, and herbaceous layer of Blue-joint Reed Grass (*Calamagrostis canadensis*). The *P. cinereus* clutch (detected 20 June 2002 by J. Bertman) was on the underside of a rotten, leaning stump surrounded by *Sphagnum*. The clutch was attended by a female and contained six eggs. We observed the *P. cinereus* on 1 July attending two eggs attached to the stump and two eggs attached to *Sphagnum*. Twice, we observed *P. cinereus* in a wetland >10 m from the wetland edge on islets (<2 m^2) that the salamanders may have reached during low water. The species can swim (Bishop 1941, *op. cit.*); however we observed *P. cinereus* placed in water initially sink, then surface and swim to shore.

We surveyed stream salamanders in Acadia National Park, Mount Desert Island, Maine, 15 May–21 June 1999 and in August 2001–2003. The only stream salamander species currently vouchered on the island is the Northern Two-lined Salamander (*Eurycea bislineata bislineata*; Brotherton et al. 2004. Acadia National Park Amphibian and Reptile Inventory: March–September 2001. Tech. Rep. NPS/NER/NRTR-2005/007. National Park Service, Woodstock, Vermont). We detected *P. cinereus* with two survey methods: 25-m long transects parallel to the stream with width 1 m onto shore and 1 m into water, and "belt" transects per-

pendicular to the stream for length spanning the stream bed plus 1 m onto each shore and 1 m width. We made 72 observations of juvenile and adult *P. cinereus* (≥ 26 individuals) in transects at four (Breakneck Stream, Duck Brook, Hadlock Brook, Kebo Stream) of six streams surveyed. *Plethodon cinereus* were observed in stream bars and bank face. Microhabitat used by individuals on stream bars typically was under rock cover and on a moist substrate of sand, gravel, or cobble. Salamanders occupying the stream bank face typically were under wet leaf litter and on soil or bedrock substrate. Salamanders were occasionally found on substrate with pooled water. *Plethodon cinereus* were observed in stream channel habitat during both periods of flow and periods of low water in which intermittent flow was interspersed with pools in the stream channel.

Plethodon cinereus are found in Maine along the vegetated shoreline of wetlands and the channels and banks of streams as well as in habitat farther from water. Individuals could be moving into wet habitat temporarily during dry conditions (e.g., summer drought) when the forest floor is otherwise too dry for the species. Alternately, *P. cinereus* may use wet habitats for a longer duration if the conditions of the surrounding terrestrial habitat (shallow, rocky, well-drained soil) are typically too dry for the species. Large numbers of Eastern Red-backed Salamanders migrate towards wetlands with *Hemidactylium scutatum* and Blue-spotted Salamanders (*Ambystoma laterale*) in the spring in Vermont (J. Andrews, unpubl. data). The timing of these migrations is too early for seasonal drying of the forest floor, which typically occurs in late summer, and Andrews suggests that at these wetlands, the salamanders may leave the wetlands only for overwintering (J. Andrews, pers. comm.) Streams in our study area annually decrease in surface water area in the summer and subsequently expose cover rocks in the stream channel. We observed *E. bislineata* moved to those cover rocks closest to the remaining surface water. *Plethodon cinereus* may have an increased opportunity to use stream bed habitat during summer drought because of a greater number of cover objects available and a simultaneous decrease in interspecific competition for cover. *Plethodon cinereus* typically are displaced from moist habitats by other plethodontid species via competitive interactions (Hairston 1949. Ecol. Monogr. 19:47–73) and depredation (Hairston 1980. Am. Nat. 115:354–366). The relatively few amphibian species (*Eurycea bislineata bislineata*, *Desmognathus fuscus fuscus*, *Gyrinophilus porphyriticus*, in streams, and *Hemidactylium scutatum* along wetland shoreline) occupying these habitats in Maine may improve the opportunity for *P. cinereus* to colonize these habitats with less interspecific competition than present in more southerly regions.

Further study is necessary to determine the spatial extent, duration, and seasonal patterns of stream- and wetland-habitat use by *P. cinereus* in Maine. *Plethodon cinereus* also may use wetland habitats elsewhere in its range, although this had not been reported in published literature. Researchers and surveyors of *P. cinereus* should consider the possibility that this species may occur in wetland habitats in northern portions of the species' range.

These data were obtained during research funded by the United States Geological Survey (USGS) Maine Cooperative Fish and Wildlife Research Unit, University of Maine, and USGS Amphibian Research and Monitoring Initiative. We thank field assistants J. Bertman and A. Murphy. The manuscript was improved by the thoughtful comments of J. Andrews and M. B. Kolozsvary.

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PLETHODON PETRAEUS (Pigeon Mountain Salamander). **PREDATION.** *Plethodon petraeus* is a large (to 84 mm SVL) scansorial plethodontid salamander endemic to karst areas of a single mountain slope in Walker and Chatooga counties in northwest Georgia, USA (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, DC. 587 pp.; Wynn et al. 1988. Herpetologica 44:135–143). Due in part to its restricted range and recent discovery, no predators have been reported for *P. petraeus* (Jensen and Camp 2005. *In* M. Lannoo [ed.], Amphibian Declines: The Conservation Status of United States Species, pp. 833–834. Univ. California Press, Berkeley). We report the first account of predation on *P. petraeus*, though by what is likely an insignificant and opportunistic predator.

At 1430 h on 17 April 2010, one of us (GJB) found a live juvenile *P. petraeus* suspended in a spider web >30 cm deep in a narrow rock crevice on the Lost Wall, on Pigeon Mountain, Walker Co., Georgia, USA (34.6592°N, 85.3717°W, WGS 84). The spider was not present at the web, so the species could not be determined, but based on the shape and location of the web we tentatively identify the family as Agelenidae (North American funnel-web spiders). Other examples of spider predation on salamanders include a wolf spider (*Hogna helluo*) feeding on a Blue-spotted Salamander (*Ambystoma laterale*; McLister and Lamond 1991. Can. Field-Nat. 105:574) and experimental data from a challenge of phyletic bias in predator-prey interactions in which adult wolf spiders (*Gladicosa pulchra*) were offered and preyed upon juvenile Spotted Salamanders (*Ambystoma maculatum*; Rubbo et al. 2003. J. Zool. Lond. 261:1–5). Both species of wolf spiders (Lycosidae) are generalist cursorial ambush predators and do not use webs to trap their prey, so this report repre-



FIG. 1. Juvenile *Plethodon petraeus* tangled in an agelenid spiderweb. Walker Co., Georgia, USA.

sents the first example of entrapment of a salamander in a spider web.

We thank J. Perry of the North Carolina State Museum of Natural Sciences for assistance with identification of the spider web.

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PSEUDOEURYCEA GIGANTEA (Giant Salamander). **MAXIMUM SIZE.** *Pseudoeurycea gigantea* is one of Mexico's largest plethodontids, reaching 161 mm SVL (Parra-Olea et al. 2005. Herpetologica 61:145–158). On 20 Nov 2009, we collected an adult male *Pseudoeurycea gigantea* in cloud forest, 0.7 km S and 0.2 km W of San Juan de las Flores, municipality of San Bartolo Tutotepec, Hidalgo, Mexico that exceeds the total length of earlier records (161 mm SVL, 228 mm TL; Parra-Olea et al. 2005, *op. cit.*). The specimen measured 149 mm SVL and 314 mm TL which represents the largest total size of this species reported. The specimen is deposited in the Colección Herpetológica, Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo (CIB-UAEH 2549). *Pseudoeurycea gigantea* is an endemic salamander restricted to a small area of eastern Mexico, found in the states of Puebla, Hidalgo, and Veracruz (Parra-Olea et al. 2005, *op. cit.*).

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***SIREN* SP.** (Mudpuppy). **PREDATION.** Although wading birds are likely predators of *Siren* (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, D.C. 587 pp.), records of specific sirenid predation events are scarce. On 15 January 2010, at approximately 1636 h a Great Egret (*Ardea alba*) was observed eating a *Siren* in the Audubon Swamp Garden in Magnolia Plantation and Gardens, Charleston County, South Carolina, USA. The egret took at least three minutes after being seen with the siren in its beak to consume it. The siren was approximately the length of the bill of the Great Egret and could have been either a Greater Siren (*S. lacertina*) or Lesser Siren (*S. intermedia*). Although previous records are available for "large, eel-like salamanders" being robbed from Great Egrets and White Ibis (*Eudocimus albus*) by American Crows (*Corvus brachyrhynchos*), these records could be for Two-toed Amphiuma (*Amphiuma means)* or *S. lacertina* (Kilham 1984. Colonial Waterbirds 7:143–145). This observation provides additional evidence of wading birds as predators of sirenids and further narrows confirmed predation by Great Egrets to members of the *Siren* genus.

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SIREN INTERMEDIA (Lesser Siren). **EXTRALIMITAL INTRODUCTION/REPRODUCTION.** The natural range of *Siren intermedia* is confined to the Atlantic and Gulf Coastal Plain from Virginia to Mexico, and extends north in the Mississippi Valley to Illinois, Indiana, and southwestern Michigan (Conant and Collins 1991. A Field Guide to Reptiles and Amphibians of Eastern and Central North America. Houghton Mifflin Co., Boston, Massachusetts).

On 25 March 2005 at least one *S. intermedia* individual was released into a permanent man-made backyard pond (500 gal, 90 cm deep) in San Mateo Co., California via an aquatic plant shipment from Arkansas. The pond had previously been stocked with Fathead Minnows (*Pimephales promelas)*, which were likely the main source of prey, and various aquatic plants which provided sufficient cover. On 10 April 2008, I discovered larval *S. intermedia* in the pond. I proceeded to drain the pond and collected approximately 40 larvae and two large putative adult individuals. Multiple adult Bullfrogs (*Rana catesbeiana)* were also recovered. All sirens were transferred to the Department of Evolution and Ecology, University of California, Davis, California and maintained in aquaria (HBS188896–906).

Although constrained mostly to the eastern United States, this event demonstrates that *S. intermedia* have the potential to reproduce in a California coastal climate even in the presence of aquatic predators such as the Bullfrog. Furthermore, breeding populations could potentially result from individuals released into permanent hydroperiod aquatic habitats in California. The transition of California's aquatic resources from vernal pools to large stock ponds has previously facilitated the establishment of the non-native Tiger Salamander (Fitzpatrick and Shaffer 2004. Evolution 58:1282–1293).

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ANURA — FROGS

BUFO BOULENGERI (African Green Toad). **CANNIBALISM.** *Bufo boulengeri* (Stöck et al. 2006 Mol. Phylogenet. Evol. 41:663–689; Stöck et al. 2008 BMC Evol. Biol. 8:56) is a prolonged breeder which typically inhabits temporary and shallow water bodies (Bologna and Giacoma 2006. *In* Sindaco et al. [eds.], Atlante degli Anfibi e dei Rettili d'Italia, pp. 306–311. Ed. Polistampa). In arid areas, similar to those used for reproduction in southern Morocco, *B. boulengeri* seems to be unevenly distributed, with dense populations in oases widely separated by unsuitable dry areas. Due to the coexistence of different developmental stages in the same wetland, levels of intraspecific competition are high.

A wetland situated near Tiznit, Morocco (28.123164°N, 11.296131°W, 87 m. elev.) was examined on 4 April 2010. The



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FIG. 1. Female *Bufo boulengueri* exhibiting cannibalism behavior.

wetland was located in a stony plain. The plant community, within the inframediterranean belt, was a scrubland dominated by *Euphorbia echinus*, *Lycium intrincatum*, *Launaea arborescens*, *Frankenia* spp., *Witthania frutescens*, *Fagonia cretica*, and *Lavandula multifida*. A high density of several dozen individual *B. boulengeri* metamorphs were observed per m^2. Adults were found along the banks of the wetland and the cannibalistic behavior of an adult female was observed (Fig. 1). The total length of the adult was 84 mm and the total length of the recently metamorphosed *B. boulengeri* was 31 mm.

Both in natural or experimental conditions, many anurans frequently exhibit cannibalistic behavior, and these interactions are thought to be relatively common, at least in larval stage (Alford 1999. *In* McDiarmid and Altig [eds], Tadpoles: The Biology of Anuran Larvae, pp. 240–278. Univ. Chicago Press, Chicago, Illinois; Crump 1992. *In* Elgar and Crespi [eds.], Cannibalism: Ecology and Evolution Among Diverse Taxa, pp. 256–276. Oxford Univ. Press, London, UK). Our observation is the first record of cannibalism for this species and contributes to our knowledge of the ecology of *B. boulengeri*.

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CERATOPHRYS CRANWELLI (Cranwell's Horned Frog). **DIET**. *Ceratophrys cranwelli* is a large terrestrial frog endemic to the Gran Chaco ecoregion of South America. Anurans have been noted as comprising a large proportion of this species' diet, but the only anuran diet items confirmed have been *Physalaemus biligonigerus* and an unidentified *Leptodactylus* sp. (Scott and Aquino 2005. *In* Donnelly et al. [eds.], Ecology and Evolution in the Tropics: A Herpetological Perspective, pp. 243–259). Here I confirm an anuran in the diet of *C. cranwelli*.



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FIG. 1. *Ceratophrys cranwelli* metamorph consuming a *Leptodactylus bufonius* metamorph.

On 15 March 2009 at 2100 h I discovered a metamorph *C. cranwelli* preying upon a small anuran around a temporary pond in the Isoceño community of Yapiroa, Province Cordilleria, Department Santa Cruz, Bolivia (19.6000°S, 62.5667°W; WGS 84). I identified the anuran as a *Leptodactylus bufonius* (Fig. 1). Though the *L. bufonius* was still alive (indicated by its multiple attempts to push itself out of the *C. cranwelli*'s mouth), the *C. cranwelli* proceeded to force the *L. bufonius* into its mouth using its hands. After ca. 20 min, the *L. bufonius* had been completely consumed by the *C. cranwelli*. To my knowledge, this is the first report confirming *L. bufonius* in the diet of *C. cranwelli*.

Funding for this trip was provided by the Applied Biodiversity Science National Science Foundation Integrated Graduate Education and Research Traineeship doctoral program (NSF-IGERT Award #0654377) at Texas A&M University.

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CORYTHOMANTIS GREENINGI (Casque-headed Tree Frog). **EGG PREDATION**. *Corythomantis greeningi* has a wide distribution in the Caatinga of northeastern Brazil where it occupies temporary water bodies in this semiarid region. The species generally reproduces in lotic environments in stony river beds (Juncá et al. 2008. Zootaxa 1686:48–56). On 29 March 2009 at 900 h we observed eggs of *C. greeningi* being predated by tadpoles of *Proceratophrys cristiceps* (about 30 individuals in Gosner stages 40–42), in a small puddle formed in a streambed, situated in Olho d'água, municipality of Santa Cruz da Baixa Verde, State of Pernambuco, Brazil (8.58889ºS, 38.176944ºW; WGS 84; 852 m elev). Such predation of eggs has been reported in other studies (Rodrigues and Filho 2004. Herpetol. Rev. 35:373–373; St. Peter et al. 2008. Mus. Biol. Mello Leitão 24:111–118). This is the first record of oophagy reported for *P. cristiceps*. Specimens of tad-

poles and images of the predation were deposited in the Herpetological Collection of Universidade Federal Rural de Pernambuco / Unidade Acadêmica de Serra Talhada - UFRPE / UAST (Lot 31), Recife, Pernambuco, Brazil.

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DENDROPHRYNISCUS CARVALHOI (Carvalho's Tree Toad). **DEFENSIVE BEHAVIOR**. Thanatosis is a defensive behavior by which an animal feigns death to escape predation. As many predators pursue only live prey, this behavior may be very effective.

The genus *Dendrophryniscus* is native to South America occurring in the Atlantic Rainforests of Brazil, Amazonian Colombia, Ecuador, Peru, and Brazil, and at Guianas (Frost 2009. Amphibian Species of the World: an Online Reference. Version 5.3 accessed 12 Feb. 2009. Electronic database accessible at http://research.amnh.org /herpetology/amphibia/. American Museum of Natural History, New York). *Dendrophryniscus carvalhoi* is known from the type locality in Santa Tereza municipality and ca. 130 km SW at the Parque Nacional do Caparaó, both in Espírito Santo state, Brazil (Cassimiro et al. 2008. Herpetol. Rev. 39:362). Herein we describe thanatosis in *D. carvalhoi*.

During a herpetological survey between 27 Oct and 3 Nov 2006, in Parque Nacional do Caparaó, Fazenda Pico da Bandeira, Santa Marta municipality, Minas Gerais State (20.467222°S, 41.733889°W; WGS 84; elev. ca. 1135 m), we observed defensive behavior of *D. carvalhoi*. One individual displayed thanatosis with stiff-leg behavior in response to hand capture. This species defends itself by stiffening its legs in the same way as was recently described for *D. brevipollicatus* and *D. leucomystax* (Bertoluci et al. 2007. Alytes 25:61–67). The frog assumes the stiff-legged posture when touched and remains immobile for almost one minute. Other specimens collected when disturbed for the first time in the field assumed this same behavior, and also sometimes under laboratory conditions.

Thanathosis with stiff-leg behavior maybe more common than previously thought and widespread among frogs living in forest litter. The behavior may be underestimated considering that certain species only exhibit thanathosis under specific conditions, with predator-specific responses (Gibbons and Gibbons 2009. Herpetol. Rev. 40:440). Moreover, the congruence among thanathosis behaviors among different species of *Dendrophryniscus* (Bertoluci et al. 2007, *op. cit.;* Russell 2002. Herpetol. Rev. 33:302) may reflect a closer relationship among *D. leucomystax*, *D. brevipollicatus*, and *D. carvalhoi* relative to *D. minutus*, in which thanathosis involves flipping over and presenting the ventral surface (Bertoluci et al. 2007, *op. cit.;* Russell, *op. cit.*).

We thank Lilian Duarte de Matos, and our field guide Paraíba, for field assistance. The Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (IBAMA) provided support and collecting permits (numbers 185/2005, and 238/2006). Estevão José Marchesini Fonseca, Director of the Parque Nacional do Caparaó, provided lodging facilities and support.

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EUPHLYCTIS CYANOPHLYCTIS (Indian Skipper Frog). **ALBINISM.** During field collections, we observed two albino tadpoles of *Euphlyctis cyanophlyctis*, one at an early stage of development (Gosner Stage 28; 31 mm in length; Gosner 1960. Herpetologica 16:183–190) and the other near metamorphosis (Gosner Stage 43; 61.8 mm in length) in a pond on the University of Pune Campus (18.554925°N, 73.86335°E), Maharashtra, India. These tadpoles were present with large numbers of conspecifics having normal pigmentation and were very conspicuous. The tadpoles were unique in that they had golden yellow color throughout and had no black pigmentation (Fig. 1A) compared to the normal tadpoles (Fig. 1B). In the early stage tadpole, although black pigmentation was absent throughout the body, the oral appara-



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FIG. 1. Albino tadpoles of *Euphlyctis cyanophlyctis* along with normal tadpoles at different stages of larval development.

tus with jaw sheaths and tooth rows were black (Fig. 1C). From the ventral side, blood vessels, gills, and the heart were visible through the transparent skin due to a lack of pigmentation. The eyes were pink and very prominent, especially during darkness when one of the tadpoles was caught. The pond is permanent, although mostly dry during the summer months. The albino tadpole at metamorphic climax (Fig. 1D) was conspicuous in the group of normal tadpoles (Fig. 1E) when collected. This tadpole metamorphosed in the laboratory within 3–4 days and the frog was normal except for pigmentation (Fig. 1F; 24.2 mm body length, 1.3 g mass). We observed behavioral aspects of its feeding and habitat sharing with normal tadpoles and observed no differences. One of the froglets matured around 4 months after metamorphosis in the laboratory and was found to be a male. We do not know the factors responsible for this phenomenon in nature. Although we have observed tadpoles from this pond for four years this is our first observation of albino tadpoles of *E. cyanophlyctis*.

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EXERODONTA SUMICHRASTI (Sumichrast's Treefrog). **SEMITERRESTRIAL LARVAE.** Except for species where the male or female frog transports the tadpoles (e.g., dorsally, marsupial pouch, etc.), free-living anuran tadpoles typically are aquatic during the entire larval period. The tadpoles of a very few species are known to be semiterrestrial, moving about on tree branches and/or rocks near water (Lawson 1993. Herpetol. Nat. Hist. 1:27–90; Wells 2007. The Ecology and Behavior of Amphibians. Univ. Chicago Press, Chicago, Illinois, 1148 pp.). Of the genera listed by Wells (2007, *op. cit.*), this behavior has been noted in but three genera in the Neotropics, the South American taxa *Leptodactylus rugosus*, *Cycloramphus*, and *Thoropa*. On 27 June 2000 I observed many tadpoles later identified as *Exerodonta sumichrasti* in a stream crossing Hwy 196, 14.2 rd km N Atoyac, Guerrero, Mexico, 610 m elev. (17.32445°N, 100.2474167°W). Most of the tadpoles were resting on rocks in splash pools below small waterfalls, while some were observed in the actual course of the stream. A small number of tadpoles (ca. 10) were observed moving across wet surfaces of rocks in the splash zone, ca. 1 m above the water line, and continuing to move vertically away from the water line. There were some lichens on the rock surfaces where the tadpoles were located, but no evident algae or moss. The tadpoles appeared to be using their enlarged mouthparts as the primary locomotor organ; larvae of this species are not gastromyzophorous. A small number of tadpoles were collected (vouchers deposited at Facultad de Ciencias, Universidad Autónoma de México: MZFC-JRM 4563), and photographic images of the semiterrestrial behavior were deposited at University of Texas at Arlington (UTA slide no. 38677–78). I believe this is the first report of semiterrestrial larvae in any Mesoamerican anuran.

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FEJERVERYA LIMNOCHARIS (Paddy Field Frog). **DIET.** *Fejerverya limnocharis* is widely distributed throughout the Indian subcontinent and feeds mainly on small insects (Chanda 2002. Handbook of Indian Amphibians. ZSI., Kolkata, India; Daniel 2002. The Book of Indian Reptiles and Amphibians. BNHS and Oxford Univ. Press, Mumbai, India; Dutta 1992. Amphibians of India and Sri Lanka [Checklist and Bibliography]. Odyssey Pub. House, Orissa, India), but there is little information on the ecology of the species.

During herpetological surveys on 16 July 2009 at 2322 h, we heard the distinct advertisement calls of anurans. Based on spectrum-homologies of our anuran sound bank as well as on morphological features we identified *Fejerverya limnocharis* in the chorus. During call recordings we observed a *F. limnocharis* feeding on a large earthworm. The frog was holding the earthworm in its jaws and pushing it into its mouth with the help of its forelegs, repeating this motion follow short intervals. Other anurans of larger size such as *Hoplobatrachus tigerinus* readily feed on earthworms (Danials 2004. Amphibians of Peninsular India. Indian Academy of Science and University Press, Hyderabad, India), although there is no report of such feeding behavior for *F. limnocharis.* The *F. limnocharis* under observation was only 3 cm SVL, while it was feeding on an earthworm measuring ca. 10 cm. Reports of *F. limnocharis* feeding on small insects are available, although this is the first report on such an unusual feeding behavior of this anuran.

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HYLA WRIGHTORUM (Arizona Treefrog). **PREDATION**. *Hyla wrightorum* is discontinuously distributed from Arizona and New Mexico, south into northern México. The population of *H. wrightorum* in and near Arizona's Huachuca Mountains, Canelo Hills, and adjacent northern Sonora are isolated from the nearest populations along the Mogollon Rim to the north in Arizona and the Sierra Madre Occidental in Sonora, México (Gergus et al. 2004. Copeia 2004:758–769; Maldonado Leal et al. 2009. Herpetol. Rev. 40:108). Recently, the U.S. Fish and Wildlife Service (USFWS) assigned the Huachuca/Canelo population of *H. wrightorum* the status of Candidate for listing as Threatened or Endangered under the U.S. Endangered Species Act as a Distinct Population Segment (DPS; USFWS 2007. Fed. Register 72:234). Among the threats to the DPS identified by USFWS was the potential for predation by introduced species, particularly American Bullfrogs (*Lithobates catesbeianus*), but empirical data were lacking (USFWS, *op. cit*.). We report the first documented instance of predation by *L. catesbeianus* on *H. wrightorum*.

On 14 July 2008, from 1245–1520 h MST, in Scotia Canyon, Huachuca Mountains, Cochise Co., Arizona, USA (31.4572°N, 110.3976°W, NAD 83, ca. 1890 m elev.), we were engaged in a larger effort to remove American Bullfrogs from aquatic habitats throughout the canyon, including a permanent, spring-fed pond near the head of the canyon where American Bullfrogs had bred for the past several years. Thunderstorms were moving through the area, and male *H. wrightorum* were calling sporadically from a well-known breeding site; a small, temporary pond ca. 50 m from the permanent pond. At that time we collected an adult male *L. catesbeianus* (SVL = 140 mm) that was calling from the temporary pond, and discovered remains of four adult *H. wrightorum* in its stomach; three were males (SVL = 30, 31, 32 mm), one was too decomposed to be measured or sexed. We returned to the site on 17 July 2008, and at 1540 h collected a female *L. catesbeianus* (SVL = 120 mm; with developing ova) at the same site. Her stomach contained three adult *H. wrightorum*, one male (SL = 34 mm); two could not be measured or sexed. Weather was overcast and a single *H. wrightorum* called at 1602 h.

Although the indiscriminate predatory habits of *L. catesbeianus* are well known and widely published (Casper and Hendricks. 2005. *In* M. Lannoo [ed.], Amphibian Declines: The Conservation Status of United States Species, pp. 540–546. Univ. California Press, Berkeley), it is clear from our data that a few adult *L. catesbeianus* can have a profound impact on small, isolated populations of rare species such as *H. wrightorum* in the Huachuca Mountains where breeding sites might comprise only 2–30 adults (Gergus et al. 2005. *In* M. Lannoo [ed.], Amphibian Declines: The Conservation Status of United States Species, pp. 461–463. Univ. California Press, Berkeley). In addition, since each of the *H. wrightorum* for which sex could be identified were adult males, it raises the possibility that the *L. catesbeianus* might have used acoustical cues to target their prey (Casper and Hendricks 2005, *op. cit.*), although it might simply be the case that females had not yet moved to the breeding site.

American Bullfrogs are known to be capable of moving quickly over relatively large distances during Arizona's summer monsoon (pers. obs.; Suhre et al. 2006. Unpubl. abstract. Joint Meeting of Ichthyologists and Herpetologists, New Orleans, Louisiana; C. Schwalbe and P. Rosen, pers. comm.). Thus, it is not unreasonable to predict that *L. catesbeianus* could temporarily occupy other nearby *H. wrightorum* breeding sites in the Huachuca Mountains and seriously deplete those populations as well, and could do so without that impact being quickly or readily identifiable.

Our fieldwork adhered to guidelines outlined in Beaupre et al. (2004. Guidelines for Use of Live Amphibians and Reptiles in Field and Laboratory Research, 2nd ed. Herpetological Animal Care and Use Committee, American Society of Ichthyologists and Herpetologists).

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HYLODES cf. AMNICOLA (NCN). **PREDATION.** Kingfishers are preferentially fish predators, although they may also include arthropods, crabs, amphibians, and reptiles in their diet (Sick 1997. Ornitologia Brasileira. Editora Nova Fronteira, Rio de Janeiro. 912 pp.). At ca. 1000 h on 17 Oct 2008, during a field trip to "Mata da Prefeitura" (22.2180556°S, 45.2569444°W; 1150 m elev.), in the municipality of Cristina, Minas Gerais State, southeastern Brazil, we observed an adult Ringed Kingfisher, *Megaceryle torquata*, preying on an adult torrent-frog, *Hylodes cf. amnicola*. After capture, the frog was beaten repeatedly on the bird's perch; after the frog was consumed the bird flew away. This is the first report of predation of this species.

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HYPSIBOAS SEMILINEATUS (NCN). **ALBINISM**. *Hypsiboas semilineatus* is a treefrog widely distributed in the Atlantic Forest of Brazil (Haddad et al. 2008. São Paulo: Editora Neotropica). Tadpoles of this species are found in lentic bodies of water forming large schools (D'Heursel and Haddad 2002. Iheringia 92:99–104). On 20 October 2007 at 1900 h and on 19 July 2008 at 1400 h we collected albino tadpoles of *H. semilineatus* at two localities in the Atlantic Forest in northeast Brazil: Reserva Particular Frei Caneca, municipality of Jaqueira (8.721667ºS, 35.850833ºW) and Reserva Particular da Usina São José, municipality of Igarassu (35.000556ºS, 7.817778ºW). These were 39.3 mm SVL/Gosner Stage 33 and 52.1 mm SVL/Gosner Stage 37, respectively. Albinism in anuran larvae is rare in nature (Rodrigues and Filho 2004. Herpetol. Rev. 35:373–373). This is the first record of albino tadpoles for this species.

The tadpoles were deposited in the herpetological collection of the Universidade Federal Rural de Pernambuco/Unidade Acadêmica de Serra Talhada - UFRPE/UAST (lot 30 and 31), Serra Talhada, Pernambuco, Brazil.

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LEPTODACTYLUS LATRANS (Criolla Frog). **PREDATION.** *Leptodactylus latrans* has a wide distribution in South America, occurring east of the Andes from Venezuela to Argentina (Heyer et al. 2010. IUCN. Red List of Threatened Species. Ver. 2010.1). The species inhabits a wide variety of environments including

open habitats in dry areas, tropical rainforests and disturbed areas (Izecksohn and Carvalho e Silva. 2001. Amphibians of Rio de Janeiro, Editora UFRJ, Rio de Janeiro, RJ, 148 pp.). Formerly known as *L. ocellatus* this species was renamed by Lavilla et al. (2010. Zootaxa 2346:1–16). The only record of predation on tadpoles of *L. latrans* refers to the Great Kiskadee (*Pitangus sulphuratus*; Vaira and Coria 1994. Herpetol. Rev. 25:118). There are no records of predation of *L. latrans* tadpoles by invertebrates. At 2120 h on 27 Oct 2009 we observed two predation events of *L. latrans* tadpoles by aquatic invertebrates. The observations were made in wetland habitat associated with a coastal sand dune (32.1654°S, 52.1523°W, Corrego Alegre, sea level) in the municipality of Rio Grande, RS, southern Brazil. Both events were observed simultaneously in a school of tadpoles in a temporary pond colonized by macrophytes (mainly *Juncus acutus* and *Spartina ciliata*). One of the tadpoles (21 mm body length) was preyed upon by a juvenile aquatic spider (*Diapontia* sp., Lycosidae) and the second tadpole (23 mm body length) by a juvenile water-bug (*Belostoma* sp., Belostomatidae). Most amphibians have a close dependence on water bodies for reproduction, thus making them vulnerable to aquatic predators (Toledo 2003. Phyllomedusa 2:105–108; Fulan and Almeida 2010. Acta. Sci. Biol. Sci. 32:121–124). This observation adds two new predators of *L. latrans* suggesting that the role of invertebrates in the population dynamics of anurans is still insufficiently known, especially in the Neotropics. Tadpoles were deposited in the Collection of the Laboratório de Ecologia de Vertebrados Terrestres of FURG (AMRG46; AMRG47). We thank CNPq and Fapergs for financial support and ICMBio for collecting permits.

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LITHOBATES AREOLATUS CIRCULOSUS (Northern Crawfish Frog). **PREDATION.** Raccoons (*Procyon lotor*) are known to consume a wide variety of prey items. They often forage at the edge of shallow water in search of their preferred prey, crayfish (Zeveloff 2002. Raccoons: A Natural History. Smithsonian Institute Press, Washington, D.C. 200 pp.). Amphibians typically do not constitute a large part of their diet. Zeveloff (2002, *op. cit.*) examined raccoon scat and found that 9% was composed of Tiger Salamander (*Ambystoma tigrinum*) remains. Whitaker and Mumford (2009. Mammals of Indiana. Indiana Univ. Press, Bloomington. 661 pp.) examined the stomach contents of 41 raccoons in Indiana and found that amphibians composed 1.7% of the raccoons' diet; both Green Frog (*Lithobates clamitans*) and Fowler's Toad (*Anaxyrus fowleri*) remains were identified. Wright (1966. Herpetologica 22:127–128) witnessed a raccoon kill and eat five Colorado River Toads (*Anaxyrus alvarius*). The raccoon avoided consuming the toxic parotoid glands by turning the animals over and eating the viscera though the anterior abdominal wall. Schaaf and Garton (1970. Herpetologica 26:334–335) reported similar findings in which raccoons preyed upon American Toads (*Anaxyrus americanus*) and often left the head and the upper back.

Parris and Redmer (2005. *In* Lannoo [ed.], Amphibian Declines: The Conservation Status of United States Species, pp. 526–528. Univ. California Press, Berkeley) state that natural predators of Crawfish Frogs (*Lithobates areolatus*) are unknown. Here we report the first known incidents of raccoon predation on Crawfish Frogs, one in Indiana, one in Illinois. During a telemetry study in southwestern Indiana, an adult male Crawfish Frog was found freshly dead the morning of 2 April 2010 along the edge of a breeding wetland where it had migrated the week before. All that remained was the top of the skull and the dorsal skin. The previously intraperitoneally implanted transmitter was a meter away, and within 50 cm, along the shoreline, were fresh raccoon tracks. On 20 March 2010, a recently predated adult male Crawfish Frog was observed at a breeding wetland in southern Illinois. The carcass consisted of a single, nearly-complete piece of skin connected to the top of the skull. The uneaten skin, which included the vocal sacs, was comprised of the dorsum, both sides, most of the venter, and one hind limb. The frog had the appearance of having been skinned.

Crawfish Frog skin, similar to that of toads, is "studded with numerous glandular warts" (Goin and Netting 1940. Ann. Carnegie Mus. 38:137–168); and like several other species of ranids, secretes antimicrobial peptides from granular glands (Ali et al. 2002. Biochimica et Biophysica Acta 1601:55–63). It is possible that skin secretions are distasteful and raccoons avoid eating the skin of Crawfish Frogs, similar to their behavior when preying upon toads.

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LITHOBATES CATESBEIANUS (American Bullfrog). **DIET.** The American Bullfrog was introduced in Brazil in the 1930s for commercial breeding. However, escapes from farms and intentional introductions have allowed this species to establish invasive populations in wild habitats, especially in the Atlantic Rainforest (Giovanelli et al. 2008. Biol. Invasions 10:585–595). Here we report data on the diet of the American Bullfrog obtained by stomach content analysis of 50 specimens collected in a reservoir located in Viçosa (20.75764°S, 42.86075°W), Minas Gerais State, southeastern Brazil. The site is known as Represa do Belvedere, and is composed of a group of small connected dams surrounded by a secondary forest fragments and a grassplot. The dams have abundant aquatic vegetation, mostly *Salvinia* sp. and Nympheaceae.

American Bullfrogs were collected during September–December 2003. After collection, specimens were fixed in 10% formalin and preserved in 70% alcohol; SVL was measured to the nearest 0.05 mm and the stomach contents tabulated. Prey items were identified to the lowest known taxonomic level; plant remains were considered to be accidently ingested.

Only 4 individuals (8%) had empty stomachs, and 16 (32%) had nothing but undetermined remains in their stomachs. Plant remains were found in 22 stomachs (44%), and two individuals

TABLE. 1. Stomach contents of 44 *Lithobates catesbeianus* from "Represa do Belvedere," municipality of Viçosa, Minas Gerais State, Brazil, collected from September to December 2003. Np = number of prey; Nbf = number of American Bullfrogs.

Prey Items	Np	% Np	Nbf	% Nbf
DIPLOPODA	1	0.88	1	2.27
ARACHNIDA				
Araneae	4	3.51	4	9.09
INSECTA				
Blattodea	1	0.88	1	2.27
Coleoptera (adults)	22	19.30	13	29.55
Coleoptera (larvae)	2	1.75	1	2.27
Diptera (adults)	2	1.75	2	4.55
Diptera (larvae)	4	3.51	3	6.82
Ephemeroptera (adults)	1	0.88	1	2.27
Ephemeroptera (larvae)	1	0.88	1	2.27
Hemiptera (Cicadellidae)	1	0.88	1	2.27
Hemiptera (Heteroptera)	12	10.53	6	13.64
Hymenoptera (Formicidae)	26	22.81	16	36.36
Hymenoptera (others)	10	8.77	8	18.18
Isoptera	3	2.63	3	6.82
Lepidoptera (adults)	2	1.75	2	4.55
Lepidoptera (larvae)	2	1.75	2	4.55
Odonata (adults)	5	4.39	3	6.82
Odonata (naiads)	6	5.26	5	11.36
ARTHROPOD REMAINS	0	0	23	52.27
AMPHIBIA				
Rhinella pombali (juvenile)	1	0.88	1	2.27
Scinax fuscovarius	1	0.88	1	2.27
Unidentified anurans	6	5.26	5	11.36
Undetermined remains	0	0	16	36.36
Plant material	0	0	21	45.65

had only plant material in the stomach. Thirty-four individuals (68%) had at least one identifiable prey in their stomachs, and prey number by frog varied from 1–16 (mean ± SD: 3.47 ± 3.07). The majority of the individuals measured (N = 28; 56%) were <50 mm SVL (range: 36.8–48.8; 43.92 ± 3.0). Sixteen frogs were between 51.5 and 84.2 mm SVL (65.65 ± 10.81), and the remaining six frogs were >90 mm SVL (range: 90.10–116.05; 100.96 ± 9.05).

Among the 114 prey items identified, the most common were ants, adult Coleoptera, and Heteroptera which represented 52.64% of the total prey ingested (Table 1). Besides these three insect groups, non-ant hymenopterans, naiads of Odonata, and anurans were also frequent prey items (occurring in >10% of the samples). Insects dominanted the diet likely due to the small size of the majority of frogs. These data add *Scinax fuscovarius* to the list of anurans reported as prey of the invasive American Bullfrog not reported by Silva et al. (2009. S. Am. J. Herpetol. 4:286–284).

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LITHOBATES SYLVATICUS (Wood Frog). **EGG PREDATION**. Predation by tadpoles on eggs and larvae of heterospecifics has been reported for a number of amphibian species (Ehrlich 1979. Bull. Maryland Herpetol. Soc. 15:25–26; Kiesecker and Blaustein 1998. Conserv. Biol. 12:776–787; Petranka et al. 1994. Copeia 1994:691–697). Among these are tadpoles of large-bodied ranids, including Bullfrogs (*Lithobates catesbeianus*) and Green Frogs (*L. clamitans*), which can overwinter in permanent wetlands and pose a serious threat to the reproductive success in pond-breeding amphibians. Vasconelos and Calhoun (2006. Wetlands 26:992–1003) reported that colonization by *L. clamitans* drastically reduced the number of emerging *L. sylvaticus* juveniles in restored wetlands. Here I report daily observations of predation on communal egg masses of *L. sylvaticus* by *L. clamitans* tadpoles contributing to total reproductive failure in a stormwater retention pond.

On 13–15 March 2010, *L. sylvaticus* breeding and oviposition occurred in a stormwater retention pond in suburban Owings Mills, Maryland, USA (39.425758°N, 76.813538°W). This pond typically dries in late summer, but significant rain during 2009 created a permanent water source allowing *L. clamitans* to successfully overwinter in the pond. A complete census of *L. sylvaticus* egg masses was conducted on 16 March and 21 total egg masses were identified: 16 in a communal mass in the northernmost section of the pond ("N Mass") and five in a separate communal mass in the easternmost section of the pond ("E Mass"). On 17 March at 2100 h, 40–60 large ranid tadpoles were observed feeding voraciously on eggs deposited in the deepest area of N Mass (ca. 60 cm water depth). On 18 March, 14.5 egg masses remained, and ca. 12.5 partially intact masses were present on 19 March at N Mass; all of which were deposited in the shallow margin of the pond. During that survey predation was first observed on E Mass eggs by 20–30 tadpoles, and only 4 partial egg masses remained. At this time no remaining eggs had developed past Gosner Stage 17, so it is unlikely that any embryos had successfully developed to free-swimming larvae (Gosner 1960. Herpetologica 16:183–190). The final survey was conducted on 20 March, four days after the first census, when only one egg mass was located at each of the two communal areas. Both egg masses had become partially stranded on woody vegetation as the pond's water level dropped, though lower remnants of each egg mass were still submerged and being consumed by ca. 20 tadpoles.

On 20 March, ten tadpoles were collected and euthanized for further analysis. All tadpoles were identified as *L. clamitans* in Gosner stages 30–37 and dissected for evidence of egg predation. Jelly coating was found in the tadpoles' guts but no discernable

embryos were discovered. Therefore, it is unknown if *L. clamitans* tadpoles were feeding exclusively on the jelly coating or on the embryos too, though no exposed embryos were observed in the general areas of the communal masses. My observations suggest that this pond might serve as an ecological trap for *L. sylvaticus* following abnormally wet years due to predation by overwintered *L. clamitans* tadpoles.

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ODONTOPHRYNUS CARVALHOI (Carvalho's Escuerzo). **DEFENSE**. Amphibians can reduce the chances of being eaten either by avoiding being found by a predator or by avoiding being consumed once they have been found (Wells 2007. The Ecology and Behavior of Amphibians. Univ. Chicago Press, Chicago, Illinois. 608 pp.). During a study of anuran diet in the Serra de Baturité, a relictual area of Atlantic Forest in the State of Ceará, northeast Brazil, between March and October 2009, we observed several defensive responses by *Odontophrynus carvalhoi*, a poorly studied leaf litter frog restricted to northeastern Brazil (Frost 2009. Amphibian Species of the World: an Online Reference. Ver. 5.3, accessed 16 October 2009). Electronic database accessible at http://research.amnh.org/vz/herpetology/amphibia/ American Museum of Natural History, New York). The first defensive response observed in all *O. carvalhoi* (N = 20) was to flee in response to the approach of the collector. However, when captured, all individuals inflated their bodies, increasing their width considerably. One individual (SVL 69.8 mm) increased its body width almost 40% (36.4 to 50.9 mm) between capture and after having being handled for one minute. While inflated they would lock their mouths very tightly, making it difficult to open them in comparison with individuals of other species included in the same study, including Bufonidae and Leptodactylidae. Some individuals (N = 8), after being stomach-flushed, remained motionless with their legs held close to their bodies. This behavior, interpreted as "death-feigning"(Abbadic-Bisogno et al. 2001 Herpetol. Rev. 32:247), would persist after being placed on the ground with their belly up. They would remain in this position for a variable period of time (10 sec to 5 min), after which they would flip themselves with a fast kick against the substrate. The act of inflating the body to look bigger has been reported for many anurans and is believed to discourage attack by predators or make ingestion more difficult, especially by snakes that swallow their prey whole. Death-feigning has also been reported for many anurans and although its significance remains poorly understood, we believe that it would represent a defense mechanism against visually oriented predators that consume live prey. *Odontophrynus carvalhoi* seems to have a diverse behavioral repertoire to avoid predation, besides its cryptic coloration. Those behavioral responses act in different steps of the predation process and probably vary according to the predator and to other variables of the environment. Some of the collected individuals are deposited at the Laboratório de Zoologia Experimental.

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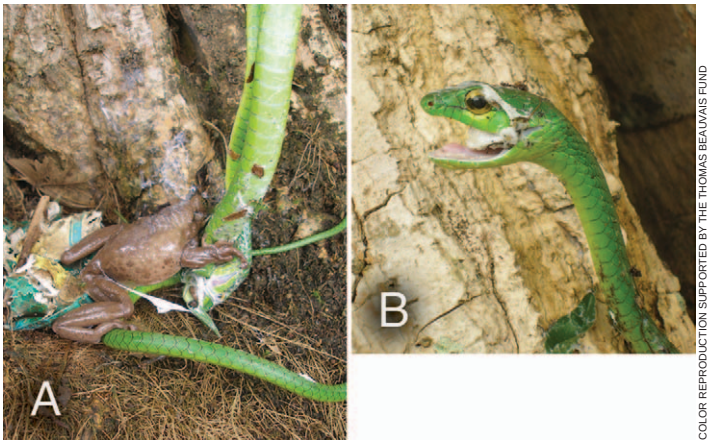


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FIG. 1. *Odontophrynus carvalhoi* inflated after being manipulated. Notice transparency of skin.

PHRYNOHYAS VENULOSA (Milky Tree Frog). **PREDATION**. *Phrynohyas venulosa* is a large and common hylid frog occurring in Middle and South America. It uses a poisonous skin secretion as a defense against predators. This secretion can produce extreme irritation, swelling, and pain if rubbed in the eyes or mucus membranes (Savage 2002. The Amphibians and Reptiles of Costa Rica. A Herpetofauna Between Two Continents, Between Two Seas. Univ. Chicago Press, Chicago, Illinois. 934 pp.). Here I offer an eyewitness account of a *Phrynohyas venulosa* that actively and manually transferred skin secretions onto a predatory snake.

On 9 Dec 2007 I was guiding a group of birdwatchers in the Cano Negro area in Costa Rica. Near the river, in an agricultural area bordering a small forest, we were standing on a road next to a couple of large, free standing trees, when we heard a rustling noise above our heads. A few seconds later, a Green Parrot Snake (*Leptophis ahaetulla*), ca. 1.5 m total length, fell from a tree and landed on a piece of barbed wire that was nailed to the tree. While still hanging on the wire, we observed the *L. ahaetulla* to have an adult *P. venulosa* in its mouth. The *P. venulosa* was held by its left front leg and while struggling to get loose it emitted a large amount of white mucus from its upper side. While it tried to control its position with its right arm, the *P. venulosa* frantically moved its legs over its back to the head of the *L. ahaetulla*. With each movement the frog smeared mucus from its back towards the snake's head (Fig. 1A). These movements seemed to alter the state of the mucus, because the mucus hardened and stiffened, forming tough threads like chewing gum, while the untouched mucus on the head of the *P. venulosa* was fluid. In about two minutes, the head of the *L. ahaetulla* received more of the rubbery mucus. The mucus seemed to shrink while drying, making it harder for the *L. ahaetulla* to manipulate and see its prey. At some



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FIG. 1A. About one minute into the attempted predation of a *Phrynohyas venulosa* by a *Leptophis ahaetulla*: fresh secretion is still coming off the frog's back. Two coils of dried secretion can clearly be seen tightly wrapped around the snout of the snake, limiting the movements of its mouth and obscuring its view.

FIG. 1B. About one minute after the predation attempt: by rubbing its head against treebark and by chewing movements of its jaws, the snake got rid of most of the secretion. The last coil of dried secretion is just hanging on, including a big chunk inside the snake's mouth.

point it appeared as if the head of the *L. ahaetulla* was tightly bound with plastic rope. Suddenly the *P. venulosa* freed itself and hopped to safety. The *L. ahaetulla* was still hanging from the barbed wire and trying to get rid of the hardened mucus. The mucus had accumulated mainly on the snake's nose, around its head, and in its mouth and was very sticky and tough. The *L. ahaetulla* had to rub its head against the tree and move its jaws horizontally and vertically again and again to remove it. After about two minutes the *L. ahaetulla* got rid of most of it, except for a big chunk in its mouth. Then it became aware of our presence and moved up the tree. When it reached a height of 3 m, its mouth seemed fully free of dried mucus.

It appeared as though the *P. venulosa* was deliberately shoving the mucus towards the snake's head, as its feet collected mucus when moving towards the snake. I am unaware if there are reports of poisonous amphibians that actively transfer their skin secretions, but that appears to be the case in this observation.

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PLATYMANTIS VITIANA (Fiji Ground Frog). **FROGLET MORPHOLOGY.** *Platymantis vitiana* is an endangered anuran found only on four small outer islands in Fiji including Viwa, Taveuni, Gau, and Ovalau. On Viwa Island (a 60-ha island, 30 km NE of Suva and 0.95 km from mainland Viti Levu, Fiji), *P. vitiana* shares its natural habitat with invasive *Bufo marinus*. *Bufo marinus* is a prolific breeder while *P. vitiana* is a seasonal breeder (Narayan et al. 2010. Gen. Comp. Endocrinol. 166:172–179). Eradication plans for *B. marinus* on Viwa include chemical use and trapping of toadlets and adults. As a precautionary conservation measure, translocation of a sub-population of *P. vitiana* adults and froglets will be necessary prior to eradication of *B. marinus*. In this process and during eradication, misidentification of *B. marinus* toadlets with froglets of *P. vitiana* is likely to affect the *P. vitiana* population and also shadow the outcome of the eradication programs. Therefore, we attempted to find morphological features of *P. vitiana* froglets for rapid identification in the field.

A clutch of *P. vitiana* eggs was monitored on Viwa Island up to hatching of froglets on 12 Dec 2007. Simultaneously, tadpoles of *B. marinus* were also monitored in a nearby natural pond on Viwa Island up to four weeks.

Bufo marinus eggs typically underwent a tadpole metamorphosis while eggs of *P. vitiana* metamorphosed directly into newly hatched froglets without a tadpole stage. Morphologically, the hatchlings of both *P. vitiana* and *B. marinus* are of similar size (mean = 8 mm SVL) and have the second digit of both the anterior and posterior limbs longer than the rest of the digits. Each anterior limb has four digits while each posterior limb has five digits. Furthermore, the hatchlings of both species have blackish-brown or greenish striped patterns on the upper surfaces of both anterior and posterior limbs. However, a morphological feature diagnostic of *P. vitiana* froglets was identified. A butterfly pattern of five brown raised warts on the dorsal head region, forming a circle with one brown raised wart in the center, was observed in all *P. vitiana* froglets (Fig. 1). However, metamorphs of *B. marinus* of similar age only have greenish raised warts distributed along the head–vent margin.

These morphological features thus can be used to identify metamorphs of *P. vitiana* in the field and help to avoid misidentification with those of invasive *B. marinus*. This study is the first record of morphological characteristics of *P. vitiana* froglets and



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FIG. 1. A group of newly hatched *Platymantis vitiana* froglets (N = 5) on soil substrate on Viwa Island. Note the characteristic butterfly pattern on the dorsal head region of each froglet.

it has useful implications for future eradication efforts of *B. marinus* in the Fiji Islands.

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PROCERATOPHRYS MELANOPOGON (Black-bearded Horned Leaf Toad). **DEFENSIVE BEHAVIOR.** *Proceratophyrs melanopogon* is a small to medium-sized cycloramphid anuran that belongs to the *Proceratophyrs appendiculata* complex (Prado and Pombal 2008. Arq. Zool. 39:1–85). Species within this complex are characterized by the presence of palpebral appendages and cryptic coloration resembling fallen leaves (Prado and Pombal 2008, *op. cit.*; Toledo and Haddad 2009. Int. J. Zool. 2009:1–12). *Proceratophyrs melanopogon* mainly inhabits leaf litter on the forest floor in Atlantic Rainforest areas of southeastern Brazil (Izecksohn et al. 1998. Rev. Univ. Rural, Sér. Ciênc. Vida 20:37–54; Prado and Pombal 2008, *op. cit.*).

On 4 Dec 2009 at 1430 h, we observed defensive behavior displayed by *P. melanopogon* upon capture. After grasped with the hand, the specimen flattened its body and stretched out its legs, keeping this position until being released on the ground (Fig. 1). The observation took place near a permanent pond in Serra do Brigadeiro State Park, an area of montane rainforest in municipality of Araponga, state of Minas Gerais, Brazil (20.7219ºS, 42.4786ºW, elev. 1320 m, SAD1969).

This defensive behavior has been called stiff-legged (Sazima 1978. Biotropica 10:158) and was reported for other horned leaf toads, including *P. appendiculata* (Sazima 1978, *op. cit.*) and *P. boiei* (Toledo and Zina 2004. Herpetol. Rev. 35:375). Similar behaviors for other leaf-litter anurans (e.g., *Dendrophryniscus leucomystax, D. brevipollicatus*, *Scythrophrys sawayae*, *Stereocyclops parkeri*) has been regarded as behavioral convergence given that leaf-litter inhabiting species are subject to similar predation pressures (Bertoluci et. al 2007. Alytes 25:1–2; Garcia 1999. Herpetol. Rev. 30:224; Sazima 1978, *op. cit.*; Toledo and Zina 2004, *op. cit.*).



FIG. 1. *Proceratophrys melanopogon* (25.9 mm SVL) from Minas Gerais, Brazil displaying stiff-legged defensive behavior.

The adaptive value of this behavior might be in enhancing crypsis among fallen leaves, confusing visually oriented predators (Sazima 1978, *op. cit.*; Toledo and Zina 2004, *op. cit.*), and/or inhibiting ingestion by predators (Angulo and Funk 2006. Herpetol. Rev. 37:203–204; Azevedo-Ramos 1995. Rev. Bras. Biol. 55:45–47).

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RHINELLA MARGARITIFERA (NCN). **PARASITES.** The *Rhinella margaritifera* complex is widely distributed in Latin America, occurring throughout the Amazon Basin and parts of Panama (IUCN, Conservation International, and NatureServe 2004. Global Amphibian Assessment. <www.globalamphibians.org>. Accessed 03 Dec 2004). Although amphibians are known to be parasitized by larvae of numerous fly species, this is a poorly studied area of amphibian biology. In Europe, North America, and India, amphibians are commonly attacked by larvae of several blow flies (Calliphoridae) and flesh flies (Sarcophagidae; Bolek and Coggins 2002. J. Wildl. Dis. 38:598–603; Dasgupta 1967. Parasitology 52:63–66; James and Maslim 1947. J. Washington Acad. Sci. 37:366–368; Strijbosch 1980. Oecologia 45:285–286), and in Australia amphibians are infected with larvae of grass flies (Chloropidae; Schell and Burgin 2001. J. Parasitol. 87:1215–1216).

In Neotropical regions, cases of flesh fly parasitism in anurans have been recorded from *Atelopus* spp. in Costa Rica (Crump and Pounds 1985. Parasitology 75:588–591), *R. granulosa* in Venezuela (Lopes and Vogelsang 1953. An. Acad. Brasil. Ciências 25:139–143), *Rana catesbeiana* in Brazil (Souza et al. 1990. Mem. Inst. Oswaldo Cruz 84:517–518), *Eleutherodactylus* sp. in Panama (Dodge 1968. Ann. Entomol. Soc. America 61:421–450), *Proceratophrys* in Brazil (Lopes 1981. Rev. Brasil. Entomol. 41:149–152), and *Epipedobates* spp. (Hagman et al. 2005. Phyllomedusa 4:60–73). Here, we offer a first report of parasitism of *R. margaritifera* by flesh flies.

On 16 August 2007 at 1000 h, we found an adult *R. margaritifera* (42.9 mm SVL, 6 g) in Floresta Nacional de Caxiuanã, near the municipality of Portel (1.96000°S, 51.6152778°W; elev. 20 m), State of Pará, Brazil. The specimen was hidden within the dry leaves and twigs of *terra firme* forest ground. During preservation we observed 21 flesh fly larvae leaving the body of *R. margaritifera* through the cloaca. The larvae were preserved in 70% alcohol.

We deposited the *R. margaritifera* and flesh fly larvae in the herpetological (MPEG 21938) and entomological collections, respectively, of the Museu Paraense Emílio Goeldi, Belém, State of Pará, Brazil. Marinus S. Hoogmoed verified identification of the frog.

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SCAPHIOPUS COUCHII (Couch's Spadefoot). **PREDATION**. Predation on adult *Scaphiopus couchii* has rarely been reported in the literature, despite numerous studies of predation on larvae of this species and other spadefoots (Duellman and Trueb 1986. Biology of Amphibians. McGraw-Hill, New York. 670 pp.). On 1 May 2008 a road-killed American Badger (*Taxidea taxus*) was salvaged from US Hwy 87 in Tom Green Co., Wall, Texas, USA (31.371819°N, 100.313141°W; WGS 84). Habitat in the area adjacent to the highway is primarily cultivated cotton fields with small areas of grassland. Analysis of stomach contents of the badger revealed the remains of four adult *S. couchii*, in addition to one Texas Spotted Whiptail (*Aspidoscelis gularis*) and three unidentified juvenile rodents. Toxic skin secretions of the spadefoots apparently were no deterrent to the predator. The multiple *S. couchii* taken by the badger suggests a high activity for spadefoots at that time. On 27 April there had been thunderstorms with accumulations of rain of 1.24 cm at the nearest weather station at San Angelo Airport. This precipitation might have been sufficient to bring about reproductive activity for adult spadefoots and the badger opportunistically preyed on these. Published accounts of the diet of *Taxidea taxus* rarely include amphibians, but to our knowledge only unidentified *Rana* species and Eastern Tiger Salamanders (*Ambystoma tigrinum*) have been reported (Errington 1937. J. Mammal. 18:213–216; Snead and Hendrickson 1942. J. Mammal. 23:380–391; Sovada et al. 1999. Amer. Midl. Nat. 142:410–414). Specimens have been deposited in the Collections of Amphibians and Reptiles, Angelo State Natural History Collections, Angelo State University, as ASNHC 14270 (*S. couchii*) and ASNHC 14271 (*A. gularis*).

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SCAPHIOPUS COUCHII (Couch's Spadefoot). **DEVELOPMENTAL MORPHOLOGY**. *Scaphiopus couchii* from the deserts of the American southwest exhibit the shortest larval period duration known among amphibians, developing from hatching to forelimb emergence in as little as 8 days (Newman 1987. Oecologia 71:301–307). Here, we report a morphological observation representing a contributing mechanism to achieve short larval periods, namely the elimination from its ontogeny of Gosner developmental stages 24 and 25 (Fig. 1; Gosner 1960. Herpetologica 16:183–190). Gosner Stage 23 (G23) is defined by the presence of external gill filaments on both sides of the body. At G24, the operculum (skin covering) covers the right gill filaments. At G25, the operculum covers the gill filaments on both sides. At G26, the hind limb buds appear. In *S. couchii* (two-day-old embryos from adults collected in Cochise Co., Arizona USA), the hind



FIG. 1. *Scaphiopus couchii* within a day after hatching showing developing hind limb bud and external gill filaments on the right side of the body (gills and hind limb bud are present on left side also, but not visible here). This developmental stage is not compatible with the Gosner staging table.

limb buds became visible prior to operculum formation on either side of the body (Fig. 1). This developmental situation does not occur in the spadefoot relatives, *Spea multiplicata* or *Pelobates cultripes*, which follow the typical Gosner stages. Other species of *Scaphiopus* should be examined. We did not observe any instance in *S. couchii* where neither the right and left nor just the right gill filaments were covered by the operculum in the absence of hind limb buds. However, G23 individuals were observed, where right and left external gills were visible in the absence of hind limb buds. Interestingly, *S. couchii* still has G26, indicating a lag in hind limb growth after its first appearance at G23. This lack of limb bud growth during operculum formation may correspond to the time lag in stage advancement during G26 in *S. multiplicata* (Buchholz and Hayes 2002. Copeia 2002:180–189). It appears that hind limb development in *S. couchii* has been heterochronically shifted to initiate at an earlier stage (from G26 to G23). The elimination of developmental stages may enable *S. couchii* to achieve subsequent stages at earlier time points, contributing to its extremely short larval periods. This divergence of *S. couchii* from the typical developmental sequence found in anuran tadpoles precludes comparing *S. couchii* to other species at these developmental stages. The developmental modification reported here accompanies two other evolutionary modifications underlying the short larval periods in *S. couchii*. First, *S. couchii* has extremely rapid cell division cycles during the embryonic period (Zweifel 1968. Bull. Am. Mus. Nat. Hist. 140:3–64), perhaps due to their relatively small genome size (www.genomesize.com). Second, increased levels of thyroid hormone tissue content and heightened sensitivity and responsivity to thyroid hormone contribute to their accelerated metamorphic period (Buchholz and Hayes 2005. Evol. Develop. 7:458–467).

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SCINAX FUSCOVARIUS (NCN). **PREDATION**. Snakes are commonly known to prey on anurans (Michaud and Dixon 1989. Herpetol. Rev. 20:39–41) including species of *Scinax* (Bernarde et al. 2000. Rev. Brasil. Biol. 60:695–699). At 2000 h on 26 Nov 2005, at Fazenda Jatobá (Buritizeiro Municipality, State of Minas Gerais, Brazil; 17.1269444°S, 44.8788889°W), we found an

adult *Xenopholis undulatus* (300 mm SVL, not collected) during a heavy rainfall, foraging among the wet grass near a temporary pond. When captured, the snake regurgitated an adult *Scinax fuscovarius* (35.6 mm SVL; AAG-UFU 3574, Museu de Biodiversidade do Cerrado, Minas Gerais, Brazil). This is the first record of *X. undulatus* preying on an anuran. Only *X. scalaris* is known to prey on anurans (Cunha and Nascimento 1993. Ofídios da Amazônia. As Cobras da Região Leste do Pará. Boletim Museu Paraense Emílio Goeldi 9:1–191). Other anurans present in the area that could be potential prey of *X. undulatus* and other snake species include *Pseudopaludicola mystacalis, Dendropsophus cf. marmoratus, Physalaemus centralis*, and *P. cuvieri*.

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SCINAX FUSCOVARIUS (Snouted Treefrog). **PREDATION.** *Scinax fuscovarius* are frogs of medium size, widely distributed in Brazil and also in Paraguay, Argentina, Bolivia, and Uruguay (Haddad et al. 2008. Anfíbios da Mata Atlântica: Guia dos Anfíbios Anuros da Mata Atlântica. São Paulo. Editora Neotropica. 244 pp.; Frost 2010. Amphibian Species of the World: an Online Reference. Version 5.4 [8 April 2010]. Electronic database accessible at http://research.amnh.org/vz/herpetology/amphibia/ American Museum of Natural History, New York). During the day the species can be found sheltered in burrows, crevices, trees, soil, and human construction (Araujo et al. 2009. Biota Neotrop. 9:77–98).

Domestic Cats (*Felis catus*) have been associated with humans for thousands of years and have accompanied humans to nearly every part of the world (Brickner 2003. Tel Aviv University report. http://www.tau.ac.il/lifesci/zoology/members/yom-tov/inbal/cats.pdf). Because they form a domestic species distinct from their wild ancestral species, Domestic Cats are considered to be an exotic, or non-native, species in all environments in which they occur (Dauphiné and Cooper 2009. Proc. Fourth International Partners in Flight Conference, pp. 205–219). Because of their ability to overwhelm existing native species and natural ecosystem processes in environments in which they have been introduced, Domestic Cats are classified as an invasive species (Dauphiné and Cooper 2009, *op. cit.*). Invasive species, particularly predators, together with habitat destruction, have been a major cause of declines and extinctions of native species throughout the world for the past few centuries (Clavero and García-Berthou 2005. Trends Ecol. Evol. 20:110). Here we report the predation of a juvenile *S. fuscovarius* by a juvenile male *F. catus*.

On 17 April 2010 at 1900 h, in a back yard of a house at the Araçatuba city, São Paulo State, a *F. catus* was observed preying upon a juvenile *S. fuscovarius*. The frog was ingested by the cat, and thus we were unable to collect the frog. The next day, we found the remains of the frog along with ants. *Felis catus* is considered a generalist mammal, including in its diet insects such as bumblebees and grasshoppers, rodents, amphibians, reptiles, and ground nesting and ground roosting birds which are particularly vulnerable (Ogan and Jurek 1997. *In* Harris and Ogan [eds.], Mesocarnivores of Northern California: Biology, Management, and Survey Techniques, workshop manual, pp. 87–92. The Wildlife Society, California North Coast Chapter, Arcata, California). However, this is the first record of *Felis catus* as a predator of *S. fuscovarius.*

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SPEA INTERMONTANA (Great Basin Spadefoot). **ALGAL SYMBIOSIS.** The occurrence of epizoic algal symbiosis has been reported in tadpoles of the American Toad (*Bufo americanus)* found in Arkansas and Missouri, USA (Drake et al. 2007. Herpetol. Rev. 38:435–436; Tumlison and Trauth 2006. Herpetol. Cons. Biol. 1:51–55), as well as those of the Gray Treefrog (*Hyla versicolor*) and the Cricket Frog (*Acris crepitans*) in Arkansas, USA (Tumlison and Trauth 2006, *op. cit.*), and was surmised to be more widespread geographically and among species with aquatic anuran larvae. Observations reported herein indicate that is indeed the case. On 15 June 2009, at 1430 h, DLD observed tadpoles of *Spea intermontana* in three natural pools and tanks in the Grand Wash Gorge, Capital Reef National Park, Wayne Co., Utah, USA, bearing bright green patches on the dorsal and lateral sides of their bodies, and tails. The ambient temperature at time of observation was 26°C with partly cloudy skies; water temperature in the large tank was 22°C. All three tanks were within 50 m of one another in the same sand and bedrock drainage.

The two smaller pools in which tadpoles were observed were 2 m diameter, 0.3–0.4 m deep, and 3 m x 6 m, max. depth 0.3 m, and had clear water and a sandy substrate with abundant algal growth. *Triops* (tadpole shrimp), fairy shrimp (Chirocephalidae), and hydrophilid beetle larvae were present, as were a few larger, later stage, non-cannibalistic morphs of *S. intermontana* tadpoles. DLD examined six of the tadpoles of *S. intermontana* (Gosner stages 34–36 [Gosner 1960. Herpetologica 16:183–190],



FIG. 1. Tadpoles of *Spea intermontana*, Wayne Co., Utah, USA, with varying degrees of epizoic algae seen as green patches on the skin.

total length 7–8 cm), in the smaller pool, four of which exhibited extensive algal patches, two did not (Fig. 1).

The largest of the tanks encountered at the site measured about 6 m in diameter and was 1–1.5 m deep. Algae were abundant on the bedrock sides of the tanks, although the bottom of the tank was not visible. Hundreds of cannibalistic and omnivorous tadpoles of *S. intermontana* were present in these tanks, as were some tadpoles of *H. arenicolor*. Bright green patches were visible on both morphotypes of the larvae of *S. intermontana*, but were not visible on those of *H. arenicolor*. Many of the larger, later stage tadpoles of *S. intermontana* in this tank exhibited extensive green patches, especially on the tails and laterally and dorsally on the body, but smaller, earlier stage tadpoles (Gosner stages 30–33, total length ca. 4–5 cm) did not appear to have algal colonies on their skin.

Tadpoles were collected and preserved in 10% formalin, then examined by SET with a scanning electron microscope. Examination of the green patches revealed a biflagellated alga, *Chlorogonium*, which was found on the tadpoles of *Bufo americanus* from Missouri and Arkansas. This finding adds a new species, family (Pelobatidae), and ecoregion (Great Basin Desert) to the list of larval anurans with algal symbionts and their distribution. There will surely be more amphibian species and the occurrence more ubiquitous as researchers continue to take notice of such phenomena.

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TOMOPTERNA CRYPTOTIS (Cryptic Sand Frog). **ALBINISM.** While conducting research on Turkana conceptions of snakes, we observed an albino adult male *Tomopterna cryptotis* (SVL 45 mm) calling from a temporary pool left from torrential rains from the previous week, where the A1 "Lodwar" road



Fig. 1. Adult male albino *Tomopterna cryptotis*. Photographed in the field in Lokichar, Turkana District, Northwest Kenya, 8 January 2009.

crosses the Lokichar River near the town of Lokichar, Turkana District, northwest Kenya. The specimen had red eyes with blood vessels visible through the skin (Fig. 1). Only the terminal tips of the warts exhibited light yellow coloration, therefore, this frog could be considered a partial albino with xanthophores (Dyrkacz 1981. SSAR Herpetol. Circ. 11, 131 pp.), otherwise, the specimen was entirely white with a pinkish tinge where the typical coloration would have exhibited very dark blotches. Over 50 other *T. cryptotis* with typical coloration were observed, with several pairs in amplexus. Whether this albinism could reduce its chances of getting a mate was not established. Only one other species of anuran was observed, a lone male *Bufo lughensis*. This report corroborates the contention of Sazima and Di Bernado (1991. Mem Inst. Butanantan 53:167–173) that albinism may occur with more frequency in nocturnal or fossorial animals (of which *T. cryptotis* is both), that theoretically are less dependant on camouflage to survive. To our knowledge this is the first report of albinism for the genus *Tomopterna*.

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ZACHAENUS CARVALHOI (Carvalho's Bug-eyed Frog). **DEFENSIVE BEHAVIOR**. Amphibians are subject to predation by an array of invertebrates and vertebrates, and are known to display a wide variety of defensive behaviors (Wells 2007. The Ecology and Behavior of Amphibians. Univ. Chicago Press, Chicago, Illinois. 1148 pp.). *Zachaenus carvalhoi* is a small leaf-litter frog known from few localities in the Atlantic Forest biome in south-



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FIG. 1. An adult *Zachaenus carvalhoi* (25.3 mm SVL) in death feigning behavior.

eastern Brazil (Motta et al. 2010. Herpetol. Notes 3:85–86). It is categorized as Data Deficient in the IUCN redlist, due to the lack of information on its occurrence and biology. On 19 Feb 2010, an adult *Z. carvalhoi* was captured in a pitfall trap with drift fences, inside a forested area in the Serra do Brigadeiro State Park, an area of montane rainforest in the municipality of Araponga, state of Minas Gerais, Brazil (20.7219ºS, 42.4786ºW, elev. 1380 m, SAD 1969). During handling, the frog displayed a defensive behavior in which it stretched out its four limbs and closed its eyes, keeping this position until being released on the ground (Fig. 1).

Similar defensive behaviors have been described for other leaf-litter frogs including *Dendrophryniscus leucomystax*, *D. brevipollicatus* (Bertoluci et al. 2007. Alytes 25:1–2), *Scythrophrys sawayae*, (Garcia 1999. Herpetol. Rev. 30:224), *Stereocyclops parkeri*, *Proceratophrys appendiculata* (Sazima 1978. Biotropica 10:158), and *P. boiei* (Toledo and Zina 2004. Herpetol. Rev. 35:375), although in these species only their hind legs are stretched out, not all four limbs, as in *Z. carvalhoi*. The observation of this behavior in several leaf-litter anurans suggests behavioral convergence reflecting similar predation pressures (Sazima 1978, *op. cit*.). The adaptive value of this behavior might reside in improving the frog's appearance as fallen or dead leaves, confusing visually oriented predators (Sazima 1978, *op. cit.*; Toledo and Zina 2004, *op. cit.*).

A voucher specimen was deposited in the herpetological collection of Museu de Zoologia João Moojen, Universidade Federal de Viçosa, in Viçosa, Minas Gerais, Brazil (MZUFV 10339). We thank the Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (IBAMA) and Instituto Estadual de Florestas (IEF) for collecting permits (IBAMA 20857-1, IEF 071/09), the Universidade Federal de Viçosa for logistic support, the Fundação de Amparo à Pesquisa do Estado de Minas Gerais (FAPEMIG, CRA-APQ-02370-09) for financial support, and the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) for fellowships granted to MRM.

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GYMNOPHIONA — CAECILIANS

GYMNOPIS MULTIPLICATA (NCN). **MATERNAL ATTENDANCE**. Post-birth parental care by a viviparous caecilian has been reported previously only once: altricial young of *Geotrypetes seraphinii* are reported to feed on the skin of the attending maternal female (O'Reilly et al. 1998. Amer. Zool. 38:187A). We report an instance of a maternal female of a viviparous species guarding her recently born young, similar to that of the maternal guarding reported for several oviparous and direct-developing species (e.g., *Ichthyophis glutinosus*: Sarasin and Sarasin 1887. Ergebnisse naturwissenschaftlichen. Forschungen auf Ceylon. C. W. Kreidel's Verlag, Wiesbaden; Breckenridge and Jayasinghe 1979. Ceylon J. Sci. 13:187–202; *Idiocranium russelli*: Sanderson 1937. Animal Treasure. Viking Press, New York. 325 pp.; *Caecilia orientalis*: Funk et al. 2004. Herpetol. Rev. 35:128–130 [a female and two males with a clutch]).

On 16 July 2008, JRM collected an adult female *Gymnopis multiplicata* (MVZ 263798; 363 mm total length; 117 primary annuli, 103 secondaries; each ovary containing many small early vitellogenic ova) and four young *G. multiplicata* (MVZ 263800, 263802, 263804, 263805; total lengths 110–126 mm) under a large log at Rawa Kiamp (15.100°N, 84.4333333°W), Gracias a Dios, at 60 m elev in the Mosquitia of northeastern Honduras. The young were apparently recently born, still having several rows of teeth of fetal morphology on the lower jaw, the labialmost row of very small teeth emerging from the skin of the jaw at the lipline, consistent with the typical aggregation of the rows of fetal teeth before all are shed shortly after birth (Wake 1976. J. Morphol. 148:33–64; Wake 1980. J. Morphol. 166:203–216). The fetal teeth are markedly different (crowns with multiple cusps and different shapes) from the arrow-shaped tooth crowns of the maternal female and other adult *G. multiplicata* (Wake and Wurst 1979. J. Morphol. 159:331–342). The adult was in direct contact with all four young with the adult looped above and around the young, forming a ball. Immediately on exposure, the adult tried to escape by quickly crawling away. The young also tried to escape, but were not as quick as the adult. The young did not follow the adult, but crawled in different directions. All caecilans in the ball were collected. There is no indication that the skin of the female is physically modified or abraded in any way, nor does there appear to be any skin in the mouths of the young, so skin-feeding is unlikely. This is consistent with their relatively large size at birth, the neonates of the direct-developing skin-feeders (*Boulengerula taitanus* and *Siphonops annulatus*) reported being smaller relative to maternal size (Kupfer et al. 2006. Nature 440:926–929; Wilkinson et al. 2008. Biol. Let. 4:358–361).

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OSCAECILIA OSAE (NCN). **PREDATION**. The coral snake *Micrurus alleni* and the endemic caecilian *Oscaecilia osae* both occur in the lowland wet rainforest of the National Park Piedras Blancas (Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna Between Two Continents, Between Two Seas. Univ. Chicago Press, Chicago, Illinois. 934 pp.), which is located in the Pacific lowlands of Costa Rica (Weissenhofer et al. 2008. Cultural and Natural History of the Golfo Dulce Region. OÖ Landesmuseum Linz, Biologiezentrum, Johann-Wilhelm Kleinstraße). The prey of *Micrurus alleni* is comprised largely of the eeliform freshwater fish *Synbrachus marmoratus* and some lizards (Roze 1996. Coral Snakes of the Americas: Biology, Identification, and Venoms. Krieger Publ. Co., Malabar, Florida. 328 pp.). During a visit to the Tropical Research Station La Gamba (www.lagamba.at), a biological field station in the NP Piedras Blancas operated by the University of Vienna, WH observed *M. alleni* preying on the caecilian *O. osae*. Around midday on 8 July 2009 a *Micrurus alleni* was seen to have an *Oscaecilia osae* in its mouth. The observation occurred directly on the "Birds Trail" (Sendero Bajaros), not far from the Esquinas Rainforest Lodge (8.6977778°N, 83.2052778°W, ca. 80 m elev.). The snake was holding the caecilian—which was still alive—in its mouth and was trying to move the prey away from the trail to the forest litter close by. It appeared as though the snake had caught the caecilian with the intention of consuming it. Until this observation, *Micrurus alleni* was not known to prey on the caecilian *Oscaecilia osae*.



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FIG. 1. *In situ* photographs of an adult *Micrurus alleni* with a living *Oscaecilia osae* in its mouth. See text for dates and location. Photos by W. Huber.

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TESTUDINES — TURTLES

CHELONOIDIS CARBONARIA (Red-footed Tortoise). **SIZE AND THERMAL BIOLOGY.** From 4–19 June 2010, we had 62 encounters with Red-footed Tortoises on Union Island (St. Vincent and the Grenadines). *Chelonoidis carbonaria* is found throughout much of Central and South America (Ernst and Leuteritz 1999. Cat. Amer. Amphib. Rept. 690:1–6), and populations on West Indian islands might be descendants of ancestors that arrived via natural over-water dispersal, as a consequence of intentional introductions by Amerindians or early colonial Europeans (perhaps for food), more recently transported pets and ornamentals, or some combination thereof (e.g., Censky 1988. Florida Sci. 51:108–114; Powell and Henderson 2005. Iguana 12:62–77). The origin of the Union Island population is unknown.

Tortoises were abundant in a variety of habitats that ranged from coastal scrub and variously disturbed dry forests to dramatically altered situations on the grounds of hotels and in urban areas at elevations ranging from sea level to 258 m (on an island with a maximum elevation of 305 m). Although dogs might take small individuals (e.g., Hodge et al., 2003. The Reptiles and Amphibians of Anguilla, British West Indies. Anguilla Natl. Trust, The Valley), the abundance of tortoises in the Grenadines in general and on Union in particular might be attributable to the fact that local residents scorn them as food because of their willingness to consume fecal matter and carrion (Daudin and de Silva 2007. Appl. Herpetol. 4:163–176).

Carapace lengths of tortoises large enough for accurate determinations of sex were 248–334 mm (301 ± 25.1 mm) for males (N = 11) and 152–330 mm (264 ± 56.9 mm) for females (N = 17). Carapace lengths of ten 6–8 week-old juveniles hatched in an outdoor enclosure were 45–63 mm (55 ± 5.1 mm). Ernst and Leuteritz (1999, *op. cit.*) listed a maximum carapace length of 400 mm for females and 600 mm for males. The smaller maximum sizes of the Union Island turtles are suggestive of insular dwarfism (e.g., Keogh et al. 2007. Evolution 59:226–233), but also might merely reflect food limitations on a xeric island.

We encountered active turtles during the morning (0538–0919 h, N = 6) and afternoon/evening (1500–2256 h, N = 22), suggesting that they avoid the heat of the day (although one individual was active at 1205 h). Unlike most squamates, turtles generally lack a narrow preferred temperature range (e.g., Weathers and White 1971. Amer. J. Physiol. 221:704–710). To test the prediction that tortoises on Union Island did not actively thermoregulate, we used a Fluke model 52 Digital Thermometer with Type K thermocouple (Fluke Corp., Everett, Washington, USA) to record cloacal and adjacent ambient (air) temperatures in the field. We measured cloacal temperatures of 26.0–34.6°C (28.1 ± 1.3°C, N = 19) at air temperatures of 25.3–30.8°C (28.9 ± 1.8°C).

Differences between ambient and cloacal temperatures were -7.0–1.5°C (-0.78 ± 1.44°C), with 30 of 41 records above and two at ambient temperatures.

We also placed nine individuals (carapace length 45–172 mm, 88 ± 56 mm) in a thermal gradient (90 x 30 cm) with extreme temperatures of 24° and 40°C. Although most individuals spent more time near the cooler end of the gradient, possibly because they heat faster than they cool under laboratory conditions (Weathers and White, *op. cit.*), cloacal temperatures after 2 h were 23.9–31.6°C (26.5 ± 2.7°C). The considerable variation in individual temperatures in both the field and the gradient was suggestive of little more than an avoidance of extremely high temperatures.

Permits to conduct research on Union Island were issued by Mr. Brian Johnson, Director, Department of Forestry, St. Vincent and the Grenadines. Protocols were approved by the Avila University Animal Care and Use Committee. Fieldwork was funded by a grant from the National Science Foundation (USA) to Robert Powell (DBI-0851610). All tortoises were released at original sites of capture.

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GOPHERUS POLYPHEMUS (Gopher Tortoise). **DIET.** Consuming scat of conspecifics and other animals may provide species of *Gopherus* with symbiotic gut microbes and/or direct nutritional benefits (Bjorndal 1987. Copeia 1987:714–720; Lance and Morafka 2001. Herpetol. Monogr. 15:124–134; Walde et al. 2006. Herpetol. Rev. 37:77–78). In addition to scat of conspecifics, *G. polyphemus* occasionally eats fox (*Vulpes vulpes* or *Urocyon cinereoargenteus*), raccoon (*Procyon lotor*), and rabbit (*Sylvilagus* spp.) feces (Anderson and Herrington 1992. Herpetol. Rev. 23:59; Garner and Landers 1981. Proc. Ann. Conf. S.E. Assoc. Fish & Wildl. Agencies 35:120–134; MacDonald and Mushinsky 1988. Herpetologica 44:345–353). Here, we report a juvenile *G. polyphemus* consuming deer pellets.

At approximately 1700 h (CST) on 4 October 2008, one of us (JRL) observed a 13-month-old *G. polyphemus* at the Camp Shelby Joint Forces Training Center (CSJFTC), Perry Co., Mississippi, USA consume the pellet of a White-tailed Deer (*Odocoileus virginianus*). Upon swallowing the pellet, the young tortoise ate another. Platt et al. (2009. Southeast. Nat. 8:335–346) reported a single deer pellet in the feces of a Florida Box Turtle (*Terrapene carolina bauri*), but to our knowledge, this is the first account of *Gopherus* eating deer droppings. It should be noted that the tortoise in the above observation was head-started in a large outdoor enclosure for most of its first year of life before being released back to its nest site only 10 days prior to our observation.

We thank the Mississippi Army National Guard for their continued support of tortoise conservation efforts on CSJFTC.

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KINOSTERNON SONORIENSE (Sonoran Mud Turtle). **PREDATION**. In much of the arid American Southwest, stock tanks (= earthen cattle ponds) are a common landscape feature, and in the Atascosa/Pajarito Mountains, Santa Cruz Co., Arizona, stock tanks that hold water throughout the year often support breeding populations of *Kinosternon sonoriense* as well as populations of invasive American Bullfrogs (*Lithobates* [*Rana*] *catesbeianus*; Jones and Akins, unpubl.). While engaged in a large-scale effort to eliminate Bullfrogs from this landscape, we routinely examined stomach contents of captured frogs, and herein provide the first documented evidence of predation by Bullfrogs on *K. sonoriense*.

On 8 May 2009, 1230–1600 h MST, we removed six large adult Bullfrogs (SVL 150–185 mm) from Yank Tank (31.42534°N, 111.18330°W; datum = NAD 83, 1252 m elev.). Two Bullfrogs, one male and one gravid female (both SVL = 180 mm) had each ingested a juvenile *K. sonoriense* (CL = 56 mm, PL = 47 mm, and CL = 59 mm, PL = 49 mm, respectively). Size and development of plastron annuli suggest these turtles were each in their second year (F. R. Hensley and T. R. Jones, unpubl.). On 18 and 19 August 2009, one of us (CMA) visited two other sites: Salty Tank (31.46360°N, 111.18866°W; 1298 m elev.) and Frog Tank (31.47352°N, 111.19686°W, 1317 m elev.), respectively. At Salty Tank (1525–1615 h MST) four subadult Bullfrogs (SVL 90–95) were removed, one of which (male, SVL = 91 mm, mass = 60 g) contained a hatchling *K. sonoriense* (CL = 23.6 mm, PL = 18.9 mm, mass = 2.11 g). At Frog Tank (1000–1130 h MST), three subadult Bullfrogs (SVL 99–115) were removed, one of which (male, SVL = 115 mm, mass = 135 g) also contained a hatchling *K. sonoriense* (CL = 25.0 mm, PL = 20.4 mm, mass = 2.75 g). The sizes and collection dates are consistent with the conclusion that these two turtles had hatched within a few weeks or less (Stone 2001. Southwest. Nat. 46:41–53; F. R. Hensley and T. R. Jones, unpubl.). Although such predation had been predicted to occur (Schwalbe and Rosen 1999. Sonoriensis 19:8–10), to our knowledge, this is the first documented report of Bullfrog predation on *K. sonoriense*.

In stock tanks in southeastern Arizona with large breeding populations of Bullfrogs we have observed a pattern in which *K. sonoriense* populations almost exclusively consist of large adults (Jones and Akins, pers. obs.), suggesting a lack of recruitment consistent with the predation reported here. This hypothesis was also suggested by Schwalbe and Rosen (1988. pp. 166–173. In Szaro et al. [eds.], Management of Amphibians, Reptiles and Small Mammals in North America, pp. 166–173. U.S. Forest Service Gen. Tech. Rep. RM-166, Fort Collins, Colorado) to explain a similar demographic pattern at San Bernardino National Wildlife Refuge in extreme southeastern Arizona. Thus, although

it might be unsurprising to document Bullfrog predation on yet another species of turtle (e.g., reviews in Bury and Whelan 1984. U.S. Department of the Interior Fish and Wildlife Service Res. Publ. 155. Washington, D.C.; Casper and Hendricks 2005. *In* Lannoo [ed.], Amphibian Declines: The Conservation Status of United States Species, pp. 540–546. University of California Press, Berkeley), the impacts of the predation reported here have important conservation implications. Our data suggest that Bullfrogs can seriously affect population dynamics of relatively small, geographically separated populations of *K. sonoriense*, by severely limiting or even eliminating annual recruitment. Further, with the expanding range of *L. catesbeianus* in the American Southwest, it is likely that we will continue to see these effects, unless steps are taken at landscape scales to address this issue.

We greatly appreciate field assistance from P. Klink, B. Stewart and R. J. Timmons. Our fieldwork adhered to guidelines outlined in Beaupre et al. (2004. Guidelines for Use of Live Amphibians and Reptiles in Field and Laboratory Research, 2nd ed. Herpetological Animal Care and Use Committee, American Society of Ichthyologists and Herpetologists).

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MACROCHELYS TEMMINCKII (Alligator Snapping Turtle). **AERIAL BASKING AND CLIMBING ABILITY**. *Macrochelys temminckii* is the largest freshwater turtle in North America (Ernst and Lovich 2009. Turtles of the United States and Canada. Smithsonian Institute Press, Washington D.C. 827 pp.), but they are seldom encountered due to their secretive nature. There are previous reports for aerial basking of *M. temminckii* hatchlings (Shelby and Jenson 2002. Herpetol. Rev. 33:304), juveniles/subadults (Ewert 1976. Herpetologica 32:150–156; Farr et al. 2005. Herpetol. Rev. 36:168; Thomas 2009. Herpetol. Rev. 40:336), and adults (Selman et al. 2008. Herpetol. Rev. 40:79). Here we report another rare aerial basking observation of a juvenile *M. temminckii*.

On 24 August 2009 (1300 h), while floating a popular recreational canoeing stretch of Black Creek (near Brooklyn, Forrest County, Mississippi, USA), we observed a juvenile *M. temminckii* (approx. 10 cm SCL) basking on a tangled root snag in the middle of the creek channel (approx. 20 m wide). The water was approximately 1.5 m deep at the site and was clear enough to see the bottom substrate (sandy gravel bottom). The tangled root snag emerged vertically out of the water approximately 50 cm and the turtle was basking near the terminus of the snag which was 5 cm in diameter at the basking site. Its head was extended completely and resting on the tip of the snag. Directly below the basking site of the turtle (approx. 15 cm from the top of the snag) was another limb (2–3 cm in diameter) that crossed perpendicular to and was touching the basking snag; from the position of the turtle, we presume it had to climb over the obstacle to get to its desired basking location. The conditions were mostly sunny (air temperature 29°C) with water discharge at 36.5 m^3/sec, well below median daily stream flow (51.8 m^3/sec; USGS Real-Time water data, Black Creek Station [station 02479130] near Brooklyn). We were unable to determine water temperatures, but at a nearby gauging station at a similar-sized creek (Tallahala Creek at Laurel, Mississippi [station 02437500]), water temperature fluctuated between 25–28°C for 24 August 2009.

The individual was initially thought to be a Razor–backed Musk turtle (*Sternotherus carinatus*) due to the similarity in basking site choice (vertical snags) and basking posture. It was only after we canoed past the individual did WS realize that it was a *M. temminckii*. Thereafter, we canoed back upstream to get a closer look and the individual dove into the water when we were within 5 m of the basking site; unfortunately, we were unable to get a photograph of the individual. Furthermore, the climbing ability of this species at this size appears to be similar to *S. carinatus* since the observed individual climbed a nearly vertical snag and maneuvered over an obstacle to get to its preferred basking site. Farr et al. (2005, *op. cit.*) also observed an individual *M. temminckii* (~35–40 cm CL) that climbed 1 m above the water and 3–4 m along a tree trunk, which also highlighted the climbing ability of this species.

Even though aerial basking is now reasonably well documented for this species, it appears to be an uncommon behavior. We suggest that future observations of this behavior should still be noted to assist in understanding the life history of this secretive turtle.

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PSEUDEMYS NELSONI (Florida Red-bellied Turtle). **TRAUMA SURVIVAL**. Chelonians are known to be capable of surviving severe trauma (Cagle 1945. Copeia 1945:45; Landberg et. al. 2010. Herpetol. Rev. 41:70). On 15 July 2008 an adult female *P. nelsoni* was brought to Miami Metrozoo by a fisherman who collected it in Biscayne Bay near Turkey Point Nuclear Power Plant east of Homestead, Florida, USA. The turtle was missing the frontal portion of its head including both eyes. Skin had grown over the traumatized area leaving the mouth as a small, circular opening with a vestige of the tongue visible (Fig. 1). Nasal openings were not visible. Radiographs revealed that the skull had been cleanly severed over the eye sockets and the anterior portion of both lower mandibles was also missing. The turtle appeared healthy in spite of its injury and held its head up, rotating it from side to side in the same manner as a normal, sighted turtle would. The turtle weighed 2.78 kg. As it had apparently been feeding on its own since the injury, it was decided to release the animal into the semi-natural conditions of one of the zoo exhibit moats where its condition could be monitored. The moat was approximately 450 m in length (with 170 m of this dry land) by 4 m wide with water a depth of up to 1 m. Potential food available in the moat for this aquatic species included aquatic vegetation (Jackson 2006. *In* Meylan [ed.], Biology and Conservation of Florida Turtles, pp. 313–324. Chelonian Research Monographs No. 3), aquatic invertebrates, and small fish. The turtle's weight was monitored over time and increased to 3.07 kg in early October. This indicates that it was capable of ingesting food, but no observations were made



FIG. 1. Close up of *Pseudemys nelsoni* head after healing from severe trauma. Mouth opening and tongue are visible. Photo by Adam Stern.

on feeding behavior. On 9 December 2008 it was treated for a minor wound to its left foreleg. Two days later it was found dead and weighed 3.04 kg. It is surprising that this turtle was able to survive and feed with such a traumatic injury.

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STERNOTHERUS ODORATUS (Eastern Musk Turtle). **NESTING**. The nesting behavior of *Sternotherus odoratus* has apparently not been previously documented in Ohio and this species has been recorded in fewer than half of the state's 88 counties (Wynn and Moody 2006. Ohio Turtle, Lizard and Snake Atlas. Ohio Biol. Surv. Misc. Contrib. No. 10). While *S. odoratus* is known to use a variety of nest locations, we believe the site described herein to be unique, as most reports are of nests in or under rotten stumps and fallen trees (Ernst 1986. J. Herpetol. 20:341–352).

On 18 September 2009 near North Chagrin Nature Center in Cleveland Metroparks, Cuyahoga County, Ohio, USA, a hatchling *S. odoratus* was observed at the edge of a small pond. In the following days, the nest location was identified as more hatchlings were found. A total of 81 hatchlings were captured, measured, and released, with a mean (range) mass of 2.66 g (1.6–3.7 g, N = 80*)* and mean (range) carapace length of 22.75 mm (19–25 mm, N = 81*)*. The nest location was 1.5 m from the edge of the shallow 6.1-acre (2.5-ha) pond, under sandstone slab decking. The hatchlings were observed exiting from a small opening in the sandstone decking (Fig. 1) to which they were most likely drawn by the bright sunlight. It is believed that the adult females entered through an opening below the waterline (which was observed when the pond was drawn down). Under the sandstone, a hollow



FIG. 1. Aboveground view of the sandstone walk where the *Sternotherus odoratus* nest was located and crack where hatchlings were observed exiting.

cavity was discovered to be serving as a communal nest chamber (Fig. 2). It is uncertain whether the cavity was formed by erosion or possibly excavated by muskrats. This area was protected from predators and presumably provided a constant warm and humid environment for incubation. Additionally, there were older egg shells present in the cavity, indicating that nesting had occurred at this site in the past.

The sandstone decking containing the communal nest chamber was slated for demolition and renovation at the time of the emergence of the hatchlings and this allowed for exploration of the site. On 30 September 2009 the sandstone was removed and the nest site was explored for additional eggs and hatchings. Twenty-one live and four dead hatchlings were found in the substrate, and a remaining intact portion of the nest contained several unhatched eggs. These eggs were removed and placed into a plastic tub to complete incubation. From the eggs collected, 18 hatchlings emerged and were released and 5 eggs were not viable. The



FIG. 2. Underground view of *Sternotherus odoratus* nest where the concentration of eggs were deposited.

nest material consisted of a damp, coarse, sand mixture combined with soil and root material from nearby plants.

Sternotherus odoratus is a documented communal nester (Doody et al. 2009. Q. Rev. Biol. 84[3]:229–252) and in Pennsylvania Ernst (1986, *op. cit.*) reported a mean clutch size of 3.25, indicating that this nest location was the result of numerous females contributing eggs. Hatchlings that did not survive when the nest was excavated will be deposited at the Cleveland Museum of Natural History as vouchers for Cuyahoga County.

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TERRAPENE CAROLINA TRIUNGUIS (Three-toed Box Turtle). **SHELL ABNORMALITY**. We collected a live adult female (SCL 148 mm) *Terrapene carolina triunguis* on 1 October 2009 with a shell abnormality at the Sam Houston State University's Center for Biological Field Studies, Huntsville, Texas, USA. This specimen lacks the nuchal scute and all vertebral and pleural scutes; one abdominal scute is partially detached. There are small patches of abnormal keratinization surrounding previously healed bite wounds in the region of the third left and right pleural scutes. The absence of scutes completely exposes the carapacial bones. Although the cause of scute loss is unknown, we suspect that it is related to a past predation attempt, evidenced by the healed bite-impressions within the carapace. The carapacial bones are in good condition, and all previous damage appears superficial; there is no recent shell damage observed. Despite this shell abnormality, this individual was active and appeared otherwise healthy.

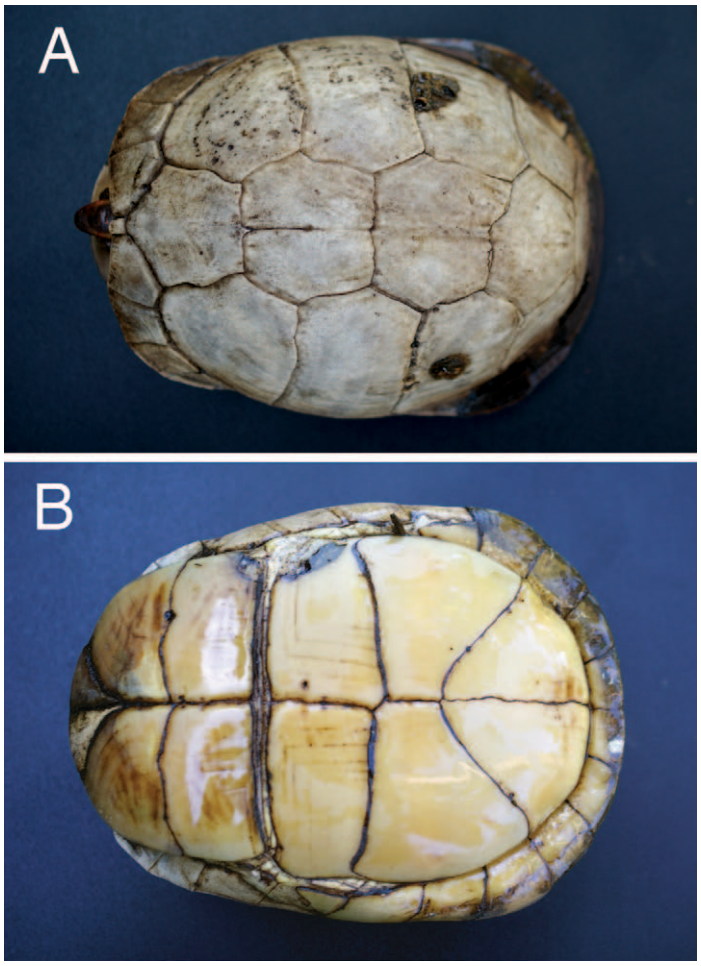


FIG. 1. *Terrapene carolina triunguis* carapace (A) and plastron (B) displaying missing and damaged scutes.

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TERRAPENE ORNATA ORNATA (Ornate Box Turtle). **MUSKING**. Musking behavior in *Terrapene ornata ornata* has been seldom reported in wild turtles and its function is yet unknown. This behavior may serve defensive, social, or other purposes (Legler 1960. Univ. Kansas Publ., Mus. Nat. Hist. 11:527–669; Dodd 2001. North American Box Turtles: A Natural History. Univ. Oklahoma Press, Norman. 231 pp.). While conducting field research on a population of Ornate Box Turtles on the sand hills of Weld Co., Colorado, USA, we have observed 14 instances of musking during the 2007, 2008, and 2009 field seasons. We also observed musking in two captive *T. o. ornata*, one a known wild specimen originating ~25 km W of the Kansas border and one found stray within the city limits of Longmont, Colorado.

During three seasons of field research, 12 of 34 (35.3%) juveniles (SCL < 100 mm) and 2 of 48 (4.2%) adult males were observed musking. Musking turtles ranged greatly in size from yearlings (34.2 mm SCL, 10 g) to full-grown adult males (122.1 mm SCL, 397 g). Observations of two musking adult males is contrary to Neill's (1948. Copeia 1948:130) speculation in *Terrapene carolina carolina* that turtles lose the ability to musk when the plastral hinge becomes functional and Patton's observations of musking only in recently hatched juvenile *T. c. triungius (*Patton et al. 2004. Proc. Louisiana Acad. Sci. 65:22–25).

A wild adult female box turtle (SCL = 102.3 mm) collected from Cheyenne Co., Colorado was obtained in 2008 after participation in the county fair's turtle races. This turtle was housed outdoors in a naturalistic setting. On presentation of a respiratory infection during 2009, this turtle received injections of antibiotics. On three occasions, musking occurred when restraining a front leg to deliver the injection. In May 2010, the same turtle also musked during restraint. Additionally, a stray juvenile (SCL = 95.1 mm) *T. o. ornata*, found in the city limits of Longmont, Colorado in 2009, musked during gentle handling.

Turtles emitted musk as they were handled for data collection, medical treatment, and observation, presumably because of induced stress. This strong odor, distinct from urine or fecal excrement and similar to that emitted by the Common Musk Turtle (*Sternotherus odoratus*), often came in "waves" of oscillating pungency. In several turtles, we observed liquid exuded below the 4th marginal in the axillary region. The liquid was more viscous than water, taupe in color, and slightly opaque.

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TERRAPENE ORNATA ORNATA (Ornate Box Turtle). **DIET AND MICROHABITAT.** *Terrapene o. ornata* is described as omnivorous, eating a broad range of animal and plant material and requiring access to water within its home range. However, within our study site standing water is generally not available and permanent water sources are well outside the typical home range areas of *T. o. ornata*. Here we provide information on one food choice, *Tradescantia occidentalis* (Prairie Spiderwort) from a wild population of Ornate Box Turtles in the sand hills of eastern Colorado that may also operate as an important water source. We also show the ready acceptance of this food item by two captive populations of wild-collected *T. o. ornata* housed in naturalistic habitats.

The present study site in Weld Co., Colorado encompasses approximately 50 ha of sand hills. The site is crossed with single-lane unpaved roads facilitating access to gas and oil wells. The property has been cattle ranched for more than 20 years; grazing is rotated with a water-pumping windmill as the focal point of each grazing section. The study area lacks any natural free-standing water and the windmill is only sporadically operated; overflow that may be used by turtles is thus unpredictable.

Average yearly precipitation at the nearest available weather station, about 16.6 km W of the study site, is 360 mm. Though more than 95% of precipitation occurs from April through October, natural ephemeral water is rarer than agriculturally related runoff. Precipitation from April though October 2009 was 32 mm greater than during the same period in 2008, and 100.6 mm greater than 2007. While 2009 precipitation was near average for the study season, the two previous years had decreased precipitation during the field study period. In 2009, *T. occidentalis* was seen during every field outing, in more areas within the study site, and in greater concentrations than in previous years.

Prairie Spiderwort is a smooth, subsucculent, perennial monocot up to 50 cm tall. Stems are often tufted, and when pulled apart, the copious mucilaginous slime inside forms what somewhat resembles a spider's web. These plants are known as "cow slobber" because of the gooey, stringy sap they produce. Given the absence of free water sources, we hypothesize that Spiderwort may be an important source of water for *T. o. ornata* in sand hills habitat. The study site also contains *Opuntia* cactus species and a variety of forbs and grasses. Ohio Spiderwort (*Tradescantia ohiensi*) has been listed as part of the floral community in *T. o. ornata* habitat in Iowa (Bowen at al. 2004. J. Herpetol. 38:562–568) and Wisconsin (Doroff and Keith 1990. Copeia 1990:387–399).

On 13 June 2008, we observed evidence of two adult turtles eating Spiderwort. The female was observed with a purple plant in her mouth, most likely *T. occidentalis* petals, and the male was observed with a chewed *T. occidentalis* stem directly in front of him and green vegetation on his beak. Several days later we located another adult female sitting in crushed Spiderwort stems with foliage stuck to her beak. During 2009, we found increased evidence of *T. o. ornata* eating Spiderwort, as well as characteristic crushed stems that may indicate turtle feeding, with three adult turtles (two females and one male) observed eating *T. occidentalis*. All observations of Spiderwort consumption occurred in the month of June.

Several specimens of *T. occidentalis* were planted into two naturalistic box turtle habitats, each more than 60 m^2. Wild-collected *T. o. ornata* readily ate this plant, often cropping it to the ground and inducing dormancy until the next growing season. This was in spite of other available food items provided on a regular basis, typically a mix of grocery-store produce (greens, vegetables, and berries). Other habitat plants including mallow (*Malva neglecta*) and common dandelion (*Taraxacum officinale*) were rarely observed being consumed. In neither captive population did we make any attempt to introduce occupants to the presence of *T. occidentalis*; turtles located and consumed this food item by free choice, often traveling 1–5 m from routine feeding locations.

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CROCODYLIA — CROCODILIANS

CROCODYLUS ACUTUS (American Crocodile). **ADULT MASS**. Few data exist on the body mass of large reptiles, due in part to the difficulties of handling and weighing these animals (Minton and Minton 1973. Giant Reptiles. Charles Scribner's Sons, New York, New York. 345 pp.). In particular, few reliable data exist regarding body size of large crocodilians (Richardson et al. 2002. Crocodiles: Inside Out: A Guide to the Crocodilians and their Functional Morphology. Surrey Beatty and Sons, Ltd., Chipping Norton, NSW. 172 pp.; Webb and Manolis 1989. Crocodiles of Australia. Reed Books Pty. Ltd., Frenchs Forest, NSW. 160 pp.; Woodward et al. 1995. J. Herpetol. 29:507–513). However, crocodile research and management rely on knowledge of individual body size and size-class structure of populations (Webb and Smith 1987. *In* Webb et al. [eds.], Wildlife Management: Crocodiles and Alligators, pp. 199–210. Surrey Beatty & Sons, Ltd, Sydney) because demographic and reproductive variables are functionally dependent on body size rather than age, and population models are generally based on the former (Nichols 1987. *In* Webb et al., *op. cit*., pp. 177–187). Here, we report the body mass of a large *Crocodylus acutus* from Costa Rica.

On 13 September 2007, we captured an adult male *C. acutus* in the lower Tarcoles River, Costa Rica (9.79906389°N, 84.615278°W) during a study of ocular disease in this crocodile population. Total length (TL; anterior tip of the snout to the posterior tip of the tail, measured along the dorsal surface) and snout–vent length (SVL; anterior tip of the snout to the anterior margin of the cloacal vent, measured along the ventral surface) of the crocodile were measured with a tape as 482.6 cm and 237.5 cm, respectively. The crocodile was wrapped in an industrial cargo net and weighed using an electronic crane scale (Dynafor LLX/LLTR; Schumann GmbH, Sillerup, Germany) and manual chain hoist secured to the limb of a tree on the bank of the river. The mass of the crocodile was 537.45 kg, after subtracting the mass of the cargo net (29.54 kg).

In 2003, two of us (BRB, JRBM) captured a large *C. acutus* (TL = 395.0 cm) for translocation during a radio-tracking project in Costa Rica and determined that it weighed 500 kg (Barr 2003.

Crocodile Spec. Newsltr. 23:19). To our knowledge, these measurements of body mass are the largest yet reported for *C. acutus*, however they do not represent a maximum value for this species. *Crocodylus acutus* is known to reach lengths of 600–700 cm (Alvarez del Toro 1974. Los Crocodylia de Mexico [Estudio Comparativo]. Recursos Naturales Renovables, Mexico City. 70 pp.; Schmidt 1924. Fieldiana 12:77–96). Using an equation derived from the relationship of TL to body mass for the morphologically similar Morelet's Crocodile (*C. moreletii*) (Platt et al. 2009. Carib. J. Sci. 45:80–93), the estimated body mass of these large *C. acutus* is predicted to range from 900 to 1283 kg.

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SQUAMATA — LIZARDS

AMEIVA FESTIVA (Central American Whiptail Lizard). **CANNIBALISM**. *Ameiva festiva* is a broadly distributed, dietary generalist that consumes diverse arthropod prey including crickets, spiders, roaches, and katydids (Vitt and Zani 1996. J. Herpetol. 30:110–117; Vitt and Zani 1998. J. Trop. Ecol. 14:537–559; Whitfield and Donnelly 2006. J. Trop. Ecol. 22:409–417). Lizards, however, have been recorded infrequently in their diet (Vitt and Zani 1998, *op. cit.*) and accounts identifying the lizard species taken are lacking. Hence, here we report an *A. festiva* preying on a conspecific in the Gandoca-Manzanillo Wildlife Refuge, Costa Rica.

At 1127 h on 21 July 2008, while walking the grounds at the Iguana Verde Foundation (09.63818°N, 82.70496°W, datum WGS84; elev. 3 m), we observed, photographed, and videotaped one adult female *A. festiva* (ca. 9 cm SVL) grasping a conspecific (ca. 4 cm SVL) by its head. The smaller lizard was alive but missing half its tail, which was seen ca. 7 cm away. The adult was biting the head of the smaller conspecific continually until a probable male (ca. 10 cm SVL) *A. festiva* approached and began undulating its tail. The adult female fled 2.5 m away and began manipulating her prey in a head-first orientation. The adult female *Ameiva* took one minute to swallow its prey, and then performed an undulating maneuver with its torso, and completed its consumption at 1134 h.

This is the first observation of cannibalism in this frequently observed species, and augments our knowledge of trophic relationships for *Ameiva* lizards and their behavioral ecology. This observation was made while conducting *Iguana iguana* research supported by the San Diego Zoo's Institute for Conservation Research.

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APHANIOTIS ACUTIROSTRIS (Indonesia Earless Agama). **REPRODUCTION.** *Aphaniotis acutirostris* is known from Indonesia (Uetz and Hallermann 2010. The Reptile Database http://www.reptile-database.org, accessed 22 July 2010). To my knowledge, the only information on *A. acutirostris* is a report of clutch sizes of two eggs deposited every 30–100 days and hatching 48–63 days later (Das 2006. A Photographic Guide to Snakes & Other Reptiles of Borneo. Ralph Curtis Publishing, Sanibal Island, Florida. 144 pp.). The purpose of this note is to provide additional information on the reproductive biology of *A. acutirostris.*

A sample of 18 *A. acutirostris* (nine males, mean SVL = 53.4 mm ± 2.2 SD, range = 51–56 mm; four females, mean SVL = 50.3 mm ± 2.1 SD, range = 48–53 mm; four subadults, mean SVL = 31.0 mm ± 4.8 SD, range = 28–38 mm; and one neonate, SVL = 23 mm, collected July 1975 at Bohorok, North Sumatra, Indonesia (3.516667°N, 98.133333°E; WGS84, 255–1390 m elev.) was examined from the herpetology collection of the Field Museum of Natural History (FMNH): FMNH 209533, 209534, 209536–209539, 209541–209545, 209552–209554, 209556, 209557, 209559, 209564. For histological examination, the left gonad was removed to check for yolk deposition in females and spermiogenesis (sperm formation) in males. Counts were made of enlarged ovarian follicles (> 4 mm length) or oviductal eggs. Tissues were embedded in paraffin and stained with hematoxylin followed by eosin counterstain. Histology slides are deposited in FMNH.

All males examined were undergoing spermiogenesis; the lumina of the seminiferous tubules were lined by clusters of sperm or groups of metamorphosing spermatids. The smallest reproductively active male measured 51 mm SVL. One female contained two vitellogenic follicles (2 mm length); two females each contained two enlarged ovarian follicles (4 mm diameter) and one female contained two oviductal eggs. The smallest reproductively active female (oviductal eggs) measured 48 mm SVL. The presence of the neonate (23 mm SVL), plus three slightly larger juveniles (28, 28, 30 mm SVL) indicates they were born earlier in the year and that *A. acutirostris* has a prolonged period of reproduction. Inger and Greenberg (1966. Ecology 47:1007–1021) reported continuous reproduction in five agamid species (*Draco melanopogon*, *D. obscurus*, *D. quinquefasciatus*, *Gonocephalus grandis*, *G. liogaster*) from a Bornean rain forest. Whether *A. acutirostris* breeds throughout the year will require examination of additional monthly samples.

I thank Alan Resetar (FMNH) for permission to examine *A. acutirostris.*

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ASPIDOSCELIS TIGRIS (Western Whiptail) **DIET.** *Aspidoscelis tigris* is a common lizard of North American arid lands. Active forager, whiptails generally forage on the ground, often near veg-

etation, where they dig in leaf litter or probe cracks and crevices in search of prey (Pianka 1970. Ecology 51:703–720). Whiptails feed primarily on diverse ground-dwelling arthropods (Best and Gennaro 1985. Great Basin Nat. 45:527–534), but are not recorded to take honey bee (*Apis mellifera*) prey. Here, I present the first record of *A. tigris* attacking and consuming a honey bee.

At 1200 h on 29 July 2002, I observed three adult *A. tigris* foraging beneath a stand of saltcedar (*Tamarix* sp.) in a dry wash in the northwest portion of the Glen Canyon National Recreation Area, Garfield Co., Utah, USA (37.642614°N, 111.067225°W, datum WGS84; elev. 1510 m). The lizards seemed unaware of my presence as they foraged in the leaf litter. The saltcedar was in full flower, and many bee species were visiting the flowers. A honey bee flew down from a low-lying flower, landing on the ground ca. 1 m from one of the *A. tigris*. The lizard immediately ran over to the bee, caught it, and began chewing it rapidly. As the *A. tigris* began ingesting the bee, it rubbed its snout on the ground several times. It is unknown whether it was trying to avoid being stung or if the hairy body of the bee was irritating the inside of its mouth. Other whiptails have been reported to rub their snout on the ground when attacking hairy arthropods, like some caterpillars (Burt 1928. J. Kansas Ent. Soc. 1:50–68). The entire attack and ingestion episode lasted <1 min. I continued to watch the lizards forage under the saltcedar for ca. 15 min, and the *A. tigris* that had ingested the bee behaved normally, showing no adverse effects from the encounter.

This record merits comment given the potentially toxic nature of this insect. Feeding experiments have revealed that the Eastern Fence Lizard (*Sceloporus undulatus*) always refused honey bees when offered them, and in one instance, a lizard was stung by a bee and died minutes later (Burt 1928. J. Kansas Entomol. Soc. 1:50–68). Whether the *A. tigris* individual was stung by the bee in this instance is unknown, but the fact that the lizard was able to attack and eat the bee without harmful consequence is noteworthy.

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GONATODES HUMERALIS (Trinidad Gecko). **ENDOPARASITES.** *Gonatodes humeralis* is widespread in northern South America and occurs in French Guiana, Suriname, Ecuador, Guyana, Peru, Bolivia, NE Venezuela, Colombia, Brazil, as well as Trinidad and Tobago (Uetz and Hallermann 2010. http.reptile-database.org, accessed 20 May 2010). The purpose of this note is to add to the helminth list of *G. humeralis.*

Fifteen *G. humeralis* (mean SVL = 36.9 mm ± 2.0 SD, range = 34–40 mm) collected from 1905 to 1973 from Peru, Loreto Department, Moropon (3.748056°S, 73.246933°W; WGS84; 107 m elev.) and deposited in the Texas Cooperative Wildlife Collection (TCWC), Texas A & M University, were examined for helminths (TCWC 36674, 36684, 36737, 36739, 38996, 41173, 41226, 41761, 41801, 41910, 41911, 41920, 41922, 42714, 42715).

The body cavities were opened and the digestive tracts removed. Contents were examined under a dissecting microscope. Digeneans were regressively stained in hematoxylin and mounted on glass slides in Canada balsam. Nematodes were cleared on glass slides in glycerol. All were cover-slipped, studied under a compound microscope and identified. Found were one species of Digenea, *Mesocoelium monas* (N = 173, small intestine, prevalence = number infected lizards/number lizards examined x 100 = 7%; mean intensity, mean number helminths per infected lizard ± 1 SD = 173) and three species of Nematoda, *Parapharyngodon scleratus* (large intestine, N = 2, prevalence = 7%, mean intensity = 2), *Physaloptera retusa* (stomach, N = 6, prevalence = 20%, mean intensity = 2.0 ± 1.0, range = 1–3), *Skrjabinelazia galliardi* (small intestine, N = 2, large intestine, N = 2, prevalence = 20%, mean intensity = 1.3 ± 0.6, range = 1–2). Voucher helminths were deposited in the United States National Parasite Collection, USNPC, Beltsville, Maryland: *Mesocoelium monas* (103203); *Parapharyngodon scleratus* (103204); *Physaloptera retusa* (103205); *Skrjabinelazia galliardi* (103206).

Mesocoelium monas is cosmopolitan in distribution and has been recorded from fishes, amphibians, and reptiles from the New and Old Worlds (Goldberg et al. 2009. Comp. Parasitol. 76:58–83). *Parapharyngodon scleratus* has been reported in a variety of lizards from Brazil and also occurs in Peru (Bursey et al. 2005. Comp. Parasitol.72:50–68). *Physaloptera retusa* is widely distributed in lizards and a few amphibians in the western hemisphere and has been reported from Mexico, North and South America, and the West Indies (Bursey et al. 2007, *op. cit.). Skrjabinelazia galliardi* was originally described from *G. humeralis* collected in Brazil (Chabaud 1973. Ann. Parasitol. Hum. Comp. 48:329–334). *Gonatodes humeralis* represents a new host record for *Mesocoelium monas, Parapharyngodon scleratus*, and *Physaloptera retusa*. Peru is a new locality record for *Skrjabinelazia galliardi*

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HELODERMA SUSPECTUM (Gila Monster). **TREE-CLIMBING**. *Heloderma suspectum* occupies a variety of terrestrial habitats in all deserts of the United States and northern mainland Mexico (Beck 2005. Biology of Gila Monsters and Beaded Lizards. University of California Press, Berkeley and Los Angeles. 247 pp.; Campbell and Lamar 2004. Venomous Reptiles of the Western Hemisphere. Cornell University Press, Ithaca, New York. 870 pp.). Despite the fact these regions substantially differ with respect to environmental factors and habitats (Brown 1994. Biotic Communities of the American Southwest—United States and Mexico. University of Utah Press, Salt Lake City. 342 pp.), *H. suspectum* selects similar types of microhabitats and shelters (Beck 2005, *op. cit*.; Beck and Jennings 2003. Herpetol. Monogr. 17:111–129), which are commonly bushes and structures with subterranean components (e.g., rock formations and small mammal burrows). Rarely, *H. suspectum* exhibits arboreal activities, particularly with regard to tree climbing (Beck 2005, *op. cit*.;

Cross and Rand 1979. Southwest. Nat. 24:703–705).

Here, we provide additional information on tree climbing of an adult *H. suspectum* from a population in the Sonoran Desert of south-central Arizona. The individual we discuss herein is the subject of an ongoing radio-telemetric study in which various features of behavior, physiology, and spatial ecology have been investigated since March 2001 (Kwiatkowski et al. 2008. J. Zool. 276:350–357; Repp and Schuett 2009. Herpetol. Rev. 40:343–345).

The present study site, located in Pinal Co., is 40 km SSE of the city of Florence, 8 km W of State Route 79, and encompasses an area of ~3 km^2 at the extreme western edge of the Suizo Mountains (Iron Mine Hill). The region is ecologically designated as Arizona Upland Desertscrub subdivision (Brown 1994, *op. cit.*).

On 25 April 2010, at 1205 h, in an area interfacing bajada (Phillips and Comus 2000, *op. cit.*) and desert flats, an adult male *H. suspectum* (HS-15: SVL = 291 mm; TL = 133 mm; tail volume = 49 ml; body mass = 470 g) was radio-tracked and located (site 5, elev. 826 m) beneath a moderate-sized (4 m H x 4 m W) Yellow Paloverde (*Cercidium microphyllum*; Fig. 1). The dominant vegetation directly beneath the tree was a dense stand of Fiddleneck (*Amsinckia intermedia*) with limited Triangle Bursage (*Ambrosia deltoidea*). Additional vegetation nearby included Engelmann's Prickly Pear (*Opuntia engelmannii*) and Buckhorn Cholla (*Opuntia acanthocarpa*). HS-15 was originally collected and processed on 12 March 2010, and has been radio-tracked on a weekly basis. Upon detection on 25 April, HS-15 began a deliberate (non-erratic) and consistent ascent into the tree that continued for about 1 min; he stopped and remained on a large (35 mm circumference) main branch angled at 20–35º and approximately 1.2 m above the ground (Fig. 1). He was outstretched facing eastward, in diffuse sunlight, and remained in that position, sometimes with his eyes closed, until we left (1230 h). Cross and Rand (1979, *op. cit.*) observed two adult *H. suspectum* ascended into Desert Willows (*Chilopsis linearis*) at similar heights (90 cm and 2.5 m) and attained similar postures on branches, as we report herein. However, they did not report dates and times of day, other than morning and evening.

The core body temperature of HS-15 (obtained via an implanted 9.0 g temperature-sensitive radio transmitter; Holohil Systems Ltd., Ontario, Canada) while he was at his final location in the tree was 32.3ºC. Ambient temperature (1 m above the ground in shade) was 28.0ºC; ground temperature in direct sunlight beneath the tree was 51ºC. Cloud cover was 0%, relative humidity was < 10%, and wind speed was slight (0–8 kph) and intermittent.

We are unable to determine whether HS-15 made his ascent to escape our presence or for other reasons, such as avoiding high ground temperatures. Support for the latter view is that we were unable to locate burrows, woodrat (*Neotoma albigula*) middens, or any other shelters often used by *H. suspectum* (see Beck and Jennings 2003, *op. cit.*). Moreover, in a nearby (4 km S) population, Davis and DeNardo (2010. J. Herpetol. 44:83–93) determined the mean activity body temperature of *H. suspectum* to be 26.4 (± 0.83°C), which indicates that the core body temperature of 32.3°C present in HS-15 was approaching the voluntary maximum of 35–37°C (D. Beck and D. DeNardo, pers. comm.). The critical thermal maximum for *H. suspectum* is believed to be ~44°C (Beck 2005, *op. cit.*).



COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND

FIG. 1. Tree climbing by an adult male, wild-living Gila Monster, *Heloderma suspectum*. This individual (HS-15) is shown at his final location in a Yellow Paloverde (*Cercidium microphyllum*). Photograph by R. A. Repp.

We did not locate bird nests in the tree used by HS-15; thus, it appears unlikely that foraging was a motivation to climb. Unlike Beaded Lizards (*H. horridum* sensu lato; see Douglas et al. 2009. Mol. Phylogenet. Evol. 55:153–167), which often forage in trees (Beck 2005, *op. cit.*), *H. suspectum* predates mostly on ground-nesting avian and mammalian species (Beck 2005, *op. cit.*; Repp and Schuett 2009, *op. cit.*). To date, there are no observations to support arboreal foraging in *H. suspectum*.

Our field studies at Suizo Mountain have been funded by Arizona State University, Zoo Atlanta, Georgia State University, and Dr. David L. Hardy, Sr. Since 2001, many individuals provided assistance in radio-tracking, but most noteworthy are Hans-Werner Herrmann and Ryan Sawby. Also, Ryan Sawby provided invaluable assistance with photography and identification of plants and invertebrates. We thank Dan Beck, Dale DeNardo, Matt Goode, Jim Jarchow, and Brian Sullivan for various favors. This study was approved by the IACUC of Arizona State University (98-429R), and appropriate scientific permits were obtained from the Arizona Game and Fish Department.

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HEMIDACTYLUS MABOUIA (Tropical House Gecko). **PREDATION.** *Hemidactylus mabouia* is a broadly distributed species in the tropics and has been introduced to the New World, with populations having successfully colonized southern areas of North America and Central and South America (Federico and Cacivio 2000. Herpetol. Rev. 31:53). The Roadside Hawk (*Buteo magnirostris*) is a medium-sized hawk that often is associated with thinned forests, forest edges, and natural or anthropogenic clearings (Bierregaard 1994. *In* Hoyo [org.], Handbook of the Birds of the World, Vol. 2, p. 179). Its diet can contain a variety

of organisms including large invertebrates and small vertebrates (Haverschimidt 1962. Condor 64:154–158; Panasci et al. 2002. Wilson Bull. 114:114–121). This note reports an observation of predation on *H. mabouia* by *B. magnirostris*.

At 1654 h on 2 November 2009, in the Central Campus of Universidade Federal do Rio Grande do Norte (UFRN), municipality of Natal, State of Rio Grande do Norte, Brazil (256117.385°E, 9354212.344°N; datum WGS84), elev. 34.5 m, BRMM observed a Roadside Hawk on a tree branch within remnant forest with a *H. mabouia* in its bill. The lizard was not moving, indicating it was no longer alive. BRMM observed the hawk closely, using binoculars (SUMAX 12-45x70 BS Ventura), to make a positive identification of the gecko. The hawk flew away with the prey item.

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HEMIDACTYLUS TURCICUS (Mediterranean Gecko). **HERMAPHRODITISM.** Many sexual anomalies have been reported in lizards including hermaphroditism caused by radiation exposure in *Lacerta vivipara* (Semenov and Ivanova 1995. Russ. J. Herpetol. 2:166–169), sexual development anomalies caused by varying incubation temperatures in *Lacerta viridis* (Raynaud and Pieau 1985. *In* C. Gans and F. Billet [eds.], Biology of the Reptilia, Vol. 15, Development B, pp. 149–300. John Wiley and Sons, New York), and development of hemipenes in female Leopard Geckos (*Eublepharis macularius*; Holmes et al. 2005. Horm. Behav. 47:439–445). However, few reports of hermaphrodite lizards from wild populations exist (but see Darevsky et al. 1978. Copeia 1978:201–207; Goldberg 1989. Copeia 1989:486–488). As part of a study of the accumulation of potential pollutants in the tissues of Mediterranean Geckos (*Hemidactylus turcicus*; Kinney et al. 2008. Herpetol. Conserv. Biol. 3:247–253), we histologically examined the gonadal tissues of specimens collected from buildings at several sites in southwestern Louisiana, USA. This study discovered a hermaphroditic Mediterranean Gecko which we describe herein.

Collections of geckos were made between June and August 2006, representing the middle of the gecko reproductive season in Louisiana, to ensure that the gonadal tissue was well developed (i.e., males would have sperm cells and females would have developing eggs). Sex of adults (SVL > 42 mm; Selcer 1986. Copeia 1986:956–962) was initially determined in the field: males were identified by the presence of pre-anal pores in a chevron pattern. Specimens were sacrificed by pithing; testes and epididimides were dissected from the males, ovaries (including eggs) were dissected from the females, and all tissues were placed in 10% neutral buffered formalin. Tissues were dehydrated in alcohol, cleared in xylene and paraffin embedded. Seven-micron-thick sections were made and slides stained with hematoxylin and eosin. Six adult male and seven adult female specimens collected from five sites in Beauregard and Calcasieu parishes, Louisiana were examined.

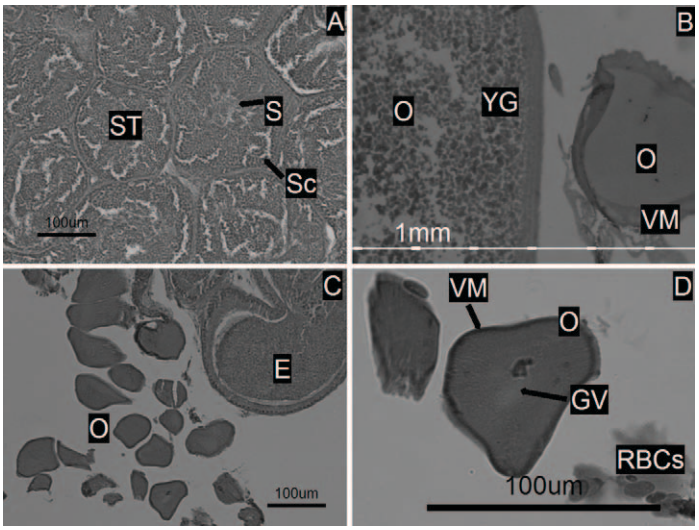


Fig. 1. **A**. Normal male *Hemidactylus turcicus*: testis with seminiferous tubules filled with all stages of germ cells. **B.** Normal female *Hemidactylus turcicus*: oocytes at various stages of development. **C.** Hermaphrodite *Hemidactylus turcicus*. Note oocytes associated with epididymis. **D.** Close-up of oocytes of hermaphrodite *Hemidactylus turcicus*. ST = seminiferous tubule; S = spermatozoa; Sc = spermatocytes; O = oocytes; YG = yolk granules; VM = vitelline membrane; E = epididymis; GV = germinal vesicle; RBCs = red blood cells.

A specimen initially identified as a male collected 13 June 2006 from the clubhouse at Lake Charles Country Club in Calcasieu Parish was found to have both testicular/epididymal and ovarian tissue (Fig. 1). The testicular tissue appeared normal and all stages of sperm development were present (including mature sperm in the epididymis, Fig 1C). The ovarian tissue was separate from the testes and appeared intimate with the epididymis (Fig. 1C). The oocytes were all immature (stage one development indicated by lack of perinucleoli or yolk development). The germinal vesicle (nucleus), as well as the vitelline membrane surrounding the eggs can also be seen (Fig. 1D). Because this individual possesses both male and female gonadal tissues, it is a true hermaphrodite (or intersex). To our knowledge, this is the first report of a hermaphroditic Mediterranean Gecko captured from a wild population.

This study was carried out in accordance with the McNeese State University Institutional Animal Care and Use Regulations. Specimens were collected under the authority of Louisiana Department of Wildlife and Fisheries Scientific Collecting Permit LNHP-06-052.

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IGUANA IGUANA (Green Iguana). **NESTING**. In Central America, female *Iguana iguana* deposit large clutches of eggs from February through April (Stafford and Meyers 2000. A Guide to Reptiles of Belize. Academic Press, New York. 356 pp.). Eggs are laid in burrows, which females often construct in sandbanks

along creeks and rivers (Stafford and Meyers, *op. cit.*). In Panama, female *I. iguana* reportedly construct nesting burrows in close proximity to American Crocodile (*Crocodylus acutus*) nests (Rand 1968. Copeia 1968:552–561; Dugan et al. 1981. J. Herpetol. 15:409–414). Here we report observations of *I. iguana* using crocodile nests as oviposition sites in southern Belize. Crocodile embryos obtained from these nests, through genetic analysis, were determined to be *C. moreletii* × *acutus* hybrids (Hekkala 2004. Conservation Genetics at the Species Boundary: Case Studies from African and Caribbean Crocodiles [Genus: Crocodylus]. PhD dissertation, Columbia University, New York. 92 pp.).

On 20 April 1997, we found two crocodile nests 240 cm apart on a sandbar along Paynes Creek, Paynes Creek National Park, Toledo District (16.35830°N, 88.56604°W, datum WGS84; elev. ca. 10 m). Each crocodile nest consisted of a sand mound ca. 140 cm wide × 90 cm high. One nest contained 25 *I. iguana* eggs, but no crocodile eggs, and the other contained one *I. iguana* egg and 42 crocodile eggs. In the latter nest, the *I. iguana* egg was buried beneath the crocodile eggs. Remains of at least five more *I. iguana* eggs were scattered around the second nest, implying that the female crocodile had unearthed them during oviposition. The extent of banding visible on the crocodile eggs (Platt et al. 2008. J. Zool. 275:177–189) indicated the clutch was deposited about five days earlier. Because crocodile nests are generally constructed 5–7 days prior to egg laying (Platt et al., *op. cit.*), the *I. iguana* clutches were likely deposited in early April. On 15 May 1997, we found two additional crocodile nests on sandbars along the Swasey Branch of Monkey River, Toledo District. The first nest (16.41888°N, 88.53466°W, datum WGS84; elev. ca. 15 m), a large sand mound measuring approximately 300 cm wide × 100 cm high, contained 38 crocodile eggs and 17 *I. iguana* eggs; the latter were buried about 5 cm beneath the crocodile eggs. We estimated the crocodile eggs to be about three weeks old. Hence, the *I. iguana* eggs were likely deposited in mid-April. A second crocodile nest (16.42833°N, 88.54361°W, datum WGS84; elev. ca. 32 m) found on a sandbar downstream from the previous nest contained 23 crocodile eggs, but no *I. iguana* eggs. However, abundant tracks and excavations indicated *I. iguana* were nesting on the sandbar adjacent to the crocodile nest.

Given an incubation period of ca. 90 days (Hirth 1963. Ecology 44:613–615; Rand 1972. Herpetologica 28:252–253), *I. iguana* eggs deposited early-to-mid April are expected to hatch early-to-mid July, a period coinciding with the onset of the wet season (Platt et al., *op. cit.*). In Belize, *Crocodylus acutus* eggs hatch after an incubation period of 78–81 days, and hatchlings emerge from the nest during the same period as *I. iguana* (Platt and Thorbjarnarson 2000. Copeia 2000:869–873). *Crocodylus moreletii* has a similar incubation period (ca. 75 days), though clutches are not deposited until after the wet season commences in late June and July (Platt et al., *op. cit.*). Although the incubation period of *C. moreletii* × *acutus* hybrids has yet to be determined, it is expected to be similar to both parental species. Thus, hatchling *I. iguana* and hatchling crocodiles probably emerge from the nest at about the same time. To our knowledge, these are the only reports outside of Panama of *I. iguana* depositing eggs in crocodile nests. Presumably, fitness advantages in the form of increased nest and hatchling survival accrue to female *I. iguana* from the nest defense behavior of female crocodiles (Dugan et al., *op. cit.*). However, female crocodiles occasionally unearth *I. iguana* eggs when excavating nests, and female *I. iguana* also risk being captured and consumed by female crocodiles defending nests (Dugan et al., *op. cit.*).

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MABUYA ARAJARA (NCN). **DEATH-FEIGNING.** Death-feigning (thanatosis) is a state of immobility in response to external stimuli that has been considered a defense mechanism against predators shared by various animals, including snakes and lizards (Gehlbach 1970. Herpetologica 24–34; Rocha 1993. Cienc. Cult. 45:116–122). This defensive behavior been observed in several different families of lizards, including Dibamidae (Torres-Cervantes et al. 2004. Herpetol. Rev. 35:384), Crotaphytidae (Gluesing 1983. Copeia 1983:835–837), Tropiduridae (Bertoluci et al. 2006. Herpetol. Rev. 37:472–473; Galdino and Pereira 2002. Herpetol. Rev. 33:54; Gomes et al. 2004; Kohlsdorf et al. 2004. Herpetol. Rev. 35:390–391), but has been less documented in Scincidae (Langkilde et al. 2003. Herpetol. J. 13:141–148). *Mabuya arajara* is a skink found only in high elevation areas of northeastern Brazil (Joventino and Loebmann 2010. Herpetol. Bull. 113:4–10; Rebouças-Spieker 1981. Pap. Avul. Zool. 34:121–123; Ribeiro et al. 2008. Cad. Cult. Ciênc. 1:67–76). Little information exists on the natural history of *M. arajara*. Here, we report thanatosis in *M. arajara* during a collecting expedition in Araripe Mountain Plateau, municipalities of Barbalha (07.3186111°N, 39.4011111°W, WGS84) and Crato (07.2552778°N, 39.4680556°W, WGS84), Ceará. Three specimens were hand captured between 1500–1600 h on 11–12 May 2010. Every time the skinks were handled, they promptly exhibited death feigning, although their eyes remained open; these behaviors lasted for about 3 min, even after being placed on the ground. Among lizard species, thanatosis is a behavior rarely observed in natural situations (Greene 1988. *In* Gans and Huey [eds.], Biology of the Reptilia, Vol. 16, Ecology and Defense, pp. 1–52. Alan R. Liss. Inc., New York) but handling may induce this behavior in many lizard species (Rocha 1993, *op. cit.*). Thanatosis in *M. arajara* may cause predators to lose interest in the potential prey and give them an additional opportunity to escape. The three skink specimens were deposited in the zoological collection of the Universidade Regional do Cariri/LZ-URCA, Ceará,

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OPHISOPS ELEGANS (Snake-eyed Lizard). **ENDOPARASITES.** *Ophisops elegans* is a widely distributed lacertid in the Middle East occurring from the Bosphorus through Iran, south to the Sinai Peninsula and Red Sea Coast of Egypt, Jordan, Iraq, and the Transcaucasian republics where it is commonly found on stony plains and hillsides (Anderson 1999. The Lizards of Iran. SSAR Contrib. Herpetol. 15:1–442). We know of no published accounts of helminths from this lizard. The purpose of this note is to establish the initial helminth list for *O. elegans*.

Six *O. elegans* (mean SVL = 45.0 ± 3.3 SD, range = 42–49 mm) from The Islamic Republic of Iran, Khuzestan Province, Shalgahi (32.416667°N, 48.866667°E, WGS84, elev. 12 m) were examined for helminths from the herpetology collection of the Museum of Comparative Zoology (MCZ), Harvard University: (MCZ R-56694, 56695, 56697, 56699, 56705, 56737).

The body cavity was opened and the digestive tract was removed and examined under a dissecting microscope for helminths. Seven cestodes were found in the small intestines of four *O. elegans* (prevalence, number infected lizards/number examined lizards × 100 = 67%; mean intensity, average number helminths per infected lizard = 1.8 ± 0.96 SD, range: 1–3). Cestodes were regressively stained in hematoxylin and identified under a compound microscope as *Oochoristica tuberculata.* They were deposited in the invertebrate collection at MCZ as IZ-95760–95763.

Oochoristica tuberculata is widely distributed in the Old World and occurs in a variety of lizards and some snakes; distribution and hosts are summarized in Yildirimhan et al. (2006. Comp. Parasitol. 73:257–262). Although the life cycle of *O. tuberculata* is unknown, the congener *O. anolis* utilizes beetles as intermediate hosts (Conn 1985. J. Parasitol. 71:10–16). *Ophisops elegans* represents a new host record for *Oochoristica tuberculata*. The Islamic Republic of Iran is a new locality record.

We thank Jonathan B. Losos and Jose Rosado (MCZ) for permission to examine *O. elegans* and Cecilia Nava (Whittier College) for assistance with dissections.

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POTAMITES JURUAZENSIS (NCN). **ENDOPARASITES.** *Potamites juruazensis* (Gymnopthalmidae) is known from Acre Province, Brazil (Avila-Pires and Vitt 1998. Herpetologica 54:235–2450) and Peru (Doan and Castoe 2005. Zool. J. Linn. Soc. 143:405–416). There are, to our knowledge, no reports of helminths from *P. juruazensis*. In this report we establish an initial helminth list for *P. juruazensis*.

Twenty *P. juruazensis* (9 females, 11 males), mean SVL = 40.3 mm ± 11.1 SD, range = 24–58 mm) from ca. 5 km N of Porto Walter (8.25861°S, 72.77694°W; WGS 84; elev. 198 m) Acre State, Brazil collected by LJV and Teresa C. Ávila-Pires and deposited in the Sam Noble Oklahoma Museum of Natural History, Norman, Oklahoma as OMNH 36861–36880 were examined for endoparasites.

The body cavity was opened and the intestines removed and examined under a dissecting microscope. Because these specimens had previously been used in an ecological study (Vitt and Avila-Pires 1998. Copeia 1998:570–582), the stomachs were not available for examination. Ten nematodes were found in the small (N = 5) and large intestines (N = 5). They were cleared in glycerol on a microscope slide, studied under a compound microscope and identified as *Cosmocerca vrcibradici*, prevalence = number infected individuals/number individuals examined × 100 = 30%; mean intensity mean number parasites per infected lizard = 1.67 ± 0.52 SD, range = 1–2. Voucher specimens were deposited in the United States National Parasite Collection, Beltsville, Maryland as USNPC 103198.

Cosmocerca vrcibradici was described from the gymnophthalmids *Prionodactylus eigenmanni* and *P. oshaughnessyi* from Brazil and Ecuador (Bursey and Goldberg 2004. J. Parasitol. 90:140–145) and has subsequently been reported from *Uranoscodon superciliosus* from Brazil (Bursey et al. 2005. J. Parasitol. 91:1395–1398), *Norops fuscoauratus* from Brazil (Goldberg et al. 2006. Phyllomedusa 5:83–86), *Alopoglossus angulatus* and *A. atriventris* from Brazil and Ecuador (Goldberg et al. 2007. Herpetol. J. 17:269–272), and *Arthrosaura reticulata* from Ecuador (Goldberg et al. 2010. Herpetol. Rev. 41:349–350). The report of *C. vrcibradici* in *Chalcides ocellatus* from Egypt by Ibrahim and Soliman 2005 (Parasite 12:317–323) requires verification. *Potamites juruazensis* represents a new host record for *Cosmocerca vrcibradici.*

We thank Cecilia Nava (Whittier College) for assistance with dissections.

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SCELOPORUS MINOR (Minor Lizard). **PREDATION.** *Sceloporus minor* is a colorful phrynosomatid restricted to saxicolous habitats in central México (Wiens et al. 1999. Evolution 53:1884–1897). To date, there are few published reports on the ecology of this species (Ramírez-Bautista et al. 2008. Herpetol. J. 18:121–127) and to our knowledge, nothing regarding predation. Between 2005 and 2008 we studied a population of *S. minor* in the Los Mármoles region of NW Hidalgo state (Stephenson 2010. Unpubl. Ph.D. dissertation, University of Miami, Coral Gables, Florida. 187 pp.) near the community of La Manzana (20.87°N, 99.22°W, WGS84; elev. 2400 m). Here, mixed oak-pine forest (primarily *Quercus crassipes* and *Pinus greggii*) is interrupted by sharp limestone outcroppings. These rocky outcrops represent the primary habitat for *S. minor* in this area, and both adults and juveniles are commonly observed basking and displaying on boulders and rock piles (Stephenson 2010, *op. cit*.). In the southern part of its range *S. minor* is sympatric with the Querétaro Dusky Rattlesnake, *Crotalus aquilus* (Campbell and Lamar 2004. The Venomous Reptiles of the Western Hemisphere. Cornell University Press, Ithaca, New York). Near La Manzana, adult *C. aquilus* are active during the day (Armstrong and Murphy 1979. Spec. Publ. Mus. Nat. Hist. Univ. Kans. [5]:1–88), and commonly observed on and around exposed boulders used by *S. minor* (Stephenson 2010, *op. cit*.). In this report we describe two observations of predation on *S. minor* by *C. aquilus*, representing the first descriptions of predation on *S. minor* by any species and extending knowledge pertaining to the diet of *C. aquilus*.

On 12 August 2006 three of us (BPS, ELMV, and NI) observed and followed an adult *C. aquilus* tracking and ultimately consuming a previously marked subadult female *S. minor* (measured 47.7 mm SVL on 28 July 2006). The lizard was found on a small dirt trail in a hillside dominated by low-growing (<1 m) shrubby vegetation. Because this encounter was lengthy (almost 3 h), we provide a detailed summary:

- 1144 h: Lizard found motionless on ground in normal upright posture; *C. aquilus* located ~10 cm away (air temperature at breast height = 17.2°C).
- 1150 h: Snake began to approach lizard from rear, and lizard began to move away slowly from snake; both stopped after a few seconds.
- 1157 h: Lizard resumed moving away from snake, stopping about 50 cm from snake.
- 1217 h: Lizard opened and closed mouth several times in quick succession.
- 1222 h: Snake resumed approach toward lizard (with occasional tongueflicks), approaching to within 10 cm.
- 1234 h: Lizard did not move; snake retreated.
- 1237 h: Snake approached again, closing to within 1 cm of the lizard.
- 1245 h: Lizard pushed its head into head of *C. aquilus*; no overt response from snake. Lizard shifted position, settling its head on midsection of snake.
- 1250 h: Snake began to encircle lizard, which briefly settled over the body of the snake more fully, then moved away from the snake again.
- 1253 h: Snake bit lizard on head; lizard shook its body and the snake retreated.
- 1258 h: Snake bit lizard again on the head; female lizard shook its body again and placed its body over snake.
- 1316 h: Snake began to move again; lizard started to move away again.
- 1330 h: Lizard moved off of dirt path into nearby shrubby vegetation, climbing onto top of cluster of small herbaceous plants (*Salvia* sp.). Snake was about 10 cm away.
- 1348 h: Snake briefly moved toward lizard again.
- 1351 h: Lizard began to lose grip on vegetation.
- 1402 h: Lizard fell onto ground, ventral side up and was motionless.
- 1404 h: Leg of lizard began to twitch. Spasms lasted about three minutes.
- 1410 h: Snake resumed approach to lizard with tongueflicks.
- 1420 h: Snake bit head of lizard again, and began to consume it headfirst.
- 1436 h: Swallowing of lizard complete.

The behavior of the lizard when found suggests that it was envenomated prior to discovery. However, the lengthy duration between a probable initial strike and lizard death (≥ 3 h) suggests that relatively little venom may have been injected. (The bites that we observed did not appear to be feeding strikes, but perhaps attempts to determine whether the prey was ready to be consumed.)

The second observation occurred on 25 August 2008 in similar open, shrubby habitat. At 1135 h, two of us (BPS and NI) found a *C. aquilus* adult consuming an adult male *S. minor* (air temperature = 16.2°C). When discovered, the snake had swallowed approximately 50% of the lizard, which was oriented ventral-side up as in the previous observation. The snake was found at the base of a limestone boulder, but retreated into nearby vegetation upon approach. By 1147 h the snake had consumed the lizard down to the base of the tail.

On several other occasions we found individuals of *S. minor* or the sympatric congener *S. torquatus* lying motionless on the ground or on rock piles with no visible wound. Close inspection of the immediate area often revealed a *C. aquilus* nearby (< 1 m) suggesting that these individuals had been recently envenomated but not yet consumed. Overall, these observations are consistent with several other reports of predation by *C. aquilus* on *Sceloporus* lizards (Klauber 1997. Rattlesnakes: Their Habits, Life Histories, and Influence on Mankind. 2nd ed. University of California Press, Berkeley, California; Mociño-Deloya et al. 2008. Herpetol. Bull. 105:10–12), indicating that *Sceloporus* lizards are probably an important food source throughout the range of *C. aquilus*.

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STENOCERCUS GUENTHERI **(**Günther's Whorltail Iguana). **REPRODUCTION.** *Stenocercus guentheri* is known from the Andes of Ecuador and Colombia (Torres-Carjaval 2000. Sci. Pap., Nat. Hist. Mus. Univ. Kansas 15:1–38). Information on *S. guentheri* reproduction consists of clutch size reports of two eggs deposited in May and June (Fritts 1974. San Diego Soc. Nat. Hist. Mem. 7:1–89; Torres-Carjaval, *op. cit.*). The purpose of this note is to report a minimum SVL for maturity in females and the first information on the testicular cycle for *S. guentheri.*

Six females (mean SVL = 64.8 mm ± 5.9 SD, range = 58–70 mm) and three males (mean SVL = 73.3 mm ± 5.8 SD, range = 70–80 mm) of *S. guentheri* were borrowed for histological gonad examination from the herpetology collection of the Natural History Museum of Los Angeles County (LACM). The specimens were collected in 1977 (Colombia) Tangua, Nariño Province (1.08333°N, 77.30000°W, datum WGS84; elev. 2286 m) (LACM 131492) and in 1970 (Ecuador), El Quinché, Pichincha Province (0.25000°S, 78.41666°W, datum WGS84; elev. 2591 m) (LACM 58782–58789).

The left gonad was removed for histological examination and embedded in paraffin. Histological sections were cut at 5 μm, mounted on glass slides and stained with Harris hematoxylin followed by eosin counterstain. Histology slides were deposited in LACM.

Four of the six females (SVL = 63–70 mm) each (from May) contained clutches of two oviductal eggs. The remaining two females (each SVL = 58 mm) contained quiescent ovaries with no yolk deposition. The minimum size for female reproductive activity was 63 mm SVL (LACM 58783). Previous records of clutch sizes of two (Fritts, *op. cit.*; Torres-Carjaval, *op. cit.*) suggest this may be typical for *S. guentheri.* However, there are reports of congeneric species of *Stenocercus* producing larger clutches: *S. humeralis* (four eggs) (Torres-Carvajal, *op. cit.*); *S. azureus* (six eggs) (Torres-Carjaval 2004. Herpetol. Rev. 35:172); *S. doellojuradoi* (six eggs) (Pelegrin and Bucher 2010. Herpetol. Rev. 41:86–87).

The three male *S. guentheri* (SVL = 70–80 mm, two from May and one from November) exhibited spermiogenesis. Lumina of the seminiferous tubules were lined by spermatozoa and clusters of metamorphosing spermatids. The minimum size for reproductive activity was 70 mm SVL (LACM 58784, 131492). The presence of males undergoing spermiogenesis at opposite ends of the year (May and November) suggests *S. guentheri* exhibits a prolonged period of sperm formation.

I thank Christine Thacker (LACM) for permission to examine *S. guentheri.*

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STENOCERCUS GUENTHERI (Günther's Whorltail Iguana). **ENDOPARASITES.** *Stenocercus guentheri* is known from the Andes of Ecuador and Colombia (Torres-Carjaval 2000. Sci. Pap., Nat. Hist. Mus. Univ. Kansas 15:1–38). To our knowledge, there are no reports of endoparasites from *S. guentheri.*

Five specimens of *S. guentheri* (mean SVL = 72.4 mm ± 8.9 SD, range = 63–82 mm) were borrowed for helminthological examination from the herpetology collection of the Natural History Museum of Los Angeles County (LACM). They were collected in May 1970 from El Quinché, Pinchincha Province, Ecuador (0.25000°S, 78.41666°W, datum WGS84; elev. 2591 m): LACM 58782, 58784, 58790, 58807, 58808.

The body cavity was opened and the digestive tract was removed, opened by a longitudinal incision, and examined under a dissecting microscope. One species of Cestoda, two species of Nematoda, and one species of Acanthocephala were found. All were studied under a compound microscope and identified. The cestodes (N = 3, from the small intestines) were regressively stained in hematoxylin, mounted in Canada balsam, and identified as *Oochoristica travassosi*, prevalence = number infected lizards/number lizards studied × 100 = 60%; mean intensity = mean number parasites per infected lizard = 1.7 ± 0.58 SD; range = 1–2. Nematodes and acanthocephalans were cleared in glycerol on a microscope slide, cover-slipped, and identified as *Physaloptera retusa* (N = 48 from the stomach, N = 1 from the small intestine) prevalence = 100%; mean intensity = 9.8 ± 6.8 SD; range = 4–21; acuariid larvae (N = 9 from the body cavity) prevalence = 20%; and acanthocephalan cystacanths (N = 7 from the body cavity) prevalence = 20%.

Helminths were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland as: *Oochoristica travassosi* (103199); *Physaloptera retusa* (103200): acuariid larvae (103201), acanthocephalan cystacanths (103202).

Oochoristica travassosi was described from *Leiocephalus* sp. from Peru by Rego and Ibáñez (1965. Mem. Institut. Oswaldo Cruz 63:67–73). It has previously been found in *Liolaemus vallecurensis* from Argentina (Goldberg et al. 2004. Comp. Parasitol. 71:208–214) and *Phyllodactylus johnwrighti* from Peru (Goldberg and Bursey 2010. Comp. Parasitol. 77:91–93). Conn (1985. J. Parasitol. 71:10–16) reported beetles served as intermediate hosts for the congeneric *O. anolis. Physaloptera retusa* is widely distributed in New World lizards and has been reported from both North and South America (Goldberg et al., *op. cit.*). Like other members of the Physalopteridae, it utilizes insect intermediate hosts (Anderson 2000. Nematode Parasites of Vertebrates. 2nd ed. CAB International, Oxfordshire, UK. 650 pp.). Adults of the Acuariidae occur in the gizzard of terrestrial birds; insects are intermediate hosts (Anderson 2000, *op. cit.*). Lizards likely serve as paratenic (transport) hosts with development completed in an avian final host. Acanthocephalans require an invertebrate intermediate host in which the cystacanth develops, infective to the final host (Kennedy 2006. Ecology of the Acanthocephala. Cambridge Univ. Press, Cambridge, UK. 249 pp.). Because no further development occurs, lizards most likely are paratenic

hosts. *Stenocercus guentheri* represents a new host record for *Oochoristica travassosi*, *Physaloptera retusa*, acuariid larvae, and acanthocephalan cystacanths.

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TROPIDURUS TORQUATUS (Lagartixa, Calango). **DIET**. *Tropidurus torquatus* is a common and widespread lizard that occurs in many habitats in central and southern regions of Brazil and neighboring countries (Rodrigues 1987. Arq. Zool. S. Paulo 31:105–230), including urban areas. It is a sit-and-wait predator that preys mainly on arthropods, but also consumes plant material and vertebrates (Bergallo and Rocha 1994. Austral. J. Ecol. 19:72–75; Teixeira and Giovanelli 1999. Rev. Bras. Biol. 59:11–18). However, few dietary studies have included data from within urban environments. Herein we report the diet of *T. torquatus* in an urban area in Brazil.

Lizards were collected between August and October of 2006, in four urbanized sites in the city of Itabira, Estado de Minas Gerais, southeastern Brazil (19.665ºS, 43.212ºW). Itabira harbors a human population of about 100,000 (IBGE 2006, available at http://www.ibge.gov.br/cidadesat/) settled in the Atlantic Rainforest domain, but the surrounding areas are highly impacted by anthropogenic activities, especially mining. All four sites are characterized by housing, paved surfaces, vacant lots, and trash consisting of construction materials. The stomachs of 20 lizards (12 male, 8 female), with SVL averaging 87.5 mm ± 23.5 SD (range 51.8–133.8 mm), were examined by dissection; all specimens had food remnants in their stomachs. Eusocial insects (ants and termites) were by far the most important prey both in numbers (N = 261, 48.6% of total prey items and N = 224, 40.7% of total prey items, respectively) and frequency in which prey was recorded (N = 17, 85% and N = 11, 55%, respectively). Ants and termites were followed by bees in number (N = 33, 6%) and frequency (N = 8, 40%). Also found were remains of beetles (number: N = 7, 1.3%; frequency: N = 2, 10%), crickets (number: N = 3, 0.5%; frequency: N = 1, 5%), cockroaches (number: N = 3, 0.5%; frequency: N = 1, 5%), unidentified arthropods (number: N = 12, 2.2%; frequency: N = 2, 10%), and insect pupae (number: N = 2, 0.4%; frequency: N = 1, 5%). Plant material was represented by flowers (number: N = 1, 0.2%; frequency: N = 1, 5%).

The predominance of eusocial insects in the diet of *T. torquatus* is in accordance with previous studies (Bergallo and Rocha, *op. cit.*; Fialho et. al. 2000. J. Herpetol. 34:325–330). This species seems to be a generalist lizard that invests in the most abundant prey available (Arruda et al. 2007. *In* Anais do VIII Congresso de Ecologia do Brasil: 1–2). Ants and termites, being highly mobile and normally locally abundant, are usually predominant in its diet (Fialho et al., *op. cit.*), which seems to hold true for this study in an urban environment.

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SQUAMATA — SNAKES

ACANTHOPHIS PYRRHUS (Desert Death Adder). **FORAGING BEHAVIOR.** *Acanthophis pyrrhus* is a short-bodied terrestrial elapid restricted to hummock grassland habitats across Australia's arid to semi-arid zone (Wilson and Swan 2003. A Complete Guide to Reptiles of Australia. New Holland Publishers. Sydney, New South Wales. 512 pp.). Both in morphology and ecology, members of this genus are highly convergent with vipers (Shine 1980. Herpetologica 36:281–289). One similarity is the presence of a pale tail tip on some species which is reportedly used to lure prey (Chiszar et al. 1990. J. Herpetol. 24:253–260). However, to my knowledge, caudal luring has only been reported in two species of death adder (*A. antarcticus*, *A. praelongus*) and has not been reported in the wild for any species (Carpenter and Carpenter 1978. J. Herpetol. 12:574–577; Hagman et al. 2008. Funct. Ecol. 22:1134–1139; Chiszar et al., *op. cit.*). Here, I report on two possible examples of caudal luring observed in wild *A. pyrrhus* encountered on Namatjira Drive (west of Alice Springs in the Northern Territory, Australia) while road-cruising as part of a broader study of arid-zone snakes.

On the 18 September 2009, at 1909 h, I encountered a small adult female *A. pyrrhus* (SVL = 389 mm) coiled on the road surface with its entire tail extending vertically into the air. The animal remained motionless in this position for several minutes before lowering its tail and attempting to move off the road surface, presumably in response to my presence. No independent movement of the tail tip was observed. On the following night, at 2022 h, I encountered a larger adult female *A. pyrrhus* (SVL = 560 mm) exhibiting the same posture as the animal from the previous night (Fig. 1). I observed the snake for approximately 10 minutes during which time the tail tip was wriggled intermittently while the remainder of the tail was maintained in the vertical



COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND

FIG. 1. Adult female *Acanthophis pyrrhus* coiled on the road surface with its tail extending vertically into the air.

position. After 10 min the snake lowered its tail and moved off the road. In both situations I find it unlikely that the snake's tails were extended into the air in response to the approach of my vehicle, as they were spotted in this position at considerable distance (approximately 50 m).

Holding the tail in an erect position has been reported for captive *A. antarcticus* and was considered to be a posture related to caudal luring (Carpenter and Carpenter, *op. cit.*). By lying in an exposed situation (road surface) with the tail erect, *A. pyrrhus* may attract prey from a greater distance than they would by laying among dense vegetation or with their tail on the ground. However, the potential cost (predation risk and road mortality) of such behavior may also be high. Alternative hypotheses for the behavior include reproduction (e.g., broadcasting for males), predator warning, or predator diversion (Greene 1973. J. Herpetol. 7:143–161).

Work was carried out under scientific permit no. 33584 from the Northern Territory Government and was approved by the Animal Care and Ethics Committee (ANZCCART) of Charles Sturt University (Ref: 09/064).

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AGKISTRODON BILINEATUS (Cantil). **ENDOPARASITES.** *Agkistrodon bilineatus* occurs from near sea level to about 1500 m elevation along the Pacific Coast from Sonora, Mexico, southward through northern Costa Rica, but is disjunctly distributed along the Atlantic Coast from the Yucatan Peninsula through Guatemala (Lee 2000. A Field Guide to the Amphibians and Reptiles of the Maya World. Cornell Univ. Press, Ithaca, New York. 402 pp.). We know of no helminths reported from *A. bilineatus*. The purpose of this note is to establish the initial helminth list for *A. bilineatus.*

The coelomic cavities of two female *A. bilineatus* from Mexico (SVLs = 543, 563 mm) were examined from the herpetology collection of the Los Angeles County Natural History Museum (LACM): LACM 59184, Tamaulipas, 84 km N Mante (22.7500°N, 99.0000°W, datum WGS84; elev. 104 m) collected June 1965; and LACM 74046, Sinaloa, Coyotitán (23.7833°N, 106.5833°W, datum: WGS84; elev. 91 m) collected November 1964. Two nematodes (LACM 74046) and one larval acanthocephalan (LACM 59184) were found. Nematodes and the acanthocephalan were cleared in a drop of glycerol on a microscope slide, coverslipped, and identified: one female *Hastospiculum onchocercum*; one third stage ascaridid (Angusticaecinae) larva, and one oligacanthorhynchid acanthocephalan cystacanth. Helminths were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland as *Hastospiculum onchocercum* (USNPC 102284), ascaridid (Angusticaecinae) larva (USNPC 102285), and acanthocephalan cystacanth (USNPC 102286).

Hastospiculum onchocercum is limited to a variety of snakes from the New World tropics (Goldberg and Bursey 2004. Carib. J. Sci. 40:62–69). *Hastospiculum* is a member of the Diplotriaenoidea, which utilizes insects as intermediate hosts (Anderson 2000. Nematode Parasites of Vertebrates. Their Development and Transmission. CABI Publishing, Wallingford, UK. 650 pp.). Snakes presumably acquire *H. onchocercum* when they ingest prey which have eaten infected insects.

Three genera of ascaridid nematodes have been reported from snakes collected in Central America (Baker 1978. Synopsis of the Nematoda Parasitic in Amphibians and Reptiles. Memorial University of Newfoundland, Occas. Pap. Biol. 11:1–325). Third stage larvae of these three genera are morphologically indistinguishable. *Agkistrodon bilineatus* likely serves as a final host. Infection was most likely acquired by ingestion of an infected transport (paratenic) host, such as a grasshopper, frog, lizard, or rodent (Anderson, *op. cit.*).

Oligacanthorhynchid acanthocephalan cystacanths are frequently found in the coelomic cavities of snakes (Goldberg and Bursey, *op. cit.*). Snakes are inappropriate final hosts for cystacanths and likely serve as transport hosts. *Agkistrodon bilineatus* represents a new host record for *Hastospiculum onchocercum*, ascarid larva, and oligacanthorhynchid acanthocephalan cystacanths.

We thank Christine Thacker (LACM) for permission to examine *A. bilineatus.*

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COLUBER* (= *MASTICOPHIS*) *FLAGELLUM TESTACEUS (Western Coachwhip). **DIET**. *Coluber flagellum testaceus* feeds on lizards, small mammals, snakes, birds and their eggs, and large arthropods (Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. Univ. New Mexico Press, Albuquerque. 431 pp.; Werler and Dixon 2000. Texas Snakes. Univ. Texas Press, Austin. 437 pp.). It has also been reported that *C. f. testaceus* feed upon small lagomorphs including *Lepus californicus* and nestling *Sylvilagus* rabbits (Whiting et al. 1992. The Snake 24:157–160) Here, we report our observation of a *C. f. testaceus* feeding upon



FIG. 1. Adult *Coluber* (= *Masticophis*) *flagellum testaceus* on first attempt at feeding upon a juvenile *Sylvilagus audubonii* (Desert Cottontail) in Big Bend National Park, Texas, USA.

a juvenile *Sylvilagus audubonii* (Desert Cottontail).

Before noon on 29 April 2006, we discovered an adult *C. f. testaceus* apparently perched 1 m off the ground in the midsection of a mesquite bush (*Prosopis glandulosa*) near the Panther Junction Visitor Center in Big Bend National Park, Texas, USA (29.3281°N, 103.2064°W, datum WGS 84; elev. 1138 m). The snake was slightly moving its head near the branching point of one of the limbs. Upon closer investigation we noticed that it was consuming a juvenile *S. audubonii* (Fig. 1). The snake attempted to consume the rabbit, though the branch obstructed its success twice. Eventually, the snake turned its head to the other side of the branch and fully consumed the young rabbit. The observation lasted for more than 30 minutes before the snake finally crawled to the ground and slowly slithered away. This observation documents the first record of *C. f. testaceus* feeding upon *S. audubonii*.

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CONOPHIS LINEATUS (Road Guarder). **DIET**. *Conophis lineatus* is a rear-fanged, diurnal Central American colubrid with a varied diet. Though *C. lineatus* is likely an opportunistic predator, field observations and dissections of museum specimens are mostly of lizard prey (Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna between Two Continents, between Two Seas. University of Chicago Press, Chicago, Illinois. 954 pp.; Stafford and Henderson 2006. S. Am. J. Herpetol. 1:210–217). On 21 June 2002, at ca. 1500 h, in Santa Rosa National Park, Guanacaste Province, Costa Rica (10.8392°N, 85.6184°W, datum NAD83), I observed an adult *C. lineatus* in an open lowland dry forest adjacent to a gravel road. The snake had struck a toad, *Bufo luetkenii*, and was grasping it in its mouth (Fig. 1). The snake kept the toad pinned to the ground for ca. 15 min and then began ingesting it head first. Ingestion took ca. 25 min, after which the snake crawled away into denser vegetation. I believe this observation represents the first time *C. lineatus* has been reported feeding on *B. luetkenii* and may represent the first record of *C. lineatus* feeding on any toad species in the wild. Photographic vouchers were verified by Twan Leenders and deposited at Yale Peabody Museum of Natural History, Herpetology media records YPM M 1211–1214.



FIG. 1. *Conophis lineatus* feeding on a toad, *Bufo luetkenii*, in Guanacaste National Park, Costa Rica.

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CROTALUS CATALINENSIS (Santa Catalina Island Rattlesnake). **REPRODUCTION.** *Crotalus catalinensis* is endemic to Isla Santa Catalina, Baja California Sur, Mexico. Although observations exist of wild female *C. catalinensis* in various reproductive states (Grismer 2002. Amphibians and Reptiles of Baja California, Including its Pacific Islands and the Islands in the Sea of Cortés. Univ. California Press, Berkeley. 399 pp.), reproductive data for *C. catalinensis* are limited. To date, the only published accounts of litter size for *C. catalinensis* include: a female collected in early August that produced two young (Grismer, *op cit*.); seven young born at Fresno Zoo on 8 July 1980 (Tremper 1981. *In* 5th Annual Reptile Symposium on Propagation and Husbandry, pp. 70–75. Oklahoma City Zoo, Oklahoma City); a single *C. catalinensis* born on 1 October 1964 at the San Diego Zoo (San Diego Zoonooz, November 1964); nine young born at the Frankfurt Zoo (Anonymous 1988. Aquarien-und Terrarien-Zeitschrift 41:328); seven young born to a captive female (G. Keasler, pers. comm. 2009); and three young born at the San Diego Zoo from a wild collected female (Boyer and Kinkaid, pers. comm. 2009). Herein, we describe a litter born to a wild collected *C. catalinensis* maintained in captivity at the Los Angeles Zoo and Botanical Gardens.

On 23 April 2009, we collected an adult (SVL = 71.12 cm; 272 g) gray phase female *C. catalinensis* on the southwest side of Isla Santa Catalina, 25.6023°N, 110.7791°W, WGS 84; elev. 0 m. This animal was transferred to Los Angeles Zoo and Botanical Garden and placed into the zoo's quarantine facility and maintained in a 20-gallon terrarium supplied with a 24-h sub-floor heated basking area and a hide box. Between 3 May and 10 June 2009 she consumed eight whole pre-killed adult mice. She refused to feed on 21 June and continued to refuse food until parturition. On 9 August a dorsal whole body radiograph was taken and showed several embryonic skeletons. On 13 August 2009, six neonates (one male, five female; mean mass 15.2 g; range 14.8–16.3 g), were found inside the hide box with the female. The litter consisted of three brown phase and three gray phase neonates.

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EPICRATES CENCHRIA (Salamanta; Rainbow Boa). **DIET**. Snakes in the genus *Epicrates* are dietary generalists, feeding on both endothermic and ectothermic prey, particularly lizards, mid-sized mammals, and birds (Henderson et al. 1987. Amphibia-Reptilia 8:251–258). The genus is endemic to the New World Neotropics and contains 14 species (Passos and Fernandes 2008. Herpetol. Monogr. 22:1–30). *Epicrates cenchria* occurs in forested regions of the Amazon Basin of Colombia, Ecuador, Peru, Bolivia, Venezuela, Guyana, Suriname, French Guyana, and Brazil and in a disjunct population in the Atlantic rainforest of Brazil, from Alagoas to Rio de Janeiro states (Passos and Fernandes, *op. cit.*). Until recently, *E. cenchria* was subdivided into nine subspecies (McDiarmid et al. 1999. Snakes Species of the World: A Taxonomic and Geographical Reference, Vol. 1. The Herpetologist's League, Washington, DC), but a taxonomic revision based on external morphology, osteology, and hemipenis characters rearranged this complex into five species that inhabit the South American continent: *E. alvarezi*, *E. assisi*, *E. cenchria*, *E. crassus*, and *E. maurus* (Passos and Fernandes, *op. cit.*). The remaining species in the genus are restricted to islands in the West Indies (Kluge, *op. cit.*; McDiarmid et al., *op. cit.*).

Several works have documented ontogenetic shifts in the diet of some species in this genus. Diet of larger species varies ontogenetically, from specializing on anoline lizards when young to widely generalist feeding as adults (e.g., Chandler and Tolson 1990. J. Herpetol. 24:151–157; Henderson et al., *op. cit.*; Sheplan and Schwartz 1974. Ann. Carnegie Mus. Nat. Hist. 45:57–143; Wiley 2003. Carib. J. Sci. 39:189–194). For the newly split *E. cenchria* complex, *E. assisi* from the Caatinga biome of Brazil eats mammals, bird eggs, and lizards. *Epicrates crassus* from the Brazilian Cerrado biome feeds on birds and mammals. *Epicrates cenchria* preys on mammals, mainly rodents, birds, bird eggs, bats, frogs, and lizards (see Pizzato et al. 2009. Amphibia-Reptilia 30:533–544, and references therein). There are no records on the diet of the other continental species. Herein, we record an additional and unusual prey item for the genus *Epicrates*.

On a morning in March 2001, JC collected a large (total length = 175 cm; tail length 20.8 cm) *E. cenchria* crossing a trail in a remnant of Atlantic rainforest (19.735914°S, 41.824673°W, datum WGS84; elev. ca. 455 m) at Reserva Particular do Patrimônio Natural Feliciano Miguel Abdala (RPPN-FMA), Caratinga municipality, Minas Gerais state, southeastern Brazil. Examination of the stomach contents of this specimen revealed an unusual food item, a quill of an unidentified porcupine (Erethizontidae: Rodentia: Mammalia). This represents a new diet record for the genus *Epicrates*. Predation on porcupines has been described for several other snakes, mostly in the family Boidae (Cherubini et al. 2003 J. Venom. Anim. Toxins 9:117–124; Duarte 2003 Phyllomedusa 2:109–112). The snake was deposited in the herpetological collection of the Museu de Zoologia da Universidade de São Paulo (MZUSP 14474; J. Cassimiro field number JC 517).

We are grateful to Bárbara N. Costa for help in the identification of the prey item. Felipe F. Curcio verified snake identification. JC also thanks Karen B. Strier for providing facilities during fieldwork and for funding during his work in the RPPN-FMA through the following institutions: Margot Marsh Biodiversity Foundation, Liz Claiborne and Art Ortenberg Foundation, National Geographic Society, and Graduate School of the Wisconsin-Madison University.

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LEPTOTYPHLOPS AUSTRALIS (NCN). **PREDATION**. Burrowing Owls (*Athene cunicularia*) are known to include snakes and other reptiles in their diet (König et al. 1999. Owls: A Guide to the Owls of the World. Yale Univ. Press, New Haven, Connecticut. 462 pp.). On 25 October 2008, on Provincial Road 7, 20 km E Paso Cordova, Departamento El Cuy, Rio Negro Province, Argentina (39.1818ºS, 67.4053ºW, datum WGS84; elev. 405 m), a set of regurgitated *A. cunicularia* pellets was collected near an active owl burrow. Laboratory study revealed remains of four snakes in the pellets, all identified as *Leptotyphlops*. The damage inflicted to the heads of the specimens made identification to species level difficult, but the coloration, morphometrics, and scale patterns of the individuals were consistent with *L. australis* (Cei 1986. Reptiles del Centro, Centro-Oeste y Sur de la Argentina. Mus. Reg. Sci. Nat. Torino, Mon. 4. 527 pp.). This represents the first record of predation on *L. australis* by Burrowing Owls.

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MICRURUS FULVIUS (Harlequin Coralsnake). **DIET**. *Micrurus fulvius* is known to prey upon amphisbaenids, anguids, scincids, elapids, and colubrids (Jackson and Franz 1981. Herpetologica 37:221–224), however it has not been documented preying upon nonindigenous species. Herein, we document *M. fulvius* preying upon a *Ramphotyphlops braminus* (Brahminy Blindsnake).

On 1 September 2009, a *M. fulvius* (female; SVL = 38.7 cm) was found dead-on-road (DOR) at the Pine Island maintenance area in Everglades National Park, Miami-Dade Co., Florida, USA (25.384178°N, 80.594128°W, datum WGS84; elev. <1 m), and was deposited in the Florida Museum of Natural History, University of Florida (UF 156838, EVER 40584). Upon taking a tissue sample from an opening likely caused by vehicle impact, we noticed a foreign body protruding from the snake's abdomen.

This object was removed and identified as a nonindigenous *R. braminus*. In Florida, Wilson and Porras (1983. Univ. Kansas Mus. Nat. Hist., Spec. Publ. No. 9) first reported *R. braminus* from Miami-Dade Co., and this species has been reported to be preyed upon by *Lampropeltis extenuata* (Short-tailed Snake; Godley et al 2008. Herpetol. Rev. 39:473–474) and both the nonindigenous *Rhinella marina* (Cane Toad) and *Anolis cristatellus* (Puerto Rican Crested Anole; Meshaka et al. 2004. The Exotic Amphibians and Reptiles of Florida. Krieger Publ. Co., Malabar, Florida. 155 pp.). This is the first record of *M. fulvius* consuming a nonindigenous snake in Florida.

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OPISTHOTROPIS KUATUNENSIS (Chinese Mountain Keelback). **ENDOPARASITES.** *Opisthotropis kuatunensis* occurs in Zhejiang, Fujian, Jiangxi, and Hong Kong, China (Zhao and Adler 1993. Herpetology of China. SSAR, Oxford, Ohio. 522 pp.). It was first reported in Hong Kong in 1974 (Karsen et al. 1986. Hong Kong Amphibians and Reptiles. The Urban Council, Hong Kong. 136 pp.). To our knowledge, there are no reports of helminths from *O. kuatunensis*. The purpose of this note is to establish an initial helminth list for *O. kuatunensis*.

One female *O. kuatunensis* (SVL = 30.5 cm) was collected at New Territories, Hong Kong (22.24°N, 114.07°E, datum WGS 84; elev. 644 m) on 23 September 2009. The snake died the next day and was preserved in 70% ethanol. Sixteen swellings (5–10 mm) were noted along the length of the *O. kuatunensis*. Four of these were opened and each contained a yellowish, elongate parasite. Each was cleared in a drop of glycerol on a slide, cover slipped, studied under a compound microscope, and identified as nymphs of the pentastome *Kiricephalus pattoni.* Voucher helminths were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland, USA as USNPC (102414).

Adult *K. pattoni* inhabit the lungs of various snakes, and nymphs have been reported in a wide variety of amphibians and reptiles (Riley and Self 1980. Syst. Parasitol. 1:127–140). John and Nadakal (1988. Invert. Repro. Devel. 14:295–298) proposed a probable three-host life cycle for *K. pattoni*, amphibian/lizard first intermediate host, snake second intermediate host, and snake definitive host. *Opisthotropis kuatunensis* represents a new host record, a probable second intermediate host, for *Kiricephalus pattoni.*

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PANTHEROPHIS OBSOLETUS (Texas Ratsnake). **DIET AND FEEDING BEHAVIOR**. *Pantherophis obsoletus* is a common colubrid that feeds extensively on birds and mammals in the wild (Weatherhead et al. 2003. Am. Midl. Nat. 150:275–281) and will feed on dead rodents in captivity (MLM, pers. obs). However, observations of this species feeding on non-living anthropogenic sources of food are lacking. Each evening from mid-March through 25 April 2004, a single *P. obsoletus* (37 cm total length) returned to the back porch of the home at 2347 Pamela Dr., Chandler, Smith Co., Texas, USA (32.217°N, 95.506°W; NAD 1983), where it ate canned dog food from the dog's bowl and then departed. This observation adds to our understanding of the opportunistic nature of this species.

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SISTRURUS CATENATUS (Massasauga). **FEMALE SPERM EVACUATION**. During mating, a single male transfers more sperm than necessary to fertilize the available ova of a female (Halliday and Arnold 1987. Anim. Behav. 35:939–941). This, coupled with the fact that females typically mate with several males during a single mating period (Uller and Olsson 2008. Mol. Ecol. 17:2566–2580), results in an abundance of sperm in the female reproductive tract. In many taxa, including reptiles, females often store this sperm for long periods (months to years) in specialized receptacles, sperm storage tubules (SST), in the infundibulum prior to fertilization (Sever and Hamlett 2002. J. Exp. Zool. 292:187–199). However, the fate of unsuccessful sperm within the female reproductive tract remains largely unknown. A detailed description of sperm evacuation from SSTs is restricted to one study on *Thamnophis sirtalis parietalis* (Halpert et al. 1982. J. Morphol. 174:149–159) in which the authors noted that sperm in infundibular SSTs from fall matings were evacuated within six hours after a spring mating. Halpert et al. (*op. cit.*) state that sperm from the spring matings replaced the sperm from fall matings within the SSTs. The fate of the evacuated fall sperm was undetermined, though the authors noted that fall sperm stained less intensely with fast green; a phenomenon they believed indicative of sperm degradation. Blanchard and Blanchard (1941. Pap. Michigan Acad. Sci., Arts Lett. 26:177–193) and Schuett and Gillingham (1986. Copeia 1986:807–811) however, observed that sperm from fall matings can be used in fertilization the following spring in *T. s. sirtalis* and *Agkistrodon contortrix*, respectively.

Siegel and Sever (2008. J. Morphol. 269:189–206) provide the only detailed description of sperm transport and storage in a viper, *Agkistrodon piscivorus*, during the fall and subsequent spring mating periods. Siegel and Sever (*op. cit.*) found that sperm remained in *A. piscivorus* SSTs for up to 22 months following ovulation until the subsequent reproductive year at which time they were no longer observed. They hypothesized the mechanism for this disappearance to be either from spermiophagy by the SST epithelium or by the natural degradation of sperm; however, nei-

ther of these processes were observed. Additionally, Siegel and Sever (*op. cit.*) failed to observe the evacuation of sperm from SSTs following the spring mating season as described by Halpert et al. (*op. cit.*). The following account adds to the scant literature above by providing an incident of sperm evacuation in a female *Sistrurus catenatus*.

As part of a long-term study focusing on the conservation of *S. catenatus* in Butler Co., Pennsylvania, USA, free-ranging individuals were implanted with radio transmitters and monitored for a suite of ecological, behavioral (including mating activities), and physiological variables three times weekly. One female was initially encountered in May 2005 at which time an ultrasound revealed the presence of enlarged vitellogenic follicles indicating that she would likely give birth later in the year (birthed 19 August 2005). A fecal sample collected on 11 July 2005 to assess her general health and parasite load revealed something striking: numerous sperm (Fig. 1). Though isolated incidents of spring reproductive behavior have been reported in *S. catenatus* (Wright 1941. Am. Midl. Nat. 25:659–672; Jellen et al. 2007. J. Herpetol. 41:451–457), mating predominately occurs in the late summer–early fall period (Jellen et al., *op. cit.*; Johnson 2000. J. Herpetol. 34:186–192; Reinert 1981. Am. Midl. Nat. 105:393–395). If this sperm represents sperm from a recent mating, it would pre-date the earliest recorded date of summer reproductive behavior in *S. catenatus* by approximately two weeks (24 July; Jellen et al., *op. cit.*). Additionally, though male *S. catenatus* have been observed to engage in reproductive behaviors with pregnant females (Jellen et al., *op. cit.*), this female was never observed in the vicinity of a male nor exhibited any mating behaviors throughout the course of the year. However, because this individual was free-ranging, and consequently not under constant surveillance, an unobserved copulation during the active season prior to 11 July 2005 cannot be ruled out. A more plausible explanation, however, is that this observation represents the systematic oviductal evacuation of sperm from matings during (or prior to) the 2004 late summer–early fall mating period, which were unsuccessful in fertilizing ova in the spring of 2005.

Siegel and Sever (*op. cit.*) report that sperm degrade in the posterior oviduct prior to ovulation in vipers and describe the only storage site for sperm during pregnancy as within SSTs. Although a definitive mechanism for sperm evacuation was not observed in *A. piscivorus*, densities of sperm decreased in the SST over time until the subsequent mating season (Siegel and Sever, unpubl. data). A similar decrease in the presence of oviductal sperm following oviposition was observed in *Tantilla coronata* (Aldridge 1992. Amphibia-Reptilia 13:219–225). We propose that after ovulation, sperm are intermittently evacuated from SSTs. This process undoubtedly takes an extended period of time due to the lack of contractile elements associated with SSTs in snakes (for review see Siegel and Sever, *op. cit.*), and culminates with the eventual collection of sperm in the cloaca (a structure previously ignored in histological studies on sperm transport in snakes). Normal defecation then provides a proximate outlet for unsuccessful sperm in the female reproductive tract. We suggest that further histological and behavioral studies on sperm transport, storage, and evacuation are needed to confirm this phenomenon.

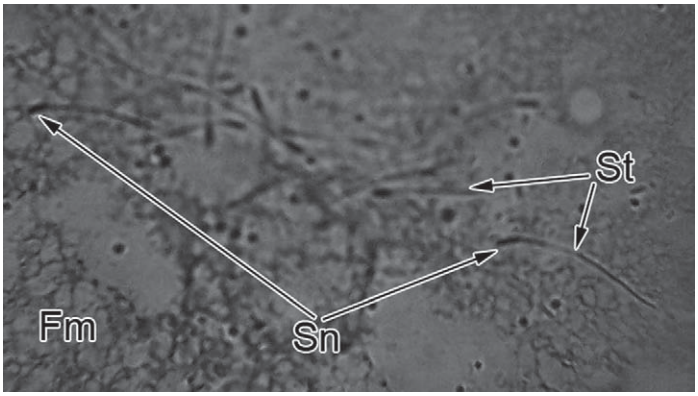


FIG. 1. Sperm in a pregnant female *Sistrurus catenatus* fecal sample collected 11 July 2005. Sn, sperm nucleus; St, sperm tail; Fm, fecal material.

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THAMNOPHIS ATRATUS HYDROPHILUS (Oregon Gartersnake). **MAXIMUM ELEVATION**. *Thamnophis atratus* has been recorded at elevations up to 1920 m (6297 ft; St. John 2002. Reptiles of the Northwest. Lone Pine Publishing, Renton, Washington. 272 pp.). Here we report a population of *T. a. hydrophilus*, occurring entirely above this reported elevational limit in the Klamath Mountains, California, USA. Our observations occurred in upper Deep Creek Basin, Trinity Alps Wilderness, Trinity Co., California, USA (40.9176°N, 122.8876°W, datum NAD83). Deep Creek Basin is a medium-sized glacial characterized cirque (342 ha) encompassed by steep jagged peaks reaching elevations up to 2497 m, which are among the highest in the Klamath Mountains.

We captured and individually marked 56 individual *T. a. hydrophilus* of various age classes during 2003–2006. We recaptured many of these individuals, with total captures reaching 127 over the four years of the study. All snakes were found in streams, ponds, and Echo Lake, at elevations ranging from 1960 to 2215 m. These observations expand the known vertical limit of *T. atratus* by 295 m (968 ft). Much of the Klamath Mountains including the Trinity Alps, Russian, Marble Mountain, and Siskiyou Wilderness areas contain similar aquatic habitats that exceed the known previous elevational limit for this species.

In lower elevation streams, native salmonid fishes are an important component of *T. a. hydrophilus* diet (Welsh and Lind 2000. J. Herpetol. 34:67–74). Over the last century, nonnative salmonids have been introduced into most of the naturally fishless high-elevation aquatic habitats in the Klamath Mountains (Welsh et al. 2006. Divers. Distrib. 12:298–309). Introduced salmonid prey in the region may have allowed *T. a. hydrophilus* to expand into these high-elevation habitats (Pope et al. 2008 Biol. Conserv. 141:1321–1331).

We are grateful for the expert field assistance of R. Bourque, C. Wheeler, and M. Larson. This research was supported by the US Forest Service and through grants from California Department of Fish and Game, the National Fish and Wildlife Foundation, and the Declining Amphibian Populations Task Force.

Submitted by **JUSTIN M. GARWOOD** (e-mail: jgarwood@dfg.ca.gov) and **HARTWELL H. WELSH JR.**, Redwood Sciences Laboratory, Pacific Southwest Research Station, USDA Forest Service, 1700 Bayview Drive, Arcata, California 95521, USA.

THAMNOPHIS PROXIMUS (Western Ribbon snake). **REPRODUCTION**. On 16 May 2008, we collected a DOR *Thamnophis proximus* 1.61 km N of the intersection of FM508 and FM1420 on FM1420, Cameron Co., Texas, USA (26.27957°N, 97.58657°W, datum NAD83). The snake was a gravid female (SVL = 786 mm; total length = 1059 mm) and appeared to have been killed less than 12 h previously. Removal of offspring revealed a fetal clutch size of 27. Offspring appeared well developed and just days away from parturition. The litter consisted of eleven males (mean ± SD SVL = 194.9 ± 4.2 mm, range = 188–201 mm) and sixteen females (mean ± SD SVL = 189.4 ± 5.63 mm, range = 179–199 mm). Female volume before removal of offspring was 200 mL and total offspring volume was 75 mL.

The clutch is remarkable for its large numerical size and large fetal clutch volume as well as the potential early parturition date. The earliest published date for *T. proximus* parturition is 23 June (Lancaster and Ford 2003. Texas J. Sci. 55:25–32). A fetal clutch size of 27 is reported as the maximum clutch size (Klein 1949. Herpetologica 5:17). Average clutch size is 10–15 (Werler and Dixon 2000. Texas Snakes: Identification, Distribution, and Natural History. Univ. Texas Press, Austin. 437 pp.). Although the preparturitient state of this litter precluded accurate assessment of relative clutch mass, the relative clutch volume (calculated as volume of offspring divided by volume of female without offspring; Shine 1980. Oecologica 46:92–100) for this female was 0.6. Female and offspring were deposited at the Texas Cooperative Wildlife Collection at Texas A&M University (TCWC 93027–93054). Identification was verified by Toby Hibbits.

Submitted by **BEI DEVOLLD**, Texas State University, San Marcos, Texas 78666, USA; **JAMES R. DIXON**, Department of Wildlife and Fisheries, Texas A&M University, College Station, Texas 77843, USA; and **MICHAEL R.J. FORSTNER**, Department of Biology, Texas State University, San Marcos, Texas 78666, USA (e-mail: forstner@centurytel.net).

GEOGRAPHIC DISTRIBUTION

Instructions for contributors to Geographic Distribution appear in Volume 41, Number 1 (March 2010, p. 102). Please note that the responsibility for checking literature for previously documented range extensions lies with authors. Do not submit range extension reports unless a thorough literature review has been completed.

CAUDATA — SALAMANDERS

AMBYSTOMA TALPOIDEUM (Mole Salamander). USA: ARKANSAS: Nevada Co.: Hwy 24, 0.9 km E of junction with Hwy 268 (33.75412°N, 93.14896°W; no datum available). 2 April 2010. Tobin Fulmer. Verified by Renn Tumlison. Henderson State University Museum of Zoology, Arkadelphia, Arkansas (HSU 1478). New county record. One adult was collected AOR during rain. Fills a distributional gap between Columbia and Clark counties (Caldwell and Tumlison 2005. Herpetol. Rev. 36:88; Trauth et. al. 2004. The Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.).

Submitted by **TOBIN FULMER**, Arkansas Natural Heritage Commission, 1500 Tower Building, 323 Center Street, Little Rock, Arkansas 72201, USA (e-mail: frogman1975@yahoo.com); and **KASIDY FULMER**, 28 South Barrow Road, Arkadelphia, Arkansas 71923, USA.

AMBYSTOMA TALPOIDEUM (Mole Salamander). USA: NORTH CAROLINA: Transylvania Co.: terrestrial adult caught by hand and gilled larvae caught by net in breeding pool at DuPont State Forest, 9.35 km airline SSE Penrose (35.19090ºN, 82.61878ºW; WGS 84). 21 April 2010 and 20 May 2010. Alan Cameron and Steven O'Neil. Verified by Jeffrey C. Beane. North Carolina State Museum of Natural Sciences photo voucher (accession #12559). First documented record for Transylvania Co. Closest previous historical record is one occurrence from Lake Summit in Henderson Co., North Carolina, 18.13 km airline ENE (Beane et al. 2010. Amphibians & Reptiles of the Carolinas and Virginia, 2nd ed. University of North Carolina Press, Chapel Hill. 274 pp.)

Submitted by **LORI A. WILLIAMS**, North Carolina Wildlife Resources Commission, 177 Mountain Laurel Lane, Fletcher, North Carolina 28732, USA (e-mail: lori.williams@ncwildlife.org); **ALAN D. CAMERON**, 1030 W. Blue Ridge Road, Flat Rock, North Carolina 28731, USA (e-mail: adcamer77@bellsouth.net); and **STEVEN K. O'NEIL**, P.O. Box 1033, Hendersonville, North Carolina 28793, USA (e-mail: snakesteve@gmail.com).

AMPHIUMA MEANS (Two-toed Amphiuma). USA: GEORGIA: Baldwin Co.: Bartram State Forest, ca. 0.63 km SW of the intersection between SR 112 and Carl Vinson Road SE, (33.016978°N, 83.207808°W; WGS84) 20 August 2010. Houston C. Chandler. Florida Museum of Natural History photo voucher (UF 159215).Verified by Dennis Parmley and John B. Jensen. First county record. Found on the piedmont at the northern edge of expected range (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.) and the northernmost county record in the Oconee River drainage.

Single juvenile captured and photographed at the shallow edge of a large pond.

Submitted by **HOUSTON C. CHANDLER**, Department of Biological and Environmental Sciences, Georgia College and State University, Milledgeville, Georgia 31061, USA; e-mail: houston_chandler@ecats.gcsu.edu

AMPHIUMA TRIDACTYLUM (Three-toed Amphiuma). USA: ARKANSAS: Calhoun Co.: ~6 km N of Ouachita River off US 167 (33.388195°N, 92.496846°W; WGS 84). 11 June 2010. M. B. Connior. Verified by S. E. Trauth. Arkansas State University Museum of Zoology Herpetology Collection (ASUMZ 31557). New county record (Trauth et. al. 2004. The Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.). Juvenile was hand captured under a log in a small slough. This species has also been collected from Union Co. in southern Arkansas (Trauth et al. 2004, *op. cit.)*

Submitted by **MATTHEW B. CONNIOR**, Health and Natural Sciences, South Arkansas Community College, 300 S. West Avenue, El Dorado, Arkansas 71730, USA; e-mail: mconnior@southark.edu.

CRYPTOBRANCHUS ALLEGANIENSIS (Eastern Hellbender). USA: TENNESSEE: Grundy Co.: Collins River, specific local withheld. 6 August 2010. J. M. Butler, S. D. Layne, and K. J. F. Dunn. Verified by K. L. Krysko. UF 159136 photo voucher. New county record which fills gap between Warren and Marion counties (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Austin Peay State University, Clarksville, Tennessee). Specimen observed beneath large rock in shallow river run.

Submitted by **J. MICHAEL BUTLER** (e-mail: scutatum@gmail.com), **SHANE D. LAYNE** and **K. J. F. DUNN**, U.S. Forest Service, London, Kentucky 40744, USA**.**

EURYCEA GUTTOLINEATA (Three-lined Salamander). USA: GEORGIA: Murray Co.: jct. of Carters Rd. and Old U.S. Hwy 411, ca. 19 air km SSE Chatsworth (34.60750°N, 84.69378°W; NAD83). 22 May 2010. Christopher E. Skelton. Verified by John B. Jensen and Kenneth Krysko (UF 157837). First county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). Single adult collected in a flooded wheel rut within a mowed field, on NW side of Old US 441. This area was probably an active part of the floodplain of the Coosawattee River which is less than 400 m SSE of the field. The river is highly regulated now (rarely floods) but the water table is very near the ground surface and the presence of numerous crayfish burrows suggests it is wet for much of the year.

Submitted by **CHRISTOPHER E. SKELTON** (e-mail: chris.skelton@gcsu.edu); and **HOUSTON C. CHANDLER**, Department of Biological and Environmental Sciences, Georgia College & State University, Milledgeville, Georgia 31061,USA.

EURYCEA QUADRIDIGITATA (Coastal Plain Dwarf Salamander). USA: ARKANSAS: Grant Co.: 3.2 km S of Grapevine off St. Hwy 35 (34.112373°N, 92.309875°W; WGS 84). 27 April 1991. H. W. Robison. Henderson State University Herpetological Collection (HSU 1553). Verified by R. Tumlison. New county record; partially fills a hiatus among Dallas, Hot Spring, and Saline counties (Trauth et al. 2004. Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.). This is the first new county record for *E. quadridigitata* in the state since Trauth et al. (*op. cit.*); the species is now known from 18 counties of south Arkansas.

Submitted by **CHRIS T. McALLISTER**, Science and Mathematics Division, Eastern Oklahoma State College, 2805 NE Lincoln Road, Idabel, Oklahoma 74745, USA (e-mail: cmcallister@se.edu); and **HENRY W. ROBISON**, Department of Biology, Southern Arkansas University, Magnolia, Arkansas 71754, USA (e-mail: hwrobison@yahoo.com).

NOTOPHTHALMUS VIRIDESCENS LOUISIANENSIS (Central Newt). USA: ARKANSAS: Cleburne Co.: 2.4 km SW of Quitman, roadside ditch (35.361336°N, 92.231255°W; WGS 84). 12 May 2003. B. Deeds. Henderson State University Herpetological Collection (HSU 1555). Verified by R. Tumlison. New county record. Fills a distributional gap among Independence, Van Buren, and White counties (Trauth et al. 2004. Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.). Since the publication of Trauth et al. (*op. cit.*), no less than nine new county records have been documented for this species in the state.

Submitted by **CHRIS T. McALLISTER**, Science and Mathematics Division, Eastern Oklahoma State College, 2805 NE Lincoln Road, Idabel, Oklahoma 74745, USA (e-mail: cmcallister@se.edu); and **HENRY W. ROBISON**, Department of Biology, Southern Arkansas University, Magnolia, Arkansas 71754, USA (e-mail: hwrobison@yahoo.com).

OEDIPINA TAYLORI (Taylor's Worm Salamander). GUATEMALA: ZACAPA: Municipality of Cabañas: El Arenal, vicinity of Zootropic Reserve for protection of *Heloderma horridum charlesbogerti* (14.8628°N, 89.7974°W, NAD27; elev. 612 m). 18 October 2008. Michael Dix and Gilberto Salazar. Verified by Sean Rovito and Theodore Papenfuss. Museo de Historia Natural de la Universidad de San Carlos de Guatemala (CRVA 1719) and Colecciones de Referencia de la Universidad del Valle de Guatemala (A1778). First record for Cabañas, extending the range ca. 70 km SW from the nearest locality in the Motagua Valley at Doña María, Gualán, Zacapa, and 112 km NE of the type locality at Finca La Trinidad, Jutiapa (Frost 2010. Amphibian Species of the World: an Online Reference. Version 5.4 [8 April 2010]. Electronic database accessible at http://research.amnh.org/vz/herpetology/amphibia/, American Mus. Nat. Hist., New York). The salamanders were found at 1000 h on a rainy morning under rotting logs within tropical dry forest dominated by Zacapan False Oak Trees (*Bucida macrostachya*) and the columnar cactus, *Stenocereus pruinosus.*

Submitted by **DANIEL ARIANO** (e-mail: darianosanchez@gmail.com) and **MICHAEL DIX**, Universidad del Valle de Guatemala, 18 avenida 11-95 zona 15. V.H. III, Guatemala City, Guatemala (e-mail: michaelwdix@gmail.com).

SIREN INTERMEDIA NETTINGI (= *SIREN INTERMEDIA TEXANA*) (Western Lesser Siren; Rio Grande Lesser Siren). USA: TEXAS: McMullen Co.: Escondido Ranch, Pond No. 11 (28.0950°N, 098.7543°W). 19 March 2010. C. Giggleman, P.

Clements, A. Miller, J. Ingold, R. Hooten, and N. Mitton. Verified by Michael R. J. Forstner. TCWC 94269. New county record (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. Texas A&M University Press, College Station, Texas. 421 pp.). Eleven specimens were seined at ca. 1 m depth from a seasonal lentic system surrounded by brush-dominated vegetation.

Submitted by **AMBER MILLER**, U.S. Fish and Wildlife Service, Corpus Christi Ecological Services Office, 6300 Ocean Drive, Classroom West, Corpus Christi, Texas 78412-5837, USA.

ANURA — FROGS

ANAXYRUS AMERICANUS (American Toad). USA: TENNESSEE: Warren Co.: Tennessee Amphibian Monitoring Program (TAMP) Route 820515, Stop 4, Lawson Mill Road, 1.22 km NW of intersection with Hwy 127 (35.629081°N, 85.803814°W; WGS 84). 12 March 2010. Amy Tolley. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19013 audio). New county record (Redmond and Scott 1996. Austin Peay St. Univ. Center Field Biol. Misc. Publ. 12:1–94). Individual heard calling from a field with pond on residential land.

Submitted by **AMY TOLLEY**, 446 NYU Place, Murfreesboro, Tennessee 37128, USA.

ANAXYRUS DEBILIS (Green Toad). USA: NEW MEXICO: Curry Co.: Melrose, 0.11 km S of US Hwy 60/84 and 0.24 km W of State Route 267 (34.42276°N, 103.61801°W; NAD83/WGS84; elev. 1342 m). 13 August 2008. Ian W. Murray. Verified by J. Tomasz Giermakowski. University of New Mexico Museum of Southwestern Biology (MSB 75398, 75399). New county record (Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. Univ. New Mexico Press, Albuquerque. 431 pp.). At ca. 2300 h during intermittent showers, thunder, and lightning, a large pool had formed, centered on a low portion of a dirt road immediately south of the railroad tracks. At least 15 male *A. debilis* and a lone *Scaphiopus couchii* were heard calling, and one amplectant pair of *A. debilis* was seen. Two males were collected.

Submitted by **IAN W. MURRAY**, MSC03 2020, Department of Biology, 1 University of New Mexico, Albuquerque, New Mexico 87131-0001, USA (e-mail: imurray@unm.edu); and **PETER E. HUMPHREY**, Harvard Medical School, Brigham & Women's Hospital Boston, Massachusetts 02115-6110, USA (e-mail: phumphrey@partners.org).

BRACHYCEPHALUS HERMOGENESI. BRAZIL: PARANÁ: Municipality of Guaraqueçaba: Reserva Natural Salto Morato (25.1666ºS, 48.2892ºW, WGS84; elev. 250–300 m). 26–29 November 2009. F. B. Oliveira and M. S. Pereira. Museu Nacional, Rio de Janeiro (MNRJ 67312–13). 27 April 2010. A. Candaten. MNRJ 67314. All verified by J. P. Pombal, Jr. This species was previously known to occur in Atlantic Rainforest areas from extreme southern Rio de Janeiro State (municipality of Parati) to southern São Paulo State (Verdade et al. 2008. J. Herpetol. 42:542–549). This note provides the first record for the state of Paraná and the southernmost for the species, extending its distribution ca. 120 km S of Ribeirão Grande and 130 km SW of the Estação Ecológica de Juréia-Itatins, the two previous southernmost confirmed records, both in the state of São Paulo (Verdade et al., *op. cit.*). Verdade et al. (*op. cit.*) also mentioned one specimen possibly referable to *B. hermogenesi* from Ilha do Cardoso, in extreme southern São Paulo State, but could not confirm the species identity because the specimen was "young and in poor condition," and thus refrained from extending the species' distribution further south. As Ilha do Cardoso lies only ca. 30 km east of the locality reported in the present note, and at about the same latitude, we consider it highly probable that the aforementioned specimen indeed represented *B. hermogenesi*.

Submitted by **MANUELA DOS SANTOS PEREIRA**, **ADRIANE CANDATEN**, **DOUGLAS MILANI**, **FREDERICO BATISTELLA DE OLIVEIRA**, **JOANA GARDELIN** and **CARLOS FREDERICO DUARTE ROCHA,** Departamento de Ecologia, Universidade do Estado do Rio de Janeiro, Rua São Francisco Xavier 524, Maracanã, 20550-011, Rio de Janeiro, RJ, Brazil; and **DAVOR VRCIBRADIC**, Departamento de Zoologia, Universidade Federal do Estado do Rio de Janeiro. Av. Pasteur 458, Urca, 22240-290, Rio de Janeiro, RJ, Brazil.

CHIROMANTIS SIMUS (Annandale's Pigmy Tree Frog). BANGLDESH: MYMENSINGH DIVISION: Tangail District: Madhupur National Park (24.6886°N, 90.1489°E, elev. 135 m). 22 June 2010. M. K. Hasan, M. Kamal Hossain, M. M. Kabir, and Fahim Hassan. Wildlife Museum, Department of Zoology, Jahangirnagar University, Savar, Dhaka, Bangladesh (JUHG 0325). Photograph voucher, Raffles Museum of Biodiversity Research, National University of Singapore (ZRC [IMG] 1.32a–1.32b). Verified by Indraneil Das. First record for Mymensingh Division, and westernmost record for Bangladesh. Other Bangladesh populations are recorded from Chittagong Hill Tracts (ca. 320 km to SE) (Asmat et al. 2003. Univ. J. Zool., Rajshahi, Bangladesh 22:141–143), and Sylhet Division (ca. 200 km to NE) (Kabir et al. 2009. Encyclopedia of Flora and Fauna of Bangladesh. Vol. 25. Amphibians and Reptiles. Asiatic Society of Bangladesh, Dhaka. 204 pp.) with no locality details, specimen number, or voucher photographs. Nearest records are from Assam (ca. 500 km to E), Mizoram (ca. 600 km to SE), and West Bengal (ca. 500 km to NW), all in India (Ahmed et. al. 2009. Amphibians and Reptiles of Northeast India. A Photographic Guide. Aaranyak, Guwahati. 168 pp.) Males observed calling between 1955–2040 h from bushes at ca. 1.7 m height, over harvested paddy field with stagnant rainwater at edge of mature *Shorea robusta* forest. Bangladesh Forest Department issued permits (CCF [Wildlife] 2M-37 [Part-3] / 2010/ 409) for this work.

Submitted by **MD. KAMRUL HASAN** (e-mail: hasan_wildlifeju@yahoo.com); **MD. KAMAL HOSSAIN** (e-mail: kamal_zool@yahoo.com); **MD. MOFIZUL KABIR** (e-mail: mofizulkabir@yahoo.com), Department of Zoology, Jahangirnagar University, Savar, Dhaka 1342, Bangladesh; and **FAHIM HASSAN**, Department of Economics, University of Alberta (e-mail: fahim_hassan169@yahoo.com).

CRAUGASTOR TABASARAE (Tabasara Rainfrog). PANAMÁ: VERAGUAS: Distrito de Santa Fe: Parque Nacional Santa Fe, El Cinco (08.641664ºN, 81.022368ºW; NAD27), 1200 m elev. 05 October 2008. Daniel Medina. Verified by Jay M. Savage. Museo de Vertebrados de la Universidad de Panamá (MVUP 2261). First

record for Veraguas. Extending the range in Panamá ca. 48 km (airline) W of the nearest locality in the Pintada district of Coclé Province (Savage et al. 2004. Herpetologica 60:519–529). *Craugastor tabasarae* is endemic to Panamá and was previously known only from three localities. The frog was found 2 m above the ground on a leaf in submontane tropical forest. To view a photograph of the live frog visit the Smithsonian Tropical Research Institute - Digital File Manager at http://biogeodb.stri.si.edu/bioinformatics/dfm.

Submitted by **DANIEL MEDINA** (e-mail: daniel_medina1984@hotmail.com), **CÉSAR A. JARAMILLO A.,** and **ROBERTO IBÁÑEZ D.,** Smithsonian Tropical Research Institute, Apartado 0843-03092, Balboa, Ancón Panamá, República de Panamá.

HYLA EUPHORBIACEA (Southern Highland Treefrog). MÉXICO: HIDALGO: Municipality of Acaxochitlán: Lindero de San Mateo (20.1008°N, 98.1443°W; WGS84), elev. 2400 m. 24 January 2009. Raciel Cruz Elizalde, Uriel Hernández Salinas, and Gustavo Rivas Granados. Verified by Adrian Leyte Manrique. Colección de Anfibios y Reptiles del Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo (CIB 2788). First record for Hidalgo and a range extension of ca. 62 km N of the closest known record in Tlaxcala (Fernández et al. 2006. Acta Zool. Mexicana [n.s.] 22:159–162). Adjacent records for this species are from the Sierra Madre Oriental of central Veracruz and Puebla (Duellman 2001. The Hylid Frogs of Middle America, Vol 2. Contributions to Herpetology, SSAR 18:i–x + 695–1159).

We acknowledge the support of Diversidad Biológica del Estado de Hidalgo, FOMIX-CONACYT- HIDALGO 43761, 95828, and S52552-Q.

Submitted by **RACIEL CRUZ ELIZALDE** (e-mail: cruzelizalde@gmail.com), **URIEL HERNÁNDEZ SALINAS** (e-mail: uhernndez3@gmail.com), and **AURELIO RAMÍREZ BAUTISTA,** Centro de Investigaciones Biológicas (CIB), Universidad Autónoma del Estado de Hidalgo, A.P. 1-69 Plaza Juárez, C.P. 42001, Pachuca, Hidalgo, México (e-mail: aurelior@edu.uaeh.mx).

HYLA GRATIOSA (Barking Treefrog). USA: FLORIDA: De Soto Co.: State Road 72, 2.0 miles W Arcadia (27.225°N, 81.8894°W, WGS84), elev. 4.9 m. 15 September 1968. Richard M. Blaney. Verified by Paul E. Moler. Florida Museum of Natural History (UF 158879). New county record (Ashton and Ashton 1988. Handbook of Reptiles and Amphibians of Florida. Part III. The Amphibians. Windward Publ., Inc., Miami, Florida. 191 pp.).

Submitted by **SARAH REINTJES-TOLEN** and **KENNETH L. KRYSKO**, Division of Herpetology, Florida Museum of Natural History, Dickinson Hall, University of Florida, Gainesville, Florida 32611, USA.

HYPSIBOAS CAINGUA (Striped Treefrog). BRAZIL: MATO GROSSO DO SUL: Municipality of Naviraí: 54.07678ºS, 22.94482ºW (SAD69). 19 July 2007. C. Aoki and P. Landgref-Filho. Museu Nacional do Rio de Janeiro, Rio de Janeiro, Brazil (MNRJ 67516) and Coleção Zoológica de Referência da Universidade Federal de Mato Grosso do Sul, Mato Grosso do Sul, Brazil (ZUFMS-AMP 1189). Municipality of Tacuru (55.12371ºS, 23.52010ºW). 05 May 2010. C. Aoki (MNRJ 67515). All verified by J. P. Pombal Jr. and C. A. G. Cruz. First state record and the northernmost occurrence, about 450 km W from the previous record in São Paulo and more than 250 km NNE from records in Paraguay and Argentina. The distribution of *H. caingua* encompasses Misiones (type locality) and adjacent Corrientes provinces in northeastern Argentina (Carrizo 1990. Cuad. Herpetol. 5:32–39) and in adjacent southeastern Paraguay (Brusquetti and Lavilla 2006. Cuad. Herpetol. 20:3–79) as well as isolated populations in São Paulo (Brassaloti et al. 2010. Biota Neotrop. 10[1]: 275–292; Condez et al. 2009. Biota Neotrop. 9[1]: 157–185; Melo et al. 2007. Biota Neotrop. 7[2]:93–102) and Rio Grande do Sul states, Brazil (Kwet 2001. Frösche im Brasilianischen Araukarienwald. Anurengemeinschaft des Araukarienwaldes von Rio Grande do Sul: Diversität, Reproduktion und Ressourcenaufteilung. Münster. Natur und Tier-Verlag. 192 pp.).

Submitted by **CAMILA AOKI**, Programa de Pós Graduação em Ecologia e Conservação, Universidade Federal de Mato Grosso do Sul, Cidade Universitária, s/n, Bairro Universitário, CEP 79070-900, Campo Grande, MS, Brazil (e-mail: aokicamila@yahoo.com.br); **PAULO LANDGREF FILHO** and **DAIENE L. HOKAMA SOUSA**, Centro de Ciências Biológicas e da Saúde, Universidade Federal de Mato Grosso do Sul, Laboratório de Zoologia, CEP 79070-900, Campo Grande, MS, Brazil; **FABRÍCIO HIROIUKI ODA**, Programa de Pós-Graduação em Ecologia de Ambientes Aquáticos Continentais, Universidade Estadual de Maringá, Nupélia - Núcleo de Pesquisas em Limnologia, Ictiologia e Aqüicultura, Laboratório de Ictioparasitologia - Bloco G-90, Av. Colombo, 5790, CEP 87020-900. Maringá, PR, Brazil; **ROBERTO MACEDO GAMARRA**, Programa de Pós Graduação em Ecologia e Conservação, Universidade Federal de Mato Grosso do Sul, Cidade Universitária, s/n, Bairro Universitário, CEP 79070-900, Campo Grande, MS, Brazil; and **FRANCO LEANDRO DE SOUZA**, Departamento de Biologia, Centro de Ciências Biológicas e da Saúde, Universidade Federal de Mato Grosso do Sul, CEP 79070-900 Campo Grande, MS, Brazil.

LITHOBATES CATESBIANUS (Bullfrog). USA: ARKANSAS: Jefferson Co.: 0.8 km N of Pinebergen off US 63 at Sandy Bayou (34.109371°N, 91.993198°W; WGS 84). 30 June 2010. H. W. Robison. Verified by R. Tumlison. Henderson State University Herpetological Collection (HSU 1538). New county record. Fills a distributional gap between Arkansas and Grant counties (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.). This frog has now been reported from 74 of 75 Arkansas counties, leaving only Perry Co. remaining undocumented (Connior 2008. Herpetol. Rev. 39:234; Trauth et al. 2004, *op. cit.*).

Submitted by **CHRIS T. McALLISTER**, Science and Mathematics Division, Eastern Oklahoma State College, 2805 NE Lincoln Road, Idabel, Oklahoma 74745, USA (e-mail: cmcallister@se.edu); and **HENRY W. ROBISON**, Department of Biology, Southern Arkansas University, Magnolia, Arkansas 71754, USA (e-mail: hwrobison@yahoo.com).

LITHOBATES MONTEZUMAE (Montezuma Leopard Frog). MÉXICO: TLAXCALA: Municipality of Atlangatepec: Ecate-

pec-Atlangatepec road (19.52375ºN, 98.16772ºW, WGS84; elev. 2575 m). 19 August 2007. Christopher Duifhuis Rivera and Jorge García Bocardo. Verified by Luis Canseco Márquez. Colección Herpetológica, Museo de Zoología, Facultad de Ciencias, UNAM (MZFC 14314). First record for Tlaxcala and bridges the distributional gaps among recorded localities in Puebla, Morelos, Distrito Federal, and Veracruz (Uribe-Peña et al. 1999. Anfibios y Reptiles de las Serranías del Distrito Federal, México. Instituto de Biología, Universidad Nacional Autónoma de México. 119 pp.). The specimen was caught in a pond located in oak forest.

Submitted by **CHRISTOPHER DUIFHUIS RIVERA** (e-mail: christopherduifhuis@gmail.com) and **URI OMAR GARCIA VAZQUEZ**, Laboratorio de Herpetología, Museo de Zoología, Facultad de Ciencias, UNAM, A. P. 70-399, México D.F. 04510, México (e-mail: urigarcia@gmail.com).

PSEUDACRIS CRUCIFER (Spring Peeper). USA: TENNESSEE: DeKalb Co.: Vaughn Lane, 0.42 km SW of jct Hwy 56 (35.933683°N, 85.814194°W; WGS 84). 12 March 2010. Amy Tolley. Austin Peay State University Museum of Zoology (APSU 19015 audio). New county record (Redmond and Scott 1996. Austin Peay St. Univ. Center Field Biol. Misc. Publ. 12:1–94). A chorus of multiple individuals was heard calling at a pond on agricultural land. Warren Co.: Tennessee Amphibian Monitoring Program (TAMP) Route 820515, Stop 1, Lawson Mill Road, 0.51 km NE of intersection with Hwy 127 (35.615157°N, 85.810378°W; WGS 84). 12 March 2010. Amy Tolley. APSU 19016 audio. New county record (Redmond and Scott 1996, *op. cit.*). A chorus of multiple individuals was heard calling in the vicinity of a pond on residential land. All identifications were verified by A. Floyd Scott.

Submitted by **AMY TOLLEY**, 446 NYU Place, Murfreesboro, Tennessee 37128, USA.

PSEUDACRIS FERIARUM (Upland Chorus Frog). USA: TENNESSEE: DeKalb Co.: Vaughn Lane, 1.03 km SW of jct Hwy 56 (35.929983°N, 85.809125°W; WGS 84). 12 March 2010. Amy Tolley. Austin Peay State University Museum of Zoology (APSU 19014 audio). New county record (Redmond and Scott 1996. Austin Peay St. Univ. Center Field Biol. Misc. Publ. 12:1–94). A small chorus was heard calling from a drainage ditch in an agricultural field along the road. Warren Co.: Tennessee Amphibian Monitoring Program (TAMP) Route 820515, Stop 1, Lawson Mill Road, 0.48 km NE of the intersection with Hwy 127 (35.613992°N, 85.811122°W; WGS 84). 20 February 2010. Amy Tolley. APSU 19012 audio. New county record (Redmond and Scott 1996, *op. cit.*). A chorus of multiple individuals was heard calling in the vicinity of a pond on residential land. All identifications were verified by A. Floyd Scott.

Submitted by **AMY TOLLEY**, 446 NYU Place, Murfreesboro, Tennessee 37128, USA.

RHINELLA MARINA (Cane Toad). USA: FLORIDA: St. Lucie Co.: Port Saint Lucie, 1692 SW Biltmore Street (27.29007°N, 80.36546°W; WGS84), elev. 5 m. 16 June 2010. Kenneth L. Krysko, Catherine A. Smith, Joseph P. Burgess. Verified by Kevin M. Enge. Florida Museum of Natural History (UF 157938–39). New county record (Meshaka et al. 2004. The Exotic Amphibians and Reptiles of Florida. Krieger Publ. Co., Malabar, Florida. 155 pp.). Two individuals (2.0 and 2.2 cm SVL, respectively) found under debris at 1200 h.

Submitted by **KENNETH L. KRYSKO** (e-mail: kenneyk@flmnh.ufl.edu), **CATHERINE A. SMITH**, Division of Herpetology, Florida Museum of Natural History, Dickinson Hall, University of Florida, Gainesville, Florida 32611, USA (e-mail: hellcat@ufl.edu); and **JOSEPH P. BURGESS**, Florida Department of Environmental Protection, GTM NERR, Ponte Vedra, Florida 32082, USA (e-mail: Joseph.Burgess@dep.state.fl.us).

SCAPHIOPUS HOLBROOKII (Eastern Spadefoot). USA: TENNESSEE: Warren Co.: Tennessee Amphibian Monitoring Program (TAMP) Route 820515, Stop 5, Lawson Mill Road, 0.79 km NNW of intersection with Hwy 127 (35.626944°N, 85.799339°W; WGS 84). 11 June 2009. Amy Tolley. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 18973 photograph). New county record (Redmond and Scott 1996. Austin Peay St. Univ. Center Field Biol. Misc. Publ. 12:1–94). Individual observed on side of the road.

Submitted by **AMY TOLLEY**, 446 NYU Place, Murfreesboro, Tennessee 37128, USA.

SCINAX STAUFFERI (Stauffer's Long-nosed Treefrog). MÉXICO: OAXACA: Municipality of Villa de Tututepéc de Melchor Ocampo: Lagartero (16.052432°N, 97.646336°W; WGS 84), elev. 9 m. 31 January 2005. Aurelio Ramírez-Bautista and Vicente Mata-Silva. Verified by Uriel Hernández-Salinas. Laboratory for Environmental Biology, Centennial Museum, University of Texas at El Paso photographic collection (G 2010.1.1). First municipality record that fills a 340 km gap between the closest published localities, 130 km to the ESE in the vicinity of San Pedro Pochutla, Oaxaca, and 210 km to the WNW near San Marcos, Guerrero (Duellman 2001. The Hylid Frogs of Middle America, Vol. 2. SSAR Contributions to Herpetology 18:i–x + 695–1159). The frog was found in grass on the floor of a coconut grove, ca. 200 m from a marsh.

Submitted by **VICENTE MATA-SILVA**. Department of Biological Sciences, The University of Texas at El Paso, El Paso, Texas 79968, USA (e-mail: vmata@utep.miners.edu); **AURELIO RAMÍREZ-BAUTISTA**, Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo, A.P. 1-69 Plaza Juárez, Pachuca, Hidalgo, C.P. 42001, México (e-mail: aurelior@uaeh.reduaeh.mx); and **JERRY D. JOHNSON**, Department of Biological Sciences, The University of Texas at El Paso, El Paso, Texas 79968, USA (e-mail: jjonhson@utep.edu).

SCAPHIOPUS COUCHII (Couch's Spadefoot). USA: NEW MEXICO: Curry Co.: Melrose, New Mexico, 0.11 km S of Hwy 60/84 and 0.24 km W of State Route 267 (34.42305°N, 103.61838°W; NAD83/WGS84), elev. 1342 m. 3 July 2003. Ian W. Murray and Peter E. Humphrey. Verified by J. Tomasz Giermakowski. University of New Mexico Museum of Southwestern Biology (MSB 75697). New county record (Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. Univ. New Mexico Press, Albuquerque. 431 pp.). The specimen was found buried ~5 cm deep in moist sandy soil at the edge of a rain-filled pool in a rutted dirt road on the north side of the railroad tracks.

Numerous tadpoles, probably *S. couchii*, were evident in the puddle, but they were not keyed out.

Submitted by **IAN W. MURRAY**, University of New Mexico Biology Department, Albuquerque, New Mexico 87131, USA (e-mail: imurray@unm.edu); and **PETER E. HUMPHREY**, Harvard Medical School, Brigham & Women's Hospital, Boston, Massachusetts 02115, USA (e-mail: phumphrey@partners.org).

TESTUDINES — TURTLES

CHRYSEMYS PICTA (Painted Turtle). USA: MINNESOTA: McLeod Co.: On CR 9 just south of Lester Prairie (44.86563ºN, 94.03034ºW; NAD83). 12 September 2010. Noah J. Anderson, Jeffery B. LeClere, Tessa L. Whitemarsh, and Randy E. Blasus. Verified by Benjamin Lowe. Bell Museum of Natural History (JFBM P362). New county record (Oldfield and Moriarty 1994. Amphibians and Reptiles of Minnesota. University of Minnesota Press, 237 pp.; Gamble and Moriarty 2006. Herpetol. Rev. 37:114–116). Found DOR on road ca. 115 m E of man-made pond surrounded by agricultural fields.

Submitted by **NOAH J. ANDERSON**, Department of Biological Sciences, University of Wisconsin-Baraboo/ Sauk County, 1006 Connie Road, Baraboo, Wisconsin 53913, USA (e-mail: noah.anderson@uwc.edu); **JEFFERY B. LECLERE**, 878 Galtier Street, Saint Paul, Minnesota 55117, USA (e-mail: reptilia74@aol.com); **TESSA L. WHITEMARSH**, 6869 Taylor Road, Sauk City, Wisconsin 53583, USA (e-mail: whitemar.tess@uwlax.edu); and **RANDY E. BLASUS**, 3224 Idaho Avenue South, Saint Louis Park, Minnesota 55426, USA (e-mail: blasus@comcast.net).

DEIROCHELYS RETICULARIA RETICULARIA (Eastern Chicken Turtle). USA: MISSISSIPPI: George Co.: Gum pond immediately to the southwest of MS Hwy 57 and Salem Rd. intersection (31.9805167°N, 89.7787667°W; no datum available). 7 July 2008, 0915 h. Will Selman and Thomas Bocek. Verified by Kurt Buhlmann. Florida Museum of Natural History Herpetology Department photographic archive (UF 159536). New county record. This record fills a distributional gap among three surrounding Mississippi counties (Jackson, Stone, Perry) and Mobile Co., Alabama (Mississippi Museum of Natural Science Collections database, http://mdwfp.com/museum/database/bio_collections_online_data.html; Mount 1975. The Reptiles and Amphibians of Alabama. Alabama Agricultural Experiment Station, Auburn, Alabama. 347 pp.; J. Iverson and K. Buhlmann, pers. comm.). Two adults (one female and one male) were observed basking in gum pond on a floating log; two *Pseudemys concinna* (River Cooter) were also observed.

Submitted by **WILL SELMAN**, Rockefeller Refuge, Louisiana Department of Wildlife and Fisheries, 5476 Grand Chenier Hwy, Grand Chenier, Louisiana, 70643, USA (e-mail: wselman@wlf.la.gov); and **THOMAS BOCEK**, Department of Biological Sciences, Box 5018, University of Southern Mississippi, Hattiesburg, Mississippi 39401, USA.

GRAPTEMYS GEOGRAPHICA (Northern Map Turtle). USA: ALABAMA: Jackson Co.: Paint Rock River at Whitaker Nature Conservancy Preserve (34.66450°N, 86.32524°W; no datum available). 25 August 2009. Gregory B. Pauly. Verified by Jim Godwin. Auburn University Museum photographic voucher AHAP-D 267–268. First county record. Adult female (214 mm straightline carapace length, 195 mm straightline plastron length, 1374 g) photographed and released. This species is known to occur elsewhere in the Tennessee River watershed (Mount 1975. Reptiles and Amphibians of Alabama. Agricultural Experiment Station, Auburn University. 347 pp.). Tuscaloosa Co.: Blue Creek at Watermelon Road bridge (33.45045°N, 87.41248°W; no datum available). 17 August 09. Gregory B. Pauly. Verified by Jim Godwin. Auburn University Museum photographic voucher AHAP-D 269–271. First county record and the most southwestern record in Alabama. Juvenile (52 mm straightline carapace length, 44 mm straightline plastron length, 25 g) photographed and released. Previously reported from elsewhere in the Black Warrior River watershed. (Mount 1975, *op. cit.*).

Fieldwork carried out under Alabama Conservation License 68-680 issued by the Alabama Department of Conservation and Natural Resources.

Submitted by **GREGORY B. PAULY**, Department of Evolution and Ecology, University of California, Davis, California 95616, USA.

GRAPTEMYS GIBBONSI (Pascagoula Map Turtle). USA: MISSISSIPPI: Lamar Co.: Black Creek, U.S. Highway 11 bridge crossing southwest of Hattiesburg (31.190224°N, 89.376778°W; no datum available). 12 May 2010, 1515 h. Will Selman and Aaron Holbrook. Verified by Peter Lindeman. Florida Museum of Natural History Herpetology Department photographic archive (UF 159527). New county record (Selman and Qualls 2009. Herpetol. Cons. Biol. 4[2]:171–184; P. Lindeman, pers. comm.). Extends known range in Black Creek upstream by ca. 12 river km (Mississippi Museum of Natural Science, specimen #4176 collected near Camp Dantzler, Forrest Co.). A single adult female was observed basking on a deadwood snag 50 m downstream of bridge crossing.

Submitted by **WILL SELMAN,** Rockefeller Refuge, Louisiana Department of Wildlife and Fisheries, 5476 Grand Chenier Hwy, Grand Chenier, Louisiana 70643, USA (e-mail: wselman@wlf.la.gov); and **AARON HOLBROOK**, Department of Biological Sciences, Box 5018, University of Southern Mississippi, Hattiesburg, Mississippi 39401, USA.

GRAPTEMYS OUACHITENSIS OUACHITENSIS (Ouachita Map Turtle). USA: OHIO: Hamilton Co.: Miami Township: Great Miami River at Cleves Community Park. (39.1615°N, 84.7625°W; WGS 84). 18 August 2010. Paul J. Krusling. Verified by Peter V. Lindeman. Cincinnati Museum Center Herpetology Collection (CMC HP 5231, 5232 and 5267 [digital files and prints]). New county record. First confirmed records from the Great Miami River system in over 130 years. These records partially fill a wide gap in the distribution of *Graptemys ouachitensis* in the Ohio River Basin. The closest known extant upstream populations have been documented from the Scioto River, Scioto Co., Ohio, ca. 136 river miles. The closest downstream populations are from Jefferson Co., Kentucky, ca. 112 river miles (Lindeman, *in press*. The Map Turtle and Sawback Atlas: Ecology, Evolution, Distribution, and Conservation of the Genus *Grapte-*

mys. University of Oklahoma Press, Norman).

Submitted by **PAUL J. KRUSLING** (e-mail: pkrusling@gmail.com**), JEFFREY G. DAVIS**, Cincinnati Museum Center- Frederick and Amye Geier Collections and Research Center, 1301 Western Avenue, Cincinnati, Ohio 45203, USA (e-mail: anura@fuse.net); and **RICK LISI**, Audubon Society of Ohio, 3398 West Galbraith Road, Cincinnati, Ohio 45239, USA.

GRAPTEMYS PSEUDOGEOGRAPHICA PSEUDOGEOGRAPHICA (False Map Turtle). USA. OHIO: Hamilton Co.: Miami Township: Great Miami River at Cleves Community Park. (39.1615°N, 84.7625°W; WGS 84). 18 August 2010. Paul J. Krusling. Verified by Peter V. Lindeman. Cincinnati Museum Center Herpetology Collection (CMC HP 5230 [digital files and prints]). The first confirmed record from the state of Ohio. Extends the range ca. 350 river miles upstream from known extant populations in the Wabash River in Indiana. (Lindeman, *in press*. The Map Turtle and Sawback Atlas: Ecology, Evolution, Distribution, and Conservation of the Genus *Graptemys*. University of Oklahoma Press, Norman).

Submitted by **PAUL J. KRUSLING** (e-mail: pkrusling@gmail.com), **JEFFREY G. DAVIS**, Cincinnati Museum Center- Frederick and Amye Geier Collections and Research Center, 1301 Western Avenue, Cincinnati, Ohio 45203, USA (e-mail: anura@fuse.net); and **RICK LISI**, Audubon Society of Ohio, 3398 West Galbraith Road, Cincinnati, Ohio 45239, USA.

KINOSTERNON SUBRUBRUM HIPPOCREPIS (Mississippi Mud Turtle). USA: ARKANSAS: Lincoln Co.: 0.8 km S of Nebo off St. Hwy. 81 at Flat Creek (34.019088°N, 91.814117°W; WGS 84). 6 July 2010. H. W. Robison. Verified by R. Tumlison. Henderson State University Herpetological Collection (HSU 1539). New county records; helps fill a distributional hiatus in southeastern Arkansas between Cleveland and Desha counties (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.).

Submitted by **CHRIS T. McALLISTER**, Science and Mathematics Division, Eastern Oklahoma State College, 2805 NE Lincoln Road, Idabel, Oklahoma 74745, USA (e-mail: cmcallister@se.edu); and **HENRY W. ROBISON**, Department of Biology, Southern Arkansas University, Magnolia, Arkansas 71754, USA (e-mail: hwrobison@yahoo.com).

PSEUDEMYS CONCINNA (River Cooter). USA: ARKANSAS: Howard Co.: 11.3 km W Umpire at US 278 bridge, Cossatot River (34.295923°N, 94.177680°W; WGS 84). 28 April 2010. H. W. Robison. Verified by R. Tumlison. Henderson State University Herpetological Collection (HSU 1523, photographic voucher, released). Sevier Co.: off US 70 at Red Wing (34.047529°N, 94.237976°W; WGS 84). 4 July 2010. C. T. McAllister. Verified by S. E. Trauth. Arkansas State University Museum of Zoology, Herpetological Collection (ASUMZ 31537, photographic voucher, DOR). New county records (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.). Help fill a distributional hiatus in southwestern Arkansas among Little River, Pike, and Polk counties.

Submitted by **CHRIS T. McALLISTER**, Science and Mathematics Division, Eastern Oklahoma State College, 2805 NE Lincoln Road, Idabel, Oklahoma 74745, USA (e-mail: cmcallister@se.edu); **HENRY W. ROBISON**, Department of Biology, Southern Arkansas University, Magnolia, Arkansas 71754, USA (e-mail: hwrobison@yahoo.com); and **STAN SPEIGHT**, Cossatot River State Park Natural Area, 1980 Highway 278 West, Wickes, Arkansas 71973, USA (e-mail: Stan.Speight@arkansas.gov).

TERRAPENE NELSONI (Spotted Box Turtle): MÉXICO: CHIHUAHUA: Municipio de Uruachi: Palo Amarillo (27.859594°N, 108.520464°W; NAD 27; elev. 1640 m). 1 July 2006. Paulino Ponce-Campos. Verified by John Iverson. Bosque Tropical photographic collection (BT, M 035a–f). New municipality record and second verified locality in Chihuahua, the first record being located 120 km SE of Palo Amarillo in Arroyo El Camuchil, Batopilas (Lemos-Espinal and Smith 2002. Herpetol. Rev. 32:274.). The closest known locality for this species is from 61 km NNW at Maycoba, Sonora (photographic collection UAZ 55581-PSV). The juvenile reported herein is the smallest (42 mm carapace length) on record for this species and was depicted along with the habitat where it was found (transitional oak woodland and *Acacia* thornscrub) in Franklin and Killpack (2009. The Complete North American Box Turtle. ECO Herp. Publ. Distrib., Rodeo, New Mexico. 242 pp). The locality also appears to be at the highest elevation known for this species. We thank Peter Reinthaler, John M. Legler, and Hans Meijer for details regarding the Maycoba specimen.

Submitted by **PAULINO PONCE-CAMPOS,** Bosque Tropical, A.C. Apartado Postal 5-515 Guadalajara, Jalisco 45042, México (e-mail: poncecp@hotmail.com); and **JAMES BUSKIRK,** San Antonio Neighborhood Health Center, 1030 International Blvd., Oakland, California 94606, USA.

TRACHEMYS VENUSTA (Mesoamerican Slider). HONDURAS: ISLAS DE LA BAHÍA: Cayos Cochinos, Cayo Cochino Pequeno, SE side of island near a freshwater outlet (15.949722ºN, 86.499722ºW; WGS84), elev. 1 m. 15 June 2006. J. A. Frazier. Verified by Steve Gotte. USNM 570530. First record for Cayo Cochino Pequeno (McCranie et al. 2005. Amphibians and Reptiles of the Bay Islands and Cayos Cochinos, Honduras. Bibliomania, Salt Lake City, Utah. x + 210 pp.).

Field work on Cayos Cochinos was supported by the Honduran Coral Reef Foundation, Operation Wallacea, and Disney Wildlife Conservation Fund.

Submitted by **JULIUS A. FRAZIER**, Biological Sciences Department, California Polytechnic State University, San Luis Obispo, California 93407, USA (e-mail: jafrazie@calpoly.edu); **CHAD E. MONTGOMERY**, Biology Department, Truman State University, Kirksville, Missouri 63501, USA (e-mail: chadmont@truman.edu); and **SCOTT M. BOBACK**, Department of Biology, Dickinson College, Carlisle, Pennsylvania 17013, USA (e-mail: bobacks@dickinson.edu).

SQUAMATA — LIZARDS

ACANTHODACTYLUS CANTORIS (Indian Fringe-fingered Lizard). IRAN: SISTAN & BALOUCHESTAN PROVINCE: Bazman: Mar-abad Valley (27.81451ºN, 60.15781ºE; no datum

available), elev. 970 m. 16 May 2010. Omid Mozaffari and Kamran Kamali. Verified by Muhammad Sharif Khan. Pars Herpetologists Institute (PHIM 00217). First country record, nearest reported locality is Ormara, Pakistan, 550 km to southeast (Minton 1966. Bull. Am. Mus. Nat. Hist. 134:27–184). Two males, one female, and one juvenile found at 1030 h near stream at Valley of Mar-abad; vegetation dominated by *Tamarix* and annual shrubs.

Submitted by **OMID MOZAFFARI,** Pars Herpetologists Institute, Tehran, Iran; e-mail: omozaffari@yahoo.com.

AMEIVA UNDULATA (Rainbow Ameiva). MÉXICO: OAXACA: Municipality of Villa de Tututepéc de Melchor Ocampo: Lagartero (16.050608°N, 97.648250°W; WGS 84), elev. 7 m. 22 December 2007. Aurelio Ramírez-Bautista and Vicente Mata-Silva. Verified by Uriel Hernández-Salinas. Colección Herpetológica del Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo (CIB 2694). First published municipality record that fills a gap between the closest reported localities ca. 250 km E in the vicinity of Tehuantepec, Oaxaca (Hartweg and Oliver 1937. Occas. Pap. Mus. Zool. Univ. Michigan 359:1–8) and ca. 222 km WNW in the vicinity of Barra Vieja, Guerrero (Flores-Villela et al. 1991. Ser. Cat. Mus. Zool. "Alfonso L. Herrera" Cat. [3]:1–222). Casas-Andreu et al. (2004. *In* A. J. Garcia-Mendoza et al. [eds.], Biodiversidad de Oaxaca, pp. 375–390. Inst. Biol. UNAM, Mexico D.F.) reported, without naming specific sites, that this species occurs in floristic-faunistic areas 1, 7, and 9 of the state. The geographic location reported herein is within floristic-faunistic area 8 in the southern coastal region of the state. The lizard was found crawling in leaf litter of tropical deciduous forest ca. 30 m from a marsh

Submitted by **VICENTE MATA-SILVA**, Department of Biological Sciences, The University of Texas at El Paso, El Paso, Texas 79968, USA (e-mail: vmata@utep.miners.edu); **AURELIO RAMÍREZ-BAUTISTA**, Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo, A.P. 1-69 Plaza Juárez, Pachuca, Hidalgo, C.P. 42001, México (e-mail: aurelior@uaeh.edu.mx); and **JERRY D. JOHNSON**, Department of Biological Sciences, The University of Texas at El Paso, El Paso, Texas 79968, USA (e-mail: jjohnson@utep.edu).

ANELYTROPSIS PAPILLOSUS (Mexican Blind Lizard) MÉXICO: TAMAULIPAS: Municipality of Ocampo: 11 air km WNW of Ocampo near Nicolas Bravo, Ejido Protacio F. Guerra (22.877222°N, 99.4425°W; WGS84; elev 501 m). 17 March 2007. Elí García-Padilla. Verified by David Lazcano-Villareal. Universidad Autónoma de Nuevo León, Facultad de Ciencias Biológicas, Laboratorio de Herpetología (UANL-6827). First municipality record and first from the Tamaulipas coastal plain, filling a distributional gap between previous records from the state (Axtell 1958. Herpetologica 14:189–191; Farr et al 2007. Herpetol. Rev. 38:226–233) and areas in neighboring San Luis Potosí (Campbell 1974. Cat. Amer. Amphib. Rept. 156.1–156.2). The lizard was found underneath a rock in tropical deciduous forest.

We thank David Lazcano for assistance. Fieldwork was conducted under SEMARNAT permit 01085/07.

Submitted by **ELÍ GARCÍA-PADILLA,** Centro de Investigaciones Biológicas del Noroeste, Mar Bermejo 195, Colonia Palo de Santa Rita, La Paz, Baja California Sur, 23090 México **(**e-mail: eligarcia_18@hotmail.com); and **WILLIAM L. FARR,** Herpetology Department, Houston Zoo, Inc., 1513 North MacGregor Drive, Houston, Texas 77030-1603, USA (e-mail: wfarr@houstonzoo.org).

ANOLIS CAROLINENSIS CAROLINENSIS (Northern Green Anole). USA: ARKANSAS: Yell Co.: 6.4 km W Aly on Ouachita National Forest Rd. 66430 (34.796325°N, 93.584290°W; NAD 83). 08 May 2010. H. W. Robison. Verified by R. Tumlison. Henderson State University Herpetological Collection (HSU 1524, photographic voucher). New county record. Fills a distributional gap between Perry and Scott counties (Trauth et al. 2004. Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.).

Submitted by **CHRIS T. McALLISTER**, Science Department, Eastern Oklahoma College, 2805 NE Lincoln Road, Idabel, Oklahoma 74745, USA (e-mail: drctmcallister@aol.com); and **HENRY W. ROBISON**, Department of Biology, Southern Arkansas University, Magnolia, Arkansas 71754, USA (e-mail: hwrobison@yahoo.com).

ANOLIS SAGREI (Brown Anole). USA: HAWAII: Hilo, 511 W Kawailani Street (19.68342°N, 155.08233°W, WGS84), elev. 102 m. 14 July 2010. Kenneth L. Krysko and Michael C. Granatosky. Verified by Kevin M. Enge. Florida Museum of Natural History (UF 158227–29, 158231, 158233–36; BPBM 36043, 36044). New island record (Kraus 2005. Bishop Mus. Occas. Pap. 88:61–62; Kraus 2009. Alien Reptiles and Amphibians: A Scientific Compendium and Analysis. Springer Science+Business Media B.V.. 564 pp.). Ten individuals, including four females (40.4, 41.3, 41.4, and 45.4 mm SVL), five males (56.0, 59.4, 60.3, 61.2, and 65.2 mm SVL), and one neonate (21.3 mm SVL) found sleeping on vegetation and a wooden fence between 2100–2120 h. On 15 July 2010 at 1545 h, an additional adult male *A. sagrei* was observed (not collected) basking on lava rocks at guard gate to Kuki'o Beach (19.81329°N, 155.98829°W, WGS84; elev. 53 m).

Submitted by **KENNETH L. KRYSKO** (e-mail: kenneyk@flmnh.ufl.edu) and **MICHAEL C. GRANATOSKY**, Division of Herpetology, Florida Museum of Natural History, Dickinson Hall, University of Florida, Gainesville, Florida 32611, USA (e-mail: mgranato@ufl.edu).

CNEMASPIS ASSAMENSIS (Assamese Day Gecko). INDIA: MEGHALAYA: Ri-bhoi: District: Nongkhellym Wildlife Sanctuary (25.9494°N, 91.8706°E), elev. 247 m. 4 April 2008. Arya Vidyapeeth College Zoological Museum (AVC A1035) (SVL 29.6 mm; TL 35.2 mm). Collected from exposed roots of teak plant (*Tectona grandis*) of a forest roadside slope, ca. 1 m above ground. Nongpoh (25.9244°N, 91.8756°E; elev. 554 m). 21 June 2010. AVC A1034; SVL 32.3 mm, TL 39.8 mm. On rock within a teak plantation, close to National Highway 40. Digital image is deposited at zoological image collection of the Raffles Museum of Biodiversity Research (ZRC [IMG] 2.124). Species described from Mayeng Reserve Forest (25.8153°N, 91.3589°E, 90 m elev.), Kamrup District, Assam (Das and Sengupta 2000. J. S. Asian Nat. Hist. 5[1]:17–23) and reported from Garbhanga Reserve Forest, Kamrup District, Assam (Sengupta et al. 2000. J. Assam Sci. Soc. 41[4]:372–378), and Diffolu camp (26.5951°N,

93.0772°E, elev. 86 m), Ghorakhati Range, Kaziranga National Park, Assam (Das and Ahmed, 2007. Zoos' Print J. 22[6]:27–30). Southernmost locality for species and first record for Meghalaya State. Species identification verified by Saibal Sengupta.

Submitted by **JAYADITYA PURKAYASTHA**, Zoology Department, Arya Vidyapeeth College. Guwahati 781 016, Assam, India (e-mail: jaya_ditya@rediffmail.com); and **ABHIJIT DAS**, Division of Herpetology, Aaranyak, 50 Samanwoy Path, Survey, Beltola, Guwahati 781 028, Assam, India (e-mail: protobothrops@gmail.com).

DRYADOSAURA NORDESTINA (NCN). BRAZIL: SERGIPE: Municipality of Itabaiana: National Park Serra de Itabaiana (10.7488ºS, 373447ºW, SAD69; elev. 240 m), 17 January 2009. M. V. Noronha-Oliveira. Herpetological Collection of the Federal Univeristy of Sergipe, Sergipe, Brazil (C240). Verified by D. Oliveira Mesquita. First state record, extending the distribution of *D. nordestina* ca. 250 km from Maceió, Alagoas (Rodrigues et al. 2005. Zool. J. Linn. Soc. 144:543–557). The species is restricted to a few remnants of Atlantic forest of northeastern Brazil, specifically between the states of Rio Grande do Norte and Alagoas (Rodrigues et al., *op. cit.*; Santana et al. 2008. Biotemas 21[1]:75–84; Sales et al. Cuad. Herpetol. 2009 23[2]:77–88), with only one record from the state of Bahia (Guerrero and Rodrigues 2007. Herpetol. Rev. 38:218). However, large distributional gaps remain, indicating the need for additional field surveys.

Submitted by **MARCUS VINICIUS NORONHA-OLIVEIRA**, Departamento de Biologia, Laboratório de Herpetologia, Universidade Federal de Sergipe, 49.000-000, São Cristóvão, Sergipe, Brazil (e-mail: mv_bioufs@hotmail.com); **CRIZANTO BRITO DE-CARVALHO** (e-mail: crizantobrito@gmail.com) and **RENATO GOMES FARIA,** Núcleo de Pós-Graduação em Ecologia e Conservação, Universidade Federal de Sergipe, 49.000-000, São Cristóvão, Sergipe, Brazil (e-mail: renatogfaria@gmail.com).

EUBLEPHARIS MACULARIUS (Indian Leopard Gecko). INDIA: DELHI STATE: South Delhi, Aravalli Biodiversity Park (28.558333ºN, 77.149167ºE; no datum available), elev. 240 m. 20 June 2006. Aisha Sultana and Stephen Sequiera. Verified by Indraneil Das. USDZ photographic voucher, ZRC (IMG) 2.126. Juvenile under rock in ditch. Two additional adults were found at same locality ZRC(IMG) 2.127. First report for the Union Territory of Delhi (Anon. [ed.] 1997. Fauna of Delhi. Zoological Survey of India, Kolkata. 903 pp.).

Submitted by **AISHA SULTANA** (e-mail: aishasultana28@yahoo.com); and **M. SHAH HUSSAIN,** Biodiversity Parks Programme, Centre for Environmental Management and Degraded Ecosystems, University of Delhi, Delhi 110007, India (e-mail: mshahhussain@rediffmail.com).

GERRHONOTUS OPHIURUS (Snake Lizard). MÉXICO: TAMAULIPAS: Municipality of Gómez Farías: El Cielo Biosphere Preserve, in Gómez Farías near Hotel Posada Campestre (23.0303222°N, 99.1479361°W; WGS84), elev. 353 m. 03 October 2008. Felipe Villegas Ruiz. Verified by Luis Canseco-Márquez. UANL 7114. First record for Tamaulipas and a range extension of 83 km N from the nearest locality in Cd. del Maíz, San Luis Potosí (Tihen 1948. Trans. Kansas Acad. Sci. 51:302–305). The lizard was found AOR in an area containing tropical deciduous forest. Presently, three species of *Gerrhonotus* (*G. farri, G. infernalis*, and *G. ophiurus*) are known to occur within Tamaulipas.

Submitted by **ELÍ GARCÍA-PADILLA,** Centro Interpretativo Ecológico, Gómez Farías, Tamaulipas, México (e-mail: eligarcia_18@hotmail.com); and **FELIPE VILLEGAS RUIZ,** Hotel Posada Campestre, Gómez Farías, Tamaulipas, México (e-mail: posadaenelcielo@hotmail.com).

HEMIDACTYLUS FRENATUS (Common House Gecko). PANAMÁ: COCLÉ: El Copé, small house ca. 30 m E of road to Barrigon (08.62151°N, 80.57864°W; WGS84), elev. 404 m. 17 December 2009. R. C. Jadin, J. M. Ray, and S. A. Orlofske. Verified by Eric N. Smith. UTA digital image library at the Amphibian and Reptile Diversity Research Center (UTADC 6520–23). First record for Coclé (Köhler 2008. Reptiles of Central America, 2nd ed. Herpeton, Verlag Elke Köhler, Offenbach, Germany. 400 pp.). This introduced species appears to be common in El Copé and its expansion into the area was predicted by Rödder et al. (2008. NW J. Zool. 4:236–246).

Submitted by **ROBERT C. JADIN** (e-mail: rcjadin@gmail.com), and **SARAH A. ORLOFSKE**, Department of Ecology and Evolutionary Biology, University of Colorado at Boulder, Boulder, Colorado 80309, USA; and **JULIE M. RAY**, La MICA Biological Station, El Copé de La Pintada, Coclé, Republic of Panamá.

HEMIDACTYLUS TURCICUS (Mediterranean Gecko). USA: GEORGIA: Muscogee Co.: Captured at private residence (2524 52nd Street) within Columbus city limits (32.51487ºN, 84.95584ºW; WGS 84). 26 July 2010. C. McClure. Verified by Craig Guyer. AUM 38918. New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens, Georgia. 575 pp.).

Submitted by **CHRISTOPHER J.W. McCLURE** (e-mail: cjm0007@auburn.edu), and **DAVID A. STEEN**, Auburn University Department of Biological Sciences, 331 Funchess Hall, Auburn University, Alabama 36949.USA.

HEMIDACTYLUS TURCICUS (Mediterranean Gecko). USA: TEXAS: Austin Co.: Farm to Market 949 ca. 3.0 km S of Cat Springs, Texas (29.87236°N, 96.84928°W; WGS 84). 11 October 2008. Romey Swanson and Vincent Farallo. Verified by Travis LaDuc. Texas Natural History Collection (TNHC 82802). First county record (Dixon 2000. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press. 421 pp.). Several individuals were observed on window screens at a private farmhouse near Bellville, Texas. A single adult was captured by hand. Measurements were: 11.3 cm total length and 5.2 cm SVL.

Submitted by **ROMEY L. SWANSON** (e-mail: romeyswanson@gmail.com), **VINCENT R. FARALLO**, and **THOMAS R. SIMPSON** (e-mail: r_simpson@txstate.edu), Department of Biology, Texas State University, San Marcos, Texas 78666, USA.

MABUYA AGMOSTICHA. BRAZIL: RIO GRANDE DO

NORTE: Municipality of Santa Maria: Fazenda Tanques (5.854ºS, 35.701ºW; datum WGS84), elev. 137 m. 10 October 2009. J. da Silva Jorge. Coleção Herpetológica do Departamento de Botânica, Ecologia e Zoologia, Universidade Federal do Rio Grande do Norte, Natal, Rio Grande do Norte (CHBEZ 2882, 2883). Verified by M. T. Rodrigues. Species previously known only from three localities: municipalities of Cabaceiras (type locality; Rodrigues 2000. Pap. Avul. Zool. 41 [21]:313–328) and São José dos Cordeiros/Sumé (Reserva Particular do Patrimônio Natural Fazenda Almas), both in the State of Paraíba (Freire et al. 2009. *In* Freire [ed.], Répteis Squamata das Caatingas do Seridó do Rio Grande do Norte e do Cariri da Paraíba: Síntese do Conhecimento Atual e Perspectivas, pp. 51–84. EDUFRN, Brazil) and Xingó in the border between the states of Alagoas and Sergipe (Rodrigues 2003. *In* Leal et al. [eds.], Herpetofauna da Caatinga. pp. 181–236. Ed. Universitária UFPE, Brazil). First state record, extends the distribution ca. 250 km NW from the municipality of Cabaceiras, state of Paraíba, Brazil.

Submitted by **JAQUEIUTO S. JORGE** (e-mail: queilto@yahoo.com.br) and **ELIZA M. X. FREIRE,** Laboratório de Herpetologia, Departamento de Botânica, Ecologia e Zoologia, Centro de Biociências, Universidade Federal do Rio Grande do Norte, Campus Universitário, Lagoa Nova, CEP 59072-970, Natal, Rio Grande do Norte, Brazil (e-mail: elizajuju@ufrnet.br).

LIOLAEMUS GRACILIS (Striped Slender Lizard). ARGENTINA: CHUBUT: Telsen Department: Provincial Route 4, 3.5 km W of Telsen City (42.44106°S, 66.98072°W, WGS84; elev. 432 m). 2 February 2003. L. J. Avila, K. Dittmar, M. Morando, C. H. F. Pérez. Herpetological collection of Centro Nacional Patagónico, Puerto Madryn, Chubut, Argentina (LJAMM-CNP 5486, adult male). Provincial Route 61, 40.3 km from junction with Provincial Route 11, between Ranquilhuao and San Manuel Ranches (42.74689°S, 66.99856°W, WGS84; elev. 117 m). 29 September 2004. L. J. Avila and N. Frutos. (LJAMM-CNP 5947, adult male). Both verified by L. E. Martínez. First department records, extending the known distribution of this species about 160 km W (straight line distance) from the nearest known record (Morando et al. 2007. Mol. Phylogenet. Evol. 43[3]:952–973), representing the westernmost locality for Chubut Province and southwesternmost locality for Argentina. Southernmost citation for this species is the type locality (Puerto Deseado, Santa Cruz Province), but actual collections between Península de Valdés in northeastern Chubut province and the type locality along the Atlantic coast or inland are not known. Present confirmed distribution includes San Luis, Mendoza, La Pampa, southern Buenos Aires, eastern Neuquén, Río Negro, and northeastern Chubut provinces (Avila et al. 2000. Ed. Esp. Asoc. Herpetol. Arg. 5:51–74).

Submitted by **IGNACIO MINOLI** (e-mail: minoli@cenpat.edu.ar), and **LUCIANO JAVIER AVILA,** Centro Nacional Patagónico, Boulevard Almirante Guillermo Brown 2915, Puerto Madryn, Chubut, Argentina (e-mail: avila@cenpat.edu.ar).

PHELSUMA MADAGASCARIENSIS (= P. GRANDIS) (Madagascar Day Gecko). USA: FLORIDA: Monroe Co.: Saddlebunch Keys, Baypoint, Palm Drive (24.62185°N, 81.59293°W, WGS 84), elev. < 1 m. 15 July 2010. Pam Gimson. Verified by Catherine A. Smith. Florida Museum of Natural History (photographic voucher UF 159376). New island record and eighth known island in the Florida Keys from which this species has been independently introduced (Krysko and Sheehy 2005. Carib. J. Sci. 41:169–172, Krysko and Hooper 2007. Gekko 5:33–38).

Submitted by **KENNETH L. KRYSKO**, Division of Herpetology, Florida Museum of Natural History, Dickinson Hall, University of Florida, Gainesville, Florida 32611, USA; e-mail: kenneyk@flmnh.ufl.edu.

PLESTIODON ANTHRACINUS PLUVIALIS (Southern Coal Skink). USA: MISSISSIPPI: Perry Co.: De Soto National Forest (31.153478°N, 89.012830°W; NAD83). 12 March 2009. James R. Lee. Verified by Robert L. Jones. Mississippi Museum of Natural Sciences (MMNS 16010). New county record (Walley 1998. Cat. Am. Amphib. Rept. 658:1–6 and references therein) that fills the void between Forrest (Smith and List 1955. Am. Midl. Nat. 53:115–125) and Greene (Burt 1937. Trans. Kansas Acad. Sci. 40:349–366) counties, positioned to the west and east, respectively. This specimen and two individuals not collected (all males) were found in a pitcher plant wetland.

Submitted by **JAMES R. LEE**, The Nature Conservancy, Camp Shelby Joint Forces Training Center, CSJFTC-ENV Building 622, Camp Shelby, Mississippi 39407, USA; e-mail: jlee@tnc.org.

PLESTIODON LATICEPS (Broad-headed Skink). USA: WEST VIRGINIA: Berkeley Co.: Sleepy Creek Wildlife Management Area, adjacent to Sleepy Creek Lake (39.531389°N, 78.151111°W; WGS84), elev. 337 m. 20 May 2010. Jeffrey W. Tamplin, Alexa D. Dostart, Derek J. Miller, and Jamie L. Thomas. Verified by Jeffrey Parmelee. Photo vouchers in Drake University Research Collection (DURCPC 135a,b,c). *Plestiodon laticeps* occurs in Fairfax, Loudoun, Prince William, and Warren counties in northern Virginia, and Jefferson Co., West Virginia, but has not previously been recorded from adjacent Berkeley or Morgan counties in the West Virginia eastern panhandle (Mitchell 1994. The Reptiles of Virginia. Smithsonian Institution Press, Washington, DC. 352 pp.; Green and Pauley 1987. Amphibians and Reptiles in West Virginia. University of Pittsburg Press, Pittsburg, Pennsylvania. 241 pp.; T. K. Pauley, pers. comm.). New county record is 25.1 km W of the Jefferson Co. line, and extends the species' range ca. 63.8 km farther N from the Warren Co., Virginia locality, and 81.7 km NW from the closest Loudoun Co., Virginia locality. One adult male and one juvenile *P. laticeps* were captured and released at ca. 1430 h. Habitat was deciduous woodland with a rocky substrate, ca. 1.4 km E of the Berkeley and Morgan county line.

Submitted by **JEFFREY W. TAMPLIN**, **ALEXA D. DOSTART, DEREK J. MILLER,** and **JAMIE L. THOMAS,** Department of Biology, University of Northern Iowa, 1227 W 27th Street, Cedar Falls, Iowa 50614, USA; e-mail: jeff.tamplin@uni.edu.

PODARCIS SICULUS **(**Italian Wall Lizard**).** USA: CALIFORNIA: Los Angeles Co.: San Pedro (33.7169ºN, 118.3022ºW; datum not available). 23 April 2010 and 7 May 2010. Gary Nafis and Guntram Deichsel. Verified by Werner

Mayer. Museum of Natural History in Vienna, Austria (photo voucher and tissue sample; catalogue number: NULA-1). Two additional voucher specimens are deposited at the Natural History Museum of Los Angeles County (LACM 180482–180483). First verified record of *P. s. siculus* from the USA. Burke and Deichsel (2008. *In* Mitchell et al. [eds.], Urban Herpetology, pp. 347–353. Herpetological Conservation Vol. 3. SSAR, Salt Lake City, Utah) present an overview of occurrences of *P. siculus* in the U.S. and mention introduced *P. siculus campestris* only for New York, Pennsylvania, and Kansas. Stebbins (2003. A Field Guide to Western Reptiles and Amphibians. Houghton Mifflin Co., Boston, Massachusetts. 544 pp.) does not mention *P. siculus* in the area covered in this book.

Werner Mayer analyzed mtDNA from the tissue sample and submitted the result to GenBank (accession number HQ154646). A sequence of 887 bp of the mitochondrial cytochrome b gene differed only by 1% mismatches from respective sequences of *P. s. siculus* from both the city of Agrigento (on the SW coast of Sicily) and from the Monti Peloritani mountains in the northeast of the island. The difference Agrigento–Peloritani is 0.9% mismatches. Sequences from Sicily differ by 1.9–2.4% from sequences from the opposite Italian mainland, i.e., extreme southern Calabria (W. Mayer, pers. comm.).

Approximately 50% of the Californian individuals are of the "concolor" (syn. "olivacea") morph characterized by plain green dorsa. Intergrades with faded, mid-dorsally lined (females) or faded checkered dorsa (males) are also present. Venters are plain white, orange, red, or white with beige spots. This inter-individual variation of coloration is consistent with a Sicilian origin: on the Italian mainland all *P. s. siculus* have plain white venters whereas on Sicily both plain white and colored venters occur (Henle and Klaver 1986. *In* W. Böhme [ed.], Handbuch der Reptilien und Amphibien Europas vol. 3 [Lacertidae III: *Podarcis*], pp. 254–342. Aula Verlag, Wiesbaden).

JH surveyed the area several times after 7 May 2010, confining the occurrence to a ca. 300 m (NW–SE) x 400 m (NE–SW) rectangle centered at South Leland & West 34th streets. We estimate the total population size as over 1,000 animals. By interviewing residents, JH identified the person who originally introduced four females and three males, all adults, from Taormina on Sicily in September 1994. According to this person, "20 male and 24 female adult Southern Italian Wall Lizards, many juveniles, and lots of hatchlings co-exist together with 2–3 Southern Alligator Lizards and 4-5 Western Fence Lizards, all adults" in his/her yard as of 29 June 2010. The total area of the person's lot minus house footprint is 474 m^2, yielding a population density of adult Southern Italian Wall Lizards of roughly one per 10 m^2. In another resident's garden measuring 72 m^2, GD counted nine *Podarcis*, yielding a similar local density. In its home range, *P. s. siculus* can reach much higher densities. We recommend that the expansion of this alien species be monitored and possible interactions with native lizard species should be investigated.

Submitted by **GUNTRAM DEICHSEL**, Friedrich-Ebert-Str. 62, Biberach an der Riss, Germany DE-88400 (e-mail: Guntram.Deichsel@gmx.de); **GARY NAFIS,** PO Box 34628-89546 Seattle, Washington 98124, USA (e-mail: grynaf@yahoo.com); and **JONATHAN HAKIM**, 937 W. 57th Street, Los Angeles, California 90037, USA (e-mail: hakim.ndmva@gmail.com).

PODARCIS SICULUS CAMPESTRIS (Italian Wall Lizard). USA: NEW JERSEY Burlington Co.: Mt. Laurel, 128 Hooton Road (39.9559833ºN, 74.9299944º W; no datum available). September 2008. Russell L. Burke. Verified by D. Kizirian. American Museum of Natural History (AMNH 163007–163019). New county and state record. The closest previously reported populations of this subspecies are Philadelphia (apparently now extirpated [Burke and Deichsel 2008. *In* Mitchell et al. (eds.), Urban Herpetology, pp. 347–353. Herpetological Conservation Vol. 3. SSAR, Salt Lake City, Utah]) and New York City (Burke et al. 2010. Herpetol. Rev. 41:85–86). The population is distributed over a 0.5 km^2 area. An anonymous source claims to have started this population by releasing about 120 *P. siculus* purchased from a Bronx commercial importer/dealer in 1984, and that they were parasitized with mites at the time.

Submitted by **RUSSELL L. BURKE**, Department of Biology, Hofstra University, Hempstead, New York 11549,USA; e-mail: biorlb@hofstra.edu.

PTYCHOGLOSSUS BILINEATUS (Largescale Lizard). COLOMBIA: NARIÑO: Barbacoas Municipality: corregimiento de Altaquer, Reserva Natural Río Ñambi (1.29631°N, 78.07183°W; Bogotá WGS 84). 16 October 2009. G. F. Medina-Rangel and M. L. Calderón-Espinosa. Verified by R. A. Moreno-Arias. Colección de Reptiles, Instituto de Ciencias Naturales, Universidad Nacional de Colombia, Bogotá, Colombia (ICN 12011). This species was known only from an unspecified locality in Ecuador (Harris 1994. Herpetol. Monogr. 8:226–275). This is the first record for Colombia, and extends species range to the Western Cordillera of Colombia.

Submitted by **GUIDO F. MEDINA-RANGEL** (e-mail: gfmedinar@unal.edu.co), and **MARTHA L. CALDERÓN-ESPINOSA** (e-mail: mlcalderone@unal.edu.co), Instituto de Ciencias Naturales, Universidad Nacional de Colombia, Apartado Aéreo 7495, Bogotá D.C., Colombia.

SCELOPORUS CLARKII (Clark's Spiny Lizard). USA: ARIZONA: Coconino Co.: Hwy 89A, approx. 1.5 rd mi. NE Uptown Sedona (34.88538056ºN, 111.74339444ºW, WGS84; elev. 1390 m). 8 September 1984. Brian Hubbs. Verified by Phil Rosen. Natural History Museum of Los Angeles County photo voucher (LACM PC 1524). New county record (Brennan and Holycross 2006. A Field Guide to Amphibians and Reptiles in Arizona. Arizona Game and Fish Department. Phoenix, Arizona. 150 pp.; Stebbins 2003. A Field Guide to Western Reptiles and Amphibians, 3rd ed. Houghton Mifflin Co., Boston, Massachusetts. 533 pp.). Two earlier vouchered specimens from this county (SDNHM 68106, UAZ 33885) apparently have not been referenced in any publication.

I thank Phil Rosen for sharing information concerning distribution of *Sceloporus clarkii* in northern Arizona.

Submitted by **BRIAN HUBBS,** P.O. Box 26407, Tempe, Arizona 85285, USA; e-mail: tricolorbrian@hotmail.com.

SCELOPORUS MELANORHINUS (Black-nosed Lizard). MÉXICO: OAXACA: Municipality of Villa de Tututepéc de Melchor Ocampo: Lagartero (16.051227°N, 97.643845°W; WGS 84), elev. 8 m. 28 December 1999. Aurelio Ramírez-Bautista and

Vicente Mata-Silva. Verified by Uriel Hernández-Salinas. Colección Herpetológica del Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo (CIB 2692). First published municipality record that fills a gap between the closest reported localities in Oaxaca ca. 73 km NNW, ca. 22 km N of Santiago Pinotepa Nacional (Flores-Villela et al. 1991. Serie Cat. Mus. Zool. "Alfonso L. Herrera" Cat. [3]:1–222) and ca. 130 km ESE near San Pedro Pochutla (Smith 1939. Field Mus. Nat. Hist., Zool. Ser. 26:1–397). The lizard was found on a tree of a living fence along an unpaved road, next to a lime grove.

Submitted by **VICENTE MATA-SILVA**, Department of Biological Sciences, The University of Texas at El Paso, El Paso, Texas 79968, USA (e-mail: vmata@utep.miners.edu); **AURELIO RAMÍREZ-BAUTISTA**, Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo, A. P. 1-69 Plaza Juárez, Pachuca, Hidalgo, C.P. 42001, México (e-mail: aurelior@uaeh.edu.mx); and **JERRY D. JOHNSON**, Department of Biological Sciences, The University of Texas at El Paso, El Paso, Texas 79968, USA (e-mail: jjonhson@utep.edu)

SCELOPORUS SINIFERUS (Long-tailed Spiny Lizard). MÉXICO: OAXACA: Municipality of Villa de Tututepéc de Melchor Ocampo: Río Grande (16.042186°N, 97.420338°W; WGS 84), elev. 43 m. 25 December 1998. Aurelio Ramírez-Bautista and Vicente Mata-Silva. Verified by Uriel Hernández-Salinas. Colección Herpetológica del Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo (CIB 2693). First published municipality record that fills a gap between the closest reported localities ca. 105 km ESE in the vicinity of Puerto Angel, municipality of San Pedro Pochutla, Oaxaca and ca. 270 km WNW near Acapulco, Guerrero (Smith 1939. Field Mus. Nat. Hist., Zool. Ser. 26:1–397). The lizard was found crawling adjacent to an unpaved road in leaf litter in remnant tropical deciduous forest next to a pasture.

Submitted by **VICENTE MATA-SILVA**, Department of Biological Sciences, The University of Texas at El Paso, El Paso, Texas 79968, USA (e-mail: vmata@utep.miners.edu); **AURELIO RAMÍREZ-BAUTISTA**, Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo, A. P. 1-69 Plaza Juárez, Pachuca, Hidalgo, C.P. 42001, México (e-mail: aurelior@uaeh.edu.mx); and **JERRY D. JOHNSON**, Department of Biological Sciences, The University of Texas at El Paso, El Paso, Texas 79968, USA (e-mail: jjonhson@utep.edu).

UROSAURUS ORNATUS SYMMETRICUS (Colorado River Tree Lizard). USA: CALIFORNIA: San Bernardino Co.: city of San Bernardino, Kendall neighborhood near NW end of College Avenue, 475 m elev. (34.178879°N, 117.343117°W; WGS84). 26 May 2010. Jonathan Hakim. Natural History Museum of Los Angeles County, LACM 179866. Verified by Neftali Camacho. Introduced population discovered in August 2007 by JB; lizards have continued to be seen in abundance at multiple life stages as of 16 July 2010. Lizards have been observed in an area of ca. 50 acres from Highway 215 northeast to Kendall Drive and from Jasmine Street northwest to the flood control channel that runs parallel to Campus Parkway. The lizards are exclusively found on residential fences and walls in a developed suburban neighborhood. The extent of the population and presence of juvenile lizards suggests the population is established and reproducing. This record is 205 km W of the westernmost native population, in the Corn Spring area on the northeast slope of the Chuckwalla Mts., Riverside Co., California (Stebbins 2003. A Field Guide to Western Reptiles and Amphibians. 3rd ed. Houghton Mifflin Co., Boston, Massachusetts. 533 pp.). Many of the local homeowners own boats, suggesting that the lizards may have been stowaways from boating trips to Lake Havasu or other nearby areas of the Colorado River where this species naturally occurs, or intentional releases from captures made on such trips.

Submitted by **JIM BASS**, 16933 Mission Avenue, Hesperia, California 92345, USA (e-mail: jimbass2001@yahoo.com); and **JONATHAN HAKIM**, 937 W. 57th Street, Los Angeles, California 90037, USA (e-mail: hakim.ndmva@gmail.com).

SQUAMATA — SNAKES

BOA CONSTRICTOR (Boa Constrictor). MÉXICO: HIDALGO: Municipality of Eloxochitlán: Reserva de la Biosfera de Metztitlán, San Juan Amaque (20.71449°N, 98.94825°W; WGS84), elev. 916 m. 18 April 2010. María Eugenia Mendiola. Verified by Jesús M. Castillo. Herpetological Photographic Collection, Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo (CH CIB 2). First record for Eloxochitlán and Reserva de la Biosfera de Metztitlán, extending the range within the state ca. 38 km S of its closest known locality at Tepehuacán de Guerrero (Mendoza, et al. 2006. Publ. Espec. Soc. Herpetol. Mexicana [3]:99–109), and ca. 95 km W of Huehuetla (Goyenechea et al. 2009. Herpetol. Rev. 40:364). The snake was found on a tree in tropical deciduous forest.

Fieldwork was funded by CONACyT- 95828.

Submitted by **IRENE GOYENECHEA** (e-mail: ireneg@uaeh.edu.mx**)**, **VICTOR D. VITE**, Centro de Investigaciones Biológicas (CIB), Universidad Autónoma del Estado de Hidalgo, A.P. 1-69 Plaza Juárez, Pachuca, Hidalgo, México; and **MA. EUGENIA MENDIOLA-GONZALEZ**, Reserva de la Biosfera Barranca de Metztitlán, Comisión Nacional de Áreas Naturales Protegidas, Loc. 61 y 62, Núcleo E, Plaza de las Américas, Fraccionamiento Valle de San Javier, C.P. 42086 Pachuca, Hidalgo.

CROTALUS TRANSVERSUS (Cross-banded Mountain Rattlesnake). MÉXICO: DISTRITO FEDERAL: Delegación Tlalpan, Volcán Xitle, San Andres Totoltepec (19.2462°N, 99.2070°W; WGS 84), elev. 2870 m. 21 July 2009. Eric Centenero Alcalá and Uri García. Verified by Luis Canseco Márquez. Museo de Zoología, Facultad de Ciencias, Universidad Nacional Autónoma de México (MZFCID-04). Second record for Distrito Federal and first record for Delegación Tlalpan, extending the known range of the species ca. 9 km from Cerro Panza, Valle del Tezontle, Delegación Magdalena Contreras (García-Vázquez et al. 2008. Herpetol. Rev. 39:484). The snake was found under a rock in oak forest.

Submitted by **ERIC CENTENERO-ALCALÁ**, Laboratorio de Ecología, Unidad de Biotecnología y Prototipos, Facultad de Estudios Superiores Iztacala, Universidad Nacional Autónoma de México. Av. de los Barrios s/n, Los Reyes Iztacala, Tlalnepantla, México. C.P. 54090 (e-mail: eca_46@hotmail.com); **URI OMAR GARCÍA-VÁZQUEZ**, **ANDRÉS ALBERTO MENDOZA-**

HERNÁNDEZ, **JOAN GASTÓN ZAMORA-ABREGO**, Museo de Zoología, Facultad de Ciencias, Universidad Nacional Autónoma de México, A.P. 70-399, México, Distrito Federal 04510, México; and **VÍCTOR HUGO JIMÉNEZ-ARCOS**, Laboratorio de Herpetología, Instituto de Biología, Universidad Nacional Autónoma de México. 3er Circuito exterior s/n, Ciudad Universitaria, Coyoacán, México, D.F. C.P. 04510.

EPICTA GOUDOTII (Black Threadsnake). MÉXICO: HIDALGO: Municipality of Hazalingo: Tepalcahuac (20.95852°N, 98.48527°W; WGS84), elev. 315 m. 01 September 2007. Victor D. Vite Silva and Alejandro Ramírez-Pérez. Verified by Raciel Cruz Elizalde. Colección de Anfibios y Reptiles del Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo (CIB 2181–2183). Municipality of Huautla: Tamayon (21.03457°N, 98.2886°W; WGS84), elev. 506 m. 10 November 2007. Victor D. Vite Silva and Alejandro Ramírez-Pérez. Verified by Raciel Cruz Elizalde. CIB 2184. First records for Hidalgo, extending the range ca. 147 km SW from the closest known locality, 2 km W of La Loma, Tamaulipas (Flores-Benabib and Flores-Villela 2008. Biol. Soc. Herpetol. Mexicana 16:13–14).

We acknowledge the following for support: Diversidad Biológica de Estado de Hidalgo, FOMIX-CONACYT - HIDALGO 43761; and Diversidad Biológica de Estado de Hidalgo (segunda fase), FOMIX-CONACYT - HIDALGO 95828 and S52552-Q.

Submitted by **URIEL HERNÁNDEZ SALINAS** (e-mail: uhhernandez3@gmail.com), **JUDITH PAMPA RAMÍREZ** (e-mail: judithpampa@gmail.com), **IRENE GOYENECHEA** (e-mail: ireneg@uaeh.edu.mx), **AURELIO RAMÍREZ BAUTISTA** (e-mail: aurelior@edu.uach.mx), and **VÍCTOR VITE SILVA,** Centro de Investigaciones Biológicas (CIB), Universidad Autónoma del Estado de Hidalgo, A.P. 1-69 Plaza Juárez, C.P. 42001, Pachuca, Hidalgo, México

FARANCIA ABACURA (Red-bellied Mudsnake). USA: GEORGIA: Peach Co.: DOR, State Rt. 49 at Mule Cr. (32.60278ºN; 83.79815ºW; no datum available). 8 May 2010. Digital image AHAP-D 246. First county record. Taylor Co.: DOR, State Rt. 96, 1 km E of Reynolds, at Flint River floodplain (Magnolia Swamp) (32.55267ºN; 84.05382ºW; no datum available). 08 May 2010. Digital image AHAP-D 245. First county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). Both specimens collected by S. Graham and verified by Craig Guyer. Decimal degrees of localities were determined using ACME Mapper 2.0 software (http://mapper.acme.com).

Submitted by **SEAN P. GRAHAM,** Auburn University, Department of Biological Sciences, 331 Funchess Hall, Auburn, Alabama 36849, USA; e-mail: grahasp@auburn.edu.

HETERODON PLATIRHINOS (Eastern Hognose Snake). USA: TEXAS: Caldwell Co.: Farm to Market Road 713 near the Caldwell/Bastrop Co. Line Road (29.82858°N, 97.39533°W; WGS 84). 12 April 2008. Romey Swanson. Verified by Travis LaDuc. Texas Natural History Collection (TNHC 82800). A single DOR was collected from the road shoulder. First county record (Dixon 2000. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 421 pp.). The individual measured 48.4 cm SVL and 60.0 cm total length and had a reddish base coloration often seen in specimens collected from Bastrop Co.

Submitted by **ROMEY L. SWANSON** (e-mail: romeyswanson@gmail.com) and **THOMAS R. SIMPSON** (e-mail: r_simpson@txstate.edu), Department of Biology, Texas State University, San Marcos, Texas 78666, USA.

LAMPROPELTIS CALLIGASTER (Mole Kingsnake). USA: GEORGIA: Putnam Co.: Burtom Rd. near Lake Sinclair (33.224543°N, 83.419154°W; WGS84). 18 April 2010. Alfred J. Mead. GCH 5280. Verified by Christopher E. Skelton. First county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). Single adult collected DOR on road flanked by mature pine forest and recently established pasture land.

Submitted by **ALFRED J. MEAD** (e-mail: al.mead@gcsu.edu) and **DENNIS PARMLEY**, Department of Biological and Environmental Sciences, Georgia College & State University, Milledgeville, Georgia 31061, USA.

LAMPROPELTIS GETULA (Common Kingsnake). USA: GEORGIA: Wilkes Co.: Tignall, Newtown Road, 1.6 km NW Elam Lunceford Road (33.87554°N, 82.83697°W, WGS84), elev. 163 m. 06 June 2009. Justin T. Oguni and Matthew A. King. Verified by Kenneth L. Krysko. Florida Museum of Natural History (photographic voucher UF 158417). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). Found AOR at 2145 h in mixed hardwood forest with residential homes.

Submitted by **JUSTIN T. OGUNI**, College of Veterinary Medicine, University of Georgia, Athens, Georgia 30602, USA; e-mail: goonie16@gmail.com

LAMPROPELTIS GETULA NIGRA (Eastern Black Kingsnake). USA: GEORGIA: Dade Co.: field ca. 100 m NE of jct of Higdon Creek and CR 13, ca. 5.9 air km W of Trenton (34.87262°N, 85.57365°W; NAD83). 17 May 2010. Houston C. Chandler. UF 157836. Verified by John B. Jensen and Kenneth Krysko. First county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). Single adult captured and photographed on the bank of a small farm pond. Rural area with mix of forest and pasture and a ca. 5 ha clearcut within sight of capture area.

Submitted by **HOUSTON C. CHANDLER** and **CHRISTOPHER E. SKELTON**, Department of Biological and Environmental Sciences, Georgia College & State University, Milledgeville, Georgia 31061, USA; e-mail: chris.skelton@gcsu.edu.

LEPTOTYPHLOPS HUMILIS (Western Threadsnake). USA: ARIZONA: Mohave Co.: Virgin River valley (36.841538°N, 113.982881°W, NAD 83), elev. 513 m. 24 July 2010. Steven Anderson. Verified by Tom Giermakowski. University of New Mexico Museum of Southwestern Biology (MSB 77882). This is the first record from the Arizona Strip and fills an important gap in the known distribution of the species. Other specimens have been recorded further south, along the lower Colorado River and

from the Grand Canyon, Arizona (Brennan and Holycross 2006. Amphibians and Reptiles in Arizona. Arizona Game and Fish Department, Phoenix, Arizona. 150 pp.) and to the northeast in Washington Co., Utah (A. Holycross, pers. comm.). NEVADA: Clark Co.: Virgin River Valley, Gold Butte recreation area (36.665935°N, 114.306052°W, NAD 83), elev. 396 m. 22 July 2010. Danny Nielsen. Verified by Andy Holycross. University of Arizona Museum of Natural History (UAZ 57242-PSV, photo voucher). This is the eighth record from southern Nevada and ca. 20 km from nearest known record in Overton, Nevada from 1939 (Grater 1981. Snakes, Lizards and Turtles of the Lake Mead Region. Southwest Parks and Monuments Association, Globe, Arizona. 48 pp.; P. Conrad, Nevada Department of Wildlife, pers. comm.), and ca. 40 km downstream from the Mohave Co., Arizona specimen reported above. Both specimens were collected from pitfall traps in upper riparian habitat of mesquite (*Prosopis* sp. and saltcedar (*Tamarix* sp.).

Collecting permits were issued by the Arizona Game and Fish Department (No. 195230) and Nevada Department of Wildlife (No. S32027).

Submitted by **HEATHER L. BATEMAN** (e-mail: heather.bateman@gmail.com) and **DANNY NIELSEN,** Arizona State University at the Polytechnic Campus, Department of Applied Sciences and Mathematics, 6073 S. Backus Mall, Mesa, Arizona 85212, USA (e-mail: dannynielsen0@gmail.com).

NERODIA ERYTHROGASTER FLAVIGASTER (Yellow-bellied Watersnake). USA: ARKANSAS: Calhoun Co.: DOR ~6 km N of Ouachita River on US 167 (33.392396°N, 92.493676°W; WGS 84). 09 September 2010. M. B. Connior. Verified by S. E. Trauth. Arkansas State University Museum of Zoology Herpetology Collection (photo voucher ASUMZ 31555). First county record (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville. 421 pp.). The species has also been collected from neighboring Bradley, Ouachita, and Union counties in southern Arkansas.

Submitted by **MATTHEW B. CONNIOR,** Health and Natural Sciences, South Arkansas Community College, 300 S. West Avenue, El Dorado, Arkansas 71730, USA; e-mail: mconnior@southark.edu.

OXYBELIS AENEUS (Mexican Vine Snake). MÉXICO: HIDALGO: Municipality of Tlahuiltepa: Boca de León (20.99139°N, 98.99193°W; WGS84), elev. 464 m. 18 November 2009. Victor D. Vite-Silva, Alejandro Ramírez-Pérez, and Oscar González-Solís. Verified by Norma Manríquez-Morán. Colección Herpetológica, Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo (CIB-UAEH 2538). First record for the municipality, extending the range in Hidalgo ca. 43 km S from the closest known record at La Vega de Metztitlán, Municipality of Metztitlán (Gelover-Alfaro et al. 1999. Rev. Zool. [10]:6–8). The snake was found near a river in tropical deciduous forest.

Fieldwork was funded by CONACyT- 95828.

Submitted by **VICTOR D. VITE-SILVA, ALEJANDRO RAMÍREZ-PÉREZ, OSCAR GONZÁLEZ-SOLÍS, JESÚS M. CASTILLO,** and **IRENE GOYENECHEA**, Centro de Investigaciones Biológicas (CIB), Universidad Autónoma del Estado de Hidalgo, A.P. 1-69 Plaza Juárez, Pachuca, Hidalgo, México; e-mail: ireneg@uaeh.edu.mx.

OXYRHOPUS CLATHRATUS (False Coral Snake). BRAZIL: BAHIA: Municipality of Camacan: Uiraçu Farm, Serra Bonita (15.39405°S, 39.56887°W; Córrego Alegre 24S), elev. 930 m. 26 February 2010. I. Dias, T. Medeiros, and M. Vila Nova. Verified by M. Solé. Museu de Zoologia da Universidade Estadual de Santa Cruz, Ilhéus, Bahia, Brazil (MZUESC 8047). Known from Misiones, Argentina, and southeastern Brazil, from Rio Grande do Sul to Bahia (Argôlo 2001. Herpetol. Rev. 32:61; Peters and Orejas-Miranda 1986. Bull. U.S. Nat. Mus. 297:231). In the state of Bahia the species was known only from Barra do Choça municipality on the Planalto Sulbaiano, a plateau with elevations between 700 and 900 m. The specimen reported here was collected on a mountain ca. 115 km SE, far away and completely isolated from that plateau. The species has never been detected in the low adjacent areas, despite twenty years of intensive study, suggesting that at this latitude the taxon has isolated populations in mountains (Argôlo 2004. As Serpentes dos Cacauais do Sudeste da Bahia, Ilhéus, Editus. 260 pp.; Argôlo 2009. Composição faunística e distribuição geográfica de serpentes na Mata Atlântica do sul da Bahia. Tese de Doutorado, Museu Nacional, Universidade Federal do Rio de Janeiro. 274 pp.). Altough it is a terrestrial species, the specimen was found ca. 2.5 m above ground on vegetation.

Submitted by **TADEU TEIXEIRA MEDEIROS, IURI R. DIAS, MARCOS FERREIRA VILA NOVA,** and **ANTÔNIO JORGE SUZART ARGÔLO,** Universidade Estadual de Santa Cruz, Departamento de Ciências Biológicas, Rodovia Ilhéus-Itabuna, km 16, Salobrinho, CEP 45662-900, Ilhéus, BA, Brazil (e-mail: ajargolo@gmail.com).

PANTHEROPHIS SPILOIDES (Gray Rat Snake). USA: ALABAMA: Henry Co.: County Road 57 NE of Abbeville (31.637933°N, 85.172217°W; WGS84/NAD83). 01 June 2010. R. Birkhead. Verified by Craig Guyer. AUM 38896. New county record. Found dead on road. *Pantherophis spiloides* has been previously documented in all surrounding counties of Alabama, but the related *P. alleghaniensis* has not been documented in adjacent Clay Co., Georgia (Jensen et al.. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens, Georgia. 575 pp.; Mount 1996. The Amphibians and Reptiles of Alabama. University of Alabama Press. xi+347 pp.).

Submitted by **ROGER D. BIRKHEAD**, Alabama Science In Motion, Auburn University, Alabama 36849-5414, USA; e-mail: birkhrd@auburn.edu.

PITUOPHIS CATENIFER SAYI (Bullsnake). USA: WISCONSIN: Pepin Co.: Township of Lima (44.673181°N, 91.871867°W; no datum available.). Verified by Christopher Phillips. Voucher photograph, Illinois Natural History Survey(INHS 2010i). New county record. Fills a gap in the currently known range of this species in Wisconsin (Casper 1996. Geographic Distributions of the Amphibians and Reptiles of Wisconsin. Milwaukee Public Museum, Milwaukee, Wisconsin. 87 pp.). Several adults were photographed near a possible den location on 26 April 2010, and had been observed in the same general area during the spring of previous years (BB). Old egg remnants encountered near the

individuals photographed in 2010 suggest that this may also be a nesting site for females. The property where the observations were made is an open grassland habitat parcel currently enrolled in the U.S. Department of Agriculture-Farm Service Agency's Conservation Reserve Program. Most adjacent land parcels appear to be dominated by active agriculture. This observation supplements unverified reports from near the township of Durand (Pepin Co.) taken in 2004 and 2008 by Wisconsin Department of Natural Resources employees. It also complements a specimen from adjacent Pierce Co. vouchered in 1988 by J. Moriarty, B. Oldfield, and D. Jones (James Ford Bell Museum 13235), and voucher photographs from adjacent Eau Claire Co. taken by J. Polk in 1988 (Milwaukee Public Museum photograph catalogue number 195-98), and Dunn Co. taken by J. Polk in 1995 (Milwaukee Public Museum photograph catalogue number 561).

Submitted by **BRENT BAUER**, W4292 State Hwy 85, Durand, Wisconsin 54736, USA; **JOSHUA M. KAPFER**, Departments of Environmental Studies and Biology, Elon University, Elon, North Carolina, 27244, USA; **RICHARD A. STAFFEN**, Wisconsin Department of Natural Resources-Bureau of Endangered Resources, 101 S. Webster St., PO Box 7921, Madison, Wisconsin, 53707-7921, USA; and **GARY S. CASPER**, University of Wisconsin-Milwaukee Field Station, 3095 Blue Goose Rd, Saukville, Wisconsin, 53080, USA.

RAMPHOTYPHLOPS BRAMINUS (Brahminy Blind Snake). USA: CALIFORNIA: San Diego Co.: City of Chula Vista, Norman Park, 270 F Street (32.64101ºN, 117.07806ºW; NAD 83). 07 November 2006. Marcos Dominguez, Sarmed D. Alzubaidi, and Stanley O'Gara. A second specimen was collected on 28 September 2009 by Daniel D. Palmer, Tony E. Garcia, Trevor H. Jordan. Verified by Jens Vindum. California Academy of Sciences (CAS 244221–244222). This is the first record for California and the west coast of the USA (Kraus 2009. Alien Reptiles and Amphibians: A Scientific Compendium and Analysis. Invading Nature: Springer Series in Invasion Ecology 4. Springer-Verlag. 563 pp.). Apparently reproducing and established given that the first specimen was an adult collected in 2006 and the second specimen collected in 2009 was a small juvenile. Both were found in an urban setting. It is not known if this species will invade native habitats in southern California or presents a risk to native species. Urban Chula Vista is dominated by invasive Argentine Ants (*Linepithema humile*) and it is assumed that this invasive will be abundant prey for the snake.

Submitted by **DANIEL D. PALMER**, Wildlife Research Institute, 18030 Highland Valley Road, Ramona, California 92065, USA; and **ROBERT N. FISHER** U.S. Geological Survey, San Diego Field Station, 4165 Spruance Road, Suite 200, San Diego, California 92101-0812, USA; e-mail: rfisher@usgs.gov.

RAMPHOTYPHLOPS BRAMINUS (Brahminy Blindsnake). FEDERATED STATES OF MICRONESIA: KOSRAE: Malem Municipality: 5.302888˚N, 163.028277˚E (WGS 84), elev. 10 m). 22 September 2009. Kenneth R Wood and Wayne Law. Verified by Allen Allison. Bernice P. Bishop Museum (BPBM 36041). New island record for Kosrae. Nearest previous recording ca. 560 km west on Lenger Island, Pohnpei, Federated States of Micronesia (Wallach 2009. Hamadryad 34:34–61). Individual, 65 mm long, collected near house adjacent to swamp forest with associated vegetation of *Horsfieldia irya*, *Neubergia celebica*, *Cocos nucifera*, and *Hibiscus tiliaceus*.

Submitted by **KENNETH R. WOOD**, National Tropical Botanical Garden, 3530 Papalina Road, Kalāheo, Kaua'i, Hawai'i 96741, USA (e-mail: kwood@ntbg.org); and **WAYNE LAW**, The New York Botanical Garden, 2900 Southern Blvd, Bronx, New York 10458, USA (e-mail: wlaw@nybg.org).

RAMPHOTYPHLOPS BRAMINUS (Brahminy Blindsnake). HONDURAS: SANTA BÁRBARA: 1 km S of San José de Colinas (15.05°N, 88.30°W; WGS84), elev. 380 m. 30 July 2008. Mario R. Espinal and Leonel Marineros. Verified by Steve W. Gotte. USNM 562754. First record for Honduran mainland and second for Honduras. The only previous Honduran record was from Isla de Utila, Islas de la Bahía (Vesely and Köhler 2009. Herpetol. Rev. 40:116). The snake was found under a rock in leaf litter on a hillside in subhumid forest.

Submitted by **JAMES R. McCRANIE**, 10770 SW 164th Street, Miami, Florida 33157–2933, USA (e-mail: jmccrani@bellsouth.net); **MARIO R. ESPINAL**, Centro Zamorano de Biodiversidad, Escuela Agrícola Panamericana, El Zamorano, Honduras (e-mail: mknorops@yahoo.com); and **ADDISON WYNN**, Department of Vertebrate Zoology, National Museum of Natural History, Smithsonian Institution, P.O. Box 37012, Washington, DC 20013-7012, USA.

RAMPHOTYPHLOPS BRAMINUS (Brahminy Blind Snake). KIRIBATI: GILBERT ISLANDS: Tarawa Island: Banreaba Village, South Tarawa (1.3457ºN, 173.0357ºE; WGS 84). July 2009. Ross Craven. AMS R174495. Nabeina Islet: North Tarawa (1.4457ºN, 173.0779ºE; WGS 84). 2007. Ross Craven. AMS R1744496. Verified by R. Sadlier. First confirmed records for Kiribati (Bonin and Shea 2009. Herpetofauna 39:74–77). Only previous record for Kiribati is inclusion of Gilbert Islands in a statement of extralimital distribution in an account of Sumatran snakes, without details, voucher, or bibliographic reference (David and Vogel 1996. The Snakes of Sumatra. An Annotated Checklist and Key with Natural History Notes. Edition Chimaira, Frankfurt am Main. 260 pp.). Nearest records are for Marshall Islands (Knight 1984. Herpetol. Rev. 15:115), and Nauru (Buden 2008. Pacific Sci. 62:499–507).

Found while digging in top 15–30 cm of soil (well drained coral sands with organic matter) adjacent to houses. Dominant vegetation consists of coconut (*Cocos nucifera*), *Guettarda speciosa*, *Morinda citrifolia*, *Pandanus tectorius*, and *Premna serratifolia* in upper and middle stories, with grass *Dactyloctenium aegyptium* at ground level. Other plants present are Breadfruit (*Artocarpus altilis*), Frangipani (*Plumeria obtusa*), *Calophyllum inophyllum*, *Ficus tinctoria*, and *Heliotropum foertherianum*, and several grasses including *Cenchrus echinatus*, *Digitaria setigera*, *Eragrostis amabilis*, *Eleusine indica*, *Lepturus repens*, *Paspalum distichum*, *Stenotaphrum micranthum*, and *Thuarea involuta*.

Submitted by **ROSS CRAVEN**, Banraeaba Village, Tarawa, Kiribati (e-mail: ross.craven@unifem.org); and **GLENN M. SHEA**, Faculty of Veterinary Science B01, University of Sydney, New South Wales 2006, Australia (e-mail: glennshea@sydney.edu.au).

RAMPHOTYPHLOPS BRAMINUS (Brahminy Blind Snake). MÉXICO: HIDALGO: Municipality of Tasquillo: Tzindeje (20.56394°N, 99.31800°W; WGS84), elev. 1617 m. 12 July 2008. Luis Alberto Trejo Corona. Verified by Adrian Leyte Manrique. Colección de Anfibios y Reptiles del Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo (CIB-2346). First record for Hidalgo, extending its known range ca. 125 km airline NW from the nearest record in Distrito Federal (Mancilla-Moreno and Ramírez-Bautista 1998. Herpetol. Rev. 29:54). The snake was found during the day among fallen logs and sand in thornscrub.

We received support from Diversidad Biológica del Estado de Hidalgo and FOMIX-CONACYT- HIDALGO 43761, 95828, and funding for fieldwork by S52552-Q.

Submitted by **URIEL HERNÁNDEZ SALINAS** (e-mail: uhernndez3@gmail.com) and **AURELIO RAMÍREZ BAUTISTA,** Centro de Investigaciones Biológicas (CIB), Universidad Autónoma del Estado de Hidalgo, A.P. 1-69 Plaza Juárez, C.P. 42001, Pachuca, Hidalgo, México (e-mail: aurelior@edu.uaeh.mx).

SISTRURUS MILIARIUS (Pygmy Rattlesnake). USA: GEORGIA: Bartow Co.: SR 293, 0.3 mi W of Todd Rd. NW (34.24231ºN, 85.01112ºW; WGS84; Coord Precision: 50; Georef Source: Google Earth ver. 4.0.2091). 10 August 2010. Grover J. Brown. Verified by Kenneth L. Krysko. UF 154935. New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens, Georgia. 575 pp.).

Submitted by **GROVER J. BROWN**, University of Georgia, Odum School of Ecology, Athens, Georgia 30602, USA; e-mail: Turtles328@gmail.com

STORERIA OCCIPITOMACULATA (Red-bellied Snake). USA: GEORGIA: Bulloch Co.: 0.5 km S of East Main Street along Willie McTail Trail in Statesboro (32.26604°N, 81.46927°W; datum not available). 26 June 2010. Submitted by Daniel May and Lance McBrayer. Verified by Ray Chandler. Georgia Southern University Herpetology Collection. GSU 9731, 9732. New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens, Georgia 404 pp.). Originally captured on 01 February 2010 and released; then recaptured in the same location (~10 m from creek) under rotten hardwood log covered with kudzu. The gravid female, (GSU 9731; 152 mm SVL, 195 mm TL) gave birth to five offspring in captivity (GSU 9732; mean SVL 57 mm, 75 mm TL). Each animal was photographed and released.

Submitted by **DANIEL MAY** and **LANCE McBRAYER**, Department of Biology, Georgia Southern University, Statesboro, Georgia 30460, USA.

STORERIA OCCIPITOMACULATA OCCIPITOMACULATA (Northern Red-bellied Snake). USA: ARKANSAS: Grant Co.: 1.6 km N of Leola off St. Hwy 46 (34.184684°N, 92.582645°W; WGS 84). 15 June 2005. H. W. Robison. Verified by R. Tumlison. Henderson State University Herpetological Collection (HSU 1556). New county record. Helps fill a distributional hiatus in central Arkansas between Jefferson and Hot Spring counties (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.).

Submitted by **CHRIS T. McALLISTER**, Science and Mathematics Division, Eastern Oklahoma State College, 2805 NE Lincoln Road, Idabel, Oklahoma 74745, USA (e-mail: cmcallister@se.edu); and **HENRY W. ROBISON**, Department of Biology, Southern Arkansas University, Magnolia, Arkansas 71754, USA (e-mail: hwrobison@yahoo.com).

SYMPHOLIS LIPPIENS (Mexican Short-tailed Snake). MEXICO: JALISCO: Municipality of Puerto Vallarta: 1 km W Quimixto (20.50289°N, 105.37747°W; WGS84), elev. 91 m. 29 July 2008. Marko Antonio Guzmán Vargas. Verified by Luis Canseco Márquez. Colección Herpetológica del Museo de Zoología Alfonzo L. Herrera, Facultad de Ciencias, UNAM (MZFCID 03). First record from Puerto Vallarta, which bridges a distributional gap between 16.8 miles (26.88 km) E of San Blas, Nayarit (Zweifel 1959. Am. Mus. Novit. 1949:1–9) and Guadalajara, Jalisco, the type locality for the species (Smith and Taylor 1945. U.S. Nat. Mus. Bull. 187:iv + 1–239). The snake was found in tropical deciduous forest.

Submitted by **IVÁN T. AHUMADA CARRILLO** (e-mail: lepidus320@hotmail.com.) and **MARKO ANTONIO GUZMÁN VARGAS**, Centro Universitario de Ciencias Biológicas y Agropecuarias, Universidad de Guadalajara, Carretera a Nogales Km. 15.5, Las Agujas, Nextipac, Zapopan, Jalisco, México; and **URI OMAR GÁRCIA-VÁZQUEZ**, Laboratorio de Herpetología, Museo de Zoología, Facultad de Ciencias, Universidad Nacional Autónoma de México, A.P. 70-399, México, D.F. 04510, México.

TANTILLA OOLITICA (Rim Rock Crowned Snake). USA: FLORIDA: Monroe Co.: Big Pine Key, Ixora Drive (24.6814°N, 81.3519°W; NAD 83). 18 December 2007. Michael A. Yirka, Joseph Flowers, Michael D. Martin, Kevin R. Messenger, and Nathan A. Shepard. Verified by Kenneth L. Krysko. Florida Museum of Natural History (UF photograph 152546). Island record. Extends the range 26.7 km west of the closest known locality on Vaca Key (Krysko and Decker 1996. Herpetol. Rev. 27:215). Only known Lower Keys record outside of questionable Key West specimen (Telford 1966. Bull. Florida St. Mus. Biol. Ser. 10:261–304).

Submitted by **MICHAEL A. YIRKA**, 6016 Countryview Ln, Raleigh, North Carolina 27606, USA; **JOSEPH N. FLOWERS**, 4325 Inwood Road, Raleigh, North Carolina 27603, USA; **MICHAEL D. MARTIN**, University of South Carolina, Department of Biological Sciences, Coker Life Sciences Room 706, Columbia, South Carolina 29208, USA; **KEVIN R. MESSENGER**, Marshall University, Department of Biological Sciences, One John Marshall Drive, Huntington, West Virginia 25703, USA; and **NATHAN A. SHEPARD**, Marshall University, Department of Biological Sciences, One John Marshall Drive, Huntington, West Virginia 25703, USA (e-mail: nathan.zoology@gmail.com).

TROPIDOCLONION LINEATUM (Lined Snake). USA: NEW MEXICO: Otero Co.: 1.93 km E of Mayhill on US Hwy 82 and 0.32 km N on Cherry Lane (32.90860°N, 105.46993°W; NAD83/WGS84), elev. 2016 m. 07 July 2006. Ian W. Murray and Christopher Newsom. Verified by J. Tomasz Giermakowski. University

of New Mexico Museum of Southwestern Biology (MSB 72651). New county record (Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. Univ. New Mexico Press, Albuquerque. 431 pp.). The specimen was found under a small board on moist soil. Other reptile species noted nearby included *Diadophis punctatus*, *Opheodrys vernalis*, *Sceloporus poinsettii*, *S. cowlesi*, and *Phrynosoma hernandesi*. During September 2005 EM found and photographed an adult female *T. lineatum* at this location, but it was not collected.

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TROPIDODIPSAS FASCIATA (Banded Snail Sucker). MÉXICO: GUERRERO: Municipality of Zihuatanejo: 27 km SW Vallecitos de Zaragoza, on México Hwy 134 (17.782°N, 101.478°W; WGS84), 333 m elev. 02 September 2008. William H. Mertz. Verified by Coleman M. Sheehy III. UTA digital collection (UTADC 3702). New municipality record, which extends the range of the species ca. 200 km W of its closest known localities in central Guerrero (Kofron 1987. J. Herpetol. 21:210–225). The snake was found AOR at night in tropical deciduous forest.

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TROPIDOPHIS GREENWAYI GREENWAYI (Big Ambergris Cay Dwarf Boa). TURKS AND CAICOS ISLANDS: Big Ambergris Cay: N end of island (21.317°N, 71.630°W; WGS84), elev. 3 m. 20 March 2009. J. Burgess, G. Gerber, and G. Reynolds. Verified by J. Iverson. Color photographic voucher, Austin Peay State University (APSU 19018). First published record for Big Ambergris Cay, the type locality, since 1936 and only the third individual ever encountered on the island. Because it had not been found since 1936, despite a great deal of herpetological investigations, the species was thought to have been extirpated from the Island (Iverson 1986. Carib. J. Sci. 22:191–198). The male snake was encountered at night, during a light rain, on a dirt road at the base of a rocky hillside.

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Noteworthy Distribution Records of Reptiles from Western Panamá

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Despite of its small size, Panamá is home to 251 species of reptiles, including 89 lizards and 143 snakes (Jaramillo et al. 2010; Köhler 2010; Köhler et al. 2010). The descriptions of new reptiles continue at a steady pace (e.g., Cadle and Myers 2003; Hulebak et al. 2007; Köhler 2010; Köhler et al. 2010, 2007; Köhler and Sunyer 2008; Myers 2003; Poe and Ibañez 2007; Poe et al. 2009; Savage and Watling 2008; Savage et al. 2008), indicating that our knowledge of the Panamanian herpetofauna is still fragmentary and investigative work remains to be done. This applies to taxonomic issues as well as to biogeography. Additionally, the distributions of many species occurring within Panamá are poorly documented. Apart from information scattered among local checklists and publications on single species, only four comprehensive works exist for the country. Pérez-Santos (1999) presented distribution maps with precise collecting localities for 129 snake species. Köhler (2008) provided distribution maps for 238 reptile species occurring in Panamá. Some of the maps pinpoint actual collection sites, but most reflected areas of generalized distribution. The only work considering distribution of the herpetofauna among Panamá's political subdivisions was by Young et al. (1999), therein summarizing the distribution of 228 species at the province level. However, their distributional records were not supported by reference to voucher material, and they did not include the results of two extensive regional inventories by Martínez and Rodriguez (1992) and Martínez et al. (1994). Recently, Jaramillo et al. (2010) summarized the distribution of the Panamanian herpetofauna within physiographic regions and vegetation zones.

During field work on reptiles conducted in western Panamá between May and August 2008, we visited localities within the provinces of Bocas del Toro, Chiriquí, Veraguas, and Comarca Ngöbe-Buglé (a recently established indigenous autonomous region that comprises areas formerly belonging to the other three provinces) (Fig. 1). We collected 217 samples representing 72 species and 17 of those constitute extensions of their known distributions in Panamá. We herein report distribution extensions of

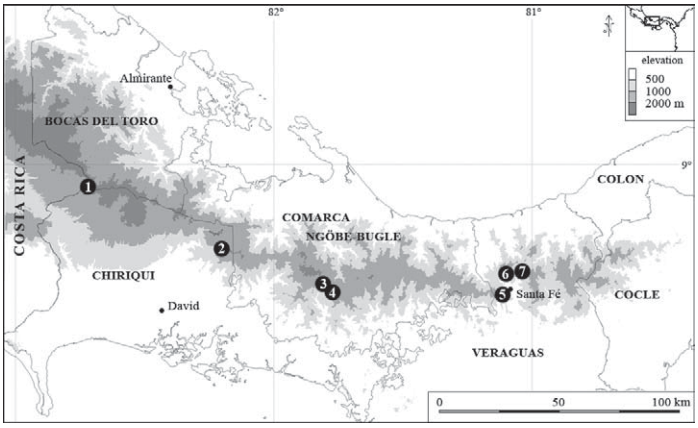


FIG. 1. Generalized localities in western Panamá visited by the authors in 2008: 1) Jurutungo, Chiriquí; 2) Reserva Forestal La Fortuna, Chiriquí; 3) road to Cerro Colorado, Comarca Ngöbe-Buglé; 4) La Nevera, Comarca Ngöbe-Buglé; 5) Cerro Mariposa (= Cerro Tute), Veraguas; 6) Cerro Negro, Veraguas; 7) Río Chilagres, Veraguas.

those 17 species, 11 of which are new provincial records; other accounts list new elevational parameters for the species.

Abbreviations for museum collections follow those of Leviton et al. (1985). Elevations were rounded to the next tenth. The map (Fig. 1) was created using DIVA-GIS and the NASA elevation datasets processed by Jarvis et al. (2006); map datum is WGS84. All vouchers were verified by Javier Sunyer. Common names came from Frank and Ramus (1995), except for *Leposoma southi* (Uetz 2008), *Urotheca guentheri* (Solórzano 2004), and by us herein for *Anolis fortunensis* and *A. pseudopachypus*, two species for which there are no published common names. We decided that for those two species, the common names should denote their type localities; Reserva Forestal La Fortuna, Panamá, and La Nevera, Panamá, respectively.

Squamata — Lizards

Sphaerodactylidae

Lepidoblepharis xanthostigma (Costa Rica Scaly-eyed Gecko). VERAGUAS: Cerro Mariposa, near Alto de Piedra, ca. 3.5 km W of Santa Fé (8.5161°N, 81.1185°W), 880 m elev. 12 May 2008. Andreas Hertz and Sebastian Lotzkat. SMF 89576. Cerro Negro, ca. 6 km NNW of Santa Fé (8.5690°N, 81.0989°W), 700 m elev. 28 July 2008. Andreas Hertz and Sebastian Lotzkat. SMF 89963. Martínez and Rodriguez (1992), in their inventory of "Cerro Tute" (= Cerro Mariposa) and Martínez et al. (1994) in their species list of the nearby mountains, Narices and La Anselma, both reported the presence of *Lepidoblepharis* sp., and considered them to resemble *L. xanthostigma*. However, because the specific identities of these geckos were not made and the respective voucher specimens were lost (V. Martínez pers. comm.), our records represent the first confirmed occurrence for the species in Veraguas. The records also fill the gap between records to the west in Chiriquí and Bocas del Toro and the east in Coclé and Colón (Young et al. 1999).

Gymnophthalmidae

Leposoma southi (Northern Spectacled Lizard). VERAGUAS: Cerro Mariposa, near Alto de Piedra, ca. 3.5 km W of Santa Fé (8.5095°N, 81.1173°W), 900 m elev. 2 August 2008. Leonhard Stadler and Nadim Hamad. SMF 89577. This record extends by 200 m, the upper confirmed elevational limit for the species previously reported by Savage (2002) and Köhler (2008). The presence of *L. southi* around Alto de Piedra was documented by Martínez and Rodriguez (1992). However, elevational distribution for their individual records was unspecified; only a general elevational range of between 800 m and 1450 m was given.

Hoplocercidae

Enyalioides heterolepis (Bocourt's Dwarf Iguana). VERAGUAS: Cerro Negro, ca. 6 km NNW of Santa Fé (8.5690°N, 81.0989°W), 700 m elev. 30 July 2008. Sebastian Lotzkat. SMF 89558. Cerro Negro, 6 km NNW of Santa Fé (8.5693°N, 81.1022°W), 713 m elev. 28 June 2008. Arcadio Carrizo. SMF 89955–56. First records for Veraguas, extending the range more than 50 km W of the formerly westernmost record from El Copé, Coclé (Lips 1999). Köhler (2008) mentioned a record of *E. heterolepis* from Bocas del Toro, which as far as we can tell is not supported by a voucher specimen. A now lost individual from Cerro Narices (between Cerro Negro and Río Chilagres, see Fig. 1) that was listed as *Sceloporus squamosus* by Martínez et al. (1994), actually represented an *E. heterolepis* (A. Rodriguez, pers. comm.).

Polychrotidae

Anolis auratus (Grass Anole). VERAGUAS: road between Santiago and Santa Fé, ca. 8 km N of Santa Fé; (8.1796°N, 80.951°W), 80 m elev. 14 May 2008. Andreas Hertz. SMF 89444. First record for Veraguas, bridging the gap between localities in Chiriquí to the west and Los Santos, Colón, and Panamá to the east (Köhler et al. 2008; Young et al. 1999).

Anolis capito (Bighead Anole). CHIRIQUÍ: Reserva Forestal La Fortuna (8.6744°N, 82.2161°W), 1460 m elev. 16 June 2008. Andreas Hertz. SMF 89449. This record increases the known elevational limit for the species by 160 m (Köhler 2008).

Anolis fortunensis (La Fortuna Anole). CHIRIQUÍ: Reserva Forestal La Fortuna (8.6776°N, 82.1981°W), 1750 m elev. 27 June 2008. Andreas Hertz and Sebastian Lotzkat. SMF 89466. This record extends the known elevational range of the species by 550 m (Köhler 2008).

Anolis humilis (Humble Anole). CHIRIQUÍ: Reserva Forestal La Fortuna (8.6761°N, 82.2006°W), 1660 m elev. 27 June 2008. Sebastian Lotzkat. SMF 89480. This record increases the known elevational range by 60 m (Köhler 2008).

Anolis pseudopachypus (La Nevera Anole). CHIRIQUÍ: Reserva Forestal La Fortuna (8.6761°N, 82.2006°W), 1660 m elev.; (8.6793°N, 82.193°W), 1800 m elev. 25 and 27 June 2008. Andreas Hertz and Sebastian Lotzkat. SMF 89523, 89526, respectively. First records for Chiriquí, and extends the range ca. 50 km WNW of the type locality (La Nevera, Comarca Ngöbe-Buglé; Köhler et al. 2007). COMARCA NGÖBE-BUGLÈ: Valley north of La Nevera, ca. 5.5 km N of Hato Chamí (8.5018°N, 81.7689°W), 1560 m elev. 9 August 2008. Andreas Hertz and Sebastian Lotzkat. SMF 89519–89521. Ridgetop NE of La Nevera, ca. 5.5 km N of Hato Chami (8.4954°N, 81.7673°W), 1810 m elev. 18 August 2008. Andreas Hertz and Sebastian Lotzkat. SMF 89522. These records, near the type locality of *Anolis pseudopachypus*, repre-

sent the lowest and highest elevational records, respectively, for the species, which was previously known only from 1600 m elevation (Köhler et al. 2007).

Anolis salvini (Salvin's Anole). CHIRIQUÍ: Jurutungo, near border with Costa Rica (8.912°N, 82.7182°W), 1980 m elev. 8 July 2008. Andreas Hertz and Sebastian Lotzkat. SMF 89527. This record extends the known elevational distribution of the species upward ca. 150 m (Köhler 2008; Savage 2002).

Anolis vittigerus (Garland Anole). VERAGUAS: Río Chilagres, ca. 9 km NE of Santa Fé (8.5872°N, 81.0363°W), 480 m elev. 3 June 2008. Andreas Hertz and Sebastian Lotzkat. SMF 89528. First record for Veraguas, extending the range ca. 50 km W of the formerly westernmost record from north of El Copé, Coclé (Poe and Ibañez 2007).

Squamata — Snakes

Colubridae

Dipsas articulata (American Snail-eater). VERAGUAS: Cerro Negro, ca. 6 km NNW of Santa Fé (8.5756°N, 81.0976°W), 1000 m elev. 29 July 2008. Arcadio Carrizo. SMF 89552. Since locality data for the holotype of *D. articulata* is imprecise (see remarks in Peters 1960), this is the first validated record for Veraguas. The record reconfirms the species' occurrence at 1000 m, reported as its upper elevational limit by Solórzano (2004).

Dipsas temporalis (Temporal Snail-eater). VERAGUAS: Cerro Mariposa, near Alto de Piedra, ca. 3.5 km W of Santa Fé (8.5107°N, 81.1207°W), 990 m elev. 10 July 2008. Leonhard Stadler and Nadim Hamad. SMF 89552. First record for Veraguas, and a range extension of ca.130 km W of the South slope of Cerro La Campana, the formerly westernmost record in Panamá (Pérez-Santos 1999). Another specimen (SMF 89553) found nearby (8.5245°N, 81.1332°W), 700 m elev., on 5 August 2008 was acquired at the lowest elevation reported for this species (Pérez-Santos 1999).

Imantodes cenchoa (Blunt-headed Tree Snake). COMARCA NGÖBE-BUGLÈ: road to Cerro Colorado west of La Nevera, ca. 10 km NNW of Hato Chamí (8.5303°N, 81.7987°W), 1660 m elev. 10 May 2008. Andreas Hertz. SMF 89573. The locality is situated at an elevation 160 m above that reported for the species by Solórzano (2004).

Oxyrhopus petola (Calico False Coral Snake). VERAGUAS: Río Chilagres, ca. 9 km NE of Santa Fé (8.5872°N, 81.0363°W), 480 m elev. 3 June 2008. Andreas Hertz and Sebastian Lotzkat. SMF 89585. First record for Veraguas, which bridges a distributional gap between localities in the provinces of Chiriquí and Bocas del Toro to the west and Colón and Panamá to the east (Young et al. 1999).

Urotheca guentheri (Striped Glasstail). VERAGUAS: Cerro Mariposa, near Alto de Piedra, ca. 3.5 km W of Santa Fé (8.5002°N, 81.1175°W), 1250 m elev. 5 June 2008. Leonhard Stadler and Nadim Hamad. SMF 89603. First record for Veraguas, filling a gap between localities in the provinces of Bocas del Toro (La Loma, ca.120 km NW) and Coclé (about 110 km E) (Myers 1974).

Viperidae

Bothriechis nigroviridis (Black-speckled Palm Viper). COMARCA NGÖBE-BUGLÈ: La Nevera, ca. 5.5 km N of Hato Chamí (8.4996°N, 81.77°W), 1650 m elev. 11 May 2008. Andreas Hertz, Leonhard Stadler, Nadim Hamad, and Sebastian Lotzkat. SMF 89534. First record for Comarca Ngöbe-Buglé, and an 80 km E range extension from the formerly easternmost record in Boquete, Chiriquí (Dunn 1947).

Bothriechis schlegelii (Eyelash Palm Viper). VERAGUAS: Cerro Mariposa, near Alto de Piedra, approx. 3.5 km W of Santa Fé (8.5157°N, 81.1197°W), 860 m elev. 13 May 2008. Gunther Köhler. SMF 89535. First record for Veraguas, which fills the gap between Isla Escudo de Veraguas, Comarca Ngöbe-Buglé (ca. 85 km NW), and El Valle de Anton, Coclé (ca. 105 km E) (Pérez-Santos 1999).

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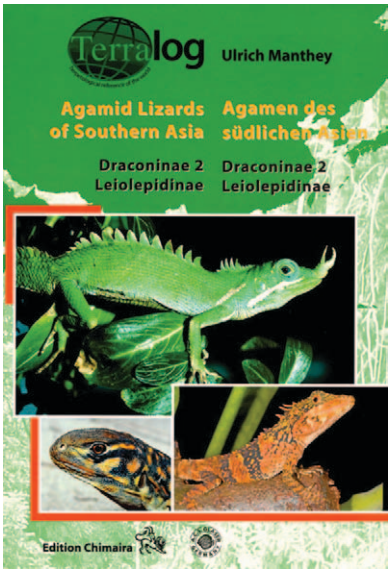
BOOK REVIEWS

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Agamid Lizards of Southern Asia — Agamen des südlichen Asien — Draconinae 2, Leiolepidinae, by Ulrich Manthey. 2010. Terralog Vol. 7b. Edition Chimaira, Frankfurt am Main. 168 pp. Hardcover. 39,80 Euros (approximately US $50.00). ISBN 978-3-89973-375-4.

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Only a handful of researchers work on South Asian agamids. Synthetic works on this group are scarce, and a new book on this subject is hence very welcome. It follows a first volume in the Terralog series on South Asian agamids, that included only part of the Draconinae (Manthey 2008), and it aims to list and illustrate the remaining taxa that were not dealt with in that first volume. Taxa newly dealt with are all currently recognized Draconinae belonging to genera starting with the letters G to S (*Gonocephalus*, *Harpesaurus*, *Hypsicalotes*, *Japalura*, *Lophocalotes*, *Lyriocephalus*, *Mantheyus*, *Mictopholis*, *Oriocalotes*, *Otocryptis*, *Phoxophrys*, *Psammophilus*, *Pseudocalotes*, *Pseudocophotis*, *Ptyctolaemus*, *Salea*, and *Sitana*), the Leiolepidinae (*Leiolepis*) and the genus *Physignathus* (whose subfamilial position is still unclear), as well as several undescribed taxa. The book, well bound and with high-quality glossy paper, is bilingual (English-German). It is divided mainly into a table of contents (pp. 3–5), an introduction in which the author gives his point of view on the taxonomic status of various taxa (pp. 6–8), a section on how to use the book, which provides brief advice on captive maintenance (pp. 9–11), literature references (pp. 12–14), and the main section, the species illustrations (pp. 16–168). The front and back covers are finely illustrated and the inner covers provide geographical and political maps of the area covered.

The literature section is short (147 references) and does not provide an exhaustive list of publications on the species concerned, but rather useful references to original descriptions. The most recent references date from 2009.

Color illustrations are provided for each species and represent the strongest point of the book. We counted a total of 524 photographs (not including the nine images on the front and back covers). Twenty-nine of them are biotope photographs. Besides these color photographs, there are four drawings. Only ten species are not illustrated alive, but by drawings or through photographs of preserved type material (clearly indicated as such). All photographs are of very high quality (the whole book is a real delight for the eyes), and many of them, taken *in situ*, provide useful information on biotopes. One of the photographs, showing a *Mantheyus* hatching *in situ*, deserves a special mention. Nearly all of the photographs are accompanied by locality data, which increases their value. Each picture is also associated with a unique coded number, facilitating reference to it, and under each species' pictures, symbols (explained on a folded page) add ecological information. Maps are provided for all species, generally with several species per map. Thirty-three species' geographical distribution maps are distributed throughout the illustrations section. They are not always complete (i.e., some published localities were sometimes omitted), but are generally very good. A very good point is that they include specific dots for the type localities of the species as well as of their synonyms. When for a given species the map is not in direct proximity to the corresponding photograph(s) there is a reference to the map page, which greatly facilitates the use of the book.

One hundred described taxa are included and illustrated, plus eleven populations whose status is unresolved, among them some representing taxa new to science. The most remarkable undescribed taxon photographed is a beautiful green arboreal agamid from Sumatra, provisionally called 'Genus X sp. A'. The others belong to *Gonocephalus*, *Phoxophrys*, *Pseudocalotes*, and *Sitana*. The photographs of these possibly undescribed taxa were smartly included directly near the most similar described species in order to facilitate visual comparisons. Some readers might wonder why the book does not mention *Physignathus lesueurii*, while it has a section on *P. cocincinus*. It is due to the fact that both species were recently shown to be distant and not congeneric, *P. lesueurii* belonging to the *Amphibolorus* group (Hugall et al. 2008).

The book proposes a new generic reallocation '*Pseudocalotes kakhienensis* nov. comb.,' for a species previously included in *Salea*; the rationale for this new placement is briefly mentioned on page 8. Such a reallocation should have deserved a more detailed explanation, but more details can be found in Mahony (2010) who reached the same conclusion in a paper published shortly after the book discussed here. It is to be noted that the monotypic genus *Mictopholis*, recognized as valid by Manthey in the presently reviewed book, is synonymized with *Pseudocalotes* by Mahony (2010). This latter author moreover synonymized *Japalura kaulbacki* with *Calotes kingdonwardi* and transferred it to the genus *Pseudocalotes*. The species had been illustrated under *Calotes k. kingdonwardi* and its synonym *C. kingdonwardi bapoensis* in the first Terralog volume on Draconinae (Manthey, 2008, pages 72–73). '*Pseudocalotes* sp. A' (pp. 144–145) was described as *Pseudocalotes ziegleri* Hallermann, Nguyen, Orlov & Ananjeva, 2010 (Hallermann et al. 2010) just after the book was published. It is a pity that such important changes could not be taken into account in the book.

Several individuals of 'Genus X sp. A' were preserved and currently are under study by one of us (DTI). Unfortunately only females are so far available. The individual in photograph RA02341-4 on page 54, identified as '? *Harpesaurus brooksi*,' is not a *Harpesaurus* (or *Thaumatorhynchus*), but more likely a *Pseudocalotes tympanistriga*; compare with the female of that latter species on photograph RA03696-4 on page 143, showing the very same color pattern. We are unclear as to Manthey's basis for regarding the genus *Thaumatorhynchus* as a synonym of *Harpesaurus*, in spite of striking differences in habitus—roundish body section in *Thaumatorhynchus* versus triangular in *Harpesaurus*, and the absence of dorsal and nuchal crests in *Thaumatorhynchus* versus presence in *Harpesaurus*. The individual in photograph RA02905-4 on page 105, identified by U. Manthey as *Lophocalotes ludekingi*, more likely belongs to the very rare species *Pseudocalotes* (or *Pseudocophotis*) *sumatrana*. The assumption that this latter species has a prehensile tail (see page 7) remains unverified. The '*Leiolepis belliana ocellata*' in photograph RA04712-4 on page 161 is apparently actually a *Leiolepis peguensis* (J. L. Grismer pers. comm. to U. Manthey). This would be good news since that latter species is otherwise illustrated in the book only through a photograph of a faded, preserved paratype of the species. We take the opportunity to mention that the '*Bronchocela* sp. A' illustrated in Manthey (2008, pages 55–56) has since been described as *B. rubrigularis* Hallermann, 2009, and that '*Acanthosaura* cf. *crucigera*' (see Manthey, 2008: 27) was since described as *A. cardamomensis* Wood, Grismer, Grismer, Neang, Chav & Holden, 2010 (see Wood et al. 2010).

Such excellent book quality is no surprise given that the author is already well known for having co-authored a remarkable synthetic opus on Southeast Asian reptiles and amphibians (Manthey and Grossmann 1997), and for his taxonomic studies on agamids (see the literature cited in the volume discussed here). He has described, among other agamid taxa, the enigmatic *Ptyctolaemus phuwuanensis* Manthey & Nabhitabhata, 1991, which was so unique that it was later placed in the distinct genus *Mantheyus* Ananjeva & Stuart, 2001, a name that was coined in recognition of the author's significant herpetological contributions.

The book's price indicated on the Chimaira website, 39.80 Euros (ca. 50 USD) excluding shipping costs, is a bit high, but is largely compensated by the excellent printing and binding quality, and the numerous beautiful photographs. We highly recommend it to all herpetologists and natural history lovers.

We moreover look forward to reading the following opus on agamids in the Terralog series, whose provisionally planned title is 'Agamid Lizards of Africa – Agaminae 1 and Uromastycinae,' by Philipp Wagner and Ulrich Manthey due to appear in 2012 (U. Manthey, pers. comm.). We are very grateful to Ulrich Manthey for kindly answering our numerous questions about his latest book.

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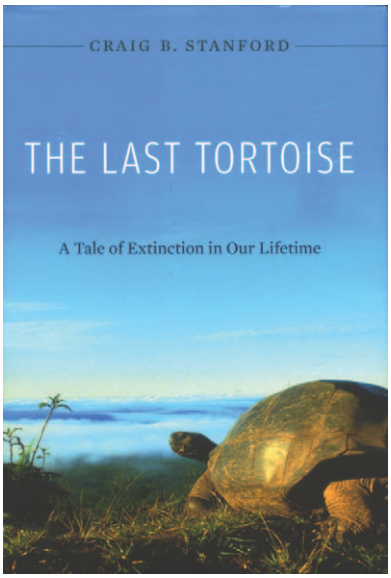
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Herpetological Review, 2010, 41(4), 525.
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The Last Tortoise: A Tale of Extinction in Our Lifetime, by Craig B. Stanford. 2010. Harvard University Press (www.hup.harvard.edu). Hardcover. viii + 210 pp., 16 pp. pls. US $23.95. ISBN 978-0-674-04992-5.

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The Last Tortoise is the reptilian version of Kathryn Phillips, *Tracking the Vanishing Frogs* (1994). It is a well written book by a non-specialist that covers various aspects of the conservation and survival issues surrounding a group of animals. Stanford travels the world to visit the tortoise hotspots the same way Phillips did at the beginning of the declining amphibian phenomenon, highlighting the work of leading tortoise conservationists at various locations.

The chapters of *The Last Tortoise* cover the decline, conservation and, in some cases, the successes of tortoises across multiple continents. The initial chapters, 'What Exactly Are Tortoises and Turtles' and 'Live Long and Prosper,' provide a good background on tortoise biology and ecology. Descriptions of shell evolution, fossil record, and species diversity are written for the layperson, but provide enough depth for a biologist.

In 'No Respect for the Ancient Lands' Stanford highlights the issues of habitat destruction, human population growth and the impact of invasive and introduced species on tortoises. The results of these activities lead to increased road kill, predation of nests and young, and loss of quality forage. The 'Eating Tortoises' chapter diverges from tortoises and covers the use of freshwater turtles in the food trade, both historic and recent. The author details how the Diamondback Terrapin fishery of the eastern United States lead to the collapse of an abundant species, which is still trying to recover, more than a half century after the end of the commercial harvest. Stanford also covers modern turtle use in China and the impact it is having around the world; although freshwater turtles are mainly at risk, many southeast Asian tortoises are also being consumed.

Many cultures have been keeping and eating tortoises for millennia. Prior to the 20th century population levels of humans were low enough to allow for sustainable use of mainland tortoises. The effect of whalers on island forms are detailed later in the book. The exponential growth of the human population starting in the 20th Century will continue to lead to the extinction of tortoises and other flora and fauna until we can control our population levels.

'Such Huge Deformed Creatures' covers the giant tortoises of the Galapagos and Aldabra. The whaling fleets of the 1800's were able to quickly decimate the populations of these unique tortoises. Several species and subspecies were harvested to extinction. Besides just taking the tortoises the whalers also left rats and goats, which decimated the nests and vegetation. Stanford covers the recovery programs on both island groups to increase and stabilize the populations.

The appendices at the end of the book provide a quick reference to the largest vs. smallest tortoises, the most endangered species and a complete listing of all tortoise species with general distributional information.

The Last Tortoise is a fun and interesting read on the disturbing subject of the potential extinction of tortoises. I would recommend this book to anyone interested in turtles and tortoises. I encourage those of us who are aware of the plight of tortoise to share this book with friends and colleagues who are not. Stanford's engaging writing style will make them advocates for tortoises by the time they are done with the last chapter.

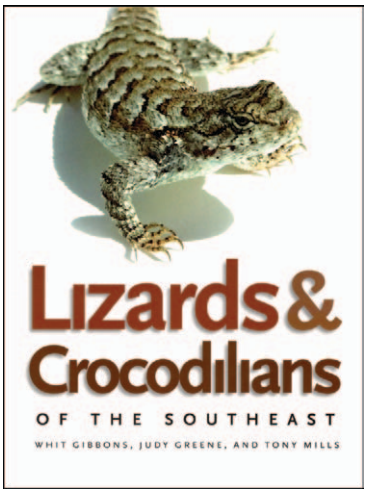
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Herpetological Review, 2010, 41(4), 526.
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Lizards and Crocodilians of the Southeast, by Whit Gibbons, Judy Greene, and Tony Mills. 2009. University of Georgia Press (www.ugapress.org). Softcover. US $24.95. ISBN 978-0-8203-3158-4.

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Niche partitioning is readily observable in books focused on regional treatments of amphibians and reptiles. *Lizards and Crocodilians of the Southeast* by Gibbons, Greene, and Mills occupies an underexploited niche, albeit a very important one, being a valuable learning source for beginning naturalists and budding herpetologists. This book also places the southeastern herpetofauna within the larger context of conservation.

The authors initially provide an overview of saurian and crocodilian global diversity, systematics, and taxonomy. Native and exotic species are clearly and concisely juxtaposed with respect to numbers, geographic ranges, and known and potential interspecific interactions. "Did you know?" boxes, which are scattered throughout the book, provide the reader with relevant interesting facts about lizards and crocodilians. Pictures are worth a thousand words, and the numerous photographs are high in quality and effectively illustrate such topics as predation and thermoregulation. I liked looking for the five Green Anoles near their hibernaculum, even though I could only find four of them!

Accounts are provided for each species that will allow a person unfamiliar with a species, such as the Southeastern Five-lined Skink, to identify it as well as learn about its biology. The approach and level of detail are appropriate not only for novices, but also for professionals and serious naturalists inexperienced with the southeastern herpetofauna. Each species account nicely covers various aspects of ecology and concludes with the conservation status of that species. Unfortunately, even some geographically wide-ranging species are no longer abundant and their futures cannot be considered secure.

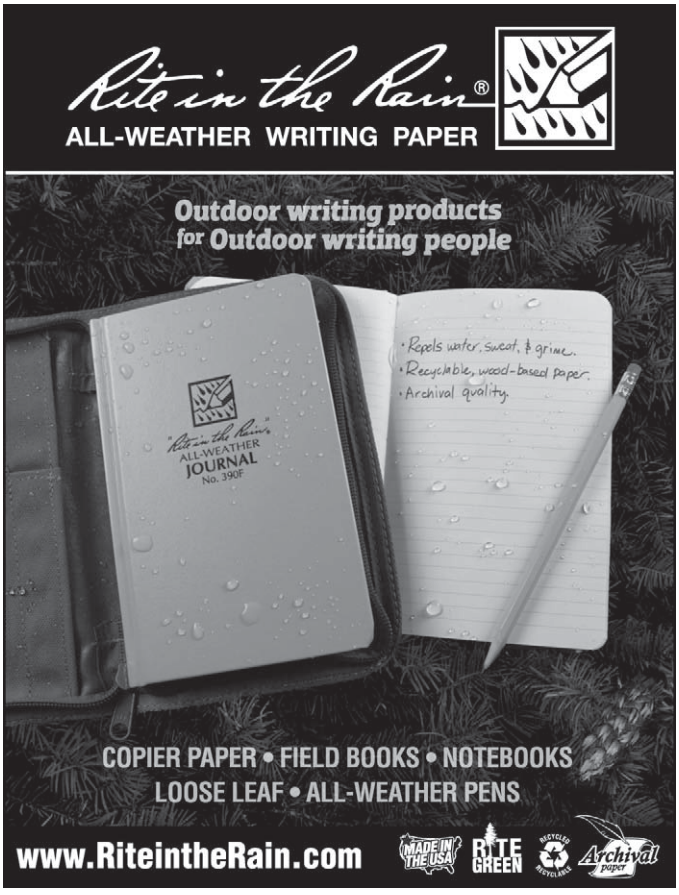
Distribution maps of both the Southeast and the United States as a whole are useful to the reader and species identifications are facilitated by numerous color photos as well side by side drawings of adults and hatchlings giving body sizes in inches. Accompanying "How do you identify a …" side bars also clearly introduce readers to the most useful and reliable key characteristics for each species.

The treatment of the exotic species is slightly different than that of native species. For example, although geographic ranges are discussed, maps are not included because of the dynamic nature of the colonization process. The topics within the exotic species accounts are fewer in light of the information gaps surrounding many of them. The authors have done an excellent job summarizing ecological data and highlighting impacts of the exotic species.

After the species accounts, the authors discuss the "Why" and "How" of studying these reptiles. A section on husbandry follows with a discussion on practical and ethical considerations. With these in mind the authors discuss which species to keep, how to feed and house lizards, and the implications of taking animals from the wild. The last section, "Conservation of Lizards and Crocodilians," concisely encapsulates the theme that permeates the entire book and argues for herpetological education as a means to achieve conservation goals.

Separate tables of the state-by-state occurrence of exotic and native species, a short list of sources for further reading, a glossary, and an index to scientific and common names are all valuable components that round out this work. The "Further Reading" section could have been enhanced by the inclusion of a few quality books on the husbandry of lizards and crocodilians.

Lizards and Crocodilians of the Southeast gets my vote as a useful and inspiring regional source for naturalists from beginners onwards. Its effective integration of perspectives on both conservation and global reptile diversity sets it apart from most other regional reptile guides.





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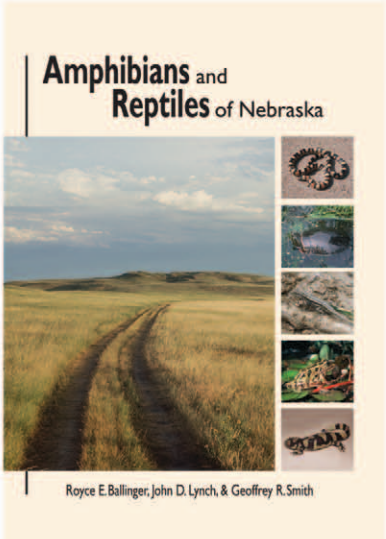
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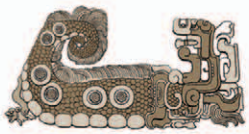
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HONDURAS IS THE SECOND LARGEST OF the seven Central American countries. Its snake fauna, however, has been one of the least known in the region and numerous studies have referred to the "Honduran hiatus" in distribution and in our understanding of the systematics of indigenous species. James R. McCranie, who began field work in Honduras in 1976, has made an intensive study of the herpetofauna and has now produced a book that will serve to make the snake



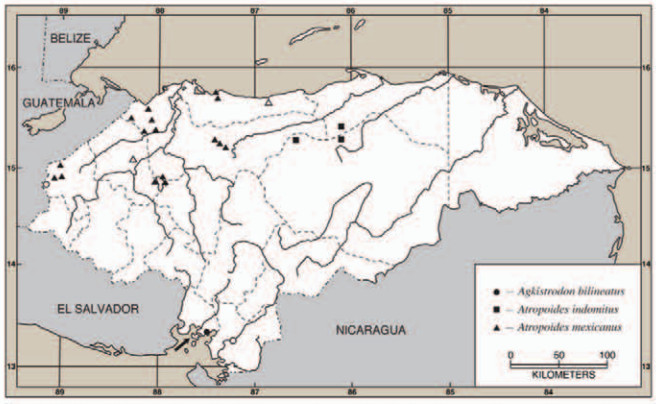


fauna of Honduras one of the best known in the world. He has spent a total of more than 1600 days in the field and has personal field experience with nearly every species. He has examined nearly 6200 specimens in researching this book. The result is a model faunal study that will be a welcome reference for scientists and conservationists alike. It will be a reminder of the potential loss of biodiversity in a country in which deforestation and loss of habitat have greatly accelerated over the last two decades. This book is a companion to "The Amphibians of Honduras," by McCranie and Larry David Wilson, also published by SSAR (2002).

The Honduran snake fauna consists of 136 species in nine families: Anomalepididae (1 genus: 1 species), Leptotyphlopidae (1:2), Typhlopidae (2:4), Boidae (2:2), Loxocemidae (1:1), Ungaliophiidae (1:1), Colubridae (50:108), Elapidae (2:6), and Viperidae (7:11). The book has extensively illustrated identification keys in both English and Spanish, a discussion of the Honduran environments, a brief history of reptilian study in Honduras, distribution, and essays about the conservation of the Honduran snake fauna. The bulk of the book consists of detailed accounts of the species (each one includes synonymy, range, diagnosis, description, references to published illustrations, remarks, ecological distribution, natural history, etymology, and specimens examined).



There is a gazetteer of Honduran localities, a glossary, a comprehensive literature cited section, and indexes to authors and taxa. Finally, there are **20 COLOR PLATES** including 22 photographs of habitats and 158 of snakes.



Map 101. Localities for Agkistrodon bilineatus, Atropoides indomitus, *and* Atropoides mexicanus.

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Herpetological Review

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SOCIETY FOR THE STUDY OF AMPHIBIANS AND REPTILES

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The Society for the Study of Amphibians and Reptiles, the largest international herpetological society, is a not-for-profit organization established to advance research, conservation, and education concerning amphibians and reptiles. Founded in 1958, SSAR is widely recognized today as having the most diverse society-sponsored program of services and publications for herpetologists. Membership is open to anyone with an interest in herpetology—professionals and serious amateurs alike—who wish to join with us to advance the goals of the Society.

All members of the SSAR are entitled to vote by mail ballot for Society officers, which allows overseas members to participate in determining the Society's activities; also, many international members attend the annual meetings and serve on editorial boards and committees.

All members and institutions receive the Society's primary technical publication, the *Journal of Herpetology,* and its news-journal, *Herpetological Review*; both are published four times per year. Members also receive pre-publication discounts on other Society publications, which are advertised in *Herpetological Review*.

To join SSAR or to renew your membership, please visit the secure online ZenScientist website via this link:

http://www.ssarherps.org/pages/membership.php

Future Annual Meetings

2010 — Providence, Rhode Island, 7–12 July (with ASIH, HL)
2011 — Minneapolis, Minnesota, dates TBA (with ASIH, HL)
2012 — Vancouver, British Columbia, dates TBA (with ASIH, HL, WCH)

About Our Cover: *Cnemaspis psychedelica*



The monophyletic Southeast Asian portion of the genus *Cnemaspis* contains 40 species of rock geckos that collectively range throughout much of Southeast Asia west of Wallace's Line. Nearly 70% of the species have been described within the last six years. Rock geckos are largely microhabitat specialists showing high degrees of local endemism, while others are insular endemics. In general, *Cnemaspis* are small, cryptically colored lizards inhabiting primary and old secondary rainforests and generally restrict their movements to the shaded surfaces of rocks, trees, and caves. The combination of cryptic behavior, microhabitat specialization, and morphological conservatism has made it difficult to delimit species boundaries and has generated considerable taxonomic confusion. Until recently, this confluence of circumstances meant that many species went unnoticed as distinct lineages. Current researchers, armed with better knowledge of morphological characters useful in sorting species and a better understanding of where and how to look for rock geckos, have resolved many of these issues. Furthermore, access into previously unexplored territories and unique landscapes has accelerated the rate of new discoveries.

Discovered in 2009, *Cnemaspis psychedelica* is endemic to the small island of Hon Khoai off the southern tip of Vietnam (Grismer et al. 2010. Zootaxa 2352:46–58). This is the most spectacularly colored species in the genus and unlike most other *Cnemaspis*, is diurnal and may even spend time basking. At night, individuals cluster together and take refuge beneath overhangs and within rocky crevices. The reason for their gaudy, seemingly incongruous combination of colors is unknown, but occurs in all age classes and both sexes. Ongoing molecular studies indicate that *C. psychedelica* is the most ancient lineage within Southeast Asian *Cnemaspis* and likely differentiated in a portion of the Sunda Shelf now covered by the South China Sea. Unfortunately, its attractive coloration puts it in the cross-hairs for illegal collection. Fortunately, Hon Khoai Island is occupied exclusively by the Ca Mau Border Army of South Vietnam and non-military personnel are expressly denied access onto the island.

The cover photo by **L. Lee Grismer** was taken *in situ* on Hon Khoai Island at night using a Nikon D300 with an SB 800 Nikon Speed Light and a Nikon VR 105mm macro lens at f.22. **Grismer** is professor of biology at La Sierra University, Riverside, California. He has been working intensively in Peninsular Malaysia since 2003 and in the last six years, his team has added considerably to the region's known herpetofauna. Grismer's latest book, *The Lizards of Peninsular Malaysia, Singapore, and the Adjacent Archipelagos: Their Description, Distribution, and Natural History*, is due to be published in early 2011.

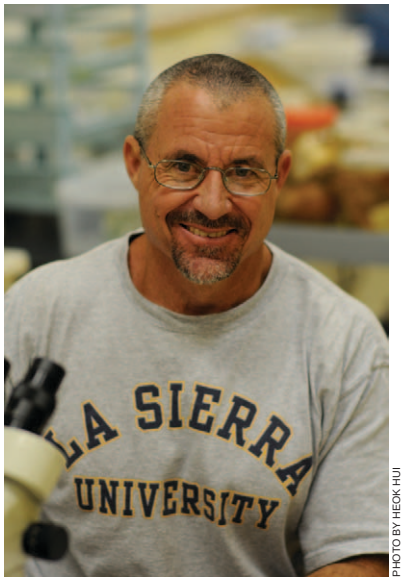


PHOTO BY HEOK HUI

SSAR BUSINESS

SSAR Grants-in-Herpetology Program: Guidelines for Proposal Submission

Proposals are now being accepted for the 2011 SSAR Grants-in-Herpetology Program. This program is intended to provide financial support for deserving individuals or organizations involved in herpetological research, education, or conservation. Grant proposals will be considered in the following categories:

1. CONSERVATION OF AMPHIBIANS AND/OR REPTILES. Proposals should address research (particularly conservation biology) on species endangered or threatened at the state, national, or international level, or address research on potentially threatened habitats or species, or on introduced injurious species. Proposals must be accompanied by a letter of support from another member of the SSAR or a student's major advisor or committee chairperson.
2. FIELD RESEARCH. Proposals may address needs for field station fees or equipment and materials in field oriented projects, or the field work portions of broader studies. This might include in-situ behavioral studies, ecological, life history, or sexual selection studies. Survey work by individuals or regional societies may be submitted here or in TRAVEL below depending on how the funds are to be used. Proposals must be from individuals only and be accompanied by a letter of support from another member of the SSAR, the president of the sponsoring regional society (if applicable), or a student's major advisor or committee chairperson.
3. LABORATORY RESEARCH. Proposals may address needs for equipment or materials in laboratory projects or laboratory portions of broader projects. This might include studies in behavior, biochemistry, molecular biology, biomechanics, or physiology. Proposals must be from individuals only and be accompanied by a letter of support from another member of the SSAR or a student's major advisor or committee chairperson.
4. HERPETOLOGICAL EDUCATION. Proposals may address an educational project or start up support for an educational program in a zoo, museum, park, nature center, regional herpetological society, etc. The project must focus on a herpetological topic. Proposals must be from individuals only and be accompanied by a letter of support from the herpetological curator, the director of the facility, or the regional society president. Applicants need not be students or a SSAR member.
5. TRAVEL. Proposals may address support for travel to field study sites near or far, or to utilize distant collections or facilities. If funding is sought to get from one place to another, proposals should be submitted in the TRAVEL category. Proposals normally submitted in the CONSERVATION or FIELD RESEARCH categories should be submitted here if travel funding is being sought. Proposals must be accompanied by a letter of support from another member of the SSAR or a student's major advisor or committee chairperson, or the regional society president.
6. INTERNATIONAL. Proposals may address needs in any of the above five categories. The applicant must be a student, but not necessarily a SSAR member. Preference will be given to students

with limited access to research funds and in countries where herpetological research has historically been under-funded.

In keeping with the Society's goal of encouraging participation by the broadest possible community, preference may be given to individuals who might not have access to other funding sources. All applicants must be students AND members of the SSAR with the following exceptions: 1) those applying for support of regional herpetological society projects need not be SSAR members; 2) those applying for the International category must be students but need not be SSAR members; 3) those applying for the Herpetological Education category need not be a student or a SSAR member.

Membership dues must be paid (to SSAR Treasurer) no later than 15 December 2010 for proposals to be considered. Applicants are limited to submission of one proposal in one category per year. *Past recipients of an SSAR GIH award in any category are not eligible for future awards*. Applicants must designate to which of the six categories their proposal is submitted (although the committee reserves the right to reassign proposals to categories). If proposals in any of the categories are not forthcoming, or judged not to be of sufficient quality, the funds in those categories may be transferred to other categories. Detailed guidelines for proposal preparation are available online at:

http://www.ssarherps.org/pages/GIH.php

Successful applicants are encouraged to submit the results of their research for publication in the Journal of Herpetology or Herpetological Review, or to present their findings at the annual meeting of the SSAR. Submit proposals or questions regarding application procedures to: Joshua M. Kapfer Chair, SSAR Grants in Herpetology, Departments of Environmental Studies & Biology, Elon University Elon, North Carolina 27244, USA. Tel. (336) 278-6229; e-mail jkapfer@elon.edu.

Grants-in-Herpetology Donor Information

Financial contributions by SSAR members, institutions, and other benefactors support this program significantly, and can increase the number and/or size of awards. Your tax-deductible (for U.S. citizens) contribution to this program will directly benefit meritorious research and education in herpetology. Contact the Treasurer of SSAR (kirsten.nicholson@cmich.edu) for additional information about contributing to the Grants-in-Herpetology Program. If you are employed by an organization that will match donations made to nonprofit organizations, please notify your employer that you have made a donation to the Grants-in-Herpetology Program.

Annual Report (2010)
Grants-in-Herpetology Committee

An award in the amount of US $500 was made to each of the following individuals:

Conservation.—**James C. Cureton II**, Sam Houston State University, "A future without box turtles? Investigating the impact of urbanization on genetic diversity in the threatened Ornate Box Turtle (*Terrapene ornata*)."

Field Research.—**Karla Moeller**, Arizona State University, "Does size matter? Ontogenetic differences in survival strategies of the Gila monster, *Heloderma suspectum*."

Laboratory Research.—**Tara A. Pelletier**, Louisiana State University, "Phylogeographic analysis of *Plethodon dunni* in the Pacific Northwest: postglacial range expansion and contemporary dispersal."

Travel.—**Lindsey Noele Swierk**, Penn State University, "Making the best of a bad situation: Reproductive compensation in mating aggregations of garter snakes in Manitoba, Canada."

International.—**Paulo Fernando Guedes Pereira Montenegro,** Universidade Federal da Paraíba (Brazil), "Water balance in *Pleurodema diplolister* (Peters, 1870) (Anura, Leiuperidae) from semiarid dryland and Atlantic forest in northeastern Brazil."

2010 Grants-in-Herpetology Committee.—Co-chairs: Erik R. Wild and Josh Kapfer. Reviewers: Jeffrey Parmelee, Christopher Beachy, Richard King, Michael Pauers, Steven Price, Bryan Stuart.

SSAR congratulates the 2010 GIH recipients and thanks the committee members for their efforts.

Kennedy Student Award

The Kennedy Award Committee (Bill Lutterschmidt, Mark Paulissen, Terry Schwaner, Lynnette Sievert, Chair) has completed its work for Volume 43 of the *Journal of Herpetology*. The committee has selected "Skin peptide activities against opportunistic bacterial pathogens of the African clawed frog (*Xenopus laevis*) and three *Litoria* frogs" by Ermin Schadich (Vol. 43:173–183). The Kennedy Award carries with it a cash prize of US $200 or the winner's selection of any SSAR publications valued at twice that amount.

The committee invites all student members of the Society to submit their work to the *Journal*, and encourages members who supervise the work of students to draw this award to the attention of those students.

Annual Report (2010)
The Metter Award Committee

There were 24 proposals submitted this year for the Dean E. Metter Memorial Award. The committee requested permission from President Crother and Treasurer Nicholson to make two awards this year in the amount of $750 each and that request was granted.

Matthew Niemiller is a Ph.D. student in the Department of Ecology and Evolutionary Biology at the University of Tennessee in Knoxville. His major professor is Ben Fitzpatrick and his dissertation research deals with the maintenance of distinct cave and surface forms in the plethodontid salamander genus, *Gyrinophilus*.

The second awardee is Michael Reichert, a Ph.D. student in Carl Gerhardt's laboratory at the University of Missouri—Columbia. His research deals with acoustic communication in *Hyla versicolor* and his proposal requested funds to support his investigations into the role of visual cues in the production of courtship calls.

Michael Reichert is the first student from the University of Missouri—Columbia to win a Metter Memorial Award. Dean Metter was a faculty member of the Department of Zoology and then the Division of Biological Sciences at that institution for approximately 30 years.

SSAR congratulates the 2010 Metter Award winners, and extends its appreciation to Metter Award Committee members (Joseph J. Beatty, Chair).

Joint Meeting of Ichthyologists & Herpetologists (JMIH) Official Logo Contest

Concept.—As is well known to all memberships, The Herpetologists' League, American Elasmobranch Society, American Society of Ichthyologists and Herpetologists, and Society for the Study of Amphibians and Reptiles, have embarked on a plan to meet jointly in most years for the foreseeable future. Thus, the Joint Meeting of Ichthyologists and Herpetologists (JMIH) is the official name for this annual meeting of the four societies. The JMIH needs a logo of its own, in part to facilitate a registration website that can be made active before the annual "local logo" may be prepared, and in part to identify the reality of this important ongoing partnership of our societies. Note that this JMIH logo will be a permanent symbol of the JMIH and will not replace the popular annual "local logo" that makes the t-shirts, programs, and other materials of each year's JMIH both memorable and unique. JMIH will hold publishing rights to the logo.

Contest.—The JMIH logo needs to reflect our interests in cartilaginous and bony fishes, amphibians, and reptiles. If you are artistic and would like to submit a logo for consideration, please:

>> Notify Joe Mendelson and submit your logo as a TIFF file by 1 March 2011.

>> Method of voting will be determined by the number of entries. If there are more than five entries, then an on-line voting mechanism will be used to identify the top five entries. This would take place from 15 March to 30 April. All members of all of the societies will be notified of the URL for the on-line voting platform.

>> The five finalist entries will be on display at the 2011 Minneapolis JMIH, where the attendees will have a chance to vote for their favorites, and the winning entry will be selected and announced at the JMIH banquet.

Submissions should be sent electronically (e.g., high resolution TIFF file) to Joe Mendelson: jmendelson@zooatlanta.org.

NEWSNOTES

Control of Disease in Living Amphibian Collections

Infectious diseases have become a well recognized threat to amphibians, both in the wild and in captive collections intended for any purpose including research, teaching, and conservation. With funding from Institute of Museum and Library Services (to San Diego Zoo and Zoo Atlanta) and support from the IUCN Conservation Breeding Specialist Group, a global delegation of amphibian veterinarians, pathologists, biologists, and keepers convened in 2009 to provide input and text for a basic manual on the control diseases in such collections. The manual includes outlines and references to the primary literature regarding recommended best-practices regarding protocols for disease diagnostics and treatment, necropsy, quarantine, routine husbandry, risk assessment, and biosecurity.

The manual is available for download, free of cost, at: http://www.cbsg.org/cbsg/workshopreports/26/amphibian_disease_manual.pdf

Pessier, A.P., and J. R. Mendelson III (Eds.). 2010. A Manual for Control of Infectious Diseases in Amphibian Survival Assurance Colonies and Reintroduction Programs. IUCN/SSC Conservation Breeding Specialist Group, Apple Valley, Minnesota. 229 pp.

Anolis Newsletter VI Available

Anolis afficionados will be pleased that the latest volume of the *Anolis Newsletter* has been issued, assembled by Luke Mahler, Anthony Herrel, and Jonathan Losos. With roughly 400 described species, *Anolis* is the largest amniote genus. Interest in the group has surged in recent years, and the purpose of the *Newsletter* is to provide "an informal forum for the presentation of data and discussion of theory relevant to anoles." The publication may be downloaded as a pdf file at:

http://anolis.oeb.harvard.edu/newsletter.html

David J. Morafka Research Award for 2011

In honor and memory of David J. Morafka, distinguished herpetologist and authority on North American Gopher Tortoises, the Desert Tortoise Council, with the aid of several donors, has established a monetary grant to help support research that contributes to the understanding, management and conservation of tortoises of the genus Gopherus in the southwestern United States and/or Mexico: *G. agassizii*, *G. berlandieri* and/or *G. flavomarginatus*.

Grant Amount.—US $2,000 to be awarded at the Desert Tortoise Council's Annual Symposium, depending on the availability of funding and an appropriate recipient.

Eligibility.—Applicants must be associated with a recognized institution (e.g., university, museum, government agency, non-governmental organization) and may be graduate students, post-

doctoral students or other researchers. They must agree to present a report on the results of the research in which grant funds were used at a future symposium of the Desert Tortoise Council.

Evaluation Criteria.—Applications will be evaluated on the basis of the potential of the research to contribute to the biological knowledge of one or more of the above species of Gopher Tortoises, and to their management and conservation. Important considerations are the significance and originality of the research problem, design of sampling and analysis, preliminary data supporting the feasibility of the research, and the likelihood of successful completion and publication.

The grant announcement, with information on how to apply for it, has been posted on the DTC website at:

http://www.deserttortoise.org/morafkaaward.html

MEETINGS

Call for Papers for the 5th National Symposium on the Ecology, Status, and Conservation of the Diamondback Terrapin 12–14 November 2010, Chauvin, Louisiana, USA

The Diamondback Terrapin Working Group is made up of individuals from academic, scientific, regulatory, and private institutions/organizations working to promote the conservation of the Diamondback Terrapin, the preservation of intact, wild terrapin populations and their associated ecosystems throughout their range. DTWG is committed to and supports research, management, conservation, and education efforts with the above goals in mind. This conference is a forum for the presentation of current information on terrapin research and conservation. In addition to updating colleagues on current research, the conference can serve as a forum to identify research needs, foster friendships, and rekindle interest in terrapins by bringing people with diverse backgrounds together. All interested individuals are invited.

We are accepting abstracts for oral papers and posters from now until 1 October 2010. Posters will be on display on Friday, Saturday, and Sunday morning. The poster session will be on Saturday afternoon. Presentations are planned to be 20 minutes in total length (15 min. presentation, 5 min. questions).

For more information please see www.dtwg.org or contact Dr. Russell Burke, Department of Biology, Hofstra University, 516.463.5521, e-mail: biorlb@hofstra.edu.

Meetings Calendar

Meeting announcement information should be sent directly to the Editor (HerpReview@gmail.com) well in advance of the event.

22–26 September 2010—VIII National Congress of Societas Herpetologica Italica, Abruzzo, Italy. Information: shiabruzzo2010.iscrizioni@gmail.com.

12–14 November 2010—5th National Symposium on the Ecology, Status, and Conservation of the Diamondback Terrapin, at Louisiana University's Marine Consortium (LUMCON) in Chauvin, Louisiana, USA. Hosted by the Diamondback Terrapin Working Group. Information: www.dtwg.org. (see announcement above)

6–7 January 2011—Declining Amphibian Populations Task Force: California / Nevada Working Group annual meeting, Yosemite Valley, Yosemite National Park, California. Information: http://www.canvamphibs.com/News.htm.

18–20 February 2011—36th Annual Symposium of the Desert Tortoise Council, Las Vegas, Nevada, USA. Information: www.deserttortoise.org.

2–7 September 2012—4th International Zoological Congress (IZC), Mount Carmel Campus, University of Haifa, Haifa, Israel. To receive the first and subsequent meeting announcements, contact the organizers at: izc2012@sci.haifa.ac.il.

CURRENT RESEARCH

The purpose of Current Research is to present brief summaries and citations for selected papers from journals other than those published by the American Society of Ichthyologists and Herpetologists, The Herpetologists' League, and the Society for the Study of Amphibians and Reptiles. Limited space prohibits comprehensive coverage of the literature, but an effort will be made to cover a variety of taxa and topics. To ensure that the coverage is as broad and current as possible, authors are invited to send reprints to the Current Research section editors, Joshua Hale or Ben Lowe; postal and e-mail addresses may be found on the inside front cover.

A listing of current contents of various herpetological journals and other publications is available online. Go to: http://www.herplit.com and click on "Current Herpetological Contents."

Squamates Also Susceptible to Effects of Climate Change

The potential impacts of climate change on amphibians have been well studied and are widely appreciated; however, little attention has been paid to the possible effects on squamates. In this paper, using 35 years of data, the authors investigated distributional and population changes in 48 species of Mexican *Sceloporus* (Phrynosomatidae). Two hundred sites for which species composition had been assessed between 1975 and 1995 were recently resurveyed. Additionally, climate data from 99 Mexican weather stations was accumulated and used to generate a climate model for the country. Using these data, the authors found a strong correlation between the degree to which spring temperatures have increased and population extirpation. Furthermore, multivariate statistical methods taking into account phylogenetic relationships revealed that species inhabiting narrow elevational and/or latitudinal bands exhibited increased incidence of extirpation, as did viviparous species. Using physiological models derived from studies of *Sceloporus serrifer* on the Yucatán peninsula, they determined that a four hour reduction in time wherein temperatures are suitable for activity was sufficient to cause a local extirpation. When extrapolated across Mexico, this reduction of suitable activity period during the breeding season

proved to be an accurate predictor of population extirpation. Given the low heritability of optimal body temperature and the rate at which the climate has and will change, lizard species are generally incapable of evolving fast enough to adapt to their changing environments. Indeed, these authors contend that 56% and 46% of populations of viviparous and oviparous Mexican *Sceloporus* (respectively) will be extirpated by 2050. Species extinctions will be almost as high, as highly endemic species are disproportionately susceptible to the effects of climate change. If extrapolated to a global scale, these findings suggest that upwards of 20% of the world's lizard species may be extinct by 2080. Hopefully these findings will lead to increased awareness of squamate declines in the herpetological and conservation communities.

Sinervo, B, and Colleagues. 2010. Erosion of lizard diversity by climate change and altered thermal niches. Science 328:894–899.

Correspondence to: Barry Sinervo, Department of Ecology and Evolutionary Biology, University of California, Santa Cruz, California 95064, USA; e-mail: lizardrps@gmail.com.

First Documentation of Tadpole Vocalization

Although vocalization in adult anurans is well documented, no records of tadpole vocalization exist. While conducting frog research in Argentina, the authors of this paper made the first observations of tadpole vocalization in the species *Ceratophrys ornata* (Ceratophryidae). These calls consist of metallic clicks and are produced via the expulsion of air from rudimentary lungs through the glottis. Tadpoles of this species are capable of vocalizations as early as 72 hours after hatching despite the lack of laryngeal cartilages. Vocalizations are accompanied by lateral undulations of the tail and are made both under and out of water (out of water vocalizations are more vigorous, presumably due to the availability of air). Tadpoles were only observed to make these calls when threatened with intraspecific predation or touched with an object such as a pipette. Therefore the investigators concluded that vocalizations fall under the category of "distress call"; indeed, they are remarkably similar to distress calls made by froglets and adults. Furthermore, the authors propose that these vocalizations aid in preventing cannibalism (as larvae of this species primarily predate other tadpoles). In support of this hypothesis, the authors report that, contrary to previous reports regarding this species, tadpoles maintained together in captivity in low densities (~5 larvae/L) were never observed to engage in cannibalism while feeding entirely on heterospecific tadpoles. Finally, the presence of lungs, glottis, and associated musculature in many other larval anurans suggests that this phenomenon may be more widespread than currently recognized.

Natale, G. S., L. Alcalde, R. Herrera, R. Cajade, E. F. Schaefer, F. Marangoni, and V. L. Trudeau. 2010. Underwater acoustic communication in the macrophagic carnivorous larvae of *Ceratophrys ornata* (Anura: Ceratophryidae). Acta Zoologica (in press). doi: 10.1111/j.1463-6395.2009.00445.x.

Correspondence to: Guillermo Natale, CIMA, Departamento de Química, Facultad de Ciencias Exactas, Universidad Nacional La Plata, 47 y 115 (1900), La Plata, Buenos Aires, Argentina; e-mail: gnatale@quimica.unlp.edu.ar.

Rate of New Reptile Species Descriptions at All-Time High

Using the Reptile Database supported by the Institute for Genomic Research (http://www.reptile-database.org), the author of this paper compiled and/or calculated a number of interesting findings pertaining to the description of reptile species. As of September 2009, the database recognized 9084 species of reptile. As the managers of this database take a conservative approach to species recognition (essentially a Biological Species Concept), many would view their totals as significant underestimates. Forty biologists are responsible for the description of more than half of all described reptile species (each having described 50 or more species; eight are alive today). Leading this elite group is George A. Boulenger, who single-handedly described 573 currently-recognized species. A graph plotting annual number of species descriptions over time reveals that the second half of the 1800s witnessed a surge in species descriptions; at the peak of this period, as many as 70 species were being described per year. Since a low of twenty species on average being described per year in 1950, a comparable trend has been occurring; we are currently in the midst of this spike in species descriptions, with an average of 90 species a year being described (and the trend shows no sign of leveling off). This paper provides tables listing and describing the journals containing the most reptile species descriptions and works containing descriptions of more than twenty species; it also provides resources for tracking down hard-to-find publications containing reptile species descriptions.

Uetz, P. 2010. The original descriptions of reptiles. Zootaza 2334:59–68.

Correspondence to: Peter Uetz, J. Craig Venter Institute, 9704 Medical Center Drive, Rockville, Maryland 20850, USA; e-mail: uetz@jcvi.org.

New Monitor Lizard Discovered in the Philippines

Even in the 21st century, unknown reptile and amphibian species remain to be discovered. Researchers conducting fieldwork in the Philippines have recently brought to light a species of monitor lizard (Varanidae) wholly new to science. Described as *Varanus bitatawa* (the specific epithet is derived from a local name for the animal), this species is a montane endemic of the eastern mountains of northern Luzon Island. Despite having gone unnoticed by science, local people have long exploited this species as a source of protein. Phylogenetic analyses reveal that this species is closely related to an ecologically similar species endemic to southern Luzon Island, *V. olivaceus*. The two species are separated by unforested, low-elevation valleys in the central portion of the island. As this geographic feature appears to have contributed to phylogeographic structuring in other taxa as well, it appears these low valleys constitute an important biogeographic feature for the region. While both species are arboreal and frugivorous, *V. bitatawa* can be distinguished from the drab *V. olivaceus* by its distinctive bands of golden spots (akin to those of the perentie, *V. giganteus*) and unique hemipenal morphology. Based on morphology, the authors showed that these species are allied with a third enigmatic, arboreal, frugivorous monitor

endemic to the Philippine island of Panay (*V. mabitang*); together these three species comprise a clade endemic to the Philippines and only distantly related to other *Varanus* species. Given the degree to which the forest habitat has been altered, this discovery heightens the need for conservation efforts focused on protecting the unique fauna and flora of Luzon Island.

Welton, L. J., C. D. Siler, D. Bennett, A. Diesmos, M. R. Duya, R. Dugay, E. L. B. Rico, M. Van Weerd, and R. M. Brown. 2010. A spectacular new Philippine monitor lizard reveals a hidden biogeographic boundary and a novel flagship species for conservation. Biology Letters (*in press*). doi: 10.1098/rsbl.2010.0119.

Correspondence to: Luke Welton, Biodiversity Institute, and Department of Ecology and Evolutionary Biology, University of Kansas, Lawrence, Kansas 66045, USA; e-mail: furcifer@ku.edu.

Evolution of Range-Expansion Phenotype Preceded Toads Colonizing the World

Members of the family Bufonidae represent an evolutionary success story. Indeed, recent studies suggest toads colonized North America, Europe, Asia, Africa, and secondarily colonized South America over the span of a mere 10 million years (essentially the Eocene). The authors of this paper set out to discover how toads managed to colonize and subsequently diversify throughout four continents in such a short period of time. Suspecting that the dispersal success of toads may be tied to the large geographic distributions exhibited by many species (as large contemporary distributions are indicative of past range expansion events), the authors collected morphological and life history data on 228 species (~43% of described species) and performed analyses (accounting for phylogenetic relationships) aimed at detecting correlations between character states and distribution size. Five character states were found to be strongly correlated with large distributions: semiterrestrial adult niche, the presence of parotoid glands and inguinal fat bodies, broad range of suitable aquatic conditions for oviposition, and reduced maternal yolk contribution. Interestingly, this "range-expansion phenotype" bears a striking similarity to the archetypal toad phenotype. Using published sequences of two nuclear and nine mitochondrial genes and six calibration points, the authors performed phylogenetic analyses and recovered divergence dates for the family Bufonidae. Subsequently, an ancestral character state reconstruction analysis was performed resulting in the ancestral states for the characters found to be correlated with large geographic distribution being mapped onto the time-calibrated phylogeny. These analyses recovered a more recent global colonization date than previous studies (Oligocene) and revealed that the bufonid age of colonization was preceded by an abrupt shift toward the archetypal toad phenotype. Interestingly, upon colonization of new continents, several lineages independently shifted away from the toad phenotype. This study reveals that the evolution of a range-expansion phenotype facilitated rapid diversification and colonization in bufonids. This novel mechanism stands in stark contrast to the typical path to rapid diversification: limitations to dispersal that promote fragmentation and subsequent allopatric speciation. Furthermore, this idea of a range-expansion phenotype provides an evolutionary explanation as to why *Bufo marinus* (= *Rhinella marina*) has been such a successful invasive species around the world.

Van Bocxlaer, I., S. P. Loader, K. Roelants, S. D. Biju, M. Menegon, and F. Bossuyt. 2010. Gradual adaptation toward a range-expansion phenotype initiated the global radiation of toads. Science 327:679–682.

Correspondence to: Franky Bossuyt, Biology Department, Amphibian Evolution Lab, Unit of Ecology and Systematics, Vrije Universiteit Brussel, Pleinlaan 2, B-1050 Brussels, Belgium; e-mail: fbossuyt@vub.ac.be.

Competition Found to be Important Driver of Natural Selection in *Anolis*

Despite much speculation regarding the relative contributions of predation and intraspecific competition toward natural selection, few field-based experiments have been carried out with the goal of teasing these two factors apart. The authors of this paper conducted an experiment with this aim using anoles (Polychrotidae: *Anolis sagrei*) on experimentally manipulated islands off the shore of the Bahamas. Lizards were measured for traits presumed to be under strong selection (body length, relative hindlimb length, and treadmill performance), marked, released onto islands in the spring, and recaptured in the fall. These islands were populated with varying densities of lizards (0.09–0.3 lizards/m^2) and either excluded from predators (via netting), exposed to avian predators only, or exposed to avian predators and seeded with ophidian predators (Xenodontinae: *Alsophis vudii*). While exposure to predators was found in regression analyses to affect survivorship and behavior (lizards in treatments with snakes exhibited significantly lower survivorship and perched higher than lizards in either of the other predation treatments), predation exposure treatment was not found to be a significant predictor of change in the measured characters. However, these analyses found lizard density to be strongly correlated with significant changes in these characters, with survivors on high-density islands exhibiting higher average values for the characters measured than at the start of the experiment (and survivors on low density islands exhibiting lower average values than at the start of the experiment). The authors conclude that while predators likely contribute to natural selection in *Anolis*, these effects are trivial relative to the effects contributed by intraspecific competition. Furthermore, these findings suggest that competition may have had a larger role in shaping *Anolis* morphological and species diversity than currently appreciated.

Calsbeek, R., and R. M. Cox. 2010. Experimentally assessing the relative importance of predation and competition as agents of selection. Nature 465:613–616.

Correspondence to: Ryan Calsbeek, Department of Biological Sciences, Dartmouth College, Hanover, New Hampshire 03755, USA; e-mail: ryan.calsbeek@dartmouth.edu.

First Documented Case of Non-hybrid Origin of Unisexuality in Vertebrates

Parthenogenetic squamate lineages have originated independently several times and all known instances have been hypothesized to have occurred via hybridization events between two sexually reproducing species. The authors of this paper present results that reveal the first conclusive evidence for populations of parthenogenetic squamates (indeed, vertebrates) originating through pathways other than interspecific hybridization. Nuclear (nDNA; 8 loci) and mitochondrial (mtDNA; 2 genes) sequence data and microsatellite marker (14 loci) genotypic data were assembled for two parthenogenetic populations of tropical night lizards (*Lepidophyma*; Xantusiidae) in Costa Rica and Panama as well as geographically proximate congeners. Sequence marker data were analyzed for allelic variation, interlocus congruence, and phylogenetic relationships; microsatellite marker data were analyzed for heterozygosity and linkage disequilibrium (it has been hypothesized that heterozygosity in unisexual lineages might degrade over time to resemble homozygosity [the "Asher Effect"]; however this phenomenon would leave the various loci in linkage disequilibrium, as the fixed loci would be randomly drawn from each of the parental species). Parthenogenetic populations of one species (*L. flavimaculatum*) were found to be genetically indistinguishable from conspecific sexually reproducing populations to the north for each sequence marker examined and the species was recovered as a well-supported clade (sister to *L. reticulatum*, the other parthenogenetic species) in phylogenetic analyses of both mt- and nDNA. Additionally, while sexual *L. flavimaculatum* exhibited moderate levels of heterozygosity, both unisexual populations showed little mtDNA heterozygosity and were fixed for all microsattelite loci (which were not in linkage disequilibrium) and most nDNA loci. These results strongly refute a hybrid origin for these parthenogenetic populations of *Lepidophyma*. Whether unisexuality evolved twice, was secondarily lost in sexual populations of *L. flavimaculatum*, or represents an ancestral polymorphism that has reached fixation in *L. reticulatum* remains unknown.

Sinclair, E. A., J. B. Pramuk, R. L. Bezy, K. A. Crandall, and J. W. Sites Jr. 2010. DNA evidence for nonhybrid origins of parthenogenesis in natural populations of vertebrates. Evolution 64:1346–1357.

Correspondence to: Elizabeth Sinclair, Botanic Gardens and Parks Authority and Department of Plant Biology, University of Western Australia, West Perth, 6005, Western Australia, Australia; e-mail: esinclair@iinet.net.au.

Dynamics of Sexual Dimorphism Revealed in Hynobiid Salamanders

Sexual size dimorphism can occur when different selection pressures are experienced by each sex. Whether or not sexual size dimorphism is evident prior to sexual maturity reveals which life stages selection is acting upon. To elucidate the patterns of development of the two sexes, the author of this paper collected data on salamanders (Hynobiidae: *Salamandrella keyserlingii*) in a marsh in Hokkaido Prefecture, Japan. Over the course of three years, animals were captured, measured for various morphological characteristics, marked via toe clipping, and released on site. Collecting events coincided with both the aquatic, reproductive phase (April–May; both pitfall traps and dip netting) and the terrestrial, non-breeding phase (late May–October; pitfall traps only). Toe clips were retained for lines of arrested growth (LAG) analyses to estimate animal ages. These data revealed that prior to sexual maturity both sexes grow at a similar rate and after maturity both experience similar declines in growth rate; however, females mature roughly a year later than males, leading to a larger size at maturity and larger size relative to age after the age of male maturity. The selective advantage of larger female size is presumably the prospect for greater clutch size (although non-adaptive explanations also exist). Interestingly, males seem to compensate for the sexual size dimorphism via secondary sexual characteristics developed prior to and lost after the aquatic breeding phase. Specifically, males develop widened heads (used in male-male combat) and elongated tails (used for detaining females) and in general achieve the size of reproductively mature females. The author posits that this temporary male sexual dimorphism may be a requirement for the development of permanent female sexual dimorphism, as the evolution of larger females requires males to have the ability to temporarily achieve similar size for successful reproduction.

Hasumi, M. 2010. Age, body size, and sexual dimorphism in size and shape in *Salamandrella keyserlingii* (Caudata: Hynobiidae). Evolutionary Biology 37:38–48.

Correspondence to: Masato Hasumi, Biological Institute, Faculty of Science, Niigata University, Niigata 950-2181, Japan; e-mail: mhasumi@bio.sc.niigata-u.ac.jp.

Comparisons Between Squamate Lineages Reveal Insights into Locomotion and Body Plan Evolution

Is it possible for lineages with morphologically dissimilar ancestors that are evolving in divergent morphological directions to converge on similar locomotor strategies? To address this question, the authors of this paper examined members of two disparate lineages (phrynosomatid lizards in the southwestern US and *Lerista* [Scincidae] in Western Australia), some members of which have evolved highly apomorphic body plans (stocky and elongate bodies, respectively) relative to their more classically proportioned ancestors. Species were scored for a variety of morphological metrics, including body width and hind limb length (both relative to body length). Subsequently, animals were subjected to filmed locomotor trials on both sandpaper and sand substrates to characterize their kinematic strategy (e.g., stride length) and locomotor performance (e.g., speed). Comparisons with ancestors revealed that stockiness was achieved solely through trunk widening (with no shortening) and elongation was attained via trunk elongation alone (no contribution from torso narrowing). Furthermore, despite widely divergent morphologies, stocky and elongate species examined exhibited locomotor similarities with each other and not shared with their ancestors. Specifically, they demonstrated similar stride length and reduced speed. However, differences between these two groups were also observed; stocky phrynosomatids had lower stride rates (due

to wide body and robust limbs) and elongate *Lerista* achieved faster speeds (due to contribution from elongate axis). Finally, substrate type had no effect on locomotor performance for any species examined, suggesting that both clades consist of substrate generalists and the derived morphological conditions are not adaptations to a particular substrate.

Bergmann, P. J., and D. J. Irschick. 2010. Alternative pathways of body shape evolution translate into common patterns of locomotor evolution in two clades of lizards. Evolution 64:1569–1582.

Correspondence to: Philip Bergmann, Department of Ecology and Evolutionary Biology, University of Arizona, Tucson, Arizona 85721, USA; email: pjbergma@email.arizona.edu.

Some Turtles Exhibit Reduced Metabolic Rates upon Hatching

Due to different costs and benefits, embryonic and post-embryonic animals might exhibit different metabolic rates. For example, due to the availability of yolk and the advantage of rapid development, embryonic reptiles should display an increased metabolic rate relative to hatchlings, which often lack a dependable food source. Yet, results of previous investigations of reptiles have been conflicting, with squamates displaying no change in metabolic rate and birds showing an increase (likely due to the switch to endothermy). To investigate this phenomenon in Testudines, the authors of this paper examined embryonic and post-embryonic metabolic rate (using heart rate as an indicator) in two species of emydid turtle (*Chrysemys picta* and *Graptemys pseudogeographica*) across a range of temperatures. Interestingly, at low temperatures (20–25ºC), no change in metabolic rate was observed, yet at high temperatures (30–33.5ºC) a significant decrease upon hatching was seen. The authors conclude that a change in selective pressure between embryonic and post-embryonic life stages is responsible for this change in metabolic rate. In particular, they point to the benefit of increased embryonic development via increased metabolic activity at high temperatures which they posit has been under strong selection in turtles. Alternatively, shorter-lived squamates have adopted a riskier strategy (given the uncertainty of food resources) of maintaining high metabolic rates into juvenile and adult life stages.

Du, W. G., B. Zhao, and R. Shine. 2010. Embryos in the fast lane: high-temperature heart rates of turtles decline after hatching. PLoS ONE 5:e9557.

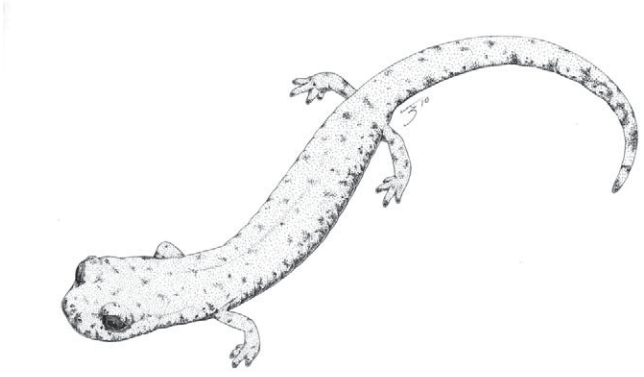
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Insights into the Evolution and Function of Snake Thermoreception

Boas, pythons, and pit vipers possess pit organs which allow them to sense heat emitted from potential prey and predators. Though much has been learned about the capabilities and limitations of these structures, remarkably little is known about how they sense heat and the evolution of ophidian thermoreception. The authors of this study used molecular techniques to divulge the particular mechanisms involved in serpent thermoreception. By investigating translated RNA fragments ("transcriptomes") recovered from the trigeminal nerve (the nerve that receives general sensory information from the face, including the pit structures) and nerves associated with dorsal root ganglia (nerves that receive sensory information the somatic region of the body), they were able to identify a single gene (*TRPA1*) coding for a protein (TRPA1) associated with a particular receptor. This was possible because in non-thermoreception-capable animals such as mammals, the two nerve types exhibit similar transcriptome profiles and therefore differences observed in thermosensory-capable snakes should reflect genes affiliated with thermoreception. Interestingly, the homologous receptor in humans has been dubbed the "wasabi receptor," as it has been found to be sensitive to the Japanese condiment. Furthermore, this finding confirmed the suspicion that thermoreception in snakes involves detection of a change in temperature of the membrane lining the pit (akin to standard epithelial thermoreceptors) rather than a direct reception of photons (akin to optic photoreceptors). Finally, a phylogenetic analysis of the *TRPA1* gene revealed that pit vipers and other thermoreception-capable snakes derived their heightened TRPA1 gene expression independently, as pit viper *TRPA1* is more closely related to phylogenetically proximate but thermoreception-incapable colubrid *TRPA1* than to boid or pythonid *TRPA1*.

Gracheva, E. O., N. T. Ingolia, Y. M. Kelly, J. F. Cordero-Morales, G. Hollopeter, A. T. Chesler, E. E. Sánchez, J. C. Perez, J. S. Weissman, and D. Julius. 2010. Molecular basis of infrared detection by snakes. Nature 464:1006–1012.

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Batrachoseps campi (Inyo Mountains Salamander). USA: California: Inyo Co.: Inyo Mountains. Illustration by Jackson Shedd.

OBITUARIES

Herpetological Review, 2010, 41(3), 265.
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Dana Payne (1955–2010)

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PHOTO BY F. SLAVENS

Dana Payne in the Columbia Gorge area in Washington State doing field work with the Western Pond Turtle (*Actinemys marmorata*). He is holding an adult female (note transmitter attached) that was part of a study to locate nesting areas.

Dana Payne, Curator of Reptiles at the Woodland Park Zoo in Seattle, lost his long-term battle with cancer on 20 March 2010. Dana was well respected in the herpetological zoo community where he was known for his comprehensive knowledge of the natural history of reptiles and amphibians, his dedication to the zoo field, and the conservation of herps around the world.

Dana was born in San Diego, California on 26 August 1955 and moved to the Seattle area when he was very young. He was the oldest of a family of seven children and developed a keen interest in animals—especially reptiles—early in life. His mother would often take him to the zoo and on each trip he learned new facts about the animals. This set the stage for Dana's long career in the zoo profession. He first began volunteering in 1974 at the Reptile House at Woodland Park Zoo. He received his first professional job as a reptile keeper at the Chaffee Zoo in Fresno (California), working with and being mentored by Curator Ron Tremper. In 1982 he returned to Woodland Park where he spent most of the next 15 years working in the Day House specializing in reptiles and amphibians. In 1997, he was promoted to Senior Keeper, then to Collection Manager, and finally to Reptile Curator in 2003, a position he held until his death.

Conservation was one of Dana's passions. He became involved with the El Valle Amphibian Conservation Center in Panama. Because of his fluency in Spanish, Dana worked to develop a Spanish-language record-keeping system, and also consulted on matters of husbandry and *in situ* breeding projects. At home in Seattle, Dana was the steward of Woodland Park's role in the Western Pond Turtle recovery program for many years. He worked alongside the Washington State Department of Fish and Wildlife overseeing the headstarting of turtles at the zoo. A more recent effort was Dana's leadership role in the conservation of the Oregon Spotted Frog, facilitating a consortium of Pacific Northwest institutions.

During Dana's time as a Reptile Curator, he was instrumental in forming a team that developed an online Antivenin Index Database. Dana brought forth the idea of a website where institutions could post their inventories of exotic types of antivenins. Poison control centers and zoos could consult this index to obtain antivenin in the case of an emergency snakebite. This could save lives by reducing the amount of time needed to locate the proper antivenin and have it shipped quickly to the treating hospital. Dana was very knowledgeable on venomous snakebites and was consulted by regional hospitals as well as providing informational tours of the zoo's venomous reptiles to local physicians.

Dana's accomplishments were not restricted to the field of herpetology. Dana had a keen interest in computers and programming. He designed several database programs that are being used not only at Woodland Park but other zoos around the globe. They were implemented for many types of record keeping and tracking of animals in collections. Dana's computing skills were so impressive and valuable to zoos that he received an award for outstanding application design.

Dana's life was centered on his enthusiasm for the zoo and the animals around the world. When he was asked what he liked best about working at a zoo, he said "It's really all about helping people to care about the natural world we're working to save." Dana was asked to write the end note in a book of animal prints by telling a story of relations between people and animals. This is what he wrote. "Those of us who have chosen a life with animals know we have chosen well. Having a conversation with a lion is a fine way to start one's day. For that matter, so is tossing tidbits to a toucan, or medicating a cobra. There's something there, in the lion's luminous eyes, in the gaudy splendor of the toucan, in the cobra's sibilant protests: it's *magic*. It's the stuff of fairy tales to interact with animals like these, even in a scientific setting, and in spite of repetitious, routine chores. You should envy us, for we are the most fortunate of humans—we take care of the animals at the ZOO."

Dana's personality left a lasting impression. He was a witty, kind, and generous friend and colleague who didn't deserve all the setbacks that life dealt him. After losing a foot in a motorcycle accident, along with all the pain and hassles of having one leg, sometimes on crutches, sometimes with his prosthesis, sometimes not being able to walk at all, he rarely complained. It was just the luck of the draw he said. After he was diagnosed with cancer and undergoing treatment, as he was contemplating his demise he looked at FS, laughed and said "Look… nobody gets out alive."

Dana will be remembered for his knowledge and devotion to herpetology and the zoo world. We can still clearly see his smile and hear his bold laugh. He will be missed by many, truly a hard act to follow.

Acknowledgments.—We thank Ron Tremper for sharing recollections.

ZOO VIEW

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Reptile Dealers and Their Price Lists

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As wholesale animal dealers and stores joined in the development of the modern pet business, they supported a more aggressive search for other animal novelties and "seasonal merchandise" in animals. Novelties were often creatures that never would have been indoor pets–or pets at all–in the nineteenth century. By the 1920s, the Max Geisler Company of Omaha had added to its stock American chameleons (*Anolis* lizards), which became a staple of childhood terrariums after World War II and were sold at circuses wearing little wire collars and leashes, at least through the mid-1960s. In 1928, the National Pet Shops of St. Louis, Missouri, offered to ship "TEXAS HORNED FROGS...Alive and Attractive...25¢ each/$1.50 Dozen - $4.50 for 50. Eight Dollars per hundred." As pet shops joined the quest for novelties to attract new customers, animals often faced unpleasant consequences. Seasonal and novelty pets had little prospect of long or healthy lives. Easter chicks, dyed like eggs, were too fragile to survive the rough handling of small children. The needs of reptiles also were too specialized for the casual purchaser; they, too, became throwaways. According to recent surveys, Americans now care for millions of reptiles as pets. As with most aquariums, reptiles as pets are often associated with the presence of children in the house, but a community of serious amateurs thrives; they can be described as "collectors" as much as pet owners. They sponsor special pet shows and sales and are engaged in serious breeding efforts to create genetic sports. (A trip to one of their shows is an astonishing experience, as large plastic storage containers full of very large snakes are unloaded from vehicles and stacked on folding tables for display.)
—*Pets in America* by Katherine C. Grier, 2006

If one tracks the development of herpetoculture by using reptile dealer price lists as a source, major trends are apparent. Due to loss of biodiversity and the public perceptions about animal protection, one will never again see the array of wild-caught amphibians and reptiles offered for sale 50 years ago—a statement as to how the world has changed. Changes are the result of shrinkage of wild populations due to habitat destruction, arrival of invasive species, chemical contaminants, infectious diseases, over-collecting, human consumption, reptile skin trade, and better captive husbandry and increased sophistication of the customers. We will examine the types of dealers (large-scale importers, biological supply houses, mass breeders, smaller private breeders, zoos and aquariums) from the perspective of animal availability, types of animals, quantities, and price. "Dealer" can mean collector (in the wild), exporter, trader, importer, and breeder. These persons were (or are) the sources of animals; their clientele were (and are) pet shops, pet owners, hobbyists, private breeders, schools and universities, traders, other dealers, zoos, museums, aquariums, and roadside attractions. There is a broad spectrum encompassed by suppliers and customers.

Also there have been changes in technology, starting from lists published in early books and magazines, on to mass mailings of mimeographed lists and evolving through facsimile distribution to Internet sites and e-mail. It is almost certain that the bulk of commerce now occurs through the Internet (Trooper Walsh, pers. comm.).

This is not an exhaustive compilation or examination of all price lists but rather a selection relevant to the history of captive herp keeping and reflective of changes in the natural world and in animal commerce. We do not in this paper propose to be the definitive source of information about the world of herpetology and herpetoculture. While we recognize that economic incentives have led to smuggling and other illegal activities, we have chosen not to focus on the perpetrators; this aspect of the animal trade has been extensively covered in other publications, for example *Animal Underworld* by Alan Green.

What We Have Experienced

Those who care for the study of Amphibia and Reptiles—the Herpetologists, to give them their scientific title—have never been numerous; but most of them have been serious students. One reason for the fact that this branch of Natural History is not very popular, is a prejudice against creatures some of which are clammy and cold to the touch, and some of which may be poisonous. People who delight in keeping Newts or Frogs, Tortoises, or Snakes, are, as a rule, considered eccentric.

—Hans Gadow, 1901

One of us (JBM) was curator of herpetology at the Dallas Zoo in Texas for 30 years. JBM is currently Smithsonian Research Associate and interim Curator at the National Zoological Park in Washington DC. The other (KM) worked for the US Fish & Wildlife Service for over 31 years in the Office of Law Enforcement, as "Office's national herpetology expert" specializing in herp smuggling and poaching investigations, writing herpetology books and identification papers, and provided training to state and federal conservation agencies. KM now works as a Major Crimes Investigator, Peninsula Humane Society and Society for the Prevention of Cruelty to Animals in San Mateo, California. Both of us are retired from full-time work. Having been interested in the keeping of herps from an early age, we have watched the major changes relative to the business of selling living amphibians and reptiles for approximately 50 years.

Many of the amphibians and reptiles we kept as children were acquired from variety stores (often called five and dime stores) in the US: baby turtles, some with decals and painted shells; horned lizards; Green Treefrogs; American Anoles (also known as Green Anoles); Red-spotted Newts, and occasionally baby American Alligators or Spectacled Caimans. In the variety stores, most animals were kept in deplorable conditions and carcasses often littered the enclosures. As our interests broadened, we graduated to the next level: checking the local pet shops where there were often more interesting amphibians and reptiles for sale. As our interests became our obsessions, we obtained price lists from animal dealers in far-away places, ordered some of our favorites which arrived through the mail or by railroad express, and we personally visited many of the establishments during school holidays. When KM was 15 years old, he amassed a crocodilian collection which lived in a large child's plastic wading pool in his bedroom and included False Gavials, Salt Water, American, and Nile Crocodiles, and Spectacled and Yacare Caimans.

Key pieces of legislation were enacted and this legislation impacted the trade. The United States Lacey Act, passed in 1900, controlled the trade in wild birds and game and subsequently was extended to cover most animal and many plant species. The Act prohibited the importation, exportation, transportation, sale, receipt, acquisition, or purchase of any animal or plant that was obtained or transported in violation of any other wildlife conservation law or regulation. The United States Endangered Species Act (1973) and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) were also legislative tools to control importation of species at risk. In 2002, legal wildlife trade to the US alone included more than 2 million reptiles and 49 million amphibians, according to Sharon Guynup in 2006.



Reptile and animal dealer William Abraham King was called "Snake King" and his business was known as "Snakeville." The compound, established in 1907, was in Brownsville, Texas and many of his snakes were sent to carnivals and traveling circuses. This ad features a Neotropical Rattlesnake (*Crotalus durissus*) in a defensive pose. The "horn" appears to be a cock spur. His autobiography was published in 1964 and titled *Rattling Yours—Snake King.* Credit: Courtesy of Patrick Burchfield, Director, Gladys Porter Zoo, Brownsville, who acquired King's snake hook, protective leggings, and other memorabilia.

We will show a number of price lists, mostly from KM's collection, which graphically demonstrate changes in the animal trade—both the types of animals for sale and prices. As an example of what was available, there was a 1962 publication connected to Ross Allen by Dick Bothwell called *The Great Outdoors Book of Alligators*. It has a chapter (pp. 61–64) entitled "Crocodilian As a Pet," in which the author refers to G. L. Thompson of Lane Wilson Company in Monroe, Louisiana claiming to ship 500 caimans a week to pet shops in the US. The numbers and varieties of venomous and potentially dangerous wild-caught species offered for sale during the mid-20th Century were amazing and prices were very low. Price lists 50 years ago from Jonathan Leakey and C. J. P. Ionides offered all sorts of wild-caught African vipers, mambas, cobras, and so on. KM ordered a shipment of baby Puff Adders and Rhinoceros Vipers from Leakey when he was 15 years old and enjoyed watching the snakes crawl around his back yard, much to the horror of his mother. Since he did not own a snake hook, he fashioned a surrogate out of a wire coat hanger.

In addition to the herps available, some of the lists being circulated offered primates, baby elephants, large cats such as jaguars, tigers, and lions, capybaras, tapirs, rare parrots, etc. We visited some wholesale tropical fish outlets where massive numbers of herps were stockpiled, sometimes in horrendous conditions. Conversely, we visited specialty shops catering to the serious collector where the animals were kept singly or in small groups in excellent conditions. We have seen the appearance and rise of commercial breeders and expanded interest in conservation issues. Commercial reptile breeders do take pressures off of wild populations but it is only fair to show that there may be downsides to the acquisition of breeding stock as well. And for those of us who have kept herps since childhood and later made a living, albeit modest, working with them, we would hate to see the day where a budding enthusiast would not have a chance to keep some as we did but we also stress that it must be done with good care and conservation in mind.

The Case of the Ball Python

THE WAY THINGS ARE MOVING IN AFRICA, THE TIME WILL SOON BE PAST WHEN EVEN A GOOD FIGHT CAN SAVE ANYTHING MORE THAN SCRAPS.

—ARCHIE CARR, *ULENDO*, 1964

IN GENERAL, WE FEEL THAT IT IS DIFFICULT TO JUSTIFY THE TRADE IN WILD-CAUGHT BALL PYTHONS, PARTICULARLY IF ONE CONSIDERS THE AVAILABILITY OF CAPTIVE-BRED AND CAPTIVE-HATCHED ANIMALS. OF COURSE, WITH FEW EXCEPTIONS, IT IS WILD-CAUGHT SNAKES WITH ANOMALOUS APPEARANCES THAT HAVE FOUNDED MOST OF THE LINEAGES OF THE MORPHS THAT ARE BEING CAPTIVE-BRED TODAY.

—DAVID G. BARKER AND TRACY M. BARKER, *BALL PYTHONS,* 2006

In this section, we deal with the challenges facing future conservation initiatives: basic needs of the collectors and exporters living in range countries, the justification for exporting large numbers of living amphibians and reptiles, the fate of these imported fauna, and the importance of captive breeding. These are not new ideas because conservationists have grappled with these issues for decades. For our model, we use the African Ball or Royal Python (*Python regius*). It is one of the mainstays of the exotic reptile trade due to its smallish size, calm temperament, long life span, and multitude of spectacular color morphs.

To begin our analysis, we feature a comprehensive book by David G. Barker and Tracy M. Barker: *Ball Pythons: The History, Natural History, Care and Breeding* (2006). In their book, the authors make several important points:

- More Ball Pythons are purchased annually than all other pythons combined.
- The number of Ball Python color morphs is astonishing and many are pictured beautifully in the Barker book. More than two hundred pictures show wild and designer morphs, listed with colorful names affixed to them by the breeders like pewter, piebald, paradox-albino, super phantom, and killer-bee.
- The coastal areas of Ghana and Togo are the source of many imported Ball Pythons.
- Although exact numbers remain elusive, estimates of up to one adult snake per acre might be accurate, according to a study by Gorzula and associates in 1998.
- Native local collectors are extremely proficient at collecting Ball Pythons.
- Ball Pythons are either collected from the wild, captive-hatched from eggs retrieved from wild gravid females, or bred in captivity.

"The captive breeding of original morphs is both accidental and inevitable, and only intentional when crossing morphs; the resultant progeny are usually then referred to as 'designer' morphs, even with single species hobby enthusiasts. Consider enthusiasts of roses, hamsters, or pigeons, as single species hobby examples (Charles Darwin chose pigeons in particular to practically illustrate the enormous diversity of genetic potential). Pigeon fanciers are not generally interested in obtaining new species of bird." (Jon Coote, pers. comm.).

The Ball Python market is illustrative of a core conservation dilemma: human needs balanced against Ball Python sustainability. In *The World Factbook*, average annual income per capita [GDP-Gross Domestic Product] converted to the US dollar was ranked for 229 countries throughout the world: Ghana ranked 200 with income of $1400 and Togo ranked 215 with income of $900. In African countries beset



Ball Pythons (*Python regius*) are imported in large numbers for the exotic reptile trade. Illustration from *Iconographie générale des ophidiens / par M. le professor Jan . . .[en collaboration avec Mr. F. Sordelli.] ...*
Imprint: Milan: chez l'auteur, [etc., etc.], 1860–1881.

with political strife, declining infrastructure, and few resources, it is completely understandable that locals collect Ball Pythons, especially those snakes with unusual colors and patterns, in order to make a living. In Ghana, trappers support an average of 10 family members and have few alternatives for employment other than snake collecting; a harvest of 7000 wild adults and 3500 gravid females represents an annual income of $925 US for a trapper (Gorzula et al. 1998). Traders want to satisfy customers but may not be sure precisely what the buyers want so all of the snakes are likely shipped.

If an aberrant snake such as an albino is collected, it is a valuable find: one was able to fetch US $7500 in the US in 1998. About six years ago, the most ever paid for a mutant ball python in the United States was US $130,000 for a wild caught adult female leucistic morph. Two other snakes were purchased for $90,000 and $100,000 respectively, of the same morph (Trooper Walsh, pers. comm.). Dave Barker (pers. comm.) said that a wild-caught leucistic male sold for $175,000, bought by a consortium of breeders. All of the money went into African pockets and not a cent went to a middleman; the snake sired one clutch and died.

Technology has entered the Ball Python business. Some of the big US breeders got together and purchased a laptop computer, digital camera, and a satellite phone, and gave them to the largest West African exporter who now looks specifically for gravid females and any unusual morphs. If a promising new morph is found in the field, a photograph is taken and immediately e-mailed to these big US breeders so that within an hour or so of discovery the snake is on its way to the USA (Trooper Walsh, pers. comm.). This arrangement may curtail the importation of unwanted snakes but the specialty breeder market is separate from the general pet market which is considerably larger.

Herpetocultural historian Jon Coote (pers. comm.) identified an economic factor in the Ball Python story which is rarely considered: "Regarding the Ball Python phenomena I would suggest that it is important to understand the reasons for the very high prices paid for unusual morphs. The pyramid market that evolved for them was fueled by the rapid inflation of assets that occurred due to the unsustainable, as we now know, cheap and widely available credit. Consider the fact also that private investors got into this market in considerable numbers who had no interest in the snakes other than their ability to generate wealth. It may well be useful to contrast this recent pyramid market with the similar market for tulips in Holland in the 1630s. Today most Ball Python morphs are available for about $100 each with even the most valuable fetching not much more than $500 each. Many of those who borrowed huge sums to set up their breeding programs are now facing financial ruin. Only those who got into the market early have actually made significant sums of money. The Ball Python market would never have evolved as it did to such dizzily high values without the unsustainable credit that fueled it, as the credit crisis that has killed it so aptly now proves. As proof look at the similar market, that preceded the Ball Pythons, for Leopard Geckos. At the height of this market the most expensive Leopard Geckos rarely fetched much more than $1000 each. An interesting point is that only reptile species that make good pets, e.g., Leopard Geckos, Corn Snakes, and Ball Pythons, have ever really established pyramid markets. The current efforts to establish a similar market in Blood Python morphs, for example, is perhaps predictably not catching on!"

In 1997, a field team led by Stefan Gorzula surveyed Ball Pythons in the whole of Ghana for CITES. In Gorzula et al. (1998) they estimated density of pythons at slightly less than one snake per acre. Based on this estimate, the projected countrywide totals in "domesticated land" [pasture] would be 18,000,000 snakes and a lower figure of 6,400,000 snakes in "crop land." In their paper, the authors presented a plan for the sustainable use of Ball Pythons which addresses the economic needs of those persons living in Ghana. CITES General Export figures for 2008 (data from CITES website) were Ghana (wild—7,000; live, ranched—50,000; live, captive-bred— 200); Togo (wild—1,500; live, ranched—62,500); Benin (wild—1000; ranched—60,000); Niger (live—500) for a grand total of 182,200 snakes.

However, the question of welfare of captive individuals of a species, and weighing that against the well being of a species in the wild, is worthy of further consideration. Are there unintended consequences once a species becomes so commonly bred and sold that it may be so easily discarded as a surplus novelty? Again, we asked Jon Coote for his perspective: "This is unlikely as the costs to produce such captive bred animals generally limit how cheap they can commercially be sold. There are 'bedroom' breeders of such things as Bearded Dragons and Corn Snakes who may well sell progeny for far less than their cost of production, and we should therefore be encouraging the pet industry to buy from reputable commercial breeders rather than from these other casual sources. The cost of production is less for many wild caught specimens, Green Anoles for example, whose cost of capture can be much less than their cost of captive reproduction, can lead to them being insufficiently valued to provide them with the captive resources that they need. It was also probably true of Green Iguanas ranched in Central America, but this trade and activity is to all extents and purposes history. In my experience here in the United Kingdom, pet reptiles are better cared for than any other category of pet based on the comparison between the numbers kept and the numbers placed in pet rescue centers. The worst pet keepers, here in the United Kingdom, based on the same criteria are keepers of first dogs, then cats and then rabbits."

In order to gain another perspective, we asked Ken White, President of the Peninsula Humane Society & Society for the Prevention of Cruelty

to Animals (SPCA) in the USA, to comment on his experiences: "It is obvious, at least for the 30 years I have been in the field, that reptiles are victimized through neglect and abuse much in the same ways we see with dogs, cats and other pet animals, and that exotic pets also enter animal shelters in need of great help. But while the past brought us a large number of a few species—mostly Iguanas, Red-eared Sliders and Snapping Turtles, caimans, and the more common large constrictors—the exotic pet industry's growth has expanded the number of species showing up at humane societies and SPCA's [facilities] around the country. Today, in addition to what we have always seen, shelters are working to care for increasing numbers of Bearded Dragons, Leopard Geckos, *Phelsuma* species, Mediterranean and African tortoises, and amazing numbers of Ball Pythons. In those animal shelters near larger cities, it is not uncommon to find Australian herps (from Carpet Pythons to Blue Tongue Skinks) added to the mix as well, along with other even more exotic species.

"And while some may laud the captive breeding of exotics as a way of decreasing the demand on wild animals by substituting with a captive bred supply of the so-called designer morphs, shelters see the other side of this coin. That is, ever increasing numbers of captive bred animals being deprived of basic husbandry and veterinary requirements, sold by an innately exploitive industry to families jazzed about adding 'something different' to the family."

Is Captive Breeding a Conservation Tool?

Are captive breeding and re-introduction viable options for conservation? Members of the Species Survival Commission (SSC) within the International Union for Conservation of Nature and Natural Resources (IUCN), the largest conservation organization in the world, certainly think so as there is a Conservation Breeding Specialist Group and Re-Introduction Specialist Group within the organization. Five Specialist Groups and Task Forces represent herps: amphibians, crocodilians, iguanas, marine turtles, and turtles. The organization views its role this way on its website: "Our vision is a just world that values and conserves nature. Our mission is to influence, encourage and assist societies throughout the world to conserve the integrity and diversity of nature and to ensure that any use of natural resources is equitable and ecologically sustainable." IUCN provides a variety of training sessions and tools to accomplish this goal, from the mechanics of small animal population management to creating and evaluating genetic models for breedings. Commercial animal breeders have proven that huge numbers of animals can be produced, from parakeets to ball pythons, and we believe that these operations could be a considerable positive force in future conservation programs if they could embrace the mission of the IUCN and other conservation organizations to assist in developing protocols, techniques, and networks for captive breeding for possible re-introduction. However, the possibility of re-introduction should be mentioned only with a large caveat. There are many questions concerning genetics, community structure, introduction of disease, preparing captive-bred animals for a life in the wild, assessing competence to survive and reproduce over generations, and other factors that have not yet been resolved. There are cases of successful re-introductions and translocations of amphibians and reptiles into the wild but examples of failures as well (see Dodd and Seigel 1991; Germano and Bishop 2009). Large iguanine lizards are good candidates for headstart and release (Jamaican Iguana and Anegada Iguana release) and for captive breeding and release (Grand Cayman Iguana) and they respond well to that conservation strategy (Alberts et al. 2004; Hudson 2006; R. Hudson, pers. comm.)

As an example of using the IUCN approach toward partnerships, this is already being done through the SSC Turtle Survival Alliance (TSA), a cooperative arrangement of private breeders and zoological institutions. "The mission of the TSA is to develop and maintain an inclusive, broad-based global network of collections of living tortoises and freshwater turtles with the primary goal of maintaining chelonian species over the long term to provide maximum future options for the recovery of wild populations" (Lawson 2004).

In any program using animals removed from the wild, the captive manager would be well-served to remember the cautionary words of the late Henry Fitch written in 1980: "Thus, captivity will result in intensive selection, molding the animal in a manner quite different from that followed in its natural environment. The final product will be an animal much better adapted to live in close association with humans, in the home or laboratory, but less well adapted for life under natural conditions."

Original traits of a species will tend to be altered in captivity: generation time is shortened; captives are less exacting in their requirements for mating; fertility is increased; and intervals between clutches or litters are shortened. These are trends well known in domestic animals (Darwin 1868). There is no doubt that we are seeing these trends now in our captive herps. In fact, The Herpetologists' League (HL) views the production of designer herps as an ethical issue and takes a strong stand against it: "Because the practice does little to advance society's understanding of amphibian and reptile biology, HL hopes that its members will avoid the capture/purchase and captive breeding of herpetofauna with the express purpose of producing anomalies in body form, coloration or pattern" (<http://www.herpetologistsleague.org/en/ethics.php>).

Reptile and Amphibian Availability over Time

Interest in reptiles and amphibians is growing rapidly. Pet shops abound with scaly forms, reptile clubs are on the increase, and a small army of snake and lizard hunters roams the countryside. Along some of our desert roads collectors may outnumber the snakes, and in some of our large municipal parks hillsides may be dotted with small boys searching for lizards on a Sunday afternoon.

—Robert C. Stebbins, *A Field Guide to the Western Reptiles and Amphibians*, 1966.

—What We Saw in the United States—

From the east to west coast of the United States, amphibians and reptiles were highlighted by two of our most prominent herpetologists: Archie Carr and Robert Stebbins. Unfortunately, their concerns are now applicable throughout the world, and when we see such issues as a potential extinction event affecting amphibians that could result in the loss of an entire vertebrate class, the future is uncertain (see Wake and Vredenburg 2008; Collins and Crump 2009). We quote them here as they eloquently describe the loss of biodiversity in regions that are familiar to us.

The late Archie Carr had a love affair with Florida but worried about the state's future. In his book *Guide to the Reptiles, Amphibians, and Fresh-Water Fishes of Florida* (with Coleman Goin, 1959), he predicted disturbing trends: "We may not be able to hold on to the asset forever. Some way to do this may be worked out but so far the way has not been found. With people flocking in so fast, the day is not far off when the frog ponds will be dry and still, and the bass fishing will be all in managed water, and the only alligators will be under fence. But for the time being at least, we have a wonderful remnant of unfenced nature to color the Florida scene and we ought to enjoy it." When this book was published in 1959, Florida was indeed a different place. As a youngster, JBM traveled with his parents on annual vacations and remembers mile after mile of unbroken wilderness in the early days but depletion over time.

Part of the allure of Florida for JBM in those early days was to visit the various reptile dealers and so the pilgrimage included stops at Ross Allen's Reptile Institute, Tarpon Zoo, Ray Singleton, Charles "Bill" Chase, Thompson Wild Animal Farm, Wild Cargo, and the Miami Serpentarium. Many of these dealers employed locals to collect herps from the area and some of these collectors were very proficient and had keen eyesight. In one instance, JBM was traveling with one to learn the techniques for snake hunting. While traveling by car going 60 mph, the hunter slammed on the brakes, hopped out and grabbed a Yellow

Ratsnake crawling on a barbed-wire fence. Most dealers used outside pits to house local snakes together: numerous species, venomous and non-venomous, with well-fed Florida Kingsnakes and Eastern Indigo Snakes.

Some Florida suppliers such as Bill Chase from Miami and Tarpon Zoo in Tarpon Springs also imported large numbers of exotics, mostly from Latin America. Tarpon Zoo had large fenced areas with sizeable ponds filled with aquatic turtles, tortoises, boas, anacondas, iguanas, and crocodilians. In the middle of the lobby was a pool with enormous tame electric eels; children were petting them but apparently no shocks or electrocutions occurred.

While traveling, JBM saw that herps were rarely kept singly or in small groups at dealer compounds. Since massive shipments regularly entered the USA through Miami and local collectors worked to supply the market as well, there simply was not enough space to separate them. One could see thousands of other animals during a tour of these facilities: tarantulas, primates, psitticines, dozens of passerine birds, small mammals such as tamanduas, ocelots, and margays, and an occasional jaguar or chimp.

As Carr felt about Florida, Robert Stebbins was equally concerned about the future of herps in the western United States. In his 1966 *Field Guide* he said, "Growth of the human population brings great and rapid changes. Marshes are drained, streams are placed in concrete troughs, canyons are dammed and inundated, the ground is cleared for subdivisions and highways, agriculture spreads into marginal lands and, spurred on by water developments, reaches out even into deserts, the stronghold of reptiles. Air, water, and soil are contaminated. Although a few species may be temporarily benefited by some of these changes, most are not and the list of creatures rendered extinct in historic times



Otto Martin Locke Nursery in New Braunfels, Texas specialized in selling the fauna from the southwestern United States and Mexico. Although not well known to reptile keepers outside of Texas, the nursery was established in 1882. Credit: Courtesy of Trooper Walsh.

Ray Singleton & Co.

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1/0	WOOLY MONKEY, three years old	250.00
1/0	CAPUCHIN MONKEY	135.00
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2/2	COATIMUNDIS, MEXICAN, each	100.00
5/5	RACCOONS, each	15.00
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5/5	SPOTTED SKUNKS, scentless, each	20.00
5/5	ARMADILLOS, each	15.00
50/50	FLYING SQUIRRELS, each	5.00
2/2	GRAY FOXES, each	40.00
2/1	BURMESE PYTHONS, 7 ft., good feeders, each	85.00
0/1	YELLOW ANACONDA, 10 ft.	125.00
10/10	EASTERN DIAMONDBACK RATTLESNAKES, 4 to 5 ft., each	20.00
10/10	RED DIAMOND RATTLESNAKES, 3 to 4 ft., each	20.00
2/0	YELLOWFOOT TORTOISES, large, each	100.00

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WANTED:
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Female Syke's Monkey
Female Yellowfoot Tortoises

In Florida during the late 1950s, dealer **Ray Singleton** obtained many local snakes from persons whose income was solely derived from collecting amphibians and reptiles. Some of these collectors were remarkably skilled at finding snakes and would bring in dozens for sale on a regular basis.

Owners:
Mike Tsalickis
Trudie Jerkins

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Day - 937-4201
(Area Code - 813)

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Revised January 1966

REPTILE PRICE LIST

CAT. NO.

Poisonous Snakes

P-1 **CASCABEL (Crotalus durissus) Tropical Rattlesnake. 2 to 4 feet.**
Small $5.00 Medium $8.00 Large $12.00 Ex. Large (4½' & over) $15.00
Handsomely marked with large brown diamonds bordered with light yellow, and a pair of vivid longitudinal bands on the neck. Feeds on birds, rabbits and rodents.

P-2 **EASTERN DIAMONDBACK RATTLESNAKE (Crotalus adamanteus) Florida. 18" to 5 feet.**
Small $5.00 Medium $10.00 Large $15.00 Ex. Large (5½' & Over) $20.00
Second largest type of rattlesnake... Heavy, dark body with yellow and black diamond markings. Feeds on birds, rabbits and rodents.

P-3 **PIGMY RATTLESNAKE (Sisturus miliarius) Florida. 1 to 2 feet.**
Small $1.00 Medium $2.00 Large $3.00 Over 2' $5.00
Small and heavy bodied. Light grey with black markings. Very hardy in captivity. Feed on frogs, rodents.

P-4 **COTTON MOUTH MOCCASIN (Ancistrodon piscivorus) Florida. 1½ to 4 feet.**
Small $1.50 Medium $3.50 Large $7.50 Ex. Large (4½' & over) $10.00
Heavy dark brown to a black body, with darker saddles. One of the hardiest snakes in captivity. Feed on frogs, toads, small snakes and fish.

P-5 **BUSHMASTER (Lachesis muta) South American. 4 to 8 feet.**
Small $50.00 Medium $100.00 Large $150.00
Largest of the poisonous snakes found in the New World. Very rare. Feed on birds and rodents.

P-6 **FER-DE-LANCE (Bothrops atrox) South American. 22 to 5 feet.**
Small $10.00 Medium $15.00 Large $25.00
Fairly heavy, brownish colored body, with pale yellow bands.

P-7 **GREEN TREE VIPER ( ) South American. Average size 18"** $15.00
Bright green, with pale yellow belly and prehensile tail. Feed on frogs, lizards, small rodents and birds.

P-8 **HOGNOSE VIPER (Bothrops hyoprora) South American. Average size 18"** $15.00
Rare coloration similar to that of the N. American Copperhead. Feed on small rodents and birds.

P-9 **BLACK & GREEN VIPER (Bothrops nigrovirides) South American. 18 to 30".**
Small $15.00 Medium $17.50 Large $22.50
Very rare. Body bright green with scales outlined in black. Feed on small rodents and birds.

P-10 **CORAL SNAKE (Micrurus fulvius) Florida. 1 to 3 feet.**
Small $5.00 Medium $7.50 Large $10.00 Ex .Large (40" & over) $15.00
Brilliantly colored with broad scarlet and black rings, separated by narrow yellow rings. Tip of nose black, with blunt head. Feed on small snakes, lizards and earth worms.

P-11 **CORAL SNAKE (Micrurus spixi) South American. 2 to 4 feet.**
Small $15.00 Medium $20.00 Large $25.00 Ex. Large (4' & over) $30.00
Has bright red rings separated by very wide black rings in triads. Each of the black rings contain two narrow yellowish-white rings Feed on small snakes, lizards and earth worms.

P-12 **CORAL SNAKE (Micrurus—various species) South American. 18" to 3 feet.**
Small $10.00 Medium $15.00 Large $20.00

Mildly Poisonous Snakes
(Rear Fanged)

M-1 **GUARDA CAMINO (Conophis lineatus) South American. 1½ to 2 feet** $2.00 to $3.50
Tan with black longitudinal stripes. Very gentle and hardy. Feed on lizards and snakes.

—1—

Tarpon Zoo was located in Tarpon Springs, Florida and was owned by Trudy Jerkins and Mike Tsalickis. Tsalickis set up an export facility in South America to supply Tarpon Zoo, resulting in the importation of many species rarely seen in the US. The animals were listed by region: 13 species of venomous snakes, 9 of rear-fanged snakes, 17 non-venomous snakes from Florida, 22 non-venomous snakes from South America, 11 of lizards from South America, 22 types of Florida and South American chelonians, and 4 of crocodilians. Cages, plants, live foods, and insects were also offered for sale. Most of the herps were kept in large outdoor enclosures. Credit: Courtesy of Trooper Walsh.

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4	BUSHMASTERS (Lachesis muta)	6-8 '	125.00
1	BUSHMASTER (Lachesis muta)	5 '	100.00
2	FER-DE-LANCE (Bothrops atrox)	5-6 '	50.00
4	FER-DE-LANCE (Bothrops atrox)	3-4 '	35.00
2	FER-DE-LANCE (Bothrops atrox)	2 '	25.00
8	SIAMESE COBRAS (Naja n. siamensis)	3-4 '	35.00
2	SUMATRAN PIT VIPERS (Trimeresurus sumatranus)	18-24 "	35.00
2	WAGLER'S VIPERS (Trimeresurus wagleri)	2½ '	35.00
1	BOLIVIAN TREE VIPER (Bothrops sp.)	18 "	35.00
12	BANDED SEA SNAKES (Laticauda semifasciata)	3-4½ '	35.00
6	MANY-BANDED SEA SNAKES (Laticauda laticaudata)	2-3 '	35.00
1	EASTERN DIAMONDBACK (Crotalus adamanteus)	4 '	15.00
2	TIMBER RATTLER (Crotalus h. horridus)	3-4 '	15.00
1	CANEBRAKE (Crotalus h. atricaudatus)	4 '	15.00
1	BANDED ROCK RATTLER (Crotalus l. klauberi)	12 "	15.00
2	PANAMINT RATTLERS (Crotalus m. sterensi)	2½ '	15.00
1	CANTIL (Agkistrodon bilineatus)	3 '	12.50
2	GREAT BASIN RATTLERS (Crotalus v. lutosus)	2-3 '	15.00
2	NORTHERN PACIFIC RATTLERS (Crotalus v. oreganus)	2-3 '	10.00
1	WATER MOCCASIN (Agkistrodon piscivorus)	1½ '	10.00
1	PRAIRIE RATTLER (Crotalus v. viridis)	2 '	5.00
1	DUSKY PIGMY (Sistrurus miliarus)	18 "	15.00
2	WESTERN DIAMONDBACKS (Crotalus atrox)	2-3 '	6.00
12	MOJAVE RATTLERS (Crotalus s. scutulatus)	2-3 '	6.00
2	SOUTHERN PACIFICS (Crotalus r. helleri)	18"-2½ '	5.00
1	WATER MOCCASIN (Agkistrodon piscivorus)	12 "	4.00
1	SOUTHERN COPPERHEAD (Agkistrodon c. contortrix)	8 "	3.00
7	SOUTHERN PACIFICS (Crotalus v. helleri)	6-10 "	1.00
	NON-VENOMOUS SNAKES		
1	INDIAN PYTHON (Python m. molurus)	7 '	150.00
5	BURMESE ROCK PYTHON (Python m. bivitattus)	7-9 '	125.00
2	DIAMOND PYTHONS (Morelia spilote spilote)	5½ '	150.00
3	CARPET PYTHONS (Morelia s. variegata)	4 '	100.00
4	BLOOD PYTHONS (Python curtus)	3-5 '	100.00
1	CENTRAL AMERICAN BOA (Constrictor c. imperator)	8 '	75.00
2	CENTRAL AMERICAN BOAS (Constrictor c. imperator)	6-7 '	65.00
2	CENTRAL AMERICAN BOAS (Constrictor c. imperator)	5 '	35.00
1	RETICULATED PYTHON (Python reticulatus)	6 '	50.00
4	RETICULATED PYTHONS (Python reticulatus)	2-3 '	25.00
2	AFRICAN ROCK PYTHONS (Python sebae)	2½ '	35.00
1	HAITIAN BOA (Epicrates s. striatus)	5 '	50.00
10	BRAZILIAN RAINBOW BOAS (Epicrates c. cenchris)	4 '	35.00
2	MEXICAN DWARF PYTHONS (Loxocemus semicrastes)	3½ '	50.00
1	TIGER RAT (Spilote pullatus) (Green Phase)	8 '	20.00
1	AUSTRALIAN TREE SNAKE (Dendrelaphis punctulatus)	4½ '	20.00

Hermosa Reptile and Wild Animal Farm was located in Hermosa Beach, California and was owned by Ray Folsom and his wife Gini. This was one of the largest operations in the US. His lists were sent monthly to customers for US $1.00 to cover mailing costs annually. This list shown here included 26 types of venomous snakes, 11 of rear-fanged snakes, 28 of non-venomous snakes, 22 of lizards, 26 of chelonians, 2 of crocodilians, and 22 of amphibians including Chinese Giant Salamanders (*Andrias davidianus*) for $100.00 each. In another list, 52 species of amphibians were for sale, mostly from the United States. Mammals and birds were also available, including douc langurs, tapirs and black bears.

Folsom possessed one of the largest personal collections of rattlesnakes ever assembled, which were kept at his home. Virtually all of the US forms were represented and a considerable number from Latin America as well. Credit: Courtesy of Trooper Walsh.

can be expected to grow. The trend is toward an ordered, domesticated world, reduced in organic variety and crowded with people and their possessions. Interest in wildlife preservation cannot be separated from concern with efforts to limit human population growth and prevent careless exploitation of remaining natural areas."

There were several large dealerships in California during this time: Hermosa Reptile and Wild Animal Farm in Hermosa Beach, Western Zoological Supply in Monrovia, and East Bay Vivarium in Oakland which still exists today, making it the oldest continuous specialist reptile store in the USA. We occasionally visited these places and were impressed with the wide range of species available for sale. In fact, one of us (KM) worked at two of these places when he was young. As a 14-year-old adolescent already obsessed with herps, he was the first (or one of the first) of owner Ronald Cauble's original employees at East Bay Vivarium when this retail reptile store first opened in Oakland. KM would travel by bus and/or train for three hours each way for the opportunity to work each Saturday cleaning cages. For reimbursement, he received a meager pittance: costs of the travel fares (buses and train) and a cheeseburger and fries at lunch time. Later, KM was employed at Western Zoological Supply where he learned to work with huge assortment of herps, including many venomous reptiles.

WESTERN ZOOLOGICAL SUPPLY

209 WEST MAPLE AVENUE, MONROVIA, CALIFORNIA 91016

IMPORTERS AND SUPPLIERS OF EXOTIC REPTILES AND AMPHIBIANS

(213) 358-3011 / 358-0802 / 797-3298

IN STOCK NOVEMBER 1, 1973

	VENOMOUS SNAKES		
2	SOUTH AMERICAN BUSHMASTERS-Lachesis m. muta	6-8'	$ 250.00 ea
3	CENTRAL AMERICAN BUSHMASTERS-Lachesis m. stenophrys	5-7'	200.00
0/1	JUMPING VIPER-Bothrops nummifer	2 1/2'	50.00
10	JUMPING VIPERS-Bothrops nummifer-CAPTIVE BORN BABIES		25.00
4	SPECKLED TREE VIPERS-Bothrops nigroviridis	1 1/2-2'	75.00
5	PALM VIPERS-Bothrops lateralis	1-2'	50.00
2	FER DE LANCE-Bothrops asper	4-5'	50.00
2	FER DE LANCE-Bothrops asper	BABIES	15.00
1	HOGNOSE VIPER-Bothrops nasuta	1 1/2'	25.00
5	EYELASH VIPERS-Bothrops schlegeli	1 1/2-2 1/2	35.00
2	ECUADORIAN EYELASH VIPERS-Bothrops schlegeli	2-2 1/2'	40.00
3	GOLDEN EYELASH VIPERS-Bothrops schlegeli	1-2 1/2'	75.00
3	CEYLONESE TREE VIPERS-Trimeresurus trigonacephalus	2-2 1/2'	75.00
4	CHINESE GREEN TREE VIPERS-Trimeresurus stejnegeri	2'	25.00
1	WAGLER'S VIPER-Trimeresurus wagleri	1 1/2'	35.00
* 3	CANTILS-Agkistrodon bilineatus	2-3'	35.00
6	CANTILS-Agkistrodon bilineatus-CAPTIVE BORN BABIES		15.00
4	HUMP NOSE VIPERS-Agkistrodon hypnale	1-1 1/2'	25.00
3	MALAYAN PIT VIPERS-Agkistrodon rhodostoma	2-3'	25.00
2	SOUTHERN COPPERHEADS-Agkistrodon c. contortrix	3'	15.00
3	NORTHERN COPPERHEADS-Agkistrodon c. mokeson	2'	10.00
1	TRANSPECOS COPPERHEAD-Agkistrodon c. pictagaster	2'	35.00
10	FLORIDA COTTONMOUTHS-Agkistrodon piscivorous-CAPTIVE BORN BABIES		10.00
* 1	LANCE HEADED RATTLESNAKE-Crotalus polystictus	2'	400.00
* 2	CENTRAL PLATEAU DUSKY RATTLESNAKE-Crotalus triseriatus	1 1/2'	150.00
* 3	MEXICAN WEST COAST RATTLESNAKES-Crotalus basiliscus	4-5'	50.00
8	NEOTROPICAL RATTLESNAKES-Crotalus d. durissus	4-5'	65.00
4	NEOTROPICAL RATTLESNAKES-Crotalus d. durissus	BABIES	40.00
* 2	SAN LUCAN SPECKLED RATTLESNAKE-Crotalus m. mitchelli	2-3'	100.00
3	SOUTHWESTERN SPECKLED RATTLESNAKES-Crotalus m. pyrrhus	2'	25.00
6	MOJAVE RATTLESNAKES-Crotalus scutulatus	2-3'	10.00
2	RED DIAMONDBACK RATTLESNAKES-Crotalus r. ruber	2-3'	15.00
* 4	SAN LUCAN DIAMONDBACK RATTLESNAKES-Crotalus r. lucanensis-BABIES		50.00
* 1	LOWER CALIFORNIA RATTLESNAKE-Crotalus enyo	2'	100.00
12	TIMBER RATTLESNAKES-Crotalus h. horridus-CAPTIVE BORN BABIES		7.50
2	CANEBRAKE RATTLESNAKES-Crotalus h. atricaudatus	3-4'	25.00
4	WESTERN DIAMONDBACK RATTLESNAKES-Crotalus atrox	3-4'	10.00
5	BLACK TAIL RATTLESNAKES-Crotalus molossus	3-4'	25.00
1	PANAMINT RATTLESNAKE-Crotalus m. stephensi	3'	25.00
* 3	RIDGE-NOSE RATTLESNAKES-Crotalus w. willardi	2'	150.00
2	MOTTLED ROCK RATTLESNAKES-Crotalus l. lepidus	1-2'	50.00
2	BANDED ROCK RATTLESNAKES-Crotalus l. klauberi	1-2'	50.00
3	PRAIRIE RATTLESNAKES-Crotalus v. viridis	2'	10.00
1	GREAT BASIN RATTLESNAKE-Crotalus v. lutosus	3'	25.00
4	MIDGET FADED RATTLESNAKES-Crotalus v. concolor	2-2 1/2'	100.00
2	SOUTHERN PACIFIC RATTLESNAKES-Crotalus v. helleri	3'	10.00
6	SOUTHERN PACIFIC RATTLESNAKES-Crotalus v. helleri	1-1 1/2'	5.00
2	TWIN SPOTTED RATTLESNAKES-Crotalus pricei	1 1/2'	50.00

BARNEY TOMBERLIN — MEMBERS A.A.Z.P.A. — JIM BROCKETT

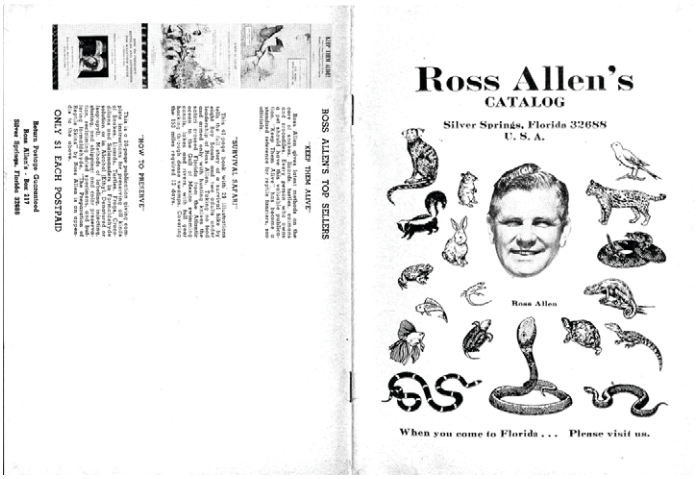
Western Zoological Supply in Monrovia, California, was one of the largest operations on the west coast of the US during the mid-1970s. Since the weather was generally pleasant, lizards, tortoises, and other reptiles could be kept in large outdoor enclosures throughout the year, such as a number of chameleon species.

—The Trade Between 1940 and 1970—

"Easy to keep" is a quality which must be differentiated sharply from the conceptions "hardy" or "resistant." By keeping a living thing in the scientific sense we understand the attempt to let its whole life cycle be performed before our eyes within the narrower or wider confines of captivity. Nevertheless, those animals are usually deceptively termed easy to keep which, in reality, are merely resistant and, to put it crudely, take a long time to die. The classic type of this type of animal is the Greek tortoise. Even under the inadequate treatment of the average ignorant owner, this poor beast takes three, four or even five years until it is really, thoroughly and irrevocably dead, but, strictly speaking, it starts on the downward path from the first day of its captivity. To keep tortoises so that they grow, thrive and multiply, they must be offered conditions of life which, in a town flat, cannot be achieved, In our own climate, nobody, to my knowledge, has truly succeeded in breeding these animals.

—Konrad Z. Lorenz, *King Solomon's Ring,* 1952

When in grade school in the 1940s, JBM ordered a "hatchling aquatic turtle den" from a dealer's price list. The transaction was to include a dozen individuals of at least six species. The shipment was packed in a large, very heavy, reinforced wooden crate and was shipped via railway express. The shipping fee was staggering and upon opening the box, a dozen adult box turtles peered out of the container. A steady stream of complaints from the recipient to the supplier ensued but none was answered; U. S. Postal Service mail fraud charges were initiated. Several years passed but justice prevailed and the proper animals were eventually received. JBM accosted the dealer—an unkempt person with beer in hand, unshaven, un-bathed, and sloppily dressed with shoes untied— at his compound. When asked why he never responded, he said that he had just been released from jail. Since the supplier was anxious to avoid additional legal difficulties, JBM left with far more herps given as



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U. S. A.

Ross Allen

When you come to Florida . . . Please visit us.

Ross Allen's Reptile Institute was located in Silver Springs, Florida and featured one of the largest crocodilian collections ever assembled. His Institute offered three publications for sale: "Special Publications," "Publications of the Research Division," and "Bulletins." The "Bulletins" covered topics ranging from snake biology and husbandry to disease treatment for captive specimens. Allen also created the Research Division in 1949 and hired Wilfred T. Neill (1922–2001) as director. Allen and Neill published a large number of short papers in *Herpetologica* and *Copeia*. This catalogue was published around 1960. Allen offered many supplies for the snake hunter: manuals, snakebite kits, hooks, tongs, snake-proof boots, transport boxes, and cloth bags. Credit: Courtesy of Dave Barker.

CENTER FOR REPTILE
AND
AMPHIBIAN PROPAGATION
5645 W. San Madele, #103
Fresno, CA 93722
(209) 276-1031

PRICELIST - February 1988

1.1	Spiny-tailed Mastigure, Uromastix acanthinurus, 6-8", c.b.	$ 400. ea.
1.1	Pakistan Mastigure, Uromastix hardwicki, 6-10"	60. ea.
1.2	Rankin's Dragon, Amphibolurus rankini, 6-8", c.b.	125. ea.
3.2	Pink-tongue Skink, Tiliqua gerrardii, 10-15", c.b.	100. ea.
1.1	Malagasy Spiny-tailed Iguanid, Oplurus cuvieri, adults, Super!	700. pr.
2.2	Malagasy Giant Plated Lizard, Zoonosaurus maxima, adults, all four must go to the same buyer. First ever in the U.S.A.	2000. pr.
1.2	Leachs' Anole, Anolis bimaculatus leachi, big blue-green & black	125. ea.
1.1	Ricords' Anole, Anolis ricordii, adults, very nice	175. ea.
1.1	Malagasy Giant Day Gecko, Phelsuma m. grandis, adults, c.b. '87	130. pr.
1.1	S.A. Gecko, Thecadactylus rapicauda, adults	150. pr.
1.1	Malagasy Gecko, Paroedura stumpfi, 4", young - grows to 6-7", RARE	450. pr.
1.0	Malagasy Gecko, Paroedura pictus, 6-7" adult, marbled colrs	125. ea.
1.1	Frog-eyed Gecko, Teratoscincus kaiserlingi, 6-7", golds, black&white	200. ea.
3	Leopard Gecko, Eublepharis macularius, 4" babies	20. ea.
0.1	Spotted Gecko, Ptyodactylus guttatus, 6-7" adult	75. ea.
2.2	African Gecko, Tropicolotes steudneri, adults, 2", ground dweller	45. ea.
2.2	African Gecko, Tropicolotes tripolitana, adults, 2-3", very hardy	45. ea.
***	Our recent Europe trip resulted in the following rare geckos which never made it on our list: Rhacodactylus sarasinorum, R. chahoua, R. auriculatus (striped phase), Palmatogecko, Blaesodactylus from Madagascar, Nephurus levis pilbarensis, Phelsuma seratocauda, Pachydactylus m. occelatus, Phyllur Lygodactylus rugosus, Uroplatus fimbriatus, and Saurodactylus brosetti. If you have interest in these forms please order now for our July '88 trip.	
1.1	Jone's Armadillo Lizard, 4-5", acclimated	40. ea.
2	Mangrove Monitor, Varanus indicus, 2½'	300. ea.
1	Green Tree Monitor, Varanus prasinus kordensis, adult	800. ea.
1.1	Malagasy Tree Boa, Sanzinia madagascariensis, 5-6', bluish phase	2000. pr.
1.1	Green Tree Python, Chondropython viridis, 4'+, c.b.'86	700. ea.
2.0	Honduran Milksnake, Lampropeltis t. hondurensis, 4', red phase	150. ea.
1.1	Yugoslavian Ratsnake, Elaphe quatrolineata, 4', eats rodents-SALE...	60. pr.
2	Galapagos Tortoise, Geochelone elephantopus, 6½", captive-bred. Photos available. Personality plus!!	2500. ea.
0.1	African Spurred Tortoise, Geochelone sulcata, 10", heavy	600. ea.
4	Marginated Tortoise, Testudo marginata, 2-2½" nippers, c.b.'87 very active with nice dark and pale contrasting color, smooth shells.	100. ea.
1.1	Pancake Tortoise, Malacochersus tornieri, adults, perfect	75. ea.
2	Pancake Tortoise, M. tornieri, 2-3" robust babies, starred patterns	50. ea.
1.1	African Leopard Tortoise, Geochelone p. babcocki, 5-6", choice	100. ea.
2	Venezuelan Wood Turtle, Rhinoclemmys diademata, RARE, 4", c.b.'87	100. ea.
3	S.A. Wood Turtle, Rhinoclemmys melanosterna, 3-4", c.b. '87	100. ea.
5	Ornate Wood Turtle, Rhinoclemmys p. manni, 3", colorful gems, c.b.	30. ea.
0.1	Snake-necked Turtle, Chelodina longicollis, 3-4", sex guaranteed	125. ea.
3	Geoffrey's Side-neck Turtle, Phrynops geoffroanus, 2", c.b.87, nice	60. ea.
1	Argentine Horn Frog, Ceratophrys ornata, 2-3", c.b.'87	30. ea.
***	SUPERWORMS - $27. per thousand + postage - wholesale & bulk prices available.	

Ronald L. & Marilyn Tremper, owner/Breeder

-over-

The **Center for Reptile and Amphibian Propagation** in Fresno, California specialized in propagating rare lizards, such as many of the Madagascan chameleons and geckos, and the New Caledonian Giant Geckos. Owner Ron Tremper was formerly herpetological curator at Fresno Zoo in California. The operation is now located in Boerne, Texas.

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Saturday(Noon to 3 P.M.)

1/1	Uracoan Rattlesnakes(Crotalus vergrandis)2½' Captive raised.	Inquire
1	Venezuelan Rattlesnake(Crotalus durissus cumanansis)1'	$50.00
2	West Coast Rattlesnakes(Crotalus basiliscus)3 & 5' Captive raised.	$50.00 & $85.00
1	Lower California Rattlesnake(Crotalus e. enyo)1½' Captive raised.	$75.00
1	Red Diamond Rattlesnake(Crotalus r. ruber)4' Long term captive.	$45.00
2	Red Diamond Rattlesnakes(Crotalus r. ruber x lucasensis)2½' Long term captives.	$45.00
2	Great Basin Rattlesnakes(Crotalus viridis lutosus) 1½' & 3'.	$35.00 & $45.00
1	Northern Pacific Rattlesnake(Crotalus viridis oreganus)3' Long term captive.	$35.00
4	Eastern Diamondback Rattlesnakes(Crotalus adamanteus)Babies & 3'.	$25.00 & $35.00
1	Forest Cobra(Naja melanoleuca)4½' Captive raised.	$100.00
3	Forest Cobras(Naja melanoleuca)1½' Captive born.	$65.00
2	Monacled Cobras(Naja n. kaouthia)2' Captive raised.	$40.00
15	Eyelash Vipers(Bothrops schlegeli)1-3'.	$35.00-$65.00
1	Western Hognose Viper(Bothrops ophryomegas)1'	$50.00
1/2	Hognose Vipers(Bothrops nasuta)1½'	$45.00
1	Jumping Viper(Bothrops nummifera)2'	$50.00
1/1	Honduran Palm Vipers(Bothrops nigroviridis marchi)1½'	$100.00
2/2	Okinawan Pit Vipers(Trimeresurus okinavensis)2'	$100.00
1	Taiwan Habu(Trimeresurus mucrosquamatus)3'	$85.00
1	Purple Spotted Pit Viper(Trimeresurus purpureomaculatus)2½'	$35.00
1	Bamboo Viper(Trimeresurus popeorum)2½' Captive raised.	$50.00
1/0	Sharp Nosed Pit Viper(Agkistrodon acutus)3'	$150.00
8	Puff Adders(Bitis arietans)1' Captive born.	$20.00
2	Desert Vipers(Vipera mauritanica deserti)2½'	$125.00
1/1	Caspian Lebantine Vipers(Vipera lebantina obtusa)3'	$100.00
2	Ottoman Vipers(Vipera x. xanthina)1' Captive born.	$50.00
1	Ottoman Viper(Vipera x. xanthina)2'	$100.00
3	Armenian Vipers(Vipera xanthina raddei)1½' Captive raised.	$85.00
2	Russell's Vipers(Vipera r. russelli)2' Captive raised.	$65.00
1/3	Long Nosed Vipers(Vipera a. ammodytes)2'	$45.00
2/2	Long Nosed Vipers(Vipera ammodytes montandoni)1' Captive born.	$50.00
2/2	Long Nosed Vipers(Vipera ammodytes ruffoi)1' Captive born.	$65.00
2	False Fer-de-Lance(Xenodon rabdocephalus) 1½'	$25.00
2	False Coral Snakes(Oxyrhopus petola)2'.	$35.00
6	False Coral Snakes(Erythrolamprus mimus)2'	$50.00
3	False Water Cobras(Cyclagras gigas)1-1½' Captive born.	$50.00
1	Mangrove Snake(Boiga dendrophila)2' Captive born.	$45.00
1	Montpellier Snake(Malpolon monspessulanus)3'	$25.00
1	Blunt Headed Tree Snake(Imantodes cenchoa)2½'	$15.00
1	New World Python(Loxecemus bicolor)2'	$175.00
1	Green Tree Python(Chondropython viridis)3'	$300.00
5	Ball Pythons(Python regius)3' Long term captives.	$65.00-$75.00
2	African Rock Pythons(Python sebae)6' Captive raised.	$200.00
3	African Rock Pythons(Python sebae)2'.	$125.00
1	Reticulated Python(Python reticulatus)16-17' Captive raised.	$800.00
1	Reticulated Python(Python reticulatus)11' Captive raised.	$275.00
2	Burmese Pythons(Python molurus bivittatus)12 & 13' Captive raised.	$400.00 & $450.00
2	Burmese Pythons(Python molurus bivittatus)8' Captive raised.	$200.00
1	Burmese Python(Python molurus bivittatus)6' Captive raised.	$125.00
6	Burmese Pythons(Python molurus bivittatus)2' Captive born.	$50.00
1/1	Ceylonese Pythons(Python molurus pimbura)7' Long term captives.	$800.00 pr.
1/1	Carpet Pythons(Python spilotus)3' Captive raised.	$300.00
1/0	Solomon Island Ground Boa(Candoia carinata paulsoni)1½' Captive raised.	$175.00
1/2	Jamaican Boas(Epicrates subflavus)1½-2½' Captive raised.	Inquire
1/1	Bimini Boas(Epicrates striatus fosteri) 4 & 5' Captive raised.	$275.00 pr.
1	Caicos Island Boa(Epicrates c. chrysogaster)3½' Captive raised.	$250.00

The Shed in Miami, Florida was one of the premier dealerships in the southeastern United States during the mid-1970s. One of the owners, Louis Porras, has written many herpetological papers and coauthored a book on invasive amphibians and reptiles in Florida. Porras took JBM on collecting trips around Miami to show the extent of the many foreign introductions: Knight, Jamaican, Puerto Rican Crested, and Bark Anoles, Green and Spiny-Tailed Iguanas, Brown Basilisks, Tokay and Yellow-Headed Geckos, and Cuban Treefrogs. The search for Spectacled Caimans along the canals was unsuccessful. One striking feature was the number of exotic fishes released into the Everglades which seemed to outnumber the native species in biomass: Oscars, several species of *Tilapia*, *Plecostomus*, several Latin American cichlids, and some killifish.

"gifts" than had been initially ordered. This dealer's snakes were kept in a ramshackle tin/wooden shed in long wooden boxes filled with sawdust. Two of the largest cottonmouth moccasins imaginable were held in an oil drum half-filled with water; the ophidians swam without stopping. The dealer was afraid that the snakes would crawl over the side of the container and escape if they could brace themselves on the bottom.

Virtually anyone at least a half-century in age can remember pithing and dissecting a live frog in high school biology lab. There were several suppliers in the US who specialized in providing a variety of amphibians and reptiles for the classroom: William A. Lemberger Co. in Oshkosh, Wisconsin; Quivira Specialties, operated by herpetologist Dr. Charles Burt in Topeka, Kansas; Ward's Natural Science near Rochester, New York; and herpetologist Ottys Sanders' Biological Supply Co. outside Dallas, Texas. The species usually offered were common at the time: Leopard Frogs, various Treefrogs, Bullfrogs, Garter Snakes, American Anoles, Red-spotted Newts, Spotted and Tiger Salamanders, Red-eared Sliders, and Box Turtles.

In the early 1950s, tropical fish wholesalers in the United States began to expand stock by including amphibians and reptiles. Most of these entrepreneurs had little experience with herps so most were kept in large numbers in crowded conditions, just like ornamental fishes. As an example in Chicago, piles of tortoises were stacked three or four

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1986 PRICE LIST OF REPTILES AND AMPHIBIANS

CODE NO	COMMON NAME	SCIENTIFIC NAME	UNIT PRICE USD
VENOMOUS SNAKES			
A1	Five Pace Snakes	Agkistrodon acutus	30.00.ea.
A2	Gold Coin Vipers	Vipera russelli	30.00.ea.
A3	White Head Vipers (Rare)	Azemiops feae	300.00.ea.
A4	Common Cobra	Naja naja	8.00.ea.
A5	King Cobra	Ophiophagus hannah	80.00.ea.
A6	Banded Krait	Bungarus fasciatus	8.00.ea.
A7	Many-banded krait	Bungarus multicinctus	9.00.ea.
NON VENOMOUS SNAKES			
B1	Rare: Sun Flowers Rat Snake	Elaphe mandarina	60.00.ea.
B2	Red Head & Tail Rat Snake	Elaphe moellendorffi	12.00.ea.
B3	Rare: Emerald Rat Snake	Elaphe prasina	50.00.ea.
B4	Black Eyed Bow Rat Snake	Elaphe taeniura	12.00.ea.
B5	Black Rat Snake	Elaphe schrenckii	50.00.ea.
B6	Three Black-lined Rat Snake	Elaphe radiata	10.00.ea.
B7	Yellow King Rat Snake	Elaphe carinata	15.00.ea.
B8	Rare: Red Coin Rat Snake	Elaphe bimaculata	50.00.ea.
B9	Grey Rat Snake	Ptyas mucosus	8.00.ea.
B10	Green Grass Snake	Opheodrys major	5.00.ea.
LIZARDS AND FROGS			
C1	Rare: Crocodile Lizards	Shinisaurus crocodilurus	
	Adult (captive born)		80.00.ea.
	Baby (captive born)		60.00.ea.
C2	Five Lined Skink	Eumeces fasciatus	1.00.ea.
C3	Chinese Tokay Gecko	Gekko gecko	3.00.ea.
C4	Two Tailed Tokay Gecko 8"long(rare)	Gekko gecko	100.00.ea.
C5	Giant Emerald Tree Frog		10.00.ea.

Scales & Tails Trading Company in Hong Kong offered five very rare reptiles in 1986: White Head Vipers (*Azemiops feae*), Crocodile Lizards (*Shinisaurus crocodilurus*), and three species of ratsnakes (*Elaphe* sensu lato).

deep: Greek, Hermann (*Testudo* spp.), Red-Footed, and Yellow-Footed (*Geochelone* spp.). Amphibians such as Red-Bellied Newts (*Cynops pyrrhogaster*), Red-Spotted Newts (*Notophthalmus viridescens*), Roughskin Newts (*Taricha granulosa*), aquatic Caecilians (*Typhlonectes compressicauda*), Oriental Toads (*Bombina orientalis*), African Clawed Frogs (*Xenopus laevis*), and African Dwarf Frogs (*Hymenochirus boettgeri*) were available but there was often no live invertebrate prey for food. Hundreds of poison dart frogs (*Dendrobates* spp. sensu lato) were held in an aquarium with piles of tropical fish flake food scattered throughout the enclosure. The owner expressed surprise when JBM told him that frogs did not eat flake food.

One enterprising wholesaler offered "Green Snake Dens" to several retail pet outlets in Chicago but later learned, to his horror, that the assemblage included Bamboo Vipers (*Trimeresurus* sp.) and Asian Vine Snakes (*Ahaetulla* sp.). Large shipments of Boa Constrictors (*Boa constrictor*), Brazilian and Colombian Rainbow Boas (*Epicrates cenchria* ssp.), and Green Anacondas (*Eunectes murinus*) regularly arrived in Chicago. Lizards included Anoles (*Anolis*), Ameivas (*Ameiva*), Whiptail Lizards (*Cnemidophorus*), Green Iguanas (*Iguana iguana*), and several types of Spiny-Tailed Iguanas (*Ctenosaura*). Spectacled Caimans (*Caiman crocodilus*) were available in large numbers.

When JBM began college in 1957 as a callow seventeen-year old youth and his parents were no longer nearby to control his impulses, he began amassing a collection of snakes, some venomous and others potentially dangerous like large constrictors. Soon the dorm room was filled with Rhinoceros Vipers, Gaboon Vipers, Indian Cobras, Gila Monsters, Bamboo Vipers, Timber and other Rattlesnakes, Copperheads, and a spectacular black Asian Spitting Cobra with a perfect white "human skull" pattern on its hood. Most of the specimens were obtained from animal dealers; no proof of age was ever requested although most lists had statements like "no venomous snakes intentionally sold to minors." In retrospect, what was most troubling was that JBM had no real experience at handling venomous snakes and no antivenin was available in case of a bite; fortunately, there were no catastrophic incidents.

One dealer offered Gila Monsters and Beaded Lizards (*Heloderma*) which appeared to be well-fed but died a month or so later. Upon necropsy, stomachs were found to be stuffed with sphagnum moss. Several species of Oriental ratsnakes (*Elaphe* sensu lato and *Spalerosophis*) were imported to the US in the mid-1970s and all died after a few weeks. Upon close examination by the Dallas Zoo veterinarian, it was discovered that gall bladders had been skillfully removed for human medicinal purposes. Prior to export, a small incision had been made but scales were never cut, only the interstitial skin, and the tiniest sutures used to complete the surgery.

One source of venomous snakes from Latin America and Southeast Asia was venom extraction laboratories but the snakes sometimes arrived clearly stressed and in poor condition due to rough handling during milking. Several other problems occurred with venomous snake importation: misidentification, especially with mimics such as False Coral Snakes (*Pliocercus*, *Erythrolamprus*) and models like Coral Snakes (*Micrurus* spp.); inaccurate counts, especially when snakes gave birth during shipments; cloth shipping bags unlabeled (especially unnerving if a spitting cobra happened to be inside); and snakes shipped either loose in the crate or having escaped from cloth bags.

INTERREP HOLLAND
REPTIELEN, AMPHIBIEËN, VOEDSELDIEREN, TERRARIA
IMPORT, EXPORT, KWEKERIJ

Waldorpstraat 38
2521 CC Den Haag
Holland
Telefoon: 070 - 89.44.73
Telex: 31004 snake nl.
K.v.K. 's-Gravenhage, nr. 108998

PRICE/STOCKLIST REPTILES & AMPHIBIANS
MARCH/APRIL 1987

TURTLES/TORTOISES :

SACALIA BEALEI,	US$	22.50
CHINEMYS KWANGTUNGENSIS,	US$	42.50
CUORA TRIFASCIATA,from Vietnam,darker variety	US$	175.00
CUORA PANI,	US$	495.00
CUORA GALBINIFRONS,	US$	95.00
MAUREMYS MUTICA,from Vietnam	US$	22.50
RHINOCLEMMYS PULCHERRIMA INCISSA,captive hatched	US$	50.00
CALLAGUR BORNEOENSIS,very large	US$	595.00
ORLITIA BORNEOENSIS,very large,(0,1 only)	US$	595.00
NOTOCHELYS PLATYNOTA,	US$	50.00
HARDELLA THURJII,	US$	75.00
KACHUGA SMITHII,	US$	42.50
CYCLEMYS DENTATA,	US$	22.50
TESTUDO EMYS EMYS,NOT nutapundi !,large	US$	595.00
TESTUDO ELONGATA,small	US$	45.00
TESTUDO ELONGATA,large	US$	85.00
TESTUDO PLATYNOTA,very rare !	US$	1250.00
TESTUDO RADIATA,captive hatched,small	US$	750.00

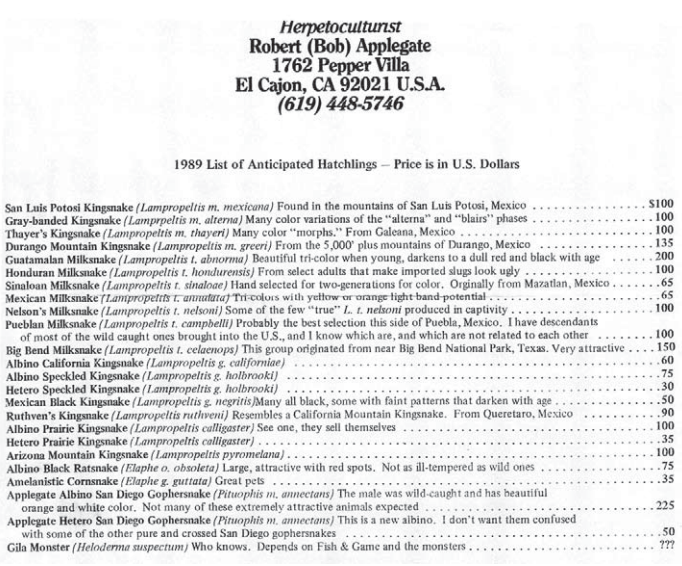
LIZARDS :

PHELSUMA MADAGASCARIENSIS GRANDIS,	US$	42.50
PHELSUMA MADAGASCARIENSIS KOCHI,	US$	47.50
PHELSUMA SUNDBERGI,	US$	42.50
PHELSUMA STANDINGI,	US$	100.00
PHELSUMA LINEATA CHLOROCELLIS	US$	22.50
PHELSUMA QUADRIOCELLATA,	US$	22.50
PHELSUMA LATICAUDA,	US$	22.50
PHELSUMA MUTABILIS,	US$	37.50
AILORONYX TRACHYGASTER,from Madagascar RARE	US$	100.00
PTYCHOZOON LIONATUM,	US$	12.50
HEMIDACTYLUS BROOKI ANGULATUS,from Liberia	US$	3.50
TARENTOLA DELALANDII,from Teneriffa	US$	9.50
ANOLIS MARMORATUS MARMORATUS,from Guadeloup	US$	35.00
ANOLIS MARMORATUS TERRAEALTAE,from Terre-de-Haut	US$	35.00
ANOLIS MARMORATUS DESIRADAE,from La Désirade	US$	35.00
ANOLIS MARMORATUS SPECIOSUS,from Guadeloup	US$	35.00
ANOLIS FERREUS,from Marie Galante	US$	45.00
ANOLIS OCULATUS MONTANUS,from Dominica	US$	45.00
ANOLIS GIRAFUS,from Guadeloup	US$	35.00
ANOLIS ROQUET SUMMUS,from Martinique	US$	35.00
ANOLIS BIMACULATUS LEACHI,from Antigua	US$	45.00

Europe has always had a strong tradition in herpetoculture. Shown here is a detailed list from **Interrep Holland** offering a variety of seldom available lizards, especially Dumeril's Yellow Gecko (*Ailuronyx trachygaster*) from Madagascar. Note that only technical names are used which suggests an international clientele.

Snakes were sold by the foot or by weight by a few dealers during the 1950s in the United States. Like the average layman when estimating the size of a serpent, lengths were often dramatically overestimated by these dealers. Also, purchasing a 'mixed snake den' from a dealer's advertisement could be a risky business, for instead of the beautiful Cornsnake, Yellow Ratsnake, Chain (Eastern) Kingsnake, and Eastern Indigo Snake promised, the crate might be filled with nasty, striking watersnakes exuding foul-smelling musk. These "snake dens" were a marketing term used by a few dealers to sell a grab bag or assortment of snakes packaged in a single box. Shipments of snakes had to be examined carefully as the Snake Mite (*Ophionyssus natricis*) or ticks sometimes accompanied the consignment, at no extra charge. If the fancier wanted to reproduce herps, it was almost futile to ask for specific sexes; rather it was necessary to purchase a minimum of six individuals to increase chances of at least a pair.

Snakes and other reptiles could occasionally be purchased from dealers who also had traveling exhibitions; the advantage for the buyer was that specimens could be examined closely at the site and the best ones purchased. The late Arthur Jones, before inventing the Nautilus exercise equipment, owned a roadside public exhibit and import-export business for wild animals in Slidell, Louisiana. Jones was a pilot who flew the animals himself in old B-25 bombers. In the 1960s, he hosted a television show called "Wild Cargo." One program showed Jones capturing gigantic Nile Crocodiles and airlifting them out of the wild by a helicopter for eventual sale in the United States. In the early 1960s, Jones brought his "Wild Cargo" show to Cincinnati, Ohio (and other cities) where he constructed large wooden pits and filled them with reptiles of all sorts: Gopher Tortoises, boas, cobras, rattlesnakes and other venomous snakes, American Alligators, several types of caimans, and a variety of mostly South American reptiles. JBM was stunned and delighted to see a dozen Emerald Tree Boas in one of the pits and purchased some of them. After the show, Jones did not want to transport the animals back to Louisiana so herp lovers from the region walked out of the auditorium with dozens of bags filled with new acquisitions, some venomous, sold at reasonable prices.

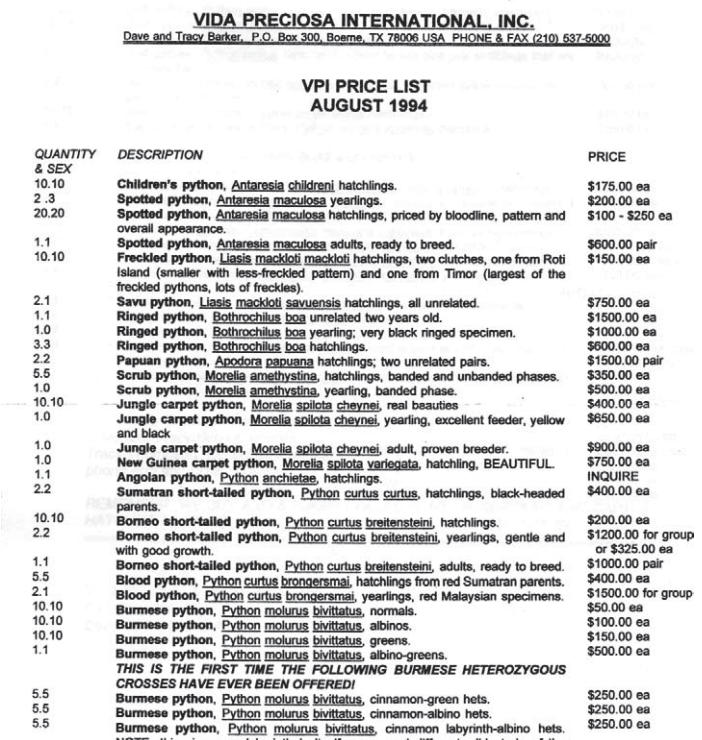


Herpetoculturist
Robert (Bob) Applegate
1762 Pepper Villa
El Cajon, CA 92021 U.S.A.
(619) 448-5746

1989 List of Anticipated Hatchlings – Price is in U.S. Dollars

San Luis Potosi Kingsnake *(Lampropeltis m. mexicana)* Found in the mountains of San Luis Potosi, Mexico $100
Gray-banded Kingsnake *(Lamprpeltis m. alterna)* Many color variations of the "alterna" and "blairs" phases 100
Thayer's Kingsnake *(Lampropeltis m. thayeri)* Many color "morphs." From Galeana, Mexico 100
Durango Mountain Kingsnake *(Lampropeltis m. greeri)* From the 5,000' plus mountains of Durango, Mexico 135
Guatamalan Milksnake *(Lampropeltis t. abnorma)* Beautiful tri-color when young, darkens to a dull red and black with age 200
Honduran Milksnake *(Lampropeltis t. hondurensis)* From select adults that make imported slugs look ugly 100
Sinaloan Milksnake *(Lampropeltis t. sinaloae)* Hand selected for two-generations for color. Originally from Mazatlan, Mexico 65
Mexican Milksnake *(Lampropeltis t. annulata)* Tri-colors with yellow or orange light band potential 65
Nelson's Milksnake *(Lampropeltis t. nelsoni)* Some of the few "true" *L. t. nelsoni* produced in captivity 100
Pueblan Milksnake *(Lampropeltis t. campbelli)* Probably the best selection this side of Puebla, Mexico. I have descendants of most of the wild caught ones brought into the U.S., and I know which are, and which are not related to each other 100
Big Bend Milksnake *(Lampropeltis t. celaenops)* This group originated from near Big Bend National Park, Texas. Very attractive 150
Albino California Kingsnake *(Lampropeltis g. californiae)* 60
Albino Speckled Kingsnake *(Lampropeltis g. holbrooki)* 75
Hetero Speckled Kingsnake *(Lampropeltis g. holbrooki)* 30
Mexican Black Kingsnake *(Lampropeltis g. negritis)* Many all black, some with faint patterns that darken with age 50
Ruthven's Kingsnake *(Lampropeltis ruthveni)* Resembles a California Mountain Kingsnake. From Queretaro, Mexico 90
Albino Prairie Kingsnake *(Lampropeltis calligaster)* See one, they sell themselves 100
Hetero Prairie Kingsnake *(Lampropeltis calligaster)* 35
Arizona Mountain Kingsnake *(Lampropeltis pyromelana)* 100
Albino Black Ratsnake *(Elaphe o. obsoleta)* Large, attractive with red spots. Not as ill-tempered as wild ones 75
Amelanistic Cornsnake *(Elaphe g. guttata)* Great pets 35
Applegate Albino San Diego Gophersnake *(Pituophis m. annectans)* The male was wild-caught and has beautiful orange and white color. Not many of these extremely attractive animals expected 225
Applegate Hetero San Diego Gophersnake *(Pituophis m. annectans)* This is a new albino. I don't want them confused with some of the other pure and crossed San Diego gophersnakes 50
Gila Monster *(Heloderma suspectum)* Who knows. Depends on Fish & Game and the monsters ..... ???

Robert (Bob) Applegate has been raising reptiles for sale for many years but he occupies an unusual historical place as he is the only person to advertise for a wife in his price lists. Although his attempt was unsuccessful, he did meet his current wife Marilee through mutual friends.

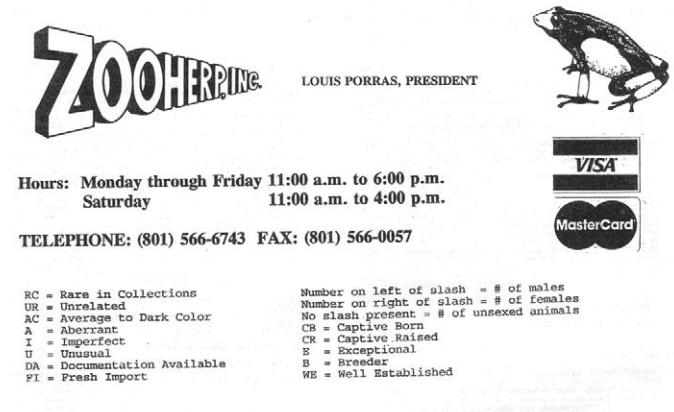


VIDA PRECIOSA INTERNATIONAL, INC.
Dave and Tracy Barker, P.O. Box 300, Boerne, TX 78006 USA PHONE & FAX (210) 537-5000

VPI PRICE LIST
AUGUST 1994

QUANTITY & SEX	DESCRIPTION	PRICE
10.10	**Children's python,** Antaresia childreni hatchlings.	$175.00 ea
2.3	**Spotted python,** Antaresia maculosa yearlings.	$200.00 ea
20.20	**Spotted python,** Antaresia maculosa hatchlings, priced by bloodline, pattern and overall appearance.	$100 - $250 ea
1.1	**Spotted python,** Antaresia maculosa adults, ready to breed.	$600.00 pair
10.10	**Freckled python,** Liasis mackloti mackloti hatchlings, two clutches, one from Roti Island (smaller with less-freckled pattern) and one from Timor (largest of the freckled pythons, lots of freckles).	$150.00 ea
2.1	**Savu python,** Liasis mackloti savuensis hatchlings, all unrelated.	$750.00 ea
1.1	**Ringed python,** Bothrochilus boa unrelated two years old.	$1500.00 ea
1.0	**Ringed python,** Bothrochilus boa yearling; very black ringed specimen.	$1000.00 ea
3.3	**Ringed python,** Bothrochilus boa hatchlings.	$600.00 ea
2.2	**Papuan python,** Apodora papuana hatchlings; two unrelated pairs.	$1500.00 pair
5.5	**Scrub python,** Morelia amethystina, hatchlings, banded and unbanded phases.	$350.00 ea
1.0	**Scrub python,** Morelia amethystina, yearling, banded phase.	$500.00 ea
10.10	**Jungle carpet python,** Morelia spilota cheynei, real beauties	$400.00 ea
1.0	**Jungle carpet python,** Morelia spilota cheynei, yearling, excellent feeder, yellow and black	$650.00 ea
1.0	**Jungle carpet python,** Morelia spilota cheynei, adult, proven breeder.	$900.00 ea
1.0	**New Guinea carpet python,** Morelia spilota variegata, hatchling, BEAUTIFUL.	$750.00 ea
1.1	**Angolan python,** Python anchietae, hatchlings.	INQUIRE
2.2	**Sumatran short-tailed python,** Python curtus curtus, hatchlings, black-headed parents.	$400.00 ea
10.10	**Borneo short-tailed python,** Python curtus breitensteini, hatchlings.	$200.00 ea
2.2	**Borneo short-tailed python,** Python curtus breitensteini, yearlings, gentle and with good growth.	$1200.00 for group or $325.00 ea
1.1	**Borneo short-tailed python,** Python curtus breitensteini, adults, ready to breed.	$1000.00 pair
5.5	**Blood python,** Python curtus brongersmai, hatchlings from red Sumatran parents.	$400.00 ea
2.1	**Blood python,** Python curtus brongersmai, yearlings, red Malaysian specimens.	$1500.00 for group
10.10	**Burmese python,** Python molurus bivittatus, normals.	$50.00 ea
10.10	**Burmese python,** Python molurus bivittatus, albinos.	$100.00 ea
10.10	**Burmese python,** Python molurus bivittatus, greens.	$150.00 ea
1.1	**Burmese python,** Python molurus bivittatus, albino-greens.	$500.00 ea
	THIS IS THE FIRST TIME THE FOLLOWING BURMESE HETEROZYGOUS CROSSES HAVE EVER BEEN OFFERED!	
5.5	**Burmese python,** Python molurus bivittatus, cinnamon-green hets.	$250.00 ea
5.5	**Burmese python,** Python molurus bivittatus, cinnamon-albino hets.	$250.00 ea
5.5	**Burmese python,** Python molurus bivittatus, cinnamon labyrinth-albino hets. NOTE: this cinnamon labyrinth is itself a new and different wild strain of the labyrinth type pattern.	$250.00 ea

Dave and Tracy Barker, owners of **Vida Preciosa International (VPI)** in Boerne, Texas, have amassed the largest captive collection of living pythons ever assembled. In addition, they have published many herpetological papers and two books on pythons. Note that the snakes on this list are sexed. The late Joe Laszlo from the nearby San Antonio Zoo published an important paper on the use of probes for sex recognition in snakes in 1975.



ZOOHERP, INC. LOUIS PORRAS, PRESIDENT

Hours: Monday through Friday 11:00 a.m. to 6:00 p.m.
Saturday 11:00 a.m. to 4:00 p.m.

TELEPHONE: (801) 566-6743 FAX: (801) 566-0057

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RC = Rare in Collections
UR = Unrelated
AC = Average to Dark Color
A = Aberrant
I = Imperfect
U = Unusual
DA = Documentation Available
FI = Fresh Import

Number on left of slash = # of males
Number on right of slash = # of females
No slash present = # of unsexed animals
CB = Captive Born
CR = Captive Raised
E = Exceptional
B = Breeder
WE = Well Established

PYTHONS & BOAS:

1/0 BLACK HEAD PYTHON (Aspidites melanocephalus) 6' CB/CK/E/DA $7000.00
1/0 DIAMOND PYTHON (Morelia s. spilota) 4' CB/CR/DA..... $3500.00
0/1 DIAMOND PYTHON (Morelia s. spilota) 4' CB/CR/DA..... $4000.00
2/2 DIAMOND PYTHONS (Morelia s. spilota) 1' CB/DA..... $2500.00
1/0 JUNGLE CARPET PYTHON (Morelia spilota variegata) 2' CB/CS/E..... $400.00
1/0 BISMARCK RINGED PYTHON (Bothrocheilus boa) 2'+ CB/CR/ Patternless..... Inquire
4 ARU ISLAND GREEN TREE PYTHONS (Morelia viridis)1' CB$1250.00
1 BROWN WATER PYTHON (Liasis fuscus) 2' CB/T..... $175.00
1/1 TIMOR PYTHONS (Python timorensis) 5'-6' CB/E/DA..... $2000.00
5 RETICULATED PYTHONS (Python reticulatus) CB..... $ 90.00
4 BALL PYTHONS (Python regius) 1'-2'..... $ 50.00
5 BALL PYTHONS (Python regius) 2' CB/Yearlings/Chosen for Color..... $ 65.00
20 BURMESE PYTHONS (Python molurus bivittatus) 1'-2' CB $ 85.00
2/2 DUMERIL'S BOAS (Acrantophis dumerili) 1'-2' CB/CR..... $375.00
2/3 TRINIDAD BOA CONSTRICTORS (Boa c. constrictor) 2'-3' CB/CR/ 2 = A..... $300.00
1/4 PERUVIAN RED TAILED BOAS (Boa c. constrictor) 3'-4'CB$300.00
0/1 GUYANA RED TAILED BOA (Boa c. constrictor) 6'-7' CB/AC $225.00
10 ARGENTINE BOAS (Boa constrictor occidentalis) 1'-2' CB/CR $225.00
1/0 COLOMBIAN BOA (Boa constrictor imperator) 5' CB/CR..$175.00
1/0 COLOMBIAN BOA (Boa constrictor imperator) 5'-6' CR/AC$135.00
15 COLOMBIAN BOAS (Boa constrictor imperator) 1'+ CB.... $ 90.00
0/1 SOLOMON ISLAND TREE BOA (Candoia bibroni) 3'..... $150.00
3/3 BLACK SAND BOAS (Eryx miliaris magajorum) 1'-2'..... $175.00
2/2 RUSSIAN SAND BOAS (Eryx tataricus) 1'-2'..... $100.00
5 TANZANIAN SAND BOAS (Eryx colubrinus loveridgeii)'-2'$ 65.00
1/0 YELLOW ANACONDA (Eunectes notaeus) 8' CB/CR..... $250.00
0/2 YELLOW ANACONDAS (Eunectes notaeus) 4' CB/CR..... $250.00
EXPECTED SOON:
3 MADAGASCAR TREE BOAS (Sanzinia madagascariensis)1'CB Inquire
AVAILABLE:
1/1 MADAGASCAR GROUND BOAS (Acrantophis madagascariensis) 4'-5' CB/CR/E..... $10,000.00/Pair
2/0 COASTAL ROSY BOAS (Lichanura trivergata roseofusca) 2' CB/CR..... $ 90.00
0/1 ALBINO BURMESE PYTHON (Python molurus bivittatus) 9' CB/CR..... $900.00
0/1 HETEROZYGOUS (Albino) BURMESE PYTHON (Python molurus bivittatus) 11' CB/CR..... $400.00
0/1 GREEN BURMESE PYTHON (Python molurus bivittatus) 14' CB/CR..... $1375.00
0/1 HYPOMELANISTIC BURMESE PYTHON (Python molurus bivittatus) 12' CB/CR/E/Absolutely Unbelievable! A First!..... $25,000.00

RAT SNAKES, KING SNAKES, & MILK SNAKES:

0/2 ALBINO RADIATED RAT SNAKES (Elaphe radiata) 4'-5'.... $2000.00
1/0 ALBINO CHINESE BEAUTY SNAKE (Elaphe t. taeniura)5' B$2000.00
0/1 AMELANISTIC CHINESE BEAUTY SNAKE (Elaphe t. taeniura) Imperfect Eye/E..... $850.00
0/2 XANTHIC? CHINESE BEAUTY SNAKES (Elaphe t. taeniura) 4'-5' B..... $650.00
1/1 KEELED RAT SNAKES (Elaphe carinata) 3'..... $ 50.00
0/1 MELANISTIC CHINESE RAT SNAKE (Elaphe rufodorsata) 2'..$ 50.00
6 CHINESE RAT SNAKES (Elaphe rufodorsata) 2'..... $ 25.00
1 SPECKLED MANDARIN RAT SNAKE (Elaphe mandarina) 3' U..$135.00
2 MANDARIN RAT SNAKES (Elaphe mandarina) 2'-3' FI..... $ 90.00
1/1 TWIN SPOTTED RAT SNAKES (Elaphe bimaculata) 1'-2'.... $ 35.00
1 KURIL ISLAND RAT SNAKE (Elaphe quadrivirgata) 3'Unusual Population/Red Eyes..... $150.00
1/1 TRANSCAUCASIAN RAT SNAKES (Elaphe hohenackeri) 2'-3' R..... $350.00
2 PERSIAN RAT SNAKES (Elaphe persica) 1'-2' E/Different Phases..... Inquire
1 RUSSIAN LEOPARD RAT SNAKE (Elaphe situla leopardina) 1'-2'..... $200.00
1/1 LADDER RAT SNAKES (Elaphe scalaris) 2' CB/CR..... $115.00
1 PARTIAL STRIPED MOTLEY RED RAT SNAKE (Elaphe g. guttata) 2' CB/CR..... $ 50.00
2 EMORY'S RAT SNAKES (Elaphe guttata emoryi) 2'-3'..... $ 25.00
1 RED X YELLOW RAT SNAKE (Elaphe g. guttata x Elaphe obsoleta quadrivittata) 4' CB/CR..... $ 35.00
1 YELLOW RAT SNAKE (Elaphe obsoleta quadrivittata) 5' CB/CR..... $ 25.00
0/1 GRAY X YELLOW RAT SNAKE (Elaphe obsoleta spiloides x E. q. quadrivittata) 3'-4' CB/CR/E..... $ 35.00
3 EVERGLADES RAT SNAKES (Elaphe obsoleta rossalleni)'CB ..... $ 25.00
1 BRINDLE BLACK RAT SNAKE (Elaphe o. obsoleta) 1' CB..$ 35.00
1 BLACK RAT SNAKE (Elaphe o. obsoleta) 2' CB/CR..... $ 15.00
1 BLACK RAT SNAKE (Elaphe o. obsoleta) 4'-5' CR..... $ 25.00
0/2 TEXAS RAT SNAKES (Elaphe obsoleta lindheimeri) 4'-5' CB/CR..... $ 17.50
1/0 TRAYER'S KING SNAKE (Lampropeltis mexicana thayeri) 2'-3' CB/CR/Milk Snake Phase..... $150.00
1/0 NELSON'S MILK SNAKE (Lampropeltis triangulum nelsoni) 1'-2' CB/CR..... $100.00
1/1 NEW MEXICO MILK SNAKES (Lampropeltis triangulum caelenopa) 2' North Texas Population..... $100.00
0/1 ARIZONA MOUNTAIN KING SNAKE (Lampropeltis p. pyromelana) 1'-2' CB/CR..... $125.00
1 CALIFORNIA KING SNAKE (Lampropeltis getula californiae) CB/Banded..... $ 40.00
0/1 STRIPED CALIFORNIA KING SNAKE (Lampropeltis getula californiae) 3' CB/CR..... $ 50.00
6 DESERT KING SNAKE (Lampropeltis getula splendida) 2'-3' ..... $30.00-$ 40.00

Zooherp in Sandy, Utah, occupied a specialized niche by mostly providing amphibians and reptiles for zoos and aquariums. Note the codes describing the specimens.

East Bay Vivarium

Specializing in Reptiles and Amphibians since 1970

1511 MacArthur Blvd., Oakland, California 94604, U.S.A.

JUNE 1973 PRICE LIST

SNAKES

2	CARPET PYTHON	Morelia argus variegata	3 & 4'	150.
0.1	RETICULATED PYTHON	Python reticulatus	15'	550.
	-this captive raised python is 5 years old and totally tame.			
2	RETICULATED PYTHON	Python reticulatus	5 & 6'	40.
*	RETICULATED PYTHON	Python reticulatus	babies	30.
1.0	INDIAN PYTHON	Python m. molurus	11'	350.
	-captive raised; very heavy bodied.			
5	INDIAN X BURMESE PYTHON	Python m. molurus X bivittatus	babies	65.
	-these products of the captive breeding of an Indian and a Burmese Python we hatched in late May.			
3.0	BURMESE PYTHON	Python molurus bivittatus	9 - 10'	175.
1.0	BURMESE PYTHON	Python molurus bivittatus	6'	75.
	-the above three Burmese are flawless and completely tame.			
3	BURMESE PYTHON	Python molurus bivittatus	babies	50.
1	BALL PYTHON	Python regius	3'	50.
1	BLOOD PYTHON	Python curtus	43"	125.
	-this captive raised snake is the most beautiful specimen I've seen.			
1	BLOOD PYTHON	Python curtus	3'	100.
	-eating rats.			
0.1	AFRICAN ROCK PYTHON	Python sebae	16'	1,000.
	-this 5 year old captive raised snake weighs about 150 pounds.			
**	AFRICAN ROCK PYTHON	Python sebae	babies	35.
1	ANACONDA	Eunectes muninus	6'	75.
1	ANACONDA	Eunectes muninus	2'	50.
1	COASTAL ROSY BOA	Lichanura trivirgata roseofusca	2'	30.
3	PACIFIC RUBBER BOA	Charina b. bottae	1 - 2'	15.-20.
1.1	PERUVIAN BOA CONSTRICTOR	Boa c. constrictor	7½'	125.
1	PERUVIAN BOA CONSTRICTOR	Boa c. constrictor		90.
1.0	PERUVIAN BOA CONSTRICTOR	Boa c. constrictor	3½'	60.
0.2	COLUMBIAN BOA CONSTRICTOR	Boa c. imperator	8'	100.
1.2	COLUMBIAN BOA CONSTRICTOR	Boa c. imperator	7'	85.
0.2	COLUMBIAN BOA CONSTRICTOR	Boa c. imperator	6'	70.
1.2	COLUMBIAN BOA CONSTRICTOR	Boa c. imperator	5'	55
0.1	COLUMBIAN BOA CONSTRICTOR	Boa c. imperator	4'	40.
2	COLUMBIAN BOA CONSTRICTOR	Boa c. imperator	3'	30.
15	COLUMBIAN BOA CONSTRICTOR	Boa c. imperator	babies	15.
1.0	PUERTO RICAN BOA	Epicrates inornatus	2'	150.
	-eating mice.			

The **East Bay Vivarium** originally located in Oakland and now in Emeryville, California is the oldest continuous specialist reptile store in the USA, opening in 1970 by the original owner, Ronald L. Cauble.

—The Rise of Herpetoculture—

There is a difference between herpetoculture and herpetology. Some facets may be similar but the objective is different. The word "herpetoculture" was first coined by the late Thomas A. Huff, Director of the now defunct Reptile Breeding Foundation in Picton, Ontario, Canada, to reflect the activities of those persons, now commonly called "herpetoculturists," working with captive reptiles and amphibians. Herpetoculturists are skilled at maintaining and breeding a large variety of amphibians and reptiles for the market but these animals have essentially no niche outside of captivity. Conversely, herpetology is a division of biological sciences, and deals with systematics, measurements of selective pressures and responses of organisms to them, physiology, ethology, and natural history.

As the availability of amphibians and reptiles increased, the knowledge of how to care for them in captivity also increased; but the latter lagged rather behind the former for many years. The accretion of herpetocultural knowledge was dramatic. As an example in the history of zoos and herpetoculture, the role of temperature was properly appreciated beginning in the early 1980s. Also of importance were diets, light cycles, humidity, and treatment of diseases (see Murphy 2007 and Petzold 2007 for examples). In the late 1970s, breeding of various species became reliable but others are still reproducing unreliably, and this demonstrates how much we still have to learn.

In German-speaking areas, a number of periodicals were available to the herpetoculturist over many years: *Blätter für Aquarien- und Terrarienkunde* 1890–1901; *Wochenschrift für Aquarien- und Terrarienkunde* 1904–1950; *Lacerta* 1908–1929; *Aquarien, Terrarien* 1954–1990; *Aqua-Terra* 1964–1973; *Das Aquarium mit Aqua-Terra* 1967–1978; *Aquarien-Magazin* 1967–1978; *Die Aquarien- und Terrarienzeitschrift (DATZ)* since 1948; *Salamandra* since 1965 and *herpetofauna* since 1979.



The **First National Reptile Breeders' Expo** was held in Orlando, Florida in 1990. Wayne Hill was the organizer and continues in this capacity to this day. When Hill visited JBM in Dallas in the late 1980s and explained his vision for an annual reptile show, the latter insisted that the idea was too far-fetched and would never work; he was wrong.

As interest in the proper keeping of live herps broadened, the First Annual Symposium on Captive Propagation and Husbandry of Reptiles and Amphibians was convened by Richard Hahn in July 1976, at Hood College in Frederick, Maryland. The International Herpetological Symposium (IHS) evolved from this meeting and is still in existence. IHS provides a forum for amateurs and professionals interested in natural history, conservation biology, and the captive management and propagation of amphibians and reptiles by holding an annual meeting and publishing the papers given at the symposium.

The Northern California Herpetological Society produced a series of special publications on the captive propagation and husbandry of reptiles and amphibians in the late 1980s.

Philippe de Vosjoli founded the first nationally distributed reptile and amphibian magazine, *The Vivarium*, and an excellent line of reptile and amphibian care books published through Advanced Vivarium Systems. There are over 30 titles in this series. He popularized the terms herpetoculture and vivarium.

Mere pet owners may evolve into enthusiasts. It is certainly true that a large number of persons appreciate herps today and want to keep and study them. Many of the amphibians and reptiles available to them are bred in captivity. To prove this point, one only has to go to the Internet (http://www.kingsnake.com/) or to some of the many pet shops and reptile shows (expos) in the US and Europe and explore the number and varieties of captive-bred herps available for sale and look at the large number of books and pamphlets published on their care; it is staggering! Reptile show organizers have contributed to this change by mostly allowing only animals bred in captivity at reptile shows during the past few decades. Now price lists are filled with a myriad of captive kingsnakes, ratsnakes, and other colubrids named for breeders' lineages. Years ago, a kingsnake breeder told JBM that given enough time, he could produce a snake having a dorsal pattern with the name "James Murphy;"

he was only partially joking! At an expo, one can see hundreds of deli cups filled with baby herps with weird colors and patterns, designated with descriptive unusual names. What is striking is that the overall condition of the amphibians and reptiles for sale appears to be excellent. JBM went to the annual Mid-Atlantic Herpetological Society Expo and International Amphibian Days Expo in Maryland for several years and did not see a single unhealthy animal, at least not visibly ill to the naked eye. In fact, some organizers have arranged for outside experts to check on the well-being of the herps. It might be noted here that proceeds from some of these shows are donated to acquire protected land and support other conservation initiatives. At these reptile shows, the percentage of amphibians and reptiles bred in captivity is increasing and the number of wild-caught imported specimens is shrinking. So many are bred, in fact, that the number of new species never kept in captivity and available to the fancier is becoming limited and commercial breeders have had to create "designer morphs" to remain financially viable.

A variation of the cooperative approach by the members of the Laboratoire d'Erpetologie in Montpellier, France in the nineteenth century is currently being tried on a smaller scale in the US. In 1976, Trooper Walsh was the first private person to breed Green Tree Pythons (*Chondropython*, now *Morelia viridis*) and he has produced 10 generations of these snakes. Walsh keeps elaborate records on shedding cycles, feeding intervals, medical management, and pedigrees. Customers receive copies of these data whenever a snake is purchased. To disseminate information about these pythons, Walsh and other breeders started "Chondro Coalition" to accumulate and share knowledge regarding reptilian biology, captive husbandry, and conservation. The mission statement reads as follows: "We are a group of dedicated Chondro breeders who, while maintaining our unique identities and individual businesses, have joined together with our collective experience, resources, and energy to promote the captive breeding and long-term value of Green Tree Pythons." Unlike many other captive-bred reptiles offered for sale during the past several decades, Green Tree Pythons have not diminished in value, likely due in part to the fact that customers know precisely what the complete history is of the snake they are buying.

Concluding Remarks

THE STUDY OF REPTILES "AT HOME"—OF THEIR NATURE, HABITS, PECULIARITIES, MODE OF LIFE, OF EVERYTHING, IN FACT, BEYOND THEIR MERE ANATOMICAL CHARACTERISTICS—SEEMS TO HAVE BEEN DEFERRED UNTIL THE ENTIRE ANIMAL CREATION, EXCLUSIVE OF THE UNPOPULAR CLASS, SHOULD HAVE RECEIVED THE ATTENTION OF PRACTICAL NATURALISTS.

—"ON THE TREATMENT OF SNAKES IN CAPTIVITY" IN THE JOURNAL *ZOOLOGIST* BY ARTHUR STRADDLING, 1882

Are we in the midst of another "Fad" similar to those fern and aquaria crazes seen during the mid-Victorian era? "Out of the thousands of small mammal species that exist only a few have proven to make suitable pets. It is likely that the same thing is true of reptiles and we probably will not find that many more than we currently have. There are two parts to the reptile industry—the one for pets and the one for enthusiasts." (J. Coote, pers. comm.). There will always be that responsible group who keep living herps for personal enjoyment, contentment, and increase of knowledge, but perhaps the total number of casual pet keepers will begin to wane.

We stress here that without access to living amphibians and reptiles when we were youngsters learning about the natural world, our lives would have likely taken very different and perhaps less fulfilling trajectories. The excitement and wonder of working with these animals guided our entire professional careers and we feel fortunate to have had this wonderful opportunity. It would be tragic if this chance were to be lost to future generations. We are concerned about the increasing number of laws and local ordinances restricting the keeping of herps, based on emotion, lack of biological awareness, and ophiophobia rather than careful scientific appraisals. Our final thought—we think that careful captive breeding produces quality stock and is a reasonable approach to ensure that living herps are available to all conscientious persons.

Acknowledgments.—This contribution is dedicated to our wives Judith Block and Rose McCloud who lived betwixt and between legions of living lower vertebrates, ranging from Komodo Dragons to African Naked Catfish. They should be pelted with trophies for holding their complaints about our obsessive behavior to a minimum for years.

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The opinions expressed in this article are those of the authors and do not necessarily represent the opinions of any organization.

A copy of the front page of each list has been deposited in the library of the Division of Amphibians and Reptiles, United States Museum of Natural History, Smithsonian Institution, in Washington, D.C.

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TABLE. 1. Here we list dealer pricelists examined during preparation of this manuscript. We collected lists from a variety of sources. It is notable that the same lists generally served the whole range of the market from the young hobbyist to the serious breeder, as well as the zoo and aquarium community. Companies are listed alphabetically, followed by owner name, location, comments, and date. In many cases, we reviewed multiple lists from a dealer but have listed only one date here.

Company Name	Owner(s)	Location	Comments	Year
AGAMA INTERNATIONAL	Bert Langerwerf	Montevallo, Alabama	Produced thousands of captive-bred lizards in outdoor enclosures	undated
AMERICAN REPTILE	Edward J. Lukacevic	Catlettsburg, Kentucky	Variety of herps	1990
ANIMAL WORLD OF MIAMI		Hialeah Lakes, Florida	Variety of mammals, birds, herps	1970
BILL JOHNSTON		Ruskin, Florida	Venomous snakes	1974
BLACK CANYON REPTILES		Tucson, Arizona	Captive-bred herps	1995
BLUE RIBBON PET FARM		Miami, Florida	Variety of herps	1975
BOTHROPS	Ron Jenkins & Jack Dambach	Ocala, Florida	Variety of herps	1983
BRIAN SHARP		Catharpin, Virginia	Captive-bred herps	1995
BREEDING COOPERATION	Klaus-Dieter Schulz & Mario Frohn	Würselen, Germany	Captive-bred ratsnakes	1990
BRONX REPTILES		Mt. Vernon, New York	Variety of herps	1988
BURGUNDY REPTILE & BREEDING INSTITUTE	Mike Ellard	Estero, Florida	Variety of herps	1990
BUSHMASTER REPTILES, INC.	Kamuran Tepedelen	Boulder, Colorado	Worldwide herps	1998
BYRON BARNES		San Antonio, Texas	Variety of herps	1994
CAL-HERP	Stephen Harkins	Upland, California	California herps	1986
CALIFORNIA ZOOLOGICAL SUPPLY	Gary Bagnall	Costa Mesa, California	Worldwide herps	1977
CAPTIVE BRED REPTILES	Ernie Wagner & Darcie Richardson	Seattle, Washington	Variety of herps	undated
CAPTIVE BRED WILDLIFE FOUNDATION	Jeff Gee & Kim Costales	Portal, Arizona	Captive-bred herps	undated
CAROLINA REPTILE	Randy McKnight	Columbia, South Carolina	Worldwide herps	1987
CASA DE PETS	Laszlo de Borondy	Studio City, California	Variety of herps	1973
CENTRAL COAST REPTILE RESEARCH CENTER	Terry Lilley & Lloyd Lemke	Morro Bay, California	Worldwide herps	1986
CENTER FOR REPTILE AND AMPHIBIAN PROPAGATION	Ron Tremper	Boerne, Texas	Worldwide herps, specializing in Madagascar lizards	1988
CHASE WILD ANIMALS	"Bill" Chase	Miami, Florida	Worldwide herps, especially Latin America	???
CHINA WILDLIFE CO.	Fred Chen	Hong Kong	Chinese herps	1970
COLD BLOOD UNLIMITED	Max Peterson & Laurel Ligon	Dallas, Texas	Variety of herps	1990
D & D ENTERPRISES	C. M. Disley &W. D. Dyson	Boroko, Papua New Guinea	PNG herps	1973
DESERT SPECIALTIES	Kerry & Gary Young	Riverside, California	California herps	1988
DIABLO VALLEY REPTILES	Chris Reimann	Pleasant Hill, California	Variety of captive-bred herps	1996
DICK GOERGEN	Dick Goergen	Alden, New York	Variety of captive-bred herps	1988
DON HAMPER		Columbus, Ohio	Variety of herps	1990
EAST BAY VIVARIUM	Ron Cauble	Berkeley, California	Oldest reptile dealer in US	1976
EAST COAST REPTILES	Michael & Carmen Powell	Miami, Florida	Variety of herps	1990
EUROTERRARIUM		Cologne, Germany	Variety of herps	1980
EXCEPTIONAL EXOTICS	Steve Hammond	Louisville, Kentucky	Variety of herps	1988
FINTIQUE		San Antonio, Texas	Variety of herps	undated
FLORIDA REPTILE AND ANIMAL EXCHANGE	Bob Udell	Miami, Florida	Variety of herps	1973
FLORIDA REPTILE IMPORTERS	Ed Chapman	Miami, Florida	Worldwide herps	1986
FLORIDA REPTILE RANCH	Vernon & Vicki Roberts	Middleburg, Florida	Worldwide herps	1986
GEORGE WATTERSON'S REPTILES	George Watterson	Medina, Ohio	Specialized in South Asian herps	1961
GLADES HERP	Rob MacInnes & Bill Love	Ft. Myers, Florida	Variety of herps	1992
GLADES HERP FARM	RobRoy MacInnes & Robbie Keszey	Bushnell, Florida	Worldwide herps	1985
GOANNA RANCH	Frank Retes	Tucson, Arizona	Varanid lizards	1996
GREAT LAKES ZOOLOGICAL SUPPLY	Tom Nelson	Warren, Michigan	Worldwide herps	undated
GULF COAST REPTILES	Chris McQuade & Eric Thiss	Fort Myers, Florida	Worldwide herps	1990
GULF HAMMOCK HERPETOCULTURE	Kevin Enright	Dade City, Florida	Captive-bred kingsnakes	1990
HENRY COHEN		Elma, New York	Variety of herps	1987
HANGZHOU LIVE ANIMAL & PLANT CO., LTD	zhiun Zhan	Hangzhou, China	Variety of Chinese herps	1996
HERMOSA REPTILE AND WILD ANIMAL FARM	Ray Folsom	Hermosa Beach, California	Wide variety of mammals, birds, herps	1967

Table. 1. Continued.

Company Name	Owner(s)	Location	Comments	Year
Herp-Diets	Thomas (Danny) Pate	Pell City, Alabama	Variety of herps	1977
Herpetocritters	John & Jennifer Organiscak	Columbus, Ohio	Variety of herps	1993
Herpetofauna, Inc.	Tom Crutchfield	Fort Myers, Florida	Worldwide herps	1986
Herpetofauna International	Hank Molt & Hugh Kelly	Horsham, Pennsylvania	Worldwide herps	1983
Herpetological Educational Reptile Propagation Program (HERPP)	Larry Rouch & Lore Devra Levin	Stafford, Virginia	Variety of herps	undated
Herpetological Institute	Willem de Rover	Den Dolder, Netherlands	Worldwide herps	1986
Herpetological Institute for Scientific Study	Stephen Hammack	Fort Worth, Texas	Variety of herps	1993
High Mountain Reptiles	Paul Lynum and others	Long Beach, California	Variety of captive-bred herps	1997
Hogtown Herpetological Supply	Doug Foster	Gainesville, Florida	Variety of herps	1991
The Hydra		Lakeside, California	Variety of herps	1985
Insoka Enterprises Ltd.	J. E. Stratford	Kitwe, Zambia	African herps	1987
International Animal Exchange	Don Hunt & brothers	Ferndale, Michigan/Grand Prairie, Texas	Giant tortoises, African Goliath frog	1973
InterPet		Wilton, Connecticut	Variety of herps	1979
Interrep Holland		Den Haag, Holland	Worldwide herps	1987
IRRPREL Manufacturing and Design	Glen J. Carlzen	Whittier, California	Variety of herps	1989
Jack Dambach		Silver Springs, Florida	Variety of herps	1983
Jardim Zoologico Nacional		Rep. Guiné-Bissau	African herps	undated
Jerry Cole		Dorset, UK	Variety of herps	1989
Joe E. Pierce	Joe E. Pierce	Alturas, California	Captive-bred herps	1988
John Hop Animalbrokers		Ermelo, Netherlands	Variety of herps	undated
Julie China International	Jo Hurley	Burlingame, California	Variety of herps	undated
Kelly Haller		Topeka, Kansas	Variety of herps	1991
Lee & Wu Alpha House	Jerry Lee	Hong Kong	Variety of herps	1973
Living Jewels		Hewitt, New Jersey	Variety of herps	undated
Mark S. Bell		Fraser, Michigan	Captive-bred herps	1992
Martin's Aquarium		Jenkintown, Pennsylvania	Variety of herps	undated
Miami Serpentarium	William "Bill" Haast	Miami, Florida	Established in 1947 as venom extraction laboratory but also sold reptiles	
Midwest Reptile and Animal Sales	Larry A. Lantz	Fort Wayne, Indiana	Specialized in chelonians	1969
Mother Nature's		Redondo Beach, California	Variety of herps	1973
Mountains and Plains Reptiles	Michael/Charley Jobin	Denver, Colorado	Captive-bred herps	1996
Natural Wonders Imports	William Thacker	Jacksonville, Florida	Variety of herps	1977
New England Reptile Distributors, Inc.	Not listed	Not listed	Variety of herps	1994
Ophiological Services	Eugene Bessette	Archer, Florida	Specializes in captive-bred Boids	1994
Otto Martin Locke Nursery	Otto Martin Locke	New Braunfels, Texas	Southwestern US fauna	1968
Ottys Sanders Biological Supply Co.	Ottys Sanders	outside Dallas, Texas	Biological supply company	1960s
The Pet Dragon	Terry Odegaard	Minneapolis, Minnesota	Worldwide herps	1977
Pet Farm	Bern Levine/Ralph Curtis	Miami, Florida	Wide variety of mammals, birds, herps	1970
Peter Kahl Reptiles		Long Green, Maryland	Captive-bred boas & pythons	1992
Philadelphia Reptile Exchange	Henry Molt	Jenkintown, Pennsylvania	Worldwide herps	1973
Pioneer Pet Supply		Franklin Park, Illinois	Variety of herps	1975
Prairieland Herpetoculture	Larry Keller	Sidney, Illinois	Variety of herps	1990
Pro Exotics	Chad Brown	Denver, Colorado	Variety of herps	1990
Quality Critters Super Pet Shop	Bill Minnick	Fort Wayne, Indiana	Worldwide herps	undated
Quality Venoms for Medical Research	Johannes F. Schuhknecht, Jr.	Punta Gorda, Florida	Variety of reptiles	1988
Quivira Specialties	Charles Burt	Topeka, Kansas	Biological supply company	1955
Rare Earth Reptiles Ltd.		Livonia, New York	Variety of herps	1994
Ravensden Zoo Ltd.		Northants, England	Small list of reptiles	1989

Table. 1. Continued.

Company Name	Owner(s)	Location	Comments	Year
Ray's Reptiles		Lincoln, Nebraska	Variety of herps	1993
Ray Singleton & Co.	Ray Singleton	Riverview, Florida	US southeastern and Latin American herps	1977
Reef and Reptile		Tampa, Florida	Variety of herps	1995
Reptile Breeders	John A. Ruiz	Mission Viejo, California	Variety of herps	1986
Reptile Haven		Escondido, California	Variety of herps	1991
Reptile Source		Tracy, California	Captive-bred colubrids	1989
Reptile Specialties		Homestead, Florida	Variety of herps	1973
Reptile Supply	Stan Chiras	Miami, Florida	Variety of herps	1983
Reptiles		Tempe, Arizona	Variety of herps	1973
Richard D. Brant		Sunland, California	Variety of herps	1975
Rich Zuchowski		Baltimore, Maryland	Variety of herps	1989
Robert (Bob) Applegate		El Cajon, California	Variety of herps	1989
Rochester Reptiles		Hilton, New York	Variety of herps	1977
Ross Allen's Reptile Institute	Ross Allen	Silver Springs, Florida	Large public exhibition	1960
San Diego Reptile Breeders	Gary Sipperley	San Diego, California	Variety of herps	1992
Sawmill		Perak, Malayasia	Asian herps	1973
Scales	Mark Parker	Ocala, Florida	Variety of herps	undated
Scales & Tails Trading Co.		Hong Kong	Asian herps	1986
Scott J. Michaels		Urbana, Illinois	Variety of herps	1987
The Serpent's Egg		Washington, D.C.	Wholesale herps	1992
The Shed	Louis Porras & Joe Beraducci	Miami, Florida	Worldwide herps	1980
Siam Farm & Zoological Co., Ltd.		Bangkok, Thailand	Asian herps	undated
Singapore Pet Farm		Singapore	Asian herps	1972
Slither' N Pets		Fort Myers, Florida	Variety of herps	1993
Snake Connection	Joey/Frank Smith	Hudson, Florida	Variety of herps	undated
Snake Farm	C. C. McClung	La Place, Louisiana	Southeastern US herps	1968
Snake King	William King	Brownsville, Texas	Mexican & Southwestern US reptiles	1964
Snake World		Piedmont, South Carolina	Captive-bred kingsnakes	1990
Southern Illinois Reptile Breeders	Scott Ballard	DeSoto, Illinois	Variety of herps	1990
Southwest Animal Imports	Leonard M. Urban	Albuquerque, New Mexico	Variety of herps	1974
Steven T. Osborne		Littlerock, California	Captive-bred colubrids	1986
Strictly Reptiles	Van Nostrand family	Hollywood, Florida	Wholesale herps	???
Taprobane Nurseries		London, England	Sri Lankan herps	1974
Tarpon Zoo	Trudy Jerkins and Mike Tsalickas	Tarpon Springs, Florida	US and Latin American herps	1966
Terry L. Vandeventer		Clinton, Mississippi	Variety of herps	1989
Thomas Pets & Supplies		Philadelphia, Pennsylvania	Variety of herps	1973
Tom Crutchfield's Reptile Enterprises		Bushnell, Florida	Worldwide herps	1990
Tom Taylor		Tempe, Arizona	Variety of herps	1989
The Tortoise Trading Company	Casey & Laurie Conway	Aguanga, California	chelonians	undated
Tote-Em-In-Zoo	George Tregembo	Wilmington, North Carolina	Specialized in African herps	1965
Trefflich's of West Broadway	Henry Trefflich	New York	Wide variety of mammals, birds, herps	1975
Tropical Amphibians & Reptiles Direct Supplies, Co.	Benjamin L. Ready	Garden Grove, California	Albino snakes	undated
Tropical Fish Pond of Miami	Andrew Briskin	Miami, Florida	Variety of herps	undated
Turtle Breeders	Harold & Naoma Carty	Chowchill, California	Chelonians	1995
Twin City Reptiles	Bruce & Connie Delles	Golden Valley, Minnesota	Variety of herps	1988
Universal Select Animals	Joe Lewis & Ralph Sager	Richmond, Virginia	Worldwide herps	1985
Vida Preciosa International (VPI)	Dave & Tracy Barker	Boerne, Texas	Largest collection of pythons in the world	1980
Vivo Animales	Leon Leopard	Lorena, Texas	Herps from Madagascar, Southeast Asia	1971
Vince Scheidt		San Diego, California	Captive-bred snakes	1990

TABLE. 1. Continued.

Company Name	Owner(s)	Location	Comments	Year
VJ'S EXOTIC REPTILES		Brooklyn, New York	Variety of herps	1991
WARD'S NATURAL SCIENCE		near Rochester, New York	Biological supply company	1950s
WEST COAST ZOOLOGICAL		San Diego, California	Variety of herps	1996
WESTERN ZOOLOGICAL SUPPLY	Barney Tomberlin & Jim Brockett	Monrovia, California	Worldwide herps	1967
WILD CARGO	Arthur Jones	Slidell, Louisiana	Roadside exhibit and animal import business	1960
WILD CARGO	Gerald Rinyu	Hollywood, Florida	Variety of herps	1972
WILD CARGO	Ralph Curtis	Hollywood, Florida	Variety of herps	1963
WILLIAM A. LEMBERGER CO.	William A. Lemberger	Oshkosh, Wisconsin	Biological supply company	1950s
WINDING CREEK HERPS	Karl Krumke	Bowie TX	Variety of snakes	undated
Y. L. KOH LTD.		Singapore	Asian herps	1973
ZOOHERP	Louis Porras	Sandy, Utah	Many herps from foreign sources	1988
ZOOLOGICAL IMPORTS & PRODUCTS, INC.	Paul A. Benson	Inglewood, California	Many herps from foreign sources	1978
ZOOLOGICAL IMPORTS UNLIMITED		Miami, Florida	Variety of herps	1986

ARTICLES

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Using Museum Frog Collections to Assign Sex and Age Categories to Frogs in Field Studies: A Case Study with the Striped Marsh Frog, *Limnodynastes peronii*

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In field studies of frogs, assignment of individuals to sex and reproductive age (i.e., immature vs. mature adult) categories is often desirable. For example, differences may exist between these categories in terms of habitat use (Griffin and Case 2001; Proehl 2002), movement patterns (Daugherty and Sheldon 1982; Pilliod et al. 2002; Vasconcelos and Calhoun 2004), survival (Funk and Mills 2003; Lauck 2005), or growth and development (Gramapurohit et al. 2005; Smith and Roberts 2003).

In some studies of frogs, the methods by which individuals are assigned to sex and age categories have been described (Gillespie and Hollis 1996; Lemckert 2005a, b; Palis 1998), but the accuracy of these methods has received little attention and is therefore unclear. In a rare example, Bosch and Marquez (1996) found that the sex of individual *Alytes obstetricans* and *A. cisternasii* could be determined with accuracies of about 95% and 98%, respectively, by using a number of morphological measurements.

In the case of the Striped Marsh Frog (*Limnodynastes peronii*), physical differences have been reported between reproductively mature males and females (Barker and Grigg 1977; Barker et al. 1995; Moore 1961), but it is unclear whether assignment of sex and maturity is accurate. Mature females have flanges on the inner sides of the first three fingers that are more developed on the second finger (Barker and Grigg 1977; Barker et al. 1995; Cogger 2000; Moore 1961). In mature males, the metacarpal bone of the first finger is elongated, rigid and sharply pointed at its tip and may perforate the skin to form a sharp 'nuptial spine,' the arms are often greatly hypertrophied relative to those of females (Barker and Grigg 1977; Barker et al. 1995; Moore 1961), and throats are sometimes colored with a 'yellowish wash' (Moore 1961). The 'spine' presumably helps a male grasp a female during amplexus (Moore 1961) and, as reported for other species within the same genus (Bulbert et al. 2005; Bush 1984; Clyne 1967), enlarged forearms could help a male obtain a mate through defense of a calling position or oviposition site or retain a mate during amplexus (GHP, pers. obs.). The smallest mature individuals reported were 42.5 mm SVL for females and 48.0 mm SVL for males (Barker et al. 1995; Moore 1961).

The primary focus of this study was to use museum specimens of *Limnodynastes peronii* to evaluate the accuracy of the methods described above for sexing individuals and to develop a method

for distinguishing adults from immatures, but we secondarily considered patterns in gonad size, as seasonal patterns in gonad size and development have been reported for other frog species that show seasonal patterns of breeding (Itoh et al. 1990; Kanamadi and Jirankali 1992; Ko et al. 1998; Kusano et al. 1991; Yoneyama and Iwasawa 1985). As *L. peronii* is known to breed at any time of year, we expected that there would be no seasonal pattern in gonad size for this species. We evaluated the relationships between gonad size and body size to help determine how maturity changes with body size and because gonad size has often been found to vary with anuran body size (Horseman et al. 1978; Huang et al. 2001; Jorgensen 1985; Kulkarni and Pancharatna 1996; Pancharatna et al. 2000; Prado and Haddad 2005).

Methods.—We examined 418 specimens of *L. peronii* collected near Sydney, Australia and housed at the Australian Museum. These specimens consisted mostly (N = 408) of frogs collected during 1996 on the Kurnell Peninsula (34.028°S, 151.184°E) and measured, dissected, and sexed on the basis of internal morphology at that time (A. Greer, pers. comm.). To increase the number of large frogs examined, we included an additional 10 specimens, also collected near Sydney, chosen from the same storage jars and hence collected on similar dates (i.e., day and year). All of these specimens had been collected throughout the year and we assigned collection dates to season (i.e., Sep–Nov = spring; Dec–Feb = summer; etc.).

We recorded additional data for sub-samples of the specimens. During the previous dissections, ovaries from a randomly-chosen sub-sample of female specimens (N = 106) had been examined, and removed and weighed if eggs were found. Subsequently, using Vernier calipers, two of us (i.e., AWW and GHP) measured testes lengths and widths of forearms (laterally at midpoints) for all males > 25 mm SVL (N = 94) and a randomly chosen subset of 13 in the range 20–25 mm (N = 64).

The specimens were also examined externally (by either JS or PC) and sexed on the basis of flanges on the fingers for females and nuptial 'spines' for males. An individual was categorized as a female if flanges were apparent on any of the first three fingers and a male if the metacarpal bone of the first finger felt rigid and sharply pointed to the touch. Individuals not assignable to either category were assigned the category "unknown." Throat color was not used as a characteristic for distinguishing sexes because it is known to be unreliable in this context (Moore 1961; GHP, pers. obs.) and may fade in preserved specimens. Although we measured forearm width, we did not use it for distinguishing sexes because no quantitative basis for doing this was known. External examination of specimens was carried out blind to the results of internal examinations.

Snout–vent length was recorded by at least one observer for each specimen in the sample. In those cases (N = 302) where SVL was measured during both dissection and external examination, we found a high correlation between the two measurements (i.e., Pearson correlation = 0.996), but a significant decrease in SVL of 2.2 mm on average between dissection and external examination ($P < 0.01$, paired t-test). This decrease was not significantly related to SVL ($P = 0.72$, General Linear Model). We therefore adopted the measurement taken during dissection when both measurements were taken (N = 300), but used the measurement taken during external examination and increased it by 2.2 mm, when it was the only one available (N = 2).

We used Logistic Regression to examine relationships between SVL and whether a frog was sexed and sexed correctly. We explored departures from linearity by considering the significance of SVL^2 and SVL^3, and considered sigmoidal relationships using Non-linear Regression. We examined the effects of season of collection and SVL on gonad size using Analysis of Covariance (ANCOVA) with season as the independent variable and SVL as the covariate. We then analyzed relationships between SVL and both gonad and forearm size using the General Linear Model (GLM), with departures from linearity determined on the basis of the significance of SVL^2 and SVL^3. For ovary mass, testis length, and forearm width, we used the means of left and right measurements for each individual. All analyses were carried out with the computer software SYSTAT (Wilkinson 1990).

Results.—Sexing was reliable and accurate on frogs with SVLs ≥ 40 mm, but not for smaller frogs (Figs. 1 and 2). All individuals > 40 mm SVL were sexed without error (Figs. 1 and 2). For individuals < 40 mm SVL, the proportions of individuals that could be sexed and that could be correctly sexed decreased sharply with decreasing SVL (Figs. 1 and 2). For the smallest frogs, the proportion of sexed individuals that were correctly sexed was close to 0.5 (Fig. 2), as would be expected if sexes were assigned at random. These relationships departed significantly from linearity (Figs. 1 and 2; all $P < 0.05$ for linear, quadratic, and cubic powers of SVL, Logistic Regression), and could be fitted with sigmoidal equations (i.e., $P_S = 1/ (1+506489 \times \exp [-0.414 \times SVL])$ where P_S is proportion sexed, $R^2 = 0.69$; $P_{SC} = 0.5 + 1/ (2 + 459319 \times \exp [-0.332 \times SVL])$ where P_{SC} is proportion sexed correctly, $R^2 = 0.18$; GLM). Neither mean ovary mass nor mean testes length varied significantly by season in which collection occurred ($P = 0.43$ and 0.52 respectively, ANCOVA). Season was therefore omitted from subsequent analysis.

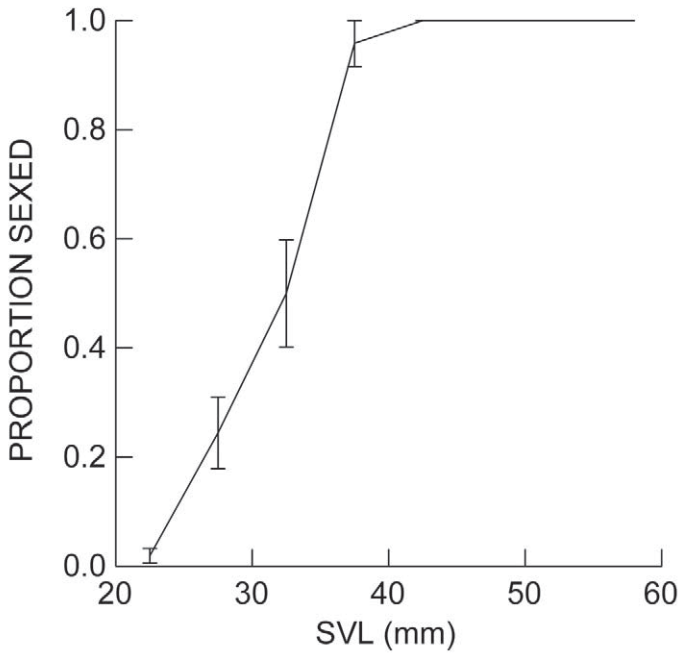


FIG. 1. Proportion of *Limnodynastes peronii* specimens that were sexed versus SVL (mm).

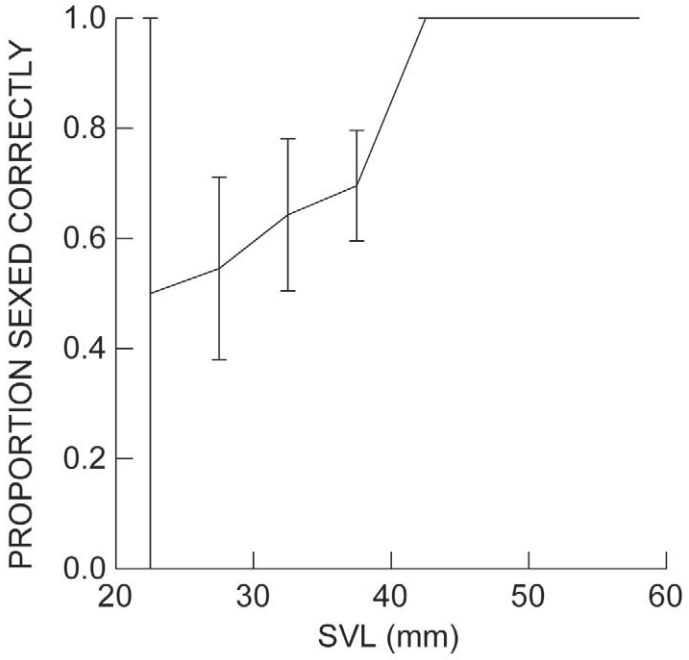


FIG. 2. Proportion of *Limnodynastes peronii* specimens that were correctly sexed versus SVL (mm).

For female frogs the proportion with eggs increased rapidly from 0 to 1 as SVL approached approximately 40 mm. We found eggs in none of the female frogs (N = 83) with a SVL of ≤ 38 mm and in two of seven 39–40 mm SVL female frogs, whereas all female frogs (N = 16) with SVL ≥ 40 mm had eggs. In addition, mean ovary mass increased as SVL increased above 38 mm (P = 0.01, GLM; Fig. 3). This relationship departed significantly from linearity (all P's < 0.05 for linear, quadratic, and cubic powers of SVL, GLM).

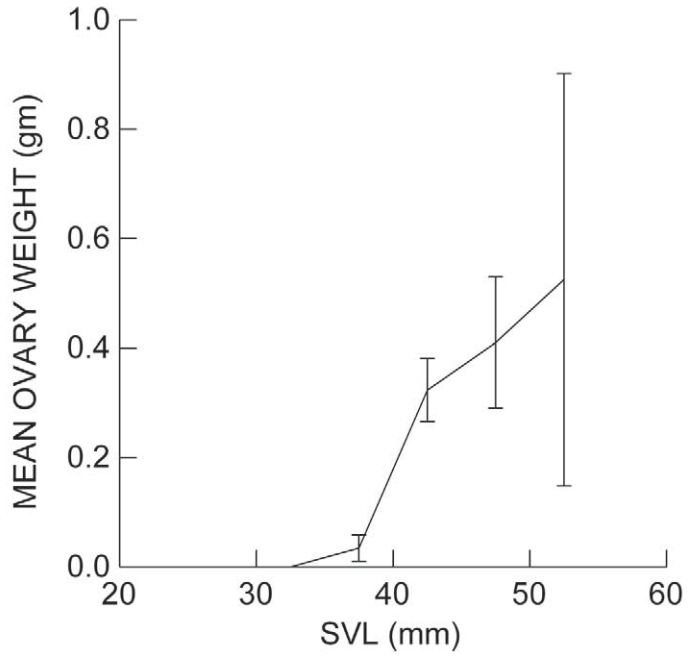


FIG. 3. Mean ovary mass (g) for female *Limnodynastes peronii* versus SVL (mm).

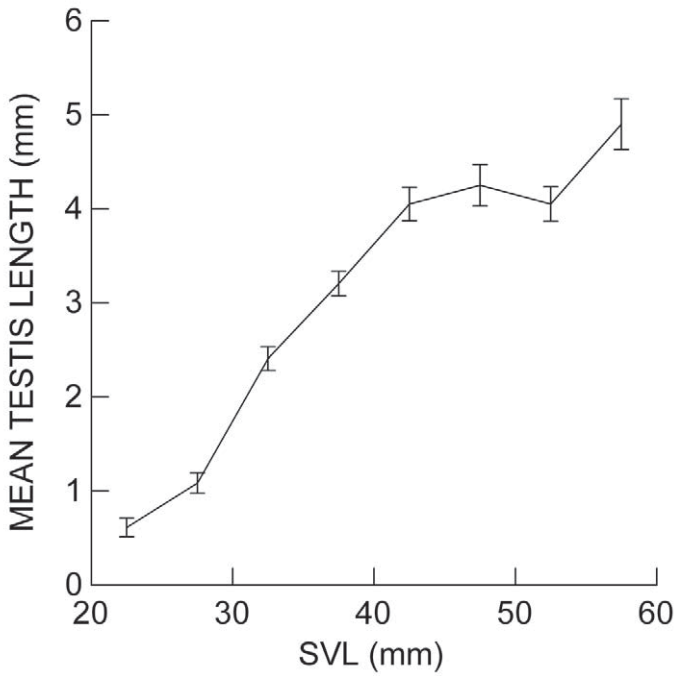


FIG. 4. Mean testis length (mm) for male *Limnodynastes peronii* versus SVL (mm).

Mean testis length increased with increasing SVL among males, leveling off after a SVL of approximately 45–50 mm (Fig. 4; all P < 0.05 for linear, quadratic, and cubic powers of SVL, GLM). Mean forearm width increased with increasing SVL among males, in a sigmoidal manner with an asymptote after about 50 mm SVL (Fig. 5; all P < 0.05 for linear, quadratic, and cubic powers of SVL, GLM).

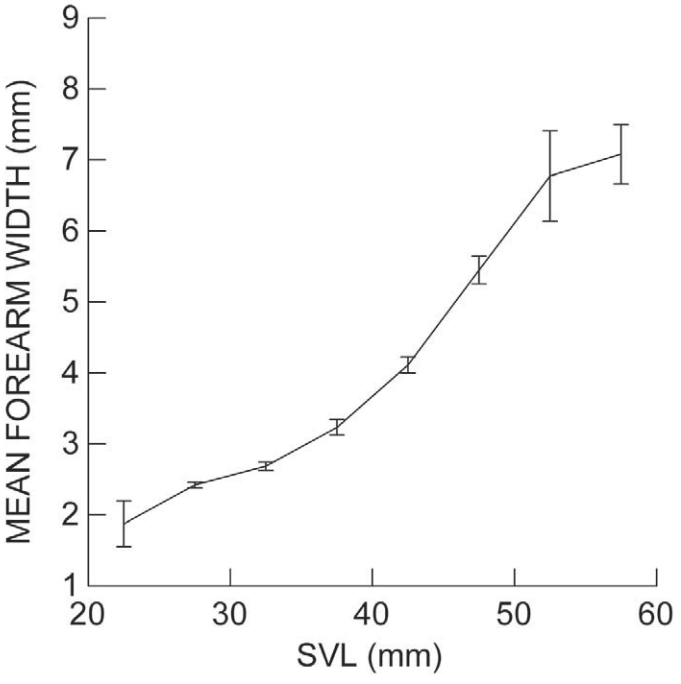


FIG. 5. Mean forearm width (mm) for male *Limnodynastes peronii* versus SVL (mm).

Discussion.—Male and female *Limnodynastes peronii* from the Kurnell Peninsula mature at different sizes. Females mature at about SVL 38–40 mm and can be considered mature at SVL ≥ 40 mm, as no females < 38 mm SVL had eggs and all > 40 mm SVL did. Males ≥ 50 mm SVL can be considered mature, as the testes attain maximum length and the forearms reach maximum width as SVL approaches 50 mm (Figs. 4 and 5). Based on data from other anurans (Pancharatna et al. 2000; Sretarugsa et al. 1997), the densities of sperm bundles and spermatozoa within the testes probably reach their maxima at maximum testis length.

Hence, individual *L. peronii* can be accurately sexed and aged (i.e., immature vs. adult) on the basis of SVL, presence/absence of flanges on fingers and presence/absence of a 'nuptial spine' with a total of four sex/age categories. All individuals < 40 mm SVL can be considered immature of unknown sex. Females ≥ 40mm SVL and males ≥ 50 mm SVL can be considered mature. Males 40-50 mm SVL can be considered immature. Similar patterns, although usually with males maturing at a smaller size than females, have been reported for other frog species (Gilbert et al. 1994).

Field observations of the sizes of mating frogs might allow further evaluation of this methodology. For example, if minimum sizes at maturity are relatively constant in this species, the smallest males and females found in amplexus would be about 50 and 40 mm SVL respectively.

The accuracies with which frogs have been assigned to age categories (e.g., immature, adult) and sexed in other studies are unclear (i.e., Bosch and Marquez 1996; present study). A general lack of discussion of this issue in the literature may reflect a similarly high accuracy in the methods for sexing and aging adopted by others. However, further tests of sexing and aging accuracy are needed to determine whether significant errors have gone unnoticed or unreported.

For both males and females, gonad size increased with increasing body size. This has been commonly observed for females of other frog species (Horseman et al. 1978; Huang et al. 2001; Jorgensen 1985; Kulkarni and Pancharatna 1996; Prado and Haddad 2005) but less frequently for males (Pancharatna et al. 2000).

Frog species with a seasonally-interrupted breeding season tend to show maximal size or development of the gonads during the periods when breeding occurs, whereas those species that breed more continuously throughout the year do not (Lofts 1974). As expected, we found no significant seasonal patterns for either mean ovary mass or mean testis length for *L. peronii*, a species reported to breed throughout the year (Anstis 2002; Cogger 2000). On the other hand, species that occur in areas where breeding is restricted to the warmer months show maximum gonad size or development during this period (Kanamadi and Jirankali 1992; Yoneyama and Iwasawa 1985).

This study illustrates one way in which a museum specimen collection can provide data that are useful and important to field ecological studies of frogs. Accurate assessments of an animal's reproductive condition or the size of its reproductive organs are generally only possible through internal examination of dead animals. Wet collections provide large sample sizes of animals, the sex of which may be verified by dissection. However, care is needed when determining relationships with body size using museum frog specimens as preservation may result in changes to morphological measurements (Lee 1982). We found, for example, a significant shrinkage in SVL over a period of about nine years after frogs were initially collected. However, we were able to rely almost exclusively on measurements taken at the time of collection and the systematic pattern of shrinkage allowed us to adjust the measurements for the few animals not measured.

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Species Diversity in the Genus *Emydocephalus* Krefft, 1869 (Serpentes, Elapidae, Hydrophiinae): Insight from Morphology and Anatomy

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The genus *Emydocephalus* Krefft, 1869 includes two geographically separated species feeding exclusively on fish eggs (Voris 1966), *E. annulatus* and *E. ijimae*. Its type species by subsequent designation of Stejneger (1907) is *E. annulatus* Krefft, 1869. Boulenger (1908) recognized the validity of that genus but considered *E. annulatus* and *E. tuberculatus* Krefft, 1869 as conspecifics and added *E. chelonicephalus* Bavay, 1869 and *E. ijimae* Stejneger, 1898 as synonyms of *E. annulatus*. He considered the characters used to distinguish among all those species as inconsistent and considered the genus as monotypic, a position generally not followed later (e.g., Smith 1926).

The Turtle-headed Sea Snake, *Emydocephalus annulatus*, was originally described from an unspecified location, "*Probably the Australian seas.*" Its distribution encompasses the Timor Sea in Indonesia to northern Australia and New Caledonia, including the Loyalty Islands and the Chesterfield Reefs, as far east as Fiji (David and Ineich 1999; Ineich and Laboute 2002; Krefft 1869). The second species, the Japanese Turtle-headed Sea Snake, *E. ijimae*, was later described from the Ryukyu Sea in southern Japan. Its distribution comprises the Ryukyus in southern Japan (Stejneger 1898), People's Republic of China and Taiwan (Kharin 2008; Mao and Chen 1980), and with some doubt the Philippines (see David and Ineich 1999). Kharin (2008) suspected the possible penetration of *E. ijimae* north into Russian waters (to Peter the Great Bay) but considered the species not extending further south than Taiwan. Dotsenko (1999) also mentioned a specimen of *Emydocephalus* from Vietnam that he identified as *E. annulatus*. This record has been overlooked by most authors in the following years (Kharin 2006; Nguyên et al. 2005, 2009). Despite all those records of *Emydocephalus* from various locations between Japan and Australia, distinction of both recognized species is still weak and mainly based on inconsistent differences in scalation (see Table 1 below). Specific attribution of geographically intermediate populations of Philippines, Vietnam, and Taiwan is still uncertain, as seems to be the validity of *E. ijimae* based solely on available external characters.

Taylor (1922) reported 10 species of elapid sea snakes from the Philippines. That number was later increased to 12 by Dunson

and Minton (1978) after intensive collecting of more than 1000 specimens in the central Philippines, however these authors did not report *Emydocephalus* from the country (see also Minton 1978). Later however, Alcala (1986) reported the genus from the Philippines for the first time and referred populations to *E. annulatus*, a species that he considered as being widespread "probably all over Philippine seas." David and Ineich (1999) tentatively considered those populations as *E. ijimae*. More recently Alcala et al. (2000) mentioned Philippine populations as belonging to an undescribed species having a restricted distribution (they provide a picture of a specimen from Bohol's "Snake Reef"). That new species is not yet described but its description is underway by H. Ota (pers. comm. April 2009). Philippine populations appear to have a patchy distribution, possibly limited to the central Philippines. To date they are known from two coral reefs southeast of Bohol Island and southeast of Negros Island. This apparent restricted distribution may result from a combination of ecological, oceanographic, and climatic factors; variation in salinity may limit sea snake distributions (Heatwole et al. 2005). A similar patchy distribution was also noticed in the Philippines for the sea krait *Laticauda semifasciata* by Herre and Rabor (1949); the species can be common but is very localized and known from only a few stations.

During a diving trip, one professional diver, Vincent Maran, observed and photographed several specimens of *Emydocephalus* off the coast of Panglao Island (Bohol Sea, central Philippines). No specimens were collected but his observations and pictures were made available to us, enabling a preliminary species level identification via high quality pictures of the specimen's head. These underwater observations of Philippine Turtle-headed Sea Snakes together with the above-mentioned specimen from Vietnam generate some doubts concerning the current taxonomy in which northern populations (*E. ijimae*) are considered specifically distinct from southern populations (*E. annulatus*).

Materials and methods.—We compared 45 specimens of *Emydocephalus ijimae* from Japan with 56 specimens *of E. annulatus* from Australian waters and 18 specimens of *E. annulatus* from New Caledonia (material examined, see Appendix). The measurements and counts follow Smith (1926) with some alterations as described in Rasmussen and Ineich (2000). The following abbreviations are used: the position of the posterior tip of the heart and the anterior tip of the liver were determined in relation to the number of the adjacent ventral scales counted from throat to vent (VS–heart and VS–liver, respectively); the relative position of the posterior tip of heart and the anterior part of liver are expressed as a percentage of the total number of ventral scales (%VS–heart and %VS–liver, respectively); scale rows around neck (about one head length behind jaw's posterior end), body (about midbody) and vent (about one head length anterior of vent) are counted directly around body (SR–neck, SR–body, and SR–vent, respectively). Mean and standard deviation (sd) are given for each character counted.

Results.—Scalation characters classically used to separate *E. annulatus* from *E. ijimae* are mentioned in Table 1. Specimens from two distinct areas in the Australian region (*E. annulatus*: Australia and New Caledonia) are compared with specimens from southern Japan (*E. ijimae*: Ryukyus) for these and additional characters. Data are summarized in Tables 2–7. Data presented in

TABLE 1. Traditional scalation characters used to separate *Emydocephalus annulatus* from *E. ijimae* (after Smith 1926:26).

Characters	*E. ijimae*	*E. annulatus*
Prefrontal plates	4	2
Posterior vertebral row	enlarged	weakly or not enlarged
Cloacal shield	divided	single/sometimes divided

Tables 2 and 3 demonstrate that the traditional suite of characters used by taxonomists (Table 1) are subject to great variation with substantial overlap among the three geographic areas, species boundaries, and between sexes. However, some of the external and anatomical characters reported in Tables 4–7 indicate relevant differences between the two recognized species. The number of ventrals were significantly different ($P<0.05$) in males (Table 4) of *E. annulatus* and *E. ijimae*, but not in females (Table 5). Also number of SR–body and subcaudals in males (Table 6) and females (Table 7) show significant interspecific differences, together with the number of bands on body in males ($P<0.05$), but not in females. The same pattern was observed in VS–heart and VS–liver, where only the males show significant difference (Tables 4–5). Specimens from all three geographic areas show significant sexual dimorphism in number of subcaudals ($P<0.01$) (Tables 4–5).

Vietnamese and Taiwanese specimens of *Emydocephalus*

The only known Vietnamese specimen is an adult male collected at Dong-Naï, near the town of Voung-Taï, on 4 September 1989 (Coll. N. N. Szczerbak, n° 1912/4696 [in Kiev, Ukraine]) and reported by Dotsenko (1999). Dotsenko (1999) referred the specimen to *Emydocephalus annulatus*, but mentioned that most characters overlap between *E. annulatus* and *E. ijimae*. If we compare the data he provided on that specimen [subcaudals (30), bands on body (21), SR–body (15), weakly enlarged posterior vertebral row] with the same characters in Australian and Japanese populations, we agree that this specimen should be referred to *E. annulatus*. Other characters mentioned by Dotsenko (1999) cannot be considered as being significant differences between Australian and Japanese populations (two prefrontals and presence of a divided cloacal plate; see Tables 2-3). Moreover, when considering the data provided by Mao and Chen (1980) for Taiwanese populations, the picture of morphological variation in the genus *Emydocephalus* is even more confused: 136–145 ventrals in males (N = 8, mean = 141), 26–30 subcaudals in males (N = 7, mean = 28), 21–24 subcaudals in females (N = 4, mean = 23). All of these data are intermediate between the values for Japanese and Australian specimens. Note however that the number of Taiwanese specimens observed by Mao and Chen (1980) was limited.

Philippine specimens of *Emydocephalus*

The most closely taken head picture of a Philippine specimen from Panglao Island clearly shows two prefrontal plates (Fig. 1), and therefore using traditional characters is referrable to *E. annulatus*. However, size of posterior vertebral row and cloacal

TABLE 2. Traditional scalation characters examined on specimens (males) of *Emydocephalus ijimae* from Japan and *E. annulatus* from Australia and New Caledonia. Brackets indicate number of specimens examined with that character state. The character state "1.5" indicates that the cloacal shield is not completely divided into two distinct shields, but still has a small connection between shields.

MALES/Characters	Number	Japan	Australia	New Caledonia
Prefrontal plates	2	(12) 44%	(34) 94%	(9) 100%
	3	(8) 30%	(1) 3%	(0)
	4	(7) 26%	(1) 3%	(0)
Posterior vertebral row		enlarged	weakly enlarged or enlarged	weakly enlarged or enlarged
Cloacal shield	1	(0)	(22) 69%	(3) 20%
	1.5	(0)	(4) 12.5%	(9) 60%
	2	(27) 100%	(6) 18.5%	(3) 20%

shield shape cannot be observed in pictures available to us of the Philippine specimen. That specimen also shows the classical black and white irregular alternating body rings of *E. annulatus*.

Emydocephalus is relatively common around Panglao Island where one popular diving site is even called 'Snake Island' (e.g., Cervera Shoal, 9.483°N, 123.85°E); that area is not an island but a submerged reef located about 10 m under water. As many as ten *Emydocephalus* were seen at one site during a single dive (V. Maran, pers. comm.).

Discussion.—As can be seen from the morphological characters we have examined, there are some clear and significant differences between *Emydocephalus ijimae* from Japan and *E. annulatus* from the Australian region. Validity of both species is confirmed by our morphological examination but there are no clear external or internal characters allowing for unequivocal species attribution. Traditional characters used to separate both species exhibited considerable interspecific overlap and intraspecific variation thus preventing unequivocal separation of *E. annulatus* from *E. ijimae*. Moreover, when including published data from Taiwanese specimens, a possible latitudinal cline is evident. Future studies should include more specimens from Philippines, Vietnam, and China. This would allow workers to confirm or not whether there are two or more species in the genus *Emydocephalus*.

Our study confirms the occurrence of *Emydocephalus* in the Philippines, and adds Panglao Island to the list of known localities for these important populations. However, without any voucher specimen available from that new location, the identification of the particular species of *Emydocephalus* in the Philippines remains uncertain. According to available data, we regard those Philippine populations as phenotypically similar to southern *E. annulatus* rather than to northern *E. ijimae*. Our conclusion is based on the few characters that can be seen on the available photographs and their comparison with our data (Tables 2–7).

One additional point in favor of the existence of at least two species in the genus *Emydocephalus* is the occurrence of melanistic specimens only in Australian and New Caledonian populations of our large samples, but not in Japan. However, Kharin (1984, 2008) reported occurrence of black melanistic specimens of *E. ijimae*. Uniform black specimens in central populations (Philippine, Taiwan, and Vietnam) have not been reported but available sample sizes are insufficient to make strong conclusions. It is interesting to note, however, that New Caledonian sea kraits are represented by three species and melanism is present in only one (Lorioux et al. 2008), thus suggesting its potential value as diagnostic character.

One topic for future studies is the questionable absence or low occurrence of statistically significant differences in scale counts between females of both species whereas such differences exist in males. This pattern might reflect selection for a conservative body plan that meets requirements of both viviparity and life in a

TABLE 3. Traditional scalation characters examined on specimens (females) of *Emydocephalus ijimae* from Japan and *E. annulatus* from Australia and New Caledonia. Brackets indicate number of specimens examined with that character state. The character state "1.5" indicates that the cloacal shield is not completely divided into two distinct shields, but still has a small connection between shields.

FEMALES/Characters	Number	Japan	Australia	New Caledonia
Prefrontal plates	2	(3) 16%	(18) 90%	(9) 100%
	3	(4) 21%	(0)	(0)
	4	(12) 63%	(2) 10%	(0)
Posterior vertebral row		enlarged	weakly enlarged or enlarged	weakly enlarged or enlarged
Cloacal shield	1	(2) 10%	(14) 70%	(0)
	1.5	(0)	(4) 20%	(5) 62.5%
	2	(18) 90%	(2) 10%	(3) 37.5%

TABLE 4. External and internal characters (males) of *Emydocephalus ijimae* from Japan and *E. annulatus* from Australia and New Caledonia. See "Material and methods" for abbreviations. * = only one specimen has 34 subcaudals, all other specimens have 25–30 subcaudals.

MALES Countries/characters	JAPAN (N = 27)	AUSTRALIA (N = 36)	NEW CALEDONIA (N = 9)
Ventrals	142.0 (139–148) ± 2.2	138.9 (133–146) ± 3.5	138.1 (135–141) ± 2.3
Subcaudals	27.7 (25–34*) ± 1.9	30.1 (27–33) ± 1.3	31.4 (30–32) ± 0.7
VS–heart	44.6 (41–47) ± 1.5	41.9 (37–47) ± 2.6	42.3 (40–44) ± 1.6
% VS–heart	31.4 (29.5–33.3) ± 0.9	30.1 (26.6–32.9) ± 1.5	30.6 (29.1–32.1) ± 1.1
VS–liver	46.2 (42–49) ± 1.6	42.5 (37–48) ± 2.7	43.0 (42–45) ± 1.2
% VS–liver	32.6 (30.2–34.3) ± 1.0	30.6 (26.6–33.6) ± 1.5	31.1 (29.8–32.1) ± 0.9

TABLE 5. External and internal characters (females) of *Emydocephalus ijimae* from Japan and *E. annulatus* from Australia and New Caledonia. See "Material and methods" for abbreviations. Note that Kharin (2008) indicated a count of 20–25 subcaudals for females *E. ijimae*.

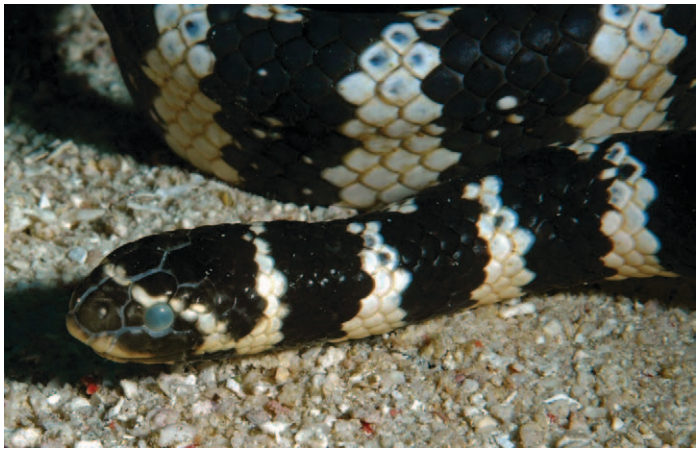
FEMALES Countries/characters	JAPAN (N = 21)	AUSTRALIA (N = 20)	NEW CALEDONIA (N = 9)
Ventrals	137.9 (136–142) ± 1.6	136.3 (130–142) ± 3.3	136.9 (133–139) ± 2.1
Subcaudals	21.5 (19–24) ± 1.4	24.8 (22–28) ±1.6	26.0 (25–27) ± 0.8
VS–heart	42.5 (40–44) ± 1.4	40.9 (38–46) ± 2.0	42.6 (41–45) ± 1.5
% VS–heart	30.8 (28.8–31.9 ± 0.9	30.0 (28.4–32.9) ± 1.0	31.1 (29.9–33.1) ± 1.0
VS–liver	43.8 (42–46) ± 1.4	41.1 (38–46) ± 1.9	43.0 (41–45) ± 1.4
% VS–liver	31.8 (30.2–33.3) ± 1.0	30.0 (28.4–32.9) ± 1.1	31.4 (29.9–33.1) ± 1.0

TABLE 6. External characters (males) of *Emydocephalus ijimae* from Japan and *E. annulatus* from Australia and New Caledonia. See "Material and methods" for abbreviations. * = some of the examined specimens are dark or completely black without bands on body and tail (melanism). Note that Kharin (2008) indicated 4–6 tail bands for *E. ijimae*.

MALES Countries/Characters	JAPAN (N = 27)	AUSTRALIA (N = 36)	NEW CALEDONIA (N = 9)
Body bands	28.2 (25–34) ± 2.1	22.7 (19–30*) ± 4.1	25.0 (25*) ± 0
Tail bands	6.5 (5–8) ± 0.7	5.0 (4–6*) ± 0.9	5.0 (5*) ± 0
SR-neck	16.0 (15–17) ± 0.6	14.9 (13–15) ± 0.4	15.1 (15–16) ± 0.4
SR-body	18.1 (17–19) ± 0.8	16.7 (15–17) ± 0.7	17.0 (17) ± 0
SR-vent	14.9 (14–15) ± 0.4	14.1 (13–16) ± 1.1	15.0 (15) ± 0

TABLE 7. External characters (females) of *Emydocephalus ijimae* from Japan and *E. annulatus* from Australia and New Caledonia. See "Material and methods" for abbreviations. * = some of the examined specimens are dark or completely black without bands on body and tail (melanism). Note that Kharin (2008) indicated 4–6 tail bands for *E. ijimae*.

FEMALES Countries/Characters	JAPAN (N = 21)	AUSTRALIA (N = 20)	NEW CALEDONIA (N = 9)
Body bands	27.0 (24–29) ± 1.6	24.3 (23–25*) ± 1.0	26.3 (26–27*) ± 0.6
Tail bands	5.3 (5–6) ± 0.5	4.0 (3–5*) ± 0.8	5.0 (5*) ± 0
SR–neck	16.1 (15–19) ± 1.1	15.0 (14–16) ± 0.3	15.0 (15) ± 0
SR–body	17.1 (16–18) ± 0.5	17.0 (16–17) ± 0.2	17.0 (17) ± 0
SR–vent	14.4 (13–15) ± 0.7	14.5 (13–16) ± 1.1	15.0 (15) ± 0



COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND

FIG. 1. Head detail of *Emydocephalus annulatus* from Panglao Island, Bohol Sea, central Philippines. Photo © V. Maran.

marine environment.

Morphological and anatomical characters provide evidence that *Emydocephalus* comprises a species complex. However, the scarcity of available specimens considerably limits the scope of our work and prevents us from making strong conclusions. Future studies would benefit from the collection of DNA sequence data and estimates of molecular divergence between known populations of *Emydocephalus*. This approach (if used together with the morphological studies) could provide insight into the origin, evolution, and diversification in the genus *Emydocephalus*.

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APPENDIX

Material examined. Acronyms used above are as follows: URB–REP: Biological Collection of the University of the Ryukyus (Reptiles), Japan; URB–FH1979: Biological Collection of the University of the Ryukyus (field numbers for herpetological specimens collected in 1979), Japan; KUZ: Zoological Collection of Faculty of Science, Kyoto University, Japan; MNHN: Muséum national d'Histoire naturelle, Paris; ZMUC: Zoological Museum, University of Copenhagen, Denmark.

Emydocephalus ijimae: URB–REP 168–176, 180–182, 185, 187–192; URB–FH 1979.69, .85, .88, .97, .99, .166, .170, .172–174, .176–177, .180–181, .225, .228–232, .234–236; KUZ 21677, 34721, 34729. All from Okinawa Islands, Central Ryukyus, Japan.

Emydocephalus annulatus: MNHN 1990.4534–35, 1990.4537–40, 1990.5114–16, 1990.5117–21, 1990.5123–26. All from New Caledonia; AMS 16793, 21452, 33358, 40484–86, 40495, 40500, 40502–03, 41512–13, 41515, 41517, 41536, 41540–41, 42025, 42702, 42704, 44396, 44433, 44451, 44466–67, 44471–72, 44489, 44540, 44573,

44585, 44590–91, 44604, 44608, 44615, 44622, 44624, 44641, 44645, 44874, 44882, 44884, 44889, 45050–1, 45052–53, 54656, 107753–54, 109675. All from the Australian region; ZMUC 661198, 661221–22, 661286. All from the Australian region.

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Rediscovery of *Abronia campbelli* (Sauria: Anguidae) from a Pine-Oak Forest in Southeastern Guatemala: Habitat Characterization, Natural History, and Conservation Status

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Guatemala is one of the world's biodiversity hotspots, in part the result of its complex topography and its privileged space between the Neartic and Neotropical (Campbell and Vannini 1989). Within this biota exists the arboreal lizards of the genus *Abronia*. These secretive lizards live within the pine-oak and cloud forests of northern Mesoamerica and belong to the family Anguidae (Campbell and Brodie 1999). Species of *Abronia* are known to occur from southern Tamaulipas and Guerrero, Mexico, to southern Honduras (Campbell and Frost 1993). Guatemala has been a region of diversification of this group, with 10 species, eight of them endemic. These national endemics are *A. anzuetoi*, *A. aurita*, *A. campbelli*, *A. fimbriata*, *A. frosti*, *A. gaiophantasma*, *A. meledona*, and *A. vasconselosii*. Two other species are shared with southern Mexico, *A. matudai* and *A. ochoterenai* (Acevedo 2006). With few exceptions, *Abronia* are known from few specimens, often from only the type or a few specimens from the immediate vicinity of the type locality (Campbell and Frost 1993). They spend most of their lives among epiphytes of the cloud forests and are strictly diurnal (Campbell and Frost 1993). Behavior patterns of *Abronia* have been poorly studied and field research on these species is almost nonexistent. Most of the information gathered has been for *A. vasconcelosii* in captivity (Formanowicz et al. 1990).

Conservation status of most species is uncertain, but restricted distributions and habitats disturbed or destroyed by human development have made most species of the genus among the most endangered lizards in the world (Campbell and Frost 1993). Moreover, many species of *Abronia* are threatened with immediate extinction. *Abronia campbelli* (Brodie and Savage 1993) and *A. frosti* (Campbell et al. 1998) were thought to have become extinct soon after their discovery (Campbell and Brodie 1999; Campbell and Mendelson 1998).

Abronia campbelli is a member of the subgenus *Auriculabronia* (Campbell and Frost 1993) and is characterized by having distinctive spinelike supra-auricular scales in subadults and adults, 14–16 ventral scale rows, a bright ring around the eye, 32–35 transverse ventral scale rows, variable adult dorsal coloration, usually gray, brown or yellow with black mottling forming indistinct dorsal crossbands; juvenile dorsal coloration gray-brown with 9–10 black crossbands on body and pale brown to yellow circumorbital region (Brodie and Savage 1993).

Material and methods.—Two trips were made to the vicinity of the type locality at Potrero Carrillo-La Pastoría, Jalapa, Guatemala, during 4–6 September 2009 and 21–23 October 2009. Structured interviews with local villagers were conducted to determine the possible presence of *A. campbelli* within the area. Manual searches for the species on oak trees within the area were also made to locate and capture any individuals of the species if present. For any specimen found, we took standard body measures including snout–vent length (SVL), total length (TL), and head width (H). Climatic data for the site were obtained from a meteorological station that has been recording data from La Pastoría since 1990. We analyzed the data from 1990 to 2008 to characterize the climate to which this species is exposed. We also made a geographic information system (GIS) analysis of the actual forest cover in the area using a forest coverage map of Guatemala from 2003 and SPOT satellite photos from 2008 with a resolution of 5 m^2.

Results.—The forest inhabited by *Abronia campbelli* is composed of two species of oak: *Quercus peduncularis* and *Q. brachystachys*, which are heavily covered by the bromeliad, *Tillandsia usneoides*, and other epiphytes. This forest is within a wetland surrounded by *Pinus oocarpa* pine trees that according to local villagers was heavily covered by an old growth oak forest until around 1970. Analysis of environmental data of the site provided by a weather station present at the site since the early 1990s showed that the average annual temperature is 16.91 ± 0.53ºC, maximum annual temperature is 21.76 ± 2.36ºC, minimum annual temperature is 8.41 ± 2.21ºC, annual average rainfall is 1328 ± 282 mm, and annual relative humidity is 83 ± 2.22%.

We captured 34 individuals of *A. campbelli* within the area (Fig. 1), including four juveniles. All were released after taking measurements. Average SVL was 112.3 ± 4.2 mm for males and 114.0 ± 7.5 mm for females. Head width was 26.0 ± 1.9 mm for males and 16.1 ± 2.1 mm for females. We found an average of 2.5 adult individuals per tree. From a total of 25 adult oak trees examined, 12 trees were inhabited by *A. campbelli* (48% occupancy). The specimens collected were found only in older trees of *Q. peduncularis* that had an average height of 10.68 ± 1.68 m and an average diameter at breast height (DBH) of 58.72 ± 9.43 cm, and that were covered by thick masses of epiphytic growth.

Although *Abronia campbelli* is not extinct, it is in critical danger of extinction if strong conservation measures are not taken. There are only 406 standing *Quercus* trees remaining at the type locality according to the GIS analysis. The area is severely fragmented consisting mainly of isolated old oak trees with an average distance between them of 55 ± 18 m (Fig. 2).

Discussion.—Environmental data gathered at the site are similar to the weather conditions we have seen for other species such as *A. vasconselosii*. The wetland where the oak forest was reported in the past still persists and makes this area very humid, contrasting with the suggestions of Brodie and Savage (1993)



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FIG. 1. First specimen rediscovered of *Abronia campbelli* found within Spanish Moss (*Tillandsia usneoides*) in the branches of an oak *Quercus brachystachys* at Potrero Carrillo-La Pastoría, Jalapa, Guatemala.

that this species inhabits the driest forest for any *Abronia* species.

Taking into account that we found an average of 2.5 individuals per tree and that the occupancy average of the trees was of 48%, we estimate that in the area there are still around 487 adult individuals remaining in a highly fragmented habitat. The main action that has been identified in the past as causing this high rate of deforestation at the type locality is logging for firewood (Brodie and Savage 1993), but our interviews with local villagers suggest that presently, the main action that is causing this dramatic deforestation is logging for raising cattle



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FIG. 2. Isolated oak tree where three specimens of *Abronia campbelli* were found at Potrero Carrillo-La Pastoría, Jalapa, Guatemala.

in the area. This shows the urgent need for habitat restoration at Potrero Carrillo-La Pastoria, Jalapa, Guatemala, as a way to increase connectivity among the last standing oak trees that remain at the site. A strong reforestation program to increase connectivity using oaks and some kind of fast growing tree from native species such as *Liquidambar styraciflua*, *Alnus* spp. or *Leucaena diversifolia* may be used. *Quercus* species need some kind of shadow to regenerate well (Dey et al. 2009). We suggest that the fast growing trees planted as part of the reforestation program can be covered with *Tillandsia usneoides* which is the main microhabitat of *A. campbelli* at the site. This will help increase the connectivity within the remaining oak trees and also promote natural regeneration and growth of the planted oak trees. Another conservation measure we suggest is joining the top of the remaining oak trees in the area with ropes that can be covered with thick masses of *Tillandsia usneoides* so they may function as artificial corridors among trees to increase genetic flow within the population. Also, random manual translocation of female individuals between the remaining trees may be useful in increasing the genetic flow within the population.

Another important threat is that the remaining individuals of *A. campbelli* in the wild now are under pressure from smugglers who trade them in foreign countries for the pet trade and collectors. At the time of our first visit in September 2009 we noticed the presence of foreigners at the type locality that were looking for the lizards. Unfortunately, at that time we did not have enough information to realize what these people were doing at the site. Additional information has led us to believe that these people were smugglers that were looking for *A. campbelli* for commercial trade in Europe. We learned from interviews with local villagers that smugglers have taken at least five individuals of *A. campbelli* with them. The destination country to which the lizards were taken is unknown. We suggest that an inclusion of the genus *Abronia* under CITES could be a management tool that can help in controlling and reducing the trade in these species. We have also secured six pairs of this species for a conservation captive breeding program held at Zootropic Herpetarium located in Guatemala City.

The inhabitants refer to *A. campbelli* as "*escorpión*," and believe it is a highly venomous animal. In the past, if they encountered these lizards, they would kill them. Taking into account such threats, we have taken steps to increase public awareness about the relevance of conservation of this species and to correct the misconceptions that exist about this species among farmers and local villagers. More recently, we have also begun actions with landowners to protect and restore the forest remnants at the type locality

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Educating Students on the Importance of Spatial and Temporal Bias in Museum Collections: An Example Using *Sonora semiannulata* from Texas

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That museum collections are biased in various ways comes as no surprise to anyone familiar with collections-based research. But the specific nature of biases and their implications for various research questions often are things that investigators learn by practice or experience. In 2004, we offered a new undergraduate non-science majors course on Natural History Museum Science at The University of Texas at Austin. The course was open to all first- and second-year students, and attracted many students from majors outside of the natural sciences. The course curriculum included touring the many natural history collections archived at The University of Texas at Austin, as well as direct field and laboratory experience in surveying, collecting, and curating specimens. During the first semester the course was offered, it became clear that students needed additional instruction on the nature of museum collections, the relevance of voucher-based collections, and the need for and importance of maintenance and growth of collections. These additional areas of instruction were required to address student concerns that emerged during collections tours when, for example, they confronted for the first time thousands of preserved specimens. The understandable and almost ubiquitous question of "why would you need more?" focused our attention on the need to specifically address temporal bias present in all historical collections. As long-term collectors we suspected, but did not ourselves fully appreciate, the severe temporal biases present in our own collections.

In order to address these concerns, we sought to develop a discovery-based project for the laboratory portion of the course. We developed a data set that would allow students to explore and understand the nature of geographic and temporal biases in collections, and to begin to assess the implications of those biases for interpreting data derived from historical collections. In reviewing the museum and collections literature, we were unable to find a similar study using a comparable data set in the classroom; the results of our discovery-based project are of sufficient interest to the herpetological community that we share them here.

Methods

Collections Records and Taxon Selection.—We exemplified the

nature of geographic and temporal bias using a data set derived from collections records of the small colubrid Common Ground Snake, *Sonora semiannulata*. As a logistical convenience, our initial compilation of collections records was derived from seven representative collections within the state of Texas. We compared initial results derived from that limited data set with distribution maps presented by Werler and Dixon (2000) and found that overall distribution data were comparable. Consequently, our survey was taken as sufficient for the goals we had in mind for students.

Distribution records were derived from Angelo State Natural History Collections (ASNHC), Sul Ross State University (SRSU), The Texas Cooperative Wildlife Collection (Texas A&M, TCWC), Texas Natural History Collections (The University of Texas at Austin, THNC; also includes the former Texas Tech University collections), The University of Texas at Arlington Amphibian and Reptile Diversity Research Center (UTA), The University of Texas at El Paso Laboratory for Environmental Biology (UTEP), and the American Museum of Natural History (AMNH; now housing the collections of Texas A&M at Kingsville). We requested locality information and date of collection for all specimens catalogued in their collections under the names *S. semiannulata* and its former designation *S. episcopa*.

We chose *S. semiannulata* as an exemplar because it is mapped as being widely distributed within Texas, is readily identifiable, is not threatened or endangered within the state, and is small enough that it is not inconvenient to collect or store. For these reasons, there is no obvious disincentive to serendipitous field collections (i.e., it is easy to identify, preserve in the field, and transport back to the museum). We retrieved records for 1737 specimens with collecting dates ranging from 1923 through 2004. For plotting purposes, multiple specimens collected from a single geographic location on the same date were treated as a single collection record. If additional specimens were collected from the same place in a subsequent year, that constituted an additional collection record. When defined in this way, a total of 843 collection records were recorded.

Data Depiction.—Most students are introduced to thinking about geographic distribution of taxa through the use of field guides. Traditional field guides depict geographic distribution through the use of shaded distribution maps (e.g., Conant and Collins 1998; Dixon and Werler 2005), in part as a result of space limitations associated with publication of such geographically expansive works. Shaded distribution maps tend to overestimate the area inhabited by a species because this method broadly fills in the gaps between single point localities of specimens. Some more recent distribution maps available to the public utilize dot-distribution format, based on data ultimately derived from museum collections records. The resolution presented is often coarse (e.g., presented at the county level by Dixon 2000), but the excellent maps in Ralph Axtell's Interpretive Atlas of Texas Lizards (e.g., Axtell 1987, 2005) were also adopted by Werler and Dixon (2000) in their major reference on Texas snakes. The conservative presentation of dot distribution maps more accurately defines the known distribution of a species, rather than its inferred presence at suitable habitats within a shaded distribution.

We plotted collection records of *Sonora semiannulata* as dot-distribution data on a base-map of Texas, with county boundaries visible. Few records were georeferenced, so all localities were plotted by eye using a gazetteer. We provided visual representation of date-of-collection data by color-coding collection records by decade of collection. For the most recent 15 years of our records (1990–2004), we color-coded records in five-year increments to provide a more refined assessment of modern collecting practices (Fig. 1). As part of a class exercise, students are asked to identify biases in collection records by manipulating the data set to view records from particular institutions, or all records from a given temporal interval, or a combination of the two.

Results

Spatial Distribution.—Not surprisingly, spatial distribution of collection records differed for each museum collection, and each collection reflected geographic biases in their holdings. As expected, much of this bias was centered on proximity of the institution to concentrations of collection records (e.g., the UTEP collection contains the vast majority of records from El Paso Co; Fig. 1A). We were surprised to note that even the smallest collections included unique county records for the species (AMNH N = 28 specimens, provided unique record for Maverick Co.; Fig 1B; SRSU N = 54 specimens, provided unique record for Oldham Co.; Fig. 1C). These observations emphasize the importance of maximal collection sampling to refine geographic distribution data, even for taxa that seemingly are well-represented in collections. Within our data set, we identified several counties for which no records of *Sonora* were recorded, but which are surrounded by counties for which there are records. This obviously calls attention to areas where future surveys might profitably be conducted, but in some cases also reveals the limitations of our logistically convenient self-restriction to survey only seven Texas collections; some of our 'empty' counties (e.g., Callahan, Fisher, Schleicher counties) do have records depicted by Werler and Dixon (2000), but others do not (e.g., Haskell Co., shaded on Fig. 1).

Our data set also displays outlying collection records, especially in eastern counties within the state. These records form a discontinuous distribution with central and western counties (a discontinuity also reflected on the map presented by Werler and Dixon, 2000), and suggest either lack of collection activities in intervening counties, or relict or isolated populations of the snake in eastern counties.

One notable spatial bias is the collection of specimens from roadways in Texas. Collection localities clearly situated along roadways include those from Texas State Highway 118 in Brewster County (Fig. 1D), Farm to Market Road 170 in Brewster and Presidio counties (Fig. 1E), and Ranch to Market Road 473 east of Comfort in Kendall County (Fig. 1F). Following the description of techniques and potentialities of road driving as a source of specimens (Klauber 1939), the practice became more prevalent, was established in Texas as early as the 1940s (e.g., Ranch to Market Road 473), and resulted in significant collection records housed in the institutions we surveyed.

Temporal Patterns in Collection Data.—The vast majority of collection records represent specimens that were collected after

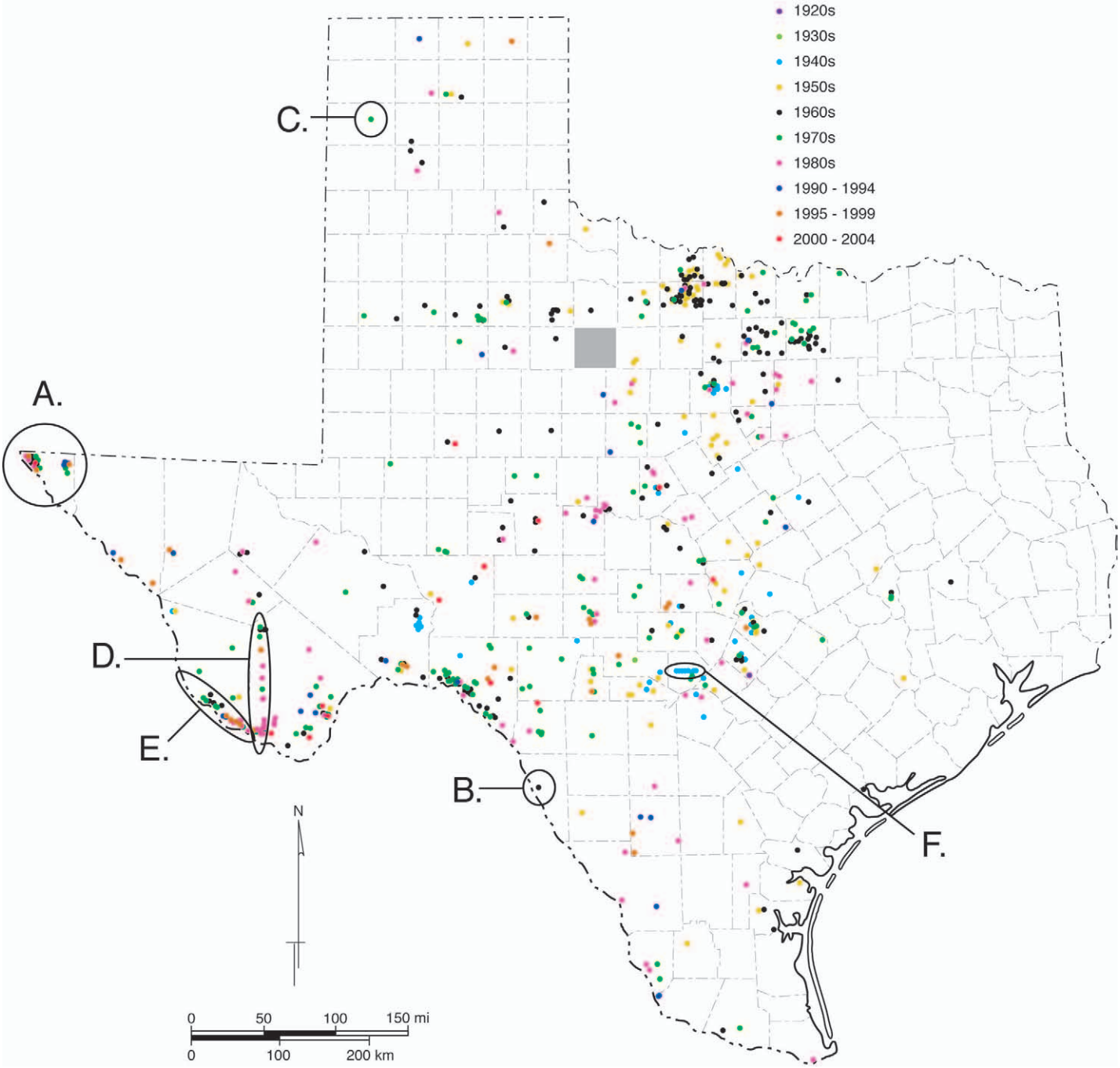


FIG. 1. Spatial and temporal distribution of *Sonora semiannulata* in Texas from all collections we surveyed. Dot distribution data are color-coded by decade of collection, with 1990–2004 broken into five-year intervals. Haskell County (shaded, in the north-central part of the state), represents a county from which no records are known, although surrounding counties all have vouchered records. A. El Paso County records; all but two of these are housed in the UTEP collection. B. Unique county record for Maverick County from AMNH collection. C. Unique county record for Oldham County from SRSU collection. D. Collection records along Texas State Highway 118 in Brewster County. E. Collection records along Farm to Market Road 170 in Brewster and Presidio counties. F. Collection records along Ranch to Market Road 473 in Kendall County.

1939 and prior to 1980. A total of only seven specimens are recorded for the 1920s and 1930s combined. Significant collecting began in the 1940s (71 collection records), but was concentrated in the central portion of the state and confined to the only three collections in existence at the time (AMNH, TCWC, and TNHC). In the 1950s, 140 collection records document expanded geographic coverage, the first records from the Panhandle region, significant collections in the vicinity of Wichita Falls and from south Texas counties, and the first collections from eastern 'outlier' counties. In the 1960s, new collections-building efforts at ASNHC, SRSU, and UTEP (coinciding with their establishment in that decade) and continued collections from TNHC and TCWC yielded 254 collections records. Those provide for the first time collections from within a single decade that yield a perspective on distribution that essentially circumscribes what we see as the 'modern' distribution of the species (e.g., easternmost record

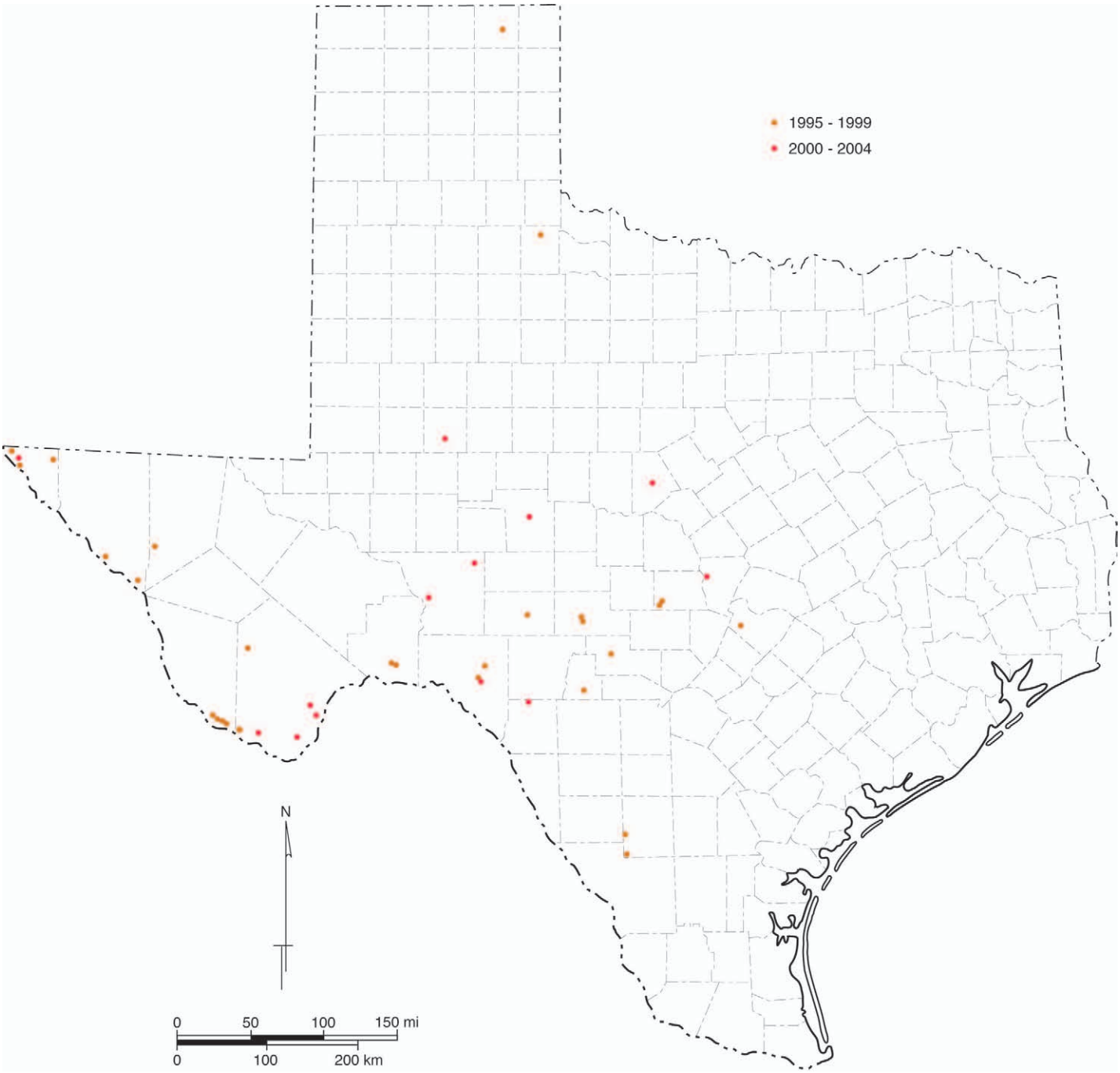


FIG. 2. The actual modern spatial distribution of *Sonora semiannulata* in Texas, based on vouchered collection records taken between 1995 and 2004, inclusive.

documented, West Texas expansion). Records from the 1970s (N = 181) also reflect collections from across the perceived range; SRSU records come predominantly from within this decade, but are concentrated in the Trans-Pecos region. Beginning in the 1980s, collection records decline (N = 111), and do not regain the prominence of earlier decades; the 1990s yield only 63 collection records and there are only 16 records from 2000 through 2004. The paucity of truly modern collections (those from 1995 to 2004) relative to the total data set is dramatically demonstrated when depicted on the base map (Fig. 2). Collections data summarized by decade, housing institution, and collection founding date are provided in Table 1.

DISCUSSION

Our data set affords us the opportunity to discuss with our students many of the challenges scientists face as they decided how (or whether) to continue building voucher-based systematic collections. At face value the seven major Texas natural history collections yield, in the aggregate, a reasonable perspective on the distribution of *Sonora semiannulata*, as it is reflected in shaded or dot-distribution maps in standard field guides (e.g., Conant and Collins 1998; Werler and Dixon 2000). When temporal data are considered, it is clear that we have a reasonable understanding of the historical distribution of the species as it existed in the 1960s and 1970s, but existing collections fail to document a 'modern'

TABLE 1. Number of *Sonora semiannulata* localities from seven institutional collections organized by year of collection.

Institution (year collection founded)	1920–29	1930–39	1940–49	1950–59	1960–69	1970–79	1980–89	1990–94	1995–99	2000–04	Total
ASNHC (~1967)	0	0	0	0	78	20	0	2	3	4	107
AMNH (1869)	3	2	5	2	4	0	1	0	0	0	17
SRSU (~1963)	0	0	0	1	6	29	1	2	0	1	39
TCWC (1936)	0	2	14	101	86	52	46	6	2	7	316
TNHC (1946)	0	0	52	34	44	36	0	1	10	1	178
UTA (1959)	0	0	0	2	27	27	43	11	7	0	117
UTEP (1965)	0	0	0	0	10	17	20	7	12	3	69
Total	3	4	71	140	254	181	111	29	34	16	843

distribution, if we take 'modern' to be the last two decades or less. Indeed, many historical records provide insights into the existence of past populations that are no longer viable because land-use change has modified native habitats to suit the needs of geographically expanding human populations (e.g., Krysko and Smith 2005). The specific reasons for declines in collections of *Sonora* are not known, but probably are multifaceted and can be conceptualized as reflecting both operational restrictions on voucher-based collecting as well as shifting attitudes towards collecting among scientists, regulators, and the public. These are fertile grounds for discussion with students.

Attitudes of scientists are shaped by their training, experience, and the exigencies of the day. Over the last decade, we have noticed that student training (undergraduate and graduate) appears to be increasingly centered on taxonomic specialization (see also Alberch 1993). The current decline in the teaching and training of students in natural history (Schmidly 2005) will likely influence whether current and future students choose to collect and contribute to natural history collections. Many herpetology classes no longer require student collections of reptiles and amphibians, further reducing the continued sampling of regional herpetofauna. The ascendancy of molecular biology has yielded vast new insights into biology, but in many cases comes with a concomitant decrease in voucher-based field work, or at least in collecting broadly beyond a focal taxon. To this end, we know of collectors who focus on increasing museum holdings of blood and tissue samples but fail to voucher a majority of those animals sampled. While such collecting endeavors may not reflect the written policy at any one institution, similar efforts may become more commonplace.

Many institutions also face increasing limitations in available funding and space to house existing collections, much less to expand them (Dalton 2003, 2007; Raven 2003). In some cases, this may lead to a cessation or decline in collections activities, or to more focused, less general collecting practices (e.g., Antunes and Vicente 2004). Reduced funding for travel may focus remaining collecting efforts towards "unique" areas of high diversity (e.g., the Big Bend of Texas) rather than allow for general, repeated collections near the home institution. More importantly, the increasingly complicated laws regulating the study, collection, and transport of specimens have resulted in long and frustrating experiences for many scientists in obtaining permits to conduct voucher-based collections (reviewed by Duellman 1999). Ironically, conservation biologists now also must confront the reality that results of their work can be used to restrict access by scientists to their research organisms, while leaving unchanged (or unregulated) access of other individuals, corporations, or special interest groups (e.g., Campbell and Frost 1993).

In Texas this general problem with permits was exacerbated recently when additional collecting restrictions were erected by the Texas Legislature based on the perceived threat of commercial over-collection and public safety issues. Texas House Bill 12 became law on 15 June 2007 along with its Section 44 (formerly Senate Bill 2414). That law prohibits the collection of any live wildlife specimens from public roads or rights-of-way (dead animals can be salvaged under state-issued salvage permits). The law does not curtail collecting activities by museum or scientific personnel collecting with an amended scientific collecting permit, but it will significantly curtail deposition of specimens serendipitously collected by non-specialists (e.g., birders, or members of the public who previously could collect legally under a Texas hunting license; see also Silvertown 2009). This has special relevance in Texas, a state in which approximately 96% of the land is held in private hands (Schmidly 2002), and often is inaccessible for scientific collection.

Although they are an improvement over shaded or county-level distribution maps, standard dot-distribution maps continue to mask the inadequacy of our actual understanding of the current geographic distribution of *Sonora semiannulata* in Texas. Although we did not test specifically the general applicability of this conclusion, we suspect and fear that it applies broadly to virtually all systematic collections, and is generalizable across the globe, and not just a deficiency of Texas collections. This is a particularly important consideration in light of extensive land-use changes in Texas and elsewhere in the last 50 years and the impacts they have on the distribution of native fauna (Schmidly 2002; Shaffer et al. 1998; Skelly et al. 2003).

An emerging reliance on museum collections for reconstruction of historical distributions of species (Elith et al. 2006; Frey 2009; O'Connell et al. 2005; Raxworthy et al. 2003) must be tempered by an understanding of the limitations and biases associated with such collections. An increased appreciation of temporal bias in collections is essential if policy and management decisions are to be based on current knowledge. Collection practices through time and across space were not and are not uniform, a point most of our students fail to grasp until they work with our data set. It is inappropriate to make assumptions of uniformity when

assessing historical records for data on past distributions of fauna or the environmental conditions under which they lived (Fagan et al. 2005), or for making predictive assessments of the likely future impacts of current policies (Pyron et al. 2008; Rodda et al. 2009). Further complications arise when species distributions are estimated from web-based biodiversity databases derived from incidental, anecdotal, or unvouchered observational data, rather than vouchered museum material. Results from extrapolations of these data can be misleading, if not spurious (Lozier et al. 2009; McKelvey et al. 2008). The recent HerpNET database (HerpNET.org) represents a collaborative effort of more than fifty institutions to provide a single portal for herpetological collection holdings, most of which are georeferenced. The existence of pooled data sources such as this now make it easier to compile and rapidly visualize temporal distribution data for many taxa (e.g., MaNIS for mammals, ORNIS for birds, FishNet for fish, OdonataCentral for odonate insects).

The value of historical collections as data sources for answering questions about past distributions and environmental or ecological conditions is well-established (e.g., Graham et al. 2004; Grinnell, 1910; Moritz et al. 2008; Myers et al. 2009; Raxworthy et al. 2008). In surveying our colleagues and students about opinions regarding the potential uses and value of voucher-based collections, we regularly encounter expectations that collections should provide baseline data to help us understand trends in taxon distributions through time, as well as alterations in population densities, demographics, and community structure, and the response of organisms to global change issues on local and wide geographic scales. We often expect collections to provide information that permits administrators to make adequate and informed management decisions, and to assess historic patterns of the emergence and significance of chemical pollutants, parasites, and other environmental factors. We also expect collections to serve as a data archive for future generations to assess similar issues about changes to fauna and flora that we are now experiencing, and to help answer questions we have not yet thought to ask. It is clear that many such popular expectations of data-yield from collections may not be attainable from existing collections, and current collecting practices are almost certainly failing the needs of our future colleagues.

With global change issues so prominently represented in the minds and daily lives of our students and ourselves, it is ironic that we are living through times in which voucher-based collections have declined. We echo the cry of the great museologist Joseph Grinnell (1915) to 'conserve the collector.' It has fallen on our generation to assume the responsibility to provide a detailed record of biotic responses to global change. But the serendipitous nature of both temporal and spatial data associated with many recent museum accessions confound modern students' understanding of museum collections and will frustrate efforts of future generations to extract meaningful patterns from those data. The general dearth of focused, systematic collection efforts (Boundy and Burbrink 1998; Hoberg et al. 2009; Shaffer et al. 1998; Winkler 1996) must be adequately addressed if we are not to be judged as having failed to meet our responsibility.

Long-term monitoring and responsible collection of voucher specimens, combined with a renewed emphasis on adequate field notes and online (and archived) databases, will help to establish a reliable data set on changing distributions of Texas fauna for future generations. Although not specifically addressed in our study, the issues we discuss for *Sonora* are likely to be exacerbated for endangered or threatened species whose conservation status may serve as an increasingly potent disincentive for voucher-based collections (Roberts and Solow 2008). Unfortunately, these are also among the species for which future generations will be most eager to find reliable data.

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On the Alleged Rediscovery of the Type Specimen of *Phrynosoma ornatum* Girard 1858

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During the preparation of a taxonomic revision of the *Phrynosoma douglasii* (Iguania: Phrynosomatidae) species complex, I had the opportunity to examine University of Michigan Museum of Zoology (UMMZ) 3849, which according to Banta (1970), is the previously missing holotype of *Phrynosoma ornatum* Girard (1858a, b). My initial review of Banta's account and conclusions led me to suspect that he was in error. A summary of the historical facts and my conclusions after further investigation of this case are presented below. Details concerning Banta's search for the missing type specimen are taken directly from Banta (1970). Museum acronyms follow Leviton et al. (1985).

Girard (1858a, b) described several species allied to *Phrynosoma douglasii*, under his subgenus *Tapaya*, including *Tapaya brevirostris*, *T. hernandesi*, and *T. ornatissima*. No descriptive account is given for *Phrynosoma ornatum*; however, in Girard's atlas (Girard 1858b: Plate 21, Figs. 1–5) this taxon is illustrated and named in the caption from material collected near Salt Lake, Utah. As explained by Stejneger (1919), Girard was uncertain about the validity of *Phrynosoma ornatum* and while his text (Girard 1858a) was in press, he decided to place the name in the synonymy of *T. douglasii*. However, Girard's decision came too late to alter the caption for the illustrations in Plate 21. Stejneger (1919) regarded the name in the caption and associated illustrations as a valid description. He expressed the opinion that *P. ornatum* was not related to *P. hernandesi*, but was sufficiently distinct from *P. douglasii* to be treated as a subspecies. He therefore revived the name and applied it to the

short-horned lizard populations in the Salt Lake Valley of Utah. Stejneger's taxonomic treatment of this form was followed by Smith (1946) and Reeve (1952).

The type specimen of *Phrynosoma ornatum* was listed by Reeve (1952:847) as unknown. Nearly a decade later, Benjamin H. Banta initiated a search to determine whether the type material was still extant. Early in his investigation, Banta reviewed the list of United States National Museum (USNM) specimens compiled by Cope (1900:414) and noticed a specimen (USNM 233) collected by Captain Stansbury near Salt Lake, Utah. Girard (1852:363) mentioned that the specimen figured in his monographic essay on *Phrynosoma* was from the Valley of the Great Salt Lake, where it had been collected by Captain Stansbury. In his later taxonomic work, Girard (1858a:398) stated under the heading *Tapaya douglassi* [sic] that "… two species may yet be confounded under this heading, one peculiar to the Northwest Coast, the other to the Great Salt Lake Basin. *The specimen figured* [emphasis added] belongs to the latter region." With this information, Banta (1970) assumed that only one specimen, namely USNM 233, had been available to Girard at the time his illustrations were prepared, and therefore USNM 233 must be the type specimen.

In an attempt to locate USNM 233, Banta wrote to Doris M. Cochran, then curator of the Division of Reptiles and Amphibians at the USNM (= National Museum of Natural History). He learned from her that USNM 233 had been sent to a museum in Chicago "in the early days." Banta reasoned that this explained why the specimen had not been listed by Cochran (1961) in the USNM type collection. Banta was already dubious that the type was in the Field Museum of Natural History (FMNH) because he had visited that institution in 1961 and had compiled substantial information on their holdings of Great Basin material. After receiving Cochran's letter, Banta wrote to W. J. Beecher, Director of the Chicago Academy of Sciences (CA), to inquire about USNM 233. Beecher had no record of the specimen and forwarded Banta's letter to Robert C. Inger at the FMNH, who only confirmed Banta's belief that the specimen was not located there. In a further effort to find the missing specimen, Banta enlarged his concept of the Chicago area to encompass the Great Lakes region, thereby including the University of Michigan as a possible repository.

In the spring of 1962, Banta received a series of specimens of *Phrynosoma douglasii* on loan from the UMMZ. Included in this shipment was UMMZ 3849 listed from Salt Lake, Utah. Upon further inquiry, Banta learned that this specimen had been received from the USNM in 1859. Banta compared UMMZ 3849 with the illustrations in Girard's atlas (Girard 1858b) and found them to be "close in many details" (Banta 1970:203). He concluded that UMMZ 3849 must be the missing type. However, there was a discrepancy concerning the collector of the specimen. According to Tappan (1861), the catalogue of the "Trowbridge collection" lists Lt. Beckwith, not Captain Stansbury as the collector of "*Tapaya brevirostris*" from Salt Lake, Utah. But, Banta dismissed this discrepancy as a typographical error.

I examined UMMZ 3849 and noted inconsistencies between it and Girard's illustrations, including the dorsal and gular pattern and arrangement of head scales. Furthermore, in my subsequent review of Girard's (1858a, b) text and figure captions, I discovered that the allusion to the use of a single specimen for the illustrations in Plate 21 was a misstatement. In fact, two specimens had been used, which constitute syntypes for the name *Phrynosoma ornatum*. An adult female is illustrated in Figs. 1–4, depicting the lateral, dorsal, and ventral views of the entire animal and a frontal view of the head, respectively. Figure 5 illustrates the thighs and postcloacal region of the male sex (Girard 1858a:399). UMMZ 3849 is an adult male and therefore could not have been used for Figs. 1–4, although it might have been used for Fig. 5. Banta, apparently failing to carefully read the figure captions in Girard's text, had been misled into thinking that only a male specimen had been available to Girard for the preparation of his illustrations. Furthermore, UMMZ 3849 could not have been used to prepare the illustration of the postcloacal region in Girard's (1858b) atlas (Plate 21, Fig. 5). Figure 5 shows a unique arrangement of enlarged scales, and a comparison of the specimen with the illustration reveals notable differences (Fig. 1). Hence it was not the specimen used for Girard's illustration.

In an effort to identify the male syntype, I next examined other USNM specimens collected from the Salt Lake Valley of Utah. Cope (1900:414) also lists USNM 234 (three specimens) secured by J. Bowman in the Salt Lake Valley. Two of these specimens have been renumbered as USNM 293246–47. Because of the fragile condition of all three specimens, they could not be shipped, but I was able to examine photographs. The two renumbered specimens are small subadults, and do not resemble the female specimen illustrated in Figs. 1–4. However, the specimen retaining the original number (USNM 234) is an adult female that is remarkably similar to the specimen in Figs. 1–4 of Girard's (1858b) Plate 21. The dorsal integument of the specimen, however, is displaced posteriorly and to the anatomical left, with abrasion resulting in some loss of pattern. Nevertheless, the dorsal pattern is similar to Girard's illustration in terms of the number, relative positions, and shapes of the dorsal spots (Fig. 2A). The specimen also has remnants of dark suffusion in the gular region as seen in Girard's (1858b) figure of the ventral aspect (Fig. 2B). There is also a unique arrangement of scales in the frontal area of USNM 234, similar to that seen in Girard's (1858b) illustration of the dorsal view. There are two enlarged frontals diverging slightly from one another. Posteriorly, there are two smaller scales in contact with the paired frontals, followed by three contacting scales (Fig. 2C). The scales in other areas of the head of USNM 234 differ from the illustration. This could be attributed to artistic license because the figure is that of the entire animal, not of the head alone. In support of this notion, other areas of this illustration appear to be stylized. Taking these considerations into account, USNM 234 could be the female specimen used in the preparation of Figs. 1–4 in Plate 21 of Girard's (1858b) atlas.

If USNM 234 is not the specimen figured in Girard's atlas, then it is possible that a specimen from a series collected by Lt. Beckwith (USNM 229–32) was used for the illustrations. This series of six specimens, two pairs each sharing the same number (see Cope 1900:414), was collected from the "Utah Basin" (an alternative early name for the Great Salt Lake Valley; see Stejneger 1919). According to Kenneth Tighe, the specimens are now lost and the lack of species cards indicates that they were not in the USNM collections when the card files were created in the early 20th century. The specimens may have been on loan to E. D.

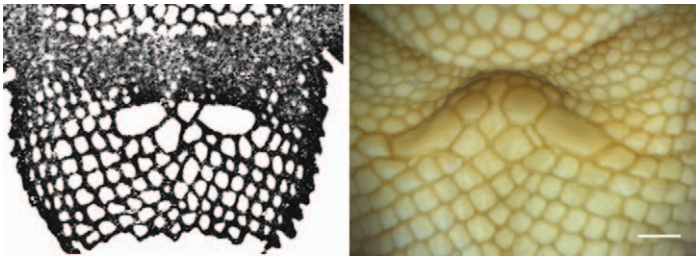


FIG. 1. Differences between the arrangement of postcloacal scales of UMMZ 3849 (right) and Girard's (1858b, Fig. 5, Plate 21) illustration of the male syntype of *Phrynosoma ornatum* (left). Bar = 1 mm.

Cope and part of the material presumed to have been lost after his death in 1897.

Banta (1970) argued that UMMZ 3849 had not only been used for the illustrations in Girard's (1858) work, but also for the figures in his earlier monographic essay (Girard 1852). As mentioned previously, the specimen depicted in Girard (1852; Figs. 6–10) with the caption "*Phrynosoma douglassii*" [sic], was obtained by Captain Stansbury in the Great Salt Lake region (Girard 1852:363). There is no doubt that the illustrated specimen is USNM 233 (presumably a male, as Girard mentioned the conspicuous femoral pores); no other USNM specimen of this taxon from the Salt Lake region was associated with Stansbury's name (see Cope 1900:414; Smithsonian collection database). But all evidence indicates that UMMZ 3849 is not USNM 233, and hence is not the specimen figured in Girard (1852). UMMZ 3849 differs notably from the illustrated specimen in general hue, dorsal pattern, degree of spinosity, and in total length: UMMZ 3849 is ~99 mm; Girard (1852) stated 3.5 inches (~87.5 mm) for the figured specimen. Moreover, the Michigan catalog entry for UMMZ 3849 indicates that its original number was USNM 207, not USNM 233. A check of the ledger records at USNM also confirmed that UMMZ 3849 was originally USNM 207 (one of three specimens, two apparently lost), collected by Lt. E. G. Beckwith. It is unclear whether Banta attempted to retrieve this information from these institutions.

The postcloacal area of USNM 233 is depicted in Fig. 10 of Girard (1852), but as rendered, the enlarged postcloacal scales are obscured. Hence, a comparison with Fig. 5 in Plate 21 of Girard's (1858b) atlas is inconclusive. There are differences in other details, which suggest that the two illustrations were based on different specimens (see Banta 1970, Fig. 4), but the differences can also be attributed to artistic style. Therefore, the question as to whether USNM 233 was the male syntype of *P. ornatum* remains unanswered.

I examined a copy of the original ledger with the entry for USNM 233, which shows the notation "1 Chicago," and hence confirms the information Cochran had sent to Banta. However, in response to my inquiry about this specimen, the personnel at the FMNH and at CA (which also includes the collections from Northwestern University) were again unable to locate or find any record of USNM 233. There is reason to believe this specimen was sent to CA. Robert Kennicott, a protégé of USNM's Spencer Baird, helped establish the CA and build its natural history collections from 1857 to 1864 (Vasile 1994). A number of specimen exchanges between the USNM and CA occurred before the 1870s (S. Gotte, pers. comm.). Hence, it is likely that USNM

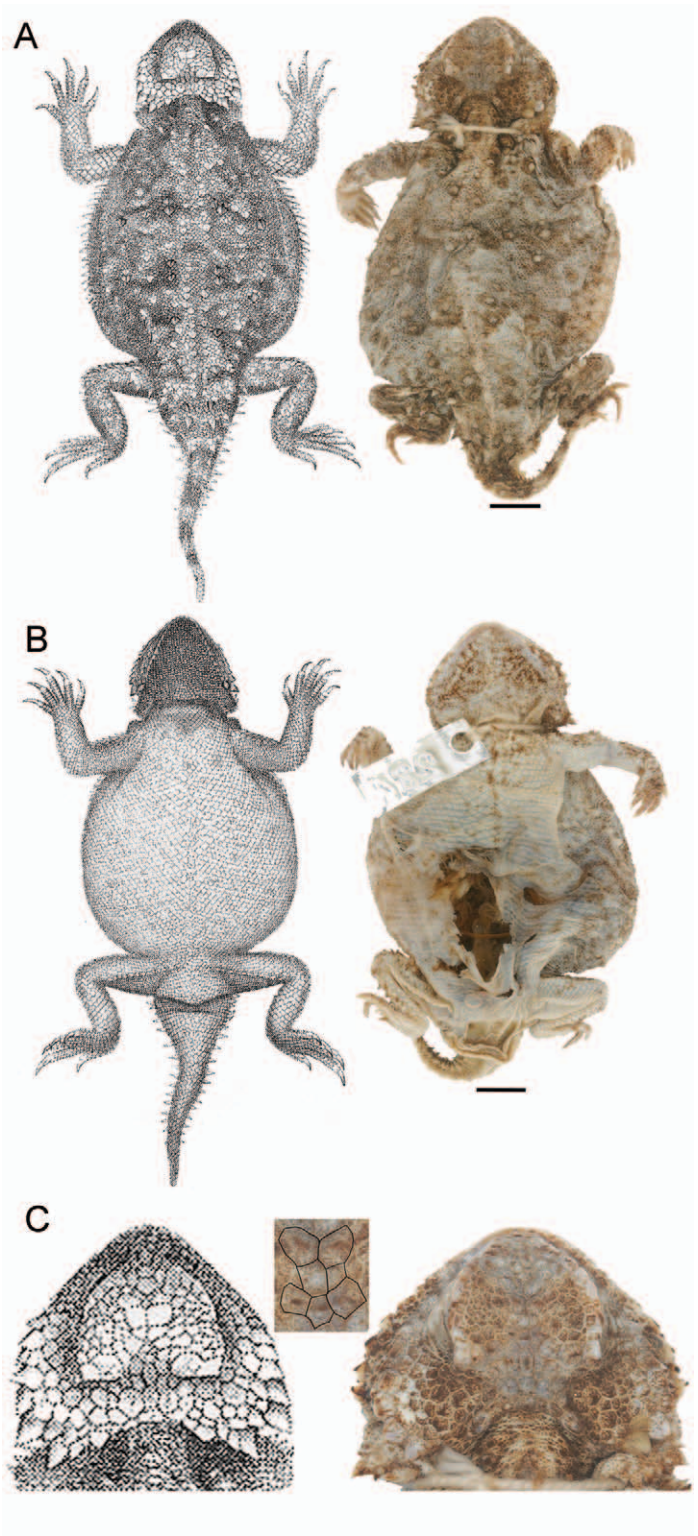


FIG. 2. Comparisons between USNM 234 and Girard's (1858b, Plate 21) illustrations from his atlas. A, dorsal view; B, ventral view; and C, detailed comparison of the head with enlarged scales outlined (see text). Bar = 1 cm.

233 was lost in the Great Chicago Fire of 1871. Although Cope (1900:414) listed the specimen as in the USNM collection for the year ending 30 June 1898, this could be an error as many other errors have been detected in that publication (S. Gotte, pers. comm.).

I also searched in the Academy of Natural Sciences of Philadelphia (ANSP) for the missing type material of *Phrynosoma ornatum*. I examined a series of nine adult specimens (ANSP 8724, 8727–28, 8731–32, 8736–38, 8740), all lacking collector or locality data, and compared them with Girard's (1858b) illustrations (Figs. 1–5 of Plate 21). However, none of the specimens shows any resemblance to the illustrated syntypes or to USNM 233 depicted in Figs. 6–10 of Girard (1852).

In summary, the illustrations of *Phrynosoma ornatum* in Plate 21 of Girard's (1858b) atlas are based on two syntypes, female and male, not on a single male holotype as Banta (1970) believed. USNM 234, which is extant but in poor condition, bears resemblance to the specimen in Figs. 1–4 in Girard's atlas, and may be the female syntype. UMMZ 3849 was originally USNM 207, not USNM 233 as Banta (1970) had argued. A comparison of UMMZ 3849 with Fig. 5 in Plate 21 of Girard's (1858b) atlas reveals that the former was not used to illustrate the male postcloacal region, and hence it is not the male syntype. Also, USNM 233, which is missing and presumed lost or destroyed, was not likely the male syntype. However, information from the original ledger indicates that USNM 233 was the only short-horned lizard specimen from the Salt Lake area associated with Captain Stansbury, and hence it undoubtedly was the specimen used for Figs. 6–10, captioned as "*Phrynosoma douglassii*" [sic] in Girard (1852).

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TECHNIQUES

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Measurement Error in Image Analysis of Fluctuating Asymmetry

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Morphometrics is defined as the numerical description of form (Lestrel 2000) and is a field that intersects a number of other biological disciplines ranging from the medical sciences (e.g., Gil et al. 2002) to genetics (e.g., Iriarte et al. 2003) to conservation biology (e.g., Clarke 1995). Because of the wide-ranging applications of morphometrics, the representation and assessment of measurement error (ME) is crucial (Yezerinac et al. 1992). Generally, ME is of greatest concern when trying to measure very small features or trying to detect very small differences among traits or individuals, such as fluctuating asymmetry.

Fluctuating asymmetry (FA) is a measure of developmental stability, the ability of organisms to buffer stresses during development. FA examines the frequencies within a population of normally distributed minor deviations from perfect bilateral symmetry (Hoffman and Woods 2001; Møller and Swaddle 1997; Palmer 1994). ME is of particular concern in FA analyses, because high ME causes an increase in variance without altering the mean (Palmer and Strobeck 1986). Thus, high ME inflates FA and masks differences in FA among populations by increasing variance (Björklund and Merilä 1997; Palmer 1994; Van Dongen 1999). Additionally, the subtle nature of FA can cause ME to be on the same magnitude or greater than that of FA (Palmer and Strobeck 1986), making it very important to accurately account for all possible types of ME.

One method to minimize ME in FA and other morphometric studies has been to use image analysis, where photographs are taken of each individual and software is used to make the actual measurements (Iriarte et al. 2003; Kokko et al. 1996; LeClerc et al. 2005). While some researchers find this to be an undesirable method (Hayek et al. 2001), image analysis is an important tool for measuring animals that are small or difficult to handle, situations where ME may frequently be larger than FA. While Palmer (1994) warns of pixellation error, the increased availability of digital cameras taking high-resolution pictures has reduced this problem. Nonetheless, few attempts have been made to establish a protocol for image analysis of FA.

One strategy for assessing ME in image analysis is to take one photograph per individual and measure each photograph three times (e.g., Gallant and Teather 2001; Trotta et al. 2005). This assumes that the ME only consists of error from the image analysis. In capturing a digital image, a three-dimensional animal is transformed into two dimensions. Slightly different three-dimensional positions may alter the two dimensional representation, causing the length of a trait on the photograph to inaccurately represent the three-dimensional trait. Thus, it is possible that error is obtained during positioning (McCoy and Harris 2003), as well as during image analysis. In this study, we compared ME from measuring one photograph three times (image analysis ME) to ME from measuring three pictures, and thus three positions, once each (overall ME or the combination of positioning error and image analysis ME).

Materials and methods.—Thirty-one Spring Peeper (*Pseudacris crucifer*) tadpoles and 31 metamorph Fowler's Toads (*Bufo fowleri*) were collected from Hancock Biological Station in Calloway County, Kentucky, USA in Spring 2005. Individuals were photographed using a Pixera model PVC 100C digital camera through a Wild microscope at 40x magnification. All individuals were photographed while alive and were returned unharmed to the site of their collection. Tadpoles were conscious during image capture but tended to remain still after positioning. Metamorph toads lacked this tendency and were anesthetized using a dab of a 2.5% lidocaine solution on the head. Photographs were taken in replicates of three and each individual was repositioned for each photograph. Positioning was limited to a few minutes for each photograph to minimize stress on the animals. Each replicate consisted of one photograph for the tadpoles and two photographs per replicate for the toads: one of the body and one of the legs. All photographs were taken with 1280 x 1024 pixels.

Photographs were measured in pixels using the software ImageJ (NIH 2006). The right and left sides were measured for all traits. Two traits were measured on tadpoles: eye width and the distance from the eye to the nare. Eight traits were measured on toad metamorphs: eye width, the distance from eye to nare, humeral length, radio-ulnal length, the distance from the humerus to the femur, femoral length, tibio-fibulal length, and calcaneum length. For each individual, the first photograph taken was measured three times, and the second and third photographs were measured once each. One data set was created from the first photograph measured three times for determining image analysis ME. The second data set was created from the first measurement of the first photograph and the measurements from the second and third photograph determining overall ME. A two-way mixed model ANOVA was performed on each data set for each trait using individual as a random effect and side (left or right) as a fixed effect, a standard method for determining whether ME is lower than FA (Palmer 1994). The significance of this interaction indicated that the between sides variation among individuals was greater than the ME and, thus, could be reliably analyzed for FA assuming it met all other assumptions (Merilä and Björklund 1995; Palmer and Strobeck 1986). This analysis was used as qualitative assessment of ME, mimicking the procedures used in routine FA analyses. In order to maintain appropriate alpha values, Bonferroni corrections were used (Hochberg 1988).

To directly compare image analysis ME and overall ME, the coefficient of variation was used as an estimate of ME. Because the true value of the trait length is not known, accuracy cannot be assessed. The coefficient of variation thus provides a measure of precision. The coefficient of variation was calculated for each side (right or left) of every trait for each individual for the image analysis ME data set and the overall ME data set. MANOVAs with all traits were used to determine whether image analysis ME and overall ME were significantly different for each of the tadpole and metamorph toad data (Bernal and Clavijo 2009) using Pillai's trace statistic (Zar 1999). Univariate ANOVAs with Bonferonni corrections were performed to determine which traits showed significant differences (Tabachnick and Fidell 2007). Statistics were performed using PC SAS (SAS 2004).

Results.—For the qualitative assessment of ME, all tests for image analysis ME were highly significant, indicating that ME was lower than FA (all $F30,_{124} \geq 2.426$, all $P < 0.001$; Table 1). Eye width in tadpoles and eye width, the distance from eye to nare, humeral length, tibio–fibulal length, and calcaneum length in metamorph toads had low overall ME compared to FA (all $F30,_{124} \geq 1.869$, all $P < 0.01$; Table 1), while the distance from eye to nare in tadpoles and radio-ulnal length, distance from humerus to femur, and femoral length in metamorph toad had overall ME greater or of the same magnitude as FA (all $F30,_{124} \leq 1.52$, all $P \geq 0.06$; Table 1).

For the direct comparison of image analysis ME and overall ME, the average coefficient of variation for overall ME was always greater than the image analysis ME (Fig. 1 and 2), although this difference was very small for some traits. In tadpoles, there was no significant difference between image analysis ME and overall ME ($F4,_{57} = 1.30$, $P = 0.28$; Fig. 1). In metamorph toads, image analysis ME and overall ME were significantly different overall ($F16,_{45} = 8.18$, $P < 0.0001$), and these differences varied by trait (Fig. 2).

Discussion—Image analysis ME was consistently lower than overall measurement error, although the magnitude of this difference varied by trait. This shows high accuracy in the use of software to measure traits. The F-statistics were higher for overall ME than for image analysis in all traits, indicating some positioning error in all traits. The difference was large in some traits, resulting in high overall ME, which indicates that positioning error is a problem in those traits.

Some traits may be more prone to high positioning error than others. Most of the traits that consistently had elevated positioning error occurred on the limbs or were associated with them: humeral length, distance from humerus to femur, femoral length, tibio–fibulal length, and calcaneum. In animals with

TABLE 1. Results of the interactions from the two-way, mixed-model ANOVAs to assess measurement error. All F-tests had 30 and 124 degrees of freedom. P-values are Bonferroni corrected.

	Image Analysis ME			Overall ME		
	MS	F	p-value	MS	F	p-value
Tadpoles						
Eye Width	10.57	2.43	< 0.001	9.95	1.87	0.02
Eye to Nare	167.21	2.91	< 0.001	78.49	1.12	0.56
Toads						
Eye Width	257.25	4.11	< 0.001	220.64	3.47	<0.001
Eye to Nare	100.13	5.66	< 0.001	125.39	3.27	<0.001
Humerus	849.58	10.65	< 0.001	619.38	4.69	<0.001
Radio-ulna	441.30	4.52	< 0.001	254.78	1.52	0.12
Humerus to Femur	906.34	18.45	< 0.001	984.11	1.36	0.23
Femur	1774.44	22.89	< 0.001	1356.81	1.25	0.39
Tibio-fibula	412.40	17.88	< 0.001	378.11	2.63	<0.001
Calcaneum	169.63	14.20	< 0.001	182.27	3.23	<0.001

appendages, it is generally the limbs that are adjusted the most during positioning, and thus traits associated with the limbs would have a high potential for positioning error. Similarly, any other traits that are adjusted to a great extent during positioning, such as gills, cerci, or flexible mouth appendages, are likely to have higher positioning error than traits fixed on the body.

The occurrence of high positioning error in this study may also be related to the amount of time spent positioning each individual. Only a few minutes were spent during each positioning event. It may be possible to spend extended periods of time positioning each individual in order lower positioning error. However, this may only be possible in dead or preserved specimens (McCoy and Harris 2003; Vershinin et al. 2007), and, if FA is to be useful for studies of declining and endangered species or for monitoring programs, it would be inappropriate to sacrifice large samples of individuals (McCoy and Harris 2003). In these cases, it is important to minimize positioning time and overall ME simultaneously.

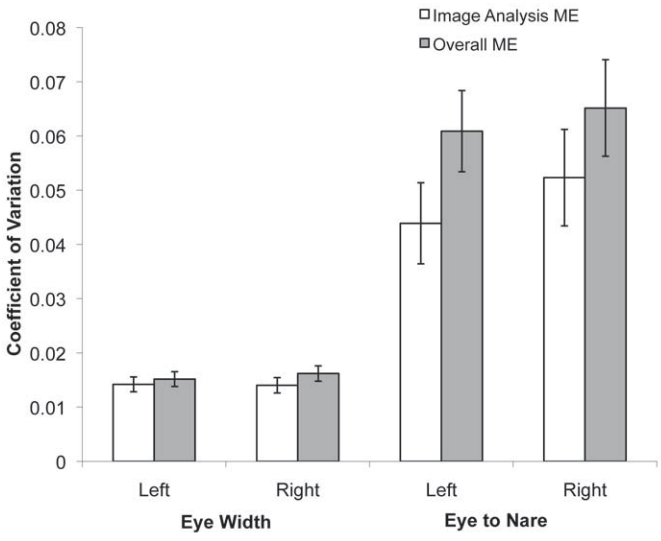


FIG. 1. Coefficient of variation for tadpole traits estimated from one photograph measured three times (image analysis ME) and three photographs measured once each (overall ME). Error bars represent standard error.

The occurrence of traits with low image analysis ME but high overall ME supports the hypothesis that determining ME using only one photograph, and thus only one positioning event, can lower the detected ME without lowering the actual ME. This could potentially lead to the assumption that ME is low enough to perform FA analyses, when it is not. High levels of ME may bias FA through inflation of the differences between sides (Palmer 1994; Van Dongen 1999), and thus, it is important to accurately detect the presence of ME in all forms, whether from image analysis or positioning error.

We recommend that, in all FA analyses utilizing photographs, two or more pictures be taken in which the individual is repositioned each time, reducing the chance that ME is artificially reduced and increasing the efficacy of FA analyses. Taking additional photographs has time costs and could cause additional stress on animals photographed while conscious. However, due to the possibility of failing to accurately detect ME, using only one photograph could jeopardize the integrity of FA analyses. In analyses with large sample sizes, it may be suitable to test a sub-sample of at least 30 individuals for overall ME with multiple photographs, just as Palmer (1994) recommends for the assessment of ME when samples are large or when replicate measurements are difficult to obtain. This sub-sample may be useful to assess both overall ME and image analysis ME to determine where improvements could be made in minimizing ME and which traits have consistently low positioning error.

Additionally, some studies have shown ME to vary among treatments (McCoy and Harris 2003), observers (Yezerinac et al. 1992), and measurement sessions (David et al. 1999). These factors should be investigated for image analysis ME and positioning error to better understand overall ME and to increase accuracy in FA analyses. Similar factors are also important in other types of morphometric studies. Further research on positioning error is also recommended for other areas of morphometrics that

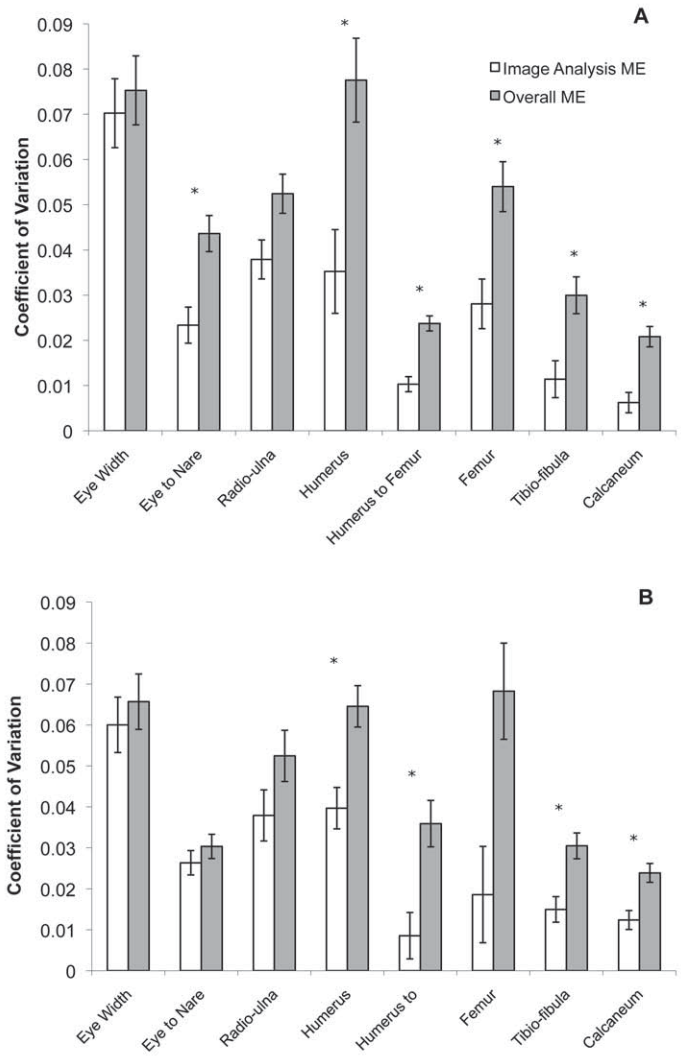


FIG. 2. Coefficient of variation for metamorph toad traits estimated from one photograph measured three times (image analysis ME) and three photographs measured once each (overall ME) for the left (A) and right (B) sides. Asterisks indicate significant differences at a Bonferroni corrected alpha. Error bars represent standard error.

currently utilize image analysis.

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A Method for Attaching Tracking Devices to Crocodilians

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Electronic tracking devices (VHF, satellite, GPS, etc.) are the most direct and accurate method of quantifying individual movement patterns in crocodilians (Franklin et al. 2009). The manner of attachment includes: neck collars (Joanen and McNease 1970; Taylor 1984), back harnesses (Kushlan and Mazzotti 1989), surgical implantation (Franklin et al. 2009; Hocutt et al. 1992; Magnusson and Lima 1991), ingestion (Magnusson and Lima 1991), and direct attachment to either the head, neck or tail using pins, wires or nylon line, usually inserted through holes drilled in the keeled scutes or osteoderms (Brien et al. 2008; Franklin et al. 2009; Kay 2004; Martin and da Silva 1998; Muñoz and Thorbjarnarson 2000; Read et al. 2007; Seebacher et al. 2005; Strauss et al. 2008; Webb and Messel 1978a). However, protocols for attachment often lack important details (Strauss et al. 2008), and due to difficulties with recapture, it is usually assumed rather than demonstrated that animal and tissue health at the attachment site has not been unduly compromised.

In crocodilian species and/or size classes where the nuchal rosette comprises robust, strongly keeled osteoderms (e.g., *Crocodylus porosus* > 2.5 m total length [TL]), the rosette provides a convenient point of attachment on the mid-dorsal surface of the neck, which appears to give good signal attenuation (Franklin et al. 2009; Kay 2004). Transmitters can be bedded between the keels and attached with wires laced through holes drilled through the bony keels, but this method is dependent upon the presence of well-developed keels (Franklin et al. 2009; Kay 2004). The method described here was used with large *C. porosus*, and allows transmitters to be mounted on the mid-dorsal neck and secured with wire running under the length of the nuchal rosette, without collars and without needing strong keels for attachment. It should thus be suitable for all species and size classes of crocodilians with or without strong keels. The method involves four stages: (a) positioning subcutaneous stainless steel wires under the rosette; (b) making a transmitter mounting platform that is a mold of the central length of the rosette; (c) locking the transmitter to the platform with the wires; and (d) using additional molding material to extend and shape the platform so that it forms a complete mold of the rosette on the ventral side, and a dome on the dorsal side that encases and protects the transmitter. Based on recaptures, the attachment method is considered benign with regard to animal health.

Materials and methods.—Thirty satellite transmitters were attached to 29 Saltwater Crocodiles, *Crocodylus porosus* (total lengths [TL] 250–452 cm) captured in the Northern Territory of Australia (Kakadu National Park [N = 20], Mary River [N = 6], Blyth River [N = 2], Adelaide River [N = 1]) between September 2005 and September 2008 (Table 1), and their movements monitored weekly for the duration of transmission life. Four individuals were recaptured between 383 and 1049 days after the transmitter was first attached.

Adult male *C. porosus* (> 3.1 m TL, Webb et al. 1978) were the target group (N = 26, mean = 381 ± 7.1 cm TL), but one smaller male (250 cm TL) and two females (301 cm and 313 cm TL) with reduced keel size were included. Crocodiles were mostly caught by harpoon at night (N = 15) or with baited cage traps (N = 14) (Walsh 1987; Webb and Messel 1977), and one individual (61687, 312 cm TL) was caught in a drying pond. Crocodiles were caught in or adjacent to tidal saline (N = 20, saline) and non-tidal freshwater wetlands (N = 10), and were released at the site of capture (N = 19, 63.3%) or relocated (N = 11, 36.7%) as part of a relocation experiment (Table 1). All were individually numbered by scute clipping (Richardson et al. 2002).

Three types of satellite transmitter were trialed in this study (Sirtrack: Lower Hut, New Zealand), with general specifications from Read et al. (2007). The following transmitters were used: the KiwiSat 101 platform terminal transmitter (PTT; both satellite and VHF capability, 12 cm x 3.2 cm x 2.4 cm high, 300 g, N = 10); KiwiSat 101 PTT (satellite only, 9.3 cm x 4.3 cm x 3.4 cm high, 170 g, N = 16); and the smaller KiwiSat 202 PTT (satellite only, 8.5 cm x 3.2 cm x 2.0 cm high, 100 g, N = 4). All transmitters had 1 or 2 flexible aerials (approx. 20 cm long), stainless steel attachment loops (5 mm diameter, 2–3 on each side) on the transmitter base, and a salt switch which disabled transmissions when the transmitter was under water in saline areas (Fig 1). Five transmitters had an additional haul-out switch designed to turn the transmitter off if a crocodile was either in fresh water or on land for more than a few hours (Table 1).

After capture, each crocodile was immobilized with an intramuscular injection of pancuronium bromide (Astra Zeneca: North Ryde, New South Wales, dosage rates described in Bates 2001). The nuchal rosette area was disinfected with Betadine and injected with a local anaesthetic, Xylocaine (Astra Zeneca: North Ryde, New South Wales). Two stainless steel needles (230 mm by 3 mm diameter) were forced through the skin on the posterior side of the rosette, and with the aid of pliers, run subcutaneously under the osteoderms of the rosette to the anterior side. The two needles were then drawn through carrying two strands of stainless steel wire (breaking strain 41–68 kg) that had been soaked in 100% ethanol. There were thus two sets of two stainless steel wires (each approx. 50 cm in length) protruding through the skin at the

TABLE 1. Attachment details and performance of 30 satellite transmitters attached to 29 *Crocodylus porosus* (27 male, 2 females*) captured in the Northern Territory of Australia, between September 2005 and September 2008. One crocodile (61688^) was recaptured after 1049 days and attached with a new transmitter (34011^). First five transmitters contained haul-out switches. Transmitters 34008, 34010 and 34011 were still active at the time of writing (13 May 2009).

Crocodile Transmitter #	Total Length (m)	River system capture location	Relocated (Yes/No)	Release site habitat	Attachment date	Longevity (days)	Satellite transmitter model (KiwiSat)
60683	3.67	Mary	N	Tidal	12-Sep-05	164	101 (includes VHF)
60682	3.85	Mary	Y	Tidal	12-Sep-05	388	101 (includes VHF)
60684	3.99	Mary	N	Tidal	13-Sep-05	76	101 (includes VHF)
60689	4.38	South Alligator, Kakadu	N	Non-tidal	14-Sep-05	0	101 (includes VHF)
60690	3.55	South Alligator, Kakadu	N	Tidal	16-Sep-05	308	101 (includes VHF)
61682*	3.13	South Alligator, Kakadu	N	Non-tidal	04-Oct-05	279	101
61685	4.52	South Alligator, Kakadu	N	Non-tidal	04-Oct-05	1162	101
61681	3.82	South Alligator, Kakadu	N	Non-tidal	06-Oct-05	883	101
61684	4.11	South Alligator, Kakadu	N	Non-tidal	07-Oct-05	1169	101
60687	3.87	South Alligator, Kakadu	N	Non-tidal	24-Oct-05	744	101 (includes VHF)
61687	3.12	South Alligator, Kakadu	Y	Tidal	26-Oct-05	660	101
60685	3.98	Mary	Y	Tidal	02-Nov-05	49	101 (includes VHF)
61679	3.67	Mary	Y	Tidal	02-Nov-05	384	101
60686	3.81	Blyth	Y	Tidal	05-Nov-05	464	101 (includes VHF)
61678	3.03	Blyth	Y	Tidal	05-Nov-05	772	101
60688	3.94	South Alligator, Kakadu	N	Non-tidal	11-Nov-05	60	101 (includes VHF)
61688^	4.21	Mary, Kakadu	N	Non-tidal	14-Nov-05	368	101
61683	2.50	South Alligator, Kakadu	N	Non-tidal	22-Nov-05	1209	101
61686	3.71	South Alligator, Kakadu	N	Tidal	08-Dec-05	1172	101
60681	4.00	South Alligator, Kakadu	N	Tidal	07-Feb-06	4	101 (includes VHF)
68553*	3.01	Adelaide	N	Tidal	27-Jul-06	819	101
61680	3.80	East Alligator, Kakadu	Y	Tidal	14-Oct-06	16	101
68551	4.02	Mary	Y	Tidal	26-Oct-06	244	101
68550	3.33	Kapalga Causeway, Kakadu	Y	Tidal	01-Feb-07	240	101
68548	3.75	Kapalga Causeway, Kakadu	Y	Tidal	01-Feb-07	660	101
68549	3.21	King River, Kakadu	Y	Tidal	04-Aug-07	268	101
34008	3.57	Magela Ck, Kakadu	N	Tidal	03-Apr-08	404	202
34009	4.00	East Alligator, Kakadu	N	Tidal	06-May-08	328	202
34010	4.23	East Alligator, Kakadu	N	Tidal	16-May-08	360	202
34011^	4.23	Mary, Kakadu	N	Non-tidal	29-Sep-08	224	202



FIG. 1. Four strands of stainless steel wire threaded subcutaneously under the nuchal rosette of a 4.21 m TL Estuarine Crocodile (*Crocodylus porosus*) used to anchor the transmitter in place. KiwiSat 202 Platform Terminal Transmitter (PTT) placed in the middle of the four nuchal scutes with attachment loops angled outward and antennae pointed towards tail. Photo by G. Lindner.

anterior and posterior ends of the rosette (Fig 1).

The mold was constructed in two parts. First, a bed of marine epoxy ("Selleys Knead-it Aqua" with limited exothermic reaction) the width of the transmitter was made along the top of the rosette. The transmitter was positioned on this bed with the aerial/s posterior. Each of the subcutaneous wires was then threaded back through the attachment loops on both sides of the transmitter, tightened and crimped with aluminum or lead sleeves that locked the anterior and posterior wires together. Additional epoxy was then used to complete the mold of the rosette, maximizing the surface area of contact between the rosette and the mold, with the upper surface shaped into a dome encasing the transmitter (Fig. 2). Two openings were left in the mold to ensure the two terminals of the salt switch were exposed. In most cases the mold was sprayed with black paint after the epoxy had hardened and prior to release of the crocodile.

The mass (in air) of the transmitter plus mold was: KiwiSat 101 PTT unit (satellite and VHF) 500–520 g; KiwiSat 101 PTT (satellite only) 350–370 g; and KiwiSat 202 PTT (satellite only) 220–250 g. Given the smallest crocodile in this study was 250 cm TL (approximately 52 kg, Webb and Messel 1978b) and the largest was 451 cm TL (approximately 355 kg, Webb and Messel 1978b), transmitter units were 0.1 to 0.7% of body mass, and thus well within recommended limits of 3–5% of body mass (Kenward 2001). The time required to fit a transmitter declined from 45 to 30 minutes with experience.

Results.—The overall mean transmission life was estimated at 463 ± 69 days (N = 30, range 0–1209 days, Table 1), with 67.8% (N = 18) lasting more than 308 days and 14.3% (N = 4) exceeding 1162 days. As the actual time a transmitter remains attached to a crocodile is difficult to determine due to difficulties in recapturing individuals, transmission life was used as a minimum index of attachment life, as a transmitter with an expired battery can remain attached. Transmission life did not differ significantly ($t = 1.09$, df = 28, $P > 0.284$) between relocated crocodiles (376.82 ± 247.02 days) and those released at the site of capture (512.26 ± 432.38 days). Three transmitters ceased transmitting within 16 days, one of which failed because it had a salt and haul-out switch that interacted technically to switch the transmitter off permanently in fresh water. The failure of the other two transmitters could have been due to the haul-out switch turning off the transmitter if the crocodiles entered fresh water and did not return to salt water, which would be required to re-activate the transmitter.

Of the remaining 27, a further three stopped transmitting between 49 and 76 days, one of which also had the salt switch and haul-out switch anomaly. It indicates a maximum failure rate of 20%, two of which were due to electronic failure. As a detached transmitter will not transmit under water, attachment failure could be responsible for the other four transmitters (13.3%), although it could equally be due to interference with transmissions when crocodiles moved into heavily vegetated swamps under a closed tree canopy.

One crocodile was recaptured after 1049 days with the transmitter missing (368 days of transmission). There was no sign of necrosis, subcutaneous wires, or any damage to the nuchal rosette. It appeared that the subcutaneous wires had pulled through when the transmitter and mold detached, which likely resulted due to failure of the crimped sleeves. The crocodile appeared healthy (large fat deposits in neck and base of tail), and fresh injuries noted when it was originally caught had healed. It was refitted with a new transmitter (34011) that was still transmitting after 224 days (13 April 2009).

Three *C. porosus* were recaptured with transmitters still attached after 383 days (60687, re-caught 11 November 2006), 424 days (60689, re-caught 12 November 2006), and 951 days (61683, re-caught 30 June 2008). When the transmitters were removed, there was no sign of infection, tissue necrosis or damage to the skin or tissues of the rosette. One of these individuals (61683, 951 days) had grown 60.5 cm TL between captures, with the nuchal plate growing out and around the site where the wires entered the skin. This crocodile was the smallest (250 cm TL) in the study and was released *in situ* with transmitter still attached. Of the remaining



FIG. 2. Satellite transmitter attached to the nuchal rosette of a 4.23-m TL Estuarine Crocodile (*Crocodylus porosus*). Stainless steel wires threaded beneath the nuchal rosette were used to anchor the transmitter in place and marine epoxy was moulded to the crocodile to secure the entire unit in place. Photo by G. Lindner.

two, the mold was undamaged in one (383 days), but broken away on the edges in the other (424 days). In the latter case salt had been mixed with the epoxy on the untested assumption that it would counter the haul out switch at the time of mounting; it may well have weakened the epoxy material. In none of the recovered transmitters were there any teeth marks or damage consistent with attacks on the neck region by conspecifics.

Discussion.—Our study reaffirms that the nuchal rosette is a good site for attaching transmitters to crocodilians, and that use of a mold held in place with subcutaneous wires is an effective method of attachment, with apparently limited adverse effects on the animals, that is well suited to long-term movement studies. In cases where young animals may be growing rapidly, and transmissions are only required for a short period of time, it would be possible to use some form of temporary erodible pin to release one end of the transmitter after a known time (Goodyear 1993) so that it can pull the wires through the skin. In terms of physical dimensions, the height of the mold on the neck is set by the height of the transmitter being attached, and thus it would appear that the lower the profile of the transmitters, the shorter the mold dome on the top of the neck. In our study, the height and robustness of the keels of individual crocodiles was largely irrelevant to the attachment process, making us confident that it can be used with crocodilian species that are not strongly keeled. Indeed, the whole concept of mounting an object on the rosette, using a mold with subcutaneous wires, was pioneered by the authors (GW, CM, DO) in conjunction with Cooper-Preston (1991), when she successfully mounted visual numbered tags on *C. johnstoni* (1.3–1.8 m long; N = 18), which have limited keeling. Recaptures < 2 years later had indicated no ill effects and several individuals were observed with numbered ID tags after 4 years (Cooper-Preston, pers. comm.). We are confident the method can be adapted for attaching electronic devices (VHF, GPS, satellite) to all crocodilians, given that the size of devices is appropriately scaled to animal size.

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Use of Remote Laser Sensing Equipment to Measure Surface Temperature and to Predict Deep Body Temperatures of Small Lizards in the Field

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Many lizards maintain their body temperature within narrow limits by adjusting to variations in their thermal environment (Adolph 1990; Angilletta 2001; Huey 1982). Critical body functions and behaviors, including active digestion, reproduction, and predator avoidance are closely coupled with the maintenance of suitable body temperature (Cowles and Bogert 1944). Thus, the ability to measure the deep body temperature of lizards is central to studying their physiology and behavior. When studying behavior, non-invasive methods are better than the traditional "noose and goose" technique. This is because they cause less disruption to the animal's natural behavioral patterns and less stress due to insertion of the thermometer bulb into the cloaca.

Hand-held laser guns or infrared thermometers (IRTs) are available to measure surface temperatures. They can be used to measure skin surface temperature of an animal, such as a lizard or frog, in order to estimate deep body temperature (Alberts and Grant 1997; Hare et al. 2007a, b; Rowley and Alford 2007). However, there are at least four difficulties likely to be encountered utilizing this device to indirectly monitor deep body temperature. 1) It may be difficult to approach an animal close enough to utilize the minimum-sized sensory field of the instrument without the animal fleeing (Hare et al. 2007a).With the device used by us the minimum-sized sensory field is a circle or ellipse with a minimum diameter of 21 mm with the device aimed from 0 to 250 mm from the object. 2) Even if close approach is possible, the minimum sensing field may still exceed the surface area of a small lizard to be monitored. This would result in inclusion of nearby objects in the field and composite temperature readings. 3) There may be insufficient clearance from objects such as leaves or blades of grass that may be blocking the path of the laser beam to measure temperature accurately. 4) The surface temperature of the animal may differ from deep-body temperature. Thus, some compensatory adjustment or correction would be required in order to estimate deep body temperature (Alberts and Grant 1997; Hare et al. 2007a, b; Rowley and Alford 2007).

In this study, we tested the feasibility of predicting the deep body temperature of a small (3–5 g), active, diurnal lizard in the field by measuring dorsal temperature with an IRT. To minimize the problem of habitat within the sensory field of the IRT contributing to the temperature reading, we captured the lizard with a noose and suspended it so that there was no background interference. To overcome the problem of the difference between surface and deep-body temperature, we constructed simple regression models relating these two temperature variables for four small lizard species in various habitats. Our study extends knowledge of the use of these devices from previous research (Alberts and Grant 1997; Hare et al. 2007a, b; Rowley and Alford 2007) by focusing on several different species of small elongate lepidosaurs while they are above ground and active in the field (Hare et al. 2007a, b). Also, we attempted to overcome the problem caused by confounding temperature of habitat in a unique way.

Materials and methods.—Data were collected during May and June, 2005. The four lizard species studied were *Uta stansburiana* (Monahans Sandhills State Park, Ward Co., Texas, USA), *Holbrookia maculata* (Rita Blanca National Grassland, Dallam Co., Texas, USA), *Anolis carolinensis* and *Sceloporus consobrinus* (Kisatchie National Forest, Natchitoches Parish, Louisiana, USA). Lizards were located and then watched for 3–5 min prior to approaching to take temperatures with the IRT. The 3–5 min delay ensured that a lizard had spent at least this much time in the thermal context where it was first seen. Temperatures of the dorsal surface of the lizard were measured on the ground before capture using a Raytek (PM-30, Santa Cruz, California) IRT. Capture usually was achieved using a noose of dental floss or fishing line affixed to the end of a fishing pole. Rarely, lizards were captured by hand. Lizards were handled for as short a time as possible, while data were collected, in order to minimize heat transfer between the surrounding air, the hand of the investigator, and the lizard. All post-capture temperatures of a lizard were obtained within 30 seconds of capture. Dorsal surface temperature was obtained within the first 10 seconds after capture using the IRT (see details below). Cloacal temperature, measured with a Miller and Weber (T-6000, New York) cloacal thermometer, was obtained within the ensuing 20 seconds. Mass was measured to the nearest 0.1 g using a Pesola scale. Snout–vent length and time from first sighting the lizard to its capture were also measured for each individual. If a lizard was chased for more than 5 minutes prior to capture, post-capture temperatures were not utilized in our analyses. After release of the lizard, the substrate temperature (Raytek) and air temperature 2–4 cm above the substrate (Miller-Weber) at the point of initial sighting were taken. All air temperatures were taken with the bulb shaded from exposure to the sun.

When taking the temperature with the IRT prior to capture, we attempted to approach the lizard close enough so that the device was less than 1 m from the dorsal surface of the lizard. This ensured the width of the sensory laser beam was $\leq$ 25 mm. In order to keep the shape of the sensory field of the laser beam as circular as possible, care was taken to keep the angle of the laser path as close as possible to perpendicular with the dorsal surface of the lizard. In reality the angle was between 45 and 90 degrees, so the field was usually ellipsoid in shape. We were unaware of the effect of orientation of the gun on effectiveness of the reading, i.e., whether the path of the laser is parallel or perpendicular to the axis of the lizard (parallel being more effective, Hare et al. 2007a), so we made no attempt to correct for this artifact with the pre-capture readings. A close-focus cone can be attached to the device so that the sensory field at very close ranges is 3–5 mm in diameter. However, with the cone attached the field widens

dramatically with distance so that readings of objects at one meter and greater distances are useless. To minimize time from pre- to post-capture reading, the close-focus cone of the device was not attached after the pre-capture reading. Therefore, the width of the sensory field was wider (a minimum of 21 mm) than the width of the animal (averaging 10–20 mm) when the device was triggered close to the animal (about four to 10 cm away). To minimize artifact from reflected temperature of reflective objects adjacent to the lizard the following method was employed. The noosed lizard was quickly suspended from the noose pole away from the ground or objects; its position was stabilized and tension of the noose around the neck was minimized by holding one hind foot of the lizard; a second investigator aimed the IRT so that its laser beam was perpendicular to the surface of the lizard, a few cm from the surface, and pointed away from any background interference (toward the sky). With the device triggered the sighting light was moved back and forth across and along the surface of the lizard for a few seconds and the maximum temperature reading was recorded. The reading of a lizard using this technique was tested for accuracy by taking subsequent readings of five *Holbrookia* with a constantan thermocouple laid snugly upon the lizard's dorsal surface with the wire end parallel to the lizard's surface. The thermocouple wires were attached to a Wescor 2-channel thermocouple thermometer (TH-65, Logan, Utah). Thermocouple readings were taken within the ensuing 10 seconds after the IRT reading and the initial contact of the thermocouple with the lizard.

Testing for the statistical significance of slopes and intercepts in regressions was performed using Type III mean squares (Milliken and Johnson 2002) in Analysis of Covariance (ANCOVA) as calculated in the PROC GLM procedure of the Statistical Analysis System (SAS; Cody and Smith 2006).

Results.—The strength of the relationship between dorsal surface temperatures and cloacal temperature was stronger when using the readings obtained when the lizard was suspended with the sky as the background (R^2 = 0.77–0.96) as opposed to when the lizard was sitting on the substrate (R^2 = 0.38–0.87) or when using only the adjacent substrate temperature (R^2 = 0.41–0.80; Table 1). The mean 95% confidence interval (CI) measured at the coolest temperatures recorded (Fig. 1) averaged ± 1.01°C (Table 2). The prediction interval (PI) averaged ± 2.09 (about twice the CI, Table 2).

The cloacal temperatures of each of the four species were higher than dorsal surface temperatures indicating a thermal gradient within the animals (Fig. 2). There was significant variation among the slopes and Y-intercepts of the regressions among the species and habitats (Tables 3 and 4). For the range of temperatures measured the regressions of the two species from the pine forest (*A. carolinensis* and *S. consobrinus*) had statistically similar and significantly smaller y-intercepts (indicating smaller differences between dorsal and cloacal temperatures) than those of the two species from more open desert-grassland or grassland habitats (*U. stansburiana* and *H. maculata*).

Two dorsal surface readings of five *Holbrookia* were taken in the field, first with the IRT using the sky as background, and then with a thermocouple reader. These readings were identical for two lizards, 2.0°C lower for the thermocouple reader for two individuals, and 2.8°C higher for the thermocouple reader for one individual. The average deviation was 0.5°C higher for the thermocouple reading, producing an absolute value difference between the two readings of 1.2°C. This suggests that readings using the two techniques and sensors are comparable.

All of the lizards studied were adults. Sizes of the lizards studied are shown in Table 5. There was marginally significant variation among species in SVL (Anova, P = 0.048, df = 3, 56) but there were no significant post-hoc differences between any two species (Tukey-Kramer post hoc tests, P > 0.05). There was a more significant variation among masses (Anova, P < 0.01, df = 3, 56) with that of *A. carolinensis* significantly lower than that of the other three species (Tukey-Kramer post hoc tests, P < 0.05). *Anolis carolinensis* is more slender than the other three species.

Discussion.—Regarding predictive accuracy, our results using the pre-capture surface temperature of a 3–5 g iguanine lizard on the ground as the predictor of cloacal temperature were similar to those of Hare et al. 2007a using post-capture readings with the similar-sized McCann's Skink (R^2 = 0.38–0.87, Table 1, mean = 0.56, for four species in this study; R^2 = 0.59 for McCann's Skink [Hare et al. 2007a]). In our study, capturing the lizard and

TABLE 1. Comparison of regressions predicting cloacal temperatures using three different independent predictors.

Species	Regression Tcloaca vs. Tdorsal with sky as background (SE slope)	R^2	Regression Tcloaca vs. Tdorsal with substrate as background (SE slope)	R^2	Regression Tcloaca versus substrate next to lizard (SE slope)	R^2
Uta stansburiana	Y = 12.8 +0.73x (0.10)	0.85	Y = 23 +0.49x (0.14)	0.58	Y = 19.7 +0.61x (0.16)	0.61
Sceloporus consobrinus	Y = -6.8 +1.07x (0.096)	0.91	Y = 15.1 +0.61x (0.20)	0.42	Y = 10 +0.79x (0.16) (0.16)	0.66
Anolis carolinensis	Y = 7.4 +0.78x (0.062)	0.96	Y = 0.59 +1.14x (0.17)	0.87	Y = 3.4 +1.02x (0.19)	0.80
Holbrookia maculata	Y = 13.6 +0.67x (0.089)	0.77	Y = 30.4 +0.21x (0.069)	0.38	Y = 3.01 +0.22x (0.065)	0.41
Perfect match	Y = x	1.0				

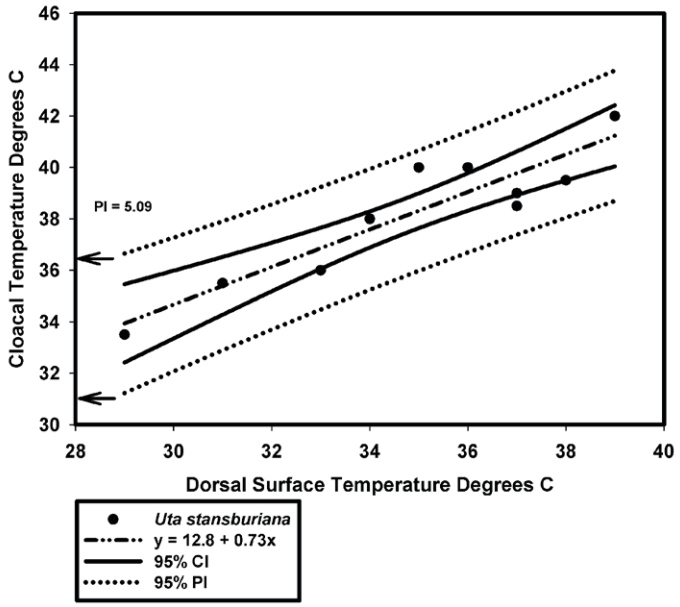


FIG. 1. Cloacal temperature as a function of dorsal surface temperature for the Side-blotched Lizard *Uta stansburiana*. Prediction (PI) and confidence (CI) intervals at the coolest temperatures are presented and discussed in the text.

using the sky as background greatly improved accuracy over our pre-capture readings or Hare et al.'s post-capture readings (R^2 = 0.77–0.96, Table 1, mean = 0.87). One reason for our better post-capture accuracy could have been due to our attention to avoid reflective objects in the laser field by pointing the gun skyward. For small lizards that cannot be closely approached but can be easily captured, our post-capture technique may be useful for generating an accurate predictive model. With such a model the sample size to estimate the mean and variance of cloacal temperature of the population can be increased by measuring dorsal surface temperature alone.

Conversely, while our post-capture technique eliminates some of the confounding background noise in the measurement and provides more accurate predictive model of deep body temperature, at least two issues remain: 1) the relationship between dorsal and deep body temperature, and thus the most appropriate model, may vary significantly due to a number of factors whose influence is yet to be precisely described, 2) the advantage of remote sensing to eliminate the stress of capture for the lizard is not realized. On the other hand negating the need to invade the cloaca with a thermometer or thermocouple could not only relieve stress on the lizard but also may be beneficial in another way. Copulation sometimes is followed by rapid physiological and behavioral change in a female lizard such that she quickly becomes non-receptive to additional copulation (e.g., in panther chameleons, Ferguson et al. 2004, p.80). It remains to be investigated whether or not mechanical stimulation by insertion of an object into a female lizard's cloaca can artificially trigger such a response and interfere with future reproduction.

When plotted on a graph, the 95% prediction interval of a model for the deep body temperature of an individual subsequently sampled based on its dorsal body temperature is roughly twice the 95% confidence

TABLE 2. Prediction intervals (PI) and confidence intervals (CI) of the individual regressions of cloacal temperature versus dorsal body temperature of each species. Interval values were calculated at the data points closest to the regression origin (coolest temperatures recorded) for each species (see Fig. 1).

Species	95% prediction interval of regression	95% confidence interval of regression	PI/CI
Uta stansburiana	5.09	2.73	1.864
Sceloporus consobrinus	4.54	1.60	2.838
Anolis carolinensis	2.80	1.42	1.972
Holbrookia maculata	4.26	2.27	1.877
Mean	4.17	2.01	2.138

limit for the estimate of mean deep body temperature for the population for each species (Fig. 1, Table 2). This means that models constructed from measurements of both dorsal and cloacal temperature of a few individuals are best used to quickly increase sample size and arrive at a population estimate of cloacal temperature. This method eliminates the need to directly measure cloacal temperature of subsequent individuals.

For any model to be predictive there must be a stable relationship between the independent and the dependent variables. The ability of dorsal surface temperature to predict a higher core temperature with some precision suggests that a somewhat stable relationship between surface, and core was established using our procedure. In our study the cloacal temperature predicted from a given dorsal temperature for the two species from dry open desert or grassland habitats (*Uta* and *Holbrookia*) were similar using their respective models. However, predictions differed significantly for the species from a shadier and more humid pine forest (*Anolis* and *Sceloporus*), using each species' respective models (Table 4). Models constructed at a given location and season may have limited applicability and may be influenced more by current climate than species-specific morphology, behavior and physiology. Thus, two species with different body shapes (*A. carolinensis* with a slender body and *S. consobrinus* with a stocky body), but in a similar climate, had similar temperature models. Whether the relationship between dorsal surface and core temperatures of a population varies seasonally or daily with changing weather conditions needs to be explored in more detail. Also, the degree to which temperature differences between surface and core represent real pre-capture differences between surface and core temperature versus artifact due to more

TABLE 3. ANCOVA results testing for intercept and slope differences among the four lizard species *Uta stansburiana*, *Sceloporus consobrinus*, *Anolis carolinenesis*, and *Holbrookia maculata*. Species effect indicates significant variance among y-intercepts of the individual regressions; dorsal temperature effect indicates a significant overall slope; species by dorsal temperature interaction indicates significant variance among slopes of the individual regressions.

Source	DF	Mean Square	F	P
Species	3	4.49	5.42	0.0029
Dorsal temperature	1	250.57	302.31	< 0.0001
Species x Dorsal temperature	3	3.45	4.17	0.0109

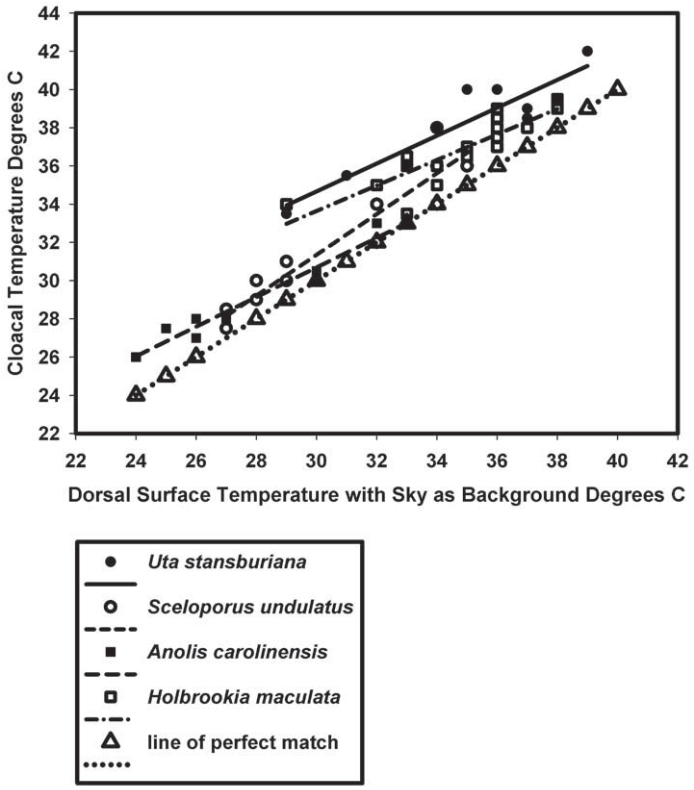


FIG. 2. Cloacal temperature as a function of dorsal surface temperature for four species of small lizards from different habitats. See Table 1 for regression equations for each species.

TABLE 4. Mean predicted cloacal temperatures for three measured dorsal temperatures using "species-specific" regression models for each species. Within each column same superscript letter shows statistical non-significance ($P > 0.05$) among species (Tukey-Kramer post-hoc tests).

	Dorsal Temperature °C		
Species	24	30	34
Uta stansburiana	30.28[a]	34.67[a]	37.58[a]
Holbrookia maculata	29.63[a]	33.64[a]	36.31[a]
Anolis carolinensis	26.03[b]	30.69[b]	33.79[b]
Sceloporus consobrinus	24.94[b]	31.34[b]	35.62[b]

TABLE 5. Snout–vent length and mass of four species of lizards studied. Within the last column the same superscript letter shows statistical non-significance ($P > 0.05$, Tukey-Kramer post-hoc tests).

Species (N)	Snout–vent length Mean ± SE	Mass Mean ± SE
Uta stansburiana (11)	51.5 ± 1.1	4.8 ± 0.3[a]
Holbrookia maculata (25)	51.6 ± 0.5	4.2 ± 0.2[a]
Sceloporus consobrinus (15)	54.8 ± 1.5	4.9 ± 0.4[a]
Anolis carolinensis (9)	50.9 ± 1.5	2.9 ± 0.3[b]

rapid cooling of the lizard's surface after capture requires further investigation.

When collecting data we purposely avoided the early-morning basking period and focused on the mid-morning to late-afternoon shuttling or maintenance phase of the day. Dzialowski and O'Conner (2001) clearly showed that heating and cooling profiles obtained during initial basking can differ from those obtained during temperature maintenance. The relationship between dorsal surface and core temperatures may be quite different and less stable during early morning basking or when the animals are not exposed to the sun.

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"Quick" DNA Extraction from Claw Clippings of Fresh and Formalin-Fixed Box Turtle (*Terrapene ornata*) Specimens

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Proven methods for obtaining quality DNA from turtles include clipping a small piece of the tail (Freedberg et al. 2005) or withdrawing blood from the femoral artery (Buchman et al. 2009). Although both of these methods are well established and produce high yields of quality DNA for molecular analyses, they are somewhat invasive and stressful to the animal. Another potential source for the high yield of quality DNA is the "quick" of the reptilian claw. The claw clipping of live specimens would serve as a less invasive method of tissue harvest thus limiting potential stress.

The reptilian claw is composed of a dorsal unguis plate and the ventral subunguis which encloses the quick, the soft viable tissue which serves as a source of DNA (Fig. 1). The quick is protected by the unguis and subunguis which are rich in beta-keratin contributing to the density and hardness of reptilian claws (reviewed by Toni et al. 2007). However, claw clippings must be long enough to provide a sample of quick within the claw for the beta-keratinized claw itself does not contain DNA.

Because of these dense and rigid beta-keratin structures of the unguis and subunguis surrounding the quick, we hypothesized that the quick of museum specimens might also provide usable DNA for molecular analyses. Common practices in the curation and long-term preservation of herpetological specimens routinely include the use of formalin ($H_2C(OH)_2$), an aqueous and saturated 37% (by mass) solution of formaldehyde or methanal (H_2CO) as a tissue fixative. A 10% formalin solution is used in standard curation practices to fix specimens by forming cross-links between adjacent protein chains and preventing autolysis and coagulation (Fink et al. 1979 in Simmons 1987). The fixation process of soft tissue in small specimens occurs in a few hours, whereas larger specimens are fixed and hardened by soaking overnight (Simmons 1987). Although the formalin molecule is small (ca. 48 g / mol MW) and has a relatively rapid diffusion rate for soft tissues, formalin diffusion though the rich beta-keratin claw would be slow thus protecting the quick tissue from complete formalin fixation during normal curation practices. We therefore questioned if the quick of formalin-fixed specimens may provide a usable source of DNA for molecular analyses.

In this study, we addressed two questions: 1) will the quick from fresh claw clippings provide high-quality DNA for molecular analyses; and 2) will the quick, potentially protected from formalin fixation by the surrounding hard and dense beta-keratinized tissue of the unguis and subunguis, allow for the extraction of usable DNA.

Materials and methods.—Fresh claw clippings from 49 *Terrapene ornata* were collected within the Matador Wildlife Management Area and 10 formalin-fixed specimens from the Texas Cooperative Wildlife Collection (TCWC) at Texas A&M University. Specimens sampled from the TCWC were collected from Brazos (N = 5; TCWC 13979, 18770, 20093, 20099, and 33110), Grimes (N = 2; TCWC 30692 and 30694), Leon (N = 1: TCWC 20096), and Walker (N = 2; TAM 297 and 298) counties, Texas. All claw clippings were stored in 22 ml (25 x 45 mm) Nalgene® vials containing ca. 10 ml of 95% ethanol prior to DNA extraction and claws from the MWMA were measured for maximum width and length.

Using a QIAGEN DNeasy Kit (QIAGEN, Valencia, California), we attempted to isolate genomic DNA from both fresh and formalin-fixed claws. An identical procedure (see QIAGEN DNeasy Kit) was used for formalin-fixed claws, except they were washed in 1X PBT three to five times one day prior to DNA extractions and then incubated in 1X PBT at room temperature overnight. This additional procedure is recommended for, but does not guarantee, the possible removal of formalin from preserved specimens allowing for DNA extraction (QIAGEN 2008).

After DNA extraction from all individuals, we attempted amplification of all DNA samples across four *T. ornata* microsatellite loci (111P, 12I, 2P, and 2T; Cureton II et al. 2009) using polymerase chain reaction (PCR). Each 20 µl reaction consisted of 4 µl 5X PCR Buffer (Promega, Sigma-Aldrich, Inc.), 0.6 mM of dNTPs, 2.5 mM of $MgCl_2$, 2.5 µM of bovine serum albumin (BSA), 0.025 µM of tagged primer, 0.05 µM of untagged primer, 0.05 μM of D4 Well-RED fluorescent primer, 0.5 U of DNA Taq Polymerase (Promega, Sigma-Aldrich, Inc.),

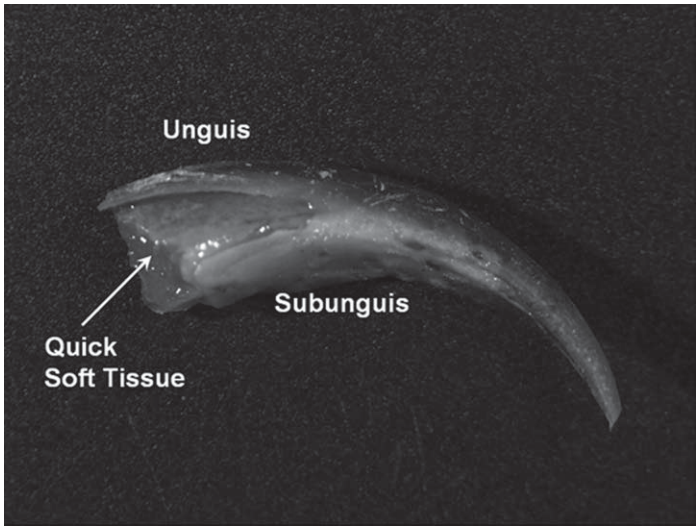


FIG. 1. Anatomical depiction of the quick potentially protected within a sheath-like structure of keratinized claw. A typical reptile claw is formed by a dorsal plate (unguis) and a ventral plate (subunguis). The unguis is curved both longitudinally and transversely and encloses the subunguis between its edges (Kent 1983; Weichert 1965). The softer subunguis and tissue that lies anterior to the terminal phalanx and between the unguis and subunguis provides viable tissue for DNA extraction. The unguis and subunguis are composed of beta-keratins and do not contain DNA.

2 µl of isolated DNA, and 6 µl of dH_2O. For all four loci, we followed the standard touchdown PCR protocol and annealing temperatures listed in Cureton II et al. (2009). To confirm the success of PCR, all products were run on a 2.0% agarose gel.

Based on the absence or presence of genomic DNA and a successful PCR, we classified each of the fresh 49 claw clippings into one of three categories: successful DNA extraction and PCR; successful DNA extraction but unsuccessful PCR; unsuccessful extraction. We used a model I, one-way analysis of variance (ANOVA) to investigate differences in maximum length and width (dependent variables) among these three classified result groups.

Results and discussion.—We successfully extracted and isolated genomic DNA from 36 of the 49 fresh field-collected *T. ornata* claw clippings (73.5% success rate) from the Matador Wildlife Management Area. The success of DNA extraction was highly dependent on the length and width of claw tissue which produced one of three results. Result group 1 (mean length = 3.809 mm ± 0.1860 SE, mean width = 1.463 mm ± 0.0524 SE, N = 36) had successful isolation of DNA, verified by PCR amplification of four *T. ornata* microsatellite loci (Cureton II et al. 2009). Result group 2 (mean length = 2.370 mm ± 0.420 SE, mean width = 1.180 mm ± 0.0800 SE, N = 2) had successful extraction of fragmented DNA, but it could not be amplified by PCR, and result group 3 (mean length = 2.719 ± 0.3170 SE, mean width = 1.176 ± 0.0949 SE, N = 11) resulted in no extraction of DNA. Differences among claw sample length and width in each result group were analyzed using a model-I, one-way analysis of variance of means. We found the mean length and width among claw samples within these three result groups to differ significantly ($F = 5.307$; df = 2, 46; $P = 0.008$ and $F = 4.042$; df = 2, 46; $P = 0.024$, respectively). Because claw tissue length significantly influenced the success of DNA extraction, we recommend that claw clippings be taken at lengths no less than 3.5 mm. Such lengths for adult turtles will most likely contain the viable tissue or quick of the claw. Claw clipping containing a quick sample is essential for DNA extraction because it is the quick, not the hard, beta-keratin claw, that contains DNA. Since developing this methodology, we have clipped an additional 23 claws with lengths of 3.5 mm (18 of which were from dead road specimens) and all claws yielded DNA that was amplified across 12 microsatellite loci (Cureton II et al. 2009).

Because beta-keratins, forming the hard and dense keratinized claw tissue, may protect the soft quick within the claw, we predicted similar success for the extraction of genomic DNA from the claws of formalin-fixed *Terrapene* specimens. Although we did not observe genomic DNA from the 10 formalin-fixed specimens on agarose gels, we successfully amplified the samples across four microsatellite loci with high success by doubling the overall primer concentration (in each reaction) listed in the materials and methods. Although amplifications from formalin-fixed claws did not produce as high of a yield for PCR product as did the fresh-claw clippings, all microsatellite alleles were able to be scored on a Beckman Coulter CEQ-8000. The descriptive statistics of these genotypes and alleles are reported elsewhere (Cureton II et al., unpubl.). Other extraction techniques for formalin preserved specimens (Chase et al. 1998; Shedlock et al. 1997) have also proven affective in yielding viable DNA for PCR amplification (Holiday 2003). However, to our knowledge this is the first paper describing successful results using claw clippings from formalin-fixed specimens.

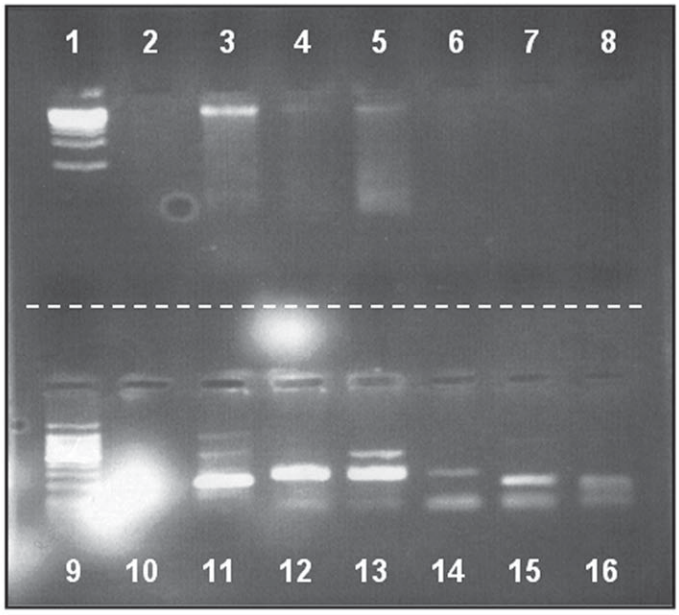


FIG. 2. Gel electrophoresis results showing genomic DNA (top row, lanes 3 through 8) and genomic DNA amplified by the microsatellite primer 111P (bottom row, lanes 11 through 16) on a 1% agarose gel where a standard 1000 BP molecular ladder appears on lanes 1 and 9; lanes 2 and 10 are empty. Lanes 1 and 11 = CG1; 3 and 12 = CG2; 5 and 13 = CG3 are fresh collected claw samples from dead road specimens. Lanes 6 and 14 = 00297; 7 and 15 = 00298; and 8 and 16 = 18770 are formalin-fixed specimens from the Texas Cooperative Wildlife Collection that were collected in the 1930s and 1940s.

Although we did not produce a high DNA yield from formalin-fixed specimens, we produced enough DNA for PCR amplification and it is likely that further pre-extraction washing would yield additional DNA. The ability to extract usable DNA from the quick of turtle claws that have been preserved and curated for more than 70 years (e.g., TCWC 297 was collected on 26 June 1936) will most likely prove to be useful to many molecular biologists working with museum-curated specimens of turtles and potentially other reptiles.

The utility of claw clipping as a less invasive technique than tail clipping (Freedberg et al. 2005) and femoral artery bleeding (Buchman et al. 2009) will aid in field collection of tissue samples. While all of these methods provide large amounts of high quality DNA, the former techniques may be more painful and cause increased stress for the animals being sampled. Thus claw clippings that produce similar DNA yields may offer some advantages over tail tip or blood collection. Claw samples only require storage in small vials of 95% ethanol and do not require heparinized collection tubes and ice as do blood samples. Finally, field collection of claw samples can be accomplished quickly (i.e., less than 30 sec) unlike blood collection from the femoral artery, and claw samples can be stored at room temperature requiring no additional preparation prior to methods of DNA extraction.

We have demonstrated the noninvasive utility of claw clippings as a viable source of high-quality DNA in both fresh and formalin-fixed *Terrapene* specimens. This described methodology and the

ability to extract usable DNA from claw clippings may prove extremely useful and aid in future molecular investigations of turtles and other reptiles.

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Assessment of Intracoelomic Implantation and Waistband Harness Radiotransmitter Attachment on Wood Frogs (*Lithobates sylvaticus*) and Boreal Toads (*Anaxyrus boreas boreas*)

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Radiotelemetry has proven to be a valuable tool for determining amphibian activity, dispersal and migration patters because amphibians are often secretive, nocturnal and sometimes move long distances in short periods of time (Madison et al. 2010; Richards et al. 1994). Despite this success, transmitter attachment is often problematic for amphibians, especially anurans. Two techniques for transmitter attachment are available: "harness attachment" (also called belt or backpack) where radios are secured externally via a waist belt, and "implantation" where radios are inserted intracoelomically (sometimes subcutaneously) via surgery through the abdominal wall.

Harness attachment is most commonly used for anurans, because fitting harnesses *in situ* is relatively quick (5–10 min) and external transmitters with whip-like antennae are detectable over great distances (> 200 m), reducing the likelihood of losing subjects. If harnesses break or are fitted too loosely animals can shed transmitters; if fitted too tightly harnesses can restrict animal mobility and cause blood pooling in extremities (Bartelt and Peterson 2000). Skin lesions are often associated with external harnesses as well (Goldberg et al. 2002; Weick et al. 2005), which can cut through muscle if left unchecked. Skin lesions can also produce infections. A wide variety of harness materials have been used in past studies in an attempt to maximize transmitter retention while minimizing harm to animals (Goldberg et al. 2002), but injuries are still common. Given these possibilities and associated behavioral changes, external transmitters can produce conclusions on activity patterns that are not representative of the species as a whole (Bartelt and Peterson 2000; Johnson 2006).

To avoid these issues, many researchers favor internal transmitters. The acute stress associated with surgical implantation of radiotransmitters may be less taxing on animals than the chronic stress associated with harnesses, particularly for prolonged studies (Johnson 2006). Intracoelomic and subcutaneous surgical implantation techniques have been used on

a variety of amphibian taxa (Eggert 2002; Johnson 2006; Stouffer et al. 1983). Surgical incisions from transmitter implantation in both laboratory and field settings have healed well in previous studies (Goldberg et al. 2002; Johnson 2006; Weick et al. 2005). Disadvantages of internal transmitters include a smaller detection radius (20–50 m) of the helical coiled antennae, increasing the likelihood of losing subjects that move greater distances over short periods of times. There is also the potential for mortality either directly from surgical error or in response to anesthesia. For example, the most problematic aspect of implantation surgery on the Barking Frog (*Eleutherodactylus augusti*) was determining the appropriate level of anesthesia to use (Goldberg et al. 2002), which can vary with water temperature (ASIH et al. 1987). Infections are also possible.

Investigations into the relative impacts of radiotransmitter attachment techniques are necessary because of these variables. Generalizations might be made for species within the same genus or family, provided that the species in question share similar physiologies, habitat requirements, life-history traits and behavior. However, species-specific responses are known to exist (Rowley and Alford 2007) and rigorous assessments of data quality and methodology are scarce. Therefore, the objective of this study was to assess the suitability of waistband-harnessed and intracoelomic implantation radiotransmitter attachment techniques for use on Wood Frogs (*Lithobates sylvaticus*) and Boreal Toads (*Anaxyrus boreas boreas*). Adult Wood Frogs are relatively small (40–57 mm snout–vent length [SVL]) semi-aquatic anurans with thin, smooth skin. Boreal Toads are larger (63–78 mm SVL) terrestrial anurans with thick, rough skin.

Methods

Radiotelemetry was conducted from May through August in 2007 and 2008, on 111 Wood Frogs (62 external and 49 internal transmitters) and 38 Boreal Toads (22 external and 16 internal transmitters) in four wetland areas on the Canadian Boreal Plain near Whitecourt, Alberta. Animals were collected by hand, using a D-frame aquatic net, or in pitfall traps maintained by an amphibian monitoring study (the Study of Forestry and Amphibians [SOFA] project) established at the same sites. All animals (regardless of intended radiotransmitter attachment method) were transported to a base camp where body weight and SVL were recorded and radiotransmitters were attached. For Wood Frogs, 0.7 g BD-2 (external) and 0.8 g BD-2H (internal) transmitters (3 week runtime) were used. For Boreal Toads, 1.4 g BD-2 and 1.5 g BD-2H transmitters (9-week runtime) were used in 2007, and 1.6 g BD-2 and 1.7 g BD-2H transmitters (11-week runtime) were used in 2008. Transmitters were obtained from Holohil Systems Ltd. (Carp, Ontario).

Transmitter attachment and radiotelemetry procedures were approved by the Lakehead University Animal Care Committee. External transmitters were attached via waistband harnesses constructed from stretch bead cord following Baldwin et al. (2006). The surgical procedure employed for radiotransmitter implantation was similar to that described in Goldberg et al. (2002). Subjects were anaesthetized in 0.01% solution of MS-222. Time to suitable anesthesia was highly variable, but generally was 10–30 min. Boreal Toads took longer to anesthetize. Lateral incisions (12–15 mm) were made first though the skin and then through the muscle layer (rectus abdominus) along the right side near the ventral midline. Transmitters were inserted within the coelomic cavity along the muscle wall. Muscle and cutaneous layers were sutured separately using absorbable suture material (4/0 chromic gut in 2007 and 4/0 polydioxanone suture in 2008). Three to five simple, interrupted sutures were used to close each tissue layer. Tissue glue (Dermabond© in 2007; Vetbond© in 2008) was applied to sutures and surrounding skin to seal the cutaneous incision. Each surgical procedure took an average of 20–30 min. Animals were revived in local stream water and held overnight for observation before being released at the site of their capture the following morning.

Table 1. Summary of tracking periods.

Tracking Period (Days)	Boreal Toad (N)	Wood Frog (N)
1–9	4	10
10–19	9	57
20–29	3	22
30–39	6	9
40–49	8	7
*	5	3
70–89	3	

* 50–69 for Boreal Toads; 50–75 for Wood Frog

The 3-week runtime of the Wood Frog radiotransmitters required that transmitters approaching the end of their battery lives be exchanged for fresh ones. Individuals with external transmitters were refitted with new transmitters only if skin lesions were absent. Re-implantation of coelomic transmitters was performed in 2007 but not in 2008.

Animals were located once every 24–48 h by using R-1000 receivers (Communication Specialists Inc., Orange, California) with a 3-element yagi-style antennae. Each animal location was marked using GPS. Animals were examined for presence of injuries or infection associated directly with radiotransmitter attachment, or notable weight loss. Animals were recaptured for transmitter removal on the final day of the average runtime of their respective transmitters. Final weights of recaptured animal were recorded after radiotransmitters were removed.

Home range is likely to be positively related to observation period for species that do not actively defend territorial home ranges; the longer an animal is followed, the farther it moves. Both species in this study were expected to exhibit this relationship. Three simple movement parameters were derived to assess the suitability of both attachment techniques for collecting geospatial data. Home range area (HR, m^2) and linear distance travelled (LD, m) describe seasonal movement patterns. Mean patch spacing (MPS, m) describes movement behavior over a shorter timeframe (24–48 h).

Univariate analysis of variance was used to describe the relationships between transmitter attachment, tracking period (the length of time data were collected on an individual), animal condition (change in body weight and the presence of injuries), and movement parameters. Movement parameters were $\log_{10}$-

TABLE 2. Summary of animal fates (pooled 2007 and 2008): HR = home range, MPS = mean patch spacing, LD = linear distance, SE = standard error.

Species	Transmitter	Animals (N)	Injuries (N)	Deaths (N)	Lost (N)	Tracking Period (days) Mean (min–max)	HR Mean (min–max) ($m^{2)}$	MPS Mean ± SE (m)	LD Mean ± SE (m)
Wood Frog	External	62	24	*7	19	20 (1–74)	175 ± 13	15 ± 2	51 ± 5
	Internal	49	9	11	7	21 (3–55)	192 ± 17	16 ± 2	54 ± 6
Boreal Toad	External	22	9	*5	7	41 (6–79)	5839 ± 623	58 ± 9	302 ± 61
	Internal	16	0	5	9	28 (1–88)	3908 ± 675	73 ± 15	223 ± 41

The difference between the total number of animals and those that died or were lost represents animals that were successfully released.

* 1 confirmed case of predation.

transformed for analysis. Species were considered separately. Tracking period was divided into six categories for Wood Frogs, and seven categories for Boreal Toads (Table 1). Animals with single observations were omitted from analysis. A critical alpha value of 0.05 was employed.

RESULTS

Tracking period and movement.—Transmitter attachment method had no effect on Wood Frog tracking period or movement parameters ($P > 0.87$). Boreal Toad tracking period ($F_{1,36} = 4.08$, $P = 0.05$) and HR ($F_{1,36} = 4.25$, $P = 0.05$) were greater with external transmitters, but MPS and LD did not differ between transmitter types ($P > 0.47$) (Table 2). Tracking period interacted with Wood Frog HR ($F_{1,104} = 18.32$, $P << 0.01$) and LD ($F_{1,104} = 2.51$, $P = 0.03$), as well as Boreal Toad HR ($F_{1,36} = 7.12$, $P << 0.01$). All other movement parameters did not interact with tracking period ($P > 0.72$).

Mortality due to surgery.—Six animals did not recover from anesthesia (1 Wood Frog and 5 Boreal Toads, not included in the 149 animals used for our analyses). We do not know why these animals died; the general surgical methodology was consistent throughout, as was the concentration of MS-222 used.

Post-operatively, most sutures healed completely and suture material disappeared after three weeks. In 2008, there were four instances where Wood Frogs either developed lesions around sutures, or suture material did not fully dissolve by the time transmitters were removed. Nevertheless, these individuals were still active in the field. There were no confirmed cases of infection associated with surgical incisions or harness lesions. Multiple implantation surgeries had no observable impact on animals in 2007, with the exception of one Wood Frog that exhibited severe weight loss.

Weight loss.—Transmitter attachment method was associated with changes in body weight in Wood Frogs ($F_{1,43} = 6.43$, $P = 0.02$). More animals gained weight with internal transmitters than with external transmitters, although individuals from both categories exhibited weight loss (Table 3). All Boreal Toads observed until the end of their transmitter runtimes exhibited weight gain regardless of transmitter attachment method (Table 3).

Injuries.—Injuries were associated most commonly with external transmitters (Wood Frog: $F_{1,104} = 8.48$, $P < 0.01$; Boreal Toad: $F_{1,36} = 8.11$, $P < 0.01$) (Table 2). Injuries interacted with tracking period for Boreal Toads ($F_{1,36} = 13.51$, $P < 0.01$), but not Wood Frogs ($F_{1,104} = 3.14$, $P = 0.08$). The presence of injuries did not influence the movement parameters of either species (Wood Frog: $P > 0.39$; Boreal Toad: $P > 0.11$). Injuries were most common and developed earlier among Wood Frogs.

Susceptibility to predation.—There were only two confirmed cases of predation (Table 2), both associated with external transmitters and attributed to avian predators.

Reproduction.—The presence of external transmitters did not prevent amplexus. Grasping males would sometimes shed transmitters fitted to gravid females. Amplexus was not observed in animals fitted with internal transmitters, but there was no evidence suggesting implantation interfered with reproduction (but see Heemeyer et al. 2010).

DISCUSSION

Transmitter attachment method had mixed effects between Wood Frogs and Boreal Toads. Both transmitter types were able to capture Wood Frog movements to the same degree. However, Boreal Toad home ranges were larger with the use of external transmitters. The toads were capable of pulse movements that far

TABLE 3. Summary of animal weight change observed during 2008 for 43 Wood Frogs and 6 Boreal Toads.

Species	Transmitter Type	Weight Loss (N)	Weight Gain (N)	Proportion of Animals Exhibiting Weight Loss (%)	Tracking Period [Days] Mean (min–max)
Wood Frog	External	18	3	86	19 (7–40)
	Internal	12	10	55	18 (13–22)
Boreal Toad	External	0	3	0	54 (34–79)
	Internal	0	3	0	68 (53–87)

exceeded the detection radius of internal transmitters, and were easily lost during these periods. This also accounts for the shorter tracking periods reported for Boreal Toads fitted with internal transmitters. HR values for both species and Wood Frog LD expressed a positive relationship with tracking period, as expect for species without fixed, defended territorial home ranges. MPS was not affected by tracking period, which reflects the relative scales of the three movement parameters. Home range and LD reflect areas exploited and distance traveled over the entire tracking period, whereas MPS reflects the distance an animal can travel in a single tracking interval (24–48 h).

Internal transmitters appear to be most appropriate for longer studies, since the chance of developing lesions as the result of chronic harness exposure increases with time. More Wood Frogs gained weight when fitted with internal transmitters than those with external transmitters. Although amphibian weights are known to be extremely variable and are often linked to dehydration (Stebbins and Cohen 1995), the weight changes observed corroborate our data on abrasion injuries which demonstrates that transmitter implantation is in fact less harmful to anurans. While there are health risks associated with either radiotransmitter attachment technique (Goldberg et al. 2002; Weick et al. 2005), the chronic distress associated with belt abrasion appears to be greater than the short-term and admittedly intense strain imposed by radiotransmitter implantation.

Boreal Toads appear to be better than Wood Frogs at withstanding the perturbations associated with transmitters. In the case of harness attachments, this could be attributed to skin structure (thickness and irregularity) and body size, but might also reflect the relative transmitter-to-animal weight ratio. The transmitter percent of body weight in Wood Frogs (approaching 10%) was greater than that for Boreal Toads (under 5%). Our findings support the recently recommended maximum ratio of 5% (Goldberg et al. 2002).

Our data also support the notion of species-specific transmitter effects (Rowley and Alford 2007), although generalizations can be made. Internal transmitters are recommended for smaller-bodied anuran species with semi-aquatic life-history traits, like Wood Frogs and many other species belonging to the genera *Rana* and *Lithobates*. Larger species, and those sharing more terrestrial or semi-arid life-history traits (e.g., *Bufo* and *Anaxyrus*) are likely better able to withstand waistband harnesses. It is also necessary to consider a species' behavior. Internal transmitters were capable of capturing the movements of Wood Frogs as accurately as external transmitters. However, external transmitters were better able to capture the longer-distance pulse movements of Boreal Toads. We generally recommend internal transmitters whenever appropriate.

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The Bender Board: A New Design for the Restraint and Measurement of Hellbenders

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The Eastern Hellbender (*Cryptobranchus alleganiensis alleganiensis*) is a large, aquatic salamander historically found throughout the eastern United States (Mayasich et al. 2003). Hellbender populations have experienced drastic declines in recent decades throughout their geographic distribution (Wheeler et al. 2003), which has created a critical need for widespread data collection of biological samples (e.g., blood or tissue samples for genetic analysis) and accurate growth data. However, acquiring biological samples and accurate morphological measurements of large salamanders in the field can be difficult.

Restraining and measuring hellbenders using existing restraint devices is problematic due to their large size, muscular body and tail, and the production of copious amounts of mucus (Wise and Buchanan 1992). To safely collect biological samples and obtain accurate measurements, it is necessary to restrain individuals to minimize handling time, stress, and the potential for injury to the animal and researchers. Traditional measuring techniques usually involve either restraining animals by hand or placing them on a standard fish measuring board (Herke 1977). However, measuring boards do not contain restraints to prevent individuals from struggling during measuring or blood and tissue collection which can increase the amount of handling time for more active individuals. Methods that have been developed to restrain and measure amphibians in the field include an anuran restraining device (Bourque 2007), a "mander masher" (Wise and Buchanan 1992), a modified clear plastic tube (Mathis 1991), and a PVC "salamander stick" (Walston and Mullin 2005). The anuran restraining device is designed specifically for a frog's morphology and would not fit a large salamander, while the latter three devices do not provide adequate access to the salamander's tail and stomach for sample collection. Squeezebox techniques have been utilized for handling venomous snakes (Quinn and Jones 1974), but to our knowledge few techniques have been specifically developed for restraining large salamanders. A technique which safely restrains individuals while allowing for consistent measurements can improve the accuracy and precision of morphological measurements in salamanders.

To resolve this issue, we have created the "bender board." This device is a specialized squeezebox designed to prevent struggling by captured hellbenders and allow for quick, accurate measurements. The board is made from lightweight wood, wooden dowels, and polyfoam (Fig. 1). The box is assembled by nailing two 65 cm x 2 cm x 7 cm boards (A) to the long edge of a 65 cm x 2 cm x 29 cm baseboard (B). Next, two 32 cm x 2 cm x 7 cm boards (C) are nailed to the ends of the baseboard to create an open box. Four 1 cm holes are drilled 7.5 cm in and 1.5 cm down from each corner on the long edge of the box. Two additional holes are drilled 4.5 cm in and 1.5 cm down from two corners of a separate 64 cm x 2.5 cm x 5 cm board (D). The holes on the separate board should line up with the holes on the constructed box as this will form the sliding restrainer board. A firm, nonabrasive polyfoam is then glued to one inside edge of the box and one edge of the sliding board. The polyfoam should be cut to conform to directional placement of salamanders into the board to hold the tail in place. Small holes should be cut in the polyfoam to allow for insertion of the dowels in the following step. Finally, the restrainer board is connected to the box by 31.5 cm x 1 cm wooden dowels inserted through the holes across the

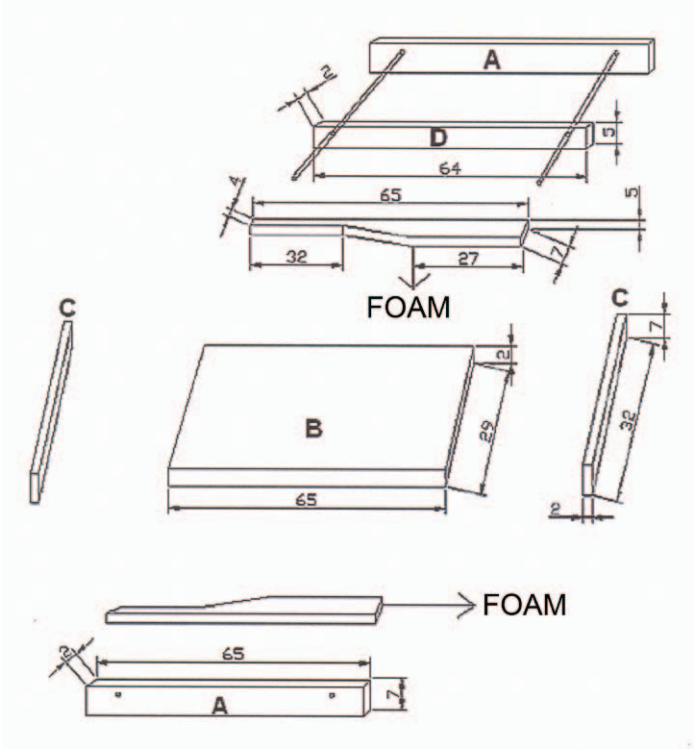


Fig. 1. Schematic of the components and construction of the bender board.



Fig. 2. Bender board shown holding an Eastern Hellbender.

board (Fig. 2). These dowels allow the animal to first be placed onto the board and then the restrainer board can be pressed against one side of the salamander. Large binder clips are placed behind the restrainer board on the dowels to hold it in place while in use. To use the bender board, the hellbender is placed onto the board with its head under the forward dowel, ventral or dorsal side up depending on the procedure and its legs are adhered laterally with tail and body straight by sliding the restrainer board closed and securing the binder clips. This allows for safe handling and measuring of total length and snout–vent length (SVL), drawing of blood, and marking individuals. This design is also ideal and efficient for use in the field when working alone. The approximate time to restrain hellbenders from the point of placement onto the board to securing the restraining board was under 10 seconds. Throughout the study 183 individuals ranging in size (SVL) from 26.2 cm to 38.3 cm were restrained using the board.

This design should increase the accuracy of measurements by eliminating the salamander's ability to struggle. The possibility of injury and stress are also reduced because researchers will not need to manually restrain individuals for longer than is necessary. The polyfoam padding creates a soft, non-abrasive cushion to securely restrain hellbenders without injury and it holds moisture which helps prevent desiccation and reduces the need to continually apply water during processing procedures. Although only tested on hellbenders, this design could easily be modified for use on other salamander species, particularly other large paedomorphic salamanders such as sirens (*Siren* spp.), amphiumas (*Amphiuma* spp.), and mudpuppies (*Necturus* spp.). Due to the polyfoam's ability to hold moisture, we recommend that researchers employ multiple boards as this would allow for adequate disinfection between sampling occasions and reduce the potential for disease transfer. This lightweight, relatively small "bender board" is portable, easy to use in the field, and can be modified to include carrying handles. Variations on the design could include replacing wooden materials with plastic to further decrease weight, improve durability, and increase the ease of cleaning. Although not illustrated, we recommend placing an additional nonabrasive restraint in the form of a small piece of plexiglass or similar material over the space between the anterior dowel to prevent individuals from sliding forward and under the dowel which could allow them to escape. The responsible use of this design could increase researcher sampling efficiency and measurement accuracy, while decreasing handling stress and the potential for injury. The use of the "bender board" also would reduce the need to anesthetize individuals using tricaine methane sulphonate (commercially available as MS-222) which has shown to produce adverse physiological effects and an alteration of behavior (Byram and Nickerson 2008; Fedewa and Lindell 2005).

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Suggested Modifications to Terrestrial Box Traps for Snakes

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There are a number of trapping methods available for capturing terrestrial snakes and numerous variations on these methods have been described (e.g., Fitch 1987; Rodda et al. 1999). Since the wooden box trap in association with drift fences was first described within the primary literature and refined with specific construction instructions (Burgdorf et al. 2005), the method has been widely applied (although often with some modifications) particularly within the southeastern United States (e.g., Hyslop 2009; Lee 2009; Linehan et al. 2010; Perry et al. 2009). It represents a useful method of capturing large terrestrial snakes (Burgdorf et al. 2005), a group that can be difficult to systematically sample. In the course of using these traps in Georgia, Florida, Tennessee, and Alabama, we have generated recommendations to make traps easier to maintain and which may decrease mortality of non-

target organisms. However, the effects of these modifications on trap efficacy for target snake species are not known.

In addition to snakes, numerous species, particularly mammals, are captured in box traps (i.e., non-targets). Rodents routinely captured in these box traps in the southeastern U.S. have included Cotton Rats, *Sigmodon hispidus*, and Old-field Mice, *Peromyscus polionotus*. Additional mammal captures have included, but are not limited to, Striped Skunk, *Mephitis mephitis*, Spotted Skunk, *Spilogale putorious*, Virginia Opossum, *Didelphis virginiana*, Pine Vole, *Microtus pinetorum*, Southeastern Pocket Gopher, *Geomys pinetus*, rabbits, *Sylvilagus* spp., Wood Rat, *Neotoma floridana*, and Long-tailed Weasel, *Mustela frenata* (Guyer et al. 2007; L. L. Smith, unpubl. data). At best, removal of non-target mammals from box traps is inconvenient and time consuming but can also be unpleasant and/or dangerous (e.g., skunks and weasels).

We suggest installing a side door in addition to the hinged door on top of the trap specified by Burgdorf et al. (2005). Figure 1d of Burgdorf et al. (2005) displayed 5.1 x 5.1 cm pieces of lumber within the corners of the box trap and another piece 15 cm from the corner. Within the original schematic these two pieces of lumber were separated with hardware cloth. We recommend replacing the hardware cloth within this gap with a hinged plywood door (Fig. 1). We recommend this door, which can be held shut with turn buttons, be placed at the opposite side of the trap as the door on the top of the box trap to facilitate easy flushing of mammals out the side. Venomous snakes can also be safely flushed out this door, or allowed to exit on their own. On occasions when regular tending of the trap may not be possible and exposure is a concern, the side door (as well as the top access door) can be left open to permit animals to escape the trap.

Burgdorf et al. (2005) suggested including a chick watering source inside the box trap. We suggest adding a shallow galvanized pan as a water source so that animals can submerge themselves; this may aid in thermoregulation. A small branch leaned against the side of the pan can be used as an access ramp by small vertebrates. A 30–60 cm piece of synthetic rope within the pan and anchored to the center or top of the trap also allows small mammals to escape the water (Borg et al. 2004). Ropes made of synthetic material are less likely to drain the watering pan due to capillary action.



FIG. 1. A hinged side door greatly enhances a researcher's ability to quickly and safely remove non-target captures from box traps.

We also reduced the size of box traps to facilitate ease of transportation to study sites. Although of limited concern when extended travel is not a component of installation, we found that reducing the length of the box from 48 to 42 inches (121.9 to 106.7 cm) and the height from 18 to 16 inches (45.7 to 40.64 cm) allowed for more traps to safely fit in the bed of a standard pickup truck.

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AMPHIBIAN DISEASES

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Northern Leopard Frogs (*Rana pipiens*) Infected with *Batrachochytrium dendrobatidis* in the Amphibian Trade

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Batrachochytrium dendrobatidis (*Bd*) is an aquatic fungus that infects amphibians with the disease chytridiomycosis, a disease that has been implicated as one of the causes of worldwide amphibian decline (Berger et al. 1998; Bosch et al. 2001; Rachowicz et al. 2006; Skerratt et al. 2007; Stuart et al. 2004). Although the manner in which *Bd* is spread is not fully understood, the amphibian trade has been implicated as a possible source of dissemination (Fisher and Garner 2007; Parker et al. 2002; Picco and Collins 2008; Rowley et al. 2007; Schloegel et al. 2009). Amphibian trade results in transport of large numbers of individuals and species nationally and internationally; with >7,000,000 amphibians imported into the United States between 1998 and 2002 (Schlaepher et al. 2005), and >4,000,000 amphibians imported to Hong Kong, China, in a single year via air transport alone (Rowley et al. 2007). Many US imports are subsequently exported to European and Asian markets (Schlaepher et al. 2005). The United States is one of the few countries to track import and export, but no regulations require screening for pathogens such as *Bd*. In 2008, the World Organization of Animal Health (OIE) listed *Bd* as OIE-notifiable, and developed standards for amphibian trade (http://www.oie.int/eng/normes/fcode/en_sommaire.htm; accessed 5 April 2010).

Bd has been isolated from Northern Leopard Frogs, *Rana pipiens*, from two biological supply companies in Massachusetts and Minnesota, USA (Woodhams et al. 2008). This and other research has suggested that *Rana pipiens* shipped from biological-supply houses may be a carrier for *Bd* (Fischer and Garner 2007; Woodhams et al. 2008).

Charles D. Sullivan Inc. (CDS) is a major biological supply company based in Tennessee, USA, specializing in amphibians for educational and research purposes. Charles D. Sullivan Inc. ships its products, both nationally and internationally, to over 100 institutions (as claimed on their web site: http://www.researchamphibians.com; accessed 26 April 2010). There have been hundreds of primary research articles based on specimens provided by CDS. To determine if frogs shipped from CDS had *Bd* we tested shipments of *R. pipiens* that were ordered for research purposes.

Shipments of 14 and 25 adult *R. pipiens* were shipped overnight from CDS to Central Washington University, Ellensburg, Washington, USA, on 18 October 2006 and 12 July 2007, respectively. Both shipments were immediately unpacked and transferred into clean and unused plastic containers, with each individual housed separately. Frogs were held at 10 or 15°C and the container cleaned twice weekly. Powder-free latex gloves were worn while handling frogs, with a new pair used for each frog. To determine infection status small pieces of shed skin were collected opportunistically from the enclosures of each of the frogs within 30 days of arrival and examined using differential interference contrast microscopy for the presence of *Bd* zoosporangia and zoospores. Samples were examined for no more than 10 min. If no *Bd* structures were found within 10 min, the sample was considered negative for the pathogen.

Bd was found in the shed skin of all *R. pipiens* (N = 39) sampled. Upon arrival at the laboratory, several frogs exhibited skin redness on the ventral surface of the abdomen and thighs, a common symptom in infected individuals (Pessier et al. 1999). These signs resolved a few days after the frogs were transferred into their enclosures. However, many frogs displayed signs of *Bd* infection intermittently throughout the 66- or 109-day experiments (Table 1), including redness on the ventral surface, lethargy, and excessive skin sloughing. There was no consistent pattern in the appearance and disappearance of the signs of *Bd* infection throughout the experiments. Six (15%) *R. pipiens* died during the experiments (Table 1).

These results indicate amphibians shipped from CDS may be infected with *Bd*. Given that the frogs were shipped overnight and assessed for *Bd* shortly after arrival, we consider it unlikely that they were infected during transport. The high infection rate more likely reflects holding conditions before shipping or natural infection rates. The relatively low mortality rates and high rates of infection in our experiments are consistent with previous research (Padgett-Flohr 2008; Woodhams et al. 2008) and suggest that some populations of *R. pipiens* may not be susceptible to mortality from chytridiomycosis and/or some strains of *Bd* are

TABLE 1. Number of *Rana pipiens* received in Ellensburg, Washington, USA, from a laboratory supplier (Charles D. Sullivan Inc., Tennessee, USA) testing positive for *Batrachochytrium dendrobatidis*, the length of the laboratory experiments for which the frogs were used, average survival time of each cohort, and the number of mortalities during each experiment.

Date sampled	No. Frogs Received from Supplier	No. Infected Frogs	Length of Experiment (days)	Average Survival Time with Infection (days)	Mortalities During Experiment
13 October 2006	14	14	109	103	6
14 July 2007	25	25	66	66	0

less virulent.

More investigation is needed to determine the extent of *Bd* in the amphibian trade. However, these results shed light on one possible mode of dissemination for *Bd*, and add to the evidence that *R. pipiens* shipped from biological supply houses may act as carriers for the pathogen. We recognize the importance of the amphibian trade for research and education, but our data emphasize the need to handle amphibians, and amphibian wastes, aseptically regardless of their origin. Further, in accordance with the OIE, we suggest systematic screening of imported and exported amphibians given the potentially devastating effects of *Bd* on amphibian persistence around the world.

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Batrachochytrium dendrobatidis in Argentina: First Record of Infection in *Hypsiboas cordobae* and *Odontophrynus occidentalis* Tadpoles, in San Luis Province

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An estimated 43.2% of global amphibians have experienced some reduction in population size (Stuart et al. 2004), with losses in several locations explained by the emerging infectious disease chytridiomycosis caused by the amphibian chytrid fungus *Batrachochytrium dendrobatidis* (*Bd*) (Berger et al. 1998; Daszak et al. 1999; Longcore et al. 1999). In Argentina, *Bd* infection was first reported in 2002, in the Spotted Thin-toed Frog, *Leptodactylus ocellatus* (Herrera et al. 2005). Since then, there have been additional detections in *Atelognathus patagonicus*, *Elachistocleis bicolor*, *Leptodactylus gracilis*, *Telmatobius atacamensis*, and *Telmatobius pisanoi* (Arellano et al. 2009; Barrionuevo and Mangione 2006; Fox et al. 2006; Ghirardi et al. 2009) in several locations in the country. Here we report the first occurrence of *Bd* in Argentinean tadpoles of two native anuran species, *Hypsiboas cordobae* and *Odontophrynus occidentalis*, in Luján, San Luis province, Argentina.

On 12 October 2009, 10 live larvae of *Hypsiboas cordobae* and *Odontophrynus occidentalis* were collected at random from a stream during a field survey in the Strict Nature Reserve

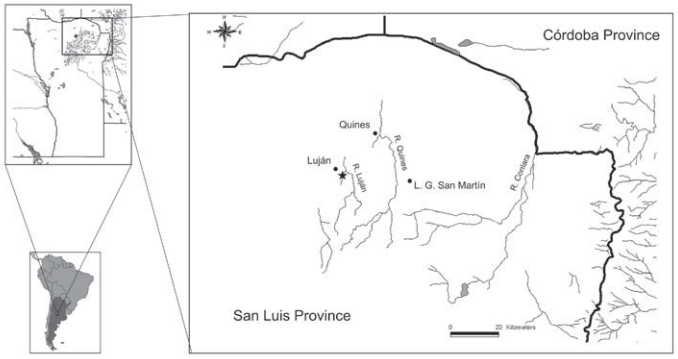


FIG. 1. Location (star) of *Batrachochytrium dendrobatidis* in San Luis province, Argentina.

"Quebarada de las Higueritas" (32.403ºS, 65.927ºW) at 800 m elevation (Anderson et al. 1970) (Fig. 1). The stream had a mean depth of 15 cm and flowed intermittently. This protected area is located in the northeastern part of the San Luis province and has climatic and geomorphological characteristics of the Chaco Serrano district of the Chacoan phytogeographic region (Cabrera 1976). Annual rainfall is 500–600 mm and is concentrated in late spring and summer. Vegetation is generally woody with less representation of drought-tolerant species that occur in neighboring regions. There are also abundant areas of grassland, frequently represented in elevated areas (Anderson et al. 1970). *Hypsiboas cordobae* is an endemic mountaine frog of Cordoba and San Luis, with a conservation status of Data Deficient (IUCN 2009). *Odontophrynus occidentalis* is broadly distributed in central and south-central Argentina, with an altitudinal range of 50–1500 m, and is categorized as Least Concern (IUCN 2009). Four other anuran species have been recorded at the site. During the field survey there was no evidence of anuran mortality and larvae seemed healthy.

The larvae were fixed in 10% neutral buffered formalin in the field and then transferred to 70% ethanol. All oral structures of tadpoles were examined visually in the laboratory under a stereoscopic microscope. Samples of the keratinized mouthparts were taken, dehydrated, paraffin-embedded and cut (Leica, RM 2125 RT) into 5 micron-thick sections for histological analysis. Then, tissues were stained with haematoxylin and eosin and examined with a light microscope (Olympus BX 40 Optical Co. Ltd., Tokyo, Japan). For *Bd* identification we followed the procedures described by Berger et al. (1999). Voucher specimens were deposited in the herpetological collection of the Universidad Nacional de San Luis, San Luis, Argentina (CH-UNSL 0420).

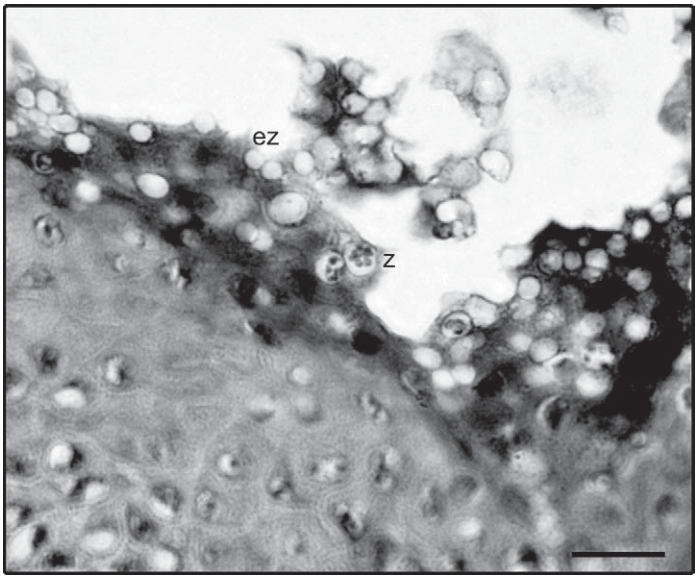


FIG. 3. Histological section of infected mouthparts of larval *Odontophrynus occidentalis* from San Luis province, Argentina, showing empty zoosporangia (ez) and containing zoospores (z). Scale bar: 30 µm. Photo by M. L. Arellano.

We identified anomalies in the keratinized mouthparts in five of 10 individuals analyzed. The anomalies included mainly lack of pigmentation in upper and lower jaw sheaths, erosion of their cutting edge and absence of serrations, and occasional loss of some labial teeth (Fig. 2). With regard to the histological analyses, seven of 10 larvae were positive for *Bd*. Spherical and ovoid zoosporangia, empty or containing zoospores, were identified in the keratinized mouthparts. The sporangia ranged between 5 and 12 µm in diameter (Fig. 3).

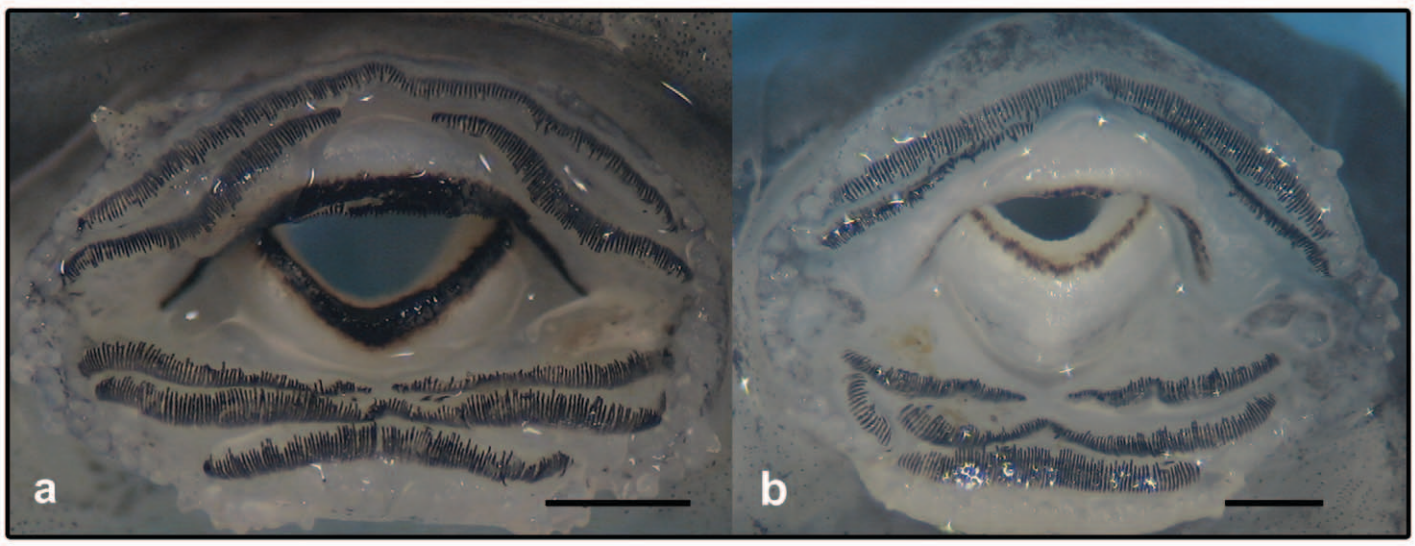


FIG. 2. Normal (a) and abnormal depigmented (b) keratinized mouthparts of larval *Hypsiboas cordobae* from San Luis province, Argentina. Scale bar: (a) 42 mm; (b) 46 mm. Photo by M. L. Arellano.

Our report of *Bd* infection extends the known distribution of the fungus to another region of the Chaco Serrano district (Cabrera et al. 1976), and to a new Argentinean province. This new locality is ca. 120 km from the locality of Ghirardi et al. (2009) in the province of Cordoba. Our discovery of *Bd* in San Luis province represents the first case of infection in tadpoles in Argentina and the presence of the fungus in two new native amphibian species. At present there are few data available on the susceptibility of Argentinean amphibians to *Bd*, and conservation efforts are needed to provide information on *Bd* distribution, ecological requirements, and pathogen-host interactions.

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Chytrid Infection of *Rana draytonii* in the Sierra Nevada, California, USA

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Amphibian chytridiomycosis, caused by the chytridiomycete fungus *Batrachochytrium dendrobatidis* (*Bd*), has been correlated with the decline and extinction of many amphibian species worldwide (Lips et al. 2006). This emergence of this disease appears to be recent, based on samples taken from the California Academy of Science Herpetological Collection, located in San Francisco, California, USA, between 1897 and 2005. *Bd* infection was not detected in any of the 223 sampled amphibians from central California collected prior to 1961 (Padgett-Flohr and Hopkins 2009). Of the 687 individuals sampled overall, including Pacific Chorus Frog (*Pseudacris regilla*), American Bullfrog (*Lithobates catesbeianus*), Foothill Yellow-legged Frog (*Rana boylii*) and California Red-legged Frog (*R. draytonii*), 13.2% were infected with *Bd*, with the most frequent infection occurring in *Pseudacris regilla* (Padgett-Flohr and Hopkins 2009). Within the southern portion of the Sierra Nevada range in central California, populations of the Sierra Nevada Yellow-legged Frog (*R. sierrae* [formerly *muscosa*]) and Southern Mountain Yellow-legged Frog (*R. muscosa*) also have been found to support *Bd* (Fellers et al. 2001; Rachowicz et al. 2006).

Little research has addressed *Bd* presence or prevalence in *Rana draytonii* in the Sierra Nevada foothills, where eight independent populations of this federally listed Threatened species occur. To aid in this regard, we sampled for *Bd* within four of the eight known Sierra Nevada *R. draytonii* populations: Big Gun Diggings, Spivey Pond, Sailor Flat, and Hughes Pond (Fig. 1). We also update the occurrence of *Bd* at Hughes Pond, where *Bd* was first detected in 2007 (www. spatialepidemiology.net/Bd-maps/surveillance/s_country.asp; accessed March 2010). Information on disease occurrence is important to guide recovery efforts for *R. draytonii* and to manage existing populations.

Big Gun Diggings is located on the Michigan Bluff 7.5-minute topographic quadrangle, Placer County (98–1055 m elevation) and is designated as the PLACER 1 Critical Habitat (CH) Unit (USFWS 2008). The site is on a south-facing slope above the Middle Fork of the American River and includes six man-made ponds of various sizes up to 0.4 ha, which range in depth from being dry in the summer to >2.5 m deep.

Spivey Pond is located on the Sly Park 7.5-minute topographic quadrangle, El Dorado County (975 m elevation) and is identified as the ELDORADO 1 CH Unit (USFWS 2008). The site is on the North Fork Weber Creek, a tributary to the South Fork American River. Weber Creek flows from east to west through the pond, which is a 0.3-ha reservoir created by a weir on the western end of the creek.

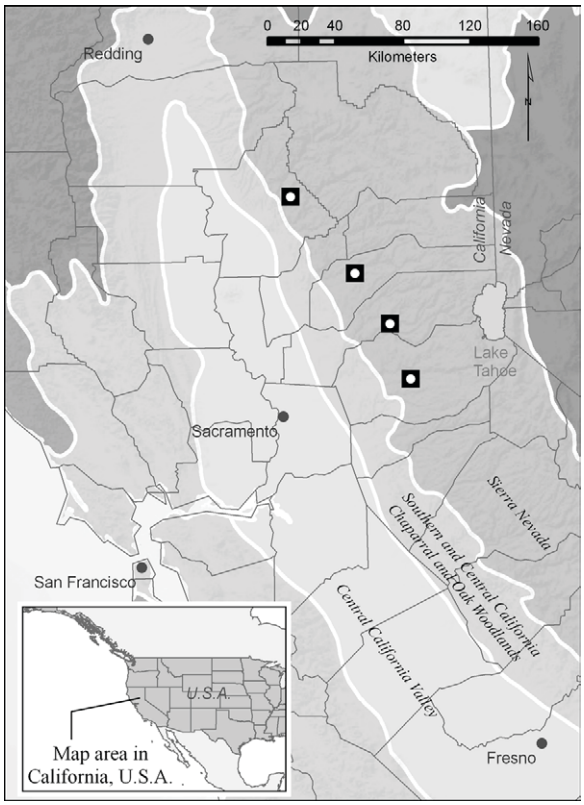


FIG. 1. Locations of study sites in the Sierra Nevada foothills, California, USA, where California Red-legged Frogs (*Rana draytonii*) were sampled for the amphibian chytrid fungus *Batrachochytrium dendrobatidis*.

Sailor Flat is located on the North Bloomfield 7.5-minute topographic quadrangle, Nevada County (929 m elevation), and is designated as CH NEVADA 1 (USFWS 2008). The site is on an east-facing slope above the South Yuba River. Several ponds occur in the area, although only one was sampled during this study, a perennial pond approximately 0.2-ha in size which ranged in depth between 0.3 and 0.69 m on the west and south, and more than 2 m on the north side of the pond.

Hughes Pond is located on the Berry Creek 7.5-minute topographic quadrangle and is designated as CH BUTTE 1 (USFWS 2008). Located at 760 m elevation in the Plumas National Forest, Butte County, the roughly 0.1-ha pond is situated northwest of the topographic blue-line headwaters of Jack Creek. Depths ranged between 0.3 and 1.4 m.

Surveys were conducted between 30 June and 12 August 2009, between 1800 and 2400. Weather conditions were clear and calm, with temperatures ranging between 15 and 32°C. Frogs were captured by hand, primarily using a dipnet which was sterilized between sites. Between-site contact between animals and containers used for animals was avoided, to reduce the potential for cross-infection. In addition, for comparison, we report *Bd* test results from 20 June 2007 and 19 May 2008 from Hughes Pond, using similar methods as described above. All individuals were identified using Biomark Passive Implant Transponder tags (Boise, Idaho, USA).

Frogs were swabbed for *Bd* using the methods described by Livo (2004). Fresh nitrile gloves were used when handling each individual. Swab samples were analyzed by Pisces Molecular, LLC (Boulder, Colorado, USA), which assayed the sampled DNA for the presence of *Bd* ribosomal RNA Intervening Transcribed sequence (ITS) region. Each polymerase chain reaction (PCR) run included three controls, a positive *Bd* DNA, a negative (non-batracho chytrid fungus) DNA, and a control with water. Signals ranged from no signal/below limit of detection (-) to very strong positive signal (+++).

Pseudacris regilla were observed at all sites, but only *R. draytonii* were sampled during this study. No frogs of any species were detected with outward signs of *Bd* infection, such as discoloration, sloughing of skin, anorexia or lack of self-righting reflex. No dead individuals were observed.

Three of the four ponds, Big Gun Diggings, Spivey Pond and Sailor Flat, were sampled only once. At Big Gun Diggings, *Bd* was detected on 5 of 8 animals (62%) sampled: 3 of 5 males and 2 of 3 females were infected, with infection rates ranging from no detection signal (-) to a strong positive signal (+++), as defined by Pisces Molecular, LLC. Tadpoles were observed but were not sampled for *Bd*. Only 2 adults were captured at the Spivey Pond site and *Bd* was detected on the adult female (+++), but not on the first-year frog. At Sailor Flat, 8 of 8 animals (100%) were *Bd*-positive, including 3 males, 3 females and 2 juveniles, with infection rates ranging from a strong positive signal (++) to a very strong positive signal (+++).

Multiple samplings at Hughes Pond detected *Bd* in 2007, 2008, and 2009. In June 2007, 4 of 13 (31%) animals sampled were *Bd*-positive: one juvenile returned a very strong positive signal (+++); another juvenile and an adult male had strong positive signals (++); another male returned a positive signal (+); while 4 females, 2 males and 3 juveniles were *Bd*-negative. In 2008, 2 of 7 (29%) animals had a very strong *Bd* presence (+++; 1 male and 1 juvenile): one of these had a strong (++) *Bd* signal in 2007 and one had not been infected in 2007. Two females and 3 juveniles were *Bd*-negative in 2008, of which one female and 3 juveniles were recaptures and were also *Bd*-negative in 2007. In 2009, *Bd* was detected on 5 of 7 (71%) individuals: 3 of 5 females and 2 of 2 males were infected, with signals ranging from no signal (-) to very strong positive signal (+++). In 2009, only one individual was recaptured from 2007 and showed an increase in infection from no signal or below detection (-) in 2007 to very strong positive signal (+++) in 2009. There were no other recaptures from 2007 and there were no recaptures from 2008.

Although the sample sizes in our study were extremely low, with only 2–8 animals sampled per site in 2009, *Bd* occurred at each site and the percentage of infection within sites (62% at Big Gun, 50% at Spivey Pond, 100% at Sailor Flat and 29–71% at Hughes Pond) appeared to be higher than previously reported rates for *R. draytonii* in central California. On average, 4% of *R. draytonii* were *Bd*-positive between the late 1800s and 2000, with a maximum of 25% and a minimum of 8.3% occurring after 1980 (Padgett-Flohr and Hopkins 2009). Currently, reported infections for *R. draytonii* along the coast of California show *Bd* occurring at 11 of 21 sites (52%: www. spatialepidemiology.net/bd-maps/surveillance/s_country.asp; accessed March 2010). *Bd* prevalence in the Sierra Nevada is also higher than reported for Ranidae species in the northeastern U.S. (between 15.5% and 25.7%, Longcore et al. 2007).

Our research was conducted with the aim of providing baseline information on the prevalence of *Bd* in the few *R. draytonii*

populations occurring in the Sierra Nevada. This knowledge is critical to inform managers that may consider actions to benefit conservation of the species, such as initiation of captive breeding or translocation activities, or by providing a disease profile of the area in which to recolonize the species from other populations. Monitoring of the frogs at these ponds is warranted to better understand the susceptibility of *R. draytonii* at these sites to chytridiomycosis. At this time, we have not observed mortality. Occurrence of *Bd* on sympatric species also needs to be examined, due to their potential role as disease carriers. As described in Padgett-Flohr (2008), *R. draytonii* are susceptible to *Bd* infection but remain asymptomatic and there may be a strong selection for *Bd* resistance. As a result, other species typically co-occurring with *R. draytonii* (e.g., *Rana boylii*) may be highly susceptible to cross infection. Biosecurity of these sites from incidental spread of the disease from recreational or other uses are management implications of the disease prevalence reported here. Although Padgett-Flohr and Hopkins (2010) did not find that recreational activity influenced the *Bd* status of a pond, indicating that humans via recreational activity are not likely transporting *Bd* between ponds, use of disinfection procedures and need for site quarantine are considerations given the status of the species.

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NATURAL HISTORY NOTES

The Natural History Notes section is analogous to Geographic Distribution. Preferred notes should 1) focus on observations in the field, with little human intrusion; 2) represent more than the isolated documentation of developmental aberrations; and 3) possess a natural history perspective. Individual notes should, with few exceptions, concern only one species, and authors are requested to choose a keyword or short phrase which best describes the nature of their note (e.g., Reproduction, Morphology, Habitat, etc.). Use of figures to illustrate any data is encouraged, but should replace words rather than embellish them. The section's intent is to convey information rather than demonstrate prose. Articles submitted to this section will be reviewed and edited prior to acceptance.

Electronic submission of manuscripts is requested (as Microsoft Word or Rich Text format [rtf] files, as e-mail attachments). Figures can be submitted electronically as JPG files, although higher resolution TIFF or PDF files will be requested for publication. Please DO NOT send graphic files as imbedded figures within a text file. Additional information concerning preparation and submission of graphics files is available on the SSAR web site at: http://www.ssarherps.org/HRinfo.html. Manuscripts should be sent to the appropriate section editor: **Jackson D. Shedd** (crocodilians, lizards, and *Sphenodon*; jackson.shedd@gmail.com); **Charles W. Painter** (amphibians; charles.painter@state.nm.us); **John D. Willson** (snakes; hr.snake.nhn@gmail.com); and **James Harding** (turtles; hardingj@msu.edu).

Standard format for this section is as follows: SCIENTIFIC NAME, COMMON NAME (for the United States and Canada as it appears in Crother [ed.] 2008. *Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico*. SSAR Herpetol. Circ. 37:1–84, available from SSAR Publications Secretary, ssar@herplit.com; for Mexico as it appears in Liner and Casas-Andreu 2008, *Standard Spanish, English and Scientific Names of the Amphibians and Reptiles of Mexico.* Herpetol. Circ. 38:1–162), KEYWORD. DATA on the animal. Place of deposition or intended deposition of specimen(s), and catalog number(s). Then skip a line and close with SUBMITTED BY (give name and address in full—spell out state names—no abbreviations). (NCN) should be used for common name where none is recognized. References may be briefly cited in text (refer to this issue for citation format).

Some further comments. The role of the "Standard Names" lists (noted above) is to standardize English names and comment on the current scientific names. Scientific names are hypotheses (or at least represent them) and as such their usage should not be dictated by a list, society, or journal.

Recommended citation for notes appearing in this section is: Medina, P., and R. L. Joglar. 2008. *Eleutherodactylus richmondi*: reproduction. Herpetol. Rev. 39:460.

CAUDATA — SALAMANDERS

AMBYSTOMA TALPOIDEUM (Mole Salamander). **POLYMELIA.** Amphibian malformations have been the topic of scientific and public interest for the past decade. Naturally-occurring deformities occur in populations, but are rare, usually less than 2% of individuals (Eaton et al. 2004. J. Herpetol. 38:283–287). Herein I describe a Mole Salamander with an unusual deformity. Paedogenic Mole Salamanders were dipnetted from a permanent pond in the Whitehall Experimental Forest near the University of Georgia campus in Athens, Georgia (USA), on 11 Dec 2008. This pond contains a large population of paedogenic Mole Salamanders in most years (ca. 300). A total of 7 males and 8 females were captured. Of these, all appeared normal except one male, which had an extra right forelimb (Fig. 1). The malformed male, along with 6 normal males ('reference males'), were examined in detail; I made note of the degree of swelling of the cloaca; total length (from snout to tail tip) was measured to the nearest 0.1 cm.

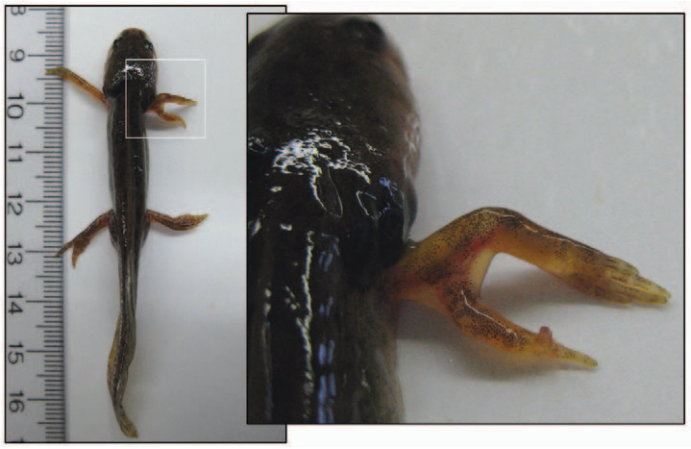


FIG. 1. Paedogenic Mole Salamander (*Ambystoma talpoideum*) with an extra forelimb on its right side. The extra limb originates from the middle part of the humerus, and has two toes (inset photo).

When examined in the lab it was clear there was an extra limb emerging from the humerus of its right forelimb (Fig. 1). The extra limb appeared to have an elbow and there were two toes. The limb was emerging from the posterior side of the right humerus, so that it trailed behind the salamander when it moved. A video of the salamander can be viewed at http://picasaweb.google.com/AndyDavisUGA/5LeggedMoleSalamander#. In the video, it appears that the extra limb did not hinder movement of the salamander, and appeared to be non-functional. The malformed male was noticeably smaller in mass and total length than most of the reference males. This male's mass was 3.0 g, average mass of the reference males was 3.5 g (± 0.3 SD); total length was 8.5 cm, average for the reference males was 9.1 cm (±0.3 SD). Though smaller than the reference males, it did have a large cloacal swelling, indicating it was in breeding condition. Three of the six reference males were also in breeding condition. Within the genus *Ambystoma*, there are scattered reports of deformities (Ouellet 2000. *In* Sparling et al. [eds.], Ecotoxicology of Amphibians and Reptiles, pp. 617–661. Soc. Environ. Toxicology Contaminants [SETAC] Press, Pensacola, Florida). Semlitsch et al. (1981. Herpetol. Rev. 12:69) reported a terrestrial adult Mole Salamander with five legs (one extra hindlimb) in South Carolina, although in that individual, the extra limb was semi-functional.

Despite only collecting 15 individuals on the sampling day, the actual frequency of malformations in this population is likely extremely small, since I have made many prior collections from this pond and others nearby (within 300 m), and have never encountered other malformed individuals. I have collected ca. 140 individuals from this and the nearby ponds, so the frequency of malformations could be less than 1% in this general area. Further, this pond is not near any source of chemical pollution, and has no history of environmental disturbance. Both of these points suggest this individual represents a "naturally occurring" deformity.

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AMPHIUMA MEANS (Two-toed Amphiuma) **x** ***AMPHIUMA TRIDACTYLUM*** (Three-toed Amphiuma). **HYBRIDIZATION**. The phylogenetic relationship among *Amphiuma* species is unclear, as molecular studies have produced discordant results (Bonett et al. 2009. PLoS ONE 4[5]:e5615. doi:10.1371/journal.pone.0005615; Karlin and Means 1994. Am. Midl. Nat. 132:1–9; Weisrock et al. 2005. Syst. Biol. 54:758–777). Although these studies indicate that the three taxa, *Amphiuma pholeter*, *A. means*, and *A. tridactylum* are separate species, intermediate specimens that possess characters of both *A. means* and *A. tridactylum* have been reported (Bonett et al. 2009, *op. cit.*; Hill 1954. Tulane Stud. Zool. 12:190–214).

Amphiuma means is identified by having two toes on each limb with uniform dark brown body color, while *A. tridactylum* has three toes on each limb, a dark brown dorsum, a pale gray belly, and a dark brown throat patch. *Amphiuma means* has a geographic range from southeastern Louisiana (East Baton Rouge Parish) to Virginia, while *A. tridactylum* ranges from eastern Texas to central Alabama. Although this is a substantial range overlap (ca. 640 km), the intermediate forms with incongruent toe number or color pattern are known only from a relatively small subset of this area (Mandeville, Talisheek Bay, and Pearl River, Louisiana, 25 km max. distance). Because these intermediate individuals represent a very small portion of the population, e.g., only three of 131 specimens collected from the overlap zone were intermediates (Hill 1954, *op. cit.*), the degree of hybridization has been largely regarded as negligible.

Here, I report additional intermediate specimens from Livingston Parish, Louisiana, 75 km farther west into the zone of overlap. Three individuals were collected from a roadside ditch in Livingston Parish, Frost, Gum Swamp Rd. 8.7 km. S. jct. Hwy 42 (30.3500°N, 90.6852°W). The first (Southeastern Louisiana University, SLU 396) had uniform coloration (like *A. means*) and a toe count, following the format of Hill (1954, *op. cit.*), of Right Forelimb/Left Forelimb, Right Hindlimb/Left Hindlimb, of 2/2, 3/3. The second individual (SLU 395) had uniformly dark coloration, but three toes on each of the four limbs. The third individual (SLU 397) had pure *A. tridactylum* characters. Baker (1947. J. Tennessee Acad. Sci. 22:9–21) described seven different toe patterns, including the normal number and shape for *A. means* and *A. tridactylum*, as well as a variety of anomalies. In each of the three individual *Amphiuma* that I collected, the two-toed and three-toed morphology was typical of *A. means* and *A. tridactylum*, as shown in Baker (1947, *op. cit.*, fig. 2a, d), and not otherwise anomalous or the result of mutilation. Discovery of these new intermediate individuals suggests that the relationship between *A. means* and *A. tridactylum* may be much more complicated than previously believed. Understanding this relationship will require extensive genetic sampling in the zone of overlap.

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ANEIDES AENEUS (Green Salamander). **RED PROTRUSIONS ON BODY.** *Aneides aeneus*, a crevice-dwelling species, is strictly terrestrial and the genus is considered



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FIG. 1. *Aneides aeneus* from northeastern Alabama showing isolated red protrusions.

to be the most terrestrial among plethodontids of the eastern United States (Gordon 1952. Amer. Midl. Nat. 47[3]:656–701). Like many amphibian species, *A. aeneus* populations have suffered drastic declines. Hafer (1992. M.S. thesis, Clemson University, Clemson, South Carolina) indicated that during the prior 15 years *A. aeneus* had disappeared from 78% of its known range. Currently, in ten of the thirteen states in which they are known to occur, *A. aeneus* are in jeopardy.

From May 2005 to December 2006 *A. aeneus* was studied at three sites in northeastern Alabama. During this study 26 (11.2%) of the 233 total collected individuals were observed having a series of red, circular, raised, capillary-filled protrusions (Fig. 1). Of the 26 individuals with protrusions, 21 (80.8%) were adults and 5 (19.2%) were sub-adults. No juveniles were observed with protrusions at any site. Occurrence of these protrusions ranged from 1 to 7 per individual.

The presence of these protrusions is new to *A. aeneus*, and possibly to terrestrial salamanders. Potentially, this occurrence is a major concern for a species that is already experiencing population declines. Other species of amphibians—*Eurycea longicauda longicauda, Notophthalmus viridescens viridescens, Pseudotriton ruber ruber, Rana clamitans melanota*, and *R. palustris*—were observed in crevices where *A. aeneus* was encountered. However, protrusions were not seen on any of these organisms. This might indicate that *A. aeneus* is more sensitive to or is experiencing more environmental stressors than sympatric amphibian species. Special attention needs to be given to other populations of *A. aeneus* to discover if these protrusions are an isolated event in northeastern Alabama or if they occur elsewhere in the species' range. Additional research is needed to determine the cause of these protrusions and their impact to individual salamanders.

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DESMOGNATHUS AENEUS (Seepage Salamander). **HABITAT.** Current species accounts for *Desmognathus aeneus* are derived mostly from observations made from the core of this species' range in the lower elevations of the Blue Ridge physiographic province of the Southern Appalachians, and habitat descriptions from this region converge on the common theme of moist mountain seepage areas in mesic hardwood forests (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens, 575 pp.; Petranka 1998. Salamanders of the United States and Canada. Smithsonian Press, Washington, D.C., 587 pp.). Outside of this region, *D. aeneus* is less common and there is less information on its habitat associations. This may eventually lead to a lack of understanding of this species' distribution, a false impression of its rarity, and has misdirected our own attempts to find these salamanders.

Here, we compile habitat information from three sites outside of the Blue Ridge, one of which represents an undocumented habitat type for this salamander. The Talbot Co., Georgia site is a recent range extension for this salamander into the Pine Mountain Ridges (Graham 2009. Herpetol. Rev. 40:232–233) in the Piedmont physiographic province, known for its unique herpetofaunal assemblage (Graham et al., *in press*). Of the three sites we examined, this site most closely matches the described habitat types for this species, although it is noteworthy how far south this site is (32.88055°N, 84.50418°W; WGS 84). It is seepage along a wet rock face on a north-facing slope with an overstory of Tuliptree, American Holly, Red Maple, Chestnut Oak, and Longleaf Pine, with a Mountain Laurel/Carolina Rhododendron shrub layer, and an herbaceous component of Trailing Arbutus, *Galax*, sphagnum, and other mosses. Other salamanders in the vicinity are *Desmognathus cf. apalachicolae*, *Gyrinophilus porphyriticus*, *Eurycea cirrigera*, and *Plethodon websteri*. Cheaha Mountain is in the Talladega Uplands of the Piedmont (Cleburne Co., Alabama), and has long been known to support populations of this species (Rubenstein 1969. J. Herpetol. 3:33–47). However, the seepage where we located this particular population (33.471962°N, 85.822916°W; WGS 84) appeared to be a typical, mucky seepage of the Piedmont and not especially montane in character. The overstory is composed of Tuliptree, White Oak, and Mockernut Hickory, with the shrubs Virginia Sweetspire and Mountain Laurel. Royal Fern and other ferns are present. Other salamanders include *D. conanti* and *P. glutinosus*. The third site in Bibb Co., Alabama, is a lowland gum swamp in the Fall Line Hills of the Coastal Plain physiographic province (32.906922°N, 87.392005°W; WGS 84). It is adjacent to a beaver dam marsh, an atypical site for this species. The dominant tree is Swamp Blackgum, along with Sweetbay, Red Maple, Tuliptree, American Holly, and Loblolly Pine. The shrub layer is Dog Hobble, and herbaceous plants include netted and Virginia Chain Fern, with abundant sphagnum moss. Salamander associates include *Pseudotriton ruber*, *P. montanus*, *D. conanti*, and *Plethodon mississippi*.

These collection trips were partially supported by NIH grant R01-A149724 to T. Unnasch under Georga collection permit 29-WBH-08-8.

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DESMOGNATHUS FOLKERTSI (Dwarf Black-bellied Salamander). **REPRODUCTION.** *Desmognathus folkertsi* is a recently described species (Camp et al. 2002. Herpetologica 58:471–484) whose reproductive biology is partially known (Camp and Marshall 2006. Southeast. Nat. 5:669–684). Egg clutches, however, have never been described. During the summer of 2009, we discovered three separate egg clutches and associated attending females of this species in northern Georgia, USA. Following measurements, all cover stones were replaced and females released beneath them.

The first clutch (found 11 July 2009), consisting of 24 eggs, was discovered at 34.6447222°N, 83.3377778°W in a small (1.5 m wide streambed) tributary of the Little Toccoa Creek in Stephens Co., Georgia. The nesting cavity lay between two flat stones, the upper stone having a flat surface area of 100 mm x 250 mm and a thickness of 25 mm. The eggs were attached singly to the upper surface of the lower stone and were submerged in a very shallow (3 mm) trickle of water. The attending female was 65 mm SVL.

The second clutch (19 July 2009) contained 36 eggs and was located at 34.8216667°N, 83.7333333°W in a small (2.1 m streambed) tributary of the Hiwassee River in Towns Co., Georgia. The nesting cavity was beneath a flat stone (upper surface 160 mm x 150 mm; thickness 71 mm) over a floor of gravelly sand. The eggs, all newly laid, were attached singly and in distinct rows on the lower surface of the overlying stone. They ranged 4.0─4.5 mm in diameter and were 31 mm deep in running water. The attending female was 71 mm SVL.

The third clutch (22 July 2009) consisted of 38 eggs. It was located at 34.6683333°N, 83.3211111°W in Rothwell (Walker) Creek (ca. 5 m streambed) in Stephens Co., Georgia. The eggs were beneath a flat stone (upper surface 190 mm x 135 mm; thickness 40 mm) overlying gravelly sand and were attached singly to the lower surface of the cover stone. They had distinct embryos and measured an average of 6.1 mm in diameter. The eggs were all in running water at a depth of 30 mm. The attending female was 66 mm SVL.

The timing and manner of clutch-laying that we report herein indicate that oviposition and nest attendance in *D. folkertsi* is largely typical of *Desmognathus* (Petranka 1998. Salamanders of the United States and Canada, Smithsonian Institution Press, Washington, DC). The exception is the first clutch, whose eggs were laid on the floor of the nesting cavity instead of the roof. This is unusual for members of this genus, but the presence of another stone rather than sand or gravel as a floor may have been a contributing factor.

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DESMOGNATHUS QUADRAMACULATUS (Black-bellied Salamander). **RECORD CLUTCH AND EGG SIZE.** *Desmognathus quadramaculatus*, a common resident of streams in the southern Appalachian Mountains, has been the subject of numerous studies of reproductive biology (Bruce 1996. Copeia 1996:783–790). The maximum size reported for field clutches of this species is 56 eggs (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, DC). Reported egg diameter is 3.9 mm (Tilley and Bernardo 1993. Herpetologica 49:154–163). On 19 July 2009, we discovered a nest attended by a female at 34.8208333°N, 83.735°W in a small (2.7 m wide streambed) tributary of the Hiwassee River in Towns Co., Georgia, USA. The clutch contained 82 eggs that averaged 7.0 mm diameter; all had well developed embryos. The eggs were submerged, suspended in running water that was 40 mm deep. Each egg was individually attached to the lower surface of an emergent, flat stone that measured 293 mm x 234 mm in upper surface area and was 24 mm thick. The attending female measured 97 mm SVL. The cover stone was replaced and the female released beneath it following measurements.

Both clutch size and egg diameter are significantly greater than previously reported. The large size and number of eggs are not unexpected, however. Both egg and clutch size is positively related to SVL in this species (Tilley 1968. Evolution 22:806–816; Camp et al. 2000. Can. J. Zool. 78:1712–1722), and populations from the Hiwassee River drainage contain the largest individuals known (Camp et al. 2002. Herpetologica 58:471–484).

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PSEUDOEURYCEA ORCHIMELAS (Tuxtlan Worm Salamander). **DEFENSIVE BEHAVIOR**. *Pseudoeurycea orchimelas* is known to flip violently and unpredictably, propelling itself by rapidly coiling and uncoiling the body when handled. By using its long tail as a launching device, these salamanders may easily flip out of the hand and disappear into the leaf litter (Brodie et al. 2002. Herpetologica 58:201). Here we present another defensive behavior observed on this species.

On 5 July 2008, we found a *P. orchimelas* (80 mm total length) under a rock (22.6ºC, 99% relative humidity) in a tropical rain forest fragment at Los Tuxtlas, Veracruz, México (18.5656528°N, 94.1268722°W, 600 m elev). When discovered, the first reaction of the salamander was to flee among the leaf litter but was immediately captured. Once in the hand of one of the authors it clasped its limbs along the body and remained straight and motionless (resembling a twig) while it was measured and examined, which took about two min. It was then placed on the leaf litter to be photographed and after a minute it had returned to a natural position and started moving again.

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PSEUDOTRITON MONTANUS DIASTICTUS (Midland Mud Salamander). **PARASITES.** Little is known about the parasites of *Pseudotriton montanus*. Rankin (1937a. Ecol. Monogr. 7:169–269; 1937b. J. Parasitol. 23:29–42) reported *Allocreadium pseudotritoni*, *Gorgoderina bilobata*, larval *Physaloptera* sp., and *Hannemania dunni* from Eastern Mud Salamanders (*P. m. montanus*) from North Carolina. Other reports include Catalano et al. (1982. Ohio J. Sci. 82:120–128) who documented *A. pseudotritoni* and *Megalodiscus temporatus* from Midland Mud Salamanders from Ohio, and Nickol and Heard (1973. Proc. Helminthol. Soc. Washington 40:204–208) who found *Fessisentis necturorum* in larval *P. m. montanus* from Georgia. Here we report a new host and distributional record for an endo- and ectoparasite of *P. m. diastictus* from Kentucky.

One *P. m. diastictus* (45 mm SVL, female) was collected by hand on 30 July 2007 from Garrard Co., Kentucky, 6.5 km NE of Crab Orchard (37.49160°N, 84.44293°W). It was euthanized with a dilute chloretone solution. Chiggers (*H. dunni*) were excised from skin lesions and processed per methods of McAllister et al. (1995. J. Helminthol. Soc. Washington 62:150–156). In addition, a midventral incision was made to expose the entire length of the digestive tract. Two trematodes (*A. pseudotritoni*) were recovered from the small intestine, stained with Delafield's hematoxylin, and mounted with Canada Balsam. Specimens are deposited in the United States Parasite Collection (USNPC), Beltsville, Maryland as USNPC 100476 (*A. pseudotritoni*) and 101115 (*H. dunni*). A host voucher is deposited in the Arkansas State Herpetological Museum (ASUMZ), State University, Arkansas as ASUMZ 30827.

We report a new distributional record for the trematode *A. pseudotritoni*, previously reported from 2 of 3 (67%) *P. m. montanus* from Durham Co., North Carolina (Rankin 1937, *op. cit.*) and 5 of 9 (56%) *P. m. diastictus* from Adams, Scioto, and Vinton counties, Ohio (Catalano et al. 1982, *op. cit.*). In addition, a new host record for the chigger *H. dunni* is documented for *P. m. diastictus*, previously reported from 1 of 3 (33%) *P. m. montanus* from Durham Co., North Carolina (Rankin 1937, *op. cit.*). We suggest additional specimens of *P. m. diastictus* from Kentucky be examined for helminths in an attempt to provide comparative prevalence and parasite intensities.

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ANURA — FROGS

AGALYCHNIS MORELETII (Morelet's Frog). **PREDATION.** *Agalychnis moreletii* is a critically endangered treefrog surviving only in small pockets in northern Central America (IUCN RedList). Here I report what appears to be a common predator of this frog in central Belize.

On 19 June 2002, I witnessed a cat-eyed snake *Leptodeira septentrionalis* eating a large female *A. moreletii*. On several further occasions that summer and in the years following, at various breeding aggregations across the region, I witnessed *A. moreletii* eggs and adults being depredated by *L. septentrionalis*, indicating that eggs and adults of *A. moreletii* are likely a common item in the diet of *L. septentrionalis*. In 2008, I found two frogs at one breeding aggregation with what appeared to be fang marks in their backs. At the sites where these observations were made, *L. septentrionalis* is a common snake, with several individuals being observed at *A. moreletii* choruses each night. Although *L. septentrionalis* is known to feed on frog eggs (Lee 2000. A Field Guide to the Amphibians and Reptiles of the Maya World. Cornell Univ. Press, Ithaca, New York. 416 pp.), feeding on *A. moreletii* has not been previously documented.

This work was supported by Cleveland State University and the Columbus Zoo and Aquarium.

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AMIETOPHRYNUS CAMERUNENSIS (Cameroon Toad). **DEFENSIVE BEHAVIOR**. Frogs show a variety of defense and predator avoidance behaviors (e.g., aposematic coloration, cryptic coloration, chemical defenses). Use of parotid secretions in toads as a means of defense is well known, as these glands contain poisonous or noxious secretions (Vitt and Caldwell 2009. Herpetology, 3rd ed. Academic Press, San Diego, California. 720 pp.). Herein I report an observation from the Mawne River Forest Reserve in western Cameroon. An individual *Amietophrynus camerunensis* was collected on 27 September 2007 in a primary rainforest (5.87765°N, 9.5148833°E; ca. 132 m elev.) and deposited in the collection of the Zoologisches Forschungsmuseum Alexander Koenig, Bonn (ZFMK 87820). When touched on the back the toad assumed a specific position and its parotids secreted a small amount of poison (Fig. 1). The toad dropped its head, lifted the abdomen and formed a "bow" with its back, its parotids being orientated towards the opponent. After a while the toad interrupted this position and started to hop away until it was disturbed again. The specimen repeated



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FIG. 1. Defensive behavior of the Cameroon Toad, *Amietophrynus camerunensis.*

the behavior and assumed the same position, oriented towards its opponent. After a couple of repetitions, the behavior became less distinct and the toad only dropped its head without lifting the abdomen. The same response to touch was later observed in another individual (ZFMK 87822; 3 Oct 2007, Cameroon, near Amebishu; 5.8977667°N, 9.55825°E; ca. 166 m elev.). A similar behavior was reported for *Rhinella* cf. *crucifer* (Toledo 2004. Herpetol. Rev. 35:370–371). In contrast, *R.* cf. *crucifer* arranged either its lifted head or lifted abdomen independently towards the opponent depending on the position of the touch on the front or hind of the dorsum. As in *R.* cf. *crucifer* the behavior in *A. camerunensis* indicates an enlargement of the surface towards the predator, as well as a more appropriate positioning of the parotids, both suggesting a means of deterrence.

Thanks to the Cameroonian authorities for permits to conduct this research (Ministry of Research and Innovation: N049/MINRESI/B00/C00/C10/C12; Ministry of Forestry and Wildlife: N0836/PRBS/MINFOF/SG/DFAP/SDVEF/SC) and the German Exchange Service DAAD for financial support.

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ANAXYRUS BOREAS (Western Toad). **ADVERTISEMENT VOCALIZATION**. The presence of advertisement vocalization (mating or breeding calls) in the Western Toad species group (*Anaxyrus* [*Bufo*] *boreas*) has not been well established. It is generally accepted that Western Toads lack vocal sacks (Black and Brunson 1971. Great Basin Nat. 31:109–113; Hammerson 1999. Amphibians and Reptiles in Colorado. 2nd ed. Colorado Div. Wildlife Publ., Univ. Press Colorado, Niwot, Colorado) and have lost their advertisement calls (Blair 1972. *In* W. F. Blair [ed.], Evolution in the Genus *Bufo*, pp. 93–101. Univ. Texas Press, Austin, Texas; Marco et al. 1998. Anim. Behav. 55:1631–1635), although there are reports to the contrary (Awbrey 1972. Copeia 1972:579–581; Cook 1983. Natl. Museums of Canada Publ. Nat. Sci., 3, Ottawa, Ontario). Males will emit 'release calls' when grasped by another toad or a researcher, consisting of a series of short chirps that identify the individual as a male and trigger a release response in males attempting amplexus (Nussbaum et al. 1983. Amphibians and Reptiles of the Pacific Northwest. Univ. Press Idaho, Moscow, Idaho. 332 pp.). Males might also give a release-like call when encountering other males (encounter call) without attempting amplexus, sometimes resulting in 'chorus-like' group vocalizations (Black and Brunson 1971, *op. cit.*). These choruses might act to attract females from the surrounding habitat, but this has not been clearly demonstrated.

A Boreal Toad (*A. b. boreas*) breeding congregation was observed in a wetland southeast of Whitecourt, Alberta, Canada (53.9822286962005°N, 115.46401912003°W; NAD 83) in 2007, 2008, and 2009. Toads usually began spawning in mid-to-late May and continued through June or later. I present video and audio evidence clearly illustrating Boreal Toads engaging in advertisement vocalization, recorded 10 June 2009. Several video and audio clips documenting this breeding congregation can be viewed at http://flash.lakeheadu.ca/~zlong/, or obtained by contacting the author. The primary clip (bts_presentation.mov) features a single male toad vocalizing in a series of rapid, extended trills characteristic of toad advertisement calls. The inflated external median subgular vocal sac of the male is clearly visible moving with the pulses of the vocalization. Other advertising males can be heard in the background, engaging in what sounds like call/reply exchanges. This is a clear example of display behavior, and not release or encounter vocalization.

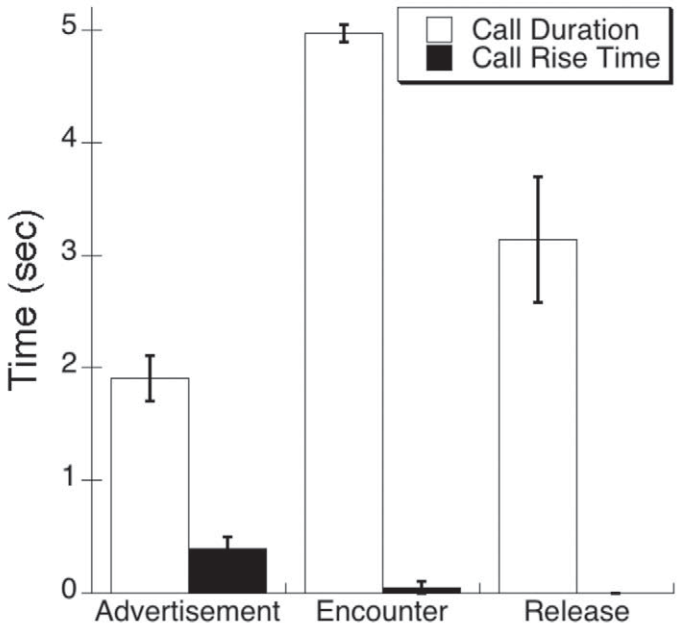


FIG. 1. Mean call duration and call rise time by vocalization type. Error bars represent standard error. Figure uses non-transformed data.

Waveform analysis was conducted on four advertisement vocalizations recorded near Whitecourt. Call duration and call rise time was measured for each discrete vocalization. Within each call, pulse duration, pulse rise time, and interpulse intervals were

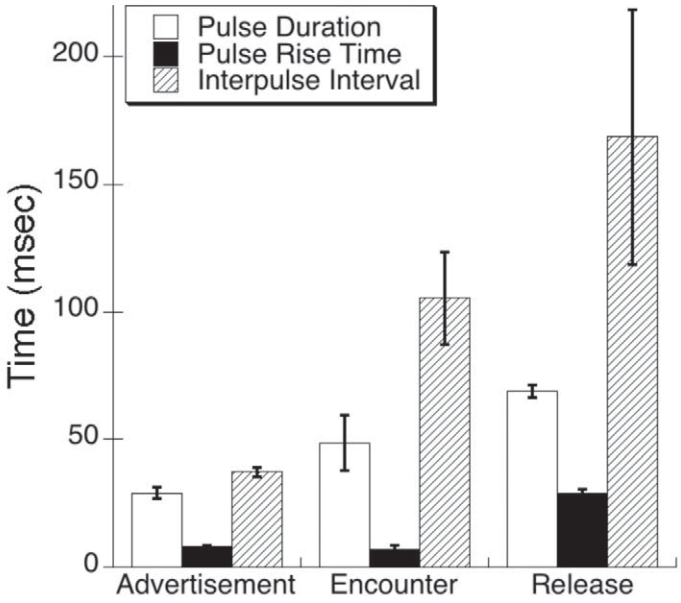


FIG. 2. Mean pulse duration, pulse rise time and interpulse intervals by vocalization type. Error bars represent standard error. Figure uses non-transformed data.

measured for five randomly selected, sequential, mid-call pulses. The Alberta recordings were compared to two encounter calls and two release calls taken with permission from CaliforniaHerps.com (2009*a*. http://www.californiaherps.com/frogs/pages/b.b.boreas.sounds.html. Accessed 28 Oct 2009; http://www.californiaherps.com/frogs/pages/b.b.halophilus.sounds.html. Accessed 28 Oct 2009) to serve as a point of reference. Analysis of variance was conducted on $\log_{10}$-transformed data to test for differences in waveform characteristics between the three call types ($\mu = 0.05$).

The advertisement vocalizations recorded in Alberta were shorter ($F_{2,5} = 18.080$, $P < 0.01$), but displayed the longest call rise time ($F_{2,5} = 10.406$, $P = 0.02$) (Fig. 1). The advertisement calls also had the shortest pulse duration ($F_{2,5} = 15.298$, $P < 0.01$) and interpulse interval ($F_{2,5} = 21.798$, $P < 0.01$) (Fig. 2). Advertisement and encounter calls displayed similar pulse rise times, both values being lower than that for release calls ($F_{2,5} = 57.859$, $P < 0.01$) (Fig. 2).

Although analyses were conducted on a small unbalanced dataset, these data strongly suggest that Boreal Toad vocalizations recorded in Alberta are indeed unique and structurally different from encounter and release calls previously described for the Western Toad species group. Combined with behavioral observations supported by video evidence, I believe that these were advertisement vocalizations. The function of these calls has not been demonstrated, but they likely serve to attract toads from the surrounding habitat, and advertise individual fitness. This has been documented in *A. americanus* through a correlation between body size and dominant call frequency (Howard and Young 1998. Anim. Behav. 55:1165–1179). The geographic range of vocal Western Toad populations remains uncertain.

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BATRACHYLA TAENIATA (NCN). **BODY TEMPERATURE.** *Batrachyla taeniata* inhabits temperate forests in southern Chile, from the province of Aconcagua and relict forests of Quintero to Chiloé and Aysén (Rabanal and Núñez 2008. Anfibios de los Bosques Templados de Chile. Universidad Austral de Chile, Valdivia, Chile. 206 pp). Almost nothing is known about amphibian thermoregulation in Chilean species, therefore the purpose of this note is to provide information on the thermal ecology of *B. taeniata*. We investigated the relationship between cloacal temperature (T_b), substrate temperature (T_s), and air temperature (T_a), and their relationship to body size of these frogs under field conditions.

Twenty-six females and 22 adult males were collected at Las Quemas (41.5°S, 79.15°W; 28 m elev.) in the Province of Llanquihue during March 2009. This locality is in the hygromorphic phytogeographical region, characterized by a temperate climate with rainfall throughout the year. Immediately after capture T_b, T_s, and T_a were recorded to +0.01°C). Frogs were weighed (g) and measured (SVL, mm). Data are shown as mean ± SD.

The mean T_b of females was 10.34ºC ± 0.79 (range 8.9–11.7ºC) and males was 10.38ºC ± 0.62 (range 9.3–12.5ºC). Because no significant differences were found between sexes in T_b ($t_{46} = -0.19$, $p = 0.85$), all data were pooled. The field T_b was positively correlated with T_a ($r^2 = 0.94$, $p < 0.0001$) and T_s ($r^2 = 0.89$, $p < 0.0001$). There was no observed association between T_b and body length ($r^2 = 0.04$, $p = 0.16$) or weight ($r^2 = 0.058$, $p = 0.09$).

Our results suggest that *B. taeniata* is a thermoconformist under field conditions. According to other studies, frogs have little ability to control body temperature because of a compromise between thermal conditions and water balance, which reduces the ability of these animals to thermoregulate behaviourally (Seebacher and Alford 2002. J. Herpetol. 36:69–75). However, this physiological performance could be related to saving time and energy for other behaviors (Labra and Vidal 2003. *In* F. Bozinovic [ed.], Fisiología Ecológica y Evolutíva, pp. 207–224. Ediciones Universidad Católica de Chile, Santiago, Chile).

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BOKERMANNOHYLA SAXICOLA (NCN), ***SCINAX CURICICA*** (Lanceback Treefrog), ***SCINAX SQUALIROSTRIS*** (Snouted Treefrog), ***TRACHYCEPHALUS MESOPHAEUS*** (Golden-eyed Treefrog), and ***ELACHISTOCLEIS* SP.** (Oval Frog). **MORPHOLOGY**. Malformation in frogs is known for adults (Blaustein et al. 2003. Front. Ecol. Environ. 1[2]:87–94) and tadpoles (Piha et al. 2006. Environ. Toxicol. Chem. 25[12]:3164–3170). In tadpoles, malformations may occur in all body parts (body, head, eyes, tails, and limbs). For tails, recorded malformations are two tails (Budischak et al. 2008. Environ. Toxicol. Chem. 27[12]:2496–2500), tail with a torsion at the distal and proximal regions (Haddad et al. 1990. Rev. Bras. Biol. 50[3]:739–744), and bifurcated or forked tails (USFWS 1999. Standard Operating Procedures for Abnormal Amphibian Surveys; Wright 2002. Life Histories of the Frogs of Okefinokee Swamp, Georgia, p. 307). The most common referred causes suggested for malformations (including those in post-metamorphic anurans) are injuries (Morgan 1990. Biol. Bull. 2[3]:111–119), parasites (Johnson et al. 2002. Ecol. Monogr. 72[2]:151–168), viral infection (Burton et al. 2008. Vet. J. 177:442–444), fungal infection (Blaustein et al. 2005. Cons. Biol. 19[5]:1460–1468), UV-B exposure (Uitregt et al. 2007. Glob. Change Biol. 13[6]:1114–1121; Licht 20003. BioScience 53[6]:551–561), environmental contamination from pesticides or other pollutants (Brunelli et al. 2009. Aq. Toxicol. 91[2]:135–142; Sayim 2008. Turk. J. Zool. 32:99–106, Paisio et al. 2009. J. Hazard. Mat. 167:64–68; Taylor et al. 2005. Environ. Health Persp. 113[11]:1497–1501), and natural hybridization (Haddad et al. 1990. Rev. Brasil. Biol. 50[3]:739–744).

During fieldwork between 1972 and 1974 five tadpoles were

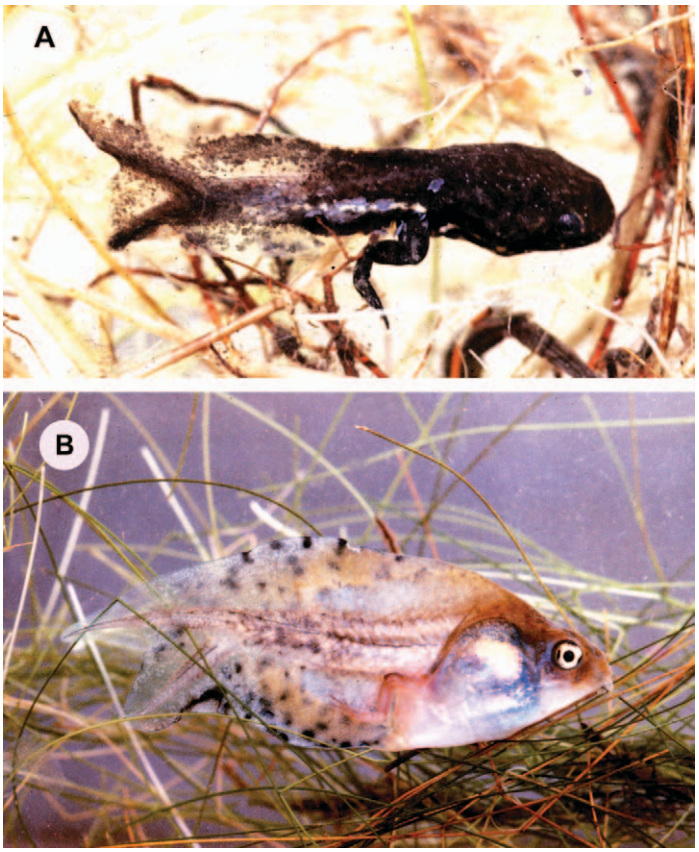


FIG. 1. Tadpoles of *Elachistocleis* sp. (A) and *Scinax curicica* (B) with bifurcated tails.

obtained that had bifurcated tails: one microhylid, *Elachistocleis* sp. (Fig. 1A) and four hylids, *Bokermannohyla saxicola* (ZUEC 15451), *Scinax curicica* (ZUEC 15575; Fig. 1B), *S. squalirostris* (ZUEC 15452), and *Trachycephalus mesophaeus* (ZUEC 16252). The microhylid and the first three hylids were collected at Serra do Cipó, municipality of Jaboticatubas, state of Minas Gerais, SE Brazil, whereas the fourth hylid was collected in the municipality of Ubatuba, state of São Paulo, SE Brazil. These specimens are in the Amphibian Collection of the Museu de Zoologia "Prof. Adão José Cardoso" (ZUEC), Universidade Estadual de Campinas, Campinas, Brazil. The swimming ability of the fork-tailed tadpoles apparently was unaffected or little affected by the malformation, although the mid-water hovering tadpole of *S. curicica* might be hampered in its foraging (I. Sazima, pers. comm.).

This type of malformation (forked tail) has been classified as superficial as it may be the result of healed injuries (Morgan 1990, *op cit.*; USFWS 1999, *op cit.*). However, we cannot rule out the possibility of the influence of one or multiple environmental contaminants for the *T. mesophaeus* tadpole, as it was collected in a drainage ditch. The remaining tadpoles were collected in relatively pristine habitats.

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BUFO DEBILIS (Green Toad). **MORTALITY**. Little is known about the negative fitness costs of reproduction on amphibians in arid regions. Herein we document a mass anuran mortality event of unknown cause(s), consisting mainly of *Bufo debilis* but also including other bufonids and pelobatids.

We sampled Chihuahuan Desert wetlands on Bureau of Land Management land for water parameters during July 2009. We found a large number of dead bufonid and pelobatid anurans at a desert playa that has an earthen cattle tank excavated within its perimeter (UTM 13S 0317867, 3565407; NAD 27). Monsoonal rains had elicited a breeding event during 4–5 July 2009, and an additional rain on 10–11 July likely prolonged the breeding event. *Bufo debilis* were present the first evening after the rain, but were not calling with the rest of the chorus. We returned on 14 July and found a large number of dead *B. debilis*, *B. cognatus*, *Scaphiopus couchii*, *Spea bombifrons*, and *Sp. multiplicata*). We then formally surveyed for bodies 15 July 2009 walking transects across the wetland and being meticulous to not double-count individuals. Carcasses appeared to be distributed randomly along the shore and around grass clumps in the water. There were likely more individuals initially dead on the upland surrounding the playa, but we sampled several days after the rain event and many, if not most, of the dead individuals on land were likely eaten or carried away. We searched the wetland (140 m x 80 m) and found 21 *B. debilis*, two *B. cognatus*, and three unidentified pelobatids dead, floating around the edges of the wetland and adjacent to grass clumps within the wetland. We had two carcasses (*B. cognatus* and *S. couchii*) tested for the presence of *Batrachochytrium dendrobatidis* (*Bd*) using PCR at Texas Tech University. Swabs were taken from the toes, and dorsal and ventral surfaces of each frog. No evidence of *Bd* infection was found. However, it should be noted that the sample size was small and the individuals sampled were degrading by the time we collected them in the field.

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BUFO TERRESTRIS (Southern Toad). **PREDATION**. While conducting a road survey at ca. 2100 h on 3 July 2009 in Okaloosa Co., Florida (USA), we encountered a juvenile Black-crowned Night-Heron, *Nycticorax nycticorax*, walking along a dirt road. The bird was apparently using the road as a foraging corridor and feeding on toads and other prey items. As we watched, the heron captured and began to consume a *Bufo terrestris*. We were unable to determine if the heron would have ingested the toad

as all parties were startled by the appearance of an individual in the course of a military exercise. Approximately 45 minutes later we encountered what was likely another juvenile Black-crowned Night-Heron also foraging on the road. We observed the bird capture and consume another toad; likely a *B. terrestris* although we were unable to confirm identification due to the small size of the toad. Our observations indicate that Black-crowned Night-Herons are predators of *B. terrestris* and roads may facilitate avian predation on anurans.

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CHIROMANTIS VITTATUS (Burmese Bushfrog). **COLORATION.** *Chiromantis vittatus* is a small rhacophorid frog distributed from northeastern India, Myanmar, Thailand, Laos, Cambodia, and Vietnam and southern China (Frost 2009. Amphibian Species of the World: an Online Reference. Version 5.3 http://research.amnh.org/herpetology/amphibia/). The typical dorsal color pattern of *C. vittatus* is yellowish to violet brown, with a series of indistinct violet brown stripes or spots (Bourret 1942. Les Batrachiens de l'Indochine. Hanoi, l'Institute Océanographique de L'Indochina, Hanoi. 547 pp.; Taylor 1962. The Amphibian Fauna of Thailand. Univ. Kansas Sci. Bull. 43:267–599; pers. obs.). During amphibian surveys in Prey Long, Kratie Province, Cambodia (13.074817ºN, 105.807267ºE; 166 m elev.), we observed a single male *C. vittatus* displaying a striking pale yellow dorsum with distinct, dark brown reticulations on all dorsal surfaces with the exception of pale yellow lateral stripes (Fig. 1, AM R 171914). Although the species displayed some color variation at Prey Long, with some individuals being uniformly pale brown or yellow and some displaying stripes or faint reticulations, of several hundred individuals observed at the site, this was the only individual displaying such distinct and unusual coloration. As such, this coloration is likely a random mutation, and not a color variant.



COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND

Fig. 1. *Chiromantis vittatus* with typical dorsal coloration (left) and unusual dorsal coloration (right), Kratie Province, Cambodia.

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DENDROPSOPHUS MINUTUS (Lesser Treefrog). **PREDATION.** Numerous authors have reported the predation of tadpoles and adult anurans principally by snakes, leeches, insects, and spiders (Toledo 2005. Herpetol. Rev. 36:395–400). *Dendropsophus minutus* is a small, nocturnal, and common hylid treefrog distributed widely in South America (Frost 2007. http://research.amnh.org/herpetology/amphibia). On 22 Sept 2001 we found a young female spider, *Ancylometes concolor* (Ctenidae) capturing and eating an adult *D. minutus* in vegetation around the margin of an artificial pond at Sucupira Experimental Farm/EMBRAPA (15.52ºS, 48.00ºW), located southwest of Brasília, Brazil in a core area of Cerrado biome. Spiders of the genus *Ancylometes* are reported to prey on *D. minutus* in the Amazonian region (Bernarde et al. 1999. Biociências 7:199–203; Menin et al. 2005. Phyllomedusa 4:39–47) but this is the first report of such predation in the Cerrado biome. The spider was deposited in the Coleção de Aracnídeos da Universidade de Brasília, Brasília, Brazil (DZUB 1289).

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HYLA CINEREA (Green Treefrog). **MORPHOLOGY.** In most anurans mate attraction is facilitated by acoustic communication, and males have an elastic vocal sac that inflates and deflates with each call (Duellman and Trueb 1994. Biology of Amphibians. John Hopkins Univ. Press, Baltimore, Maryland). This vocal sac can sometimes be damaged or deformed, often with catastrophic consequences for the affected male (McCallum et al. 2001. Herpetol. Rev. 32:248–249).

On 14 June 2009 we captured an amplexed pair of *Hyla cinerea* at a pond at Beechwood Fish Hatchery in central Louisiana. The male had a vocal sac that was stuck half inflated, and had an additional large, air-filled "hump" on his back that extended all the way from the head to the vent (Fig 1). After separating the male from the female, he began to produce several advertisement calls. The male stopped calling before call recordings for detailed acoustic analysis could be obtained, but to an experienced observer, the calls did not sound different from calls produced by frogs with normal vocal sacs. The male did not seem to suffer major negative consequences despite the extent of the deformity. His movements seemed relatively unimpaired by the extended vocal and dorsal sacs, and he was in good body condition, suggesting that he was capable of catching prey and feeding



FIG. 1. Adult male Green Tree Frog (*Hyla cinerea*) with abnormal vocal and dorsal sacs.

normally. He was also able to call and enter amplexus, although it is impossible to verify whether he attracted the female himself or found her via satellite behavior. This alternative mating tactic—where silent males intercept females attracted by calling males—is frequently observed in *Hyla cinerea* (Perrill et al. 1978. Science 200:1179–1180). The male was released at the point of capture.

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HYPSIBOAS ALBOPUNCTATUS (Spotted Treefrog). **PREDATION.** Anurans have behavioral traits that expose them to the risk of predation, and are preyed on by invertebrates, fishes, anurans, reptiles, and birds (Pombal Jr. 2007. Rev. Bras. Zool. 24[3]:841–843; Muniz et. al. 2008. Iheringia 98[2]:254–259; Ghizoni-Jr et. al. 2000. Melopsittacus 3[3]:137–139). However, predation is difficult to document in nature, but it is estimated that such events occur frequently (Pombal Jr. 2007, *op. cit.*).

Hypsiboas albopunctatus is a medium-sized hylid found in Brazil, Argentina, Uruguay, Bolivia, and Paraguay (Frost 2009. Amphibian Species of the World: an Online Reference.< http://research.amnh.org/herpetology/amphibia>. 10 Sept 2009), and is known to occur in Floresta Nacional (FLONA) of Silvânia (16.6588889°S, 48.6080556°W, 900 m elev.), state of Goiás, central Brazil. *Hypsiboas albopunctatus* are often observed in open areas and along streams. Herein, we record predation of an adult *H. albopunctatus* by the viper, *Bothrops moojeni* in the FLONA.

On 08 January 2009 at 2230 h, a juvenile *B. moojeni* was observed ingesting a *H. albopunctatus*. This observation occurred along a stream, where other anurans including *H. lundii*, *H. goianus*, and *Scinax centralis*, are found and could be potential prey of *B. moojeni*. This event was photographed and observation began when the snake had already captured the *H. albopunctatus*. Observations lasted ca. three minutes until the frog was fully ingested, and after this the *B. moojeni* remained still. In Atlantic rainforest**,** *B. jararaca* is a sit and wait predator, where the prey approaches the predator (Hartmann et. al. 2003. Phyllomedusa 2[1]:35–41). We suggest that the predation event reported herein may have occurred in a similar way.

The photographs were deposited at Laboratório de Comportamento Animal/DBG/ICB.

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ISCHNOCNEMA RAMAGII (Paraiba Robber Frog). **PREDATION.** Spiders are well known predators of small amphibians (Del-Grande and Moura 1997. Herpetol Rev. 28:147; Formanowicz et al. 1981. Herpetologica 37:125–129; Menin et al. 2005. Phyllomedusa 4[1]:39–47). *Ischnocnema ramagii* is typical of areas of the Atlantic forest in northeastern Brazil, occurring in the state of Paraíba to Bahia (Frost 2008. Amphibian Species of the World 5.2 – An Online Reference Amer. Mus. Nat. Hist.: http://research.amnh.org/herpetology/amphibia/index.php, accessed 12 May 2008). *Ischnocnema ramagii* lives in the sub-forest above the forest floor litter (Juncá 2006. Biota Neotrop. 6[2]:1–17).

Herein we report two events of predation on adult *I. ramagii* (21.1 and 19 mm SVL, Fig. 1) by the spiders *Ancylometes rufus* and *Ctenus rectifier* (Ctenidae). The observation occurred on 02 October 2008 at 1900 h and on 20 November 2008 at 1930 h in an area of Atlantic forest in the Parque Nacional Serra of Itabaiana (10.7488889°S, 37.3419444°W; SAD 69), Sergipe, Brazil. In Brazil, the spiders *Ancylometes* and *Ctenus* are known anuran predators (Bernarde et al. 1999. Biociências 7:199–203; Rodrigues et al. 2007. Herpetol. Rev. 38; Menin et al. 2005. Phyllomedusa 4:39–47; Serafin et al. 2007. Herpetol. Rev. 38:437, but these reports are from the northern and southeastern regions of Brazil; there are no reports from northeastern Brazil. Additionally, we are unaware of any reports documenting the



FIG. 1. The spider *Ancylometes rufus* preying on an adult *Ischnocnema ramagii*.

predation of *Ischnocnema ramagii* by spiders. The spiders were collected and deposited in the Coleção of Arachnids and Chilopoda, Instituto Butantan (IBSP122.178 and IBSP122.179) and the anurans in Coleção Herpetológica, Universidade Federal of Sergipe (CHUFS 00200, 00201).

We thank Antonio D. Brescovit (Laboratório of Aracnologia - Instituto Butantan) for identification of the spiders and Fábio Santos do Nascimento (Universidade Federal of Sergipe) and Thaís B. Guedes (LEEV - Instituto Butantan) for revision of the manuscript.

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LEPTODACTYLUS SAVAGEI (Smoky Jungle Frog) **ANTIPREDATOR DEFENSE.** Amphibians possess a broad suite of chemical defenses to deter predators (Toledo and Jared 1995. Comp Biochem Physiol. 111A:1–29), and this can lead to an evolutionary arms race between predator and prey. Snakes are common predators of amphibians and many amphibians have evolved toxins that deter them (Williams et al. 2003. Herpetologica 59:155–163). *Leptodactylus savagei* (Heyer 2005. Arq. Zool. 37:269–348) is a large, robust frog with males reaching 177 mm and females reaching 185 mm SVL (Savage 2002. Amphibians and Reptiles of Costa Rica. A Herpetofauna Between Two Continents, Between Two Seas. Univ. Chicago Press, Chicago, Illinois. 934 pp). This species ranges from Honduras to central Colombia and is a common inhabitant of SW Costa Rica. It has been reported anecdotally that this species produces noxious compounds in its skin that may cause a skin rash, sneezing, and irritation of mucus membranes in humans (Savage 2002, *op. cit.*; Toledo et al. 2007. J. Zool. 271:170–177). These noxious skin compounds may have evolved to deter vertebrate predators, yet Roberts (1997. Herpetol. Rev. 28: 84–85.) reported predation of *L. pentadactylus* by the mustelid *Lutra longicaudus* in Brazil.

One of the more commonly encountered snakes in SW Costa Rica is the viper *Bothrops asper*, which can reach lengths of 2.3 m (Solórzano 2004. The Snakes of Costa Rica. INBio. 791 pp.). This snake is a generalist predator, and juveniles and subadults consume mostly frogs and lizards and broaden their diets to include birds and mammals when they become adults (Solórzano 2004, *op. cit.*). Solórzano (2004, *op. cit.*) reports that *B. asper* consumes members of Leptodactylidae, and there are no reports of *B. asper* having adverse reactions to noxious prey. Herein we report a predation attempt by *B. asper* (109 cm TL) on an adult *L. savagei* (101 mm male) where the snake experienced severe deleterious effects apparently from skin toxins of *L. savagei*.

Our observations occurred at a small stream at Tres Piedras, Puntarenas Province, Costa Rica (9.325°N, 83.8666667°W; 95 m elev.) on 24 July 2004. We first encountered the predation event at 2030 h, after the snake had struck the frog and began to consume it. We observed the snake for ca. 10 min. from a distance of 2 m in the streambed. During this time the snake was slowly ingesting the frog headfirst and had reached the frog's forelimbs when we left. The ingesting motions were extremely slow at this time, and we estimate that in 10 min. the snake had consumed ca. 0.5 cm of the frog. We marked the spot of the predation event along the stream and continued our survey. We returned to the location after 45 min. to find the frog dead and regurgitated on the sandy stream bank with two fang marks on its head. The snake was about 1 m downstream of the frog. The snake was lethargic and had difficulty moving when approached. When disturbed, the snake made no attempt to coil and exhibited no defensive actions. We gently turned the snake onto its back using a stick and the snake had difficultly righting itself and made no attempt to strike or escape. We observed the snake for 60 min. after finding it in this state and gently disturbed it every 15 min. to judge possible recovery. After 30 min. the snake still made no defensive or escape movements and when turned on its back it could no longer right itself. After 45 min. the snake began to show signs of recovery, slowly reacting to being touched. We slowly turned the snake on its back a third time and it was able to right itself, but was still moving very slowly. After 60 min. the snake appeared to become more aware and reacted with a quick jerk when touched, and eventually slithered slowly up the stream bank. However, the snake still did not appear to be acting normally at this point as most of its reactions were slow and its movements seemed disoriented. At ca. 105 min. after we discovered it attempting to prey on the *L. savagei*, the snake was finally moved out of the stream bank and it took cover under a log.

We infer that the sluggish behavior of the *B. asper* was due to toxic skin secretions from the *L. savagei* it was attempting to ingest. To our knowledge this is the first report of poisoning of a *B. asper* by *L. savagei*. Although the long-term effects of poisoning on this snake are unknown, it was totally incapacitated and incapable of moving or defending itself for ca. 45 minutes.

One of the skin compounds found in *L. pentadactylus*—sister species to *L. savagei*—is leptoxin, a novel, proteic toxin that is one of the most lethal protein toxins known (Limaverde et al. 2009. Toxicon 54:531–538). When ingested by laboratory rats, leptoxin induced cardiorespiratory collapse with abundant



FIG. 1. Adult *Bothrops asper* attempting to swallow an adult *Leptodactylus savagei* in SW Costa Rica. This photo was taken when the event was first observed and the snake was already lethargic. Soon after this photo the snake regurgitated the frog.

tracheal secretion followed by sudden death (Limaverde 2009, *op. cit.*). Leptoxin is not active orally at doses greater than 100 times higher than LD_{50} and therefore appears not to be a predator deterrent (Limaverde 2009, *op. cit.*). It is unclear if leptoxin played a role in poisoning the *B. asper*, but it is apparent that *L. savagei* possess a skin compound that can harm a predator. Even though the frog we observed died from the predation attempt, this snake may avoid *L. savagei* as a prey item in the future.

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LIMNONECTES KUHLII (Kuhl's Creek Frog). **DIET**. *Limnonectes kuhlii* is a medium-sized stocky anuran with a conspicuously broad head in males (Inger 2005. The Systematics and Zoogeography of the Amphibia of Borneo. Natural History Publications [Borneo] Sdn. Bhd. Kota Kinabalu. 402 pp.). This widespread species occurs in northeastern India, southern China, Hong Kong, Taiwan, Myanmar, Laos, Vietnam, Thailand, Peninsular Malaysia, Sumatra, Java, Borneo, and Sulawesi (AmphibiaWeb. http://amphibiaweb.org/ accessed 25 Sept 2009; Das 2007. A Pocket Guide: Amphibians and Reptiles of Borneo. Natural History Publications [Borneo] Sdn. Bhd. Kota Kinabalu. 200 pp.; Inger 2005, *op. cit.*). *Limnonectes kuhlii* dwells along the banks and in small to medium-sized streams with moderate to weak currents and rocky bottoms, as well as in silty rain puddles in primary and old secondary forests, and in the vicinity of human settlements from near sea level to 1750 m elev (Inger and Stuebing 2005. A Field Guide to the Frogs of Borneo. 2nd ed. Natural History Publications [Borneo] Sdn. Bhd. Kota Kinabalu. 201 pp.; Malkmus et al. 2002. Amphibians and Reptiles of Mount Kinabalu [North Borneo]. A.R.G. Gantner Verlag K.G. Ruggell. 424 pp.). To our knowledge, previous publications on the diet of *L. kuhlii* reported that the prey items are ants and insect larvae (Das 2007, *op. cit.*).

On 28 September 2008, between 1900 and 2200 h, an adult *L. kuhlii* (75 mm SVL, 41.3 g) was sampled at Sungai Lidan (5.9767°N, 116.52645°E; 1063 m elev.), Bundu Tuhan, Ranau District, West Coast Division, Sabah, Bornean Malaysia. Within 24 h, the anuran was identified, photographed, euthanized, and dissected, and the stomach contents were extracted. Upon examination, an adult *Tropidophorus beccarii* (71 mm SVL, partial tail length 54 mm) in the early stage of digestion was found in the stomach. The approximate prey/predator SVL ratio was 0.95. *Tropidophorus beccarii* (Scincidae) is a large and slender skink (< 99 mm SVL) endemic to Borneo, which prefers rocky streams in hilly forests up to 1000 m elev (Das 2007, *op. cit.*; Malkmus et al. 2002, *op. cit.*). The anuran (HEP00617) and skink (HEP00956) were deposited in BORNEENSIS, the Bornean reference collection of the Institute for Tropical Biology and Conservation, Universiti Malaysia Sabah.

Between June and December 2008, another 75 *L. kuhlii* were sampled and dissected as part of research on the biology of anurans at Bundu Tuhan. However, stomach content examination found no vertebrate prey items. Hence, this is the first and only record of *L. kuhlii* predating a reptile as well as a vertebrate.

We are grateful to Indraneil Das (Institute of Biodiversity and Environmental Conservation, Universiti Malaysia Sarawak) for verification of the skink. We thank Agnes James Lintanga for field assistance and Paulus Abas for field transportation. Sampling was conducted under permission granted by Jawatankuasa Pemegang Amanah Hutan Simpanan dan Tanah Perumahan Bumiputera Kg. Bundu Tuhan, Ranau, to KBH. We also thank the Institute for Tropical Biology and Conservation, Universiti Malaysia Sabah for support.

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LIMNONECTES KUHLII (Kuhl's Creek Frog). **MAXIMUM SIZE**. *Limnonectes kuhlii* is commonly found in or around water from in primary forests to the vicinity of human settlements up to 1750 m elev in northeastern India, southern China, Hong Kong, Taiwan, Myanmar, Laos, Vietnam, Thailand, Peninsular Malaysia, Sumatra, Java, Borneo, and Sulawesi (Das 2007. A Pocket Guide: Amphibians and Reptiles of Brunei. Natural History Publications [Borneo] Sdn. Bhd. Kota Kinabalu. 200 pp.; Inger and Tan 1996. The Natural History of Amphibians and Reptiles in Sabah. Natural History Publications [Borneo] Sdn. Bhd. Kota Kinabalu. 101 pp.; Inger and Stuebing 2005. A Field Guide to the Frogs of Borneo. 2nd ed. Natural History Publications [Borneo] Sdn. Bhd. Kota Kinabalu. 201 pp.; Malkmus et al. 2002. Amphibians and Reptiles of Mount Kinabalu [North Borneo]. A.R.G. Gantner Verlag K.G. Ruggell. 424 pp.). *Limnonectes kuhlii* is an anuran with a stocky body and short muscular limbs. The broad head is more prominent in males, enabling the males to grow larger than the females (Inger 2005. The Systematics and Zoogeography of the Amphibia of Borneo. Natural History Publications [Borneo] Sdn. Bhd. Kota Kinabalu. 402 pp.). Previous publications report the maximum size for *L. kuhlii* as 75 mm SVL (Das 2007, *op. cit.*; Inger 2005, *op. cit.*). Herein we report a new maximum size for the species.

On 17 Aug 2009, between 1900 and 2200 h, an adult *L. kuhlii* was sampled at Sungai Kepungit (6°N, 116.5439°E; 1394 m elev.), Bundu Tuhan, Ranau District, West Coast Division, Sabah, Bornean Malaysia. Air temperature was 18.6°C, and relative humidity was 84%. The specimen was 88 mm SVL, mass 61.7 g; measurements were taken with a standard metric tape and an electronic balance. The presence of a pair of conspicuous tooth-like projections on the lower jaw, and large size suggest that the anuran was male. The specimen (HEP00959) was deposited in BORNEENSIS, the Bornean reference collection of the Institute

for Tropical Biology and Conservation, Universiti Malaysia Sabah.

On the same night, 7 other *L. kuhlii* were sampled along the same river (range 27–81 mm SVL, mass range 1.7–61.6 g). Two specimens were larger than 75 mm SVL (HEP00960, 81 mm SVL, mass 61.6 g; and HEP00963, 77 mm SVL, mass 39.5 g).

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LITHOBATES CATESBEIANUS (American Bullfrog). **DIET**. *Lithobates catesbeianus* has been introduced globally. In Argentina, the species has been introduced in several provinces including San Juan (Sanabria et al. 2005. Multequina 14:65–68), Misiones (Pereyra et al. 2006. Cuad. Herpetol. 20:37–40), Buenos Aires (Barrasso et al. 2009. S. Amer. J. Herpetol 4:69–75), Córdoba (Akmentins et al. 2009. Cuad. Herpetol. 23:25–32), and Salta (Akmentins and Cardozo 2009. Biol Invasions DOI 10.1007/s10530-009-9515-3). These introductions have had negative impacts on the native fauna.

During March 2004, in the Calingasta department (coordenadas), San Juan Province, we captured 18 *L. catesbeianus* (145 ± 6.5 mm SVL). The diet consisted of ten prey categories, which were dominated by decapods. Table 1 provides a summary of these data.

We thank V. Videla and S. Segovia for help with field work.

TABLE 1. Stomach contents of the American Bullfrog, *Lithobates catesbeianus*, from San Juan Province, Argentina. N = total number of prey; % N = percentage of the total prey; % V = percentage of the total volume; % FO = percentage of the frequency of occurrence; IRI = Index of relative importance of each category.

	N	% N	% V	% FO	IRI
Anura	2	3.7	0.12	8.6	17.04
Decapoda (Aeglidae), *Aegla* sp.	54	67.5	98.1	47.8	7919.2
Hymenoptera - Formicidae	6	7.5	0.01	8.7	65.3
Hymenoptera - Others	1	1.2	0.17	4.3	6.2
Coleoptera - Adults	2	2.5	0.03	8.6	22
Coleoptera - Larvae	2	2.5	0.1	4.3	10.9
Isoptera	8	10	0.1	4.3	44
Diptera	1	1.2	0.002	4.3	5.4
Hemiptera	1	1.2	0.001	4.3	5.4
Araneae	3	3.7	0.12	8.6	33.7
Total	80	100	100	100	

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LITORIA NANNOTIS (Australian Waterfall Frog). **FOOT FLAGGING.** Visual displays, including those involving movements of the feet, may act as a substitute for vocal communication in streamside environments where noise may interfere with detection of vocal signals (Heyer et al. 1990. Arq. Zool. 31:231–410). Foot flagging behavior by male *Litoria nannotis* has only been observed in the presence of conspecific males, and the display was presumed to be related to male-male aggression (Richards and James 1992. Mem. Queensland Mus. 32:302). In this note we describe, for the first time, foot flagging by a male *L. nannotis* in the presence of a female.

We observed the courtship at 22:00 h AEST 2 Sept 2009 on Cloudy Creek (18.9926167°S; 146.2103833°E; ca. 530 m elev.) in north Queensland, Australia. A male and female *L. nannotis* were observed on the vertical face of a granite boulder (ca. 0.6 m in diameter) near a small waterfall. The rock surface was barely wet, only just within reach of the splash zone. The pair were separated by a distance of ca. 30 cm; the female facing away from the male. The male was heard to call (a low growl) seven times at intervals of 3–5 minutes. When lit with shielded light, the male was seen to foot flag while calling; extending the left rear leg perpendicular to the body and rapidly vibrating the foot on a vertical plane with toes outstretched before returning the leg to the side of the body. The right leg was not involved. The female did not display any responses to the male, and did not move during our 45 minutes of observations. Although no other males were observed nearby, it is unknown if the intent of the foot flagging was to attract the female's attention, or discourage potential male rivals. We did not follow the behavior of the pair longer due to potential disturbance, as the male would cease foot flagging and calling with extended exposure to artificial light.

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OSTEOPILUS SEPTENTRIONALIS (Cuban Treefrog). **PREY**. *Osteopilus septentrionalis* is native to Cuba, Cayman Islands, and Bahamas (Meshaka et al. 2004. The Exotic Amphibians and Reptiles of Florida. Krieger Publ. Co., Malabar, Florida. 155 pp.), and has been introduced into five states in the United States, but is established only in Florida (Barbour 1931. Copeia 1931:140; Crother 2008. Scientific and Standard English Names of Amphibians and Reptiles of North America. SSAR Herpetol. Circ. 37. 84 pp.). In Florida, *O. septentrionalis* is known to prey primarily on roaches (Dictyoptera), but has also been documented consuming lizards (anoles and geckos), frogs (including its own



FIG. 1. Non-native Cuban Treefrog (*Osteopilus septentrionalis*) preying upon native Ring-necked Snake (*Diadophis punctatus*).

species) (Meshaka et al. 2004, *op. cit.*), and the Florida Brown Snake (*Storeria victa*) (Maskell et al. 2003. Herpetol. Rev. 34:137). Herein, we report *O. septentrionalis* preying upon a native Ring-necked Snake (*Diadophis punctatus*) in Florida.

In Sept 2008 at 2100 h, an *O. septentrionalis* (ca. 6.3 cm SVL) was observed on SE Island Way, 0.08 km NE Loxahatchee River Road, Jupiter, Martin County (26.973996°N, 80.137637°W; WGS84, elev. <1 m) on a sidewalk holding a *Diadophis punctatus* (ca. 15 cm SVL) in its mouth. After being photographed (photographic voucher UF 154586), the frog continued to hold onto the snake without ingesting it entirely for more than 40 min, at which time the frog was left alone. This is the second record of this nonindigenous frog preying upon a native snake in Florida.

We thank Susan Speaks McGirt for use of this information and photographic voucher for documentation.

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PHYSALAEMUS SPINIGER (Iguape Dwarf Frog). **PREDATION**. Anuran eggs, tadpoles, and post-metamorphic individuals are known to be preyed upon by vertebrates, invertebrates, and even carnivorous plants (Toledo et al. 2007. J. Zool. 271:170–177). Herein we here report dipteran maggot predation of *Physalaemus spiniger* eggs in a foam nest and spider (Theraphosidae) predation of an adult male. *Phylsalaemus spiniger* is a small frog (mean SVL males 18.8 mm; mean SVL females 21.1 mm) (Haddad and Pombal Jr. 1998. J. Herpetol. 32:557–565) that calls on the forest floor near temporary ponds. The eggs are laid in a foam nest that is deposited on the water surface near the edges of ponds, on the humid leaf litter near ponds, or in the axils of terrestrial bromeliads (Haddad and Pombal 2008, *op. cit.*). *Physalaemus spiniger* is known from the states of Paraná (Guaraqueçaba) and São Paulo (Ilha do Cardoso, Cananéia, Estação Ecológica da Juréia, Iguape, Caverna do Diabo, Iporanga, Jacupiranga), southern and southeastern Brazil

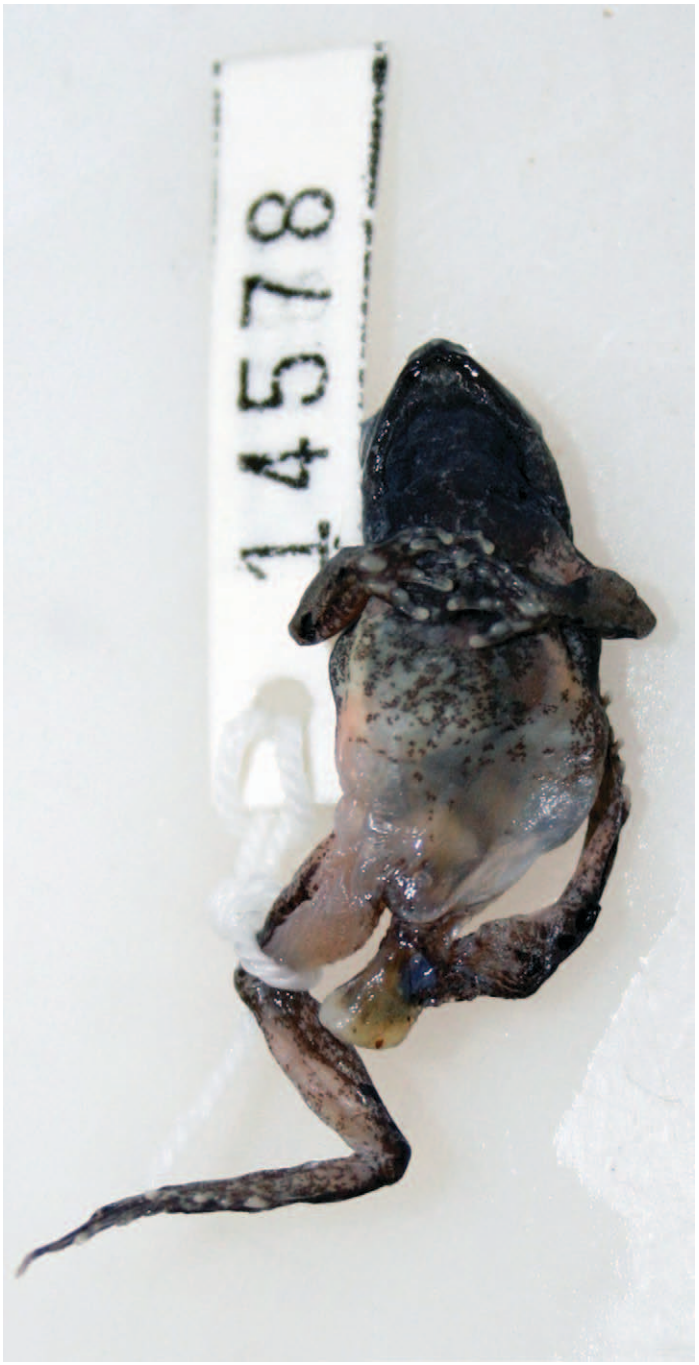


FIG. 1. *Physalaemus spiniger* preyed upon by a spider (Theraphosidae). The partially digested left leg is indicated by an arrow.

(Haddad and Pombal 2008, *op. cit.*). The risk of predation by invertebrates is greater during the breeding season (Toledo 2005. Herpetol. Rev. 36:395–400). Spiders are the most important invertebrate predator of post-metamorphic anurans (Toledo et al. 2007, *op. cit.*), and dipteran maggots are common predators of eggs and embryos (Menin and Giaretta 2003. J. Zool. 261:239–243). Reports of predation by invertebrates upon *Physalaemus* spp. have been published (Brasileiro et al. 2003. Herpetol. Rev. 34:137; Toledo 2003, *op. cit.*; Toledo 2005, *op. cit.*), and there is a report of spider predation (Lycosidae) upon *P. spiniger* (Toledo et al. 2007, *op. cit.*). On 27 October 2008 we found a *P. spiniger* foam nest with dipteran maggots that were feeding on the eggs. The following night we observed an adult male *P.*

spiniger (SVL 18.5 mm) being preyed upon by a juvenile spider (Theraphosidae; TL 19.5 mm). The *P. spiniger* was calling on the forest floor in Reserva Natural Salto Morato, Guaraqueçaba, Paraná, Southern Brazil (25.186643°S, 48.254730°W) at the edge of a temporary pond when it was captured by its left leg by the spider. Both individuals were captured and deposited in the Museu de Zoologia "Prof. Dr. Adão José Cardoso," at Unicamp, Campinas, Brazil (ZUEC 14578). After collecting the animals, the spider released the now paralyzed anuran, which died three hours after the observation with its left leg partially digested (Fig. 1). The size relationship observed in this predation event is consistent with data presented by Toledo et al. (2007, *op. cit.*) where solitary, venomous, and invertebrate predators generally eat prey that are a little shorter or equal to their own size.

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PSEUDIS MINUTA (Lesser Swimming Frog). **CANNIBALISM.** Reports of cannibalism between adult anurans are scarce. Few reports have been published but include the ranids *Lithobates catesbeianus* (Stuart and Painter 1993. Herpetol. Rev. 24:103), *Rana cascadae* (Rombough et al. 2003. Herpetol. Rev. 34:138), and *R. luteiventris* (Pilliod 1999. Herpetol. Rev. 30:93), and the leptodactylid *Leptodactylus ocellatus* (Kokubum and Rodrigues 2005. Herpetol. Rev. 36:303). The paucity of reports suggests this interaction is uncommon among adult anurans (Toledo et al. 2007. J. Zool. 271:170–177), although it is well documented that tadpoles or adults eat conspecific tadpoles or eggs (Bragg 1946. Herpetologica 3:89–97; Caldwell and Araujo 2006. Biotropica 30:92–103; Crump 1990. Copeia 560–564; Drewes and Altig 1996. Tropical Zool. 9:333–347; Summers 1999. Oecologia 119:557–564;). Herein we report cannibalism in an adult male *Pseudis minuta.*

The specimens were collected in a temporary pond in the Department of Tacuarembó, Uruguay (32.4118611°S, 55.5369167°W; WGS84, 99 m elev.), on 8 Aug 2009. Air temperature was 10.3ºC; water temperature was 11.3ºC. The predator was an adult female (44.44 mm SVL, 11.85 g, mandibular width 15.3 mm), whereas the prey was a male (23.17 mm SVL, 1.39 g, mandibular width 9.32 mm) (Fig. 1). The male (dead when was recovered), was catalogued into the Vertebrates



FIG. 1. Female *Pseudis minuta* eating conspecific male (ZVCB 19898).

Collection of the Faculty of Sciences (ZVCB 19898).The marked female was not collected as this population is being monitored in a long-term mark-recapture study.

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RANA LUCTUOSA (Mahogany Frog). **ALTITUDE AND MAXIMUM SIZE**. *Rana luctuosa* is an anuran with a distinctive coloration of rich reddish chocolate dorsum of the head and body separated by two thin dorsolateral whitish stripes from its greyish black sides of head and body (Inger and Stuebing 2005. A Field Guide to the Frogs of Borneo. 2nd ed. Natural History Publications [Borneo] Sdn. Bhd. Kota Kinabalu. 201 pp.). The species occurs in Central Peninsular Thailand, Peninsular Malaysia, Sumatra, and Borneo (western Sabah, and Sarawak) (Frost 2009. Amphibian Species of the World: an Online Reference, ver. 5.3 [12 Feb 2009]. http://research.amnh.org/herpetology/amphibia/. American Museum of Natural History, accessed on 14 Oct 2009; Inger 2005. The Systematics and Zoogeography of the Amphibia of Borneo. Natural History Publications [Borneo] Sdn. Bhd. Kota Kinabalu. 402 pp.; van Dijk et al. 2004. *In* IUCN 2009. IUCN Red List of Threatened Species. Version 2009. <www. iucnredlist.org>, accessed on 14 Oct 2009). Previous publications reported the altitudinal range for the species to be 100–1400 m (Malkmus et al. 2002. Amphibians and Reptiles of Mount Kinabalu [North Borneo]. A.R.G. Gantner Verlag K.G. Ruggell. 424 pp.; van Dijk et al. 2004, *op. cit.*), and the maximum size to be 60 mm SVL (Inger and Stuebing 2005, *op. cit.*; Malkmus et al. 2002, *op. cit.*).

On 13 Dec 2008, between 1900 and 2200 h, an adult *R. luctuosa* was collected at an artificial pond within the compound of Haleluyah Retreat Centre (6°N, 116.536° E; 1500 m elev.), Bundu

Tuhan, Ranau District, West Coast Division, Sabah, Bornean Malaysia. Air temperature was 16°C, and relative humidity was 89.1%. Due to proximity to protected areas (Kinabalu National Park on the east, and Tenompok Forest Reserve on the west), and the mostly retained surrounding vegetation, Haleluyah Retreat Centre houses other forest and forest edge species of anurans: *Philautus petersi*, *Megophrys baluensis*, and *Limnonectes kuhlii*, in addition to the human commensal species *Polypedates leucomystax*. The locality represents an altitude record for *R. luctuosa*, as well as suggests an extension of habitat previously expected to be forests for the species.

The specimen was 68 mm SVL, mass 26.1 g; measurements were taken with a standard metric tape and an electronic balance. The specimen (HEP00951) was deposited in BORNEENSIS, the Bornean reference collection of the Institute for Tropical Biology and Conservation, Universiti Malaysia Sabah. The specimen represents a new maximum size for *R. luctuosa*. On the same night, two additional *R. luctuosa* were obtained at Haleluyah Retreat Centre. Both were larger than the previously known maximum size for the species (HEP00950, 64 mm SVL, mass 19.7 g, and HEP00952, 63 mm SVL, mass 22.1 g).

We thank Haleluyah Retreat Centre for permission to collect specimens, and the Institute for Tropical Biology and Conservation, Universiti Malaysia Sabah for support.

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RHACOPHORUS FEAE (Thao Whipping Frog). **DEFENSIVE BEHAVIOR.** A wide variety of defensive behavior aimed at predation avoidance has been reported in amphibians. During surveys in Kon Tum Province, Vietnam, we captured a single specimen of the large rhacophorid frog, *Rhacophorus feae*. When grasped by the hand, on several occasions, the individual raised its forearms to the head, positioning its thumb below the eye and the remaining fingers splayed above the eye. The pale pink ventral surfaces of the fingers contrast with the dark green head and dorsal surface of the frog. The eyes were always open during this behavior, with the nictating membrane at most partially covering the eye (Fig. 1). No sounds or obvious smell was emitted by the frog during this behavior. Similar behavior has been reported in a taxonomically and geographically diverse group of frogs; the North American ranid frogs *Rana aurora draytonii* (Wilkinson 2006. Herpetol. Rev. 37:207–208) and *R. capito* (Means 2004. Herpetol. Rev. 35:163–164), the South American hylids *Hyla calcarata* and *H. fasciata* (Angulo and Funk 2006. Herpetol. Rev. 37:203–204), the Madagascan mantellid frog *Boophis albilabris* (Andreone 2002. Herpetol. Rev. 33:299–300), and the Southeast Asian rhacophorid *Nyctixalus pictus* (Das et al. 2004. Herpetol. Rev. 35:363–374). Previous suggestions as to the adaptive significance of the behavior include disrupting the search image of predators by changing the outline of the head (Channing and Howell 2003. Herpetol. Rev. 34:52), "increasing" head size, or making ingestion difficult (Angulo and Funk 2006, *op. cit.*).



COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND

FIG. 1. Defensive display of *Rhacophorus feae* from Kon Tum Province, Vietnam.

The distinctly contrasting color of the ventral surface of *R. feae* displayed during this behavior might also act aposematically.

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RHINELLA PYGMAEA (Rio Parahyba Toad). **ECTOPARASITISM.** *Rhinella pygmaea* is a bufonid endemic to the Atlantic Rainforest biome, occurring in restingas (coastal sand-dune shrublands) of Rio de Janeiro State, Brazil (Carvalho-e-Silva et al. 2000. *In* Esteves and Lacerda [eds.]. Ecologia de Restingas e Lagoas Costeiras, pp. 89–97; Rocha et al. 2005. Braz. J. Biol. 65:159–168) and in a disturbed forest fragment of Mimoso do Sul municipality in Espírito Santo state (Silva et al. 2007. Herpetol. Rev. 38:97). It is threatened by habitat loss, but its conservation status is reported as Least Concern (IUCN 2008. The IUCN Red List of Threatened Species. <http://www.iucnredlist.org/details/54740>. 04 Mar 2009). Here we report observations of parasitism on *Rhinella pygmaea* by a tick of the genus *Amblyomma*.

On 9 Feb 2009, during fieldwork at the Grussaí restinga, municipality of São João da Barra, in northern Rio de Janeiro State (21.9813889°S, 41.0608333°W), a subadult *Rhinella pygmaea* (ca. 30 mm SVL) was observed parasitized by a tick of the genus *Amblyomma*. The female tick (length 10 mm x width 5 mm) was attached on the posterior part of the toad's dorsum (Fig. 1). The tick was collected and preserved in 70% ETOH. In the laboratory, the tick was identified as *A. rotundatum* using the key of Aragão and Fonseca (1961. Mem. Inst. Oswaldo Cruz 59:115–129). This is one of the few tick species that reproduce by parthenogenesis (Aragão 1912. Mem. Inst. Oswaldo Cruz 4:96–118), and also the one that most frequently feeds on amphibians (Hanson et al. 2007. J. Med. Entomol. 44[1]:155–157). *Amblyomma rotundatum* previously has been reported to feed on other species of *Rhinella*



FIG. 1. Subadult *Rhinella pygmaea* (about 30 mm SVL) parasitized by the tick, *Amblyomma rotundatum* (length 10 mm x width 5 mm).

(Lampo and Bayliss 1996. Parasitology 113:199–206; Luque et al. 2005. Acta Parasitol. 50:215–220; Smith et al. 2008. J. Parasitol. 94:560–562). This ixodid tick is native to Central and South America but is also found in North America (Florida, USA) where it was probably introduced with the Giant Toad, *Rhinella marina* (Oliver et al. 1993. J. Parasitol. 79:786–790). This is the first report of parasitism by *A. rotundatum* on *Rhinella pygmaea*.

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SCINAX X-SIGNATUS **(**Venezuela Snouted Treefrog). **PREDATION**. Anurans are often predated by invertebrates, including spiders (Barbo et al. 2009. Herpetol. Notes 2:99–100; Menin et al. 2005. Phyllomedusa 4:39–47), chilopods (Forti et al. 2007. Braz. J. Biol. 67:583–584), and hemipterans (Pombal 2007. Rev. Brasil. Zool. 24:841–843). Predation is an important factor regulating anuran populations (Duellman and Trueb 1994. Biology of Amphibians. Johns Hopkins, New York. 670 pp.).

Scinax x-signatus is a species typical of non-forest habitats and occurs in northern Colombia and Venezuela to Suriname, and in eastern, southern, and southeastern Brazil (Frost 2009. Amphibians Species of the World 5.2 – an online reference. Am. Mus. Nat. Hist.: http://research.amnh.org/herpetology/amphibia/references; accessed 08 Sept 2009). In northeastern Brazil, *S. x-signatus* has been observed active near the margins of ponds



FIG. 1. A nymph of the Giant Water Bug, Belostomatidae, preying on an adult Venezuela Snouted Treefrog, *Scinax x-signatus*.

under vegetation (Vieira et al. 2007. Oecol. Bras. 11:383–396) as well as in this study area.

Herein we report predation of an adult *S. x-signatus* (39.5 mm SVL, Fig. 1) by a nymph Giant Water Bug (Belostomatidae). The observation occurred on 04 Aug 2009 at 2200 h in a temporary pond in Poço Redondo city, (9.6869444°S, 37.6813889°W; SAD-69), Sergipe, Brazil. Belostomatids are found in ponds and lakes and feed on other insects, tadpoles, and small fishes. (Borror et al. 1989. Introduction to the Study of Insects. 6th ed., Saunders College Publishing. 875 pp.). Predation on frogs involving belostomatids have been reported from southeast Brazil (Pombal 2007. Rev. Brasil. Zool. 24:841–843; Toledo 2003. Phyllomedusa 2:105–108), although there are no reports from the Caatinga areas. The Giant Water Bug was collected and is deposited in Coleção do Laboratório de Entomologia (ENT100) and the *S. x-signatus* in Coleção Herpetológica da Universidade Federal de Sergipe (C360).

We thank Leandro de Sousa Souto, Yana Teixeira dos Reis, and José Oliveira Dantas (Laboratório de Entomologia) for identification of the belostomatid, Luciano de Araujo Pereira for the photograph, and Bruno Durte da Silva (Universidade Federal of Sergipe) for help in translation of this manuscript.

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TRACHYCEPHALUS JORDANI (Jordan's Casque-Headed Treefrog). **PREDATION.** *Trachycephalus jordani* is a moderately large hylid frog native to the Pacific lowlands of Colombia, Ecuador, and Peru. We report an instance of *T. jordani* feeding on the hylid frog, *Hypsiboas pellucens* (Palmar Treefrog), which is sympatric with *T. jordani* in the Pacific lowlands of Colombia



COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND

FIG. 1. Jordan's Casque-headed Treefrog (*Trachycephalus jordani*) eating a Palmar Treefrog (*Hypsiboas pellucens*) in Pichincha, Ecuador.

and Ecuador (Icochea et al. 2004. *In* IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded 12 Nov 2009.).

At 2135 h on 14 May 2007, in Bosque Protector La Perla, 1.54 km SSW of La Concordia (0.013113°S, 79.3879908°W, elev. 252 m) in Pichincha Province, Ecuador, we found a *T. jordani* of unknown gender measuring 38.2 mm SVL. Protruding from the *T. jordani*'s mouth were the hind feet of a live *H. pellucens* of unknown gender measuring 20.75 mm SVL (Fig. 1).

Documented cases of anurans in the diet of other frogs have thus far been limited to: 1) cannibalism of eggs and other larvae by tadpoles, usually of tree cavity or bromeliad-nesting species (Crump 1983. Am. Nat. 181:281–289); 2) a few cases of conspecific cannibalism of adults; and 3) opportunistic predation of non-conspecifics by such 'convenience predators' (Toledo et al. 2007. J. Zool. 217:170–177). To our knowledge only two observations of a hylid frog reported to consume other treefrogs have been reported (*Hypsiboas faber*, Solé et al. 2004. J. Nat. Hist. 41:2757–2763; *Osteopilus septentrionalis*, Wyatt and Forys 2004. Southeast. Nat. 3:695–700).

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GYMNOPHIONA — CAECILIANS

***DERMOPHIS* SP**. (NCN). **PREDATION**. *Dermophis* is a caecilian genus with a Mesoamerican distribution. It is known from lowland to mid elevation forests ranging between Mexico and Colombia (Savage 2002. The Amphibians and Reptiles of Costa Rica. Chicago Univ. Press). As with most caecilians, the biology of this genus is largely unknown. There are several reports of caecilians as prey of snakes in Africa (Gower et al. 2004. Afr. J. Ecol. 42:83–87), Asia (Kupfer et al. 2003. Amphibia-Reptilia 24:212–215) and the Americas (Savage 2002, *op. cit.*; Schmidt 1932. Copeia 1932:6–9), however there are few observations of the predator-prey behavior in the field (Kupfer et al. 2003, *op. cit.*).

On 8 July 09 at 1000 h, at Piedras Blancas National Park near Esquinas Lodge in La Gamba (Golfito, Puntarenas, Costa Rica) the author observed the predation of *Dermophis* sp. by the elapid snake *Micrurus alleni*. Both animals were at the edge of a forest trail. The substrate was composed of red clay, crushed stone (placed there artificially), and leaf litter, with some tree roots on the surface. In general the soil, roots, and litter were moist to wet, and the closed canopy didn't allow much light to reach the ground. A small creek was located ca. 100 m away from the observation. At the moment of the sighting the weather was cloudy, even though from dawn to 0930 h of the same day it was clear and the previous day it had rained in the afternoon. Upon my arrival I observed that the snake had already captured the caecilian, holding the anterior portion of the amphibian (part of the cervical area) in its mouth (Fig. 1). Even though neither animal was measured, the *Dermophis* was longer but thinner than its predator. The complete ingestion of the caecilian by the snake was not observed, but during the course of the observation (ca. 15 minutes) the caecilian remained alive and the snake did not release it, keeping its mouth in place, even after the snake noticed the presence of humans ca. 1.5–2 m away. The anterior portion of the caecilian did not move as much as its posterior portion, which writhed slowly and rather inactively. About 3 min. after the initial observation, the snake started to move, wriggling backwards, pulling the caecilian across the trail. This behavior was repeated 3 times until I left. Between each pulling activity the snake remained largely still for periods ranging between 3 and 7 minutes.

It was suggested that the species of *Dermophis* observed was *D. parviceps* according to the characteristics of the head, and the color and proportions of the body. However this specimen was unusually long, so the identification to species level has not been confirmed.

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TESTUDINES — TURTLES

APALONE SPINIFERA (Spiny Softshell Turtle). **MAXIMUM CLUTCH SIZE.** Maximum clutch size for *Apalone spinfera* is currently recognized as 39 eggs (Ernst and Lovich 2009. Turtles of the United States and Canada. Second Edition. Johns Hopkins Univ. Press, Baltimore, Maryland. 828 pp.). Here, I report an observation of a single *A. spinifera* nest from Butler Co., Iowa, USA that contained 42 eggs, apparently a record clutch size for this species, as well as the largest known clutch for any of the

three North American *Apalone* species (*A. ferox*, *A. mutica*, and *A. spinifera*).

On 17 June 2009 at 1930 h I observed an adult female *A. spinifera* constructing a nest on the bank of the West Fork Cedar River. The eggs were deposited in open sand, approximately 12 m from water, at a site that *A. spinifera*, *A. mutica* and *Chelydra serpentina* frequently use for nesting. The nesting female was left undisturbed and the nest was excavated shortly after completion. Total clutch wet mass was 399.71 g; mean egg mass was 9.52 g (SD = 0.63 g, range = 8.18–10.74 g), and mean egg diameter was 25.61 mm (SD = 0.70 mm, range = 24.30–27.17 mm). Eggs in this clutch (N = 42) were more numerous and significantly ($p<0.0005$) lighter and smaller than eggs from 14 other *A. spinifera* nests from this site. Mean clutch size of 14 *A. spinifera* nests (249 eggs total) at this site was 19.26 (SD = 5.19; range = 11–27); mean total clutch wet mass was 180.10 g (SD = 59.89 g, range = 94.18–294.20 g), mean egg wet mass was 10.25 g (SD = 1.07 g, range = 7.95–12.82 g), and mean egg diameter was 26.56 mm (SD = 1.09 mm, range = 22.97–29.39 mm). Total wet mass of this record clutch was ≈120% heavier than the mean wet mass of nests recorded from this site. This clutch was collected and incubated in the laboratory; 39 of the 42 eggs proved fertile, but unfortunately a storm-caused power outage and a subsequent spike in incubator temperature resulted in embryonic death in these eggs.

Clutch size varies greatly in all three *Apalone* spp.; nests may contain as few as 1–3 eggs and maximum clutch size is 40 for *A. ferox* and 33 for *A. mutica*. *Apalone spinifera* may produce two, and possibly even three, clutches per nesting season (Ernst and Lovich, *op. cit.*). Since 2003, *Apalone spinifera* nesting dates have ranged from May 30–July 29 at this site, with early clutches often laid from late-May to mid-June and second clutches laid throughout July. In 2009, following a harsh winter and an unusually cold, wet spring, turtle nesting at this site was delayed by several weeks; consequently, this record clutch may have represented a delayed first clutch and possibly included eggs that would, in a more normal year, have been deposited in a second clutch.

I thank Rick Fisher for access to the nesting site. This work was conducted under Iowa DNR Scientific Collecting permit SC-648.

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CHELYDRA SERPENTINA (Common Snapping Turtle). **DIET, FRUGIVORY.** On 18 June 2008 a DOR adult *C. serpentina* was found on the shoulder of Interstate 85 in Macon Co Alabama (32.4519833°N, 85.7396667°W; WGS84) with an estimated carapace length of ~25 cm and a 6 cm skull width. Though the carapace was damaged and the flesh putrefied, it was collected for deposition as an osteological specimen in the AU Natural History Museum collection (AUM Osteo 4655). The entire specimen was wrapped securely in window screen (to prevent loss of small bones) and placed under half a 208-liter plastic drum weighted with cinderblocks to continue decomposition. After several months the specimen was removed and the bones picked from the remaining detritus. During this process, several small, hard, round objects were encountered in the abdominal region and at first were thought to be disarticulated wrist or ankle bones. Upon closer examination, they were identified as the pits of the Common Black Cherry (*Prunus serotina*). All of the bones and materials previously picked through were carefully re-examined and a total of 14 pits were recovered from the carcass as well as a cheliped from a crayfish (*Procambarus* sp.) and two additional crayfish exoskeleton fragments.

It seems highly unlikely that a small rodent would have cached the seeds in the carcass as it was under a weighted barrel and tightly wrapped in mesh. In addition, there are no *P. serotina* trees growing in the vicinity of the skeletonizing site. Furthermore, the number of seeds found within the carcass implies that they were ingested deliberately.

Though *C. serpentina* are primarily carnivores, they have been documented to consume a variety of plant material (Ernst and Lovich. 2009. Turtles of the United States and Canada. Johns Hopkins Univ. Press. 840 pp.; Steyermark et al. [eds]. 2008. Biology of the Snapping Turtle. Johns Hopkins Univ. Press. 240 pp.). More recently, a report by Aird (2008. Bull. Chicago Herpetol. Soc. 43[12]:189–195) contains an amusing account of terrestrial frugivory by this species. This observation provides additional support for occasional frugivory in this turtle and is the first record of *P. serotina* being consumed by *C. serpentina*. Because the seeds noted here were intact, there is the potential for seed dispersal by this species, however neither seed viability nor germination were tested.

Thanks to S. Graham for reviewing this note.

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DEIROCHELYS RETICULARIA (Chicken Turtle). **COURTSHIP BEHAVIOR**. *Deirochelys reticularia* is a semi-aquatic species that inhabits the southeastern United States. Extant *Deirochelys* is a monotypic genus in the family Emydidae, subfamily Deirochelyinae which also includes *Chrysemys* (Painted Turtles), *Graptemys* (Map Turtles), *Malaclemys* (Diamond-backed Terrapins), *Pseudemys* (Cooters), and *Trachemys* (Sliders). Courtship behavior referred to as "titillation" has been considered a unique characteristic of the Deirochelyinae (Seidel and Fritz. 1997. Herpetol. Rev. 28:70–72). Males are typically smaller than females and have elongate foreclaws. During titillation courtship, the male approaches the female in water and extends his forelegs, while rapidly vibrating the claws against or near the female's ocular region. It has been inferred that this behavior is represented in all genera of the subfamily (Ernst and Lovich 2009. Turtles of the United States and Canada, 2nd ed., Johns Hopkins Press, Baltimore; Fritz 1991. Salamandra 27:129–142; Seidel and Fritz 1997, *op. cit.*).

Courtship in *Deirochelys* has not been well documented and to my knowledge has not been reported in nature. Thus all observations are based on captive individuals. Krefft's publication in German (1951. Aquar. -u. Terrar. -Z., Stuttgart, 4:157–160) apparently was the first description of *D. reticularia* courtship behavior. This paper has been cited several times as evidence for titillation-like courtship in *Deirochelys* (Ernst and Lovich 2009, *op. cit.*;

Fritz 1991, *op. cit.*; Seidel and Fritz 1997, *op. cit.*). However, re-evaluation of Krefft's report does not substantiate vibration of the male's foreclaws around the female's ocular region. Uwe Fritz (Museum of Zoology, Dresden, Germany) recently provided me with the following exact translation of Krefft's (1951, *op. cit.*) pertinent statements: " [male *Deirochelys*…approaching the other turtle from the front]…whereby the forelegs were widely spread, sometimes performing shaking/ vibrating movements. These movements were much slower and with a distinctly more divergent angle than in *Pseudemys* [= *Trachemys scripta*]." Fritz stated (pers. comm.) that Krefft's description can be literally interpreted as if only the arms are performing the movements, confirming that Krefft did not specifically mention involvement of the foreclaws. A more recent description of courtship activity in Chicken Turtles is presented by Ewert et al. (2006. *In* Meylan [ed.], Chelonian Res. Monogr. [3]:249–259). These authors stated that: "In several cases the male swam obliquely, with a forelimb leading, as he approached the female from the front. During the approach, the male fluttered both forelimbs in a series of many (often > 10) short, rapid swimming strokes, with his head partly extended and with his gaze from one eye, seemingly focused on the female's head." Dale Jackson (Florida Natural Areas Inventory, Tallahassee) added (pers. comm.) that Ewert (now deceased) referred to the male's activity as "flopping his front legs around (sort of waving)."

Another recent account comes from Rudolf Wicker (Frankfurt Zoological Garden, Germany), who informed me (pers. comm.) that he and his zoo staff "…regularly observe courtship behavior in *Deirochelys*, but never observed anything like titillation, but waving with one arm alternately." As a final note, I observed attempted mating of a captive pair of Chicken Turtles. In this incident the young male did not display courtship but pursued the female several times from behind, nudging her with his snout, then extending his tail to achieve cloacal apposition.

When all evidence of courtship is considered, it appears doubtful that *D. reticularia* employs actual titillation behavior. Males do not have especially long foreclaws and do not vibrate their digits, as seen in other genera of the subfamily. Nevertheless, if the waving or vibrating of the male Chicken Turtle's forelegs is homologous with titillation, it may have evolutionary significance. Modern phylogenetic theories (based on morphology and nucleotide sequence data) indicate that *Deirochelys* is the sister group (basally divergent) to a complementary clade of *Chrysemys*, *Pseudemys*, *Trachemys*, *Malaclemys*, and *Graptemys* (Bickham et al. 1996. Herpetologica 52:89–97; Stephens and Wiens 2003. Biol. J. Linn. Soc. 79:577–610; Iverson et al. 2007. *In* Shaffer et al. [eds.], Chelonian Res. Monogr. [4]:85–106). Consistent with this relationship, the courtship pattern seen in *Deirochelys* may be a rudimentary, ancestral form of behavior which later evolved into titillation along the lineage of other extant genera. This would characterize Chicken Turtle courtship as a primitive (plesiomorphic) character state in the subfamily Deirochelyinae. An alternative interpretation, perhaps less likely, is that the waving of the male forearms in *D. reticularia* was derived as a vestigial relict of titillation. Evolutionary loss of elongate foreclaws and titillation behavior has presumably occurred in several species or subspecies of *Graptemys* (Vogt 1980. Tulane Stud. Zool. Bot. 22:17–48), *Trachemys* (Legler 1990. *In* Gibbons [ed.], Life History and Ecology of the Slider Turtle. Smithsonian Inst. Press, Washington, DC) and possibly *Malaclemys* (Seigel 1980. J. Herpetol. 14:420–421). These turtles, however, do not display the elements of forelimb movement exhibited by Chicken Turtles. In conclusion, the polarity of *Deirochelys* courtship behavior remains unclear and caution should be exercised when employing it as a phylogenetic character.

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HYDROMEDUSA TECTIFERA **(**South American Snake-necked Turtle). **EPIZOIC TEMNOCEPHALIDA**. Soares et al. (2007. Ciência Rural 37[3]:901–903) recorded the occurrence of *Temnocephala* sp. in *Hydromedusa tectifera* (Pleurodira, Chelidae), in Encruzilhada do Sul (Rio Grande do Sul, Brazil) (30.5588889°S, 52.5825°W). We found the same species parasitized by Temnocephalida, on the Rio Grande do Sul at the Uruguayan border during field work in March, 1976, for the Project on Brazil-Uruguay Herpetofauna (Lema and Fabián-Beurmann 1977. Iheringia Zool. [50]:61–92), financed by Organization of American States.

Two specimens were caught in Livramento (Rio Grande do Sul) (30.8611111°S, 55.5552778°W), near the border with Uruguay, and in both the plastron was heavily infested with Temnocephalida. The Platyhelminthes were pedunculate and formed a high stratum, with the individuals very close to each other. Each worm was tubular and narrow, about one centimeter long, differing from the *Temnocephala* sp. described by Soares et al. (2007, *op. cit.*). The turtles were later joined in a tank with the emydid species *Trachemys dorbigni* that then became infested with these worms. The same infestation occurred with two specimens of the chelid *Acanthochelys spixii*, later put in the same tank. After two days the worms moved to the periphery of the plastron, after laying their eggs in the center and, after a few more days, the worms died and were removed and sent to the Department of Zoology, Universidade de São Paulo, S. Paulo, where they were identified as belonging to the genus *Temnocephala* Blanchard 1849, with species designation not specified.

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MACROCHELYS TEMMINCKII (Alligator Snapping Turtle). **SUBMERGENCE TIME.** As part of a mark-recapture study of turtles in the Santa Fe River, Florida, USA, we continuously observed the behavior of an adult male *Macrochelys temminckii* (615 mm straight midline carapace length). On 12 December 2009, we initially encountered this animal at 2015 h in a clear, spring-fed area of the river (29.8473°N, 82.7092°W, datum

WGS84, elev. 6 m) in 22.3°C water as it walked along the bottom of the channel at a depth of ca. 2 m. At 2030 h, the turtle stopped moving and placed its head under a limestone ledge ca. 2.5 m deep. The turtle began moving again at 0430 h on 13 December and was hand captured as it headed to deeper water >4 m deep. During the entire 8 h 15 min period of continuous observation (from a distance of 5–6 m), the turtle remained submerged and did not surface to breathe air. This observation substantially increases the estimated maximum voluntary submergence time known for this species. This species had previously been thought to have a limited ability to remain submerged for long periods at warmer water temperatures (Ernst and Lovich. 2009. Turtles of the United States and Canada. Johns Hopkins Univ. Press, Baltimore. 827 pp.). In the only previous report of *M. temminckii* submergence time, Allen and Neill (1950. Ross Allen's Reptile Institute, Spec. Publ. No. 4) stated that this turtle cannot remain submerged for more than 40–50 min at water temperatures of 21–24°C.

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RHINOCLEMMYS NASUTA (Chocoan River Turtle). **DIET AND FEEDING BEHAVIOR.** Published information on the diet of *Rhinoclemmys nasuta* is very limited, but the available reports indicate it is largely herbivorous, eating plant leaves, seeds, flowers, and fruits (Corredor-Londoño et al. 2007. Tortugas del Valle del Cauca. Corporación Autónoma Regional del Valle del Cauca, Santiago de Cali, Colombia. 74 pp.; Medem 1962. Rev. Acad. Colomb. Cien. Exac., Fís. Nat. 11:279–303). Medem (1962, *op. cit.*) also reported a grasshopper (Orthoptera) in stomach contents, and that in captivity they ate ripe plantains and raw meat. Other aquatic species of *Rhinoclemmys* have also been reported to have a primarily herbivorous diet, e.g., *R. funerea* (Moll and Jansen 1995. Biotropica 27:121–127) and *R. melanosterna* (Medem 1962, *op. cit.*). With respect to time and location of feeding activity, *R. funerea* was reported to make late afternoon and nocturnal forays to feed on land (Moll and Jansen 1995, *op. cit.*; Moll and Legler 1971. Bull. Los Angeles Co. Mus. Nat. Hist. [11]:1–102), whereas Medem (1962, *op. cit.*) stated that *R. melanosterna* was diurnal and would leave the water to feed on land.

While conducting sampling on the night of 30 June 2007, we encountered an individual of *Rhinoclemmys nasuta* on land eating carrion. Observations were made on Isla Palma, Department of Valle del Cauca, ca. 1.5 km off the Pacific Coast of Colombia (3.90019°N, 77.35597°W; WGS84). The island is in the tropical rain forest life zone (Holdridge 1967. Life Zone Ecology, rev. ed. Tropical Science Center, San Jose, Costa Rica. 206 pp.) and has average annual precipitation of ca. 6000 mm and 90% relative humidity. The predominant height of forest trees is between 10 and 50 m, with many shrubs and ferns in the understory (Castellanos 2003. Interacciones Tróficas y Espaciales de un Ensamblaje de Peces de Charcos Intermareales en un Acantilado Rocoso Tropical, Bahía Malaga-Pacífico Colombiano. Universidad del Valle, trabajo de grado. Cali, Colombia, 88 pp.; Montoya 2003. Estructura de la Comunidad de Gasterópodos: Diversidad, Distribución y Abundancia con Relación a la Heterogeneidad Espacial en Dos Acantilados Rocosos Intermareales de Isla Palma, Pacífico Colombiano. Universidad del Valle, trabajo de grado. Cali, Colombia, 82 pp.). We were sampling Río E (a first order stream) by wading upstream. At a point where we were going around an obstruction, a specimen of *R. nasuta* was spotted and captured while on land headed downhill quickly in the stream direction. The time was 2221 h local time, more than 4 h after nightfall. It seems clear the turtle had seen our lights and was retreating to the water. The specimen was a first-time capture (#747); a juvenile with carapace length = 129.1 mm and weight = 240 g. We noticed it smelled bad (usually they are odorless) and that it had what looked like feathers stuck to its head, and its

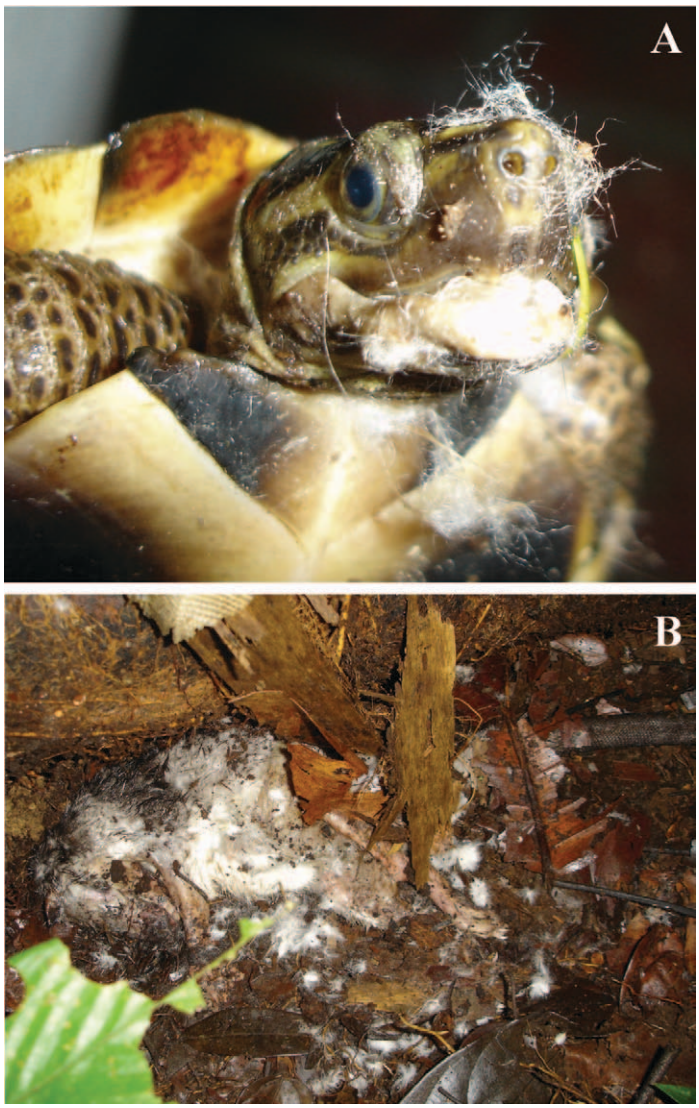


FIG. 1. A) Specimen of *Rhinoclemmys nasuta* shortly after capture with buccal cavity stuffed with fur. B) Body of the Water Opossum (*Chironectes minimus*) with the log lifted away. Note the left hindlimb has been stripped of fur down to the muscle. Photos by A. Quintero-Angel.

entire mouth was full of white "fluff" as it tried to bite. The turtle specimen had fur filling the buccal cavity, coming out the corners of the mouth, and little pieces stuck in scattered spots on the side of the head and forelimbs (Fig. 1A). We began a search to find what it had been eating and soon found a mammal body nearby. The body was up against and partly under a section of fallen tree trunk—about half the body under the log and half out, with a blow to the skull. The dead body was that of a male *Chironectes minimus* (Water Opossum or chucha de agua; Emmons and Feer 1990. Neotropical Rainforest Mammals: A Field Guide. University of Chicago Press, Chicago, Illinois. 281 pp.), a semi-aquatic opossum common on the island. There was an area at the front of the body where there was fur scattered about, and at least one hind leg had all the fur removed down to muscle (Fig. 1B). The straight-line distance from the water's edge to the *Chironectes* body was 3.80 m, but the over the surface distance would have been greater for the turtle to traverse because of the slope and its convexity.

The turtle was retained overnight in a container without access to water and was found to have swallowed the majority of the fur in the buccal cavity 9–10 h later. Generally speaking, aquatic and semi-aquatic turtles are restricted to feeding in the water (Bels et al. 2008. *In* Wyneken et al. [eds.], Biology of Turtles, pp. 187–212. CRC Press, Boca Raton, Florida), or returning to water to swallow after ingesting an item on land (Carr 2008. Southeast. Nat. 7:748–752; Winokur 1988. J. Morphol. 196:33–52). Our observations provide evidence that *R. nasuta* will feed on carrion, and that this feeding behavior may occur at night on land. It is not only capable of ingesting the food on land, but also swallowing while out of water.

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CROCODYLIA — CROCODILIANS

CAIMAN CROCODILUS (Spectacled Caiman). **PREY**. *Caiman crocodilus* is native to southeastern Chiapas, Mexico south to the coastal plain of Ecuador on the Pacific versant, and from northeastern Honduras to the southern edge of the Amazon Basin on the Atlantic versant (Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna Between Two Continents, Between Two Seas. University of Chicago Press, Chicago, Illinois. xx + 934 pp.). This species has been introduced on Isla de Juventud, Cuba, Puerto Rico (Schwartz and Henderson 1991. Amphibians and Reptiles of the West Indies: Descriptions, Distributions, and Natural History. University of Florida Press, Gainesville, Florida. xvi + 720 pp.), and in seven states of the United States, but is established only in Florida (Crother 2008. Scientific and Standard



FIG. 1. *In situ* photograph of dissected Spectacled Caiman (*Caiman crocodilus*) with Walking Catfish (*Clarius batrachus*) lodged in throat.



FIG. 2. Walking Catfish (*Clarius batrachus*) removed from throat of Spectacled Caiman (*Caiman crocodilus*) for size comparison.

English Names of Amphibians and Reptiles of North America. SSAR Herpetological Circular 37. 84 pp.). Little is known about the natural history of *C. crocodilus* in its introduced Florida range. With regards to diet, Ellis (1980. Copeia 1980:152–154) examined stomach contents of 30 *C. crocodilus* representing all age and size classes from Homestead Air Force Base, Miami-Dade Co., Florida, and recorded unidentified invertebrates and mammal hair, a Double-crested Cormorant (*Phalacrocorax auritus*), Southern Leopard Frogs and its tadpoles (*Lithobates sphenocephalus*), and fishes (native: *Centropomus undecimalis*, *Gambusia holbrooki*, *Ictalurus nebulosus*, *Lepomis macrochirus*, *Megalops atlanticus*, and *Poecilia latipinna*; nonindigenous: *Tilapia mariae*). Herein, we augment Ellis' diet data and report *C. crocodilus* preying upon the nonindigenous Walking Catfish (*Clarius batrachus*) in Florida.

On 4 February 2009 at 1500 h, an adult (94.8 cm SVL, 174 cm total length [TL]) *Caiman crocodilus* was observed basking on horizontally matted down Jamaica Swamp Sawgrass (*Cladium jamaicense*) in ca. 0.3 m water at the Frog City boat ramp, 7.6 mi W CR 997, Everglades National Park, Miami-Dade County (25.75976513°N, 80.59881673°W; datum: WGS84, elev. <1 m). This species is typically alert and "quite violent during initial capture" (Hertner 2006:267. Wilderness Environ. Med. 17:267–

270), however it allowed us to approach on an airboat and slip a noose around its head. The crocodilian's behavior was quite docile and allowed us to easily hoist it aboard and secure it for exotics removal from the park. The animal was later deposited in the Florida Museum of Natural History, University of Florida (UF 154567). While being dissected for diet contents and reproductive status, we found that the animal had a nonindigenous adult (25 cm TL) Walking Catfish (*Clarius batrachus*) lodged in its throat with both of the fish's pectoral fins (9.5 cm extended) penetrating through the esophagus. Page and Robins (2006. Raffles Bull. Zool. 54:455–457) classified this type of deleterious effect of an introduced species (i.e., catfish) as environmental degradation or ecological disruption. In Puerto Rico, at least 20 endangered Brown Pelicans (*Pelecanus occidentalis*) have been killed while attempting to prey on the nonindigenous Sailfin Catfish (*Pterygoplichthyes multiradiatus*) (Bunkley-Williams et al. 1994. Carrib. J. Sci. 30:90–94). The observed atypical behavior of our *C. crocodilus* suggests that it may have been affected by the catfish lodged in its throat. This is the first record of this nonindigenous crocodilian preying upon a nonindigenous catfish in Florida.

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SQUAMATA — LIZARDS

ANOLIS GARMANI (Jamaican Giant Anole). **NEMATODE PARASITE.** Little is known about the parasites of *Anolis garmani*. Bundy et al. (1987. J. Helminthol. 61:77–83) reported encapsulated juvenile acanthocephalans (*Centrorhynchus spinosus*?) and an atractid nematode (*Cyrtosomum longicaudatum*) from *A. garmani* collected in Jamaica. We report a new host and distributional record for a second nematode parasite of *A. garmani* from Jamaica.

A single wild born adult *A. garmani* from an unknown locale in Jamaica was obtained on 18 November 1988 from a reptile dealer at Pet Farm in Miami, Florida, and housed at the Houston Zoological Gardens, Houston, Texas, where it remained until it died on 30 April 1989. A midventral incision was made to expose the entire length of the digestive tract. Four female nematodes were recovered from the stomach, cleared on glass slide with undiluted glycerol and identified with the use of a compound microscope as *Physaloptera squamatae*. These nematodes are deposited in the United States Parasite Collection (USNPC), Beltsville, Maryland as USNPC 85444; host was not accessioned.

McAllister and Bursey (2007. Proc. Oklahoma Acad. Sci. 87:65–67) provided a summary of the hosts and localities of *P. squamatae*, which has been previously reported to infect 17 species of lizards in the families Phrynosomatidae, Polychrotidae, Scincidae, Teiidae, and Tropiduridae, and a snake species in the family Viperidae. Localities of *P. squamatae* include the United States (Florida, Hawaii, Oklahoma, and Texas) and the Caribbean (Anguilla, Bahamas, Caicos Islands, Cayman Islands, and Cuba) (McAllister and Bursey, *op. cit.*). *Anolis garmani* represents a new host record for *P. squamatae*; Jamaica is a new locality record.

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ARTHROSAURA RETICULATA (Yellow-bellied Arthrosaura). **ENDOPARASITES.** *Arthrosaura reticulata* (Gymnopthalmidae) is known from the Amazonian regions of Brazil, Ecuador, Peru, and Suriname (Avila-Pires 1995. Zool. Verh., Leiden 299:1–706). It is an inhabitant of leaf litter on the forest floor (Duellman 1978. Univ. Kansas Mus. Nat. Hist. Misc. Pub. 65:1–352). To our knowledge there are no reports of helminths from *A. reticulata*. The purpose of this note is to establish the initial helminth list for *A. reticulata*.

Twelve *A. reticulata* (4 female, 8 male, mean SVL = 47.5 mm ± 10.9 SD, range = 31–65 mm) from Reserva Faunistica Cuyabeno, Estación Biología da Universidad Católica (Quito) (0°S, 76.1166667°W; WGS 84, elev. 260 m) Sucumbios State, Ecuador collected March–April 1994 by LJV and deposited in the herpetology collection of the Sam Noble Oklahoma Museum of Natural History, Norman, Oklahoma as OMNH 36443–36454 were examined for endoparasites.

The body cavities were opened and the intestines removed and examined under a dissecting microscope. These specimens had been used previously for an ecological study (Vitt and Zani 1996. Can. J. Zool. 74:1313–1335); the stomachs were not available for examination. All endoparasites were found in the small intestines. Trematodes were regressively stained in haematoxylin and mounted in balsam. Nematodes were cleared in glycerol on a microscope slide. All were studied under a compound microscope. We found *Mesocoelium monas* (Trematoda), *Cosmocerca vrcibradici* (Nematoda) and *Oswaldocruzia vitti* (Nematoda). Two individuals of *M. monas* (prevalence [number infected/number examined x 100] = 8%, mean intensity [average number of parasites per infected lizard] = 2), 7 (1 male, 6 female) individuals of *C. vrcibradici* (prevalence = 42%, mean intensity = 1.4 ± 0.5 SD, range = 1–2), and 20 (5 male, 15 female) individuals of *O. vitti* (prevalence = 50%, mean intensity = 3.3 ± 2.9 SD, range = 1–7) were in the sample. Helminths were deposited in the United States National Parasite Collection, Beltsville, Maryland USA as: *Mesocoelium monas* (USNPC 102886), *Cosmocerca vrcibradici* (USNPC 102887), *Oswaldocruzia vitti* (USNPC 102888).

Mesocoelium monas is cosmopolitan in distribution and a recent host list is available (Goldberg et al. 2009. Comp. Parasitol.76:58–83). In Ecuador, it has been previously reported in the gymnophthalmid lizard *Alopoglossus angulatus* (Goldberg et al. 2007. Herpetol. J. 17:269–272). *Cosmocerca vrcibradici* is known from Brazil and Ecuador. *Oswaldocruzia vitti* is known from Brazil, Ecuador, and Peru. Both species were described from the gymnophthalmid lizards *Priondactylus eigenmanni* and *P. oshaughnessyi* (Bursey and Goldberg 2004. J. Parasitol. 90:140–145). *Cosmocerca vrcibradici* has been reported from *Al. angulatus* and *Al. atriventris* (Goldberg et al. 2007, *op. cit.*), the polychrotid lizard *Anolis fuscoauratus* (Goldberg et al. 2006a. Phyllomedusa 5:83–86) and the tropidurid lizard, *Uranoscodon superciliosus* (Bursey et al. 2005. J. Parsitol. 91:1395–1398). *Oswaldocruzia vitti* has been reported from *Al. angulatus* and *Al. atriventris* (Goldberg et al. 2007, *op. cit.*), *An. fuscoauratus* (Goldberg et al. 2006a, *op. cit*.), *An. punctatus* (Goldberg et al. 2006b. Amphibia-Reptilia 27:575–579), and the tropidurid lizards *Plica plica and P. umbra* (Goldberg et al. 2009. Herpetol. J. 19:49–52). *Arthrosaura reticulata* represents a new host record for *Mesocoelium monas*, *Cosmocerca vrcibradici*, and *Oswaldocruzia vitti*.

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ASPIDOSCELIS CALIDIPES (Río Tepalcatepec Valley Whiptail). **REPRODUCTION**. *Aspidoscelis calidipes*, a small member of the *A. sexlineata* species group, was described from 18 specimens from the Tepalcatepec Valley, Michoacán, México, by Duellman (1955. Occas. Pap. Mus. Zool., Univ. Michigan 574:1–7). It has also been reported from Guerrero (Pérez-Ramos et al. 2000. An. Inst. Biol. Univ. Nac. Autón. Méx., Ser. Zool. 71[1]:21–40; Pérez-Ramos and Saldaña-De la Riva 2005. Rev. Zool. 16:16–24). Variation, distribution, and ecology of the species were discussed by Duellman (1960. Copeia 1960:97–101) and summarized by Duellman and Zweifel (1962. Bull Am. Mus. Nat. Hist. 123:155–210) based on 136 specimens from Michoacán. Here, we provide reproductive data (clutch range and mean ± SE, SVL ranges and mean ± SE, and ovarian egg range and mean ± SE) for *A. calidipes* for which only a mean for clutch size has been presented in a table of comparisons with other species (Walker 1981a. Am. Midl. Nat. 105:217–224).

We examined 50 of the 52 specimens labeled as *A. calidipes* from University of Kansas Natural History Museum (KU, N = 15) and University of Colorado Museum (UCM, N = 37). We also examined specimens of this species from Museo de Zoología "Alfonso L. Herrera," Facultad de Ciencias (MZFC, N = 8) y del Instituto de Biología (IBH), Universidad Nacional Autónoma de México. Included from Michoacán are: 25.6 km S of Arteaga [3 December 1950 (KU 29747, N = 1)]; 19.4 km SSW of Apatzingán [30 November 1950 (KU 29748, N = 1)]; 1.6 km S of Capirio [26 August 1960 (KU 62602–62612, N = 11)]; Capirio [25 April 1956 (KU 69036–69037, N = 2)]; 8.0 km N of Nueva Italia [4 June 1972 (UCM 49687–49692, N = 6)]; 17.6 m S of Nueva Italia [5 June 1972 (UCM 49693, N = 1); 7 June 1972 (UCM 49694–49697, N = 4); 10 June 1972 (UCM 49698–49723, N = 26)]. Included from Guerrero are: Juntas de Cujarán [11 May 1979 (MZFC 701, 703, N = 2); 12 May 1979 (MZFC 702, 706, 708, N = 3); 11 June 1979 (MZFC 704, N = 1); 12 June 1979 (MZFC 700, 705, N = 2)].

The pooled KU and UCM samples from Michoacán included by sizes (as 5 mm SVL increments) these frequencies (in parens) for 19 females followed by 31 males: 40–44 (0:1); 45–49 (1:0); 50–54 (3:1); 55–59 (8:1); 60–64 (4:6); 65–69 (3:14); 70–74 (0:5); and 75–79 (0:3). The MZFC sample from Guerrero included by sizes (as 5 mm SVL increments) these frequencies (in paren) for a female followed by 7 males: 55–59 (0:1); 60–64 (0:3); 65–69 (1:2); and 70–74 (0:1). The smallest gravid female of 52 mm SVL among the specimens of *A. calidipes* is comparable to the smallest gravid females reported by Walker (1981a, *op. cit.*) and Walker (1981b. J. Herpetol. 15:321–328) for *A. parvisocia* from Puebla (50 mm SVL) and Oaxaca (52 mm SVL). Each of the following statements for a SVL group from Michoacán includes the numbers of gravid females followed by clutch size based on the same or a smaller number of lizards with undamaged eggs. In *A. calidipes* 1 of 3 (33.3%) females 50–54 mm SVL had a clutch of 2 eggs. Among females 55–59 mm SVL, 5 of 8 (62.5%) had clutches of 1–2 eggs (mean = 1.8). Among females 60–64 mm SVL, 3 of 4 (75%) had clutches of 3–4 eggs (mean = 3.3). Among females 65–69 mm, 3 of 3 (100%) had clutches of 1–4 eggs (mean = 2.3). The female of 67 mm SVL from Guerrero had a clutch of 3 eggs. Overall, only two specimens of 44 and 49 mm SVL were arguably sub-adults. Females with data from Michoacán (N = 12) had clutches (sample size in each category in parens) of 1 (2), 2 (6), 3 (2), and 4 (2); mean clutch size, SVL, and ovarian egg size for these females were 2.33 ± 0.28 (1–4) eggs, 60.1 ± 1.03 (52–65) mm, and 5.61 ± 0.36 mm, respectively. No correlation existed between clutch size and SVL in the sample of 12 gravid females of *A. calidipes* (adjusted r^2 = -0.0086, P = 0.3636), a finding that may reflect sample size. However, lack of a correlation persisted after pooling the gravid specimen of *A. calidipes* from Guerrero with the sample from Michoacán. It is noteworthy to mention that mean clutch size and SVL for 85 *A. parvisocia* gravid females from Puebla and Oaxaca were 1.78 ± 0.06 (1–4) eggs and 59.5 ± 0.38 (50–69) mm; thus, a correlation existed between clutch size and SVL in this species (adjusted r^2 = 0.165, P = 0.0001) (Walker 1981a, *op. cit.*).

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ASPIDOSCELIS COSTATA GRISEOCEPHALA (Blue-throated Whiptail). **REPRODUCTION**. *Aspidoscelis costata griseocephala* (*sensu* Reeder et al. 2002. Am. Mus. Novit. 3365:1–61) is among many named, but biologically poorly known reptiles from remote areas of México. Zweifel (1959. Bull. Am. Mus. Nat. Hist. 117:57–116) described the subspecies as *Cnemidophorus sacki griseocephalus* based on 78 specimens from the type locality (18.2 km E of Navojoa, Sonora) and other sites in the states of Sonora and Sinaloa. Duellman and Zweifel (1962. Bull. Am. Mus. Nat. Hist. 123:155–210) reallocated the subspecies to *C. costatus griseocephalus* (= *A. costata griseocephala*; Reeder et al., *op. cit.*). Wright (1993. *In* Wright and Vitt [eds.]. Biology of Whiptail Lizards (Genus *Cnemidophorus*), pp. 27–81. Oklahoma Mus. Nat. Hist., Norman, Oklahoma) provided no data in support of his use of the name *A. burti griseocephala*. Here, I present reproductive data (clutch ranges and mean ± SE, SVL ranges and mean ± SE) for a form that Bogert and Oliver (1945. Bull. Am. Mus. Nat. Hist. 83:297–426) and Zweifel (*op. cit.*) reported only limited clutch and SVL observations.

I examined 62 specimens labeled as *C. costatus griseocephalus* (= *A. costata griseocephala*) from the California Academy of Sciences (CAS) collected by A. E. Greer and F. W. Burley at these five sites in Pacific coastal Sinaloa: 10.6 km N of Los Mochis on Hwy 15 [15 June 1963 (CAS 115004, N = 1); 21 July 1963 (115683–115695, N = 13)]; 15.7 km NE of Topolobampo on Los Mochis Road [21 July 1963 (CAS 115681–115682, N = 2)]; 16.5 km N of Río de Fuerte on Hwy 15 [22 July1963 (CAS 115707–115710, N = 4); 23 July 1963 (CAS 115711–115712, N = 2)]; 4.3 km N of Masiaca on Hwy 15 [23 July 1963 (CAS 115769, N = 1); 24 July 1963 (CAS 115772–115781, 115786–115787, 115789, N = 13)]; and 49.4 km S of Masiaca on Hwy 15 [23 July 1963 (CAS 115719–115744, N = 26)]. I obtained size (as SVL to the nearest 1 mm) for all specimens in the CAS sample. Females were dissected to identify the number and measure oviductal eggs and ovarian follicles (this was precluded in three damaged gravid females).

A male-biased sex ratio of ca. 1.6:1 (38:24) in the CAS sample of *A. c. griseocephala* approached the ca. 2:1 (129 males:64 females) ratio observed in *A. costata nigrigularis* (Walker 2008a. Herpetol. Rev. 39:86–87), but much less skewed than the ca. 3:1 (187 males:68 females) ratio observed in *A. costata huico* (Walker 2008b. Herpetol. Rev. 39:85–86). None of the 16 (three damaged) gravid females of *A. c. griseocephala* contained oviductal eggs; all had yolked ovarian follicles of 3.5–10.0 mm in diameter. Bias in the sex ratio of each of these taxa may pertain to secretive female behavior during egg maturation and oviposition that make them less susceptible to collection than other adults. Alternatively, shorter life expectancy in females is a non-mutually exclusive explanation that may also contribute to the male-biased sex ratio. The latter may be reflected by the relative male:female numbers, respectively (in parens), by 10-mm SVL increments (where applicable) in the CAS sample: 50–59 (0:1); 60–69 mm (4:8); 70–79 mm (8:6); 80–89 mm (8:7); 90–99 mm (11:2); 100–109 mm (3:0); 110–118 mm (4:0). Assuming any secretive behavior by adult females is unrelated to their size, *A. c. griseocephala* appears sexually dimorphic in favor of males.

Females of *A. c. griseocephala* attain reproductive maturity at a small body size (ca. 61–66 mm SVL) similar to *A. costata barrancarum* in southwestern Chihuahua (Walker et al. 2004. Herpetol. Rev. 34:366), *A. c. nigrigularis* in Sinaloa (Walker 2008a, *op. cit.*), and *A. c. huico* in Sinaloa and Nayarit (Walker 2008b, *op. cit.*). In *A. c. griseocephala*, four (50%, one damaged) females 60–69 mm SVL had clutches of 2–3 eggs (= 2.3, N = 3). Among females 70–79 mm SVL, 5 (83.3%, one damaged) were gravid; clutch size was 2–5 eggs (mean = 3.0 ± 0.8 SD, N = 4). Among females 80–89 mm SVL, 5 (71.4%, one damaged) were gravid; clutch size was 4–6 eggs (mean = 5.0 ± 0.8 SD, N = 4). Among females 90–99 mm SVL, two (100%) were gravid; clutch size was five eggs (mean = 5.0, N = 2). For the period 15 June–24 July 1963, 13 females with data had clutches (sample size in each category in parens) of 2 (3), 3 (3), 4 (2), 5 (4), and 6 (1); mean clutch size and SVL for these females were 3.8 ± 0.37 (2–6) eggs and 78.7 ± 2.68 (66–96) mm, respectively. A strong relationship exists between clutch size and SVL (based on adjusted $r^2 = 0.67$, $P = 0.0004$, N = 13). Data for the CAS sample established these additional reproductive characteristics for *A. c. griseocephala;* SVL of all adult males, 86.7 ± 2.27 (62–115, N = 38) mm; SVL of all adult females, 76.0 ± 2.12 (61–96, N = 23) mm; reproductive season, June–July (this study) and into late August (Zweifel, *op. cit.*) and perhaps longer; and reproductive potential, multiple clutches based on early maturation of both sexes at small body sizes in an extended activity cycle in subtropical México.

I thank Robert C. Drewes (CAS) for the opportunity to examine specimens in his care. This note was materially improved by the editorial expertise of Marc P. Hayes.

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ASPIDOSCELIS SCALARIS SEPTEMVITTATA (Big Bend Spotted Whiptail). **ENDOPARASITES.** *Aspidoscelis scalaris septemvittata* is known from Northern Chihuahuan Desert, populations exist in the Big Bend region of Texas and adjacent Mexico where they can be found in the states of Chihuahua, Coahuila, Durango, and Zacatecas (Leavitt 2009. *In* Jones and Lovich. Lizards of the American Southwest, pp. 378–381. Rio Nuevo Publishers, Tucson, Arizona). Herein, we present data on a high parasite load and a new species of parasite for *A. s. septemvittata*.

Scudday and Dixon (1973. Southwest. Nat. 18:279–289) reported 17 of 74 stomachs of *A. s. septemvittata* from Trans-Pecos, Texas contained nematodes with a maximum of 15 per stomach. During a gut content analysis of 27 *A. s. septemvittata* from Big Bend National Park, Brewster Co., Texas (Leavitt 2007. MS thesis. Sul Ross State University. 126 pp.), 25 of 27 stomachs analyzed contained nematodes. We found an average of 7.76 ± 5.71 (range: 0–23) nematodes per stomach in this sample. A sympatric population of 19 *Aspidoscelis marmorata*, collected at the same time, only contained 2 members with nematode infestation.

Two male *A. s. septemvittata* (SRSU 6637, 6661) were examined for endoparasite identification. We identified one species of Nematoda, *Abbreviata terrapenis*, from both individuals. *Abbreviata terrapenis* was originally described from the chelonian *Terrapene ornata* (Hill 1941. Trans. Am. Micro.

Soc. 60:59–64). It has also been reported for four other species of lizards, including *Sceloporus jarrovii* (Goldberg et al. 1996. Am. Mid. Nat. 135:299–309), *Aspidoscelis sonorae* (Goldberg et al. 1997. Great Basin Nat. 57:273–277), *Aspidoscelis tigris* (Goldberg et al 1997, *op. cit.*), *Crotaphytus collaris* (McAllister et al. 2008. Comp. Parasitol. 75:241–254), and three species of snakes including *Thamnophis cyrtopsis* (Goldberg and Bursey 2002. W. N. Am. Nat. 62:160–169), *Crotalus lepidus klauberi* (Goldberg et al. 2002. J. Wild. Dis. 38:453–456), and *Coluber constrictor* (McAllister et al. 2008, *op. cit.*). Voucher helminths from this population of *A. terrapenis* have been sent to the United States National Parasite Collection, USNPC, Belltsville, Maryland, USA as: *A. terrapenis* (USNPC 101523).

Permission to collect lizards was granted to D. J. Leavitt by National Park Service permit number BIBE-2006-SCI-001.

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COLEONYX BREVIS (Texas Banded Gecko). **DIET.** Little has been published about the diet of *Coleonyx brevis*, with only one published study focusing on the subject (Punzo 1974. Copeia 1974:779–780). Here we report on the diet of *C. brevis* from Coahuila, Mexico.

We examined 42 specimens of *C. brevis* from the collection of the Laboratorio de Ecología, UBIPRO – FES-Iztacalal UNAM. These specimens were collected from Coahuila, Mexico, primarily 80 km S Químicas del Rey (26.443333°N, 103.035889°W, datum: WGS84; elev. 1091 m), but also from additional sites in the area S of Químicas del Rey. We dissected lizards to obtain information on diets. We identified each prey item to order or family as possible, and measured the length and width of each item using an electronic caliper (to nearest 0.1 mm). We estimated prey volume using the formula for a prolate spheroid.

Of the 42 specimens examined, only 18 (43%) contained prey in their stomachs. Numerically, isopterans (termites) were the most important prey items, and represented >75% of the prey items consumed (Table 1). Volumetrically, termites were also the most important prey items, followed by homopterans. However, isopterans were only found in 5 of the 18 stomachs that contained prey, suggesting they are likely patchy prey. Punzo (1974, *op. cit.*) found that the most important prey item numerically were beetles for a population of *C. brevis* from Texas. Interestingly, Punzo (1974, *op cit.*) found no isopterans in the stomachs he examined. Parker and Pianka (1974. Copeia 1974:528–531) found termites were numerically an important item in the diets of *C. variegatus*, but this importance varied seasonally. It may be that isopterans are more available in the environment in the vicinity of the populations our specimens were collected from.

TABLE 1. Diet of *Coleonyx brevis* from Chiahuahua, Mexico.

Prey Category	Number (%)	Percent Volume	Frequency
Araneae	1 (1.35)	0.63	1
Coleoptera			
Adult	4 (5.41)	3.75	3
Larvae	4 (5.41)	< 0.5	2
Diptera	3 (4.05)	8.13	2
Hemiptera	1 (1.35)	1.25	1
Homoptera	1 (1.35)	21.25	1
Isoptera	56 (75.7)	38.75	5
Lepidoptera			
Larvae	1 (1.35)	6.88	1
Orthoptera			
Acrididae	3 (4.05)	19.38	3

Indeed, observations published in association with the collection data indicate that the lizards were "feeding on huge numbers of flying ants [actually termites]" (Smith et al. 2005. Bull. Chicago Herpetol. Soc. 40:45–51). Thus, the presence of termites in *Coleonyx* diets may be temporally variable depending on termite abundance in the environment. Further research is required to determine how much the differences in diets reflect differences in prey availability or differences in prey selectivity.

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COPHOSAURUS TEXANUS (Greater Earless Lizard). **MULTIPLE TAILS**. Records of bifid and trifid-tail regeneration in lizards have previously been published for *Plestiodon* (=*Eumeces*) *egregius* (Taylor 1935. Univ. Kansas Sci. 23:1–643), *Elgaria multicarinata* (Banta 1963. Turtox News 41:207), *Christinus* (=*Phyllodactylus*) *marmoratus* (Crouch 1969. Wildlife in Australia 6:101), *Anolis sagrei* (Goin and Goin 1971. Introduction to Herpetology, 2nd ed. W. H. Freeman and Co., San Francisco, California. 353 pp.), *Sceloporus occidentalis* (Clark 1973. HISS News-J. 1:158), *Plestiodon* (=*Eumeces*) *fasciatus* (Scott 1982. Herpetol. Rev. 13:46), and *Microlophus bilineatus* (Colwell 1992. Herpetol. Rev. 23:118). Herein, we report the first record of a trifid-tailed *Cophosaurus texanus* found in the Chihuahuan Desert of Trans-Pecos, Texas.

On 7 September 2008, at 0020 h, an adult male *C. texanus* (SVL 75 mm; 13.8 g) with three irregular regenerated tails was found resting on sandy substrate surrounded by Chihuahuan Desert scrub vegetation, 1.6 km SE of the headquarters complex of the Indio Mountains Research Station, located ca. 40 km SW of Van Horn, Hudspeth Co., Texas (30.773392°N, 105.012430°W,



FIG. 1. An adult male trifid-tailed *Cophosaurus texanus* caught at Indio Mountains Research Station, Hudspeth County, Texas.

WGS84; 1233 m elev.). The trifurcation point was positioned 24.0 mm posterior from the cloaca (Fig. 1). Length of the large middle tail was 30.0 mm and the other two were 6.0 mm (left side) and 4.0 mm (right side), respectively.

It has been suggested that multiple regenerated tails are mostly the result of new tails growing from irregular cuts due to injury (Clark 1973, *op. cit*.; Goin and Goin 1971, *op. cit.*), which appears to be the case for this lizard. All three tails were clearly regenerated as indicated by the re-grown surfaces having smaller scales and an absence of color pattern like that found on the non-regenerated tail section. The lizard is deposited in the Herpetology Collection, Laboratory for Environmental Biology, Centennial Museum, at the University of Texas at El Paso (UTEP 19872). We thank A. F. Scott and R. Webb who kindly provided us with some of the literature sources.

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CROTAPHYTUS VESTIGIUM (Baja Black-collared Lizard). **ENDOPARASITES.** *Crotaphytus vestigium* occurs from the peninsular ranges of southern California to the southern margin of the Magdalena Plain in Baja California Sur, México (McGuire 1996. Bull. Carnegie Mus. Nat. Hist. 32:1–143.). To our knowledge there are no reports of helminths for this species. The purpose of this note is to establish the initial helminth list for *C. vestigium*.

Two nematodes were found in one female *C. vestigium* (SVL = 79 mm) collected July 1949 at Bahía de Concepción, Baja California Sur, México (26.750000°N, 111.883333°W, WGS84; elev. 2 m) and deposited in the herpetology collection of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California, USA as LACM 63172. The nematodes were cleared in a drop of glycerol on a glass slide, cover-slipped and identified as two adult female *Thubunaea iquanae*. They were deposited in the United States National Parasite Collection, Beltsville, Maryland, UDSA as USNPC (102963).

Thubunaea iguanae is a common stomach parasite of lizards from the southwestern United States and Mexico (Baker 1987. Mem. Univ. Newfoundland, Occas. Pap. Biol. 11:1–325) and also occurs in colubrid snakes (Goldberg and Bursey 2001. Bull. South. California Acad. Sci. 100:109–116). It is in the family Physalopteridae, which utilizes intermediate insect hosts (Anderson 2000. Nematode Parasites of Vertebrates: Their Development and Tranmission, 2nd ed. CABI Publishing, Oxfordshire, UK. 650 pp.). *Crotaphytus vestigium* represents a new host record for *Thubunaea iguanae*.

We thank Christine Thacker (LACM) for permission to examine *C. vestigium*.

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CTENOTUS HELENAE (Helen's Comb-Eared Skink). **HERMAPHRODITISM**. On 20 November 2008, SEG and ERP caught a hermaphroditic adult *Ctenotus helenae* (88 mm SVL, 14.1 g, 117 mm tail with an 87 mm regenerated portion) in a pitfall trap at their Red Sands study site (28.19397ºS, 123.58247ºE, datum WGS 84; elev. 430 m) in the Great Victoria Desert of Western Australia. During examination for sexual condition and diet, the specimen was found to have a regular testicle on its right side but an ovotestis on its left side. The latter consisted of a smaller testicle with a cluster of ovarian follicles attached antero-laterally. The follicle cluster was separated from the left testicle by a thin brown sheet of tissue not typically present on the gonads of this species. The right testicle measured (maximum width × length) 5.0 × 10.4 mm, the left testicle was 3.5 × 6.8 mm, and the four ovarian follicles were all between 0.9 and 3.0 mm in maximum diameter. The left half of the cloaca lacked a hemipenis but the right hemipenis was everted. Functionality as a male seems likely due to the fully developed appearance of the testicles and everted right hemipenis. The lizard appeared normal

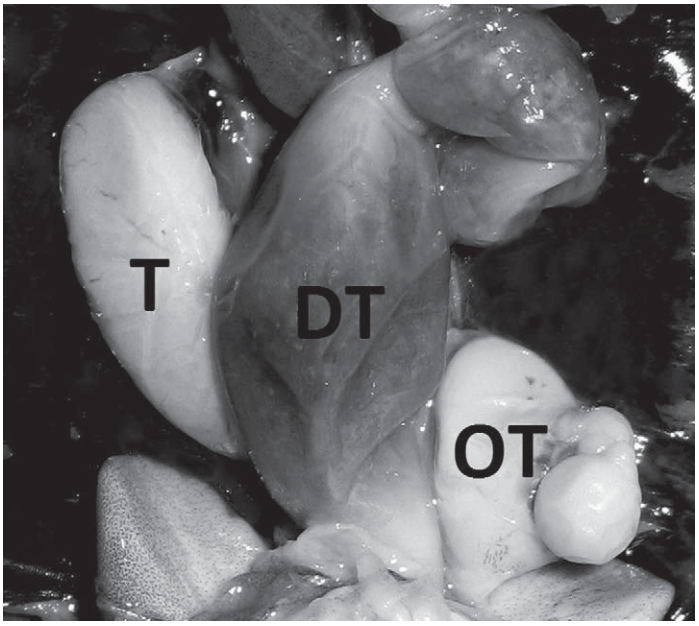


FIG. 1. Posteroventral body cavity of a hermaphroditic *Ctenotus helenae*. Labels indicate the testis (T), ovotestis (OT) and digestive tract (DT). Photograph by S. Goodyear.

and uninjured besides the regenerated tail and a few missing scales. Horner (1991. Skinks of the Northern Territory. Northern Territory Government Printing Office. Darwin, Australia. 174 pp.) reports a maximum 95.0 mm SVL for this species. Of conspecifics collected by ERP, fresh SVL (mm) for 60 males averaged 76.6 with a maximum of 95.0 whereas fresh SVL for 83 females averaged 83.3 with a maximum of 98.0. These data show the hermaphrodite is typical but larger in size. The skink was captured during the September–February breeding season for the species (Horner, *op. cit*.).

Few reports of intersex observations among lizards exist. Tayler (1918. Proc. Zool. Soc. London 1918:223–230) described a *Lacerta viridis* with both left and right ovotestes. Badir (1958. Zeit. Wiss. Zool. 160:290–351) found a *Chalcides ocellatus* with a right gonad containing mostly ovarian follicles attached to a nonfunctional testicular rudiment. Bons and Bons (1969. C. R. Acad. Sci. Paris 268:695–696) reported an *Ophisaurus koelikeri* with a full set of male and female reproductive structures. Darevsky et al. (1978. Copeia 1978:201–207) found a *Lacerta armeniaca* with a right ovotestis. Goldberg (1989. Copeia 1989:486–488) reported a *Sceloporus occidentalis* with left and right ovotestes consisting of testes attached to ovarian follicles clustered anteriorly and Brown (2008. Biawak 2008:87–88) described a *Varanus acanthurus* with a right testicle and left ovary, oviducts and uterine tissue. In our case, ERP collected and examined nearly 30,000 lizards before we found this exceptional one.

We deposited the specimen in the Western Australian Museum (WAM R169499). We thank Marc Hayes and Jackson Shedd for comments on the manuscript.

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GAMBELIA WISLIZENII (Long-Nosed Leopard Lizard). **ESCAPE BEHAVIOR/ SWIMMING AND FLOATING**. Swimming and floating abilities in lizard species that inhabit desert environments are not often observed under natural conditions. Here, I report the aquatic behavior of an inhabitant of the xeric Mojave Desert of the southwestern United States. An account describing aquatic escape behavior of a closely related species, the Eastern Collared Lizard (*Crotaphytus collaris collaris*) (McAllister 1983. Herpetol. Rev. 14:11), reported individuals avoiding capture by running into a quarry pond, inflating their lungs, and floating or actively swimming to return to shore. A recent account (Estrada-Rodriguez and Leyva Pacheco 2007. Herpetol. Rev. 38:84–85) documents the swimming ability of the Coahuila Fringe-toed Lizard (*Uma exsul*), a sand dune specialist in Coahuila, Mexico. On several occasions these lizards were observed swimming and floating across open expanses of water between dune complexes with a "serpentine pattern that was especially evident in the tail, this animal would stop periodically to float and to change direction." Carpenter and Ferguson (1977. *In* Gans and Tinkle [eds.] Biology of the Reptilia, vol. 7, pp. 335–554. Academic Press, London) did not consider swimming behavior as "steryotyped" and therefore it was not included in their chapter (C. C. Carpenter, pers. comm.).

On 12 July 1990, while I was approaching a remote pond at Well Site (J-12) on the edge of Fortymile Canyon near the southern boundary of the Nevada Test Site, Nye Co., Nevada, USA, an

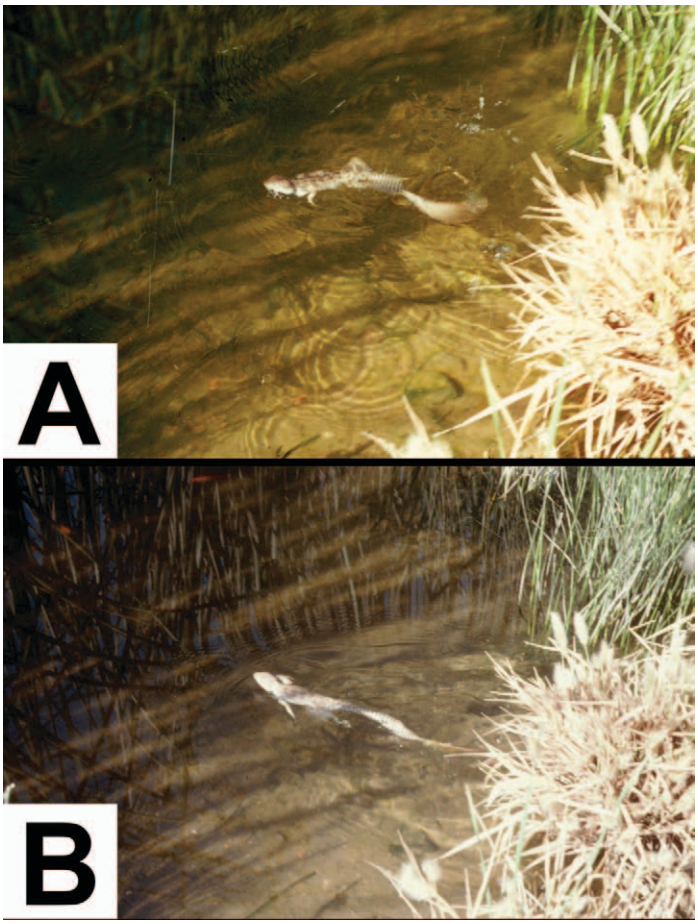


FIG. 1. A) Adult female Long-nosed Leopard Lizard (*Gambelia wislizenii*) swimming with serpentine motion of its body and tail. B) Hand over hand paddling of anterior legs while swimming.

adult female *Gambelia wislizenii* ran across the sandy soils ca. 3 m in front of me and sprang directly into the water, swam briefly to an adjacent cat-tail (*Typha latifolia*) and perched there half submerged. The lizard stayed perched in this position for a few minutes until it was captured. Astounded by this unusual escape behavior which took place instantaneously as I approached the pond, I attempted to see if the lizard would repeat this behavior and document it with photographs. Subsequently, the lizard was placed gently in the shallow water at the edge of the pond and it proceeded to swim away from the shore several meters (Figs. 1A, B), with its body and tail undulating in a serpentine pattern, and its legs appearing to be paddling alternately. Ultimately, the lizard remained in the water, appeared to inflate its lungs, and floated into the reeds.

I thank C. C. Carpenter for his comments on this and an earlier version of this observational note, and K. Nussear, K. Phillips, R. Fisher, and J. Richmond for their reviews. I also thank C. Dull and P. Greger for their assistance in the field, and K. Nolte and K. Drake for preparing the figures. I gratefully acknowledge the U.S. Department of Energy, National Nuclear Security Administration for continued access to our study sites.

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GYMNODACTYLUS DARWINII (Darwin's Atlantic Rainforest Naked-toed Gecko; lagartixa-de-dedos-nus da Mata Atlântica). **COMMUNAL OVIPOSITION**. Little has been published on phyllodactylid geckos of the genus *Gymnodactylus* regarding reproductive behavior or biology. Aside from the works by Vitt (1986. Copeia 1986:773–786) and Colli et al. (2003. J. Herpetol. 37:694–706), there are only sporadic records on *Gymnodactylus* reproduction. *Gymnodactylus geckoides*, an endemic species of the Caatinga bioregion, appears to produce eggs continuously throughout the year with individual females producing at least two clutches per year of one egg each (Vitt 1986, *op. cit.*). Alternatively, *G. amarali*, an endemic species of the Cerrado region, has a pattern that differs from *G. geckoides*, with one or two (more frequently two) eggs per clutch, with reproduction concentrated during the dry season (May to September), although reproductive individuals have been found throughout the year (Colli 2003, *op. cit.*). Despite the similar size of adult females, *G. geckoides* lays smaller clutches of larger eggs than *G. amarali* (Colli 2003, *op. cit.*). Vanzolini (1953, *op. cit.*) reported that a female of *G. darwinii*, an endemic species of the Atlantic Rain Forest bioregion, captured on 2 July 1950 in the São Sebastião island, São Paulo state, after approximately six months in captivity, produced two eggs on 26 December in an oval nest. In addition, he also described the egg-laying behavior. Righi et al. (2004. Herpetol. Rev. 35:395–396) mentioned that *G. guttulatus*, known only from the vicinity of Diamantina municipality, in Espinhaço Range, Minas Gerais state, has eggs with almost spherical shape. These anecdotal accounts are the only published data on reproduction in *Gymnodactylus* species. Herein we report evidence of communal nesting for the common Atlantic Rainforest Naked-toed Gecko, *Gymnodactylus darwinii*.

On 26 February 2009, one of us (JC) found six small, uniformly white, hard-shelled calcareous eggs, slightly oval (mean length = 10.2 ± 0.31305; mean width = 8.55 ± 0.130384) in a disturbed area in the vicinity of Canavieiras municipality (15.66908333°S, 38.98469444°W; datum WGS84, elev. ca. 10 m), Bahia state, Brazil. They were identified as those of *G. darwinii* based on size and general appearance, and the fact that this is the only species of *Gymnodactylus* that occurs in the region. The eggs were found together under a fallen log, in a cavity with fragments of rotten wood. We could not obtain precise dimensions on the nest (ca. 50 mm), as it was partially destroyed when found. In the same fallen log, in other cavities, we captured seven adult specimens of *G. darwinii*, apparently using this microhabitat gregariously. The nest was collected and two eggs hatched in a terrarium at the laboratory, one after 95 days, and the other after 109 days from collection. The hatchlings measured 21.8 and 21.95 SVL and 21.4 and 21.6 mm tail length, respectively. The other four eggs died.

Gekkotan lizards usually produce one or two white eggs per clutch, and they may lay several clutches per year (Kluge 1967. Bull. Am. Mus. Nat. Hist. 135:1–60; Fitch 1970. Misc. Publ.Univ. Kansas Mus. Nat. Hist. 52:1–247). Communal egg-laying or nesting appears to be widespread in lizards, particularly geckos, even involving more than one species (e.g., Krysko et al. 2003. Amphibia-Reptilia 24:390–396; Oda 2004. Acta Amazonica 34:331–332). Communal oviposition was defined by Espinoza and Lobo (1996. Herpetol. Nat. Hist. 4:65–68) as "the non-incidental deposition of eggs at a shared nest cavity by two or more conspecifics," and Krysko et al (2003, *op. cit.*) amended this definition to include "the non-incidental deposition of eggs by geckos of different genera." On the other hand, not all egg aggregations should be interpreted as communal nesting, because large aggregations of gecko eggs may also represent the repeated use by a single female or a combination of both (Bock 1996. Herpetol. Rev. 27:181–183). To our knowledge, this behavior has only been verified in *Phyllopezus pollicaris* among South American phyllodactylids (Righi et al., *op. cit.*; Vitt, *op. cit.*).

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PHELSUMA LATICAUDA **(**Gold Dust Day Gecko**). PREY.** The diurnal geckos of the genus *Phelsuma* of Madagascar are sit-and-wait predators (Ikeuchi et al. 2005. Amphibia-Reptilia 26:475–483). Geckos of this genus have varied diets, but are mainly insectivorous (Ikeuchi et al. 2005, *op. cit.). Phelsuma laticauda*



COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND

FIG. 1. Gold Dust Day Gecko (*Phelsuma laticauda*) attempting to feed on a Stump-toed Gecko (*Gehyra mutilata*).

is widely distributed and abundant in the coastal northeast and Sambirano regions (Glaw and Vences 2007. A Field Guide to the Amphibians and Reptiles of Madagascar. 3rd ed. Cologne, Vences and Glaw Verlag. 496 pp.).

On 7 August 2009 at 1315 h on the office door of World Wide Fund for Nature (WWF) in Andapa (14.660°S, 49.650°E), Sava Region, northeastern Madagascar, I found an adult *P. laticauda* attempting to feed on a juvenile Stump-toed Gecko (*Gehyra mutilata*) (Fig. 1). The *Gehyra* had been bitten and was being held by the head with its hind limbs and tail curled towards the *Phelsuma*'s mouth. As I approached to take a closer photo of this predatory prey interaction, the *Phelsuma* released its hold on the *Gehyra* gecko. The *Gehyra* gecko was fatigued and extremely weak, but still had the ability to crawl into a narrow refuge between planks in the office floor where the *Phelsuma* could not follow it. Because of its age, the nocturnal juvenile prey species may have less diurnal hiding experience and may have been detected by the *Phelsuma*. I believe this is the first recorded observation of a predation attempt by a *P. laticauda* on a relatively large prey item *G. mutilata*, or any other vertebrate. The foraging behavior of *Phelsuma* species may change greatly according to prey abundance and distribution, as suggested by Ikeuchi et al. 2005 (*op. cit.*).

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PHRYNOSOMA MODESTUM (Round-tailed Horned Lizard). **PREDATION AND NESTING.** While I was studying nesting behavior of *Phrynosoma modestum*, a gravid female of this species (SVL 50 mm, mass 8.2 g) was followed daily by radio-telemetry (Holohil™ BD-2, 1.5 g transmitter/ Telonix™ TR-4 receiver with Telonix™ Model RA-14K antenna). The female had been collected in Hidalgo Co., New Mexico, USA (31.9671167°N, 108.6207667°W, datum WGS 84) 25) in May 2009 and released 27 June at the study site (31.9121667°N, 109.08765°W) in Cochise Co., Arizona (Chihuahuan Desert shrub/grassland vegetation; Brown et al. 1997. Proc. Natl. Acad. Sci. USA 94:9729–9733). On 10 July (0830 h), while searching for the female lizard I encountered an adult *Masticophis flagellum lineatulus* (SVL 116 cm, TL 35 cm; mass 280 g) and captured it by hand. *M. flagellum* is known to predate other larger species of horned lizards (see references in Sherbrooke 2008. J. Herpetol. 42:145–152; Sherbrooke and May 2008. Herpetol. Rev. 39:156–162), but has not been reported to prey on *P. modestum*. While holding the snake, I continued the search for the lizard and soon found myself turning in circles attempting to locate the direction of the transmitted signal from the lizard. Refocusing my efforts, I noted that the transmitter signal was coming from the snake, still in my hand. There was no obvious bulge in the snake's body but my conclusion was that the snake had recently eaten the lizard. During my initial search for the lizard, just prior to seeing the snake, I had noted a freshly excavated hole in the soil (with an adjacent pile of loose soil) that appeared to be the result of lizard nest-digging. The horizontal-elliptical opening was the size of the round-tailed horned lizard and deep enough to accommodate its body, but it had not been fully excavated (only about 2 cm deep) and was without eggs. This suggests that the female's nest-digging activities might have attracted the snake, and that lizards are vulnerable to predation during diurnal-nesting activities. Other horned lizards were concurrently nesting at the same site. A larger female *P. modestum* (SVL 63 mm; 14.7 g), also being followed in the same study, had nested on 4 July (nest covered by late morning; a previously observed *P. modestum* nested nocturnally at the same location, Sherbrooke 2000. Herpetol. Rev. 31:242–243), and several (N = 7) *Phrynosoma cornutum* nested here between 27 June and 11 July 2009. Rain fell at the site on 25, 26, and 28 June, and 2, 3, 4 and 5 July, 2009. The snake was subsequently held in captivity and the radio-transmitter was recovered, having passed its digestive tract by 20 July 2009.

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PODARCIS PITYUSENSIS (Ibiza Wall Lizard). **DEATH-FEIGNING BEHAVIOR**. Many animals display thanatosis, or death-feigning behavior, as an anti-predatory mechanism (Arduino and Gould 1984. Anim. Behav. 32: 921–923; Sargent and Eberhardt 1975. Am. Midl. Nat. 94:108–109; Sazima 1974. J. Herpetol. 8:376–378), and while thanatosis has been widely documented in snakes (Gehlbach 1970. Herpetologica. 26:24–34) this behavior is much less common among lizards (Gallup 1973. Copeia 1973:623–624). Here, I present evidence that the *Podarcis pityusensis* feigns death after being held on its back for two to five seconds. Once this behavior has initiated, the lizard can be clapped at without moving—in some cases for an excess of five minutes. However, if one walks away from the lizard for more than a few seconds, the lizard quickly rolls over and attempts to escape.

Podarcis pityusensis is a diurnal, ground dwelling lizard endemic to Ibiza and Formentera (and nearby rocky islets) in the Balearic Island chain off the coast of Spain (Cirer and Martinez-Rica 1990. Herpetol J. 1:465–473; Martinez and Cirer 1982. Biol. Cons. 22:295–314). A host of animals prey on *P. pityusensis* including birds, snakes, and mammals (Alcover 1984. Saügetierkundliche Mitteilungen 31:189–195; Carretero 2004. Ital. J. Zool. 2:121–133; Pérez–Mellado 1988. Fauna Ibérica. 10:294–302).

Using a noose, I collected 96 *P. pityusensis* from five different populations. I captured 20 lizards from each of the following sites within the Balearic Islands: 1) Tagomago (39.037°N, 1.645°E), 2) Ses Salinas (38.822°N, 1.411°E), and (3) Mirador des Savinar (38.871°N, 1.411°E) on Ibiza, 4) the islet s'Espalmador (38.784°N, 1.425°E), and 16 lizards from 5) Es Trocadors (38.766°N, 1.435°E) on Formentera. All lizards were brought into a nearby tent, where I measured coloration on various parts of their body using a spectrophotometer and then photographed their backs, sides, and stomachs. Naturally, the lizards continuously attempted to escape by squirming, biting, and defecating; however, when I placed them on their backs, gently holding them down for two to five seconds in order to photograph their bellies, the lizards went limp, relaxing their limbs, head, and tail, curling their toes, and in many cases continued to defecate. Further, some lizards would arch their heads back, leaving their mouth slightly agape. Lizards initiated this behavior only after several seconds of being overpowered and while I quantified this behavior by placing lizards on their back, many lizards also initiated this defense strategy when they were overpowered right-side-up. Of the 96 lizards photographed, 74 initiated thanatosis when they were first held on their backs. The remaining 22 lizards displayed this behavior on the second or third try. Once limp, clapping my hands close to the lizards did not elicit any reaction. In fact, the only movement I observed during this behavior was their breathing and defecating. Once thanatosis initiated, 84 lizards remained in this position until I walked ca. 2 m away, at which time the majority of them promptly turned over and tried to escape. 41 of these 84 lizards remained in thanatosis for over two minutes, and in three cases, lizards remained on their backs for an excess of five minutes, turning over only when I gently poked their belly with my index finger. The remaining 12 lizards remained limp on their backs for 20 seconds or less, trying to escape before I walked away from them.

Although the adaptive significance of this behavior is not investigated here, presumably this behavior is an anti-predatory adaptation intended to confuse predators that have managed to catch a lizard (Gehlbach 1970, *op. cit.*; Pasteur 1982. Ann. Rev. Ecol. Syst. 13:169–199). This is a risky strategy, as lacertid lizard bellies are one of the softest parts of their body (pers. obs.); however, from my observations, it is a strategy that they adopt only after being overpowered—perhaps a strategy of last resort.

Patterns of thanatosis in other taxa suggest that individuals who exhibit death-feigning behavior maximize their probability of survival even after being captured. For example, Sargent and Eberhardt (1975, *op. cit.*) found that ducks who feigned death in response to being captured by red foxes increased the likelihood of their survival when compared with ducks that did not feign death because staying still seemed to minimize further attacks. It seems reasonable that death feigning in lizards could similarly affect their predators and increase the likelihood of a lizard's survival after capture. By going limp, a lizard might convince a predator that it is dead and, as a result be left alone long enough to escape. In conjunction with the visual immobility tactic, I observed that most of the lizards defecated before or during their death feigning response. Various other animals combine visual and olfactory cues to deter predators. For example, Doody et al. (1996. Herpetol. Rev. 27:82–83) found that the Mud Snake (*Farancia abacura*) defecates during or just before playing dead. Using both strategies together might maximize an individual's likelihood of survival.

It is well known among experienced herpetologists and pet keepers that many lizards seem to relax when they are turned on their backs. This behavior, referred to as tonic immobility or animal hypnosis, is characterized by a state of intense unresponsiveness and apparent temporary paralysis produced by a form of physical restraint (Gallup 1973, op. cit.). However, I believe that the death-feigning behavior exhibited by *P. pityusensis* is distinct from this commonly observed "relaxing" behavior. First, as defecation is an anti-predatory behavior used across many taxa, its employment in conjunction with putative death-feigning suggests that the strategy displayed in *P. pityusensis* is in fact an anti-predatory behavior. Additionally, the lizards in this study seemed to gather environmental cues to determine the duration with which they remained immobile. The duration of thanatosis in *P. pityusensis* was affected by how close I was to the lizards. As I moved farther away, lizards were more likely to terminate death-feigning and attempted to escape. Similar reports have been described of the recovery time from immobility in juvenile Eastern Hognose Snakes (*Heterodon platirhinos;* Burghardt and Greene 1988. Anim. Behav. 36:1842–1844) and the Green Anole (*Anolis carolinensis*; Gallup 1973, *op. cit.*). Finally, some lizards arched their heads back and opened their mouth during this behavior. Snakes that display thanatosis, such as *H. platirhinos,* also lie on their backs with their mouth open (Burghardt and Greene 1988, *op. cit.*). Although *P. pityusensis* do not leave their tongues protruding like snakes do, this open mouth display has not been described in other lizards that that exhibit tonic immobility. Together, these observations strongly suggest that the visual immobility displayed by *P. pityusensis* should be categorized as thanatosis, making this one of the first documented cases of lizards employing this behavior.

This may be a strategy common in other, closely related lizards (Gallup 1973, *op. cit.*). Future research should investigate the presence of this behavior in related lizard species and interperet its adaptive significance. Predator diversity among different populations living on various islands within this chain has not been quantified, however, differences in predation pressure is suggested in the striking color variation observed among populations of *P. pityusensis* with cryptic lizards representing some populations and conspicuously colored in others (Cirer and Martinez-Rica 1990, *op. cit.*; Dappen, unpubl. data). Moreover, predator regimes have been found to vary dramatically among Northern Balearic Islands, and these differences have affected other aspects of anti-predatory behavior in lizard populations such as the employment of caudal autonomy, or the minimum distance to which these lizards will allow potential predators to approach them before es-

caping (Pafilis et al. 2007. Naturwissenschaften 7:320–325). As I observed variation in both the initiation and duration of thanatosis in *P. pityusensis*, a logical next step would be to investigate the employment of this behavior among populations of lizards that are exposed to varying degrees of predation pressure.

Many thanks to the Balearic Park Service for transportation to and from various islands and permission to work with these lizards (Permit #Exp: 513/2009). I thank Matthias Kuhn for allowing me access to his private island and Jochen Krieg for transportation to and from Tagomago. Also, thanks to Sara D'Anzeo, Neil Losin,Yoel Stuart, and Jackson Shedd for help in improving the quality of this note. Lastly, I thank Valentin Perez-Mellado for helping introduce me to this species.

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XENOSAURUS PHALAROANTHEREON (Chin-spotted Knob-scaled Lizard). **LITTER SIZE.** All species in the lizard genus *Xenosaurus* are viviparous (Ballinger et al. 2000. Cat. Amer. Amphib. Rept. 712:1–3). Our understanding of reproduction and reproductive variation among species and populations of *Xenosaurus* has been increasing recently, however our knowledge of reproductive traits (e.g., litter size, age at maturity, etc.) of each species is frequently limited and based on only one or two populations of each species. Here we report on the litter size of a population of *X. phalaroanthereon*, a recently described species (Nieto-Montes de Oca et al. 2001. Herpetologica 57:32–47) from Oaxaca, Mexico. Some basic information on the reproduction of *X. phalaroanthereon* has been published, but has been limited to observations on age at maturity (Lemos-Espinal and Smith 2005. Phyllomedusa 4:133–137) and limited observations of litter size and relative litter mass (Zamora-Abrego et al. 2007. J. Herpetol. 41:630–637).

We examined specimens of *X. phalaroanthereon* from the collection of the Laboratorio de Ecología, UBIPRO – FES-Iztacalal UNAM (N = 26). These specimens were collected from the vicinity of Santa Maria Ecatepec, Oaxaca, Mexico (16.245444°N, 95.960722°W, datum WGS84; 2185 m elev.) (see Lemos-Espinal and Smith 2005, *op. cit.* for description of the general area). We measured SVL for each specimen. We then dissected lizards to obtain information on litter size based on the presence of embryos.

Mean litter size was 2.00 ± 0.36 (N = 6). There was a marginally significant trend for litter size to decrease with increasing SVL (N = 6, r^2 = 0.60, P = 0.07; LS = 26.5 – 2.1 SVL). This litter size is slightly smaller than that reported for a small sample of *X. phalaroanthereon* (2.34) in Zamora-Abrego et al. (2007, *op. cit.*). The litter size reported here is among the smallest reported for any *Xenosaurus* (e.g., Ballinger et al. 2000. Stud. Neotrop. Fauna Environ. 35:179–183; Lemos-Espinal and Rojas-González 2000. Herpetol. Rev. 31:153; Lemos-Espinal et al. 2003. J. Herpetol. 37:192–196; Lemos-Espinal et al. 2004. Amphibia-Reptilia 25:204–210; Zamora-Abrego et al. 2007, *op cit.*; Rojas-González et al. 2008. J. Herpetol. 42:332–336). The influence of female SVL on litter size in *Xenosaurus* appears to be variable, with some populations and species showing a positive relationship (e.g., Ballinger et al. 2000, *op. cit.*; Rojas-González et al. 2008, *op. cit.*) and others showing no relationship (e.g., Ballinger et al. 2000, *op. cit.*; Lemos-Espinal et al. 2004, *op. cit.*). However, no previous study has found a negative relationship.

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XENOSAURUS PHALAROANTHEREON (Chin-spotted Knob-scaled Lizard). **DIET.** Lizards in the genus *Xenosaurus* appear to be opportunistic foragers, with diets that can include a variety of prey, such as arthropods and vertebrates, but consist primarily of insects (e.g., Ballinger et al. 1995. Biotropica 27:128–132; García-Vázquez et al. 2009. Herpetol. Rev. 40:93; Lemos-Espinal et al. 2003. Southwest. Nat. 48:119–122; Lemos-Espinal et al. 2004. Amphibia-Reptilia 25:204–210; Presch 1981. Herpetol. Rev. 12:81). Our knowledge of the ecology of *Xenosaurus* has rapidly increased in the past 10 years, however our knowledge of individual species is still relatively limited, and frequently confined to one or two populations for each species. For some species, we still know very little about their diet. Here we report on the diet of a population of the fairly recently described *X. phalaroanthereon* (Nieto-Montes de Oca et al. 2001. Herpetologica 57:32–47) from Oaxaca, Mexico. Information on the ecology and biology of *X. phalaroanthereon* is limited to aspects of its thermal biology, microhabitat use, sex ratio, age at maturity (Lemos-Espinal and Smith 2005. Phyllomedusa 4:133–137), some aspects of its reproduction based on a small sample (Zamora-Abrego et al. 2007. J. Herpetol. 41:630–637), and a note on its consumption of a mammal (García-Vázquez et al. 2009, *op. cit.*).

We examined specimens of *X. phalaroanthereon* from the collection of the Laboratorio de Ecología, UBIPRO – FES-Iztacalal UNAM (N = 26). These specimens were collected from the vicinity of Santa Maria Ecatepec, Oaxaca, Mexico (16.245444°N, 95.960722°W, datum WGS84; 2185 m elev.) (see Lemos-Espinal and Smith 2005, *op. cit.* for description of the general area). We dissected lizards to obtain information on diets. We identified each prey item to order or family as possible, and measured the length and width of each item using an electronic caliper (to nearest 0.1 mm). We estimated prey volume using the formula for a prolate spheroid.

Of the 26 lizards examined, only 15 (58%) contained prey items. The diet of *X. phalaroanthereon* is summarized in Table 1. Numerically, the most important diet items were ants (Formicidae), and volumetrically the most important items were coleopterans. Ants and dipteran larvae were found in the most stomachs. This diet is similar to previous reports on the diets of *Xenosaurus* that have found that they consume primarily insects (Ballinger et al. 1995, *op. cit.*; Lemos-Espinal et al. 2003, *op. cit.*; Lemos-Espinal et al. 2004, *op. cit.*). We found no evidence of vertebrates in the

TABLE 1. Diet of *Xenosaurus phalaroanthereon* from Oaxaca, Mexico.

Prey Category	Number (%)	Volume (%)	Frequency
Araneae	1 (4.6)	0.01 (0.65)	1
Coleoptera	1 (4.6)	0.42 (27.3)	1
Diptera			
Adult	1 (4.6)	0.01 (0.65)	1
Larvae	4 (18.2)	0.13 (8.4)	4
Hymenoptera			
Formicidae	8 (36.4)	0.21 (13.6)	4
Other	2 (9.1)	0.13 (8.4)	1
Isoptera	1 (4.6)	0.12 (7.8)	1
Lepidoptera	1 (4.6)	0.15 (9.7)	1
Orthoptera			
Gryllidae	2 (9.1)	0.16 (10.4)	2
Other	1 (4.6)	0.2 (13.0)	1
Total	22	1.54	

diet, however other studies have found mammals and lizards in the diets of *Xenosaurus* species, including *X. phalaroanthereon* (Ballinger et al. 1995, *op. cit.*; García-Vázquez et al. 2009, *op. cit.*; Lemos-Espinal et al. 2003, *op. cit.*; Presch 1981, *op. cit.*).

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SQUAMATA — SNAKES

AGKISTRODON PISCIVORUS (Cottonmouth). **INTERSEXUAL COMBAT.** Male-male combat has been thoroughly described in many snake species, and is recognized as a form of competition for access to mates (Carpenter and Gillingham 1990. *In* Gloyd and Conant [eds.], Snakes of the *Agkistrodon* Complex, pp. 523–531. Contributions in Herpetology, No. 6, SSAR, Oxford, Ohio.). Combat behavior between males and females has never been described in nature, although reports of intersexual combat have been described from adders kept in semi-natural outdoor enclosures (e.g., *Vipera berus*—Kelleway 1982. Brit. J. Herpetol. 5:225–230). The sequence of behaviors listed in Table 1 occurred between an adult male (SVL = 64 cm; 265 g) and adult female (SVL = 60 cm; 220 g) *Agkistrodon piscivorus*, and was observed while conducting long-term, mark-recapture research on a population in Alabama, USA (Tuskegee National Forest, Macon County; 32.430613°N, 85.647406°W, WGS84) on 03 May 2007 (ca. 1845 h). Both snakes were sexed (by probing) and had been previously marked (PIT tagged). Their sex had been identified consistently during previous captures. Both snakes were of mature body size (Gloyd and Conant 1990, *op. cit.*). After processing, both snakes were released at their point of capture.

The behavioral sequence described in Table 1 is nearly identical to that of male-male combat in snakes (Gillingham 1987. *In* Seigel et al. [eds.], Snakes: Ecology and Evolutionary Biology, pp. 184–209. Macmillan Publ. Co., New York). We observed behaviors typical of combat (e.g., head, neck, and trunk raised from substrate, topping, apparent chasing and retreating; Table 1), yet few of the aspects typical of courtship (e.g., chin rubbing, mounting, tongue flicking the dorsal surface of female; components of the tactile chase and any component of the tail searching copulatory attempt). The chasing behavior observed is common to the late phase of combat and the early phase of courtship, although in our observation they were followed by vertical trunk raising and topping, not mounting. Head jerking by males is usually indicative of courtship, although males occasionally exhibit this behavior toward other males during the late phases of combat (G. W. Schuett, pers. comm.).

If the interaction described in Table 1 is interpreted as courtship, it suggests the courtship sequence in *A. piscivorus* (which has not been thoroughly described; Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Inst. Press, Washington D.C. 668 pp.) can be very different from that of other pitvipers and its congener, *A. contortrix* (Copperhead). This raises the possibility that earlier literature reports of ritualized "dances" in this species (e.g., Carr and Carr 1942. Proc. New England Zool. Club 20:1–6) could indeed be describing a component of courtship between males and females (which most authors have discounted—Lowe 1948. Herpetologica 4:129–135; Gillingham 1987, *op. cit.*). This could function as some sort of mate assessment by females (e.g., Schuett and Duvall 1996. Anim. Behav. 51: 367–373). It is also possible that *A. piscivorus* occasionally engage in intersexual combat, as reported in adders (Kelleway 1982, *op cit.*).

In *Vipera berus*, combat behavior outside the mating period includes intersexual combat and may represent competition for food (Kelleway 1982, *op. cit.*). Our observation took place much later in spring than the apparent spring mating season in *A. piscivorus* (i.e., March—Beyer 1898. Am. Nat. 32:17–24; Wharton 1966. Copeia 1966:149–161; Johnson et al. 1982. Herpetologica 38:16–25), and too early for the late summer/fall mating period (i.e., August-September—Zaidan et al. 2003. Copeia 2003:231–240; Graham et al. 2008. Gen. Comp. Endocrinol. 159:226–235). However, the mating season of *A. piscivorus* is equivocal (Graham et al. 2008, *op. cit.*), and combat behavior in *A. piscivorus* has been reported in March (Carr and Carr 1942, *op. cit.*), June (Ramsey 1948. Herpetologica 4:228), August (Hill and Beaupre 2008. Copeia 2008:105–114), and September (Martin 1984. Copeia 1984:772–774; Fogleman et al. 1986. Bull. Chicago Herpetol. Soc. 21:26–28). We suggest the possibility that combat sometimes occurs for motives other than mating in this species (see Blem 1987. J. Herpetol. 21:64–65), and that intersexual combat may sometimes occur in *A. piscivorus*.

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TABLE 1. Interaction sequence between a male and female *Agkistrodon piscivorus* from Tuskegee National Forest, Alabama, USA. Interpretations are based upon Gillingham (1987. *In* Seigel et al. [eds.], Snakes: Ecology and Evolutionary Biology, pp. 184–209. Macmillan, New York).

Time (CST)	Male behavior	Female behavior	Microhabitat	Distance between snakes	Interpretation
1845	swimming movements, similar to "craning-cruising," e.g., Savitsky, 1992. *In* Campbell and Brodie (eds.), Biology of the Pitvipers, pp. 347–369. Selva, Tyler, Texas.	in water, body submerged, head held at ca. 75º angle	beaver dam pool	4 m	
1846	paused, faced away from female	motionless in same position	beaver dam pool	4 m	
1849	swam directly toward female	motionless in same position	beaver dam pool	< 4 m	
1850	continued swimming toward female	appeared to notice male	beaver dam pool	10 cm	
1850	"face-off"; head and neck raised above surface face-to-face out of the water (ca. 10 cm) without contact; followed by quick series of upper trunk/neck contacts and writhing (e.g., anterior part of their bodies partially entwined and moving), snakes then moved ~ 0.5 m out of view		beaver dam pool	0 cm	combat
~1851	swam away from female toward observers	swam ~3 m away from observers to beaver dam	beaver dam pool	4 m	
~1852	paused, appeared alert with head raised at ~75º angle	paused, appeared alert with head raised at ~75º angle	beaver dam pool	4 m	
1854	swam directly toward female; tongue flicked slowly, ~1/sec	paused, appeared alert with head raised at ~75° angle	beaver dam pool	< 4m	combat or courtship
1854	"face-off": rapid writhing motions; upper part of the snakes At least one "topping" event took place, (observer unsure which snake actually topped the other).		on top of beaver dam in vegetation	0 cm	combat
1855	pursuing female, body jerking motions	retreat into water, swimming away from male	beaver dam pool	2 m	combat or courtship
1856	broke off pursuit of female	paused	beaver dam pool	2 m	combat or courtship
1859	paused	swam ~1 m toward male	beaver dam pool	2 m	
1900	raised neck and body toward female	swam toward dam	beaver dam pool	5 cm	combat
1900	swam away from dam	crawled out of water onto dam; disappeared into vegetation	beaver dam and pool	3 m	
1901	swam away from dam toward observer	unknown	beaver dam pool	4 m	
1901	resumed slow swimming/tongue flicking behaviors, at one point tongue flicking a bottle several times.	unknown	beaver dam pool	?	courtship
1902	swam to the dam, crawled out of water, and disappeared into vegetation where female was last seen.	unknown	beaver dam pool	?	
1905	snake captured	snake captured	beaver dam	~1 m	

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ALSOPHIS SIBONIUS (NCN). **COPULATION.** *Alsophis sibonius* is a diurnal, actively foraging snake inhabiting the Commonwealth of Dominica, West Indies. The snake was formerly considered a subspecies of *A. antillensis* but was recently elevated to full species status (Hedges et al. 2009. Zootaxa 2067:1–28). In general, little is known about mating behavior for *Alsophis* (*sensu stricta* Hedges et al. 2009, *op.cit*.) and to our knowledge, no accounts for mating behavior exist for *A. sibonius* (Henderson and Powell *In press*. Natural History of West Indian Reptiles and Amphibians. University Press of Florida, Gainesville). Here we report a field observation of copulation for *A. sibonius* from the Caribbean side of Dominica.

At 1125 h on 27 April 2009, we discovered a mating pair of *A. sibonius* on the forest floor in the Batali River Valley (15.44999°N, 61.44223°W, datum: WGS84), ca. 550 m from the Caribbean Sea. The snakes were partially concealed by leaf litter and were thus captured for identification before realizing they were in coitus. The pair differed both in color and size (Fig. 1). The male (SVL = 563 mm; total length = 772 mm) was black with a double alternating series of white blotches anteriorly, which graded to solid black posteriorly. The female (SVL = 683 mm; total length = 859 mm) had a stub tail and exhibited the same dorsal pattern as the male but with a light brown ground color and tan blotches.

The pair remained in coitus while they were manipulated for photographs and measured. When released on the ground for brief periods, the female attempted to escape while dragging the smaller male behind her. After 20 minutes the snakes disengaged and moved apart. Throughout the observation period, the female exhibited a swollen body cavity ca. 5 cm anterior to the cloaca (Fig. 1). Timing of this copulation event is consistent with a 6 April report for *Alsophis manselli* (*sensu* Hedges et al. 2009, *op. cit.*) on Montserrat (Schwartz and Henderson 1991. Amphibians and Reptiles of the West Indies: Descriptions, Distributions, and Natural History. University of Florida Press, Gainesville, Florida. 720 pp.).

We thank Robert Henderson for advice and comments concerning this account. This observation was made while conducting *Iguana delicatissima* research on Dominica funded through the San Diego Zoo's Institute for Conservation Research.

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FIG. 1. *Alsophis sibonius* copulating on Dominica, West Indies. Note the body cavity bulge anterior to the cloaca on the larger female (left of the head).

BOA CONSTRICTOR OCCIDENTALIS (Argentine Boa). **DIET.** *Boa constrictor occidentalis* is the southernmost subspecies of *Boa constrictor* and is distributed from 33º–36º S. It is found in extreme climates in the semiarid plains of the Phytogeographic regions of Chaco, Monte, and Espinal of Argentina (Chiaraviglio et al. 1998. Gayana Zool. 62:83–85; Di Cola et al. 2008. Amphibia-Reptilia 29:299–310). In central-eastern San Juan Province, this subspecies occurs in Chaco Árido, an ecotonal region between the Chaco and Monte Phytogeographic regions (Acosta et al. 2000. Cuad. Herpetol. 14:163). In Argentina, *B. c. occidentalis* is considered a "threatened" species (Lavilla et al. 2000. Categorización de Anfibios y Reptiles de la República Argentina. Asoc. Argentina Herpetol. 79 pp.) due to hunting pressure and habitat loss related to human population growth and agricultural expansion. Sightings of this species in Argentina are uncommon and data on trophic ecology are limited.

On 15 December 2008, we observed a free-ranging adult *B.*



FIG. 1. *Boa constrictor occidentalis* consuming a *Chunga burmeisteri* in Sierra de Guayaguas, Argentina (photo by JM).

c. occidentalis (total length ca. 3 m) in Sierra de Guayaguas, 25 de Mayo Department, corresponding to the Chaco Árido Phytogeographic Region in Argentina (31.85°S, 67.17°W, datum WGS84; elev. 557 m). The snake was apparently in an ambush posture on the ground beneath the canopy of *Ximenia americana* (albaricoque) shrubs along a trail used by "walking birds" (*Chunga burmeisteri*; "chuña patas negras," Cariamidae). Later, a *C. burmeisteri* that was passing along the trail was caught by a fast strike from the snake and was subsequently constricted and ingested over the course of ca. 25 min (Fig. 1). *Boa constrictor* are opportunistic predators that are known to feed on a variety of mammals, birds, and lizards, and are sit-and-wait foragers (Savage 2002. The Amphibians and Reptiles of Costa Rica. Univ. of Chicago Press, Illinois, 934 pp.; Solorzano 2004. Snakes of Costa Rica. Instituto Nacional de Biodiversidad, Costa Rica, 791 pp.). This note constitutes a first record of predation on *C. burmesteri* by *B. c. occidentalis* and confirms that this snake uses ambush foraging to feed on "walking birds."

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BOTHROPS MOOJENI (Brazilian Lancehead). **DIET.** The pitviper *Bothrops moojeni* occurs throughout the Cerrado region of central and southeastern Brazil, mainly in open and forested riparian areas (Campbell and Lamar 2004. The Venomous Reptiles of the Western Hemisphere, Vol. I. Cornell Univ. Press, Ithaca, New York. 475 pp.; Nogueira et al. 2003. J. Herpetol. 37:654–659). This terrestrial lancehead has a variable diet that includes mammals, frogs, lizards, snakes, birds and even centipedes, with adults preying more frequently on mammals (Nogueira et al. 2003, *op. cit.*). On 5 December 2008 at 1930 h, we captured an adult male *B. moojeni* (SVL = 958 mm) in a palm swamp ("vereda") site in Área de Proteção Ambiental do Rio Pandeiros (15.43ºS, 44.81º W, datum SAD1969), a conservation unit in municipality of Januária, north of Minas Gerais State, southeastern Brazil. After dissection, we found an adult *Leptodactylus fuscus* (SVL = 41.7 mm) in snake's stomach, that had been ingested head-first. *Leptodactylus fuscus* has been recorded in the diet of *B. moojeni* and *B. atrox*, an Amazonian lancehead closely related to *B. moojeni* (França et al. 2008. Copeia 2008:23–28; Macedo-Bernarde and Bernarde 2005. Herpetol. Rev. 36:456; Nogueira et al. 2003, *op. cit.*). This observation supports the hypothesis of diet similarity between these species and corroborates the idea that despite ontogenetic dietary shifts, adult *B. moojeni* do not eliminate small prey from their diets (Martins et al. 2002. *In* Schuett et al. [eds.], Biology of the Vipers, pp. 307–328. Eagle Mountain Publ., Eagle Moutain, Utah). Voucher specimens were deposited in the herpetological collection of Museu de Zoologia João Moojen, Universidade Federal de Viçosa, in Viçosa, Minas Gerais, Brazil (*B. moojeni*, MZUFV 1639; *L. fuscus* MZUFV 9258).

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COLUBER CONSTRICTOR (North American Racer). **PULL-TAB ENTANGLEMENT.** Entanglement of reptiles and amphibians in human-made materials is increasingly evident (reviewed by Vann et al. 2005. Herpetol. Rev. 36:322; Dean et al. 2005. Herpetol. Rev. 36:179–180; Stuart et al. 2001. Herpetol. Rev. 32:162–164). Most previous reports have involved entanglement in plastic materials (but see Dean et al., *op. cit.;* Herrington 1985. Herpetol. Rev. 16:11). Here I report the first case of girdling of a snake by an aluminum pull-tab, apparently from a soft drink can.

On 5 July 2009, I discovered a male *Coluber constrictor* (total length = 121 cm) in a window well at my rural residence (Indiana, Wayne Co., USA, ca. 7 km WSW Richmond: 39.7978°N, 84.9658°W, datum: WGS84). Although it was typically robust and feisty, its torso was encircled by an aluminum pull-tab at a point ca. 30 cm from the tip of the snout (Fig. 1). The pull-tab was the removable kind used on soft drink cans in the USA between 1962 and 1975 (www.squidoo.com/canpulltab), but with only the circular ring left intact. Based on the apparent health of the snake and the evident (but not extensive) external damage to the snake, it must have been girdled for only a short time (estimated at 2–4 weeks). Upon removal of the pull-tab, the snake was released; it moved into a forest edge quickly with no apparent long-term locomotor damage. This observation demonstrates that although



FIG. 1. Aluminum pull-tab girdling a male *Coluber constrictor* from Wayne Co., Indiana, USA.

contemporary pull-tabs remain attached to drink cans, the older removable types remain a danger to wildlife, even in rural settings with minimal access to human refuse. Notably, this site was an agricultural field adjacent to a middle growth forest until 1997.

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CROTALUS VIRIDIS VIRIDIS (Prairie Rattlesnake). **NOXIOUS WEEDS AS A HAZARD TO SNAKES.** Invasive species and their deleterious effects on native species are well known (e.g., Cox 2004. Alien Species and Evolution. The Evolutionary Ecology of Exotic Plants, Animals, Microbes, and Interacting Native Species. Island Press, Washington DC. 377 pp.). However, the direct effects of noxious plants on native snakes have not been described. Here I report the presence of seed heads of an invasive species, the Longspine Sandbur Grass (*Cenchrus longispinus*), in the buccal cavity of a *Crotalus viridis viridis*.

While processing a rattlesnake from a den site in Weld Co., Colorado, USA, a tumor-like lump was observed in the floor of the mouth. After venom extraction and PIT-tagging, the mouth of the restrained snake was held open by an assistant, and a soft greyish mass approximately 12.5 x 22 x 10 mm was removed. This mass covered much of the rear buccal cavity, from ca. 5 mm posterior to the glottal opening to the back of the mouth. Upon cleaning the soft flocculent material from the surface of the harder core, two spiny seed heads (mature inflorescences) of the noxious grass *Cenchrus longispinus* were revealed (Fig. 1).

Cenchrus has long been recognized as a noxious invasive species in the western United States (California Department of Food and Agriculture Encycloweedia: Data Sheets - http://www.cdfa.ca.gov/phpps/ipc/weedinfo/cenchrus.htm). It has more recently become widespread in eastern Colorado, often in association with overgrazing and soil disturbance. Although we have occasionally found rattlesnakes in the field with plant spines (commonly the small spines of *Opuntia* sp.) imbedded in their skin, this is the first observation of a noxious weed causing internal injury to a snake. It is unclear how the seeds were ingested, but it is likely that they were consumed along with rodent prey and became lodged in the mouth. The nature of the soft grey matter covering the seed heads is unknown, but the end effect was to provide a soft surface over the spines of the seeds which were anchored to the floor of the mouth by embedded spines. The snake appeared to suffer no long-term ill effects of the embedded seed heads, but it is difficult to imagine that swallowed seed heads would remain benign. This observation underscores the fact that invasive species can affect native species in multiple ways; *Cenchrus* could lead to decreases in prey abundance as it displaces native grasses and its seed heads can directly impact snake foraging activities. Further, because this species appears to be increasing in abundance northward from a more subtropical distribution (Parker and Boydston 2008. Longspine Sandbur, *Cenchrus longispinus*. PNW Regional Extension Publication 0353. http://www.ars.usda.gov/research/publications/publications.htm?seq_no_115=231551), climate change may exacerbate its effects on snakes by favoring its establishment in more northern habitats such as northeastern Colorado and elsewhere across the plains states.

I thank R. Malecki for assistance with processing snakes, C. Rex for photography, and R. Loose for allowing access to his property.

Submitted by **STEPHEN P. MACKESSY**, School of Biological Sciences, University of Northern Colorado, Greeley, Colorado 80639, USA; e-mail: stephen.mackessy@unco.edu.

DRYMOBIUS MARGARITIFERUS FISTULOSUS (Central American Speckled Racer). **DIET**. *Drymobius margaritiferus* is a terrestrial colubrid inhabiting lowland tropical and subtropical areas from southern Texas to Colombia (Campbell 1998. Amphibians and Reptiles of Northern Guatemala, the Yucatan, and Belize. Univ. Oklahoma Press, Norman. 212 pp.). As anurans are the most important prey of *D. margaritiferus* (86% of their diet), this species generally inhabits wet or moist habitats. Additionally, *D. maragritiferus* is most active during the wet season when amphibians are most active (Henderson and Hoevers 1977. Copeia 1977:349–355).

Between 1100 and 1300 h on 6 June 2008, we observed a *D.*

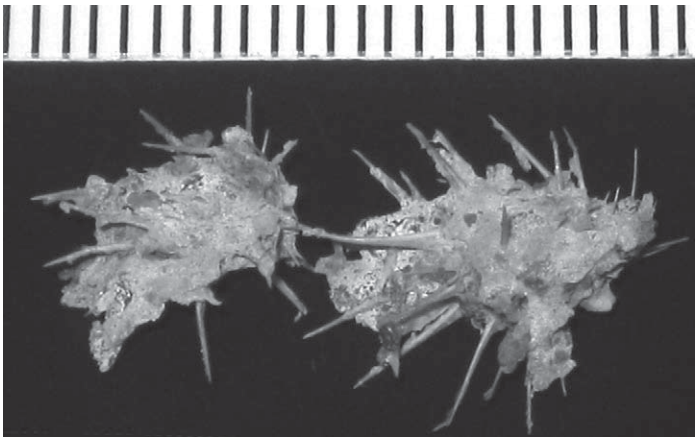


FIG. 1. Longspine Sandbur (*Cenchrus longispinus*) seed heads removed from the mouth of a *Crotalus viridis viridis* in Weld Co., Colorado, USA. Bars at top represent 1 mm gradations.



FIG. 1. A *Drymobius margaritiferus fistulosus* preying upon a *Hyla loquax* in Toledo District, Belize.

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m. fistulosus consuming an anuran at the Aguacaliente Wildlife Sanctuary (16.1492667°N, 88.7718167°W, datum WGS84; elev. 15.2 m), Big Falls, Toledo District, Belize (Fig. 1). This event took place during the wet season about 38 m away from the nearest lagoon, viewed from a boardwalk, 1 m off the ground. Upon discovery, the frog's head was inside the mouth of the snake yet it still appeared alive. The snake was continuously biting the frog, a behavior executed by *D. m. fistulosus* to kill its prey (Werler and Dixon 2000. Texas Snakes. Univ. Texas Press, Tyler. 437 pp.). Although the head of the prey was not observed, examination of its feet and physical morphology identified the frog as *Hyla loquax* (Red-footed Treefrog). This observation represents the first documentation of *H. loquax* as a prey species for *D. m. fistulosus*.

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DRYMOBIUS MELANOTROPIS (Black Forest Racer) and ***DRYMOBIUS RHOMBIFER*** (Esmarald Racer). **ENDOPARASITES**. *Drymobius melanotropis* ranges from eastern Honduras through southeastern Costa Rica at 35–1000 m elevation. *Drymobius rhombifer* occurs from Nicaragua south through Central America, Colombia, Venezuela, and the Guianas, and much of the Amazon basin to southern Peru and northern Bolivia at 13–1200 m elevation (Savage 2002. The Amphibians and Reptiles of Costa Rica. Univ. Chicago Press, Chicago, Illinois. 934 pp.). To our knowledge, there are no reports of helminths from these snakes. The purpose of this note is to establish initial helminth lists for *D. melanotropis* and *D. rhombifer*.

Four *D. melanotropis* (SVLs = 850, 794, 572, 220 mm) and two *D. rhombifer* (SVLs = 543, 453 mm) from Costa Rica were examined: *D. melanotropis* LACM 150529–150532 (collected 1974, 1985, 1986); *D. rhombifer* LACM 150533, 150534 (collected 1964, 1972). A mid-ventral incision was made in the posterior third of the body cavity and the coelomic cavity was searched for helminths. Nematodes and acanthocephalans were cleared in lactophenol and identified from wet-mounts.

Found in both *D. melanotropis* and *D. rhombifer* were nematode larvae (*Porrocaecum* sp.) in cysts, and acanthocephalan larvae (oligacanthorhynchid cystacanths). Prevalence of infection (number hosts infected/number hosts examined x 100) for *D. melanotropis*: 25% each for both *Porrocaecum* sp. (N = 5 helminths) and acanthocephalan cystacanths (N = 10); prevalence for *D. rhombifer*: 50% each for both *Porrocaecum* sp. (N = 2) and acanthocephala cystacanth (N = 1). Helminths were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland, USA as *D. melanotropis: Porrocaecum sp.* (USNPC 102145), acanthocephala cystacanth (USNPC 102146; *D. rhombifer*: *Porrocaecum* sp. (USNPC 102147), acanthocephala cystacanth (USNPC 102148).

Species of *Porrocaecum* are parasites of the intestines of birds; earthworms serve as intermediate hosts and small animals that consume earthworms may serve as paratenic (= transport) hosts (Anderson 2000. Nematode Parasites of Vertebrates. Their Development and Transmission. 2nd ed. CABI Publishing, Oxon, UK. 650 pp.). Because the larvae occurred in cysts, we believe these snakes serve as transport hosts. Acanthocephalans require an arthropod intermediate host in which the cystacanth stage develops (Kennedy 2006. Ecology of the Acanthocephala. Cambridge University Press, Cambridge, UK. 249 pp.). Again, because the cystacanths occurred in cysts, snakes likely serve as paratenic hosts. Larvae of *Porrocaecum* and oligacanthorhynchid cystacanths are common in Central American snakes (Goldberg and Bursey 2004. Carib. J. Sci. 40:62–69) and have both been reported in the congener *D. margaritiferus* from Costa Rica (Goldberg and Bursey 2005. Texas J. Sci. 57:103–106). *Drymobius melanotropis* and *D. rhombifer* represent new host records for both larvae of *Porrocaecum* and oligacanthorhynchid cystacanths.

We thank C. Thacker (LACM) for permission to examine snakes which are part of the CRE (= Costa Rica Expeditions Collection) donated to LACM by J.M. Savage in 1998.

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HETERODON PLATIRHINOS (Eastern Hog-nosed Snake). **OVIPOSITION**. Snake oviposition in the wild is seldom observed or described. In *Heterodon platirhinos*, nesting behavior was recently reported from four nests at the northern limits of the species' distribution (Cunnington and Cebek 2005. Am. Midl. Nat. 154:474–478). We observed nesting, nest chamber configuration, and clutch success after captive incubation for an *H. platirhinos* from Bryan, Brazos Co., Texas, USA. The female was first observed on 9 June 2007 at 1000 h at the entrance to a hole using her snout to push dirt out using side to side head movements. The hole began at 4 cm diameter in sandy loam, achieving 5 cm x 4.5 cm by the morning of 10 June 2007. Depth was unknown at that time. The female exited the nest at 1600 h on 13 June 2007, moving to shelter beneath a piece of tin 6.1 cm from the entrance. The entrance hole was completely refilled and was not apparent to the casual observer at that time. The female exited the site early on the morning of 12 June 2007. On 15 June 2007 the nest was excavated (Fig. 1) and found to contain 13 eggs. Eggs were found at depths ranging from 5 cm deep closest to the entrance to 12.7 cm deep 43 cm from the entrance hole. The eggs were incubated in vermiculite at 27.7°C in a Brinsea Octagon 20 (Brinsea Products Inc., Titusville, Florida, USA). After 65 days, on 14 Aug 2007, slits were observed in all but one of the eggs (92% hatch success). By 16 Aug 2007 the clutch had emerged and hatchlings were measured on 24 Aug 2007 after all had completed post-emergence ecdysis. The clutch means were 232.6 mm SVL, 40.3 mm tail length and 17.3 g. The sex ratio was 5M:7F; 8 of 12 (67%) were red in color with the remainder predominantly tan. All snakes were subsequently released at the nest site.

Our observations are in agreement with those of Cunnington

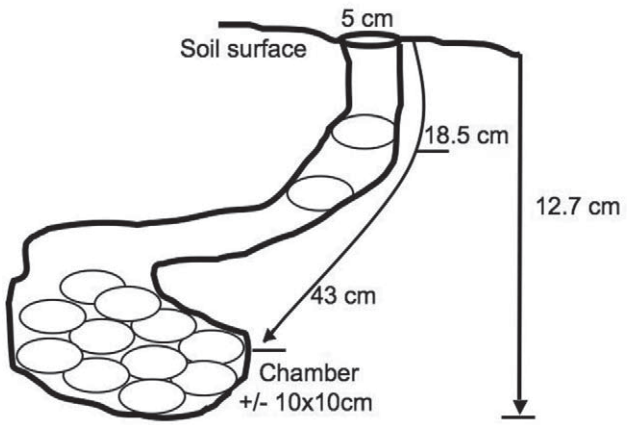


FIG. 1. *Heterodon platirhinos* nest cavity details after oviposition in central Texas, USA.

and Cebek (2005) with their report of 2–4 days for nest excavation to a depth of 10–15 cm. Our hatching success was higher (92%) than any Cunnington and Cebek (2005) reported from the wild (33–74%) or captivity (85%). As expected, our nesting dates were nearly one month earlier than their observations and, interestingly, our incubation times agree with two of their wild clutches, despite the dramatic difference in latitude between the sites.

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HETERODON PLATIRHINOS (Eastern Hog-nosed Snake). **PREDATOR/PREY MASS RATIO**. Snakes are renowned for their ability to consume large prey relative to their body size. However, a recent review indicated that reported anuran prey items were always smaller than the snake predator (Toledo et al. 2007. J. Zool. 271:170–177). Herein we report two observations in which prey mass was greater than predator mass.

On 26 May 2009, we captured a *Heterodon platirhinos* within a box trap (Burgdorf et al. 2005. Herpetol. Rev. 36:421–424) on Eglin Air Force Base, Okaloosa Co., Florida, USA, that regurgitated a live 36 g *Scaphiopus holbrookii* (Eastern Spadefoot), despite attempts by us to minimize disturbance. Several days after this event, the *H. platirhinos* weighed 34 g, yielding a prey/predator mass ratio of 1.06. On 24 September 2008, we captured a 6 g *H. platirhinos* along a drift fence at Fort Benning, Chattahoochee Co., Georgia, USA. This snake regurgitated an 8 g *Anaxyrus terrestris* (Southern Toad; AUM 34804), a prey/predator mass ratio of 1.33. Although colubrid snakes may often consume large prey relative to their body size, they rarely take prey larger than themselves; the predator/prey mass ratios presented here are considerable.

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LAMPROPELTIS CALLIGASTER CALLIGASTER (Prairie Kingsnake). **THERMAL ECOLOGY.** Although the thermal ecology of some species of snakes has been studied, the thermal ecology of many more snake species has not. Kapfer et al. (2008. J. Therm. Biol. 33:174–179) attributed this lack of emphasis on thermal ecology to the decline in the number of publications reporting natural history or field-based research on herpetofauna. The thermal ecology of snake species deserves more attention because maintenance of body temperature is important for the ecology and fitness of snakes (Blouin-Demers and Weatherhead 2008. Isr. J. Ecol. Evol. 54:361–372). My main objective was to investigate diurnal variation in body temperature of *Lampropeltis calligaster calligaster* associated with sex of the snake, month of sampling, and behavior.

Temperature-sensitive transmitters (Models SB-2T and SI-2T; Holohil Systems Ltd., Carp, Ontario, Canada) were surgically implanted by veterinarians (after Reinert and Cundall 1982. Copeia 1982:702–705; Blouin-Demers and Weatherhead 2001. Ecology 82:2882–2896), into six male and four female *L. c. calligaster* caught at Jim Edgar Panther Creek (JEPC) State Fish and Wildlife Area, in Cass Co., Illinois, USA (40.01°N, 90.04°W, datum WGS84). Snakes emerged from hibernation in late March and entered hibernation mid-October (Richardson et al. 2006. J. Herpetol. 40:423–428), so I tracked snakes for periods ranging from 14 to 193 d (mean = 120 d) from 10 May to 16 October 2004 and 29 March to 3 May 2005 to complete one annual activity cycle. I located each snake every 2 d between 0550 and 2022 h to incorporate variation in diurnal body temperature. Upon locating a snake, I recorded its body temperature and behavior (i.e., exposed aboveground, under cover aboveground, or underground). Means throughout are reported ± 1 SE.

I measured the body temperature of snakes 526 times from

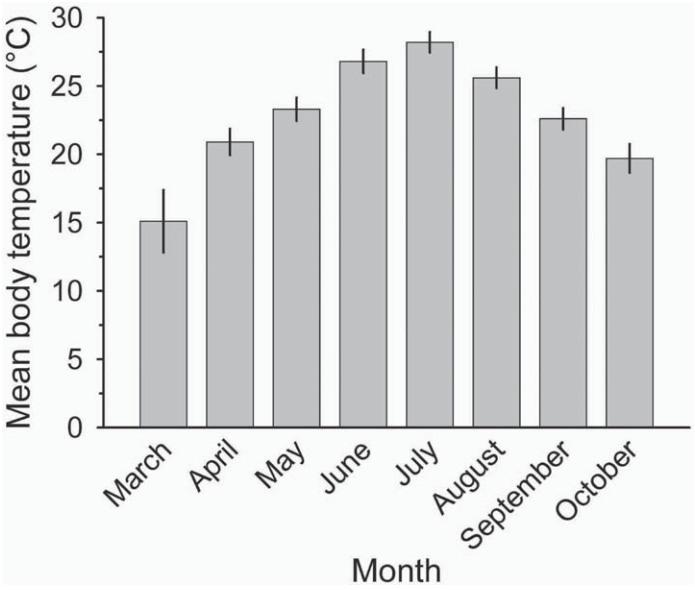


FIG. 1. Mean monthly body temperature (± 1 SE) of radio-tracked *Lampropeltis calligaster* from Cass County, Illinois, USA.

2004 to 2005. Females had a mean body temperature nearly two degrees higher than males across the active season (23.6 ± 0.67°C vs. 21.9 ± 0.63°C, respectively). Gravid females of other snake species often have higher body temperatures than males, but non-gravid females also may have higher body temperatures that promote rapid growth and ultimately achieve earlier reproductive maturity or larger clutch sizes (Blouin-Demers and Weatherhead 2008. Isr. J. Ecol. Evol. 54:361–372). The mean body temperature of both sexes combined increased from March through July and then steadily declined through October when snakes entered hibernation (Fig. 1), which may be influenced by ambient temperatures at the field site. The mean body temperature of snakes was similar aboveground, regardless of whether snakes were exposed or under cover (24.4 ± 0.86°C; 23.5 ± 0.79°C, respectively), indicating that snakes can thermoregulate under cover while being concealed from predators. However, body temperature of snakes was several degrees lower when snakes were underground (20.4 ± 0.55°C).

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LEPTODEIRA MACULATA (Southwestern Cat-eyed Snake). **DIET.** *Leptodeira maculata* occurs in the Pacific coastal lowlands and adjacent slopes of the Sierra Madre Occidental, Mexico, from southern Sinaloa southeastward to the Rio Balsas, and inland in the Balsas Basin in Michoacán and Guerrero to elevations of ca. 2000 m (Duellman 1958. Bull. Am. Mus. Nat. Hist. 114:1–151). Although little is known about the diet of this species, it is presumed to feed primarily on amphibians. Known prey taxa include *Bufo* (= *Incilius*) *mazatlanensis*, *Hypopachus oxyrrhinus*, and *Smilisca baudinii* (Duellman 1961. Univ. Kansas Publ. Mus. Nat. Hist. 15:1–148; Duellman and Trueb 1966. Univ. Kansas Publ. Mus. Nat. Hist. 17:281–375; Hardy and McDiarmid 1969. Univ. Kansas Publ. Mus. Nat. Hist.18:39–252). Here we report a novel prey species for *Leptodeira maculata*, *Lithobates neovolcanica* (Transverse Volcanic Leopard Frog), a ranid frog that is found in the states of Jalisco, Guanajuato, and Michoacán, Mexico (Hillis and Frost 1985. Occas. Pap. Nat. Hist. Mus. Univ. Kansas 117:1–14).

On 16 November 2008, we discovered a *L. maculata* while conducting a survey of the herpetofauna in the largest mangrove forest in Mexico, "Marismas Nacionales," in the state of Nayarit. While traveling between San Vicente-Unión de Corrientes, near "Los Espejos" ranch, Municipality of Tuxpan (21.9955556°N, 105.4386111°W, datum NAD27), a loud calling sound attracted our attention to a pond on the side of the road. Upon closer examination, we observed a *L. maculata* (total length ca. 70 cm) preying upon an adult *L. neovolcanica*. The animals were neither disturbed, nor collected.

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LEPTOTYPHLOPS GOUDOTII (Black Blind Snake). **UNUSUAL MICROHABITAT.** *Leptotyphlops goudotii* is a small fossorial snake distributed along the Mexican Pacific coastal and foothill regions of Colima, Michoacán, Guerrero, and Oaxaca, and slopes of the Gulf of Mexico from Tamaulipas and Veracruz, México, southward to Central America, Colombia and Venezuela (modified from McDiarmid et al. 1999. Snake Species of the World, a Taxonomic and Geographic Reference. Vol. 1. Herpetologists' League, Washington, DC. 511 pp.). Here, we report a specimen of *L. goudotii* collected from a microhabitat that is atypical for the species.

On 20 April 2002, we collected a specimen of *L. goudotii* in Punta Delgada, Municipality of Alto Lucero de Gutierrez Barrios, Veracruz, México (19.5129°N, 96.2732°W, datum WGS 84; elev. 2 m). The location was a rocky area of beach by the seashore. We believe the specimen reached the area by means other than overland dispersal; probably it was washed up on shore, because the species is typically found in vegetative debris, or under logs or rocks (Pérez-Higareda et al. 2007. Serpientes de la Región de Los Tuxtlas, Veracruz, México: Guía de Identificación. Instituto de Biología, UNAM), but not by the seashore. The specimen was deposited in the herpetological collection of Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo (CH CIB 0410).

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LIOPHIS POECILOGYRUS (Yellow-bellied Liophis). **DIET.** *Liophis poecilogyrus* is distributed across the South American continent and preys on a wide variety of animals, including anurans, lizards, fishes, insects, and rodents (Michaud and Dixon 1989. Herpetol. Rev. 20:39–41). Here I report an observation of *L. poecilogyrus* feeding upon two additional anuran species, *Leptodactylus bufonius* and *Physalaemus biligonigerus.*

At 2315 h on 15 March 2009 and at 2155 h on 20 March 2009, two *L. poecilogyrus* (SVL = 604 mm; tail length = 94 mm; 75 g post prey removal and SVL = 536 mm; tail length = 98 mm; 93 g post prey removal, respectively) were captured in a temporary pool in the Isoceño community of Yapiroa, Provincia Cordilleria, Departmento Santa Cruz, Bolivia (19.6000°S, 62.5667°W, datum

WGS84). The stomach contents of both snakes were checked by forced regurgitation. The snake captured on 15 March contained the posterior portion of a *L. bufonius*) and the individual captured on 20 March had a *P. biligonigerus* in its stomach. Both snakes were released the night following their capture.

As with *L. poecilogyrus*, both *L. bufonius* and *P. biligonigerus* are associated with temporary pools in the Gran Chaco (Cei 1980. Monitore Zool. Ital. Monogr. 2:1–609; pers. obs.), however this is the first record of either of these species in the diet of *L. poecilogyrus*.

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LIOPHIS VANZOLINII (NCN). **CLUTCH SIZE.** *Liophis vanzolinii*, a colubrid snake belonging to the *Liophis "anomalus"* complex (Nixon 1985. Copeia 1985:565–573), is distributed in the San Luis and Córdoba provinces of central-eastern Argentina. This species occurs in mid-elevation mountain ranges, where grassy and rocky streams are common. No reproductive data exist for *L. vanzolinii* (Cei 1993. Reptiles del Noroeste, Nordeste y Este de la Argentina. Herpetofauna de las Selvas Subtropicales, Puna y Pampas. Museo Regionale di Scienze Naturali Torino. Monografie XIV. 944 pp.). Here we report the first data on clutch size for *L. vanzolinii*.

On 12 October 2008, we captured a gravid female (total length = 460 mm) *L. vanzolinii* at Estancia Las Verbenas, Valle de Pancanta (32.9°S, 66.1°W, datum WGS84; elev. 1650 m). The snake was maintained in a 120 x 60 x 40 cm terrarium with abundant leaves and gravel and it laid five eggs on 16 November 2008. The length and width of each egg were measured with Vernier calliper and the volume of each egg was calculated using the formula for volume of an ellipsoid sphere (Dunham 1983. *In* Huey et al. [eds.], Lizard Ecology, pp. 261–280. Harvard University Press, Cambridge, Massachusetts). The eggs averaged 30.8 mm (s = 1.17) in length; 14.7 mm. (s = 0.46) in width; and 4025.4 mm^3 (s = 404.7) in volume. Cei (*op. cit.*) reports clutch sizes of 6–15 for *L. anomalus* and *L. elegantissimus*, similar to more northerly *Liophis* species. Thus, typical clutch size for *L. vanzolinii* may be small in comparison with the other species in this group.

We deposited the eggs in the herpetological collection of Universidad Nacional de San Juan. We thank Rodrigo Acosta and Sol Acosta for capturing and care of the specimen.

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MASTIGODRYAS BIFOSSATUS (Swamp Racer). **PREDATION AND ECTOPARASITES**. *Mastigodryas bifossatus* is a large colubrid snake that occurs predominantly in open areas of South America. This species is active during the day and eats mainly frogs, small mammals and lizards (Leite et al. 2007. Rev. Bras. Zool. 24:729–734). On 15 September 2007 at 1643 h, we observed a snake being harassed by two Crab-eating Foxes (*Cerdocyon thous*) at the edge of a temporary pond in the Pantanal biome, Fazenda Nhumirim, municipality of Corumbá, State of Mato Grosso do Sul, Brazil (18.9927ºS, 56.6477ºW, datum WGS84). The foxes bit the snake one at a time, until one of them carried the snake to a forest near the pond. The other fox also ran toward the forest, but when approached, both foxes fled. Upon close examination, the snake was identified as *M. bifossatus* and was found to host 13 ticks, which we collected and preserved in 70% alcohol. The ticks were identified as *Amblyomma dissimile* (10 males and 3 females) and were deposited in the Laboratório de Parasitologia of the Instituto de Pesquisas Veterinárias Desidério Finamor, Rio Grande do Sul State, Brazil (NI 333). After collecting the ticks and photographing the snake we left the forest and the Crab-eating Foxes resumed feeding on the snake. Although Crab-eating Foxes are omnivorous, opportunistic hunters and commonly feed on small reptiles and other vertebrates (Gatti et al. 2006. J. Trop. Ecol. 22:227–230), this is the first record of them preying upon *Mastigodryas bifossatus*.

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MICRURUS IBIBOBOCA (Caatinga Coral Snake). **PREDATION**. Spiders are potential predators of a number of small vertebrates, including amphibians (Del-Grande and Moura 1997. Herpetol. Rev. 28:147; Menin et al. 2005. Phyllomedusa 4:39–47) and birds (Peloso and Sousa 2007. Rev. Bras. Ornitol. 15:461–463; Teixeira et al. 1991. Ararajuba 2:69–74). However, predation events are rarely observed in the wild or published (Martins et al. 1993. Amphibia-Reptilia 4:273–296), and we are unaware of any report of predation on *Micrurus ibiboboca* by spiders. Here we report on the attempted predation of a juvenile *M. ibiboboca* by a spider, *Pachistopelma rufonigrum* (Araneae, Theraphosidae).

The event was observed on 27 March 2009, in an area of Atlantic Forest within the Serra de Itabaiana National Park (10.7489°S, 37.3419°W, datum SAD-69) in the Brazilian state of Sergipe. The spider immobilized the snake in leaf litter on the forest floor for four minutes. Subsequently, the snake writhed vigorously and was eventually able to escape. A video and four photographs documenting the event were deposited in the



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FIG. 1. Attempted predation of a juvenile *Micrurus ibiboboca* by a spider *Pachistopelma rufonigrum.*

Herpetological Collection of the Federal University of Sergipe (VC 001).

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NERODIA SIPEDON INSULARUM (Lake Erie Watersnake). **OFFSPRING RETENTION AND MORTALITY.** We observed several instances of mortality in gravid female *Nerodia sipedon insularum* following retention of fully formed embryos over the hibernation period. The first occurrence was on 5 June 2006, when we captured an adult female *N. s. insularum* (SVL = 990 mm; 564 g) on Green Island (Lake Erie, Ottawa Co., Ohio, USA) that was extremely lethargic and visibly emaciated except for a large swelling in the posterior third of her body. Upon further examination, we noted scrape wounds on both the dorsal and ventral sides surrounding this swelling. Palpation revealed the presence of distinct lumps within the swollen area similar in feel to developing embryos in gravid females. Because Lake Erie Watersnakes give birth between late August and early October (King 1986. Copeia 1986:757–772), any offspring she might have been carrying would have been retained from the previous year. The snake was held for observation for 17 days, during which time she refused food and remained lethargic. On 23 June 2006, we chose to euthanize the snake via injection of sodium pentobarbital, and performed a gross necroscopy. Fourteen fully developed deceased offspring were removed from both oviducts, confirming that this snake had retained offspring from the previous year.

On 31 May 2007, we encountered another female *N. s. insularum* (SVL = 737 mm; 198 g) from the South Bass Island State Park (Lake Erie, Ottawa Co., Ohio, USA) that appeared as though she had retained offspring. We noted this within our capture records, but chose to release her. We also noted possible retained offspring in three other females captured within this same week, but released them as well. We captured the State Park female again 9 June 2007 and on 20 June 2007, at which time we noted that she had visible trauma to the cloaca (heavy abrasion and oozing) and had lost almost 50 g (from 198 g to 153 g). After cleaning the abraded area we found a fully formed, partially decayed offspring protruding from the cloaca and blocking the passage of feces and urates. We successfully removed the offspring and held the female for observation but she died prior to receiving veterinary care. Post-mortem examination revealed four additional offspring (three of which were clumped together in an elongate mass) and one undeveloped yolk retained within her reproductive tract.

On 18 June 2009, we encountered yet another adult female *N. s. insularum* on the beach at the South Bass Island State Park (Lake Erie, Ottawa Co., Ohio, USA) that appeared to be near death (limp, lethargic, no righting response). This snake died during transport back to our laboratory. We palpated the lower third of the body and felt several large hard masses. Gross necroscopy revealed 12 full term offspring, one partially developed offspring with a small yolk attached, and one large unfertilized yolk retained within the reproductive tract.

The frequency of our observations (three different confirmed



FIG. 1. A dead *Nerodia sipedon insularum* from Pelee Island, Ontario, Canada, was found to contain 21 retained offspring from the previous year.

instances in the past four years and four other suspected, but unconfirmed cases), led us to search for other researchers who might also have unreported observations of this type of mortality. These queries resulted in an additional case of offspring retention in *N. s. insularum* noted in Lake Erie by one of us (DDJ). On 19 April 2004, an adult female *N. s. insularum* (SVL = 870 mm; 500 g) was captured on the northeast corner of Pelee Island (Lake Erie, Essex Co., Ontario, Canada). This snake appeared unusually heavy-bodied for so early in the season, and had a noticeable bulge on her right side, mid way down the thickened portion of her body, about 3 cm in size. Immediately anterior to this bulge was a small puncture wound, ca. 0.5 cm in diameter, that was dried around the edges (no blood or fluid present), presumably representing an old injury. The female was weighed, measured, PIT tagged, and released at the site of capture. On 5 May 2004 during a survey of the same location, the snake was found in the open and appeared to be basking, but was freshly deceased. Collection of this female was not possible, but a quick dissection was performed in the field. Twenty-one neonates were removed from this female, the most posterior of which was in a hardened egg-shaped mass (Fig. 1). The other neonates were in various states of decay, with the anterior young seeming more decomposed than the posterior. Many were noted as appearing to be shedding.

Other researchers have observed the retention of embryos by viviparous snakes but have not reported any adverse affects on the female. Shine (1977. Aust. J. Zool. 25:655–666) recorded the presence of ectopic embryos in several species of elapid snakes (*Notechis scutatus*, *Pseudechis porphyriacus*, and *Austrelaps superbus*) but noted that they were in the process of resorption. He further postulated the retention of these offspring may have been caused by an injury in the previous breeding season, as may have been the case in the *N. s. insularum* observed in 2004. Another instance of offspring retention in *Acrochordus javanicus* was noted in which a female was found to contain three full term embryos that had been encapsulated in a damaged oviduct and retained for at least six months (Shine et al. 1995. J. Herpetol. 29:352–360). Magnusson (1979. Copeia 1979:744–745) recorded an instance of a "mummified" embryo inside an *Acrochordus arafurae* that had been isolated for seven years. Shine et al. (*op. cit.*) hypothesized that female acrochordids may have the ability to maintain these dead encapsulated offspring for long periods of time.

The reasons why these particular female *N. s. insularum* retained offspring are unknown (e.g., previous injury, blockage by a hardened yolk mass, or lack of adequate gestation time), however, the consequences (lethargy, visible emaciation, external trauma, and subsequent death) suggest that this is a previously unrecognized source of mortality for female *N. s. insularum* and potentially other natricines. Notably, three of the four additional adult females suspected of having retained offspring were not seen again in subsequent surveys. This source of mortality could impose selection on reproductive timing in temperate snake species, and affect the relative benefits of viviparity vs. oviparity, especially at northern latitudes.

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OXYBELIS AENEUS (Brown Vinesnake). **REPRODUCTION**. *Oxybelis aeneus* is an arboreal colubrid snake that occurs from Arizona, USA to southeastern Brazil. Clutch sizes from populations in the USA and Mexico range from 3–8 (Goldberg 1998. Texas J. Sci. 50:51–56) and in Costa Rica from 2–6 (Goldberg 2005. Herpetol. Rev. 36:70; Solórzano 2004. Snakes of Costa Rica. Distribution, Taxonomy and Natural History. Instituto Nacional de Biodiversidad, Santo Domingo de Heredia, Costa Rica. 791 pp.). Herein, we present information on clutch sizes of *O. aeneus* from the state of Ceará, Brazil. We examined three females that contained oviductal eggs from the herpetology collection of Universidade Federal do Ceará (CHUFC). One female (CHUFC 213), collected in June 1971 from Limoeiro do Norte Municipality (5.14598°S, 38.09835°W, datum WGS84), SVL = 955 mm, contained seven oviductal eggs (maximum length = 36 mm). The second female (UFC 3148), collected in January 2008 from São Gonçalo do Amarante Municipality (3.60764°S, 38.96868°W), SVL = 790 mm, contained three oviductal eggs (maximum length = 35 mm). The third female (UFC 3215), collected in January 2009 from Pentecoste Municipality (3.79320°S, 39.27063°W), SVL = 1030 mm, contained nine oviductal eggs (maximum length = 27 mm). The clutch of nine eggs represents a new maximum clutch size for *O. aeneus*.

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OXYBELIS FULGIDUS (Green Vinesnake). **FORAGING BEHAVIOR**. Adopting efficient foraging behavior is important for snakes, given that the time spent pursuing, capturing, and handling prey all affect the profitability of a prey item (Cooper and Anderson 2006. Herpetologica 62:356–365). There is immense variation in the behaviors used by snakes to locate and capture prey (Shine et al. 2004. Funct. Ecol. 18:16–24). Their behavioral repertoire ranges from ambushing to active foraging, and from constriction to the use of mild or toxic venoms. *Oxybelis fulgidus* has a widespread distribution from Mexico to Argentina; however, it is considered uncommon in Costa Rica (Savage 2002. The Amphibians and Reptiles of Costa Rica. Univ. Chicago Press, Chicago, Illinois. 934 pp.). At the Organization for Tropical



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FIG. 1. *Oxybelis fulgidus* seizing an *Ameiva festiva* lizard from the fork of a small limb.

Studies' La Selva Biological Station, one of the most heavily studied sites in the Neotropics, *O. fulgidus* has been observed only a few times (Guyer and Donnelly 2005. Amphibians and Reptiles of La Selva, Costa Rica and the Caribbean Slope. Univ. California Press, Berkeley. 299 pp.). Its semiarboreal habits, high speed, and extremely cryptic coloration make observing *O. fulgidus* in its natural habitat difficult.

At 1115 h on 3 August 2008, in Tirimbina Rainforest Center, Heredia Province, Costa Rica (10.4167ºN, 84.1167ºW, datum WGS84; elev. 180 m), two *O. fulgidus* were observed foraging in a light-gap of a late successional secondary forest near a swamp with abundant palms and a few small trees. The first individual (SVL ca. 125 cm) was lying horizontally with the posterior two-thirds of its body in two small bushes but with its head and the anterior one-third of its body held vertically from the fork of a small limb (Fig. 1). In that position, the snake had seized a very large (SVL ca. 13 cm) *Ameiva festiva* (Central America Whiptail Lizard) laterally by the head and was lifting it 0.5 m off the ground. Although the lizard kicked with its hind feet and moved its body frantically during the next 15 minutes, the snake showed no movement whatsoever. I observed blood on the snake's head and jaws, likely resulting from envenomenation of the lizard. Once the prey was dead, the snake, still in a vertical position, briefly released it. Then, using alternate movements of the lower and upper jaws, the snake started to swallow the prey headfirst. Once the snake reached the hind limbs of the lizard, it retracted its head to the limb fork, and holding its head in a horizontal position, swallowed the rest of the lizard in about 10 min. While the first individual was swallowing its prey, another *O. fulgidus* (SVL ca. 100 cm) was observed about 3 m away. This snake subsequently captured a small (SVL ca. 6 cm) *A. festiva* from the ground with a lateral bite on the neck, and then climbed up a 2-m tall tree. The snake then repositioned the lizard, and swallowed it in approximately five minutes.

From these observations, some comments are of note. First, both *O. fulgidus* were using the same microhabitat at the same time, probably because the high abundance of prey available at the site at that particular time made it especially suitable for foraging. Second, the larger *O. fulgidus* used the limb fork to facilitate ingestion of the prey (as in Norris and Burtt 1998. Herpetol. Rev. 29:243) and to help seize and lift the large prey item that might be have been risky to handle on the ground. Although this observation adds to our knowledge of the foraging behavior of *O. fulgidus*, microhabitat selection and feeding behavior of this species warrant further study.

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OXYRHOPUS PETOLA DIGITALIS (NCN). **PREDATION.** The dipsadids *Oxyrhopus petola* and *Philodryas patagoniensis* are widely distributed in South America, with *O. petola* ranging from southern South America to Mexico, and *P. patagoniensis* ranging from Brazil to Bolivia, Paraguay, Argentina, and Uruguay (Peters and Orejas-Miranda 1970. Bull. U.S. Natl. Mus. 297:1–347). *Oxyrhopus* are nocturnal and terrestrial, feeding primarily on lizards and rodents (França et al. 2008. Copeia 2008:23–38; Strussmann and Sazima 1993. Stud. Neotrop. Fauna Environ. 28:157–168). *Philodryas patagoniensis* is a diurnal and predominantly terrestrial species that feeds on a wide variety of small vertebrates, particularly amphibians, lizards, mammals, birds, and occasionally snakes (Hartmann and Marques 2005. Amphibia-Reptilia 26:25–31; Rocha and Vrcibradic 1998. Ciência e Cultura 50:364–368). Here we report an adult female *O. petola* suffering a predation attempt by *P. patagoniensis* in a patch of restinga (coastal sand dune shrubland habitat) in the municipality of Iguaba Grande (22.8547°S, 42.1955°W, datum WGS 84), state of Rio de Janeiro, southeastern Brazil.

At 1630 h on 2 November 2008 one of us (MBV) and L. Freire found an adult *P. patagoniensis* (total length ca. 140 cm) with the anterior portion of its body (ca. 30 cm) inserted in a cavity on a 40 cm high bank of sand bordering a narrow dirt road. When the snake was spotted, we suspected that it might be preying on something inside the cavity. However, as soon as the snake noticed us, it fled rapidly to the nearest bush. We then checked the cavity and found the tip of a snake tail exposed. After digging a bit, we removed a live *O. petola* (SVL = 71 cm; total length = 91 cm) from the hole. There were several bite marks on the posterior

part of its body, and it is probable that the *P. patagoniensis* had already started to swallow it tail-first when we arrived. We kept the wounded snake under veterinary care, but it died two days later and was deposited at the reptile collection of the Museu Nacional, Rio de Janeiro (MNRJ 17927).

In southern Brazil (state of Rio Grande do Sul), Hartmann and Marques (*op. cit.*) reported the colubrids *Liophis poecilogyrus* and *Pseudablabes agassizi*, as well as a conspecific, as prey of *P. patagoniensis*. Two other cannibalistic events were reported by Pontes et al. (2003. Herpetol. Rev. 34:154) in the same state. In northeastern Argentina, Lopez and Giraudo (2008. J. Herpetol. 42:474–480) recorded a relatively high frequency of snakes in the diet of *P. patagoniensis* (13 of a total of 92 food items were snakes); nevertheless, only two snake species could be identified: *L. jaegeri* and *L. dilepis*. Thus, although some cases of ophiophagy have previously been reported for *P. patagoniensis*, our record from Iguaba Grande is the first one involving a species of the genus *Oxyrhopus*.

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Submitted by **ANGELE DOS REIS MARTINS** (e-mail: angelemartins@hotmail.com), **SÁVIO FREIRE BRUNO** (e-mail: saviofreirebruno@hotmail.com), Universidade Federal Fluminense, Faculdade de Veterinária, Depto. Patologia e Clínica Veterinária, Rua Vital Brasil, 64, Santa Rosa, 24320-240, Niterói, RJ, Brazil; and **MAURÍCIO B. VECCHI**, Universidade do Estado do Rio de Janeiro, Rua São Francisco Xavier 524, Maracanã, 20550-011, Rio de Janeiro, RJ, Brazil (e-mail: mbvecchi@yahoo.com).

PANTHEROPHIS ALLEGHANIENSIS (Eastern Ratsnake). **DIET.** At 0830 h on 12 May 2009, a *P. alleghaniensis* was observed in the act of constricting a live bat (Fig. 1). The bat was almost certainly a Northern Yellow Bat (*Lasiurus intermedius*) but could potentially be an Eastern Red Bat (*L. borealis*). The bat was struggling and emitting a high-pitched cry as the snake constricted its torso. The snake was ca. 60 cm in total length and the bat was an adult male with a forearm length near the species average of 48 mm (Webster et al. 1980. Mammal. Species 132:1–3). The two were on the edge of a sidewalk along Museum Road on the campus of the University of Florida, in Gainesville, Florida USA. The sidewalk was adjacent to a Sabal Palm (*Sabal palmetto*) and also near several holly bushes (*Ilex* sp.).

The most likely scenario that led to this observation is that the snake captured the bat in the palm tree (ca. 5 m tall) and the two subsequently fell together to the sidewalk, where their struggle continued. When the two were revisited at 0850 h, the bat was dead and the snake was attempting to consume it. The snake appeared small relative to the bat and consumption of the large bat did not appear possible unless the snake managed to fold the wings significantly. At 0856 h both snake and deceased bat were moved out of harm's way from the sidewalk to the holly bushes.

Prior records of ratsnakes feeding on bats were limited to *Eptesicus*, *Myotis*, *Pipistreullus*, and *Tadarida* (Ernst and Ernst 2003. Snakes of the U.S. and Canada. Smithsonian Inst. Press, Washington, DC. 668 pp.). A Mexican Freetail Bat, *Tadarida brasiliensis*, was found in the gut of a *P. obsoletus* (Ridlehuber and Silvy 1981. Southwest. Nat. 26:70–71). In addition, *P. alleghaniensis* has been recorded feeding upon Big Brown Bats, *Eptesicus fuscus fuscus* (Boyles and Storm 2007. Behaviour 144:1019–1032; Silver 1928. J. Mammal 9:149) as well as bats of the genus *Myotis* (e.g., Indiana Bat, *M. sodalis*: Barr and Norton 1965. J. Mammal. 46:672; Cary et al. 1981. Trans. Kansas Acad. Sci. 84:223–224). Predation of the Georgian Bat, *Pipistrellus subflavus*, by a captive ratsnake has also been noted (Fowler 1947. Copeia 1947:210). This is the first published evidence of a wild *Pantherophis* preying upon a bat of the genus *Lasiurus*.



COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND

FIG. 1. *Pantherophis alleghaniensis* (Eastern Ratsnake) actively constricting a bat, likely *Lasiurus intermedius* (Northern Yellow Bat).

I thank Jason Bourque, Angelo Soto, Kurt Neubig, and Steve Manchester for assistance with identification and revision of submission.

Submitted by **ALEXANDER K. HASTINGS**, Florida Museum of Natural History, University of Florida, Gainesville, Florida 32611, USA; e-mail: akh@ufl.edu.

PANTHEROPHIS OBSOLETUS (Texas Ratsnake). **DIET AND FORAGING BEHAVIOR**. The contents of bird nests are important prey for *Pantherophis obsoletus* (Fitch 1963. Copeia 1963:649–658), a major nest predator in some areas (Stake et al. 2005. J. Herpetol. 39:215–222). *Pantherophis* are known to be intraspecifically social during certain activities such as male-male combat (Stickel et al. 1980. Am. Midl. Nat. 103:1–14), but we are not aware of any recorded instances of group nest depredation in this species.

On 15 July 2007, we filmed two *P. obsoletus* simultaneously engaged in the depredation of an Indigo Bunting (*Passerina cyanea)* nest (http://www.biosci.missouri.edu/avianecology/cox/video.htm). We recorded the event using an infrared camera system that continuously monitored the nest on the Baskett Research and Education Area in Boone Co., Missouri, USA. The nest was located 0.45 m above the ground in a small shrub near a forest edge. A single *P. obsoletus* began depredation of the nest at 2048 h. A second *P. obsoletus* arrived at the nest at 2053 h. The video sequence demonstrated that both individuals engaged in foraging behavior (i.e., consumption of nestlings or a search of the nest interior). The depredation event ended at 2057 h after

both the nestlings were consumed.

The field of view of the camera was insufficient to determine if the snakes hunted cooperatively, though the 5 min lag between the onset of the event and the arrival of the second individual suggests that this is unlikely. *Pantherophis* are attracted to edge habitats (Blouin-Demers and Weatherhead 2001. Ecology 82:2882–2896) such as the site of this observation, so it is possible that the activities of the first *P. obsoletus* attracted a nearby individual. To our knowledge, this is the first documented occurrence of a songbird nest being depredated by multiple individuals of *P. obsoletus.*

Submitted by **CURTIS ALEXANDER KUKAL**, Department of Natural Resources Management, Texas Tech University, Lubbock, Texas 79409, USA (e-mail: curtis.kukal@ttu.edu); and **W. ANDREW COX**, Division of Biological Sciences, 105 Tucker Hall, University of Missouri, Columbia, Missouri 65211, USA.

PHILODRYAS MATTOGROSSENSIS (Two-colored Racer). **DIET.** *Philodryas mattogrossensis* is a medium-sized, terrestrial colubrid found in Argentina, Bolivia, Brazil, and Paraguay (Thomas 1976. Unpubl. PhD. thesis. Texas A&M University). Life history data on this species are lacking. Here I report a new anuran diet item for *P. mattogrossensis*.

At 1300 h on 29 April 2009, a *P. mattogrossensis* (SVL = 1014 mm; tail length = 440 mm; 270 g post prey removal) was captured in a pile of adobe bricks in the Isoceño community of Yapiroa, Provincia Cordilleria, Departmento Santa Cruz, Bolivia (19.6000°S, 62.5667°W, datum WGS84). When the snake's stomach was checked for food by forced regurgitation, it regurgitated an adult *Leptodactylus bufonius* (Shovel-nosed Chamber Frog; SVL = 60 mm). *Philodryas mattogrossensis* has been described as an opportunistic feeder (Amaral 1933. Bol. Bio. 1:2–4), but this is the first record of *L. bufonius*, an anuran commonly found in the Gran Chaco (Cei 1980. Monitore Zool. Ital. Monogr. 2:1–609; pers. obs.), in the diet of *P. mattogrossensis*.

Funding for this research was provided by the Applied Biodiversity Science National Science Foundation Integrated Graduate Education and Research Traineeship doctoral program (NSF-IGERT Award #0654377) at Texas A&M University.

Submitted by **CHRISTOPHER M. SCHALK** Department of Wildlife and Fisheries Sciences, Texas A&M University, College Station, Texas 77843-2258, USA; e-mail: cschalk@tamu.edu.

PSEUDOERYX PLICATILIS (South American Pond Snake). **DIET**. The aquatic colubrid snake *Pseudoeryx plicatilis* is distributed in Amazon lowland rainforests and also in the Chaco of northern Argentina and Paraguay (Peters and Orejas-Miranda 1970. Catalogue of the Neotropical Squamata. Part I. Snakes. Bull. U.S. Nat. Mus. 297, Washington D.C. 347 pp.). Despite its wide distribution, *P. plicatilis* is seemingly rare and little is known about its natural history (Schargel et al. 2007. Herpetologica 63:236–244). Fishes and frogs are reported to compose the diet of *P. plicatilis* (Amaral 1978. Serpentes do Brasil: Iconografia Colorida. Editora da Universidade de São Paulo, Melhoramentos, São Paulo. 248 pp.; Starace 1998. Guide des Serpents et Amphisbènes de Guyane. Ibis Rouge Editions, Guadeloupe. 452 pp.), but there are few specific reports of this species' diet in the literature. Here we report an observation of a freshwater eel, *Synbranchus* sp. (Teleostei: Synbranchidae), as prey of *P. plicatilis*.

On 8 May 2009, at 1400 h, an adult male *P. plicatilis* (SVL = 714 mm; tail length = 162 mm) was seen in the water ingesting a freshwater eel headfirst. The snake was collected near the Unini River's southern margin (01.7658°S, 62.2247°W, datum WGS 84), Barcelos, Amazonas, Brazil, and was maintained in a snake bag for ca. 10 min. During that time, the snake regurgitated a *Synbranchus* sp. (total length = 349 mm). Both specimens were deposited at their respective collections at the Instituto Nacional de Pesquisas da Amazônia (*P. plicatilis* = INPA-H 25370; *Synbranchus* sp. = INPA 32629).

We thank Albertina P. Lima and Niro Higuchi for providing us with field opportunities at Rio Unini, and Jansen S. Zuanon for the fish identification.

Submitted by **IGOR LUIS KAEFER** (e-mail: igorkaefer@hotmail.com), and **ANELISE MONTANARIN** (e-mail: aneta_bio@yahoo.com.br), Coordenação de Pesquisas em Ecologia, Instituto Nacional de Pesquisas da Amazônia, CP 478, 69011-970, Manaus, Amazonas, Brazil.

THAMNOPHIS SIRTALIS SIRTALIS (Eastern Gartersnake). **HIBERNACULA.** On 14 April 2008 at 1400 h we counted 25 *Thamnophis s. sirtalis* crawling out of a hole under an oak leaf located at the Bartlett Arboretum in Stamford, Fairfield Co., Connecticut, USA (41.1338°N, 73.7955°W, datum NAD 83). The day was partially sunny and the temperature was 11°C. We removed the leaf when snakes stopped emerging and observed that the hole was smaller than the diameter of a US quarter (23.5 mm). At first this opening seemed too small to permit the passage of these adult snakes. However, measurements of a random sample of 18 Fairfield Co. adult *T. sirtalis* from the Yale Peabody Museum of Natural History yielded an average head width of 11.90 mm at widest point and an average of 8.57 mm in head height (measured from the posterior-most end of the chin shields to the parietal). Thus, this inconspicuous hole would easily provide these snakes with access to the surface from their hibernaculum.

The hole was embedded in loamy soil surrounded by a labyrinth of decomposing root channels in a northeastern deciduous forest comprised primarily of beech, birch, and oak trees. This hole was located 26.5 m NW of a southerly flowing brook, ca. 1.5 m above the water level. Excavation of a test hole and probing with flexible fiberglass sticks revealed a vertical depth of 55.9 cm. Lateral side tunnels 19.1 cm long were observed at a vertical depth of 15.2 cm. Two additional surface holes were found in close proximity of our test hole, 86.4 cm and 71.1 cm away. These had vertical depths of 21.6 cm and 22.9 cm, respectively. Such a mesophytic habitat can provide a moist and humid environment that is covered in the fall by a leaf mat that traps moist warm air. This may help to insulate the holes and underground labyrinth, preventing desiccation or freezing in the winter. In the past, ant mounds with numerous small (6–25 mm diameter) entrances

have been reported to provide access to tunnels for yearling and adult *T. sirtalis* in Michigan (Carpenter 1953. Ecology 34:74–80), and Carpenter's account is consistent with the size of the hole we report here. Hibernation is a critical but poorly-understood aspect of the natural history of many snake species and knowledge of situations that provide suitable hibernacula improves our ability to conserve important habitats for these species.

We thank the students of the Western Connecticut State University Herpetology Class for their observations, and Greg Watkins-Colwell, Yale Peabody Museum of Natural History, for reviewing the manuscript and help in accessing specimens.

Submitted by **THEODORA PINOU** (e-mail: Pinout@wcsu.edu), **PETER WARNY** (e-mail: prwarny@yahoo.com), and **JEFF PIOLI** (e-mail: falconpunch1201@aol.com), Western Connecticut State University, Department of Biological and Environmental Sciences, 181 White Street, Danbury, Connecticut 06810, USA.

WAGLEROPHIS MERREMII (Wagler's Snake). **FEEDING BEHAVIOR.** Snakes of the monotypic genus *Waglerophis* occur in South America and feed mainly on bufonid anurans (Jordão 1996. Estudo Comparativo da Alimentação e da Reprodução de *Waglerophis merremii* e *Xenodon newiedii* (Serpentes: Colubridae). USP-SP. 93 pp.). In the Brazilian Caatinga biome, *W. merremii* preys primarily on *Rhinella jimi* (Lima-Verde 1991. Estado Atual do Conhecimento da Fauna Reptiliana do Ceará. Universidade Federal do Ceará, Fortaleza. 209 pp.). On 2 June 2008 we observed a *W. merremii* (CHUFC 3040) in coastal vegetation ("mata de tabuleiro") of São Gonçalo do Amarante Municipality, Ceará, Brazil (03.304856ºS, 38.552752ºW, datum WGS84), preying on an adult *Rhinella jimi*. We captured the snake for studies at the Núcleo Regional de Ofiologia da Universidade do Ceará (NUROF-UFC), Brazil. When we examined the snake's cage the following day, we found a pile of viscous material (Fig. 1A) containing parts of coleopterans (Family Scarabeidae; Fig. 1B), typical prey of *Rhinella jimi* (Cei 1972. *In* Blair [ed.] Evolution of the Genus *Bufo*, pp. 82–92. Univ. Texas Press, Austin). We offered additional *R. jimi* to the same snake on 2 July 2008 and to another *W. merremii* (CHUFC3041) from the "mata de tabuleiro" of Caucaia, Ceará (03.282088ºS, 38.552752ºW) on 18 August 2008. The toads also were originally from the same coastal vegetation of Caucaia Municipality. In both cases, the snakes began ingestion at the prey's head, as expected, but around eight minutes after deglutition, regurgitated material similar to that noted in the first observation. We observed that during the ingestion phase, the snakes regurgitated only the toad's stomach contents and never any part of the anuran.

We believe that the likely mechanism for this behavior is that the toad regurgitates within the snake's stomach. The snake subsequently regurgitates the coleopterans, which are probably toxic. Many instances of snakes regurgitating whole prey have been reported in the literature; but, to our knowledge, none report regurgitation of only the prey's stomach contents. Although the behavior has been observed on three occasions in two individual *W. merremii*, it is not always exhibited when a *Waglerophis* consumes a toad.

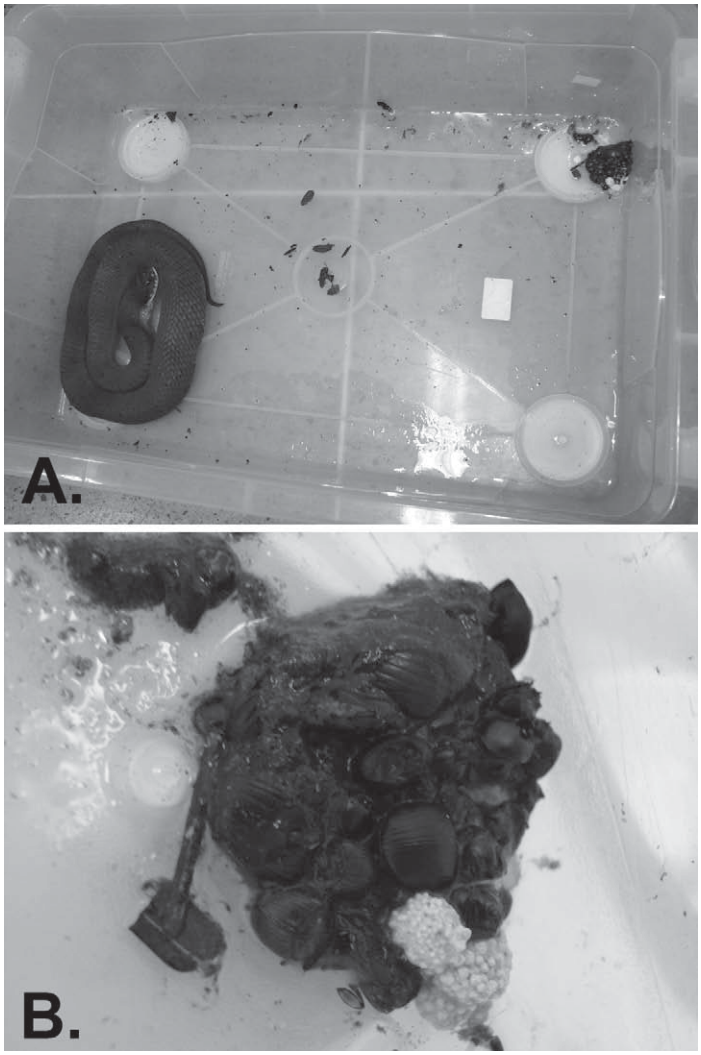


FIG. 1. *Waglerophis merremii* with material regurgitated soon after ingesting a *Rhinella jimi* (A). Close examination of the material reveals parts of coleopterans (Scarabeidae) but no anuran material (B), suggesting that the material represents the toad's stomach contents.

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GEOGRAPHIC DISTRIBUTION

Instructions for contributors to Geographic Distribution appear in Volume 41, Number 1 (March 2010, p. 102). Please note that the responsibility for checking literature for previously documented range extensions lies with authors. Do not submit range extension reports unless a thorough literature review has been completed.

CAUDATA — SALAMANDERS

AMBYSTOMA TALPOIDEUM (Mole Salamander). USA: ARKANSAS: Craighead Co.: Lake City Township: 0.01 km N of St. Hwy 18 (35.82098ºN, 90.43948ºW; NAD 83). 14 March 2008. Phillip Jordan. Verified by Stan Trauth. Arkansas State University Museum of Zoology (ASUMZ 30959). New county record (Trauth et al. 2004. Amphibians and Reptiles of Arkansas. Univ. of Arkansas Press, Fayetteville. 421 pp.); known previously from adjacent Greene County and seven other eastern Arkansas counties and from eight southern Arkansas counties.

Submitted by **PHILLIP N. JORDAN**, 91 Skylark Lane, Lake City, Arkansas 72437, USA; e-mail: phillipnjordan03@hotmail.com.

AMPHIUMA TRIDACTYLUM (Three-toed Amphiuma). USA: ARKANSAS: Howard Co.: Mine Creek, 2.4 km SE Nashville (more detailed specifics not available). 23 July 1953. H. S. Sublette. Henderson State University (HSU 521). Clark Co.: SE of Arkadelphia, Deceipher Creek near jct. with Ouachita River. August 1998. Collector name not recorded. HSU 833. Both specimens verified by Stan Trauth. Specimens each represent first county records. Clark Co. record extends range ca. 65 km NNW nearest record in Union Co., and Howard Co. record extends range ca. 65 km N of the nearest record in Lafayette Co. (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. Univ. Arkansas Press. Fayetteville. 421 pp.)

Submitted by **RENN TUMLISON**, Department of Biology, Henderson State University, Arkadelphia, Arkansas 71999, USA.

NOTOPHTHALMUS VIRIDESCENS LOUISIANENSIS (Central Newt). USA: ARKANSAS: Woodruff Co.: Specimens were found near Brushy Lake Road on the Cache River National Wildlife Refuge 0.2 miles S of AR 260 W (35.21080ºN, 91.26437ºW; WGS84; elev. 53 m). 21 May 2010. Thomas J. Belford. University of Kansas Natural History Museum (KUDA 012136). Verified by William E. Duellman. First county record (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas, Univ. Of Arkansas Press, Fayetteville. 421 pp.). Extends range ca. 22 km from nearest known record from White Co., Arkansas. Two specimens were found beneath a decaying log on the forest floor.

Submitted by **THOMAS J. BELFORD**, 701 W Academy Avenue, Searcy, Arkansas 72143, USA; e-mail: thomasbelfordiniraq@yahoo.com.

PLETHODON ALBAGULA (Western Slimy Salamander). USA: ARKANSAS: Prairie Co.: Near Holloway Memorial Natural Area, 0.54 miles N of State Highway 11 on Allred Drive (35.06930ºN, 91.54400ºW; WGS84; elev. 64 m). 07 May 2010. Thomas J. Belford. University of Kansas Natural History Museum (KUDA 011949). Verified by William E. Duellman. First county record (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. Univ. Of Arkansas Press, Fayetteville. 421 pp.). Extends range 20.5 km from nearest known record inWhite Co., Arkansas. Single specimen was found beneath a rotting log on a flatwoods forest floor.

Submitted by **THOMAS J. BELFORD**, 701 W Academy Avenue, Searcy, Arkansas 72143, USA; e-mail: thomasbelfordiniraq@yahoo.com.

ANURA — FROGS

ANAXYRUS AMERICANUS (American Toad). USA: INDIANA: Clay Co.: northeast of Clay City (39.30762ºN, 87.06380ºW; NAD 83). 15 April 2010. Sarabeth Klueh and Jason Mirtl. Verified by Chris Phillips. Illinois Natural History Survey (INHS 2010f). New county record (Minton 2001. Amphibians and Reptiles of Indiana. 2nd ed., revised. Indiana Academy of Science. vii–404 pp.) Individuals were calling from farm pond along with *Anaxyrus fowleri*. This species occurs commonly throughout most of Indiana but appears to be largely absent from a pocket of counties in the southwest part of the state (Minton, *op. cit*.). This record partially fills a gap in the range of this species in southwest Indiana.

Submitted by **SARABETH KLUEH** (e-mail: sklueh@dnr.in.gov) and **JASON MIRTL**, Wildlife Diversity Section, Indiana Department of Natural Resources Division of Fish and Wildlife, 553 E. Miller Drive, Bloomington, Indiana 47401, USA.

ANAXYRUS AMERICANUS (American Toad). USA: INDIANA: Vermillion Co.: Clinton Township (39.62180°N, 87.51672°W; NAD 83). 30 March 2010. Sarabeth Klueh and Jason Mirtl. Illinois Natural History Survey (INHS 2010b). Vouchers for a second Vermillion Co. location were also obtained (INHS 2010c). Both specimens verified by Chris Phillips. New county record (Minton 2001. Amphibians and Reptiles of Indiana. 2nd ed., revised. Indiana Academy of Science. vii–404 pp.). Adults in Clinton Twp. were calling from a vernal pool in a farm field. Adults in Highland Twp. were calling from a small pond in the front yard of a farmhouse. These records partially fill a gap in the range of this species in western Indiana.

Submitted by **SARABETH KLUEH** (e-mail: sklueh@dnr.in.gov) and **JASON MIRTL**, Wildlife Diversity Section, Indiana Department of Natural Resources Division of Fish and Wildlife, 553 E. Miller Drive, Bloomington, Indiana 47401, USA; and **NATHAN ENGBRECHT**, 135 Holmstedt Hall, Indiana University School of Medicine-Terre Haute, Indiana State University, Terre Haute, Indiana 47809, USA (e-mail: nengbrecht@indstate.edu).

ANAXYRUS FOWLERI (Fowler's Toad). USA: INDIANA: Clay Co.: northeast of Clay City (39.30762°N, 87.06380°W; NAD 83). 15 April 2010. Sarabeth Klueh and Jason Mirtl. Verified by Chris Phillips. Illinois Natural History Survey (INHS 2010g). New county record (Minton 2001. Amphibians and Reptiles of Indiana. 2nd ed., revised. Indiana Academy of Science. vii–404 pp.). Individuals were calling from farm pond along with

Anaxyrus americanus.

Submitted by **SARABETH KLUEH** (e-mail: sklueh@dnr.in.gov) and **JASON MIRTL**, Wildlife Diversity Section, Indiana Department of Natural Resources Division of Fish and Wildlife, 553 E. Miller Drive, Bloomington, Indiana 47401, USA.

ELEUTHERODACTYLUS COQUI (Puerto Rican Coquí). COSTA RICA: CARTAGO: Distrito Turrialba, Barrio Jorge Debravo (09.900001°N, 83.666768°W; datum not available; 622 m elev.). 01 July 2009. A. García-Rodríguez, C. Chaves, M. Wainwright, and A. Villegas. Verified by Rafael L. Joglar. UCR 20746–47. First records of *E. coqui* in Costa Rica (Frost 2009. Amphibian Species of the World: an Online Reference. Version 5.3 [12 February 2009]) and both were part of a chorus of over 100 males in an area of about 100 x 400 m in size within a residential neighborhood. Originally a Puerto Rican endemic, *E. coqui* has invaded the Bahamas, the Dominican Republic, Ecuador, Guam, New Zealand, and parts of the United States (Global Invasive Species Database [http://www.issg.org/database], downloaded 13 July 2009). We know of no other population in Costa Rica, but the dispersal of this exotic species or its introduction to other areas of the country are of concern to wildlife biologists alarmed with the effects of invasive species on local ecosystems.

Submitted by **ADRIÁN GARCÍA-RODRÍGUEZ** (e-mail: garciar.adrian@gmail.com), **GERARDO CHAVES** (e-mail: cachi13@gmail.com), **MARK WAINWRIGHT** (e-mail: markwainwright@racsa.co.cr), and **ALEXANDER VILLEGAS** (e-mail: alexmont@costarricense.cr), Museo de Zoología, Departamento de Biología, Universidad de Costa Rica, San José, Costa Rica.

HYLA WRIGHTORUM (Arizona Treefrog). USA: NEW MEXICO: McKinley Co.: Marquez Wildlife Area. 250 m E of Ojo de Marquez, Cañon de Marquez and 3.2 km WNW of Marquez, Sandoval Co.. (35.3246°N, 107.3353°W; WGS84; elev. 2224 m). 30 July 2009. J Tomasz Giermakowski, Cassandra M Wilson, and Howard L Snell. Verified by Michael J. Sredl. University of New Mexico Museum of Southwestern Biology (MSB 76435 [lot of two tadpoles]). New county record (Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. Univ. New Mexico Press, Albuquerque, xix + 431 pp.). First record in the Chivato Mesa/Mount Taylor region of Cibola, McKinley, and Sandoval counties of New Mexico. Extends the known range by ca. 80 km ENE of the nearest verified locality at El Malpaís National Monument, Cibola Co., New Mexico (Monatesti et al. 2005. Herpetol. Rev. 36:74–75; USGS Biological Surveys Collection BS/FC 7837–39, now MSB 87837–39, listed in *op. cit*. as BS/FC 7818–20). These records, as well as an unidentifiable 19th century specimen from Nutria, McKinley Co. (Gehlbach 1965. Proc. U.S. Nat. Mus. 116[3505]:243–332), indicate that the species may be present throughout other relatively isolated mountains in the region.

Collection was made under New Mexico Department of Game and Fish authorization #3329.

Submitted by **J. TOMASZ GIERMAKOWSKI (**e-mail: tomas@unm.edu), **CASSANDRA M. WILSON**, and **HOWARD L. SNELL**, Museum of Southwestern Biology, MSC03 2020, University of New Mexico, Albuquerque, New Mexico 87131-0001, USA.

HYPSIBOAS EXASTIS. BRAZIL: PERNAMBUCO: Municipality of Jaqueira: Reserve Private Frei Caneca (08.73061°S, 35.84606°W; WGS 84; elev. 600 m). 10 November 2007. S. P. Lima dos Santos and E. Maranhão dos Santos. Coleção Herpetologica da Universidade Federal Rural de Pernambuco, Unidade Acadêmica de Serra Talhada, Serra Talhada, Pernambuco, Brazil (CHUFRPE 904, adult specimen SVL 70.2 mm). Verified by M. Trefault Rodrigues. Previously known only from the type locality: Fazenda Unacau, Municipality of São José da Vitoria, State of Bahia (Caramaschi and Rodrigues 2003. Arq. Mus. Nac., Rio de Janeiro 61[4]:255–260). First state record, extends the known distribution 800 km northeast from type locality.

Submitted by **SUENY PALOMA LIMA DOS SANTOS,** Universidade Federal de Pernambuco, Centro de Ciências Biológicas Av. Prof. Moraes Rego, 1235 - Cidade Universitária, 50670-901, Recife, PE, Brazil; and **EDNILZA MARANHÃO DOS SANTOS**, Unidade Acadêmica de Serra Talhada, Universidade Federal Rural de Pernambuco, 56900-000, Serra Talhada, PE, Brazil.

HYPSIBOAS ROSENBERGI (Medium Gladiator Frog). PANAMÁ: COLON: Barro Colorado Island: Barro Colorado Nature Monument, upper lab clearing (9.16298ºN, 79.83795ºW; NAD83). 06 July 2009. Robert V. Horan III and Edward Hurme. Verified by Roberto Ibáñez. Smithsonian Tropical Research Institute Digital File Manager, reference numbers 30522–30525. First records (two males and a female) from Barro Colorado Island (Rand and Myers 1990. *In* Gentry [ed.], Four Neotropical Forests, pp. 386–409. Yale Univ. Press, New Haven, Connecticut). Because the herpetofauna of Barro Colorado Island has been surveyed extensively over the last 80 years (Rand and Myers 1990, *op. cit.*) and because the mating call of this species is loud and conspicuous (the two males were vocalizing), we view the species as being a recent colonist to the island. The addition of *H. rosenbergi* to Barro Colorado Island raises the number of amphibian species occurring there to 35 (Ibáñez et al., 1999. The Amphibians of Barro Colorado Nature Monument, Soberania National Park and Adjacent Areas. Mizrachi and Pujol Editorial, Panama). The vegetation community at the site is tropical moist forest.

Submitted by **ROBERT VINCENT HORAN III,** D. B. Warnell School of Forestry and Natural Resources, University of Georgia, Athens, Georgia 30602, USA (e-mail: rvhoran@uga.edu); and **EDWARD R. HURME**, Department of Ecology and Evolutionary Biology, Princeton University, Princeton, New Jersey 08544, USA (e-mail: ehurme@princeton.edu).

LITHOBATES SEPTENTRIONALIS (Mink Frog). CANADA: ONTARIO: Michipicoten Island Provincial Park: Forested beaver dam complex (47.72777°N, 85.82694°W, NAD 83). 09 May 2010. Benjamin Kuchta. Verified by Stephen Hecnar and Amy Lathrop. Royal Ontario Museum (ROMdm 00268, digital photograph). First island record (Oldham and Weller 2000. Ontario Herpetofaunal Atlas. National Heritage Information Centre, Ontario Ministry of Natural Resources. http://nhic.mnr.gov.on.ca/MNR/nhic/herps/ohs.html [updated 10-01-2010]).

Several individuals were observed in a large, lowland beaver dam complex. Mink Frogs were not previously known to inhabit Michipicoten Island, the third largest island in Lake Superior. The island is 16 km from shore at its nearest point and the record is 40 km SW of the nearest confirmed Mink Frog location. These populations are likely genetically isolated and may represent novel opportunities for study.

Submitted by **BENJAMIN KUCHTA**, Department of Natural Resources Management, Lakehead University, 955 Oliver Road, Thunder Bay, Ontario, Canada, P7B 5E1; e -mail: bkuchta@lakeheadu.ca.

OSTEOPILUS SEPTENTRIONALIS (Cuban Treefrog). USA: FLORIDA: Nassau Co.: Fort Clinch State Park, Fernandina Beach, 0.2 km E of Willow Pond (30.69816°N, 81.445638°W; WGS 84; elev. 1 m). 04 August 2009 and 21 October 2009. Lisa M. Wilson. Verified by Kenneth L. Krysko. Florida Museum of Natural History (UF 157779–84). New county record. Extends the range ca. 45 km north of the closest known verified locality in Duval Co. (UF 140832; also see Krysko et al. 2005. Herpetol. Rev. 36:85–87). Six gravid females collected from PVC refugia.

Submitted by **LISA M. WILSON** and **DAVID L. BECHLER**, Department of Biology, College of Arts and Sciences, Valdosta State University, Valdosta, Georgia 31698, USA (e-mail: dbechler@valdosta.edu).

PHYSALAEMUS AGUIRREI (Linhares Dwarf Frog). BRAZIL: MINAS GERAIS: Municipality of Periquito, Fazenda Coqueria (19.1°S, 42.183°W; SAD 69; elev. 174 m). 16–19 September 2008. M. A. S. Canelas and R. Filogonio. Verified by L. B. Nascimento. Museu de Ciências Naturais, Pontifícia Universidade Católica de Minas Gerais, Belo Horizonte, Minas Gerais (MCNAM 11207–11031, 11036, and 11043). This represents the most inland record for the species and extends known distribution ca. 220 km airline W from Linhares and 240 km SW from Nanuque. *P. aguirrei* was only known from the type locality at Refúgio Sooretama, Linhares, Espírito Santo, Brazil (Frost 2009. Amphibian Species of the World: an Online Reference. Version 5.3, 12 February 2009. Electronic database accessible at http://research.amnh.org/herpetology/amphibia/); Caravelas, Bahia, Brazil (Van Sluys 1998. Herpetol. Rev. 29:49); and Nanuque, Minas Gerais, Brazil (Carvalho-Jr and Nascimento 2005. Herpetol. Rev. 36:200).

Submitted by **MARCO ANTÔNIO SCHETTINO CANELAS**, Herpeto Consultoria Ambiental LTDA, Rua Caraça 539, Serra, 30220-260, Belo Horizonte, MG, Brazil (e-mail: marcocanellas@hotmail.com); and **RENATO FILOGONIO**, Programa de Pós-Graduação em Zoologia, Universidade Estadual Paulista "Júlio de Mesquita Filho," Instituto de Biociências, Departamento de Zoologia, Avenida 24A, n.1515, Bela Vista, 13506-900, Rio Claro, SP, Brazil (e-mail: renatofilogonio@gmail.com).

PSEUDACRIS CLARKII (Spotted Chorus Frog). USA: TEXAS: DeWitt Co.: near Gonzales Co. Road 296 ca. 3.5 km NE of Cheapside, Texas (29.29131°N, 97.36864°W; WGS84). 12 April 2010. Romey Swanson and Christian Swanson. Verified by Travis LaDuc, Texas Natural History Collection (TNHC 82801). First county record (Dixon 2000. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station Texas. 421 pp.). On a night after heavy rains several choruses of *P. clarkii* were heard while we were working on the Carr Ranch located on the Gonzales/DeWitt county line. A single adult male was captured by hand in flooded hay field heavily encroached by mesquite (*Prosopis glandulosa*) and huisache (*Acacia farnesiana*). Specimen measured 2.8 cm SVL.

Submited by **ROMEY L. SWANSON** (e-mail: romeyswanson@gmail.com), **CHRISTIAN SWANSON,** and **THOMAS R. SIMPSON** (e-mail: r_simpson@txstate.edu), Department of Biology, Texas State University, San Marcos Texas 78666, USA.

SCINAX AROMOTHYELLA. BRAZIL: RIO GRANDE DO SUL: Munipalitity of Sertão: Parque Natural Municipal de Sertão (28.045665°S, 52.214153°W; WGS84; 650 m elev.). 30 May 2008. N. Zanella. Universidade de Passo Fundo, Passo Fundo, Rio Grande do Sul (CAUPF 2147). Verified by C. Haddad and J. Faivovich. Previously known from Chapecó, Santa Catarina (Lucas and Fortes 2008. Biota Neotrop. 8[3]:51–59), São Domingos and Ipuaçu, Santa Catarina, Brazil (Hartmann et al. 2008. *In* J. J. Cherem and M. Kammers [eds.], A Fauna das Áreas de Influência da Usina Hidrelétrica Quebra Queixo, pp. 89–110. Habilis Editora, Erechim), and Misiones Province, Argentina (Faivovich 2005. Herpetologica 61[1]:69–77). First state record, extends range ca. 250 km E from Misiones Province, Argentina and ca. 111 km S from Floresta Nacional de Chapecó, Santa Catarina, Brazil.

Submitted by **CARMEN SILVIA BUSIN** (e-mail: carmen@upf.br), **NOELI ZANELLA, SAMARA ARSEGO GUARAGNI, ALMIR DE PAULA,** and **MARIA CRISTINA KURTZ DE LIMA,** Instituto de Ciências Biológicas, Universidade de Passo Fundo, Campus I, Bairro São José, Passo Fundo, Rio Grande do Sul, 99001-970, Brazil.

XENOPUS RUWENZORIENSIS (Ruwenzori Clawed Frog). DEMOCRATIC REPUBLIC OF THE CONGO: NORTH KIVU: Ndjuma [= Djuma], Virunga National Park, Northern Sector (00.4919ºN, 29.4701ºE; WGS 84; 1174 m elev.). 9–10 July 2008. E. Greenbaum, C. Kusamba, M. M. Aristote, and W. M. Moniga. Laboratory of Environmental Biology, University of Texas at El Paso (UTEP 20008–09). ORIENTALE: Mayimbili, near Epulu (01.2382ºN, 28.3515ºE; WGS 84; 742 m elev.). 18 July 2009. E. Greenbaum, C. Kusamba, M. M. Aristote, and W. M. Moniga. (UTEP 20010). Verified by Ben Evans. First country record (Tinsley and Kobel 1996. The Biology of *Xenopus*. Clarendon Press, Oxford, United Kingdom. xxii + 440 pp.). Verification supported with mitochondrial data from 12S and 16S ribosomal DNA, transfer RNAVal, and the cytochrome c oxidase subunit I (CO1) gene, and nuclear data from the RAG1 gene (Evans, Greenbaum, Kusamba and colleagues, unpubl. data). Species described from lowland rainforest at Bundibugyo in Semliki Valley, Uganda, at foothills of Ruwenzori Mountains. New localities extend range ca. 45 km west (Ndjuma) and 180 km northwest (Mayimbili) from type locality.

Submitted by **ELI GREENBAUM**, Department of Biological Sciences, University of Texas at El Paso, El Paso, Texas 79968,

USA (e-mail: egreenbaum2@utep.edu); and **CHIFUNDERA KUSAMBA**, Laboratoire d'Herpétologie, Département de Biologie, Centre de Recherche en Sciences Naturelles, Lwiro, République Démocratique du Congo (e-mail: chifundera@yahoo.co.uk).

TESTUDINES — TURTLES

KINOSTERNON SUBRUBRUM (Mississippi Mud Turtle). USA: ARKANSAS: Logan Co.: ~5 km N of Magazine, AOR crossing AR 109 (35.1845°N, 93.8047°W; WGS 84). 05 April 2009. M. B. Connior. Verified by S. E. Trauth. Arkansas State University Museum of Zoology Herpetology Collection (ASUMZ 31319). New county record. Hand captured adult. Fills a distributional hiatus between previous records in Franklin, Johnson, Yell, and Scott counties in west-central Arkansas (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville. 421 pp.).

Submitted by **MATTHEW B. CONNIOR,** Department of Biological Sciences, Arkansas State University, P.O. Box 599, State University, Arkansas 72467, USA; e-mail: mconnior@astate.edu.

KINOSTERNON SUBRUBRUM HIPPOCREPIS (Mississippi Mud Turtle). USA: ARKANSAS: Lee Co.: near Lee County Wildlife Management Area 3.4 miles E Haynes (34.89067ºN, 90.73201ºW; WGS84; elev. 73 m). 31 May 2010. Thomas J. Belford. University of Kansas Natural History Museum (KUDA 012137–012138). Verified by William E. Duellman. First county record (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. Univ. of Arkansas Press, Fayetteville. 421 pp.). Extends range 22.4 km from nearest known record from St. Francis Co. Single specimen was found crossing AR 131 mid-morning.

Submitted by **THOMAS J. BELFORD**, 701 W Academy Avenue, Searcy, Arkansas 72143, USA; e-mail: thomasbelfordiniraq@yahoo.com.

PELODISCUS SINENSIS (Chinese Soft-shelled Turtle). PHILIPPINES: MINDANAO PROVINCE: South Cotabato; Municipality: Tupi (6.200939°N, 124.563437°E; no datum available). 19 March 2010. Pierre Fidenci. California Academy of Sciences photo voucher (CAS-HPV 63). Verified by Jérome Maran. First confirmed record for South Cotabato (Diesmos et al. 2008. Chelon. Cons. Biol. 7:157–177), and ca. 500 km from only record in Mindanao. Adult observed at fish pond within city limits of Tupi.

Submitted by **PIERRE FIDENCI,** Endangered Species International, 77 Brady St., San Francisco, California 94108, USA; e-mail: pfidenci@endangeredspeciesinternational.org.

STERNOTHERUS MINOR PELTIFER (Stripe-necked Musk Turtle). USA: ALABAMA: Chilton Co.: 7.4 km S of CR 25 on CR 73 (33.01586°N, 87.52242°W; WGS84). 01 March 2009. J. Burling and J. Wicknick. University of Montevallo Collection of Vertebrates (UMCV-RT0021). Verified by Joseph R. Mendelson III. Two males (8.4, 7.5 cm straight-line carapace length) and one female (8.4 cm). First county record; fills a gap among Shelby, Bibb, Perry, Coosa, and Elmore counties (Mount 1975. The Reptiles and Amphibians of Alabama. University of Alabama Press, Tuscaloosa. 347 pp. We also searched *Herpetological Review* records from 1967–March 2010 and all museums on www.herpnet.org).

Collection was made under the authority of Alabama Department of Conservation and Natural Resources collecting permit # 4784 (JAW).

Submitted by **JOHN W. BURLING**[1] and **JILL A. WICKNICK**[2], Departments of Psychology[1] and Biology[2], University of Montevallo, Montevallo, Alabama 35115, USA; e-mail: wicknickja@montevallo.edu.

STERNOTHERUS ODORATUS (Eastern Musk Turtle). USA: TENNESSEE: Chester Co.: Henderson, Freed-Hardeman University (35.4387°N, 88.6338°W; WGS84). 16 October 2009. Benjamin M. Reese, Jared Symonds, Lamont Otey, Tiffany N. Odom, Sequina Robinson, and David Tidwell. Verified by A. Floyd Scott. Austin Peay State University's David H. Snyder Museum of Zoology (APSU 19007 color photo). First record for county (Scott and Redmond 2008. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available from http://www.apsu.edu/reptatlas; accessed 09 February 2010). Specimen was collected from one of FHU's research ponds using a mesh hoop net baited with sardines. The pond is surrounded by dense hardwoods and boarders a swamp. Voucher collected under Tennessee Wildlife Resources Agency Permit 1494.

Submitted by **BENJAMIN M. REESE** (e-mail: ben.reese@students.fhu.edu), **JARED SYMONDS**, **LAMONT OTEY**, **TIFFANY N. ODOM**, **DAVID TIDWELL**, **SEQUINA ROBINSON**, and **BRIAN P. BUTTERFIELD**, Department of Biology, Freed-Hardeman University, Henderson, Tennessee 38340, USA (e-mail: bbutterfield@fhu.edu).

TRACHEMYS SCRIPTA ELEGANS (Red-eared Slider). USA: INDIANA: Pike Co.: Patoka River National Wildlife Refuge and Management Area (38.35046ºN, 87.12078ºW; NAD 83). 16 April 2009. Sarabeth Klueh, Angela Garcia, and Alisha Maves. Verified by Chris Phillips. Illinois Natural History Survey (INHS 2009ai). New county record (Minton 2001. Amphibians and Reptiles of Indiana. 2nd ed., revised. Indiana Academy of Science. vii–404 pp.) Adult male caught in hoop trap.

Submitted by **SARABETH KLUEH** (e-mail: sklueh@dnr.in.gov) and **ANGELA GARCIA**, Wildlife Diversity Section, Indiana Department of Natural Resources Division of Fish and Wildlife, 553 E. Miller Drive, Bloomington, Indiana 47401, USA; **ALISHA MAVES** and **LINDSEY LANDOWSKI** (e-mail: Lindsey_Landowski@fws.gov), US Fish and Wildlife Service, Patoka River National Wildlife Refuge, 510 1/2 West Morton Street, P.O. Box 217, Oakland City, Indiana 47660, USA.

TRACHEMYS SCRIPTA SCRIPTA (Yellow-bellied Slider). USA: GEORGIA: Wilkes Co.: Tignall, Jane Hill Road, 0.48 km NE Newtown Road (33.83098°N, 82.80704°W; WGS84; elev. 5 m). 29 April 2010. Justin T. Oguni. Verified by Kenneth L. Krysko. Florida Museum of Natural History (photographic voucher UF 157776). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575

pp.). Observed basking on a log in a wetland surrounded mostly by mixed hardwood forest at 1723 h.

Submitted by **JUSTIN T. OGUNI**, College of Veterinary Medicine, University of Georgia, Athens, Georgia 30602, USA; e-mail: goonie16@gmail.com.

SQUAMATA — LIZARDS

HEMIDACTYLUS TURCICUS (Mediterranean Gecko). USA: ALABAMA: Tuscaloosa Co.: Northport, 3550 Watermelon Road (33.238706°N, 87.552747°W; WGS84). 25 September 2009. Christopher Thawley. University of Alabama Herpetological Collection (UAHC 16363). Verified by Kenneth L. Krysko. New county record (Mount 1975. Amphibians and Reptiles of Alabama. Auburn University Agricultural Experiment Station, Auburn, Alabama. 347 pp.). The nearest known record is from Jefferson Co., Alabama (Marion and Bosworth 1982. Herpetol. Rev. 13:52) 74 km NE. Juvenile, captured by hand, observed along with two adults, suggesting presence of potential breeding population. Anecdotal reports place additional populations in some dormitories on the University of Alabama main campus in Tuscaloosa, less than 3 km S and in Cottondale, ca. 10 km SE.

Submitted by **CHRISTOPHER J. THAWLEY**, Department of Biological Sciences, University of Alabama, Box 870345, Tuscaloosa, Alabama 35487, USA; e-mail: cjthawley@crimson.ua.edu.

LEIOCEPHALUS CARINATUS (Northern Curly-tailed Lizard). USA: FLORIDA: St. Lucie Co.: Port Saint Lucie, SW Biltmore Street & SW Molloy Street (27.28645°N, 80.36385°W, WGS84; elev. 5 m). 04 April 2010. Kenneth L. Krysko, Steve A. Johnson, Kyle E. Giddens, Kurt H. Gielow, Travis S. Lowke, William M. Moore, Eric Suarez, Cailey D. Thomas. Verified by Kevin M. Enge. Florida Museum of Natural History (UF 157453). New county record and extends the range ca. 44 km northwest of the closest known verified locality in Martin Co. (Hauge and Butterfield 2000. Herpetol. Rev. 31:53).

Submitted by **KENNETH L. KRYSKO** (e-mail: kenneyk@flmnh.ufl.edu), **KYLE E. GIDDENS, KURT H. GIELOW, TRAVIS S. LOWKE, WILLIAM M. MOORE, ERIC SUAREZ, CAILEY D. THOMAS**, Division of Herpetology, Florida Museum of Natural History, Dickinson Hall, University of Florida, Gainesville, Florida 32611, USA; and **STEVE A. JOHNSON**, Gulf Coast REC-Plant City Center and Department of Wildlife Ecology & Conservation, 1200 N. Park Road, Plant City, Florida 33563, USA.

OHPHISAURUS ATTENUATUS ATTENUATUS (Western Slender Glass Lizard). USA: TEXAS: Tyler Co.: Big Thicket National Preserve, Turkey Creek Unit (30.58471ºN, 94.33588ºW; WGS 84). 28 November 2008. P. Crump, R. Rommel, and H. Pate. Verified by Carl Franklin. University of Texas Arlington UTADC 4015 – 4017. New county record (Dixon, J.R., 2000. Amphibians and Reptiles of Texas. 2nd ed. TAMU Press, College Station, Texas. 432 pp.).

Submitted by **PAUL CRUMP** (e–mail: pcrump@houstonzoo.org), **RACHEL ROMMEL** (e–mail: rrommel@houstonzoo.org), Department of Conservation and Science, Houston Zoo, 1513 North Macgregor Way, Houston, Texas 77030, USA; and **HAIGLER PATE**, National Park Service, Big Thicket National Preserve, 6044 FM 420, Kountze, Texas 77625, USA (e-mail: Haigler_Pate@nps.gov).

PLESTIODON LATICEPS (Broad-headed Skink). USA: ARKANSAS: Ouachita Co.: ~23 km W of Camden (33.584058°N, 93.085246°W; WGS 84). AOR on Ouachita Co. Rd. 76, 1.5 km W Junction Co. Rd. 76/AR 57. 29 May 2010. K. Roberts and M. B. Connior. Verified by S. E. Trauth. Arkansas State University Museum of Zoology Herpetology Collection (photo voucher ASUMZ 31528). New county record (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville. 421 pp.). The species has also been collected from neighboring Columbia and Union counties in southern Arkansas.

Submitted by **MATTHEW B. CONNIOR**, Health and Natural Sciences, South Arkansas Community College, 300 S. West Avenue, El Dorado, Arkansas 71730, USA (e-mail: mconnior@southark.edu); **KORY ROBERTS**, Rogers High School, 2300 South Dixieland Road, Rogers, Arkansas 72758, USA; and **IDUN GUENTHER**, Fisheries and Wildlife Biology, Arkansas Tech University, Russellville, Arkansas 72801, USA.

SQUAMATA — SNAKES

AGKISTRODON CONTORTRIX MOKASEN (Northern Copperhead). USA: GEORGIA: Whitfield Co.: Heritage Point Park (34.7942972ºN, 84.9445944ºW; no datum available). 19 May 2010. Chris Manis and John Patrick. Verified by John Jensen. University of Tennessee at Chattanooga Museum of Natural History (UTC Digital Collection 4667TPW-GMU). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 570 pp.) Specimen was found in an open fairway of a canopied disc golf course.

Submitted by **CHRIS MANIS** and **THOMAS P. WILSON**, Department of Biological and Environmental Sciences, University of Tennessee at Chattanooga, 215 Holt Hall, Department 2653, 615 McCallie Avenue, Chattanooga, Tennessee 37403, USA; and **JOHN PATRICK**, Dalton Middle School, 1250 Cross Plains Trail, Dalton, Georgia 30721, USA.

AGKISTRODON PISCIVORUS LEUCOSTOMA (Western Cottonmouth). USA: TENNESSEE: Lewis Co.: Buffalo River, 6.3 km downstream from Natchez Trace Parkway (35.4687°N, 87.5027°W; NAD 83). 10 July 2008. Todd Crabtree and Dwayne Estes. David H. Snyder Museum of Zoology, Austin Peay State University (APSU 18924, 18925, color photos). Verified by Nathan Parker. New county record (Scott and Redmond. 2008 [latest update: 14 July 2008]. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available from http://apsu.edu/reptatlas/ [accessed 23 July 2008]). Range extension of ca. 150 river km up the Buffalo River drainage from the nearest downstream record in Humphreys Co. Adult on log overhanging water and juvenile on lower ledge of shale bluff along river; sky overcast with light rain, 1346 h.

Submitted by **TODD CRABTREE,** Division of Natural

Areas, Tennessee Department of Environment and Conservation, Nashville, Tennessee 37243, USA; **DWAYNE ESTES** and **A. FLOYD SCOTT**, Department of Biology and Center for Field Biology, Austin Peay State University, Clarksville, Tennessee, USA (e-mail: scotta@apsu.edu).

CEMOPHORA COCCINEA (Scarletsnake). USA: ARKANSAS: Ouachita Co.: ~25 km W of Camden; (33.566811°N, 93.094641°W; WGS 84). Under a board 1 km N jct Ouachita Co. Rd. 27 and Hwy 278. 29 May 2010. I. Guenther. Verified by S. E. Trauth. Arkansas State University Museum of Zoology Herpetology Collection (photo voucher ASUMZ 31527). New county record. This species has also been collected from neighboring Columbia and Union counties in southern Arkansas (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville. 421 pp.).

Submitted by **MATTHEW B. CONNIOR**, Health and Natural Sciences, South Arkansas Community College, 300 S. West Avenue, El Dorado, Arkansas 71730, USA (e-mail: mconnior@southark.edu); **KORY ROBERTS**, Rogers High School, 2300 South Dixieland Road, Rogers, Arkansas 72758, USA; and **IDUN GUENTHER**, Fisheries and Wildlife Biology, Arkansas Tech University, Russellville, Arkansas 72801, USA.

CLONOPHIS KIRTLANDII (Kirtland's Snake). USA: OHIO: Brown Co.: Washington Twp: 13413 Wardlow Road (39.0080°N, 83.8506°W; WGS 84). 20 September 2008. Todd Rosenhoffer. Verified by John W. Ferner and Jeffrey G. Davis. Cincinnati Museum Center Herpetology Collection (CMC HP 5222–5223 [digital files and prints]). New county record (Wynn and Moody 2006. Ohio Turtle, Lizard, and Snake Atlas. Ohio Biol. Surv. Misc. Contrib. No. 10, Columbus).

Submitted by **TODD ROSENHOFFER**, Greater Cincinnati Herpetological Society, P.O. Box 14783, Cincinnati, Ohio 45250, USA (e-mail: trosenhoffer@msn.com); and **PAUL J. KRUSLING**, Geier Collections and Research Center, Cincinnati Museum Center, 1301 Western Avenue, Cincinnati, Ohio 45203, USA (e-mail: pkrusling@gmail.com).

COLUBER (=MASTICOPHIS) FLAGELLUM FLAGELLUM (Eastern Coachwhip). USA: ARKANSAS: Ouachita Co.: near White Oak Lake State Park 5.9 miles S Bluff City (33.68647ºN, 93.09792ºW; WGS84; elev. 82 m). 15 Apr 2010. Thomas J. Belford. University of Kansas Natural History Museum (KUDA 911879). Verified by William E. Duellman. First county record (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. Univ. of Arkansas Press, Fayetteville. 421 pp.). Single specimen was found on the forest floor along a woodland trail.

Submitted by **THOMAS J. BELFORD**, 701 W Academy Avenue, Searcy, Arkansas 72143, USA; e-mail:thomasbelfordiniraq@yahoo.com.

CONIOPHANES IMPERIALIS IMPERIALIS (Tamaulipan Black-striped Snake) USA: TEXAS: Starr Co.: approximately 7 km NNE of Roma, along N. Ebony Ave. (26.46343°N, 98.98797°W; WGS 84). 27 March 2010. Gilbert Martinez Jr. and Edwin Quintero. Verified by Frank W. Judd. University of Texas – Pan American Vertebrate Museum (UTPA 03101, photographic voucher). First county record. Westernmost record in the United States, ca. 70 km WNW of the nearest published record. Previously reported in adjacent Hidalgo Co. (Dixon 2000. Amphibians and Reptiles of Texas. 2nd ed. Univ. of Texas A&M Press, College Station. viii + 421 pp.; Werler and Dixon 2000. Texas Snakes: Identification, Distribution, and Natural History. University of Texas Press, Austin. xv + 437 pp.). Male (24.4 cm SVL, 32.0 cm TL) found under cardboard box on moist, loose soil. Nearby habitat was typical thorn scrub with tall grasses.

Submitted by **GILBERT MARTINEZ Jr., EDWIN QUINTERO, JOSÉ MANUEL CANTÚ MARTÍNEZ,** and **FREDERIC ZAIDAN III**, Department of Biology, University of Texas – Pan American, 1201 W. University Drive, Edinburg, Texas 78539, USA (e-mail: fzaidan@utpa.edu).

DIADOPHIS PUNCTATUS (Ring-necked Snake). USA: CALIFORNIA: Inyo Co.: Ninemile Canyon Rd, 0.5 rd mi. E of Inyo/Tulare Co. line (35.85645°N, 118.00072°W, WGS84; elev. 1848 m). 06 June 2010. D. Tobler. Verified by N. Camacho. Natural History Museum of Los Angeles County, LACM PC 1509 (photo voucher). Second record for Inyo Co. and first occurrence for eastern slope of Sierra Nevada. Nearest records are for Death Valley National Monument, 143 airline km NE of this record (Emmerich and Cunningham 2003. Herpetol. Rev. 34:169), and Kern River Canyon at Cow Flat Creek (MVZ 56716, 59979), 74 airline km to the SW. Present specimen was an adult male encountered AOR at 1650 h. This species has remained undetected until now despite long-running (1982–2010) herpetofaunal surveys in this canyon (RWH and colleagues, unpubl. data).

Submitted by **ROBERT W. HANSEN**, 16333 Deer Path Lane, Clovis, California 93619, USA (e-mail: herpreview@gmail.com); and **DAVID TOBLER**, Fresno Chaffee Zoo, 894 West Belmont Avenue, Fresno, California 93728, USA (e-mail: dtobler@fresnochaffeezoo.com).

DIADOPHIS PUNCTATUS (Ring-necked Snake). USA: WASHINGTON: Whitman Co.: Wawawai Grade Rd, 3.2 km E of Wawawai County Park (46.6211667ºN, 117.3335333ºW; WGS 84, 460 m elev.). 23 May 2009. Edward A. Myers and Kari Maupin. Verified by Hugo Alamillo. Charles R. Conner Museum (CRCM-09-84), School of Biological Sciences, Washington State University. Adult female collected DOR (48.9 cm SVL and 15.4 g). First documented specimen in 71 years. Some regional field guides indicate *Diadophis punctatus* as being fairly common in southeastern Whitman Co. (Nussbaum et. al., 1983. Amphibians and Reptiles of the Pacific Northwest. Univ. of Idaho Press, Moscow. 367 pp.). However, no individuals have been documented with either photo or specimen vouchers in this region of Washington state since the 1930s (Svihla 1938. Copeia 1938:47).

Submitted by **EDWARD A. MYERS,** School of Biological Sciences, Washington State University, Pullman, Washington 99164, USA (e-mail: edward_myers@wsu.edu); **KARI A. MAUPIN,** 1510 NW Turner Dr. #5, Pullman, Washington 99163, USA (e-mail: kari_maupin@yahoo.com); and **ROBERT E. WEAVER,** School of Biological Sciences, Washington State University, Pullman, Washington 99164, USA (e-mail: weaverr@wsu.edu).

DIPSAS GRACILIS (Graceful Snail Eater). COLOMBIA: CESAR: San Martín: Alto de La Paz (7.950556°N, 73.349528°W; WGS84; 1019 m elev.) 26 February 2009. R. Moreno-Arias. Colección de reptiles Instituto de Ciencias Naturales-Universidad Nacional de Colombia, Bogotá D.C, Cundinamarca, Colombia (ICN 12019). Verified by J. E. Carvajal-Cogollo. New state record. Previously known from lowland Pacific humid forests from northwestern Ecuador to northwestern Colombia (Peters 1960. Misc. Publ. Mus. Zool. Univ. Michigan 114:44–48; Castaño-Mora et al. 2004. Reptiles en el Chocó biogeográfico. Colombia Diversidad Biótica IV:599–632). Extends known range to premontane humid forest of "Cordillera Oriental" ca. 423 km NW from nearest locality (Colombia: Chocó: Riosucio; Castaño-Mora et al., *op. cit.*)

Submitted by **RAFAEL MORENO-ARIAS,** Instituto de Ciencias Naturales, Universidad Nacional de Colombia, Apartado Aéreo 55187, Bogotá D.C. Colombia; e-mail: rafamorearias@gmail.com.

DRYMARCHON COUPERI (Eastern Indigo Snake). USA: FLORIDA: Leon Co.: junction of state roads 20 and 267 (30.389436°N, 84.628069°W, WGS84, elev. 32 m). 7 July 1976. Kenneth L. Richmond. Verified by Brian J. Camposano. Florida Museum of Natural History (UF 149816; 107 cm SVL, salvaged roadkill). New county record (Moler 1992. *In* P. E. Moler [ed.], Rare and Endangered Biota of Florida, Volume 3, Amphibians and Reptiles, pp. 181–186. University Press of Florida, Gainesville), extending the range 29 km from the nearest known vouchers to the west (UF 115046; Liberty Co.) and 45 km to the southeast (UF 73644; Wakulla Co.).

Submitted by **D. BRUCE MEANS**, Coastal Plains Institute and Land Conservancy, 1313 Milton St., Tallahassee, Florida 32303, USA (e-mail: means@bio.fsu.edu); **KENNETH R. SIMS**, US Horticultural Research Laboratory, USDA, Ft. Pierce, Florida, USA (e-mail: kenrsims@hotmail.com); and **KENNETH L. KRYSKO**, Florida Museum of Natural History, Division of Herpetology, University of Florida, Gainesville, Florida 32611, USA (e-mail: kenneyk@flmnh.ufl.edu).

FARANCIA ABACURA ABACURA (Eastern Mudsnake). USA: ALABAMA: Elmore Co.: Hwy 14 near the town of Elmore (32.541900°N, 86.310283°W; WGS84/NAD83). 5 May 2010. R. Birkhead. DOR. AUM 38652. Verified by Craig Guyer. New county record. *Farancia a. abacura* has been previously documented to the south in Montgomery Co., to the southeast in Macon Co., and to the west in Autuaga Co. (Mount 1996. The Amphibians and Reptiles of Alabama. University of Alabama Press, Auburn. xi + 347 pp.). A warm, heavy rain occurred two days prior to finding this specimen.

Submitted by **ROGER D. BIRKHEAD**, Alabama Science In Motion, Auburn University, Alabama 36849-5414, USA; e-mail: birkhrd@auburn.edu.

LAMPROPELTIS GETULA HOLBROOKI (Speckled Kingsnake). USA: ARKANSAS: Pope Co.: 11.3 km S Ben Hur off St. Hwy. 16 (34.290126°N, 94.072151°W; WGS 84). 22 April 2010. C. T. McAllister. Verified by R. Tumlison. Henderson State University Herpetological Collection (HSU 1516). New county record filling a distributional hiatus among Johnson (Robison and McAllister. 2008. Herpetol. Rev. 39:244–245) and Van Buren counties (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.). This snake has now been documented from 74 of 75 Arkansas counties; only Grant Co. remains.

Submitted by **CHRIS T. McALLISTER**, RapidWrite, 102 Brown Street, Hot Springs National Park, Arkansas 71913, USA (e-mail:drctmcallister@aol.com); and **HENRY W. ROBISON**, Department of Biology, Southern Arkansas University, Magnolia, Arkansas 71754, USA (e-mail: hwrobison@yahoo.com).

LAMPROPELTIS TRIANGULUM (Milksnake). USA: ALABAMA: Marshall Co.: Collected near Union Grove ca. 2.71 km SW of the Tennessee River. 18 May 2005. Raymond N. Little and Carmen Barnard. Auburn University Museum AHAP-D 274. Verified by George Cline. First county record. Male was observed and captured in leaf litter at the base of a limestone rock outcropping at ca. 0915 h. Rock outcropping was located in a power line cut. This specimen helps fill a distribution gap for this species in north-central Alabama.

Submitted by **RAYMOND N. LITTLE**, P.O. Box 5013, Everglades City, Florida 34139, USA; e-mail: Raymond_Little@nps.gov.

LAMPROPELTIS TRIANGULUM GENTILIS (Central Plains Milksnake). USA: KANSAS: Norton Co.: Hwy 36, 1.3 rd mi. E of Rd E7 (39.8298417°N, 99.7354278°W; WGS84; elev. 2281 ft.). A second specimen was located at 39.8297389°N, 99.7349556°W. 04 May 2010. Brian Hinds. University of Texas at Arlington photo vouchers (UTADC 6721, 6722). Verified by J. W. Streicher. New county record (http://webcat.fhsu.edu/ksfauna/herps/index.asp?page=kansas). Snakes were found under rocks in an area of prairie grass and sandstone rock ridges (habitat photo UTADC 6723). I thank Brian Hubbs for confirming the absence of previous records for Norton Co.

Submitted by **BRIAN HINDS,** 14530 Mulberry Drive, Whittier, California 90604, USA; e-mail: fundad@kingsnake.org.

LAMPROPELTIS TRIANGULUM SYSPILA (Red Milksnake). USA: ARKANSAS: Searcy Co.: vic. Mull, ~3 km S of jct AR 14/ Ramblewood Trail (36.052048°N, 92.594601°W; WGS 84). 21 May 2010. M. B. Connior. Verified by S. E. Trauth. Arkansas State University Museum of Zoology Herpetology Collection (ASUMZ 31524). First county record (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville. 421 pp.). Hand caputured male (SVL 164 mm). Species has also been collected from neighboring Marion and Stone counties in northern Arkansas.

Submitted by **MATTHEW B. CONNIOR,** Health and Natural Sciences, South Arkansas Community College, 300 S. West Avenue, El Dorado, Arkansas 71730, USA; e-mail: mconnior@southark.edu.

LICHANURA TRIVIRGATA ROSEOFUSCA (Coastal Rosy Boa). USA: CALIFORNIA: Los Angeles Co.: Sierra Pelona, Lake Hughes Rd, ca. 17.6 km by air NNE of jct with Interstate

5 (34.5844444°N, 118.5602778°W; datum WGS84), 555 m elev. 3 June 2010. DOR male. J. Lauermann and Z. West. A second specimen (adult female) was found on 5 June 2010, ca. 1.2 km by air NNW from the first locality (34.5941667°N, 118.5638889°W), 585 m elev. J. Lauermann and D. Lawrence. Verified by N. Camacho. Los Angeles County Museum photo vouchers (LACM PC 1505, 1506). These are the first records for the Sierra Pelona and help define the distribution of this species along the northwestern edge of the range. SDNHM 5563 (collected by F. E. Walker in 1931), listed as having been obtained in Castaic (presumably from the hills near that city), lies ca. 12 km by air SSW from LACM PC 1505. Habitat at the Sierra Pelona collection sites is chaparral vegetation with numerous rock outcrops and talus.

Submitted by **ZACK WEST**, 12507 Appleton Way, Los Angeles, California 90066, USA (e-mail: ectoredexotics@gmail.com); and **JOHN LAUERMANN**, 28002 Woodstock Ave, Castaic, California 91384, USA (e-mail: ricrabt@aol.com).

NERODIA RHOMBIFER (Diamond-backed Watersnake). USA: ALABAMA: Limestone Co.: Intersection of Harris Station Rd. and Lucas Ferry Rd. (34.68862°N, 87.00095°W; WGS 84). 12 May 2010. R. King. AUM 38893. Verified by Craig Guyer and Harry W. Greene. New county record (Mount 1975. Amphibians and Reptiles of Alabama. Auburn Printing Co., Auburn. 347 pp.). First record from the Tennessee River drainage in Alabama (Gibbons and Dorcas 2004. North American Watersnakes: A Natural History. University of Oklahoma Press, Norman. 438 pp.), and extends its range ca. 150 km NE from the nearest Alabama locality (Tuscaloosa Co.), and ca. 100 km SE from the nearest Tennessee River drainage locality (Hardin Co., Tennessee).

We thank C. Guyer and H. W. Greene for verifying this record. S. Graham is supported in part by NIH grant R01-A149724 to T. Unnasch.

Submitted by **SEAN P. GRAHAM**, Auburn University Department of Biological Sciences, 331 Funchess Hall, Auburn, Alabama 36849, USA (e-mail: grahasp@auburn.edu); **ERIC C. SOEHREN,** Alabama Department of Conservation and Natural Resources, State Lands Division, 64 North Union Street, Montgomery, Alabama 36130, USA; and **RITCHIE L. KING**, 1004 7th Ave., Athens, Alabama 35611, USA.

OPHRYACUS UNDULATUS (Mexican Horned Pitviper). MÉXICO: PUEBLA: Municipality of Tlatlauquitepec: Xocayucan (19.53479°N, 97.28437°W, estimated from map, 1493 m elev.). 27 May 2005. Israel Solano Zavaleta. Verified by Edmundo Pérez Ramos. Colección Herpetológica del Museo de Zoología Alfonso L. Herrera, UNAM (MZFC 17663). New municipality record. Second record for Puebla, and a state range extension of 180 km SE of Coyomeapan (Canseco-Márquez et al. 2000. Herpetol. Rev. 31:259–263) and an extension of 93 km NW of Tenango de Doria, Hidalgo (Flores-Villela et al. 1992. Texas J. Sci. 44:249–250) and 92.5 km SE of Pico de Orizaba, Veracruz (Pérez-Higareda and Smith 1999. Inst. Biol. Publ. Espec. [7]:1–122. The snake was found in pine forest.

Submitted by **ISRAEL SOLANO-ZAVALETA** (e-mail: crotalus.viper@gmail.com)**, ANDRÉS ALBERTO MENDOZA-HERNÁNDEZ** (e-mail: andreasmeher@gmail.com), and **LUIS CANSECO-MÁRQUEZ,** Museo de Zoología, Facultad de Ciencias, UNAM, A. P. 70-399, México D. F. 04510, México (e-mail: lcanseco@gmail.com).

OXYRHOPUS LEUCOMELAS. VENEZUELA: ESTADO TÁCHIRA: Las Delicias, Municipio Rafael Urdaneta, northeastern versant of the Cordillera Oriental de Colombia (07.0056666ºN, 72.4388333ºW; SAD 69, elev. 1688 m). 12 March 2010. D. Calcaño. Colección de Vertebrados, Universidad de los Andes, Mérida, estado Mérida (CVULA 7499). Verified by E. Smith and W. Lamar. First country record and northernmost for the species. Its occurrence in Venezuela was expected as there is a close report from Departamento Norte de Santander between Arboledas and Salazar (Pérez-Santos and Moreno 1988. Ofidios de Colombia. Museo Regionale de Science Naturali Torino. 517 pp.; Lynch 2009. Papeis Avulsos Zool. 49:319–337) at ca. 26 km SW from the locality reported herein. *Oxyrhopus leucomelas* remains a rare species only known from a few specimens in Colombia (Lynch 2009, *op. cit.*), Peru, and Ecuador (http://www.jcvi.org/reptiles/species.php?genus=Oxyrhopus&species=leucomelas; accessed 13 March 2010).

Submitted by **DANIEL CALCAÑO,** Serpentario los Llanos, Avda Intercomunal 13, Barinitas, 5206 Barinas, Venezuela (e-mail: serpentariolosllanos@hotmail.com); and **CÉSAR L. BARRIO-AMORÓS,** Fundación Andígena, Apartado 210, Mérida 5101-A, Venezuela (e-mail: cesarlba@yahoo.com).

OXYRHOPUS PETOLA (Calico False Coral Snake). BRAZIL: DISTRITO FEDERAL: Brasília municipality: Parque Nacional de Brasília (15.594167ºS, 48.029722º; SAD 69). 10 February 2008. T. Barros. Coleção Herpetológica da Universidade de Brasília (CHUNB 51437). Verified by G. Colli. New state record. This widely distributed species is found from Mexico to northeast Argentina (Peters and Orejas-Miranda 1986. Catalogue of the Neotropical Squamata. Part I – Snakes, 2nd ed. Smithsonian Inst. Press, Washington. 174 pp.). It principally inhabits forest habitats of Amazonia and Atlantic Forest (Jorge da Silva and Sites 1995. Conserv. Biol. 9 [4]:873–901; Pontes and Rocha 2008. Serpentes da Serra do Mendanha, RJ. Technical Books Ed. 147 pp.). There are sparse records from Brazilian Cerrado (Strussmann 2000. *In* C. J. R. Alho et al. [ed.], Fauna Silvestre da Região do Rio Manso MT, pp. 153–189. IBAMA; Valdujo and Nogueira 2001. Herpetol. Rev. 32:128–130; Vaz-Silva et al. 2007. Checklist 3 [4]:338–345). Extends the known distribution ca. 470 km NE of the nearest locality, Espora Hydroeletric Power Plant, GO (Vaz-Silva et al. 2007, *op. cit.*) and increases the number of snake species known from the Distrito Federal to 62 (França et al. 2008. Copeia 2008:20–36).

Submitted by **FREDERICO G. R. FRANÇA**, Dept. de Engenharia e Meio Ambiente, Universidade Federal da Paraíba, CEP 58297-000, Rio Tinto – PB, Brazil (e-mail: frederico@ccae.ufpb.br); **THIAGO BARROS** (e-mail: thiagoobarros@gmail.com), and **GABRIEL HORTA,** Dept. de Zoologia, Universidade de Brasília, 70910-900, Brasília, Brazil.

PANTHEROPHIS GUTTATUS (Red Cornsnake). USA: TENNESSEE: Rutherford Co.: Hwy 70S, (35.808208ºN, 86.187722ºW; NAD83). 14 May 2010. Brian T. Miller. Verified

by M. L. Niemiller. Herpetology Collection at Middle Tennessee State University (MTSU 182S). First record for county. (Scott and Redmond 2008 [latest update: 18 February 2010]. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. http://apsu.edu/reptatlas/(accessed 10 June 2010). Adult female found DOR ca. 12 km NW of Cannon Co. record which decreases the size of the hiatus in records for middle Tennessee (Miller and Miller 1993. Herpetol. Rev. 24:156).

Submitted by **BRIAN T. MILLER**, Department of Biology, Middle Tennessee State University, Murfreesboro, Tennessee 37132, USA (e-mail: bmiller@mtsu.edu); and **JOYCE L. MILLER**, MIMIC, Middle Tennessee State University, Murfreesboro, Tennessee 37132, USA (e-mail: jlmiller@mtsu.edu).

RAMPHOTYPHLOPS BRAMINUS (Brahminy Blindsnake). USA: FLORIDA: Escambia Co.: 9933 Hillview Road, Pensacola (30.54027°N, 87.22084°W; WGS84; elev. 15 m). 18 May 2010. Elizabeth Barber. Florida Museum of Natural History (UF 157774 photographic voucher). New county record. Extends the range ca. 290 km W of the closest known verified locality in Leon Co. (UF 140540–41; Krysko et al. 2005. Herpetol. Rev. 36:85–87).

Submitted by **KENNETH L. KRYSKO**, Division of Herpetology, Florida Museum of Natural History, University of Florida, Gainesville, Florida 32611, USA (e-mail: kenneyk@flmnh.ufl.edu); and **MELVIN P. GRAMKE,** Division of Herpetology, Florida Museum of Natural History, University of Florida, Gainesville, Florida 32611, USA (e-mail: gramkem@ufl.edu).

RAMPHOTYPHLOPS BRAMINUS (Brahminy Blindsnake). USA: FLORIDA: St. Lucie Co.: Port Saint Lucie, Southwest Biltmore Street, 0.24 km N of Sea Holly Terrace (27.29151°N, 80.36685°W; WGS84; elev. 5 m). 04 April 2010. Kenneth L. Krysko, Steve A. Johnson, Kyle E. Giddens, Kurt H. Gielow, Travis S. Lowke, William M. Moore, Eric Suarez, Cailey D. Thomas. Verified by Kevin M. Enge. Florida Museum of Natural History (UF 157451). New county record. Extends the range ca. 68 km NW of the closest known verified locality in Palm Beach Co. (UF 101766; also see Delorey and Mushinsky 1987. Herpetol. Rev. 18:56).

Submitted by **KENNETH L. KRYSKO** (e-mail: kenneyk@flmnh.ufl.edu), **KYLE E. GIDDENS, KURT H. GIELOW, TRAVIS S. LOWKE, WILLIAM M. MOORE, ERIC SUAREZ, CAILEY D. THOMAS**, Division of Herpetology, Florida Museum of Natural History, Dickinson Hall, University of Florida, Gainesville, Florida 32611, USA; and **STEVE A. JOHNSON**, Gulf Coast REC-Plant City Center and Department of Wildlife Ecology & Conservation, 1200 N. Park Road, Plant City, Florida 33563, USA.

SIBON ANNULATUS (Ringed Snail Sucker). COLOMBIA: CESAR: San Martín: Alto de La Paz (7.956254°N, 73.348031°W; WGS84; 1402 m elev.). 21 February 2009. R. Moreno-Arias. Colección de reptiles Instituto de Ciencias Naturales-Universidad Nacional de Colombia, Bogotá D.C, Cundinamarca, Colombia (ICN 12020). Verified by J. E. Carvajal-Cogollo. First record from South America and Colombia. This Central Amerian snake was known from Atlantic premontane slopes and lowlands of Honduras, Nicaragua, Costa Rica, and Panamá (Savage and McDiarmid 1992. Copeia 1992:421–432; http://www.jcvi.org/reptiles/species.php?genus=Sibon&species=annulatus). Extends known range to "Cordillera Oriental" in Colombia ca. 500 km W from nearest locality (Darién, Panamá; Savage and McDiarmid, *op. cit.*).

Submitted by **RAFAEL MORENO-ARIAS,** Instituto de Ciencias Naturales, Universidad Nacional de Colombia, Apartado Aéreo 55187, Bogotá D.C. Colombia; e-mail: rafamorearias@gmail.com.

TANTILLA GRACILIS (Flat-headed Snake). USA: ARKANSAS: Howard Co.: 2.4 km W of Umpire off St. Hwy. 278 (34.290126°N, 94.072151°W; WGS 84). 23 March 2006. H. W. Robison. Verified by R. Tumlison. Henderson State University Herpetological Collection (HSU 1520). New county record. Partially fills a distributional hiatus among Polk and Sevier counties (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.).

Submitted by **CHRIS T. McALLISTER**, RapidWrite, 102 Brown Street, Hot Springs National Park, Arkansas 71913, USA (e-mail:drctmcallister@aol.com); **CHRISTA BRUMMETT** and **HENRY W. ROBISON**, Department of Biology, Southern Arkansas University, Magnolia, Arkansas, 71754, USA (e-mail: hwrobison@yahoo.com).

TANTILLA OOLITICA (Rim Rock Crowned Snake) USA: FLORIDA: Monroe Co.: Big Pine Key (24.680°N, 81.352°W; NAD 83). 18 December 2007. Michael A. Yirka, Joseph N. Flowers, Michael D. Martin, Kevin R. Messenger, and Nathan A. Shepard. Verified by Kenneth L. Krysko. Florida Museum of Natural History (UF photograph 152546). Island record. Extends the range 26.7 km W of the closest known locality on Vaca Key (Krysko and Decker 1996. Herpetol. Rev. 27:215.). Only known Lower Keys record outside of questionable Key West specimen (Telford 1966. Bull. Florida St. Mus. Biol. Ser. 10:261–304). Specimen was found under artificial cover in an upland hardwood hammock 0.28 km from the ocean.

Submitted by **MICHAEL A. YIRKA**, 6016 Countryview Lane, Raleigh, North Carolina 27606, USA; **JOSEPH N. FLOWERS**, 66 Lyon Drive, Sparta, North Carolina 28675, USA; **MICHAEL D. MARTIN**, University of South Carolina, Department of Biological Sciences, Coker Life Sciences Room 706, Columbia, South Carolina 29208, USA; **KEVIN R. MESSENGER** and **NATHAN A. SHEPARD,** Marshall University, Department of Biological Sciences, One John Marshall Drive, Huntington, West Virginia 25703, USA.

THAMNOPHIS PROXIMUS (Western Ribbonsnake). USA: ARKANSAS: Nevada Co.: ~8 km S of Bluff City (33.648175°N, 93.115576°W; WGS 84), AOR Nevada Co. Rd. 447. 30 May 2010. K. Roberts and M. B. Connior. Verified by S. E. Trauth. Arkansas State University Museum of Zoology Herpetology Collection (photo voucher ASUMZ 31526). New county record (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville. 421pp.).This species

has also been collected from neighboring Calhoun, Columbia, and Union counties in southern Arkansas.

Submitted by **MATTHEW B. CONNIOR,** Health and Natural Sciences, South Arkansas Community College, 300 S. West Avenue, El Dorado, Arkansas 71730, USA (e-mail: mconnior@southark.edu); and **KORY ROBERTS**, Rogers High School, 2300 South Dixieland Road, Rogers, Arkansas 72758.

THAMNOPHIS RADIX (Plains Gartersnake). USA: MINNESOTA: Nicollet Co.: Minnesota Hwy 99 ca. 4.15 km E of Nicollet (44.282455°N, 94.135587°W; WGS 84). 3 April 2010. Found DOR, photographic records were deposited in the James Ford Bell Museum (JFBM P355a –c). Verified by Kenneth H. Kozak and Amy M. Luxbacher. Updated county record. Oldfield and Moriarty (1994. Amphibians & Reptiles Native to Minnesota. University of Minnesota Press, Minneapolis. 237 pp.) list a vouchered record dated pre-1960. A single specimen collected in Nicollet Co. in 1939 is the only other specimen from this county accessioned at the James Ford Bell Museum.

Submitted by **NOAH T. MARTYN,** 1218 Oak Street, New Ulm, Minnesota 56073, USA (e-mail: Noah.Martyn@gmail.com); and **CHRISTOPHER E. SMITH**, Wildlife Research & Consulting Services, LLC, 348 Bankers Drive, Saint Paul, Minnesota 55127, USA (e-mail: Christopher.Smith@WildlifeRCS.com).

THAMNOPHIS RADIX (Plains Gartersnake). USA: MINNESOTA: Olmsted Co.: County Hwy 19 ca. 12 km SE of jct I-90 (43.906580°N, 92.257339°W; WGS 84). 12 June 2009. Photographic records were deposited in the James Ford Bell Museum (JFBM P354a – d). Verified by Kenneth H. Kozak and Amy M. Luxbacher. New county record and the first vouchered specimen for Olmsted Co. (Oldfield and Moriarty 1994. Amphibians & Reptiles Native to Minnesota. University of Minnesota Press, Minneapolis. 237 pp.). Found by flipping rocks along highway.

Submitted by **CHRISTOPHER E. SMITH,** Department of Fisheries, Wildlife, and Conservation Biology, University of Minnesota, 1980 Folwell Ave., Saint Paul, Minnesota 55108, USA (e-mail: smit4155@umn.edu); **ERICA P. HOAGLUND**, Minnesota Department of Natural Resources, Division of Ecological Resources, Nongame Wildlife. 1335 Oakdale Ave. Apt. 209, West Saint Paul, Minnesota 55118, USA (e-mail: Erica.Hoaglund@dnr.state.mn.us); and **DUANE McDERMOTT** 1083 Geranium Ave. E., Saint Paul, Minnesota 55106, USA (e-mail: dmcdermott23@yahoo.com).

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An Additional Bioblitz Competition in Northwest Georgia Yields New County Records

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Due to an earlier bioblitz competition's success at documenting new county records in the Talladega Uplands of Georgia in the spring of 2007 (Graham et al. 2007), we organized an additional contest in the same region during the following fall. To increase participant turnout and enthusiasm, the second bioblitz competition was touted as a rematch between the participants from Auburn University and the University of Georgia. As a result of this survey (mostly 5–7 October 2007), we documented 25 new county records (Jensen et al. 2008), surpassing the first competition's total. Severe drought conditions appeared to increase our success, as amphibians and reptiles were frequently found under moist cover objects at drying bodies of water. Localities were recorded using handheld GPS units with datum settings of WGS 84 and confirmed using Google Earth. The results presented below illustrate how the spirit of competition can be exploited for quick and useful presence-absence surveys, and the utility of surveying during multiple seasons.

Unless otherwise noted, all records were verified by Craig Guyer. AHAP-D indicates digital photo vouchers, AUM indicates specimens collected.

Caudata — Salamanders

Desmognathus monticola (Seal Salamander). Paulding Co.: Collected along headwaters of Raccoon Cr. ~100 m W of US Hwy 278 (33.939672°N, 84.981411°W). 06 October 2007. S. Hoss and D. Steen. AUM 37566–37567. Verified by George Folkerts.

Eurycea guttolineata (Three-lined Salamander). Polk Co.: Collected in Sewell Cr. 10 m W of Barrett/Wilson Rd. bridge

(33.952913°N, 85.284356°W). 07 October 2007. D. McMoran. AUM 37569.

Notophthalmus viridescens (Eastern Newt). Heard Co.: Found AOR on Roosterville Rd. at Centralhatchee Cr. bridge (33.391166ºN, 85.175040°W). 04 October 2007. S. Graham. AHAP-D 44.

Anura – Frogs

Lithobates palustris (Pickerel Frog). Heard Co.: Collected DOR on Barr Farm Rd. E of Ephesus at Centralhatchee Cr. bridge (33.412723°N, 85.208393°W). 04 October 2007. S. Graham. AUM 37494. Haralson Co.: Found under rock along Watermill Cr. 50 m S of Watermill Cr./Coppermine Rd. bridge (33.854506°N, 85.085676°W). 06 October 2007. S. Graham and V. Johnson. AHAP-D 48.

Testudines – Turtles

Apalone spinifera (Spiny Softshell). Haralson Co.: Found in Lake Olympia, a small drying reservoir along State Rt. 120 at VFW Post 7402 ~ 4.8 km E of Buchanan (33.811200°N, 85.141821°W). 06 October 2007. S. Graham and V. Johnson. AHAP-D 55. Paulding Co.: Found along Raccoon Cr., 0.05 km N of intersection with Braswell Mountain Rd. (34.007853°N, 84.892615°W). 06 October 2007. S. Cox. APAP-D 43.

Chrysemys picta picta (Eastern Painted Turtle). Haralson Co.: Found in Lake Olympia (33.811200°N, 85.141821°W). 06 October 2007. S. Graham and V. Johnson. AHAP-D 54.

Pseudemys concinna (River Cooter). Haralson Co.: Found in Lake Olympia (33.811200°N, 85.141821°W). 06 October 2007. V. Johnson and S. Graham. AHAP-D 52–53.

Sternotherus odoratus (Eastern Musk Turtle). Heard Co.: Captured in crayfish trap in beaver marsh 50 m S of intersection of US Hwy 27 and State Rt. 34 (33.288574°N, 85.087331°W). 05 October 2007. S. Graham and V. Johnson. AHAP-D 49. Haralson Co.: Captured in crayfish trap in Lake Olympia (33.811200°N, 85.141821°W). 07 October 2007. S. Graham and V. Johnson. AHAP-D 56.

Trachemys scripta (Pond Slider). Haralson Co.: Shell collected in Lake Olympia (33.81120034°N, 85.14182165°W). 07 October 2007. S. Graham and V. Johnson. AHAP-D 57. Paulding Co.: Found in private farm pond to the east of power line cut, south of intersection with Braswell Mountain Rd. (34.007109°N, 84.890804°W). 06 October 2007. S. Cox, A. Durso, E. Susko. AHAP-D 89.

Squamata – Snakes

Agkistrodon contortrix (Copperhead). Heard Co.: Found DOR on Roosterville Rd. (33.387313°N, 85.171920°W). 04 October 2007. S. Graham. AHAP-D 45.

Coluber constrictor (North American Racer). Haralson Co.: Found DOR on Mt. View Rd. (33.888953°N, 85.146418°W). 07 October 2007. S. Graham and V. Johnson. AHAP-D 59. Polk Co.: Found AOR along logging road ~ 4.7 km N of Braswell (34.023600°N, 84.949600°W). 06 October 2007. K. Nelson. AHAP-D 84.

Lampropeltis getula getula (Eastern Kingsnake). Haralson Co.: Found DOR at intersection of State Rt. 120 and 113 (33.827837°N, 85.046283°W).06 October 2007. S. Graham and V. Johnson. AHAP-D 61–63.

Nerodia erythrogaster (Plain-bellied Watersnake). Paulding Co.: Found in dry creek bed of Right Prong Cr., ~ 1.77 km W of Corley Lake (34.022497°N, 84.945434°W). 06 October 2007. K. Nelson. AHAP-D 85.

Opheodrys aestivus (Rough Greensnake). Heard Co.: Found DOR on State Rt. 100, 0.3 km NW of Franklin (33.284879°N, 85.109545°W). 05 October 2007. S. Graham and V. Johnson. AHAP-D 50.

Pantherophis alleghaniensis (Eastern Ratsnake). Haralson Co.: Collected DOR on State Rt. 120 at mile marker 15 (33.816196°N, 85.108115°W). 06 October 2007. S. Graham and V. Johnson. AUM 37496. See comments under *Pantherophis spiloides*.

Pantherophis guttata (Red Cornsnake). Bartow Co.: Found DOR on Stamp Creek Rd., 1.6 km E of US Hwy 411 intersection (34.274876°N, 84.735115°W). 06 October 2007. S. Graham and V. Johnson. AHAP-D 59. Paulding Co. Collected DOR on US Hwy 278 at intersection with Hulseytown Rd. (33.914859°N, 84.917788°W). 07 October 2007. S. Graham and V. Johnson. AUM 37497. Polk Co.: Collected freshly shed skin from power line cut at intersection with dirt logging road ~ 5 km N of Braswell (34.026953°N, 84.958205°W). 06 October 2007. A. Durso. AHAP-D 81–82.

Pantherophis spiloides (Gray Ratsnake).: Haralson Co.: Collected DOR at intersection of US Hwy 27 and State Rt. 120 in Buchanan. 07 October 2007. D. McMoran. AUM 34795. The genetic affinities of the *E. alleghaniensis* and *E. spiloides* listed above were not determined; AUM 37496 has a color pattern consistent with the formerly recognized taxon *Elaphe obsoleta obsoleta*; AUM 37495 is an adult (> 150 cm SVL) with a color pattern consistent with the formerly recognized taxon *Elaphe obsoleta spiloides*. Both individuals were collected in the same county on the same highway ~6–7 km apart within the same 24 h period.

Thamnophis sirtalis sirtalis (Eastern Gartersnake). Haralson Co.: Found DOR on State Rt. 120, 1.6 km SW of Buchanan at intersection with Matt Dillion Rd. (33.786517°N, 85.209427°W). 07 October 2007. S. Graham and V. Johnson. AHAP-D 61–63.

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New County Records of Amphibians and Reptiles from the Northern Coastal Plain of South Carolina, USA

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The southern Atlantic Coastal Plain of North American is known for having a very high species richness of herpetofauna with approximately 100 native species (Conant and Collins 1991). A single study, at only one location, in the northern South Carolina Coastal Plain yielded 72 species of amphibians and reptiles (Leiden et al. 1999). As part of a larger project on the reptiles of the state of South Carolina, documentation of the fauna of this relatively poorly studied part of the state has been undertaken. Previous locality records for this region have been published by Broach and McMahan (2009), Camper (2001), Camper and Knowles (2007), Camper and Brooks (2005) and Camper and Cloninger (2005).

All specimens represent new county records. All specimens have been deposited in the Charleston Museum (CA, CR) or the Vertebrate Collection of the Campbell Museum of Natural History at Clemson University (CUSC). All specimens deposited in the Charleston Museum were verified by A. Sanders and those in the Clemson collection by S. Miller. Nomenclature and common names follow Crother (2008). Unless stated otherwise, all specimens were collected by the author. Locality coordinates are in decimal degrees in WGS 84.

Caudata – Salamanders

Siren lacertina (Greater Siren). DARLINGTON CO.: Back Swamp, Pee Dee Research and Education Center, 7 km N Florence. 19 October 1999. CA 4545. Caught in a funnel trap in permanent water at the edge of a swamp. FLORENCE CO.: Lynches River County Park, 11 km S Florence. 3 October 2008. CUSC 2611. Caught in a funnel trap in a flooded ditch in hardwood forest.

Anura – Frogs

Acris gryllus (Southern Cricket Frog). FLORENCE CO.: Woods Bay State Natural Area, 4 km W Olanta. CA 4561. One specimen taken along the edge of an artificial pond. WILLIAMSBURG CO.: Wee Tee State Forest, NW end of Wee Tee Lake, 12.5 km E St. Stephen. 29 March 2008. CUSC 2595.

Hyla gratiosa (Barking Treefrog). FLORENCE CO.: Lynches River County Park, 11 km S Florence. 11 September 2008. Caught in a funnel trap along a drift fence in pine barrens habitat. CUSC 2608

Pseudacris crucifer (Spring Peeper). DARLINGTON CO.: Pee Dee Research and Education Center, 7 km N Florence. 12 May 1999. CA 4553.

Testudines – Turtles

Apalone spinifera aspera (Gulf Coast Spiny Softshell). CHESTERFIELD CO.: Sand Hills State Forest, Woodduck Pond, 11 km SE Patrick. 29 October 2006. CR 2777. B. T. Camper and J. D. Camper. Ten ribs and four vertebrae found on the pond dam.

Chelydra serpentina serpentina (Eastern Snapping Turtle). DARLINGTON CO.: Pee Dee Research and Education Center, 7 km N Florence. 21 June 1999. CR 2713. MARLBORO CO.: Blenheim (34.40158°N, 79.64535°W). CR 2818. R. J. Brooks, J. E. Krebs, and J. D. Camper.

Clemmys guttata (Spotted Turtle). MARLBORO CO.: Blenheim, AOR on Highway 38. 18 April 2004. CR 2807. R. J. Brooks.

Kinosternon subrubrum subrubrum (Eastern Mud Turtle). MARLBORO CO.: Bennettsville, AOR on Lightwood Road. 18 April 2004. CR 2809. R. J. Brooks.

Pseudemys concinna (River Cooter). CLARENDON CO.: Woods Bay State Natural Area, 4 km W Olanta (33.947617° N, 79.978314° W). CUSC 2603. M. Nordgren. DARLINGTON CO.: Pee Dee Research and Education Center, 7 km N Florence. 30 March 2000. CR 2712. FLORENCE CO.: Florence. CR 2711. New county record.

Sternotherus odoratus (Eastern Musk Turtle). WILLIAMSBURG CO.: Wee Tee State Forest, NW end of Wee Tee Lake, 12.5 km E St. Stephen. 29 March 2008. CUSC 2599.

Terrapene carolina carolina (Eastern Box Turtle). MARLBORO CO.: DOR on County Road 312 4 km NE junction with US Highway 1. CR 2775.

Trachemys scripta scripta (Yellow-bellied Slider). MARLBORO CO.: Bennettsville DOR on County Road 47 at Wallace Lake. 23 July 2004. CR 2819. R. J. Brooks, J. E. Krebs, and J. D. Camper. WILLIAMSBURG CO.:CR 2808. 33.685921°N, 79.853636° W. C. W. Morris.

Squamata – Lizards

Anolis carolinensis (Green Anole). FLORENCE CO.: Lynches River County Park, 11 km S Florence. 16 October 2008. CUSC 2612. LANCASTER CO.: Forty-Acre Rock Heritage Preserve, 21 km ESE Lancaster. 9 November 2008. CUSC 2628. B. T. Camper and J. D. Camper.

Aspidoscelis sexlineata sexlineata (Eastern Six-lined Racerunner). CLARENDON CO.: Woods Bay State Natural Area, 4 km W Olanta. CR 2763. New county record. G. Haught. One individual collected on the south sand rim of the bay. MARLBORO CO.: 1 km E Fulton. 6 July 2000. CR 2702.

Ophisaurus ventralis (Eastern Glass Lizard). MARLBORO CO.: Blenheim (34.40793° W, 79.54321° W). CR 2817. R. J. Brooks.

Plestiodon fasciatus (Common Five-lined Skink). CLARENDON CO.: Woods Bay State Natural Area, 4 km W Olanta. 18 March 2000. CR 2719. One individual collected on the south sand rim of the bay.

Plestiodon inexpectatus (Southeastern Five-lined Skink). DILLON CO.: Little Pee Dee State Park Bay Heritage Preserve. 3 April 2004. CR 2822. Two specimens collected along the south sand rim of the bay. FLORENCE CO.: Lynches River County Park, 11 km

S Florence. 11 September 2008. CUSC 2609.

Plestiodon laticeps (Broad-headed Skink). Marlboro Co.: Bennettsville, 4554 Lightwood Road. 18 April 2004. CR 2820. R. J. Brooks.

Sceloporus undulatus (Eastern Fence Lizard). Clarendon Co.: Woods Bay State Natural Area, 4 km W Olanta. 18 March 2000. CR 2715. One individual collected on the south sand rim of the bay.

Scincella lateralis (Little Brown Skink). Lancaster Co.: Forty-Acre Rock Heritage Preserve, 21 km ESE Lancaster. 9 November 2008. CUSC 2630. B. T. Camper and J. D. Camper.

Squamata – Snakes

Agkistrodon contortrix (Copperhead). Marlboro Co.: Blenheim, DOR on Highway 38. 16 April 2004. CR 2803. R. J. Brooks. Williamsburg Co.: 33.547349°N, 79.760276°W. 28 May 2004. CR 2826. C. W. Morris.

Agkistrodon piscivorus piscivorus (Eastern Cottonmouth). Marlboro Co.: Blenheim (34.38842° N, 79.64011° W). 13 August 2004. CR 2815. R. J. Brooks.

Carphophis amoenus amoenus (Eastern Wormsnake). Chesterfield Co.: Sand Hills State Forest, 2.8 km W Patrick. 26 June 1997. CR 2397. Darlington Co.: Great Pee Dee River Heritage Preserve, 19.6 km NNE Florence. 25 March 2000. CR 2706. Marlboro Co.: Bennettsville. 17 April 2004. CR 2825. R. J. Brooks.

Coluber constrictor (North American Racer). Williamsburg Co.: DOR on Highway 512 9 km E of 34.78366°N, 79.76848°W. 1 July 2003. CR 2773.

Coluber flagellum flagellum (Eastern Coachwhip). Marlboro Co.: DOR on Highway 177, 4.8 km S North Carolina State Line. 6 July 2000. CR 2776.

Crotalus horridus (Timber Rattlesnake). Marion Co.:. 1 km N Britton's Neck, DOR on Highway 908. 9 October 1996. CR 2652. First voucher specimen for Marion County. Marlboro Co.: 5.7 km SSE Blenheim. 8 September 1999. CR 2708. Williamsburg Co.: DOR on Highway 521 (33.549845°N, 79.759195°W). 15 May 2004. CR 2828. C. W. Morris

Diadophis punctatus punctatus (Southern Ring-necked Snake). Darlington Co.: Pee Dee Research and Education Center, 7 km N Florence. 30 March 2000. CR 2710. Marlboro Co.:Bennettsville. 17 April 2004. CR 2824.. R. J. Brooks.

Farancia erytrogramma (Rainbow Snake). Florence Co.: Lynches River County Park, 11 km S Florence. 2 April 2008. CUSC 2606. P. Johnson. DOR on County Park Road at park entrance gate.

Nerodia erythrogaster erythrogaster (Red-bellied Watersnake). Marlboro Co.: DOR on Highway 38, 6.6 km S Bennettsville. 6 July 2000. CR 2704. Williamsburg Co.: Wee Tee State Forest, NW end of Wee Tee Lake, 12.5 km E St. Stephen. 1 April 2006. CR 2796.

Nerodia fasciata fasciata (Banded Watersnake). Darlington Co.: Pee Dee Research and Education Center, 7 km N Florence. 28 August 1998. CR 2672.

Nerodia taxispilota (Brown Watersnake). Darlington Co Pee Dee Research and Education Center, 7 km N Florence. 1 October 1999. CR 2705. Marlboro Co.: Blenheim, DOR on Highway 38. 16 April 2004. CR 2802. R. J. Brooks.

Opheodrys aestivus aestivus (Northern Rough Greensnake). Darlington Co.: Lauther's Lake, 13.3 km NE Florence. 29 March 2006. CR 2792. Williamsburg Co.: DOR on Highway 512 15 km E of 34.78366°N, 79.76848°W. 1 July 2003. CR 2771.

Pantherophis guttatus (Red Cornsnake). Marlboro Co.: Wallace, DOR on County Road 165. 18 April 2004. CR 2801. R. J. Brooks.

Pantherophis alleghaniensis (Eastern Ratsnake). Williamsburg Co.: 33.69558°N, 79.847886°W. June 2004. CR 2806. C. W. Morris.

Tantilla coronata (Southeastern Crowned Snake). Florence Co.: Lynches River County Park, 11 km S Florence. 20 April 2000. CR 2707.

Thamnophis sauritis sauritis (Common Ribbonsnake): Williamsburg Co.: Wee Tee State Forest, NW end of Wee Tee Lake, 12.5 km E St. Stephen. 1 April 2006. CR 2793.

Virginia valeriae valeriae (Eastern Smooth Earthsnake). Darlington Co.: Dargan Farm, 3.2 km N junction County Roads 173 and 35. 22 October 2001. CR 2769. D. Daniel.

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New County Records for Amphibians and Reptiles in Southwest Indiana

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The distribution records reported here are the results of drift fence/pitfall trap sampling coupled with dip-netting, funnel trapping, and random encounters at several localities in southwestern Indiana during 2009. Several of these records fill in gaps between counties where the individual species had not previously been reported (see Minton 2001). The coordinates given for each species were recorded with a handheld Garmin® GPSMAP 76CSx. Datum for the GPS was set at NAD 83. Specimens were verified by Christopher A. Phillips at the Illinois Natural History Survey (INHS). All new county records are backed by vouchered photographs housed at INHS.

Caudata — Salamanders

Ambystoma opacum (Marbled Salamander). Greene Co.: Hillenbrand Fish and Wildlife Area, ca. 0.34 km SW of the intersection of 600N and 1500W (39.11066°N, 87.22505°W). 25 March 2009. Vanessa C. Kinney and Jennifer L. Heemeyer. INHS 2009ab. Adult specimen captured in a pitfall trap outside of an ephemeral wetland.

Ambystoma tigrinum (Eastern Tiger Salamander). Clay Co.: Approximately 9.1 km WNW of Clay City (39.290601°N, 87.218976°W). 07 April 2009. Nathan J. Engbrecht. INHS 2009ac. Single adult captured in a funnel trap in a cattle pond. This record partially fills a gap in the range of this species in SW Indiana. Greene Co.: Hillenbrand Fish and Wildlife Area, ca. 0.14 km SW of the intersection of 650N and 1500W (39.119404°N, 87.22371°W). 08 March 2009. Vanessa C. Kinney, Jennifer L. Heemeyer, and Michael J. Lannoo. INHS 2009aa. Adult specimen captured in a pitfall trap outside of a semi-permanent wetland.

Notophthalmus viridescens (Eastern Newt). Daviess Co.: Approximately 5 km W of the intersection of Hwy 231 and Hwy 558 (38.896501°N, 86.927999°W). 21 July 2009. Nathan J. Engbrecht. INHS 2009ad. Single larva captured in an artificial pond. This record partially fills a large gap in the range of this species in SW Indiana. Greene Co.: Hillenbrand Fish and Wildlife Area, ca. 0.34 km SW of the intersection of 600N and 1500W (39.11066°N, 87.22505°W). 23 September 2009. Vanessa C. Kinney. INHS 2009z. Eft stage newt captured in a pitfall trap outside of an ephemeral wetland.

Testudines – Turtles

Sternotherus odoratus (Eastern Musk Turtle). Greene Co.: Hillenbrand Fish and Wildlife Area, ca. 0.90 km SW of the intersection of 600N and 1500W (39.107704°N, 87.23046°W). 26 June 2009. Vanessa C. Kinney. INHS 2009y. Adult captured in a pitfall trap outside of an ephemeral wetland at the edge of a grassland and wooded area. The hind legs of this individual were malformed; it is not known whether this was caused by a predation attempt, injury, or developmental complications.

Terrapene carolina (Eastern Box Turtle). Greene Co.: Hillenbrand Fish and Wildlife Area, ca. 0.14 km SW from the intersection of 650N and 1500W (39.119404°N, 87.22371°W). 22 May 2009. Vanessa C. Kinney, Jennifer H. Heemeyer, and Michael J. Lannoo. INHS 2009x. Adult captured in a pitfall trap outside of a semi-permanent prairie wetland.

Squamata — Snakes

Clonophis kirtlandii (Kirtland's Snake). Greene Co.: Hillenbrand Fish and Wildlife Area, ca. 0.90 km SW of the intersection of 600N and 1500W (39.107704°N, 87.23046°W). 25 March 2009. Vanessa C. Kinney and Alex Robinson. INHS 2009v. Adult captured in a pitfall trap entering an ephemeral wetland at the edge of a grassland and wooded area. Extends the known range of this species in Indiana one county to the SW. Kirtland's Snakes are listed as an Endangered Species in Indiana.

Diadophis punctatus (Ring-necked Snake). Greene Co.: Hillenbrand Fish and Wildlife Area, ca. 0.34 km SW of the intersection of 600 N and 1500 W (39.11066°N, 87.22505°W). 06 September 2009. Vanessa C. Kinney. INHS 2009w. Adult captured in a pitfall trap outside of an ephemeral wetland. Partially fills a gap in the range of this species in SW Indiana.

Lampropeltis getula (Common Kingsnake). Greene Co.: Hillenbrand Fish and Wildlife Area, ca. 0.24 km SE of the intersection of 650 N and 1500 W (39.119194°N, 87.219734°W). 11 June 2009. Jennifer L. Heemeyer. INHS 2009s. Adult found on a footpath in a managed prairie. This record partially fills a gap in the range of this species in southern Indiana.

Storeria dekayi (Dekay's Brownsnake). Greene Co.: Hillenbrand Fish and Wildlife Area, ca. 0.90 km SW of the intersection of 600N and 1500W (39.107704°N, 87.23046°W). 08 March 2009. Vanessa C. Kinney, Jennifer L. Heemeyer, and Michael J. Lannoo. INHS 2009t. Adult captured in a pitfall trap outside of an ephemeral wetland near a prairie-forest edge.

Thamnophis sauritus (Eastern Ribbonsnake). Greene Co.: Hillenbrand Fish and Wildlife Area, ca. 0.34 km SW of the intersection of 600 N and 1500 W (39.11066°N, 87.22505°W). 26 April 2009. Vanessa C. Kinney and Zachary J. Terrell. INHS 2009u. Adult individual found moving along a drift fence surrounding an ephemeral prairie wetland. Partially fills a gap along the edge of this species range in Indiana.

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New Geographic Distribution Records for Reptiles from North Carolina, USA

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The geographic distribution of reptiles in North Carolina (USA) was summarized by Palmer and Braswell (1995) and has been supplemented by Beane (1998), Beane and Palmer (2006), and Eskew et al. (2008). We here report additional new records based upon specimens and photographs verified by William M. Palmer and/or Alvin L. Braswell and housed at the North Carolina State Museum of Natural Sciences (NCSM) unless otherwise indicated. Geocoordinates are based on datum WGS 84.

Crocodilia – Crocodilians

Alligator mississipiensis (American Alligator). CUMBERLAND CO.: ca. 8.4 km SW Vander (34.9747°N, 78.8547°W). Summer 2002. North Carolina Wildlife Resources Commission. NCSM 65371. First voucher for county. Palmer and Braswell (1995) reported unvouchered observational records. DARE CO.: 8.5 km ESE East Lake (35.87333°N, 75.87842°W). 20 December 2007. C. P. White. NCSM 73838 (37 eggs and eggshells from failed nest). First voucher for county. Palmer and Braswell (1995) reported unvouchered observational records. Also represents the northernmost nesting record for the species in North Carolina (Palmer and Braswell 1995).

Testudines – Turtles

Apalone spinifera aspera (Gulf Coast Spiny Softshell). ROBESON CO.: 4.8 km ESE Barnesville, Lumber River State Park, Lumber River (34.38778°N, 79.00098°W). 14 August 2009. Brian S. Ball and Jessica Ball. NCSM photographic vouchers BSB 09-1. New county record. STANLY CO.: 8.9 km SE Norwood, Pee Dee River at Montgomery County line (35.1605555°N, 80.0602166°W). 18 July 2008. Bryn H. Tracy, Rick Smith, et al. NCSM photographic vouchers BHT 08-1. First photographic voucher for county. Palmer and Braswell (1995) reported an unvouchered observational record for the Stanly-Union County line.

Apalone spinifera spinifera (Eastern Spiny Softshell). BUNCOMBE CO.: 6.4 km NNE Leicester, Turkey Creek (35.704°N, 82.6689°W). 11 June 2007. Bryn H. Tracy et al. NCSM photographic vouchers ALB 12096. First photographic voucher for county. Palmer and Braswell (1995) reported unvouchered observational records.

Chelydra serpentina (Snapping Turtle). CHOWAN CO.: "near Rockyhock" (ca. 36.17°N, 76.70°W). 20 June 1988. David King and Eileen Kenny. NCSM 75972. A second specimen, NCSM 39946, was recorded in 1995. New county record.

Chrysemys picta picta (Eastern Painted Turtle). BLADEN CO.: 3.2 km NNW Carvers (34.4875°N, 78.4289°W). 4 July 2003. J. Chris Turner. NCSM 65111. New county record. Extends range ca. 80 km SE of nearest record in Cumberland County (Palmer and Braswell 1995). MOORE CO.: 7.1 km S Robbins (35.3713°N, 79.5944°W). 10 August 2003. James Callicutt. NCSM photographic voucher LTP 03-1. New county record. SCOTLAND CO.: 17.7 km NW Wagram, Sandhills Game Lands (34.989872°N, 79.511056°W). 3 March 2005. L. Todd Pusser. NCSM photographic voucher LTP 05-1. New county record.

Clemmys guttata (Spotted Turtle). CURRITUCK CO.: Knotts Island, Mackay Island National Wildlife Refuge (36.506°N, 75.972°W). 4 May 1987. Donald J. Schwab and Thomas Padgett. NCSM 65481. 5 June 1988. Donald J. Schwab. NCSM 65537. First vouchers for county. Palmer and Braswell (1995) reported an unvouchered observational record. EDGECOMBE CO.: 9.0 km NE Conetoe, Conetoe Creek (35.8759°N, 77.3934°W). 9 May 2007. Bryn H. Tracy et al. NCSM photographic vouchers ALB 12097. New county record.

Deirochelys reticularia reticularia (Eastern Chicken Turtle). COLUMBUS CO.: 8.0 km SSE Lake Waccamaw (town), Lake Waccamaw State Park along SE shore of Lake Waccamaw (34.25863ºN, 78.47922ºW). 15 January 2007. Zachary S. Barfield. Adult female nesting; NCSM photographic vouchers ZSB 07-1. New county record. Also represents the only record of any reptile depositing eggs during January in North Carolina (Palmer and Braswell 1995).

Glyptemys (= *Clemmys*) *muhlenbergii* (Bog Turtle). GASTON CO.: 1.6 km N.NE Dallas (35.3298°N, 81.1743°W). 1 August 1994. Ann B. Somers et al. NCSM 39367. Additional vouchers NCSM 64942 and 65630, were also collected within this county. First specimen vouchers for county. Herman et al. (1992) and Palmer and Braswell (1995) reported photographic records. MCDOWELL CO.: 7.6 km SW Dysartsville (35.5477°N, 81.9226°W). 23 June 2008. Gabrielle J. Graeter, Lori A. Williams, Dottie Brown, and Ida Evretjarn. NCSM 75964. First specimen voucher for county. Herman et al. (1993) and Palmer and Braswell (1995) reported photographic records. YANCEY CO.: 5.6 km ENE Celo (35.879°N, 82.146°W). 31 July 1993. Dylan and Kevin Ellis. NCSM 37460 (egg deposited by female found 31 July 1993 and released 10 August 1993). 4.5 km SE Celo (35.82°N, 82.17°W). 22 August 2001. Dennis W. Herman et al. NCSM 62165 (eggshells). First specimen vouchers for county. Herman (1986) and Palmer and Braswell (1995) reported photographic records.

Kinosternon subrubrum subrubrum (Eastern Mud Turtle). LEE CO.: 8.5 km SE Sanford (35.425°N, 79.103°W). 26–27 June 1981. Alan L. Kyles and William M. Palmer. NCSM 21616 (adult female) and 21620 (adult male). Additional vouchers (NCSM 24980 and 64795) are known from this county. New county records. MCDOWELL CO.: 7.6 km SW Dysartsville (35.5477°N, 81.9226°W). 23 June 2008. Dottie Brown, Gabrielle J. Graeter, Lori A. Williams, and Ida Evretjarn. NCSM photographic vouchers GJG 08-1. New county record.

Pseudemys concinna concinna (Eastern River Cooter). MARTIN CO.: 3.7 km S Hamilton (35.9099°N, 77.2067°W). 26 May 1994. Alvin L. Braswell et al. NCSM 36272. New county record. Two additional vouchers (NCSM 64032, 65152) are reported from this county.

Sternotherus odoratus (Eastern Musk Turtle). Warren Co.: 10.9 km NNE Macon, along Lake Gaston (36.53378°N, 78.05519°W). 15 August 2008. Jamie M. Smith. NCSM 74547 (six embryos, two unhatched eggs, and eggshell fragments from communal nest). New county record.

Terrapene carolina carolina (Eastern Box Turtle). CASWELL CO.: 5.8 km S.SW Milesville (36.2564°N, 79.4277°W). 28 April 1979. Fred Scott. NCSM 20017. New county record.

Squamata – Lizards

Anolis carolinensis (Green Anole). MARTIN CO.: 3.1 km W.NW Williamston (35.85969°N, 77.09282°W). 17 October 2003. J. Edward Corey III. NCSM 65308. New county record. An additional voucher NCSM 66632 was collected in this county. WARREN CO.: 10.9 km NNE Macon, along Lake Gaston (36.53378°N, 78.05519°W). 28 September 2008. Macy Cox. NCSM photographic voucher JMS 08-1. New county record.

Anolis (=*Norops*) *sagrei* (Brown Anole). NEW HANOVER CO.: 1.8 km NNE Wrightsville Beach (34.21862ºN, 77.78902ºW). 13 October 2008. Andrew R. Wood. NCSM 74677. New county record and first record for North Carolina. Additional specimens have been observed at this locality and at a nearby locality, 2.3 km NW of Wrightsville Beach (34.22570ºN, 77.81074ºW) (A. R. Wood and David Smith, pers. comm.), suggesting a breeding population of this invasive species.

Aspidoscelis sexlineata sexlineata (=*Cnemidophorus sexlineatus sexlineatus*) (Six-lined Racerunner). MADISON CO.: 4.3 km NW Walnut (35.8801°N, 82.7706°W). 13 September 2003. Stephen Rice. NCSM 70720. New county record. Extends range ca. 52 km WNW of nearest record in Buncombe County (Palmer and Braswell 1995).

Hemidactylus turcicus (Mediterranean Gecko). NEW HANOVER CO.: 3.1 km NNE center Wilmington (34.2614ºN, 77.9356ºW). 11 November 2003. Andrew R. Wood. NCSM 65405. New county record and first record for North Carolina. Numerous other specimens (juveniles and adults) have been observed at this locality from 2003 to 2008 (A. R. Wood and C. Keith Farmer, pers. comm.), strongly suggesting an established population.

Ophisaurus attenuatus longicaudus (Eastern Slender Glass Lizard). PENDER CO.: 7.7 km N.NE Hampstead, Holly Shelter Game Lands (34.43840ºN, 77.70270ºW). 28 September 2004. Jeffrey G. Hall. NCSM 69334. New county record.

Ophisaurus mimicus (Mimic Glass Lizard). PENDER CO.: 8.3 km N Hampstead (34.44236°N, 77.70553°W). 22 April 2004. Jerald H. Reynolds et al. NCSM 71561. New county record.

Ophisaurus ventralis (Eastern Glass Lizard). CURRITUCK CO.: Corolla (36.3828°N, 75.8345°W). 31 May 2003. Alvin L. Braswell. NCSM 64912. New county record.

Plestiodon (=*Eumeces*) *anthracinus* (Coal Skink). HAYWOOD CO.: Shining Rock (ca. 35.37°N, 82.86°W). 28 July 1962. R. Gordon. Verified by M. Elizabeth McGhee. Georgia Museum of Natural History (GMNH 2456). New county record. A second voucher, NCSM 71660, was also collected from this county.

Plestiodon (=*Eumeces*) *fasciatus* (Five-lined Skink). DARE CO.: 8.5 km SSE East Lake (35.8369°N, 75.9172°W). 14 April 2006. Jeffrey C. Beane and L. Todd Pusser. NCSM 70474. New county record. HENDERSON CO.: near Flat Rock, Carl Sandburg Home National Historic Site (35.273°N, 82.443°W). 5 June 2004. R. N. Reed. NCSM 73670. New county record. MARTIN CO.: 3.1 km W.NW Williamston (35.85969°N, 77.09282°W). 23 July 2003. J. Edward Corey III. NCSM 65067. New county record.

Sceloporus undulatus hyacinthinus (Northern Fence Lizard). CASWELL CO.: 0.6 km NNW Frogsboro. 26 May 2005. Rufus W. Gaul Jr. NCSM 67642. New county record. CATAWBA CO.: 12.2 km NNW Claremont, River Bend Park along Catawba River (35.82037°N, 81.18770°W). 5 November 2008. Jeffrey C. Beane, J. Edward Corey III, et al. NCSM photographic vouchers JCB 08-2142. New county record. CLEVELAND CO.: 3.9 km SW Boiling Springs (35.2259°N, 81.6966°W). 21 October 2008. Dennis W. Herman. NCSM 74597. New county record.

Scincella lateralis (Ground Skink). ALAMANCE CO.: 2.6 km SSE center Burlington (36.0715°N, 79.4347°W). 20 April 2006. Stanley L. Alford. NCSM 70666. First voucher for county. Palmer and Braswell (1995) reported an unvouchered observational record. CASWELL CO.: 2.1 km E Frogsboro (36.3480°N, 79.1608°W). 14 April 1984. David L. Stephan and Daniel F. Lockwood. NCSM 24917. First voucher for county. Palmer and Braswell (1995) reported an unvouchered observational record. WILKES CO.: 1.4 km N Traphill (36.3775°N, 81.0258°W). 9 May 2006. Jeffrey C. Beane, Tammy B. Sawyer, and Thomas J. Thorp. NCSM 70717. New county record. Extends range ca. 21 km WSW of nearest record in Surry County (Palmer and Braswell 1995) and partially fills range hiatus shown in Conant and Collins (1998).

Squamata – Snakes

Agkistrodon contortrix (Copperhead). FORSYTH CO.: 6.0 km W Belews Creek (36.2424°N, 80.1332°W). 5 September 2007. Lance Cook. NCSM 73663. First voucher for county. Palmer and Braswell (1995) reported an unvouchered observational record. IREDELL CO.: 5.5 km SSE Turnersburg (35.8640°N, 80.7829°W). June 2006. Gene Johnson and Deb Lazenby. NCSM photographic vouchers GJ 06-1. First photographic voucher for county. Palmer and Braswell (1995) reported an unvouchered observational record.

Carphophis amoenus amoenus (Eastern Wormsnake). WARREN CO.: 10.8 km N.NE Macon, along Lake Gaston (36.532806°N, 78.056367°W). 10 January 2009. Jamie M. Smith. NCSM 75062. New county record.

Cemophora coccinea copei (Northern Scarletsnake). ALEXANDER CO.: ca. 8.0 km NE Taylorsville, Rocky Face Mountain (35.972°N, 81.109°W). 7 April 2008. Michael S. Coone and Cerce Coone. NCSM photographic vouchers MSC 08-1. New county record. ANSON CO.: 4.7 km E Lilesville (34.9656°N, 79.9373°W). 11

August 2006. Jeffrey C. Beane and L. Todd Pusser. NCSM 71484. New county record.

Crotalus horridus (Timber Rattlesnake). Gates Co.: 0.5 km N Sandycross (36.379467°N, 76.549425°W). 6 June 2009. Lacey Wilkins and J. Chris Turner. NCSM photographic vouchers JCT 09-1. New county record. Lincoln Co.: 2.9 km E Triangle (35.4784°N, 80.9643°W). 24 August 2003. D. Crow. NCSM 65177. First specimen voucher for county. Palmer and Braswell (1995) reported a photographic record and Brown (1992) reported unvouchered observational records. Martin Co.: 14.5 km SSW Jamesville (35.6977°N, 76.9762°W). 14 April 2006. J. Edward Corey III. NCSM 70464. New county record. A second specimen, NCSM 70722, from the county was also vouchered.

Farancia abacura abacura (Eastern Mudsnake). Montgomery Co.: 11.9 km SE Emery (35.1709°N, 79.6310°W). 14 July 2006. Jeffrey C. Beane. NCSM 72081. First voucher for county. Palmer and Braswell (1995) reported an unvouchered observational record.

Farancia erytrogramma erytrogramma (Rainbow Snake). Chowan Co.: 1.4 km S center Edenton, along Queen Anne Cr. (36.0561°N, 76.6059°W). 2 April 2008. Daniel Grother. NCSM photographic vouchers DG 09-7. First photographic voucher for county. Palmer and Braswell (1995) reported an unvouchered observational record.

Heterodon platirhinos (Eastern Hognose Snake). Alamance Co.: 1.0 km WSW Ossipee (36.1688°N, 79.5236°W). 28 October 2006. Julie P. Litten. NCSM photographic vouchers JPL 06-1. New county record. Wilkes Co.: 4.7 km WNW Traphill (36.3707°N, 81.0651°W). Ca. September 2003. David T. Sawyer and Tammy B. Sawyer. NCSM 65638. New county record.

Lampropeltis calligaster rhombomaculata (Mole Kingsnake). Alexander Co.: 3.2 km ENE Millersville (35.8993°N, 81.1525°W). 28 September 2004. Michael S. Coone. NCSM 71480. New county record. Caswell Co.: 5.5 km SSE Yanceyville (36.358821°N, 79.310371°W). 12 April 2007. Kendrick C. Weeks, Jeff Marcus, and Anne Brown. NCSM photographic vouchers KCW 07-1. New county record. Franklin Co.: 3.5 km N Louisburg (36.1287°N, 78.2961°W). 26 August 2007. Alvin L. Braswell. NCSM 73598. New county record. Martin Co.: 9.8 km ESE Beargrass (35.72439°N, 77.03581°W). 10 April 2009. J. Edward Corey III. NCSM 75890. First voucher for county. Palmer and Braswell (1995) reported an unvouchered observational record.

Lampropeltis getula getula (Eastern Kingsnake). Chowan Co.: 2.6 km WSW Hancock (35.0909°N, 76.6545°W). 9 June 2009. Elizabeth Hanrahan. NCSM photographic voucher EH 09-1. First photographic voucher for county. Palmer and Braswell (1995) reported an unvouchered observational record.

Lampropeltis triangulum elapsoides (Scarlet Kingsnake). Cumberland Co.: ca. 9.7 km E.NE Spring Lake, Carver's Creek State Park (35.1839°N, 78.8714°W). 22 April 2007. J. Edward Corey III, Perry Aycock, and Ross Maynard. NCSM photographic vouchers JEC 07-1. New county record.

Lampropeltis triangulum triangulum (Eastern Milksnake). Polk Co.: 5.2 km WNW Tryon (35.2229°N, 82.2923°W). 14 September 2003. Dale A. Jackan. NCSM 65223. New county record. Conant (1943) reported a specimen of *L. t. elapsoides* from Polk County near Tryon, but noted that it in some respects resembled an *L. t. elapsoides* x *temporalis* intergrade. That specimen is now apparently lost (Palmer and Braswell 1995). The specimen reported here (NCSM 65223) conforms morphologically to *L. t. triangulum*.

Nerodia erythrogaster erythrogaster (Red-bellied Watersnake). Durham Co.: Ca. 8.5 km SE Bahama, Butner Game Lands (36.1154°N, 78.8057°W). 10 June 2003. David G. Cooper. NCSM 64915. New county record. Additional vouchers (NCSM 72496, NCSM 72497) were also collected in this county. Granville Co.: Ca. 4.2 km WSW Butner, Butner Game Lands (36.117°N, 78.798°W). 10 May 2003. Joseph S. Zawadowski. NCSM 64806. New county record. Together, these records extend range ca. 31 km NW of nearest records in Wake County (Palmer and Braswell 1995).

Nerodia taxispilota (Brown Watersnake). Chowan Co.: 1.4 km S center Edenton, Queen Anne Cr. (36.0561°N, 76.6049°W). 12 April 2009. Daniel Grother. NCSM photographic voucher DG 09-1. New county record.

Pantherophis guttatus (Red Cornsnake). Washington Co.: 3.9 km SE Roper (35.8599°N, 76.5775°W). 30 April 2005. Rufus W. Gaul Jr. et al. NCSM 67725. New county record. A second voucher specimen, NCSM 68727, was also collected from the county.

Regina rigida rigida (Glossy Crayfish Snake). Pender Co.: "near Maple Hill" (ca. 34.67°N, 77.71°W). Ca. 1982. James Estes and Jutta Bray. NCSM 75969. New county record.

Regina septemvittata (Queen Snake). Rockingham Co.: 14.0 km SSW Reidsville, Haw River State Park property along Haw R. (36.25542°N, 79.75789°W). 15 November 2007. J. Edward Corey III. NCSM 73817. New county record.

Sistrurus miliarius miliarius (Carolina Pigmy Rattlesnake). Pitt Co.: 1.2 km NE Grimesland (35.5709°N, 77.1822°W). 4 August 2002. Zachary R. Orr. NCSM 65446. New county record. Extends range ca. 11 km W of nearest record in Beaufort County (Palmer and Braswell 1995, Braswell et al. 2003). Tyrrell Co.: 8.0 km E Gum Neck, Grapevine Landing (35.7179°N, 76.0615°W). 18 October 2005. Woody Webster and John Fear. NCSM 69664. New county record. Extends range ca. 25 km ENE of nearest record in Hyde County (Braswell et al. 2003).

Storeria dekayi dekayi (Northern Brownsnake). Martin Co.: 2.9 km W Williamston (35.85582°N, 77.09362°W). 13 March 2003. J. Edward Corey III. NCSM 64550. New county record.

Storeria occipitomaculata occipitomaculata (Northern Red-bellied Snake). Granville Co.: 5.3 km N.NW Stem (36.24704°N, 78.74015°W). 18 October 2006. Nathan A. Shepard. NCSM photographic voucher NAS 06-2. New county record. Person Co.: 2.8 km NE Bethel Hill (36.5229°N, 78.8959°W). 5 April 1977. A. L. Braswell, J. Brellenthin, and R. Yates. NCSM 17682. New county record.

Tantilla coronata (Southeastern Crowned Snake). MARTIN CO.: 3.1 km W.NW Williamston (35.85969°N, 77.09282°W). 7 March 2003. J. Edward Corey III. NCSM 64548. New county record. Extends range ca. 40 km NE of nearest record in Pitt County (Palmer and Braswell 1995).

Thamnophis sauritus sauritus (Common Ribbonsnake). CURRITUCK CO.: Knotts Island, Mackay Island National Wildlife Refuge (36.5059°N, 75.9717°W). 9 November 1986. Donald J. Schwab and Paul O'Neil. NCSM 65558 and 65559. New county records. Another voucher (NCSM 65555) was collected from this county. GASTON CO.: 4.0 km NNW center Gastonia, between Long Cr. and Rankin Lake (35.29498°N, 81.20568°W). 10 May 2008. Zachary S. Barfield. NCSM photographic voucher ZSB 08-1. New county record. MARTIN CO.: 14.8 km SSW Jamesville (35.69501°N, 76.97914°W). 11 March 2006. J. Edward Corey III. NCSM 70199. New county record. A second voucher, NCSM 70463, was also collected from this county.

Thamnophis sirtalis sirtalis (Eastern Gartersnake). CHOWAN CO.: 1.4 km S center Edenton, Queen Anne Park (36.0561°N, 76.6061°W). 26 April 2008. Daniel Grother. NCSM photographic vouchers DG 09-3. First photographic voucher for county. Palmer and Braswell (1995) reported an unvouchered observational record. MARTIN CO.: 3.4 km WNW Williamston (35.8580°N, 77.0935°W). 24 June 2006. J. Edward Corey III and J. Edward Corey Jr. NCSM 71077. New county record.

Virginia valeriae valeriae (Eastern Smooth Earthsnake). WARREN CO.: 10.8 km N.NE Macon, along Lake Gaston (36.532833°N, 78.054528°W). 25 July 2004. Jamie M. Smith. NCSM 65995 and 65996. New county records.

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New Distribution Records for Six Species of Turtles in Ohio

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The geographic distribution of Ohio's reptiles was summarized by Wynn and Moody (2006). They reported the most current record for each reptile species by county. Twelve species of turtles were represented by 408 county distribution records. Of those, only 37 percent represented specimens collected since 1976. Two species in particular were of interest as we prepared to conduct a statewide turtle survey. The Midland Smooth Softshell (*Apalone m. mutica*), a species of apparent limited distribution in Ohio, had only been documented in nine Ohio counties and five of those (55.5%) records were more than 50 years old. The Eastern Spiny Softshell (*Apalone s. spinifera*) had been confirmed in 55 of Ohio's 88 counties, but 71% of its Ohio distribution records were more than 30 years old.

In Ohio, the Midland Smooth Softshell has been reported from the Ohio River and several of its larger tributaries. It has been collected from the lower reaches of the Great Miami and Little Miami Rivers in southwest Ohio, and the Scioto River in south central Ohio. In eastern Ohio, it has been reported from the Muskingum River and the Tuscarawas River, a tributary of the Muskingum (Conant, 1951; Zemko, 1974; Wynn and Moody, 2006). Smooth Softshells generally require soft sand into which they burrow near the shoreline of rivers they inhabit. Unlike the Eastern Spiny Softshell (*Apalone s. spinifera*), the Midland Smooth Softshell avoids burrowing into gravelly sand and mud.

Aerial maps of Ohio were scanned for bends in rivers where sand is often deposited. Once located, the sites were visited and searched for Smooth Softshells. In shallow water, generally less than 20 cm, we sifted through the sand with our finger tips to feel for the carapace of buried turtles, found their posterior end, then pulled the turtles from the sand or we raked the shallows with potato rakes reaching into the water and pulling it toward the shore. Buried turtles are generally flipped upside down by the potato rake and make little attempt to escape for the first few seconds.

The distribution of the Midland Smooth Softshell in the Great Miami River was extended upstream by approximately 29 river miles into Butler County, Ohio. The range extension in the Scioto

River was far more significant. While previously known only from Scioto and Pike counties in the Scioto River, we captured turtles in Ross, Pickaway, and Franklin counties and extended the range approximately 88 river miles upstream from Camp Creek Township in Pike County, the locality that represented the record from farthest upstream until 2008.

Seven other species were collected during the survey, four of which are represented by new county records reviewed below. One of those, *Graptemys ouachitensis* had been documented in only three Ohio counties, all in the Scioto River, through 2006. An individual captured in the Muskingum River represents the first from that drainage system. The other six species collected include *Chelydra serpentina*, *Chrysemys picta*, *Graptemys geographica*, *Sternotherus odoratus*, *Terrapene carolina* and *Trachemys scripta*.

Voucher specimens were deposited into the Herpetology Fluid Collections (CMC) and photographs into the Herpetological Photodocumentation Collection (CMC HP) of the Cincinnati Museum Center's Frederick and Amye Geier Research and Collections Center. Tissue samples were taken from those specimens placed into the fluid collection. We report 17 new county records for turtles collected during the 2008 – 2009 survey. Identification of all specimens was verified by John W. Ferner. The datum for all GPS readings was WGS 84.

Apalone mutica mutica (Midland Smooth Softshell). USA: OHIO: Butler Co.: Fairfield Township. Great Miami River (39.34387°N, 84.59238°W). 29 May 2008. Paul J. Krusling and Jeffrey G. Davis. Cincinnati Museum Center (CMC 11163). Franklin Co.: Jackson Township. Scioto River (39.83235°N, 83.00908°W). 22 July 2008. Paul J. Krusling and Jeffrey G. Davis. Cincinnati Museum Center (CMC 11301). Pickaway Co.: Harrison Township. Scioto River (39.72147°N, 83.01099°W). 22 July 2008. Paul J. Krusling and Jeffrey G. Davis. Cincinnati Museum Center (CMC 11302). Ross Co.: Green Township. Scioto River (39.43317°N, 82.98454°W). 04 May 2008. Paul J. Krusling, William J. Letsche, and Jeffrey G. Davis. Cincinnati Museum Center (CMC 11166). Ross Co.: Scioto Township. Scioto River (39.3447°N, 82.98265°W). 02 November 2008. William J. Letsche. Cincinnati Museum Center (CMC 11346). Ross Co.: Twin Township. Paint Creek (39.31874 °N, 83.09517°W). 02 June 2009. Sarah Stevenson and Joe Letsche. Cincinnati Museum Center (CMC 11596).

Apalone spinifera spinifera (Eastern Spiny Softshell). USA: OHIO: Belmont Co.: Washington Township. Captina Creek approximately 500 m upstream from the State Route 148 bridge (39.90852°N, 81.01125°W). 13 July 2009. Jeffrey G. Davis, Greg Lipps Jr., and Ralph A. Pfingsten. Cincinnati Museum Center (CMC 11687). Columbiana Co.: Elk Run Township. Middle Fork Little Beaver Creek at Elkton (40.76117°N, 80.69533°W). 12 August 2009. Jeffrey G. Davis and Paul J. Krusling. Cincinnati Museum Center (CMC 11770). Fayette Co.: Union Township. Paint Creek in Washington Courthouse (39.53964°N, 83.44557°W). 05 July 2009. Paul J. Krusling and Jeffrey G. Davis. Cincinnati Museum Center (CMC 11802). Mercer Co.: Washington Township. Wabash River at Saint Anthony Road (40.50915°N, 84.74214°W). 28 July 2009. First record from the Wabash River drainage in Ohio. Jeffrey G. Davis and Paul J. Krusling. Cincinnati Museum Center (CMC 11700). Scioto Co.: Valley Township. Scioto River upstream from the State Route 348 bridge (38.88282°N, 83.01859°W). 13 September 2008. Jeffrey G. Davis and Paul J. Krusling. Cincinnati Museum Center (CMC 11308–11310). Stark Co.: Sandy Township. Little Sandy Creek on the north side of Magnolia (40.65823°N, 81.20761°W). 12 August 2009. Jeffrey G. Davis and Paul J. Krusling. Cincinnati Museum Center (CMC 11765). Tuscarawas Co.: Oxford Township. Tuscarawas River at Newcomerstown (40.27365°N, 81.59315°W). 12 August 2008. Jeffrey G. Davis and Paul J. Krusling. Cincinnati Museum Center (CMC 11313).

Chelydra serpentina serpentina (Eastern Snapping Turtle). USA: OHIO: Shelby Co.: Washington Township. Pond near Lockington (40.21613°N, 84.25694°W). 31 May 2009. Jeffrey G. Davis and Paul J. Krusling. Cincinnati Museum Center (CMC 11610).

Graptemys geographica (Northern Map Turtle). USA: OHIO: Clermont Co.: Franklin Township. Backwater of the Ohio River at Crooked Run (38.79069°N, 84.12711°W). 27 April 2008. Jeffrey G. Davis and Paul J. Krusling. Cincinnati Museum Center Herpetological Photodocumentation Collection (CMC HP 503).

Graptemys ouachitensis ouachitensis (Ouachita Map Turtle). USA: OHIO: Muskingum Co.: Cass Township. Muskingum River (40.12972°N, 81.98303°W). 24 June 2009. Paul J. Krusling and Jeffrey G. Davis. Cincinnati Museum Center (CMC 11824). Scioto Co.: Clay Township. Scioto River (38.77517°N, 82.99201°W). 18 June 2008. Paul J. Krusling and Jeffrey G. Davis. Cincinnati Museum Center Herpetological Photodocumentation Collection (CMC HP 549–550). Paul J. Krusling and Jeffrey G. Davis.

Trachemys scripta elegans (Red-eared Slider). USA: OHIO: Montgomery Co.: Mad River Township. Collected from an abandoned gravel pit adjacent to the Mad River (39.78293°N, 84.13837°W). 10 July 2008. Jeffrey G. Davis and Paul J. Krusling. Cincinnati Museum Center (CMC 11320). Lawrence Co.: Hamilton Township. Ohio River (38.56654°N, 82.80201°W). 07 July 2008. Jeffrey G. Davis and Paul J. Krusling. Cincinnati Museum Center Herpetological Photodocumentation Collection (CMC HP 483).

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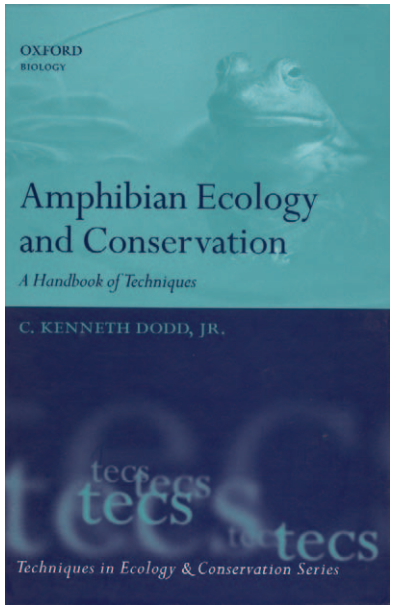
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BOOK REVIEWS

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Amphibian Ecology and Conservation: A Handbook of Techniques, edited by C. Kenneth Dodd, Jr. 2009. Oxford University Press, New York (www.oup.com). Hardcover. xxvii + 556 pp. US $120.00. ISBN 978-0-19-954118-8 [Paperback. US $59.95. ISBN 978-0-19-954118-5].

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The diversity of amphibians, and their associated ranges of life histories, habitats and breeding modes means there is no simple set of research methods which are suitable for this group of animals. Add to this a diverse set of complex and synergistic threats to population persistence, and the difficult task of conservation and management of amphibians is daunting. Fortunately, Ken Dodd has assembled some of the world experts in methods for studying amphibians across their many habitats and life history stages into an accessible text. This book was written as a reference guide and synthesis for graduate students, researchers and conservationists, and it serves this purpose well. This text provides good general discussion of methods and techniques for studying amphibians, including morphology (chapters 2, 8), physiology, disease and feeding (chapters 5, 10, 20, 21, 27), sampling for population size and distribution (chapters 4, 9, 13–16, 18, 22), experimental venues for asking detailed research questions (chapters 6, 12), and issues regarding study design and state variable choice (chapters 1, 23–25).

The emphasis of the book is to delineate new developments in amphibian research, evaluate techniques and relate to the inference possible under each, focus attention on potential biases under each method, and highlight sampling as one part of a well thought out research program. The book is a useful supplement to existing methodological texts, while it presents new material related to advances in inference models, landscape ecology, telemetry, genetics, and disease monitoring. It provides a good introduction to amphibian research, but you will most likely also need a stack of papers particular to your organism, method, and research objectives, along with existing texts on methods in amphibian ecology (Gent and Gibson 1998; Henle and Veith 1997; Heyer et al 1994).

Several chapters should be read by anyone interested in amphibian research and conservation (chapters 2, 23–26). In particular, an emphasis on carefully defined research objectives is made early on in the text (chapter 2), which is commendable, as hard thinking before any sampling is undertaken will guide the study design, methods, and modeling which will provide the strongest inference (e.g., Platt's classic 1964 paper). Many chapters repeat this emphasis on the need for clear definition of objectives. The introduction to chapter 23,'Selection of species and sampling areas: the importance to inference,' outlines Platt's steps to strong inference. Successful research relies on the careful specification of study objectives, followed by a sampling design selected to be representative of the population of interest. The choice of how, what, and where to sample must be linked to the objectives. The strongest inference combines both experimental and observational approaches.

Each chapter provides a general discussion of the methods and techniques needed to approach a research question, and many chapters discuss how a particular approach may influence the inference from the data. The summary section of most chapters is useful, as are the literature cited sections for each chapter, as the application of each method could not be treated in sufficient detail in an introductory text. It is, however, disappointing that several chapters are not as well-referenced as they may have been, or are more regionally based and limited by the experiences of the authors. Further, a separate citation index for each chapter means that novel applications of research methods for, say, physiological measurements (chapter 20) may not be readily found by someone reading the field enclosures section (chapter 12), though research objectives under each topic might certainly be related.

Most folks won't read this text cover-cover, though by doing so, one could recognize nine major research gaps highlighted across the 27 chapters: (1) relating estimates of abundance from reproductive effort (e.g., egg mass counts or larval surveys) to population size, which are complicated by potential variation in return rates of breeding adults, (2) details of foraging in field settings, which are complicated by temporal patterns of activity and prey availability and life history stage, (3) a large gap in our understanding of movement behavior and dispersal, including variation across seasons and space, (4) terrestrial ecology, especially of wetland-breeding amphibians which are unobservable throughout much of the year, (5) integration across levels of sampling detail, including issues of scaling among estimates of detection probability, false presences, occupancy, abundance, survival rates, genetic diversity and relatedness, (6) integrating unknown features of life history and distribution to guide management of amphibian populations, (7) habitat preference and use, especially across temporal and spatial scales, (8) community ecology, species richness, diversity, and interactions, and (9) integrating physiology, movement behavior, terrestrial ecology, and habitat preference to understand population dynamics and distribution.

Part 1 discusses the challenges in studying amphibians, and the importance of setting clear and focused research objectives. Chapter 2: "setting objectives in field studies" should be required

reading for all amphibian ecologists. The first sentence of the chapter summarizes an important point which is repeated in several other chapters in the text: poor planning leads to wasted resources and cannot effectively further conservation and management of amphibian species and their habitats. Defining research objectives is essential to scientific progress and the success of a research program. The authors point out that combining experimental and observation evidence are the best way to truly understand a system, which focuses research on the *causes* of an observed phenomenon. Hard thinking during the design phase of a study should narrow the types of experiments and observations that should be most important to the accumulation of knowledge (see also chapter 23). The chapter sets the proper tone for the remainder of the book, where the specific research methods are detailed.

Part 2 includes chapters on larval morphology, sampling, design and use of aquatic mesocosms, water quality and dietary assessment. The larval stage is often the target of amphibian research, for two reasons—one more practical and one more appropriate ('logistic' vs. 'strategic' considerations). Larvae are often more easily sampled and represent a critical life history stage, though important caveats include the assumption that there is a relationship between the larval and adult population sizes, and that the factors affecting larval populations are independent of the adult population. Chapter 4 provides an overview of techniques for sampling this life stage. The authors do an excellent job of detailing nine different approaches to larval sampling, and provide a 'considerations' subsection for each technique – discussing under what circumstances each technique is most useful (though perhaps this section could have benefitted from more citations of exemplary studies). Chapter 5 provides excellent detail for sampling and analysis of larval diets, including both manipulative experiments and observational studies. The literature cited section of this chapter will be especially useful.

Chapter 6 details the use and application of aquatic mesocosms using cattle tanks, plastic wading pools, and field enclosures/cages in situ. The authors provide a convincing argument for the use of mesocosms in developing strong inference as one component of a scientific course of study, in which observations lead to the development of expectations (via models), which are then tested using experiments. Notable is the absence of a discussion of artificial stream experimental systems ('flumes'), though these setups require an external source of water to maintain flow and therefore do not strictly fit the 'self-sustaining' definition provided by the authors. Many amphibians are reliant on wetland or stream habitats for at least a portion of their life cycle; chapter 7 introduces important water quality parameters and methods for obtaining appropriate values for a suite of water quality variables.

Part 3 includes chapters on marking, egg mass and nest counts, dietary assessment, tracking movements and terrestrial experimental venues. Chapter 8 gives an overview of techniques useful for marking adult animals, with a good discussion of ethical issues in the choice and application of marking technique. In particular, emphasis should be made on evaluating the potential for violation of the criteria for marking, and one may consult the mark-recapture literature for discussion of the impacts of violating one or more of the assumptions provided in the introduction to the chapter (e.g., Amstrup et al. 2005; Williams et al. 2002). A common technique for monitoring amphibian populations is the counting of egg masses or nests (chapter 9), and such counts are typically used as indices of population size. This chapter describes characteristics of a species which make egg mass/nest counts potentially useful, and discusses factors in designing a study which relies on these counts to make inference to a population status. This technique may not be suitable for many species (see table in Appendix 9.1). The use of egg mass counts as an index of population size is confounded with breeding effort, such that counts may more reasonably index the conditional probability of breeding effort, given population size. Alternatively, the presence or absence of a breeding population may be of primary interest, in which a large number of sites over a broad area are surveyed for the presence of eggs/nests. In both the abundance and site-occupancy cases, the estimation of the probability of detecting an egg mass (or nest) is critical (chapter 24, 25). In both cases, the state variable describes the annual reproductive effort, which is a function of the number of populations, population sizes, and factors influencing breeding probability.

Dietary assessments of adult and juvenile animals are an important component of management and conservation strategies for amphibians, and chapter 10 provides excellent detail on techniques for obtaining these data, as well as important considerations for study design and interpretation of data. While foraging opportunities and prey availability may be critical for population growth or persistence, these data are unknown for most species, and complexities in ontogeny, seasonal variability, and interactions with community structure, prey availability and diet make dietary assessment a large gap in our understanding of what may limit amphibian populations.

Movement within and between habitats is an important component of population ecology, though reliable and accurate estimates of movement and dispersal are difficult to obtain. Direct observation of animals is important for understanding patterns of habitat use and identification of dispersal rates, timing, and pathways. Chapter 11 provides good description of methods useful for direct observation of movement, as well as an introduction to analysis of movement data (although interested readers should see Turchin [1998] for a more detailed discussion). A major research gap involves movement behavior across seasons and under varying habitat conditions. As dispersal is a key component of population models, a focus on movement behavior is important in conservation and management decisions for amphibians.

The importance of the terrestrial life stage in amphibian population dynamics is woefully understudied, and factors underlying population change may affect terrestrial and aquatic stages differentially. There exists a critical need to better characterize terrestrial ecology (outside of factors relating to emigration/immigration at breeding sites) for amphibian management and conservation. Chapter 12 details the use of these research tools for a suite of questions in amphibian ecology and conservation, including (1) creating a venue for application or evaluation of experimental treatments, (2) capturing individuals in the course of moving among habitat patches, and (3) estimating terrestrial densities of amphibians. Table 12.1 is useful (though not exhaustive), in outlining the type of questions which have

been asked using terrestrial enclosures. As in the use of aquatic mesocosms, these research tools can be most informative when paired with large-scale surveys.

Part 4: "Amphibian populations" includes chapters on sampling methods for capturing or detecting amphibians, including trapping and area-based survey methods, 'rapid assessment' methods, auditory detections, and measuring habitat covariates. Drift fences and pitfall traps are the 'bread-and-butter' of amphibian ecologists studying wetland breeding habitats. These research tools, along with coverboards and other means of trapping free-ranging animals, are discussed in chapter 13. The chapter has a few illustrations of examples of traps and trap arrays, and discusses the application and appropriateness of passive vs. active trapping methods. For details on construction and design of trapping methods, one would be better served to consult (Heyer et al. 1994). Another old-standby method includes area-based surveys, which incorporate replicated and standardized areas of habitat surveyed and are a vast improvement over 'haphazard' surveys, from which little population-level inference may be drawn. The authors of chapter 14 outline examples of this method, and provide a useful section on design issues in applying this method (which are of course directly related to the study objectives). One omission in section 14.5.1 is that of the program GENPRES (Bailey et al. 2007), which can be useful for study design.

Rapid assessments of biodiversity are seen as useful for establishing 'baseline' information about an understudied region, though the authors of chapter 15 point out that there is a tradeoff in a large area sampled with robust inference. Incorporation of fundamentals of sampling (independence, randomization, and replication of sampling sites) could certainly improve the value of these programs. Though the authors insist that a rapid assessment has different objectives than other biodiversity inventories, I am not convinced that the reasons given are sufficient to support a biased inventory, especially when conservation and resource allocation decisions are made based on the inventory results. Chapter 18 describes approaches useful for estimating the number of species present in a study region, including both occupancy and abundance-based estimators (though estimators based on presence-only data, such as the Maxent model of Phillips and Dudik [2008], are not discussed). Though the author discusses the difference between a count (which is some fraction of the total population detected during a given survey) and abundance (which is a count of individuals adjusted for the probability of detecting an individual, given it is present and available to be counted), many traditional biodiversity estimators do not incorporate this detection bias (similarly for presence/absence data; see Chapters 23–25). With a modicum of extra effort and probabilistic site selection, these inventories can use newly developed multi-species models to improve inference (e.g., Kery and Royle [2008]; Royle and Dorazio [2008]; Zipkin et al. [2010]).

The authors of chapter 17 point out that the variability in habitat use (and condition) may be more important to the ecology of a species than single or season-specific observations. Section 17.4: "approaches for examining habitat selection" is a useful outline, though emphasis should be placed on (1) the differences among selection, preference, and use, and (2) the relationship between the probability of detecting a species at a location and the habitat characteristics, which might mask important relationships (MacKenzie 2006). Table 17.1 could be much improved with citations.

Part 5: "Amphibian communities" includes chapters on estimating diversity from field data, and applying concepts from landscape ecology to the conservation and management of amphibian populations. The information in Chapter 19 on landscape ecology and GIS methods were not included in earlier texts on methods in amphibian research. The challenge remains in describing a landscape, *as seen from the perspective of an individual amphibian*. Integrating physiology (chapters 20 and 21), habitat use and selection (chapter 17), and movement (chapter 11) is important in determining how the composition and configuration of the landscape may influence a population. The use of genetics (chapter 22) is one additional tool for describing how a landscape may influence patterns of relatedness, genetic diversity, and the definition of a population.

Part 7: Monitoring, status, and trends may be of the most interest to many. Many times, interest lies either in the abundance or the distribution of a population. Chapters 24 and 25 should therefore be read whenever either of these variables is included in the research objectives. Chapter 24 discusses two important sources of variation: (1) spatial variation in animal distribution, and (2) the probability of detecting an individual (given it is present at a site during a survey; detection probability). The underlying issue is that the detection of an individual of a species is a combination of presence and the probability the individual is observed. Both may be affected by a suite of variables, and can be related to each component (presence and detection) differently. The authors go on to provide details on how estimation methods for abundance and occupancy (and the associated rates of change in each variable) may be incorporated into studies of amphibian populations, while Chapter 25 demonstrates the bias and potential for incorrect inference when one ignores detection probability. In section 25.4, the authors discuss ways to deal with imperfect detection, which may be either at the study design stage, or after data have been collected (i.e., with models).

In the last chapter, Ken Dodd outlines important considerations for management of amphibian populations. He provides "five cardinal rules [for] developing management programs for amphibians," and provides a table (27.1) of conceptual ideas important for amphibian population management. The chapter could use better description of existing management programs and more citations, and could discuss in more depth issues with choosing among management objectives. Both wetland and terrestrial habitat management are discussed, though the discussion of headwater stream management is overlooked. Embedding management decisions in a formal process can help sort out the available management actions, and an associated monitoring program can help inform decision making by providing information as to whether the system is responding as expected (Lyons et al. 2008; Williams et al. 2002).

At US $120 (hardcover) or $60 (paper) the book is an investment, but should be a valuable addition to a herpetologist's or conservation biologist's shelf. The challenge of amphibian conservation and management will require carefully focused research questions, carefully designed surveys for distribution and associated changes, integration of genetics, abundance and distribution, and landscape ecology, and the incorporation of

these data into management decisions. This text furthers that goal, and sets a good foundation for researchers and practitioners in support of amphibian conservation and management.

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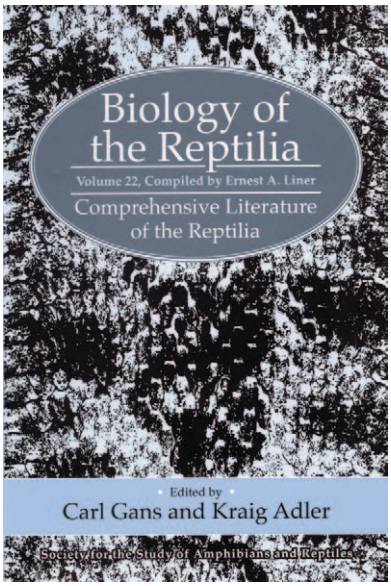
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Biology of the Reptilia, Volume 22. Comprehensive Literature of the Reptilia, compiled by Ernest A. Liner, Edited by Carl Gans and Kraig Adler. Society for the Study of Amphibians and Reptiles (www.ssarbooks.com). Hardcover. xx + 1366 pp. US $130.00. ISBN 978-0-916984-80-9.

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In 1969, as a final year undergraduate student, I was excited to see (and buy) the first volume in a new series, the *Biology of the Reptilia*. This series was to be devoted to chapters written by experts in their fields on all aspects of reptilian biology. Little did I (or, I suspect, the editors) realize at the time the magnitude of the enterprise that was being entered into, and that it would be 39 years before the final chapter-based volume (Volume 21) appeared. Two years later we have the final volume in the series, a contribution that pulls together the literature resources and subject heading areas that underpin the entire synthetic overview of animals commonly known as reptiles. Over the 41 years of publication, 19 editors and compilers have overseen the efforts of 169 authors from 21 countries who have collectively contributed to 142 chapters.

Volume 22 is by far the most physically imposing of the series and comprises complete bibliographic citations for 22,652 references (as claimed on the dust jacket—I did not attempt to verify this count!!). This list occupies 990 pages, and a further 361 pages are devoted to an integrated subject index for all of the chapters. The remainder of the volume is taken up by a Preface (three pages); a Foreword (three pages) that provides a brief summary of the life and work of Carl Gans (interested readers may like to follow this up with the more detailed accounts provided by Dudley et al. 2006; Adler 2010; Bauer 2010; Bell 2010; Northcutt 2010; Rosenberg 2010); a set of photographs of all of the editors and compilers (three pages); an Introduction (four pages); a Table of Contents of the entire series (eight pages); a List of Contributors to the entire series (two pages); and a list of published volumes of the *Biology of the Reptilia* (two pages).

The series was the brainchild of Carl Gans, and his energy and drive maintained the momentum and cajoling needed to complete this daunting undertaking. Sadly Carl passed away in late 2009, shortly before the release of this final volume,

although he had seen it in proof form. The series stands as an impressive memorial to Carl's many accomplishments, and the herpetological community will be continually grateful for his insightfulness and sense of purpose in marshalling the production of this invaluable resource. Through the duration of the project the Reptilia went from being recognized as a distinct Class of vertebrates to a cluster of clades in the sauropsid lineage. This systematic transformation probably served to intensify research on this cluster of organisms, and the chapters in the *Biology of the Reptilia* have likely been contributory to this, serving to catalyze many new lines of inquiry. If this is so, then the series has fulfilled Carl's goal of facilitating new work rather than simply summarizing what was known up to a particular point in time.

Volume 22 provides us with the opportunity to reflect upon what a monumental contribution the *Biology of the Reptilia* represents. The 13,385 pages (11,997 pages for the chapter-based volumes 1–21) have involved literally hundreds of people over a time span of more than four decades. In this regard it bears comparison to other major synthetic undertakings. One that comes to mind is the assembly of the *Oxford English Dictionary*. From May 12, 1860 (the date of its formal inception), through January 1884 (when the first fascicle was published), to April 19, 1928 (when the final fascicle was published), the time elapsed was almost 68 years, resulting in 15,490 pages that traced the meanings and etymology of every word known in the English language to that time (Winchester 2003). Like the *OED*, the *Biology of the Reptilia* did not appear in parts that followed a structurally sequential pathway, but once the entire enterprise was revealed in its fully-assembled form its potential utility became greatly enhanced. This current volume provides the integrative guide to the series and will serve as a key to many future forays into the literature by reptile biologists seeking new insights and directions. It is unlikely that another exercise of this magnitude will ever be undertaken for these animals.

The sheer magnitude of the task of compiling Volume 22 is brought home in Liner's Introduction. What he expected to take him a year ended up taking 17. Liner provides information on how the compilation was accomplished, and explains how to use the bibliography. The resulting list is more than simply a merging of the reference lists for all chapters, and extensive efforts have been made to correct errors and inconsistencies. Some of these arose as a result of different authors citing the same reference in different ways, and some resulted from the differences in style practiced by the five publishers involved in the series as a whole (Academic Press, Volumes 1–13; John Wiley and Sons, Volumes 14–15; Alan R. Liss Inc., Volume 16; University of Chicago Press, Volumes 17–18; Society for the Study of Amphibians and Reptiles, Volumes 19–22).

The development of consistency is a major accomplishment, although it has, in itself, resulted in certain new errors of which the user will have to be carefully aware (see below). Because these are likely to have been introduced in a rather idiosyncratic manner, each user will likely discover them in relation to the literature that they are most familiar with but will likely not notice them in citations to literature less central to their own research interests.

Doubtless the alphabetical listing of the references will be of major service to those interested in the biology of reptiles in all its guises, but this mode of compilation also limits its searchability. What will probably turn out to be the most helpful and useful component of the volume is the integrated subject index. This serves as a guide to the entire series and allows treatments of topics and taxa to be located directly to page in all pertinent volumes.

Overall, the literature compilation appears to be accurate. I investigated this for my own chapter (Russell and Bauer 2008) and for the first chapter in the first volume (Carroll 1969). I cross-checked for all references listed under the letters "A" and "G" in both of these with the master list in Volume 22—they were all there. As mentioned above, however, the literature list is not without transcriptional errors. For example, the citation for Broili (1905) is correctly formulated in Carroll's (1969) chapter whereas Volume 22 refers to "*hohemicus*" rather than "*bohemicus*" in the title. I am sure that in most cases "corrections" that have been made to citations are effective, but I noted, by cross-checking with my own chapter (Russell and Bauer 2008) and with the original literature, that some have resulted in bibliographic miscitations. For example, the entries for George (1948, 1956) both include "*Uromastyx*" in the title. Although this is the correct spelling for the genus, it is not the form that occurs in the actual titles of these two papers (where "*Uromastix*" is employed). Similarly, all of the publications first authored by Sabine Renous are listed collectively under the name "Renous-Lécuru." This is potentially misleading because publications by this author appear under the names "Lécuru," Renous-Lécuru," and "Renous." The chosen method of compilation will likely lead to a proliferation of errors as a result of the unfortunate practice of secondary citation. Because this volume will be taken to be authoritative it is more likely to engender such introduced errors. Although I recognize that such moves were made so that all publications by a single author could be brought together, this requires prior knowledge of the association of particular names with the same individual. Inconsistency, therefore, creeps in – I note that "Halstead, L.B." and "Tarlo, L.B.H." are listed separately, even though they refer to the same individual. Overall, I feel that it would have been preferable to cite authors and titles exactly as they appear in the original publications as this allows bibliographic searching to be as exact as possible.

These relatively minor concerns aside, however, this volume constitutes an amazingly important resource that deserves a place in the library of every student of reptile biology. An inbuilt shortcoming results, of course, from the time elapsed between the publication of the first (1969) and last (2008) chapter-based volumes, meaning that literature coverage is not equally complete (as of 2010) for all subject areas covered by the series. It is also evident that the hugely valuable compiled literature list could be so much more effective if it was available in electronic, searchable format. One hopes that it will eventually be made available in that way, but until then the impressively large paper version will have to serve as the literary workhorse of herpetologists.

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PUBLICATIONS RECEIVED

Mysteries of the Komodo Dragon, the Biggest, Deadliest Lizard Gives Up its Secrets, by Marty Crump. 2010. Boyds Mill Press (www.boydesmillspress.com). Hardcover. 40 pp. US $18.95. ISBN 978-1-59078-757-1.

This book by well-known herpetologist and children's author Marty Crump provides a wealth of information about *Varanus komodoensis* for younger readers. Drawing heavily on the work of Walter Auffenburg and other researchers, she provides a concise and accessible, but not watered-down, overview of the discovery, natural history, reproductive biology, and conservation status of Komodo Dragons. In addition to explaining the science, the book explains how science is done and is enlivened by photos and anecdotes of varanid researchers from Auffenburg to current students. This is not your grandfather's kid's book. In addition to conveying real information in the text, the book is provided with a bibliography of 21 "adult" references, an index, and information about the Komodo Survival Program. The "mysteries" covered include toxic saliva and parthenogenesis, but the most recent revelations regarding varanid venoms are not discussed.

Recognition and Alleviation of Pain in Laboratory Animals, by Committee on Recognition and Alleviation of Pain in Laboratory Animals (National Research Council of the National Academies). 2009. The National Academies Press (www.nap.edu). Softcover. xv + 170 pp. US $37.95. ISBN 978-0-309-12834-6.

This volume, which updates a 1992 report of the same name, defines pain, considers how animals feel pain, and how pain can be recognized and reduced in vertebrates under experimental conditions. Although the majority of the text is focused on the most commonly used laboratory mammals, the authors have made an effort to provide practical information on birds, reptiles, amphibians, and fish to help foster better care of these animals in the laboratory. It examines the relationship between pain, anxiety, fear, and stress and considers the conditions under which pain is justifiable. The bulk of the book addresses the clinical recognition of pain, pharmacologic and non-pharmacologic approaches to pain management, and humane endpoints for animals in pain, including euthanasia. The report makes discrete recommendations on alleviating pain, but recognizes that information for making such decisions is incomplete, especially for non-mammalian lab animals. An appendix overviews U.S. regulations and guidelines relating to pain recognition and alleviation. The book is extensively referenced and there is a short glossary of about 20 terms and an index. It is aimed at laboratory researchers, institutional veterinarians, animal care and use committee members, and anyone interested in the current state of both scientific and ethical issues related to animal pain.

Sexy Orchids Make Lousy Lovers & Other Unusual Natural Histories, by Marty Crump. 2009. The University of Chicago Press (www.press.uchicago.edu). x + [1] + 214 pp. Hardcover. US $25.00. ISBN 978-1-226-122185-7.

This readable volume presents a series of short vignettes illustrating the natural history of living things, with an emphasis on the interrelationships between animals of the same species, animals of different species, and animals and plants, fungi, and bacteria. The examples selected serve to highlight the diversity of such biotic interactions and focus on some of the more interesting or unfamiliar of these. Although drawn from all sorts of organisms, many examples feature amphibians or reptiles and many are derived from the author's own field experiences. Although accessible to a broad general audience, herpetologists and other field biologists will certainly enjoy the book — even if many examples are familiar to professional biologists, others may not be, and reading about so many interesting types of interactions back-to-back engenders a new appreciation for the sheer diversity and interconnectivity of life. Among the herpetological stories are those dealing with Harlequin Frog amplexus, Marine Iguanas and Sally Lightfoot crabs, alligators and the animals that share their nests, poison dart frogs and the ants that contribute to their toxicity, box turtles and the seeds they help germinate, and the buccal bacteria of Komodo Dragons. Although sources are not referenced directly in the text, the book provides an extensive bibliography of primary and secondary literature relating to the topics discussed, as well as a glossary and an index.

Photoperiodism, the Biological Calendar, edited by Randy J. Nelson, David L. Denlinger, and David E. Somers. 2010. Oxford University Press (www.oup.com). xiii + 581 pp. Hardcover. US $74.00. ISBN 978-0-19-533590-3.

This edited volume clearly illustrates how pervasive photoperiodism is in the natural world. Some of the most well known examples come from plants (e.g., flowering and

dormancy)—treated in six chapters, and insects (e.g., migration, diapause)—dealt with in five chapters, but examples are also provided from fungi, mollusks, and copepods. Seven chapters treat vertebrates, and one of these, by Zachary Weil and David Crews (pp. 399–419) reviews 'Photoperiodism in Amphibians and Reptiles.' This and other chapters discuss the mechanisms by which photoperiodic signals are decoded, the molecular and physiological bases for the regulation of body functions influenced by photoperiodism, and the resultant effects on whole organism biology, for example, reproductive activities. In the case of amphibians and reptiles the interaction of photoperiodic cues with other environmental variables, such as temperature and rainfall, are particularly important. Each chapter is well referenced and illustrated by line drawings and graphs and the book as a whole has a comprehensive index. Physiologists, endocrinologists, as well as ecologists and reproductive biologists should find this a useful, if somewhat selective, overview of this field.

The Evolution of Primary Sexual Characters in Animals, edited by Janet L. Leonard and Alex Córdoba-Aguilar. 2010. Oxford University Press (www.oup.com). ix + 537 pp. Hardcover. US $79.95. ISBN 978-0-19-532555-3.

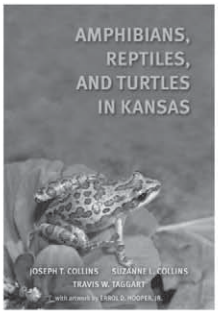
This multi-authored volume considers the evolution of genitalia and other primary sexual characters, as well as the evolution of sexes and sexual systems. After several introductory chapters, including one by Michael Ghiselin on 'The Distinction between Primary and Secondary Sexual Characters,' the bulk of the book is devoted to examining the sexual characters of selected taxa of animals, chiefly mollusks, arthropods, and vertebrates. One chapter each is devoted to amphibians and reptiles. Lynne Houck and Paul Verrell discuss the amphibian reproductive system, sperm, sperm storage, and sperm transfer, and oviposition in caecilians, frogs, and salamanders. Tobias Uller, Devi Stuart-Fox, and Mats Olsson consider similar topics in reptiles and also present a phylogenetic analysis of testis size and sperm production. Both chapters, like others in the book, present suggestions for future research and cite many references, thereby providing entry into the literature. This work is illustrated by numerous black-and-white illustrations and graphs and has an extensive index and will be of special interest to reproductive biologists, morphologists, and evolutionary biologists.

Errata

A geographic distribution note for *Hemidactylus mabouia* (Somma 2010. Herpetol. Rev. 41:107) had been previously published (Somma 2009. Herpetol. Rev. 40:452); thus, the newer version should be disregarded. We regret the error.

In a recent natural history note (Wojnowski 2010. Herpetol. Rev. 41:216–217), the identity of the lizard involved was erroneously reported as *Aspidoscelis sonorae*, but instead appears to represent *A. tigris*. The author also notes that he mistakenly attributed confirmation of the incorrect species identification to W. Sherbrooke. He is grateful to Sherbrooke, C. J. Cole, and B. K. Sullivan for pointing out the error.

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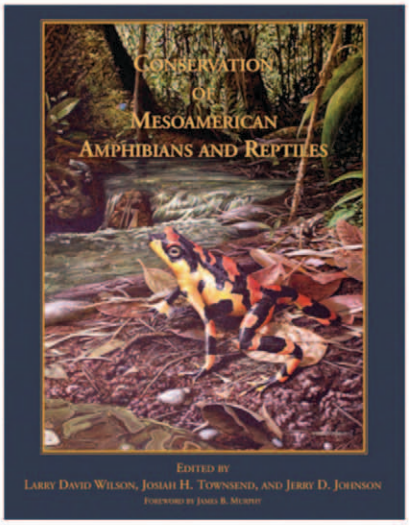
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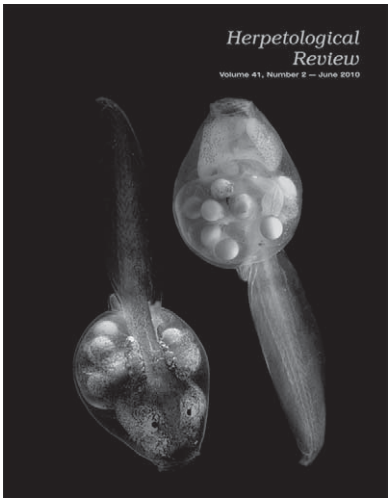
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About Our Cover: *Anotheca spinosa*



Middle America, the waistband of the Western Hemisphere, seems to contain all of its features. Land forms, climate, soils, vegetation and fauna are more varied in Mexico and Central America than most anywhere else on earth. Owing to its contemporary mountain-building, the region boasts no fewer than four tectonic patterns that leave it rich in rugged plateaus sundered by steep escarpments and dotted with massive volcanic cones. Pristine montane rainforests at low to moderate elevations from Veracruz, Mexico, south into western Panama contain a rarely seen and engrossingly distinctive gargoyle of a frog called *Anotheca spinosa.*

It dwells in trees, usually at heights, so the monotypic *Anotheca* remains poorly known. Our knowledge of its life history derives mostly from captive observations performed 132 years after Steindachner described *Anotheca* (Jungfer 1996. Herpetologica 52:25–32; Steindachner 1864. Verh. Zool. Bot. Ges. Wien. 14:539–552). Fertilized eggs are deposited just above the water line in flooded tree holes, bamboo internodes, and other phytotelmata so the larvae must rely on the female for nutrition. She provides them with infertile eggs which often are ingested whole by the tadpoles. Depending upon need and opportunity, minute arthropods and fellow tadpoles may also be included in the diet.

William E. Duellman (pers. comm.) relates an amusing encounter between two accomplished, but feuding, herpetologists—Edward H. Taylor and Emmett Reid Dunn. Having just acquired strange anuran larvae with egg-filled body cavities, Taylor rushed back from fieldwork in Central America and made a preliminary presentation at the 1953 herpetological meetings. He believed he had stumbled upon a gravid neotenic tadpole about to lay eggs. Dunn, taking a wild guess, openly suggested that Taylor was unable to distinguish between the reproductive and digestive tracts. Turns out Dunn was correct and the larvae were subsequently found to be *Anotheca* (Taylor 1954. Univ. Kansas Sci. Bull. 36[8]:589–595). Considering how little was known about oophagous macrophage anuran larvae at the time, Taylor's error is understandable.

Likely uncommon in nature, *Anotheca* is being bred in captivity at the Atlanta Botanical Garden as part of their work with imperiled anurans from Panama. This live collection of amphibians was initially developed as a collaboration between Zoo Atlanta and the Atlanta Botanical Garden and has subsequently evolved into a resource with multiple purposes: 1) to provide an emergency genetic repository for imperiled species, 2) to provide specimens for research and education at other institutions, 3) to develop and refine captive breeding and husbandry techniques for these species, and 4) to transfer the resultant methodology to collaborators working with the same imperiled amphibian species in Panama. Success with this ambitious effort may help assure that future herpetologists might hear that rarest of nocturnal songs: the mysterious "boop-boop" of a calling *Anotheca* in the mist-shrouded treetops of Middle America.



PHOTO BY W. W. LAMAR

A female *Anotheca* kept in the Garden's "Frog Pod" was observed producing food eggs for a clutch of tadpoles from which the cover image was produced. **Danté Fenolio** used a digital Sony Alpha 100 at a shutter speed of 1/125th of a second with a 100mm macro lens set at f/25 and a Sony Macro Flash Unit to record the cover image.

Fenolio is the resident Amphibian Conservation Scientist for the Atlanta Botanical Garden's amphibian conservation program. His work with the Garden currently focuses on Darwin's Frog (*Rhinoderma*) conservation in Chile and ecological and population studies of the Georgia Blind Salamander (*Eurycea wallacei*). An avid wildlife photographer for most of his life, Fenolio is wrapping up a photographic book that focuses on wildlife that spends all or much of their lives in the dark.

SSAR BUSINESS

Thomas Beauvais Fund to Support Color Photographs in SSAR Publications

SSAR is pleased to announce the establishment of the Thomas F. Beauvais Fund to support the increased use of color in both the *Journal of Herpetology* and *Herpetological Review*. The goal of this fund is to encourage the use of high quality color images of amphibians and reptiles for both scientific and aesthetic purposes. This especially applies to new or never-before-illustrated species. Where authors have appropriate images to accompany their articles, they should contact the editor for particulars.

Thomas Beauvais is an amateur herpetologist who lives in Ann Arbor, Michigan. For several years he has been engaged in an extensive bibliographic, biogeographic, and distributional monograph on the Eastern Massasauga (*Sistrurus c. catenatus*). The accompanying photo shows Tom with an exceptionally large specimen from Indiana at the Field Museum in Chicago. Tom is a graduate of Eastern Michigan University and recently retired from a research position at NSF International, a public health and safety company in Ann Arbor. In 2001, he won a Conservation Achievement Award from the Niagara Peninsula Conservation Authority in Ontario for his cartographic and historical research on the massasauga. SSAR salutes his vision and generosity in establishing this fund, which will more fully record the natural appearance of these beautiful animals that we are privileged to study and enjoy. Those persons who wish to contribute to the Beauvais Fund may contact the SSAR Treasurer, Kirsten Nicholson (address on inside front cover).



NEWSNOTES

New Herpetology Collections Manager at LACM

The sections of Ichthyology and Herpetology at the Natural History Museum of Los Angeles County (LACM) are pleased to announce the appointment of Neftali Camacho as Collections Manager of Herpetology. Neftali has worked in Ichthyology and Herpetology for the past six years, assisting with our skeleton fungus decontamination project, curating our frozen tissue collections, and performing a variety of curatorial duties in both sections. Prior to that he was employed at the museum's Marine Biodiversity Processing Center. Neftali brings extensive natural history collections experience to his new position, as well as ex-

pertise on the herpetofauna of California. Many of you are already familiar with Neftali from specimen loan and data requests; he will continue to provide these services in Herpetology as well as overseeing the Herpetology collection and providing access and assistance to collection visitors. Neftali's appointment fills a position left vacant for the past seven years, during which time the Herpetology collection has been overseen by Ichthyology staff. Herpetology holds an estimated 178,000 catalogued specimens from around the world, with special emphasis on collections from the southwestern United States, Mexico, Central America, the Galapagos Islands, and Australia. All inquiries regarding loans, data requests, or collection visits may be directed to Neftali at 213-763-3371 or at <ncamacho@nhm.org>.

Integration of USGS Herpetology Collection Completed at UNM Museum of Southwestern Biology

The collection of amphibians and reptiles curated by the U.S. Geological Survey (USGS) Arid Lands Field Station in Albuquerque has been integrated into the University of New Mexico's Museum of Southwestern Biology (MSB). Specimen data have been merged and the combined database is now available online through several portals, including HerpNET <www.herpnet.org>.

With more than 12,300 fluid-preserved specimens and 200 skeletons, the USGS collection contains large holdings from Colorado (40%), Nevada (32%), and Nebraska, Arizona, Utah, and California (18% combined). The collection includes early (1920s-1940s) reference specimens for studies of food habits (skeletons) collected by Charles C. Sperry, as well as the Colorado State University herpetological teaching collection, with specimens collected by D. Pettus, A. W. Spencer, D. D. Post, and T. P. Maslin. A large series (3500) of reptiles collected from the Nevada Test Site in the 1960s was catalogued in 2008 and includes many Side-blotched Lizards (*Uta stansburiana*) and Western Whiptails (*Aspidoscelis tigris*), as well as other lizards and snakes. These specimens were donated by USGS scientist Phil Medica. Drs. Bruce Bury and Steve Corn of USGS have provided vital support to the collection in many ways during their studies in the western United States. Voucher specimens from surveys of national parks on the Colorado Plateau are the most recent acquisitions.

The USGS collection was relocated from Fort Collins, Colorado to Albuquerque, New Mexico when MSB collections moved to a renovated facility. Specimens previously cited in the published literature with the acronym BS/FC (Biological Surveys Collection/Fort Collins) have been assigned MSB catalog numbers and are cross-referenced with the original BS/FC catalog number. Although the specimens are property of the U.S. Department of the Interior, and primary responsibility for their care and management rests with USGS, integration of the specimens and their associated data with MSB facilitates their use by the greater scientific community.

Information and loan requests can be directed to collection managers Tom Giermakowski (MSB) at <tomas@unm.edu>; 505-277-5130, and Cindy Ramotnik (USGS) at <ramotnik@usgs.gov>; 505-277-5369.

Seeking Herpetologists with Military Experience

Joseph Mitchell and Rob Lovich are gathering information for an article on herpetologists with military experience. The article is to be published in *Natural Selections*, a newsletter produced by the U.S. Department of Defense Legacy Resource Management Program. If you have military service with your country, please consider providing information for their article. The following elements are needed:

1) A brief paragraph on your military experience—branch, where stationed, combat experience if any, other service of note, awards, rank, dates of service, and anything else you can add.

2) A copy of your CV.

3) A photograph of you holding a herp.

The authors will create a paragraph for each herpetologist and will highlight accomplishments subsequent to military service especially if in the area of management where appropriate.

Information and questions should be directed to Joseph C. Mitchell at <dr.joe.mitchell@gmail.com>.

Instituto Butantan Collection Destroyed in Fire

One of South America's largest herpetological collections, focused on snakes and numbering approximately 80,000 preserved specimens, was destroyed in a fire on 15 May 2010. The curatorial offices were not affected. Founded in 1901 by the Brazilian physician Vital Brazil as the Instituto Serumtherapico Butantan, it was renamed as Instituto Butantan in 1915. Aside from its size, the IB collection has been the focus of ongoing active research and had historical importance in that many specimens were endemic to Brazil, and represented large series, often from habitats that no longer exist. Discussions are underway regarding how the international community can come to the aid of our colleagues at Instituto Butantan.

MEETINGS

Meetings Calendar

Meeting announcement information should be sent directly to the Editor (HerpReview@gmail.com) well in advance of the event.

7–12 July 2010—Joint Meeting of Ichthyologists and Herpetologists (ASIH / HL / SSAR), Providence, Rhode Island, USA. Information: http://www.dce.k-state.edu/conf/jointmeeting/

21–24 July 2010—33rd Annual International Herpetological Symposium, Tucson, Arizona, USA. Information: http://www.kingsnake.com/ihs/

5–8 August 2010—Southwest Partners in Amphibian and Reptile Conservation, Colorado State University, Fort Collins, Colorado, USA. Information: www.swparc.org.

10–11 August 2010—Northeast Partners in Amphibian and Reptile Conservation Annual Meeting, Acadia National Park, Maine, USA. Information: http://www.pwrc.usgs.gov/neparc/

13–15 August 2010—Midwest Partners in Amphibian and Reptile

Conservation Annual Meeting. Theme: "Blanding's Turtle Biology, Conservation, and Management." Lorado Taft Field Campus of Northern Illinois University, Oregon, Illinois, USA. Information: http://www.mwparc.org/meetings/2010/

16–19 August 2010—Turtle Survival Alliance & IUCN/SSC Tortoise and Freshwater Turtle Specialist Group Joint Symposium, Orlando, Florida, USA. Information: http://www.turtlesurvival.org/get-involved/2010-conference.

22–26 September 2010—VIII National Congress of Societas Herpetologica Italica, Abruzzo, Italy. Information: shiabruzzo2010.iscrizioni@gmail.com

12–14 November 2010—5th National Symposium on the Ecology, Status, and Conservation of the Diamondback Terrapin, at Louisiana University's Marine Consortium (LUMCON) in Chauvin, Louisiana, USA. Hosted by the Diamondback Terrapin Working Group. Information: www.dtwg.org.

CURRENT RESEARCH

The purpose of Current Research is to present brief summaries and citations for selected papers from journals other than those published by the American Society of Ichthyologists and Herpetologists, The Herpetologists' League, and the Society for the Study of Amphibians and Reptiles. Limited space prohibits comprehensive coverage of the literature, but an effort will be made to cover a variety of taxa and topics. To ensure that the coverage is as broad and current as possible, authors are invited to send reprints to the Current Research section editors, Joshua Hale or Ben Lowe; postal and e-mail addresses may be found on the inside front cover.

A listing of current contents of various herpetological journals and other publications is available online. Go to: http://www.herplit.com and click on "Current Herpetological Contents."

Partitioning of Temporal Activity in Desert Lizards

Competition between similar species coexisting in an ecological community is ameliorated if the species segregate along the lines of food, habitat, or activity time. Of these three factors, foraging ecology and habitat use have received considerable attention; however, research on temporal partitioning is much more limited. In this study, the authors investigated temporal activity in a diverse lizard assemblage in the Simpson Desert in central Australia. Three time periods were defined; sunset to sunrise (daytime), sunset to midnight (early night), and midnight to sunrise (late night), and were examined in both September and November. Ambient temperature and invertebrate prey activity were measured at these times as well. Thirteen lizard species were observed in the assemblage (*Ctenotus ariadne, Ctenotus dux, Ctenotus pantherinus, Egernia inornata, Morethia ruficauda, Menetia greyii, Ctenophorus isolepis, Ctenophorus nuchalis, Pogona vitticeps, Nephurus levis, Varanus brevicauda, V. eremius, V. gouldii*) with 77% of all captures occurring in the day. Only three species (*Ctenotus pantherinus, Egernia inornata, Nephurus levis*) were observed to demonstrate significant nocturnal activity. Abundance of invertebrates was variable, depending on time of day and month, and some lizards, in particular the skink species, had a wider degree of temperature tolerances than the agamids and varanids. The authors conclude that partitioning within the lizards in this assemblage is not evenly distributed temporally.

Gordon, C. E., C. R. Dickman and M. B. Thompson. 2010. Partitioning of temporal activity among desert lizards in relation to prey availability and temperature. Austral Ecology 35:41–52.

Correspondence to: Chris Dickman, Institute of Wildlife Research, School of Biological Sciences, Heydon-Laurence Building (A08), University of Sydney, New South Wales 2006, Australia; e-mail: cdickman@bio.usyd.edu.au.

Impact of Low Population Densities on Fertility in Marine Turtles

Depensation, or the Allee Effect, the reduced per capita growth rate in low density populations, can have severe consequences for already dangerously small populations. Many marine turtles worldwide have suffered serious declines, primarily due to historic overexploitation. In this study, the authors conducted a meta-analysis to examine the potential for depensation on Green Turtles (*Chelonia mydas*) and Loggerhead Turtles (*Caretta caretta*). Using hatching success as an indicator of fertilization success, the authors found no evidence for depensation for either of these species in small nesting aggregations throughout the world. The authors propose a number of mechanisms which may mitigate depensation, including a polyandrous mating system, opportunistic matings between breeding aggregations, and interchange between rookeries. The authors emphasize the importance of monitoring small nesting aggregations, in part to understand the mechanisms that mitigate depensation in these species.

Bell, C. D., J. M. Blumenthal, A. C. Broderick, and B. J. Godley. 2010. Investigating potential for depensation in marine turtles: How low can you go? Conservation Biology 24:226–235.

Correspondence to: B. J. Godley, Marine Turtle Research Group, Centre for Ecology and Conservation, University of Exeter, Cornwall Campus, Penryn TR10 9E2, United Kingdom; e-mail: b.j.godley@exeter.ac.uk.

Senescence in Garter Snakes

Within a life-history context, evolutionary theories of senescence (aging) focus on a trade-off between investing in survival versus investing in growth and reproduction. In high mortality environments, organisms are predicted to develop rapidly and invest in high early reproduction, instead of survival and longevity. In contrast, longevity and delayed reproduction is predicted to be favored in less hazardous environments. Despite these theoretical predictions, investigating these hypotheses empirically is difficult. In this study, the authors investigated six northern Californian populations of Western Terrestrial Garter Snakes (*Thamnophis elegans*), which can be divided into high and low mortality habitats. These populations have been extensively studied and have been demonstrated to have evolved different life spans in keeping with theoretical predictions. In this study, the authors examined a number of physiological traits in neonates after stressed or control gestations to examine different responses of the two populations. Results indicated that neonates from the long-lived

populations were smaller, had more efficient DNA repair mechanisms (but also suffered higher levels of DNA damage), and had more efficient cellular antioxidant defenses and mitochondria. The authors conclude that their study highlights the interrelatedness of stress and life history evolution in reptiles.

ROBERT, K. A., AND A. M. BRONIKOWSKI. 2010. Evolution of senescence in nature: Physiological evolution in populations of garter snake with divergent life histories. The American Naturalist 175:147–159.

Correspondence to: Anne M. Bronikowski, Department of Ecology, Evolution and Organismal Biology, Iowa State University, Ames, Iowa 50011; e-mail: abroniko@iastate.edu.

Costs of Mate Guarding Behavior in Male Whiptail Lizards

Males of many species guard their mates following mating, which may have a number of benefits including reducing extra-pair copulations by females. Despite the potential benefits to the male in terms of fertilization success, mate guarding is also energetically costly. In this study, the authors have examined mate guarding in the Western Mexican Whiptail Lizard (*Aspidoscelis costata*), paying particular attention to the reduction in energy intake when guarding and the increase in male-male competition. The authors also tested whether males adjust their guarding behavior in relation to the perceived fecundity (as assessed by body size) of the female. Observations of a number of matings and subsequent mate guarding behaviors were made. The authors observed that males engaged in mate guarding consumed substantially smaller and less prey than non-guarding males. Further, guarding males were subject to 120% more male-male competitive behaviors than when not guarding. Finally, males were more aggressive when females were large. The authors suggest that these demonstrated costs of mate guarding, and possible survival consequences, must be less than the benefits accrued through mate guarding for this behavior to persist.

ANCONA, S., H. DRUMMOND, AND J. ZALDÍVAR-RAE. 2010. Male whiptail lizards adjust energetically costly mate guarding to male-male competition and female reproductive value. Animal Behaviour 79:75–82.

Correspondence to: Sergio Ancona, Laboratorio de Conducta Animal, Departmento de Ecología Evolutiva, Instituto de Ecología, Universidad Nacional Autónoma de México, A.P. 70-275, C.P. 04510, México; e-mail: ancona.s@gmail.com.

Patterns of Malagasy Chameleon Diversity Revealed

With its impressive diversity and incredibly high level of endemism, the island of Madagascar has long been an area of elevated interest for researchers studying the factors responsible for speciation and endemicity. Chameleons of the genus *Brookesia* are particularly diverse in the region (26 described species) and display a pattern of elevated microendemism, with as many as half only known from a single locality. In this paper, the authors explored three hypotheses potentially driving speciation, geographic distribution, and community assembly. First, mountains may serve as refugia during dry periods; if this is the case, endemic species would be restricted to these high-elevation regions and sister species would tend to occur on adjacent mountains. Second, watersheds may also serve as refugia during dry periods; in this scenario, watersheds with high-elevation headwaters would contain mostly wide-ranging species, endemic species would occur in headwaters with low-elevation headwaters, and sister species pairs would tend to occupy adjacent watersheds (especially low-elevation watersheds and therefore low elevation regions would exhibit greater diversity). Originally postulated by previous researchers, these first two hypotheses were suggested to be caused by Pliocene and Pleistocene climatic fluxuations. A third hypothesis, major rivers functioning as important barriers to dispersal, was also evaluated; this hypothesis predicts that the distributions of species pairs meet at major rivers and that low elevations are the most species-rich. To determine species pairs and examine the timing of speciation, using both mitochondrial and nuclear DNA data from most of the described members of the genus as well as several undescribed taxa (and including samples from multiple localities if possible), the authors simultaneously reconstructed the *Brookesia* phylogeny and inferred the divergence dates within the group. Second, distributional information was accumulated for all taxa (for the nine species known from seven or more localities, correlative niche modeling methods were employed to construct predicted distributions; otherwise point localities were used). These distributional data were used to infer regional species richness and endemism values across the island. The phylogenetic analyses revealed most of the species level diversification far predates the Pliocene. Furthermore, the patterns of species richness and sister species distribution reject rivers or watersheds as important drivers of speciation but support the mountain refugia hypothesis. This study exemplifies the importance of explicit hypothesis testing in evaluating hypotheses of evolutionary history.

TOWNSEND, T. M., D. R. VIEITES, F. GLAW, AND M. VENCES. 2009. Testing species-level diversification hypotheses in Madagascar: the case of microendemic *Brookesia* leaf chameleons. Systematic Biology 58:641–656.

Correspondence to: Ted Townsend, Department of Biology, San Diego State University, 5500 Campanile Drive, San Diego, California 92182-4164, USA; e-mail: townsend@sciences.sdsu.edu.

Resource Use Over Different Spatial Scales in a Snake

Resource selection within a species can be broadly thought of occurring on three different spatial scales: 1) the entire geographical range of a species, 2) the home range of an individual within the landscape, and 3) specific locations within the home range. Most studies of resource selection occur on the second and third of these levels, but as resources in a landscape may be scale dependent, in order to fully understand a species habitat and resource use, wider scales must be considered. In this study, the authors have examined landscape level resource use in the Eastern Hognose Snake (*Heterodon platirhinos*), in southern New Hampshire, USA. Eight snakes were radiotracked for two years, and once landscape availability was controlled for, at the landscape level, snakes were found to choose forest-edge and old field habitats preferentially, and neglect forested habitats and

wetlands. Investigating resource allocation at the landscape level also indicated that snakes preferred low slope and sandy loam soils. These patterns were not detected when only the home range of an individual was considered. The authors therefore emphasize the importance of taking a landscape approach when investigating resource use.

LaGory, K. E., L. Walston, C. Goulet, R. A. Van Lonkhuyzen, S. Najjar, and C. Andrews. 2009. An examination of scale-dependent resource use by eastern hognose snakes in southcentral New Hampshire. The Journal of Wildlife Management 73:1387–1393.

Correspondence to: Kirk LaGory, Environmental Science Division, Argonne National Laboratory, 9700 S Cass Avenue, Argonne, Illinois 60439, USA; e-mail: lagory@anl.gov.

Predator Avoidance Outweighs Thermal Benefits in a Gecko

Many species are faced with multiple predators, which may pose different levels of risk. According to the threat-sensitive predator avoidance hypothesis, prey should match their behavior to the level of risk posed by each predator. In this study, the authors have examined this in the nocturnal Velvet Gecko (*Oedura leseurii*), from eastern Australia, which is preyed upon by two snakes, the relatively dangerous Broad-headed Snake (*Hoplocephalus bungaroides*), which preys on geckos, and the less dangerous Small-eyed Snake (*Cryptophis nigrescens*), which preys on skinks. In the laboratory, geckos show generalized antipredator behaviors to chemical cues from both snakes, however, in nature, these behaviors may have costs, in particular thermal costs. In this study, a number of laboratory trials were used to investigate this question. In the first trial, geckos were presented with two identical shelters, one unscented and the other containing chemical cues from either the Broad-headed or Small-eyed Snake. Next, geckos were presented a cold unscented shelter and a warm shelter, again scented with either Broad-headed or Small-eyed snake chemicals. Finally, two warm shelters were presented, this time one was scented like the Broad-headed Snake, and the other like the less dangerous Small-eyed Snake. In each trial, regardless of the thermal suitability of the shelter, geckos avoided equally shelters scented with either snake, preferring to remain outside a shelter when both were scented, suggesting that Velvet Geckos treat these snakes as equally dangerous. These results were then confirmed in a natural setting, with geckos avoiding sites previously used by both snake species.

Webb, J. K., D. A. Pike and R. Shine. 2009. Olfactory recognition of predators by nocturnal lizards: Safety outweighs thermal benefits. Behavioural Ecology 21:72–77.

Correspondence to: Jonathan Webb, School of Biological Sciences, A08, University of Sydney, NSW 2006, Australia; e-mail: jwebb@bio.usyd.edu.au.

Function of Tentacles in the Aquatic Snake, *Erpeton tentaculatus*

The Tentacled Aquatic Snake (*Erpeton tentaculatus*), has a unique pair of scaled tentacles projecting from the rostral margins of the head. For over a century their function has remained a source of contention, with suggestions that they aid in camouflage, act as lures or ornaments, or aid in the detection of prey by sensing water movement. In this study, in an attempt to shed light on the function of these tentacles, the authors investigated snake behavior and tentacle morphology, induced the optic and trigeminal nerves, and mapped the resulting visual and somatosensory responses in the optic tectum and trigeminal ganglion, respectively. Dissection and microscopy failed to reveal minute sensory structures (which could bestow electromagnetic reception) associated with the tentacle scales; however tentacles were found to be heavily innervated via the trigeminal nerve (as is the pit organ of crotaline viperids). Furthermore, recordings of nervous impulses returning from the tentacles revealed that the tentacles were able to sense very minute water movements (equivalent to the force exerted by 8mg). Finally, snakes were found to strike accurately at digital fish under both normal and infrared conditions, suggesting that detection of water movement alone was sufficient to locate prey. The authors suggest that these tentacles operate alongside the visual system to aid in prey detection, especially in low-light environments.

Catania, K. C., D. B. Leitch, and D. Gauthier. 2009. Function of the appendages in tentacled snakes (*Erpeton tentaculatus*). The Journal of Experimental Biology 213:359–367.

Correspondence to: Ken Catania, Vanderbilt University, Department of Biological Sciences, Nashville, Tennessee, USA; e-mail: ken.catania@vanderbilt.edu.

Are Amphibians Good Indicators of Ecosystem Health?

Amphibians are often considered important indicators of ecosystem health. This is primarily because they are expected to be sensitive to a range of contaminants as they possess permeable skin, a complex terrestrial and aquatic life cycle, and a relatively simple immune system. In this study, the authors have examined the veracity of this reputation, completing a meta-analysis comparing the sensitivity to environmental challenges of amphibians relative to other taxa. Almost twenty-four thousand studies involving 1075 species and 73 chemical agents were examined. Overall, the results suggested that amphibians demonstrate only moderate responses to waterborne toxins. Amphibians are relatively insensitive to heavy metals and pesticides, but demonstrate high sensitivity to phenols, a class of toxins that has been largely overlooked in amphibian studies. The authors suggest that amphibians may not serve as very good barometers of ecosystem health and are prone to persisting in areas that have already been severely impacted. While chemical contaminants may play a role in amphibian declines, this may be indirect, reflecting the population loss or extinction of more sensitive taxa, in particular invertebrates.

Kerby, J. L., K. L. Richards-Hrdlicka, A. Storfer, and D. K. Skelly. 2010. An examination of amphibian sensitivity to environmental contaminants: are amphibians poor canaries? Ecology Letters 13:60–67.

Correspondence to: Jacob Kerby, Department of Biology, University of South Dakota, Vermillion, South Dakota 57069, USA; e-mail: Jacob.kerby@usd.edu.

ZOO VIEW

Herpetological Review, 2010, 41(2), 134–142.
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The Evolution of Keeping Captive Amphibians and Reptiles

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SEVERAL OF THE LADIES IN SOUTHPORT HAVE PURCHASED PETS AMONG THEM, AND IT MAY BE THAT NO SOUTHPORT LADY WILL CONSIDER HER ESTABLISHMENT PERFECT WITHOUT A BABY ALLIGATOR TO BASK ON THE HEARTH RUG, AND GO OUT ON A WALK ON THE PROMENADE WITH HER. WHEN THE PET DEFUNCTS, HE CAN BE STUFFED, GILT, AND PUT IN THE HAT FOR AN ORNAMENT, DON'T YOU KNOW?

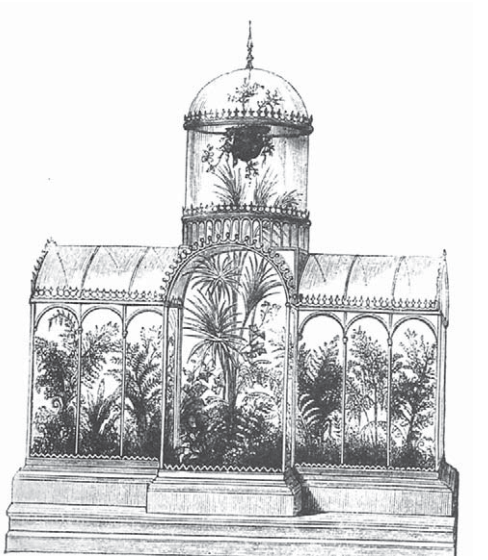
—Frank Buckland in *Notes and Jottings from Animal Life* in 1882

Nature Encased in Glass

In 1688, the French produced polished plate glass in large sizes by casting and hand polishing. Over 45 years later in the United Kingdom, Robert Lucas Chance introduced improved cylinder sheet glass using a German process to produce finer quality and larger panes. "A better system of making sheet glass, from blown cylinders, was introduced into England in 1832 by Chance Brothers and Bontemps. Although the new method, already established in Germany and France, required five types of skilled workers, it was cheaper, produced bigger sheets, and was free from the blemish in the centre… But after only seven years Chance Brothers devised a process by which the sheets could be ground and polished like plate glass… The manufacture of plate glass was introduced into England from Northern France in 1773…" (Derry and Williams 1961:594–595). This glass was used to create the first Crystal Palace in London in 1851. The process was used extensively until early in the 20th Century to make window glass. From this period onwards machines were developed to automate the production of window glass.

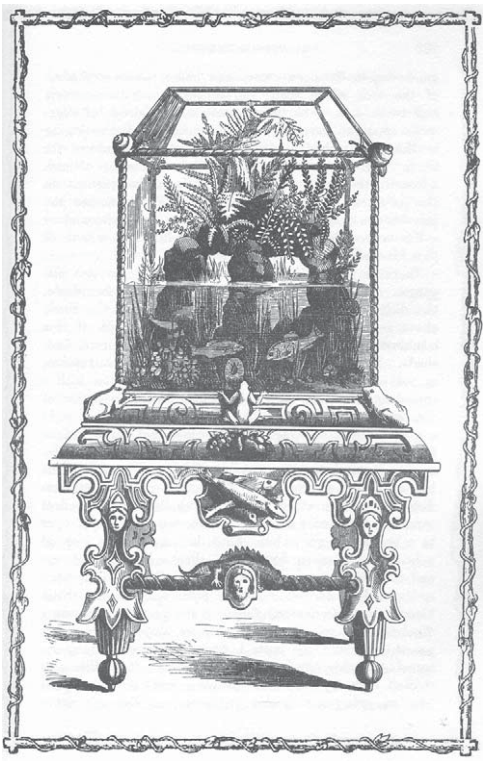
There is no question but that the availability of inexpensive window glass was one of the main factors for the rise of fern cases, aquaria, terraria, and vivaria in Europe. Fanciers interested in the behavior and biology of fishes, tadpoles, and newts were now able to look closely at them in an aquarium rather than peering into a pond or small bottle to catch a fleeting glimpse.

In 1829, Nathaniel Bagshaw Ward discovered that two seedlings, a grass and a fern, had *accidentally* sprouted in a closed glass bottle, containing a layer of damp soil he was using to pupate a sphinx moth chrysalis. He experimented with other closed glass containers and found that he could keep a number of ferns successfully. Glass was expensive as it was subject to a heavy excise tax (to pay for the Napoleonic wars) until 1845. After the tax was repealed, glass was affordable so Ward's "Closely Glazed Cases" were available widely and his invention reached its full potential. Wardian Fern Cases became the rage and virtually every wealthy Victorian lady's drawing room had fern-growing cases. Shirley Hibberd (1856) loved ferns: "Plumy emerald green pets glistening with health and beadings of warm dew." Pteridomania, the craze for ferns, was fueled by books such as *The Ferns of Great Britain* by Anne Pratt in 1855, *Hardy Ferns: How I Collected and Cultivated Them* by Nona Bellairs in 1865, and even as late as 1905 with George Schneider's work called *Choice Ferns for Amateurs: Their Culture and Management in the Open and Under Glass*. Well-dressed Victorian women often collected wild plants and animals for their enclosures, as seen in the picture "Gathering Ferns" from *London Illustrated News* in 1871. The picture is by William Kay Blacklock and is available on the web at http://goldenagepaintings.blogspot.com/2009/02/william-kay-blacklock-gathering-ferns.html. Orchids and other tropical plants were kept in fern-cases as well.



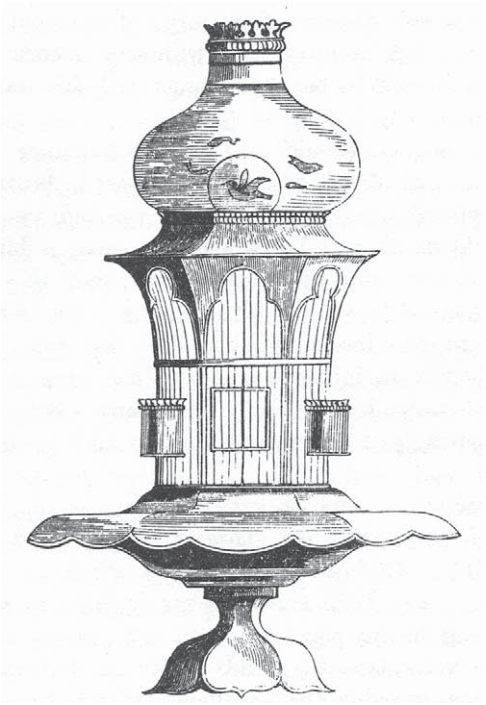
Wardian Fern Cases could be very elaborate. This terrarium was modeled after the Crystal Palace of London's Great Exhibition in 1851.

By the mid-1800s, the drawing rooms of the wealthy were often filled with a myriad of glass containers, large and small, housing plants and animals. All of these items were sometimes advertised in natural history books available during this time. One of the curious facts is that fern and aquarium crazes were almost always feminine interests during the Victorian era. "But the role of women as encouragers of natural history must not be underrated. It is unlikely that so many natural history societies, museums, zoological and botanical gardens and public aquaria would have been founded if they could not have relied on regular female support." (Barber 1980). Charles Kingsley described the Victorian lady naturalist at home in *Glaucus* in 1855: "I have seen the young London beauty, amid all the excitement and temptation of luxury and flattery, with her heart pure and her mind occupied in a boudoir full of shells and fossils, flowers and sea-weeds, and keeping herself unspotted from the world, by considering the lilies of the field, how they grow." Why were



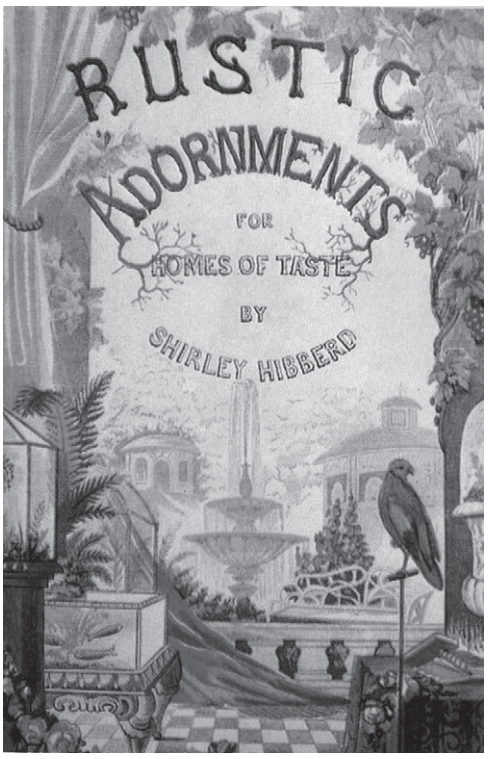
In 1856, Shirley Hibberd published *Rustic Adornments for Homes of Taste*. Pictured here is Aquarium combined with Fernery. Note frogs at base.

so many natural history books and periodicals published during this period? Victorians believed that it was slightly common to obtain animals and plants for parlors and drawing rooms simply for amusement; if flora and fauna were to be shown, there had to be an educational component attached to their passion for collecting. George Brettingham Sowerby the Second in *Popular History of the Aquarium* put it this way in 1857: "Nor is it only for amusement that such parlour oceans and lakes are prepared and stocked; they are invaluable as a means of instruction."



Combination aquarium and bird cage from *Rustic Adornments for Homes of Taste*. At top of enclosure are two bowls. Birds had access (from lower wire cage) to smaller bowl within the larger one where they were juxtaposed to fishes swimming around them. This was a popular Victorian design feature.

In 1856, the pioneer naturalist Shirley Hibberd published *Rustic Adornments for Homes of Taste and Recreations for Town Folk in the Study and Imitation of Nature* . This is the most complete book published during the Victorian era covering fern cases, marine and freshwater aquaria, aviaries, apiaries, and outdoor gardens and it is one of the most beautiful with elaborate drawings and colored floral borders on each page. Hibberd wrote in the Preface, "Whatever serves to heighten the enjoyments of home, and add fresh graces to the domestic hearth, must be worthy of encouragement and culture."



Cover from *Rustic Adornments for Homes of Taste*.

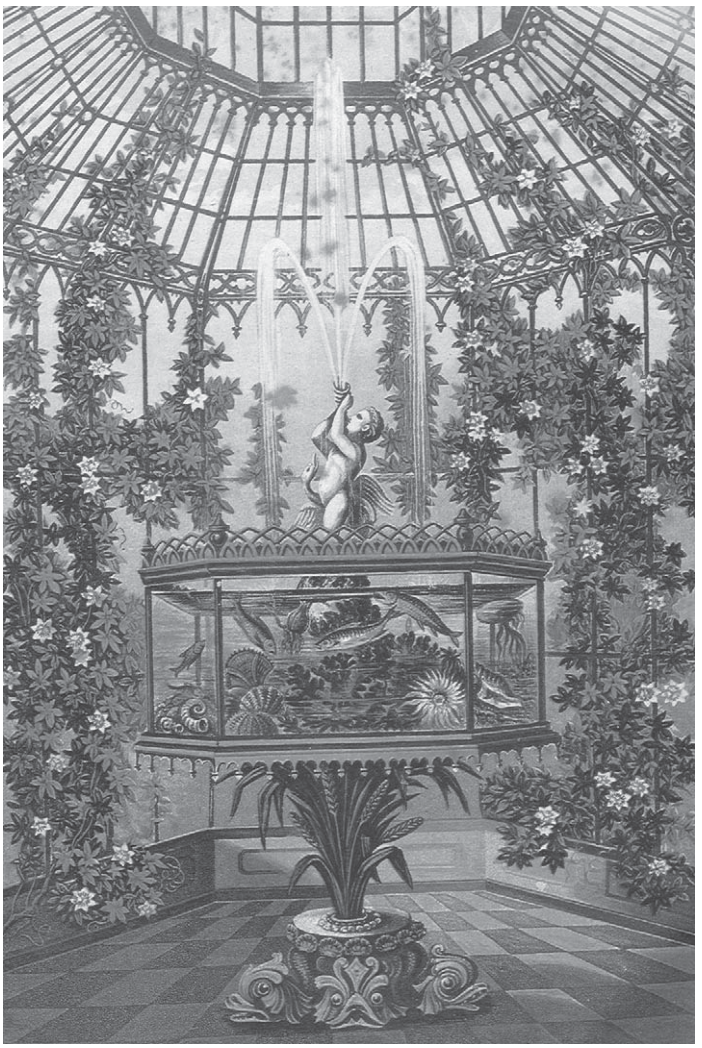
But there was a downside to the fern craze: "The poor Ferns, like the wolves in olden times, have a price set upon their heads, and they in like manner will soon disappear. We must have 'Fern laws,' and preserve them like game" (Bellairs 1865). Another problem which surfaced was that ferns quickly died in the polluted London air. As interest in ferns began to wane in England, the development of aquaria filled the void. "When every drawing-room contained a fern case, they began to seem a little dull, or even—horrid thought!—a little vulgar." (Barber 1980.).

From Land to Water

The keeping of goldfish substantially predates the aquarium craze, dating back to at least 1000 AD in China. The Chinese exported goldfish breeding to Japan and Korea around 1500 AD. Goldfish reached Europe around the beginning of the 17th Century and the US in 1876. These fishes were bred to be seen from above in shallow porcelain bowls.

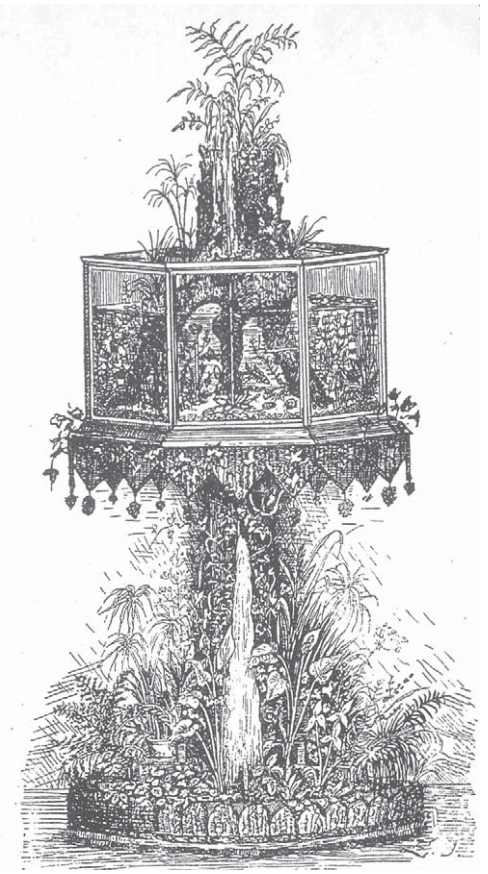
In 1850, Robert Warington kept two small goldfish and a *Valisneria spiralis* plant in a twelve-gallon tank for almost a year without changing the water. He is credited with discovering the "Balanced Aquarium." During the same period, Philip Henry Gosse was independently pursuing the same experiments. Gosse published *A Naturalist's Rambles on the Devonshire Coast* which described his somewhat unsuccessful adventures at aquarium-keeping. In 1853, he said "Let the word AQUARIUM then be the one selected to indicate these interesting collections of aquatic animals and plants."

Warington and Gosse were important figures in contributing to the new aquarium craze in Victorian England. In 1856, Gosse wrote the first book on the marine aquarium entitled *A Handbook to the Marine Aquarium* . . . and it contained an advertisement by W. Alford Lloyd: For Sale—15,000



Some aquarium presentations were stunning. Illustration from *Cassell's Household Guide* in 1869?–1871?.

specimens comprising over 200 genera in 50 large glass aquaria. Other authors published books on aquarium keeping: *Ocean Gardens: The History of the Marine Aquarium, and the Best Methods Now Adopted for its Establishment and Preservation* by H. Noel Humphreys in 1857; *The Marine Aquarium: Directions for its Preparation and Management* by R. M. Stark in 1857; *Common Objects of the Sea-Shore* by Reverend John G. Wood in 1857; *The Family Aquarium; or, Aqua Vivarium ... Being a Familiar and Complete Instructor upon the Subject of the Construction, Fitting-up, Stocking, and Maintenance of the Fluvial and Marine Aquaria* by Henry D. Butler in 1858; *Cassell's Household Guide* in 1869?–1871?; *The Student's Aquarium (Marine and Fresh Water): How to Make and Manage* by S. Jacob in 1886; *The Amateur Aquarist* by Mark Samuel in 1894; and *Das süsswasser-aquarium. Geschichte, flora und fauna des süsswasser-aquariums, seine anlage und pflege* by Ernst Bade in 1898. Some of these books offered instructions for collecting animals and plants at the seashore and early pictures again show Victorian women with billowing dresses, buckets, and long-handled dip nets searching the tide-pools (see Bedell 2009).



Beautiful aquarium from *Das süsswasser-aquarium. Geschichte, flora und fauna des süsswasser-aquariums, seine anlage und pflege* by Ernst Bade in 1898.

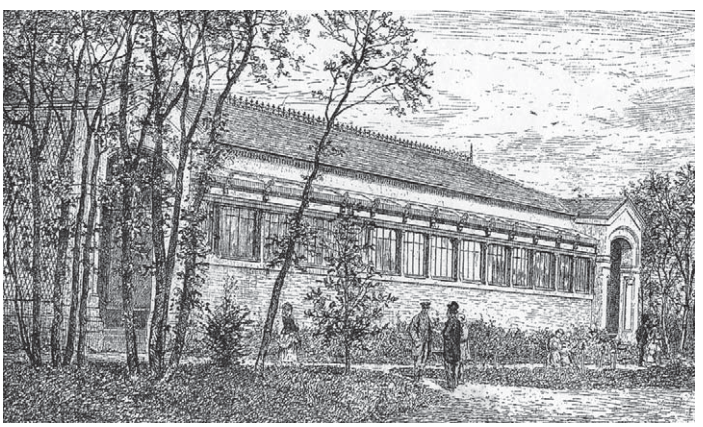


Illustration of public aquarium in Jardin Zoologique d'Acclimatation in Paris from *Le Jardin d'acclimatation illustré: Animaux et plantes / par Pierre-Amédée Pichot ... Avec une préface par M. Albert Geoffroy-Saint-Hilaire . . .*

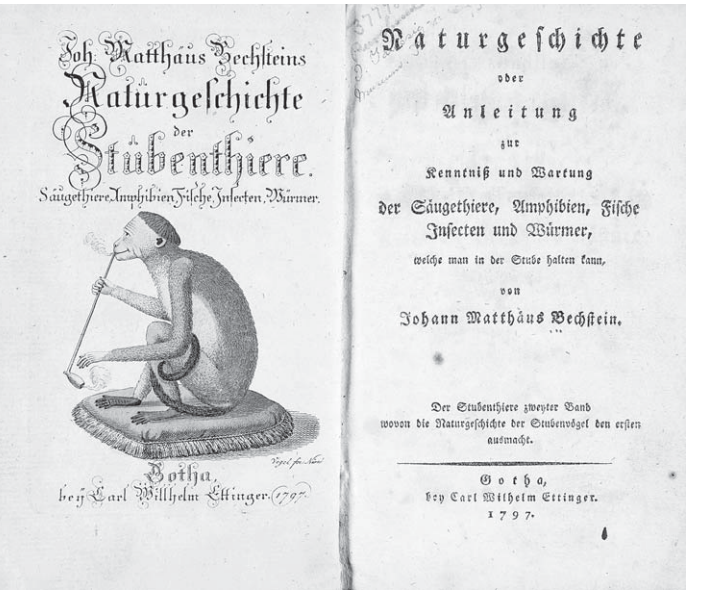
Imprint: Paris, Hachette et cie [etc.] 1873. Credit: Courtesy of Polly Lasker, Smithsonian National Zoological Park.

Public interest in aquatic organisms gave rise to three public aquariums in Europe: Natura Artis Magistra in Amsterdam in 1838, London Zoo in 1858, and Jardin d'Acclimatation in France in 1873.

But then interest in aquaria began to slow down as well. "Some years ago, a complete aquarium mania ran through the country. . . The fashionable lady had magnificent glass-plated aquaria in her drawing room, and the schoolboy managed to keep an aquarium of lesser pretensions in his study. . . So, in due course of time, nine out of every ten aquaria were abandoned; many of the shops were given up, because there was no longer any custom; and to all appearance the aquarium fever had run its course, never again to appear, like hundreds of similar epidemics." (Wood 1859).

Reptiles and Amphibians Are Added to the Mix

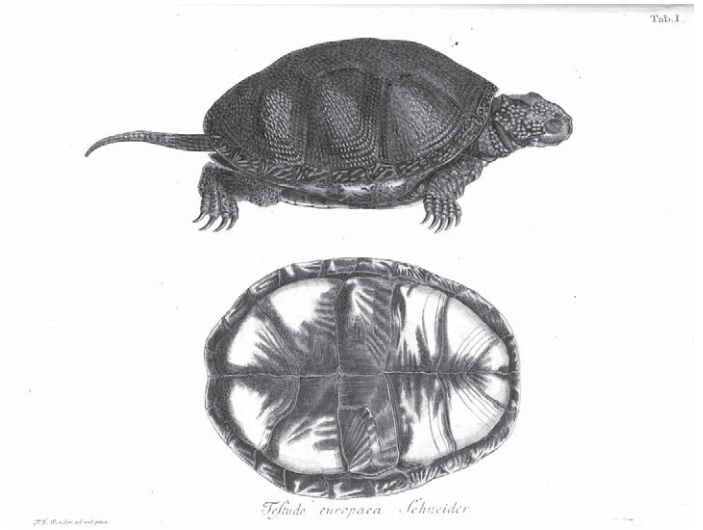
Johann Matthaeus Bechstein wrote the first book on captive care of domestic animals and pets in 1797. This intriguing volume was called *Naturgeschichte; oder, Anleitung zur Kenntniss und Wartung der Säugethiere, Amphibien, Fische, Insecten und Würmer, welche man in der Stube halten kann* (Natural History; or, Guide to the Knowledge and Care of Mammals, Amphibians, Fish, Insects and Worms Which Can Be Kept in the Home). His book dealt with five herp species: European Pond Turtle (*Testudo orbicularis*, now *Emys orbicularis*), Common Treefrog (*Rana arborea*, now *Hyla arborea*), sand lizard (*Lacerta agilis*), Great Crested Newt (*Lacerta palustris* and *lacustris*, now *Triturus cristatus*) and European Grass Snake (*Coluber Natrix*, now *Natrix natrix*). The terms aquarium, terrarium, or vivarium had not yet arrived and plate glass was not widely available, so Bechstein used descriptors like little boxes, buckets, sugar glasses, containers made of porcelain, stoneware and so on (Heichler and Murphy 2004).



Engraved title page and printed title page of *Naturgeschichte; oder, Anleitung zur Kenntniss und Wartung der Säugethiere, Amphibien, Fische, Insecten und Würmer, welche man in der Stube halten kann* by Johann Matthaeus Bechstein in 1797. Published in color in *Herpetological Review* 2004, 35(1):8–13.

Nathaniel Ward discovered a robin trapped in his fern-house—it lived and thrived for six months until escaping. This episode gave him the idea of developing the vivarium. He described this idea in an article called "On vivaria" in the *Garden Chronicle* in 1855.

When the reptile building opened at the London Zoo in 1849 and the collection needed to be expanded, zoo employees exchanged herps with private fanciers to fill in the gaps (Keeling 1992). One such example was C. R. Walker at the establishment called "The Vivarium" who sent twenty-five assorted skinks, geckos (possibly *Naultinus*?) from New



Johann Matthäus Bechstein on the Commendable Characteristics of the European Pond Turtle (translated from German): "It cannot be said that their movements are varied or beautiful, or that these animals may be counted among those which are entertaining; however, their very rarity, and the desire to have something alive also from this class of animals under one's care and supervision makes them attractive to the amateur. They can also be fattened up so as to make use of their tasty (even though hard to digest) meat, once the eyes have been satisfied by their sight. Already clever experiments have been made with these animals: Mr. Merz in Paris shut the mouth of one with wire and closed up the nostrils with sealing wax; nevertheless the animal lived another 30 days without food or breathing. This reveals the tenacious vitality which these animals possess."

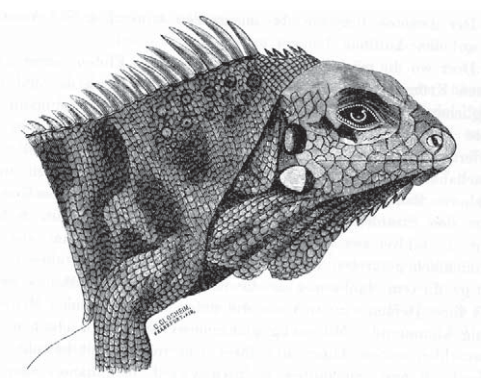
Illustration from *Ioannis Davidis Schoepff Historia testudinum iconibus illustrata* by Johann David Schöpf, 1792 [–1801].

Credit: Collections of Ernst Mayr Library, Museum of Comparative Zoology, Harvard University.

Zealand, and treefrogs. In addition to the exchanges, many private parties generously donated rare and unusual amphibians and reptiles to the Zoo, such as Long-Nosed Crocodiles, Radiated Tortoises, and a variety of cobras, African Rock Pythons, Emerald Tree Boas, and a multitude of European taxa.

The Exeter Exchange in London was a famous menagerie, beginning in the 1770s and lasting until 1829, which specialized in the sale of exotic reptiles. In 1810, the menagerie was acquired by Edward Cross, who renamed the operation the "Royal Grand National Menagerie" and developed a thriving commercial supply company with customers in Europe and the US. Another well-known dealer in London was a Mr. Kendrick who assured his clients that every reptile for sale came from "Brazil," including Red-eared Sliders, Painted Turtles, and Chameleons (Coote 2001).

In 1884, Johann von Fischer from Vienna, known by many as the founder of modern herpetoculure, published *Das Terrarium, seine Bepflanzung und Bevölkerung*, with recommendations for aquaria and terraria design, plants suitable for the terrarium, food and feeding, and detailed descriptions of the husbandry requirements for a wide array of amphibians and reptiles; his book is accompanied by many drawings. In addition to his book, Johann von Fischer published detailed descriptions on the maintenance and behavior of other captive herpetofauna, many of which were published in the journal *Der zoologische Garten* (see Murphy, 2005 for list). In his book (1884), Johann von Fischer listed his recommendations for amphibian and reptile combinations in various mixed-species terrariums. His lists were long and varied, and filled with rare taxa. What seems true is that there were many sources throughout the world for obtaining herps to be sold in Europe. One example should suffice: taxa which can be kept in the "Chamaeleonshaus" with the Common Chameleon (*Chamaeleo chamaeleon*): *Platydactylus*, *Hemidactylus*, *Ptyodactylus*, *Phyllodactylus*, *Spaeriodactylus*, *Gymnodactylus*, *Stenodactylus*, various *Phrynosoma*, *Ecphymotes torquatas*, *Stellio vulgaris*, *S. cyanogaster*, *Tropidosaura algira*, *Psammosaurus Edwardsii*, young *Scuicus officinalis* and *Gongylus ocellatus*, *Seps chalcides*, *Heteromeles mauritanicus*, *Ophiomorus miliaris*, and *Typlops vermicularis* (nomenclature follows J. v. Fischer).



In 1884 Johann von Fischer published *Das Terrarium, seine Bepflanzung und Bevölkerung*. Shown here is Tuberculated Iguana (*Iguana tuberculata*, now *Iguana iguana*).

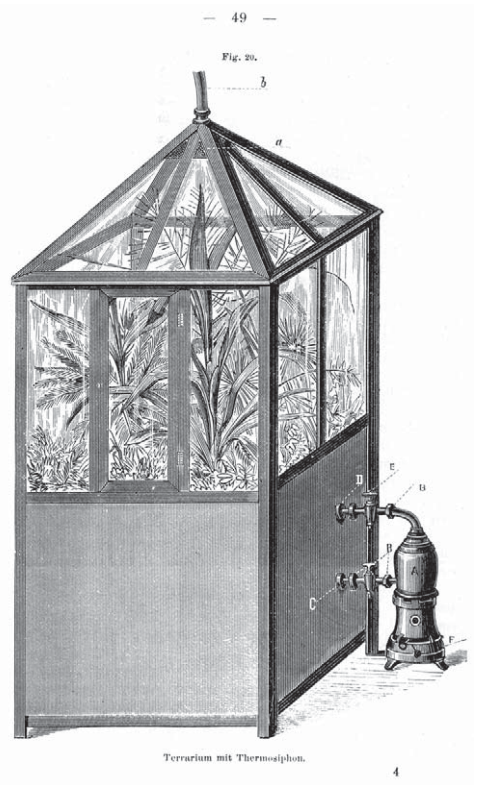


Illustration of Terrarium with "Thermosiphon" for temperature control from *Das Terrarium, seine Bepflanzung und Bevölkerung.*

The first book on herpetoculture in English was the Reverend Gregory Climenson Bateman's *The Vivarium*, published in 1897. There were many advertisements for animals, plants, and supplies in his book. According to Bateman, a broad range of live reptiles and amphibians were obtainable in London in 1897. In addition to the common European species, a number of rarer exotic types were offered for sale: Small Monitor Lizards, Common and Red Tegus, Bearded Dragons, young American Alligators and Crocodiles, Diamond Pythons, African Rock Pythons approximately 4 feet long, Ball Pythons, Anacondas, Horned Frogs, Giant Salamanders, and Olms. Remarkably, Tuataras were accessible, described by Bateman: "Some time ago, I was looking at the various animals in a very large dealer's establishment, when I made a remark about a fine pair of Tuateras which I saw in a big cage. The assistant who was with me immediately opened the door of the den and seized one of the reptiles by the tail, and I shall not readily forget the ominous sound made by the animal's closing jaws as he just missed the man's fingers, at which he had just snapped. I at once mentally resolved never to catch a Tuatera by the tail. As I congratulated the man upon his escape, he said, 'I am a bit lucky this time, for I have just come out of the 'orspital, where I have been laid up with blood-poisoning through the bite of one of them pythons.'"

Bateman also published on aquarium construction, captive husbandry of plants, weeds, fishes, mollusks, insects, etc, and management of freshwater and marine aquaria. Murphy (2007) provided a list of amphibians and reptiles with prices which were available in London during the time.

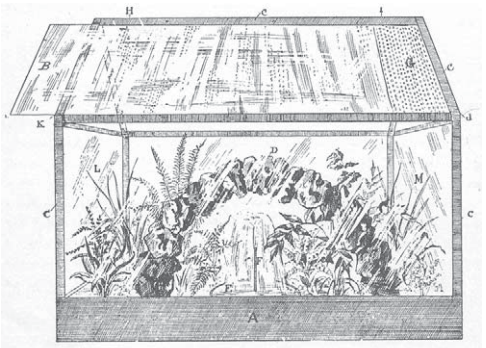


FIG. 9.—FERNERY, WITH FOUNTAIN AND ARCH, VERY SUITABLE FOR SOME REPTILES AND BATRACHIANS.

James L. Willson,

Live Stock Provider,

6 & 8, Goodge St., London, W.

(Two doors from Tottenham Court Road).

IMPORTER AND EXPORTER OF

Every Description of Wild or Domestic Animal,

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REPTILES, Cold Water GOLDFISH, and BIRDS.

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SUPPLIED AND STOCKED.

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Choice Singing Canaries.

AVIARIES, CAGES, AND SPECIAL SEEDS.

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STATE WANTS. LIST POST FREE.

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ERNEST CLIFTON & CO.,

43, Oxford Street, & 1, Saville Street,

MANCHESTER.

Aquarium, Vivarium, & Fern Case Manufacturers, Rockworkers, &c.

THE rapid and general appreciation of the Vivarium in the last few years has caused us to largely import and cater for the stocking of same. We have now collectors in Algiers, Cairo, Alexandria (Africa), Bologna, Rome (Italy), Berlin, Vienna, Buda Pesth, Sydney, Paris, &c., and nearer home, so we have no hesitation in asking new and old patrons to write to us for our list from time to time.

When we say that the Professors of Owen's College (Manchester), University College (Liverpool), University (Edinburgh), Royal College of Science (Dublin), Queen's College (Cork), &c., patronise us largely, and solely rely on us for special reptiles, &c., it speaks for itself.

In the Manufacturing Department we are able to compare most favourably with others, and in addition to our sixteen-page Illustrated Catalogue we will send a sketch and price of any new idea that our patrons wish carried out. As a proof of the soundness of our work, Mr. Walmsley, Manager, Blackpool Aquarium, has engaged our Mr. Clifton to make sixty Vivaria (various sizes) for the next season.

[COPY.]

Brighouse, July 10th, '97.

Dear Sir,—Permit me to give you a perfectly unsolicited testimonial, not only as to the value of your wares, but also as to the *base fides* of yourself. I have done business with you for years, and *every* transaction I have had with you has been executed with a completeness and promptitude beyond compare. The specimens dealt in by yourself and the prices charged for them compare most favourably with those charged by the best London, Parisian, and Continental wholesale dealers, with whom I am frequently in contact.

Faithfully yours,

MR. ERNEST CLIFTON. HENRY J. BARBER.

AQUARIUM & FERN CASES

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REPTILE CASES, WINDOW CONSERVATORIES, BOXES, &c., MANUFACTURED BY

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A. GREEN,

Taxidermist and Dealer in British Reptiles, and British and Foreign Birds,

4, CUMNOR TERRACE, BOURNEMOUTH.

GENUINE SPECIMENS of the CORONELLA often ON HAND. ESTABLISHED 1871.

EDWARD GERRARD & SONS,

Naturalists, Taxidermists, & Osteologists,

61, College Place, Camden Town, LONDON,

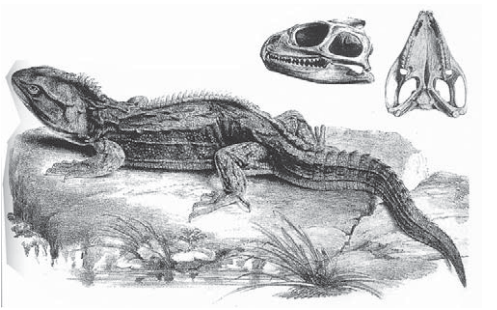
HAVE A

Large Collection of Reptiles in Spirit,

For sale. Lists sent on application.

Skins Dressed and Mounted for Museums or Decoration.

Advertisements for animals and equipment from Reverend Gregory Climenson Bateman's *The Vivarium*, published in 1897. Bateman offered sage advice for the herpetoculturist in 1897. "In the construction of Vivaria, all chance of the captive's escape should be avoided as far as possible. For it is rather mortifying to realise the loss of a valuable Snake, or a favourite lizard; nor does one get much encouragement in a hobby of this kind should he be often obliged to ask the ladies or servants of his home if they may happen to have seen anything of the missing Reptiles."



At the end of the 19th Century, Tuataras were offered for sale by London animal dealers. Reverend Bateman purchased a pair from the London Zoo for £2.00 ($3.00 US). John Edward Gray had described the "Tuatera" from New Zealand in his *The Zoological Miscellany* in 1842, naming it *Hatteria punctata* and placing the taxon in the lizard family Agamidae. Today it is called Tuatara (*Sphenodon punctatus*) and placed in the Suborder Rhynchocephalia. This lovely plate (#20) is from *The Lizards of Australia and New Zealand in the Collection of the British Museum* by Gray, 1867.

Carl Hagenbeck Senior is a name known by virtually every zoo and aquarium professional for in 1907 he developed one of the finest zoos in the world in Hamburg, Germany: Carl Hagenbeck's Tierpark at Stellingen. He built the first exhibits without bars for zoos and served as a design consultant for zoos throughout the world. From 1841 until 1863, he ran a small pet shop featuring exotic animals, including reptiles such as boas and pythons. Later in 1866, his son Carl Junior took over the reins and built the operation into a major animal supplier, sending reptiles to dealers and zoos throughout the world (Coote 2001).

Oskar Boettger described a unique herpetological cooperative arrangement in his paper *Bericht über die Leistungen* in 1890: "Regarding the purpose and setup of the Laboratoire d'Erpetologie in Montpellier [France], a trading and buying organization, one finds information in Humboldt (Dammer), Volume 8, pages 34–35." [translated from German in *Archiv für Naturgeschichte* on p. 160.]. This paper in Humboldt is here loosely translated with some comments in parentheses to clarify how the text was interpreted: "The Laboratoire d'Erpetologie in Montpellier is an organization that exchanges and sells under the direction of our worthy colleague, the well-known herpetologist Dr. J. v. Fischer. The Laboratoire, in which salesmen (researchers would be a better word) can offer living wares, encompasses 147 members throughout Europe and 203 in other parts of the world. The purpose of the organization is to offer reptiles and amphibians of all sorts to members at cost and to make the study of these animals easier. The excess (surplus animals) are released and the profits are divided among members. Donated animals are not sold. Each member is obligated annually to publish two articles in a domestic or foreign publication. The honorarium for

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Aquarien- und Terrarien-Tieren.

Seltenheiten stets auf Lager.

Alleiniger Vertreter der Firma Otto Eggeling-New-York.

Es kommen nur gesunde gut fressende Tiere zum Versand.

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in einfacher und besserer Ausführung.

Aquarien- und Terrarientiere und -Pflanzen in grösster Auswahl, sowie sämtliche Hilfsapparate. — Preisliste frei.

Heinrich Henkel

Neuwiese Glasberg,

Darmstadt.

Gross. Hess. Hofbouquetlieferant, Kaiserlich Russischer Hoflieferant. Hoflieferant weiland Ihrer Majestät der Königin Victoria von England.

Permanente Aquarium-Ausstellung.

Nymphaea, Flor März bis Oktober; **Nelumbium,** Flor Juni, Juli, August. **Vorzüglichste Neuheiten in Pflanzen und Fischen durch eigene Sammler.** — Cataloge auf Anfrage frei. — Besuch jederzeit gestattet.

Advertisement from Hugo Kukhoff's *Das Terrarium und seine Bewohner: ein kurzer illustrierter Ratgeber für Terrarienfreunde* around 1903.

each publication is given to the organization and at the end of the fiscal year is allotted equally. In addition, these colleagues take charge of distributing the excess animals and disposing of dead animals and retain 50% of the profit. The Laboratoire has a fund donated by members to encourage young people to go to unexplored provinces or regions of the world to collect and learn. In addition, for the best collectors there are prizes, which include a microscope from Zeiss in Jena, books, or further travel. Anyone can become a member as long as he demonstrates that he works in this field. Members must prove that they give any uncommon animals to appropriate institutions at no cost if they (the institution) promise to publish accounts of the animals. They keep the honorarium. Eventually a society journal will appear. Each violation—so far there have been none—will result in ejection from the society. The personal word of honor is the only guarantee other than the signature of the member. No hearing will be held, but his name will be circulated as 'manquant a sa parole' (a breaker of his word). The institute up to this point makes a profit of about 1000–1200 francs. The director holds sole responsibility for leadership and is only assisted by a book keeper."





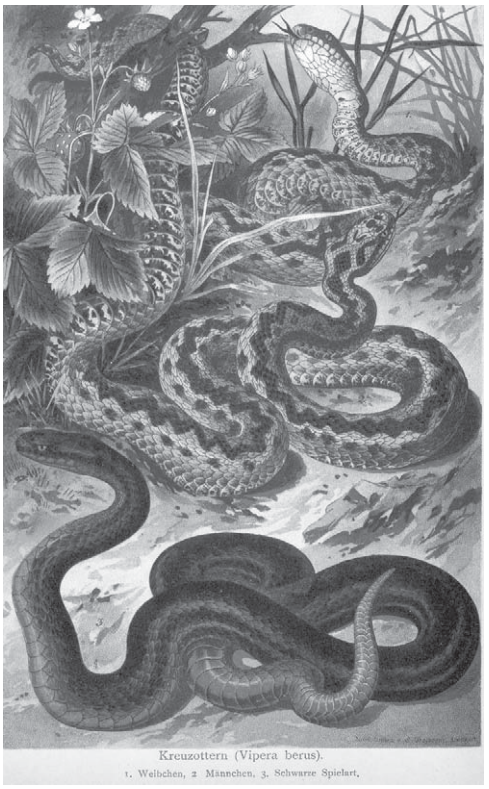
Paul Krefft wrote a major guide to terrarium science in 1908 called *Das Terrarium* with many illustrations of aquaria and terraria. Pictured here are living plants suitable for the terrarium.

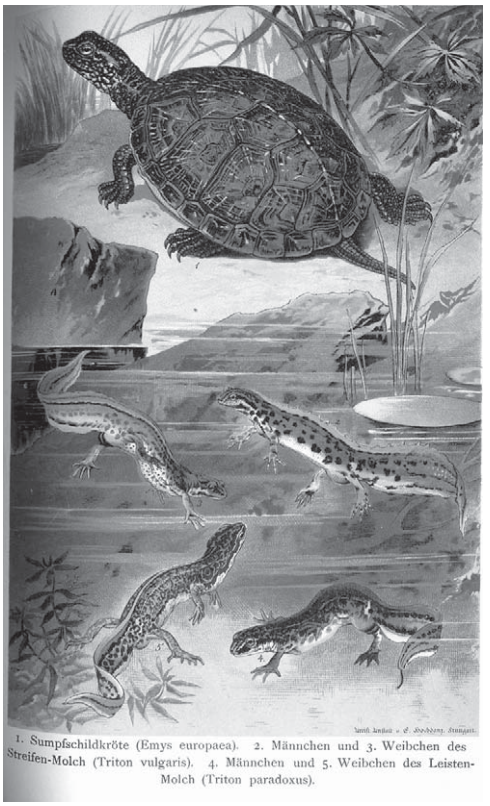
Strolling on the promenade in 19th Century Paris with a live turtle was all the rage, as described by Walter Benjamin in his essay: "Around 1840, it was briefly fashionable to take turtles for a walk in the arcades. The *flâneurs* [idlers] like to have the turtles set the pace for them. If they had had their way, progress would have been obliged to accommodate itself to this pace . . . this attitude did not prevail."

A number of books and articles on herpetoculture began to appear after the Bateman volume. Hugo Kukhoff's *Das Terrarium und seine Bewohner: ein kurzer illustrierter Ratgeber für Terrarienfreunde* was written around 1903. Five years later, Paul Krefft wrote a seminal guide to terrarium science called *Das Terrarium.* Dr. Ernst Bade published *Praxis der Terrarienkunde,* a slim volume filled with pictures of terraria and suitable inhabitants for the enclosures. *The Freshwater Aquarium and its Inhabitants; A Guide for the Amateur Aquarist with Many Illustrations from Nature* by Otto Eggeling and Frederick Ehrenberg, written in 1908, had many references to captive herps.

There were books that combined the amateur literature on herp keeping with professional literature, such as Robert Snedigar's *Our Small Native Animals: Their Habits and Care* (1939) and Vinson Brown's *How to Make a Miniature Zoo* (1956). Raymond L. Ditmars of the Bronx Zoo popularized captive herps in his many books during the early part of the 20th Century although he did not write a specific guide to herp keeping.

During the second half of the 20th Century, books and papers on captive amphibians and reptiles exploded on to the scene. In 1955, Wilhelm Klingelhöffer, a German medical doctor, compiled an extraordinary treatment of reptiles and amphibians in captivity called *Terrarienkunde.* This four volume work was the "bible" for European zoo workers and herpetoculturists. Six years later, Alfred Leutscher, founder and secretary of the British Herpetological Society wrote *Vivarium Life.*





Some books on keeping amphibians and reptiles in captivity had beautiful artwork. These original colored drawings are from Ernst Bade's *Praxis der Terrarienkunde* in 1907. Also shown is a terrarium from the period.

A Manual on Amphibians, Reptiles and Cold-Water Fish.

Around 1952 in Great Britain, there were three main suppliers: Palmers of Camden Town; South-Western Aquarists of Glenburnie Road, Balham, owned by George Boyce; and Robert Jackson from Altrincham, Cheshire. Most of the stock was from Europe: Grass Snake, Tessellated Water Snake, Aesculapian Snake, Four-lined Ratsnake, Wall Lizard, Jewelled or Eyed Lizard, Berber Skink, European Pond Turtle, Spur-Thighed and Hermann's Tortoises, and Spanish Terrapin (Keeling, 1992).

Germany was and continues to be one of the strongest centers for herpetoculture. For example, a recent catalogue by the antiquarian book dealer Chimaira in Frankfurt/Main, lists hundreds of titles in German and English dealing with captive amphibians and reptiles. In the book *Die Geschichte der Herpetologie und Terrarienkunde im deutschsprachigen Raum* (edited by Rieck, W., et al., 2001; p. 263), a contribution by Gerhard Hallman is titled as "A selection of traders that offer animals for terrariums, or terrarium technology to the society and its members through ads or price lists." Hallman wrote, "The number of specialty traders that handle reptiles is large. . .The following list, with no aspiration to being complete, attempts to demonstrate this." Then, the chapter shows names of dozens of dealers between 1950 and 2001 in a variety of countries and includes some lists of the herps available as well as their prices. People today might believe that reptile shows or expos are a recent phenomenon but in chapters written by Werner Rieck, there are three fascinating photographs of enormous shows held in Germany in the years 1896 [p. 47], 1908 [p. 50], and 1924 [p. 71].

In the UK from the mid-1960s onwards, the most important resource for the herpetoculturist was the book by Zdeněk Vogel entitled *Reptiles and Amphibians. Their Care and Behaviour* (J. Coote, pers. comm.). In 1969 and 1972, Günther Nietzke summarized much of what was known about terrarium animals in two volumes: (1) Construction, Technical Equipment, and Planning of Terraria; (2) Care and Feeding of Terrarium Animals. The set was called *Die terrarientiere: Bau, technische Einrichtung und Bepflanzung der Terrarien: Haltung, Fütterung und Pflege der Terrientiere in zwei Bänden.*

As ideas, protocols and technologies improved for keeping herps in zoos, two of the most important persons disseminating this vital information were Carl F. Kauffeld at the Staten Island Zoo, and Hans-Günter Petzold at Tierpark Berlin-Friedrichsfelde. Kauffeld deserves special mention, for in addition to his classic *Snakes: The Keeper and the Kept*, he wrote many papers on captive management. Petzold's book (1982), translated from German and published by SSAR in 2008, is the most thorough overview of captive management currently available: *Petzold's The Lives of Captive Reptiles* (see HR 2009, 40:471–472 for review). Later, other zoo workers published books on terrarium keeping: Eugène Bruins (1999) from Natura Artis Magistra in Amsterdam, and Sergei Kudryavtsev and associates (1991) from the Moscow Zoo.

With numbers of captive herps increasing, there was a need to address medical management. H.-H. Reichenbach-Klinke published the first book on the topic called *Krankheiten der Amphibien* in 1961 and *Krankheiten der Reptilien* two years later. An English version was available in 1965 by Reichenbach-Klinke and E. Elkan: *The Principal Diseases of Lower Vertebrates.* For a complete list of titles, consult Murphy (2007; Table 2.1).

The SSAR published two other books on captive and medical management: *Reproductive Biology and Diseases of Captive Reptiles* (Murphy and Collins, 1980) and *Captive Management and Conservation of Amphibians and Reptiles* in 1994 (Murphy et al.). It is beyond the scope of this contribution to list all of the books, serials and papers that have been valuable to our understanding of captive animals but many references have been published in the four-part series called "Updating the Bookshelves" in *Herpetological Review* during 2008–9.

The herpetoculturist of today owes much to his or her predecessors who developed the beautiful and ornate planted terrariums filled with exotic foliage, the heavily planted aquaria, the spectacular semi-aquatic vivaria placed on pedestals in the drawing room with fishes and herps, and the arresting terrestrial terraria filled with mesic or xeric plants, truly a showcase in the home. It is not surprising that there are dealers specializing in antique aquaria and terraria to this day for these are often lovely works of art. Animal collectors and dealers filled a void: they provided specimens from exotic locales that were out of reach to the average fancier.

Acknowledgments.—This paper is dedicated to the late Carl Kauffeld and Harry W. Greene. When one of us (KM) wrote letters full of questions about herpetology, each took his valuable time and responded in writing to the inquiries of a fourteen-year old boy. We thank David Barker, Judith Block, David Chiszar, Jon Coote, Gary Ferguson, Rick Hudson, John Moriarty, Louis Porras, John Simmons, and Trooper Walsh for reviewing early drafts and suggesting improvements. Smithsonian Librarians Polly Lasker, Leslie Overstreet, and Daria Wingreen allowed us to examine publications under their care and arranged loans of obscure books and papers. Margie Gibson and Lucian Heichler assisted with translations. We are grateful to Emily Becker, Dana Fisher, and James Hanken from the Museum of Comparative Zoology, Harvard University for providing illustrations.

The opinions expressed in this article are those of the authors and do not necessarily represent the opinions of any organization.

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and zoo animals. In a historical sense, these animals thus came to be seen in a new light: they served not just as a kind of ersatz nature or exotic showpieces for the Victorian bourgeoisie, but also as a means to understand the proximity of humans and animals to one another." (p. 217). The statement on the flyleaf states that "This publication accompanies the exhibition "Endless Forms: Charles Darwin, Natural Science and the Visual Arts," which is currently at the Yale Center for British Art.].

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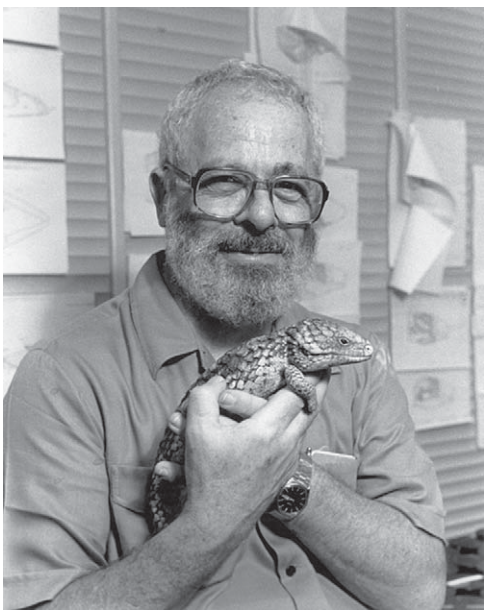
OBITUARIES

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Carl Gans (1923–2009) and the Integrative Biology of Reptiles

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Carl Gans, the preeminent specialist on reptilian biology of his generation, died on 30 November 2009 at the age of 86. This occurred after nearly a decade of poor health that followed a stroke in January 2001. Originally trained as a mechanical engineer, Gans made contributions to the systematics, comparative and functional morphology, physiology, biomechanics, and behavior of reptiles and, to a lesser extent, amphibians, all within an evolutionary context. His ability to integrate diverse approaches to life science—a field today called "integrative biology" that he helped to pioneer—was unrivaled, both conceptually and technically, and has laid the foundation for numerous studies across a broad spectrum by other biologists around the world.



In his laboratory at the University of Michigan with an Australian skink, *Tiliqua rugosa* (ca. 1997). Photo courtesy Robert Dudley.

Carl Gans was born in Hamburg, Germany, on 7 September 1923 where he attended the Talmud Thora Realschule. In his early teens while still in Germany, he loved to read books by the German storyteller, Karl May, first-person narratives about overseas explorations, especially in Asia, and collecting exotic animals. May's books were fiction because he never left Germany until very late in his life. Nevertheless, these volumes made a real impression on Carl who later enjoyed extensive international travel in search of unusual reptiles and amphibians. These books were important enough for him to purchase English translations of them that were still in his home library at his death.

The Gans family immigrated to the United States as Jewish refugees in 1939 and settled in New York City where Carl finished his schooling at George Washington High School. They lived in Upper Manhattan near the George Washington Bridge and on Sundays Carl would walk across this mile-long span to the wet undeveloped lands and high cliffs of the New Jersey Palisades along the Hudson River to capture frogs and snakes for his collection. His first herpetological paper, in *Copeia* in 1945, reported on salamanders and snakes he caught near the Harlem River on Manhattan. He discovered a natural population of the Dusky Salamander (*Desmognathus fuscus*) there, the first report on the island since C. S. Rafinesque's in 1820, and he appealed for it to be conserved. (A breeding population was reported from the site as recently as 2005.) Despite this early interest in animals (and conservation), his father insisted that he would financially support him in college only on the condition that he choose a practical career, so he studied mechanical engineering at New York University (B.Mech.Eng. 1944) and then joined the U.S. Army Corps of Engineers. After basic training, he served in the Pacific Theater during World War II, first in the Philippines and then in Japan. It was then the practice of the U.S. Government not to send soldiers overseas unless they were U.S. citizens; accordingly, Gans was naturalized in January 1945, just before departing for the Pacific. He was slated to be part of the invasion of Japan, clearing beaches with the engineering unit to which he was assigned in the Philippines.

After discharge from the army in September 1946, Gans was hired as a mechanical engineer by Babcock and Wilcox Co. of New York City (1947–1955) to install power boilers in electric generating stations in Pennsylvania and Ohio. Through home study courses he completed a graduate degree in mechanical engineering at Columbia University (M.S. 1950), the year his father died. He had begun to publish on herpetological topics in the mid-1940s including notes on the breeding dates of rhacophorid frogs based on observations he had made in Japan, a bibliography of the herpetology of Japan, and an article on adaptations for egg-eating in a Japanese ratsnake, but Gans continued his career as an engineer. He held several patents for devices he had invented. One of his early engineering ideas, never realized, was the development of automobile headlights that would follow the road.

During 1953–1954, Gans took leave from his job to do fieldwork in Brazil and Bolivia supported by a Guggenheim Memorial Foundation fellowship, during which time he was introduced to amphisbaenians, fossorial squamates that were to become one of his favorite subjects for studies in systematics and functional morphology. He duly returned to his engineering position in 1954, but by then his career goals had radically changed. In 1955, he was accepted as a doctoral student in biology at Harvard University by the vertebrate morphologist, paleontologist, and doyen of American zoologists, Alfred Sherwood Romer. At the age of 32, Gans embarked on an entirely new career in biology and on a fast track. Ernest E. Williams, curator of herpetology in the Museum of Comparative Zoology at Harvard, eventually became his doctoral advisor and by 1957 Gans had completed his dissertation.

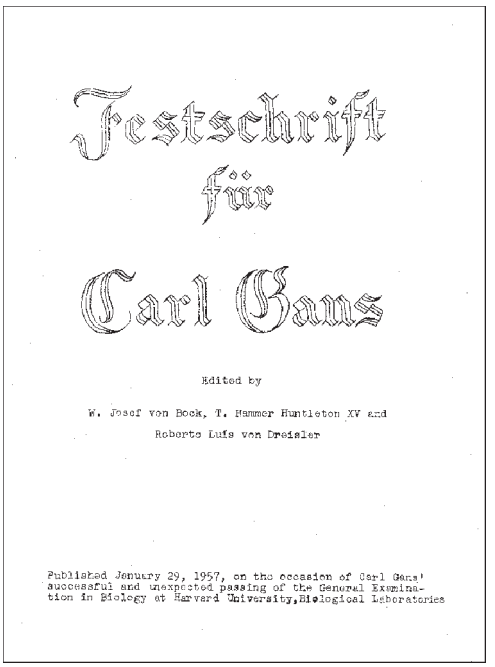
Because of his relative seniority to the other graduate students and his esteemed position among them, his professors and fellow graduate students played a good-humored prank on him by issuing a booklet of articles—entitled "Festschrift für Carl Gans"—on the occasion of his "successful and unexpected passing" of his general examination. Inside the booklet there was a table showing major events in Carl's life in the first column and corresponding world events in the other. A sampling: "Born 1923 in Germany" vs. "Panic, inflation and great distress in Germany"; "Left Germany in 1939" vs. "World War II starts"; and "Enters Harvard

in 1955" vs. "President Eisenhower has a heart attack." Even Carl's professors had some fun: "He has done so little in his life so far and yet that little has disturbed the world so much (E. E. W[illiams].)."



As a senior graduate student at Harvard University (about 1957). Photo courtesy Kraig Adler.

Gans's dissertation combined his interests in engineering and evolution, as well as his keen observational skills, in a study of the African egg-eating snakes (*Dasypeltis*) from which he drew major insights. (He had begun to publish on the egg-eating adaptations of *Dasypeltis* in 1952, based on his private research.) He described the morphological and biomechanical adaptations that allow these nearly toothless snakes to eat large eggs, crack the shells within the esophagus, empty out the liquid contents, and regurgitate the shell as a cigar-shaped mass. Later, he used vector analysis to describe in trigonometric terms the initial swallowing process, among other actions. He also discovered that the color patterns of these snakes varied geographically and in parallel to those of several small vipers (*Bitis*, *Causus*, and especially *Echis*). These, in addition, display C-shaped coiling behaviors and, in *Dasypeltis* and *Echis*, stridulating warning reactions when disturbed. He recognized that the color pattern and behavioral convergence of these snakes represented an example of Batesian mimicry and then extended this idea to develop a new concept of "empathic learning" that explains how mimicry can evolve even when the model is lethal. This project, integrating Gans's interests in systematics, morphology, biomechanics, and evolution, provided the pattern for his highly versatile research career.



Cover of the spoof booklet, "Festschrift für Carl Gans," prepared by fellow students and professors at Harvard University on completion of his doctoral studies (1957). Photo courtesy Kraig Adler.

On completing his doctoral work, Gans became a postdoctoral fellow at the University of Florida before joining the faculty of the University of Buffalo in western New York State in 1958. His most extensive publication from this period was his book-length monograph, "A Taxonomic Revision of the African Snake Genus *Dasypeltis*" (1959). He quickly rose from assistant professor to full professor and by 1970 was chairman of the biology department. The next year he moved to the University of Michigan, which had long been a prominent center for herpetological research and graduate education, as chairman of the zoology department (1971–1975). He was a hard-driving leader of the department who set very high standards for his faculty and became the nemesis of the botany department, which shared a building with zoology and competed for the same space. After retiring as professor in 1997, Gans moved to Austin, Texas, where he was an adjunct professor at The University of Texas.

Gans's research program covered a very broad scope including functional morphology (mainly of vertebrates), systematics of reptiles, the evolution of early vertebrates, and adaptations of limbless and burrowing tetrapods (mainly caecilians, amphisbaenians, and uropeltid snakes). His pioneering studies on the origin of vertebrates focused on the invention of the head (and thus the neck), which was made possible by the evolution of a new kind of embryonic cell (called neural crest) that he believed led to bone. This project was conducted together with his former zoology colleague at Michigan, R. Glenn Northcutt, and arose from their teaching a course on the comparative anatomy of vertebrates.

Carl took an engineer's approach to studying and experimenting with functional problems such as locomotion, burrowing, feeding (especially chewing), respiration, sound production, and hearing, all studied from an evolutionary perspective. His classic studies on breathing in frogs were conducted primarily in collaboration with a Dutch functional morphologist, H. J. de Jongh. They used sophisticated technologies in their work (electromyography, cinematography, and cinefluorography; monitoring buccal and pulmonary pressures; and recording gas flow in frogs placed in atmospheres with variable concentrations of argon and nitrogen) and demonstrated that relatively pure air was pumped into the lungs. Carl's favorites, the amphisbaenians, provided yet other models for application of biomechanical analysis. These burrowing wormlizards propel themselves underground using concertina and rectilinear mechanisms and he discovered that significantly different digging methods were employed among the families of wormlizards. Gans's textbook, "Biomechanics: An Approach to Vertebrate Morphology" (1974) summarized much of his early work in functional morphology and has become the standard sourcebook for the field.

First and foremost, however, Gans was a naturalist who loved reptiles and was fascinated with the ways in which they lived their lives. He was equally at ease studying them in the lab as he was in the field and regularly made numerous trips overseas to study them in South America, Africa, Australia, and especially in India and Sri Lanka. He collaborated and published regularly with numerous biologists at universities and museums throughout the world. He was also a major proponent of the value of collaborations with herpetologists at zoos. Although relatively few graduate students took their degrees with Carl, many colleagues and their students flocked to work with him on joint projects. His wife, Kyoko A. (Mabel) Gans, who had been the executive secretary of the biology department at Harvard and who he married in 1961, actively supported his research, writing, and editing and she graciously hosted legions of visitors who came to work with Carl. They were a real team until she died of cancer in 1999.

Besides his personal research contributions, Gans served the biological community in numerous ways. He was president of several major societies (American Society of Ichthyologists and Herpetologists, American Society of Zoologists [now called Society for Integrative and Comparative Biology], and Society for the Study of Amphibians and Reptiles) and served as editor of the *Journal of Morphology* for 25 years. While still a postdoc at Florida, he joined SSAR during its first year (1958) and under its former name, The Ohio Herpetological Society. When he discovered that it was run by a bunch of teenagers, he promptly resigned. He rejoined OHS a few years later, however, and in 1967 showed up for the 10th Anniversary Meeting in Columbus, Ohio, and thereafter became a regular participant in society meetings. He became involved in many other society activities and helped to draft the new SSAR Constitution



As president of SSAR, together with the presidents of the American Society of Ichthyologists and Herpetologists (Marvalee Wake) and The Herpetologists' League (Ronald Brandon), at the Joint Meeting of Ichthyologists and Herpetologists at the University of Oklahoma (August 1984). Photo by Kraig Adler.

in 1970. As SSAR president for 1984, he was an activist leader who enjoyed his freedom to innovate without the encumbrance of an overly circumscriptive society constitution.

Carl's supreme achievement in his service to our discipline, however, was the 22-volume series, "Biology of the Reptilia" (1969–2010), which he conceived, edited, and partly wrote. This compendium, covering the behavior, development, ecology, neurology, physiology, and especially the morphology of reptiles, is one of the monuments of modern herpetological and biological science. Some 169 persons from 21 countries contributed 142 chapters to it. After 42 years, the final volume, a comprehensive list and cross-index to the literature on reptilian biology, appeared in March 2010. It was a great honor when Carl entrusted publication of this classic series to SSAR, which had the privilege to issue the final four volumes.

Carl was also one of the most prolific authors in our field and published more than 700 titles including five books, in addition to the 22 volumes of "Biology of the Reptilia." Among them were a photographic atlas of shark anatomy (1964), his highly popular "Reptiles of the World" (1975, later translated into several other languages including Chinese), and a practical manual on electromyography (1986). Most of his taxonomic papers dealt with the systematics of amphisbaenians (on this topic, from 1957 to 2008, 94 titles including 10 major works), but he also authored numerous titles on the evolutionary basis of adaptation, physiology of snake venom, evolutionary origin of vertebrates, mechanics of hearing and sound production, functional significance of muscle architecture, mechanics of limbless locomotion, and feeding mechanisms in tetrapods.

Despite his long list of titles, his distinguished reputation, and his sometimes gruff demeanor, Carl also had a soft heart and a tendency for pranks. At scientific meetings, he could be very tough (and also usually very helpful) during the Q&A period following a graduate student's presentation when he sometimes displayed a trace of his German accent. He would often then invite the student to go swimming with him (he routinely brought his bathing suit if there was to be a pool or ocean nearby). At SSAR's 25th Anniversary Meeting in Raleigh, North Carolina, Carl was scheduled to present a plenary lecture on amphisbaenians, but wanted instead to talk about functional morphology. He hatched a plot in which Steve Arnold, Paul Hertz, Ray Huey, Ken Miyata, and I were conscripted as co-conspirators. After Carl talked about amphisbaenians for a few minutes, Paul stood up to declare, "With due respect, sir, you've been talking about amphisbaenians for years. Do you really have anything new to say about them?" There was an audible gasp from the audience. One of them leaned over to tell Paul that he had just committed academic suicide! Carl, glaring down at Paul over the top rim of his glasses and seeming quite annoyed, continued on with amphisbaenians. One at a time, the rest of us stood up to voice other comments or complaints. More gasps. Finally, one of us asked him to talk about functional morphology instead, which Carl proceeded to do with feigned resignation. (This event was accurately, but cryptically, reported in *Herpetological Review*, 13:107, 1982: "After repeated interruptions by the audience, the author switched his topic to functional morphology.") After the talk, one senior herpetologist and close friend of Carl's, who was completely taken in and who had wanted to hear about amphisbaenians, dressed me down in no uncertain terms for interrupting the talk. Carl's master plan thus worked perfectly and he was absolutely thrilled to have completely fooled the audience!

Carl Gans was, of course, one of our most distinguished herpetologists. Other biologists, however, tend to think of him as a physiologist, behaviorist, bioengineer, comparative morphologist, or an evolutionary biologist. He also became an active conservationist. Above all, he was a naturalist in the most integrative sense of that old-fashioned, yet refreshingly modern label. And he knew every facet of the lives and evolutionary history of his animals. As he once replied to a newspaper reporter's question, "I can look at a reptile and know if it is happy or not." And Carl Gans could probably do it, too.

Acknowledgments.—Leo Gans kindly filled in the early years of his older brother's life. Several academic colleagues have read over and commented on my manuscript, for which I am most grateful. For help in locating some photos, I thank Robert Dudley, Andrew Gans, and Gregory Schneider.

Carl Gans: The Buffalo Years of 1961–1967

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I met Carl in 1961 when he was 38, clean shaven, unmarried, and had completed just three years at the University of Buffalo (UB) as a faculty member in the Biology Department. He was at UB from 1958–1971 and I worked under him for about half his stay there. I was a "floating" grad student at first and enrolled in Carl's course in evolutionary biology. Two things stand out from that course: 1) an evening field trip in the pouring rain searching for spring peepers in roadside ditches while Carl, replete in suit, tie, and raincoat directed the soaked students in their quest; and 2) enlightening discussions about Lee Dice's work on black and white mice in areas of black lava flows and white sand.



During his days as an assistant professor at the University of Buffalo (1962). Photo by M. Graham Netting; courtesy Kraig Adler.

Somehow I scraped through the course and one night Carl wandered into my grad cubicle, handed me a jar of preserved Emerald Tree Boa heads and two papers by Albright and Nel-

son. He challenged me to see what I could make of the snake's head morphology. Thus started a relationship that lasted some 48 years. Carl was my teacher, PhD advisor, mentor, den mother, role model, friend, and anything else he needed to be for this aspiring but clueless kid from Brooklyn whose knowledge of natural history extended from stickball to the Brooklyn Dodgers. Carl's first grad students were A. A. Alexander, Jim Bonin, Aaron Taub, then there was me, followed by Ed Saiff and H. M. Pandit.

Animals kept in Carl's lab: amphisbaenids, cobras and kraits, and *Bitis gabonica*

Carl's grad students were expected to become familiar with all aspects of herp care hence we served as his animal care technicians in those early, lean years. Carl had a great affinity for amphisbaenids and he focused on biomechanical analyses of their burrowing behavior. Many of these limbless squamates tunnel in sand so it was our job to autoclave vast quantities of sand, set up aquaria filled with sand, keep the sand at the proper humidity, feed the amphisbaenids a variety of food, and observe their feeding behavior. In most cases ingestion takes place after the reptiles draw their food back into the tunnel. We spent many hours staring at mealworms and pinks wriggling on a sandy plane but were rarely rewarded by observations of feeding behavior.

Carl had discovered that he had to attack the taxonomy and relationships of the amphisbanids in order to place his biomechanical observations into a meaningful framework. Part of the lab became a museum-like shipping department as parcels containing preserved specimens arrived from all over the world. We learned how to become curatorial assistants unpacking specimens, checking them off the shipping documents, and setting up jars for future study. We went through enough ethanol to pickle the entire campus but filtered out debris and reused alcohol whenever possible.

What does one do with a preserved amphisbaenid? Measure length of body regions, count annuli, record patterns of head and pre-anal shields, plot characters on geographic grids, take photographs (so we learned every aspect of macrophotography and darkroom technique), and then help Charlene (Carl's technician) prepare the manuscript for publication. Much of this work was later summarized (Gans 2005. Checklist and bibliography of the Amphisbaenia of the world. Bulletin of the American Museum of Natural History 289:1–130).

One of my earliest grad projects with Carl was a histological study in 1967 of serial cross sections that I prepared of everted amphisbaenian hemipenes (to be followed up by an SEM study in 1991). I obtained specimens to be sectioned by rummaging through the jars of preserved specimens in Carl's collection. One day Carl called me into his office and began to tear a strip off my hide….I had snipped off the everted hemipenis of a type specimen from the MCZ! Carl phoned Dr. Williams and the tempest was calmed when Ernest suggested that when the type is returned we include the slide box of serial sections as well. This is one of the very few times I saw Carl lose his temper. So somewhere on a shelf of the herp collection at the MCZ, hidden by jars of preserved whole specimens, sits a little box of slides made by yours truly.

At least amphisbaenids are not venomous! Carl focused on ophidian envenomation as an offshoot of his interest in reptilian feeding mechanisms. Aaron Taub worked on the structure and function of Duvernoy's gland, Elazar Kochva from Tel Aviv University spent a long sabbatical with Carl furthering his investigations of viperid venom glands, the late Bill Elliott fractionated and analyzed fresh venom, and I chipped in with a thesis on venom glands of elapids and sea snakes.

Thus Carl began to house all sorts of kraits, cobras, and vipers in his "animal room." Why is it that shipments of live kraits from Thailand always arrive in the middle of the night? Carl and grad students would drive to the airport with snake sticks, Pilstrom tongs, cages, bags, etc. We always offered to open the boxes for customs but somehow they always declined our offer. That's when my true colors began to show. It's one thing to stare at the mealworms in an amphisbaenid's sandy world but it's something else to clean the cage of a cobra or the fattest Gaboon Viper I ever saw. Carl never hesitated to keep these dangerous reptiles but I must say he was very cautious. Thus, he would never order live specimens unless he had a supply of the proper antivenin in his fridge. Carl developed an elaborate protocol with campus security so that each time we had to take dangerous specimens out of their cages, the campus police had to sit in his lab (while the red light was on) prepared to do a hospital run with the "victim" and a stock of antivenin. As far as I know, there never was a mad dash to the Buffalo General but there were several entertaining practice runs.



Formal portrait with Kyoko A. (Mabel) Gans, three years after their marriage and during his period at the University of Buffalo (December 1964). Photo courtesy Andrew Gans.

Caged animals somehow manage to escape. Venomous snakes were not a problem as they were all secured in padlocked cages designed by Carl. I will never forget one Saturday night when some arboreal lizard managed to gain its freedom and Carl was immediately notified as per his instructions. Carl and Mabel arrived dressed to the nines for a night at the theatre. Carl slipped out of his jacket and suspenders, then stepped out of his trousers and took off after the lizard in his boxer shorts, shirt, and tie. Mabel and I averted our gaze not so much out of modesty but to prevent bursting out in laughter. Carl caught the lizard, dressed, and headed off for a night on the town with Mabel.

Work habits in the Gans lab: time, technology, and writing

There is Eastern Standard Time and there was Gans time. Carl had a very different biological clock. He would usually arrive at the lab in the mid-afternoon and work till early morning of the next day. Of course his grad students were expected to be in the lab while he was there but they often had to teach an undergrad lab at 8 AM the next morning! Several times a week Carl would treat us to pizza at 2 AM; he would return to work and we would stagger home with our sleep impeded by a gastrolith of spicy, rubbery cheese and dense dough. Those were our good old days!

Carl would arrive at his office, spend time with phone messages, incoming mail, signing letters that had been typed by his secretary (Gloria) during the morning, and checking on grad students. Then he would settle down to work and revise manuscripts. Each manuscript was kept in a three-ring binder with the most recent version on top. Carl would read and "mark up" the manuscript in a very distinct, almost illegible scrawl for his secretary to retype the next morning. Thus, a manuscript was gone over again and again and eventually honed into a finished product to be submitted for publication. Grad students read the "final" version and were rewarded for any typos we might spot (they were few and far between). When the proofs were sent to Carl we would team up and

the grad student would read every word, punctuation mark, and number (think of all those columns of scale counts!) while Carl corrected the proof. Talk about hands-on learning. We followed the same process as we wrote our theses and prepared them for publication. Carl always acknowledged our help in print at the beginning of each publication we had been involved with.

One pillar of Carl's reputation rightly rests on the huge number of his publications (those written alone and those co-authored with colleagues). He had to rely on the technology of the day and would have been very much more productive if his entire career had been supported by computer-based word processing. When I arrived in Buffalo, Carl was progressing through a wide variety of voice recorders that he would use to dictate letters, memos, and first drafts of the several manuscripts he was working on. He always had a pocket- sized recorder with him to dictate memos to himself, students, et al. and these were constantly being replaced by newer models. Remember, his handwriting was not easy to decipher so his secretary played back his words through earphones while she typed the transcription. Carl would read through what was typed, edit the text, mark up the pages, and return them to the secretary for re-typing. This process would be repeated again and again with total retyping often being required! When I first arrived there was a manual office typewriter, then there was an IBM Selectric, followed by an IBM Magcard Selectric that stored information on magnetic cards, and eventually word processing (after I had moved on). When Carl finished with one typewriter, he would place it in the lab for his students to use; we were always one step behind in IT.

Carl was very innovative when he turned to biomechanical, physiological, and functional morphological investigations. Even before that he constantly sought to improve his efficiency in the lab. Thus, he invented (along with Bill Tanski) a foot pedal device (manufactured by Gomco in Buffalo) that allowed the operator to focus a dissecting microscope and leave both hands free to hold dissecting instruments (U.S. Patent Office 3,350,977). My role in this was to be the male model, sit at the lab bench, and pretend to be dissecting a snakehead for the sake of the publicity photos. While I was decked out in a tie and starched lab coat, my feet were clad in worn-out basketball sneakers. Imagine my surprise when the ad that appeared in *Bioscience* showed me wearing well-polished brogues that had been airbrushed over the sneakers (and this before the advent of Photoshop)! Later, Carl added a second foot pedal that activated a tape recorder so he could dissect with both hands, continue to keep the field of work in focus, and record his observations on tape all at the same time.

Carl became a great proponent of electromyography (EMG) as an analytical tool for functional studies. He spent a sabbatical in the lab of George Hughes learning the basics of EMG and was sure that if Hughes could record electrical activity from branchial muscles of sharks in tanks of water, he could certainly record from muscles used by tortoises in pulmonary ventilation on dry land. Thus started a prolonged series of EMG studies in a great diversity of vertebrates that focused on feeding, locomotion, ventilation of lungs, and other topics. Carl became involved with electrodes, amplifiers, oscilloscopes, all sorts of recording devices, and high-speed movie cameras (in some cases using strobe lights designed for aircraft!). Most of these technical accomplishments were reported in Loeb and Gans (1986. Electromyography for Experimentalists. The University of Chicago Press, Chicago, Illinois. 373 pp.).

Surrounded by the Central Dogma

The molecular biology bandwagon started to roll in the Biology Department at Buffalo in the early1960s. Suddenly, new faculty members arrived on the scene, vast areas of "open space" were occupied (goodbye to graduate cubicles), and the hum of ultracentrifuges filled the air. The nature of seminar programs was altered and traditional graduate pathways were complemented by those that went from DNA to RNA to protein synthesis. Carl more than held his own during this inundation but tended to spend more time with departmental politics. Friendly competition prevailed on the softball field as well as indoors. When Carl invited Professor Romer to deliver a departmental seminar, he requested his grad students to make the arrangements for coffee and cookies. Here was a chance for us to gain on the molecular types; no Oreo cookies for us. We set up a grand spread of bagels, lox, and cream cheese much to Carl's (and the ever-hungry grad students') delight. What a memorable event that seminar was!

Carl's libraries: in the lab, at home

Carl developed one library in his lab and one at home. The scientific library grew as a result of an extensive network of reprint exchanges with friends and colleagues around the world (*Current Contents* was less than five years old then). He also purchased important volumes from book dealers in North America and Europe. Whole sets of reprints had to be located and ordered whenever a new project took shape. The library was organized in a somewhat confusing but logical (to Carl) fashion so reprints could be retrieved from their boxes. First of all there was a geographical level of organization, set up by continent and then country; then the North American reprints were set up alphabetically by journal title; but there were also a variety of special sections that I was never too sure about. Of course in those lean times grad students would be required to learn about the world's literature by refiling reprints. We tried our best but not to worry, periodically we would "go through the collection" with Carl looking on to set things straight.

The collection at home consisted of cowboy novels, detective stories, science fiction, and whatever Carl happened to enjoy. Steel bookshelves in the attic of his Buffalo (and later Ann Arbor) home were lined with hundreds upon hundreds of paperbacks. Students had access to this collection as well but we never had to reshelve these books.

Barbeques galore

Carl was the consummate host and he loved his beef. Thus for summer, outdoor entertaining he typically fired up the barbecue in his backyard while Mabel produced large bowls of salad (that Carl barely glanced at). Grad students, undergrads, technicians, secretaries, colleagues, and visiting firemen were always invited. The beef was plentiful but almost as important Carl would always introduce the students to visiting zoologists from the famous to the infamous and inform them of our research programs. Just a few who stand out were the Belgian herpetologist G. F. de Witte, the Swiss neuroanatomist Werner Stingelin (who spent a sabbatical with Carl), the morphologist from Brooklyn, Paul Maderson, the morphologist Tom Parsons, the Israeli zoologist Elazar Kochva (who spent a prolonged sabbatical and helped mentor me in venom gland architecture), the Dutch physiologist Hank DeJongh (also spent a sabbatical in Buffalo), Toby and Sandra Gaunt, Carl's mother, and of course, A. S. Romer and E. E. Williams. At times it seemed as if there was a steady stream of visitors to Carl's lab and then backyard.

Conclusion

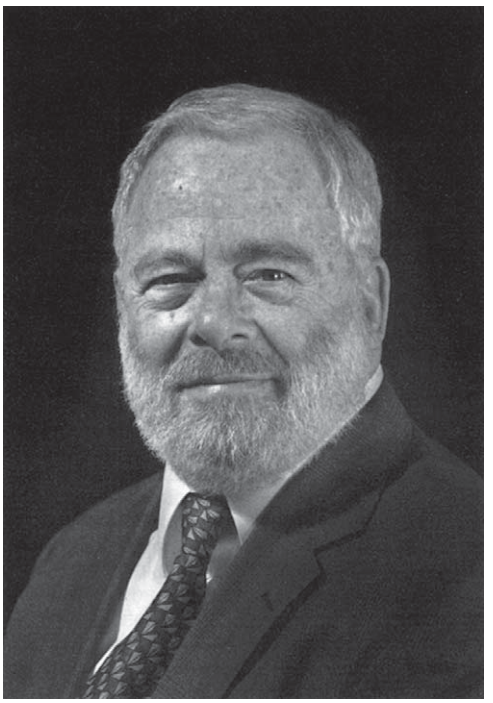
Thus, Carl's grad students received a very full regime of preparation for the real world. If Carl took you under his wing it meant that he took a deep interest in all facets of your education. Carl required me to complete a course in Botany, a full-year course in Human Anatomy in the UB medical school, a summer field course with OTS in Costa Rica (1965), and a post doc in chemical communication of insects at Cornell University with Carl's friend Tom Eisner (who else would accept me?).

Carl taught me many things beyond zoology. He was generous when it came to supporting various charitable organizations. He went out of his way to invite students, post docs, and faculty members to a stint in his lab from all over the globe knowing that their experience would further their careers once they returned home. He gave back to the profession by serving as the editor of the *Journal of Morphology* for 25 years. Carl also went out of his way to help authors rewrite and polish manuscripts

they submitted to the 21 volumes of "Biology of the Reptilia" that he co-edited and edited. Sure, he was demanding and had high standards but we were the ones who gained and eventually passed on the traditions to our students. Thank you, Carl.

Carl Gans: The Ann Arbor Years

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Formal portrait as Professor of Zoology at the University of Michigan (ca. 1994). Photo courtesy of the University of Michigan and Greg Schneider.

In 1971, at age 48, Carl moved to the University of Michigan in Ann Arbor as Chair of the Department of Zoology. He was near the peak of his scientific powers then and for the next 27 years, during which he continued to edit the *Journal of Morphology* and "Biology of the Reptilia" in Ann Arbor. During his first year as Chair, Carl paved the way for my own move to UM, where we taught, collaborated, ate and drank together, often with our wives, for the next 14 years. Our one-semester course in Comparative Vertebrate Anatomy usually involved around 100 students and consisted of four lectures and six hours of laboratory each week. Carl and I usually divided the lectures equally, and after each class we routinely repaired to a local pastry shop to critique the day's efforts, making sure that our discussion ended on a sweet note. Our papers together on the origin of vertebrates literally grew out of our reorganization of the Comparative Vertebrate Anatomy course at Michigan.

During his first four years in Ann Arbor, Carl provided strong leadership for the department at a particularly difficult time. Higher administrative officials were forcing a merger between Botany and Zoology, an action highly unpopular with both departments. The effects of this imposed merger were exacerbated by a downturn in Michigan's economy, which could have resulted in the loss of the university's non-tenured faculty in many departments. To Carl's great credit, he convinced the tenured members of his faculty to forgo raises in order to keep the entire faculty intact. His principles of fairness continued to be in evidence, as he was very active in correcting salary inequalities for women and minorities, at a time when the justice of such parity was anything but assumed.

While in Ann Arbor, Carl maintained an incredibly active laboratory, including graduate students, postdoctoral fellows, and an endless number of international visitors. Carl was a gruff colleague, however, and—although he was basically kind—he could be remarkably caustic, and he was not an ideal mentor for anyone with a hide less thick than a crocodilian's. I first met Carl while I was a graduate student with Hobart Smith at the University of Illinois. Hobart introduced us, then left to attend to other duties. Carl grilled me for at least 30 minutes on my research, albeit offering some good advice in the process. When he finally stopped, I asked, "And what are you working on now, Dr. Gans?", and Carl replied, "Everything," before leaving the room. Despite being somewhat put off by this reply—which I later decided was not totally inaccurate—I thus began my friendship with Carl Gans.

In addition to his scientific passions—namely morphology, biomechanics, and the biology of amphibians and reptiles—Carl had a passion for life in general, including food, wine, the arts, and travel. He did a great deal of the last in the course of his research, and he was an acute observer of political systems in the countries he visited—such as Australia, India, Sri Lanka—reading extensively on their social systems as well as their fauna. It was also rather a badge of honor with him to have endured fairly primitive field conditions in pursuit of his science. He was intensely fond of numerable art forms, everything from grand opera and early Japanese erotica to "The Cremation of Sam McGee," which he could often be persuaded to recite from memory after the wine had been flowing freely. After dinners at Mary Sue's and my home, he also sometimes led other guests in a rousing chorus of Gilbert and Sullivan songs. Carl was an exhaustive reader, virtually inhaling serious literature and hard-boiled detective stories with equal gusto. As a movie fan, his tastes were similarly catholic. He was particularly fond of Clint Eastwood's "Dirty Harry," who became his alter ego, but he appreciated foreign films and "serious" films. He also once persuaded me to accompany him to a showing of "Deep Throat," after which he remarked, "Oh well, there are only so many orifices in the human body." Always the morphologist, Carl was.

His wife Mabel (Kyoko) shared many of his passions, including travel, though not the deprivations of field work. She was confidant, research assistant, social secretary, and hostess. Regardless of whatever professional or personal pressures the two were experiencing, they were unfailingly gracious hosts, and always demonstrated love and support for one another. Scientifically and personally, Carl and Mabel had a profound effect upon Mary Sue and me, as well as on other academic couples who had the good fortune to interact with them for an extended period of time.

During his years in Ann Arbor, Carl was not always easy, as a colleague or as a friend, but what stands out in my mind is the respect and affection I had for him then and now.

Reminiscences of Carl Gans

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Although I never attended a school where Carl Gans taught and cannot claim to have been particularly close to him, he was an important influence on my personal and professional development, as he was for many other herpetologists. Perhaps appropriately, I learned of his death after a week of collecting in the Caprivi Strip of Namibia, which yielded a diversity of organisms that played a role in Carl's career, among them the egg-eating snake *Dasypeltis*—the subject of his doctoral dissertation, and several species of amphisbaenians—the organisms most intensely studied by him.

In the spring of 1980 I was an 18-year-old freshman at Michigan State University and, after taking Comparative Vertebrate Anatomy in the winter quarter, signed up for a graduate seminar in "advanced morphology" taught by Jim Edwards. The course included some lectures and stu-

dent-led discussions of relevant primary literature in vertebrate morphology. Carl's "Biomechanics" was the course text. Each student selected a prominent morphologist and was responsible for selecting and leading the discussion on papers by that author. As a budding herpetologist, I chose Carl Gans, whose work on locomotion in amphisbaenians—a group then practically unknown to me—I found fascinating. The course also featured guest lectures by visiting morphologists, one of whom was Carl. Because of my special interest in reptile morphology and because I was "responsible" for Carl's papers in the course, I was invited to dinner with Carl at the Kellogg Center, just across from my dorm. Although I was clearly out of my depth, I was thrilled to have the opportunity to talk to the great Professor Gans, who engaged me in conversation as if my opinion actually mattered and thus cemented my intention to pursue research in reptile morphology.

I next encountered Carl at my first SSAR meeting (Salt Lake City in 1983). I was in a morphology session, back-to-back with a number of my fellow Berkeley graduate students. Carl was in the audience and all the students in the session were on edge, hoping that he didn't find fault with their presentations and turn the question period into an uncomfortable grilling. For one of the speakers before me it was a worst case scenario. When questions opened, Carl stood up and began by saying "Your premise is fundamentally flawed …." Somehow, seeing that my colleague survived this settled my own nerves and 15 minutes later I gave my first scientific presentation with confidence. Carl's questions were direct and generally on the money and his criticisms were typically valid, revealing either real flaws or inadequacies in presentation that detracted from the arguments presented. Although it could be intimidating to face Carl under such circumstances, his criticisms were typically fair, and his negative opinions, especially in the case of students, were usually aimed at the work and not the individual. However, Carl did make enemies, and close association with those on his bad side could strain relations with him. Carl enjoyed the fact that he was held in awe (or fear) by students (and many more senior colleagues) and that he was taken deadly seriously by nearly everyone. In reality, despite the gruff exterior, he was fond of playing subtle jokes that would be signaled by winks and nods to those in the know.

At the SSAR annual meeting in 1984, Carl, then president of SSAR, had donated several items for the SSAR auction. One was Da Silva's "Snakes of Sri Lanka," which had been published shortly before. The work was not generally available outside Sri Lanka and Carl had picked it up on one of his trips there. For bibliophiles the book was a rare prize and there was spirited bidding. Ultimately I was one of three bidders left when the price exceeded $100 (then more than 10% of my monthly TA salary and more than half my rent). My competitors both had "real" jobs and I eventually dropped out at about $150. Later in the evening Carl came up to me and said "Thanks for driving the bidding up. I'll send you one next week." He did and through the years occasionally remembered my interest and picked up extra copies of obscure titles for me.

After I became gainfully employed, Carl and I began an abortive project on locomotion in limbless skinks of the genus *Acontias*. Having just returned from South Africa with live specimens, I flew to Detroit in the dead of winter and stayed with Carl in Ann Arbor, "running" the lizards on pegboards in his lab and writing in tandem, sitting with Carl at his computer while he typed. Carl's schedule, rising late and working until the wee hours of the morning, was more or less six hours phase-shifted from my own and I could barely stay awake as a new set of animals was introduced to the pegboards at 3 AM. This was exacerbated by an unfortunately timed bout of recurrent malaria. Carl barely noticed that I was sweating and shivering in his single-minded pursuit of the project. However, back at home, he immediately switched modes and became "daddy" to his dog P.C., who brought out his softer side.

Although I would never dare to compare my accomplishments to Carl's, I did end up following in his footsteps in terms of research venues and for many years I have passed in Carl's wake in southern Africa, India, Sri Lanka, Australia, Eastern Europe, and elsewhere. In nearly every place I have visited people know Carl, many personally from his own extensive travels, but certainly at least by reputation. Indeed, Carl was probably the most well-known herpetologist in the world at large for a period of 20 years from about 1970 to 1990. As Carl's health declined and his travels decreased, my foreign colleagues would always ask about him. Many were profoundly affected by him and most considered it a genuine privilege that they were able to interact with him, both personally and professionally. A visit from Carl Gans brought prestige to any researcher or institute.



Carl Gans and field crew in 1978 in the Pilbara region of Western Australia where, on their way back to Perth, the party stopped to see some aboriginal rock carvings at Woodstock Station. Among those present are Gans (crouching) with Harold Cogger on his left (in shorts), Hubert Saint Girons on his right (with cap), and Donald Bradshaw at the wheel of the vehicle Photo courtesy of Donald Bradshaw.

Carl Gans was larger than life. His domination of diverse biological disciplines was unparalleled in the late 20th century. That his was both the first and last word on so many topics is attested to by his bibliography, which lists a score of "prefaces" and "concluding remarks." I only had the opportunity, along with Rainer Günther, to co-author one paper with Carl, in 1997, on the amphisbaenian types in the Berlin Museum. However, my favorite of his 600+ works, or at least my favorite title, is a 1978 paper from *American Zoologist*—"All animals are interesting!" As reflected by his life's work, Carl certainly believed this and helped the rest of us believe it too.

Carl Gans: The Austin Years 1997–2009

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Carl Gans and his wife Mabel retired to Austin, Texas in 1997. Serendipitously, that was the same year I arrived in Austin, but they beat me here by several months. I had maintained a fruitful and entertaining correspondence with Carl for many years, beginning in 1993 with the publication of my first papers on fossil lizards. I sent copies of those papers, as a 'calling card' of sorts, to many people who had published on fossil reptiles, introducing myself and my shared interest in that topic. At the end of the accompanying (and, in retrospect, startlingly naive) cover letter, I included a brief request for copies of all papers the recipient might still have available for distribution. Carl was one of the recipients of that letter. Soon after, I received a reply from him indicating that he was somewhat taken aback by my open-ended request for reprints, but had decided to send me copies of all titles he still had on hand. Even now I cringe a bit when I recall the day I received a large box containing

hundreds of monographs and reprints authored and co-authored by Carl. He apparently was amused by both my initial request and the humble 'thank you' letter that followed, and we continued to exchange letters and publications for several years, but never actually met until I arrived in Austin. A few months after settling here I answered my telephone one afternoon and heard a deep and somewhat gruff voice admonishing me for not having been in contact... "You haven't called me, so I thought I'd better call you." I had no idea to whom I was listening until he identified himself as Carl Gans. He proposed dinner, I accepted, and we met in person for the first time.

Those who knew Carl in his days at the University of Michigan have made clear to me that I knew him in a different way than they did. The descriptions I would provide of my interactions with Carl seemed impossible to some of them, as if I were describing a second person of the same name. A few hints of the sobering interactions that sometimes arose between Carl and graduate students are found in the reflections that accompany my own in this compilation; the rumor mill carries many other stories. Carl even implicated himself one night during dinner with my wife and me, when he joked "I used to eat graduate students for lunch." I knew Carl as a serious scientist, critical thinker, meticulous editor, avid reader, and bibliophile, but also as a genial colleague with a subtle sense of humor who enjoyed a good chuckle, and gave and accepted lighthearted teasing with equal delight. I have no terror stories, no squirming moments of discomfiture as my ideas were dissected and ego bruised in a clash with Carl. Instead, I always received considered advice, support for my endeavors, and a subtle but persistent encouragement toward higher standards in everything. Carl shared his time and expertise freely, along with a seemingly endless supply of reminiscences and anecdotes about his collections, field trips, colleagues from around the world, and parties at the annual herp meetings.

Carl's retirement was not a retreat from science, nor from active engagement with students and his colleagues. He enjoyed acquainting himself with the herpetological fauna of Texas, and took particular delight in announcing his Austin home address on Slow Turtle Cove. He moved here at the invitation of Robert Dudley, a collaborator and colleague who was then on the faculty in the Department of Integrative Biology at The University of Texas at Austin. Carl held the position of Adjunct Professor and maintained a research laboratory in that department, served as a member of PhD student committees, and participated as guest lecturer or discussant in several courses in the departments of Integrative Biology and Geological Sciences. His research activities were truncated shortly after arriving in Austin, when Mabel was diagnosed with cancer. Following her death in 1999, Carl refocused his attention on his scientific and literary pursuits with emphasis on three major projects in herpetology. One was an intensified effort to obtain from authors the final manuscripts for a new volume in the "Biology of the Reptilia" series, and to see those manuscripts through the review and revision process (these were eventually published as volumes 20 and 21 in 2008). The second project was an ongoing collaboration with Ricardo (Ueso) Montero on the cranial osteology and skeletal development of amphisbaenians (published in 1999 and 2008). The third was compiling and editing an updated checklist of the Amphisbaenia of the world, accompanied by an extensive bibliography on the group (2005).

He regularly hired undergraduate and graduate students to help him with research tasks and to work in his libraries. One of those libraries was an extensive collection of paperback novels that were housed in a loft above his master bedroom. His more expansive scientific research library filled a three-car garage and represented an intensely personal collection, incorporating books from his early career as an engineer, and reflecting his broad interests in natural history. He maintained subscriptions to no fewer than 85 serial publications, several of which are rarely seen in personal collections. Carl had a particular fondness for ferreting out what others have called 'obscure' literature, but he was adamant in his denial of the existence of such a category. In his view literature simply exists, and it is our responsibility to seek it out and cite it where relevant. He had an amazing ability to remember exactly what was in his library, as well as how to find it. The latter was no small accomplishment in a library the size of his. Apart from special topics (e.g., mimicry, conference abstract volumes, functional morphology), he generally filed his books, monographs, and reprints geographically. Usually the geographical referent was the topic, but sometimes he filed based on the location of the publisher. For example, Duellman's monograph on the equatorial herpetofauna of Amazonian Ecuador might be filed in South America, or in Kansas, depending on how Carl thought about it at the time he obtained and shelved it. Until you learned to think like he did about the organization, finding particular items could be a challenge.

Carl suffered a debilitating stroke in late January, 2001. After a short period in hospital he returned home, but was confined to a wheelchair. He and his brother arranged for some renovations to his house after the stroke, but among other inconveniences he was no longer able to enter the stacks in his research library. The fixed shelving was spaced to accommodate a maximum of printed material, not the width of a wheelchair. After his return from the hospital, my visits with Carl always included some time in his library, filing newly-received materials and pulling titles that Carl needed or wanted to see as he continued the increasingly frustrating effort to maintain his research activities.

In the years following his stroke a major priority for Carl was making arrangements for the disposition of his remaining collections. Prior to his retirement, most of his skeletal and alcoholic specimens were deposited in the Museum of Comparative Zoology at Harvard University and the Carnegie Museum of Natural History in Pittsburgh. He retained his amphisbaenian and uropeltid snake collections until it became clear that he would no longer be able effectively to work with those specimens. Although a small collection of dry skeletal specimens was donated to the Vertebrate Paleontology Laboratory at UT Austin, the majority of the uropeltid snakes ultimately were deposited at the California Academy of Sciences in San Francisco, and the amphisbaenians went to the Field Museum of Natural History in Chicago.

As far as I know, Carl recognized only two 'subcollections' within his scientific library, constituting materials that were filed and housed independently from the main body of his collection. The first was his lancelet collection, the second his reprints and monographs pertaining to amphisbaenians. His attempt to survey the extensive literature on lancelets included gathering physical copies of the majority of the 2696 titles cited in the published 'bibliography of the lancelets' (1999). That collection was deposited at the Scripps Institute of Oceanography in La Jolla, California. A substantial portion of his literature on the Amphisbaenia was sent to Maureen Kearney at approximately the same time that his specimens went to the Field Museum. The remainder of his library, along with 13 filing cabinets containing his scientific correspondence, was deposited at the Ben Gurion University of the Negev, in Midreshet Ben-Gurion, in the Negev Desert in Israel.

Although he struggled with declining health in his later years in Austin, Carl always enjoyed visits from colleagues and former students, and drew satisfaction from the simple pleasures of a fully retired lifestyle. He especially enjoyed his contact with graduate students, hearing about their projects and offering advice or suggestions for interesting questions or problems. He enjoyed and appreciated letters from other scientists who wrote with data or questions following up on one of Carl's earlier publications. He was especially gratified when he heard the news in 2008 that salamanders had been discovered once again in the parks on Manhattan Island in New York City (see Kraig Adler's account above).

Carl was a connoisseur of fine coffees and chocolates. He pursued these with increasing enjoyment after his stroke, and drew greater satisfaction from the pursuit of favored comestibles as his research activities waned. He maintained an impressive mental list of 'favorite' restaurants in Austin, as well as a slightly more select register of appropriate venues for the consumption of dessert. An evening meal with Carl often was a multi-hour event, and could involve stops at as many as three establishments. Such evenings were always a welcome opportunity for Carl to

enjoy good company, good food, and good conversation. He died on 30 November 2009, and is buried in the Cook-Walden Jewish Cemetery in Pflugerville, Texas.

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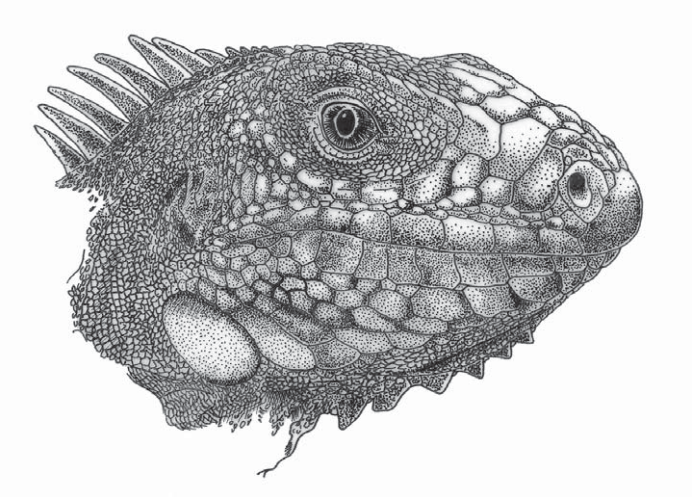
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Iguana iguana (Green Iguana). Colombia: Department of Casanare: municipality of Orocue. Illustration by Fernando Vargas Salinas, based on a photograph by Luis Alberto Rueda and Fernando Vargas S.

ARTICLES

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Reconsidering Extinction: Rediscovery of *Incilius holdridgei* (Anura: Bufonidae) in Costa Rica After 25 Years

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Amphibian populations are declining around the world (Wake 1991). Of the 6433 amphibians species (Frost 2009), close to 500 species are considered endangered (Stuart et al. 2008). Thirty-eight amphibian species have been declared extinct (IUCN 2008). For Costa Rica, the magnitude of amphibian declines has been so severe that three endemic species were declared extinct: the famous Golden Toad, *Incilius periglenes*, in 2002 (IUCN 2003), and both *I. holdridgei* and *Craugastor escoces* (Craugastoridae) in 2007 (IUCN 2008). The reduced geographic range of these species, their conspicuity, and the substantial search effort invested in areas where they previously were abundant justified categorizing these species as Extinct (IUCN 2008). These disappearances have been attributed to different causes, including climate change (Pounds 1997, 2001) and emergent diseases such as chytridiomycosis (Lips et al. 2006), or the synergistic effect between these two agents (Pounds et al. 2006).

A species is considered extinct when, as defined by IUCN (2001), there is no reasonable doubt that the last specimen has died. Difficulties with this designation may arise for secretive species or when the reproductive behavior of the species changes in relation with the reduction in population density (Mattsson et al. 2008). For example, explosive reproduction is a strategy to reduce the individual predation rate and increase the attraction of females (Duellman and Trueb 1994). When such species decrease in numbers, it is common to assume they are headed to extinction, but it is possible that they use an alternative reproductive behavior. The Costa Rican highland toads represent a classic example of these problems. Most of them are subterranean, emerge during explosive breeding events, and produce little to no audible vocalization. The need to form aggregations during reproduction may

cause difficulties to mate when population densities are reduced (Novak and Robinson 1975).

In 2006, Costa Rican herpetologists created a national strategy for the conservation of amphibians (Bolaños et al. 2007). This strategy included *in situ* and *ex situ* conservation, basic and applied research, and public education. Amphibian species that experienced the most drastic declines were recommended for *ex situ* conservation actions (Bolaños et al. 2008). A fundamental component of the national conservation strategy is increasing fieldwork to locate remaining populations of declining species. Amphibian species with relict populations represent an opportunity to test hypotheses concerning the causes of declines and ecological and evolutionary responses.

Here we report the recent rediscovery of *Incilius holdridgei* in a young secondary forest of Alto El Roble in the Cordillera Volcánica Central of Costa Rica. *Incilius holdridgei* (Taylor 1952) was described based on a single specimen collected at Finca Georgina, on the west slope of Volcán Barva at 2280 m (Savage 1974). Subsequently, other substantial populations were found on the southern and eastern slopes of the same volcano, with known localities including Sacramento (G. Barrantes, pers. comm.), Cerro Chompipe, and Alto El Roble (Novak and Robinson 1975). This species used to be very abundant at the last locality (J. Savage, pers. comm.), and their ecology and reproduction was described by Novak and Robinson (1975). The discovery of *I. holdridgei* represents the first in 25 years and removes the species from the Extinct category (IUCN 2008).

Materials and Methods.—On 1 May 2008, during a field trip by students in the herpetology course from the Universidad Nacional de Costa Rica, eight juvenile bufonids were observed in Alto El Roble (10.0946°N, 84.0624°W, 1900 m elev.) by JA. All juveniles were found during the day in leaf litter, or among rushes and grasses. As only two species of bufonids had been reported in Alto El Roble, the extinct *Incilius holdridgei* and the secretive *Crepidophryne epiotica* (Savage 2002), it should not have been difficult to establish the identity of these specimens. However, the specimens were only photographed by one of the students and the quality of the pictures was not suitable to allow identification.

From April to May, 2009, we visited the same area four additional times to conduct diurnal and nocturnal surveys to collect specimens to resolve the species identification. We searched for eggs and tadpoles in the pond located along the 2 km stretch of road between Alto El Roble and Río Las Vueltas (10.0878°N, 84.0739°W, 2100 m elev.). We collected several tadpoles to determine species; tadpoles were later returned to the same pond. At the small trail in Alto El Roble where the juvenile toads had been observed in 2008, we conducted an exhaustive sampling of the forest floor during the first survey. We inspected the leaf litter, logs and rocks in an area of 2000 m^2. Each amphibian observed was collected, identified in the field, and returned to the forest. Some specimens were collecting as vouchers and were deposited in the Herpetological collections of the Museo de Zoología of the Universidad de Costa Rica. Other survey methods employed by us included 300 m visual encounter transects (Crump and Scott 1994) in the forest. We also surveyed ponds for presence of eggs and tadpoles.

Results.—Contrary to the patterns described in previous decades when pastures and open areas dominated Alto El Roble (Novak and Robinson 1975), today, the area consists of secondary forest



COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND

FIG. 1. Adult male *Incilius hodridgei* (UCR 20657), found in Alto El Roble, Costa Rica, 25 years after the last observation in the 1980s. Photograph by José Salazar.

dominated by oak trees (*Quercus* spp.) with dense undergrowth. Water sources near the site include areas of slow drainage and shallow puddles. We also found temporary ponds in the same area in which *Incilius holdridgei* was observed in the 1970s (Novak and Robinson 1975); however, we found only the tree frog *Isthmohyla pseudopuma* in these ponds (egg masses, tadpoles, and adults).

One adult male (UCR 20671), clearly identified as *Incilius holdridgei* (Fig. 1), was found on the night of 24 April 2009 at 2149 h, inactive in the leaf litter, at a location only 5 m away from the site where the juveniles were seen in 2008. During surveys in the forest, both juveniles and adults of *I. holdridgei* were observed in an abandoned trail cover with bushes and grasses. We did not observe eggs, amplexus, or male aggregation in the small ponds surveyed. On the morning of 25 April 2009, one adult male was found 2 cm below the soil surface, possibly indicating that prior to the reproductive season, individuals of this species may remain in underground refugia.

On 3, 9, and 17 May 2009, two juveniles (15 mm SVL) and three adults (34 mm, 31 mm, and 31mm SVL) were observed by JA at the same locality. We have no records of mating thus far, but the fact that we have found juveniles in both years indicates recent reproductive activity. We have yet to see the large aggregations described in the 1970s (Novak and Robinson 1975).

Discussion.—The rediscovery of *Incilius holdridgei* requires reconsideration of this species to the current IUCN category Extinct (IUCN 2008). We suggest reassigning *I. holdridgei* to the Critically Endangered category (IUCN 2001). Also, the rediscovery of *I. holdridgei* indicates the necessity to do more fieldwork to encounter other declined species in Costa Rica. As part of these efforts, we are working on geographic models that combine the potential distributions of the most severely declined species, the localities of the relict populations, and the climatic conditions in these areas. Such analysis should help to define areas with higher probabilities for locating endangered species and facilitate the selection of areas to survey.

This finding also has implications in the discussion of the

emerging diseases hypothesis and the amphibian conservation strategies. Chytridiomycosis has been considered a devastating disease capable of extirpating amphibian populations of sensitive species over large areas (Lips et al. 2006). However, our discovery of a population of *Incilius holdridgei* in a region with well documented chytridiomycosis (Puschendorf et al. 2006), allows a test of its vulnerability to this disease. The survival of some members of this species creates opportunities for amphibian conservation through *ex situ* reproduction and reintroduction programs. However, this discovery forces us to reconsider conservation efforts. Traditionally, conservation has been relegated to *ex situ* efforts or *in situ*-based efforts in protected areas. We believe that the role of recently abandoned agriculture and livestock areas, as in the case of this population of *I. holdridgei*, should be more closely evaluated together with the traditional protected areas, as it appears to have been critical to this species survival. A continuous field monitoring program is needed to quantify the population status of this species, including the identification of potential breeding sites and reproductive aggregations.

In recent years, the Alto El Roble area has become a tourist destination that receives thousands of persons per year, mainly during the weekends. Most of them travel by foot but the use of cars, quadracycles, and mountain bikes is not rare. The breeding sites for treefrogs, ranids, and bufonids in Alto El Roble are the small ponds around the principal road (Novak and Robinson 1975), most of them exposed to tourist traffic. The recovery of the *Incilius holdridgei* population in Alto El Roble could be difficult under an increasing trend in tourist activity with the potential destruction of critical breeding sites.

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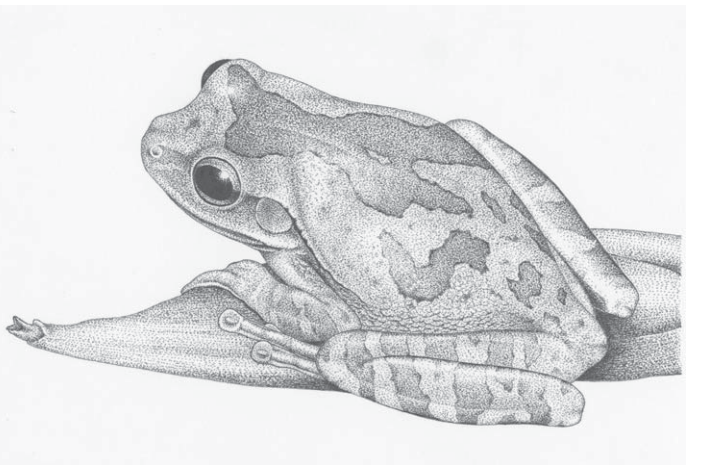
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Smilisca baudinii (Mexican Treefrog). Belize: on bract of *Heliconia* sp. Illustration by Peter Stafford.

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Toe-Twitching During Feeding in the Australian Myobatrachid Frog, *Pseudophryne corroboree*

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A number of anuran species exhibit behaviors involving pedal movements, which have been suggested to either lure or promote activity in prey animals. A recent review has summarized this behavior from 13 taxa within seven anuran families (Sloggett and Zeilstra 2008). In some larger species that feed primarily on vertebrate prey, the movement of toes as a feeding response appears to be aimed at attracting prey (Bertoluci 2002; Hagman and Shine 2008; Murphy 1976; Radcliffe et al. 1986). This behavior is most elaborate in the South American horned frogs (*Ceratophrys* spp.), where toes from the rear foot are raised and waved in a luring fashion in front of the frog's mouth (Murphy 1976). In smaller species that feed predominantly on small invertebrates, toe-twitching may often occur during feeding (Sloggett and Zeilstra 2008). Sloggett and Zeilstra (2008) proposed that toe-twitching in these instances may provide a vibrational stimulus to ensure that the intended prey continues to move and be detected.

Here we describe toe-twitching behavior as a component of feeding behavior in an Australian myobatrachid frog, the terrestrial Southern Corroboree Frog (*Pseudophryne corroboree*). *Pseudophryne corroboree* is a critically endangered species, restricted to areas above 1300 m elevation in Kosciuszko National Park, New South Wales, Australia. This toxic, yellow and black species reaches a length of only 25–30 mm (Fig. 1). Because of its small size and cryptic nature, direct observations of feeding behavior in the wild are limited. However, studies based on gut contents show that the closely related Northern Corroboree Frog (*P. pengilleyi*) feed predominantly on ants and occasionally other small invertebrates in the wild (Pengilley 1971).

The frogs in this study were housed at Taronga Zoo, Sydney, as a captive component of a collaborative conservation program. All frogs were housed in clear plastic containers (33 cm long x 19 cm wide x 21 cm high) on a substrate of sphagnum moss above a layer of aquarium gravel (Fig. 2). Frogs were fed twice per week, and the substrate was sprayed with water the day after each feeding to help break down and wash away waste.

Observations were made on 88 three-year-old frogs, housed in containers of 2–4 individuals. On 23 September 2008, prior to feeding, all frogs were sighted and no toe-twitching behavior was observed. This is consistent with our observations that toe-twitching has never been observed prior to feeding. At 0800 h, frogs were given 15–20 live hatchling crickets per individual via a central opening in the top of each container. Observations on toe-twitching began five minutes after the addition of crickets and



COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND

FIG. 1. Captive example of an adult *Pseudophryne corroboree* at the Taronga Zoo.

continued for almost ten minutes. Each container was observed for 20–30 seconds unless each frog in the container had demonstrated the behavior earlier.

Pedal movements were observed in 84% of frogs (74 of the 88 individuals). The movements could be described as rapid twitches of the outer digit on both rear feet simultaneously. In all cases, the behavior only occurred after the presence of prey was detected by sight. The frogs faced directly toward the moving prey, remaining motionless, with the exception of the twitching digits. Frogs captured crickets with a rapid protrusion of the tongue, and toe-twitching continued immediately after the cricket was eaten, though it was not recorded when the toe-twitching ceased.

Eight frogs were observed continuously for a period of two minutes each within twenty-five minutes of feeding while live crickets were still present. The number of twitches within this time was counted through visual observation with the use of a tally counter and an average was calculated per minute. The outer digit twitched at an average rate of 108 twitches per minute

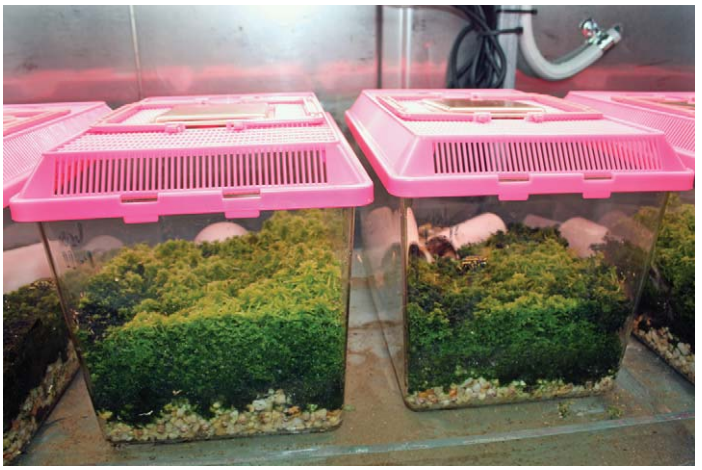


FIG. 2. Housing containing captive *Pseudophryne corroboree* at Taronga Zoo.

(maximum 128, minimum 74). The observations reported here were based on three-year old frogs, but toe-twitching in captive *P. corroboree* has been observed in all ages from metamorphs to adults, beginning as early as six days after the completion of metamorphosis (McFadden, pers. obs.).

Interestingly, for the vast majority of individuals, the twitching digit was raised off the substrate. This would minimize the potential impact of its use as a vibrational stimulus as proposed for a number of anuran species predating on smaller invertebrates (Sloggett and Zeilstra 2008). Rather, the rapid movement of a raised digit would suggest that toe-twitching in this genus might primarily be a visual stimulus, either to attract or displace prey (Radcliffe et al. 1986). Alternately, it is possible that the twitching could be simply an excited response to the presence of prey. In this study, there is no indication that the crickets responded to the twitching digit. However, it is possible that a response could be elicited from their natural prey of ants, though this was not tested in this study.

The genus *Pseudophryne* consists of about 13 endemic Australian species, all of which are small, cryptic ground-dwelling species similar to *P. corroboree*. Toe-twitching has been observed in at least one other species (*P. bibroni*; P. Byrne, pers. comm.) and might prove to be widespread within the genus. The purpose of feeding-induced pedal movements in *P. corroboree* is unknown, but this predominantly ant-feeding genus may use toe-twitching behavior to attract prey or simply to inducing prey movement, which in turn may enhance detection of prey by frogs.

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The Diets of Subadult Fowler's Toads (*Bufo fowleri*) and Eastern Spadefoot Toads (*Scaphiopus h. holbrookii*) at Cape Cod National Seashore, USA

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Fowler's Toad (*Bufo fowleri*) and the Eastern Spadefoot (*Scaphiopus h. holbrookii*) are two ecologically similar, sympatric anuran species that inhabit early successional habitats at Cape Cod National Seashore (CACO), USA. Densities of these two species at CACO rival those from any other known locality in the northeastern U.S., likely in large part due to the abundance of optimal upland and wetland habitats present in combination with limited human development at CACO. Though locally abundant at CACO, these two species are regionally rare (*S. h. holbrookii*; Klemens 1993) and/or are in decline in areas of the northeastern U.S. (*B. fowleri* and *S. h. holbrookii*; Klemens 1993), largely as a result of habitat loss and development occurring in the region. As such, an improved knowledge of specific life-history traits (e.g., dietary composition, upland habitat preferences, movement patterns) of these two species will prove valuable to their long-term conservation in the northeastern U.S.

While several previous studies have reported on the stomach contents of *B. fowleri* (Barbour 1953; Brown 1974; Bush 1959; Bush and Menhinick 1962; Clarke 1974; Klimstra and Myers 1965) and *S. h. holbrookii* (Pearson 1955; Punzo 1992), with the exception of one study reporting stomach contents of *B. fowleri* in Connecticut (Clarke 1974), none of these studies were conducted in the northeastern U.S. Furthermore, none of these studies for either species reported results for subadult age class individuals. Thus the ability to extrapolate results from these studies to subadult *B. fowleri* and *S. h. holbrookii* in the northeastern U.S. is limited.

We report on the stomach contents of subadult *B. fowleri* and *S. h. holbrookii* captured in pitfall traps during terrestrial arthropod sampling in a coastal dune ecosystem (i.e., the "Province Lands") at CACO from early June through late September 2007. We report results only for the subadult age class (~1–2 year-old individuals, determination based on measured snout–vent lengths [SVL] as that was the only age class captured in pitfall traps. To characterize the diet of each anuran species, we calculated the *proportional occurrence* of each invertebrate taxon in the stomach contents (calculated as the proportion of stomachs containing at least one individual of that taxon) and the *proportional abundance* of each invertebrate taxon in the stomach contents (calculated as the proportion, by count, of total stomach contents comprised of each taxon).

To compare dietary overlap of the two anuran species, we calculated Schoener's diet similarity index (*Cxy*; Schoener 1968):

$$Cxy = 1 - 0.5 \Sigma \left| P_{ix} - P_{iy} \right|$$

TABLE 1. Cumulative stomach contents of captured subadult *Bufo fowleri* and *Scaphiopus h. holbrookii*.

Invertebrate Taxon	*B. fowleri*	*S. h. holbrookii*
Araneae	67	16
Opiliones	0	1
Isopoda	10	18
Collembola	19	7
Orthoptera	1	1
Blattodea	14	6
Homoptera	2	0
Coleoptera	43	14
Coleoptera larvae	4	0
Lepidoptera	13	0
Lepidoptera larvae	14	0
Diptera	107	5
Formicidae	2710	60
Hymenoptera (excluding Formicidae)	4	0
Total	3008	128

where P_{ix} and P_{iy} are the proportion of species' *x* and *y* diet comprised of the i^{th} prey taxon. *Cxy* ranges from 0–1 with values approaching 1 indicating greater dietary overlap between species.

To examine dietary niche breadth of the two anuran species, we calculated Hurlbert's niche breadth (*B'*; Hurlbert 1978):

$$B' = 1/\sum (p_j^2/a_j)$$

where, for each species, p_j is the proportion of individuals containing the j^{th} prey taxon in their stomach, and a_j is the proportion of total stomach contents over all individuals comprised of the j^{th} prey taxon. For purposes of comparison we used Hurlbert's standardized niche breadth (B'_A; Hurlbert 1978):

$$B'_A = (B' - a_{min})/(1 - a_{min})$$

where a_{min} is the smallest observed proportion of all the prey taxa for a given species. B'_A ranges from 0-1 and represents the ratio of observed niche breadth to the maximum possible niche breadth.

A total of 76 subadult *B. fowleri* (SVL mean: 36.1mm, range: 25–45 mm) and 18 subadult *S. h. holbrookii* (SVL mean: 36.6 mm, range: 26–45 mm) were captured and had their stomach contents analyzed. Of the total individuals captured, ~6% (5/76) of *B. fowleri* and ~11% (2/18) of *S. h. holbrookii* had empty stomachs. Excluding individuals with empty stomachs, the number of prey items per stomach was greater for *B. fowleri* (mean = 42.37, range = 1–141; total = 3008) than for *S. h. holbrookii* (mean = 8.00, range = 1–25, total = 128).

Fourteen different invertebrate prey taxa and life stages were identified in the anuran stomachs; 13 of these were present at least once in *B. fowleri* stomachs and nine were present at least once in *S. h. holbrookii* stomachs (Table 1). Formicidae was the dominant prey taxon in the stomachs of both anurans, comprising 88% and 90% of the *B. fowleri* diet and 56% and 47% of the *S. h. holbrookii* diet based on proportional occurrence and abundance, respectively (Table 2). The Schoener diet similarity index was 0.556, indicating modest dietary overlap between the two study species. Lastly, the standardized Hurlbert's niche breadth was greater for the stomach contents of *S. h. holbrookii* (B'_A = 0.152) compared to *B. fowleri* (B'_A = 0.028).

Both species contained a diversity of invertebrate taxa in their stomachs, and although the total number of taxa consumed by *B. fowleri* (13) was greater than by *S. h. holbrookii* (9), the proportion of the diet represented by the various taxa was more highly skewed in *B. fowleri* than in *S. h. holbrookii*, which accounted for the smaller dietary niche breadth of *B. fowleri*. *Bufo fowleri* appeared to be an ant (Formicidae) specialist; ants accounted for 88–90% of the diet (by proportional abundance). *Scaphiopus h. holbrookii* appeared to be more of a dietary generalist; five invertebrate taxa were required to account for >90% of the diet (by proportional abundance). The larger dietary niche breadth of *S. h. holbrookii* compared to *B. fowleri* suggests that the former species may be more of a dietary generalist than the latter. This is generally consistent with results obtained from other studies in other geographic locations comparing individual species of these two families (Anderson et al. 1999; Smith et al. 2004), although one previous study found a similar niche breadth for one *Bufo* and one *Scaphiopus* species (Punzo 1992). The broader dietary niche breadth of *S. h. holbrookii* may be an evolutionary adaptation that enables this species to coexist with ecologically similar, dietary specialists such as *B. fowleri* and/or cope with the highly dynamic conditions of the coastal dune ecosystem in this study area (Anderson et al. 1999).

The importance of ants in the diet of subadult *B. fowleri* and *S. h. holbrookii* in our study is consistent with results reported in several previous studies of *B. fowleri* (Brown 1974; Bush and Menhinick 1962; Clarke 1974; Klimstra and Myers 1965) and *S. h. holbrookii* (Pearson 1955; Punzo 1992). In fact, the percentage of *B. fowleri* diet comprised of ants that we observed (88-90%) is the largest reported value that we are aware of for any *Bufo* species

TABLE 2. Proportion of stomachs containing a particular invertebrate taxon ("P_1"), and proportion of stomach contents based on counts of individual food items ("P_2") in all subadult *Bufo fowleri* and *Scaphiopus h. holbrookii*.

Invertebrate Taxon	*B. fowleri* (N = 76)		*S. h. holbrookii* (N = 18)	
	P1	P2	P1	P2
Araneae	0.26	0.02	0.50	0.13
Opiliones	—	—	0.06	0.01
Isopoda	0.09	0.00	0.22	0.14
Collembola	0.12	0.01	0.22	0.05
Orthoptera	0.01	0.00	0.06	0.01
Blattodea	0.09	0.00	0.17	0.05
Homoptera	0.03	0.00	—	—
Coleoptera	0.41	0.01	0.28	0.11
Coleoptera larvae	0.03	0.00	—	—
Lepidoptera	0.11	0.00	—	—
Lepidoptera larvae	0.09	0.00	—	—
Diptera	0.43	0.04	0.11	0.04
Formicidae	0.88	0.90	0.56	0.47
Hymenoptera (excluding Formicidae)	0.03	0.00	—	—

"—" indicates that there were no individuals of that invertebrate taxon present

worldwide. The ability to eat ants and other noxious and armored invertebrates (e.g., beetles; Coleoptera) may be an adaptation that insures an adequate food supply for these anuran species, as there is little competition for these invertebrate groups from other predators (Clarke 1974). Moreover, consuming large numbers of ants to meet the species' dietary needs may be highly adaptive for these anurans because the ant populations may be capable of sustaining very high predation rates since most of the ants eaten by anurans are workers and not reproductive units. As stated by Toft (1980), "ant specialists are more like grazers or browsers that eat the leaves of a tree rather than like predators that take whole individuals". Consequently, anuran predation may have relatively limited impact on the availability of ants. Additionally, the toxic skin secretions of some anurans (including members of Bufonidae and Pelobatidae) are at least partially sequestered from dietary sources (primarily ants and beetles; Isacch and Barg 2002; Saporito et al. 2004). Therefore, a diet comprised of a relatively large number of ants and/or beetles (as is the case for *B. fowleri* and *S. h. holbrookii* in this study) may be necessary to produce the toxic secretions used as a chemical defense against potential predators. The use of toxic skin secretions as a defense against potential predators is well documented in Bufonidae and Pelobatidae (Duellman and Trueb 1986). In fact, toxic skin secretions of *S. h. holbrookii* can cause symptoms similar to an allergic reaction in humans, including watery irritated eyes, runny nose, sneezing, and strong burning sensation in the nose and eyes during and subsequent to handling of individuals (B.C. Timm, pers. obs.).

Differences we observed between species in the proportion of the diet comprised of ants (*B. fowleri*, 88–90%; *S. h. holbrookii*, 47-56%) may be an indication of differing feeding strategies. Specifically, other investigators have noted that anuran species with a higher proportion of ants (and/or termites) in their diet are more active foragers than those with a comparatively lower proportion of ants (and/or termites) in their diet (Gerritsen and Strickler 1977; Krebs 1978; Toft 1980). These authors suggest that prey species that are patchily distributed in space and time (such as ants and termites) are more likely to be discovered and eaten by actively foraging predators than by sit-and-wait predators. Thus, *B. fowleri* may be more of an active forager while *S. h. holbrookii* may be more of a sit-and-wait predator. While we are not aware of any published studies on the foraging strategy of subadults of either species, our preliminary results from nocturnal radio-telemetry work on adult *S. h. holbrookii* suggest that they are in fact best characterized as sit-and-wait predators (B. C. Timm, unpubl. data).

Results from this study provide the first published account of the diets of subadult *B. fowleri* and *S. h. holbrookii*. In addition to a general understanding of dietary composition, these results also provide insight into potential feeding strategies exhibited by these species as well as potential interspecific competition between these species via dietary overlap. Though we only captured subadult individuals of the two study species, we suggest that future studies examining diets of individual and sympatric amphibian species include an assessment of these attributes for different age classes (e.g., newly metamorphosed juveniles, subadults, and adults) of the focal species of interest. Results from such studies will provide much needed information regarding ontogenetic dietary consistency/shifts, an aspect of amphibian ecology for which there is currently a dearth of scientific information.

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The Hemipenis of *Trimorphodon quadruplex*

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Scott and McDiarmid (1984:2) stated that "Most early attempts to clarify the relationships of *Trimorphodon* have been misled by an inadequate description of the hemipenis…" Recently, the *Trimorphodon biscutatus* complex has received some significant attention both in molecular and morphological analyses (Devitt 2006; Devitt et al. 2008) and much of its evolutionary history is becoming better understood. However, these recent studies have not included hemipenial morphology and earlier papers appear to provide inaccurate descriptions (e.g., Klauber 1940; Scott and McDiarmid 1984; Smith 1941). Cope (1895, 1900) dissected the tails of male *Trimorphodon* and noted that their hemipenes possessed calyces. This was later rejected by Scott and McDiarmid (1984) and although Savage (2002) stated that *Trimorphodon* possess calyces, he did not provide a reference or evidence for his statement. In this study we dissect, illustrate, and describe the hemipenis of one of the species in the *Trimorphodon biscutatus* complex, *T. quadruplex*.

Methods

A partially everted left hemipenis from a large adult-male specimen (SVL 1075 mm; tail length 226 mm; 89 divided subcaudals) of *Trimorphodon quadruplex* (UTA R-44978) was measured and then removed at the base. We followed the hemipenial preparation procedures of Myers and Cadle (2003) and Zaher and Prudente (2003) with the addition of blue petroleum jelly, inserted into the base of the hemipenis and resulting in full eversion of the hemipenis. The latter method is further described and illustrated by Smith and Ferrari-Castro (2008). Finally, we examined the retracted left hemipenis of USNM 32274—*in situ*, as originally studied and illustrated by E. D. Cope in 1895 and 1900. The description follows the terminology of Dowling and Savage (1960), Myers and Campbell (1981), and Zaher (1999), as adopted by Savage (2002).

Hemipenis Description

Trimorphodon quadruplex (UTA R-44978); Figs. 1, 2

The specimen comes from the town of Santa Cruz, Guanacaste, Costa Rica, and was collected by M. Sasa in 1997. The everted left hemipenis extends approximately 55 mm in length and is 12.5 mm at its maximum width. The pedicel of the hemipenis is long and narrow, extending approximately 20 mm, and its distal half is covered in minute spines. The spinous truncus occupies approximately 10 mm of the hemipenis. This region possesses about 87 hooks (noticeably large spines), ranging from about 1.0 to 1.6 mm in length. When fully everted the spines start at the beginning of the 8th subcaudal and end at the 13th subcaudal. The calyculate apical region extends to the 21st subcaudal. The single semicentripetal *sulcus spermaticus* extends to the tip of the organ. Following the spines is the spinous and papillate calyx region, extending for about 25 mm and includes 20 rows of calyces on the sulcate side. The calyces bear on their edges minute papilla, distally, or spines, proximally. A unique feature of the hemipenis is the enlargement of the two most proximal calyces on the asulcate side, over part of the truncus and resembling naked or striated pockets. The first and largest calyx extends about 4 mm. At the apex of the hemipenis the final 2–3 rows of ornamentation consist of numerous, small papillae.

Trimorphodon quadruplex (USNM 32274); Fig. 1

The specimen comes from San Juán, Nicaragua, and was collected by M. Oviedo. The SVL could not be taken of this specimen but the tail has a length of 173 mm and has 91 subcaudals, excluding the tip. The left hemipenis was examined uneverted, as illustrated by Cope (1895 and 1900). This hemipenis extends in length to the 25th subcaudal, the first minute spines appear at the level of subcaudal 8, and the first hooks at the level of subcaudal 14.

Discussion

The only illustration of *Trimorphodon* hemipenes we are aware of was presented twice by Cope (1895: plate 30, figure 7; 1900: plate 28, figure 7). Cope (1900, p. 1101) mentioned examining only four specimens of *T. biscutatus* (then including *T. quadruplex*), so his illustration was thought to come from one of them. Cope (1861) mentioned a specimen of *T. biscutatus* (= *T. quadruplex*) from Realejo Nicaragua (USNM 5569) and in 1870 (1869) de-

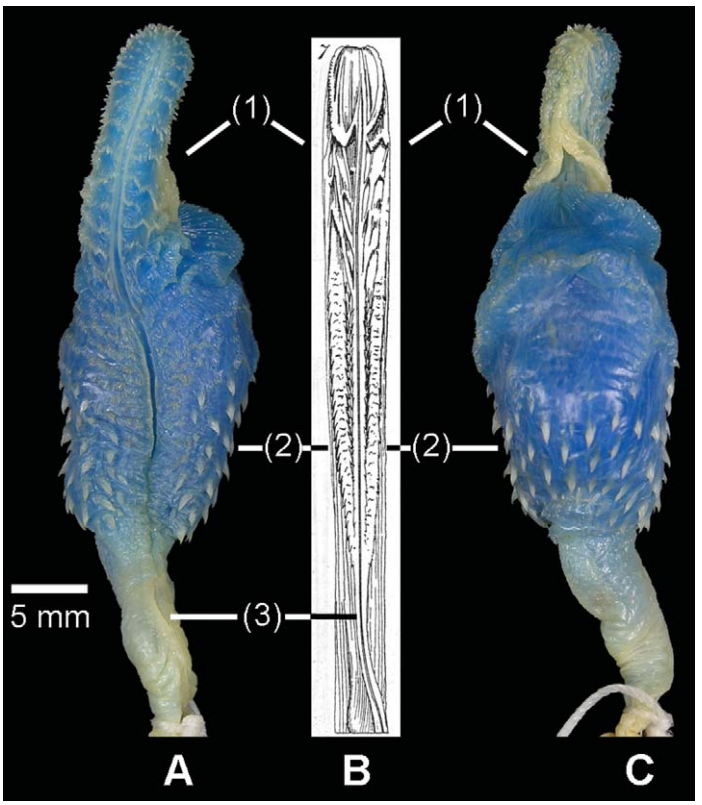


Fig. 1. Hemipenis of *Trimorphodon quadruplex*. Sulcate (A) and asulcate (C) view of the left hemipenis of UTA R-44978, compared to Cope's (1900: plate 28, image 7) *in situ* illustration of the left organ of USNM 32274 (B), showing calyces (1), spines (2), and sulcus spermaticus (3).



FIG. 2. Side view of the hemipenis of *Trimorphodon quadruplex* (UTA R-44978), showing the protruding lower calyces and curvature of the hemipenis.

scribed *T. major* (shortly synonymized by him as *T. biscutatus*, Cope 1876 [1875], p. 131) from Tehuantepec, Oaxaca, based on three specimens (two specimens mentioned by him but three cotypes, USNM 30427–9, are listed by Cochran 1961). However, our examination determined that the hemipenes of none of these specimens were examined by Cope. The illustrated hemipenis belongs to the left hemipenis of a *T. quadruplex* (as currently recognized by Devitt et al. 2008), USNM 32274, a paratype from San Juan, Nicaragua (Smith 1941), which was returned by Cope's estate after his death. Our figure 1 includes an image of Cope's illustration for direct comparison of the retracted and the everted hemipenes. The existence of calyces is quite obvious on the fully everted hempenis (Figs. 1, 2), and as mentioned by Cope (1900), these structures are very unusual.

Although beyond the scope of this study, we examined specimens of *T. biscutatus* (UTA R-51832, from Carretera El Camaron-Mitla Km 106 on Mex 190, Oaxaca) and *T. paucimaculatus* (UTA R-52654, from Arroyo Colorado, Municipio La Huerta, Jalisco) and found these same features (e.g., unusual and extended proximal calyces) on their everted hemipenes. A thorough analysis of the hemipenis of the other species of *Trimorphodon* (*biscutatus*, *lambda*, *lyrophanes*, *paucimaculatus*, *tau*, *vilkinsonii*) is needed to add morphological support to the currently recognized species. King et al. (2009) found that reproductive behavior may correlate with hemipenis morphology. An investigation of the reproductive behavior causing this odd morphological evolution would be interesting.

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TECHNIQUES

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Effectiveness of Using Burlap Bands to Sample Arboreal Green Salamander Populations in the Blue Ridge Mountains of Georgia and North Carolina

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Green Salamanders, *Aneides aeneus*, occur as two distinct populations in the eastern United States. The more extensive population is located throughout the Cumberland and Allegheny Mountain regions from Pennsylvania to Alabama and northeastern Mississippi. The smaller disjunct population is located in the Blue Ridge Mountains of Georgia, South Carolina, and North Carolina (Petranka 1998). A study conducted in the Blue Ridge Escarpment of western North Carolina, northwestern South Carolina, and northeastern Georgia documented a 98% decline in some populations of Green Salamanders since 1970 (Corser 2001). The U.S. Fish and Wildlife Service currently recognizes *A. aeneus* as a species of concern. The Blue Ridge Escarpment population is listed as rare in Georgia, endangered in North Carolina, and a species of special concern in South Carolina. Corser (2001) attributed declines to climate change, loss and alteration of habitat, a chytrid fungal pathogen, and exploitation through collection by researchers. The issue of forest ecosystem alteration and its importance in understanding Green Salamander arboreality and species declines have recently garnered attention (Pauley and Watson 2005; Waldron and Humphries 2005).

Green Salamanders are generally considered crevice-dwelling species associated with rock outcrops, and only "weakly" arboreal (Pauley and Watson 2005). Green Salamander morphology is consistent with rock-crevice habits, particularly their dorso-ventrally compressed bodies with elongate limbs and toes with expanded square toe tips (Petranka 1998). Most associations with Green Salamanders and non-rock outcrop habitats were reports of large numbers of individuals under the bark of dead and fallen trees, particularly large American Chestnut (Barbour 1949). Contradicting the perception of Green Salamanders as weakly arboreal, Waldron and Humphries (2005) recently documented large numbers of Green Salamanders using arboreal habitats in some Blue Ridge Escarpment populations. Using day and night searches with flashlights, they recorded 345 Green Salamander observations between April and October, of which 43% occurred in trees, 41% in rock outcrops, and only 15% on or in logs. They also reported arboreal nesting. Additionally, Wilson (2003) documented Green Salamanders in woody and arboreal habitats at sites throughout the Blue Ridge Mountains. These studies raise questions about the importance of arboreal habits to Green Salamander populations and highlight the potential need to include methods for searching arboreal habitats as part of Green Salamander monitoring.

Although the technique used by Waldron and Humphries (2005) was successful at discovering many salamanders using arboreal habitats, it was very time consuming (more than 210 h over a 3.5 yr period) and difficult to standardize. Survey success varied widely based on weather conditions and other variables. Further, the effectiveness of the technique is likely to vary greatly among observers who differ in ability to spot salamanders high in trees. A standardized and less labor-intensive technique for studying arboreal habits of Green Salamanders would be useful.

Artificial cover is widely utilized as a technique for standardized monitoring of terrestrial salamanders (Houze and Chandler 2002; Monti et al. 2000). Artificial cover can provide the necessary microclimates to attract salamanders during diurnal retreat, making detection of species less dependent upon the immediate climate. Artificial cover generally involves the application of boards or other materials to the forest floor, or litter bags or baskets along stream banks (Monti et al. 2000). We are not aware of any standardized artificial cover technique for capturing salamanders in arboreal habitats. However, burlap fabric attached to trees (known as burlap bands) has been used to sample arboreal invertebrates and reptiles (Campbell and Sloan 1977; Duguay et al. 2000; Horn and Hanula 2006; Reardon 1976). In addition to attracting invertebrates, these artificial shelters are sometimes occupied by salamanders, including Red-backed Salamanders (*Plethodon cinereus*) and Northern Two-lined Salamanders (*Eurycea bislineata*) (J. Waldron, pers. comm.). Attaching artificial cover to trees at distance and heights determined within the predicted range of Green Salamanders may provide a reliable technique for capturing Green Salamanders occupying arboreal habitats. In 2005, we deployed burlap bands on trees at four study sites in Georgia and North Carolina in order to determine whether Green Salamanders will occupy burlap bands as an artificial cover type.

Methods.—The populations of Green Salamanders surveyed were located in the Nantahala National Forest in Jackson County, North Carolina, and Chattahoochee National Forest in Rabun

County, Georgia. Both populations are located in the Blue Ridge physiographic province. We identified three study sites in the Chattahoochee National Forest and one site in the Nantahala National Forest where Green Salamanders were known to occur (M. Elliott, Georgia Natural Heritage Program, pers. comm.). The vegetation at all sites consists of mixed, uneven-aged conifer/hardwood forest with dense Rhododendron (*Rhododendron maximum*) midstory. The dominant tree species at the sites are Eastern Hemlock (*Tsuga canadensis*), Red Maple (*Acer rubrum*), Tulip Poplar (*Liriodendron tulipifera*), Frasier Magnolia (*Magnolia fraseri*), White Oak (*Quercus alba*), Eastern White Pine (*Pinus strobus*), Pignut Hickory (*Carya glabra*), Northern Red Oak (*Quercus rubra*), Chestnut Oak (*Quercus montana*), and Witchhazel (*Hamamelis virginiana*) (Gordon 1952). Annual precipitation in the area ranges from 215–254 cm (Bruce 1968). The rock outcrops at sites known to be occupied by Green Salamanders are composed of granite. The deep, narrow crevices and asymmetrical walls provided by the granite outcrops offer individuals protection from sunlight (Bruce 1968) and predators. Green Salamanders overwinter, mate, and lay eggs within the outcrops (Pauley and Watson 2005; Petranka 1998). The site in the Nantahala National Forest is located at 950 m elevation (Gordon and Smith 1949) with 15% slope and 75% canopy cover. The three sites in the Chattahoochee National Forest range in elevation from 600–750 m with 10–55% slope and 25–65% canopy cover. Herbaceous understory is dominated by Galax (*Galax aphylla*), Hayscented Fern (*Dennstaedtia punctilobula*), Pansy (*Viola* sp.), Striped Wintergreen (*Chimaphila maculata*), Speckled Wood Lily (*Clintonia umbellata*), and Mountain Laurel (*Kalmia latifolia*) (Gordon 1952).

Burlap fabric was washed with a concentrated liquid detergent formulated for use in laboratories to remove chemicals that aid water resistance and may potentially harm salamanders (Liqui-Nox®). Prior to use, the burlap fabric was tested for anions at U.S. Forest Service, Coweeta Hydrologic Laboratory and results show the fabric contained less than 0.5 ppm of chloride, sulfate, nitrate, phosphate, and bromide. At each site, burlap strips measuring 76.2 cm by 45.7 cm were attached to hardwood trees with hemp rope two meters from the ground on 15 trees with a diameter at breast height (DBH) ≥ 20.3 cm (Fig. 1). Trees ranged from 1-50 m from the rock outcrops. Large hardwood trees were selected because previous research suggested that Green Salamanders are observed on large hardwoods compared to conifers (Waldron and Humphries 2005).

We visited each site three times per month (~1-2 weeks between visits) from June–December 2005. During each visit, we lifted the fabric and searched the entire area under the burlap with a flashlight. For comparative purposes, we also searched crevices for salamanders on each occupied rock outcrop during each visit. We recorded the number and species of salamanders observed, measured individuals (we did not capture and measure salamanders observed in rock crevices), and recorded distance from the nearest occupied rock outcrop. Green Salamanders under burlap were classified as adults (> 44.5 mm total length, TL), sub-adults (29.5–44.4 mm TL), or juveniles (< 29.5 mm TL) (Waldron and Humphries 2005). Salamanders were released at their capture location. Sites were surveyed during the day, at dusk, and after dark.

Results.—Over 16 sample days, we observed 31 salamanders under burlap, only 11 of which were Green Salamanders (Table 1). We also observed Southern Appalachian Slimy Salamanders (*Plethodon chattahoochee*), Southern Gray-cheeked Salamanders (*Plethodon metcalfi*), and a single Ocoee Salamander (*Desmognathus ocoee*). We observed a greater number (16) of juvenile Southern Appalachian Slimy Salamanders under burlap than Green Salamanders. By comparison, we observed 80 salamanders in rock outcrops including 57 Green Salamanders during the same sample period (Fig. 2). Though we did not systematically search for salamanders on non-burlap trees, we did not observe any salamanders on trees outside of burlap covers. Further, while we observed few Southern Gray-cheeked Salamanders under burlap, we did observe them routinely off the forest floor on Rhododendron during wet nights. All Green Salamanders and Southern Appalachian Slimy Salamanders found under the burlap were sub-adults, while the Ocoee Salamander and the Southern Gray-cheeked Salamanders were adults. We determined Ocoee Salamander and Southern Gray-cheeked Salamander adult and juvenile size classes by comparing measurements of each individual to published size classes for the two species (Petranka 1998). Southern Gray-cheeked Salamanders were observed singly, while up to five Southern Appalachian Slimy Salamanders were observed under one piece of burlap at the same time. One Green Salamander was observed under a piece of burlap with three Southern Appalachian Slimy Salamanders. All individu-



FIG. 1. Burlap bands were attached to hardwood trees with hemp rope two meters from the ground on trees with a diameter at breast height (DBH) ≥ 20.3 cm to assess arboreality of Green Salamanders in the Nantahala National Forest, North Carolina and Chattahoochee National Forest, Georgia, 2005.

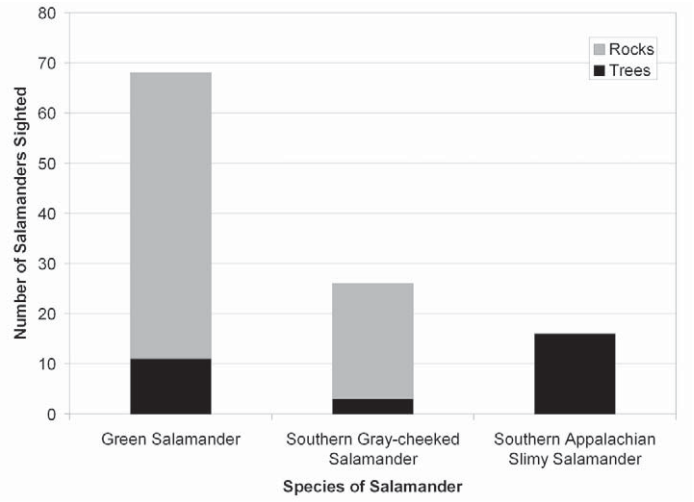


FIG. 2. Number of Green Salamanders, Southern Gray-cheeked Salamanders, and Southern Appalachian Slimy Salamanders in and on rocks versus the number observed under the burlap cover on trees in Chattahoochee National Forest, Georgia, and Nantahala National Forest, North Carolina, 2005.

als were observed between the burlap and tree bark, not between the two layers of the burlap at the top of the band where the burlap was attached to the tree with hemp rope (Fig. 1).

Salamanders were only observed beneath burlap from August–November. However, Green Salamanders and Southern Gray-cheeked Salamanders were observed in the rock outcrops as early as May, when we began establishing transects, until late November. Green Salamanders were found a maximum distance of 10 m from rock outcrops. Southern Gray-cheeked Salamanders were found up to 7 m from rock outcrops. Southern Appalachian Slimy Salamanders were never observed on the rock outcrop; they were only observed under burlap on trees located within 1 m of the rock outcrop.

No salamanders were observed under burlap in surveys conducted before 1600 h and individuals were most abundant under burlap in months with high precipitation (correlation between cumulative monthly rainfall and number of salamanders observed under burlap: $R^2 = 0.87$, $p = 0.067$). Southern Appalachian Slimy and Gray-cheeked Salamanders were common on the forest floor. However, we never observed Green Salamanders on the forest floor, similar to Waldron and Humphries (2005). More Green Salamanders and Southern Gray-cheeked Salamanders were observed in rock crevices than on trees during our surveys.

Discussion.—Our results indicate that Green Salamanders and other terrestrial plethodontid salamanders will occupy burlap as artificial cover during periods of sufficient precipitation. That we did not opportunistically observe any Green or slimy salamanders on trees outside of burlap suggests that despite low captures of salamanders the burlap did improve observation of arboreal habitat use by salamanders. In contrast to the observations of Waldron and Humphries (2005), we did not observe any Green Salamanders on trees during day searches. All arboreal observations of salamanders occurred after dusk following recent rains. This is consistent with other observations of plant climbing behavior in terrestrial *Plethodon* (e.g., Jaeger 1978) and strongly suggests that all salamanders, including Green Salamanders, were moving from forest floor or rock habitats up the trunks of trees to forage on rainy nights. We did observe large numbers of invertebrates under the burlap. We did not capture any Green Salamanders on trees farther than 10 m from the associated rock outcrops, which contrasts sharply with prior observation of Green Salamanders up to 40 m from rock outcrops at one of the same study sites (Waldron and Humphries 2005). This may simply be an artifact of the greater sampling effort of Waldron and Humphries increasing the opportunity to detect Green Salamanders farther from rock outcrops.

One interpretation of our results is they are more consistent with the characterization of Green Salamanders as "weakly arboreal," and their use of trees may be comparable to that of other forest plethodontids. Alternatively, the difference between our results and those of Waldron and Humphries (2005) may be an artifact of the suitability of burlap as refugia. The burlap did not retain much water and the surface under the burlap usually dried within days of a rain. Dry conditions are unfavorable to salamanders, and may explain why we did not observe any individuals under the burlap during the day. Waldron and Humphries (2005) report Green Salamanders in trees, often tucked beneath small flaps of bark, even during dry periods. Burlap apparently did not adequately simulate loose bark that could be used by Green Salamanders; therefore, burlap may be suitable for use if surveying arboreal foraging habits of plethodontids, but unsuitable for measuring other arboreal habits. The effectiveness of burlap might be improved if a strip of foam is attached at the top of the burlap flap to absorb and retain water. Alternately, another substrate such as slabs of real or artificial bark could be attached to trees to provide better microclimates for salamanders.

Further, Waldron and Humphries (2005) found that Green Salamanders prefer American Beech trees and hardwood trees over other tree species. Therefore, conducting a study to determine

TABLE 1. Number of individuals of each species of salamander observed at sites surveyed using burlap bands attached to trees in Chattahoochee National Forest, Georgia, and Nantahala National Forest, North Carolina, 2005. T = Trees, RO = Rock Outcrops.

Salamander Species	Chattahoochee I		Chattahoochee II		Chattahoochee III		Nantahala	
	T	RO	T	RO	T	RO	T	RO
Aneides aeneus	0	2	5	3	4	23	2	31
Plethodon metcalfi	0	0	0	5	0	8	3	9
Plethodon chattahoochee	0	0	16	0	0	0	0	0
Desmognathus ocoee	0	0	1	0	0	0	0	0
Total	0	2	22	8	4	31	5	40

Green Salamander tree species preference is important in assessing arboreality of the species. Trees in this study were chosen because of their size since American Beech trees were scarce at our sites or did not meet size requirements. Tree preference may be because of species of invertebrates found on different species of trees. Future studies include determining if a correlation exists between number of arthropods on trees and number of salamanders present.

Number of salamanders observed under burlap on trees and in the rock outcrops in November 2005 supports earlier findings (Waldron and Humphries 2005) that Green Salamanders as well as Southern Gray-cheeked Salamanders and Southern Appalachian Slimy Salamanders (Petranka 1998) show strong seasonal use of the forest floor and trees. We did not observe any species of salamanders under burlap in trees after November. Most likely Green Salamanders move to rock outcrops where they overwinter, then emerge and disperse in late-March or early-April (Waldron and Humphries 2005). Southern Appalachian Slimy Salamanders are suggested to overwinter in caves in Georgia. Southern Gray-cheeked Salamanders are suggested to overwinter in the ground in extensive burrows. Southern Gray-cheeked Salamanders move to their overwintering habitats and emerge and disperse in the spring at approximately the same time as Green Salamanders (Petranka 1998); therefore, surveys assessing arboreal habitat use should be conducted from August–November or late March–May.

The issue of arboreal habitat use by Green Salamanders and its importance to their population ecology remains unclear. While our results do not disagree with the characterization of Green Salamanders as "weakly arboreal", the results of Waldron and Humphries (2005) suggest that studies of Green Salamander arboreal habits needs greater attention. A 100-m buffer zone around each outcrop containing Green Salamanders has been suggested (Petranka 1998) to maintain cool microclimates on rock outcrops. If arboreal habitats are as important as Waldron and Humphries (2005) observations suggest, then the importance of forest buffers goes beyond maintenance of mild climates on rock outcrops. Though we did not capture large numbers of Green Salamanders under burlap, numerous individuals of other Southern Appalachian Salamanders were found. It should be noted that our study was only conducted during a few months during one season. Just as coverboards used in other reptile and amphibian studies oftentimes need time to "age" before they are successful, burlap or other artificial cover objects may increase in efficiency as they remain in the forest. We suggest the use of numerous sampling techniques for Green Salamanders and other salamander species in the Appalachians, as all methods have their benefits and biases.

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Monitoring of Stream Salamanders: The Utility of Two Survey Techniques and the Influence of Stream Substrate Complexity

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Stream salamanders are often the most abundant vertebrates in headwater streams (Peterman et al. 2008) and they play an integral role as both predators and prey in these ecosystems (Greene et al. 2008; Resetarits 1997). Because stream salamanders often use both terrestrial and aquatic habitat, they may be vulnerable to the degradation or contamination of either environment (Semlitsch 2000). As a consequence, stream salamanders have proven to be susceptible to terrestrial disturbances such as deforestation (Crawford and Semlitsch 2008; Johnston and Frid 2002) and aquatic disturbances such as siltation (Lowe et al. 2004) and stream acidification (Kucken et al. 1994). Because of this susceptibility to a range of environmental perturbations, it is widely believed that stream salamanders are useful as biological indicators of ecosystem health (Rocco and Brooks 2000; Welsh and Droege 2001). As a result, they have been increasingly incorporated into stream and watershed monitoring efforts (Jung et al. 2000).

A wide range of sampling techniques may be used to study stream salamanders, including active techniques such as dipnetting and visual encounter surveys (Grover 2006; Shaffer et al., 1994), or passive techniques such as funnel trapping or leaf litter bag sampling (Pauley 1995; Willson and Dorcas 2003). In this study, we examine the utility of two common techniques for monitoring stream salamanders: leaf litter bag sampling and nighttime visual encounter surveys (VES). The leaf litter bag refugia technique has long been used to sample aquatic invertebrates (Hilsenhoff 1969; Crossman and Cairns 1974), and has more recently been described as a method for surveying stream salamanders (Pauley 1995). Leaf litter bags may be ideal for many salamander monitoring efforts because they are cheap, non-destructive, easy to employ, and likely result in minimal observer bias (Chalmers and Droege 2002; Jung and Pauley 2003; Pauley and Little 1998; Waldron et al. 2003). Although leaf litter bags have been recommended for developing occupancy estimates for certain aquatic salamanders (Chalmers and Droege 2002; Pauley and Little 1998), this technique may be biased towards the larval and juvenile lifestages (Pauley and Little 1998). Furthermore, larval captures from litter bag sampling may be highly variable and may not demonstrate a clear relationship with actual abundances (Chalmers and Droege 2002; Waldron et al. 2003). Visual encounter surveys require relatively little equipment, are effective for a large range of species, and can be conducted across a wide range of habitats including terrestrial, riparian, and aquatic (Toft et al. 1982; Pough et al. 1987). However, visual encounter surveys may have variable results due to differences in capture rates between researchers (Crump and Scott 1994; but see Marsh 2009) and may yield results that are highly dependent on prevailing stream and weather conditions (Barr and Babbitt 2002; Crump and Scott 1994).

Another potential source of variation in stream salamander captures is the variability in stream substrate complexity that often exists at both a local and regional scale. A number of studies have demonstrated that the species richness of stream organisms is positively correlated with habitat complexity (Gorman and Karr 1978; Reice 1980; Schlosser 1982). In the southern Appalachians, larvae of many stream-dwelling salamander species frequently utilize leaf litter, rock cover, and interstitial spaces in gravel streambeds (Petranka 1998). As a result, we believe that variability in stream substrate complexity may influence both salamander abundance and species richness on a local scale, as well as the accuracy of abundance indices derived from capture data. For example, variability in leaf litter bag captures between sites may be at least partially explained by salamanders preferring litter bags no more than surrounding cover objects in areas of higher substrate complexity (Chalmers and Droege 2002).

Although there are several potential techniques for sampling stream salamanders, researchers may be limited by practical considerations such as time, resources, and the availability of surveyors. The primary objective of this study was to determine how stream substrate complexity influences both capture rates and observed species richness of stream salamanders of two common sampling techniques with the goal of developing monitoring recommendations to optimize capture rates and species detection ability. Specifically, we sought to compare 1) catch-per-unit-effort (CPUE) and observed species richness between sampling techniques and 2) CPUE and observed species richness between stream segments with low and high substrate complexity.

Methods.—We conducted this study at four first to second-order streams in the vicinity of Highlands, North Carolina, USA. The streams sampled were located within 8 km of the Highlands Biological Station (35.0323ºN, 83.1117ºW), (35.0312ºN, 83.1115ºW), (35º0317ºN, 83.1120ºW), (35.0209ºN, 83.1323ºW). At each stream, we surveyed two separate 10-m transects; one with simple substrate and one with complex substrate. Although substrate complexity would typically be considered a continuous variable, we purposefully selected transects with either an extreme abundance or a complete lack of cover objects and treated substrate complexity as a dichotomous variable. Transects with complex substrate had >85% in-stream habitat cover (boulder, cobble, leaf litter, coarse woody debris), while those with simple substrate were entirely sandy or muddy with only sparse leaf litter for cover. At all four streams, the two transects were separated by a minimum of 50 m. Stream segments were selected by systematically searching 13 streams in the area around the Highlands Biological Station. The four streams included in this study were the only streams which met the aforementioned criteria of having: 1) a potential 10-m transect containing exclusively simple substrate and 2) a potential 10-m transect, at least 50 m from the first transect, containing complex substrate.

We constructed 40 leaf litter bags (Pauley and Little 1998) from 1.9 cm^2 polypropylene mesh. To create each leaf litter bag we filled 70 x 70 cm squares of netting with dry leaf litter, twisted the

corners together, and cinched a cable tie around the joined corners. On 18 June 2008, five leaf litter bags were systematically placed throughout each 10-m transect and were covered or surrounded by rocks to keep them in place in the stream. All bags were placed in at least 4 cm of water and were submerged to no more than three fourths of the bag's height.

Leaf litter bags were checked on 2, 16, and 30 July. During sampling, leaf litter bags were removed quickly from the stream and placed in a large white dishpan. As each bag was lifted from the water, a 15 x 20 cm baitnet was swept beneath it to capture any salamanders taking refuge underneath. Bags were held above the dishpan and shaken from side to side, dipped into the stream, and then shaken from front to back for a total of approximately 15 seconds. The water, sediment, and debris collected in the trays were then poured through the baitnet. The sediment and debris from the baitnet was then manually searched for salamanders. All captured salamanders were identified to species and then released within 1 m of the point of capture. We also conducted a time-constrained search (VES) for larval and adult salamanders at each transect in order to compare count data and observed species richness to those obtained with leaf litter bag sampling. Each 10 m transect was searched by two observers for a total of 30 minutes between 2100 h EST on 4 August 2008 and 0200 h EST on 5 August 2008. Salamanders were captured and identified to species and released in the stream.

With the goal of assessing techniques in terms of their ability to optimize capture rates during sampling efforts, we used our count data to compare the catch-per-unit-effort (CPUE) for each sampling technique. This capture rate is reported as the number of salamanders caught per hour of sampling. It is difficult to estimate total sampling time using leaf litter bags because they are in the water "sampling" for days or weeks before being checked. Therefore, the time we used to determine our capture rates is the total time spent by researchers actively sampling in the field. Leaf bags took 20 person-minutes to check per transect, and 60 person-minutes per transect for three days of sampling. One night of visual encounter survey took 60 person-minutes per transect.

We analyzed total CPUE data using the ANOVA procedure of SAS (SAS® Version 9.1 for Windows, SAS Institute, Cary, North Carolina). We conducted a two-way nested ANOVA to examine the effect of substrate type (simple vs. complex) and survey technique (leaf bag vs. VES) on capture rates, while accounting for the fact that our true level of replication was at the stream level. We also conducted a repeated-measures ANOVA to examine the background variability in leaf litter bag capture rates over time. Finally, we ran an independent samples t-test to compare the mean number of species detected in simple and complex substrates.

Results.—We captured a total of 690 salamanders, with leaf litter bag sampling accounting for 54% (N = 374) of total captures and VES accounting for 46% (N = 316) of total salamander captures. Larvae made up a majority of captures from both leaf litter bag sampling (89%) and VES (92%). The two techniques together detected every stream-affiliated salamander species known to be present at our study sites. We found that catch per unit effort (CPUE) did not differ significantly between litter bag sampling and VES ($F_{1,3}$= 0.21, p=0.6769; Fig. 1). Catch per unit effort from both techniques combined did not show a significant relationship with substrate complexity ($F_{1,3}$= 1.61, p=0.2941). With leaf litter bag sampling, CPUE did not significantly differ across sampling occasions ($F_{1,8}$= 1.77, p= 0.2318).

Although CPUE was similar for both sampling techniques, leaf litter bag sampling and VES sampling differed slightly in the species they captured (Table 1). The two sampling techniques each accounted for roughly half of total salamander captures, yet litter bags captured a slight majority of *Desmognathus ocoee* individuals (61%), while nighttime VES captured a majority of *D. quadramaculatus* individuals (77%). In addition, we captured one *Pseudotriton ruber* metamorph and two *Gyrinophilus porphyriticus* larvae in leaf litter bags while neither species was detected at any site during VES. Both sampling techniques captured a large number of *Eurycea wilderae* larvae, while *D. monticola* was not commonly captured using either technique (Table 1).

Overall, we detected significantly more species in transects with complex substrate using both leaf litter bags (T_6= 2.954, p=0.025) and VES (T_6= 3.0, p=0.024). Litter bag sampling detected a mean of 3.75 ± 1.26 SD species in transects with complex substrate and a mean of 1.75 ± 0.50 SD species in simple substrate. Using nighttime VES sampling we found a mean of 3.25 ± 0.96 SD species per transect with complex substrate and a mean of 2.00 ± 0.82 SD species per transect with simple substrate. Overall, surveying in complex transects tended to yield a higher observed species richness primarily because *D. monticola* and *D. quadramaculatus* were

TABLE 1. Total larval and adult salamanders captured by sampling technique and substrate type (Leaf = leaf litter bag, VES = visual encounter survey).

		Desmon	Desoco	Desqua	Eurwil	Gyrpor	Pserub
Leaf							
	larvae	0	0	4	328	2	0
	adults	5	19	1	14	0	1
	total	5	19	5	342	2	1
VES							
	larvae	0	0	13	278	0	0
	adults	7	12	4	2	0	0
	total	7	12	17	280	0	0
Complex							
	larvae	0	0	14	375	1	0
	adults	12	12	5	5	0	1
	total	12	12	19	380	1	1
Simple							
	larvae	0	0	3	231	1	0
	adults	0	19	0	11	0	0
	total	0	19	3	242	1	0

Desmon = *Desmognathus monticola* Desoco = *Desmognathus ocoee* Desqua = *Desmognathus quadramaculatus* Eurwil = *Eurycea wilderae* Gyrpor = *Gyrinophilus porphyriticus* Pserub = *Pseudotriton ruber*

only frequently encountered around complex, rocky substrates (Table 1).

Discussion.—Accurate estimations of amphibian abundances across time, locations, and observers require the use of standardized sampling methods and protocols (Crump and Scott 1994). Because substrate can be highly variable both within and between streams (Inoue and Nunokawa 2002; Vannote et al. 1980), it is important to determine whether this variability influences the efficacy of sampling techniques, particularly when using artificial refugia. Also, because certain sampling techniques may be inherently biased towards particular species or life stages while failing to detect others, any effect of stream substrate complexity on capture rates or observed species richness may significantly affect the utility of many survey techniques (Strain et al. 2008). Although we found no significant difference in CPUE between substrate types and between sampling methods, sampling in areas with greater substrate complexity revealed the presence of more species. For both sampling techniques, fewer species were found in areas of simple substrate than in areas of complex substrate. Stream salamander species have been shown to exhibit different substrate preferences, with *D. quadramaculatus* and *D. monticola* demonstrating a strong preference for rocky substrates (Southerland 1986). Although we found 3 *D. quadramaculatus* larvae in transects with simple substrate, the vast majority of *D. quadramaculatus* (19 of 22) and all *D. monticola* were found in transects with complex substrate (Table 1). These results are consistent with studies of other stream organisms where species richness has been found to be positively correlated with habitat complexity (Gorman and Karr 1978; Reice 1980; Schlosser 1982). Habitat complexity has repeatedly been shown to moderate predatory and competitive interactions (Babbitt and Tanner 1998; Crowder and Cooper 1982; Heck and Crowder 1991), and it has specifically been demonstrated that lotic habitat substrate complexity can decrease the susceptibility of larval salamanders to predation (Barr and Babbitt 2002). As a result, it seems likely that substrate complexity plays a critical role in sustaining high levels of salamander diversity and species richness in these headwater ecosystems.

This study demonstrates that leaf litter bag sampling and VES both have their strengths and weaknesses. Leaf litter bags are cheap, non-destructive, easy to employ, and likely result in minimal observer bias (Chalmers and Droege 2002; Jung and Pauley 2003; Pauley and Little 1998; Waldron et al. 2003). Leaf litterbags also take less time than nighttime VES sampling during repeated surveys and can be particularly useful for large scale inventories and when time-constrained sampling of individual sites is limited (Waldron et al. 2003). Although leaf litterbag sampling was relatively ineffective at capturing large body *D. quadramaculatus*, this technique did capture more *D. ocoee* than the nighttime VES technique. Further, *Pseudotriton ruber* and *Gyrinophilus porphyriticus* were only detected using leaf litter bags, which is consistent with other studies in which leaf bags effectively captured hard to detect species (Waldron et al. 2003). Visual encounter surveys are simple and require relatively little equipment. They are not as biased towards any particular life stage, and they can be implemented over a wide range of habitats. Because different sampling techniques appear to target different ranges of species, we believe the use of more than one sampling technique may allow more accurate estimation of stream salamander abundances and species richness. Following this recommendation, while considering the effects of stream substrate complexity on salamander diversity, can result in more effective stream salamander monitoring.

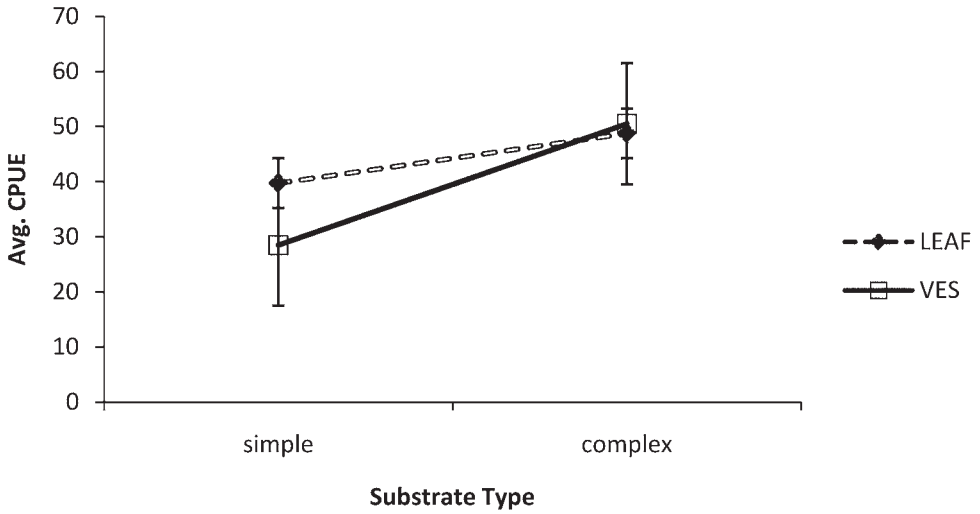


FIG. 1. Average catch-per-unit-effort (CPUE) using leaf litter bags (LEAF) and visual encounter surveys (VES) in simple and complex substrates.

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A Functional and Cleanable Substrate for Snake Testing Arenas

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When studying snake behavior in experimental arenas, several considerations must be made when choosing an appropriate substrate. Because of the importance of olfactory information to snakes, and because of their high sensitivity to chemical cues, we often desire an ability to control or eliminate odors in the experimental setting (Ford and Burghardt 1993). This, and the occasional need to reduce unwanted exploratory behaviors such as burrowing, often precludes the use of naturalistic litter substrates. Instead, we opt for a floor surface that is easy to clean or, in the case of paper

substrate, can be discarded and replaced. Many snakes rely heavily on lateral undulation for locomotion (Gans 1986; Gray 1946), which requires a substrate with considerable texture, and the use of smooth, easily cleaned or disposable substrates limits this ability. In experimental arenas with such substrates, snakes often use alternatives to lateral undulation (e.g., concertina and rectilinear motion; Gans 1986; Gray 1946) that may be perfectly acceptable or appropriate depending on the conditions of the study. However, concertina locomotion is apparently far less efficient than lateral undulation (Walton et al. 1990), and under some circumstances the relatively low rate of travel achieved by concertina or rectilinear locomotion can be counterproductive to behavioral studies. Snakes and other legless squamates will also resort to slide-pushing when other methods prove ineffective (Gans 1984; Gasc and Gans 1990), and this often involves vigorous movements of the entire body that might detract from a subject's ability to attend to stimuli important to a given experiment.

Researchers have found alternatives to paper or smooth flooring, such as artificial turf or indoor-outdoor carpeting (Finkler and Claussen 1999; Winne and Hopkins 2006). These provide more texture than many paper substrates and are resilient enough to be washed and reused many times. However, the labor and time required to thoroughly wash and let dry the large number of carpet pieces required to conduct numerous experimental trials seems hardly worth the small improvement in snake locomotion obtained by using these as substrates, particularly the latter (personal observation). Because of this, we have sought and found what we believe to be a better solution.

Perlite is a lightweight, crumb-like material having many applications, the most familiar perhaps being its use as an incubation substrate for reptile eggs and to improve aeration of soils for gardening. It is readily and inexpensively available at garden supply stores worldwide. Another use of perlite, and the one that led to its use here, is as an additive to paints to provide visually pleasing texture to the ceilings and walls in our homes. When sold as a paint texturizer, perlite can have a fine, medium, or coarse grain. By mixing a coarse perlite with animal-safe paint, applying this mixture to an arena floor, and then coating it with several additional paint-only layers, we have obtained a substrate that is easy to clean thoroughly (we wash it with warm soapy water, rinse, and then finish with a microfiber cloth dampened with isopropanol), dries quickly afterward, and is resilient to frequent cleaning. The substrate remains fixed and weighs very little, allowing one to keep the test arena highly portable if desired. During the first few cleanings, a small number of the perlite pieces might become broken or dislodged, but this soon ceases after recoating with paint. The treatment is extremely easy to apply, and it can be used on surfaces of any size, shape, or orientation. Moreover, one can vary the location, amount, and coarseness of texture to suit specific needs. Vermiculite, which is very similar to perlite, is also likely to function well for this purpose, though its more angular nature might inhibit satisfactory paint coverage.

Although we have not empirically tested for effects of this treatment on the chemosensory behavior of snakes, we have noticed no aversive responses (e.g., tongue flicks followed by abrupt evasive motions) from any study subjects in arenas treated in this manner. However, in order to limit the possibility of adverse paint-related chemical effects, all new applications of paint should be subjected

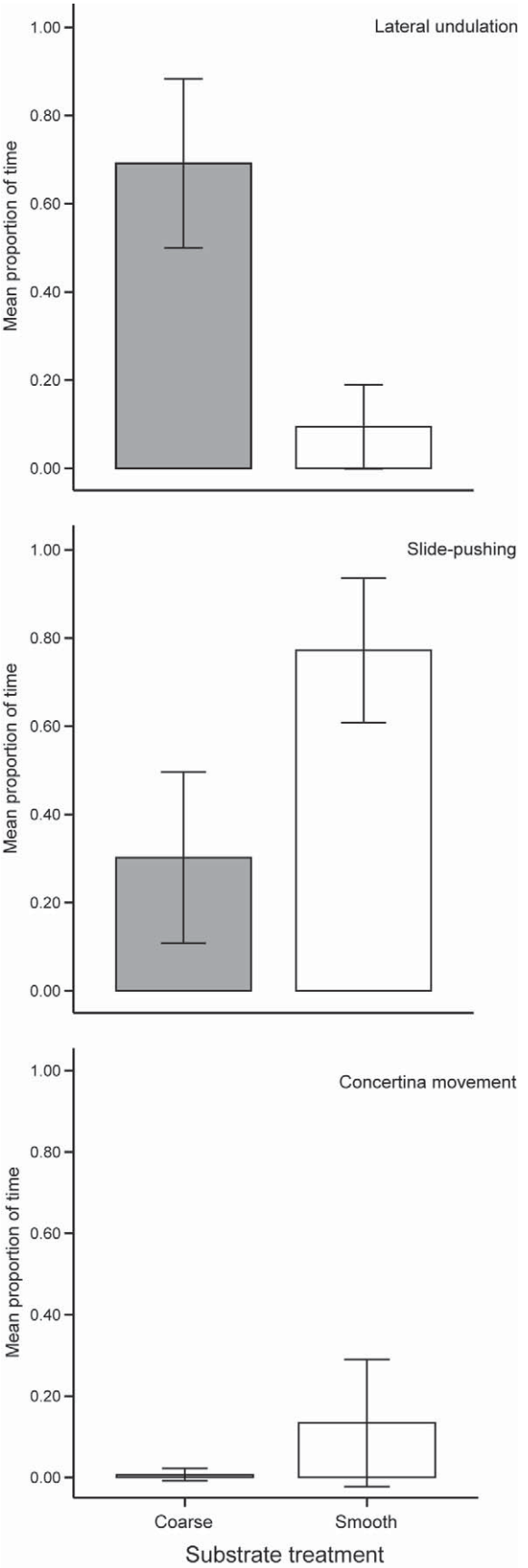


FIG. 1. Mean proportions of time spent by 10 *Nerodia clarkii compressicauda* engaging in three locomotory methods on a smooth painted surface (smooth) and on a surface treated with perlite-infused paint (coarse). Error bars indicate 95% confidence intervals.

to several cycles of washing and drying before use. Furthermore, by preparing arenas well in advance, at least twice the suggested curing time of the paint, one can thoroughly wash newly treated arenas several times as soon as the paint has been allowed to dry for the suggested length of time, dislodging any fragile or poorly anchored pieces of perlite in the process, and still have time to recoat the surface and allow the paint to properly cure prior to experimentation.

In an examination of this substrate's effect on snake locomotion, we observed 10 Mangrove Saltmarsh Watersnakes (*Nerodia clarkii compressicauda*; mean SVL = 21.3 cm) traversing each of two wooden-floored, 13 x 60 cm trackways, one treated in the manner described above (the coarse treatment) and one treated with only paint (the smooth treatment). Data for each subject were the proportions of time spent using lateral undulation, concertina movement, and slide-pushing (the only three locomotory modes we observed), averaged over three trials in each of the two treatments. The proportions of time spent engaged in lateral undulation (Wilcoxon Signed Ranks Test; $Z = 2.67$; $p = 0.008$), slide-pushing (Wilcoxon Signed Ranks Test; $Z = 2.67$; $p = 0.008$) and concertina movement (Wilcoxon Signed Ranks Test; $Z = 2.20$; $p = 0.028$) differed significantly between the coarse and smooth surface treatments (Fig. 1). Subjects primarily used lateral undulation on the coarse surface and slide-pushing and concertina movement on the smooth surface. Thus, the perlite treatment provides a texture that facilitates the use of lateral undulation better than does a surface treated only with paint. In addition to tests involving snakes on dry arena floors, the painted perlite substrate has proved beneficial in experiments involving snakes in shallow-water test arenas and in a study involving terrestrial monitor lizards. Studies involving other squamates, legless or otherwise, may also benefit from such a substrate when more naturalistic materials are not feasible.

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A New Technique for Capturing Burrow-Dwelling Anurans

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Although a substantial proportion of North American frogs and toads will use burrows facultatively, as retreats from stressful environmental conditions (typically cold and/or dry weather; Lannoo et al. 2005; individual species accounts in Lannoo 2005), a handful of species use borrows obligately—relying on them to meet physiological or ecological needs. The Nenirana group of Hillis and Wilcox (2005) contains three species, *Lithobates areolatus* (Crawfish Frogs), *L. capito* (Gopher Frogs), and *L. sevosus* (Dusky Gopher Frogs) that inhabit burrows constructed by other species (predominantly crayfish in the case of *L. areolata*, and Gopher Tortoises [*Gopherus polyphemus*] in the case of *L. capito* and *L. sevosus*, though they are also known to inhabit small mammal burrows and holes in dead or rotting trees; Lannoo 2005). Adults of these three species are secretive and rapidly retreat into burrows when disturbed. Therefore, outside of the breeding season these frogs are rarely seen, and when seen near burrows (as they almost always are) they are next to impossible to capture. All three species are of conservation concern (Jensen and Richter 2005; Parris and Redmer 2005; Richter and Jensen 2005); *L. sevosus* is known from only two populations and is listed as federally endangered (USFWS 2001).

If we are to gather the basic ecological information needed to conserve these species, we must develop techniques for capturing animals year-round, through all life history stages. Once captured, animals can be weighed and measured, assessed for health, marked, and implanted with radiotransmitters. The best techniques for capturing animals retain the integrity of the burrow, because animals are known to use the same burrow throughout the warm season (Richter et al. 2001; JLH, unpubl. data) and perhaps longer. Further, it has been suggested that burrows are a limiting resource (Thompson 1915; Jensen and Richter 2005).

We developed a technique to capture Crawfish Frogs from their burrows, but the technique can be applied to Gopher Frogs and other animals occupying small-diameter burrows. We work on Crawfish Frogs in southwestern Indiana; *L. areolatus* is classified as state endangered in Indiana. Crawfish Frogs spend the majority of their adult lives associated with upland burrows, primarily those created by crayfish. Several different species of crayfish construct suitable burrows; at our study site in southwestern Indiana there are *Cambarus diogenes*, *Fallicambarus fodiens*, and *Cambarus* (*Tubericambarus*) *polychromatus* (Thoma and Armitage 2008). Crayfish burrows extend from the soil surface down to the water

table, and while chambers and side passages may be common, crayfish burrows are not usually a part of a vast burrow network. Burrows tend to be in clay soils, which create well-defined burrow walls and retain water (Grow and Merchant 1980). Compared with Gopher Tortoise burrows, crayfish burrows are narrow; burrows used by Crawfish Frogs are typically not much wider at the surface than the frog itself.

It follows that methods used to extract crayfish from burrows would be effective at extracting Crawfish Frogs. Published methods of successful crayfish extraction include excavation of burrows (Simon 2001), Norrocky pipe traps (Norrocky 1984), plungers (Simon 2001), motorized pumps (Thoma and Armitage 2008), and burrowing crayfish mist nests (Welch and Eversole 2006). However, several of these methods (excavation, plungers, pumps, and pipe traps) permanently damage burrows and the surrounding area (Ridge et al. 2008), and they all could potentially stress or injure the frog.

In addition to considering the above techniques, we tried securing a collapsible mesh minnow trap over the crayfish burrow. We also tried inserting a piece of PVC pipe at the burrow entrance with the idea that once the frog entered we would remove and cover the burrow end of the pipe (with a spatula) to trap the frog. We tried putting mist netting outside the burrow (similar to the Welch and Eversole [2006] crayfish net) as well as putting variations of a trap door over the burrow opening. Though occasionally successful, all of these methods turned out to be less than ideal for the capture of Crawfish Frogs. The success of some traps (minnow traps and PVC pipe traps) was limited because they did not prevent animals from returning to their burrows and all traps required constant monitoring, potentially for several days, while waiting for the frog to emerge from the burrow.

We were compelled to find a technique that would induce animals to leave their burrows while we were present, and would prevent them from returning to burrows once they were aware of our presence. The key observation (JLH) was that following heavy rains and burrow flooding, Crawfish Frogs surface every 20–40 min to breathe. The technique we introduce here has two basic components: flooding burrows to induce animals to surface, and blocking their retreat with an inflated balloon.

We outfitted a bicycle tire pump with a long (> 2 m) plastic tube (8 mm diameter) and attached a circular-shaped balloon to the end with a rubber band, so that when the bike pump handle was depressed, the balloon inflated (Fig. 1A, B). When inflated, the balloon conforms to the interior contours of the burrow but does not alter the burrow itself. To capture frogs we inserted the deflated balloon into the burrow (~20–30 cm). We then filled the burrow from a 23-liter jug containing water from a nearby lake. It usually took about 12 liters of water to fill burrows, and more water to maintain the water level at the surface of the burrow. Crawfish Frogs take an average of 30 min to surface. When they surface, we inflate the balloon, trapping the frog at the burrow entrance. In response, the frogs typically inflate their bodies and lower their head, tucking their jaws towards their chest. To extract them we gently pull up on the tubing and the balloon, forcing the frog out. For stubborn frogs, we insert a spatula and gently pry them out. This technique does not damage the burrow when done carefully, and we do not use enough force to harm the frog. The vegetation around the burrows gets trampled but recovers. Some frogs come

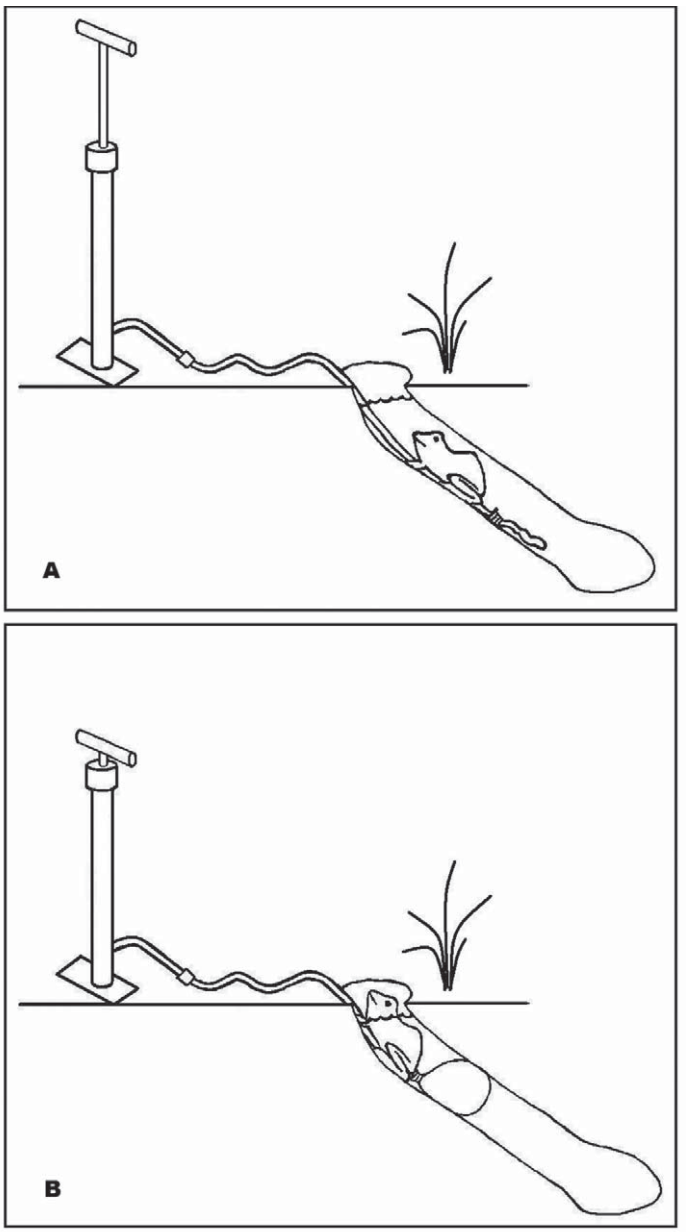


FIG. 1. A) Crawfish Frog in burrow below water surface, balloon deflated, tire pump plunger up. B) Crawfish Frog rises to water surface, balloon inflated, tire pump plunger down.

up for air and quickly escape back into the burrow before the balloon can be inflated. In these cases, we repeat the procedure. On a few occasions the balloon ruptured.

This method was also successful for retrieval of a Southern Leopard Frog (*Lithobates sphenocephalus*), but it took the frog about 165 minutes to surface. In addition to applying this technique to burrows known to be occupied (most of our known burrow sites were discovered following the implantation of their inhabitants with transmitters (3.8g PD-2 temperature sensing transmitters Holohil Systems Ltd. [Carp, Ontario, Canada]), we have also used this technique with success to determine the occupancy of suspected Crawfish Frog burrows (JLH, unpubl. data). The one time this technique did not work on a burrow known to be inhabited by a Crawfish Frog, the burrow branched uphill and therefore could not be sufficiently filled with water to force the

frog to surface. We suspect a modification of this technique could be used to extract Gopher Frogs and Dusky Gopher Frogs from Gopher Tortoise burrows, small mammal burrows, and other small refugia situated in clay substrates. This technique may be also applied to other amphibian species and perhaps to reptiles and other burrow-dwelling taxa.

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AMPHIBIAN DISEASES

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Detection of the Chytrid Fungus, *Batrachochytrium dendrobatidis*, on Recently Metamorphosed Amphibians in the North-Central United States

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The pathogenic chytrid fungus, *Batrachochytrium dendrobatidis* (*Bd*), has been associated with population declines of many amphibian species around the world, including relatively pristine habitats (e.g., Berger et al. 1999; Fellers et al. 2001; Herrera et al. 2005; Skerratt et al. 2007; Lips et al. 2008; Wake and Vredenburg 2008). Chytridiomycosis, the disease induced by *Bd*, likely is the proximate cause of many of these declines (Lips et al. 2006; Rachowicz et al. 2006; Skerratt et al. 2007). While the foci of much current research, we lack a clear understanding of the origin of *Bd*, its distribution and persistence, and the mechanisms by which it spreads across the landscape and ultimately kills amphibians (Longcore et al. 2007; Morgan et al. 2007; Lips et al. 2008; Wake and Vredenburg 2008), although Voyles et al. (2009) recently reported disruption of electrolyte transport and cardiac arrest as potential mechanisms for causing mortality.

Typically, vulnerable individuals die after *Bd* has infected their keratin, but vulnerability varies with life stage and species traits (Ouellet et al. 2005; Rollins-Smith and Conlon 2005; Longcore et al. 2007; Morgan et al. 2007; Bielby et al. 2008; Harris et al. 2009). Some species, such as the African Clawed Frog (*Xenopus laevis*) and American Bullfrog (*Rana catesbeiana*), are known to carry *Bd* without symptoms of the disease whereas diseased individuals have been observed in populations of other species without associated die-offs (Ouellet et al. 2005; Corn 2007; Kriger and Hero 2006; Longcore et al. 2007). As a fundamental first step in understanding these ecological processes and the resultant threats *Bd* poses to amphibian populations in specific areas, we need to know whether populations are exposed to the pathogen (e.g., Retallick et al. 2004; Ouellet et al. 2005; Pearl et al. 2007; Frias-Alvarez et al. 2008). We report here on results of our efforts to produce baseline data on *Bd* detection in US states for which few data have been reported: Minnesota, Wisconsin, and Iowa (Loda and Otis 2009).

We sampled recently metamorphosed amphibians at 75 unique breeding sites across five general areas within the north-central US: 1) Voyageurs National Park, 2) the St. Croix National Scenic Riverway, 3) the Upper Mississippi River National Wildlife and Fish Refuge, 4) northern Iowa, and 5) southwestern Wisconsin

(Fig. 1). We sampled 29 sites during July and August 2006 and 64 sites during June, July, and August 2007, including 18 sites in both years (Table 1). We chose sampling locations based upon our knowledge of species occurrences at these sites gained during previous studies.

We sampled nine amphibian species, including *Bufo americanus*, *Acris crepitans*, the *Hyla chrysoscelis-versicolor* complex, *Pseudacris triseriata*, *R. catesbeiana*, *R. clamitans*, *R. septentrionalis*, *R. pipiens*, and *R. sylvatica* (Table 1). Our goal was to sample 20 live, apparently healthy recent metamorphs of each species available per site in 2006 and 30 such metamorphs in 2007. We sampled fewer metamorphs when we captured fewer animals than expected at a site (Table 1). Metamorphs were collected individually by hand capture or net during visual-encounter surveys in littoral or nearby habitat. We only sampled metamorphs with fully resorbed tails. Once captured and swabbed, we retained individuals until we completed all sampling at a site, at which time we released them near the point of capture. We sampled metamorphs of as many species as were available at each site during our sampling windows in a given year.

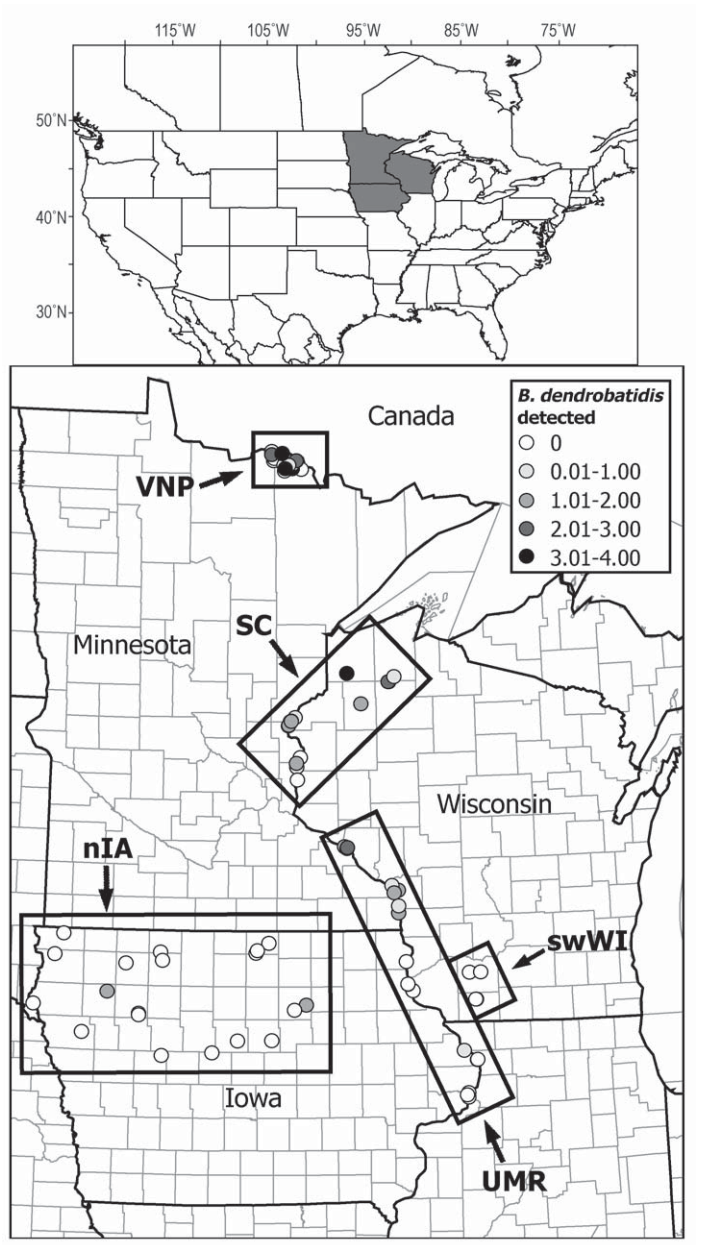


FIG. 1. The locations sampled in the north-central United States and relative quantities of *Batrachochytrium dendrobatidis* (*Bd*) detected across amphibian breeding sites and areas. Quantities are averages across species and years for each site based upon samples scored as 0 = not detected, 1 = weak positive signal, 2 = positive signal, 3 = strong positive signal, and 4 = very strong positive signal, as reported to us by Pisces Molecular LLC. Note that some breeding sites are not easily visible due to overlap at this scale. VNP = Voyageurs National Park; SC = the St. Croix National Scenic Riverway; UMR = the Upper Mississippi River National Wildlife and Fish Refuge; swWI = southwestern Wisconsin; nIA = northern Iowa.

We used decontaminated equipment and fresh disposable gloves to capture and handle each individual specimen and one cotton-tipped swab (Puritan brand, 15 cm, no-glue cleaning sticks) to swab each animal 30 times across the ventral skin on the thighs, abdomen, and hind limbs, including the interdigital webbing, similar to Livo (2004). Typically, we pooled the ten individual cotton-tipped swabs we used to sample ten individual conspecific metamorphs at each site in one sterile vial containing 70% EtOH. This enabled us to limit analytical costs (two samples of pooled swabs per species per site in 2006 and three in 2007) while increasing our chances of detecting *Bd* within a sample simply due to more animals represented in each sample analyzed. We sealed vials on site and sent them to Pisces Molecular LLC (Boulder, Colorado) for PCR analyses as per their instructions. Pisces Molecular LLC used methods described in Annis et al. (2004) and reported results to us as not detected, weak positive signal, positive signal, strong positive signal, or very strong positive signal. According to Pisces Molecular LLC, the detection limit was 0.1 zoospore equivalent DNA per PCR reaction.

Bd was detected on at least one species at 34 of 75 sites (45%) and in 4 of the 5 general areas sampled (Table 1; Fig. 1). *Bd* was detected most often on *R. clamitans* (23 of 27 sites) and *R. septentrionalis* (7 of 9 sites) in relatively moderate to heavy quantities. The remaining detections also were on ranids, in relatively small quantities on *R. pipiens* (5 of 39 sites) and *R. sylvatica* (6 of 9 sites) and in moderate quantities on *R. catesbeiana* (1 of 2 sites). *Bd* was not detected on *B. americanus*, *A. crepitans*, *H. chrysoscelis/versicolor*, and *P. triseriata* (Table 1).

We sampled *R. clamitans* and *R. pipiens* at 11 of the same sites in 2007. *Bd* was detected on *R. clamitans*, but not *R. pipiens*, at six of those sites, and on both species at one other. *Bd* was not detected on either species at the remaining four sites (Table 1).

Our results provide the first baseline information we know of on the detection of *Bd* at our study sites and add to the sparse published *Bd* data for the north-central U.S. (Green et al. 2002; Ouellet et al. 2005; Spatialepidemiology.net/Bd-Maps 2009; Loda and Otis 2009). Although detection varied with year, site, and species, our results are similar to the relatively widespread distribution and variable detection reported for other regions in the U.S. and around the world (Ouellet et al. 2005; Longcore et al. 2007; Pearl et al. 2007; Spatialepidemiology.net/Bd-Maps 2009; Loda and Otis 2009). Our results also support previously reported observations that *Bd* detection can be a function of the species sampled (e.g., Retallick et al. 2004; Ouellet et al. 2005; Longcore et al. 2007; Pearl et al. 2007).

Other researchers have demonstrated *Bd* detection was greater

TABLE 1. Relative quantities of *Batrachochytrium dendrobatidis* (*Bd*) detected on swabs of recent metamorphs by species, year, area, and site in the north-central United States. Ac = *Acris crepitans*, Rcl = *Rana clamitans*, Rp = *R. pipiens*, Rse = *R. septentrionalis*, Ba = *Bufo americanus*, Hc/v = *Hyla chrysoscelis—versicolor* complex, Pt = *Pseudacris triseriata*, Rca = *R. catesbeiana*, and Rsy = *R. sylvatica*. Each number represents the relative quantity of *Bd* DNA detected in the extracts from ten pooled swabs (one swab per individual), unless noted as a different pooled number of swabs via a superscripted number in parentheses. 0 = not detected, 1 = weak positive signal, 2 = positive signal, 3 = strong positive signal, and 4 = very strong positive signal, as reported to us by Pisces Analytical LLC. These different signal strengths represent different relative quantities of *Bd* DNA present in samples (based upon comparisons of results using the 45-cycle, single-round, PCR amplification method used here with results from quantitative PCR; J. Wood, Pisces Molecular LLC; pers. comm.). VNP = Voyageurs National Park; SC = the St. Croix National Scenic Riverway; UMR = the Upper Mississippi River National Wildlife and Fish Refuge; swWI = southwestern Wisconsin; nIA = northern Iowa.

Area & Site	Species and Year Sampled												
	Ac		Rcl		Rp		Rse		Ba	Hc/v	Pt	Rca	Rsy
	2006	2007	2006	2007	2006	2007	2006	2007	2007	2007	2007	2007	2007
VNP													
1DB1	—	—	—	—	—	—	—	—	—	0,0,0	—	—	—
2DF1	—	—	4,4	3	—	—	4,4	3,4,4	—	—	—	—	—
3DAI1	—	—	—	—	—	0,0,0	—	0,0,0	—	0(1)	—	—	0,0,3
3DC1	—	—	—	—	—	—	0,4	0,0,2	—	—	—	—	—
4DC1	—	—	0,3	2,2,3	—	0(7)	3,4	3,3,4	—	—	—	—	—
4DC2	—	—	—	—	—	—	—	—	—	—	—	—	2,2,3
5DA1/2	—	—	—	—	—	—	4,4	2,4,4	—	—	—	—	—
7DE1	—	—	—	—	0,0	0,0,0	—	—	—	0,0,0	—	—	0,0,3
8DB1	—	—	—	—	—	—	0(1)	—	—	—	—	—	—
8DC1	—	—	—	—	—	0,0,0	—	—	—	—	—	—	0,0,4
8DC3	—	—	—	—	—	—	4,4	—	—	—	—	—	—
9DBI1	—	—	—	—	—	—	—	—	—	0	—	—	—
10DC1		—	—	—	—	—	—	—	—	0,0,0	—	—	—
11DA1	—	—	0,2	0,0(1)	—	0(9)	—	—	—	—	—	—	—
11DB4	—	—	3(1)	—	—	0,2,4	4,4	4	—	—	—	—	—
SC													
1DA1	—	—	3,4	0,0,0	—	0,0,0	—	—	—	—	—	—	—
1DE1	—	—	—	0,0,0	—	—	—	—	—	—	—	—	—
2DB1	—	—	—	0,0,0	—	—	—	—	—	—	—	—	—
2DD2	—	—	3,4	0,0,3	—	—	—	—	—	—	—	—	0,0,2
4DA3	—	—	—	0,3,3	—	—	—	—	—	—	—	—	0,0,0
4DB1	—	—	—	0,3,3	—	—	—	—	—	—	—	—	—
4DB2	—	—	2,2	—	—	—	—	—	—	—	—	—	—
4DB9	—	—	—	—	—	—	—	—	—	—	0,0,0	—	0,0,0
4DBI2	—	—	—	—	—	—	—	—	—	—	0,0,0	—	0,0,0
4DC1	—	—	2,4	—	—	—	—	—	—	—	—	—	0,0,3
4DCI2	—	—	—	—	—	—	—	—	—	0,0,0	—	—	—
8DB1	—	—	4,4	—	—	—	—	—	—	—	—	—	—
10DC1	—	—	1,3	—	—	—	—	—	—	—	—	—	—
12DB1	—	—	3,4	0,3,3	0,0	0,0,0	—	—	—	—	—	—	—
12DC1	—	—	—	2,3,3	—	—	—	—	—	—	—	—	—
12DE1	—	—	0,2	0,0,2	—	—	—	0(5),2	—	—	—	—	—
UMR													
P4DA1	—	—	—	0,0(3)	0,0	0,0,0	—	—	—	—	—	—	—
P4DA2	—	—	—	0,3,3	—	—	—	—	—	—	—	—	—
P4DC1	—	—	—	0,0,0	—	0,0,0	—	—	—	—	—	—	—
P4DD1	—	—	—	3,4,4	0,3	0,0,4	—	—	—	—	—	—	—
P7DAI1	—	—	—	2,3,3	—	—	—	—	0,0,0	—	—	—	—
P7DE3	—	—	—	0,2,3	—	0,0,0	—	—	—	—	—	—	—
P7DH1	—	—	—	0,3,4	—	0,0,0	—	—	—	—	—	—	—
P8DB1	—	—	—	3,3,4	0,0	0,0,0	—	—	—	—	—	—	—
P8DG1	—	—	—	—	0,0	0,0,3	—	—	—	—	—	—	—

TABLE 1. Continued.

Area & Site	Species and Year Sampled												
	Ac		Rcl		Rp		Rse		Ba	Hc/v	Pt	Rca	Rsy
	2006	2007	2006	2007	2006	2007	2006	2007	2007	2007	2007	2007	2007
UMR													
P10DA3	—	—	—	0,0,2	—	—	—	—	—	—	—	—	—
P10DA4	—	—	—	—	—	0,0,0	—	—	—	—	—	—	—
P10DB3	—	—	—	4	—	0,0,0	—	—	—	—	—	—	—
P10DB4	—	—	—	—	0,0	—	—	—	—	—	—	—	—
P10DD1	—	—	—	—	0,0	0,0,0	—	—	—	—	—	—	—
P13DA1	—	—	—	—		0,0,0	—	—	—	—	—	—	—
P13DA4	—	—	—	—	0,0	—	—	—	—	—	—	—	—
P13DA6	—	—	—	—	—	—	—	—	—	—	—	0[(5)]	—
P13DB3	—	—	—	—	0,2	0,0,0	—	—	—	—	—	—	—
P14DA1	—	—	—	—	—	0,0,0	—	—	—	—	—	—	—
P14DB2	—	—	—	—	—	0,0,0	—	—	—	—	—	—	—
P14DC1	—	—	—	—	—	0,0,0	—	—	—	—	—	—	—
swWI													
CP	0,0	—	—	—	—	—	—	—	—	—	—	—	—
MP	0,0	—	—	—	—	—	—	—	—	—	—	—	—
RG	0,0	—	—	—	—	—	—	—	—	—	—	—	—
TV	0,0	—	—	—	—	—	—	—	—	—	—	—	—
nIA													
A1WRP04	—	—	—	—	—	0,0,0	—	—	—	—	—	—	—
A1WRP05	—	0,0,0	—	—	—	—	—	—	—	—	—	—	—
A2WRP01	—	0,0,0	—	—	—	—	—	—	—	—	—	—	—
A2WRP07	—	—	—	—	—	0,0,0	—	—	—	—	—	—	—
A3WRP02	—	—	—	—	—	—	—	—	—	—	—	0,2,2	—
A3WRP03	—	—	—	—	—	0,0,0	—	—	—	—	—	—	—
A4WRP04	—	—	—	—	—	0,0,0	—	—	—	—	—	—	—
A4WRP05	—	—	—	—	—	0,0,0	—	—	—	—	—	—	—
A5WRP02	—	—	—	—	—	0,0,0	—	—	—	—	—	—	—
A5WRP05	—	—	—	—	—	0,0,0	—	—	—	—	—	—	—
A6WRP04	—	0,0,0	—	—	—	—	—	—	—	—	—	—	—
A6WRP07	—	0,0,0	—	—	—	—	—	—	—	—	—	—	—
A7SITE05	—	—	—	—	—	0	—	—	—	—	—	—	—
A7WRP03	—	—	—	—	—	0,0,0	—	—	—	—	—	—	—
A7WRP05	—	—	—	—	—	0,0,0	—	—	—	—	—	—	—
A8WRP01	—	—	—	—	—	0,0,0	—	—	—	—	—	—	—
A8WRP05	—	0,0	—	—	—	0,0,0	—	—	—	—	—	—	—
A9WRP01	—	—	—	—	—	0,0,0	—	—	—	—	—	—	—
A9WRP04	—	—	—	—	—	0,2,2	—	—	—	—	—	—	—

on more aquatic species, including several of the species we sampled (e.g., Retallick et al. 2004; Ouellet et al. 2005; Longcore et al. 2007; Pearl et al. 2007). For example, we did not detect *Bd* in relatively small samples of *B. americanus*, *H. chrysoscelis/versicolor*, *P. triseriata*, and *A. crepitans* and we detected it infrequently on *R. pipiens*. These results were similar to those from previous studies showing lower detections or infections in these less-aquatic species (Ouellet et al. 2005; Longcore et al. 2007). As possible further support for such observations, we also detected *Bd* less often on *R. pipiens* than on *R. clamitans* sampled from the same sites. Rollins-Smith and Conlon (2005) demonstrated that *R. pipiens* produces skin peptides that confer *Bd* resistance. This might or might not have affected our detections of *Bd* on *R. pipiens* in this study. Our detections of *Bd* on the largely terrestrial *R. sylvatica* from six of nine sites ran counter to the trend of lower detections on less aquatic species and is a higher frequency than reported previously for this species (Ouellet et al. 2005; Longcore et al. 2007; Reeves 2008). All told, because of variance in detection among species, limited sample sizes, and because we were not able to sample species with apparent higher detection rates, such as *R. clamitans* or *R. septentrionalis*, across all sites, we cannot conclude *Bd* was not present at sites where

we did not detect it. This is especially true for northern Iowa, where we sampled only *A. crepitans* and *R. pipiens* at 18 of the 19 sites, and southwestern Wisconsin, where we sampled only *A. crepitans* at all four sites.

We have conducted call and/or visual-encounter surveys at these breeding sites and many others since 2002 as part of the U.S. Geological Survey's Amphibian Research and Monitoring Initiative (ARMI) in ARMI's Midwest Region. While we cannot speak to trends in the demographics of any of these populations or breeding subpopulations, we observed most of the species we expected to be present during our surveys. An exception has been *A. crepitans*, which we did not observe at many potential breeding sites and is known to have declined throughout the northern portion of its range, including much of the area in Iowa we report on here. In addition to observing most of the expected species, we rarely have observed dead postmetamorphic amphibians, although this is not unusual in association with chytridiomycosis (Skerratt et al. 2007). *Rana clamitans* and *R. septentrionalis* from four of the Voyageurs sites we report on here had clinical chytridiomycosis in previous years (D. E. Green, pers. comm.), but we did not observe live animals displaying any behavioral symptoms of chytridiomycosis (Berger et al. 1999) at these sites or elsewhere. Thus, based upon all of our observations, we have no evidence of dramatic recent population declines associated with any of these *Bd* detections, similar to what others have stated for other regions (e.g., Longcore et al. 2007). Clearly, however, we lack a substantive understanding of amphibian population dynamics in relation to *Bd* presence and chytridiomycosis at these sites to comment on this meaningfully. More intensive studies are necessary to understand any impacts of *Bd* exposure on amphibian populations in this region.

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Occurrence of the Amphibian Chytrid Fungus (*Batrachochytrium dendrobatidis*) in Ozark Caves, Missouri, USA

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Amphibian chytrid fungus (*Batrachochytrium dendrobatidis*, hereafter *Bd*) has been documented in a variety of species and habitats across North America, although the full extent of its faunal and geographic distribution is not yet known (Adams et al. 2007; Briggler et al. 2008; Longcore et al. 2007; Ouellet et al. 2005; Pearl et al. 2007; Reeves and Green 2006). To our knowledge, no surveys for the presence of this fungal pathogen have been published on cave amphibian populations. Missouri contains 6200 caves and 927 documented species (Elliott 2007) with eight amphibian species commonly inhabiting Ozark caves and one salamander that is cave restricted (Sutton 1993). The goal of this study was to test for the presence of *Bd* among multiple amphibian taxa found in caves across the lower Missouri Ozarks.

From November 2007 to October 2008 we tested 35 adult and larval amphibians from 12 caves in 5 counties in the Missouri Ozarks for *Bd*. Adults and some larvae were tested for *Bd* by swabbing a cotton-tipped wooden shaft applicator over the ventral surface of each foot, the back, the abdomen, and around the thigh and vent area. The wooden tip end of the applicator was first lightly rubbed on these surfaces followed by the cotton end of the applicator. Both wooden and cotton tip were broken off and placed in a 2.0 ml screw-cap tube with 1 ml of 70% ethanol. Larval salamanders that were too small to swab effectively were collected and placed in a 2.0-ml screw-cap tube with 1 ml of 70% ethanol. All samples were shipped to Pisces Molecular, Boulder, Colorado, for PCR (polymerase chain reaction) assay.

Of the 35 individuals sampled in this study, 11 were infected with *Bd*. Positive *Bd* test results were detected from at least one cave in all 5 counties tested (Fig. 1; Table 1). Adult animals comprised the bulk of our sampling (29 of 35 individuals sampled). Ten adult samples showed positive *Bd* test results. Of the six larval salamander samples collected, one larval *Eurycea spelaea* (Grotto Salamander) tested positive for *Bd*, which is of interest as there are few documented cases of *Bd* in larval salamanders (Brodman and Briggler 2008). Although we tested both salamander and anuran species for *Bd*, more salamander species were tested and *Bd* was more prevalent among anurans; 20% of anurans tested positive for *Bd* while only 11.4% of salamanders tested positive ($\chi^2 = 9.37$; df = 1; P = 0.002). *Bd* samples were collected from amphibians classified as trogloxenes (species that use caves but cannot complete their life cycle entirely within a cave), troglophiles (species that can complete their life cycle within a cave but are also widely seen above ground), and troglobites (species that are cave obligates) (Table 1). The majority of samples were collected from troglophiles (60.0%); trogloxenes, which comprised 25.0% of our samples, showed the highest percent of *Bd* infection (17.1%), followed by troglophiles (11.4%) and troglodytes (2.9%).

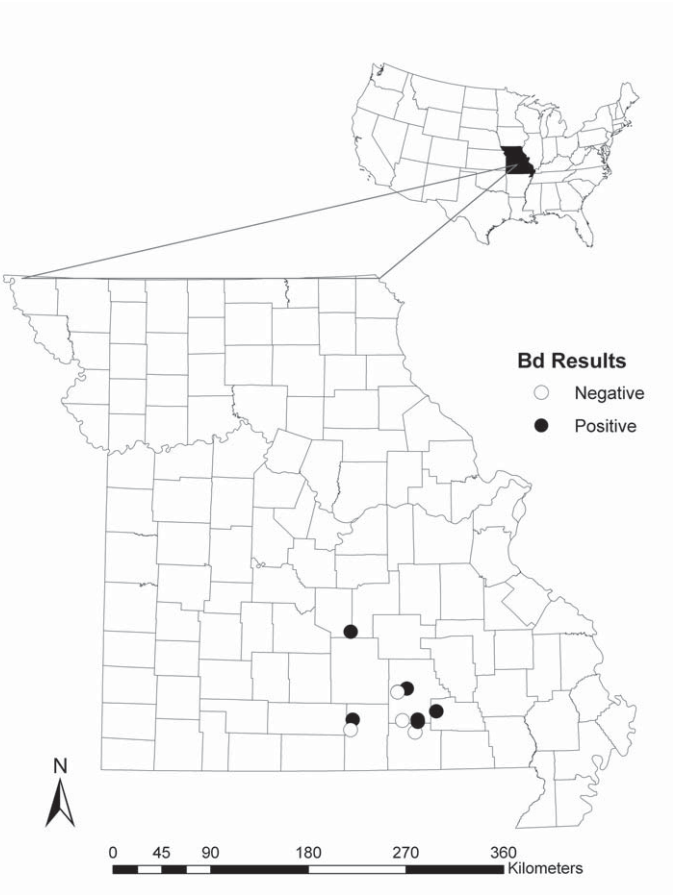


FIG. 1. Cave locations surveyed for *Batrachochytrium dendrobatidis* (*Bd*). Open circles indicate caves where all samples were negative for *Bd*, while closed circles indicate caves that had at least one positive *Bd* test. Proximity of caves led to overlap of symbols for three locations.

Bd grows and reproduces at temperatures of 4–25ºC with maximal growth at 17–25ºC (Piotrowski et al. 2004). The thermal environment of the Ozark caves in this study, while not ideal, is suitable for *Bd* growth with average water temperatures of 11.6ºC.

In this study, anurans were infected with *Bd* in higher proportions than were salamanders, although our relatively modest sample size may not accurately reflect *Bd* prevalence. *Lithobates palustris*, which comprised the bulk of our anuran *Bd* samples, typically seek caves for refuge from hot weather during summer and from cold temperatures during winter, exiting for periods to breed and feed

TABLE 1. Locations and associated species data for all amphibians tested for *Batrachochytrium dendrobatidis* in caves in Missouri, USA. MSS Cave ID = Missouri Speleological Survey cave identification number; TX = trogloxene; TP = troglophile; TB = troglobite; T-R = Township and Range of legal description for cave location.

MSS Cave ID	County	Species	Life Stage	Results	Date	Eco Type	T-R
CTR032	Carter	*Eurycea spelaea*	Adult	Negative	10-Jan-08	TB	27N 2W
CTR033	Carter	*Eurycean spelaea*	Adult	Negative	10-Jan-08	TB	27N 2W
CTR033	Carter	*Eurycea spelaea*	Adult	Negative	10-Jan-08	TB	27N 2W
CTR033	Carter	*Eurycea spelaea*	Larvae	Positive	10-Jan-08	TB	27N 2W
CTR033	Carter	*Lithobates catesbeianus*	Adult	Positive	10-Jan-08	TP	27N 2W
HWL037	Howell	*Eurycea spelaea*	Larvae	Negative	8-Jan-08	TB	26N 10W
HWL037	Howell	*Lithobates palustris*	Adult	Positive	8-Jan-08	TX	26N 10W
HWL037	Howell	*Lithobates palustris*	Adult	Positive	8-Jan-08	TX	26N 10W
HWL023	Howell	*Eurycea longicauda*	Larvae	Negative	27-Feb-08	TP	25N 10W
HWL023	Howell	*Eurycea longicauda*	Adult	Positive	27-Feb-08	TP	25N 10W
HWL023	Howell	*Eurycea longicauda*	Larvae	Negative	27-Feb-08	TP	25N 10W
HWL023	Howell	*Eurycea longicauda*	Larvae	Negative	27-Feb-08	TP	25N 10W
HWL023	Howell	*Eurycea longicauda*	Larvae	Negative	27-Feb-08	TP	25N 10W
ORE014	Oregon	*Lithobates palustris*	Adult	Positive	9-Nov-07	TX	25N 4W
ORE014	Oregon	*Eurycea longicauda*	Adult	Negative	9-Nov-07	TP	25N 4W
ORE014	Oregon	*Eurycea longicauda*	Adult	Negative	9-Nov-07	TP	25N 4W
PUL010	Pulaski	*Eurycea lucifuga*	Adult	Negative	15-Oct-08	TP	34N 10W
PUL010	Pulaski	*Eurycea lucifuga*	Adult	Negative	15-Oct-08	TP	34N 10W
PUL010	Pulaski	*Eurycea longicauda*	Adult	Negative	15-Oct-08	TP	34N 10W
PUL010	Pulaski	*Lithobates palustris*	Adult	Negative	15-Oct-08	TX	34N 10W
PUL010	Pulaski	*Lithobates palustris*	Adult	Positive	15-Oct-08	TX	34N 10W
PUL010	Pulaski	*Eurycea longicauda*	Adult	Positive	15-Oct-08	TP	34N 10W
SHN578	Shannon	*Lithobates palustris*	Adult	Negative	13-Nov-07	TX	29N 4W
SHN578	Shannon	*Eurycea longicauda*	Adult	Positive	13-Nov-07	TP	29N 4W
SHN328	Shannon	*Eurycea lucifuga*	Adult	Negative	27-Nov-07	TP	26N 4W
SHN328	Shannon	*Eurycea longicauda*	Adult	Negative	27-Nov-07	TP	26N 4W
SHN328	Shannon	*Lithobates palustris*	Adult	Positive	27-Nov-07	TX	26N 4W
SHN281	Shannon	*Plethodon serratus*	Adult	Negative	6-Dec-07	TP	26N 4W
SHN281	Shannon	*Eurycea longicauda*	Adult	Negative	6-Dec-07	TP	26N 4W
SHN281	Shannon	*Lithobates catesbeianus*	Adult	Positive	6-Dec-07	TX	26N 4W
SHN591	Shannon	*Plethodon albagula*	Adult	Negative	24-Sep-08	TP	29N 6W
SHN591	Shannon	*Eurycea lucifuga*	Adult	Negative	24-Sep-08	TP	29N 6W
SHN591	Shannon	*Eurycea lucifuga*	Adult	Negative	24-Sep-08	TP	29N 6W
SHN589	Shannon	*Eurycea lucifuga*	Adult	Negative	24-Sep-08	TP	29N 6W
SHN588	Shannon	*Lithobates palustris*	Adult	Negative	26-Sep-08	TX	26N 5W

(Johnson 2000; Prather and Briggler 2001; Resetarits 1986). This life history trait may help to explain the prevalence of *Bd* among the anurans in our samples and also to explain a possible transport mechanism of *Bd* in cave systems. Similarly, trogloxenes had the highest overall rates of *Bd* infection is this study when compared to troglophiles and troglodytes. As with *Lithobates palustris*, which is a trogloxene ecotype, trogloxene species tend to be very mobile and will spend a large amount of time outside of the cave during different life stages or seasons (Briggler and Prather 2006; Mittleman 1950; Petranka 1998). This behavior may serve to move *Bd* into, out of, and among different caves. However, in the Lower Missouri Ozarks, streams, creeks, caves, and springs in watersheds are connected by a system of karst (Elliott 2005) and presence of *Bd* among aquatic hellbenders throughout the Ozarks (Briggler et al. 2008) has been well documented. The karst system itself also may be serving as a conduit to spread *Bd* throughout watersheds and among caves throughout this region.

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care guidelines and appropriate permits were obtained.

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The Presence of *Ranavirus* in Anuran Populations at Itasca State Park, Minnesota, USA

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Viruses in the genus *Ranavirus* are implicated as a possible contributing factor to global amphibian declines (Daszak et al. 1999). Previous studies have associated ranaviruses with mass amphibian die–offs throughout North America (Chinchar 2002 Greer et al. 2005; Williams et al. 2005) including Minnesota, USA (Green et al. 2002; Vandenlangenberg et al. 2003). However, it is unclear whether ranavirus infections exist in wild anuran populations without causing die-offs. This study investigates the presence of ranavirus in six anuran species at the headwaters of the Mississippi River in Itasca State Park, Minnesota, USA.

Methods.—We collected recently metamorphosed and adult frogs and toads by hand and with nets from twenty-six sites in Itasca State Park, Clearwater County, Minnesota (47.2397°N, 95.2075°W) in June and July 2009. Sites were chosen for maximum species diversity and for accessibility. There have been no reports of mass amphibian die-offs in the park, which has been the site of a University of Minnesota field station since 1909 (D. Biesboer, pers. comm., 30 July 2009; C. Handrick, pers. comm., 3 Aug 2009). Both field-based and lab-based courses are taught during summer months and there are few places in the state that have had such a consistent and thorough presence of biologists during peak periods of amphibian activity. This steady stream of students and faculty provides some level of confidence that amphibian die-offs will be observed and reported. That said, there is no guarantee that amphibian die-offs, particularly of aquatic larvae, went unobserved.

To minimize contamination among sites, nets and waders were rinsed with 5% bleach solution between collecting events. Captured frogs were kept individually in separate plastic bags. Individuals were classified as either young-of-the-year (YOY) or adults by comparing their snout-vent length to published sizes of adult frogs (Oldfield and Moriarty 1994; Wright and Wright 1995). Frogs were returned to the laboratory and humanely euthanized with MS-222 (tricaine methanesulfonate) (Simmons 2002). Liver samples were stored in RNAlater (Ambion, Austin, Texas, USA) or 99% ethanol at 4°C until processing. Vouchers were deposited in the Bell Museum of Natural History, University of Minnesota (JFBM).

We used disposable razor blades to subsample between 15–30 mg of liver tissues for DNA extraction using the Qiagen DNeasy Blood and Tissue Kit (Qiagen, Valencia, California, USA) follow-

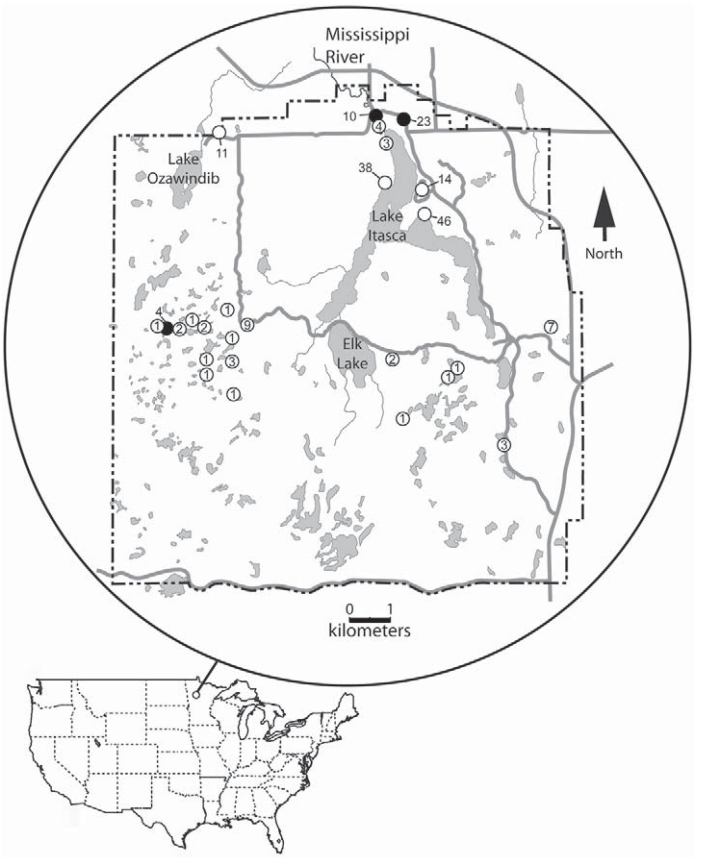


FIG. 1. Collecting locations (circles) of anurans screened for ranavirus at Itasca State Park, Minnesota, USA. Numbers reflect sample size at each site. Sites with ranavirus positive specimens indicated by filled circles, localities with no ranavirus positive specimens indicated by open circles. Park boundaries shown by a dashed line. Light gray areas are water.

ing the manufacturer's protocol. We screened DNA for the presence of ranavirus using polymerase chain reaction (PCR) to amplify a highly conserved ~500-bp fragment of the ranavirus major capsid protein (MCP) using the MCP4 and MCP5 primers (Mao et al. 1997). PCR was carried out in 12.5 μl volumes using conditions described by Greer et al. (2005) and the product visualized by gel electrophoresis on 1% agarose gels stained with ethidium bromide. We ran negative (water in place of genomic DNA) and positive controls (DNA extracted from a specimen verified to be ranavirus positive) with each PCR reaction.

All positive samples were verified by sequencing using Big Dye terminator cycle sequencing on an ABI 3730xl at the Advanced Genetic Analysis Center, University of Minnesota. Sequences were identified as ranavirus using BLAST (Altschul et al. 1990). We gel-purified the positive PCR product from *L. pipiens* prior to sequencing using 3% agarose due to the presence of some non-specific PCR products. Positive PCR products of *L. sylvatica* were purified using Exonuclease I and Shrimp Alkaline Phosphatase (Hanke and Wink 1994).

Results.—We collected and tested 191 YOY and adult frogs of six different species. Four individuals (2%) from two species tested positive for ranavirus (Table 1): three *Lithobates sylvatica* (JFBM 16793, 16923, and 17116) and one *Lithobates pipiens* (JFBM 16932). Four frog species, *Lithobates septentrionalis*, *Pseudacris crucifer*, *Hyla versicolor*, and *Anaxyrus americanus*, had no positive samples. We captured infected frogs from three different sites within Itasca State Park (Fig. 1); the infected *L. pipiens* shared a site with one of the infected *L. sylvatica* (JFBM 17116). One *L. sylvatica* (JFBM 17116) and the infected *L. pipiens* were adults while the two remaining *L. sylvatica* were recent YOY. Aside from one dead ranavirus-negative *L. pipiens* (cause of death undetermined), all specimens appeared healthy at the time of capture.

DNA sequences (Genbank accession # GQ856477) from the four infected individuals were identical to each other and to other Frog Virus 3 (FV3) sequences from infected North American amphibians (Genbank FJ459783, GQ144408, FJ601916, AY548484, and U36913) and the *Terrapene* Virus 3 (TV3) sequence (U82553) from a turtle (Mao et al. 1997).

Discussion.—FV3 was originally isolated from a Northern Leopard Frog (*L. pipiens*) collected from Minnesota or Wisconsin, and proved to be fairly benign in metamorphosed amphibians in laboratory experiments (Granoff et al. 1966; Tweedell and Granoff, 1968; see Williams et al. 2005 for historical review), but since then, amphibian ranaviruses have been primarily associated with mortality events, especially in larval amphibians (Gray et al. 2009, but see Gray et al. 2007). The presence of ranavirus in apparently healthy metamorphosed frogs at Lake Itasca State Park, an area with no reported amphibian die-offs, suggests that die-offs may not be an inevitable outcome of ranavirus infections and that ranavirus may be more common than previously thought.

There are several possible explanations for our observations of ranavirus in the absence of large-scale mortality events. These include: genetic resistance in these anuran populations (Green et al. 2002; Pearman et al. 2004; Teacher et al. 2009); a less virulent strain of FV3-like virus; the absence of some environmental conditions necessary to cause mass die-offs (Gahl and Calhoun 2008; Greer et al. 2005); or that die-offs occurred but went unnoticed or unreported, particularly since mortality in early, aquatic life history stages would be difficult to observe.

TABLE 1. Ranavirus infections in six frog species collected in Itasca State Park, Minnesota, USA, in 2009.

Species	Family	Adults positive / tested	YOY positive / tested	All individuals positive / tested	Prevalence in all individuals (95% CI)
Lithobates sylvatica	Ranidae	1/21	2/47	3/68	4.4 (2.01–12.69)
Lithobates pipiens	Ranidae	1/68	—	1/68	1.5 (0.01–8.63)
Lithobates septentrionalis	Ranidae	0/27	—	0/27	0 (0–10.85)
Pseudacris crucifer	Hylidae	0/3	0/2	0/5	0 (0–40.10)
Hyla versicolor	Hylidae	0/7	0/2	0/9	0 (0–26.93)
Anaxyrus americanus	Bufonidae	0/3	0/11	0/14	0 (0–19.08)

Other studies have confirmed that five of the frog species we examined are susceptible to ranavirus (Duffus et al. 2008; Green et al. 2002). Although the susceptibility of *A. americanus* to ranavirus remains unknown, ranavirus has been identified in other bufonids such as *Anaxyrus fowleri*, *Bufo bufo*, and *Rhinella marina* (Chinchar 2002; Cunningham et al. 2007; Zupanovic et al. 1998). Given our small sample sizes and the potential for false negatives (Greer and Collins 2007), we cannot eliminate the possibility that species we identified as negative were also infected at low levels.

It is important to document the baseline prevalence of ranavirus infections in amphibian populations in order to understand its epidemiology and transmission in wild populations. In much of the ranavirus literature, amphibians are sampled and tested only after or during die-offs. While this response-based sampling is valuable, it offers a skewed estimate of ranavirus prevalence and perhaps virulence in amphibian populations. Future studies should expand the limited documentation of baseline ranavirus levels in randomly-sampled wild populations and also investigate the factors that may cause sublethal infections to become virulent. Such research would allow scientists to better evaluate the causes and consequences of ranavirus infections in amphibian communities.

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Increasing Detections of *Batrachochytrium dendrobatidis* in Central Florida, USA

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The fungal pathogen *Batrachochytrium dendrobatidis* (*Bd*) was first detected in Florida, USA in 2008 in one American Bullfrog (*Lithobates catesbeianus*) and in one Florida Cricket Frog *(Acris gryllus dorsalis)* (Rizkalla 2009). Here, I report the results of further testing on 16 amphibian species in Walt Disney World's Wildlife Management and Conservation Area (WMCA) in central Florida.

The WMCA is a network of primarily forested wetlands with interspersed upland spanning 3380 ha in Orange and Osceola counties designed as a buffer area for Reedy Creek and managed by the Reedy Creek Improvement District. The Reedy Creek basin includes a significant portion of the headwaters of the Kissimmee River. Sampling for this study was restricted to the northern portion of the WMCA, centered approximately at 28.39929703°N, 81.60801927°W. A HOBO data logger (Onset Computer Corporation, Bourne, Massachusetts, USA) recorded weather conditions at approximately 28.398159°N, 81.597216°W. Amphibians were captured using plywood coverboards, minnow traps, and during incidental encounters. Thirty-four coverboard arrays were placed 250-m apart with each array checked once a month. Ten minnow traps were placed in canals, a marsh, and a pond for three days each month. Because the first positive bullfrog was found in an exhibit within Disney's Animal Kingdom® Theme Park, we also sampled native anurans found within the water features of many exhibits. Clean disposable gloves were worn when handling each animal.

As described in Rizkalla (2009), live amphibians were swabbed along the ventral surface and legs 25 times with cotton-tipped swabs (Puritan, Guilford, Maine, USA). Swab tips were stored at room temperature in 2-ml screw cap microcentrifuge tubes (Fisher #02-681-343) containing 1 ml of 70% ethanol. The keratinized regions around the mouths of six tadpoles found dead (American Bullfrog and Southern Leopard Frog, *L. sphenocephalus*) were also submitted for analysis. Sample collection occurred from July 2008 – July 2009. Maximum daily temperature during sample days ranged from 15.2–37.9°C. Samples were sent in August 2008, and June, August 2009 to Pisces Molecular (J. Wood, Boulder, Colorado, USA) for analysis using a polymerase chain reaction to detect *Bd* presence (Annis et al. 2004). For this report, 266 samples from 16 species were analyzed.

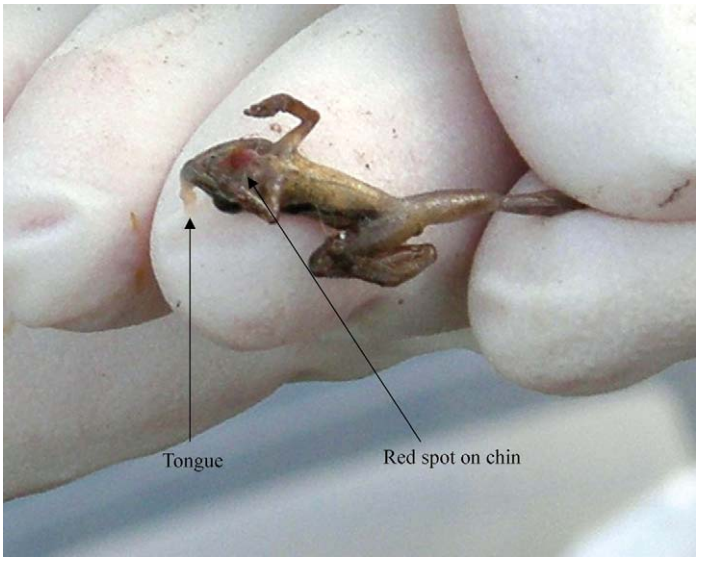


FIG. 1. Symptoms of *Batrachochytrium dendrobatidis* (*Bd*) in a Little Grass Frog (*Pseudacris ocularis*) included lethargy, loss of righting mechanism, a red spot on the chin (arrow), and inability to retract the tongue.

Several species were *Bd*-positive within the WMCA, including five Florida Cricket Frogs, three Greenhouse Frogs (*Eleutherodactylus planirostris*), two Southern Toads (*Anaxyrus terrestris*), and one Little Grass Frog (*Pseudacris ocularis*) (Table 1). Only the Little Grass Frog showed clinical signs of infection. When captured, it appeared lethargic, could not retract its tongue, and had a red spot on its chin (Fig. 1). When released upon swabbing, it did not right itself and died soon after. Infection was also detected in one adult American Bullfrog and one Cuban Treefrog (*Osteopilus septentrionalis*) found within Disney's Animal Kingdom®.

TABLE 1. Prevalence in 2008 (Rizkalla 2009), 2009, and total prevalence (no. animals testing positive/total sampled; "—" indicates none detected) of *Batrachochytrium dendrobatidis* on amphibians in Walt Disney World's Wildlife Management and Conservation Area, Florida, USA.

Species	2008	2009	Total Prevalence
Amphiuma means	0/1	0/1	0/2
Siren lacertina	—	0/4	0/4
Notophthalmus viridescens piaropicola	—	0/2	0/2
Eleutherodactylus planirostris	0/59	3/12	3/71
Anaxyrus terrestris	0/7	2/60	2/67
Acris gryllus dorsalis	1/5	5/70	6/75
Hyla cinerea	0/6	0/36	0/42
Hyla femoralis	—	0/6	0/6
Hyla squirella	—	0/1	0/1
Osteopilus septentrionalis	0/1	1/37	1/38
Pseudacris nigrita	—	0/4	0/4
Pseudacris ocularis	—	1/6	1/6
Gastrophryne carolinensis	—	0/2	0/2
Lithobates catesbeianus	1/2	1/5	2/7
Lithobates grylio	—	0/1	0/1
Lithobates sphenocephalus	—	0/19	0/19

Sample sizes in the previous study (Rizkalla 2009) were too low to assess prevalence. For the well-sampled species in this study (Cuban Treefrog, Florida Cricket Frog, Greenhouse Frog, Southern Toad), prevalence of *Bd* infection appeared low (2.6–8%) or absent (Green Tree Frog). Given the small sample size of American Bullfrogs and Little Grass Frogs, it is premature to determine rates of infection. Although a histological examination was not performed, it appeared that *Bd* was the cause of death for the Little Grass Frog, as symptoms matched those described in a previous report for another species (Todd-Thompson 2009).

Optimal pathogen growth in culture has been reported to occur at 23ºC (Daszak et al. 2003). Further laboratory experiments have indicated that *Bd* does not grow or grows slowly at temperatures above 28°C, suggesting infections at these temperatures may not be fatal (Piotrowski et al. 2004). To increase the probability of detection in the previous study (Rizkalla 2009), sample collection was restricted to the cooler months of the year. In this study, sampling occurred year round to increase the sample size. There were four cases of *Bd* when high air temperatures were above 28ºC, including the Little Grass Frog sampled in April when the air temperature was 31°C and an American Bullfrog sampled in July at 38°C.

It is possible that water temperatures and shaded areas may not have been as warm as the ambient temperature recorded at the weather station. Thus, it could be difficult to attribute the fatality of the Little Grass Frog to *Bd* despite the high temperature. However, species' behavior should also be a consideration. Little Grass Frogs tend to perch in vegetation above the water line (Conant and Collins 1998). Similarly, other *Bd*-positive species in this study, such as Florida Cricket Frog and Southern Toad, exhibit diurnal or terrestrial activity which would expose them to warm temperatures for prolonged periods (which is a recommended treatment for captive species (Piotrowski et al. 2004)). Thus, infection in these species is notable.

The unique patterns of infection observed in central Florida may be an artifact of a particular strain of the fungus. The pathogen is also capable of adapting to changing temperatures (Woodhams et al. 2008), trading fecundity for maturation rate; as temperatures increased, growth rate increased but fewer zoospores were produced per zoosporangium. However, temperatures above 28°C were not tested, and laboratory conditions may not accurately represent the behavior of the pathogen in the wild. Thus, warm temperatures could explain the low prevalence observed in central Florida but it could take a low zoospore load to cause fatality. We should not presume that species in warm climates are less likely to be impacted by *Bd* infection. Sampling should occur throughout the year to improve estimates of prevalence.

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HERPETOLOGICAL HUSBANDRY

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Captive Husbandry in the Rocky Mountain Tailed Frog, *Ascaphus montanus*

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The Rocky Mountain Tailed Frog, *Ascaphus montanus*, is a small, semi-aquatic frog found in cold, torrential streams of the northwestern United States. Tailed frogs are the most basal living anurans and possess a number of unusual features as adults including a tail-like intromittent organ, vestigial tail-wagging muscle, nine presacral vertebrae, and free ribs (Duellman and Trueb 1994). In addition, *Ascaphus* tadpoles possess a suctorial mouth which they use to climb rocks amid strong currents in order to feed on periphyton (Altig and Brodie 1972). Tailed frogs are not available commercially and knowledge of laboratory husbandry is limited (Held 1985). Given the increased risk of chytridiomycosis in stream-dwelling frogs (Kriger and Hero 2007), the presence of chytrid fungus in the northwestern United States (Muths et al. 2008; Pearl et al. 2007), and documented infection in another stream-dwelling leiopelmatid frog (*Leiopelma archeyi*; Bell et al. 2004), the development of husbandry techniques for this unique frog is increasingly important. As a torrent species, tailed frogs present a particular challenge because of their unusual habitat requirements.

Our objective was to mimic as closely as possible the first-order streams typically inhabited by adult tailed frogs. Key features of those streams include high flow rates, cold temperatures, slightly acidic pH, and granite cobbles. Herein we present husbandry in-

formation gathered over 2 ½ years (July 2007–December 2009) for a colony of adults (N = 16; 8 male, 8 female) and tadpoles (N = 15; 1–3 years of age; see Metter 1967 for aging criteria).

Individuals were collected by hand from streams in the Payette National Forest, Valley County, Idaho, USA and placed in individual plastic containers (Gladware) filled with stream water. Holes were placed in lids for aeration and containers were stacked and kept cool with a 12-V thermoelectric cooler (Igloo PowerChill). Animals were transported by automobile to the animal care facility at Southern Illinois University Edwardsville. Upon arrival, animals were acclimated by gradual addition of aquarium water to individual containers.

Adults (N = 16) and tadpoles (N = 15) were placed separately in two rectangular aquaria constructed from 1.9 cm × 28.6 cm pine boards (Fig. 1). Inside dimensions were 121.9 cm × 27.9 cm × 26.7 cm. Angle brackets were used to join boards together at corners. The interior surface of the floors and walls of the aquaria were coated with waterproof blue marine paint and sealed with silicone aquarium sealant. Lids were constructed from 0.16 cm thick Plexiglass with 0.5 cm diameter holes spaced approximately 10.0 cm apart for aeration. The floor of each aquarium included a filter-guarded drainage hole at one end. Aquaria were placed adjacent to one another on wooden scaffolding located above a 1.5 m diameter round plastic tub that served as a reservoir tank. The complete setup contained approximately 265 L of deionized water.

Water flow was powered by a 9085 Lph submersible utility pump (Supreme model 24) placed at the bottom of the reservoir. Water was filtered at the intake with a filter canister and sleeve (Marineland Magnum) containing a mixture of activated carbon and ammonia removing media (Aquarium Pharmaceuticals Ammocarb). A 10 cm length of plastic tubing connected the filter canister to 1.9 cm inside diameter schedule 40 PVC pipe. Filtered water was pumped to a ½ hp chiller (Aqua Logic Delta Star) cycled at 20-minute intervals with a plug-in timer to maintain a temperature of 9 ± 1°C, near the temperature recommended by Pough (2007) for cold water amphibians such as *Ascaphus*. Chilled water was directed over each aquarium with additional 1.9 cm PVC with flow controlled via stopcocks. Water flowed into aquaria from above through a 5.0 cm opening in the Plexiglas lid, simulating a cascading stream and providing aeration. A third stopcock directed excess water into the plastic reservoir tank. Water depth was maintained in aquaria at 7 cm with a PVC standpipe attached to the coarse filter. The pH was kept at ~6.8 by placing a nylon mesh bag of sphagnum peat moss in the reservoir tank. Lighting cycles were adjusted monthly to reflect seasonal changes in photoperiod. In addition, a 26 W fluorescent light bulb was used to provide low-level lighting at night for prey detection during feeding (Pough 2007). Room temperature was kept at 20°C.

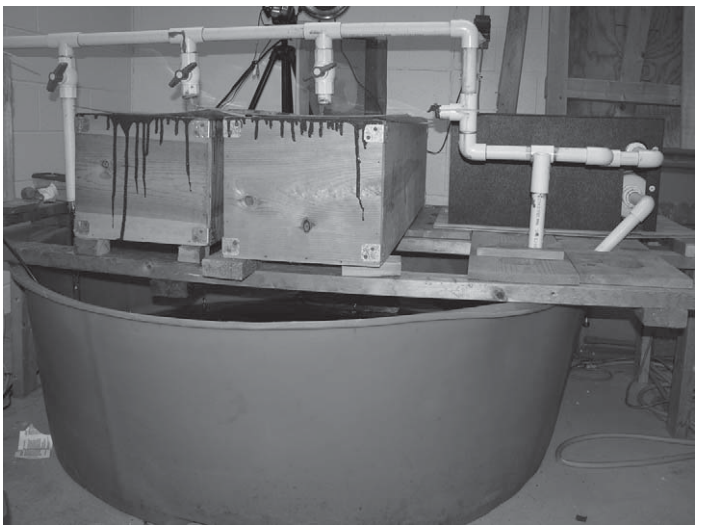


FIG. 1. Husbandry setup for a colony of Rocky Mountain Tailed Frogs, *Ascaphus montanus*. Adult frogs (N = 16) and tadpoles (N = 15) are housed separately in rectangular aquaria containing aquarium gravel and granite cobbles. Deionized water is chilled and circulated into the aquaria and reservoir tank via PVC.

Aquarium substrates consisted of aquarium gravel and granite cobbles of varying diameters (range = 5–30 cm) purchased from a landscape supplier. Cobbles were placed in an overlapping arrangement to provide refugia for adults. Large flat cobbles protruding from the water were used as feeding platforms for adults. Cobbles also served as a feeding surface for tadpoles which moved along them using their suctorial mouths (Altig and Brodie 1972).

Water quality (pH, alkalinity, chlorine, hardness, nitrite, nitrate) was tested twice weekly with test strips (Jungle Quick Dip) or with a pH meter (Hanna HI98103). Increases in nitrite or nitrate levels were controlled with water conditioner (Kordon Amquel Plus). Slight decreases in pH were adjusted as needed with a phosphate-based buffer (Seachem Neutral Regulator). Water levels were checked frequently and any losses due to evaporation were replaced as needed. Aquaria were cleaned and water was changed completely on a bimonthly basis. The health status of adults and tadpoles was monitored weekly by lifting large rocks and visually examining and censusing all individuals. Nitrile gloves were used whenever it was necessary to handle individuals or aquarium contents in order to reduce the likelihood of pathogen transmission.

Adult tailed frogs are known to eat a variety of arthropods, including Orthopterans (Bury 1970; Held 1985; Metter 1964). We fed adults twice weekly with 1.0–1.5 cm gut-loaded crickets purchased from Timberline Fisheries, Inc. (Marion, Illinois). Crickets were maintained on a diet of Timberline Cricket Power Food. Tadpoles were fed periphyton that became established on cobbles from two sources: 1) introduction of original stream water from transport containers; and 2) addition of a colony of living diatoms and desmids from Carolina Biological (Burlington, North Carolina). Once periphyton became established, cobbles developing an algal coat in the adult aquarium were transferred to the tadpole aquarium to provide additional food.

Adult frogs were marked for individual identification by injection with white visible implant elastomer in the webbing between digits of the pes (Northwest Marine Technology, Shaw Island, Washington; Nauwelaerts et al. 2000). Prior to marking, adults were anesthetized by immersion in tricaine methanesulfonate (MS-222) at a dose of 1.0 g/L. Individuals were removed from anesthesia once they lost the righting reflex.

After 18 months individuals were weighed to monitor changes in growth. All individuals experienced growth over this period with the greatest increases in body mass occurring in females. The mean body mass (± SD) at time of capture for 12 surviving adults (from a starting population of N = 16) was 4.37 ± 0.24 g for males (N = 6) and 6.73 ± 0.86 g for females (N = 6; Table 1). The percent increase in body mass over 18 months in captivity was 22.2

± 9.4% for males and 67.4 ± 36.7% for females (Table 1). Initially, 4 out of 8 females were visibly gravid at the time of capture. After 18 months 6 out of 6 remaining females were gravid. During this time period follicles (visible through the skin) became noticeably larger. Presumably, the greater increase in female body mass was due largely to gravidity.

TABLE 1. Change in body mass for a colony of Rocky Mountain tailed frogs, *Ascaphus montanus*, during the first 18 months in captivity.

Males			Females		
Mass 07/01/07	Mass 01/01/09	% Increase	Mass 07/01/07	Mass 01/01/09	% Increase
4.59	5.2	13.3	8.28	9.34	12.8
4.07	4.67	14.7	7.0	10.68	52.6
4.71	5.67	20.4	6.47	9.94	53.6
4.35	5.34	22.8	6.70	11.33	69.1
4.21	5.17	22.8	5.89	12.03	104.2
4.28	5.97	39.5	6.03	12.78	111.9
*4.71	—	—	*6.12	—	—
*3.51	—	—	*8.15	—	—

* indicates mortality

Male nuptial pads began to appear in October 2007 and persisted throughout the observation period. Copulexus *sensu* Sever et al. (2001) was observed on 12 occasions, with the earliest observation occurring on 19 May and the latest on 3 January (Fig. 2). Durations ranged from 1–3 days and no males were observed displacing rivals. Extended copulexus and an absence of male-male combat was previously reported by Stephenson and Verrell (2003) in a laboratory study of reproductive behavior in *Ascaphus.* Of the 12 events observed in our colony, only two involved pairings of the same individuals. Stephenson and Verrell (2003) also determined that there was no significant relationship between body mass and mating success in male *Ascaphus.* Our observations are consistent with this, since males in our colony exhibited similar numbers of copulations regardless of size. Courtship behavior involving males grasping unreceptive females in the absence of copulation occurred throughout the year as described by Metter (1967).

To date, we have not observed oviposition in the laboratory, despite providing conditions similar to those characterizing oviposition sites in *Ascaphus montanus* (see Karraker et al. 2006). Held (1985) had a similar experience with the Coastal Tailed Frog, *A. truei*. Karraker et al. (2006) determined that water temperature explained the greatest amount of variation in the timing of oviposition in *A. montanus*. Our setup maintained a relatively constant water temperature of 9 ± 1°C, within the range 11.4 ± 2.9°C reported by Karraker et al. (2006) for oviposition sites. Gradually increasing water temperature and photoperiod might be a way to stimulate natural oviposition. Alternatively, oviposition could be induced through injection of hormones (Brown 1975; Noble and Putnam 1931).

Four (3-year old) tadpoles metamorphosed from November to December 2007. The temperature range at which metamorphosis occurred (9 ± 1°C) was near the optimum reported for inducing metamorphosis in *Ascaphus truei* (10°C; Brown 1990). The first two individuals to metamorphose were placed in the adult aquarium. These individuals disappeared after several days and were assumed to have been cannibalized. We subsequently added a separate 18.9 L glass aquarium with a similar drainage system and substrate for juveniles. A T-fitting was inserted into the PVC pipe to divert water to a fourth stopcock above the aquarium. The two remaining froglets were fed a diet of flightless *Drosophila melanogaster* from Timberline Fisheries, Inc. (Marion, Illinois) *ad libitum* for approximately 1 month, at which point both stopped eating and died. In retrospect, a diet of flightless *Drosophila* raised on standard fruit fly media was probably insufficient for raising newly metamorphosed froglets. This stage of rapid growth and development might require the addition of supplemental nutrients (e.g. calcium) to *Drosophila* media.

After approximately 8 months in captivity (March 2008), three adult specimens (two males and one female) developed skin lesions and became noticeably lethargic. It was assumed that they had contracted an infection from an unknown pathogen, possibly due to the introduction of food (crickets) or from cross-contamination from a nearby colony of leopard frogs (*Rana pipiens*) maintained in the animal care facility. In response, water was changed completely and a broad spectrum treatment with antibiotics (Mardel Maracyn [tetracycline]), fungicides (Jungle Fungus Clear), and anti-protozoan medication (Aquarium Products Quick Cure) at dosages recommended for sensitive fish, was initiated for a one-week



FIG. 2. Copulexus in a pair of captive Rocky Mountain Tailed Frogs, *Ascaphus montanus*.

COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND

period. Water temperature was raised to room temperature (20°C) and carbon was removed from the filter to prevent adsorption of medications. All three individuals died, but no further adult mortality occurred at that time. A necropsy was performed on one of the specimens by a veterinary pathologist. Histological sections were prepared by staining with H&E and silver. Upon examination, no evidence of disease or fungal infection was observed and a cause of death could not be determined.

Unfortunately, the antibiotic treatment altered the microbial flora in the tank resulting in a precipitous drop in pH (<5) approximately three weeks after completion of the broad spectrum treatment. This resulted in 100% tadpole mortality. There were no noticeable effects on adults, presumably due to their ability to climb onto rocks. Following the loss of tadpoles, adults were redistributed to take advantage of the additional space (Tank 1: N = 7; Tank 2: N = 6).

A fourth adult frog (gravid female) became lethargic in August 2008 and died. A cluster of ~40 eggs was removed postmortem and placed under a granite cobble directly beneath the inflow pipe to encourage development. However, the eggs soon became enveloped in a coat of filamentous fungus and failed to develop. A necropsy was also performed on this individual using the same methods described earlier, but a cause of death could not be determined.

In conclusion, this husbandry setup represents a good starting point for keeping *Ascaphus montanus* in captivity. The frequency with which they engage in copulexus in the laboratory makes captive breeding a possibility; however, oviposition remains a challenge. The described setup is relatively inexpensive, easily reproducible, and will provide a suitable environment for tailed frogs over an extended period of time.

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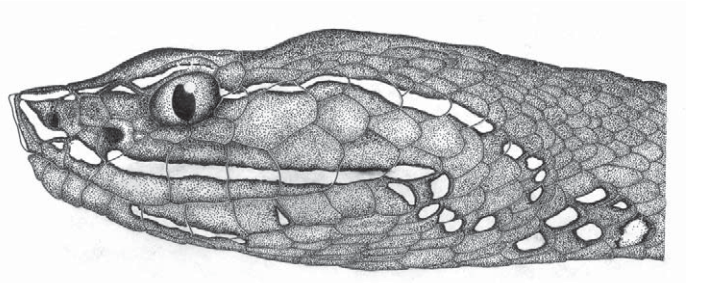
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Agkistrodon bilineatus (UMRC 88-3), 388 mm SVL. Mexico: Yucatán: 20 km ESE Mérida. Illustration by Julian C. Lee.

NATURAL HISTORY NOTES

The Natural History Notes section is analogous to Geographic Distribution. Preferred notes should 1) focus on observations in the field, with little human intrusion; 2) represent more than the isolated documentation of developmental aberrations; and 3) possess a natural history perspective. Individual notes should, with few exceptions, concern only one species, and authors are requested to choose a keyword or short phrase which best describes the nature of their note (e.g., Reproduction, Morphology, Habitat, etc.). Use of figures to illustrate any data is encouraged, but should replace words rather than embellish them. The section's intent is to convey information rather than demonstrate prose. Articles submitted to this section will be reviewed and edited prior to acceptance.

Electronic submission of manuscripts is requested (as Microsoft Word or Rich Text format [rtf] files, as e-mail attachments). Figures can be submitted electronically as JPG files, although higher resolution TIFF or PDF files will be requested for publication. Please DO NOT send graphic files as imbedded figures within a text file. Additional information concerning preparation and submission of graphics files is available on the SSAR web site at: http://www.ssarherps.org/HRinfo.html. Manuscripts should be sent to the appropriate section editor: **Jackson D. Shedd** (crocodilians, lizards, and *Sphenodon*; jackson.shedd@gmail.com); **Charles W. Painter** (amphibians; charles.painter@state.nm.us); **John D. Willson** (snakes; willson@uga.edu); and **James Harding** (turtles; hardingj@msu.edu).

Standard format for this section is as follows: SCIENTIFIC NAME, COMMON NAME (for the United States and Canada as it appears in Crother [ed.] 2008. *Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico*. SSAR Herpetol. Circ. 37:1–84, available from SSAR Publications Secretary, ssar@herplit.com; for Mexico as it appears in Liner and Casas-Andreu 2008, *Standard Spanish, English and Scientific Names of the Amphibians and Reptiles of Mexico*. Herpetol. Circ. 38:1–162), KEYWORD. DATA on the animal. Place of deposition or intended deposition of specimen(s), and catalog number(s). Then skip a line and close with SUBMITTED BY (give name and address in full—spell out state names—no abbreviations). (NCN) should be used for common name where none is recognized. References may be briefly cited in text (refer to this issue for citation format).

Some further comments. The role of the "Standard Names" lists (noted above) is to standardize English names and comment on the current scientific names. Scientific names are hypotheses (or at least represent them) and as such their usage should not be dictated by a list, society, or journal.

Recommended citation for notes appearing in this section is: Medina, P., and R. L. Joglar. 2008. *Eleutherodactylus richmondi*: reproduction. Herpetol. Rev. 39:460.

CAUDATA — SALAMANDERS

AMBYSTOMA MACULATUM (Spotted Salamander). **UNUSUAL MALFORMATION**. Malformations such as missing and extra limbs and digits have been observed in both salamander and frog species at least since the mid-1990s (Johnson et al. 2002. Ecol. Monogr. 72:151–168; Lannoo 2005. Amphibians Declines: The Conservation Status of United States Species. Univ. California Press, Berkeley, California. xxi + 1094 pp.). On 28 March 2009, I captured a female *Ambystoma maculatum* at the Central Kentucky Wildlife Management Area, Madison County, Kentucky, USA (37.6299156°N, 84.1961575°W) that possessed an unusual growth directly adjacent to the cloaca. The growth appeared to be a fully formed toe having the same banding pattern, length, and keratinized tip as the individual's normally placed toes. No other abnormalities were present on this individual. However, this and other malformations involving digits and appendages have been observed in other individuals of this species at this location.

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FIG. 1. Photograph showing an *Ambystoma maculatum* female with a fully formed toe adjacent to the cloaca. Note that all limbs were present and showed no sign of malformation.

AMBYSTOMA OPACUM (Marbled Salamander). **COLORATION**. Color anomalies have been well documented in amphibians, especially albinism (Bechtel 1995. Reptile and Amphibian Variants: Colors, Patterns, and Scales. Krieger Publ., Malabar, Florida. 224 pp.; Hensley 1959. Publ. Michigan State Univ. [Biol.] 1:133–159). Accounts of partial albino Marbled Salamanders are known from Maryland, Mississippi, and Illinois (Dyrkacz 1981. Herpetol. Cir. 11:1–31; Walston 2004. Herpetol. Rev. 35:365). Further, Mitchell (2002. Banisteria 24:67–69) has reported capture of leucistic *A. opacum* larvae in Virginia. However, accounts of darker variants are lacking in comparison to reports of albinism (Richards and Nace 1983. Copeia 1983:979–990). In the family Ambystomatidae, observations of melanistic Spotted Salamanders (*A. maculatum*) are known from Arkansas (Easterla 1972. Herpetologica 24:330–331) and a melanistic Axolotl (*A. mexicanum*) was reported by Humphrey and Bagnara (1979. J. Hered. 58:251–256). Here, we have adapted the term "melanoid," first used by Humphrey and Bagnara (1979, *op. cit.*) and later by Richards and Nace (1983, *op. cit.*), to describe all of our melanistic specimens due to the varying degrees of melanism in each. Thus, we report the first known captures of three melanoid and one hypomelanistic *A. opacum* in Tennessee. A melanoid adult male (63 mm SVL, 7 g) was observed at the Volunteer Army Ammunition Plant (VAAP) site in Hamilton Co., Tennessee (35.10437°N, 85.13053°W) on 9 Oct 2007. The specimen exhibited an overall black coloration, completely lacking the conspicuous white patterns usually present in male *A. opacum* (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, D.C. 587 pp.). At the same location, a melanoid female (66 mm SVL, 10 g) was observed on 8 Oct 2008. This specimen exhibited regular patterning on the dorsal surface, although all patterned areas were extremely faint and almost completely hidden. Our third melanoid specimen was a female (72 mm SVL, 7 g) observed at the VAAP site on 11 Dec 2008. Again, remnants of white crossbands were almost entirely undetectable. Lastly, a hypomelanistic

adult female (67 mm SVL, 8 g) was observed at the VAAP site on 8 Oct 2008 during autumn breeding movements. The specimen exhibited an overall pinkish-purple coloration due to the decrease in melanophores, with the white crossbands appearing normal. All specimens were collected under TWRA Permit No. 3082 and UTC AUP No. 0408TPW-04.

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AMBYSTOMA TIGRINUM (Tiger Salamander). **PREDATION**. Birds have been hypothesized to prey upon Tiger Salamander larvae when they are trapped in drying ponds (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington D.C. 587 pp.; Lannoo and Phillips 2005. *In* M. J. Lannoo [ed.], Amphibian Declines: The Conservation Status of United States Species, pp. 636–639. Univ. California Press, Berkeley). However, aquatic predation by birds on Tiger Salamander larvae has not been confirmed. On 4 Aug 2008, at 1230 h, we observed an adult *Ardea herodias* (Great Blue Heron) capture and eat a large larval *Ambystoma tigrinum* at Jasper-Pulaski Fish and Wildlife Area, in Jasper County, Indiana, USA (41.1576111°N, 86.9703333°W). The heron was observed wading in a wetland and struck at prey under the surface of the water. It held a salamander larva in its bill for a few minutes before swallowing it whole. During this time we were able to identify the salamander larva by observation through a 10-power spotting scope. Its size and the presence of four limbs ruled out all other species known at the site.

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AMBYSTOMA TIGRINUM TIGRINUM (Eastern Tiger Salamander). **REPRODUCTION**. Terrestrial salamanders of the family Ambystomatidae typically reproduce through explosive breeding aggregations formed in temporary and permanent water bodies. Among species known to utilize this strategy, breeding is typically associated with precipitation events and occurs at night (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington. 587 pp.). Here, however, I report repeated observations of diurnal breeding activities within populations of *A. t. tigrinum* in southern Illinois.

Between 9 Feb and 15 March 2008, nine individual *A. t. tigrinum* (five females, four males) were observed engaged in diurnal breeding activities within two forested ponds of the Shawnee National Forest, Gallatin and Hardin counties, Illinois, USA (37.60569°N, 88.25950°W and 37.57192 °N, 88.25472°W). Breeding behaviors were observed between 1210–1520 h and consisted of males and females depositing spermatophores and egg masses on submerged tree branches and vegetation. Ponds were characterized by high turbidity at all times during these observations, with Secchi disk transparencies ranging from 0.18–0.41 cm (N = 10 readings/pond). No ice was observed on the ponds' surfaces, and skies were clear.

To my knowledge, this is the first report of diurnal breeding activities by any pond-breeding ambystomatid salamander. These preliminary observations suggest that light cues necessary for the formation of nocturnal breeding aggregations among ambystomatid salamanders are absent or reduced in ponds with high turbidity, resulting in diurnal breeding because individuals are unable to recognize an external photoperiod. In adjacent ponds with clear water (i.e., Secchi disk transparencies exceeding the actual pond depth), breeding activities were only observed at night, though on the same dates as the diurnal activities described above. Many of the permanent fishless ponds within the Shawnee Forest exhibit similarly high turbidity, attributable to substrates composed of well-decomposed organic muck and constant resuspension of particles by precipitation events. Therefore, in these ponds, diurnal breeding activities may be commonplace, and future studies should focus on ponds with high turbidity to determine the prevalence of these behaviors.

All research was conducted in accordance with Southern Illinois University Carbondale IACUC Protocol # 05-036 and with permission of the United States Forest Service. This research was funded by a grant from the Chicago Herpetological Society.

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BOLITOGLOSSA ORESTES (Culata Climbing Salamander) and ***BOLITOGLOSSA SPONGAI*** (NCN). **LIFE HSTORY**. Herein we report information on reproduction, habitat, and diet of two plethodontid salamanders from the cloud forests of Mérida, Venezuela. A removal survey was conducted during June to August 2008, in La Mucuy, San Javier del Valle, and San Eusebio cloud forests. For all specimens, length (SVL, from tip of snout to the anterior edge of vent) was measured. Specimens were dissected to determine sex and reproductive condition; egg number and diameter were measured; testis length and width were measured and surface average was calculated. The stomach contents were washed from the dissected stomach, separated, and identified with a dissecting microscope. All specimens were deposited in the Amphibians and Reptiles Collection of the Universidad de Los Andes (CVULA).

Salamanders were found within logs and moist litter associated with mats of mosses and lichens. The majority of prey items were soil invertebrates including ants, pseudoscorpions, spiders, acari, beetles, and isopods.

Two gravid female *Bolitoglossa orestes* (CVULA 7101, 7108) collected in San Javier del Valle, had enlarged and convoluted oviducts with two rows of 8 light yellow, yolk-filled eggs. Eggs were joined together without pedicels. Female size and average diameter egg are given in Table 1. A small female (CVULA 7099) collected in La Mucuy, had a total of 56 whitish jelly eggs of different sizes and its oviducts were straight. One male (CVULA 7109) collected in San Javier del Valle has small white testes.

An adult female *Bolitoglossa spongai* from San Eusebio Forest (CVULA 7092) with an enlarged and convoluted oviduct had only

TABLE 1. Reproductive characteristics of *Bolitoglossa orestes* and *Bolitoglossa spongai* collected in three cloud forests of the Andes of Venezuela.

Species	CVULA	Date	SVL (mm)	Sex	Oviductal egg number right / left	Mean egg diameter (mm)	Mean testis surface (mm^2) right / left
B. orestes	7101	07/17/08	102.66	F	8/8	1.33 ± 0.25	—
B. orestes	7108	07/17/08	99.81	F	8/8	1.51 ± 0.21	—
B. orestes	7109	07/17/08	70.81	M	—	—	6.73/8.98
B. orestes	7099	06/27/08	74.00	F	31/25	0.42 ± 0.06	—
B. spongai	7092	06/13/08	103.00	F	11/10	1.7 ± 0.54	—
B. spongai	7096	06/13/08	94.00	M	—	—	14.23/13.56
B. spongai	7094	06/13/08	70.00	M	—	—	10.32/9.74

21 large yellow yolk-filled eggs. Two males (CVULA 7096 and 7094) were collected in the same locality with whitish enlarged testes. Despite the small sample size in each species, SVL for females exceeds that of males (Table 1).

The best predictors of salamander presence at these sites were deep ground cover and high humidity. From this field work we concluded that subterranean elements are important components of the salamander environment. Based on egg numbers and egg development they might reproduce throughout the year as other tropical species Chan (2003. J. Linn. Soc. 78[4]:489–496). Many aspects of the biology and natural history of these salamander species remain to be ascertained.

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BOLITOGLOSSA STRIATULA (Striated Salamander). **PREDATION**. *Bolitoglossa striatula* is the only salamander in Costa Rica with paired dorsal and lateral dark longitudinal stripes. This species forages on the leaves of herbaceous vegetation at night and hides during the day in the plants located near ponds. Many aspects of its biology are unknown. This is the first report of predation of *B. striatula*.

On 15 April 2004 at 1100 h, an individual *Micrurus nigrocinctus* (Central American Coralsnake) (300 mm SVL) was captured near an artificial pond at the University of Costa Rica, campus "Sede de Occidente," San Ramón, Alajuela, Costa Rica (10.083°N; 84.467°W; 1070 m elev.). The snake was placed in a glass bottle where it regurgitated a *B. striatula* (55 mm SVL, 65 mm TL) 30 min later. The *B. striatula* was partly digested, and was deposited at the Museo de Zoología, Universidad de Costa Rica (UCR 17581).

In Costa Rica, the diet of *M. nigrocinctus* is primarily colubrid snakes, small lizards, and occasionally members of their own species (Solórzano 2004. Snakes of Costa Rica: Distribution, Taxonomy and Natural History. INBio. Santo Domingo, Heredia, Costa Rica. 792 pp.). This is the first record of a salamander in its diet.

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DICAMPTODON TENEBROSUS (Coastal Giant Salamander). **REPRODUCTION**. Little is known about the nesting habits of *Dicamptodon* spp. Only three observations of *D. tenebrosus* nests have been published (Henry and Twitty 1940. Copeia 1940[4]:247–250; Nussbaum 1969. Herpetologica 25[4]:257–262; Jones et al. 1990. Northwest. Nat. 71:93–94). On 19 Sept 2007, at 1415 h, we observed a terrestrial adult (SVL 158.0 mm, 96.7 g), with eggs and recently hatched larvae. It was located in a first order tributary of Texas Creek, about 16 km NE of Washougal, Washington, USA, in the Cascades Mountains at 447 m elev. When the nest site was disturbed, a terrestrial adult *D. tenebrosus*, presumed to be the female, appeared from under a downed log directly adjacent to the boulder where the nest was located. The presence of the female tending to the nest is consistent with observations made at other nest sites (Henry and Twitty 1940, *op. cit.*; Nussbaum 1969, *op. cit.*). There was at least one embryo and ca. 6 hatchlings. The nest appeared to have originally contained 20–30 eggs, fewer than the 70 eggs observed in other documented *D. tenebrosus* nests (Henry and Twitty 1940, *op. cit.*; Nussbaum 1969, *op. cit.*). The remaining embryo was separated from the other empty egg casings, possibly due to the disturbance. The hatchlings, which still contained their yolk sacs, were in close proximity to one other and the remnants of the nest. The nest was in 5 cm of 10°C water, under a flat boulder with a substrate of fine gravel next to the stream bank. Surrounding vegetation included Salmonberry (*Rubus spectabilis*), Vine Maple (*Acer circinatum*), and Red Alder (*Alnus rubra*). The pedicels of the eggs attached to the rock were indicative of *D. tenebrosus* as compared to *D. copei* (Steele et al. 2003. Herpetol. Rev. 34:227–228). On 20 Sept, JGM returned to the site to retrieve a tail clip for genetic analysis for species confirmation and the adult was still present, but no larvae were found. However, several crayfish (*Pacifastacus* sp.) were at the nest site, suggesting predation of the larvae. Genotyping was performed in the laboratory of Andrew Storfer (School of Biological Sciences, Washington State University) and confirmed that the adult was *D. tenebrosus.*

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EURYCEA JUNALUSKA (Junaluska Salamander). **OCCURRENCE AND REPRODUCTION**. *Eurycea junaluska*, a rare salamander in southwestern North Carolina and southeastern Tennessee, is thought to be extirpated from the Cheoah River in Graham County, North Carolina (Ryan and Sever 2005. *In* M.

J. Lannoo [ed.], Amphibian Declines: The Conservation Status of United States Species, pp. 745–746. Univ. California Press, Berkeley, California). Additionally, it is reported that around mid-May adults attend egg clutches in streams (Ryan and Sever 2005, *op. cit*.) Contrary to these reports, we discovered three adult *E. junaluska* attending their egg clutches on 12–13 April 2005 in the Cheoah River, Graham County, North Carolina, along with one live adult crossing a wet road from deciduous forest toward this river during a nighttime search. All three egg clutches were deposited in cup-shaped depressions on the underside of large cobble or small boulders at the top of small riffle or run areas in the river. We observed one of the clutches hatching out which would further indicate an earlier date of egg deposition than reported in published accounts. Egg counts were ca. 36 from the hatching clutch, with 31 and 58 eggs in the remaining two clutches. On 19 Sept 2005 we observed a large, gilled larva (90 mm TL, 46 mm SVL) in the Cheoah River 200 m upstream from the previous location and one adult under artificial cover in adjacent riparian habitat, and on 14 June 2006 in aquatic searches, we found one adult in this same area. Voucher photos were verified by J. C. Beane, North Carolina State Museum of Natural Sciences (accession numbers 12294 and 12352).

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NOTOPHTHALAMUS VIRIDESCENS (Eastern Newt). **POLYMELIA**. The presence of extraneous limbs (polymelia) is known to naturally occur in both larval and adult salamanders (Sessions and Ruth 1990. J. Exp. Zool. 254:38–47; Cecala et al. 2007. Herpetol. Rev. 38:434). Emergent research suggests that although polymelia in wild salamander populations does occur, it is rare (Williams et al. 2008. Biol. Lett. 4:549–552) and may be associated with trematode parasites (Johnson et al. 2006. Ecology 87:2227–2235). In North America, in situ examples of polymelia are primarily restricted to ambystomatid salamanders (e.g., Johnson et al. 2003. Cons. Biol. 17:1724–1737). For the extant Nearctic salamandrid genera (*Taricha* and *Notophthalamus*), records of polymelia are few and restricted to the hind limbs (North American Reporting Center for Amphibian Malformations [NARCAM] website; via http://www.nbii.gov). Here we report a naturally occurring case of forelimb polymelia in *N. viridescens*. On 29 Sept 2007 we collected an eft stage *N. viridescens* near the city of Lindale (Smith County., Texas, USA) from underneath a fallen log along County Road 4106 (32.57°N, 95.35°W). The specimen (SVL 19.19 mm, TL 15.90 mm) possesses two right forelimbs that coalesce near the midpoint of the humerus (Fig. 1). Based on external examination it appears that the bones comprising each arm include at least a partial humerus in addition to a full radius and ulna. Other than exhibiting polydactyly (two extra digits) and associated brachydactyly, the extraneous appendage (4.28 mm) appears comparable in gross morphology to its natural counterparts (4.92 mm right arm; 4.90 mm left arm) albeit slightly shorter. Although polymelia is known to occur in *N. viridescens* (Record ID 51, NARCAM website), the frequency and geographic distribution of its occurrence are not well documented.

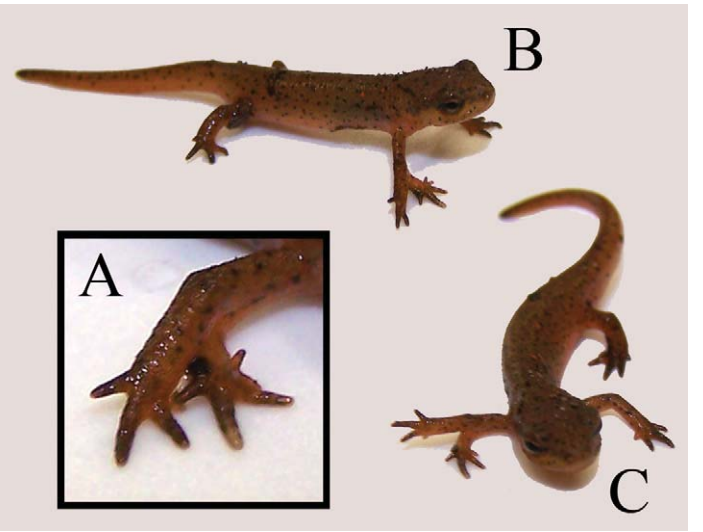


FIG. 1. Close-up (A), lateral (B), and dorso-frontal (C) views of forelimb polymelia in an eft stage *Notophthalamus viridescens* (UTA A-59131) from eastern Texas, USA.

The specimen was deposited at the University of Texas at Arlington Amphibian and Reptile Diversity Research Center (UTA A-59131) and in vivo photographic vouchers were deposited in the UTA Digital Collection (UTADC 3494–3500). All measurements were taken using a digital caliper. Limb measurements were taken distally from the elbow. We thank C. M. Sheehy III for comments on the manuscript. Collecting was conducted under Texas Parks and Wildlife scientific permit number SPR-0707-1387 to CJF.

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NOTOPHTHALMUS VIRIDESCENS (Eastern Newt). **OVERWINTERING BEHAVIOR**. The movements and homing ability of *Notophthalmus viridescens* efts have been previously documented (Healy 1975. Amer. Mid. Nat. 93[1]:131–138; Gill 1978. Evolution 32[4]:839–849). In Virginia, most adults were observed to exit ponds in autumn, presumably to overwinter in terrestrial sites surrounding their resident ponds; however, considerable variation in life history has been reported across the range of this species and regular overwintering of adults in aquatic sites has been reported for other populations (Gill 1978. Ecol. Monogr. 48:145–166). Healy (1975, *op. cit*.) reported that efts were sometimes located near the base of the same tree in successive springs and that the root system of these trees may have served as winter hibernacula. Consequently, he suggested that proximity to trees in April and early May could indicate that efts at this time (in Charlton, Massachusetts) remain close to the site of their winter emergence. Congregation of juvenile *N. viridescens* at winter hibernacula has not been previously reported. Herein I describe the occurrence of such a congregation of *N. viridescens* efts at a terrestrial site believed to have been used for overwintering.



FIG. 1. Aggregation of *Notophthalmus v. viridescens* efts at hibernacula site in Ashtabula Co., Ohio, USA.

On 2 April 2006, I observed a minimum of 19 *N. viridescens* red efts congregated beneath a slab of stone (Fig. 1). The observation was made at ca. 1645 h under partly cloudy conditions with an ambient air temperature of ca. 13.5°C. The stone was not particularly close to the base of any trees, but was located within 30 m of a small woodland pool in Ashtabula County, Ohio, USA. The pool, which currently holds water year-round, was excavated to a depth of ca. 1–2 m about 10 years prior and an adult *N. viridescens* was observed surfacing near the edge of this pool. Beneath the slab were a number of small holes leading to subterranean spaces of unknown depth. At least one eft was observed to escape down one of these holes (Fig. 1). The group of efts encompassed a wide range of sizes and appeared to represent multiple age-classes. Also found beneath the slab was a Red-backed Salamander (*Plethodon cinereus*) and a Leopard Slug (*Limax maximus*) The spaces beneath this slab coupled with the large number of efts and the rapidity with which they moved toward the holes gave the strong impression that this site was used as winter hibernacula. A thorough search of additional cover objects in the surrounding area revealed no additional efts. To the best of my knowledge this is the first report of such behavior by *N. viridescens* efts. However, the utilization of specific sites as winter hibernacula would seem to be congruent with reports of strong homing ability and spatial cognition in this species.

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PLETHODON CINEREUS (Red-backed Salamander). **LEUCISM.** Leucism, a lack of skin pigmentation caused by defective chromatophores (Bartlett and Bartlett 2005. Designer Reptiles and Amphibians. Barron's Educational Series. New York), has been recorded in a number of plethodontid salamanders (Seeliger 1945. Copeia 1945:122; Miller and Braswell 2006. Herpetol. Rev. 37:198). Documented cases of leucism in *Plethodon cinereus* exist for West Virginia (Pauley 1974. Redstart 42:104), Maryland (Harris 1968. Bull. Maryland Herpetol. Soc. 4:57-60; Mitchell and Mazur 1998. Northeast. Nat. 5:367–369), and southern Ontario (Rye 1991. Can. Field Nat. 105:573–574). Here, we report two additional cases of leucism in *P. cinereus*, in Massachusetts and New York.

During August 2007, an adult *P. cinereus* of unknown sex, white in coloration with darkly colored eyes, was discovered beneath a decaying log in the Stony Brook Reservation in West Roxbury, Suffolk County, Massachusetts (WGS84, 42.2652778°N, 71.14°W, elev. 64 m) (E. O'Brien, pers. comm.). The specimen was found within 1 m of a heavily traveled footpath in a forested area comprised predominately of *Pinus strobes* and *Fagus grandifolia* with *Comptonia peregrine*s ground cover, and was left in situ. An abundance of decaying logs was present. Both "red-backed" and "lead-backed" phenotypes of *P. cinereus* are common in the area. Several successive searches of the area were carried out over the next two weeks in an effort to photograph the specimen. On 5 Sept 2007, a leucistic adult of unknown sex measuring ca. 6.5 cm TL was found together with an adult and a neonate of the "red-backed" phenotype beneath a log in the immediate area where the original leucistic specimen was discovered (Fig. 1). Since there is no photographic record from O'Brien's original sighting, it remains unclear whether this second sighting represents the original specimen or a second individual.

On 20 Sept 2008, an adult *P. cinereus* of unknown sex (ca. 7.5 cm TL) lacking skin pigmentation and patterning with dark eyes, was discovered beneath some fallen tree bark among a 2–3 cm layer of moist leaf litter in a wooded area located directly behind the reptile house and service yard of the Wildlife Conservation Society's Bronx Zoo in Bronx County, New York (WGS84; 40.8502583°N, 73.8777417°W, elev. 20 m). The overall coloration of the specimen was white, although its skin was partially transparent, allowing visibility of some visceral organs. The wooded area is situated on a slight 10–15° north-facing incline, is bordered by service yard



FIG. 1. Leucistic *Plethodon cinereus* with "red-backed" adult and juvenile from Suffolk County, Massachusetts.

buildings to the south and a paved public pathway to the north, and is dominated by *Quercus* sp., *Acer* sp., and *Liquidambar styraciflua*. An abundance of felled trees and tree bark litter the area and provide considerable ground cover. *Plethodon cinereus* of the "red-backed" morph are common in the immediate area although no "lead-backed" or additional polymorphic phenotypes have been found.

Plethodon cinereus is considered to be one the most abundant terrestrial vertebrates in deciduous forests of northeastern North America (Burton and Likens 1975. Copeia 1975:541–546), with densities reaching up to 2.8 salamanders/m^2 (Mathis 1991. Oecologia 86:433–440). Likewise, it also has an extensive distribution, ranging from North Carolina to Quebec and westward to Minnesota (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, DC. 587 pp.). Given these attributes, combined with a general ease of locating them beneath logs, rocks, and leaf litter, it can be expected that occasional specimens exhibiting coloration abnormalities will be found. The fact that there are currently more documented cases of leucism in *P. cinereus* than any other caudate is likely an artifact of the relative abundance of *P. cinereus*, rather than a greater incidence of color anomaly in the species. Given its fossorial and nocturnal terrestrial habits (Petranka 1998, *op. cit.*), leucism as well as other conspicuous phenotypes documented for *P. cinereus* such as albinism (Hensley 1959. Pub. Mus. Michigan State. Univ., Ser. 1:135–139; Dyrkacz 1981. SSAR Herpetol. Circ. 11:1–31; Gilhen 1986. Can. Field Nat. 100:375) may not be as deleterious to *P. cinereus* as they would be for less reclusive amphibian species. Both observed leucistic individuals were adults in good physical condition and were found in close proximity to conspecifics.

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PLETHODON CINEREUS (Red-backed Salamander). **ELEVATION**. On 2 Sept 2008, we observed a single dead, adult red-backed salamander in a granitic seepage at 1173 m elevation on the north headwall of the North Basin, Katahdin, Mount Katahdin Township (T3 R9 WELS), Piscataquis County, Maine, USA (45.931°N, 68.922°W). Red-backed Salamanders are commonly reported from low elevations in the Katahdin region, and have been reported at elevations exceeding 1219 m in the southern Appalachians, but similar elevation records do not exist for the northeastern United States, where tundra communities occur above 1200 m (Hunter et al. 1999. Maine Amphibians and Reptiles. University of Maine Press, Orono, Maine; Taylor 1993. The Amphibians and Reptiles of New Hampshire. Nongame and Endangered Wildlife Program, New Hampshire Fish and Game Department, Concord, New Hampshire). This record provides limited information about the potential elevational distribution of this species and is unusual because the surrounding vegetation is subalpine and arctic-alpine, a vegetation type not present in the southern Appalachians. Dominant vascular plants observed in the surrounding snowbed community included the following unusual subalpine assemblage: *Carex intumescens*, *Carex flava*, *Carex scirpoidea*, *Glyceria striata*, *Campanula rotundifolia*, *Dasiflora fruticosa*, *Sibbaldiopsis tridentata*, *Drosera rotundifolia*, *Arnica lanceolata*, and *Prenanthes trifoliolata*. *Plethodon cinereus* is not the only amphibian occurring at this elevation on Katahdin; 179 m SW of this location at a similar elevation, we observed an adult American Toad (*Anaxyrus americanus*). The amphibian communities of these northern, alpine communities are more diverse than typically acknowledged and are in need of additional, focused research.

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PLETHODON DORSALIS / EURYCEA LUCIFUGA / ANEIDES AENEUS (Zigzag Salamander, Cave Salamander, Green Salamander). **ARBOREALITY**. Salamanders of the genus *Aneides* are found in arboreal habitats in temperate rainforests of northwestern North America (Spickler et al. 2006. Herpetol. Cons. Biol. 1:16–26) and hardwood forests of the eastern United States (Wilson 2003. Contemp. Herpetol. 2003[2]:1–6). However, no studies have reported the use of arboreal habitats by salamanders in the genera *Plethodon* and *Eurycea*. Herein, I report arboreal habitat use in both *Plethodon dorsalis* and *Eurycea lucifuga*. On 12 May 2005 and 15 Oct 2006, I observed *P. dorsalis* (N = 3), *E. lucifuga* (N = 5), and *Aneides aeneus* (N = 2) between 1.5 m and 4 m above ground on tree trunks (dbh greater than 114 cm). All areas of observation were adjacent to small streams. Observations were made in two different old-growth hardwood forest stands of southeastern Tennessee, USA (site 1, Dick's Cove, [35.2199417°N, 85.9599778°W]; site 2, Morgan's Steep, [35.2026833°N, 85.9320167°W]). Both sites were mesic cove forests. Individuals were observed between 2200 and 0100 h. On the two nights of observation the weather was cool with light rain. *Plethodon dorsalis* and *A. aeneus* were both observed on large Black Oak (*Quercus velutina*; site 1) while *E. lucifuga* were observed on Tulip Poplars (*Liriodendron tulipifera*; site 2). One individual *P. dorsalis* was observed foraging (ca. 2 m above ground) on small flies. These observations provide new habitat associations for both *P. dorsalis* and *E. lucifuga*.

I thank J. Berton, C. Harris, and M. Hess for assistance.

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PLETHODON GLUTINOSUS (Northern Slimy Salamander). **REPRODUCTION AND BEHAVIOR.** *Plethodon glutinosus* has an extensive geographic distribution in the eastern United States. Extensively studied accounts of female reproductive behavior in nature remain sparse, leaving gaps in the knowledge of the reproductive behavior of this species. Currently much of what is known about nesting and associated behavior has been gained from observations made during experimental manipulations of brooding female *P. glutinosus*, their clutches, or nesting environments (Peterson 2000. Ethology 106:781–794; Trauth et al. 2006.

Herpetol. Nat. Hist. 9:141–149). To date, reported egg deposition sites for *P. glutinosus* include rotting stumps, logs, and under rocks (Beamer and Lannoo 2005. *In* M. J. Lannoo [ed.], Amphibian Declines: The Conservation Status of United States Species, pp. 808–811. Univ. California Press, Berkeley, California). Here we report a new type of egg deposition site used by *P. glutinosus* in the Appalachian Plateau region of northern Alabama.

On 29 Sept 2008 a female *P. glutinosus* was observed in attendance of a clutch of at least 5 observable eggs attached at a single point to the roof of a crevice, 10.37 mm height, in a sandstone/siltstone bluff along Clear Creek in Winston County, Alabama (WGS84, 34.02759°N, 87.37294°W). The observed eggs were in a late stage of development. The female was positioned partially coiled around and underneath the nest. The female remained motionless while viewing and photographing the nest. A second female *P. glutinosus* was encountered in attendance of a nest in a separate crevice within the same bluff system ca. 30 m from the first nest and female. The second female did exhibit an aggressive response while viewing the nest by moving between the clutch and the crevice opening and exhibiting an all-trunk raised (ATR) posture. This posture is considered an aggressive response in terrestrial salamanders (Jaeger 1984. Copeia 1984:309–314). The placement of the second nest within the crevice prevented a clear photograph and egg count from being taken.

HRC returned 3 Oct 2008 and found the first female still in attendance with five observable hatchlings; no eggs could be observed. The female was positioned coiled around the hatchlings. At the second nest the female was again found in attendance with the nest; no hatchlings were observed. On 23 Oct 2008 we found the female *P. glutinosus* was still in attendance at the first nest with two remaining hatchlings. The second female *P. glutinosus* was also observed in attendance of the second nest although no eggs or hatchlings were observed. Because of the depth of the second crevice it is possible that hatchlings were present but not observed from the crevice opening. We returned on 10 Nov 2008 and found no females or hatchlings in either crevices. To our knowledge this is the first record of this type of habitat use for egg deposition in *P. glutinosus*.

Digital photographs of the female and clutch and female and hatchlings were deposited in Alabama Herp Atlas Project-Digital at Auburn University; AHAP-D 206 and AHAP-D 207.

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PSEUDOEURYCEA NIGROMACULATA (Black-spotted Salamander). **PREDATION**. On 27 Sept 1995 in central Veracruz, México, 6 km. S of Acultzingo (WGS84, 18. 6966°N, 97.3155°W, 2183 m. elev.), Walter Schmidt observed an adult male *Rhadinaea fulvivitis* (258 mm SVL, 119 mm TL), predating a *Pseudoeurycea nigromaculata* (56.5 mm SVL) on the forest floor. These specimens were collected and deposited at the Collection of Museo de Zoologia, Facultad de Ciencias, UNAM (*R. fulvivitis* MZFC 17669; *P. nigromaculata* MZFC 8457). This observation represents the first report of predation on this species (Parra-Olea 1998. Cat. Amer. Amphib. Rept. 664:1–2).

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PSEUDOTRITON RUBER (Red Salamander). **HABITAT USAGE / MOVEMENT**. *Pseudotriton ruber* is found in both aquatic and terrestrial habitats and can occur in relatively dry habitats away from aquatic sites (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn Printing, Auburn, Alabama. 345 pp.). *Pseudotriton ruber* seldom disperses >30 m from overwintering sites (Axtell and Axtell 1948. Copeia 1948:64), however few studies document *P. ruber* migration or dispersal capabilities. In a recent survey of ephemeral ponds (N = 26) on the Cumberland Plateau, Corser (2008. Am. Midl. Nat.159:498–503) identified 18 of a potential 21 known amphibian species to breed in the region, but he did not document *P. ruber*. On 13 and 17 Oct 2006, I found three adult *P. ruber* at two different ephemeral ponds on the Cumberland Plateau (elev. 585 m) in southeastern Tennessee, USA (wetland site 1 [35.2235361°N, 85.9710694°W]; wetland site 2 [35.2361861°N, 85.8928694°W]). The Cumberland Plateau is bounded by moist cove forest, and ephemeral ponds represent the only natural body of water on the plateau. All three individuals were found under moist decaying logs within completely dry ephemeral ponds. The hydroperiod of plateau ephemeral ponds follows an annual cycle in which ponds are typically flooded between November and June and are completely dry for the remainder of the year. Two salamanders were located at a pond (site 1) greater than 388 m from the nearest possible stream habitat and the third salamander was located at a pond (site 2) over 1 km from the nearest stream. The two ephemeral ponds were 7.2 km apart. It is unlikely that *P. ruber* uses ephemeral ponds for breeding, given that the larval period is usually 1.5–3.5 years (Petranka 1998. Salamanders of the United States and Canada, Smithsonian Institute Press, Washington. 302 pp.) and that ephemeral ponds dry each year. It is also unlikely that these individuals use ephemeral ponds as overwintering sites because previous study shows that many individuals, particularly females, move back to stream habitats to overwinter (R. Bruce pers. comm.). Therefore, it is most likely that *P. ruber* has extensive dispersal capabilities that range from 388 m to over 1 km from stream sites and may use ephemeral ponds as an important moist stop over site during migration and dispersal events in an otherwise xeric, drought prone landscape. The present observations confirm that *P. ruber* uses ephemeral ponds on the Cumberland Plateau. My observations suggest that ephemeral ponds may be important to *P. ruber* on the Cumberland Plateau and further highlight the importance of ephemeral ponds in an area where wetlands are declining and federal regulatory oversight is limited (Scheffers et al. 2006. J. Field. Ornthol. 77:178–183).

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ACRIS CREPITANS (Northern Cricket Frog) and ***ACRIS GRYLLUS*** (Southern Cricket Frog). **INTERSPECIFIC AGONISM.** *Acris crepitans* and *A. gryllus* have sympatric ranges in the southeastern United States (Nevo and Capranica 1985. Evol. Biol. 19:147–214). In North Carolina, range overlap occurs in the Coastal Plain and Fall Zone and the species are syntopic (co-occur locally) in a few locations, but they are not known to interbreed, probably because females can recognize conspecific males by vocalizations (Micancin 2008. Ph.D dissertation, Univ. North Carolina). In *A. crepitans*, aggressive interactions between males include complex acoustic signals that include information on the individual's body size and size-independent willingness to physically interact (Burmeister et al. 2002. Anim Behav. 64:715–725). Agonistic encounters among *A. crepitans* can result in the use of an alternative mating tactic by subdominant males (i.e., satellite behavior, Wagner 1989. Behav. Ecol. Sociobiol. 25:429–436). We have observed two prominent behaviors, leg extension and grappling, in observations of both species of *Acris* in North Carolina. These behaviors are exhibited by calling males in high-density choruses or when a satellite male is in close proximity to the calling male. In leg extension, the individual repeatedly extends and contracts a hind leg in an exploratory fashion. When the foot or leg contacts another male, the individual turns to face the opponent before grappling until one male hops free. Physical interactions continue until either male moves away from the immediate area.

On 8 June 2007 at 2403 h, in an area of Merchants Millpond State Park (Gates County, North Carolina, USA) with an extensive mixed chorus of *Acris* (36.4261°N, 76.6770°W; NAD83 datum), we found an *A. crepitans* male and *A. gryllus* male interacting aggressively. We video recorded the interaction with a Canon Powershot A80 digital camera with light from two Petzl Duobelt halogen headlamps. We recorded for two 3-min periods. The aggressive interaction included leg extensions, grappling, and vocalizations by both males. The vocalizations allowed us to conclusively identify the males as *A. crepitans* and *A. gryllus* without capturing them (and thus interrupting their interaction).

Despite the exceptionally large populations of *A. crepitans* and *A. gryllus* at this location and our extensive work at the site in 2006 and 2007, this is the only case in which we have observed such prolonged physical agonism within or between the species, and we know of no previous reports of this behavior. Since conspecific recognition occurs by females at Merchants Millpond, interspecific agonism in males is likely a product of competition for calling space on aquatic macrophytes and woody debris, not competition for mates. Because male competition is mediated by vocalizations in *A. crepitans*, it is possible that the prolonged interaction we observed resulted from the inability of the two males to mediate their spacing acoustically. Future investigations of male competition in mixed choruses of *Acris* could include an analysis of the aggressive thresholds of both species toward intrusion by conspecific and heterospecific males.

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ACRIS GRYLLUS (Southern Cricket Frog). **DISPERSAL**. On 8 July 2004 around 0300 h at Cliffs of the Neuse State Park (Wayne County, North Carolina, USA), I observed a female Acris gryllus feeding on insects under the lights of a building (35.2412°N, 77.8873°W). If the female originated or bred at the nearest chorus of *A. gryllus* (35.2362°N, 77.8867°W), then she moved at least 562 m through forested habitat and up a hill to reach the location where I observed her.

Acris crepitans (Northern Cricket Frog) and *A. blanchardi* (Blanchard's Cricket Frog) have declined near northern range margins. In North Carolina, *A. gryllus* has also declined near the northern edge of its range and the Cliffs of the Neuse population is adjacent to that area (Micancin and Mette 2009. Zootaxa 2076:1–36). An important consideration in the conservation of cricket frogs is the extent of nonbreeding or upland habitat use. This observation indicates that the population of *A. gryllus* at Cliffs of The Neuse State Park can use upland habitat far from breeding wetlands during the breeding season. The well-known jumping ability of *Acris* apparently allows them to move far from wetlands in search of food.

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BUFO BUFO (Common Toad). **DAVIAN BEHAVIOR.** Misdirected copulation with dead conspecific or other species is known as Davian behavior. It was described in mammals (Dickerman 1960. J. Mammal. 41:403), and birds (Lehner 1960. Wilson Bull. 100:293–294; Moeliker 2001. Deinsea—Annual of the Natural History Museum Rotterdam 8:243–247). In anurans it has been reported, although not as Davian behavior, in the Cane Toad (*Bufo marinus*) (Lewis 1989. Cane Toads: An Unnatural History. Doubleday. New York, New York. 98 pp.), and the Cuban Treefrog (*Osteopilus septentrionalis*) and Southern Toad (*Bufo terrestris*) (Meshaka 1996. Florida Sci. 59[2]:74–75). The first report of Davian behavior in the study area was described for *Bufo bufo* (Ayres 2008. Podarcis 9:11–12). Here I present new observations about this unusual behavior.

Field observations were made at clay pits in the Gandaras de Budiño e Ribeiras do Louro (GBRL) wetland, municipality of Porriño, NW Spain (42.1023°N, 8.6301167°W) on 6 Jan 2009. GBRL wetland consists of a complex of gallery forests, flooded areas, and artificial ponds created by the extraction of clay. Abandoned clay pits have been colonized by aquatic vegetation, and constitute an important breeding area for *B. bufo*, which are an important food resource for Eurasian Otters (*Lutra lutra*) during winter. I monitored clay pits by walking along the shore and banks, looking for anuran reproductive activities, or remains of toads predated by otters.

On 6 Jan 2008 I found three female *B. bufo* predated by otters in an area with shallow water (<20 cm deep), but in a deeper area (to 1 m deep) I found another predated female. When I recovered the corpse from the bottom of the pond, I noted a live male attached to the remains of the female (Fig. 1).



FIG. 1. Male *Bufo bufo* (top) in amplexus with a dead female conspecific that had been partially consumed by a Eurasian Otter.

This behavior is unusual, as it seems that it represents an ecological trap for male toads. The absence of sex recognition by *B. bufo* has been studied by Marco and Lizana (2002. Ethol. Ecol. Evol. 14:1–8) who reported the lack of a release call in the Iberian Green Frog (*Pelophylax perezi)* leads male *B. bufo* to amplex with this species, wasting time and energy, and missing opportunities to mate with gravid conspecific females. They also reported amplexus with the Fire Salamander (*Salamandra salamandra*), dead fishes, or pieces of wood.

Males detected in amplexus with dead females in winter 2008 were located in shallow areas and females lacked hind legs (Ayres and Garcia 2007. Galemys 19:45–50), so it seems that body shape does not affect male choice. But the pair in amplexus detected in 2009 were in deep water. This increased the risk of the male being predated by otters, and the depth did not allow the male to breath without leaving the dead female. Males in amplexus with dead females could pass several days attached to the body, which increases the risk of predation and results in a loss of mating opportunities.

It is unclear why male toads perceive corpses as suitable mates. It has been suggested that movement is a factor that leads males to grasp individuals or objects, even observer's toes (Ayres, pers. obs.; Meshaka 1996, *op. cit*.). Nevertheless, dead females remain motionless in the bottom of the ponds, which suggests that chemical factors may influence this unusual behavior. Further studies will be necessary to assess if this hypothesis is true.

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BUFO HOUSTONENSIS (Houston Toad). **PREDATION**. Few predators of the federally endangered *Bufo* (=*Anaxyrus*) *houstonensis* have been recorded: snakes (*Nerodia erythrogaster*, *Thamnophis proximus*) predate on tadpoles (Freed and Neitman 1988. Texas J. Sci. 40:454-456), snakes (*Heterodon* sp., *N. erythrogaster*) on adult toads (USFWS 1984. Houston Toad Recovery Plan. U.S. Fish and Wildlife Service, Albuquerque, New Mexico), and red imported fire ants (*Solenopsis invicta*) on newly metamorphosed toadlets (Freed and Neitman. 1988, *op. cit*.). Here, we report the first record of predation of an adult *B. houstonensis* by another anuran, the American Bullfrog, *Rana catesbeiana*.

On 28 Mar 2008 at 2312 h, an adult female *R. catesbeiana* (158.8 mm SVL) was observed on the shoreline of a pond on the Boy Scouts of America's Griffith League Ranch in Bastrop County, Texas, where *B. houstonensis* had been and were actively breeding. American Bullfrogs are reported to eat anything they can swallow, from insects to mammals (Bolek and Janovy 2007. Herpetol. Rev. 38:325-326; Dixon 2000. Amphibians and Reptiles of Texas. 2nd ed. Texas A&M Univ. Press, College Station, Texas. 421 pp.; Frost 1935. Copeia 1935:15–18), and hence, they are potential predators of all life stages of this endangered toad. The *R. catesbeiana* was collected and later dissected to determine if predation on *B. houstonensis* had occurred. An adult male *B. houstonensis* (50.3 mm SVL) was discovered in the stomach, along with an *Acris crepitans* and three *Hyla versicolor*. We have determined this was predation rather than scavenging due to the well-preserved nature of the *B. houstonensis*. While this toad was partially digested, its cranial crests and parotids remain apparent, and spotting may be seen on its venter. Additionally, we compared its D-loop mitochondrial sequence to other sequences we generated from sympatric *Bufo* species, which support its identification as *B. houstonensis*. This record represents the first published account of *B. houstonensis* as a diet component of another anuran.

Specimens were deposited at the Texas Cooperative Wildlife Collection, Texas A&M University, College Station, Texas, USA (TCWC 93562 includes *R. catesbeiana* and its stomach contents: *B. houstonensis*, *A. crepitans*, 3 *H. versicolor*). Identification were verified by T. Hibbitts. We thank D. J. Brown and L. M. Villalobos for field and lab assistance.

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BUFO PARITALIS (Forest Toad). **DIURNAL RETREAT**. *Bufo paritalis* is a large, rare, and little-known, endemic toad that lives in the tropical rainforests of the Western Ghats (Molur and Sally 1998. Zoo's Print 13[12]:29). Little information on the distribution and natural history of the species exists (Daniels 1992. Hamadryad 17:40-42; Krishna and Krishna 2004. Herpetol. Rev. 35:156-157; Krishna and Krishna 2001. J. Bombay Nat. Hist. Soc. 98:456-457). From 18 Feb to 17 March 1999, I studied the breeding behavior and reproduction of *B. paritalis* at the Bisle Reserve Forests of the Western Ghats (12°15'N; 75°37'E, 150 m elev.). During the day, *B. paritalis* retreats inside tree crevices or buttresses of live trees and dead wood ca. 0.3–0.6 m above ground. During the first hours of the night it emerges from this retreat to feed and mate. Between 1900–1930 h the toads emerge from the crevices adjacent to a stream and either enter the water or perch on rocks in the flowing stream. A few males arrive early and began calling, afterwards

many males emerge from the hideouts and join the calling group. This retreat habitat and calling behavior has not been reported for *B. paritalis*.

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COCHRANELLA ALBOMACULATA (White-spotted Cochran Frog). **PREDATION**. Predation on adult anuran amphibians by invertebrates, especially by spiders (e.g., Blackburn et al. 2002. Herpetol. Rev. 33:299; Formanowicz et al. 1981. Herpetologica 37:125–129; Jansen and Schulze 2008. Herpetol. Rev. 39:459; Pontes et al. 2009. Herpetol. Rev. 40:71), but also by crabs (Duellman and Trueb 1986. Biology of Amphibians. The Johns Hopkins University Press. Baltimore and London), or bugs (Toledo 2003. Phyllomedusa 2:105–108) have been reported several times. Herein we report, to our knowledge, the first account of a whip scorpion (Amblypygi) feeding on a glass frog.

At 2200 h on 31 March 2009, at Cerro Negro, Veraguas Province, Panama (08.569°N, 81.097°W; 770 m elev.), we detected a large whip scorpion holding an almost digested female *Cochranella albomaculata* between its chelicerae. The whip scorpion was sitting on a rock, amidst a small mountain stream. At the time of observation all that remained of the frog were one leg and a clutch of eggs that poured out of the frogs remains (Fig. 1).

Amblypygi are not frequently reported as predators of frogs (Armas 2001. Revista Ibérica de Aracnología 3:87–88), nevertheless they might play an important role as predators of glass frogs. White-spotted Cochran Frogs are known to call from rocks in the stream during drier periods, whereas they prefer riparian vegetation during wet periods (Kubicki 2007. Glass Frogs of Costa Rica. Editorial INBio. Santo Domingo de Heredia, Costa Rica). Therefore the dry season is when whip scorpions might encounter these frogs frequently, as both seek out humidity on rocks near streams.

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FIG. 1. Large whip spider (Amblypygi) holding the remains of a female *Cochranella albomaculata* between its chelicerae.

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DENDROBATES PUMILIO (Strawberry Poison-dart Frog). **COLORATION.** *Dendrobates pumilio* of Central America is noted for its exceptionally high level of color polymorphism (Savage 2002. The Amphibians and Reptiles of Costa Rica. Univ. Chicago Press, Chicago and London. 954 pp.). For decades this species has been the focus of numerous studies to elucidate the function, evolution, and maintenance of this color variation (Wang and Shaffer 2008. Evolution 62:2742–2759). An integral aspect of this research is to develop a detailed knowledge of the geographical range and description of all the color morphs.

The purpose of this note is to expose the existence of a previously unknown population of *D. pumilio* that differ from previously described populations. The existence of this population is based on numerous individuals that were consistently encountered during the years of 2005–2007, while the author was conducting unrelated research in the region. This new color morph is all blue, similar to the previously described morph found in the Cerro Brujo region, but has the large black spotting on the dorsum like those morphs found on Bastimentos (Fig. 1).

Individuals from this population were encountered on the mainland of the Bocas del Toro Province, Panama in the foothills between the Rio Changuinola and the Rio Risco within the vicinity of 9.218863°N, 82.460632°W. Although individuals of the nominate color morph were often encountered in adjacent areas along the Rio Changuinola, the two morphs were never seen within the area.


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FIG. 1. The newly discovered color morph of *Dendrobates pumilio* differs from the nominate color form in being uniformly dark blue with large black spots on the dorsum.

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DENDROPSOPHUS MICROCEPHALUS (Yellow Treefrog). **PREDATION.** Many frog species group together in a chorus to increase their mating success; however a significant risk they face in doing so is an increased detection by predators (Ryan et al. 1981. Behav. Ecol. Sociobiol. 8:273–278; Wells and Taigen 1989. Behav. Ecol. Sociobiol. 25:13–22) as olfactory, auditory, and vibratory signals are substantially increased in choruses. Anuran chorus behavior is prevalent due to the high probability of attracting a mate relative to calling alone (Ryan et al. 1981, *op. cit.*). Herein we report observations of predation on *D. microcephalus* by the Cat-eyed Snake *Leptodeira septentrionalis* in the vicinity of Las Cuevas Research Station (16.71667°N 88.9833°W), within the Chiquibul Forest Reserve, Belize. The advertisement call of this frog is generally described as a "creek-eek-eek" (Duellman 1970. The Hylid Frogs of Middle America Vol. 1. Monograph Mus. Nat. Hist., Univ. Kansas). On 6 Aug 2008 at ca. 2100 h, we heard a squeak-like repetitious call, differing substantially from the advertisement call: this call was higher pitched and although not analyzed, call rate seemed constant. Additionally, these calls were not triggered by conspecific call bouts as is generally observed in *D. microcephalus* (Schwartz and Wells 1985. Copeia 1985:27–38). Upon locating the source in the pond vegetation (a mixture of sedges and shrubs), we discovered that a male *D. microcephalus* had been attacked by a *L. septentrionalis* from the rear and was vocalizing what was most likely a distress call. The frog did not physically struggle as the snake consumed it, but did continue to vocalize until it was completely ingested. Ingestion took ca. seven minutes. Despite general knowledge of distress calls in anurans (Gerhardt 1994. Annu. Rev. Ecol. Syst. 24:293–324), this type of call remains undescribed in *D. microcephalus.* Moreover, little is known about predators of this species.

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DENDROPSOPHUS MINUTUS (NCN). **PREDATION**. Dragonfly larvae are commonly known to prey on small frogs and tadpoles (Caldwell et al. 1980. Oecologia 46:285–289), including species of Hylidae (McCollum and Leimberger 1997. Oecologia 109:615–621). On 28 Sept 2008 (ca. 2100 h), at Poço Azul, Brasília National Park, Federal District, Brazil (15º30'S, 47º50'W), we found a larval female odonate *Castoraeschna longfieldae* (50.5 mm length, catalogued at Museu Nacional do Rio de Janeiro [MNRJ]) preying on a tadpole of *Dendropsophus minutus* during a night of hard rainfall. This observation took place in a grassy pond where numerous anurans were heard calling. When captured, the odonate larva continued to grasp the tadpole. This is the first record of *C. longfieldae* preying on tadpoles. To accurately identify the dragonfly, we maintained the larva in the laboratory until metamorphosis (77.26 mm length). Other anurans in the area include *Rhinella schneideri*, *Phyllomedusa azurea*, *Hypsiboas lundii*, *Bokermannohyla pseudopseudis*, *Odontophrynus salvatori*, *Leptodactylus ocellatus*, and *L. furnarius*. Tadpoles of all these species may be potential prey to *C. longfieldae* and other larval odonates.

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ELEUTHERODACTYLUS JOHNSTONEI (NCN). **MICROHABITAT**. *Eleutherodactylus johnstonei* has exhibited exceptional colonizing abilities, and exploits a wide variety of macro- and microhabitats, including outbuildings and shower stalls (Henderson and Powell 2009. Natural History of West Indian Reptiles and Amphibians. University Press of Florida, Gainesville). At 1930 h on 11 June 2009 at Lazy Lagoon Guest House in St George's, St. George Parish, Grenada, an adult *E. johnstonei* was found utilizing the top inside rim of a porcelain indoor toilet (Titon, 6.1 liters/flush). Its presence became known when the toilet was flushed, and the force of water from inside the upper rim caused the frog to descend into the bowl of the toilet; from there it vacated the toilet and escaped to the outside under a door. As business had been slow at Lazy Lagoon and this occurred at the end of the dry season, the frog was likely exploiting a convenient moist microhabitat. I am unaware of any previous report of *E. johnstonei* using the interior of an indoor toilet as a retreat.

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HADDADUS BINOTATUS (Clay Robber Frog). **EGG CLUTCH**. *Haddadus binotatus* has direct development and a hatchling egg tooth (Hedges et al. 2008. Zootaxa 1737:1–182). During May 1987 in the Parque Nacional da Tijuca, an egg clutch of *H. binotatus* was found containing 14 eggs (Fig. 1). The eggs were collected, taken to the laboratory, and kept until hatching for identification. After hatching the material was fixed in 10% formalin and included in the amphibian collection of the Zoology Department of the Universidade Federal do Rio de Janeiro (ZUFRJ 3083). The egg clutch was found under a rotten tree trunk on the ground of the forest. The eggs were separated from each other in an area of 4.5 cm. A thin layer of substrate was stuck to the outer membrane of the egg. The eggs were large, ca. 10 mm, and two membranes were observed surrounding the embryo (Fig. 2). The embryos were a clear beige color when alive, they were all at the same stage of development,



FIG. 1. Egg clutch of *Haddadus binotatus* with 14 eggs found in the Parque Nacional da Tijuca.

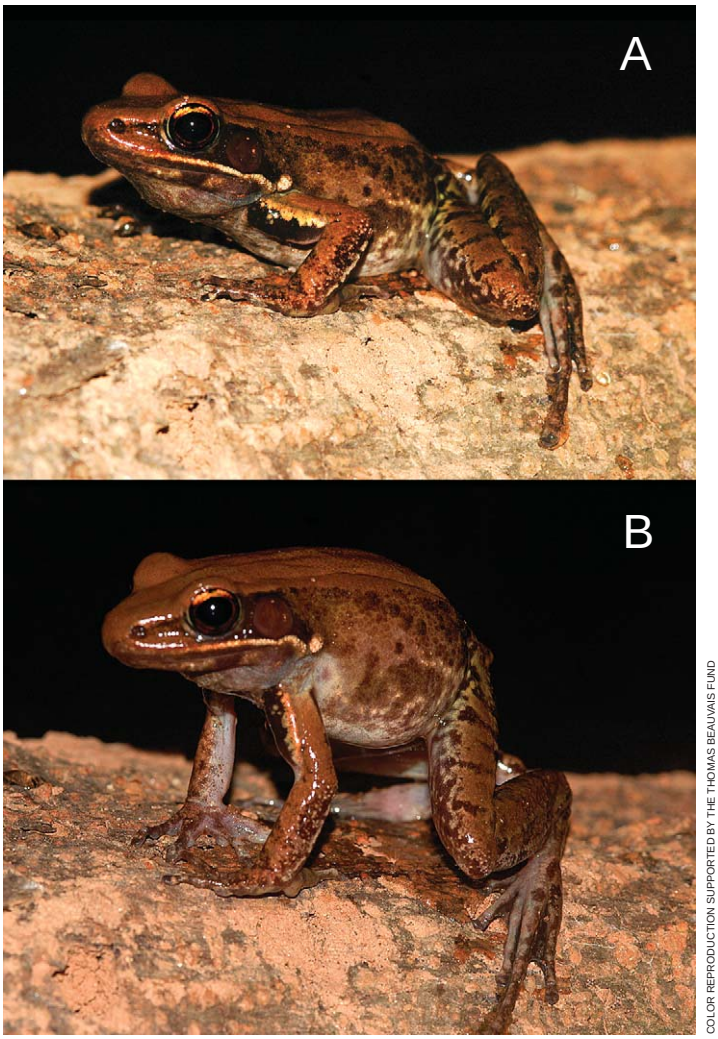


FIG. 2. Egg and embryo of *Haddadus binotatus* (about 10 mm).

and had a lot of yolk and a large, highly vascularized tail covering almost its entire body (Fig. 2). Near hatching, the characteristic egg tooth of the embryo could be observed. This tooth is keratinized and black in its distal portion as reported by Townsed and Stewart (1985 Copeia 1985:423–436) in *E. coqui* and *E. antillensis*, the egg tooth falling off shortly after hatching. The hatchling left the egg at ca. 9 mm SVL. The embryo tail of *Haddadus binotatus* covers almost its entire body, different from that of *Ischnocnema venancioi* (Izecksohn and Albuquerque 1972. Arq. Univ. Fed. Rur. Rio de Janeiro 2[1]:13–15), *I. guentheri* (Lynn and Lutz 1946. Bol. Mus. Nac. Zool. 71:1–46), *I. parva* (Lutz 1944. Bol. Mus. Nac. Zool. 15:1–30), and *E. coqui* (Townsed and Stewart 1985, *op. cit.*) which covers only part of the body. The tail is very vascularized, which suggests, as observed by Izecksohn and Albuquerque (1972, *op. cit.*), to be the main respiratory organ. Pombal (1999. Rev. Bras. Zool. 16[4]:967–979) observing the oviposition of *Brachycephalus ephipium*, showed that this species had parental care. The female rolled the eggs on the substrate to stick particles of substrate on its membrane to better camouflage them, to protect them from parasites, and to keep the embryos hydrated. It is possible that this behavior is the same in *H. binotatus* because the eggs were found covered by particles of substrate as observed by Pombal (1999, *op. cit.*). This is the first report of an egg clutch of *H. binotatus*.

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HYLARANA LEPTOGLOSSA (Long-tongued Frog). **DEFENSIVE BEHAVIOR.** *Hylarana leptoglossa* is an aquatic frog, inhabiting subtropical lowland forests and forming breeding aggregations on the edges of permanent, macrophyte-dominated



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FIG. 1A. *Hylarana leptoglossa* in typical resting position. 1B. *Hylarana leptoglossa* in defensive posture.

waterbodies during the early monsoons (between the months of March to May). An adult male (Museum of Arya Vidyapeeth College, AVC 0943; SVL 60.5 mm) collected from near Lailad village (25.9320278°N, 91.7756944°E; 225 m elev.), Nongkhyllem Wildlife Sanctuary, East Khasi Hills, Meghalaya State, northeast India on 25 March 2009 displayed the following behavior as a response to handling during a photography session: all four limbs were planted on the substratum, while the body was greatly elevated, till the forelimbs were nearly vertical to the ground with the knee raised, the body raised > 50% depth of body (Figs. 1A–B). It maintained the position for ca. 10 secs each time.

Defensive postures are familiar methods of defense in anuran amphibians (review in Dodd 1976. Smithson. Herpetol. Inf. Serv. [37]:1–10), and were previously unreported in this species. The described posture results in elevated body position, presumably confusing potential predators. Another behavioral defense mechanism noticed was puffing of the body and of the gular region, although no glandular secretions or odor were detected.

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LITHOBATES AREOLATUS CIRCULOSUS (Northern Crawfish Frog). **PREDATION.** The Eastern Hog-Nosed Snake, *Heterodon platyrhinos,* is generally considered to be specialized for eating toads (Bufonidae); it has been suggested that their enlarged posterior maxillary teeth assist in holding and deflating these prey (Edgren 1955. Herpetologica 11:105–17; Minton 2001. Amphibians and Reptiles of Indiana. Indiana Academy of Science. Indianapolis, Indiana. 404 pp.). However, *H. platyrhinos* is also known to consume other anuran species including several species of ranids (Edgren 1955, *op. cit.*; Platt 1960. Univ. Kansas Pub. Mus. Nat. Hist. 18:253–420). Here, we report predation by *H. platyrhinos* on *Lithobates areolatus circulosus*. To our knowledge, this is the first documentation of this snake species preying upon this frog species, which is in decline across portions of its northern range, including Indiana (Parris and Redmer 2005. *In* Lannoo [ed.] Amphibian Declines: Conservation Status of United States Species, pp. 526–528. Univ. Calif. Press, Berkeley, California).

On 14 May 2009 at 0750 h, an adult *H. platyrhinos* was observed at Hillenbrand State Fish and Wildlife Area in Greene County, Indiana (USA), regurgitating a recently consumed adult female *L. a. circulosus*. This frog was one of 19 implanted with transmitters (Model PD-2 Holohil Systems Ltd. [Carp, Ontario, Canada]) for a study of the movements and habitat use of this state endangered species. The snake (SVL 48.5 mm, TBL 62.1 mm, mass 130 g) was observed and captured near the frog's burrow. Upon being caught, the snake immediately performed a defensive display that included defecation and regurgitation; stomach contents included the frog implanted with the transmitter.

The *L. a. circulosus* (108 mm SVL) was first observed on 4 April 2009 in gravid condition (mass 134 g) while entering a semi-permanent breeding wetland. She left the wetland on 19 April 2009 after depositing her eggs (weight 90 g; Kinney, unpubl. data). After breeding, the frog traveled, over the course of 10 days, 730 m (straight line distance) NE to a burrow, which it inhabited for 14 days prior to being eaten. The regurgitated carcass was missing a portion of its head, suggesting the snake took the frog head on (and that there was resistance), a position consistent with occupancy of a burrow (JLH, pers. obs.), not an animal fleeing. The frog had been in the burrow the previous morning, and the carcass was fresh, suggesting that the frog had been eaten within the past 24 hours. Toads are uncommon at our study site. Only two *Anaxyrus fowleri* have been observed, another was heard calling (JLH; pers. obs.). None have been collected along 1100 m of drift fencing (184 buckets; four wetlands encircled; Kinney, unpubl. data). Low toad densities at our study site may result in *H. platyrhinos* predation on ranids.

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LITHOBATES AREOLATUS CIRCULOSUS (Northern Crawfish Frog). **BREEDING.** *Lithobates a. circulosus* is declining throughout parts of its range and listed as state endangered in Indiana (Parris and Redmer 2005. *In* Lannoo [ed.] Amphibian Declines: Conservation Status of United States Species, pp. 526–528. Univ. Calif. Press, Berkeley, California.). We have been studying the breeding biology of this species in an attempt to understand factors contributing to recent declines (Minton 2001. Amphibians and Reptiles of Indiana. Indiana Academy of Science. Indianapolis, Indiana. 404 pp.).

Here we report an instance of atypical, perhaps satellite-like, breeding in *L. a. circulosus*. On 1 May 2009 at 0803 h, one of us (VCK) found an amplexed pair (Fig. 1) in a drift fence pit fall trap located at our study site, Hillenbrand State Fish and Wildlife Area in Greene County, Indiana, USA. The female was gravid. Both animals were pit-tagged prior to their release—still in amplexus—in the wetland, and were individually weighed and measured after separating and upon exiting. The male was 86 mm SVL, 74 g; the female was 101 mm SVL, 96 g, and was spent. There were three unusual components to these field observations: 1) This pair arrived 25 days after the end of peak breeding at this wetland, which occurred from 2 April 2009 through 5 April 2009 (VCK, unpubl. data). This was 26 days later than the previous last female, 20 days later than the previous last male. 2) The pair was in amplexus when found. While males and females occasionally occurred in the same bucket over the course of the breeding season, at no other time were *L. a. circulosus* (97 breeding animals total observed at our drift fences encircling two wetlands) found in amplexus before entering breeding wetlands. 3) The animals left the pond separately, a week apart (the female on 6 May 2009, the male on 14 May 2009), and upon exiting were found at the same bucket on the opposite side of the wetland where they had entered.

Explosive breeding in temperate amphibians such as *L. a. circulosus* typically involves males arriving early (Smith et al.



FIG. 1. Amplectant pair of *Lithobates areolatus circulosus* entering a breeding wetland. The female is gravid. Photograph by Vanessa C. Kinney.

1948. Amer. Midl. Nat. 39:608–614), and calling for competitive reasons (to establish dominance among males or access to favorable breeding sites) and to attract females. Once in the wetland, females are generally thought to exercise choice in determining mates or breeding sites (Wells 2008. The Ecology and Behavior of Amphibians. Univ. Chicago Press, Chicago. 1148 pp.). Alternately, satellite males, which tend to be smaller and younger, may sneak matings by remaining silent and intercepting females, avoiding competitive interactions with males and not affording females choices (Krebs and Davies 1978. Behavioural Ecology: An Evolutionary Approach. Sinauer, Sunderland, Massachusetts. 494 pp.; Wells 2008, *op. cit.*).

It is likely that neither male competition nor female choice occurred with this amplexed pair of *L. a. circulosus*. They came from a direction (east) with no known breeding wetlands (indeed, the wetland where they were found may be the easternmost extant breeding wetland for this species at this latitude). The next closest wetland in any direction is > 1 km away. It is possible that they coupled in this distant wetland and traveled overland in amplexus to the wetland where they were found; this would account for their tardiness. But at least eight other females bred at this second wetland, and there were no features of this wetland such as drying or the presence of fish that appeared to us to make it unfavorable. It seems more likely that the male intercepted the female on the way to the wetland where they were found—perhaps at some distance away, which, again, would account for their tardiness. If so, there was likely no calling involved in attracting this female and little opportunity for female choice. At 86 mm SVL, this male was not small (Parris and Redmer 2005. *op. cit.*); nevertheless, this observation suggests some form of previously undescribed alternate mating tactic, perhaps a satellite-type male behavior, in this species.

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LITHOBATES NEOVOLCANICUS (Transverse Volcanic Leopard Frog). **DIET**. *Lithobates neovolcanicus* inhabits lakes and low streams in open areas surrounded by oak-pine forest and mesquite prairies throughout the Transverse Neovolcanic Belt (1500–2500 m elev.) across the states of Guanajuato, Jalisco, Michoacán, and México in central México. On 1 Dec 2008 at 1935 h we observed and photographed a *Lithobates neovolcanicus* (IBH-RF 027; 51 mm LHC), eating an *Anaxyrus punctatus* (Red-spotted Toad) in a small pond situated at Rio Las Lajitas (21.4932333°N, 99.961°W; 947 elev.), in the Tortugas locality at Xichú Municipality, Guanajuato, México. Other reports on the diet of *Lithobates zweifeli, L. catesbeianus, L. vaillanti,* and *L. brownorum* (Field and Beatty 2003. Herpetol. Rev. 34:228; Ramírez-Bautista and Lemos-Espinal 2004. Southwest. Nat. 49[3]:316–320; Mendoza-Estrada et al. 2008. Acta Zool. Mex. [n.s.] 24[1]:169–197) indicate that most species feed on invertebrates and terrestrial and aquatic vertebrates, including fish and tadpoles of *Lithobates* sp. *Lithobates vaillanti* was reported eating *Agalychnis callidryas* (Vaughan 2003. Herpetol. Rev. 34:238), but no reports on feeding habits of *L. neovolcanicus* occur in the literature.

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LITHOBATES ONCA (Relict Leopard Frog). **CANNIBALISTIC OOPHAGY**. Oophagy, the consumption of eggs, is not uncommon among anurans (Crump 1992. *In* Elgar and Crespi [eds.], Cannibalism: Ecology and Evolution Among Diverse Taxa, pp. 256–276. Oxford University Press, New York; Alford 2009. *In* McDiarmid and Altig [eds.], Tadpoles: the Biology of Anuran Larvae, pp. 240–278. Univ. Chicago Press, Chicago, Illinois; Gunzburger and Travis 2005. J. Herpetol. 39:547–571). It is one of many forms of cannibalism exhibited by amphibians, most commonly by the larval stages (Crump 1992, *op. cit*). The larvae of a number of hylids and dendrobatids that occur in various phytotelmons eat heterospecific and homospecific (trophic) eggs. The larvae of two species of *Lithobates* have been reported to be oophagous (*L. sylvatica* and *L. temporaria*), but cannibalistic oophagy has only been reported for *L. temporaria* (Alford 1999, *op. cit.* and Gunzberger and Travis 2005, *op. cit.*).

Homospecific oophagous activities by tadpoles of *Lithobates onca* were observed in two different canyons within Black Canyon, Clark Co., Nevada, USA. On the morning of 25 April 2008, I observed two large (7–9 cm total length, estimated Gosner [1960. Herpetologica 18:183–190] stages 34–36) tadpoles that initially appeared to be resting on a 1–2 day old egg clump of *L. onca* (terminology from Altig and McDiarmid 2007. Herpetol. Monogr. 21:1–32). The egg clump was within 20 cm of the shore, about 5 cm below the water surface, and attached to overhanging Bermuda Grass (*Cynodon* sp.). As I observed for about 7 min, it became evident that the tadpoles were eating the eggs. The tadpoles wriggled and tore at the eggs at the top and sides of the clump. There was a second, recently-laid clump within 30 cm of the feeding tadpoles that was also attached to overhanging grass. The permanent pool was in a natural warm-water spring system; the pool measured 6 × 4 m with a maximum depth of about 1 m. The substrate was

silt over bedrock. There was no emergent or submergent aquatic vegetation, but the bottom did have visible algal growth. Water temperature was 22° C. Five *L. onca* tadpoles of similar size to those seen on the eggs were in the pool. When I returned to the site on 27 April 2008, there was no evidence of either egg clump, and no hatchlings were seen in the pool. Hatchlings were not expected to have already hatched because it takes about 5-7 days for embryos of *L. onca* to hatch at this temperature (personal observation).

At about 1900 h on 28 April 2008, in a second canyon off Black Canyon, *L. onca* tadpoles were observed eating a later stage egg clump (Gosner Stages 15–18) of *L. onca*. In a permanent pool filled by flow from warm-water springs in the system, three *L. onca* tadpoles about 7–9 cm total length, at Gosner stages 34-36, were tearing at the eggs. The pool measured about 2 x 3 m with a maximum depth of 0.4 m. Pool substrate was cobble, silt and bedrock with visible algal growth. Water temperature was 21° C. There was a smaller, more recently oviposited egg clump of *L. onca* in the pool about 20 cm from the eggs being consumed. Both egg groups were attached to *Typha* sp. at 10 and 5 cm below the water surface. On 1 May 2008, the first egg clump was absent; the majority of the jelly of the second group remained, but the embryos were absent. The egg membranes were torn and appeared partially consumed. The observations of the state of the egg masses and absent embryos were consistent with those described by Petranka and Thomas (1995. Anim. Behav. 50:731-739). There were no hatchlings seen in the pool, but as seen at the previous site, these also were not expected to have hatched in such a short period. In both cases, no other predators were seen in the pool, nor were there tracks or prints seen around the shoreline of the pool.

Typically, cannibalism is expected to occur under conditions including high density and low food availability (Caldwell and Carminoza de Araujo. 1998. Biotropica 30:92-103). Potential benefits of oophagy include elimination of potential competitors, increasing resources available for survivors, and energy-rich nutrients from the eggs in the form of calcium and phosphorus, necessary components for proper skeletal development (Crump 1983. Am. Nat. 121:281-287). Neither high density nor low food availability appeared to be factors in the two pools in which I observed cannibalistic oophagy exhibited by *L. onca*. It has been suggested that explosive breeding in amphibians is a response to cannibalism by reducing differences in developmental stages and therefore reducing the opportunity for cannibalism to occur. *Lithobates onca* is not an explosive breeder, but rather has a prolonged breeding season extending for several months (Bradford et al. in Lannoo (ed) 2005. Amphibian Declines. Univ. California Press: Berkeley, pp. 567-568; personal observation). While Fox (2008. Herpetol. Rev. 39:151-154) reported only early stage *Spea intermontana* tadpoles fed on conspecific hatching tadpoles, the observations reported here were more in line with the reports from Crump (1983. *op. cit*.) that no tadpoles of *Hyla pseudopuma* under Gosner 35 were observed to be cannibalistic. There was no apparent fungal or algal growth on the eggs or developing embryos of *L. onca* that were being cannibalized, unlike those of *Spea* (Fox 2008. *op. cit.)*. Unlike most other oophagous tadpoles, the tadpoles of *L. onca* are not morphologically specialized for eating eggs. The mouth is relatively small with well developed keratinized jaw sheaths that have only small serrations; oophagous larvae typically have powerful jaws, enlarged jaw sheaths and broad oral labia. The tadpoles of *L. onca* also lack the modified, shortened intestinal tract found in other oophagous larval anurans, suggesting that the tadpoles of *L. onca* are only opportunistically oophagous.

Crump (1990. Copeia.1990:560–564) and Wildy et al. (1998. J. Herpetol. 32:286–289) reported that cannibalism resulted in enhanced growth of larval treefrogs and larval salamanders. We currently have no data to indicate that this is the case for tadpoles of *L. onca.* Several species of *Lithobates* have been reported to consume heterospecific eggs (Gunzberger and Travis 2005, *op. cit.*). *Lithobates onca* currently co-occur with *Bufo woodhousii*, *B. punctatus*, and *H. arenicolor* (unpubl. data). It would be interesting to observe whether the opportunistically cannibalistic oophagous tadpoles of *L. onca* are also opportunistically heterospecific oophagous.

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LITORIA CAERULEA (Green Treefrog). **SAUROPHAGY**. *Litoria caerulea* is a large hylid frog from northeastern Australia (Cogger 2000. Reptiles and Amphibians of Australia. 6th edition. Ralph Curtis Publishing, Sanibel, Florida. 808 pp.). *Litoria caerulea* are known to be opportunistic predators, even capable of eating small rats (Tyler 1994. Australian Frogs: A Natural History. Cornell Univ. Press, 51 pp.). Reports of reptiles being eaten in the field by *L. caerulea* are rare. During the evening of 16 Sept 2006 I observed a gecko (*Hemidactylus frenatus*) at ca. 2 m height in a palm tree on the campus of James Cook University in Townsville, Queensland, Australia. *Hemidactylus frenatus* is native to Southeast Asia and is introduced into Australia (Wilson 2005. A Field Guide to Reptiles of Queensland. New Holland Publishers, 45 pp.). While observing the gecko, I watched a *L. caerulea* jump from a higher location in the palm and attack the gecko. The gecko was grabbed near its hind legs and bit the frog before being eaten. Photographs were taken during the event and deposited in the digital image collection at the Amphibian and Reptile Diversity Research Center at the University of Texas at Arlington (UTADC 4007). This is the first record of saurophagy in *L. caerulea*.

I thank J. A. Campbell for cataloguing the digital image at UTA, L. Schwarzkopf for confirming the identification of the gecko, and R. C. Jadin for comments on this note.

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LITORIA CYCLORHYNCHA (Spotted Thighed Frog). **SALINE HABITAT**. With some rare exceptions (e.g., Balinsky 1981. J. Exp. Zool. 215:335–350) anurans are generally intolerant of salt water, particularly in the larval stage. For example, recent studies in Australia reported upper conductivity tolerance limits in the field for tadpoles between 10^3 and 10^4 μS cm^{-1} (2–10% sea water)

for six common frog species found in waters affected by secondary salinisation in western Victoria, Australia (Smith et al. 2007. Freshwater Biol. 52:75–84). During a recent survey of the water quality and biodiversity values of the rivers of the South Coast Region undertaken by the Centre of Excellence in Natural Resource Management, University of Western Australia, tadpoles were collected in waters with comparatively high salt loads at sites on the Twertup Creek system, Fitzgerald River: 20.7 mS cm^{-1} (salinity of 12.4 ppt, 35% seawater: site C2, Mum's Creek, 33.780617°S, 119.2975767°E, 15 Jan, 21 tadpoles) and 22.2 mS cm^{-1} (salinity of 13.37 ppt, 38% seawater: site JC8, on Jacup Creek, 33.749267°S, 119.209667°E, 12 Jan, 1 tadpole). Tadpoles were identified as *Litoria cyclorhyncha* using Main (1965. Frogs of Southwestern Australia. Western Australian Naturalists' Club, Perth, Australia. 73 pp.) and Anstis (2002. Tadpoles of South-eastern Australia. Reed New Holland, Sydney, Australia. 281 pp.). At C2 tadpoles were at Gosner Stages 24 (1), 25(14), 26 (4), 28 (1) and 37 (1). At JC8 the single tadpole collected was at Gosner Stage 37 and had a total length of 64 mm. The late stage of development for some tadpoles at both sites suggests an extended period exposed to high salinities. The cluster of tadpoles at early post-hatching stages at C2 might indicate a recent breeding event—presumably also in relatively saline water. There is variation in salinity at these sites. In late spring sampling at the same sites (11 and 12 Nov 2008) salinities were much higher at 51.32 mS cm^{-1} (C2) and 48.79 mS cm^{-1} (JC8) (33.79 and 31.7 ppt, 86 and 91% seawater). Local rainfall and runoff reduce salinities and there was rainfall in the period November to January: November, 89.8 mm, 19 rain days, maximum daily fall 17.4 mm; December, 65 mm, 12 rain days, maximum daily fall 23.4 mm; January, 16.4 mm, 4 rain days, maximum daily fall 10.0 mm (rainfall data for Jacup, ca. 5 km WNW of sampling sites, from http://www.bom.gov.au/climate/dwo/IDCJDW6058.latest.shtml, accessed 16 April 2009).

On 8 Sept 2008 an adult frog jumped into a pool on Twertup Creek (site TWE03, 33.9156°S, 119.19808°E). The frog was captured in the pool and identified as *L. cyclorhynca*. Water in the pool had a salinity of 56.9 mS cm^{-1} (salinity of 37.4 ppt, 107% seawater). The frog jumped back into the pool again when released on granite rocks on the bank. The sound made when the frog jumped into the pool was frequently heard along this hypersaline creek system suggesting *L. cyclorhyncha* may commonly and voluntarily enter highly saline waters.

Salt levels in these tributaries of the Fitzgerald River system are partly elevated due to secondary salinity generated by clearing of native vegetation but the streams also have naturally high salinities as this region has a long, geological history of primary, natural salinity in a variety of water bodies (e.g., at least 3 million years; George et al. 2008. Aust. J. Soil. Res. 46:751–767). Our data suggest these sites might be highly saline when this species breeds in spring and summer (Tyler et al 2001. Frogs of Western Australia. WA Museum, Perth, Western Australia). Anurans can have well-developed capacities to distinguish salinities (Haramura 2008. Copeia 2008:64–67) so the use of saline waters is unlikely to be a mistake and, both adults and tadpoles of *L. cyclorhyncha* can clearly tolerate elevated salinity levels. Tadpoles of a closely related species, *L. aurea* from eastern Australia (Burns and Crayn 2006. Mol. Phylog. Evol. 39:573–579), have been reported in water between 5 and 15% seawater (Christy and Dickman 2002. Amphibia-Reptilia 23:1–11) but not in salinities as high as reported here.

If this truly is a high salinity tolerance in *L. cyclorhyncha* this might reflect natural tolerance evolved during extended exposure to naturally saline waters (George et al. 2008, *op. cit.***)** which may have been accentuated during earlier periods of lower rainfall in south-western Australian (e.g., in the Plio-Pleistocene; Byrne 2008. Quaternary Sci. Rev. 27:2576–2585). Secondary salinization has generally been seen as having a negative impact on amphibians in the field (e.g., Smith et al 2007, *op. cit.*) but our observations suggest that one Australian frog species may have a much higher salinity tolerance than anticipated. More extensive field work is required to clarify how generally *L. cyclorhyncha* uses saline waters and what life history stages can persist in saline water.

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MELANOPHRYNISCUS MOREIRAE (Maldonado Red-bellied Toad)**. DEFENSIVE BEHAVIOR.** When threatened, many amphibians show a defensive behavior called unken reflex (Duellman and Trueb 1994. Biology of Amphibians. McGraw Hill, New York. 670 pp.). In this behavior, the individual arches its back, lifting the head and the posterior part of the body while remaining motionless. The forelegs are brought forward and upward and the hind legs are flexed upward, showing the aposematic coloration of the throat and limbs as described and figured by Noble (1951. Biology of the Amphibia. McGraw Hill, New York; p. 381, fig. 131). However, nontoxic and drab colored species may also exhibit this posture (Noble 1951, *op. cit.;* Firschein 1951. Copeia 1951[1]:74).

The bufonid genus *Melanophryniscus* contains 25 species, all distributed in southeastern South America (Frost 2009. Amphibian Species of the World. An Online Reference. Version 5.3 <http://research.amnh.org/herpetology/amphibia/index.php>. 15 Nov 2009; Céspedez 2008. Facena 24:35-48). *Melanophryniscus* species are arranged in three phenetic groups: *M. stelzneri* group, *M. tumifrons* group, and *M. moreirae* group (Cruz and Caramaschi 2003. Bol. Mus. Nac. [N.S.] Zool. 500:1–11). All species have aposematic coloration (e.g., Cruz and Caramaschi 2003, *op. cit.*; Kwet et al. 2005. Salamandra 41[1/2]:3–20). Fernández (1927. Bol. Acad. Nac. Cienc. Córdoba, 29:271–320) was the first to report unken reflex for *Melanophryniscus* (*M. stelzneri*) and this behavior has been observed in nine other species—six in *M. stelzneri* group and three in *M. tumifrons* group: *M. dorsalis, M. montevidensis, M. cupreuscapularis* and *M. pachyrhynus* (Kwet et al. 2005, *op. cit.*), *M. krauczuki*, and *M. atroluteus* (Baldo and Basso 2004. J. Herpetol. 38:140–150), *M. rubriventris* (Laurent 1973. Acta Zool. Lilloana 26[23]:319–334), *M. devincenzii* (Manzano et al. 2004. Inst. Sup. Correl. Geol. Miscellánea 12:271–290), and *M. orejasmirandai* (Kolenc et al. 2003. Aquamar, Madrid 5[30]:16–21).

During a long-term study carried out at the plateau of Parque Nacional do Itatiaia (between 22.3095278°S, 44.6739444°W and 22.38975°S, 44.6723611°W), 1950–2400 m elev., states of Minas

Gerais and Rio de Janeiro, Brazil, nine adults of *Melanophryniscus moreirae* (seven males and two females) were observed exhibiting unken reflex in potentially threatening situations such as fall (N = 2), handling (N = 6), and accidental trampling (N = 1), exposing the bright red coloration of limbs and throat. All nine individuals also exhibited the posture when their backs were pressed with a finger against our hands, vegetation, or other substrate, as shown in Fig. 1. The observations were made between September–December (Spring–Summer) during 2005–2008 and in October 2009. The individual observed in 2009 was a male and displayed the behavior during amplexus (Fig. 2), persisting even when the female moved. After a few minutes the male released his hold but still displayed the unken reflex behavior. This is the first report of unken reflex in *M. moreirae* group and, as far as we know, the first record for unken reflex behavior in a paired amphibian.





COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND

FIG. 1 (top). Adult male *Melanophryniscus moreirae* (SVL = 26.6 mm) exhibiting unken reflex after being pressed by a finger against the substrate (photo: P. Almeida-Santos).

FIG. 2 (bottom). Adult male *Melanophryniscus moreirae* exhibiting unken reflex behavior during axillary amplexus. Photo: P. Almeida-Santos.

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ODONTOPHRYNUS cf. AMERICANUS (NCN). **PREDATION** Despite the great variety of taxa known to prey on amphibians, records from Argentina are scarce. Current information on predation of *Odontophrynus* spp. is lacking. Here we provide with the first report of *Liophis vanzolinii* (Colubridae) predating *Odontophrynus cf. americanus*. On 12 Oct 2008 at 1520 h at Estancia Las Verbenas, Valle de Pancanta (WGS84, 32.8666667°S, 66.1°W; 1650 m elev.), Central Ranges of San Luis Province, Argentina, we observed an adult *L. vanzolinii* (460 mm TL) predating an *O. cf. americanus* (43 mm SVL). This interaction was observed in a pasture near a rocky stream bordered by *Cortaderia selloana* grass. These specimens were collected and immediately after capture, the snake released the frog, which died within a few minutes.

These specimens are deposited in the Herpetological Collection of Universidad Nacional de San Juan (UNSJ-1000 *Odontophrynus cf. americanus*; UNSJ-1002 *Liophis vanzolinii*). Both species are common in this area and it is possible that this interaction occurs on a regular basis. This observation suggests that *L. vanzolinii* is a natural predator of *O. cf. americanus* and that the "blue" skin toxins (unreported blue coloration of toxin secretion; Laspiur and Buff, pers. obs.) of *O. cf. americanus* might not be an effective defense against *L. vanzolinii*. We thank Sol Acosta for help with field work and review of this note.

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PHYLLODYTES LUTEOLUS (Yellow Heart-tongued Frog) **PREDATION**. Spiders and invertebrates are well known predators of frogs (Formanowicz et al. 1981. Herpetologica 37:125–129; Prado and Borgo 2003. Herpetol. Rev. 34:238–239; Toledo 2005. Herpetol. Rev. 36:395–400; Menin et al. 2005. Phyllomedusa 4[1]:39–47). On 13 April 2006 at 2015 h we observed predation of *Phyllodytes luteolus* by the spider *Phoneutria* cf *bahiensis* (Fig. 1). This observation occurred on a terrestrial bromeliad in the coastal ecosystem at Belmonte Municipality, Bahia, Brazil. This is the first



FIG. 1. *Phyllodytes luteolus* being predated for spider. Photo by Thais Silva.

report of spider predation on *Phyllodytes* sp. in Brazil (Menin et al. 2005, *op. cit*. and Toledo 2005, *op. cit*).

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PHYSALAEMUS BILIGONIGERUS (NCN). **PREDATION.** As amphibians undergo ontogeny, their relative vulnerability to predators can shift with their life stage (Wells 2007. Ecology and Behavior of Amphibians. Univ. Chicago Press, Chicago, Illinois. 1148 pp.). Herein I document two predation events of *Physalaemus biligonigerus* at two different life stages; the first by a giant water bug (Belostomatidae) on an adult frog, and the second by a domestic pig (*Sus scofra domestica*) on a nest.

Giant water bugs are known to be major invertebrate predators of post-metamorphic anurans (Toledo 2005. Herpetol. Rev. 36:395–400). On 21 March 2009 at 2045 h, I observed a large belostomatid (body length ca. 75 mm) consuming a *P. biligonigerus* in a temporary pond in the Isoceño community of Yapiroa, Provincia Cordilleria, Departmento Santa Cruz, Bolivia (WGS 84, 19.6000°S, 62.5667°W). The giant water bug and the *P. biligonigerus* were ca. 200 mm from the shore of the pond. When I approached the pair, the belostomatid released the frog and swam into deeper water and I was unable to identify it to species. I retrieved the dead frog from the surface of the water (adult male; SVL 39 mm) and observed a puncture wound on its venter. Male *P. biligonigerus* call from the shallows close to the edge of a pond or from the middle of temporary pools (up to 20 cm deep; Schalk, unpubl. data). As with other *Physalaemus* species, male *P. biligonigerus* call from the surface of the water and generate waves that may attract aquatic predators (Toledo 2003. Phyllomedusa 2:105–108; pers. obs.).

Physalaemus biligonigerus construct foam nests to protect eggs from desiccation and predators (Prado et al. 2005. Amphibia-Reptilia. 26:211–221). These nests float on the water's surface and are generally deposited near emergent vegetation close to the pond's shore (pers. obs.). On 24 March 2009 at 1430 h, I observed an adult domestic pig eat a foam nest of a *P. biligonigerus* in the same temporary pond described above. The pig took the entire nest in its mouth and proceeded to chew it with smaller pieces of foam falling out of its mouth. After swallowing the large piece, it proceeded to eat the smaller pieces of foam floating in the water. There were no other *P. biligonigerus* nests in the pond. After consuming the nest, the pig walked into the surrounding forest. It is uncertain whether foam nests are regularly consumed by pigs in this region. My observations of 55 nests from February to March 2009 indicate that many, if not most, foam nests are not consumed or disrupted by pigs.

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PSEUDACRIS REGILLA (Northern Pacific Treefrog). **CAVITY USE.** Frogs of the family Hylidae use a variety of natural refuges, such as interstices among rocks (*Hyla macrocephala*, McIntyre 2003. Herpetol. Rev. 34:51) and cavities in standing trees (*H. japonica*, Kojima and Osawa 2003. Bull. Herpetol. Soc. Japan 2003:1–2; *H. cinerea* and *H. versicolor/chrysocelis*; McComb and Noble 1981. Wildl. Soc. Bull. 9:261–267). In the Pacific Northwest, *Pseudacris regilla* have been found in arboreal nests of tree voles (*Arborimus* spp.; Forsman and Swingle 2007. Herpetol. Cons. Biol. 2:113–118). Besides anecdotal reports of use of cover objects (Jameson 1957. Copeia 1957:221–228; Weitzel and Panik 1993. Great Basin Nat. 53:379–384) and "log crevices" (Nussbaum et al. 1983. Amphibians and Reptiles of the Pacific Northwest. Univ. Idaho Press, Moscow. 332 pp.), we found little information on use of natural cavities by *P. regilla*. Here, we report extensive use by *P. regilla* of pre-existing cavities in logs around a breeding pond in northeastern Oregon, USA.

We made our observations at a shallow pond 20.5 km SSW of Baker City, Oregon (44.6165°N, 117.9583°W; elev. 1597 m). This pond hosts large breeding populations of *P. regilla* and *Ambystoma macrodactylum*. The pond is within an opening in a forest comprised mainly of Ponderosa Pine (*Pinus ponderosa*). The understory is sparse grasses with an abundance of downed branches and logs. The pond fills with water in spring to reach ca. 1 m deep and 40 m × 40 m in surface area. By late summer, the

pond was reduced to ca. 0.2 m deep (8 m × 10 m surface area) when we made our observations. Vegetation on the exposed, shallowly sloping benches ringing the summer pool was grasses and sedges matted by livestock use. The receded water left 28 large logs (> 2m long) stranded around the exposed benches and concentrated in the NW quadrant of the pond. Most logs had little to no bark, and met the definition of decay Structure Class 2 (on ground, missing some limbs and bark, minor decay; Bull et al. 1997. Trees and logs important to wildlife in the interior Columbia River basin. USDA Forest Service Report PNW-GTR-391, 55 pp.).

During a morning (0930–1100 h) survey on 12 August 2005, we observed at least 80 small *P. regilla* wedged into cracks and hollows in one of the larger logs (hereafter 'Log A'; ca. 5 m long × 0.5 m diam.). Our visual assessment was that all of these *P. regilla* were between 17 and 21mm SVL, which is consistent with them having transformed in July and August of that same summer. Log A was in the NW quadrant and had its long axis running NE/SW so it received direct morning insolation along its length by the end of our survey. Log A was the closest (ca. 0.75 m) of the logs to the water. We observed at least 15 cases where 2–4 frogs were packed together in the same cavity (Fig. 1). We noted 4 occasions at Log A where a partially exposed frog emerged from a deep cavity followed by a second frog that emerged from an obscured position further inside the log. Over the course of our survey, frogs moved progressively out of cavities and dispersed over the southeast-facing surface of the log. By the time we departed, frogs had emerged from almost all the cavities occupied previously, and we observed several frogs on the ground around the log where we had not observed frogs previously.

We saw one *P. regilla* emerge from a cavity in a second log ('Log B', 0.6 m long, 0.4 m diam.) located 24 m NE of the small pool. Attached bark confirmed this log as *P. ponderosa*. We counted 10 holes in this log, all of which had sharp edges and were roughly oval in shape (mean diam.= 14 ± 1.6 SE mm). We were able to insert a finger into a few of the holes and determine that they enlarge a little below the surface.

Close inspection revealed *P. regilla* emerging from cavities in 3 of 10 other logs along the ponds northern benches near Log A and Log B. Of the logs we inspected, Log A appeared to have the most cavities. The hollows, grooves, and holes that were occupied in Log A appeared to be cracks and insect cavities whose size and shape had been altered by natural decay and possibly fire. Cavities in Log A measured 8–15 mm in diameter and of the 6 we probed with twigs, most extended at least 110 mm into the log. Cavities occupied by frogs in other logs typically had entries that were oval and measured 10–15 mm in diameter.



FIG. 1. Recently metamorphosed *Pseudacris regilla* clustered into, and emerging from, cavities in a decaying log.

The use of pre-existing burrows for moisture regulation, predator avoidance, aestivation, and thermoregulation has been documented for many amphibians (Duellman and Treub 1986. Biology of Amphibians. J. Hopkins University Press, Baltimore, Maryland. 670 pp.).

Our observations suggest that cavities in downed wood can be used extensively by recently-transformed *P. regilla* near their breeding sites. Retreats such as those we describe could be valuable for a number of reasons, including serving as refuges near water sources for rehydration during the dry season, thermally buffered retreats during cold nights, or protection from some predators.

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PSEUDACRIS REGILLA (Northern Pacific Treefrog)**. PREDATION.** Mallards (*Anas platyrhynchos*) are omnivorous ducks which have been observed eating a number of frog species, including *Rana aurora, R. boylii, R. sylvatica,* and *R. temporaria* (Hayes and Rombough 2004. Herpetol. Rev. 35:375–376; Rombough et al. 2005. Herpetol. Rev. 36:438–439). However, *Pseudacris regilla* has not been reported as prey.

On 17 Jan 2009, while hunting ducks on the Willamette River near St. Paul, Marion County, Oregon, we shot a hen mallard as it flew into our decoys on a flooded gravel bar. Immediately after death, an adult *P. regilla* (44.5 mm SVL, 5.5 g, gravid female) emerged from the duck's mouth and hopped across the floor of our boat. The frog was collected, examined, and found to have no visible injuries. It was placed in a container for observation and was still alive the next day. The crop and digestive tract of the duck was removed and examined; it contained sand and a small amount of plant matter.

Pseudacris regilla in the northern Willamette Valley typically gather for spawning during late January and early February, and mallards in this area have been observed feeding on *P. regilla* life stages (eggs, adult frogs) at spawning sites (C. Rombough, unpubl. data). The mallard hen described here was collected at 0930 h, when air temperature was –2.2° C, and the surfaces of still and slowly flowing waters in the area were frozen. *Pseudacris regilla* in this area had begun breeding a week before this observation (10 Jan 2009). We speculate that the frog had been in a torpid state, possibly under ice at the edge of a breeding pool, when the duck consumed it, and that the post-mortem spasms of the duck assisted in its escape from the bird's crop.

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RANA CASCADAE (Cascades Frog). **NECROGAMY.** Necrogamy has been previously documented in *Rana boylii* (Bettaso et al. 2008. Herpetol. Rev. 39:462). Herein we report a similar mating observation in *R. cascadae* while conducting egg mass surveys at Deep Creek Basin, Trinity Alps Wilderness, Trinity County, California, USA. On 18 May 2009 at 1326 h, an adult male *R. cascadae* (60.6 mm SVL) was observed in amplexus with a deceased gravid female *R. cascadae* (77.3 mm SVL) ca 20 cm underwater in a shallow stream alcove (Fig. 1). The deceased female *R. cascadae* was partially decomposed and a film of fungal hyphae covered both sides of the body. The male *R. cascadae* appeared to be in good condition upon inspection after removal from the deceased female. This behavior could allow negative population effects for *R. cascadae* by reducing overall male courtship availability during their brief and explosive breeding seasons. Additionally, this behavior could have negative implications with direct transmission of diseases.



FIG. 1. Male *Rana cascadae* in amplexus with deceased conspecific in Deep Creek basin, Trinity Alps Wilderness, California.

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RANA CATESBEIANA (American Bullfrog)**. PREDATION.** The Osprey, *Pandion haliaetus*, is a large (to 1.8 m wingspan) raptor whose breeding range includes western North America (Udvardy 1997. National Audubon Society Field Guide to North American Birds. Chanticleer Press, New York. 822 pp.). The osprey's diet consists almost exclusively of fish, although other vertebrates, including amphibians, are occasionally taken as prey (Birds of North America, Cornell Lab of Ornithology: http://bna.birds.cornell.edu/BNA/). However, taxon-specific accounts of amphibians as items of osprey diet are lacking. I here provide an account of osprey predation on *Rana catesbeiana*.

At 1300 h on 15 May 2007, I was watching male *R. catesbeiana* call and defend territories along the banks of a small (0.4 ha) farm pond in western Oregon, USA (WGS84, 50.08761°N, 51.6528°E). Frogs were calling while floating at the water's surface; their bright yellow throats were highly visible. Periodically, one would rush an intruding male from several meters away, grabbing at it and driving it out of its territory. At 1310 h, an adult osprey circled the pond; it passed over the frogs at between 10 and 15 m height. At this, the frogs immediately became silent and disappeared under cover. No amount of calling by me (normally a successful technique at this pond) could coax them to emerge or continue. The osprey, meanwhile, had landed ca. 15 m up in a fir tree overlooking the pond; it remained there, almost motionless. At 1317 h, after seven minutes of silence, the osprey leapt from its perch, flapped up into the air, and made a swift glide toward the far end of the pond. Stooping low over the water, it snatched a (ca. 150 mm SVL) *R. catesbeiana* from the surface with its talons, circled the pond once (with the frog), then flew away.

Besides the identity of the prey, an interesting aspect of this observation is the fact that the osprey made a long swoop at the prey. Typically, when capturing fish (Rainbow Trout, *Oncorhynchus mykiss*; Black Crappie, *Pomoxis nigromaculatus*; and Bluegill, *Lepomis macrochirus*) in this and adjacent ponds, ospreys hover over the target and make a swift, often vertical dive. Additional observations of osprey capturing frogs may reveal whether different capture methods are used for fish versus amphibian prey.

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RANA DRAYTONII (California Red-legged Frog). **DISPERSAL.** Very little information is available regarding dispersal of post-metamorphic juvenile *R. draytonii* from perennial ponds, although mass emigration in response to receding water has been documented for other pond-breeding anurans (Paton et al. 2000. Northwest. Nat. 7[3]:255–269, Pilliod et al. 2002. Can. J. Zool. 80[11]:1849–1862). During the 2003–04 and 2004–05 rain seasons, we captured *R. draytonii* incidentally in pitfall traps while conducting studies for *Ambystoma californiense* at five perennial ponds on the ca. 8094 ha Santa Lucia Preserve near Carmel, Monterey County, California, USA. The study area consisted primarily of a mosaic of grassland, coastal scrub, oak woodland, and redwood forest habitats in four watersheds (Potrero, Robinson Canyon, Las Garzas, San Clemente) that drain into the Carmel River and Pacific Ocean. The property was historically used to graze cattle, and the manmade stock ponds, which ranged in size from 0.08–0.53 ha, were situated in relatively open areas in or near grassland or oak savanna. The purpose of this note is to document mass dispersal of *R. draytonii* metamorphs from perennial ponds, which has conservation and land management implications given that the species is listed as Threatened by the federal government.

We initiated drift fence studies on 15 Oct in 2003 and 2004, prior to the first significant rain each season, and completed them by 1 April. Every pond was partially enclosed with 20 m lengths of 0.914 m high silt fence (Enge 1997. Herpetol. Rev. 28:30–31) buried at least 15 cm and situated 2–10 m from the high water line. Two to 10 m gaps were left between lengths of drift fence to allow free movement of amphibians on nights when the pitfall traps were shut. Each of the five study ponds were ≥ 65% enclosed by drift fence spaced equidistant around the entire perimeter. Paired pitfall

traps (7.6 L) were installed 10 m apart at the ends and middle of each length of fence and covered with an elevated plywood shade. On evenings when rain was forecast (>50% likelihood), traps were opened and checked on the following morning; after each rain event traps were left open for one additional night. We recorded length measurements snout–urostyle length (SUL) from a subset of captured *R. draytonii* and released them in the nearest dense, moist vegetation on the opposite side of the drift fence (outward-bound) or at the edge of the pond (inward-bound).

Pitfall traps were open 57 nights in 2003-04 and 49 nights in the 2004–05 winter seasons. We recorded 308 captures of *R. draytonii* in both years combined, of which 220 were metamorphs (73%). Metamorphs were captured at all ponds although the number varied considerably by location (Table 1). Average size (SUL) of dispersing metamorphs was 30.7 mm (range 22–42 mm; N = 213). The actual number of metamorphs, sub-adults (ca. 45–75 mm) and adults (>75 mm) recaptured was unknown because individuals were not marked. Since there were gaps in the drift fence arrays, any metamorphs captured in outside traps at the end of a drift fence section were still considered to be dispersers; those captured in interior outside traps (N = 15) were excluded from analysis. Therefore, 93% of captured metamorphs were assumed to be dispersers. Given that no inward-bound individuals captured from Dec through March measured < 57 mm SUL (N = 32), there was no indication that any metamorphs returned to the ponds.

In 2003–2004, 95% of all metamorphs were captured by 25 Dec (Fig. 1). Only three metamorphs were captured after 1 Jan, in spite of heavy rains from Jan through March. In 2004–05, 95% of metamorphs were captured by 12 Nov. Similar to the previous year, despite frequent rain from Jan through March, no metamorphs were captured after 30 Dec. In both years, the highest capture frequency occurred during the first significant precipitation of the rain season, even though the magnitude of these events differed markedly (8 mm on 1 Nov 2003 vs. 24 mm on 17 Oct 2004). Precipitation during 2003-04 was 88% of normal while precipitation in 2004-05 was 143% of normal for Carmel Valley, California. These results suggest that the first rains of late summer/early fall, regardless of magnitude, incite dispersal and that most *R. draytonii* metamorphs have left by the end of the calendar year.

The number of captured metamorphs varied considerably between seemingly productive *R. draytonii* breeding ponds. Comparisons of relative abundance to estimate potential recruitment should be viewed with caution, since this study did not target *R. draytonii*. Furthermore, over-wintering *R. draytonii* tadpoles (Fellers et al. 2001. Herpetol. Rev. 32:156–157) were observed at two of the five ponds, and individuals may therefore transform and disperse

TABLE 1. Number of *Rana draytonii* captured in 2003–04 and 2004–05 on the Santa Lucia Preserve, Carmel, California, USA.

Pond #	Season	Metamorphs	Subadults	Adults	Total
2	2003-04	31	0	4	35
3	2004-05	16	2	38	56
13	2003-04	27	1	5	33
17	2004-05	42	12	11	65
27	2004-05	110	0	9	119

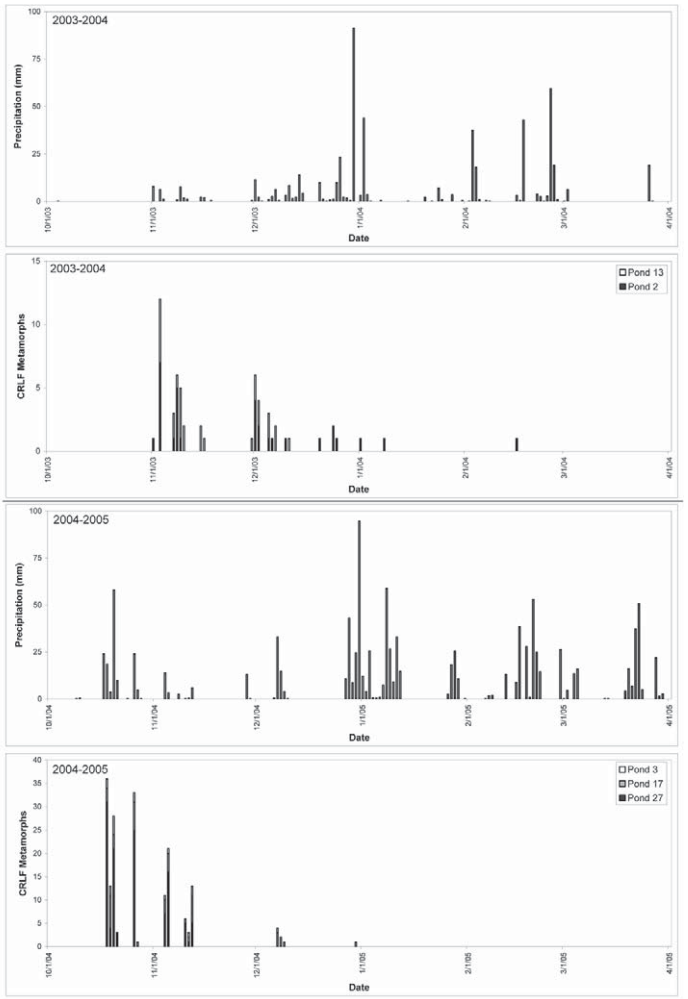


FIG. 1. Precipitation and number of *R. draytonii* metamorphs captured in 2003–04 and 2004–05, Santa Lucia Preserve, Carmel Valley, California, USA.

at nearly anytime of the year when environmental conditions are appropriate. Nevertheless, our data indicates that the first several precipitation events of the fall season incite mass dispersal of *R. draytonii* metamorphs, even at perennial ponds that may appear to provide the appropriate habitat requirements for all age classes. In addition to avoiding predators (including conspecifics), metamorphs presumably disperse to seek appropriate non-breeding habitat until they reach reproductive age and either return or colonize new locations. Our data supports the contention that core-habitat conservation models, which are often symmetrical, may be insufficient for *R. draytonii* and other pool-breeding amphibians that require appropriate movement corridors to ensure connectivity between breeding and non-breeding habitat across a varied landscape (Baldwin et al. 2006. J. Herpetol. 40:442–453; Fellers and Kleeman 2007. J. Herpetol. 41:276–286).

This work was conducted under the authority of U. S. Fish and Wildlife Service Endangered Species Recovery Permits and California Department of Fish and Game scientific collecting permits. The Western Regional Climate Center (Reno, Nevada) provided precipitation data from the Carmel Valley station (#041534). We are grateful to the Santa Lucia Preserve for access to the ponds and assistance with installation of the drift fences, and to the Rancho San Carlos Partnership for partial funding of this study.

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RANA DRAYTONII (California Red-legged Frog). **PREY.** Although ranid frogs generally have indiscriminant diets, data regarding vertebrate food items taken by *Rana draytonii* are sparse. Vertebrates documented as prey include *Gasterosteus aculeatus* (Three-spined Stickleback), *Pseudacris regilla* (Pacific Chorus Frog), *Peromyscus californicus* (California Mouse) (Hayes and Tennant 1985. Southwest. Nat. 30:601–605), *Microtus californicus* (California Vole), and *Reithrodontomys megalotis* (Western Harvest Mouse) (Hayes et al. 2006. Herpetol. Rev. 37:449). Although expected, snakes have not been reported as dietary items.

On 13 Aug 2008, at 0030 h, while conducting surveys for *R. draytonii* at a pond in the Sierra Nevada foothills in northern California (Placer Co.), an adult frog (ca. 100 mm) was observed grabbing and quickly devouring a juvenile (ca. 20 cm SVL) *Thamnophis sirtalis* (Common Gartersnake). The *T. sirtalis* had been slowly moving across a flat, muddy bank covered with *Eleocharis* sp., and the *R. draytonii* was situated at the water/mud bank margin, quiescent, facing into ponded open water. Consistent with other feeding observations of ranid frogs (Anderson 1993. J. Exp. Biol. 179:1–12), the *R. draytonii*, upon lunging and grabbing the snake, used its forelimbs to manipulate the snake farther into its mouth. The capture and swallowing of the snake occurred within a period of five to seven seconds and the snake was entirely engulfed within that time. The temperature at the time of observation was 23°C, water temperature was 23.5°C, humidity was ca. 50%, and moon phase was waxing, approaching full.

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RANA PIPIENS (Northern Leopard Frog). **WINTER ACTIVITY**. On 10 Dec 2006 at ca. 1200 h, a *Rana pipiens* was observed on the north shore of Lake Winter located in Northern Wisconsin (45.8°N, 91.1°W). The lake was covered with approximately 2–3 inches of ice, except the occasional narrow opening near the shore. The south-facing shoreline was somewhat undercut from erosion and about 30.5 cm of soil was exposed. While walking out onto the ice from the shoreline a *R. pipens* was observed jumping away from shore and out onto the ice and snow. The *R. pipens* appeared to be rather torpid and its skin appeared rather dry and leathery.

The previous weather was cold, often with maximum temperatures well below the average maximum temperature for those days. On 9 Dec 2006 the temperature increased to a maximum of 1.7°C and then continued to climb to around 4–5°C during the day of the observation, which was mostly sunny. 5.6°C was the maximum temperature that day; two degrees below the 6.7°C record set in 2002 and well above the typical average maximum temperature of -1.6°C (temperature data accessed on-line from www.undergroundweather.com).

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RANA SYLVATICA (Wood Frog). **EGG MASS SURVEYS.** Egg mass counts have become an increasingly popular method for estimating reproductive effort of Wood Frogs in seasonal breeding pools in the northeastern United States. Scientists, conservation organizations, and regulatory agencies use egg mass counts to determine population size and track population trends over time, to identify breeding pools in need of protective measures, and to develop indices based upon biological significance (Couch and Paton 2000. Wildl. Soc. Bull. 28[4]:895–901; Oscarson and Calhoun 2007. Wetlands 27[1]:80–95). Wood Frog ovipositioning typically occurs in communal rafts attached to submerged vegetation at or near the water surface (Couch and Paton, *op. cit.*; Egan and Paton 2004. Wetlands 24(1):1–13; Seale 1982. Copeia 1982[3]:627–635). In many northeastern states, citizen scientists are being trained to assess the ecological value of vernal pools through egg mass counts. Using snorkel equipment for one such survey in Maine, I found that the subsurface view of a large raft of Wood Frog egg masses revealed numerous masses on the pool bottom. Between 0.5 and 1 m below the communal aggregation of egg masses attached to *Ilex verticillata* at the water surface, some masses were clearly attached to submerged vegetation at the pool bottom while others were merely resting on a substrate of leaf litter. During 2009 springtime assessments (27 April–5 May), three pools (Penobscot County, Maine, USA; 44.884°N, 68.688°E; NAD 1983) were found to contain Wood Frog egg masses directly below and around the margins of rafts attached to vegetation near the water surface. There was no lack of attachment sites near the water surface in any of the three pools. Whether they were originally deposited in situ or were secondarily dislodged and came to rest on the pool bottom is unknown. In deep or tannic pools where visibility is poor, egg mass counts may have the potential to underestimate the true number of masses that occur within a pool.

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RHINELLA ARENARUM (Common Toad). **MORTALITY**. Car traffic often results in high amphibian casualties when roads are encountered during breeding or other movements. *Rhinella arenarum* is the common toad in Argentina (Cei 1980. Amphibians of Argetina. Monitore Zoologico Italiano [NS]. Monogr. 2, 609 pp.). In San Juan Province this species is distributed in all wetted areas including the watering systems of towns. On 23 Nov 2008, we counted the toads dead on the streets in Valle Fértil Departament. This region belongs to the Chaco Seco Phitogeografical Province (Cabrera 1994. Enciclopedia Argentina de agricultura y ganadería. Editorial ACME S.A.C.I., 81 pp.). During this time 84 dead toads were encountered on the road in 900 m. All toads were 89 ± 18.8 mm, typical of adult reproductive *R. arenarum*. This is

the first report of the extent of toad mortality on the roads of San Juan Province, Argentina.

We thank L. Quiroga for review of this note.

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SCAPHIOPUS HOLBROOKII (Eastern Spadefoot). **PREDATION**. *Scaphiopus holbrookii* is an aquatic breeding terrestrial amphibian which, with exception to several days in any year when the species may breed, is predominantly nocturnal in its habits; diurnal hours are spent underground in burrows (Pearson 1955. Ecol. Monogr. 25:233–267). This activity pattern is believed primarily to be an adaptation to avoid desiccation (Bragg 1961. Anim. Behav. 9:178–186), though may also act to reduce predation risk.

Known predators of *S. holbrookii* include various species of mammals, snakes, and birds, though we are not aware of any reports of raptor predation on *S. holbrookii*. During a pilot radiotelemetry investigation of adult *S. holbrookii* movement patterns at Cape Cod National Seashore in Provincetown, Massachusetts (USA), we observed indirect evidence of owl predation on an adult *S.. holbrookii*. Specifically, during 25 August 2005 we found a radio-transmitter from an adult male *S. holbrookii* (SVL 5.4 cm, mass: 19.25 g) inside a small owl pellet on the ground surface. While we were unable to identify the owl species the pellet was from, there are only three species of owl known to inhabit the study area during the late-August time period including: Great Horned Owl (*Bubo virginianus*), Barred Owl (*Strix varia*), and Northern Saw-whet Owl (*Aegolius acadicus*).

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SCINAX LITTORALIS (Snouted Treefrog). **PREDATION**. Amphibians and reptiles are commonly preyed upon by spiders (Neill 1948. Herpetologica 4:158). In the Atlantic Forest, the spider *Ancylometes* spp. (Araneae, Ctenidae) has been reported as an anuran predator (Bernarde et al. 1999. Biociências 7:199-203; Serafim et al. 2007. Herpetol. Rev. 38:437; Haddad et al. 2008. Atlantic Forest Amphibians: Guide for the Atlantic Forest Anurans. Editora Neotropica, São Paulo. 244 pp.). Herein, we report predation of an adult *Scinax littoralis* in Ubatuba, São Paulo, southeastern Brazil (23º30'02.4''S, 45º05'01.4''W, 40 m elev.). On 21 Sept 2008 at 2000 h, one of us (PJPC) observed an adult male *Scinax littoralis* (27.3 mm SVL) that was being consumed by the spider *Ctenus medius* (Araneae, Ctenidae) (46 mm SVL) (Fig.1).

This frog was collected and deposited in the Coleção Jorge Jim, UNESP, Botucatu, SP. We thank A.D. Brescovit for identification of the spider.

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FIG. 1. The spider *Ctenus medius* preying on an adult *Scinax littoralis*.

SMILISCA BAUDINII (Mexican Treefrog). **DIET.** *Smilisca baudinii* is a moderate to large (55–65 mm SVL) nocturnal treefrog (Savage 2002. The Amphibian and Reptiles of Costa Rica: A Herpetofauna Between Two Continents, Between Two Seas. University of Chicago Press, Chicago, Illinois. 934 pp.). Mexican Treefrogs are known invertivores feeding mostly on insects and spiders (Lee 2000. A Field Guide to the Amphibians and Reptiles of the Maya World: The Lowlands of Mexico, Northern Guatemala, and Belize. Cornell University Press, Ithaca, New York), with grasshoppers reported in the stomachs of specimens collected from Nicaragua (Noble 1918. Bull. Amer. Mus. Nat. Hist. 38[10]:311–347). Here we report the first vertebrate prey item for *S. baudinii*.

At 1015 h on 7 Jan 2007 we located a female *S. baudinii* (6.0 cm SVL, 13.0 g) ca. 2.0 m high on the trunk of an oak tree (*Quercus oleoides*) in Cayo Cochino Pequeño, Cayos Cochinos Archipelago, Islas de la Bahia, Honduras. The frog contained a large food item in its gut and appeared to have a lizard tail protruding from its mouth. After capturing the frog and forcing it to regurgitate the prey item, we identified the partially digested lizard as an adult male (6.5 cm SVL, 12 cm tail, 5.0 g) *Norops lemurinus*. The lizard represented a 38.5% meal by mass and a 108.3% prey item by SVL length. Our observation represents the first report of *N. lemurinus* in the diet of *S. baudinii*, as well as the largest reported meal by mass or length for *S. baudinii*.

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SMILISCABAUDINII (Mexican Treefrog) and ***PACHYMEDUSA DACNICOLOR*** (Mexican Leaf Frog). **REPRODUCTION**. Interspecific mating interactions are known to occur when the reproductive activities of amphibian species overlap temporally and spatially (Höbel 2005. Herpetol. Rev. 36:55–56; Höbel 2005. Herpetol. Rev. 36:439–440; Waterstrat et al. 2008. Herpetol. Rev. 39:458). In some cases, it has been suggested that these encounters may act as reproductive interference leading to negative demographic consequence (Pearl et al. 2005. Am. Midl. Nat. 154:126–134). Herein we report an instance of interspecific amplexus between two hylid species. On 11 June 2008 at ca. 0100 h near the city of Uruapan, Michoacán, México (19.24277°N, 102.05228°W, 931 m elev.) we encountered an extremely large (>1500 individuals) multiple-species breeding chorus of anurans. The chorus included five species: *Pachymedusa dacnicolor*, *Leptodactlyus melanonotus*, *Tlalocohyla smithii*, *Rhinella marina*, and *Smilisca baudinii*. The most frequently encountered species were *P. dacnicolor* and *S. baudinii*. Amidst this majestic euphony we located an amplectant pair consisting of a male *S. baudinii* and a female *P. dacnicolor* (Fig. 1). Although cross-species amplectant behavior has frequently been reported among anurans and can be inferred for a number of temperate hylid species known to hybridize (e.g., Lamb et al. 1990. J. Evol. Biol. 3:295–309), there are few published reports of mating errors in tropical hylids or of amplectant interaction between hylid subfamilies.



FIG. 1. Male *Smilisca baudinii* in amplexus with female *Pachymedusa dacnicolor*, found during large multi-species breeding chorus in western Michoacán, México (UTADC 4000).

We thank J. A. Campbell for assistance. Identifications were verified by E. N. Smith. A photographic voucher of this pairing was deposited in the University of Texas at Arlington Digital Collection (UTADC 4000).The National Science Foundation (DEB-0613802 to J. A. Campbell) provided financial support.

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SMILISCA PHAEOTA (Masked Tree Frog). **UNILATERAL MYDRIASIS**. Excessive dilation of the pupil is known as mydriasis. In anurans, fixed mydriasis has been reported during local population declines in conjunction with the presence of the fungal pathogen *Batrachochytrium dendrobatidis* (Hale et al. 2005. USDA Forest Service Proc. 36:407–411). The condition of unilateral mydriasis (excessive dilation of a single pupil) in frogs, defined as an abnormality by the U.S. Fish and Wildlife Service (USFWS Abnormality Classification SOP website via http://www.fws.gov), is rarely reported outside of North America and Europe. Here we report the in situ occurrence of fixed unilateral mydriasis in a tropical hylid species. On 16 March 2008 we made a small collection of anurans near the town of San Lorenzo in Esmeraldas, Ecuador (1.26219°N, 78.79528°W, 40 m elev.). Part of the collection was an adult *Smilisca phaeota* (48.5 mm SVL) that possessed an uneven dilation of its pupils (Fig. 1A). When exposed to daylight, the right pupil of the specimen (Fig. 1B) was excessively dilated whereas the left pupil (Fig. 1C) appeared to respond normally. Most unilateral ophthalmic abnormalities documented in frogs are suggestive of

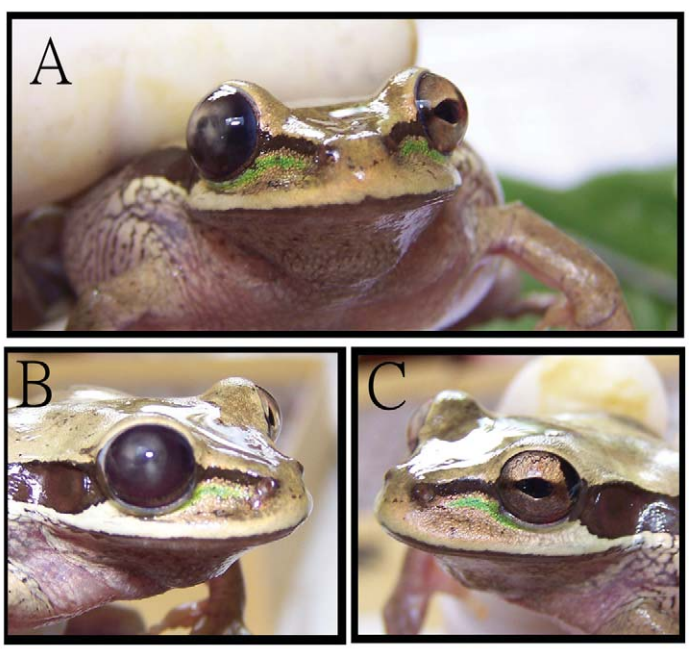


FIG. 1. Unilateral mydriasis in a *Smilisca phaeota* (UTA A-58905) from western Esmeraldas, Ecuador.

trauma or focal disease (Ballard and Cheek 2003. Exotic Animal Medicine for the Veterinary Technician. Blackwell Publishing. 379 pp). Stimulation or damage of sensory nerves is known to cause pupil dilation (Klopper 1951. Acta. Physiol. Pharmacol. Neerl. 2:8–13) as are subcutaneous drug injections and direct exposure to certain chemicals (Meltzer and Auer 1904. Am. J. Physiol. 11:449–454; Wright and Whitaker 2001. Amphibian Medicine and Captive Husbandry. Krieger Publishing, Malabar, Florida. 449 pp.). Based on examination in the field and a subsequent assessment of the preserved animal, there are no obvious external injuries to the specimen. However, it remains unclear whether the condition reported herein resulted from traumatic injury or an association with disease. Additionally, tropical hylids possessing ocular anomalies have been reported to survive in the wild for at least short periods of time (Carvaho et al. 2008. Herpetol. Rev. 39:211), so it is difficult to assess if this case of mydriasis was of relatively recent origin or a longer held affliction.

The specimen was deposited in the herpetological collection of the University of Texas at Arlington (UTA A-58905, Field ID: ENS 12598) and was collected under permit N 001-08 IC-FAU-DN-BAPVS/MA. In vivo images of the frog were deposited in the UTA Digital Collection (UTADC 3718–3720). Financial support was provided to ENS by the Instituto Bioclon (Mexico), UTA (start-up funds), and the National Science Foundation (DEB-0416160).

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SPEA MULTIPLICATA (Mexican Spadefoot). **PREDATION.** The fact that spiders prey on anurans is well documented. Much of the literature on the subject was reviewed and summarized by McCormick and Polis (1982. Biol. Rev. 57:29–58) and Toledo (2005. Herpetol. Rev. 36:395–400) and subsequent to the latter, multiple new accounts have appeared in every volume of this journal. Considering the diversity of the two orders however, the extent of published examples specifically identifying the species involved is relatively limited. Toledo (2005, *op. cit.*) recorded 68 post-metamorphic species of anuran preyed upon by 30 species of Araneae documented in the literature. This amounts to only 1.2% of the 5602 anuran species currently listed by Frost (2008. Amphibian Species of the World: an Online Reference. Version 5.2 (15 July 2008). http://research.amnh.org/herpetology/amphibian/index.php) and 0.07% of the 40,462 Araneae species listed by Platnick (2008. The World of Spider Catalog, ver. 9.0 http://research.amnh.org/entomology/spiders/catalog/index.htm/). Jackman et al. (1983. Science 222:515–516) recorded the larvae of the fly *Tabanus punctifer* preying on recently metamorphosed *S. multiplicata*. Pomeroy (1981. Ph.D. thesis. Univ. California, Riverside. *fide* McCormick and Polis 1982, *op. cit.*) identified the nymphs of dragonflies (Odonata), backswimmers (*Notonecta undulata*), dung beetles (Scarabaeidae), and larvae of diving beetles (*Thermonectes* sp.) as predators of *S. multiplicata* tadpoles, and a tiger beetle (*Cicindela sedecimpunctata*) as predators of adults.

This appears to be the first record of an Araneae, in this instance an unidentified tarantula (Theraphosidae), preying on *S. multiplicata*, although Toledo (2005, *op. cit.*) included eight examples of Theraphosidae preying on other species of frogs. The observation occurred at 1819 h on 14 Oct 2006 in the state of Tamaulipas, Mexico, in the municipality of Miquihuana, 1 km SW of the remote village of Aserradero, located on a dirt road 12.5 km. N of the town of Miquihuana (WGS84, 23.6791667°N, 99.7563889°W; 2473 m elev), Temperature was 21°C; barometric pressure 31.33. The habitat at this locality in the Sierra Madre Oriental is pine-oak forest with madrone (*Arbutus xalapensis*) and agaves (*Maguey americana* and *M. asperrima*). It is generally a semiarid environment with surface water limited to a few arroyos and washes that seldom support more than a few isolated shallow pools although afternoon rains occur almost daily throughout the summer. A few distantly located cattle tanks and seasonally active seeps are present in the region. In the immediate area where the observation took place, ca. 2 or 3 hectares had been cleared of the smaller trees and undergrowth, presumably for livestock grazing, leaving only some of the larger trees in a pasture with occasional bunchgrass and an abundance of fallen logs. An arroyo delineates the north side of the pasture.

The event was observed while turning over rocks in the pasture. The initial attack was not witnessed. The tarantula was first seen holding the *S. multiplicata* after a moderately large stone was turned. We observed the spider, which remained motionless for ca. 2–3 minutes, seemingly disturbed from feeding by the rock having been moved. When attempts were made to take photographs, the spider dropped the toad and retreated ca. 10–20 cm and did not return to its prey. The *S. multiplicata* was alive but appeared to be paralyzed, presumably from the effect of the spider's venom. The toad was whole, intact, with no obvious wounds or necroses, suggesting that it had only very recently been caught and the spider had not begun consuming its prey. The elytra and some other body parts from a Beetle (Tenebrionidae), presumably preyed on earlier by the same spider, where found in a small tunnel excavated under the rock, the rock its self providing the ceiling of the chamber before it was turned over. Toledo (2005, *op. cit.*) reported that almost 90% of recorded instances of invertebrates preying on post-metamorphic anurans take place in or at the water's edge, when either recently metamorphosed frogs are leaving the water, or when adults congregate and enter the water for breeding, all circumstances which are not applicable to this case. The *S. multiplicata*, a small adult (2.4 cm SVL; 1.25 g), was weighted and measured in the field before being preserved. It was deposited in the collection of the Universidad Autónoma de Nuevo Leon, UANL 6500 along with a second specimen UANL 6501, measuring 2.6 cm. found under a nearby rock. The spider was left in the field where found. Fieldwork was conducted under SEMARNAT permit no. 00800/06 and funded by HZI.

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STEREOCYCLOPS INCRASSATUS (Brazilian Dumpy Frog). **DEFENSIVE BEHAVIOR.** *Stereocyclops incrassatus* is a Brazilian microhylid, found in humid coastal forests in eastern Brazil from Espírito Santo to Bahia (Frost 2009. Amphibian Species of the World: an Online Reference. Version 5.3; http://research.amnh.org/herpetology/amphibia/. American Museum of Natural History, New York). Ecological or behavioral information for this genus is scarce, but includes a description of feeding habits in *S. incrassatus* (Teixeira et al. 2006. Bol. Mus. Biol. Mello Leitão 19:53–58) and a description of defensive behavior in *S. parkeri* (Sazima 1978. Biotropica 10:158). Herein, we describe an unreported defensive behavior for *S. incrassatus*.

At ca. 1700 h on 12 March 2009, we observed the defensive behavior of an adult male *S. incrassatus* (44 mm SVL) against a predation attempt by an adult colubrid snake, *Liophis milliaris merremi* (559 mm SVL. 127 mm TL). The animals were found in the vicinity of the municipality of Itacaré, Bahia state, Brazil (WGS84, 14.2888128°S, 38.984219°W; elev. ca. 10 m). The snake was trying to swallow the frog headfirst. With the head already inside of snake's mouth, the frog was displaying the following defensive position: the head was pressed against the ground, the back was raised, the body inflated, and the fore and hind limbs were strongly retracted against the body, giving the frog a solid and round shape. When we approached, the snake regurgitated the frog and we noticed that its mouth and a small part of the frog's body was covered by a glue-like secretion produced by the frog. The secretion was visibly sticky, as it adhered sand grains to both animals. It was not apparently whitish, but the adhered sand might influence our perception of the color of the secretion. The secretion made it difficult for the snake to open its mouth for approximately a minute. After several unsuccessful attempts, the snake was finally able to open its mouth by itself. During that time, the frog remained in the position described above until, in the hands of one of us, it flattened its body and stretched out its four limbs. When placed on the ground it raised its head and remained in this flattened position for more than a minute (Fig. 1).

This is the first description of defensive behavior for *S. incrassatus*. This is the first time that a defensive posture with all the limbs pressed against the body and the head pressed against the ground has been reported for a Brazilian microhylid. Flattening the body and stretching all the limbs at the same time has also not been previously described for any Brazilian microhylid. We did not see any color in the *S. incrassatus* secretion. Secretion of sticky substances is a useful defensive tactic, as it causes almost immediate liberation of the prey (Evans and Brodie. 1994. J. Herpetol. 28:499–502). All these data support the idea that many anurans may combine secretions with different body positions to increase defense success.



FIG. 1. Posture maintained by a *Stereocyclops incrassatus* after being handled by one of the observers.

The specimens are deposited in the herpetological collection of the Museu de Zoologia da Universidade de São Paulo (MZUSP), São Paulo, Brazil (*Liophis miliaris merremi*, MZUSP 17732, and *S. incrassatus*, MZUSP 141343). We thank IBAMA for collection permits (14555-1).

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CROCODYLIA — CROCODILIANS

CROCODYLUS ACUTUS (American Crocodile). **NESTING ECOLOGY.** *Crocodylus acutus* is widely distributed in the Atlantic and Pacific coasts of Mexico, Central America, and northern South America, many Caribbean islands, and southern Florida (Ernst et al. 1999. Cat. Amer. Amph. Rept. 700:1–17). Information on nesting ecology has been documented in Caribbean atolls and coast habitat (Ogden 1978. J. Herpetol. 12:183–196; Platt and Thorbjarnarson 2000. Copeia 2000:869–873; Casas-Andreu 2003. Acta Zool. Mex. [n.s.] 89:111–128; Mazzotti et al. 2007. Herpetol. Rev. 38:285–289; Charruau et al. 2010. J. Nat. Hist., *in press*). However, there is a paucity of information on nesting ecology of *C. acutus* in mainland and man-made habitat. Hence, here we present observations on its nesting ecology in El Cajon Reservoir in central Honduras.

We searched for nests around the main rivers and secondary tributaries of El Cajon Reservoir (15.01078ºN, 87.71149ºW, datum: WGS84, elev. 285 m) in February–April 2005. We found 30 nests of *C. acutus*: two on the Yure River, 16 on the Humuya River, and 12 on the Sulaco River. Nest holes were constructed by *C. acutus* that were found in the shoreline vegetation and elevated areas away from shoreline and creeks. The nest areas were characterized by very steep slopes and the presence of sandy and rocky soil.

We observed hatchlings at each nest site during May and June. The number of hatchlings varied from 10 to 21 per nest on the Yure River, 10 to 27 on the Humuya River, and 10 to 33 on the Sulaco River. Successful nests were determined by the presence of eggshell membranes indicating the nests were excavated by the nesting female. Platt and Thorbjarnarson (2000, *op. cit.*) observed that females defend nests from predators but parental care was minimal or non-active. In El Cajon Reservoir, we observed active parental care during our surveys.

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RYNCHOCEPHALIA — TUATARA

SPHENODON PUNCTATUS (Tuatara). **FRUGIVORY.** The unique assemblage of plants and limited animal species in New Zealand, as on many isolated islands, has allowed novel seed dispersal relationships to evolve (Valido and Olesen 2007. *In* Dennis et al. [eds.], Seed Dispersal: Theory and its Application in a Changing World, pp. 124–147. CAB International, Wallingford). Seed dispersal is essential for gene flow and maintaining ecological structure in plant communities. Our understanding of these systems and their dispersal vectors are vital for the conservation of native ecosystems with nearly 70% of woody species in New Zealand possessing fruit suitable for vertebrate seed dispersal (Clout and Hay 1989. New Zealand J. Ecol. 12:27–33). Some New Zealand plants exhibit growth forms that are thought to be conducive to lizard-mediated seed dispersal (Lord and Marshall 2001. New Zealand J. Bot. 39:567–576). Twelve species of frugivorous lizards in New Zealand have been identified as potential seed dispersers (Whitaker 1987. New Zealand J. Bot. 25:315–328). New Zealand's largest lepidosaurian, *Sphenodon punctatus*, has been characterized as a generalized opportunistic carnivore that subsists primarily on beetles, insect larvae, arachnids, and weta (Ussher 1999. New Zealand J. Zool. 26:117–125; Walls 1981. New Zealand J. Ecol. 4:89–97). Seeds in tuatara scat and stomach contents (Ussher 1999, *op. cit.*; Walls 1981, *op. cit.*; Southey, cited in Whitaker 1987, *op. cit.*) have been dismissed as instances of reptile frugivory and seed dispersal because they were thought to be indirectly or accidentally consumed (Valido and Olesen 2007, *op. cit.*). Here we provide the first evidence for intentional frugivory by the tuatara and report on its implications for effective seed dispersal.

During fieldwork on Stephens Island (40.67°S, 174.00°E) in March 2009, two *Sphenodon punctatus* scat samples were discovered that contained a large number of seeds. The first sample (Sample 1) was freshly deposited on 11 March inside the collection bag of an adult male tuatara (SVL = 230 mm, mass = 370 g) and the second sample (Sample 2) was discovered on 23 March deposited by an unknown tuatara on a concrete pathway roughly 75 meters from Sample 1. The distance between these samples make it unlikely to be the same individual, as this species is highly territorial (Moore et al. 2009. J. Herpetol. 43:570–578).

Dissection of Sample 1 and Sample 2, revealed a few arthropod body fragments, identified as common small beetle species with the majority of the sample being comprised of seeds and several stems. Comparison with collected seed samples identified the seeds as Kawakawa (*Macropiper excelsum*), and thorough counts yielded at least 407 intact seeds in Sample 1 and 1343 intact seeds and 41 seed fragments in Sample 2. Seed fragments were considered any seed that had sustained damage that exposed the endosperm. Kawakawa is a common understory shrub in the regenerated and degraded original forest patches on Stephens Island (Mulder and Keall 2001. Oecologia 127:350–360), and was fruiting in abundance in March 2009. Kawakawa possess bright orange, aromatic, aggregate fruit spikes which can contain up to 150 seeds per spike (Burrows 1995. New Zeal J Bot**.** 33:131–140). When Sample 1 was collected it had a distinct orange-tinge aiding in the plant's identification. Comparison with fresh fruit spikes shows that the stems found in the fecal samples were the central stems of the aggregate fruit with three and nine stems found in Sample 1 and Sample 2, respectively. The fruit spikes can fall intact to the ground when the plant is agitated and fruit are ripe (K. C. Burns, pers. comm.) making them available to terrestrial animals. The presence of the fruit spike stems in the scat samples provides evidence for direct consumption of several whole fruit spikes since other frugivores (e.g., geckos and Weta) with smaller mouths remove the fruit flesh from the central stem (pers. obs.). In order to ingest the large number of seeds found in each sample, the number of whole fruit spikes that would need to be consumed is at least two and nine, respectively, for Sample 1 and Sample 2. The absence of large prey remains, the presence of fruit spike stems and the large number of seeds all suggest the direct consumptions of fruit spikes by tuatara.

To examine the viability of these seeds, germination trials were performed on two subsets of seeds that were deemed intact under 10× magnification from fecal Sample 1 (N = 53, 50) and Sample 2 (N = 65, 50), along with two sets of controls comprising defleshed seeds from ripe Kawakawa fruit spikes (N = 66, 50). Once removed from the island, seeds were stored in plastic petri dishes in a cool refrigerator. For the trials, seeds were placed in glass Petri dishes with a saturated filter paper substrate and placed under 12-h light: dark timer controlled fluorescent grow lights. The first sets were started on 16 April 2009 with the second sets beginning on 30 June 2009. Seeds were checked weekly over the following seven weeks by performing counts of radicle and cotyledon emergence. The control, Sample 1, and Sample 2 average percent emergence rates of radicle (93.2%, 79.1%, 99.1%, respectively) and cotyledon (49.5%, 31.3%, 43.1%, respectively) were roughly similar between samples. Critically, this indicates that many seeds passed by the tuatara are still viable.

Excretion of viable seeds provides the possibility of seed dispersal by tuatara regardless of the method of consumption or germination rate. Other examples of seed dispersal by traditionally carnivorous animals have been documented in recent years (Calviño-Cancela et al. 2007. Écoscience 14: 529–534; Otani 2002. Ecol Res. 17:29–38). It has even been suggested that a carnivore's dentition lend them to be more effective seed dispersers than herbivores because they cause less damage to seeds during mastication (Otani 2002, *op. cit.*). Tuatara should not be disregarded as a potential seed dispersal vector because of their primary diet.

A whole suite of potential questions raised by this observation can be divided into two general groups. The first group is those questions about the biology of tuatara: How frequent is this behavior? What implication does this have for the diet of tuatara? With the dense population of tuatara on Stephens Island (Moore et al. 2007. Biol Conserv. 135:181–188), could frugivory be an alternative feeding strategy due to intense resource competition? These fecal samples were found during the mating season of the tuatara; could a high caloric demand be leading to fruit consumption? If tuatara are intentionally eating the Kawakawa fruit, are

they locating them by olfaction, color, or ultraviolet vision? The second group involves questions about the ecological implication for this frugivory: How does the deposition pattern and microhabitat, e.g. clumped or scattered on sunny open soil or down a burrow, of deposited seeds impact germination (Williams et al. 2000. Austral Ecol. 25:523–532; Wotton 2002. New Zealand J. Bot. 40:639–647)? Stephens Island only has a subset of New Zealand plants; could the tuatara's historical range have included access to other fruiting plants they would consume? Does the territorial tuatara move over enough area to effectively disperse seeds? Further research is needed to understand this occurrence of tuatara frugivory and its implications for their diet and seed dispersal in remnant and historical New Zealand ecosystems.

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TESTUDINES — TURTLES

ACTINEMYS* (= *EMYS*) *MARMORATA (Western Pond Turtle). **PREDATION**. The Western Pond Turtle is in decline over 80% of its historical range in California, primarily due to habitat loss and competition from introduced species (Stebbins 2003. A Field Guide to Western Reptiles and Amphibians, 3rd ed., Houghton Mifflin, Boston, Massachusetts). Wild pigs *(Sus scrofa)*, hybrids of feral domestic pigs and European wild boars, are a purposely introduced species rapidly increasing in range and population throughout the state (Waithman et al. 1999. J. Wild. Manag. 63[1]: 298–308). Wild pigs are omnivores, and forage for and consume a wide variety of vertebrate prey (Wilcox and Van Vuren 2009. J Mammal. 90[1]:114–118). Worldwide, feral pigs have been documented to consume eggs and young of four chelonian species, including Green Sea Turtles *(Chelonia mydas)*, giant tortoises *(Chelonoidis nigra [=Geochelone elephantopus])* in the Galapagos (Coblentz and Baber 1987. J. Appl. Ecol. 24:103–118), Spur-thighed Tortoises *(Testudo* spp.*)* in Sardinia (Corbett [ed.], 1989. The Conservation of European Reptiles and Amphibians. C. Helms, London), and Texas Tortoises *(Gopherus berlandieri)* (Taylor and Hellgren 1997. Southwest. Nat. 42[1]:33–39). I report below on the first documented case of wild pig predation on the eggs of Western Pond Turtles.

Early on the morning of 21 October 2003, I went to check the progress of a pond-draining project at Cabin Pond (37.37953°N, 121.73146°W) on the Blue Oak Ranch in Santa Clara County, California, USA. In the heat and aridity of the California autumn, the moist basin of the receding pond had attracted wild pigs. Overnight, they had wallowed in the deep mud and thoroughly rooted for earthworms in the moist soil around the shallow end of the pond basin. Three pigs were in the basin when I arrived. Two were rooting beyond where the soil moisture ended in the grass-covered uplands on the slope, ca. 20 m above and beyond the pond. The pigs bolted for cover as soon as they saw me. Moments later, while inspecting the area, I discovered remnants of three turtle eggs in the mounds of soil and dried plant matter where the pigs had rooted. There was a moist, viscous fluid still clinging to the inside of the shells. In the hard earth just below the mound of soil that held the eggs was an elliptical depression about 5 cm across and 3 cm wide. The exact dimensions were difficult to judge due to the rooted conditions.

A number of morphological and behavioral traits make wild pigs ideal predators of turtle nests and eggs. Nest sites of Western Pond Turtles typically are within close proximity of streams and ponds; riparian areas are likewise favored resting and foraging places for wild pigs. Turtle nests typically are no more than 8 cm in depth (Rathbun et al 1992. Southwest. Nat. 37[3]:319–324); wild pigs often root to depths much greater than 8 cm, depending on the soil depth and moisture. Wild pigs' excellent sense of smell may help them detect turtle nests (though they also may encounter turtle eggs in the course of routine rooting). Pigs also have remarkable oral dexterity, which allows them, for example, to detect and swallow earthworms without ingesting soil and may allow them to do the same with small eggs.

In the incident described above, wild pigs were interrupted in the act of predating on turtle eggs—but wild pigs normally swallow their prey whole, leaving no evidence on the ground. The behavior observed serendipitously on the Blue Oak Ranch may therefore happen more often than is witnessed. The spread of wild pigs throughout California could be exacerbating the decline of Western Pond Turtles where these species occur together.

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CHELONIA MYDAS (Green Seaturtle). **DISEASES**. Infectious agents such as fungi and bacteria are known pathogens in marine turtles. Derivative of these kinds of diseases, external and internal tumors may be generated and mainly affect immature animals (Herbst 1994. Annu. Rev. Fish. Dis.4:389–425). In *Chelonia mydas*, *Vibrio harveyi* and *Bacillus* sp. have been described as infectious agents (Work et al. 2003. Dis Aquat Org. 53:41–46). Fungi like *Fusarium oxysporum*, *Fusarium solana* and *Pseudallescheria boydii* are found in the eggs of *Chelonia mydas*, *Eretmochelys imbricata*, *Caretta caretta*, and *Natator depressus* and can cause death of embryos (Phillott and Parmenter. 2001. Aust. J. Zool. 49:713–718; Phillott 2004. Herpetologica. 34:44–47). There are reports of *Colletotrichum acutatum* in juvenile *Lepidochelys kempii*, with infection in lungs and kidneys (Manire et al. 2002. J. Clin. Microbiol. 40:4273–4280).

There are apparently no published studies on the incidence of infectious agents in marine turtles and nests in Mexico, even though these agents may be important causes of mortality in embryos and hatchlings. Here we document the presence of fungi and bacteria in nests of *C. mydas* on a beach in Veracruz, Mexico.

We took 26 vitello samples from the beach of the "Centro de Protección y Conservación de Tortugas Marinas" in Santander, Veracruz, Mexico. The eggs tested did not appear damaged or show visible signs of infection. For each nest, we counted living and dead hatchlings. The samples were obtained using sterile cotton applicator and cultured on potato dextrose. The samples were kept at 21°C to 23°C during 72 h of incubation. To identify the differences among the infectious agents we used a Cochran Q test, using a 1-0 matrix.

In the samples of *Chelonia mydas* eggs we found *Candida albicans* fungi in 20 samples, and *Staphylococcus aureus* and *Escherichia coli* bacteria were found in eight and five samples, respectively. Ninety-six per cent of all nests presented with at least one of the three infectious agents, although none of the 26 nests presented with the three agents at the same time.

In nests with *Escherichia coli*, mortality was 100%, even when all the embryos were completely developed. In the nests with *Candida albicans* and *Staphylococcus aureus*, mortality was 15% and 20%, respectively. Some individuals showed malformations, including blindness, absence of anterior flippers, and notable differences in size and weight.

The presence of the infectious agents was similar in all nests ($Q = 12.53$; $P>0.05$), nevertheless, for each agent, significant differences were found ($Q = 15.12$: $P< 0.05$).

The source of bacteria and fungi in the Green Seaturtle nests on Santander beach is unclear. Nest invasion by domestic animals such as dogs and pigs, or the disruption of older nests by later nesting females could be a possible source for infectious agents. When the eggs are broken, protein concentration increases in the sand, stimulating bacterial and fungal proliferation (Acuña et al. 1999. Appl. Environ. Microbiol. 65:336–338). Nesting female turtles can carry infectious agents. For example, *Vibrio mimicus* has been reported from marine turtle vents in Costa Rica. This infectious agent could be picked up during nesting, when the female has contact with the sand, and later dispersed into the sea water (Phillott et al. 2002. Aust. J. Zool. 50:687–695).

Humans can transport the bacteria and fungus as well. In Costa Rica, Bangladesh, India, and United States there have been reports of human infections due to the ingestion of turtle eggs (Campos et al. 1996. Appl. Environ. Microbiol. 62:1141–1144). Human transport of pathogens during the handling of eggs may occur if hygiene protocols in the conservation centers are inadequate.

The most damaging nest pathogen was *Escherichia coli* and is an important cause of infection in captive animals (George 2005. *In* Lutz and Musick [eds.], The Biology of Sea Turtles, pp. 363–385). *Candida albicans* fungus is a common cause of respiratory infections (Hernandez and Stephen 2001. J. Zoo. Wild. Med. 32:352–359), and *Staphylococcus aureus* causes skin and gastrointestinal infections (Bennett et al. 1986. J. Food Sci. 51:1337–1339). However, there are no previous reports of these bacteria and fungi in turtle nests in Mexico.

In conclusion, this is the first record of infectious bacteria in *Chelonia mydas* nests in the state of Veracruz. The proximity of human communities to the nesting sites as well as poor hygiene in the marine turtle protection centers are possible sources for infective agents in turtle nests.

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CHELYDRA SERPENTINA (Snapping Turtle). **DEFORMITY.** To our knowledge, there are no previous reports of a wild adult *Chelydra serpentina* found completely lacking a tail. Here we report an adult female *C. serpentina* observed on 23 July 2009 on the Marsh Trail at Rondeau Provincial Park (Ontario, Canada; 42.27830°N, 81.87108°W; 178 m elev.) with no tail. We have examined many Snapping Turtles with partial tail loss but none to this extent. The vertebrae could be felt down from the base of the tail to just past the cloaca and the skin cleanly covered the end. The cloaca was not distorted and was fully intact and there were no signs of scar tissue or wounds from amputation. There were no other deformities through injury or scarring and the turtle appeared to be a healthy adult female. Photographs available from Christina Davy (contact information below).

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GOPHERUS POLYPHEMUS (Gopher Tortoise). **GROWTH**. On 3 January 2009 a large adult female Gopher Tortoise was captured at Jonathan Dickinson State Park, Martin County, Florida, USA (JDSP; 27.0061°N, 80.1288°W). This tortoise had been previously captured nearly 20 years (7134 days) earlier on 23 June 1989. At the time of first capture this animal weighed 7995 g and had a carapace length (CL) of 358 mm. Upon recapture this animal weighed 9163 g and had a CL of 375 mm. Both CL measurements were performed using calipers and each is the average of 10 replicate measurements (Timmerman and Roberts 1994. Herpetol. Rev. 24:64). The average growth rate of the recaptured tortoise was 0.87 mm CL/year. There exists a substantial literature on growth rates in Gopher Tortoises across the species' range (Ernst and Lovich 2009. Turtles of the United States and Canada. John Hopkins University Press, Baltimore, Maryland. 827 pp). Ashton and Burke (2007. J Wildl. Mgmt. 71:783–787) report an average growth rate of 1.8 ± 1.9 mm CL/year for adult female tortoises from the Lake Wales Ridge of Florida, a habitat similar to JDSP.

The age of the JDSP tortoise was estimated based on counts of abdominal growth rings. At the time of first capture in 1989 age was estimated to be >29 years. Although this aging method has been shown to be unreliable in adults of some turtle species (Wilson et al. 2003. Herpetologica 59:178–194), we are unable to estimate age using growth models based on tortoise populations from central Florida (Mushinsky et al. 1994. Herpetologica. 50:119–128) or southcentral Alabama (Aresco and Guyer 1999. Herpetologica 55:499–506) because the JDSP tortoise exceeds the asymptotic limit of CL for both the 1989 and 2009 captures.

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GRAPTEMYS OUACHITENSIS SABINENSIS (Sabine Map Turtle). **COLORATION**. In 2005, six spotting scope observations of aberrantly colored *Graptemys ouachitensis sabinensis* of both sexes (as determined by tail length and head size) were made in the Old Sabine Bottom Wildlife Management Area (OSBWMA) in Lindale, Texas, USA (J. L. Coleman, pers. obs.). Although the striping pattern was typical for *G. o. sabinensis*, the yellow color was replaced with bright red throughout the body and carapace. These individuals were not reported due to a lack of sufficient photographic evidence. A similarly aberrant female *G. o. sabinensis* was trapped along the same stretch of river on 1 July 2009 while sampling using a fyke net and carphorn (Vogt 1980. Copeia 1980[2]:368–371) (Fig. 1). This female was within the documented size range (i.e., carapace length and mass) for *G. o. sabinensis* and bears the typical markings of the subspecies, with the exception of the red coloration and gold colored eyes (Institute of Natural Resource Sustainability at the University of Illinois at Urbana-Champaign, Illinois Natural History Survey photo voucher INHS 2009r). In addition, several other *G. o. sabinensis* captured during the 2009 field season had similar red patterning on their carapaces but lacked the red facial and limb markings.

The only *Graptemys* species reported to exhibit any level of hypererythrinism (increased red pigmentation**)** are Gibbon's Map Turtle (*G. gibbonsi*), the Ringed Map Turtle (*G. oculifera*), and the Texas Map Turtle (*G. versa*) which are described as having yellow to red carapace markings (Buhlman et al. 2008. Turtles of the Southeast. University of Georgia Press, Athens, Georgia. 251 pp.). No record of a completely hypererythristic map turtle of any species has been reported, nor have red carapace markings been reported for *G. o. sabinensis*. Here we note several different individuals of both sexes over a four-year period, indicating that the trait is not restricted to one sex despite its rarity. Although integumental staining due to environmental influences, such as substrate iron deposits, is possible (J. Harding, pers. obs.), it seems unlikely in the instances reported here, given that our observations were species-specific despite the presence of two other *Graptemys* species and other aquatic turtle species utilizing the same habitat. Additionally, the coloration is not patchy as might be expected in integumental staining and aberrant coloration extends to the iris. We hypothesize that this coloration has a genetic basis; however further validation of this hypothesis is needed.

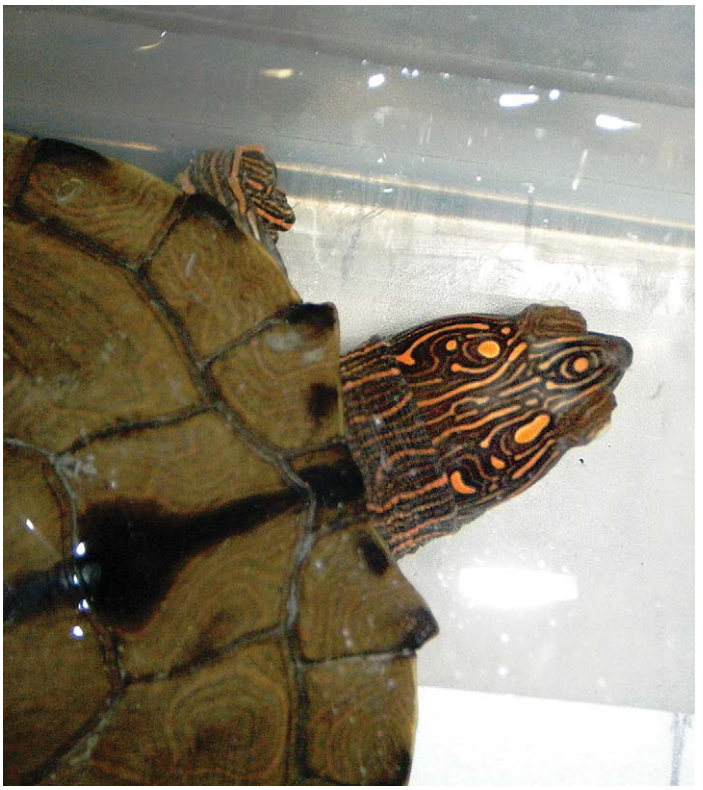


FIG. 1. Aberrent red coloration of a *Graptemys ouachitensis sabinensis* female caught in the Old Sabine Bottom Wildlife Management Area, Lindale, Texas.

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KINOSTERNON SONORIENSE (Sonoran Mud Turtle). **HATCHLING BEHAVIOR**. For many turtle species, little is known about the behavior of hatchlings in the wild. On 14 August 2009, we observed an interaction between two hatchling *Kinosternon sonoriense* in the Peloncillo Mountains, Coronado National Forest, New Mexico, USA (31.503°N, 109.016°W, NAD83, elev. 1706 m). The interaction lasted ca. 2 min and occurred in a rain-filled rock pool (0.23 m^2) approximately 3.5 cm maximum depth. The water temperature was 25.5°C, and the pool was exposed to full sun. We recorded the last minute of the interaction with a camera, which provided durations of behaviors. When we approached the pool, one hatchling (T1) was on top of the other hatchling (T2), holding onto the carapace of T2 with all 4 limbs. Both turtles were underwater, and it appeared that T2 was attempting to swim away from T1. T1 repeatedly bit at the head and anterior carapace of T2. After 80 sec, T1 bit and held fast to the head of T2 for 4 sec while releasing the carapace of T2. T2 then swam away, and T1 followed and eventually perched on the carapace of T2 for 6 sec. T1 then turned and swam to the opposite end of the pool and attempted to bite a water beetle. At this point we retrieved both hatchlings to determine if they were recaptures and record shell measurements. The midline carapace lengths for T1 and T2 were 22.7 and 22.9 mm, respectively, and the yolk scar and caruncle were still present on both hatchlings.

The context of the behavior we observed is unclear. Most likely we observed precocious courtship or social play, which has been described in hatchling turtles (Cagle 1955. Copeia 1955:307; Morris 1976. Herpetol. Rev. 7:111; Kramer and Burghardt 1998. Ethology 104:38–56). The interaction we observed is similar to the description of courtship behavior for other kinosternids (Mahmoud 1967. Copeia 1967:314–319; Lardie 1975. J. Herpetol. 9:223–227). However, Kramer and Burghardt (1998, *op. cit.*) discussed the possibility of social play instead of courtship. Although we were unable to identify the proper context of the behavior, our observation adds to the limited knowledge about the behavior of hatchling kinosternid turtles in the wild.

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(SUP0080-01).

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LEPIDOCHELYS OLIVACEA (Olive Ridley). **EGG SCAVENGING BY FISH.** Sharks and fin-fishes have been documented as significant predators on hatchling sea turtles (Carr 1986. NOAA Tech. Memo. NMFS-SEFC-190, pp. 3–9; Stancyk 1982. *In* K. A. Bjorndal [ed.], Biology and Conservation of Sea Turtles, pp. 139–153. Smithsonian Institution Press, Washington, D.C.). To date, however, there are apparently no reports of fish consumption of sea turtle eggs, presumably because the eggs are buried in a terrestrial nest.

We are studying the ecology of *Lepidochelys olivacea* in the Gahirmatha Marine Wildlife Sanctuary, Orissa, India. The Gahirmatha site is the largest known mass nesting rookery for the Olive Ridley in the world at peak nesting in March and April (Bustard 1976. Tiger Paper 3:3). The Gahirmatha rookery is on a lagoon backed by the Brahmani and Maipura rivers. This mangrove dominated area has notably high fish diversity and productivity (Dash and Kar 1990. The Turtle Paradise: Gahirmatha. Interprint, New Delhi. 295 pp.). Olive Ridleys arrive offshore of Gahirmatha in November and nesting peaks in March and April and continues to May (Dash and Kar 1990, *op. cit.*; Pandav 2000. Conservation and Management of Olive Ridley Sea Turtle Population along the Orissa Coast. PhD. thesis. Utkal University, Bhubaneswar, Orissa. 77 pp.). During the same period, human fishing activities are intensive in the area. In February 2009, three eggs of the Olive Ridley were found in the gut of a catfish, *Arius arius*, which was caught in the Gahirmatha. Diameters of turtle eggs found in the gut ranged from 37.5–37.9 mm.

Unregulated intensive offshore fishing activity has been reported as a major cause for large-scale seaturtle mortality in Orissa (Pandav and Choudhury 1999. Marine Turtle Newsl. 83:10–12). Several thousand dead, gravid Olive Ridleys were found floating on the sea surface during February 2009, possible victims of fishing activities. Therefore, it is presumed that the catfish might have scavenged the eggs from floating dead turtles. Years of research show that Olive Ridleys congregate in small and specific offshore areas of the Orissa Coast, but management programs have failed to provide adequate protection to these congregations from intensive fishing.

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SQUAMATA — LIZARDS

AMEIVA AMEIVA (Giant Ameiva) **DIET**. *Ameiva ameiva* is a medium sized teiid lizard found naturally over a wide range at low elevations from Costa Rica (Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna Between Two Continents, Between Two Seas. University of Chicago Press, Chicago, Illinois. 934 pp.) to northern South America, and a few Caribbean islands. Introduced populations occur in Florida (Uetz et. al., The JCVI/TIGR Reptile Database, http://www.reptile-database.org, accessed 21 January 2010; Schwartz and Henderson 1985. A Guide to the Amphibians and Reptiles of the West Indies Exclusive of Hispanola. Milwaukee Public Museum, Milwaukee, Wisconsin. 165 pp.). They are active, diurnal foragers known to feed primarily on insects (Duellman 1978. The Biology of an Equatorial Herpetofauna in Amzonian Ecuador. University of Kansas, Lawrence, Kansas. 352 pp.). Lizards and frogs are also known prey items (Duellman *op. cit.*;Vitt and Colli 1994. Can. J. Zool. 72:1986–2008; Pianka and Vitt 2003. Lizards: Windows to the Evolution of Diversity. University of California Press, Berkeley. 346 pp.). Other vertebrate remains have consisted of lizard and frog eggs (Duellman 2005. Cusco Amazonico. Cornell University Press, Ithaca, New York. 433 pp.) The following observations add mammals to the vertebrate taxa eaten by this species.

On 21 November 2003 at 1430 h in the village of Apoteri (confluence of the Rupununi and Rewa rivers), Region 9, Guyana, an adult *Ameiva ameiva* was observed consuming the phalanges of an unidentified species of bat. The lizard had some difficulty swallowing the extended, stiffened but still articulated bones. About 30 minutes later, ca. 5 m distance from where the first observation was made, an *A. ameiva* was observed carrying a bat carcass that was intact, fully furred and appeared relatively fresh. The lizard bit and held the bat in the head/neck region while repeatedly scratching the body with its forefeet. In this manner small pieces of flesh were removed and immediately swallowed. Eventually a hole ca. 1 cm in diameter was created in the bat's skin. At 1520 h the lizard carried the carcass out of view.

These observations were made in the vicinity of a rarely occupied house that supported a large colony of bats. The *A. ameiva* may have been exploiting the natural mortality of this colony as a food source. Alternatively, the lizard could have opportunistically killed a bat that had fallen from its roost.

I thank Peter Taylor for the opportunity to travel in Guyana.

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ANOLIS PORCATUS (Cuban Green Anole, Caguayo). **SAUROPHAGY**. *Anolis porcatus* is a Cuban endemic that has also been introduced to Hispaniola (Powell et al. 1990. Amphibia-Reptilia 11:421–425) and Florida (Meshaka et al. 1997. Herpetol. Rev. 28:101–102). It is polytypic (Pérez-Beato 1996–1997. Rev. Biol. Trop. 44/45:295–299), widely distributed in the Cuban Archipelago, and abundant in the gardens associated with homes. Principally in Western Cuba, it is sympatric with several other widely distributed lizards that occur in houses, namely *Anolis sagrei sagrei* and *A. homolechis homolechis*, *Gonatodes albogularis fuscus*, *Hemidactylus haitianus*, *Sphaerodactylus elegans elegans.* Previously published reports on saurophagy in *A. porcatus* include a juvenile *A. homolechis* and younger conspecifics (Socarrás et al. 1988. Misc. Zool. 38:4). Here I provide a second observation of saurophagy in *A. porcatus*, and the first published account of predation on a *Gonatodes a. fuscus*.

At 1630 h on 24 August 2004, an adult (estimated at 50 mm

SVL) female *A. p. porcatus* was observed in the garden of a house in Bejucal (22.925°N, 82.3915°W, elev. 111 m; WGS84), Havana Province, Cuba, devouring a juvenile (~10 mm SVL) *G. a. fuscus*. The *Anolis* lizard was observed with the live juvenile gecko inside its open mouth. The specimen was swallowed poster end first. The *A. porcatus* exhibited some difficulties in swallowing the gecko, probably because of the relatively large size of the juvenile gecko. The posterior part of the gecko body was swallowed quickly but the head was swallowed very slowly. The culmination of the predation was not observed since the animal moved out of view. This episode lasted ca. 15 min.

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ANOLIS STRATULUS (Saddled Anole). **DIET**. *Anolis stratulus* is commonly found throughout the Puerto Rico Bank, including the British Virgin Islands (BVI; Powell and Henderson 2009. Natural History of West Indian Reptiles and Amphibians. University Press of Florida, Gainesville.). It is generally considered a trunk-crown species, although in the BVI it is often found closer to the ground than in other parts of its distribution (Lieht 1974. Copeia 1974:215–221; Perry 2005. *In* J. Lazell, Island: Fact and Theory in Nature, pp. 187–188. University of California Press, Berkeley). *Anolis stratulus* is a sit-and-wait predator of small invertebrates, but has also been known to occasionally drink nectar from flowers (Perry and Lazell 1997. Herpetol. Rev. 28:150–151; Powell and Henderson, *op. cit.*) .

In October 2009 we conducted a study of nectivorous bird food preferences on Guana Island, BVI. As part of this study, a sugar water feeder was placed on a small wooden platform hung from a tree. The platform held a bowl of granulated sugar for attracting Bananaquits (*Coereba flaveola*), small local nectivorous bird. Anoles were often observed on the tree and occasionally basked on the platform. On three separate occasions (occurring once on 16 October 2009, and two observations recorded within 30 minutes of each other on 18 October 2009), we observed at least one adult *A. stratulus* drinking from the feeder located on the platform. The feeder contained 10% and 40% sugar solution during the days of observations, respectively. All observations were recorded between 0830 h and 0930 h. In one case, the lizard was feeding along with a Bananaquit. Although another sympatric nectivorous bird, the Antillean Crested Hummingbird (*Orthorhyncus cristatus*), has been reported to sometimes attack Saddled Anoles (Boal 2008. Carib. J. Ornithol. 21:48–49), Bananaquits have not been reported to show such aggression. Over several years, we have also noted *A. stratulus* licking droplets containing dissolved sugar from the bowl following rain, but have never seen them eat granulated dry sugar.

Reptiles capable of utilizing human habitats such as artificial night-lights have an increased potential for such species to become invasive (Perry et al. 2008. *In* Jung and Mitchell [eds.], Urban Herpetology, pp. 239–256. Herpetological Conservation Vol. 3, Society for the Study of Amphibians and Reptiles, Salt Lake, Utah). Although we have never seen *A. stratulus* at night-lights, observations of them supplementing their diet from artificial feeders suggest they have some potential to become invasive, if introduced outside their native range. To date, however, the only record of introduction of this species is associated with a research project (Kraus 2009. Alien Reptiles and Amphibians. Springer, New York).

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ASPIDOSCELIS SONORAE (Sonoran Spotted Whiptail). **SCAVENGING BEHAVIOR.** *Aspidoscelis sonorae* is a moderately large (to 91 mm SVL), parthenogenetic teiid that occurs in northern Sonora, Mexico, southeastern Arizona, and extreme southwestern New Mexico, and known to be an active foraging insectivore (Sredl et al. 2009. *In* Jones and Lovich [eds.], Lizards of the American Southwest: A Photographic Field Guide, pp. 386–389. Rio Nuevo Publishers, Tucson, Arizona). On 24 April 2009 at 0838 h, in the Saguaro National Park East (Rincon Mountains), southeast Arizona, USA, I observed an adult *A. sonorae* scratching in organic litter at the base of a rock outcrop beneath a large saguaro cactus in bloom. As I observed the lizard forage, it tongue-flicked and scratched the substrate with its forefeet and poked the litter with its rostrum. During this foraging process, a dead honeybee (*Apis millifera*) was uncovered. The *A. sonorae* continued to scratch at the litter in the same area glancing over towards the dead honeybee twice, even moving the dead insect with its front right foot once while continuing to dig for a few more seconds (Fig. 1A). However, upon tongue-flicking the bee the *A. sonorae* turned its full attention

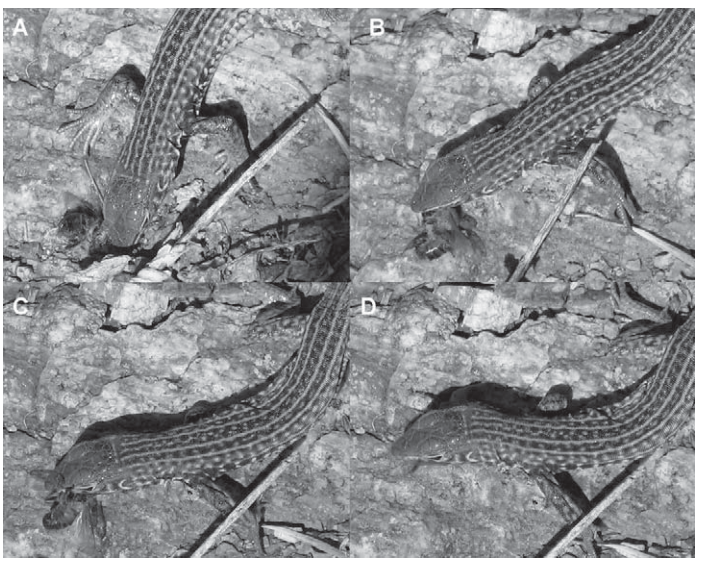


FIG. 1. *Aspidoscelis sonorae* consuming scavenged honeybee at Saguaro National Park East, Arizona, USA.

onto the unresponsive honeybee and after two successive tongue-flicks bit the bee on the head (Fig. 1B) and proceeded to consume the dead honeybee (Fig. 1C–D). To my knowledge, this is the first recorded observation of scavenging by *A. sonorae in situ*.

I thank Wade Sherbrooke for positive identification of the whiptail and comments, and Danny Martin for configuration of the photographs. I would also like to thank Mike Nolan for sharing some of his photographic expertise and hospitality during my trip to Tucson.

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BARISIA CILIARIS (Northern Imbricate Alligator Lizard). **ANTIPREDATOR BEHAVIOR**. The defensive loop posture has been observed in other anguid lizards including *Elgaria kingi* (Bowker 1987. Herpetol. Rev. 18:73–75), and *Barisia imbricata planifrons* (Bille 1997. Herpetol. Rev. 28:202). Here we document this defensive behavior in another anguid lizard, *Barisia ciliaris*. This behavior has sequences of occurrence with the following phenotypic categories, as defined by Greene (1988. *In* Gans and Huey [eds.], Biology of the Reptilia, Vol. 16, Ecology B, pp. 1–152. Academic Press, New York), the following models were recognized: 1) locomotory escape (attempting to avoid capture by hiding in forest litter); 2) head hiding (attaining a loop posture, the head is hidden under the tail); and 3) eversion of hemipenes. This behavior is common in most lizards.

Barisia ciliaris is distributed in the mountainous regions of the northern Mexican Plateau, from extreme southern Coahuila to Guanajuato, east to San Luis Potosi, Zacatecas, Durango, and Nuevo Leon (Smith and Taylor 1950. An Annotated Checklist and Key to the Reptiles of Mexico Exclusive of Snakes. Smithsonian Institution, Washington, D.C. 253 pp.; Lemos-Espinal and Smith 2007. Anfibios y Reptiles del Estado de Coahuila, México. Universidad Nacional Autónoma de México y Comisión Nacional Para El Conocimiento y Uso de la Biodiversidad. 550 pp.).

On 28 May 2007 an adult female *Barisia ciliaris* was caught on Cerro El Potosí in the municipality of Galeana, Nuevo Leon, (24.8675°N, 100.248338°W, elev. 3270 m, NAD27). The specimen was found at 1650 h, and was basking on top of a dry log. Upon detection of our presence, it immediately took refuge in a crevice within the log. The lizard was extracted from the log for data collection using a pair of forceps. Immediately after being captured, it rolled its body into a tight coil, attempting to hide its head under its tail. This posture was maintained until the lizard was released a half hour later.

The specimen was 104.9 mm SVL, with 147.2 mm TL, weight 31.5 g, with 17°C dorsal temperature, and 15°C substrate temperature. Surrounding habitat consisted of pine forest with *Pinus hartwegii* as the dominant species.

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CNEMIDOPHORUS OCELLIFER (Spix's Whiptail). **CANNIBALISM.** *Cnemidophorus ocellifer* is a widely distributed neotropical lizard, occurring in Argentina, Bolivia, Paraguay, and throughout Brazil, excluding Amazonia (Vanzolini et al. 1980. Répteis das Caatingas. Acad. Bras. de Ciênc., Rio de Janeiro, Brazil. 161 pp.). The diet of this lizard is composed mainly of arthropods, in which termites, insect larvae, orthopterans, spiders, and beetles are the main food items (Mesquita and Colli 2003. J. Herpetol. 37:498–509; Vitt 1995. Occas. Pap. Oklahoma Mus. Nat. Hist. 1:1–29). Here, we report the first recorded case of cannibalism in a population of *C. ocellifer* from the Caatinga of northeast Brazil.

During an ecological study of a population of *C. ocelllifer* in the Ecological Station of Seridó, Rio Grande do Norte state (06.5767°S, 37.2558°W; datum: WGS84; elev. 192 m), a sample of 70 individuals was collected between September 2008 and August 2009. The stomach contents of an adult female (70.7 mm SVL), collected on 26 June 2009, revealed conspecific ingestion. An undigested juvenile, indicative of recent ingestion, was found whole (32.5 mm SVL, volume = 1170.9 mm^3)(Fig. 1). The juvenile exhibited bite marks on the head, which was pointed toward the distal portion of the predator's stomach. This evidence indicates that the conspecific was captured in an attack and ingested head first, characteristic of a cannibalistic event.

To date, cases of cannibalism in Brazilian lizards have been recorded in nine species belonging to the families Gekkonidae, Liolaemidae, Scincidae, and Tropiduridae (see Siqueira and Ro-

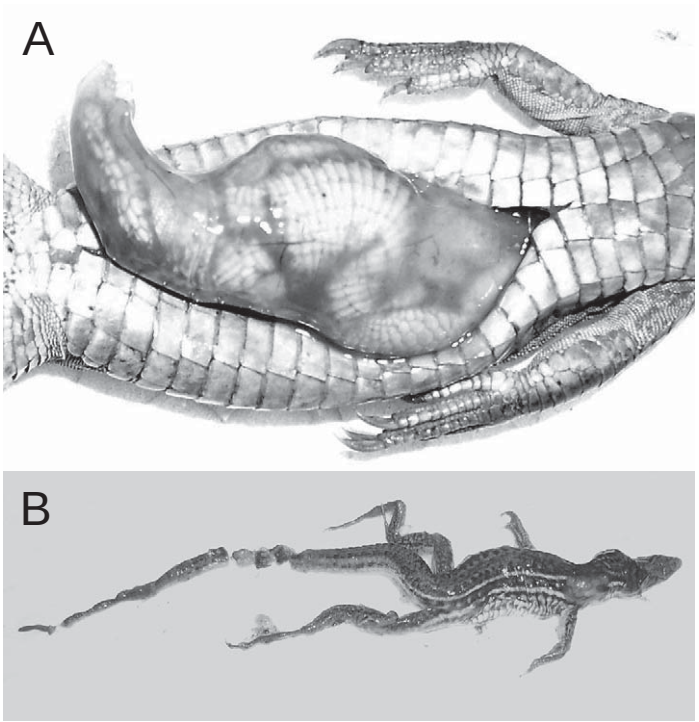


FIG. 1. Cannibalism in *Cnemidophorus ocellifer*: (A) stomach being removed; (B) young conspecific; note signs of bite marks on the head.

cha 2008. S. Am. J. Herpetol. 3:82–87). In the cases involving lizards with sexual dimorphism in body size, and when the sex of the cannibal was reported, the cannibalistic act was always committed by the sex with the larger body size (Siqueira and Rocha 2008, *op. cit.*). In our study, the opposite occurred; cannibalism was practiced by a single female, the sex with the smaller body size in this species.

The frequency of cannibalism occurrence in the population was low (1.4%), a finding consistent with the other reported cases of cannibalism in populations of Brazilian lizards (frequency ranged from 0.7 to 3.8%; Siqueira and Rocha 2008, *op. cit.*). According to Vitt (2000. Herpetol. Monogr. 14:388–400), lizards that capture large prey, such as vertebrates, may not need to forage for several days, owing to the large amount of nutrients provided by the ingested prey. Thus, what seems to be a "rare" event may be an event rarely recorded by investigators.

During the time we recorded the cannibalistic event, we observed an increased number of juveniles in the study area, reflecting a recruitment period. Relatively small body size, lack of experience in detecting potential predators, and the still inefficient recognition of habitat structure make juveniles potential prey for various types of predators (Siqueira and Rocha 2008, *op. cit.;* Vitt 2000, *op. cit.*). The elevated density of juveniles, along with the fact that a predator obtains greater nutritional benefits by capturing conspecifics or phylogenetically similar prey (Mayntz and Toft 2006. J. Anim. Ecol. 75:288–297; Pfennig 2000. Am. Nat. 155:335–345), might have been the main factors that led to the occurrence of this cannibalistic event.

The female specimen of *C. ocellifer* was deposited in the herpetological collection of the Universidade Federal do Rio Grande do Norte, Natal, Brazil (CHBEZ 2681). We thank the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) for financing the PELD-Caatinga Program entitled Structure and Functioning, and for the research scholarship granted to RFDS (process 127543/2008-2), LBR (process 141993/2006-5), and EMXF (process 304077/2008-9); IBAMA provided a permit (Permit 206/2006 and Process 02001.004294/03-15).

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COLEODACTYLUS NATALENSIS (NCN). **PREDATION.** *Coleodactylus natalensis*, described from the Parque Estadual Dunas de Natal (Freire 1999. Bol. Mus. Nac. 399:1–14), is a gecko considered to be endemic to Atlantic forest remnants in Rio Grande do Norte State, Brazil (Sousa and Freire, *in press*). Considered the smallest lizard in South America, it is a denizen of leaf litter within shaded forests (Capistrano and Freire 2009. PublICa 4:48–56; Freire 1999, *op. cit.*; Sousa and Freire, *op. cit.*). Aside from the description of the species (Freire, *op. cit.*), few ecological studies have been performed. Only some aspects of its diet, reproduction, and habitat preference have been published (Capistrano and Freire, *op. cit*; Lisboa et al. 2008. Herpetol. Rev. 39:221; Sousa and Freire, *in press*, Herpetol. Rev.). Few studies are available regarding prey-predator relationships between reptiles and arthropods within Brazilian communities, due to the time required for sampling and the elusive habits of many reptile species (Rocha and Vrcibradic 1998. Ciência e Cultura 50:364–368). Given the limited distribution of this species within remnant forests, additional information on its ecological relationships are essential to understanding its life history. Here, we report on an observation of predation on *Coleodactylus natalensis* by the ant, *Dinoponera quadriceps*.

The ant genus *Dinoponera* contains species with body sizes varying from 3–4 cm (Paiva and Brandão 1995. Ethol. Ecol. Evol. 7:297–312). *Dinoponera* ants are described as solitary foragers with predominantly carnivorous habits, ranging from humid forest soil to dry savannas (Fourcassié and Oliveira 2002. J. Nat. Hist. 36:2211–2227). The neotropical ant *D. quadriceps* is a typical queenless species of the subfamily Ponerinae, found in the isolated forest range (known locally as "Brejos de Altitude") in the semiarid Caatingas, Cerrado, and Atlantic Forest (Paiva and Brandão, *op. cit.*).

During a study of behavioral ecology on 7 March 2009, in the Parque Estadual Mata da Pipa (PEMP), municipality of Tibau do Sul, State of Rio Grande do Norte, Brazil (6.24861ºS, 35.05750°W; datum WGS84; elev. 63 m), PAGS saw an adult male *C. natalensis* (18.3 mm SVL) in the leaf litter of dense forest at 1100 h. The gecko crossed paths with a *D. quadriceps* (~3 cm from the anterior tip of the head to the posterior end of the abdomen) that was foraging in the near vicinity. The ant immediately grabbed the gecko by the neck with its jaws and proceeded to carry it to the nest. The animals were intercepted in order to collect the lizard.

This is the first record of a known predator for *C. natalensis*. We deposited the specimen (CHBEZ 2518) in the herpetological collection of the Universidade Federal do Rio Grande do Norte, Natal, Brazil. We thank the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) for the research scholarship granted to PAGS (process 127543/2008-2) and EMXF (process 304077/2008-9).

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COLEODACTYLUS NATALENSIS (NCN). **DIET.** *Coleodactylus natalensis*, described from the Parque Estadual Dunas de Natal (Freire 1999. Bol. Mus. Nac. 399:1–14), is considered endemic to Atlantic Forest remnants in Rio Grande do Norte State, Brazil (Sousa and Freire, *in press*). Considered the smallest lizard in South America, it is a shaded forest leaf-litter dweller (Capistrano and Freire 2009. PublICa 4:48–56; Freire 1999. Bol. Mus. Nac. 399:1–14; Sousa and Freire, *op. cit.*). The diet of *C. natalensis* in Parque Estadual Dunas de Natal is mostly arthropods. Isopods and spiders are the most frequent prey based on numbers, volume, and frequency, implying a preference for large prey that is less abundant in leaf litter (CMCAL, pers. obs.). *Coleodactylus meridionalis* has a similar diet, differing only in its relatively larger prey (Dias et al.

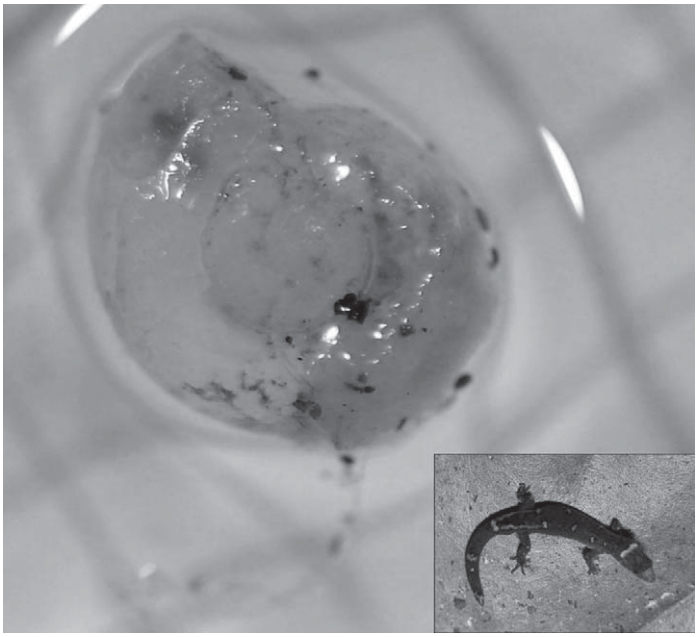


FIG. 1. The *Streptaxis* sp. snail taken from the stomach of *Coleodactylus natalensis* (inset).

2003. Herpetol. Rev. 34:142–143). *Coleodactylus septentrionalis* feeds mainly on termites (Isoptera) and earwigs (Dermaptera) (Vitt et al. 2005. Herpetol. Monogr. 19:137–152). *Coleodactylus amazonicus* seems to prefer collembolans (Collembola) and mites (Acari) (Ramos 1981. Acta Amaz. 11:511–526; Vitt et al., *op. cit.*). Though members of the genus *Coleodactylus* consume a relatively diverse assemblage of invertebrate prey, records of mollusk consumption are lacking. Hence, here we provide the first report of mollusk ingestion in the genus.

During a study of the structure of lizard assemblages in the Parque Estadual Mata da Pipa (PEMP), municipality of Tibau do Sul, State of Rio Grande do Norte, Brazil (6.24861ºS, 35.05750°W; datum WGS84; elev. 63 m), we examined the stomach contents of 16 *C. natalensis*. During this examination, we found a snail of the genus *Streptaxis* (Gastropoda, Streptaxidae) (2.1 mm long, 1 mm width, 10.99 mm^3 volume; Fig. 1), in the stomach of an adult female (20.3 mm SVL, 0.14 g) captured at 1230 h on 13 March 2009 (dry season) in the leaf litter of dense forest.

We deposited the *C. natalensis* (CHBEZ 2509) in the herpetological collection of the Universidade Federal do Rio Grande do Norte, Natal, Brazil. We thank the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) for the research scholarship granted to PAGS (process 127543/2008-2) and EMXF (process 304077/2008-9). We thank Marc Hayes for helpful comments on this note and Roberto Lima for identifying the snail.

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DIPLOGLOSSUS DELASAGRA (Cuban Pale-necked Galliwasp). **REPRODUCTION AND PARENTAL CARE.** Three endemic species of the subfamily Diploglossinae occur in Cuba, including *Diploglossus delasagra*, *D. garridoi*, and *D. nigropunctatus* (Thomas and Hedges 1998. Copeia 1998:97–103), however, information available on the natural history of these species is scarce. This is probably due to the cryptic and elusive habits exhibited by members of this genus, as observed in most anguids. For this reason, we feel that any attempt to gather and provide information on these species may be relevant to the current knowledge and understanding of their biology.

On 15 June 2007, a gravid female *D. delasagra* was collected in the leaf litter of a woodland patch by an unpaved road connecting the Las Palmas rural community (22.200889°N, 78.8394861°W, WGS84) and the town of Enrique Varona (Falla) (22.172875°N, 78.2002889°W), Chambas municipality, Ciego de Avila province, Cuba. These localities are separated from one another by ca. 6.4 km. The animal was brought to the Centro de Investigaciones de Ecosistemas Costeros (CIEC), and kept in captivity in order to collect data on its reproductive biology.

The individual was kept alive in a plastic bucket placed in a dark room for about 48 h from the time it was collected until it was brought to CIEC. Afterwards, the lizard was placed into a 170 × 190 mm plastic terrarium. One sample of the nearby semideciduous forest leaf litter was taken, allowing us to have a 3–4 cm depth layer at the bottom of the container. It was kept at room temperature, avoiding direct sunlight and thus excessive dehydration. Every two days, the leaf litter was sprayed with tap water to maintain relatively constant moisture.

The animal was periodically fed by providing forest soil-dwelling invertebrates, taking into consideration the feeding preferences for this species (Martínez Reyes and Moreno 2003. *In* L. Rodríguez Schettino [ed.], Anfibios y Reptiles de Cuba, pp. 90–97. UPC Print, Vaasa). The invertebrates were mostly spiders, ants, termites, and small mollusks. Around the mouth of the container, a thick mesh was firmly tied up to keep prey from escaping, and provide the lizard access to fresh air.

Behavioral observations were conducted during daylight hours in 90 min intervals for four days, 5–8 July 2007, between 0730 to 1900 h. The observations also comprised one 24 h cycle, but only on 9 July. Each observation period lasted 15 min, which totalled 12 h of direct observations. During the behavioral experiment, leaf litter temperature ranged between 27.5 and 30.6°C.

The female measured 96.0 mm SVL and 8.58 g body mass, and laid six eggs, which coincided with Schwartz and Henderson (1991. Amphibians and Reptiles of the West Indies. Descriptions, Distributions, and Natural History. University of Florida Press, Gainesville. xvi + 720 pp.); however, Cuban species of this genus may have up to nine eggs per clutch (Martínez Reyes and Moreno, *op. cit.*). Oviposition took place between 19 and 25 June; the clutch size was six eggs and after four days (29 June) measurements were made. Three eggs were chosen to be measured because they were laid at a shallow depth of 10 mm. The resulting egg measurements were slightly lower than those obtained by Barbour and Ramsden



FIG. 1. Female *Diploglossus delasagra* protecting its clutch with the body bent around one egg (arrow).

(1919. Mem. Mus. Comp. Zool. 47:69–213) (8.1 × 14.3 mm, 496.0 mm^3 vs. 9 × 17 mm, 720.6 mm^3).

In this study, the female was observed with her body coiled around one of the eggs 11–12 h post-laying (Fig. 1), which coincides with observations made on a female *D. nigropunctatus* (Barbour and Shreve 1937. Bull. Mus. Comp. Zool. 80:377–387). We noticed that the female remained indifferent to several kinds of stimuli such as camera flash and handling of the container. We also observed the female to rest her snout on one egg. Similar behavior has been described by Savage (2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna Between Two Continents, Between Two Seas. Univ. Chicago Press, Chicago, Illinois. 934 pp.) for a female *D. bilobatus* (Costa Rica).

On some occasions, when the female was completely hidden in the leaf litter layer, we searched the top layer to be certain of her position relative to her clutch. She never showed any evasive behaviors. A few times, she slowly buried herself into deeper levels of the leaf litter, but always stayed close (30–50 mm) to her eggs. Similar behavior was also observed in *D. nigropunctatus* by Barbour and Ramsden (*op. cit.*). The female did not display any aggressive behavior while we poked gently around the eggs, contrary to observation for *D. monotropis* (Central and South America) by Solórzano (2001. Fauna 2:8–12). In our case, the female remained indifferent to this kind of stimulus, but always kept an alert posture during disturbance.

No active feeding behavior was observed during the period in captivity, although food was always available. We interpret this as an indication that nest attendance was a priority, and which might be an energetically low-cost activity. However, during nocturnal cycles of observations, the female spent most of the time under the leaf litter, such that foraging might have gone undetected given that this species is thought to exhibit nocturnal habits (Martínez Reyes and Moreno, *op. cit.*).

Our observations on captive *D. delasagra* indicate that the adult female maintains a close and persistent physical proximity to its clutch, which is supported by observations by Greene et al. (2006. S. Am. J. Herpetol. 1:9–19). Other descriptions dealing with the parental care in this group of reptiles such as ingestion of embryonic remains and the closeness to the neonates by the female parent were not possible in this study, as the female was found dead on the morning of 11 July 2007. The cause of death is unknown.

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DRACO BECCARII (Beccar's Flying Dragon). **NESTING**. Nesting is often little-known in secretive animals such as reptiles, and lizards are no exception (Perry and Dmi'el 1994. Amphibia-Reptilia 15:395–401). Anecdotal observations can pave the way for quantitative studies that uncover behaviors associated with nesting and their evolutionary history, and the influence of nest site choice on reproductive success. Little information exists on the nesting habits of flying dragons, genus *Draco*.

On 9 July 2009 at 1245 h we discovered a nesting flying lizard (*Draco beccarii*) near Lapago Base Camp, ~7 km from Labundo Bundo, on the island of Buton in Sulawesi, Indonesia. The mother was on the ground with her head over an open chamber with three visible eggs in the bottom (Fig. 1). The eggs were not dimpled and were arranged in one layer (egg sizes, length followed by width: #1 = 12.6, 7.1; #2 = 12.2, 7.1; #3 = 12.7, 7.2). The mother (SVL = 76.4 mm, TL = 147.2 mm, mass = 5.5 g) was captured for photographs and measurements, palpated and found to contain no other eggs, and released at the nest site the following day. We backfilled the nest (depth to the top egg = 1.8 cm; chamber depth = 3.1 cm; chamber diameter ~3 cm). The nest site was in a small (~10 × 10 cm) spot of bare ground in an area with scattered leaf litter, on a scarcely used trail in rainforest. There was a sparse understory but



COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND

FIG. 1. A female *Draco beccarii* sits over her nest cavity with three eggs she just laid.

no shrubs near the nest site. The overstory was >95% canopy cover and was not visibly different than the surrounding area. The distance to the nearest tree was 1.5 m and there were several other trees within 10 m. The soil was luvisol and was moist but not saturated. Weather conditions during the observation were mostly sunny and ~27ºC, and followed a day of similar conditions but with some patchy, light rainfall.

Two nesting *D. beccarii* were similarly observed in July, 2000 (Table 1). Nine additional individuals were recorded as gravid females due to palpation, dissection, or terrestrial behavior (Table 1). The mean body sizes of gravid or nesting *D. beccarii* were SVL = 72.2 ± 9.99 mm SD; TL = 148.7 ± 9.94 mm SD; mass = 7.0 ± 1.29 g SD. Based on our observations the nesting season in *D. becarrii* spans (at least) all of July and August on Buton (Table 1).

TABLE 1. Female *Draco becarrii* observed or captured during the nesting season on Buton, Sulawesi. 1 = range for the previous 24 hrs (minimum-maximum); 2 = discovered while nesting, captured and palpated; 3 = captured by hand and palpated; 4 = captured in pitfall trap and palpated; 5 = discovered while nesting, not captured; 6 = sighted on ground but not captured 7 = found dead, dissected; S = sunny, C = cloudy, R = rainy; numbers after weather indicate rainfall amounts over the previous 24 hrs. * Sex determined by lack of colorful dewlap.

Date	time (h)	$(ºC)_1$	SVL (mm)	TL (mm)	mass (g)	reproductive condition	observation
10 Aug 00	~1200	n/a	75.0	n/a	n/a	laid 1 egg	2,S,0
28 Aug 00	~1200	n/a	79.0	n/a	n/a	laid 2 eggs	2,S,0
9 Jul 09	1245	~27	76.4	147.2	5.5	laid 3 eggs	2,S,0
19 Jul 09	1330	22.5-26.0	80.7	154.0	8.5	gravid (N = 4)	3,R,0
31 Jul 09	n/a	22.0-25.0	75.0	163.5	9.0	gravid (N = 4)	4,C,40
1 Aug 09	0945	22.0-24.5	n/a	n/a	n/a	digging nest	5,S,0
4 Aug 09	0900	22.5-26.0	47.3	153.8	6.5	gravid (N = 4)	3,C,0
4 Aug 09	1230	22.5-26.0	n/a	n/a	n/a	female*	6,S,0
6 Aug 09	1330	22.5-26.0	n/a	n/a	n/a	female*	6,S,0
11 Aug 09	1100	23.0-26.5	76.3	137.9	6.5	gravid (N = 3)	7,S,0
11 Aug 09	n/a	23.0-26.5	71.1	149.9	7.0	gravid (N = 3)	4,S,0
13 Aug 09	n/a	23.0-26.0	69.4	134.6	6.0	gravid (N = 2)	4,S,0

We are unaware of any published observations of this or other *Draco* species nesting in the wild, although there may be published information in non-indexed regional journals. The nesting behavior of *D. volans* and *D. spilopterus* in captivity was described by Magdefrau (1992. The Vivarium 4:13–15) and Card (1994. Herpetol. Rev. 25:65), respectively. It appears that *D. beccarii* does not seek out sunny places for nesting like most agamids, but rather nests more or less randomly with respect to canopy openness like many other rainforest-inhabiting tropical agamids (Greer 1989. The Biology and Evolution of Australian Lizards. Surrey Beatty and Sons, Chipping Norton, New South Wales). However, *Draco* appears to conform to the agamid pattern of nesting in the substrate on the forest floor (Greer 1989, *op. cit.*), despite its highly arboreal nature. In fact, it is possible that *Draco* only leaves the trees for nesting. Clutch size in the present observation fell between that reported for *D. melanopogon* (mean = 2, N = 14 and N = 90) and *D. volans* (mean = 4, N = 20) by Hendrickson (1966. Bull. Raffles Mus., Singapore 34:53–71) and Shine et al. (1998. J. Zool. Lond. 246:203–213).

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ENYALIUS PERDITUS (NCN) and ***ENYALIUS BILINEATUS*** (NCN). **PREDATION.** *Enyalius perditus* and *E. bilineatus* are typical Brazilian Atlantic forest species. However, *E. perditus* inhabits areas with humid vegetation and closed canopies, whereas *E. bilineatus* has a preference for more open areas (Jackson 1978. Arq. Zool. 30:1–79). Nevertheless, both species are sympatric with the leaf-litter spider, *Ctenus ornatus* (Ctenidae). This spider is nocturnal, spends most of its time hidden inside cracks or holes, has a preference for areas with dense vegetation, and avoids antropized areas (Almeida et al. 2000. Rev. Brasil. Biol. 60[3]: 503–509). We observed two separate predation events involving this spider on the young of two different *Enyalius* species—the first on *E. bilineatus* and the second on *E. perditus*. We believe these observations to be the first records of this spider predating on these respective lizard species.

On 14 October 2008, in the Municipal Park of Lajinha, in the municipality of Juiz de Fora, state of Minas Gerais, Brazil (21.792417°S, 43.380889°W; WGS84, 893 m elev.), we observed a young *E. bilineatus* (31.3 mm of SVL) being consumed by a *C. ornatus* spider with a cephalothorax length of 28.2 mm during the inspection of a funnel trap used in a reptile survey study. This animal had already been captured by the spider and was held by the neck region at the moment of the initial observation, with no signs of necrosis, which suggests that the capture probably occurred a short time before it. On 22 October, 2008, a young *E. perditus* (31.8 mm of SVL) was found being ingested by a spider of 21.8 mm (cephalothorax length). Upon intial observation, the spider was present inside the trap together with the lizard, with no signs of a predation event. As we initially attempted to take the lizard out of the trap, it evaded capture and approached the spider. It was then captured by the spider, also being held at the neck region. The observation of the necrosis evolution in both animals was carried out and, after about 7 h they were totally consumed, with the exception of a part of each animal's tail.

Because they inhabit the same environment, we believe that this kind of predation may commonly occur in the area. The spiders were deposited in the collection of terrestrial invertebrates of Universidade Federal de Juiz de Fora (CIUFJF 002–003). We thank the Cordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) for financial support and also IBAMA for issuing collection permit 16895-1.

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GEKKO GECKO (Tokay Gecko). **PREY.** *Gekko gecko* is an introduced species to Florida from SE Asia (King and Krakauer 1966. Quart. J. Florida Acad. Sci. 29:144–154). Known to be a highly aggressive predator (Smith 1935. The Fauna of British India. Reptilia and Amphibia Vol. II. Taylor and Francis, London. xiii + 440 pp.), *G. gecko* preys on a wide variety of food items in Florida (Meshaka et al. 1997. Florida Field Nat. 25:105–107; Love 2000. Herpetol. Rev. 31:174) and in SE Asia (Aowphol et al. 2006. Amphibia-Reptilia 27:491–503). *Romalea guttata* (Eastern Lubber Grasshopper), native to SE United States, is a chemically defended arthropod, which produces a highly complex defensive secretion when stressed (Whitman et al. 1991. Can. J. Zool. 69:2100–2108). Yosef and Witman (1992. Evol. Ecol. 6:527–536) reported that *Lanius ludovicianus* (Loggerhead Shrike) was the only species of 21 birds and lizards observed during laboratory and field studies to successfully feed on *R. guttata*. Common reactions by various species having ingested *R. guttata* are gagging, regurgitation, and death (Yosef and Witman 1992, *op. cit*.). Here we report the observation of an adult *G. gecko* successfully predating on an adult *R. guttata*.

On 6 June 2008 at ca. 0945 h (DST), an adult *G. gecko* was observed on the eastern-facing wall of a house in a residential community in Broward County, Florida, USA (26.0490°N, 80.3984°W). After turning to leave the area where the gecko was observed, a rustling sound followed by a crunching sound was heard. Upon investigation, the adult *G. gecko* was observed to have seized an adult *R. guttata* cross ways in its jaws. The gecko then moved to another wall of the house where it finished eating the grasshopper. The entire process took approximately ten minutes and at no time did the gecko flinch, gag, or regurgitate the grasshopper. Repeated examinations (1, 3, and 24 h) afterwards of the gecko and feeding locations produced no evidence of regurgitation.

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GERRHOSAURUS NIGROLINEATUS (Black-lined Plated Lizard). **ENDOPARASITES.** *Gerrhosaurus nigrolineatus* is known from Uganda, Rwanda, Tanzania, northeastern South Africa, west to Congo-Brazzaville, southwest to Angola (Spawls et al. 2002. A Field Guide to the Reptiles of East Africa. Academic Press, San Diego. 543 pp.). We established an initial helminth list for *G. nigrolineatus* by examining three specimens (two females, one male) (SVL = 160, 132, 143 mm) collected in February 1968 from Rakai District, Uganda and deposited in the Natural History Museum of Los Angeles County, Los Angeles, California USA (LACM 39470, 39474, 39483). The lizards were opened by a mid-ventral incision. The digestive tract was removed and examined for endoparasites using a dissecting microscope. The body cavity was also searched. Six cestodes were found, three in the small intestines of LACM 39474 and 39483. The cestodes were cleared in xylol, regressively stained in haematoxylin, mounted in balsam, studied under a compound microscope and identified as *Oochoristica truncata* (prevalence, lizards infected/lizards examined × 100 = 67%). Cestodes were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland, USA as *Oochoristica truncata* (USNPC 102415).

Oochoristica truncata is likely the most common tapeworm in reptiles in southern Africa and has been reported from agamid, chamelonid, gekkonid and scincid lizards and boid and colubrid snakes (Spasskii 1951. Anoplocephalate Tapeworms of Domestic and Wild Animals. Acad. Sci. USSR, Moscow. 783 pp.; Goldberg and Bursey 2004. Afr. Zool. 39:111–114; Goldberg et al. 1999. Comp. Parasitol. 66:78–80). Although the life cycle of *O. truncata* is not known, Conn (1985. J. Parasitol. 71:10–16) reported beetles acted as intermediate hosts for the congener, *O. anolis*. *Oochoristica truncata* in *Gerrhosaurus nigrolineatus* represents a new host record and the Gerrhosauridae represents a new host family record for *O. truncata*.

We thank Christine Thacker (LACM) for permission to examine specimens and Cecilia Nava (Whittier College) for assistance with dissections.

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GONATODES ATRICUCULLARIS (Cajamarca Gecko). **ENDOPARASITES.** *Gonatodes atricucullaris* is known only from Bellavista, Cajamarca Department, Peru (Uetz and Hallermann 2009. www.reptile-database.org. Accessed 2 February 2010). To our knowledge there are no reports of helminths from this species. The purpose of this note is to establish the initial helminth list for *G. atricucullaris*.

Four *G. atricucullaris* (mean SVL = 31.5 mm ± 1.3 SD, range: 30–33 mm SVL) collected in November 1968, from Bellevista, (7.06667°S, 76.5333°W, datum WGS84; elev. 295 m) Cajamarca Department, Peru, were borrowed from the herpetology collection

of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California: LACM 49352, 49355, 49358, 49359.

The body cavities were opened and the digestive tracts were removed. Contents were examined under a dissecting microscope. Found in the stomachs of LACM 49355 and 49359 were 5 and 21 mature nematodes, respectively. In the large intestine of LACM 49352 was one 3rd stage larva. These were each placed in a drop of glycerol on glass slide, cover-slipped and identified using a compound microscope as *Physaloptera retusa.* Prevalence (number infected lizards/total lizards examined × 100) was 75%. Mean intensity (mean number of worms/infected host ± SD) was 9.0 ± 10.6 SD, range: 1–21. Voucher helminths were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland, USA as USNPC 102885.

Physaloptera retusa is widely distributed in lizards in the western hemisphere and is known from North and South America, the Caribbean and Mexico (Goldberg et al. 2007. Comp. Parasitol. 74:327–342). Species of *Physaloptera* utilize insects as intermediate hosts; lizards become infected by ingesting insects that contain infective larvae (Anderson 2000. Nematode Parasites of Vertebrates: Their Development and Transmission 2nd ed. CABI Publishing, Oxfordshire, UK. 650 pp.) *Gonatodes atricucullaris* represents a new host record for *Physaloptera retusa*.

We thank C. Thacker (LACM) for permission to examine specimens and O. Mac (Whittier College) for assistance with dissections.

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GYMNODACTYLUS GECKOIDES (Naked-toed Gecko). **ENDOPARASITES.** *Gymnodactylus geckoides* is known from northeastern Brazil to Central Brazil (Vanzolini 2004. An. Acad. Brasil. Cien. 76:663–698). Three subspecies are recognized (Vanzolini, *op. cit.*). Kossack (1910. Centralbl. Backteriol. Parasit. 56:114–120) found a digenean in a liver cyst of *G. geckoides*. Herein we add to the helminth list for this species.

Thirty-five *G. geckoides amarali* (mean SVL = 38.8 mm ± 9.7 SD, range = 22–49 mm) collected in Brazil, Tocantins State, Caseara (09.2111111°S, 49.8369444°W; WGS 84; elev. 210 m) in September–October 2005 by LJV and deposited in the Sam Noble Oklahoma Museum of Natural History, Norman, Oklahoma as OMNH 42362–42396 were examined for helminths.

The body cavity was opened and the digestive tract was removed and examined under a dissecting microscope. Stomachs had been previously removed and were not available for examination. Eight female nematodes were found in the large intestine of OMNH 42366. Prevalence (infected lizards/lizards examined × 100) was 3%. Nematodes were cleared in glycerol, studied under a compound microscope and identified as *Spauligodon oxkutzcabiensis.* They were deposited in the United States National Parasite Collection, Beltsville, Maryland, USA as USNPC 102694.

Spauligodon oxkutzcabiensis is known from lizards in Mexico, Central and South America. Records are listed in Goldberg and Bursey (2009. Herpetol. Rev. 40:224). To this list should be added: *Microlophis occipitalis* from Peru (Goldberg and Bursey 2009. Salamandra 45:125–128); *Phyllodactylus inaequalis, P. johnwrighti, P. microphyllus* from Peru (Goldberg and Bursey 2010. Comp. Parasitol. *in press*) and *P. unctus* from Mexico (Goldberg and Bursey 2010. Herpetol. Rev. 41:84–85). The life cycle of *S. oxkutzcabiensis* is not known, however, infection of the congener *S. giganteus* occurs by ingestion of eggs in fecal contaminated substrate (Goldberg and Bursey 1992. J. Parasitol. 78:539–541). *Spauligodon oxkutzcabiensis* in *G. geckoides* is a new host record. Brazil is a new locality record.

We thank Cecilia Nava (Whittier College) for assistance with dissections.

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HEMIDACTYLUS MABOUIA (Tropical House Gecko). **CANNIBALISM**. Intraspecific predation of juveniles by adult lizards has been reported in some species (Polis and Myers 1985. J. Herpetol. 19:99–107; Germano and Williams 1994. Herpetol. Rev. 25:26–27; Siqueira and Rocha 2008. S. Am. J. Herpetol. 3:82–87). Among 67 stomachs examined of *Hemidactylus mabouia* specimens, only a single adult stomach contained a conspecific juvenile (Zamprogno and Teixeira 1998. Herpetol. Rev. 29:41–42). Herein, we report the second observation of cannibalism in this gecko.

At ca. 0100 h on 4 January 2010, outside of a house in an urban area (22.9091667°S, 47.0477778° W, 680 m elev.), municipality of Campinas, State of São Paulo, southeastern Brazil, we observed an adult *H. mabouia* with the head of a conspecific juvenile inside its mouth (Fig. 1). The adult gecko had a SVL of ca. 120 mm and the smaller lizard was ca. 50 mm SVL. However, ingestion of the



FIG. 1. An adult *Hemidactylus mabouia* preying upon a conspecific juvenile in municipality of Campinas, State of São Paulo, Brazil.

juvenile was not successful by the adult gecko and the juvenile escaped. We do not know if the unsuccessful predation is result of photographer disturbance. JPP thanks CNPq for financial support.

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HOLBROOKIA APPROXIMANS (Speckled Earless Lizard). **PREDATION.** This phrynosomatid lizard has a wide distribution throughout the southwestern United States and much of the northwest central portion of Mexico (Conant and Collins 1998. A Field Guide to the Reptiles and Amphibian of Eastern and Central North American, 3rd ed. Houghton Mifflin, Boston, Massachusetts. 450 pp.; Stebbins 2003. A Field Guide to Western Reptiles and Amphibians, 3rd ed. Houghton Mifflin, New York. 533 pp.). Smith (1979. Handbook of Lizards. Comstock Publishing Associates, Cornell University Press, Ithaca, New York. 557 pp.) mentioned that a specimen of this species had been consumed by a large *Bufo alvarius* (=*Incilius alvaria*), and another by a "small hawk" but did not provide any specific species. The Burrowing Owl (*Athene cunicularia*) has a wide distribution throughout much of North and South America including the Caribbean (American Ornithologists Union 1983.Check-list of North American Birds, 6th ed. Allen Press, Inc. Lawrence, Kansas. 877 pp.; Wellicome and Holroyd 2001. J. Raptor Res. 35:269–273). This species has been the focus of extensive study in the last twenty years (McDonald et al. 2004. The Burrowing Owl (*Athene cunicularia*): A Technical Conservation Assessment. USDA Forest Service, Rocky Mountain Region. http://www.fs.fed.us./r2/projects/scp/assessments/burrowingowl.pdf). Reports of its food habits have been documented (Coulombe 1971. Condor 73:162–176; Grant 1965. Loon 37:2–17; Marti 1974. Condor 76:45–61; Valdez-Gómez 2003. Dieta del tecolote llanero occidental *Athene cunicularia* [Bonaparte 1825], durante su estancia invernal en el bajío mexicano. Las Agujas Zapopan, Universidad de Guadalajara. Licienciatura 41 pp.) but most predation records are for mammals, birds, and invertebrates, with a limited number of herpetofaunal species (Moulton et al. 2006. J. Wildl. Manag. 70:708–716). Here, we add *Holbrookia approximans* as prey to this owl's diet.

On 12 December 2002, during analysis of regurgitated owl pellets collected during a survey on the winter ecology of *A. cunicularia*, a skull (14.3 mm) of an adult *H. approximans* was discovered in one of 128 pellets examined from Llano de la Soledad (25.0958111°N, 100.8104056°W; datum WGS84, elev. 1850 m), in the municipality of Galeana, Nuevo Leon, Mexico. Native vegetation of the study area consists of open grassland bordered by an association of *Larrea tridentata*, *Flourensia cernua*, *Rhus microphylla*, *Prosopis* sp., and *Acacia* sp. The study area has been modified by extensive potato culture.

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IGUANA IGUANA (Green Iguana). **PREDATION.** Both juvenile and adult Green Iguanas are preyed on by a wide variety of avian, mammalian, and reptilian predators (Greene et al. 1978. J. Herpetol. 12:169–176; Rivas et al. 1998. Herpetol. Rev. 29:238–239). In general, juvenile Green Iguanas suffer higher mortality from birds while larger size classes are taken more frequently by reptilian and mammalian predators (Rivas et al. 1998, *op. cit*). Here we report a nocturnal predation event on a subadult *Iguana iguana* by an avian predator at the Iguana Verde Foundation (IVF) located in the Gandoca-Manzanillo Wildlife Refuge (09.63818°N, 82.70496°W; datum WGS84), Limón, Costa Rica. The IVF is an education and conservation breeding facility with several natural iguana open-air exclosures (up to 2000 m^2) of mixed male and female age classes.

At 1830 h on 28 May 2009, we observed an adult Spectacled Owl, *Pulsatrix perspicillata*, flying overhead with a subadult (ca. 20 cm SVL) *I. iguana* in its talons. Nocturnal predation events are observed rarely and to our knowledge this is the first account of predation on *I. iguana* by any avian species in the family Strigidae and augments our knowledge of nocturnal predators of Green Iguanas.

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JAPALURA SWINHONIS (Swinhoe's Tree Lizard). **SPINAL DEFORMITY**. Scoliosis and kyphoscoliosis have been recorded in lizards, snakes, and a few chelonians and crocodilians, and may appear at birth or hatching, or after some period of apparent normal skeletal growth and development (Frye 1991. Biomedical and Surgical Aspects of Captive Reptile Husbandry. Krieger Publ. Co., Malabar, Florida. 637 pp.). As for the latter, the etiologies may be due to an expression of sub-lethal genetic defects, or may be caused by some acquired environmental condition such as thermal or physical trauma, metabolic bone diseases, or osteomyelitis (Frye, *op. cit*.).

At ca. 1000 h on June 4 2008, JHW observed two male *Japalura swinhonis* engaged in a territorial dispute next to a paved road in Yunlin County, Taiwan (23.6092ºN, 120.5784ºE; TWD97, elev. 178 m). After capturing one of them as part of a study of internal parasites, we noted that it had a deformed spine and base of tail (Fig. 1). The lizard had a SVL, tail length, and mass of 66 mm,

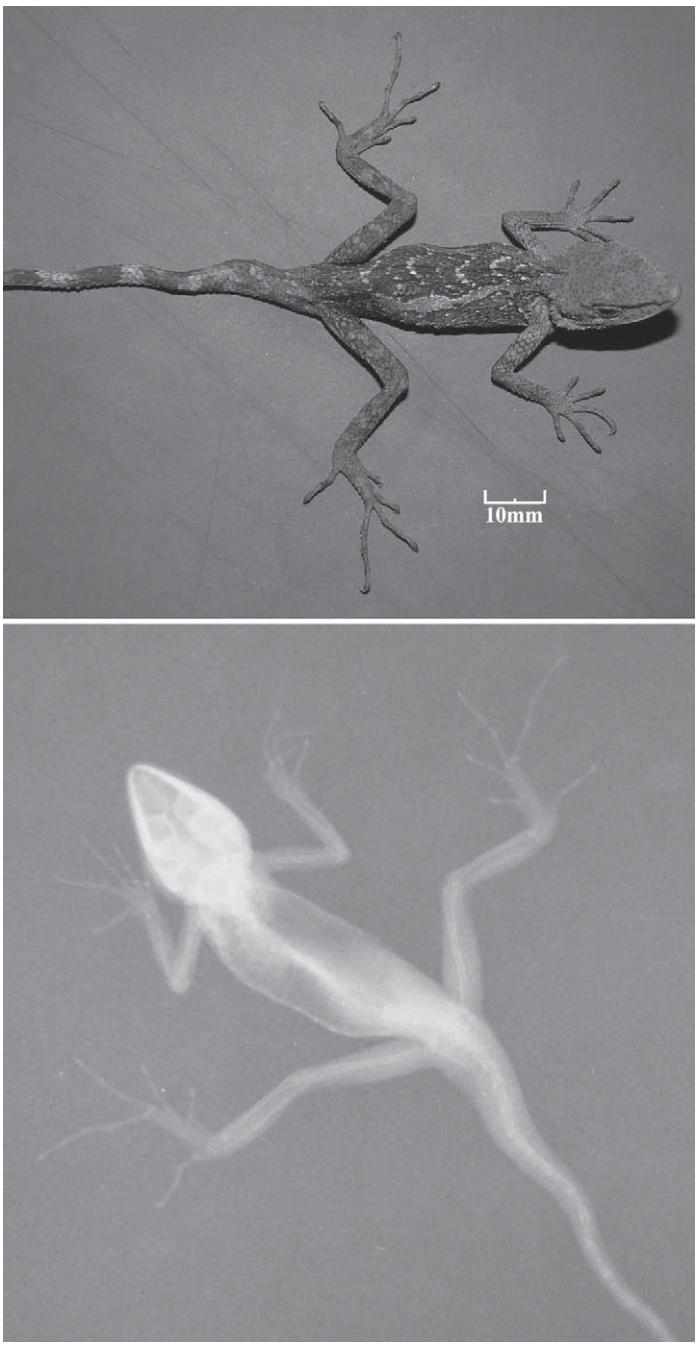


FIG. 1. The dorsal view (top), and radiograph (bottom) of the Swinhoe's Tree Lizard (*Japalura swinhonis*), illustrating the deformed spine.

159 mm, and 6.9 g, respectively. A radiograph was taken, but we observed no fractures or other abnormalities (Fig. 1). The common symptoms of osteodystrophy—fractured limbs or hindlimb paresis, swollen limbs and digits, swollen mandibles, dull coloration, anorexia and lethargy, and/or hypocalcaemic tetany and seizures (O'Malley 2007. Irish Vet. J. 60:303–309)—were not observed, and the lizard appeared healthy. After flushing its stomach for internal parasites, the animal was maintained in captivity for a month, and was then released back into the wild at the same location where it was collected. During the period of captivity, the condition of the lizard did not visibly deteriorate or improve, and since the animal was free-living, we believe that this condition is due to a sub-lethal genetic defect. To our knowledge, this appears to be the first reported instance of such a condition in *J. swinhonis* in the wild.

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KENTROPYX VANZOI (NCN). **ENDOPARASITES.** The poorly known teiid *Kentropyx vanzoi* is a medium-sized lizard that inhabits open habitats along river systems in central Brazil (Gallagher and Dixon 1980. Copeia 1980:616–620). To the best of our knowledge no reports on endoparasites have been published for this species. Herein, we provide information on helminth parasites of *K. vanzoi* from two localities of Mato Grosso state, Central Brazil.

Three *K. vanzoi* specimens were examined for endoparasites from the Coleção Zoológica de Vertebrados da Universidade Federal de Mato Grosso. The lizards were collected from two localities dominated by Cerrado (savanna-like vegetation) in the Mato Grosso state in the municipality of São José do Rio Claro (13.8122°S, 56.6900°W; datum: SAD69); and in the municipality of Primavera do Leste (15.2267°S, 54.0469°W; datum SAD69). The specimen (UFMT 398) from São José do Rio Claro was an adult female collected from a pit-fall trap on 27 May 2001. The specimens (UFMT 1757, 1758) from Primavera do Leste were an adult female and an adult male, respectively, also collected from pitfall traps between 10–14 July 2008. We opened and separately examined the specimens for helminths in the body cavity, esophagus, stomach, lungs, and small and large intestines under a stereomicroscope. Helminths were cleared in phenol, identified, and deposited in the Coleção Helmintológica do Instituto de Biociências da Unesp de Botucatu. The nematode *Physalopteroides venancioi* was found in the body cavity of the female specimen from São José do Rio Claro. Larvae of the cestode *Oochoristica* sp. were recovered from the body cavity and two females of the nematode *Parapharyngodon senisfaciecaudus* were recovered from the large intestine of the female specimen from Primavera do Leste. The male specimen from Primavera do Leste was uninfected.

Reports on endoparasites from *Kentropyx* species in Brazil are scarce and restricted to *K. calcarata*, and include *Kentropyxia sauria* (Baker 1982. Proc. Helminthol. Soc. Washington 49:252–257; Goldberg et al. 2007. Comp. Parasitol. 74:327–342), *Oswaldocruzia* sp. (Ávila and Silva 2009. J. Helminthol. 83:267–269), *Piratuba shawi* (Vicente et al. 1993. Rev. Bras. Zool. 10:19–168), *P. digiticauda* (Ávila and Silva, *op. cit.*), *Physalopteroides venancioi* (Ávila and Silva, *op. cit.*), and *Physaloptera retusa* (Ávila and Silva, *op. cit.*; Goldberg et al., *op. cit.*). Thus, *K. vanzoi* represents a new host record for *Oochoristica* sp., *P. senisfaciecaudus*, and *P. venancioi*. To the best of our knowledge, Brazil represents a new country record for *P. senisfaciecaudus* and Mato Grosso state represents a new locality record for *Parapharyngodon senisfaciecaudus*.

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LEIOSAURUS CATAMARCENSIS (NCN). **CLUTCH SIZE**. *Leiosaurus catamarcensis* is an inhabitant of the Monte phytogeographical province (Cei. 1993. Mus. Reg. Sci. Nat. Torino Monogr. 14:1–949). The biology of this species is poorly known. Blanco and Acosta (2003. Herpetol. Rev. 34:145) reported on clutch size for one female of this species, observing 10 eggs. Villavicencio et al. (2006. Actas de Congreso Argentino de Herpetología, Corrientes. 15 pp.), established the thermal parameters for this species. In this note we report the clutch size for one lizard under laboratory conditions in order to contribute to the limited knowledge of this species' reproductive biology.

During December 2008, a basking female *L. catamarcensis* (84 mm SVL, 21 g) was hand-captured in the field at 0930 h, in San Juan Province, Calingasta Department, on Nacional Route Nº 149 (31.14°S, 69.01°W; datum WGS 84, elev. 2500 m).

Six days after capture on 11 December 2008, this lizard laid a clutch of seven eggs in the laboratory (25ºC and 30% relative humidity). Total egg mass was 6 g, 28.5% of the female mass. Mean egg length was 17.67 ± 0.53 mm and mean egg width was 10.97 ± 0.45 mm. Mean egg volume was estimated (114.5 ± 7.07 mm^3), using the equation [V= 4/3π (L/2) $(W/2)^2$] for an elliptical sphere (Dunham 1983. *In* Huey et al. [eds.], Lizard Ecology, pp. 261–280. Harvard University Press, Cambridge, Massachusetts). To our knowledge, this is the second report of clutch size for this species.

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PHRYNOSOMA BRACONNIERI (Short-tailed Horned Lizard). **DEFENSIVE BLOOD-SQUIRTING BEHAVIOR.** On 6 June 2007, one of us (CR) picked up an adult *Phrynosoma braconnieri* (sex unknown) at 1400 h in hills 8.0 km NW of Cacaloapan, Municipio de Tepanco de López, Puebla, México. The lizard was carried by hand up the trail a short way until it was realized that it had ejected blood from its right eye. Blood on the lizard's eyelids, face, and lower jaw was photographed. It may have been the result of a single or a few squirts. There were no canids in the field with the collector. Six other encounters (CR) involving hand collection of the same species failed to elicit blood-squirting behavior: (N = 1) 5.3 k further west of Cacaloapan (later the same day; 1600 h); (N = 1) at (San Juan Bautista) Cuicatlan, Oaxaca, México (17 June 2006); and (N = 4) at Rancho Tejas (near Ixtlan de Juarez), Oaxaca, México (27 September 2009). All animals were of subadult to adult size (sexes 0.2.2). Similar encounters with *P. braconnieri* (N = 5) in Puebla, México, in 2003 all failed to elicit blood-squirting during hand-capture by humans (Sherbrooke and Mendoza-Quijano 2005. Herpetol. Rev. 36:65–66). Combining our similar encounters (human capture-by-hand), 8% (1 of 12) of the lizards squirted blood.

In the first recognition of the possibility of differences in the occurrence of anti-predator blood-squirting responses between living species of horned lizards (*Phrynosoma* spp.) Sherbrooke and Middendorf (2001. Copeia 2001:1114–1122) predicted, based on purported phylogenetic relationships, that *P. braconnieri* would be determined to be a species utilizing a blood-squirting defense. That prediction was based solely on *P. braconnieri* being a sister taxon of *P. taurus*, a species previously reported to be capable of blood-squirting (Ruthling 1919. Copeia [72]:67–68). Subsequently, following reevaluation of the occurrence of blood-squirting in *P. taurus* that involved both field collection by humans and canid (dog-bioassay) trials, the earlier report (Ruthling 1919, *op. cit.*) of blood-squirting by *P. taurus* was questioned (Sherbrooke et al. 2004. Herpetol. Rev. 35:345–347). With that apparent reversal of designation of *P. taurus* (from a blood-squirting to an apparent non-blood-squirting species) it was suggested that *P. braconnieri* might also have lost its defensive blood-squirting. This attribute appears to be plesiomorphic in the genus (Sherbrooke and Middendorf 2001, *op. cit.*; Leaché and McGuire 2006. Mol. Phylogen. Evol. 39:628–644). The conclusion that *P. braconnieri* may have lost its blood-squirting defense was further supported by negative results during limited dog-bioassay trials (Sherbrooke and Mendoza-Quijano 2005. Herpetol. Rev. 36:66–67). It had also been noted that the earlier prediction that *P. braconnieri* might be a blood-squirting species (Sherbrooke and Middendorf 2001, *op. cit.*), based on its sister-taxon relationship with *P. taurus*, was premature. In addition, Hodges (2004. Southwest. Nat. 49:267–270) reported no blood squirting in response to human hand-capture of *P. braconnieri* (N = 6) and *P. taurus* (N = 20). The negative results, from field encounters by humans and from dog-bioassay trials, and the apparent reversal in status of *P. taurus* did not fully resolve the blood-squirting status of *P. braconnieri*. Confounding factors such as the occurrence of eyelid puffiness during dog trials (a precondition to blood ejection; Middendorf and Sherbrooke 1992. Copeia 1992:519–527) and the inherent difficulty in establishing negative conclusions from negative results remained.

Shortly thereafter a field report of an apparent single squirt of blood during human hand-capture of a *P. taurus* (Garcia-Vazquez and Canseco-Marquez 2006. Herpetol. Rev. 37:347) brought into question the earlier suggestion that *P. taurus*, and, by implication, possibly *P. braconnieri* were non-blood-squirting species (Sherbrooke et al. 2004, *op. cit.*). In a similar apparent "reversal" in evaluation of blood-squirting status for a species (see discussion below), we here report the first evidence of a blood-squirting response (to human handling) by *P. braconnieri*, the other member of its sister-taxon pair *braconnieri-taurus*.

This report leaves unresolved questions surrounding the natural conditions under which a horned lizard's defense of squirting blood from ocular blood-sinuses may be employed by *P. braconnieri*, with canids or other predators (Middendorf and Sherbrooke 1992, *op. cit.*; Sherbrooke and Mason 2005. Southwest. Nat. 50:216–222; Sherbrooke and Middendorf 2004. Copeia 2004:652–658). In addition, our report, with that of Garcia-Vazquez and Canseco-Marquez (2006, *op. cit.*) for *P. taurus*, suggests the need for cau-

tious revisions to interpretations of the phylogenetic history of blood-squirting presented by Sherbrooke and Middendorf (2001, *op. cit.*) and by Leaché and McGuire (2006, *op. cit.*). The *braconnieri-taurus* lineage can probably no longer be considered as one in which blood-squirting has been "lost," certainly not completely. Can such decisions regarding evolutionary trends/changes in a species be based on a one-time observation of a single individual? The frequency of occurrence, effectiveness, and taxonomic range (of target predators) (natural: coyotes, foxes, etc.; unnatural: humans) of horned lizards utilizing this defense remain largely unknown (but see Middendorf and Sherbrooke 1992, *op. cit.*; Sherbrooke and Middendorf 2001, 2004, *op. cit.*). And, in both cases, the "reversals" in blood-squirting status of *P. braconnieri* and *P. taurus* are based on single observations with humans. Under stress of capture by a human other lizards may rarely exhibit ocular bleeding (*Sceloporus jarrovii* and *Urosaurus ornatus*, Sherbrooke 2000. Herpetol. Rev. 31:243; *Sceloporus occidentalis* Klauber 1939. Bull. Zool. Soc. San Diego 14:80–100, and J. Shedd, pers. comm.).

Without the presentation of a proper stimulus or stimuli, and other possibly unknown conditions, we should not expect to elicit a defensive blood-squirting response from a horned lizard even if it is capable of the response. One species, *P. ditmarsi*, was evaluated in two series of dog-bioassay trials before it was shown to squirt ocular-sinus blood (Sherbrooke and Middendorf 2001, *op. cit.*; Hodges 2004, *op. cit.*).

The history of evaluations of *P. braconnieri* and *P. taurus* as blood-squirting or non-blood-squirting serves as a cautionary tale for those trying to come to conclusions regarding the occurrence, presence or absence, of blood-squirting in species of horned lizards. Note should be made that the "nonblood-squirting" designation used by Sherbrooke and Middendorf (2001, *op. cit.*) called attention to the low frequency of blood squirting (relative to *P. cornutum*, *P. hernandesi*, and *P. solare*) within the clade *mcallii-modestum-platyrhinos* of horned lizards, not to its complete absence (two of the three species within this clade were reported to have squirted blood on rare occasions). Without knowing more about the frequency of occurrence of blood squirting within and between geographic populations of a species and under a broader array of potential predator-prey encounters, it remains difficult to conclude that a species has lost blood squirting as a defense, even if it has never been recorded. Conclusions based solely on an absence or reduced frequency of blood-squirting during limited field encounters with humans (probably not representative of evolutionarily determined predator-threat stimuli) and on dog-canid trials (as in the cases of *mcallii-modestum-platyrhinos* and *braconnieri-taurus*) may be suggestive of evolutionary trends but may also lead to confusion. This could be due to their limited scope and subtleties in the nature of the evolved role(s) of blood-squirting in horned lizard species. Lower frequencies of occurrence in some species may be influenced by lack of appropriate elicitation stimuli (type of predator), the physiological condition of lizards, or factors such as individual, population or species dietary history (types and predominance of ants; a potential source of anti-predator chemical compounds [Sherbrooke and Middendorf 2004, *op. cit.*; Sherbrooke and B. A. Kimball, unpubl. data]).

Thus, we are left with questions; are species of horned lizards in which blood squirting remains unreported (*P. douglassi* and *P. mcallii*; also *P. coronatum*, *P. cerroense*, *P. wigginsi*, *sensu* Montanucci 2004. Herpetologica 60:117–139, and Leaché et al. 2009. PNAS 106:12418–12423) or has been reported at low frequencies to humans and canids (*P. braconnieri*, *P. goodei*, *P. modestum*, *P. platyrhinos*, *P. taurus*) "non-blood squirting" species? Are these species in some stage of losing the defense, or is their apparent "non-blood squirting" designation the result of our own restricted insights into its frequency and distribution of occurrence under varied conditions in nature? We hope that awareness of these issues can help us formulate and test hypotheses that may lead to a better understanding of this fascinating defense.

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PHRYNOSOMA HERNANDESI (Greater Short-horned Lizard). **PREDATION**. Although arthropods are well known predators of vertebrates (review in McCormick and Polis 1982. Biol. Rev. 57:29–58), the impact of arthropod predation on lizards has received little attention (Vitt 2000. Herpetol. Monogr. 14:388–400). Among arthropods, spiders are often reported to prey on vertebrates, especially anurans (review in Toledo 2005. Herpetol. Rev. 36:395–400), although they infrequently include lizards (Cokendolpher 1977. J. Arachnol. 5[2]:184; Corey 1988. J. Arachnol. 16[3]:391–392). Blondheim and Werner (1989. Brit. Herpetol. Soc. Bull. London 30:26–27) reported the lacertid lizard, *Mesalina guttulata*, predated by the widow spiders (*Latrodectus pallidus* and *L. revivensis;* Theridiidae), Schwammer and Baurecht (1988. Herpetozoa, Wien 1[1/2]:73–76) reported the lacertid, *Podarcis melisellensis*, as prey of the widow spider (*L. mactans*), and Hodar and Sanchez-Piñero (2002. J. Zool. Lond. 257:101–109) reported the lacertids, *Acanthodactylus erythrurus*, *Psammodromus hispanicus*, and *P. algirus*, and the gekkonid, *Tarentola mauritanica* as prey of the widow spider, *L. lilianae*. Large arthropods incapable of capturing adult lizards are likely significant predators of neonatal lizards, especially those < 50 mm SVL (Vitt 2000, *op cit.*).

On 21 July 2009 one of us (LKK) discovered a subadult female Western Black Widow Spider (*Latrodectus hesperus*; ca. 9 mm body length) that had completely ensnared a neonate *Phyrnosoma hernandesi* (SVL 21 mm; TL 9 mm) that was caught in a large funnel trap set for terrestrial snakes in grassland habitat. The observation occurred in New Mexico, Bernalillo County, Albuquerque, Kirtland Air Force Base, USA. The *P. hernandesi* was dead and was being attended by the Black Widow as if feeding on the lizard. Both were collected and are deposited in the Museum of Southwestern Biology Division of Arthropods (*L. hesperus* MSBA 23492) and Division of Herpetology (*P. hernandesi* MSB 76339). To our knowledge this is the first report of *P. hernandesi* being preyed upon by the Western Black Widow Spider.

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PHRYNOSOMA MODESTUM (Round-tailed Horned Lizard). **BLOOD-SQUIRTING**. *Phrynosoma modestum* was heretofore thought to be a member of a "non-blood-squirting" clade including *P. mcallii* and *P. platyrhinos* (Sherbrooke and Middendorf III. 2001. Copeia 2001:1114–1122). Here we report blood-squirting by *P. modestum*.

At 1530 h on 14 August 2009 we collected an adult male (50 mm SVL, 6.4 g) Round-tailed Horned Lizard (*Phrynosoma modestum*) ca. 7 km SE of Fowler in Otero County, southeastern Colorado, USA. When first captured, the specimen squirmed and ultimately wriggled out of DW's hand. The animal darted several meters while evading capture, and was subsequently pinned to the ground with more pressure than normal to prevent a second escape. At this time the specimen squirted a small amount of blood (ca. 0.025 ml) from an ocular sinus of the right eye. Blood was also visible surrounding the right eye, which was still swollen and engorged a few moments following the blood-squirting event when photos were taken (Fig. 1A). While photographing this individual at close range (<1 m) following its release, DM noted rapid swelling and subsequent rapid dissipation of swelling of the upper and lower lids around the left eye (Fig. 1B–1D). It is presumed that the lizard was preparing to squirt blood again, this time from the other eye, but found it unnecessary.

Blood-squirting is thought to be primarily a defense against predation attempts by canids (Middendorf and Sherbrooke 1992. Copeia 1992:519–527); potential canid predators in the area include Coyotes (*Canis latrans*), Domestic Dog (*C. lupus familiaris*), and Swift Fox (*Vulpes velox*), but can also be elicited by human contact (Hodges 2004. Southwest. Nat. 49:267–270). To our knowledge this is the first substantiated incidence of *P. modestum* squirting blood (confirmed by W. Sherbrooke, pers. comm.). Field work was conducted under Colorado Division of Wildlife scientific collection license 09HP927 and with permission of the landowner.

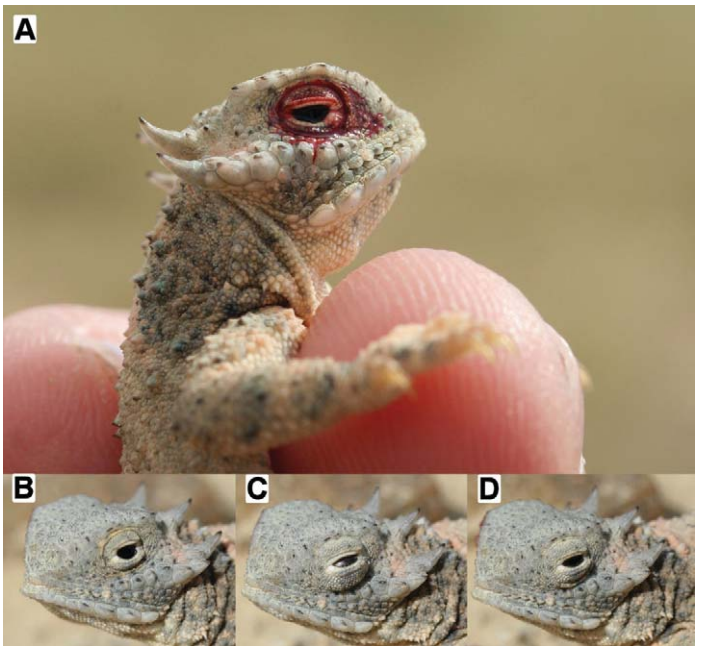


FIG. 1. A) Adult male *Phrynosoma modestum* after squirting blood from the ocular sinus of the right eye. B–D) The same individual after release at 15:43 h, apparently preparing to squirt blood from the left eye, demonstrating the lizards eye before swelling (B, 15:44:55 h), during swelling (C, 15:45:07 h), and after dissipation of swelling (D, 15:45:10 h). Photographed in the field in Otero County, Colorado, 14 August 2009.

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PLESTIODON FASCIATUS (Five-lined Skink). **PREDATION**. Few reports document spider predation on small squamates, and most involve larger spiders, i.e. wolf spiders or orb weavers. Cokendolpher (1977. J. Arachnol. 5:184) observed an orb weaver (*Argiope aurantia*) eating a Broad-headed Skink (*Plestiodon laticeps*); Corey (1988. J. Arachnol. 16:392–393) observed a wolf spider (*Lycosa ammophila*) feeding on a Green Anole (*Anolis carolinensis*); and Hampton et al. (2004. Herpetol. Rev. 35:269–270) observed a wolf spider (*Hogna carolinensis*) feeding on a Ground Skink (*Scincella lateralis*). To our knowledge, no prior records exist of predation of lizards by cobweb spiders (Family Theridiidae), a family of spiders with relatively small body sizes (cephalothorax length range: 1–8 mm; Craig 1987. Am. Nat. 129:47–68). Here we provide an observation of predation by an American House Spider, *Achaearanea tepidariorum,* on a juvenile *Plestiodon fasciatus*.

At ca. 1000 h on 11 August 2006, we observed an *A. tepidariorum* with its fangs deployed in a juvenile (36.0 mm SVL) *P. fasciatus* inside a building at the Tennessee Aquarium Conservation Institute at Cohutta Springs, ca. 1.2 km S of Red Clay, Georgia (34.9739°N, 84.9503°W; datum: WGS84, elev. 259 m). The skink was near death and struggling listlessly. After photographing the scene, we preserved both the spider and the skink. The skink had lost a portion of its tail. As the spider appeared to be actively feeding on the skink at the time of capture, we discount the possibility that the spider was merely investigating a disturbance in its web.

Specimens are deposited in the California Academy of Sciences collections (*Plestiodon*, CAS 235426; *Achaearanea*, CASENT 9024310). We thank J. Miller and J. Vindum for confirming identifications and accessioning the specimens.

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PODARCIS MURALIS (Common Wall Lizard). **CONTROL.** *Podarcis muralis* is a medium-sized European lizard that has been introduced into at least three states/provinces (Ohio, Kentucky, and British Columbia; Burke and Deichsel 2008. *In* Jung and Mitchell [eds.], Urban Herpetology, pp. 347–353. Herpetol. Conserv., Vol. 3, SSAR). Walker and Deichsel (2005. Herpetol. Rev. 36:202) report

the discovery of this exotic species at The Falls of the Ohio State Park, Indiana. Werner Mayer (Museum of Natural History, Vienna, Austria) determined the subspecies as *Podarcis muralis maculiventris*, western clade based on mtDNA sequences. This form is identical to that of specimens observed within Cincinnati, Ohio for over 50 years now. Here we report on measures of controlling this alien species in Indiana and its impact on a native one.

Concerns regarding the presence of *Podarcis muralis* in Indiana resulted in the Indiana Department of Natural Resources (IDNR) enacting an executive order to control this species. The executive order was designed to address two concerns regarding the presence of this species. The first concern was that *Podarcis muralis* might displace native Five-lined Skinks (*Plestiodon fasciatus*) where both species are sympatric. The second concern was to act quickly before the lizards became established and spread to adjacent habitats. The control program was first conducted from 7 July to 15 August 2005 by Nick Burgmeier, and subsequently by two contractors in 2006 and 2007. A total of ca. 30 *P. muralis* were removed from the park and euthanized, most of which were discarded. Two specimens were deposited at the Purdue University Biology collection in West Lafayette, Indiana (25.021, 25.022). One specimen from the Falls of the Ohio State Park is in the Field Museum collection (FM 265504).

The control program was accompanied by visual surveys inside and outside the State Park. As sightings of *Podarcis* decreased, there were increased observations of *P. fasciatus.* However, there were fewer *Podarcis* observed and subsequently captured than predicted. This might be attributed to the flooding of the Falls of the Ohio State Park during the winter of 2004–2005. During this time, the riprap below the interpretative center's observation deck (the focus of *Podarcis* occurrence) was submerged. This flood event possibly drowned many of the *Podarcis* hibernating there. Additionally, local predators might have helped to reduce the *Podarcis* population. Feral Cats (*Felis silvestris catus*) and Mockingbirds (*Mimus polyglottos*) were seen preying upon *Podarcis* within the state park.

After control programs were concluded, GD inspected the area from 11–13 October 2007. Surveys were performed under excellent weather conditions but no *Podarcis* were observed. However, two *P. fasciatus* were seen during this same time period. In the summer of 2008, park personnel and visitors reported additional sightings of juvenile and adult *P. muralis* as well as several *P. fasciatus* (Sarabeth Klueh, pers. comm.). During 2009, park personnel reported only sightings of *P. fasciatus*, but no sightings of *Podarcis* as of 18 September (Bett Etenohan, pers. comm.)

We conclude that the return of *P. fasciatus* after *Podarcis* removal is a good indication that the exotic species likely has had a negative impact on natives. However, the quick recovery of the *Podarcis* population during 2008 might indicate that there is a flow of lizards into the park from illegal release and/or from rafting on driftwood originating from places upriver from Clarksville and as far as Cincinnati. We suggest that the population dynamics of both species be further observed. We would further recommend that land managers take appropriate measures to control the introduced species as necessary.

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SCELOPORUS SPINOSUS SPINOSUS (Spiny Lizard). **BROOD**. *Sceloporus spinosus* is distributed along the central plateau of Mexico. Three subspecies are recognized: *spinosus* is the most widely distributed, while two others—*apicalis* and *caeruleopunctatus*—are endemic to the state of Oaxaca (Bell et al. 2003. Acta Zool. Mex. [n.s.] 90:103–174; Sites et al. 1992. Bull. Am. Mus. of Natl. Hist. 213:1–110; Smith 1939. Zool. Ser. Field Mus. Nat. Hist. 26:59–172; Smith and Taylor 1950. U.S. Natl. Mus. Bull. 199:1–253). Here we report record egg size and dimensions for the species and incubating time under laboratory conditions.

Mean size of sexually mature females varies among populations (69–106 mm SVL), courtship occurs in early spring, and eggs are laid mainly during middle or late summer (Calderón-Espinosa et al. 2006. Herpetol. Monogr. 20:47–158). Females of some populations lay a single clutch per season while females in other populations may lay more than one (Castro-Franco 2002. M.Sc. dissertation, Facultad de Ciencias, Universidad Nacional Autónoma de México; Valdéz-Gonzáles and Ramírez-Bautista 2002. J. Herpetol. 36:36–43). Oviposition is asynchronous within populations as females at all stages of gravidity are found at any one time during the reproductive season (Calderón-Espinosa. et al. 2006, *op. cit*).

On 23 June 2007, a gravid female *S. spinosus spinosus* was obtained from Los Reyes La Paz, Estado de Mexico, Mexico, (19.3543°N, 98.9403°W, 2633 m elev.), and brought into the laboratory and assigned collection number 4401-E. The lizard weighed 50.55 g before oviposition, and was maintained in a plastic box measuring 32 × 20 × 14 cm, with newspaper as substrate, fresh water in a dish, and ambient temperature at 26–28ºC.

On the morning of 4 July 2007, the female laid a clutch of 13 eggs (female weighed 35.74 g post-oviposition), which were placed in plastic boxes with agrolite substrate. An incubator was used to provide a 28–30ºC thermal gradient and relative humidity fluctuated between 50–70%. Mean measurements of the eggs were as follows: length 16.2 ± 01.5 mm and width 10.8 ± 00.7 mm, mean mass 1.13 ± 0.12 g.

Four hatchlings emerged on 28 August 2008 and the remaining nine the next day. The mean incubation time was 55.5 ± 0.5 days at 28–30ºC. Mean measurements were as follows: 27.6 ± 01.7 mm SVL, 34.1 ± 01.2 mm tail length and the neonates weighed 0.86 ± 0.03 g. Hernández-Ibarra et al. (2001. XVI Congreso de Zoología, Memorias, Zacatecas, p. 43) reported that this species lays clutches ranging from 10 to 30 eggs, and Valdez-González (1998. Graduate dissertation, Facultad de Estudios Superiores Iztacala, Universidad Nacional Autónoma de México) reported clutch numbers of 15.3 ± 1.2 eggs; mean measurements of the eggs were as follows: length 15.1± 0.65 mm and width 8.8 ± 0.3 mm, with mean weight of 1.69 ± 0.808 g.

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TRACHYLEPIS PLANIFRONS (Tree Skink). **REPRODUCTION.** *Trachylepis planifrons* is known from Kenya, Tanzania, Somalia, eastern Ethiopia, northern Zambia, and southeastern Democratic Republic of Congo (Spawls et al. 2002. A Field Guide to the Reptiles of East Africa, Kenya, Tanzania, Uganda, Rwanda and Burundi. Academic Press, San Diego, California. 543 pp.). Other than a report that *T. planifrons* is oviparous (Spawls et al., *op. cit.*), I know of no information on the reproduction of this species. The purpose of this note is to report information on the reproduction of Kenya *T. planifrons* from a histological examination of gonadal material.

A sample of 11 *T. planifrons* consisting of four adult males (mean SVL = 87.0 mm ± 14.0 SD; range: 70–90 mm) and seven adult females (mean SVL = 98.4 mm ± 5.4 SD; range: 90–104 mm) collected 1971 or 1973 were examined from the herpetology collection of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California (by Kenya District): Lamu: LACM 93191–93196; Samburu: 65770–65772, 65899, 65902. The left testis was removed from males and the left ovary was removed from females for histological examination. Tissues were embedded in paraffin and cut into sections at 5 μm. Slides were stained with Harris hematoxylin followed by eosin counterstain. Slides of testes were examined to determine the stage of the spermatogenic cycle. Slides of ovaries were examined for the presence of yolk deposition. Histology slides are deposited in LACM.

The only stage noted in the testicular cycle was spermiogenesis (= sperm formation) in which the seminiferous tubules are lined by clusters of sperm or metamorphosing spermatids. Spermiogenesis was noted in one male from February and three from June. The smallest reproductively active male (spermiogenesis in progress) measured 70 mm SVL (LACM 65772) and was from June. Ovaries were classified (sample size in parentheses) as to their reproductive state: quiescent (no yolk deposition): February (1); early yolk deposition (yolk granules in the cytoplasm): February (2), June-July (1); oviductal eggs: February (2), 8 and 9 oviductal eggs, respectively; corpora lutea: June-July (1). Eight and nine eggs are the first clutch sizes reported for *T. planifrons*. The smallest reproductively active female (corpora lutea present) measured 90 mm SVL (LACM 65902) and was from June–July. The presence of reproductive activity in February and June-July suggests *T. planifrons* exhibits a prolonged period of reproduction.

I thank Christine Thacker (LACM) for permission to examine specimens.

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TRACHYLEPIS SULCATA (Western Rock Skink). **REPRODUCTION.** *Trachylepis sulcata* is viviparous and occurs from karroid areas of the Cape and adjacent Free State of the Republic of South Africa through Namibia to southern Angola (Branch 1998. Field Guide to Snakes and Other Reptiles of Southern Africa. Ralph Curtis Books, Sanibel Island, Florida. 399 pp.). Information on its reproduction in the Republic of South Africa was summarized by Bates (1995. Afr. Herp News 24:23–25). The purpose of this note is to compare information on *T. sulcata* reproduction from the Republic of South Africa with data from Namibia taken from a histological examination of museum specimens.

A sample of eight females from Namibia collected in 1972, 1976, 1977 (mean SVL = 64.3 mm ± 8.4 SD, range: 57–83 mm) was examined from the herpetology collection of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California USA. Specimens examined by the Namibia region are: Erongo LACM 127496, 127497; Karas LACM 77017; Khomas LACM 77432, 77433, 77435, 77437, 77439. For histological examination the left ovary was removed from females to check for vitellogenesis (yolk deposition). Counts were made of oviductal eggs/embryos or enlarged ovarian follicles (> 5 mm length). Tissues were embedded in paraffin, sections cut at 5 μm, and stained with Harris hematoxylin followed by eosin counterstain. Histology slides are deposited in LACM.

One October female (LACM 77437) contained corpora lutea from a previous litter and concomitant yolk deposition for a subsequent litter verifying *M. sulcata* may produce multiple litters in the same reproductive season as stated by Bates (*op. cit*) and Branch (*op. cit.*). Mean litter size for four females was 3.5 ± 2.4 SD, range: 2–7. Seven embryos is a new maximum litter size for *T. sulcata* and was recorded from LACM 127497, collected in May. It is not known when these embryos would have completed development. Another October female of the same size (LACM 77433) had quiescent ovaries (no yolk deposition). It was not possible to count litter sizes for two females from October with enlarged follicles that had been shot (LACM 77017, 77439). The smallest reproductively active female from Namibia (enlarged follicles > 5 mm) measured 57 mm (LACM 77439) and was from October. In contrast, Bates (1995, *op. cit*.) reported the smallest reproductively active female *T. sulcata* from the Free State Province of South Africa to measure 63 mm SVL and that parturition occurred from November to March. The presence of two October females from Namibia reported herein, one with two full-term embryos (LACM 77432) and one with corpora lutea (LACM 77437) from a previous litter October suggests there may be geographic variation in the ovarian cycle of *T. sulcata*.

I thank Christine Thacker (LACM) for permission to examine *T. sulcata.*

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TROPIDURUS ITAMBERE (Rock Lizard). **HAEMOPARASITES.** *Plasmodium* (*Sauramoeba*) *tropiduri* (Apicomplexa: Plasmodiidae) is a malaria parasite that can infect lizards of the genus *Tropidurus*. This parasite was described by Aragão and Neiva (1909. Mem. Inst. Oswaldo Cruz 1:44–50) in individuals of *T. torquatus* from Minas Gerais state, southeastern Brazil. Carini (1941. Arq. Biol. São Paulo 235:46–47) subsequently reported it in *T. torquatus* from Goiás state, central Brazil. Later, its presence was reported in *Tropidurus* species from other Brazilian states (Pessoa and Souza Lopes 1963. Inst. Med. Trop. São Paulo 5:133–139; Rocha-Silva and Rodrigues 1974. Rev. Saúde. Publ. São Paulo 8:163–170) and from Venezuela (Scorza 1971. J. Protozool. 18:403–410). During our literature review, we could not find any reports of *P. tropiduri* infecting *Tropidurus* lizards after the 1970s. Considering that the taxonomy of this genus was later

revised (Rodrigues 1987. Arq. Zool. São Paulo 31:105–230; Frost et al 2001. Mol. Phylogenet**.** Evol. 21:352–371) and consequently new species were described, one of which was *Tropidurus itambere*, new studies regarding the presence of this haemoparasite in the *Tropidurus* genus are important.

Herein, we provide the first report of *Plasmodium* (*Sauramoeba*) *tropiduri* in the blood of the lizard *Tropidurus itambere*. It is a medium-sized lizard (mean adult SVL = 71.8 mm) (Rodrigues 1987, *op. cit*.) belonging to the *torquatus* group (Frost et al. 2001, *op. cit*.). It commonly occurs in open, and sometimes rocky, areas in central and southeastern Brazil (Rodrigues 1987, *op. cit*.).

This study was accomplished with 12 adult individuals of *T. itambere* (eight males and four females) collected in a rocky outcrop area located at Ibitipoca State Park (21.696667°S, 43.889167°W; elev. 1200 m), Minas Gerais state, southeastern Brazil, between February and May 2007. We made sanguine smears of collected circulating blood from the abdominal vein of the lizards. The parasitemia was calculated through the number of parasites found in 100 homogeneous microscopic fields of each sanguine smear (parasite density), and the value found was multiplied by 100 and divided by 10.000 (×*100/10.000).

We identified the parasite *P. tropiduri*, with a low parasitemia (mean = 0.16%), in three lizards (two females and one male) of the 12 examined. The low parasitemia of this lizard species was also reported by other authors (Carini 1941, *op. cit*.; Laison and Shaw 1969. Parasitology 59:163–170; Rocha-Silva and Rodrigues 1974, *op. cit*.). The diagnosis of *P. tropiduri* was based on the following characters: all the intraerythrocytic stadia (trophozoites, schizonts, and gametocytes) were identified and usually located in the polar or lateropolar region of the erythrocyte (host cell); rounded gametocytes; schizonts with about 18 merozoites; hypertrophied and lightly deformed erythrocytes.

The morphological analysis of the intraerythrocytic stadia of *P. tropiduri* revealed circular, rounded, prolonged, and ellipsoidal forms. The same was reported by Aragão and Neiva (1909, *op. cit*.), Carini (1941, *op. cit*.), Gahram (1966. Malaria Parasites and Other Heamosporidia. Blackwell Scientific Publications, Oxford. 1114 pp.), Laison and Shaw (1969, *op. cit*.) and Rocha-Silva and Rodrigues (1974, *op. cit*.).

The lizard specimens are deposited in the herpetology collection of the Department of Zoology of the Federal University of Juiz de Fora (numbers: 466, 467, 489, 491, 506–508, 515–517, 614, 618).

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TROPIDURUS OREADICUS (Neotropical Ground Lizard). **PREDATION**. Many arthropods are predators of lizards (McCormick and Polis 1982. Biol. Rev. 57:29–58). Lizards of the genus *Tropidurus* (Tropiduridae) are widely distributed in Brazil and species of the *torquatus* group are abundant in savanna and semi-arid vegetation (Rodrigues 1987. Arq. Zool. 31:105–230).

Tropidurus oreadicus is generally abundant in openly vegetated habitats (Colli et al. 1992. J. Herpetol. 26:66–69) and common in Cerrado areas and open enclaves in the Amazon forest (Rodrigues 1987, *op. cit.*). Carvalho-Filho (2008. Herpetol. Rev. 39:230) observed a juvenile *T. oreadicus* predated by a Guira Cuckoo (*Guira guira*) in Belém, Pará state. However few predation events have been recorded involving this species by other vertebrates or arthropods. Herein, we report predation of *T. oreadicus* by a spider in Cerrado area.

At 1116 h on 16 April 2008, we found an adult of *T. oreadicus* (783 mm SVL, 127 mm tail) in Fazenda Floryl (14.04670ºS, 45.89124ºW; datum: SAD69, elev. 900 m), municipality of Jaborandi, Bahia, Brazil. This lizard had been captured and eaten by an adult wolf spider *Lycosa erytrognata* (Lycosidae, Aranae) in a 60-liter bucket pitfall trap in cerrado. In their review, McCormick and Polis (*op. cit.*) considered wolf spiders as predators of amphibian and fish. This is the first record of predation by this wolf spider on a lizard.

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TROPIDURUS OREADICUS (NCN). **CANNIBALISM AND PREY.** *Tropidurus oreadicus* belongs to the *torquatus* group (Frost et al. 2001. Mol. Phylogenet. Evol. 21:352–371) and is distributed in the states of Mato Grosso, Mato Grosso do Sul, Minas Gerais, Goiás, Maranhão, Bahia, and Piauí, from the margins of the lower Tocantins River to Belém. It usually occurs in open areas (Rodrigues 1987. Arq. Zool. 31:105–230). Species of the *torquatus* group are, in general, heliothermic, diurnal, and mostly insectivorous (Rodrigues 1987, *op. cit*.), though sometimes they may also consume small vertebrates (Kiefer and Sazima 2002. Herpetol. Rev. 33:136; Dias and Rocha 2004. Herpetol. Rev. 35:398–398). Here, we report on cannibalism in *T. oreadicus* and on the predation of the gymnophtalmid lizard *Cercosaura schreibersii* by this same tropidurid.

The observations were carried out in the municipality of Porto Velho, state of Rondônia, northern Brazil (08.7619°S, 63.9038°W). The cannibalism was observed in an urban area on 4 August 2009 at 0950 h. An adult male *T. oreadicus* (93 mm SVL, 23 g after prey removal) was standing on a wall, when it noticed the movement of a conspecific juvenile (34 mm SVL, 1.2 g) near the ground; it approached and ate the juvenile. The predator lizard was captured four hours later and its stomach was examined, from which the

smaller lizard was removed pre-digested. The two specimens were deposited as vouchers in the herpetological collection of Universidade Federal do Acre - Campus Floresta (UFACF 2632, UFACF 2633).

The observation of predation on *Cercosaura schreibersii* took place on the 6 August 2009 at 1140 h, in an open area next to a forest edge in a city park in Porto Velho. A juvenile female *T. oreadicus* (35 mm SVL, 1.8 g after prey removal) was caught after ingesting a juvenile gymnophtalmid lizard *C. schreibersii* (19 mm SVL, 0.3 g). The *C. schreibersii* had still been struggling to free itself from the mouth of the *Tropidurus* when first encountered by the observer. The *T. oreadicus* specimen was collected after a few minutes and the prey was removed from its stomach, which accounted for 16.6% of its body mass. The two lizards were deposited as vouchers in the herpetological collection of Universidade Federal do Acre – Campus Floresta. (*T. oreadicus* UFACF 2634; *C. schreibersii* = UFACF 2635).

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TROPIDURUS TORQUATUS (NCN). **AVIAN ATTACK.** *Tropidurus torquatus* is distributed throughout west-central, northeastern (south of the Bahia state), and southern regions of Brazil (Rocha 2000. Ecologia de Restingas e Lagoas Costeiras. NUPEM/UFRJ, Macaé, Rio de Janeiro, Brazil, pp. 99–116; Rodrigues 1987. Arq. Zool. São Paulo 31:105–230). It is active throughout the year and is easily found in open areas and in environments altered by anthropogenic action, such as "roçados," back yards, and gardens. They are seen mainly on rocks, termite mounds, fallen logs, and on the forest floor, and can climb easily on walls and logs (Araújo 1987. Anais de Etologia 5:189–197).

The House Sparrow (*Passer domesticus*) originates from the Middle East. However, this bird spread throughout Europe and Asia reaching the Americas around 1850 (Silva et al. 2007. Anais do VIII Congresso de Ecologia do Brasil, 2 pp.). It was introduced to Brazil early in the 20th century in the city of Rio de Janeiro and spread throughout the south, southeast, west-central, and northeast portions of of Brazil (Sick 1985. Ornitologia Brasileira, uma Introdução, v.II. Brasília: Editora UnB). Today this bird occurs in almost all countries of the world, and is often characterized as an exotic and bioinvasive species (Silva et al. 2007, *op. cit*.). Bioinvasion is defined as the arrival, establishment, and expansion of an exotic species into a region that is outside its known natural distribution, resultant of accidental or intentional dispersion through human activities (Carlton 1996. Biol. Cons. 78:97–106). Introduced exotic species are adaptive not only by their ability to easily establish new populations, but also by becoming invasive, affecting native communities in their respective ecosystems, altering the structures and function of those ecosystems (Reusch and Williams 1998. Oecologia 113:428–441). Here we report the attack of a juvenile lizard *Tropidurus torquatus* by an adult female *Passer domesticus*.

On 22 Nov 2008 at 1800 h, in a residential garden in the city of Araçatuba, state of São Paulo, Brazil, a juvenile *T. torquatus* was observed exhibiting escape behavior from a House Sparrow. The lizard climbed down from a tree, crossed a street, and climbed a residence wall by a garden. The lizard stayed immobile in alert position. At this time, a female House Sparrow that was nesting in the tree from which the lizard had descended flew down in an apparent aggressive attack. The bird pecked at the lizard's head several times. The lizard fled into the vegetation of the garden.

Female House Sparrows are more aggressive than males around nesting sites due to the lack of rivalry between males (which do not establish territories around the nest) (Sick 1997. Ornitologia Brasileira. Nova Fronteira, Rio de Janeiro, 912 pp.). We believe that the female House Sparrow displayed this aggressive behavior in response to the lizard's presence near the bird's nest.

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TUPINAMBIS MERIANAE (Common Tegu). **FEEDING BEHAVIOR.** Tegus are diurnal, terrestrial, actively foraging omnivores that often feed on fruit, invertebrates, and small vertebrates (Vanzolini et al. 1980. Répteis das Caatingas. Acad. Bras. Ciências, Rio de Janeiro, RJ, Brazil. 161 pp.; Mercolli and Yanosky 1994. Herpetol. J. 4:15–19; Vitt 1995. Occ. Pap. Oklahoma Mus. Nat. Hist. 1:1–29). Although tegus are known to commonly consume vertebrate eggs (e.g., alligators: A. Lima, pers. comm.; turtles: Gonçalves et al. 2007. Rev. Bras. Zool. 24:1063–1070), eggs are poorly represented (birds: Mercolli and Yanosky, *op. cit*.) or absent (Kiefer and Sazima 2002. Amphibia-Reptilia 23:105–108) in systematic studies of tegu diet. However, this bias might result from the methods typically used to describe lizard diets. For instance, soft or quickly digested food items might not be present or distinguishable in stomach content analysis, a method commonly employed to assess lizard diets. Therefore, the poor representation (or absence) of eggs in tegu diet may simply reflect lizard feeding behavior. Here, I report on an opportunistic observation of predation of an egg of the Solitary Tinamou *(Tinamus solitarius)* by a *Tupinambis merianae* (locally known as *teiú*) that puts perspective on this bias.

At 1245 h on 17 October 2002, I witnessed an adult tegu (ca. 40 cm SVL) eat the egg of a *Tinamus solitarius* at the margin of an old dirt road (19.71°S, 41.825°W; elev. 430 m), in the northern part of the Reserva Particular do Patrimônio Natural Feliciano Miguel Abdala (RPPN-FMA), eastern Minas Gerais, Brazil. I encountered the lizard apparently just after it had begun eating the egg. As soon as it became aware of my presence, the lizard took the egg in its mouth and moved about one meter away. The tegu then placed the egg on the ground, and after a few seconds of watching me, resumed eating. Following this initial movement, it was not disturbed again, a pattern unlike that commonly observed during other encounters with basking tegus in this reserve. My presence may not have further disturbed the tegu because I became immobile at a distance of approximately six meters as soon as I saw it. To access the inside of the egg (62 mm length, 46 mm width), the lizard made a small (25 mm radius) hole on its side through which it lapped up the entire contents. This process lasted approximately two minutes. The tegu then abandoned the eggshell and disappeared into the forest. I collected the eggshell and took it to the RPPN-FMA field laboratory for examination.

It may be that eggs are a resource that tegus often consume, but are rarely recorded because only the egg contents are typically eaten and the eggshell is discarded. As a consequence, soft portions of eggs are unlikely to be recognized in stomach content analyses. This observation emphasizes the importance of direct observations to complement studies of lizard diets in order to fully understand the food resources they use.

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VARANUS MITCHELLI (Mitchell's Water Monitor). **DIET AND FORAGING BEHAVIOR**. The diet of *Varanus mitchelli*, a small arboreal and terrestrial monitor lizard inhabiting tropical Australia, was summarized by Shultz and Doody (2005. *In* Pianka and King [eds.],Varanoid Lizards of the World. Indiana University Press, Bloomington). The species is considered a generalist predator, consuming a wide range of small vertebrates and large invertebrates (Shine 1986. Herpetologica 42:346–360; Losos and Green 1986. Biol. J. Linn. Soc. 35:379–407). However, our knowledge of its diet is based almost solely on dissections of limited museum specimens (but see one account of foraging behavior in Vincent and Wilson 1999. Australian Goannas. Reed New Holland, Sydney). The foraging habits and diet of this species have been little studied in nature.

At 1345 h on 7 June 2009 we observed a pair of Crimson Finches (*Neochmia phaeton*) vocalizing and assuming defensive postures near their nest on a tree limb (*Pandanus aquaticus*) overhanging the water, on the Ord River, ~20 km upstream of Kununurra, Western Australia (15.968611°S, 128.743056°E). Closer inspection revealed a juvenile *V. mitchelli* inside the nest. Our presence flushed the goanna from the nest and it fled along the tree limb to the shore. Inspection of the nest revealed one broken egg and two intact eggs. We were unable to return to the nest site to determine if further predation occurred on the eggs. The weather was partly cloudy with an air temperature of 29.3ºC.

At Mornington Wildlife Sanctuary (MWS), approximately 340 km WSW of the Ord River site, one of us (OM) has monitored Crimson Finch nests for three consecutive breeding seasons between 2006 and 2009. During that study, 397 nests were found that had begun clutch initiation, and of these 237 (59.7%) were preyed upon either during the egg stage or nestling stage. Due to competing objectives, systematic data on predation events were not collected. However, some observations were made that are relevant to the abovementioned predation attempt. *Varanus* species were found in four Crimson Finch nests, of which three were identified as *V. mitchelli*, and the fourth was unidentified. Also, *V. mitchelli* were found within two meters of three additional active finch nests. For comparative purposes, we list the observations of other (potential) predators: An Olive Python (*Liasis olivaceus*) was found in one nest, two unidentified snakes were within 2 m of two nests, and one nest was infested with Green Ants (*Oecophylla smaragdina*). One additional nest preyed upon had a hole opened up in the back of the nest, and seven other nests were 'destroyed' or 'torn apart' by unknown predators (possibly avian predators or monitor lizards).

The three confirmed cases of *V. mitchelli* predation on Crimson Finch nests occurred during the egg stage. However, nestlings may also be taken. Both Crimson Finches and *V. mitchelli* are riparian habitat specialists (Higgins et al. 2006. Handbook of Australian, New Zealand & Antarctic Birds (HANZAB): Boatbill to Starlings Part B. Oxford University Press, South Melbourne; Schultz and Doody, *op. cit.*). Between 55% and 98% of Crimson Finch nests are found in Pandanus (Todd 2002. Austral. Bird Watcher 19:161–171; O. Milenkaya, unpubl. data), a microhabitat often used by *V. mitchelli* (Schultz and Doody, *op. cit.*). It is possible that *V. mitchelli* is a major predator of Crimson Finch nests due to their shared microhabitat. It is also likely that *V. mitchelli* prey upon nests of other riparian bird species nesting in the *Pandanus* such as Purple-crowned Fairy Wrens, *Malurus coronatus* (Rowley and Russell 1993. Emu 93:235–250). At MWS, Purple-crowned Fairy Wrens are obligate-Pandanus nesters, and Bar-shouldered Doves, (*Geopelia humeralis*) and Double-barred Finches (*Taeniopygia bichenovii*) occasionally nest in Pandanus (M. Hall, unpubl. data; O. Milenkaya, unpubl. obs.). Finally, while *V. mitchelli* may prey heavily on bird eggs during the wet season, this may constitute a smaller portion of their diet during the dry season. Crimson Finches, for example, nest mainly during the wet season (December to early June; Todd, *op. cit.*).

The Cane Toad (*Bufo marinus*) is moving rapidly toward the Kimberley region. In the Northern Territory invasive toads caused 71–97% declines in *V. mitchelli*, which die after attempting to ingest the toxic toads (Doody et al. 2008. Anim. Cons. 12:46–53). It is likely that toad-induced declines in *V. mitchelli* at Ord River and MWS will occur, and will greatly reduce *V. mitchelli* predation on nests of Crimson Finches and Purple-crowned Fairy Wrens. Studies are underway to determine the importance of *V. mitchelli* as nest predators on those species, and thus to determine the indirect impact of cane toads on nest success of these Pandanus-nesting birds as cane toads invade.

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XANTUSIA WIGGINSI (Wiggins' Night Lizard). **DEFENSIVE BEHAVIOR**. With recent morphological and molecular work on the genus *Xantusia*, the number of recognized species in the state of California has grown from three to six in the last decade (Bezy et al. 2008. J. Herpetol. 42:680–688; Leavitt et al. 2007. Mol. Ecol. 16:4455–4481; Lovich 2001. Herpetologica 57:470–487; Sinclair et al. 2004. Am Nat. 163:396–414). The more isolated and geographically restricted of these species (e.g., *X. gracilis*, *X. sierrae*, and *X. wigginsi*) remain poorly known and in need of study. The purpose of this note is to add to the limited knowledge of the behavioral biology of one of these species, *X. wigginsi*.

On 2 January 2010 at 1355 h, an adult *X. wigginsi* was uncovered beneath a decaying *Agave deserti* ca. 7.2 km E of Jacumba, San Diego County (32.636178°N, 116.114167°W; datum WGS84). Once grasped by hand, the night lizard immediately defecated on the captor and initiated mouth-gaping behavior, threatening to bite. The mouth-gaping behavior lasted for ca. one to two minutes while the lizard was in hand and initially positioned for photographs. The mouth-gaping was not elicited by high temperatures as a means of panting, as air temperature at the time of capture was ca. 21°C and the temperature (not taken) within the decaying *Agave* refuge was substantially cooler and damp. The gaping behavior ceased soon after the lizard was placed on a dead piece of *Agave* for the photographs.

Mouth-gaping is a common threat display among Lacertilia, including the much larger congeneric *Xantusia riversiana* (Mautz et al. 1992. Herpetologica 48:271–279). However, this behavioral observation involving *X. wigginsi* is of interest because of the incredibly small size of the species (44 mm maximum snout–vent length; Bezy 2009. *In* Jones and Lovich [eds.], Lizards of the American Southwest: A Photographic Field Guide, pp. 440–443. Rio Nuevo Publishers, Tucson, Arizona), in that the lizard's diminutive mouth appeared incapable of inflicting a bite to a human finger. An attempt to bite was never made by the lizard.

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SQUAMATA — SNAKES

BOTHROPS JARARACA (Jararaca). **ALTITUDINAL RECORD.** *Bothrops jararaca* is a generalist species that inhabits several environments in Brazil (from Bahia to Rio Grande do Sul states), Argentina, and Paraguay, from sea level to 1200 m elevation (Sazima 1992. *In* Campbell and Brodie Jr. [eds.], Biology of the Pitvipers, pp. 199–216. Selva, Tyler, Texas; Campbell and Lamar 2004. The Venomous Reptiles of the Western Hemisphere. Cornell University Press, Ithaca, New York. 870 pp.). On 15 October 2006, a *B. jararaca* (SVL = 500 mm) was found in a high altitude field (elevation ca. 1565 m) at the Caraíbas Farm (13.118664°S, 41.381491°W; datum: SAD 69), Chapada Diamantina, municipality of Mucugê, state of Bahia, Brazil. This record increases the altitudinal range of the species by ca. 365 m from previous reports (Sazima, *op. cit.*). The specimen is deposited in Zoological Museum of Universidade Estadual de Santa Cruz (MZUESC 6326).

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BOTHROPS LEUCURUS (Jararaca/Bahia Lancehead). **DIET.** *Bothrops leucurus* is a medium-sized terrestrial viperid snake, widespread in the Atlantic Forest of northeastern and eastern Brazil (Campbell and Lamar 2004. The Venomous Reptiles of the Western Hemisphere. Cornell University Press, Ithaca, New York. 870 pp.). The diet of the species consists of small vertebrates with an ontogenetic shift from frog and lizard prey as juveniles to rodents as adults (Freitas 2003. Serpentes Brasileiras. Malha-de-Sapo Publicações, Lauro de Freitas, Bahia, Brazil. 160 pp.). On the morning of 10 November 2002, we collected a juvenile *B. leucurus* (ca. 400 mm SVL) on the ground of the forest at Palmeira farm (15.950833°S, 39.627778°W; datum: SAD 69), municipality of Itapebi, state of Bahia, Brazil. The snake subsequently regurgitated a Marbled Swamp Eel, *Symbranchus marmoratus* (Pisces, Actinopterygii, Synbranchidae). To our knowledge, this is the first record of *B. leucurus* preying on a fish. The specimen is deposited in the Zoological Museum of Universidade Estadual de Santa Cruz (MZUESC 4119).

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CAUSUS RHOMBEATUS (Rhombic Night Adder). **PREY SIZE**. Snakes are well known for their ability to consume large prey relative to their body size. In particular, viperids are documented to have high prey to predator mass ratios, with prey exceeding 100% of the snake's mass in some cases (Greene 1983. Am. Zool.

23:431–441). Reports of maximum prey size are important for understanding a species' foraging ecology and the evolution of gape size throughout the evolutionary history of snakes. Yet, detailed records of maximum prey sizes are lacking in many snake clades, particularly those from the Old World. The African viper *Causus rhombeatus* commonly consumes frogs and toads. Herein I report a large prey item for *C. rhombeatus*.

I examined a specimen of *C. rhombeatus* at the Field Museum of Natural History in Chicago (FM 74241). The specimen was collected from Huila, Angola and contained a fully intact toad (probably *Amietophrynus* sp.). The snake measured 566 mm SVL, 20.27 mm head length, 17.21 mm head width and weighed 79 g. The prey item was 95.67 mm SVL, 183 mm total length, 37.59 mm maximum width and weighed 64 g. The prey to predator mass ratio was 81.0% and the prey width to head width ratio was 218.4%. To my knowledge this is the largest prey to predator weight ratio reported for this species.

I thank A. Resestar and the staff at the Field Museum of Natural History in Chicago for their assistance and financial support.

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CROTALUS HORRIDUS (Timber Rattlesnake). **HABITAT USE**. *Crotalus horridus* is threatened or endangered throughout much of its range due largely to human alteration of habitat (Brown 1993. SSAR Herpetol. Circ. 22, 78 pp.). An understanding of habitat use in relation to human impacts will be important in conservation of this species. In the southern Appalachian Mountains, extensive logging and fire suppression in the 20th century resulted in large areas of even-aged closed canopy forest and a reduction in canopy gaps which can be important for reptile species (Greenburg 2001. For. Ecol. Manage. 148:135–144). More recently, rapid suburban development is fragmenting forest habitats across this region (Turner et al. 2003. Landscape Ecol. 18:449–464). Although *C. horridus* are highly dependent on winter dens and summer gestation sites, males and non-gestating females in summer have been reported to favor closed canopy forests with few fallen logs or rocks (Reinert and Zappalorti 1988. Copeia 1988:964–978; Reinert and Rupert 1999. J. Herpetol. 33:45–61). This note describes varying degrees of selection for open canopy sites among four adult *C. horridus* in Jackson County, North Carolina, USA during spring–fall of 2007 and 2008.

In 2007, two adult female *C. horridus* (020 and 040) were captured in early June gestating on a rock dam within a municipal watershed, and two adult males (060 and 081) were captured in early July within an active housing development. Both areas have been extensively logged and are dominated by second growth, closed canopy forests with dense understory shrubs in many areas. Both sites have numerous roads from past logging with road use highly restricted in the watershed and increasing in the development. In the watershed, female 040 remained on the dam until parturition in early September while female 020 left the dam in late July 2007, presumably due to a failed pregnancy. Of the 16 non-gestation locations for 020, three occurred in open canopy sites (Fig. 1). Two of these locations were directly on a seldom used road and one occurred in a natural tree fall opening. After parturition, 040

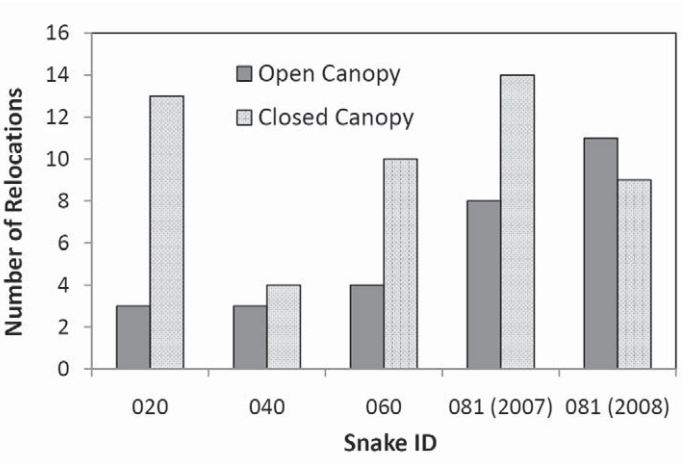


FIG. 1. Use of open vs. closed canopy habitats by four *Crotalus horridus* at two southern Appalachian study sites during Spring–Fall 2007–2008.

moved immediately into adjacent forests using a secondary road as a corridor before moving to a natural tree fall opening. Both snakes used natural log piles while in open sites, and on one occasion 020 used a sapling tree which overhung a log pile.

Within the housing development, male 060 moved onto adjacent private residential lands by August 2007 and used open areas in 4 of 16 of his summer-fall locations (Fig. 1). Three of these locations occurred at road edges (thick grass or shrub cover but no trees) with the remaining location in an old field with thick grass but no tree cover. Male 080 was captured and released within a commercially thinned forest and had eight of 22 locations in 2007 distributed between two such forest stands (Fig. 1). In 2008, 11 of 20 locations for 080 occurred in the same thinned stand in which he was captured. The other thinned stand was avoided entirely in 2008, presumably because of home construction. Of the remaining open canopy locations, one occurred at a road edge just before hibernation in 2007 and the other two occurred in natural openings in the spring of 2008. This male used both natural log piles (spring 2008) and a slash pile from thinning (4 locations in August 2007).

With the predominance of even-aged closed canopy forest in this region, natural and human induced canopy gaps provide benefits to some reptile species and appear to be used to some extent by *C. horridus*. Given limited data, it is unclear if snakes were responding to increased sunlight, shelter from logs and thick shrubs, potential food sources, or other factors. Future investigations should assess the use of open canopy sites, particularly thinned forests, in order to inform potential habitat management for this species.

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CROTALUS LEPIDUS (Rock Rattlesnake). **DIET**. The diet of *Crotalus lepidus* reportedly includes arthropods, frogs, small rodents, and reptiles, especially lizards (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Institution Press, Washington, D.C. 668 pp.). The species has also been shown to feed on *Gyalopion canum* (Chihuahuan Hook-nosed Snake) in the wild and on a *Virginia striatula* (Rough Earthsnake) in captivity (Milstead et al. 1950. Texas J. Sci. 2:543–562; Wright and Wright 1957.



FIG. 1. Adult *Crotalus lepidus* ingesting a freshly killed *Hypsiglena jani* at Indio Mountains Research Station, Hudspeth Co., Texas, USA.

Handbook of Snakes of the United States and Canada. Comstock Publ. Co., Ithaca, New York. 1105 pp.). In addition, Williamson (1971. Herpetol. Rev. 3:18) described cannibalism on two neonate *C. lepidus* born in captivity; one was eaten by a brood mate that five days later was itself consumed by the mother. From the scant information on feeding behavior in the wild, it is assumed that *C. lepidus* consumes nearly any small animal that it can subjugate, although lizards, because they are usually abundant in habitats used by this rattlesnake, are probably the primary diet item (Beaupre 1995. Herpetologica 51:45–56). We report the first known record of *C. lepidus* preying on *Hypsiglena jani* (Chihuahuan Nightsnake), a small colubrid commonly found in the Chihuahuan Desert.

On 27 June 2008, at 2020 h, an adult male *C. lepidus* (SVL = 565 mm; tail length = 60 mm; 175 g), fitted with a 5.0 g temperature-sensitive radio-transmitter (Holohil Systems Ltd, Ontario, Canada), was tracked on Indio Mountains Research Station (IMRS), Hudspeth Co., Texas, USA (30.4635°N, 105.0055°W; datum: WGS84; elev. 1215 m). IMRS is controlled by the University of Texas at El Paso and situated in an area containing rocky mountainous substrates covered by Chihuahuan Desert scrub vegetation. The snake was positioned in a loose coil within an arroyo next to a Prickly Pear (*Opuntia engelmannii*) and was ingesting a freshly killed adult *H. jani* (Fig. 1). The *H. jani* was being swallowed head first in a folded position, which allowed easily identification of the prey item. When the rattlesnake became aware of our presence, it stopped swallowing for about one minute, but then continued on for approximately 20 more minutes until the entire snake was consumed.

We thank A. Rocha, A. Gandara, L. Miranda, and C. Tweedie for their help in the field. Partial funding for field work was supplied by a grant from T&E Inc., the Joseph Family Trust Fund, a G. A. Krutilek Fellowship, and a F. B. Cotton Trust Scholarship to V. Mata-Silva.

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DRYMARCHON CORAIS CORAIS (Yellowtail)**. DIET.** *Drymarchon corais corais* is known to prey upon a wide range of vertebrates, including other snakes (Beebe 1946. Zoologica 31:11–52; Cunha and Nascimento 1978. Publ. Avul. Mus. Par. Emílio Goeldi 31:1–128). On 2 February 2006 at 1000 h, while conducting fieldwork in riparian forest at the Acangaú Reserve (17.181389°S, 47.070278°W; datum: Córrego Alegre; elev. 665 m) in the municipality of Paracatu, Minas Gerais, Brazil, one of us (AS) found an adult *D. c. corais* (total length ca. 1250 mm) preying on an adult *Liophis miliaris* (ca. 700 mm total length) on the leaflitter of the forest floor. The snakes were left undisturbed and the *D. corais* swallowed the *L. miliaris* head first over the course of approximately 20 minutes. To the best of our knowledge, this is the first published description of a wild *D. corais* preying upon a snake in Brazil and documents a novel prey species for *D. corais*.

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HETERODON NASICUS (Plains Hog-nosed Snake). **DIET AND PREY SIZE.** At 1650 h on 20 September 2007, a juvenile female *Heterodon nasicus* (SVL = 178 mm; tail length = 34 mm; 7.6 g without prey item) was collected in the Assiniboine Corridor Wildlife Management Area, Manitoba, Canada (49.6667ºN, 99.5676ºW; datum = NAD83, elev. 348 m). The *H. nasicus* had an enlarged mid-body and after gentle palpation the snake regurgitated an adult *Plestiodon septentrionalis* (Prairie Skink; Fig. 1) that had been recently swallowed tail first (SVL = 77 mm; tail length = 105 mm; 3.9 g). The skink had damage to its tail with punctures at the base of its tail, presumably a consequence of the struggle with the snake. After being scale-clipped for future identification the snake was released at the capture site.

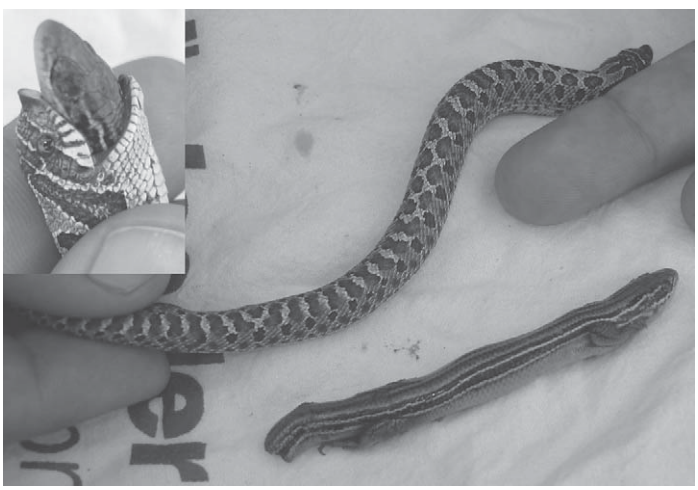


FIG. 1. Juvenile *Heterodon nasicus* with recently regurgitated adult *Plestiodon septentrionalis*. The prey item is also evident in the mouth of the snake prior to regurgitation (inset).

Heterodon nasicus is known to frequently feed on amphibians with a preference for toads, although they also prey upon small mammals, nestlings of ground nesting birds, small lizards, reptile eggs, and snakes (Pendlebury 1976. Can. Field Nat. 90:416–422; Platt 1969. Univ. of Kansas Publ. 18:253–420). *Plestiodon septentrionalis* have been reported in the diet of *H. nasicus* (Oldfield and Moriarty 1994. Amphibians and Reptiles Native to Minnesota. University of Minnesota Press, Minneapolis. 237 pp.), although this the first detailed description. Of considerable note is the size of the prey item (prey/predator mass ratio of 0.51), which is well above the typical meal size for a colubrid snake. Similarly, large anuran prey items (prey/predator mass ratio of 1.06–1.33) recently have been reported for *H. platirhinos* (Steen et al., *in press*. Herpetol. Rev.)

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LEPTODEIRA CUSSILIRIS (Duellman's Cat-eyed Snake). **DIET, CANNIBALISM**. On 26 August 2007 we collected an adult female *Leptodeira cussiliris* (SVL = 220 mm; tail length = 170 mm), in tropical dry forest habitat in Copala, Guerrero, México (16.555975ºN, 98.89425ºW; datum WGS84). When the specimen was examined by dissection, we discovered a partially digested male *L. cussiliris* (verified by Rubén Castro Franco) in the stomach. Duellman (1958. Bull. Amer. Mus. Nat. Hist. 114:1–150) reports that this genus prefers anurans (e.g., Bufonidae, Hylidae, and Ranidae) and lizards (e.g., *Anolis*, *Ctenosaura*, *Ameiva*) as prey. To our knowledge, this represents the first record of cannibalism in *Leptodeira*. Both specimens were deposited in the Colección de Anfibios y Reptiles de la Universidad de Morelos (CARUM).

We thank Rubén Castro Franco for assistance.

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PHILODRYAS PATAGONIENSIS (Parelheira). **FEEDING BEHAVIOR**. *Philodryas patagoniensis* is a medium to large terrestrial colubrid that feeds on a wide variety of prey, including mammals, birds, frogs, lizards and other snakes (including conspecifics) (Rocha and Vrcibradic 1998. Ciência e Cultura 50:364–368; Hartmann and Marques 2005. Amphibia-Reptilia 26:25–31; França et al. 2008. Copeia 2008:23–38; López and Giraudo 2008. J. Herpetol. 42: 474–480). Nevertheless, limited information is available on its predatory behavior, particularly in the wild.

On 19 November 2007 the first author observed two events of predation on lizards (*Ameiva ameiva*) by *P. patagoniensis* in the restinga habitat of Massambaba (22.937111ºS, 42.292056ºW; datum WGS 84), Praia Seca district, municipality of Araruama, state of Rio de Janeiro, Brazil. The first event occurred at the border of a trail at 1026 h. An adult *P. patagoniensis* was seen close to the base of a ground bromeliad. Startled by the presence of the observers, the snake started to move away and it was then seen that it was carrying an adult *A. ameiva* in its mouth. The lizard was being held by the side of the body and was apparently alive. Unfortunately, the snake moved into vegetation and disappeared from view before the outcome of the event could be observed.

The second observation occurred about 18 min later, 150 m from the first encounter. This time, the snake was seen moving towards the lizard and capturing it as it ran. During the ensuing struggle, the snake threw two coils of its body around the lizard, bit its head, and then slowly moved its jaws forward until they completely engulfed the immobilized lizard's head (Fig. 1). They remained in that position for about 22 min, during which the lizard occasionally struggled and the snake responded by quickly jerking its head to the side and/or moving its jaws, presumably using its rear fangs to inject toxic secretions into its prey. After the lizard had stopped moving, the snake let it free of its coils and started to swallow it, a process that was completed in about 6 min. It is also noteworthy that, in spite of being venomous (Araújo and Santos 1997. Rev. Soc. Bras. Med. Trop. 30:517–519), *P. patagoniensis* may use a combination of constriction and envenomation to subdue relatively large prey. *Ameiva ameiva* has been reported as prey of many snake species, including *P. patagoniensis* (França et al., *op. cit.*). This medium-sized teiid is one of the most widely distributed lizard species in South America and is probably a frequent component of the diet of *P. patagoniensis*.



FIG. 1. Adult *Philodryas patagoniensis* immobilizing its prey, an adult *Ameiva ameiva*.

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SISTRURUS CATENATUS EDWARDSII (Desert Massasauga). **DIET, PREY SIZE, AND FEEDING RELATED MORTALITY**. *Sistrurus catenatus edwardsii* feeds on lizards, small mammals, small snakes, centipedes, and anurans (Holycross and Mackessy 2002. J. Herpetol. 36:454–464). Whiptails of the genus *Aspidoscelis* have been reported to be in the diet of *S. c. edwardsii*, however *A. marmorata* (Marbled Whiptail) has not yet been identified as prey (Holycross and Mackessy, *op. cit.*). This is rather intriguing, given the overlap that exists for both species' known geographic ranges (Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. Univ. New Mexico Press, Albuquerque. 431 pp.). Furthermore, little published information exists regarding prey size for *S. c. edwardsii*. Here, I report feeding related mortality of an *S. c. edwardsii* following consumption of an adult *A. marmorata*.

At 1018 h on 7 August 2008, I discovered a deceased female *S. c. edwardsii* (TCWC 93556) lying in the bottom of a large sand dune blowout in Lea County, New Mexico, USA (32.7847°N, 103.8089°W; datum: WGS 84, elev. 1173 m). The individual was lying dorsum up, appeared bloated, and had recently died. Both lizard and snake tracks were observed near the dead snake. The individual was collected and dissected to determine what was causing the large bulge in the snake's mid-section. Upon dissection, I discovered that the snake had consumed a female *A. marmorata* (TCWC 93557). The lizard's girth had caused a 35 mm long rupture in the snake's stomach which was likely the cause of death for the snake.

The *S. c. edwardsii* measured 310 mm SVL and 18 g mass post mortem and the *A. marmorata* measured 100 mm SVL and 21 g mass post mortem. This indicates that the snake attempted to ingest a prey item 1.17 times its own mass. This measurement is slight in comparison to the record for snakes (relative prey mass = 1.72; Mulcahy et al. 2003. Herpetol. Rev. 34:64). However, perhaps it illustrates a differential consumption/mortality threshold exists among species or individuals.

This observation is noteworthy for two reasons. First, although the ranges of *S. c. edwardsii* and *A. marmorata* overlap, their trophic relationship had not yet been clarified. Second, it indicates the consumption of large prey items may result in increased energy stores for *S. c. edwardsii*, but the potential threat of death due to a ruptured stomach exists.

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THAMNOPHIS MARCIANUS (Checkered Gartersnake). **DIET**. *Thamnophis marcianus* hunt in a variety of habitats and are known to feed on a more diverse group of prey items than many of their congeners (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Books, Washington, D.C. 668 pp.). During a two-week survey in the state of Coahuila, Mexico, on 31 July 2007 between 2100 and 2200 h, we found a foraging adult *T. marcianus* near Mota de Corona (27.41528ºN, 101.17090ºW; datum: WGS84, elev. 353 m). When captured, the individual immediately regurgitated a partially digested adult *Coleonyx brevis* (Texas Banded Gecko). The prey item was deposited in the herpetological collections of the University of Texas at Arlington (UTA R-55494) along with a photographic voucher of its predator (UTADC 2055). Only three genera of lizards, *Cophosaurus*, *Holbrookia*, and *Aspidoscelis* have been documented as prey for *T. marcianus* (Hampton and Fontenot 2007. Herpetol. Rev. 38:94–95). This is the first report of predation on *C. brevis* or any gecko by *T. marcianus* in the wild.

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THAMNOPHIS SIRTALIS INFERNALIS (California Red-sided Gartersnake). **DIET.** *Thamnophis sirtalis* is a terrestrial-aquatic generalist predator that feeds on a wide variety of prey groups (Fitch 1941. California Fish and Game 27:1–32). Although the diet is broad, amphibians often constitute a major component of their prey (Cunningham 1959. Herpetologica 15:17–19; Fitch, *op. cit.*; Fox 1952. Herpetologica 8:4–8). *Thamnophis sirtalis* can shift prey species in response to temporal availability of prey (Fitch, *op. cit.*) and due to gape limitation, may exhibit ontogenetic shifts in diet. Here I describe the diet of *T. s. infernalis* at a seasonal marsh in California.

I examined *T. s. infernalis* diet at Ledson Marsh, an 11-ha seasonal wetland, located in Annadel State Park, Sonoma County, California, USA (38.4086°N, 122.5995°W; datum: NAD83). The marsh is situated in hilly terrain surrounded by oak woodland and Douglas-fir forest. Winter rains typically fill the marsh to a maximum depth of ca. 150 cm that gradually recedes and the marsh is usually dry by early fall. The marsh is densely vegetated with wetland plants and is inhabited by an abundance of amphibians including: *Pseudacris regilla* (Northern Pacific Treefrog), *Taricha torosa* (California Newt), *T. granulosa* (Rough-skinned Newt), *Rana draytonii* (California Red-legged Frog), and *R. catesbeiana* (American Bullfrog). These species breed during the winter or spring and larvae typically metamorphose from mid-summer through early fall, before the marsh dries. Although abundant in

summer, *R. catesbeiana* tadpoles rarely metamorphose at the marsh due to late-season breeding and a protracted tadpole life stage.

I captured garter snakes at the marsh on 12, 13, 19, and 20 September 1998 using 12 drift fence and trap arrays located along the marsh shoreline, supplemented with hand captures. I hand palpated each snake captured until stomach contents were regurgitated and marked each snake by scale clipping. I grouped snakes into sub-adult and adult age groups based on review of a length frequency histogram that showed a clear bimodal size distribution.

Of the 62 *T. s. infernalis* captured during this study (no recaptures), 19 contained retrievable stomach contents and four snakes had multiple prey items (Table 1). I identified three prey species in the stomachs of snakes including: newly metamorphosed *P. regilla*, larval *Taricha* (species undetermined), and newly metamorphosed *R. draytonii*. No *R. catesbeiana* tadpoles were retrieved. *Rana draytonii* with a mean SVL of 32.1 mm (N = 14) was the largest prey consumed followed by larval *Taricha* with a mean SVL of 22.7 mm (N = 7). A single *P. regilla* was recovered with an SVL of 12 mm. The age (size) of *T. s. infernalis* corresponded to prey species taken (Table 1). Adult snake diet consisted of 84.2% *R. draytonii*, 10.5% larval *Taricha*, and 5.2% *P. regilla*. In contrast, the smaller sub-adult snakes consumed larval *Taricha* exclusively.

This diet study indicates that pre- and post-metamorphic amphibians are important seasonal prey for the Ledson Marsh *T. s. infernalis* population. The relatively high species richness of amphibians at Ledson Marsh apparently maintains a sizeable *T. s. infernalis* population, based on lack of recaptures during this study. *Thamnophis s. infernalis* consumed four of the five amphibian species that occurred at the marsh, the exception being the non-native *R. catesbeiana*. I suspect that *R. catesbeiana* were not taken because during the time of the study, they occurred as either small-sized tadpoles or large adults, both of which are likely outside the size preference for *T. s. infernalis*. Small *R. catesbeiana* tadpoles may be energetically too costly to forage for and adults are too large for snakes to consume. Finally, my results suggest that young *T. s. infernalis* may have a more specialized diet than adults, a pattern that has been noted for *T. sirtalis* in general (Rossman et al. 1996. The Garter Snakes: Evolution and Ecology. Univ. Oklahoma Press, Norman. 332 pp.) and *T. s. tetrataenia* (San Francisco Gartersnake; Larsen et al. 1991. Trans. West. Sect. Wildl. Soc. 27:37–41).

Fitch (*op. cit.*) reported that *R. draytonii* is an important food item for *T. sirtalis*. In my study, *R. draytonii* also appeared to be an important prey item. Juvenile *R. draytonii* were the dominant and largest prey taken by adult snakes, and presumably contributed the largest proportion of consumed biomass. This frog has declined substantially during the past century and is listed as threatened under the Federal Endangered Species Act (Miller et al. 1996. Fed. Reg. 61:25,813–25,833). Although *T. s. infernalis* is not considered rare, *T. s. tetrataenia* has been state and federally listed as endangered since 1971 and 1967, respectively, and the South Coast garter snake (*T. s.* sp.) is a state species of concern (Jennings and Hayes 1994. Amphibian and Reptile Species of Special Concern in California. California Dept. Fish and Game, Rancho Cordova, California. 255 pp.). Recovering *R. draytonii* populations could have substantial benefits for populations of *T. sirtalis* and other species of *Thamnophis*.

TABLE 1. Diet of *Thamnophis sirtalis infernalis* at Ledson Marsh, Sonoma County, California, USA. Prey species included: newly metamorphosed *Pseudacris regilla*, larval *Taricha* spp., and newly metamorphosed *Rana draytonii*.

	Snakes		Stomach Contents		
Snake age class	Mean total length (cm)	N	*Pseudacris regilla*	*Taricha* spp.	*Rana draytonii*
Sub-adult	19.3	26	0	6	0
Adult	41.3	36	1	2	16
All	32.0	62	1	8	16

I thank J. Alvarez for reviewing a draft manuscript and M. Hastings for supporting this study. Field studies were conducted under permits from California Department of Fish and Game and California Department of Parks and Recreation.

Submitted by **DAVID G. COOK**, 3003 Magowan Drive, Santa Rosa, California 95405, USA; e-mail: dcook@scwa.ca.gov.

GEOGRAPHIC DISTRIBUTION

Instructions for contributors to Geographic Distribution appear in Volume 41, Number 1 (March 2010, p. 102). Please note that the responsibility for checking literature for previously documented range extensions lies with authors. Do not submit range extension reports unless a thorough literature review has been completed.

CAUDATA — SALAMANDERS

AMBYSTOMA MACULATUM (Spotted Salamander). USA: INDIANA: GIBSON CO.: Patoka River National Wildlife Refuge and Management Area (38.3622ºN, 87.380ºW; NAD 83). 27 August 2009. Sarabeth Klueh and Angela Garcia. Verified by Chris Phillips. Illinois Natural History Survey (INHS 2009ae). New county record. (Minton 2001. Amphibians and Reptiles of Indiana. 2nd ed., revised. Indiana Academy of Science, vii–404 pp.) Juveniles were found under a log.

Submitted by **SARABETH KLUEH** (e-mail: sklueh@dnr.in.gov) and **ANGELA GARCIA**, Wildlife Diversity Section, Indiana Department of Natural Resources Division of Fish and Wildlife, 553 E. Miller Drive, Bloomington, Indiana 47401, USA.

AMPHIUMA MEANS (Two-toed Amphiuma). USA: GEORGIA: BULLOCH CO.: Statesboro. In ephemeral pond on Georgia Southern University campus adjacent to US Hwy 301 (32.42673°N, 81.788009°W; no datum available). 20 June 2009. Jocelyn Hyers, Angel Shepard, and Lance McBrayer. Verified by Ray Chandler. Georgia Southern University - Savannah Science Museum Herpetology Collection (SSM 2324)**.** New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). Three individuals were captured at this site on separate dates, using minnow traps. One specimen was vouchered, the others were photographed and released.

Submitted by **JOCELYN HYERS, ANGEL SHEPARD**, and **LANCE MCBRAYER,** Department of Biology, Georgia Southern University, Statesboro, Georgia 30460, USA.

AMBYSTOMA OPACUM (Marbled Salamander). USA: INDIANA: Gibson Co.: Patoka River National Wildlife Refuge and Management Area. (38.36869ºN, 87.32598ºW; NAD 83). 28 April 2009. Alisha Maves. Verified by Chris Phillips, Illinois Natural History Survey (INHS 2009af). New county record (Minton 2001. Amphibians and Reptiles of Indiana. 2nd ed., revised. Indiana Academy of Science. vii–404 pp.). Single individual found under a wooden pallet among moist leaf litter.

Submitted by **ALISHA MAVES** and **LINDSEY LANDOWSKI,** US Fish and Wildlife Service, Patoka River National Wildlife Refuge, 510 1/2 West Morton Street, P.O. Box 217, Oakland City, Indiana 47660, USA (e-mail: Lindsey_Landowski@fws.gov).

AMPHIUMA TRIDACTYLUM (Three-toed Amphiuma). USA: ARKANSAS: Nevada Co.: 9.7 km E of Prescott off St. Hwy. 24 (33.790561ºN, 93.280106ºW; WGS 84). 06 September 1973. H. W. Robison. Verified by R. Tumlison. Henderson State University Herpetological Collection (HSU 1476). New county record. Specimen is an adult collected from a flooded roadside ditch. *Amphiuma tridactylum* has now been reported from 26 of 75 (35%) counties of the Coastal Plain of Arkansas (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.; Plummer et al. 2008. Herpetol. Rev. 39:103).

Submitted by **CHRIS T. McALLISTER**, RapidWrite, 102 Brown Street, Hot Springs National Park, Arkansas 71913, USA (e-mail: drctmcallister@aol.com); and **HENRY W. ROBISON**, Department of Biology, Southern Arkansas University, Magnolia, Arkansas 71754, USA (e-mail: hwrobison@yahoo.com).

DESMOGNATHUS AENEUS (Seepage Salamander). USA: GEORGIA: Bartow Co.: Pine Log WMA, at Stamp Creek Rd. and Stamp Creek; seepage at head of first order branch N of bridge (34.25530°N, 84.68699°W; WGS 84). 12 March 2010. S. Graham and Z. Felix. AUM 38307–38310. Paulding Co.: Paulding Forest WMA, seepage along ravine and first order branch, ~ 50 m S of U.S. Hwy 278; headwaters of Raccoon Creek (33.93520°N, 84.96891°W; WGS 84). 12 March 2010. S. Graham and Z. Felix. AUM 38311–38313. All verified by Craig Guyer. New county records (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.).

Although range maps currently illustrate the distribution of seepage salamanders as continuous from the Blue Ridge Mountains of Georgia southwest through the Talladega Uplands to high elevation sites in Alabama (e.g., Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington. 587 pp.), few or no records actually support this (Jensen et al. 2008, *op. cit*.; Graham 2009. Herpetol. Rev. 40:232–233). Disjunct populations of this salamander apparently exist (Mount 1975. Amphibians and Reptiles of Alabama. Auburn Printing Co., Auburn, Alabama. 347 pp.; Graham 2009, *op. cit*.), and it was therefore possible that a distribution gap occurred in this area. These new records fill this substantial distribution gap (~ 70 km) between the nearest recorded populations to the NE in Cherokee County, Georgia, and to the SW in Haralson and Carroll Counties, Georgia, confirming that the distribution of this species is indeed continuous along the Talladega Uplands in Georgia as range maps suggest.

Sean Graham is supported in part by NIH grant R01-A149724 to T. Unnasch.

Submitted by **SEAN P. GRAHAM,** Auburn University Department of Biological Sciences, 331 Funchess Hall, Auburn, Alabama 36849, USA (e-mail: grahasp@auburn.edu); and **ZACH I. FELIX** Biology Department, Reinhardt College, Waleska, Georgia, USA.

EURYCEA CHAMBERLAINI (Chamberlain's Dwarf Salamander). USA: ALABAMA: Barbour Co.: Barbour County WMA; 50 m S County Rd. 49 at small tributary of Johnson Creek, ~ 1.5 km E of WMA boundary (32.00626°N, 85.40797°W; WGS 84). 26 March 2010. S. Graham and R. Birkhead. AUM 38343–38345. Henry Co.: Small branch 200 m S Hutto Pond and County Rd. 117 (31.66042°N, 85.31718°W; WGS 84). 13 May 2009. S. Graham. AUM 34913–34914. Russell Co.: Swamp S of County Rd. 163 (Huguley Rd.), ~ 4 km (by road) SE of State Rt. 51 intersection (32.40518°N, 85.33476°W; WGS 84). 26 March 2010. S. Graham and R. Birkhead. AUM 38342. All verified by Craig Guyer. New county records (Mount 1975. Amphibians and Reptiles of Alabama. Auburn Printing Co., Auburn, Alabama. 347 pp.; Graham et al. 2008. Herpetol. Rev. 39:476). These records fill a distributional gap (~ 30 km) for this species from Lee County, Alabama to the N, Bullock and Macon counties, Alabama, to the W (Graham et al. 2008, *op. cit.*), and Muscogee, Stewart, and Early counties, Georgia, to the E (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.; Graham et al. 2010. Southeast. Nat., *in press*).

S. Graham is supported in part by NIH grant R01-A149724 to T. Unnasch.

Submitted by **SEAN P. GRAHAM** Auburn University Department of Biological Sciences, 331 Funchess Hall, Auburn, Alabama 36849, USA (e-mail: grahasp@auburn.edu), and **ROGER D. BIRKHEAD** Alabama Science In Motion, Auburn University, Alabama, USA; (e-mail: birkhrd@auburn.edu).

GYRINOPHILUS PORPHYRITICUS (Spring Salamander). USA: ALABAMA. Randolph Co.: Small creek W of U.S. Hwy. 431, 0.32 km S of intersection with County Rd. 610. 07 March 2010. S. Graham. AUM AHAP-D 268. Digital photo. Verified by Craig Guyer. New county record (Mount 1975. Amphibians and Reptiles of Alabama. Auburn Printing Co., Auburn, Alabama. 347 pp.). Extends range ca. 40 km SE of nearest records in Cleburne County, Alabama.

Submitted by **SEAN P. GRAHAM** Auburn University Department of Biological Sciences, 331 Funchess Hall, Auburn, Alabama 36849, USA; e-mail: grahasp@auburn.edu.

HEMIDACTYLIUM SCUTATUM (Four-toed Salamander). USA: MASSACHUSETTS: Nantucket Co.: Nantucket, southeast shore of Sesachacha Pond near a small tributary stream (41.29231°N, 69.98880°W; WGS 84). 02 October 2009. Collected under a plywood cover board by Andrew A. McKenna-Foster. Color digital photo voucher verified by J. Martinez and J. Rosado. Museum of Comparative Zoology (MCZ A-139525). New county record (Cardoza and Mirik 2009. Massachusetts Division of Fisheries & Wildlife, State Reptiles and Amphibians List). This is the first record of this species on the island of Nantucket.

Submitted by **ANDREW A. MCKENNA-FOSTER**, Maria Mitchell Association, 4 Vestal St., Nantucket, Massachusetts 02554,

USA (e-mail: andrew.mckennafoster@gmail.com); and **SCOTT D. SMYERS**, Oxbow Associates, Inc., P.O. Box 971, Acton, Massachusetts 01720, USA (e-mail: smyers@oxbowassociates.com).

ANURA — FROGS

HYLA VERSICOLOR (Gray Treefrog). USA: PENNSYLVANIA: Clarion Co.: State Gamelands 63 wildlife pond ca. 0.15 km S from Buckhorn Rd. access (41.23532°N, 79.48662°W; WGS 84). 26 June 2009. Luke P. Bobnar and Kurt J. Regester. Verified by Charles Williams. Clarion University Vertebrate Collections and Museum (CUP A024). Adult male. New county record (Hulse et al. 2001. Amphibians and Reptiles of Pennsylvania and the Northeast. Cornell University Press, Ithaca, New York. xii + 419 pp.).

Submitted by **LUKE P. BOBNAR** (e-mail: s_lpbobnar@clarion.edu), and **KURT J. REGESTER**, Department of Biology, Clarion University, Clarion, Pennsylvania 16214, USA.

PSEUDACRIS BRACHYPHONA (Mountain Chorus Frog). USA: ALABAMA: Randolph Co.: Seepage E of U.S. Hwy. 431, 0.64 km S of Big Buck Rd. intersection (33.43538°N, 85.55646°W; WGS 84). 07 March 2010. S. Graham. AUM AHAP-D 269. Digital video file with audio. New county record (Mount 1975. Amphibians and Reptiles of Alabama. Auburn Printing Co., Auburn, Alabama. 347 pp.). Chorus of calling males recorded. GEORGIA: Haralson Co.: (Mountain View Rd. East, 50 m N of Tallapoosa River (33.87875°N, 85.16297°W; WGS 84). 12 March 2010. S. Graham. AUM AHAP-D 271. Video file with audio. Single male recorded calling. GEORGIA: Polk Co.: At intersection of Cobb Mountain Rd. and Mountain View Rd. (33.90718°N, 85.19728°W; WGS 84). 12 March 2010. S. Graham. AUM AHAP-D 270. Video file with audio. Single male recorded calling. New county records (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens, Georgia. 575 pp.). All identifications verified by Craig Guyer.

Range maps illustrate the distribution of *Pseudacris brachyphona* as continuous from the Blue Ridge Mountains of Georgia west through the Talladega Uplands to high elevation sites in Alabama (Mount 1975, *op. cit.*; Jensen et al. 2008, *op. cit.*), however, records are lacking for portions of this presumably continuous range. These new records fill a distribution gap (~ 70 km) between the nearest recorded populations to the E in Paulding County, Georgia, and to the SW in Cleburne County, Alabama, confirming that populations occur along the Georgia section of the Talladega Uplands, and that the distribution of this species is indeed continuous here as range maps suggest.

Submitted by **SEAN P. GRAHAM,** Auburn University, Department of Biological Sciences, 331 Funchess Hall, Auburn, Alabama 36849, USA; e-mail: grahasp@auburn.edu.

PSEUDACRIS CRUCIFER (Spring Peeper). USA: GEORGIA: Haralson Co.: Coppermine Rd., 100 m E of intersection of Coppermine Rd. and Corinth-Five Points Rd. (33.83487°N, 85.12062°W; WGS 84). 12 March 2010. S. Graham. AUM AHAP-D 272. Video file with audio. Verified by Craig Guyer. New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens, Georgia. 575 pp.). Chorus of multiple males recorded.

Submitted by **SEAN P. GRAHAM,** Auburn University, Department of Biological Sciences, 331 Funchess Hall, Auburn, Alabama 36849, USA; e-mail: grahasp@auburn.edu.

PSEUDACRIS CRUCIFER (Spring Peeper). USA: TENNESSEE: Hamilton Co.: Volunteer Army Ammunition Plant site (35.10437°N, 85.13053°W; WGS 84). 20 April 2009. Daniel S. Armstrong, Joseph F. Simpson, Thomas P. Wilson. Verified by C. Manis. UT Chattanooga Natural History Museum (TPW/UTCH-ERP 4657). First record for Hamilton County (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee, 19 pp. Hard copy and Internet [http://www.apsu.edu/amatlas/]. Accessed 20 April 2009). Specimen collected using a drift fence/pitfall array surrounding an ephemeral wetland. Voucher collected under Tennessee Wildlife Resources Agency Permit 3082 and UTC AUP No. 0408TPW-04.

Submitted by **JOSEPH F. SIMPSON** (e-mail: joseph-simpson@utc.edu), **DANIEL S. ARMSTRONG** (e-mail: daniel-armstrong@utc.edu), and **THOMAS P. WILSON**, Department of Biological and Environmental Sciences, University of Tennessee at Chattanooga, 615 McCallie Avenue, Chattanooga, Tennessee 37403, USA (e-mail: thomas-wilson@utc.edu)

PSEUDACRIS FERIARUM (Upland Chorus Frog). USA: GEORGIA: Haralson Co.: Coppermine Rd., 100 m E of intersection of Coppermine Rd and Corinth-Five Points Rd. (33.83487°N, 85.12062°W; WGS 84). 12 March 2010. S. Graham. AUM AHAP-D 272. Video file with audio. Chorus of calling males recorded. Paulding Co.: Seepage at head of first order branch S of U.S. Hwy. 278 (33.93227°N, 84.97599°W; WGS 84). 12 March 2010. Z. Felix. AUM AHAP-D 267. Audio file. Chorus of calling males recorded. All verified by Craig Guyer. New county records (Jensen et al. 2008. Amphibians and Reptiles of Georgia, University of Georgia Press, Athens, Georgia. 575 pp.).

Submitted by **ZACH I. FELIX,** Biology Department, Reinhardt College, Waleska, Georgia 30183, USA (e-mail: zif@reinhardt.edu); and **SEAN P. GRAHAM,** Auburn University, Department of Biological Sciences, 331 Funchess Hall, Auburn, Alabama 36849, USA (e-mail: grahaspauburn.edu).

GYMNOPHIONA — CAECILIANS

GEOTRYPETES SERAPHINI (Gaboon Caecilian). REPUBLIC OF CONGO. Mayongongo Village (04.11ºS; 14.57ºE; no datum available; elev. 331 m.) 09 December 2008. USNM 576262. Verified by George Zug. First records from the southern Republic of Congo. Two individuals (one collected) captured by villager, Célestine Louboko, while digging at edge of river in degraded forest near manioc field. Specimens were preserved, including tissue sampling and testing for chytrid fungus by Ange-Ghislain Zassi-Boulou and Sylvestre Boudzoumou, Groupe D'Etude et de Recherche sur la Diversité Biologique, Brazzaville, Republic of Congo. Previously reported from Gabon, Democratic Republic of Congo, Ivory Coast, and Ghana (Dumeril 1859. Arch. Mus. Natl. Hist. Nat. Paris 10:222; Laurent 1974. Copeia 1974:787–788; Rödel and Branch 2002. Salamandra 38:245–268; Rödel et al.

2005. Salamandra 41:107–127). Presence in southern Republic of Congo assumed (e.g., www.amphibiaweb.org), but not previously documented.

Submitted by **ANGE-GHISLAIN ZASSI-BOULOU** and **SYLVESTRE BOUDZOUMOU**, GERDIB (Groupe D'Etude et de Recherche sur la Diversité Biologique), BP: 2400, Brazzaville, Republic of Congo; and **KATE JACKSON**, Whitman College, Walla Walla, Washington 99362, USA (e-mail: jacksok@whitman.edu).

***POTAMOTYPHLUS KAUPII*.** BRAZIL: MARANHÃO: Municipality of Estreito (06.58459ºS, 47.44936ºW; no datum available), Tocantins River, Estreito hydroelectric power plant (UHE Estreito). 16 September 2007. I. Martins. Herpetological collection Museu de Zoologia da Universidade de São Paulo, São Paulo, Brazil (MZUSP 141871). Verified by H. Zaher. Previous general references to Amazon and Orinoco drainage systems of Colombia, Venezuela, Ecuador, Peru, and Brazil, below 500 m (Caramaschi and Pombal 2000. Herpetol. Rev. 31:49; Frost 2010. Amphibian Species of the World: an Online Reference. Version 5.4 [8 April 2010]. Electronic database accessible at: http:research.amnh.org/vz/herpetology/amphibia/, American Museum of Natural History, New York; Taylor 1968. The Caecilians of the World. A Taxonomic Review. Univ. Kansas Press, Lawrence. xiv + 848 pp.; Wilkinson et. al. 2004. IUCN Red List of Threatened Species. Version 2009. A Taxonomic and Geographical Reference. Allen Press, Inc., Lawrence, Kansas. vi+732 pp.). First record for the state of Maranhão and upper Tocantins River and also the first record for Cerrado biome. this is southern limit of the distribution, located 800 km from the previous southern limit of distribution at Amapá (Caramaschi and Pombal 2000, *op. cit.)*.

Submitted by **CARLOS EDUARDO DOMINGOS CINTRA**[2], **HELDER LUCIO RODRIGUES SILVA**[1,2], **FERNANDA ANZILIERO GONÇALVES**[2], and **NELSON JORGE DA SILVA JR.**[1,2]. [1]Universidade Católica de Goiás, Centro de Estudos e Pesquisas Biológicas – CEPB, Av. Universitária, 1440, S. Universitário, CEP 74.605-010, Goiânia, Goiás, Brazil; [2] Systema Naturae Consultoria Ambiental Ltda., Rua 58, N. 217, Jardim Goiás, Goiânia, Goiás, Brazil, CEP 74.810-250.

CROCODILIA — CROCODILIANS

ALLIGATOR MISSISSIPIENSIS (American Alligator). USA: GEORGIA: Miller Co.: Mayhaw Wildlife Management Area, 0.26 mi NE junction Griggs Lucille Road and Cypres Creek (31.19848°N, 84.79229°W; WGS84). 03 March 2006. Collected by A. M. Durso and UGA herpetology class. Verified by Kenneth L. Krysko. FLMNH 157207. First county record documented by a voucher (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens, Georgia. 575 pp.). The carcass of a subadult *A. mississipiensis* was found by the margin of a pond. This record lies ca. 18.7 km S of a 1997 record from Early County, Georgia (Moulis 1997. Status Survey of Barbour's Map Turtle [*Graptemys barbouri*] in Georgia. Unpubl. report to Georgia DNR. 38 pp. + appendices).

Submitted by **ANDREW M. DURSO**, Eastern Illinois University, Department of Biological Sciences, Charleston, Illinois 61920, USA; e-mail: amdurso@gmail.com.

TESTUDINES — TURTLES

APALONE MUTICA MUTICA (Midland Smooth Softshell). USA: IOWA: Butler Co.: S bank of West Fork Cedar River, ca. 1 km NE of Co Rd T-55 bridge, 9.2 km N of New Hartford (42.636867°N, 92.6379°W; WGS84). 278 m elev. 28 June 2004. Jeffrey W. Tamplin and Matt Keller. Verified by James W. Demastes. University of Northern Iowa Vertebrate Collection (UNI-JWT13). New county record. Extends the species' range into the West Fork Cedar River drainage in Iowa. *Apalone mutica* inhabits the Missouri, Mississippi, lower Cedar, Iowa, and Des Moines river drainages in Iowa but is thought to be absent from interior river systems in northern Iowa (Christiansen and Bailey 1997. The Lizards and Turtles of Iowa. Iowa Department of Natural Resources, Nongame Technical Series No. 3. Des Moines, Iowa. 20 pp.; Ernst and Lovich 2009. Turtles of the United States and Canada. 2nd edition. Johns Hopkins Univ. Press, Baltimore, Maryland. 828 pp.; http://www.herpnet.net/Iowa-Herpetology/). Adult *A. mutica* have been trapped and released along the West Fork Cedar River in Butler County, Iowa since 2004 and successful nesting has been observed since 2006. Habitat is riverine with a sand and gravel bottom, containing sand bars and sandy stream banks; banks are lined with patchy clearings of grasses and willow (*Salix* sp.) saplings, interspersed among deciduous woodlands.

Submitted by **JEFFREY W. TAMPLIN**, Department of Biology, University of Northern Iowa, 1227 W 27th Street, Cedar Falls, Iowa 50614, USA; e-mail: jeff.tamplin@uni.edu.

MORENIA PETERSI (Indian Eyed Turtle). INDIA: UTTARKHAND: Haridwar, Bhikampur, Laksar Road (29.44ºN, 78.02ºE; no datum available). Archana Bahuguna. 29 August 2009. ZSI NRC 02. Verified by Indraneil Das. First record from Uttarakhand State. From marshy area. Previously known from Assam, Bihar, West Bengal, and Uttar Pradesh in India, as well as Nepal and Bangladesh (Das 1995. Turtles and tortoises of India. Oxford University Press, Bombay. x + 176 pp.). Extends range west ca. 400 km from Dudhwa National Park, Uttar Pradesh, reported by Javed and Hanfee (1995. Hamadryad 20:21–26).

Submitted by **ARCHANA BAHUGUNA**, Northern Regional Centre, Zoological Survey of India, 218, Kaulagarh Road, Dehra Dun 248 195 Uttarakhand, India; e-mail: archana.bahuguna65@gmail.com.

TERRAPENE CAROLINA (Eastern Box Turtle). USA: INDIANA: Gibson Co.: Patoka River National Wildlife Refuge and Management Area (38.37535ºN, 87.35398ºW; NAD 83). 22 April 2009. Sarabeth Klueh, Angela Garcia, and Alisha Maves. Verified by Chris Phillips, Illinois Natural History Survey (INHS 2009ah). New county record. (Minton 2001. Amphibians and Reptiles of Indiana. 2nd ed., revised. Indiana Academy of Science. vii + 404 pp.)

Submitted by **SARABETH KLUEH** (e-mail: sklueh@dnr.in.gov) and **ANGELA GARCIA**, Wildlife Diversity Section, Indiana Department of Natural Resources Division of Fish and Wildlife, 553 E. Miller Drive, Bloomington, Indiana 47401, USA; **ALISHA MAVES** and **LINDSEY LANDOWSKI** (e-mail: Lindsey_Landowski@fws.gov), US Fish and Wildlife Service, Patoka River National Wildlife Refuge, 510 1/2 West Morton Street, P.O.

Box 217, Oakland City, Indiana 47660, USA.

TRACHEMYS VENUSTA (Mesoamerican Slider). USA: FLORIDA: Gilchrist Co.: Santa Fe River, 1.2 km downstream from Rum Island (29.834354°N, 82.690575°W; datum WGS84). 19 January 2010. Matthew H. Kail. Verified by Kurt Buhlmann and Michael Seidel. Florida Museum of Natural History (UF 157304). New state record. Adult male (straight carapace length 243 mm, plastron length 216 mm, mass 1690 g) captured by hand at 2130 h along the northern shoreline. High leech load (80–100 leeches) and presence of algae on carapace suggest that this is not a recently released captive. This non-native species may potentially harm the closely related native Yellow-bellied Slider (*Trachemys scripta scripta*) population through interbreeding and genetic introgression.

Submitted by **MATTHEW H. KAIL** (e-mail: snappergi@aol.com), and **DARCY T. GARRENTON**, Teaching Zoo, Santa Fe College, Gainesville, Florida 32606, USA (e-mail: dgarrent@kent.edu); **ERIC SUAREZ**, Department of Wildlife Ecology and Conservation, University of Florida, Gainesville, Florida 32611, USA (e-mail: eric.suarez725@yahoo.com); **GERALD R. JOHNSTON**, Department of Natural Sciences, Santa Fe College, Gainesville, Florida 32606, USA (e-mail: jerry.johnston@sfcollege.edu); and **JOSEPH C. MITCHELL**, Mitchell Ecological Research Services, Gainesville, Florida 32627, USA (e-mail: dr.joe.mitchell@gmail.com).

SQUAMATA — LIZARDS

ANOLIS (=NOROPS) SAGREI (Cuban Brown Anole). USA: TEXAS: Fort Bend Co.: Collected in author's backyard (29.702888°N, 95.790955°W; WGS84). 10 March 2010. A. Wood. Texas Cooperative Wildlife Collection (TCWC 94268). Verified by James R. Dixon. New county record (Dixon 2000. Amphibians and Reptiles of Texas. 2nd ed., Texas A&M Univ. Press, College Station, 421 pp.)

Submitted by **ADAM WOOD**, 24018 Seventh Heaven, Katy, Texas 77494, USA; e-mail: saleenadam@hotmail.com.

ANOTOSAURA VANZOLINIA. BRAZIL: RIO GRANDE DO NORTE: Municipality of Tenente Laurentino Cruz, Serra Nova (06.109°S, 36.719°W; datum WGS84, elev 704 m). 21 September 2009; 21 and 23 October 2009. L. Barros Ribeiro. Coleção Herpetológica do Departamento de Botânica, Ecologia e Zoologia, Universidade Federal do Rio Grande do Norte, Natal. Rio Grande do Norte (CHBEZ 2863, 2924, 2925). Verified by M. T. Rodrigues. First state record, extends the known geographical distribution of this species ca. 135 km N from the nearest record in the municipalities of São José dos Cordeiros/Sumé (Reserva Particular do Patrimônio Natural Fazenda Almas) (07.471°S, 36.881°W), state of Paraíba.

The gymnophthalmid lizard *Anotosaura vanzolinia* has been found in Rui Barbosa, Bahia State (Freitas and Silva 2007. Guia Ilustrado: a Herpetofauna das Caatingas e Áreas de Altitudes do Nordeste Brasileiro. Editora USEB, Pelotas, Brazil. 384 pp.); Agrestina (type locality) and district of Serra Negra, Bezerros municipality, state of Pernambuco (Rodrigues 1986. Pap. Avul. Zool. 36[20]: 237–250); Cabaceiras (Rodrigues 1986, *op. cit.*); São José da Mata (Delfim and Freire 2007. Oecol. Bras. 11[3]:365–382), São José dos Cordeiros and Sumé (Reserva Particular do Patrimônio Natural Fazenda Almas) in the state of Paraíba (Freire et al. 2009. *In* E. M. X. Freire [org.], Répteis Squamata das Caatingas do Seridó do Rio Grande do Norte e do Cariri da Paraíba: Síntese do Conhecimento Atual e Perspectivas, pp. 51–84. Editora da UFRN. Natal, RN, Brazil).

Submitted by **MELISSA GOGLIATH** (e-mail: melbiologa@gmail.com)[1,2], **LEONARDO B. RIBEIRO** (e-mail: ribeiro.lb@gmail.com)[1,2], and **ELIZA M. X. FREIRE** (e-mail: elizajuju@ufrnet.br)[1,2], [1]Laboratório de Herpetologia, Departamento de Botânica, Ecologia e Zoologia, Centro de Biociências, Universidade Federal do Rio Grande do Norte, Campus Universitário, 59072-970, Natal, RN, Brazil; [2]Programa de Pós-graduação em Psicobiologia/ Universidade Federal do Rio Grande do Norte, 59078-970, Natal, RN, Brazil.

ASPIDOSCELIS SEXLINEATA (Six-lined Racerunner). USA: ILLINOIS: Hancock Co.: One *Aspidoscelis sexlineata* was captured on the Mississippi River sand levee south of Warsaw, Illinois (40.34295ºN, 91.44906ºW; WGS 84). 09 August 2009. James T. Lamer and Terri L. Tobias. Illinois Natural History Survey (INHS) 21467. Verified by Chris Phillips. New county record (Phillips et al. 1999. Field Guide to Amphibians and Reptiles of Illinois. Illinois Nat. Hist. Surv. Manual 8, 282 pp.). Four other individuals were observed in the area.

Submitted by **TERRI L. TOBIAS** and **JAMES T. LAMER,** Western Illinois University, Alice Kibbe Field Station, Warsaw, Illinois 62379, USA.

CHAMAELEO GRACILIS (Slender Chamaeleon). MALI: SIKASSO REGION: 8 km E of Yanfolila (11.11ºN, 08.04ºW; no datum available). 05 July 2008. Sébastien Trape. Institut de Recherche pour le Développement at Dakar (IRD TR-2953). Verified by Laurent Chirio. First record for Mali where only *Chamaleo senegalensis* and *C. africanus* were previously known (Joger and Lambert 1996. *In* Ulrich [ed.], Tropical Biodiversity and Systematics. Proceeding of the International Symposium on Biodiversity and Systematics in Tropical Ecosystems, Bonn, 1994, pp. 189–202. Zoologisches Forschunginstitut und Museum Alexander Koening, Bonn; TIGR Reptile Database 2009. http://www.reptile.database.org/. Accessed December 2009).

Submitted by **SEBASTIEN TRAPE**, Laboratoire ECOLAG, Université Montpellier II, 34095 Montpellier Cedex 5, France; e-mail: sebastien_trape@yahoo.fr.

DAREVSKIA BRAUNERI SZCZERBAKI (Rock Lizard). GEORGIA: ABKHAZIA: Gudauta District: Lzaa village, Pitsunda-Myussera Hills. ZISP 24397, 25816–25818. 17 April 2006. Three specimens found by Konstantin Milto and Mark Pestov. Several specimens were registered in 5–7 July, 7–9 August 2008, and 7–12 August 2009 by Mark Pestov and Olga Bezman-Moseyko. Verified by Ilya S. Darevsky. Lizards observed on clay-rock cliffs of Black Sea coast between Lzaa settlement (43.16813ºN, 40.4108ºE; no datum available) and mouth of Mysra River (43.15009ºN, 40.45921ºE). Known from a small territory on northeastern coast of Black Sea in Krasnodar Region, Russia, and a subspecies endemic to Crimea-Novorossisk subprovince of East Mediterranean Province in Caucasus, inhabiting narrow coastal zone from Anapa

town to Cape of Utrish. This new locality, 297 km to southeast from earlier localities, may be the southernmost border of the range, and is a first record for the country.

Submitted by **KONSTANTIN D. MILTO** (e-mail: coluber@zin.ru), **MARK V. PESTOV**, and **OLGA S. BEZMAN-MOSEYKO**, Zoological Institute, Department of Herpetology, St. Petersburg, Universitetskaya emb., 1, 199034, Russia.

MESALINA BREVIROSTRIS (Short-nosed Desert Racer). IRAN: SISTAN & BALUCHISTAN PROVINCE: Gando Protected Area: Garm Beet (61.30ºN, 25.47ºE; ca. 146 m elev.). Nastaran Heydari. 20 October 2008. Verified by Steven C. Anderson. Zoology Museum Golestan University, ZMGU 2429. First confirmed record for Sistan and Baluchistan Province. Associated with *Phoenixdactylifera*, *Prosopis cineraria*, and *Nannorhops ritchieana* in lowland sandy hills. 850 km E of nearest record (Qeshm Island and Mahor Birinji; Anderson 1999. The Lizards of Iran. Society for the Study of Amphibians and Reptiles, Ithaca, New York. 415 pp.; Haas and Werner 1969. Bull. Mus. Comp. Zool., Harvard Univ. 138[6]:327–405).

Submitted by **NASTARAN HEYDARI**, Department of Biodiversity, Khuzestan University of Science and Research, Ahwaz, Iran (e-mail: heydari.pr@gmail.com); **HAJI GHOLI KAMI,** Department of Biology, Faculty of Sciences, Golestan University, Gorgan, Golestan Province, Iran (e-mail: hgkami2000@yahoo.com); and **SOHEILA SHAFIEI**, Department of Biology, Faculty of Science, Shahid Bahonar University of Kerman, Iran (e-mail: shafiei_soheila@yahoo.com).

PANASPIS NIMBAENSIS (Mount Nimba Lidless Skink). SENEGAL: ZIGUINCHOR REGION: Djibonker (12.32ºN, 16.21ºW; no datum available). 01 March 2009. Sébastien Trape. Institut de Recherche pour le Développement at Dakar (IRD TR-2954). Verified by Laurent Chirio. First record for Senegal (Cisse and Karns 1978. Bull. IFAN. 40A:144–211; TIGR Reptile Database 2009. http://www.reptile.database.org/. Accessed December 2009). Species previously reported from Guinea (Angel 1944. Bull. Mus. Nat. Hist. nat. Paris. 16:293–294), Ivory Coast (Barbault 1974. Bull. Soc. Zool. France. 99:345–361), and Gambia (Emms et al. 2007. Herpetol. Bull. 99:3–18).

Submitted by **SEBASTIEN TRAPE**, Laboratoire ECOLAG, Université Montpellier II, 34095 Montpellier Cedex 5, France; e-mail: sebastien_trape@yahoo.fr.

PLESTIODON FASCIATUS (Five-lined Skink). CANADA: ONTARIO: Lambton Co.: Village of Point Edward, ca. 60 m from shore of St. Clair River (42.992970ºN, 82.410727ºW; WGS 84). 20 May 2009. Daniel W. A. Noble and Jonathan D. Choquette. Verified by Ross D. MacCulloch. Royal Ontario Museum photographic vouchers (ROMdm 00251–00254). First municipality record and first observations in vicinity since 1932. Nearest record is historical from ca. 6 km S in the city of Sarnia, Ontario in 1932 (NMC 1740; Patch 1934. Copeia 1934:50–51). The Sarnia population (NHIC EO 16753) is considered extirpated by Ontario Ministry of Natural Resources Natural History Information Centre (NHIC). Records exist for only two other distant locations in Lambton County (both extant): Walpole Island (NHIC EO 1218) 45 km S and Pinery Provincial Park (NHIC EO 1212) 55 km NE. Three skinks (1 male, 1 female, 1 juvenile) were observed in a pile of logs, railway ties, and metal pipes in an isolated marina waste area. Two juveniles were observed 26 August and five juveniles on 11 September 2009 at same site. All were actively foraging or basking.

Submitted by **JONATHAN D. CHOQUETTE**, School of Environmental Design and Rural Development, University of Guelph, Guelph, Ontario N1G 2W1, Canada (e-mail: jchoquet@uoguelph.ca); **STEPHEN J. HECNAR**, Department of Biology, Lakehead University, Thunder Bay, Ontario P7B 5E1, Canada (e-mail: shecnar@lakeheadu.ca); **DANIEL W. A. NOBLE** (e-mail: nobled@uoguelph.ca), and **RONALD J. BROOKS**, Department of Integrative Biology, University of Guelph, Ontario N1G 2W1; (e-mail: rjbrooks@uoguelph.ca).

SQUAMATA — SNAKES

CROTALUS HORRIDUS (Timber Rattlesnake). USA: FLORIDA: Volusia Co.: Lake Woodruff National Wildlife Refuge (29.105°N, 81.36697°W; WGS84). 20 July 2009. Wesley Allie and Wyatt Brouillard. Florida Museum of Natural History (UF 155622). Verified by Kenneth Krysko. First state record. Extends distribution ca. 61.2 km SE of nearest locality, Silver River State Park (Ashton and Ashton 1988. Handbook of Reptiles and Amphibians of Florida. Part One: The Snakes. Revised edition. Windward Publ. Co., Miami, Florida. 176 pp.).

Submitted by **W. BOYD BLIHOVDE** (e-mail: boyd_blihovde@fws.gov) and **KELLY A. BRADY,** Lake Woodruff National Wildlife Refuge, 2045 Mud Lake Road, DeLeon Springs, Florida 32130, USA (e-mail: kbrady@stetson.edu).

EUNECTES MURINUS (Green Anaconda). BRAZIL: PIAUÍ: Municipality of Ilha Grande, Delta of Parnaíba River, locality of Saquim (2.775656°S, 41.804756°W; datum WGS84). 13 October 2008. E. B. de Andrade and P. da C. Silva. Coleção Herpetológica do Museu Paraense Emílio Goeldi, Belém, Brazil (MPEG 23.36). Verified by T. C. Ávila-Pires. Species distributed in Trinidad Island, Venezuela, Colombia, Peru, Ecuador, Guiana, French Guiana, Suriname, and Brazil (Amazon Basin, central, and northeastern Brazil (Cunha and Nascimento 1993. Bol. Mus. Para. Emílio Goeldi, sér. Zool. 9[1]:1–191; Freitas and Silva 2007. A Herpetofauna das Caatingas e Áreas de Altitudes do Nordeste Brasileiro. 384 pp.). First record for state of Piauí, extending range ca. 332 km NE from the municipality of Arari, state of Maranhão (Cunha and Nascimento 1993, *op. cit.*) and ca. 390 km W from the municipality of Aquiraz, state of Ceará (Mendonça et al. 2009. Herpetol. Rev. 40:238).

Submitted by **ROBERTA R. DA SILVA-LEITE,** Universidade Federal do Piauí, Campus Ministro Reis Velloso, Av. São Sebastião nº 2819, Parnaíba, Piauí, Brazil, CEP 64202-020 (e-mail: Roberta.ufpi@gmail.com); **IGOR JOVENTINO ROBERTO**, Aquasis - Associação de Pesquisa e Preservação de Ecossistemas Aquáticos, Programa Biodiversidade. Praia de Iparana s/n, SESC Iparana, Caucaia, Ceará, Brazil, CEP 61627-010; **DANIEL LOEBMANN,** Departamento de Zoologia, Instituto de Biociências, Universidade Estadual Paulista, Rio Claro, São Paulo, Brazil, Caixa Postal 199, CEP 13506-970; **THIAGO DA SILVA NASCIMENTO**, Universidade Federal do Piauí, Campus Ministro Reis Velloso, Av. São Sebastião nº 2819, Parnaíba, Piauí, Brazil, CEP 64202-020; **PEDRO DA COSTA**

SILVA, Associação de Guias e Condutores de Turismo de Ilha Grande, Centro, Ilha Grande, Piauí, Brazil, CEP 64224-970.

HETERODON PLATIRHINOS (Eastern Hog-nosed Snake). USA: ILLINOIS: Schulyler Co.: 2.3 km SW of Sugar Grove, 0.2 km N of jct. Co. Rd. 1700E (La Grange Lock Road.) and Co. Rd 270N (Quarry Road.) on Co. Rd. 1700E (40.0122°N, 90.5871°W; NAD 83). 10 May 2007. J. E. Petzing and K. L. Knuffman. Verified by C. A. Phillips. Illinois Natural History Survey (INHS) 20531. First county record (Phillips et al. 1999. Field Guide to Amphibians and Reptiles of Illinois. Illinois Nat. Hist. Surv. Manual 8, Champaign, Illinois. 300 pp.). DOR adult.

Submitted by **JOHN E. PETZING**, 1018 Prickett Avenue, Edwardsville, Illinois 62025, USA; e-mail: jepetzing@yahoo.com.

OPHEODRYS VERNALIS (Smooth Green Snake). USA: MINNESOTA: Houston Co.: County Hwy 26 ca. 4.8 km N of Reno (43.64493°N, 91.27580°W; WGS 84). 19 September 2009. Found DOR, photographic records were deposited in the James Ford Bell Museum (JFBM P316). Verified by Kenneth H. Kozak and Amy M Luxbacher. Oldfield and Moriarty (1994. Amphibians & Reptiles Native to Minnesota. Univ. Minnesota Press, Minneapolis. 237 pp.) list no museum record for this species in Houston County but do plot its occurrence with a symbol representing sightings or literature records. To the best of our knowledge this is the first vouchered specimen for Houston County.

Submitted by **ERICA P. HOAGLUND**, Minnesota Department of Natural Resources, Division of Ecological Resources, Nongame Wildlife, 1335 Oakdale Ave. Apt. 209, West Saint Paul, Minnesota 55118, USA (e-mail: Erica.Hoaglund@dnr.state.mn.us); and **CHRISTOPHER E. SMITH**, Department of Fisheries, Wildlife, and Conservation Biology, University of Minnesota, 1980 Folwell Avenue, Saint Paul, Minnesota 55108, USA; (e-mail: smit4155@umn.edu).

SONORA SEMIANNULATA SEMIANNULATA (Variable Groundsnake). USA: NEVADA: Lander Co.: Shoshone Range, 34.8 air miles N of Austin (39.99452°N, 117.14979°W; WGS84), elev. 1680 m. 12 June 2009. J. Shedd. Verified by J. Vindum. California Academy of Sciences photo voucher (HPV 62). First documented account from Lander County aside from two unverified reports from the vicinity of Battle Mountain (L. Teske, pers. comm.). Only one other specimen (CAS-SUR 10032) of this species is formally documented from Lander County, at 22 mi E of Battle Mountain. This distance from Battle Mountain appears to actually be Eureka County by both road or air miles. Found under rock after heavy rains at 1100 h. The specimen was orange and black-saddled morph. Predominant vegetation consisted of *Artemisia tridentata*, *Atriplex confertifolia*, and *Chrysothamnus viscidiflorus*. Sheds from two other individuals also found in the vicinity under rocks.

Submitted by **JACKSON D. SHEDD**, 516 Civic Center Drive, Oceanside, California 92054, USA (e-mail: jackson.shedd@gmail.com); and **GUSTAVO GONZALEZ**, P.O. Box 873, McGill, Nevada 89318, USA.

STORERIA DEKAYI WRIGHTORUM (Midland Brownsnake). USA: ILLINOIS: Whiteside Co.: SE of Fulton, tributary of Cattail Creek at Union Pacific RR trestle/overpass just W of Chase Road (41.8448°N, 90.1405°W; NAD 83). 05 October 2007. J. E. Petzing. Verified by C. A. Phillips. Illinois Natural History Survey (INHS) 20865. First county record (Phillips et al. 1999. Field Guide to Amphibians and Reptiles of Illinois. Illinois Nat. Hist. Surv. Manual 8, Champaign, Illinois. 300 pp.). Adult collected on east bank of tributary.

Submitted by **JOHN E. PETZING**, 1018 Prickett Avenue, Edwardsville, Illinois 62025, USA; e-mail: jepetzing@yahoo.com.

THAMNODYNASTES ALMAE (NCN). **BRAZIL:** PARAÍBA**:** Cabaceiras: Fazenda Bravo (7.483333ºS, 36.283333ºW; WGS84). 28 February 2003. S. Abrantes et al. Universidade Federal da Paraíba (UFPB 4263); BAHIA: Itiúba (10.700000ºS, 39.850000ºW; WGS84). 5–9 May 1973. Expedition ABC-MZUSP. Museu de Zoologia da Universidade de São Paulo (MZUSP 5433–34) and Paulo Afonso (9.400000ºS, 38.216667ºW; WGS84). 22 March and 10 April 1988. Anonymous collector. Museu de Zoologia da Universidade Federal da Bahia (MZUFBA 131–38); PERNAMBUCO: Petrolândia (9.133333ºS, 38.300000ºW; WGS84). 20 April 1988. Companhia Hidroelétrica do São Francisco. Instituto Butantan (IB 52119). ALAGOAS: Piranhas (9.616667ºS, 37.750000ºW; WGS84). 29 April 1994. Companhia Hidroelétrica de Xingó. Museu de Zoologia da Universidade Federal da Bahia (MZUFBA 847). All verified by F. L. Franco. The species was known from the type locality, Rodelas municipality, Bahia state (Franco and Ferreira 2002. Phyllomedusa 1:57–74) and a recent record in Milagres, Ceará state (Roberto et al. 2009. Herpetol. Rev. 40:238). First records for the states of Paraíba, Pernambuco, and Alagoas, all in Caatinga habitats, extending range ca. 289 km NE and the two new records from Bahia extend the range ca. 244 km S from type locality (Franco and Ferreira 2002, *op. cit.*). Funded by FAPESP (2009/50627-4).

Submitted by **THAÍS BARRETO GUEDES,** Laboratório de Ecologia e Evolução, Instituto Butantan, Av. Vital Brazil 1500, CEP 05503-900, São Paulo, SP, Brazil; e-mail: thaisguedes@butantan.gov.br.

THAMNOPHIS PROXIMUS PROXIMUS (Orange-striped Ribbonsnake). USA: IOWA: Bremer Co.: Sweet Marsh Wildlife Management Area, 1.6 km NW of Co Rd C-28 and Sable Avenue Intersection, 3.3 km NE of Tripoli (42.812997°N, 92.217967°W; WGS84). 303 m elev. 30 April 2004. Jeffrey W. Tamplin, Thomas F. Bierman, and Gretchen R. Spies. Verified by James W. Demastes. University of Northern Iowa Vertebrate Collection (UNI-JWT15). New county record extends the species' range into northeastern Iowa. *Thamnophis proximus* occurs across southern Iowa but was thought to be absent from north-central and northeastern Iowa (Christiansen and Bailey 1990. The Snakes of Iowa. Iowa Department of Natural Resources, Nongame Tech. Ser. No. 1. Des Moines, Iowa. 16 pp.; Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Books, Washington, D.C. 668 pp.; http://www.herpnet.net/Iowa-Herpetology/). Two adults were observed mating at ca. 1530 h. After mating was completed the male was collected as a voucher specimen. Habitat was a grassy clearing with forbs and small saplings, adjacent to marshes and cultivated fields.

Submitted by **JEFFREY W. TAMPLIN**, Department of Biol-

ogy, University of Northern Iowa, 1227 W 27th Street, Cedar Falls, Iowa 50614, USA; e-mail: jeff.tamplin@uni.edu.

VIRGINIA VALERIAE ELEGANS (Western Smooth Earthsnake). USA: ARKANSAS: Cleveland Co.: 3.2 km SE of Kingsland off St. Hwy. 97 (33.834775°N, 92.287903°W; WGS 84). 14 June 1986. D. Ragland. Verified by R. Tumlison. Henderson State University Herpetological Collection (HSU 1477). New county record. Partially fills a distributional hiatus among Bradley and Ouachita counties (McAllister and Robison 2009. Herpetol. Rev. 40:367; Robison and Daniel. 2006. Herpetol. Rev. 37:502; Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.).

Submitted by **CHRIS T. McALLISTER**, RapidWrite, 102 Brown Street, Hot Springs National Park, Arkansas 71913, USA (e-mail: drctmcallister@aol.com); and **HENRY W. ROBISON**, Department of Biology, Southern Arkansas University, Magnolia, Arkansas 71754, USA (e-mail: hwrobison@yahoo.com).

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More Range Extensions for Papuan Reptiles and Amphibians

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The herpetofauna of the Papuan region—comprising New Guinea, the Solomon Islands, and associated satellite islands—is extremely rich but remains relatively poorly known. Hundreds of species likely remain to be discovered, scores are known but remain to be described, geographic ranges of known species are often poorly understood, and important parts of the region remain sparsely surveyed. Recent work has considerably expanded our knowledge of species' distributional ranges in this region (Günther 2003; Kraus and Allison 2004, 2006a; Kraus and Shea 2005), but much remains to be done. Much of this recent expansion in our understanding has resulted from expeditions to previously unstudied localities. However, additional relevant information already resides in museum collections but has remained unsurveyed. Herein I report a number of significant range extensions for amphibians and reptiles from New Guinea, the majority of these records coming from the holdings of the Australian Museum in Sydney and the Bishop Museum in Honolulu, but supplemented with additional records from the Museum of Comparative Zoology and United States National Museum. Coordinates for BPBM specimens use the AGD66 datum unless otherwise noted; those from other museums are taken from their catalogues, converted by me to decimal degrees, and presumably were taken from maps using the AGD66 datum.

Frogs

Albericus darlingtoni. PAPUA NEW GUINEA: Southern Highlands Prov.: E slope Mt. Itukua, Muller Range, 5.66954°S, 142.62334°E (WGS84 datum), 2177 m elev. 26–30 March 2009. F. Kraus, J. Anamiato. BPBM 33664–33668. Range extension of ca. 125 km WNW of nearest locality at Mendi (Menzies 1999).

Albericus gunnari. PAPUA NEW GUINEA: Central Prov.: Dorobisoro, 9.4592391ºS, 147.9371584ºE, 600 m elev. 7–8 October 2003. F. Kraus. BPBM 18347–51; halfway between Laronu and Mimai, 8.4501811ºS, 147.9772933ºE, 1000 m elev. 14 February 2004. F. Kraus. BPBM 19223–33. Range extension of ca. 40 km to NE of type locality (Menzies 1999).

Choerophryne burtoni. PAPUA NEW GUINEA: Southern Highlands Prov.: E slope Mt. Itukua, Muller Range, 5.67046°S, 142.63038°E (WGS84 datum), 2037 m elev. 25 March 2009. native collectors. BPBM 33671. Range extension of ca. 80 km to NW of type locality at Moran area of same province (Richards et al. 2007).

Cophixalus riparius. PAPUA NEW GUINEA: Madang Prov.: Fungoi, Kaironk Valley, Schrader Mts., 5.333333ºS, 144.41666667ºE. 14 December 1963–2 January 1964. H. G. Cogger. AMS R22667–22756. First record for province and for Schrader Mts.; range extension of ca. 80 km NW of nearest locality at Mt. Wilhelm (Zweifel 1962).

Cophixalus shellyi. PAPUA NEW GUINEA: Madang Prov.: Fungoi, Kaironk Valley, Schrader Mts., 5.333333ºS, 144.41666667ºE. 24 December 1963. H. G. Cogger. AMS R23086, 23123. First records for Schrader Mts. and range extension of ca. 60 km NW of nearest locality at Wahgi-Sepik Divide (Zweifel 1980).

Cophixalus variabilis. PAPUA NEW GUINEA: Central Prov.: Sogeri Plateau, Itikinumu Rubber Plantation. 14 November 1971. G. R. Zug. USNM 197456, 231508; Northern Prov.: 10 km NNW Popondetta. 27 December 1971. G. R. Zug. USNM 197457. First record is a range extension of ca. 20 km N of previously northernmost record along Musgrave River; second is a new provincial record and first report of species along northern versant of Owen Stanley Mts. (Kraus and Allison 2006b).

Hylarana daemeli. PAPUA NEW GUINEA: New Ireland Prov.: Napus, New Hanover Island. 29 August 1973. P. Comorford. AMS R41249; Taskul, New Hanover Island. 28 August 1973. P. Comorford. AMS R41250. First record for province (Menzies 2006).

Hylarana milneana. PAPUA NEW GUINEA: Morobe Prov.: Bulolo. No date. C. Gunther. AMS R12186, 12188, 12190–95; Northern Prov.: Inamaturu, Mt. Lamington, 8º56'S, 148º10'E. No date. C. T. McNamara. AMS R9874. First records for each province, and latter is range extension of 270 km to the N; previously known only from Milne Bay and Central provinces (Kraus and Allison 2007).

Hylophorbus richardsi. PAPUA NEW GUINEA: Southern Highlands Prov.: E slope Mt. Itukua, Muller Range, 5.66954°S, 142.62334°E (WGS84 datum), 2177 m elev. 20–27 March 2009. F. Kraus, J. Anamiato, and native collectors. BPBM 33756–62. Range extension of ca. 55 km to NW of type locality at Mt. Sisa (Günther 2001).

Lechriodus platyceps. PAPUA NEW GUINEA: West Sepik Prov.: summit Mt. Somoro, Torricelli Mts., 3.392ºS, 142.133ºE. 8 March 1990. T. Flannery. AMS R136293. Second record for country, first record for Torricelli Mts., and range extension of ca. 110 km E of

Bewani Mts. (Kraus and Allison 2006a).

Liophryne allisoni. PAPUA NEW GUINEA: Central Prov.: 2.3 km SSW Fane, 8.56933ºS, 147.07675ºE, 1800 m elev. 5 October 2003. F. Kraus. BPBM 18315. New provincial record and range extension of ca. 140 km to S of area around Wau (Zweifel 2000).

Litoria auae. PAPUA NEW GUINEA: Southern Highlands Prov.: Bobole, 6.20ºS, 142.76666667ºE. October 1985. S. Donnellan. AMS R132359–71; Namosado, 6.25ºS, 142.783333ºE. 1985. S. Donnellan. AMS R132380–81. In describing this species and *L. kumae*, Menzies and Tyler (2004) noted that five poorly preserved specimens from these localities (in SAM) appeared to be *L. kumae*. However, all AMS specimens listed above have white spots, have lighter ground color than seen in *L. kumae*, and are larger (male SVL = 29.3–35.3, N = 12; female SVL = 34.2–39.8, N = 3) than that species; they clearly fit the diagnosis of *L. auae*. They thus bring the range of *L. auae* to at least the edge of the range of *L. kumae* and serve to fill in the gap between eastern populations of *L. auae* and the Ok Ma isolate to the west (Menzies and Tyler 2004).

Litoria kumae. PAPUA NEW GUINEA: Southern Highlands Prov.: 1.2 km N Tangi, 5.64700ºS, 142.65259ºE (WGS84 datum), 1660 m elev. 5 April 2009. Native collectors. BPBM 33991–400. Range extension of ca. 35 km to NW of Tari for this restricted-range species (Menzies and Tyler 2004).

Litoria purpureolata. PAPUA NEW GUINEA: West Sepik Prov.: Imonda, 3.3333ºS, 141.166667ºE. 1 March 1990. P. German. AMS R135573; vicinity of Utai aerodrome, 3.389ºS, 141.585ºE, 210 m elev. 26 April 1986. A. Allison. BPBM 14463–65, 14467; base of Mt. Sumbau, 3.38333ºS, 142.5333ºE. 8 March 1990. P. German. AMS R135576. First records for country, and range extensions of ca. 280 km, 330 km, and 470 km E of type locality (Oliver et al. 2007).

Litoria pygmaea. PAPUA NEW GUINEA: Madang Prov.: Madang. 8 September 1964. Collector unrecorded. AMS R111666. First record for province and range extension of ca. 120 km from populations in the Central Highlands (Richards and Price, 2004) and 300 km from population at Wamangu, East Sepik Province (Dahl et al. 2009).

Nyctimystes fluviatilis. PAPUA NEW GUINEA: West Sepik Prov.: Parkop, Torricelli Mts., 3.42457°S, 142.51866°E, 416 m elev. 14 May 2005. F. Kraus. BPBM 23251–52; 3.2 km SSE Mt. Sapau summit, Torricelli Mts., 3.39329°S, 142.52826°E, 550 m elev. 18–25 May 2005. F. Kraus. BPBM 23253, 23256–59, 23263–65; Wilbeite Village, Torricelli Mts., 3.416667°S, 142.116667°E, 10 June 1988. T. Flannery. AMS 130396. Western Prov.: Kavorabip, 5.133333°S, 141.11666667°E. 22 August 1972. F. Parker. MCZ 110312–13. First records for country and range extensions of ca. 450 km to E and 330 km to SE, respectively, from the type locality along the Idenburg River (Zweifel 1958).

Nyctimystes zweifeli. PAPUA NEW GUINEA: Chimbu Prov.: Doido, 6.55°S, 144.83333°E. 14 April 1985. S. Donnellan. AMS R114802, 114804; Southern Highlands Prov.: Bobole, 6.20ºS, 142.76666667ºE. October 1985. S. Donnellan. AMS R132353–58. First records for each province and range extensions of 360 km ESE and 150 km SE of the type locality at Telefomin (Tyler 1967).

Hypsilurus hikidanus. PAPUA NEW GUINEA: Chimbu Prov.: Toromambuno, Mt. Wilhelm, 5.8442028ºS, 145.1018018ºE. 4 July 1955. J. L. Gressitt. BPBM 2693–96. First record for country and range extension of 850 km to the east from type locality at Wissel Lakes (Manthey and Denzer 2006).

Hypsilurus longii. SOLOMON ISLANDS: Isabel Island: Alu Alu village, 8.3ºS, 159.55ºE. 23 February 1991. H. Parnaby and I. Aujare. AMS R137241; Kaipitu River, near Alu Alu village, 8.3ºS, 159.55ºE. 24 February 1991. H. Parnaby and I. Aujare. AMS R137243; Makira Island. 20 November 1987. G. Mengden. AMS R127290; Makira Island: Sgsgna village. 16 November 1987. T. Flannery. AMS R130465. New island records that extend the range of this species to the southern end of the Solomon Islands. Previously reported only from Bougainville at the NW end of the chain (Manthey and Denzer 2006). McCoy (2006) inferred that the Isabel Island specimens, which he had not seen, belonged to this species based on their large size. I confirm that presumption.

Hypsilurus macrolepis. SOLOMON ISLANDS: Choiseul Island: Malangona, 7.049ºS, 156.778ºE. 14 March 1964. P. Temple. BPBM 2488. New island record and range extension to NW from Santa Isabel Island (Manthey and Denzer 2006).

Hypsilurus magnus. PAPUA NEW GUINEA: Central Prov.: Moitaka, Port Moresby. September 1985. S. Donnellan and K. Aplin. AMS R122448; Madang Prov.: Warius River, 5.9592435ºS, 145.86632ºE, 400 m elev. 31 August 1987. C. P. Kendrick. BPBM 21635. Morobe Prov.: Tekadu, 7.664855ºS, 146.5638586ºE, 400 m elev. 20 October 1996. A. Allison. BPBM 13171. Southern Highlands Prov.: Bobole, 6.20ºS, 142.76666667ºE. October 1985. S. Donnellan and K. Aplin. AMS R122427–29, 122441, 122476; Namosado, 6.25ºS, 142.783333ºE. 1985. S. Donnellan and K. Aplin. AMS R122433–40, 122442–46, 12249–51, 122461–70; Fogamaiyu, 6.51666ºS, 143.083333ºE. December 1985. S. Donnellan and K. Aplin. AMS R122471–75; confluence of Libano and Hegigio rivers, 6.3990666ºS, 142.9761333ºE, 250 m elev. 4–6 August 2003. A. Allison. BPBM 28231–35. Western Highlands Prov.: Manjim, Ganz River, 5.53333ºS, 144.483333ºE. 16 July 1954. Troughton and Campo. AMS R14751–57; Jimi River, 5.35ºS, 144.3333ºE. 21 July 1954. Troughton and Campo. AMS R14761–62; Baiyer River, 5.55ºS, 144.0ºE. 14 August 1969. Collector unrecorded. AMS R28690; West Sepik Prov.: Trefas Village, 5.9 km N, 7.3 km E of Utai, 3.333ºS, 141.651ºE, 320 m elev. 22 September–23 October 1996. A. Allison. BPBM 23159, 23165, 23172; Menawa River, 8.4 km N, 11.4 km E of Utai, 3.312ºS, 141.688ºE, 560 m elev. 24 September 1996. A. Allison. BPBM 23161–62. First records for country (Manthey and Denzer 2006), suggesting the species is widely distributed across most of New Guinea.

Hypsilurus schultzewestrumi. INDONESIA: Papua Prov.: Bokondini, 40 km. N. of Baliem Valley, 3.63ºS, 138.6ºE (datum unknown), 1400 m elev. 18 November 1961. L.W. Quate and S. Quate. BPBM 3296; PAPUA NEW GUINEA: Chimbu Prov.: Goglme, 5.93333ºS, 145.03333ºE. No date. J. Hope. AMS R29126–28; Eastern Highlands Prov.: Roka Estate Village on Goroka-Daulo Pass Road, 6.05S, 145.4E. No date. A. K. Lee. AMS R64740–71;

Koge, 6.10ºS, 145.01666ºE. 16 October 1965. F. Parker. AMS R68895; Irumbafoi, 6.23333ºS, 145.26666ºE. 13 July 1964. Collector unrecorded. AMS R86887; Enga Prov.: Yaramanda, West Baiyer Valley, 5.61666ºS, 143.916666ºE. 22–28 August 1955. R. N. H. Bulmer. AMS R14849–50; Madang Prov.: Fungoi, Kaironk Valley, Schrader Mts., 5.333333ºS, 144.41666667ºE. 14 December 1963–1 January 1964. H. G. Cogger. AMS R21190–91, 23039, 24328–30; West Sepik Prov.: Telefomin, 5.136775ºS, 141.633333ºE. 30 August 1963. P. Temple. BPBM 3858. First is new country record; remainder are new provincial records. Previously known with certainty only from type locality at Nondugl, Western Highlands Province, Papua New Guinea (Manthey and Denzer 2006).

Snakes

Toxicocalamus stanleyanus. MADANG PROVINCE: between Hinihon and Reinduk, 1000 m elev. 24 March 1974. G. B. Opit. BPBM 5711. First record for province; nearest record is Gulf Province ca. 300 km away on S side of Central Dividing Range (McDowell 1969; O'Shea 1996).

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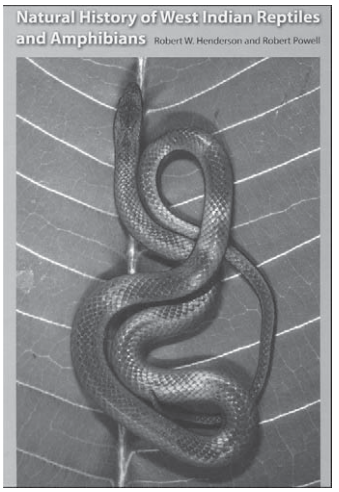
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BOOK REVIEWS

Herpetological Review, 2010, 41(2), 249–250.
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Natural History of West Indian Amphibians and Reptiles, by Robert W. Henderson and Robert Powell. 2009. University Press of Florida (www.upf.com). Hardcover. xxiv + 495 pp. US $85.00. ISBN 978-0-8130-3394-5.

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The West Indies are home to more than 6.3% of the world's reptile species, including more than 600 species found nowhere else on earth (Hedges 1996). This extraordinary diversity, combined with the presence of herpetology's best-known example of adaptive radiation (*Anolis* lizards) and the region's proximity to the United States have made the West Indies a Mecca of herpetological research for over a century. When it comes to comprehensive book length treatments of this herpetofauna, West Indian herpetologists have tended to prefer substance over style. For nearly two decades, the best example of this was Schwartz and Henderson's (1991) *Amphibians and Reptiles of the West Indies: Descriptions, Distributions, and Natural History* (hereafter S&H), which makes up for a lack of illustrations with comprehensive species descriptions, dot maps, and natural history notes for every species of West Indian amphibian and reptile. S&H remains one of the most impressive compendia ever published on a regional herpetofauna and has served a foundation for herpetological research in the West Indies for nearly two decades.

Henderson and Powell's (2009) (hereafter H&P) new compendium on the natural history of West Indian amphibians and reptiles expands the foundation provided by S&H, and provides an impressive resource for the next generation of West Indian herpetological research. Although it shares S&H's emphasis on style over substance (there are few illustrations), it is much more than a mere rehash of S&H's classic work; instead, H&P focus primarily on updating and expanding the natural history information included in S&H. H&P also provide the first comprehensive assessment of the conservation status of reptiles and amphibians—a key contribution given the relatively small ranges of many of the region's endemic species. Along the way, H&P nearly triple the number of references contained in S&H, a testament to H&P's scholarship and the expanding body of literature pertaining to the natural history, ecology and conservation of West Indian herps (over 2600 references in H&P versus 883 in S&H).

Henderson and Powell lead off with an insightful review of the West Indian herpetofauna and efforts to study it, including a wide-ranging consideration of this fauna's future. The "Where We are Today" section includes an excellent summary of the history of West Indian herpetology. H&P also use informal meta-analyses to illuminate the uniqueness of the West Indian herpetological fauna and to highlight the taxonomic imbalance of previous work on West Indian herps; some taxa have enjoyed sustained natural history research while little is known of many other taxa beyond their existence. Following up on this observation, H&P's introduction closes with a discussion of the future of West Indian herpetology that serves as both a roadmap for future research and a call to arms for the herpetological community.

One of the most important features of H&P is the information it contains on the conservation status of West Indian reptiles and amphibians, including a comprehensive summary of the various threats facing this fauna. Although the West Indies are home to hundreds of narrowly distributed endemic species living in heavily disturbed environments, conservation efforts are focused almost exclusively on a few particularly charismatic species like rhinoceros iguanas, boas, and racers. One reason for this is that the tenuous status of many lesser-known West Indian reptiles and amphibians has been overlooked by the broader community of conservationists. H&P begin their efforts to overcome this oversight with an extensive review of the literature that considers the impact of threats like introduced species, habitat loss, accidental and intentional killing by humans, climate change, natural disasters, non-native parasites, pollution, loss of prey sources, human overpopulation, and commercial exploitation.

The remainder of the book is composed primarily of species accounts (arranged alphabetically and by Linnaean rank). The structure of the species accounts in H&P differs substantially from those found in S&H. Gone are range maps, physical descriptions of species, type specimen and locality data, and discussion of the systematic relationships among species. Missing from both books are images of species and characterization of calls for amphibians, although H&P point to other resources for these data. Information on natural history, meanwhile, is greatly expanded. Material new to this volume includes impressive species-by-species conservation summaries including IUCN, CITES, or other assessments as well as any relevant literature on specific threats to each species (e.g., habitat loss, active hunting/extermination by Amerindians or current residents, etc).

H&P contains accounts for 152 species not recorded in S&H (an increase of 26%), reflecting both increased interest in West Indian Herpetology as well as a shift in taxonomic methods over the last two decades. Unlike S&H, however, subspecies are only rarely discussed and phenotypic or ecological distinctions among subspecies are not addressed. The content of each species' Natural History section varies depending on the available references. Headings include: abundance, activity, behavior, biomass, competition, diet

and foraging, dispersal, growth, home range, movement, parasites, population size and density, predation, reproduction, sex ratio, size, tail autonomy, thermal biology, as well as ecomorphology information for anoles. H&P draw upon years of field experience, an exhaustive literature review, and an international network of West Indian herpetologists to compile each detailed and rigorously researched species account.

We have only a few minor complaints with H&P, including unqualified use of generalizations and anecdotal field observations, the absence of a small number of natural history references, and the potential that geographic variation in the natural history of species is overlooked by focusing exclusively on taxa recognized at the species level. The inclusion of anecdotes and antiquated natural history observations is a double-edged sword. Although we agree with H&P's comprehensive approach, we caution readers against over-interpreting information that is presented in accounts without bias or explanation. Anecdotal claims like the suggestion that *Anolis strahmi* is "[n]ot easily alarmed," for example, are often oversimplifications. The *Bothrops caribbaeus* account cites Tyler (1849) on envenomation: "If not bitten in a large blood vessel, little danger exists for a loss of life if a mixture of lime juice, rum, and salt is imbibed, followed by intoxication and sleep." Although amusing to the experienced herpetologist, this account could easily be misconstrued as factually accurate information by the uninitiated. Although this is an extreme example of the potential problems with anecdotal information, it might be useful to include some evaluation of poor or unreliable references.

We conducted basic literature searches for natural history information on 73 taxonomically dispersed accounts; this work confirmed the thoroughness of H&P's scholarship. In most cases H&P cited every reference to a species that we could find, in many cases supplementing the references we were able to find with somewhat more obscure references that could not be located with internet-based searches. The few neglected references we did find tend to originate from journals outside the purview of practicing herpetologists; for example, H&P missed a note on Burrowing Owl predation on *Typhops hectus* from the Journal of Raptor Research (Wiley 1998). In other cases, individual species accounts did not reference relevant material that is cited elsewhere in the volume. Species accounts for *A. porcatus* and *A. allisoni*, for example, should have included some mention of the character displacement that Schoener (1977) reported in central Cuba.

Although it may be asking too much, including some information on taxonomic relationships among species would have been a useful addition. With such information, it might be possible to extract some suggestive information about the natural history of recently described or relatively poorly known species by examining accounts of closely related taxa. For instance, the account for *A. marron* contains very little detail. This species was elevated to species status from populations previously placed in *Anolis brevirostris* (Arnold 1980). Although specific natural history studies since this elevation are lacking, the close evolutionary relationship of these species suggests some overall similarity between the two.

H&P's book is a monumental contribution to West Indian herpetology. Its comprehensive coverage and the level of detail afforded each species is virtually unparalleled among references for diverse herpetofaunas. H&P is a necessary companion to S&H for any herpetologist working in the West Indies. Henderson and Powell's new volume provides much more comprehensive natural history information for the West Indies than its predecessor, although S&H remains important because of its dot maps, type records, and morphological descriptions. We can now look forward to the forthcoming field guide (S. B. Hedges, *in prep*.), complete with range maps and color photographs for every West Indian species, which will complete an important trinity for West Indian herpetology.

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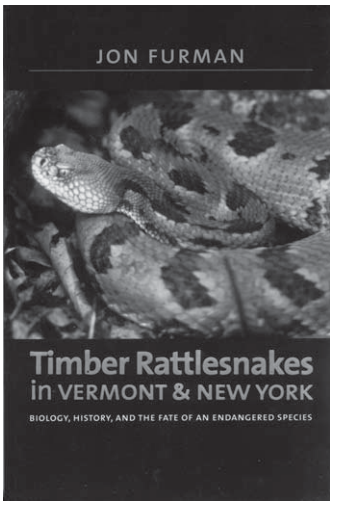
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Timber Rattlesnakes in Vermont and New York—Biology, History, and the Fate of an Endangered Species, by Jon Furman. 2007. University Press of New England (www.upne.com). Softcover. xiii + 207 pp., 8 pp. pls. US $24.95. ISBN 978-1-58465-656-2

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What better way to demonstrate obstacles and solutions to conserving and saving a sometimes misunderstood endangered species than to document the process in a readable fashion? Conservation can be particularly difficult with long-reviled and late-maturing species such as venomous snakes, which engender an innate response of fear and repulsion in many people. Herpetologists are thoroughly familiar with common negative attitudes among the general public toward snakes, especially venomous ones (but you'd never know it if you visit a reptile house at any zoo). Furman

approaches this dilemma in some detail, contrasting the knowledge, experiences, attitudes, and behavior of professional biologists and conservationists with those of outdoors laymen and snake hunters. This has resulted in a book of intimate detail including documentation of extensive field trips by the author guided by those doing field research specifically on conservation and population biology of Timber Rattlesnakes, plus in-depth interviews with 'the other side,'i.e., individuals and their family members who have historically harvested (killed) thousands of these animals for sport, bounty, or some valued feature of their bodies.

Timber Rattlesnakes were once found across much of the eastern United States east of the Mississippi River but are now exterminated or found more often in geographically restricted areas. Furman's book covers the current northern limit of the species' range in the east, focusing on a pocket encompassing three counties in New York and one adjacent county in Vermont where bounties on this species over a 75-year span led to elimination or decimation of most populations. Since the bounties were legally discontinued by state laws in the 1970s, many of these populations have recovered to some extent. The snake's recovery process has been followed and enhanced for the past 40 years by a handful of dedicated biologists and concerned citizens.

Furman's first chapter is the longest and most comprehensive, providing a broad introduction to Timber Rattlesnake anatomy, foraging, prey, predators, habitats, dens, movements (including swimming), body temperatures, basking areas, aggressive behavior, use in church rituals, mating, and longevity. For these features, he draws on an extensive recent literature and provides detailed sources (accumulated at the end of the text) which include quotes and comments from current researchers. Answered are questions about the complex structure of the jaws, fangs, and facial pits and their complex functioning in the lives of these animals; the significance of the rattle and its maximum number of segments; and the age at sexual maturity and frequency of litter production by the late-maturing females, some of which may reproduce only once every five or six years, depending upon food availability.

Chapter 2 is short and concerns mainly maximum body sizes, discussing the uncertainty about whether individuals have ever reached six feet in total length. Earlier workers may have included the rattle in their measurements and may also have stretched the snakes to try and achieve record lengths. Perhaps a six-footer is possible but current workers seldom find individuals as long as five feet.

Snakebite is the focus of the longer chapter 3 and includes statistics on 'dry' bites, constituents of the venom, symptoms, and treatment of bites based on consultation with noted experts. Furman includes case studies of individuals he has known personally, detailing the circumstances of their bites, the treatments and consequences including lasting damage, both psychological and physical. This is one of the most pertinent sections of the book for those who are concerned about avoiding or dealing with a bite from one of these snakes.

Rattlesnake fossils go back as far as the Miocene and those of Timber Rattlesnakes back nearly a million years. The species was once more abundant at the northern limits of its range but has been exterminated from eastern Canada, Rhode Island, Maine, and much of New York State (Chapter 4). Furman documents some of the most egregious killings, sometimes numbering in the thousands of snakes. Even our early presidents Jefferson and Madison, traveling together on an outing in May 1791, shot two rattlesnakes near "Fort George" within the area covered in Furman's book (Ketcham 1971). However, well over 100 dens still exist in southern New York and a few dozen in the other northeastern states. Conservation efforts, elimination of bounties, and state endangered species listings have mostly assured protection and rejuvenation of many of these populations. Chapter 5 addresses this transition during the 1980s and 1990s in New York and Vermont as the species was listed in 1983 as threatened in New York and in 1987 as endangered in Vermont.

Chapter 6 is a fascinating one, tracing the history of bounty hunting in New York and Vermont over the years and documenting the dollar amounts of the per-snake bounty, which worked its way up from 25 cents in 1896 to five dollars in each of New York's three timber rattlesnake counties by 1956. Bounties were discontinued in both states in 1971, with the last payment in 1973 in New York. Resolutions on the bounty systems by the County Board of Supervisors in the three New York counties are a valuable part of the historical record (heretofore undocumented) and are included in Furman's source notes. Higher bounties in New York encouraged some collectors to bring snakes or snake parts from other states, including Vermont, to get the larger payments. Since termination of the bounty system, snake numbers have recovered to perhaps 8–10,000 statewide in New York, and observers have noted greater numbers of the largest individuals in recent years.

Furman's last three chapters are each devoted to one of the famous (or infamous) rattlesnake bounty hunters and their families in Vermont and New York. Furman personally spent many hours interviewing these now elderly (or deceased) individuals to gain insight into why they started killing and/or collecting rattlesnakes and how many they may have killed over the years (thousands) for rather substantial annual profits in several cases. Much as we would like to completely deplore their behavior, some of these individuals performed at least a few redemptive services. These included enabling the sale of family land in Vermont which included a rattlesnake den for protection by The Nature Conservancy. One of the bounty hunters performed crude experiments on feeding and hibernation but hosted "snake roasts" for local social gatherings, while others boiled rattlesnake fat and used the resulting oil as a medicinal ointment for burns, joint pains, and such.

The book finishes up with a short chapter called 'Rays of Hope' which reemphasizes the elimination of bounties, the establishment of formal endangered status, and the willingness of many residents to refrain from killing 'nuisance' snakes and instead to cooperate with conservationists to relocate them unharmed to other places nearby. These workers also give frequent public talks about the nature of the snakes and the need for their conservation. Furman relates the experiences of conservationists and professional biologists in New York who continue to struggle with pressures from real estate developers and industrialists wanting to destroy critical habitat for Timber Rattlesnakes, and who often testify in court cases.

The book is enhanced by individual photos of biologists and former bounty hunters, plus color photos of timber rattlesnakes. There are also sobering color photos of a snakebite victim's hand. Excellent color maps by W. H. Martin of the species' former and current distributions are also presented. An extensive nine-page

cross-reference index concludes the work.

I have had the good fortune to have spent many hours in the field and at conferences with the author and many of the biologists and colleagues whose work forms the crux of this book. Over the years, I have been overwhelmed with their knowledge and dedication to the welfare of this most complex and sophisticated species of snake. Several have contributed their entire professional careers to this species and have expended their own funds to study the species or buy lands for its protection. My appreciation for the snakes themselves has also grown immensely after seeing their quiet and retiring nature in the field. Furman's book is well worth the read as it captures this species' natural history and many insights about nature, enabling conservation for the future through solid and intimate knowledge of Timber Rattlesnakes.

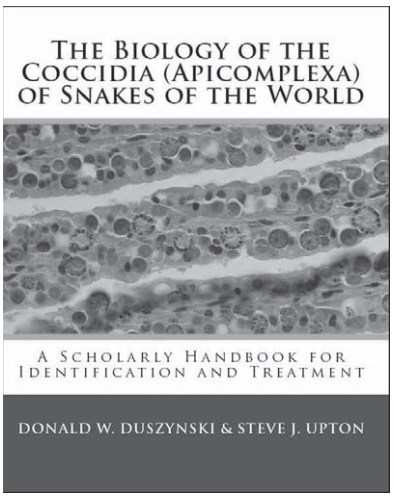
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Herpetological Review, 2010, 41(2), 252–254.
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The Biology of the Coccidia (Apicomplexa) of Snakes of the World, by Donald W. Duszynski and Steve J. Upton. 2009. Published by the authors (available at: https://www.createspace.com/3388533). 422 + i–viii pp. Softcover. US $70.00. ISBN 97814486179.

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This is an excellent and much welcome summation of all of the coccidian parasites (Protista: Apicomplexa) of the suborder Ophidia (= Serpentes) by two well-known parasitologists who have had a life-long interest in and are the world's foremost authorities on the subject. The book has already received favorable reviews (see Agnew 2010; Graczyk 2010; Modrý 2010) as well as positive reviews provided within the text by six knowledgeable parasitologists with experience in the study of coccidia (see pp. iii–iv). I will not stray too far from those previous reviews except to say I will provide an equally fair assessment but with some balance.

The content includes 13 chapters, literature cited, glossary (and list of abbreviations), and index. One of its major strengths is the extensive literature cited section which spans some 27 pages (>6% of the book). If ever anyone needed to locate vague or hard to find citations on the coccidia of snakes, they need only check this compilation. The book is an easy read for herpetologists and parasitologists alike, and others (zoo biologists and veterinarians) will find it a valuable asset to their personal library.

The introductory chapter deals with some general aspects of snake and coccidian biology, as well as several terms (in bold face) relating to the subject and helpful to the layperson. It also provides figures of Nomarski interference-contrast photomicrographs of oocysts of three genera and six species of coccidia for comparative purposes. A minor error appears in the figure legend (Fig. 1.1 F); I believe the oocyst of *Isospora wilsoni* from *Tantilla gracilis* is from the symbiotype host snake collected from Arkansas, not Florida (see Upton et al. 1992, Figs. 5–6). Inclusion of Fig. 1.2 on phylogenetic relationships among the major taxa of snake families (cladogram) strongly suggests that a great deal of knowledge on snake coccidia remains to be discovered as only select members of seven of 17 (41%) snake families have been previously reported to harbor species of coccidia. In other words, about 235 species of snakes in 10 families have **never** had coccidian parasites reported from them, not to mention many others from the other seven families!

Chapter 2 provides more detailed information on the general systematics and life-cycles of coccidia. It is very well done and shows the reader that coccidia have varied, somewhat complex life-cycles, including direct or indirect ones that include both sexual and asexual reproduction. Development of coccidia occurs within various host cell types of the vertebrate intestinal tract or related structures and some (those with indirect life-cycles) even utilize an intermediate host. Several figures within this chapter enhance our understanding of these life-cycles and are a must read for those needing to know details of the four major types of life-cycle strategies employed by snake coccidia. There are some minor typos on line 2 of Fig. 2.4 (A) and font sizes are larger but the photomicrographs of the *Caryospora* spp. are superb.

Chapter 3 covers techniques, including collection, storage, and identification of coccidia. This is another very important chapter in the book. It helps teach the non-specialist (and herpetologists and veterinarians with little experience) to process hosts for coccidia as well learning detailed methods for the isolation of oocysts. However, be forewarned that some cost is involved in acquiring the materials necessary for such study and practice is recommended before wasting important specimens for which you have limited snake fecal material. One thing not said on page 24 is that some commercial microscopic coverslips do not adequately allow oocysts to adhere to their surface via the flotation method. So, if you have enough material, do some practice runs using the various types of coverslips. And, those fortunate enough to spend some time on a brief sabbatical in a laboratory with an expert will certainly be trained thoroughly enough to be on their own. This all takes a lot of practice and many herpetologists have soon learned that collecting the snake, getting its feces, placing an equal aliquot in vials of 2.5% (w/v) aqueous potassium dichromate, and then shipping it overnight to a trained specialist, may be the best way to go. But even that has some limitations and requires a previously understood collaboration. The chapter ends with a discussion of taxonomic terms that are found throughout the book and professional quality line drawings (Fig. 3.1A–D) showing oocyst morphological

structures that should be measured and documented for species identification and formal description.

The following eight chapters (Chapters 4–11) deal with the individual major snake taxa (families, genera, and species) harboring coccidia in a useful, easy to follow, standardized format. The arrangement of taxa is mostly according to the system given by Uetz (2007) via the JCVI/TIGR Reptile Database (http://www.reptile-database.org/); however, the reader should be warned that some snake taxonomy has been in a state of flux and has changed since the book was written and may be expected to change even further. And for some published binomials that have undergone recent nomenclatural changes, the authors attempt to report both the old and new names, but they do so inconsistently (i.e., *Python* vs. *Broghammerus*; *Elaphe* vs. *Pantherophis*). In addition, *Eimeria desotoensis* was described from *Virginia striatula* from Arkansas and Texas (i.e., city of DeSoto is type locality), not just Arkansas (see p. 86, but corrected on p. 116). And, the symbiotype host of *Eimeria rhombifera* is *Nerodia rhombifer*, not *Nerodia cyclopion* (see p. 109 and check type locality). Some of the taxonomic confusion is abated by thoroughly cross-referencing in the index, but some host taxonomic confusion and different common name usage still occurs. And most unfortunately, other errors (mostly typos) become exponential in these chapters (see criticism below).

I must admit that it is somewhat troubling that the authors overlooked many of the typos contained within the book (primarily in Chapters 4–11, pp. 31–302). Some of these errors appear to be typical word.doc problems (and possibly pdf errors), and with two authors writing separately, hidden codes may have leaked into the final document without them knowing. These errors (typos) include, but are not limited to: misspellings, lack of required italicization, letters left out, extra letters/words, different font sizes, transpositions, etc. Examples include misspellings: species inquirendae at least 12 times (pp. 34, 40, 41, 44, 144, 197, 200, 210, 265, 271, 288 [twice]), the specific or subspecific epithets *reticulatus* (misspelled *reticulates* on pp. 40 [twice], 44 [twice], 338 [twice], 345, 366 [three times], 368, 411), *obsoleta* (misspelled *obsolete* on pp. 146, 242, 260 [twice], 328, 341–342, 365), *lineata* (misspelled *lineate* on pp. 148, 156, 277, 365), *catenifer* (misspelled *cantenifer* on pp. 145, 277, 334, 339, 356), *vulpina* (misspelled *vulpine* on pp. 260, 337 and *vupina* on p. 335) authors Freed (misspelled Free on pp. 126, 199), Lainson (misspelled Lanison on pp. 136–137) and Ovezmoukhammedov (misspelled Ovezmoukhammedova on pp. 349 and 390 [three times]).

Other corrections needed are to include the hosts *Agkistrodon piscivorus* in Table 7.1 and *Masticophis flagellum* in Table 9.2. The misconception that no species within the family Leptotyphlopidae (blind snakes) have been examined for coccidia (p. 220) is incorrect as McAllister et al. (1995, p. 63) examined four specimens of *Leptotyphlops* (=*Rena*) *dulcis* from New Mexico (n = 1) and Texas (n = 3) and none were infected with coccidia. On a lighter side, the shakes on (p. 109) should be snakes, the Lind Snakes (p. 219) should be Blind Snakes, and the western coachwhip "terrapin" (pp. 261, 342) should, of course, be a snake.

The authors report that there are about 4000 known species of parasitic protists in six major taxonomic groups that infect a wide variety of vertebrates and invertebrates. Of these, only 156 coccidians of snakes are considered valid species and only 208 of 3180 (7%) extant snake species have been examined for and reliably reported to harbor coccidia. This is especially true about the 55+ unknown species of *Sarcocystis* previously known from snakes and reported simply as *Sarcocystis* species inquirendae. Part of this enigma lies in the fact that it is impossible to determine *Sarcocystis* species definitively without experimental transmission studies because the sporocysts found in the feces of the definitive host, are very similar in size and morphologies (Duszynski and Upton 2009; McAllister et al. 1995). In an attempt to abate this problem, the authors make several pleas (Chapters 9, 13) for cooperation between herpetologists and parasitologists to work as equal partners "*if we are ever to have an inkling of the true biodiversity of snake parasites*…" and "*to be more receptive to working together*….". As someone who has collaborated on snake coccidia with academic herpetologists, including those with state and federal agencies and employed by zoos (McAllister et al. 1993, 1995, 1996), I could not agree more.

The authors provide descriptions of four new species of coccidia (**ii and Chapters 5, 7, 9) to include one eimerian (p. 64), one caryosporan (p. 200), and two *Sarcocystis* spp. (pp. 225, 236). One description, however, contains a serious typo (Chapter 5, p. 64) of the new species of *Eimeria* from *Lampropeltis getula californiae*. The spelling of the specific epithet as first given is misspelled: *Eimeria lamporpeltisgetuli* should be *E. lampropeltisgetuli* but it must stand until corrected in a future justified emendation under Article 32.5 of the Code (Ride et al. 2000). Interestingly, on pages 85, 147, 154, and 414, that specific epithet is spelled correctly but incorrectly twice (pp. 331, 350).

The photomicrographs and line drawings are top-notch and improve the overall message of the book. They allow the reader to employ a quick and user friendly comparative approach when examining different morphologies among similar oocysts of the various coccidian taxa of snakes. However, the following five figures of sporulated oocysts appear to be photomicrographs, not line drawings, as suggested in their respective figure legends (Figs. 4.1C, 5.6, 5.35, 5.98, 7.1G). The book cover includes a nice black and white photomicrograph showing numerous endogenous developmental stages of an *Eimeria* sp.

Chapter 12 provides strategies for management and therapy of reptilian coccidiosis, including the more serious disease, cryptosporidiosis. This chapter should be of special interest to veterinarians and zoo personnel who treat and house sensitive species. It includes very detailed information about a proprietary website, Veterinary Information Network (VIN; http://www.vin.com), where veterinarians from all over the world discuss common issues, problems, drugs, and treatment regimens (see Table 12.1). Ultimately, this will allow veterinarians immediate access to what therapies have worked for others and to access appropriate references.

The book ends with Chapter 13 in which the authors ask the question "*so what does all of this mean*?" The authors provide two very important tables in this chapter (13.1–13.2), although they contain numerous typos (pp. 320 [five], 328, 331, 333 [two], 334–335, 337 [three], 338 [five], 339 [two], 340–341, 342 [three], 343. 345, 346, 349, 350 [two], 351 [two], 353 [two], 356). Most importantly, these tables allow the reader to quickly see an alphabetical list of all coccidian parasites recorded from all snake hosts and a host-parasite index (through 2008). This will be indispensable to those needing to cut-to-the-chase if they have a new host and/or distributional record, or even better, a new species of coccidian.

Two additional tables (13.3–13.5) may be directed toward the more serious snake coccidian researcher as they cover cross-transmission studies, pathologies, and endogenous developmental stages from snakes. Needless to say, there are several typos in these tables (i.e, original is misspelled orignal 12 times!) and other typos are found on pp. 362, 365 (three), 366 (three), 368, and 370 (two).

It is abundantly evident that these authors devoted much time and energy to preparing this work, reviewing hundreds of references as well as spending several years developing a readable text for specialists and non-specialists alike. Drs. Duszynski and Upton should be commended for taking on this task effectively and covering global aspects of the biology of the coccidia of snakes. On the other hand, there are too many typos and errors and hopefully those will be corrected if a second edition is done. The $70 cost for a paperback may be a little out of line and could dissuade some non-specialists from purchasing a copy but all parasitologists and those herpetologists, veterinarians, and zoo biologists interested in snake coccidia should own a copy, regardless of the cost.

In summary and with these typographical concerns aside, the authors have done a yeoman's job in having in one place and in a highly organized manner, all of the world's literature on snake coccidia through 2008. First and foremost, they have produced a text that all parasitologists, but particularly those interested in coccidian biology, could use as a quick identification guide on species that they might recover from snakes. They have also produced a compilation that professionals, amateurs, and zoo herpetologists might use should they be interested in knowing anything about coccidia that could be infecting their snake of interest, research subject, captive specimen, or even pet. Lastly, they have produced a book that could be useful to small-animal veterinarians who examine snakes brought in as patients to their practice. As a whole, it is the gold standard and is much enhanced by the figures and layout. Undoubtedly, this book will become indispensable and THE source for any person remotely interested in snake coccidia, and I emphatically recommend it.

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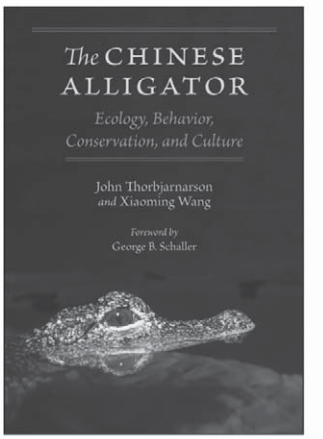
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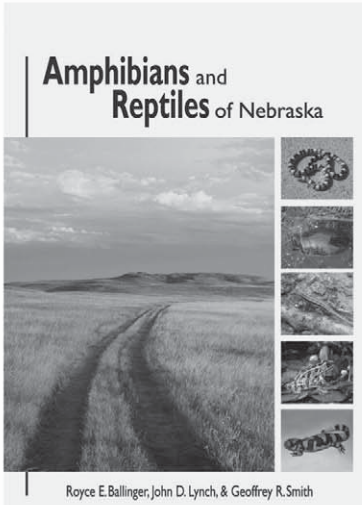
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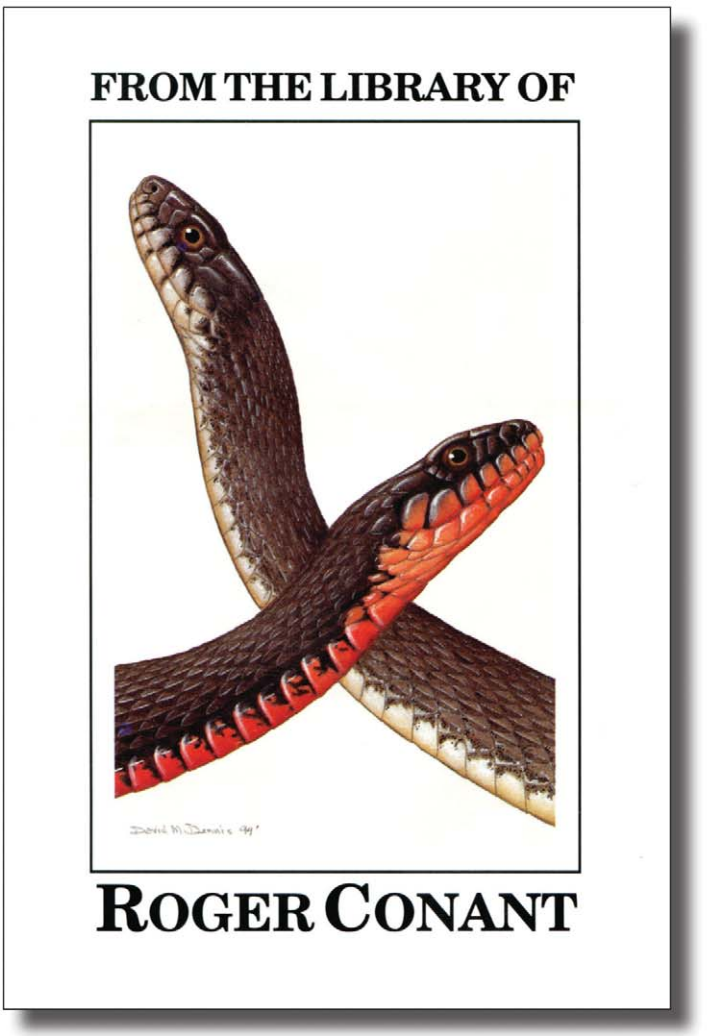
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Herpetological Review

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The Society for the Study of Amphibians and Reptiles, the largest international herpetological society, is a not-for-profit organization established to advance research, conservation, and education concerning amphibians and reptiles. Founded in 1958, SSAR is widely recognized today as having the most diverse society-sponsored program of services and publications for herpetologists. Membership is open to anyone with an interest in herpetology—professionals and serious amateurs alike—who wish to join with us to advance the goals of the Society.

All members of the SSAR are entitled to vote by mail ballot for Society officers, which allows overseas members to participate in determining the Society's activities; also, many international members attend the annual meetings and serve on editorial boards and committees.

All members and institutions receive the Society's primary technical publication, the *Journal of Herpetology,* and its news-journal, *Herpetological Review*; both are published four times per year. Members also receive pre-publication discounts on other Society publications, which are advertised in *Herpetological Review*.

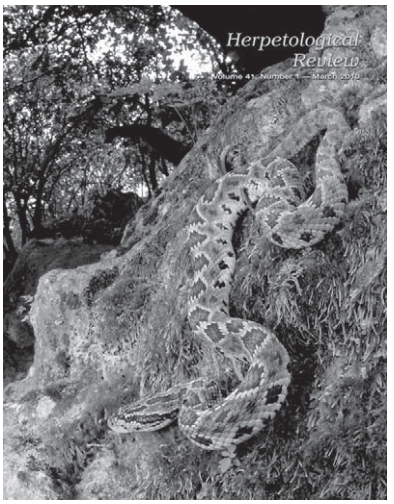
To join SSAR or to renew your membership, please visit the secure online ZenScientist website via this link:

http://www.ssarherps.org/pages/membership.php

Future Annual Meetings

2010 — Providence, Rhode Island, 7–12 July (with ASIH, HL)
2011 — Minneapolis, Minnesota, dates TBA (with ASIH, HL)
2012 — Vancouver, British Columbia, dates TBA (with ASIH, HL, WCH)

About Our Cover: *Crotalus lannomi*



In the summer of 1966, Joseph R. Lannom, Jr. traveled south from the U.S. to collect lizards along the west coast of Mexico for University of Arizona herpetologist Charles Lowe, but spent his evenings searching the roads for snakes. On the night of 26 June, he chanced upon a road-killed rattlesnake in the mountains of western Jalisco. That snake would turn out to be a new species, and the only one of its kind known over the next half century. Countless herpetologists—professionals and amateurs—ventured into the mountains of western Jalisco in the decades that followed, hoping to find another. But all who tried failed, and *Crotalus lannomi* seemed to take on near-mythic proportions—becoming a sort of "holy grail" of rattlesnakes.

In describing the new species, Wilmer Tanner (1966. Herpetologica 22[4]:298–302) noted the morphological similarity to the Sinaloan Long-tailed Rattlesnake, *C. stejnegeri*, another rare rattlesnake occurring farther north in the mountains of Sinaloa; both species were notably characterized by a long, slender tail, terminating in small rattles. Very recently, Jonathan Campbell and Oscar Flores-Villela described *C. ericsmithi*—the Guerreran Long-tailed Rattlesnake—from the Sierra Madre del Sur of Guerrero, roughly 500 km south of the type locality of *lannomi* (Campbell and Flores-Villela 2008. Herpetologica 64[2]:246–257). Campbell and Flores-Villela confirmed the alliance of *ericsmithi*, *lannomi*, and *stejnegeri* based on scalation, color pattern, and morphology. These three species occur in lower montane ecotonal habitats—transitional between lower-elevation tropical deciduous forest and upper-elevation oak or pine-oak forests. As a group, the long-tailed rattlesnakes also seem to be rare, with two of the three species (*ericsmithi* and *lannomi*) known only from single types, and the third (*stejnegeri*) known from only about a dozen specimens.

Over the last few years, field searches have intensified to locate populations of *Crotalus lannomi* in various mountain ranges in Nayarit, Jalisco, and Colima. In 2008, five specimens assignable to *C. lannomi* were found at two localities in the foothills of Colima, roughly 50 km from the type locality in adjacent Jalisco. This new material is reported in this issue of *HR* (Reyes-Velasco et al., pp. 19–25), adding significantly to our knowledge of the distribution and natural history of these elusive snakes.

The cover image depicts an adult female (61 cm TL) *Crotalus lannomi* recorded in the field in Colima. The photograph was a collaborative effort by **Ginny Weatherman**, **Jacobo Reyes-Velasco**, **Jason Jones**, and **Chris Grünwald**. The image was recorded with a Nikon D200 DSLR with a Tokina 10–17mm wide angle lens (17mm focal length, f/14, ISO 500), illuminated by a single Nikon SB800 flash with a Gary Fong dome diffuser. Reyes-Velasco is a student at the Universidad de Guadalajara; his herpetological field work in southwestern Mexico has resulted in a number of important finds (e.g., Reyes-Velasco et al. 2009. Herpetological Review 40:117–120; Reyes-Velasco and Mulcahy 2010. Herpetologica 66[1]:99–110). Weatherman, Jones, and Grünwald have spent considerable time in recent years traveling throughout Mexico; their efforts have yielded many significant herpetological finds.

SSAR is pleased to acknowledge the financial support of Ronald A. Javitch, Montreal, in making possible the publication of the cover image as well as the color figures in the Reyes-Velasco et al. article elsewhere in this issue.

SSAR BUSINESS

SSAR Henri Seibert Awards for 2010

The Henri Seibert Awards were initiated in 1992 to provide recognition for the best student papers presented at the annual meeting of the SSAR. To be eligible, the presented paper must be the result of research by the individual making the presentation. The research must have been conducted while the student was enrolled in either an undergraduate or graduate degree program. Please refer to *Herpetological Review* 28(4):175 and the SSAR website (http://www.ssarherps.org/pages/seibert.php) for recommendations to students entering the Henri Seibert Competition. Students entering the competition must be members of SSAR. The presentations will be judged by the SSAR student prize committee. One Henri Seibert Award of US $200 may be given in each of the following four categories: Systematics/Evolution, Ecology, Physiology/Morphology, and Conservation. Students may win a Henri Seibert award only one time. Please indicate the appropriate category for which you are applying on the abstract submission form. Announcement of winners will be made at the SSAR Business Meeting. All participants should be present at the business meeting. Contact Patrick Owen for further information, patrick.owen@uc.edu.

SSAR Silent Auction Donations

The SSAR announces the Fourteenth Annual Silent Auction to be held at the 2010 Joint Meeting of Ichthyologists and Herpetologists (JMIH) in Providence, Rhode Island, USA, 7–12 July. In previous years, items for the Silent Auction have been limited to frameable art. However, this year, we are glad to accept any herp-related donations, including but not limited to, frameable art (photographs, paintings, and line illustrations), books, music, glassware, jewelry, clothing and gift certificates for Providence area services/events during the meeting week. The SSAR Student Travel Committee organizes the Annual Silent Auction to raise money to fund the student travel awards to the JMIH. Your donations help provide opportunities for students to attend and present their research. If you are interested in donating an item or two (tax deductible for U.S. residents), please contact Matthew D. Venesky (mvenesky@memphis.edu) for more information.

NEWSNOTES

The J. Larry Landers Student Research Grant

The J. Larry Landers Student Research Grant is a Gopher Tortoise Council competitive grant program for undergraduate and graduate college students. Proposals can address research concerning Gopher Tortoise biology or any other relevant aspect of upland habitat conservation and management. The amount of the award is variable, but projects up to $2,000.00 have been awarded.

The proposal should be limited to four pages in length and should include a description of the project, a concise budget, and a brief resume of the student. Email submissions in word are preferred.

This is an excellent opportunity for undergraduate and graduate students to access funding for their projects. The deadline for grant proposals each year is the 15th of September. Please send submissions to: Bob Herrington, Chairperson, Research Advisory Committee, Department of Biology, Georgia Southwestern State University, Americus, Georgia, 31709, USA; e-mail: bherring@canes.gsw.edu.

Announcing a New Panamanian Field Station

La MICA Biological Station is located in El Copé, Coclé Province, Republic of Panama, near Omar Torrijos Herrera National Park. This area has been important for amphibian and reptile research and offers opportunities for any discipline of terrestrial biology. Much of the area is mid-elevation cloud forest with sites between 200 and 1440 m (station at 400 m). La MICA is situated on the Continental Divide, offering opportunities for studies in the Atlantic and Pacific versants.

La MICA Biological Station welcomes students, researchers, courses, and general tourists from around the world. Our facilities are under development, but currently offer a cabin, bathhouse, and soon a dormitory for 26 people with classroom. Logistics, including local transportation, food, guides/field assistants, and access to remote sites are all in place.

Nearly every position for employment is filled by local residents, thus providing them sustainable, conservation-oriented employment.

Visit the project website at http://www.lamica.org for more information.

Kansas Herpetological Society Annual Meeting

The Kansas Herpetological Society held its 36th Annual Meeting at MidAmerica Nazarene University in Olathe, Kansas, on November 7–8, 2009. Over 135 participants attended scientific paper sessions presented by scientists and students from across the nation. Featured speaker was Alexander Pyron (SUNY Stony Brook).

J. Kent Daniel, student at Pittsburg State University, received the 2009 Howard K. Gloyd/Edward H. Taylor Scholarship, honoring the memory of two great biologists with strong ties to Kansas.The 2009 Alan H. Kamb Grant for Research on Kansas Snakes was made to Mindy Walker, Rockhurst University. Paul Rodriguez, University of Nebraska, Omaha, was chosen as the twelfth recipient of "The Suzanne L. & Joseph T. Collins Award for Excellence in Kansas Herpetology." Emilie Blevins, Kansas State University, was presented with the George Toland Award for the best student paper given at the meeting. In 2010, the Society will meet at the Topeka Zoo, Topeka, Kansas.

MEETINGS

Meetings Calendar

Meeting announcement information should be sent directly to the Editor (HerpReview@gmail.com) well in advance of the event.

22–24 April 2010—57th Annual Meeting, Southwestern Association of Naturalists, Llano River Field Station, Junction, Texas, USA. Information: http://www.biosurvey.ou.edu/swan/annualm10.html

7–12 July 2010—Joint Meeting of Ichthyologists and Herpetologists (ASIH / HL / SSAR), Providence, Rhode Island, USA. Information: http://www.dce.k-state.edu/conf/jointmeeting/

21–24 July 2010—33rd Annual International Herpetological Symposium, Tucson, Arizona, USA. Information: http://www.kingsnake.com/ihs/

10–11 August 2010—Northeast Partners in Amphibian and Reptile Conservation (NEPARC) Annual Meeting, Acadia National Park, Maine, USA. Information: http://www.pwrc.usgs.gov/neparc/

22–26 September 2010—VIII National Congress of Societas Herpetologica Italica, Abruzzo, Italy. Information: shiabruzzo2010.iscrizioni@gmail.com

12–14 November 2010—5th National Symposium on the Ecology, Status, and Conservation of the Diamondback Terrapin, at Louisiana University's Marine Consortium (LUMCON) in Chauvin, Louisiana, USA. Hosted by the Diamondback Terrapin Working Group. Information: www.dtwg.org

CURRENT RESEARCH

The purpose of Current Research is to present brief summaries and citations for selected papers from journals other than those published by the American Society of Ichthyologists and Herpetologists, The Herpetologists' League, and the Society for the Study of Amphibians and Reptiles. Limited space prohibits comprehensive coverage of the literature, but an effort will be made to cover a variety of taxa and topics. To ensure that the coverage is as broad and current as possible, authors are invited to send reprints to the Current Research section editors, Joshua Hale or Ben Lowe; postal and e-mail addresses may be found on the inside front cover.

A listing of current contents of various herpetological journals and other publications is available online. Go to: http://www.herplit.com and click on "Current Herpetological Contents."

New Frog Family Found in South America

Studies over the last decade have brought to light evidence that the frog family known as "Leptodactylidae" for most of the 20th century is, in fact, wildly polyphyletic. Efforts to rectify this problem have resulted in the erection of numerous new families across Neobatrachia (including a much more exclusive Leptodactylidae). A recent phylogenetic study of a clade containing a subset of the former Leptodactylidae (named

Terrarana by the authors of the study and consisting of New World direct-developing frogs) revealed that one sample represented a deeply divergent and previously unrecognized lineage. Based on morphology, the sample had been assigned to the speciose terraranan genus *Pristimantis*, yet it was recovered as sister to the remainder of Terrarana. During subsequent searches of the locality in Guyana from which the sample in question was taken, one of the authors was able to procure more samples of this frog which they have described as a new genus and species, *Ceuthomantis smaragdinus*, and placed in a new family, Ceuthomantidae. An analysis confirming the placement of the new samples as belonging to a clade sister to the remainder of Terrarana also found a sister relationship between Terrarana and Hemiphractidae (marsupial frogs), illustrating that direct development was present in the common ancestor of these two groups of New World frogs. Furthermore, based on shared morphological characters, the authors were able to assign two other species of *Pristimantis* from Venezuela's Guiana Shield to the newly-erected family and genus. The discovery of this deeply-divergent lineage illustrates how much biodiversity remains to be discovered in the Guiana Highlands.

Heinicke, M. P., W. E. Duellman, L. Trueb, D. B. Means, R. D. MacCulloch, and S. B. Hedges. 2009. A new frog family (Anura: Terrarana) from South America and an expanded direct-developing clade revealed by molecular phylogeny. Zootaxa 2211:1–35.

Correspondence to: Blair Hedges, Department of Biology, 208 Mueller Laboratory, Pennsylvania State University, University Park, Pennsylvania 16802, USA; e-mail: sbh1@psu.edu.

Turtles, Salamanders, and Mammals Exhibit an Ancestral Mode of Germ Cell Specification

In most developing vertebrates, competent calls are either induced in the embryo to become specific tissues ("inductive mode;" seen in mammals and salamanders) or exist as a pre-determined germ plasm ("predetermined;" seen in frogs, snakes, and birds). These two different modes of cell differentiation are distinguished by the location of the primordial germ cells (PGCs) on the embryo (determined via in situ hybridization). In a few others (notably some Lepidosaura, including *Sphenodon*), PGCs are distributed all around the embryo (called the "circumferential pattern") and the mode of cell differentiation is unclear and may be either inductive or predetermined (or perhaps even both). The authors of this paper determined that turtles, unlike birds, exhibit the inductive mode of germ cell formation. Furthermore, they reconstructed the evolutionary history of germ cell specification mode in tetrapods. This analysis provided support to the hypothesis that inductive mode is the ancestral condition of tetrapods. Additionally, it was revealed that while germ plasm has evolved several times independently in tetrapods, reversion back to the inductive mode may not be possible. Finally, a change from inductive mode of germ cell formation to the circumferential pattern of PGC distribution occurred in the lineage leading to lepidosaurs.

Bachvarova, R. F., B. I. Crother, K. Manova, J. Chatfield, C. M. Shoemaker, D. P. Crews, and A. D. Johnson. 2009. Expression of *Dazl* and *Vasa* in turtle embryos and ovaries: evidence for inductive specification of germ cells. Evolution & Development 11:524–533.

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Diverse Lines of Evidence Used to Delineate Species of Horned Lizards

Stemming from disagreement among researchers as to which characters are important in species delineation, the Coast Horned Lizard (*Phrynosoma coronatum*) of coastal California and Baja California has undergone several taxonomic re-arrangements over the years. The authors of this paper aimed to examine different lines of evidence and generate a hypothesis of species limits compatible with a modern, coalescence-informed understanding of speciation. Morphological (horn shape), genetic (mitochondrial and nuclear DNA), and ecological (environmental) data were procured for samples from across the distribution of the species. Morphological and ecological data were subjected to principal components analyses to identify geographically-cohesive groupings. Analyses of the genetic data were performed to examine evolutionary relationships (Bayesian analysis of mtDNA plus a topology test comparing the recovered phylogeny with an alternate, previously-published, morphologically-based phylogeny which recognizes four species) and to determine levels of gene flow across contact zones (nuDNA). As a criterion for species delineation, the authors looked for corroboration between independent lines of evidence. Based on DNA and ecological data correspondence, three species were recovered (one largely coincident with each of the states of Baja California Sur, Baja California, and California [from south to north]); this hypothesis was found to fit the genetic data far better than the alternate four-species hypothesis. Horn morphology separated the southern species; however, it was not able to differentiate the two northern species from each other. Furthermore, genetic subdivision of the California species recovered in the mtDNA analysis failed to align with other lines of inference and therefore was regarded as intraspecific genetic variation. As the Coast Horned Lizard has suffered precipitous population declines across much of its range, discovering that it is comprised of three genetically isolated species elevates the importance of conserving what remains of its coastal habitat.

Leaché, A. D., M. S. Koo, C. L. Spencer, T. J. Papenfuss, R. N. Fisher, and J. A. McGuire. 2009. Quantifying ecological, morphological, and genetic variation to delimit species in the coast horned lizard species complex (*Phrynosoma*). Proceedings of the National Academy of Sciences 106:12418–12423.

Correspondence to: Adam Leaché, Genome Center and Section of Evolution and Ecology, One Shields Avenue, University of California, Davis, CA 95616, USA; email: aleache@ucdavis.edu

Communal Egg-laying More Widespread Among Herps than We Thought

Historically, communal egg-laying in reptiles and amphibians has been viewed as an uncommon phenomenon and hypotheses

to explain instances of this phenomenon often have invoked a paucity of suitable oviposition sites. The authors of this paper suggest that this paradigm is false. They performed a meta-analysis of published accounts of communal egg-laying and found the phenomenon to be far more pervasive than previously acknowledged. Failure to recognize the prevalence of communal egg-laying in these groups may stem from a general lack of knowledge of oviposition behavior (reproductive biology is known for perhaps as few as 7% of squamates of the southern continents and Asia). Furthermore, it has long been noted that herp species known to engage in communal egg-laying frequently lay solitarily as well. Through game theory, the authors illustrate scenarios that would maintain both communal and solitary egg-laying strategies in a population. This work demonstrates the scarcity of knowledge about egg-laying and the importance of understanding reproductive behavior in amphibians and reptiles.

Doody, J. S., S. Freedberg, and J. S. Keogh. 2009. Communal egg-laying in reptiles and amphibians: evolutionary patterns and hypotheses. The Quarterly Review of Biology 84:229–252.

Correspondence to: Sean Doody, Applied Ecology Research Group, University of Canberra, ACT 2601, Australia; e-mail: scott.doody@anu.edu.au.

Niche Tracking and Adaptation in *Liolaemus* Lizards

Animals seem well adapted to their environments and genetic theory suggests that quantitative traits should be able to evolve quickly to fit changing environmental conditions. However, studies of niche evolution repeatedly recover a strong signal of phylogenetic niche conservatism (stasis). To explore this paradox, the authors of this paper collected distribution, physiological (e.g., body temperature, rates of heating and cooling), and ecological (thermal environment) data for 32 species of Chilean *Liolaemus* (Iguania: Liolaemidae). Using a phylogeny of the genus, they reconstructed environmental conditions inhabited by the ancestral lineages along the phylogeny; this was subsequently analyzed for patterns of niche evolution. Physiological data and environmental conditions were also investigated for correlations. Interestingly, temperature preference and physiology seem capable of evolving rapidly to new conditions (i.e., exhibit a strong correlation); however a strong phylogenetic signal of niche conservatism was recovered from the phylogenetic analysis. Given the changes in climatic conditions during the late Cenozoic in South America and the ability of the lizards to adapt quickly, what explains the strong phylogenetic signal? The authors invoke "niche tracking," changes in distribution to follow favorable conditions, to explain this. Further, they suggest that while adaptation occurs rapidly, perhaps it only allows *Liolaemus* populations to change to a moderate degree; they are therefore unable to adapt to wide fluctuations and must overcome these types of changes via niche tracking. These findings illustrate that perhaps the ability to adapt quickly to new environmental conditions and phylogenetic niche conservatism are not necessarily contradictory.

Labra, A., J. Pienaar, and T. F. Hansen. 2009. Evolution of thermal physiology in *Liolaemus* lizards: adaptation, phylogenetic inertia, and niche tracking. The American Naturalist 174:204-220.

Correspondence to: Antonieta Labra, Department of Biology, Centre for Ecological and Evolutionary Synthesis, University of Oslo, PB1066, 0316 Oslo, Norway; e-mail: antonieta.labra@bio.uio.no.

Patterns of Size Evolution in *Amphiuma* Salamanders

Amphiumidae is a family of aquatic, limb-reduced salamanders from the southeastern United States comprising three species: the one-, two- and three-toed amphiumas. The later two species achieve enormous size (>65 cm in total length and rivaling only members of the family Cryptobranchidae). Using genetic samples from across the range of the family, the authors conducted phylogenetic analyses of this group (both mitochondrial and nuclear DNA, analyzed separately). Interestingly, these analyses revealed that the two large species were not each other's closest relative (contrary to earlier studies); the large two-toed is most closely related to the modest-sized one-toed and more distantly related to the similarly-sized three-toed. This suggests that either the two large species underwent gigantism independently or, alternatively, the one-toed species experienced a size-reversal. Furthermore, as the one- and two-toed amphiumas are sympatric, this finding could represent an example of character displacement, whereby coexisting lineages diverge in some way to reduce interspecific competition. Alternatively, as the two species are rarely syntopic and the one-toed occupies a much smaller range than the other two species, this might represent the evolution of a small specialist from a large generalist (the authors favor this latter hypothesis). Finally, the authors posit that this reduction in body size may have been accomplished through neotony (the retention of juvenile characteristics); as evidence for this, they point to the fact that one-toed amphiuma reach sexual maturity earlier than their larger relatives.

Bonett, R. M., P. T. Chippindale, P. E. Moler, R. W. Van Devender, and D. B. Wake. 2009. Evolution of gigantism in amphiumid salamanders. PLoS ONE 4(5):e5615. doi:10.1371/journal.pone.0005615.

Correspondence to: Ronald Bonett, Department of Biological Sciences, University of Tulsa, Tulsa, Oklahoma 74104, USA; e-mail: ron-bonett@utulsa.edu.

Hawksbill Turtles Go with the Flow When Dispersing

All species of sea turtles are recognized as either threatened or endangered. Unfortunately, efforts to conserve them are hampered, as little is known about the factors that contribute to hatchling dispersal. Traditionally, studies trying to assign samples from a mixed-stock to separate sources would perform a one-to-many assignment analysis (one stock, many sources). However, as animals from the sources are also going to other, unsampled mixed-stocks, a many-to-many mixed stock analysis is much more appropriate. Using a many-to-many method recently developed to investigate dispersal, the authors of this study analyzed genetic samples accumulated from a foraging aggregation of juvenile hawksbill turtles (*Eretmochelys*) in the Cayman Islands and from likely rookeries throughout the Caribbean Sea. Their findings demonstrate that the Cayman Islands foraging aggregation is

indeed derived from animals from every corner of the Caribbean. Furthermore, results from simulations using high-resolution ocean current data and a passive drift model of dispersal were significantly correlated with the recovered feeding aggregation genetic composition, suggesting that ocean currents play an important role in hatchling dispersal. The simulations also reveal that there is a high degree of dispersal pattern heterogeneity among the rookeries. While these results divulge how complex the system is, these findings also greatly inform sea turtle conservation efforts.

Blumenthal, J. M., F. A. Abreu-Grobois, T. J. Austin, A. C. Broderick, M. W. Bruford, M. S. Coyne, G. Ebanks-Petrie, A. Formia, P. A. Meylan, A. B. Meylan, B. J. Godley. 2009. Turtle groups or turtle soup: dispersal patterns of hawksbill turtles in the Caribbean. Molecular Ecology 18:4841–4853.

Correspondence to: Brendan Godley, Centre for Ecology and Conservation, School of Biosciences, University of Exeter Cornwall Campus, Penryn TR10 9EZ, UK; e-mail: b.j.godley@exeter.ac.uk.

Behavior Evolution in *Anolis*

We have known for some time that adaptive radiations often lead species occupying similar microhabitats to evolve similar morphologies (the "ecomorph" paradigm). Does this phenomenon also lead species to evolve similar behaviors? To answer this question, the authors of this study investigated 13 *Anolis* species belonging to various ecomorph types at several Caribbean sites. They collected extensive behavioral and microhabitat data (including territorial display and territory size, visibility, and overlap). Analyses of these data were then performed to reveal correlations between ecomorph type and behavioral traits. Analyses performed include MANOVA (which controls for phylogenetic relationship), regression, and principal components analysis (PCA). Indeed, when the results from the PCA analysis were plotted in two dimensions, the various ecomorphs clustered together. The MANOVA analysis also recovered a strong correlation between ecomorph type and behavior. Post-hoc ANOVAs revealed that the data strongly support a correlation between ecomorph type and amount of male-male territorial overlap but not between ecomorph and display behavior. In particular, male ground-trunk specialists tolerate significantly more males with overlapping territories than male twig specialists do. Furthermore, it was revealed in the regression analyses that *Anolis* species occupying microhabitats with similar visibilities also engage in similar territorial displays. This study definitively demonstrates that like morphology, behavior is reflective of the environment in which the organism exists.

Johnson, M. A., L. J. Revell, and J. B. Losos. 2010. Behavioral convergence and adaptive radiation: effects of habitat use on territorial behavior in *Anolis* lizards. Evolution (in press). doi: 10.1111/j.1558–5646.2009.00881.x.

Correspondence to: Michele Johnson, Trinity University, Department of Biology, One Trinity Place, San Antonio, Texas 78212 USA; e-mail: michele.johnson@trinity.edu.

Sister Taxon to New World Pitvipers Revealed

Over the last decade, research into viperid systematics has revealed many new insights. For instance, we now know that New World pitvipers form a clade and likely are derived from a single dispersal across the Bering Land Bridge; however, attempts to discern which group of Asian pitvipers gave rise to them have not succeeded. To investigate this, the authors of this paper accumulated sequence data from seven genes (four mitochondrial; three nuclear) for representatives from every pitviper group. Analyses of these data revealed that New World pitvipers are sister to the genus *Gloydius*; interestingly, members of this genus were once considered congeneric with members of the New World *Agkistrodon*. Furthermore, this analysis found two enigmatic species, *Ovophis okinavensis* and *Trimeresurus gracilis*, falling outside their respective genera and instead forming a clade sister to the *Gloydius* + New World pitviper clade. The authors contend that these two species should be removed from their respective genera and placed together in a new genus (of which they are preparing a description). This study further illustrates the utility of incorporating nuclear data into studies of phylogenetic relationships, particularly in groups where mitochondrial DNA data alone has failed to resolve deeper-level relationships.

Malhotra, A., S. Creer, C. E. Pook, R. S. Thorpe. 2010. Inclusion of nuclear intron sequence data helps to identify the Asian sister group of New World pitvipers. Molecular Phylogenetics and Evolution 54(1):172–178.

Correspondence to: Anita Malhotra, School of Biological Sciences, College of Natural Sciences, Bangor University, 3rd Floor ECW, Deiniol Road, Bangor, Gwynedd LL57 2UW, UK; e-mail: a.malhotra@bangor.ac.uk.

Chytrid Extirpations are Non-random

When *Batrachochytrium dendrobatidis* (*Bd*) infection spreads through a region and causes local extirpations, are the extirpations random or do certain ecological characteristics make one species of frog more prone to be eliminated than another? If species with small distributions are disproportionately affected, *Bd* epizootics should have a homogenizing effect on regional diversity. Using data from eight sites across Panama and Costa Rica, the authors of this study investigated the changes in patterns of frog diversity before and after *Bd* swept through the region. The results of this study show that *Bd* epidemics disproportionately remove locally endemic species and that frog communities are more homogeneous after *Bd* passes through. Prior to *Bd*, the various localities exhibited a strong positive correlation between geographic distance and community dissimilarity; afterward, this correlation was no longer significant. Further analysis revealed that the sites had significantly more similar frog communities after the epizootic than would be expected if the extirpations were randomly distributed. Post-*Bd* homogeneity also extended to familial-diversity, reproductive mode, and microhabitat. This study demonstrates the need to be concerned about not only the local but also the regional impacts of *Bd*.

Smith, K. G., K. R. Lips, and J. M. Chase. 2009. Selecting for extinction: nonrandom disease-associated extinction homogenizes amphibian biotas. Ecology Letters 12:1069–1078.

Correspondence to: Kevin Smith, Tyson Research Center, Washington University in St. Louis, 6750 Tyson Valley Rd, Eureka, Missouri 63025, USA; e-mail: kgs@wustl.edu.

Importance of Venom in Feeding Strategies of Giant Varanids

Recent studies have found that, contrary to previous speculation, the Komodo Dragon (*Varanus komodoensis*) possesses venom and likely does not rely on bacterial infection to subdue prey. However, the degree to which the venom delivery system is developed and the complexity and potency of the venom has remained unclear. To investigate this phenomenon, the authors analyzed the cranial mechanics and venom of *V. komodoensis*. Their results confirmed previous findings that the skull of *V. komodoensis* is unable to sustain large bite forces (relative to similar large reptilian predators such as *Crocodylus*). However, previous studies underestimated potential bite force by assuming that optimal forces were achieved when the mouth was closed; computer simulations conducted in this study showed that maximal bite force occurs when the mouth is open at an angle of 20°. Instead, the skull seems best suited for stresses associated with pulling forces (similar to sharks and saber-toothed cats). Analyses of the venom found it to possess a diverse array of chemicals, including toxins known to exhibit anti-coagulant, hypotensive, hemorrhagic, and shock-inducing properties (many of these proteins have also been found in other members of the clade Toxicofera). Additionally, magnetic resonance imaging revealed large, paired mandibular venom glands (running parallel to the salivary glands), each divided into five compartments and possessing ducts that deliver venom into the spaces between the teeth. These venom glands combined with strong pulling forces and large, serrated teeth provide *V. komodoensis* with a highly effective venom delivery system. As previous studies have shown that squamate lineages that adopt feeding strategies not reliant on venom (e.g., constricting, egg-eating) quickly lose their venom capabilities (as venoms and their accompanying architecture are metabolically expensive), the fact that *V. komodoensis* still possesses a highly-derived, functioning venom apparatus strongly suggests that it remains an essential part of their feeding strategy. Furthermore, as the skeletal morphology of the extinct *Varanus priscus* closely parallels that of *V. komodoensis*, this implies that *V. priscus* also likely utilized venom in its feeding strategy and therefore was the largest venomous animal to have walked the face of the earth.

Fry, B. G., and Colleagues. 2009. A central role for venom in predation by *Varanus komodoensis* (komodo dragon) and the extinct giant *Varanus* (*Megalania*) *priscus*. Proceedings of the National Academy of Sciences 106:8969–8974.

Correspondence to: Bryan Fry, Venomics Research Laboratory, Department of Biochemistry and Molecular Biology, University of Melbourne, Parkville, Victoria 3010, Australia; e-mail: bgf@unimelb.edu.au.

ZOO VIEW

Herpetological Review, 2010, 41(1), 6–16.
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Updating the Bookshelves Part V: Biographies and Autobiographies, Amphibian Extinction, Snake Ecology and Conservation, Rattlesnakes, Chelonians, Lizards and Crocodilians, Anoles

JAMES B. MURPHY
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3001 Connecticut Ave., N.W., Washington, DC 20008, USA
e-mail: jbmurphy2@juno.com

No passion in the world is equal to the passion to alter someone else's draft.
—H. G. Wells

Autobiographies and Biographies

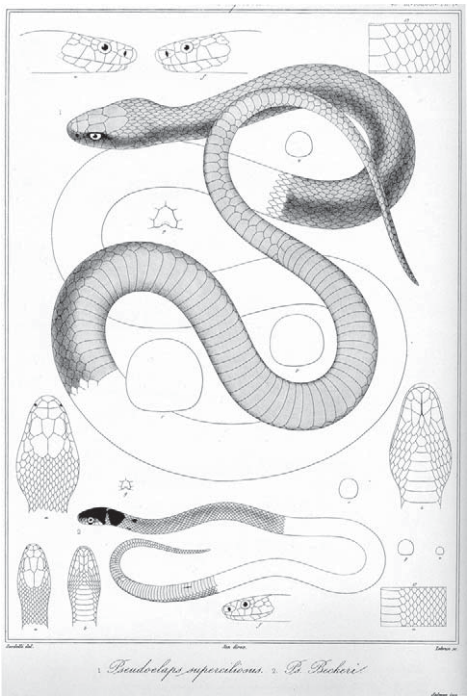
When I was young, one of my favorite pastimes was to read the books of Raymond L. Ditmars, William Beebe, Thomas Barbour, Arthur Loveridge, Alexander Ruthven, and Ivan T. Sanderson and imagine the thrill of traveling to faraway places to search for amphibians, reptiles, and other exotic creatures. As I got older, looked at newer books, and actually had an opportunity to see some of the places mentioned, the pleasure intensified as I compared those experiences between the writers and my own. And if the opportunity to visit these locales did not materialize, then there was always the fallback of visualizing myself in these settings. Listed in Appendix I are some of my favorite titles.

Three new herpetological autobiographies have appeared on the scene. D. Bruce Means has written a lovely book called *Stalking the Plumed Serpent and Other Adventures in Herpetology* (2008, Pineapple Press, Sarasota, Florida; ISBN: 978-1-56164-433-9). Twenty-two vignettes document his travels over 40 years studying amphibians and reptiles, ranging from his experiences with Eastern Diamondback Rattlesnakes to Bushmasters in Costa Rica. How many herpetologists can say that they encountered five of the deadliest Australian terrestrial elapids in the field: Inland Taipan (*Oxyuranus microlepidota*), Coastal Taipan (*O. scutellatus*), Eastern Brown Snake (*Pseudonaja textilis*), Mt. Chappell Island Ti-



D. Bruce Means found that White's Treefrog (*Litoria caerulea*) preys upon the Little-Bent-Winged Bat (*Miniopterus australis*) in a cave in Queensland, Australia. Illustration from John White's *Journal of a voyage to New South Wales, with sixty-five plates of nondescript animals, birds, lizards, serpents, curious cones of trees and other natural productions.*
Imprint: London: Printed for J. Debrett, 1790.

ger Snake (*Notechis ater serventyi*), and King Brown Snake (*Pseudechis australis*). One of his most interesting observations, accompanied by an arresting photograph, was that in addition to a number of snakes preying upon the Little-Bent-Winged Bat (*Miniopterus australis*) in a cave in Queensland, White's Treefrog (*Litoria caerulea*) also preys upon the mammals. Means tells many other stories relating his field experiences with the Moccasin, Alligator Snapping Turtle, Apalachicola Kingsnake named in his honor (*Lampropeltis getula meansi*), Eastern Indigo Snake, Alabama Red Hills Salamander, Yucatán Peninsula Rattlesnake, American Alligators, and a number of species from Madagascar. This is a book well worth reading.



D. Bruce Means encountered five of the most dangerous Australian elapids in the field, including the Eastern Brown Snake (*Pseudoelaps beckeri*, now *Pseudonaja textilis*). Illustration from *Iconographie générale des ophidiens / par M. le professor Jan . . .[en collaboration avec Mr. F. Sordelli.] ...*

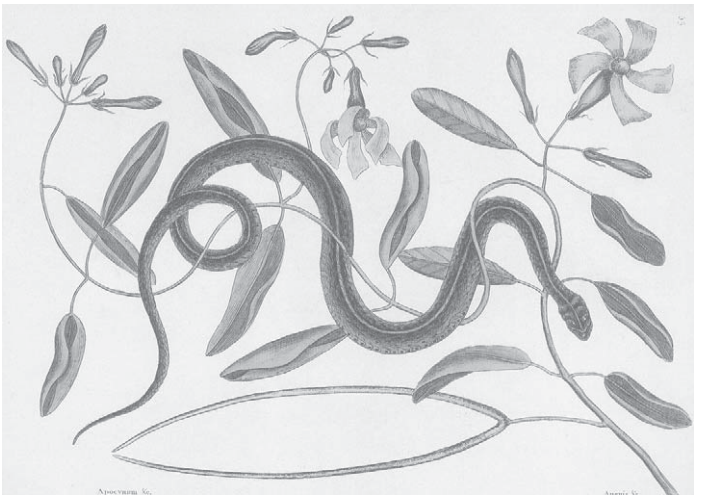
Imprint: Milan: chez l'auteur, [etc., etc.], 1860–1881.

The second autobiography was written by Leslie Anthony and called *Snakebit. Confessions of a Herpetologist* (2008; GreyStone Books; Vancouver, Toronto, Berkeley; ISBN 978-1-55365-236-6). Anthony was trained as a biologist (his herpetological name is Leslie A. Lowcock), working with Robert W. Murphy at the Royal Ontario Museum (ROM) for his doctorate and as a postdoc at McGill University's Redpath Museum in Canada. One of the strongest features of this book is his ability to explain complex biological principles in simple terms so the layman can understand. One example is his clear description of salamander reproductive isolation in Chapter 3 called "A Salamander under a Log."

Upon emergence from hibernation in Manitoba, Canada, hundreds of Red-Sided Gartersnakes (*Thamnophis sirtalis parietalis*) form snake balls where scores of males pursue and envelop a female in order to mate. Females secrete a sexually attractive pheromone which attracts potential mates. These spectacular aggregations are described by Anthony in the chapter "Ode to a Gartersnake"—"A human version of this chemical would be worth billions, its power evident in the almost comical spectacle of "mating balls" observed at dens in the spring, where a single pheromone-secreting female is assailed by up to a hundred males. On second thought, writhing masses of humans would not only look ridiculous but also pose a definite traffic hazard."

He captures our keen fashion sense—"It was déjá vu all over again when I realized [groups of herpetologists] were also executing familiar fashion-suicide pacts. Herpetologists thought cargo pants, with all their loops and sagging pockets, were invented for them, and they'd long taken ownership with gusto. But their almost comical devotion to khaki was more CRAP than GAP; the official uniform of established herpetologists was cargo shorts, Hawaiian shirt, white tube socks, and running shoes that had never been run in."

At the summer herp meetings at University of Michigan in 1988, the debut of the delightful rock opera ROMMY occurred, watched by ca. 3000 delegates and me. This clever satiric creation, based on conflicting theories of phylogenetics and phenetics, was the brainchild of the ROM group and other Canadian herpetologists who created the characters, wrote the score, and played a variety of instruments for the performance—"Somehow we pulled it off, helped by vast amounts of beer consumed during the performance, and a boozed-to-the-hilt crowd that clapped, laughed, and guffawed from the opening bar."



The Common Garter Snake (*Thamnophis sirtalis sirtalis*) includes 12 recognized subspecies, one of which ranges into Manitoba, Canada. The Red-Sided Garter Snake (*T. s. parietalis*) occurs in prodigious numbers and when emerging from den sites in the Spring as described by Leslie Anthony, is one of the most overwhelming snake assemblages in the world.

Illustration from Mark Catesby's *The natural history of Carolina, Florida and the Bahama islands: containing the figures of birds, beasts, fishes, serpents, insects, and plants: particularly the forest-trees, shrubs, and other plants, not hitherto described, or very incorrectly figured by authors. Together with their descriptions in English and French. To which, are added observations on the air, soil, and waters: with remarks upon agriculture, grain, pulse, roots, &c. To the whole, is prefixed a new and correct map of the countries treated of.*

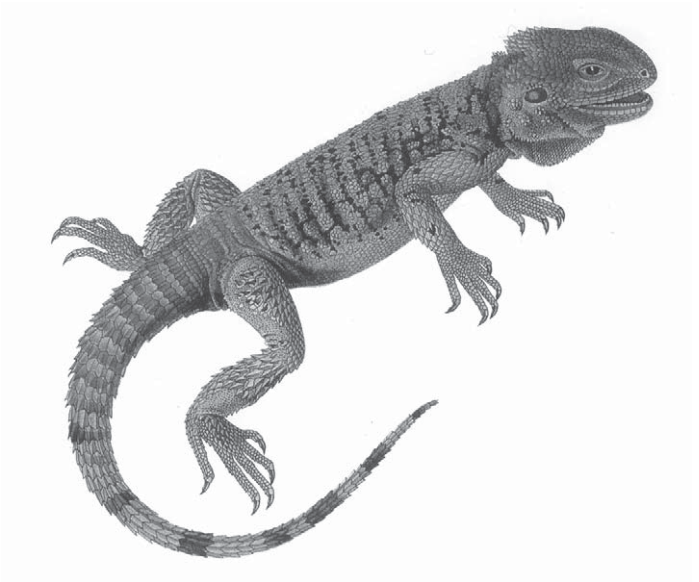
Catesby calls this "*Anguis viridis maculatus*. The green spotted snake." (vol. 2, pl. 53). His description says: "These Serpents sometimes grow to four times the Bigness of the Figure, are said not to be venomous, and are great Robbers of Hen-Roosts, sucking Eggs, tho' their Size seldom enables them to devour the Fowls.

As the change of Marks and Colour in some Serpents cause Confusion in distinguishing them, I would willingly avoid Mistakes, by describing the same Snake twice, and multiplying the Kinds to more than there are: And I am diffident in determinating, whether this be a different Kind from the spotted Ribbon Snake, p. 51. Which somewhat resembles it, tho' of a different Colour."

In the Beehive Press facsimile of selected plates (1974), Joseph Ewan identifies it as *Thamnophis ordinatus* [Linn.] and adds that the plate is cited in L. M. Klauber's discussion of the snake in Copeia 1948, (1):8–10. Today, this taxon is known as the Common Garter Snake (*Thamnophis s. sirtalis*). Credit: Courtesy of Smithsonian Institution Libraries, Washington, DC.

Anthony describes many experiences with a variety of herps from Tortuga Island Rattlesnakes to Armenian Vipers. One of the most interesting was his encounter with the Bola or Fiji Cobra (*Ogmodon vitianus*), a small, exceedingly rare elapid from the Fiji Islands. His writing style is terrific and his oblique sense of humor permeates the book—I laughed aloud many times. I know some of the herpetologists he mentioned and his descriptions of their eccentricities is spot on. Do pick up a copy.

The next book is entitled *LIZARD MAN. The Life and Adventures of Bert Langerwerf*, by Bert Langerwerf and Russ Gurley (2009, Living Art Publishing, Ada, Oklahoma; www.livingartpublishing.com; ISBN 0-9787556-6-9). The late Bert Langerwerf was an extraordinary reptile breeder, reproducing over 135 species. He was the owner of Agama International, Inc., a seven-acre breeding facility in Alabama where thousands of lizards were produced annually. He personally constructed over

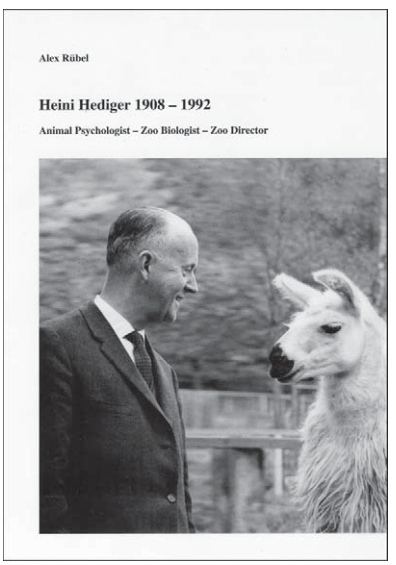


Bert Langerwerf published an account of captive management and reproduction of the Roughtail Rock Iguana (*Agama stellio*, now *Laudakia stellio*) in 1994. Illustration from Georges-Louis Duvernoy, *La Règne Animal par Georges Cuvier, Reptiles volume. Disciple edition*. Paris 1842.

400 outdoor terraria and outbuildings by hand. This book is large: 467 pages, hundreds of photographs, a list of his many papers on captive management, and reasonably priced. For anyone interested in the history of herpetoculture, these photos alone are worth the price of the book as many prominent reptile and amphibian breeders are pictured. His remarkable life is detailed in an obituary published in *Herpetological Review* (2008, 39:400–401).

An excellent biography has also been recently published. Heini Hediger, late Director of the Basel and Zürich Zoos in Switzerland, wrote several seminal books on psychology, psychopathology, and captive management which have influenced zoo biologists. He also published a number of papers in herpetology and his doctoral dissertation "Beiträge zur Herpetologie und Zoogeographie Neu Britanniens und einiger umliegender Gebiete (Contribution to the herpetology and zoogeography of New Britain and some adjacent regions)" included information on the habits of species collected there and the relationship to the environment. The venomous snake *Parapistocalamus hedigeri* was named in his honor by Jean Roux in 1934. Hediger described three taxa: Amiralty Island Webbed Frog (*Discodeles vogti* [Hediger 1934]), Roux's Skink (*Lipinia rouxi* [Hediger 1934]), and a worm snake (*Typhlops buehleri* Hediger 1933, now *Ramphotyphlops depressus*).

Alex Rübel has published a biography detailing his life and extraordinary contributions to zoo biology. The book is called *Heini Hediger 1908–1992. Animal Psychologist — Zoo Biologist —Zoo Director* (English edition 2009, Sales point: Bookstore Beer AG, St. Peterhofstadt 10, 8022 Zurich, Switzerland; ISBN 978-3-906262-22-2).



Cover of book on life of Heini Hediger.

During the period between 1932 and 1943, Hediger published many papers in herpetology on a variety of topics (Appendix II; Honegger 2009).

Amphibian Decline and Extinction

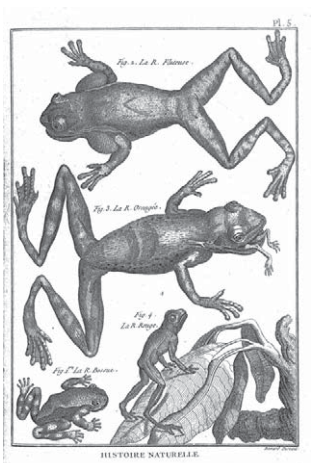
We began this project to summarize our understanding of why amphibian populations declined, some to extinction, late in the 20th and early in the 21st century. We know enough now to place this problem in a larger context of historical and present-day biodiversity losses. The knowledge we have raises several final questions: How will humans react to an increased awareness that Earth's biodiversity is diminishing? What are these losses telling us about our place on the planet, our role in the biosphere? What is our role in conserving biodiversity as we become custodians of a planet that has clear limitations? And how can we pass on to future generations the wisdom needed to make sound environmental decisions? The answers to these questions will tell us much about ourselves, and science will take us only part of the way along that journey.

One mystery yields another.

—James P. Collins and Martha L. Crump

When a zoo visitor hears about the global decline and possible extinction of amphibians, they may ask what non-technical books are available to learn more about the subject. In the past, I have recommended several: *In Search of the Golden Frog* by Marty Crump, *Tracking the Vanishing Frogs: An Ecological Mystery* by Kathryn Phillips, and *A Plague of Frogs: The Horrifying True Story* by William Souder. James P. Collins and Martha L. Crump have added another book to the list which is readable and comprehensible for the layman but is also valuable for the specialist. To achieve this balance, the authors have included hundreds of endnotes to document sources as well as explain situations and concepts in greater detail. Their book is called *Extinction in Our Times. Global Amphibian Decline* (2009, Oxford University Press; ISBN 978-0-19-531694-0). There are many reasons for every zoo herpetologist to own this book. First, the text paints an historical picture of the problem, from the beginning days of skepticism that declines were a real phenomenon to the present day when humans are trying to deal with the potential extinction of an entire class of vertebrates. Second, the role of infectious diseases, climate change, and other deleterious factors are explained in detail. Third, the authors present a primer as to how science policy, future research, and other initiatives should be conducted to address the problem. Finally, they address the role of zoos: "Although they are committed to conservation, for understandable reasons many zoos cannot allocate substantial space or personnel to species with little potential for exhibits. Nevertheless, collection-based institutions are the only ones maintaining species on a continuing basis to ensure their survival, because few governmental agencies have made such commitments. Policies are needed to guide the housing and management of large numbers of threatened or endangered, perhaps non-charismatic, species (p. 180)."

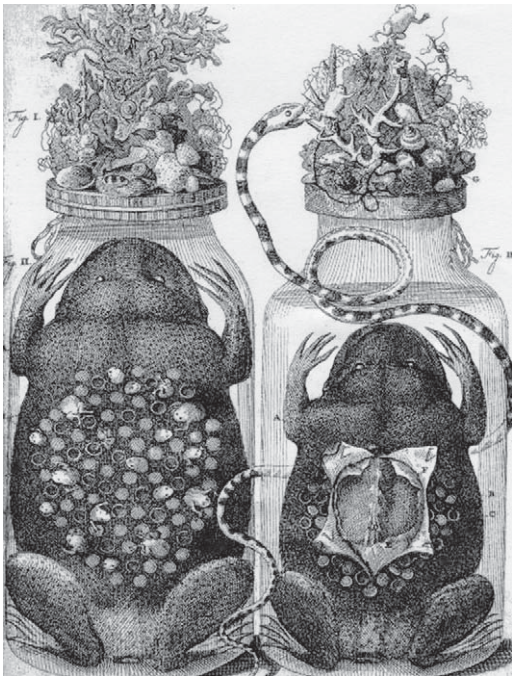
Every zoo professional must become



James P. Collins and Martha L Crump have written a rigorous but sobering overview of global amphibian declines. Illustration from *Tableau encyclopédique et méthodique des trois règnes de la nature ... Erpétologie. / Par m. l'abbé Bonnaterre ...*

Imprint: Paris: Chez Panckoucke, 1789. Credit: Library of Roy McDiarmid.

familiar with and conversant about the scope of the problem outlined by the authors in order to facilitate change in zoos and aquariums by convincing administrators and policy makers that greater human and financial resources must be allocated to attack this extraordinary crisis. In fact, it would be a great idea to buy a few extra copies and circulate them among your bosses!



Collins and Crump present mounting evidence in their book that humans are witnessing an amphibian extinction event. Could it be that the only way that frogs will be seen in the future is like this? Illustration from Frederik Ruysch's book on a natural history cabinet in 1710—*Frederici Ruischii ... Thesaurus animalium primus = / Het eerste cabinet der dieren / van Frederick Ruysch ...*
Imprint: Amstelædami, apud J. Wolters. Credit: Courtesy of Smithsonian Institution Libraries, Washington, DC.

This recent paper is required reading for all zoo and aquarium personnel: Voyles, J., et al. 2009. Pathogenesis of chytridiomycosis, a cause of catastrophic amphibian declines. Science 326:582–585.

Snakes: Ecology and Conservation

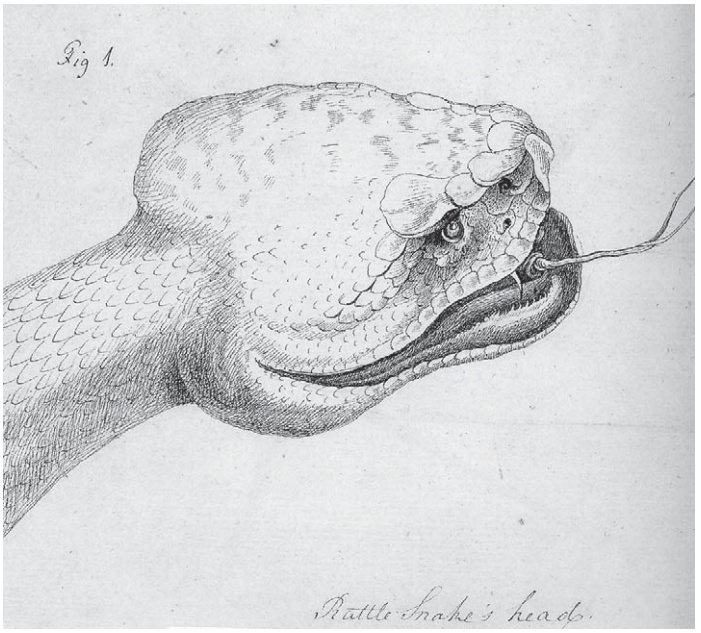
When people abroad see a live snake they rush upon it and batter it to death with sticks and stones, as though every inch of it possessed a separate and fifty-feline power of life calling for special destruction; then they pick up what is left of it, and after an uncertain interval of time, very often in the broiling midday heat of the tropics, put it into a bottle of cachasse, canha, aguadiente, or some other coarse spirit which disintegrates its actual structure, label it with the wrong name, and send it home.

—Arthur Stradling, On the treatment of snakes in captivity, 1882



A new book on snakes provides the most current information on ecology and conservation. Illustration from *Naturgeschichte des Thierreichs ... vol. 3.* by Gotthilf Heinrich von Schubert in 1869.
Imprint: Esslingen, J.F. Schreiber. Credit: Courtesy of Polly Lasker, Smithsonian National Zoological Park Library Collection.

In 1987, the book *Snakes—Ecology and Evolutionary Biology* was published and was followed six years later by the next in the series *Snakes: Ecology and Behavior*. The third one has now appeared: *Snakes: Ecology and Conservation*, edited by Stephen J. Mullin and Richard A. Seigel (2009; Comstock Publishing Associates, A Division of Cornell University Press, Ithaca and London; ISBN 978-0-8014-4565-1). Eleven chapters are geared to conservation and present the most current information on molecular phylogeography; population and conservation genetics; distribution and habitat; behavioral ecology; reproductive biology, population viability, and options for field management; captive rearing, translocation, and repatriation; habitat manipulation; and ecosystem properties. [Full disclosure: I contributed to the chapter on combating ophiophobia.].



In 1792, William Bartram describes an encounter with the Timber Rattlesnake (*Crotalus horridus*) in the Catskill Mountains, located in the state of New York, in his book *Travels through North and South Carolina, Georgia, East and West Florida, the Cherokee country, the extensive territories of the Muscogulges, or Creek confederacy, and the country of the Chactaws; containing an account of the soil and natural productions of those regions; together with observations on the manners of the Indian*—". . . when at the instant, my father being near, cried out 'A rattle snake, my son!' and jerked me back, which probably saved my life. I had never seen one before. That was of the kind which our guide called a yellow one, it was very beautiful, speckled and clouded." (p. 224). According to librarian and author Judith Magee, this unpublished illustration by Bartram is in the collection of the Natural History Museum in London. It was drawn during his travels in the south. The page measures 150 × 160 mm, but this has been trimmed by someone in the Museum in the past. Figure 2 is the head of a Cottonmouth or Water Moccasin (*Agkistrodon piscivorus*) and she suspects they were drawn together on the same sheet of paper but have subsequently been cut up for mounting. There is no text with these drawings but they were sent to his patron John Fothergill in 1774. Credit: By permission of the Trustees of the Natural History Museum, London.

Rattlesnakes

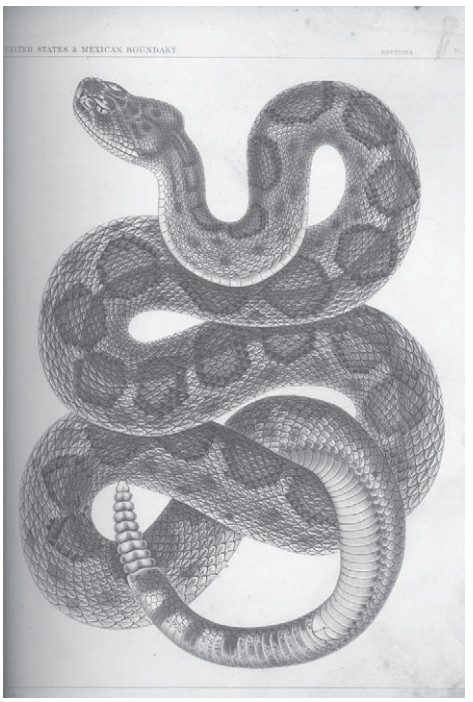
But let us again resume the subject of the rattle snake; a wonderful creature, when we consider his form, nature, and disposition. It is certain that he is capable by a puncture or scratch of one of his fangs, not only to kill the largest animal in

America, and that in a few minutes time, but to turn the whole body into corruption; but such is the nature of this dreadful reptile, that he cannot run or creep faster than a man or child can walk, and he is never known to strike until he is first assaulted or fears himself in danger, and even then always gives the earliest warning by the rattles at the extremity of the tail.

—William Bartram in *Travels…*in 1791

Rattlesnakes being such popular zoo exhibits, there are several books which are essential for the zoo herpetologist's reference library—*The Rattlesnakes, Genera Sistrurus and Crotalus. A Study in Zoogeography and Evolution* by Howard K. Gloyd, 1940; *Rattlesnakes: Their Habits, Life Histories, and Influence on Mankind* by Laurence M. Klauber, 1956; *The Venomous Reptiles of Latin America* by Jonathan A. Campbell and William W. Lamar, 1989; *Biology of the Pitvipers* by editors Jonathan A. Campbell and Edmund D. Brodie, Jr., 1998; *Rattlesnake: Portrait of a Predator* by Manny Rubio, 1998; and *The Venomous Reptiles of the Western Hemisphere* by Jonathan A. Campbell, William W. Lamar, with contributions by Edmund D. Brodie III ... [et al.], 2004.

A new book entitled *The Biology of Rattlesnakes* (2008, Loma Linda University Press, Loma Linda CA; over 600 pages, 50 chapters, and over 90 color images; edited by William K. Hayes, Kent R. Beaman, Michael D. Cardwell, Sean P. Bush, foreword by Gordon W. Schuett; ISBN 978-1594190-011-6), presents the most up-to-date research by nearly one hundred authors specializing in rattlesnake biology. It is not necessary to go into specifics here in terms of content; suffice it to say that virtually every aspect pertaining to the life of a rattler is covered in detail. This is an awesome book, in part because so much original material is included by these researchers. I cannot remember a single book in herpetology with a larger number (>50) of original contributions. The book is divided into Research and History, Systematics, Morphology and Physical Ecology, Learning and Evolution of Behavior, Behavioral Ecology of Feeding and Defense, Population Ecology and Habitat Use, Thermal Ecology, Spatial Ecology, Reproductive Behavior and Ecology, Conservation Ecology and Education, Venom, and Snakebite. Of particular interest to the zoo worker will be the chapter on San Diego Zoo (SDZ) curator and rattlesnake authority Laurence M. Klauber by his granddaughter Janet. Another chapter describes the many observations contained in his monumental two-volume book which were made with Clarence B. (Si) Perkins and later Charles E. Shaw at the SDZ (see Murphy, 2007 for biographies).



In the southwestern United States, the attendees at annual rattlesnake roundups destroy thousands of Western Diamondback Rattlesnakes (*Crotalus atrox*). Many herpetologists have never attended one of these events; if they did so, they would be horrified by the barbaric and inhumane treatment accorded the snakes by so-called civilized human beings. Years ago, I watched a young girl, wearing a party dress covered in blood, chop the heads off restrained living snakes with a meat cleaver. What is remarkable and unsettling is that these displays showing the most negative side of human behavior still exist, attract thousands of onlookers, and animal rights groups ignore the carnage. Illustration from *Reptiles of the Boundary ... With Notes by the Naturalists of the Survey* by Spencer F. Baird, 1859.

I was pleased to see the names of many zoo people as authors: Allison Alberts, Fred Antonio, Tracey Brown, Nick Clark, Craig Ivanyi, Jeffrey Lemm, Hugh McCrystal, Jean-Pierre Montagne, R. Andrew Odum, Douglas Whiteside, as well as those from the academic community who have collaborated with them on various projects.

Turtles, Tortoises, and Terrapins of the United States and Canada

Everyone recognizes a turtle, of whatever size, shape, color, or origin. Would that the names applied to them were so straightforward—"turtle," "tortoise," "terrapin"—they mean one thing to one person, something else to another. Biologically all members of the order Testudines are correctly called turtles. Terrapins and tortoises are certainly turtles; tortoise is usually applied to terrestrial turtles, particularly the larger ones; terrapin is usually applied to edible, more or less aquatic hardshelled turtles.

—Carl H. Ernst, Jeffrey E. Lovich, and Roger W. Barbour, in *Turtles of the United States and Canada* in 1994

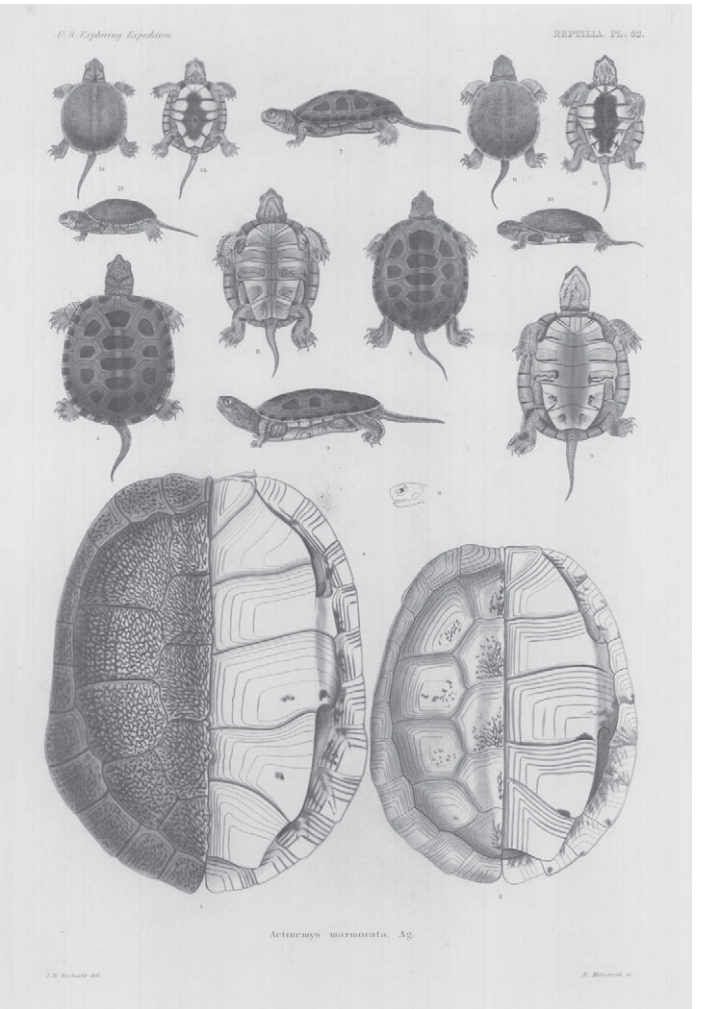
In 1972, Carl H. Ernst and the late Roger W. Barbour published *Turtles of the United States*. Twenty-two years later, an expanded *Turtles of the United States and Canada* appeared by Ernst, Jeffrey E. Lovich, and Barbour. Now, the second edition of *Turtles of the United States and Canada* by Ernst and Lovich has been written and this tome is enormous (2009; Johns Hopkins University Press, Baltimore, Maryland; xii, 827 pp.: ill. (chiefly col.), maps, ISBN 13:978-0-8018-9121-2; 10: 0-8018-9121-3), only approximately 100 pages less than the combined number of pages (which were smaller in size) of the earlier books. Do not be fooled into believing that if you own the first two books, purchasing this second edition is unnecessary—this latest version is dramatically different. Although the sub-categories are essentially the same in each species account (i. e., recognition, karyotype, fossil history, distribution, geographic variation and so on) for all books, the new one is published in a larger format, contains more information, and a greater number of excellent color plates accompany the accounts. Taxonomic name changes after the 1994 edition are included.

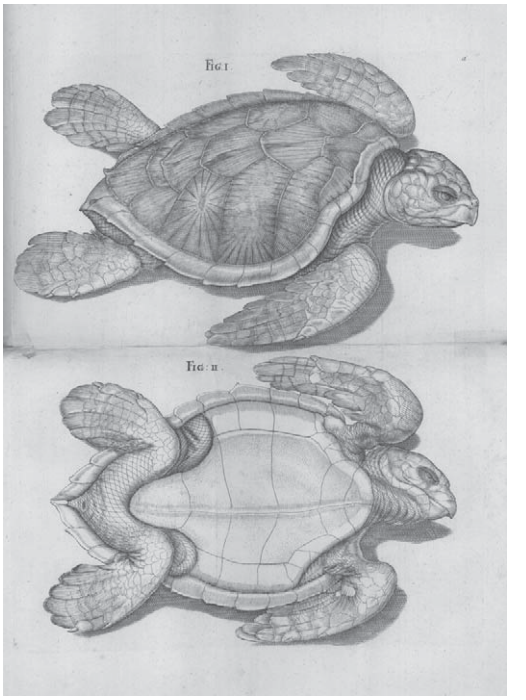
There is in this second edition an extensive section on conservation, a topic missing in the earlier books. This addition reflects the increasingly perilous plight of chelonians globally. W. B. Spencer in *The Victorian Naturalist* in 1921 explains the situation applicable to aquatic turtles "... fresh-water fauna is disappearing rapidly, and unless we now make an organized effort it will be too late to study it effectually, and future generations will wonder what manner of people we were not to leave behind us some adequate record of the marvellously interesting forms of animal life which we had succeeded in exterminating . . . "

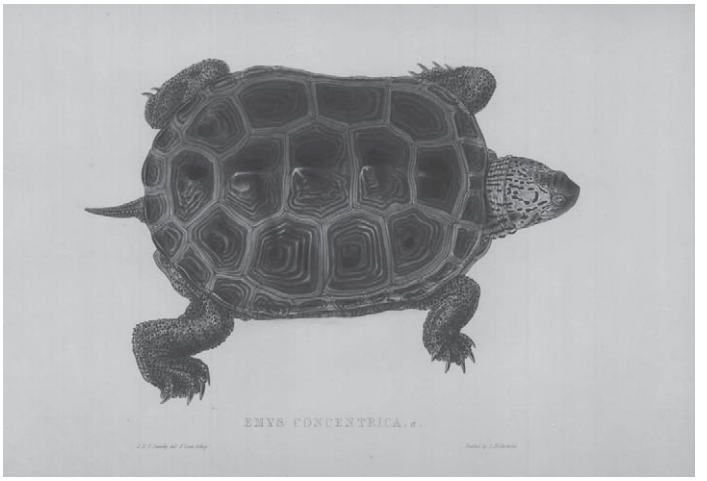
In the August 2009 issue of *Turtle Survival Alliance Newsletter*, an article by Heather Lowe shows current turtle legislation as it relates to commercial harvest in the eastern United States (pp. 49–52). For membership information, visit www.TurtleSurvival.org and also read the article by Dwight Lawson (2004. Partners in saving turtles: The Turtle Survival Alliance. Herpetol. Rev. 35:110).

Lizards and Crocodilians of Southeastern United States

In an earlier issue of *Herpetological Review* (2008, 39:405), I reviewed four books on the amphibians and reptiles of the southeastern United States and enthusiastically recommended all of them for the zoo biologist's library. A new one covering the lizards and crocodilians has been written: *Lizards & Crocodilians of the Southeast* by Whit Gibbons, Judy Greene, and Tony Mills (2009; The University of Georgia Press, Athens, Georgia; ISBN 978-0-8203-3158-4). This book equals the quality of the earlier ones and should be purchased in haste to complete the set.







Many of the chelonians pictured in the revised book by Carl Ernst and Jeffrey Lovich are under siege. Clockwise, from lower left are plate XXXIII– Diamondback Terrapin (*Emys concentrica*, now *Malaclemys terrapin*) from *Tortoises, Terrapins, and Turtles Drawn from Life* by James de Carle Sowerby and Edward Lear, 1872; plate 32 –Pacific Pond Turtle (*Emys marmorata*, now *Actinemys* [=*Clemmys*] *marmorata*) from *United States Exploring Expedition, Baird/Girard Herpetology*; early drawing of a sea turtle from *Physikalish- anatomische Bemerkungen über die Schildkröten, aus dem Lateinischen übersezt. Mit 10 Kupfertafelen* by Christoph Gottwald, 1781. All sea turtles are now endangered, mostly due to human causes. Credit: From the collections of the Ernst Mayr Library, Museum of Comparative Zoology, Harvard University.

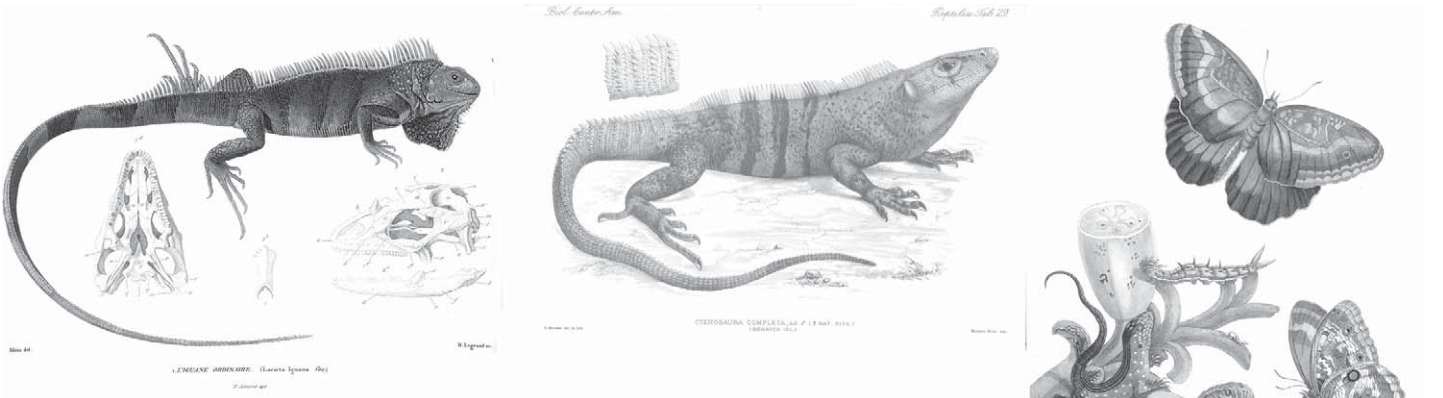
How to Exhibit an Anole

Some of the Anoles make very charming pets. Personally, I think them to be the most beautiful of all Lizards. Those I have fortunate enough to possess have proved themselves hardy while in confinement. They are extraordinarily active, and, for Reptiles, very intelligent: they soon become tame enough to take a fly from the fingers. Owing to their great activity and power of changing colour, mine have several times escaped from their case.

—Reverend Gregory C. Bateman, *The Vivarium*, 1897

During the mid-1950s, I regularly visited the reptile building at the Lincoln Park Zoo in Chicago. In the middle of the public area was a large free-standing planted terrarium housing dozens of American and Brown Anoles. Throngs of visitors always surrounded this enclosure. The anoline life style was on display—male-male combat with dewlap extension, color change, sexual selection, courtship and copulation, oviposition, hatching, and feeding. Even in this limited space, male Brown Anoles were dominating male American Anoles. It was clearly the most popular exhibit in the building, due in large part to the fact that the lizards were very active, attractive, and familiar.

An anole exhibit is the perfect way to introduce the zoo patron to evolutionary biology, and the task of preparing graphics and other educational elements is now much easier with the recent appearance of a superb reference—*Lizards in an Evolutionary Tree. Ecology and Adaptive Radiation of Anoles* by Jonathan B. Losos (2009; The University



In the southeastern part of the United States, invasive lizard species outnumber native forms by a two-to-one margin. From left to right are three prominent aliens pictured in early publications: Green Iguana (*Iguana iguana*) from Georges-Louis Duvernoy's *La Règne Animal par Georges Cuvier, Reptiles volume. Disciple edition* in 1842; Black Spiny-Tailed Iguana (*Ctenosaura similis*) from *Biologia Centrali-Americana. [7], Reptilia and Batrachia* by Albert C. L. G. Günther in 1885–1902; Spotted Racerunner (*Cnemidophorus lemniscatus*) from Maria Sibylla Merian's *Dissertatio de generatione et metamorphosibus insectorum surinamensium* in 1726.

of California Press, Berkeley, Los Angeles, London; ISBN 978-0-520-25591-3). The book is arranged in 17 chapters and includes the following topics: phylogenetics, evolutionary inference, anole relationships, biogeography, life history, ecology, natural selection and microevolution, form, function, and adaptive radiation, ecomorphs, and so on. Creative informative graphics and interactive displays could be developed using any one of these topics and this book is a critical source of information should one embark on a project of this kind. Anoline lizards, numbering about 380 species, can be effectively used to demonstrate the development of ecological theory, ecological questions of interest, conservation issues, and evolutionary diversification.

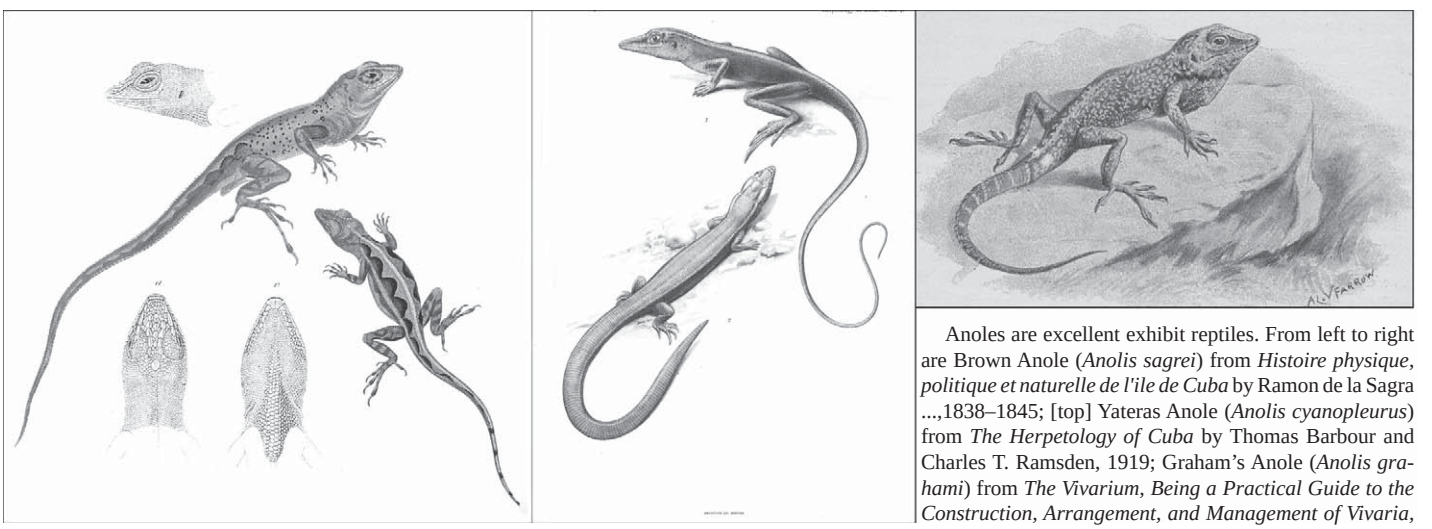
An Essential Reference Book

Editors often complain that bibliographies are the most error-filled part of submitted manuscripts. The reason for this may be that authors are so relieved to have finished their paper that adding the bibliography and checking the accuracy of the citations is almost an afterthought. In a thought-provoking paper by Liner and Hutchison (1998), the senior author reviewed 1000 entries and discovered that 20% were in error. Liner and Hutchison describe the proper way that citations should be listed by addressing the following elements—surname, given name, year, title, source, and ethics and professionalism. They conclude: "Although the errors of existing bibliographies are now history, we hope that this summation of some common problems will lead to increased vigilance on the part of authors, reviewers, and editors, and the incidence of errors will decline."

This goal is now much easier for an extraordinary new book published by SSAR is now available—*Biology of the Reptilia, Comprehensive Literature of the Reptilia*, Volume 22, edited by Carl Gans and Kraig Adler, compiled by Ernest A. Liner; 1,400 pages. To order this volume, please visit: http://www.ssarbooks.com.

The *Biology of the Reptilia* series (21 volumes) is an essential tool for zoo biologists (see HR 2009, vol. 40:17 for details), editors, reviewers, librarians, and others dealing with reptile biology and literature. Over 22,000 references are listed in this new book, compiled from the earlier volumes. There are several important and invaluable features—subject/species and author indices, and cross-reference index to the entire 21-volume series.

Errors can occur by copying citations from previous publications or downloading them from the internet; in both cases, these documents are sometimes erroneously cited and mistakes are perpetuated. The permanence of a printed book with "accurate" citations is essential to meet the challenge of Liner and Hutchison. This tome will be the standard for decades to come; it is unlikely that another book like this will ever again be published.



Anoles are excellent exhibit reptiles. From left to right are Brown Anole (*Anolis sagrei*) from *Histoire physique, politique et naturelle de l'ile de Cuba* by Ramon de la Sagra ...,1838–1845; [top] Yateras Anole (*Anolis cyanopleurus*) from *The Herpetology of Cuba* by Thomas Barbour and Charles T. Ramsden, 1919; Graham's Anole (*Anolis grahami*) from *The Vivarium, Being a Practical Guide to the Construction, Arrangement, and Management of Vivaria, Containing Full Information as to all Reptiles Suitable as Pets, How and Where to Obtain Them, and How to Keep Them in Health* by the Rev. Gregory C. Bateman, 1897.

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Acknowledgments.—I am grateful to Emily Becker, Dana Fisher, and James Hanken from the Museum of Comparative Zoology, Harvard University, Judith Magee from the Natural History Museum in London, Kraig Adler, and Roy McDiarmid for providing some of the illustrations. Polly Lasker, Leslie Overstreet, and Daria Wingreen from Smithsonian Institution Libraries searched archival materials to locate biographical information on Catesby. David Cundall and René Honegger kindly sent literature. Judith Block reviewed early drafts and made helpful suggestions for improvement.

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Judith A. Block is the retired registrar from the Smithsonian National Zoological Park in Washington DC. She is a founding (and now honorary) member of the Zoo Registrars' Association (ZRA), an organization in existence for over 25 years. In 2007, the organization established the "Judith Block Professional Excellence Award," a prestigious honor given to select members to recognize significant achievement in this profession; Block was the first recipient. In the following article, she reviews the book by John E. Simmons (*Things Great and Small. Collection Management Philosophies*) from the perspective of a zoo registrar.

Simmons is well known to herpetologists for he was the collections manager for many years at the University of Kansas before retirement. He is the author of two editions of *Herpetological Collecting and Collections Management*, published by SSAR in 1987 and 2002.

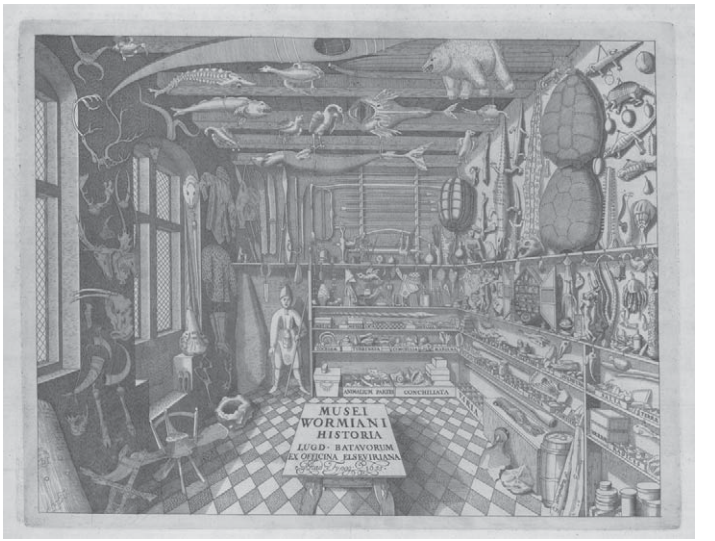
—James B. Murphy, Section Editor

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Essential Reading for Zoo Registrars and Others with Collections Responsibilities

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Things Great and Small: Collections Management Policies, by John E. Simmons (2007; 208 pp.; American Association of Museums; ISBN-13:978-1-033256-03-9; ISBN-10:1-9233253-03-7) is a textbook on collections management policies and it is anything but dry. The book is totally engaging; I found myself making notes, jotting down questions and reflecting on how I would apply what I was reading. The author has a fluid style and a sense of perspective that includes humor, making the sections unexpectedly readable. I even laughed out loud a couple of times.



This frontispiece pictured is the Copenhagen natural history museum or cabinet of curiosities of Oleus Worm in 1655 with snake skins, turtle carapaces and skulls, crocodiles, and lizards hanging on the wall. These private cabinets held biological treasures, arranged in no particular order, to excite wonder. The cover of the Simmons book shows a recreation of the Worm cabinet by Rosamund Purcell for "Two Rooms," Santa Monica Museum of Art, 2003.
Worm, Oleus. 1655. *Museum Wormianum; seu, Historia rerum rariorum, tam naturalium, quam artificialium, tam domesticarum, quam exoticarum, quae Hafniae Danorum in a aedibus authoris servantur. / Adornata ab Olao Worm ...*
Imprint: Lugduni Batavorum, ex officina Elseviriorum, 1655.
Credit: From the collections of the Ernst Mayr Library, Museum of Comparative Zoology, Harvard University.

This book makes clear what collections management policies are and why they are essential. "Collections management is everything that is done to take care of collections, develop the collections and make the collections available for use." (p. 2) Policies are developed to address aspects of management and other collections-related activities and they clarify who is responsible for each; they are the basis for procedures and collection plans. Each institution has its own requirements and constraints but there are commonalities and this book is a most useful guide for developing comprehensive documents or reviewing existing policies.

Each chapter covers a particular topic, such as authority, acquisitions, dispositions, loans, documentation, access and use, ethics and appraisals. There are apt and amusing quotes at the start of each; the section on authority has Ambrose Bierce (1911), "Accountability is the mother of caution." Interspersed with the text in the chapters are boxes titled, "when policy meets reality" which give surprising and informative examples; some are worthy of "news of the weird" such as the theft of two 40 ton locomotives in the risk management and insurance chapter. Each chapter has its own references, explanatory and summary tables, and relevant examples of actual policies in use by various institutions. At the end of the book are appendices including a glossary, a section on laws and regulations, and an expanded list of resources; the bibliography is thorough, the online references less so because a couple of years have passed since publication.

The book was designed as a textbook for Museum Studies graduate students. It seems to be geared particularly to natural history collections although there are plentiful examples from the art world. While I was disappointed to note that zoos are conspicuous by their absence I found that virtually all of the issues are the same and thus the book can be extremely useful to those with living collections.

Anyone who has stewardship responsibilities or deals with collections in institutions would profit from reading—and applying—this book.

LETTERS TO THE EDITOR

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Reexamination of New State Record for *Desmognathus monticola* (Seal Salamander) from Ohio

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Graziano and Reid (2006) reported a range extension of the Seal Salamander (*Desmognathus monticola*) into southern Ohio (Adams County, Monroe Township), the first documentation of the species north of the Ohio River (Pfingsten and Matson 2003). The species verification was made from two specimens collected from two seepages where the closely related *Desmognathus fuscus*, the Northern Dusky Salamander, also was present. No morphological information was provided for either of the specimens, nor was there any discussion of the characters used to distinguish them from the coexisting *D. fuscus*.

Due to the importance of this possible new addition to the herpetofauna of Ohio, and given that the Ohio Department of Natural Resources is now undertaking a major revision of the status of salamanders in the state, we report our collective findings of a reexamination of the two specimens collected by Graziano and Reid (2006). The specimens were deposited at the Fort Hays State University Sternberg Museum of Natural History and were assigned catalog numbers MHP-H 12169 and MHP-H 12170. Both individuals are males with standard lengths (snout-posterior vent lengths) 66.5 and 53.2 mm, respectively.

Both specimens collected by Graziano and Reid are patterned with a dorsal stripe that is most evident posterior to the front legs, a character reported by Hulse et al. (2001) to be lacking in *D. monticola* from Pennsylvania (Fig. 1). Neither specimen has the deeply cut "bold, dark wormy marks" on the dorsum and/or tail that are characteristic of *D. monticola* we have observed and were reported by Petranka (1998). The venter of one of the specimens (MHP-H 12169) has pigmentation with evidence of a reticulate pattern beginning to form, a characteristic of *D. fuscus* as they age. One of us (RAP) has searched for *D. monticola* in southern Ohio counties north of the Ohio River and has collected individuals in Adams County thought to be *D. fuscus* with a dorsal pattern similar to the Graziano and Reid specimens. A "*monticola* like" dorsal pattern has been observed by one of us (RDD) in *D. fuscus* populations from northern Ohio (Lake County), approximately 160 km from the closest known *D. monticola* records in western Pennsylvania (Hulse et al. 2001). From our external examination of the specimens collected by Graziano and Reid (Fig. 1), we find no compelling evidence to suggest that either is *D. monticola*.

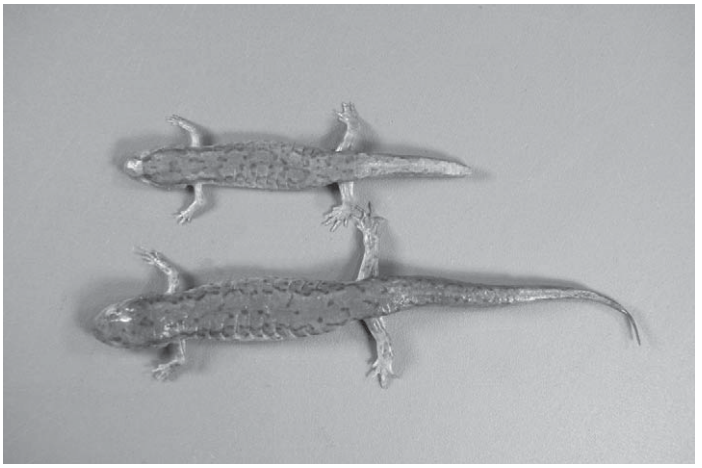


FIG. 1. Specimens of Graziano and Reid (2006) collected from Adams County, Monroe Township, Ohio. Top is Sternberg Museum of Natural History (MHP) 12169, bottom is MHP 12170.

However, because there can be extreme intraspecific variation in morphology, color, and pattern in the genus *Desmognathus*, we also examined tooth morphology and toe pads as presented by Caldwell and Trauth (1979). They report differences in tooth morphology between *D. fuscus* and *D. monticola* from the posterior half of the dentary that can be used to help distinguish the two species. Figure 1 in Caldwell and Trauth (1979) shows *D. monticola* collected from Kentucky having a pointed and piercing-type tooth crown in the posterior half of the dentary, with the lingual cusp being much higher than the labial cusps. In contrast, the crown is blunt and relatively flat in *D. fuscus* with lingual and labial cusps approximately equal in height.

We compared the tooth morphology of the two specimens collected by Graziano and Reid with those presented in Caldwell and Trauth (1979) with two additional specimens in the collection of the Cleveland Museum of Natural History; CMNH 3307, a *D. fuscus* collected by RAP from Adams County, Ohio very near the collection sites of Graziano and Reid; CMNH 6020, a *D. monticola* collected by RAP from Wayne County, West Virginia. We examined teeth from the most posterior region of the dentary from all four specimens at 150x magnification using a Zeiss Discovery V12 stereomicroscope with photographic capability.

The tooth morphology of the specimens we examined is presented in Fig. 2. The Graziano and Reid specimens (B and C in Fig. 2) have teeth nearly identical to those of the CMNH 3307 (A in Fig. 2), the *D. fuscus* from Adams County, Ohio. Differences in length and width of teeth may be related to sex, age, or some other factor. Neither specimen collected by Graziano and Reid has teeth that are consistent with CMNH 6020 (D in Fig. 2), the *D. monticola* collected from West Virginia nor those collected from Kentucky (fig. 1 of Caldwell and Trauth 1979).

Caldwell and Trauth (1979) also discuss differences in pigmentation of toe pads (friction pads) between *D. monticola* and *D. fuscus*.

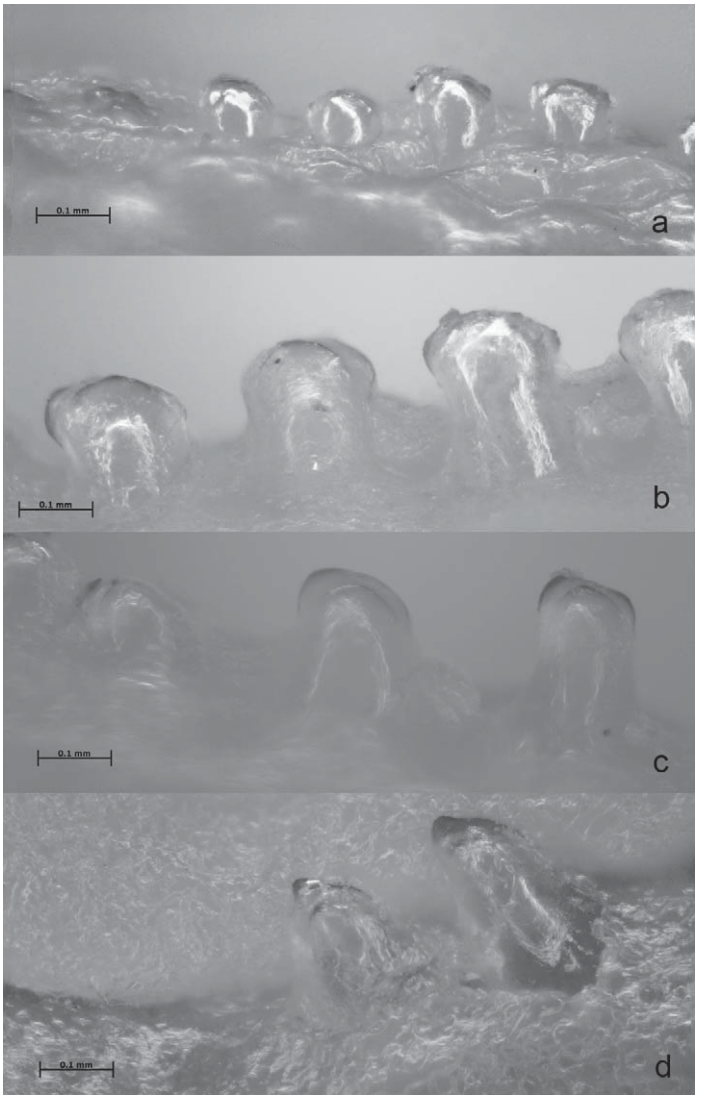


FIG. 2. Tooth morphology from the most posterior region of the dentary of four *Desmognathus* specimens. Label A = *D. fuscus* female from Adams County, Ohio from the collection of the Cleveland Museum of Natural History (CMNH 3307); Label B = MHP 12169 of Graziano and Reid (2006), a male; Label C = MHP 12170 of Graziano and Reid (2006), a male; Label D = *D. monticola* from Wayne County, West Virginia (CMNH 6020), sex undetermined. Both specimens of Graziano and Reid (2006) have teeth nearly identical to those of the cataloged *D. fuscus*.

They report that *D. fuscus* examined from Kentucky (N = 119) was never found to possess friction pads with dark pigmentation at the tip of the toes. If pigmentation was present at the toe tip, it was not significantly darker than surrounding tissue. In contrast, they found dark friction pads were present on at least some of the toes in 94.4% of *D. monticola* examined from Kentucky (N = 62). No evidence of ontological variation was found with dark pigmentation evident in larvae as well as large adults. Our microscopic examination of the 20 total digits of the two specimens of Graziano and Reid (2006) revealed no evidence of dark pigmented friction pads differing from the surrounding tissue. While this character alone is not taxonomically conclusive, we find no evidence of friction pads on the toes of the Graziano and Reid specimens suggesting they are *D. monticola*.

In summary, we conclude from our reexamination of the two Graziano and Reid specimens that they both have attributes of body color and pattern, tooth morphology, and friction pads on the toes that are indicative of *D. fuscus* found in the state of Ohio. We consider this published range extension to be untenable and cannot support recommending that it be used to include *D. monticola* to the list of herpetofauna of Ohio.

Acknowledgments.—We thank the Ohio Department of Natural Resources Division of Wildlife for granting permission to us to examine the two putative specimens of *Desmognathus monticola*. We thank Steve Tilley and Kenneth Wray for providing helpful comments leading to improved readability of the manuscript.

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Living Reptiles and Amphibians Available from Smithsonian National Zoological Park, Washington DC

The following are available gratis to qualified non-profit institutions: nature centers, living material centers, and academic institutions:

Gonyosoma oxycephala, adult female, (Red Tailed Rat Snake)
Tiliqua scincoides, 2 adult females, (Blue-tongued Skinks)
Elaphe obsoleta rossalleni, 2 adult males, 1 adult female, (Everglades Rat Snakes)
Eublepharis macularius, group of five adults, (Leopard Geckos)

Some of the specimens are habituated long-term captives and could be used for demonstrations. Potential recipients will undergo a review process. Shipping costs must be borne by recipient.

If interested, contact curator James B. Murphy for additional details: Department of Herpetology, Smithsonian National Zoological Park, PO Box 37012 MRC 5507, Washington DC 20013-7012; e-mail: murphyj@si.edu; cell phone: 202-327-3767.

ARTICLES

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Rediscovery of the Rare Autlán Long-Tailed Rattlesnake, *Crotalus lannomi*

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Among Mexico's diverse herpetofauna, the rattlesnakes (*Crotalus* and *Sistrurus*) have intrigued both herpetologists and non-herpetologists alike for centuries. One group of rattlesnakes, however, has remained especially enigmatic. The long-tailed rattlesnake group includes three rare species (*C. stejnegeri*, *C. lannomi*, and *C. ericsmithi*) and is represented in museum collections by fewer than 15 specimens, most of which are *C. stejnegeri* (Campbell and Flores-Villela 2008; Campbell and Lamar 2004). Their unique body structure and unusually long tails have raised numerous questions regarding their natural history and ancestry.

The Autlán Long-tailed Rattlesnake, *C. lannomi*, has been known only from a single specimen, collected in June 1966 by Joseph R. Lannom, Jr. from "1.8 miles west of the pass: Puerto Los Mazos, Jalisco" (Tanner 1966). Despite numerous attempts to locate additional specimens (Campbell and Flores-Villela 2008; Campbell and Lamar 2004), none have been reported since the initial description.

Since 2004, we have searched for rattlesnakes in the western foothills of the Sierra Madre Occidental and associated ranges in Nayarit, Jalisco, and Colima. Over the course of several weeks in July 2008, five additional specimens of long-tailed rattlesnakes were found in the foothills of Colima, México. Based on features of lepidosis, this new material is referred to *Crotalus lannomi*. The snakes were found approximately 50 km SW of the type locality (Fig. 1). Herein, we provide detailed morphological descriptions of the new specimens, notes on natural history, comparisons with the other species of long-tailed rattlesnakes, and review the conservation status of the species.

Methods

The new specimens of *Crotalus lannomi* were collected at two localities in Colima: 42 km SE (Site 1) and 48 km ESE (Site 2) by road from Cuautitlan, Jalisco (Fig. 1). Protocols for making scale counts and definitions of external morphological features follow Klauber (1972) and Campbell and Lamar (2004). Measurements were made using a meter stick to the nearest 1 mm or with a digital caliper. All specimens were photographed by digital camera (Nikon D200 and Sony Cyber-Shot F828) and the images were deposited at the University of Texas at Arlington Digital Image Collection (UTADC). One specimen was deposit at the Museo de Zoologia, Facultad de Ciencias, UNAM (MZFC 22941).

Measurements for other species of long-tailed rattlesnakes were taken from published sources (Campbell and Flores-Villela 2008; Campbell and Lamar 2004; Dunn 1919; Tanner 1966).

Results

Description of the new material.—The specimens of *Crotalus lannomi* reported herein (N = 5; 3 males, 2 females) agree in most characters with the original description by Tanner (1966). A comparison of morphological characters is given in Table 1. The following is a summary of scutellation in *C. lannomi*: rostral wider

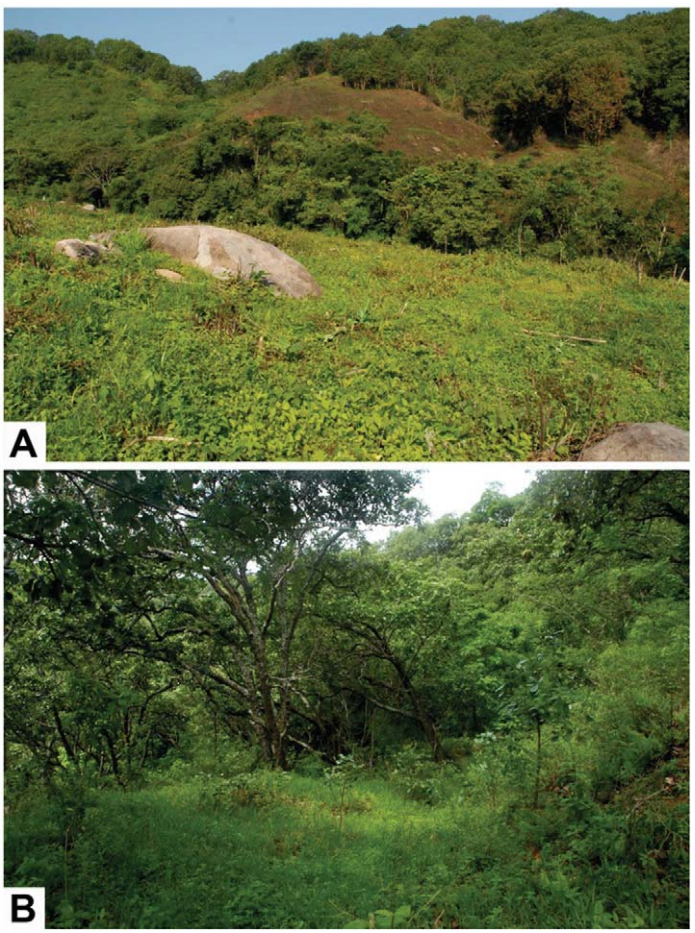


Fig. 1. New localities for *Crotalus lannomi* in Colima, Mexico. A) 42 km by road SE of Cuautitlan, Jalisco. Cleared field in open oak/TFD ecotone, 805 m elevation. B) 48 km by road ESE of Cuautitlan, Jalisco. Steep hillside in open oak/TDF ecotone, 1150 m elevation.

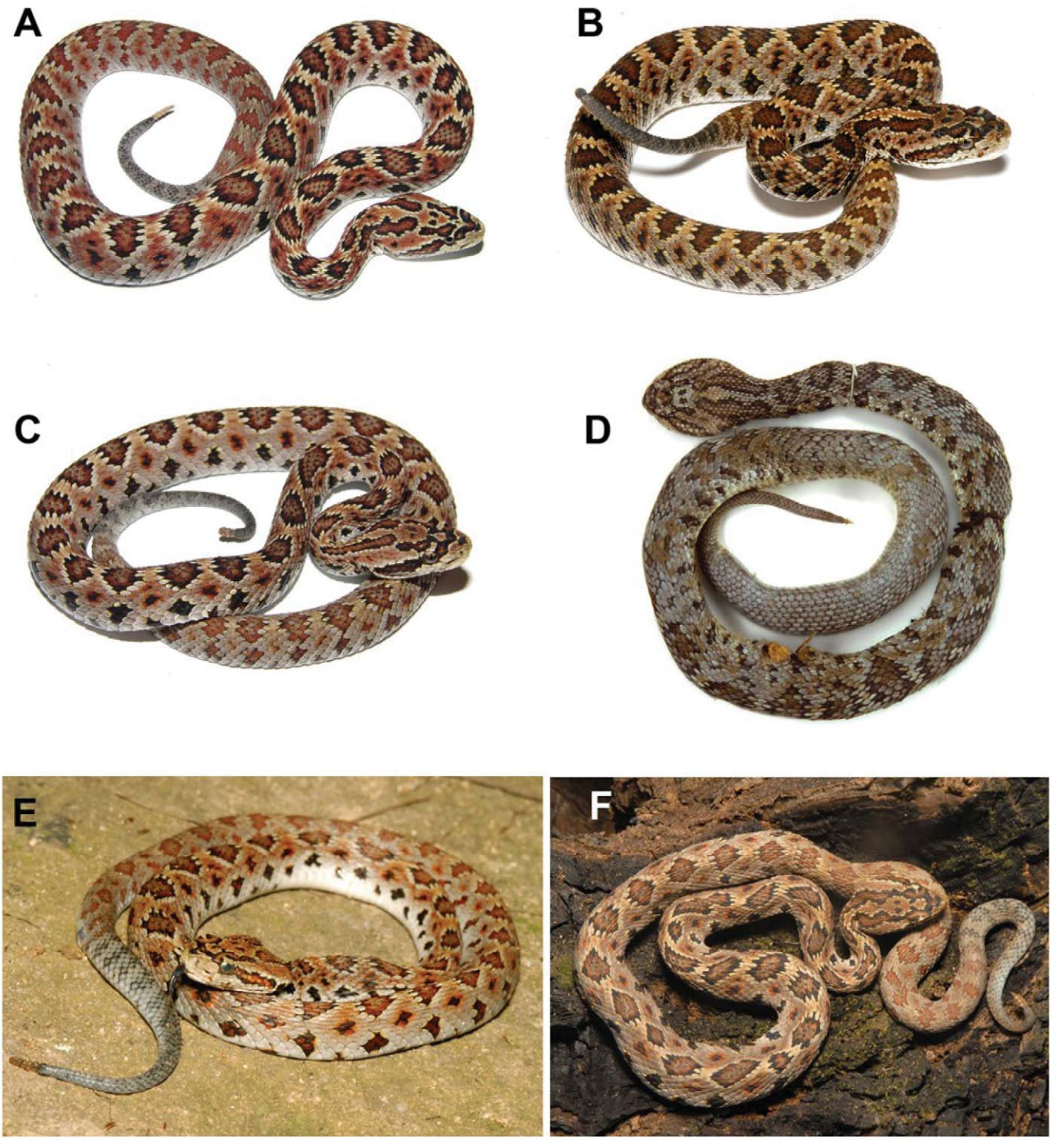


FIG. 2. Known specimens of *Crotalus lannomi*: A) UTADC-4005, female; B) UTADC-4002, female; C) UTADC-4003, male; D) BYU-23800, female, holotype; E) MZFC-22941, male; F) UTADC-4006, male.

than high; canthals moderate to large; 2–4 scales between canthals (but in two specimens canthals in contact); internasals relatively narrow; intersupraoculars 3, 4, or 5 at midlevel; 1–4 scales between intersupraoculars and intercanthals; dorsal scale rows (DSR) extremely variable: midbody 25–29; one head length behind neck 23–27; one head length anterior to cloaca 20–22; ventrals 168–175; subcaudals in males 49; in females 35–36; body slender in both sexes though slightly more stout in females.

Coloration.—In life coloration is as follows: ground color varies from rust-red to various shades of brown and yellow; dorsal blotches 31–35 (31–33 in females, 35 in males); blotches brown with central highlights and dark black or dark brown edges surrounded by a pale cream or white border one scale in width; blotches fade to pale brown or rust with the dark edges and pale border becoming indistinguishable towards the posterior part of the body; primary dorsal blotches 3–10 scales wide and 2–11 scales

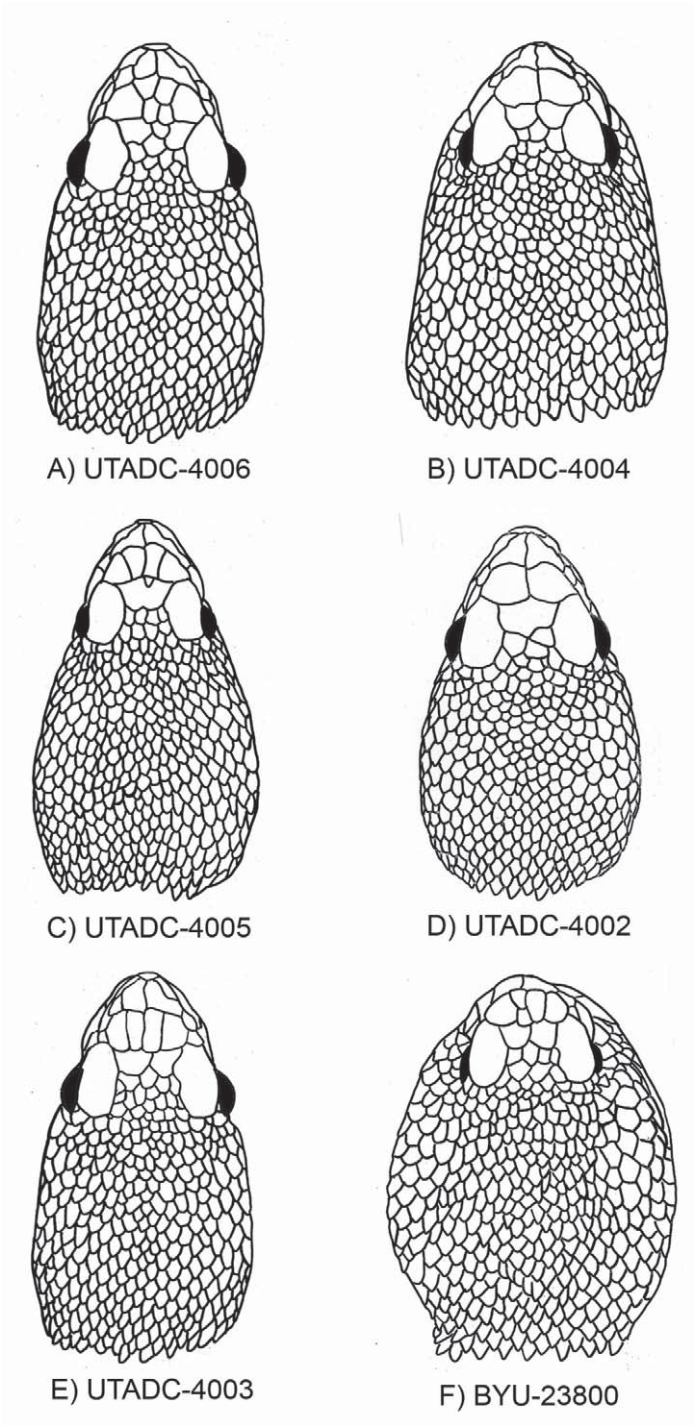


FIG. 3. Head scalation of *Crotalus lannomi*: A) UTADC 4006, male; B) MZFC 22941, male; C) UTADC 4005, female; D) UTADC 4002, male; E) UTADC 4003, female; F) BYU 23800, female, holotype (the unusual appearance can likely be attributed to the snake being run over by a vehicle).

long (9–12 scales wide and 3–5 scales long in the holotype), narrowing towards the posterior of the body; blotches separated by 0.5–4 scales; a dark brown or black spot present on both sides of each dorsal blotch, on scales 2–4; spots become paler on the posterior part of the body; a small dark lateral spot is present, usually on scale rows 4–6 between dorsal blotches, bordered by bright orange on surrounding scales; a secondary row of smaller dark lateral spots is present just above the ventrals; tail pale blue-gray, with 12–17 gray bands; venter white with an irregular series of two black spots near the margin of each ventral. In preservative most colors turn dull gray or brown.

Habitat.—Both new localities for *Crotalus lannomi* reported here are within an ecotone of tropical deciduous forest (TDF) and oak forest (Fig. 1). The area is characterized by wet canyons harboring tropical semi-deciduous forest with large old growth trees. Areas above 1200 m have medium to dense pine or pine-oak forest. Site 1, at 805 m elev., lies along an arroyo and consists of a cleared field with scattered large boulders, covered by grasses and secondary growth ca. 0.5–1 m high. It is bordered by open oak/TDF (Fig. 1A). Site 2 is a steep hillside in open oak/TDF located at 1150 m elev. (Fig. 1B). It is mostly undisturbed, with the exception of some light grazing and logging. Introduced grasses (*Panicum, Hyparrhenia, Andropogon*) and small bushes represent the principal vegetation cover at Site 1. Small bushes (*Montano* sp., *Verbesina* sp.) and some herbaceous plants (*Adiantum* sp., *Cheilanthes* sp., *Hemiontis* sp.) form the understory at Site 2. Oak trees (*Quercus magnolifolis, Q. iltisii, Q. elliptica*) and tropical arborescent species (*Bursera bipinnata, Cecopia* sp., *Lysiloma* sp., *Sapium* sp.) represent the principal tree species at both localities.

NATURAL HISTORY

Diet.—Examination of fecal samples from a juvenile specimen (UTADC 4003) revealed lizard scales (*Sceloporus* sp.), arthropod remains, plant matter, and the mandible of a colubrid snake. The colubrid mandible measures 2.3 mm in length and has two posterior fangs with deep grooves.

Reproduction.—Umbilical scars were present in the two juvenile specimens (UTADC 4002, 4003), both of which were found ca. 20 m apart on the same hillside at Site 1 on 15–16 July, respectively. An adult female and male (UTADC 4005, 4006) were found on 24 July 2008 basking together beneath grasses and small ferns at Site 2 (Fig. 1B). The previous day, a single male (MZFC 22941) was observed at this site.

Activity and behavior.—All specimens were found partially hidden beneath vegetation between 1130 and 1300 h, and were quick to rattle and retreat when disturbed. None assumed a defensive posture nor struck when handled. We spent many hours actively searching at night, both in the field and on roads, but were not able to locate any specimens. However, based on published observations of related taxa (Campbell and Flores-Villela 2008; McDiarmid et al. 1976a), we expect this species to be crepuscular and/or nocturnal when weather permits.

DISCUSSION

Comparison with other long-tailed rattlesnakes.—The paucity of specimens available for study coupled with minimal sampling over a wide geographic range has made it difficult to determine relationships within this group. Until now, two of the three species (*C. lannomi* and *C. ericsmithi)* were each known only from a single specimen. Although the specimens reported here add to our understanding of variation in *C. lannomi* (Table 2), further sampling within the expected collective range of the long-tailed species group is needed to confirm the distinctiveness of the cur-

TABLE 1. Morphological variation in *Crotalus lannomi*. Measurements for BYU 23800 were taken from Tanner (1966) and Campbell and Flores-Villela (2008). DSR = Dorsal Scale Rows.

Characters	UTADC-4004	UTADC-4002	UTADC-4006	UTADC-4003	UTADC-4005	BYU-23800
Sex	Male	Male	Male	Female	Female	Female
Rattle segments	6	2	5	2	5	2 remaining
DSR at mid body	25	29	25	29	29	27
DSR 1 head length behind head	—	28	23	27	27	31
DSR 1 head length before cloaca	20	21	21	21	22	22
Ventral scales	175	173	171	175	168	176
Subcaudals	49	49	49	35	36	37
Scales between canthals	In contact	In contact	4	2	2	3
Intersupraoculars	3	3	4	5	4	4
Body blotches	35	35	35	33	32	31
Width of blotches (in scales)	6–10	8–10	6–9	3–4	7–10	9–12
Length of blotches (in scales)	2–4	3–7	3–7	7–11	3–5	3–5
Scales between blotches	1–4	1–2	1–2	1–2	0.5–2	1.5 or less
Tail bands	17	16	12	12	15	—
Total length (mm)	541	346	603	300	612	638
SVL (mm)	470	302	516	272	548	569
Tail length (mm)	71	44	87	28	64	69
Head length (mm)	39	19	31	19	35	31.6
Tail % of total length	13.10%	12.70%	14.40%	9.30%	10.40%	10.80%

rently recognized species.

Coloration of *C. lannomi* is very similar to that of the type specimen of *C. ericsmithi*. The bright orange color of *C. ericsmithi* was one of the most distinctive characters reported in the original description (Campbell and Flores-Villela 2008). Both adult male specimens of *C. lannomi* reported here also display bright orange to reddish coloration (Fig. 2). *Crotalus stejnegeri* is significantly duller in color, although Campbell and Flores-Villela (2008) noted that some specimens had orange-colored scales.

The additional specimens of *C. lannomi* demonstrate that this species is also highly variable in scutellation (Table 1). Previous differences thought to distinguish *C. lannomi* from *C. ericsmithi* have proven unreliable, including size of canthals, number of scales between canthals, number of intersupraoculars, number of ventrals, and general head and body coloration, as all of these characters overlap considerably between the two species. The number of mid-dorsal body blotches was believed to be a distinguishing feature between *C. lannomi* and *C. stejnegeri*. The additional material described here, however, demonstrates an overlap in all three species. *Crotalus lannomi* was believed to have a more stout body than *C. ericsmithi* and *C. stejnegeri*, but this trait seems to be a sexually dimorphic condition unique to females. Conversely, we have found the following characteristics to be useful in distinguishing *C. lannomi* from the other two species of long-tailed rattlesnakes: a reduced number of scales between the intersupraoculars and intercanthals, numbering 1–4 (12 in *C. ericsmithi*, more than 10 in *C. stejnegeri*) and by having fewer prefoveals, 4 (7–8 in *C. stejnegeri;* 5–6 in *C. ericsmithi*). The first pair of infralabials is mostly separated by the mental in *C. ericsmithi*, while it is in broad contact in both *C. lannomi* and *C. stejnegeri*.

Although each of the three species of long-tailed rattlesnakes occupies a very small area, their ranges are undoubtedly far greater than presently understood (Fig. 4). All three species occur at similar elevational and vegetation associations, and in similar climate zones that can be found almost continuously along the western slopes of the sierras from northwestern Durango to Oaxaca. Here we suggest some specific areas for future field efforts, as new material from within range gaps will be important in resolving relationships within the group.

1. The coastal foothills of Guerrero and Oaxaca, south of the low pass of the Sierra Madre del Sur, located near Chilpancingo.

2. The Sierra de Coalcomán in coastal Michoacán is located between the ranges of *C. lannomi* and *C. ericsmithi* and it seems likely that at least one of these species occurs there.

3. Also warranting attention is the Balsas/Tepalcatepec Basin of Jalisco, Michoacán, México, Guerrero, and Morelos, where a humid tropical semi-deciduous forest appears on the southern slopes of the central transverse ranges.

4. No species of long-tailed rattlesnake has been reported from Nayarit, however the state likely has *C. stejnegeri* and potentially *C. lannomi*.

5. Another area of interest is the region where the states of Sonora, Sinaloa, and Chihuahua meet, where we have heard rumors of long-tailed rattlesnakes from east of Álamos, Sonora and near Cosalá, Sinaloa.

Although it is unclear why no additional specimens of *Crotalus lannomi* had been found since the original description, and why long-tailed rattlesnakes in general are so seldom found, the following factors undoubtedly serve to reduce collecting efforts in long-tailed rattlesnake habitat.

TABLE 2. Morphological variation in long-tailed rattlesnakes. Measurement for *Crotalus ericsmithi* and *C. stejnegeri* were taken from Campbell and Flores-Villela (2008).

Characters	*Crotalus lannomi*	*Crotalus stejnegeri*	*Crotalus ericsmithi*
Tail % of TL	Males, 12.7–14.4% Females, 9.3–10.8%	Males, 10.4–14.5% Female, 9.7%	Male, 15.9%
Internasals	Relatively narrow	Broad	Relatively narrow
Size of canthals	Moderate to very large	Moderate	Large
Scales between canthals and intersupraoculars	0–4 3–5	2–3 5–8	3 5
Scales between intersupraoculars and intercanthals	1–4	>10	12
Ventrals	Males, 171–175 Females, 168–175	Males, 172–178 Females, 171–176	Male, 172
Subcaudals	Males, 49 Females, 35–37	Males, 48 Females, 36–37	Male, 41
Dorsal body blotches	Males, 35 Females, 31–33	34–43	35

Social issues.—The narrow band of habitat where long-tailed rattlesnakes are found is favorable for marijuana and opium production (pers. obs.). The type locality of *C. stejnegeri*, for example, has a long history of drug-related violence, as does Mexican Hwy 40, where additional specimens of that species have been collected (Hardy and McDiarmid 1969; McDiarmid et al. 1976). The coastal sierra of Guerrero, the only known locality for *C. ericsmithi*, is an important center for narcotics production, as is the Sierra de Coalcomán in Michoacán. In general, the western sierras of Nayarit, Jalisco, and Colima are somewhat less affected, but still have areas of marijuana and opium poppy harvesting.

Roads.—There are few accessible roads through long-tailed rattlesnake habitat. There are between four and eight paved roads traversing areas inhabited by long-tailed rattlesnakes, several of which are some of the most dangerous in Mexico. Aside from poor road conditions, domestic livestock, heavy fog, rain and flooding, treacherous curves, and dangerous traffic, highway robberies and kidnappings are not uncommon. Access on dirt roads is more widespread; however, navigating them during the rainy season can be near impossible.

Conservation of Crotalus lannomi**.**—The tropical foothills of Colima, where the additional specimens of *C. lannomi* were found, are some of the state's last remaining wilderness areas, as most of the lowlands have been severely altered by human activity. Issues affecting the conservation of *C. lannomi* have not been studied, but here we list anthropogenic factors potentially affecting *C. lannomi* habitat:

• Agriculture.—Corn and coffee are being cultivated with some

TABLE 3. Amphibians and reptiles associated with *Crotalus lannomi* at two localities in Colima, Mexico.

Snakes	Lizards	Turtles	Amphibians
Agkistrodon bilineatus	*Ameiva undulata*	*Kinosternon integrum*	*Chaunus marinus*
Boa constrictor	*Anolis smithii*	*Rhinoclemmys pulcherrima*	*Ollotis marmoreus*
Crotalus basiliscus	*Aspidocelis linneattissimus*		*Craugastor augusti*
Dryadophis melanolomus	*Elgaria kingii*		*Craugastor hobartsmithii*
Drymobius margaritiferus	*Eumeces parvulus*		*Eleutherodactylus nitidus orarius*
Enulius flavitorques	*Heloderma horridum*		*Exerodonta smaragdina*
Leptodeira maculata	*Phyllodactylus lanei*		*Gastrophryne usta*
Leptotyphlops humilis	*Sceloporus bulleri*		*Hyla arenicolor*
Manolepis putnami	*Sceloporus utiformis*		*Pachymedusa dacnicolor*
Masticophis mentovarius	*Sphenomorphus assatus*		*Rana forreri*
Micrurus proximans			*Smilisca baudini*
Trimorphodon biscutatus			*Tlalocohyla smithii*
Trimorphodon tau			
Tropidodipsas annulifera			

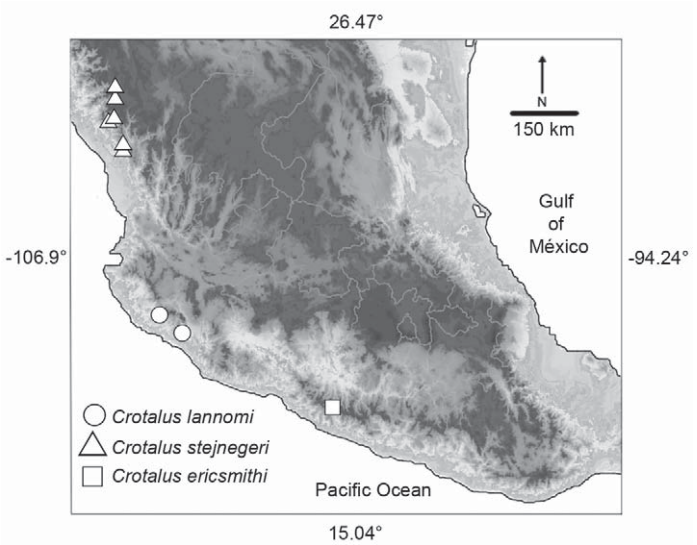


FIG. 4. Distribution of species of the long-tailed rattlesnake group in western Mexico.

frequency at Site 1. However, general inaccessibility and rough terrain limit the threat to most of this area.

• Cattle grazing.—Small-scale cattle grazing is common at both sites. Animals are usually free ranging and feed on native vegetation and introduced grasses. Some hillsides are considerably eroded, presumably due to overgrazing.

• Logging.—Minimal logging for charcoal production occurs in the vicinity of both localities.

• Mining.—Several active ore mines are found throughout the known and predicted range of *C. lannomi*. The expansion of these mining operations represents a potential risk to *C. lannomi* and its habitat.

Crotalus lannomi is listed as threatened by the Secretaría de Medio Ambiente y Recursos Naturales (SEMARNAT). This is equivalent to the vulnerable category as defined by the IUCN. Although these rankings are assumed to be similar, this species is listed as "data deficient" in the IUCN Red List of Threatened Species (Ponce-Campos and Garcia-Aguayo 2007) rather than vulnerable. We consider *C. lannomi* vulnerable throughout its very limited known range.

Several species of unique plants and animals share the habitat with *Crotalus lannomi*. The tree *Inga colimana* (Fabaceae) is endemic to the area (Padilla Velarde et al. 2005). The Peregrine Falcon (*Falco peregrinus*) is known to nest at similar elevations in western Colima (Santana et al. 2006). This represents the southernmost reported nesting site for the species. At least one Puma (*Puma concolor)* was observed while searching for snakes at night. Some 716 species of plants are reported from a nearby sierra, and of those, 16 are considered to be in some kind of risk category and two are endangered (Padilla-Velarde et al. 2008). We believe that the west-central foothills of Colima should be protected to ensure the conservation not only of *Crotalus lannomi* but the rich flora and fauna sharing its habitat. Further studies are necessary to understand the ecology and natural history of this elusive species and to promote its conservation.

Type locality of Crotalus lannomi.—After an interview with Joseph R. Lannom, Jr. (interviewed by JRV on 6 February 2009), collector of the holotype of *C. lannomi*, it seems likely that the original locality reported in Tanner (1966) is in error. During the interview, Lannom described the type locality of *C. lannomi* as a bridge where the highway crosses a lush canyon, which he referred to as "Wildcat Canyon." A canyon fitting his description, known locally as "Arroyo el Tigre" is located at 550 m elevation, 12 km SW by road from the locality given in Tanner (1966). This locality lies within the TDF/oak forest ecotone. This difference might explain why searches at the published type locality, situated in a more arid oak forest, have failed to produce additional specimens.

Common name of Crotalus lannomi.—Tanner (1966) suggested the name "Autlán Rattlesnake" for *C. lannomi*. This name was later changed to "Autlán Long-tailed Rattlesnake" by Campbell and Flores-Villela (2008). The city of Autlán de Navarro, Jalisco, is located a short distance from the type locality of *C. lannomi* (ca. 13 airline km NE), but boasts habitat and climatic conditions significantly different from those at all known collection sites. The city is located in the rain shadow of the Sierra Manantlán, and the habitat is a dry, desert-like thornscrub. We believe it unlikely that *C. lannomi* would inhabit the area surrounding the city of Autlán, and therefore consider the name "Autlán Long-tailed Rattlesnake" inappropriate for this species. Given that both the type locality and the abovementioned collection sites are located in, or associated with, the Sierra de Manantlán, we propose the name "Manantlán Long-tailed Rattlesnake" for *C. lannomi*.

Herpetofauna associated with Crotalus lannomi.—A number of amphibians and reptiles were found at or in proximity to the new localities given here for *Crotalus lannomi*. Table 3 summarizes the herpetofaunal species found at these localities. Most are typically lowland inhabitants, but several (*Elgaria kingii*, *Sceloporus bulleri*, *Exerodonta smaragdina*, and *Hyla arenicolor*) are mid-elevation or highland species in west-central Mexico.

Acknowledgments.—We thank Joseph R. Lannom, Jr. for his insight and most of all for finding the first specimen of *Crotalus lannomi* over 40 yrs ago, which started this quest. We thank Oscar Avila-Lopez, Alexander Hermosillo, Chris Rodriguez, Ana Pacheco, Loreli Nuño, and R. Michel for their assistance in the field. We also thank Jonathan Campbell, Robert Bryson, Carlos Ibarra, Juan Rodriguez, and Jeff Streicher for their support. Special thanks to Oscar Avila and Francisco Santana for identifying some of the plant species at the new localities. Jonathan Campbell, Robert Bryson, Jesse Meik, and Dan Mulcahy kindly reviewed previous versions of the manuscript. Joseph Collins provided the image of the *C. lannomi* holotype. We are deeply indebted to the Michel family, as well as to Leo and Roman for all of their help and hospitality. We are also especially thankful to Oscar Flores for his assistance in reviewing this manuscript. Fieldwork was conducted under a collecting license issued to Oscar Flores by SEMARNAT (FAUT-0015). We gratefully acknowledge the support of Ronald A. Javitch, Montreal, for making possible the publication of color plates.

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Checklist of Terrestrial Reptiles in Three Protected Areas in the Kingdom of Saudi Arabia

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Because of under-collecting and general understudy, there is an overall paucity of data for reptiles in the various protected areas within the Kingdom of Saudi Arabia. Reptile species lists of occurrence (i.e., inventories of species occurring in protected areas or specific conservation areas) have not been published for the Kingdom of Saudi Arabia. However, a provisional checklist for the Mahazat as-Sayd protected area was published by Gaucher and Asmodé (1991). Previous general checklists for the region include Arnold (1986a) [lizards and amphisbaenians], Gasperetti (1988) [snakes]; Hillenius and Gasperetti (1984) [chameleons]; Gasperetti et al. (1993) [turtles], with general publications including reptiles from the Gulf Region by Leviton et al. (1992). Most recently, Egan (2007) published a field guide on the snakes of the Arabian Peninsula. General species-focused publications are more numerous with a number of reptile publications by various authors in the volumes of the Fauna of Saudi Arabia dating from 1979 onwards.

Study area.—A survey using a comprehensive literature review as well as confirmed sightings was conducted for three protected areas (Mahazat as-Sayd, Uruq Bani M'arid and the King Khalid Wildlife Research Centre – Latin transliteration of Arabic follows Child and Grainger 1990) within the Kingdom of Saudi Arabia (Fig. 1). These three areas are described individually:

1. The **Mahazat as-Sayd Protected Area** is a flat, arid desert steppe located ca. 150 km NE of Taif and 700 km W of Riyadh in western central Saudi Arabia (28.25°N, 41.67°E, between 900 and 1100 m above sea level) covering an area of 2190 km^2 (Child and Grainger 1990). The climate is arid with the annual rainfall (occurring mainly between March and May) highly variable ranging between 50 and 100 mm and the mean monthly minimum and maximum temperatures ranging between 2 and 21°C and 29 and 40°C (Islam et al. 2007). The general area is undulating sandy and gravel plains with shallow stony, often saline, soils with a low organic content and low levels of nitrogen, phosphorous, and potassium (Child and Grainger 1990) and dominated by *Acacia tortilis* trees and *Salsola spinescens* shrubs (Combreau and Rambaud 1994).

2. The **Uruq Bani M'arid Protected Area** is located ca. 750 km SW of Riyadh and 250 km N of Najran bordered on its west by the southernmost extension of the Tuwaiq Escarpment, a remnant Jurassic limestone massif, and to the east by the extensive sands (mainly longitudinal dunes) of the notorious Rub' al-Khali (Empty Quarter), the largest sand sea in the world. The overall size is 12,500 km² (core area 5000 km²) and the entire area is sparsely vegetated (19.13°N, 45.13°E, between 720–940 m above sea level) (Child and Grainger 1990). Trees, mainly *A. tortilis* and *A. ehrenbergiana*, occur in the interdune troughs (*shiqqat* in Arabic) and extend for only a short distance from the escarpment. Dune soils are windblown, sandy and loose with the desert pavement areas (interdune troughs) having high exchangeable sodium content and often saline (Child and Grainger 1990). The rainfall is highly variable and low with a mean of less than 47 mm annually, consequently with the lowest plant growth after the Empty Quarter within Saudi Arabia (Dunham 1997).

3. The **King Khalid Wildlife Research Centre (Thumamah)** is located approximately 70 km N of Riyadh in central eastern Saudi Arabia. The limestone Tuwaiq Escarpment borders the area towards the east with sandy-gravel plains and a belt of sand dunes towards the west (25.217°N, 46.617°E, at 600 m above sea level) (Child and Grainger 1990). Plateau soils (of which the gravel plains are part) are shallow and stony, often saline and with a low organic content

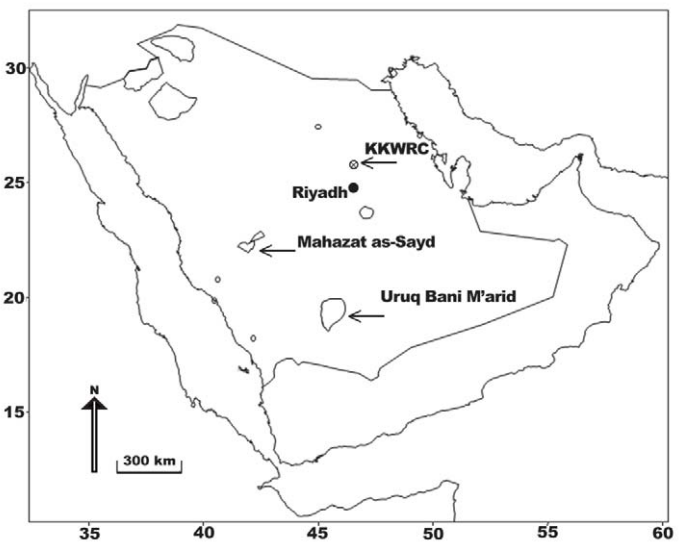


FIG. 1. Map of the Kingdom of Saudi Arabia, indicating the protected areas where the surveys were conducted.

TABLE 1. Checklist of reptiles expected, confirmed or presence unclear in three protected areas in the Kingdom of Saudi Arabia. [1]Identified as *Trapelus mutabilus* by Tilbury (1988) from the Riyadh area; [2]According to Arnold (1986a) this species only occurs in north-western Saudi Arabia although Tilbury (1988) recorded it from the Riyadh area; [3]Found in the Dhana area, east of Riyadh (Leviton et al. 1992; Tilbury 1988); [4]Known only from the Al-Kharj area south of Riyadh (Leviton et al. 1992). Reptiles expected from the above mentioned protected areas (general areas) were determined using references to distribution (site localities) and distribution maps by [a]Arnold (1986a), [b]Gasperetti (1988), [c]Tilbury (1988), [d]Leviton et al. (1992), [e]Disi et al. (2001) and [f]Egan (2007). Confirmed sightings using species characteristics include my own observations as well as the provisional checklist by [g]Gaucher & Asmodé (1991) (for Mahazat as-Sayd) and personal records from M. Grobler, E. R. Robinson, M. Sher Shah, H. Tatwani (pers comm.).

Species	Mahazat as-Sayd		Uruq Bani M'arid		Thumamah	
	Presence	References	Presence	References	Presence	References
Trogonophidae						
Diplometopon zarudnyi					Expected	c
Agamidae						
Phrynocephallus arabicus	Expected	a,d,e	Confirmed	a,d,e	Expected	a,d,e
Phrynocephallus maculatus					Expected	a,f
Pseudotrapelus sinaitus werneri	Confirmed	a,d,e,g	Unclear	a,d,e	Expected	a,c,d,e
Trapelus pallidus agnetae[1]	Confirmed				Expected	c
Trapelus flavimaculatus	Confirmed	a,d	Expected	a,d	Expected	a,c,d
Trapelus persicus fieldi	Unclear	d,e			Confirmed	c,d,e
Uromastyx aegyptia	Confirmed	a,d,e,g	Confirmed	a,d,e	Confirmed	a,c,d,e
Gekkonidae						
Bunopus spatalurus	Unclear	d			Unclear	d
Bunopus tuberculatus	Confirmed	a,d,e,g			Confirmed	a,c,d,e
Cyrtopodion scabrum	Expected	a,d,e	Expected	a,d,e	Confirmed	a,c,d,e
Hemidactylus turcicus	Expected	a,d	Expected	a,d	Confirmed	a,c,d
Hemidactylus persicus					Expected	c
Pristurus rupestris					Expected	c
Pristurus gasperetti gasperetti	Unclear	d	Confirmed			
Ptyodactylus hasselquistii ssp.	Confirmed	a,d,e,g	Confirmed	a,d,e	Confirmed	a,c,d,e
Stenodactylus arabicus	Unclear	a,d	Expected	a,d	Expected	a,c,d
Stenodactylus doriae	Expected	a,d,e	Expected	a,d,e	Expected	a,c,d,e
Stenodactylus slevini	Confirmed	d,e,g			Confirmed	c,d,e
Tropiocolotus steudneri[2]					Expected	c
Lacertidae						
Acanthodactylus boskianus	Confirmed	a,d,e,g	Expected	a,d,e	Confirmed	a,c,d,e,
Acanthodactylus gongrorynchaetes[3]					Unclear	a,c,d
Acanthodactylus opheodurus	Expected	a,d,e	Expected	a,d,e	Expected	a,c,d,e
Acanthodactylus schmidti	Confirmed	a,d,e,g	Expected	a,d,e	Confirmed	a,c,d,e
Acanthodactylus tilburyi					Expected	a,c,d,e
Mesalina brevirostris	Confirmed	e,g			Expected	c,e
Mesalina guttulata	Unclear	a,e			Expected	a,c,e
Scincidae						
Chalcides levitoni[4]					Unclear	d
Chalcides ocellatus	Unclear	e			Expected	c,e
Eumeces schneideri princeps					Expected	a,c,d,e
Trachylepis septemtaeniata (*Mabuya aurata*)					Confirmed	c
Mabuya brevicollis	Expected	a,d			Expected	a,c,d
Scincus scincus mitranus	Confirmed	a,d,e	Confirmed	a,d,e	Expected	a,c,d,e
Scincus scincus conirostris			Expected	a,d	Unclear	a,d
Varanidae						
Varanus griseus griseus	Confirmed	a,d,f	Expected	a,d,f	Confirmed	a,c,d,f
Typhlopidae						
Ramphotyphlops braminus					Expected	b,d,f
Leptotyphlopidae						
Leptotyphlops macrorhynchus macrorhynchus					Expected	b,f
Boidae						
Eryx jayakari	Expected	a,b,f	Confirmed	a,b,f	Confirmed	a,b,c,f

TABLE 1. Continued.

Species	Mahazat as-Sayd		Uruq Bani M'arid		Thumamah	
	Presence	References	Presence	References	Presence	References
Colubridae						
Eirenis coronella fennelli	Unclear	e				
Platyceps elegantissimus	Expected	b,d,e,f			Confirmed	b,d,e,f
Platyceps saharicus	Expected	b,d,e,f	Unclear	b,d,e,f	Expected	b,c,d,e,f
Lytorhynchus diadema	Unclear	b,d,e,f			Expected	b,d,e,f,
Malpolon moilensis	Confirmed	b,d,e,f,g			Confirmed	b,c,d,e,f
Malpolon monspessulana insignita	Unclear	d			Confirmed	d
Psammophis schokari	Confirmed	b,d,e,f,g	Unclear	b,d,e,f	Confirmed	b,c,d,e,f
Sparelosophis diadema cliffordi	Expected	b,d,e,f			Confirmed	b,c,d,e,f
Telescopus dhara	Expected	b,d,e,f			Unclear	b,d,e,f
Atractaspididae						
Atractaspis microlepidota engaddensis	Expected	d,e,f				
Elapidae						
Naja haje arabica	Expected	f				
Walterinnesia aegyptia					Confirmed	b,c,d,e
Viperidae						
Cerastes gasperettii	Confirmed	b,d,e,f,g	Expected	b,d,e,f	Confirmed	b,c,d,e,f
Echis coloratus coloratus	Expected	b,d,e,f	Expected	b,d,e,f	Confirmed	b,c,d,e,f

and low levels of nitrogen, phosphorous and potassium (Child and Grainger 1990). The vegetation is dominated by shrubs such as *Ranterium eppaposum* and *Haloloxylon salicornicum* and the grasses *Panicum turgidium* and *Stipagrostis plumosa*. The overall size is 350 km² (fenced) with the KKWRC fenced enclosure within this being approximately 20 km². The rainfall is highly variable and a long-term average of 117 mm per annum has been recorded since 1989/1990 (Robinson 2007).

Methods.—Sampling was done primarily on an *ad hoc* basis while conducting fieldwork on the ecology of the Arabian Sand Gazelle (*Gazella subgutturosa marica*) in the various protected areas, and was not quantitative, thus no attempt at estimating the abundance of species. Consequently, the sampling intensity (i.e., amount of time spent in each protected area including time spent searching for reptiles) varied between protected areas. Sampling was conducted from January to November 2008, with most of the recordings occurring during the warmer months from March to September. Nocturnal observations were made using vehicle headlights while travelling slowly on tracks throughout the areas or on foot using a gas lantern. Individuals were photographed *in situ* or captured by using an extendable fishing rod and noose and photographed for confirmation and identified to species level using a variety of literature available or consulting regional experts listed in acknowledgments. Additional notes were made of the habitats in which each species was observed, and habits of some species were gathered to increase the knowledge regarding the ecology of reptiles within the protected areas. After confirmation of identification, all reptiles captured were released at the point of capture.

Results.—According to the available literature, a total of 52 species were expected to occur in the three protected areas although differences in distribution were expected between these areas due to different habitats. The highest reptile diversity was expected from the King Khalid Wildlife Research Centre, Thumamah area (40 species or 77% of the maximum total number of species expected from the 3 protected areas) followed by Mahazat as-Sayd (27 species or 52%) and Uruq Bani M'arid (18 species or 35%). Lizards dominated the expected reptile richness in the three protected areas (34 species or 65%) and included 7 agamas, 12 geckos, 7 lacertids, 7 skinks, and 1 varanid. Gekkonidae dominated the expected lizard richness (12 species or 35%). At least 17 species of snakes were expected in the three protected areas together (pooled) and included 1 Atractaspididae, 1 Boidae, 9 Colubridae, 2 Elapidae, 1 Leptotyphlopidae, 1 Typhlopidae, and 2 Viperidae. Colubridae dominated the expected snake richness (9 species or 53%) and 1 species of Amphisbaenia (*Diplometopon zarudnyi*) was expected.

The survey results confirmed 20, 15, and 6 species from the King Khalid Wildlife Research Centre, Mahazat as-Sayd, and the Uruq Bani M'arid protected areas, respectively. Furthermore (although not yet confirmed) at least another 23, 14, and 12 species are expected while the distribution for 9, 3, and 5 species is unclear in the King Khalid Wildlife Research Centre, Mahazat as-Sayd, and the Uruq Bani M'arid protected areas, respectively (Table 1).

Table 1 presents the reptiles that are expected to occur in the three protected areas as I concluded from Arnold (1986a), Gasperetti (1988), Leviton et al. (1992), Disi et al. (2001), Egan (2007), Tilbury (1988), and Gaucher and Asmodé (1991) and those confirmed by me or positively confirmed by co-researchers (e.g., personal records).

Discussion.—Much of the overall distribution of reptiles throughout the Arabian Peninsula is unknown. Data on even the basic ecology of many species is still lacking aggravating our limited understanding of ecosystem functioning. This preliminary, *ad hoc*, investigation into the biodiversity of reptiles in three protected areas highlights the lack of baseline information on the distribution for most species in Saudi Arabia. The presence of a number of reptiles in the protected areas is unclear but could be confirmed with increased collection and should be encouraged. The overall dry (drought) conditions throughout 2008 in all three protected areas certainly affected the reptile sightings and therefore no general comments are made on the abundance of species observed.

Species of notable conservation importance include *Uromastyx aegyptia* whose numbers have declined outside of protected areas due to illegal collecting for food or financial incentives (Sher Shah pers com). Very little is known about the distribution and status of endemics such as the skink, *Chalcides levitoni*, which is only known from one locality in the Al-Kharj area (Leviton et al. 1992)—i.e., a potential endemic to Saudi Arabia—ca. 50 km SE of Riyadh. Rapid development in the general area may negatively affect this species, but this would have to be investigated further. Although not recorded from the Thumamah area, the close proximity to Al-Kharj and lack of any contrary distribution data makes it a possibility. Another potential endemic is the gecko *Pristurus gasperetti gasperetti* now known only from two locations—Makkah area (Arnold 1986b) and Uruq Bani M'arid (this study). The generally unknown lacertid, *Acanthodactylus tilburyi*, has a disjunct distribution in Saudi Arabia with specimens known from the Riyadh area (Tilbury 1988) and Al Jawf in northwestern Saudi Arabia (Leviton et al. 1992). Such understudied species are important as development may decimate their populations before the basic ecology of these species can be elucidated. All snakes, due to a variety of reasons ranging from the obvious to the superstitious, are of concern as they are usually killed on sight. Except for two turtle species (Green and Hawksbill) listed under the IUCN's Red List of Threatened Species, no other reptile's conservation status is listed for Saudi Arabia (IUCN 2007).

Species newly identified for the respective protective areas—i.e., distribution not previously documented from the areas—include *Pristurus gasperetti gasperetti* from Uruq Bani M'arid (Cunningham 2008a), *Trapelus pallidus agnetae* from Mahazat as-Sayd (Cunningham 2008b), and *Trachylepis septemtaeniata* (formerly *Mabuya aurata*) from the Thumamah area (Cunningham 2008c). These sightings and confirmation of the species are viewed as range extensions for the Arabian Peninsula.

Although this publication reports on sporadic observation of reptiles from three protected areas only, it is expected to increase the knowledge of reptile distribution in these areas in Saudi Arabia and it is hoped that it would stimulate further research into this relatively understudied region. Such knowledge can be used to strengthen the importance of protected areas—i.e., indicating the importance of protected areas for overall biodiversity protection—as well as facilitate the holistic management of such areas in Saudi Arabia.

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A Proposed Weight-Length Relationship for the Common Mudpuppy

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The Common Mudpuppy, *Necturus maculosus maculosus*, is a large (20–30 cm) paedomorphic salamander that is aquatic in all life stages (Conant and Collins 1998). The mudpuppy is found in lakes and streams throughout eastern North America, ranging from the Great Lakes region to eastern Oklahoma and the northern borders of Mississippi, Alabama, and Georgia (Bartlett and Bartlett 2006).

Amphibians play a critical role in food webs, transferring energy from the lowest trophic levels to the higher organisms, and from aquatic to terrestrial systems through predation (Wilbur 1997). The Common Mudpuppy is essentially nocturnal, preying mainly upon fish, fish eggs, crayfish, aquatic insects, snails, and mussels, and residing beneath structures such as logs, rocks, and weeds during the day to avoid predators (Bishop 1941; Petranka 1998). Mudpuppies are reportedly consumed by large fish, Northern Watersnakes (*Nerodia sipedon*), Snapping Turtles (*Chelydra serpentina*), aquatic birds including Double-crested Cormorants (*Phalacrocorax auritus*; Coleman 2009), and possibly River Otters (*Lutra canadensis*) and Mink (*Mustela vison*; Gibbs et al. 2007). In systems where the mudpuppy acts as predator or prey, information regarding its life history and physiology contributes to the understanding of the system's ecological processes.

Bioenergetics models have been used to address a variety of ecological and management questions (Hansen et al. 1993; Kitchell 1983). Model applications vary, but typically require physiologically-based bioenergetics equations with empirically derived parameters (Hansen et al. 1993). For models that estimate predator growth or consumption, predator size and diet are essential parameters. Diet is usually described by examination of stomach contents that identify, to the lowest taxon possible, individual prey items and ideally provides information on prey size (typically length or age). Examination of stomach contents rarely provides direct measures of prey consumption by weight due to weight reduction attributable to digestion. Model consumption and growth estimates are based on weight, so prey length or age is converted to weight using species-specific regressions.

The objective of this note is to propose a weight-length relationship for the Common Mudpuppy. Mudpuppy weight-length information is currently lacking in the literature, so data relating mudpuppy weight to length should improve estimates from models in which the mudpuppy acts as predator or prey.

Methods.—Weight-length data were recorded from mudpuppies collected from two lakes in New York State. Oneida Lake is located in central New York and is the state's largest inland lake. The lake is 20,700 ha, shallow (mean depth = 6.8 m, max depth = 16.8 m), and polymictic (Mills et al. 1978). Oneida Lake is currently considered a mesotrophic lake (Mayer et al. 2002) and is characterized as a warmwater fishery (VanDeValk and Rudstam 2001). Trout Lake, located 135 km north of Oneida Lake in St. Lawrence County, New York, is a 150-ha lake with a mean depth of 7.4 m and a maximum depth of 33.5 m (Swart and Guetti 1987). The lake provides both coldwater and warmwater fisheries and has a "sustaining of trout" classification (Swart and Guetti 1987).

Mudpuppies were collected from Oneida Lake using trapnets in April 2001 and electrofishing in October and November 2002, and from Trout Lake by electrofishing in October 2001. Mudpuppies were caught incidentally in trapnets set to collect spawning Walleyes (*Sander vitreus*) in Oneida Lake. The net design consisted of a 1.8 × 1.8 × 1.8 m crib, outside and inside wings with a combined length of 12.8 m, and a first heart with turnaround that led into a second heart with turnaround that funneled into a third heart in the crib (Kingsbury 1964). The net utilized a 45.4-m lead, and all sections were constructed of 25.4 mm-bar-mesh multifilament netting. Shoreline boat electrofishing surveys were conducted primarily to collect Walleye samples, with mudpuppies as a secondary target. Electrofishing was conducted at night using DC to produce a current of 8 A (354 V, 60 pulses/s).

Mudpuppies were anesthetized using MS-222, and total length (mm) and weight (g) recorded. After data were recorded, mudpuppies from Oneida Lake were placed in a tank with fresh lake water until they recovered, and then released. Mudpuppies from Trout Lake were euthanized and preserved after data collection. Voucher specimens are housed at the Cornell Biological Field Station, Bridgeport, New York.

Weight-length relationships were determined for all data combined and for lake- and season-specific data sets using regression analysis of the $\log_{10}$-transformed data. Linear regression of body mass versus body length is one of the most common methods of describing body condition and has been used in many vertebrate taxa (Schulte-Hostedde et al. 2005). Lake- and season-specific regressions were compared using homogeneity of slopes (Sokal and Rohlf 1969).

Results and Discussion.—Fifty-three mudpuppies were measured and weighed; 30 mudpuppies were sampled from Oneida Lake ranging in length from 215 to 356 mm and 23 mudpuppies were sampled from Trout Lake ranging in length from 133 to 279 mm. The equation describing the pooled weight-length relationship is:

$$\text{Log}_{10}(W) = \text{Log}_{10}(TL) * 3.47 - 6.43 \quad (1)$$
$$r^2 = 0.94,\ df = 52,\ p < 0.001$$

where W represents mudpuppy weight and TL represents mudpuppy total length (Fig. 1A). Sample sizes of 30 and 23 are small for describing weight-length relationships. For fish that have body forms similar to that of the Common Mudpuppy, the rule of thumb for minimum sample size for studies investigating the relationship between weight and length is 100 (Quist et al. 2009). However, adequate sample size is related to variance associated with the sample.

Because 94% of the variation in weight of the pooled mudpuppy sample was explained by length, we believe Equation 1 provides a reasonable description of the relationship between mudpuppy weight and length for the range of lengths sampled.

Equation 1 likely describes the weight-length relationship of adult mudpuppies. Bishop (1926) provided lengths-at-age of 185 mudpuppies collected from French Creek, Crawford County, Pennsylvania. None of the specimens sampled attained 130 mm until age 4, and mudpuppies at age 5 ranged from 169–210 mm. Sexual maturity is reached when individuals exceed 200 mm (Bishop 1926). All but three of the mudpuppies sampled in this study were larger than 210 mm and, therefore, were likely adults.

Species weight-length relationships can vary among seasons within a system. The equations describing the spring and the fall weight-length relationships for mudpuppies in Oneida Lake are:

$$\text{Spring: } \text{Log}_{10}(W) = \text{Log}_{10}(TL) * 2.06 - 2.92 \qquad (2)$$
$$r^2 = 0.54,\ df = 19,\ p < 0.001$$

$$\text{Fall: } \text{Log}_{10}(W) = \text{Log}_{10}(TL) * 2.85 - 4.88 \qquad (3)$$
$$r^2 = 0.94,\ df = 9,\ p < 0.001$$

For Oneida Lake, a weight-length regression comparison of spring and fall mudpuppies indicated mudpuppies caught in the spring were heavier than mudpuppies caught in the fall (homogeneity of slopes: df = 26, t = 2.55, $t_{0.05(2),\ 25} = 2.06$), and the difference in weight at a given length decreased with increasing length (Fig. 1B). A possible explanation for this difference may be attributed to differences in method of collection. Spring mudpuppies were collected from trapnets constructed of 25.4 mm-bar-mesh multifilament netting. It is possible that for smaller mudpuppies, this mesh size was not capable of retaining individuals that were leaner (weighed less) but was capable of retaining larger individuals regardless of their condition. This would result in a spring weight-length regression that would overestimate the calculated weight of smaller mudpuppies. Annual reproductive cycles may offer another possible explanation for the seasonal variability we observed. Although mating generally occurs in the fall, females store sperm and do not oviposit until May or early June (Bishop 1941; Gibbs et al. 2007). Thus, the presence of gravid females in April samples may have resulted in higher weights at a given length than if eggs were already deposited (Welsh et al. 2008). Harris (2008) found female weights at a given length varied within a population of Four-toed Salamanders (*Hemidactylium scutatum*) and attributed this variation to nesting behavior.

An alternative explanation for the differences in spring and fall weights at a given length is the effect of outliers. Visual inspection of the data suggested the smallest mudpuppy in the spring data set was heavier than would be expected. Elimination of this data point from the spring data set increased the slope of the spring regression to 2.68 and increased the r-square to 0.61. Further analysis testing the homogeneity of slopes indicated the spring and fall relationships were not statistically different for Oneida Lake mudpuppies once the outlier was removed (df = 25, t = 0.55, $t_{0.05(2),\ 25} = 2.06$). The resulting weight-length relationship of the pooled Oneida Lake data is:

$$\text{Log}_{10}(W) = \text{Log}_{10}(TL) * 2.82 - 4.78 \qquad (4)$$
$$r^2 = 0.84,\ df = 28,\ p < 0.001$$

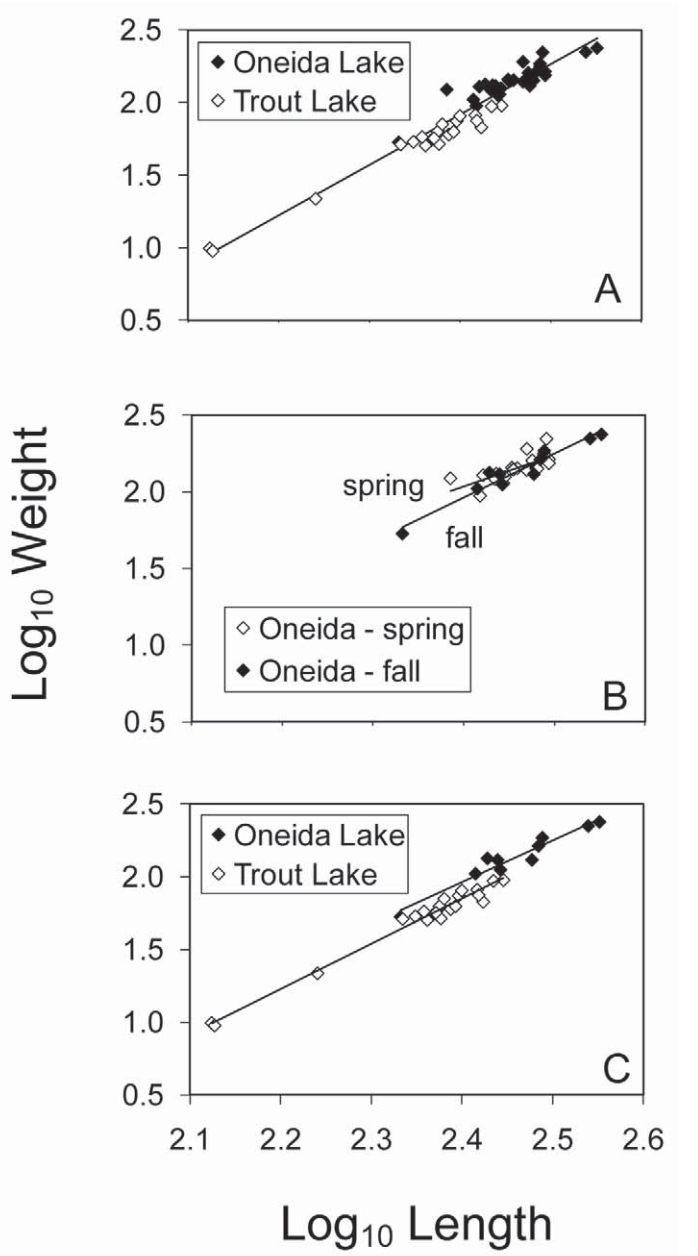


FIG. 1. Weight versus length data ($\log_{10}$ transformed) for the Common Mudpuppy (*Necturus maculosus maculosus*) from A) Oneida and Trout lakes, pooled; B) spring and fall from Oneida Lake; and C) Oneida and Trout lakes, fall only.

Empirical data are inherently variable and removal of individual data from data sets needs to be justified. While we cannot identify any reasons, other than nonconformity (possibly due to recording error), to eliminate the smallest mudpuppy from the spring data set, Equation 4 likely provides the most appropriate description of the weight-length relationship for the Common Mudpuppy in Oneida Lake.

Slopes from the weight-length relationships for mudpuppies from Oneida Lake were less than 3.0, suggesting a compressed body form. Mudpuppies sampled from Oneida Lake were observed to have a somewhat flattened body form that was most obvious for larger individuals. This observation is consistent with other published descriptions. Bishop (1941) described mudpuppy body

form as "The body is stout, depressed, and with a distinct median dorsal groove." Gibbs et al. (2007) describes mudpuppies as having "flat heads" and a "laterally compressed tail."

Species weight-length relationships can vary among systems. The equation describing the Trout Lake weight-length relationship for mudpuppies caught in the fall is:

$$\text{Log}_{10}(W) = \text{Log}_{10}(TL) * 3.10 - 5.60 \quad (5)$$
$$r^2 = 0.98,\ df = 22,\ p < 0.001$$

Lake-specific regression comparison indicated mudpuppies caught in the fall from Trout Lake and Oneida Lake increased in weight with length at a similar rate ($df = 29$, $t = 0.73$, $t_{0.05(2),\ 29} = 2.05$), but that mudpuppies from Oneida Lake were heavier at any given length within the observed length range (Fig. 1C). An explanation for this difference in weight at a given length may be related to differences in lake water temperatures. Salamander growth during the larval (aquatic) stage has been related to temperature, with higher temperatures resulting in increased growth rates (Keen et al. 1984). Similar effects of temperature have been shown for fish (Fry 1971). While no temperature data are available for Trout Lake, the existence of a sustaining coldwater fishery is indicative of a cooler environment than Oneida Lake which supports a warmwater fishery. Regardless, differences in size ranges of mudpuppies captured in Oneida Lake and in Trout Lake limit the conclusiveness of regression comparisons between the two systems.

This study presents the only Common Mudpuppy weight-length information that we are aware of. Because this study provides evidence of differences in weight at a given length between systems, system-specific relationships are desirable for investigative studies. However, in the absence of system-specific relationships, we believe the relationships presented in this paper can be useful for investigations that require information on mudpuppy weight and length. Lake-specific regressions presented in this paper can be used to represent weight-length relationships for mudpuppy populations in lakes with similar characteristics, and the pooled relationship (Equation 1) can serve as a representation for populations in other water bodies. Clearly, collection of mudpuppy weight and length data from other systems will enhance our understanding of this important relationship.

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Sex Differences in the Genitalia of Hatchling *Caiman latirostris*

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Newly hatched crocodilians have a structure called a "cliteropenis" (CTP), which generally is similar in morphology between sexes (Raynaud and Pieau 1985). Neonates of *Caiman crocodilus* and several species of *Crocodylus* display discernable differences between the penis and clitoris (Hutton 1987; Lang et al. 1989; Lang and Andrews 1994; Ziegler and Olbort 2007). The cliteropenis has an asymmetrical structure with a rounded sector (head), supported from the base by an elongated structure (neck). The head has a cleft on the top, in which the tip rests when in a relaxed position, but from which it protrudes when it is erect (Kelly 2002).

The development of the sexual phenotype in crocodilians is also interesting because in all species studied the temperature at which the eggs are incubated determines the sex (Lang and Andrews 1994). Indeed, many reptiles exhibit this temperature-dependent sex determination (TSD). The TSD pattern varies among species and percentage of sexes in nest can be 100% male or 100% female according to the incubation temperature (Janzen and Paukstis 1991), making it difficult to ascertain the sex of individuals without knowing the thermal conditions they experienced during embryonic development.

The Broad-snouted Caiman (*Caiman latirostris*) is the southernmost South American crocodilian, reaching to 32.53°S in its geographic distribution (Melo 2002). This species exhibits the FMF (female – male – female) pattern of TSD (Elf 2003), where females are obtained at 30ºC and 34.5ºC and males at 33ºC (Piña et al. 2003). As in other crocodilians, sexing hatchling *C. latirostris* by cloacal examination is currently possible only when they are larger than 60 cm snout–vent length (SVL) (AL, pers. obs.). However, depending on incubation temperature, genital differentiation in hatchlings varies among species (Allsteadt and Lang 1995; Guillette et al. 1999). Previous studies have even shown differences in size and shape of the CTP in hatchling *Alligator mississippiensis* (Ziegler and Olbort 2007).

The aim of this study was to measure the genitalia of male and female *C. latirostris* at hatching to identify a method of sexing hatchlings by cloacal inspection using digital images. There is no background research on this issue for *C. latirostris*, which currently requires the sacrifice of hatchlings to ascertain sex. However, the species is a valuable natural resource in Argentina (Larriera 1998) and Brazil (Verdade 2001), where conservation and management programs have stimulated research on many aspects of its biology. We hypothesized that the CTP of hatchlings differs between males and females of *C. latirostris*. In particular, we expected to find sex-related differences in the morphometry of the CTP.

Materials and Methods.—Wild *Caiman latirostris* eggs were collected from the San Cristóbal region (30.197406°S, 61.008717°W), Santa Fe, Argentina, during the 2006 nesting season (December–January) (Larriera and Imhof 2006). Seventy-eight eggs (one week old) from three clutches (the clutches were split evenly between two temperatures) were artificially incubated at constant temperatures of 30°C or 33°C (Larriera et al. 2008) to ensure the availability of females and males, respectively (Piña et al. 2003).

At hatching, each neonate was weighed (OHAUS, CS 200, ± 0.1 g) and snout–vent length (SVL; Vernier caliper ± 0.02 mm) from the tip of snout to posterior edge of the cloaca was measured. Twenty hatchlings (10 males, 10 females) were randomly selected for examination of genital morphology. The neonates were sacrificed for removal of the CTP and examination of the gonads. Gonadal sex was identified by the shape, texture, and color of the gonads and by the presence or absence of oviducts (Guillette et al. 1995).

CTPs were removed using a scalpel and preserved in 4% formalin for two hours. Following preservation, the right and upper sides of CTPs were photographed through a stereoscopic binocular microscope (ARCANO®; 20x). A scale alongside each CTP (+ 0.001 mm) (Fig. 1) allowed calibration of the software used for measurements of digital images (Image Pro Plus Version 4.5.0.20; 1993–2001 Media Cybernetics, Inc.). The software needs to set a calibration unit for the active picture, in this case our unit was 1 mm (obtained from the digital caliper alongside the CTP).

Three dimensions were measured from digital images of preserved CTP tissue: 1) Head Width (HW), measured from the

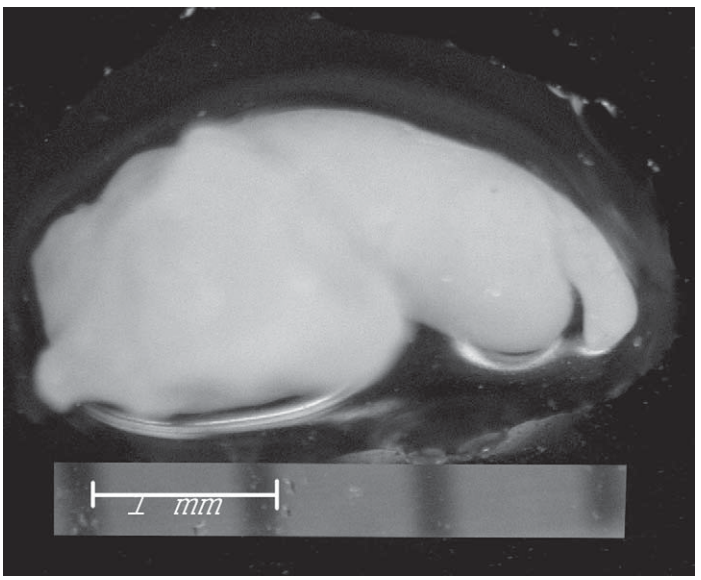


FIG. 1. Preserved CTP of hatchling *Caiman latirostris* removed from the cloaca. The scale below is from the digital caliper positioned in every picture to ensure real scale on the image in the moment of digital treatments. Scale: 1 mm

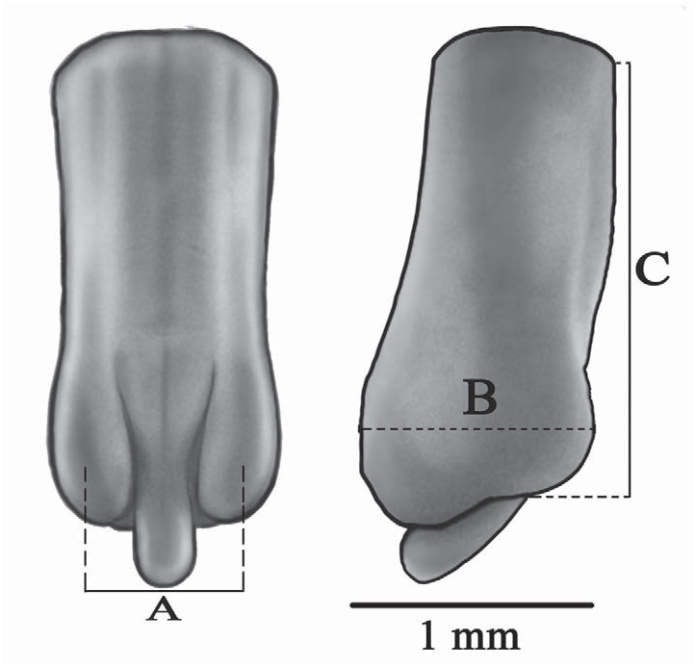


FIG. 2. Dimensions of hatchling cliteropenis *Caiman latirostris* (Left) **A** = Head Width (mm). (Right) **B** = Lateral Width (mm) and **C** = Total length (mm) of the CTP measured as the shortest distance from the base to the beginning of the tip.

upper surface (Fig. 2A); 2) Lateral Width (LW), measured as the maximum vertical width at the midsection of the head (Fig. 2B); and 3) Total Length (TL), measured from the base to the tip where it begins to separate from the head region (Fig. 2C). Also CTP volume was calculated by assuming a cylindrical structure with an ellipsoid base ($V = \pi$ [LW/2] [HW/2]TL), which slightly underestimates real volume.

InfoStat/Profesional version 1.1 was used for all statistical procedures (F.C.A 1999). All data were checked for normality and homogeneity of variances (Shapiro-Wilks and Levene test). Differences in CTP dimensions between the sexes were evaluated with t-tests (Zar 1999). A discriminant analysis with cross-validation for the variables for both sexes was subsequently run on the data set. Scatter plots were then made to create a key for future assessments of hatchling sex.

Results.—Internal sex identification: female gonads were elliptical and elongate in shape, and light beige in color with a granular texture; Müllerian ducts were clearly visible on the side of each ovary (Fig. 3). Male gonads had a similar shape, except the left testis was more elongate than the right testis (a characteristic of the sex), the color was a dark yellow, and the texture was less granular than ovaries of females; the vasa deferentia were present (Fig. 4). All females (N = 9; one of the samples was damaged in the process and we removed it from the analyses) were produced from constant incubation at 30°C and all males (N = 10) from constant 33°C incubation, consistent with the pattern of TSD in this species (Piña et al. 2003).

Cliteropenis of hatchlings: There was no significant difference in TL of the CTP between males and females ($P = 0.065$), but the CTP of males was significantly wider (t-test: LW, $P < 0.01$; HW, $P < 0.01$), and as a consequence volume was also significantly greater in males than in females ($P < 0.01$) (Table 1).

TABLE 1. Average values of variables for both sexes ± SD. (*) Significant average values ($\alpha = 0.05$) (t-test).

CTP variables	FEMALES (N = 9)	MALES (N = 10)
Lateral Width (LW*)	(1.08 ± 0.10) mm	(1.34 ± 0.07) mm
Head Width (HW*)	(0.57 ± 0.11) mm	(0.74 ± 0.13) mm
Total Length (TL)	(2.19 ± 0.48) mm	(2.73 ± 0.76) mm
Volume (*)	(1.09 ± 0.31) mm^3	(2.12 ± 0.17) mm^3

Discriminant analysis showed the presence of separate groups of males and females and the cross-validation analysis showed evidence of a strong model considering the sample size and the CTP variables (proportion hatchlings correct in classification with cross validation is 0.895 versus initial classification of 0.947). Cross-validation reduces the number of measurements, thereby reducing handling time and stress to the animals and compensates for an optimistic apparent error rate in classifications, defined as the percentage of misclassified observations (MINITAB, 2000)

A homogeneity of covariance matrix test suggested that this analysis is suitable for these data ($N = 19$; $df = 21$; $P < 0.05$), with HW the most significant variable in the group discrimination ($F = 9.03$; $df = 17$; $P < 0.01$). In cross classification results, all males

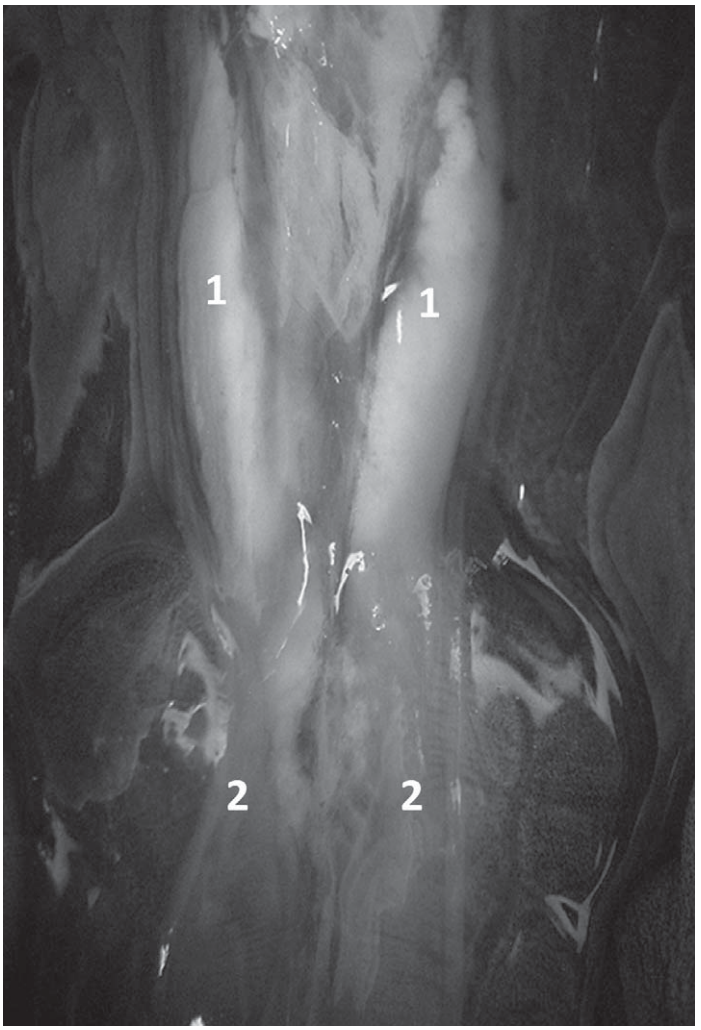


FIG. 3. Gonads of female hatchling *Caiman latirostris*. (1) ovaries, (2) Müllerian ducts.

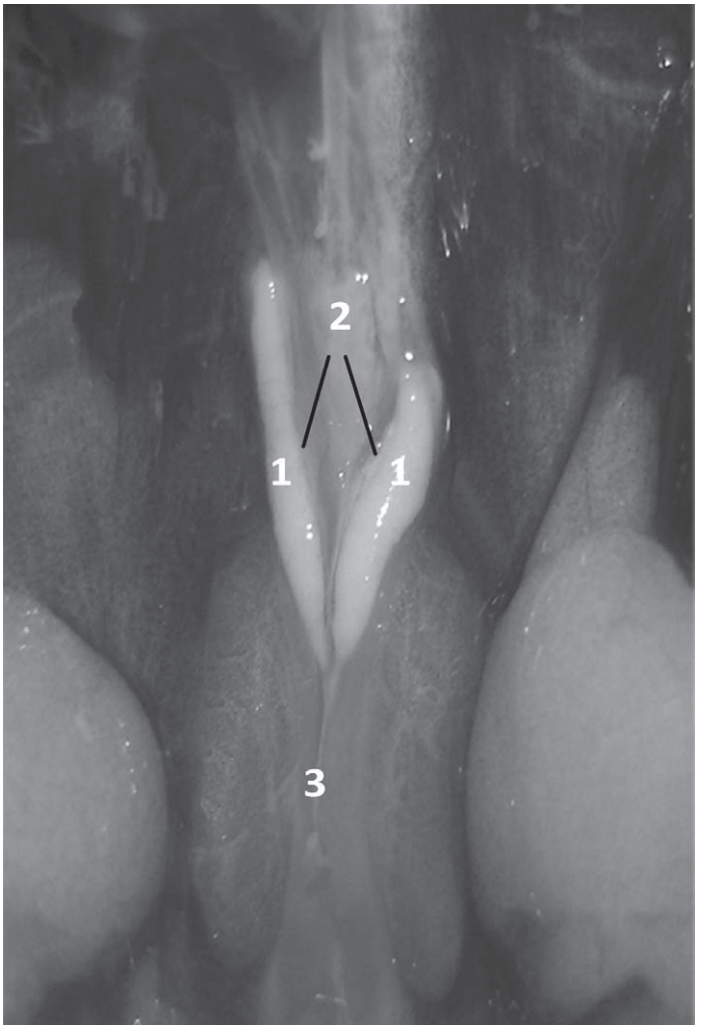


FIG. 4. Gonads of male hatchling *Caiman latirostris*. (1) testicles, (2) adrenal glands, and (3) vasa deferentia.

were classified correctly and only one female of nine was misclassified. Scatter plots of LW and HW of the CTP of hatchling *C. latirostris* revealed two groups: males formed a cluster above and to the right of the female cluster (Fig. 5).

Scatter plots of LW vs. SVL and HW vs. SVL were made to examine the distribution of these two variables in the group of hatchlings tested (Fig. 6). These results are consistent with those obtained in the discriminant analysis. We selected width limits to create a preliminary "key for sex differentiation" to classify hatchlings as males or females based on CTP measures. Of 19 samples, we sexed nine correctly as males and seven as females in the first step of the process. One more sample was classified as a male in the second step but two remained indeterminate (no. 7 and no. 9) using the key. These latter two samples were identified as females upon subsequent inspection of the gonads. Using the size limits on the graphics, we determined sex for 85% of the samples correctly, which is similar to the error rate in the discriminant analysis (i.e., 11%).

Discussion.—Previous studies found that reptiles such as *C. latirostris* exhibit TSD (Crews et al. 1994; Lance 1997; Lang and Andrews 1994; Pieau 1999). We corroborate this finding by obtaining 100% males at 33°C and 100% females at 30°C (Piña et al. 2003) as assessed by gonadal inspection (Ferguson and Joanen

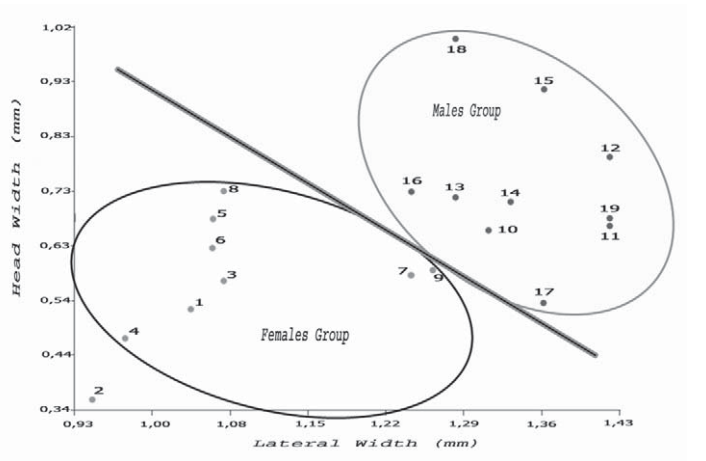


FIG. 5. Scatter plot showing the relationship between Lateral Width (mm) and Head Width (mm) of females (numbered 1–9) and males (numbered 11–19).

1983; Guillette et al. 1995).

Male CTP width and volume dimensions were significantly larger than those for females, which was somewhat surprising because the genital morphology in young crocodiles is similar. Still, prior studies found that incubation temperature affected both genital dimensions and gonadal sex determination in other crocodilians. Hatchling CTPs in *A. mississippiensis* differed in volume between the sexes and increased with increasing temperature of incubation from 30°C to 33°C (Allsteadt and Lang 1995). The CTP in hatchling *C. porosus* differed in HW and LW (Webb et al. 1984) and in size and shape in *C. niloticus* between males and

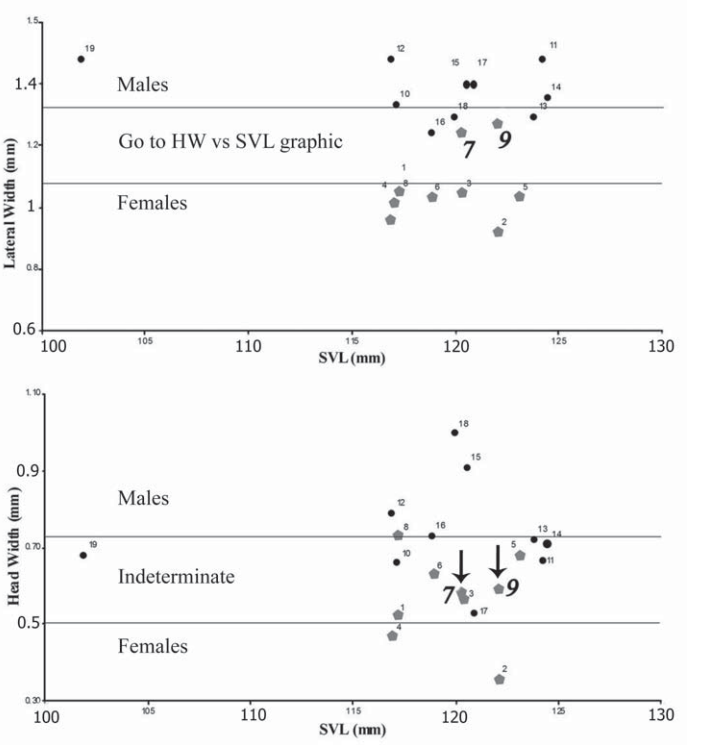


FIG. 6. Scatter plots of LW (mm) vs. SVL (mm) (*upper*) and HW (mm) vs. SVL (mm) (*lower*) values for males (black circles) and females (grey pentagons) groups. Arrows indicate hatchlings designated indeterminate by this method, but sex as females by gonadal inspection.

females (Hutton 1987).

To date the discrimination of newly hatched caiman into males and females has not been possible by observing the external genitalia. We show that such separation can be achieved from simple measures that can be recorded on the cliteropenis. The photographic measurement technique detailed herein was also tried on live hatchlings, which decreases stress on the hatchlings compared to measuring with digital calipers. This work continues in that this technique will be tried on live animals measured at hatching for which we will evaluate sex after one year of growth under controlled conditions of temperature, light, and diet.

To determine the sex in this and other species of crocodiles using a simple methodology opens the possibility of analyzing the sex ratio of offspring born in natural conditions, an unfinished agenda so far. This work is an important precedent for *C. latirostris* and similar species and lays the groundwork for a more advanced method of measurement that minimizes manipulation of individuals and measurement errors that can lead us to sex hatchlings incorrectly. Moreover, this new technique eliminates the current need to sacrifice young caimans to sex them for research work, ranching programs, and husbandry activities.

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TECHNIQUES

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Dual-Energy X-ray Absorptiometry (DXA) as a Non-Invasive Tool for the Prediction of Bone Density and Body Composition of Turtles

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Knowledge of animal body composition is important to studies of energetics, reproduction, and life history (Congdon et al. 1982; Secor and Nagy 2003), because it allows researchers to estimate body condition, parental energy investment, fitness, and productivity throughout an individual's life. Additionally, quantifying body composition is important for clinical studies of nutrition and metabolic disorders (Elowsson et al. 1998). The use of non-destructive techniques to determine body composition is essential for many studies including those involving mark-recapture and endangered species (Secor and Nagy 2003). With growing concern for the status of many species and the increased availability of technology for non-invasive procedures, destructive techniques will become increasingly unpopular.

A need for non-destructive techniques in chelonian research is becoming more apparent. Currently 80 chelonian species are listed as extinct, extinct in the wild, endangered, or critically endangered (IUCN 2007). As long-lived vertebrates with delayed sexual maturity, some turtle populations may be prone to anthropogenic harvest especially when adult survivorship is reduced (Congdon et al. 1993; Heppell et al. 1995). Therefore, the development of techniques that could reduce the permanent harvest of adult turtles for scientific purposes is important in helping reduce impacts to turtle populations. Potentially, dual-energy x-ray absorptiometry (DXA) could provide this service.

DXA was originally developed as a non-invasive tool that predicts bone density and risk of osteoporosis in humans. The physical principles of DXA technology have allowed expansion of its uses to the quantification of body composition in humans and other mammals. Recent applications to snakes and lizards have shown promise for the use of this technique in reptiles (Secor and Nagy 2003; Zotti et al. 2004). In turtles, DXA has been utilized to compare the effects of dietary treatments on bone density (Fledelius et al. 2005). To our knowledge, DXA has not been used to assess other measures of body composition, nor has the accuracy of DXA estimates been previously validated, in turtles. The morphology of chelonians may preclude accurate determination of body composition with DXA without prior validation. Prediction of body composition analysis, particularly lean tissue and fat mass, may be complicated in chelonians by the bony encasement of the internal organs. The estimation of lean tissue and fat mass is complicated when a large proportion of the scanning area contains bone (Jebb 1997). Moreover, turtles have a higher proportion of bone relative to body mass than most other animal species (Iverson 1984) which, along with their unique morphology, makes them of great interest for bone density research. The development of techniques to assess bone density in turtles is not only relevant to taxon-specific research, but could have broader applications in nutrition, ecology, and physiology, as well as practical applications in veterinary research and practice.

In the present study, we examined the precision and effectiveness of DXA in predicting bone density and body composition of turtles. Our aim was to develop predictive models that can be used to assess body composition from DXA measurements. These models would then be available for researchers to monitor body composition of turtles in settings where destructive techniques are not feasible (e.g. clinical practice, mark-recapture studies). We collected DXA estimates of body composition on 25 male *Trachemys scripta* and then compared these values to estimates determined later by chemical analysis of dried carcasses. Secondarily, this study compared the effects of three different techniques of immobilization (anesthesia, cooling, and euthanasia) on DXA body composition estimates because the accuracy of DXA results are known to be influenced by the movement of test subjects during scanning (Engelke et al. 1995).

Materials and Methods

Animal Housing & Use.—We obtained an in-house transfer of 25 male *Trachemys scripta* from a previous study conducted at Oklahoma State University (Ligon, Gregory, Kazmaier, and Lovern, unpubl. study). Subjects were originally wild-caught from two populations in Eastern Oklahoma and Southern Texas. *Trachemys scripta* were chosen for this study because of their accessibility, wide distribution, abundance, and well studied life-history. Subjects ranged in straight carapace length (SCL) from 123.9 to 222.8 mm (mean ± 1 SD = 159.3 ± 25.7 mm), in greatest width from 102.9 to 168.0 mm (127.4 ± 16.0 mm), and in mass from 260 to 1525 g (610 ± 281 g). Turtles were housed individually in plastic storage containers partially filled with water and were fasted for one week prior to DXA scanning to ensure evacuation of gut contents.

DXA Estimation of Body Composition.—To determine the effects of anesthesia, euthanasia, and cooling on DXA estimates, each individual was scanned using all three immobilization techniques. Scanning was performed on a Hologic® QDR-4500A fan-beam scanner equipped with a small-animal software program. Prior to scanning, the densitometer was quality-checked daily using Hologic® calibration models (anthropomorphic spine phantom and small-step phantom). Calibration procedures followed those provided by the manufacturer. Body mass was determined for all individuals prior to scanning. Each individual was scanned four times per day for three consecutive days. During scanning, indi-

viduals were positioned with the plastron inferior (dorsoventral projection). The cranial end of the individuals was facing towards, and 1 cm behind, the laser-alignment crosshair. The individual's midline was position directly in the middle of the scanning area. Each day, turtles were scanned twice without movement, repositioned, and then scanned twice more without movement. During the first two days of scanning, individuals were randomly placed in either the "anesthetized" or "cooled" condition. Anesthetized individuals received a 0.1 mg/kg medetomidine-5.0 mg/kg ketamine combination (administered IM) for immobilization during scanning followed by 0.5 mg/kg atipamezole (IM) for recovery (Greer et al. 2001). Cooled individuals were placed in a 4°C incubator for a minimum of 5 h prior to scanning and transported on ice. Individuals that were anesthetized on the first day were cooled on the second day and vice versa. On the third day of scanning, all turtles were euthanized with an overdose of sodium pentobarbital (60–100 mg/kg IP) and scanning was repeated as above. Following the three scanning days, individuals were frozen for subsequent chemical analysis of body composition.

Non-DXA Estimation of Body Composition.—We estimated the following indices of body composition for each turtle: bone mineral content (BMC), fat mass (FM), bone-free lean tissue mass (LTM), fat-free tissue mass (FFM = LTM + BMC or BM-FM), total body water mass (WM), and body mass (BM). To achieve this, individuals were thawed, dissected to remove fat bodies for easier analysis, and then dried to constant mass at 60°C. Body mass was measured after drying (BM_{dry}) to a constant mass and then used to estimate water mass (WM) by subtracting it from wet body mass (BM_{wet}) determined prior to scanning. Carcasses (fat bodies excluded) were then ground and homogenized in a Wiley mill to be used for the determination of fat, lean tissue, and bone content. Fat mass (FM) was estimated by adding the dried mass of fat bodies to total body lipid mass. Total body lipid mass was estimated by determining the average percent lipid content of two 2-g subsamples of the ground carcass, and then multiplying by BM_{dry}. The lipid content of carcass subsamples was determined by the Folch method (Folch et al. 1957). To estimate bone mass, four 1-g subsamples of the ground carcass were ashed in a muffle furnace at 600°C for a minimum of 8 h. The mean percent mineral content of the four samples was used to estimate total body bone mass by multiplying by dried BM. Lean tissue mass was determined by subtraction.

Statistics.—We regressed body mass and straight carapace length against each body composition parameter (determined chemically) using simple least-squares regression in an attempt to develop models that could be used to predict body composition from standard morphometrics. Regression was performed on $\log_{10}$ transformed data, but is presented in original scale by back-transforming regression coefficients. To examine the precision of DXA, intraindividual coefficients of variation (CV) were calculated from two scans without movement, from two scans with movement, and from all four scans for each type of body composition. To examine the effects of immobilization technique on DXA output parameters we performed repeated-measures ANOVA for each DXA parameter. Subject was analyzed as a blocking variable. When significant differences among treatment levels were detected, Tukey multiple-comparisons were used to examine where differences existed. Prior to analysis all variables were tested and deemed significantly non-normal (Anderson-Darling Test $P<0.001$). Therefore, we $\log_{10}$ transformed all masses prior to analysis. All results involving transformed data are presented in the untransformed scale using back-transformed means and asymmetric 95% confidence limits (Sokal and Rohlf 1987).

We selected anesthesia as the preferred method of immobilization and all further validation analyses were performed using DXA data of anesthetized turtles. Anesthesia was selected as the most desirable method of immobilization because it reduced difference between DXA and chemical estimates of body composition. Mean ± 1SD differences between DXA and chemical estimates for combined FM, LTM, and BMC, were 160.0 ± 94.3, 168.8 ± 101.6, and 185.4 ± 139.8 g for anesthesia, cooling, and euthanasia, respectively. Additionally, anesthesia generally resulted in more precise measurements compared to cooling (see results).

We performed simple and multiple least-squares regression analysis to develop models predicting chemical body composition (dependent variable) from DXA estimates (independent variable). We employed a best subsets regression procedure to select the variable(s) most useful in creating the predictive models. After generating predictive models we employed a jackknife cross-validation procedure as described by Secor and Nagy (2003). All values are given as mean ± 1 SD. The level of statistical significance was set at $P < 0.05$. Statistical analyses were performed on Minitab version 13.1.

Results

Water comprised 69.46 ± 3.25% of total body mass. Body composition of wet body mass was comprised of 84.82 ± 1.85% lean tissue, 13.83 ± 1.58% ash, and 1.35 ± 1.06% fat mass. Of dried body mass, 50.29 ± 2.95, 45.48 ± 4.78, and 4.23 ± 2.84 percent, was comprised of LTM, AM, and FM, respectively. The results of the least-squares regression between morphometrics and body composition estimates, determined chemically, are presented in Table 1. All models resulted in significant non-zero slopes ($P \leq 0.002$). All models had strong relationships between morphometric and body composition variables ($r^2 \geq 96.6\%$), with the exception

Table 1. Results of least-squares regressions of water mass (WM), fat-free tissue mass (FFM), lean tissue mass (LTM), fat mass (FM), and ash mass (AM), determined chemically, against body mass (BM) and straight carapace length (SCL) in male *Trachemys scripta* (N = 25). All mass units are in grams and length in millimeters.

Regression Coefficients	F	*P* Value	r^2
WM = 0.863(BM)0.965	2730.7	< 0.001	0.992
FFM = 0.993(BM)0.999	50475.2	< 0.001	1.000
LTM = 0.982(BM)0.977	16040.4	< 0.001	0.999
FM = 0.005(BM)1.125	13.0	0.001	0.361
AM = 0.063(BM)1.125	1038.1	< 0.001	0.978
WM = 2.662*10-4(SCL)2.799	652.89	< 0.001	0.966
FFM = 2.193*10-4(SCL)2.907	1168.33	< 0.001	0.981
LTM = 2.686*10-4(SCL)2.837	935.18	< 0.001	0.976
FM = 3.404*10-7(SCL)3.284	12.73	0.002	0.356
AM = 4.155*10-6(SCL)3.302	943.00	< 0.001	0.976

TABLE 2. Mean intra-individual coefficients of variation (%) of DXA scans for the three methods of immobilization and four tissue components in male *Trachemys scripta* (N = 25). Values for movement represent the coefficient of variation (CV) of two repeated measurements where the individual was moved between scans (scans 1 and 3). Still represents the CV of two repeated measurements where the subject was not moved between scans (Scan 1 and 2). The combined data represents the CV of all four scans combined. Values are mean ± SD. Abbreviations: BMC = bone mineral content, BMD = bone mineral density, FM = fat mass, LTM = lean tissue mass.

	Anesthesia			Cooling			Euthanasia		
Body Composition Type	Movement	Still	Combined	Movement	Still	Combined	Movement	Still	Combined
BMC	1.71 ± 1.36	1.00 ± 0.82	1.63 ± 0.89	2.05 ± 1.65	1.96 ± 1.67	2.00 ± 1.18	1.49 ± 1.05	0.74 ± 0.57	1.36 ± 0.75
BMD	1.81 ± 1.49	0.97 ± 0.73	1.59 ± 1.24	1.54 ± 1.52	1.53 ± 1.40	1.63 ± 1.04	1.34 ± 1.47	0.70 ± 0.49	1.23 ± 1.02
FM	52.11 ± 42.48	28.54 ± 24.16	78.89 ± 63.85	65.7 ± 58.65	77.38 ± 62.39	97.03 ± 60.75	51.58 ± 45.64	46.0 ± 51.51	53.72 ± 41.93
LTM	2.01 ± 3.00	1.05 ± 1.45	3.40 ± 6.03	2.39 ± 5.43	1.57 ± 3.36	2.49 ± 3.65	7.31 ± 13.33	4.28 ± 4.80	6.59 ± 8.01

of models predicting fat mass which showed a poor relationship between variables ($r^2 \leq 36.1\%$).

Precision of DXA.—Mean intraindividual CV was calculated for 4 DXA parameters using all three immobilization techniques (Table 2). Mean intraindividual CV for four combined scans was greater than 53.7% for Fat Mass, but less than 2.0% and 6.6% for BMC and LTM, respectively. CV tended to be highest for cooled individuals and lowest for euthanized individuals when examining BMC, BMD, and FM; however for LTM there was less precision when examining euthanized individuals while anesthesia resulted in more precise measurements (Table 2).

Effects of immobilization technique.—Immobilization technique significantly influenced the use of DXA to determine BMC (repeated-measures ANOVA; $F_{2,48} = 12.07$; $P < 0.001$), BMD ($F_{2,48} = 25.51$; $P < 0.001$), FM ($F_{2,48} = 16.26$; $P < 0.001$), LTM ($F_{2,48} = 15.44$; $P < 0.001$), and body mass ($F_{2,48} = 4.99$; $P = 0.011$). The effect of immobilization method was not consistent among the DXA parameters analyzed (Fig. 1).

Evaluation of DXA accuracy.—DXA estimates of body composition were highly correlated with chemical estimates for bone mass ($r^2 > 0.986$) and lean tissue mass ($r^2 > 0.964$) regardless of the method used to immobilize individuals during DXA scanning (Fig. 2A, B); however DXA estimates were poorly correlated with chemical estimates for fat mass ($r^2 < 0.261$; Fig. 2C). DXA estimates were significantly different than chemical estimates for AM (paired T-test; $T = 112.95$; $P < 0.001$), LTM ($T = 7.71$; $P < 0.001$), BM ($T = 4.42$; $P < 0.001$), and FM ($T = 4.46$; $P < 0.001$). DXA underestimated BMC, but overestimated FM, LTM, and BM regardless of the immobilization method used (Fig. 3).

DISCUSSION

The goal of developing new techniques to quantify observations is to provide users with advantages not afforded by previous methodologies. The application of non-destructive techniques, although non-invasive and therefore desirable, often sacrifices accuracy and precision. The utility of any technique is dependent on its ability to produce accurate and more importantly precise measurements. Accuracy is less important because predictive regression equations can be developed to correct for any biases inherent to the technique. The use of DXA for the quantification of body composition brought great promise because it is non-invasive and has a high degree of precision compared to other in vivo techniques (Jebb 1997).

We assessed the precision and accuracy of DXA in predicting bone density and body composition of turtles. With the exception of fat mass, the precision of tissue components, as determined by DXA, was relatively high and similar to that determined for other species/studies. In our study lean tissue mass, fat mass, and bone mineral content of anesthetized turtles had CV of 1.05, 28.54, and 1.00%, respectively. In mice, CV was similar to this study for BMC (1.60%) and LTM (0.86%), but fat mass (2.20%) was predicted much more precisely than in our study (Nagy and Clair 2000). In rats, mean CV of five rats over a three day period was 1.07% (BM), 12.16% (FM), 2.88% (LTM), and 6.34% (BMC; Rose et al. 1998). DXA also provided precise measurements of BMC (CV = 0.90%) for excised humeri of rats, but other body composition variables were not examined (Kastl et al. 2002). In domestic pigs CV was 0.74%, 0.94%, 1.91%, and 13.51% for BM, LTM, BMC, and FM, respectively (Elowsson et al. 1998). Studies investigating DXA precision of non-mammalian vertebrates, although less prevalent, suggest similar degree of precision. Korine et al. (2004) measured CV of 1.28%, 1.87%, and 4.92% for BM, LTM, and FM, respectively for live specimens of two species of birds. Precision of body composition estimates for snakes were also similar to that of this study for BMC (CV = 1.0%) and LTM (CV = 0.6%; Secor and Nagy 2003). Overall, precision of body composition estimates determined in this study fall within or below ranges found in other studies. The most notable exception is fat mass which has high intraindividual variability. Although the precision of DXA fat mass estimates are discouraging, the similar degree of precision in estimating other indices of body composition in turtles is promising. The similarity of precision compared to that of other species in particular humans and rodents, for which software was originally designed, is promising for the continued application of DXA in research involving chelonians.

Influence of immobilization.—Use of DXA requires that subjects remain motionless during the entire scanning process. Subject movement during scanning significantly and unpredictably influences the accuracy and precision of body composition estimates (Cawkwell 1998; Koo et al. 1995). A goal of this study was to determine which, if any, of the immobilization techniques resulted in the most precise and accurate measurements while at the same time reducing negative consequences associated with immobilization. Negative consequences associated with immobilization include: cost, ease of use, recovery rate, and potential for harm of test subject. Ignoring precision and accuracy, cooling is the most

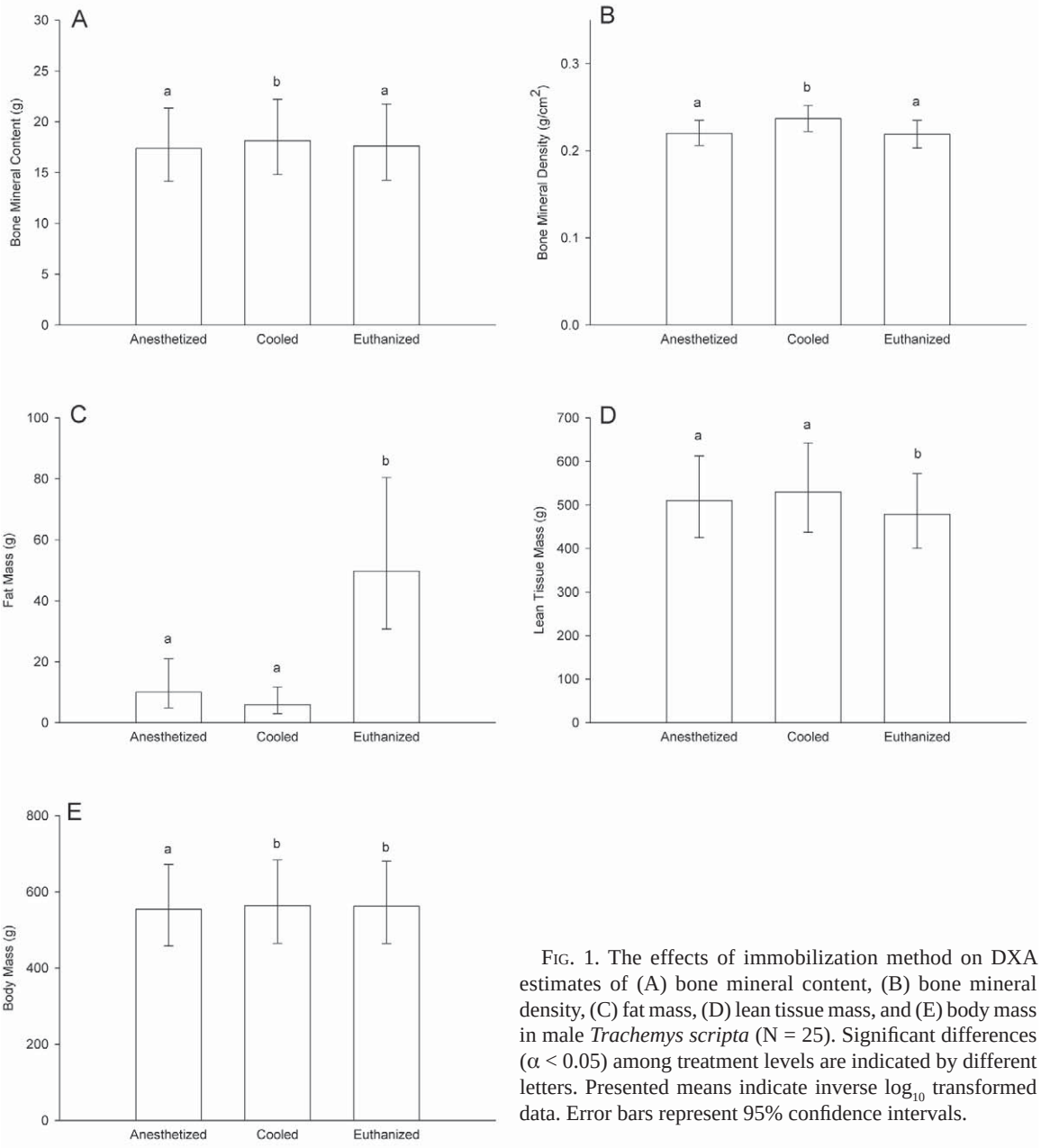


FIG. 1. The effects of immobilization method on DXA estimates of (A) bone mineral content, (B) bone mineral density, (C) fat mass, (D) lean tissue mass, and (E) body mass in male *Trachemys scripta* (N = 25). Significant differences ($\alpha < 0.05$) among treatment levels are indicated by different letters. Presented means indicate inverse $\log_{10}$ transformed data. Error bars represent 95% confidence intervals.

desirable method of immobilization, because it eliminates the cost of narcotics associated with anesthesia/euthanasia, is easy to perform, results in virtually no mortality if cooling is monitored, and has quick recovery rates. A negative consequence of using cooling is a relatively reduced effectiveness on immobilization compared to the other techniques used in this study. We found cooled individuals were more likely to move during scanning (personal observation) and could account for the lower precision of body composition estimates. Anesthesia effectively produces immobilization if a sufficient dose is given for induction; however, anesthesia can be less predictable in reptiles, occasionally producing long recovery periods, variable induction dosages, and increased mortality compared to mammalian species (Bennett 1998; Read 2004). Despite these limitations, anesthesia produces more precise and accurate estimates of body composition than cooling. Euthanasia, although required in this study for comparisons, is the least desirable method of immobilization with DXA because it necessarily defeats the purpose of using non-destructive techniques. Although the influence of immobilization technique produced significant differences in estimates and noticeable variation in precision, each technique correlated well with chemical estimates and therefore each is generally acceptable if predictive equations are produced.

Limitations of DXA.—The results of this study suggest that accurate prediction of fat mass and, to a lesser degree, lean tissue mass using DXA is questionable in chelonians. The morphology of chelonians precludes the ability to effectively determine fat mass, due to the method that DXA utilizes to estimate fat mass. Fat and bone-free lean tissue mass can be distinguished and are calculated from the ratio of attenuation from the low and high-energy beams when calculations are performed on non-bone areas; however, when calculations are performed where lean tissue, fat, and bone overlap, the calculations of fat and lean tissue components are indirect, leading to less reliable estimates (Jebb 1997). Fat and lean tissue mass estimates are less accurate when a large portion

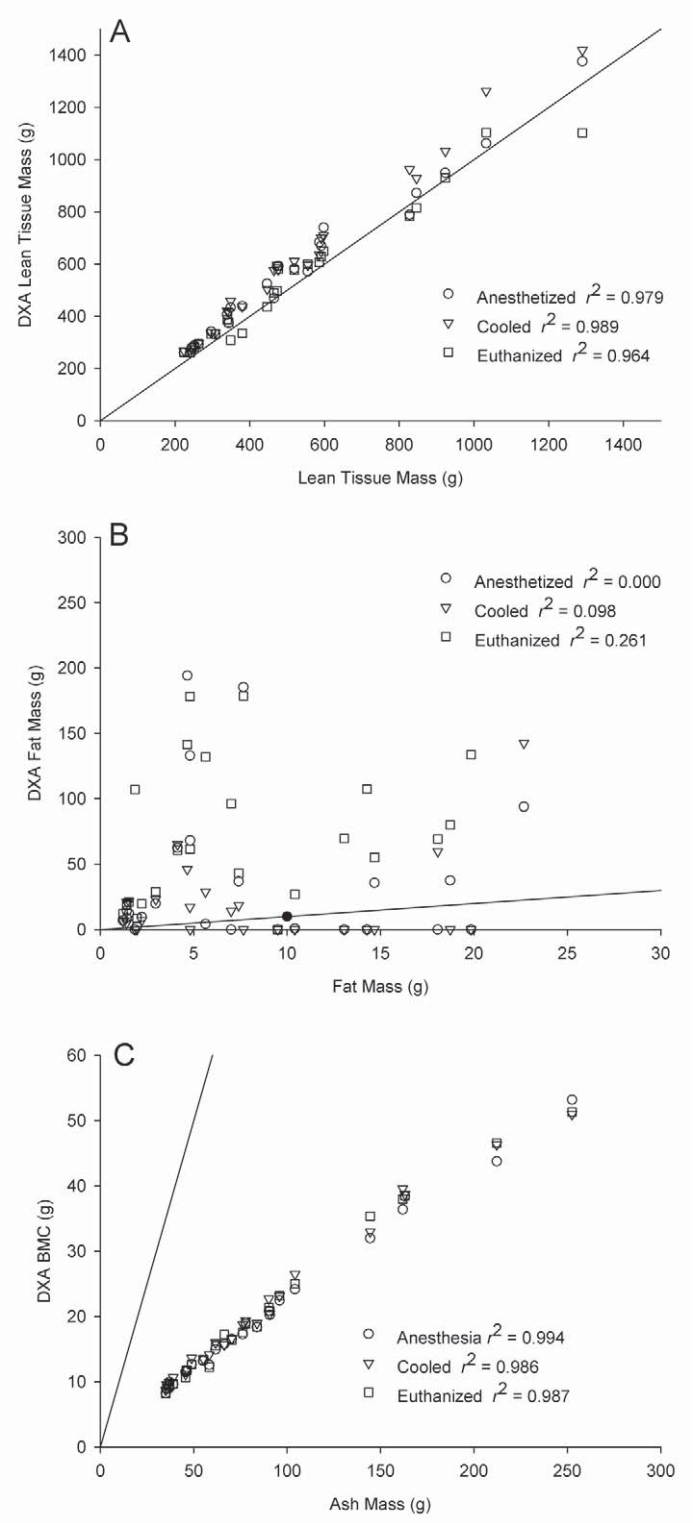


FIG. 2. Correlation between DXA and chemical estimates of (A) lean tissue mass, (B) fat mass, and (C) bone mass for all three methods of immobilization in male *Trachemys scripta* (N = 25). The solid line represents a slope of 1.

of the pixel area contains bone, such as in the thoracic region and brain in humans (Jebb 1997). The scanning of chelonians results in nearly 100% of the scanning pixels containing bone, depending on whether the appendages are extended beyond the margins of the carapace. Therefore, DXA cannot use non-bone-containing

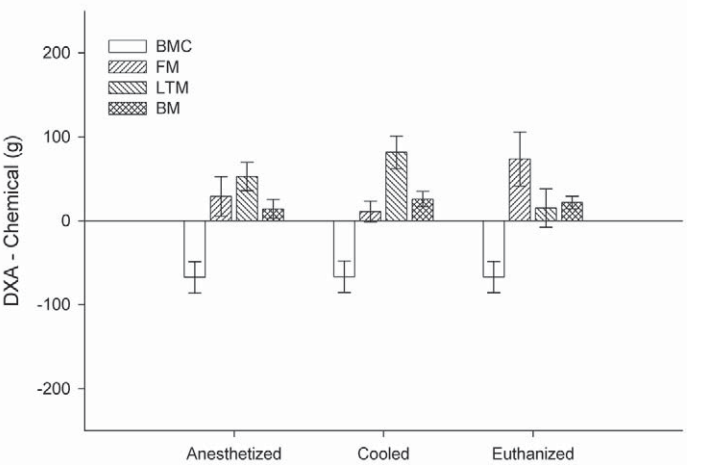


FIG. 3. Mean difference between DXA and chemical estimates of bone mineral content (BMC), fat mass (FM), lean tissue mass (LTM), and body mass (BM) for the three methods of immobilization in male *Trachemys scripta* (N = 25). Error bars represent 95% confidence intervals.

neighbor pixels to calculate the proportion of fat to be used for the majority of pixels that contain bone. Thus the unique morphology of turtles most likely prevents the use of current DXA technology to accurately estimate fat mass. Our data corroborate this view, particularly when compared to another reptile. Secor and Nagy (2003) found a relatively low CV when using DXA to measure FM in snakes (9.2% versus 28.5–97.0% in this study). Because current DXA technology precludes the use of this tool for the prediction of fat mass in turtles, chelonian research with primary interests in obtaining fat estimates will have to use other established methods. The establishment of triple or multiple-energy x-ray absorptiometry may solve this issue in turtles by using a three compartment system rather than the two compartment approach of DXA (Swanpalmer et al. 1998). Another potential approach that may help overcome this caveat could be to position the individuals such that the x-ray beams will pass craniocaudal. This approach would reduce the total scanning area that contains bone and therefore could allow for a more accurate estimate of fat and lean tissue components; however this has not been attempted and at this point is limited to speculation.

Future Research.—Future studies should examine the variation among scanners. We developed models linking body composition and DXA estimates; however the utility of these models for users of other DXA brand scanners is unknown. Significant effects of DXA manufacturers, hardware, and software have been documented (Tothill et al. 1994a; Tothill et al. 1994b; Jebb 1997; Tothill and Hannan 2000). Further validation of these predictive models on other brands of DXA scanners is needed before they can be applied to research using other brands. We also suspect that there may be interspecies variation, and separate predictive models should be developed for individual species. The use of these predictive equations, developed for *T. scripta*, with species differing drastically from the emblematic turtle morphology (e.g. soft-shelled turtles) will likely provide erroneous estimates of body composition.

In conclusion, DXA could potentially be used for a variety of evolutionary, ecological, nutritional, physiological, and diagnostic applications in animals. However, a poor ability to predict fat mass in turtles severely limits some of its application to energetic and nutrition studies until advances in technology overcome the

TABLE 3. Predictive models for chemically determined body composition variables in male *Trachemys scripta* (N = 25) determined by the regression of chemical estimates of body composition against DXA estimates for anesthetized individuals. Predictor variables were selected using best-subsets regression. The simplest model was included and multivariate models were added if they had more explanatory power. Values for difference represent the average difference between actual tissue mass determined chemically and predicted tissue mass determined from the regression or cross-validation model. Values for percent difference represent the absolute difference represented as a percentage of total mass for the tissue component in question. Abbreviations: AM = ash mass, BMC = bone mineral content, LTM = lean tissue mass, FM = fat mass, FFM = fat-free tissue mass, WM = water mass.

		Regression Model		Cross-validation	
Model	r^2	difference (g)	difference (%)	difference (g)	difference (%)
$AM = 4.81BMC_{DXA} - 8.75$	0.994	3.24 ± 3.07	4.03 ± 3.08	3.69 ± 3.75	4.41 ± 3.34
$LTM = 0.98LTM_{DXA} - 39.66$	0.979	31.62 ± 24.17	6.44 ± 3.99	34.14 ± 25.41	6.89 ± 4.14
$LTM = 0.89LTM_{DXA} + 0.70FM_{DXA} - 15.76$	0.992	16.84 ± 18.26	3.30 ± 2.69	20.11 ± 22.70	3.76 ± 3.08
$FM = FM_{DXA} + 8.14$	0.00	5.46 ± 3.56	152.23 ± 175.50	5.86 ± 3.77	162.22 ± 184.00
$FM = 0.04LTM_{DXA} - 0.03FM_{DXA} - 0.62BMC_{DXA} - 1.51$	0.528	3.60 ± 2.68	85.40 ± 87.70	4.43 ± 3.11	100.81 ± 94.9
$FFM = 1.13FFM_{DXA} - 60.20$	0.978	39.96 ± 28.10	6.81 ± 3.58	43.86 ± 30.97	7.34 ± 3.71
$WM = 0.79LTM_{DXA} - 30.07$	0.969	31.80 ± 23.22	8.13 ± 5.23	34.31 ± 24.40	8.70 ± 5.43
$WM = 0.68FM_{DXA} + 0.71LTM_{DXA} - 7.11$	0.987	19.34 ± 16.85	4.86 ± 3.7	22.72 ± 20.87	5.48 ± 4.06

difficulties of distinguishing the soft tissues in species containing a high proportion of bone. Although the use of DXA in turtles is limited by soft tissue, DXA is still effective at measuring bone content and density, and therefore would prove useful for studies of bone dynamics in turtles. From an applied approach DXA could be used in the identification of metabolic bone disease in a clinical setting. The ability to monitor an individual's bone density over a lifetime could provide a wealth of information on the long-term dietary impacts on bone density. In short, the potential applications of DXA in scientific research are many; however, continued validation is required before DXA can be put into practical use for chelonian research.

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The Biology of Crawfish Frogs (*Lithobates areolatus*) Prevents the Full Use of Telemetry and Drift Fence Techniques

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One assumption, implicit or explicit, often made by researchers when designing field studies is that techniques that work well in one species will work without qualification in other species, often closely related, in which they have never been employed. This is not always true. During our ongoing work to understand the natural history and life history of Crawfish Frogs (*Lithobates areolatus*) on reclaimed surface coal mines in Indiana, we employed two techniques—internal transmitters for a radiotelemetry-based movement study and drift fences with pitfall traps for a mark-recapture demographic study—that are recommended and proven tools for amphibian field research (Dodd and Scott 1994; Gibbons and Bennett 1974; Gibbons and Semlitsch 1981; Madison 1997; Richards et al. 1994), though not without qualification (Bull 2000; Dodd 1991; Goldberg et al. 2002; Weick et al. 2005). In fact, both drift fence and radiotelemetry studies have been used successfully with closely related species, Gopher Frogs (*L. capito*; Palis 1998; Roznik and Johnson 2009) and Dusky Gopher Frogs (*L. sevosus*; Richter and Seigel 2002; Richter et al. 2001). We report here two previously undescribed difficulties with the implementation of these techniques in Crawfish Frogs.

We have discovered that surgically weakened abdominal musculature following the implantation of internal transmitters can lead to visceral herniation through the incision site in calling male Crawfish Frogs. Secondly, we have observed that upon exiting wetlands and encountering a drift fence, postbreeding Crawfish Frogs do not usually move laterally along the drift fences to then fall into buckets. Instead—perhaps because they must travel in a specific direction, often over great distances, to find a burrow (J. Heemeyer, unpubl. telemetry data)—they often remain against the fence until early in the morning when they then turn around to re-enter the wetland or surrounding vegetation. This appears to be the first time that these two issues have been reported in amphibian field studies.

Transmitter implantation can result in visceral herniation.—The advantages of radiotelemetry are well known, with the one limitation most cited being transmitter longevity, which is related to transmitter size (Richards et al. 1994; Van Nuland and Claus 1981). Smaller transmitters, often necessary for use in smaller animals such as amphibians, have smaller batteries, which have a shorter life, either making for short-term studies or adding to the number of transmitter replacements. External harnesses have been used successfully on Gopher Frogs (Richter et al. 2001; Roznik and Johnson 2009). However, because Crawfish Frogs at our study site must negotiate densely vegetated upland prairie habitat and use small burrows (made by crayfish), we felt external harnesses might interfere with mobility and decided to implant transmitters intraperitoneally.

Intraperitoneal transmitter implantation is often used in amphibians and may be the most effective way of tracking these animals for long periods (Goldberg et al. 2002; Johnson 2006; Madison 1997; Richards et al. 1994; Weick et al. 2005). However, problems can arise both during and after surgery (Goldberg et al. 2002; Weick et al. 2005). Complications among anuran species arise from response to anesthesia (Goldberg et al. 2002; Weick et al. 2005), infection (Werner 1991), tearing of sutures, lesions around sutures, and transmitter expulsion (Weick et al. 2005). Goldberg et al. (2002) note that many anuran telemetry studies fail to discuss deleterious effects of implantation surgeries.

In the present study, Crawfish Frogs (72–188 g) were captured during the spring of 2009 either on their way into breeding wetlands (drift fences) or in breeding wetlands (minnow traps). Because Crawfish Frogs will often quit calling at the least sign of disturbance (Parris and Redmer 2005), and because intraperitoneal transmitters had been considered safe in calling frogs (Goldberg et al. 2002; Lamoureux and Madison 1999), we decided to implant a subset of males (8 out of 59 Crawfish Frog males encountered entering the pond) in order to identify wetland calling sites and where animals find refuge when they are not calling. We implanted animals with Holohil Systems Ltd. (Carp, Ontario) PD-2 transmitters with internal helical antennae (average weight of 3.8 g). Implantation surgeries were initially practiced (by JLH) on Southern Leopard Frogs (*L. sphenocephalus*) under the supervision of a researcher with over 20 years experience with animal surgeries (MJL). Richards et al. (1994) recommend the use of transmitters weighing no more than 10% of body weight; Goldberg et al. (2002) recommend no more than 5%. Our transmitters accounted for 2–5% of total body weight.

Knowing the potential negative effects of anesthesia on anurans (Goldberg et al. 2002), we started with a concentration of 200 mg/L MS-222 (ethyl 3-aminobenzoate methanesulfonic acid salt;

Sigma-Aldrich, St. Louis, MO) dissolved in a buffer solution (500 ml phosphate buffered saline [PBS], pH 7.2, giving the anesthetic solution a pH of 6.8) at room temperature. We observed the animal for 20–30 min and if it was still responsive we added 200 mg/L MS-222. This continued every half hour until the animal became fully anesthetized, indicated by loss of righting reflex and lack of pain response to toe pinching (Johnson 2006). After several surgeries, we were able determine that a concentration of 600 mg/L was optimal. At this concentration, animals usually took 20–30 min to become anesthetized and remained anesthetized through the duration of the surgery (~30 min). Transmitters were placed intraperitoneally by making a left side, off-midline abdominal incision through the skin and a parallel incision through the rectus abdominus (Johnson 2006). After transmitter insertion, the rectus abdominus was closed with five or six continuous (Weick et al. 2005) sutures (Vicryl™ [polyglactin 910] 5-0 RB1, #36; Ethicon, Somerville, NJ), and the skin was closed with five or six continuous sutures (Vicryl™) and glued (Vetbond™ [n-butyl cyanoacrylate] adhesive). Postoperatively, animals were placed in deionized water and observed until they awoke. They were allowed to recover overnight in a cold, dark environment (a cooler placed in a refrigerator) to minimize stress, and then released on the inside (opposite side) of the drift fence, or near the minnow trap, where they were captured.

Postoperatively, we periodically examined animals in the field. At various times following surgeries (5–27 days), we observed asymmetrical ventral swellings in five animals. Swellings were caused by a hard mass of tissue (Figs. 1A, B), not by fluid or air accumulation. We collected these animals, anesthetized them, did exploratory surgery, and found visceral herniations through the rectus abdominus at the point of surgical incision. The liver had herniated in all animals; the left lung, stomach, and/or intestine herniated in a subset of animals. To repair these herniations, the viscera were carefully re-inserted into the peritoneal cavity, the incised edges of the rectus abdominus were trimmed (ensuring blood flow and enabling healing in case the wound was dehisced), the muscle and skin were individually sutured closed as before, and Vetbond™ was applied to the skin. The animals were again kept overnight before they were released at their respective capture locations.

All five animals exhibiting herniations were males entering or trapped in breeding wetlands. The three other males implanted at the same time did not show signs of herniation. Herniations were not, and have not been at any time, seen in females (four females were implanted at the time and eight more females have been subsequently implanted). We (JLH and MJL) observed one of the implanted males calling (distended vocal sacs) and in amplexus prior to discovering its hernia. The breeding call of male Crawfish Frogs has enormous energy, generating sound capable of carrying over a kilometer under favorable acoustic conditions (Busby and Brecheisen 1997; Minton 2001). We suspect the abdominal pressure necessary to generate these calls (Wells 2007) caused the viscera to herniate through the healing incision and the sutures in the muscular wall.

Four of the five reconstructive surgeries were successful. A herniation in one animal was initially misdiagnosed as internal swelling underneath the muscle layer (necropsy showed liver herniation); this animal died the next day. Of the four surviving animals, the transmitter in one was removed during surgery. This frog was returned to its wetland and was captured three days later at the drift fence as it was leaving; it was behaving normally. The three remaining animals were released postoperatively at the point of capture; one died two and a half weeks later from unknown causes. At the time of this writing (~150 days post surgery), the two remaining herniated frogs with transmitters had been tracked since their release and are behaving similarly to implanted animals that did not suffer visceral herniations. One of the two animals was examined 12 days (Fig. 2A) and 40 days (Fig. 2B) after hernia reconstruction and showed no signs of recurrent herniation. Its cutaneous incision had completely healed, although portions of suture material and Vetbond™ remained adherent. These have since dissolved or been worn away.

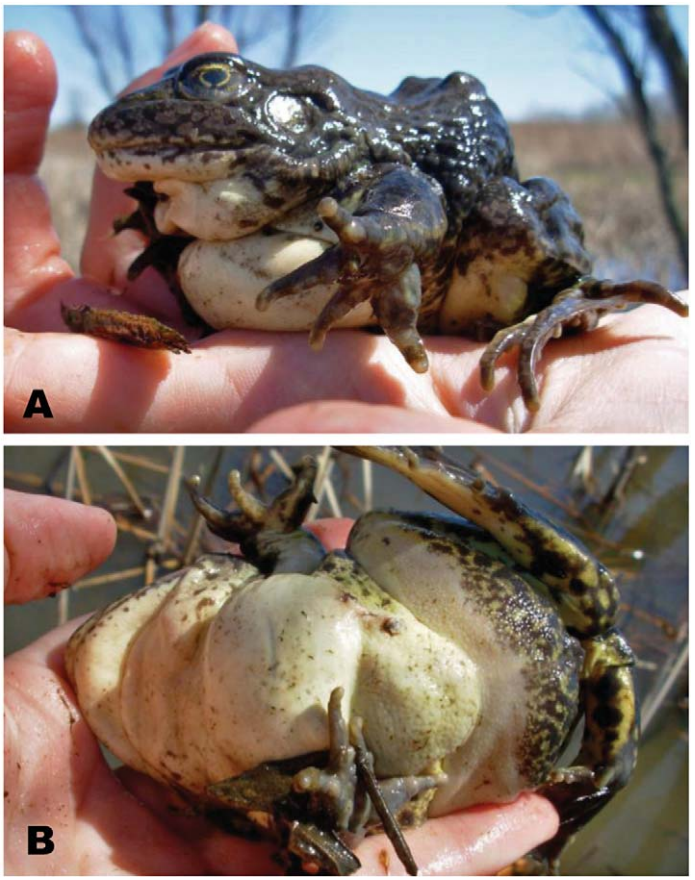


FIG. 1. A) Left lateral oblique view of a male Crawfish Frog (93 mm SVL) showing external appearance of visceral herniation through the rectus abdominus. B) Ventral view of same animal. The more anterior bulge is due to liver herniation and the posterior bulge is due to intestinal herniation.

Drift fences inhibit postbreeding migrations.—Drift fences in combination with pitfall traps constitute a useful tool for amphibian biologists interested in the timing and demographics of breeding populations, as well as measures of reproductive success (Dodd and Scott 1994; Gibbons and Bennett 1974; Richter and Seigel 2002; Semlitsch et al. 1995). One assumption with this technique is that upon encountering a drift fence, an animal will turn left or right to move laterally along the fencing until they tumble into a pitfall trap to be captured and processed by the researcher. Crawfish Frogs entering breeding wetlands seemed to do this, but Crawfish Frogs

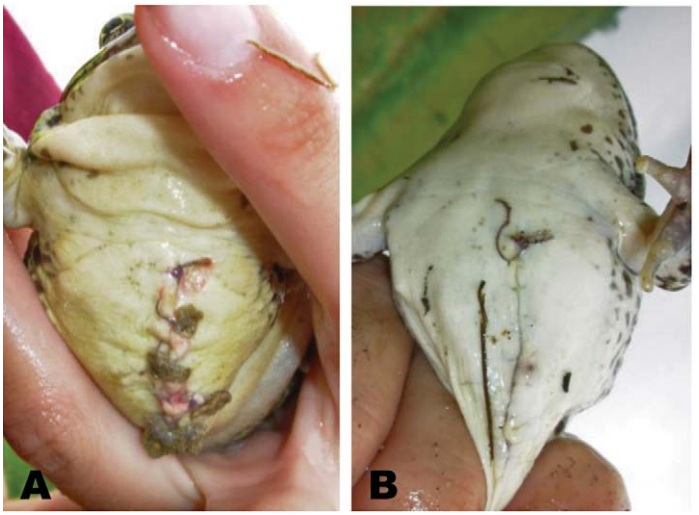


FIG. 2. Ventral view of a male Crawfish Frog (85 mm SVL) showing healing following hernia repair surgery on 16 April 2009. A) The scar on 28 April, 12 days following surgery. B) The scar on 26 May, 40 days after surgery.

exiting wetlands often did not. Difficulties with capturing animals in pitfall traps had not been specifically reported in studies that involved the closely related Gopher Frogs (Palis 1998) and Dark Gopher Frogs (Richter et al. 2001; Richter and Seigel 2002).

On the night of 12–13 April (11°C with 2.0 cm of rainfall), several postbreeding frogs were observed on the inside of the silt drift fence after having left their breeding wetland. Despite this potential emigration activity, on the morning of 13 April, no Crawfish Frogs were found in pitfall traps at this wetland. We suspected escapes, but had had no evidence that frogs trespassed entering this wetland and so doubted Crawfish Frogs could negotiate fences upon leaving. After noting emigration behavior, but an absence of frogs in pitfall traps, we began returning to our study ponds during nighttime rains. We found that when emigrating animals encountered the silt drift fence they often tried to work their way through the fence to continue their direction, sometimes laboring until, if at the aluminum hardware cloth portion of our fences, they abraded their snouts (Fig. 3). The hardware cloth—installed in drainage areas to prevent washing out of the silt fences—comprises two sections at one pond (2.86 m, 1.14% of the whole fence) and four sections at the second pond (4.87 m, 1.87% of the whole fence). The silt fence itself, made from woven polypropylene composite, did not injure frog snouts. After realizing this, we began to relocate emigrating Crawfish Frogs across fences. One night alone (19–20 April) we transferred a total of 40 (23 at one wetland, 17 at a second) postbreeding Crawfish Frogs to the outside of fences (a total of 97 animals entered our two drift-fenced breeding wetlands). Overall, 35% of emigrating Crawfish Frogs were relocated in this way, the other 65% were caught in pitfall traps. The use of drift fences may lengthen the duration of Crawfish Frogs in breeding wetlands, and therefore bias results.



FIG. 3. Head-on view of Crawfish Frog (103 mm SVL) whose snout was abraded during attempts to negotiate a direct route through drift fencing.

Recommendations.—The advantages of telemetry and drift fence trapping techniques will typically outweigh disadvantages if certain precautions are heeded (e.g., Gibbons and Bennett 1974). Several measures can be taken to adapt the telemetry and drift fence modifications described here to Crawfish Frogs, which in turn could also be useful for research on other species. In our opinion, implantation of transmitters remains a viable method for Crawfish Frogs, however, we suggest only implanting postbreeding animals to avoid the possibility of visceral herniation. We also recommend using interrupted sutures (Weick et al. 2005), which may provide stronger closure, to close the peritoneal incision. We have wondered whether the notoriously unstable, acidic, nutrient poor, and droughty soils of mine spoils (Brothers 1990) stressed Crawfish Frogs to the point of hindering healing and producing these herniations. At the present time we have no data to support this idea.

Drift fence studies for Crawfish Frogs must be accompanied by all-night visual encounter surveys for emigrating adults during or following rainfall. Animals at, or approaching, fences should be captured and relocated to the opposite side. To prevent abrasion, we recommend using softer perforated fencing in areas where water accumulates, or attaching strips of cloth or Gorilla Tape© (Gorilla Glue Inc., Cincinnati, Ohio) across the bottom of the hardware cloth. A height of two inches would provide ample protection for Crawfish Frogs, and still allow water flow through the fence.

When utilizing field techniques, even well-established techniques, we recommend not assuming that techniques that have worked well on other species will work well on novel species. We suggest incorporating either a period of preliminary analysis or an intense initial observational component to prevent unintended animal injury.

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AMPHIBIAN DISEASES

This section offers a timely outlet for streamlined presentation of research exploring the geographic distribution, host range, and impact of emerging amphibian pathogens, especially the amphibian chytrid fungus *Batrachochytrium dendrobatidis* (*Bd*) and ranaviruses. *Bd* is an emerging pathogen linked to mass mortality and declines of amphibians worldwide, yet Bd has also been detected in amphibians without disease. Ranaviruses also cause mass mortality, but have not yet been linked to large-scale declines. We know relatively little about their global distribution, host range, or impacts on host populations. To improve our understanding of the scope of this issue, we encourage submission of studies that illuminate the geographic distribution, host ranges, and impact of these pathogens on amphibian populations, including research on individual species or groups of species, wild or captive animals, native or non-native species, live animals or museum specimens, environmental samples, and, provided there is sufficient sampling[1], reports of non-detections.

We ask authors to: 1) restrict the Introduction of their paper to a **maximum** of two paragraphs to highlight the context of their study; 2) briefly include both field and laboratory Methods; 3) present Results in a Table, although a map might also be useful, and limited text; and 4) have a short discussion of a **maximum** of three paragraphs to touch upon key findings. Please include the following information in submissions as appropriate: coordinates and description of sampling areas (or please note if locations are extremely sensitive to reveal, and provide general area instead); species name(s) and life history stages examined, as well as other species present; whether samples were collected randomly or just from dead or moribund animals; date of specimen collection; evidence of unusual mortality; numbers of positive and negative samples; disposition of voucher specimens; name of collaborative laboratory or researcher conducting histological sections or PCR analyses; and names of cooperative land owners or land management agencies. We encourage researchers to conduct post-mortem examinations when possible to identify the cause of death when reporting mortalities. We aim to expedite the review and publication process! Please e-mail submissions directly to Associate Editor, Dr. Dede Olson: dedeolson@fs.fed.us.

[1]If a sample of 30 individuals of a particular life history stage of a particular species yields no positive results, and the diagnostic test is highly sensitive, one can conclude that the prevalence of infection is less than 10% with 95% confidence. With a sample of 10 an infection in one of four individuals could go undetected. We encourage researchers to collect sufficient samples that negative results are meaningful.

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Batrachochytrium dendrobatidis in Adult *Notophthalmus viridescens* in North-Central Alabama, USA

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Batrachochytrium dendrobatidis (Bd) has devastated many amphibian populations, especially in tropical areas (Berger et al. 1998; Daszak et al. 1999). However, the geographic distribution of

this emerging pathogen is not well known (see http://www.spatialepidemiology.net/Bd-maps/information/#PD). There is currently only one published report of *Bd* in Alabama, USA, at Horseshoe Bend National Park located in Tallapoosa Co. (Byrne et al. 2008); the affected species was the semi-terrestrial *Eurycea cirrigera* (Southern Two-lined Salamander). Rothermel et al. (2008) found *Bd* across the southeastern United States, but Alabama was not sampled. However, they found *Bd*-infected *Notophthalmus viridescens* (Eastern Newt) in Georgia, North Carolina, and Virginia. Additional reports have detected *Bd* in anurans and caudates in eastern Georgia (Timpe et al. 2008) and southwestern Tennessee (Venesky and Brem 2008). We report on a haphazard collection of dead adult *Notophthalmus viridescens* discovered during a field zoology class trip conducted by KAB in Birmingham, Alabama.

Methods.—On 25 February 2009, seine and dipnet sampling were conducted at Red Lakes, Ruffner Mountain Nature Preserve, Birmingham, Alabama (33.5623ºN, 86.6900ºW). Many (30–40) live adult Eastern Newts in breeding condition (smooth skin; males with nuptial pads) were sampled. We also noticed a number of recently deceased newts. The dead animals were slightly bloated, presumably due to dying in the water, were floating just above the bottom of the shallow pond (ankle to thigh deep, 15–90 cm), but otherwise appeared normal (no loose or peeling skin, no discoloration, no signs of trauma). Twelve dead newts were collected, and we saw at least another 15 dead newts. Nine newts were fixed in formalin, then stored in 70% ethanol. Three newts were preserved by freezing at -10ºC. *Ambystoma maculatum* (Spotted Salamander) egg masses were present in the pond where the dead newts were collected and two large adult Spotted Salamanders (appeared healthy) were found in the woods approximately 40 m away from the pond and released after examination. Presumably, this pond also is used by anurans as a breeding site because it is fishless and periodically dries due to evaporation when there is a hot, dry summer.

Two formalin-fixed newts were examined by APP. The fixed carcasses were demineralized in hydrochloric acid (RDO Rapid Decalcifier, Apex Engineering Corporation, Aurora, IL USA), followed by preparation of serial transverse histological sections through the entirety of head and body and longitudinal sections through the hindlimbs and feet. Body, limb and foot slices were then automatically processed for histology, embedded in paraffin, sectioned at 5-6 μm and stained with hematoxylin and eosin. Liver from 2 frozen newts was submitted to the Amphibian Disease Laboratory at the San Diego Zoo for real-time PCR for ranaviruses using previously described techniques (Pallister et al. 2007).

Results.—Lesions in the two formalin-fixed newts examined histologically were limited to the skin. Changes were diffuse and involved over 90% of the skin surfaces examined (which included multiple sections of dorsal and ventral skin from the head, torso, legs, feet, and tail) and consisted of mild to moderate orthokeratotic hyperkeratosis and epidermal hyperplasia with moderate numbers of fungal organisms in cells of the stratum corneum (superficial keratinized skin layers) typical of *Batrachochytrium dendrobatidis*. Features of these organisms considered to be diagnostic of *Bd* included colonial thalli and flask-shaped zoosporangia with prominent discharge papillae (Longcore et al. 1999). Skin lesions were significantly more severe than the relatively focal and minimal lesions observed in *Bd* infected, but healthy American bullfrogs (Hanselmann et al. 2004) and were similar to those associated with mortality in naturally and experimentally infected anurans (Nichols et al. 2001). Lesions were also subjectively more severe than those previously observed by one of the authors (APP) in other salamander species (Davidson et al. 2003; Vasquez et al. 2009). Other tissues examined histologically, including but not limited to, brain, liver (including subcapsular hematopoietic tissue), kidney, spleen, gastrointestinal tract, bone and skeletal muscle were considered to be within normal limits. Specifically, no lesions typical of a lethal *Ranavirus* infection (Green et al. 2002) or of the *Ichthyophonus*-like infections previously reported in *Notopthalmus viridescens* (Raffel et al. 2006) were observed. The examined newts were determined to be in good nutritional condition based on abundant coelomic cavitary fat stores. Real-time PCR for ranaviruses was negative. Based on these findings, chytridiomycosis was determined to be the likely cause of death. However, the small number of newts sampled for diagnostic investigation means that other potential causes for this mortality event, including but not limited to, other unidentified infectious agents and events such as chemical exposure or altered water quality. Chemical and environmental changes especially may not result in distinctive lesions that can be identified by histologic examination.

Discussion.—This report is significant in documenting the presence of *Bd* in another salamander species 110 km from the nearest known locality, Tallapoosa Co. Alabama. This is the first report of a mortality event associated with *Bd* in Alabama. Ruffner Mountain is currently used as a nature education center and is also the second largest urban nature preserve in the United States (S. McCracken, pers. comm.). However, iron ore mining was conducted here from 1886–1953 and it served as a limestone quarry through the 1920s (White 1981). Red Lakes (there were once six, now two remain) where the infected newts were found, was originally a settling pond for the water used in a beneficiation process that separated high quality from low quality ore (S. McCracken, pers. comm.). The water is a rust-red color and stains field equipment. Although we did not test for industrial contaminants such as heavy metals, pH was 8.4 (water temp = 10.1ºC, air temp 13.4ºC, RH = 52.5%). The pH optimum for *Bd* is 6–7 with less growth at a pH of 8, the highest pH tested (Piotrowski et al. 2004). Future work should examine potential linkages between environmental contaminants and the incidence and/or severity of *Bd* infections in aquatic amphibians.

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Batrachochytrium dendrobatidis Detected in Amphibians from National Forests in Eastern Texas, USA

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The amphibian disease chytridiomycosis, caused by the pathogenic fungus *Batrachochytrium dendrobatidis* (*Bd*, Longcore et al. 1999), is well known as a major threat to amphibians resulting in mass die-offs and population declines throughout the world (Berger et al. 1998; Blaustein and Keisecker 2002; Daszak et al. 2003; McCallum 2005; Rachowicz et al. 2006). *Batrachochytrium dendrobatidis* has been detected on amphibians from sites across North America (Ouellet et al. 2005; Woodhams et al. 2008) and appears to be most prevalent in the western and the northeastern United States (Longcore et al. 2007; Schlaepfer et al. 2007). Whereas infected anurans also have been found throughout the southeastern US (Green and Dodd 2007), there have been no reports of *Bd* from amphibians in eastern Texas, a broad area encompassing 10,000,000 ha. We sampled amphibians for the presence of *Bd* in four National Forests in eastern Texas (approximately 31°N latitude).

Amphibians were sampled for *Bd* from 9 January to 27 May 2009 in the Angelina, Davy Crockett, and Sabine National Forests, and the Stephen F. Austin Experimental Forest (Fig. 1). The Stephen

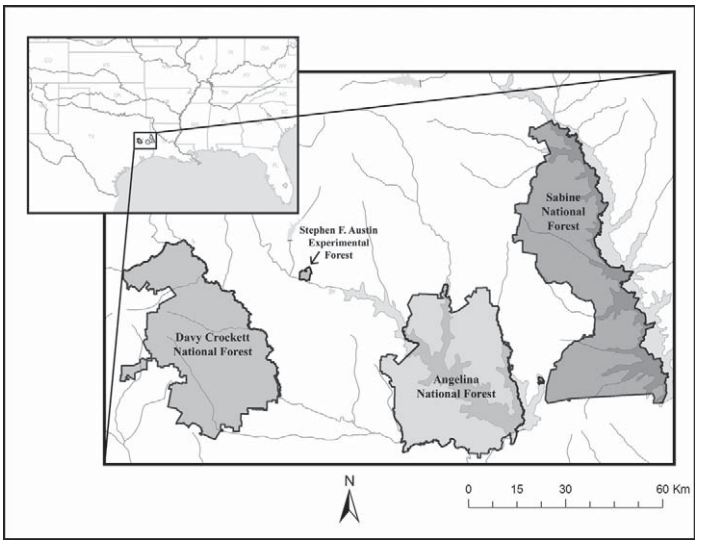


Fig. 1. Locations of the Angelina, Davy Crockett, Sabine National Forests, and the Stephen F. Austin Experimental Forest where 6 of 18 amphibian species tested positive for the amphibian chytrid fungus, *Batrachochytrium dendrobatidis*.

TABLE 1. Amphibian species tested for the presence of *Batrachochytrium dendrobatidis* (*Bd*) within Angelina, Davy Crockett, and Sabine National Forests, and the Stephen F. Austin Experimental Forest, Texas. Bold font indicates that *Bd* was detected in the species.

		No. animals infected/examined	No. animals infected/examined	No. animals infected/examined	No. animals infected/examined
Family	Species	Angelina National Forest	Davy Crockett National Forest	Sabine National Forest	Stephen F. Austin Experimental Forest
Ambystomatidae	*Ambystoma maculatum*	0/5	-	-	-
	Ambystoma opacum	0/10	0/2	0/5	0/10
	Ambystoma talpoideum	0/2	-	-	-
Plethodontidae	***Eurycea quadradigitata***	0/8	-	0/8	**3/10**
Salamandridae	*Notophthalmus viridescens*	0/1	-	-	0/2
Bufonidae	***Anaxyrus woodhousii***	**1/7**	0/10	-	0/1
	Incilius nebulifer	0/3	0/8	0/1	-
Hylidae	***Acris crepitans***	**1/10**	**1/10**	-	-
	Hyla cinerea	0/10	0/6	-	0/10
	Hyla versicolor	0/8	0/10	-	0/8
	Pseudacris crucifer	0/10	**1/10**	-	0/10
	Pseudacris fouquettei	**3/5**	-	-	**2/10**
Microhylidae	*Gastrophryne carolinensis*	0/5	-	-	0/2
Ranidae	***Lithobates catesbeianus***	0/1	0/6	-	**1/1**
	Lithobates clamitans	0/2	0/4	-	0/2
	Lithobates palustris	-	-	0/1	0/4
	Lithobates sphenocephalus	0/8	0/7	-	0/10
Scaphiopodidae	*Scaphiopus hurteri*	-	0/1	-	-
	TOTAL	**5/95 (5.3%)**	**2/76 (2.6%)**	**0/15 (0.0%)**	**6/80 (7.5%)**

F. Austin Experimental Forest is a disjunct unit of the Angelina National Forest, administered by the Southern Research Station, US Forest Service. The dominant habitats of these areas include secondary growth Loblolly (*Pinus taeda*), Longleaf (*P. palustris*), and Shortleaf (*P. echinata*) upland pine forests and mixed deciduous bottomland forests. East Texas experiences occasional freezing temperatures, warm winter days, and extremely hot summers (Chang et al. 1996). From 1901 to 1993, the overall mean air temperatures for January and August are 8.4°C and 27.8°C, respectively (Chang et al. 1996). In winter, cold air masses often meet warm moist air pushed up from the Gulf of Mexico resulting in frequent rain events, placing the study sites in one of the wettest regions of Texas (Bomar 1995).

We searched for amphibians near ponds, streams, moist lowland areas, and upland pine forest habitat. We captured specimens by hand. Each individual was handled with a new pair of sterile nitrile gloves. We sampled for *Bd* by rubbing a sterile cotton swab on the dorsum, ventral surfaces, and feet of each frog for approximately 30 seconds, after which the animal was released at its place of capture. The swab was then immediately placed in a sterile microcentrifuge tube containing 1 ml of 70% ethanol and later sent to Pisces Molecular Laboratory (Boulder, Colorado, USA) for PCR analyses. Global positioning system (GPS) coordinates were taken at each capture site using a Garmin® GPS unit.

Overall, we sampled a total of 266 adult amphibians of 18 different species, from 8 different families (Table 1). Of these 18 species, six had at least one individual that tested positive for *Bd*. Thirteen of the 266 individuals tested positive for an overall detection rate of 4.8%. The Stephen F. Austin Experimental Forest had the highest detection rate among the four areas sampled, with six of 80 (7.5%) individuals testing positive for *Bd* (Table 1). During sampling, no sick or dead frogs were observed at any sites.

We found similar *Bd* detection rates for anurans and caudates (4.93% and 4.76%, respectively), although the only salamanders to test positive for *Bd* were three individuals of *Eurycea qudradigitata* from the Stephen F. Austin Experimental Forest. Despite 34 ambystomatids being sampled, none tested positive for *Bd*.

Five of the 15 (33.33%) *Pseudacris fouquettei* samples tested positive for *Bd*, which was the highest detection rate among anuran species, including species which were breeding at the same time and place where the *Bd*-positive *Pseudacris fouquettei* were found. Individuals of both *P. crucifer* and *Lithobates sphenocephalus* were collected at locations where *Bd*-positive *P. fouquettei* were found, yet no *L. sphenocephalus* and only one of 30 (3.33%) *P. crucifer* samples tested positive for *Bd*. However, small sample sizes make it difficult to assess whether there is actually a higher detection rates among *P. fouquettei* than other species.

Batrachochytrium dendrobatidis has been present in North American amphibian populations since at least the early 1960s (Ouellet et al. 2005). Yet, within the United States, *Bd* has been associated with amphibian die-offs predominantly in western states (e.g., Bradley et al. 2002; Briggs et al. 2005; Muths et al. 2003).

Although the fungus is present in the southeastern United States, to our knowledge no amphibian declines have been attributed to chytridiomycosis in this region. Several studies have detected higher rates of *Bd* infections during the fall or winter months (McDonald et al. 2005; Ouellet et al. 2005; Retallick et al. 2004), a phenomenon possibly explained by the fact that amphibian immune systems function less effectively at cooler temperatures (Carey 2000; Cooper et al. 1992; Maniero and Carey 1997). It is possible that the immune systems of amphibians inhabiting eastern Texas are more capable of resisting *Bd* infections because of the relatively warm winters and hot summers.

Also, it is possible that the fungus may never reach an epizootic state in eastern Texas because the warm air temperatures are less than optimal for *Bd* growth and infection of amphibians (Kriger and Hero 2006; Longcore et al. 1999; Retallick et al. 2004). Evidence for an enzootic state includes the relative low incidence of detection in PCR samples and the fact that no sick or dead frogs were encountered. Amphibians appeared to be abundant at all four of our study sites. Follow-up population and *Bd* sampling is needed to confirm what impacts *Bd* may be having on the National Forests in Texas.

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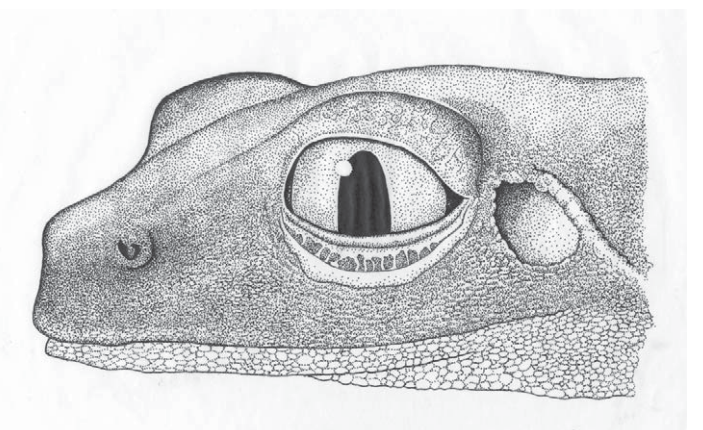
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Agalychnis callidryas (UMRC 79-257, 41 mm SVL). Mexico: Quintana Roo: 8 km N Felipe Carrillo Puerto. Lateral view of head, showing the vertically elliptical pupil and the reticulate palpebral membrane. Illustration by Julian C. Lee.

HERPETOLOGICAL HISTORY

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Very Early Photographs of Reptiles

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Following a publication by John Edwards in *Herpetological Review* (1998) of three early photographs of living reptiles, dated 1865, Kraig Adler and Harold Cogger (1998) presented another, even older photograph. It shows the German-born herpetologist Gerard Krefft with three live reptiles and was taken in the year 1864 by the Sydney photographer William Hetzer. Adler and Cogger invited readers to a contest to find the earliest photograph of a living reptile. Herein, I follow this invitation and contribute to the contest.

Francis Frith was born in 1822 in Chesterfield, Derbyshire, England. Not very successful at school and in an apprenticeship in a cutlery, he had a nervous breakdown, then traveled a few years in his home country, and in 1850 he set up his own printing business in Liverpool. That business thrived and he sold it in 1856 to his major competitor. The substantial profit he realized made him independent and he started his career as a photographer with a first trip to Egypt in this very year. His inaugural book, "Egypt and Palestine Photographed and Described," began to appear in 1858 and was completed in 1860, consisting of 25 parts with 76 albumen prints altogether. Among these photographs there is one of a living adult crocodile, *Crocodylus niloticus*, on a sand bank presumably along the Nile River (Fig. 1). It was taken in 1857 as can be seen from the remark "Frith-Photo, 1857" underneath the published photograph in the first volume of his two-volume book. Frith writes: "I am satisfied that they never attack mankind openly, although, no doubt, if they had an opportunity of seizing a man without exposing themselves, they would be dangerous." The main objects of Frith's photographs are buildings (both antique and contemporary) and landscapes. Only very few of his studies portray wildlife (such as a dead flamingo in the hands of an Arab "sportsman" and a cook). This is understandable also in the light of the fact that wildlife move and photographic equipment then posed serious technical limitations to wildlife photography. A large crocodile resting on a sand bank seems to be the ideal object, presenting—as compared to birds and mammals—several advantages for early photographers from this point of view. So for now this seems to be the oldest known photograph of a *living* reptile.



FIG. 1. The precise location in Egypt where Frith took this photograph of a *Crocodylus niloticus* is unknown. Additionally, it is not known if he was aware that he was perhaps the first photographer to take a picture of a living reptile.

The earliest photograph of a *herpetological specimen* I found is even older and falls in the earliest times of photography. It shows two stuffed specimens of monitor lizards, indicated below the photograph as "Varanus Bellii Duméril et Bibron" and "Varanus Varius. Merrem. Duméril et Bibron" (Fig. 2). Both are referable to *Varanus varius* (White, 1790). The two *Varanus* are clearly identifiable as dead specimens. The left one shows a crack in the skin above the left foreleg and the stuffing material is visible inside it. This photograph was first published in March 1853 in an atlas of zoological photographs which was meant to document and show the treasures of the Museum of Natural History in Paris ("Photographie zoologique ou Représentation des Animaux Rares des Colections du Muséum d'Histoire Naturelle") by L. Rousseau and A. Devéria, and then again published in 1854 in the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale, Paris* (Vol. 53, Ser. 2, Volume I). This *Bulletin* is as a historical source at least as interesting as the atlas itself because it contains two articles directly relevant here. First, there is an article (pp. 117–119) by Claude Félix Abel Niepce de Saint-Victor (1805–1870). He was the son of the first cousin of Joseph-Nicéphore Niepce (1765–1833) who is considered to be the inventor of photography, as he was the first one to take a picture with a camera obscura and to get it fixed and light resistant on a metal plate. Niepce called this technique heliogravure as it was "written with sunlight." In this article entitled "Gravure héliographique," Abel Niepce describes some improvements to Joseph-Nicéphore's process (referring to him as his "uncle") developed by him together with the engraver Augustin-François Lemaître (1797–1870) who had already worked with Joseph-Nicéphore Niepce doing the etchings. After the death of Joseph-Nicéphore Niepce it was Louis Daguerre (1787–1851)—who had worked with both Joseph-Nicéphore and Abel Niepce—to develop Niepce's invention further and to bring it to a commercial stage. This Daguerrotype process was presented formally to the French Academy of Science and finally bought by the French Government as a "gift to the world" in 1839.

Abel Niepce's article is followed by one on "Photographie zoologique," written by Louis Pierre Rousseau and Achille Devéria (1800–1870), the authors of the atlas with the same title, which relates the history of this atlas.

According to their article, the first plates of photography applied to natural history ("photographie appliquée aux sciences naturelles") were received by the Académie des Sciences in Paris on March 14, 1853. Indeed, the minutes of the meeting of the Academy (Compte Rendu des Séances de l'Académie des Sciences, Tome trente-sixième. Janvier – June 1853, p. 500) state that these two gentlemen presented at the meeting "divers spécimens



FIG. 2. The caption to this photograph published in the "Bulletin de la Société d'Encouragement pour l'Industrie Nationale (1854)" differs from that in the atlas "Photographie zoologique" (1853) in the following: While here above the indication of the animals the artists involved are mentioned (from left to right): Négatif par Bisson - Photographié sur acier par Mme Pauline Riffaut - A. Riffaut sculp, in the atlas this line is lacking and below the animal description the photographers and editing companies are indicated (from left to right): Bisson fréres Photographes - Paris, chez Masson_Londres, chez Gambart - Lemercier, Paris.

Note the crack in the skin of the left specimen showing the stuffing material.

de photographie appliquée aux sciences naturelles" and that these plates, printed on paper, showed skeletons or parts thereof and other complete individuals belonging to the principal divisions of the animal kingdom.

The Bisson brothers had produced the negatives and Pauline Riffaut transferred the pictures to the steel plates. Once the acid had etched the metal plate, it was still necessary to do the finishing by hand, which was done by engraver A. Riffaut who is the third party mentioned under the prints.

In the session of June 6, 1853, the commission consisting of the zoologists Isidore Geoffroy Saint-Hilaire (1805–1861) and Achille Valenciennes (1794–1865), Henri Victor Regnault (1810–1878), a chemist and physicist who became in 1854 the founding president of the Société Française de Photographie, and zoologist Henri Milne Edwards (1800–1885) as the rapporteur received the report of Rousseau and Dévéria on the completed, but not yet edited, work and discussed it. The minutes (Compte Rendu des Séances de l'Académie des Sciences, Vol. Janvier - June 1853, pp. 991–994) give a very good idea of the enthusiasm with which the work was received. For example found the committee that even the best painter would not have the patience and ability to make visible all the details and structures of the polypes visible in the photograph which shows the object enlarged (as compared to natural size). The committee discussed the potential and advantages of the new technique at length, but it was also said that there was still something left to do by the authors to give their work the "stabilité désirable." The committee expressed confidence that the authors, with the appropriate instruments and means at their disposition, would soon reach results very useful to science, and vividly wished that photography becomes of "emploi usuel pour les zoologists." Rousseau was then "aide-naturaliste" at the Museum while Dévéria was artist at the Bibliothèque impériale.

Both *Varanus* specimens shown in the photograph (Fig. 2) are still extant in the collection of the Muséum d'Histoire Naturelle (MNHN) in Paris and registered as "*Varanus varius* (White, 1790)," the left one—ocellated, number 2—in the photograph bearing number MNHN 8284 (formerly 1551), the right one—banded, number 1—MNHN 8281 (formerly 1560), and were collected between 1842 and 1847 in "Nouvelle-Hollande" (New Holland) by Jules Pierre Verreaux (1807–1873) (Roger Bour, in litt.). Verreaux was a famous French biologist, collector of and professional trader in a wide range of natural history specimens and the Muséum d'Histoire Naturelle in Paris was a good client of his. In 1864 he obtained the position of an assistant naturalist there.

Dead animals, here in the form of two *Varanus*, or a lazy, sun-basking crocodile certainly were ideal objects in the early times of photography, given the required long exposure time. Interestingly enough, this (as far as is known) first photograph of a living reptile was taken during an expedition which was described by Manchip White (1980) as the "world's first methodically planned and executed safari" while the production of the even earlier photograph of dead reptiles described here directly involved true pioneers of photography and was published in the first book on zoological photography ever issued.

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HERPETOLOGICAL HUSBANDRY

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Observations on the Captive Reproduction of the Horned Marsupial Frog *Gastrotheca cornuta* (Boulenger 1898)

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The marsupial frogs (Family Hemiphractidae) from Latin America are some of the most intriguing anuran species known. As their name implies, females of these frogs bear a dorsal pouch in which they carry eggs, tadpoles, and/or froglets. In this family, there are 93 species contained in five genera ranging from Costa Rica through South America to Brazil and northwestern Argentina (Frost 2009). The natural history and reproductive behavior of marsupial frogs is well documented in only a few taxa, mostly through wild-collected specimens brought into captivity at different stages. *Flectonotus pygmaeus*, *Gastrotheca riobambae*, and *G. argenteovirens* were observed in the field and laboratory (Duellman and Maness 1980). The Ecuadorian species *G. riobambae*, has been the most heavily studied by far. This species carries eggs until they develop into tadpoles (taking up to 120 days) that are released into a small body of water (usually a shallow depression or pond). Reproduction in captivity has been reported and has afforded several opportunities for documentation of breeding, gestation, and parturition (Auber-Thomay and Letellier 1986; Boonman 1985; Fitzgerald et al. 1979). Reproduction of *Gastrotheca plumbea* was also observed in the laboratory, including the positioning of eggs in the pouch of the female and birth of fully formed froglets (Auber-Thomay et al. 1986).

Differences in gestation times, fertility, and pouch morphology among taxa have been reviewed along with role of the male in assisting with inserting eggs into the pouch in *F. pygmaeus* and *G. riobambae* (Duellman and Maness 1980).



FIG. 1. Adult Horned Marsupial Frog *Gastrotheca cornuta*. Photo by Brad Wilson.

We recently began working with captive populations of the Horned Marsupial Frog, *Gastrotheca cornuta* (Boulenger 1898; Fig. 1). Historically, this species ranged from Costa Rica to Ecuador; however, in many localities, it has become increasingly rare during the past two decades.

In the field, *G. cornuta* is difficult to encounter. It is thought that this shy species stays high in the canopy of old growth forests, far from anthropogenic disturbance. Juveniles are hardly ever encountered and adults only rarely. In El Valle de Antón, Provincia de Coclé, Panama, we encountered two gravid females (eggs visible through the skin of the abdomen) and one female with eggs inside the pouch in primary forest in close proximity to the Río María ca. 1.5 m above the forest floor during June and July 2005. In June 2006, we observed an amplectant pair of *G. cornuta* ca. 10 m above the ground. Newly emerged froglets have not been found to date in this area. However, in early 2006, we encountered two juveniles ca. 2 m above the ground; these may be offspring born in late 2005.

Marsupial frogs exhibit multiple modes of parental care depending on species (Duellman 1970). In some species, such as *G. riobambae*, the female parent carries tadpoles in the pouch until they are released at late stages of growth into a water source. In other species, the female carries and delivers fully developed froglets, as in the case of *G. cornuta*. Considering all species of *Gastrotheca* and *Flectonotus*, there are six morphological pouch types based on size, position, and degree of coverage (del Pino 1980; Mendelson et al. 2007). The evolution of each of the differing types of pouch morphology and reproductive behavior bears further study for contributions to the science of natural history, evolution, and phylogenetics. Application of these findings to captive reproduction will have implications for *ex situ* conservation and potentially survival of threatened species.

The pouch develops from the skin of the dorsum and can extend nearly up to the back of the skull or even to the lateral lymph spaces. After eggs are inserted into the pouch, usually by the male, the interior skin of the pouch becomes vascularized and in some cases



FIG. 2. Enclosure for maintaining *Gastrotheca cornuta*. Photo by Robert Hill.

forms partitions between embryos (del Pino 1980). Species, such as *G. cornuta*, that undergo direct development of eggs to frogs within a pouch, exhibit an interesting example of a life history completely free of any significant body of water—a method far removed from the plesiomorphic and most common amphibian strategy involving the deposition of eggs directly into water (Wells 2008). Presumably this life history allows species to live under less than favorable environmental conditions with respect to availability of bodies of water, and may reduce exposure of developing offspring to water-borne threats such as predation or disease. Wells (2008) provided a thorough summary of the evolutionary and ecological aspects of this important question, and Todd (2007) proposed an important role of disease and parasites as selective agents in the evolution of alternative reproductive strategies in amphibians.

As the scope of the crisis of global amphibian extinctions becomes clear (Stuart et al. 2004) and the threat of emerging infectious diseases such as amphibian chytridiomycosis become more apparent (Daszak et al. 2003), a collaborative effort of the International Union for the Conservation of Nature (IUCN), Captive Breeding Specialist Group (CBSG), and World Association of Zoos and Aquariums (WAZA) has brought about the Amphibian Ark organization (www.amphibianark.org). The Amphibian Ark is dedicated to safeguarding the species that cannot currently be saved in nature; this is accomplished by managed breeding programs to safeguard species while threats can be further mitigated. In some cases, managed populations may serve as a stopgap for many species heading for extinction. The IUCN Amphibian Conservation Action Plan (Gascon et al. 2007) specifically calls for captive breeding and research programs for threatened amphibians. The use of captive breeding programs as a conservation tool is not new and summaries can be found in Zippel et al. (2002) and Gagliardo et al. (2008).

As chytridiomycosis entered the range of *G. cornuta* (Lips et al. 2006), adversely affecting this and other species (Gagliardo et al. 2008), a conservation breeding program was launched. In 2005, specimens of *G. cornuta* were legally exported from Panama to the Atlanta Botanical Garden (ABG), and in 2006 similar specimens were collected and moved to the El Valle Amphibian Conservation Center (EVACC) in El Valle de Antón, Panama. Here we present an overview of our program, some interesting behavioral observations (e.g., toe tapping, male and female vocalizations, egg fertilization and deposition), along with husbandry challenges for long-term care in captivity we have encountered.

Results at the El Valle Amphibian Conservation Center in Panama

Adults at EVACC were maintained in top-opening glass enclosures (60 cm × 30 cm × 40 cm). The substrate consisted of a "false bottom floor" constructed of plastic light diffuser material covered with soft fiberglass screen secured in place with plastic "zip" ties. Non-bleached paper towel was used as covering on the bottom of this false bottom. Potted plants including *Philodendron* and *Heliconia* were added along with pieces of cork bark or half-inch PVC for refuge and perching sites. Two 96-watt power compact fluorescent lights provided lighting and the temperature was maintained at 23–25°C. The frogs were misted automatically 10 times daily with filtered water. Males and females were housed separately until breeding attempts were made, at which time a male was introduced in late afternoon to the female's enclosure. The male vocalized occasionally during the day but mostly in the early evening and throughout the night. All adults were fed katydids (*Neoconocephalus saturatus*) every other day. Because of observed cannibalism, the males were kept individually until placed with a female. On several occasions we noted that the dominant male would attempt to consume another male. In one case, the whole front limb (all the flesh off the bones) and part of the back (partially) of the less dominant male were partially digested. During this process the less dominant male (attributed to its proclivity to hiding rather than perching in the open) was still alive despite being partially digested by its cage mate.

Information on specimens used in breeding event:

Female *Gastrotheca cornuta* (EVACC 001-3) was collected from Río María on 17 June 2006 (found in amplexus with a male) and male *G. cornuta* (EVACC 001-5) collected (also from Río María) on 20 June 2006.

Female history:

On 29 December 2006, the female (EVACC 001-3) was observed to be gravid. Different males (EVACC 001-8, 001-7, and 001-6) were placed with the female individually over the course of several weeks but removed when the male did not amplex the female. On 28 January 2007 amplexus was noted with male EVACC 001-6. On 4 February 2007 the female had eggs in her pouch. Fertiliza-

tion was not observed. On the morning (0800 h) of 20 April 2007, froglets (N = 14) were observed in the enclosure along with two incompletely formed young that were apparently aborted.

2008 Breeding event:

21 February: Male *G. cornuta* (EVACC 001-5) placed in tank with resident female (EVACC 001-3).

22 February: Male and female observed in axillary amplexus. Male had all hand digits in axillary position except one (unclear exactly which due to position and ambient light levels), which was on top of female's front limb.

23 February, 1429–41 h: Male and female observed in axillary amplexus on paper towel at bottom of terrarium. Male arched hind limbs to about a 50° angle while female started to rock (i.e., pushing movement) for about 10 seconds (s). Female maintained front limbs out in front of her, underneath her body (i.e., "praying" position). Male maintained the 50° position for about 5 s, and then settled in so that his legs were held tightly against his body, with his head resting perfectly on top of female's head.

1441–49 h: Male placed his feet on female's back and pushed hind limbs in the air in a 50–60° angle. The male inflated himself, and then raised his legs so that his heels were touching, and maintained position for about 10 s. Female remained motionless during this time, until 1449 h when she pushed against the ground with her back limbs, while the male moved his limbs slightly (15° angle).

1450 h: Male inflated and engaged in movement for 45 s.

1510 h: Female's cloaca reddened and pushed out with male's movement.

1512 h: Male inflated again and engaged in movement for 4 s.

1514 h: Appeared as if the male's movements were an attempt to help the female push out eggs. Female's cloaca tilted upward and aligned with male's swollen cloaca. No egg was released but male moved his hind leg as if to find an egg.

1519–24 h: Male inflated, then female moved her hind legs to 45°. Male inflated again, and then female's cloaca could be seen moving in a pulsing manner.

1525–29 h: Female lifted cloaca. Male touched female cloaca (raising hind limbs) with his left toes making sweeping motion on female's back. Male's feet (toes) were in the vicinity of female's pouch. Female then spread her hind limbs a bit farther apart and assumed a broader stance.

1530–34 h: Male inflated, then deflated, and a gel-like substance appeared. It was not clear if this originated from the cloaca or from the skin. It appeared that the male was glistening first and then after some time it was apparent that the female was coated with this substance as well. The male rubbed substance all over the lower back and pouch of the female with his toes.

1535–54 h: Male began cycles of inflation and deflation. Female moved forward and moved her hind legs; they still maintained a 45°angle but heels were now closer together. Male proceeded to rub the gel-like substance all over the female with his toes.

1555–1601 h: Female rearranged her feet, first right then left in a motion (position) similar to as if preparing to jump. Male and female cloacas aligned with each other. Male continued cycles of inflation and deflation, and continued to spread gel over female's body with his toes. The side of female glistened with the gel-like substance. Male's body was also covered by the substance, which did not appear to dry.

1602–05 h: Female's body was observed to contract. Female pushed forward while the male rose up and down (but did not inflate). Male moved his cloaca into a position directly dorsal to female's cloaca.

1607–14 h: Female arched body, raising her cloaca above the angle of her feet, and cycles of body contractions were observed. Male continues to inflate and deflate. Male then slid forward, pushing female downward and continued to spread the gel over her.

1617–22 h: Male continued inflating and deflating, and rubbing the gel over female with his feet. Then a round egg could be seen in the aperture of female's cloaca. Female rearranged her hind legs, and raised her cloaca while male inflated and deflated. Male moved to bring his cloaca in alignment with that of female.

1628 h: Male deflated. Egg inside of female's cloaca slightly visible as male pushed down. Male moved his toes toward female's pouch.

1630–53 h: Female's body continued with cycles of contractions, and male continued to inflate and deflate. The egg could be seen alternately appearing and disappearing at the aperture of females' cloaca.

1655 h: First egg emerged from female's cloaca, while her body appeared to be in a strong contraction. Male cradled the egg with his body, and maneuvered it into female's pouch with his hind toes. Male continued to inflate and deflate.

1701 h: Male pushed down on female. A second egg almost emerged from female's cloaca.

1706 h: The second egg emerged, and was pushed into the pouch by the male using his feet.

1711 h: Third egg emerged, and male trapped it with his cloaca and pushed it toward the pouch opening. Male used hind legs to position it in female's pouch.

1719 h: Fourth egg emerged, and male repeated behavior to insert it into female's pouch. It appeared as if the male's toes were inserted inside of the pouch, at least dextrally.

1724 h: Male engaged in head bobbing behavior.

1726 h: Fifth egg emerged, and male observed to insert toes into the pouch while inserting the egg.

1729–1834 h: Pair maintained amplexus, male continued to inflate and deflate and began to perform a "rocking" motion, but no additional eggs were produced. The female changed position in minor ways several times before disengaging amplexus.

Results at the Atlanta Botanical Garden

As part of a pilot study aimed at learning the logistics of an ex situ response to the rapid spread of the amphibian chytridiomycosis through pristine amphibian populations in Panama, several threatened amphibian taxa were exported to facilities at the ABG and Zoo Atlanta in 2005 (Gagliardo et al. 2008). The original breeding group of six male and two female *G. cornuta* was maintained at the ABG where several breeding events have occurred. Adults were maintained in either 60 × 30 × 60 cm or 60 × 60 × 90 cm front-opening glass enclosures for maintenance (smaller) or breeding (larger). The substrate consisted of a "false

bottom floor" constructed of plastic light diffuser material covered with soft fiberglass screen secured in place with plastic "zip" ties. Potted plants including *Philodendron*, *Heliconia*, and *Calathea* were added for hiding places. Pieces of driftwood or similar twigs were provided for perching sites (Fig. 2). Two 96-watt power compact fluorescent lights provided lighting and the temperature was maintained between 18°C and 27°C. The frogs were misted twice daily with filtered water either through an automated system or by hand sprayer bottle. A 15–20 cm diameter, 6-cm-deep shallow water dish containing smooth river stones was refreshed with clean water daily. The stones afforded a climb-out option for not only the frogs after soaking in water but also food items that happened to fall into the water. Males and females were housed separately until breeding attempts were made, at which time a male was introduced in late afternoon to the larger enclosure containing one female. Male vocalization, a very loud, single note similar to the sound of removing a cork from a bottle, was common in early evening.

The first breeding event occurred in April 2006, less than 48 h after introducing a male into a female's enclosure. Both individuals were exposed to an imposed "dry season" simulated by six weeks of slightly warmer temperatures and lower humidity achieved by less frequent misting of the enclosure and increasing ambient day time temperatures from 20–25°C. There were no signs of courting or amplexus before the female was discovered in the early morning (0700 h) on the second day after introduction of the male. Fourteen eggs appeared to have been inserted into the female's pouch (Fig. 3) and there were two infertile eggs found on the surface of a leaf in the tank. The recovered eggs were approximately 1.0 cm in diameter, not unexpected as this species is reported to produce the largest anuran egg known (Duellman and Trueb 1986). Immediately following this breeding event, the male was moved to separate enclosure to reduce stress on the gravid female.

Video surveillance of this first attempt did not record any breeding activity but did record evident toe tapping of the female who upon sight of a live, moving cricket (*Acheta domestica*), became keenly interested in the prey and began to tap and motion with toes of her hind feet. Pedal luring (Bertoluci 2002; Murphy 1976; Radcliffe et al. 1986) and providing a vibrational stimulus resulting in prey movement and ultimately prey detection (Sloggett and Zeilstra 2008) are two hypotheses for toe twitching and toe tapping in anurans. Although toe twitching and tapping are thought to be a common behavior among many frogs and toads (Sloggett and Zeilstra 2008), and have been reported in numerous anuran genera from several different families, including Batrachophrynidae (Radcliffe et al. 1986), Bufonidae (Hagman and Shine 2008; Radcliffe et al. 1986; Sloggett and Zeilstra 2008), Dendrobatidae and Hylidae (Bertoluci 2002), this is the first documentation of pedal luring in the Hemiphractidae.



FIG. 3. Female *Gastrotheca cornuta* with eggs in pouch. Photo by Brad Wilson.



FIG. 4. Newly emerged *Gastrotheca cornuta*. Photo by Heidi Ross and Edgardo Griffith.

An additional breeding event occurred in Atlanta in the spring of 2008. On 14 April a male was introduced to an enclosure containing a visibly gravid female. Within 24 h, amplexus was observed, followed overnight by eggs being visible in the pouch. These eggs incubated until 15 June 2008 when thirteen live froglets and two infertile eggs were discovered in the enclosure.

Gestation, Birth, and Handling of Offspring

Gestation periods ranged from 60–80 days over the course of several breeding events. In the final week before froglets emerged from the pouch, it was possible to see movement of the limbs of the embryos just beneath the skin of the pouch. At both ABG and EVACC, the newly born offspring were approximately 1.0 cm in length and averaged 400 mg in mass (Fig. 4). Upon their birth, offspring were separated into individual enclosures to avoid predation by the female and offered a variety of prey items including fruit flies, houseflies, and small (3–5 mm) crickets. Food items were dusted alternately with vitamins (Men's Health® multivitamin, once per week) and calcium supplements (RepCal® with Vitamin D3, twice per week).

Abortion of Developing Offspring

Case 1: On 20 June 2007, a gravid female ca. 50 days post-breeding aborted five developing offspring and seven non-developed eggs. There were no outward physical signs of any problems prior to this event. The pouch remained partially inverted for approximately 48 h before repositioning to its normal state (Fig. 5). The developing offspring displayed long, 2–4 cm filamentous gills attached through the skin under the throat (Fig. 6).

Case 2: An abortion of eggs occurred immediately following



FIG. 5. Inverted pouch of female *Gastrotheca cornuta* less than 24 h after emergence of froglets. Photo by Ron Gagliardo.

a July 2008 breeding event. Although our attempts to record the breeding event via night-vision video were unsuccessful (likely due to disturbance caused by shifting of blinds, camera tape changes, noise, etc.) and we did not capture the breeding event on film, we did observe vocalization by the female that consisted of a single soft "bop" periodically prior to amplexus. This could be an encounter call and although we found this unusual, encounter calls have been documented in other anurans (Quiguango-Ubillús and Coloma 2008). Five eggs were never inserted into the pouch and the seven eggs successfully moved into the pouch were aborted within 72 h. We noted that in contrast to the previous case, the lining of the pouch was not extruded possibly because the pouch never became vascularized. Attempts to artificially incubate five eggs on sterile paper toweling or sphagnum moss failed and the eggs disintegrated within 24 h.

Obstacles for Long-term Captive Management

Whereas the captive reproduction of *Gastrotheca cornuta* proved much less difficult than expected, raising offspring has been extremely challenging. Most losses occurred during the first 5–20 weeks after birth. Necropsy results indicated a range of issues including internal parasites (mostly rhabditiform nematodes), squamous metaplasia ("short-tongue syndrome" possibly indicative of Vitamin A deficiency), and signs of metabolic bone disease. Currently, there are 11 captive-born offspring in existence,



FIG. 6. Partially developed offspring of *Gastrotheca cornuta* that were aborted during the final weeks of development. The bell gills that characterize this group of frogs are clearly visible. Photo by Ron Holt.

6 at EVACC and 5 at ABG. The five frogs at ABG are over one year in age, weigh between 7.1–12.7 grams and have snout–vent lengths (SVL) of 42–55 mm. Specimens appear to be in overall good health, but have grown very slowly and show some slight rear limb deformities possibly attributable to improper vitamin and mineral supplementation, and/or inadequate exposure to UV-B. At EVACC, the offspring are 12–15 months of age and five of the six also exhibit problems consistent with metabolic bone disease and other skeletal deformities. One frog, (a single survivor from a clutch that emerged on 27 May 2008) has received exposure to UV-B radiation (45 minutes daily from an Eiko® 50-watt halogen bulb with lens removed and positioned atop enclosure) and has not developed any obvious skeletal deformities. The slightly deformed animal from the first clutch born in April 2007 actively hunts and is now calling (Fig. 7). Experiments with Vitamin A supplementation and UV-B exposure currently underway are aimed to mitigate these problems. It is crucial to the survival of these colonies to decipher the husbandry issues, raise offspring to adulthood, and produce subsequent generations.



FIG. 7. Juvenile captive born *Gastrotheca cornuta* exhibiting skeletal deformity. Photo by Brad Wilson.

Conclusions and Implications for Conservation

In comparison to other anuran families such as Dendrobatidae and Ranidae, relatively little is known about the natural or captive reproduction of hemiphractine frogs. Mating behavior in captive specimens of *Gastrotheca riobambae* by Matthews (1957), Deckert (1963), and Hoogmoed (1967), as summarized by Means et al. (2009), was similar to what we have described here, in the male producing a fluid that is rubbed over the posterior area of the female (from cloacal region extending to the anterior limit of the brood pouch) and using his hind legs to insert eggs into the pouch as they are extruded. We speculate that the clear fluid observed by Means et al. (2009) and by us in Panama might have been produced by the male. We should not rule out the possibility that such secretions from the male may contain hormones or other chemicals that stimulate observed contractions in the females. In addition, the vocalization of the female during amplexus remains a mystery. Clearly, these interesting observations should be subject to future investigation.

Along with the actual physical reproductive behavior in hemiphractine frogs such as *Flectonotus* and *Gastrotheca*, we should consider how the natural history affects the developmental physiology of these taxa. Some species are known to bask only while incubating embryos, thus exposing themselves to UV-B radiation (Auber-Thomay et al. 1990). Does this suggest that eggs or developing froglets need UVB or heat for proper development? There are also reports of infection of tadpoles by rhabditiform nematodes while incubating inside the pouch (Auber-Thomay et al. 1990).

What are the Implications of Such Parasitism in the Wild or Captivity?

Over half of the 57 known species of *Gastrotheca* are exhibiting population declines (www.iucnredlist.org). The IUCN Red list categorizes *G. cornuta* as Endangered, and a more recent prioritization by the Panamanian government and the Amphibian Ark placed it among the top Panamanian species in need of *ex situ* intervention (Amphibian Ark 2009; IUCN 2009). This highly threatened status warrants continued searches in Panama and elsewhere for additional founder specimens to increase genetic variability of managed colonies. Clearly, the phylogenetically, taxonomically, and physiologically unusual masterpieces that are *Gastrotheca* (Fig. 9) are worthy of conservation efforts. In cases where threats in nature cannot be mitigated in time, managed *ex situ* populations may be the only hope for safeguarding these species until such threats are reversed or until other methods for re-establishing these species in nature are developed. Learning more about the complex natural history and physiology will certainly be of great assistance in the future conservation of these and other endangered amphibian species. We also offer that our natural history and behavioral observations presented here are unlikely to have been documented in the wild, thus supporting the claim that captive programs provide real opportunities for basic research (Chiszar et al. 1993), in this case relating to natural history and behavior. As such, these programs function as a crucial component of the "multidisciplinary approaches to conservation" (Gans 1994).

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NATURAL HISTORY NOTES

The Natural History Notes section is analogous to Geographic Distribution. Preferred notes should 1) focus on observations in the field, with little human intrusion; 2) represent more than the isolated documentation of developmental aberrations; and 3) possess a natural history perspective. Individual notes should, with few exceptions, concern only one species, and authors are requested to choose a keyword or short phrase which best describes the nature of their note (e.g., Reproduction, Morphology, Habitat, etc.). Use of figures to illustrate any data is encouraged, but should replace words rather than embellish them. The section's intent is to convey information rather than demonstrate prose. Articles submitted to this section will be reviewed and edited prior to acceptance.

Electronic submission of manuscripts is requested (as Microsoft Word or Rich Text format [rtf] files, as e-mail attachments). Figures can be submitted electronically as JPG files, although higher resolution TIFF or PDF files will be requested for publication. Please DO NOT send graphic files as imbedded figures within a text file. Additional information concerning preparation and submission of graphics files is available on the SSAR web site at: http://www.ssarherps.org/HRinfo.html. Manuscripts should be sent to the appropriate section editor: **Marc P. Hayes** (crocodilians, lizards, and *Sphenodon*; mhayesrana@aol.com); **Charles W. Painter** (amphibians; charles.painter@state.nm.us); **Andrew T. Holycross** (snakes; AndrewHolycross@gmail.com); and **James Harding** (turtles; hardingj@msu.edu).

Standard format for this section is as follows: SCIENTIFIC NAME, COMMON NAME (for the United States and Canada as it appears in Crother [ed.] 2008. *Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico*. SSAR Herpetol. Circ. 37:1–84, available from SSAR Publications Secretary, ssar@herplit.com; for Mexico as it appears in Liner and Casas-Andreu 2008, *Standard Spanish, English and Scientific Names of the Amphibians and Reptiles of Mexico.* Herpetol. Circ. 38:1–162), KEYWORD. DATA on the animal. Place of deposition or intended deposition of specimen(s), and catalog number(s). Then skip a line and close with SUBMITTED BY (give name and address in full—spell out state names—no abbreviations). (NCN) should be used for common name where none is recognized. References may be briefly cited in text (refer to this issue for citation format).

Recommended citation for notes appearing in this section is: Medina, P., and R. L. Joglar. 2008. *Eleutherodactylus richmondi*: reproduction. Herpetol. Rev. 39:460.

CAUDATA — SALAMANDERS

ANEIDES FERREUS (Clouded Salamander). **ARBOREAL ACTIVITY.** *Aneides ferreus* inhabits the forests of western Oregon and extreme northwestern California. Although thought to be primarily terrestrial, *A. ferreus* has occasionally been found as high as 60 m up in trees (Jones et al. 2005. Amphibians of the Pacific Northwest. Seattle Audubon Society. 227 pp.), and two recent reports suggest that it may be more arboreal than previously believed (Spickler et al. 2006. Herpetol. Conserv. Biol. 1:16–26; Forsman and Swingle 2007. Herpetol. Conserv. Biol. 2:113–118). However, it is difficult to evaluate the amount of arboreal activity by this species because almost all sampling efforts have been focused on terrestrial habitats.

On 23 May 2008 near the Coquille River in southwest Oregon we observed two adult *A. ferreus* in a cavity 75 m above ground in a Douglas-fir tree (*Pseudotsuga menziesii*) that was 78 m tall and 195 cm diameter at breast height (43.1797°N, 123.8122°W; WGS 84). Exposed when a limb broke off, the small cavity in the trunk contained copious amounts of Red Tree Vole (*Arborimus longicaudus*) fecal pellets. Two days later we photographed what we presumed to be the same two salamanders in the cavity (Fig. 1). Based on the shape of their heads, we suspected they were a male and female. These observations add to the increasing evidence that *A. ferreus* is more active in the canopy of Douglas-



FIG. 1. *Aneides ferreus* inside a cavity 75 m above ground in the top of an old-growth Douglas-fir (*Pseudotsuga menziesii*), Coquille River, Oregon, USA.

fir forests than is generally known and also support the hypothesis that nests of arboreal rodents may be important microhabitats for *A. ferreus* (Spickler et al. 2006, *op. cit.*; Forsman and Swingle 2007, *op. cit.*). It remains unknown if use of the forest canopy by *A. ferreus* is restricted to foraging and shelter, or includes occasional breeding as well.

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CRYPTOBRANCHUS ALLEGANIENSIS ALLEGANIENSIS (Eastern Hellbender). **SECRETION PRODUCTION.** Of the potential antipredator mechanisms exhibited by amphibians, noxious skin secretions are considered the most effective against potential predators (Brodie et al. 1979. Copeia 1979:270-274). Many species produce toxic and irritating skin secretions as adults, but the larvae of many salamanders are palatable to various predators because toxic and distasteful secretions generally do not develop until after metamorphosis (Formanowicz and Brodie 1982. Copeia 1982:91–97).



FIG. 1. Larval Eastern Hellbenders (*Cryptobranchus alleganiensis alleganiensis*) immediately after producing a white secretion composed of sticky and foamy components.

Adult *Cryptobranchus alleganiensis* are large amphibians (60+ cm) and probably have few predators. When stressed or being captured, adult hellbenders often produce a milky secretion that is bitter and distasteful when applied to the tongue (Brodie 1971. Herpetol. Rev. 3:8), and the secretion may be unpalatable to predators. Larval hellbenders hatch between 23 and 30 mm total length and metamorphose 1.5–2 yrs after hatching, and are probably highly vulnerable to predation due to their small size and slow developmental rate (Nickerson and Mays 1973. The Hellbenders. Milwaukee Public Museum. Wisconsin. 106 pp.). It is unknown when the ability to produce secretion develops in hellbenders. In Oct–Nov 2007 several Eastern Hellbender egg clutches were collected in Missouri for captive rearing. On 29 April 2008 at 0900 h, 12 larval hellbenders (25 weeks post hatching, mean TL ± SE = 91.75 ± 1.8 mm) were collected in a small net for transport to a separate container for behavioral observations. The larvae immediately produced copious amounts of a secretion that appears to have two components. The first component was water-soluble and had a "foamy soap" appearance (Fig. 1). The second component was very sticky and was not soluble in water (Fig. 1); it remained adhered to the individual hellbenders for up to 48 h. Both components are similar in appearance to those produced by adult hellbenders (Nickerson and Mays 1973, *op. cit.*).

Immediately after secretion production, BGG put a small amount of the foamy secretion on his tongue and experienced a strong bitter sensation lasting for ca. 5 sec. The sensation was not accompanied with burning or numbness. The larval secretion tasted very similar to that produced by adult hellbenders.

Our observations suggest that, unlike most salamanders with aquatic larvae, larval hellbenders are capable of producing noxious skin secretions that might function to deter potential predators.

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SIREN INTERMEDIA (Lesser Siren). **DROUGHT SURVIVAL.** Adult sirens are able to survive prolonged exposure to drought conditions with larger animals being more successful at surviving laboratory-induced aestivation than smaller conspecifics (Gehlbach et al. 1973. Am. Midl. Nat. 89:455–463; Etheridge 1990. Herpetologica 46:407–414). Larger Greater Sirens (*Siren lacertina*) can possibly survive droughts for 2–3 years and very small sirens (~1 g) are likely able to survive droughts of 146 days (Etheridge 1990, *op. cit.*). Despite the numerous reports of aestivating sirenids in the literature, it remains unknown whether small, young of the year sirens can survive short drought conditions under field conditions. In 2007, many isolated wetlands on the Savannah River Site in Barnwell County, South Carolina, USA, dried completely as a result of a severe drought in the southeastern United States. Even some of the most permanent wetlands on the site dried completely for the first time in nearly 10 years. One of these semi-permanent wetlands, Craig's Pond, is a 72.8-ha Carolina Bay wetland that is the largest natural bay on site. We visited Craig's Pond on 23 Feb 2008 from 2100–2300 h after a series of heavy rains passed through the area. There was a film of dried organic matter floating on the surface of the bay that was presumably formed when the bay dried, the water was uncharacteristically clear and the bottom of the wetland was still comprised of cracked mud and (now submerged) green terrestrial grasses (indicating that the water in the wetland was mostly, if not all, from recent rainwater). During this time, we saw a few *Siren intermedia* moving along the wetland bottom. Judging from Gehlbach and Kennedy's (1978. Southwest. Nat. 23:423–429) estimates of year class data, these were likely individuals that would have hatched in 2006 (~20 g). On a subsequent visit on 12 March 2008 from 2100–2300 h we captured two *S. intermedia* that were yearlings from 2007 (~5 g) and sighted several more small sirens. The presence of the two smallest size classes from the previous year's population in Craig's Pond indicates that even the smallest *S. intermedia* were able to successfully survive a short term wetland dry down from ca. November 2007 to February 2008. Additionally, many fish were present in Craig's Pond prior to the drought, including Redfin Pickerel (*Esox americanus*), and cyprinids. Despite several person-hours of searching on both nights, no fish were seen. This suggests that no temporary waterways connected Craig's Pond with other water sources where fish or sirens may have persisted. Consequently, it is likely that the small sirens we observed in Craig's Pond were in fact drought survivors and not dispersers from connected waterways. To our knowledge, this is the first record of juvenile sirens surviving drought conditions in the field.

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ANURA — FROGS

AGALYCHNIS CALLIDRYAS (Red-eyed Treefrog). **EGG PREDATION**. Red-eyed Treefrogs are found in low elevation tropical forests from the southern Yucatan through Panama. Females deposit clutches of eggs on leaves that overhang ponds, and eggs spontaneously hatch after 5–8 days (Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna Between Two



FIG. 1. Upper: Juvenile *Cupiennius getazi* in close proximity to a clutch of *Agalychnis callidryas* eggs. Lower: Close-up of spider consuming the developing embryo.

Continents, Between Two Seas. Univ. Chicago Press, Chicago, Illinois. 934 pp.). Eggs are often attacked by aerial (wasp: Warkentin 2000. Anim. Behav. 60: 503–510) and arboreal (snake: Donnelly and Guyer 1994. Oecologia 98:291–302; Warkentin 1995. Proc. Natl. Acad. Sci. USA 92:3507–3510) predators. Here we present an account of predation of an *Agalychnis callidryas* embryo by a spider.

While conducting field work in the Researcher's Swamp at La Selva Biological Station near Puerto Viejo de Sarapiqui, Costa Rica, we observed a spider occupying a territory (i.e., seen on consecutive days within a limited area) on a leaf that contained a clutch of *A. callidryas* eggs (26 June–1 July 2008). On the fourth day after oviposition, the spider appeared to defend the clutch by moving rapidly into a position on top of the eggs as we approached. The following evening (28 June, ca. 2200 h), we witnessed the spider consuming one of the embryos from the egg clutch (Fig. 1). Although vibrational cues are known to trigger hatching in *A. callidryas* eggs (Savage 2002, *op. cit.*; Warkentin 2005. Anim. Behav. 70:59–71), none of the eggs hatched during this predation event. Before the onset of spontaneous hatching (1 July), we collected and preserved the spider, and it was later identified as a juvenile *Cupiennius getazi* (Family Ctenidae).

This is the first account of spider predation on eggs of *A. callidryas*, and to our knowledge, the only account of a spider consuming amphibian eggs. The spider was deposited at the La Selva Biological Station Museum (collection code MG.08,06; specimen LS814539). We thank Carlos Viquez (INBio, Costa Rica) for identifying the spider.

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BUFO MELANOSTICTUS (Asian Common Toad). **RECORD SIZE**. *Bufo melanostictus* is known to be the largest toad in South China, attaining an SVL of "about 10 cm" (Karsen et al. 1998. Hong Kong Amphibians and Reptiles, Provisional Urban Council, Hong Kong, China). The largest published record available is 106 mm SVL (Fei [ed.] 1999. Atlas of Amphibians of China, Henan Science and Technology Press, Zhengzhou, China). On 11 Aug 2008, at night after a rain at Wuzhi Shan (Five Finger Mountain) National Nature Reserve (18.83333°N, 109.55°E; ca. 900 m elev., WGS 84), Hainan Island (Province), we captured a female toad of great size. Pressed flat on a table, snout tip against the wall, she measured 115 mm SVL (relaxed view: Fig. 1). Identity of the species, gender, and measurement were verified by James Lazell. We had no collecting permit and released this toad to grow even larger. The photograph is accessioned at the Museum of Comparative Zoology (MCZ K-959). Our field work was sponsored in part by the Falconwood Foundation and by the grant from the Natural Science Foundation of Guangdong Province (No. 06025054). We thank J. Rosado and J. Lazell, MCZ, for photo accession assistance.

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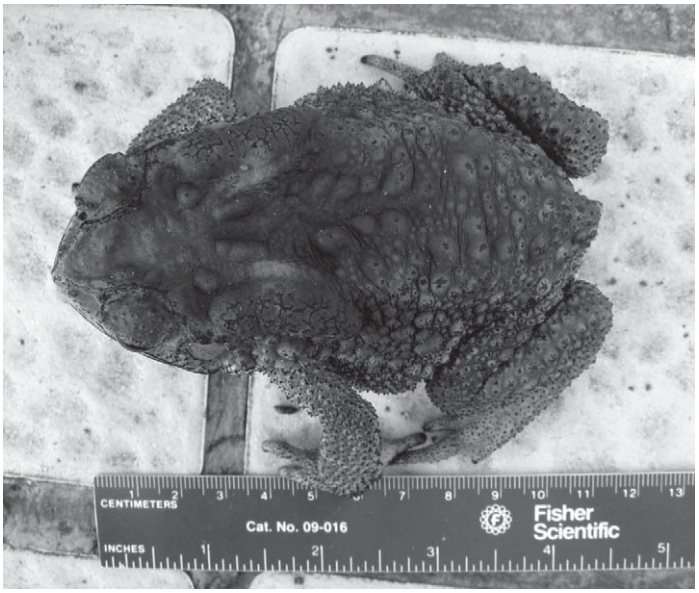


FIG. 1. Record size *Bufo melanostictus* from Hainan Island, South China.

CENTROLENE PROSOBLEPON (Glass Frog). **REPRODUCTION.** *Centrolene prosoblepon* is a neotropical frog ranging from Honduras to Ecuador (Frost 2008. Amphibian Species of the World, ver. 5.3. <http://research.amnh.org/herpetology/amphibia/index.html> Accessed 14 Aug 2008). There are no data available on reproductive characteristics of this species including the number of the egg per clutch, egg size, and color of embryos at an early stage of development, i.e., less than Gosner Stage 10 (Gosner 1960. Herpetologica 16:183–190). Herein, we report this information collected near Falan (5.11666°N, 74.96666°W; WGS 84), Tolima, Colombia. Between November 2007 and May 2008, we found more than 200 egg clutches of *C. prosoblepon* laid on the top of leaves over a stream along a 600 m transect. Of these, we collected data from 40 clutches. We recorded an average of 32 eggs per clutch



FIG. 1. Egg clutch of *Centrolene prosoblepon* from near Falan, Tolima, Colombia.

(range: 25–47), mean diameter of the eggs was 2.56 mm (N = 27), and all embryos were pale yellow (Fig. 1).

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CENTROLENE PROSOBLEPON (Glass Frog). **FUNGAL INFECTION.** Amphibian decline is a global phenomenon caused by multiple factors (Stuart et al. 2004. Science 306:1783–1786). Some declines have been attributed to the infectious disease caused by the fungus *Batrachochytrium dendrobatidis*, which is found in the oral disc of larvae and the skin of adults (Zellmer and Richards 2008. Herpetol. Rev. 39:196–199; Zippel and Tabaza 2008. Herpetol. Rev. 39:192–193). It is less detectable in newly metamorphosed frogs and may not be reliably detected in some species until two to three weeks after metamorphosis (Chestnut et al. 2008. Herpetol. Rev. 39:202–204). Few data are available regarding the fungal pathogens of embryos. Kiesecker and Blaustein (1997. Conserv. Biol. 11:214–220) reported *Saprolegnia ferax* on embryos of three anurans (*Bufo boreas*, *Rana cascadae*, and *Hyla regilla*) common to the Pacific Northwest, USA, and suggested that eggs in communal masses are highly susceptible to infection with *S. ferax*.



FIG. 1. Embryos of *Centrolene prosoblepon* infected by *Saprolegnia* sp.

Between November 2007 and March 2008, we found 20 different egg clutches of *Centrolene prosoblepon* infected by fungus (Fig. 1) near Falan, Tolima, Colombia (5.11666°N, 74.96666°W; WGS 84). We recorded between 25 and 35 dead embryos per clutch. We collected some of these clutches and transported them to the University of Tolima where the fungus was identified as *Saprolegnia* sp. Thus, mortality of embryos from fungal pathogens other than *B. dendrobatidis* may contribute to the global amphibian population decline.

We thank Oscar Cardozo and Gloria Palma for the identification of the fungus.

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DENDROPSOPHUS MICROCEPHALUS (Yellow Cricket Tree Frog) **BEHAVIOR.** *Dendropsopus microcephalus* is a small nocturnal, yellowish frog that inhabits humid and dry lowlands along the Pacific slope of Costa Rica. It is generally found in open areas, perching in vegetation over water bodies (Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna Between Two Continents, Between Two Seas. University of Chicago Press, Chicago, Illinois. 934 pp.) Little is known about the ecology of dry-season aestivation for this and many other tropical anurans.

During the peak of the dry season during February 2004, we visited Palo Verde dry forest to observe the diurnal and nocturnal activity of *D. microcephalus* around a waterhole, and to observe behavior that might suggest a period of aestivation for this species. During the December–May dry season (Hartshorn 1983. *In* D. Janzen [ed.], Costa Rican Natural History, pp. 118–157. University of Chicago Press, Chicago, Illinois), the reduction of water bodies in this area leaves widely scattered pools that become very important for water-dependant organisms (Vaughan et al. 1997. Int. J. Trop. Biol. Cons. 45:1679–1682). We observed *D. microcephalus* perching between 1730 h and 0530 h, in aggregations of individuals in *Ardisia revoluta* shrubs around the waterhole. At all times the individuals stayed motionless and did not emit vocalizations or show conspicuous foraging activity. Between 0530 h and 1730 h, the individuals hid under the leaf-litter and remained motionless and silent as well. Such inactivity was constant throughout the peak of the dry season. Variation in water availability has been shown to induce behavioural responses in anurans to control evaporative water loss. This implies that amphibians respond to water shortage by adopting water-conserving postures (Pough et al. 1983. Ecology 64:244–252; Storey 2002. Comp. Biochem. Physiol. Part A 133:733–754). Hence, we suggest that *D. microcephalus* may be aestivating through the adoption of water-conserving postures around the waterhole, a limited resource during the driest months of the year.

Moreover, we observed that most individuals perched in the interior of the crowns of *A. revoluta*. We created categories to study the location of these perches to determine if individuals preferred perching in the interior of the crowns. We suggest that selecting perches that are less exposed in the vegetation might

serve as a strategy to avoid water loss. Our classification was based on two parameters: height and position of the perch in the crown of the shrub. Perch height was described in terms of three categories: Higher stratum (Hstr, the higher third of the crown), Middle stratum (Mstr, the intermediate third of the crown), and Lower stratum (Lstr, the lower third of the crown). Perch position was also placed in one of three categories: Periphery Zone (the external third of the crown, using the trunk as reference), Middle zone (the third that is found between the periphery and the internal part of the crown), and Inner zone (the third that is located in the internal part of the crown, next to the trunk). We expect that most individuals will select perches in the inner zone and the middle stratum.

Most individuals selected perches in the interior part (Middle stratum and Inner Zone) of the crown of *A. revoluta* (Higher stratum = 16 individuals, Middle stratum = 52 individuals, Lstr = 33 individuals; $\chi^2 = 19.26$, df = 1, $p < 0.05$) (Periphery zone = 6 individuals, Middle zone = 47 individuals, Inner zone = 48 individuals; $\chi^2 = 554$, df = 1, $p < 0.05$). Additionally, we used ANOVA to determine there was no relation between body size and perch selection, both in perch height ($F_{2.98} = 0.65$, $p = 0.52$) and perch position ($F_{2.98} = 0.56$, $p = 0.57$). This suggests that there is no evidence for size-mediated intraspecific competition for more protected perches, which may be because aestivation is characterized by a general lack of activity that could preclude active selection and defence of desirable perches.

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ELEUTHERODACTYLUS ALTAMAZONICUS (NCN). **REPRODUCTION**. *Eleutherodactylus* species undergo direct development, forgoing an aquatic larval stage. It is generally assumed that species deposit eggs in trees within cavities or bromeliads, or on the ground amid moisture-retaining leaf litter or under rotting logs. However, records of oviposition by most species of *Eleutherodactylus* are rare.

On 26 May 2005, at 0830h we encountered a male (22.3 mm SVL, 0.66 g) and female (34.5 mm SVL, 2.03 g) *E. altamazonicus* in amplexus at the base of a large tree in primary, terra firma forest within Yasuní National Park in Ecuador (Provincia de Orellana). The pair was positioned over a small depression in the ground. The cavity was circular in shape, devoid of leaf litter, and roughly 3 cm in diameter and 1 cm deep. The pair was captured, placed together in a ziplock bag and taken back to the laboratory so measurements could be taken. Overnight, the female deposited 38 unpigmented eggs ca. 3.5 mm in diameter inside the bag. The eggs were returned to the depression from which the frogs were originally taken the next day. The study period ended 4 days after the pair was found. Therefore, we were not able to observe whether the eggs hatched. On 27 May, we encountered a second gravid *E. altamazonicus* female (32.1 mm SVL, 2.78 g) less than 100 m from the spot the first two individuals were encountered. These observations support previous suggestions that the beginning of the rainy season marks the onset of breeding in this species (Duellman 1978. Misc. Publ. Univ. Kansas, Mus. Nat. Hist. 65:1–352).

To our knowledge, only three clutches have been previously described for *E. altamazonicus.* The clutch size reported here is much greater and the eggs larger than those clutches (mean number of eggs in other reported clutches = 18.7, mean size = 2.8 mm) (Duellman 1978, *op. cit.*). This difference may be attributable to the large size of the female or potential geographic variation in reproduction in this species.

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HYLA AVIVOCA (Bird-voiced Treefrog). **DISTANCE FROM BREEDING SITE**. Essentially nothing is known regarding the distance *Hyla avivoca* moves from the breeding habitat after the breeding season. Smith (1961. Illinois Nat. Hist. Surv. Bull. 28:1–298) speculated that *H. avivoca* inhabits breeding sites year-round. Observations by Rossman (1960. Quart. J. Florida Acad. Sci. 22:207–225) and Redmer et al. (1999. Illinois Nat. Hist. Surv. Bull. 36:37–66) also suggest that *H. avivoca* remains at or near breeding sites outside the breeding season.

In contrast to these observations, I encountered two *H. avivoca* in Johnson County, Illinois, USA, away from breeding sites. I found an adult female on 8 May 2007 perched 1.2 m above the ground on a *Lonicera maackii* within a narrow strip of forest between a shrubby fallow field and a pasture (37.372778°N, 88.975°W). The female was 440 m west of the nearest *H. avivoca* breeding chorus located in June 2008 (37.3725°N, 88.97°W). On 20 May 2008, I heard a male *H. avivoca* diurnally vocalize from *Acer saccharinum*-dominated riparian forest (37.326003°N, 88.922953°W) 695 m from the nearest breeding site (37.332222°N, 88.921667°W).

The congeners, *H. versicolor* and *H. chrysoscelis* are known to make long-distance movements from breeding sites. Johnson et al. (2007. Biol. Cons. 140:250–258) followed a radio-tagged *H. versicolor* 271 m from its breeding site and Ritke et al. (1991. J. Herpetol. 25:123–125) documented movement of *H. chrysoscelis* up to 630 m between breeding sites. My observations indicate that *H. avivoca* is also capable of long-distance movements, suggesting that terrestrial habitat might provide essential resources outside the breeding season. Long-distance movements by *H. avivoca* might also allow exchange of individuals among disparate breeding choruses. This is especially important in southern Illinois where breeding locations of this state-threatened species are often separated by considerable distances.

I thank John Petzing and Floyd Scott for providing copies of difficult-to-procure literature, and the Illinois Endangered Species Protection Board for supporting Bird-Voiced Treefrog surveys.

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HYLA SQUIRELLA (Squirrel Treefrog). **REPRODUCTION**. Clutch size is an important aspect of an organism's reproductive strategy and population biology. However, few studies report clutch sizes for *Hyla squirella*. Wright (1932. Frogs of the Okefinokee Swamp, Georgia. Macmillan Co., New York) reported clutch sizes of 942 and 972 eggs for two females allowed to oviposit in the laboratory. Subsequently, Livezey and Wright (1947. Am. Midl. Nat. 37:179–222) suggested clutches > 950 eggs. Martof et al. (1980. Amphibians and Reptiles of the Carolinas and Virginia. Univ. North Carolina Press, Chapel Hill. 264 pp.) speculate that clutches contain approximately 1000 eggs. The best estimate of *H. squirella* clutch size is from five females in Florida with a mean of 1059 (311 SD) eggs (Brugger 1984. Aspects of Reproduction in the Squirrel Treefrog. Unpubl. Master's thesis. University of Florida, Gainsville). Herein, I report the clutch sizes of four females from South Carolina.

I caught 10 female and 10 male *H. squirella* on 13 July 2005 from a small pond on the Savannah River Site in Barnwell County, South Carolina, USA. When captured, females were not in amplexus and all appeared to be gravid. Individuals were brought back to the Savannah River Ecology Laboratory (SREL) where males and females were paired in plastic containers (20.3 × 7.6 × 7.6 cm) with pond water. Five of the females oviposited within 36 hours of capture, but one clutch was excessively disturbed by the adults preventing an accurate count of the eggs. The four remaining clutches had a mean of 1511 eggs. This mean clutch size is considerably greater than those previously described. The snout-vent length (SVL) for three individuals was 32.0, 32.5, and 35.5 mm and they oviposited 1277, 1392, and 1592 eggs. One individual escaped prior to measurement. Although the sample size is small, clutch size appears positively correlated with female body size and warrants further investigation.

I thank Tom Luhring and Rachel Mahan for help catching animals and SREL for use of their facilities.

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HYPSIBOAS ALBOMARGINATUS (White-edged Treefrog). **PREDATION.** Amphibians are frequently preyed upon by many types of predators, from carnivorous plants to large vertebrates. They provide a food source for many snake species and complement the diet of birds and mammals (Aucone and Card 2002. Herpetol. Rev. 33:48; Haddad et al. 2008. Atlantic Forest Amphibians. Neotropica, São Paulo, 243 pp.). *Hypsiboas albomarginatus* is widely distributed in Brazil, occurring in the Atlantic Forest from Rio Grande do Norte to Santa Catarina (Lutz 1973. Brazilian Species of *Hyla*. University of Texas, Austin). Reproduction occurs throughout the year in temporary ponds near the forest. During the day, individuals are observed sleeping in bromeliads or shrubs next to the breeding site or are found in trees at more distant sites. The Black Tufted-ear Marmoset, *Callithrix penicillata*, ranges from southeastern Maranhão and Piauí state, throughout most of Bahia, Minas Gerais, and Goiás state (Rylands et al. 1996. *In* Norconk et al. [eds.], Primates of the Atlantic Forest: Origin, Distributions, Endemism, and Communities, pp. 21–51. Plenum Press, New York). *Callithrix penicillata* is adapted to forest patches, gallery forests, scrub forests, and degraded forests in the Cerrado. This marmoset is omnivorous, feeding mainly on gum, fruits, arthropods, bird eggs, and small vertebrates. Herein, we report predation of an adult of *H. albomarginatus* by *C. penicillata* at Parque Estadual da Ilha Anchieta (23.5408889°S, 45.0658611°W; WGS 84), Ubatuba municipality, São Paulo state, southeastern Brazil. This monkey is an exotic species that was introduced in 1983 by the Fundação Parque Zoológico de São Paulo. Currently, *C. penicillata* occurs in high abundance on Ilha Anchieta and can severely affect the native fauna. In March 2007, an adult *C. penicillata* was observed eating an adult *H. albomarginatus* in a tree 2 m above ground. While holding the treefrog by its abdomen, the marmoset bit its head, and after eating the head, ate the forelimbs and the abdomen. The treefrog might have been sleeping when attacked. *Hypsiboas albomarginatus* has not been reported previously as prey for *C. penicillata*, since those animals did not occur in sympatry.

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LEPTODACTYLUS OCELLATUS (Butter Frog). **BARN OWL PREDATION**. *Leptodactylus ocellatus* is a large frog characterized by black dots irregularly distributed over an olive green dorsum, which allows camouflage in the environment (Izecksohn and Carvalho-e-Silva 2001. Anfíbios do município do Rio de Janeiro. Editora UFRJ, Rio de Janeiro. 148 pp.). The species is widely distributed, occurring in most of South America east of the Andes (Frost 2007. Amphibian Species of the World: an Online Reference. Version 5.1; 10 Oct 2007. Electronic Database accessible at http://research.amnh.org/herpetology/amphibia/index.php. American Museum of Natural History, New York).

The stomach contents of a Barn Owl (*Tyto alba*, MBML 7380 [Museu de Biologia Prof. Mello Leitão]) were examined on 25 June 2008, and the almost intact legs and sacral region of *L. ocellatus* were found; only the forearms and head were digested. The Barn Owl was run over at km 53 of the Rodovia do Sol, a highway located at Municipality of Guarapari (20.6666667°S, 40.4975°W), State of Espírito Santo, Brazil, and was collected on 26 Oct 2007 at 2325 h. The Barn Owl is nocturnal and is found in a variety of habitats, including open areas and human modified environments (Sick 1999. Ornitologia Brasileira. Ed. Nova Fronteira, Rio de Janeiro, Brazil). Its diet is composed mainly of small mammals and invertebrates. Amphibians are also found, but in small quantities (Motta-Junior 2006. Rev. Brasil. Ornitol. 14[4]:359–377; Roda 2006. Rev. Brasil. Ornitol. 14[4]:449–452). This is the first report of *L. ocellatus* in the diet of *T. alba*. We

thank Rodosol S.A. for donation of material to the Museu Prof. Mello Leitão.

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OOPHAGA PUMILIO (Poison Dart Frog). **NOCTURNAL ACTIVITY.** *Oophaga pumilio* is found over the leaf-litter of the Atlantic lowlands of Nicaragua, Costa Rica, and Panamá. It is usually seen in abandoned open areas and undisturbed forests throughout its range. This species has been characterized by its high abundance and diurnal habits by field studies mainly carried out at OTS, La Selva Biological Station in Sarapiquí, Costa Rica (Donnelly and Guyer 2004. Amphibians and Reptiles of La Selva, Costa Rica and the Caribbean Slope: A Comprehensive Guide. Univ. California Press, California, 367 pp.; Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna Between Two Continents, Between Two Seas. Univ. Chicago Press, Chicago, 934 pp.).Territoriality occurs in males of this species, as activity is constrained to an area that is defended from intruders (McVey et al. 1981. Copeia 1981[1]:1–8; Prohl 1997. Amphibia-Reptilia 18[4]:437–442.). Such defense has been associated with intraspecific competition related to resource availability (Donnelly 1989. Ecol. Monogr. 59[3]:207–221; Donnelly 1989. Oecologia 81[2]:212–218). Intrusions arise at different hours during the day, causing energetically expensive displays from resident frogs to repel the intruders (Gardner and Graves 2005. J. Herpetol. 39[2]:248–253). Male territories usually vary between 6 and 16 m^2 at La Selva Biological Station, and are maintained through vocalizations (Savage 2002, *op. cit.*).

The territorial behavior of *O. pumilio* includes vocalizations (Bunnell 1973. Copeia 1973[2]:273–284) and direct resident-intruder pinning, chasing, grappling, and tracking, among other agonistic behaviors. Postures such as body elevation using the forelimbs and statue behavior are also agonistic behaviors present in male-male interactions. Resident frogs usually remove the intruders, displaying greater dominance (Baugh and Forester 1994. Behavior 131[3–4]:207–224). Savage (2002, *op. cit.*) described a resident-intruder encounter, in which both males wrestle facing one another, and seizing each other's forelimbs. Generally the resident pins the intruder and the latter is released from the territory.

On 15 July 2003, we observed variations in the described behavior of *O. pumilio* at El Surá Trail in La Selva Biological Station (10.433°N, 83.983°S). We observed a nocturnal fight starting at 2008 h and finishing at 2143 h. The encounter started as both individuals were emitting vocalizations, an unexpected behavior since this species is regarded as diurnal. The encounter occurred as one individual (resident and intruder could not be identified) approached his opponent with several head bashes, making the latter fall on his back. This agonistic behavior has not been described previously. It consisted of both individuals facing each other a few centimeters away and abruptly colliding their heads without grasping each other's limbs. Subsequent to the attack, the offended individual bounced back and their heads collided again. A few minutes later, the individuals assumed a position that resembled an amplexus, eventually with one individual's pelvic region joined with the other's head. Both emitted vocalizations very different from those emitted against intruders during the day. Next, the individuals performed occasional leaps, in which one individual jumped from a perch to make the other fall on his back. The fight occurred intermittently as both males ceased the aggressions erratically and after a few minutes returned to the described behavior. At 2143h rain interrupted the encounter. After three minutes of inactivity, one individual emitted a loud vocalization from a 1m perch. His opponent, presumably the intruder, did not respond and abandoned the territory. All agonistic interactions occurred in a 1.5 × 1.5 m leaf-litter plot.

The described interactions show behavior variations from those described in earlier studies. Hence, there may be important variations in activity patterns, as well as in resident-intruder interactions during agonistic encounters.

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PELOPHYLAX PEREZI (Iberian Green Frog). **POLYDACTYLY**. Teratological aberrations are common in Iberian amphibians, although data regarding this condition in *Pelophylax perezi* is scarce in natural populations (reviewed in García-París et al. 2004. Amphibia. Lissamphibia. *In* Ramos et al. [eds.], Fauna Ibérica Vo. 24. MNCN-CSIC, Madrid. 639 pp.). However, in introduced populations from the Canary Islands a large portion of the population shows morphological abnormality.

On 02 Feb 2006 an adult male *P. perezi* with a supernumerary toe was found in an eutrophic permanent pond from Central Spain (vicinity of Sieteiglesias de Tormes, province of Salamanca; 40.7282861°N, 5.6207972°W; 820 m elev.). The animal displayed another well-developed toe on the right hand (polydactyly; Meteyer 2005. Field Guide to Malformations of Frogs and Toads with Radiographic Interpretations. Biol. Sci. Rep. USGS/BRD/BSR-2000-0005. U.S. Geological Survey, Madison, Wisconsin. 18 pp.), between the fourth and fifth toe of a normal hand. After releasing, this frog was not recaptured in consecutive surveys.

Between 2001 and 2008 we monitored the amphibian population of this area, mainly in eutrophic ponds and recorded ca. 350 *P. perezi*. Only this one individual had any deformity (0.29% of the population) indicating this was an isolated case.

This malformation has not been previously described in this species. A high incidence of teratological cases was reported in an introduced population of the species in the Canary Islands (Luis and Báez 1987. Vieraea 17:295–296), however, polydactyly was not reported in any individuals.

We have no data to assess the cause of these malformations although limb abnormalities are mostly related to environmental pollution, genetic or developmental factors (also in synergy with the previous factor), parasites, or a failure in the regeneration processes (Álvarez et al. 1995. Arch. Environ. Cont. Tox. 28[3]:349–356; Blaustein and Johnson 2003. Front. Ecol. Environ. 1[2]:87–94; Meteyer 2005, *op. cit.*; Johnson et al. 2006. Ecology 87[9]:2227–2235).

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RANA CLAMITANS **(**Green Frog). **COLORATION**. Herein I describe an unusual color pattern in a *Rana clamitans* that was found at the Edmund Niles Huyck Preserve in Rensselaerville, Albany County, New York, USA. Rather than the characteristic combination of brown and olive green, this individual displayed brilliant yellow across much of its dorsum. The abnormal frog (47.6 mm SVL) was found during Sept 2007, along a spring-fed stream (42.52545°N, 74.1594333°W). The front and back legs were more typical *R. clamitans* coloration, as was a large spot in the center of the animal's back (Fig. 1). Although most *R. clamitans* have a speckled venter, this individual had a creamy yellow underside, free of spots. Blue morphs of this species have been reported throughout New York State (Gibbs et al. 2007. Amphibians and Reptiles of New York State: Identification, Natural History, and Conservation. Oxford University Press, New York). Berns and Narayan (1990. J. Morphol. 132:169–180) determined that the blue morphs have reduced carotenoids and that xanthophores are absent or lacking carotenoid vesicles. The underlying mechanisms that led to the yellow coloration of the individual described here is unknown, as it is the first description of such coloration in New York State. It is unclear whether the morph seen here suffers from the loss or under expression of certain pigments.

I thank P. Ducey, A. Breisch, and J. Gibbs for their assistance in preparing this note.



FIG. 1. Unusual color pattern of *Rana clamitans* found in Albany County, New York.

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RANA DRAYTONII **(**California Red-legged Frog). **PREY**. On 19 June 2004 in a large cattle pond in Morgan Territory Regional Preserve, Alameda County, California, USA (37.82°N, 121.79°W), I observed an adult *Rana draytonii* (ca. 95 mm SVL) eat a Western Toad (*Bufo boreas*) tadpole. It was unclear if the frog simply snapped at the motion of the tadpole which had swam underneath the frog's chin, or had deliberately sought out the tadpole.

I returned to the pond five days later and observed 10 adult *R draytonii* sitting in the shallows at the edge of the pond in an area with large numbers of *B. boreas* tadpoles. In 30 min I observed three instances of *R. draytonii* eating *B. boreas* tadpoles. One adult frog was observed twice in that time eating toad tadpoles. A second adult frog was observed jumping forward into an aggregation of tadpoles, using its front feet to help push tadpoles into its mouth. The frog paused with the tail of a toad tadpole hanging out of its mouth, and then swallowed. There was no indication in any of these instances that the tadpoles were in any way unpalatable or distasteful. Since *R. draytonii* and *B. boreas* often share ponds, predation by *R. draytonii* on bufonid tadpoles may not be an uncommon event. Because *R. draytonii* is only recently recognized as a full species (Schaffer et al. 2004. Mol. Ecol. 13:2667–2677) there is limited dietary information available for the species (Hayes and Tennant 1985. Southwest. Nat. 30:601–605; Hayes and Jennings 2006. Herpetol. Rev. 37:449).

This report points to a mystery. Given that ranid frogs and *Bufo* often share the same ponds, and *Bufo* tadpoles are potentially an abundant source of food at certain times, why are there not more reports of ranid frogs eating *Bufo* tadpoles? Bufonid tadpoles contain skin chemicals that make them unpalatable to at least some predators (Brodie et al. 1978. Herpetologica 43:369–373). However, a recent review of tadpole palatability experiments concluded that *Bufo* tadpoles are rarely unpalatable to predators, and no more so than other families of anurans (Gunzburger and Travis 2005. J. Herpetol. 39:547–571). A review of the predation sections of the natural history accounts for North American *Bufo* in Lannoo [ed.] (2005. Amphibian Declines: Conservation Status of United States Species. Univ. California Press, Berkeley. 1094 pp.) found only one report of ranid frog predation on *Bufo* tadpoles, that of Mountain Yellow-legged Frog (*Rana muscosa*) consuming Yosemite Toad (*Bufo canorus*) tadpoles (Mullally 1953. Copeia 1953[3]:182–183), and only a single other report of an anuran predator on *Bufo* tadpoles —that of Great Plains Toad tadpoles (*Bufo cognatus)* being eaten by Mexican Spadefoot tadpoles (*Spea multiplicata*) (Bragg 1940 Am. Nat. 74:322–349). Pearl and Hayes (2002 Am. Midl. Nat. 147:145–152) observation of Oregon Spotted Frogs (*R. pretiosa*) frequently eating recently metamorphosed *B. boreas* appears to be the only report in the literature of an anuran predator on *B. boreas*.

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RANA PICTURATA (Yellow-spotted Frog). **PREDATION**. Among invertebrates, spiders are one of the most important predators of amphibians (Wells 2007. The Ecology and Behavior of Amphibians. Univ. Chicago Press, Chicago, Illinois. 647 pp.). Predation of spiders on amphibians has often been reported (Duryea



COLOR PUBLICATION COURTESY OF RONALD A. JAVITCH

FIG. 1. Right: A dead adult male *Rana picturata* wrapped up by spider's thread. Left: Huntsman spider (*Heteropoda* sp.) feeding on *Rana picturata*.

et al. 2008. Herpetol. Rev. 39:209–210), but records from Southeast Asia are few, probably due to paucity of natural history surveys in the region. We observed a huntsman spider (*Heteropoda* sp.) preying on an adult male *Rana picturata* (SVL 39.1 mm) in Takah Selow Waterfall, Selai, in the Endau-Rompin National Park, Johor, Peninsular Malaysia (2.4427778°N, 103.2419444°E, 111 m elev.) at 2215 h on 2 Aug 2008. *Rana picturata* is common in this area, and males were found calling perched on stones, fallen wood, or leaves of shrubs close to stream edges. The frog was found dead, wrapped up in the spider's thread (Fig. 1), on the side of vertical dead trunk (3.5 cm diam.). It was located ca. 1.5 m above the surface of a rocky stream. The spider ran away when disturbed, leaving the dead frog behind. We stopped observation to continue our amphibian survey, but when we returned the spider was found feeding on the frog (Fig. 1). We collected the spider and the frog for further examination. Like members of other genera in the family Heteropodidae, *Heteropoda* do not build webs and are ambush predators, killing their prey by injection of venom. The other genus within the family reported to have preyed upon amphibians is *Olios* (giant crab spider) from Puerto Rico (Formanowicz et al. 1981. Herpetologica 37[3]:125–129). The spider was retained by H. Ono, Natural Science Museum, Tokyo, for identification.

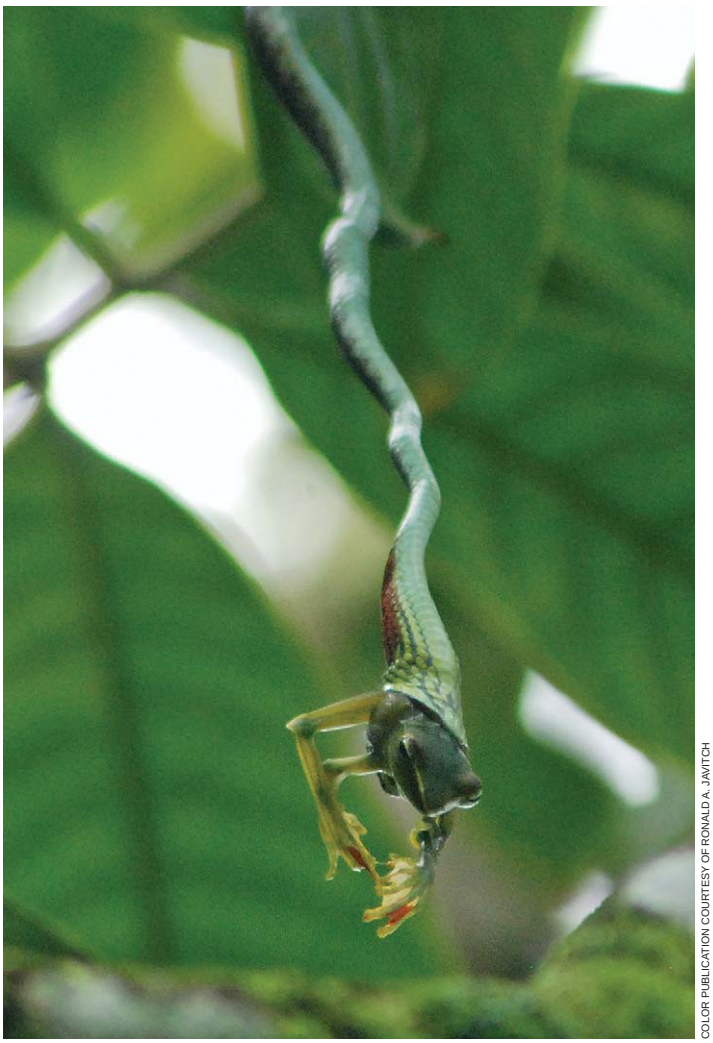
Field work was conducted with permission of the Economical Planning Unit (EPU), and financed by the Japan Society for the Promotion of Science (JSPS: No. 20405013) and by Universiti Kebangsaan Malaysia to MM. We are grateful to Yong Hoi Sen (University of Malaya) and H. Ono for help in identification of the spider.

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RHACOPHORUS DULITENSIS (Jade Tree Frog). **PREDATION.** Tree frogs of the genus *Rhacophorus* are distributed from India to Japan, the Indomalayan archipelago, and the Philippines. Due to their arboreal lifestyle, most species are seldom encountered and there is little information available regarding their natural history. *Rhacophorus dulitensis* is endemic to Borneo (Harvey et al. 2002. Herpetol. Monogr. 16:46–92), where it occurs in primary and old secondary forests. Herein, I report predation on this species by the tree snake, Kopstein's Bronzeback (*Dendrelaphis kopsteini*).

On 12 Dec 2007 between 1330 and 1355 h I observed an adult *R. dulitensis* being preyed upon by a subadult *D. kopsteini* (total length ca. 70 cm) in the top of a medium-sized tree, about seven meters above the ground in the alluvial forest near the headquarters of Gunung Mulu National Park, Sarawak, East Malaysia (Borneo). When the observation started the snake had already grabbed the frog by one of its hind limbs. After a few minutes it maneuvered the frog in its mouth with chewing motions, until the posterior part of the frog's trunk was between its jaws. Then it began to devour the frog (Fig. 1). The frog remained alive at least until it was completely swallowed.

I thank the Sarawak Forest Department for permission to conduct research in Gunung Mulu National Park. Field work was supported by a grant from the German Academic Exchange Service



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Fig. 1. Predation on *Rhacophorus dulitensis* by *Dendrelaphis kopsteini*.

(DAAD).

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RHACOPHORUS GAUNI (Short-nosed Tree Frog). **EGG MORTALITY.** To prevent predation by aquatic predators, many frog species do not place their eggs directly in the water but deposit them in foam nests either floating on the water's surface or attached to vegetation above the water. Outside the water, however, frog eggs are exposed to a large number of invertebrate and vertebrate predators (Wells 2007. The Ecology and Behavior of Amphibians. University of Chicago Press, Chicago and London. 1148 pp.). Fly larvae have been reported to be very destructive on these foam nests. Investigations in Central and South America, Australia, and Taiwan have shown that in foam nests of particular frog species the prevalence of fly larvae infestation and the mortality caused by it can be very high (Wells 2007, *op. cit.*). Herein I report predation by fly larvae on the eggs of *Rhacophorus gauni*. All Bornean members of the genus *Rhacophorus* lay their eggs in foam nests attached to leaves overhanging water (Malkmus et al. 2002. Amphibians and Reptiles of Mount Kinabalu [North Borneo]. Koeltz Scientific Books, Königstein. 424 pp.), apart from *R. kajau* which attaches its eggs directly to leaves without producing a foam nest (pers. obs.). So far, there have been no reports of predation on eggs of Bornean *Rhacophorus*.

Observations were made in Gunung Mulu National Park, Sarawak, East Malaysia (Borneo). Adult *R. gauni* were found in abundance along sections of two rivers, Sungai Melinau near Camp Five and Sungai Melinau Paku near Deer Cave. Frogs were sitting on leaves 2–6 m above ground. Calling males and recently produced foam nests were regularly observed from October 2007 to January 2008, indicating that breeding is prolonged and perhaps occurs throughout the year. Two foam nests sampled on 7 Oct 2007 at Sungai Melinau Paku and on 4 Dec 2007 at Sungai Melinau contained fully developed tadpoles, numbering 9 and 13. There were no signs of infestation by parasites or predators. On 7 Jan 2008, I found two foam nests at the Sungai Melinau Paku site. In both, fly larvae (Diptera) were visible from the outside. Closer examination revealed that the nests were heavily infested with fly larvae (Fig. 1). No living frog embryos, but only the remains of undeveloped eggs were found within the nests. According to these preliminary observations, the prevalence of fly larvae infestation seems to be moderate in foam nests of *R. gauni*. Mortality of eggs, however, appears to be absolute in infested nests.



FIG. 1. Foam nest of *Rhacophorus gauni*, heavily infested with fly larvae.

I thank the Sarawak Forest Department for permission to conduct research in Gunung Mulu National Park. Field work was supported by a grant from the German Academic Exchange Service (DAAD).

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CROCODYLIA — CROCODILIANS

CROCODYLUS SIAMENSIS (Siamese Crocodile). **DIET.** Few published observations are available on the diet, feeding, or predatory habits of *Crocodylus siamensis*, among the most critically endangered and least known of crocodilians (Ross [ed.] 1998. Crocodiles. Status Survey and Conservation Action Plan. 2nd ed. IUCN, Gland. 96 pp.). A study of 291 fecal samples from Cambodia provides the only published dietary data for *C. siamensis*, and which recorded the remains of snakes (in 35.7% of samples), fish (31.6%), insects (18.6%), mammals (11.0%), and birds (5.2%), suggesting *C. siamensis* is a generalist feeder similar to many other *Crocodylus* (Daltry et al. 2003. Status of the Siamese Crocodile in the Central and Southern Cardamom Mountains, Cambodia. Findings of Recent 'Kropeu Phnom' Surveys. FFI/Department of Forestry and Wildlife, Phnom Penh; Simpson and Han 2004. *In* Proc. 17th Working Meeting Crocodile Specialist Group. pp. 110–120. IUCN, Gland). Dietary studies based only on feces present a biased view of crocodilian diet due to the variable digestibility of prey (keratinous and chitinous substances are commonly recorded in feces while soft-bodied prey [e.g., frogs] are absent) and of digestion times among differently sized crocodiles, which prevent analysis of food preferences and the contribution of individual prey species to total mass of food consumed (Fisher 1981. Paleobiology 7:262–275; Shoop and Ruckdeschel 1990. Am. Midl. Nat. 124:407–412; Webb et al. 1991. J. Herpetol. 25:462–473; Webb et al. 1982. Aust. J. Zool. 30:877–899; Santos et al. 1996. The Herpetological J. 6: 111-117). Yet in the absence of studies involving live wild crocodiles, fecal samples provide preliminary insight on dietary habits, and for *C. siamensis*, are particularly useful because extant populations are so depleted that wild individuals are rarely observed or caught.

Here I report on the contents of seven *C. siamensis* fecal samples collected during crocodile surveys in the Lao People's Democratic Republic (hereafter 'Laos') (Bezuijen et al. 2006. Preliminary status review of the Siamese Crocodile [*Crocodylus siamensis* Schneider, 1801] [Reptilia: Crocodylia] in the Lao People's Democratic Republic. LARReC/WCS/MWBP, Vientiane. 114 pp.; Bezuijen et al. 2006. Strengthening Siamese crocodile conservation in Lao PDR. Crocodile Specialist Group Newsletter 25:10–11).

Crocodylus siamensis feces were collected in the dry season at three permanent, freshwater lakes (elevations 120–150 m elev.) with extensive macrophyte growth: Bung Pulone Lake (14.70888°N, 106.46555°E), Attapu Province, 13 April 2005 (N = 5 samples), and Kout Mark Peo Lake (16.35250°N, 105.22083°E), 12 March 2005 (N = 1) and Xe Lat Nyai Lake (16.44722°N, 105.19277°E), 20 September 2006 (N = 1), Savannakhet Province. These lakes are located on floodplains of the Mekong River and are subject to extensive seasonal changes in water level. Six fecal samples were located along seasonally-exposed lake margins and one, at Kout Mark Peo Lake, was on a mat of floating vegetation. Fecal diameter (widest point of bolus) ranged from 30–45 mm (Table 1), representing a range of differently sized crocodiles. Feces were initially dry and hard, and were subsequently soaked in water. They were then broken apart and observed under a dissecting microscope.

Six of seven samples contained prey items; the sample from Xe Lat Nyai Lake contained no prey remains. Prey items and their frequency of occurrence were: mammal (86%, N = 6 samples), fish (71%, N = 5), and snake (57%, N = 4) (Table 1). The chitinous fragments of coleopteran elytra (beetle forewings) were present in four samples. A small amount of plant matter and four sand grains <1 mm diameter were found in six and one sample respectively. It is unclear whether the insects were deliberately caught as prey; the plant matter and sand were probably secondarily ingested.

No prey items could be identified to species level. Bone fragments present in one sample, including one incisor (3 mm length) and intact vertebrae (3–4 mm diameter excluding transverse processes) were identified as those of a rodent (Muridae). To identify the mammalian hair present in six samples, mounted slide cross-sections and longitudinal-sections from 10–15 hairs in each sample were prepared by H. Brunner and examined under ×470 magnification, following Brunner and Coman (1974. The Identification of Mammalian Hair. Inkata Press, Melbourne. 173 pp.), and compared against a hair reference database (Ecobyte Pty Ltd et al. 2002. Hair ID vers. 1.00. CSIRO Publishing, Collingwood, Victoria). No commercial hair reference database is available for Southeast Asia and the current database, although developed principally for Australian mammals, was used because it includes datasets for several orders of Asian mammals. All hair samples were from the same prey species, a rodent (not *Rattus*), and possessed the following features: a two-tiered layer of relatively long (15–20 mm), stiff, primary guard-hairs, brown-black and tinged red, with a cross-sectional diameter of 175–200 μm, and shorter, finer, grey under-hairs. These hair features, the size of bone fragments (presumably from the same prey species), and the habitat where feces were located, suggests a medium-sized, ubiquitous rodent common in lowland wetlands of the Mekong Basin, such as *Bandicota indica* (Greater Bandicoot Rat) (Francis 2008. A Field Guide to the Mammals of Thailand and South-East Asia. Asia Books Co., Ltd, Bangkok. 392 pp.).

Fish remains comprised the scales of at least two species (Table 1), which, based on scale size and shape, and wetland habitat, were possibly *Channa* spp., one of few fish genera able to tolerate dry-season conditions of these floodplain lakes (Hill 1995. Nat. Hist. Bull. Siam Soc. 43: 263–288; Kottelat 2001. Fishes of Laos. WHT Publications [Pte] Ltd., Colombo. 198 pp.). Snake remains comprised dorsal and ventral scales.

In addition to data derived from fecal samples, on 13 March 2005 at 2130 h, I briefly observed a wild hatchling *C. siamensis* catching insects at the water surface near the margin of Kout Mark Peo Lake.

TABLE 1. Contents of seven *Crocodylus siamensis* fecal samples from Laos.

Site	Dung size (mm)	Contents
Bung Pulone Lake	85 × 37	Mammal hair; fish scales (sp. A–scales transparent, thin, 3–5 mm diameter)
Bung Pulone Lake	95 × 45	Mammal hair; fish scales (sp. A); snake scales; insect chitin fragments; plant matter
Bung Pulone Lake	125 × 30	Mammal hair; fish scales (sp. A); snake scales; insect chitin fragments; plant matter
Bung Pulone Lake	175 × 40	Mammal hair; fish scales (sp. A+B–scales brown, opaque, thick, 6 mm diameter); plant matter
Bung Pulone Lake	150 × 45	Mammal hair, bone (incisor, vertebrae, other fragments); fish scales (sp. B); snake scales; insect chitin fragments; plant matter
Kout Mark Peo Lake	180 × 43	Mammal hair; snake scales; insect chitin fragments; plant matter; sand particles
Xe Lat Nyai Lake	130 × 40	Plant matter

The small sample size of these data precludes comparison with other studies, although the identified remains indicate a broad diet, and the high frequency of occurrence of mammalian remains compared with Cambodian samples may be of note. Further collection and analysis of *C. siamensis* fecal samples from Laos, as well as examination of the fresh stomach contents of wild-caught individuals, would be required to ascertain any seasonal differences in diet or prey preference between *C. siamensis* of different age, size, or geographic distribution.

Fecal samples were collected during crocodile conservation activities by the Laos Department of Forestry/Wildlife Conservation Society, and Laos Department of Livestock and Fisheries/WWF Laos, respectively. I am grateful to Hans Brunner for preparing and analyzing hair samples. Roger Mollot gave advice on fish identification, and Jennifer C. Daltry, Jackson Shedd, Boyd Simpson, and John B. Thorbjarnarson provided critical comments which improved the draft manuscript.

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TESTUDINES — TURTLES

APALONE MUTICA (Smooth Softshell). **PREDATION.** Around 1300 h on 2 July 2006 on the Buffalo River in Marion County, Arkansas, USA, we observed an adult *Apalone mutica*, ca. 30 cm in carapace length, being attacked by a group of otters (*Lontra canadensis*). This event occurred in riffle habitat about one meter deep below debris from two fallen trees. We were standing in the stream about 3–4 m from the attack, but our presence did not appear to disrupt the behavior of the animals. The turtle was clearly

alive and trying to escape from 2–3 otters that were biting its shell and continually pulling it below the surface of the water. The turtle appeared disoriented and exhausted. The otters in the stream were also vocally communicating with 1–2 otters that were on the bank, at least one of which did not appear to be an adult. After observing the encounter for about five minutes, the turtle was carried upstream by the otters, which had apparently subdued it.

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CHELYDRA SERPENTINA (Snapping Turtle). **CLEANING SYMBIOSIS**. The removal of ectoparasites, necrotic tissue, and epibionts from marine turtles by reef fishes (Grossman et al. 2006. Chelon. Conserv. Biol. 5:284–288; Losey et al. 1994. Copeia 1994:684–690) and invertebrates (Davenport 1994. J. Mar. Biol. Assoc. U.K. 74:735–737) has been well documented. Cleaning symbioses involving freshwater turtles are also known (Moll and Moll 2004. The Ecology, Exploitation, and Conservation of River Turtles. Oxford Univ. Press, New York. 393 pp.); however, observations of these interactions in freshwater species are rare in the literature compared with those of marine turtles. Here, I report an apparent episode of mutualistic cleaning between a *Chelydra serpentina* and Bluegill Sunfish (*Lepomis macrochirus*).

On 06 June 2007 at 1830 h, I observed a *C. serpentina* (ca. 20 cm SCL) in shallow water along the shoreline (39.33882°N, 82.34693°W; WGS 84) of Lake Hope at Lake Hope State Park, Vinton County, Ohio, USA. When first encountered, the turtle was floating just below the surface in open water. The limbs and tail of the turtle were extended out and downwards from the body and its neck was fully extended horizontally. A school of ca. 9 *L. macrochirus* surrounded the turtle. As the fish slowly swam around the *C. serpentina*, they frequently oriented towards the turtle and approached to within 2–3 cm of it. The fish appeared to inspect the *C. serpentina* and individuals were twice seen nipping at the turtle. The fish primarily concentrated on the posterior and inguinal regions of the turtle; however, they would occasionally swim to the anterior of the carapace and axillary areas. Interactions between the turtle and fish were observed and photographed for ca. 30 min before the *C. serpentina* became aware of my presence and submerged. During the observation period, the turtle did not appear bothered by the actions of the fish; it made no movements except to raise its head to breathe and slowly turn to examine its surroundings. The *C. serpentina* did not attempt to strike at the fish despite the fact that several individuals ventured close to the turtle's head.

Facultative cleaning behavior is not unusual in *L. macrochirus* and other centrachid fishes (Powell 1984. Copeia 1984:996–998; Spall 1970. Trans. Amer. Fish. Soc. 99:599–600; Sulak 1975. Anim. Behav. 23:331–334). Bluegills have previously been reported to bite at resting turtles (Kaufmann 1991. Herpetol. Rev. 22:98; Powell, *op. cit.*). However, to my knowledge, this observation represents the first report of a turtle that appeared to encourage attention from *L. macrochirus*. The neck extension and behavior of the *C. serpentina* were similar to the posture and movements described by Kaufmann (*op. cit.*) for *Glyptemys* (= *Clemmys*) *insculpta* being cleaned by Blacknose Dace (*Rhinicthys atratulus*). Snapping turtles are frequent hosts for leeches (Brooks et al. 1990. J. Parasitol. 76:190–195; McCoy et al. 2007. Southeast. Nat. 6:191–202) and epizoophytic algae (Edgreen et al. 1953. Ecology 34:733–740). Both items appear in the diet of sunfish (Etnier 1971. Trans. Amer. Fish. Soc. 100:124–128), suggesting a possible route for opportunistic cleaning symbiosis to develop between these species. Given the widely overlapping distributions of *C. serpentina* and *L. macrochirus*, this relationship may be common but previously unrecognized.

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CHELYDRA SERPENTINA (Common Snapping Turtle). **SURVIVAL AFTER INJURY.** We here report an adult *Chelydra serpentina* from Wethersfield Cove, Wethersfield, Connecticut, USA, missing most of its lower jaw (Fig. 1). This old injury to the jaw would presumably disable both the suction-feeding apparatus (by reducing flow speed during strike and increasing backflow during buccopharyngeal compression) described for this species (Lauder and Prendergast 1992. J. Exp. Biol. 164:55–78) and eliminate bite force (Herrel et al. 2002. J. Evol. Biol. 15:1083). Yet this turtle weighed 17.5 kg and had a carapace length of 44.5 cm; visual examination showed ample fat deposits indicating that this turtle was in good condition despite its injury. The turtle was apparently able to heal and grow after the loss of the lower jaw, thus compensating for the lack of normal biting and prey-handling behaviors.



FIG. 1. Male Common Snapping Turtle missing most of its lower jaw, Wethersfield Cove, Hartford, Connecticut, USA (44.5 cm carapace length, 17.5 kg). This animal apparently healed and grew without being able to suction feed or produce bite force.

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GLYPTEMYS INSCULPTA (Wood Turtle). **MAXIMUM ADULT SIZE.** On 21 June 2009, we captured an adult male *Glyptemys insculpta* in a tributary of the Kennebec River in Somerset County, Maine, USA. This turtle had been captured and radiotracked as a subadult by BWC in 1998 (Compton 1999. Ecology and Conservation of the Wood Turtle [*Clemmys insculpta*] in Maine. Unpubl. M.S. thesis, Univ. of Maine, Orono). Age estimates from plastral annuli in 1998 and 2009 indicate that the animal was ca. 25 years old upon recapture in 2009. Carapace and plastron dimensions were measured using a 12-inch dial caliper and the animal was subsequently released at the capture location. Shell dimensions (to nearest 0.1 mm) were as follows: straightline carapace length (SCL)(from cranial end of nuchal scute to caudal end of seam between 12th marginal scutes): 240.0; maximum carapace length (MCL)(from cranial edge of 1st or 2nd marginal scute to caudal end of 12th marginal scute): 251.0; straightline plastron length (from cranial end of seam between gular scutes to caudal end of seam between anal scutes): 200.9; maximum plastron length (from cranial edge of left gular scute to caudal edge left anal scute): 220.2; plastron width (at seam between humeral and pectoral scutes): 89.4; carapace width (at 8th marginal scutes): 180.3. Body mass was 1895 g. This turtle is markedly larger than the ten adult male *G. insculpta* measured at this site by Compton (1999) (MCL median = 215.0 mm; MCL max = 232.5 mm) and 48 adult male *G. insculpta* from New Hampshire (MCL median = 190.8; MCL max = 208.8) and 198 adult male *G. insculpta* from Massachusetts (MCL median = 188.5; MCL max = 213.9) measured by MTJ (Jones 2009. Spatial Ecology, Population Structure, and Conservation of the Wood Turtle in Central New England. Unpubl. Ph.D. dissertation, Univ. of Massachusetts, Amherst). The animal's current shell dimensions appear to be larger than most or all reported measurements from across the range of *G. insculpta*. Saumure (1992. Herpetol. Rev. 23:116) reported two extremely large males from Pontiac Co., Québec, with carapace lengths of 238.0 and 234.5 mm. In a review of the status of Wood Turtles in Québec, where the species appears to attain a relatively large adult size, Galois and Bonin (1999. Rapport sur la situation de la tortue des bois (*Clemmys insculpta*) au Québec. Faune et Parcs Québec, Direction de la faune et des habitats, Québec) reported a maximum carapace length of 244 mm. The authors did not indicate whether this represented SCL or MCL in the sense outlined above.

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KINOSTERNON SUBRUBRUM (Eastern Mud Turtle). **MASS MOVEMENT AND MORTALITY**. About 0930 h on 25 April 2009, after a night of heavy rain, we began a survey of paved secondary roads south of Winnie in Chambers County, Texas, USA looking for shorebirds (Scolopacidae, etc.) in rice fields. We drove west on St. Rd. 1985 and then north to and back east on St. Rd. 65, parallel roads about 13 km apart, and beginning and ending on the north-south running St. Rd. 124.

We found few shorebirds, but instead encountered an extraordinary mass movement and associated road mortality of the mud turtle *Kinosternon subrubrum.* Especially on the eastern ends of both roads, and mostly on 1985, we saw hundreds of dead and smashed turtles, some moribund, and perhaps 20 or so more trekking across the roads. The movement we saw of live turtles was entirely north to south across the east-west running roads; we noticed little, if any similar mortality on Rd. 124.

We estimated a very conservative 300 dead and dying mud turtles; the total was possibly much higher than this. Even crude quantification was difficult because of heavy local farm traffic, but at times it was possible to count 20–30 dead turtles in a stretch of 20 m; the circumstances also prevented us from examining specimens and determining sex ratios.

This was a monospecific event, as we otherwise noted only two large cooters (*Pseudemys* sp.), one living and one dead; we also saw a snake (*Nerodia* sp.) that successfully crossed the road before we could turn around to identify it. We are familiar with similar mass movements (and mortality) following rains by toads, frogs, and salamanders, but saw none of these in this instance, and we had not previously witnessed such a movement by turtles. Reports of other significant (though much smaller) movements of *K. subrubrum* seem associated with drying habitat (e.g., Strecker and Gibbons et al. *In* Ernst et al. 1994. Turtles of the United States and Canada, p. 172. Smithsonian Inst. Press, Washington, DC).

Interpretation of the phenomenon we observed was confounded by the inundation of thousands of the surrounding hectares in 2–3 m of salt water during the storm surge of Hurricane Ike on 13 September 2008. We overheard residents talking of flooding fields to leach the salt before rice could be planted. Nevertheless the movement we saw was coincident with a local deluge of rain. The nearest official rain gauge in Beaumont, Texas, 38 km to the east, recorded only 0.52 inches of rain 24–25 April (Donna Work, Texas Forest Service, pers. comm., 20 May 2009), but around Winnie the total was manifestly much more that that; we heard local commentary on the extraordinary rainfall the night of 24–25 April and saw abundant evidence in flooded fields and residential yards, and water overflowing drainage ditches onto the roads, so the local rainfall must have been considerable.

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PODOCNEMIS EXPANSA (Giant South American River Turtle). **PRE-NESTING BASKING BEHAVIOR**. *Podocnemis expansa* is a freshwater pleurodiran turtle native to the Amazon basin. This species was historically common and could be observed basking and nesting in large numbers, but this is now a rare occurrence over most of the Amazon (Rueda-Almonacid et al. 2007. Las Tortugas y los Crocodilianos de los Países Andinos del Trópico. Serie de Guias Tropicales de Campo nº 6. Conservación Internacional. Editora Panamericana, Formas y Impresos. Bogotá, Colombia, 538 pp.). In this species, basking behavior is reportedly restricted to the period just prior to, or during, nesting (although RCV has one record of a juvenile ca. 8 cm in carapace length basking on a log in Anavilhanas National Park, Amazonas Brazil, 23 February 1989). In many areas of the Amazon, pre-nesting basking is no longer observed, a behavioral change possibly in response to human predation (Vogt 2008. Tartarugas da Amazônia. Grafica Biblos, Lima, Peru. 104 pp.) However, on the Trombetas River, Pará, Brazil, basking behavior prior to nesting is still observed, perhaps due to the efforts of the Brazilian Environmental National Institute (IBAMA) to protect the nesting beaches against human predation.

Here we report basking observations during the reproductive season of 2008, from 30 September to 2 November (230 h of observations) on the Praia do Jacaré (1.530494ºS, 55.473148ºW; WGS84). The average number of turtles basking per day was 106 (min. 7 – max. 295; SD = 87). The turtles started basking on 30 September in small numbers (7–15), increasing over subsequent days until they reached a peak on 21 October (295 turtles). At this point the nesting season began (21 October) and the average number of turtles basking daily dropped to 51, and continued to decrease until basking ceased on 3 November. During the basking period, the turtles aggregated in large groups, including the turtles on the beach as well as those in the water. Basking behavior in this circumstance may increase the metabolic rate of the female, accelerating egg development and ovulation (Vogt 1980. Tulane Stud. Zool. Bot. 22:17–48). Despite living in warm waters (mean water temperature = 30.2°C [RCV, unpubl. data] from 3538 temperature recordings in the field in Trombetas Reserve from Nov–September), the physiological advantages of basking to the turtles apparently outweigh the risks involved from the increased exposure to predation.

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SQUAMATA — LIZARDS

AMEIVA AMEIVA (Giant Ameiva). **PREDATION.** Despite its broad distribution in South America (Vitt and Colli 1994. Can. J. Zool. 72:1986–2008) and various aspects of natural history having been described (Colli 1991. Copeia 1991:1002–1012), few data exist on the predators of *Ameiva ameiva* (Martins and Oliveira 1998. Herpetol. Nat. Hist. 6:78–150). Hence, we add to the limited data on *A. ameiva* predators with an observation of predation by a Pearl Kite (*Gampsonyix swainsonii*).

On 27 April 2008 at ca. 1200 h, while conducting an ornithological survey as a part of the Environmental Impact Study of the Foz do Apiacás Hydroelectric Power Plant in Mato Grosso State, Brazil, we collected an adult *G. swainsonii* with a pressure gun from a grassland area of Paranaíta, Mato Grosso (57.1092°W, 9.4155°S, datum: SAD69; elev. 701 m); dissection revealed two juveniles *A. ameiva* (40.82 mm and 34.93 mm, SVL) in the stomach. The grasslands were surrounded by rain forest dominated by Babaçu Palms (*Orbignya oleifera*).

Gampsonyix swainsonii are known to prey on insects, birds and lizards (Sick 2001. Ornitologia Brasileira. Editora Nova Fronteira. Rio de Janeiro, Brazil. 862 pp.), but to our knowledge, none of the lizards recorded as prey were identified to species.

The *G. swainsonii* specimen (JB 395 – collection license 10698-1/IBAMA) (length: 22.5 cm) and its stomach contents were deposited in Laboratório de Ornitologia, Campus of Cuiabá, Universidade Federal de Mato Grosso (UFMT).

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AMEIVA AMEIVA (Giant Ameiva). **SAUROPHAGY.** *Ameiva ameiva* is one of the most widely distributed Neotropical lizards, occurring from the Caribbean Islands and Costa Rica to southern Brazil, northern Argentina, and the eastern Andes in South America (Vanzolini et al. 1980. Répteis das Caatingas. Acad. Bras. de Ciênc., Rio de Janeiro, Brazil. 161 pp.; Vitt and Colli 1994. Can. J. Zool. 72:1986–2008). The diet of *A. ameiva* is composed mainly of arthropods (Vitt and Colli 1994, *op. cit.*). Gastropods and plant matter (fruits and leaves) are also commonly present (Vitt 1995. Occ. Pap. Oklahoma Mus. Nat. Hist. 1:1–29; Zaluar and Rocha 2000. Ciência e Cultura 52:101–107). Orthopterans, termites, beetles, and insect larvae are the most numerically important items in the diet of the populations of this species within different Brazilian ecosystems (Gainsbury and Colli 2003. Biotropica 35:503–519; Vitt and Colli 1994, *op. cit.*). Volumetrically, cockroaches, beetles, insect larvae, spiders, and orthopterans were among the most important items in a great number of studies (Vitt and Colli 1994, *op. cit.*; Zaluar and Rocha 2000, *op. cit.*). In addition to invertebrates and plant matter, *A. ameiva* occasionally feeds on small vertebrates (Vitt 1995, *op. cit.*), including lizards (Vitt 2000. Herpetol. Monogr. 14:388–400; Zaluar and Rocha 2000, *op. cit.*). Here, we report on the ingestion of a lizard previously unrecorded as prey for *A. ameiva* in the caatinga at the Ecological Station of the Seridó (ESEC Seridó), in the municipality of Serra Negra do Norte, Rio Grande do Norte, Brazil.

During the ecological study of a population of *A. ameiva* in the ESEC Seridó (06.5767°S, 37.2558°W, datum: WGS84; elev. 192 m), a total of 18 stomachs were analyzed. A gymnophthalmid lizard, *Vanzosaura rubricauda* (24.0 mm SVL, 35.0 mm in total length, 6.0 mm in width and 659.4 mm^3 in volume) was found in

the stomach contents of an adult female (125.7 mm SVL) captured on 29 March 2009, near decomposing trunks in herbaceous vegetation.

In an analysis of 55 stomachs of *A. ameiva* conducted by Zaluar and Rocha 2000 (*op. cit.*) in a restinga ecosystem in southeastern Brazil, juveniles of two sympatric lizard species (*Tropidurus torquatus* and *Mabuya agilis*) were found in the stomachs of two adult males. Vitt 2000 (*op. cit.*) reports on the predation of two *Kentropyx striata* adults by an adult *A. ameiva* in an Amazonian savanna in northern Brazil. Owing to the large body size of *A. ameiva* compared to many sympatric lizard species throughout its wide distribution, saurophagy may be more common than is currently represented in the literature (Vitt 2000, *op. cit.*).

The *A. ameiva* (CHBEZ 2507) was deposited in the herpetological collection of the Universidade Federal do Rio Grande do Norte, Natal, Brazil. We thank the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) for financing the PELD-Caatinga Program entitled Structure and Functioning, and for the research scholarship granted to RFDS (process 127543/2008-2), LBR (process 141993/2006-5) and EMXF (process 304077/2008-9); and to PROPESQ/UFRN for the research scholarship awarded to HWBA. IBAMA provided a permit (Permit 206/2006 and Process 02001.004294/03-15).

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AMPHISBAENA VERMICULARIS (NCN). **PREDATION.** Amphisbaenians are little known and secretive animals, but it is recognized that elapid snakes of the genus *Micrurus* are important predators. *Amphisbaena vermicularis* is a small amphisbaenian (325 mm total length) known from the Brazilian states of Pará to Minas Gerais, Mato Grosso, and Mato Grosso do Sul, usually in Caatinga domains (Uetanabaro et al. 2007. Biota Neotropica 7:279–289; Vanzolini et al. 1980. Répteis das Caatingas. Acad. Bras. de Ciênc., Rio de Janeiro, 161 pp.). Here, we document the predation of *A. vermicularis* by the elapid *Micrurus ibiboboca*, a widespread reptile within the Caatinga region of eastern Brazil (Roze 1996. Coral Snakes of the Americas: Biology, Identification, and Venoms. Krieger Publ. Co., Malabar, Florida. 328 pp.; Vanzolini, *op. cit.*) and a known amphisbaenian predator (Gomes et al. 2005. Herpetol. Rev. 36:170).

At 2100 h on 23 August 2007, one of us (CMCAL) collected an adult female *M. ibiboboca* that was in a residence in the municipality of Natal (3.1221ºS, 43.2122ºW; datum: SAD69; elev. 41 m). The residence's owner killed the snake, exposing its stomach which contained the recently ingested amphisbaenian prey. The prey was 203 mm SVL, 25 mm tail length, 4.54 g and the snake was 577 mm SVL, 34 mm tail length and 46.2 g.

The snake and amphisbaenian prey were deposited in the herpetological collection of Universidade Federal do Rio Grande do Norte, Natal municipality, under numbers CHBEZ 1910 and CHBEZ 1911, respectively.

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BARISIA IMBRICATA (Transvolcanic Alligator Lizard). **RECORD LITTER SIZE.** The viviparous anguid lizard *Barisia imbricata* occurs in the Mexican Transvolcanic axis (Flores-Villela 1993. Spec. Publ. No. 17, Carnegie Museum of Natural History, 73 pp). The species is widespread in several states that are a part of this axis, including Morelos, Mexico, Michoacán, Puebla, Oaxaca, Veracruz, Hidalgo, and Distrito Federal (Smith and Taylor 1966. Herpetology of Mexico. Annotated Checklist and Keys to the Amphibians and Reptiles. Eric Lundberg, Asthon, Maryland). Lizards of the genus *Barisia* have been poorly studied in aspects of their reproduction; however, there are data available for litter sizes among various subspecies of *B. imbricata*. For example, it has been reported that *B. imbricata imbricata* has a mean litter size of 6.9 (Guillette and Casas-Andreu 1987. Herpetologica 43:29–38), and there is a single report for a litter of 10 neonates (Navarro-López et al. 2003. Bol. Soc. Herpetol. Mex. 11:51–52). Other subspecies are recorded to have similar mean litter sizes: 6.9, *B. i. ciliaris*; 7.2, *B. i. jonesi*; 7.7, *B. i. planifrons* (Guillette and Casas-Andreu, *op. cit.*).

On 12 May 2009, during a field trip to El Pedregal, Municipality of Coyoacac, Mexico State, Mexico (19.24594°N, 99.45181°E; datum WGS84; elev. 2614 m), two gravid females were found in oak-pine forest with snout–vent lengths (SVL) of 132.4 mm and 123.0 mm, and body mass of 42.0 and 40.0 g, respectively. They were collected and housed in the laboratory in a terrarium. Two weeks later (May 26), the first female gave birth to 20 offspring (mean SVL = 32.8 mm [29.5–35.2 mm]; mean weight = 0.546 g [0.41–0.68 g]; mean tail length (TL) = 45.5 mm [38.0–50.7 mm] Fig. 1). The second female also gave birth to 20 offspring (May 31) (mean SVL = 33.4 mm [30.6–35.7 mm]; mean weight = 0.759



FIG. 1. Fifteen of 20 offspring from a single litter of *Barisia imbricata* from El Pedregal Municipality of Mexico State, Mexico.

g [0.65–0.87 g], mean TL = 45.7 mm [38.7–49.2 mm]). Offspring of the first female had a lower collective body mass than that of the combined offspring of the second female ($t = 11.7$, $P < 0001$), but the two litters were similar in SVL and TL ($P = 0.313$). These records for *B. imbricata* litter size suggest that variation exists in the reproductive characteristics among populations of this species.

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BARISIA LEVICOLLIS (Chihuahuan Alligator Lizard). **REPRODUCTION.** *Barisia levicollis* is currently known only from the state of Chihuahua, Mexico where it is limited to the Sierra Madre Occidental at elevations of about 2500 m (Lemos Espinal and Smith 2007. Amphibians and Reptiles of the State of Chihuahua, Mexico. Universidad Nacional Autónoma de México, Comisión Para el Conocimiento y uso de la Biodiversidad, México, D.F. 613 pp.). The purpose of this note is to provide the first information on its reproduction.

One *B. levicollis* female (142 mm SVL) was examined from the herpetology collection of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California (LACM 75502). It was collected 14 September 1971 in Chihuahua, 17 km NE El Largo (29.6833°N, 108.4500°W, WGS84; elev. 2150 m).

A small slit was made in the lower part of the abdomen to expose the ovaries. A total of 13 vitellogenic eggs (5 mm diameter) were counted (*in situ*). This September evidence of ovarian activity indicates *B. levicollis* exhibits an autumn reproductive period similar to some New World anguids: *Barisia imbricata* (Guillette and Casas-Andreu 1987. Herpetologica 43:29–38), *Elgaria kingii* (as *Gerrhonotus kingi*) (Goldberg 1975. Southwest. Nat. 20:412–413), and *E. paucicarinata* (Goldberg and Beaman 2004. S. California Acad. Sci. 103:144–146).

I thank C. Thacker (LACM) for permission to examine *B. levicollis.*

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CALOTES ROUXI (Forest Dwarf Calotes). **CAPTIVE REPRODUCTION AND BREEDING BEHAVIOR.** On 5 May 2008, during one of our field studies in the forest belt of the village of Kanakumbe (15.6933333°N, 74.2166667°E; WGS84), Western Ghats in Karnataka State, India (2500 m elev.), *Calotes rouxi* were observed on tree trunks. Nuptial coloration was evident in males in that the head and nuchal area were brick red. Some females appeared gravid based on the bulge of their abdomens. We collected one male (SVL 7.34 cm; body mass 10 g) and one gravid female (SVL 6.26 cm; body mass 8 g) and brought them to our laboratory and maintained them in an outdoor terrarium. All sides of the terrarium were made up of aluminum mesh except for the bottom, which had sand substratum of ~ 8 cm. The terrarium housed dry twigs that served as perches for the lizards and small herbs and grasses grew on the substratum. It also housed broken earthen pots and bricks that provided refugia for the lizards. The lizards were fed insects including grasshoppers and moths every other day. On 29 July 2008, 30 days after they were housed in the terrarium, the female appeared to have laid the eggs based on her flattened abdomen. Upon searching the substratum, we found five eggs. The eggs were about 3 cm deep in the nest. Apparently, the female had dug the nest in the soil, oviposited eggs, and then covered them with soil as we have observed in other agamid species including *Calotes versicolor*, *Psammophilus dorsalis*, and *Sitana ponticeriana*. These eggs were retrieved from the nest and incubated on moist sand substratum in a plastic box at ambient temperature following the procedure adopted for *C. versicolor* (Radder et al. 2002 Amphibia-Reptilia: 23:71–82). All eggs hatched on day 45 following oviposition. Mean snout–vent length (SVL) of these hatchlings was 23.3 ± 0.32 mm and mean body mass was 400 mg.

Interestingly, the day after oviposition, the adult male in the terrarium developed brick red nuptial coloration in the anterior part of the body including the head, began exhibiting courtship behavior composed of characteristic four-legged push-up and gular displays, and attempted to mate with the female, but was unsuccessful. The coloration disappeared soon after the male ceased courtship behavior. However, the next day, on 30 July 2008, the red nuptial coloration reappeared and a successful mating was observed between the pair. The male then lost his nuptial coloration again soon after the mating**.** Within a week of that mating, abdominal palpation revealed gravidity of the female. The female retained eggs for ~ 60 days and laid a second clutch of seven eggs on 2 September 2008 following heavy rainfall. All eggs hatched successfully after 44 days of incubation. The hatchling SVL measured 23.4 ± 0.13 mm and weight was 314.29 ± 14.29 mg.

This study is the first report on breeding behavior and reproduction in this species The fact that the same female laid more eggs in the second clutch suggests that the food (insects) provided was adequate and met the energy requirements for reproduction under captive conditions. We have been successful in rearing and breeding captive born *Calotes versicolor* in the outdoor terraria for the last 6–7 years. The present study demonstrates that outdoor terraria meant for captive breeding of *C. versicolor* was equally congenial for breeding of wild caught *C. rouxi* as well.

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CNEMIDOPHORUS OCELLIFER (Spix's Whiptail). **USE OF SCORPIONS AS PREY IN AN UNSTABLE ENVIRONMENT.** Whiptail lizards **(***Cnemidophorus*) are terrestrial, active-foraging teiids that consume primarily sedentary prey, such as termites and insect larvae (Vitt 1991. J. Herpetol. 25:79–90). *Cnemidophorus*

ocellifer exploits termites, orthopterans and spiders in the dry forests (Caatinga) of Northeastern Brazil (Vitt 1995. Occas. Pap. Oklahoma Mus. Nat. His. 1:1-29). We recorded a high frequency of predation on scorpions by this lizard on alluvial terraces of the lower São Francisco River, in Sergipe, Brazil (Caatinga Dominion).

Data were collected at the Monumento Natural Grota do Angico (9.6622222°S, 37.6697222°E; datum SAD-69), on the right bank of the São Francisco River, where alluvial terraces are formed by sand deposited during river floods, believed to occur naturally once a century (Dominguez and Brichta 1997. Estudos sedimentológicos a montante da UHE de Xingó. Sergipe: Cad. Arqueol. MAX). However, following the construction of the Xingó hydroelectric dam in 1994, 15 km upriver from the site, floodgates are opened every few years (most recently in 2003), flooding the terraces downriver and replenishing associated biota, but leaving sandy shores with sparse vegetation along the river bank.

Between October and November 2008, ten specimens of *C. ocellifer* were collected during the dry season. The examination of stomach contents revealed the presence of scorpions in seven lizards, ranging from one to three scorpions per stomach, as well as fragments. Coleoptans and orthopterans were recorded in four specimens, and spiders and ants in three. No termites were recorded. According to A.P.L. Giupponi (Museu Nacional, Rio de Janeiro, pers. comm.), at least two species of scorpions occur in the area, *Bothriurus rochai* and *Rhopalurus rochai*. It is relevant to note that *Cnemidophorus* are diurnal lizards, while scorpions are strictly nocturnal. This suggests that *C. ocellifer* may be targeting scorpion shelters during active foraging, possibly due to a scarcity of other resources in a poor and unstable environment, caused by frequent flooding and accentuated by the severe dry season at Caatinga, exhibiting considerable ecological flexibility.

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COPHOSAURUS TEXANUS (Greater Earless Lizard). **MORTALITY.** *Cophosaurus texanus* is distributed from southern portions of Arizona, New Mexico, and Texas and south from northeastern Sonora and Chihuahua to northern San Luis Potosí and western Tamaulipas, Mexico (Conant and Collins 1998. Reptiles and Amphibians of Eastern/Central North America. 3rd ed., Houghton Mifflin Co., Boston, Massachussets 450 pp.; Lemos Espinal and Smith 2007. Anfibios y Reptiles del Estado de Coahuila, México. CONABIO. México. 550 pp.). *Cophosaurus texanus* is known to prey on at least 12 different arthropod taxa (Maury 1995. J. Herpetol. 29:266–272; Kasson 2001. Herpetol. Rev. 32:40). Saurophagy has been reported (Castañeda et al. 2005. Herpetol. Rev. 36:174).



FIG. 1. Partial carcass of an adult *Cophosaurus texanus* found in Nuevo Leon, Mexico. Cause of death appears attributable to ingestion of a red rubber balloon, remains of which are clearly visible within the decomposing body.

On 8 February 2009, during an arachnid faunal survey at La Huasteca in the municipality of Santa Catarina in Nuevo Leon, Mexico, we encountered the trunk and limbs of a dead *C. texanus* (57 mm length, 17 mm width, 2.48 g) at 1330 h with a piece of red rubber balloon (49 mm length and 16 mm width) inside the decomposing body (Fig. 1), this material apparently being the cause of death. This locality is frequently visited by a large number of local tourists whose poor ecological and conservation practices result in a great amount of litter. The rubber balloon was apparently ingested by the lizard, but why and how remain a mystery.

A probable case of envenomation resulting in death of *C. texanus* caused by the ingestion of honeybees (*Apis mellifera*) has been documented (Mata-Silva et al. 2006. Herpetol. Rev. 37:464). Here we document for the first time the death of an adult *C. texanus* by an anthropogenic product and note the impact of litter on herpetofauna.

The lizard was collected, identified, measured, weighed, photographed, and deposited in the herpetological collection of the Facultad de Ciencias Biologicas/UANL (UANL 6997). We thank Pamela Gonzalez del Pliego Castañeda for use of the photograph.

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CORYTOPHANES CRISTATUS (Smooth Helmeted Iguana). **ENDOPARASITES.** *Corytophanes cristatus* is known from lowland and premontane areas of central Veracruz and the Yucatán Peninsula, Mexico south to northwestern Colombia; it is strictly arboreal (Savage 2002. The Amphibians and Reptiles of Costa Rica. A Herpetofauna Between Two Continents, Between Two Seas. University of Chicago Press, Chicago, Illinois. 934 pp.).

To our knowledge, there is one report of helminths; Bursey et al. (2007. Comp. Parasitol. 74:108–140) reported *Cyrtosomum longicaudatum* and *Macdonaldius grassi* in specimens of *C. cristatus* collected in Panama. The purpose of this note is to add to the helminth list of *C. cristatus.*

Four *C. cristatus* (SVL = 97.5 mm ± 8.3 SD, range = 89–106 mm) were borrowed from the herpetology collection of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California and examined for helminths (LACM 131039–131042 collected August 1979, in Costa Rica, Limón Province ca. 46 km W Tortuguero, 10.4166°N, 83.6000°W, WGS84; elev. 25 m). The body cavity was opened by a longitudinal incision and the digestive tract was removed, and the stomach and intestines were opened and examined using a dissecting microscope. Only nematodes were present. These were placed on microscope slides, cleared in glycerol, coverslipped, and studied under a compound microscope.

Found in LACM 131040 (large intestine) were 220 *Cyrtosomum longicaudatum* (prevalence = number infected lizards/number lizards examined = 25%) and 199 *Cyrtosomum mega* (prevalence = 25%); LACM 131042 (large intestine) contained 128 *Africana telfordi* (prevalence = 25%). Voucher endoparasites were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland as *Cyrtosomum longicaudatum* (USNPC 102114), *Cyrtosomum mega* (USNPC 102115) and *Africana telfordi* (USNPC 102116).

Cyrtosomum longicaudatum was described from *Ctenosaura similis* collected in Costa Rica by Brenes and Bravo Hollis (1960. Libro Homenaje al Dr. Eduardo Caballero y Caballero. Universidad Autónoma de México, México City, pp. 451–464) and is frequently reported from Central American lizards; a host list will be found in Bursey et al. (*op. cit.*). *Cyrtosomum mega* was described from *Cyclura carinata* from the Caicos Islands, West Indies by Bowie and Franz (1974. J. Parasitol. 60:628–631). *Corytophanes cristatus* is the second host reported to harbor this nematode. *Africana telfordi* was described from *Enyalioides heterolepsis* from Panama by Bursey and Goldberg (2002. J. Parasitol. 88:926–928). It was also reported in *Gonatodes albogularis* from Panama by Bursey et al. (*op. cit.*). *Corytophanes cristatus* is the third known host to harbor this nematode.

Species of *Africana* and *Cyrtosomum* are nematodes that do not utilize an intermediate host (Anderson 2000. Nematode Parasites of Vertebrates. Their Development and Transmission, 2nd ed. CABI Publishing, Wallingford, UK. 650 pp.). Infection likely occurs by ingestion of eggs from contaminated substrate. Pearce and Tanner (1973. Great Basin Nat. 33:1–18) considered species of *Cyrtosomum* to be commensals that feed on fecal matter in the large intestine rather than parasites. *Corytophanes cristatus* represents a new host record for *Africana telfordi* and *Cyrtosomum mega*. Costa Rica is a new locality record for both species.

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CTENOTUS REGIUS (Regal Striped Skink). **PREDATION.** The largest group of lizards in Australia belong to the genus *Ctenotus*, which contains close to 100 species. The species in this genus occur throughout much of Australia, particularly in arid and semi-arid regions (Cogger 2000. Reptiles and Amphibians of Australia, 6th ed. Reed New Holland, Sydney, 808 pp.). The ecology of many of these species remains poorly known, including predators and description of predation events. Here we present an observation of an immature Grey Butcherbird (*Cracticus torquatus*) preying on *Ctenotus regius*.

At 1230 h on 13 April 2009, south of Lake Becking, Murray-Sunset National Park (Victoria, Australia) (35.0380°S, 141.7138°E), in degraded *Allocasuarina*/*Callitris* woodland on red sands, bordering mallee country, a Grey Butcherbird flew from a mallee *Eucalyptus* ~25 m to the ground beneath another mallee. The butcherbird stayed on the ground for ~10 seconds where it became obvious that it had captured a skink, later identified as *Ctenotus regius.* The butcherbird then flew to the lower branch of a dead *Callitris* with the *C. regius* in its bill. It proceeded to hop up the branches and wedged the skink in the fork of the frayed hollow spout of the tree and began tearing at the skink. This method is commonly used by butcherbirds for handling larger prey items and for caching (Higgins et al. [ed] 2006. Handbook of Australian, New Zealand and Antarctic Birds Vol. 7 Boatbill to Starlings. Oxford Univ. Press, Melbourne. 1992 pp.). Upon our approach to photograph and identify the skink, the butcherbird hurriedly tore off the rear half of the skink and flew off (Fig. 1).

Grey Butcherbirds prey on invertebrates, mainly insects, and small vertebrates, especially small birds and their nestlings (Higgins et al. 2006, *op. cit.*). Grey Butcherbirds are known to take skinks (e.g., Barker and Vestjens 1991. The Food of Australian Birds 2. Passerines. CSIRO, Canberra, 557 pp.; Davis and Recher 1998. West. Aust. Nat. 22:135–136; Lea and Gray 1935. Emu 35:335–347; Rose 1999. Aust. Bird Watcher 18:164–178) but the identity of the skink species are rarely recorded. No *Ctenotus* species have been recorded in the diet of Grey Butcherbirds nor other *Cracticus* species, including the widespread and well-studied Australian Magpie (*C. tibicen*) (Higgins et al. *op cit.*).

Ctenotus regius occurs in Australia's semi-arid interior in woodlands and shrublands on heavy to sandy reddish soils in association with spinifex (Swan and Watharow 2005. Snakes, Lizards and Frogs of the Victorian Mallee. CSIRO Publishing, Collingwood. 104 pp.; Wilson and Swan 2008. A Complete Guide to Reptiles in Australia 2nd ed., New Holland, Sydney. 512 pp.) and overlaps with the range of Grey Butcherbirds throughout much of its distribution. *Ctenotus regius* and other *Ctenotus* species occurring in this range (e.g., Coventry 1996. Proc. Roy. Soc. Victoria 108:107–119) are likely to be prey for this and other *Cracticus* species.

Aumann (2001. Wildl. Res. 28:379–393 and supplementary appendices) found that a number of diurnal raptor species took a small number of *Ctenotus* species in arid central Australia. However, Pianka (1969. Ecology 50:1012–1030) believed it "doubtful" that many *Ctenotus* in the Great Victoria Desert species fall prey to birds or mammals due to the unlikelihood that these predators would pursue the skinks into dense *Triodia* tussocks. Pianka (1969, *op. cit.*) found the main predators of *Ctenotus* in that region to be *Varanus* monitors and elapid snakes. Read (1998. Aust. J. Zool. 46:617–629) suggested that larger *Ctenotus* such as *C. regius*



FIG. 1. A Regal Striped Skink (*Ctenotus regius*) wedged in the fork of a tree and dismembered by a Grey Butcherbird (*Cracticus torquatus*) in Murray-Sunset National Park, Australia.

conserve energy by remaining inactive on many days, regardless of food availability or temperature and thereby may decrease their risk of predation. Henle (1989. Acta Oecologica Oecologia Generalis 10:19–35) considered that it is likely that predation generally plays an important role in segregating lizard communities, including those containing *C. regius*, but does not describe the types of predators.

The apparent preference for more open woodlands by *C. regius* in northwest Victoria (Coventry 1996. Victorian Nat. 113:289–299) and their habit of actively foraging around ground vegetation (Swan and Watharow 2005, *op. cit.*) may make this species more susceptible to predation by birds than others in the genus.

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CYCLURA CYCHLURA INORNATA (Allen Cays Rock Iguana). **PARAPHIMOSIS AND PROLAPSED CLOACA**. In reptiles, several problems can arise involving the cloaca and the prolapse of different organs (e.g., colon, oviducts, hemipenes, etc.; see Bennett and Mader 2006. *In* Mader [ed.], Reptile Medicine and Surgery, pp. 751–755. Elsevier/Saunders, St. Louis, Missouri; Barten 2006. *In* Mader [ed.], *op. cit.*, pp. 862–864; DeNardo 2006. *In* Mader [ed.], *op. cit.*, pp. 376–390). Published observations of cloacal prolapse in natural populations of reptiles are relatively rare (see Pernetta and Reading 2009. Herpetol. Rev. 40:95). Here we report two observations of prolapse from the cloaca in the Allen Cays Rock Iguana (*Cyclura cychlura inornata*) from Leaf Cay and Southwest Allen Cay in the Bahamas (24.75°N, 76.83°W; see Iverson et al., 2004: Herpetol. Monogr. 18:1–36 for a detailed description of the study area).

On 9 May 2001, we observed an adult male (snout–vent length, SVL = 35.0 cm, SVL) on Leaf Cay with a prolapsed right hemipenis that was hard and shriveled. This male was subsequently captured in 2002, 2003, and 2004 with no obvious health problems, and no evidence of the prolapsed hemipenis. He was not subsequently captured between 2005 and 2009, but may have been poached or died of other causes. Prolapsed hemipenes typically arise from damage to the hemipenis during copulation (Barten 2006, *op. cit.*; DeNardo 2006, *op. cit.*).

On 29 March 2008 we observed a large female (SVL = 32.0 cm, SVL) with a prolapsed cloaca on Southwest Allen Cay (Fig. 1). This female was found to have an elevated corticosteroid level (30.6 ng mL-1) compared to others in the population (mean = 5.9 ng mL-1) as determined by blood tests conducted on samples collected within three minutes of capture to avoid increased glucocorticoid concentrations (see Romero and Wikelski 2002. Biol. Conserv. 108:371–374). She was subsequently found dead less than two months later on 14 May 2008. Cloacal prolapse can occur due to straining during oviposition or straining during defecation due to constipation or other causes (Bennett and Mader 2006, *op. cit.*). Of particular concern for the Allen Cays Rock Iguana is the potential increase in strained defecation due to the feeding of iguanas by tourists. Diets high in grapes, the most commonly provided food item, result in sand and liquid-filled scat that dries to a cement-like consistency (Fig. 2; see also Hines 2007. Iguana 14:243). The density of these cement-like scats is greater than those formed from a natural diet of leaves and fruits, potentially increasing the incidence of constipation and tenesmus, and thereby cloacal prolapse. The death of this female suggests that cloacal prolapse may result in



FIG. 1. Prolapsed cloaca of a female Allen Cays Rock Iguana found on Southwest Allen Cay, Exumas, Bahamas in March 2008.

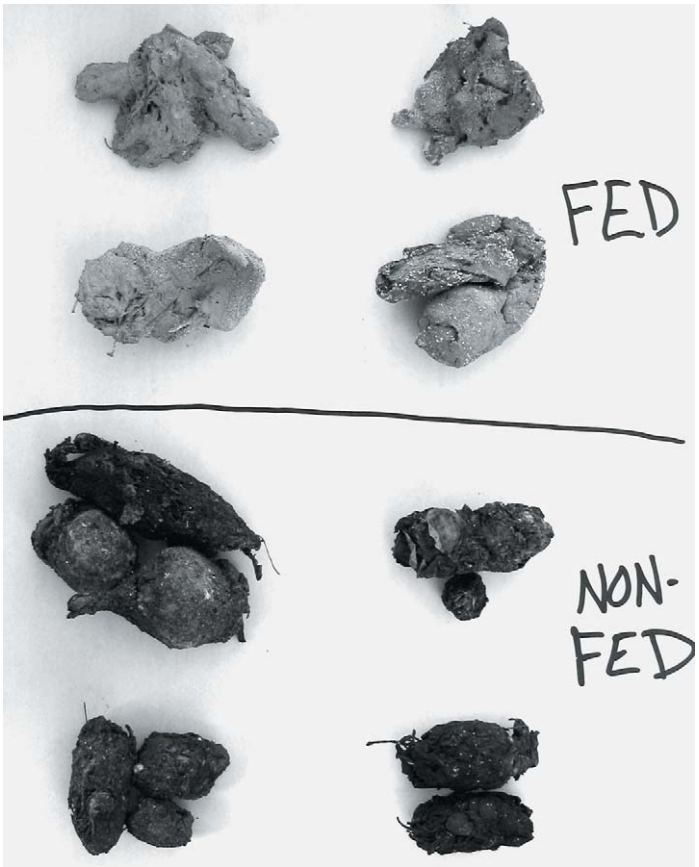


FIG. 2. Comparison of scat samples from the tourist feeding beach (top) versus non-visited areas (bottom) of Leaf Cay, Exumas, Bahamas.

death, or alternatively, may be a sign of another health issue that may result in death.

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DELMA IMPAR (Striped Legless Lizard) **REPEATED USE OF COMMUNAL NESTING SITE**. Communal nesting is a reproductive trait commonly observed in some groups of reptiles (Graves and Duvall 1995. Herpetol. Monogr. 9:102–119). The benefits of communal nesting may include a response to the limited availability of suitable nest sites in the environment due to thermal, hydric and anti-predator constraints, or fitness benefits for offspring born in a cluster of eggs (Radder and Shine 2007. J. Anim. Ecol. 76:881–887). The trait has been identified in some species of pygopodids, a family of flap-footed snake and worm-like lizards confined to the Australian region (Greer 1989. The Biology and Evolution of Australian Lizards. Surrey Beatty & Sons Pty Limited, Chipping Norton, N.S.W. 264 pp.). This family includes the Striped Legless Lizard, *Delma impar*, with females known to lay a single clutch of up to two eggs annually in early summer. Communal nesting has so far been reported three times in this species; once with four eggs and twice with six eggs clumped together in substrate cavities or under rocks, inferring the joint use of a nesting site by at least two and three female *D. impar*, respectively (Banks et al. 1999. Herpetofauna 29:18–30; Coulson 1995. Management Directions for the Striped Legless Lizard (*Delma impar*) in the Australian National Territory. ACT Parks & Conservation Service, Canberra, ACT; Mills 1992. Report of *Delma impar* trapping survey conducted at Werribee, Jan–Feb 1992. Unpubl. report to the Striped Legless Lizard Working Group, Victoria). Further information on this aspect of the species' reproductive biology is important for its management and conservation, as *D. impar* is listed as threatened under state, national, and international legislations (Smith and Robertson 1999. National Recovery Plan for the Striped Legless Lizard (*Delma impar*): 1999–2003. Environment Australia, Canberra) and general knowledge of its biology is sparse.

As part of an intensive survey program for this species in Western Victoria, southeastern Australia, we report the repeated use of an artificial, communal nesting site exceeding the aggregations reported previously and discuss environmental parameters associated with the site. In 2000, four survey grids were established in native grassland on a private property near Hamilton in Western Victoria with the aim of determining the presence of *D. impar*. Each survey grid consisted of fifty roof tiles arranged in a 20 × 45m grid formation. Grids were monitored first annually, and since 2005, quarterly, with the presence of all terrestrial vertebrate fauna within the grids recorded. On 9 December 2007 we captured two female *D. impar* (90 and 93 mm SVL) that appeared to be gravid and also noted the presence of six *D. impar* eggs deposited in a prominent soil crack underneath a single tile on grid #1 (37.5016°S, 142.3314°E). We released the gravid females within an hour underneath the same tile and returned on 20 April 2008 and retrieved, with minimum disturbance to the crack, a total of 32 eggs shells. This finding infers a communal nesting site with contribution of at least 16 female *D. impar*. On 30 November 2008 we attached a temperature data logger (Thermochron iButton®, Dallas Semiconductor) programmed to collect temperature (± 0.5°C) every hour until 31 January 2009 beneath the above roof tile with the data logger situated just above the soil crack. On 5 January we returned and briefly lifted the tile and confirmed the presence of at least six *D. impar* eggs. On 27 March 2009 we collected a total of 16 egg shells from the soil crack, again with minimal disturbance. This inferred that the same nesting site had been used again by at least eight females. Data logger records showed that temperatures underneath the roof tile between 1 December 2008 and 31 January 2009 had ranged from 3°C to 72°C (mean = 23.6°C, SD = 15.52).

The site on which the four grids were established is one of a few remaining large, high-value natural temperate grassland remnants on the Victorian Volcanic Plain. The site consists of mostly intact native grassland vegetation and soil crust with submerged volcanic rocks along the slopes of a creek gully. The conservation status of *D. impar* is increasingly being linked to the survival of such remnant habitats so that the presence of a large number of gravid *D.*

impar at this site may not be surprising and treated as an indication of the ecological value of the habitat. In the greater context of the project, this is the only communal nesting site discovered so far underneath roof tiles across 73 survey grids where *D. impar* has been detected (3650 roof tiles lifted approximately 43,800 times). The low success rate in finding such sites and the repeated use of a single communal nesting site by a large number of gravid females suggest that the species is very selective in choosing oviposition sites. It may be possible that aggregating eggs may protect them from desiccation in extreme weather conditions, like the temperature extremes displayed by our thermal data, or provide a selective fitness advantage to the offspring. More than 90% of egg shells recovered indicated successful hatching so the former may be plausible. Alternatively, suitable soil cracks or cavities with protection from predators and environmental extremes may be a limited resource (and the roof tile may have added a favorable element to produce a suitable oviposition site). Grid #1 was located on a small flood plain at the bottom of the gully with a deep layer of clay soil that cracked in summer, as opposed to shallow sandy clay horizon on the slopes. Further work to identify the oviposition preferences of the species will aid in the preparation of informed management and conservation strategies for *D. impar* in the wild.

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GERRHONOTUS PARVUS (Pygmy Alligator Lizard). **JUVENILE SIZE**. *Gerrhonotus parvus*, an anguid endemic to Nuevo León, Mexico, is known from only adult specimens (Knight and Scudday 1985. Southwest. Nat. 30:89–94; Banda-Leal et al. 2002. Southwest. Nat. 47:614–615; Banda et al. 2005. Herpetol. Rev. 36:449). Although one adult female maintained in captivity reportedly laid four eggs (Knight and Scudday, *op. cit.*), nothing has been reported on the size of the young of this species. Here, we report on the size of a juvenile *G. parvus* found in the wild.

On 1 October 2005, we found a juvenile *G. parvus* under a small rock in a canyon bottom near San Isidro, Municipio Santiago, Nuevo León. The canyon (ca. 1600 m elev.) runs east to west and is characterized by steep limestone walls covered with various agaves (*Agave* spp.), sotol (*Dasylirion* sp.), and scrub oak (*Quercus* sp.), and has intermittent pools of water, piles of leaf litter, and large rocks scattered throughout. The *G. parvus* measured 25.1 mm SVL, had an unbroken tail 28.5 mm in length, and a mass of 0.4 g. Previous reports of juvenile size in the small-bodied and closely related alligator lizard *Gerrhonotus lugoi* ranged from 37–55 mm SVL (Lazcano et al. 1993. Bull. Chicago Herpetol. Soc. 28:263–265), making the specimen of *G. parvus* reported herein one of the smallest known gerrhonotine lizards in North America.

The specimen was deposited in the Universidad Autónoma de Nuevo León Herpetological Collection (UANL 6785). Research and collecting were conducted under the authority of SEMARNAT scientific research permits OFICIO NÚM/SGPA/DGVS/01612 and 01454 issued to DL.

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IGUANA DELICATISSIMA (Lesser Antillean Iguana). **DISPLAY BEHAVIOR**. Iguanine lizards typically use headbob displays consisting of ritualized up-and-down motions. Forms of these displays often are referred to as "signature" displays because the number and timing of motions carry information about the individual, sex, and species identity of the displaying animal. Headbob displays serve primarily in territorial maintenance, frequently are directed toward individuals at a distance, often are used in aggressive displays (most commonly by males), and occasionally by males during courtship (Martins and Lacy 2004. *In* Alberts et al. [eds.], Iguanas: Biology and Conservation, pp. 101–108. Univ. California Press, Berkeley, and references therein). Although signature displays have been described for many iguanine lizards, we present here observations of such displays in *Iguana delicatissima*.

From 5–25 June 2008, in the course of a study examining movements and allocations of time and space in a community of *I. delicatissima* at the Sunset Bay Club on Dominica, Lesser Antilles (15.4514°N, 61.4465°W; elev. ~5 m), we observed dozens of displays and videotaped six displays by males and two by females with a Sony digital video camera recorder (model DCR-TVR120).

Headbob displays were used by both males and females. Those of males were of slightly higher amplitudes than those of females and were more likely to be repeated (especially when directed toward other males). Each display consisted of two to five headbobs of decreasing amplitude, with most (six of eight videotaped displays, five by males; 16 of 18, 12 by males; and two by individuals of unknown sex, for which data were recorded) involving four sequential bobs.

The first bob was inevitably of highest amplitude (position 2 in Fig. 1), after which the head returned to the initial position (1). Headbobs 2 and 3 (positions 3 and 5, respectively) were of lower amplitude and were followed by the head dropping to below the starting point (positions 4 and 6). The final headbob was little more than a "jiggle," after which the head returned to the initial position.

Marcella & Roger Dutrieux Cools, owners of the Sunset Bay Club, work diligently to coexist with Dominica's wildlife and were very tolerant of our antics. Mr. Arlington James, Forest Officer, Forestry, Wildlife, and Parks Division, Ministry of Agriculture & the Environment, Commonwealth of Dominica, was instrumental in issuing permits to conduct research in Dominica. Protocols were approved by the Avila University Animal Care and Use Committee. Fieldwork was funded by a grant from the National Science Foundation (USA) to RP (DBI-0242589).

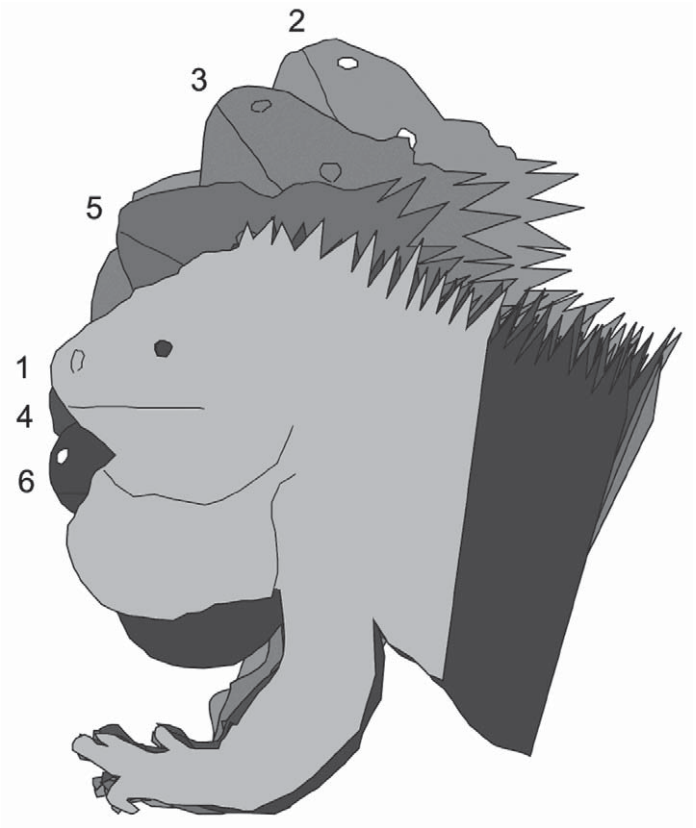


FIG. 1. Signature display in *Iguana delicatissima* drawn by PAT from a videotaped display by an adult male. See text for description of the display.

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LEPIDOBLEPHARIS XANTHOSTIGMA (Orange-tailed Gecko). **PREDATION.** Many species of gekkonid lizards have been reported as prey of various vertebrates, such as mammals (Daugherty et al. 1994. New Zealand J. Zool. 21:317–323; Gardner 1977. *In* Baker et al. [eds.], Biology of Bats of the New World Family Phyllostomatidae, Part II. Spec. Pub., Mus. Texas Tech Univ.), birds (McKeown 1983. *In* 6th Annual Reptile Symposium on Captive Propagation and Husbandry. Zoological Consortium, Thurmont, Maryland), snakes (Bernarde et al. 2000. Rev. Brasil. Biol. 60:695–699; Downes and Shine 1997. Anim. Behav. 55:1373–1385), and lizards, including large geckos (Bauer 1990. Herpetol. Rev. 21:83–87). Invertebrate predators of geckos have also been reported, including arachnids, centipedes, mantids and ants (Bauer 1990, *op. cit.*; Henle 1990. Herpetol. Monog. 4:30–60; Henle 1993. J. Arachnol. 21:153–155; Punzo 1993. Psyche 100:151–162). Vitt et al. (2005. Herpetol. Monog. 19:137–152) reported a high rate of tail-loss in *Lepidoblepharis xanthostigma* and commented on the interest in obtaining information on their interactions with invertebrate predators; however, no predators have previously been reported for the species.

This note reports a single observation of an arthropod attack on *L. xanthostigma* on Isla Palma, Department of Valle del Cauca, approx. 1.5 km off the Pacific coast of Colombia (3.90019°N, 77.35597°W, WGS84). The island is in the tropical rain forest life zone (Holdridge 1987. Life Zone Ecology. Tropical Science Center, San Jose, Costa Rica) and has average annual precipitation of 6000 mm and 90% relative humidity—the predominant height of forest trees is between 10 and 50 m, with many shrubs and ferns in the understory (Castellanos 2003. Interacciones Tróficas y Espaciales de un Ensamblaje de Peces de Charcos Intermareales en un Acantilado Rocoso Tropical, Bahía Malaga-Pacífico Colombiano. Universidad del Valle, undergraduate thesis. Cali, Colombia, 88 pp.; Montoya 2003. Estructura de la Comunidad de Gasterópodos: Diversidad, Distribución y Abundancia con Relación a la Heterogeneidad Espacial en dos Acantilados Rocosos Intermareales de Isla Palma, Pacífico Colombiano. Universidad del Valle, undergraduate thesis. Cali, Colombia, 82 pp.). We made the observations during a light rain along the crude trail to Punta Brava near the southeastern corner of the island on 29 June 2007 at 2045 h. A spider was captured on the ground in the leaf litter with a *Lepidoblepharis xanthostigma* in the grasp of its chelicerae. Injuries on the gecko's body indicate the spider had likely attacked the gecko in at least two places. One pair of wounds involved the dorsal, occipital region of the head and dorsum of the torso behind the forelimb on the left side of the body, and a separate area with broken skin at the base of the tail, which was missing. As the spider was lifted from the ground it released the gecko, the spider was then dropped, and both ran into the leaf litter where they were recaptured. The gecko was an adult male (SVL 24.1 mm) and the spider was an unidentified species of brushed trapdoor spider (Barychelidae) of the genus *Trichopelma* (cephalothorax length 29 mm), locally known as "chicken-eating tarantula." The gecko specimen was deposited in the collections of the Museo de Ciencias Naturales "Federico Lehman" in Cali, Colombia (IMCN-Rep 197).

We are indebted to the Dirección General Marítima (DIMAR) for allowing us access to the island, to the Grupo de Ecología Animal of the Universidad del Valle for its assistance in the fieldwork, Carlos Valderrama for help with identification of the spider, and Eli Greenbaum for comments on the manuscript.

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LIOLAEMUS GRACILIS (Striped Slender Lizard). **PREDATION**. *Liolaemus gracilis* occurs from northern Chubut to southern La Rioja provinces, in western Argentina (Cei 1986. Reptiles del Centro, Centro-Oeste y Sur de la Argentina, Mus. Reg. Sci. Nat. Torino, Mon. 4:1–527). Only a few data are available on its biology (e.g., Vega and Bellagamba 2005. Cuad. Herpetol. 18:3–13) and no data regarding its predators have been published. Hence, here we report an observation of *Philodryas psammophidea* predation on *L. gracilis*.

Philodryas psammophidea is a common snake in the Monte and Chaco arid and semiarid regions of western and northwestern Argentina and has been reported as a lizard-eater in general citations (Cei 1993. Reptiles del Noroeste, Nordeste y Este de la Argentina. Mus. Reg. Sci. Nat. Torino, Mon. 14:1–949). At 1030 h on 19 October 2008 during a collecting trip through western San Luis province a DOR juvenile *P. psammophidea* (sex undetermined, 490 mm SVL, 555.0 mm TL, 28 g) was found on Provincial Road 3, 43.7 km S of San Luis City, La Capital Department, San Luis province (33.6171°S, 66.4139°W, datum = WGS 84, 515 m elev.). As we were preserving the specimen, we extracted from its stomach an adult *Liolaemus gracilis* (47.0 mm SVL, 134.0 mm TL, 1.8 g). The lizard's body was nearly completely intact, with only its tail autotomized near the base and its head possessing a severe wound, probably inflicted when the snake caught it. The specimens of *L. gracilis* (LJAMM 10937) and *P. psammophidea* (LJAMM 10935) were deposited in the herpetological collection at Luciano Javier Avila Mariana Morando (LJAMM) of the Centro Nacional Patagónico – CONICET, Puerto Madryn, Argentina.

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LIOLAEMUS HATCHERI (NCN). **MULTIPLE MORTALITY**. *Liolaemus hatcheri* is a small liolaemid lizard endemic to a small region in northwestern Santa Cruz Province, northern Patagonian, Argentina (Etheridge 1998. Cuad. Herpetol. 12:31–36). Only anecdotal data are known about its biology and natural history (Cei 1986. Reptiles del Centro, Centro-oeste y Sur de la Argentina. Mus. Sci. Nat. Torino Mon. 4:1–427). During field work carried out on 18 January, 2008 in Estancia Cerro Beltza (47.9937ºS, 71.6804ºW; datum: WGS84; elev. 912 m), Rio Chico Department, Santa Cruz Province, we found a population of *L. hatcheri* inhabiting a gently sloping area with highly degraded vegetation overgrazed by sheep. Lizards were found basking on medium-sized rocks scattered in the area and typically retreated to nearby rock crevices or burrows upon disturbance. Upon lifting a roughly oval-shaped, medium-sized rock (70 × 25 × 40 cm; ~30 kg) that overlaid a larger, imbedded rock, and thus provided a crevice between the two, we found three lizard carcasses that we identified by comparison with live individuals as adult specimens of *Liolaemus hatcheri* (~75 mm, SVL) (Fig. 1). This finding revealed that *L. hatcheri* use small crevices as communal shelters, but the cause of death is unclear. We hypothesize two potential causes: lizards use this refugia for temporary shelter during the normal season of activity and unusually low temperatures caused their demise inside the crevice, or the rock was moved by human or domestic livestock activity in the area and the lizards were crushed underneath. Findings on multiple deaths of *Liolaemus* in Patagonia are uncommon and formal reports are non-existent to our knowledge. Voucher specimens (LJAMM 7615–7617) are deposited in the Luciano Javier Avila Mariana Morando (LJAMM) collection housed in CENPAT-CONICET.

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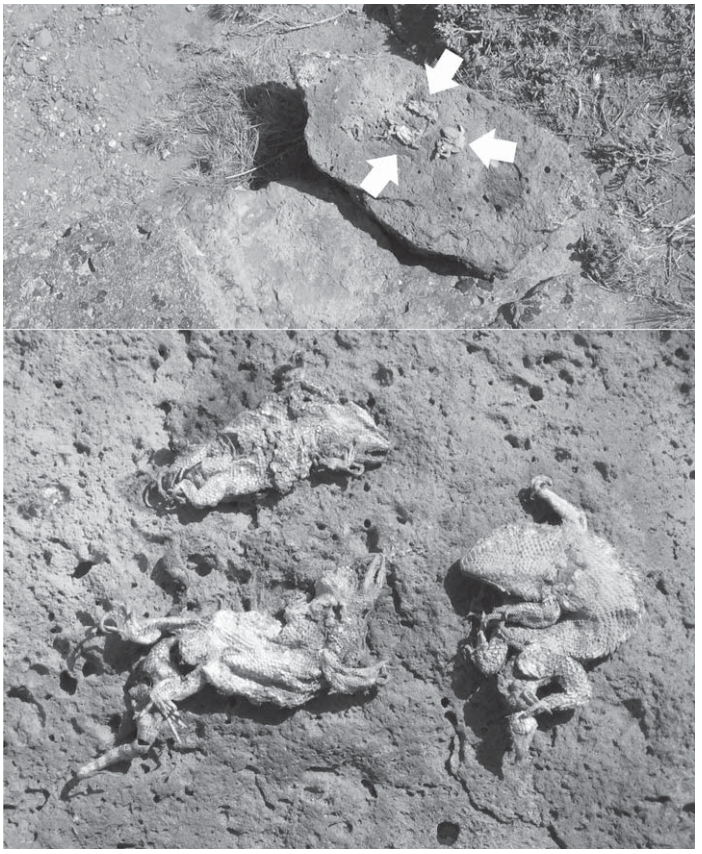


FIG. 1. Upper: general view of the site where the three lizards were found dead in the rock. Below: Detail of the three carcasses.

LIOLAEMUS OLONGASTA (NCN). **PREDATION**. *Liolaemus olongasta* is an oviparous and insectivorous, small-sized lizard inhabiting the arid landscape of Monte desert in western Argentina. Its geographic distribution ranges through central-west La Rioja to northern Mendoza provinces (Etheridge 1993. Boll. Mus. Reg. Sci. Nat. Torino 11:1–99; Sanabria et al. 2005. Herpetol. Rev. 36: 337). Only a few data are available on its biology (e.g., Canovas et al. 2006. Herpetol. Rev. 37:87–88) and no data about its predators have been published. Hence, here we report an observation of *Pseudotomodon trigonatus* predation on *L. olongasta*.

Pseudotomodon trigonatus is a rare snake, endemic to western Argentina, inhabiting mainly the Monte and southern Chaco regions and has been reported as a lizard-eater in general citations (Etheridge, *op. cit.*). At 1000 h on 19 October 2008 during a collecting trip through northern San Juan province we observed a juvenile female *L. olongasta* basking in an open area between bushes outside National Road 40, 6.5 km E Huaco River Bridge, in the road to Huaco, Jachal Department, San Juan province (30.3323ºS, 68.6537ºW, datum = WGS 84, 1096 m elev.). As we approached, the lizard ran away looking for refuge between the branches of a *Larrea cuneifolia* bush. When it reached the proximity of a small burrow between the branches, we observed the lizard's body writhing, as something appeared to be grabbing it from inside the burrow. We continued to observe this activity until only a hind limb and the tail remained outside the burrow. When we grabbed

the lizard something was still trying to pull it back into the burrow but finally we were able to pull the complete animal out with a large wound across its chest and belly. We dug into the burrow and found a *P. trigonatus* (SVL 240 mm, TL 278 mm, weigh 70 g) coiled within, which we collected after the snake attempted to flee. The specimens of *L. olongasta* (LJAMM 10699) and *P. trigonatus* (LJAMM 11087) were deposited in the herpetological collection Luciano Javier Avila Mariana Morando of the Centro Nacional Patagónico–CONICET, Puerto Madryn, Argentina.

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LIOLAEMUS PETROPHILUS (NCN). **PREDATION**. Although birds are often acknowledged as feeding on lizards, direct observations of predation are relatively rare under natural conditions. *Liolaemus petrophilus* is a medium-sized lizard inhabiting the Patagonian steppe in association with rocky outcrop habitats in central Rio Negro and Chubut provinces, Argentina (Avila et al. 2006. Check List 2:66–69). Despite its abundance in its natural habitats, only recent information regarding its avian predators is available (Perez and Avila 2005. Herpetol. Rev. 36:451–452). On 13 January 2009 at ca. 1900 h, in the course of a herpetological survey carried out on the edge of a volcanic plateau, within a small valley known as Cañada La Leona (42.4084°S, 68.2615°W; datum: WGS84; elev. 1062 m), north of the town known as Gan Gan, Telsen Department, Chubut Province, CHFP observed the remains (tail with spinal axis) of a lizard *Liolaemus petrophilus* (SVL was estimated in 84 mm and a TL of 226 mm) below an American Kestrel (*Falco sparverius*) nest. The nest was on a small cliff and contained fledglings, with an adult also present. A few minutes following the initial observation, another adult kestrel arrived with an adult *L. petrophilus* in its talons. The lizard was approximately of the same size as the former dead specimen, suggesting that during summer the kestrel is an active predator of this lizard. *Falco sparverius* is widely distributed in Patagonia and is an active diurnal predator (Narosky and Yzurieta 2003. Guía para la Identificación de las Aves de Argentina y Uruguay. A.O. P., Vázquez Mazzini, Buenos Aires, Argentina. 346 pp.). It is a generalist predator known to eat lizards in summer (Figueroa Rojas and Corales Stappung 2004. Hornero 19:53–60). This is the first record of predation on *L. petrophilus* by *F. sparverius*.

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MABUYA NIGROPUNCTATA (NCN). **PREDATION.** *Mabuya nigropunctata* occurs throughout Amazonian rain forest, living along forest edges, open patches and on the margins of terra firme forest (Avila-Pires 1995. Lizards of Brazilian Amazonia. Zool. Verh. Leiden 299; Vitt et al. 1996. J. Trop. Ecol. 13:199–220). The species is heliothermic and is often observed basking (Avila-Pires 1995, *op. cit.*). Hoogmoed (1973. Biogeographica 4:1–419) reported a *M. nigropunctata* preyed upon by a pygmy-owl (*Glaucidium* sp.), and Cunha and Nascimento (1994. Bol. Mus. Paraense E. Goeldi 9:1–191) also encountered an individual in the stomach of the snake *Siphlophis cervinus*. Herein, we report an observation of Pearl Kite (*Gampsonyix swainsonii*) predation on *M. nigropunctata*.

On 27 April 2008 at ca. 1200 h, while conducting an ornithological survey as a part of the Environmental Impact Study of the Foz do Apiacás Hydroelectric Power Plant in Mato Grosso State, Brazil, we collected an adult *G. swainsonii* with a pressure gun from a grassland area of Paranaíta, Mato Grosso (57.1092°W, 9.4155°S, datum: SAD69; elev. 701 m); dissection revealed a tail of one adult *M. nigropunctata* in the stomach. The grasslands are surrounded by rain forest dominated by Babaçu Palms (*Orbignya oleifera*).

Gampsonyix swainsonii, the smallest raptor in Brazil, inhabits open areas and forest edges (Antas 2005. Pantanal Guia de Aves: Espécies da Reserva Particular do Patrimônio Natural do SESC - Pantanal. Editora Serviço Social do Comércio, Rio de Janeiro-RJ, Brazil. 225 pp.). Previous studies of *G. swainsonii* diet report insects, birds, and unidentified lizards (Sick 2001. Ornitologia Brasileira. Editora Nova Fronteira. Rio de Janeiro, Brazil. 862 pp.).

The *G. swainsonii* specimen (JB 396 - collection license 10698-1/IBAMA) (length: 24.1 cm) and its stomach contents were deposited in Laboratório de Ornitologia, Campus of Cuiabá, Universidade Federal de Mato Grosso (UFMT).

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MICRABLEPHARUS MAXIMILIANI (Blue-tailed Lizard). **PREDATION.** *Micrablepharus maximiliani* is a widely distributed heliothermic lizard, occurring from Brazilian Amazonia to Paraguay (Ávila - Pires 1995. Zool. Verh. Leid. 299:1–706; Peters and Donoso–Barros 1986. Bull. Uni. Stat. Nat. Mus. 297 pp.; Rodrigues 1990. Simp. Ecos. Cost. Sud. Bras. pp. 404–410; Vanzolini 1988. Proc. Work. Neotropical Distribution Patterns, pp. 317–342; Vanzolini et al. 1980. Acad. Bras. Ciên. 161 pp.). It occurs in coastal areas and the edges of forested areas where it can also be found in the isolated forest range (known locally as 'Brejos de Altitude') in the semi-arid Caatingas (Vanzolini 1974. Pap. Avul. Zool. 28[4]:61–90; Freire 1996. Rev. Bras. Zool. 13[4]:903–921; Rodrigues, *op. cit.*; Borges–Nojosa and Caramaschi 2003. Ecol. Cons. Caat. V. 01, pp. 489–540). It is commonly observed in leaf

litter, herbaceous vegetation and can be found in association with eusocial insects like termites and ants (Vitt 1991. J. Herpetol. 25:79–90; Mesquita et al. 2006. Copeia 2006(3):460–471; Sousa and Freire, *in press*, S. Amer. J. Herpetol.). Theraphosid spiders are part of the infraorder Mygalomorphae which includes a great diversity of spiders that occupy a variety of habitats and are common in Brazil, where they are known as "aranhas caranguejeiras" ('crab spiders') because of their large size (Brescovit et al. 2002. *In* Adis (org.), Amazonian Arachnida and Myriapoda, pp. 303–343). The large size of these spiders allow them to consume large invertebrates and small vertebrates (Vitt 2000. Herpetol. Monogr. 14:388–400; Brescovit et al., *op. cit.*).

Few studies are available regarding prey-predator relationship of these spiders within Brazilian communities, especially involving reptiles, due to the time required for sampling and the elusive habits of many reptiles species (Rocha and Vrcibradic 1998. Ciência e Cultura 50[5]:364–368). Here, we report on an observation of predation on *M. maximiliani* by a theraphosid spider.

At 0930 h on 1 July 2009, in the Parque Estadual Mata da Pipa (PEMP), municipality of Tibau do Sul, State of Rio Grande do Norte, Brazil (6.24861ºS, 35.05750°W, datum: WGS84; elev. 63 m), PAGS saw a medium-sized spider (~6 cm from the anterior tip of the head to the posterior end of the abdomen) in bare sand of open forest with a specimen of *M. maximiliani* grasped in its chelicerae. The lizard had no head, no front legs and no chest, but its color pattern and the absence of records of other species of this genus in the State served for a positive identification. The specimen of *M. maximiliani* could not be used for scientific collection, due to its high degree of deterioration caused by spider´s digestive enzymes.

We thank the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) for the research scholarship granted to PAGS (process 127543/2008-2) and EMXF (process 304077/2008-9), Jackson D. Shedd for helpful comments on this note and Roberto Lima Santos for identifying the spider.

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NOROPS CARPENTERI (NCN). **ENDOPARASITES.** Nematodes are known as endoparasites of several species of anoles (e.g., Bursey et al. 2003. J. Parasitol. 89:118–123; Dobson et al. 1992. Oecologia 91:110–117; Goldberg and Bursey 2004. Herpetol. Rev. 35:269). Herein, I report a case of nematode infestation in *Norops carpenteri*. In the Reserva Biológica Hitoy Cerere (Costa Rica, Limón Province, 9.667°N, 83.033°W, ca. 250 m elev.) on 25 August 2005, I encountered a male *N. carpenteri* on the forest floor. The anole was hardly moving and at closer examination I noticed that it was heavily infested with nematodes, apparently ascaridids. The body loop of one nematode protruded from the anole's cloaca and while I carefully handled the anole, several nematodes emerged (Fig. 1). This is the first report on endoparasites in *Norops carpenteri.*



FIG. 1. Nematodes protruding from the cloaca of *Norops carpenteri*.

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PHRYNOSOMA CORNUTUM (Texas Horned Lizard). **NESTING BEHAVIOR.** Few detailed accounts of nesting activities of the Texas Horned Lizard (*Phrynosoma cornutum*) have been published that span the early digging of a nest through oviposition and subsequent completion of an undetectable nest site. Nesting behaviors have been reported by Sherbrooke (2002. Herpetol. Rev. 33:206–208) and Allison and Cepeda (2009. Southwest. Nat. 54[2]:211–213). This note describes previously unreported behaviors during a nesting event.

At 1020 h on 25 May 2008, we observed a female (87 mm SVL; 52 g on 22 May) Texas Horned Lizard (*Phrynosoma cornutum*) excavating a nest under extremely hot, dry, windy conditions in Randall County, Texas, USA (ca. 34.98°N, 101.93°W, datum: NAD27; elev. 1080 m). Temperatures recorded for 25 and 26 May reached 32 and 33°C, respectively. At 1655 h the lizard (now 31.4 g) had laid eggs and was 10 m upslope from the site of excavation, resting in the shade of a nearby fence, but in clear view of, and intently watching, the nest site. This is the only observation we have made of a nesting female leaving the immediate area of the nest after ovipositing and before backfilling the nest, leaving the eggs exposed, and attribute it to the need for thermoregulation (lowering her body temperature). The lizard returned to, and resumed work at, the nest ca. 1855 h.

At ca. 2100 h, the lizard was working inside the nest with a large mound of loose soil outside the cavity when a violent thunderstorm approached. The storm, with 80 km/h winds (gusting to 112 km/h), hail, and driving rain, passed quickly and resulted in pea to marble sized hail, but minimal precipitation. When we checked the nest immediately after the worst of the storm had passed, the lizard and eggs were concealed within the excavation by a mound of loose soil (with the mounded soil having the appearance of a pocket gopher [Geomyidae] mound). The mound was 4–5 cm in height and 10–12 cm in diameter. However, at 0700 h the next morning, the entrance tunnel was exposed with the lizard asleep inside the

now-open tunnel, facing outward. This behavior is consistent with two other nesting events we observed in which the nest cavity and entrance tunnel remained open overnight.

Of three other nesting events we have observed, two nests were oviposited and backfilled during the night before the lizard rested (see also Sherbrooke 2002, *op. cit.*), and one nest was backfilled in late evening (second nest in Allison and Cepeda 2009, *op. cit.*).

At 0839 h the lizard was awake but not yet moving, and became active by 0915 h. By 1140 h the nest had been backfilled, and the lizard was resting in the shade of the nearby fence upslope in view of the nest.

At 1140 h, the lizard proceeded to camouflage the nest surface by walking back and forth across, out of and into, the nest site while shuffling feet at each step (noted also in Sherbrooke 2002, *op. cit.*). Camouflaging was complete at 1224 h. At that time, the lizard traveled 1 m upslope from the nest-site, and assumed a standing, upright pose on hind legs until after 1314 h. The posture included two firmly planted hind feet, one somewhat in front of the other, and forelimbs resting on small, herbaceous plants. The posture was striking in both its erectness and its prolonged duration. During this time period, the lizard maintained her two-legged stance without pause. The lizard closed her eyes while an ant (*Pogonomyrmex rugosus*) climbed over her head. The only other movements we observed were periodic head-bobbing and three rapid upper-body twists to look in the direction of sounds from nearby.

We have observed similar postures by two other lizards following nesting events, although neither was as erect, and durations were unrecorded. Sherbrooke (2002, *op. cit.*) reported a lizard "standing high on stretched legs" following the backfilling of a nest cavity and prior to camouflaging activities, but we interpret his account to have been a four-legged stance.

Lizards were weighed, measured, and immediately released in accordance with permit SPR-0294-659 issued by the Texas Parks and Wildlife Department. The Texas Horned Lizard (*P. cornutum*) is designated as a Threatened species in the State of Texas.

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PHYLLODACTYLUS UNCTUS (San Lucan Gecko). **REPRODUCTION.** *Phyllodactylus unctus* is restricted to the Cape Region of Baja California and several nearby islands (Grismer 2002. Amphibians and Reptiles of Baja California, Including its Pacific Islands and the Islands in the Sea of Cortés. University of California Press, Berkeley. 399 pp.). Anecdotal information on its reproduction is given in Asplund (1967. Amer. Midl. Nat. 77:462–475) and Grismer (*op. cit.*). The purpose of this note is to report additional information on the reproduction of *P. unctus* from a histological examination of gonadal material from museum specimens.

A sample of 26 *P. unctus*, consisting of 12 adult males (mean snout vent length, SVL = 46.0 mm ± 6.1 SD, range: 39–60 mm), 11 adult females (mean SVL = 45.4 mm ± 3.2 SD, range: 39–48 mm) and 3 presumed neonates (mean SVL = 22.0 mm ± 1.0 SD, range: 21–23 mm) collected 1947, 1959, 1961, 1964, 1975, 1978, were examined from the herpetology collection of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California. The left testis was removed from males and the left ovary was removed from females for histological examination. Tissues were embedded in paraffin and cut into sections of 5 μm. Slides were stained with Harris hematoxylin followed by eosin counterstain. Slides of testes were examined to determine the stage of the spermatogenic cycle. Slides of ovaries were examined for the presence of yolk deposition. Histology slides were deposited in LACM. The following specimens of *P. unctus* were examined from LACM: 3263, 9811, 13971, 13973, 13974, 13976, 13977, 13979–13984, 13987, 13988, 51832, 51833, 122508,127882–127889.

Testes were classified (sample size in parentheses) as to their spermatogenic state: spermiogenesis, the seminiferous tubules are lined with sperm and/or groups of metamorphosing spermatids: March (1), April (7), June (1); regressed, the seminiferous tubules are reduced in size and mainly contain spermatogonia and Sertoli cells: August (3). The smallest reproductively active males (spermiogenesis) each measured 39 mm SVL (LACM 9811, 127883). Ovaries were classified (sample size in parentheses) as to their reproductive state: quiescent: no yolk deposition March (2), August (8), December (1); early yolk deposition: yolk granules in the cytoplasm: April (1). The smallest reproductively active female (yolk deposition) measured 41 mm SVL (LACM 127886). Three presumed neonates were collected in August.

My findings indicate breeding occurs in spring to early summer with a late summer hatching period. This concurs with Asplund (*op. cit.*) who observed *P. unctus* ovaries (N = 6) were quiescent during August and neonates were present in that month. Examination of additional females are needed to elucidate Grismer's (*op. cit.*) observation of gravid August *P. unctus* females. Timing of events in the *P. unctus* reproductive cycle appear similar to those of the congener *P. nocticolus* (formerly *P. xanti*) from southern California (Goldberg 1997. Herpetol. Rev. 28:152–153).

I thank Christine Thacker (LACM) for permission to examine *P. unctus*.

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PHYLLODACTYLUS UNCTUS (San Lucan Gecko). **ENDOPARASITES.** *Phyllodactylus unctus* is restricted to the Cape Region of Baja California and several nearby islands (Grismer 2002. Amphibians and Reptiles of Baja California, Including its Pacific Islands and the Islands in the Sea of Cortés. University of California Press, Berkeley. 399 pp.). To our knowledge, there are no reports of helminths from *P. unctus.* The purpose of this note is to establish the initial helminth list for *P. unctus.*

Five individuals of *P. unctus* (mean SVL = 49.8 mm ± 6.9 SD, range = 41–60 mm) from the herpetology collection of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California (LACM 127884–127888) collected in 1978 were examined for endoparasites. The lizards were opened by a midventral incision and the gastrointestinal tract removed and opened longitudinally. The esophagus, stomach, small and large intestines as well as the body cavity were searched for endoparasites using a dissecting microscope. Eight juvenile (11–15 proglottids) cestodes (small intestine, LACM 127885; prevalence, number infected

lizards/number lizards examined × 100 = 20%) were stained in hematoxylin, mounted on slides in Canada balsam and identified as *Oochoristica* sp. Nematodes were cleared in a drop of glycerol, cover-slipped, studied as wet mounts and identified as one female *Thubunaea iguanae* (stomach, LACM 127884; prevalence = 20%) and seven female *Spauligodon oxkutzcabiensis* (large intestine, LACM 127884, 127886, 127887; prevalence = 60%, mean intensity, mean number infected lizards = 2.33 ± 1.5, range = 1–4). Voucher helminths were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland as: *Oochoristica* sp. (USNPC 102324), *Spauligodon oxkutzcabiensis* (USNPC 102325), *Thubunaea iguanae* (USNPC 102326).

Species of *Oochoristica* are often identified by number of testes, structure of scolex and ovary as well as sucker size and shape. While structure of the scolex and ovary allow assignment to the genus *Oochoristica*, we were unable to assign the juvenile cestodes to a species. *Spauligodon oxkutzcabiensis* has been reported from lizards in Mexico, Central and South America (see Goldberg and Bursey 2009. Herpetol. Rev. 40:224). *Phyllodactylus unctus* is the fourth species of gecko reported to harbor *Spauligodon oxkutzcabiensis* and represents a new host record for this nematode. Baja California Sur is a new locality record. *Thubunaea iguanae* has been reported in a variety of lizards from the southwestern United States and Mexico (Telford 1965. Jpn. J. Exp. Med. 35:111–114; Goldberg et al. 2009. Herpetol. Rev. 40:85) as well as colubrid snakes (Goldberg and Bursey 2001. Bull. South. California Acad. Sci. 100:109–116). *Phyllodactylus unctus* represents a new host record for *Thubunaea iguanae*.

We thank Christine Thacker (LACM) for permission to examine *P. unctus* and Cecilia Nava (Whittier College) for assistance with dissections.

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PHYMATURUS FLAGELLIFER (Matuasto). **BRUMATION BEHAVIOR.** *Phymaturus flagellifer* is an endemic lizard of the Andes Mountains, ranging from 32º to 37ºS latitude (Lamborot and Navarro 1984. Herpetologica 40:258–264). During the breeding season (October to March), hierarchy reproductive systems have been described with one male congregating numerous females on large stones, while in sites with smaller stones, only lone couples or solitary individuals are observed (Habit and Ortiz 1994. Bol. Soc. Biol. Concepción, Chile 65:149–152; Habit and Ortiz 1996. *In* Peáur [ed.], Herpetología Neotropical, pp. 141–154). There is almost no information regarding brumation behavior in this species within its extreme environment (areas covered with snow for six to seven months).

From 19 to 23 May 2008, while performing fieldwork in the Andes Mountains (Laguna del Maule (35.984074°S, 70.532293°W; WGS84; 2184 m elev., Maule Administrative Region, Chile), we found a group of 37 *P. flagellifer* in brumation underneath a stone (1 m × 40 cm; 40 cm depth) resting on a substrate of volcanic sand. The group was composed of 4 males, 18 females, 11 juveniles, and 5 neonates.

Our observation suggests that aggregation behavior in *P. flagellifer* is likely important in enabling this species to survive harsh winter conditions. Brumation behavior of reptiles at high elevations of the Andes is poorly known and this report contributes to the limited knowledge concerning the life history of *P. flagellifer*.

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PODARCIS SICULUS (Italian Wall Lizard). **PREDATION.** *Podarcis siculus campestris* is a medium-sized Italian lacertid lizard that has been introduced into at least four U.S. states (New York, Pennsylvania, and Kansas—Burke and Deichsel 2008. *In* Mitchell et al. [eds.], Urban Herpetology, pp. 347–353. SSAR Herpetol. Conserv. 3, Salt Lake City, Utah; New Jersey—Burke, unpubl. data). Here we report on the predation of this introduced species by a native species.

At least three different American Kestrels (*Falco sparverius)* were observed feeding on Italian Wall Lizards (*P. siculus campestris*) in New York City. One *F. sparverius* was an adult (sex undetermined) at a nest on Broadway between 68th and 69th streets, Manhattan, observed clutching a lizard in the summer of 2006. Two male *F. sparverius*, one at East 75th Street, Manhattan and another in Sunnyside, Queens, were observed bringing *P. siculus campestris* to their mates and young. Although observations were not systematic in any of these cases, the East 75th Street male was observed with at least six different lizards between 8 June and 6 July, 2009 and the Queens male was observed with at least five different lizards during the spring of 2009, and five lizards in spring of 2008. A photograph, (Fig. 1) taken 4 July 2009 at the East 75th Street nest, is clearly that of a gravid female *P. siculus campestris* being passed from an adult male *F. sparverius* to a juvenile. Male-biased foraging is not surprising because female *F. sparverius* are largely dependent on their mates for provisioning during the last few weeks of incubation and until hatchlings are about ten days old (Smallwood and Bird 2002. Birds of North America Online http://bna.birds.cornell.edu/bna/species/602).

Although there may be others, we are aware of only five *Podarcis siculus* populations in the area: Queens College (Queens), Bronx Botanical Gardens and Pelham Bay Park (Bronx), Washington Cemetery (Brooklyn), and Baker Field (Manhattan). These populations are a minimum of 13 km from any of these nests, thus we suspect that there may be other *Podarcis* populations closer to the nests.

Falco sparverius are common inhabitants of urban, suburban, and rural habitats of North America and South America and feed on a wide variety of small vertebrates and invertebrates (Smallwood and Bird, *op. cit.*). *Falco sparverius* have not been previously



FIG. 1. Male kestrel passes *Podarcis* lizard to young. Photograph by Deborah Allen.

reported to predate *Podarcis*, but they have been reported to consume *Anolis* lizards (Adolph and Roughgarden 1983 Oecologia 56: 313–317) and *Sceloporus occidentalis, S. graciosus*, and *Elgaria coerulea* (Balgooyen 1976 Univ. California Publ. Zool. 103:1–87). The natural range of *P. siculus* is restricted almost entirely to Italy. There *Podarcis* spp. are predated by *Falco tinnunculus* (Eurasian Kestrel) (Martín and López 1990. Smithson. Herpetol. Info. Serv. No. 82, pp. 1–43; Costantini et al. 2005. Behaviour 142:1409–1421), but *P. siculus* has not specifically been positively identified as *Falco* prey.

This is the second report of predation by a native predator on *Podarcis* in New York (see Mendyk 2007 Herpetol. Rev. 38:82); introduced *Podarcis* in Kansas are predated by Great Plains Skinks (*Eumeces obsoletus*) and Blue Jays (*Cyanocitta cristata*) (Burke and Deichsel, *op. cit.*). Should populations of *Podarcis siculus* expand, it is likely the list of species that prey on this non-native lizard will increase.

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SCELOPORUS CLARKII (Clark's Spiny Lizard). **AQUATIC BEHAVIOR**. Several terrestrial lizard species have been observed attempting to escape potential predators by submerging their bodies underwater, including *Cnemidophorus sexlineatus* (Dillon and Baldauf 1945. Copeia 1945:174; Trauth et al. 1996. Herpetol. Rev. 27:20), *Crotaphytus collaris* (Burt and Hoyle 1934. Trans. Kansas Acad. Sci. 37:193–216), and *Scincella lateralis* (Akin and Townsend 1998. Herpetol. Rev. 19:43). Herein, we report an observation of similar behavior in *Sceloporus clarkii*, a non-aquatic, typically arboreal, lizard.

On 30 June 2008 at 0823 h, we observed an adult *S. clarkii* sprinting across bedrock in the bottom of a deeply-incised canyon in the Rincon Mountains east of Tucson, Arizona (32.16271°N, 110.69902°W, WGS84). The lizard disappeared under a rock ledge below us, and moments later we heard a splash. We found the lizard completely submerged in a shallow pool of water with a gravel-lined bottom (ca. 60 mm deep) under the rock ledge. The lizard remained underwater for approximately three minutes, lifted its head out of the water and took a breath, and then submerged its head and body completely for several more minutes. The lizard then lifted its snout and eyes above the surface of the water and remained in this position for more than 10 minutes, after which we stopped observing to avoid disturbing the lizard any more than necessary. The use of water as a refuge from predators has not been widely reported for terrestrial lizards, probably due to the thermodynamic costs associated with submergence. In this case, however, the lizard may have tolerated prolonged submergence because the water temperature was relatively high due to elevated ambient temperatures (>32°C) and the shallow depth of the pool.



FIG. 1. Adult *Sceloporus clarkii* partially submerged in shallow canyon pool in southern Arizona, USA.

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STENOCERCUS DOELLOJURADOI **(NCN). CLUTCH SIZE**. *Stenocercus doellojuradoi* (Tropiduridae) is a Chaco endemic species of Argentina, and regarded as a vulnerable species associated with Chaco forests (Pelegrin et al. 2006. Herpetozoa 19(1/2):85–

86). The Chaco ecoregion is a vast woodland that covers more than 1.2 million km^2, including portions of Argentina, Bolivia, and Paraguay, ranging from tropical (18ºS) to subtropical (31ºS) latitudes. The southernmost portion of the Chaco (Dry Chaco) is characterized by having lower temperatures and rainfall (Bucher 1982. Ecological Studies 42:48–79). Although *S. doellojuradoi* is a common species within its limited distribution, its natural story has been poorly studied, and there is no available information on its reproductive biology. In the context of an ecological study on lizard assemblages in the Dry Chaco of Córdoba, Argentina (30.37ºS, 65.43°W), we recorded females with oviductal eggs in November, January, and February; one female (SVL = 77 mm, 18 g) from November was found to be carrying six eggs (mean length ± SD = 13.33 ± 1.37 mm). This is the first report of reproductive data for this species.

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TROPIDURUS HISPIDUS (Calango). **PREY**. Lizard species of the widely distributed South American genus *Tropidurus* (Rodrigues 1987. Arq. Zool., São Paulo 31:105–230) are sit-and-wait ambush predators that feed predominantly on arthropods (Fialho et al. 2000. J. Herpetol. 34:325–330; Van Sluys 1993. J. Herpetol. 27:347–351; Vitt 1991. J. Herpetol. 25:79–90). Some species also are known to prey on vertebrates such as mammals, lizards, and frogs (Gasparini and Peloso 2007. Herpetol. Rev. 38:464). Saurophagy is already recorded for species of *Tropidurus*, be these conspecifics (Araújo 1987. Rev. Brasil. Biol. 51:857–865; Dias and Rocha 2004. Herpetol. Rev. 35:398–399; Kiefer and Sazima 2002. Herpetol. Rev. 33:136; Kohlsdorf et al. 2004. Herpetol. Rev. 35:398) or other lizard species (Galdino and Van Sluys 2004. Herpetol. Rev. 35:173; Kiefer 1998. Herpetol. Rev. 29:41; Kiefer et al. 2006. Herpetol. Rev. 37:475–476; Teixeira and Giovanelli 1999. Rev. Brasil. Biol. 59:11–18). *Tropidurus hispidus* has a wide distribution and is locally abundant (Rodrigues, *op. cit.*). This species is considered a generalist, its diet consisting primarily of arthropods (Vitt and Carvalho 1995. Copeia 1995:305–329), although there are records of predation on frogs (Vitt et al. 1996. J. Trop. Ecol. 12:81–101) and an attempt of predation on the gekkonid lizard *Hemidactylus palaichthus* (Rojas-Runjaic et al. 2006. Herpetol. Rev. 37:474). Here we present two instances of saurophagy and one of anurophagy in a coastal population of *T. hispidus*. Several individuals of this species were caught in April and May 2006, during a study carried out in a restinga habitat (characterized by sand dunes and sparse vegetation) on the beach of Panaquatira (2.561944°S, 44.054167°W), São José de Ribamar municipality, State of Maranhão, Brazil. One hundred and eleven specimens were dissected for gut content investigation; these specimens and their prey are in the Museu de Zoologia "Prof. Dr. Adão José Cardoso" (ZUEC), Universidade Estadual de Campinas. An adult male (ZUEC REP 03193; 85.3 mm SVL; 25 g) contained a partially digested juvenile (ca. 50.66 mm SVL) teiid lizard *Cnemidophurus ocellifer*; another adult male (ZUEC REP 03194; 83.9 mm SVL; 19 g) contained one adult (ca. 48 mm SVL) of the gymnophtalmid lizard *Colobosaura modesta*, and a female (ZUEC REP 03195; 80.4 mm SVL; 15.5 g) contained a skull bone (12.14 mm) of an unidentified frog. The two lizard prey items were partly digested, however, the head to the anterior part of the tail remained nearly intact. Further, the heads of each lizard were positioned in the anterior part of the stomach, thus indicating that both lizards were probably swallowed tail-first. *Cnemidophorus ocellifer* and *Colobosaura modesta* are active foragers (Bergallo and Rocha 1994. Austral. J. Ecol. 19:72–75; Rocha 1994. *In* Nascimento et al. [eds.], Herpetologia no Brasil 1, pp. 39–57. PUC-MG: Fundação Biodiversitas: Fundação Ezequiel, Belo Horizonte), whereas *T. hispidus* is a territorial sit-and-wait predator (Van Sluys et al. 2004. J. Herpetol. 38:606–611; Vitt and Carvalho, *op. cit.*). Active foragers are on the move and thus are exposed to risk of predation by sit-and-wait predators (Pianka 1986. Ecology and Natural History of Desert Lizards. Princeton University Press, Princeton, New Jersey. 208 pp.). Our observations on the positions of the two lizards in the stomachs of each *T. hispidus*, in addition to a record of a *C. ocellifer* also ingested tail-first by the conspecific *T. torquatus* (Kokubum and Lemos 2004. Herpetol. Rev. 35: 270–271) indicate that all three lizard prey were chased down by the predator and swallowed as they were caught. The occurrence of lizards among the prey items sampled was of low frequency (1.8%), which suggests that saurophagy in *T. hispidus* is opportunistic. Predation on frogs by *T. hispidus* (0.9%) is even lower in our sample and also seems to be opportunistic as recorded for other populations of the same species (Vitt et al., *op. cit.*). Predation on *C. ocellifer* and *C. modesta* presented here are the first records of saurophagy for *T. hispidus*.

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TUPINAMBIS LONGILINEUS (NCN). **ENDOPARASITES.** *Tupinambis longilineus* is the smallest and least known species of its genus, with distribution records for only four localities documented from the Brazilian states of Amazonas, Pará, Rondônia and Mato Grosso (Costa et al. 2008. Check List 4[3]:267–268). No records of parasites are published for this species. Here, we report the nematode *Physaloptera retusa* infecting the stomach of an adult male *T. longilineus* (MZUFV 564; 230 mm SVL) from Aripuanã, Mato Grosso State, Brazil (10.16°S, 59.47°W; datum: WGS84) housed in the herpetological collection of Museu de Zoologia João Moojen, Universidade Federal de Viçosa, municipality of Viçosa, Minas Gerais State, Brazil. Six adult *P. retusa* were recovered while we conducted a dietary study. The nematodes were deposited at Coleção Helmintológica de Referência do Instituto de Biociências da UNESP-Botucatu (CHIBB 4006).

Physaloptera retusa is one of the most common parasites of Neotropical herpetofauna, known to infect more than 60 hosts, including *Tupinambis teguixin* and *T. rufescens* (Bursey et al. 2007. Comp. Parasitol. 74:108–140). *T. longilineus* is a new host record for *P. retusa* and the state of Mato Grosso represents a new locality record for this parasite.

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TYMPANOCRYPTIS LINEATA (Lined Earless Dragon). **ENDOPARASITES.** *Tympanocryptis lineata* is known from eastern and southeastern Western Australia to the western slopes of New South Wales and southern Victoria where it occurs in a wide variety of terrestrial habitats (Cogger 2000. Reptiles and Amphibians of Australia, 6th ed. Ralph Curtis Books, Sanibel Island, Florida. 808 pp.). We know of no reports of endoparasites from this species. The purpose of this paper is to establish the initial helminth list for *T. lineata*.

Seven individuals of *T. lineata* (mean SVL = 53.3 mm ± 4.0 SD, range = 48–61 mm) were borrowed from the herpetology collection of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California and examined for helminths. Three were collected between 28.9500°S to 32.5500°S and 134.3167°E to 137.2167°E; WGS 84, elev. ca 200 m, in South Australia during 1966 and 1968 (LACM 55380–55381, 57944) and four were collected between 18.3833°S to 31.9833°S and 125.7333°E to 125.8500°E; WGS 84, elev. 125–400 m, in Western Australia during 1966–1967 (LACM 55382–55383, 55385–55386). The body cavity was opened by a longitudinal incision and the large and small intestines were removed and examined using a dissecting microscope. Stomachs were not available for examination. Only cestodes were present, which were regressively stained in hematoxylin, mounted in Canada balsam, studied under a compound microscope and identified as *Oochoristica piankai*.

One, one, and two individuals of *O. piankai* were found in the small intestines of LACM 55381, 55382, and 55385, respectively. Prevalence (number infected lizards/number examined lizards × 100) was 43%. Mean intensity (mean number parasites) was 1.3 ± 0.57 SD, range = 1–2.

Voucher endoparasites were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland as *Oochoristica piankai* (USNPC 102139, 102140).

Oochoristica piankai was originally described from the small intestines of *Moloch horridus* by Bursey et al. (1996. J. Helminthol. Soc. Washington 63:215–221). It has subsequently been reported in *Ctenophorus fordi*, *C. isolepis*, and *C. reticulatus* (Goldberg et al. 2000. Comp. Parasitol. 67:109–114) and *Nephrurus laevissimus* (Bursey and Goldberg 1999. J. Helminthol. Soc. Washington 66:175–179). The life cycle of *O. piankai* has not been studied, but Conn (1985. J. Parasitol. 71:10–16) reported beetles (*Tribolium*) acted as intermediate hosts for the congener *Oochoristica anolis*. *Tympanocryptis lineata* represents a new host record for *Oochoristica piankai*.

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SQUAMATA — SNAKES

AGKISTRODON PISCIVORUS (Cottonmouth). **ECTOPARASITE**. Many internal parasites have been reported for *Agkistrodon piscivorus* (Gloyd and Conant 1990. Snakes of the *Agkistrodon* Complex: A Monographic Review. Society for the Study of Amphibians and Reptiles, Oxford, Ohio. 614 pp.). However, no data on ectoparasites from wild-caught individuals are available, with the exception of reports of blood feeding by mosquitoes (Burkett-Cadena et al. 2008. Am. J. Trop. Med. Hyg. 79:809–815). On 31 July 2008, 2020 h CST, we captured a large adult male *A. piscivorus* (SVL = 83.8 cm; 595 g) in a small creek at Tuskegee National Forest, Macon County, Alabama, USA (32.434486ºN, 85.643901ºW; WGS 84). While restraining (tubing) the snake for processing, we noticed a leech attached to the posterior one-third of the snake's dorsum. The leech was placed in water in a plastic vial and was later keyed (by EB) as *Placobdella ornata*, a leech that commonly parasitizes turtles (Siddal and Gaffney 2004. J. Parasitol. 90:1186–1188). We could not confirm that this leech had obtained a blood meal from the snake, so the attachment may have been only phoretic (e.g., for dispersal).

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AGKISTRODON PISCIVORUS (Cottonmouth). **DIET**. On 19 April 2008, at 1647 h at an oxbow pond in Tuskegee National Forest, Macon County, Alabama, USA (32.43875203°N, 85.63422342°W, datum: WGS 84), we captured an adult male *Agksitrodon piscivorus* (SVL = 75.7 cm) with a pronounced bulge in its posterior half. We palpated the snake and discovered the bulge to be a partially digested subadult *Agkistrodon contortrix* (Copperhead). *Agkistrodon piscivorus* has one of the broadest diets of any known snake, with >100 species of invertebrates, fish, amphib-

ians, reptiles, mammals, and birds listed as prey (Ernst and Ernst 2003. Snakes of the Unites States and Canada. Smithsonian Press, Washington, D.C., 668 pp.). However, this is the first record of an *A. contortrix* being consumed by an *A. piscivorus*. A photograph of both snakes was deposited in the AUM digital database (AHAP-D 42). The *A. piscivorus* was released at its point of capture and the palpated copperhead was left next to the cottonmouth.

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BOTHROPS INSULARIS (Golden Lancehead). **MAXIMUM LENGTH.** *Bothrops insularis* is a viperid endemic to Queimada Grande Island (0.43 km^2), approximately 35 km from the coast of São Paulo State, Brazil (Amaral 1922. Mem. Inst. Butantan 1:39–44). *Bothrops insularis* is considered critically endangered (IUCN 2007. Red List of Threatened Species; Machado et al. 2005. Lista da Fauna Brasileira Ameaçada de Extinção. Fundação Biodiversitas. Belo Horizonte. 157 pp.) and may be declining (Martins et al. 2008. South Am. J. Herpetol. 3:168–174). In December 1995, one of us (OAVM) found a female *B. insularis* that weighed 391 g and measured 1093 mm total length (SVL = 950 mm; tail length = 143 mm). In December 2007 we found a male that weighed 185 g and measured 912 mm total length (SVL = 775 mm; tail length = 137 mm). Of the 520 individuals observed over 15 years of fieldwork on the island, the specimens above represent the largest individuals of each sex. The size of these snakes also exceeds the length of all preserved specimens (250 males and 400 females) from the herpetological collection of the Instituto Butantan.

In 1920, Amaral (1922) collected a female *B. insularis* (IB 1900) that reportedly measured 1180 mm in total length. The current total length of this specimen is 992 mm (SVL = 882 mm; tail length = 110 mm). When re-measured, we found other specimens cited by Amaral (1922) to be smaller than originally reported. This incongruence in lengths suggests that the specimens either shrunk substantially over time or were measured incorrectly at the time of collection. Regardless of the status of specimens collected by Amaral (1922), the lengths reported here likely represent the maximum sizes currently attained by male and female *B. insularis* in the field.

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CONOPSIS LINEATA (Large-nosed Earthsnake). **LITTER SIZE.** Little is known about reproduction of *Conopsis lineata* (Fitch 1970. Univ. Kansas Mus. Nat. Hist. Misc. Publ. 52:1–214). Anecdotal information indicates that litter size ranges from 2–3 for individuals from Hidalgo, Mexico (Goyenechea 2003. Herpetol. Rev. 34:63), 3–5 for individuals from Veracruz, Mexico (Greer 1966. Copeia 1966:371–373), and 2–6 for individuals from Mexico City (Uribe-Peña et al. 1999. Anfibios y Reptiles de Las Serranías del Distrito Federal. Universidad Nacional Autónoma de México. 118 pp.). On 14 June 2008 we found a dead gravid female *C. lineata* on the road from Municipality of Mineral de la Reforma, Mexico (20.09011ºN, 98.71064ºW, datum: WGS84; elev. 2431 m; xerophytic vegetation). The female measured 225 mm SVL, weighed 17. 5 g, had a litter size of seven well-developed embryos (stage 40). Measurements of embryos (mean ± SE, range) are as follows— mass: 0.78 ± 0.02 g, 0.70–0.84; SVL: 64.5 ± 7.5 mm, 34.6–77.6; total length: 82.4 ± 7.9 mm, 51.4–101.1.

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CORALLUS HORTULANUS (Amazon Tree Boa). **TIMING OF REPRODUCTION**. Observations of snakes giving birth in nature are rarely published and little is known about timing of reproduction in most tropical snake species (Greene 1997. Snakes the Evolution of Mystery in Nature. Univ. California Press, Los Angeles. 351 pp.). *Corallus hortulanus* are known to give birth to 3–24 newborns (total length: 282–455 mm) from January to June and litter size is positively related to female SVL (Pizzatto and Marques 2007. S. Am. J. Herpetol. 2:107–122).

On 17 November 2008, at 2040 h, in Parque Nacional dos Campos Amazônicos, Amazonas state, Brazil (8.05°S, 61.58°W; datum WGS84; elev. ca. 100 m), we observed a female *C. hortulanus* (SVL = 1040 mm; tail length = 290 mm) on the ground and four newborns (SVL: 462, 465, 460, 467 mm; tail lengths: 121, 122, 119, and 126 mm) on vegetation (40–250 cm high) nearby. The specimens were photographed, measured, and immediately released. This observation extends the known birthing season for the species and possibly suggests year-round reproduction or geographic variation in timing of reproduction for *C. hortulanus* in Brazil.

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CROTALUS DURISSUS (South American Rattlesnake). **ARBOREAL HABITAT USE.** *Crotalus durissus* is the most widespread rattlesnake species and is the only one to reach South America. It occurs in all mainland countries except Ecuador and Chile, with a discontinuous distribution from Colombia to Argentina (Campbell and Lamar 2004. Venomous Reptiles of the Western Hemisphere.



FIG. 1. An adult *Crotalus durissus* using an arboreal resting site in small trees at the edge of Cerrado canopy woodland (*cerradão*) in Volta Grande Environmental Station, southeastern Brazil.

Cornell Univ. Press, Ithaca, New York. 870 pp.). *Crotalus durissus* inhabits open habitats (Campbell and Lamar, *op. cit.*; Wüster et al. 2005. Mol. Ecol. 14:1095–1108), and also colonizes anthropogenically deforested areas (Bastos et al. 2005. Rev. Bras. Zool. 22:812–815; Sazima and Haddad 1992. *In* Morellato [ed.], História Natural da Serra do Japi, pp. 212–236. Editora da UNICAMP e FAPESP, Campinas). It is primarily crepuscular or nocturnal and terrestrial, using holes on the ground as diurnal shelters (Sazima and Haddad, *op. cit.*).

At 1500 h on 11 January 2006, we observed arboreal habitat use by an adult *C. durissus* at Volta Grande Environmental Station (20.024917°S, 48.235750°W, datum: SAD69), municipality of Conceição das Alagoas, state of Minas Gerais, southeastern Brazil. The rattlesnake was found coiled and stationary on branches of a small tree, at the edge of a Cerrado canopy woodland (*cerradão*), about 2 m above ground (Fig. 1).

Campbell and Lamar (*op. cit.*) reviewed published reports of *Crotalus* species resting, foraging, or feeding above ground. They reported arboreal habitat use in several species, including *C. adamanteus*, *C. catalinensis*, *C. enyo cerralvensis*, *C. horridus*, *C. lepidus klauberi*, *C. molossus*, *C. oreganus helleri*, *C. ruber lorenzoensis*, and *C. willardi willardi*, sometimes up to 9 m high. By resting above the ground, a snake may be less vulnerable to terrestrial predators (Martins 1993. Herpetol. Rev. 24:83–84). Another hypothesis for the behavior is that the snake was thermoregulating in the sun-shade mosaic formed by vegetation, a behavior commonly observed in the sympatric pitviper *Bothrops jararaca* (Sazima 1988. Mem. Inst. But. 50:83–99).

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CROTALUS OREGANUS LUTOSUS (Great Basin Rattlesnake). **ELEVATION**. On 18 June 2007 we observed a *Crotalus oreganus lutosus* at an elevation of 3962 m near the summit of Wheeler Peak, Great Basin National Park, White Pine County, Nevada, USA (38.986°N, 114.314°W, datum: WGS1984). A color slide of the snake was cataloged as a photo voucher (BYU 49442; verified by Jack Sites) (Fig. 1). The snake was found well above the treeline, in rocky, talus, fell-field habitat. It rattled upon approach and crawled over a snowfield. In July 2000 we observed three *C. o. lutosus* at 3090 m in south-facing, rocky, low sagebrush (*Artemisia arbuscula*) steppe habitat, in Great Basin National Park. *Crotalus o. lutosus* was previously reported at a maximum elevation of 3063 m (Klauber 1972. Rattlesnakes: Their Habits, Life Histories, and Influence on Mankind. Volume I. 2nd ed. Univ. California Press, Berkeley, 740 pp.). To our knowledge, these observations represent the maximum elevations reported for *C. o. lutosus*. Wheeler Peak is the second highest point in the Great Basin, at 3982 m, suggesting that *C. o. lutosus* may occur at all elevations within its range.



FIG. 1. *Crotalus oreganus lutosus* (BYU 49442) crawling through talus and snowfields at 3962 m in Great Basin National Park, White Pine County, Nevada, USA.

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DIADOPHIS PUNCTATUS PUNCTATUS (Southern Ring-necked Snake). **DIET.** *Diadophis punctatus* eats a variety of small animals, including insects, slugs, earthworms, snakes, lizards, anurans and salamanders (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Institution Press, Washington D.C. 668 pp.). In addition to the salamandrid *Taricha torosa*, plethodontid salamanders in the genera *Aneides*, *Batrachoseps*, *Desmognathus*,

Eurycea, and *Plethodon* have been reported as prey of *Diadophis*, as well as salamander eggs. Specifically, *Eurycea bislineata*, *E. cirrigera*, *E. longicauda*, and *E. quadridigitata* are known to be constituents of the diet of *D. punctatus*. Uhler et al. (1939. Trans. N. Am. Wildl. Conf. 4:605–622) reported that salamanders made up 80% by volume of the diet of Virginia *D. punctatus*. We report a novel species of *Eurycea*, *E. lucifuga* (Cave Salamander), in the diet of *D. punctatus*.

At 1545 h on 25 April 2009, one of us (KTN) found an adult ringneck snake crawling ~2 m inside the entrance to Pettijohn's Cave on Pigeon Mountain, Walker Co., Georgia, USA (34.663947°N, 85.363547°W; WGS 84). At 1610 h, the snake regurgitated an adult *E. lucifuga* weighing 3.37 g and measuring 67 mm SVL (total length = 157 mm), swallowed headfirst. At least 15 live *E. lucifuga* had been observed in crevices and on rock faces immediately surrounding the cave entrance, as well as at least two *Plethodon petraeus*, so presumably these salamanders represent a fairly abundant and predictable source of food.

D. punctatus are known to occasionally enter moist caves (Ernst and Ernst, *op. cit.)* and locate their prey by scent (Lancaster and Wise 1996. Herpetologica 52:98–108). Venom (Taub 1967. Bull. Am. Mus. Nat. Hist. 138:1–50; O'Donnell et al. 2007. Toxicon. 50:810–815) may enable *D. punctatus* to overcome salamander defensive behaviors (Brodie Jr 1977. Copeia. 1977:523–535). Cave salamanders have been suggested to be top predators in many cave communities (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, D.C. 587 pp.), so the addition of a higher trophic level is significant, especially since *E. lucifuga* are reported to depredate *Plethodon glutinosus*, another predator (Peck and Richardson 1976. Annales de Speleologie 31:175–182).

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DINODON RUFOZONATUM RUFOZONATUM (Asian Kingsnake). **DIET, OVOPHAGY**. Recorded prey items of *Dinodon rufozonatum rufozonatum* include a nestling bird (species unknown), anurans (*Bufo bankorensis*, *B. melanostictus*, *Rana adenopleura*), skinks, snakes (including *Sinonatrix percarinata*), and a beetle (Lee and Lue 1996. Biol. Bull. Natl. Taiwan Normal Univ. 31:119–124; Lee and Lue 1996. J. Taiwan Mus. 49:137–138; Lin et al. 1995. Newsletter of Wildlifers 3:19–21; Norval and Mao 2004. Herpetol. Rev. 35:65; Mao, unpubl. data).

On 20 April 2008, at 2010 h, a juvenile female *D. r. rufozonatum* (SVL = 462 mm; tail length = 122 mm; 33.8 g) was found at the edge of a field that had been tilled and left to lay fallow in Santzepu, Sheishan District, Chiayi County, Taiwan (23.4308667°N, 120.4845333°E, datum: WGS84; elev. 64 m). Palpation revealed an object in the stomach and the snake was induced to regurgitate the object; a reptilian egg (length = 9.3 mm; width = 5.3 mm; 0.1 g). Two days later, the remains of four additional eggs were found in the excrement of the snake. *Plestiodon* (= *Eumeces*) *elegans* and *Takydromus kuhnei* are very common lizards in this area. Eggs of *P. elegans* are larger (mean length ± SD = 15.25 ± 1.89 mm; width = 10 ± 0.82 mm; 1.25 g; Mao et al. 2008. Sauria 30:51–54) than those of *T. kuhnei* (mean length = 10.25 ± 0.69 mm; width = 5.93 ± 0.23 mm; 0.23 ± 0.05 g). Thus, based on the size, we believe that the eggs retrieved from the *D. r. rufozonatum* were those of *T. kuhnei*. The fact that no other prey remains were found leads us to believe the snake preyed only on the eggs. To our knowledge this is the first report of *D. r. rufozonatum* predation on reptilian eggs.

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DRYMARCHON COUPERI (Eastern Indigo Snake). **LONG-DISTANCE INTERPOPULATION MOVEMENT**. *Drymarchon couperi* was listed by the U.S. Fish and Wildlife Service (USFWS) as threatened in 1978 due to population declines caused primarily by habitat loss and habitat degradation (USFWS 1982. Eastern Indigo Snake Recovery Plan. U.S. Fish and Wildlife Service, Atlanta, Georgia. 23 pp.). In the northern part of their range (northern Florida and the Coastal Plain of southern Georgia, USA), adult *D. couperi* rely on Gopher Tortoise (*Gopherus polyphemus*) burrows for winter dens (Diemer and Speake 1983. J. Herpetol. 17:256–264; Stevenson et al. 2009. Herpetol. Cons. Biol. 4:30–42). In southeastern Georgia, *D. couperi* populations are typically restricted to sites where intact xeric sandhill habitats supporting *G. polyphemus* occur contiguous with extensive areas of poorly-drained or mesic upland habitats (pine flatwoods, mixed pine-oak forests, slope forests) and wetlands (Diemer and Speake 1981. *In* Odum and Guthrie [eds.], Proc. Nongame and Endangered Wildlife Symposium, pp. 52–61. Georgia Dept. Nat. Resources, Game and Fish Div. Tech. Bull.WL–5; Diemer and Speake 1983, *op. cit.*). Although *D. couperi* may use sandhill habitats throughout the year, during their period of greatest surface activity and movements (April–October) mesic habitats and wetlands are used frequently, particularly by foraging snakes (Hyslop 2007. Movements, Habitat Use, and Survival of the Threatened Eastern Indigo Snake [*Drymarchon couperi*] in Georgia. Unpubl. dissertation, University of Georgia, Athens). Adult *D. couperi* may range 2–6 km from their overwintering sites and typically exhibit overwintering site fidelity by returning to the same sandhills, commonly using some of the same tortoise burrows in successive years (Hyslop et al. 2009. Copeia 2009:460–466; Stevenson et al., *op. cit.*).

From 1998–2006, we monitored four *D. couperi* populations at Fort Stewart Military Installation in the lower Coastal Plain of southeastern Georgia. For the purposes of this note, we define a *D. couperi* population as overwintering adult *D. couperi* occupying a discrete sandhill area known to support *G. polyphemus* that is separated > 6.0 km from a similar sandhill area. Distances between populations in this study ranged from 6.5–27 km. We monitored these populations by surveying for snakes from mid-November through mid-March (see Stevenson et al., *op. cit.* for additional details). During the seven-year period we captured and marked 77 individual *D. couperi* (51 males, 26 females). We recaptured 33 of these snakes (20 males, 13 females) in at least one additional survey year, and we recaptured 17 individuals (12 males, 5 females)

in 3–5 different survey years. Of these multi-year captures, we documented only a single instance of a snake moving between populations.

On 8 November 2002, we captured an adult male *D. couperi* (SVL = 140 cm; 1.86 kg) in sandhill habitat along Beards Creek, Long Co., Georgia, USA. The snake was marked with a passive integrated transponder (PIT) implanted subcutaneously and was released at the site of capture. On 23 December 2004, the snake was recaptured 22.2 km linear distance NE of its initial capture site in sandhill habitat N of the Canoochee River, Bryan Co., Georgia, USA. The snake was twice recaptured (at different tortoise burrows) the following fall/winter at the same sandhill site in Bryan Co.

The snake may have moved in search of mating opportunities; the Long County site where it was originally captured seems to support a very small *D. couperi* population, with only four males and no females found during our eight-year survey, while the site it moved to supports a larger population (9 adult females captured). If this snake moved between sites in a direct route (ca. 22 km), it would have traversed extensive areas of mesic pine flatwoods dotted with depressional wetlands and would have crossed numerous blackwater creek swamps. Because of poorly-drained soils, *G. polyphemus* are very uncommon and locally distributed on this part of Fort Stewart. Alternatively, a less direct route (ca. 27 km) would have the snake traveling north along a north-south trending upland terrace, and then traveling east (parallel to the Canoochee River), often through sandy uplands populated by *G. polyphemus*.

Interpopulation dispersal in snakes is generally thought to be low (Parker and Plummer 1987. *In* Seigel et al. [eds.], Snakes: Ecology and Evolutionary Biology, pp. 253–301. McGraw Hill, New York, New York), and even short distances (e.g., 1.6 km) of unsuitable habitat can potentially restrict gene flow (Prior et al. 1997. Conserv. Biol. 11:1147–1158). This type of long-distance movement by an imperiled species underscores the importance of conserving large tracts of land and the value of maintaining habitat connectivity and dispersal corridors between populations.

We thank David C. Rostal for first capturing the snake, and M. Rebecca Bolt, Kevin M. Enge, and John G. Palis for helpful comments on the manuscript.

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DRYMARCHON COUPERI (Eastern Indigo Snake). **DEATH FEIGNING.** At 1100 h on 5 November 2008, I captured an adult female *Drymarchon couperi* (SVL = 1080 mm) ca. 10 km SW of Townsend, McIntosh Co., Georgia, USA. When found, the snake was on the ground, moving through open-canopied sandhill habitat, vegetated with scattered clumps of Saw Palmetto (*Serenoa repens*); numerous Gopher Tortoise (*Gopherus polyphemus*) burrows were located within 100 m of the capture site. Upon capture, the snake actively struggled in my hands, rattled its tail, flattened its neck vertically, and released musk—characteristic defensive behaviors for wild *D. couperi* when threatened (Stevenson et al. 2008. *In* Jensen et al. [eds.], Amphibians and Reptiles of Georgia, pp. 339-341. University of Georgia Press, Athens). Ambient temperature at the time of capture was 18°C, following an overnight low of 12°C; skies were cloudy and a very light, misty rain was falling. The snake had recently shed its skin, and appeared in good health.

When I attempted to pose the snake for photographs, it became motionless, rolled its head and neck to one side, and gaped (Fig. 1). It lay on the ground stationary and immobile, its mouth continuously open in the same position, for ca. 5 minutes. Occasionally, its tail would slowly and weakly twitch back and forth. Similar to Gehlbach's (1970. Herpetologica 26:24–34) description of death-feigning in the Western Coachwhip (*Masticophis flagellum testaceous*), the head and neck of the *D. couperi* were rigid while the posterior part of the snake was limp, and a bend in the neck caused the snake's head to face downward. When I moved to a distance of 5 m, within 45 seconds the *D. couperi* closed its mouth, fully righted itself, and crawled off normally. Twice, I captured the snake and elicited the behavior described above—both times followed by the snake again closing its mouth, righting itself, and crawling away within ca. 45 seconds when I retreated. It never struck or made any attempt to bite during the entire time it was being handled.

On 3 December 2008, I observed a second adult female *D. couperi* (SVL = 1295 mm; Wheeler Co., Georgia, USA) exhibit the same behavior. This snake, eyes opaque and nearing a shed event, was captured as it emerged from a tortoise burrow at 1210 h on a clear, sunny day (temperature at time of collection = 10°C) following a cold night (2.2°C) and frost event. The snake displayed the behavior for ca. 1 minute during my processing and marking; it moved slowly, albeit normally, when released at its capture burrow.

I interpret this behavior as death-feigning (thanatosis), a defensive strategy that has not previously been reported for *D. couperi*. Over a 15-year period (1992–2008), I have captured and handled over 150 *D. couperi* in southern Georgia as part of population moni-



FIG. 1. An adult female Eastern Indigo Snake (*Drymarchon couperi*) exhibiting death-feigning behavior (McIntosh Co., Georgia, USA).

toring studies (Stevenson et al. 2003. Southeast. Nat. 2:393–408), and had never observed this behavior. Similar death-feigning behavior has been observed in Eastern Coachwhips (*M. f. flagellum*) in North Carolina (Palmer and Braswell 1995. Reptiles of North Carolina. Univ. of North Carolina Press, Chapel Hill. 412 pp.) and in the Coastal Plain region of southeastern Georgia, including the Wheeler Co., Georgia site mentioned above (D. Stevenson, unpubl. data).

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FARANCIA ABACURA REINWARDTII (Western Mudsnake). **FEEDING BEHAVIOR.** Rossman (*in* Dundee and Rossman 1989. The Amphibians and Reptiles of Louisiana. Louisiana State Univ. Press, Baton Rouge. 300 pp.) recounts witnessing a captive Western Mudsnake chewing "vigorously back and forth along the trunk" of a Western Lesser Siren (*Siren intermedia nettingi*) "– inflicting deep gashes – before swallowing it headfirst." During mid-morning on 28 June 1995, in a riparian area near the town of Kisatchie, Natchitoches Parish, Louisiana, USA, a repeated faint "yelp" drew my attention to a shallow puddle measuring about 0.3 m^2. Protruding out of the water, near the middle of the puddle, I saw the anterior 15–18 cm of an *F. abacura* that I judged to be about 75 cm total length. The snake had an *S. intermedia* ca. 18–20 cm total length, which was the source of the yelps, grasped by the midsection in its jaws. Most of the snake was completely concealed by the thick layer of dead hardwood leaves covering the bottom of the puddle. As I watched, the *F. abacura* proceeded to chew methodically back and forth along the trunk of the siren before finally swallowing it headfirst. Shortly after swallowing its prey, the snake withdrew the exposed portion of its body straight back into the opening in the submerged leaf litter, completely disappearing from view. This observation confirms that the captive behavior witnessed by Rossman was not unique, and may represent a typical feeding behavior in *Farancia abacura*.

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HELICOPS ANGULATUS (Watersnake). **DIET AND REPRODUCTION.** The primarily nocturnal snake *Helicops angulatus* is a large colubrid that occurs in ponds, streams, and rivers of northern South America (Duellman 1978. Univ. Kans. Mus. Nat. Hist. Misc. Publ. 65:1–352; Martins and Oliveira 1998. Herpetol. Nat. Hist. 6:78–150). On 15 September 2007 we collected an adult female *H. angulatus* (SVL = 720 mm) in herbaceous vegetation next to a waterfall in a fragment of Atlantic Forest (12.950°S, 38.375°W; datum WGS84) in the Municipality of Salvador, Bahia State, Brazil. The snake was collected with official authorization (IBAMA-RAN 02010.000230/07-60) and deposited at the Zoologic Museu of Universidade Federal da Bahia (MZUFBA 1921). The specimen was dissected, and food items identified and counted. Except for a small quantity of arthropods (Acarina, Hymenoptera, and Isoptera) that could have been secondarily ingested, stomach contents were composed entirely of four toads—*Rhinella margaritifer* (mean ± SE SVL = 120 ± 4 mm). Anurans and fishes are common prey of *Helicops* spp. (e.g., *H. leopardinus, H. caricaudus*; Marques et al. 2001. Serpentes da Mata Atlântica: Guia Ilustrado para a Serra do Mar. Editora Holos, Ribeirão Preto, São Paulo, 184 pp.; *H. angulatus* in Trinidad—Ford and Ford 2002. Carib. J. Sci. 38:129–132).

The *H. angulatus* was gravid with 17 vitellogenic follicles (mean length = 11.6 mm) and 37 previtellogenic follicles. The reproductive cycle for this species has been reported to last from February to November (Martins and Oliveira, *op. cit*.) with clutch sizes ranging from 11 to 18 (Ford and Ford, *op.cit.*). The observation of anuran predation in a vitellogenic female is further indication of the opportunistic foraging behavior of *H. angulatus*.

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HELICOPS POLYLEPIS (Norman's Keelback). **DIET AND INTRASPECIFIC COMPETITION**. The genus *Helicops* is widespread throughout most of South America, from Colombia to Argentina (Rossman 1970. *In* Peters and Orejas-Miranda (eds.), Catalogue of the Neotropical Squamata Part 1. Snakes. U.S. Nat. Mus. Bull. (297):122–125). *Helicops polylepis* is little known and no diet information for the species has been published (Duellman 2005. Cusco Amazónico. Cornell University Press, Ithaca, New York. 433 pp.). Additionally, intra- and interspecific competition has been observed among North American watersnakes and on several occasions a single prey item (i.e., fish or frog) has been attacked by multiple individuals (Himes 2003. J. Herpetol. 37:126–131). Here we identify the first diet item for *H. polylepis* and report an observation of intraspecific competition in this species.

On 28 September 2006 (1056 h) two adult (total length of each ca. 70 cm) *H. polylepis* were observed consuming opposite ends of a freshwater eel, likely *Synbranchus marmoratus* (Fig. 1). A photograph was taken of the event (UTADC 1927), which occurred in a small stream 50 m N of the port at Lake Sandoval (approx. 12.6041667°N, 69.0472222°W, datum: WGS 84; 190 m elev.). Lake Sandoval is located in the Provincia Tambopata, ca. 3 km E of the Rio Madre de Dios in southeastern Peru. Both the snakes and their prey were identified from the photo and *H. polylepis* was distinguished from other *Helicops* by having paravertebral spots less than 3 scales long (Rossman, *op. cit.*). Duellman (2005, *op. cit.*) conjectured that this species likely feeds on fish and/or tadpoles and *Synbrachus marmoratus* has been found to be eaten by *H. infrataeniatus* and *H. leopardinus* (Aguiar and Di-Bernardo 2004. Stud. Neotrop. Fauna Environ. 39:7–14; Ávila et al. 2006. J. Herpetol. 40:274–79).



COLOR PUBLICATION COURTESY OF RONALD A. JAVITCH

FIG. 1. Photograph of two adult *Helicops polylepis* consuming a freshwater eel, likely *Synbranchus marmoratus* (UTADC 1927). Photograph by E. Flores.

We thank J. A. Campbell for cataloguing the photograph and Jose Koechlin and Inkaterra for logistical support.

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LAMPROPELTIS GETULA GETULA (Eastern Kingsnake). **SCAVENGING AND DIET**. *Lampropeltis getula* is an ophiophagous colubrid known to consume other colubrid, viperid and elapid snakes (Ernst and Ernst 2002. Snakes of the United States and Canada. Smithsonian Institution Press, Washington D.C. 661 pp.). Here we report evidence that *L. getula* may venture out onto roads to scavenge dead snakes that have been killed by vehicles, in turn exposing themselves to road mortality. Additionally, we report a novel diet record for *L. getula*, *Pantherophis guttatus* (Red Cornsnake).

Historically, carrion feeding by snakes has been largely downplayed or ignored, despite recent work suggesting that scavenging is a common component of snake behavior (Sazima and Strüssmann 1990. Rev. Brasil. Biol. 50:463–468; Shivik and Clark 1997. J. Exp. Zool. 279:549–553) and the observation that nearly all snake species will readily accept pre-killed prey in captivity (e.g., Rossi 1992. Special Issue: 7th Annual Conference, Assoc. of Rept. and Amph. Vets. 107–108). At least 26 snake species from five families have been observed scavenging carrion from at least 35 species of vertebrate taxa (reviewed in DeVault and Krochmal 2002. Herpetologica 58[4]:429–436). However, because scavenged carcasses are difficult to differentiate from live prey through stomach content or fecal surveys, the majority of scavenging events that take place in the field are likely overlooked. The costs associated with exploiting carrion as a food source are generally low compared to other costs incurred through foraging on live prey (e.g., stalking, production of venom, and potential injury during prey capture). However, the risk of scavenging carcasses from roads is relatively high, especially considering the lengthy amount of time snakes take to consume large food items. Additionally, while the use of carrion as a major food source may be unrealistic for many endothermic scavengers due to its ephemeral and unpredictable availability, snakes' exceptionally low metabolic demands make it possible for them to capitalize on these irregular, energy-rich meals (DeVault and Krochmal, *op. cit.*).



FIG. 1. Road-killed *Lampropeltis getula* (left) with *P. alleghaniensis* protruding from mouth (upper right) and *P. guttatus* protruding from burst body cavity (lower right, partially obscured by *P. alleghaniensis*).

At 1130 h on 2 April 2006, we found a road-killed female *L. getula* (SVL = 575 mm SVL; total length = 675 mm) on Turney Anderson Road, 0.15 road mi. E of the junction with Arline Road in Jefferson County, Florida, USA (30.581152°N, 83.844966°W, WGS84; elev. 56.4 m). Protruding from the mouth of the *L. getula* was a dead female *Pantherophis alleghaniensis* (Eastern Ratsnake; SVL = 365 mm; total length = 455 mm), ca. 70 mm of which had been ingested by the *L. getula*. Additionally, protruding from the stomach through the body wall of the *L. getula* was a partially digested segment of a *Pantherophis guttatus* (Red Cornsnake) of indeterminable sex, measuring at least 240 mm SVL (Fig. 1). Surprisingly, *P. guttatus* has not been documented in the literature as a food item for *L. getula*, although at least nine other colubrid species including conspecifics and *P. alleghaniensis* have been recorded (Ernst and Ernst, *op. cit.*).

Our findings suggest potential direct costs (mortality) for snakes scavenging roadkill or foraging on roads and reports a new aspect of the feeding ecology of *L. getula*.

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LIOPHIS ALMADENSIS (NCN). **PREDATION.** *Liophis almadensis* is a small terrestrial xenodontine snake that occurs from the southern side of the Rio Amazonas (Marajó Island) to the Rio

Grande do Sul in Brazil, south of the Paraguayan Chaco (Dixon 1991. Texas J. Sci. 43:225–236). This species feeds on anurans and possesses red ventral coloration contrasting with a predominantly gray dorsum (Marques et al. 2005. Serpentes do Pantanal. Holos Editora, Ribeirão Preto, SP. 179 pp.). There are no published records of predation on *L. almadensis*. At 1700 h on 29 July 2008, I observed a *Furnarius rufus*, a large ovenbird (Rufous Hornero, Furnariidae), handling a *L. almadensis* along an unpaved road that crosses a pasture (30.2042°S, 50.8700°W; datum Córrego Alegre; elev. 50 m) in a rural area in municipality of Viamão, State of Rio Grande do Sul, south Brazil. On my approach, the bird flew off, leaving the snake (juvenile male; SVL = 190 mm; total length = 204 mm) on the ground. Examination of the snake revealed that the top of its head, between the eyes, was deeply perforated by bird's beak. Five more perforations and additional peck marks were present on the snake's dorsum and part of the digestive tract was exposed. The snake was still showing motor reflexes, indicating that it had been recently attacked.

This observation reports a novel predator for *L. almadensis*. The record is even more interesting because *F. rufus* is known to eat only invertebrates (arthropods and earthworms) and seeds (Sick 1988. Ornitologia Brasileira: uma Introdução. Universidade de Brasília, Brasília, DF. 828 pp.) and the red ventral coloration of *L. almadensis* may mimic a sympatric coral snake (*Micrurus altirostris*). The *L. almadensis* voucher (MCP 18412) was deposited in the Coleção Herpetológica do Museu de Ciência e Tecnologia da PUCRS.

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NERODIA ERYTHROGASTER (Plain-bellied Watersnake). **FORAGING BEHAVIOR**. Published observations of watersnake foraging behavior in nature are few (Gibbons and Dorcas 2004. North American Watersnakes: A Natural History. Univ. Oklahoma Press, Norman. 438 pp.). On 3 June 2006, I observed a *Nerodia erythrogaster* (total length = 76 cm) in a shallow (< 3 cm), 1.5 m × 3 m, muddy-water pool in a floodplain forest, Union County, Illinois, USA. As I entered the pool, the snake began to make a series of circular loops, first in one direction, then in the other. Initially, I assumed the snake was making an ineffectual attempt to escape. As I watched, however, I realized it was foraging for prey.

The snake foraged as follows: with head and body just under the water's surface, the snake rapidly coiled in one direction one or more times, ducked its head beneath its coiled body, repeated the coiling motion in the opposite direction, ducked its head beneath its coiled body, repeated the coiling motion in the opposite direction, etc. (Fig. 1). Forward movement, including change of direction, was continuous. The overall pattern created by the snake was that of a series of figure eights. However, because the loops did not follow the same path each time, the snake foraged over a different area with each change in direction. Foraging behavior was confirmed when, after performing a series of figure eights, the snake raised its head above water holding a small fish in its mouth. Four species of fishes (*Ameiurus natalis*, *Aphredoderus sayanus*, *Esox americanus*, and *Notemigonus crysoleucus*; all ≤ 75 mm total length) and *Rana clamitans* tadpoles (≤ 25 mm total length) inhabited in the pool.

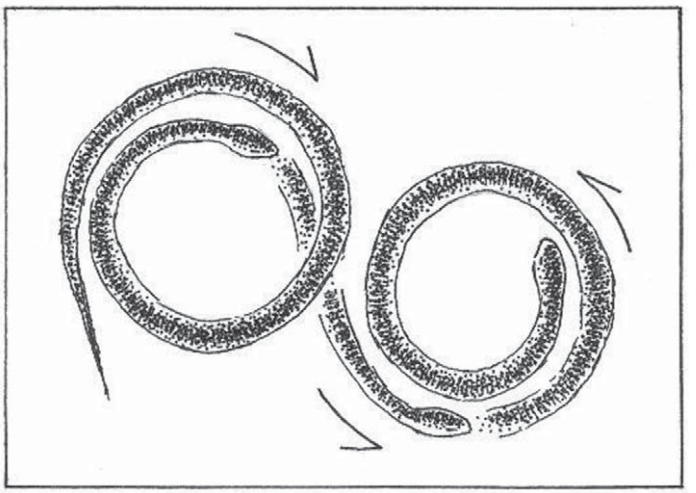


FIG. 1. Movement path of foraging *Nerodia erythrogaster*.

Evans (1942. Chicago Nat. 5:53–55) described watersnakes (*Nerodia* spp.) moving, open-mouthed, "through the water…in a series of figure eights, the entire body following the path of the head." Although Evans assumed the snakes were foraging, he never saw snakes actually capture prey while engaging in the behavior. Although I could not see if the snake foraged open-mouthed due to the turbidity of the water, it is likely that the foraging behavior I observed is that described by Evans. My observation of prey capture supports Evans' contention that he observed watersnakes foraging.

I thank J. W. Gibbons for providing a copy of the Evans reference, and E. L. Palmer for rendering the figure.

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OPHEODRYS AESTIVUS (Rough Greensnake). **FORAGING**. *Opheodrys aestivus* is an entomophagous colubrid known to consume spiders, harvestmen, millipedes, isopods, land snails, small hylid frogs and insects from several orders (Coleoptera, Ephemeroptera, Lepidoptera, Odonata, Orthoptera; Ernst and Ernst 2002. Snakes of the United States and Canada. Smithsonian Institution Press, Washington D.C. 661 pp.). Captive feeding trials on orthopterans have suggested that vision is the sole sense used to detect moving prey; motionless insects were overlooked despite tongue flicking (Goldsmith 1986. Southwest. Nat. 31:246–249). Here, we report evidence that *O. aestivus* will forage on visually concealed, gall-living insects (Price et al. 1987. Environ. Entomol. 16:15–24).

At 1445 h on 26 July 2007, one of us (KPD) spotted an adult *O. aestivus* in a Water Tupelo (*Nyssa aquatica*) along a boardwalk trail at the Virginia Marine Science Center, Virginia Beach, Virginia, USA (36.816144°N, 75.987989°W, WGS84; elev. <1 m). The trail is adjacent to the southern shore of Lake Rudee, a brackish water estuary that empties into the Atlantic Ocean via Rudee Inlet. The



FIG. 1. *Opheodrys aestivus* probing the surface of a crown gall in search of concealed insects.

snake was probing the surface of a large (>30 cm diameter) decayed woody "crown gall" identified as being caused by a bacterium, *Agrobacterium tumefaciens* (Smith and Townsend 1907. Science 25:671–673; Stafford 2000. Bot. Rev. 66:99–118). After several minutes, the snake inserted the anterior third of its body through a concealed hole in the gall and withdrew a minute later with a live insect, which it immediately swallowed. We watched and photographed the snake for 15 minutes as it repeated this behavior (Fig. 1) before it departed.

We thank S. Covert (University of Georgia) and S. Fraedrich (U.S. Forest Service) for their assistance in identifying the gall.

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OVOPHIS MONTICOLA MAKAZAYAZAYA (Taiwan Mountain Pitviper). **DIET**. *Ovophis monticola* feeds primarily on small rodents and insectivorous mammals (Zhao et al. 1998. Fauna Sinica-Reptilia Vol. 3. Science Press, Beijing. 522 pp.). However, little natural history or dietary information has been published regarding *O. monticola makazayazaya*, a subspecies inhabiting Taiwan. This is likely a consequence of nocturnal and secretive behavior, activity during periods of light rain or fog, and occurrence in montane forests (Mao, pers. obs.).

On 24 November 2007, a female *O. m. makazayazaya* (SVL = 498 mm; tail length = 72 mm) was found in a funnel trap along a drift fence in Minchi, Yilan County, Taiwan (24.6442°N, 121.4631°E; datum WGS84; elev. 1130 m). The snake had an obvious bulge at mid-body, which slightly reduced its mobility. We palpated a partially digested *Niviventer coxingi* (Spinous Country Rat; 15.4 g), which had been ingested head-first. Based on a comparison with specimens in the National Museum of Natural Science (NMNS), Taiwan, we believe the rat had a body length ca. 95–130 mm. The snake was released.

Niviventer coxingi is endemic to Taiwan and occurs throughout the country in mountainous forests below 2200 m elevation (Pei 1995. Zool. Stud. 34:55–58) and appears to decrease activity in response to strong moonlight (Lin et al. 1995. Notes and Newsletter of Wildlifers 3:11–13). Although the moon was nearly full at the time of these observations, dense fog may have reduced the lunar effect on the rat's activity pattern.

We thank Y.-J. Chen (NMNS) for assistance.

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PHILODRYAS NATTERERI (Paraguay Green Racer). **DIET.** The diet of the medium-sized colubrid snake *Philodryas nattereri* is relatively well studied and includes lizards and mammals (Vitt 1980. Pap. Avul. Zool. 34:87–98.). On 24 November 2008, at 1400 h, we found an adult female *P. nattereri* (SVL = 879 mm; 175 g after dissection) that had been killed by local farmers, in a fish farm near Pentecoste, Ceará, Brazil (3.82145°S, 39.33824°W; datum WGS 84). Upon dissection, we found a *Myotis nigricans* (Little Brown Bat), a small bat of the family Vespertilionidae, that had been eaten head first by the snake. The prey was nearly intact and weighed 7 g. This insectivorous bat species is widespread in Central and South America and inhabits open habitats, including urban areas (Emmons and Feer 1999. Neotropical Rainforest Mammals, a Field Guide. Univ. Chicago Press, Chicago, Illinois. 307 pp.). The ingestion of bats by snakes is seldom reported in the literature, but may not be infrequent because bat colonies can represent a potential concentration of food that is constantly available (Esberárd and Vrcibradic 2007. Rev. Bras. Zool. 24:848–853). There is a report of bat predation by *Philodryas viridissimus*, which is primarily arboreal (Otto and Miller 2004. Herpetol. Rev. 35:277). To our knowledge, this is the first record of bat predation by the mainly terrestrial *P. nattereri*. The snake and the bat are deposited together in the herpetological collection of Universidade Federal do Ceará (CHUFC 3087).

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PSOMOPHIS JOBERTI (Sand Snake). **DEFENSIVE BEHAVIOR**. The genus *Psomophis* is composed of small, poorly-understood colubrid snakes with short tails that terminate in a spine (Myers and Cadle 1994. Am. Mus. Novitates 3101:1–33).

Psomophis spp. are restricted to South America and *P. joberti* is the only species that occurs in northeastern Brazil, which is dominated by caatinga vegetation (França et al. 2006. Occas. Pap. Oklahoma Mus. Nat. Hist. 17:1–13). On 3 July 2008, we collected a *P. joberti* (Co-0826) in São Gonçalo do Amarante Municipality (3.5741667°S, 38.8886111°W; datum WGS84), state of Ceará, Brazil, that displayed a defensive behavior after being collected—bending its body and pressing the tail spine against the collector's hands, causing slight pain, but not inflicting any damage to the skin. The same behavior was observed in another specimen (Co-0829) collected on 12 September 2008 from Itapipoca Municipality, Brazil (3.4175°S, 39.6919444°W; datum WGS84). *Psomophis* are said to not bite defensively when touched (Carvalho and Nogueira 1998. Cad. Saúde Pública. 14:753–763). Lima-Verde (1991. Unpublished thesis, Universidade Federal do Ceará, Fortaleza, Brazil) collected 57 specimens of *P. joberti* in northeastern Brazil and described the species as diurnal, oviparous, and gentle. Although the defensive behavior reported here has not been noted previously, all works mention the presence of the tail spine. Tail spines and spine-pressing behavior have been reported in snakes of the genera *Typhlops* (Richmond 1955. Am. Mus. Novitates 1734:1–7), *Farancia* (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Inst. Press, Washington DC. 668 pp.), and *Carphophis* (Ernst and Ernst, *op. cit.*).

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PYTHON MOLURUS BIVITTATUS (Burmese Python). **CLUTCH SIZE.** Through instances of pet release or escape, a reproducing population of *Python molurus bivittatus*, native to Southeast Asia, has recently become established in and around Everglades National Park, Florida, USA (Snow et al. 2007. *In* Henderson and Powell [eds.], Biology of the Boas and Pythons, pp. 416–438. Eagle Mountain Publishing, Utah). On 2 March 2007, an adult female *P. m. bivittatus* (EVER 055842; SVL = 4240 mm; total length = 4710 mm; 56.69 kg) was captured near Ficus Pond (25.3749ºW, 80.8274ºW; datum WGS 1984) in Everglades National Park, Florida, USA. This specimen contained 85 large vitellogenic follicles (44.4 to 53.5 mm diameter) and 7.18 kg of fat bodies. Of these follicles, 48 were located in the right ovary (weight 2.49 kg) and 37 in the left ovary (weight 1.90 kg). A previous study reports a mean clutch size for *P. m. bivittatus* in Florida of 35.75 ± 3.35 (N = 8; range 19–46; Brien et al. 2007. Herpetol. Rev. 38:342). This finding of 85 follicles marks the largest recorded clutch size for *P. m. bivittatus* found in Florida.

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PYTHON MOLURUS BIVITTATUS (Burmese Python). **DIET.** Although Burmese pythons are native to southeastern Asia, both juvenile and adult specimens have been collected in Everglades National Park and surrounding areas in Florida since the mid 1990s (Snow et al. 2007. *In* Henderson and Powell [eds.], Biology of the Boas and Pythons, pp. 416–438. Eagle Mountain Publishing, Utah). On 20 March 2006, an adult female *P. m. bivittatus* (SVL = 4320 mm; total length = 4870 mm; 69 kg) was captured near Ficus Pond (25.3739°N, 80.8241°W, datum: WGS 1984; elev. <1 m) in Everglades National Park, Florida, USA. This specimen was deposited in the Florida Museum of Natural History, University of Florida (UF 146019). While examining gut contents, we found hair and four hooves of a fawn White-tailed Deer *(Odocoileus virginianus). Python m. bivittatus* is a dietary generalist known to eat a wide variety of mammalian, avian, and crocodilian prey (Snow et al., *op. cit.*). This observation constitutes the first record of White-tailed Deer predation by *P. m. bivittatus*.

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RHINOBOTHRYUM LENTIGINOSUM (Ringed Tree Snake). **DIET AND MAXIMUM SIZE**. The *Rhinobothryum* are poorly known (Greene 1997. Snakes: the Evolution of Mystery in Nature. Univ California Press, Berkeley. 351 pp.). *Rhinobothryum lentiginosum* is a nocturnal lizard specialist that seems to prefer riparian forest or edges of creeks or streams, as has been noted for *R. bovalli* (Solórzano 2004. Snakes of Costa Rica: Distribution, Taxonomy, and Natural History. Inbio, San José, Costa Rica 791 pp.). Here I report a *R. lentiginosum* that had consumed a juvenile green iguana (*Iguana iguana*) at Vitória do Xingu, Pará State, Brazil. At 2100 h on 11 July 2007, a large *R. lentiginosum* was found moving close to a fishing camp on the banks of the Xingu River and was killed. A visitor of the camp, Ian-Arthur Sulocki (IAS), took several photographs of the snake and the juvenile green iguana contained in the snake's gut (Fig. 1). Based on the description and photographs by IAS, the snake was at least 1800 mm total length, substantially



FIG.1. *Rhinobothryum lentiginosum* (decapitated) with juvenile *Iguana iguana* that it had consumed.

larger than the largest (total length = 1498 mm) reported by Cunha and Nascimento (*op. cit.*). Thus, this event is noteworthy not only because it reports a new prey species and additional case of saurophagy in *R. lentiginosum*, but also because the snake likely represents the maximum size for this species. Additionally, this note documents a novel predator for juvenile *Iguana iguana* (Greene et al. 1978. J. Herpetol. 12:169–176).

I thank Ian-Arthur Sulocki for reporting the event and contributing photographs.

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SIBON ANNULATUS (Ringed Snaileater). **MAXIMUM SIZE.** *Sibon annulatus* is a small snake for its genus and has previously been recorded to a maximum total length of 557 mm (Savage 2002. Amphibians and Reptiles of Costa Rica: A Herpetofauna Between Two Continents, Between Two Seas. Univ. Chicago Press, Chicago, Illinois. 934 pp.). At 2230 h on the 31 December 2004, during a nocturnal visual encounter transect for amphibians, we found an adult female *S. annulatus* in *Manicaria* swamp forest at Caño Palma Biological Station (8 km N of Tortuguero, Limón Province, Costa Rica). The snake was found at a perch height of 4.5 m in a *Loreya* sp. (Melastomataceae) tree. The live snake measured 362 mm SVL, 214 mm tail length, and weighed 8.8 g. At 576 mm total length, this specimen is the longest known *S. annulatus.* The specimen was collected under permit (Resolucion No. 171-2004-OFAU) and deposited in the herpetological collections at Universidad de Costa Rica.

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SISTRURUS CATENATUS EDWARDSII (Desert Massasauga). **DIET, PREY SIZE, AND FEEDING-RELATED MORTALITY.** *Sistrurus catenatus edwardsii* feeds on lizards, small mammals, small snakes, centipedes, and anurans (Holycross and Mackessy 2002. J. Herpetol. 36:454–464). Whiptails of the genus *Aspidoscelis* have been reported to be in the diet of *S. c. edwardsii*, however *A. marmorata* (Marbled Whiptail) has not yet been identified as prey (Holycross and Mackessy, *op. cit.*). This is rather intriguing, given the overlap that exists for both species' known geographic ranges (Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. Univ. New Mexico Press, Albuquerque. 431 pp.). Furthermore, little published information exists regarding prey size for *S. c. edwardsii*. Here, I report feeding-related mortality of an *S. c. edwardsii* following consumption of an adult *A. marmorata*.

At 1018 h on 7 August 2008, I discovered a deceased female *S. c. edwardsii* (TCWC 93556) lying in the bottom of a large sand dune blowout in Lea County, New Mexico, USA (32.7847°N, 103.8089°W; datum WGS 84; elev. 1173 m). The individual was lying dorsum up, appeared bloated, and had recently deceased. Both lizard and snake tracks were observed near the dead snake. The individual was collected and dissected to determine what was causing the large bulge in the snake's mid-section. Upon dissection, I discovered that the snake had consumed a female *A. marmorata* (TCWC 93557). The lizard's girth had caused a 35 mm long rupture in the snake's stomach which was likely the ultimate cause of death for the snake.

The *S. c. edwardsii* measured 310 mm SVL and 18 g mass post mortem and the *A. marmorata* measured 100 mm SVL and 21 g mass post mortem. This indicates that the snake attempted to ingest a prey item 1.17 times its own mass. This measurement is slight in comparison to the record for snakes (relative prey mass = 1.72; Mulcahy et al. 2003. Herpetol. Rev. 34:64); however, perhaps it illustrates a differential consumption/mortality threshold exists among species or individuals.

This observation is noteworthy for two reasons. First, although *S. c. edwardsii* and *A. marmorata* overlap in geographic range, their trophic relationship had not yet been clarified. Second, it indicates the consumption of large prey items may result in increased energy stores for *S. c. edwardsii*, but the potential threat of death due to a ruptured stomach exists.

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TANTILLA GRACILIS (Flat-headed Snake). **ARACHNID PREDATION**. *Tantilla gracilis* is found in the south-central region of the United States and is known to have 20 species of mammalian, avian, and snake predators (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Institution Press, Washington, D.C. 668 pp.). Because of the highly fossorial nature of this species, much of its life history remains unknown (Cobb 2004. Copeia 2004:397–402) and spider predators have not been reported. Here we report the first arachnid predation documented for *T. gracilis*.

On 27 September 2007, at ca.1000 h, a juvenile (SVL = 74 mm; tail length = 22 mm; 0.095 g) *T. gracilis* (UTA R-55476) was observed in the web of a spider (0.034 g) of the genus *Steatoda* (Theriidae); the snake was being consumed from behind the neck by its captor. At its lowest point, the juvenile *T. gracilis* was ca. 23 cm from the floor. It is highly unlikely that the snake fell or climbed into the web and therefore it is probable that the spider hoisted the snake to this position. While in the web, the snake's tail was tethered to its neck with webbing. Photographs were taken of the event, which occurred in the shower room of a large outdoor restroom at Camp Tyler, Smith County, northeastern Texas, USA (32.2566722°N, 95.1847778°W; datum WGS 84; elev. 129 m). This restroom hosts a group of >50 adult spiders of the family Theridiidae.

We thank J. A. Campbell and C. J. Franklin for cataloguing the photograph and specimen, D. Formanowicz for identifying the spider to genus, and V. A. Cobb for reviewing this manuscript. We also thank Alan and Jenny Byboth, Jim Connally, and the Camp Tyler Foundation for giving us a welcome place to live at Camp Tyler during much of our stay at Tyler. The specimen was collected under Texas Parks and Wildlife scientific permit no. SPR-0691-418.

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TANTILLA OOLITICA (Rim Rock Crowned Snake). **DEFENSIVE BEHAVIOR.** At 0950 h on 25 May 2007 we captured a *Tantilla oolitica* (total length = 199 mm; 1.65 g) resting in an elongate coil under a rotting board in Dove Creek Hammock, Key Largo, Florida, USA, during a study by The Institute of Regional Conservation to determine the conservation status of this species. The ambient temperature was 25.2°C and the relative humidity was 80%. Upon capture, the snake began to feign death by remaining limp in our hands with its mouth open and tongue slightly extended. It continued to behave this way for about 10 minutes as we measured and weighed the snake. The act was very convincing and the three of us present at the time believed it to be dead or dying. We were particularly convinced of this when it continued the act even when placed upon a rock. It remained as posed for several minutes before slowly starting to crawl away. When we started to handle the snake again, it repeated the process of feigning its death. This cycle continued for 30 minutes until the snake was deemed healthy and was released. The ecology of this species is poorly-understood and whether this behavior represents a common defensive response or an isolated instance remains unknown.

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THAMNOPHIS SIRTALIS (Common Gartersnake). **SCAVENGING.** Although snakes often accept dead food items in captivity, observations of scavenging by wild snakes are relatively rare. In a recent review, DeVault and Krochmal (2002. Herpetologica 58:429–436) suggested that scavenging may be a deliberate feeding strategy in some snake species rather than just an opportunistic event.

Thamnophis sirtalis is considered to be a dietary generalist and studies have indicated that it preys upon invertebrates, fishes, amphibians, mammals, and birds (Rossman et al. 1996. The Garter Snakes, Evolution and Ecology. Animal Nat. Hist. Series, vol. 2. Univ. of Oklahoma Press, Norman. 332 pp.). Published records of scavenging by wild *T. sirtalis*, however, are rare, and to date only six reports exist, all involving birds and anurans as prey. Gray (2002. Herpetol. Rev. 33:142–143) suggested that scavenging of dead anurans by *T. sirtalis* may be common but scavenging of birds is rare. However, there are four reports of this species scavenging birds (Ruthven 1908. Bull. U.S. Natl. Mus. 61:1–201; Feldman and Wilkerson 2000. Herpetol. Rev. 31:248; Gray, *op. cit.*; Sajdak and Sajdak 2007. Herpetol. Rev. 30:229–230) and only two on frogs (Ruthven, *op. cit.*; Brown 1979. Brimleyana 1:113–124). The latter two reports lack detail and only Ruthven (*op. cit.*) specified the scavenged anuran species (*Rana clamitans*; Green Frog). Given the abundance of *T. sirtalis* in many areas and high levels of road mortality often suffered by frogs and other prey items, frequent opportunities for scavenging should occur. Thus, the scarcity of reports suggests that scavenging by *T. sirtalis* is either rare in nature or frequently goes unreported. Here, I report two additional instances of scavenging of anurans by *T. sirtalis*.

At 1815 h on August 8 2008, I observed a *T. sirtalis* (total length ca. 30 cm) consuming a small (SVL ca. 3.0 cm), recently road-killed *Anaxyrus terrestris* (Southern Toad) on Road 161 (gravel) in Francis Marion National Forest, Berkeley County, South Carolina, USA (33.1853°N, 79.6946°W; datum WGS84). The incident occurred on the road surface approximately one meter from the heavily vegetated road shoulder. When discovered, the snake had already ingested the anterior one-third of the toad and continued to ingest it in my presence; complete ingestion took an additional six minutes.

At 1515 h on 17 September 2008, I observed another adult *T. sirtalis* (total length ca. 60 cm) attempting to engulf a road-killed *Lithobates pipiens* (Northern Leopard Frog; SVL ca. 7.5 cm) on Lyman Rd. (blacktop) bordering the southern edge of Big Bend State Fish and Wildlife Area, Whiteside County, Illinois, USA (41.6332°N, 90.0417°W; datum WGS84). The incident occurred

on the blacktop about 50 cm from the road shoulder, which was heavily vegetated. In this case, the frog was not freshly killed and desiccation of the skin indicated that it was killed about an hour before the observation. The anterior portion of the frog was stuck to the road surface and the snake was rather awkwardly attempting to ingest the left rear leg. The snake released it upon my approach. Following this observation, three more adult *T. sirtalis* and four more road-killed adult *L. pipiens* were observed on the road near the shoulder within 20 m of the location where the scavenging incident occurred. Despite observing the road for about 30 minutes, no other incidents of scavenging were noted.

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TOXICOCALAMUS STANLEYANUS (Stanley's Forest Snake). **DIET.** Snakes of the genus *Toxicocalamus* are widespread in New Guinea, with published reports suggesting that the species *T. stanleyanus* is relatively common in the Purari basin region of Papua New Guinea (PNG; O'Shea 1996. A Guide to the Snakes of Papua New Guinea. Independent Publishing, Port Moresby, PNG. xii + 239 pp.). There is some evidence that *Toxicocalamus* spp. prey on earthworms (O'Shea, *op. cit*.). However, because of the secretive nature of these snakes, little is known of the ecology of many of the species and no data are available on the size of earthworms typically consumed for any species. While conducting herpetological censuses on 1 December 2008, at 1216 h (Australian EST), I captured a *T. stanleyanus* (total length ca. 670 mm) active in a disturbed area of lowland rainforest in the Purari basin of PNG (7.4955556°S, 145.3594444°E; datum WGS84; elev. 110 m). Immediately following capture, the snake was placed in a bag in a cooler maintained at 24°C. On checking the snake five hours later, it was revealed that the specimen had regurgitated a large, partly digested earthworm (Class Oligochaeta) measuring 150 mm in total length and 17 mm in width at mid-body. Following proper identification, the snake was released

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TYPHLOPS ANOUSIUS (NCN). **MAXIMUM SIZE.** On 8 March 1978, N. Drosdov collected a male *Typhlops anousius* (CZACC 4.5530; Colecciones Zoológicas del Instituto de Ecología y Sistemática, Cuba) from Tortuguilla, San Antonio del Sur municipality, Guantánamo province, Cuba. The specimen measured 273 mm SVL and 5 mm tail length. It had 24 scale rows anteriorly, reducing to 22 posteriorly at 7.6% TL or 49th middorsal scales row, 460 middorsal scale counts, 13 dorsal and 14 ventral caudal counts, snout sharp-pointed, rostral broad in dorsal aspect, 0.82 widest part of the posterior rostral to the internasal sutures in dorsal view / standard length of the rostral from the internasal sutures to the posterior tip in dorsal aspect (RWD/RLD). The body was straight-sided and very acuminate posteriorly, and lacked pigmentation. The specimen was previously identified as *T. biminiensis* (by the collector and also by Orlando H. Garrido). I have re-identified the specimen as *T. anousius*. The specimen is a topotype and the first specimen of *T. anousius* reported since the species was described by Thomas and Hedges (2007. Zootaxa 1400:1–26). The previously-reported maximum length for this species is 193 mm SVL. Thus, this record represents a substantial increase in maximum size for the species and extends the range of variation in middorsal scale counts from 465–513 to 460–513 and RWD/RLD from 0.74–0.77 to 0.74–0.82 (Thomas and Hedges, *op. cit.*).

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TYPHLOPS BRONGERSMIANUS (Brongersma's Threadsnake). **REPRODUCTION.** The genus *Typhlops* contains 121 species of pantropical snakes and is the largest of six genera within the Typhlopidae (Kley 2003. *In* M. Hutchins et al. [eds.], Grzimek's Animal Life Encyclopedia, 2nd ed. Vol. 7, Reptiles, pp. 379–385. Gale Group, Farmington Hills, Michigan). Six species of *Typhlops* have been reported for Brazil (Rodrigues and Juncá 2002. Pap. Avul. Zool., São Paulo 42:325–333). The biology of the Typhlopidae is still poorly known and the few available data refer to African species. For Brazil, biological information is scarce and restricted to anecdotal data (Ávila et al. 2006. J. Herpetol. 16:403–405). *Typhlops brongersmianus* is widely distributed through South America (Vanzolini 1972. Zool. Mededel. 47:27–29).

A gravid female *T. brongersmianus* (MZUESC 6531; SVL = 350 mm), captured on 21 December 2007 in a pit-fall trap in a cocoa (*Teobroma cacao*) plantation on the campus of Universidade Estadual de Santa Cruz, Ilhéus, southern Bahia, Brazil, was held in captivity until it began ovipositing eggs twelve days later. Fifteen eggs measuring (mean ± SD) 22.5 ± 2.2 mm in length and 13.0 ± 0.3 mm in width were laid. Four of the 15 eggs hatched after 34 days, while the others failed to hatch. The four hatchlings (MZUESC 6532) averaged 91.0 mm SVL and weighed 1.2 g. The hatchlings were light blue in color at birth but changed into the characteristic brown coloration of adults after 12 days. One of the hatchlings shed its skin in a continuous slough and not in pieces as reported by Kley (*op. cit*.).

Ávila et al. (*op. cit*.) reported four clutches from female *T. brongersmianus* originating from the Pantanal of Mato Grosso, Brazil. Clutch size averaged 4.67 eggs (range 4–5) and averaged 4.11 mm in length and 8.27 mm in width. The eggs reported here are 172% larger and 215% broader than those reported by Ávila et al. (*op. cit*.), perhaps reflecting geographic variation in reproductive strategy and/or local environmental conditions.

We thank G. E. Iack-Ximenes, A. Argôlo, and I. R. Dias for assistance. IBAMA issued the collecting permit (003/07 – IBAMA/RAN).

Submitted by **EUVALDO MARCIANO JUNIOR, JULIANA ALVES DE JESUS,** and **MIRCO SOLÉ** (e-mail: mksole@uesc.br), Universidade Estadual de Santa Cruz (UESC), Departamento de Ciências Biológicas, Rodovia Ilhéus-Itabuna, km 16, Salobrinho, CEP 45662-000, Ilhéus, BA, Brazil.

VIRGINIA VALERIAE VALERIAE (Eastern Smooth Earthsnake). **PREDATION**. Although many North American raptors include reptiles in their diets, reports of predation on snakes by passerine birds other than shrikes (Laniidae) and corvids are relatively uncommon (Ross 1989. Amphibians and Reptiles in the Diets of North American Raptors. Wisconsin Endangered Species Report No. 59). Most such incidents involve relatively large or mid-sized ground foragers such as thrashers (Browning 1973. Chat 37:107) and thrushes (Davis 1969. Wilson Bull. 81:471; Erickson 1978. Murrelet 59:26; Palmer and Braswell 1995. Reptiles of North Carolina. Univ. North Carolina Press, Chapel Hill. 412 pp.).

At ca. 1700 h on 31 January 2009, at Howell Woods, ca. 14 km ESE of Four Oaks, Johnston Co., North Carolina, USA (35.371°N, 78.307°W; datum WGS84), CEM heard rustling in the leaf litter 10 m away from and below his elevated position 5 m off the ground. The air temperature was ca. 6°C with a light wind (5–10 mph). Approximately 20 sec later, a Tufted Titmouse (*Baeolophus bicolor*) perched at the spot of the rustling in a small plant just above the ground surface. The bird then flew straight up to a tree branch ca. 5 m above the ground, carrying what later was identified as a *Virginia v. valeriae*. The titmouse immediately began pecking the snake and continued for 60 sec. The bird then flew to a branch 25 m above the ground while still carrying the snake, and resumed the pecking behavior. Between 5 and 10 min later, the bird was observed perched at the same spot, but without the snake. It swiped its bill as birds often do following predation. At ca. 1820 h, CEM scanned the area beneath the perch and located the remains of the snake. The head had been completely removed and punctures, likely from the bird's bill and claws, were scattered over the snake's body. The remains of the snake measured 19.69 cm in total length and weighed 2.1g.

This observation is particularly interesting because the Tufted Titmouse is such a small bird—averaging 17 cm long, 20 g in weight (Grubb and Pravosudov 1994. *In* A. Poole [ed.], The Birds of North America Online. Cornell Lab of Ornithology, Ithaca, New York; http://bna.birds.cornell.edu.www.lib.ncsu.edu:2048/bna/species/086). It eats primarily arthropod (e.g., caterpillars, beetles, ants, wasps, spiders, and scale insects) and vegetable foods, and typically forages by gleaning foliage and probing bark crevices (Grubb and Pravosudov, *op. cit*.). Although titmice generally forage in high vegetation, they may also spend considerable time feeding on or near the ground, especially on cold, windy days (Grubb and Pravosudov, *op. cit*.). To our knowledge, this represents the first report of a titmouse, or any similarly-sized passerine, as a predator of *V. valeriae*. The specimen is deposited in the North Carolina State Museum of Natural Sciences (NCSM 75790). It also represents a new county record and an early date of activity for the species in North Carolina (Palmer and Braswell, *op. cit*.).

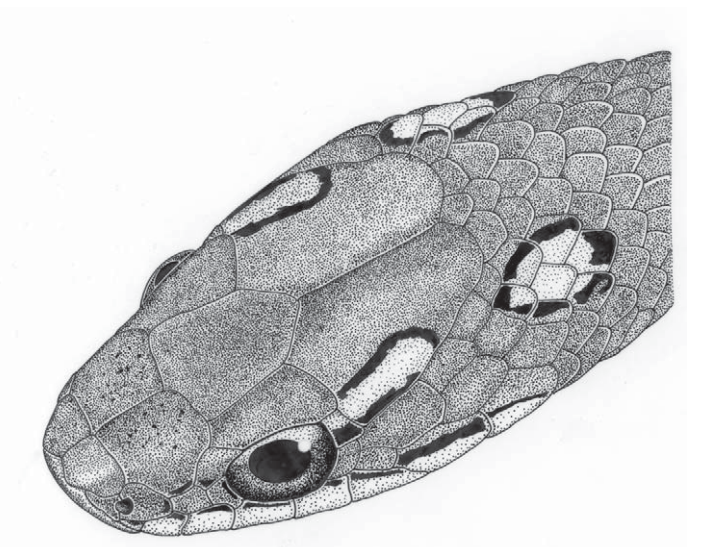
Submitted by **CHRISTOPHER E. MOORMAN**, Fisheries and Wildlife Sciences Program, Department of Forestry and Environmental Resources, North Carolina State University, Raleigh, North Carolina 27695, USA (e-mail: chris_moorman@ncsu.edu); and **JEFFREY C. BEANE**, North Carolina State Museum of Natural Sciences, Research Laboratory, MSC # 1626, Raleigh, North Carolina 27699-1626, USA (e-mail: jeff.beane@ncdenr.gov).

XENOPHOLIS SCALARIS (Wucherer's Ground Snake). **DIET**. *Xenopholis scalaris* is believed to be a predatory specialist of frogs and its diet is known to be composed of *Adenomira andreae*, *Eleutherodactylus* species, *Hamptophryne boliviana*, and *Ischnocnema quixensis* (Duellman 1978. Univ. Kansas Nat. Hist. Mus. Misc. Publ. No. 65; Duellman 2005. Cusco Amazónico. Cornell University Press, Ithaca, New York. 433 pp.; Martins and Oliveira 1998. Herpetol. Nat. Hist. 6:78–150). Here we report an additional anuran food item for the species.

On 26 December 2007 an adult *X. scalaris* was observed and photographed consuming a subadult *Leptodactylus didymus* at Reserva Amazónica, Peru (UTADC 1954–55). The snake was found with the left leg of the anuran in its mouth. Over the next few minutes the snake engulfed the frog with its mouth, however the final ingestion of the prey item was not observed. The *L. didymus* was distinguished from *L. bolivianus*, also found at Reserva Amazónica, by having a creamy white longitudinal stripe across the thighs (Duellman 2005, *op. cit.*). Reserva Amazónica occurs in the Provincia Tambopata, ca. 12 km E of Puerto Maldonado on the north shore of the Rio Madre de Dios in southeastern Peru (ca. 12.5416667°N, 69.0527778°W; datum WGS 84; elev. 195 m). During our surveys from 18 December 2007 to 9 January 2008 we found *L. didymus* to be the most common anuran encountered. In addition, three *X. scalaris* were observed during surveys and the abundance of *L. didymus* may represent a large part of the prey base for *X. scalaris* in the area.

We thank J. A. Campbell for cataloguing the photograph and Jose Koechlin and Inkaterra for logistical support.

Submitted by **ROBERT C. JADIN**, Amphibian and Reptile Diversity Research Center and Department of Biology, University of Texas at Arlington, Arlington, Texas 76019, USA (e-mail: snakeman1982@hotmail.com); and **SARAH A. ORLOFSKE**, Department of Ecology and Evolutionary Biology, University of Colorado at Boulder, Boulder, Colorado 80309, USA.



Rhadinaea decorata (UMMZ 126432; 225 mm SVL). Guatemala: El Petén, Tikal. Illustration by Julian C. Lee.

GEOGRAPHIC DISTRIBUTION

Herpetological Review publishes brief notices of new geographic distribution records in order to make them available to the herpetological community in published form. Geographic distribution records are important to biologists in that they allow for a more precise determination of a species' range, and thereby permit a more significant interpretation of its biology.

These geographic distribution records will be accepted in a **standard format** only, and all authors *must* adhere to that format, as follows: SCIENTIFIC NAME, COMMON NAME (for the United States and Canada as it appears in Crother [ed.] 2008. *Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico*. SSAR Herpetol. Circ. 37:1–84, gratis PDF available (http://www.ssarherps.org/pages/HerpCommNames.php); for Mexico as it appears in Liner and Casas-Andreu 2008, *Standard Spanish, English and Scientific Names of the Amphibians and Reptiles of Mexico.* Herpetol. Circ. 38:1–162), LOCALITY (use metric for distances and give precise locality data, including lat/long coordinates in **decimal degrees** and cite the map datum used), DATE (day-month-year), COLLECTOR, VERIFIED BY (*cannot* be verified by an author; curator at an institutional collection is preferred), PLACE OF DEPOSITION (where applicable, use standardized collection designations as they appear in Leviton et al. 1985, *Standard Symbolic Codes for Institutional Resource Collections in Herpetology and Ichthyology,* Copeia 1985[3]:802–832) and CATALOG NUMBER (required), COMMENTS (brief), CITATIONS (brief and must adhere to format used in this section; these should provide a geographic context for the new record), SUBMITTED BY (give name and address in full—spell out state or province names—no abbreviations). Please include distance from nearest previously known record (provide a citation or refer to existing vouchered material to substantiate your report). If publishing specific locality information for a rare or endangered species has the potential to jeopardize that population, please consult with the Section Editor at time of record submission. If field work and/or specimen collection occurred where permits were required, please include permit number(s) and authorizing agency in the text of the note.

Some further comments. The role of the "Standard Names" lists (noted above) is to standardize English names and comment on the current scientific names. Scientific names are hypotheses (or at least represent them) and as such their usage should not be dictated by a list, society, or journal.

Additionally, this geographic distribution section does not publish "observation" records. Records submitted should be based on preserved specimens that have been placed in a university or museum collection (private collection depository records are discouraged; institutional collection records will receive precedence in case of conflict). A good quality photograph (print, slide, or digital file) may substitute for a preserved specimen *only* when the live specimen could not be collected for the following reasons: it was a protected species, it was found in a protected area, or the logistics of preservation were prohibitive (such as large turtles or crocodilians). Photographic vouchers *must* be deposited in a university or museum collection along with complete locality data, and the photographic catalog number(s) must be included in the same manner as a preserved record. Before you submit a manuscript to us, check Censky (1988, *Index to Geographic Distribution Records in Herpetological Review: 1967–1986*; available from the SSAR Publications Secretary), subsequent issues of *Herpetological Review*, and other sources to make sure you are not duplicating a previously published record. The responsibility for checking literature for previously documented range extensions lies with authors. **Do not submit range extensions unless a thorough literature review has been completed.**

Please submit any geographic distribution records in the **standard format only** to one of the Section Co-editors: **Alan M. Richmond** (USA & Canada records only); **Jerry D. Johnson** (Mexico and Central America, including the Caribbean Basin); **Indraneil Das** (all Old World records); or **Gustavo J. Scrocchi** (South American records). Short manuscripts are discouraged, and are only acceptable when data cannot be presented adequately in the standard format. **Electronic submission of manuscripts is required** (as Microsoft Word or Rich Text format [rtf] files, as e-mail attachments)**.** Refer to inside front cover for e-mail addresses of section editors.

Recommended citation for new distribution records appearing in this section is: Schmitz, A., and T. Ziegler. 2003. Geographic distribution: *Sphenomorphus rufocaudatus*. Herpetol. Rev. 34:385.

CAUDATA – SALAMANDERS

NOTOPHTHALMUS VIRIDESCENS VIRIDESCENS (Red-spotted Newt). USA: OHIO: Belmont Co.: Wayne Township, Raven Rock (39.88036°N, 81.04077°W; WGS 84). 04 April 2006. Cincinnati Museum Center (CMC 8957–8958). Vouchers for a second Belmont Co. location were also obtained (CMC 8998–8999). Shelby Co.: Washington Township, Lockington Preserve (40.21596°N, 84.25667°W; WGS 84). 12 August 2008. CMC 11283. All material collected by Jeffrey G. Davis and Greg Lipps Jr. and verified by John W. Ferner. First county records (Pfingsten and Matson 2003. Ohio Salamander Atlas, Ohio Biological Survey Misc. Contrib. No. 9, Columbus).

Submitted by **JEFFREY G. DAVIS**, Cincinnati Museum Center – Fredrick and Amye Geier Research and Collections Center, 1301 Western Avenue, Cincinnati, Ohio 45203-1130, USA (e-mail: anura@fuse.net); and **GREG LIPPS JR.**, 1473 County Road 5-2, Delta, Ohio 43515, USA (e-mail: GregLipps@aol.com).

SALAMANDRA SALAMANDRA (Fire Salamander). HUNGARY: BUDAPEST: Pesthidegkút (47.34ºN, 18.56ºE; elev. 260 m). 01 June 2009. Gábor Szelényi. Verified by Judit Vörös, Hungarian Natural History Museum (HNHM 2009.2.1). First county record. Species previously known from Budapest Hills (Méhely 1918. Fauna Regni Hungariae [Reptilia et Amphibia]. Királyi Magyar Természettudományi Társulat 13 pp.), but report did not specify locality. No specimens had been observed in the area since 1918. Adult specimen collected close to stream in forested valley surrounded by buildings and roads.

Submitted by **GÁBOR SZELÉNYI**, Middle-Danube-Valley Inspectorate for Environmental Protection, Nature Conservation and Water Management, 1072 Budapest, Nagydiófa u. 10–12, Hungary; **ISTVÁN KISS**, Szent István University, Department of Zoology and Animal Ecology, 2100 Gödöllő, Páter K. u. 1, Hungary (e-mail: kiss.istvan@mkk.szie.hu); and **JUDIT VÖRÖS**, Hungarian Natural History Museum, 1088 Budapest, Baross u. 13, Hungary.

ANURA – FROGS

ACRIS CREPITANS (Northern Cricket Frog). USA: ARKANSAS: Woodruff Co.: near Brushy Lake Road on Cache River National Wildlife Refuge, 0.2 mi. S of AR 260 W (35.22372ºN, 91.25617ºW; WGS84; elev. 60 m). 25 Oct 2009. Thomas J. Belford. University of Kansas Natural History Museum photo voucher (KUDA 9109). Verified by William E. Duellman. Four specimens were found in a grassy flooded ditch. First county record. Extends range ca. 29 km from nearest known record in White Co., Arkansas. (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. Univ. Arkansas Press. Fayetteville. 421 pp.)

Submitted by **THOMAS J. BELFORD,** 701 West Academy Avenue, Searcy, Arkansas 72143, USA; e-mail: thomasbelfordiniraq@yahoo.com.

ACRIS CREPITANS (Northern Cricket Frog). USA: TENNESSEE: Lawrence Co.: Tennessee Amphibian Monitoring Program (TAMP) Route 820513, Stop 10, Dry Creek Rd. 0.39 km S of intersection with County Line Rd (35.43605°N, 087.22462°W;

WGS84). 15 May 2007. Brian Stewart. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU audio). New county record (Redmond and Scott 1996. Austin Peay St. Univ. Center Field Biol. Misc. Publ. 12:1–94).

Submitted by **BRIAN STEWART**, 850 Lion Parkway, Columbia, Tennessee 38401, USA.

ANAXYRUS WOODHOUSII (Woodhouse's Toad). USA: COLORADO: Chaffee Co.: Ute Creek drainage north of Salida (38.54967°N, 106.00728°W; NAD 83; elev. 2150 m), 14 September 2009. Raquel Stotler and Heather Adams. Verified by Lauren J. Livo. Photograph deposited in the Ancillary Collection of the University of Colorado Museum, Boulder, Colorado (UCM-AC 171). First county record. Extends range along Arkansas River northwest ca. 11 km from Wellsville record in Fremont Co. (Hammerson 1999. Amphibians and Reptiles in Colorado, 2nd ed. University Press of Colorado, Niwot. xxvii +484 pp.).

Submitted by **RAQUEL STOTLER**, Colorado Division of Wildlife, 7405 U.S. Highway 50, Salida, Colorado 81201, USA; e-mail: Raquel.Stotler@state.co.us.

CHIASMOCLEIS ALAGOANUS (NCN). BRAZIL: PERNAMBUCO: Municipality of São Lourenço da Mata: Engenho Tapacurá **(**08.014522ºS, 35.087728ºW; WGS 84; elev. 153 m). 27 September 2006. E. M. dos Santos and F. O. de Amorim. Coleção Herpetológica da Universidade Federal Rural de Pernambuco, Unidade Acadêmica de Serra Talhada, Serra Talhada, Pernambuco, Brazil (CHUFRPE 972, adult specimen SVL 26.4 mm). Verified by M. A. Freitas. First state record. Previously known from the type locality: Mata do Catolé, Municipality of Maceió, state of Alagoas (Cruz et al. 1999. J. Zool., London 249:123); and Mata do Buraquinho, municipality João Pessoa, state of Paraiba (Vieira et al. 2008. Biotemas 21[1]:75–84). Extends the known distribution 195 km N from type locality and 100 km S from municipality of João Pessoa.

Submitted by **EDNILZA MARANHÃO DOS SANTOS,** Unidade Acadêmica de Serra Talhada, Universidade Federal Rural de Pernambuco, 56900-000, Serra Talhada, PE, Brazil; and **FABIANA OLIVEIRA DE AMORIM,** Rua Eng. Gercino de Pontes, n.129, apto.101, Iputinga, 50800-110, Recife-PE, Brazil.

CHIROMANTIS DORIAE (Doria's Bush Frog). BANGLADESH: SYLHET DIVISION: Maulvibazar District, Sreemangal, Lawachara National Park (24.3306333ºN, 91.793°E). 12–13 June 2008. M. K. Hasan. Jahangirnagar University Herpetological Group, Department of Zoology, Jahangirnagar University, Savar, Dhaka, Bangladesh (JUHG 0292–0296). Verified by S. D. Biju. First country record for Bangladesh. Nearest locality record, from Namdapha Tiger Reserve, Arunachal Pradesh, NE India, is ca. 630 km NE of this locality (Pawar and Birand. 2001. CERC Tech. Rep. [6]:1–118). Males observed calling between 1950–2015 h from foliage of climbing plants, on wall bordering railroad track that transects mature secondary forested area. Numerous foam nests observed on underside of leaves overhanging small, stagnant water body, at base of wall.

Collection permit issued by Bangladesh Forest Department (CCF[wildlife]/2M–37[part 3]/2007/1047). MKH and MFK would like to thank Mushfiq Ahmed for lab assistance and SM would like to thank Barry Clarke (BMNH) for permitting access to collections.

Submitted by **MD. KAMRUL HASAN**, Jahangirnagar University Herpetological Group, Department of Zoology, Jahangirnagar University, Savar, Dhaka, Bangladesh (e-mail: hasan_wildlifeju@yahoo.com); **STEPHEN MAHONY**, Madras Crocodile Bank Trust, Post Bag 4, Mamallapuram, Tamil Nadu 603 104, India (e-mail: stephenmahony2@gmail.com); and **MD. MOFIZUL KABIR**, Jahangirnagar University Herpetological Group, Department of Zoology, Jahangirnagar University, Savar, Dhaka, Bangladesh.

GASTROPHRYNE OLIVACEA (Western Narrow-mouthed Toad). USA: NEBRASKA: Webster Co.: 8.0 km S Red Cloud (40.017017°N, 98.51895°W; NAD 83). 21 and 23 July 2008. Keith Geluso and Greg D. Wright. Verified by Thomas E. Labedz, University of Nebraska State Museum, Lincoln, Nebraska (UNSM ZM 23866–23867). New county record. Represents only second county in Nebraska with observations. Previous records reported from Gage Co. (Lynch 1985. Trans. Nebraska Acad. Sci. 13:33–57). Multiple individuals observed at night feeding on tiny ants on moderately vegetated slopes with small limestone rocks. An additional specimen from this location was collected on 03 June 1985 (UNSM ZM 8814).

Submitted by **KEITH GELUSO** (e-mail: gelusok1@unk.edu) and **GREG D. WRIGHT**, Department of Biology, University of Nebraska–Kearney, Kearney, Nebraska 68849, USA.

HYLA CINEREA (Green Treefrog). USA: TENNESSEE: McNairy Co.: Finger, 294 Sherry Lynn Drive (35.357800˚N, 88.635583˚W; datum WGS84). 22 September 2009. Brian P. Butterfield and Joseph B. Butterfield. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 18975 color photo). First county record. Specimen was collected on the inside wall of a garage in a rural, residential subdivision located in an oak/hickory forest. (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12. Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Hard copy and Internet versions [http://www.apsu.edu/amatlas/]. Accessed 23 October 2009). Collection was made under the authority of Tennessee Wildlife Resources Agency Permit 1494.

Submitted by **BRIAN P. BUTTERFIELD**, Department of Biology, Freed-Hardeman University, Henderson, Tennessee 38340, USA (e-mail: bbutterfield@fhu.edu); and **JOSEPH B. BUTTERFIELD**, 294 Sherry Lynn Drive, Finger, Tennessee 38334, USA.

ISCHNOCNEMA OCTAVIOI (Octavio's Robber Frog). BRAZIL: ESPÍRITO SANTO STATE: Matilde, Municipality of Alfredo Chaves (20.330306ºS, 40.480560ºW; datum: Córrego Alegre; elev. 632 m). 22 July 2008. R. B. Dantas. Zoology Collection, Museu de Biologia Mello Leitão, Santa Teresa, Espirito Santo, Brazil (MBML 6762). Verified by G. M. Prado). First state record, extends range ca. 258 km NE from Casimiro de Abreu municipality, Rio de Janeiro state. Previously known only from Brazil, in the state of Rio de Janeiro (Vrcibradic et al. 2008. Check List 4:103–106).

Submitted by **ROBERTO DE BARROS DANTAS** (e-mail: dantasbio@hotmail.com); and **RODRIGO BARBOSA FER-**

REIRA (e-mail: rodrigoecologia@yahoo.com.br), Museu de Biologia Mello Leitão, Av. José Ruschi, Nº 4, CEP 29.650-000, Santa Teresa, Espírito Santo, Brazil.

LEPTODACTYLUS FRAGILIS (White-lipped Frog). MÉXICO: OAXACA: Municipality of Santiago Jamiltepec, Atotonilco (16.189444°N, 97.819722°W; WGS 84), 68 m elev. 01 January 2006. Aurelio Ramíez-Bautista and Vicente Mata-Silva. Verified by Uriel Hernández-Salinas. Colección Herpetológica del Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo (CIB 2498–2503). First municipality records. Fill a gap between the closest reported localities ca. 210 km WNW near Acapulco, Guerrero (Flores Villela et al. 1991. Serie Cat. Mus. Zool. "Alfonso L. Herrera" Cat. [3]:1–222) and ca. 270 km ENE of several records in the vicinity of Tehuantepec, Oaxaca (Hartweg and Oliver 1940. Misc. Publ. Mus. Zool. Univ. Michigan [47]:1–31; Duellman 1960. Univ. Kansas Publ. Mus. Nat. Hist. 13:19–72). Casas-Andreu et al. (2004. *In* Garcia-Mendoza et al. [eds.], Biodiversidad de Oaxaca, pp. 375–390. Inst. Biol. UNAM, Mexico D.F.) reported that this species occurs in floristic-faunistic areas 9 and 10 in the eastern portion of Oaxaca. These animals were found within floristic-faunistic area 8 in the southern coastal/foothills region. The frogs were found swimming along the cooler periphery of a hot spring.

Submitted by **VICENTE MATA-SILVA**, Department of Biological Sciences, The University of Texas at El Paso, El Paso, Texas 79968, USA (e-mail: vmata@utep.miners.edu); **AURELIO RAMÍREZ-BAUTISTA,** Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo, A. P. 1-69 Plaza Juárez, Pachuca, Hidalgo, C.P. 42001, México (e-mail: aurelior@uaeh.reduaeh.mx); and **JERRY D. JOHNSON**, Department of Biological Sciences, The University of Texas at El Paso, El Paso, Texas 79968, USA (e-mail: jjonhson@utep.edu).

LITHOBATES CATESBEIANUS (American Bullfrog). USA: TENNESSEE: Maury Co.: Tennessee Amphibian Monitoring Program (TAMP) Route 820513, Stop 6, Dry Creek Rd. 0.53 km S of intersection with Hwy 166 (35.50888°N, 087.21322°W; WGS84). 13 March 2007. Brian Stewart. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 18886 audio), New county record (Redmond and Scott 1996. Austin Peay St. Univ. Center Field Biol. Misc. Publ. 12:1–94).

Submitted by **BRIAN STEWART**, 850 Lion Parkway, Columbia, Tennessee 38401, USA.

NANORANA LIEBIGII (Liebig's Hill Frog). BHUTAN: PARO DZONGKHAG: Susuna Highway, 28 km SW confluence with Haa Road (27.36ºN, 89.31E; elev. 2350 m). 08 February 1969. B. Biswas and S. S. Saha. ZSIC A10964. SVL 129 mm, female. Verified by S. K. Dutta. First record from Bhutan (Das and Palden 2000. Herpetol. Rev. 31:256–258; Delorme and Dubois 2001. Alytes 19:141–153). Known from the Himalayan region of Nepal, northern and northeastern India and southern Xizang, China.

Submitted by **KAUSHIK DEUTI**, Zoological Survey of India, Amphibia Section, 27 Jawaharlal Nehru Road, Kolkata 700 016, India; e-mail: kaushikdeuti@rediffmail.com.

PHYLLODYTES ACUMINATUS. BRAZIL: PERNAMBUCO: Municipality of Buíque: Parque Nacional do Catimbau (08.489014°S, 37.716667°W; WGS 84; elev. 858 m). 09 March 2008. E. M. dos Santos, T. F. Campus, and G. L. da Silva. Coleção Herpetologica da Universidade Federal Rural de Pernambuco, Unidade Acadêmica de Serra Talhada, Serra Talhada, Pernambuco, Brazil (CHUFRPE 973). Adult specimen SVL 23.3 mm. Verified by M. T. Rodrigues. First state record from the semi-arid of state Pernambuco. Extends the known distribution 204 km NE from type locality and 267 km NE from municipality of Recife. Previously known only from the type locality: Municipality of Mangabeira, State of Alagoas (Bokermann 1966. An. Acad. Brasil. Cienc. 38:342); Zona da Mata, municipality Recife, State Pernambuco (Frost 2009. Amphibian Species of the World: An Online Reference, ver. 5.3. http://research.amnh.org/herpetology/amphibia/. American Museum of Natural History, New York, accessed on 17 December 2009).

Submitted by **EDNILZA MARANHÃO DOS SANTOS** and **GEANE LIMEIRA DA SILVA**, Unidade Acadêmica de Serra Talhada, Universidade Federal Rural de Pernambuco, 56900-000, Serra Talhada, PE, Brazil.

PSEUDACRIS FERIARUM (Upland Chorus Frog). USA: TENNESSEE: Maury Co.: Tennessee Amphibian Monitoring Program (TAMP) Route 820513, Stop 3, S. Cross Bridges Rd. 0.44 km N of intersection with Ashwood Rd. (35.58850ºN, 087.20668ºW; WGS84). 13 March 2007. Brian Stewart. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 18884 audio). New county record (Redmond and Scott 1996. Austin Peay St. Univ. Center Field Biol. Misc. Publ. 12:1–94).

Submitted by **BRIAN STEWART**, 850 Lion Parkway, Columbia, Tennessee 38401, USA.

SCINAX LUIZOTAVIOI (Santa Barbara Snouted Treefrog). BRAZIL: MINAS GERAIS: Municipality of São José do Mantimento (20.06671ºS, 041.75322ºW, WGS84, elev. 415 m). 10–17 December 2008; 22–29 April 2009; 8–15 September 2009. M. D. Rocha. Museu de Ciências Naturais da Pontifícia Universidade Católica de Minas Gerais, Belo Horizonte, Minas Gerais, Brazil (MCNAM 11577–11578, 11582). Verified by L. B. Nascimento. Extends known distribution ca. 180 km E from Catas Altas, MG, near the frontier with Espírito Santo state. The species is known only from the southern portion of the Espinhaço Range, Minas Gerais, southeastern Brazil: Parque Natural do Caraça, in the municipality of Catas Altas, MG (Santa Bárbara in the original description of species) (Caramaschi and Kisteumacher 1989. Bol. Mus. Nac., Rio de Janeiro, N.S., Zool. 327:6; Estação Ambiental de Peti, in the municipality of São Gonçalo do Rio Abaixo, MG (Bertoluci et al. 2007. Herpetol. J. 17:18; Parque Estadual do Itacolomi, in the municipality of Ouro Preto, MG (Pedralli et al. 2001. Ciência Hoje 30 [178]:70–73); Área de Proteção da Captação da Mutuca, in the municipality of Nova Lima, MG (Nascimento et al. 1994. Bios 2:5–12); and Estação Ecológica de Fechos, also in the municipality of Nova Lima, MG (Bertoluci et al. 2007. *op. cit.*).

Submitted by **RONALD REZENDE DE CARVALHO JÚNIOR**, Táxon Meio Ambiente – Estudos e Projetos, Rua Marco Aurélio de Miranda, n. 406/903, Buritis, CEP 30575-210, Belo

Horizonte, Minas Gerais, Brazil (e-mail: rcjunior.bh@terra.com.br); **LUCAS GRANDINETTI**, Limiar Engenharia Ambiental, Avenida Luís Paulo Franco, n. 651/9º andar, Belvedere, CEP 30320-570, Belo Horizonte, Minas Gerais, Brazil(e-mail: grandinetti@terra.com.br); **MICHELLE DRUMOND ROCHA,** Rua Salinas, n. 2.410, Santa Tereza, CEP 31015-190, Belo Horizonte, Minas Gerais, Brazil (e-mail: mixcabr@gmail.com); **VIVIANE AMÉLIA FURTADO CALIXTO,** Rua Curupaiti, n. 751, Padre Eustáquio, CEP 31730-130, Belo Horizonte, Minas Gerais, Brazil (e-mail: vivitscalixto@yahoo.com.br); and **LEONARDO LOPES MACHADO,** Rua Paquetá, n. 1068, Giovanini, CEP 35170-094, Coronel Fabriciano, Minas Gerais, Brazil (e-mail: leolmachado@yahoo.com.br).

TESTUDINES – TURTLES

CHRYSEMYS PICTA (Painted Turtle). USA: NEBRASKA: Furnas Co.: 0.3 km W, 5.0 km S Oxford (40.207183°N, 99.63923°W; NAD 83). 27 June 2009. Keith Geluso and Owen J. Johnson. Verified by Curtis J. Schmidt, Sternberg Museum of Natural History, Hays, Kansas (MHP 14675). New county record. Known from adjacent Red Willow County to the west (Lynch 1985. Trans. Nebraska Acad. Sci. 13:33–57). Found dead on road.

Submitted by **KEITH GELUSO** (e-mail: gelusok1@unk.edu) and **OWEN J. JOHNSON**, Department of Biology, University of Nebraska–Kearney, Kearney, Nebraska 68849, USA

CUORA AMBOINENSIS KAMAROMA (Malayan Box Turtle). PHILIPPINES: BALABAC: Barangays: Agutayan, Catagupan, Melville, Indalawan, and Salang; rice paddies near Basak Creek, Timbangan, Saray, Lagdong, Busay, and Baoang Creek. February 10–25 2007. P. Fidenci. California Academy of Sciences photo vouchers (CAS-HPV 48–54). Verified by Hallie Brignall. First records for Balabac (Diesmos et al. 2008. *Chelonian Conserv. Biol.* 7:157–177). One adult observed at rice paddies near Basak Creek, two adults at Timbangan Creek, one adult at Saray Creek, one adult in Lagdong Creek, three juveniles at Busay Creek, and two adults at Baoang Creek.

Submitted by **PIERRE FIDENCI**, Endangered Species International, 79 Brady St, San Francisco, California 94103, USA; e-mail: pfidenci@endangeredspeciesinternational.org.

GRAPTEMYS GEOGRAPHICA (Common Map Turtle). USA: INDIANA: Lawrence Co.: Buddha Bypass Bridge south of Buddha (38.7704250°N, 86.4093305°W; no datum available). 30 July 2008. Peter V. Lindeman. Verified by John B. Iverson. Florida Museum of Natural History Herpetology Dept. photographic archive (UF 153477). New county record (Minton 2001. Amphibians & Reptiles of Indiana, 2nd ed. Indiana Academy of Science, Indianapolis. 404 pp.). Basking adult female.

Submitted by **PETER V. LINDEMAN**, Department of Biology and Health Services, 150 Cooper Hall, Edinboro University of Pennsylvania, Edinboro, Pennsylvania 16444, USA; e-mail plindeman@edinboro.edu.

GRAPTEMYS GIBBONSI (Pascagoula Map Turtle). USA: MISSISSIPPI: Pike Co.: Bogue Chitto River, 50 m upstream of Route 98 bridges (31.1773722°N, 90.2795194°W; no datum available). 25 May 2008. Peter V. Lindeman. Florida Museum of Natural History Herpetology Dept. photographic archive (UF 153478). Verified by Will Selman. New county record (Cliburn 1971. J. Mississippi Acad. Sci. 16:16–19), extending known range in the Bogue Chitto upstream by ca. 10 river km. Basking juvenile.

Submitted by **PETER V. LINDEMAN**, Department of Biology and Health Services, 150 Cooper Hall, Edinboro University of Pennsylvania, Edinboro, Pennsylvania 16444, USA; e-mail: plindeman@edinboro.edu.

GRAPTEMYS OUACHITENSIS (Ouachita Map Turtle). USA: INDIANA: Lawrence Co.: Buddha Bypass Bridge south of Buddha (38.7704250°N, 86.4093305°W; no datum available). 31 July 2008. Peter V. Lindeman. Verified by John B. Iverson. Florida Museum of Natural History Herpetology Dept. photographic archive (UF 153479). New county record (Minton 2001. Amphibians & Reptiles of Indiana, 2nd ed. Indiana Academy of Science, Indianapolis. 404 pp.). Basking adult female.

Submitted by **PETER V. LINDEMAN**, Department of Biology and Health Services, 150 Cooper Hall, Edinboro University of Pennsylvania, Edinboro, Pennsylvania 16444, USA; e-mail: plindeman@edinboro.edu.

GRAPTEMYS OUACHITENSIS (Ouachita Map Turtle). USA: MINNESOTA: Dakota Co.: Pool 2 of the Mississippi River at approximately river mile 827 (44.8127°N, 093.009118°W; datum NAD83). 30 May 2009. Richard McCarthy. Verified by Kenneth Kozak and Amy Luxbacher. James Ford Bell Museum (photographic vouchers JFBM P317–P319). New county record (Oldfield and Moriarty 1994. Amphibians and Reptiles Native to Minnesota. University of Minnesota Press, Minneapolis. 233 pp.). Three individuals observed in slough and on adjacent mound in protected area bordering Pool 2. Northernmost known occurrence on Mississippi River. Species may have reoccupied Pool 2 following water quality improvements in recent decades.

Submitted by **RICHARD McCARTHY**, Macalester College Ordway Natural History Study Area, 9950 Inver Grove Trail, Inver Grove Heights, Minnesota 55076, USA; e-mail: rmccarth@macalester.edu.

SQUAMATA – LIZARDS

ACRATOSAURA MENTALIS (NCN). BRAZIL: RIO GRANDE DO NORTE: Municipality of Tenente Laurentino Cruz, Serra Nova (06.109°S, 36.719°W; datum WGS84; elev. 704 m). 24 October 2009. M. Gogliath. Coleção Herpetológica do Departamento de Botânica, Ecologia e Zoologia, Universidade Federal do Rio Grande do Norte, Natal, Rio Grande do Norte (CHBEZ 2930). Verified by M. T. Rodrigues. First record in the state of Rio Grande do Norte, and extends the known geographical distribution of this species ca. 135 km N from the nearest record in the municipalities of São José dos Cordeiros/Sumé (Reserva Particular do Patrimônio Natural Fazenda Almas) (07.471°S, 36.881°W), state of Paraíba. According to Rodrigues (1986. Pap. Avul. Zool. 36[20]:237–250), *Acratosaura mentalis* has a disjunct distribution and has been found in Senhor do Bonfim (type locality), Mucugê (Freitas and Silva 2007. Guia Ilustrado: A Herpetofauna das Caatingas e áreas de Altitudes do Nordeste Brasileiro. Editora USEB, Pelotas, Bra-

zil. 384 pp.) and Maracás (Rodrigues et al. 2007. Am. Mus. Nov. 3565:1–27), state of Bahia; Grão Mogol (Rodrigues 1986, *op. cit.*) in the state of Minas Gerais; Estação Ecológica de Xingó, states of Alagoas/Sergipe (Bandeira 2000. Aspectos Zoogeográficos e Ecológicos da Saurofauna da Estação Ecológica de Xingó, AL/SE. Monograph, Universidade Federal de Alagoas, Maceió, Brazil. 35 pp.); Brejo da Madre de Deus, Pernambuco State (Queiroz and Lema 1996. Biociências 4[1]:87–90); Cabaceiras (Rodrigues 1986, *op. cit.*), Cacimba de Dentro (Arzabe et al. 2005. *In* Araújo et al. [orgs.], Herpetofauna da área do Curimataú, Paraíba, pp. 264–280. Ministério do Meio Ambiente, Brasília, Brazil), São José dos Cordeiros and Sumé (Reserva Particular do Patrimônio Natural Fazenda Almas; Delfim and Freire 2007. Oecol. Bras. 11[3]:365–382; Freire et al. 2009. *In* Freire [org.], Répteis das Caatingas do Seridó do Rio Grande do Norte e do Cariri da Paraíba: Síntese do Conhecimento Atual e Perspectivas, pp. 51–84. Editora Universitária da UFRN, Natal, Brazil), state of Paraíba.

We thank the municipal government of Tenente Laurentino Cruz for logistical support.

Submitted by **MELISSA GOGLIATH** (e-mail: melbiologa@gmail.com)[1,2], **LEONARDO B. RIBEIRO** (e-mail: ribeiro.lb@gmail.com)[1,2], and **ELIZA M. X. FREIRE** (e-mail: elizajuju@ufrnet.br)[1,2], [1]Laboratório de Herpetologia, Departamento de Botânica, Ecologia e Zoologia, Centro de Biociências, Universidade Federal do Rio Grande do Norte, Campus Universitário, 59072-970, Natal, RN, Brazil; [2]Programa de Pós-graduação em Psicobiologia/UFRN, 59078-970, Natal, RN, Brazil.

AGAMA AGAMA AFRICANA (African Rainbow Lizard). USA: FLORIDA: Duval Co.: 15981 Croaker Road, Jacksonville (30.5285°N, 81.4820°W; WGS84). 07 August 2009. David Hoffer. Florida Museum of Natural History photographic voucher (UF 155901). Verified by Kenneth L. Krysko. First county record. Extends range ca. 195 km N of a population in Seminole Co. (Enge et al. 2004. Florida Sci. 67:303–310). Adult male observed on a pile of slate. Other individuals of different sizes have been observed on the property since 2008, indicating a potential breeding population of unknown provenance. This nonnative species has now been recorded from 10 counties in Florida.

Submitted by **KEVIN M. ENGE**, Florida Fish and Wildlife Conservation Commission, 1105 SW Williston Road, Gainesville, Florida 32601, USA (e-mail: kevin.enge@myfwc.com); **CHUCK HUBBUCH**, University of North Florida, 1 UNF Drive, Jacksonville, Florida 32224; and **DAVID HOFFER**, 15981 Croaker Road, Jacksonville, Florida 32226, USA.

CHALCIDES SEXLINEATUS BISTRIATUS (NCN). SPAIN: CANARY ISLANDS: La Palma Island, Tazacorte, La Florida (28.639326°N, 17.928760°W; datum: WGS84; elev. 158 m). 08 September 2008, Two adults and two juveniles deposited in collection of Department of Animal Biology of La Laguna University (adults: DZUL 3018–3019; juveniles: DZUL 3020–3021). Verified by A. Martín. Species endemic to northern Gran Canaria Island. At least 60 individuals were brought to La Palma Island over 50 years ago. At the time, the species was absent from the island (Izquierdo et al. 2004. Lista de Especies Silvestres de Canarias [Hongos, Plantas y Animales Terrestres]. Gobierno de Canarias, Santa Cruz de Tenerife. 497 pp.). Presence of juveniles suggests an established population. This species appears to occur over a small area (ca. 4 ha) dominated by intensive banana cultivation. Both native and introduced predators such as kestrels (*Falco tinnunculus*), lizards (*Gallotia* spp.), and feral cats (*Felis silvestris catus*) are known to eat skinks (Santana et al. 1986. Vierarea 16:113–117; Barbadillo 1987. La Guía Incafo de los Anfibios y Reptiles de la Península Ibérica, Islas Baleares y Canarias. Incafo, S.A., Madrid). These facts, together with the proximity of this population to villages and roads could affect the possible spread of the species to the rest of the island.

I thank A. Martín and M. Nogales for suggestions on the manuscript and J. A. Campbell for editorial assistance.

Submitted by **FÉLIX MANUEL MEDINA,** Consejería de Medio Ambiente, Cabildo Insular de La Palma, Avenida Los Indianos, 20, 2º, 38700 Santa Cruz de La Palma, Canary Islands, Spain; e-mail: felix.medina@cablapalma.es.

CHALCIDES VIRIDANUS (West Canary Skink). SPAIN: CANARY ISLANDS: La Palma Island: Los Llanos de Aridane (28.639326ºN, 17.928760ºW, datum: WGS84; elev. 158 m). 08 September 2008. Department of Animal Biology of La Laguna University, DZUL 3022. Verified by A. Martín. First island record with location data. Endemic to Tenerife Island, and probably introduced through wood commerce between both islands of the Canarian Archipelago, and absent on La Palma Island (Izquierdo et al. 2004. Lista de Especies Silvestres de Canarias [Hongos, Plantas y Animales Terrestres]. Gobierno de Canarias, Santa Cruz de Tenerife. 497 pp.). This is the second record for this species on the island (Mateo 2002. *In* Pleguezuelos et al. [eds.], Atlas y Libro Rojo de los Anfibios y Reptiles de España, pp. 173–174. Dirección General de Conservación de la Naturaleza – Asociación Herpetológica Española, Madrid.

Submitted by **FÉLIX MANUEL MEDINA**, Consejería de Medio Ambiente, Cabildo Insular de La Palma, Avenida Los Indianos, 20, 2º, 38700 Santa Cruz de La Palma, Canary Islands, Spain; e-mail: felix.medina@cablapalma.es.

DAREVSKIA BRAUNERI SZCZERBAKI (Rock Lizard). GEORGIA: REPUBLIC OF ABKHAZIA: Gudauta District: Lzaa village, Pitsunda-Myussera Hills (Herpetological Collection of Zoological Institute, St. Petersburg, ZISP 24397, 25816–25818). Verified by Ilya S. Darevsky. First country record. 17 April 2006. Konstantin Milto and Mark Pestov. Additional specimens were seen on 5–7 July, 7–9 August 2008, and 7–12 August 2009 by Mark Pestov and Olga Bezman-Moseyko. Lizards were encountered on the clay-rock cliffs of the Black Sea coast between Lzaa settlement (43.16813ºN, 40.4108ºE) and mouth of Mysra River (43.15009ºN, 40.45921ºE). The previously known distribution of *Darevskia brauneri szczerbaki* is limited to a small territory on the northeastern coast of the Black Sea in Krasnodar Region, Russia. This subspecies is endemic of Crimea-Novorossisk subprovince of the East Mediterranean Province in Caucasus and inhabits a narrow coastral zone from Anapa town to the Cape of Utrish. New record is 297 km SE of previously documented locations. The Myussera Hills are probably the southernmost border of *D. b. szczerbaki* distribution.

Submitted by **KONSTANTIN D. MILTO** (e-mail: coluber@zin.ru)**, MARK V. PESTOV,** and **OLGA S. BEZMAN-MOSEYKO,** Zoological Institute, Department of Herpetology, St. Petersburg, Universitetskaya emb., 1, 199034, Russia.

HELODERMA SUSPECTUM CINCTUM (Banded Gila Monster). USA: CALIFORNIA: San Bernardino Co.: Mojave National Preserve: Vulcan Mine (34.55353ºN, 115. 35160ºW; WGS 84; elev. 1077m). 02 May 2009, 1615 h, 24ºC air, 420 mm total length. Ron M. Ruppert. Verified by K. Beaman. Natural History Museum of Los Angeles County voucher photographs (LACM-PC 1461–1466).

There are only 26 records of *Heloderma suspectum* from California over the past 153 years. The most recent photographic documentation from the Vulcan Mine area was 1968. The most recent record in California was 2006 from an area 100 km to the north of Vulcan Mine (Lovich and Beaman 2007. Bull. So. California Acad. Sci.106[2]:39–58).

Submitted by **RON M. RUPPERT**, Biology Department, Cuesta College, Highway One, San Luis Obispo, California 93403, USA; e-mail: rruppert@cuesta.edu.

HEMIDACTYLUS FRENATUS (Common House Gecko). MEXICO: BAJA CALIFORNIA SUR: Municipality of Comondú: Ciudad Constitución, Hotel Oasis (25.036472º N, 111.6795º W; WGS84; elev. 54 m) 25 October 2008. J. B. Granados. Verified by Oscar Flores-Villela. Herpetological collection of the Centro de Investigaciones Biológicas del Noroeste, La Paz, Baja California Sur, México (CIBNOR 0721–22). First records for the municipality. Bridges a distributional gap between La Paz (208 km SE) and Loreto (149 km NE) (Grismer 2002. Amphibians and Reptiles of Baja California: Including its Pacific Islands and the Islands in the Sea of Cortez. Univ. California Press, Berkeley, California. 399 pp.). Both juveniles were collected at night on the hotel wall, and because adults were also observed from the same location, this exotic species is assumed to be well-established there.

Submitted by **VÍCTOR H. LUJA** (e-mail: lujastro@yahoo.com), **JAVIER BRUNO GRANADOS**, and **RICARDO RODRÍGUEZ-ESTRELLA**, Centro de Investigaciones Biológicas del Noroeste (CIBNOR), Mar Bermejo #195 Colonia Playa Palo de Santa Rita, La Paz, Baja California Sur, 23090, México.

HEMIDACTYLUS MABOUIA (Wood Slave). USA: FLORIDA: St. Lucie Co.: Fort Pierce, 2100 Elizabeth Avenue (27.40840ºN, 80.34595ºW; WGS 84). 11 May 2009. Ken Hibbard. Verified by Kenneth L. Krysko. Florida Museum of Natural History, University of Florida (UF 155444). First county record. One adult female, heavily infested with ectoparasitic pterygosomatid mites, was collected from a porch screen of a residence at 2200 h. Three other individuals were observed at this same locality at 2000 h on 13 May 2009; they are common in sections of the Fort Pierce area. This invasive African species is currently the most widespread and rapidly spreading nonindigenous gecko in southern and central Florida (Meshaka et al. 2004. The Exotic Amphibians and Reptiles of Florida. Krieger Publ. Co., Malabar, Florida; Krysko and Daniels 2005. Caribb. J. Sci. 41:28–36), with a more recently established population in northern peninsular Florida (Krysko and Somma 2007. Herpetol. Rev. 38:352).

Submitted by **LOUIS A. SOMMA**, Department of Biology, PO Box 118525, 220 Bartram Hall, University of Florida, Gainesville, Florida, USA; e-mail: somma@ufl.edu.

HEMIDACTYLUS TURCICUS (Mediterranean Gecko). USA: ARKANSAS: Union Co.: South Arkansas Community College, El Dorado (33.209186°N, 92.666117°W; WGS 84). 30 September 2009. W. Bibby. Verified by S. E. Trauth. Arkansas State University Museum of Zoology Herpetology Collection (ASUMZ 31385). First county record (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville. 421 pp.). This hatchling was found on the floor of the Whitfield Building on the campus of South Arkansas Community College. It has been previously collected in neighboring Columbia Co. (Fowler and Robison 2007. Herpetol. Rev. 38:218) and nearby Ouachita and Webster Parishes in Louisiana (Meshaka et al. 2006. Herpetol. Conserv. Biol. 1[1]:45–50).

Submitted by **MATTHEW B. CONNIOR,** Health and Natural Sciences, South Arkansas Community College, PO Box 7010, 300 South West Avenue, El Dorado, Arkansas 71731,USA; e-mail: mconnior@southark.edu.

MESOSCINCUS MANAGUAE (Managua Skink). GUATEMALA: ZACAPA: Municipality of Cabañas, El Arenal (14.8796°N, 89.7711°W; NAD27; elev. 410 m). 22 August 2004. Daniel Ariano-Sánchez and Gilberto Salazar. Verified by Carlos Vásquez and Theodore Papenfuss. Museo de Historia Natural de la Universidad de San Carlos de Guatemala (USAC 1128). Second record, but first documented locality for this species in Guatemala, extending the range ca. 5 km NE of an individual reported from Rosario, Guatemala (Acevedo 2006. Biodiversidad de Guatemala, Vol. 1. Univ. del Valle de Guatemala, Guatemala. 524 pp.), and ca. 110 km NW from the nearest confirmed record in Imposible National Park, El Salvador (YPM 12436). The lizard was found at 1100 h as it crawled through a dry gulley within tropical dry forest dominated by the columnar cacti, *Stenocereus pruinosus*, and the thorn shrub, *Mimosa zacapana*, a vegetation formation similar to that depicted by Köhler (2008. Reptiles of Central America. Herpeton, Verlag Elke Köhler, Offenbach, Germany. 400 pp.).

Submitted by **DANIEL ARIANO-SÁNCHEZ** (e-mail: darianosanchez@gmail.com); **ANTONIO URBINA**, and **GILBERTO SALAZAR**, Research and Conservation Projects Direction, Asociación Zootropic, 12 Calle 1-25 Zona 10, Edificio Geminis 10 torre sur, nivel 18 oficina 1801A, Guatemala.

OPHISAURUS GRACILIS (Burmese Glass Lizard). THAILAND: CHAIYAPHUM PROVINCE: Khon San District: Phu Khiew Wildlife Sanctuary (16.3833°N**,** 101.5667°E; elev. 800 m) 10 April 2009. USDZ photographic archive, ZRC (IMG) 2.121. Verified by Olivier S. G. Pauwels. SVL 182 mm, TL 160 mm, 51 g. Released as species protected under Thai law. First record for Province. Found in lower montane forest near Sanctuary headquarters. P. Duengkae. Known from the provinces of Chiang Mai, Mae Hong Son, and Loei (Nabhitabhata et al. 2000 [2004]. Checklist of Amphibians and Reptiles in Thailand. Office of Environmental Policy and Planning, Bangkok. 152 pp.). Previous herpetological surveys in Phu Khiew Wildlife Sanctuary overlooked the species (Phophinit 1991. Species Diversity and Distribution of Reptiles in Suborder Lacertilia at Phu Khiew Wildlife Sanctuary. MS thesis, Kasetsart University.129 pp.; Kamsook et al. 2000. J. Wildlife Thailand 8[1]:63–75; Kamsook et al. 2006. BRT 2006 Research Reports 2006:270–284).

Kelvin Kok Peng Lim and Olivier S.G. Pauwels are thanked for their assistance.

Submitted by **YODCHAIY CHUAYNKERN**, Thailand Natural History Museum, National Science Museum, Technopolis, Khlong 5, Khlong Luang, Pathum Thani, 12120, Thailand and Muséum national d'Histoire naturelle, Département de Systématique et Evolution, UMR 5202 CNRS OSEB, Reptiles et Amphibiens, Case 30, 25 rue Cuvier, 75005 Paris, France (e-mail: ychuaynkern@yahoo.com); and **PRATEEP DUENGKAE**, Department of Forest Biology, Faculty of Forest, Kasetsart University, Jatujak, Bangkok 10900, Thailand (e-mail: prateep.du@ku.ac.th).

PLESTIODON FASCIATUS (Common Five-lined Skink). USA: FLORIDA: Clay Co.: Black Creek Ravines Conservation Area, 3.7 km E jct of State Road 21 and County Road 218 (30.0669°N, 81.8358°W; WGS84; 10 m elev.). Florida Museum of Natural History (UF 154255). Verified by Kenneth L. Krysko. New county record. 25 November 2008. Kevin M. Enge. Collected inside a large pine stump in mixed hardwood forest along a steephead stream ravine. Museum vouchers now exist for seven northern peninsular counties: Citrus, Clay, Columbia, Hamilton, Levy, Marion, and Suwannee. Ashton and Ashton (1991. Handbook of Reptiles and Amphibians of Florida. Part Two: Lizards, Turtles & Crocodilians. Windward Publ., Miami, Florida. 191 pp.) show eight additional peninsular counties, but the validity of their most southeasterly records from Volusia County is questionable. Specimens of *Plestiodon laticeps* with four labial scales anterior to the subocular scale on one side and five labials on the other side are sometimes mistakenly identified as *P. fasciatus*. In the Florida Museum of Natural History collection, the only purported specimens of *P. fasciatus* from Lafayette (UF 136039), St. Johns (UF 69883), and Taylor (UF 91096) counties were misidentified. Unverified reports exist for Baker, Bradford, and Taylor counties (see Enge 1997. A Standardized Protocol for Drift-fence Surveys. Florida Game Fresh Water Fish Comm. Tech. Rep. No. 14, Tallahassee).

Submitted by **KEVIN M. ENGE**, Florida Fish and Wildlife Conservation Commission, 1105 S.W. Williston Road, Gainesville, Florida 32601, USA; e-mail: kevin.enge@myfwc.com.

PLESTIODON MULTIVIRGATUS EPIPLEUROTUS (Variable Skink). USA: TEXAS: Schleicher Co.: Eldorado, 12.9 air mi NW of jct U.S. Hwys 277 and 190, along Schleicher County Road 426 (30.94115ºN, 100.79705ºW; WGS 84) 2486 ft elev. 07 April 2006. M. S. Price and S. G. Price. Verified by Travis J. LaDuc (photographic voucher TNHC 7340100). First county record (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. Texas A&M University Press. College Station, Texas. 421 pp.). Fills in distributional gap.

Submitted by **MICHAEL S. PRICE,** San Angelo Nature Center, 7409 Knickerbocker Road, San Angelo, Texas 76904, USA; e-mail: michael.price@sanangelotexas.us.

SCELOPORUS CYANOGENYS (Blue Spiny Lizard). USA: TEXAS: Kleberg Co.: Business Hwy 77 (State Loop 428), 0.65 road km NE from junction with FM 1355, below bridge overpass at intersection with San Fernando Creek (27.550267°N, 97.840796°W; WGS 84). Collected on 9 and 16 July 2009. Randy Powell, William Lukefahr, William Moore, and Robert Rabe. Verified by Travis J. LaDuc. Texas Natural History Collections (TNHC 78101–78102). Five additional specimens were captured at this location between 4 July and 11 August; the animals were measured, tagged with Passive Integrated Transponders (PIT), blood samples were taken, and they were released at the site. County record. An additional location within Kleberg County yielded two more specimens (TNHC 78103–78104). All specimens were caught in glue traps. The collection sites are ca. 1.6 air km apart and both are adjacent to San Fernando Creek and ca. 1.5–2 km S of the Nueces-Kleberg county line. Extends the range south one county (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. Texas A&M Univ. Press. College Station. 421 pp.).

Submitted by **RANDY L. POWELL** (e-mail: randy.powell@tamuk.edu),**WILLIAM D. LUKEFAHR**, **WILLIAM L. MOORE**, and **ROBERT W. RABE**, Department of Biological and Health Sciences, MSC 158, Texas A&M University, Kingsville, Texas 78363, USA.

SCELOPORUS CYANOSTICTUS (Blue-spotted Spiny Lizard). MEXICO: NUEVO LEON: Municipality of Mina; 58.7 air km SW of Sabinas Hidalgo along Mex. Hwy 53 (26.24959ºN, 100.69002ºW; WGS84; elev. 785 m). 07 October 2007. Michael S. Price, Christopher R. Harrison, Travis J. Fisher, and David Lazcano. Verified by Hobart M. Smith. UANL 6987. First state record (Liner 2007. Occas. Pap. Mus. Nat. Sci. Louisiana St. Univ. [80]:1–59). A range extension of ca. 70 km E from the closest known locality in SW Coahuila (Lemos Espinal and Smith 2007. Anfibios y Reptiles del Estado de Coahuila, México. UNAM, Tlalnepantla, Estado de México and CONABIO, México, D.F. 550 pp.). The lizard was found in a boulder pile at the base of a north-facing canyon wall bounded by Chihuahuan Desert scrub vegetation.

Submitted by **MICHAEL S. PRICE**, San Angelo Nature Center, 7409 Knickerbocker Road, San Angelo, Texas 76904, USA (e-mail: michael.price@sanangelotexas.us); **CHRISTOPHER R. HARRISON**, Biology Department, Northwest Vista College, San Antonio, Texas 78251, USA (e-mail: crharrison@satx.rr.com);and **DAVID LAZCANO,** Universidad Autónoma de Nuevo León, Facultad de Ciencias Biológicas, Laboratorio de Herpetología, Apartado, Postal – 513, San Nicolás de los Garza, Nuevo León, C.P. 66450, México (e-mail: dlazcanov@hotmail.com).

SCELOPORUS JARROVII (Yarrow's Spiny Lizard). USA: NEW MEXICO: Grant Co.: 2.3 km S of Pinos Altos, 17 Sanctuary Road (32.84231ºN, 108.22386ºW, datum WGS84). 03 August 2008. Shawn White. Verified by J. Lee. Western New Mexico University, Gila Natural History Collection (WNMU 14782, small adult female, 57 mm SVL). Second county record. Increases the range by ca. 37 km. An additional large adult male (90 mm SVL) was found nearby in a boulder pile in a wooded lot and one juvenile (41 mm SVL) was found inside a residential structure. Both locations within Grant Co. are widely separated and at different elevations. This indicates the spread of a lizard into suitable habitat which it could not historically invade because of inhospitable terrain. Grant County has numerous mountain ranges interspersed with lower elevation plateaus which create the so called "sky islands." We believe the second record represents expansion by human efforts

beyond the historical range and therefore has value in documenting this type of movement. This species has been recorded numerous times in neighboring Hidalgo Co.

Submitted by **SHAWN R. WHITE** (e-mail: whites7@wnmu.edu) and **RANDY D. JENNINGS**, Western New Mexico University, P.O. Box 680, Silver City, New Mexico 88062, USA (e-mail: jenningsr@wnmu.edu); **DOUGLAS E. RUBY**, University of Maryland Eastern Shore, Backbone Road, Princess Anne, Maryland 21853, USA (e-mail: deruby@umes.edu); and **GEORGE A. MIDDENDORF**, Howard University, Washington, District of Columbia 20059, USA (e-mail: gmiddendorf@howard.edu).

SCELOPORUS MERRIAMI AUSTRALIS (Canyon Lizard). MEXICO: NUEVO LEON: Municipality of Mina: 58.7 air km SW of Sabinas Hidalgo along Mex. Hwy 53 (26.24959ºN, 100.69002ºW;WGS 84; elev. 785 m). 27 April 2008. Michael S. Price, Travis J. Fisher, and David Lazcano. Verified by Hobart M. Smith. UANL 6988. First state record (Liner 2007. Occas. Pap. Mus. Nat. Sci. Louisiana St. Univ. [80]:1–59). A range extension of ca. 70 km E from the closest known locality in SW Coahuila (Lemos Espinal and Smith 2007. Anfibios y Reptiles del Estado de Coahuila, México. UNAM, Tlalnepantla, Estado de México and CONABIO, México, D.F. 550 pp.). The lizard was found on a north-facing canyon wall bounded by Chihuahuan Desert scrub vegetation.

Submitted by **MICHAEL S. PRICE,** San Angelo Nature Center, 7409 Knickerbocker Road, San Angelo, Texas 76904, USA (e-mail: michael.price@sanangelotexas.us); and **DAVID LAZCANO,** Universidad Autónoma de Nuevo León, Facultad de Ciencias Biológicas, Laboratorio de Herpetología, Apartado, Postal – 513, San Nicolás de los Garza, Nuevo León, C.P. 66450, México (e-mail: dlazcanov@hotmail.com).

SQUAMATA – SNAKES

CARPHOPHIS AMOENUS (Eastern Wormsnake). USA: INDIANA: Pike Co.: Patoka River National Wildlife Refuge and Management Area (38.34910ºN, 87.12384ºW; NAD 83, Zone 16). 10 April 2009. Michael J. Lodato and Alisha Maves. Verified by Chris Phillips. Illinois Natural History Survey (INHS 2009l). First county record (Minton 2001. Amphibians and Reptiles of Indiana, 2nd ed., revised. Indiana Academy of Science. vii + 404 pp.). Juvenile was found beneath a coverboard, adjacent to a cliff.

Submitted by **LINDSEY LANDOWSKI** (e-mail: Lindsey_Landowski@fws.gov), **MICHAEL J. LODATO**, and **ALISHA MAVES**. US Fish and Wildlife Service, Patoka River National Wildlife Refuge, 510 1/2 West Morton Street, P.O. BOX 217, Oakland City, Indiana 47660, USA.

COLUBER CONSTRICTOR (North American Racer). USA: NEBRASKA: Dawson Co.: Hiles Canyon, 10.2 km S Gothenburg (40.835333°N, 100.16305°W; NAD 83). 13 June 2009. Keith Geluso and Owen J. Johnson. Verified by Curtis J. Schmidt. Sternberg Museum of Natural History (MHP 14676). First county record. Fills gap in distribution in central Nebraska (Lynch 1985. Trans. Nebraska Acad. Sci. 13:33–57). Known from adjacent Lincoln Co. to the west and Frontier Co. to the southwest (Lynch 1985, *op. cit.*).

Submitted by **KEITH GELUSO** (e-mail: gelusok1@unk.edu) and **OWEN J. JOHNSON**, Department of Biology, University of Nebraska—Kearney, Kearney, Nebraska 68849, USA.

DIADOPHIS PUNCTATUS ARNYI (Prairie Ring-necked Snake). USA: TEXAS: Schleicher Co.: Eldorado, 12.8 air mi NW of jct U.S. Hwys 277 and 190, along Schleicher County Road 426 (30.9410167ºN, 100.79505ºW; WGS 84; elev. 2486 ft.). 07 April 2006. M. S. Price and S. G. Price. Verified by Travis J. LaDuc (photographic voucher TNHC 73400). First county record and fills a distributional gap (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. Texas A&M University Press, College Station, Texas. 421 pp.).

Submitted by **MICHAEL S. PRICE,** San Angelo Nature Center, 7409 Knickerbocker Road, San Angelo, Texas 76904, USA; e-mail: michael.price@sanangelotexas.us.

ECHINANTHERA AMOENA. BRAZIL: MINAS GERAIS: Municipality of Santa Rita de Ibitipoca: Parque Estadual do Ibitipoca (21.703659°S, 43.885971°W; datum: SAD 69; elev. 1450 m). 16 December 1987. R. N. Feio. Museu Nacional / Universidade Federal do Rio de Janeiro, Rio de Janeiro, RJ, Brazil (MNRJ 7706, 7707). RIO DE JANEIRO: Municipality of Cachoeiras de Macacu: Reserva Ecológica de Guapiaçu (22.392222°S, 42.739444°W; datum: SAD 69; elev. 500 m). 14 January 2009. D. Vrcibradic. (MNRJ 18068). All verified by R. Fernandes. Species is known in southeastern Brazil, from southern Minas Gerais to southern Paraná, with one record in Minas Gerais, Municipality of Baependi and one record in Rio de Janeiro, Pedra Branca, Municipality of Parati (Di-Bernardo 1992. Comun. Mus. Cienc. PUCRS, sér. Zool. 5[13]:225–256). The record for the Parque Estadual do Ibitipoca is the northernmost for the species and the second for the state of Minas Gerais, ca. 105 km ENE from the closest previous record, Baependi. The record from the Reserva Ecológica de Guapiaçu is the easternmost for the species and the second for the state of Rio de Janeiro, ca. 220 km ENE from the closest previous record, Parati. Both localities are within the Atlantic Forest biome.

Submitted by **ADRIANO LIMA SILVEIRA**, Setor de Herpetologia, Departamento de Vertebrados, Museu Nacional / Universidade Federal do Rio de Janeiro, Quinta da Boa Vista, São Cristóvão, 20940-040, Rio de Janeiro, RJ, Brazil (e-mail: biosilveira@yahoo.com.br); **DAVOR VRCIBRADIC** (e-mail: davor@centroin.com.br), **CARLOS FREDERICO DUARTE ROCHA**, Departamento de Ecologia, Universidade do Estado do Rio de Janeiro, Rua São Francisco Xavier, 524, 20550-011, Rio de Janeiro, RJ, Brazil (e-mail: cfdrocha@uerj.br); and **CARLA DA COSTA SIQUEIRA**, Universidade Federal do Rio de Janeiro, Programa de Pós-Graduação em Ecologia, Instituto de Biologia, Av. Carlos Chagas Filho 373 Bl. A, Cidade Universitária, 21941-902, Rio de Janeiro, RJ, Brazil (e-mail: carlacsiqueira@yahoo.com.br).

GEOPHIS TARASCAE (Tarascan Earth Snake). MÉXICO: JALISCO: Municipality of Quitupan: 28 km (airline) S of Valle de Juárez (19.6725°N, 102.921°W; WGS84; elev. 1965 m). 26 November 2006, 13 October 2007. Christoph I. Grünwald and Jason M. Jones, respectively. Verified by Luis Canseco-Marquez. UTA Digital Collection (UTADC 1091, 1092). New municipality record. Fills a distributional gap of ca. 157 km between Nevado de Colima, Jalisco, 67 km to the SW (Dixon 1968. Southwest. Nat. 13:452–454) and Parque Nacional near Uruapan, Michoacán

(the type locality), ca. 90 km to the SE (Downs 1967. Misc. Publ. Mus. Zool. Univ. Michigan [131]:1–193). Both snakes where found under rocks of a fallen stone wall in a clearing surrounded by pine-oak forest.

Submitted by **JACOBO REYES-VELASCO,** Centro Universitario de Ciencias Biológicas y Agropecuarias, Carretera a Nogales Km. 15.5, Las Agujas, Nextipac, Zapopan, Jalisco, México (e-mail: jackobz@gmail.com); **CHRISTOPH I. GRÜNWALD,** Careterra Chapala - Jocotepec Oriente #57-1, Col. Centro, Ajijic, Jalisco 45920, México (e-mail: cgruenwald@switaki.com); and **JASON M. JONES,** 16310 Avenida Florencia, Poway, California 92064, USA (e-mail: jjones@switaki.com).

LAMPROPELTIS TRIANGULUM (Milksnake). USA: TEXAS: Schleicher Co.: Eldorado, 12.7 air mi NW of jct U.S. Hwys 277 and 190, along Schleicher County Road 426 (30.9410667ºN, 100.7935333ºW; WGS 84; elev. 2480 ft). 04 May 2001. M. S. Price and K. Conder. Verified by Travis J. LaDuc (photographic voucher TNHC 73402). First county record and fills distributional gap (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. Texas A&M University Press, College Station, Texas. 421 pp.).

Submitted by **MICHAEL S. PRICE,** San Angelo Nature Center, 7409 Knickerbocker Road, San Angelo, Texas 76904, USA; e-mail: smichael.price@sanangelotexas.us.

LAMPROPELTIS TRIANGULUM ELAPSOIDES (Scarlet Kingsnake). USA: GEORGIA: Miller Co.: Mayhaw Wildlife Management Area, Griggs Lucille Road, 0.23 mi E Cypress Creek (31.197972°N, 84.792792°W; WGS 84). 03 March 2006. Collected by E. Adair, A. M. Durso, J. C. Maerz, K. A. Buhlmann, L. L. Smith, T. M. Luhring, A. M. Grosse, J. Norman, and the UGA Herpetology class. FLMNH 154594. New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). An adult *L. t. elapsoides* was found under bark by the margin of a pond at ca. 1600 h. Extends the range 32 km SW from Baker Co., Georgia. Calhoun Co.: Chickasawhatchee Wildlife Management Area, unnamed road, 1.0 mi W Chickasawhatchee, (31.46611°N, 84.43340°W; WGS 84). 06 April 2008. Collected by K. T. Nelson, A. M. Durso, J. L. Devore, E. C. Susko, J. M. Pahlas, and R. C Joshi. FLMNH 154398. New county record (Jensen et al. 2008, *op. cit.*). An adult *L. t. elapsoides* was found under bark at the base of a snag at ca. 1100 h. This record is 45 km NE from Miller Co., Georgia (FLMNH 154594) and 20.4 km N of a 2007 record from Baker Co., Georgia. Both specimens verified by Kenneth L. Krysko.

These two records, together with the 2007 Baker Co. record (Stevenson et al. 2009. Herpetol. Rev. 40:247–249), represent the first reports of this species from the Dougherty Plain region of Georgia. The previous dearth of records may be due to limited sampling effort. The majority of non-agricultural land in the Dougherty Plain is under private ownership, creating accessibility issues for large-scale sampling. This may indicate that other species with poorly documented distributions within this region could be found in larger numbers with a concerted search.

Submitted by **ANDREW M. DURSO**, Eastern Illinois University, Department of Biological Sciences, Charleston, Illinois 61920 (e-mail: amdurso@gmail.com); and **KERRY T. NELSON**, University of Georgia, Warnell School of Forestry and Natural Resources, Athens, Georgia 30602, USA (e-mail: kerrytnelson@gmail.com).

LAMPROPELTIS TRIANGULUM MULTISTRIATA (Pale Milksnake). USA: NEBRASKA: Garden Co.: 100 m ESE Crescent Lake National Wildlife Refuge Headquarters (41.7605556ºN, 102.4355556ºW; WGS 84). 11 May 2007. Florida Museum of Natural History (UF 155187). Verified by K. L. Krysko. Third record for Garden County. Captured in pitfall trap by J. B. Iverson. ca. 14 km N of previous record (Converse and Baker 2000. Herpetol. Rev. 31:186). Previous records were from areas of rock outgroups, but new record is from sandhill country, at least 10 km (NW) from the nearest meager exposure of sandstone along an intermittent tributary of Blue Creek. This new specimen is also the first for the Crescent Lake Refuge despite field work at the site by Iverson over 29 years (ca. 46 field months, including 900–1100 m of drift fence with funnel traps and bucket traps run during most months), and 78 years of activity by Refuge personnel (including drift fences for snakes operated in 1939–1942 by Imler [1945. J. Wildl. Mgmt. 9:265–273]; and 7.4 km of drift fence run from 1987–94 [e.g., Smith and Iverson. 1993. J. Herpetol. 27:333–335]).

Submitted by **JOHN B. IVERSON,** Department of Biology, 801 National Road West, Earlham College, Richmond, Indiana 47374, USA; e-mail: johni@earlham.edu.

LAMPROPELTIS ZONATA (California Mountain Kingsnake). USA: CALIFORNIA: Alameda Co.: Camp Ohlone Regional Park, 8 km E of Calaveras Rd., 394 m elev. (37.49°N, 121.74°W; WGS84). 23 May 2009. Dino Labiste. Verified by Mitchell F. Mulks (University of California, Santa Cruz). MVZ Obs-Herp 1. New county record. Extends the range ca. 11 km N of the nearest documented record for the species (CAS 190487). At ca. 1200 h an adult male (78.8 cm total length, 110.5 g) was observed moving along an exposed, rocky streambed of a semipermanent creek. The surrounding east–west running valley is an extensively grazed, riparian mixed oak woodland, with sandstone outcrops dominating the southern-facing slopes, habitat more commonly associated with the *Lampropeltis getula* rather than *L. zonata (*Hubbs 2004. Mountain Kings: A Collective Natural History of California, Sonoran, Durango and Queretaro Mountain Kingsnakes. Tricolor Books, Tempe, Arizona. 324 pp.). Although in certain regions, the co-occurrence of these two species may not be uncommon (R. E. Staub, pers. comm.).

The occurrence of *L. zonata* throughout the Diablo Range is poorly documented, and little is known about populations occupying this region. There are undocumented observations of this species at Camp Ohlone and ~ 10 km NW near Arroyo del Valle Creek, Alameda Co. (M. F. Mulks, pers. comm.; Hubbs 2004, *op. cit.*). Museum specimens confirm that the species occurs at Mount Hamilton (CAS-SUR 1812, MVZ 229892), Alum Rock Park (CAS 190487), and from Henry Coe State Park (MVZ 229890–91). However, suitable habitat is present elsewhere in the Diablo Range and the lack of records may reflect a lack of sampling rather than a disjunct distribution as figured in currently published maps (Hubbs 2004, *op. cit.*; Stebbins 2003. A Field Guide to Western Reptiles and Amphibians, 3rd ed. Houghton Mifflin Harcourt, Boston, Massachusetts. 560 pp.).

This research was funded by a National Geographic Society/ Waitt Grant #W17-08 to Rulon W. Clark, San Diego State University. Scientific collecting permit (SC-9704) was issued by the California Department of Fish and Game.

Submitted by **ZACHARY A. CAVA**, Department of Biology, Ithaca College, 953 Danby Road, Ithaca, New York 14850, USA (e-mail: zcava1@ithaca.edu); and **MATTHEW A. BARBOUR**, Department of Biology, San Diego State University, 5500 Campanile Drive, San Diego, California 92182, USA (e-mail: matthew.a.barbour@gmail.com).

PITUOPHIS MELANOLEUCUS MUGITUS (Florida Pinesnake). USA: FLORIDA: Nassau Co.: Ralph E. Simmons Memorial State Forest, 2.4 km ENE State Hwy 301 at Boulogne (30.779768°N, 81.954327°W; datum unavailable). 21 October 2009. D. Stevenson. Verified by Kenneth L. Krysko. Florida Museum of Natural History (photographic voucher UF 156876). First county record (Ashton and Ashton 1988. Handbook of Reptiles and Amphibians of Florida. Part One: The Snakes. Windward Publ. Co., Miami, Florida. 176 pp.). Adult female found at active Gopher Tortoise (*Gopherus polyphemus*) burrow in xeric sandhill.

Submitted by **DIRK J. STEVENSON,** Project Orianne, Ltd., Indigo Snake Initiative, 414 Club Drive, Hinesville, Georgia 31313, USA; e-mail: dstevenson@projectorianne.org.

PROSYMNA BIVITTATA (Two-striped Shovel-snout). SOUTH AFRICA: KWAZULU-NATAL PROVINCE: Mkhuze Game Reserve (27.59903ºS, 32.13666ºE; 27.59812ºS, 32.13637ºE; 27.62135ºS, 32.17783ºE). 20 August 2007. J. K. Warner and X. Combrink. Port Elizabeth Museum, South Africa (PEM 17431–17433). Verified by W. R. Branch. First provincial records for the species. Three juveniles found under rocks at foothills of Lebombo Mountains.

Fieldwork financed by the iSimangaliso Threatened Species Project and Operation Wallacea, with permission from Ezemvelo KwaZulu-Natal Wildlife (EKZNW SR/014).

Submitted by **JONATHAN K. WARNER**, School of Biological and Conservation Sciences, University of KwaZulu-Natal, Private Bag X01, Scottsville, Pietermaritzburg 3209, South Africa (e-mail: jonathan.k.warner@gmail.com); and **XANDER COMBRINK**, Ezemvelo KwaZulu-Natal Wildlife, P.O. Box 398, St. Lucia Estuary 3936, South Africa (e-mail: combrinx@kznwildlife.com).

PSAMMODYNASTES PULVERULENTUS (Mock Viper). INDIA: ANDHRA PRADESH: Mahendragiri (Eastern Ghats complex), Mandasa, Srikakulam District (18.56ºN, 84.21ºE; elev.1093 m). BNHM 3462. Verified by Indraneil Das. First record for Andhra Pradesh State, and ca ~ 400 km S of previous locality. 1600 h on 23 August 2009. One animal (SVL 158 mm, TL 35 mm) found moving on the the floor of a moist deciduous forest near road, 50 m from rocky hill stream. Previously known from Similipal Tiger Reserve, Mayurbhanj District, Northern Orissa (Sanyal 1993. Reptilia. *In* State Fauna Series I: Fauna of Orissa, Part 4, pp. 51–74. Zoological Survey of India, Calcutta; Whitaker and Captain 2004. Snakes of India. The Field Guide. Draco Books, Chennai. 481 pp.).

Submitted by **PRATYUSH P. MOHAPATRA**, Species Division, World Wide Fund for Nature, 172-B- Lodi Estate, New Delhi 100 003, India (e-mail: wolfsnakes@gmail.com); **ABHIJIT DAS**, Division of Herpetology, Aaranyak, Samanwoy Path, Survey, Beltola, Guwahati 781 028, Assam, India (e-mail: protobothrops@gmail.com); and **S. K. DUTTA**, P. G. Department of Zoology, North Orissa University, Takatpur, Baripada 757 003, Orissa, India (e-mail: sk_dutta@yahoo.com).

RHINOTYPHLOPS LALANDEI (Delalande's Beaked Blind Snake). SOUTH AFRICA: KWAZULU-NATAL PROVINCE: Mkhuze Game Reserve (27.60967ºS, 32.17166ºE). 16 November 2007. J. K. Warner and X. Combrink. PEM 17429, 17407. Verified by W. R. Branch. First provincial records for species. Two individuals captured in a pitfall trap at foothills of Lebombo Mountains.

Fieldwork financed by the iSimangaliso Threatened Species Project and Operation Wallacea, with permission from Ezemvelo KwaZulu-Natal Wildlife (EKZNW SR/014).

Submitted by **JONATHAN K. WARNER**, School of Biological and Conservation Sciences, University of KwaZulu-Natal, Private Bag X01, Scottsville, Pietermaritzburg 3209, South Africa (e-mail: jonathan.k.warner@gmail.com); and **XANDER COMBRINK**, Ezemvelo KwaZulu-Natal Wildlife, P.O. Box 398, St. Lucia Estuary 3936, South Africa (e-mail: combrinx@kznwildlife.com).

SIBON DIMIDIATA (Slender Snail Sucker). BELIZE: CAYO DISTRICT: Chiquibul Forest Reserve (16.733333°N, 88.983333°W; WGS84; ca. elev. 500 m). 08 July 2008. Susanne Marczak. Verified by Paul Edgar. LACMPC 1467. New district record. A northern range extension in Belize from records in the Toledo District, and a 400 m elevational expansion for the country (Stafford and Meyer 2000. A Guide to the Reptiles of Belize. Academic Press, San Diego, California. 356 pp.). The snake was found at 2345 h crossing a dirt road surrounded by tropical evergreen forest. Photographed and released at the site.

We thank the Columbus Zoo for providing funding for our field work.

Submitted by **SUSANNE MARCZAK (**e–mail: susanimal@gmail.com**), MENEMSHA ALLOUSH, ROBIN M. JONES, KATHERINE MARTINEAU, MARK A. OLIVA,** and **KRISTINE KAISER** (e-mail: kristinekaiser@gmail.com), Department of Ecology and Evolutionary Biology, UCLA, Los Angeles, California 90095-1606, USA.

STORERIA OCCIPITOMACULATA OCCIPITOMACULATA (Northern Red-bellied Snake). USA: OHIO: Washington Co.: Independence Township, Upper Archers Fork Rd. 120 m W of intersection with Cady Run Rd. (39.482914°N, 81.206478°W; NAD 1983). 10 May 2007. Michael A. Austin. Ohio University Vertebrate Collection (OUVC 9187). Verified by Scott M. Moody. New county record (Wynn and Moody 2006. Ohio Turtle, Lizard, and Snake Atlas. Ohio Biol. Surv. Misc. Contrib. No. 10, Columbus). DOR.

Submitted by **MICHAEL A. AUSTIN**, Ohio Department of Transportation District 10, 338 Muskingum Drive, Marietta, Ohio 45750, USA; e-mail: michael.austin@dot.state.oh.us.

TRICHEILOSTOMA ANTHRACINUM. ECUADOR: PROVINCIA DE ZAMORA CHINCHIPE: 6.5 km SE of Tundayme (ca. 3.58712°S, 78.43307°W; datum WGS84; elev. 1300–1500 m). April 2004. E. O. Carrillo and S. Aldás A. Colección de Reptiles, Museo de Zoología, Pontificia Universidad Católica del Ecuador (QCAZ 7396). Verified by O. Torres-Carvajal. Southernmost record for the species, extends its distribution ca. 220 km SE from the nearest locality (Balsapamba, Provincia de Bolívar, ca. 1.76667°S, 79.18333°W) in central Ecuador. Adult female found during the day by mining workers that were unearthing primary forest vegetation with bulldozers). This species is known from

only three localities on the eastern and western versants of central Ecuadorian Andes at 1000–1800 m elev. (Cisneros-Heredia 2008. Check List 4[2]:178–181). The present locality lies within a Low Montane Humid Shrub formation (Palacios et al. 1999. *In* Sierra [ed], Propuesta Preliminar de un Sistema de Clasificación de Vegetación para el Ecuador Continental, pp. 109–119. Proyecto INEFAN/GEF-BIRF and EcoCiencia, Quito) and is located on the western versant of the Cordillera del Cóndor mountain range.

Submitted by **DAVID SALAZAR-VALENZUELA** (e-mail: davidsalazarv@gmail.com), **EDWIN O. CARRILLO**, and **SILVIA ALDÁS A.**, Museo de Zoología, Centro de Biodiversidad y Ambiente, Escuela de Biología, Pontificia Universidad Católica del Ecuador, Av. 12 de Octubre 1076 y Roca, Aptdo. 17-01-2184, Quito, Ecuador.

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New Herpetofaunal Records from Southern Honduras

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Central American dry and pine-oak forests (Dinerstein et al. 1995; Olson et al. 2001) are among the most imperiled (Olson and Dinerstein 2002) yet understudied ecoregions (Sánchez-Azofeifa et al. 2005) within the Mesoamerican hotspot (Mittermeier et al. 2004; Myers et al. 2000). Less than 2% of the original dry forests and only 6% of pine-oak forests remain intact, with very little of either (< 5%) set aside in protected areas (Dinerstein et al. 1995; Janzen 1988). Accordingly, these forests formerly covered nearly all of southern Honduras, including the departments of Choluteca and Valle, but the persistent human need for subsistence agriculture, cattle production, and timber extraction has degraded or destroyed most of them, and many of the remaining patches are small and unprotected (AFE-DAPVS 2006; Carrillo and Vaughan 1994; Dinerstein et al. 1995; McCranie and Wilson 2002; Vreugdenhil et al. 2002). Despite this history of pervasive environmental degradation, the herpetofauna of the region has been reasonably well documented (McCranie 2007; McCranie and Wilson 2002; Sasa and Bolaños 2004; Wilson and McCranie 1998). Fifty-one species have been reported in this region, but like dry and pine-oak forests elsewhere in the country and across Central America, the herpetofauna has received little attention compared to that for other forest types. To remedy this deficiency, we sought to assess the herpetofaunal diversity of the only terrestrial protected areas in southern Honduras (AFE-DAPVS 2006). During 26 days in November 2005 and January and June 2006, we inventoried three Multiple Use Areas (MUAs) in the departments of Choluteca and Valle (Montaña La Botija, Cerro Guanacaure, and Isla del Tigre). Our surveys resulted in the documentation of 51 species of amphibians (15) and reptiles (36) (Lovich et al. 2006). We documented seven reptile species that were unknown from, but expected in the region (*Ameiva undulata*, *Lampropeltis triangulum*, *Ninia sebae*, *Oxybelis fulgidus*, *Scolecophis atrocinctus*, *Senticolis triaspis*, and *Spilotes pullatus*) and five others (two amphibians, three reptiles) that were unexpected (*Craugastor laevissimus*, *Ptychohyla hypomykter*, *Anolis cupreus*, *Hemidactylus frenatus*, and *Sceloporus malachiticus*), based on published accounts (IUCN, Conservation International, and NatureServe 2006; Köhler 2001, 2008; Köhler et al. 2006; McCranie 2007; McCranie and Wilson 2002; Villa 1972; Wilson and McCranie 1998) and unpublished field notes of Roy McDiarmid (pers. comm.). Two additional species (*Incilius coccifer* and *Oxybelis aeneus*), although known from the region, represent new records for Isla del Tigre, a volcanic island 1.9 km from the mainland, which contains the only protected dry forest in the Department of Valle. Museum acronyms follow Leviton et al. (1985). All vouchers were verified by J. R. McCranie unless otherwise noted. Locality coordinates were taken with a GPS device using map datum WGS84. If no English common name is available for a species, then the Spanish common names for amphibians are those found in McCranie and Castañeda (2007) and reptile common names are from one of the above listed publication sources in either Spanish or in English.

Anura – Frogs

Craugastor laevissimus (Ranita de Arroyo de Piel Lisa). CHOLUTECA: Quebrada La Fortuna, Cerro Guanacaure MUA, 15 km ESE Choluteca (13.259949ºN, 87.068716ºW), 350 m elev. 7 January and 4 June 2006. Mason Ryan and Walther Monge. Verified by Jay Savage. UNAH 5152, UNAH 5156, SDSNH 72860–72861. First records for the department of Choluteca, with the closest localities occurring in the departments of El Paraiso, Honduras (McCranie 2007) and Nueva Segovia, Nicaragua (Köhler 2001). One non-vouchered specimen from the same locality was sacrificed to test for the fungus, *Batrachochytrium dendrobatidis*, and the result was negative. All frogs were found among rocks and leaf

litter along a riparian habitat.

Incilius coccifer (Southern Roundgland Toad). VALLE: Isla del Tigre: La Laguna, ca. 1 km SSE Amapala (13.282400ºN, 87.654717ºW), 10 m elev. 14 June 2006. Robert Lovich. UNAH 5235. First record for Isla del Tigre, with the closest records occurring on the mainland in the departments of Valle and Choluteca (McCranie 2006), and in the neighboring departments of La Unión, El Salvador (Köhler et al. 2006) and Chinandega, Nicaragua (Köhler 2001, 2008). The frog was found at night along the shoreline of La Laguna.

Ptychohyla hypomykter (Rana Trepadora Común de Montaña). CHOLUTECA: Finca Jayacayan, Quebrada del Horno, Montaña La Botija MUA, 8 km SSW San Marcos de Colon (13.359615ºN, 86.832380°W), 1000 m elev. 9 January 2006. Mason Ryan. Verified by Jay Savage. UNAH 5155. First record for the department of Choluteca, with the closest recorded localities occurring in the neighboring departments of El Paraiso, Honduras (McCranie 2007), and Esteli, Nicaragua (Köhler 2001). The frog was found in riparian vegetation on a tree branch overhanging a stream.

Squamata – Lizards

Hemidactylus frenatus (Common House Gecko). CHOLUTECA: La Fortuna, Cerro Guanacaure MUA, 15 km ESE Choluteca (13.259949ºN, 87.068716ºW), 350 m elev. 3 January 2006. Thomas Akre, Robert Lovich, Antonio Robinson, Mason Ryan, and Norm Scott. SDSNH 72726; UNAH 5185–5186. First records for the department of Choluteca and confirm the presence of a population in Cerro Guanacaure MUA. While the species is reported as "widely introduced" on the Honduran mainland (McCranie et al. 2005, 2006), the nearest published records are from the department of Atlántida (Franklin 2000). Introduced to several locations in Central America (Köhler 2001, 2008), this species was first collected in Honduras in 1997, although its colonization since has been poorly documented (McCranie et al. 2006). The closest reported localities to our records are in the neighboring departments of La Libertad, El Salvador (Greenbaum 2002), and Chinandega, Nicaragua (Köhler 2001). All specimens were collected on buildings at night.

Sceloporus malachiticus (Lagartija Espinosa Verde). CHOLUTECA: Quebrada de la Florida, Montaña La Botija MUA, 11 km SSW of San Marcos de Colon (13.335833ºN, 86.840000ºW), 1263 m elev. 9 January 2006. Robert Lovich. SDSNH 72765. Quebrada del Horno, Montaña La Botija MUA, 8 km SSW San Marcos de Colon (13.359615ºN, 86.832380ºW), 1000 m elev. 9 June 2006. Thomas Akre. UNAH 5136. Las Moras, Montaña La Botija MUA, 9 km SSE San Marcos de Colon (13.356667ºN, 86.76000ºW), 1600 m elev. 10 January 2006. Walther Monge. UNAH 5125. First published records for the department of Choluteca (Köhler 2008, Wilson and McCranie 1998), with the closest known records being from the departments of Nueva Segovia, Nicaragua (Köhler 2001) and San Miguel, El Salvador (Köhler et al. 2006). The lizards were collected either on rock outcrops or logs exposed to sunlight in mixed deciduous forest.

Anolis cupreus (Anolí Común). CHOLUTECA: La Fortuna, Cerro Guanacaure MUA, 15 km ESE Choluteca (13.259949ºN, 87.068716ºW), 350 m elev. 3, 4, 6 January and 4, 6 June 2006. Sofia Nuñez. SDSNH 72729–72732, 72734, 72737–72739, 72741, 72743–72750, UNAH 5089–5091, 5093–5099, 5103–5110, 5111–5112. Cima de Cerro Guanacaure, Cerro Guanacaure MUA, 15 km SE Choluteca (13.243533ºN, 87.064450ºW), 950 m elev. 4 June 2006. Sofia Nuñez. SDSNH 72735. Tres Pilas, Montaña La Botija MUA, 5 km SE El Jocote (13.307568ºN, 86.766220ºW), 1160 m elev. 12 January 2006. Sofia Nuñez. SDSNH 72736; UNAH 5092). First published records for the department of Choluteca (Köhler 2001, 2008; Wilson and McCranie 1998), with the closest published localities being from the department of Chinandega, Nicaragua (Köhler 2001, 2008). Lizards were collected from shrub and tree branches in tropical deciduous forest no more than 2 m off the ground.

Ameiva undulata (Rainbow Ameiva). CHOLUTECA: La Fortuna, Cerro Guanacaure MUA, 15 km ESE Choluteca (13.259949ºN, 87.068716ºW), 350 m elev. 5 January and 6 June 2006. Sofia Nuñez. UNAH 5168, 5171, 5179, 5183, 5189; SDSNH 72692, 72697. Cima de Cerro Guanacaure, Cerro Guanacaure MUA, 15 km SE Choluteca (13.243533ºN, 87.064450ºW), 750–900 m elev. 4 January 2006. Sofia Nuñez. SDSNH 72693, 72696, SDSNH. Finca Guayabol, Cerro Guanacaure MUA, 16 km ESE Choluteca (13.253788ºN, 87.056948ºW), 590 m elev. 3 January 2006. Sofia Nuñez. UNAH 5180. La Isnaya, Montaña La Botija MUA, 0.5 km SSE Santa Rita (13.362283ºN, 86.732517ºW), 1140 m elev. 11 January and 11 June 2006. Robert Lovich. UNAH 5160, 5177; SDSNH 72695. La Pacaya, Montaña La Botija MUA, 5 km SW San Marcos de Colon (13.399552ºN, 86.834444ºW), 1000 m elev. 11 January 2006. Robert Lovich. SDSNH 72694. First published records for the department of Choluteca (Köhler 2001, 2008; Wilson and McCranie 1998). The closest known localities for this species are in neighboring departments of Chinandega, Nicaragua (Köhler 2001) and La Unión, El Salvador (Köhler et al. 2006). Specimens were collected among leaf litter and ground vegetation in disturbed tropical deciduous forest.

Squamata – Snakes

Lampropeltis triangulum (Milksnake). CHOLUTECA: Tres Piedras, Hwy 3, 7 km WNW of Nicaragua (13.086389ºN, 87.009444ºW), 70 m elev. 26 November 2005. Thomas Akre. LACM PC 1448. San Marcos de Colón (13.428889ºN, 86.804722ºW), 1000 m elev. 13 June 2006. Robert Lovich. UNAH 5044. First records for the department of Choluteca, with UNAH 5044 confirming the presence of the species in the newly declared Montaña La Botija MUA. Nearest published records are from the departments of Francisco Morazán, Honduras (Wilson and Meyer 1985), Jinotega and Matagalpa, Nicaragua (Köhler 2001), and San Miguel, El Salvador (Köhler et al. 2006). LACM PC 1448 was found on a road in disturbed tropical deciduous forest and UNAH 5044 was found in an urban setting.

Ninia sebae (Red-backed Coffee Snake). CHOLUTECA: Quebrada de la Florida, Montaña La Botija MUA, 11 km SSW San Marcos de Colon (13.337639ºN, 86.844611ºW), 1250 m elev. 9 January 2006. Thomas Akre and Norman Scott. SDSNH 72801; UNAH 5278. Las Moras, Montaña La Botija MUA, 9 km SSE San Marcos de Colon (13.356667ºN, 86.76000ºW), 1600 m elev. 10 June 2006. Sofia Nuñez. UNAH 5280. First records for the department of Choluteca, with the nearest published localities being from

the departments of Francisco Morazán and El Paraiso, Honduras (Wilson and Meyer 1985), Jinotega and Matagalpa, Nicaragua (Köhler 2001), and Morazán, El Salvador (Köhler et al. 2006). The specimens from Quebrada de la Florida were found under rocks in riparian habitats, whereas the Las Moras snake was beneath a rock near a cattle pond surrounded by disturbed cloud forest.

Oxybelis aeneus (Brown Vinesnake). VALLE: Playa Negra, 4 km S of Amapala, Isla del Tigre (13.251892ºN, 87.649656ºW), 25 m elev. 15 June 2006. Robert Lovich. UNAH 5267. First published record for Isla del Tigre, with the closest record known from nearby Isla Zacata Grande, Valle (Wilson and Meyer 1985). Nearest records in neighboring countries are from the departments of Chinandega, Nicaragua (Köhler 2001), and Morazán, El Salvador (Köhler et al. 2006). The snake was caught during the day on a roadside tree branch in disturbed dry forest vegetation, ca. 1.5 m above the ground.

Oxybelis fulgidus (Green Vinesnake). CHOLUTECA: Tres Pilas, Montaña La Botija MUA, 5 km SE El Jocote (13.307568°N, 86.766220°W), 1160 m elev. Norman Scott. UNAH5265. First record for the department of Choluteca, and highest elevation reported within its entire range (Köhler 2001, 2008). This species is known from nearby departments of Francisco Morazán, Honduras (Wilson and Meyer 1985), Chinandega, Nicaragua (Köhler 2001), and San Miguel, El Salvador (Köhler et al. 2006). The snake was caught during the day on a tree branch in a riparian habitat surrounded by pine-oak forest.

Scolecophis atrocinctus (Ringed Centipede Snake). CHOLUTECA: La Isnaya, Montaña La Botija MUA, 0.5 km SSE Santa Rita (13.362283°N, 86.732517°W), 1140 m elev. 7 October 2003. Charles Mayer. Verified by Kent Beaman. LACM PC 1455. First record for the department of Choluteca and increases the known elevational range by ca. 440 m (Köhler 2001, 2008). This species is also known from the nearby departments of Francisco Morazán, Honduras (Wilson and Meyer 1985), Esteli, Nicaragua (Köhler 2001), and San Salvador, El Salvador (Köhler et al. 2006). The snake was photographed along a trail in a pine-oak forest.

Senticolis triaspis (Green Ratsnake). CHOLUTECA: Las Moras, Montaña La Botija MUA, 9 km SSE San Marcos de Colon (13.356667°N, 86.76000°W), 1600 m elev. 5 February 2005. Charles Mayer. Verified Kent Beaman. LACM PC 1454. First record for the department of Choluteca and highest elevation reported for its range in Central America (Köhler 2001, 2008). This species is also known from nearby departments of Francisco Morazán, Honduras (Wilson and Meyer 1985), Esteli, Nicaragua (Köhler 2001), and San Salvador, El Salvador (Köhler et al. 2006). The snake was photographed along a trail in a remnant cloud forest.

Spilotes pullatus (Tropical Treesnake). CHOLUTECA: La Isnaya, Montaña La Botija MUA, 0.5 km SSE Santa Rita (13.362283°N, 86.732517°W), 1140 m elev. 11 January 2006. Charles Mayer. Verified Kent Beaman. UNAH 5275. First record for the department of Choluteca, with the closest localities found in neighboring departments of Francisco Morazán and Paraiso, Honduras (Wilson and Meyer 1985). The species is known from the departments of Matagalpa, Nicaragua (Köhler 2001) and San Miguel, El Salvador (Köhler et al. 2006). The snake was found on a tree branch ca. 2 m above the ground in mixed oak woodland.

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New and Noteworthy County Records of Amphibians and Reptiles from Southeastern Washington State

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Despite several extensive surveys and a wealth of historical records chronicling the distribution of reptiles and amphibians in Washington (for review see McAllister 1995), there are still large gaps in the documentation of species occurring within the southeastern portion of the state. This region comprises some 8800 km^2 and includes Asotin, Columbia, Franklin, Garfield, and Whitman counties. Most records for species reported to occur in this area are nearly half a century old, with several over 70 years old (Metter 1960; Svihla and Svihla 1933). Given concerns over the documented decline of many amphibian species around the globe (Alford and Richards 1999; Beebee and Griffiths 2005), a current knowledge of species' distributions is of utmost importance for the implementation of conservation strategies. Indeed, the need for further surveys reconfirming the presence of species in this area of Washington State is warranted, as recent surveys have revealed several novel county records (Dornburg and Weaver 2007a, 2007b; Weaver and Dornburg 2007).

In this note we report several first county records, in addition to noteworthy distribution records for reptile and amphibian species in southeastern Washington State. The records reported here were collected during 2005–2007 and verified by Kelly M. Cassidy at the Conner Museum, Washington State University (CMWSU). Coordinates listed use NAD83/WGS84 datum recorded with a hand-held Garmin® geographic positioning system (GPS) unit. The nomenclature used follows Crother et al. (2008). All specimens or photo vouchers were deposited within the Herpetology Collection, Department of Biological Sciences, Central Washington University, Ellensburg Washington.

Anura – Frogs

Anaryxus boreas (Western Toad). Garfield Co., Almota-Ferry Road (46.6708833ºN, 117.5054ºW). Two individuals (CWU 1685 and 1686) were observed on this road on14 May 2007. These are the first verified reports of this species for this county in 50 years.

Spea intermontana (Great Basin Spadefoot). Asotin Co., Peola Grade Road (46.3852167°N, 117.112483ºW). Four specimens were found along this road during a precipitation event on 02 May 2007. (CWU 1670–1674) These specimens represent the first verified records reported for this county in 34 years. Columbia Co., Tucannon River Road (46.4820167ºN; 117.9348333ºW). A total of four specimens were collected on 26 June 2005. (CWU 1677–1681). An additional specimen (CWU 1682) was collected on 10 June 2007 along this road (46.4579833º N,117.81495ºW). These represent first county records. Garfield Co., State Route 127 (46.61255ºN, 117.7904833ºW). A single individual was observed (CWU 1687) on 18 April 2007. This is the first verified report of this species from this county in 50 years. Whitman Co., State Route 127. (46.6699333ºN, 117.8033833ºW). Two individuals (CWU 1688) were observed on 17 April 2007. These are the first verified reports of this species for this county in 56 years

Squamata – Lizards

Plestiodon skiltonianus (Western Skink). Asotin Co., Asotin Creek (46.3148333ºN, 117.25335ºW). A single individual was observed under a rock on 10 September 2007. (CWU 1699). This is the first verified report of this species from this county in 69 years. Franklin Co., Palouse Falls State Park (46.6531333ºN, 118.2246ºW). An adult female and male (CWU 1683 and 1684) were observed under the same rock along the Palouse River within the state park on 07 June 2007. These represent first county records. Whitman Co., Snake River Canyon (46.6338167ºN, 117 15.001ºW). Three individuals (CWU 1688–1691) were observed on 01 May 2007. These are the first verified reports for this county in 54 years.

Sceloporus occidentalis (Western Fence Lizard). COLUMBIA CO., Tucannon River Hatchery (46.003 ºN, 117.711111ºW). Several individuals (one collected, CWU 1676) were observed basking on rocks along the river's edge on 27 July 2006. These are the first verified reports of this species from this county in 54 years.

Squamata – Snakes

Charina bottae (Northern Rubber Boa). ASOTIN CO., Asotin Creek Road (46.3290833ºN, 117.1006667ºW). A specimen was collected (CWU 1695) dead-on-road on 21 July 2008. This is the first verified report of this species from this county in 88 years. COLUMBIA CO., Tucannon River Road (46.3412 ºN, 117.682ºW). A single individual was observed alive-on-road (CWU 1675) on 16 October 2007. This is the first verified report of this species from this county in 77 years.

Hypsiglena chlorophaea (Desert Nightsnake). ASOTIN CO., Asotin Creek Road (46.3007167ºN, 117.265333ºW). An adult female was collected (CWU 1696) alive-on-road on 07 September 2007. Two additional specimens were collected (CWU 1697–1698) on 10 September 2007 along this same stretch of road. These represent first county records.

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BOOK REVIEWS

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Extinction in Our Times: Global Amphibian Decline, by James P. Collins, J. P. and Martha L. Crump. 2009. Oxford University Press, New York (www.oup.com). Hardcover. 304 pp. US $29.95. ISBN 978–0–195316–94–0.

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The extinction and decline of amphibians is either approaching or it has already reached a precipitous wall. Authors Collins and Crump deliver an informative and accessible resource about global amphibian declines in their recently published book *Extinction in Our Times: Global Amphibian Decline*. This book is well-organized, well-researched, and presented in a format that can be read by naturalists, students, and scientists who are interested in the recent history of amphibian declines. Understanding the cause and nature of declines while navigating through the science, government, and civil society is critically important to those who want to address this great challenge.

The foreward written by Thomas Lovejoy highlights the most important aspects of the book in a few brief pages. His message is that the response to amphibian declines requires more than a science-as-usual approach. Addressing and understanding amphibian declines requires scientific teamwork, organizational learning, community involvement, educational programs, and socio-political engagement on biodiversity issues. This book covers these topics within the context of scientific studies that identify causes of global amphibian declines.

The book starts with an overview and introduction to biodiversity, conservation biology and key issues of amphibian decline. Collins and Crump adopt Noss and Cooperriders's (1994) definition for biodiversity, which includes and considers the evolving interactions, relations, and processes shared among genes, individuals, populations, and species. Adaptations and the sustaining functions of ecosystem services are supplied from all levels biodiversity.

Collins and Crump do not make clear the distinction between species extinction and population declines. The distinction is necessary so that conservation perspective and priorities address issues of decline to scale (Luck et al. 2003). The authors write that they will focus on and consider only the species level because it is "…easier, faster and cheaper (p. 1)." This assessment runs counter to the analysis by Naidoo et al. (2008) suggesting that species

targets as the conservation priority do not conserve optimal levels of global ecosystem services. Green (1997), Hugues et al. (1997), Molnar et al. (2004), and Wood and Gross (2008) also focus on and discuss the importance of conserving population levels of demographics and diversity. Contrary to the authors' statement that they will focus on the species level, examples of population decline are well described throughout the book. Collins and Crump even suggest, "…we need to monitor as many populations as possible (p. 45)." Researchers should not be monitoring population declines only to determine what species are threatened, but because population diversity holds the largest reservoir of ecological energy and biomass. Population levels of biodiversity are the main supplier of global ecosystem services (Luck et al. 2003).

Collins and Crump note that climate change, disease and pollution have reached beyond 'protected' boundaries of national parks and other 'pristine' areas, which was "historically the best way to ensure a species' survival (p. 88)." The 'historical' approach as based on species centered conservation and continues to be used as many conservation biologists seek to contain as many endangered species into protected and networked areas as possible for the least amount of cost (Kareiva and Marvier 2003; Molnar et al. 2004). Orchard (1999) also cites one of the significant dangers with the species conservation approach preventing researchers' eligibility for funding unless species are red-listed in their jurisdiction. Conservation efforts must shift the focus, effort and fund research on population declines (Molnar et al. 2004). Local populations are more familiar and meaningful to people than abstract species binomials for animals living in a far off place. "A more profound way to encourage public appreciation for wetlands and for the animals that live in them is to familiarize people with ponds, marshes, and lakes (p. 34)." Although there are few amphibian species in Canada, for example, the abundance of amphibian populations provides many places where conservationists can educate and communicate about the extinction process in a direct way (e.g., Green 1997). While Collins and Crump steer toward a species level approach, their book is a valuable resource for educators and conservationists living in places where there are few amphibian species.

Chapter 2 covers the history of organizational and institutional responses to amphibian declines since 1989. The history is informative and interesting to read with large amounts of personal insight into scientific meetings, organizations and government initiatives aimed at putting amphibian conservation plans into action. The third chapter reviews case examples by describing the behind-the-scenes work of researchers and organizations working together to face difficult challenges as they unravel the mystery and communicate on the nature of amphibian declines. Through their combined history, Collins and Crump have intimate knowledge and lots of personal anecdotes that bring to light some of the more interesting yet unpublished aspects of the research and response into amphibian declines.

Subsequent chapters use accessible language in reviewing scientific details that unravel the mystery behind the major threats and declines in amphibian populations around the globe. They book includes some surprising statistics on the economics of introduced amphibian species, amphibian commerce in the pet-trade, and amphibians for food and lab specimens. The authors relate this information back to conservation management and declines. Although it is mentioned on p. 197 that the Global Amphibian Assessment (2008) identifies habitat loss and degradation as the greatest threats by far, the treatment of this topic by the authors is disproportionately small. There is a small section on land use change, but less discussion on the magnitude of declines caused by habitat fragmentation (e.g., Eigenbrod et al. 2008; Green 1997; Puky 2005). The conservation and management of populations poses significant challenges in context of roads, forestry, and urban development. The conservation topics chosen by Collins and Crump, in context of declines, include agricultural contaminants (although not others such as road de-icing contaminants), UV radiation, and emerging infectious disease. For each topic they explain how each issue relates to or is the cause of developmental abnormalities such as extra limbs or missing eyes.

Batrachochytrium dendrobatidis (Bd) causing chytridiomycosis (aka. the chytrid fungus) is discussed in every chapter. Chapter seven is devoted solely to this topic with an extensive review about the spread, epidemiology, biology, and effects of the Chytrid fungus. This story is both interesting and holds great importance in relation to the issue of amphibian declines because the disease has caused rapid and massive die offs in Central America and has spread to many other populations world wide (Lips et al. 2009). The authors highlight that chytridiomycosis has a unique and previously misunderstood relation to extinction; they call this the hyperdisease hypothesis (p. 200). Chytridiomycosis is indeed exceptional. With the single exception of the American chestnut blight no other infectious disease has been linked with or known to cause extinction.

Chapters 8 and 9 review the evolving and sometimes tense relationship between the scientist, the conservationist and the institutions they share. They explore the complex moral implications and challenges in decision-making among conservation biologists with respect to the spread of chytrid disease. Do we translocate wild animals to zoos and holding facilities when extinction is predicted via the path of a chytrid epidemic? Once the chytrid has spread it is likely to stay in the environment. This means that repatriation, difficult under 'normal' circumstances (Dodd and Siegel 1991), is unlikely to succeed. The authors address and review these and other challenges in context of the unique circumstances that the amphibian extinction crisis poses for conservation biologists. While the book raises some insightful points, clearer advice is needed for animal care committees, colleagues, scientific panels, government and granting agencies who may not weigh in appropriately on the morals, ethics, and priority in dealing with amphibian conservation research proposals. The authors mention a new field of 'ecological ethics' that is being established to address these problems (p. 188). This area of research is needed to put ecological consequences versus the individual rights of an animal into context. The debate surrounding the use of toe clips for mark-recapture studies (Funk et al. 2005) is recent example highlighting the importance of guidelines for ecological ethics.

The final chapter reviews the story of amphibian declines in context of what has been learned. The end of the chapter summary provides a list of questions in need of answers. In context of the types of questions being asked, Collins and Crump wonder if the 'canary in the coal mine' metaphor aptly describes the sensitivity of amphibians by noting that, "by the time amphibians respond, environmental quality has already deteriorated (p. 203)." The utility or truth to this metaphor is also questioned by Pechmann and

Wilbur (1994) who find no evidence to substantiate the proposal that amphibians are more susceptible to contaminants through their unique life history or because of their permeable eggs, skin, and gills.

In contrast to the arguments against the metaphor it may serve as a message to say that humanity must pay attention to amphibian declines as coal miners paid attention to a dying canary. A dead canary mobilized miners in much the same way that the ACAP has called for an unprecedented response to the declines (Gascon et al. 2007). In this framework, the metaphor is meaningful and serves a conservation utility. Metaphors can have different meanings and utilities (MacCormac 1985). Climatologists, for example, cite the canary in the coalmine metaphor in context of the rapid retreat of glaciers and climate change (Erdman 2009). With respect to amphibian declines, the metaphor delivers a message that we are in the midst of the sixth major extinction and amphibians are the predominant global extinction risk group (Wake and Vredenburg 2008). Amphibian declines are alerting us that there is a problem for life on earth. The loss of amphibians and their habitats threatens the steady supply of ecological services sustaining humanity, just as the mine atmosphere sustains a miner. Despite their contention with the metaphor, Collins and Crump do not loose sight of the message that "amphibians are a cautionary tale alerting us (p. 203)" or that "amphibians are a warning and a glimpse of possible future events (p. 203)".

An alternate hypothesis stemming from the canary in coalmine metaphor suggests that amphibians serve as better sentinels, indicators, or a bellwether of environmental degradation and contamination compared to other organisms in a local context. This is the interpretation that Collins and Crump disagree with as they cite research suggesting that some amphibian species are not as sensitive an environmental indicator as other species. Moreover, as the scientific narrative in this book demonstrates, monitoring declines, deformities and causal stress factors is tough work that requires robust analytical and proven field methods to distinguish natural from abnormal fluctuations. Hence, amphibians may not serve as good indicators for monitoring the immediate local response often required in environmental assessments (e.g., Pearce and Venier 2009). As global indicators, however, amphibian declines are alerting humanity about a modern ecological process that is cataclysmic in magnitude (p. 203).

Extinction in our Times: Global Amphibian Decline is a highly recommended read for herpetologists, students of herpetology, conservation biologists, non-profit organizations, nature enthusiasts, and citizens who want to learn about the nature and response to the crisis. The message in the book is relevant, clear, and includes 28 pages of references and 23 pages of footnotes. The hardcover is affordably priced at US $29.95 with good binding and effective black and white images capturing details of amphibians in crisis situations. While enjoyable to read, this book is also an important addition to the literature of amphibian declines that highlights the moral imperative and action that is needed to address extinction in our times.

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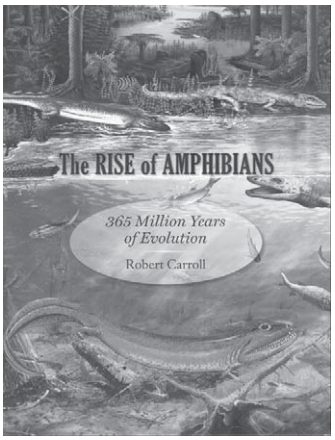
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The Rise of Amphibians, by Robert L. Carroll. 2009. John Hopkins University Press (www.press.jhu.edu). Hardcover. xii + 360 pp. US $65.00. ISBN 978-0-8018-9140-3.

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This book would have been better titled "The Rise of Limbed Vertebrates" because the taxa called "amphibians" in the book include genuine amphibians (the largest clade which includes lissamphibians but not amniotes), stem-tetrapods, and reptiliomorphs (amniotes included). It is abundantly illustrated, and the color plates are nice, but the illustrations are generally of low resolution and appear to have been treated as grayscale images, even though they are really line art. This results in an annoying diffusion dither pattern, especially visible around the scale bars and lettering of the figures.

The book is organized into fourteen chapters. The first chapter, on the history of earth and life, is nice and briefly covers topics from the Big Bang to the Cambrian explosion in biodiversity.

Chapter two, on "Advanced metazoans and the ancestry of vertebrates," which also covers the evolution of primitively aquatic vertebrates, is not as good. Some statements are not supported by recent works. For instance, it states (p. 29) that anaspids are "thought to be the ancestors of the modern lampreys," and that bone "is lost in the living jawless fish." Neither statement is supported by a phylogenetic analysis of early vertebrates (Janvier 1996a), which shows that hagfishes and lampreys are excluded from the smallest clade of vertebrates with a bony skeleton. Strangely, neither that paper, nor the most detailed, up-to-date review of early vertebrates (Janvier 1996b), are cited. The chondrichthyans are reported to be divided into two "categories," the sharks and the rays. Actually, the most fundamental division in chondrichthyans is between the holocephalans (chimaeras; not mentioned in the book) and the elasmobranchs, which include skates and rays (forming a clade), as well as "sharks," a paraphyletic group, since skates and rays are nested within it (this paraphyly is not mentioned in the book). The book also states that early osteichthyans had a paired swim bladder used to control buoyancy (p. 31), but the taxonomic distribution of the lung (a primarily respiratory structure) and of the swim bladder (primarily involved in buoyancy control) suggests that the lung is more primitive, since most sarcopterygians (dipnoans and tetrapods) and the basalmost actinopterygians (polypterids) have a lung, whereas the swim bladder is restricted to part of Actinopterygii (Laurin 2008a). Carroll's idiosyncratic view of phylogenetics peeks through in statements such as "These specializations of the feeding apparatus preclude lungfish from close affinities with terrestrial vertebrates." (p. 32), which will puzzle many readers. Similar statements are found in other chapters, about *Tiktaalik* (p. 44), *Ventastega* (p. 59) *Acherontiscus* (p. 107), *Ichthyostega* and *Acanthostega* (both on p. 151), amniotes and "lepospondyls" (p. 160), and some of them (e.g. for *Ventastega*) lead Carroll to suggest relationships that are not most parsimonious and are contradicted by the most recent phylogenies. Although Hennig (1966) clearly demonstrated that autapomorphies are phylogenetically uninformative (at least under parsimony) beyond demonstrating the monophyly of a taxon, Carroll states that autapomorphies can refute sister-group relationships (for instance, p. 212 on archegosaurids; pp. 262, 301 on aïstopods, adelogyrinids, and lysorophians), or that a taxon is sufficiently primitive to be a sister-group (p. 301, on "microsaurs"). Elsewhere (p. 160, ch. 5), Carroll uses widespread plesiomorphies to refute some relationships supported by synapomorphies (in this case, between "microsaurs" and lysorophians). Such statements presumably reflect Carroll's frequent confusion between sister-groups and ancestors, which surfaces in various sections of the book.

Chapter three provides a detailed description of the anatomy and evolution of the first limbed vertebrates and of their closest finned relatives. Some errors have crept in; for instance, figure 3.2 suggests that *Eusthenopteron* is more closely related to tetrapods than to *Panderichthys*, but this is contradicted both by the text and by conventional wisdom. The interpretation is sometimes naïve. For instance, the fact that *Tiktaalik* has been found in apparently freshwater deposits "indicates a major shift from marine to fresh water" (p. 41). In fact, sarcopterygians have frequently moved between both environments (Vermeij and Dudley 2000), and there is evidence of many marine limbed vertebrates (Laurin and Soler-Gijón 2006), including the barely more crownward Devonian *Tulerpeton* (Lebedev 1986), so this particular shift is unlikely to have been "major." This chapter includes a useful review of gene expression patterns in developing fin and limb buds, but it does not incorporate recent work on the basal actinopterygian *Polyodon*, which shows that many patterns previously considered unique to tetrapods are probably osteichthyan synapomorphies. Their loss in *Danio* is presumably an autapomorphy (possibly of a much larger group of teleosts) that may be associated with the loss of the metapterygial axis in teleost fins (Davis et al. 2007). There are also errors in the coverage of Devonian taxa. For instance, Carroll (p. 59) calls *Ventastega* an "unquestioned tetrapod," which is misleading given that digits are not preserved and that there is no guarantee that they were present (Laurin et al. 2000). The statement (p. 72) that "The retention of many primitive features of the skeleton confirms the position of *Ossinodus* near the base of tetrapods, and its divergence prior to the loss of the intertemporal bone and other derived features of *Ichthyostega* and *Acanthostega*" is contradicted by every phylogenetic analysis that has included *Ossinodus* (Warren and Turner 2004; Ruta and Coates 2007; Warren 2007).

Chapter four, on "the radiation of Carboniferous amphibians," includes detailed descriptions of early stegocephalians (limbed vertebrates) that constitute a strong point of the book. The taxa are presented in stratigraphic order, which does not always seem optimal, as when the earliest "microsaurs" are described on pages 107–117, and more recent ones on pages 128–130. Similarly, aïsto-

pods are described on pages 72, 97, and 130–141. The discussion of phylogenetic relationships is largely left to the next chapter, but many statements formulated in terms of ancestor-descendant relationships could have been replaced by statements of sister-group relationships (e.g., the statement on p. 141 that "No later amphibians are plausible descendants of this assemblage [aïstopods]").

The nomenclature is not formulated in phylogenetic terms either, or these terms have an idiosyncratic meaning. For instance, the statement (p. 91) that baphetids are "close to the base of the tetrapod stem" disregards the fact that this stem encompasses many finned sarcopterygians (all those that are closer to the limbed ones than to the dipnoans), such as *Eusthenopteron* and *Osteolepis*; Carroll actually means something like "along the tetrapod stem, close to the base of the clade of limbed vertebrates." Several statements suggest that Linnaean categories have an objective reality and that research can lead to "correct" rank assignments. One example (p. 141) mentions that for aïstopods, "as more has become known of these groups, it has become evident that there are no significant gaps allowing taxonomic distinction above the level of genera." Other examples can be found on pp. 91, 93, and 99. In fact, Linnaean categories are purely artificial and even undefined constructs required by rank-based nomenclature (Laurin 2008b).

More serious problems concern the lack of alternatives presented. For instance, the enigmatic *Westlothiana* is presented as a relative of amniotes (p. 102); there is no mention of the fact that the most comprehensive phylogenetic analyses suggest that it is either a stem-tetrapod (Laurin and Reisz 1999) or a basal "lepospondyl" (Ruta et al. 2003, Ruta and Coates 2007). Similarly, Carroll assumes that a tympanum was present in most temnospondyls, even those with a massive stapes such as *Balanerpeton* (p. 102) or *Dendrerpeton* (p. 117). The stapes of *Dendrerpeton* is even described as "reduced"(p. 262, ch. 10), but it is much more massive than its homologue in tetrapods with a tympanum (Laurin and Soler-Gijón 2006: fig. 7); and the presence of a tympanum in most temnospondyls is highly debatable (Laurin 1998a; Laurin and Soler-Gijón 2006).

Several functional interpretations are dubious. For instance, we read (p. 93) that the largely cartilaginous endoskeleton of *Crassigyrinus* "would have increased buoyancy in the water." Selective pressures to increase buoyancy are unlikely to have resulted in decreased ossification in an animal that presumably seldom came to the surface, and in which air in the lungs would instead created selective pressure to increase ossification to create a ballast, as we see in several aquatic tetrapods (Kriloff et al. 2008). The explanation is more likely to reside in the lower metabolic cost of producing and maintaining cartilage than bone.

Chapter five, on "adaptation, radiation, and relationships", opens with a long, unnecessary discussion of gaps in the fossil record that fails to consider that Hennig developed cladistics as a way of inferring phylogeny even with a scanty (or absent) fossil record. It also makes the usual mistake of considering that cladistics assumes evolution to be parsimonious (p. 146), rather than just representing a way to choose between alternative hypotheses; in that respect, parsimony in the most general sense is part of the scientific method itself.

The chapter then presents several stegocephalian phylogenies in figure 5.1, but lissamphibians were pruned from most of them. Only Carroll's (2007: fig. 77) phylogeny (reproduced in the book as figure 5.1D) includes lissamphibians. This is a poor choice, given that it shows temnospondyls (represented by "basal temnospondyls", Branchiosauridae and Amphibamidae) as the stem-group of a clade encompassing lissamphibians, "lepospondyls", and even amniotes. Even Carroll did not seem to accept this topology, since he presented another, less parsimonious, tree (Carroll 2007: fig. 78) in which temnospondyls form the stem of batrachians (anurans and urodeles) only. Fortunately, another figure (5.3) shows a stegocephalian phylogeny with lissamphibians, although Ruta et al. (2003) was used as the source, rather than the more recent tree derived from the expanded dataset of Ruta and Coates (2007). Even that tree was perhaps not the best choice, given that two recent doctoral theses (Pawley 2006, Germain 2008) contain reevaluations of its supporting matrix and have reached drastically different conclusions, with a monophyletic origin of lissampibians among "lepospondyls" rather than among temnospondyls (Marjanović and Laurin 2009).

Most of the text that discusses these phylogenies (pp. 146–147) is either plainly wrong or difficult to understand. For instance, we read (p. 147) that "A number of taxa at the base, including *Eusthenopteron* and other osteolepiform fish, *Acanthostega* and/or *Ichthyostega*, whatcheerids, *Crassigyrinus*, and baphetids appear as a series of separate lineages, without indication of the specific relationships between one another." This suggests a large basal polytomy, but that is not what the phylogenies show; instead, we simply have highly asymmetrical trees showing several sister-groups of crown-tetrapods. Even more misleading is the statement (p. 147) that "the cladograms of both Laurin and Reisz (1997) and Ruta et al. [2003] were concerned with the interrelationships of the modern amphibian orders, and yet were based on very few characters of these groups and so were unable to resolve their specific affinities with any of the Paleozoic taxa." In fact, both studies were based on numerous parsimony-informative characters (154 and 308, respectively), and both provided well-resolved and robust (though mutually incompatible) phylogenies showing a monophyletic origin of Lissamphibia either among "lepospondyls" (Laurin and Reisz 1997) or among temnospondyls (Ruta et al. 2003). Similarly misleading statements are made (p. 147) about the phylogenies presented by Clack (2002) and Ahlberg and Clack (1998). Chapter five is best ignored.

Chapter six on "the zenith of amphibian diversity" thoroughly describes the Permian diversity of stegocephalians. As elsewhere in the book, the interpretations do not always represent all plausible alternatives. For instance, it mentions (p. 163) "freshwater sharks" being associated with various stegocephalians. Probably this refers to xenacanthids, but Schultze and Soler-Gijón (2004) showed that at least some xenacanthids were able to live in saltwater. Similarly, we read (p. 185) that "Nearly all branchiosaurid species are represented by gilled larvae, but almost none are known from terrestrial adults. This implies that most were neotenic, spending their entire life in the water." Another equally plausible alternative is that the adults lived in another, more terrestrial, environment and were not preserved for that reason.

Chapter seven on amniotes does not present a phylogeny. The only amniote phylogeny is presented on page 3, and is an old-fashioned "bubble diagram" in which the width reflects the number of families. Such use of taxa of higher ranks as proxies of biodiversity has been strongly criticized because taxa of

a given rank fail to share any objective properties (Bertrand et al. 2006; Laurin 2008b). This amniote phylogeny contains more artificial – paraphyletic – groups than clades. The former include mammal-like reptiles (non-mammalian synapsids), reptiles other than archosauromorphs (apparently lepidosaurs, turtles, and various unspecified extinct taxa), and archosauromorphs (normally a clade, but here redelimited to exclude birds). In fact, paraphyletic taxa are enthusiastically used throughout the book.

Instead of a phylogeny, chapter seven presents a list of amniote characters sorted into autapomorphies, synapomorphies with other (unspecified) taxa, and primitive characters. The criteria for these polarizations are not given, although they appear to assume Carroll's preferred phylogeny. For instance, the absence of an intertemporal, of labyrinthine infolding, of palatal fangs, of lateral-line canal grooves, and of an otic notch, which are synapomorphies of crown-tetrapods under some phylogenies (e.g. Vallin and Laurin 2004; Pawley 2006: 386, 393–394), are thus interpreted as autapomorphies of Amniota, which is misleading. Carroll (p. 196) also suggests that "Of the Paleozoic tetrapods, only anthracosaurs are plausible sister-taxa of amniotes, but this affiliation may lie at the level of *Tulerpeton*, which indicates a very long ghost lineage…" In fact, this hypothesis has never been supported by a single published data matrix. Recent analyses (e.g. Ruta et al. 2003; Vallin and Laurin 2004) clearly show that diadectomorphs are the sister-group of amniotes, and that "lepospondyls" are the next sister-group of amniotes.

Carroll's scenario on the origin of the amniotic egg, originally proposed in 1970, is presented, but there is no mention that the only quantitative, statistical test of that hypothesis confirmed only one of its three predictions about body size evolution (Laurin 2004). Similarly, the possible taphonomic explanation for the small size of the earliest amniotes (preserved in tree trunks, which may have introduced a size filter) is not evoked.

Chapter eight on stereospondyls starts with an interesting review of extinction events, especially the end-Permian event. It also reviews recent phylogenies on this large clade of temnospondyls and scenarios about its origin.

Chapter nine on "The enigma of modern amphibian origins" is mostly phylogenetic and contains several misleading statements. For instance, Carroll (p. 229) states that herpetologists think that extant amphibians form the clade Lissamphibia, but that "Paleontologists… have suggested that they may have evolved from two or three separate groups of ancestral amphibians." This is a false dichotomy because many paleontologists consider lissamphibians to form a clade that excludes all known Paleozoic vertebrates. Carroll then erroneously states (p. 231) about the matrices presented by Laurin and Reisz (1997) and Ruta et al. (2003) that "none of the many unique derived features that distinguish each of the three groups of living amphibians from one another were included in these databases." Both matrices included such characters; for instance, characters 33 and 34 of the matrix of Laurin and Reisz (1997) are autapomorphies of Gymnophiona (maxilla palatal shelf and tentacular foramen). Carroll adds (p. 232) that "Even if it were true that frogs, salamanders, and caecilians had an immediate common ancestry from a single antecedent stock, there would still be many problems of determining how and when the key characters of the living orders had evolved and what was the nature of the immediate common ancestor. Neither of these questions is even considered in the analyses of Laurin and Reisz or Ruta and his colleagues." This is misleading because Laurin and Reisz (1997) focused on amniote origins, so lissamphibians were not extensively discussed, but a revised and expanded version of the matrix was presented by Laurin (1998a, b), and the two questions raised by Carroll were discussed there. Carroll states (p. 234) that "If the prior applications of PAUP have failed to resolve the specific patterns of interrelationships among the modern amphibian orders or to find their plausible ancestry among one or more Paleozoic lineages, what other means of analysis might be followed?" In fact, applications of PAUP have not failed; they have only failed to support Carroll's hypotheses.

Fortunately, chapter nine provides anatomical and functional data on lissamphibians (about breathing, prey capture, and locomotion, among others), which makes the non-phylogenetic parts of this chapter worth reading. These do not enable the reader to understand lissamphibian origins, but they are interesting in their own right.

Chapter ten reviews "The ancestry of frogs." It is framed in the age-old search for ancestors. Of course, the possibility that lissampibians are monophyletic is not evoked in that context. An extensive list of nested synapomorphies assumes that anurans (alone) originated among amphibamid temnospondyls. This is inconsistent with the hypothesis of urodele origins among branchiosaurid temnospondyls, which are nested among amphibamids (Fröbisch and Schoch 2009). But the descriptive parts of the chapter are useful.

Chapter eleven, on "The ancestry of salamanders," describes several Jurassic and Cretaceous urodeles. Carroll states that (p. 280) "In fact, it is the larvae that provide much of the data that enable us to trace the ancestry of salamanders into the Paleozoic." In light of this assertion, the simplistic interpretations of such data are surprising. For instance, Carroll opposes the "gradual" pattern of ossification in branchiosaurs with the "complete ossification of the skull at a very small size" in other stegocephalians and "as far back as *Eusthenopteron*." Yet, on the same page, he mentions that "In nearly all branchiosaurs that had been described previously, the smallest preserved specimens had already ossified nearly all the dermal bones of the skull." On the next page, he adds "At present, no branchiosaurids other than those of the genus *Apateon* clearly show the protracted sequence of ossification of the dermal skull." From all this, he concludes that "the capacity of branchiosaurs to ossify the dermal bones of the skull in a slow, sequential manner evolved only later, between the Westphalian D and near the end of the Carboniferous." Is it not much more likely that poorly ossified, weakly mineralized, tiny larvae have a low preservation potential and that they are thus generally not known? Hence, the absence of well-documented cranial ossification sequences in "lepospondyls" is almost certainly a taphonomic artifact. Developmental biologists usually consider that simultaneity in developmental events simply reflects lack of temporal resolution reflecting limitations in data, rather than true simultaneity (Bininda-Emonds et al. 2003: 341).

Chapters twelve covers "*Eocaecilia* and the origin of caecilians". For lack of space, the specific strengths and weaknesses of this chapter will not be discussed; they are similar to those of the other sections of the book. Chapter thirteen, "the success of modern amphibians", covers the fossil record of lissamphibians and their phylogeny. Chapter fourteen, "the future of amphibians," surveys

their fate in extinction events, especially in the current one cause by anthropic effects. These last two chapters are among the best in the book.

The bibliography is highly selective. For instance, Carroll cites Zhang et al. (2005), the first paper that provides molecular dating of the origin of Lissamphibia, Lee and Anderson (2006), a commentary, and other recent studies (San Mauro et al. 2005; Roelants et al. 2007). All these papers concluded an Early Carboniferous or Late Devonian origin of Lissamphibia, which is, as Carroll states (pp. 304–305), consistent with a polyphyletic origin of Lissamphibia. Yet, these ancient ages of Lissamphibia have been shown to reflect a suboptimal choice of dating constraints (Marjanović and Laurin 2007), and three dating techniques with very different assumptions point to a Permian origin (Marjanović and Laurin 2008), which is clearly incompatible with the polyphyly hypothesis. Molecular dating performed in another lab (Hugall et al. 2007: table 3) also concluded to a Late Carboniferous to Early Permian origin of Lissamphibia – even though no calibration points lay inside that clade, which is expected to lead to overestimation of all dates for nodes in it (Brochu 2004a, b; Marjanović and Laurin 2007), as Hugall et al. (2007:558) noted themselves. Omission of these papers from the bibliography will give readers the erroneous impression that molecular data unequivocally supports an Early Carboniferous origin of Lissamphibia and hence its polyphyly.

Similarly, Carroll cites Schoch and Carroll (2003), who concluded that developmental similarities between branchiosaurs and urodeles suggested an origin of the latter among the former, but he cites neither Schoch (2006), who showed that these similarities are primitive, nor Germain and Laurin (2009), who showed that these similarities are far fewer than initially proposed (although the second paper may have been published too late to be discussed in the book).

To sum up, this book contains much useful anatomical information, and is abundantly illustrated. It thus constitutes a valuable factual account of anatomical diversity of early stegocephalians. However, the large-scale phylogenetic interpretations, especially those concerning the origin of lissamphibians, are best ignored. The book also indulges in extensive story-telling which is, fortunately, not representative of modern paleontological thought. For more objective and rigorous assessments of early stegocephalian evolution and the origin of extant amphibians, the readers should consult some recent reviews (e.g. Anderson 2008; Coates et al. 2008; Marjanović and Laurin 2009).

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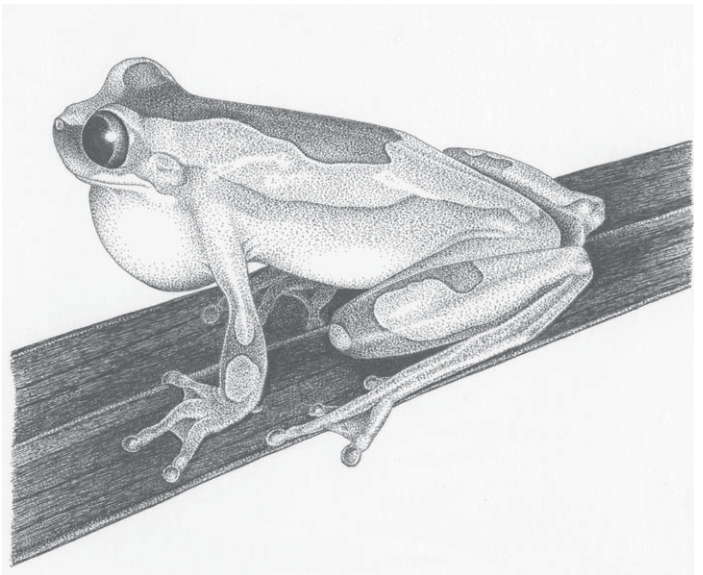
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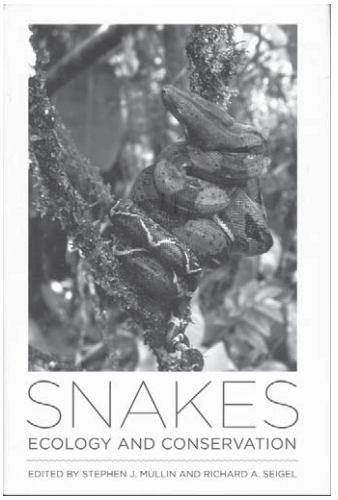


Dendropsophus ebraccata (Hourglass Treefrog), Belize. Illustration by Peter Stafford.

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Snakes: Ecology and Conservation, edited by Stephen J. Mullin and Richard A. Seigel. 2009. Cornell University Press (www.cornellpress.cornell.edu). xiv + 365 pp. Hardcover. US $60.00. ISBN 978-0801445651.

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There are many books about snakes. Just a few examples: a decade ago, Greene (1997) published one, illustrated with stunning photos by the Fogdens; half a decade earlier, Seigel and Collins (1993) informed "herpetologists, biologists, and others" about snake ecology and behavior; and half a decade earlier yet, Seigel et al. (1987) focused on the ecology and evolution of snakes. Do we need yet another one?

Early in their Introduction, Mullin and Seigel point out that habitat loss, caused by the seemingly endless increase in the human population and coupled with escalating technological abilities and standards of living, is causing the declines of many organisms. A decade ago, Gibbons et al. (2000) pointed out that in the rush to focus on declining amphibians – certainly a real and pressing problem – the roughly equal declines in reptile populations are mostly being ignored. Although a number of the snake books that have appeared since then include a conservation component—the attractive contribution from Henderson and Powell (2007) has seven conservation-related papers, for example, and both previous "snake" books (Seigel et al. 1987; Seigel and Collins 1993) had a chapter on the subject—none have *focused* on this important topic. Of the eleven numbered chapters in the current volume, seven include the word "conservation" in their title and all at least touch on the topic. Each chapter also contains a short "future directions" section identifying areas requiring additional attention.

The first half of the book (Chapters 1–4, pages 5–148) is methodological in nature. Whole books have been written about the material covered in these chapters. The extensive coverage provides for an excellent starting place for anyone designing a new snake study, but for details, especially of complex software packages or procedures, one will probably need to proceed to more specialized literature once an approach is chosen. Many advances have occurred since research methods were reviewed by Fitch in the first "snake" book (Seigel et al. 1987), and Chapter 1 starts with those but quickly goes beyond them. There is more overlap with the recent contribution by Ferner (2007; strangely missing

from the reference section). Some of the newer or more complex methods covered here, such as occupancy modeling, are not covered by either previous publication, however. The second chapter is focused on using molecular techniques to infer the processes that determined current distribution. The authors cover sources of DNA, the methods for constructing trees, and—most important, and supported by several full-page illustrations—the biological significance of possible phylogenetic patterns. How phylogeography informs conservation decisions is also covered, although not in great detail; that task is taken over by Chapter 3, which focuses on population genetics. A long table—3.5 pages—detailing available microsatellite primers for snake species is likely to be a useful resource, though additional ones will doubtlessly be available before long. Tables listing studies and levels of intra-population (6 pages) and inter-population (3 pages) genetic variation will also be convenient references. The fourth chapter focuses on another new set of tools, habitat modeling. These have recently attracted much attention when they were carefully applied to predicting the potential final distribution of large constrictors that have invaded and are expanding their ranges and impacts in Florida (Rodda et al. 2008). The chapter touches not only on the models and their data requirements, but also on conservation applications. Unfortunately, it does not provide advice on how to respond to hysterical complaints from readers who do not like model outputs.

The second half of the text (Chapters 5–10, pages 149–280) offers reviews. The question of how behavioral data can be incorporated into conservation decisions is addressed in Chapter 5, which is arranged by study area (e.g., "invasive prey and predators"). Chapter 6 focuses on reproductive biology and its conservation implications—arguing that habitat protection, for a variety of reasons, simply isn't enough and an understanding of reproductive processes is essential for long term population viability. Captive rearing, and what to do with the individuals produced, are covered in Chapter 7, which provides a useful review of snake translocation projects—few of them successful, unfortunately. Chapter 8 addresses a complaint made by Dodd in the second "snake" book (Seigel and Collins 1993): that the efficacy of habitat manipulation tools such as creation of corridors has not been carefully assessed. A five-page table summarizing existing studies suggests very mixed impacts on snakes, and many other studies that do not provide conclusive results. Managers, who often rush to act without ensuring funding for long-term assessment of impacts, need to hear the authors' recommendation: "Until the safety and effectiveness of habitat manipulation is firmly established … [such] projects should be monitored experimentally." The authors of Chapter 9 take an unusual tack: instead of always being on the defensive, given the bad name snakes generally have in the general public and among managers, why not show that they are useful? In this case, they are suggesting snakes can act as indicators of environmental health—a term that is often poorly defined. They explore how snakes could be appropriate in monitoring for chemical contamination, for example, but point out that such use "by resource managers has been almost nonexistent." Chapter 10, which focuses on the widespread fear of snakes in many cultures, may both explain why this has been the case and suggest that it is not likely to change any time soon. The authors point out that familiarity breeds tolerance and focus on education as the only possible solution.

In the final chapter, the editors sum up where we are and consider where the future might lead. The chapter is divided into several sections, some of which summarize previous chapters and many that do not. Some of these are important for scientists with an interest in conservation to consider if they have not done so before. Two important examples: we need to acknowledge that some measure of uncertainty will remain no matter how much research we do, so we need to become better at learning when to feel secure enough to make recommendations for management; and we need to learn to better communicate these recommendations to managers. Among the priorities they identify for future work: add studies of processes, rather than individual species; examine the impacts of roads; better integrate molecular tools; and rely more on experimental, rather than correlational, inference. The summary is followed by over 60 pages of references, ranging from the 1500s to 2008, a five-page taxonomic index, and a shorter subject index.

This is not a book for the general public, but managers and scientists, both beginning and well-established, will find something of value. Upper-level undergraduate and graduate students may particularly benefit from this book as they begin to conduct their first research projects. Regardless, one topic we wished was covered is urban ecology. Conservation biologists have unfortunately long treated urban environments as worthless, something the extensive urban herpetology volume (Mitchell et al. 2008) shows to be untrue. Not only do urban settings offer the only growth industry in our field – as pointed out by the first line of the Introduction – but they also offer a great opportunity to educate a public increasingly disassociated from anything "natural." We feel this book may have also benefited from a chapter reviewing our current understanding of the natural histories of each major clade, and what conservation measures may be unique to these groups. The editors acknowledge the need for "research on a much broader array of snake taxa." Scolecophidians, for example, comprise around 10% of ophidian diversity yet are granted only three sentences in the entire book. These caveats aside, don't let the unassuming cover photo dissuade you from getting a copy of this book if you study or manage snakes—it belongs in your bookcase.

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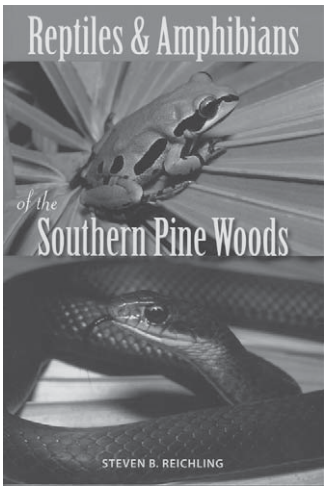
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Reptiles and Amphibians of the Southern Pine Woods, by Steven B. Reichling. 2008. University Press of Florida (www.upf.com). Softcover. xxi + 252 pp. US $29.95. ISBN 978-0-8130-3250-4.

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"I trekked through this landscape in a perpetual state of anticipation." Thus, the author describes his first foray into the southern pine woods. These words aptly describe my own first experiences as well – anxious to see a unique herpetofauna previously known to me only from books. I had the unique opportunity to explore the pine woods herpetofauna as a salaried biologist with a perspective on management. I was repeatedly told that the woods needed to be managed. Ecologists, foresters, naturalists … all knew how the forests functioned and were sure of the keys to managing them: 'lightning-caused fires are vital,' 'fires by indigenous people had to supplement lightning,' 'a high stocking rate keeps a closed canopy, thereby preventing hardwood succession,' 'herbicide must replace fire,' 'prescribed burns in winter…or in summer;' one-by-one they offered clues, often conflicting, about pine woods management. Thus, when I opened Reichling's book, I looked first for a chapter on managing the southern pine woods. There was none.

Instead, the book begins with two introductory chapters and ends with an epilogue. The remaining 200 pages contain species accounts of amphibians and reptiles that characterize the Pine Woods herpetofauna. Reichling begins the Introduction with a wise disclaimer that assembling a catalogue of species that are defined by an ecotype is subjective. He then presents his criterion for how he selected each species: they are restricted primarily to what was, or remains of, woods dominated by four species of fire-resistant pines in the coastal plain from North Carolina to eastern Texas. Chapter One characterizes the Southern Pine Woods in terms of geography, stand structure, hydrology and other factors. The woods are subdivided into hydrologic series (flatwoods, ridge, savanna and rockland), and into areas of regional endemism (e.g., central Florida ridges, Apalachicola), each of which is further described in terms of the geographic and environmental factors that have produced and maintained each series. A section on pine plantations is included, and each of the categorized pine woods types is illustrated by a color photograph.

Chapter Two, "Observing amphibians and reptiles," begins with conflicting guidance. Reichling starts by encouraging the reader to seek out the pine woods herpetofauna, but follows with a plea that animals not be collected and a frightening paragraph on how destructive one's footfalls are to the fragile ecosystem of the litter layer—the basis for his next plea—to remain on established trails. The next paragraph describes the amount of hardcore, off-trail work needed to efficiently locate the pine woods herpetofauna: the logs to be rolled, the amount of ground to be covered, and the value of dumping tin sheets and cover boards about the landscape. The literal reader will be quite frustrated attempting to see a Pine Barrens Treefrog or Blue-tailed Mole Skink from the trail. "Locating suitable habitats" begins with a summary of state and federal sites that maintain natural pine stands, and follows with a summary of microhabitats and how some species of amphibians and reptiles use them. Absent from the list of state-owned pine lands are Louisiana's Wildlife Management Areas, including Sandy Hollow and Sicily Island Hills.

The species accounts are segregated into generalists, then flatwoods, savanna, ridge and rockland specialists, and finish with an "other" category of species not restricted to pine woods, but often found therein. Each species account begins with a topical essay—one that is pertinent to that species but also covers a broader concept such as cooperative agreements, land development, scientific discovery, field techniques, biogeography, captive management, invasive species, etc. A morphological description follows the introductory essay, always very detailed, including descriptions of larvae for amphibians. All but two of the 38 taxa are illustrated by a color photograph, and many are accompanied by specific habitat photographs as well.

Distribution Notes discusses the historic range, which is compared to recent records of occurrence. A map is associated with this section (except for the "other" species), which can be misleading if the reader has not read pages 6–7. The maps show existing pine woods enclaves currently inhabited by each species rather than the actual range of the species. Additional sections cover Habitat, Ecology and Natural History, and Conservation, and each account ends with a Summary. The habitat is described in terms of hydrologic series and dominant tree species, followed by microhabitat use by the animal. Aspects of natural history covered include feeding habits and reproduction, and there are frequent recurrences of microhabitat discussion.

For some taxa, Reichling discusses physiological adaptations and responses such as thermal preferences and dehydration rates. In these latter sections, he presents much information about the interactions of each species with their immediate environment. The essays are modestly referenced, and many of the details seem novel. At times, I wished I could put the book down, dash off to the local pine woods, and try some new search method suggested by Reichling.

Discussions under "Conservation" are inconsistent between species: for *Plethodon kisatchie* only habitat preferences are reiterated; for *Pantherophis slowinskii* I gather that forest cutovers and trash dumps are positive conservation measures; for *Terrapene carolina major* we learn how to properly keep them as pets. For other species, conservation is discussed in terms of threats, typically direct human take, timber harvest practices or land development.

Remedies must be inferred.

The ten species considered in the "other" pine woods species category receive only a page or two that serve to introduce the species, then discuss some aspect of its biology; e.g., *Sceloporus undulatus* inhabits sites where it can bask; the defensive behavior of *Masticophis* is detailed; *Lampropeltis elapsoides* thermoregulates under pine bark. I agree with the author about the subjectivity of the species he has assembled, but I believe it would have been reasonable to have included *Rana capito* and *Plestiodon inexpectatus* in this section. Literature references are scattered within the species accounts, and approximately 180 citations are included in the Bibliography.

Despite the upbeat first paragraphs, the overall tone of the book is one of lamentation: the problem is loss of the pinelands, the culprits are industry and development. In the epilogue, Reichling's pessimism is unbridled, and any hope of saving the pinelands seems almost futile. He notes that local objectives such as protecting the Trans-Mississippi sandhills tend to be ignored, as global environmental issues have achieved top priority with the media and public. He offers few solutions, and these only on the last few pages. Here and elsewhere in the book Reichling offers provocative opinions on issues with which some readers may disagree. For example, he and I differ on the utility of Endangered Species listing, but I commend his view that conservationists should learn forest economics. Overall, Reichling has masterfully mingled his topics within the entirety of the book, and these are covered in various formats throughout the text. I finally discovered that pine woods management is covered extensively in the book—you just have to read the entire thing: forest dynamics on page 23, plantation silviculture on page 58, soil disturbance on page 160, prescribed burning on page 234, etc.

My wish list for this book, some directed at the publisher, includes better photographic reproduction and more anecdotes. Many of the 100 color photos are too dark (e.g., plates 1.19, 3.4, 6.14). The paucity of personal stories leaves me wondering how many of these species Reichling has found afield, and makes his personal affection for the pine woods seem a little distant. A few instances of strict adherence to the metric system are awkward: "approximately 324 ha;" "storm surge was 61–122 cm" (stick with 2–4 feet).

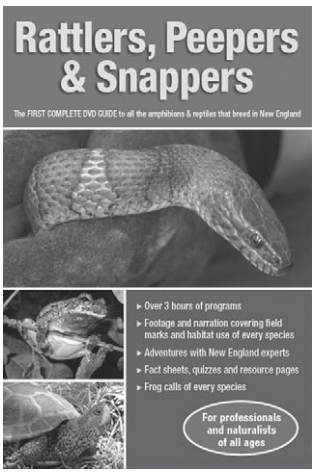
Reptiles and Amphibians of the Southern Pine Woods is less a textbook and more a story of the pinelands and their herpetofauna. After reading the book, I ventured into familiar pine woods with a revitalized spirit, with a modified perspective, as if a fresh set of eyes were pointing out things I had never realized, renewing in me the boundless enthusiasm that Reichling and I both experienced in our respective first trips to the pines.

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Rattlers, Peepers, and Snappers, produced by Vince Franke, Science Advisor Jim Andrews. 2008. Peregrine Productions (www.peregrineproductions.com or www.rpsdvd.com). DVD. US $24.95.

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Rattlers, Peepers, and Snappers represents the first complete DVD field guide to all of New England's breeding reptiles and amphibians, focusing on the general ecology, life history, and conservation concerns of each of the region's 52 species. This is presented in two main sections, which may be viewed as a whole or as individual "adventures" (chapters) covering amphibians and reptiles respectively. The program includes narrations from ten researchers and conservation specialists working with various New England species in addition to over an hour and a half of extra features not in the primary film segments.

The primary amphibian segment has a run time of 38 minutes and is partitioned into six chapters. These draw on the research and experiences of Jim Andrews (The Vermont Reptile and Amphibian Atlas), Tom Tyning (Berkshire Community College), Aram Calhoun (University of Maine), Rebecca Chalmers (Vermont Department of Conservation), and Sean Blomquist (University of Maine). It opens with a discussion of amphibian spring migrations and introduces the common theme of the DVD: how the complex ecology and natural history of these organisms is often at odds with anthropogenic factors. The program next takes the viewer from the topic of spring migrations to the impact of road crossing mortality on amphibian populations, giving a first hand account of the challenges these organisms face when moving between habitats. Habitats are discussed in more detail in the next three sections that in turn cover species most often associated with vernal pools, streams, or bodies of permanent water. The program ends with a chapter on wood frog responses to various degrees of deforestation around vernal pool breeding sites featuring the research of Sean Blomquist, a Ph.D. candidate at the University of Maine.

The primary reptile segment runs for 49 minutes across nine chapters hosted by Jim Andrews, Liz Willey (University of Massachusetts), Tom Tyning, Chuck Smith (University of Connecticut), Dave Paulson (University of Massachusetts), Steve Parren

(Vermont Wildlife Division of Non-Game), and naturalist Alcott Smith. This program follows a similar theme of depicting the delicate balance of reptilian life history and ecological needs with their current and future conservation concerns. It opens with Jim Andrews guiding a field group through several continuous habitats to find multiple species of native snake and New England's only lizard species, the five-lined skink. The central themes are carried through the next sections on box turtle habitat use, the state of timber rattlesnake populations in New England, and cryptic suburban populations of wormsnakes. These sections are followed by a chapter focusing on habitat mitigation for racers in Vermont, demonstrating to the viewer that primary research can be incorporated into conservation use by non-wildlife state agencies. Chuck Smith's section on copperheads is next, followed by three sections covering fall migration, man-made turtle tunnels to prevent high levels of road mortality, and a concluding section on turtle nesting along the shores of the heavily developed Lake Champlain.

The DVD contains many additional features that enhance its educational value. Fact sheets for each species, including introduced species, highlight the conservation status of each of the species in the six individual New England states. These also contain an extra video discussing identification, natural history, and conservation concerns for each species. The video quizzes are designed for use in classroom settings and test the viewer's ability to visually identify several common species and frog calls. A chapter on taxonomy narrated by Jim Andrews explains that the taxonomy follows the Scientific and Standard English Names list published by SSAR (Crother 2008). Finally, a section entitled "what you can do," provides a downloadable pdf list of resources and suggested conservation projects that may give the viewer direction for further involvement.

Errors are minimal and include a typographical error on a quiz answer (e.g., Spadefott vs. Spadefoot), and editing errors such as video of an eastern gartersnake release during a section on ribbonsnakes. Additionally, the species list may be difficult to navigate if the viewer does not know the current common name, though the diversity of each species group is low making this a slight inconvenience at most. Overall these are very minor points and do not detract from the presentation of the material.

The section hosts give a human face and personality to each topic, allowing the viewer to witness wildlife professionals working with several northeastern species, many of which are declining. This is exemplified by the repeated appearance of Jim Andrews, whose presence provides not just visual continuity, but also a contagious, near-childlike enthusiasm for these animals that is coupled with an appreciation for the various habitats in which they reside. He manages to avoid alienating the viewers with subjects as potentially off putting as road kill (in which he stacks crispy snake and frog wafers he found while walking along a small stretch of road) or taxonomy where the presence of a Star Trek mug on the shelf behind his head further endears him to the viewers.

What may be the most complete DVD of amphibians and reptiles for any region in North America, *Rattlers, Peepers, and Snappers*, provides teachers, educators, and interested individuals with a resource from which to gain insights into the lives of these often misunderstood animals. Although most segments were filmed in Vermont, the overall messages apply to a broader stage and are most certainly applicable to the rest of the New England region if not larger sections of North America. The species fact sheets and included quizzes act as teaching aids and greatly enhance the potential value of the primary film segments for teachers and educators wanting a new way of engaging students' interests in local biodiversity. To conclude, the film segments are well thought out and clearly represent a labor of love. We highly recommend this DVD.

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Crother, B. I. (Committee Chair). 2008. Scientific and Standard English Names of Amphibians and Reptiles of North America Nnorth of Mexico, with Comments Regarding Confidence in Our Understanding, 6th ed. SSAR Herpetological Circular 37. Society for the Study of Amphibians and Reptiles, Shoreview, Minnesota. [4] + 84 pp.

PUBLICATIONS RECEIVED

The Fruit, the Tree, and the Serpent, Why We See So Well, by Lynne A. Isbell. 2009. Harvard University Press (www.hup.harvard.edu). Hardcover. xi + 207 pp. US $45.00. ISBN 978-0-674-03301.

This intriguingly titled book outlines the author's 'Snake Detection Theory' which attributes a significant role to snakes as a driving force in the evolution of primates. Constricting snakes are argued to have evolved roughly concomitantly with primates and to have played a role in the increased role of vision over olfaction in these mammals and in the evolution of larger brain size. More specifically, catarrhine primates, including anthropoid apes, are part of a lineage that evolved along with venomous snakes and developed the most sophisticated visual system and the largest brains of any primates (versus, for example, the smaller-brained, more olfactory lemurs of venomous snake-free Madagascar). The author links changes in diet and sensory modalities to brain size and an enhanced 'fear module' that are key elements in the evolutionary arms race between primates and their ophidian predators. The underlying neurological bases of the theory are outlined, testable predictions are presented, and the relationship between the theory and human fears and mythology are explored in this extensively referenced book. The book is accessible to a general readership and, although focused on the mammalian perspective, will be of equal interest to herpetologists concerned with the evolution of snakes.

Sex, Size and Gender Roles, Evolutionary Studies of Sexual Size Dimorphism, edited by Daphne J. Fairbairn, Wolf U. Blanckenhorn, and Tamás Székely. 2007. Oxford University Press (www.oup.com). ix + 266 pp. Softcover. US $60.00. ISBN 978-0-19-954558-2 [also available in hardback edition].

The 20 chapters in this volume are derived from a workshop on sexual size dimorphism (SSD) held in Switzerland in 2005. The book is divided into three main sections exploring macro-patterns, micro-patterns, and mechanisms. Five of the chapters are herpetological in focus. In the macro-pattern part are chapters dealing with amphibians (by Alexander Kupfer) and reptiles (by Robert Cox,

Marguerite Butler, and Henry John-Alder) in general. The former chapter examines ontogenetic patterns in dimorphism, whereas the latter explores phylogenetic and geographic trends in SSD and considers the roles of selection and constraint in the patterns observed. Studies by Evgeny Roitberg on variation in dimorphism in the widespread Palearctic lizard *Lacerta gailis* and by Lukáš Kratochvíl and Daniel Frynta on SSD in eublepharid geckos are more fine-scaled analytical investigations. Finally, at the mechanistic level, John-Alder and Cox consider the role of testosterone in influencing SSD through growth rates. Other chapters deal with birds, mammals, insects, spiders, and even plants. The book as a whole includes an extensive list of approximately 1000 references and a glossary of nearly 100 terms. The contributed chapters represent a spectrum of approaches to the topic of SSD and the book should be of particular value to herpetologists with interests in behavioral and evolutionary ecology, as well as physiology and endocrinology.

My Life in Natural History: An Autobiograph, by Walter J. Breckenridge. 2009. Bell Museum of Natural History, 10 Church St. SE, Minneapolis, Minnesota 55455. V + 178 pp., 44 pp. pls. Softcover. US $29.95. ISBN 978-1-885209-59-7.

This is the autobiography of Minnesota's greatest naturalist, Walter Breckenridge, who died in 2003 at the age of 100. His notes for the autobiography were transcribed and organized by his daughter, Barbara Breckenridge Franklin, and have been published by the Bell Museum, with which he was affiliated starting in 1926. Breckenridge's detailed reminiscences paint a detailed portrait of both his personal and professional life. His 300+ publications (1929–1999) are enumerated in an appendix compiled by John Moriarty. Although most of his work was ornithological, Breckenridge's interests were varied and he published 34 papers on amphibians and reptiles and is known to most herpetologists for his 1944 book *Reptiles and Amphibians of Minnesota*, based on his Ph.D. dissertation — a pioneering work for the upper Midwest. The text provides some anecdotes about this research, as well as later work on toads and softshell turtles. Although known for his studies in Minnesota, Breckenridge traveled widely in the U.S. and Canada as well as the Neotropics. Beginning as a taxidermist at the Bell Museum he rose to become director. Aside from his academic and administrative activities, he also lectured widely to the general public across America and was a talented natural history artist. Forty-four color plates illustrate 67 of Breckenridge's paintings (most ornithological, but including two reptiles). This inexpensive book will be of special interest to herpetologists with an historical bent and those working or living in Minnesota, Breckenridge's native Iowa, or elsewhere in Midwest.

Erratum

In the September 2009 issue (vol. 40, no. 3, page 367), the range extension note for *Storeria dekayi texana* by Streicher used the term "longitudinal gap," when it should have appeared as "latitudinal gap."



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The Society for the Study of Amphibians and Reptiles, the largest international herpetological society, is a not-for-profit organization established to advance research, conservation, and education concerning amphibians and reptiles. Founded in 1958, SSAR is widely recognized today as having the most diverse society-sponsored program of services and publications for herpetologists. Membership is open to anyone with an interest in herpetology—professionals and serious amateurs alike—who wish to join with us to advance the goals of the Society.

All members of the SSAR are entitled to vote by mail ballot for Society officers, which allows overseas members to participate in determining the Society's activities; also, many international members attend the annual meetings and serve on editorial boards and committees.

All members and institutions receive the Society's primary technical publication, the *Journal of Herpetology,* and its news-journal, *Herpetological Review*; both are published four times per year. Members also receive pre-publication discounts on other Society publications, which are advertised in *Herpetological Review*.

To join SSAR or to renew your membership, please visit the secure online Allen Press website via this link:

http://www.ssarherps.org/pages/membership.php

Future Annual Meetings

2010 — Providence, Rhode Island, 7–12 July (with ASIH, HL)
2011 — Minneapolis, Minnesota, dates TBA (with ASIH, HL)
2012 — Vancouver, British Columbia, dates TBA (with ASIH, HL, WCH)

About Our Cover: *Pseustes sulphureus*



Puffing Snakes or Birdsnakes, genus *Pseustes* (Wagler, 1824), comprise 2, 3, or 5 species depending upon the authority, and range collectively from Mexico through tropical America. The Giant Birdsnake, *Pseustes sulphureus*, with two subspecies, occurs on Trinidad, throughout the Amazon Basin, and in the Atlantic Coastal Plain of Brazil from the state of Ceará south to São Paulo. Reports of this species on Tobago are erroneous (Boos 2001. The Snakes of Trinidad and Tobago, Texas A & M Press). It is one of the largest New World colubrids (reaching at least 3,015 mm TL; Jorge da Silva 1993. Herpetological Natural History 1[1]:37–86). Although it lives in the understory and canopy of primary and transitional rainforests, the Giant Birdsnake also forages on the ground, where its prey includes nesting and hatchling tinamous, caprimulgids, nunbirds, eggs, and occasionally small mammals. When on the ground this snake and its congener *P. poecilonotus* often assume an odd position rigidly locked in an undulating pose.

A dramatic film on the internet features this species (misidentified as *Chironius fuscus*) raiding the nest of a Crimson-crested Woodpecker (*Campephilus melanoleucos*) while being attacked by the adults. Giant Birdsnakes, like many arboreal species, have a defensive display that is most effective when viewed laterally (Sajdak 2010 [*in press*], Hunters in the Trees: A Natural History of Arboreal Snakes. Kreiger Publ. Co.). The body is inflated from the eyes to about the level of the heart (Rossman and Williams 1966. Proc. Louisiana Acad. Sci. 29:150–156).

In the upper Amazon Basin, *P. sulphureus* is often observed in *várzea*, seasonally flooded forest. The margins (*restinga)* consist of alluvial soils supporting groundcover and a mixed canopy. The cover image, taken in this habitat, has an unusual history. An *Anolis transversalis* was being photographed 90 cm up a liana when the *Pseustes*, estimated at 3 m long, slowly wound its way down from the canopy. It advanced horizontally 2.3 m along the liana, pausing frequently. Upon reaching the camera the Birdsnake froze, practically touching the lens, and the exposure was made. Then it slowly retraced its path into the canopy. Such an encounter with any snake would be unusual, but the fact that this was an alert, visually oriented, diurnal species makes it unforgettable. The cover photograph was taken on the Shimbillo River, Loreto, Peru, by **William W. Lamar** using a Pentax LX 35mm SLR camera on tripod, a Pentax 20mm f/3.5 rectilinear lens set at the hyperfocal point and stopped down to f/22, with Fujichrome Velvia film pushed to ISO 100 at 8 seconds. Bill's experience in the Amazon and Orinoco Basins spans 35 years, and his efforts in northeastern Peru have produced nearly 400 species of amphibians and reptiles. Lamar is an Adjunct Professor of Biology at the University of Texas at Tyler. He is co-author with Jonathan A. Campbell of *The Venomous Reptiles of Latin America* and *The Venomous Reptiles of the Western Hemisphere*. He leads natural history tours for GreenTracks, Inc., **http://www.greentracks.com**. Recent travel has taken him to Chile, Amazonian Brazil and several islands in the tropical Pacific.

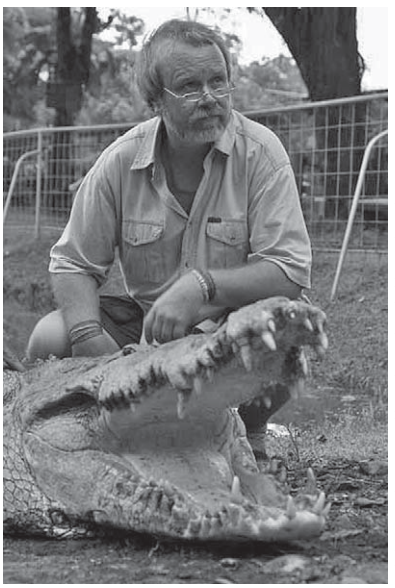


PHOTO BY ANDY SHILLABEER, COURTESY NATIONAL GEOGRAPHIC FILMS

SSAR BUSINESS

Seibert Award Winners for 2009 Announced

The 18th annual Seibert Awards were presented at the 52nd Annual Meeting of the SSAR in Portland, Oregon, 22–27 July 2009. These awards are named in honor of Henri C. Seibert, an early and tireless supporter of SSAR (having served as an officer for over 20 years). In recognition of outstanding student presentations at the annual meeting, a single award was given in each of the following categories: Evolution/Systematics (9 presentations), Ecology (12 presentations), Physiology/Morphology (6 presentations) and Conservation (8 presentations). All awardees will receive a check for US $200 and a book from Chuck Crumly at University of California Press.

The Winners.—Systematics/Evolution: Jamie Oaks, University of Kansas, "Objective partition choice and the phylogenetic systematics and biogeography of the true crocodiles." Ecology: John Willson, Brian Todd, and Christopher Winne, University of Georgia, Savannah River Ecology Lab, Virginia Polytechnic Institute and State University, "Trap-happiness, temporary emigration and other factors affecting detectability and population estimation in aquatic snakes." Physiology/Morphology: Victoria Arch, T. Ulmar Grafe, Marcos Gridi-Papp, and Peter Narins, University of California Los Angeles, University Brunei Darussalam, "An Old World frog communicates in pure ultrasound." Conservation: Kristine Kaiser, Menemsha Alloush, Robin M. Jones, Susanne Marczak, Katherine S. Marineau, Mark V. Oliva, and Peter M. Narins, University of California Los Angeles, "When sounds collide: effects of anthropogenic noise on frog calling behavior."

Honorable Mention.—Ecology: Javan Bauder, Holly Akenson, and Charles Peterson, Idaho State University, University of Idaho, "Over the hills and far away: movements of prairie rattlesnakes across a mountainous landscape in a designated wilderness." Conservation: Anna Savage, Cornell University, "Experimental infection with *Batrachochytrium dendrobatidis* demonstrates genetic resistance to chytridiomycosis in *Lithobates yavapiensis*."

The judges were Laine Giovanetto (New Jersey City University), Todd Jackman (Villanova University), Eric Juterbock (The Ohio State University), Jacqueline Litzgus (Laurentian University), Laura Mahrt (Eastern Oregon University), Patrick Owen (University of Cincinnati), Benjamin Pierce (Southwestern University), Robert Reed (USGS), and Emily Taylor (California Polytechnic State University).

2009 Annual Meeting, Portland, Oregon

The Annual Meeting of SSAR took place from 22–27 July, 2009 at the Hilton Portland and Executive Tower, Portland, Oregon. In attendance were members of SSAR, American Elasmobranch Society (AES), American Society of Ichthyologists and Herpetologists (ASIH), The Herpetologists' League, Early Life History Section, Herpetological Conservation and Biology, Society for Northwestern Vertebrate Biology, and Society for the History and Bibliography of Herpetology. The meeting was hosted by USGS Forest and Rangeland Ecosystem Science Center, Portland State University, United States Forest Service, Washington Department of Fish and Wildlife, Washington State University, and Oregon State University.

The local hosts were R. Bruce Bury, Stan Hillman, Carl J. Ferraris, Jr., Deanna Olson, Marc P. Hayes, Peter Ritson, Robert Kaplan, David J. Germano, Tara Chestnut, Gwendolynn W. Bury, Douglas F. Markle, Jason Podrabsky, Brad Buckley, David L.G. Noakes, Brian Sidlauskas, Selina S. Heppell, Scott A. Heppell, and M. Rockwell Parker. The efforts of the local hosts, staff of the Kansas State University Division of Continuing Education, and many student volunteers resulted in another great JMIH.

There were 1170 herpetologists and ichthyologists from around the world at the 2009 JMIH. This number was up substantially compared with that in the previous year. Approximately 42% of attendees were students, and around 700 papers and 300 posters were presented. Eleven symposia, including the very well-attended "Darwin at 200: A View from Ichthyology and Herpetology," and three student workshops were scheduled. One of these workshops ("How to Get a Job after Graduation: Advice from Experts," see below) was organized by Dawn Wilson and other members of the SSAR Graduate Student Participation Society. The Henri Seibert Competition attracted 37 students in four categories this year (a greater than 50% increase over numbers in 2008). Most participants were in the Ecology category.

The Annual Meeting began officially at 0830 h on Thursday, 23 July with a welcome from R. Bruce Bury. Bruce provided a history of Oregon and Oregonians and a quick tutorial on ordering local beers (an apparently very complicated process). This was necessary as, to the delight of some of our members, the JMIH coincided with the 22nd Annual Oregon Brewer's Festival, one of the nation's longest-running craft beer festivals.

Hartwell Welsh, from the US Forest Service, spoke on the NW herpetofauna and threats to its persistence, including disease, manipulation of water flow, introduced predators, forestry practices, and contaminants. Douglas Markle and David Noakes (Oregon State Univ. and Oregon Dept. of Fish) gave a presentation on the diversity of freshwater fish in Oregon. Particularly interesting were the presumed effects of colossal floods and spectacular volcanic activity. President of ASIH, John Lundberg, then introduced a number of individuals who presented awards. Rick Winterbottom presented the Gibbs Award to Leonard Compagno, Brian Crother presented Jay Savage with the Johnson Award for excellence in service, and Mo Donnelly presented Bruce Bury with the Fitch Award for long-term excellence in the study of amphibians and reptiles.

The ASIH Past-President's Address was given jointly by Henry Mushinsky and his long-time collaborator Earl McCoy. They spoke on "Science, Advocacy, and Race to Extinction: The Tortoise and the Skink." Julian Lee was introduced by David Cundall as the 2009 Herpetologists' League's Distinguished Herpetologist. Julian gave a presentation entitled "From Bloomington, Indiana to Balankanche, Yucatan: Reflections of a Naturalist in Tropical America." He asked the excellent question "why would anyone wish to be anything other than a herpetologist (or maybe an ichthyologist)" and then proceeded to trace his own interest in herpetology beginning with a 1954 article in *National Geographic* magazine "Our Snake Friends and Foes."

Kenneth Goldman was the AES plenary speaker ("AES Fit *Agentea*") and the plenary session was closed by Bruce Bury.

Social and Professional Events

Mo Donnelly (Florida International University) kicked off SSAR's participation in the 2009 JMIH with the President's Travelogue on the evening of 22 July. Despite competing with a social in the hotel lobby, all seats were occupied as Mo spoke about "How Herps Helped Me See the World: A Travelogue (Fig. 1). Who knew Mo was almost a dental hygenist? She acknowledged the many people who have influenced her career, including Bayard Brattstrom, Lon McClanahan, and Jay Savage, and spoke about her work at La Selva (Costa Rica) and throughout much of South America. Great slides, great story—exactly what a President's Travelogue should be!

On the evening of 23 July, SSAR combined with HL to host another very successful reception for student members of both societies and invited



FIG. 1. Mo Donnelly presented the President's Travelogue. (Photo M. Preest)

professionals. This was intended as an opportunity for the students to meet professionals in their field, to make useful contacts, and to encourage their participation and contributions. Thanks to those who generously donated door prizes (Fig. 2). The Joint Meeting Reception was held immediately after the Student Reception at Oaks Park and doubled as the Picnic this year. Barbeque was enjoyed by most, and carnival rides by some!

The Student Participation Committee held a student workshop "How to Get a Job after Graduation" and Pizza Lunch on 24 July. The workshop involved a panel of professional herpetologists in a variety of positions (large research institutions, small colleges, regional universities, zoological parks, research stations, museums, and governmental agencies) speaking

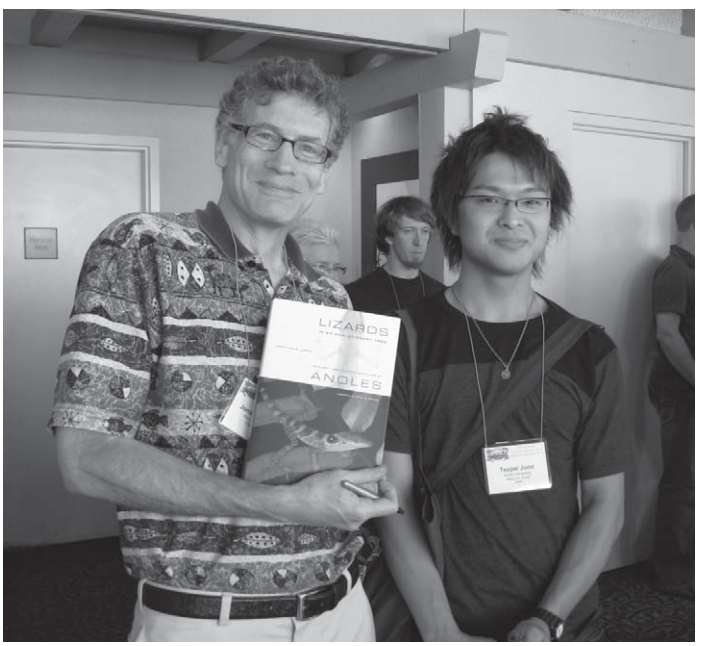


FIG. 2. Teppei Juno with Jonathan Losos, author of "Lizards in an Evolutionary Tree: Ecology and Adaptive Radiation of Anoles." A signed copy of Jonathan's book was the door prize won by Teppei at the Student Reception. (Photo M. Preest)



FIG. 3 Angela Marion, a very happy new owner of the "Leapin' Lizards" puzzle at the SSAR/HL Auction. (Photo M. Preest)

about their experiences getting jobs and serving on search committees and responding to questions from the students. The students completed a survey before they left the workshop. Their view of the workshop was uniformly favorable and they suggested some useful ideas for improvement and topics for future workshops.

The SSAR/HL Live Auction occurred on 26 July and raised $4048 to support graduate student travel (Fig. 3). Steve Werman and Robert Fisher were the auctioneers and were assisted ably by Stu Nielson, Perry (JR) Wood, Ed Stanley, Samantha Wisniewski, Ben Jellen, Lauren Adderly, and especially Greg Watkins-Colwell. Stan Hillman served as onsite coordinator before the meeting began.

Matt Venesky and Cari Hickerson (co-Chairs, Student Travel Award Committee) worked especially hard to pull together a successful Silent Auction ($612 raised). Matt and Cari have ideas to improve the visibility of this event for the 2010 meeting.

The Joint Meeting Banquet was held on the last evening of the meeting, and Larry Allen served as Master of Ceremonies. SSAR was represented at the head table by Joe Mendelson, III (President-Elect), Kirsten Nicholson (Treasurer), and Marion Preest (Secretary). At the end of the Banquet, a warm invitation was issued to attend the 2010 Joint Meeting of Ichthyologists and Herpetologists in Providence, Rhode Island, 7–12 July.

Board Meeting and Business Meeting Summaries

Society President Brian Crother called the Board Meeting to order at 0802 h on 22 July 2009 in the Hilton Portland and Executive Tower, Portland, Oregon. In attendance were 11 members of the Board of Directors and 17 Editors, Committee Chairs, or members of the Society (Fig. 4). Apologies were received from Roy McDiarmid, Kraig Adler, Andy Price, John Moriarty, Robert Hansen, Al Savitzky, and Ann Paterson. Minutes of the 2008 Board of Directors Meeting (Montréal, Canada) were approved.

Annual reports for 2008/2009 were submitted by all Officers, Editors, and Committee Chairs. President Brian Crother reported several personnel changes. Dawn Wilson stepped down as chair of the Student Travel Awards Committee, and Matt Venesky and Cari Hickerson (both student members) were appointed as co-Chairs. Kirsten Nicholson was replaced by Greg Watkins-Colwell as chair of the Nominations Committee and Lisa Hazard was added as a member of this Committee. Henry Mushinsky stepped down as organizer of the SSAR/HL Live Auction after many years and was replaced by Greg Watkins-Colwell. Stu Nielsen (another student member) replaced Richard Wassersug as Resolutions Chair.

Brian wrote over 70 letters of thanks to people who have provided



FIG. 4. Members of the Board and the Society at the Board Meeting. (L to R) Dawn Wilson, Travis LaDuc, Dick Durtsche, Stephen Richter, Robin Andrews, Kevin de Queiroz, Matt Parris, Betsie Rothermel, Charles Linkem. (Photo M. Preest)

service to SSAR in the past year, as well as letters of congratulations to winners of various SSAR student awards. He was involved (along with a number of other members of SSAR—particularly Joe Mendelson, III) in writing a short contribution to *Herpetological Review* and *Science and Children* that was a response to an article about using amphibians in the classroom and advocated the release of amphibians into the wild. A copy of this response is available on the SSAR website.

Journal of Herpetology received a prestigious award recently. It was recognized as one of the 100 most influential journals in the past 100 yrs in the Vertebrate Biology (Reptiles and Amphibians) Category by the Special Libraries Association (SLA; Fig. 5). This is a tribute to the many editors, editorial board members, and reviewers for this journal, and of course to the authors who send us their quality research. It is also a tribute to the officers and boards of directors over the years that have provided moral and financial support. Brian asked Past-President Roy McDiarmid and Board Member Kevin de Queiroz to attend a celebratory luncheon in Washington, DC on 16 June 2009 to accept the award on behalf of the Society. This award is announced on the website and a piece was published



FIG. 5. A toast at the end of the Board Meeting to the *Journal of Herpetology* for the Award it received from the Special Libraries Association. (Photo M. Preest)

in the September 2009 issue of *Herpetological Review*. A suggestion was made that the SLA Top 100 Journals logo be printed on the front cover of the *Journal*.

Brian arranged for Mo Donnelly to present this year's President's Travelogue. Additionally, he served as SSAR representative on the Meeting Management and Planning Committee (MMPC) and was involved in discussions concerning the future of SSAR with Allen Marketing and Management (AM&M, who currently handle our membership duties). Modest mark-ups in the costs of reprints and PDFs were approved.

Past-President Roy McDiarmid was involved with continued discussion of SSAR's participation as a full partner in JMIH. He provided input on a survey sent to the membership about annual meetings and also helped with interpretation of the results of the survey.

Treasurer Kirsten Nicholson reported that, while fiscal year 2008 was challenging, the Society ultimately fared better than was projected at the last Board Meeting. The approved 2008 budget projected overspending by almost $70,000; however, actual overspending was less than $3,900. Nearly all forms of income were substantially higher than predicted, although a few budget line items came in significantly overbudget.

The Society's investments lost an average of 42% of market value ($671,450 to $383,743). However, the value of the portfolio is slowly creeping back up. Kirsten regularly reviews the portfolio contents in consultation with accountant John Psaltos. The market value of all restricted funds as of December 2008 was $180,253.

Reprints from the Roger Conant library are available for purchase on the web. Breck Bartholomew (Publications Secretary) is making progress deciding how to handle the books from this library.

Kirsten will work on preparing the paperwork needed to satisfy IRS auditing requirements. This material will be circulated to the Board for approval. (Note added later: John Psaltos informed Kirsten that, because of the financial size of the Society, we do not need to have the paperwork in place for the 2008 tax filing. This gives us time to discuss this issue further at the 2010 Board Meeting.)

In the past year, Secretary Marion Preest prepared Board and Business meeting agendas and minutes for officers, editors, and committee chairs. Additionally, she prepared a summary of the 2008 meeting for publication in *Herpetological Review* and prepared the Annual Report for this year's Board meeting. Ongoing duties include updating SSAR letterhead and material on the website, answering or forwarding numerous emails, and ensuring that reports from Committee chairs are submitted for publication. Marion was involved in the student activities planned for the Portland meeting, in Nominations Committee duties, and she assisted President-Elect Joe Mendelson, III with an effort to recruit new members from the zoological, aquarium, and botanical park communities. She has continued (with tremendous help from Travis LaDuc, Regional Societies Board Member) to work on compiling a list of regional, national, and international herpetological societies so that SSAR can acknowledge significant events (e.g., anniversaries) in our sister societies. Marion called for a vote from the Board on a statement from the National Center for Science Education regarding the teaching of evolution in Texas schools. This statement was supported unanimously by the Board.

Breck Bartholomew reported that total income from the Publications Office in 2008 was $27,300.

Andy Price (Editor, *Catalogue of American Amphibians and Reptiles*) reported that an issue of *CAAR* will be ready by the end of 2009. Because *CAAR* is being published on an "as ready" schedule and no longer annually, we will eliminate all memberships that include receipt of *CAAR*. The Secretary will contact members who should have received *CAAR* as part of their membership benefits. She will explain the situation and ensure that they receive the issues they are entitled to. When *CAAR* is published in the future, it will be advertised on the website and available for purchase (or possibly free).

Contributions to Herpetology Editor Kraig Adler reported that "*Tasks and Problems in Studying the Life of Reptiles in Zoos*," by Hans-Günter Petzold, was published May 2008. "*Biology of the Reptilia, Volumes 20–21 (Morphology),*" edited by Carl Gans, Abbot Gaunt, and Kraig Adler were published in December 2008. These are the final text volumes in this series (begun in 1969) and both are selling strongly. "*Biology of the Reptilia, Volume 22, Comprehensive Literature of the Reptilia*," by Ernest A. Liner, will be issued in winter, 2009–2010. "*A Guide to the Snakes of the Philippines*" (Rafe Brown, Alan Leviton, Maren Gaulke, and Arvin Diesmos), "*Field Guide to Amphibians and Reptiles of the West Indies*" (S. Blair Hedges), and "*Lizards of Southern Africa*" (edited by William R. Branch and Aaron Bauer) are planned beyond 2009.

Facsimile Reprints in Herpetology Editor Aaron Bauer reported that "*Life and Herpetological Contributions of August Friedrich Schweigger"* was published in October 2008. A paperback edition of this work was distributed *gratis* at the 6th World Congress of Herpetology. Printing costs were supported by a donation from Mr. Ronald Javitch. "*Gray's Catalogue of the Specimens of Amphibians and Reptiles in the Collection of the British Museum*" is planned for 2010. Aaron anticipates one publication every two years for the foreseeable future. There was some discussion of other ways that herpetologists can access the material being published as part of this series.

Herpetological Circular 39 ("*Reptile Dealers and their Price Lists*," by Murphy and McCloud) is planned for late Fall 2009. *Herpetological Circular* 37—Crother et al., *Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico*, is already out of print. Editor John Moriarty requested funds to print anther 100–200 copies. This request was approved.

Joe Mitchell (co-Editor, *Herpetological Conservation*) reported that *Herp. Conservation, Vol. 3* (*Urban Herpetology*) is being very well received and has already turned a profit for SSAR. Robin Jung-Brown and Breck Bartholomew stepped down as co-editors; however, Joe will remain as editor for one or two more volumes. A possible topic for Volume 4 is "Herpetological Conservation in Agricultural Landscapes."

Herpetological Review continues to operate smoothly according to Editor Robert Hansen. There have been some personnel changes: Brent Thomas and Michael Jorgensen stepped down and were replaced by Margaret Gunzberger and Dan Portik, respectively; Chris Phillips stepped down in July after five years of service. The "Amphibian Chytridiomycosis Geographic Distribution Section" was introduced in 2007. It receives considerable manuscript submissions and has been given a broader focus and renamed "Amphibian Diseases." Manuscripts submitted to this section are fast-tracked for publication. Bob requested continued consideration of publishing an online version of *Herpetological Review* and more extensive use of color.

Geoff Smith stepped down as *Journal of Herpetology* Editor in January 2009; however, he continues to process manuscripts submitted before 2009. Current Editor Matt Parris reported that submission rates were up slightly for 2008. The rejection rate continues at around 60% and there is a 9–12 month wait between acceptance and publication. This is expected to decrease given a 34% reduction in submissions in 2009.

Authors are now allowed to generate keywords and this will be useful for abstracting services, for those who use EndNote, etc. Matt and Geoff revised the "Guidelines for Authors" and the new version is available on the SSAR website.

Matt is exploring the option of converting to a trim size of 8.5 × 11 inches. He thinks this could facilitate modern mechanisms of document delivery, increase ease of PDF file transfer, stimulate increased interest in the journal, and would also help deal with the backlog of accepted papers. Matt will look into the budgetary implications of such a change.

Breck Bartholomew suggested that Matt consider using different photos/cover art on each issue of *Journal of Herpetology* as *Herpetological Review* does. Matt will remove the membership pricing information from the inside back cover. From now on, membership pricing will only be published on the website.

Betsie Rothermel (Chair, Conservation Committee) reported that Stephen Richter stepped down as co-chair. He was replaced by Joe Mendelson, III, who then stepped down when he was elected President-Elect in Oct.,

2009. Three new student members were added to the Committee—April Barreca, Jen Germano, and Andrea Dreyer. The Committee took action on a number of matters: a) they submitted a letter in support of the listing of the recently described Reticulated Flatwoods Salamander under the ESA as endangered, b) they supported the designation of critical habitat for the Reticulated Flatwoods and Frosted Flatwoods Salamanders, c) they submitted a letter opposing proposed changes to rules governing interagency consultation under Section 7 of the ESA (this would have removed the requirement for federal agencies to consult with USFWS or NMFS when determining impacts to threatened and endangered species), and d) they wrote a letter in support of the State of Florida's new regulations regarding the harvesting of freshwater turtles.

The Committee is considering whether it is better to submit joint letters or individual letters from the herpetological Societies. The answer probably depends upon to whom the letter is being addressed, e.g. in some cases number of letters received may carry more weight than who actually signed the letter. The Committee may conduct an online survey to identify members interested in receiving boiler plate letters from the Conservation Committee that they can then sign and submit to relevant agencies.

Chair of the Dean Metter Award Committee, Joe Beatty, received 24 proposals this year. All were of high quality and two winners were chosen. They are: Benjamin Jellen (St. Louis University) who is working on pre- and post-copulatory determinants of reproductive success in *Nerodia sipedon*, and Jeanine Refsnider (Iowa State University) who is attempting to determine if nest site selection can compensate for global climate change effects on sex determination in *Chrysemes picta*.

Erik Wild and Josh Kapfer (co-Chairs, Grants-in-Herpetology Committee) received 71 proposals in 2009. Applications were sent from 27 states in the US and eight countries (including the US). Most applications were received in the "Field Research" category. The winners each receive $500 and they are:

Conservation: Rosalinda Palomo-Ramos, New Mexico State Univ.

Field Research: Jeanine Refsnider, Iowa State Univ.

Laboratory Research: Brittany Barker, Univ. of New Mexico

Travel: Arley Camargo, Brigham Young Univ.

International: Carlos Miguel Del Valle-Useche, Universidad Nacional de Colombia

Education: Dan Costel, Lowry Park Zoo

Eric and Josh plan to work with webmaster Raul Diaz to introduce a more formalized process for receipt of grant applications.

The 17th annual Seibert Awards Competition was run at the 51st Annual Meeting of the SSAR in Montréal, Québec. There were 21 eligible presentations. The Seibert Award winners for 2008 were: **Systematics/Evolution**: Julienne Ng, University of Rochester, "Dewlap color and reproductive isolation in *Anolis distichus*." **Ecology**: Forrest Brem, University of Memphis, "Environmental transmission: a mechanism of disease-induced amphibian extinctions." **Conservation**: David Pike, (with co-authors Jonathan Webb and Richard Shine), University of Sydney, "Landscape-scale reptile conservation: experimentally manipulating canopy cover to restore a reptile assemblage." Honorable mentions were: **Ecology**: April Barreca (with co-author Jason T. Irwin), Central Washington University, "Seasonal habitat use and movement of Cascades frogs (*Rana cascadae*) in Washington." **Conservation**: Brian Todd (with co-authors Thomas Luhring, Betsie Rothermel, and Whit Gibbons), Savannah River Ecology Lab and Austin Peay State University, "Interspecific effects of upland forest clearing on amphibian migrations: implications for habitat and population connectivity." All winners received a check for US $200 and a book from University of California Press compliments of Chuck Crumly.

Two new members (Carlos Navas and Michael Dorcas) were added to the Herpetological Education Committee in the past year. Chair, Cathy Bevier reported that an updated webpage with information and resources for educators and students is accessible from the SSAR website. The committee invites submission of materials that promote teaching and learning about topics in herpetology. The Committee submitted a proposal for a Meritorious Teaching Award in Herpetology to be considered by the governing boards of SSAR, HL, and ASIH. The annual award would be presented to a nominated and qualified individual, and would include a plaque and cash prize ($500). The Board voted unanimously in support of providing this Award.

Lynnette Sievert (Chair, Kennedy Award Committee) announced that the winning paper for 2008 is by Erica Bree Rosenblum, "Preference for local mates in a recently diverged population of the lesser earless lizard (*Holbrookia maculata*) at White Sands" *Journal of Herpetology* 42:572–583." Erica will receive a check for $200 or $400 in SSAR publications.

The Meeting Management Planning Committee (MMPC) met in Portland in April to develop a meeting schedule and review conference facilities. SSAR representative on this committee, Brian Crother, noted that over 1000 presentations (papers and posters) will be made at the 2009 meeting. Future meetings are to be held as follows:

- Providence (2010)
- Minneapolis (2011)
- Vancouver (2012; with the WCH)
- Albuquerque (2013)

There was ongoing discussion of the current hotel-based meetings with professional organizers versus the former university-based meetings and the issues of cost, ease of planning, and workload placed on the local hosts. The Albuquerque meetings are being evaluated for either university or hotel meetings.

The MMPC developed a survey to poll the JMIH membership on the state of the meetings. 713 members of SSAR, HL, ASIH, and/or AES completed the survey and the results were sent to all members in mid-summer, 2009. Responses to some key questions are presented below:

Should SSAR and HL meet separately from ASIH and AES?
42% no, 35% neutral, 25% yes

Is meeting status quo acceptable?
70% yes

Where would you prefer to meet regardless of cost?
60% - University-setting

Should cost be the main factor in choosing between university and hotel?
77% yes

Are you satisfied with hotel rates?
57% no, 16% yes

Most respondents were satisfied with geographic locations, meeting duration, meeting space, program quality, and the information provided prior to the meeting.

Another meeting organizing company will bid against Kansas State for future meetings. The Board discussed the roles of the picnic and banquet at the meeting. The general consensus was that the picnic was more popular than the banquet. A suggestion was made that we hold a picnic/banquet hybrid earlier in the meeting. This may lower cost and increase attendance at this event. There was also discussion of the possibility of shortening the meeting by a day or two, the cost of housing, and the implications to the Society(s) financially responsible for the JMIH of not filling the room block.

Greg Watkins-Colwell replaced Kirsten Nicholson as chair of the Nominations Committee and Lisa Hazard was added as a new member. In 2008 the Nominations Committee generated a list of candidates for President-Elect, three regular Board Members, and one non-US Board member. Kirsten Nicholson and Marion Preest were willing to run again for the positions of Treasurer and Secretary respectively. The members of the Nominations Committee thank all Society members willing to run for these positions. There is no election being held in 2009, but the Committee welcomes suggestions for 2010.

Richard Wassersug presented resolutions at the SSAR Business Meeting in Montréal in 2008. Richard stepped down as Resolutions Chair and was replaced by Stu Nielsen.

The 6th Edition of the Scientific and Standard English names list was published one year ago and the web version is in development. Brian

Crother reported that the Committee is uncertain how updates will proceed (i.e., quarterly or as new information comes in). The 6th Edition has attracted attention because of certain name usage, claims of authoritarianism, and the review process. These claims are forthcoming as a Point of View paper in *Herpetologica*. The Committee has responded with two contra papers.

In Montréal, SSAR hosted a reception and a pizza lunch for student members of SSAR. A new committee, the Student Participation Committee (SPC; Dawn Wilson, Chair) was formed at the Board Meeting in 2008. Members of the SPC are professionals and students interested in furthering student involvement and student-centered activities in our Society.

Ten students were selected randomly from a pool of 23 applicants to receive travel awards ($400) for 2009. Matt Venesky and Cari Hickerson (co-Chairs, Student Travel Awards Committee) organized the 2009 Silent Auction to raise funds for this Award. There was discussion for next year of putting the materials in the Silent Auction in a high-traffic area to encourage bidding on items, e.g., where the Poster Sessions are held. A suggestion was offered that receipt of a travel award next year be made contingent on the awardees staffing the silent auction materials when they are on display. This suggestion received wide support among the members of the Board. A further suggestion was made to do away with the Silent Auction, and instead just hold the Live Auction (both auctions raise funds for Student Travel). This would have implications for the SSAR Travel Awards budget as the proceeds from the Silent Auction are for SSAR alone, whereas the proceeds from the Live Auction are shared with HL. The Board decided to let Matt and Cari try some new ideas to reinvigorate the Silent Auction next year and to continue to hold both auctions for the time being.

Anne Maglia (Chair, Web Oversight Committee) reported that, over the past year, the Web Oversight Committee focused on enhancing the utility and information content of the SSAR website as well as modifying page infrastructure and server support so that the forums are more secure. The website continues to be updated on a regular basis. The image gallery was converted and the photographs from the 50th Anniversary banquet are available for viewing and purchase. Suggestions for additional changes to the website are welcomed. Anne thanked Raul Diaz (webmaster) for his many volunteer hours and dedication to the Society.

For the first time, voting in the SSAR election was carried out electronically (although for those members without access to email, paper ballots were provided). Elections Officer, Dan Noble reported that this new procedure did not increase voting participation substantially.

The following SSAR members were elected:

President-Elect: Joe Mendelson, III

Treasurer: Kirsten Nicholson

Secretary: Marion Preest

Regular Board members: David Cundall, Kevin de Queiroz, Ann Paterson

Non-US Board member: Pat Gregory

All amendments to the By-laws were approved (minor changes were needed because of the switch to electronic voting and also because of a change in how we deal with members in arrears for payment of dues). The Board talked about how to increase voting participation, e.g., use Facebook to contact student members to increase communication and encourage voting, etc.

Al Savitzky attended the AIBS Council Meeting and Annual Meeting and part of BioOne Publishers and Partners Meeting in May, 2009. Reports were made on the first 14 months of progress on the Encyclopedia of Life and on the status of NSF funding for biological sciences, particularly organismal and environmental biology. Expected priorities for future funding include support for studies of changing biosphere dynamics, energy systems, educational enhancement, broadening participation, and climate change research.

A representative from the Public Policy Office (PPO) reported that there is a better environment for science funding following the recent presidential election and also new emphasis on greater transparency related to the regulatory process. The PPO is still active in issues relating to the teaching of evolution in public schools. AIBS launched the Legislative Action Center, an online resource that facilitates contact between scientists and legislators. Individuals can register with the Center to receive monthly alerts concerning breaking issues of interest, and then will be emailed letters that can be modified or sent as written. A direct link to the appropriate legislators will be provided. The Legislative Action Center conducted a successful campaign to remove restrictions from the government's economic stimulus package that would have prevented funds from being allocated to museums.

Al reported that BioOne now has two collections (BioOne and BioOne.2) and continues to grow with the addition of new titles. A new platform increases the ease of accessing material. BioOne is conducting a review to determine whether to publish new journals in emerging fields, reference books, and textbooks. The meeting ended with discussion on the future of print publications and continued declines in Society memberships.

SSAR and HL are co-sponsoring the symposium "Headstarting Turtles—Learning from Experience" planned for the 2010 JMIH. Symposium Coordinator Richard Durtsche, reported that SSAR allocated $3,000 in funds. There was discussion of a need to contact members to remind them to be generating ideas for future symposia.

This concluded discussion of reports submitted, and the Board then turned to new business. Breck Bartholomew's proposal to resume providing membership duties was considered by the Board. Our contract with AM&M ends 31 December 2009, and dissatisfaction, both with service and the price of that service, has been expressed. Breck will be able to offer additional services plus those we currently enjoy at a substantially lower cost. The cost will include an initial set up per member, plus 10% of membership dues/member. This cost structure will act as an incentive to Breck to retain and attract new members. He will provide two databases. One will be accessible to Society officers, the other to individual members (will permit logging in to check on status of membership, update personal info, etc.). Additional functionalities will be added when the website is up and running, e.g. wiki-type database, literature database, etc. Electronic voting will be possible. According to Kirsten Nicholson, leaving AM&M has no implications for staying with Allen Press for the printing of journals. The Board voted unanimously to accept Breck's proposal. Breck will begin to set up user profiles within the next month and predicts the membership website will be up and running by October 2009. Membership renewal notification will begin with an email blast in August, and Breck will follow this up with a mailing for bounce-backs and lack of responses. (Note added later: HL, which has a joint agreement with AM&M, has also accepted Breck's proposal).

Roy McDiarmid was contacted in late 2008 by the owner of a US reptile shop offering a donation to the Society (< $1000). There was some email correspondence about what we could do with this donation. The Board discussed the larger issue of accepting such donations, as there was some concern about accepting funds from individuals unknown to the Society, e.g., what are their credentials, are there any strings attached, etc. Roy will investigate this specific case further and the issue of donations will be discussed by the Board at the next Annual Meeting.

The possibility of offering an award for the best student poster(s) at the annual meeting was discussed (this was previously raised at the 2008 Board Meeting). The student award could be a certificate, banquet tickets, and/or a cash prize. A suggestion was made that this competition could be targeted towards more junior students (graduate and undergraduate). Joe Mendelson, III offered to form and chair an *ad hoc* committee to look into this.

Kirsten Nicholson brought to the Board's attention the fact that Allen Press Management is transitioning its association bank accounts from Douglas County Bank to US Bank. The Board decided that acceptance of such a move was up to the Treasurer and did not require its approval.

SSAR presently lacks copyright agreements with authors who have published recently in our journals. Kirsten will draft a copyright agree-

ment and distribute this to the Board electronically for comments and a vote before the next Board Meeting. A suggestion was made that we could allow authors to purchase low cost, high quality PDFs of papers and the authors could then distribute copies as they wish. If they chose to not purchase PDF copies, they then do not have the right to distribute their paper widely as the copyright is held by the Society.

Currently, although the Society is charged for color figures in *Journal of Herpetology*, page charges are not enforced and thus we do not insist on passing this cost along to the authors. After some discussion, the Board indicated that it was in favor of charging for color plates. Matt Parris offered to produce a policy for dealing with this. A suggestion was made that we could give authors a time line to pay for color figures, and until the author pays for color plates the manuscript is not published. This would have to be handled carefully so as to not interfere with layout and scheduling.

Allen Press wants to do away with the mailing sheets that are currently included with *Journal of Herpetology* (these sheets contain membership information which is now on the website). Mailing addresses will be printed on a white stripe on polywrap covers. The Board approved this change.

Brian submitted a proposal regarding the SSAR representative on the Meeting Management and Planning Committee (MMPC). This individual attends the planning meeting in the April preceding the JMIH and would serve a four-year term. Typically this person would be President-Elect or President when they begin their term. There will be overlap in year one of the four-year term with the outgoing SSAR Rep who is in year 4 of their four-year term. Thus, the SSAR rep will overlap with another rep for two years (beginning and end of term) and serve on their own for the middle two years. SSAR will cover the cost of sending the rep(s) to the planning meeting. Because of the scheduling of this scheme, every third President will not serve as SSAR rep; instead, this duty will skip to the next President-Elect in their second year. This scheme (although somewhat complicated), ensures continuity (because of the overlap at the beginning and end of the term) without costing the Society a great deal. If the President or President-Elect is unable to serve (e.g. they might be an international member) a proxy will be appointed from among the officers. This proposal received unanimous support.

The Board returned to the issue of sharing financial responsibility for the JMIH with the other participating Societies. This issue was considered briefly at the Board Meeting in 2008. Several officers (President, President-Elect, Treasurer, Secretary, one Board member) had met informally with officers from other Societies the previous evening to discuss this. The Board voted unanimously to proceed with an investigation of the many issues associated with such an arrangement (including what happens in years when SSAR meets with the WCH) and the generation of a proposal to be considered later.

There was brief discussion of offering an online-only membership. Typically, having this form of membership would reduce membership income, but it might increase overall membership. The fact that *Herpetological Review* is not yet published in an electronic format would need to be addressed before we could move forward with this type of membership. Brian will ask Raul Diaz and Bob Hansen to look into this. (Note added later: Brian, Bob, and Breck have already begun this conversation.)

The Board was in favor of forming a Membership Campaign Committee. Brian will appoint a chair. The committee will include both professionals and students.

Joe Mendelson, III recommended that SSAR consider ways of engaging the media and better publicizing SSAR activities and research published in our journals. There was wide-ranging discussion of this suggestion. The Board voted unanimously in support of the formation of a Media Liaison Committee. In order to better communicate with the public, the Editor of *Journal of Herpetology* could ask authors to submit a second abstract written in layperson's terms. There was discussion of a Presidential essay/op-ed piece to be published biannually on the website and *Journal of Herpetology*. The aim of these pieces would be to highlight



FIG. 6. Kris Kaiser and John (J.D.) Wilson, winners of the 2009 Henri Seibert Awards in the *Conservation* and *Ecology* categories, respectively. These awards were presented at the Business Meeting. Jamie Oaks was the winner for *Systematics/Evolution* and Victoria Ash was the winner for *Physiology/Morphology*. (Photo M. Preest)

SSAR activities, put SSAR in a larger context, etc., and they would make members aware of what SSAR is doing (e.g., conservation and education initiatives) and the fact that SSAR is more than just a publisher of journals. The President could ask others to submit essays. The Editor of *Journal of Herpetology* will contact the President when they are needed.

Steve Godley presented a proposal to make appendices to papers published in our journals available on the website. These appendices could include audio and video files, photographs, databases, etc. ENTRIX employee, Steve Smith, has volunteered to write the programs necessary to host the appendices. Allen Press will not charge us for this and in fact are already set up to do this. The Board voted to support this proposal and Brian will contact Allen Press to pursue this further.

A balanced budget for 2010 of $255,000 was approved and the meeting was adjourned by President Crother at 1440 h.

The Annual SSAR Business Meeting was called to order by President Crother at 1800 h on 25 July. Approximately 24 members of SSAR were in attendance. Officers, Editors, and Committee Chairs who were at the Business Meeting introduced themselves to the other attendees and gave brief summaries of their Annual Reports and relevant information from the Board Meeting. Aaron Bauer (Secretary General, WCH) spoke about the 7th World Congress of Herpetology to be held in Vancouver, British Columbia, Canada (8–14 August 2012). SSAR will meet with WCH in Vancouver and the other participating JMIH Societies will be invited. Pat Gregory (SSAR non-US Board Member) is one of the local hosts for the meeting.

Winners of the 2009 Dean Metter Award, Kennedy Award, Henri Seibert Student Awards (Fig. 6), Grants-in-Herpetology Awards, and Student Travel Awards (Fig. 7) were announced.

Stu Nielsen (Resolutions Chair) read the following 2009 resolutions.

SSAR wishes to acknowledge the dedication and hard work of our Immediate Past-President, Roy McDiarmid. Roy was particularly focused on student participation in the Society and organized a student reception at the JMIH last year that was so successful that we repeated it this year along with HL. He also initiated a change in the format of the Business Meeting to make it more interactive and welcoming to student members. Roy was heavily involved during his term in the highly successful 50th Anniversary Celebration of SSAR, he helped smooth the transition to working with AM&M, and he participated in the ongoing discussion of the role of SSAR in JMIH planning. He continues to be active on behalf



FIG. 7. Two of the ten winners of Student Travel Awards (Gareth Hopkins and David McLeod). In recognition of the high cost of attending the Annual Meeting, the SSAR Board voted in 2008 to increase the Travel Awards from $200 to $400 each. (Photo M. Preest)

of SSAR, particularly in regards to a plan to house the Societies' archives at the Smithsonian.

Four members of the Board stepped down at the end of 2008. They were: Rafe Brown, Meredith Mahoney, Jim McGuire, and Rick Shine. The Society greatly appreciates their efforts on behalf of the Society.

There have been few personnel changes in the last year at *Herpetological Review*. Brent Thomas, an Associate Editor, stepped down at the end of 2008 after a two-year run and was replaced by Margaret Gunzburger. Chris Phillips, another Associate Editor, stepped down in July marking the five-year anniversary of his service to *Herpetological Review*. Michael Jorgensen, a Copy Editor, completed his service as of July 2008 and was replaced by Dan Portik.

As of the beginning of this year, Geoff Smith stepped down as Editor of the *Journal of Herpetology* and was replaced by Matt Parris. Geoff was Editor of the *Journal* for three years and, with Brian Sullivan (the previous Editor), was instrumental in the transition to online submission via AllenTrack. With current Editor, Matt Parris, he updated the *Journal's* Ethics Statement and he continued to uphold the high standard of publications for which the *Journal* has become known. Geoff is processing all manuscripts initially submitted in calendar years preceding 2009.

Breck Bartholomew and Robin Jung-Brown both served as co-Editors on the 3rd volume in the *Herpetological Conservation* series. Urban Herpetology was a highly ambitious project—40 chapters and 13 case studies authored by 120 authors worldwide—and is being very well received. Joe Mitchell will continue as sole Editor of that series.

SSAR wishes to acknowledge Kirsten Nicholson who chaired the Nominations Committee for six years and also the following individuals who agreed to run for Officer positions last year: Joe Mendelson III, Stan Fox, David Cundall, Kevin de Queiroz, Ann Paterson, Lisa Hazard, John Moriarty, Jeff Parmalee, Greg Watkins-Colwell, Alison Cree, and Pat Gregory.

Dawn Wilson served as chair of the Student Travel Awards Committee for more years than we can count before stepping down last year. Her hard work as organizer of the associated Silent Auction has provided funds for well over 100 students to help them cover the costs of attending the annual meetings. Just this year SSAR doubled the amount of money we provide to winners of the Travel Awards. Dawn continues to be very active in the Society—not 30 minutes after stepping down as chair of the Travel Awards Committee at the Board Meeting last year, she was appointed chair of the Student Participation Committee.

Raul Diaz deserves special thanks as our hard-working and talented volunteer webmaster. If you haven't had a good look at the SSAR website recently, you really should!

Stephen Richter stepped down as co-chair of the Conservation Committee at the end of last year. He served as chair and then co-chair for five years. As a result of his efforts (and those of others), this Committee has become increasingly visible and influential. Andy Kouba and Howard Whiteman rotated off the Conservation Committee and we thank them for their service.

SSAR thanks Richard Wassersug who stepped down after serving for three years as Resolutions chair. Thanks to Mo Donnelly for another great President's Travelogue. There was standing room only at her talk on the opening day of the meeting. Joe Mendelson III spearheaded a membership campaign last year targeting members of the zoo, aquarium, and botanical park communities. As a result we have seen a slight upswing in number of members from this constituency.

Henry Mushinsky has served as coordinator of the SSAR/HL Live Auction for more than five years. Although Henry was never the "face" of the auction, he worked tirelessly behind the scenes to ensure that for years we had a smooth running auction with terrific items.

We welcome the increased involvement of students in the Society; in the past year and a half, we have appointed students to serve as Elector, Resolutions Chair, members of the Student Participation Society, Conservation Committee, Student Travel Award Committee, and so on. There's no shortage of work, so if you're interested in getting more involved, speak with President Crother or Dawn Wilson, chair of the Student Participation Society.

Finally, SSAR thanks the many members who serve in various capacities—continuing officers, editors, and members of committees, judges of student competitions, reviewers of manuscripts submitted to our journals, contributors to the Live and Silent Auctions, as well as those who attend these Joint Meetings.

The 2009 Business Meeting was adjourned at 1970 h.

Members of SSAR were greatly saddened early in the meeting to learn of the passing of Dr. Barbara Savitzky at her home in Virginia after a battle with cancer that lasted more than 20 years. Barb had been a member of SSAR since the early 1980s and attended nearly all SSAR meetings since 1987. She and her husband Al first met at the 1986 SSAR meeting in Springfield, Missouri. SSAR extends deep condolences to Al and his family.

—Respectfully submitted by Marion Preest, SSAR Secretary

NEWSNOTES

Slowinski Award Announced for 2009

The Center for North American Herpetology is pleased to announce that the recipient of the Joseph B. Slowinski Award for Excellence in Snake Systematics for 2009 is Kate L. Sanders, University of Adelaide.

On 12 September 2001, the world lost one of its premier herpetologists, a loss that went virtually unnoticed in the wake of the tragedy that befell the United States the previous day. Joseph Bruno Slowinski, the 39-year-old curator of herpetology at the California Academy of Sciences in San Francisco, died in the jungles of Burma from the bite of a venomous snake. Joe was bitten on 11 September and succumbed to the effects of the bite the next day. Eventually, the world took notice and media outlets throughout the

U.S. and beyond chronicled Joe Slowinski's exemplary career, cut so tragically short.

A distinguished committee, comprised of Simon Creer (University of Wales, Bangor), Hussam Zaher (Museu de Zoologia da Universidade de Sao Paulo, Brazil), and Christopher L. Parkinson (committee chairperson, University of Central Florida, Orlando), has deemed the paper "Molecular phylogeny and divergence dates for Australasian elapids and sea snakes (Hydrophiinae): evidence from seven genes for rapid evolutionary radiations" published in volume 21 of the *Journal of Evolutionary Biology*, as the most distinguished paper on snake systematics to appear during 2008. The paper was co-authored with Michael S. Y. Lee, Remko Leys, Robert Foster, and J. Scott Keogh.

As senior author of the paper, Dr. Sanders becomes the seventh recipient of the Slowinski Award, and will receive a check from the Center for North American Herpetology for US $500 along with a commemorative memento in recognition of her achievement.

MEETINGS

Meetings Calendar

Meeting announcement information should be sent directly to the Editor (HerpReview@gmail.com) well in advance of the event.

26–28 February 2010—35th Annual Desert Tortoise Council Symposium, Ontario, California, USA. Information: http://www.deserttortoise.org/symposia.html

16–18 March 2010—Conference: **"**Climate Change and Conservation of Native Amphibians and Reptiles." Hosted by Southwest Region, U.S. Fish and Wildlife Service, Albuquerque, New Mexico, USA. Information: http://www.fws.gov/southwest/Climatechange/amphibreps.html#agenda

30 March–2 April 2010—Biology of the Vipers Symposium, Natural History Museum, University of Pisa, Italy. Information: http://www.msn.unipi.it/vipere/default.aspx

22–24 April 2010—57th Annual Meeting, Southwestern Association of Naturalists, Llano River Field Station, Junction, Texas, USA. Information: http://www.biosurvey.ou.edu/swan/annualm10.html

7–12 July 2010—Joint Meeting of Ichthyologists and Herpetologists (ASIH / HL / SSAR), Providence, Rhode Island, USA. Information: http://www.dce.k-state.edu/conf/jointmeeting/

21–24 July 2010—33rd Annual International Herpetological Symposium, Tucson, Arizona, USA. Information: http://www.kingsnake.com/ihs/

22–26 September 2010—VIII National Congress of Societas Herpetologica Italica, Abruzzo, Italy. Information: shiabruzzo2010.iscrizioni@gmail.com

CURRENT RESEARCH

The purpose of Current Research is to present brief summaries and citations for selected papers from journals other than those published by the American Society of Ichthyologists and Herpetologists, The Herpetologists' League, and the Society for the Study of Amphibians and Reptiles. Limited space prohibits comprehensive coverage of the literature, but an effort will be made to cover a variety of taxa and topics. To ensure that the coverage is as broad and current as possible, authors are invited to send reprints to the Current Research section editors, Joshua Hale or Ben Lowe; postal and e-mail addresses may be found on the inside front cover.

A listing of current contents of various herpetological journals and other publications is available online. Go to: http://www.herplit.com and click on "Current Herpetological Contents."

Basking Opportunity Impacts Birthing Asynchrony in a Viviparous Lizard

Birthing asynchrony, the spread of time over which mothers give birth to a brood of offspring or lay a clutch of eggs, can have considerable fitness consequences for offspring, and the optimal degree of asynchrony may depend on environmental conditions. It is therefore predicted that females with the ability to control the degree of birthing asynchrony would do so to the degree that maximizes the fitness of the offspring. However, the study of birthing asynchrony has been traditionally limited to avian studies, and few empirical investigations have been completed. In this study, the authors examined the impacts of environmental quality on birthing asynchrony in a viviparous skink, *Egernia whitii*. While most reptiles give birth to their offspring all at once, *Egernia* skinks display asynchronous birth. Additionally, it has been shown that *Egernia* juveniles experience a high degree of intra-size-class competition, with smaller (= later born) individuals being driven to disperse (a move that potentially increases their fitness), and that females exhibit control over degree of birthing asynchrony. Environmental quality was determined by a female's access to basking opportunity, with gravid females assigned at the start of gestation to either a restricted (4 hours access to a heat lamp each day) or extended (10 hours access) basking treatment. Offspring of females in the extended treatment were larger and were born earlier than those in the restricted treatment. Furthermore, females held in the restricted basking treatment increased their birthing asynchrony, suggesting that this behavior is under strong selection in this species.

While, G. M., and E. Wapstra. 2009. Effects of basking opportunity on birthing asynchrony in a viviparous lizard. Animal Behaviour 77:1465–1470.

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Reproductive Output Not Reduced in Flat Lizards

Differences in size and shape are strong determinants of the reproductive output of most animals. Thus, selection favoring specific body sizes and shapes may have a direct effect on reproductive output (the quantity of offspring and eggs that can be produced). In reptiles, species that occupy rocky habitats are often flattened, a morphological character that aids locomotion and life on rocks, but which may constrain reproductive output by reducing the amount of abdominal space available to fill with eggs or offspring. In this study, examining 20 species of tropical skink from a wide range of habitats, the authors quantified habitat use, body height, body volume, and reproductive output, to determine whether the evolution of a flattened body was correlated with a reduction in abdominal volume, and, in turn, with reduced reproductive output. In this group of lizards, the occupation of rocky habitats led to the evolution of a flattened body, which caused a reduction in abdominal volume. However, despite this reduction in abdominal volume reproductive output was unaffected, as flatter species compensate by being more "full" of eggs. This study demonstrates that morphological adaptation for enhanced performance in specific habitats does not necessarily result in a reduction in instantaneous reproductive output.

Goodman, B. A., S. C. Hudson, J. L. Isaac, and L. Schwarzkopf. 2009. The evolution of body shape in response to habitat: is reproductive output reduced in flat lizards? Evolution 63:1279–1291.

Correspondence to: Brett Goodman, School of Marine & Tropical Biology, James Cook University, Townsville 4812, Queensland, Australia; e-mail: Brett.Goodman@jcu.edu.au.

Three Independent Origins of TTX Resistance in *Thamnophis* Garter Snakes

Tetrodotoxin (TTX) is a neurotoxin that disables nervous and muscle tissue by binding to gated sodium channels and is employed in defense by several taxa, including *Taricha* salamanders. Three species of garter snakes (*Thamnophis*) in western North America are known to prey on *Taricha* and exhibit relative immunity to the effects of TTX. This phenomenon has been investigated in one species, *Th. sirtalis*, and it has been revealed that changes in a few amino acids residing on the extracellular portions of the protein responsible for forming the cell's sodium channels ($Na_v1.4$) bestow TTX immunity. As two additional, phylogenetically distant species (*Th. atratus* and *Th. couchii*) display TTX immunity, this phenomenon either evolved independently three times or once and is the result of ancestral polymorphism or horizontal transfer. If TTX resistance evolved once, sequences from resistant snakes would form a clade in the $Na_v1.4$ gene genealogy; if it evolved independently, the $Na_v1.4$ gene genealogy would be largely congruent with the accepted species tree. To address this, the authors accumulated $Na_v1.4$ DNA (and inferred amino acid) sequence data for the two additional TTX-resistant *Thamnophis*, as well as for non-resistant relatives (including non-resistant *Th. sirtalis*). Results showed the $Na_v1.4$ gene genealogy is congruent with the *Thamnophis* species tree (indicating independent origin); indeed the suite of specific amino acid changes bestowing TTX immunity is unique in each lineage. Furthermore, as the $Na_v1.4$ amino acid sequences in the regions of TTX binding for non-resistant taxa are highly conserved (even in humans; evidence of purifying selection), it is highly unlikely that genetic variation present in the common ancestor of *Thamnophis* is the source of TTX resistance. By showing that three unique, diminutive changes in amino acid sequence can result in a single, radically different phenotype, this study provides insight into the importance of large-effect mutations in adaptation.

Feldman, C. R., E. D. Brodie Jr., E. D. Brodie III, and M. E. Pfrender. 2009. The evolutionary origins of beneficial alleles during the repeated adaptation of garter snakes to deadly prey. Proceedings of the National Academy of Sciences 106:13415–13420.

Correspondence to: Chris Feldman, Department of Natural Resources and Environmental Science, University of Nevada, Reno, Nevada 89557-0816, USA; e-mail: ophis@cabnr.unr.edu.

Crocodilian Vocalization Reviewed

Both extant archosaurian lineages, birds and crocodilians, extensively employ vocalizations in both inter- and intraspecific contexts. In contrast to the deep understanding of avian communication that was achieved in the 20th century, our knowledge of crocodilian vocalization remains inadequate. The authors of this review paper summarize what is known of crocodilian communication. Crocodilian vocalizations can be placed into several categories. Both adults and hatchlings make use of defensive calls to warn off potential predators. Additionally, vocalizations directed toward conspecifics are employed by both adults (courtship and territorial) and juveniles (to coordinate hatching and engender cohort cohesiveness). Crocodilian vocalizations, unlike those of birds, do not originate from a specific, highly developed anatomical structure and are therefore short, simple, and repetitive ("calls"). Contrary to their poorly developed sound production anatomy, crocodilians possess an advanced, tri-partitioned, single-ossicle ear similar to birds; muscular "ear lids" enable them to dive underwater while leaving the outer ear dry (crocodilians are capable of hearing both in and out of water). Crocodilians exhibit a breadth of optimal sound frequencies equivalent to that observed in passerine birds but with a center of optimal hearing slightly lower (resulting in greater sensitivity at lower frequencies). As they are known to emit infrasonic (very low frequency) sounds that would be inaudible via standard sound perception, perhaps an alternate, undescribed mode of crocodilian sound detection exists. The details of the neurological components of crocodilian sound perception are particularly poorly known; understanding of the degree to which they can distinguish between and comprehend different sounds awaits future inquiry.

Vergne, A. L., M. B. Pritz, and N. Mathevon. 2009. Acoustic communication in crocodilians: from behaviour to brain. Biological Reviews 84:391–411.

Correspondence to: Amelie Vergne, Université de Saint-Etienne, Ecologie & Neuro-Ethologie Sensorielles EA3988, Saint-Etienne, France; e-mail: amelie.vergne@gmail.com.

Cryptic Diversity in Australian Geckos

A number of fields of study require an accurate assessment of species diversity; however, much of the world's diversity remains undocumented. While most unrecognized diversity is found in invertebrates and in developing countries, this is not always the case. Although Australia is a developed nation, with scientific institutes in every state from the nineteenth century, the true species diversity is still not known, even in vertebrate groups. In this study, the authors have examined the cryptic diversity in the Australian gecko family, the Diplodactylidae. Mitochondrial DNA, allozymes, and chromosomal variation were used to examine species diversity in the genus *Diplodactylus*. Results indicated that actual species diversity in this genus has been underestimated, with estimates from this study increasing the number of species from 13 to 29. It was found that four currently recognized species actually represent species complexes, with three of these not recovered as monophyletic. The authors suggest that their study highlights the importance of conducting detailed assessments of species diversity with special attention paid to identifying cryptic species, even in developed countries with conspicuous and well-studied taxa.

Oliver, P. M., M. Adams, M. S. Y. Lee, M. N. Hutchinson, and P. Doughty. 2009. Cryptic diversity in vertebrates: molecular data double estimates of species diversity in a radiation of Australian lizards (*Diplodactylus*, Gekkota). Proceedings of the Royal Society of London, Series B 276:2001–2007.

Correspondence to: Paul Oliver, Terrestrial Vertebrates, South Australian Museum, Adelaide, South Australia 5000, Australia; e-mail: paul.oliver@adelaide.edu.au.

Cost of Migration for Female Newts

Partial migration, where a portion of individuals in a population complete a migration, is common among mammals, insects, fish and birds, but is rare in amphibians. The eastern newt, *Notophtalmus viridescens*, is one of the only known amphibian species to demonstrate partial migration, with a subset of the population migrating to terrestrial habitats after the breeding season while the rest remain in the breeding pools. In this study, the authors examined the fitness costs of migration in females of this species in Virginia, USA. Field enclosures were used to sample the egg laying behaviors of resident and migrant newts across the breeding season. Despite resident females being larger than migrants, there was no difference observed in the timing of egg laying or the number of eggs laid. The eggs of resident females did develop into larger larvae than those laid by migratory females; this may be due to the larger size of resident females. The authors suggest that future work should examine the cost of migration for male newts as they expect that, due to male-male competition, mate availability, and sperm precedence, migration may be more costly for males.

Grayson, K. L., and H. D. McLeod. 2009. Evaluating the reproductive cost of migration for females in a partially migrating pond-breeding amphibian. Journal of Zoology 279:71–77.

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Nest-site Selection in a Freshwater Turtle

Nest-site choice can have significant consequences on incubation conditions, and in turn, on the phenotype and fitness of hatchlings. In species that lack parental care, nest sites may be chosen by females to maximize offspring fitness; alternatively, nest sites may be chosen for other, non-selective factors, including random nest-site selection and socially induced nest-site selection ("social facilitation," where gravid females simply lay clutches where other conspecifics have chosen to oviposit; an infrequently considered hypothesis). In this study, the authors have examined nest-site choice in the South American freshwater turtle *Podocnemis unifilis* in Venezuela to determine if nest location patterns best represent random processes, adaptive nest-site selection (selection of nest-sites exhibiting environmental conditions which maximize the fitness of the offspring), or social facilitation. Results demonstrated that nest-site selection was non-random; however, environmental conditions at nest sites were not associated with offspring survival. The authors suggest that these results are most indicative of social facilitation. Furthermore, nest sites clustered closely together and laid on the same night suffered lower predation than nests laid on different nights. The authors suggest that selection operating on nest-site choice in this species is likely to be related to maximizing conspecific cues, and less likely to be related to environmental conditions of the nest itself.

Escalona, T., N. Valenzuela, and D. C. Adams. 2009. Nesting ecology in the freshwater turtle *Podocnemis unifilis*: spatiotemporal patterns and inferred explanations. Functional Ecology 23:826–835.

Correspondence to: Tibisay Escalona, Department of Ecology, Evolution, and Organismal Biology, Iowa State University, Ames, Iowa 50011, USA; e-mail: escalona@iastate.edu.

Perceived Beauty of Snakes Consistent Across Cultures

The study of the innate tendency for humans to relate to other animals, termed "biophilia," has revealed, among other phenomena, that categorizations of animals are consistent across cultures. In this study, the authors have examined whether this cross-cultural similarity extends to aesthetic perceptions of snakes. A number of photographs of pythons and boas were shown to people from the Czech Republic and from Papua New Guinea and they were asked to rank the photographs in order of beauty. The perceived beauty of the photographs between the two cultures was found to be tightly correlated. The authors suggest that this result may be important for conservation policies, as humans may be more likely to support conservation of some species over others.

Marešová J., A. Krása, and D. Frynta. 2009. We all appreciate the same animals: cross-cultural comparison of human aesthetic preferences for snake species in Papua New Guinea and Europe. Ethology 115:297–300.

Correspondence to: Daniel Frynta, Department of Zoology, Faculty of Sciences, Chareles University, Vinićná 7, 128 44 Praha 2 Czech Republic; e-mail: frynta@centrum.cz.

Complete Mitochondrial Genomes Used to Infer Higher-level Salamander Relationships

The family-level phylogentic relationships of living salamanders remains an area of controversy, largely because resolving these relationships is complicated by the fact that salamanders have a long evolutionary history, with diversification occurring within a relatively short time. In this paper, the authors have examined these family level relationships by sequencing seven complete mitochondrial genomes of salamanders from 5 of the 10 families, four of which were not previously represented. Combined with published genomes representing 6 of the 10 families and a number of outgroups, the authors used two different data sets to ascertain phylogenetic relationships: one combined the entire mitochondrial sequence (except for the D-loop region), and the other used the deduced amino acid sequence for the 13 mitochondrial protein coding regions. Two Bayesian-inference programs (Multidivtime and BEAST) were used to perform molecular dating analyses. The analyses of the two data sets recovered similar phylogenetic relationships (discrepancies include the precise placement of Rhyacotritonidae), with each family shown to be monophyletic. The internally fertilizing salamanders formed a clade made up of two well-supported clades: one consisting of Ambystomatidae, Salamandridae and Dicamptodontidae and the other comprised of Proteidae, Rhyactritonidae, Amphiumidae and Plethodontidae. The results also support the hypothesis that Sirenidae is the sister-group to all other salamanders. The dating analysis indicates that the diversification of living amphibians occurred from the Late Carboniferous to the Early Permian, later than previously thought. Further, it was estimated that living salamanders originated in the Early Jurassic, while most families had diversified by the Late Cretaceous.

Zhang, P., and D. B. Wake. 2009. Higher-level salamander relationships and divergence dates inferred from complete mitochondrial genomes. Molecular Phylogenetics and Evolution 53:492–508.

Correspondence to: Peng Zhang, Department of Integrative Biology, Museum of Vertebrate Zoology, 3101 Valley Life Science Building, University of California, Berkeley, California 94720-3160, USA; e-mail: alarzhang@gmail.com.

Nitrate Impacts Male Attractiveness in Newts

Endocrine disruptors released by human activities have been demonstrated to have serious negative impacts on wildlife, both on the fitness of individual organisms and on population dynamics. As endocrine disruptors operate on hormonal systems, they can impact metabolism, development, reproduction and behavior, and are commonly associated with mortality and malformations. However, non-lethal endocrine disruptors can still have more subtle yet still serious consequences for individual fitness and population dynamics. In this study, the authors have examined the impact of a specific endocrine disruptor, nitrate (a chemical commonly used in agriculture), on the expression of male secondary sexual traits in the palmate newt *Triturus heleviticus* from western France. The authors exposed male newts to high (but realistic) nitrate levels and then examined expression of secondary sexual traits: tail height and hind-foot web area. Males exposed to the nitrate treatment for three weeks demonstrated reduced growth and expression of secondary sexual traits. Exposure for 10 days did not have an impact on the expression of secondary sexual traits, but females preferred males unexposed to nitrate levels in olfactory female-choice trials, but not visual trials, regardless of their length of nitrate exposure. The authors suggest that nitrate may alter population dynamics both by interfering with the development of male secondary sexual traits, but also by disrupting the production of olfactory cues.

Secondi, J., E. Hinot, Z. Djalout, S. Sourice, and A. Jadas-Hécart. 2009. Realistic nitrate concentration alters the expression of sexual traits and olfactory male attractiveness in newts. Functional Ecology 23:800–808.

Correspondence to: Jean Secondi, LEESA Université d'Angers, 2 bd Lavoisier, 49045 Angers cedex, France; e-mail: jean.secondi@univ-angers.fr.

Pathogenesis of Chytridiomycosis

Although chytridiomycosis, the amphibian skin disease caused by the pathogen *Batrachochytrium dendrobatidis* (*Bd*), has been strongly implicated in amphibian declines globally, the mechanism by which it causes death has not been established. In this study, the authors have sought to investigate the pathogenesis of chytridiomycosis by following *Bd* infections in green tree frogs, *Litoria carulea*, in laboratory experiments. The results of histopathology on skin biopsies and PCR analysis confirmed that disease symptoms and mortality occurred in individuals with the highest levels of *Bd* infection. The authors also monitored epidermal electrolyte transport in skin preparations, changes in blood and urine biochemical parameters and cardiac electrical activity from clinically diseased, aclinical and control frogs. Electrolyte transport across the skin was inhibited by greater than 50% in samples from diseased frogs and sodium and potassium levels in the plasma were also significantly reduced. As there was no observed difference in water volume, the authors suggest that the decreased sodium and potassium levels observed in diseased frogs are a result of reduced sodium and chloride channel activity, rather than dilution by water. The authors suggest that these epidermal channels are potentially disrupted by the release of fungal toxins, or by direct damage to infected host cells. Frogs in the terminal stage of infection were administered an oral electrolyte treatment and did recover some function and lived more than 20 hours longer than untreated frogs. While this treatment does have some efficacy, the authors suggest that unless epidermal damage can be revered it will not prevent death from *Bd* infection. Cardiac electrical activity of severely diseased frogs in the final stages of life resembled cardiac standstill, or cardiac arrest, which the authors suggest is related to the electrolyte level abnormalities, and is likely to be the proximate cause of mortality in chytridiomycosis.

Voyles, J., S. Young, L. Berger, C. Campbell, W. F. Voyles, A. Dinudom, D. Cook, R. Webb, R. A. Alford, L. F. Skerratt and R. Speare. Pathogenesis of chytridiomycosis, a cause of catastrophic amphibian declines. Science 326:582–585.

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OBITUARIES

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Henry S. Fitch (1909–2009): Field Notes on a Wonderful Life

Henry Sheldon Fitch passed away on 8 September 2009, just a bit shy of his 100th birthday (25 December). In lieu of a traditional obituary, and because an autobiographical account of his life recently appeared (Echelle and Stewart 2000), several former students and colleagues each describe their personal memories of the man deservedly referred to as the "father of snake ecology." Although each of the remembrances brings a different perspective, three common threads run through all of them, namely: Henry Fitch's energy, enthusiasm, and decency.

Henry Fitch and the Practice of Natural History

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Texas Alligator Lizards were first described from the Devil's River in 1858 and a century later, when I encountered them in photographs, there was still almost nothing known about those snaky, bright-eyed reptiles. As a Missouri youth, hungry for wilder places and imagining myself a trailblazing naturalist, I pored over accounts in Hobart Smith's *Handbook of Lizards* of two related West Coast anguids—especially field studies by Henry Fitch, who referred to them as "unusually intelligent" and saw a Southern Alligator Lizard hold off Yellow-billed Magpies by hissing and threatening with open jaws, tail curled forward like a shield. Someday, I thought, I'll roam the Mexican borderlands and learn something exciting about *Gerrhonotus infernalis*!

Fitch's photo also caught my attention among the "influential saurologists" profiled in Smith's *Handbook* because he wore a World War I cavalry hat and looked intense, as if distracted from some important task. His publications in our local college library provided a University of Kansas address, so I wrote announcing my upcoming herpetological career and asking questions about proposed Texas fieldwork. However pretentious that letter, right back came Henry's cordial, hand written explanation of how to sex alligator lizards: "By grasping the base of the tail, gently twisting it, and exerting pressure with the thumb ventrally, one can cause a hemipenis to be exposed. Failing in several such attempts, one may be reasonably sure the specimen is a female."

I knew ventral meant underside and penes were for copulation, but couldn't have realized a high school internship with Henry would set my course or that he would author almost 200 publications, more than 4,000 pages on plants, snails, spiders, and diverse vertebrates. This unassuming man started graduate work at Berkeley's Museum of Vertebrate Zoology in 1931, when the discoveries of Charles Darwin and Alfred Russel Wallace were still relatively fresh, and took his first academic position in 1948, five years before James Watson and Francis Crick unraveled DNA. Decades later, after Henry summarized half a century of fieldwork at a symposium in his honor, a graduate student wryly noted that thanks to him she couldn't call four years of horned lizard population research "long term." Applause typically occurs *after* presentations, but his arrival at the podium that day provoked a standing ovation before he began speaking.

With Henry's passing I want to honor his impact on biology and me personally by reflecting on a conundrum. Although Darwin, Wallace, and countless others have been drawn into nature by orchids, beetles, or whatever seized their fancy, and this is surely truer now than ever before, acclaim typically comes from generalizing rather than gathering facts. Ernst Mayr, for example, was renowned for evolutionary theory and less widely so for describing more than 400 new species and subspecies of birds. At first glance then, Henry's career-long focus on organisms seems anachronistic, the widespread esteem in which he's held a bit surprising. In a forthcoming book, *Tracks and Shadows: Field Biology as Art*, I've set out to illuminate that stature as well as more generally assess the enduring values of natural history. Here I'll draw on correspondence and interviews of my teenage mentor, with the goal of addressing a question: why did he do it?



HSF and Rainbow Trout: ca. 1920 at Klamath Lake, Oregon. Photo courtesy of Alice F. Echelle.

One of our extended dialogs was soon after Henry had fallen and spent a chilly night stranded in a creek, and except for the incident's notoriety he seemed surprisingly unfazed —search dogs were hopelessly confused because his scent trail was *everywhere* on the Reservation, and he'd been conscious when helicoptered to a hospital. Daughter Alice was visiting her folks, and we talked all afternoon and late into evening. Almost 80, with raven black hair, Virginia served fried chicken, mashed potatoes with gravy, corn on the cob, and home-made rolls, and she fairly sparkled as conversation meandered from our first visit and the whereabouts of former graduate students to details of Fitch family life. When I smiled at her mention of "youthful indiscretions," Virginia said she married young and divorced the other guy. "Then," she exclaimed, grinning at me and hugging her husband from behind his chair, "I met this wonderful guy!"

From time to time I checked a list of questions, and although in correspondence Henry had been enthusiastic about my book proposal, his answers weren't effusive. I'd known this wasn't going to be easy, if for no other reason than constitutional reticence—as Randy Reiserer wrote in a dissertation acknowledgment of his undergraduate advisor, "I never met anyone who can say so much with so few words, or indeed, without any at all." But I wanted to understand why Henry does the work, keeps catching still more snakes, and what the practice of natural history meant to him, so finally I blurted out something about having my own problems shrink in the face of grandeur and diversity. "Sounds good to me" was all he said, with a soft chuckle and maybe a hint of irony.

I also hoped to learn how Henry knew what to record, given he began gathering data in the 1930s for which there were no guiding theories. His papers typically set forth the ecology of target species, with insights woven among empirical findings—the thesis work on alligator lizards, e.g., addressed advantages of viviparity by noting that "Eggs left in the ground are exposed to…egg-eating reptiles, mammals, and insects, and to extremes of temperature and danger of desiccation, while those carried by the female probably stand a better chance of developing into independently successful young." In 1949 he'd laid out in *Ecology* details of *what* to write down, but almost nothing as to *why* particular information would interest other biologists. And in 1966 Robert MacArthur and Eric Pianka's brilliant paper on optimal foraging would inspire widespread measurement of parameters that Henry had been recording for decades

with no conceptual prompting.

So I kept coming at the questions from various directions, hoping Virginia and Alice would jump in with something definitive or nudge him for details. My query about god resulted in a slight pause and "I have no religious beliefs although raised in that environment. Natural history does it for me." Asked about favorite habitats, Henry attributed his preference for deserts, "because they are open and have interesting animals," to a Nevada field trip during graduate school. At the mention of favorite species, he responded "alligator lizards, Copperheads, and gartersnakes, because they have interesting natural histories." By evening's end the best I could get was "my initial interest in zoology was innate" and "I wrote down everything that interested me."

Two years later I was back trudging up a hill on the Reservation. Henry was audibly winded as we crested the familiar limestone ridge and explained without a trace of self-pity that he'd lost stamina but hoped to complete one more field season. Otherwise he seemed no different than my last visit and at 91 his hair was light brown. He walked slightly stooped, in work boots with visibly thin soles, and was wearing khaki pants, a Berkeley herpetology course t-shirt, and a baseball cap decorated with various university insignia. The tattered cotton bag stuffed through his belt, custom made by Virginia, was for carrying snakes back to the house. He used a smooth, sturdy stick with a nail head protruding on the bottom to steady himself, hold onto tree limbs, turn over cover items, and probe matted grass for the long narrow tin pieces he'd laid out to attract snakes.

As our conversation turned to current projects, Henry spoke with quiet fatherly pride of a paper with Alice about changes in tree diversity over the past 50 years at the Reservation. Their findings were thought-provoking: Once largely prairie, perhaps the best-known square mile in North America had lost a third of its fauna since he arrived because of fire prevention, lack of grazing, and forest encroachment. On the bright side, there were still Bobcats and Timber Rattlesnakes in the vicinity, and a Black Bear was seen near here recently. As we returned to the house he pointed out a large cedar by the driveway, planted many years ago as a tiny family Christmas tree.

That night Henry sat in the front row for my campus lecture on organisms as the central focus of biology, during which I held up his capstone opus, *A Kansas Snake Community*, and introduced my teenage hero. I praised Henry's contributions to ecology and systematics, then said his greatest legacies are immediate products of the work itself—tens of thousands of observations archived, many museum specimens collected—and that in the scholarly tradition of his Berkeley advisor, Joseph Grinnell, he'd bridged Darwin's synthesis with twenty-first century science. As it happens, those individual organisms he studied demonstrated such things as substantial shifts in Copperhead diets over the decades, as prey populations responded to the habitat changes he documented.

Henry's accomplishments amounted to several better-than-average careers, I told the K.U. crowd, given his California and Louisiana work, decades at the Reservation, and his tropical expeditions. In fact, although mainly known as a herpetologist, his publications on mammals would eclipse those of the average "mammalogist." During the lecture I showed photos of island Cottonmouths that eat fish regurgitated by seabirds and have exceptionally large young, exemplifying, I pointed out, unusual and unexpected opportunities for research and enlargement of theory. Afterward Henry asked about the number of young in island snake litters, said he'd enjoyed my talk and our hike, then added with a characteristic grin and swing of the chin, "Oh, and thanks for the plug!"

Work can be a job, a career, or a passion, and for Henry the practice of natural history was all three. When I complained about funding he responded "I have always spent my time on whatever interested me—with or without grants—and have greatly enjoyed all my projects, especially the fieldwork." In his eighties he was quoted in a book on Kansas personalities, "I wouldn't change a thing. People who work with animals in the field, whether snakes or birds or rodents or monkeys, find it deeply satisfying and wouldn't trade it for any other kind of career—even though



HSF and Virginia Fitch in 1975 at the University of Kansas Natural History Reservation (now the Fitch Natural History Reservation). Photo by Michael V. Plummer.

it may not be very financially rewarding." And in 1995 he wrote Alice, "If as a young person I could have dreamed of my future and the world I would like to see, it would have been about the same as the life I have had. Getting a Ph.D., having a loving, supportive wife, children like you and John and Chester, grandchildren like Tyson, Lena, and Ben, living on the Reservation, teaching natural history, studying anoles and pitvipers, and making two dozen trips to nine countries in the tropics for herpetological research have all been great experiences."

One visit, after the Fitches walked me to my truck, I drove back to Lawrence on a sultry Kansas night. A huge moon shone through fog and orange lightning flashed over surrounding fields as I pondered my admiration and affection for Henry. What, I wondered, makes him *tick*? Certainly he marched to his own drummer, unmindful of fads, which makes it all the more fascinating to contemplate his accomplishments, as well as how that stance affected his life more broadly. Maybe verbal frugality reflected limited interest in analytic thought, personally and professionally, which if nothing else protected him from the pettiness so common in universities. Maybe he was always so much within himself that he simply didn't pay much attention to theorizing. And maybe those like Henry who go deeply into nature as children—he was catching snakes as a five-year-old—are especially prone to immersion as adults. We have to be out there.

Just weeks before Henry died he asked Alice and her husband Tony Echelle, if they might visit a local creek and catch watersnakes. When she replied, "Well, what then dad?" he said simply, "We'll mark and recapture them." Evidently the answers to my questions are equally straightforward: Henry was always driven by passionate curiosity and a penchant for detail, accentuated by parental encouragement, and those attributes combined in grad school with a framework for understanding biological diversity that harked back to Darwin and Wallace. That was enough. His approach worked, against formidable odds at times, and he was not inclined to do otherwise. A special gift for field biology and quiet but stubborn confidence must have been obvious to Grinnell in 1931, when an unusually shy but promising new student arrived at Berkeley, fresh off an Oregon pear ranch. Those traits were undiminished to the end, and Henry's long, happy life was inseparable from the quest to understand nature.

Reminiscences of Henry S. Fitch

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For the past half century I was fortunate to have been a colleague and friend of Henry S. Fitch. During that time, we served on doctoral committees of one another's students, co-advised some graduate students, and team-taught a graduate course in reptile biology. Although we never collaborated on a published paper, we each named a species of *Anolis* for the other. Henry avoided university politics and only reluctantly attended departmental meetings. Many of his colleagues mused that Henry lived in his own little world. But that world was much larger than they thought. He was at home on the University of Kansas Natural History Reservation (subsequently named for him), where he conducted intensive studies on the ecology and behavior of reptiles. Over the years he witnessed the succession of hardwood forest on the reservation, while methodically searching this square mile of land, capturing and recapturing thousands of snakes, and logging hundreds of pages of notes. His dedicated efforts culminated with the publication in 1999 of "A Kansas Snake Community: Composition and Changes Over 50 Years."

However, Henry had a long and distinguished publication record before this finale. While at the University of California at Berkeley prior to moving to Kansas in 1948, he published a classic work on alligator lizards in 1935 and a highly perceptive work on western garter snakes (*Thamnophis*) in 1940. Two of his best-known works are on the natural history of reptiles, especially that on the Five-lined Skink in 1954 and his exhaustive study of the Copperhead in 1960. In addition to these systematic and ecological studies, Fitch provided us with important syntheses—reproductive cycles in lizards and snakes (1970) and sexual size differences in reptiles (1981). Consequently, his publications are cited extensively. A number of years ago, while Fitch was still an active member of the department, the chairman took it upon himself to tally citations to publications by all members of the department. For several consecutive years, Henry Fitch was the most cited.

During the warmer months of the year, the major exception to conducting field studies were the basketball games on the "sand lot" by the Fitch's residence. Games would involve all members of the family and anyone who happened to be visiting the reservation. Henry displayed his usual dogged determination from his fieldwork to the basketball "court," and one quickly learned to avoid his elbows under the basket.

In 1967 I introduced Henry to the tropical rainforest in Amazonian Ecuador, where he was the only member of the field party who would work in the field during the torrid afternoons, all the while lamenting the apparent absence of snakes. Customarily he went into his cabin and emerged a few minutes later with a towel wrapped around his middle and untied sneakers on his feet. To get to the dribbling bamboo spout loosely referred to as the shower, he had to cross the dirt "courtyard," the home territory of a very aggressive goose, which took particular delight in nipping at Henry's buttocks. One afternoon we heard Henry exclaim "ouch," as he stood naked snapping his towel at the goose. He was completely unaware that he was the "floorshow" in the middle of camp.

Here I learned that Henry had poor night vision and consequently was primarily a diurnal biologist, but he was constantly amazed that we found so many snakes at night. Only after much cajoling did he accompany us twice on nocturnal forays during a month in the forest. However, I like to think that I influenced much of Henry's subsequent work in the tropics, where he conducted numerous studies on the systematics and ecology of anoles and on populations and conservation of iguanas.

Henry Fitch was one of the last remaining naturalists. His breadth of knowledge was matched by very few of his contemporaries and scarcely imagined by his younger colleagues. His careful work on natural history is well worth emulating. Our knowledge of animals in nature would be far greater if many more biologists around the world followed in the footsteps of Henry S. Fitch.

Memories of Henry Fitch

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Henry Fitch was one of the most gracious, kind, and gentle men I have ever known. I greatly respected him for his long list of professional achievements, but I also respected him for the man he was and how he treated others. He was always the gentle encourager to me and I often think of his example when I get in an exasperating situation with my students or colleagues. I never heard a degrading word spoken against Henry the man by anyone. Any and all who happened to come by the Natural History Reservation were heartily welcomed by Henry and his lovely wife Virginia, and that seemed to happen frequently.

My formal association with Henry began in July 1972 when I came to KU to begin a Ph.D. program. I found it difficult to believe I had the opportunity to work with such a professional giant. I remember standing in awe as we spoke about potential research projects and thinking that since Henry was 64 at the time, I just might be his last student before he retired (wrong! I only missed by about 30 years). Henry was THE man as far as snake ecology was concerned and I assumed my dissertation would become yet another monograph of a Reservation snake species. But then he suggested we go down on the "Kaw" (Kansas River) to look for softshell turtles. I was fascinated by the sandbars, the softshells, and Henry's nonstop fountain of knowledge about them – talk about information overload! But what I remember most about our inaugural softshell trip was this 27-yr-old kid in the prime of life trying desperately to keep up with an aging 64-yr-old walking (more like running) on the soft sand as he talked. I looked for a red "S" on his chest.

Henry once had a guest at the Reservation, a gentleman from the Bombay Natural History Society, and because India is near the center of softshell diversity, Henry asked me to take the gentleman out on the Kaw and show him our American softshells. By that time, I had captured hundreds of *Apalone mutica* and I assured Henry that it would be no problem seeing numerous softshells. Any field biologist could probably guess what happened. After working hard for a couple of hours, we saw maybe two or three juvenile softshells. I learned that day that one should never make such rash statements regardless of how confident he is about seeing animals in the field. Henry was apologetic to the gentleman and I was embarrassed, but Henry never said another word about it to me.

Henry frequently encouraged his students to do "interesting" side projects along with their thesis or dissertation work. He suggested a project on softshell glands in the summer of 1972 that would fit in "nicely" with my ecological Ph.D. work. Being a swamped and overwhelmed new grad student, I wasn't terribly interested in his suggestion at the time, but I never forgot it (probably because of who suggested it). Well Henry, you would be pleased to know that I finally did do the project and it was published in 2009 just before you left us. Sorry I'm so slow; it only took 37 years. Thanks for the treasured memories.

Henry Fitch at Home and in the Tropics

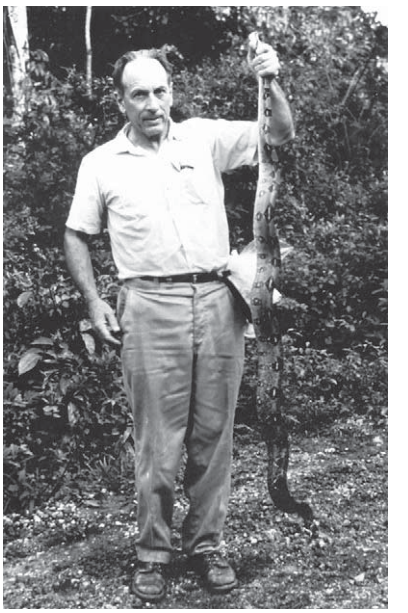
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I was, herpetologically speaking, incredibly green when I entered the University of Kansas as an undergraduate in 1967. The attraction of KU was its long history of herpetological fieldwork in the Neotropics, and I was aware of the ambitious research program of William Duellman and his students in, at that time, Ecuador. I was not, however, aware of the existence of Henry Fitch. I did know that I wanted to study the way snakes lived, but I had absolutely no idea of how to do it or that anyone was already doing it. Eventually, while browsing through the library in the herpetology division, I came across *Autecology of the Copperhead*. I read it from cover to cover, realized this was the kind of research I wanted to do, and I had to meet Dr. Fitch, who just happened to teach at KU.

The Fitches lived on the grounds of KU's Natural History Reservation and I became a frequent visitor, often making the rounds of coverboards (sheets of tin) in Quarry Field to collect the Prairie Ring-necked Snakes on which Dr. Fitch was then working. I have fond memories of the warm hospitality of Virginia Fitch, energetic basketball games played on the bare ground at the Reservation, the Fitch's yellow VW bug with the smiling happy face stuck to the roof, and of many seemingly carefree hours tramping over the Reservation and encountering Osage Copperheads, Eastern Yellow-bellied Racers, and Prairie Kingsnakes. Despite the time we spent together while I was an undergrad, I somehow convinced Dr. Fitch to take me on as a graduate student, and thus began a 30-year collaboration.

Although my primary interest was in snake ecology, and Dr. Fitch's long-term snake population studies continued to be the focus of his Kansas fieldwork, we never collaborated on a research project with an ophidian concentration. Our tropical fieldwork always had lizards as our primary objective. Mexico was the scene for our first field trip together, primarily in the states of Chiapas and Oaxaca, to collect ecological and morphological data on various species of *Anolis*. This was followed by travels in Nicaragua and Belize for work on the conservation of *Iguana* and *Ctenosaura*, and then more Mexican fieldwork (where one night he suggested we bathe in the Pacific at about 10 pm; I was terrified, certain some creature would lop off my legs while I tried to get clean). Aside from the many hours spent in a truck or jeep, once at a site there was little downtime. On weekends in Nicaragua, we did not have access to the jeep and driver provided for iguana work, but Dr. Fitch knew that anoles awaited us somewhere, so off we went with local transportation, never quite knowing where we were headed or if we'd get back to our quarters in Managua. It was exhausting fun.

I became enamored of the West Indies in the late 1970s, and was pleased when Dr. Fitch joined me in the Dominican Republic (DR) for a project with *Anolis bahorucoensis* in 1985. I know he had a good time in the DR because he kept commenting on the numbers of lizards encountered everywhere all the time. He came up with one wonderful idea after another on how best to study this elusive anole. He later returned to the DR to study the invasive *Anolis cristatellus* and its impact on native anoles in the La Romana area. Cumulatively, we spent months together doing fieldwork in the tropics. Dr. Fitch's energy and enthusiasm for looking for lizards and snakes never waned and, although I was much younger than he, it was not always easy to keep up with him. He had no qualms about sleeping in crummy hotels and, despite his diabetes, he could be pretty malleable when it came to food (although we ate Spam and boiled potatoes *every* night for six weeks in Mexico). I sense Dr. Fitch never lost the enthusiasm I last observed more than 20 years ago, and that's borne out by his incredible productivity well into his 90s. As he noted in an interview conducted by his daughter in 2000 (Echelle and Stewart, 2000), "interest in reptiles and amphibians has been a dominant influence in my life, and other interests have seemed relatively minor." I recall him telling me about one of his KU colleagues who went off on a two-week fishing trip. He intimated that he would not be able to stand doing that, and seemed genuinely perplexed that his colleague could forego research for that long.



HSF and *Boa constrictor*: Taken in February 1972 in Chiapas, Mexico. Photo by Robert W. Henderson.

Dr. Fitch was the ideal collaborator: He always met deadlines (and expected the same from me), and was generous in sharing authorship. I'm sure I must have tried his patience many times (while a student, often showing up at his home unannounced to discuss some "important" issue), but he never visibly lost it. Even a minor falling-out was quickly forgotten. He did, however, at one time inform me that I was no John Lynch or Marty Crump!

While he was alive, Henry Fitch was an inspiration to me and I consider myself amazingly fortunate to have been one of his students and collaborators. He remains my herpetological inspiration and I'm confident that his incredible body of work will continue to inspire researchers for many decades to come. We spoke infrequently on the phone during his last years on the Reservation (and before moving in with his daughter and son-in-law in Stillwater, Oklahoma), but one of our last conversations was my favorite. I don't recall the exact wording, but you'll get the idea.

RWH: So, you must be, what, 91 or 92 now?
HSF (chuckling): No, 93.
RWH: Well, how're you doing?
HSF: Not so great. I have a bad hip and my back is painful, so getting around is difficult.
RWH: I'm sorry to hear that. No fieldwork, I guess.
HSF: Ah, well I just came back from radio-tracking six Timber Rattlesnakes.
RWH (shaking his head in awe and admiration): Amazing.

I always hoped he knew how much he had influenced my efforts and I was looking forward to sending him a copy of a forthcoming book on the natural history of West Indian amphibians and reptiles. I doubt that he would've been up to reading it, but I did want him to know that I had written it (with Bob Powell). Perhaps my ego (or insecurity) hoped he'd at least think, "Bob's done OK."

In the Field with Henry Fitch

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I received a phone call from Alice Fitch Echelle in the fall of my junior year at Baylor University. I knew Alice, Henry Fitch's daughter, through her husband Tony Echelle. Tony was teaching a graduate course in Systematics at Baylor, and had given me permission to enroll in his class as an undergraduate. That course opened my eyes to the exciting possibilities of phylogenetics. Tony and Alice often let me come along on their many

field trips to collect fishes throughout Texas, so Alice knew that I was enthusiastic about fieldwork.

Over the phone, Alice described how her father had received a small grant to study the impact of human exploitation of iguanas for food, and was planning a semester-long field trip through Mexico and Central America. As Henry was nearing retirement, Alice was worried about him making the trip alone, and she knew that I had a passion for anything to do with herpetology. She wanted to know if I was interested in taking off a semester from school and accompanying Henry in the field.

"I would love to do it, but I'll need to think about it," I said, as I considered how delaying my graduation by a semester might affect my future plans for graduate school. I hung up the phone and thought for about 30 seconds, then called Alice back. "I'll do it…when do we leave?" That was the extent of the background and the planning for what was to be my most educational semester as an undergraduate.

I was already quite familiar with Henry Fitch through his books and research articles. I had met him the previous summer as he visited Alice and Tony, when I asked him to sign my copy of his book, *Reproductive Cycles of Lizards and Snakes*. I remember that he was pleased to see that my copy of the book was worn and obviously heavily used. Henry had been embarrassed and modest, acting as if he felt honored to be asked by an over-eager undergraduate for his autograph. I couldn't believe that such a famous person could be so modest.

Henry drove down from Kansas and picked me up in Texas in early January, in an old International Harvester pickup with a well-worn camper in the bed, which was to be our home for the next four months. We crossed into Mexico the next day, and I learned very quickly that there was little justification for Henry's modest demeanor. I asked questions about everything we saw, and rarely did I manage to stump him. At every camping site, I caught practically every herp, fish, insect, spider, crustacean and mammal that I could find, and Henry told me something about them all. He also would frequently explain fundamental concepts of geology, climate, ecology, and just about every other aspect of natural history as we slowly moved south through Mexico into Central America. His impromptu lectures stimulated me to write long entries in my field journal every evening.

The funded purpose of the trip was to study iguana exploitation, and we did that. But Henry was fascinated with anoles, and it became clear to me that Henry was much more interested in studying the systematics, ecology, and behavior of anoles than he was in studying iguanas. That was fine with me; I didn't care what we studied, as long as it was related to herpetology. We traveled fairly slowly, so that we had plenty of time to collect anoles and other herps at every campsite.

I had never before met an adult who was so completely immersed in the study of natural history, so we hit it off immediately. Henry was as enthusiastic about being in the field as I was, at least by day. I was surprised, however, that Henry did not accompany me on my nightly forays into the forests around our campsites after dark. His diabetes had affected his night vision, and so he did not see well at night. But he was always enthusiastic about all the herps I would find and bring back to him in the camper after dark, and we would often stay up late talking about our latest captures and what interesting research problems they might suggest. To Henry, every species provided new questions that were waiting to be answered. I couldn't imagine a more exciting life.

As much as I was enjoying myself, there were a few aspects of Henry's approach to fieldwork that caused me some aggravation. First, he insisted on doing all the driving, even though I'd been asked by Alice to accompany Henry on the basis that he would need some help. Given his poor night vision, his night-driving proved quite frightening to everyone on the road except Henry, and more than once I was convinced we would drive off one of the many precipitous roadsides in the mountains of Central America. Eventually, I insisted that he had to let me drive at night, or else I would only get in the truck with him by day. We drove only by day from then on; I was still not permitted to drive the old International Harvester pickup.

A second minor aggravation was what can generously be described as Henry's rather parsimonious nature. We bought and cooked all our own food, which was fine with me, except that Henry was a straight Midwestern meat-and-potatoes man, and we almost never had any meat. So we ate mostly potatoes. After the first few weeks of a steady potato diet, I was getting desperate for something I could taste. I started buying a few peppers and spices from the markets on the sly, and catching land crabs, freshwater prawns, and fish from the streams around our campsites. Soon I was cooking up two meals: boiled potatoes for Henry, and a spicy concoction of whatever I could catch around our campsites for me. Henry politely tried my attempts at culinary diversity a few times, but he always returned to potatoes for dinner. Sometimes, for excitement, he would put a little salt and pepper or butter on them, or even add a scrambled egg when he was feeling extravagant.



HSF examining an iguana in a market in El Salvador, February 1979. Photo by David Hillis.

Other than gasoline (which cost about 30 cents a gallon in Mexico at the time), I think Henry was spending less than dollar a day for all our other living expenses. So when we reached the Guatemala–El Salvador border on a Saturday in February, and Henry discovered that the weekend fee for crossing the border was 50 cents/person, but that the weekday rate was 25 cents, we of course had to turn around and camp out in Guatemala until Monday morning to save 50 cents. At our Guatemalan campsite near the border, I found synbranchid eels in a small stream, and I had a blast figuring out how to catch them (and I still have fond memories of *Synbranchus* stew). By Sunday I had to hang my clothes out to dry, and some locals who had been drinking decided to take advantage of the situation. They grabbed my clothes and ran, and I briefly gave chase, until one of them turned and pulled out a machete. I returned to camp and suggested to Henry that we might want to find a new camping spot. Henry did not seem very interested in doing so until rocks started raining down on us from the cliff above our campsite. We pulled out just as a large rock smashed our windshield. When I last saw that pickup many years later, that broken windshield had never been repaired.

On Monday morning after the windshield-smashing event, we arrived at the border at 8 AM, just when the weekend rate was supposed to change back to the weekday rate. But after the customary spraying of the truck with DDT (a ritual that was practiced on both sides of every Central American border), the border official charged us 50 cents a person. Henry objected, and pointed to the clock on the wall, which said 8:05 AM. The border official calmly went to the clock, changed the time to 7:55, and charged us the weekend rate. It was one of the few times in four months I saw Henry mad about anything. For the most part, he would roll with whatever life dished out, and make the best of every situation.

Our study of human exploitation of iguanas and ctenosaurs reached a peak during Lent, when the markets of Central America became well stocked with these large lizards (see Figure 1). Lizard is not considered "meat" by many people who give up meat for Lent, so iguanas and ctenosaurs were sold and eaten by the thousands during this time. But after Lent, we were back into the mountains, looking for more species of anoles. By then, we had hatched a project to study intra- and interspecific variation of anole dewlaps, and were busy collecting series of as many species as we could locate.

One might think that it would have been a physical mismatch to pair a young strapping undergraduate with a professor nearing retirement on an extended field trip. It was…I had a hard time keeping up with Henry. He wasn't fast, but he never stopped. He could walk all day up steep mountainsides in pursuit of the next species of anole, and we did so just about every day. Some years later, as a graduate student at the University of Kansas, I would take public education classes of schoolchildren out to the KU Natural History Reservation where Henry and his wife Virginia lived. Even well into his "retirement" years, Henry took great pride in leaving kids in the dust. As he cruised through the Reservation, he would grab snakes as he walked, checking their ventral clips for individual identification. "Aha! It's female number 1675! I have captured this racer more than 300 times in her life…I am glad to see that she is still alive." The kids were always wide-eyed with amazement, as they stood there trying to catch their breath before Henry rushed off to the next snake.

As it turned out, Alice need not have worried about Henry's "advancing age" when we set off for our Central American field trip. Henry remained active in the field for another three decades after that trip…a full career for many people. Henry collected more data after he "retired" than most people collect in their lifetimes. I doubt anyone will ever be able to repeat the kind of long-term autecological studies that he perfected. But more than the specific knowledge that I learned from Henry, what I admired most about him was his child-like enthusiasm for nature and everything in it, and his unquenchable need to ask questions about everything he encountered. Several generations of herpetologists benefited from his wisdom, his kindness, and his passion. Mention his name to anyone who ever met him, and you will get a smile and story. I can't think of a better legacy for a great naturalist who squeezed so much out of such a long and productive life. Henry, we will all miss you, but we will smile every time your name is mentioned.

Henry Fitch as a Mentor and Teacher

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Most herpetologists today know Henry S. Fitch only as a name on his classic papers and monographs (e. g., *Autecology of the Copperhead*, *A Kansas Snake Community*). In this remembrance, I would like to give my perspective on Henry in the roles I knew him best, as a mentor and teacher.

In 1979, all I knew about Henry Fitch was his outstanding publication record. I had been accepted to the Ph.D. program at the University of Kansas for the fall 1979 semester, and, through a series of letters, Henry had tentatively agreed to accept me as his doctoral student. However, he had cautioned me that he was retiring in 1980 and that I might want to reconsider coming to KU as his final student. Thus, in June 1979, my wife Nadia and I drove to Kansas to meet Henry and his wife Virginia for the first time. Little did I know that this initial meeting would lead to a 30 year relationship with Henry and Virginia and that my appreciation and respect for them would go far beyond anything I might have expected.

As we drove on the unpaved entrance road leading to Henry's house on the KU Natural History Reservation (now the Fitch Natural History Reservation), I saw numerous metal coverboards ("shelters" in Henry's terminology) and drift fences scattered at what appeared to be random intervals along the road. As soon as we reached the small, incredibly modest house where the Fitches lived on the Reservation, Henry and Virginia were out the front door to greet us. Almost immediately, I gained an insight into Henry's character: Knowing what to call your presumptive major professor is always a delicate proposition for a new student ("Dr. Fitch?" "Professor Fitch?"), but Henry dealt with that by holding out his hand and introducing himself as "Henry Fitch," and we were on a first name basis from then on. Virginia went even further and gave Nadia and me a huge hug, inviting us in for lunch.

Feeling much more at ease, we only got to the Fitch's front porch when I saw that there were a large series of jars, cans, and snake bags, all holding various live herps. Asking Henry where these came from, he proceeded to tell us that was today's catch and then tell much more about the ecology and natural history of his "finds" than four years of field work and reading had provided me so far. I was struck especially by the detailed notes Henry took on each find and how much data he was extracting from each individual.

After lunch, Henry suggested that we do "a round" of his traps and shelters, and the two of us set off up the hillside by the house. Within minutes I discovered that this 69-year old man was in better shape than most grad students, as he went up the hill on what felt like a trot. As we went, he began to tell me a detailed history of what felt like every tree and critter we saw. Phrases such as "I am hearing a Yellow-billed Cuckoo" were thrown out casually, leading to two thoughts I dared not express: "I thought this was a herpetologist" and "I am glad YOU are hearing this, since I surely don't!"

I was thrilled when we came to the first series of shelters at what was known as Quarry Field, since the pace finally slowed down and Henry said this was the best place to see Copperheads. Sure enough, there were two gorgeous Copperheads curled up under the first shelter we flipped and they were right in front of Henry. Problem was, there were also four Ringneck snakes right in front of me, and, while I had eyes only for the Copperheads (and did not see the Ringnecks), Henry did exactly the opposite. Thus, I went for the Copperheads in front of Henry with my hook and Henry bent down to get the Ringnecks in front of me (thinking, I am sure, "who is this dummy who does not see snakes right in front of him?"). As we bounced off of each other, Henry stumbled forward, putting his foot right in front of the copperheads, one of which immediately struck his boot!. I could see the headline now: "Famed herpetologist killed by venomous snake; new grad student to blame."

Fortunately, the snake managed only to clip the front of Henry's boot, and we quickly captured both Copperheads and at least some of the Ringnecks. After flipping a few more shelters, we had a total of four Copperheads, three of which were marked individuals, one as long as nine years ago. I found this nothing short of amazing, having only recently read that high recapture rates were impossible for snakes, and said as much to Henry. He shook his head and said: "If I had just a few more fences and more shelters, I'd have a 100% recapture rate." I glanced at Henry, trying to decide if he was saying this in jest or if he was angling for a compliment. I quickly realized that neither of these were true; he genuinely felt that he had simply not worked hard enough and needed to do more to satisfy his own standards. What a great example for a new Ph.D student!

A few years later, I got to see a second example of Henry's genuine humility regarding his fieldwork when the noted lizard ecologist Laurie Vitt visited the Reservation. Knowing that Laurie was especially interested in lizards, Henry made sure to check the shelters where he knew Slender Glass Lizards could be found, and we quickly got several of them. When Laurie said something to the effect of "are you going to publish anything on these?" Henry indicated that the sample size was still too small for a solid publication. Laurie asked: "How many of them have you found?", thinking (I am sure) that the answer would be a hundred or so. Henry's response floored us: "About 1500 so far" he said rather casually. When we tried to convince Henry that 1500 glass lizards was nothing short of phenomenal and far more than anyone else had, he just shook his head and said he needed more data! By the way, Henry did publish a monograph on these lizards in 1989; the sample size was 2216 individuals captured 3353 times! (Fitch 1989).

In addition to doing field research with Henry, I was also lucky enough to be his TA for the last two courses he taught at KU, Vertebrate Natural History and Animals of Kansas. Both courses were combined lecture/field trip formats and my main role was driving students to and from the field sites and helping in the field any way that I could. Although

Henry's lectures were detailed and comprehensive, the fun part of both classes was the field trips. Students enjoyed trying to "challenge" Henry by bringing him whatever odd insect, snake skin, or mammal dropping they found, then having him act as a living version of Wikipedia and proceed to lecture them on everything that was known about the species under question. One of my favorite memories was when a student found a newly hatched Five-lined Skink and asked Henry how much the tiny lizard weighed. Henry held the lizard for a few seconds and then replied: "1.15 grams." The class immediately burst out laughing at the absurdly precise answer. So, the whole class walked over to the old, dilapidated building that Henry called his "lab" and we proceeded to weigh the skink on an old triple-beam balance. Sure enough: 1.15 grams! Somewhat awed, one of the students asked "How could you possibly know that?" Henry's response was typically low-key: "When you have processed over 5000 of something, you know their weights pretty well!"

Given Henry's low-key approach and humility, it would be easy to conclude that he was not competitive and that he would let his grad students get away with things. Neither conclusion would be true. I recall quite well the first time Henry came to my study site in northwestern Missouri where I was doing mark-recapture studies on snakes. After catching our first snake of the day, I marked it using scale-clipping (no PIT tags in those days) and proudly showed it to Henry. "Oh," he said, "I guess you don't want to be able to recognize this snake if you capture it again?" This was Henry's way of telling me I was not marking properly, and the message was delivered loud and clear. To this day when I scale clip snakes, I follow Henry's methods and can tell you, they work extremely well.

Henry's competitive nature may be illustrated by something only a select few got to experience, something called "Fitchian Basketball." Henry always had a grass/dirt basketball "court" set up outside his front door and during the spring of 1980, his current students got a taste of how competitive Henry Fitch could be at times. There were eight of us that day, three women (Nancy Zushlag [Henry's master's student], my wife Nadia, and Jim Knight's wife, Karin), and five men (Henry, myself, and three of Henry's other students, Larry Hunt, Luis Malaret, and Jim Knight). When the time came to play, Henry started explaining the "rules"; first, there were two hoops, one at 10 feet, the other at 8 feet. The 10-foot hoop was for the guys, the 8 foot hoop for the women. Next, there were odd but very specific rules about the men and women taking the ball out separately, whether the women could be guarded, and how the points were tallied. What we all found most amusing was how new rules suddenly appeared whenever someone scored against Henry's team. My personal favorite was "no jump shots from the corner," which just happened to be my best place to shoot from. Needless to say, we all spent more time laughing than we spent playing, as watching Henry morph into this competitive jock was something none of us had seen before.

Basketball finished, we then got to see a fine demonstration of Henry's character. Henry was due to retire that year and it fell to our group of graduate students to find an appropriate way to celebrate Henry's many achievements. With the help of Joseph Collins, Bill Duellman, and many others, we organized a symposium at the 1980 herp meetings in Milwaukee, with many of Henry's former students presenting papers. We also planned to publish a volume based on that symposium, which appeared in 1984. After lunch, we sprang all this on Henry, including a plaque made especially for the occasion. Henry was deeply moved (Virginia was in tears), but I could tell that while he was clearly touched, part of him was saying to himself: "I need to get out there and check the shelters…"

No discussion of Henry could possibly be complete without mentioning Virginia. Her pride in Henry's accomplishments and her irreplaceable role in his life cannot be overestimated. Watching her beam from ear to ear during our symposium honoring Henry in 1980 was a joy to watch. For me (and Nadia), Virginia was more like a grandmother than the wife of my major professor. From giving us furniture when we were starving grad students to giving our son his first tricycle, her warmth and devotion to Henry and his students was truly remarkable.

As I think of Henry now, I see him heading off to do another "round" at the Reservation. May he always have as many shelters to check as he could ever want and may his traps always have many marked snakes. When his morning rounds are over, he'll be headed back home, where Virginia has lunch waiting.

Natural History Observations of Henry Fitch

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The Second World Congress of Herpetology was held in Adelaide, Australia in 1994. One symposium was on the biology of snakes, and Henry Fitch was a presenter. For many in the audience, this was their first time to hear the legend in person. So as Henry walked to the podium, the audience's initial mood (or at least mine) was one of excitement, anticipation, and respect.

Henry gave an amazing talk. The theme was long-term (really long-term!) demographic trends of all of the snakes on the Kansas Natural History Reserve. The results were stunning but depressing: the density of essentially every species had declined over time.

The audience (largely snake buffs of the first order) quickly became somber. Adding to the poignancy of the moment, we all recognized that this grim result was being delivered by a kind and gentle man whose deep love for snakes and their natural history had inspired him to carry out a life-long study of these snakes. But the clear conclusion emerging from all of his immense work was that his beloved subjects were declining to extinction. Sometimes, life doesn't seem fair.

Either in his talk, or in the question period afterwards, Henry noted that a primary cause was a policy of suppressing fires on the Reserve: as a result, succession was unchecked, such that habitats on the reserve were increasingly forested and increasingly unfavorable to snakes.

Someone asked, "Why don't you light a fire?" Henry thought for a moment, and then replied quietly, "I can't do that." My distinct impression at the time was that he really did want to do just that, but ethically that he couldn't do so, given his position at the Reserve.

But I also remember distinctly feeling at the time that Henry was sending a subliminal message to us in the audience: "If you want to start a fire..."

For me Henry's talk was certainly among the most memorable ones of the entire Congress. Moreover its central lesson still haunts my thoughts. We should do science because we love the process, not because we need to love the results. Henry Fitch could not have loved the results of his work, but there's no doubt he loved the process.

Henry Fitch: The Twilight of an Incredible Career

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I first met Henry Fitch in 1968, forty-one years ago, while visiting a friend in Lawrence. I'd read many of his papers in the course of my studies, and when I met him again in 1970 I was again impressed by two things beyond his vast store of knowledge. At age fifty-nine he could, while making a round in the field, walk the legs off many people far younger. And, for someone whose many papers had essentially established the field of snake ecology as we now know it, he was incredibly unassuming and reserved (except when playing the, ummm… *rules-modified*, basketball games that then were a Reservation feature event).

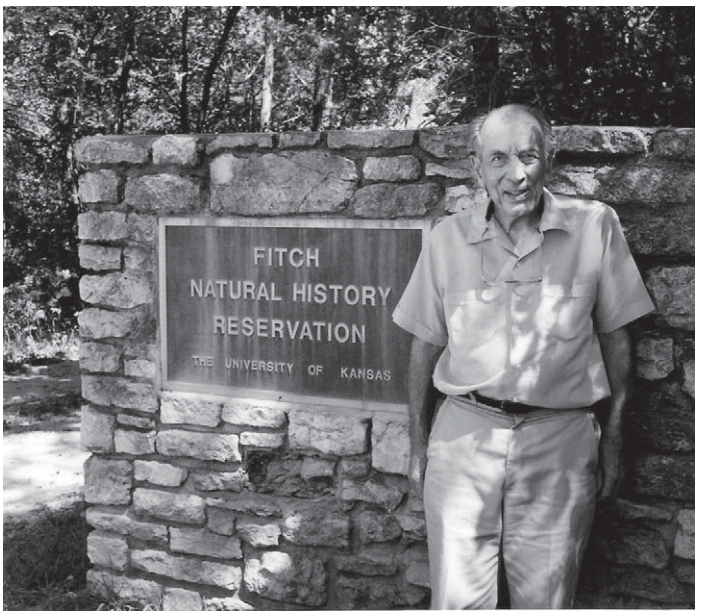
Many herpetologists accompanied this remarkable man into the field in the course of his long, distinguished career. It was my distinct privilege to be among them at various times, and to work with him during the final few years of that career. Our close professional relationship really began in the mid-1980s with our collaboration on Timber Rattlesnake telemetry. I built an effective (albeit awkwardly maneuverable) antenna. Using that and some transmitters (immense by current standards!) assembled by Dr. Tony Shirer and which Henry pushed gently down the throats of large rattlers, we spent a summer gathering movement data that retrospectively turned out more a learning experience about the technique than about the snakes. Henry assimilated all this, and nearly 20 years later, when we had far better equipment and far more background knowledge on the subtleties of using it, we were able to initiate an ongoing study of this species in northeast Kansas.

In 1987 Henry and I received funding from Oklahoma Dept. of Natural Resources to study rattlesnake roundups and their effects on the populations of Western Diamondback Rattlesnakes. It was no secret that Henry's long-term enthusiasm for rattlesnake study wasn't shared by his wife Virginia, perhaps out of recognition that his reflexes were slowing, as do everyone's with time, hampering the avoidance response essential for such work. It's one thing to dodge the feint of a 2-foot copperhead, but quite another to dodge the long strike of a 5-foot *Crotalus*. Virginia's reaction was subdued apprehension. But after some discussion we agreed to handle the captive snakes after cooling them, a reassuring model that Virginia accepted and which proved effective for safely gathering the morphological data we sought.

Henry's enthusiasm for field work and for learning all there was to learn about snake ecology never diminished, though by 2002 time plainly was having its inexorable effect of limiting bone and muscle. In these later years of his career I had retired, and so was able to help him make rounds in the field using one of the field station's "Gator" ATVs. I drove while Henry's gaze was fixed firmly on our destination of the day, wherever it happened to be. By 2003, he was gamely trying to maneuver using crutches on a local ledge that served as a Timber Rattlesnake den. I emphasized to him that I didn't plan to be remembered as the guy who brought him back from the field with a severe envenomation or a broken leg, and so he agreed (perhaps acquiesced is a more accurate term!) with a change of model— I'd do the rough and tumble stuff and he'd wait in the 6-wheeler to share in the results, and we'd collaborate on papers that of course required his incredible store of knowledge. Or if topography allowed, he'd hunt close to the 'Gator while I ventured further. That model worked well through the remainder of the time he was able to live independently on FNHR, and other persons, younger than either of us, pitched in to help Henry make productive rounds in the field safely. Notable among these are Scott Sharp (a high school teacher in a nearby district) and his family, and KU undergrads Mike Zerwekh, and Joey Brown.

As late as 2006, the "Henry and George team" (which I once pointed out to him had an average age of 79, a realization he greatly enjoyed) still made joint rounds, these in my Smooth Earth Snake study area not far from FNHR. This was a species he'd barely seen, with just 3 FNHR records. He was fascinated by the fact that the species was so close, yet he'd seen so few. When on our first trip into that area I caught the first of several we subsequently found in tall grass habitat, his reaction was to look at it intently and softly remark "Well, I'll be damned." I think it was the only time I heard him say that! I'm glad I sent him the final draft of the article summarizing that research. When I emailed it to his daughter Alice, his primary care-giver by then, I asked her to "tell Henry he has to stick around to see this in print." Planned publication was for December 2009. Alice read it to him and afterward told me how attentive he'd been and how he'd enjoyed learning about this elusive species.

On 8 September 2009, just a few months shy of his centennial birthday, Henry Sheldon Fitch passed away, leaving for science one of the most outstanding legacies of ecological study ever known. Best known for his extensive long-term study of the herpetofauna of what in 1948 was The University of Kansas Natural History Reservation (renamed in 1986 the Fitch Natural History Reservation [FNHR]), his published studies in animal ecology extending back to 1933 also include a wide range of birds, mammals and invertebrates, as well as the local successional flora of their habitats. Harry Greene, interviewed by the Lawrence Journal-World, accurately reflected on Henry's legacy by stating "It's not an exaggeration to say that Henry's the father of snake biology." His studies on the ecology and relations of these many species were refined through his extensive career to reflect his unique insights regarding the way they form communities of interacting organisms. All of us who continue to build on this legacy, and those who follow us and will do the same, owe a tremendous thanks to this modest man of great talent.



HSF at the entrance to the Fitch Natural History Reservation, 1997. Photo by Sharon Hagen, courtesy of Chester Fitch.

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Note.—All of Henry Fitch's papers published by the University of Kansas are incorporated in the Biodiversity Heritage Library, where they can be downloaded at www.biodiversitylibrary.org. The family suggests donations to honor Professor Fitch be directed to the Henry and Virginia Fitch Memorial Fund at the KU Endowment Association:

<www.kuendowment.org>

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Ilya S. Darevsky (1924–2009): Discoverer of Parthenogenesis in Reptiles

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Ilya S. Darevsky, discoverer of natural parthenogenesis in reptiles and the leading herpetologist of his country for nearly half a century, died on 8 August 2009 in St. Petersburg at the age of 84. His death is a great loss to Russian herpetology and, as a measure of the greatly changed political situation in his country in recent years, it is also deeply felt by his many colleagues and friends throughout the world.

This change could hardly have been imagined at the time Darevsky was beginning his professional career in the 1950s. Correspondence between Soviet and Western herpetologists then was virtually nonexistent. (My own correspondence with Ilya began in 1963 when I was a first-year graduate student. His letters to me had clearly been opened and clumsily re-sealed. He later told me that all of my letters to him also had been opened, by the Soviet authorities.) Exchange visits in those times were all but impossible. (I first met Ilya at a conference in Budapest in 1981. As an indication of the realities faced by Soviet scientists even when travelling to fraternal socialist countries, there was a KGB agent accompanying the Soviet delegation at that meeting.)

As a result of this prior minimal contact, herpetologists in the United States who had noticed unusual sex ratios in species of teiid lizards and ambystomatid salamanders were initially unaware that Darevsky had already announced his fundamental discovery of natural parthenogenesis in a 3-page paper published in Moscow in 1958. Because this article was in Russian, the precedence of his discovery was not immediately recognized by American and other Western herpetologists. Only in 1966, when Darevsky authored a long review paper in English in the last issue of the *Journal of The Ohio Herpetological Society* (predecessor to SSAR's *Journal of Herpetology*), did the full scope and depth of his research on natural parthenogenesis in lizards become widely known in America.

The existence of apparently all-female populations of the Caucasian rock lizards (*Lacerta* [now *Darevskia*] *saxicola*) had been known in Armenia since at least 1914, but it was Darevsky who demonstrated that this was not a mere sampling artifact. In a preliminary paper in 1957, he reported the absence of males in many populations of this lizard in northern Armenia. Suspecting that they might reproduce parthenogenetically, he decided to check the sex ratios of newly hatched lizards to be certain that the absence of males in nature was due to a genetic mechanism and not to differential selection after hatching. Gravid females were collected and held in individual enclosures where they oviposited. Each clutch was incubated separately and the sex of each hatchling was determined by observing the presence of oviducts or hemipenes and by sectioning the gonads. All hatchlings were females (published in 1958). His techniques were not difficult ones even then; the hard part was having the idea in the first place.

Subsequently, Darevsky and his colleagues demonstrated the hybrid origin of the parthenogenetic forms of *Darevskia saxicola*, which he regarded as distinct species. As the years progressed he was able to establish the genetic nature of the parthenogenetic species, which he showed had arisen through interspecific hybridization, and he proceeded to study the genetic mechanisms and the molecular biology of clonal species. For his pioneering studies on parthenogenesis in reptiles he was awarded the prestigious Mechnikov Prize of the USSR Academy of Sciences in 1987. Later that same year he was elected a member of this venerable academy that was founded by Peter the Great in 1725. Darevsky thus became an academician, the highest honor accorded to a scientist by his country.



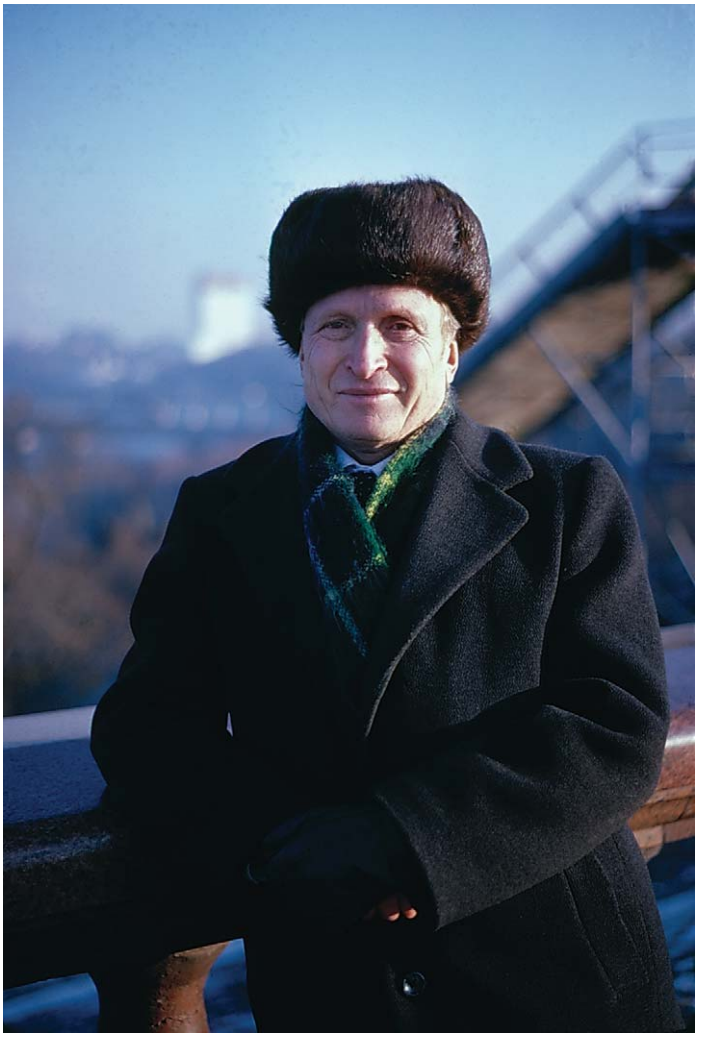
As a Soviet Army infantryman (about 1945). He was wounded twice in battle and earned two decorations for valor. Courtesy Natalia B. Ananjeva.

Ilya Sergeevich Darevsky was born in Kiev, Ukraine, in 1924, an only child who, as he once told me, was "crazy about herps" from his early youth. Before he could enter college, however, he was inducted into the Soviet Army in 1942 and served with distinction during World War II—the Great Patriotic War as it is called in Russia. After the war's end in 1945, he worked at Moscow Zoo and then studied zoology at Moscow State University (1948–1953) before joining the staff of the Zoological Institute of the Armenian SSR Academy of Sciences, located in Yerevan near the Turkish border. At the same time, he was working on his candidate's degree, the first-level postgraduate degree (C.Sc., 1957). His thesis was on the reptile fauna of Armenia and its zoogeographic analysis, which put him in the field in the ideal location to discover all-female populations and parthenogenesis in lacertids.

After a few more years in Yerevan, he was called to Leningrad in 1962 as curator of the Department of Herpetology at the Zoological Institute of the USSR Academy of Sciences, in succession to Sergius A. Chernov who had been his graduate supervisor. In Leningrad, Darevsky completed his second thesis, on the Caucasian rock lizards (D.Sc., 1967). In 1974, he became head of a combined Department of Ornithology and Herpetology, a post he held until 1996 when he was named a senior researcher in the department. He was succeeded as head by Natalia B. Ananjeva, his former student who was, in effect, his chief of staff for many years and who most ably ran the department during his many absences in the field or for other travel. From 1978, Darevsky was also a professor at Leningrad (now St. Petersburg) State University where he lectured on herpe-



As a postgraduate student in Leningrad (November 1957), about the time that his original paper on parthenogenesis was published. Courtesy Natalia B. Ananjeva.



During a very cold winter visit to Moscow (December 1986). Photo by Kraig Adler.

tology. Characteristically, he never forgot his colleagues in Armenia, where his epochal research began, and he regularly returned to lecture at Yerevan University.

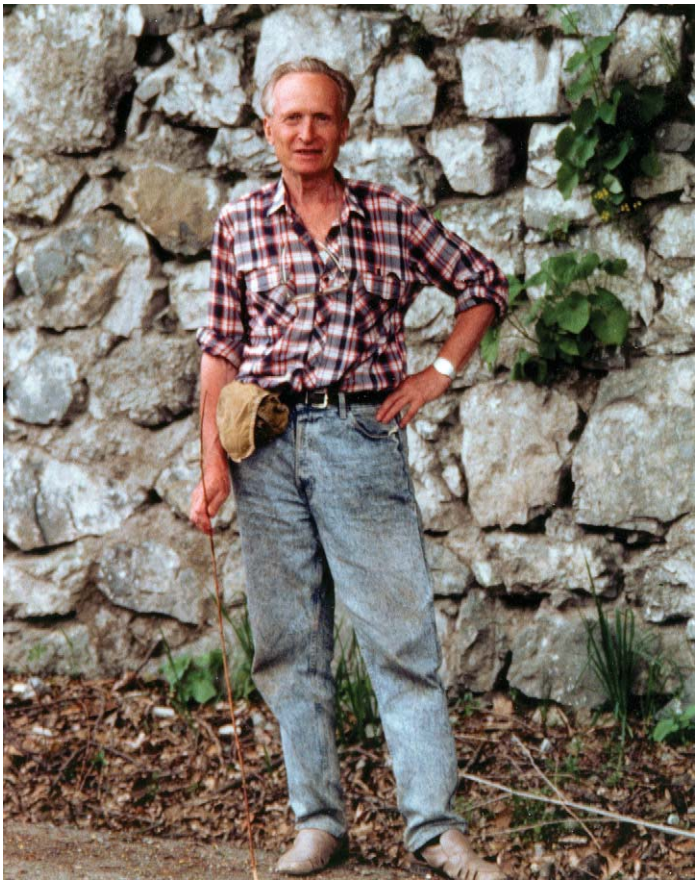
Darevsky was married twice. His first wife, Irina G. Bei-Bienko, was an entomologist at the agricultural institute in Pushkin, a Leningrad suburb. She often assisted him in his research, both in the lab and the field. She died in 1978. They had one child, Alexander Ilyevich, a member of the Oriental Faculty at St. Petersburg University and a specialist on the Burmese language. Darevsky later married Vernata V. Grechko, a molecular biologist at the Institute of Molecular Biology of the Russian Academy of Sciences in Moscow. As Darevsky's work took on a molecular dimension, Grechko became actively involved and they co-authored several studies. She continues this line of research today including the associated fieldwork.

Darevsky became the natural leader of the large, but widely dispersed, herpetological community in the former Soviet Union. He was actively involved in sponsoring several of the All-Union Herpetological Conferences. These had been started by Paul V. Terentjev, Darevsky's colleague at Leningrad State University, as a means to promote the development of herpetology in the country. Terentjev organized the first two in 1964 and 1966, both held in Leningrad (abstracts published in *Herpetological Review* in 1967 and 1968). Darevsky, ably assisted by Ananjeva and other colleagues, ran the next four in Leningrad (1973, 1977), Ashkhabad (1981), and Tashkent (1985), and he edited a volume of proceedings for each one. Beginning in 1989, this organization became the Nikolsky Herpetological Society.

He was staunchly internationalist and promoted contacts with scientists in other countries, to the extent allowed by the Soviet authorities. It is difficult for many Westerners today to appreciate the extent to which herpetologists and other scientists in the former USSR and its associated socialist countries had their academic activities, to say nothing of their personal freedoms, affected by the caprice of communist bureaucrats. When Darevsky wanted to travel to the West in the 1980s, his requests were routinely turned down and usually without explanation, or at least a credible one.

Carl Gans and I attempted to bring him to the United States on several occasions, without success, but with his rise to academician status in 1987 it was finally possible. Even then, however, the Soviet authorities toyed with him as to the exact timing of his departure, which made the scheduling of his complex itinerary very difficult. When the authorities delayed his departure again and again, we had to revise our plans each time. As luck would have it, his eventual time of arrival could not have been more advantageous for him to meet American herpetologists, for he arrived just in time for the joint annual ASIH / HL / SSAR meeting in Ann Arbor, Michigan, in late June 1988 where he delivered the keynote address. This meeting was as memorable for him as it was for his audience.

A two-week tour followed, in order for him and his colleague, Natalia Ananjeva, to visit major museum collections and meet colleagues. Besides the University of Michigan, they visited the University of Kansas, Carnegie Museum (with an overnight at the museum's



On a field excursion in Armenia (1992), posing in front of what became known as "Darevsky's Wall" where he discovered the first unisexual lizards. The pole in his right hand was used to noose lizards. Photo by Robert W. Murphy.

Powdermill Nature Reserve), Cornell University, National Museum of Natural History (where they joined in Fourth of July celebrations on the National Mall), the Virginia countryside (for a full-day's field trip when, in his excitement, he caught a copperhead with his bare hands!), Academy of Natural Sciences and Philadelphia Zoo, American Museum of Natural History, and Harvard University. We had to make up for a lot of lost time! As he wrote on returning to Leningrad, "It's better one time to see than many times to hear."

Darevsky's visit to America was propitious also for his major involvement in planning the First World Congress of Herpetology that was to be held in Canterbury (UK) the next year. He was an active member of the executive committee of the congress secretariat. If Soviet herpetologists were to attend the congress, Darevsky was the key, for both the USSR and Soviet bloc countries, and he played his role masterfully, again with the important assist of Ananjeva. Because the Soviets would come as a delegation, they had to be selected and properly funded. It is safe to say that without Darevsky's leadership the congress would not have attracted delegates from as many countries as it did. (A total of 1,368 persons from 61 countries attended, still the largest and most nationally diverse herpetological meeting ever held.) As a personal gesture, Darevsky had commemorative metal badges made—complete with the congress's chameleon logo—which he passed out to the delegates. His role before, during, and after the congress was exemplary of his commitment to international science.

At home, Darevsky was equally devoted to being all-inclusive and open to new developments. His enthusiastic and ebullient personality attracted and inspired the best students, and his staff appreciated his democratic form of administration. He developed his department in Leningrad into his country's major center for the training of young herpetologists, both those who were his own students as well as those from other laboratories. They came from throughout the USSR and Vietnam.

Despite all his official duties for the institute and overseas, Darevsky continued to publish research papers on the reproductive biology and genetics of Caucasian rock lizards. He also authored or edited a large number of books. The most notable was an early summary of his work on rock lizards (1967; English edition 1978). He co-authored, with the conservationist Andrei G. Bannikov and others, the first color-illustrated field guide to the amphibians and reptiles of the Soviet Union (1971; second edition 1977). He wrote the herpetological volume, also with Bannikov, in a series on the animals of the world (1969; second edition 1985). With his department colleagues, Natalia Ananjeva, Leo Borkin, and Emilia I. Vorobjeva, he co-edited a number of volumes of collected papers on the herpetology of the USSR and Mongolia. Darevsky was also committed to amphibian and reptilian conservation and produced two books on the subject (one about the protected territories in the USSR, with Vladimir G. Kreven in 1987, and the other a color-illustrated review of rare and endangered amphibians and reptiles of the world, with Nikolai Orlov in 1988). Darevsky, together with Ananjeva, Borkin, and Orlov, produced a highly useful dictionary of the amphibians and reptiles of the world (1988), a checklist that is cross-indexed in five languages (Latin, Russian, English, German, and French). The same four authors wrote the herpetological volume in an encyclopedia of Russian animals (1998). His last book, written with five co-authors, was a colored atlas of the reptiles of North Eurasia (2004).

Darevsky's ability to conduct field research outside the Soviet Union was severely constrained, unless political reasons made it possible. In 1962, during a short period of Soviet influence in Indonesia, he spent two months in the Lesser Sunda islands as part of the Indonesian-Soviet Zoological Expedition to Komodo and surrounding islands. He worked in Iran in 1974 during a period when the USSR was seeking to improve its relations with Tehran. With the American military defeat in Vietnam in 1975, the new Socialist Republic of Vietnam strengthened its ties with the USSR and in 1982 Darevsky began a completely new line of research, on the amphibians and reptiles of Vietnam. This research was primarily done in collaboration with Nikolai Orlov and other colleagues in Leningrad. Darevsky, who was always an enthusiastic field naturalist, went to Vietnam on almost annual expeditions through 1995. His special interest was the herpetofauna of the offshore islands along the lengthy Vietnamese coast. He and his colleagues discovered many new species there and on the adjacent mainland and the high rate of new species discovery and description continues unabated to this day. Among them were several new all-female species of lizards. At the same time, he extended his work on the Caucasian rock lizards with a long series of genetic studies (molecular evolution of satellite DNA, allelic polymorphism of parthenogenetic populations, and nucleotide sequences of microsatellite loci, to name just a few of them).

Darevsky was seriously ill during his last few years and could not come to the Zoological Institute to work, but he was busy writing his memoirs, tentatively entitled "Herpetology and Life." His life and herpetology were indeed closely entwined, from his boyhood days in Ukraine to the dual pinnacles of Russian and international science. He was passionate about his animals, his country, about herpetology and biology, and about his wide circle of friends and colleagues. And he made a difference for them all.



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ZOO VIEW

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History of Early French Herpetology. Part II: Picture Gallery

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The classic herpetological works produced in Paris around the time of the French Revolution were *Les animaux quadrupèdes ovipares, et les serpens* by Louis-Jean-Marie Daubenton, 1784; *Histoire naturelle des quadrupèdes ovipares et des serpens* by Count de Lacepède, 1788–1789; *Tableau encyclopédique et méthodique des trois règnes de la nature ... Erpétologie* and *Ophiologie* by abbé (Pierre Joseph) Bonnaterre, 1789, 1790; *Histoire naturelle, générale et particulière, des reptiles; ouvrage faisant suite à l'Histoire naturelle générale et particulière, composée par Leclerc de Buffon, et rédigée par C. S. Sonnini. / Par F. M. Daudin*, [1802–1803]; and *Histoire naturelle des reptiles: avec figures dessinées d'après nature / / par C. S. Sonnini et P. A. Latreille*, 1802. In all of these works, illustrated herps are not as naturalistic as those pictured later.

Dr. Ulrich Schuerer, Director of the Wuppertal Zoo in Germany, has alerted me to the existence of a rare publication "Nouvelle Ménagerie des Reptilies au Jardin des Plantes a Paris" by M. J. André, Architecte. Paris Librairie Générale de l'Architecture et des Travaux Publics. Ducher & Cie, 1880. This six-page paper describes the construction of the facility and is accompanied by 10 beautifully drawn plates showing the façade, floor plans, reptile enclosures, and illustrations of the visitor areas. Of particular interest are the drawings depicting the elaborate carpentry and ironwork, support columns for the ceiling, and the large crocodilian exhibit. These are not typical architectural drawings but rather works of art. National Zoological Park librarian Polly Lasker could only find one library listing this work—Bibliothéque Centrale du National d'Histoire Naturelle in Paris.

I have selected an array of interesting plates which reflect the essence of living amphibians and reptiles and the fine artwork created during this period. These are shown mostly in chronological order. All colored originals have been converted to a black-and-white format.

Acknowledgments.—The association of a menagerie of living animals as part of a museum of natural history is unique and provides an important model for cooperation between these entities. The remarkable educational, research and artistic scope in Paris for over 200 years, as described in the important contributions of Patrick David, Jean Lescure, and Michel Thireau, has led to a greater understanding of the proper role between a zoological garden and museum of natural history. I am grateful to these authors for their insight and input.

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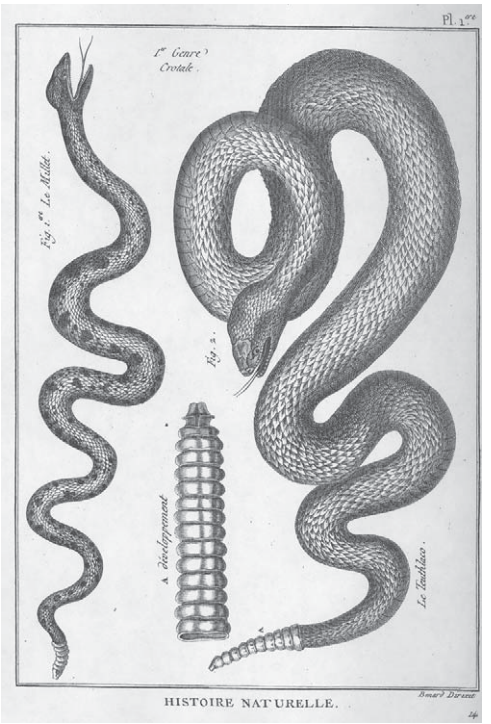
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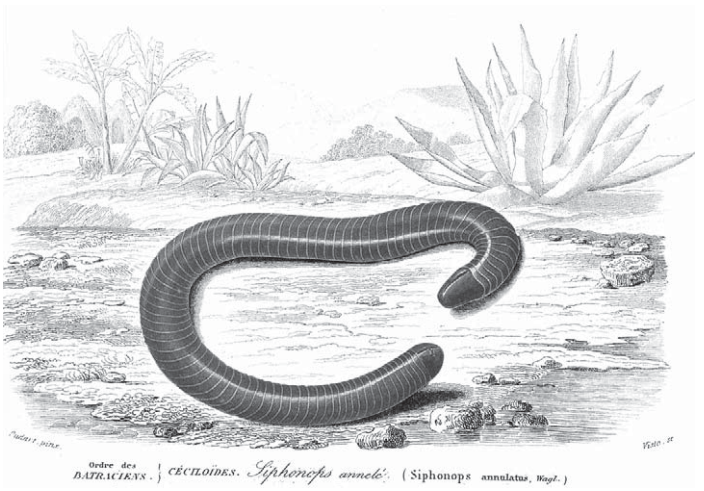
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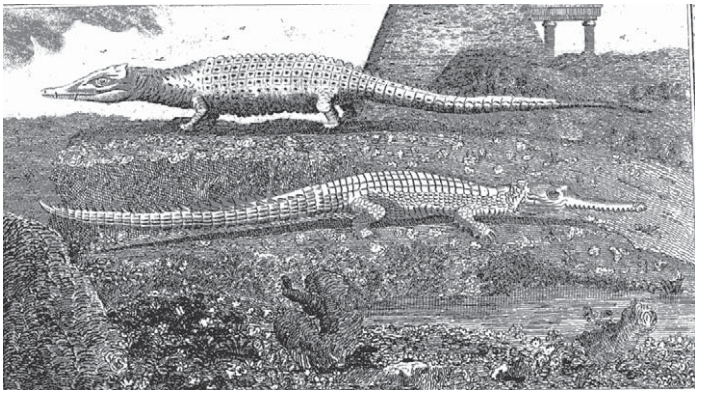
It is remarkable that the rare and elusive cave-dwelling European Olm (*Proteus anguinus*) was displayed at the Ménagerie in 1823. Illustration from Georges Buffon's *Natural History*.



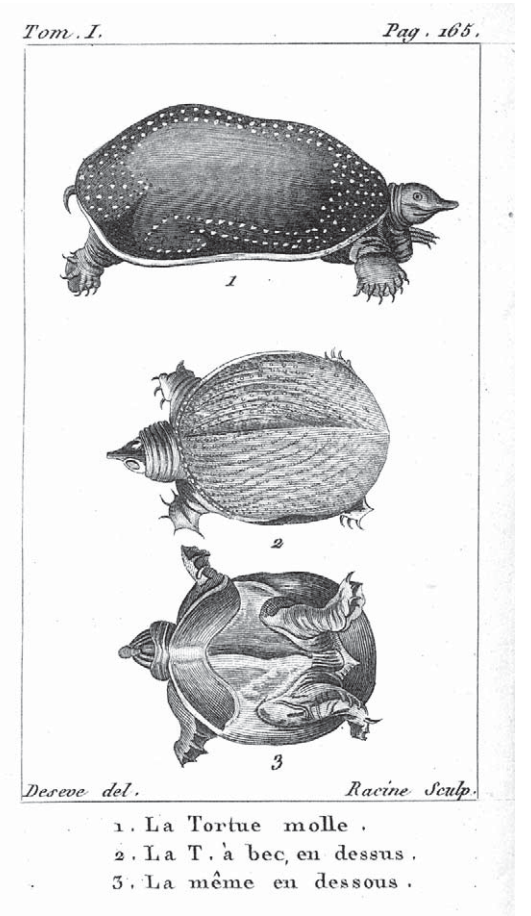
Louis Daubenton (1716–1800) was first director of the museum in 1793 and a colleague of Buffon. Most of the observations on foreign animals that were described by them in the fifteen first volumes of the Natural History were done at the menagerie. Daubenton's *Les animaux quadrupèdes ovipares, et les serpens* was not illustrated so the publisher commissioned Pierre-Joseph Bonnaterre (1751–1804) to oversee the production of the plates and write captions—Daubenton's work and Bonnaterre's *Erpétologie* and *Ophiologie* are often bound together. Shown here are rattlesnakes from Bonnaterre. Credit: Library of Roy McDiarmid.



Except for the aquatic genus *Typhlonectes*, caecilians are rarely kept in zoo collections, likely due to their secretive nature. Shown here is a Ringed Caecilian (*Siphonops annulata*) from *Dictionnaire universel d'histoire naturelle* by Alcide D'Orbigny.



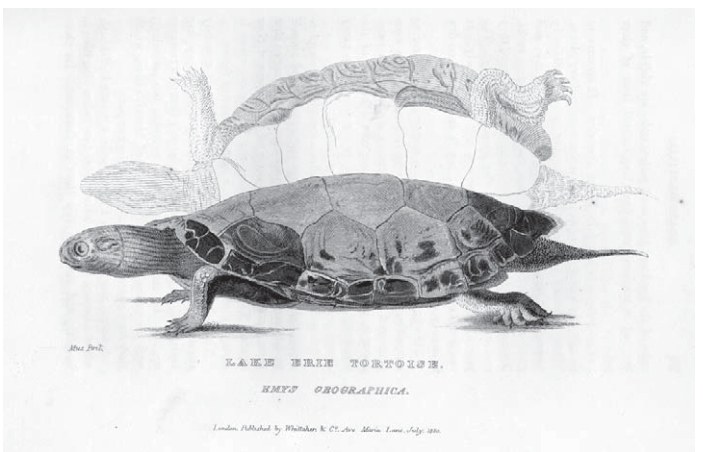
Lovely drawings of Nile Crocodile, and Gavial from *Histoire naturelle des quadrupèdes ovipares et des serpens. Par M. le Comte de la Cepede*. Imprint: Hôtel de Thou, Paris, 1788–89. In the plates, herps are sometimes juxtaposed to humans or manmade objects such as formal gardens, buildings, temples, pyramids, and so on; this was part of the artist visual vocabulary of the time—it was not just random placement. Credit: Collections of Ernst Mayr Library, Museum of Comparative Zoology, Harvard University.



In 1801, Charles-Nicolas-Sigisbert Sonnini de Manoncourt (1751–1812) and Pierre-André Latreille (1762–1833) co-authored the four-volume *Histoire Naturelle des Reptiles*, a comprehensive work covering amphibians and reptiles worldwide. This work was included in Georges Buffon's great encyclopedia, an ambitious attempt to summarize all of natural history. Twenty-five years later, the book was reissued, followed by another edition four years after the second one — all three editions were offered with either 54 plain or hand-colored plates. Shown here from Tome 1 — La Tortue molle. Credit: Collections of the Ernst Mayr Library, Museum of Comparative Zoology, Harvard University.

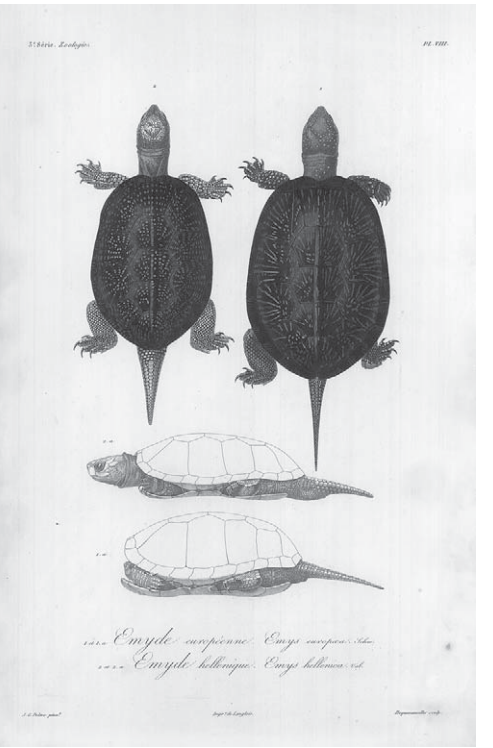


René Primevère Lesson (1794–1849) clearly thought that painting animals from nature was important, as evidenced by his book title in 1832–1835? and the accuracy of its drawings. This illustration of Le Caméléon Madécasse (*Chamæleo madecasseus*, now *Calumma parsoni*) is from *Illustrations de zoologie, ou Recueil de figures d'animaux peintes d'après nature* (Zoological Illustrations, or Collection of Animal Figures Painted from Nature). Credit: Courtesy of Smithsonian Institution Libraries, Washington, DC.



Common Map Turtle (*Emys geographica*, now *Graptemys geographica*) from *The animal kingdom, arranged according to its organization, serving as a foundation for the natural history of animals, and an introduction to comparative anatomy. / With figures designed after nature: the Crustacea, Arachnides, & Insecta, by M. Latreille. Translated from the latest French ed. With additional notes, and illustrated by nearly 500 additional plates* by Baron Georges Cuvier, 1834–37. G. Henderson, London.

Credit: Collections of Ernst Mayr Library, Museum of Comparative Zoology, Harvard University.



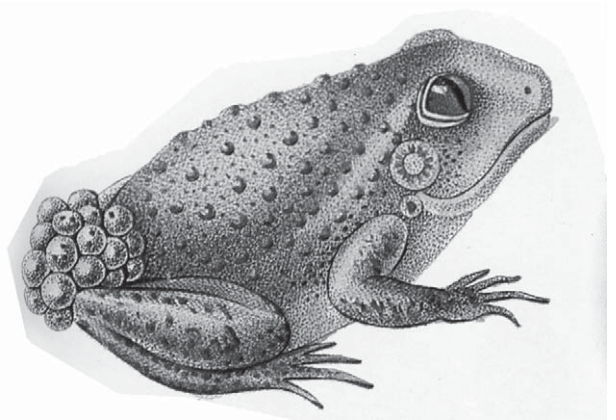
European Pond Turtle (*Emys orbicularis*) from *Expédition scientifique de Morée (1831–1838). Expédition scientifique de Morée. Section des sciences physiques. Zoologie: sect. 1. Des animaux vertébrés*. Imprint: F.G. Levrault, Paris, etc., 1832 [–1836]. This 3 volume set includes contributions by Étienne Geoffroy Saint- Hilaire (1772–1844) and his son Isidore Geoffrey Saint-Hilaire (1805–1861). The elder was the founder of the Ménagerie during the French Revolution and was the director for more than four decades until replaced by his son in 1838. The section on reptiles and fishes was written by G. Bibron and Jean Baptiste George Marie Bory de Saint-Vincent (1778–1846).

The most famous herpetological work by the Geoffroy father and son combination was the amphibian and reptile section in *Description de l'Egypte*, published in 1827 with a second edition two years later. The enormous plates are stunning. Two are particularly impressive: Nile Softshell Turtle and full-sized cobra in a defensive posture with hood extended.

Credit: Collections of Ernst Mayr Library, Museum of Comparative Zoology, Harvard University.



Jean-Théodore Cocteau (1798–1838) worked under Constant Duméril at the museum. His most important herpetological work was the section in Ramón de la Sagra's *Histoire ... de I'Ile de Cuba*, covering turtles, crocodiles, and lizards; Gabriel Bibron wrote the section on snakes and frogs. Pictured here is the False Chameleon (*Chamaeleolis chamaeleonides*, now *Anolis chamaeleonides*), clearly one of the most spectacular herpetological drawings. Credit: Library of Roy McDiarmid.



Midwife Toad (*Alytes obstetricans*) from *Zoologie classique, ou, Histoire naturelle du règne animal* by Félix-Archimède Pouchet (1800–1872) in 1841. Paris, Roret.

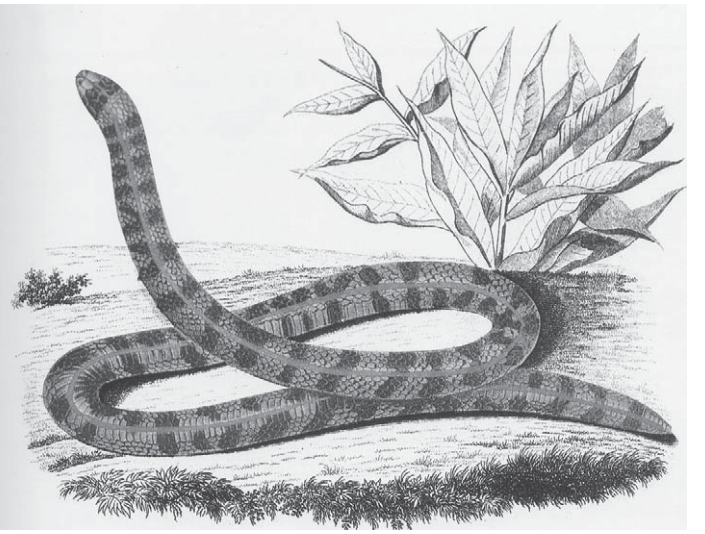
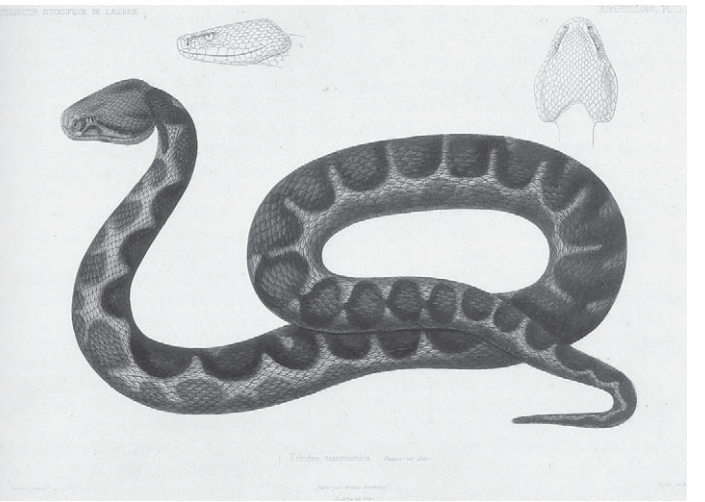


Illustration of Coral Pipe Snake (*Anilius scytale*) from *Dictionnaire universel d'histoire naturelle. Atlas. Zoologie. Reptiles, Poissons et Insectes* by Alcide D'Orbigny. Credit: Library of Roy McDiarmid.



Nile Softshell Turtle (*Trionyx triunguis*) from *Zoologie classique, ou, Histoire naturelle du règne animal* by Félix-Archimède Pouchet.



Alphonse Guichenot's (1809–1876) father was a gardener at the menagerie. Hired as a junior naturalist at the museum, he prepared specimens for examination to be used in the nine volume *Erpétologie générale*. Guichenot published a number of herpetological works on his own, including the one covering the Algerian expedition of 1840–1842; he was a participant in that enterprise. This Moorish Viper (*Echidna mauritanica*, now *Macrovipera mauritanica*) is pictured in *Histoire naturelle des reptiles et des poissons*, 1850.

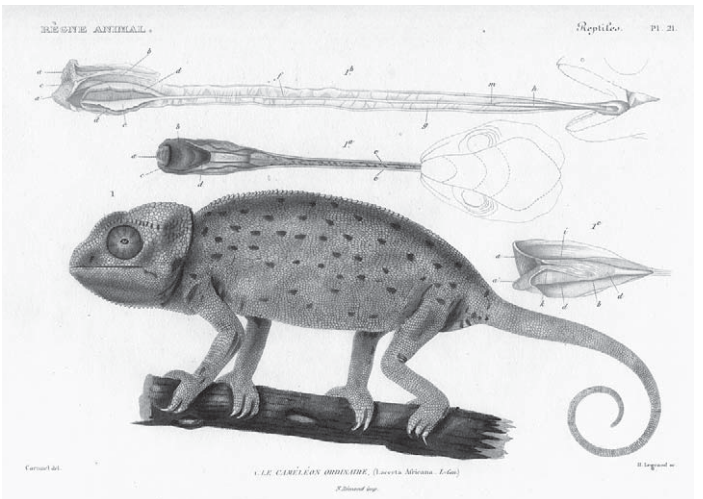
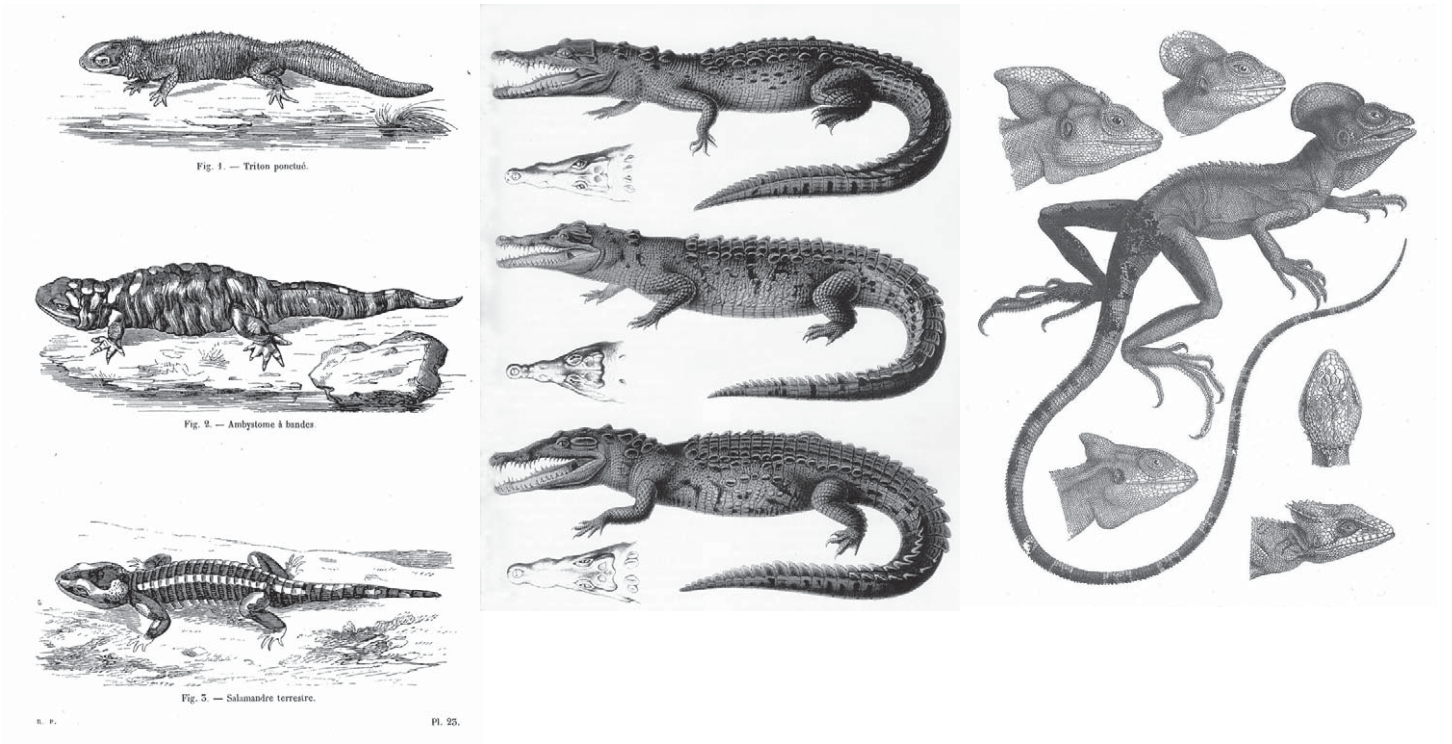


Illustration of African Chameleon (*Lacerta africana*, now *Chamaeleo africanus*) from Georges-Louis Duvernoy's (1777–1855) Disciple edition of the Reptiles volume in *La Règne Animal par Georges Cuvier* in 1842. Many prominent herpetologists who were disciples (students) of the late Cuvier are listed on the title page. Credit: Courtesy of Kraig Adler.

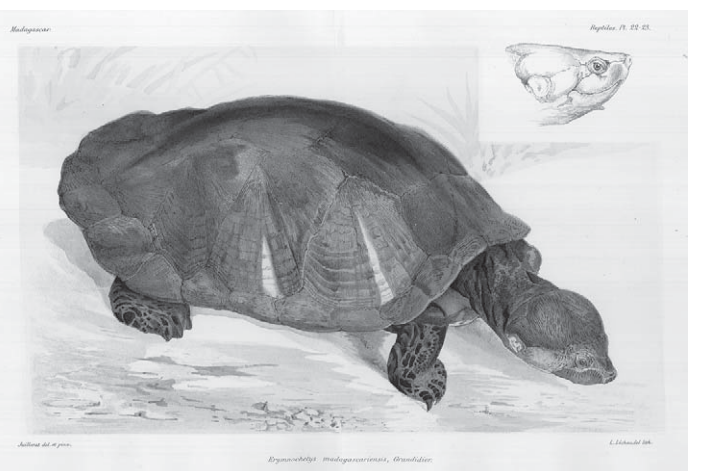


Left. Illustration of Newt and Salamanders from volume 3 of *Encyclopédie d'histoire naturelle; ou, traité complet de cette science d'après les travaux des naturalistes les plus éminents de tous les pays et de toutes les époques: Buffon, Daubenton, Lacépède, G. Cuvier, F. Cuvier, Geoffroy Saint-Hilaire, Latreille, De Jussieu, Brongniart, etc. / Ouvrage résumant découvertes modernes jusqu'à nos jours, par le Dr. Chenu ... Éd. Firmin-Didot et cie* by Jean Charles Chenu (1808–1879), 1856. Imprint: Paris, E. Girard et A. Boitte, [186-?–187-?]. Center. Marie Firmin Bocourt (1819–1904) worked closely with Aug. Duméril on the monumental *Études sur les Reptiles*, one of the seventeen parts of *Mission Scientifique au Mexique et dans L'Amérique Centrale*. The total number of lithographs drawn by Bocourt for this book was 92 and some of them included as many as 50 separate drawings. Shown here from top to bottom are *Crocodilus americanus*, *C. lewyanus*, and *C. mexicanus*. All are now recognized as the American Crocodile (*Crocodylus acutus*). Right. Illustration of Basilisk (*Basiliscus*) and Casqueheaded (*Laemanctus*) Lizards from Aug. Duméril's *Description des reptiles nouveaux ou imparfaitement connus de la collection du Muséum d'histoire naturelle et remarques sur la classification et les caractères des reptiles.* [Arch. Mus. Paris, vol. 8:437–588 (1856)]. These are some of the best plates in herpetology. Credit: Courtesy of Polly Lasker, Smithsonian Institution Libraries, Washington, DC.



Emerald Tree Boa (now *Corallus caninus*) from *Histoire naturelle de Lacépède, comprenant les cétacés, les quadrupèdes ovipares, les serpents et les poissons* by Bernard Germain Etienne de La Ville sur Illon La Cépède (Count de Lacepède**)** in 1860.

Imprint: Paris, Furne, 1860.



One of the rarest species on the planet is nearly extinct: Madagascan Big-Headed Turtle (*Erymnochelys madagascariensis*) shown here from *Histoire physique, naturelle, et politique de Madagascar* in 1910. This book by Léon Vaillant (1834–1914) and Guillaume Grandidier (1873–1957) has spectacular plates of crocodilians and chelonians fashioned by several different artists. Credit: Collections of the Ernst Mayr Library, Museum of Comparative Zoology, Harvard University.

ARTICLES

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Lunar Illumination and Sea Turtle Nesting

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Predicting peak sea turtle nesting can help turtle conservation groups improve their monitoring strategies by planning intensified beach monitoring during the predicted peak nesting periods (Garcia et al. 2003). Currently, few of the factors controlling the emergence of sea turtles on land to lay eggs are understood, and it is unclear whether these factors are consistent among all sea turtle species. Bustard (1979), working on the Atlantic coast, suggested that nesting cycles of sea turtles might be associated with high tides where tidal cycles are pronounced. Frazer (1983) concurred, but demonstrated that this relationship did not hold for Atlantic beaches with similar slopes between high and low tide lines for *Caretta caretta* (Loggerhead). Girondot and Fretey (1996), studying *Dermochelys coriacea* (Leatherback) in French Guiana, also reported peak nesting cycles during high tides associated with spring tides (e.g., during the full and new moon). However, Bernardo and Plotkin (2007) suggested that *Lepidochelys olivacea* (Olive Ridley) nesting cycles in the eastern Pacific likely coincided with the third quarter moon, but admitted that it was unclear how lunar stages related to *L. olivacea* nesting.

Here we contribute to the understanding of *L. olivacea* nesting by confirming periodicity of nesting with lunar cycles, with an inverse relationship between *L. olivacea* nesting abundance and lunar illumination. Our results have both economic and environmental implications because they allow researchers and survey organizers to better predict the likelihood of encountering nesting turtles by calculating the fraction of the moon's visible disk illuminated by the sun. Such predictive power contributes to resource allocation strategies that can improve sea turtle monitoring programs, as well as our understanding of *L. olivacea* nesting behavior in relation to the moon's gravitational effects on tides and actual light (reflected from the sun) available on the beach.

Materials and Methods.—Our study area was Playa Teopa, located on the Pacific coast of Mexico in Jalisco State, part of an area commonly referred to as the Costa Alegre. Playa Teopa is 13 km south of the town of Chamela (19.5°N, 105.1°W). During 2000–2002, trained local volunteers and staff of the Teopa Beach Monitoring Project scanned the beach nightly (from midnight to sunrise) for nesting turtles from mid-July to early December and recorded standard monitoring information such as date, time, nest number and position, and turtle species. In prior years (1986–1992, 1994, 1997) scans were conducted on a less frequent basis. Playa Teopa is ca. 3 km long, undeveloped, and illuminated by celestial light only.

Lunar illumination data were obtained by entering nesting dates into the "Fraction of the Moon Illuminated" astronomical application under *Data Services* at the US Naval Observatory website (http://aa.usno.navy.mil), and recorded as 0 (= 0% illumination) through 100 (= 100% illumination). Although no climatic information (e.g., cloud cover) was recorded directly by observers as part of the Playa Teopa nesting surveys, data for temperature (degrees F), rainfall (inches), and visibility (km) were obtained for the nearby Playa de Oro weather station (19.1°N, 104.6°W) from the NOAA National Climatic Data Center website (http://www.ncdc.noaa.gov/oa/climate/climatedata.html) and incorporated into the dataset. Correlation, linear regression, and ANOVA were used to examine the effects of lunar illumination, a lag of nesting count, temperature, and visibility on nightly turtle nesting counts (rainfall was recorded in the Playa del Oro data for less than 5% of our nesting survey dates, and hence was not included). Statistical analyses were conducted using SAS Version 9.1 for Windows (2003, SAS Institute Inc., Cary, North Carolina).

Results and Discussion. —A total of 1925 nesting observations were recorded for *Lepidochelys olivacea* during this study. The majority of observations (N = 1237) were made during 2000–2002, the years of most intensive and consistent sampling; another 688 observations were made during prior years (1986–1992, 1994, 1997). The peak nesting period occurred from August to October (N = 1781 observations; 93% of total). This peak is consistent with other published reports for *L. olivacea* on this coast (Garcia et al. 2003). Statistical analysis focused on these three peak months. Spearman Rank correlation tests revealed a negative correlation between peak turtle nesting count and lunar illumination in 8 of the 12 study years, two of these being significantly negative (Table 1). Qualitatively similar results were obtained by performing linear regressions, by year, of nesting events against lunar illumination, lag, temperature, and/or visibility (Table 1), although lunar illumination was not significant in these analyses. In an attempt to increase power by combining data for the three well-sampled years 2000–2002, an ANOVA was conducted using all variables, with lunar illumination grouped into classes (1 = 0–19%, 2 = 20–39%, 3 = 40–59%, 4 = 60–79%, 5 = 80–100%). Lunar illumination, lag, and year were significant effects in this model (see Table 2; excluding temperature and visibility yielded comparable results).

These analyses indicate a modest inverse relationship between nesting counts and lunar illumination for *L. olivacea* at the Playa Teopa study site, and conflicts with the suggestion that peak nesting cycles occur during the third quarter moon for this species (Bernardo and Plotkin 2007). In fact, our data suggest that the best time to encounter nesting turtles is surrounding the dark period of the moon, where we recorded the greatest number of nesting events for each year surveyed. The new moon cycle is also consistent with the reported inter-nesting period for *L. olivacea* (e.g., approximately 28

TABLE 1. Relationship between *Lepidochelys olivacea* peak nesting counts and lunar illumination at Playa Teopa, as shown by non-parametric correlation and linear regression. N = number of sampling dates. Model A incorporates lunar illumination and lag of nightly nesting counts as dependent variables; Model B also incorporates temperature and visibility. Coefficients significant at p < 0.5 given in bold.

Year	N	Spearman R	Regression (Model A)	Regression (Model B)
1986	12	-0.33	-1.27	-0.62
1987	45	0.12	0.12	0.11
1988	23	0.11	0.19	0.62
1989	34	-0.20	-0.12	-0.12
1990	30	-0.04	0.08	0.09
1991	25	**-0.46**	-0.48	-0.27
1992	30	0.00	0.19	0.06
1994	30	0.10	0.02	0.12
1997	35	-0.06	-0.01	0.05
2000	85	**-0.19**	-0.32	-0.35
2001	90	-0.10	-0.10	-0.08
2002	92	-0.16	-0.20	-0.23

days), which is longer than most sea turtle species that have been examined (Rostal 2007). Such a pattern of nesting is not unique for turtles. A peak nesting cycle for the aquatic turtle *Podocnemis erythrocephala* has also been reported during the dark phase of the moon (Batistella and Vogt 2008).

Frazer (1983) noted that the advantage to nesting during high tide was a shorter crawl distance between water and nest, thus reducing the time of exposure to predators—darkness can also contribute to a decrease in the visual recognition of turtles by predators. Nesting during the new moon period offers the opportunity for high tides due to the centrifugal force caused by the earth's rotation. Another advantage of nesting during the period of the new moon may be an increase in prey availability to turtles post-nesting. For example, Lang et al. (2005) reported that the availability of katydid prey during the new moon period influenced foraging by their bat predators, resulting in a greater activity of both during the dark phase of the moon. Lunar cycles are also reportedly synchronized with emergence patterns in some invertebrates (Saigusa and Oishi 2000). Wild *L. olivacea* has been reported to feed primarily on crabs (Shaver and Wibbels 2007), which are most active, and forage, in darkness. Playa Teopa is not known to attract *arribadas*, thus the *L. olivacea* females we observed are likely solitary nesters. Solitary nesters are known to use multiple beaches hundreds of kilometers apart during a nesting season (Morreale et al. 2007). Therefore, it seems reasonable to suggest that *L. olivacea* prefers to emerge during the high tide of the new moon to lay eggs, because shorter crawls combined with the availability of prey may improve the likelihood of successful nesting, and subsequent feeding that can help support such travel.

TABLE 2. Analysis of variance of *Lepidochelys olivacea* peak nesting counts at Playa Teopa against lunar illumination, year, lag of nightly nesting counts, visibility and temperature. See text for descriptions of dependent variables. Significant model effects are given in bold.

Effect	df	F	p
Lunar Illumination	4	4.22	**0.002**
Year	2	4.25	**0.015**
Year*Lunar Illumination	8	0.77	0.632
Lag(Nesting Count)	1	30.30	**0.000**
Visibility	1	1.58	0.210
Temperature	1	2.40	0.122
Error	358		

We encourage other researchers to reassess their long-term nest conservation data to test whether the lunar phase results reported here are specific to Playa Teopa and *L. olivacea*, or may be more broadly applicable to sea turtles in general.

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Post-Natal Movements and Overwintering Sites of Hatchling Blanding's Turtles, *Emydoidea blandingii*, in East-Central Minnesota

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The Blanding's Turtle (*Emydoidea blandingii)* is known to nest considerable distances from water (Congdon et al. 1983; Ross and Anderson 1990), and it has been generally assumed that hatchlings travel to wetlands in order to survive their first winter in aquatic environments following emergence in late summer or early fall. The behavior of neonate Blanding's Turtles has been studied in Massachusetts (Butler and Graham 1993, 1995), Nova Scotia (Standing et al. 1997), and Minnesota (Refsnider 2005). All three studies tracked neonates for varying time periods, but not through the first winter. Butler and Graham (1993, 1995) believed emerged hatchlings sought standing water. Standing et al. (1997) tracked hatchlings for a maximum of 11 days and found overall the newly emerged hatchlings avoided water. Refsnider (2005) tracked three hatchlings to burrows in moist microhabitat and monitored hatchlings until either the 21-day battery expired or the hatchling was predated. From our previous years of monitoring *Emydoidea* nests, we have never found hatchlings to successfully overwinter in their nests. In previous years, hatchlings emerged by October or, as in 2004 with unseasonably cool temperatures, hatchlings that did not emerge in the fall were found dead within the nest chamber the following spring (pers. obs.; Refsnider 2005).

This study was part of a larger ecological study of Blanding's Turtles conducted by Three Rivers Park District (Park District) within 2,600-acre Crow-Hassan Park Reserve, northwestern Hennepin County, Minnesota. This study attempted to estimate numbers of adult and subadult turtles and to identify and protect nesting habitat. From 1994–2005, Blanding's Turtle nests located on road shoulders or in the middle of gravel roads were deemed at-risk from road traffic and predation by mammals and were salvaged for artificial incubation at 29°C. After hatching and yolk sacs were absorbed, hatchlings were released into the water at the edge of the wetland closest to the original nest location. Since previous research did not identify hatchling wintering locations, it was unknown if the release sites were appropriate for the hatchlings. This study was initiated to identify hatchling overwintering microhabitat, to assess predation while hatchlings were moving to overwintering sites, and determine overwinter survival at these sites.

Methods.—To determine hatchling survival and microhabitat use, newly emerged hatchling Blanding's Turtles were radio tracked in 2005 and 2006 to what were presumed to be overwintering sites. Seven hatchlings from two field nests in 2005 and seven hatchlings from two field nests in 2006 (including one nest that had been reburied ca 15 m from its original location) were radio tracked. Wire cages were placed over nests to trap hatchlings as they emerged; cages were checked daily. Transmitters weighing 0.48 g (Holohil Systems, Ltd., model BD-2N, battery life of 21–24 days) were affixed with a few drops of 5-minute epoxy on the 2nd and 3rd vertebral carapacial scutes of the largest hatchlings (37–39 mm maximum carapace length) (Fig. 1). Refsnider (2005) working with hatchlings in the Park District with the same transmitters determined the transmitters weighed a maximum of 5.1% of the hatchling's weight. Hatchlings were then released back at the nest sites within 24–48 h of emergence. Transmitters were replaced on seven of the hatchlings after 21–24 days; following replacement hatchlings were then released at the point of capture. Transmitters popped off easily with no apparent injury to the scutes.

Hatchlings were tracked (ATS, Inc. FM100 receiver; 3-element Yagi antenna) daily and were located within 30 cm of actual locations. Locations were flagged and GPS locations were taken with a Garmin 72. Visual observations of the hatchlings were obtained most days, with some exceptions resulting from dense vegetation and a desire not to disturb the animals. Monitoring was sufficient to determine general condition of the hatchling, its activity, condition of the transmitter, and type of habitat. Once the hatchlings had not moved in 2–3 weeks and temperatures dropped to near 0°C at night we assumed they had reached their wintering locations. At that point we caged them to prevent the hatchlings from escaping in spring. Wire cages were 0.6 m in height and 0.6 m in diameter and covered with 1.27 cm hardware cloth attached to 2.54 cm poultry wire and were secured in the ground with sod stakes. None of the caged locations were located in water at the time of caging. The cages were checked every 2 days beginning the following April for appearance of the hatchlings and to determine if any of the hatchlings survived.

Results.—In 2005, seven hatchlings (1930–1933;1938–1940) from two caged nests were tracked for varying periods of time (Table 1). Three hatchlings that were tracked for a total of 42–48 days to what appeared to be overwintering locations were in close proximity to each other. Each of these hatchlings was captured once to replace its radio transmitter. Although the monitoring period continued until batteries expired, no significant change in location was detected after an initial 5–6 days of travel from the nest.



FIG. 1. Hatchling *Emydoidea blandingii* with epoxied radio transmitter.

The hatchlings moved 350–487 m from the nest site. Two of the hatchlings burrowed out of sight into damp leaf litter in a dry drainage gully. A non-radioed hatchling, origin unknown, was also found in this same gully. The third radioed hatchling stopped ca. 15 m north of the gully, on higher ground within a grove of Gray Dogwood (*Cornus racemosa*). It stayed on the surface of the ground for several weeks. None of the three hatchlings were disturbed to remove the transmitters. Their locations were caged in late October, after no movement was detected for several weeks and air temperatures dropped to freezing at night.

Three other hatchlings from the second nest were tracked from 21–24 days into heavy vegetation of sedges (*Carex* spp.) and Reed Canary Grass (*Phalaris arundinacea*) at the edges of three different small, shallow pothole wetlands (<0.5 acres) (Table 1). Since we did not have enough replacement transmitters the transmitters were removed just prior to end of battery life. At the time of transmitter removal, none of the hatchlings had been observed to enter the water of the wetland. Although daytime ambient air temperature was often greater than 21°C and the animals appeared alert on the surface, the hatchlings made no significant change of location once they reached the wetland edge. It is not known in what microhabitat these hatchlings overwintered, since they were still on the surface when the transmitters were removed. However, based on the behavior of the three hatchlings monitored for 42–48 days, it was assumed that these hatchlings had also stopped movement in wintering locations. A fourth hatchling from the second nest was not recaptured prior to its transmitter expiring, but this hatchling traveled 743 m (cumulative daily straight-line distance) in approximately 10 days and was

TABLE 1. Summary of radiotracked *Emydoidea blandingii* hatchling movement from nests 2005–2006.

	Hatchling ID	Emergence date	# Days monitored	Overwinter date (caged)	Cumulative distance (m)	Overwintering site description	Emergence date/fate
2005							
Nest 1	1930	4 Sept 05	42	24 Oct 05	350	15 m upland from wooded gully	Alive in cage 13 Apr 2006
	1931	4 Sept 05	48	24 Oct 05	487	Damp leaf litter in wooded gully	Dead in cage in flooded leaf litter April 2006
	1932	4 Sept 05	48	24 Oct 05	363	Damp leaf litter in wooded gully	Fate unknown, hatchling not relocated
	1933	4 Sept 05	24	N/A	743	Last observed edge of pothole	Fate unknown, transmitter failed
Nest 2	1938	13 Sept 05	21	N/A	488	Last observed on vegetation in pothole	Transmitter removed 4 Oct 05
	1939	13 Sept 05	21	N/A	406	Last observed at edge of pothole	Transmitter removed 4 Oct 05
	1940	13 Sept 05	21	N/A	233	Last observed at edge of pothole	Transmitter removed 4 Oct 05
2006							
Nest 1	1945	25 Aug 06	6	N/A	316	N/A	Transmitter found without hatchling
	1946	25 Aug 06	48	11 Oct 06	346	Burrowed in damp organic soil under *Phalaris*, 5 m from edge of pothole	Hatchling found alive within cage 9 Apr 07
Nest 2	1947	5 Sept 06	42	17 Oct 06	340	Burrowed in damp soil beneath *Phalaris*, 3 m from edge of pothole	Fate unknown, hatchling not relocated in cage
	1948	5 Sept 06	43	17 Oct 06	543	Burrowed under mound of *Phalaris* 0.6 m from edge of 28-acre lake	Fate unknown, hatchling not relocated in cage
	1949	5 Sept 06	14	N/A	412	N/A	Found dead in aquatic vegetation at edge of pothole
	1950	5 Sept 06	12	N/A	378	N/A	Transmitter found without hatchling
	1951	5 Sept 06	42	17 Oct 06	253	6 m from pothole, under prairie grasses within tree saplings	Found dead in 12 cm of water in cage 09 Apr 07

last observed in ca 2 cm of water within *Phalaris arundinacea* at the edge of a shallow wetland adjacent to a woodlot.

Beginning in the first week of April 2006, cages were checked frequently for appearance of the hatchlings. The two cages in the ditch were flooded by the 2nd week in April when water started flowing through the ditch. One hatchling was not relocated within its cage, but the cage had shifted due to frost, leaving gaps at the base. After searching through water and wet leaf litter, the second hatchling was found dead amidst the leaf litter in its cage, which had become flooded about 12 cm deep by fast moving spring snow melt. It could not be determined when the hatchling died or how, but there were floating sticks and vegetation within the cage and over 45cm of airspace above water. The third radioed hatchling that had been caged on the higher ground within the grove of saplings was found moving above ground within the cage on 13 April 2006. The hatchling appeared to have come out of a ca 5 cm burrow-like depression. The hatchling had survived a winter of frequently 0 mm of snow cover with < 5 cm leaf litter and air temperatures of –25.6°C for several days in February.

In 2006, seven hatchlings (1945–1951) were initially fitted with transmitters (Table 1). Two hatchlings were lost because of detachment of their glue-on transmitters. A third hatchling was found dead 14 days after release. It was intact with no sign of physical injury, buried within a thick vegetation mat on the shore of a pothole. This was the only mortality documented for radioed hatchlings during the active season in the 2 years of study.

Four other hatchlings were tracked to what were presumed to be overwintering locations. They were tracked for 42–48 days before their individual locations were caged. Although three of the hatchlings entered shallow water for varying short periods, each later left the water. Each hatchling ended up close to, but not in, the water of a wetland or lake. The hatchlings were estimated to move between 253–543 m. All long distance movement (> 6 m) ceased after 9–26 days. Each hatchling was caged in mid-October. Prior to caging, the radio of one hatchling was removed because the hatchling's carapace was visible from just below the surface of the soil and the hatchling could be quickly retrieved for transmitter removal and returned to its burrow. However, since the other hatchlings had burrowed out of sight, they were not disturbed for transmitter removal.

Hatchlings could not be found the following spring (April 2007) in two of the cages, but these cages had gaps at the base from freezing and thawing. One hatchling whose transmitter had been removed was found intact but dead within its cage in ca 12 cm of water. It was not possible to determine cause of death, but either freezing or drowning was possible. The fourth hatchling was found alive and clinging to woody debris in ca 12 cm of water within its cage on 9 April 2007. In late October, this hatchling had been burrowed down 8–9 cm into rich, very damp, but not saturated, organic soil, containing either shrew or vole tunnels and earthworms ca 5 m south of a pond's edge within a woodlot. The soil in this location was moist in the fall, but flooded in April from melting snow.

Discussion.—Standing et al. (1997) reported newly emerged hatchlings entering water but soon reemerging and heading towards upland habitat. Several of our tracked hatchlings went into a wetland, but later moved out onto land. Once the hatchlings in this study found suitable overwintering locations, almost all movement stopped despite warm, sunny days. The average number of days the turtles moved was 11.9 days (range 5–28 days) over the two tracking seasons. Hatchlings moved from 253–743 m, but this measurement reflected zigzag movement and not straight-line distance. Longest single-day movements recorded were 73.4 m by one hatchling and 104 m by a second on first day of travel. Our 2005–06 findings corroborate those of Refsnider (2005) that hatchlings appear to seek out damp terrestrial areas and eventually burrow under the soil for overwintering (Refsnider 2005). While they may enter water temporarily, probably to hydrate themselves, the hatchlings seem to move out of the water to overwinter. Captive hatchling *Emydoidea* maintained during winter were observed to sleep out of the water on flat rocks in aquaria, rather than in shallow water (ML, pers. obs.)

All but one of the seven caged hatchlings (3 from 2005 and 4 from 2006) chose to overwinter in damp soil on the edge of a wetland or in a dry stream bed that would be subject to winter freezing. All six of these locations in damp soil flooded the following spring. The seventh hatchling was on a more upland site ca. 15 m from a dry stream bed. Two of the seven hatchlings were known to have survived, including the one on the more upland site, two died in the cages, possibly from drowning or freezing, although there was a minimum of 45cm of airspace and considerable floating woody debris within the cages. The remaining three hatchlings were never located, perhaps because they escaped their cages.

There was no way to determine if the hatchlings fed during the first fall, despite warm air temperatures. Some of the turtles never entered water prior to hibernation. Burrowing into moist soil that floods in spring may benefit the hatchlings by placing them in productive feeding areas that warm up quickly, rather than forcing them to move again in spring when they may be in a weakened condition. The survival of one hatchling in an upland site during the winter 2005/06 and one in winter 2006/2007 suggests that Blanding's Turtle hatchlings have the ability to survive a first winter in a terrestrial situation, even without major snow cover and with temperatures dropping to -25°C. Hatchling Painted Turtles (*Chrysemys picta marginata*) are reported to tolerate freezing in the nest chamber during winter (Storey et al. 1988). Standing et al. (1997) speculated that because several of their tracked neonate *Emydoidea* in Nova Scotia survived overnight temperatures of -5.5°C, neonate *Emydoidea* might have the ability to super cool.

Our research results suggest that hatchling Blanding's Turtles that are artificially incubated or collected from relocated nests should not be released in water, but, rather, near the periphery of wetlands that will flood in spring within heavy vegetation with damp substrates so there is opportunity for them to burrow beneath the surface. Hatchlings that are caged at presumed overwintering sites need to be checked daily once wetlands have thawed in the spring because such areas typically flood and present a potential drowning hazard for hatchlings.

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An Adult Microphthalmic Gekkotan *Pygopus schraderi* (Squamata: Pygopododiae)

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Experimental and field studies have demonstrated that some squamate groups can at least partially compensate for the loss of key sensory capabilities (Aubret et al. 2005; Graves et al. 1993). Among the seven recognized families of gekkotan lizards (Gamble et al. 2008), vision is clearly a key source of environmental information. They have relatively large and well-developed eyes (Greer 1989; Roth and Kelber 2004), respond to visual cues (Marcellini 1977), and at least one study has found that blinding geckos reduces hunting success (Chou et al. 1988). However, it is also clear that olfactory and auditory cues are very important to these lizards (Chou et al. 1988; Marcellini 1977; Schwenk 1993). Herein we document an adult microphthalmic Hooded Scalyfoot, *Pygopus schraderi* (Pygopodidae) that demonstrates the extent to which senses other than sight are developed among at least some gekkotans.

The specimen, SAMA R05386 (SVL 135 mm, original tail 55 mm, regrown portion 80 mm), is an adult male as determined by the possession of elongate hind limbflaps, preanal tubercles, and preanal pores. It was collected from Domagee Mission (17°56'S, 138°49'E) in far northwest Queensland, Australia, in November 1963 by L. Fawcett. No more precise information about the time and locality of collection are given.

Relative to a normal adult *Pygopus schraderi* (Fig. 1A) both the left and right eyes and adjacent scalation on this specimen are severely deformed (Fig. 1B and C). The eye opening is reduced to two small slits on the left hand side, and a small irregular opening on the right hand side. There does appear to be a small dark body internal to both eye slits, which is probably a reduced or poorly developed eyeball.

It is difficult to assess the head morphology of this specimen further without damaging it, however there is no evidence of any mechanical damage. The deformation of the scalation is greatest around the eyes but is also evident on the temporal and parietal region and the lower labials and chin shields. The midline scalation from rostral to the two frontals is relatively normal with some mild irregularities on the right side. The extensive occurrence of asymmetric scale fusions and anomalous scale shapes indicate that the most likely cause of the condition is a developmental anomaly that occurred during embryology. It is possible that the condition was developed post-hatching, as for example via a severe ophthalmic infection that spread to adjacent soft tissues and healed with extensive deformation of the scales. If the deformation is due to pathology, it must have occurred many months or years prior to the collection of the specimen, as the area is fully healed. The visual ability of this specimen is at best likely to have been far worse than a normal *Pygopus*, and it could have been completely blind. Nonetheless, this specimen was an otherwise healthy adult at the time of its collection, having attained sexual maturity, and survived and regrown its tail after at least one autotomy event. Even if damage to the eyes was acquired post-hatching, the lizard was able to maintain itself in good body condition for a significant period of its life.

The ability to at least partially compensate for loss or severe impairment of key sensory capabilities has been demonstrated in some other squamate groups (e.g., Aubret et al. 2005; Chou et al. 1988; Graves et al. 1993), but this is the first evidence of such abilities in a pygopod. The ecology of *Pygopus* is not well documented, but there are suggestions from what is known that chemoreception (olfaction or vomerolfaction) may well be central to foraging in this genus. Patchell and Shine (1986), Pianka (1986) and Kluge (1974) have reported that species of *Pygopus* appear to be arachnid specialists, foraging especially for hole-dwelling prey. Such hidden prey would best be located using chemical as well as visual cues. The existence of fossorial foraging in other pygopods such as *Aprasia* and *Ophdiocephalus* would further support the contention that senses other than sight are very well developed within the Pygopodidae (Greer 1989).

Behaviorally, pygopods differ strikingly from their limbed gekkotan relatives in their regular use of oscillatory tongue flicking while active (pers. obs), an indication that vomerolfaction is important for investigating their surroundings. This contrasts with Schwenk's (1993) evidence that geckos (but not specifically including pygopods) may be olfactory specialists, with vomerolfaction playing a lesser role. Pygopods also possess a nasolacrimal duct between the Harderian gland and the vomeronasal organ. This duct has not been recorded in conventional gekkotans,

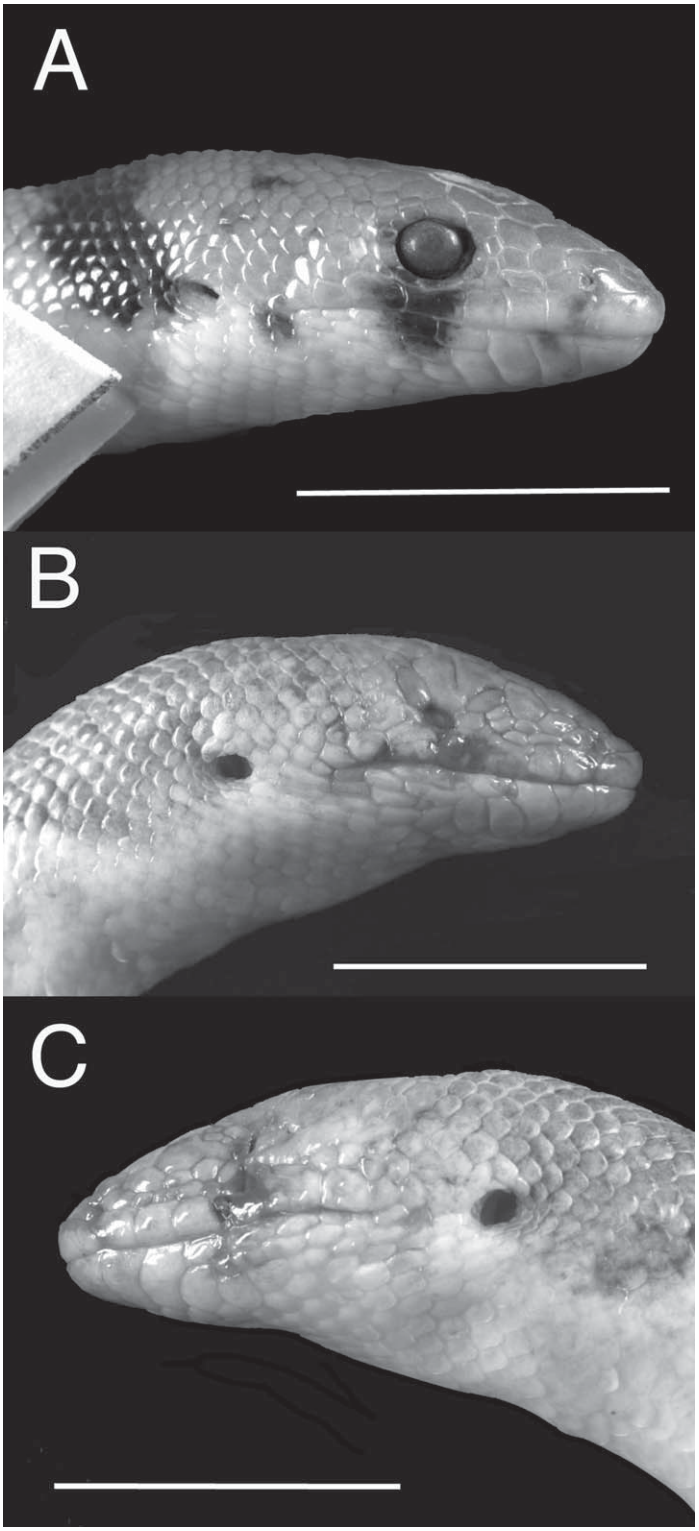


FIG. 1. Left lateral view of head of normal *Pygopus schraderi* SAMA R55293 (A); right (B) and left (C) lateral views of head of microophthalmic *Pygopus schraderi* SAMA R05386. Scale bar = 10 mm. Photographs by M. Hutchinson.

but is present in snakes, and it has been suggested that it may be a convergent adaptation associated with enhanced vomerolfaction (Rehorek et al. 2000). Relative to other gekkotans, pygopods are relatively wide-foraging and show an unusual degree of dietary specialization (Bauer 2007); as a general rule these foraging strategies are both correlated with the best developed abilities of vomerolfaction (Cooper 2007).

Multiple studies have demonstrated that pygopods are nested well inside the extant gekkotan radiation, and are relatively closely related to two other Australasian endemic gecko families; the Diplodactylidae and the Carphodactylidae (Donnellan et al. 1998; Gamble et al. 2008; Han et al. 2004). However, despite their evolutionary relationships, pygopods are strikingly divergent from all other geckos morphologically and ecologically, and remarkably convergent with the most successful limbless squamate radiation, the snakes (Bauer 2007; Greer 1989; Patchell and Shine 1986). The survival of a pygopod with greatly compromised visual ability emphasizes how the divergent evolutionary trajectory of this clade of lizards might have influenced all aspects of their biology.

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Gape Width: An Alternative to Snout–Vent Length for Characterizing Anuran Size

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Snout–vent length (SVL) is the most frequently used metric to describe the size of anurans captured in the field (Hammerson 1999; Stebbins 2003). In addition to taxonomy and systematics, SVL has been commonly used in a wide variety of studies including those on age (e.g., Kellner and Green 1995; Schroeder and Baskett 1968), growth (e.g., Quinn and Mengden 1984; Ritke et al. 1991), demography (e.g., Miller 1977; Van Gelder and Rijsdijk 1987), fecundity (e.g., Quinn and Mengden 1984; Reading 1986; Tejedo 1992), mate selection (e.g., Arak 1988; Marco et al. 1998; Olson et al. 1986; Reading 1991), and locomotion (e.g., Daugherty and Sheldon 1982; Navas et al. 1999). Despite the pervasive use of SVL, little has been published on the precision and accuracy of this metric (Blouin-Demers 2003). Users may have recognized the limitations of SVL, but continued to acquire this metric presumably because of its ease of use and lack of a robust alternative. Measuring mass has become increasingly popular as a metric to describe size (Alvarez and Nicieza 2002; Carey 1978), but its properties have also not been well studied and can be more difficult to obtain in the field. Inadequacies in SVL are a direct result of the inherent malleability in the anurans being studied, as amphibian vertebral columns are somewhat flexible (Fellers et al. 1994). Unlike fish where measurements between researchers on the same individual yield functionally equivalent results (Anderson and Neumann 1996), measurements on frogs appear to be highly variable (K. Rogers, personal observation). Perhaps measurement of more rigid structures that are still clearly defined and easy to isolate would provide more consistent results. This study seeks to quantify variation in SVL measurement as well as that in some alternative metrics expected to be more reproducible between researchers.

Methods.—This study examined 100 animals representing three different year classes from nine lots of the Boreal Toad (*Anaxyrus boreas boreas*) brood stock housed at the Colorado Division of Wildlife's Native Aquatic Species Restoration Facility (NASRF) in Alamosa, Colorado. Husbandry practices at NASRF sought to emulate conditions found in the wild where possible and generally followed Scherf-Norris et al. (2002). Brood stock was reared in captivity from eggs collected in the wild. Animals were maintained on a normal circadian pattern with photoperiod matching ambient conditions. Tanks were maintained at a minimum temperature of 20°C, ranging up to 26°C on hot summer afternoons, with a UVA basking light available in each tank. Boreal Toads were fed 3-week old crickets powdered with nutrient supplements (Scherf-Norris et al. 2002) and hibernated from October 1 through May 1 at 5°C in four environmental chambers subdivided into hibernacula that could house up to five individuals each (Scherf-Norris et al. 2002).

Metrics used in this study were obtained by passing animals down an assembly line of six biologists who each measured the SVL, length of the tibiofibula (TF), width of the gape (GW; Fig. 1), and mass for every toad. Lengths were measured in mm with digital calipers, while mass (g) was obtained with digital balances tared before each measurement. An ANOVA was used to evaluate differences between readers. The coefficient of variation (CV) between readers for each Boreal Toad was also calculated, and a mean CV for all 100 toads for each body metric was determined. Differences between mean CVs were also evaluated with an ANOVA followed by Bonferroni's multiple comparison test with simultaneous 95% confidence intervals.

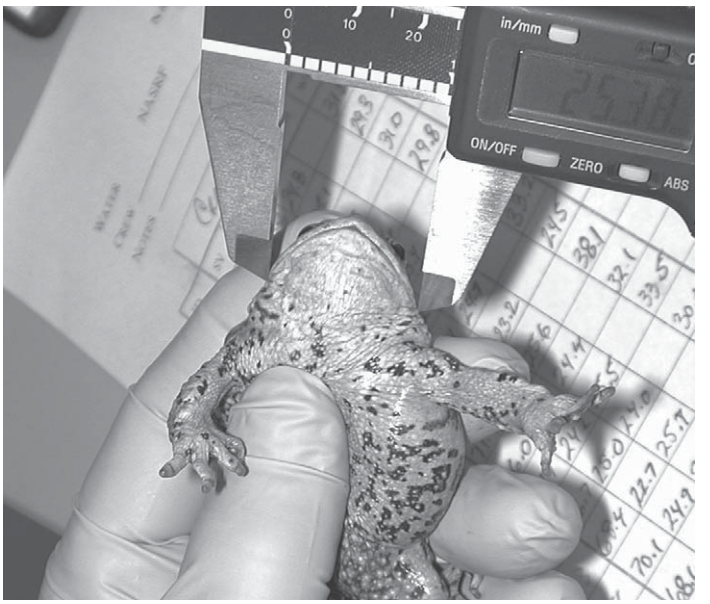


FIG. 1. Gape width measurements were taken with a digital caliper from the corners of each Boreal Toad's mouth.

Results.—There was considerable variation between readers ($P = 0.029$) in the average SVL calculated for all 100 toads measured (Fig. 2). In fact, measurements varied by as much as 30% of the calculated mean SVL for a given toad, with a mean of 12% (95% CI from 11–13%). Significant variation occurred between readers measuring TF as well ($P = 0.035$). Differences between biologists were not evident for GW ($P = 0.081$) or mass ($P > 0.999$).

Coefficients of variation were greatest for SVL and TF and least for mass (Fig. 3). Gape width did provide significantly more precision than SVL and TF, but not mass. As captive Boreal Toads used in this study were of known age, correlation of the various metrics with age was possible. Animal age ranged from 16–40 months. All metrics were positively correlated with age, with highly significant regressions ($P < 0.001$). However, mass was least predictive with an $r^2 = 0.76$. SVL and TF were intermediate, while GW showed the highest correlation with age ($r^2 = 0.85$; Fig. 4)

Discussion.—Variation in mean SVL measurements was considerable, and potentially a function of how aggressively Boreal Toads were handled during the measurement process. Body parts easily isolated for measurement produced consistent results, while those that required holding the animal in uncomfortable positions induced movement, and therefore more measurement error. It was expected that measurements of body parts less flexible than the anuran vertebral column would be more reproducible between readers. It was surprising therefore that the TF measurement was

no better than SVL for repeatability as the tibiofibula bone is rigid and should have yielded more consistent results. Perhaps subject movement induced by the awkward holding position required to measure TF played a role in the relatively large mean coefficient of variation seen for this metric (Fig. 3). GW was significantly less variable between readers. In fact this assessment is probably conservative, as much of the variation observed was due to contributions from only one of six biologists (Fig. 2). Consistency in GW measurement was facilitated by mouth corners being well defined and easily located by most readers. In addition, Boreal Toads could be held in a comfortable position while acquiring this dimension; reducing writhing that can complicate measurement of SVL and TF. This benefit was also conferred to measurement of mass. It was also not surprising that mass was the most repeatable measure used in this study, as it is the least subject to interpretation as implemented here with top-loading digital scales. Mechanical tube scales commonly used in field surveys might introduce additional measurement variation, but mass will remain a valuable metric for describing Boreal Toad size.

Perhaps the most useful aspect of measuring the width of the gape is that in addition to being very repeatable between measurers, it gave the tightest correlation with age over the size ranges examined here—a function that mass was not able to consistently achieve. While condition or plumpness of an individual can greatly affect the mass of a Boreal Toad, it often

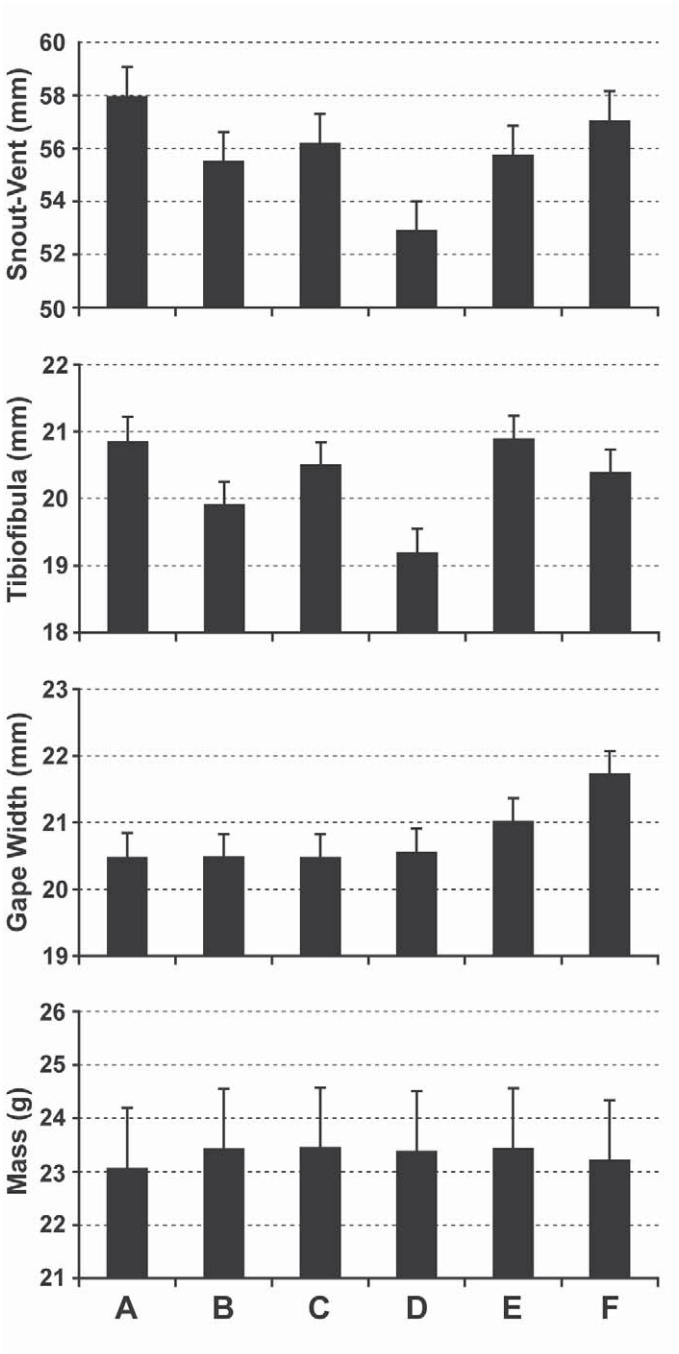


FIG. 2. Average snout–vent length (mm), average tibiofibula length (mm), average gape width (mm), and average body mass (g) for 100 Boreal Toads measured by each of six biologists (A–F) with associated standard errors.

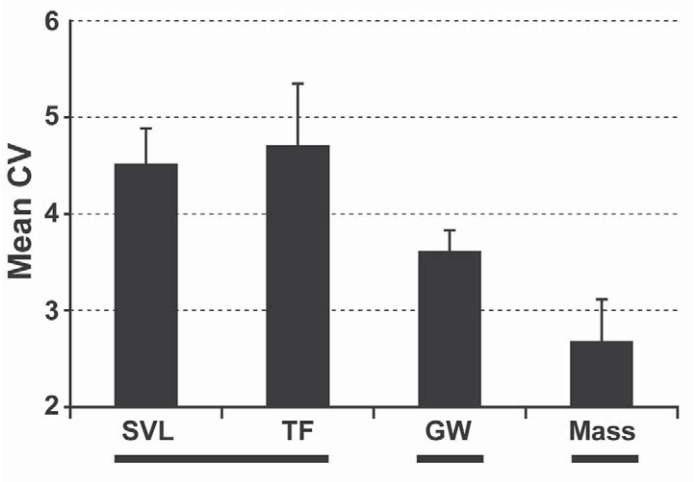


FIG. 3. Mean coefficient of variation (CV) calculated from 100 CVs generated across six biologists for snout–vent length (SVL), tibiofibula length (TF), gape width (GW), and mass with associated 95% confidence intervals. Bars sharing the same bold line below the x-axis are not significantly different ($\alpha = 0.05$).

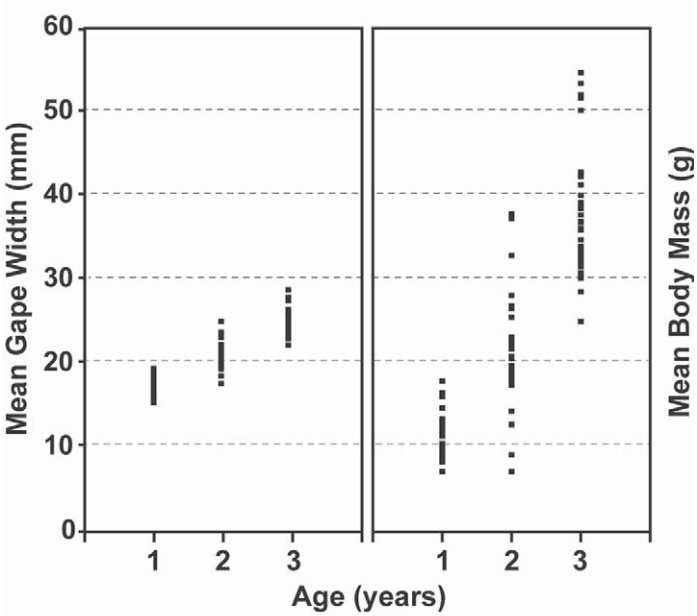


FIG. 4. Mean values for gape width (mm) and mass (g) calculated across biologists as a function of toad age.

has little to do with age. GW on the other hand is intimately tied to the animal's more rigid cranial dimensions. Though others have documented a poor relationship of SVL or mass to age in sexually mature amphibians (Halliday and Verrell 1988; Reading 1991; Wake and Castanet 1995), cranial dimensions in the first several years of a Boreal Toads life appear to more closely reflect age of the individual than mass, at least in the captive Boreal Toads used in this study. Although environmental conditions at NASRF were matched to ambient conditions, the steady diet furnished to these captive Boreal Toads might have provided for more consistent growth than would be realized in the wild. An additional study on known age wild Boreal Toads would be required to confirm the tight link between gape width and age in natural populations.

Indeed, for many analyses where only a rough index of size is required, SVL is probably adequate even with variation between readers. Certainly some of this variation can be mitigated if the same biologist acquires all of the readings. However, if precision is critical to the outcome of the study, or if a metric that is more closely correlated with age is required, then using GW is recommended.

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TECHNIQUES

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Comparison of Two Artificial Cover Objects for Sampling Herpetofaunal Communities in Missouri

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Amphibian and reptile communities are difficult to sample as many species are cryptic organisms with variable life histories and habitat requirements. One method for sampling herpetofauna is by searching under or within natural cover objects; however, this method is time intensive, non-standardized and can result in the destruction of microhabitat sites (Davis 1997). Consequently, many alternative census techniques are used (e.g., Bishop et al. 1997; Gibbons and Semlitsch 1982; Grant et al. 1992; Shirose et al. 1997; Todd et al. 2007). Ryan et al. (2002) used various sampling techniques (i.e., drift fence, coverboard arrays [i.e., ACOs] and time-constrained searches) and concluded that coverboards effectively measured herpetofauna presence-absence and revealed species not detected by drift fences and time-constrained surveys. Many researchers in North America have used ACOs to sample salamanders (e.g., DeGraaf and Yamasaki 1992; Moore 2005), snakes (e.g., Engelstoft and Ovaska 2000; Kjoss and Litvaitis 2001) and lizards (Ryan et al. 2002). Though various ACOs are commonly used, more research is needed that compares different materials for sampling herpetofauna (Grant et al. 1992; Moore 2005).

In this study, we used two ACO materials (wood and carpet) to sample herptetofaunal communities in oak-hickory forests of the upper Ozark Plateau, Missouri. This area supports more than 30 species of amphibians and reptiles, many of which are common through much of the eastern United States; therefore, the results of this study have specific applications to Midwest herpetofauna as well as other areas throughout eastern North America.

Methods.—Research was performed at three sites within the 1424 ha Daniel Boone Conservation Area, Warren County, Missouri (38.77°N, 91.38°W). The study site is dominated by a mature, secondary growth oak-hickory forest (*Quercus* spp. and *Carya* spp.) and has a rolling hill geomorphology categorized by ridge top to rock ravine with local relief (i.e., elevation change within 2.59 km^2) ranging from 46–76 m (Rittenhouse and Semlitsch 2007). A pond (160–330 m^2) centers each study site.

Artificial cover objects (ACOs) were placed at sites in April–May 2006. All transects were perpendicular to the pond edge. There were eight transects per site, primarily in second growth oak-hickory forests but extending into some sites that had been recently logged or logged and burned. Each transect was 110 m long with paired ACOs every 10 m (11 paired ACOs per transect; total of 264 paired ACOs). We used two types of ACOs, a solid untreated wood board measuring ~ 90 × 30 × 2.5 cm, and an undyed Berber style carpet slab of equal length and width, but ~1.5 cm depth. These ACOs were placed side by side, less than 10 cm apart, parallel to the transect at each 10 m interval. The soil beneath each ACO was cleared of any litter, debris, and/or large rocks to ensure that each ACO lay flat. Carpet ACOs were placed carpet side down.

ACOs were monitored from 6 June to 25 August 2006, and again from 11 April to 13 September 2007. We randomized the order in which each site was checked on collection dates. ACOs were checked during daylight hours, between 0900 and 1800 h and approximately every 10 days during the monitoring period. In order to minimize disturbance of microhabitats, ACOs were never checked more than once every seven days (Marsh and Goicochea 2003). All vertebrates beneath ACOs were recorded. Additionally, we measured salamander mass using a 20 g Pesola® (accuracy ± 0.1 g) spring scale and snout–vent length (SVL) with a hand ruler.

We recorded microhabitat variables during the weeks of 23 August 2006, 17 May 2007, and 24 July 2007. We used an infrared laser thermometer (Raytek, MT4) to measure surface temperature and a 4-prong moisture meter (Aquaterr, M-300) to measure moisture content under each ACO. We measured litter depth by inserting a metric ruler into the litter at three randomly chosen spots, 1 m from ACOs. Canopy cover was determined using a concave spherical densiometer held 1 m directly over the ACOs.

We used binomial exact tests to determine if captures were equal under wood and carpet ACOs for each species with greater than ten total captures. A bonferroni adjustment was used for comparisons ($\alpha < 0.007$). Tests were performed using SAS v9.1.3 (SAS Institute Inc.) with the exact binomial option in PROC FREQ. We were also interested in size differences among salamanders using the different ACOs. We used a T-test to compare SVL of *P. albagula* found under the two types of cover objects.

To test for microhabitat differences under wood and carpet ACOs, we descriptively compared mean temperature and moisture values for three sampling periods, fall, summer and winter. Due to differences in slope, aspect, and microhabitat, we considered each pair of coverboards to be independent.

Results.—Of the 31 possible amphibian and reptile species found within our study area, 58% (18/31) of potential herpetofauna species were captured using both types of ACOs. However, the sampling effectiveness between ACO types in detecting the most species present in our study area was not equivalent as 17 of 31 potential species were captured by wood ACOs whereas 11 of 31 species were captured using carpet. Though 18 species were captured in total, 11 species contained low total captures for our two year period (<10 captures). Within our study area, both ACO types detected the presence of 67% (4/6) of salamanders, 20% (2/10) of anurans, 75% (3/4) of lizards, and 82% (9/11) of snakes.

More amphibians and lizards were captured under wood ACOs than carpet, whereas few differences in snake captures existed between ACO types (Table 1). Of the 18 species captured using both ACOs, five of the 18 species had high captures for wood ACOs. No

species in this study were captured significantly more under carpet than wood ACOs (Table 1). *Plethodon albagula* and *Bufo americanus* were the most captured amphibian species, two snake (*Carphophis vermis, Lampropeltis triangulum*) and two lizard species, (*Eumeces fasciata, Scincella lateralis*) were also frequently captured, all of which were captured more under wood ACOs than carpet. *Diadophis punctatus* and *Virginia valeriae* were the two most captured snake species; however, captures were not particular to either ACO type. There was no significant difference in *P. albagula* SVL among the ACO types (t = -1.42, df= 3 P = 0.2511). Additionally, there were no apparent differences in soil temperature or moisture between ACO types and sampling periods.

TABLE 1. Total captures of all amphibians and reptiles. Binomial exact tests for species with greater than ten captures to evaluate if captures were equal under wood and carpet artificial cover objects. Significant *P*-values are in bold (Bonferroni adjustment for multiple comparisons $\alpha < 0.007$). "Unknown sp." represents species that escaped before identification.

	Cover Object Type			
Species	Carpet	Wood	Total	*P*
Plethodon albagula	47	256	303	**<0.0001**
Ambystoma annulatum	2	2	4	
Ambystoma opacum	0	1	1	
Notophthalmus viridescens	0	2	2	
Bufo americanus	0	11	11	**0.0010**
Rana clamitans	0	1	1	
Eumeces fasciata	16	41	57	**0.0013**
Eumeces laticeps	0	5	5	
Eumeces unknown sp.	1	3	4	
Scincella lateralis	35	53	88	0.0693
Carphophis vermis	3	13	16	0.0213
Diadophis punctatus	29	24	53	0.5831
Elaphe obsoleta	0	1	1	
Lampropeltis triangulum	0	6	6	
Opheodrys aestivus	1	0	1	
Storeria dekayi	2	1	3	
Storeria occipitomaculata	2	1	3	
Thamnophis proximus	0	1	1	
Virginia valeriae	10	8	18	0.8145

Discussion.—Wood and carpet ACOs confirmed the presence of all known fossorial snake species in our study area. Similarly, Willson and Dorcas (2004) used plywood ACOs to sample fossorial snakes in North Carolina and detected all five species present within their study area. In particular, we captured *C. vermis* more often under wood ACOs than carpet, and both ACO types had high captures of *V. valeriae* and *D. punctatus* compared to other snake species in our study area. Wood also detected the presence of other cryptic species such as *L. triangulum.* Size of ACO may have affected our low detection of larger snake species such as *Thamnophis* spp. and *Coluber* spp., as the majority of snakes captured by ACOs were small bodied species.

In our study, we had higher lizard captures under wood over carpet ACOs and caught three of four possible species. *Sceloporus undulatus* is present in our study site but was not captured by either wood or carpet ACOs. Our study, as well as studies from different geographical regions (i.e., Grant et al. 1992; Tietje and Vreeland 1997; Hampton 2007), indicates that wood ACOs could be used across North America to sample skink species (*Eumeces* and *Scincella* spp.); however, our methods did not capture *S. undulatus* in our Midwestern study site, whereas both *S. occidentalis* and *S. undulatus* were sampled using ACOs in the East and West (Grant et al. 1992; Tietje and Vreeland 1997). Further research is needed to definitively decipher the regional effectiveness of sampling methodologies for herpetofauna guilds.

Similar to other studies of plethodontid salamanders (see review by Moore 2005 and Grant et al. 1992), Western Slimy Salamander (*P. albagula*) accounted for 94% (303/322) of all amphibians captured in our study. *B. americanus* was the only other amphibian species that was sampled in high numbers via wood ACO. Six salamander species were captured using drift fences in our study area (Hocking et al. 2008) and we caught four of the six using ACOs. However, drift fences often resulted in *P. albagula* mortality in our study area (RDS, unpublished data). Both ACOs detected the presence of six of 16 amphibian species present in our study area; however, captures for all but *P. albagula* and *B. americanus* were low in numbers. We, therefore, suggest using wood ACOs to sample for *Plethodon* salamanders because of high *P. albagula* captures compared to carpet ACOs and wood ACOs caused no mortality compared to drift fences.

In our study, as well as Houze and Chandler (2002), body size did not affect choice of ACO type by slimy salamanders (*P. albagula* and *P. ocmulgee*, respectively). In contrast, salamander (*Plethodon cinereus*) size class influenced the use of artificial and natural cover objects in Virginia (Marsh and Goicochea 2003), whereas Monti et al. (2000) found that body size class did not influence the use of artificial and natural cover objects by *P. cinereus* in Maine. A species use of ACO may vary by habitat type, regional temperatures and climate, and natural history of target organism (Davis 1997), thus sampling techniques that use ACOs may regionally differ among similar taxa. Further research is needed to definitively decipher the regional effectiveness of sampling methodologies for herpetofauna guilds, particularly those in the Midwest.

Various materials have been previously deployed as an ACO, however, no studies to date used carpet to sample herpetofauna. Overall, wood was more effective than carpet in detecting the most species in our study area. However, carpet type should be selected with caution as many carpets contain chemicals that may affect use by some taxa. One potential benefit for using carpet may be the cost of carpet over wood ACOs. We purchased wood at a cost of $7.05 per ACO whereas the cost of carpet was $2.88 per ACO. However, we were only able to conduct this comparative study for two years as carpet significantly degraded by the third sample

season whereas wood ACOs had minimal degradation. Therefore, the initial costs of carpet, though less expensive, may not be as economical in a multiyear study when compared to the initial costs and extended life span of using wood.

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Use of Visual Implant Alpha (VIAlpha) Fluorescent Tags in a Small Hylid Frog with a New Technique for Application

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In recent years, the use of elastomers to mark amphibians has been gaining acceptance. Several studies have reported the use of injected tags such as Visual Implant Elastomers (VIE) and Visual Implant Alpha (VIAlpha) tags (Northwest Marine Technologies, NMT) for marking individual amphibians in the field and laboratory (e.g., Gower et al. 2006; Moosman and Moosman 2006; Nauwelaerts et al. 2000). VIAlpha tags are small medical grade elastomers available in a variety of fluorescent colors. Each tag is stamped on one side with a letter (A–Z) and a number (00–99). Use of a UV light aids in detection and readability of tags. VIAlpha tags have been shown to be safe for amphibians (Buchan et al. 2005), and lack the drawbacks that may be associated with toe-clipping, such as reduced survivorship, behavioral changes, or inflammation (Golay and Durrer 1994; Lemckert 1996; McCarthy and Parris 2004). In addition, VIAlpha tags are relatively inexpensive.

VIAlpha tags are not without disadvantages. One disadvantage is the difficulty of marking frogs with loose skin. Developed for tagging fish, the injector available from NMT is not well-suited to species with skin that easily slides on the body (pers. obs.). Moreover, in amphibians, tags may migrate once injected. The webbing between toes is a stable place for elastomer tags in some amphibians (Nauwelaerts et al. 2000), but the small size of many species make this a difficult undertaking. Indeed, many studies using VIAlpha tags have involved ranid frogs, and few have focused on the viability of using tags in smaller frogs (but see Buchan et

al. 2005). Tag retention also may vary among species. Finally, VIAlpha may not be suitable for use in heavily pigmented species because the skin may obscure the tag.

We tested the use of VIAlpha tags in the neotropical treefrog *Dendropsophus microcephalus* (Hylidae). Our objectives were to: 1) test a new technique for injecting VIAlpha tags in *Dendropsophus microcephalus*, a small species with loose skin, wherein we grasp the skin with forceps, make a small incision in the skin, and then inject the tag; 2) determine whether dorsal application of tags is suitable in this species; and 3) assess whether marked frogs can be individually identified without recapture.

We marked and observed 87 male *Dendropsophus microcephalus* in the field between June and August 2008 at nocturnal breeding aggregations in the Chiquibul Forest Reserve, Belize. Frogs were hand-captured and subset was measured using photographs and ImageJ (National Institutes of Health, Bethesda, MD). Frogs averaged 24.7 mm snout-vent length (SVL) with anterior phalange length averaging less than 3 mm, precluding the use of toe clipping. All individuals were marked using red VIAlpha tags with black lettering (size = 1.0 × 2.5 mm).

Frogs were prepared for marking by grasping the loose skin of the dorsum caudal to the sacrum, close to the articulation of the femur and pelvis, with forceps and cutting a 2–3 mm slit using a pair of surgical scissors. The use of forceps provided an advantage over other techniques by preventing displacement of the incision. The tag could then easily be placed into the slit using the injector provided by NMT, with the procedure generally taking less than one minute. No anesthesia or veterinary glue was used and frogs did not demonstrate excessive signs of discomfort typical of restraint. Frogs were placed in air-filled plastic bags and monitored for several minutes, often until they began calling again, before release at the site of capture.

From the day we marked the first individual, the study ran for 50 d, with ponds checked nightly. Frogs were marked throughout the course of the study. Of 87 individuals marked, we recaptured 71 (81%) individuals. In addition, 60/89 (67%) frogs were recaptured more than once suggesting that stress of handling did not discourage individuals from returning to breeding aggregations. One individual sustained minor injury during the marking process but was observed calling the following night. No evidence of infection was observed in the marked individuals.

Our second goal was to observe the stability of tags placed at the caudal end of the dorsum, where the femur articulates with the pelvis. Few tags remained in place, generally migrating ventrally on the body. In one case, a tag was found under the chin of an individual. Tags also inverted within the frog easily, so that the printed side was no longer facing out. We were able to restore tags to the correct orientation by prodding with fingers, but the need to do so was common enough (sometimes more than one recapture per night) that the inconvenience would be substantial over time or with larger numbers of frogs. In addition, some tags were expelled from the incision site during handling, and some individuals lacked tags, but were recognized by unique markings or by the presence of the surgical site. Moreover, tags migrated in two recaptured individuals resulting in frogs being marked twice. In cases where VIAlpha tags are not easily detected, this could lead to extra incisions on the animals and wasted resources. The additional handling as a result of tag migration may have adverse effects on research, such as behavioral changes due to handling stress, although we did not see any evidence of such effects in this study.

Our final goal was to assess the use of VIAlpha tags as a marking technique that would not require recapture of individuals. The only candidate site for marking that is visible from a distance is the dorsum. While Moosman and Moosman (2006) had no migration in midbody dorsal markings in *Rana sylvatica*, the small size and lack of loose skin at midbody on our animals precluded midbody markings. We found that when tags did remain in place, they were difficult or impossible to read without the frog in hand. The light yellow pigmentation in the dorsum obscured the numbers sufficiently, even with the UV flashlight provided by NMT, that capture was necessary. Even if hand capture wasn't necessary, we would have had to approach the frog with a UV light for proper identification, and still would have risked disturbing it or affecting its behavior. In all cases we were able to discern alphanumeric identity with individuals in hand.

VIAlpha tags are appealing because of the relatively low cost (approximately US $1 per tag plus cost of injector and LED tag reading light, US $250 total), and because the tagging is relatively non-invasive. The problem of tag expulsion may be solved by the application of veterinary glue to the wound; however tag migration may remain a problem in some species and with some injection sites. By developing and implementing this new insertion technique, we successfully tracked the majority of 87 tagged frogs for almost two months. This suggests that while VIAlpha tags did not meet the goal of identifying individuals from a small distance, they did provide a marking technique that was easy to implement, fast, safe, and usually, but not always, easy to detect.

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Interspecific Variation in Use of Polyvinyl Chloride (PVC) Pipe Refuges by Hylid Treefrogs: A Potential Source of Capture Bias

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Amphibian trapping techniques are designed to exploit various behaviors; as knowledge regarding the behavior of the target taxa increases, sampling techniques must be adapted accordingly. Refinement of the technique increases effectiveness and reduces capture biases that might influence detection probability. Equal detectability is a critical assumption of many mark-recapture models, and unequal, imperfect, or inconstant detectability will affect estimates of population size, species richness, and site occupancy (Mazerolle et al. 2007). Therefore, it is critical that researchers consider potential sources of variation when planning studies in order to reduce capture biases, and select models for data analysis that incorporate estimates of detection probability (Mazerolle et al. 2007).

In recent years, researchers have begun to take advantage of the propensity of hylid treefrogs to use cavities as diurnal shelters (McComb and Noble 1981; Ritke and Babb 1991; Walters and Kneitel 2004) by deploying artificial refuges that mimic natural cavities to sample hylid populations (Meshaka 1996; Moulton et al. 1996). Polyvinyl chloride (PVC) pipe refuges are perhaps the most popular method for studies of hylid population ecology and ongoing monitoring efforts (e.g., Boughton et al. 2000; Campbell et al. 2009; Hirai 2006; Johnson et al. 2008; Moulton et al. 1996; Pittman et al. 2008; Smith et al. 2006; Zacharow et al. 2003). The PVC refuges are more effective for hylid sampling than traditional drift-fence arrays, and passively attract (rather than trap) frogs. As this effectively eliminates trap mortality, there is no need to remove or close "traps" between sampling periods, making PVC sampling less labor-intensive than many trapping methods. Sampling can be conducted throughout the day without fear of heat stress to "captured" animals. This method is also potentially less biased than call surveys as it facilitates year-round sampling of both genders (but see Pittman et al. 2008), and it allows identification of individual frogs for mark-recapture studies.

However, a wide variety of factors affect use of PVC refuges by hylids and can result in capture bias and influence detection probability. Although vegetative cover does not influence captures of some hylids (Moulton et al. 1996), hylids may prefer refuges in close proximity to breeding sites (Boughton et al. 2000; Pittman et al. 2008). Arboreal placement of refuges and tree type (hardwood vs. pine) may also influence the composition of the hylid sample (Boughton et al. 2000; Johnson et al. 2008; Myers et al. 2007; Townsend 1989). Capture rates may also be influenced by refuge design (i.e., pipe diameter or length, T-shaped or straight, end caps to hold water), age of pipes (i.e., outgassing of new pipes), or other variables that affect the microclimate within the PVC refuge (Bartareau 2004; Boughton et al. 2000; Buchanan 1988; Moulton et al. 1996; Zacharow et al. 2003). Season, temperature, humidity, and rainfall may also influence refuge use (Johnson et al. 2008; Pittman et al. 2008; Zacharow et. al. 2003). Some field data suggest that interspecific variation in refuge use may exist (Boughton et al. 2000; Zacharow et al. 2003), but this potential source of bias has not been explicitly investigated.

In order to unequivocally evaluate interspecific variation in PVC refuge use, it is necessary to determine the location of each study frog during each sampling period, even when frogs choose an alternative refuge (i.e., they choose natural cover rather than a PVC refuge). This can only be achieved by controlled behavioral trials or radio telemetry field studies. However, size of available radio transmitters precludes telemetry of smaller hylid species for any length of time, and the arboreal nature of some hylids makes it difficult to pinpoint diurnal refuges (Johnson 2005; M. E. McGarrity, unpubl. data). Therefore, we conducted refuge choice trials to evaluate interspecific variation in refuge preference among four species of hylids in a controlled setting in order to provide insights on potential variation in detection probability of these species in the field. As previously mentioned, numerous factors can influence variation in PVC pipe refuge use, including weather and microclimate of the PVC refuge. By conducting a laboratory study, we were able to control for many of these sources of variation and focus on behavioral variation among species. We then analyzed original field data from several of our field sites and published data from one field site (Zacharow et al. 2003), and compared laboratory and field data to evaluate the relevance of trends seen in the laboratory study.

Methods.—We collected frogs for laboratory trials during June–July 2007 from multiple urban and rural sites in Alachua, Hillsborough, and Polk Counties, Florida, USA, using PVC refuges and hand collection. Collection sites included natural marshes and swamps, retention ponds, parks, roadside and agricultural ditches, paved roads, and buildings. We conducted laboratory experiments at the University of Florida/IFAS Gulf Coast Research and Education Center (Wimauma, Florida, USA) in rooms equipped with individual climate and lighting control systems. We maintained frogs in individual 0.75 L clear plastic containers with 3 mm air holes for a maximum of 18 days; containers were disinfected between frogs. We fed all frogs crickets *ad libitum* during captivity. We set temperature to 24°C during the day (the maximum the system would allow); temperature fell to a minimum of 21°C during the night. We used a 14-hour light cycle (0630–2030 h) to approximate the natural photoperiod in central Florida during the study (June/July).

We evaluated refuge preferences in a controlled setting for four species of hylids commonly encountered in PVC refuges in the

southeastern USA: *Hyla cinerea* (Green Treefrog), *H. squirella* (Squirrel Treefrog), *H. femoralis* (Pine Woods Treefrog), and *Osteopilus septentrionalis* (Cuban Treefrog, nonindigenous). We conducted 30 individual trials per species to evaluate refuge preference; each frog participated in only one refuge choice trial. We placed each frog into a 38 L aquarium with a wet sand substrate and screen lid. Since we were unable to regulate humidity in the room, we used the wet sand substrate to increase relative humidity in the aquarium to approximately 65% to prevent desiccation and minimize variation. We offered the frog a choice of two refuges placed at opposite ends of the aquarium: a PVC pipe installed vertically in the sand (3.8 cm diameter, 20 cm tall) and an herbaceous plant (*Vinca* sp., ~20 cm tall). We alternated the placement order of the two refuges within the aquarium to control for potential directional bias in refuge choice. Although the plant was not a native Florida species, all hylid species in this study readily used it when it was the only refuge provided and it closely mimicked the structural complexity of small, native shrubs. We initiated trials at 2000 h and recorded refuge choice (i.e., PVC pipe, plant, other location) at 1000 h the following day, by which time frogs in natural habitats would likely have sought diurnal shelter. After completion of each trial, we marked indigenous hylids with visible implant elastomer to prevent re-capture (and re-testing), and released them at the site of capture. Since *O. septentrionalis* is an invasive, nonindigenous species in Florida, we euthanized these frogs immediately after trials by applying 20% benzocaine to the skin of the ventral surface followed by freezing for 48 hrs. Frog collection techniques, captive maintenance, experimental trials, and euthanasia procedures were approved by the Institutional Animal Care and Use Committee of the University of Florida (protocol E870).

We evaluated frequency of refuge use in the field with data we collected during several previous studies using PVC pipe refuges. We deployed ground-based PVC pipe refuges in 100 × 100 m grids of 121 pipes each in flatwoods habitat at sites in the Lower Suwannee National Wildlife Refuge (LSNWR, Chiefland, Florida, USA; August 2003–July 2004), Wekiwa Springs State Park (WSSP, Apopka, Florida, USA; July 2006–February 2007), and Flatwoods Wilderness Park (FWWP, Thonotosassa, Florida, USA; August 2006–June 2007). We monitored these PVC refuges at 3–4 week intervals, and individually marked each frog by toe clipping (LSNWR) or using a combination of visible implant elastomer with toe clipping (WSSP, FWWP; Hoffmann et al. 2008). We also evaluated frequency of refuge use from data in a published study that used transects of ground-based PVC refuges to sample hylid populations (at weekly intervals) at sites between breeding ponds and mesic hardwood hammocks (Gainesville, Florida, USA; August 2001–April 2002; Zacharow et al. 2003). We calculated capture frequency (i.e., number of individually marked frogs captured once, twice, etc., *not* frequency of presence/absence of any frog in a given pipe) and mean number of captures per frog for each species at each site. Since frogs were individually marked, we were able to determine frequency of capture for each frog.

We evaluated variation among species in frequency of refuge use during controlled behavior trials using a Pearson Chi-square test (SYSTAT 10.2, SYSTAT Software Inc., Richmond, California, USA; $\alpha = 0.05$). We evaluated variation among species in frequency of refuge use at our field sites (number of captures per individually marked frog) using ANOVA with *a priori* contrasts ($\alpha = 0.05$).

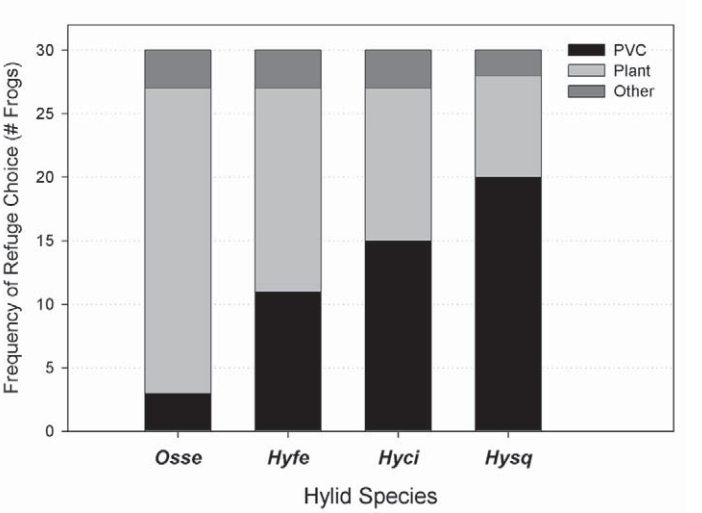


FIG. 1. Frequency of refuge choice for four hylid species (N = 30/species): *Osteopilus septentrionalis* (*Osse*; Cuban Treefrog), *Hyla femoralis* (*Hyfe*; Pine Woods Treefrog), *H. cinerea* (*Hyci*; Green Treefrog), and *H. squirella* (*Hysq*; Squirrel Treefrog). "PVC" indicates vertical PVC refuge, "Plant" indicates *Vinca* sp. plant, and "Other" indicates other (exposed) resting places in the aquarium.

Results.—Frequency of refuge use during controlled behavior trials differed significantly among species ($\chi^2_{0.05, 6} = 21.61$, $P = 0.001$; Fig. 1). *Osteopilus septentrionalis* chose to rest in the plant eight times as often as the PVC pipe, whereas *Hyla squirella* chose the PVC pipe more than twice as often as the plant. The remaining two species, *H. femoralis* and *H. cinerea*, did not exhibit an obvious refuge preference. Individuals of all species preferred to use PVC pipe and plant refuges as diurnal shelters, as opposed to more exposed areas of the aquarium (Fig. 1), and rarely chose to rest elsewhere (i.e., on sand substrate, on glass walls, or under edge of lid).

Frequency of capture in PVC refuges in the field also varied among species (Table 1). When data from our field sites (LSNWR, WSSP, FWWP) were subjected to ANOVA, mean number of captures (per individual frog) differed greatly among species ($F = 12.173$; $P < 0.001$). Mean number of captures of *H. squirella* and *H. femoralis* at our field sites were similar ($P > 0.1$), and were significantly higher than the mean number of captures per *O. septentrionalis* ($P < 0.001$). Mean number of captures of *H. squirella* differed by 33% (Table 1) between our study site and the site used by Zacharow et al. (2003); however habitat also differed greatly between these sites (respectively, flatwoods vs. breeding ponds and surrounding hardwood hammock). Across all sites (including Zacharow et al. 2003), native *H. femoralis*, *H. squirella*, and *H. cinerea* were at least 1.5 times more likely to be recaptured than *O. septentrionalis*.

Discussion.—We identified significant interspecific variation in artificial refuge use that may present a significant source of bias when using PVC refuge sampling. Our laboratory trial setup provided the advantage of controlling for climatic, microclimatic, seasonal, and other variables that might obscure interspecific variation in frog behavior in the field, and yielded insights to

TABLE 1. Frequency of capture at field sites for four hylid species: *Osteopilus septentrionalis* (Cuban Treefrog), *Hyla femoralis* (Pine Woods Treefrog), *H. cinerea* (Green Treefrog), and *H. squirella* (Squirrel Treefrog). Data are shown as the number of frogs captured *x* times at a given site, followed in parentheses by the percent of total frogs of that species captured *x* times. Sources correspond to abbreviations in study area descriptions (ZACH corresponds to Zacharow et al. 2003).

Number of captures / frog	*O. septentrionalis*		*H. femoralis*		*H. cinerea*	*H. squirella*	
1	65 (71%)	77 (71%)	205 (45%)	53 (52%)	106 (58%)	84 (60%)	70 (39%)
2	23 (25%)	22 (20%)	97 (21%)	14 (14%)	42 (23%)	17 (12%)	39 (22%)
3–5	3 (3%)	8 (7%)	118 (26%)	24 (24%)	28 (15%)	29 (21%)	45 (25%)
6–10	0 (0%)	1 (1%)	37 (8%)	9 (9%)	7 (4%)	10 (7%)	24 (13%)
Mean ± SD	1.32 ± 0.53	1.45 ± 0.87	2.37 ± 1.70	2.46 ± 2.04	1.95 ± 1.66	2.11 ± 1.75	2.82 ± 2.36
Range	1–3	1–6	1–8	1–10	1–10	1–9	1–11
Source	WSSP	FWWP	LSNWR	FWWP	ZACH	LSNWR	ZACH

guide future field studies. However, these laboratory trials were limited, in that they restricted the refuge choices available to the frogs, rather than mimicking the natural conditions where many natural refuge choices are available around each artificial PVC refuge. Therefore, we used data from field studies to evaluate the applicability of our laboratory results to more natural settings. Capture frequencies from PVC sampling field studies have been used to make comparisons of interspecific variation in site fidelity (Zacharow et al. 2003), and may also be good descriptors of fidelity to PVC refuges, or the propensity of a species to seek shelter in them. Theoretically, individuals of a species that prefers PVC refuges to more natural shelters will be recaptured in the PVC refuges more frequently. Factors including interspecific differences in physiology, seasonal habitat use, site fidelity, susceptibility to predation, and microhabitat preferences likely contribute to variation in PVC refuge use among species.

Capture frequencies from field studies are consistent with the results of our controlled behavioral trials. During behavioral trials, *Hyla squirella* showed an obvious preference for PVC pipes over plant refuges (Fig. 1). In the field, *H. squirella* had the highest documented number of captures per frog (Table 1; Zacharow et al. 2003), in keeping with the demonstrated tendency of this species to choose PVC refuges under controlled laboratory conditions. In addition, *H. squirella* were nearly seven times more likely to choose a PVC refuge during behavioral trials than *Osteopilus septentrionalis*, which preferred to seek refuge in the plant as opposed to the PVC pipes. Similarly, *O. septentrionalis* at our field sites were much less likely to be recaptured in PVC refuges than native hylids; only 28% of *O. septentrionalis* were captured more than once. This suggests that, although this species is well known to use PVC refuges in the field, they may use these shelters less frequently than other species, especially when alternative refuges are available. Overall, native hylids were 1.4–2.1 times more likely than *O. septentrionalis* to be recaptured in the field. Capture frequencies and mean number of captures per frog were similar for each species between field sites (Table 1), with the greatest amount of variation seen for *H. squirella* between sites in different habitat types.

Although artificial PVC refuges are the most effective method for sampling hylids currently available, sources of potential capture bias must be carefully considered in order to minimize bias, increase detectability, and reduce effects on population estimates inferred from these studies. We have identified interspecific differences in PVC refuge use as a major source of variation that could mask the difference between low abundance and low capture rate. We suggest that researchers consider behavioral differences, including diurnal refuge use, of all target species when planning PVC refuge sampling studies. When data for a given target species are not readily available in the literature, a small laboratory pilot study might be advisable to identify potential interspecific variation in refuge use and thus detectability. Furthermore, our results suggest that researchers should consider using mark-recapture methods rather than point counts to estimate population parameters, as interspecific variation in PVC refuge use may be misinterpreted as variation in relative abundance.

The implications of this interspecific variation in PVC refuge use are particularly important with regard to efforts to monitor and manage invasive species such as *O. septentrionalis*. This nonindigenous hylid is believed to impact native hylid populations through predation and competition (Knight et al. 2009; Meshaka 2001; Rice et al. 2003; Smith 2005). Management efforts to date largely consist of point-counts and removal of *O. septentrionalis* from PVC refuges used to monitor hylid populations. However, our results show that only a small portion of the population is likely to be captured using this method. The preference of *O. septentrionalis* for natural refuges, shown in this study, reduces detectability and suggests that even small numbers of *O. septentrionalis* in point-count PVC monitoring studies may be indicative of a significant infestation. Furthermore, the highly arboreal nature of this species (McGarrity and Johnson, *in press*) indicates a need for evaluation of optimal placement of PVC refuges (e.g., arboreal vs. ground-based). Until the PVC sampling method is further refined in order to maximize capture, when possible, managers should not solely rely on point-counts using ground-based PVC refuges to monitor and remove *O. septentrionalis*. Other techniques, including mark-recapture and dip netting of larvae or hand capture of breeding adults, should be considered to enhance monitoring and removal efforts that rely on PVC pipe refuges.

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AMPHIBIAN DISEASES

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Evaluation of Chytrid Infection Level in a Newly Discovered Population of *Anaxyrus boreas* in the Rio Grande National Forest, Colorado, USA

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The Western Toad, *Anaxyrus boreas*, ranges throughout the western United States, exclusive of the desert southwest (Goebel et al. 2009; Hammerson 1999). In the southern Rocky Mountains, *A. boreas* breeds in slow moving water, such as wetlands, marshes, ponds and lakes, in subalpine forest at high elevation, 2000–3500

m (Hammerson 1999). The species has been experiencing population declines in the southern Rocky Mountains since the 1970s (Carey 1993), leading to listing as a state endangered species in Colorado in 1994 (Loeffler 2001). Population declines of *A. boreas* have been linked to infection by the pathogenic chytrid fungus, *Batrachochytrium dendrobatidis* (*Bd*), which also has been implicated in causing amphibian declines throughout the world (Carey 2006; Muths et al. 2003; Scherer et al. 2005). In Colorado, there are currently 80 known breeding sites, making up 44 populations of *A. boreas*. A single population may consist of multiple breeding sites. Of the 44 populations, only one is considered viable by the Colorado Division of Wildlife (Jackson 2008). Twenty two breeding sites, from 19 populations, have tested positive for *Bd*, 35 breeding sites tested negative, and 23 breeding sites have not been tested (Jackson 2008). Two of the known *A. boreas* populations in Colorado occur within the Rio Grande National Forest of the San Juan Mountains (Jackson 2008). Our study objective was to survey areas of the Rio Grande National Forest in the San Juan Mountains for A. *boreas* populations and to determine if these populations are infected by *Bd*.

We conducted amphibian surveys from 11 to 14 August 2008 at ponds in the upper Squaw Creek drainage (~3200 m elevation), high elevation kettle ponds (~3800 m) at the base of Chief Mountain, and a pond (~3100 m) within the Little Squaw Creek (LSQ) drainage in Hinsdale County, Colorado, USA. We made a second trip to the Little Squaw Creek drainage on 4 September 2008 to resurvey the original pond (south LSQ pond) and survey an additional pond (north LSQ pond; ~3000 m). Both ponds in the Little Squaw Creek drainage are downstream (north) of the Fern Creek Trail crossing. We conducted visual encounter surveys for adult toads, juveniles, tadpoles, and egg masses in the pond and for juvenile and adult toads around the margins of the pond. Prior to approaching each pond and after each survey we sterilized all equipment, including boots, with a bleach solution, following the Colorado Division of Wildlife protocol (Livo 2004), to limit the possibility of transferring *Bd* among sites.

When toads were encountered we used sterile technique in the capture and handling of animals, following the Colorado Division of Wildlife protocol (Livo 2004), to prevent transfer of *Bd* among individuals. At the point of capture we determined sex (males possessed a nuptial pad and emitted a release call), age (metamorph, juvenile, adult), swabbed for *Bd* testing, and took digital photographs for future identification. We swabbed toads by running a sterile cotton swab over the ventral surface of the toad, including the groin, inner thighs, chin, chest, and abdomen. Swabs were stored in 70% ethanol and sent to Pisces Molecular (Boulder, Colorado, USA) for *Bd* testing using PCR analysis. All Bd analyses were conducted within three months of sample collection.

We observed no evidence of *A. boreas* at the 12 overflow ponds at the upper Squaw Creek drainage or at the kettle ponds at the base of Chief Mountain. During the first survey (14 August 2008) of the Little Squaw Creek drainage we located *A. boreas* at the pond immediately north (downstream) of the Fern Creek Trail crossing (south LSQ pond), and captured 4 (3M:1F) adults. The three male toads tested positive for *Bd*. No tadpoles or egg masses were observed, but five metamorphs were discovered during the second visit (4 September), although no metamorphs were tested for *Bd*.

During the second survey (4 September 2008) of the Little Squaw Creek drainage, we surveyed north LSQ pond, which was further north (downstream) from south LSQ pond. At this site we captured 4 adults in the pond, with a fifth toad discovered immediately west of the pond. Of the 5 toads (4M:1F), 3 of the male toads tested positive for *Bd*. No egg masses or tadpoles were observed at this site.

The Little Squaw Creek drainage site where toads were observed represents a new locality for *A. boreas* within the Rio Grande National Forest. Anecdotal reports of toads in the area had been made to the US Forest Service previously (D Gomez, pers. comm.). Based on the presence of metamorphs during the second survey of the south LSQ pond, we designate this site as the third known breeding population of *A. boreas* in the San Juan Mountains. The closest known breeding population of *A. boreas* to the LSQ drainage is ~ 11 km east in Jumper Creek and Trout Creek, Mineral County, Colorado (Jackson 2008). The observed male-biased sex ratio is typical of *A. boreas* late in the active season because males remain closer to ponds, while females typically travel further from ponds (Bull 2006; Muths 2003).

Bd analyses revealed that 6 of 9 (67%) toads (all male) exhibited a "strong positive" signal, indicating that the infection could be potentially lethal (L. Livo, pers. comm.; Carey 2006). Six of seven male toads tested positive for *Bd*, while no females tested positive. Male toads have been shown to die off from sites earlier than females (Muths et al. 2003). Differences in life history between males and females may make males more susceptible to chytrid infection because males spend longer periods of time at breeding ponds than females, allowing for greater chance of infection. Uninfected *A. boreas* at the LSQ sites, particularly males, are likely to become infected with *Bd* due to interactions with infected toads and infected habitat. Male toads may spend less time away from water sources than females, making them unlikely to leave the pond and thus avoid contracting *Bd* (Muths et al. 2003; Muths 2003).

Although the Little Squaw Creek drainage represents an additional population of *A. boreas* in Colorado, the level of *Bd* infection in the population is discouraging given that previous declines in this species have been linked to chytridiomycosis. However, the relatively high elevation of the LSQ sites correlates with a lower mean daily maximum temperature, which falls within the "reduced growth zone" of *Bd*. The lower mean daily maximum temperature may limit the success of *Bd* at the LSQ sites (Muths et al. 2008). In addition, infected toads have been shown to clear infection in the wild (Corn 2007). Further survey and *Bd* testing of the population need to occur during the breeding season to maximize captures of adults and to determine the level of reproduction that is occurring within the populations.

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Low Prevalence of Amphibian Chytrid Fungus (*Batrachocytrium dendrobatidis*) in Northern Leopard Frog (*Rana pipiens*) Populations of North-Central Iowa, USA

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In recent years mass die offs and declines of amphibian populations in many parts of the world have been linked with the emerging disease chytridiomycosis, caused by the fungal pathogen *Batrachochytrium dendrobatidis* (*Bd*) (e.g., Carey et al. 2003; Daszak et al. 1999; Johnson 2006). Although *Bd* is not specifically linked with any amphibian population declines in the Midwest US, effects of this pathogen on amphibian populations in other parts of the world make it a potential threat that should not be ignored. In much of the agriculturally dominated Midwest landscape, amphibians may be especially susceptible to disease given that they are subject to a number of other stressors such as habitat loss and fragmentation, and exposure to pesticides and excessive aquatic nutrient levels. Ouellet et al. (2005) discovered *Bd* in preserved museum specimens from Minnesota, Wisconsin, Missouri, and Indiana. Green et al. (2002) diagnosed *Bd* presence in Northern Leopard Frogs (*Rana pipiens*) collected from a mortality event in North Dakota. *Bd* was detected at low prevalence levels in populations of Wood Frogs (*Lithobates sylvaticus*) in Michigan (Zellmer et al. 2008). Steiner and Lehtinen (2008) reported detection of *Bd* on samples collected from Blanchard's cricket frogs (*Acris crepitans*) in several Midwestern states, including a single detection from 17 samples collected in four southern Iowa counties. We conducted a more intensive survey for *Bd* in northern Iowa where there have been no previously reported studies.

Methods.—We sampled Northern Leopard Frogs in 22 randomly selected semi-permanent wetlands in north-central Iowa (Fig. 1) in 2006 and 2007. Wetlands were located in the Winnebago River watershed, an area within the Prairie Pothole Region that is dominated by row-crop agriculture. Sampling was conducted on both public (9 sites) and privately owned (13 sites) lands.

We captured leopard frogs for sampling by hand, with a net, or in funnel traps. All field equipment was scrubbed and soaked in bleach and/or allowed to completely dry before use in another site. In 2006 we sampled tadpoles because this stage of development is sensitive for assessing the presence of *Bd* (Berger et al. 1999). We attempted to sample 60 tadpoles per wetland in order to detect at least one affected animal, with 95% confidence, given the assumption that *Bd* prevalence in the population was 5% (DiGiacomo and Koepsell 1986). We also sampled any adult leopard frogs that were captured in the funnel traps, and we sampled metamorphs at sites where tadpole sample sizes were low, capturing them by hand or with nets. In 2007 we conducted less extensive sampling and did not focus on a particular life stage.

We used sterile fine tip swabs (Medical Wire MW113) to collect skin tissue samples. Samples were collected from tadpoles by swabbing their mouthparts (Retallick et al. 2006). The swab was rubbed over and between the teeth rows. We collected samples from adult and metamorph leopard frogs by swabbing the ventrum 30 times. The 30 strokes were allocated to 10 on each of the left and right sides of the underside of the frog and 5 on each foot. We air dried all swabs for 5 minutes, avoiding direct sunlight, and placed them in pre-sterilized microcentrifuge tubes (Fisher 05-669-17). Swabs were stored dry, as recommended by Hyatt et al. (2007). We transported the samples in a cooler and stored them in a freezer before laboratory analysis.

For samples collected in 2006 we used quantitative real-time Taqman PCR assay (Boyle et al. 2004) at the USGS National Wildlife Health Center in Madison, Wisconsin, USA, to test for the presence of *Bd* on swabs. This technique has been found to have a higher degree of sensitivity and specificity than other diagnostic assays (Boyle et al. 2004; Hyatt et al. 2007). To quantify the amount of *Bd* on the swabs we included six standards in every plate: two wells each of 10, 1, and 0.1 genome equivalents (zoospores) of *Bd*. We ran initial assays of DNA samples from two swabs pooled together. When *Bd* was detected in a well, we ran samples in triplicate for each of the individual swabs from this well. We considered samples to be positive if *Bd* was detected in all three wells. For those with equivocal results, in which *Bd* was detected in only one or two wells, we ran the sample in triplicate an additional time and considered it to be positive if *Bd* was detected in at least three

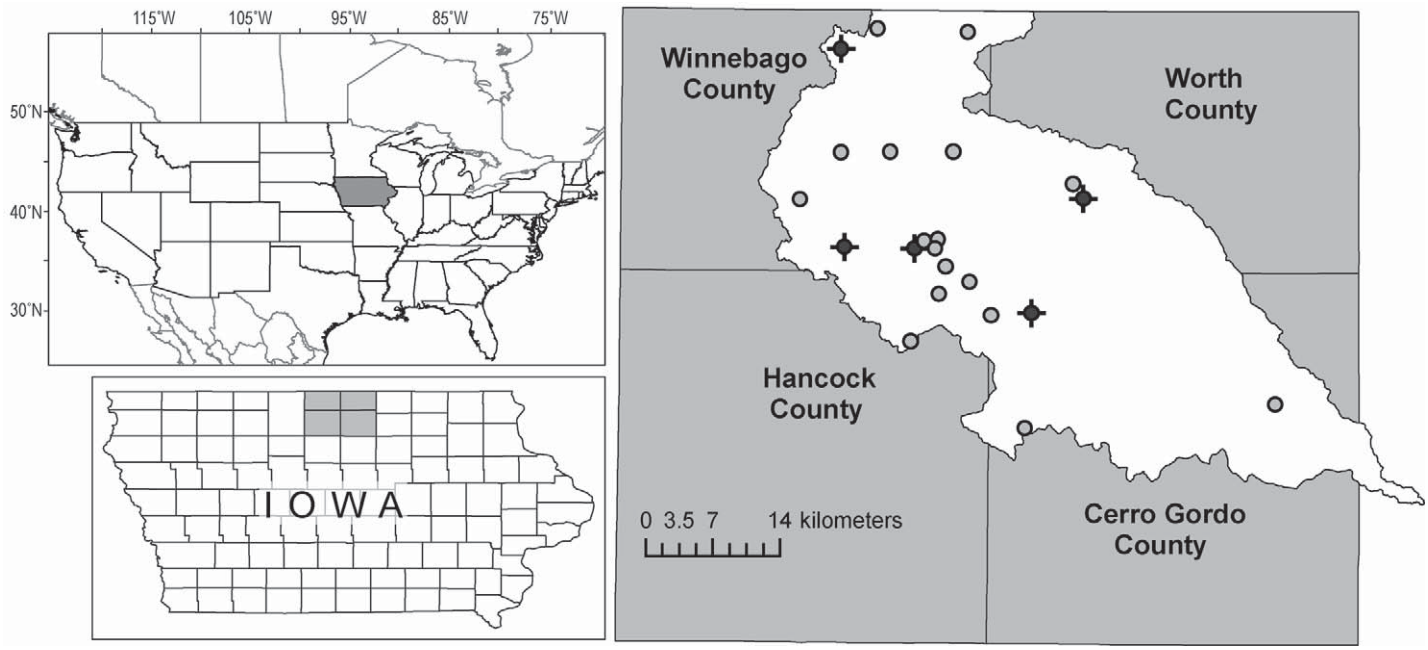


FIG. 1. Location of study sites in the Winnebago watershed of Iowa, USA, where Northern Leopard Frogs (*Rana pipiens*) were sampled for *Batrachochytrium dendrobatidis* (*Bd*). "+" indicates *Bd* detection; "•" indicates no *Bd* detection.

wells from all runs. In 2007, we pooled samples into groups of 3–8 swabs and sent them to Pisces Molecular (J. Wood, Boulder, Colorado) for PCR analysis (Annis et al. 2004).

Results.—In 2006 we collected swabs from 720 tadpoles, 25 metamorphs, and 10 adults from 22 sites. We achieved our target sample size (N = 60) in only 10 of the 22 wetlands due to inadequate trapping success. We detected *Bd* on five swabs from adults and did not detect *Bd* on tadpoles or metamorphs (Table 1). We collected each of the positive swabs from a different site, for a detection of *Bd* at 23% of all sites sampled. These five sites are located in three counties: Cerro Gordo, Winnebago, and Worth (Fig. 1). Less than 1% of all swabs were positive for *Bd*, although 62% of sites with adult samples were positive. The mean amount of *Bd* detected on the positive swabs ranged from 0.241 to 33.370 genome equivalents of *Bd*. In 2007, we collected 200 swabs from 10 sites. These samples were taken from 58 tadpoles, 141 metamorphs, and 1 adult (Table 1). None of these samples tested positive for the presence of *Bd*.

Discussion.—Although we detected *Bd* in this Iowa watershed, the overall prevalence of the pathogen was less than 1%. Because detections were not concentrated in one area, and one positive sample was collected from a fairly isolated wetland, this pathogen is likely present throughout the watershed, although at low levels. We also note that small sample sizes at many of our wetlands substantially reduced our probability of detecting *Bd* at low prevalence levels. Other field studies in the USA have reported higher prevalence rates. Pearl et al. (2007) detected *Bd* on 28% of samples, collected from all life stages of multiple species of amphibians in the Pacific Northwest. In the Northeast, Longcore et al. (2007) found 19.8% of sampled adults and metamorphs to be infected with *Bd*, including 25.7% of Northern Leopard Frogs. However, Zellmer et al. (2008) found a low prevalence of *Bd* (0.8%) in Wood Frog populations in southeastern Michigan and Woodhams et al. (2008) estimated a prevalence of 0-6.49%, with 95% confidence, of *Bd* in Northern Leopard Frogs from a site in Michigan. Although it appears likely that *Bd* is geographically distributed throughout the USA, reported prevalence varies substantially at both local and regional scales.

All of the positive samples were collected from adults, despite the small number of adult samples. This result may have been related to temperature because all of the adults were sampled earlier in the season when the temperatures were cooler. Several studies have documented higher infection levels of *Bd* at lower temperatures (Drew et al. 2006; Kriger and Hero 2006; Longcore et al. 2007; Pearl et al. 2007; Retallick et al. 2004; Woodhams and Alford 2005). It is also possible that there are differences in the prevalence of the pathogen at different life stages of a species. We note that no metamorphs or larvae were positive in either 2006 or 2007. In a field survey of the Pacific Northwest, *Bd* was found on all life stages of amphibians but at different levels of detection; adults had the highest percentage of positive samples (Pearl et al. 2007). Northern Leopard Frog tadpoles experimentally infected with *Bd* had lower activity levels than uninfected tadpoles (Parris et al. 2006). This may have caused our sample to be biased against capturing infected tadpoles since funnel traps are more likely to catch active tadpoles. Based on our results, we suggest that future studies should attempt to examine a large number of samples from multiple life stages in order to gain a more accurate assessment of the presence of *Bd* and to contribute to a better understanding of its distribution and potential population effects.

Acknowledgments.—Funding was provided by the USGS National Wildlife Health Center (NWHC), the Iowa Department of Natural Resources (DNR), and the Department of Natural Resource Ecology and Management at Iowa State University. We thank the Iowa DNR, the Cerro Gordo County Conservation Board, the Winnebago County Conservation Board, and the many private landowners for allowing us to access their properties. Susan Kwak assisted with field sampling. Vince Evelsizer and Matt Fisher, both of the Iowa DNR, helped with logistics. Rebecca Cole

TABLE 1. Northern Leopard Frog (*Rana pipiens*) samples collected in north-central Iowa, USA, wetlands and tested for the presence of *Batrachochytrium dendrobatidis*.

County	Site Name	2006 Life Stage	2006 No. detected / total sampled	2007 Life Stage	2007 No. detected / total sampled
Cerro Gordo	Private-1	Larvae	0/9		
Cerro Gordo	Teal Basin	Adult	1/1	Metamorphs	0/3
		Larvae	0/9		
Cerro Gordo	Haugen Wildlife Area	Adult	0/1		
Cerro Gordo	Private-2	Larvae	0/65	Adult	0/1
				Metamorphs	0/3
Hancock	Gabrielson	Larvae	0/9	Metamorphs	0/24
		Metamorphs	0/15		
Hancock	Private-3	Adult	0/1		
		Larvae	0/24		
Hancock	Private-4	Larvae	0/60		
Winnebago	CA Block	Larvae	0/1		
Winnebago	Private-5	Larvae	0/2	Larvae	0/1
				Metamorphs	0/5
Winnebago	Private-6	Adult	1/2	Larvae	0/21
		Larvae	0/60	Metamorphs	0/26
Winnebago	Private-7	Larvae	0/60		
Winnebago	Harmon Lake	Adult	1/2	Metamorphs	0/18
		Larvae	0/60		
Winnebago	Pilot Knob Recreation Area	Larvae	0/60	Larvae	0/15
				Metamorphs	0/35
Winnebago	Private-8	Adult	1/1		
		Larvae	0/60		
Winnebago	Hogsback	Larvae	0/25		
Winnebago	Private-9	Larvae	0/60	Larvae	0/13
				Metamorphs	0/17
Winnebago	Private-10	Adult	0/1		
		Larvae	0/4		
Winnebago	Private-11	Metamorphs	0/10		
Winnebago	Private-12	Larvae	0/32		
Winnebago	Private-13	Larvae	0/60	Larvae	0/8
Worth	Hanlontown	Adult	1/1		
Worth	Hanlontown-2	Larvae	0/60	Metamorphs	0/10

of the NWHC provided guidance in the planning stages of the project and allowing us to use the NWHC lab for PCR analyses. David Reinitz at NWHC taught J. Loda how to run the PCR analyses and interpret the results. We complied with the guidelines of a collecting permit issued by the Iowa Department of Natural Resources (permit SC 739). All methods were approved by the Institutional Animal Care and Use Committee at Iowa State University (6-05-5923-Z).

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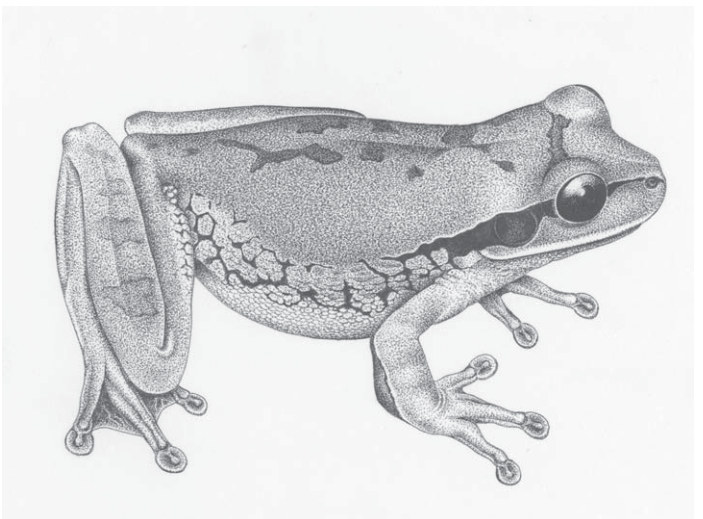
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Smilisca cyanosticta (Blue-spotted treefrog). Belize. Illustration by Peter Stafford.

NATURAL HISTORY NOTES

Instructions for contributors to Natural History Notes appear in Volume 40, Number 1 (March 2009, p. 66) and also are available online at: http://www.ssarherps.org/pages/HRinfo.php

CAUDATA — SALAMANDERS

CHIOGLOSSA LUSITANICA (Golden Striped Salamander). **LEECH PARASITISM**. Leeches are known to parasitize many freshwater species including amphibians (Romano and Di Cerbo 2007. Acta Zool. Sinica 53:750–754) and turtles (MacCoy et al. 2007. Southeast. Nat. 6[2]:191–202). Trophic relationships with amphibians are very complex, leeches predate or parasitize all life stages of amphibians, including eggs (Romano and Di Cerbo 2007, *op. cit.*), larvae (Gunzburger and Travis 2005. J. Herpetol. 39:547–571), and adults (Merilä and Sterner 2002. Ann Zool. Fennici 39:343–346). Here, leech parasitism of *Chioglossa lusitanica* in NW Spain is reported.

Chioglossa lusitanica is a streamside salamander endemic to the northwestern corner of the Iberian Peninsula (Salvador and Garcia-Paris 2001. Anfibios Españoles. Canseco Eds. 270 pp.) where it inhabits brooks, streams, and caves. Its range is well defined by precipitation, inhabiting regions with more than 1000 mm per annum, and not exceeding 1500 m elevation (Arntzen 1981. Amphibia-Reptilia 1:187–203).

Our observation was made on 20 May 2008 during herpetological monitoring of the Rio Barosa area, Barro, Spain (42.55638°N, 8.62944°W; WGS 83). This is a recreational area, due to the Barosa River cascades and adjacent channels, with some small, fast-flowing streams of high gradient. Under a stone in this area we found a large male *C. lusitanica*. During manipulation of the specimen we detected a small leech (*Batracobdella* sp.) attached to the salamander. These leeches are common ectoparasites of amphibians in Spain, having been detected on Iberian Brown Frog (*Rana iberica*) and Iberian Painted Frog (*Discoglossus galganoi*) from NW Spain (Galán and Fernandez Arias 1993. Anfibios e Réptiles de Galicia. Edicions Xerais, Lugo, España). However, to our knowledge there are no reports of leech parasitism on urodeles in NW Spain (Galán, pers. comm.), although there are reports of parasitism from other areas (see Merilä and Sterner 2002, *op. cit.*). Further studies will be necessary to assess the degree of parasitism by leeches on *C. lusitanica*.

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ANURA — FROGS

ENGYSTOMOPS PUSTULOSUS (Tungara Frog) and ***HYBSIBOAS CREPITANS*** (Colombian Tree Frog). **PREDATION ON ANURAN EMBRYOS.** Fish and invertebrates are well known predators on aquatic anuran embryos (Smith et al. 2005. Copeia 2005:169–173) whereas terrestrial eggs are eaten by a variety of insects, including carabid and tenebrionid beetles (Duellman and Trueb 1994. Biology of Amphibians. Johns Hopkins University

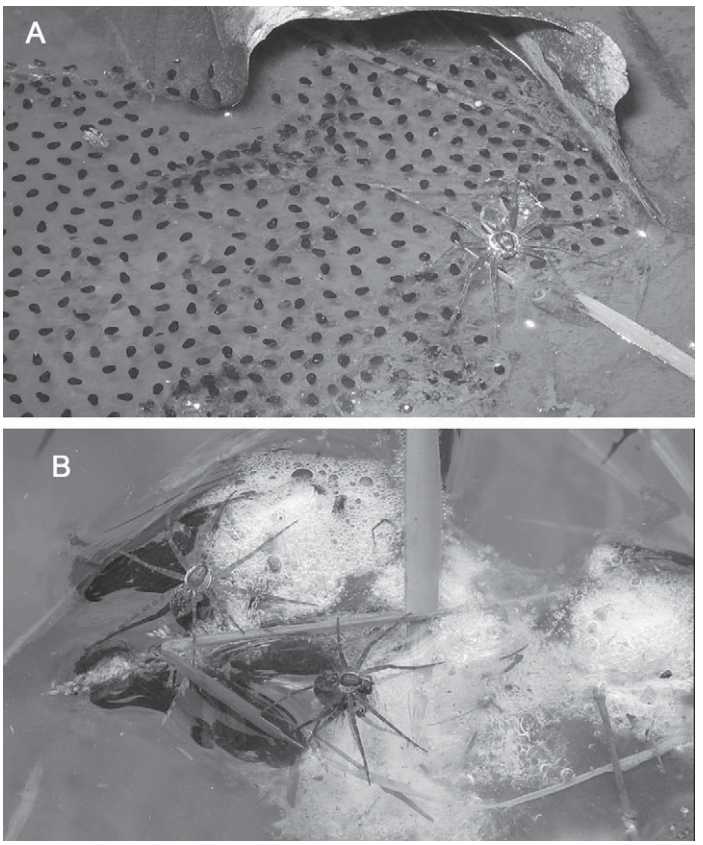


FIG. 1. Water spiders (*Trechalea* sp.) eating the embryos of *Hypsioboas crepitans* (1A) and *Engystomops pustulosus* (1B) at the same pond.

Press, Baltimore. 670 pp.). Here we report predation of Gosner Stage 10 embryos (Gosner 1960. Herpetologica 16:183–190) in the aquatic foam nest of *Engystomops pustulosus* and of aquatic embryos in Gosner Stage 17 of *Hypsiboas crepitans* by a water spider, *Trechalea* sp., family Trechaleidae (Flórez 1996. Arañas del Valle del Cauca-Colombia. p. 54 Inciva-Colciencias; Carico 2005. Trechaleidae. *In* Ubick et al. [eds.], Spiders of North America, p. 229. AAS). During fieldwork in a small temporary pond near the Coello River in Tolima, Colombia (4.25ºN, 75.3166667°W; WGS 84), on several occasions we observed water spiders (ca. 10 mm) eating the embryos of these two species (Figs. 1A, B). These observations occurred between 0915–1100 h on 15 May and during July 2007, within the rainy season and explosive reproductive period of these species.

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LEPTODACTYLUS FUSCUS (Rufous Frog). **PREDATION**. Amphibians are common prey for a great variety of vertebrates, arthropods, and even carnivorous plants (Duellman and Trueb 1986. Biology of Amphibians. McGraw-Hill, New York; Pough et al. 1998. Herpetology. Prentice-Hall, New Jersey). *Leptodactylus fuscus* are frogs of medium size (Martins 1988. Rev. Bras. Biol. Rio de Janeiro 48[4]:969–977), found throughout much of South America in open and disturbed habitats (Heyer and Reid 2003. An. Acad. Bras. Cienc. 75[1]:39–54). Here we report the predation of an adult *L. fuscus* by an adult Common Water Snake, *Liophis miliaris*.

On 21 Oct 2007 at 2100 h, in a temporary pond in a pasture area, municipality of Tangará da Serra, state of Mato Grosso, Brazil, an adult *Liophis miliaris* was observed preying upon an adult *L. fuscus*. The snake was observed grasping the frog from the inguinal region. The snake and frog were photographed (Fig. 1). The specimens were collected and deposited at the Coleção Zoológica Unemat, in Departamento de Ciências Biológicas, Universidade do Estado de Mato Grosso, campus Tangará da Serra, municipality of Tangará da Serra, state of Mato Grosso, Brazil (MZT 15: snake, MZT 200: frog). To our knowledge this is the first report of *L. fuscus* being preyed upon by *Liophis miliaris*. We thank Paulo S. Bernarde for comments on this manuscript.

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FIG. 1. An adult *Leptodactylus fuscus* being preyed on by an adult Common Water Snake (*Liophis miliaris*) in a temporary pond in a pasture area, municipality of Tangará da Serra, State of Mato Grosso, Brazil.

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TESTUDINES — TURTLES

ACTINEMYS* (= *CLEMMYS*) *MARMORATA (Pacific Pond Turtle**). NESTING / DEPREDATION.** Although *Actinemys marmorata* is known to travel intermittently between aquatic and terrestrial habitat for upland aestivation and hibernation, dispersal, and nesting (Reese and Welsh 1997. *In* J. Van Abbema [ed.], Proceedings: Conservation, Restoration, and Management of Tortoises and Turtles—An International Conference, pp. 352–357. New York Turtle and Tortoise Society), females are thought to expose themselves to heightened risks during nesting activity. This vulnerability may play a significant role in reproductive failure and limited recruitment if either the gravid female or her eggs or offspring are depredated. Here we report the discovery of the remains of a gravid female *A. marmorata* depredated during an upland nesting foray and an observation of a Gray Fox (*Urocyon cinereoargenteus*) attempting to prey upon a gravid female in the process of nest construction.

On 31 May 2008, the depredated remains of a gravid female *A. marmorata* were found by MPB in a clearing approximately 100 m N of a vernal lake in Lake County, California. The remains consisted of a predominantly intact shell and partial skeleton found in a clearing surrounded by mixed evergreen forest and manzanita. The shell (153 mm straight-line carapace length) was situated upside down with the plastron exposed and appeared to be in an advanced stage of decomposition; post-mortem signs of desiccation and sun-bleaching were evident on both the plastron and carapace in the way of discolored epidermal scutes detached or blistering from the underlying dermal bone. Three brittle eggs remained within the abdominal cavity; one was intact, while the remaining two eggs were between 50–75% intact. Beginning in 2004 and 2005 (Bettelheim et al. 2006. Herpetol. Rev. 37:213–215) and continuing into 2008, evidence of *A. marmorata* nesting and nest depredation have been reported in an approximately .202-ha exposed clearing along the lake's western shoreline. During the summer 2008 investigation of nesting patterns at this site, nesting activity was first observed on 06 June and continued through 29 June, when nesting activity appeared to taper off and the study ended. Based on the shell's advanced stage of decomposition and the observed start of nesting activity in 2008, this female was most likely depredated during a previous year's nesting season.

Two known predators of *A. marmorata* nests, Striped Skunk (*Mephitis mephitis*) and Gray Fox (Holland 1994. The Western Pond Turtle: Habitat and History. Final report, U.S. Dept. Energy, Bonneville Power Admin. 303 pp.), were confirmed inhabiting the study area in 2008; other known predators – coyote (*Canis latrans*), raccoon (*Procyon lotor*), and opossum (*Didelphis virginiana*) (Holland, *op. cit.*) – have been seen by the authors in the vicinity (coyote) or are likely residents of the area. Any of these species may be responsible for both nest depredation and predation upon gravid females during upland nesting forays.

On 06 June 2008, AZD made the following observations during an investigation of nesting patterns from the vantage point of a camouflaged hunter's tree stand, ca. 5.2 m off the ground. At approximately 1700 h, while surveying the 0.202-ha shoreline where *A. marmorata* nesting activity appears to be concentrated, a Gray Fox was observed approaching a female turtle ca. 10 minutes into a nesting attempt. The female had trampled the surrounding dead vegetation and begun to hollow out a nest chamber when the fox began smelling the posterior end of the turtle and the nest chamber. Before this encounter could progress further, the fox became aware of the observer and left within one minute of the initial observation. The *A. marmorata* remained completely still for ca. 5 min. after the encounter before resuming nesting activity. Ultimately the female abandoned the nesting attempt and returned to the water; this abandonment was later attributed to the presence of a rock that may have obstructed the construction of the nest chamber. The following morning NRG located two freshly depredated nests surrounded by eggshell fragments within 10 m of the previous day's fox/turtle encounter.

Special thanks are in order to the California Department of Fish and Game, The Nature Conservancy, Sonoma State University, and Zoo Oakland for providing supporting staff for field monitoring and initial funding, Nicole Karres, and Vanessa Farnham for observation and identification of potential *A. marmorata* predators.

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GLYPTEMYS INSCULPTA (Wood Turtle). **DIET.** *Glyptemys insculpta* is an omnivorous, semi-terrestrial species known to consume a variety of plant and animal material. Fungi, fruits, green leaves, flowers, and invertebrates factor prominently in reported diets (Ernst et al. 1994. Turtles of the United States and Canada, Smithsonian Press, Washington, DC). We conducted a five-year radio-telemetry study of 186 adult Wood Turtles, during which up to ~55 turtles were radio-tracked in each year. Our study area was comprised of 22 discrete stream segments along 19 streams and large rivers in the Connecticut (42.300°N, 72.600°W), Housatonic (42.233°N, 73.400°W), and Merrimack (43.800°N, 71.667°W) watersheds in Massachusetts and New Hampshire. We observed feeding behavior on 555 occasions between April 2004 and September 2008, and determined the food item on 395 occasions. On 90 occasions, we observed Wood Turtles eating the green leaves of plants, which included the following groups (number of observations; * denotes invasive species meeting the criteria of "invasive"

or "likely invasive"; Massachusetts Invasive Plant Advisory Group 2005, http://www.mass.gov/dfwele/dfw/nhesp/conservation/pdf/invasive_plant_list.pdf): Ostrich Fern (*Matteuccia struthiopteris*) (2), Bracken (*Pteridium aquilinum*) (5), unidentified sedge (*Carex* sp.) (1), unidentified grass (2), Reed Canary Grass (*Phalaris arundinacea*) (1*), Trout Lily (*Erythronium americanum*) (2), Painted Trillium (*Trillium undulatum*) (1), Bishop's Goutweed (*Aegopodium podagraria*) (1*), Jack-in-the-Pulpit (*Arisaema triphyllum*) (2), Common Milkweed (*Asclepias syriaca*) (2), Oriental Bittersweet (*Celastrus orbicularis*) (1), Spotted Joe-pye Weed (*Eupatorium maculatum*) (1), Bedstraw (*Galium* sp.) (2), hawkweed (*Hieracium* sp.) (1), Jewelweed (*Impatiens capensis*) (30), Wood Sorrel (*Oxalis montata*)(1), Japanese Knotweed (*Polygonum cuspidatum*) (1*), raspberry (*Rubus* sp.) (1), Raspberry (*Rubus idaeus*) (2), Sheep Sorrel (*Rumex acetosella*) (1), Meadowsweet (*Spiraea alba*) (1), Dandelion (*Taraxacum officinale*) (5), Red Clover (*Trifolium pratense*) (2), violet (*Viola* sp.) (3). Wood Turtles were observed eating the following fruits: Corn (*Zea mays*) (1), strawberry (*Fragaria* sp.)(13), apple (*Malus* sp.) (1), unknown raspberry (*Rubus* sp.) (5), Blackberry (*Rubus* cf. *allegheniensis*) (2), dewberry (*Rubus* cf. *hispidus*) (1), Raspberry (*Rubus idaeus*) (3), grape (*Vitis* spp.) (2).

Additional food items taken included egg masses of Spotted Salamander (*Ambystoma maculatum*) (1), trout (Salmonidae) and other fish remains (2), an unidentified bird eaten as carrion (1), fungi including, but not limited to, the genera *Russula* and *Lactarius* (27), and slugs (221) and other invertebrates (25). The tendency for slug remains to remain visible on the beak probably accounts for the high rate of observation. Substrate and surface debris taken incidentally included cobwebs (1), dirt (4), feathers (1), dead graminoids (6), dead leaves (15), mud (2), Hemlock (*Tsuga canadensis*) and White Pine (*Pinus strobus*) needles (6), and sand (1).

We obtained permission to radio-track turtles from the Massachusetts Division of Fisheries and Wildlife (permit #138.08SCRA), the New Hampshire Department of Fish and Game (by letter of authorization), and the U.S. Department of Agriculture – White Mountain National Forest (by letter of authorization). Our field methods were approved by the University of Massachusetts Institutional Animal Care and Use Committee (protocol #24-02-01; #27-02-02). We gratefully acknowledge the assistance of Renée LeBeuf in identifying the fungi species.

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GLYPTEMYS INSCULPTA (Wood Turtle). **REPRODUCTION AND DIET.** Here we report an instance of cannabilistic oophagy in a radio-equipped adult *Glyptemys insculpta* in the Connecticut River Watershed, Southampton, Massachusetts (Hampshire County) (42.233°N, 72.667°W). This event was observed during the course of a five-year radio-telemetry study of Wood Turtles in Massachusetts and New Hampshire. When our field technician located the turtle on 11 May 2005, a freshly deposited Wood Turtle egg was found on the ground immediately behind the turtle. The egg was removed from the site and incubated in the lab; it failed to initiate development. The turtle was radio-located two days later and was found eating the contents of a broken turtle egg, which we believe was also deposited by this turtle. At this time, the turtle was palpated to determine whether she was gravid, and no eggs were felt in either oviduct. On 29 May, this turtle was again palpated, and eggs were detected in both oviducts. She nested during the evening of May 31, the first of 32 radio-equipped female Wood Turtles to nest in that year (the median nesting date in 2005 was 10 June). Her nest consisted of seven eggs, one of which hatched successfully. The remaining six eggs apparently did not initiate development. Additionally, we observed egg deposition outside of the nest chamber (i.e., exposed on the ground) by another radio-equipped, free-ranging wild Wood Turtle (# 722) in West Stockbridge, Massachusetts, on 29 May 2008. While several species of terrestrial emydids have been reported to feed upon avian eggs (e.g., *G. insculpta*, *Terrapene ornata*, *Terrapene carolina*) (Legler 1960. Univ. Kansas Publ. Mus. Natur. Hist. 11:669; Ernst et al. 1994. Turtles of the United States and Canada. Smithsonian Inst. Press, Washington, DC), and cannibalistic oophagy has been reported in a captive *T. carolina* (Ernst et al. 1994, *op. cit*.), cannibalistic oophagy appears to be a rare occurrence in free-ranging turtles; we did not find reference to this behavior in other species.

We obtained permssion to radio-track turtles from the Massachusetts Division of Fisheries and Wildlife (permit 138.08SCRA), and our field methods were approved by the University of Massachusetts Institutional Animal Care and Use Committee (protocol 24-02-01, 27-02-02).

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GLYPTEMYS MUHLENBERGII (Bog Turtle). **MORTALITY**. On 20 June 2008, we found the intact, but desiccated carcass of a male *Glyptemys muhlenbergii* (carapace length = 92 mm; deposited in Campbell Museum, Clemson University, CUSC 2367) along the Metro-North railway line near Wingdale, Dutchess County, New York, USA. The carcass was found where the railroad traverses a freshwater marsh dominated by *Typha* sp. and *Phragmites communis*. The condition of the carcass suggested that death occurred within the previous month when the turtle became trapped between two rails of an abandoned spur line and overheated. Kornilev et al. (2006. Herpetol. Rev. 37:145–148) demonstrated that Eastern Box Turtles (*Terrapene carolina*) usually cannot climb over rails, and once trapped between railroad tracks, overheat and approach lethal body temperatures in a short time even on relatively mild days. Owing to their smaller adult body size, it is likely that railroad tracks pose an insurmountable barrier to *G. muhlenbergii*, which probably also succumb to overheating more rapidly than *T. carolina*. Although railroad-induced mortality of *T. carolina* is documented

(Palmer and Braswell 1995. Reptiles of North Carolina. University of North Carolina Press, Chapel Hill. 412 pp.; Kornilev et al., *op. cit.*), to our knowledge this is the first report of a *G. muhlenbergii* death associated with railroad tracks. Henceforth, we recommend that railroads traversing potential habitat be regarded as a potential threat to *G. muhlenbergii* populations, particularly where road crossings provide easy access to tracks (Kornilev et al., *op. cit.*). We thank Lewis Medlock for field assistance.

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GOPHERUS POLYPHEMUS (Gopher Tortoise), ***CTENOSAURA SIMILIS*** (Gray's Spiny-tailed Iguana). **PREDATION**. *Gopherus polyphemus* is currently listed as a threatened and protected species in the state of Florida (Mushinsky et al. 2006. *In* Meylan [ed.], Biology and Conservation of Florida Turtles, pp. 350–375. Chelonian Research Monographs 3). Documented natural predators of *Gopherus polyphemus* include the Raccoon (*Procyon lotor*), Gray Fox (*Urocyon cinereoargenteus*), Striped Skunk (*Mephitus mephitus*), Opposum (*Didelphis virginianus*), Armadillo (*Dasypus novemcinctus*), and crows (*Corvus* sp.) (Mushinsky et al., *op. cit.*), and the introduced Savannah Monitor (*Varanus exanthematicus*) (Owens et al. 2005. Herpetol. Rev. 36:57–58). Herein, we augment this list to include the nonindigenous Gray's Spiny-tailed Iguana (*Ctenosaura similis*).

In its native range of central and southern Mexico, the Yucatán Peninsula, and Central America, *C. similis* is known to consume a variety of plants and animals, including leaves, flowers, fruits, insects, spiders, crabs, fishes, rodents, hatchling sea turtles, lizards and their eggs, birds and their eggs, bats, as well as its own eggs and hatchlings (Montanucci 1968. Herpetologica 24:305–315; Fitch and Henderson 1978. Univ. Kansas Sci. Bull. 51:483–500; Alvarez del Toro 1982. Los Reptiles de Chiapas. Instituto de Historia Natural, Tuxtla Guiterrez. 248 pp.; Van Devender 1982. *In* Burghardt and Rand [eds.], Iguanas of the World, pp. 162–183. Noyes Publications, Park Ridge, New Jersey; Krysko et al. 2003. Florida Sci. 66:74–79). In its introduced range in Florida, *C. similis* has been documented consuming at least 24 native plants and 13 invertebrates, and 14 nonindigenous plants and 2 vertebrates (Krysko et al. 2009. Florida Sci. 72:48–58).

On 28 May 2008, in a residential area on northern Gasparilla Island, Charlotte Co., Florida (26.8094°N, 82.2815°W, datum WGS84, elev. < 1 m), we observed an adult (37.5 cm SVL, 1.54 kg) male *Ctenosaura similis* enter a *Gopherus polyphemus* burrow. Later that morning, as part of an ongoing iguana removal program on Gasparilla Island, this lizard was trapped and transferred to USDA's National Wildlife Research Center Florida Field Station. Stomach contents revealed various stems, leaves, and seeds, as well as several small bones and scutes from the plastron and carapace of a juvenile *G. polyphemus* (Fig. 1).

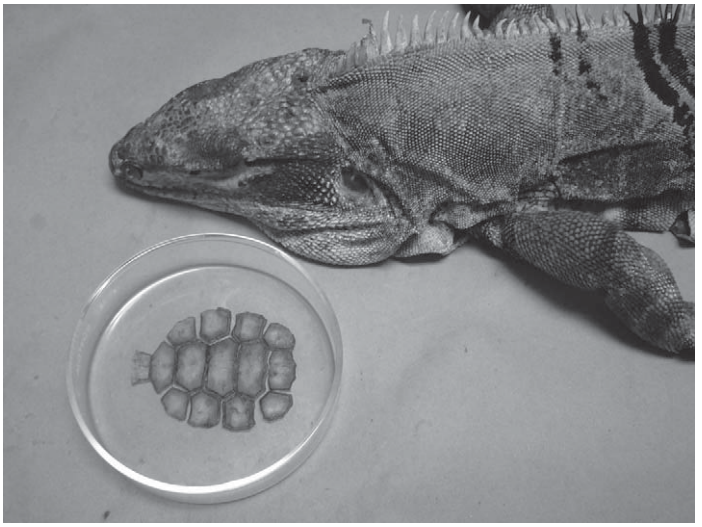


FIG. 1. Adult male *Ctenosaura similis* and scutes of the carapace of a juvenile *Gopherus polyphemus* recovered from its stomach.

Given the close proximity of *Ctenosaura similis* to *Gopherus polyphemus* burrows, ctenosaurs on Gasparilla Island undoubtedly encounter tortoises regularly. Although previous studies have noted the potential negative effects of ctenosaurs on Gopher Tortoises through burrow usurpation (Engeman et al. 2009. Herpetol. Rev. 40:84) and competition for food (Krysko et al. 2009, *op. cit.*), direct predation has not been previously documented. Invasive carnivorous reptiles represent potentially serious impacts to tortoise populations already imperiled by habitat degradation and native predators.

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HYDROMEDUSA MAXIMILIANI (Brazilian Snake-necked Turtle). **GROOMING BEHAVIOR.** Grooming behavior in chelid turtles of Australia and Asia is thought to facilitate removal of dead skin from the axilar and inguinal pockets and the tail and neck (Legler 1978. Can. J. Zool. 56:2449–2453; Legler and Georges 1993. *In* Glasby et al. [eds.], Fauna of Australia Series, pp. 1–27. Australian Government Publishing Service; Green 1996. Herpetofauna 26:46–47). Grooming behavior in Brazilian chelid turtles has apparently not been reported to date.

In February and October 2005 we studied four adult specimens of *H. Maximiliani* captured in Reserva Biológica Municipal Santa Cândida (21.6888889°S, 43.3444444°W, 770 m elev.), Juiz de Fora, Minas Gerais state, Brazil, under laboratory conditions. The behavioral observations were made on individual specimens

housed in an aquarium (110 × 39 × 40 cm) containing approximately 64 liters of water, using the focal animal method (Altmann 1974. Behaviour 49:227–267), during 30 min per specimen. All turtles were naturally infested by a turbellarian ectosymbiont *Temnocephala brevicornis* often associated with *H. maximiliani* (Damborenea and Cannon 2001. J. Nat. Hist. 35:1103–1118).

Grooming behavior was observed in all four specimens of *H. maximiliani*. This behavior resulted in removal of the ectosymbiont together with dead skin from the soft parts of the body, facilitated by the tomial edges of the turtle's jaws, in the axillary and inguinal pockets, sites of infestation of *T. brevicornis*.

The behavior most associated with removal of ectoparasites in freshwater turtles is aerial basking (Janzen et al. 1992. J. Herpetol. 26:217–221). Atmospheric or terrestrial basking is a common phenomenon in many species of freshwater turtles, and functions include elevation of body temperature (to enhance the capacity for activity, digestion, reproduction, vitamin D synthesis, and acceleration of egg development in adult females) and drying of the body surface to retard or remove fungi, algae, bacterial and ectoparasites (Cagle 1950. Ecol. Monogr. 20:31–54; Boyer 1965. Ecology 46:99–118; McAuliffe 1977. J. Parasitol. 63:580–581; Crawford et al. 1983. Ecology 64:989–999; Chessman 1987. Herpetologica 43:301–306; Janzen et al., *op. cit.*; Manning and Grigg 1997. Copeia 1997:579–584). However, basking has not been studied or reported in some taxa of freshwater turtles, and particularly, data on this behavior in some species of Pleurodira are scarce, being limited to observations of captive specimens (Miller 1979. Herpetologica 34:39–42). The Australian chelids *Chelodina expansa* and *C. longicollis* reportedly bask only occasionally (Webb 1978. Herpetologica 34:39–42).

H. maximiliani seldom leaves the water for basking (Souza 2004. Reptilia 40:47–51), thus grooming behavior could be an alternative strategy for removal of the ectosymbiont *T. brevicornis*. This behavior could aid a non-atmospherical basking turtle in keeping the skin in good condition and may be an adaptation to a highly aquatic mode of life (Legler, *op. cit.*). A relationship may exist between an almost completely aquatic mode of life, the absence of basking, and the occurrence of autogrooming in *C. expansa* and *Rheodytes* sp. (Legler and Georges, *op. cit.*). Grooming is common in captive *Rheodytes* sp. and *C. expansa* and serves to remove the cornified layer of the soft skin, wherever the head can reach (Legler and Georges, *op. cit.*). This report demonstrates the use of this behavior for removal of the ectosymbiont *T. brevicornis* in *H. maximiliani*.

This work was licensed by IBAMA (Process nº 02015.003546/04-11), and was performed under the principles adopted by COBEA (Colégio Brasileiro de Experimentação Animal), which were approved by the Committee of Ethics in Animal Experimentation (Pro-Rectory of Research) of the Universidade Federal de Juiz de Fora, in a meeting which took place on 04/12/2004 (Protocol nº 011/2005-CEA).

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PHRYNOPS GEOFFROANUS (Geoffroy`s Side Necked Turtle). **NEST PREDATION**. There are apparently to date no published reports of predation on *Phrynops geoffroanus* nests in nature. Here we report *P. geoffroanus* nest predation by a teiid lizard, *Tupinambis teguixin*, on the Guaporé River on the border of Brazil and Bolivia. In July 2008, during seasonally falling water levels, we sought *P. geoffroanus* nests on the banks of the Guaporé River. From 600 to 1000 h daily we surveyed the river from the border region in Brazil (12.238ºS, 64.4637ºW; WGS84) to Versalles village in Bolivia (12.4396°S, 63.9271°W). The position of each nest was recorded by GPS and the total number of the eggs (predated and not predated) was also noted. Of the 39 nests found, only three were not predated by *Tupinambis teguxin*. Identification of the nest predator was confirmed by several methods: direct observation of the predation event, by the tracks made around the predated nest or characteristic marks made in the soil when the nest was excavated by the lizards, and/or the tooth marks on the egg shells remaining. *Tupinambis teguxin* was the only large carnivorous lizard seen active in the nesting area; tracks made were too large to be those of an *Ameiva*, another potential lizard nest predator indigenous to the area. This high predation rate may be related to the fact that as seasonal flood waters recede, *P. geoffroanus* is the first species to lay eggs on the emerging river banks. In this part of the Amazon, deforestation has increased recently due to land clearing for cattle ranching and illegal harvest of forest products, particularly lumber. Consequently this lizard is forced to live in the sparse riparian forest habitat, which may in turn affect the availability of its normal prey. Food may be difficult to find during high water; thus as soon as the water levels fall, *P. geoffroanus* eggs may offer the lizards an easily obtained resource.

High population densities and the efficient foraging behavior of *T. teguxin* may have significant consequences for survival of this turtle species on the Guaporé River. Further studies are needed on the effects of deforestation on this lizard's habits and turtle nest predation levels. *P. geoffroanus* is one of the few turtle species that is not widely consumed by humans in this region; consumption of its meat supposedly has caused an allergic reaction in some people, perhaps as a result of its consumption of toxic mushrooms which grow on floating logs and tree trunks in the flooded forest (Vogt 2008. Tartarugas da Amazônia. Grafica Biblos, Lima, Peru. 104 pp.). In addition, the bright orange color of this turtle's plastron suggests to some people that the meat is poisonous. Future studies should assess both the population status of this turtle species and the effects of habitat loss on the lizard species that may be its primary nest predator.

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TERRAPENE CAROLINA TRIUNGUIS (Three-toed Box Turtle). **ANOMALOUS SCUTATION**. Modal carapacial scutation for *Terrapene* is: 1 nuchal, 5 vertebrals, 4 pairs of costals, and 12 pairs of marginals (Dodd 2001. North American Box Turtles. University of Okalahoma Press, Norman). We have examined the carapacial scutation of 3430 *T. c. triunguis* hatchlings and found only three with a reduced number of vertebrals (each one had just four vertebral scutes). Thus a reduction in the number of vertebral scutes in *T. c. triunguis* is apparently rare.

On 18 July 2007, an adult female *T. c. triunguis* was found at Black Bayou Lake National Wildlife Refuge, Louisiana, USA. She had only one vertebral scute, the most posterior one (Fig. 1). We judged her age to be 30+ years, as her scutes were almost smooth with little trace of growth lines (Schwartz et al. 1984. The Three-toed Box Turtle in Central Missouri, Part II: A Nineteen Year Study of Home Range, Movements and Population. Dept. of Conservation, Jefferson City, Missouri). The highly atypical vertebral scutation appeared to be congenital, as opposed to injury induced, and this specimen appeared to be in good health. The fifth vertebral can be seen to be unusually narrow on the anterior end and there is midline contact between all four enlarged pairs of costal scutes; otherwise her carapacial scutation was typical in number.

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FIG. 1. *Terrapene carolina triunguis* with only one vertebral scute.

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TRACHEMYS DORBIGNI (Brazilian Slider). **MORPHOLOGY.** A kyphotic adult male *Trachemys dorbigni* (Fig. 1) was captured on 6 September 2004 in Delta do Jacuí State Park, Rio Grande do Sul, Brazil (-30.0311111°S, 51.2519444°W). The specimen had the following maximum dimensions: carapace length = 178.3 mm, carapace width = 138.7 mm, plastral length = 158.6 mm, plastral width = 104.8 mm, and the kyphotic shell height was 85.3 mm.

The highest point of the carapace was at the second vertebral shield. Besides the kyphotic deformity of the carapace, several anomalies in the epidermal shields were recorded (Bujes & Verrastro 2007. Supernumerary epidermal shields and carapace variation in Orbigny's Slider Turtles, *Trachemys dorbigni* (Testudines, Emydidae). Revista Brasileira de Zoologia 24: 666-672.). Out of 57 *T. dorbigni* (13 males, 37 females, 7 unsexed) captured at this site, only this specimen had kyphosis.

Kyphosis ("hump-back") in turtles is defined as a column deformity dorsally convex to the sagital plane of the animal. Hypothesized causes include temperature variations in the nest during embryonic development (Glazebrook and Campbell 1990. Dis. Aquatic Org. 9:83–95), premature shell fusion (Saumure 2001. Chelon. Conserv. Biol. 4:159), or yolk retraction problems (Williams 1957. Herpetologica 13:236). However, there are records of captive-held animals that have acquired the deformity as a result of metabolic bone diseases, and of wild turtles that were victims of unidentified metabolic pathologies (Gerlach 2004. Afr. J. Herpetol. 53:77–85). Thus, the reason for the occurrence of kyphosis in chelonians is unknown.

Kyphosis and related shield deformations are reported in the literature for marine turtles including *Chelonia mydas* (Rhodin

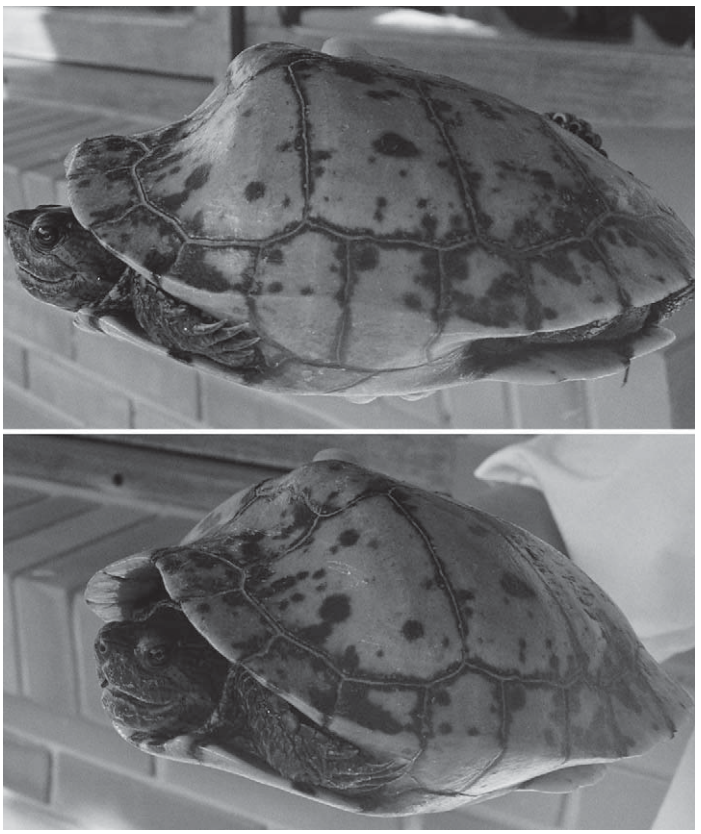


FIG. 1. Kyphotic adult male *Trachemys dorbigni* from Delta do Jacuí State Park, Rio Grande do Sul, Brazil.

et al. 1984, Brit. J. Herpetol. 6:369–373), and *Caretta caretta* (Drennen 1990. Mar. Turt. Newsl. 48:19–20), and in *Sternotherus odoratus* (Saumure 2001, *op. cit.*; Iverson 2007. Herpetol. Rev. 38:334), *Trachemys scripta elegans* (Tucker et al 2007, Herpetol. Rev. 38:337–338), *Apalone spinifera* (Burke 1994. Herpetol. Rev. 25:23), *Chrysemys (= Trachemys) scripta yaquia* (Plymale et al. 1978. Southwest. Nat. 23:457–461), and other freshwater turtle species (Stuart 1996. Bull. Chicago Herpetol. Soc. 31:60–61; Bell et al 2006. Environ. Pollution 142:457–465). This type of pathology is reported to date in five families, 12 genera, and 21 species, thus potentially occurring occasionally in all chelonian species (Plymale et al. 1978, *op. cit.*). This is the first report of kyphosis in *Trachemys dorbigni*.

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SQUAMATA — LIZARDS

CNEMIDOPHORUS OCELLIFER (Whiptail Lizard)**. PREDATION.** *Cnemidophorus ocellifer* is a common lizard that is widespread in Brazil, excluding Amazonia (Vanzolini et al. 1980. Répteis da Caatinga. Academia Brasileira de Ciências, Rio de Janeiro. 161 pp.). This species utilizes open habitats in the Cerrado bioregion, frequently associated with rocks (Mesquita and Colli 2003. J. Herpetol. 37:498–509). Several aspects of this species' biology are well known, but information on predators is scarce. Mato Grosso Pantanal, Morais and Pinho (2007. Herpetol. Rev. 38:453) recorded a Road Hawk (*Ruphornis magnirostris*) preying on a juvenile *C. ocellifer*. França et al. (2008. Copeia 2008:23–38) documented the colubrid *Liophis paucidens* with two *C. ocellifer* in its stomach in Cerrado at Brasília. Here, we add to the known predator set on *C. ocellifer* with observations of predation by another colubrid snake and a centipede.

On 23 July 2008 at 1201 h, we captured an adult Pampas Snake (*Phimophis guerini*; 716 mm SVL, 297 mm tail, 15 g) of unknown sex in Fazenda Floryl (14.04670ºS, 45.89124ºW, datum: SAD69; elev. 900 m), municipality of Jaborandi, Bahia, Brazil. This individual, captured in a 60-liter bucket pitfall trap, regurgitated a juvenile *C. ocellifer* (51 mm SVL, 85 mm tail, 9 g). Ingestion had occurred headfirst. *Phimophis guerini* is a moderate-sized fossorial colubrid that occurs in different Cerrado habitats (Vaz-Silva et al. 2007. Check List 3:338–345; Sawaya et al. 2008. Biota Neotrop. 8[2]:http://www.biotaneotropica.org.br/v8n2/en/abstract?inventory+bn01308022008) and feeds on lizards (França and Araújo 2007. Braz. J. Biol. 67:33–40; Sawaya et al., *op. cit.*). França et al. (*op. cit.*) recorded a gymnophthalmid lizard eaten by a *P. guerini*, but this is the first record of predation by *P. guerini* on *C. ocellifer*.

On 29 January 2009 ca. 1100 h in the same area of the aforementioned predation event, we observed an adult centipede, *Scolopendra viridicornis* (size not measured) feeding on a juvenile male *C. ocellifer*. The abdominal region of the *C. ocellifer* was punctured and its contents had been completely consumed by the centipede. Centipedes of the genus *Scolopendra* are known to prey on anurans (Carpenter and Gillingham 1984. Caribb. J. Sci. 20:71–72), snakes (Easterla 1975. Southwest. Nat. 20:411), rodents (Clark 1979. J. Mammal. 60:654), bats (Molinari et al. 2005. Caribb. J. Sci. 41:340–346), and lizards (Butler 1970. West. Aust. Nat. II:146). This is the first record of *S. viridicornis* preying on *C. ocellifer*.

We thank Fazenda Floryl/Jatobá for assistance and IBAMA for capture permit #11596.

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KENTROPYX STRIATA (NCN) and ***LEPOSOMA HEXALEPIS***. (Six-scaled Tegu). **INTERSPECIFIC INTERACTION**. The genus *Kentropyx* comprises eight heliothermic teiid species that have active feeding habits and inhabit savannas or forest environments, generally near water (Gallagher and Dixon 1992. Boll. Mus. Reg. Sci. Nat. Torino 10:125–171). Saurophagy has been recorded only for three species of *Kentropyx*; *K. calcarata* on *Iphisa elegans* (Hoogmoed 1973. Biogeographica 4:1–419), *K. pelviceps* on *Anolis trachyderma* (Duellman 1978. Misc. Publ. Mus. Nat. Hist. Univ. Kansas 65:1–352), and a specimen of *K. striata* for which remains of an unidentified lizard were found in its gut (Vitt and Carvalho 1992. Can. J. Zool. 70:1995–2006). Here, we report predation by *K. striata* on the microteiid, *Leposoma hexalepis*.

During field work at 1010 h on 13 February 2006 at a location along road from Puerto Ayacucho to Gavilán 12 km S of Puerto Ayacucho, Estado Amazonas, Venezuela, (5.57°N, 67.53°W, datum: La Canoa; elev. ~80 m), we observed an adult male *K. striata* (89.9 mm SVL) attempting to swallow an adult female *L. hexalepis* (33.9 mm SVL) on leaf litter in a small patch of secondary forest along a small creek. Air temperature was 31.4ºC; relative humidity was 65%. The lizards were collected and preserved before the *K. striata* could swallow the *L. hexalepis*; both were deposited in the Museo de Historia Natural La Salle, (*K. striata* MHNLS 17696, *L. hexalepis* MHNLS 17695). The *Leposoma* was unscarred.

Kentropix striata, which actively forages on tree branches or in leaf litter, feeds mostly on spiders, frogs, and even fruits (Gallagher and Dixon, *op. cit.*; Manzanilla and Natera 1997. Herpetol. Rev. 28:50), whereas *L. hexalepis* is non-heliothermic species that actively forages in litter (Molina et al. 2002. Herpetologica 58:485–491). Saurophagy among members of the genus *Kentropix* seems infrequent (Vitt 1991. Can. J. Zool. Vol. 69:2791–2799; Vitt and Carvalho, *op. cit.*), but *K. striata* may have the opportunity to prey with some frequency on *L. hexalepis* in this locality because of the abundance of the latter. Vitt and Carvalho (*op. cit.*) found that *Ameiva ameiva* often prey on *K. striata*; the latter in turn feed on other lizards, as in our observation, implies that trophic interactions among lizards comprise an important part of the food web in these ecosystems.

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Smith. Collection was made under permit 01-03-03-2050 (Gilson Rivas), and 01-03-03-1146 (Fernando J. M. Rojas-Runjaic) by the Ministerio del Ambiente (MinAmb) through Fundación La Salle de Ciencias Naturales, Caracas.

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SCELOPORUS UNDULATUS (Eastern Fence Lizard). **DIET**. The Eastern Fence Lizard feeds on diverse insects, though hymenopterans (especially formicids) and coleopterans comprise the majority of their diet (Lemos-Espinal et al. 2003. J. Herpetol. 37:722–725; McCauley 1939. Am. Mid. Nat. 22:150–153). Juvenile *Sceloporus* typically eat a higher proportion of smaller prey (e.g., ants) than do adults (DeMarco et al. 1985. Copeia 1985:1077–1080). To the best of our knowledge, no author has identified invertebrate prey to species for *S. undulatus*. Hence, here we describe an observation of a juvenile *S. undulatus* consuming an unusually large lepidopteran larva that we were able to identify to species.

At 1216 h on 10 October 2007, 200 m SE of the St. Francis National Forest Head Office, Lee County, Arkansas, USA (34.75828533°N, 90.72192372°W, 110 m elev.), we collected a juvenile *S. undulatus* (39 mm snout–vent length; 10 mm head width; 2.1 g) and placed it in a clean empty cloth bag for ca. 1 h. Upon removal from the bag and subsequent processing, the lizard regurgitated an intact *Pseudaletia unipuncta* larva (Lepidoptera: Noctuidae) 38 mm in length, 7 mm in diameter, and weighing 0.7 g (Fig. 1). This prey item was only 1 mm shorter than the body length of the lizard, and represented one third of its mass.

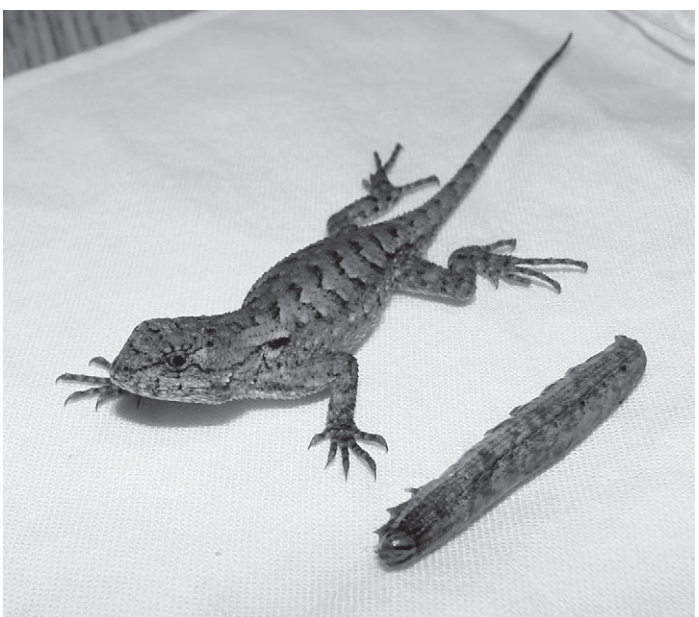


FIG. 1. Juvenile *Sceloporus undulatus* with a regurgitated Armyworm larva, *Pseudaletia unipuncta.*

This observation supports recent findings that lizards can take large prey, but gape width appears to restrict prey size (DeMarco et al. 1985. Copeia 1985:1077–1080; Shine and Thomas 2005. Oecologia 144:492–498). Consuming a prey item of this size may have increased the lizard's vulnerability to predation, but the return in energy obtained would be presumably high relative to the cost of pursuing, subduing, and swallowing (Pough and Andrews 1985. Ecology 66:1525–1533). The larval stage of *P. unipuncta* coincides with hatching of *S. undulatus* and may therefore represent an important seasonal prey source (Forbes 1954. The Lepidoptera of New York and Neighboring States. Cornell University, Ithaca, New York. 433 pp.).

We thank T. McCabe for identification of the *P. unipuncta*.

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TUPINAMBIS MERIANAE (Common Tegu). **DIET**. Vertebrate predation on anurans is well known (Toledo et al. 2007. J. Zool. 271:170–177), and some reports cite lizards of the genus *Tupinambis* (Kiefer and Sazima 2002. Amphibia-Reptilia 23:105-108; Souza et al. 2002. Herpetol. Rev. 33:209). However, reports of *Tupinambis merianae* predation on anurans is limited to *Leptodactylus ocellatus* (Leptodactylidae) and *Rhinella schneideri* (Bufonidae) (Toledo et al., *op. cit.*; Silva and Hillesheim 2004. Herpetol. Rev. 35:399). Here, we add to available reports of *T. merianae* predation on anurans with a report of predation on the hylid frog *Scinax fuscovarius*.

At ca. 1300 h on 30 January 2008, we observed a juvenile (ca. 35 cm total length) *T. merianae* preying on an adult *S. fuscovarius* ca. 100 m NE of Sede Dam, near the small village of Rio Claro Farm, municipality of Lençóis Paulista, São Paulo State, Brazil (22.7708°S, 48.8767°W; datum: WGS84; elev. 635 m). The *S. fuscovarius* was captured by the tegu by the posterior part of the body. The tegu chewed on the frog with the latter's head and forelimbs exposed for ~1 min. The tegu pressed the treefrog to the substratum several times to assist swallowing. After completing ingestion, the tegu disappeared into nearby vegetation. The entire process lasted ~3 min.

Lizards of the genus *Tupinambis* are considered active foragers that cover large areas while foraging, mainly during the heat of the day. They are considered to have a generalist diet that includes eggs, fruits, invertebrates, and small vertebrates, among which anurans appear prominent (Pianka and Vitt 2003. Lizards: Windows to the Evolution of Diversity. University of California Press, Berkeley, California. 333 pp.). To our knowledge, this is the first report of *S. fuscovarius* as anuran prey by a lizard.

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SQUAMATA — SNAKES

APOSTOLEPIS CEARENSIS (Gomes' Burrowing snake). **DIET.** The diet of the small colubrid snake *Apostolepis cearensis* is poorly reported (Freitas 2003. Serpentes Brasileiras. Malha de Sapo Publicações e Consultorias, Lauro de Freitas, Bahia, Brazil. 160 pp.). On 24 August 2008, at 1400 h, we collected an adult *A. cearensis* (SVL = 255 mm; 4 g after prey removal) in a hen house, killed by a young chicken, near Pentecoste, Ceará, Brazil (3.82130°S, 39.33824°W, datum: WGS 84). Upon dissection, we found a *Tantilla melanocephala* that had been eaten headfirst by the *A. cearensis*. The head of the prey was partially digested (SVL ca. 215 mm; 3 g). The prey/predator mass ratio was high (0.75). The mass and length of the prey may have limited the movements of the predator, allowing the young chicken to kill it. This is the first report of *T. melanocephala* in the diet of *A. cearensis*. The snakes were deposited in the herpetological collection of Universidade Federal do Ceará (CHUFC 3019 and CHUFC 3058).

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BITIS SCHNEIDERI (Namaqua Dwarf Adder). **DIET**. On 25 July 2008, a female *Bitis schneideri* (SVL = 214 mm; total length = 235 mm; 16.4 g) was found dead on the Kleinzee-Koingnaas road, Northern Cape Province, South Africa (30.1813°S, 17.2586°E, datum: WGS84). The damage to the snake exposed a recently ingested male *Bradypodion occidentale* (Namaqua Dwarf Chameleon; SVL = 80 mm; total length = 138 mm; 4.9 g). The chameleon had been ingested headfirst. Haacke (1975. Cimbebasia 4:115–128) recorded anurans (specifically of the genus *Breviceps*), geckos, skinks, and lacertid lizards in the diet of the species. This record represents the first known case of *B. schneideri* feeding on a chameleon. These two species inhabit sparsely vegetated Succulent Karoo Sandveld, and habitat structure forces chameleons to frequently cross the ground. Given that *B. schneideri* show sit-and-wait feeding habits, they are likely to be fairly opportunistic in their prey choice. Thus, though novel, this record is not surprising.

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COLUBER CONSTRICTOR (North American Racer). **DEFENSIVE BEHAVIOR.** Many prey species have predator-specific responses that may go unobserved when a human is perceived as the threat. For example, horned lizards are more likely to squirt blood from their eyes when approached by a canid than when approached by a human (Middendorf and Sherbrooke 1992. Copeia 1992:519–527). On 12 October 2007, one of us (PWG) found a *Coluber c. constrictor* (total length ca. 1 m) in a wooded residential area in Aiken, South Carolina, USA. The snake was lying limp on the ground with two domestic House Cats (*Felis catus*), each ca. 50 cm away, looking at the snake, which appeared to be dead. We picked the snake up, and it hung limply for 10 seconds until we observed it flicking its tongue, indicating that it was alive. The snake was released 2 m away from the cats and immediately fled approximately three additional meters into a pile of logs. The following day, another observer (Carolyn C. Gibbons) saw a *C. constrictor* of the same size (possibly the same individual) lying in pine straw ca. 30 m from the release site of the previous day. The snake was limp and its head was beneath its body. One of the same cats was looking at it. The cat was picked up and removed, and the snake was nudged. It immediately became active and crawled rapidly into a nearby brush pile.

Typical behavior of racers when pursued by humans is to continue moving to escape, often climbing into vines, bushes, or trees and, if cornered, the species often assuming a defensive pose with mouth open and striking repeatedly (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian, Washington DC; Gibbons and Dorcas 2005. Snakes of the Southeast. Univ. of Georgia Press, Athens). A single observation of death feigning was reported by Lynch (1978. Blue Jay 36:92–93) for *C. c. flaviventris* in Saskatchewan.

Our interpretation of the observed phenomenon is that a snake defensive behavior was revealed that may be a prevalent response to felids that are more agile and likely to capture the snake than are humans. Such predator-specific responses might not be invoked when a human is perceived by the snake to be the primary threat. Thus, death-feigning might be much more prevalent among some snake species, even common species like *C. constrictor*, than is typically observed by humans.

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CROTALUS POLYSTICTUS (Mexican Lance-headed Rattlesnake). **MAXIMUM ELEVATION**. We observed 25 *Crotalus polystictus* (11 males:14 females) near Acambay, Estado de México, México (19.862º N, 99.802º W, NAD83) between 25 June and 21 August 2007. All snakes were encountered at elevations of 2715–2739 m. Previous to these encounters, *C. polystictus* was known to inhabit a vertical distribution of 1450–2600 m (Campbell and Lamar 2004. Venomous Reptiles of the Western Hemisphere. Cornell University Press, Ithaca, New York. 870 pp.). Habitat was similar to other areas where we have observed *C. polystictus* in the Estado de México, consisting of relatively level, seasonally mesic grassland.

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CROTALUS TRISERIATUS (Mexican Dusky Rattlesnake). **CANNIBALISM**. Cannibalism is widespread among snakes, and is an important element of the ecology of many species (Polis and Myers 1985. J. Herpetol. 19:99–107). Cannibalism has been observed in several species of rattlesnakes (Mitchell 1986. Cannibalism in Reptiles: A Worldwide Review. SSAR Herpetol. Circ. 15. 37 pp.; Campbell and Lamar 2004. The Venomous Reptiles of the Western Hemisphere. Cornell University Press, Ithaca, New York. 870 pp.). In almost all cases involving wild snakes, prey items were young animals (neonates or juveniles) (Mitchell, *op. cit.*; Campbell and Lamar, *op. cit.*). To our knowledge, cannibalism has not been reported in *Crotalus triseriatus*. Here, we describe cannibalism of an adult *C. triseriatus*. On 1 August 2007 at 1228 h, one of us (EMD) encountered an adult male *C. triseriatus* (480 mm SVL, 56.5 mm tail length) basking among bunchgrass in the municipality of San José del Rincón, Estado de México, México (19.668ºN, 100.185ºW, NAD83) at a elevation of 2824 m asl. The snake contained a very large, obvious food bolus, weighed 218.4 g, and was retained in captivity until defecation.

On 1 August 2007, the snake deposited a fecal sample that contained ventral and keeled dorsal scales as well as vertebral bones from a snake, a second sample was obtained on 2 August and contained additional vertebral bones and a section of skin consistent with the dorsal pattern of *C. triseriatus*. Two additional fecal samples contained scales and vertebral bones, On 19 August the snake deposited a fifth and final fecal sample which included a rattle with 4 intact segments measuring 4.2, 4.2, 4.1, and 4.1 mm in width. The snake weighed 165.7 g after defecating, 52.7 g less than when captured. *Crotalus triseriatus* is the only rattlesnake we have observed at this site. The only other rattlesnake which might occur nearby (based on geographic proximity and habitat type) is *C. molossus*, a species with much larger rattles, even as juveniles.

Based on the size of rattle segments, the *C. triseriatus* ingested likely was ca. 400–450 mm SVL (Campbell and Lamar, *op. cit.*; pers. obs.), only slightly smaller than the snake that consumed it. Although we have no evidence from which to infer a cause of death, we mention that the snake was encountered at a site frequently traversed by local inhabitants, and from where they describe killing many *C. triseriatus*. We consider it possible that the smaller individual was killed by humans and later consumed as carrion by the larger snake.

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CROTALUS TRISERIATUS (Mexican Dusky Rattlesnake). **REPRODUCTION.** On 8 October 2007, one of us (KS) encountered an adult female *Crotalus triseriatus* (SVL 521 mm, tail 40 mm, mass 174 g) near San José del Rincón, Estado de México (19.668ºN, 100.207ºW; NAD83) within mixed pine-oak woodland and bunchgrass at an elevation of 3091 m. On 1 November 2007, at which time it weighed 182 g, this snake was transported to the Houston Zoo, where she was subsequently maintained. On the night of 26 December 2007, this snake gave birth to 12 live, healthy neonates as well as a single unfertilized ovum. Neonates were weighed on 28 December (3.9, 4.3, 4.4, 4.4, 4.4, 4.5, 4.6, 4.6, 4.6, 4.8, 4.8, and 4.9 g); the unfertilized ovum was not weighed. Mean neonate mass was 4.5 g, total clutch mass (exclusive of the ovum) was 54.2 g. The female weighed 155 g immediately following parturition. Relative clutch mass (calculated using the female's weight on 1 November) was 0.30. The female fed readily throughout her pregnancy, including taking a juvenile *Mus musculus* on 26 December 2007.

Few data on reproductive phenology are available for *C. triseriatus*. Campbell and Lamar (2004. The Venomous Reptiles of the Western Hemisphere. Cornell University Press, Ithica, New York 870 pp.) summarize data from three wild litters, all born in July, and an additional litter born to a captive female on 30 October. Ramírez-Bautista et al. (1995. Herpetol. Rev. 26:12–13) present data on embryos contained by three gestating females collected between July and September. Available data from three central Mexican highland congeners (*C. aquilus*, *C. polystictus*, and *C. transversus*) suggest that these species typically give birth during summer months (Campbell and Lamar, *op. cit.*; pers. obs.). The paucity of data makes it difficult to evaluate the phenology of the event we describe; however, we suggest that it is probable that exposure to a captive environment induced this female to accelerate development of her litter. It seems unlikely that wild female *C. triseriatus* give birth during winter months or produce multiple litters per year. We also note that a recent report of a *C. aquilus* litter born in March to a captive gravid female collected on Cerro del Tenayo, Estado de México might represent a similar phenomenon (Correa-Sanchez and Rivera-Velázquez 2007. Herpetol. Rev. 38:205).

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DIADOPHIS PUNCTATUS (Ringneck Snake). **OPHIOPHAGY**. *Diadophis punctatus* is known to consume a variety of invertebrates and small vertebrates, including snakes. However, the diet of the Mexican Ringneck Snake, *D. punctatus dugesi* in central México is not well known. We are aware of just a single published record (Sánchez-Herrera 1980. Bull. Maryland Herpetol. Soc. 16:9–18), describing a captive *D. p. dugesi* from the Distrito Federal that ate a *Conopsis lineata*.

Garter snakes (*Thamnophis* species) have commonly been recorded in the diet of *D. punctatus* in other areas of North America. Prey species have included *T. couchii, T. hammondii, T. ordinoides*,

and *T. sirtalis* (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Books, Washington D.C.; Wiseman et al. 2007. Herpetol. Rev. 38:344–345; O'Donnell et al. 2007. Toxicon 50:810–815).

Here we report two additional observations of *Thamnophis* predation by *D. punctatus*. At 1000 h on 25 June 2007, one of us (AMH) collected an adult female *D. p. dugesi* (522 mm SVL, 87 mm tail length, 52.0 g including food bolus). The snake was found basking in a dry concrete canal near San Pedro de los Metates, Municipio de Acambay, Estado de México (19.905ºN, 99.878ºW, NAD83; ca. 2500 m elev.). We palpated an obvious food bolus to the snake's mouth revealing that the snake had recently consumed a small male *T. scaliger* (estimated at ca. 250 mm total length). The prey item was repalped to the snake's stomach; the *Diadophis* was maintained in captivity for ca. 1 month. Following several defecations, the snake weighed 39.1 g when released on 23 July 2007.

At 1334 h on 31 July 2008, one of us (KS) collected an adult male *D. p. dugesi* (340 mm SVL, 82 mm tail length, 18.3 g). The snake was found loosely coiled on bare soil between clumps of bunchgrass (zacatón) near La Estancia, Municipio de Acambay, Estado de México (19.862ºN, 99.803ºW; ca. 2725 m elev.). A few hours after capture, this snake defecated remains of a snake skin identifiable as *Thamnophis*. We were unable to identify the remains to species; however, *T. eques, T. melanogaster, T. scalaris,* and *T. scaliger* have been observed at this site.

Submitted by **ANDRÉS ALBERTO MÉNDOZA-HERNÁNDEZ**, Museo de Zoología de la Facultad de Ciencias, Universidad Nacional Autónoma de México, A.P. 70-399, C.P. 04510, México D.F. (e-mail: andreasmeher@gmail.com); **ESTRELLA MOCIÑO-DELOYA** and **KIRK SETSER**, Departamento de Biología Animal, Facultad de Ciencias, Universidad de Granada, C.P. E-18071, Granada, España.

PYTHON MOLURUS BIVITTATUS (Burmese Python). **CLUTCH SIZE.** Through instances of pet release or escape, a reproducing population of *Python molurus bivittatus*, native to Southeast Asia, has recently become established in and around Everglades National Park, Florida, USA (Snow et al. 2007. *In* Henderson and Powell [eds.], Biology of the Boas and Pythons, pp. 416–438. Eagle Mountain Publishing, Utah). On 2 March 2007, an adult female *P. m. bivittatus* (EVER 055842; SVL = 4240 mm; total length = 4710 mm; 56.69 kg) was captured near Ficus Pond (25.3749ºN, 80.8274ºW, datum: WGS 1984) in Everglades National Park, Florida, USA. This specimen contained 85 large vitellogenic follicles (44.4–53.5 mm diameter) and 7.18 kg of fat bodies. Of these follicles, 48 were located in the right ovary (weight 2.49 kg) and 37 in the left ovary (weight 1.90 kg). A previous study reports a mean clutch size for *P. m. bivittatus* in Florida of 35.75 ± 3.35 (N = 8; range 19–46; Brien et al. 2007. Herpetol. Rev. 38:342). This finding of 85 follicles marks the largest recorded clutch size for *P. m. bivittatus* found in Florida.

Submitted by **MIKE ROCHFORD** (e-mail: mikerochford@hotmail.com)**, MATTHEW L. BRIEN** (e-mail: mbrien@ufl.edu)**,** and **JEMEEMA CARRIGAN** (e-mail: jjc2710@hotmail.com), University of Florida, Fort Lauderdale Research and Education Center, 3205 College Avenue, Fort Lauderdale, Florida 33314-7719, USA; **RAY W. SNOW**, South Florida Natural Resources Center, Everglades National Park, 40001 State Road 9336, Homestead, Florida 33034, USA (e-mail: skip_snow@nps.gov); and **FRANK J. MAZZOTTI**, University of Florida, Fort Lauderdale Research and Education Center, 3205 College Avenue, Fort Lauderdale, Florida 33314-7719, USA (e-mail: fjma@ufl.edu).

SALVADORA BAIRDI (Baird's Patch-nosed Snake). **DIET.** To our knowledge, no prey items have been recorded from *Salvadora bairdi*. Field guides list prey items of *S. bairdi* as amphibians, lizards, and small mammals (Díaz and Díaz 2005. Anfibios y Reptiles de Aguascalientes. CONABIO, México, Distrito Federal, México 318 pp.), and principally diurnal lizards (Uribe-Peña et al. 1999. Anfibios y Reptiles de las Serranías del Distrito Federal, México. Instituto de Biología, México, Distrito Federal, México 119 pp.). However, these accounts do not appear to be based on published records or museum specimens and lack detail. Here we report predation by *S. bairdi* on an adult field mouse (*Reithrodontomys* or *Peromyscus* sp.). On 28 May 2003, we observed a young *S. bairdi* attempting to eat an adult field mouse along a dry irrigation canal. Cornfields dominated the surrounding agricultural matrix of a broad volcanic valley at 2520 m elev. (Municipio de Atlacomulco, Estado de México, México). When encountered, the snake was holding the dead mouse in its jaws, as well as with a loose loop of its body. The rear third of the snake was hidden from sight within a rodent burrow. We attempted to hand capture the snake, however it escaped down the rodent burrow. We estimate the snake's total length to have been ca. 80 cm.

Submitted by **KIRK SETSER (**e-mail: kwsetser@gmail.com)**, ESTRELLA MOCIÑO-DELOYA**, Departamento de Biología Animal, Facultad de Ciencias, Universidad de Granada, C.P. E-18071, Granada, España; **DAVID LAZCANO**, Universidad Autónoma de Nuevo León, Facultad de Ciencias Biológicas, Laboratorio de Herpetología, Apartado Postal - 513, San Nicolás de los Garza, Nuevo León, C. P. 66450, México; and **ALAN KARDON**, San Antonio Zoological Gardens, 3903 N. St. Marys Street, San Antonio, Texas 78212, USA.

THAMNOPHIS SCALARIS (Mexican Alpine Blotched Garter Snake). **OPHIOPHAGY**. *Thamnophis scalaris* is known to eat earthworms, amphibians, lizards, and rodents, and there is a single report of predation upon a neonate *Crotalus triseratus* (Manjarrez et al. 2007. Southwest. Nat. 52:258–262).

Here we report an additional observation of ophiophagy by *T. scalaris*. One of us (MF) collected a large adult male *T. scalaris* (483 mm SVL, 102 mm tail length, tail tip missing, 67.0 g after regurgitation) on 14 July 2008 near Acambay, Estado de México, México (19.863ºN, 99.803ºW, NAD83; 2720 m elev.). Within hours of capture, this snake voluntarily regurgitated an adult male *Thamnophis scaliger* (363 mm SVL, 93 mm tail length, 32.3 g; Fig. 1) which had been ingested head first. We estimate that approximately 10–15% of the consumed snake's body mass had been lost to digestion. We released the *T. scalaris* at the capture site; the *T. scaliger* was deposited in the Colección de Anfibios y Reptiles



FIG. 1. Adult male *Thamnophis scalaris* with a recently regurgitated, partially digested adult male *Thamnophis scaliger*.

del Museo de Zoología de la Facultad de Ciencias, Universidad Nacional Autónoma de México (MZFC 22105).

Submitted by **ESTRELLA MOCIÑO-DELOYA** (e-mail: allertsemoci@yahoo.com), **MÓNICA FERICHE, SENDA REGUERA**, **KIRK SETSER,** and **JUAN M. PLEGUEZUELOS,** Departamento de Biología Animal, Facultad de Ciencias, Universidad de Granada, C.P. E-18071, Granada, España.

THAMNOPHIS SCALIGER (Mesa Central Blotched Garter Snake). **MAXIMUM ELEVATION**. We obtained a partially digested adult male *Thamnophis scaliger* (363 mm SVL, 93 mm tail length, 32.3 g) that was regurgitated by a *Thamnophis scalaris* collected on 14 July 2008 near Acambay, Estado de México, México (19.863ºN, 99.800ºW, NAD83) (Mociño-Deloya et al. 2009. Herpetol. Rev. 40:442–443). The *T. scaliger* was deposited in the Colección de Anfibios y Reptiles del Museo de Zoología de la Facultad de Ciencias, Universidad Nacional Autónoma de México (MZFC 22105). We observed a second male *T. scaliger* (316 mm SVL, 77 mm tail length, 22.0 g) at the same site on 24 July 2008. Both snakes were encountered in a broad, flat, montane valley lying at ca. 2720 m elev. Previous to these encounters, *T. scaliger* was known to inhabit a vertical distribution of 2288–2575 m (Rossman et al. 1996. The Garter Snakes: Evolution and Ecology. Univ. Oklahoma Press, Norman. 331 pp.). Habitat in this valley is similar to other areas where we have observed *T. scaliger* in the Estado de México, consisting of seasonally mesic grassland and agricultural fields.

Submitted by **ESTRELLA MOCIÑO-DELOYA** (e-mail: allertsemoci@yahoo.com), **KIRK SETSER, SENDA REGUERA**, **MÓNICA FERICHE,** and **JUAN M. PLEGUEZUELOS,** Departamento de Biología Animal, Facultad de Ciencias, Universidad de Granada, C.P. E-18071, Granada, España.

GEOGRAPHIC DISTRIBUTION

Instructions for contributors to Geographic Distribution appear in Volume 40, Number 1 (March 2009, p. 106). Please note that the responsibility for checking literature for previously documented range extensions lies with authors. Do not submit range extension reports unless a thorough literature review has been completed.

CAUDATA – SALAMANDERS

AMBYSTOMA OPACUM (Marbled Salamander). USA: TENNESSEE: MARSHALL CO.: (35.6700ºN, 86.7856ºW, NAD83). 21 April 2009. Michael Anderson. Verified by B. T. Miller. Numerous larvae observed in pond, one reared through metamorphosis. Deposited in the Herpetology Collection at Middle Tennessee State University (MTSU 423C). First record for county and establishes species in the interior of the Central Basin ca. 48 km from previous site in Rutherford County (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12. Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Internet version [http://www.apsu.edu/amatlas] contains links to information regarding Tennessee distribution of amphibians recorded since 1996; accessed 21 April 2009).

Submitted by **MICHAEL A. ANDERSON** and **DANIEL ESTABROOKS,** Department of Biology, Middle Tennessee State University, Murfreesboro, Tennessee 37132, USA.

AMBYSTOMA TIGRINUM (Eastern Tiger Salamander). USA: GEORGIA: WALKER CO.: Drag Fold Cave (34.611111°N, 85.459722°W; datum NAD83). March 2009. Jonny Prouty and Brian Killingbeck. UF 155378. Verified by Kenneth L. Krysko. First county record and first Georgia record outside of the Coastal Plain. Extends range ca. 75 km SSE of nearest record (Franklin County, Tennessee; Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Austin Peay State University. Misc. Publ. No. 12. 94 pp.) and 240 km NNW of nearest Georgia record (Chattahoochee Co.; Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.) One adult photographed at the bottom of the cave's vertical pit entrance, presumably after falling in.

Submitted by **JOHN B. JENSEN**, Georgia Department of Natural Resources, Nongame Conservation Section, 116 Rum Creek Dr., Forsyth, Georgia 31029, USA; e-mail: john.jensen@gadnr.org.

EURYCEA CIRRIGERA (Southern Two-Lined Salamander). USA: INDIANA: PIKE CO.: Patoka River National Wildlife Refuge and Management Area. (38.38977°N, 87.29393°W; NAD 83, Zone 16). 12 February 2009. Lindsey Landowski. Verified by Chris Phillips. Illinois Natural History Survey (INHS 2009k). This capture provides a new county record for Indiana (Minton 2001. Amphibians and Reptiles of Indiana. 2nd ed., revised. Indiana Academy of Science. vii–404 pp.). Several individuals were found near the mouth of a spring. This species was previously thought to be absent from the Wabash lowlands region of southwestern Indiana.

Submitted by **LINDSEY LANDOWSKI**, US Fish and Wildlife Service, Patoka River National Wildlife Refuge, 510 1/2 West Morton Street, P.O. Box 217, Oakland City, Indiana 47660, USA; e-mail: Lindsey_Landowski@fws.gov.

EURYCEA GUTTOLINEATA (Three-lined Salamander). USA: GEORGIA: Madison Co.: Eugene Odum Spring Hollow property, 0.6 km NE of intersection of Hudson River Church Rd. and Wesley Chapel Rd. (34.201441°N, 83.304608°W; WGS 84). 03 May 2009. Mark O. Milby and Andrew M. Durso. Verified by Kenneth L. Krysko. FLMNH 155681. New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). An adult *E. guttolineata* was found on a log in a streambank at ca. 0815 h. This record is ca. 22.1 km NE of a 1953 record from Athens-Clarke County, Georgia (GMNH 233).

Submitted by **ANDREW M. DURSO** (e-mail: amdurso@gmail.com) and **MARK O. MILBY (**e-mail: markmilby@gmail.com), University of Georgia, Odum School of Ecology, Athens, Georgia 30602, USA.

EURYCEA LONGICAUDA MELANOPLEURA (Dark-Sided Salamander). USA: ARKANSAS: Cleburne Co.: near Heber Springs (35.45494ºN, 91.95382ºW; WGS84; elev. 103 m). 04 May 2009. Thomas J. Belford. Verified by William E. Duellman. University of Kansas Natural History Museum (KUDA 005367). Six specimens were found in a rocky draw next to a small stream. First county record (Trauth et al. 2004 The Amphibians and Reptiles of Arkansas. Univ. of Arkansas Press, Fayetteville. 421 pp.), ca. 49 km SE of nearest record in Stone County.

Submitted by **THOMAS J, BELFORD**, 701 West Academy Avenue, Searcy, Arkansas 72143, USA; e-mail: thomasbelfordinraq@yahoo.com.

EURYCEA LUCIFUGA (Cave Salamander). USA: ARKANSAS: Cleburne Co.: near Heber Springs (35.45513ºN 91.95355ºW; WGS84; elev. 126 m). 04 May 2009. Thomas J. Belford. Verified by William E. Duellman. University of Kansas Natural History Museum (KUDA 005369). Two specimens were found in a rocky draw next to a small stream. Both specimens were observed at the entrance of what appeared to be a small crevice. First county record (Trauth et al. 2004 The Amphibians and Reptiles of Arkansas. Univ. of Arkansas Press, Fayetteville. 421 pp.), ca. 56 km SE of near known record in Stone County.

Submitted by **THOMAS J, BELFORD**, 701 West Academy Avenue, Searcy, Arkansas 72143, USA; e-mail: thomasbelfordinraq@yahoo.com.

NOTOPHTHALMUS VIRIDESCENS LOUISIANENSIS (Central Newt). USA: ARKANSAS: Faulkner Co.: near Woolly Hollow State Park, 7.1 miles S of AR-65 (35.28900ºN, 92.28250ºW; WGS84; elev. 159 m). 01 Jun 2009. Thomas J. Belford . Verified by William E. Duellman. University of Kansas Natural History Museum (KUDA 007614). Single specimen was found beneath a moss covered log on the forest floor. First county record (Trauth et al. 2004 The Amphibians and Reptiles of Arkansas. Univ. of Arkansas Press, Fayetteville. 421 pp.), extending range ca. 45 km from nearest known record in Conway County.

Submitted by **THOMAS J, BELFORD**, 701 West Academy Avenue, Searcy, Arkansas 72143, USA; e-mail: thomasbelfordinraq@yahoo.com.

NOTOPHTHALMUS V. VIRIDESCENS (Red-spotted Newt). USA: OHIO: Belmont Co.: Wayne Township. Raven Rock (39.88036°N, 81.04077°W; WGS 84). 04 April 2006. Jeffrey G. Davis and Greg Lipps Jr. Cincinnati Museum Center (CMC 8957–8958). Shelby Co.: Washington Township. Lockington Preserve (40.21596ºN, 84.25667ºW; WGS 84). 12 August 2008. Jeffrey G. Davis and Greg Lipps Jr. CMC 11283. All specimens verified by John W. Ferner. New county records (Pfingsten and Matson 2003. Ohio Salamander Atlas. Ohio Biol. Surv. Misc. Contrib. No. 9, Columbus).

Submitted by **JEFFREY G. DAVIS**, Cincinnati Museum Center – Fredrick and Amye Geier Research and Collections Center, 1301 Western Avenue, Cincinnati, Ohio 45203-1130, USA (e-mail: anura@fuse.net); and **GREG LIPPS JR.**, 1473 County Road 5-2, Delta, Ohio 43515 USA (e-mail: GregLipps@aol.com).

NOTOPHTHALMUS VIRIDESCENS (Eastern Newt). USA: INDIANA: Pike Co.: Patoka River National Wildlife Refuge and Management Area (38.34905°N, 87.12464°W; NAD 83). 15 April 2009. Angela Garcia, Sarabeth Klueh, and Alisha Maves. Verified by Chris Phillips. Illinois Natural History Survey (INHS 2009m). New county record (Minton 2001. Amphibians and Reptiles of Indiana. 2nd ed., revised. Indiana Academy of Science. vii–404 pp.).

Submitted by **ANGELA GARCIA** and **SARABETH KLUEH** (e-mail: sklueh@dnr.in.gov), Wildlife Diversity Section, Indiana Department of Natural Resources, Division of Fish and Wildlife, 553 E. Miller Drive, Bloomington, Indiana 47401, USA; **LINDSEY LANDOWSKI** (e-mail: Lindsey_Landowski@fws.gov) and **ALISHA MAVES,** US Fish and Wildlife Service, Patoka River National Wildlife Refuge, 510 1/2 West Morton Street, P.O. BOX 217, Oakland City, Indiana 47660, USA.

NOTOTRITON BRODIEI (NCN). HONDURAS: CORTÉS: Parque Nacional Cusuco, Danto Camp (15.530290ºN, 88.276323ºW; 15.514672ºN, 88.271379ºW; WGS84), 1540–1590 m elev. 6–13 July 2008. Michael Wall**.** Verified by David B. Wake. MVZ 258034–36. First records for Honduras and extends range about 50 km NE of the only other locality for this species, the type locality at Izabal, Guatemala, in the Sierra de Caral, Morales (Campbell and Smith 1998. Sci. Pap. Nat. Hist. Mus., Univ. Kansas 6:1–8). The salamanders were collected in pitfall traps located in lower montane wet forest within a remote protected region of Cusuco National Park, which may serve as a stronghold for this species barring further habitat destruction.

Submitted by **JONATHAN E. KOLBY**, 1671 Edmund Terrace, Union, New Jersey 07083, USA (e-mail: j_kolby@hotmail.com); **JAMES R. McCRANIE**, 10770 SW 164th Street, Miami, Florida 33157–2933, USA (e-mail: jmccrani@bellsouth.net); and **SEAN M. ROVITO,** Museum of Vertebrate Zoology, University of California at Berkeley, Berkeley, California 94720–3160, USA (e-mail: smrovito@berkeley.edu).

ANURA – FROGS

ANAXYRUS AMERICANUS (American Toad). USA: INDIANA: Sullivan Co.: Fairbanks Township: 0.74 km E of Wabash River (39.2047°N, 87.575°W; NAD 83, Zone 16). 27 April 2009. Sarabeth Klueh, Angela Garcia, and Nathan Engbrecht. Verified by Chris Phillips. Illinois Natural History Survey (INHS 2009.p). New

county record for Indiana (Minton 2001. Amphibians and Reptiles of Indiana. 2nd ed., revised. Indiana Academy of Science. vii–404 pp.). Adults were found on road. This species occurs commonly throughout most of Indiana but appears to be largely absent from a pocket of counties in the southwest part of the state (Minton, *op. cit.*). This record partially fills a gap in the range of this species in southwest Indiana.

Submitted by **SARABETH KLUEH** (e-mail: sklueh@dnr.in.gov) and **ANGELA GARCIA**, Wildlife Diversity Section, Indiana Department of Natural Resources Division of Fish and Wildlife, 553 E. Miller Drive, Bloomington, Indiana 47401, USA; and **NATHAN ENGBRECHT**, 135 Holmstedt Hall, Indiana University School of Medicine-Terre Haute, Indiana State University, Terre Haute, Indiana 47809, USA (e-mail: nengbrecht@indstate.edu).

BOMBINA ORIENTALIS (Oriental Fire-bellied Toad). REPUBLIC OF KOREA: JEJU ISLAND: Jeju Province: Hallasan National Park (33.3125361°N, 126.5493444°E; Google Earth). 15 May 2009. P. Fidenci. Verified by Hallie Brignall. California Academy of Sciences photo vouchers (CAS-HPV 55–56). First record for Jeju Island (Song 2007. A Field Guide Book of Amphibians and Reptiles in the Korean National Park. National Park Research Institute, Annual Report No. 2007-3. KNPS, Namwon. 77 pp.). Four adults observed on backwater pools along a tributary of Hallansan River.

Submitted by **PIERRE FIDENCI**, Endangered Species International, 79 Brady St., San Francisco, California 94108, USA; e-mail: pfidenci@endangeredspeciesinternational.org.

CRAUGASTOR BERKENBUSCHII (Berkenbusch's Stream Frog). MÉXICO**:** TABASCO: Municipality of Macuspana: Parque Estatal Agua Blanca, ca. 85 km SW of Villahermosa (17.36574°N, 92.28005°W, WGS 84), 80 m elev. June, November, December 2003, July 2004. Marco Antonio Torrez Pérez, Diana Ivette Triana Ramírez, and Isidro Pérez Hernández. Verified by Luis Canseco Márquez. Colección de Anfibios y Reptiles de Tabasco, Universidad Juárez Autónoma de Tabasco (CART 00469, 00494-495, 00516–519, 00525, 00527–528, 00530, 00532, 00596–597. First records for Tabasco, extending known range ca. 180 km NW of municipality Las Choapas, Veracruz, México (Aguilar-López and Canseco-Márquez 2006. Bol. Soc. Herpetol. Mex. 14:20–37). All frogs were collected along a stream near a waterfall surrounded by tropical evergreen forest.

Submitted by **MARCO ANTONIO TORREZ-PÉREZ** (e-mail: marcotorrezp@yahoo.com) and **MARIA DEL ROSARIO BARRAGÁN-VÁZQUEZ**, División Académica de Ciencias Biológicas, Universidad Juárez Autónoma de Tabasco, km 0.5 carretera Villahermosa-Cárdenas, entronque con Bosque de Saloya, C.P. 86090, Villa Hermosa, Tabasco, México; e-mail: barragan@cicea.ujat.mx.

DENDROPSOPHUS HADDADI. BRAZIL: PERNAMBUCO: Municipality of Igarassu: Mata da Usina São José (07.838563°S, 35.004074°W; WGS 84, elev. 128 m). 25 March 2007. F. Oliveira de Amorim, E. Maranhão dos Santos, and M. Camargo Guarnieri. Verified by U. Caramaschi. Coleção Herpetologica da Universidade Federal Rural de Pernambuco, Unidade Acadêmica de Serra Talhada, Serra Talhada, Pernambuco, Brazil (CHUFRPE 918 adult specimen SVL 19 mm). Previously known from Conceição da Barra municipality (type locality), Espírito Santo, Brazil (Bastos and Pombal 1996. Amphibia-Reptilia 17:326). First state record, extends the known distribution 1292 km NE from type locality.

Submitted by **FABIANA OLIVEIRA DE AMORIM**, Rua Eng. Gercino de Pontes, 129, Apto 101, 50800-110, Iputinga - PE, Brazil; **EDNILZA MARANHÃO DOS SANTOS,** Unidade Acadêmica de Serra Talhada, Universidade Federal Rural de Pernambuco, 56900-000, Recife, PE, Brazil; and **MÍRIAM CAMARGO GUARNIERI**, Universidade Federal de Pernambuco, Departamento de Zoologia, 50670-901, PE, Brazil.

DENDROPSOPHUS MARMORATUS. BRAZIL: MATO GROSSO: Municipality of Sinop (11.866667ºS, 55.483333ºW; datum: Córrego Alegre), Gleba Bandeirantes, Fazenda Sant'ana. October 1976. H. Cunha. Verified by S. P. de Carvalho e Silva. Departamento de Zoologia, Universidade Federal do Rio de Janeiro (ZUFRJ 10556–567). Previously known in Brazil from Marmelo (State of Rondonia) and Jacareacanga (State of Pará) (Bokermann 1964. Senck. Biol. 45:243–254). New state record, extends the range ca. 230 km S and 250 km E from localities previously known (Bokermann, *op. cit.*).

Submitted by **MARCIA DOS REIS GOMES**, Universidade Federal do Rio de Janeiro, Departamento de Zoologia, caixa postal 68.044, CEP 21944-970, Cidade Universitária, Rio de Janeiro, Brazil; and **OSWALDO LUIZ PEIXOTO**, Universidade Federal Rural do Rio de Janeiro, Instituto de Biologia, km 7, Rodovia BR 465, Seropedica, Rio de Janeiro, Brazil 23890-000 (e-mail: pedra10@yahoo.com).

GASTROTHECA PULCHRA: BRAZIL: PERNAMBUCO: Municipality of Jaqueira: Private Reserve Frei Caneca (08.722500ºS, 35.841667ºW, WGS 84, elev. 631 m). 25 October 2008. S. P. Lima dos Santos and E. Maranhão dos Santos. Verified by U. Caramaschi. Coleção Herpetologica da Universidade Federal Rural de Pernambuco, Unidade Acadêmica de Serra Talhada, Serra Talhada, Pernambuco, Brazil (CHUFRPE 970, adult specimen SVL 36.8 mm). Previously known only from the type locality: Reserve Biological of Pau Brasil (CEPLAC), Municipality of Porto Seguro, Macote, Ilheus and Itamari, State of Bahia, Brazil (Caramaschi and Rodrigues 2007. Bol. Mus. Nac., N.S., Zool., Rio de Janeiro, 525:1–19); Amargosa and Elíseo Medrado municipality, State Bahia, Brazil (Freitas et al. 2009. Herpetol. Rev. 40:233–234). First state record, extends the known distribution ca. 918 km NE from type locality and 563 km NE from Elíseo Medrado municipality.

Submitted by **SUENY PALOMA LIMA DOS SANTOS,** Universidade Federal de Pernambuco, Centro de Ciências Biológicas Av. Prof. Moraes Rego, 1235 - Cidade Universitária, 50670-901, Recife, PE, Brazil; and **EDNILZA MARANHÃO DOS SANTOS**, Unidade Acadêmica de Serra Talhada, Universidade Federal Rural de Pernambuco, 56900-000, Serra Talhada, PE, Brazil.

GASTROPHRYNE OLIVACEA (Western Narrow-mouthed Toad). USA: TEXAS: Guadalupe Co.: 160 m N intersection Old Seguin Road with Long Branch Creek, along the banks of the creek (29.792472°N, 97.93575°W, WGS84). 09 September 2009. Michael Vandewege and Amber Harper. Verified by James R.

Dixon. Texas Cooperative Wildlife Collection (TCWC 94267). One adult (19.8 mm SUL, 1.6 g) found after rains. New county record (Dixon 2000. Amphibians and Reptiles of Texas 2nd ed. Texas A&M University Press, College Station, Texas. 421 pp.).

Submitted by **MICHAEL W. VANDEWEGE** (e-mail: mike.vandewege@txstate.edu), **AMBER HARPER**, **VINCENT R. FARALLO**, and **MICHAEL R.J. FORSTNER**, Department of Biology, Texas State University, San Marcos, Texas 78666, USA (e-mail: MF@txstate.edu).

HYLA CINEREA (Green Treefrog). USA: ARKANSAS: CLEBURNE CO.: Dry Mountain Road 0.78 miles NW of Wilburn (35.51588ºN 91.89280ºW; WGS84; elev. 105 m). 04 May 2009. Thomas J. Belford. Verified by William E. Duellman. University of Kansas Natural History Museum (KUDA 005371). Adult specimen was found on the roadside during a thunderstorm. First county record (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. Univ. of Arkansas Press, Fayetteville. 421 pp.), extending range ca. 22.8 km from nearest record in White County.

Submitted by **THOMAS J, BELFORD**, 701 West Academy Avenue, Searcy, Arkansas 72143, USA; e-mail: thomasbelfordini raq@yahoo.com.

KALOULA PULCHRA (Asian Painted Frog). PHILIPPINES: PALAWAN ISLAND: Municipality Puerto Princesa: Barangay, Bancao Bancao (9.734425°N, 118.7648528°E; Google Earth). 05 February 2007. P. Fidenci. Verified by Hallie Brignall. California Academy of Sciences photo vouchers (CAS-HPV 57–59). First record for Palawan Island. Known records for the Philippines in Luzon (Diesmos et al. 2006. J. Env. Sci. Manage. Philippines 9:41–53). 36 adults and 11 metamorphs observed at night along ditches and grassland in Puerto Princesa City. Introduced species in the Philippines.

Submitted by **PIERRE FIDENCI**, Endangered Species International, 79 Brady St., San Francisco, California 94108, USA; e-mail: pfidenci@endangeredspeciesinternational.org.

LITHOBATES* (=*RANA*) *BLAIRI (Plains Leopard Frog). USA: INDIANA: VIGO CO.: 3.8 km SW of Prairieton (39.358909°N, 87.516249°W; NAD 83). 16 October 2008. Nathan Engbrecht and John Crawford. Verified by Chris Phillips. Illinois Natural History Survey (INHS 2009.n.). New county record (Minton 2001. Amphibians and Reptiles of Indiana. 2nd ed., revised. Indiana Academy of Science. 404 pp.) Captured in minnow trap. *Lithobates blairi* is currently listed as a species of special concern in Indiana, but is a candidate for being listed as a state endangered species (Indiana DNR Amphibian and Reptile Technical Advisory Committee-2008). Occurrence records for *L. blairi* in Indiana are scarce with only five vouchered localities (Minton, *op. cit.).* This represents the first documented occurrence of this species in Indiana since 1978 and extends the current known range of the species eastward in west-central Indiana.

Submitted by **NATHAN J. ENGBRECHT** (e-mail: nengbrecht@indstate.edu), **JOHN A. CRAWFORD**, and **MICHAEL J. LANNOO**, Indiana University School of Medicine-TH, Holmstedt Hall, Rm 135, Terre Haute, Indiana 47809, USA.

LITHOBATES YAVAPAIENSIS (Yavapai Leopard Frog). MÉXICO: CHIHUAHUA: Municipio de Temosachi: 1) along Río Tutuaca at Rancho Nogal, 16.5 air km N Yepachi (28.56134°N, 108.35596°W to 28.56887°N, 108.36528°W; WGS84), 1640 m elev. 14 June 2006. MSB 75152–153 (two adults); MSB 75148–151 (four post-metamorphic individuals, 27–31 mm SUL); MSB 75124 (lot of five tadpoles). 7.7 road km N Yepachi, tributary to Río Yepachi (28.47368°N, 108.38462°W; WGS84), 1729 m elev. 15 June 2006. MSB 75125 (lot of four pre-metamorphic tadpoles. R. D. Jennings and C. W. Painter. All verified by Mike Sredl. First records from Chihuahua (Lemos-Espinal and Smith 2007. Anfibios y Reptiles del Estado de Chihuahua, México. Univ. Nac. Autón. de México; Comis. Nac. Conoc. y Uso de la Biodiv., México, D.F. xiii + 613 pp.). Specimens were found in backwater habitats and in off-channel pools. Specimens were collected under authority of Mexico's Secretaría De Medio Ambiente y Recursos Naturales Permit SGPA/DGVS/01442/06.

Submitted by **RANDY D. JENNINGS**, Western New Mexico University, P.O. Box 680, Silver City, New Mexico 88062, USA (e-mail: jenningsr@wnmu.edu); and **CHARLES W. PAINTER,** New Mexico Department of Game and Fish, One Wildlife Way, P.O. Box 25112, Santa Fe, New Mexico 87507, USA (e-mail: charles.painter@state.nm.us).

PHASMAHYLA GUTTATA. BRAZIL: ESPÍRITO SANTO: Municipality of Atílio Vivacqua: Serra das Torres (21.001194°S, 41.216472°W; WGS84, elev. 600 m). J. C. F. Oliveira, L. Coco, F. F. de Deus, R. Pagotto, and E. S. da Silva. 10 June 2009. Verified by J. P. Pombal Jr and D. Baêta. Museu Nacional, Rio de Janeiro (MNRJ 58975). This species, endemic to the Brazilian Atlantic Rainforest, was previously known to range from Morretes (25.476944ºS, 48.833889ºW) in the state of Paraná to Santa Maria Madalena (21.878611ºS, 41.903889ºW) in the state of Rio de Janeiro (Cruz et al. 2008. S. Am. J. Herpetol. 3:187–195). The present note provides the first record for the state of Espírito Santo and the northernmost for the species, extending its distribution ca. 120 km N from Santa Maria Madalena.

Submitted by **JANE C. F. OLIVEIRA, LIVIA COCO, FLÁVIO F. DE DEUS, RENATA PAGOTTO, ELIEL SOARES DA SILVA, CARLOS FREDERICO D. ROCHA,** and **DAVOR VRCIBRADIC,** Departamento de Ecologia, Universidade do Estado do Rio de Janeiro, Rua São Francisco Xavier 524, Maracanã, 20550-011, Rio de Janeiro, RJ, Brazil.

PHYSALAEMUS SIGNIFER (Octavio's Robber Frog). BRAZIL: ESPÍRITO SANTO: Matilde, municipality of Alfredo Chaves (20.330306ºS, 40.480560ºW; datum: Córrego Alegre; 632 m elev.). 22 July 2008. R. B. Dantas. Verified by G. M. Prado. Zoology Collection, Museu de Biologia Mello Leitão, Santa Teresa, Espírito Santo, Brazil (MBML 6736–39). Previously known from the states of Bahia, Rio de Janeiro, and São Paulo (Bokermann 1962. An. Acad. Brasil. Cienc. 34:563–568; Cochran 1955. Bull. U.S. Natl. Mus. 206:351; Silvano and Pimenta CD-ROM, Ilhéus, IESB/CI/CABS/UFMG/UNICAMP; Wogel et al. 2002. Iheringia, Sér. Zool. 92[2]). First state record extends range ca. 317 km N from Saquarema municipality, Rio de Janeiro state (Wogel et al., *op. cit.*) and ca. 612 km S from Una municipality, Bahia state (Silvano and Pimenta, *op. cit.*).

Submitted by **RODRIGO BARBOSA FERREIRA,** Museu de Biologia Mello Leitão, Av. José Ruschi, N 4, CEP 29.650-000, Santa Teresa – Espírito Santo, Brazil (e-mail: rodrigoecologia@yahoo.com.br); **ROBERTO DE BARROS DANTAS,** Museu de Biologia Mello Leitão, Av. José Ruschi, N 4, CEP 29.650-000, Santa Teresa – Espírito Santo, Brazil (e-mail: dantasbio@hotmail.com); **CAMILA MATTEDI**, Universidade Federal do Espírito Santo, Departamento de Ciências Biológicas. Av. Marechal Campos, N 1468, Maruípe, CEP 29040-900, Vitória – Espírito Santo, Brazil (e-mail: ketmattedi@hotmail.com); and **THIAGO SILVA-SOARES**, Universidade Federal do Rio de Janeiro, Departamento de Zoologia, Lab. de Anfíbios e Répteis, Caixa Postal 68.044, CEP 21944-970, Cidade Universitária, Rio de Janeiro, Brazil (e-mail: thiagossoares@ufrj.br).

PSEUDACRIS ORNATA (Ornate Chorus Frog). USA: ALABAMA: Lowndes Co.: Chorus of calling males recorded at flooded vernal pool in pasture, 0.37 km S. of Lowndes County Rd. 40, 3 km N of White Hall (32.324712°N, 86.700823°W; WGS 84). 10 January 2009. S. Graham and K. Gray. Verified by Craig Guyer. AHAP-D 198 (audio file). New county record. This record fills a distribution gap for this species, and is approximately equidistant between historical localities for this species to the south in Butler Co. (~ 70 km), to the east in Macon Co. (~ 100 km), and to the north in Bibb and Chilton counties (~ 80 km; Mount 1975. Amphibians and Reptiles of Alabama. Auburn University Agricultural Experiment Station, Auburn Printing Co., Auburn, Alabama. 347 pp.).

Submitted by **SEAN P. GRAHAM** and **KATHERINE M. GRAY**, Department of Biological Sciences, 331 Funchess Hall, Auburn University, Alabama 36849, USA (e-mail: grahasp@auburn.edu).

RANITOMEYA BIOLAT (Bamboo Poison Frog). BRAZIL: ACRE: Open forest with bamboo (*Guadua weberbaueri*) in Fazenda Experimental Catuaba "Plot Control" (10.0822ºS, 67.06258º W; datum WGS84, elev. 180 m). 10 February 2005. P. R. Melo Sampaio. Verified by R. Schulte. Herpetological Collection, Universidade Federal do Acre, Rio Branco, Acre, Brazil (UFAC 4157–58). These specimens were found in leaf litter in "tabocal" habitat, 0800–1100 h. Species previously known from the Tambopata Region, Madre de Dios, Peru (Doan and Arriaga 2002. Biotropica 34[1]:101–117; Morales 1992. Carib. J. Sci. 28[3–4]:191–199; Waldram 2008. J. Herpetol. 42:232–237) and Department of Pando, Bolivia (Maldonado and Reichle 2007. Kempffiana 3[1]:14–17). First country record, extends the known distribution ca. 450 km NE from type locality in Peru (Morales, *op. cit.*)

Submitted by **PAULO ROBERTO MELO SAMPAIO**, Laboratório de Herpetologia (HerPet), Universidade Federal do Acre, BR-364 km 04, Campus Universitário Áulio Gélio Alves de Souza, Distrito Industrial, CEP: 69.915-900, Rio Branco, Acre, Brazil (e-mail: herpeton@gmail.com); and **MOISÉS BARBOSA DE SOUZA**, Universidade Federal do Acre - Centro de Ciências Biológicas e da Natureza (CCBN), BR-364 km 04, Campus Universitário Áulio Gélio Alves de Souza, Distrito Industrial, CEP: 69.915-900, Rio Branco, Acre, Brazil (e-mail: moisebs@terra.com.br).

RHACOPHORUS BIPUNCTATUS (Twin-spotted Tree Frog). BANGLADESH: HABIGANJ DISTRICT: Satchari National Park (24.1166667ºN, 91.4166667ºE; 195–210 m elev.). 06 March 2009. Sharif A. Mukul. Verified by Guin Wogan. Digital image deposited at USDZ, Raffles Museum of Biodiversity Research, National University of Singapore (ZRC [IMG] 1.29). Taxonomy revised (see Bordoloi et al. 2007. Zootaxa 1653:9) since first report from country as *R. htunwini* (Chakma 2007. Herpetol. Rev. 38:478). First verified record for Sylhet Division (northeastern evergreen forests). Nearest population reported from Kaptai National Park, Chittagong Division, > 200 km S of present locality (Chakma 2007, *op. cit.*). Nearest extraterritorial records include Assam (Bordoloi et al. 2007, *op. cit.*; ~ 300 km N), Nagaland (Ao et al. 2003. Zoo's Print J. 18:1124; > 500 km NE), Manipur (Devi and Singh 2006. J. Exp. Zool. India 9:317–324; ~ 400 km E) in India, and Rakhine State (Wilkinson et al. 2005. Proc. California Acad. Sci. 56[4]:42–52; ~ 1200 km S) in Myanmar. Adult found before sunset on forested trail, ca. 1.5 km from old Dhaka-Sylhet highway, and heavily used for firewood collection by local villagers. Habitat includes several *Acacia* plantations with major undergrowth of *Phrynium*, *Lantana*, *Amomum*, *Mikenia*, and *Macaranga*.

Submitted by **A. H. M. ALI REZA**, Department of Natural Resources Management, Texas Tech University, Lubbock, Texas 79409, USA & Department of Zoology, Jahangirnagar University, Dhaka 1342, Bangladesh (e-mail: wild_reza@yahoo.com); and **SHARIF A. MUKUL**, Department of Forestry and Environmental Science, Shahjalal University of Science and Technology, Sylhet 3114, Bangladesh (e-mail: sharif_a_mukul@yahoo.com).

SCAPHIOPUS HOLBROOKII (Eastern Spadefoot). USA: OHIO: Scioto Co.: Porter Township. From a breeding pool at Sand Hill (38.69527°N, 82.85141°W; WGS 84). 28 March 2008. Jeffrey G. Davis and Paul J. Krusling. Verified by John W. Ferner. Cincinnati Museum Center (CMC 11283). New county record (Davis and Menze 2000. Ohio Biol. Surv. Misc. Contrib. No. 6) and represents the earliest known chorusing date for Ohio.

Submitted by **JEFFREY G. DAVIS (**e-mail: anura@fuse.net) and **PAUL J. KRUSLING** (e-mail: krusling@fuse.net), Cincinnati Museum Center – Fredrick and Amye Geier Research and Collections Center, 1301 Western Ave., Cincinnati, Ohio 45203-1130, USA.

SCAPHIOPUS HOLBROOKII (Eastern Spadefoot). USA: INDIANA: Sullivan Co.: south of Busseron Creek (38.92429ºN, 87.48477ºW; NAD 83). 14 May 2009. Angela Garcia and Sarabeth Klueh. Verified by Chris Phillips, Illinois Natural History Survey (INHS 2009.q). New county record (Minton 2001. Amphibians and Reptiles of Indiana. 2nd ed., revised. Indiana Academy of Science. vii–404 pp.). A full chorus of individuals was heard calling from a flooded field. Several other choruses of *S. holbrookii* were heard nearby.

Submitted by **SARABETH KLUEH** and **ANGELA GARCIA**, Wildlife Diversity Section, Indiana Department of Natural Resources Division of Fish and Wildlife, 553 E. Miller Drive, Bloomington, Indiana 47401, USA (e-mail: sklueh@dnr.in.gov).

TRACHYCEPHALUS VENULOSUS (Veined Treefrog). MÉXICO: PUEBLA: Municipality of Tenampulco: Lázaro Cárdenas

(20.185194°N, 97.195721°W; WGS84), 68 m elev. 25 March 2008. Tania Ramírez Valverde. Verified by Luis Canseco Márquez. Museo de Zoología, Universidad Nacional Autónoma de México (MZFC 22266). First record for Puebla, although many localities exist for adjacent Veracruz (Duellman 2001. Hylid Frogs of Middle America. SSAR Contrib. Herpetol. 18:xvi + 696 pp., x +1159 pp.). The frog was found in a seasonal evergreen forest (bosque tropical subperennifolia).

Submitted by **TANIA RAMÍREZ VALVERDE, AMAURI SARMIENTO ROJAS, YOCOYANI MEZA PARRAL,** and **ALDO MARTÍNEZ CAMPOS,** Laboratorio de Herpetología, Escuela de Biología, Benemérita Universidad Autónoma de Puebla, Ciudad Universitaria, Edif. 112-A, Boulevard Valsequillo y Av. San Claudio, Col. San Manuel, CP 72570, Puebla, Puebla, México (e-mail: crazygiro_20@hotmail.com).

TESTUDINES –TURTLES

APALONE MUTICA MUTICA (Midland Smooth Softshell). USA: KENTUCKY: Bracken Co.: Ohio River, 1.9 km W of Capt. Anthony Meldahl Locks and Dam (38.7974ºN, 84.1923ºW; WGS 84). 17 August 2009. Paul J. Krusling. Verified by Jeffrey G. Davis and John W. Ferner. Cincinnati Museum Center Herpetology Collection (CMC 11776). New county record (Kentucky's Comprehensive Wildlife Conservation Strategy. 2005. Kentucky Department of Fish and Wildlife Resources, Frankfort, Kentucky; http://fw.ky.gov/kfwis/stwg/).

Submitted by **PAUL J. KRUSLING**, Geier Collections and Research Center, Cincinnati Museum Center, 1301 Western Avenue, Cincinnati, Ohio 45203, USA (e-mail: pkrusling@gmail.com); and **JUDY GAMMON**, Scott High School 5400 Old Taylor Mill Road, Covington, Kentucky 41015, USA.

APALONE SPINIFERA (Spiny Softshell Turtle). MÉXICO: GUERRERO: Municipality of Copalillo: 5 km NE of Papalutla at the edge of Río Atoyac (18. 56766°N, 98.9511°W; WGS84), ca. 682 m elev. 11 December 2006. Juan Esteban Flores. Verified by Fausto R. Méndez de la Cruz. Colección del Laboratorio de Herpetología Vivario, Facultad de Estudios Superiores Iztacala, Universidad Nacional Autónoma de México (CLHV 4462-E). New municipality record and second record for the state, extending range 74.5 km NW of the Mezcala Bridge, Guerrero (Lemos-Espinal 1999. Bull. Maryland Herpetol. Soc. 35:40–42).

Submitted by **VÍCTOR HUGO JIMÉNEZ-ARCOS**, Laboratorio de Herpetología, Instituto de Biología, Universidad Nacional Autónoma de México, 3er Circuito exterior s/n, Ciudad Universitaria, Coyoacán, México, D.F. C.P. 04510 (e-mail: vhjimenezarcos@yahoo.com.mx); **SAMUEL SANTA CRUZ-PADILLA,** and **ARABEL ESCALONA-LÓPEZ,** Facultad de Estudios Superiores Iztacala, Universidad Nacional Autónoma de México, Av. de los Barrios s/n, Los Reyes Ixtacala, Tlanepantla, México, C.P. 54090; **GUSTAVO CASAS-ANDREU**, Colección Nacional de Anfibios y Reptiles del Instituto de Biología, Universidad Nacional Autónoma de México. 3er Circuito exterior s/n, Ciudad Universitaria, Coyoacán, México, D.F. C.P. 04510; and **ERIC CENTENERO-ALCALÁ**, Laboratorio de Ecología, Unidad de Biotecnología y Prototipos, Facultad de Estudios Superiores Iztacala, Universidad Nacional Autónoma de México, Av. de los Barrios s/n, Los Reyes Ixtacala, Tlalnepantla, México, C.P. 54090.

CHELUS FIMBRIATUS (Matamata Turtle). BRAZIL: AMAZONAS: Santa Isabel do Rio Negro (0.3335º S; 65.3116º W; WGS84). Collected in Jaradi River with trammel nets. 18 Jan 2006. L. Schneider, R. C. Vogt, L. B. Santos-Junior, C.R. Ferrara. Verified by L. Bonora. Coleção de Repteis e Anfibios, Instituto Nacional de Pesquisas da Amazonia, Manaus, Amazonas, Brazil (INPAH 18506 and 18507). *Chelus* ranges throughout the Orinoco and Amazon River basins of Venezuela, Colombia, Ecuador, Peru, northern Bolivia, Surinam, French Guiana, and Brazil (Vogt 2008. Amazon Turtles. Grafica Biblos, Lima, Peru. 104 pp.). The nearest locality record is at the mouth of Rio Branco (1.468ºS; 61.548ºW; WGS84), on the border of Amazonas State and Roraima State, 400 km to the southeast (Hartline 1967; cited in Pritchard and Trebbau 1984. The Turtles of Venezuela. Society for the Study of Amphibians and Reptiles, Oxford, Ohio. 403 pp.). The present record for the Jaradi River, in the upper Rio Negro Basin, begins to fill in the 331,662 km^2 gap in the distribution between San Gabriel de Cachoeira, Brazil and the hydrographic basin of Venezuela and Guyana.

Submitted by **LARISSA SCHNEIDER** (e-mail: laribio@terra.com.br), **RICHARD C. VOGT**, **LADISLAU B. SANTOS-JUNIOR,** and **CAMILA R. FERRARA**, Instituto Nacional de Pesquisas da Amazônia (INPA), Caixa Postal 478, CEP 69011-970, Manaus, Amazonas, Brazil.

CHELYDRA SERPENTINA SERPENTINA (Eastern Snapping Turtle). USA: TEXAS: Hidalgo Co.: Male turtle (7.6 kg) captured in a pond at Frontera Audubon (26.14691°N, 97.98856°W; NAD 83). 30 May 2009. Brian E. Dickerson, Amanda D. Schultz, and Donald J. Brown. Verified by Toby Hibbits. Texas Cooperative Wildlife Collection (TCWC 93912), Texas A&M University. MRJF observed a *Chelydra s. serpentina* in Harlingen, Texas in 1983 but was unable to capture the turtle. During preparation for this record we were informed that additional *Chelydra* have been observed in the last ten years from both Hidalgo and Cameron counties (P. Burchfield, pers. comm.). Although the potential for anthropogenic dispersal cannot be ignored, in context, this individual and the other reports of this species in the area are evidence of an established wild population in extreme south Texas. Historically, the lack of surface water south of the Nueces River would likely have provided a barrier to dispersal for the species. However, modern drainage and livestock pond systems in this area are now very extensive. Trapping was conducted for the Texas Parks and Wildlife Department freshwater turtle assessment (permit SPR-0102-191). New county record (Dixon 2000. Amphibians and Reptiles of Texas. 2nd Edition. Texas A&M Univ. Press, College Station, 421 pp.).

Submitted by **BRIAN E. DICKERSON, AMANDA D. SCHULTZ, DONALD J. BROWN, BEI DeVOLLD,** and **MICHAEL R. J. FORSTNER (**e-mail: mf@txstate.edu), Department of Biology, Texas State University-San Marcos, San Marcos, Texas 78666, USA; and **JAMES R. DIXON**, Department of Wildlife and Fisheries Sciences, Texas A&M University, College Station, Texas 77843, USA.

CHRYSEMYS PICTA (Painted Turtle). USA: GEORGIA: Wilkes Co.: Washington, Newtown Road, 1.6 km N Jane Hill Road

(33.84235°N, 82.81744°W, WGS84; elev. 138 m). 23 April 2009. Justin T. Oguni. Verified by Kenneth L. Krysko. Florida Museum of Natural History (photographic voucher UF 155280). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). Found AOR at 1636 h over a creek surrounded by undeveloped forest adjacent to cattle pastures.

Submitted by **JUSTIN T. OGUNI**, College of Veterinary Medicine, University of Georgia, Athens, Georgia 30602, USA; e-mail: goonie16@gmail.com.

CUORA AMBOINENSIS (Malayan Box Turtle). PHILIPPINES: BATAS ISLAND: Palawan Province: Taytay Municipality: along unnamed creek (11.1810028°N, 119.6140111°E; Google Earth). 02 March 2008. P. Fidenci. Verified by Hallie Brignall. California Academy of Sciences photo vouchers (CAS-HPV 60–61). First records for Batas Island (Diesmos et al. 2008. Chelon. Conserv. Biol. 7:157–177). Six adults observed along seasonal creek.

Submitted by **PIERRE FIDENCI**, Endangered Species International, 79 Brady St., San Francisco, California 94103, USA; e-mail: pfidenci@endangeredspeciesinternational.org.

GRAPTEMYS GEOGRAPHICA (Northern Map Turtle). USA: NORTH CAROLINA: Cherokee Co.: 7.6 km WSW of Violet, Hiwassee River below Apalachia Lake Dam, just E of Tennessee state line (35.1681°N, 84.2959°W, WGS84). 22–23 June 2009. Jeffrey C. Beane, L. Todd Pusser, and Robert A. Davis. Verified by William M. Palmer. North Carolina State Museum of Natural Sciences (NCSM 75934, 75935, 75943 [3 males collected 22 June 2009]; 75936 [female collected 23 June 2009]; several additional individuals were observed and photographed]. New county record and first vouchered records for North Carolina (Palmer and Braswell 1995. Reptiles of North Carolina. University of North Carolina Press, Chapel Hill. 412 pp.). Extends range ca. 32 km ENE and ca. 42 km SSE of nearest records in Georgia and Tennessee, respectively (Iverson 1992. A Revised Checklist with Distribution Maps of Turtles of the World. Privately published, Richmond, Indiana. xiii + 363 pp.; Jensen et al. [eds.] 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. xviii + 575 pp.).

We thank Gabrielle J. Graeter and Kendrick C. Weeks of the North Carolina Wildlife Resources Commission for assistance in documenting this population, and the Tennessee Valley Authority for allowing access to their reservations.

Submitted by **JEFFREY C. BEANE**, North Carolina State Museum of Natural Sciences, Research Laboratory, MSC# 1626, Raleigh, North Carolina 27699-1626, USA (e-mail: jeff.beane@ncdenr.gov); **L. TODD PUSSER**, P.O. Box 122, West End, North Carolina 27376, USA (e-mail: tpusser@nc.rr.com); and **ROBERT A. DAVIS**, 11320 Peed Dead End Road, Raleigh, North Carolina 27614, USA (e-mail: radavis413@msn.com).

KINOSTERNON SUBRUBRUM (Eastern Mud Turtle). USA: GEORGIA: Madison Co.: Eugene Odum Spring Hollow property impoundment, 0.45 km NE of intersection of Hudson River Church Rd. and Wesley Chapel Rd. (34.200065°N, 83.304924°W; WGS 84). 02 May 2009. Andrew M. Durso. Verified by Kenneth L. Krysko. Florida Museum of Natural History (FLMNH 155676). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). An adult *K. subrubrum* was captured in a hoop trap baited with canned sardines in soybean oil. This record is ca. 22.1 km NE of a 1952 record from Athens-Clarke County, Georgia (GMNH 39).

Submitted by **ANDREW M. DURSO**, University of Georgia, Odum School of Ecology, Athens, Georgia 30602, USA; e-mail: amdurso@gmail.com.

KINOSTERNON SUBRUBRUM (Eastern Mud Turtle). USA: GEORGIA: Wilkes Co.: Washington, Newtown Road, 1.6 km N Jane Hill Road (33.84235°N, 82.81744°W, WGS84; elev. 138 m). 28 April 2009. Justin T. Oguni. Verified by Kenneth L. Krysko. Florida Museum of Natural History (photographic voucher UF 155279). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). Found AOR at 1636 h over a creek surrounded by undeveloped forest adjacent to cattle pastures.

Submitted by **JUSTIN T. OGUNI**, College of Veterinary Medicine, University of Georgia, Athens, Georgia 30602, USA; e-mail: goonie16@gmail.com.

RHINOCLEMMYS PUNCTULARIA (Spot-legged Turtle). BRAZIL: PARÁ: Porto de Moz. Approximately 3 km from the Xingu River in chácara do Elias (02.18194ºS, 52.2861ºW; WGS84). Captured on the forest floor at 1030 h. 02 Dec 2008. L. Schneider, A. A. Kuniy, R. C. Vogt. Verified by E. Hingst Zaher. Coleção de Repteis e Anfibios, Museu de Zoologia da Univesidade de São Paulo, Sao Paulo, Brazil (MZUSP 4365). The known range of this species is concentrated along the coastal plain of Venezuela, the Guianas, and northern Brazil to the state of Maranhão (Rueda-Almonacid et al. 2007. Las Tortugas y los Crocodilianos de los Países Andinos del Trópico. Serie de Guías Tropicales de Campo 6. Conservación Internacional. Editora Panamericana, Formas e Impresos. Bogotá, Colombia, 538 pp.). This is the first record for the Xingú basin, the fourth largest drainage of the Amazon Basin (Vogt 2008. Tartarugas da Amazônia, Grafica Biblos, Lima, Peru. 104 pp.). The closest previous record (MZUSP 2207) was in Corcovado, Pará (51.65ºS, 50.008ºW; WGS84) (Pritchard and Trebbau 1984. The Turtles of Venezuela. Society for the Study of Amphibians and Reptiles, Oxford, Ohio. 403 pp.). This new record extends the range for this species 360 km S in the Amazon Basin.

Submitted by **LARISSA SCHNEIDER** (e-mail: laribio@terra.com.br), **ADRIANA A. KUNIY**, and **RICHARD C. VOGT**, Instituto Nacional de Pesquisas da Amazônia (INPA), Caixa Postal 478, CEP 69011-970, Manaus, Amazonas, Brazil.

STERNOTHERUS ODORATUS (Eastern Musk Turtle). USA: GEORGIA: Madison Co.: Eugene Odum Spring Hollow property impoundment, 0.45 km NE of intersection of Hudson River Church Rd. and Wesley Chapel Rd. (34.200065°N, 83.304924°W; WGS 84). 02 May 2009. Andrew M. Durso. Verified by Kenneth L. Krysko. Florida Museum of Natural History (FLMNH 155677–155678. New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). An adult *S. odoratus* was captured in a hoop trap baited with canned sardines in soybean oil. Additionally, a juvenile *S. odoratus* was captured in an unbaited minnow trap. These records are ca. 12.1 km NE of

a 2000 record from Jackson County, Georgia (GHA 04242).

Submitted by **ANDREW M. DURSO**, University of Georgia, Odum School of Ecology, Athens, Georgia 30602, USA; e-mail: amdurso@gmail.com.

STERNOTHERUS ODORATUS (Eastern Musk Turtle). USA: OHIO: GALLIA CO.: Raccoon Township. Tycoon Lake Wildlife Area (38.92051ºN, 82.35867ºW; WGS 84). 03 June 2001. Jeffrey G. Davis and Paul J. Krusling. Verified by John W. Ferner. Cincinnati Museum Center (CMC 11022). New county record (Wynn and Moody 2006. Ohio Turtle, Lizard, and Snake Atlas. Ohio Biol. Surv. Misc. Contrib. No. 10, Columbus).

Submitted by **JEFFREY G. DAVIS (**e-mail: anura@fuse.net) and **PAUL J. KRUSLING (**e-mail: pkrusling@fuse.net), Cincinnati Museum Center – Fredrick and Amye Geier Research and Collections Center, 1301 Western Avenue, Cincinnati, Ohio 45203-1130, USA.

TRACHEMYS SCRIPTA (Pond Slider Turtle). USA: GEORGIA: ELBERT CO.: Elberton, SR 79, 0.72 km S Cooter Creek Road (33.98314ºN, 82.63454ºW; WGS84; elev. 127 m). 28 April 2008. Justin T. Oguni. Verified by Kenneth L. Krysko. Florida Museum of Natural History (photographic voucher UF 155281). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). Found AOR at 1650 h in undeveloped forest.

Submitted by **JUSTIN T. OGUNI**, College of Veterinary Medicine, University of Georgia, Athens, Georgia 30602, USA; e-mail: goonie16@gmail.com.

SQUAMATA – LIZARDS

ABRONIA DEPPEI (Deppe's Arboreal Alligator Lizard). MÉXICO: MICHOACÁN: Municipality of Zitacuaro: Molcajete Mountain, 3 km S of Lazaro Cardenas (19.3946°N, 100.3586°W; WGS84), 2360 m elev. Eric Centenero Alcalá. Verified by Uri García Vázquez. Museo de Zoología Luis Herrera de la Facultad de Ciencias de la UNAM (MZFC 22673). First state record for genus and species, extending the known range ca. 34 km W from Valle de Bravo, México (Flores-Villela and Sanchez-Herrera 2003. Herpetologica 59:524–531). The specimen was found on a tree in oak forest

Submitted by **ERIC CENTENERO-ALCALÁ**, Laboratorio de Ecología, Unidad de Biotecnología y Prototipos, Facultad de Estudios Superiores Iztacala, Universidad Nacional Autónoma de México. Av. de los Barrios s/n, Los Reyes Ixtacala, Tlalnepantla, México, C.P. 54090 (e-mail: eca_46@hotmail.com); **VÍCTOR HUGO JIMÉNEZ-ARCOS**, Laboratorio de Herpetología, Instituto de Biología, Universidad Nacional Autónoma de México. 3er Circuito exterior s/n, Ciudad Universitaria, Coyoacán, México, D.F. C.P. 04510; and **ARABEL ESCALONA-LÓPEZ** and **SAMUEL SANTA CRUZ-PADILLA**, Facultad de Estudios Superiores Iztacala, Universidad Nacional Autónoma de México. Av. de los Barrios s/n, Los Reyes Ixtacala, Tlanepantla, México, C.P. 54090.

ANOLIS INSIGNIS (Giant Banded Anole). COSTA RICA: GUANACASTE: Trail to top (Sendero Derrumbe) of Cerro Cacao (10.929166°N, 85.466016°W; WGS84), 1270 m. elev. 13 March 2009. G. Köhler and J. Sunyer. Verified by Sebastian Lotzkat. Senckenberg Forschungsinstitut und Naturmuseum (SMF 89790). Northwesternmost record within the known range of this species, with the closest reported locality being near Bijagua, ca. 50 km to the southeast (Savage and Talbot 1978. Copeia 1978:480–492; Savage 2002. The Amphibians and Reptiles of Costa Rica. Univ. Chicago Press, Chicago, Illinois. 934 pp.). The lizard was found in an area containing premontane moist forest.

Submitted by **GUNTHER KÖHLER** and **JAVIER SUNYER,** Senckenberg Forschungsinstitut und Naturmuseum, Senckenberganlage 25, 60325 Frankfurt a.M., Germany (e-mail: gkoehler@senckenberg.de).

ANOLIS NEBULOSUS (Clouded Anole). MÉXICO: GUANAJUATO: Municipality of Yuriria: Cerro La Angostura (20.28083ºN, 101.10805ºW; WGS84), 1824 m elev. 22 May 2006. Marina Sánchez Luna and Adriana J. González Hernández. Verified by Adrian Nieto Montes de Oca. Colección Nacional de Anfibios y Reptiles, Instituto de Biología, Universidad Nacional Autónoma de México (IBH 21960–64). First state records, extending the range of the species 146.5 km NE from closest known locality at Nuevo Urecho, Michoacán (González and Garza 2006. *In* Ramírez-Bautista et al. [eds.], Inventarios Herpetofaunísticos de México: Avances en el Conocimiento de su Biodiversidad, pp. 140–151. Publ. Soc. Herpetol. Mexicana No. 3, México, D.F.). The lizards were found on trees in remnant tropical deciduous forest. Field work was supported by Fondos Mixtos de Conacyt-Concyteg, grant number 04-07-A-051.

Submitted by **MARINA SÁNCHEZ-LUNA**, Facultad de Agrobiología, Universidad Autónoma de Tlaxcala, Carretera Autopista Tlaxcala-San Martin, San Felipe Ixtacuixtla, Tlaxcala, México; and **ADRIANA J. GONZÁLEZ-HERNÁNDEZ, ELISA CABRERA-GUZMÁN**, and **VÍCTOR H. REYNOSO (**e-mail: vreynoso@ibiologia.unam.mx), Colección Nacional de Anfibios y Reptiles, Instituto de Biología, Departamento de Zoología, Universidad Nacional Autónoma de México, Circuito Exterior Ciudad Universitaria, México D.F., C.P. 04510.

ANOLIS PORCATUS (Cuban Green Anole). ARUBA: Radisson Aruba Resort in southwest Aruba (12.56864ºN, 70.04664ºW; WGS84). 18 January 2009. R. Andrew Odum and Facundo Franken. Verified by Gregory Schneider. University of Michigan Museum of Zoology (UMMZ 239619). First record for Aruba (van Buurt 2006. Applied Herpetol. 3:307–321) and was most likely introduced from Cuba with a shipment of palm trees during construction of the resort. It was found in garden vegetation along with numerous other adults and juveniles, indicating an established population.

Submitted by **R. ANDREW ODUM**, Toledo Zoological Society, Toledo, Ohio 43614, USA (e-mail: Andrew.Odum@toledozoo.org); and **GERARD VAN BUURT**, Curacao, Netherlands Antilles (e-mail: gvanbuurt@gmail.com).

ASPIDOSCELIS SEXLINEATA (Six-lined Racerunner). USA: NEBRASKA: STANTON CO.: 3.2 km S, 4.8 mi E Stanton (41.9279°N, 97.1661°W; NAD83). 14 July 2008. Greg D. Wright and Keith Geluso. Verified by Travis Taggart. Sternberg Museum of

Natural History (MHP 14308, photographic voucher). First county record. Represents a 72 km range extension into northeastern Nebraska from records reported from Platte County (Lynch 1985. Trans. Nebraska Acad. Sci. 13:33–57; University of Nebraska State Museum, Lincoln, UNSM ZM 3265–3266).

Submitted by **GREG D. WRIGHT** and **KEITH GELUSO (**e-mail: gelusok1@unk.edu), Department of Biology, University of Nebraska—Kearney, Kearney, Nebraska 68849, USA.

CALOTES EMMA (Spiny-headed Forest Lizard). BANGLADESH: HABIGANJ DISTRICT: Satchari National Park (24.1166667ºN, 91.4166667ºE; no datum available; 195–210 m elev.). 08 May 2009. Sharif A. Mukul. Verified by Aaron M. Bauer. Photograph deposited at USDZ, Raffles Museum of Biodiversity Research, National University of Singapore (ZRC [IMG] 2.101). First verified locality for Habiganj District. Cited for Bangladesh with a possibility of misidentification with *C. jerdoni* (Ahsan 1998. Proceeding of the International Conference on the Biology and Conservation of the Amphibians and Reptiles of South Asia, Sri Lanka, pp. 9–17). Mentioned in a herpetofaunal checklist without voucher specimen, photograph, or locality information (Khan 2004. Cobra 57:1–31). Nearest record outside Bangladesh is from Dampa Tiger Reserve (~100 km southeast) in Mizoram, India (Pawar and Birand 2001. A Survey of Amphibians, Reptiles, and Birds in Northeast India. CERC Tech. Rep. No. 6, Centre for Ecological Research and Conservation, Mysore, India). An adult and a juvenile found preying on ants in a *Tectona grandis* plantation with a mixture of *Artocarpus chaplasha*, *A. lakoocha*, and *Ficus* sp. vegetation. Undergrowth includes *Calamus*, *Lantana*, *Mikenia*, *Micromelum*, and *Alpinia*. A preserved specimen (CAS 94323) in California Academy of Sciences was collected from Lawachara Forest under Moulvibazar District (~50 km northeast) in 1961, which has been overlooked for many years (IUCN 2000. Red Book of Threatened Amphibians and Reptiles of Bangladesh. Dhaka, Bangladesh. 95 pp.).

Submitted by **A. H. M. ALI REZA**, Department of Natural Resources Management, Texas Tech University, Lubbock, Texas 79409, USA & Department of Zoology, Jahangirnagar University, Dhaka 1342, Bangladesh (e-mail: wild_reza@yahoo.com); and **SHARIF A. MUKUL**, Department of Forestry and Environmental Science, Shahjalal University of Science and Technology, Sylhet 3114, Bangladesh (e-mail: sharif_a_mukul@yahoo.com).

COLEONYX ELEGANS (Yucatan Banded Gecko). MÉXICO: PUEBLA: Municipality of Coyuca de Andrade: El Sauce (98.1088°N, 18.4289°W, WGS 24), 1693 m elev. 6 October 2007. Carlos Hernández Jiménez. Verified by Edmundo Perez Ramos. Museo de Zoología, Facultad de Ciencias, Universidad Nacional Autónoma de México (MZFC ID1613). First record for municipality and second from Puebla, extending the known range in the state ca. 53 km (airline) from Huehuetlan el Chico (Canseco-Marquez et al. 2006. Herpetol. Rev. 37:495). The lizard was found in tropical deciduous forest.

Submited by **CARLOS A. HERNÁNDEZ-JIMÉNEZ** (e-mail: acaltetepon22@gmail.com); and **URI OMAR GARCÍA VÁZQUEZ**, Museo de Zoología, Facultad de Ciencias, Universidad Nacional Autónoma de México, A.P. 70-399. México, D.F. 04510, México.

CTENOSAURA ACANTHURA (Northeastern Spinytail Iguana). GUATEMALA: HUEHUETENANGO: Municipio de Nentón: Miramar, Finca El Zapotál (15.89722°N, 91.787222°W; WGS84), 700 m elev. 21 November 2007. M. Acevedo and Q. Dwyer. Verified by Enio Cano. Colecciones Zoológicas de Referencia, Museo de Historia Natural, Universidad de San Carlos de Guatemala (MHN-USAC 1130). First verified record for Guatemala, with the closest known localities being in adjacent Chiapas, México (Köhler 2008. Reptiles of Central America, 2nd ed. Herpeton, Verlag E. Köhler, Offenbach, Germany. 400 pp.). The previous record from Guatemala from the same general area reported herein, listed by Acevedo (2006. *In* E. Cano [ed.], Biodiversidad de Guatemala, Vol. 1, pp. 487–524. Univ. del Valle, Ciudad de Guatemala, Guatemala) was a sight record with no voucher specimen. The lizard was found in an area containing subtropical dry forest.

Submitted by **MANUEL ACEVEDO**, Centro de Documentación para la Conservación/Centro de Estudios Conservacionistas (CDC/CECON), Universidad de San Carlos de Guatemala, Avenida Reforma 0-63 zona 10, Ciudad de Guatemala, Guatemala (e-mail: manuelaceved@gmail.com); **MILAN VESELÝ**, Dept. Zoology, Palacky University, Tr. Svobody 26, 771 46 Olomouc, Czech Republic; **JAVIER SUNYER**, Forschungsinstitut und Naturmuseum Senckenberg, Sektion Herpetologie, Senckenberganlage 25, D-60325 Frankfurt a.M., Germany; and **QUETZAL DWYER**, Parque Reptilandia, APDO-692-8000, San José, Costa Rica.

HEMIDACTYLUS BROOKII (NCN). HONDURAS: FRANCISCO MORAZÁN: Barrio Bella Vista, Comayagüela, (14.08333°N, 87.216667°W, no datum available), 950 m elev. 15 November 1999 (SMF) and 05 February 2006 (USNM). Leonel Marineros. Verified by Javier Sunyer and Steve W. Gotte. SMF 81770–71; USNM 572074. First precise Honduran records for this species (Powell and Maxey 1990. Cat. Amer. Amphib. Rept. 493.1–493.2), although Köhler (2008. Reptiles of Central America, 2nd ed. Herpeton Verlag E. Köhler, Offenbach, Germany. 400 pp.) plotted this and another Honduran locality on his distribution map of the species. All specimens were collected at night on the walls of a house.

Submitted by **GUNTHER KÖHLER**, Forschungsinstitut und Naturmuseum Senckenberg, Sektion Herpetologie, Senckenberganlage 25, D-60325 Frankfurt a M., Germany (e-mail: gkoehler@senckenberg.de); **JAMES R. McCRANIE**, 10770 SW 164th Street, Miami, Florida 33157–2933, USA (e-mail: jmccrani@bellsouth.net); and **LEONEL MARINEROS**, Barrio Bella Vista, Calle 9, entre 8 y 9 avenida, casa 813, Comayagüela, Honduras (e-mail: lmarineros@gmail.com).

HEMIDACTYLUS FLAVIVIRIDIS (Yellow-green House Gecko). INDIA: ASSAM: Kamrup District: Guwahati city: Arya Vidyapeeth College Zoological Museum (AVC) A0927. Fancy Bazar (26.1911944ºN, 91.7386139ºE; no datum available; 58 m elev.); AVC A0928, Gorchuk (26.1211944ºN, 91.7355278ºE; 47 m elev.). AVC A0929. Christanbasti (26.1593611ºN, 91.7865278ºE; 36 m elev.). J. Purkayastha. 2009. Verified by A. Das. Distributed throughout northern India and westwards, not extending to east of Bengal (Smith 1935. The Fauna of British India, Ceylon and Burma, Including the Whole of the Indo-Chinese Region. Vol. III. Sauria. Taylor and Francis, London. xiii + 440 pp + 1 pl.). Occurs exclusively in commercial sites, apparently through transportation.

First record for Assam State. High density in Fancy Bazar area appears to have adverse effect on *H. frenatus* population locally.

Submitted by **JAYADITYA PURKAYASTHA** and **MADHURIMA DAS**, Zoology Department (Herpetological Lab), Arya Vidyapeeth College, Guwahati 781 016, Assam, India; e-mail: sjaya_ditya@rediffmail.com

HEMIDACTYLUS FRENATUS (Common House Gecko). HONDURAS: ISLAS DE LA BAHIA: Cayo Cochino Pequeño (15.952261ºN, 86.499075ºW; WGS84), 1 m elev. 28 December 2008. P. J. Muelleman. Verified by Robert Powell. MPM Herp Photos P741–P743. First record for Cayo Cochino Pequeño (McCranie et al. 2005. Amphibians and Reptiles of the Bay Islands and Cayos Cochinos, Honduras. Bibliomania, Salt Lake City, Utah. xiv + 210 pp.). The closest record for this species, on Cayo Cochino Grande, was accounted for in an unpublished report submitted to the Honduran Coral Reef Foundation (HCRF) by Ferrari in 2002. The lizard was found clinging to a tree adjacent to the HCRF helicopter landing pad. We thank HCRF and Operation Wallacea for supporting our Cayos Cochinos herpetological research.

Submitted by **PETER J. MUELLEMAN (**e-mail: pjm563@truman.edu) and **CHAD E. MONTGOMERY (**e-mail: chadmont@truman.edu), Department of Biology, Truman State University, Kirksville, Missouri 63501, USA; **EMILY N. TAYLOR, JULIUS A. FRAZIER,** and **JORDAN C. AHLE,** Department of Biological Sciences, California Polytechnic State University, San Luis Obispo, California 93407, USA; and **SCOTT M. BOBACK**, Department of Biology, Dickinson College, Carlisle, Pennsylvania 17013, USA.

HEMIDACTYLUS MABOUIA (Wood Slave). USA: FLORIDA: St. Lucie Co.: Fort Pierce, 2100 Elizabeth Avenue (27.40840ºN, 80.34595ºW). 11 May 2009. Ken Hibbard. Verified by Kenneth L. Krysko. Florida Museum of Natural History, University of Florida. UF 155444. First county record. One adult female, heavily infested with ectoparasitic pterygosomatid mites, collected from a porch screen of a residence at 2200 h. Three other *H. mabouia* were observed at this same locality at 2000 h on 13 May 2009; they are common in sections of the Fort Pierce area. This invasive African species is currently the most widespread and rapidly spreading nonindigenous gecko in southern and central Florida (Meshaka et al. 2004. The Exotic Amphibians and Reptiles of Florida. Krieger Publ. Co., Malabar, Florida; Krysko and Daniels 2005. Caribb. J. Sci. 41:28–36), with a more recently established population in northern peninsular Florida (Krysko and Somma 2007. Herpetol. Rev. 38:352).

Submitted by **LOUIS A. SOMMA**, Department of Biology, PO Box 118525, 220 Bartram Hall, University of Florida, Gainesville, Florida 32611, USA; e-mail: somma@ufl.edu.

HEMIDACTYLUS MABOUIA (Wood Slave). TURKS AND CAICOS ISLANDS: Salt Cay: Balfour Town behind beach (21.331°N, 71.214°W; WGS 84), 1 m elev. 04 August 2008. R. Graham Reynolds and Matthew L. Niemiller. APSU 18945 (photograph). Middle Caicos: Bambarra Town, Middle Caicos Conservation Centre (21.813°N, 71.724°W; WGS84), 20 m elev.). 10 August 2008. R. Graham Reynolds and Matthew L. Niemiller. APSU 18947 (photograph). Providenciales: west end of island (21.810°N, 72.297°W; WGS84), 15 m elev. 16 July 2008. R. Graham Reynolds. APSU 18946 (photograph). All verified by Bryan Naqqi Manco. New island records (Schwartz and Henderson 1991. Amphibians and Reptiles of the West Indies: Descriptions, Distributions, and Natural History. Univ. Florida Press. 720 pp.). This exotic species is well established on the above islands, as juveniles were observed on walls of lighted buildings and nests were found under rocks or boards.

Submitted by **R. GRAHAM REYNOLDS** (e-mail: rgraham@utk.edu) and **MATTHEW L. NIEMILLER (**e-mail: mniemill@utk.edu), Department of Ecology and Evolutionary Biology, University of Tennessee, Knoxville, Tennessee 37996, USA.

HEMIDACTYLUS TURCICUS (Mediterranean Gecko). MÉXICO: CHIHUAHUA: Municipality of Juárez: Instituto de Ciencias Biomédicas de la Universidad Autónoma de Ciudad Juárez (31.747353ºN, 106.442831ºW; WGS84), 1113 m elev. 08 August 2001. Ana Gatica-Colima. Verified by Héctor Gadsden. Sección Herpetológica, Colección Científica de Vertebrados, Universidad Autónoma de Ciudad Juárez (UACJ 310–312).

First record for the municipality. The only other record for Chihuahua is at La Perla, Camargo (Lemos et al. 2007. Anfibios y Reptiles del Estado de Chihuahua, México. UNAM-CONABIO, Tlanepantla, México, México. xiii + 613 pp.), 423 km SE of Ciudad Juárez. This species is well established on walls of buildings located on the UACJ campus in Ciudad Juárez and has been reported from directly across the Río Grande in El Paso, Texas (Price 1980. Herpetol. Rev. 11:39).

Submitted by **ANA GATICA-COLIMA** (e-mail: agatica@uacj.mx), **ALEJANDRA AGUIRRE-TERRONES**, and **CÉSAR MUÑOZ-RIVAS**, Programa de Biología, Laboratorio de Ecología y Biodiversidad Animal, Universidad Autónoma de Ciudad Juárez, Estocolmo y Anillo Envolvente y PRONAF, Juárez, Chihuahua, México, CP 32310.

HEMIDACTYLUS TURCICUS (Mediterranean Gecko). USA: ALABAMA: Jefferson Co.: Homewood. 06 November 2008. Kristin A. Bakkegard. Verified by Craig Guyer. AUM 34876. Captured by hand at Mamie Mell Smith Hall on Samford University campus (33.4666ºN, 86.7935ºW; datum WGS84). Juvenile, suggesting breeding population. Six adults seen outside Mamie Mell Smith Hall on 24 June 2009 (R. Donaldson, pers comm.). New county record (Mount 1975. Amphibians and Reptiles of Alabama. Auburn University Agricultural Experiment Station, Auburn, Alabama, 347 pp.). Search of 55 museum databases (HerpNET, http://www.herpnet.org/ accessed 06 July 09) show no voucher specimens for Jefferson Co., despite range maps indicating the potential presence of this species in Jefferson Co. (Conant and Collins 1998. A Field Guide to Reptiles and Amphibians of Eastern and Central North America, 3rd ed. expanded, Houghton Mifflin, Boston, Massachusetts. 616 pp.). Moves the known range of this species 96 miles N of nearest known record in Alabama (AUM 35803, 35808, 36034–36057, Lee Co.).

Submitted by **KRISTIN A. BAKKEGARD**, Department of Biological and Environmental Sciences, Samford University, Birmingham, Alabama 35229, USA; e-mail: kbakkega@samford.edu.

HEMIDACTYLUS TURCICUS (Mediterranean Gecko). USA: ALABAMA: MONTGOMERY CO.: Captured at private residence (2611 Wildwood Drive) within Montgomery city limits (32.342544°N, 86.266818°W; WGS 84). 12 May 2009. C. and A. Kohn. Verified by Craig Guyer. AHAP-D 205. New county record (Mount 1975. Amphibians and Reptiles of Alabama. Auburn University Agricultural Experiment Station, Auburn Printing Co., Auburn, Alabama. 347 pp.).

Submitted by **SEAN P. GRAHAM**, Auburn University Department of Biological Sciences, 331 Funchess Hall, Auburn University, Alabama 36849, USA (e-mail: grahasp@auburn.edu); **CHARLES KOHN,** and **ALEX KOHN,** 2611 Wildwood Drive Montgomery Alabama, USA.

HEMIDACTYLUS TURCICUS (Mediterranean Gecko). USA: GEORGIA: SEMINOLE CO.: Brick wall of northwest corridor Charterhouse Inn, Bainbridge, along US Hwy 27 (30.88955°N, 84.565433°W; WGS84/NAD83). 31 July 2009. R. Birkhead. Verified by Craig Guyer. AUM 34917. New county record. *H. turcicus* has been documented to the north in Baker County (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens, Georgia. 575 pp.), but no records exist from Florida counties immediately to the south (Gadsden or Leon counties.; Townsend and Krysko 2003. Florida Sci. 66:204–208). This hotel has been frequented by local and regional herpetologists (including J. Jensen) during annual *Macrochelys* sampling trips in nearby Spring Creek for the last ten+ years, yet this is the first *H. turcicus* specimen collected, suggesting that at least this building has been recently colonized by this species within that time. The sudden appearance of disjunct populations corresponds to the stratified distribution pattern for this species predicted along trucking routes by Townsend and Krysko (*op. cit.*) and Meshaka et al. (2006. Herpetol. Cons. Biol. 1[1]:45–50). Thanks to S. Graham for reviewing this note.

Submitted by **ROGER D. BIRKHEAD**, Alabama Science In Motion, Auburn University, Alabama 36849-5414, USA; e-mail: birkhrd@auburn.edu

HEMIDACTYLUS TURCICUS (Mediterranean Gecko). USA: TEXAS: BLANCO CO.: State Highway 281, 2.99 km N of County Road 32 (30.094278ºN, 98.423167ºW; NAD27). 25 February 2008. Romey Swanson, Vincent Farallo, Jeff Troy, and Glen Hood. Verified by Toby Hibbitts, Texas Cooperative Wildlife Collection (TCWC 93008). Several individuals were seen under lights and one sub-adult was captured by hand. This individual represents the first recorded occurrence of this species in Blanco County (Dixon 2000. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station. 421 pp.).

Submitted by **ROMEY L. SWANSON (**e-mail: rs56761@txstate.edu), **VINCENT R. FARALLO**, **JEFF R. TROY**, **GLEN R. HOOD**, and **MICHAEL R. J. FORSTNER,** Department of Biology, Texas State University, San Marcos, Texas 78666, USA.

LEPIDODACTYLUS LUGUBRIS (Mourning Gecko). COSTA RICA: LIMÓN: Cocles, Talamanca: Gandoca-Manzanillo Wildlife Refuge (09.63818°N, 82.70496°W; WGS84), 3 m elev. 27 June 2008. Charles R. Knapp. UCR 20511. Punta Uva, Talamanca: Gandoca-Manzanillo Wildlife Refuge (09.643806°N, 82.686639°W; WGS84), 1 m elev. 23 July 2008. Juan G. Abarca and Priscilla Alvarado. UCR 20512. Both verified by Gerardo Chaves. First records for the Atlantic versant of Costa Rica, but its occurrence there was expected (Savage 2002. The Amphibians and Reptiles of Costa Rica. Univ. of Chicago Press, Chicago, Illinois. 934 pp.). The gecko in Cocles was encountered in an open-aired building at the Iguana Verde Foundation. The one at Punta Uva was found on the beach under a coconut husk.

Submitted by **JUAN G. ABARCA** (e-mail: antinosedal@yahoo.es) and **PRISCILLA ALVARADO** (e-mail: priste18@yahoo.com), Escuela de Ciencias Biológicas, Universidad Nacional, Heredia, Costa Rica; and **CHARLES R. KNAPP,** San Diego Zoo's Institute for Conservation Research, Zoological Society of San Diego, 15600 San Pasqual Valley Road, Escondido, California 92027, USA (e-mail: cknapp@ufl.edu).

PLESTIODON FASCIATUS (Five-lined skink). USA: GEORGIA: MADISON CO.: Eugene Odum Spring Hollow property, 0.5 km NE of intersection of Hudson River Church Rd. and Wesley Chapel Rd. (34.199431°N, 83.303010°W; WGS 84). 02 May 2009. James Moree and Charles Stoudenmire. Verified by Kenneth L. Krysko. FLMNH 155680. New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). This record is ca. 25.7 km NE of a 1952 record from Athens-Clarke County, Georgia (GMNH 28).

Submitted by **ANDREW M. DURSO**, University of Georgia, Odum School of Ecology, Athens, Georgia 30602, USA (e-mail: amdurso@gmail.com); **JAMES MOREE**, University of Georgia, Odum School of Ecology, Athens, Georgia 30602, USA (e-mail: jmoree@uga.edu); and **CHARLES STOUDENMIRE**, University of Georgia, Franklin College of Arts & Sciences, Athens, Georgia 30602, USA (e-mail: stoudey@uga.edu).

PLESTIODON MULTIVIRGATUS (Many-lined Skink). USA: NEBRASKA: VALLEY CO., 16.1 km N, 8 km E Ord (41.74043°N, 98.81868°W; NAD 83). 02 August 2008. Greg D. Wright and Keith Geluso. Verified by Travis Taggart. Sternberg Museum of Natural History, Hays, Kansas (MHP 14309, photographic voucher). First county record. Fills in gap along southern boundary of distribution in Nebraska (Lynch 1985. Trans. Nebraska Acad. Sci. 13:33–57). Known from adjacent Greeley County to the east (Lynch 1985. *op. cit.*). Individual was stripeless and had a tail partially regenerated. Stripeless individuals previously were known from Arthur, Brown, and Keith Counties (Lynch 1985, *op. cit.*).

Submitted by **GREG D. WRIGHT** and **KEITH GELUSO** Department of Biology, University of Nebraska—Kearney, Kearney, Nebraska 68849, USA; e-mail: gelusok1@unk.edu.

PODARCIS MURALIS (European Wall Lizard). USA: KENTUCKY: BOONE CO.: near confluence of Woolper Creek and the Ohio River (39.0198ºN, 84.8595ºW; WGS 84). October 2008. Scott Fennell. Verified by Jeffrey M. Goessling. Cincinnati Museum Center Herpetology Photographic Collection (CMC HP 5078 [digital file and print]). New county record (Ferner 2004. J. Kentucky Acad. Sci. 65[1]:1–4). An adult was found on rocks near shore. Anecdotal reports of others seen in area.

Submitted by **SCOTT FENNELL**, Center for Applied Ecol-

ogy, Northern Kentucky University, Highland Heights, Kentucky 41076, USA; and **JOHN W. FERNER**, Department of Biology, Thomas More College, Crestview Hills, Kentucky 41017, USA (e-mail: john.ferner@thomasmore.edu).

SCINCELLA GEMMINGERI (Forest Ground Skink). MÉXICO: CHIAPAS: Municipality of Villa Flores: 2.3 km N of Tierra y Libertad (16.2440ºN, 93.2678ºW; WGS84), 1095 m elev. 09 September 2006. Itzel Durán Fuentes and Edmundo Perez Ramos. Museo de Zoología, Facultad de Ciencias, UNAM (MZFC 22725–27). 3.3 km SE Tierra y Libertad (16.2276ºN, 93.30972ºW; WGS84), 1294 m elev. 08 September 2006. Uri Omar García Vázquez and Itzel Durán Fuentes. MZFC 22728–29. All verified by Luis Canseco Márquez. First records for Villa Flores and the Sierra Madre de Chiapas (in Chiapas), second series from the state, and extends the known range in Chiapas ca. 87 km (airline) SW from the Tuxtla Gutierrez-Cañon del Sumidero road, north of Tuxtla Gutierrez on the southern edge of the Northern Highlands region of Chiapas (Luna-Reyes et al. 2007. Herpetol. Rev. 30:353). The closest previously known locality is about 55 km NW at Rodulfo Figueroa, Oaxaca (MZFC 15558), which is also located in the Sierra Madre de Chiapas. All specimens were active during the day in pine forest.

Submitted by **URI OMAR GARCÍA-VÁZQUEZ** (e-mail: urigarcia@gmail.com), **EDMUNDO PÉREZ-RAMOS,** and **ITZEL DURÁN-FUENTES,** Laboratorio de Herpetología, Museo de Zoología, Facultad de Ciencias, UNAM, A.P. 70-399, México D.F. 04510, México.

SCINCUS MITRANUS (NCN). IRAN: KHUZESTAN PROVINCE: Kupal dunes, sand dunes 53 km E Ahvaz via Ahvaz-Haftgel Road (31.2731667ºN, 49.2365ºE; no datum available; 75 m elev.). 10 May 2001. T. J. Papenfuss. University of California, Berkeley, Museum of Vertebrate Zoology, MVZ 234488–91, 234535–8. First record for Iran. Habitat described by Anderson (1999. The Lizards of Iran. SSAR Contrib. Herpetol., Vol. 15. vii + 442 pp. Ithaca, New York). Species known from similar habitat in Saudi Arabia, UAE, and Oman. Occurrence at this locality is somewhat surprising, as *S. scincus conirostris* occurs in similar habitat 90 km to southeast. However, the two species are sympatric, if not syntopic, on the Arabian Peninsula. Specimens in agreement with those collected in UAE and with 110 specimens in the California Academy of Sciences, collected by John Gasperetti and others elsewhere on the Arabian Peninsula.

Submitted by **HADI FAHIMI**, No 1, 17 Alley, Shafa St: Kerman city, Kerman Province, Iran and Science & Research Azad University, Iran (e-mail: ha_fahimi@yahoo.com); **THEODORE J. PAPENFUSS**, Museum of Vertebrate Zoology, University of California, Berkeley, California 94720, USA (e-mail: asiaherp@berkeley.edu); and **STEVEN C. ANDERSON**, California Academy of Sciences, San Francisco, California 94118, USA, and University of the Pacific, Stockton, California 95211, USA (e-mail: asaccus@aol.com).

SQUAMATA – SNAKES

AGKISTRODON CONTORTRIX (Copperhead). USA: TENNESSEE: Cannon Co.: Burt Burgen Road at Cove Hill Road intersection (36.7311ºN, 86.1219ºW; NAD83). 24 June 2007. Brian T. Miller. Verified by M. L. Niemiller. Adult found dead on road. Deposited in the Herpetology Collection at Middle Tennessee State University (MTSU 181S). First record for county, which also decreases size of conspicuous gap in records reported for central Tennessee (Scott and Redmond 2008. Atlas of Reptiles in Tennessee. Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available from http://www.apsu.edu/reptatlas; accessed 04 June 2009).

Submitted by **JOSHUA A. MILLER**, Sinks Miller Road, Bradyville, Tennessee 37026, USA; **JACOB H. MILLER**, Sinks Miller Road, Bradyville, Tennessee 37026, USA; and **JOYCE L. MILLER**, MIMIC, Middle Tennessee State University, Murfreesboro, Tennessee 37132, USA (e-mail: jlmiller@mtsu.edu).

AGKISTRODON PISCIVORUS (Cottonmouth). USA: TENNESSEE: Coffee Co.: Duck River (35.5ºN, 86.0ºW; datum WGS 84). 25 July 2008. Rob Colvin. Verified by Jack Sites. Brigham Young University, BYU 5379. Gloyd and Conant (1990. Snakes of the *Agkistrodon* Complex: A Monographic Review. Society for the Study of Amphibians and Reptiles, Oxford, Ohio. 614 pp.) and the Tennessee Reptile Atlas (http://www.apsu.edu/reptatlas/frames_file.htm, accessed 27 May 2009) report the occurrence of an isolated, potentially introduced population of *Agkistrodon piscivorus* in Coffee County but provide no documentation. We were unable to locate any museum specimens of *A. piscivorus* from Coffee County (http://www.herpnet.org, accessed 30 May 2009) and here report a new county record, a male, with a snout to vent length of 79.7 cm and mass of 600 g.

Collection was made under the authority of Tennessee Wildlife Resources Agency Scientific Collection Permit #3486. Tissue is available by request from the authors.

Submitted by **BRYAN HAMILTON,** 100 Great Basin National Park, Baker Nevada 89311, USA (e-mail: bryan_hamilton@nps.gov); and **ROBERT COLVIN,** Tennessee Wildlife Resources Agency, Region I, 200 Lowell Thomas Dr, Jackson, Tennessee 38301, USA.

AGKISTRODON PISCIVORUS LEUCOSTOMA (Western Cottonmouth). USA: ARKANSAS: Cleburne Co.: Near Brewer Road 3.37 miles NW of AR 225 (35.67192ºN, 92.15800ºW; WGS84; elev. 234 m). 13 Sep 2008. Thomas J. Belford. University of Kansas Natural History Museum (KUDA 6357). Verified by William E. Duellman. Single specimen was found thermoregulating near the opening of a den site. First county record; extends range 10.11 km from nearest known record in Van Buren County, Arkansas (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. Univ. of Arkansas Press, Fayetteville. 421 pp.).

Submitted by **THOMAS J. BELFORD**, 701 West Academy Avenue, Searcy, Arkansas 72143, USA; e-mail: thomasbelfordiniraq@yahoo.com.

AGKISTRODON PISCIVORUS PISCIVORUS (Eastern Cottonmouth). USA: SOUTH CAROLINA: Edgefield Co.: 15.5 km N of Edgefield, where SC Highway 25 crosses Turkey Creek. 100 m E of the SC Highway 25 bridge. 20 August 2006. Photographic record South Carolina State Museum 2006.39.1a, 1b (photographs by K. Knight). Verified by J. Camper. New county record (Gloyd

and Conant 1990. Snakes of the *Agkistrodon* Complex: A Monographic Review. SSAR Contrib. Herpetol., No. 6). Inland-most record for South Carolina, first record for the central Piedmont of the state, first record for Edgefield Co. A second, larger specimen was observed ca. 200 m downstream of the above locality on 27 August 2006.

Submitted by **JAMES L. KNIGHT**, South Carolina State Museum, 301 Gervais St., Columbia, South Carolina 29202, USA; e-mail: jim.knight@scmuseum.org.

CEMOPHORA COCCINEA (Scarletsnake). USA: GEORGIA: Bartow Co.: White, Macedonia Road, 1.0 mi SE Macedonia Camp Road (34.16937°N, 84.66865°W, WGS84; elev. 304 m). 07 July 2009. Justin T. Oguni. Verified by Kenneth L. Krysko. Florida Museum of Natural History (photographic voucher UF 155510). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press. 575 pp.). Found AOR at 2225 h surrounded by mixed pine-hardwood forest.

Submitted by **JUSTIN T. OGUNI**, College of Veterinary Medicine, University of Georgia, Athens, Georgia 30602, USA; e-mail: goonie16@gmail.com

CEMOPHORA COCCINEA COPEI (Northern Scarletsnake). USA: ARKANSAS: Cleburne Co.: Specimen was found near Pickens Mountain road 1.1 miles N of AR 310 (35.36305º N, 091 52.220ºW; WGS84; elev. 95 m). 05 Jun 2009. Thomas J. Belford and Madison K. Price. The University of Kansas Natural History Museum (KUDA 6829). Verified by William E. Duellman. Single specimen was found beneath a rock in cedar glade habitat. First county record; extends range 15.41 km from nearest known record in White County, Arkansas (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. Univ. Of Arkansas Press, Fayetteville. 421 pp.).

Submitted by **THOMAS J. BELFORD**, 701 West Academy Avenue, Searcy, Arkansas 72143, USA (e-mail: thomasbelford iniraq@yahoo.com); and **MADISON K. PRICE** 244 Pickens Mountain Road, Searcy, Arkansas 72143, USA.

CLONOPHIS KIRTLANDII (Kirtland's Snake). USA: ILLINOIS: DeKalb Co.: 2.4 km W of Sandwich. 08 October 1961. Juvenile specimen collected by Harlan D. Walley and deposited in the Michigan State University Museum. Verified by James Harding. MSUM HE.14207. This previously overlooked specimen represents a new county record (Phillips et al. 1999. Field Guide to Amphibians and Reptiles of Illinois. Illinios Natural History Survey. 300 pp.). Based on the timing and format of written records, this specimen probably came to the Michigan State University Museum via Dr. Marvin "Max" Hensley who taught herpetology at MSU and maintained a collection in the Department of Zoology. Following his retirement in 1986, herpetological specimens collected in the 1950s, 1960s, and early 1970s were transferred to the MSU Museum (Laura Abraczinska, MSU Museum, pers. comm.). In a conversation with RBK in spring 2008, Harlan Walley (since deceased) recalled collecting this specimen but was unsure how it ended up at MSU.

Submitted by **RICHARD B. KING**, Department of Biological Sciences, Northern Illinois University, DeKalb, Illinois 60115, USA.

COLUBER (= MASTICOPHIS) FLAGELLUM FLAGELLUM (Eastern Coachwhip). USA: ARKANSAS: Searcy Co.: vic. Mull, ~3 km S of jct AR 14 and Ramblewood Trail (36.052048°N, 92.594601°W; WGS 84). 11 June 2009. M. B. Connior. Verified by S. E. Trauth. Arkansas State University Museum of Zoology Herpetology Collection (ASUMZ 31369).. This female is a new county record partially filling a distributional hiatus among previous records in Marion, Baxter, and Stone counties in northern Arkansas (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville. 421 pp.).

Submitted by **MATTHEW B. CONNIOR**, Department of Biological Sciences, Arkansas State University, P.O. Box 599, State University, Arkansas 72467, USA; e-mail: matthew.connior@smail.astate.edu.

DIADOPHIS PUNCTATUS (Ring-necked Snake). USA: GEORGIA: Madison Co.: Eugene Odum Spring Hollow property, 0.5 km NE of intersection of Hudson River Church Rd. and Wesley Chapel Rd. (34.199431°N, 83.303010°W; WGS 84). 02 May 2009. Collected by JM and CS. Verified by Kenneth L. Krysko. FLMNH 155679. New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). An adult *D. punctatus* was hand captured beneath a log at 1115 h. This record is ca. 29.5 km NE of a 1950 record from Athens-Clarke County, Georgia (GMNH 6870).

Submitted by **ANDREW M. DURSO** (e-mail: amdurso@gmail.com) and **JAMES MOREE**, University of Georgia, Odum School of Ecology, Athens, Georgia 30602, USA (e-mail: jmoree@uga.edu); and **CHARLES STOUDENMIRE**, University of Georgia, Franklin College of Arts & Sciences, Athens, Georgia 30602, USA (e-mail: stoudey@uga.edu).

DRYMARCHON CAUDOMACULATUS (Falcon Indigo Snake). COLOMBIA: DEPARTAMENTO DE GUAJIRA: Municipio de Uribia, Corregimiento de Nazareth, vereda Yorijaru 12.181°N 71.28°W (datum MAGNA-SIRGAS), 107 m elev. M. Fernandez. 12 July 2008. Colección de Herpetología, Museo de Historia Natural ANDES, Universidad de los Andes, Bogotá, Colombia (ANDES-R 169). Verified by W. Wüster. Previously known from Falcon and Zulia states, Venezuela (Wüster et al. 2001. Herpetol. J. 11:157–165; Infante Rivero et al. 2005. Herpetol. Rev. 36:203). First country record extends range ca. 200 airline km NW from Falcon and 280 airline km NW from Zulia state, Venezuela.

Submitted by **JUAN SALVADOR MENDOZA** and **MATEO FERNANDEZ LUCERO**, Museo de Historia Natural, Universidad de los Andes, Colección de Herpetología, Bogotá, Colombia.

EPICRATES MONENSIS GRANTI (Virgin Islands Treeboa). BRITISH VIRGIN ISLANDS: Great Camanoe Island: near boat dock on a stone wall in a drainage culvert (18.46293°N, 64.53426°W; NAD83), 50 m elev. 20 October 2008. Brittany S. Barker. Verified by J. Lazell. MPM-P 740 (photograph). First documented record for island. Lazell (1983. *In* Rhodin and Miyata [eds.], Advances in Herpetology and Evolutionary Biology: Essays in Honor of Ernest E. Williams, pp. 99–117. Mus. Comp. Zool., Harvard Univ., Cambridge, Massachusetts) reported a sight record, but without a voucher. The snake was found at night perched on the wall in an area surrounded by subtropical dry forest.

Financial support for this work was provided by The Conservation Agency through a grant from the Falconwood Foundation.

Submitted by **BRITTANY S. BARKER**, Department of Biology, University of New Mexico, Albuquerque, New Mexico 87131, USA (e-mail: barkerbr@unm.edu); **ROBERT W. HENDERSON**, Milwaukee Public Museum, Milwaukee, Wisconsin 53233, USA (e-mail: henderson@mpm.edu); and **ROBERT POWELL**, Avila University, Kansas City, Missouri 64145, USA (e-mail: Robert.Powell@avila.edu).

FARANCIA ABACURA REINWARDTII (Western Mudsnake). USA: ARKANSAS: CALHOUN CO.: ~3 km N of Ouachita River on US 167 (33.3724°N, 925101°W; WGS 84). 27 September 2009. M. B. Connior. Verified by S. E. Trauth. Arkansas State University Museum of Zoology Herpetology Collection (photo voucher ASUMZ 31375). DOR. This adult is a new county record filling a distributional hiatus among previous records in Dallas, Bradley, Ouachita, and Union counties in southern Arkansas (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville. 421 pp.).

Submitted by **MATTHEW B. CONNIOR,** Health and Natural Sciences, South Arkansas Community College, PO Box 7010, 300 South West Avenue, El Dorado, Arkansas 71731, USA; e-mail: mconnior@southark.edu.

HETERODON PLATIRHINOS (Eastern Hog-nosed Snake). USA: WISCONSIN: BUFFALO CO.: North of Fountain City (44.177489°N, 91.758078°W; datum WGS84). 13 June 2009. Verified by Erik Wild. Illinois Natural History Survey INHS 2009o (photograph). New county record. Fills gap in known range of species in Wisconsin (Casper 1996. Geographic Distributions of the Amphibians and Reptiles of Wisconsin. Milwaukee Public Museum, 87 pp.). Discovered in a residential development surrounded by disturbed sand prairie/fallow grassland at the base of bluff habitat.

Submitted by **JASON BECKER**, W522 State Road 35, Fountain City, Wisconsin, USA; **PATRICK THORSELL** and **LISA THORSELL**, S2887 Willow Lane, Fountain City, Wisconsin, USA; and **JOSHUA M. KAPFER**, Natural Resources Consulting, Inc., 209 Commerce Parkway, PO Box 128, Cottage Grove, Wisconsin 53527, USA.

LAMPROPELTIS GETULA (Common Kingsnake). USA: GEORGIA: MADISON CO.: A live adult found at 1400 h on a snowdrift at a private residence (34.075994°N, 83.363706°W; WGS 84). 03 March 2009. Shelby Jarrett and Carla Jarrett. Verified by Kenneth L. Krysko. FLMNH 155682. A DOR adult *L. getula* was found on GA-106, 0.17 km N of intersection with Ben Crawford Rd (34.092558°N, 83.312641°W; WGS 84). 02 May 2009. Andrew M. Durso. Verified by M. Elizabeth McGhee. GMNH 50117. New county records (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). These records are ca. 18.1 km NW and 15.3 km N of a 1952 record from Athens-Clarke County, Georgia (GMNH 116), respectively.

Submitted by **ANDREW M. DURSO**, University of Georgia, Odum School of Ecology, Athens, Georgia 30602, USA (e-mail: amdurso@gmail.com); **SHELBY JARRETT, CARLA JARRETT (**e-mail: cjarrett@uga.edu**),** and **JUSTIN T. OGUNI** (e-mail: goonie16@gmail.com), University of Georgia, College of Veterinary Medicine, Athens, Georgia 30602, USA.

LEPTOPHIS DEPRESSIROSTRIS (NCN). HONDURAS: GRACIAS A DIOS: Raudal Kiplatara, nuclear zone of Río Platano Biosphere Reserve (15.6150°N, 84.9608ºW; WGS 84), 270 m elev. 07 August 2003. Jorge A. Ferrari. Forschungsinstitut Senckenberg (SMF 86015). Pomokir, nuclear zone of Río Platano Biosphere Reserve (15.4885°N, 84.9535W; WGS 84), 200 m elev. 23 January 2004. Jorge A. Ferrari. SMF 86016. Both verified by Javier Sunyer. First records for Honduras (Köhler 2008. Reptiles of Central America. 2nd ed. Herpeton Verlag E. Köhler, Offenbach, Germany. 400 pp.); McCranie et al. 2006. The Amphibians and Reptiles of the Honduran Mosquitia. Krieger Publ. Co., Malabar, Florida. 291 pp.). The nearest record is about 160 km SSW in Reserva Biosfera Bosawas, Jinotega, Nicaragua (Köhler 2001. Anfibios y Reptiles de Nicaragua. Herpeton Verlag E. Köhler, Offenbach, Germany. 208 pp.).

Submitted by **GUNTHER KÖHLER,** Forschungsinstitut und Naturmuseum Senckenberg, Senckenberganlage 25, 60325 Frankfurt a.M., Germany (e-mail: gkoehler@senckenberg.de); and **JORGE A. FERRARI**, Organización de Rescate y Protección de Reptiles y Anfibios de Honduras, Apdo. Postal 30.724 Tocontin, Tegucigalpa, Honduras (e-mail: herpetoking@yahoo.com).

LEPTOPHIS DIPLOTROPIS (Pacific Coast Parrot Snake). MÉXICO: GUANAJUATO: Municipality of Yuriria: Cerro La Angostura (20.28083ºN, 101.10805ºW; WGS84), 1824 m elev. 22 May 2006. Marina Sánchez Luna and Adriana J. González Hernández. Verified by Edmundo Pérez Ramos. Colección Nacional de Anfibios y Reptiles, Instituto de Biología, Universidad Nacional Autónoma de México, México (IBH 21959). First state record, and extends the range of the species ca. 146 km NE from closest known locality at Nuevo Urecho, Michoacán (González and Garza 2006. *In* Ramírez-Bautista et al. [eds.], Inventarios Herpetofaunísticos de México: Avances en el Conocimiento de su Biodiversidad, pp. 140–151. Publ. Soc. Herpetol. Mexicana No. 3, México, D.F.). The snake was found in secondary vegetation next to a remnant patch of tropical deciduous forest. Project was supported by Fondos Mixtos de Conacyt-Concyteg, grant number 04-07-A-051.

Submitted by **MARINA SÁNCHEZ-LUNA**, Facultad de Agrobiología, Universidad Autónoma de Tlaxcala, Carretera Autopista Tlaxcala-San Martin, San Felipe Ixtacuixtla Tlaxcala, México; and **ADRIANA J. GONZÁLEZ-HERNÁNDEZ, ELISA CABRERA-GUZMÁN**, and **VÍCTOR H. REYNOSO (**e-mail: vreynoso@ibiologia.unam.mx), Colección Nacional de Anfibios y Reptiles, Instituto de Biología, Departamento de Zoología, Universidad Nacional Autónoma de México, Circuito Exterior Ciudad Universitaria, México D.F., C.P. 04510.

MICRUROIDES EURYXANTHUS (Sonoran Coral Snake). MÉXICO: CHIHUAHUA: Municipality of Urique: 7.2 km E of El Divisadero, near Río Urique (27.496389°N, 107.796°W; WGS84). 28 July 2008. Javier Guardado. Verified by Pablo Lavín. Seccion de Herpetología, Coleccion Científica de Vertebrados, Univesidad Autónoma de Ciudad Juárez, Colección digital (CCV-UACJ 12-29 08). First record for the municipality, extending the range 52.38 km N of Batopilas, Batopilas (Lemos Espinal and Smith 2007. Anfibios

y Reptiles del Estado de Chihuahua, México. UNAM-CONABIO. xii + 613 pp.). The snake was found at 1300 h laying on a rock near a small creek surrounded by gallery forest.

Submitted by **JAVIER GUARDADO** and **ANA GATICA-COLIMA (**e-mail: agatica@uacj.mx), Programa de Biología, Laboratorio de Ecología y Biodiversidad Animal, Universidad Autónoma de Ciudad Juárez, Estocolmo y Anillo Envolvente y PRONAF, CP. 32310, Juárez, Chihuahua, México.

NERODIA TAXISPILOTA (Brown Watersnake). USA: SOUTH CAROLINA: York Co.: DOR adult on West Oak Road ca. 1 km W. of Pennington Rd., about 1 km from Big Dutchman Creek, the nearest water source. 19 June 2001. Steven Fields. Verified by Jeff Camper. Cultural and Heritage Museum of York County 2009.015.001, photographic record. Additional sight records on file at the Cultural and Heritage Museum of York County. First record for York County (Gibbons and Dorcas 2004. North American Water Snakes: A Natural History. Univ. Oklahoma Press, Norman. 438 pp.).

Submitted by **STEVEN E. FIELDS**, Cultural and Heritage Museum of York County, Rock Hill, South Carolina 29732, USA; and **JAMES L. KNIGHT**, South Carolina State Museum, 301 Gervais Street, Columbia, South Carolina 29202, USA (e-mail: jim.knight@scmuseum.org).

NINIA ESPINALI (Espinal's Coffee Snake). HONDURAS: COMAYAGUA: Parque Nacional Cerro Azul Meámbar, from the western side of Cerro Azul on a steep slope ca. 200 m above the Río de Varsovia (14.826389°N, 87.883333°W; WGS84), 1660 m elev. 09 July 2008. Ileana R. Luque-M. and Josiah H. Townsend. Verified by Larry David Wilson. UF 155102. First record for the Department of Comayagua and easternmost locality for the species, extending the range ca. 85 km SSE of records in Parque Nacional Cusuco, Cortés, and ca. 75 km N of localities in the vicinity of Guajiquiro, La Paz (McCranie and Wilson 1995. J. Herpetol. 29:224–232). The snake was found crawling at night on a steep slope in an exposed root mass of a tree in lower montane wet forest.

Submitted by **ILEANA R. LUQUE-MONTES**, Instituto Regional de Biodiversidad (IRBio), Centro Zamorano de Biodiversidad, Escuela Agrícola Panamericana Zamorano, Honduras (e-mail: ileanaluquem@gmail.com); and **JOSIAH H. TOWNSEND**, School of Natural Resources and Environment, and Florida Museum of Natural History, University of Florida, Gainesville, Florida 32611-7800, USA (e-mail: jtwnsnd@ufl.edu).

OPHEODRYS AESTIVUS (Rough Greensnake). USA: GEORGIA: Oglethorpe Co.: Carlton, New Hope Vesta Road, 1.0 mi SE McCannon Road (33.93019°N, 82.90739°W, WGS84; elev. 144 m). 28 April 2009. Justin T. Oguni. Florida Museum of Natural History (photographic voucher UF 155271). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). Found AOR at 1610 h in undeveloped forest and temporary wetlands with small streams. Wilkes Co.: Tignall, CR 184, 4.8 km E Newtown Road (33.89546°N, 82.79621°W, WGS84; elev. 160 m). 13 May 2009. Justin T. Oguni. UF 155334, photographic voucher. New county record (Jensen, *op. cit*.) Found DOR at 1518 h in undeveloped forest. Both verified by Kenneth L. Krysko.

Submitted by **JUSTIN T. OGUNI**, College of Veterinary Medicine, University of Georgia, Athens, Georgia 30602, USA; e-mail: goonie16@gmail.com.

OPHEODRYS VERNALIS (Smooth Greensnake). USA: NEBRASKA: Webster Co.: Nebraska Highway 4, 3.5 km S, 5.25 km E Bladen (40.29232°N, 98.65855°W, NAD 83). 23 July 2008. Keith Geluso and Greg D. Wright. Verified by Travis Taggart. Sternberg Museum of Natural History, Hays, Kansas (MHP 14310, photographic voucher). First county record. Southernmost record in Nebraska, where it is documented from only four counties (Lynch 1985. Trans. Nebraska Acad. Sci. 13:33–57).

Submitted by **KEITH GELUSO** (e-mail: gelusok1@unk.edu), and **GREG D. WRIGHT**, Department of Biology, University of Nebraska—Kearney, Kearney, Nebraska 68849, USA.

OPHEODRYS VERNALIS (Smooth Greensnake). USA: OHIO: Greene Co.: Bath Township. Prairie Road (39.80587°N, 84.07247°W; WGS 84). 20 May 2009. William J. Letsche and Jeffrey G. Davis. Verified by John W. Ferner. Cincinnati Museum Center (CMC 11600). New county record and first record for this species in southwest Ohio since 1961 (Wynn and Moody 2006. Ohio Turtle, Lizard, and Snake Atlas. Ohio Biol. Surv. Misc. Contrib. No. 10, Columbus).

Submitted by **JEFFREY G. DAVIS**, Cincinnati Museum Center, Fredrick and Amye Geier Research and Collections Center, 1301 Western Avenue, Cincinnati, Ohio 45203-1130, USA (e-mail: anura@fuse.net); and **WILLIAM J. LETSCHE**, 168 Crouse Chapel Road, Chillicothe, Ohio 45601, USA (e-mail: salamanderhunter71@yahoo.com).

REGINA SEPTEMVITTATA (Queen Snake). USA: OHIO: Holmes Co.: Prairie Township. Killbuck Marsh Wildlife Area County Road 1 (40.66359ºN, 81.95791ºW; WGS 84). 03 April 1999. Jeffrey G. Davis. Verified by John W. Ferner. Cincinnati Museum Center (CMC 5816). New county record (Wynn and Moody 2006. Ohio Turtle, Lizard, and Snake Atlas. Ohio Biol. Surv. Misc. Contrib. No. 10, Columbus).

Submitted by **JEFFREY G. DAVIS**, Cincinnati Museum Center – Fredrick and Amye Geier Research and Collections Center, 1301 Western Ave., Cincinnati, Ohio 45203-1130, USA; e-mail: anura@fuse.net.

STORERIA DEKAYI (Dekay's Brownsnake). USA: OHIO: Adams Co.: West Union, Waggoner Riffle Road (38.3071ºN, 83.46387ºW; WGS 84). 28 March 2009. Paul J. Krusling. Verified by Jeffrey G. Davis. Cincinnati Museum Center Herpetology Collection (CMC HP 590–593 [digital files and prints]). New county record (Wynn and Moody 2006. Ohio Turtle, Lizard, and Snake Atlas. Ohio Biol. Surv. Misc. Contrib. No. 10, Columbus).

Submitted by **PAUL J. KRUSLING**, Geier Collections and Research Center, Cincinnati Museum Center, 1301 Western Avenue, Cincinnati, Ohio 45203, USA; **JEFFREY GOESSLING, EMILY ANNEKEN, JACOB BOTKINS, JOSHUA HORN,** and **JOHN W. FERNER**, Department of Biology, Thomas More College, Crestview Hills, Kentucky 41017, USA (e-mail: john.ferner@thomasmore.edu).

STORERIA DEKAYI (DeKay's Brownsnake). USA: OHIO: Gallia Co.: Greenfield Township. C, H, and D Road (38.8058°N, 82.5397°W; WGS 84). 04 April 2008. Jeffrey G. Davis and Paul J. Krusling. Verified by John W. Ferner. Cincinnati Museum Center (CMC 11022). New county record (Wynn and Moody 2006. Ohio Turtle, Lizard, and Snake Atlas. Ohio Biol. Surv. Misc. Contrib. No. 10, Columbus).

Submitted by **JEFFREY G. DAVIS (**e-mail: anura@fuse.net) and **PAUL J. KRUSLING** (e-mail: krusling@fuse.net), Cincinnati Museum Center – Fredrick and Amye Geier Research and Collections Center, 1301 Western Ave., Cincinnati, Ohio 45203-1130, USA.

STORERIA OCCIPITOMACULATA (Red-bellied Snake). USA: ARKANSAS: Cross Co.: near Village Creek State Park, 6.0 mi. S US 64 (35.1620167°N, 90.7205833°W; WGS84; elev. 97 m). 10 Jun 2009. Thomas J. Belford. Verified by William E. Duellman. University of Kansas Natural History Museum (KUDA 6907–08). First county record, extending range 35 km from nearest known record in St. Francis County, Arkansas (Trauth et al. 2004, The Amphibians and Reptiles of Arkansas. Univ. of Arkansas Press, Fayetteville. 421 pp.).

Submitted by, **THOMAS J. BELFORD**, 701 W Academy Avenue, Searcy, Arkansas 72143, USA; e-mail: thomasbelfordini raq@yahoo.com.

TANTILLA YAQUIA (Yaqui Black-headed Snake). MÉXICO: SONORA: Municipality of Guaymas: SW slope of the Sierra El Aguaje, 5.75 km (airline) N of San Carlos (27.983573°N, 111.083391°W; NAD27), 60 m elev. 18 December 2008. M. Bogan and L. Findley. Verified by Charles J. Cole. UAZ 57150-PSV (photo). First municipality record, extending the range ca. 222 km (airline) NW of the vicinity of Navojoa, Sonora (McDiarmid 1977. Cat. Amer. Amphib. Rept. 198.1–2) and 242 km (airline) WSW of Maycoba, Sonora (Lemos-Espinal et al. 2004. Bull. Chicago Herpetol. Soc. 39:206–213). This important biogeographical record marks first known observation of the species from Sonoran Desertscrub (*Acacia willardiana*, *Bursera microphylla*, *Parkinsonia [=Cercidium] microphylla*, and *Stenocereus thurberi*), and represents an isolated locality that is well removed from the main distribution of *T. yaquia* in the Sierra Madre Occidental region where it occurs in oak woodland, tropical deciduous forest, and thornscrub. The snake was discovered on an open, south-facing rocky hillside located about 15 m upslope from a subtropical riparian-lined canyon consisting of *Sabal uresana* and *Ficus petiolaris*.

Submitted by **MICHAEL T. BOGAN**, Department of Zoology, Oregon State University, 3029 Cordley Hall, Corvallis, Oregon 97331, USA; **LLOYD T. FINDLEY**, Centro de Investigación en Alimentación y Desarrollo-Unidad Guaymas, Carretera al Varadero Nacionál Km. 6.6, Guaymas, Sonora, Mexico 85480; and **ERIK F. ENDERSON**, Drylands Institute, PMB 405 2509 North Campbell Avenue, Tucson, Arizona 85719, USA (e-mail: erikenderson@msn.com).

THAMNOPHIS SAURITUS (Eastern Ribbonsnake). USA: GEORGIA: Elbert Co.: Elberton, River Road, 1.0 km W SR 79 (33.99865°N, 82.65883°W, WGS84; elev. 135 m). 08 May 2009. Justin T. Oguni. Verified by Kenneth L. Krysko. Florida Museum of Natural History (photographic voucher UF 155322). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). Found AOR at 2043 h in undeveloped forest with interspersed wetlands and small streams.

Submitted by **JUSTIN T. OGUNI**, College of Veterinary Medicine, University of Georgia, Athens, Georgia 30602, USA; e-mail: goonie16@gmail.com.

THAMNOPHIS SAURITIS (Eastern Ribbonsnake). USA: OHIO: Tuscarawas Co.: Wayne Township. Dundee Wilmont Road NW (40.59683°N, 81.61469°W; WGS 84). 13 July 2009. Greg Lipps Jr., Jeffrey G. Davis, and Ralph A. Pfingsten. Verified by John W. Ferner. Cincinnati Museum Center (CMC 11706). New county record (Wynn and Moody 2006. Ohio Turtle, Lizard, and Snake Atlas. Ohio Biol. Surv. Misc. Contrib. No. 10, Columbus).

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TROPIDOPHIS MORENOI (NCN). CUBA: CIEGO DE ÁVILA: Bolivia Municipality: Loma de Cunagua (22.099658°N, 78.450001°W; WGS84). August or September 1999. O. Martínez. Photographic collection of the Centro de Investigaciones de Ecosistemas Costeros, Cayo Coco, Ciego de Ávila (CIEC 66). Morón Municipality: Alevinaje (22.118611°N, 78.599444°W; WGS84), 16 m elev. 14 December 2000. E. Socarrás. CIEC 67. Sabana-Camagüey Archipelago: Coco Key (22.498333°N, 78.461111°W; WGS84). 05 November 1996. O. Moreno. CIEC 150. All verified by L. V. Moreno. First records for Ciego de Ávila Province, and in the case of CIEC 150, for Coco Key and the Sabana-Camagüey Archipelago, extending the range 75.6 km E from Caguanes, the only other known record at the type locality in Sancti Spiritus Province (Hedges 2002. Bull. Nat. Hist. Mus. London [Zool.] 68:83–90. Three species of *Tropidophis* were previously known from Coco Key: T. *melanurus* (Estrada 1993. Poeyana 432:1–21); *T. pardalis* (Garrido 1976. Misc. Zool. 3:3–4); and *T. semicinctus* (Martinez-Reyes et al. 2005. Poeyana 493:1–11), so with the addition of *T. morenoi*, Coco Key contains the highest number of species among Cuban keys, being only surpassed by 12 species found on the mainland (Hedges, *op. cit*.).

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New Distributional Records for Amphibians and Reptiles from the State of Tamaulipas, México II

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Flores-Villela and Pérez-Mendoza (2006) presented a compilation of literature citations addressing the herpetofauna of each of the 32 states in México, therein indicating that Tamaulipas was one of the most, if not the most, data deficient states in México. Ongoing field surveys in Tamaulipas continue to produce noteworthy records and included herein is significant distributional information on 23 species, including four new state records. The information presented is expressed in the same manner as established in Farr et al. (2007), with the addition of the museum abbreviation: University of Texas, Arlington, Digital Collection (UTADC). In addition to literature sources and our own field observations, approximately 12,000 museum records (of which about 39% have been examined by us) from the state were considered when creating the following species accounts and are specified in parentheses in the text as having been examined, or not examined, by the authors. The vegetation associations used here (and generally in Farr et al. 2007) are derived from Martin (1958), which in turn are equivalent to eight of the 12 vegetation zones in México recognized by Leopold (1950). We use the term "Chihuahuan Desert scrub" to describe the primary vegetation type found in the municipality of Tula and areas at lower elevations in the municipalities of Bustamante and Miquihuana. Locality coordinates and elevations of our original field data were determined using a GPS device, but those of museum and literature records are expressed in the manner established by Farr et al. (2007) using topographic maps; both used map datum WGS84. The standard English and scientific names follow Liner and Casas-Andreu (2008). The state of Tamaulipas is divided into 43 municipalities (equivalent to U.S. counties) and the capital of each is a city or town bearing the same name. In the following text, when referring to municipalities, they are specified as such (i.e., Municipio Tula or municipality of Tula) and the capital community is referred to only by its name (e.g., Tula).

Caudata

Pseudoeurycea cephalica (Chunky False Brook Salamander). Municipio Tula/Ocampo (near border): near Lagunas Las Hondas, 24 km SE of Tula (22.8125°N, 99.558333°W), 1206.3 m elev. 24 August 2006. William Farr. Verified by Fernando Mendoza-Quijano. UANL 6461. Southernmost record for the species in Tamaulipas, extending its range 44 km SW from the closest reported locality (Martin 1958) at Agua Linda [23.066667°N, 99.233333°W], 1800 m elev. in the Sierra de Guatemala (= El Cielo International Biosphere Reserve). Two additional individuals were observed at this locality and all were found in or under dead logs in humid oak forest. Additionally, we have observed *P. cephalica* (and *P. scandens*) at an intermediate locality near Mexican Hwy 66 in humid oak forest, 15 km E of Tula (22.930833°N, 99.586111°W, 1376.4 m elev.) in the municipality of Tula. Martin (1958) reported a hiatus in the distribution of *P. cephalica* (and *P. belli*) between populations in the cloud forest of the Sierra de Guatemala, Tamaulipas, and northern Hidalgo, a distance of *ca.* 220 km (and *P. belli* populations near Xilitla, San Luis Potosí). The locality recorded here closes this gap by 20%. Wake and Lynch (1976) inferred the distribution of the genus (*P. cephalica* and/or *P. belli* by implication) to be continuous without supporting localities. Approximately 35 km to the south across the state line in San Luis Potosí, there is an unpublished record of *P. cephalica* (MVZ 138037, not examined by us), from Municipio Ciudad del Maíz: Mexican Hwy 80, 3.3 mi [5.3 km] E (by road) of Ciudad del Maíz (22.437063°N, 99.580134°W), 1371.6 m elev., and Johnson et al. (1978) also recorded *P. scandans* (= *P. scandens*) in San Luis Potosí: 27.7 km NE Ciudad del Maíz [22.466667°N, 99.516667°W, 1200–1400 m elev.] in the same area, collectively closing this gap by 36%. Further collecting is needed in the Sierra Madre Oriental of southeastern San Luis Potosí to determine the precise distribution of *P. cephalica* (and *P. belli* and *P. scandens*) in that state, and to determine if the Tamaulipas/San Luis Potosí populations are in fact isolated from the Hidalgo and southern populations.

Anura

Anaxyrus cognatus (Great Plains Toad). Municipio Tula: Near Ejido San Pablo 15 km SW of Tula (22.903056°N, 99.823056°W), 1064 m elev. 12 October 2007. William L. Farr. Verified by Fernando Mendoza-Quijano. UANL 6462–63. First state records, easternmost locality reported in México, and a range extension of ca. 60–70 km SE of the nearest site in Nuevo León (Krupa 1990). Additional specimens were observed AOR at and near this locality on this same night. The vegetation in the area is Chihuahuan Desert scrub.

Anaxyrus debilis (Green Toad). Municipio Xicoténcatl: 16 km E of Xicoténcatl on the road to Fortín Agrario (23.041667°N, 98.793056°W), 138.9 m elev. 18 September 2006. Toby Hibbitts, William Farr, and James R. Dixon. Verified by Fernando Mendoza-Quijano. UANL 6464–65. These records extend the range ca. 160 km S on the coastal plain of Tamaulipas (Savage 1954). The map in Savage (1954) included only one locality from Tamaulipas (a literature record from the central coast) and only shaded areas north of that locality; most subsequent sources (e.g., Conant and Collins 1998; IUCN 2006; Morafka 1977) follow this distribution pattern. Savage (1954) also speculated that the toad may range into extreme northern Veracruz, as did Sanders and Smith (1951) without supporting localities for the area south of 6 mi. [9.6 km, road?] SW of Jiménez [24.15333°N, 98.552778°W, 111 m elev.] in central Tamaulipas. We are unaware of any confirmed records from extreme northern Veracruz, or adjacent areas of San Luis

Potosí east of the Sierra Madre Oriental, but its occurrence there seems plausible based on habitat associations. We are aware of 48 additional museum records from 16 localities within Tamaulipas deposited subsequent to Savage (1954) (26 specimens from nine localities were examined by us), and those and personal observations from throughout the coastal plain confirm previous contentions of an extended southward distribution.

The two toads were collected from a small chorus observed in a roadside ditch after an early evening rain. The area is predominantly sugarcane fields with some elements of tropical thorn scrub and thorn forest. Martin (1958) speculated that this region of the state, which was predominantly sugarcane fields even then, may originally have included extensive grassland.

Gastrophryne elegans (Elegant Narrow-mouthed Toad). Municipio Ocampo: 4.5 km. N of Ocampo on the road to El Tigre (22.885833°N, 99.335°W), 348 m elev. 13 October 2007. William Farr. Verified by Fernando Mendoza-Quijano. UANL 6466. This is the second record from the state, first municipality record, and a 154 km range extension W from Rancho Los Colorados, 26 km NE Aldama [22.908333°N, 97.841667°W, 5 m elev.] in the municipality of Aldama (Sampablo-Brito and Dixon 1998). The species occurs in isolated and disjunct populations on the Atlantic versant of México southward to Honduras, and collectively, the records from Tamaulipas are isolated from the nearest confirmed locality ca. 280 km to the south in central Veracruz (Nelson 1972). We have observed *G. elegans*, sometimes in large choruses, in the municipalities of Aldama, Antiguo Morelos and Ocampo, all positioned on the Gulf Coastal Plain in the southern end of the state. Its occurrence should be anticipated in some of the adjacent municipalities (Altamira, El Mante, Gonzalez, Nuevo Morelos, and Tampico) in-between and south of the confirmed localities in the state. The toad reported here was found under a dead log in tropical deciduous forest.

Hypopachus variolosus (Sheep Frog). Municipio Reynosa: 30 km SW of junction of Hwy 40 and Hwy 2 in Reynosa (25.868333°N, 98.459167°W), 109 m elev. 8 October 2007. William Farr. Verified by Michael R. J. Forstner. UTADC 1943. This verified record fills a distributional gap of ca. 200 km between the south Texas population and the closest Mexican population in central Tamaulipas (AmphibiaWeb 2009; Conant and Collins 1998; Judd and Irwin 2005; Santos-Barrera et al. 2008). Nelson (1974) did not discuss or identify a distributional gap in this species' range in Tamaulipas, and in fact included a locality from this region, 28 km NNW of San Fernando (TCWC), although no museum number was given. It was probably TCWC 27722 from [Municipio San Fernando] 17.6 mi [28.3 km] NNE, 6.5 mi [10.45 km] (road miles) NNW of San Fernando [25.125°N, 98.155556°W] collected by C. A. Ketchersid and J. R. Dixon on 31 August 1968 (examined by authors). Additionally, we observed a chorus of *H. variolosus* in the municipality of Méndez, 5 km N of La Noria (25.461667°N, 98.226667°W, 60 m elev.). The lack of records from northern Tamaulipas probably reflects a collecting bias or prior extirpation of populations in this largely agricultural area, rather than a natural hiatus in the species' distribution. The frog was caught AOR after a rain in thorn scrub habitat.

Lithobates catesbeianus (American Bullfrog). Municipio El Mante: Near Tantoyuquita, 45 km SE of Ciudad Mante (22.550278°N, 98.574722°W), 25.2 m elev. 17 October 2007. William Farr. Verified by Fernando Mendoza-Quijano. UANL 6467. Municipio González: near López Rayón, 32 km S of González (22.5325°N, 98.397778°W), 46.8 m elev. 17 October 2007. William Farr. Verified by Michael R. J. Forstner. UTADC 1946. Municipio Gómez Farías: in an irrigation canal, 8 km S of Gómez Farías (22.973611°N, 99.122778°W), 102.3 m elev. 23 May 2005. William Farr, Adam Ferguson and David Rodríguez. Verified by Michael R. J. Forstner. UTADC 1945. New municipality records for each, and range extensions of 74 km NW, 56 km NW, and 145 km NW, respectively, from the vicinity of Altamira [22.358333°N, 99.12778°W, ca, 15 m elev.] (Morafka 1977). The vegetation types south of Gómez Farías are tropical deciduous and gallery forest, and the predominant vegetation type in the municipalities of González and El Mante localities is tropical thorn scrub, with some marshlands in low areas.

The distribution of *L. catesbeianus* in northeastern México and its purported range in Tamaulipas and the neighboring states of Nuevo León and Coahuila has not been carefully examined or well documented. Numerous publications and other sources, including Bury and Whelan (1984), IUCN (2006), and partial maps in Conant and Collins (1998) and Stebbins (2003) imply the distribution is widespread and continuous in Tamaulipas east of the Sierra Madre Oriental from the Río Grande to northern Veracruz. However, Morafka (1977), depicting the only map to record actual localities, showed one isolated site for the state in the vicinity of Altamira north of Tampico. Field surveys, literature, and museum records available to us confirm that Morafka (1977) is most accurate. All locality records known to us are discussed below.

Jean Louis Berlandier, *fide* Smith et al. (2003), noted *L. catesbeianus* in the vicinity of the Río Grande and Matamoros sometime between 1829 and 1851 in unpublished manuscripts now archived in the Smithsonian Institution. Kellogg (1932) appears to have published the first confirmed record of the species in Tamaulipas and stated the range as "probably" the coastal lowlands of Tamaulipas and northern Veracruz, but only documented two localities for México (mapped in Morafka 1977): Altamira, Tamaulipas (USNM 47114, verified by Steve Gotte) collected by Nelson and Goldman in 1898 and near Cadereyta, Nuevo León (USNM 3340), which included three larva and two adults (not examined by us); the adults were later recatalogued as USNM 344032–344033, collected by Couch in 1853. It appears that many subsequent authors accepted this presumed distribution without question. Only four additional museum records of *L. catesbeianus* from the state are known to us and all are from the municipality of Altamira (not examined by authors): AMNH A-165003, 1.6 mi. [2.5 km] NW Tres Marias; KU 51349–51350, 4 mi. [6.4 km] S Altamira; and OKMNH 26471, 9.0 mi. [14.5 km] N Tampico. Although expressed differently, the KU and OKMNH localities are approximately the same [22.358333°N, 97.891667°W, ca. 15 m elev.] and roughly correspond to the one Tamaulipas locality referred to in Morafka (1977) and Kellogg (1932). The AMNH locality is located 21 km NW of there [22.488889°N, 98.031944°W]. In field surveys, we have occasionally encountered *L. catesbeianus* along the Texas border only a few kilometers south of the Río Grande in the northwest "panhandle" region of Tamaulipas. We also observed a few others and photographed one individual on 23 May 2005 in irrigation canals 8 km S of Gómez Farías. Locals informed us that

those frogs had ether escaped or were released after failed attempts to farm them in the area. Martin's (1958) comprehensive surveys of the region did not record the species, so it can be assumed the introductions took place after his field surveys ended in 1953. Also, at least 12 bullfrogs were observed in roadside ditches, ponds, marshes, canals, and AOR at various localities on 17 October 2007 in the municipalities of González and El Mante.

With a distributional gap of over 375 km between records from the municipality of Altamira and observations from near the Río Grande and Matamoros from Berlandier's and our current surveys, we wonder if the Altamira population may have been introduced there as well, and whether our new records for the species in the adjacent municipalities of González and El Mante reflect dispersal northward and westward from that area. Nelson and Goldman's 1898 record (Kellogg 1932) seems early for the introduction of an alien species, however commercial frog farming dates back at least to 1914 (Randel 1914). Alternatively, the isolated and disjunct records for *L. catesbeianus* from northeastern México, including Berlandier's report from Saltillo, Coahuila (Smith et al. 2003), could represent relict populations from a formerly wider distribution; *Sistrurus catenatus* exhibits a similar distributional pattern in northeastern México.

We are unaware of any records from Nuevo León other than the Couch record (Kellogg 1932) cited above. Although we have not performed an exhaustive search of literature for that state we did query 23 institutions for records (ANSP, APSU, CAS, CM, CU, DMNH, UF, FMNH, KU, LACM, LSUS, MPM, MSUM, OKMNH, SRSU, TNHC, UANL, UAZ, UCM, UIMNH, UMMZ, USNM, UTEP), and these, as well as current queries of HerpNET, and many years of collecting and field experience by one of us (DL), yielded no additional localities for that state other than the Couch (Kellogg 1932) record cited above. Similarly, Smith et al. (2003) noted major distributional discrepancies between what is commonly indicated in current literature for Coahuila versus actual localities; the species was not included among that state's herpetofauna by Lemos Espinal and Smith (2007a).

Testudines

Trachemys venusta (Meso-American Slider). Municipio Camargo: below the overflow spillway of Presa R. Marte Gómez, 14.5 km SW of Camargo (26.225°N, 98.902778°W), 70.2 m elev. 21 May 2005. William Farr, Adam Ferguson, and David Rodríguez. Verified by Michael R. J. Forstner. UTADC 1947–50. On the road from El Azúcar to Santa Gertrudis 17 km SE of Camargo (26.1675°N, 98.764167°W), 45 m elev. 14 May 2006. William Farr. Verified by Michael R. J. Forstner. UTADC 1951–53. New municipality records, northernmost localities for the species, and range extensions in Tamaulipas of ca. 139 km and 126 km NW, respectively, from the nearest record, 4.5 mi. [7.2 km] N of Santa Teresa (Seidel et al. 1999); recorded in Auth et al. (2000) as 4 mi. [6.4 km] N of Santa Teresa [Municipio San Fernando (25.335833°N, 97.875°W), 9 m elev.]. Both localities are in thorn scrub and located in the Río Grande drainage.

The overflow spillway of Presa Marte R. Gómez, (on the Río San Juan), where the first specimen was found, flows directly into the Río Grande 14.5 km to the north, although most water is diverted into the Guillermo Rode irrigation canal before reaching the river. The second specimen was found 13.5 km S of the Río Grande, crossing a dirt road in arid thorn scrub where the nearest permanent surface water was the Guillermo Rode canal, located 3 km to the east. Based on these observations, *T. venusta* may also occur in Starr County, Texas.

The species may have been introduced to the border area through recreational and fishing activities at Presa Marte R. Gómez. Alternatively, the turtles may be moving northward through the extensive network of irrigation canals constructed in northern Tamaulipas over the past few decades. Another possibility is that the species emigrated overland from the vicinity of China, Nuevo León, were the headwaters of the Río San Lorenzo, a tributary of the Río San Fernando (Río Conchos on some maps) are separated from Presa El Cuchillo and Río San Juan (a Río Grande tributary) by a distance of ca. 10 km. Overland movements are well documented in *Trachemys* (Cagle 1944; Gibbons 1970, 1990). Gibbons et al. (1990) recorded mark and recapture distances as far as 9 km attributed to overland travel by turtles. Therefore, it is unclear if both adult individuals reported here represent members of an established population, a question for future research.

Distribution maps published in Ernst (1990), Legler (1990), and Seidel (2002) illustrate a gap between the ranges of *T. venusta* and *T. scripta* in northern Tamaulipas. Legler (1990) also states that little suitable habitat exists in the 110 km distance between the Río San Fernando and Río Grande near Brownsville, Texas, implying a natural barrier partitioning the two species. Indeed, Goldman (1951) reported traveling by wagon from Matamoros to San Fernando, 22–25 February 1902, without crossing a stream and Sutton (1972) noted the absence of water in this agricultural area during a trip, 6–8 January 1949. It should be noted however, that both Goldman and Sutton passed through the area during the December to May dry season (Martin 1958). Iverson (1992) and Auth et al. (2000) subsequently recorded *Trachemys* localities in this region and Seidel et al. (1999) mapped and discussed in detail several *T. scripta* and *T. venusta* sites, therein identifying a hiatus of no more than 10 km between the ranges of the two species. Seidel et al. (1999) concluded that because many bodies of water in this arid region are temporary, the two species may not contact each other. Although no concerted effort has been made on our part to identify the exact distributional limits of *T. scripta* and *T. venusta*, our field observations are generally consistent with Seidel et al. (1999), who determined that *T. scripta* occurs up to 85 km S of the Río Grande and that *T. scripta* and *T. venusta* do not hybridize. We have reservations about accepting a hiatus between the two species in northern Tamaulipas. Our field surveys include multiple observations of *Trachemys* in this region, including *T. scripta* occurring 75 km and *T. venusta* occurring 90 km S of the Río Grande and that they do not normally inhabit the same locality (but see below). Although the environment between the Río San Fernando and the Río Grande is primarily arid, numerous smaller ríos, arroyos, and resacas, some with names (north to south: Río El Tigre, Río El Diablo, Río Las Blancas, and Arroyo El Abra), and others without names, as well as marshland, manmade cattle tanks, and numerous irrigation canals provide substantial habitat for *Trachemys* within that previously perceived distributional gap. It is also possible that excess irrigation water is now channeled into those natural waterways increasing their normal volume and seasonal duration of water that would historically have been in these drainage systems. Field surveys revealed *Trachemys* and *Apalone*

spinifera living in many bodies of water, including roadside ditches, transected by Mexican Hwy 101 between Matamoros and San Fernando, and finding turtles crossing roads throughout the arid coastal plain was not unusual. Several *T. scripta* were observed in a cattle tank near a remote unpaved road in the municipality of Reynosa, 33 km SW junction of Hwy 40 and Hwy 2 in Reynosa (25.833611°N, 98.461667°W, 122.4 m elev.) near the Nuevo León border. Additionally, *T. scripta* are also known to enter brackish water and occupy barrier islands in Georgia and South Carolina (Ernst et al. 1994; Gibbons and Coker 1978). Dozens of lagunas of various sizes and degrees of salinity on the Gulf Coast could provide additional routes of dispersal in northern Tamaulipas.

Seidel et al. (1999) suggested that differences in courtship behavior limit interbreeding between *T. scripta* and *T. gaigeae* in the Río Grande. Legler (1990) also discusses sexual dimorphism (foreclaw length, snout profile) and how mating differences separated *Trachemys* in Texas from Mexican species. So perhaps factors associated with reproductive isolation separate *T. scripta* and *T. venusta* in Tamaulipas? Based on the color patterns of the carapace, we have never observed *Trachemys* that appeared to be hybrids. Seidel et al. (1999) addressed hybrids referred to by Legler (1990) from "La Laca (lat. 25-6, long. 98-7)" [= La Loca, properly named Aguila Azteca, 25.115278°N, 98.147222°W, 50 m elev., a locality in the Arroyo El Abra / Estero La Resaca drainage] and concluded that they were *T. venusta*. We have also never observed the two species occupying the same body of water, with the exception of the overflow spillway at Presa Marte R. Gomez, where *T. scripta* were observed on later occasions than the individual *T. venusta* from that locality reported above, and it may well have been introduced. Pritchard (1979) recorded *T. s. elegans* as far south as Ciudad Victoria, Tamaulipas, but Seidel et al. (1999) regarded those as likely introductions. We concur with Seidel et al. (1999) on that point and add that we have observed other probable introduced *T. scripta* in southeastern Tamaulipas at Cenote La Poza Verde (22.993056°N, 98.15556°W, 180 m elev.), a recreational area near El Nacimiento, 8 km NW of Aldama.

Lacertilia

Hemidactylus frenatus (Common House Gecko). Municipio Aldama: Hotel Rancho Viejo in Aldama (22.921667°N, 98.073333°W), 130 m elev. 1 June 2002. William Farr and Jerry Caraviotis. Verified by Michael R. J. Forstner. UTADC 1937. Municipio Antiguo Morelos, Antiguo Morelos (22.553889°N, 99.078056°W), 208 m elev. 29 March 1997. David Lazcano. Verified by Fernando Mendoza-Quijano. UANL 4479-80. Municipio El Mante: 25 km SE of Ciudad Mante (22.5225°N, 98.861111°W), 113 m elev. 15 October 2007. William Farr. Verified by Michael R. J. Forstner. UTADC 1941-42. Municipio Gonzalez: on the walls of the Bonito Inn in Gonzalez (22.821389°N, 98.434167°W), 79.8 m elev. 28 October 2004. William Farr. Verified by Michael R. J. Forstner. UTADC 1938. Municipio Ocampo: on the walls of Hotel Vergel in Ocampo (22.845833°N, 99.330556°W), 350 m elev. 23 September 2006. William Farr, James R. Dixon, and Toby J. Hibbitts. Verified by Michael R. J. Forstner. UTADC 1940. Municipio Ocampo: Poza Madre, 4 km S of Chamal Viejo, 11 km SE of Ocampo (22.78944°N, 99.234722°W), 228.9 m elev. 22 July 2006. Eli Garcia Padilla and William Farr. Verified by Fernando Mendoza-Quijano. UANL 6468. First state records and northernmost localities for the Atlantic slopes of México, and range extensions of 140 km, 54 km, 62 km, 109 km, 97 km, and 89 km N, respectively, from the nearest record in Ciudad Valles, San Luis Potosí [21.991944°N, 99.010556°W, 90 m elev.] (Marcellini 1971). During the period since Smith and Taylor (1950) recorded this lizard from the vicinity of Acapulco, Guerrero, it has become widespread in México (Ballardo et al. 1996).

We were unfortunately at fault during our surveys by considering *H. frenatus* to be of secondary interest because of its nonnative status and failed to collect adequate voucher specimens or keep complete records of its occurrence in other areas of the state. However, our limited information does indicate that viable populations were established in the municipalities of Gómez Farías, Jiménez, Llera, Tampico, Soto La Marina, and Jaumave, and we are certain it occurs in additional municipalities from Jiménez south. With the exception of an observation in a hotel in Jaumave (23.410278°N, 99.386389°W, 751 m elev.), located in the Jaumave Valley within the Sierra Madre Oriental, all other records were from the coastal plain at elevations below 350 m. The hotel in Jaumave is also one of the very few places where we observed *H. frenatus* occurring in sympatry with *H. turcicus*. Eighty-eight museum records of *H. turcicus* from Tamaulipas (19 examined by us) indicate that they were widespread in the state by the 1970s. However, we have rarely observed *H. turcicus* south of San Fernando in the last 15 years, suggesting that *H. frenatus* has displaced *H. turcicus* in the southern half of the state.

Hemidactylus frenatus are frequently associated with human structures and habitation and the vast majority of our observations have been on hotel and restaurant walls. Because it is an invasive species with the potential of having a detrimental effect on the native fauna, a few exceptions are worth noting. At Laguna del Carpintero, a park in the city of Tampico (22.238889°N, 97.8575°W, 1 m elev.) we observed two individuals while pealing bark from a dead tree in a densely wooded area ca. 500 m from any manmade structures. The El Mante specimen reported above, a juvenile, was found with a juvenile *Sceloporus variabilis*, under a cinder block in a dry concrete water trough and additional individuals were heard vocalizing in a water well about 2 m from the trough. The well and trough were located in thorn scrub that had been partially cleared for cattle grazing and completely devoid of any buildings. At the Poza Madre locality recorded above, situated at the end of a dead end road in what was otherwise undisturbed tropical deciduous and gallery forest, we found at least four deserted palapas supporting thatched roofs. The immediate area, perhaps 0.1 ha in size, had been cleared and intended for recreation, but appeared to be in a general state of abandonment. Numerous *H. frenatus* could be seen and heard vocalizing from the thatch roofs, and additional individuals, including the voucher specimen recorded here, were found inside dead logs in the immediate area. Deeper in the forest *H. frenatus* ceased to be observed, but various numbers of *Sceloporus variabilis*, *Lepidophyma sylvaticum*, *Ameiva undulata*, and *Ctenosaura acanthura* were detected there. Although *H. frenatus* is most commonly associated with human structures, it is able to utilize tropical deciduous forest and thorn scrub habitats, at least in disturbed areas.

Coleonyx brevis (Texas Banded Gecko). Municipio Reynosa: 37 km SW of junction of Hwy 40 and Hwy 2 in Reynosa (25.796389°N, 98.466667°W), 147 m elev. 13 August 2007. William Farr. Verified

by Fernando Mendoza-Quijano. UANL 6469. The southeastern-most locality within the species' geographic range (Dixon 1970), first municipality record, and a range extension of ca. 60 km S from the nearest locations in the vicinity of Mission/La Joya [26.2525°N, 98.494444°W, 38.5 m elev.], Hidalgo County, Texas (Axtell 1986). Although this species can be assumed to occur throughout the northwestern "panhandle" region of Tamaulipas due to the numerous records in adjacent areas of Texas and Nuevo León (Axtell 1986; Dixon 1970, 2000), this is only the second confirmed record from Tamaulipas. It was found under a tire in thorn scrub.

Crotaphytus collaris (Eastern Collared Lizard). Municipio Miquihuana: on the road to La Joya de Herrera, 8.5 km SW of Miquihuana (23.5375°N, 99.825556°W), 1651.8 m elev. 19 September 2007. William Farr and Tim Burkhardt. Verified by Michael R. J. Forstner. UTADC 1935. Municipio Bustamante: highway from El Capulin to Bustamante, km marker 14 (23.331944°N, 99.713333°W), 1350 m elev. David Lazcano. 8 September 1996. Verified by Fernando Mendoza-Quijano. UANL 4231. First municipality records that fill gaps between localities in the municipalities of Tula (Axtell and Webb 1995) and Jaumave (Farr et al. 2007), and confirms the occurrence of *C. collaris* in four of the five municipalities in Tamaulipas lying west of the Sierra Madre Oriental. Its occurrence should also be anticipated with near certainty at lower elevations in the arid canyons in the municipality of Palmillas, as these would be obvious dispersal routes east into the Jaumave Valley. The vegetation at both localities is Chihuahuan Desert scrub. Also of note, the color and pattern of *C. collaris* from Tamaulipas (22 observed in field surveys) are distinctly different from the more familiar Texas populations and agree with the description of *C. c. melanomaculatus* in Axtell and Webb (1995), although McGuire (1996) subsequently synonymized all subspecies of *C. collaris*.

Crotaphytus reticulatus (Reticulate Collared Lizard). Municipio Reynosa: 22 km SW of the junction of Hwy 40 and Hwy 2 in Reynosa. (25.933056°N, 98.428056°W), 103.5 m elev. 9 September 2007. Tim Burkhardt and William Farr. Verified by Michael R. J. Forstner. UTADC 1936. A range extension of 16 km E of the nearest record in McGuire (1996) and Montanucci (1976), expanding the distribution southeastward outside the panhandle region into northern Tamaulipas. The lizard was found perched on a large rock by a gravel road in thorn scrub.

Phrynosoma orbiculare (Mountain Horned Lizard). Municipio Bustamante: on the road to Las Antonias, 9.5 km W of Bustamante (23.405°N, 99.839772°W), 2004 m elev. 12 October 2007. William Farr. Verified by Fernando Mendoza-Quijano. UANL 6470. First municipality record and a range extension of 22 km SW of the only other confirmed record from the state (Horowitz 1955) at Miquihuana [23.575°N, 99.75°W, 1860 m elev.], 80 mi. [128.7 km] SW of Ciudad Victoria. The specimen was found DOR in high elevation Chihuahuan Desert scrub.

Aspidoscelis inornata (Little Striped Whiptail). Municipio Tula: 27 km SW of Cd. Tula (22.832222°N, 99.913056°W), 1067.1 m elev. 26 September 2006. Toby Hibbitts, James R. Dixon, and William Farr. Verified by Fernando Mendoza-Quijano. UANL 6471. First confirmed record for the state and a range extension of 30 km NE from the closest known locality in San Luis Potosí (Chaney and Liner 1995). Although maps in Wright (1994) and Axtell (1994) depict the distribution of the species in Tamaulipas, neither provided specific localities or data verifying that conclusion. Most publications, both prior and subsequent to 1994, do not record the species in the state (e.g., Axtell 1961; Conant and Collins 1998; Degenhardt et al. 1996; Lemos Espinal and Smith 2007a, 2007b; Smith and Smith 1976; Smith and Taylor 1966; Stebbins 2003; Walker et al. 1996; Wright 1968; Wright and Lowe 1993). We have only observed *C. inornata* in the municipality of Tula, in extreme southwestern Tamaulipas, in Chihuahuan Desert scrub; however, it is locally very abundant in that area.

Gerrhonotus infernalis (Texas Alligator Lizard). Municipio Soto La Marina: 14 km SW of Soto La Marina on the "old" highway 70, in the northeastern foothills of the Sierra de Tamaulipas (23.655278°N, 98.339444°W), 228.9 m elev. 9 October 2005. William L. Farr. Verified by Fernando Mendoza Quijano. UANL 6437. A range extension of 110 km E from the closest locality in the vicinity of Gómez Farías, 1 km WNW of Pano Ayuctle, ca. 150 m elev. [23.123611°N, 99.165278°W] (Martin 1958). The easternmost locality in Tamaulipas and the first record from the isolated Sierra de Tamaulipas (Good 1988, 1994). This specimen was found DOR in localized tropical deciduous forest that occurs at lower elevations of the Sierra de Tamaulipas between the thorn scrub of the coastal plain and pine-oak forest of higher elevations.

Serpentes

Coniophanes fissidens (Yellow-bellied Snake). Municipio Tula/Ocampo (near border): on the trail from Emperadores Aztecas to Lagunas Las Hondas, 31 km SE of Tula. (22.790833°N, 99.54°W), 1228.2 m elev. 19 July 2006. Eli García Padilla and William Farr. Verified by Jonathan Campbell. UTADC 1930–34. Northernmost record for the species in México, first state record, and a range extension of 28 km NW from the closest known locality at El Salto, San Luis Potosí [22.586111°N, 99.383333°W, 450 m elev.] (Taylor 1953). This snake was found inside a large decaying log in humid oak forest. In the course of researching this account, it became apparent that, as Myers (1969) indicated 40 years ago, *C. fissidens* is in need of an updated review, as Bailey (1939) and Fisher (1968; unpubl. thesis) were the last complete evaluations of this species (Lee 1996; Savage 2002; Wilson and Meyer 1985). The most widespread species in the genus, *C. fissidens*, reportedly ranges from Ecuador (Cadle 1989) northward into México. However, there has been confusion regarding the actual distributional range on the Atlantic versant of México, with various authors (e.g., Campbell 1998; Köhler 2008; Köhler et al. 2006; Lee 2000; Peters and Orejas-Miranda 1970) describing the northern limit as southern Veracruz, central Veracruz, or San Luis Potosí.

Lampropeltis mexicana (San Luis Potosí Kingsnake). Municipio Jaumave: On the road to Avila y Urbina, 31 km NW of Jaumave (23.601944°N, 99.6025°W), 1703 m elev. 15 October 2006. William Farr and Andrew Godambe. Verified by Fernando Mendoza-Quijano. UANL 6472. The second state and first municipality record and a range extension of 16 km E from the only published locality for species in Tamaulipas at Miquihuana [23.574722°N, 99.752222°W, 1833 m elev.], the type locality of *L. thayeri* (Garstka 1982; Gehlbach 1967; Loveridge 1924). The snake was found under a rock in dry pine-oak forest. Bryson et al. (2007)

recently presented evidence that *L. mexicana* is polyphyletic, with the implication that populations in the Sierra Madre Oriental of Tamaulipas are not conspecific with *L. mexicana*.

Pantherophis bairdi (Baird's Rat Snake). Municipio Hidalgo: road to Conrado Castillo (24.018333°N, 99.484167°W) [1200 m elev., 44 km NW of Ciudad Victoria]. 18 October 2001. Pablo A. Lavín Murcio. Verified by Fernando Mendoza-Quijano. UTADC 1956. Municipio Victoria: 10 mi. [16.09 km] SW of Ciudad Victoria on Rt. 101 [ca. 23.6°N, 99.2°W, 1200 m elev.]. 22 September 1969. T. W. Walker. Verified by Juan E. de Jesus. AMNH R 104464. New municipality records for each, first confirmed records from the Sierra Madre Oriental of Tamaulipas, and range extensions of 87 km SW, and 115 km SW, respectively, from the only confirmed records from Tamaulipas in the Sierra San Carlos (Schulz 1996). Although Lemos Espinal and Smith (2007a) included the Sierra Madre Oriental of Tamaulipas to be within the species range, no locality data were provided. In addition to the records above, Alan Kardon (pers. comm.) showed us photographs of *P. bairdi* he observed in the vicinity of Las Joyas de Miquihuana [ca. 11 km N of La Peña, 23.65°N, 99.7°W, 2900 m elev.] in the municipality of Miquihuana, confirming its occurrence there. The vegetation at the Hidalgo and Miquihuana municipality localities is dry pine-oak and juniper forest, and oak forest at the site in the municipality of Victoria. The localities recorded here, combined with three records from the Sierra San Carlos (specimens examined by Lawson and Lieb 1990, and mapped in Schulz 1996) collectively represent every record of *P. bairdi* from Tamaulipas known to us. We suspect that these localities represent the southern limit of the species distribution, but the occurrence of this uncommon and secretive snake cannot be ruled out from high elevation areas supporting pine, oak, and juniper habitats farther south in the municipalities of Bustamante, Palmillas, and Tula.

Rhadinaea gaigeae (Gaige's Pine Forest Snake). Municipio Casas: 8 km N of Rancho La Sauceda in the Sierra de Tamaulipas [50 km N of Manuel] (23.197222°N, 99.340833°W), [1140 m elev.]. 21 January 2005. Gilberto Herrera. Verified by Fernando Mendoza-Quijano. UTADC 1957. First record from the isolated Sierra de Tamaulipas, easternmost record in the state (Myers 1974), and range extension of 88 km E from the nearest localities in the Sierra de Guatemala (Martin 1958). The vegetation in the area is predominately pine-oak forest.

Tantilla atriceps (Mexican Black-headed Snake). Municipio Tula: Las Cruces (= Colonia Agrícola), 25 km S of Tula (22.765556°N, 99.679722°W), 1021.8 m elev. 17 July 2006. William Farr and Eli García Padilla. Verified by Fernando Mendoza-Quijano. UANL 6473. The first confirmed record from southwestern Tamaulipas (an isolated population is recorded from the Sierra de San Carlos in the north-central region of the state) and a range extension of ca. 60 km W from the closest known locality in San Luis Potosí (Cole and Hardy 1981, 1983). The snake was found under a stone near abandoned buildings surrounded by Chihuahuan Desert scrub vegetation.

Tantilla wilcoxi (Chihuahuan Black-headed Snake). Municipio Bustamante: Near La Joya de Herrera, 7 km W of the town of Bustamante (23.420278°N, 99.820278°W), 1916.4 m elev. 19 September 2007. Tim Burkhardt and William Farr. Verified by Fernando Mendoza-Quijano. UANL 6474. First record for Tamaulipas and a range extension of ca. 125 km SE of the nearest locality in Nuevo León (Liner 1983). The snake was found under a rock in a pasture surrounded by Chihuahuan Desert scrub that contained scattered juniper trees.

Trimorphodon tau (Mexican Lyresnake). Municipio Palmillas: on the road to Miquihuana, 10.5 km N of Cd. Palmillas (23,3925°N, 99.605833°W), 1520.7 m elev. 12 October 2007. William Farr. Verified by Fernando Mendoza-Quijano. UANL 6476. First municipality record and range extension of 40 km NW from the nearest locality at La Joya de Salas [23.172222°N, 99.3°W] in the Sierra de Guatemala (Martin 1958). It is also the first published record from the plateau and interior canyons and valleys of the Sierra Madre Oriental of Tamaulipas, although museum records (not examined by authors) collected subsequent to McDiarmid and Scott (1970) are from interior localities. Other publications following McDiarmid and Scott (1970) have reported northward range extensions for the species in Tamaulipas and Nuevo León (e.g., Blody et al. 1987; Contreras-Lozano et al. 2007; Dundee and Liner 1997; Lazcano et al. 1992; Nevárez 1999). This snake was found DOR in Chihuahuan Desert scrub containing some scattered juniper trees.

Tropidodipsas fasciata (Banded Snail Sucker). Municipio Hidalgo: 12 km W of Villa Hidalgo, on the road to El Chorrito (24.251944°N, 99.558056°W), 450 m elev. 27 September 2006. Toby Hibbitts, William Farr, and James R. Dixon. Verified by Fernando Mendoza-Quijano. UANL 6475. Northernmost record for the species and a range extension of 72 km NW from the closest recorded locality reported by Jackson (1971) from 25.7 km NNE of Ciudad Victoria near Parque Nacional Río Corona, Hwy 101 and Río Corona (22°56'N, 98°56'W [coordinates in error, this locality is 23°56'N, 98°56'W = 23.933333°N, 98.933333°W, 140 m elev.]). The Jackson (1971) locality was later mapped in Kofron (1987). The habitat west of Villa Hidalgo, where this specimen was found DOR, is located near the base of the Sierra Madre Oriental where the mountains abruptly rise from the arid coastal plain. The canyons and surrounding landscape at the base of the eastern Sierra Madre Oriental, ranging as far north as the Iturbide/Linares Canyon in Nuevo León, support a narrow and sometimes disjunct band of relatively lush vegetation with elements of tropical deciduous and gallery forest. In addition, Parque Nacional Río Corona has been a popular destination for U.S. biologists and bird watchers, but has never been officially designated a national park by the Mexican Government.

Micrurus tener (Texas Coral Snake). Municipio Jaumave: on the road to Avila y Urbina, 13.5 km NW of Jaumave (23.435556°N, 99.510278°W), 1120.5 m elev. 17 September 2007. Tim Burkhardt and William Farr. Verified by Fernando Mendoza-Quijano. UANL 6477. Municipio Tula: 16 km SW of Tula near Ejido San Pablo (22.900556°N, 99.827778°W), 1066 m elev. 12 October 2005. William Farr and Tiffany Kosch. Verified by Michael R. J. Forstner. UTADC 1944. The first records of this species occurring in and west of the Sierra Madre Oriental in Tamaulipas, and range extensions of ca. 51.5 km SW for the Jaumave municipality record, and ca. 60 km W for the Tula municipality record (Campbell and Lamar 2004; Roze 1996). These records partially fill a gap in this species' distribution on the Mexican Plateau between populations to the north in eastern Coahuila and to the south in Guanajuato,

Querétaro, and Morelos (Campbell and Lamar 2004). Hernández-Ibarra (2005) and Hernández-Ibarra and Ramírez-Bautista (2006) also recorded *M. tener* from the municipality of Guadalcázar, San Luis Potosí adjacent to municipality of Tula, Tamaulipas, but did not provide locality details. The Jaumave municipality record was collected DOR in a canyon rising from the western slope of the Jaumave Valley where the vegetation transitions from thorn scrub to dry pine-oak and juniper forest. The Tula municipality record was found crawling at night in Chihuahuan Desert scrub.

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Noteworthy Records of Amphibians and Reptiles from Puebla, México

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Until recently, the diversity and distribution patterns of the herpetofauna within the state of Puebla, México, were not well known (Canseco-Márquez et al. 2000). However, with the discovery of new distributional records (e.g., Canseco-Márquez et al. 2003, 2004, 2005; Canseco-Márquez and Gutiérrez-Mayén 2006; García-Vázquez et al. 2006; Solano-Zavaleta et al. 2006) and descriptions of new species (Canseco-Márquez et al. 2002; Canseco-Márquez and Smith 2004; Parra-Olea et al. 2004), the number of amphibians and reptiles known to occur within the state has increased significantly. There continue to be mostly unexplored regions in Puebla, one of which was, until recently, the Sierra Negra located in the southeastern portion of the state.

During 2006 and 2007 we conducted field trips to the Sierra Negra and verified 18 new records for Puebla (9 amphibians and 9 reptiles) and confirmed 16 other noteworthy distributional accounts (5 amphibians and 11 reptiles). Collections were made by the authors, all verified by Alberto Mendoza Hernández, and all vouchers were deposited in the collection of Museo de Zoología, Facultad de Ciencias, UNAM (MZFC). All locality coordinates were taken with a Garmin GPS unit, using map datum WGS84. Distances between localities are airline measures. Common and scientific names, unless more recently revised, follow those found in Liner and Casas-Andreu (2008). Species listed are arranged in alphabetical order by their family names. Vegetation classification follows Rzedowski (1978).

New State Records

Anura

Incilius valliceps (Southern Gulf Coast Toad). Municipality of Eloxochitlán: 2 km SW of La Pedrera (18.4856ºN, 96.857ºW), 123 m elev. 26 July 2006. MZFC 20499-50. Along Rancho Nuevo-Tepeyac Road (18.487ºN, 96.866ºW), 125 m elev. 27 July 2006. MZFC 20520. Municipality of Tlacotepec de Díaz: Tlacotepec de Díaz (18.4058ºN, 96.845ºW), 255 m elev. 29 June 2007. MZFC 21958–59. These records fill gaps between localities in adjacent Oaxaca and Veracruz (Mendelson 1998). All vouchers, except MZFC 20520, were found in water pools either in solitary or as amplexing pairs. All localities contained tropical semideciduous forest.

Hyalinobatrachium fleischmanni (Fleischmann's Glass Frog). Municipality of Eloxochitlán: Tepequezquiapan (18.4862°N, 96.916°W), 1041 m elev. 27 June 2007. MZFC 20529, 21948–50. These records extend the known range about 78 km NW from localities in northern Oaxaca (Lips et al. 2004). All frogs were found calling while sitting on leaves in cloud forest.

Eleutherodactylus leprus (Leprus Chirping Frog). Municipality of Zoquitlán: along El Tepeyac-Tlacotepec de Díaz Road (18.4443°N, 96.857°W), 91 m elev. 26 July 2006. MZFC 20507. A range extension of ca. 74 km SE of Coyame, Veracruz, filling a gap between localities in central Veracruz and northern Oaxaca (Lynch 1970). The frog was found calling from a tree branch in tropical evergreen forest.

Agalychnis callidryas (Red-eyed Leaf Frog). Municipality of Tlacotepec de Díaz: along El Tepeyac-Tlacotepec de Díaz Road (18.4247ºN, 96.851ºW), 115 m elev. 26 July 2006. MZFC 20501, 20508, 20516. This locality represents a range extension of about 131 km WNW of Los Mangos, Playa Escondida, in Central Veracruz (Duellman 2001). All frogs were males found calling from branches of bushes located near a pond surrounded by tropical semideciduous forest.

Dendropsophus microcephalus (Small-headed Treefrog). Municipality of Tlacotepec de Díaz: along Tepeyac-Tlacotepec de Díaz Road (18.418ºN, 96.854ºW), 107 m elev. 27 July 2006. MZFC 20503, 20509, 20510, 20519. This locality represents a range extension of about 178 km W of 2.4 km N Juan Díaz Covarrubias, the nearest locality known in central Veracruz (Duellman 2001). The frogs were found in tropical semideciduous forest.

Ptychohyla zophodes (Gloomy Mountain Stream Frog). Municipality of Eloxochitlán: 1 km S Eloxochitlán (18.5098°N, 96.95°W), 1332 m elev. 27 July 2006. MZFC 22150. A range extension of 50 km NE of the type locality, 16.1 km W of Jalapa de Díaz, on the Gulf versant of northern Oaxaca (Campbell and Duellman 2000). The frog was found calling from a tree branch in cloud forest.

Smilisca cyanosticta (Blue-spotted Mexican Treefrog). Municipality of Eloxochitlán: Tepequezquiapan (18.4862°N, 96.916°W), 1041 m elev. 27 June 2007. MZFC 20530. The record extends the range ca. 105 km W of Dos Amates, in central Veracruz (Duellman 2001). The frog was found calling from a pond in cloud forest.

Leptodactylus melanonotus (Sabinal Frog). Municipality of Tlacotepec de Díaz: along El Tepeyac-Tlacotepec de Díaz Road (18.423ºN, 96.851ºW), 133 m elev. 29 June 2006. MZFC 22151. First verified record from Puebla, extending the known range 86 km NW from the nearest locality at Tuxtepec, Oaxaca (Juárez-López et al. 2006). The species was reported from Puebla by Smith and Taylor (1966), but they mentioned no specific locality. The specimen was found in tropical semideciduous forest.

Lithobates vaillanti (Vaillant's Frog). Municipality of Tlacotepec de Díaz: Tlacotepec de Díaz (18.4058°N, 96.845°W), 255 m elev. 29 June 2007. MZFC 21961. This record represents a range extension of about 48.5 km SW from the nearest known locality at Córdoba, Veracruz (Hillis and de Sá 1988). The frog was found in a patch of tropical semideciduous forest.

Lacertilia

Anolis cymbops (Cope's Veracruz Anole). Municipality of Eloxochitlán: Tepequezquiapan (18.4862ºN, 96.916ºW), 1041 m elev. 27 July 2006. MZFC 22173. This record extends the known range ca. 45 km S from Cuautlapan, Veracruz (Nieto-Montes de Oca 1994). The specimen was captured in cloud forest.

Anolis tropidonotus (Greater Scaly Anole). Municipality of Eloxochitlán: El Crucero (18.4887ºN, 96.887ºW), 569 m elev. 26 July 2006. MZFC 22171. Tepequezquiapan (18.4749ºN, 96.918ºW), 978 m elev. 27 June 2007. MZFC 21952. El Tepeyac (18.4877ºN, 96.854ºW), 94 m elev. 29 June 2007. MZFC 20538, 21954–55. 30 June 2007. These records extend the known range ca. 44 km SE from Cuautlapan, Veracruz (Luna-Reyes 2006). All lizards were found in a tropical semideciduous forest.

Sphenomorphus cherriei stuarti (Stuart's Brown Forest Skink). Municipality of Eloxochitlán: Tepequezquiapan (18.4862ºN, 96.916ºW), 1041 m elev. 28 June 2007. MZFC 22178. Extends the known range ca. 45 km SE from Potrero Viejo, Cuautlapan, Veracruz (Smith and Taylor 1966). The lizard was captured in a tropical semideciduous forest.

Xenosaurus grandis (Knob-scaled Lizard): Municipality of Eloxochitlán: Tepequezquiapan (18.4749ºN, 96.918ºW), 978 m elev. 27 June 2007. MZFC 22176. Extends the known range of the species ca. 47 km SE from Orizaba, Veracruz (King and Thompson 1968). The specimen was found in a tropical semideciduous forest.

Serpentes

Lampropeltis triangulum polyzona (Atlantic Central American Milksnake). Municipality of Eloxochitlán: Tepequezquiapan (18.4862ºN, 96.916ºW), 1041 m elev. 28 June 2007. MZFC 22157. Extends the range ca. 104 km S from Xico, Veracruz (Perez-Higareda and Smith 1991). The specimen was collected in tropical semideciduous forest.

Leptodeira polysticta (Small-spotted Cat-eyed Snake). Municipality of Eloxochitlán: Tepequezquiapan (18.4862ºN, 96.916ºW), 1041 m elev. 28 June 2007. MZFC 20533. This record extends the known range ca 40 km S from Amatlan de los Reyes, Veracruz (Perez-Higareda and Smith 1991). The snake was captured in a tropical semideciduous forest.

Oxyrhopus petola (Calico False Coral Snake). Municipality of Eloxochitlán: Tepequezquiapan (18.4862ºN, 96.916ºW), 1041 m elev. 28 June 2007. MZFC 21953. This record extends the known range ca. 168 km NW from Hueyapan, Veracruz (Perez-Higareda and Smith 1991). The specimen was captured in a tropical semideciduous forest.

Micrurus diastema (Variable Coralsnake). Municipality of Eloxochitlán: Tepequezquiapan (18.4862ºN, 96.916ºW), 1041 m elev. No specific date. MZFC 19735. A range extension of about 39 km N of Cuauhtémoc, Córdoba, Veracruz (Júarez-López et al. 2006). The snake was found in tropical semideciduous forest.

Typhlops tenuis (Coffee Blindsnake). Municipality of Eloxochitlán: El Tepeyac (18.4877ºN, 96.854ºW), 94 m elev. 30 June 2007. MZFC 22152. Extends the range 47 km S from Cordoba, Veracruz (Perez-Higareda and Smith 1991). The specimen was collected in tropical semideciduous forest.

Range Extensions

Anura

Craugastor loki (Rana del Volcan San Martin): Municipality of Eloxochitlán: Tepequezquiapan (18.4749ºN, 96.918ºW), 978 m elev. 27 June 2007. MZFC 20531–32. Municipality of Tlacotepec de Díaz: El Tepeyac (18.423ºN, 96.851ºW), 133 m elev. 29 June 2007. MZFC 21960. 1 km S of Tlacotepec de Díaz (18.4058ºN, 96.845ºW), 255 m elev. 29 June 2007. MZFC 21962. Together, these comprise the second, third, and fourth records for Puebla and represent a ca. 53 km NW range extension from the closest known locality at San Jose Tenango, Oaxaca (Lynch 2000). The closest known Puebla record is from Cuetzalan del Progreso, about 180 km NW of our localities (Canseco-Márquez and Gutiérrez-Mayén 2006; as *C. rhodopis*). The frogs were found in leaf litter in tropical semideciduous forest.

Craugastor pygmaeus (Pigmy Robber Frog). Municipality of Coyomeapan: road to Coyomeapan near Tilancingo stream (18.393ºN, 97.068ºW), 2530 m elev. 8 July 2008. MZFC 22280. Southernmost record for Puebla, and about a 172 km NNW range extension in the state from Ocotlán de Betancourt, Municipality of Tlatlauquitepec, Sierra Norte de Puebla, and bridges the distri-

butional gaps between reported localities in Oaxaca and Veracruz (Solano-Zavaleta 2008).

Ecnomiohyla miotympanum (Small-eared Treefrog). Municipality of Eloxochitlán: along Eloxochitlán-Tlacotepec de Díaz Road (18.4862°N, 96.916°W), 1041 m elev. 27 July 2006. MZFC 22148–49, 22154–56. Bridges a distributional gap between Xocayucan, Municipality of Tlatlauquitepec, Sierra Norte de Puebla, 168 km NNW (Solano-Zavaleta 2008) and along Puente de Fierro Road at Río Eloxochitlán in northern Oaxaca, 38 km S (Duellman 2001). The specimens were collected in cloud forest.

Scinax staufferi (Stauffer's Long-nosed Treefrog). Municipality of Tlacotepec de Díaz: along Tepeyac-Tlacotepec de Díaz Road (18.418ºN, 96.854ºW), 107 m elev. 27 July 2006. MZFC 20502, 20517–18. Southernmost record for Puebla, extending the range ca. 42 km from a site located 40 km W of Orizaba, Veracruz (Duellman 2001). The frog was found in tropical semideciduous forest.

Leptodactylus fragilis (White-lipped Frog). Municipality of Tlacotepec de Díaz: along El Tepeyac-Tlacotepec de Díaz Road (18.4247ºN, 96.851ºW), 115 m elev. 26 July 2006. MZFC 22153. Municipality of Eloxochitlán: Ejido el Tepeyac (18.4877ºN, 96.854ºW), 94 m elev. 29 June 2007. MZFC 22158. Southernmost record for Puebla and a range extension of ca. 184 km NNW of the other reported locality in the state, Municipality of Cuetzalan del Progreso, Sierra Norte de Puebla (Canseco-Márquez and Gutiérrez-Mayén 2006) and ca. 40 km SW from the closest localities in central Veracruz (Heyer et al. 2006). The frogs were found in tropical semideciduous forest.

Lacertilia

Corytophanes hernandezii (Hernandez's Helmeted Basilisk). Municipality of Eloxochitlán: El Tepeyac (18.4877ºN, 96.854ºW), 94 m elev. 30 June 2007. MZFC 20543. Southernmost record for the state and ca.193 km NNW range extension from the only other Puebla locality at Quetzapa, Tlatlauquitepec (Solano-Zavaleta 2008). The specimen was captured in a tropical semideciduous forest.

Hemidactylus frenatus (Common House Gecko). Municipality of Tlacotepec de Díaz: La Pedrera (18.4877ºN, 96.854ºW), 87 m elev. 26 July 2006. MZFC 20498. Municipality of Eloxochitlán: El Tepeyac (18.493ºN, 96.837ºW), 94 m elev. 30 June 2007. MZFC 20540, 21985. Southernmost records for the state that fill a gap between Mixteca de Puebla, Puebla (ca. 171 km WNW) (García-Vázquez et al. 2006) and Agustín Millán, Orizaba, Veracruz (ca. 47 km N) (Vázquez-Cisneros 2006). The lizards were collected on the walls of a house located in a tropical semideciduous forest.

Sceloporus variabilis (Rose-bellied Lizard). Municipality of Eloxochitlán: along Rancho Nuevo-El Tepeyac Road (18.487°N, 96.866°W), 125 m elev. 1 July 2007. MZFC 20542. El Tepeyac (18.4877ºN, 96.854°W), 94 m elev. 29 June 2007. MZFC 22159. Southernmost records for the state, extending the known distribution in Puebla 169 km SSE of Xocayucan, Tlatlauquitepec (Solano-Zavaleta 2008). The nearest known locality is Coscomatepec, Veracruz, located about 66 km NNE of our localities (Mendoza-Quijano et al. 1998).

Anolis laeviventris (White Anole). Municipality of Eloxochitlán: 1 km W of Eloxochitlan (18.5098ºN, 96.95ºW), 1041 m elev. 27 July 2006. MZFC 22175. Southernmost record for the state, extending the known range in Puebla 172 km SE of Caltepec, Tlatlauquitepec (Solano-Zavaleta 2008), and 44 km S of the nearest known locality at Orizaba, Veracruz (Mendoza-Quijano and Nieto-Montes de Oca 1995). The specimen was captured in tropical semideciduous forest.

Anolis sericeus (Silky Anole). Municipality of Tlacotepec de Díaz: Tlacotepec de Díaz (18.4058°N, 96.845°W), 255 m elev. 29 June 2007. MZFC 21957. Southernmost record for the state extending the range ca. 55 km S of the closest known locality at Cordoba, Veracruz, and also fills a gap between more northern localities in Puebla and Veracruz, and in Oaxaca (Lee 1980). The specimen was captured in a tropical semideciduous forest.

Scincella silvicola (Taylor's Ground Skink): Municipality of Eloxochitlán: 2 km E of El Tepeyac (18.487ºN, 96.866ºW), 125 m elev. 27 July 2006. MZFC 22172. Southernmost record for Puebla, extending the known range in the state 160 km SE of Tzinacapan, Cuetzalan del Progreso (García-Vázquez 2003), and ca. 44 km S of the nearest locality at San Lorenzo, Córdoba, Veracruz (Taylor 1937). The specimen was captured in a tropical semideciduous forest.

Ameiva undulata (Rainbow Ameiva): Municipality of Eloxochitlán: 2 km E of El Tepeyac (18.487ºN, 96.866ºW), 125 m elev. 1 July 2007. MZFC 20541. Previously known only from the northern part of the State (Echternacht 1971), and a range extension of ca. 43 km S from the closest known locality at Cuautlapan, Veracruz. The specimen was captured at roadside in a remnant patch of tropical semideciduous forest.

Serpentes

Geophis semidoliatus (Broken-ringed Earth Snake). Municipality of Eloxochitlán: Tepequezquiapan (18.4862°N, 96.916ºW), 1041 m elev. 28 June 2007. MZFC 22177. Southernmost record for the state. Previously only known from Puebla ca. 171 km NNW in the Sierra Norte region (Canseco-Marquez et al. 2000). Its closest known locality is ca. 24 km S at Cuautlapan, Veracruz (Pérez-Higareda and Smith 1991).

Imantodes cenchoa (Cope's Blunt-headed Tree Snake). Municipality of Eloxochitlán: Tepequezquiapan (18.4862°N, 96.916ºW), 1041 m elev. 28 June 2007. MZFC 20534. Southernmost record for the state. Previously only known from Puebla 171 km NNW in the Sierra Norte region (Solano-Zavaleta 2008). Its closest known locality is from 26 km NE at Otatitlán, Veracruz (Pérez-Higareda and Smith 1991).

Leptophis mexicanus (Mexican Parrot Snake). Municipality of Eloxochitlán: along El Crucero-Tlacotepec de Díaz Road (18.4768°N, 96.875ºW), 292 m elev. 26 July 2006. MZFC 20514. Extends the range ca. 24 km SW of the nearest localities at Motzorongo, Veracruz (Pérez-Higareda and Smith 1991), and fills a distributional gap between more northern localities in Puebla and Veracruz. The specimen was captured AOR surrounded by tropical semideciduous forest.

Ninia sebae (Common Red-backed Coffee Snake). Municipality of Eloxochitlán: Tepequezquiapan (18.4862ºN, 96.916ºW), 1041 m elev. 28 June 2007. MZFC 20535, 20560. Southernmost records

for the state, extending the range from Cuetzalan del Progreso, located ca. 180 km NW (Canseco-Márquez and Gutiérrez-Mayén 2006) and 26 km NNE of the closest known locality at Minatitlán, Veracruz (Pérez-Higareda and Smith 1991).

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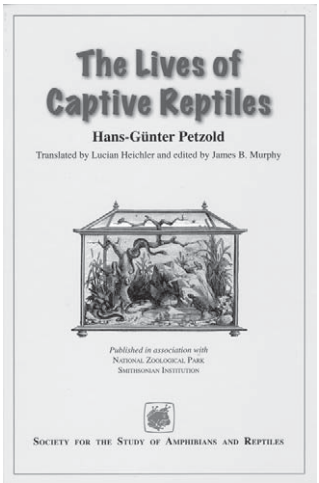
BOOK REVIEWS

Herpetological Review, 2009, 40(4), 471–472.
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The Lives of Captive Reptiles, by Hans-Günter Petzold. 2008. Society for the Study of Amphibians and Reptiles (www.SSARherps.org). Hardcover. xxix + 275 pp. US $55.00. ISBN 978-0-916984-73-1.

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> *"When I was a boy of fourteen, my father was so ignorant I could hardly stand to have the old man around. But when I got to be twenty-one, I was astonished by how much he'd learned in seven years."*
>
> *—Mark Twain*



A recurring theme at professional zoo conferences is young people announcing discoveries or revelations that are new to them, as though they are "new" to everyone. This natural hubris often ends with an embarrassing sting when the young person realizes that his older colleagues know far more than he anticipated. After reading *The Lives of Captive Reptiles*, I realize I've been guilty of hubris on a grander, historical scale. Much of the foundational knowledge in our field was assembled far earlier than I realized, and some of what I thought I knew was shattered by careful science done 50, 80, or even 100 years ago. This book is not a "page-turner" in the vernacular sense, and certainly would not appeal to the broad audience of amateur herpetoculturists. But for career zoo herpetologists and serious terrarium practitioners, it offers a one-stop retrospective of the contributions made by terrarium science. If you want to know whose shoulders you're standing on, this book is worth reading.

The work is, in large part, a historical review, and the author combed an enormous body of international literature—formal and informal, well known and obscure—to produce an encyclopedic survey. Petzold completed this volume in 1982, and died prior to its printing in book form, so the state of terrarium science he describes is more than 25 years old. But the breadth of the backward look easily makes up for the lack of near-term information. The book is a sweeping amalgamation of more than 150 years of terrarium science and observation. The literature cited section alone is a wonderful resource.

But the book is more than just a historical summary. Petzold is making an extended argument for the scientific and conservation value of terrarium herpetology. The author expends as much effort defining the gaps in our collective knowledge as celebrating the achievements. Time and again he points out open fields of research for future terrarium practitioners, suggesting specific approaches to resolving questions. In many cases his suggestions were prescient, and subsequent research has since shed light on questions he posed. Throughout the text Petzold argues that observational and experimental research is central to the responsibilities of terrarium practice, particularly in zoos. He argues for careful observation and record keeping, acquiring specimens of known locality, and collaborating with natural history museums to maximize the research impact of living collections. Unfortunately 25 years after the book's original publication, none of these suggestions has been universally adopted. Meaningful record keeping in zoos is improving, but consistency remains a problem. Acquiring specimens of known locality is still very difficult when buying from animal dealers, and many wild-born zoo animals are of uncertain origin. Although zoo-museum collaborations occur, living collections are generally underutilized and relatively few zoo animals are used as research specimens.

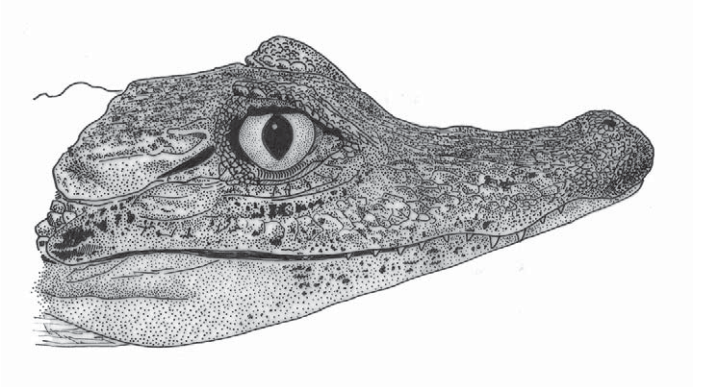
In addition to research, Petzold emphasizes the potential of zoos and terrarium enthusiasts to contribute to conservation of species through captive breeding. He argues for managing populations in captivity, rather than individuals, as a means of reducing dependence on wild imports, and repatriating captive animals to support dwindling wild populations. To accomplish this, he suggests, zoos and private sector terrarium enthusiasts need to work together to pool resources and divide tasks. While there have been undeniable successes in herpetological conservation breeding projects over the last 25 years, we are far from truly managing populations in most captive reptiles and amphibians. Efforts to organize population management in US zoos are stymied by institutional policies that restrict distribution of captive born animals to the private sector, making it impossible to remove surplus offspring from the population and quickly swamping all available institutional space. These restrictive policies also make it difficult for many zoos to include private terrarium practitioners (who have, collectively, more space and time to dedicate than zoos) in cooperative breeding programs. These constraints, as well as the logistical/legal complexities of moving animals internationally, have shifted zoo conservation efforts toward range country breeding facilities where US zoos provide financial and training support.

An underlying theme of the book is zoo advocacy. Petzold clearly aims to fend off charges that zoos are philosophically corrupt and unjustifiable, and his argument centers on achievements in terrarium science and ex-situ conservation potential. The argument is convincing on its own, but lacks any mention of the primary function of modern zoos—interpretation and public education. Zoos, by definition, work in the medium of public exhibits, setting them apart from non-public research or conservation centers. While science and ex-situ conservation clearly justify keeping wildlife in captivity, the only justification for exhibiting wildlife—the activity that makes zoos unique after all—is to convey a meaningful message to an audience. Petzold certainly does not argue against the value of interpretation, but he treats meaningful education/public impact as an assumed quality of modern zoos. Unfortunately, many US zoos have shifted emphasis away from excellence in interpretation, as they have striven to be seen as conservation entities. In many institutions educational content has been shorn from graphic panels, leaving only a species name and range map. Some

major US zoos and aquariums have even removed all mention of evolution, the backbone of biological science, from interpretive programming to avoid public controversy. Interpretation is as difficult to do well as research or conservation. It deserves at least equal emphasis in an argument for zoo advocacy and desperately needs to be re-prioritized in US institutions.

The book is an English translation of Petzold's original work in German. Text is fairly readable, but some sentence structures are awkward. The content is organized into seven chapters plus a literature cited and index to scientific names. The first chapter is laced with ideological propaganda which, according to the introduction to the English edition, was required to achieve publication under the communist regime of the former German Democratic Republic. It is worth wading through the jargon, however, as this chapter also lays out a fascinating factual history of the evolving function of zoos, from the earliest known menageries—Bronze Age sacred groves and temples—through the "modern" institutions of the late 20th Century. The second chapter reviews the historical role of reptiles (and some amphibians) in zoo collections. Chapter 3 accounts for the bulk of the book and explores the results and problems with herpetological terrarium science as related to reproduction, growth and development, and nutrition. Chapter 4 suggests opportunities for research of other miscellaneous behaviors (e.g., sleep and thermoregulation). Chapter 5 explores the value of terrarium data and addresses the research advantages and limitations of captivity. Chapter 6 addresses the potential for ex-situ conservation in terrarium and zoo programs. Chapter 7 is a concluding argument that summarizes Petzold's aims for the book. I suggest reading this first as a helpful introduction.

The Lives of Captive Reptiles is a foundational book for zoo herpetologists and serious terrarium practitioners. It provides a comprehensive history of zoo and terrarium herpetological science. It speaks to some of the foundational principles of modern zoos and serves as a primer/refresher of basic ideals to which terrarium practitioners should aspire. For me it also provided back-story in the philosophy that guided the careers of a generation of zoo herpetology curators whom I have come to know and respect.

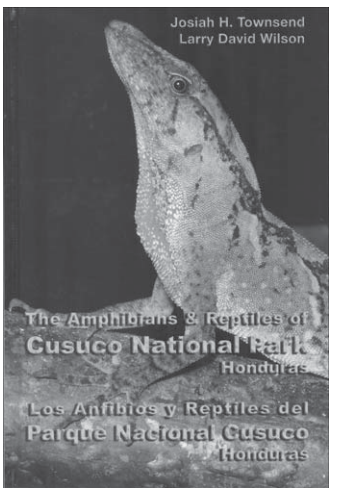


Caiman crocodilus. Colombia: Departmente de Casanare: Orocue. Illustration by Fernando Vargas Salinas based on a photograph by Luis Alberto Rueda and Fernando Vargas S.

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The Amphibians & Reptiles of Cusuco National Park, Honduras / Los Anfíbios y Reptiles del Parque Nacional Cusuco, Honduras, by Josiah H. Townsend and Larry David Wilson. 2008. Bibliomania!, Salt Lake City (www.herplit.com). xiv + 322 pp. Hardcover. US $44.95. ISBN 978-1-932871-12-8.

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Although our knowledge of Latin American herpetology has advanced considerably over the last century, there still is a lack of appropriate field guides for most regions of South and Central America. Moreover, the majority of the existing works are written exclusively in English (rendering them incomprehensible to most Latin Americans) and cover whole countries (i.e., are not the format one would wish to carry around). Up-to-date field guides dealing with the herpetofaunas of distinct, well-studied places, apart from a handful of exceptions like La Selva (Costa Rica) or Barro Colorado Island (Panama), remain unwritten. Thus, much diversity information that may well be familiar to the scientific community remains unavailable to the people coming across this diversity every day, or to those naturalist travelers wishing to explore it.

One such gap in knowledge has recently been closed. In their book, Townsend and Wilson provide a comprehensive and detailed account of the 50 species of amphibians and reptiles currently known to occur within Cusuco National Park. Established in 1987, this reserve protects a vast stretch of isolated cloud forest in extreme northwestern Honduras. Owing to the Spanish translation by Pauline M. Kulstad, the bilingual book is able to serve as a source of information for both Hondurans and their visitors, as is the explicit intention of the authors. The price of US $45 should make it affordable for anyone interested, even if they are not lucky enough to receive First World salaries.

The book's dimensions of roughly 16 × 24 cm and 850 g allow it to easily fit into a daypack. However, before taking the book into the moist forests of Cusuco, one should consider reinforcing the binding to keep the pages together in the long run.

After separate forewords in English and Spanish, the first part of the introductory chapter briefly familiarizes the reader with Honduras and the geographic and socioeconomic setting of Cusuco National Park. As to the presented maps (Figs. 1 and 2), some more detail and especially scale bars would have been highly appreciated. In the following, the natural environment of Cusuco's

surroundings and the park itself are described in detail, including useful photographs of each forest formation, essential information on physiography, climate and vegetation, and a short summary of non-herp diversity. Especially useful for those readers who are not familiar with the area is the subsequent "visitor's guide." Here crucial hints on access (unfortunately lacking any mention of public transport), accomodation, and facilities are followed by especially useful suggestions for different ways to experience Cusuco. The encouraging section on "remote" camping is a real teaser for any adventurous mind.

The chapter on Methods and Materials comprehensively elucidates the sources of all information presented. Recent nomenclatural changes related to Cusuco's herpetofauna are explicitly addressed here.

In this way—well prepared—the reader approaches the core of the book: the chapter on Cusuco's herpetofauna. After a short summary (which erroneously states the presence of 13 lizard species—it should read 12) the authors provide separate keys for salamanders, anurans, tadpoles, lizards, and snakes. Diagnostic features are either illustrated within the keys (here, in some cases, arrows pointing out the features in question could have been inserted to help the amateur) or explained in the glossary. All keys seem practicable, permitting the identification of any of the 50 covered species if the animal in question is at hand. Preceding the respective species accounts, each group is briefly characterized. The species accounts, amounting to more than half of the book, each begin with scientific name (the advisability of the artistic italics used is debatable) followed by a brief synonymy, common name, and information on type specimen and locality. The next paragraph compares the respective species with all species from Cusuco with which it might be confused. The descriptions are short and concise, focusing on general morphology and coloration. The information on overall distribution is complemented by localities inside Cusuco where the species has been found. After notes on natural history, four indicators of the species' conservation status (distributional range, status of Cusuco's populations, Environmental Vulnerability Score, and IUCN classification) are given. Additional remarks (including short a risk assessment for the five species of venomous snakes) and specific references complete every account. All but two accounts are illustrated with photographs of predominantly good quality. Due to their position, the photos can easily be assigned to the respective species, albeit lacking figure legends. However, figure legends should have been included for other reasons, such as enabling text reference to a figure, or explaining to the amateur why one *Oedipina tomasi* has a much shorter tail than the one on the facing page.

The final chapter on the conservation of Cusuco's herpetofauna highlights the importance of the park for the conservation of the Honduran biota, developing a reasonable argumentation on the basis of its diverse, isolated, and highly endemic (nine of the 50 species are known only from the park!) herpetofauna. A summary of distribution, conservation status and population trends reveals many of the recorded species to be vulnerable or endangered. In view of Cusuco's crucial role as a reserve for a unique ecosystem, the authors point out present threats, predict future trends and set conservation priorities. It can only be hoped that their call for protection will be followed.

The book continues with a gazetteer defining the locality names used throughout the text and a comprehensive glossary which will be especially useful for readers without professional background. The glossary is followed by Acknowledgements, References, an Appendix listing known voucher specimens from Cusuco and the systematic index.

An important aspect of the present work is its bilingualism, which certainly offers the advantage of addressing more, and different, people. Notwithstanding, this concept is also likely to threaten certain qualities, be it size, format, or sheer readability. Of course the book would be handier, and probably cheaper, if restricted to one language, but luckily it has not reached excessive size or weight. Furthermore, the languages are clearly separated and the corresponding parts more or less exactly face each other owing to appropriate figure layout. Apart from missing a few expressions and the unavoidable typos (which are also found in the English part), the Spanish translation is very good and highly consistent with the English text. With these challenges satisfactorily mastered, this guide can truly serve to increase the popularity of, and the passion for, the cloud forest island of Cusuco among Hondureños as well as the gringos visiting them in search of natural beauty.

In summary, Townsend and Wilson are to be congratulated on presenting a comprehensive, reasonable and useful treatment of a unique cloud forest herpetofauna that will equally inspire and serve the professional herpetologist and the ecotourist as well as local students and future decision-makers.



Craugastor laticeps (Broad-headed Rainfrog). Belize. Illustration by Peter Stafford.

Crawl, Slither, Scamper, Scuttle, or Swim



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Natural History of West Indian Reptiles and Amphibians

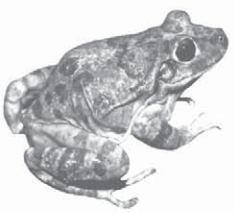
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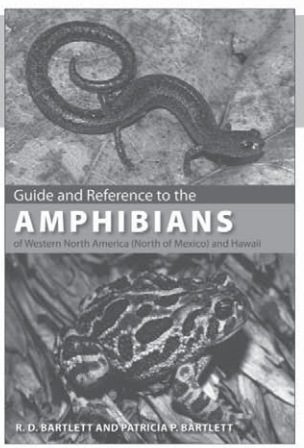
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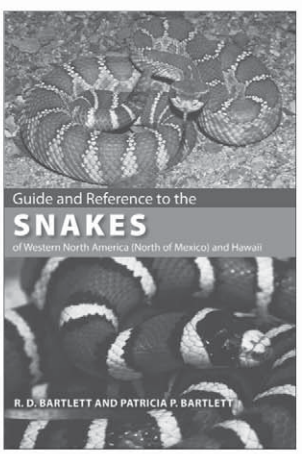
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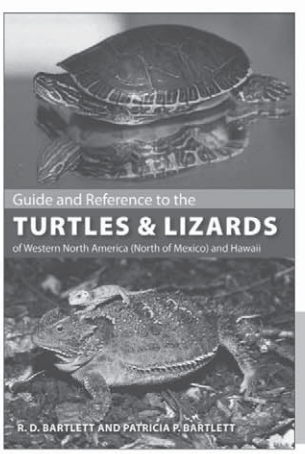
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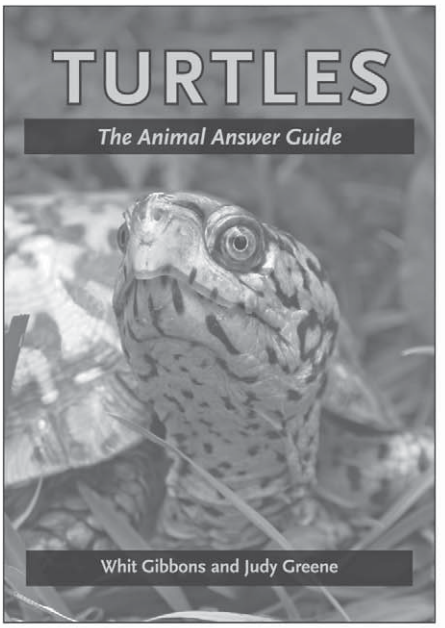
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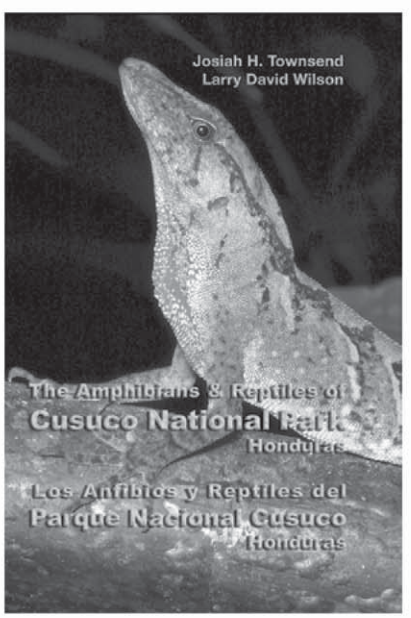
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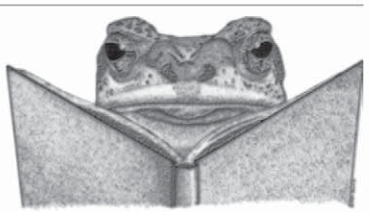
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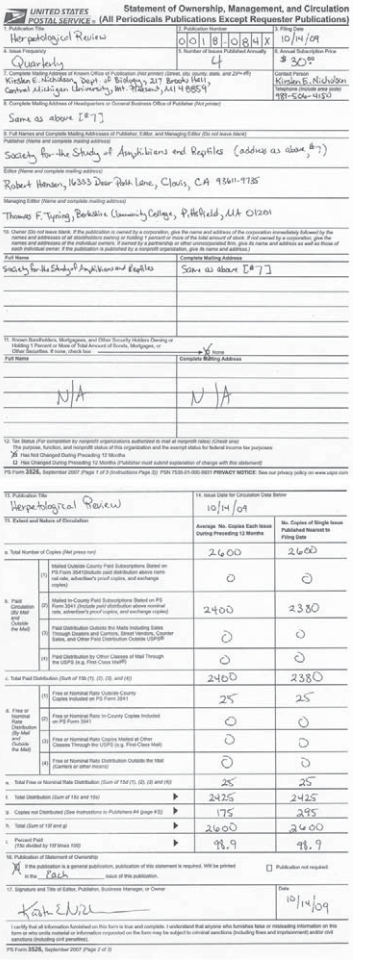
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All members of the SSAR are entitled to vote by mail ballot for Society officers, which allows overseas members to participate in determining the Society's activities; also, many international members attend the annual meetings and serve on editorial boards and committees.

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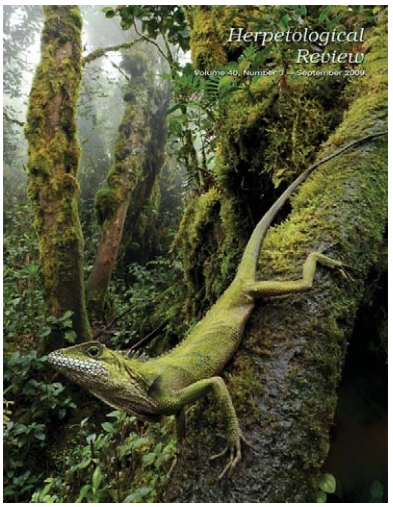
To join SSAR or to renew your membership, please visit the secure online Allen Press website via this link:

http://www.ssarherps.org/pages/membership.php

Future Annual Meetings

2010 — Providence, Rhode Island, 7–12 July (with ASIH, HL)
2011 — Minneapolis, Minnesota, dates TBA (with ASIH, HL)
2012 — Vancouver, British Columbia, dates TBA (with ASIH, HL, WCH)

About Our Cover: *Gonocephalus robinsonii*



Of the 28 species of agamid lizards in Peninsular Malaysia and its associated archipelagos, only six occur in the genus *Gonocephalus* (Grismer 2008. Zootaxa 1860:28–34; Wood et al. 2009. Zootaxa 2012:28–46). All *Gonocephalus* in Peninsular Malaysia are diurnal, arboreal species and most show significant degrees of sexual dimorphism. *Gonocephalus robinsonii* is an arboreal, diurnal, upland species restricted to hill dipterocarp forests between 700 and 1700 m in elevation. This strange-looking lizard goes well with the mysterious lichen and moss-covered forests it inhabits. During the day, individuals are most commonly seen on the sides of both large and small tress, usually less than three meters above ground. Juveniles seem to be more active than adults and will flee up the trunk of a tree at the slightest provocation, whereas adults generally tend to hold their position. At night, all age classes can be found sleeping on the branches of tree ferns as well as the vertical branches of smaller trees as high as 9 m above ground. Breeding generally coincides with the winter monsoons with hatchings appearing near the end of the season. *Gonocephalus robinsonii* occurs in at least two different isolated mountain ranges: the extensive Banjaran Titiwangsa in the west that runs nearly the entire length of the peninsula, and the much smaller Gunung Tahan in the east.

The cover photo was taken by **L. Lee Grismer**, professor of biology at La Sierra University, Riverside, California. Grismer has been working intensively in Peninsular Malaysia since 2003 and in the last six years, his team has discovered and described over 25% of this region's known lizard fauna, describing more species than had been identified during the previous century. They have also discovered several new species of frogs and snakes. Grismer's latest book, *The Lizards of Peninsular Malaysia, Singapore, and the Adjacent Archipelagos*: *Their Description, Distribution, and Natural History*, is scheduled for publication in early 2010 and will be patterned after his earlier book on the herpetofauna of Baja California.

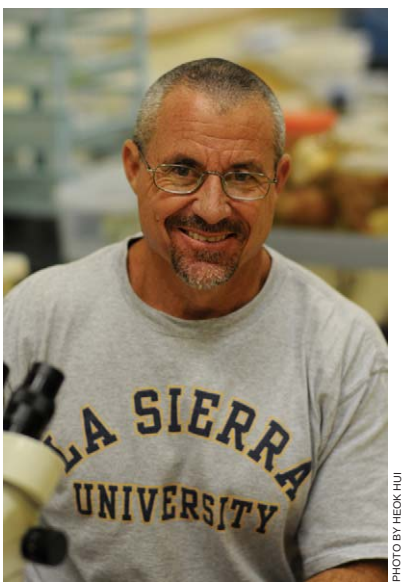


PHOTO BY HEOK HUI

The cover photo was recorded at Cameron Highlands, Pahang, with a Nikon D300 and a Sigma 14mm lens. The scene was metered to ambient light at ISO 200, and recorded using fill flash (Nikon SB20) set to -3EV at f22. According to Grismer, "What really made it work was after I began shooting, the clouds rolled in, surrounding the trees in mist, thus really adding a 'cloud forest' feel to the shot."

SSAR BUSINESS

Journal of Herpetology Receives Award: Ranked Among Top 100 Journals in Biology and Medicine in the Past 100 Years

In conjunction with the Special Libraries Association's Centennial, the BioMedical & Life Sciences Division conducted a poll to identify the 100 most influential journals of Biology & Medicine worldwide over the last 100 years. The division was led in 2008 by Chair John Tebo, University of Cincinnati, and in 2009 by Chair Jean Crampon, University of Southern California. Three panels consisting of three experts each were recruited from the DBIO membership. Each panel composed a series of voter preference questions comparing journals in categories of biology or medicine that fell within its areas of expertise.

The *Journal of Herpetology* was considered by the Natural History Panel and competed in the category of "Vertebrate Biology—Reptiles and Amphibians." It surpassed some estimable competitors to make it into the top 100 journals. The other top journals recognized include *Nature*, *Science*, *Ecology*, *Animal Behavior*, and *Proceedings of the Royal Society (Biology)*. SSAR was represented at a luncheon and awards celebration in Washington, DC on 16 June 2009 by Past-President, Roy McDiarmid, and Board Member, Kevin de Queiroz.

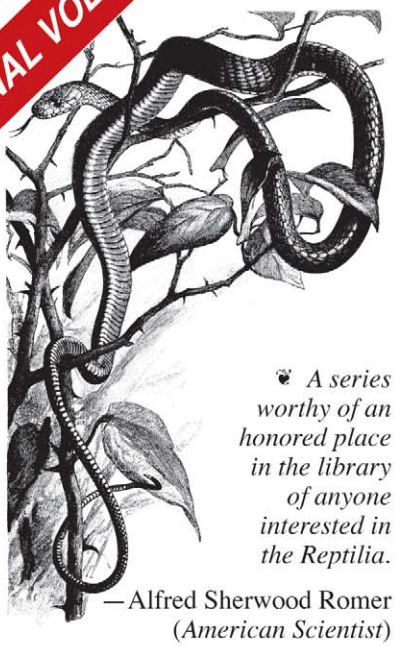
SSAR is pleased to recognize the longstanding commitment



SSAR President Brian Crother is flanked by Matt Parris (Editor, *Journal of Herpetology*, left) and Kevin de Queiroz (SSAR Board Member, right), after sharing the Top 100 Journals award during the SSAR Board Meeting in Portland.

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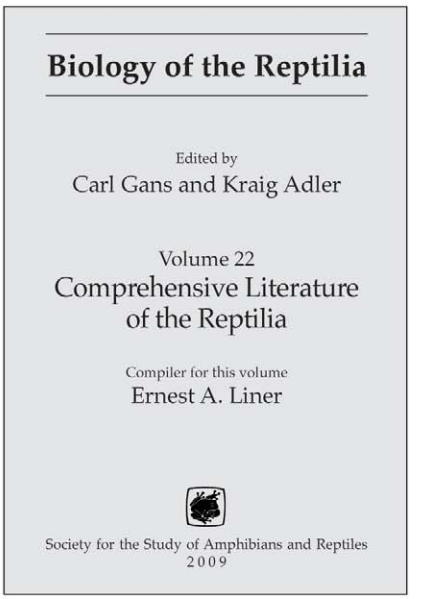
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—Garth Underwood (*British Journal of Herpetology*)

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Specifications: Volume 22, 1,400 pages (ISBN 978–0–916984–80–9). Clothbound with dust jacket. **To be published: December 2009.**

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NOTE: Copies of Volumes 19–21 (Morphology G–I) are available from SSAR. SSAR did not publish and does not sell volumes 1–18 in the series.

to excellence by the editors of the *Journal of Herpetology* from its inception: Kraig Adler (1958–1963), James A. MacMahon (1964), Corson Jay Hirschfeld (1965–1967), J. P. Kennedy (1968–1979), Rodolfo Ruibal (1980–1989), Samuel S. Sweet (1990–1992), Richard A. Seigel (1993–2000), Brian K. Sullivan (2001–2005), Geoffrey R. Smith (2006–2008), Matthew J. Parris (2009–present). The award is also a credit to the associate editors, editorial board members, and hundreds of anonymous reviewers who have served over the 52-year existence of the journal.

Consult the complete list of awardees at:

http://units.sla.org/division/dbio/publications/resources/dbio100.html

2008 Official Names List Now Available Online Free

The newest edition of *Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico*, the official names list adopted by the American Society of Ichthyologists, The Herpetologists' League, and the Society for the Study of Amphibians and Reptiles, is now available as a free download from the SSAR website:

http://ssarherps.org/pages/HerpCommNames.php

Kennedy Student Award 2009

The Kennedy Award Committee (Carl Anthony, Bill Lutterschmidt, Terry Schwaner, Lynnette Sievert, Chair) has completed its work for Volume 42 of the *Journal of Herpetology*. The Committee has selected "Preference for Local Mates in a Recently Diverged Population of the Lesser Earless Lizard (*Holbrookia maculata*) at White Sands" by Erica Bree Rosenblum (Vol. 42:572–583). The Kennedy Award carries with it a cash prize of US $200 or the winner's selection of any SSAR publications valued at twice that amount.

The committee invites all student members of the Society to submit their work to the Journal, and encourages members who supervise the work of students to draw this award to the attention of those students.

Dean E. Metter Memorial Award for 2009

There were 25 proposals submitted this year for the Dean E. Metter Memorial Award. The proposals were all of high quality; two stood out from the others. The committee requested permission from President Crother to make two awards this year and that request was granted.

The first award winner is Benjamin Jellen of Saint Louis University. He is a Ph.D. student in the Department of Biology working with Robert Aldridge. His proposal is entitled "Pre-and post-copulatory determinants of reproductive success in Missouri northern watersnakes (*Nerodia sipedon*)." The research attempts to show how these snakes communicate using pheromones and how this relates to male and female reproductive success.

The second award winner is Jeanine Refsnider. Her proposal deals with Painted Turtles (*Chrysemys picta*) and is designed to determine whether local adaptations to nest site choice are more genetically or environmentally driven ("Can maternal nest-site choice compensate for the effects of global climate change on reptiles with temperature-dependent sex determination? A common garden experiment using a model species"). She is working in Fred Janzen's laboratory in the Department of Ecology, Evolution, and Organismal Biology at Iowa State University.

NEWSNOTES

Panama Amphibian Rescue and Conservation Project

Recognizing that Panama's rich diversity of amphibians is an important natural treasure with significant direct, cultural, biomedical, ecological and existence values that warrants protection from extinction, a group of organizations came together to respond to the crisis. Africam Safari Park (Mexico), Cheyenne Mountain Zoo (Colorado), Defenders of Wildlife (Washington DC), the Smithsonian National Zoological Park (Washington DC), the Smithsonian Tropical Research Institute (Panama), Zoo New England (Massachusetts) and Houston Zoo (Texas) have pooled their energy and resources, collectively pledging more than $750,000 in cash and in kind over the next three years to the Panama Amphibian Rescue and Conservation Project.

The Project will consist of three distinct and complementary parts: 1) the ongoing operation of El Valle Amphibian Conservation Center (EVACC) in Western Panama, run by the Houston Zoo; 2) the amphibian chytrid cure research program to be initiated at the National Zoo in collaboration with Vanderbilt University; and 3) the construction and operation of the new Summit Park Amphibian Rescue Center in Panama. One "amphibian rescue pod" which is a biosecure, modified shipping container that will house the first rescued species from Eastern Panama has already been established.

Please find out more about this project at:

http://www.amphibianrescue.org/

MEETINGS

Meetings Calendar

Meeting announcement information should be sent directly to the Editor (HerpReview@gmail.com) well in advance of the event.

2–4 October 2009—Symposium on *Anolis* Biology, Harvard University, Cambridge, Massachusetts, USA. Information: http://anolis.oeb.harvard.edu.

17 October 2009—Texas Herpetological Society Fall Meeting and Lizard Symposium, Brazos Center, Bryan, Texas, USA. Information: http://www.thehibbitts.net/THS/.

17–19 October 2009—Gaffney Chelonian Fossil Symposium, Drumheller, Alberta, Canada. Information: http://www.tyrrellmuseum.com/events/turtlesymp09.php

26–28 February 2010—35th Annual Desert Tortoise Council Symposium, Ontario, California, USA. Information: http://www.deserttortoise.org/symposia.html

22–24 April 2010—57th Annual Meeting, Southwestern Association of Naturalists, Llano River Field Station, Junction, Texas, USA. Information: http://www.biosurvey.ou.edu/swan/annualm10.html

7–12 July 2010—Joint Meeting of Ichthyologists and Herpetologists (ASIH / HL / SSAR), Providence, Rhode Island, USA. Information: http://www.dce.k-state.edu/conf/jointmeeting/

21–24 July 2010—33rd Annual International Herpetological Symposium, Tucson, Arizona, USA. Information: http://www.kingsnake.com/ihs/

CURRENT RESEARCH

The purpose of Current Research is to present brief summaries and citations for selected papers from journals other than those published by the American Society of Ichthyologists and Herpetologists, The Herpetologists' League, and the Society for the Study of Amphibians and Reptiles. Limited space prohibits comprehensive coverage of the literature, but an effort will be made to cover a variety of taxa and topics. To ensure that the coverage is as broad and current as possible, authors are invited to send reprints to the Current Research section editors, Joshua Hale or Ben Lowe; postal and e-mail addresses may be found on the inside front cover.

The current contents of various herpetological journals and other publications can be found at: http://www.herplit.com/contents.

Impacts of Climate Change on Tropical Lizard Communities

As tropical lizard taxa occurring in forested habitats are adapted to narrow temperature intervals and are functionally thermoconformers, slight elevations in mean temperature due to climate change may disproportionately affect them. To gain insight into this phenomenon, the authors first accumulated body temperature, thermal maximum, minimum, and optimum, maximum latitude, habitat type (open or forested), thermoregulation method (basking or not), and phylogenetic relationship data for 66 species (determined in previous studies) and performed a meta-analysis in order to reveal correlations between the physiological traits and the ecological, behavioral, distributional, and phylogenetic information. Second, fine-scale environmental and physiological data for diurnal Puerto Rican *Sphaerodactylus* and *Anolis* (four and two species, respectively) were used to determine the effect predicted climate change will have on lizards occupying different environments. The meta-analysis reveals that some tropical taxa indeed have low thermal maxima relative to the environment in general and are restricted to cool microclimates. Furthermore, the study of the Puerto Rican taxa reveals that these thermoconformers are already operating at temperatures in excess of their thermal maxima and likely will be pushed beyond their thermal tolerance with predicted temperature increases. This study further substantiates that the effects of climate change will be multifarious and will impact every sector of the globe.

Huey, R. B., C. A. Deutsch, J. J. Tewksbury, L. J. Vitt, P. E. Hertz, H. J. Álvarez Pérez, and T. Garland Jr. 2009. Why tropical forest lizards are vulnerable to climate warming. Proceedings of the Royal Society B 276:1939–1948.

Correspondence to: Raymond Huey, Department of Biology, University of Washington, PO Box 351800, Seattle, Washington 98195, USA; e-mail: hueyrb@u.washington.edu.

Greater Species Richness in the Tropics: Extinction, Speciation, or Historical Biogeography?

Traditionally, the elevated species richness in the tropics has been explained by higher rates of speciation or lower rates of extinction relative to temperate regions. However, recent research has revealed that in some systems, rates of speciation and extinction are comparable in the two regions and that the higher species richness in the tropics is a result of the lineages of interest having occupied these regions for a longer period of time. In this study the authors aimed to determine if this was the case with ranid frogs. In addition to presenting a new phylogeny of the family Ranidae, divergence times and ancestral geographic distributions were estimated using the software BEAST and Mesquite, respectively. A simple regression revealed a highly significant correlation between regional diversity and cumulative time of lineage presence in a region. A regression of diversification rate of clade against latitudinal midpoint revealed a weak positive correlation, with higher latitudes exhibiting a slightly higher diversification rate, which further demonstrates that higher species richness in the tropics is not due to higher speciation rates or lower extinction rates in that region. This study reiterates the importance of taking historical biogeography into account when trying to explain patterns of biodiversity.

Wiens, J. J., J. Sukumaran, R. A. Pyron, and R. M. Brown. 2009. Evolutionary and biogeographic origins of high tropical diversity in Old World frogs (Ranidae). Evolution 63:1217–1231.

Correspondence to: John Wiens, Department of Ecology and Evolution, Stony Brook University, Stony Brook, New York 11794, USA; e-mail: wiensj@life.bio.sunysb.edu.

Documenting Salamander Declines in the Neotropics

Anuran declines have received much deserved attention; however, in some parts of the globe, salamander species are disappearing at an equally alarming rate. In this paper the authors compare recent and historical salamander abundance data from several sites in southern Mexico and Guatemala, many of which still contain abundant suitable habitat. Analyses revealed that many taxa have experienced precipitous declines and local extirpations, with very

few species maintaining or increasing in abundance. These findings span Mexico's Isthmus of Tehuantepec, across which there is a complete turnover in the salamander biota. Analyses further revealed that these population declines and extirpations seem to disproportionately affect upper cloud forest and high elevation species. Additionally, within these habitats, species that utilize arboreal microhabitats seem to be relatively unaffected while the terrestrial microhabitat specialists are experiencing most of the population declines and extinctions. Interestingly, the low-elevation species disproportionately utilize arboreal microhabitats. Finally, based on records from southern Mexico, the timing of the declines seems to coincide with dramatic declines in anuran species in the region, suggesting that chytridiomycosis may have played a role in the decline of these salamander species as well.

ROVITO, S. M., G. PARRA-OLEA, C. R. VÁSQUEZ-ALMAZÁN, T. J. PAPENFUSS, AND D. B. WAKE. 2009. Dramatic declines in neotropical salamander populations are an important part of the global amphibian crisis. Proceedings of the National Academy of Sciences 106:3231–3236.

Correspondence to: David Wake, Museum of Vertebrate Zoology and Department of Integrative Biology, University of California, Berkeley, California 94720-3160, USA; e-mail: wakelab@berkeley.edu.

Quantifying the Chameleon's Ability to Adjust UV Exposure in Response to Low Vitamin D_3 Diet

Vitamin D_3 is a hormone essential to most vertebrates including squamates; however, excessive vitamin D_3 is fatal. Therefore, animals should be expected to exhibit behaviors that regulate D_3 levels. Previous studies have determined the optimal level of UVB exposure (necessary for the production of D_3) for chameleons and have shown that they have the ability to behaviorally compensate for a low D_3 diet by increasing UVB exposure time. However, these studies failed to quantify the accuracy and precision of this ability. To address this question, the authors of this study placed six Panther Chameleons (*Furcifer pardalis*) in outdoor enclosures and divided them into high and low D_3 diet treatments. Daily movements were monitored via video camera. Using models soaked in provitamin D_3 (a chemical vitamin D_3 precursor that converts to vitamin D_3 when exposed to UVB), the recorded movements were replicated the following day to allow for quantification of the level of D_3 production. These experiments revealed the chameleon's ability to behaviorally compensate for different levels of vitamin D_3 to be both highly precise and accurate, with low D_3 diet treatment lizards maintaining optimal levels of D_3 via increased UVB exposure and those in the high D_3 diet treatment similarly maintaining optimal levels of D_3 by moderating UVB exposure.

KARSTEN, K. B., G. W. FERGUSON, T. C. CHEN, AND M. F. HOLICK. 2009. Panther chameleons, *Furcifer pardalis*, behaviorally regulate optimal exposure to UV depending on dietary vitamin D_3 status. Physiological and Biochemical Zoology 82:218–225.

Correspondence to: Kristopher Karsten, Department of Biology, Texas Christian University, Fort Worth, Texas 76129, USA; e-mail: k.karsten@tcu.edu.

Malagasy Anuran Diversity Greatly Underestimated

Madagascar, together with the oceanic islands of the Indian Ocean, is considered one of 34 biodiversity hotspots by the organization Conservation International and possesses a unique herpetofauna. Malagasy anurans are particularly diverse and unique, constituting five evolutionary lineages (including two endemic families) and exhibiting 100% species endemicity. One of the primary goals of conservation groups is to document the biodiversity within these hotspots before it is too late. With this goal in mind, the authors conducted surveys and analyses with the goal of assessing Malagasy anuran diversity. A combination of mitochondrial sequence, vocalization, morphological, and geographic data were accumulated for ca. 2850 specimens. Molecular analyses were performed to identify divergent lineages within currently recognized species. If these lineages were found to be morphologically or bioacoustically divergent, they were categorized as Confirmed Candidate Species (CCS); if no morphological or bioacoustic data were available, they were classified as Unconfirmed Candidate Species (UCS). These analyses revealed a veritable cornucopia of undescribed diversity. Assuming the CCS and UCS categories reflect legitimate species, this study raises the number of species occurring in Madagascar from 244 to 465 (an increase of 90.6%). These results reiterate how much of the world's diversity remains to be discovered and emphasizes the importance of quantifying the biodiversity of hotspots.

VIEITES, D. R., K. C. WOLLENBERG, F. ANDREONE, J. KÖHLER, F. GLAW, AND M. VENCES. 2009. Vast underestimation of Madagascar's biodiversity evidenced by an integrative amphibian inventory. Proceedings of the National Academy of Sciences 106:8267–8272.

Correspondence to: David Vieites, Museo Nacional de Ciencias Naturales, Consejo Superior de Investigaciones Científicas, c/ José Gutierrez Abascal 2, 28006 Madrid, Spain; e-mail: vieites@mncn.csic.es.

Box Turtle Abscesses Heal Themselves

Cranial abscesses are a frequently observed phenomenon in box turtles (*Terrapene*). While standard procedures exist for treating this disease in captive animals, the final result of such abscesses in nature has remained uncertain. The author reports on findings resulting from tracking 144 Eastern Box Turtles (*T. carolina*). Twenty cases of aural abscesses were recorded over the course of a decade. Of these, fifteen cases healed naturally and five required researcher-induced amputation (after turtle exhibited obvious weight loss). This is the first evidence in support of the hypothesis proposing that these abscesses spontaneously disappear in nature.

BELZER, W. R. 2008. Spontaneous resolution of aural abscesses in the eastern box turtle, *Terrapene carolina carolina*. Journal of Herpetological Medicine and Surgery 18:64–66.

Correspondence to: William Belzer, Box Turtle Conservation Trust, 304 East Bissell Ave., Oil City, Pennsylvania 16301, USA; e-mail: billbelzer@hotmail.com.

Piscivory Correlated with Morphological Evolution in Natricine Snakes

The various species of natricine snakes exhibit the full spectrum of percentage of diet composed of fish. However, much remains to be learned about how morphology and feeding performance are related to obligate piscivory in these snakes. The authors of this study accumulated data on quadrate bone length (as they hypothesize an increase in quadrate length would allow snakes to more easily feed on odd-shaped prey items), fish-eating performance, and fraction of fish in diet, and incorporating accepted hypotheses of evolutionary relationships, tested for convergent evolution in natricines. Experiments ascertaining feeding performance involved feeding snakes fish and timing the event. Results revealed that increased feeding performance was indeed correlated with elongation of the quadrate when the prey is fish. Furthermore, an ancestral state reconstruction suggested that all major lineages were ancestrally generalists; specialization on fish or non-fish evolved several times quickly and recently within those lineages. Finally, an independent contrasts analysis confirmed increased quadrate length is highly correlated with increased percent fish in diet and scales allometrically with increased head length. This fascinating example of convergent evolution suggests that dietary specialization can have dramatic effects on all aspects of an organism's biology.

VINCENT, S. E., M. C. BRANDLEY, A. HERREL, M. E. ALFARO. 2009. Convergence in trophic morphology and feeding performance among piscivorous natricine snakes. Journal of Evolutionary Biology 22:1203–1211.

Correspondence to: Anthony Herrel, UMR 7179 C.N.R.S/M.N.H.N., Département d'Ecologie et de Gestion de la Biodiversité, 57 rue Cuvier, Case postale 55, 75231, Paris Cedex 5, France; e-mail: anthony.herrel@mnhn.fr.

Where Does the Ring End? Testing Biogeographic Hypotheses in *Ensatina*

Ensatina salamanders have served as the textbook example of a "ring species" for decades. Historically, it has been suspected the terminus of this ring occurred in the mountains of southern California. However, geologic data suggests that a significant barrier to dispersal existed in coastal central California, as the southern Coast Range was first an island chain, then (once joined with the mainland) separated from the northern Coast Range by the outlet of the inland sea at what is now Monterey. Under this scenario, dispersal south along the Sierra Nevada, west to the coast, then north to Monterey would be the more likely dispersal scenario and Monterey should be the terminus of the ring. If the terminus is in the south, lineages on either side of Monterey would be closely related and lineages in the mountains of southern California would be deeply divergent. If the terminus is in Monterey, the opposite would be true. To evaluate these two hypotheses, a phylogeographic analysis was conducted using mitochondrial DNA sequences from samples obtained from throughout the distribution of the species. An analysis of the credible set of trees revealed a sister-species relationship of the two southern California lineages (and the Monterey terminus hypothesis) could confidently be rejected. Alternatively, greater than 99.9% of the trees were consistent with a southern California terminus and find lineages north and south of Monterey to have a sister relationship. Interestingly, a molecular clock analysis revealed that this coastal California clade originated no sooner than nine million years ago, vastly predating the unification of the Coast Range.

KUCHTA, S. R., D. S. PARKS, R. LOCKRIDGE MUELLER, AND D. B. WAKE. 2009. Closing the ring: historical biogeography of the salamander ring species *Ensatina eschscholtzii*. Journal of Biogeography 36:982–995.

Correspondence to: Shawn Kuchta, Department of Animal Ecology, Lund University, Ecology Building, Sölvegatan 37, SE-223 62 Lund, Sweden; e-mail: shawn.kuchta@zooekol.lu.se.

Venom Potency Correlated with Diet in *Echis* Vipers

Given the different physiologies of different prey items, it would follow that major dietary changes would lead to venom evolution in snakes. This hypothesis was tested in snakes of the genus *Echis*. Previous work suggests that *Echis* is made up of four species groups. Mitochondrial and nuclear sequence data were generated for representatives of each of the four lineages and a Bayesian phylogenetic analysis was performed to reveal the relationship of these lineages to each other. Additionally, data were accumulated on diet and aspects of the venom (LD_{50} and time to death) when administered to scorpions. Placing dietary preference on the resulting tree, it was discovered that the ancestral condition for the genus is an arthropod diet, with one *Echis* lineage secondarily evolving a rodent diet. Additionally, a correlation was revealed between percentage of arthropods in diet and toxicity (LD_{50}) to scorpions. Interestingly, time to death did not appear to be correlated with arthropod diet, suggesting that venom conservation alone is the target of selection.

BARLOW, A., C. E. POOK, R. A. HARRISON, AND W. WÜSTER. 2009. Coevolution of diet and prey-specific venom activity supports the role of selection in snake venom evolution. Proceedings of the Royal Society B 276:2443–2449.

Correspondence to: Axel Barlow, School of Biological Sciences, Environment Centre Wales, Bangor University, Bangor LL57 2UW, UK; e-mail: bsu004@bangor.ac.uk.

Lampropeltine Relationships Resolved

Hypotheses regarding the evolutionary relationships and the resulting taxonomy of the North American lampropeltine snakes have been in flux recently. Using mitochondrial and nuclear DNA sequence data, the authors performed a comprehensive phylogenetic analysis of this group using Old World rat snakes for outgroups. This analysis revealed a monophyletic Lampropeltini and clades largely concordant with morphology (including monophyletic *Pantherophis* and *Pituophis*), upon which the original taxonomy was based. Three taxa (*Arizona*, *Rhinocheilus*, and *Cemophora*) were revealed to be closely allied with *Lampropeltis* (king snakes); a fourth (*Stilosoma*) was recovered as highly nested within *Lampropeltis*. Furthermore, several novel relationships were revealed

within *Lampropeltis* and one species (*L. triangulum*) was found to be comprised of no fewer than two deeply divergent lineages. Finally, a molecular clock analysis found the origin of Lampropeltini to be concordant with an initial dispersal into North America via Beringia.

PYRON, R. A., AND F. T. BURBRINK. 2009. Neogene diversification and taxonomic stability in the snake tribe Lampropeltini (Serpentes: Colubridae). Molecular Phylogenetics and Evolution 52:524–529.

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Australian Cane Toads More Susceptible to Ant Attack than Native Anurans

As invasive species originated in and were adapted to different environmental conditions, they should be expected to exhibit vulnerabilities to certain dangers not shared with native animals, regardless of overall successfulness in the new environment. In this study, the authors investigated the susceptibility of Cane Toads (*Bufo* [*Rhinella*] *marinus*) to ant attack relative to native anurans. Metamorphic Cane Toads, *Litoria* (five species), and myobatrachids (two species), all of which co-occur in Australia's Northern Territory, were measured for various morphometric traits, sprint speed performance, and response to a simulated ant attack. Daily activity patterns were documented both in captivity and in the field for meat ants (*Iridomyrmex* spp.; common predatory ants in ecosystems of interest) and in captivity for the anurans. Furthermore, ants were introduced to anuran terraria and interactions were recorded. Finally, bait was placed in specific microhabitats within enclosures to look for variation in detectability; bait was also placed in the center of a piece of paper laden with species-specific anuran secretions and ants were introduced to terraria to determine how the ants responded. The Cane Toads were found to come into contact with ants more frequently than the other anurans because of their diurnal activity and preferred, exposed microhabitats. Additionally, they failed to anticipate an impending attack more frequently than native frogs and the toad's short hops and frequent reliance on crypsis increased their susceptibility to ant attack. Ants failed to elicit a species-specific response to the anuran secretions. Now that they have been identified, these vulnerabilities could perhaps be employed in cane toad eradication projects.

WARD-FEAR, G., G. P. BROWN, M. J. GREENLEES, AND R. SHINE. 2009. Maladaptive traits in invasive species: in Australia, cane toads are more vulnerable to predatory ants than are native frogs. Functional Ecololgy 23:559–568.

Correspondence to: Richard Shine, School of Biological Sciences A08, University of Sydney, NSW 2006, Australia; e-mail: rics@bio.usyd.edu.au.

ZOO VIEW

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History of Early French Herpetology. Part I: The Reptile Menagerie of the Museum of Natural History in Paris

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Today the Jardin des Plantes is interesting to visit purely on an historical perspective as it has two separate buildings devoted to reptiles. The most interesting dates from the Victorian era, while the "new" one looks as if it was constructed in the 1930s. The Victorian building still retains and uses the original ornate legged, glass-fronted, mahogany reptile cases and marble-walled crocodile pits. To see the reptile cages here is to step back in time and view the first dawning of modern herpetoculture.

—Jon Coote, 2001

The Site.—The Ménagerie, called Les Jardin des Plantes, of the Museum of Natural History in Paris (la ménagerie du Muséum d'histoire naturelle) was created in 1793 and was the first of the national menageries. Prior to the inception of the Jardin des Plantes, practically all exotic animal collections were held by kings, queens, rulers, and other powerful political figures. During the French Revolution, the Jardin des Plantes was appropriated by the revolutionaries from the Jardin du Roi in Versailles. In 1793 this Royal Menagerie was renamed Jardin des Plantes and moved from Versailles to Paris. In Lewis Pyenson and Susan Sheets-Pyenson's book, *Servants of Nature. A History of Scientific Institutions, Enterprises, and Sensibilities*, they describe it this way: "The splendors of Versailles, including its extensive gardens and menagerie, became one of the most powerful symbols of the ancien régime to the revolutionaries of the 1790s. In the context of this upheaval, a Jacobin mob set out from Paris to liberate the animals, resulting in the senseless slaughter of most of them. The surviving animals went to the Jardin des Plantes in Paris, to serve as the nucleus of a new national collection. Other animals were added that had been seized from private menageries and circuses" (p. 166). It was the first truly public collection. If one compares it to the Schönbrunn Menagerie in Vienna, Austria, the latter was a collection that had enclosures surrounded by a central viewing pavilion, designed to provide views of the animals only to those privileged enough to be inside it. The Jardin conversely has broad walkways and avenues, down which ordinary people could, and still can, stroll to admire the animals. This design reflects its unique origin—a royal menagerie appropriated by the people for the people. Truly an important change in zoo history!

The Jardin is a short walk from the Museum so it is likely that herpetologists from both places regularly interacted with each other. In fact, it is reasonable to assume that herpetologists stationed at the museum would dash over to the menagerie whenever a new shipment of interesting live amphibians and reptiles arrived. In the mid-18th and early 19th century, three famous herpetologists were associated directly or indirectly with the menag-

erie: Georges-Louis Leclerc compte de Buffon (Fig. 1), Baron Georges Cuvier (Fig. 2), and Count de Lacepède (Fig. 3). The rich history as a center for experimental zoology is detailed extensively by Gustave Loisel (1912) and other references are provided below.

The Terrarium, from 1839 under the charge of André Marie Constant Duméril, was a separate section in the old monkey house, which housed 80 reptiles of 24 species, amphibians, fishes and insects. A common practice in Europe was to encourage travelers to secure specimens for collections; in some cases, written instructions were given to the collectors.

Built in the 1870s, the Menagerie's reptile building today has a large aquatic exhibit which houses an impressive collection of crocodilians. At one end of the building, large tortoises are on display. Madagascan reptiles are well represented. Several extensive graphic displays with lifelike models of reptiles are situated throughout the building. Some of the larger enclosures are being remodeled. In the newer Vivarium building located near the reptile building, smaller amphibians and reptiles are represented in naturalistic settings.

Publications.—Between 1834–1854, Constant Duméril (Fig. 4), his son Auguste Henri André Duméril (Fig. 5), and Gabriel Bibron (Fig. 6) published the monumental multi-volume work called *Erpétologie générale, ou, Histoire naturelle complète des reptiles*. In one of the volumes—the Atlas—are 120 nice illustrations of amphibians and reptiles.



FIG. 1. Portrait of Georges-Louis Leclerc comte de Buffon (1707–1788) in M. Boitard's *Le Jardin des Plantes. Description et Moeurs des Mammifères* in 1845. Pyenson and Sheets-Pyenson said that "…Buffon added greenhouses and a natural history cabinet" to the garden (p. 154) and that "When the Jardin des Plantes reached its apogee under the old regime, private menageries still flourished in France. Especially important from a scientific standpoint was the comte de Buffon's menagerie at Montbard. There Buffon had purchased the picturesque ruins of an old castle. He reconstructed the castle, planted gardens, established laboratories, and founded a zoological park. He stocked the park with a wide range of exotic animals, which served as a basis for writing his multivolume *Historie naturelle*. At Montbard, he also undertook varied research in experimental zoology, notably in reproduction and hybridization" (p. 168). In *Zoological Illustration*, David Knight says that Buffon "…summed up the work of pre-Linnaean natural historians" (p. 96).

As Director of the Jardin du Roi in Versailles, he became the model of the scientific collector and lobbied for a formalized relationship between the museum and menagerie. He transformed the king's garden into a scientifically significant museum and research center. Buffon became the curator in 1739 and he expanded the gardens greatly. His massive *Histoire naturelle* (36 volumes) [other sources say it was published in 44 volumes between 1749 and 1788, with subscribers purchasing volumes ahead of production. Knight (1977) says that it was 44 volumes, but that the last eight were completed by Lacepède] set out to organize all that was then known about the natural world. Credit: Courtesy of Smithsonian Institution Libraries, Washington, DC.



FIG. 2. Portrait of Baron Georges Cuvier (1769–1832) in M. Boitard's *Le Jardin des Plantes. Description et Moeurs des Mammifères* in 1845. In 1802, he became titular professor at the Jardin des Plantes. His most famous work is the *Règne animal distribué d'après son organisation* (1817; translated into English as *The Animal Kingdom*). Credit: Courtesy of Smithsonian Institution Libraries, Washington, DC.

In 1854–55, Auguste Duméril wrote *Notice historique sur la Ménagerie des Reptiles du Muséum d'histoire naturelle et observations qui y ont été recueillies*, featuring six beautifully hand-colored plus two uncolored plates. This work listed the observations collected at the menagerie, summarized in the Index (Fig. 7). In the *Notice historique*, Duméril included many references to the earlier *Erpétologie générale* so some relevant ones from the *Erpétologie générale* Atlas and one from *Études sur les reptiles* are shown here (Figs. 8–11, 12–20). In three additional papers published by the Museum, Auguste Duméril recorded information about specimens in the Ménagerie. In 1858–61, he provided a list of fishes, reptiles and amphibians, and notes on the menagerie of reptiles. In 1865, reptile and amphibian holdings between 1838–1864 were compiled. New herps in the collection were recorded in the museum archival publication in 1869–70 (Fig. 21).

Arrival of the "Victorian" Building.—The London Zoo opened the World's first reptile building in 1849 (see Murphy, 2007 for details). In 1870–1874, an architect Emile Blanchard designed a reptile menagerie with a pavilion (Figs. 22–24). The facility was 30 m long, with two halls which contained smaller squamates and chelonians. Two large center exhibition halls were called "Crocodile Hall" and "Aquarium Hall;" the latter contained freshwater fishes and amphibians. One unusual feature is that the rear walls of enclosures on the outer wall are glass. As a result, these displays contained living plants which thrived in natural light. The glass-



FIG. 3. Portrait of Bernard-Germain-Etienne de la Ville-sur-Illon comte de Lacepède (1756–1825). This French naturalist, principally known for his herpetological work, published several seminal papers on zoo history, philosophy, and design. Credit: Courtesy of Kraig Adler.

fronted, mahogany cages standing on ornate legs and the marble-walled crocodile pits are still in use (Coote 2001). Bronze sculptures were placed throughout the menagerie: "The Snake Charmer" and "The Crocodile Hunter" by Arthur Bourgeois in front of the reptile pavilion and "Eve" by Guitton near the outdoor crocodile pool.



FIG. 4. Portrait of André Marie Constant Duméril (1774–1860). Credit: Courtesy of Kraig Adler.

In addition to his regular duties in the museum working with the collection, Léon-Louis Vaillant was in charge of the reptile menagerie and aquarium. In 1898, he produced *Muséum d'histoire naturelle guide à la ménagerie des Reptiles*. On the front cover of this guide are drawings of Count de Lacepède, C. Duméril, A. Duméril, and Vaillant himself (Fig. 25). There is a picture of the floorplan (Fig. 26) and another one of visitors enjoying a trip to the reptile building (Fig. 26a).

Scientific Discoveries.—Pierre Bernard mentioned that a female python laid 15 eggs, eight of which hatched in Le Jardin (Bernard 1842–1843). In 1841, Achille Valenciennes reported his observations on the incubating female python (called *Python bivittatus*) at the Menagerie to the French Academy (Valenciennes 1841; Fig. 27). The belief that brooding female pythons produce heat to incubate their eggs was a controversial issue during the nineteenth century (Duméril 1842, 1858). Duméril was convinced that the "cold-blooded nature" of reptiles could not lead to these temperature increases and the issue remained unresolved for many years (see Murphy 2007).

Likely the most famous description presented by Auguste Duméril was his discovery in the menagerie that the larval axolotls of Mexico grow, become sexually mature, reproduce, and yet retain larval features such as external gills—the neotony of *Ambystoma mexicanum* (Figs. 28, 28a). Duméril published papers on reproduction, developmental anomalies, and an amelanotic strain. This now-critically endangered salamander is found in the Xochimilco aquatic ecosystem around Mexico City; this taxon is negatively impacted by pollution threats and invasive species, effects currently under study by a number of zoo biologists (Koenig 2008; Johnson et al., Connect [October 2008:6–9]).

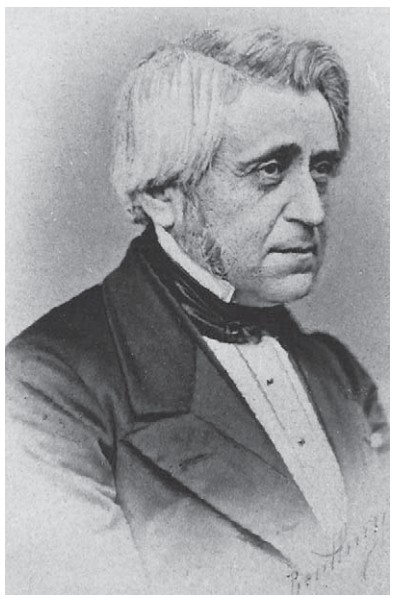
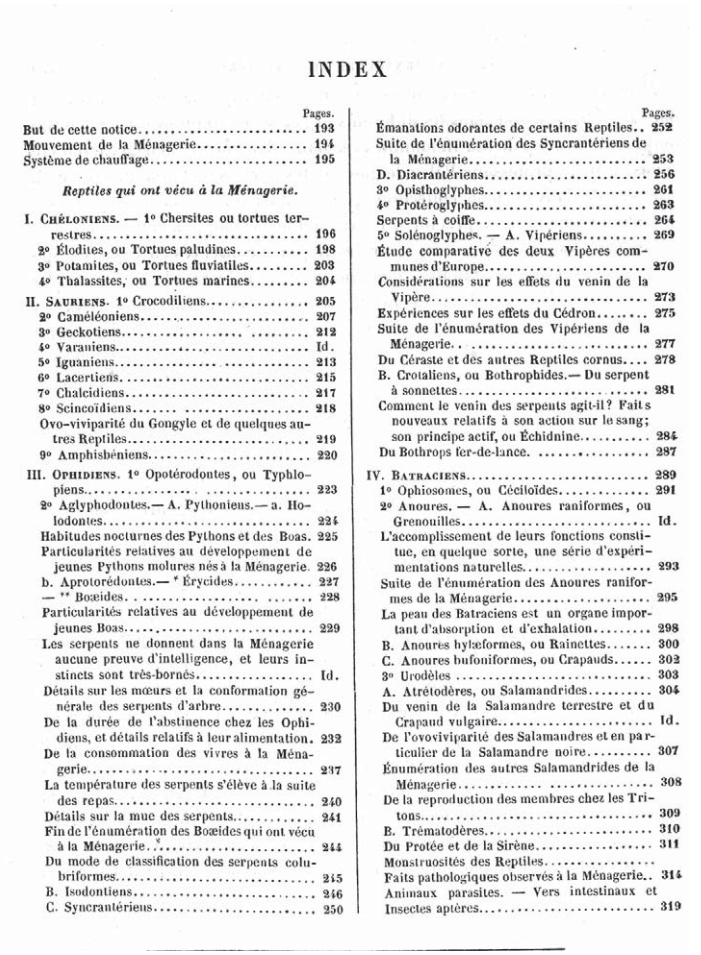


FIG. 5. Portrait of Auguste Henri André Duméril (1812–1870). Credit: Courtesy of Kraig Adler.

Collection.—Deleuze (1823) described an enclosure divided into five parts housing smaller aquatic birds, long-legged birds and gallinaceous fowls, and a large semi-aquatic exhibit for chelonians. The list of species kept was impressive: Radiated, Geometric, Angulated, and Greek Tortoises; Painted, European Pond, Snapping, and Snake-Necked Turtles; Diamondback Terrapin; a number of undescribed taxa; and, amazingly, a Hawksbill Seaturtle which likely lived in fresh water. There were also



FIG. 6. Portrait of Gabriel Bibron (1806–1848). Credit: Courtesy of Kraig Adler.



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FIG. 7. Index from *Notice historique sur la Ménagerie des reptiles du Muséum d'histoire naturelle et observations qui y ont été recueillies*. Credit: Library of Roy McDiarmid.

Timber Rattlesnakes, African Chameleons, and European Olms on exhibit.

In 1910, the collection numbered 216 reptiles and 237 amphibians. Longevities included a 60-year-old American Alligator, 35 year old Australian turtle, 22-year-old snapping turtle, three giant tortoises over 20 years, Madagascan boa over 21 years, 14-year-old Reticulated Python and a "molure" python two years older, Japanese salamander for 30 years and a siren for 23 years.

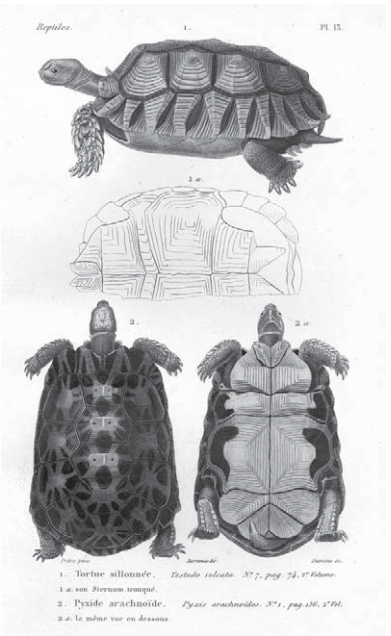


FIG. 8. Illustration of African Spurred Tortoise (*Testudo sulcata*, now *Geochelone sulcata*) above and Common Spider Tortoise (*Pyxis arachnoides*) from *Erpétologie générale*. Credit: Collections of Ernst Mayr Library, Museum of Comparative Zoology, Harvard University.

Jacques Pellegrin at the museum also published on herp longevities at the menagerie: longevity in fish and amphibians (Rev. Gen. Sci. Paris 36:510–512, 1925); longevity in reptiles (Rev. Gen. Sci. Paris 37:47–49, 1926); longevity in alligator (Bull. Mus. Nat. Hist. ser. 2, 9:176–177, 1937). One may consult Flower (1925, 1936, 1937) for additional longevities.

Concluding Remarks.— Count de Lacepède wrote important papers at the museum detailing the mission of zoos, design recommendations, and integration of science. In 1801, he said, "When an animal dies, it is immediately brought to the laboratory of anatomy. There

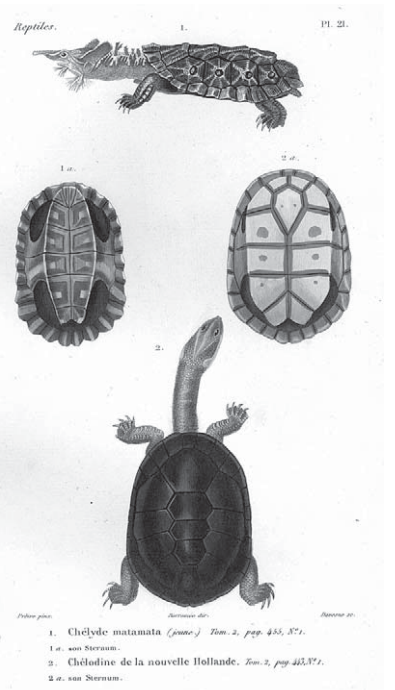


FIG. 9. Illustration of Mata Mata Turtle (*Chelus fimbriatus*) and Snake-Necked Turtle from New Holland from *Erpétologie générale*. The Snake-Necked Turtle called *Chelodina novaehollandiae* is the Common Snake Neck Turtle (*Chelodina longicollis*). Credit: Collections of Ernst Mayr Library, Museum of Comparative Zoology, Harvard University.

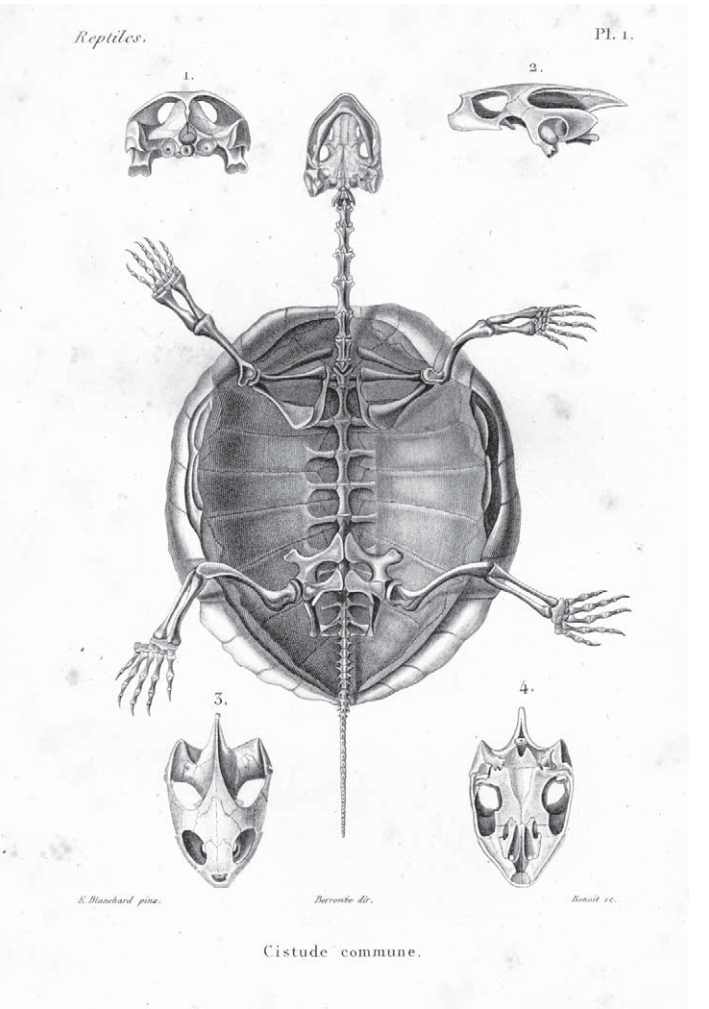


FIG. 10. Illustration of Box Turtle skulls and skeleton from *Erpétologie générale*. Credit: Library of Roy McDiarmid.

the skin is taken and sent to the laboratory of zoology where the professor has it mounted if it is not yet on exhibit." He clearly understood the proper relationship between a museum and a zoological garden, stressing cooperation between the two institutions

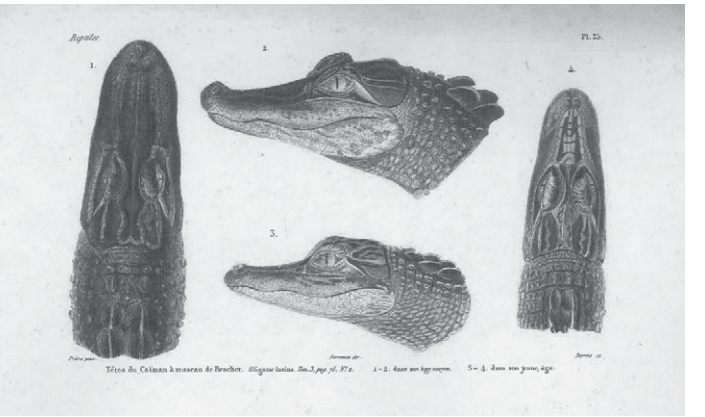


FIG. 11. Illustration of crocodilian heads from *Erpétologie générale*. The scientific name *Alligator lucius* is the old name for the American Alligator. The name "Caiman a Tète de Brochet," is sometimes used in books from the 19th century and is translated as "Caiman with the snout of a pike." Credit: Library of Roy McDiarmid.

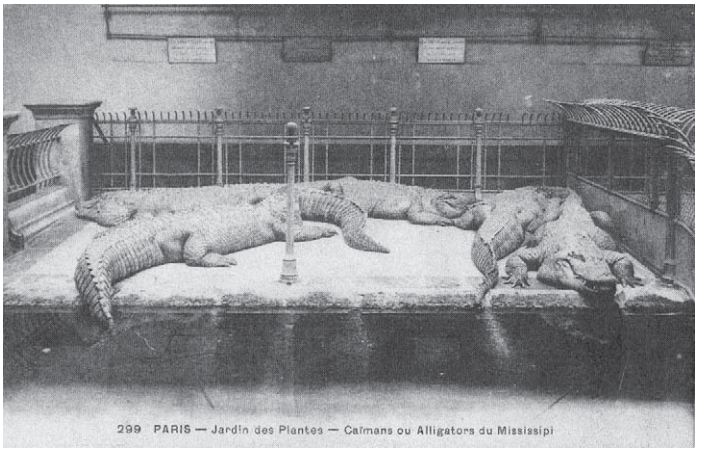


FIG. 11a. In the past, crocodilians were often kept in dense numbers in small enclosures in zoos. In this undated postcard (but possibly from the late 19th or early 20th century), American Alligators are shown in an exhibit at the Jardin surrounded by recurved bars. An American Crocodile was received in 1851 and Émile Wapler from New Orleans donated six American Alligators to the Menagerie the next year where they lived for many years (Duméril, 1854–1855, 1858–1861). Credit: Collection of Smithsonian National Zoological Park.

to use animals upon death to the fullest (see Murphy and Iliff 2004).

There are several examples which serve to illustrate the value of this living collection. Marie Firmin Bocourt learned how to draw herpetological subjects by watching living models at the Ménagerie when he was young. Léon-Louis Vaillant published on reptilian behavior and physiology, based on observations collected at the Ménagerie. Auguste Duméril wrote some of his treatises on the amphibians and reptiles in the Jardin's collection, often accompanied by exquisite illustrations.

The Ménagerie and earlier Terrarium served an important function for artists and biologists from that period—a place where living animals could be observed. As a result, many illustrations published by French biologists began to be more precise: natural poses, fine detail of diagnostic characters, and accurate coloration. Improvements in printing technology

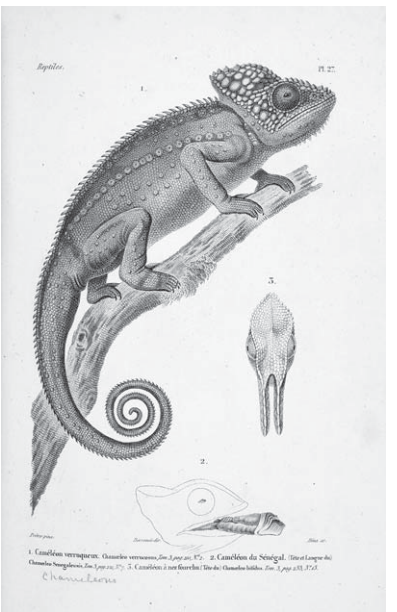


FIG. 12. Illustration of chameleons from *Erpétologie générale*. Auguste Duméril found that European chameleons which began arriving at the Jardin in August 1851 were delicate captives. Over the next four years, more than 160 were kept with none living more than 13 months. His lizards fed on a variety of insects but quickly died. Duméril noticed that females became egg-bound or often died after oviposition and no eggs ever hatched. Credit: Courtesy of Smithsonian Institution Libraries, Washington, DC.

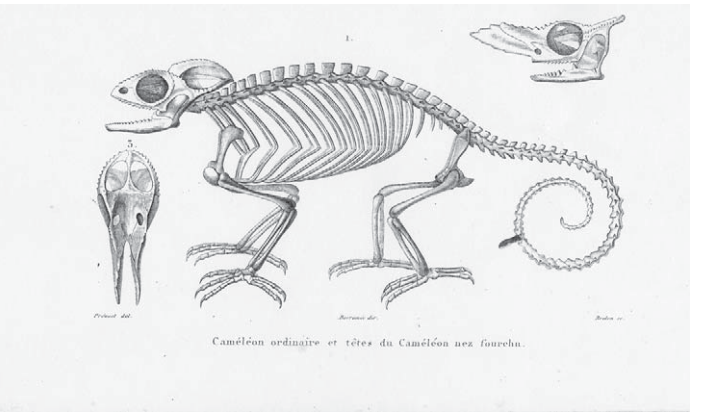


FIG. 13. Illustration of chameleon skulls and skeleton from *Erpétologie générale*. Note that the two outer and three inner fingers are not fused on the forefeet and three outer and two inner toes are not fused on the hind feet. Chaméléon ordinaire is the Common Chameleon (*Chamaeleo chamaeleon*) and the Chaméléon Nez-Fourchu is now *Furcifer bifidis*. Credit: Library of Roy McDiarmid.

also occurred which contributed to this precision. Lithography was important in the late 18th century and multicolored lithographic prints replaced hand coloring in the early 19th century. The improvement in animal illustrations in France and elsewhere in Europe took place in less than 100 years. The change to more realistic depictions of animals came about from the availability of better preserved specimens and live animals, advances in printing technology, and the evolution away from the use of patterns that dominated Renaissance art. This last point is significant, because plant illustration was already very realistic due to the fact that specimens were more widely available (plants were already being pressed and dried and attached to sheets), and the fact that Renaissance animal illustration was still based heavily on myth, as in the bestiary tradition. Consider the contrast between Albrecht Durer's beautiful, lifelike and realistic depictions of a rabbit (an animal he had seen alive frequently) and his famous boiler-plate rhino, an animal he was drawing based on a sketch and description, in the context of the bestiary tradition.

Lavishly illustrated books were designed to be sold not just to people interested in natural history, but those interested in art as well as neither audience was big enough to support the costs

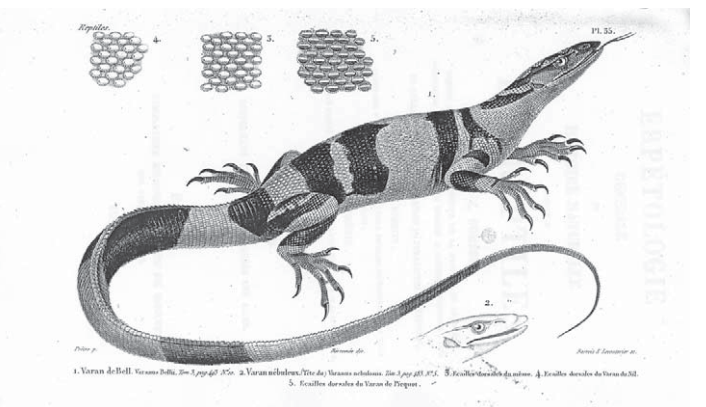


FIG. 14. Illustration of banded phase (sometimes called Bell's Monitor) of the Lace Monitor (*Varanus Bellii*, now V*aranus varius*) and Clouded Monitor (*Varanus nebulosus*) from *Erpétologie générale*. Credit: Library of Roy McDiarmid.

of publication alone (this point is made in Rifkin and Ackerman 2006. *Human Anatomy* [*From the Renaissance to the Digital Age*]. Buffon is a great example of this—his natural history was a very popular book in its day, selling well to the general public as well as naturalists and art collectors. Rifken and Ackerman quote Cuvier as having said that "One must say that without the art of the printer, natural history and anatomy, as they exist today, would not be possible" (p. 271 in their book). More expensive books with hand-colored illustrations sold well to art collectors, then as now.

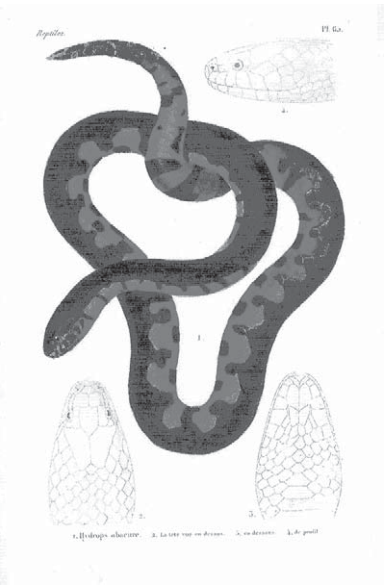


FIG. 15. Illustration of Mud Snake (*Hydrops abacure*, now *Farancia abacura*) from *Erpétologie générale*. Credit: Library of Roy McDiarmid.

Copperplate printing was in use in the mid-16th century, but although copperplates could produce finer lines and hence finer details, the copper plates did not last as long as woodblocks, so woodblocks remained popular with printers for a long time due to their durability. Lithography came out of Germany in the late 18th century, discovered by Alois Senefilder.

I have selected an array of interesting plates which reflect the essence of living herps and the fine artwork created during this period. These will appear in Part II. All colored originals have been converted to a black-and-white format.

Acknowledgments.—This contribution is dedicated to Ken Kawata, retired curator at the Staten Island Zoo in New York. Throughout his professional career, he has stressed the importance of looking at zoo and aquarium history by returning to our earlier roots to improve chances of not duplicating efforts already tried. Kawata has become a mentor to a whole new generation of zoo workers.

I am grateful to Emily Becker, Dana Fisher and James Hanken from the Museum of Comparative Zoology, Harvard University for providing some of the illustrations. Polly Lasker, Smithsonian Institution Libraries, searched archival materials to assure that citations were correct.

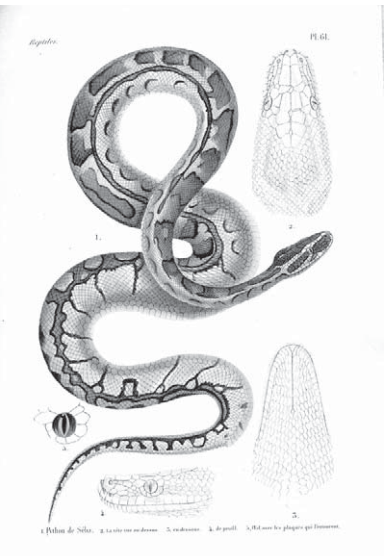


FIG. 16. Illustration of African Rock Python (*Python sebae*) from *Erpétologie générale*. Credit: Library of Roy McDiarmid.

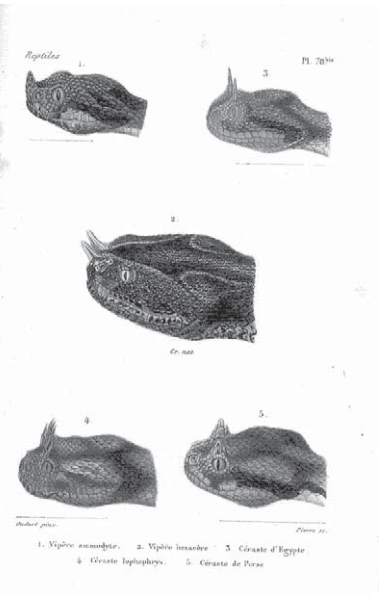


FIG. 17. Illustration of True Viper heads with horns from *Erpétologie générale*. Current common and scientific names are #1 Sand Viper (*Vipera ammodytes*); #2 Rhinoceros Viper (*Bitis nasicornis*); #3 possibly Sahara Sand Viper (*Cerastes vipera*); #4 Many-Horned Adder (*Bitis cornuta*); #5 Persian Horned Viper (*Pseudocerastes persicus*). Credit: Library of Roy McDiarmid.

Thanks are also due to Jean-Luc Berthier, Leslie Overstreet, and Daria Wingreen. My wife Judith Block, Kraig Adler, Jon Coote, Roy McDiarmid, and John Simmons read early drafts and made many helpful suggestions.



FIG. 18. Illustration of snake skulls from *Erpétologie générale*. Current common and scientific names are #1 Reticulate Worm Snake (*Typhlops reticulatus*); #3 Indian Python (*Python molurus*); #4 Emerald Tree Boa (*Corallus caninus*). Credit: Library of Roy McDiarmid.

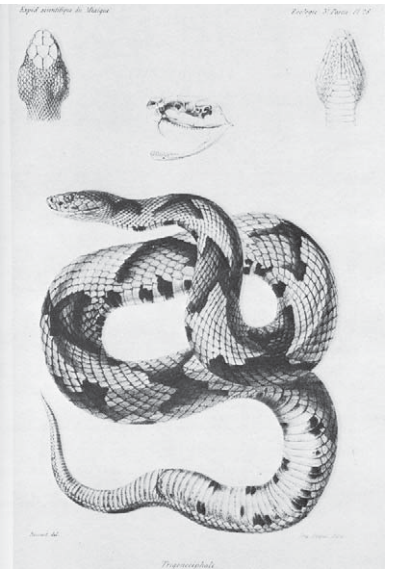


FIG. 19. Drawing of Copperhead (*Trigonocephalus contortrix*, now *Agkistrodon contortrix*) by Firmin Bocourt from *Études sur les reptiles*. Many extralimital species from the United States, South America, and the West Indies were included.

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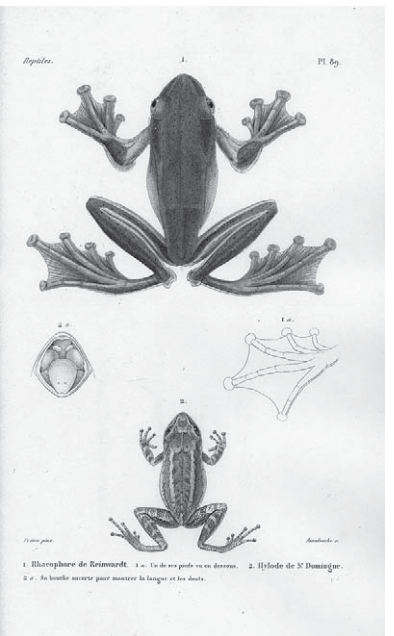
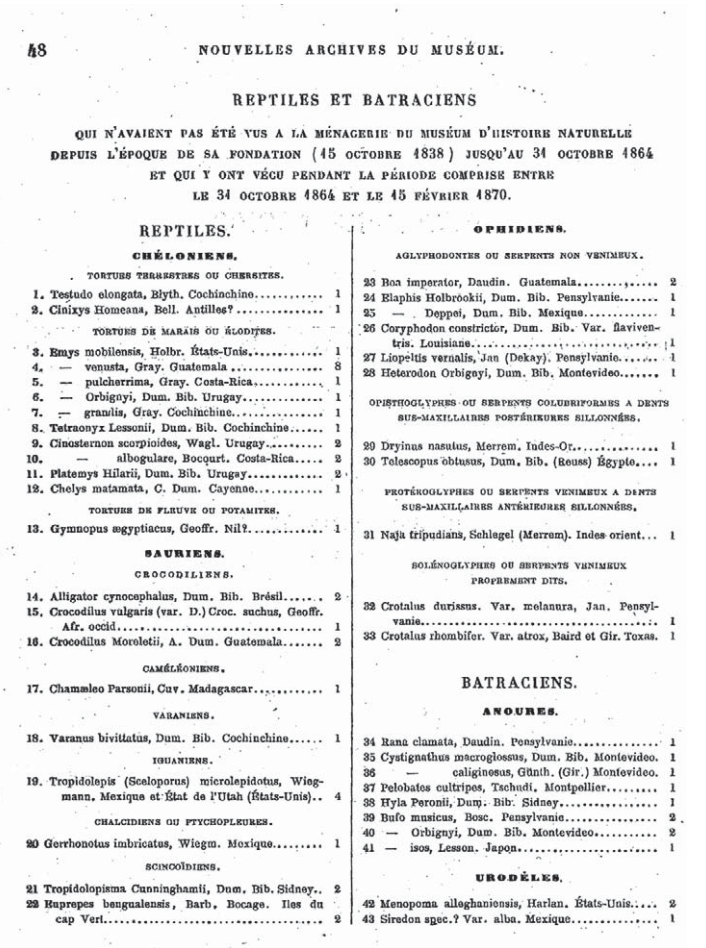


FIG. 20. Illustration of frogs from *Erpétologie générale*. Rhacophore de Reinwardt is *Rhacophorus reinwardtii*. L'Hylode de la Martinique is *Eleutherodactylus martinicensis*. Credit: Library of Roy McDiarmid.



48 NOUVELLES ARCHIVES DU MUSÉUM.

REPTILES ET BATRACIENS

QUI N'AVAIENT PAS ÉTÉ VUS A LA MÉNAGERIE DU MUSÉUM D'HISTOIRE NATURELLE DEPUIS L'ÉPOQUE DE SA FONDATION (15 OCTOBRE 1838) JUSQU'AU 31 OCTOBRE 1864 ET QUI Y ONT VÉCU PENDANT LA PÉRIODE COMPRISE ENTRE LE 31 OCTOBRE 1864 ET LE 15 FÉVRIER 1870.

REPTILES.

CHÉLONIENS.

TORTUES TERRESTRES OU CHERSITES.

1. Testudo elongata, Blyth. Cochinchine..... 1
2. Cinixys Homeana, Bell. Antilles?..... 1

TORTUES DE MARAIS OU ÉLODITES.

3. Emys mobilensis, Holbr. États-Unis..... 1
4. — venusta, Gray. Guatemala..... 8
5. — pulcherrima, Gray. Costa-Rica..... 1
6. — Orbignyi, Dum. Bib. Urugay..... 1
7. — grandis, Gray. Cochinchine..... 1
8. Tetraonyx Lessonii, Dum. Bib. Cochinchine..... 1
9. Cinosternon scorpioides, Wagl. Urugay..... 2
10. — albogulare, Bocourt. Costa-Rica..... 2
11. Platemys Hilarii, Dum. Bib. Urugay..... 2
12. Chelys matamata, C. Dum. Cayenne..... 1

TORTUES DE FLEUVE OU POTAMITES.

13. Gymnopus ægyptiacus, Geoffr. Nil?..... 1

SAURIENS.

CROCODILIENS.

14. Alligator cynocephalus, Dum. Bib. Brésil..... 2
15. Crocodilus vulgaris (var. D.) Croc. suchus, Geoffr. Afr. occid..... 1
16. Crocodilus Moreletii, A. Dum. Guatemala..... 2

CAMÉLÉONIENS.

17. Chamæleo Parsonii, Cuv. Madagascar..... 1

VARANIENS.

18. Varanus bivittatus, Dum. Bib. Cochinchine..... 1

IGUANIENS.

19. Tropidolepis (Sceloporus) microlepidotus, Wiegmann. Mexique et État de l'Utah (États-Unis).. 4

CHALCIDIENS OU PTYCHOPLEURES.

20 Gerrhonotus imbricatus, Wiegm. Mexique..... 1

SCINCOÏDIENS.

21 Tropidolopisma Cunninghamii, Dum. Bib. Sidney.. 2
22 Ruprepes bengualensis, Barb. Bocage. Iles du cap Vert..... 2

OPHIDIENS.

AGLYPHODONTES OU SERPENTS NON VENIMEUX.

23 Boa imperator, Daudin. Guatemala..... 2
24 Elaphis Holbrookii, Dum. Bib. Pensylvanie..... 1
25 — Deppei, Dum. Bib. Mexique..... 1
26 Coryphodon constrictor, Dum. Bib. Var. flaviventris. Louisiane..... 1
27 Liopeltis vernalis, Jan (Dekay). Pensylvanie..... 1
28 Heterodon Orbignyi, Dum. Bib. Montevideo..... 1

OPISTHOGLYPHES OU SERPENTS COLUBRIFORMES A DENTS SUS-MAXILLAIRES POSTÉRIEURES SILLONNÉES.

29 Dryinus nasutus, Merrem. Indes-Or..... 1
30 Telescopus obtusus, Dum. Bib. (Reuss) Égypte.... 1

PROTÉROGLYPHES OU SERPENTS VENIMEUX A DENTS SUS-MAXILLAIRES ANTÉRIEURES SILLONNÉES.

31 Naja tripudians, Schlegel (Merrem). Indes orient... 1

SOLÉNOGLYPHES OU SERPENTS VENIMEUX PROPREMENT DITS.

32 Crotalus durissus. Var. melanura, Jan. Pensylvanie..... 1
33 Crotalus rhombifer. Var. atrox, Baird et Gir. Texas. 1

BATRACIENS.

ANOURES.

34 Rana clamata, Daudin. Pensylvanie..... 1
35 Cystignathus macroglossus, Dum. Bib. Montevideo. 1
36 — caliginosus, Günth. (Gir.) Montevideo. 1
37 Pelobates cultripes, Tschudi, Montpellier..... 1
38 Hyla Peronii, Dum. Bib. Sidney..... 1
39 Bufo musicus, Bosc. Pensylvanie..... 2
40 — Orbignyi, Dum. Bib. Montevideo..... 2
41 — isos, Lesson. Japon..... 1

URODÈLES.

42 Menopoma alleghaniensis, Harlan. États-Unis..... 2
43 Siredon spec.? Var. alba. Mexique..... 1

FIG. 21. List of herpetological specimens from *Quatrième notice sur La Ménagerie des Reptiles du Muséum d'histoire naturelle*.

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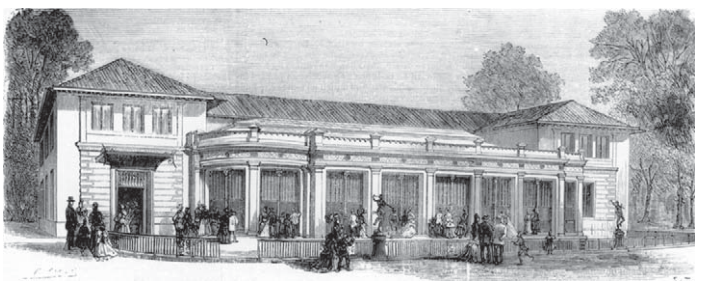


FIG. 22. Undated illustration, possibly around mid-1870s, of exterior of reptile building at La Ménagerie Jardin des Plantes. Credit: provided by Jean-Luc Berthier, Jardin des Plantes Archives.

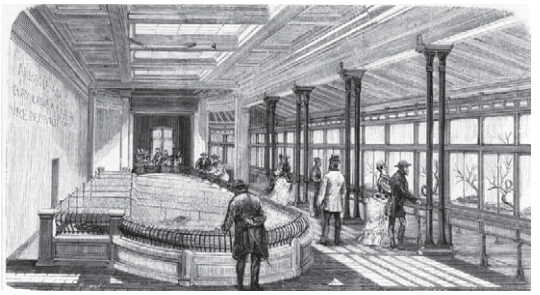


FIG. 23. Undated illustration, possibly around mid-1870s, of interior of reptile building at La Ménagerie Jardin des Plantes. Note glass-fronted, mahogany cages standing on ornate legs on right. Credit: provided by Jean-Luc Berthier, Jardin des Plantes Archives.

snake. He defended the need for a living animal collection as a valuable vehicle for research and education.].

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FIG. 24. Cover of *Le Monde Illustré* published 24 October 1874 showing reptile display and inhabitants at Ménagerie Jardin des Plantes. Credit: provided by Jean-Luc Berthier, Jardin des Plantes Archives.

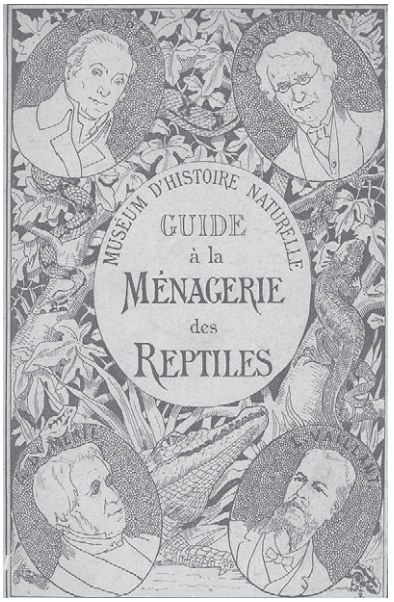


FIG. 25. Cover of Guidebook for reptile building at Ménagerie Jardin des Plantes, by Léon-Louis Vaillant in 1898. On the front cover of this guide are drawings of Lacepède, C. Duméril, A. Duméril and Vaillant. Credit: provided by Kraig Adler.

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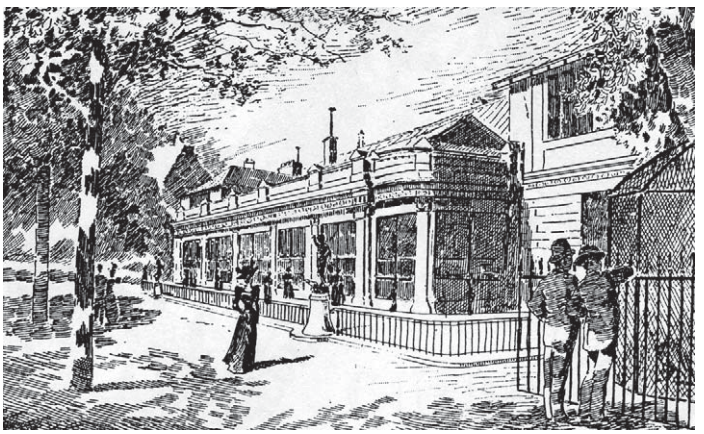
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FIGS. 26, 26a. Title page and floorplan of the Ménagerie Jardin des Plantes, by Léon-Louis Vaillant in 1898. This nice drawing of the building's façade shows the bronze statues at center and right of building. Credit: provided by Kraig Adler.

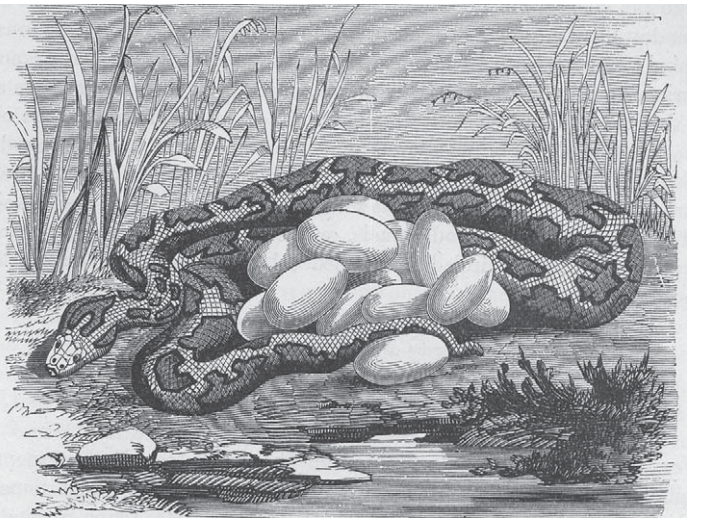


FIG. 27. Indian Python (*Python molurus*) incubating eggs at Ménagerie Jardin des Plantes. Illustration reproduced from S. G. Goodrich's *Johnson's Natural History, Comprehensive, Scientific, and Popular, Illustrating And Describing The Animal Kingdom With Its Wonders And Curiosities, From Man, Through All The Divisions, Classes, And Orders, To The Animalculae In A Drop of Water; Showing The Habits, Structure, And Classification Of Animals, With Their Relations To Agriculture, Manufactures, Commerce, And The Arts*. Volume 2 in 1870. Credit: Courtesy of Smithsonian Institution Libraries, Washington, DC.

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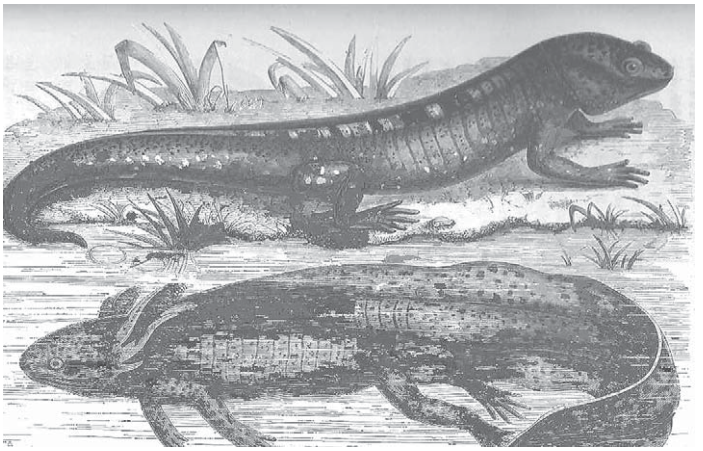
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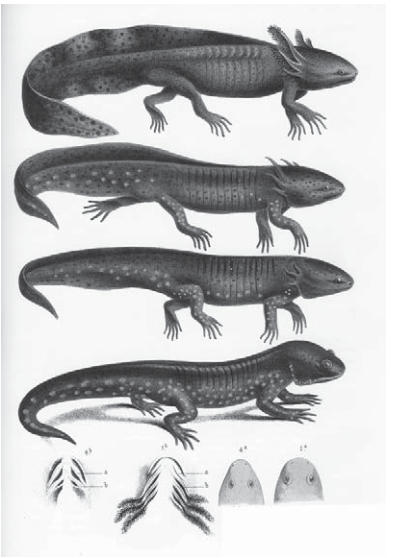
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FIGS. 28, 28a. Two illustrations from the papers by Auguste Duméril describing neoteny in Mexican Axolotls (*Ambystoma mexicanum*).

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Amplectant pair of *Agalychnis moreletii* (Morelet's Treefrog), Belize. Illustration by Peter Stafford.

LETTERS TO THE EDITOR

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The State of Natural History: A Perspective from the Literature on West Indian Herpetology

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Natural History: The study and description of organisms and natural objects, especially their origins, evolution, and interrelationships.[1]

Definitions of natural history vary, with differences attributable to changing historical perspectives (what we now call "biology" was referred to as natural history until the early 20th century) and motive (either laudatory or derogatory). Recent years have seen a spate of papers addressing the "state" of natural history, whether it's dying or healthy, exactly what encompasses natural history, and what is "good" or "contemporary" natural history. Arnold (2003) and Greene (2005) provided effective, albeit somewhat contradictory, perspectives. Some would suggest that natural history has a long and storied heritage, embodied by great 19th-century naturalists like Alexander von Humboldt and Charles Darwin and their modern-day counterparts like Henry Fitch and John Iverson, whose detailed multi-year studies of the lives of reptiles are primary references for anyone studying those species. In contrast, others propose that natural history today has little relevance beyond a small role in more "conceptual" investigations of our natural world. WordNet (Cognitive Science Laboratory, Princeton University) defines natural history as "the scientific study of plants or animals (more observational than experimental) usually published in popular magazines rather than in academic journals."

Detailed observations of natural history may be deemed old-fashioned and out of vogue—but they will be as valid 100 years from now as on the day they were published. Not surprisingly, Fitch (1987) stated this quite clearly: "When an observer is fortunate enough to see and record behavior significant in the natural history of a species, his observations should be published.... Even a single observation may constitute a valuable contribution and may be a break-through in understanding the species' ecology."

Although we are not particularly interested in entering the debate regarding the state or status of natural history, we do have an interest in the subject—in fact, curiosity regarding the lives of animals in their natural (and often altered) habitats led us to our life-long careers—and, based on our recent experience in accu-

[1] http://dictionary.reference.com/browse/Natural+history?jss=1

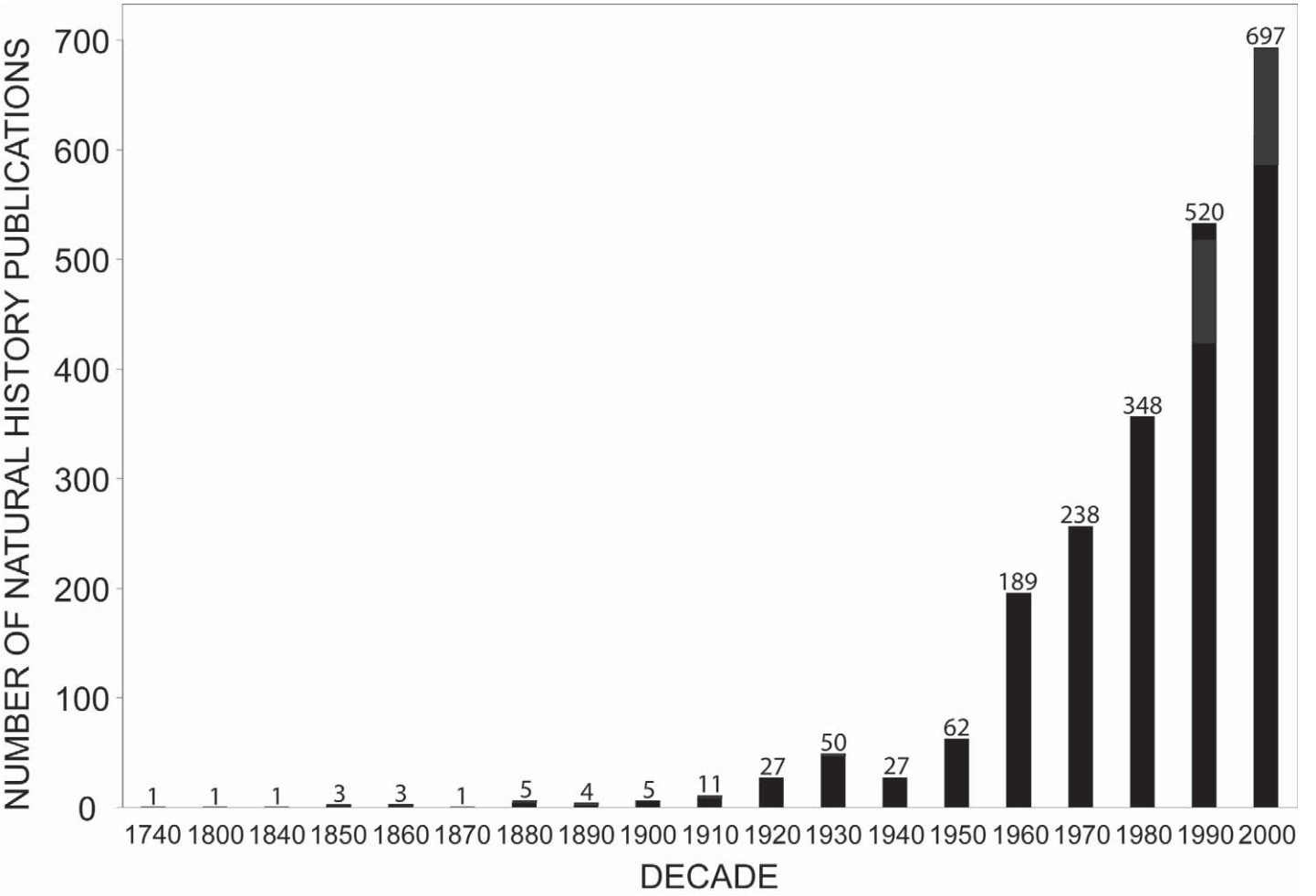


FIG. 1. The number of publications produced by decade (1740–49 ... 2000–09) that include some natural history information relevant to West Indian amphibians and reptiles. The 1910s and 1920s largely represent the efforts of Thomas Barbour (with E. R. Dunn and K. P. Schmidt contributing in the 1920s); Barbour remained active in the 1930s. The drop-off in the 1940s can be attributed to World War II, although Chapman Grant was active at this time. The 1950s mark the initiation of studies by Albert Schwartz and Ernest Williams in the region. Interest in Antillean herpetology blossomed in the 1960s with Orlando Garrido, James Lazell, A. Stanley Rand, Rodolfo Ruibal, Schwartz, Richard Thomas, and Williams as major contributors. By the 1970s, an ecological focus began to share the spotlight with alpha taxonomy through the contributions of Thomas Schoener, Judy Stamps, and others. Research activity has continued to increase in the region to the present day, with major emphases on conservation, ecology, and phylogenetics, with biologists who live on the islands as well as researchers from North America and Europe making valuable contributions. The number of contributions published subsequent to the previous compendium on West Indian herpetology (Schwartz and Henderson 1991) rivals the number published during the previous 250 years.

mulating information for our book on the natural history of West Indian reptiles and amphibians (Henderson and Powell 2009), "natural history" data are being published in a staggering number of journals with an incredibly broad range of foci. Evidently, a great many people remain interested in and are practitioners of natural history.

Background.—In 2005, we proposed to the University Press of Florida a book manuscript summarizing the natural history of each of about 700 species of West Indian frogs and reptiles. We soon thereafter signed a contract agreeing to deliver a 500-page manuscript in December 2007. We both have long histories of working in the West Indies and, we thought, a fairly intimate knowledge of the literature pertaining to its herpetofauna. We were mistaken. By the time we submitted the final version of the manuscript in February 2009 (after reviews and copyediting), it had expanded to over 1800 pages covering 737 species and we had cited more than 2600 sources of information. Those 2600+ citations were gleaned from 317 different sources, including 74 books, 180 book chapters, and more than 300 different scientific journals and publication series. Details of the natural history of Antillean frogs and reptiles came from many obscure (to us) sources, including, for example, the *Journal of Aviation/Aerospace Education and Research*, *Insectes Sociaux*, *Letters in Applied Microbiology*, and *Peptides*. Pertinent literature came from publications originating in nations far removed from the West Indies, including Japan, Russia, and Czechoslovakia. We cited publications that appeared between 1740 and 2009 (Fig. 1), but only 18 publications with some germane natural history data appeared in the 1800s, and another 16 during the first two decades of the 20th century. The numbers began to increase in the 1920s and 30s with the contributions of Thomas Barbour, Emmett R. Dunn, Gladwyn K. Noble, and Karl P. Schmidt. The 1940s showed a decline in relevant publications, almost certainly attributable to WWII. Albert Schwartz and Ernest E. Williams became active in the islands in the 1950s, and this is reflected in the resurgence of activity throughout the Caribbean Region. The 1960s are, we believe, the real turning point for

interest in West Indian herpetology. Schwartz and Richard Thomas, and Williams and his students (most notably A. Stanley Rand) were amazingly prolific, and the number of contributions more than tripled between the 1950s and 60s. The number of contributions containing some natural history information pertinent to the West Indian herpetofauna has steadily increased each decade, with more than 1200 appearing since 1990.

Results.—Henderson and Powell (2009) included 737 species accounts, varying in length from a few lines to many pages. In order to make the accounts as complete and detailed as possible, we sought to include data from all of the relevant sources we could locate, regardless of whether the project from which the published information came was systematic in nature, hypothesis-driven and presented in a conceptual context, or was based on an anecdotal observation. We did not consider the impact factor of journals from which we extracted information. If information was available, no matter how obscure the publication outlet, we felt it was our responsibility to find it (a process that often entailed considerable help from many colleagues throughout the world).

We determined that studies dedicated to some aspect of natural history[2] have addressed 43% of West Indian species. "Dedicated" implies an a priori plan to study some facet of natural history, and that the observations were not based solely on fortuitous occurrences. This by no means suggests that we have a good handle on the natural history of 43% of the Antillean herpetofauna. To the contrary, we have a fairly broad knowledge of only about 5% of West Indian species.

The most frequently cited publication in our book is the *IUCN Red List of Threatened Species* (268 citations; with the vast majority on frogs, reflecting the 2004 Global Amphibian Assessment); the fourth most was the *Catalogue of American Amphibians and Reptiles* (147). Because neither of these generally contains original data, we omit them from our list of the top 10 sources of natural history information pertaining to the West Indian herpetofauna: (1) *Herpetological Review* — 156 citations, (2) *Caribbean Journal of Science* — 151, (3) *Journal of Herpetology* — 107, (4) *Copeia* — 89, (5) *Herpetologica* — 88, (6) *Iguana* (now *Reptiles & Amphibians*) — 69, (7) *Breviora* (Museum of Comparative Zoology) — 53, (8) *Poeyana* (Cuba) — 52, (9–tie) *Ecology* and *Iguana Specialist Group Newsletter* — 31, and (10) *Bulletin of the Museum of Comparative Zoology* — 28.

Most of the top ten was not a surprise. These publications share a willingness (at least historically) to accept and publish studies involving descriptive natural history. *Herpetological Review* (HR) devotes a section to brief natural history observations in each issue, and the *Caribbean Journal of Science* (CJS), based in Puerto Rico, is the most important biological journal published in the West Indies. The *Journal of Herpetology* (JH), although the youngest of the three most influential herpetological journals in North America, provided the most citations, but the number did not differ all that much from those in *Copeia* or *Herpetologica*. *Poeyana* is published in Cuba, and most of its contributions appeared in the 1960s–1980s; today, Cuban herpetologists publish primarily in "mainstream" journals, including HR, CJS, JH, and others in the top ten.

The Museum of Comparative Zoology (MCZ) at Harvard University has a long (>125 years) history of West Indian fieldwork and publications focused on Antillean herpetology. Curators Samuel W. Garman, Thomas Barbour, Ernest E. Williams, and, currently, Jonathon B. Losos have been active in the Caribbean. That the MCZ was the institution that produced the most citations was predictable (87 including six *Memoirs* of the MCZ). Its closest competitor was the American Museum of Natural History with 20. In the West Indies, Cuban herpetologists were far and away the most prolific publishers, often in one of several institution-based publication series.

Based on the *Journal Citation Reports*, the mean impact factor (a measure of the frequency with which the "average article" in a journal has been cited in a given period of time) for the four publications in our top 10 that were listed in the Reports (HR, CJS, *Iguana*, *Breviora*, *Poeyana*, and the *Bulletin of the Museum of Comparative Zoology* were not listed) was 1.620 ± 0.807 (range = 0.527–4.822). By comparison, the average of the top 10 publications (based on impact factor) that we cited, but that did not necessarily make the top 10 of the most frequently cited, was 11.219 ± 2.974 (range = 3.934–28.751). The mean number of times the journals in our top 10 were cited was 82.7 ± 14.7 (range = 31–156), and the mean for the top 10 with the highest impact factors was 9.7 ± 2.8 (range = 2–31). Only one publication (*Ecology*) made both top 10 lists, undoubtedly reflecting the reality that high-impact journals are more likely to include review articles, be interdisciplinary (i.e., not focus on a particular geographic region or taxonomic group), and emphasize topics more "conceptual" than descriptive natural history.

Despite our efforts to be as complete as possible, we are certain that some citations have been missed. Nevertheless, in addition to expanding our own awareness of what we know (and don't know) about many West Indian species, we developed a broader appreciation for the scope of "natural history" and how many aspects of the subject are widely integrated into studies that range far beyond descriptions of how animals make a living in their natural (and sometimes unnatural) habitats.

[2] Our categories of "natural history" included (obviously not all were applicable to all species): abundance, activity, behavior, biomass, burrows (retreats), commensalism, competition, conservation status, defense, desiccation, diet and foraging, disease, distribution, ecomorphology (anoles), ecosystem processes, energetics, growth, habitat, home range, homing, hurricane effects, hybridization, injuries, interspecific (or interclass) interactions, life expectancy, life history, longevity, miscellany, mortality, movement, nesting, parasites, performance, population size and density, population structure, predation, reproduction, salinity tolerance, sex ratios, site fidelity, size, source of introduced populations, survival, swimming, tail autotomy, territoriality, thermal biology, vision, vocalization.

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ARTICLES

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The Taxonomic Status of the Inornate (Unstriped) and Ornate (Striped) Whiptail Lizards (*Aspidoscelis inornata* [Baird]) from Coahuila and Nuevo León, México

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The Little Striped Whiptail (*Aspidoscelis* [*Cnemidophorus*] *inornata*) includes 10 (Wright and Lowe 1993) or 11 (Reeder et al. 2002) subspecies ranging from Arizona, New Mexico, and Texas in the USA, south into Chihuahua, Coahuila, Durango, Nuevo León, San Luis Potosí, and Zacatecas States in México. Although usually faintly to vividly striped dorsally (ornate) over its vast range, individuals and/or populations of inornate (unstriped) *A. inornata* occur at a minimum of one locality in Chihuahua (Cordes and Walker 1996; Walker et al. 1996) and nine in Nuevo León (Axtell 1961; Wright and Lowe 1993; this study). The genetic basis and taxonomic implication of an inornate morph in Nuevo León has been the subject of considerable debate, dating back more than 150 years, with different whiptail investigators drawing conflicting conclusions (Axtell 1961; Baird 1858; Reeder et al. 2002; Wright and Lowe 1993). We discuss taxonomic issues pertaining to *A. inornata* in the context of a widely distributed polytypic species (Liner 2007; Liner and Casas-Andreu 2008; Wright and Lowe 1993) in which there are numerous unresolved problems pertaining to the significance of variation in color pattern (Reeder et al. 2002; Walker et al. 1996; Wright and Lowe 1993). There also exists an alternative classification of populations of "Little Striped Whiptail" in the United States based on the evolutionary species concept. Collins (1997) and Crother (2000, 2008) listed three color-pattern variants (i.e., subspecies sensu Wright and Lowe 1993) from New Mexico and Arizona as species (i.e., *A. arizonae*, *A. gypsi*, and *A. pai*) based on apparent allopatric distributions (Wright and Lowe 1993; p. 134) and morphological diagnosibility. Using these criteria, a minimum of three subspecies recognized by Wright and Lowe (1993) from México also could be elevated to species rank (i.e., *A. cienegae*, *A. chihuahuae*, and *A. paulula*). The genetic contributions of *A. inornata* to the origins of no fewer than two diploid (i.e., *A. innotata* and *A. neomexicana*) and six triploid (i.e., *A. exsanguis*, *A. flagellicauda*, *A. opatae*, *A. sonorae*, *A. uniparens*, and *A. velox*) hybrid-derived parthenogenetic species have been discussed by Densmore et al. (1989a, b) and Wright (1993).

This study pertains to what Baird (1858) described as two species of whiptail lizards from Pesquería Grande (= Villa de García = García), Nuevo León. He named *Cnemidophorus inornatus* to reflect a "...light greenish olive..." dorsum in one, and *C. octolineatus* in allusion to "...eight equidistant and approximated light lines" on the dorsum of the other (Baird 1858; p. 255). Opinions differ on whether *C. octolineatus* should be treated as a synonym of *C. inornatus* (Axtell 1961; Burger 1950; Walker et al. 1996; Williams 1968) or whether these two represent diagnosable taxa (Reeder et al. 2002; Wright and Lowe 1993). That the different color patterns in these otherwise similar forms represent dimorphism within a subspecies is based on Axtell's (1961) report of their coexistence and intimate relationship at a site at Villa de García. The case for partitioning *C. i. inornatus* into two taxa is based on Wright and Lowe's (1993) report of an association of lizards at a different site near Villa de García consisting of inornate and ornate individuals and their possible intergrades or hybrids. Wright and Lowe (1993; p. 136) concluded that "...the possibility that two distinctive taxa (species or subspecies) exist in the vicinity of the type locality is by no means eliminated [by available data]." Most recently, Reeder et al. (2002) placed all species of *Cnemidophorus*, except those in the paraphyletic "*C. lemniscatus*" species group, into the genus *Aspidoscelis*. However, without comment, they allocated inornate lizards from Nuevo León, México, into *Aspidoscelis inornata inornata* (= *Cnemidophorus inornatus* Baird) and revived *A. i. octolineata* (= *C. octolineatus* Baird) from the synonymy of *C. i. inornatus* to accommodate ornate lizards from Coahuila and Nuevo León. Herein, we (1) present data for variation in ornate lizards from Coahuila, (2) data for both ornate and inornate individuals from Nuevo León, (3) list new locality records for inornate lizards from Nuevo León that support recognition of *A. i. octolineata* as a valid taxon, as listed by Reeder et al. (2002), and (4) redefine *A. i. inornata*.

We studied the inornate and inornate specimens of Little Striped Whiptail (*A. inornata*), listed by Axtell (1961) and Wright and Lowe (1993) from the vicinity of Villa de García in the course of a reassessment of their distributional, morphological, and taxonomic relationships. We also examined other samples from Coahuila and Nuevo León for the presence of the inornate form. Specimens were from the following collections (institutional acronyms follow Leviton et al. [1985]): LACM, TCWC, TNHC, UAZ, UCM, USNM (specimens referenced from the literature), UTEP (specimen transferred from another collection), and R. W. Axtell's personal collection (RWA). Each collection site for *A. inornata* was assigned a code consisting of C (= Coahuila) or NL (= Nuevo León) and a number (i.e., C-1–C-24 and NL-1–NL-17; Appendix 1). Two type specimens (USNM 3032A [lectotype] and 3032B [paralectotype]; Baird 1858; Wright and Lowe 1993) from the type locality, six lizards from NL-1 (Axtell 1961), and nine from NL-2 (Wright and Lowe 1993) have previously served as vouchers for inornate *A. inornata* from Nuevo León. We studied 42 additional inornate specimens from the state, which were held in LACM, RWA, and TCWC. These specimens were from NL-2

(10 inornate [IN] and 48 ornate [OR] lizards), northwest of the type locality (four IN and one OR at NL-3 and one IN and no OR at NL-4), and sites accessed by the part of México Highway 53 extending northwest from Mina to the Nuevo León–Coahuila border (27 IN and no OR at NL-5–9). We used Google Earth (www.earth.google.com) to locate collection sites with known coordinates, scan topography, determine elevations, and measure line distances between sites from which *A. i. inornata* has been collected in Nuevo León. However, the exact spatial relationship of the sites originally visited by RWA (NL-1) and by J. W. Wright and associates (NL-2) could not be determined as no coordinates were included in the catalog entries for Wright's UAZ and LACM samples. We used the Federal Communications Commission website (www.fcc.gov/mb/audio/bickel/DDDMMSS-decimal.html) to convert data accompanying museum samples for degrees, minutes, and seconds to decimal degrees latitude and longitude.

Meristic characters (terminology after Burt 1931; Smith 1946; Walker et al. 1996; Wright and Lowe 1993; Tables 1, 2) included counts of: (1) granules (= scales) at midbody from the right outer row of ventral scales over the body to the left outer row of ventral scales (GAB), (2) dorsal granules longitudinally from the occipitals to the first row of caudals (OR), (3) granules between the paravertebral stripes at midbody (PV; only possible for ornate lizards), (4) percent of granules around midbody between paravertebral stripes (PV/GAB x 100; only possible for ornate lizards), (5) femoral pores (FP, summed from both sides), (6) subdigital lamellae of the fourth toe of the left pes (SDL), (7) circumorbitals (COS; summed from both sides), (8) lateral supraocular granules (LSG; summed from both sides), and (9) interlabials (ILS; summed from both sides). Each specimen of *A. inornata* was sexed (via inspection of femoral pores and cloacal region), and its snout–vent length (SVL) measured to the nearest mm (Table 1).

We used ANOVA in JMP v. 7 (SAS Institute, Cary, NC) to generate a mean ± 1 SE for SVL pooled by sex, and for each univariate character of scutellation in each geographical and pooled sample of *A. inornata* (Tables 1, 2). We selected the treatment "All Pairs-Tukey-Kramer HSD" to determine statistical differences between any two means. This procedure yields post-hoc comparisons, which preserves alpha ($P < 0.05$) in statistical comparisons of multiple means (Sokal and Rohlf 1981). Chi-square values were computed using SPSS v. 14.1 (SPSS, Chicago, IL) to separately compare ratios of numbers of dorsal color pattern variants designated A–D for the 1962 UAZ and 1975 LACM samples of *A. inornata* from site NL-2 in Nuevo León.

Aspidoscelis i. inornata lacks dorsal stripes and spots (Fig. 1A, B, C). In contrast, *A. i. octolineata* has 7–11 pale longitudinal dorsal stripes and darker intervening fields; each side of the body (ventral to dorsal) has a lateral, a dorsolateral, and a paravertebral primary stripe (Fig. 1D, J, L). The middorsal region between the paravertebral stripes in each ornate lizard has 1–4 additional supernumerary stripes (sensu Wright and Lowe [1993], if more than the usual number of two). We used "7+ stripes" to denote the presence of an intermittently joined and split vertebral stripe between the head and tail of a lizard. In ornate *A. inornata*, the dark fields between the stripes always lack spots; however, certain fields may develop an indistinct longitudinal line (supernumerary stripes, sensu Walker et al. [1996]) between the primary stripes.

Axtell (1961) described an area ca. 50 × 100 m of wind-formed sand mounds just under 3 m high at NL-1, referenced by him as the type locality of *A. inornata*, from which he collected six inornate and five ornate specimens (three ornate lizards were obtained approximately 100 m to the southeast among mounds less that 0.5 m high). He described each of the inornate adults from NL-1 as having a "...completely unicolor brownish olive..." dorsum and each of the ornate adults as being "...distinctly striped with eight light lines on a brownish gray to olive background..." (Axtell 1961; p. 149). None of these specimens was intermediate in color pattern between the inornate and ornate morphotypes. A return to NL-1 by RWA in the 1960s revealed that the area previously inhabited by inornate and ornate *A. inornata* had been destroyed by construction activities.

Wright and Lowe (1993) described a differently constituted association of whiptail lizards at site NL-2 located 1.6 km west and 1.6 km south of Villa de García, where inornate and ornate *A. inornata* and apparent intergrades (or hybrids) were collected. We agree that adults UAZ 14067–75 are inornate (our variant A; 29.0%) and that adults UAZ 14076–88, 14093–95, 14097–102 are ornate (our variants B–D; 71.0%), the latter having stripes ranging from distinct to indistinct, straight to irregular, and with or without supernumerary stripes. Among the inornate specimens are four females (UAZ 14067, 14069, 14072, 14075; 54–60 mm SVL) and five males (UAZ 14068, 14070–71, 14073–74; 55–60 mm SVL). Among the 22 ornate specimens in the UAZ sample are four females (UAZ 14078, 14080, 14083, 14095; 57–61 mm SVL) and one male (UAZ 14099; 60 mm SVL) (designated variant B; 22.7%) with gray-tan fields of only slightly darker hues than the stripes; four of these individuals have 9–10 stripes rather than the usual number of eight, and in some the stripes are atypical. In the ornate group from NL-2 designated variant D (50%), six females (UAZ 14077, 14079, 14082 [Wright and Lowe (1993, figure 7)], 14093, 14097–98; 58–62 mm SVL) and five males (UAZ 14081, 14085, 14087 [Wright and Lowe (1993, figure 7)], 14094, 14101; 56–60 mm SVL) have the pattern of *A. i. octolineata* comparable to specimens from NL-12, in which dark fields strongly contrast with seven (one specimen), eight, or nine pale stripes. Last, in the ornate group from NL-2 designated variant C (27.3%) are three females (UAZ 14076, 14086, 14088; 56–58 mm SVL) and three males (UAZ 14084, 14100, 14102; 58–61 mm SVL) with dorsal patterns of intermediate contrast between the fields and stripes.

A large unreported sample of *A. inornata* collected in LACM from NL-2 in 1975 includes seven (14.0%; LACM 116195–201; Fig. 1A, B, C) inornate and 43 (86.0%; LACM 116152–94) ornate specimens of *A. inornata*. Among the ornate lizards are six (14.0%, Fig. 1D, E, F) of variant B, nine (20.9%, Fig. 1G, H, I) of variant C, and 28 (65.1%, Fig. 1J, K, L) of variant D. Another unreported LACM sample from NL-2 collected in 1980 includes three (37.5%) inornate and five (62.5%) ornate specimens of *A. inornata*.

The variation in color pattern described above in samples from NL-1 and NL-2 is not attributable to either sexual dimorphism or ontogenetic development; both males and females over a similar SVL range in both groups have the patterns described. We concur with Wright and Lowe (1993) that some of the variation observed among the ornate specimens from NL-2 likely reflects gene exchange between inornate and ornate lizards. The disparate ratios of inornate to ornate lizards in the 1962 (9:31, $\chi^2 = 5.452$, $P = 0.02$) and 1975 (7:44, $\chi^2 = 26.843$, $P = 0.0005$) samples from NL-2 are

TABLE 1. Meristic characters (see text for definitions of abbreviations) of *Aspidoscelis inornata* from Nuevo León, México. Data are (first row) mean ± SE, (second row) range and (N) and tabulated by site code (see text for explanation), color pattern variant (IN = inornate *A. i. inornata*), OR = ornate *A. i. octolineata*), and museum collection.

Character	NL-2 (IN) UAZ, LACM	NL-2 (OR) UAZ, LACM	NL-3 (IN) TCWC	NL-5 (IN) TCWC	NL-11 (OR) TCWC	NL-12 (OR) UCM
GAB	71.9 ± 0.74 66–75 (15)	70.9 ± 0.45 64–81 (65)	69.5 ± 1.66 66–74 (4)	69.9 ± 0.77 64–80 (21)	70.8 ± 0.98 66–72 (6)	72.9 ± 1.18 70–77 (7)
OR	179.5 ± 2.31 164–191 (15)	183.7 ± 1.20 160–205 (65)	171.5 ± 4.87 160–181 (4)	181.0 ± 1.62 166–191 (21)	173.3 ± 4.59 154–186 (6)	185.1 ± 2.76 176–195 (7)
PV	— —	16.6 ± 0.23 13–21 (65)	— —	— —	17.5 ± 0.85 14–20 (6)	14.9 ± 0.61 13–18 (8)
PV/GAB	— —	23.5 ± 0.33 17.8–30.4 (65)	— —	— —	24.6 ± 0.93 21.0–27.7 (6)	20.7 ± 0.67 18.3–23.3 (7)
FP	34.0 ± 0.51 31–37 (15)	34.6 ± 0.32 28–40 (65)	36.0 ± 0.41 35–37 (4)	36.9 ± 0.56 33–44 (21)	34.8 ± 1.42 29–39 (6)	34.8 ± 0.75 32–38 (8)
SDL	29.8 ± 0.46 27–34 (15)	29.6 ± 0.20 26–33 (65)	30.8 ± 0.25 30–31 (4)	31.0 ± 0.29 28–33 (21)	31.7 ± 0.33 30–32 (6)	32.3 ± 0.49 30–35 (8)
COS	12.3 ± 0.53 9–15 (15)	12.3 ± 0.26 8–18 (65)	11.0 ± 1.58 7–14 (4)	11.7 ± 0.42 9–15 (21)	10.7 ± 1.02 6–13 (6)	11.5 ± 0.87 9–16 (8)
LSG	26.1 ± 1.74 18–41 (15)	26.5 ± 0.66 17–45 (65)	25.8 ± 4.30 19–37 (4)	29.3 ± 1.55 17–49 (21)	26.3 ± 1.63 21–31 (6)	31.3 ± 3.02 22–47 (8)
ILS	25.4 ± 1.30 18–38 (15)	25.7 ± 0.67 16–41 (65)	25.8 ± 2.43 21–32 (4)	27.5 ± 1.21 17–41 (21)	25.2 ± 2.61 15–33 (6)	31.4 ± 2.46 23–44 (8)

not likely explained by chance or sampling effort. The 1975 sample also includes fewer ornate individuals with unusual stripe characteristics than were present in the 1962 sample. Although the 1962 sample has statistically indistinguishable frequencies of the three ornate variants represented in Fig. 1 ($\chi^2 = 2.818$, $P = 0.24$), this was not the case for the 1975 sample ($\chi^2 = 21.318$, $P = 0.0005$).

In Nuevo León, inornate lizards were previously known from two sites at Villa de García, both also inhabited by ornate lizards (Axtell 1961; Wright and Lowe 1993) and one with intergrades or hybrids of the two (Wright and Lowe 1993). We describe a distribution area for the inornate variant in Nuevo León of larger size than those of subspecies of Little Striped Whiptail in México (e.g., *A. i. cienegae*) and the United States (e.g., *A. i. gypsi*) (Wright and Lowe 1993, p. 134). This area in Nuevo León extends from Villa de García and La Paz thence north–northwest to southeast of Soledad (spanning 25.8167–26.3333ºN latitude, 100.5833–100.8333ºW longitude, and 693–930 m elevation). The linear distance between the most widely separated sites for inornate lizards (i.e., *A. i. inornata*) in Nuevo León is ca. 65 km from NL-2 to NL-9.

In addition to the two sites noted, both inornate (TCWC 44262–65) and ornate (TCWC 44261) individuals of *A. inornata* also occur at a third site (NL-3), located 14.1 km NW of Villa de García, Nuevo León. Two juvenile males from NL-3 (TCWC 44263 and 44264) are the smallest (36 and 39 mm SVL, respectively) inornate lizards known to us. In ethanol, both are similar to adults in that they lack stripes and have a gray-brown dorsum. One male (TCWC 44266) from NL-4 at 1.6 km west of La Paz establishes the presence of the inornate variant at a fourth site in the general area of Villa de García. All other samples of inornate lizards were collected well north of Villa de García, the largest sample consisting of 13 adult males (TCWC 43591–92, 43595–98, 43600–01, 43603–04, 43606, 43610–11; 54–59 mm SVL) and eight adult females (TCWC 43593–94, 43599, 43602, 43605, 43607–09; 51–64 mm SVL) from NL-5 at 8.2 km west of Mina. Specimens of *A. marmorata* with strongly contrasting dorsal patterns also occur at NL-5 and nearby (Hendricks and Dixon 1986). Only inornate specimens of *A. inornata* are present in samples from NL-6 (N = 1), NL-7 (N = 1), NL-8 (N = 3), and NL-9 (N = 1), which are between 8.2 km northwest of Mina and 17.8 km southeast of Soledad over a road distance of about 42 km. Two samples containing ornate lizards from 0.6 km southeast of Soledad (NL-10, N = 1) and 4.0 km northwest of Soledad (NL-11, N = 6) suggest that *A. i. octolineata* replaces *A. i. inornata* to the northwest of NL-9. All 143 specimens of *A. i. octolineata* that we examined from 24 sites in southwestern Coahuila (Appendix 1) have ornate patterns consisting of 7+ (27.2%), 8 (38.1%), or 9 (34.5%) stripes.

No statistical differences were found between the pooled mean SVL for each of inornate females, inornate males, ornate females, and ornate males of our sample of 189 adult *A. inornata* from Coahuila and Nuevo León (Table 2). Likewise, we found no significant differences in scutellation (excluding PV and PV/GAB) between samples of inornate lizards collected at NL-2 in 1962 versus those from 1975 and 1980, between samples of ornate lizards collected at NL-2 in 1962 versus those from 1975 and 1980, or between all

samples of inornate and ornate individuals from NL-2 (Table 2). We suspect that the greater variation in GAB, OR, FP, COS, LSG, and ILS in ornate relative to inornate lizards from NL-2 is a reflection of the larger sample size of ornate lizards (N = 65 vs. 15, respectively). Sample sizes were sufficient (N ≥ 4) to compare scutellation data of inornate lizards from Nuevo León for only three sites: NL-2 (N = 15), NL-3 (N = 4), and NL-5 (N = 21). The only significant difference among these samples for the seven characters we studied was the number of FP between NL-2 (34.0 ± 0.51) and NL-5 (36.9 ± 0.56). Among the ornate lizards from Nuevo León, sample sizes were sufficient (N ≥ 6) to compare scutellation data for three sites as well: NL-2 (N = 65), NL-11 (N = 6), and NL-12 (N = 8). The only significant difference for nine characters in these samples (Table 1) was SDL between NL-2 (29.6 ± 0.20) and NL-12 (32.3 ± 0.49). We pooled all inornate and ornate individuals of *A. i. inornata* from Nuevo León into separate samples for comparisons of univarate meristic characters (Table 2). Significant differences were found between two characters in the pooled samples: OR (179.0 ± 1.26 for inornate and 182.6 ± 1.13 for ornate lizards) and FP (35.8 ± 0.37 for inornate and 34.8 ± 0.32 for ornate lizards). Examples of significant differences between Nuevo León and Coahuila samples of *A. i. inornata* are apparent in OR and PV (Table 2).

TABLE 2. Summary of meristic characters and SVL (see text for definitions of abbreviations) for *Aspidoscelis inornata inornata* (inornate) from Nuevo León and *A. i. octolineata* (ornate) from Nuevo León and Coahuila, México. Data are mean ± SE (first row) and range and (N) (second row).

Character	Nuevo León *A. i. inornata*	Nuevo León *A. i. octolineata*	Coahuila *A. i. octolineata*
GAB	70.5 ± 0.48 64–80 (44)	71.0 ± 0.38 64–81 (80)	68.7 ± 0.66 57–79 (59)
OR	179.0 ± 1.26 160–191 (44)	182.6 ± 1.13 154–205 (80)	172.4 ± 1.63 140–178 (59)
PV	— —	16.5 ± 0.30 13–21 (81)	14.5 ± 0.33 7–21 (59)
PV/GAB	— —	23.3 ± 0.30 17.8–30.4 (80)	21.0 ± 0.40 10.3–26.5 (59)
FP	35.8 ± 0.37 31–44 (44)	34.7 ± 0.28 32–40 (81)	34.8 ± 0.32 30–41 (59)
SDL	30.5 ± 0.24 27–34 (44)	30.0 ± 0.20 26–35 (81)	30.0 ± 0.32 26–37 (59)
COS	11.8 ± 0.30 7–15 (44)	12.1 ± 0.24 6–18 (81)	11.1 ± 0.26 6–15 (59)
LSG	27.6 ± 1.05 17–49 (44)	26.9 ± 0.63 17–47 (81)	28.0 ± 0.92 16–50 (59)
ILS	26.3 ± 0.78 17–41 (44)	26.2 ± 0.34 15–44 (81)	24.0 ± 0.79 11–48 (59)
SVL (females)	58.2 ± 0.71 52–64 (19)	57.6 ± 0.42 51–63 (44)	57.2 ± 0.84 51–64 (16)
SVL (males)	56.8 ± 0.46 51–62 (28)	57.4 ± 0.39 51–63 (45)	56.1 ± 0.55 52–65 (37)

Specimens of *A. inornata* referenced in this study voucher new distribution records extending the known range of this species in western Nuevo León well north of Villa de García. Several samples from northwest of Mina, which include only inornate lizards, indicate that true-breeding demes occur in the absence of ornate lizards in a sizeable area of northwestern Nuevo León. Consequently, we agree with Reeder et al. (2002) that the striped subspecies from Coahuila and several sites in Nuevo León, which was previously known as *A. i. inornata*, should be recognized as *A. i. octolineata*, and that the inornate form in Nuevo León be recognized as *A. i. inornata*. Moreover, our analyses of samples of *A. inornata* from UAZ and LACM collected in 1962 and 1975 revealed that the relative abundance of the inornate and ornate B–D variants at NL-2 might vary over time, possibly as a result of fluctuations in rates of gene flow among co-occurring populations of the color-pattern variants. The extent of geographic coexistence between inornate and ornate pattern types in the general vicinity of Villa de García appears to be on the order of a few hectares.

Elsewhere within the range of Little Striped Whiptail, there are either populations or individual lizards with dorsal patterns that trend toward the extreme inornate morph. Wright and Lowe (1993) described *A. i. gypsi* from the White Sands Missile Range (WSMR) in the Tularosa Basin, Otero County, New Mexico, based on a dorsal pattern of reduced contrast between stripes and fields. However, Rosenblum (2005, 2006) and Rosenblum et al. (2004) have intensively investigated the evolutionary and ecological implications of this blanched dorsum in *A. inornata*, but did not draw taxonomic conclusions. Persistence of this color combination on matching sand dune formations is an apparent result of selection for crypsis (Dixon 1967; Rosenblum 2005, 2006; Rosenblum et al. 2004), and may be an apomorphy of the pale stripes and dark fields in *A. i. llanuras* in areas peripheral to WSMR. We infer that complete loss of stripes in *A. i. gypsi* by gradualism is unlikely, as that would require loss of the genetic potential for organization of dorsal pigment into a lineate (i.e., ornate) pattern.

That an unstriped pattern can arise spontaneously in a population of *A. inornata* is shown by the discovery of such individuals at Picacho, west of the Río Conchos, Chihuahua. At Picacho, well within the range of *A. i. heptagramma*, there is a population of ornate lizards characterized by unusual striping among which inornate individuals are occasionally found (Cordes and Walker 1996; Walker et al. 1996, figure 2). Repeated visits to this site by JEC in different years produced no evidence that the proportion of inornate individuals is increasing in the population. Although the genetic basis of color expression in *A. inornata* is inadequately known despite intensive research on *A. i. gypsi* by Rosenblum et al. (2004), we suspect that the inornate pattern of *A. i. inornata*

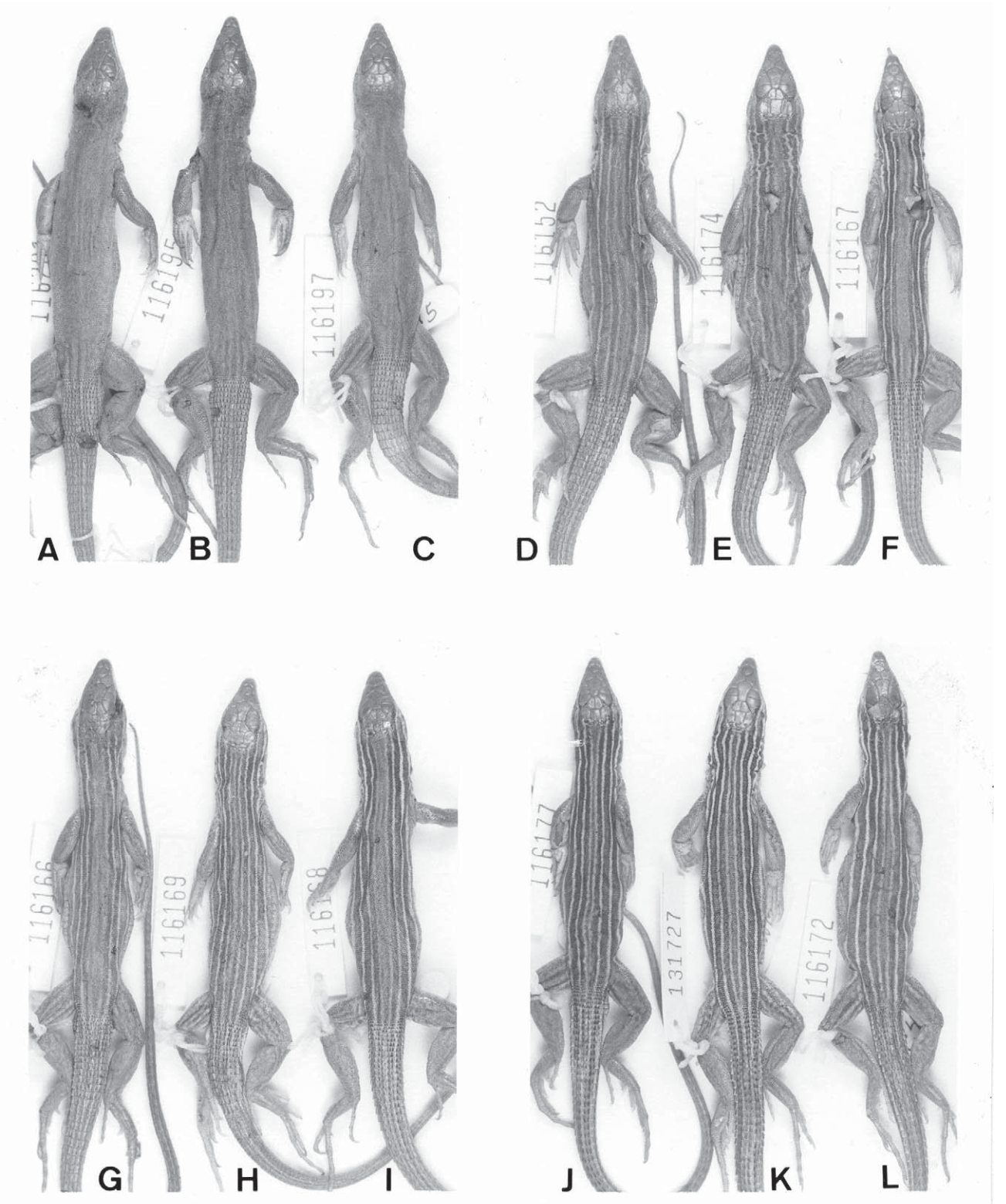


FIG. 1. Dorsal color-pattern variation in *Aspidoscelis inornata* from 1.6 km W, 1.6 km S of Villa de García (NL-2), Nuevo León, México in LACM collection (A, LACM 116201, 60 mm SVL; B, LACM 116195, 62 mm SVL; C, LACM 116197, 56 mm SVL; D, LACM 116152, 60 mm SVL; E, LACM 116174, 57 mm SVL; F, LACM 116167, 55 mm SVL; G, LACM 116166, 60 mm SVL; H, LACM 116169, 58 mm SVL; I, LACM 116168, 61 mm SVL; J, LACM 116177, 57 mm SVL; K, LACM 131727, 61 mm SVL; L, LACM 116172, 60 mm SVL). A–G, J are males; H–I, K–L are females.

in Nuevo León appeared suddenly as was reported for specimens with unstriped dorsal pattern at Picacho, Chihuahua (Walker and Cordes 1996). In fact, *A. i. inornata* is the only taxon in the diverse *A. sexlineata* species group characterized by absence of stripes at all ontogenetic stages of pattern development. We infer that this attribute in *A. i. inornata* represents one or more mutations

that have silenced the mechanism involved in the organization of pale dorsal stripes, as was deduced for the few individuals from Picacho, Chihuahua. Although contact zones for *A. i. inornata* and *A. i. octolineata* at Villa de García have been known from as early as the 1850s (Baird 1858) until as late as the 1980s (this study), elsewhere in Nuevo León the inornate subspecies has either replaced the ornate subspecies or now inhabits areas where it does not occur.

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Appendix 1

Specimens of *Aspidoscelis inornata inornata* (IN) and *A. i. octolineata* (OR) Examined

Exclusively ornate form: MÉXICO. Coahuila: UCM 37936: 8.2 km W of Monclova (C-1); TNHC 30301–02: 12.8 km NNE of Monclova (C-2); TCWC 43139–42: 54.1 km S of Monclova (975 m) (C-3); TCWC 43143–44: 5.1 km S of San Lazaro (1097 m) (C-4); TCWC 43145: 28.8 km N of Santa Cruz (C-5); TNHC 30679–82: 4.8 km SSE of Est. Gloria (C-6); TNHC 30688–89: 11.2 km SSE of Est. Gloria (C-7); TNHC 30692: 14.4 km SSE of Est. Gloria (C-8); TCWC 43569–71: 19.5 km SE of Castaños (26.6333ºN, 101.3167ºW, 930 m) (C-9); TCWC 43616–17: 23.0 km S of Castaños (26.6167ºN, 101.3500ºW, 1005 m) (C-10); TCWC 43572–89: 24.6 km SE of Castaños (26.60ºN, 101.2833ºW, 935 m) (C-11); TNHC 30268–69: 25.6 km S of Castaños (C-12); TNHC 30266: 35.5 km S of Castaños (C-13); TCWC 43590: 37.8 km SE of Castaños (26.5000ºN, 101.1333ºW, 1006 m) (C-14); TCWC 43612–15: 1.9 km S of Santa Teresa (26.4333ºN, 101.3500ºW, 1128 m) (C-15); TCWC 43618–21: 30.6 km E of Casas Colorados (26.2167ºN, 101.3833ºW, 1219 m) (C-16); LACM 130634: 24.0 km NW of Santa Cruz (C-17); LACM 130631–33: 25.3 km NW of Santa Cruz (C-18); UCM 37886–92: 7.2 km W of Ojo Caliente (C-19); UCM 37934: 28.3 km N of Saltillo (C-20); UCM 37935: 20.3 km N of Saltillo (C-21); UCM 37893–933: 12.2 km N of Saltillo (C-22); TNHC 30237: 22.4 km NNW of La Rosa (C-23); TNHC 30236: 16 km NNW of La Rosa (C-24).

Inornate (IN) and ornate (OR) forms: MÉXICO. Nuevo León: RWA 2779–84 (2783 = UTEP 14506) IN, RWA 2785–93 OR: 30–50 m E of highway and 10–15 m S of bridge over the Río Pesquería at Villa

de García (25.8167ºN, 100.5833ºW) (NL-1); UAZ 14067–75, LACM 116195–201, 131729–31 IN; UAZ 14076–88, 14093–95, 14097–102, LACM 116152–94, 131727–28, 131732–34 OR: 1.6 km W, 1.6 km S of Villa de García (NL-2); TCWC 44262–65 IN; TCWC 44261 OR: 14.1 km NW of Villa de García (25.8500ºN, 100.6833ºW, 716 m) (NL-3); TCWC 44266 IN: 1.6 km W of La Paz (25.9333ºN, 100.6500ºW, 716 m) (NL-4); TCWC 43591–611 IN: 8.2 km W of Mina by México Hwy 53 (26.0333ºN, 100.6667ºW, 671 m) (NL-5); TCWC 51814 IN: 8.5 km NNW of Mina (NL-6); TCWC 51815 IN: 14.4 km NNW of Mina (NL-7); RWA 6049–51 IN: 9.2 km N, 10.3 km W of Mina (26.0833ºN, 100.6306ºW, 644 m) (NL-8); TCWC 46866 IN: 17.8 km SE of Soledad (26.3333ºN, 100.8333ºW, 930 m) (NL-9); TCWC 46867 OR: 0.6 km SE of Soledad (26.4000ºN, 100.9667ºW, 640 m) (NL-10); TCWC 46868–73 OR: 4.0 km NW of Soledad (26.4333ºN, 101.0167ºW, 701 m) (NL-11); UCM 37937–45 OR: 1.3 km W of Casa Blanca (NL-12); (TCWC 51816–24 OR: 5.6 km W of Aramberri (24.1000ºN, 99.8167ºW) (NL-13); TNHC 30123–24 OR: 19.2 km S of El Canelo (NL-14); TNHC 30169 OR: 1.6 km S of San Roberto (NL-15); TCWC 56790 OR: 22.7 km N of Doctor Arroyo (NL-16); TCWC 56788 OR: 20.3 km N of Doctor Arroyo (NL-17).

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Discovery of a Surviving Population of the Montane Streamside Frog *Craugastor milesi* (Schmidt)

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Amphibian declines are taking place worldwide, but are most prevalent among montane stream-associated species in the neotropics (Stuart et al. 2004). Some of these declines are due to habitat loss, but many are taking place in seemingly pristine habitats (Stuart et al. 2004). Lips et al. (2006) reported the link between the chytrid fungus *Batrachochytrium dendrobatidis* and a rapid mass mortality and loss of amphibian diversity at a site in Panama. Pounds et al. (2006) provided evidence that the chytrid fungus in combination with global warming may be responsible for the disappearances of various species of the neotropical frog genus *Atelopus*.

The Honduran endemic montane streamside frog *Craugastor milesi* (Schmidt) was last seen alive in 1983, even though one of its known localities remains in a pristine condition (McCranie and Castañeda 2007; McCranie and Wilson 2002). Subsequently, numerous efforts to find this frog at its remaining pristine locality in Parque Nacional Cusuco have failed (McCranie and Castañeda 2007; McCranie and Wilson 2002; Townsend and Wilson 2008), even though it was a common frog at that locality in the late



FIG. 1. Adult male *Craugastor milesi* found 29 June 2008 in Parque Nacional Cusuco, Honduras.

1970s and early 1980s. Consequently, *C. milesi* was one of only nine New World anuran species classified as extinct by Young et al. (2004).

On 29 June 2008, an adult male *Craugastor milesi* (Fig. 1) was collected in Parque Nacional Cusuco while conducting a nocturnal herpetological survey. The site was located at an elevation of 1841 m and the weather was cool and breezy with light precipitation. A nearby data logger recorded the air temperature to be 16°C during this period of activity. The specimen was perched on a low branch along the edge of a small montane stream. This stream is a tributary of the larger Rio Cantilles, with which it joins approximately100 m downstream from the collection site. A skin swab was collected from this specimen for the detection of *B. dendrobatidis*. The sample was processed by PCR analysis and produced a negative result for infection.

On 30 June 2008 and 5–6 July 2008, extensive day and nighttime surveys of the same site and surrounding habitat failed to produce additional specimens of *Craugastor milesi*. During these surveys, four *Plectrohyla dasypus* larvae were collected from the stream and swabbed for *B. dendrobatidis*. Two of the four tadpoles exhibited severe oral defects and subsequently tested positive for infection. Surveys along portions of the nearby Rio Cantilles were similarly unsuccessful in locating additional *C. milesi*, but revealed the presence of *B. dendrobatidis* in six out of seven additional *P. dasypus* larvae. Although other *Craugastor* species could be found widely distributed across Parque Nacional Cusuco, the forest surrounding the *C. milesi* collection site appeared to be unusually devoid of terrestrial anurans.

The rediscovery of *Craugastor milesi* in Parque Nacional Cusuco is significant in light of the current global amphibian extinction crisis. Despite the common global threat of habitat destruction, the pristine condition of Parque Nacional Cusuco during the 1980s negates habitat destruction as a possible explanation for the unexpected disappearance of *C. milesi*. The most likely agent responsible for *C. milesi*'s demise, *B. dendrobatidis*, has recently

been identified in Parque Nacional Cusuco and may be responsible for the declining populations of several other critically endangered amphibian species in the park (Kolby et al. 2009). If true, the discovery of an uninfected adult *C. milesi* from within the heart of a *B. dendrobatidis*-ridden habitat produces hopeful implications for resistance to chytridiomycosis, as it is highly unlikely that this individual successfully evaded infection throughout development while being exposed to contaminated water sources.

On 14 July 2007, a specimen with striking resemblances to *C. milesi* was encountered in direct proximity to the confirmed collection site in 2008, but efforts to capture and positively identify this specimen proved unsuccessful at the time. Although a genetically robust population of *C. milesi* may exist in Parque Nacional Cusuco, it is too early to estimate the extant population size and determine whether this species is rebounding from the brink of extinction or still in a period of decline.

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Observations on the Ecology of *Trachemys adiutrix* and *Kinosternon scorpioides* on Curupu Island, Brazil

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Brazil has an extensive coastline in the state of Maranhão, including many islands and a continental area called the "Baixada Maranhense," where several turtle species of the families Chelidae, Pelomedusidae, Kinosternidae, and Emydidae occur. Both *Kinosternon scorpioides* and *Trachemys adiutrix* occur on Curupu Island. *Kinosternon scorpioides* lives in both still and running water, frequently in areas affected by human activity, especially drainage canals (Pritchard and Trebbau 1984). This species is distributed from Mexico to South America, where it thrives along the coast in Colombia, Guiana, Trinidad, and Brazil as well as the interior of the Amazon to Bolivia (Pritchard and Trebbau 1984). The genus *Trachemys* ranges from North America into Central America (Savage 1966), southern Brazil, Uruguay, and Argentina (Vanzolini 1995) and has the largest geographic distribution of any turtle genus in the New World (Seidel 2002). *Trachemys adiutrix* is an aquatic species that inhabits permanent and seasonal bodies of water, and may move great distances during the rainy season (Vanzolini 1995). The only published reference on *Trachemys* in Maranhão is the original description of *T. adiutrix* from the northeastern region of the state (Vanzolini 1995). Information on the occurrence of *K. scorpioides* in the coastal region of Brazil consists of one record reported by Pritchard and Trebbau (1984), who observed the species on Marajó Island, Pará state. Because little is known of *K. scorpioides* and *T. adiutrix*, we report data on selected aspects of their biology in the coastal zone of northeastern Brazil. We specifically examined reproductive ecology (nesting behavior and season) and population structure of these two species.

Materials and Methods

Curupu Island (2.4025°S, 44.0219°W) is located ca. 30 km from the center of São Luís, state of Maranhão, Brazil. The island is ringed by extensive sandy beaches, with flooded fields, marshy vegetation, dunes, freshwater lagoons, and mangroves further inland. The rainy season extends from January to June and the dry season from July to December. Two-day sampling periods were conducted every 15 d throughout the year from August 2000 to March 2002 (Figs. 1, 2). During each sampling period, data were

collected between 0500 h and 1200 h. During each field visit, we captured turtles in three lagoons located in the central part of the island. These lagoons were located ca. 20 m apart and were ca. 400 m^2 in area each. They ranged from oligotrophic to eutrophic and contained an abundance of macrophytes, pteridophytes, macroalgae, and fish. Turtles were collected using baited funnel traps (one trap per lagoon) constructed of wooden slats with a funnel entrance. These traps were made by the local community using wood stems or wire, and were similar to crayfish traps (Rocha et al. 1997). Traps were baited with fresh fish and placed in the water 2–3 m from shore the night before the sampling period. We also recorded any sightings of turtles moving across land during each sampling period.

Reproductive ecology.—The time period when females were gravid was determined by inguinal palpation (Pritchard and Trebbau 1984), and the nesting period was determined by the presence of nests in the wild. We searched for nests every 15 d in two consecutive days during only the dry season of the sampling period, totaling 20 d of searching. Turtle nests were located each morning (between 0500 h and 0600 h) by following tracks left by nesting females in the sand. We measured the eggs (length and width) of one nest found intact to the nearest mm using dial calipers. The period of hatchling emergence of both species was determined by the presence of hatchlings in traps of local fishermen. All hatchlings caught were measured. They were identified as hatchlings by their thin carapace, caruncle, and lack of growth rings.

Analysis of population structure.—Population structure of the two species was estimated by quantifying the distribution of number of individuals in different size classes and sexes throughout the year. All animals were measured using straight-line maximum carapace length (SCL) and plastron lengths to the nearest mm with calipers**,** sexed, and marked with a unique cut in the center of the marginal scutes (Cagle 1939). All turtles were immediately released at their point of capture after processing. Turtles were individually marked as part of an ongoing research project. The sex of the animals was determined by examination of tail length (for both species) and plastron concavity (only for *K. scorpioides*) (Pritchard and Trebbau 1984) and, for analysis of size distribution the individuals from each species were grouped into 1 cm size classes. A one-way ANOVA was used to determine whether there was a significant difference in mean size (CL) between males and females in each species. The overall sex ratio was compared to an expected sex ratio of unity using a chi-square test. We had no reason to suspect that this population exhibited a 1:1 ratio, and were merely using the 1:1 ratio as a reference point for comparison. All statistical analyses were performed with STATISTIC v. 6.0 (Statsoft 2001) and according to Sokal and Rohlf 1981.

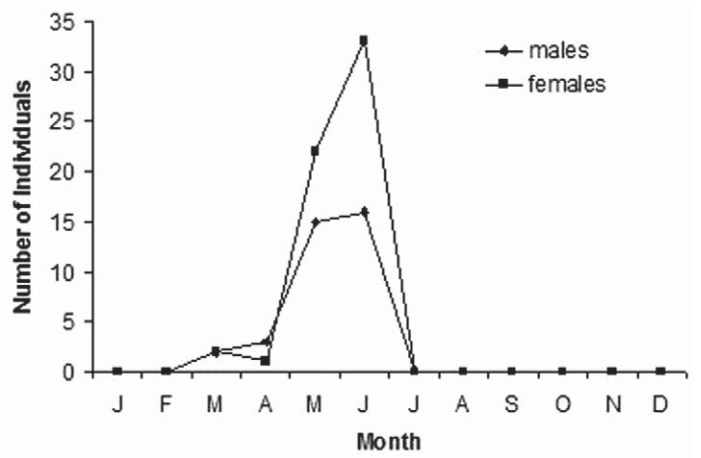


FIG. 1. Number of male and female *Kinosternon scorpioides* captured by month during the sampling period from August 2000 to March 2002.

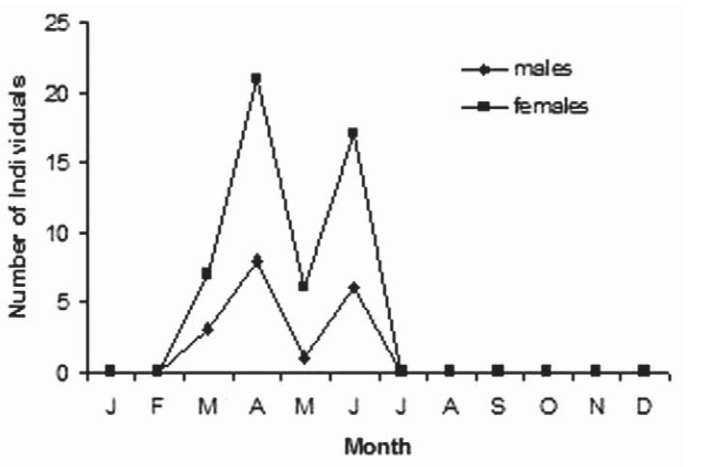


FIG. 2. Number of male and female *Trachemys adiutrix* captured by month during the sampling period from August 2000 to March 2002.

We separated mature and immature individuals for the two species based on the minimum size of carapace length of gravid females found in this study, supplemented with information in the literature from closely related species (e.g., Bager 2003; Iverson 1986; Pritchard and Trebbau 1984) and unpublished data of a specialist (R. Vogt). Adult female *Kinosternon scorpiodes* are sexually mature at 10.4 cm CL and males are mature at 10.1 cm in the Yucatan Peninsula of Mexico (R. Vogt, pers. comm.). *Trachemys adiutrix* are considered adults in seasonal lakes when males reach 9.9 cm CL and females 10.1, in permanent lakes when males reach 13.7 cm and females reach 16.5 cm (Batistella 2008). For this study, we considered an age estimation of maturity for *K. scorpioides* and *T. adiutrix* individuals with minimum carapace length of 10.0 cm for males and females.

RESULTS AND DISCUSSION

Turtles were observed crossing dunes, in grassy areas, and in the bottom of lagoons. The bottom of the lagoons are full of organic material and mud. Individuals of both species were observed throughout the sampling period walking across dunes during the early morning (0600 h) and late afternoon (1800 h).

Gravid turtles were captured during August (N = 38 for *K. scorpioides*; N = 4 for *T. adiutrix*). We found gravid females with maximum and minimum carapace length sizes of 13.7 and 10.0 cm for *K. scorpioides*, and 15.0 and 12.8 cm for *T. adiutrix*, respectively. Fifteen nests were observed in the study area, but identification to species was not possible because the nests had been ravaged by predators (probably foxes, *Cerdocyon thous*, T. Oliveira, pers. comm.). The nests were observed in grassy areas 15–20 m from water. All nests were found between August and

December, during the dry season, with the greatest number being recorded in October and December (N = 7 and 5, respectively). In October 2001, one intact *T. adiutrix* nest was found. This nest was in sandy substrate shaded by grass, was 9.4 cm deep and 11.5 cm in diameter, and contained six elongated eggs with parchment-like shells. Mean egg size was 3.8 ± 0.08 cm (3.7–3.9) in length and 2.4 ± 0.04 (2.4–2.5) in width.

Three *K. scorpioides* hatchlings had a mean carapace length of 3.5 ± 0.07 cm (3.47–3.61). Hatchling *T. adiutrix* (N = 23) had a mean SCL of 3.5 ± 0.2 cm (2.79–3.78). All of these hatchlings were captured in January and February.

We captured 109 *K. scorpioides*; the overall sex ratio (45 females: 35 males = 1.28) did not differ significantly from unity (χ^2 = 4.24, df = 3, P = 0.23). We captured 69 T. adiutrix; 20 females and 15 males. The overall sex ratio was 1.34:1, again not significantly different from unity (χ^2 = 11.83, df = 6, P = 0.06) (see Figs. 1–2 for details). The most abundant size class of *K. scorpioides* was the 11–12 cm size class, and for *T. adiutrix* in the 8, 9, and 15 cm size class (Figs. 3 and 4, respectively). Male *K. scorpioides* were significantly larger than females (F = 12.57, df = 39, P = 0.001). There was no significant difference in size between male and female *T. adiutrix* (F = 0.66, df = 23, P = 0.42).

In our study, hatchling *K. scorpioides* had a mean CL of 3.5 cm and were observed at the onset of the rainy season. We suspect that larger hatchlings had grown prior to first capture because smaller hatchling sizes have been reported than those observed in our study (see Pritchard and Trebbau 1984). Rocha and Molina (1990) reported a mean CL of 2.85 cm for hatchlings incubated in captivity.

In the coastal area of Maranhão State, Vanzolini (1995) observed that *T. adiutrix* laid its eggs in sand close to the water, similar to our observations. Molina (1996) observed that *T. dorbignyi* females in captivity preferred to lay their eggs in a predominantly sandy substrate and in areas without vegetation. The nesting period of *T. dorbignyi* in captivity extends from August to January with the majority of egg laying being concentrated in October and November (Molina 1995, 1996). Rocha and Molina (1990) observed that the nesting period of *K. scorpioides* in captivity lasted from March to August during the dry season. In our study area, the majority of nests were discovered during October and December during the dry season.

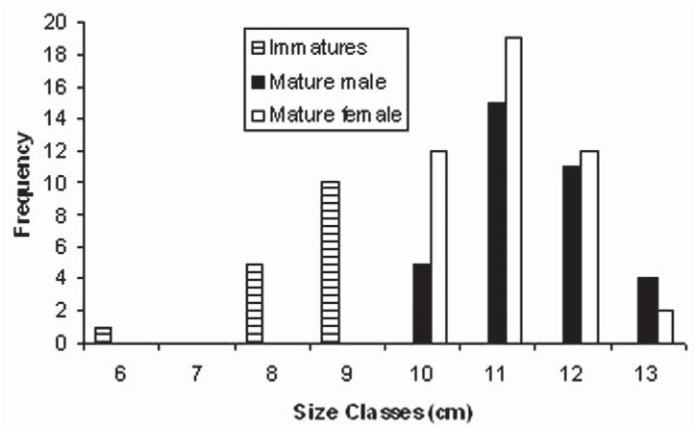


FIG. 3. Size distribution of *Kinosternon scorpioides* at Curupu Island, Maranhão, Brazil from turtles trapped January 2001 to December 2002.

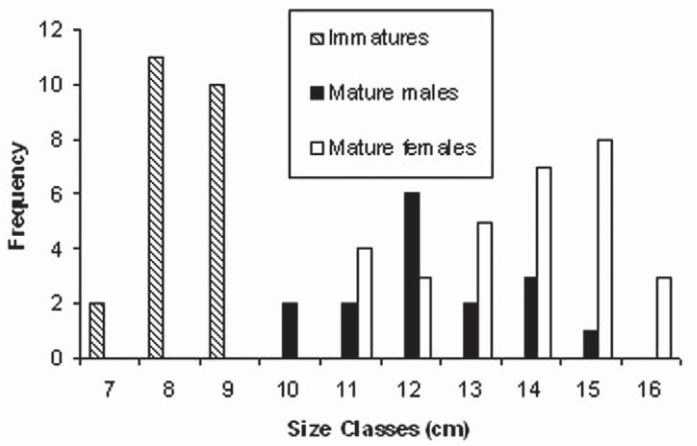


FIG. 4. Size distribution of *Trachemys adiutrix* at Curupu Island, Maranhão, Brazil from turtles trapped January 2001 to December 2002.

The relatively small maximum size of *T. adiutrix* (16 cm) can probably be linked to the hunting of these animals by local people in the study area on Curupu Island, and not because the entrance of the traps prohibited catching larger turtles. In Curupu, because larger sizes of *T. adiutrix* are targeted for their meat, hunting may remove the largest animals from the population. In another locality (Caju Island in Maranhão State) where there is no turtle hunting, we found turtles larger than 21 cm (L. Barreto, pers. obs.).

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Foraging Ecology of Spotted Turtles (*Clemmys guttata*) in Ontario, Canada

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The conservation of animal species relies on the identification and protection of suitable habitat. While general habitat features are important to the success of vertebrate ectotherms because they provide structures for thermoregulation (Blouin-Demers and Weatherhead 2001; Downes and Shine 1998) and predator avoidance (Spencer 2002), biotic elements such as food resource use and distribution are often overlooked in studies of habitat selection. Qualitative descriptions of diet do little to further the understanding of resource use and requirements, which ultimately affect the fitness of individuals. The recent use of stable isotope analysis has shed light on the relationship between foraging ecology and nutrient assimilation in some turtle species (Aresco and James 2005; Bulte and Blouin-Demers 2008; Hatase et al. 2006; Seminoff et al. 2007). Detailed observations of species-specific foraging behavior assist in the implementation of stable isotope analysis by focusing sampling efforts on likely prey, reducing potential costs and time spent in the field.

The Spotted Turtle (*Clemmys guttata*) is a species for which diet and foraging behavior have been qualitatively described (Ernst 1976; Milam and Melvin 2001; Surface 1908). Stomach content analyses of 27 Spotted Turtles revealed three individuals with plant material, while all individuals contained aquatic and terrestrial invertebrates in their guts (Surface 1908). These findings were supported by Ernst's (1976) observations of Spotted Turtles ingesting both plant and animal materials. Spotted Turtles are noted to be opportunistic omnivores, with a highly variable list of diet items including cranberries, earthworms, aquatic insect larvae, crustaceans, snails, salamanders, fish, birds, algae, and tadpoles (Ernst 1976). The relative importance of these food items has not been reported. Spotted Turtles are cold-tolerant and most active in the early spring (Ernst 1976, 1982; Haxton and Berrill 1999; Litzgus and Mousseau 2004; Milam and Melvin 2001; Ward et al. 1976), but they have not been recorded foraging in water cooler than 14°C (Ernst 1976). The broad distribution of this species, as well as differing habitat use between northern and southern populations (Haxton and Berrill 1999; Litzgus and Mousseau 2004; Milam and Melvin 2001; Ward et al. 1976), indicate that detailed dietary and foraging choices should be documented to further our understanding of resource use and habitat selection. In Canada, Spotted Turtles are listed as an endangered species (COSEWIC 2004), and declines and local extirpations have been documented within Ontario despite habitat protection (Browne and Hecnar 2007). Recovery plans should take into account resource distribution, as well as general habitat qualities, in order to create effective management guidelines for this species. The purpose of our study was to quantify dietary choices in a population of Spotted Turtles and describe foraging behaviours observed in natural settings.

Materials and Methods.—The foraging ecology of Spotted Turtles in a population on the shores of Lake Huron in Ontario, Canada was documented during a radio telemetry study in 2007 and 2008. The study site consists of a 95-ha mosaic of Great Lakes coastal wetlands bounded by forested swamps, upland forests, and minimal human development. One hundred and seventeen individuals (54 females, 49 males, 14 juveniles) were captured and marked (Cagle 1939), with an equal distribution of adult males and females ($\chi^2 = 0.24$, df = 1, $p > 0.05$). Fifteen individuals (5 males, 10 females) were located 2–4 times a week from April to August 2007 and 2008 using radio telemetry, with up to 16 additional females located daily during June of both years. Transmitters (SI-2F and SI-2T, 12g, Holohil Systems Ltd, Carp, Ontario) were attached to the rear marginal scutes using copper wire and putty epoxy. Turtles without transmitters were also observed opportunistically. Behavior was characterized for each turtle sighting over the entire study period. Foraging behavior was defined as any aquatic or semi-aquatic activity in which the turtle was actively searching, grabbing, or biting at items. Target items were identified by observing the item during the foraging period, and any unidentifiable items were recorded as "unknown." For each individual turtle observed foraging, ambient air (10 cm from the ground in shade), substrate surface (direct sunlight on substrate), and water temperature (mid-depth of water column) were measured to 0.1°C using a digital thermometer. Temperature-sensitive transmitters allowed the estimation of turtle body temperature from the pulse rate.

Results.—Two hundred and twenty-seven foraging observations were made during the study (Table 1), all within 2–40 cm of water. The greatest proportion of foraging observations were of turtles taking aquatic invertebrates (74%), followed by fish (~16%). Foraging was observed throughout the active season (April to Au-

gust) in both years; however, observations of foraging were more numerous in the earlier months (Fig. 1). While the number of observers (MLR and JEP) remained constant over both years of the study, it is likely that experience gained in 2007 contributed to an increase in overall sightings in 2008. To account for this, monthly observations are presented as percentages of the total observations per year (Fig. 1).

In 2007, water temperatures recorded during foraging ranged from 13°C to 33.8°C. In 2008, water temperatures ranged from 7.7°C to 31.7°C. For individuals outfitted with radio transmitters in 2008, estimated body temperature during foraging ranged from 9.9°C to 31.9°C. Prey items chosen were not related to differences in water temperatures ($F = 0.44$, $df = 3,164$, $p = 0.72$) or estimated turtle body temperatures ($F = 0.09$, $df = 3,113$, $p = 0.96$).

TABLE 1. Observations of foraging by Spotted Turtles (*Clemmys guttata*) in Ontario, Canada over the course of a two-year (2007, 2008) radio telemetry study. Targets indicated by * were consumed as carrion.

Target Item	2007	2008	Total	% of Foraging Observations (excluding unidentified targets)
Aquatic Invertebrates Total	13	19	32	74.0
Freshwater snails	8	8	16	37.2
Trichoptera	1	4	5	11.6
Leech	1	0	1	2.3
Crayfish	1	0	1	2.3
Unidentified	2	7	9	20.9
Vegetation	0	1	1	2.3
Rainbow Trout (*Onchorhynchus mykiss*)*	0	1	1	2.3
Carp (*Cyprinus carpio*)*	0	2	2	4.6
Small Ciprinids and other minnows*	2	2	4	9.3
Leopard Frog (*Rana* [*Lithobates*] *pipiens*)*	1	0	1	2.3
Tadpoles (*Bufo* [*Anaxyrus*] *americanus*)	0	1	1	2.3

Discussion.—The large proportion of invertebrates in Spotted Turtle diets observed in our study agrees with findings of the stomach content analysis by Surface (1908), and foraging observations by Ernst (1976). When consuming hard-shelled snails, individuals would repeatedly bite and release the snail, eventually consuming the soft body and discarding the hard shell. While the majority of animal materials were assumed to be consumed post-mortem, tadpoles were consumed live. Stomach content analysis by Surface (1908) indicated the presence of land-dwelling invertebrates. Whether these items were captured on land or accidentally fell into the water was unknown. Foraging for terrestrial prey was confirmed once during our study. An individual male was observed in shallow water (3 cm) positioning himself vertically using his front legs, and biting at the remains of a spider's web hung between short rushes. Capture and consumption of the spider or items in the spider web was not directly observed. This observation would suggest that while Spotted Turtles are confined to consuming prey items aquatically, these prey items could be captured in a terrestrial environment.

Observations of foraging behavior were most numerous in May, June, and July, with few observations in August (Fig. 1). Foraging is probably most important in early spring after emergence from hibernation, and during the mating and nesting seasons. The energetic demands of sperm production, egg production, copulation, and nesting (Hughes and Brooks 2006; Morreale et al. 1984; Pearse and Avise 2001) require a large effort to be expended in resource gathering early in the season for turtles at northern latitudes. The lack of foraging observations in August could be due to periods of inactivity. Aestivation has been observed in Spotted Turtles and is thought to conserve energy and water during high temperatures in the summer months (Ernst 1982; Perillo 1997). However, temperature data gathered in one Ontario population documented that inactive individuals were not choosing cooler microclimates, and therefore may not be aestivating (Litzgus and Brooks 2000). Alternatively, higher August temperatures may allow turtles to forage in more heavily-vegetated waters reducing our ability to observe foraging behavior later in the season. Capital energy acquired during foraging late in the summer may help supplement income energy gains during the limited time available for foraging between emergence and reproductive activities the following year (Gregory 2006).

Prior to our study, Spotted Turtles were not recorded foraging in waters cooler than 14°C (Ernst 1976). In both years, we observed individuals foraging in water cooler than this minimum. In 2007, we observed foraging at 13°C and made multiple observations of foraging in water temperatures as low as 7.7°C in 2008. We

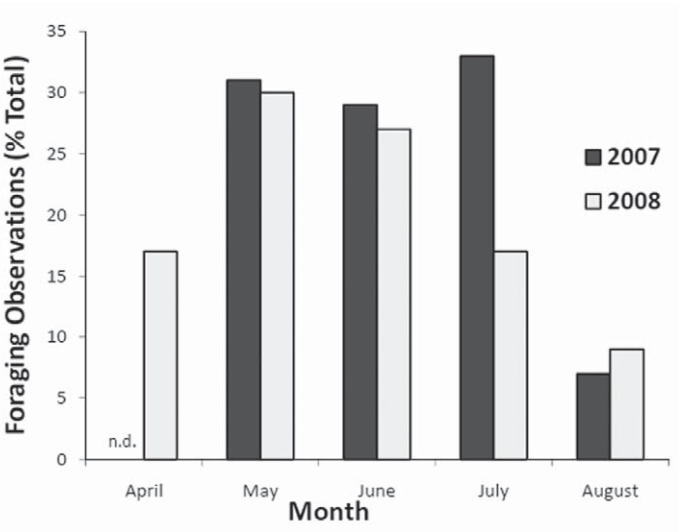


FIG. 1. The percentage of foraging behavior observations for Spotted Turtles (*Clemmys guttata*) in Ontario, Canada for the active seasons of 2007 (black, N = 58 observations) and 2008 (white, N = 170 observations). In April 2007, a lack of researcher presence resulted in no data being collected, denoted as "n.d." on the graph.

did not detect prey choice differences at different environmental temperatures, and this can be explained by the apparently opportunistic nature of foraging. The ability of Spotted Turtles to forage at low temperatures may give them a fitness advantage in the unpredictable and short active seasons typical of northern climates. The acquisition of resources during the active season is vital to an individual's survival from year to year, and also to their ability to produce offspring (Litzgus and Brooks 1998; Litzgus et al. 2008). If Spotted Turtles are restricted by variable water levels in their shallow wetland habitats, then the ability to forage successfully in the cooler months of April and May would certainly be advantageous.

Our study quantitatively highlights the relative importance of food items in the diet of a population of Spotted Turtles. The importance of vegetative matter in Spotted Turtle diets, at least in our population, appears to be minimal. Close observation revealed that although they may appear to be targeting aquatic vegetation, it is in fact most likely that individuals are seeking small freshwater snails and benthic invertebrates within the matrix of aquatic vegetation. This vegetative material may not contribute to energy stores. Stable isotope analysis combined with stomach content analysis in Snapping Turtles (*Chelydra serpentina*) showed that although large amounts of vegetation may be found within the stomach, little of this is translated into tissues (Aresco and James 2005). It appears as though Spotted Turtles are most dependent on macroinvertebrates, with a strong tendency to detect and consume carrion. Future studies of Spotted Turtle foraging ecology should examine the importance of various diet items through stomach content analysis coupled with radio-isotope analysis to explore the relative importance of various food items in tissues, as well as the turtle's trophic position in aquatic ecosystems. This information should be used to supplement habitat selection studies in dictating protection and enhancement guidelines for the continued presence of this species in our ecosystems.

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Herpetofaunal Conservation in the Rainforest: Perceptions of Ecotourists

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The Tambopata region of Peru has the highest overall species diversity of reptiles and amphibians recorded in the world (Doan and Arizábal 2002). Notable amphibians include five species of poison dart frogs and 45 tree frog species (Doan and Arizábal 2002). Three large reptile species are under threat of extinction due to harvesting for eggs or skins: the black caiman (*Melanosuchus niger*), the spectacled caiman (*Caiman crocodilus*), and the yellow-spotted river turtle (*Podocnemis unifilis*) (Kirkby et al. 2000). Ecotourists visiting the Tambopata region have the opportunity to see many herpetofaunal species during their visit.

The rise of ecotourism in Latin America has brought a mix of benefits and problems for local people, national economies, and natural habitats (Groom et al. 1991). In the Tambopata region of Peru, the number of rainforest tourist lodges has increased greatly in recent years, with a corresponding influx of foreign visitors (Groom et al. 1991; Kirkby 2002). As tourist lodges seek greater profits by attracting more visitors, the local habitats may be stressed or altered (Doan 2000; Fennell 1999; Grossberg et al. 2003; Mieczkowski 1995; Orams 2002; Wheeler 1997). Moreover, tourist operations may affect the behavior (Arianoutsou, 1988; Grossberg et al. 2003) or populations (Kirkby and Cornejo Farfán 2000) of fauna in an attempt to create a memorable experience for visitors. Offering guided hikes into the rainforest and boat journeys on rivers allows tourists to encounter many animal species. In some cases guides or other lodge personnel may capture certain animals so that tourists can observe the animals up close. In most cases the animals are then released back into their natural habitat. In addition, many tourist operators capture and restrain animals so that they remain near the lodge, forming a zoo-like atmosphere for personal encounters with animal species (Orams 2002; pers. observ.). Capturing, restraining, and provisioning wild animals have been hypothesized to be detrimental to wild animal populations (Orams 2002).

The practice of capturing or caging animals at ecotourist lodges may have two impacts on the rainforest experience of the ecotourists that visit such lodges. The first effect would be a positive one, where the tourist is able to view animals that are not easily viewed or view animals at close proximity that are normally wary of the presence of humans. In this case, the tourism experience is enhanced by close contact with animals. However, as many international ecotourists are well educated, environmentally conscious individuals (Sekercioglu 2002), it is possible that the practices of capturing and provisioning animals would be perceived negatively, because tourists may be aware of the potential detrimental effects on the captive or tame animals and their populations.

The perceptions of ecotourists toward the treatment of wild animals may differ depending on the animal group concerned. Tourists are thought to have deep affection for animals such as monkeys and birds, but lower affection for less desirable animals such as turtles or frogs (Pough et al. 2004; Tremblay 2002). Many bird watchers are content to devote much time and money to viewing interesting bird species. Moreover, the thoughts of ecotourists about the conservation status of less desirable animals such as reptiles and amphibians may be far removed from their feelings about well-liked mammals and birds. Tourists who are highly concerned about the well being of mammals and birds may have little or no interest or concern for reptiles and amphibians.

Tambopata, Peru currently has twelve large tourist lodges lining the Madre de Dios and Tambopata Rivers, in addition to several smaller lodges (Kirkby 2002). Among these lodges, the policies and practices of capturing, restraining, and provisioning wild animals differ from an absolute ban on these practices, to common use of such practices, including the viewing of captive and tame animals as one of the primary foci of the rainforest lodge experience. As pointed out by Budowski (1976), ecotourists may not always be lucky enough to encounter the large charismatic mammals or birds that they wish to see, but they have a good chance to see the smaller creatures, such as reptiles and amphibians. To determine if the conservation practices of rainforest tourist lodges in southeastern Peru matched the wishes of their ecotourists, tourists were requested to fill out a questionnaire that queried their attitudes towards a rather unpopular group of animals: reptiles and amphibians.

Methods

Study Area.—The study took place in the Tambopata Province of the Madre de Dios Department of southeastern Peru. The four tourist lodges included in the study lie in the buffer zone surrounding the Reserva Nacional Tambopata. This region has seen a marked increase in tourism in the past 25 years and tourism has become one of the most important industries for the region (Groom et al. 1991; Kirkby 2002). The habitat in the Tambopata Province is classified as a Tropical/Subtropical Moist Forest according to the Holdridge system (Gentry and León 1997; Holdridge et al. 1971) and receives an average of 2400 mm of rain annually (Duellman 2005).

The majority of tour visits to each of the four lodges last two nights, although longer tours are available. A typical tour package includes retrieval of the visitors at the airport in Puerto Maldonado on the first morning, followed by bus and boat transport to the lodge. An orientation talk and afternoon hike complete the first day. The second morning guides take groups out for a longer hike that may include a canoe ride on an oxbow lake. The second afternoon is typically free and the second night may offer a lecture by one of the guides or visiting scientists and/or a boat excursion on the river to view caimans, other nocturnal wildlife, and the stars. During the nocturnal boat trip guides may capture small caimans and bring them aboard the boat to show the tourists, after which the caimans are released back into the river. The next morning the tourists are taken back to the airport for their return flight to Cusco or Lima.

Ecotourist Questionnaire.—During 1997 and 1998 tourists at four ecotourism lodges in the Tambopata Province, Peru were asked to fill out a questionnaire during the last night of their rainforest visit. Both English and Spanish versions of the

questionnaire were offered. All guests were invited to fill out the questionnaire but a small percentage (<5%) declined to partake in the survey. The four lodges were: EcoAmazonía (EA) and Reserva Amazónica (RA; formerly named Cuzco Amazónico; Duellman and Koechlin 1991) on the Madre de Dios River and Explorer's Inn (EI; Erwin 1984) and Libertador Tambopata Lodge (LTL; formerly named Tambopata Jungle Lodge; Yu et al. 1997) on the Tambopata River. The questionnaire asked tourists to rate familiarity, viewing desirability, and feelings about the conservation status of the avifauna and herpetofauna (bird questionnaire results are not presented in this paper). They were additionally asked if they would like the lodges to capture animals during guided trips or to keep animals as pets of the lodge. The herpetofaunal portion of the English questionnaire is depicted in Figure 1.

Not all respondents answered every question; therefore, the results of each question are based on different total numbers. Chi-square goodness-of-fit statistical tests were conducted for question numbers 16–23. For each of these, the number of agree and strongly agree responses were tested versus disagree and strongly disagree responses. For these statistical tests, neutral responses were not used (they were a miniscule fraction of responses on most questions). Chi-square tests were also used for question 24, with one test used to determine if there were significant differences in "1" responses (largest threat) and another test used to determine if there were differences in "6" responses (least threat).

Results

In total 129 questionnaires were filled out by ecotourists at the four sites included in the study (EA 26; RA 14; EI 13; LTL 26; the remainder did not indicate which lodge they had visited). Nineteen of the questionnaires completed were the Spanish version and 110 were the English version. Ecotourists that filled out questionnaires ranged in age from 14–82 years and were from 17 different countries (Argentina, Australia, Belgium, Canada, France, Germany, Ireland, Israel, Italy, Luxemburg, The Netherlands, New Zealand, Peru, Spain, Switzerland, United Kingdom, and United States). The mean age of the respondents was 41.2 years and the most common nationalities were United States (29.09%), Australia (16.36%), Canada (12.73%), and the United Kingdom (10.00%). All other nationalities were represented by less than 10 respondents. Of the tourists that indicated their gender, 56 were male and 56 female. Thirty-two respondents (28.6%) stated that they have a scientific background or qualifications. A summary of the questionnaire results is given in Table 1.

Familiarity and Local Experience.—Out of the reptile and amphibian groups about which tourists were asked to rate familiarity, tree frogs were the most familiar animals. Tourists were least familiar with poison dart frogs and coral snakes. Tourists claimed to have seen a wide variety of reptiles and amphibians during their stay. Although crocodiles do not occur in the area, four tourists claimed to have seen both caimans and crocodiles during their lodge visit.

Desire to View.—Tourists wished to see a large variety of reptiles and amphibians. The most popular animals were caimans, followed closely by boa constrictors, but no tourist wished to see venomous snakes and two respondents stated they did not wish to see any reptiles or amphibians at all.

When asked if they would like to see more reptiles and amphibians than they had seen during their stay, the large majority of tourists stated that they would. The difference between respondents who answered agree or strongly agree versus those who answered disagree or strongly disagree was highly significant, both for amphibians and reptiles.

Although not regularly offered by any of the lodges included in this study (but sometimes offered on an ad hoc basis), the large majority of tourists (91.1%) would like to participate in a night hike to view nocturnal animals, including most reptiles and amphibians.

Caiman Viewing.—Just over half (59.8%) of tourists who responded participated in a nocturnal boat journey to view caimans (primarily spectacled caimans, *Caiman crocodilus*). All of the respondents to this question (n = 67) but one saw caimans during their trip. The number of caimans seen by individuals ranged from one to ten.

Pets and Capture of Reptiles and Amphibians.—Contrary to the beliefs of most of the lodge operators and guides (pers. comm.), the large majority of tourists (91.8%) did not wish to see reptiles and amphibians kept as pets and did not approve (94.2%) of guides capturing caimans during the nocturnal boat ride.

Conservation.—The large majority of tourists (95.4%) agreed that reptile and amphibian conservation is as important as bird and mammal conservation and perceived that deforestation was seen as the most important threat (57.1% ranked it number 1), whereas tourism and global warming were seen as least threatening to reptile and amphibian species (41.9% and 32.4%, respectively, ranked them number 6).

More Information Needed.—Seventy-three percent of responding tourists felt that they needed additional information regarding venomous snakes in the area. Suggestions by the lodge tourists were a nighttime presentation in the dining room and that in general more information about all snakes, both venomous and nonvenomous, would be welcome.

Discussion

The highly significant results of this study were remarkable. Contrary to expectations and the beliefs of tourist operators at the four lodges included in this study, visitors had strong interest in reptiles and amphibians. Despite their low level of familiarity prior to the visit, nearly all visitors expressed interest in observing more reptiles and amphibians, and most tourists wished to participate in a night hike. None of the four tourist lodges included in this study regularly offer night hikes to their visitors. Tourist operators may think that tourists would rather rest at night or would be fearful of walking in the forest at night, but the results of this study clearly show the contrary. Tourist operators could increase the unique experience of the rainforest visit for their tourists by offering night hikes, allowing their guests to see not only many more amphibians and reptiles, but also give them the chance to see other nocturnal animals, such as tarantulas, opossums, bats, and owls. Also, tourists would have the opportunity to understand the differences in the ecology of nocturnal animals versus diurnal ones.

A significant majority of visitors would like to view more reptiles and amphibians in their natural setting and did not wish to have

Project Tambopata Ecotourism Questionnaire

13). Which groups of reptiles and amphibians are you familiar with? Circle all that apply.

Tree Frogs	Crocodiles
Pit Vipers	Poison Dart Frogs
River Turtles	Boa Constrictors
Caimans	Coral Snakes

14). Which reptiles and amphibians did you see during your stay at the lodge? Circle all that apply.

Turtles	Venomous Snakes
Lizards	Crocodiles
Nonvenomous Snakes	Tree Frogs
Poison Dart Frogs	Caimans

15). Which reptiles and amphibians would you most like to see during your stay at the lodge? (Please rank: 1=most like to see, 9=least like to see).

Caimans	Boa Constrictors
Poison Dart Frogs	Turtles
Venomous Snakes	Crocodiles
Tree Frogs	Lizards
No Reptiles or Amphibians	

16). Did you participate in a nighttime boat ride to view caimans? YES NO

17). If so, did you see caimans during the trip? YES NO
How many?

For Statements 18-23, mark 1-5 where:

1=Strongly Agree	4=Disagree
2=Agree	5=Strongly Disagree
3=Neutral	

18). I would like to see more amphibians.
19). I would like to see more reptiles.
20). The lodge should keep captive reptiles and amphibians for viewing by the tourists.
21). If it were offered by the lodge, I would like to go on a night walk in the forest to see night-active reptiles and amphibians.
22). The lodge should capture caimans during the nighttime caiman viewing session so that the tourists can see them better.
23). Endangered reptiles and amphibians should be protected as endangered mammals and birds are.

24). What are the biggest threats to reptile and amphibian species in the rainforest (Please rank: 1=largest threat, 6=least threat).

Deforestation	Hunting
Collection for Pet Trade	Water Pollution
Tourism	Global Warming

25). Do you think that there should be more information available about venomous snakes in the area? YES NO
Why?

26). Are you male or female?

27). What is your age?

28). What is your nationality?

29). Which lodge did you visit?

30). Are you a bird watcher? YES NO

31). Do you have any scientific background or qualifications? YES NO

Thank you for taking part in this questionnaire!

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Coordinator of Avifauna

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Coordinator of Herpetofauna

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Coordinator of Herpetofauna

PROJECT TAMBOPATA, TRES-RAMOS, CASILLA 28, PUERTO MALDONADO, PERU

FIG. 1. The English language version of the herpetofaunal questionnaire. Questions 1–12 surveyed the tourists about birds and are not included in this study.

TABLE 1. Results of select questions of the questionnaire. *n* is total responding for each question.

Question	*Answers*				*n*	χ^2	*p*
Tourists are familiar with:	Tree Frogs	81	Crocodiles	76	105		
	Pit Vipers	40	Poison Dart Frogs	27			
	River Turtles	68	Boa Constrictors	71			
	Caimans	72	Coral Snakes	35			
During their stay tourists saw:	Caimans	85	Nonvenomous snakes	25	109		
	Turtles	68	Poison dart frogs	10			
	Lizards	67	Venomous snakes	5			
	Tree frogs	44	Crocodiles	4			
Tourists would most like to see:	Caimans	39	Crocodiles	4	104		
	Boa constrictors	25	Lizards	1			
	Poison dart frogs	9	Venomous snakes	0			
	Tree frogs	6	No reptiles or amphibians	2			
	Turtles	6					
Tourists would like to see more amphibians:	Strongly agree	49	Disagree	0	109	90.000	< 0.001
	Agree	41	Strongly disagree	0			
	Neutral	19					
Tourists would like to see more reptiles:	Strongly agree	48	Disagree	4	110	72.516	< 0.001
	Agree	41	Strongly disagree	2			
	Neutral	15					
Tourists would like to participate in a night walk:	Strongly agree	42	Disagree	4	112	60.844	< 0.001
	Agree	40	Strongly disagree	4			
	Neutral	22					
The lodge should keep captive reptiles and amphibians:	Strongly agree	4	Disagree	33	110	68.612	< 0.001
	Agree	4	Strongly disagree	57			
	Neutral	12					
The lodge should capture caimans to show the tourists:	Strongly agree	2	Disagree	28	111	80.398	< 0.001
	Agree	4	Strongly disagree	69			
	Neutral	8					
Reptiles and amphibians should be as protected as birds and mammals:	Strongly agree	84	Disagree	1	109	88.926	< 0.001
	Agree	19	Strongly disagree	4			
	Neutral	1					
Largest threat to herpetofaunal conservation:	Deforestation	72	Hunting	13	126	163.333	< 0.001
	Water pollution	23	Global warming	5			
	Collection for pet trade	13	Tourism	0			
Least threat to herpetofaunal conservation:	Tourism	62	Hunting	12	107	119.242	< 0.001
	Global warming	48	Water pollution	10			
	Collection for pet trade	14	Deforestation	2			
Tourists request more information about venomous reptiles:	Yes	73	No	27	100		

them captured or kept as pets. Two of the tourist lodges included in this study (EA and RA) have recently devoted much of their effort into raising animals as pets or attracting them to the lodge with food. Although the animals they currently restrain and attract have been mammals and birds, it is conceivable that they would also keep animals such as tortoises or frogs as pets. The results of this study clearly show that keeping reptiles or amphibians as pets would be contrary to the wishes of the ecotourists.

In addition, respondents were concerned about the conservation of reptiles and amphibians. They cared about the conservation status of these strange, unfamiliar animals, just as they would for more charismatic mammals and birds. Ecotourists considered deforestation to be the most important threat to reptile amphibian conservation by far. Few tourists considered water pollution, collection for the pet trade, hunting, global warming, or tourism to be important threats. While deforestation is obviously an important threat for

all rainforest species (Duellman and Trueb 1986; Laurance and Bierregaard 1997), collection for the pet trade of animals such as boa constrictors, and hunting of caimans and river turtle eggs also are deleterious to local populations (Duellman 2005; Kirkby 2002; Pough et al. 2004). In addition, water pollution has been shown to impact amphibian populations in some areas (Duellman and Trueb 1986; Stebbins and Cohen 1995), and global warming has been hypothesized to be contributing to the global amphibian population decline (Pough et al. 2004; Stebbins and Cohen 1995). Tourists in Tambopata need to receive more education about the potential threats to the herpetofauna to be fully informed about conservation issues affecting local species.

The results of this study seemed to be consistent over all groups of people who responded to the questionnaire—nationalities, genders, and ages, and did not depend upon which lodges the tourists were visiting. This suggests that these results may be broadly applicable to other rainforest lodges and, perhaps, to other areas of the world. Ecotourism has the potential to be a sustainable form of utilizing rainforest resources (Groom et al. 1991; Scace 1993), and the encouraging results of this study suggest that the visitors to Tambopata may contribute to sustainability by promoting responsible ecotourism.

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Distribution and Natural History Notes on Some Poorly Known Frogs and Snakes from Peninsular Malaysia

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Despite having been studied for many years, the status and knowledge of the herpetofauna of Peninsular Malaysia is far from being complete or fully understood. Although relatively recent new species discoveries have added significantly to the overall biodiversity of the region (Chan and Grismer 2008; Chan et al. 2009; Das et al. 2007; Das and Lim 2001; Grismer and Chan 2008; Grismer et al. 2006 and references therein; Grismer et al. 2008a, b, c; Grismer et al. 2009; Grismer and Norhayati 2009; Leong and Lim 2003; Matsui and Jaafar 2006; McLeod and Norhayati 2007; Van Rooijen and Vogel 2008; Vogel and Van Rooijen 2007; Wood et al. 2008, 2009), information on existing species are still inadequate or lacking altogether. Alongside these new findings, intensive and systematic field work has also uncovered a number of rare species (e.g., *Cyrtodactylus sworderi*, Grismer et al. 2007; *Enhydris pahangensis*, Chan, *in press*) which have not been recorded since their discoveries in the early 1900s. Many of these species lack complete descriptions and/or proper color illustrations and next to nothing is known about their life history as they have rarely been observed in the wild. This paper addresses some of these issues by providing expanded descriptions, color photographs, life history observations, and new locality records of the more poorly known frogs and snakes of Peninsular Malaysia.

Materials and Methods

Color photographs were taken for vouchers and color pattern comparisons. Measurements were taken with Mitutoyo digimatic caliper to the nearest 0.1 mm. Measurements taken for frogs are as follows: snout–vent length (SVL); tibia length (TiL), measured from the center of the knee to the centre of the ankle. For snakes: snout–vent length (SVL); tail length (TaL), from cloaca to tail tip; number of dorsal scale rows (DoS), counted at one head length posterior to head, at midbody, and one head length anterior to vent; number of ventral scale rows (Ven); number of supralabials (SupL), with the number of SupL in contact with the orbit in brackets; number of infralabials (InfL). Voucher specimens or photographs are provided to support new locality records. All specimens have been deposited at the museum of the Department of Wildlife and National Parks Peninsular Malaysa (DWNP) and the herpetological collection at Universiti Kebangsaan Malaysia (UKM). HC refers to the Herpetological Collection of Universiti Kebangsaan Malaysia (UKM), Bangi, Selangor, Peninsular Malaysia; UKMDPC refers to Universiti Kebangsaan Malaysia Digital Photograph Collection; LSUDPC refers to the La Sierra University Digital Photograph Collection. Institutional abbreviations follow Leviton et al. (1985), except we retain ZRC for USDZ, following conventional usage. Measurements taken on voucher specimens are presented in Table 1.

Results

Species accounts

Rhacophorus robinsoni Boulenger 1903
Robinson's Treefrog
Fig. 1

Rhacophorus robinsonii Boulenger 1903 *in* Annandale and Robinson (eds.), Fasciculi Malayenses, 2(1):136. Type locality: "Bukit Besar. 2500 feet", Pattani, Thailand.
Rhacophorus (Rhacophorus) robinsonii Ahl 1931:157
Rhacophorus pardalis robinsoni Wolf 1936:208
Rhacophorus robinsoni Inger 1954:372; Berry 1975:109; Manthey & Grossman 1997:138; Das & Norsham 2007:70

Description. SVL male 59 mm; female 82 mm; Vomerine teeth in two long oblique series touching the inner edge of the choanae; snout obtusely pointed; canthus rostralis sharp; tympanum distinct, as high as wide; supratympanic fold distinct, outlined with black, extends horizontally posterior to the orbit, slants, and ends abruptly posterior to the tympanum.

Finger tips expanded into large disks bearing circum-marginal and transverse ventral grooves; width of three outer fingers equal to tympanum diameter; broad webbing reaches base of disks of outer three fingers but only halfway to disk of first finger; nuptial pad present in males. Toe disks smaller than those of fingers, bearing circum-marginal and transverse ventral grooves; completely webbed to disks on all toes; a small inner metatarsal tubercle; no outer metatarsal tubercle.

Skin above smooth; slightly granular on flanks and throat; belly covered with large, smooth, rounded granules; arms and tarsus without flaps of skin; no anal flap.

Color in life. Pale brown or dark chocolate brown to light green above; two thin, black bars on the head, one crossing the snout, and another longer bar between the orbits; dorsum scattered with dark blotches; with or without a white spot below the tympanum; sides of head a darker shade of brown; flanks, inner and outer sides of limbs yellowish with black and whitish-blue reticulations; limbs bearing dark cross-bars; interdigital webbing black with fine brown veins; throat whitish, mottled with brown; belly white with dark reticulations. Juveniles: yellow to orange interdigital webbing; underside of the body yellowish.

Life history. *Rhacophorus robinsoni* inhabits primary or old, undisturbed secondary forests and has been found on tree tops as high as 10 m above the forest floor (Grismer et al. 2004) and on leaves as low as 1 m above the ground. Like many of its other congeners, frogs descend lower to the ground following heavy rainfall to breed along stagnant puddles or ponds. However, one specimen from Ulu Gombak was found sitting on a leaf during an extremely dry night when no other frogs were abroad and Grismer et al. (2004) recorded a gravid female during the day, crouched in

the interstices of truck tracks on a logging road far from any body of water.

Distribution in Peninsular Malaysia. Kuala Teku, Pahang (Berry 1975); Gombak, Selangor (Yong 1977); Temenggor, Perak (Grismer et al. 2004); Cameron Highlands, Pahang; Kampung Chennah, Negeri Sembilan (this report).

Notes. In Peninsular Malaysia, *Rhacophorus robinsoni* has only been recorded three times, the first being from Kuala Teku, Pahang in the early 1900's (Boulenger 1912) and the second from Gombak, Selangor (Yong 1977). A third specimen was reported by Grismer et al. (2004) from Temenggor Forest Reserve, Perak, but was left unidentified (*Rhacophorus* sp.). This species has since been found at Cameron Highlands, Pahang (UKMDPC 1.0002) and Kampung Chennah, Negeri Sembilan (HC 191,192; Fig. 1). Given the current distribution pattern of *R. robinsoni* which ranges from southern Thailand to its southernmost record in Negeri Sembilan, it is likely that this species has a wider distribution range and probably occurs throughout Peninsular Malaysia.

Theloderma leprosa Tschudi 1838
Fig. 2

Theloderma leprosa Tschudi 1838, Classification der Batrachier, 32: 73. Type locality: "Sumatra", Indonesia.
Hyla leprosa Schlegel 1858:55
Theloderma leprosum Boulenger 1884:21
Polypedates leprosus Günther 1887:315
Rhacophorus leprosus Boulenger 1890:324; Berry 1975:100
Theloderma leprosa Das & Norsham 2007: 71

Description. SVL 65 mm; Vomerine teeth in two short series touching the inner front edge of the choanae; head broader than long; canthus rostralis visible, angular; lores distinctly concave; nares protruding from snout with an internarial sulcus; tympanum distinct, ¾ eye diameter, ellipsoidal, covered with small, rounded warts not bearing asperities; supratympanic fold absent. Finger tips expanded into disks bearing circum marginal grooves; fingers free of web; outer metacarpal tubercle present; nuptial pad present in males. Disks of toes smaller than those of fingers, bearing circum marginal grooves; toes nearly entirely webbed, reaching disks of third and fifth, third phalanx of fourth; subarticular tubercles well developed; inner metatarsal tubercle present.

Entire upper surface covered with prominent warts of varying sizes, all bearing granular asperities; a series of large, ridge-like warts on back and hind limbs; throat with raised granules bearing apical asperities; chest and belly covered with large, smooth, rounded granules.

Chocolate to grayish brown above; asperities on warts whitish which gives it a speckled appearance; underside of body, lower side of flanks and inner side of limbs black with whitish and pale blue reticulations; interdigital webbing and disks orange.

Life history. *Theloderma leprosa* has been observed in tree-holes as high as 3 m above ground (pers. obs.) The size of these large thelodermids (Max. SVL 65 mm) may play a role in habitat stratification within this group, with smaller congeners (*T. asperum, T. horridum*, and *T. licin*) and other tree-hole dwellers (*Metaphrynella pollicaris* and *Phrynella pulchra*) occupying smaller tree holes and cavities closer to the ground. Thus far, frogs have only been found in primary and old secondary forests where bigger trees are presumably able to provide the specific microhabitat requirements for these large tree-hole breeders. Berry (1975) noted that a specimen was found in a hole made by cicadas in the ground while Dring (1979) found a specimen on a palm leaf 1.5 m above ground at 790 m in elevation. *Theloderma leprosa* appears to be a high altitude species, occurring at elevations of approximately 800 m and above sea level.

Distribution in Peninsular Malaysia. Bukit Larut, Perak; Gunung Angsi, Negeri Sembilan; Gunung Tapis, Pahang (Berry 1975); Gunung Lawit, Terengganu (Dring 1979); Cameron Highlands, Pahang; Gunung Besar Hantu, Negeri Sembilan (this report).

Notes. *Theloderma leprosa* was first discovered in the Malay Peninsula by Mr. L. Wray from Larut Hills [Bukit Larut], Perak at 4000 feet elevation (Boulenger 1912). Subsequent locality records were from Gunung Angsi, Negeri Sembilan (at 2600 feet) and Gunung Tapis, Pahang (Berry 1975). Dring (1979) reports this species from Gunung Lawit, Terengganu. Since then, this species has also been discovered in Cameron Highlands, Pahang and Gunung Besar Hantu, Negeri Sembilan (HC 281; Fig. 2). Thus far, *T. leprosa* has been shown only to occur at high elevations in all three of Peninsular Malaysia's main mountain ranges, Bukit Larut on Banjaran Bintang; Cameron Highlands, Gunung Besar Hantu and Gunung Angsi on Banjaran Titiwangsa; Gunung Lawit and Gunung Tapis on Banjaran Timur. Following such trends, this species is likely to occur on other mountain tops throughout those mountain ranges.

Hylarana siberu (Dring, McCarthy & Whitten 1990)
Fig. 3

Rana siberu Dring, McCarthy & Whitten 1990. *Indo-Malayan Zoology*, 6(1989): 119-132. Type locality: "Teitei Bulak, Sabeuleleu, Siberut [Island], 1° 21´S, 98° 59´E", Mentawai Islands, Indonesia.
Rana (Pulchrana) siberu Dubois 1992:326
Pulchrana siberu Frost et al. 2006:369
Hylarana siberu Che et al. 2007:1

Description. SVL male 39.5 mm; female 44.9 mm; Skin above smooth, slightly rugose on back, flanks and underside of body. Tympanum visible, slightly higher than wide, about ½ eye diameter; supratympanic fold absent. Nuptial pads absent in males; humeral glands enlarged. Fingers with rudimentary web; outer metatarsal tubercle round, inner one oval. Web reaching one half phalanx of first toe and first phalange of second toe, one half phalanx between second and third toes, base of disk of third toe and second phalanx of fourth toe, two half phalanges between fourth and fifth toes; inner metatarsal tubercle oval. Dorsum completely black without markings; complete or nearly complete reddish/orange dorsolateral stripe from rostrum, along the canthal region, lateral margin of upper eyelid, along body and terminating at sacral region; series of small, white spots on upper labial; flanks and upper side of limbs with round, creamy yellow spots, sometimes connected together forming short, roundish streaks; throat and underside of limbs whitish, heavily stippled with dark brown; belly whitish with dark brown reticulations

Life history. *Hylarana siberu* inhabits lowland primary forest and has been found along the edge of a temporary pool in a swampy area away from streams. Another specimen was caught in a pit-fall trap away from streams as well which may indicate that this species is not a riparian as is its putatively close relative

Hylarana picturata which it most closely resembles.

Distribution in Peninsular Malaysia. Lakum Forest Reserve, Pahang (Leong and Lim 2004); Kuala Gandah, Pahang (this report).

Notes. *Hylarana siberu* was previously known from the Indonesian Island of Siberut (west Sumatra) and Sumatra only (Dring et al. 1990). The first record of this species in Peninsular Malaysia was of a single adult male from the Lakum Forest Reserve, Pahang (Leong and Lim 2004). This paper reports the second known specimen of an adult female (DWNP 1189; Fig. 3) from Kuala Gandah, Pahang, approximately 25 km from Lakum Forest Reserve. In Peninsular Malaysa, *H. siberu* most closely resembles *H. picturata* but differs by having an immaculate dorsum vs. a spotted dorsum; continuous, unbroken dorsolateral stripe vs. discontinuous dorsolateral stripe formed by closely linked spots; and reduction in webbing on toes vs. nearly full webbed.

Reptilia

Calliophis gracilis Gray 1835
Spotted Coral Snake
Fig. 4

Calliophis gracilis Gray 1835. Illustrations of Indian Zoology, chiefly selected from the collection of Major - General Hardwicke. Vol. 2. London (1833–1834): 263 pp.
Callophis gracilis Günther 1864
Elaps nigromaculatus Cantor 1847:1029
Callophis gracilis Boulenger 1912:203
Calliophis gracilis Tweedie 1983:110
Calliophis gracilis Welch 1994:39; Slowinski, Boundy & Lawson 2001

Description. Body slender, relatively long, up to 740 mm total length; tail very short, terminating in a blunt point; dorsal scales arranged in 13/13/13 rows; ventrals 303–324; subcaudals 21–28; six supralabials, 3rd and 4th touching the orbit; five infralabials.

Body gray above with a thin, black, vertebral stripe connected to a series of small black spots. Similar lateral stripe connects a series of larger, black spots which alternate with smaller, vertebral spots. Top of head with dark, symmetrical markings. Underside of body with alternating black and yellow bands. Underside of tail banded black and orange.

Life history. A specimen from Cameron Highlands was found by Orang Asli collectors above 700 m elevation. At Bukit Lagong, Selangor, a subadult specimen was observed in the afternoon, swimming across a dammed-up portion of stream at 350 m elevation.

Distribution in Peninsular Malaysia. Penang, southern Perak, Selangor (Boulenger 1912); Fraser's Hill, Pahang (Leong and Lim 2003); Cameron Highlands, Pahang (this report)

Notes. According to Cantor (1847), *Calliophis gracilis* is common in the hills of Penang but no reports of this species have been made from that island since his early observations. In Selangor, this snake is known from Gombak and Bukit Lagong, Kepong.

Xenelaphis ellipsifer Boulenger 1900
Ocellated Brown Snake
Fig. 5

Xenelaphis ellipsifer Boulenger 1900. Description of new reptiles and batrachians from Bomeo. Proc. Zool. Soc. London: 182–187. Type locality: Sarawak river.
Xenelaphis ellipsifer Tweedie 1983:48; Manthey & Grossmann 1997: 396; Malkmus et al. 2002:369

Description. Maximum recorded length 2320 mm; 1-2 preoculars, one subocular, two postoculars; one loreal; 8-9 supralabials; 2+2 or 1+2 temporals; dorsal scales arranged in 17/17/15 rows; 186–203 ventrals; anal plate divided; 129–134 subcaudals. Brown above, paler on the sides with a series 18-20 black, circular or ellipsoidal markings, each crossing the back and touching the ventrals on either side; the circles are bordered externally with paler brown or white and in between each circle, lower on the sides is an irregularly shaped black spot; top of head and neck rusty brown with longitudinal black markings on side of neck; sides of head and neck yellow; belly creamy white.

Life history. *Xenelaphis ellipsifer* inhabits primary and old secondary forests from lowlands to 1100 m in elevation. Adults probably feed on fish and rodents while juveniles prefer fish, frogs and lizards (Malkmus et al. 2002). According to the Orang Asli collectors who found this species in Kampung Chennah, Negeri Sembilan, the snake was abroad at night, foraging in and along a moderately flowing stream and was quick to escape when approached. The same snake was observed along the same stream a number of instances which might suggest a narrow home range.

Distribution in Peninsular Malaysia. Bukit Larut, Perak; Cameron Highlands, Pahang (Tweedie 1983); Gombak, Selangor (pers. comm.); Kampung Chennah, Negeri Sembilan (this report).

Notes. *Xenelaphis ellipsifer* was not known from Peninsular Malaysia until 1954 when a specimen was found in a collection from Bukit Larut, Perak. It was then the fifth specimen of *X. ellipsifer* known to science, with previous records being from Borneo and Sumatra (Tweedie 1983). Lim (1958) reported a skin obtained from Cameron Highlands in 1957. Since then, *X. ellipsifer* has not been seen until Sheperd and Auliya (pers. comm.) reported a sighting of this species at Gombak, Selangor. Following that, another specimen was found by Orang Asli collectors in the lowland forests of Kampung Chennah, Negeri Sembilan which constitutes a new locality record (HC 194; Fig. 5).

Oligodon signatus (Günther 1864)
Barred Kukri Snake
Fig. 6

Simotes signatus Günther 1864. The Reptiles of British India. London (Taylor & Francis), xxvii + 452 pp.

FIGURES 1–8, OPPOSITE PAGE.

FIG. 1. *Rhacophorus robinsoni* from Kampung Chennah, Negeri Sembilan (HC 191).

FIG. 2. *Theloderma leprosa* from Gunung Besar Hantu, Negeri Sembilan (HC 281).

FIG. 3. *Hylarana siberu* from Kuala Gandah, Pahang (DWNP 1189).

FIG. 4. *Calliophis gracilis* from Cameron Highlands (HC 193).

FIG. 5. *Xenelaphis ellipsifer* from Kampung Chennah, Negeri Sembilan (HC 194).

FIG. 6. *Oligodon signatus* from Kampung Chennah, Negeri Sembilan (HC 196).

FIG. 7. *Asthenodipsas malaccanus* from Gunung Besar Hantu, Negeri Sembilan (HC 195).

FIG. 8. *Enhydris pahangensis* from Nenasi Forest Reserve, Pahang (HC 198).


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Oligodon signatus Wall 1923; Tweedie 1985:53; Hendrickson 1966:67; Manthey & Grossman 1997:373

Description. Maximum length 600 mm; seven supralabials, third and fourth contact orbit; loreal usually present, rarely absent on one side of the head; dorsal scales arranged in 17/15/15 rows; 141–157 ventrals; 47–60 subcaudals. Chocolate brown above with a series of reddish, chevron-like markings mid-dorsally that begin just posterior to the nape until the tip of tail. Markings are spaced approximately 8–10 scales apart at midbody. These markings are larger and more elongate at the anterior portion of the body and decrease in size towards the tail. Underside of body pinkish red.

Life history. This semi-fossorial snake inhabits lowland to upper hill forests.

Distribution in Peninsular Malaysia. Selangor; Malacca (Batchelor 1958); Gunung Panti Forest Reserve, Johor (Yong 2006); Cameron Highlands, Pahang; Kampung Chennah, Negeri Sembilan (This report).

Notes. In Peninsular Malaysia, Batchelor (1958) reports *Oligodon signatus* from Selangor and Malacca. Yong (2006) reports a specimen from Gunung Panti Forest Reserve, Johor, which was positively identified from a roadkill. Two additional localities reported here are Kampung Chennah, Negeri Sembilan (HC 196; Fig. 6) and Cameron Highlands, Pahang (UKMDPC 1.0077). The latter represents the northern most record for this species.

Asthenodipsas malaccanus
Malayan Slug Snake
Fig. 7

Asthenodipsas malaccana Peters 1864. Über neue Amphibien (*Typhloscincus, Typhlops, Asthenodipsas, Ogmodon*). Mber. k. preuss. Akad. Wiss., Berlin: 271–276.
Amblycephalus malaccanus Boulenger 1892; De Rooij 1917
Pareas malaccanus Robinson & Kloss 1920; Grandison 1972, 1978
Internatus malaccanus Rao & Yang 1992
Asthenodipsas malaccanus Iskandar & Colijn 2002; Grossman & Tillack 2004

Description. Body cylindrical with a very weak vertebral ridge; 6–8 supralabials, 3rd and 4th, rarely only 3rd touching orbit; 5–7 infralabials; dorsal scales arranged in 15/15/15 rows; 154–180 ventrals; 26–56 subcaudals. Ground color of dorsal surface of body and tail greyish brown; top and sides of head and supralabials dusky white smudged with irregularly shaped, gray to brown markings; iris red; dull, white, vertebral line extending posteriorly approximately 14 scale rows connects white head markings with first white, dorsal body band; dorsum overlain with approximately 28 irregularly shaped to squarish, white vertebral blotches; some blotches occur only on one or the other side of the vertebral region, covering 3–5 scale rows; others straddle the vertebral region covering 5–7 scale rows; series of broken to continuous white markings on vertebral scales connect dorsal blotches; brown stippling on centralmost scales of blotches give blotches a smudged appearance; sides of body and tail immaculate; infralabials, gular region and throat white with dark grey-brown mottling; ventral scales grayish brown, slightly lighter than color of dorsum; white midventral line extends from throat to tip of tail.

Life history. A gravid female carrying three eggs was found above 800 m elevation on Gunung Besar Hantu, Negeri Sembilan during the month of September (HC 195; Fig. 7).

Distribution in Peninsular Malaysia. Asahan Estate, Malacca; Gunung Benom, Pahang; Perak; Selangor (Tweedie 1983); Endau-Rompin National Park, Johor (LSUDPC 4860); Gunung Besar Hantu, Negeri Sembilan (this report).

Notes. *Asthenodipsas malaccanus* ranges from Thailand, through Peninsular Malaysia to Indonesia (Sumatra and the Mentawai Islands). Stuebing and Inger (1999) reported this species from Borneo, however, we have examined a series of eight specimens of *A. malaccanus* from Thailand, Indonesia, and Peninsular Malaysia, including the holotype (see appendix) and found them to differ notably from the Bornean population by having a weak vertebral ridge vs. a strong ridge; and a blackish dorsum with white, squarish, paravertebral blotches vs. a tan dorsum with dark, vertical bars. Therefore, we consider the *A. malaccanus* of Borneo to be a potentially new species.

Enhydris pahangensis
Pahang Water Snake
Fig. 8

Enhydris pahangensis Tweedie 1946. Tweedie, M.W. F. 1946. A new snake from the Malay Peninsula. Ann. Mag. nat. Hist. (11) 13 (98):142–144.

Description. Males up to 300 mm SVL; females up to 392 mm SVL; dorsal scales arranged in 25/25/21 rows; 129–132 ventrals; 47–55 subcaudals; eight supralabials, 4th touching the orbit; 11 infralabials. Grayish or yellowish brown above with a series of paired, dark spots beginning from the nape to the base of tail. Spots are usually half a scale wide and may not always be parallel to each other. Anterior portion of the head darkly stippled, slightly darker than ground body color. Labials white, heavily stippled with black. A cream-colored lateral stripe on each side of the body extends from the side of the head to the tail tip. On the body, this stripe covers four of the lowest dorsal scale rows, reduced to three towards the vent. The stripe is bordered above and below by a black zig-zag line, the line bordering the ventral scales is thicker and more pronounced. Ventrals white, edged with black, with an antero-medial dark blotch on each ventral scale. Chin scales white, mottled with black.

Life history. This species inhabits primary or undisturbed secondary forests and has been found among decaying leaves in a stagnant portion of a small and slow moving stream.

Distribution in Peninsular Malaysia. Kuala Tahan, Pahang (Tweedie 1983); Sungai Kura, Hulu Terengganu (Chan, *in press*); Nenasi Forest Reserve, Pahang (this report).

Notes. In Peninsular Malaysia, *Enhydris pahangensis* most resembles *E. plumbea* but differs by having 25 dorsal scale rows vs. 19; a creamy lateral stripe distinctly bordered above and below by a black zig-zag line vs. a creamy lateral stripe lacking distinct zig-zag borders; labials, chin scales, and anterior portion of snout mottled with dark gray vs. no mottling; ventral and subcaudal scales white, edged with black and an antero-medial dark blotch on each ventral scale vs. immaculate white. Previously, *E. pahangensis* was only known from the type specimen from Kuala Tahan, Pahang. Subsequently, a second specimen was collected from Hulu Terengganu (Chan, *in press*), thereby expanding its

distribution to the neighboring state. We report of a third locality from Nenasi Forest Reserve, Pahang (HC197, HC198; Fig. 8). Due to its close resemblance to *E. plumbea* whose identity it has probably been masquerading under most of the time, this species is likely to encompass a wider distribution which might be revealed upon closer examination of existing museum specimens.

Discussion

Herpetofaunal surveys generally result in skewed observation frequencies with some species observed much more frequently than others (e.g., Das 1996; Murphy et al. 1994; Ziegler 2002) and several factors can contribute to the perceived rarity of a particular species. First, some species are rarely seen simply because of their association with specific, isolated, habitats like forest canopies, karst formations, mountain tops or islands (e.g., Chan and Grismer 2008; Chan et al. 2009; Grismer and Chan 2008; Grismer 2007, 2008; Grismer et al. 2008a, b, c; Stuebing and Tan 2002). Surveys to these locations are usually more infrequent resulting in fewer reports. Other factors include elusive lifestyles or morphology (nocturnal or fossorial habits and camouflage) and the fact that some species do actually occur in low densities. These factors are difficult to disentangle in practice unless very strict survey methodologies are applied. However, species abundance patterns in many taxa are known to correspond roughly to a log-normal distribution with some species being abundant and many occurring in low densities (e.g., Limpert et al. 2001; Longino et al. 2002; Loreau 1992). Not surprisingly, such uneven species abundance patterns also appear to hold true for reptiles and amphibians. For instance, Lloyd et al. (1968) carried out a very thorough herpetological survey in a lowland rainforest in Sarawak and concluded that the herpetofaunal species abundance is fairly uneven, with other workers coming to similar conclusions (e.g., Dash and Mahanta 1993; Inger and Colwell 1977; Karns et al. 2005).

Knowledge on the herpetofauna of Peninsular Malaysia has seen great progress in recent years with new locality records and new species growing at an unprecedented rate (Chan and Grismer 2008; Chan et al. 2009; Grismer 2008; Grismer and Chan 2008; Grismer and Pan, 2008; Grismer et al. 2004, 2006; Wood et al. 2008, 2009). Such reports are crucial for biogeographic studies and focus on the importance and utilization of regional checklists which are not to be underestimated. Grismer and Pan (2008) highlighted regions of Peninsular Malaysia most understudied and suggested areas where focused research efforts should continue and Grismer et al. (2009) stressed the importance of looking more closely at species that have already been collected. This two-pronged approach to studying the diversity of this region's herpetofauna has already proved invaluable (see the review by Grismer et al. 2009) and will only generate more discoveries as time passes.

Acknowledgments.—We thank L. Lee Grismer and Johan van Rooijen for their critical insights, comments, and contributions.

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Table 1. Measurements taken for examined specimens. See methods and materials for abbreviations. Blank = not applicable.

Species	Locality	Mus. No.	Sex	SVL	TiL	TaL	DoS	Ven	SubC	SupL	InfL
Rhacophorus robinsoni	"Kampung Chennah, Negeri Sembilan"	HC 191	Adult Male	59.2	25.7						
Rhacophorus robinsoni	"Kampung Chennah, Negeri Sembilan"	HC 192	Juvenile	30.4	13.9						
Theloderma leprosa	"Kampung Chennah, Negeri Sembilan"	HC 281	Adult Male	61.1	33.1						
Hylarana siberu	"Kuala Gandah, Pahang"	DWNP 1189	Adult Female	37.7	16.9						
Calliophis gracilis	"Cameron Highlands, Pahang"	HC 193	Adult Male	550		30	13/13/13	311	25	6 (3+4)	5
Xenelaphis ellipsifer	"Kampung Chennah, Negeri Sembilan"	HC 194	Adult Female	850		351	17/17/15	191	130	8 (4)	10
Oligodon signatus	"Kampung Chennah, Negeri Sembilan"	HC 196	Adult Female (gravid)	315		88	17/15/15	156	54	7 (3+4)	8
Asthenodipsas malaccanus	"Gunung Besar Hantu, Negeri Sembilan"	HC 195	Adult Female (gravid)	384		39	15/15/15	170	28	7 (3+4)	5
Enhydris pahangensis	"Nenasi Forest Reserve, Pahang"	HC 197	Adult Male	300		69	25/25/21	132	55	8 (4)	11
Enhydris pahangensis	"Nenasi Forest Reserve, Pahang"	HC 198	Adult Female	392		68.5	25/25/21	131	47	8 (4)	11

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APPENDIX

Specimens examined

Asthenodipsas malaccanus: ZMB 5041, Malacca; BMNH 1924.10.23.7, Labong Tendai, Sumatra, Indonesia; BMNH 1967.2276, Gunung Benom, Malaysia; SMF 32580, Perak, Malaysia; ZMH R06836, Lebong-Tandai, Benkoelen, Sumatra, Indonesia; ZFMK 45131, Satun, Thailand; ZMB 50673, Thung Song, Thailand; ZRC 2.2746, Asahan Estate, Melaka.
Calliophis gracilis: HC 193, Cameron Highlands, Pahang, Peninsular Malaysia.
Enhydris pahangensis: HC 197,198, Nenasi Forest Reserve, Pahang, Peninsular Malaysia.
Hylarana siberu: DWNP 1189, Kuala Gandah, Pahang, Peninsular Malaysia.
Oligodon signatus: HC 196, Kampung Chennah, Negeri Sembilan, Peninsular Malaysia.
Rhacophorus robinsoni: HC 191, 192, Kampung Chennah, Negeri Sembilan, Peninsular Malaysia.
Theloderma leprosa: HC 281, Gunung Besar Hantu, Negeri Sembilan, Peninsular Malaysia.
Xenelaphis ellipsifer: HC 194, Kampung Chennah, Negeri Sembilan, Peninsular Malaysia.

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On the Distribution and Status of *Plectrohyla hazelae* (Taylor, 1940) (Amphibia: Hylidae) from Oaxaca, Mexico

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Duellman (2001) reviewed and updated the distributional status of all hylid species in Mesoamerica that were known at the time. We examined the updated distributional map for *P. hazelae* (Duellman 2001:fig. 386, and presented here as Fig. 1a). This same geographic information is also reflected on the map accompanying the account of *P. hazelae* appearing on the online IUCN Red List (http://www.iucnredlist.org/), which is the same information compiled by the Global Amphibian Assessment (Stuart et al. 2004). Based on these sources, the prevailing concept of the distribution of this species (Fig. 1a) is that it occurs disjunctly in three montane areas in Guerrero and Oaxaca, Mexico, namely the Sierra Madre del Sur, Sierra Yucuyacua, and Sierra Aloapaneca. The type locality is on Cerro San Felipe, in the Sierra Aloapaneca, and a small number of specimens from various localities on those slopes are deposited in museums; most of these are listed by Duellman (2001:704). A review of available specimens of *P. hazelae* listed by Duellman (2001:1125), however, revealed several misidentified specimens and other problems. The status of some specimens of *P. hazelae* listed by Duellman (2001:1125) is given in Table 1. The specimens from Puerto de Gallo, Sierra Madre del Sur, Guerrero (CAS 143106–07) are referable to *Plectrohyla mykter.* The two records from the vicinity of Putla, Oaxaca (Sierra Yacuyacua) are more problematic. Duellman (2001:1125, fig. 386) listed and mapped two specimens from "16 kilometers southwest of Cuquila" in the

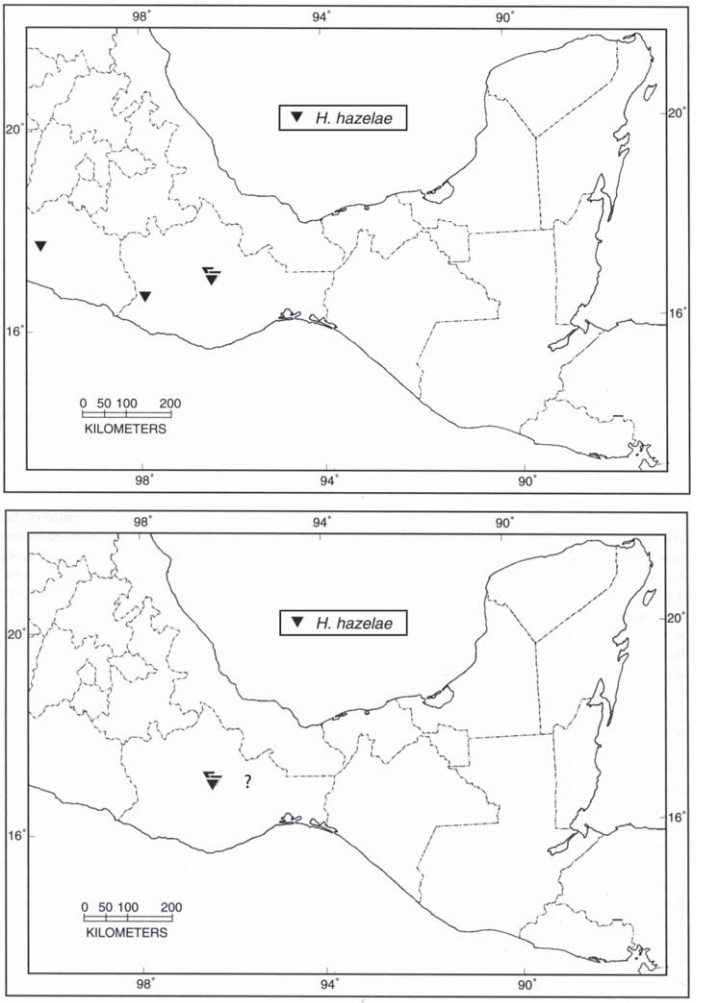


FIG. 1a (top). The distribution of *Plectrohyla hazelae*, as presented by Duellman (2001:fig. 386), showing putative localities for the species in the Sierra Madre del Sur, Sierra Yucuyacua, and the Sierra Aloapaneca or Guerrero and Oaxaca, Mexico. This figure does not indicate the record (KU 13707) from near the town of Tamazulapan, Oaxaca, in the Sierra Mixes; this record was listed by Duellman (2001) but does not appear on this map (see text). This figure has been modified from the original (Duellman, 2001:fig. 386) to exclude locality records of species not relevant to the current paper.

FIG. 1b (bottom). Our current concept of the distribution of *Plectrohyla hazelae*, indicating that it is once known to have once existed only on the slopes of Cerro San Felipe, in the Sierra Aloapaneca of Oaxaca, Mexico. The species was last seen alive in 1975 (see text). The question mark indicates the locality for the specimen (KU 137037) from near Tamazulapan, in the Sierra Mixes of Oaxaca, Mexico, that is here referred to *Plectrohyla* sp. indet.

TABLE 1. Identifications and notes on specimens referred to *Plectrohyla hazelae* by Duellman (2001:1125).

Specimens	Locality	New Identification	Comments
CAS 143106–07	Guerrero: Puerto de Gallo	*Plectrohyla mykter*	Juveniles
MSU (uncatalogued)	Oaxaca: 16 km SE Cuquila	n/a	Specimens lost (see text)
USNM 224499	Oaxaca: 4.7 km W La Cumbre	*Plectrohyla hazelae*	Last known specimen of *P. hazelae;* collected in 1975
KU 13707	Oaxaca: between Tlahuitoltepec and Tamazulapan	*Plectrohyla* sp. indet.	Metamorphic individual; identity uncertain. Unclear if this record was incorrectly mapped by Duellman (2001: fig.386), or whether it was not mapped (see text).

collections of Michigan State University; however, these specimens cannot be located under any taxonomic name (L. Abraczinskas, *in litt.*). Subsequent research indicated that two hylid frogs were collected at that locality by Robert G. Webb on 21 July 1968 (Field Numbers: RGW 4784, 4785; original locality written as "10 mi southwest Cuquila"); squamate specimens collected there at the same time are present in the MSU collection. Webb (*in litt.*) verified the collection of the specimens from his field notes and recalls physically showing them to W. E. Duellman in some informal setting, perhaps at a meeting. Duellman, however, (*in litt.*) has no written record, nor recollection, of the specimens. All other material collected by Webb during that era was deposited at MSU, but our search (www.herpnet.org) and queries to other collection managers, including KU, found no amphibians bearing locality information referencing the tiny village of Cuquila. Evidently, the specimens were never catalogued in a museum and are missing. Based on the lack of voucher specimens, and our own opinion that this is an unlikely locality for a species otherwise known only from the slopes of Cerro San Felipe, we believe this locality record to be in error. An additional specimen (KU 137037) reported by Duellman (2005:1125) from Oaxaca "btw Tlahuitoltepec & Tamazulapan" is also problematic. The specimen is a barely post-metamorphic individual, and thus difficult to identify. However, the presence of nearly complete webbing on the feet (versus about half-webbed in *P. hazelae*) indicates that it is not referable to *P. hazelae;* we here refer it to *Plectrohyla* sp. indet., pending review of other specimens from the region. An additional inconsistency exists in the map presented by Duellman (2001:fig. 386) in that it does not show a locality in the Sierra Mixes, where KU 137037 was collected. It is possible that this locality was confused with another village named Tamazulapan existing in the Sierra Yacuyuna, near the towns of Tlaxiaco and Putla; however, the map shows only one symbol for that region, so it is not clear if that symbol refers to KU 137037 and/or the missing MSU specimens, or was intended to indicate both localities (because, as it turns out, the village of Tamazulapan in this region is near Cuquila). In either case, the symbol should be removed from the distributional map of *P. hazelae* because there is no evidence that the species occurs there. In Fig. 1b, we illustrate our concept of the distribution of this species, which can now be summarized simply as the immediate vicinity of Cerro San Felipe, in the Sierra Aloapaneca of Oaxaca, Mexico. We also note that specimens (TNHC 28598–99; Oaxaca: 13 km NW Ixtlán de Juárez) referred to *P. hazelae* by Duellman (2001:704) do not represent that species and are perhaps referable to *Ecnomiohyla miotympanum.*

Finally, we sadly report that recent intensive amphibian surveys on Cerro San Felipe have uncovered no specimens of *Plectrohyla* (G. Parra-Olea, T. Papenfuss, and D. Wake, *in litt.*). Whereas adults of *Plectrohyla* spp. sometimes can be difficult to locate, the stream dwelling tadpoles are obvious, and present year-round (JRM, personal observation; J. A. Campbell, personal communication; Lips et al., 2004). We estimate this species became extinct sometime probably not very long after 1975—just as proposed by Lips et al. (2004)—when the last known specimen (USNM 224499) was collected on Cerro San Felipe by our colleague Roy W. McDiarmid.

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Specimens examined.—Ecnomiohyla cf. miotympanum: **MEXICO: OAXACA:** Ixtlán de Juárez, 8 mi [by road] NW, 7600 ft (TNHC 28598, 28599). *Plectrohyla mykter:* **MEXICO: GUERRERO:** Puerto de Gallo, 8200 ft (CAS 143106, 143107). *Plectrohyla hazelae:* **MEXICO: OAXACA:** 2 km S El Punto, 2390 m (KU 100969); Cerro San Felipe, about 10 miles north of Oaxaca, Oaxaca (FMNH 126323, 108509–13, 126419); Cerro San Felipe (USNM 114576, 114577); La Cumbre, 4.6 mi W of, on road to Cerro San Felipe (USNM 224499). *Plectrohyla* sp. indet.: **MEXICO: OAXACA:** btw Tlahuitoltepec and Tamazulapan, 2200 m (KU 13707).

TECHNIQUES

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A Method for Constructing an Adjustable Platform to Obtain Lateral Photographs of Larval Anurans

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Digitally photographing specimens and using computer software to obtain morphological measurements is a commonly used technique in larval anuran research. Lateral photographs of specimens can be used to obtain measures such as snout-vent length, body height, tail length, tail height, tail musculature length, and tail musculature height (Dayton et al. 2005; Lardner 2000; Relyea 2001). However, obtaining quality lateral photographs of larval anurans can be difficult due to their general body plan (a rounded body and laterally compressed tail).

When a specimen is laid on its side in a lateral view, the tail remains flat and in the horizontal plane, but the curvature of the body often causes the specimen to bend so that the body and tail are no longer aligned in the horizontal plane (Figs. 1a and 1b). If the specimen is bent when photographed, measurements of total length or snout-vent length are likely to be underestimates (Fig. 1b). Thus, it is necessary to compensate for the lateral curvature of the body in order to maximize the accuracy of measurements obtained from lateral photographs.

McDiarmid and Altig (1999) describe a modified aquarium apparatus for photographing larval anurans. While this apparatus may be ideal for photographing specimens for voucher or identification purposes, its application in morphological studies may be suboptimal due to its large size, need for clear water to submerse specimens in, and requirement of an electronic flash that is independent of the camera. Because morphological studies often require large sample sizes, decreasing the amount of time it takes to prepare a specimen for photographing is important for efficiency purposes. We describe a simple method for constructing an adjustable platform that enables researchers to consistently and rapidly obtain quality lateral photographs of formalin fixed, or anesthetized, tadpoles. This platform supports specimens in a manner that prevents bending caused by the lateral curvature of the body (Figs. 1c, 1d), and can accommodate variously sized species or broad ontogenetic series of specimens.

Platform construction can be completed in less than 30 minutes with the following materials: two standard microscope slides (3 in. x 1 in.); two hollow tubes, one with a slightly larger diameter than the other; and epoxy glue. The microscope slides act as a platform on which the tail and tip of snout of rest. The hollow tubes are glued beneath the microscope slides and allow the platform to be adjusted. For tubes, we used a drinking straw and the shaft of a disposable ink pen. The smaller diameter tube (i.e., the straw) is cut into two 3-inch pieces and glued parallel to the short edge of the slide approximately one-half inch from each end. The pieces of straw should protrude at least one-half inch from the long edge of the microscope slide. The larger tubes (pen shafts) are then glued to the second microscope slide in the same manner as previously described, with the exception that the circular openings of the shafts should not protrude from underneath the microscope slide (Fig. 2). The microscope slides are aligned and the two pieces of drinking straw (or tube with smaller diameter) are inserted into the pen shafts (tube with larger diameter).

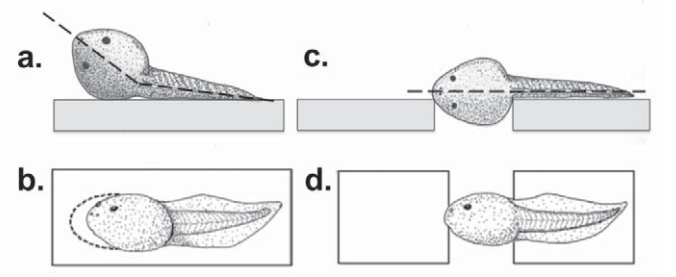


FIG. 1. (a) Side view illustration showing the bending of a larval anuran specimen caused by the lateral curvature of the body. The dashed line is provided to enhance visualization of the degree of bending. (b) Specimen a, viewed from above. The dashed line shows where the outline of the head would be if the specimen's body and tail were aligned in a flat plane. (c) Side view of a specimen supported in a manner that prevents the lateral curvature of the body. (d) Specimen c, when viewed from above.

The larger diameter of the disposable ink pen allows the stage to be quickly and easily manipulated to accommodate specimens of different sizes. A scale bar can be glued to the surface of either microscope slide so that it will be in the field of view with the specimen and in the same plane as the specimen when it is photographed from directly above (Fig. 2). Specimens are positioned on the platform so that only the extreme anterior of the body (snout) is touching the slide on the left, and the tail is supported by the slide

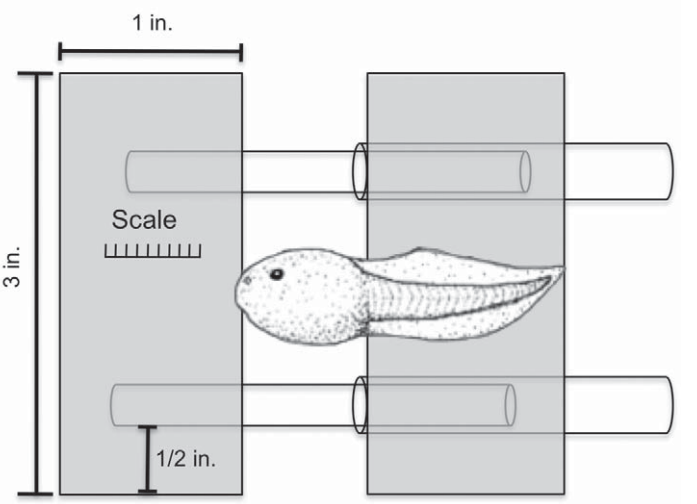


FIG. 2. Larval anuran specimen properly positioned on the completed platform. Selected dimensions of the platform are provided. The finished platform rests on a flat surface and photographs may be obtained by positioning a camera directly above.

on the right (Figs. 1c, 1d, and 2). From the author's experience, the apparatus is easily manipulated and facilitates rapid handling and photographing of specimens.

We have found this apparatus to be both durable and efficient, as it has been used to obtain over 500 photographs of specimens, with an approximate handling time of under 20 seconds for each specimen. Further, this platform is especially useful when photographing smaller species of larval anurans (e.g., *Bufo terrestris*, < 40 mm total length), or very small specimens at early developmental stages. Simple modifications such as adding an additional microscope slide to one side of the platform may be necessary in order to photograph very large specimens (e.g., *Rana catesbeiana*) or late developmental stages of large species.

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Baiting Differentially Influences Capture Rates of Large Aquatic Salamanders, *Siren* and *Amphiuma*

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Understanding the potential biases associated with a sampling method are necessary before undertaking a study of the ecology of any organism (Dodd 2003; Gunzburger 2007). Trapping is an effective way to determine whether a species is present in a certain habitat, and many forms of passive traps for aquatic salamanders have been developed, including minnow traps and other funnel traps, leaf litterbags, and box traps (Dodd 2003; Heyer et al. 1994). Baiting passive traps to attract organisms may increase the number of animals captured, but it may also introduce sampling bias to a study (Sorensen 2003). Baiting might attract more animals to an area than normally would be found there, which could lead to an overestimate of abundance. Another bias could be a potential change in behavior or survival of the target species due to predators that are also attracted to the bait. There also could be differences among target species in their food preferences and response to different types of bait.

The Greater Siren (*Siren lacertina*) and Two-toed Amphiuma (*Amphiuma means*) are large aquatic salamanders that are relatively poorly studied, perhaps because of their cryptic behavior and the perceived difficulty in sampling their habitats. These species co-occur throughout most of their geographic ranges in the Southeastern Coastal Plain of the United States (Petranka 1998), though inter-specific interactions may affect microhabitat occupancy (Snodgrass et al. 1999). Both salamanders are primarily nocturnal, with daylight activities restricted to either dense aquatic vegetation or hiding in burrows in the substrate (Duellman and Schwartz 1958; Freeman 1958; Knepton 1954). Limited data on their movement patterns suggest these salamanders have relatively small home ranges (Sorensen 2004) with occasional short dispersal across land during heavy rain or flooding (Aresco 2002; Carr 1940; Gibbons and Semlitsch 1991).

The diet of these salamanders may have significant influence on the effectiveness of baiting to attract these species to traps. Although there is considerable overlap in the diet of these species, diet studies suggest Amphiumas are more carnivorous than Sirens. This is supported by stable isotope analysis that placed Amphiumas at a higher trophic position than Sirens in a North Florida lake (Aresco and James 2005). Dietary analyses of Amphiumas, based on foraging habits or stomach contents, have shown they are entirely carnivorous, feeding on insects (both aquatic and terrestrial), many types of amphibians (including conspecifics), reptiles, fish, crayfish, mollusks, and spiders (Chaney 1951; Hamilton 1950; Hargitt 1892; Lee 1969; Machovina 1994). In contrast, plant material has often been found in dietary analyses of Sirens (Davis and Knapp 1953; Dunn 1924), although other studies have shown Sirens ingest invertebrates, especially mollusks, and fish along with vegetation (Burch and Wood 1955; Hanlin 1978; Moler 1994). *Siren lacertina* are able to effectively digest plant material, as the gastrointestinal structure of *S. lacertina* is similar to other vertebrates that use fermentative digestion (Pryor et al. 2006).

Differential movement patterns also may affect the capture of these salamanders, with more mobile species having a greater likelihood of encountering a passive trap than sedentary species. Unfortunately, there have been few studies examining movements of these species within habitats. A study conducted in Missouri of *Siren intermedia* noted most movements were > 10 m (75% of the population), with a mean home range of 94.8 m^2 (Frese et al. 2003). Another study found > 77% of the movements of *S. intermedia* in Texas were < 6 m (Gehlbach and Kennedy 1978).

The objective of this study was to evaluate the effect of baiting traps on capturing *Siren* spp. and *Amphiuma means*. A previous study (Sorensen 2004) found that baiting did not influence the capture rates of *Siren* spp. and *A. means* in crayfish traps, but we

believe that study may have been biased by the close proximity (one meter apart) of baited and unbaited traps. Chemical cues from the bait (canned sardines in oil) may have pervaded the entire trapping area (Sorensen 2004). The difference in trap spacing used for this study should eliminate the biases that may have been involved in the previous study.

Materials and Methods.—This study was conducted during two trapping intervals in June–July 2006 at Lake Suggs, a 34 ha dark-water lake at the Ordway Swisher Biological Station in Putnam County, Florida (USA). Our study used a blocked design, with four blocks of 10 traps for a total of 40 traps. Traps were deployed along a single transect with one trap every five meters (195 m long transect). The transect was set ca. 3–4 m from the shoreline in dense submergent aquatic vegetation (*Limnobium spongia*, *Pontedaria cordata*, and *Hydrocotyle* sp.). Two blocks (one half of the transect line) were baited in the first trapping interval (5–9 June 2006) and the other two blocks were baited in the second trapping interval (3–7 July 2006). The remaining two blocks in each trapping interval did not have bait added to them. Baiting an entire block of traps and separating each block by 5 m allowed us to prevent contamination of unbaited traps by chemical cues from nearby baited traps. Because it is unlikely salamanders are distributed equally along the length of the transect, our design allowed us to evaluate separately the effect of baiting and block location on the number of animals captured.

We used modified crayfish traps (Lee Fisher International, Tampa, Florida) lined with 0.5 mm mesh which were attached to a PVC pipe anchored into the substrate (Johnson and Barichivich 2004). Traps were baited with canned sardines in olive oil; holes were punched in the can and the can was suspended inside the trap with a length of cord. Bait was not replaced daily, but rather one can of bait was left in each baited trap for the entire trap interval. Traps were set for four nights per interval (320 total trap-nights) and checked every morning.

We analyzed capture rates of each salamander species separately because we do not know the actual population size of either species nor the proportion that were captured in the traps, so we cannot evaluate the relative efficacy of the traps across species. Capture data could not be made normal with transformation, so we conducted Kruskal-Wallis one-way ANOVAs for each species with number captured as the dependent variable and presence of bait, sampling interval (June or July), and block as factors.

Results.—A total of 147 individuals (new captures and recaptures) were caught during the two sampling intervals, including 87 *Amphiuma means*, 56 *Siren lacertina*, 3 *S. intermedia*, and 1 small *Siren* sp. that escaped prior to identification. The number of new captures of unmarked individuals was 106, comprised of 52 *A. means*, 50 *S. lacertina*, 3 *S. intermedia*, and 1 unidentified *Siren* sp. Numbers of all *Siren* species were pooled for data analysis. The mean catch per unit effort (CPUE; captures/trap-night) for the two-month duration of this study was 0.27 *A. means*/trap-night and 0.18 *Siren* spp./trap-night. This CPUE was higher than the previous study (0.11 *A. means* /trap-night and 0.10 *Siren* spp./trap-night; Sorensen 2004).

Baited traps captured 72% (N = 106) of the animals whereas unbaited traps captured 28% (N = 41). Several individuals from the two-month sampling period were recaptured more than once, and multiple salamanders were captured in the same trap on several occasions. Multiple salamanders were captured in the same trap on 23 occasions during the two-month sampling period: six traps with multiple *A. means*, three traps with multiple *Siren* spp., and 14 traps with a combination of *A. means* and *Siren* spp. Sorenson (2003) reported multiple captures in the same trap on seven occasions over a 12-month period. The results of the Kruskal-Wallis analyses showed that the effects of block and sampling interval were not significant for either species. Significantly more *Amphiuma* were caught in baited traps relative to unbaited traps (Mann-Whitney $U = 1492$, $p < 0.001$); there was no correlation of capture rates of *Siren* with baiting (Fig. 1).

Discussion.—Baiting of traps did not have the same effect on capture rates of these two species of salamanders. The dietary differences of these species accurately predict their response to bait: The carnivorous *Amphiuma means* is strongly attracted to bait, while the omnivorous *Siren* spp. were apparently not attracted to bait. Although not significant, both this study and Sorensen (2003) demonstrated a trend towards higher capture rates of *S. lacertina* in unbaited traps (Fig. 1).

The high capture rate of *A. means* could be due to the more predaceous behavior of *A. means* or other factors such as the ability of *A. means* to detect and locate bait. *Amphiuma means* can be caught on a trotline baited with dead crayfish (Chaney 1951), suggesting that chemoreception may play a role in locating prey by these salamanders. In contrast, a laboratory experiment suggested that chemical cues do not seem to play a role in prey location by *S. intermedia* (Sullivan et al. 2000).

Although we did not conduct comparisons across species, Willson et al. (2005) noted higher numbers of *Siren* spp. captures (N = 228) in commercial funnel traps compared with *A. means* (N = 14). Baiting was not part of their experiment, but the lack of bait within traps could explain the higher capture rates of *Siren* spp. over *A. means*. If baiting does attract *A. means*, then *Siren* spp. may be avoiding these traps because *S. lacertina* has been documented as a prey item in *A. means* stomach analyses (Machovina 1994).

Our study demonstrates that the decision of whether or not to use baited traps is likely to influence the outcome of trapping efforts for

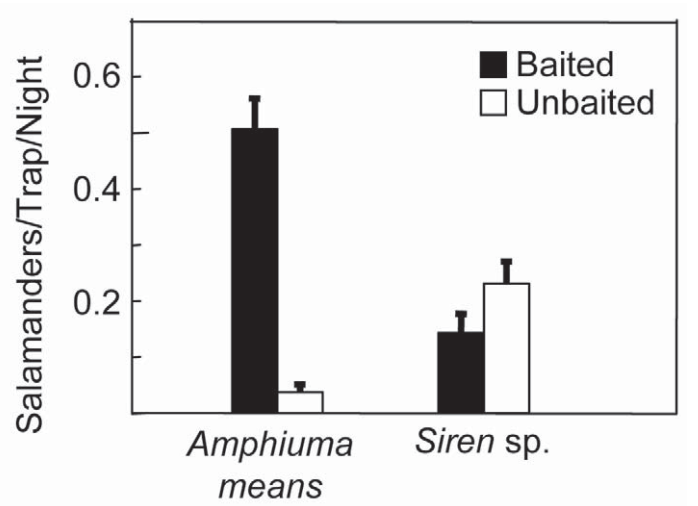


FIG. 1. Mean and standard error of catch per unit effort (number of captures/trap/night) of *Amphiuma means* and *Siren* sp. in 20 baited and 20 unbaited crayfish traps in two four-night sampling intervals.

these species of aquatic salamanders. We suggest that researchers conducting rapid assessment surveys for large aquatic salamanders, in which the response variable is detection or non-detection of a species, should use both baited and unbaited traps to increase the likelihood of trapping both *Siren* spp. and *Amphiuma* spp. if they are present. In contrast, if researchers are more interested in conducting long-term demographic studies, using unbaited traps may result in a more accurate and unbiased reflection of the relative abundance of the two species. We suggest researchers may minimize the likelihood of making critical errors in interpreting population data by conducting even a short-term series of trials designed to understand sampling biases prior to initiating longer-term studies.

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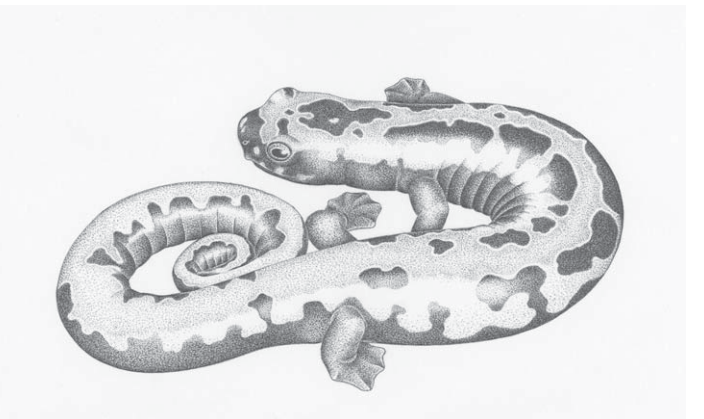
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Bolitoglossa mexicana (Mexican Mushroom-tongues Salamander), Guatemala. Illustration by Peter Stafford.

AMPHIBIAN DISEASES

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Reassessment of the Historical Timeline for *Batrachochytrium dendrobatidis* Presence in Honduras and Conservation Implications for *Plectrohyla dasypus*

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The amphibian chytrid fungus *Batrachochytrium dendrobatidis* (*Bd*) has been identified as an exceptionally devastating amphibian pathogen, capable of acting as both the proximate and ultimate causes of amphibian extinction (Wake and Vredenberg 2008). As described by Skerrat et al. (2007), *Bd* is a highly transmissible pathogen, which has recently been recognized as an invasive species and listed as notifiable by the World Organization for Animal Health (OIE: http://www.oie.int/eng/normes/fcode/en_chapitre_2.4.1.htm#rubrique_batrachochytrium_dendrobatidis). In recent years, significant advances in field and laboratory techniques have enabled scientists to detect *Bd* within amphibian species using non-lethal methods (Annis et al. 2004, Boyle et al. 2004, Hyatt et al. 2007) which has increased our ability to test amphibians that would otherwise not be testable due to regulatory restrictions on take of endangered species. Detection of *Bd* in extant populations is an important component in assessing the status of a population or species because it reveals an elevated risk for subsequent population declines. Therefore, identifying the distribution of *Bd*-infected amphibians can help guide the investment of resources towards areas in most need of frequent monitoring. However, contemporary *Bd* occurrence does not provide data as to when the pathogen was introduced into a geographic area. Contemporary surveys are often unable to show the length of time between the arrival of *Bd* and the onset of population declines.

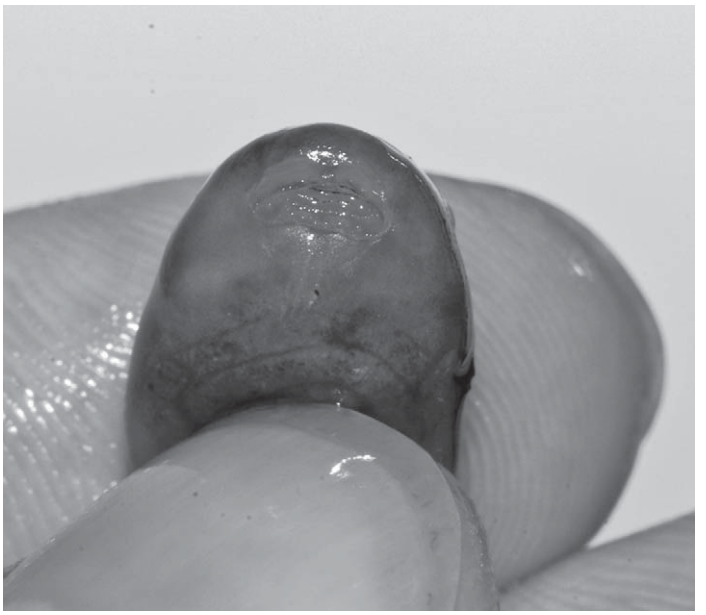


FIG. 1. Ventral anterior surface of the larval *Plectrohyla dasypus* collected in 1996 (USNM 523472) which was examined histologically for *Batrachochytrium dendrobatidis* infection. Specimen displayed gaps in tooth rows and erosion of jaw sheaths.

Developing a timeline of *Bd* introduction in a specific area requires multiple surveys that encompass a timeframe ranging from pre-*Bd* introduction through post-*Bd* arrival. *Bd* was identified only 11 years ago, and by the time it was described and testing techniques for infection were made available, *Bd* had already become widespread (Stuart et al. 2004); thus for many localities, determining the timeline for *Bd* introduction requires retrospective analyses of archived specimens. As we demonstrate in this article, such retrospective studies need not be expansive to produce valuable data regarding the earliest known occurrence of *Bd* in a species or geographic location.

In 2007, we confirmed the presence of *Bd* within Cusuco National Park, Honduras (Kolby et al. 2009). A species of particular concern was *Plectrohyla dasypus*, an amphibian endemic to Cusuco National Park which displayed an alarmingly high prevalence (78%) of *Bd*. This species is listed as Critically Endangered by the IUCN Red List of Threatened Species, in part "… because of a drastic population decline, estimated to be more than 80% over the last ten years, inferred from the apparent disappearance of most of the population (probably due to chytridiomycosis)" (Cruz et al. 2004). Although current and historic observations suggest the involvement of *Bd* in these declines, a cause and effect relationship has not been definitively demonstrated. This is especially relevant for *P. dasypus*, now a candidate for *ex situ* management, as the future of the species is dependent upon an accurate identification of the causative factors driving the impending extinction. Therefore, the answer to the following question carries profound importance: Has *Bd* been present in Cusuco National Park, Honduras for at least 10 years?

Field surveys conducted in 2007 revealed a high incidence of oral defects in *Bd*-infected *P. dasypus* larvae (Kolby et al. 2009), leading us to suspect that oral defects in this species may often be indicative of *Bd* infection. The earliest published record of larval oral defects in this species originated from a series of five larvae (USNM 523472) collected from Cusuco National Park in 1996 (McCranie and Wilson 2002). Morphological examination of this larval series was conducted at the Smithsonian Museum of Natural History on 27 February 2008. Using a 20x hand lens, oral defects were observed in two of the five specimens, which included gaps in tooth rows and erosion of jaw sheaths. We selected one of these two specimens for histological examination to diagnose *Bd* (Fig. 1).

We excised the complete oral disc intact including the underlying soft tissue and stored the samples in 70% ethanol. Tissues

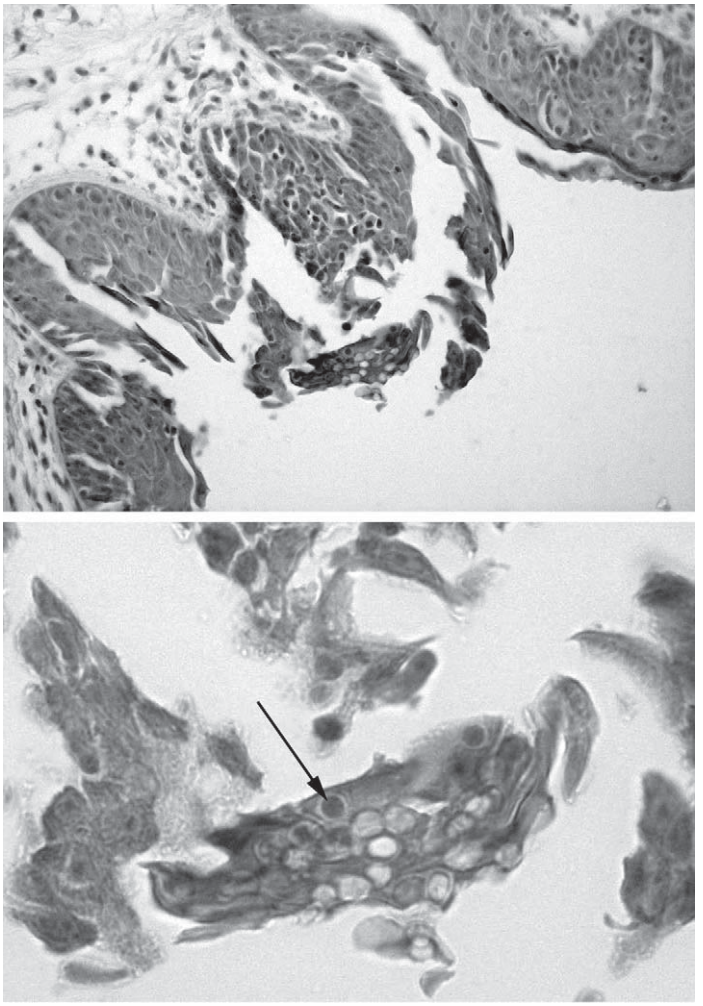


FIG. 2. Top: *Batrachochytrium dendrobatidis* infection in the toothrow of larval *Plectrohyla dasypus* viewed via light microscopy at 200×. Bottom: *B. dendrobatidis* infection viewed at 400×. Dark staining in some cells indicates bacterial colonization of empty zoosporangia (arrow).

were paraffin-embedded, serial-sectioned in 4-µm increments and haematoxylin-eosin (H&E) stained for examination under light microscopy. The specimen was found to be infected with *Bd* when serial sections were viewed by light microscopy. *Bd* thalli and empty zoosporangia were clearly distinguishable in the toothrows and were characterized by thick cell walls and slight ovoid shape (Fig. 2).

Our examination confirmed the presence of *Bd* in Cusuco National Park, Honduras in 1996, seven years earlier than is currently documented for the country (Puschendorf et al. 2006). Since the population decline of *P. dasypus* is believed to have commenced in approximately 1994 (Cruz et al. 2004), our findings chronologically align the presence of *Bd* with the onset of enigmatic decline. Analysis of samples collected in 2007 (Kolby et al. 2009) revealed a high prevalence of *Bd* and confirmed infection in a recently metamorphosed *P. dasypus* which displayed behavioral symptoms of amphibian chytridiomycosis (lethargy, loss of righting reflex, etc.) immediately preceding death. Integrating our contemporary field survey data with retrospective histological analysis, it now seems reasonable to consider *Bd* as a potential proximate and ultimate factor in the decline of *P. dasypus* over the past decade. Since a multitude of other factors (e.g., global climate change, habitat alteration, and xenobiotics) could similarly precipitate an amphibian population decline, the testing of potential cause-effect relationships related to these variables is crucial in determining whether an *ex situ* conservation management plan will be necessary and feasible to prevent extinction of *P. dasypus*.

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Local and Regional Patterns of Amphibian Chytrid Prevalence on the Osa Peninsula, Costa Rica

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In Costa Rica, 34% of known amphibian species are classified as threatened; chytridiomycosis (infection caused by *Batrachochytrium dendrobatidis* (*Bd*)) is listed as a known or possible cause of decline for more than half of these species (Stuart et al. 2004). While *Bd* is known to be associated with extirpations of amphibian populations at high elevations in Latin America (Lips et al. 2006), this pathogen also exists at low elevations (Puschendorf et al. 2006), where its effects on amphibian populations are unclear.

The Osa Peninsula, on the southern Pacific coast of Costa Rica, contains a mixture of lowland tropical forest and cattle pastures (Sanchez-Azofeifa et al. 2002). Annual precipitation in this area reaches 5500 mm per year, with a dry season from December to April and a wet season from May to November (Sanchez-Azofeifa et al. 2002). Mapping of *Bd* outbreaks from northwest to southeast in Latin America indicates that this area may have been exposed between 1988 and 1993 (Lips et al. 2006); however, ecological niche modeling does not predict that the Osa Peninsula includes the fundamental niche of this fungus (Ron 2005). While no rapid declines of frog populations have been documented in the Osa Peninsula, population declines of some species of the genera *Craugastor* and *Allobates* are suspected to have occurred in recent years (M. Sasa, pers. comm.). We tested frogs for *Bd* along three streams in this region to quantify the prevalence of this pathogen and investigate local patterns of infection.

Methods.—We surveyed three streams on the Osa Peninsula between 27 May and 8 June 2006 (Fig. 1). The first stream was Quebrada Aguabuena in the Rincón area on the north side of the peninsula (70 m elev., 1.4 km survey length; 8.7001°N, 83.5234°W), the second was Quebrada Bilingual on a private farm near Piro on the southeastern side of the peninsula (30 m elev., 0.8 km survey length; 8.4292°N, 83.3583°W), and the third was Quebrada Cameronal near the Sirena station in Corcovado National Park, on the south-central side of the peninsula (25 m elev., 0.9 km survey length; 8.4292°N, 83.3583°W). Over 1000 researchers and students visited the Rincón area between 1962 and 1973 because the Osa (Rincon) Field Station was located there (Christen 1995), and the Sirena station currently receives a large number of international visitors per year. Piro has had very few visitors outside of local families. Due to heavy rain and low activity of frogs on the stream at Sirena, we supplemented our sample by surveying higher ground and collected samples from six frogs along the stream at a later date (21–22 September 2006).

We sampled each site on several consecutive nights, from just after sundown until frog encounters became less frequent (usually around midnight). We hand captured each frog using fresh, powder-free latex gloves. We swabbed the underside of each frog, including toes, with a wooden-handled swab (Puritan Medical Products, Guilford, Maine, USA) for approximately 20 passes and preserved the swab in salt solution (20% DMSO, 0.25 M EDTA, 100 mM Tris, pH 7.5 and NaCl to saturation; Seutin et al. 1991). These tubes were stored at room temperature until DNA extraction. Locations of captured frogs were recorded with a Garmin GPS 12XT (Garmin Ltd., Olathe, Kansas, USA) or determined using compass and measuring tape from GPS locations.

We extracted DNA from the swabs using a DNeasy Blood & Tissue Kit (Qiagen, Valencia, California, USA), adapting the tissue protocol by heating the AE solution to 55ºC before elution and incubating the sample in the AE solution at 70ºC for five minutes before the final centrifugation. We used an Applied Biosystems 7500 Fast Real-Time PCR System (Applied Biosystems, Foster City, California, USA) to test for the presence of *Bd* using the protocol of Boyle et al. (2004) with the following changes: total reaction volume was 20µl, probe concentration was 125 nM, extracted DNA was not diluted, and one out of the three wells for each sample contained the internal control recommended by Hyatt et al. (2007) to ensure there was no inhibition of the reaction. International quantification standards were obtained from the Australian Animal Health Laboratory (Geelong, Victoria, Australia). Any sample testing positive at fewer than all three wells was rerun. A second test with any positive wells confirmed a positive result, while a second test with no positive wells was regarded as a negative result. A negative control was included in each extraction to confirm that there was no contamination.

We calculated overall prevalence of infected individuals at each site and used binomial probabilities to calculate the upper bound of a 95% confidence interval by finding the highest level of prevalence where we had up to a 5% chance of not detecting the pathogen when no *Bd* was detected at a site. For sites where we detected *Bd*, we determined confidence intervals using the relationship between the *F* distribution and the binomial distribution (Zar 1984). For these calculations, we assumed that our procedure was 100% accurate in detecting infection on a sampled individual. Ecological group was determined using breeding and habitat descriptions from Savage (2002).

Results.—Across the three sites, we sampled 178 individuals and found 9 samples that tested positive for *Bd* (Table 1). Overall prevalence of frogs testing positive for *Bd* was highest at Sirena and lowest at Piro, where we found no infected individuals; however, 95% confidence intervals overlapped for all sites. Frogs testing positive were spread among ecological groups (Table 1). Six of seven frogs testing positive for *Bd* at Rincón were found within 120 m of a dirt road crossing the stream; the remaining individual (*Smilisca sordida*) was found 760 m downstream from the road crossing (Fig. 1).

Discussion.—We found a low level of *Bd* infection (approximately 8% prevalence) at two sites on the Osa Peninsula of Costa

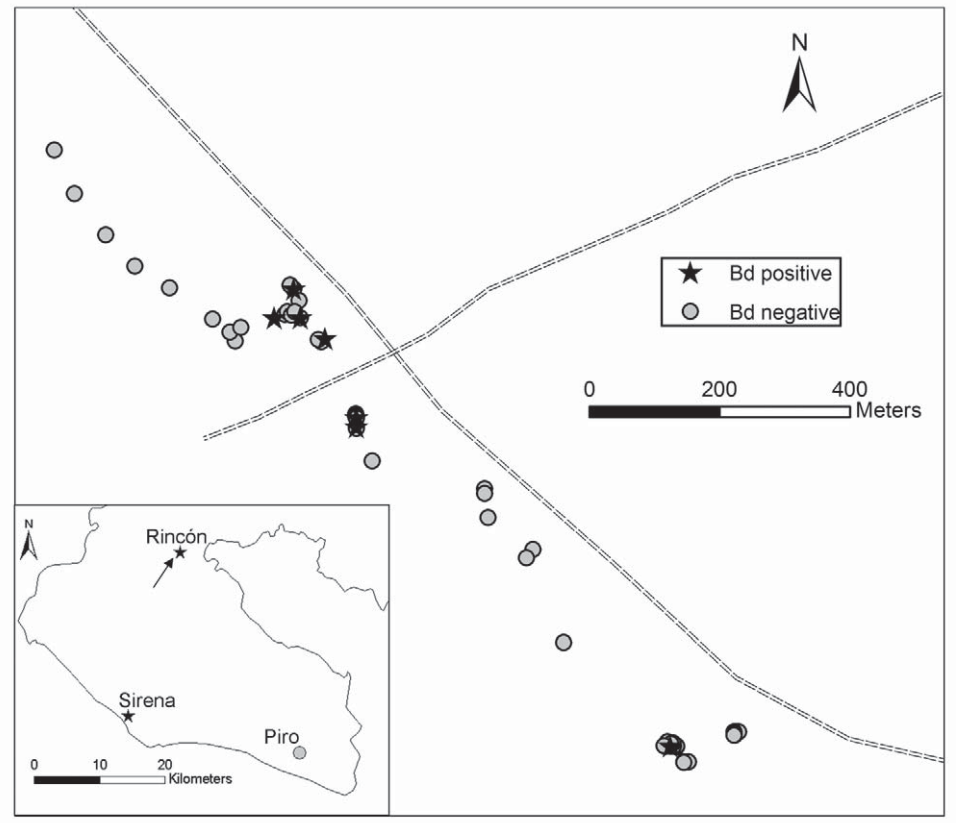


FIG. 1. Location of the three sampling areas on the Osa peninsula, Costa Rica, and *Bd* status of individuals sampled May–September 2006. Large map displays *Bd* status of individual anurans in the Rincón sampling area. Dashed lines indicate dirt roads.

Rica, a lowland region not predicted to contain this pathogen by the niche model of Ron (2005), and we detected no *Bd*-positive individuals at a third site. This estimate of prevalence is similar to that found in live adults by Puschendorf et al. (2006) in an apparently pre-decline amphibian community in Braulio Carrillo National Park, Costa Rica (5.9%) and by Lips et al. (2003) in a declining amphibian community in Las Tablas, Costa Rica (14.3%). Both survey sites on the Osa Peninsula with *Bd*-positive individuals have a history of large numbers of international visitors; the third has received few visitors from outside of the local area. However, our sample size was not large enough to determine if prevalence differed among sites and more data would be required to determine whether frequency of human visitation and *Bd* infection prevalence are correlated.

Within-stream patterns of *Bd* infection may be structured by differences in habitat use and behavior among species (Rowley and Alford 2007; Woodhams et al. 2003). However, the few *Bd*-infected frogs we found were distributed across ecological groups that differed in microhabitat and mode of reproduction. This pattern of infection across species groups is consistent with a survey of Braulio Carrillo National Park, Costa Rica (Puschendorf et al. 2006), and does not follow the pattern found in southeast Queensland, Australia, where frogs breeding in permanent water were more likely to be

TABLE 1. Anurans tested for *Bd* on the Osa Peninsula, Costa Rica, in May, June, and September 2006. For each site (Rincón, Piro, Sirena), number of each species sampled (N) and number testing positive for *Bd* (+) are presented, followed by the quantification of the amount of *Bd* collected in genome equivalents in parentheses. Confidence intervals for prevalence were calculated using the binomial distribution. * Indicates samples collected in September 2006.

Species	Ecological group	Rincón		Piro		Sirena	
		N	+	N	+	N	+
Allobates talamancae	Terrestrial stream-breeder	6	0	6	0	0	0
Cochranella granulosa	Stream-associated arboreal breeder	0	0	4	0	0	0
Cochranella pulverata	Stream-associated arboreal breeder	1	0	20	0	0	0
Craugaster fitzingeri	Terrestrial direct-developer	9	2	2	0	5*	2
			(177, 638)				(15, 510)
Hyalinobatrachium valerioi	Stream-associated arboreal breeder	7	2	13	0	0	0
			(22, 125)				
Leptodactylus savagei	Terrestrial pond-breeder	8	0	4	0	4	0
						(1 sample*)	
Rhinella marina	Terrestrial pond-breeder	5	0	10	0	16	0
Smilisca sordida	Terrestrial stream-breeder	55	3	3	0	0	0
			(289, 863, 1012)				
Prevalence			0.077		0		0.080
(95% Confidence interval)			(0.031–0.184)		(0–0.047)		(0.010–0.395)

infected than frogs breeding in ephemeral or terrestrial habitats (Kriger and Hero 2007).

Along the Rincón stream, we found most infected individuals near a dirt road crossing, with the exception of one *S. sordida* individual found further downstream. While this concentration of infected frogs may be located near the road for unrelated reasons, the pattern could indicate that a reservoir for this pathogen is located outside of the stream and stream frogs are potentially exposed through the movement of vehicles or animals traveling along the road.

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Occurrence of *Batrachochytrium dendrobatidis* in an Anuran Community in the Southeastern Talamanca Region of Costa Rica

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Soon after the discovery of the amphibian disease chytridiomycosis, caused by the pathogenic fungus *Batrachochytrium dendrobatidis* (*Bd*, Longcore et al. 1999), it became apparent that *Bd* was a major threat to amphibians resulting in mass die-offs and population declines throughout the world (Berger et al. 1998; Blaustein and Keisecker 2002; Daszak et al. 2003; McCallum 2005; Rachowicz et al. 2006). Evidence suggests that *Bd* infected amphibian populations in Central America as early as the 1980s (Pounds et al. 1997). Work done in Central America has implicated that a wave of *Bd* has moved through the montane regions of Central America and was associated with major declines in amphibian populations and species richness (Lips et al. 2006; Puschendorf et al. 2006). However, in some cases, *Bd* also may occur in amphibian communities with little or no effect on populations (Berger et al. 1998; Brem and Lips 2008; Garner et al. 2006).

We sampled amphibians for the presence of *Bd* in the Kèköldi Indigenous Reserve in the lower elevations of the Talamanca region, Costa Rica, to determine *Bd* infection rates in an area not previously surveyed. Also, we attempted to determine which species might be at greatest risk from *Bd*. Although our study site had not been sampled prior to this study, *Bd* likely reached this region in the early 1990s (see Lips et al. 2006).

We sampled anurans for *Bd* from 6 to 17 January 2008 in the 3538-ha Kèköldi Indigenous Reserve, located in southeastern Costa Rica near Hone Creek in Limon Province (Fig. 1). The habitat in the reserve is mostly secondary forest, underplanted with cacao trees; however some primary lowland tropical rainforest occurs at higher elevations in the reserve. The climate at Kèköldi is hot and

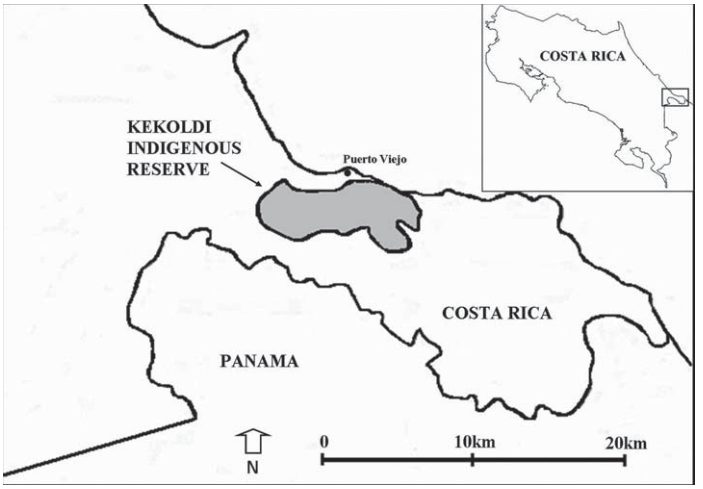


FIG. 1. Study site location, Kèköldi Indigenous Reserve, Costa Rica, where 20 frog species were examined for the amphibian chytrid fungus, *Batrachochytrium dendrobatidis*.

humid year-round, with an annual mean temperature of 26ºC and average rainfall of approximately 2500 mm per year.

We searched for adult frogs along the trails and streams in the reserve and captured them by hand. Each individual was handled with a new pair of sterile nitrile gloves. We sampled for *Bd* by rubbing a sterile cotton swab on the dorsum, ventral surfaces and feet of each frog for approximately 30 sec, then the animal was released. The swab was then immediately placed in a sterile microcentrifuge tube containing 1 ml of 70% ethanol and later sent to Pisces Molecular Lab (Boulder, Colorado, USA) for PCR analyses. Global positioning coordinates and elevation were taken at each capture site using a Garmin® GPS unit.

During 12 days of sampling at Kèköldi, no sick or dead frogs were observed. We sampled 126 adult frogs of 20 different species, from 10 different Families. Of these 20 species, only 8 tested positive for *Bd*. Ten of the 126 individuals tested positive for an overall detection rate of 7.9% for the anuran community. Too few individuals were sampled to determine *Bd* prevalence per species. Only one species, *Craugastor crassidigitus*, had more than one individual (3 of 12) test positive for *Bd* (Table 1). Anurans were sampled at elevations ranging from 29 to 150 m. We had too few positive samples to test for effects of elevation on *Bd* detection rates.

Numerous studies have documented the presence of *Bd* in Central America (Brem and Lips 2008; Lips 1998; Lips et al. 2003; Picco and Collins 2007; Puschendorf et al. 2006). Puschendorf et al. (2006) demonstrated through histological examination of museum specimens that the fungus was present in Braulio Carrillo National Park, Costa Rica, by 1986 at almost all elevations sampled. Declining species richness in amphibian communities along a north-to-south transect in Central America has been linked to *Bd* (Lips et al. 2006). According to the timeline in Lips et al. (2006) tracking the epidemic wave of *Bd* in Costa Rica, the fungus probably reached the Kèköldi Reserve in the early to mid 1990s.

Since *Bd* likely moved through Kèköldi 15 to 20 years prior to this study, it is possible that an initial epizootic event took place resulting in declines in amphibian species richness and abundance followed by a rebound to an enzootic state (Brem and Lips 2008). It is also possible that the fungus never reached an epizootic state in the low elevation Kèköldi Reserve because the warm air temperatures are less than optimal for *Bd* growth and infection of amphibians (Kriger and Hero 2006; Longcore et al. 1999; Retallick et al. 2004). Evidence for enzootic *Bd* includes the relative low incidence of detection in PCR samples and the fact that no sick or dead frogs were encountered. Frogs appeared to be very abundant in the reserve; however follow-up population and *Bd* sampling is needed to confirm whether the *Bd* is currently epizootic or enzootic.

TABLE 1. List of anuran species tested for the presence of *Batrachochytrium dendrobatidis* (*Bd*) within Kèköldi Indigenous Reserve, Costa Rica.

Family	Species	No. animals infected / examined
Aromobatidae	*Allobates talamancae*	0/2
Bufonidae	*Incilius coniferus*	0/1
	Rhinella marinus	0/1
Centrolenidae	*Hyalinobatrachyum valerioi*	0/5
Craugastoridae	*Craugastor bransfordii*	1/13
	Craugastor crassidigitus	3/12
	Craugastor gollmeri	0/1
	Craugastor megacephalus	0/12
	Craugastor noblei	1/2
	Craugastor sp.	0/3
Dendrobatidae	*Dendrobates auratus*	1/9
	Oophaga pumilio	1/16
	Phyllobates lugubris	1/4
	Silverstoneia flotator	0/15
Eleutherodactylidae	*Diasporus diastema*	1/16
Hylidae	*Agalychnis callidryas*	0/1
	Smilisca phaeota	0/1
	Smilisca sordida	1/3
Leptodactylidae	*Leptodactylus savagei*	0/6
Ranidae	*Lithobates warszewitschii*	0/2
Strabomantidae	*Pristimantis cerasinus*	0/1

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Detecting *Batrachochytrium dendrobatidis* in the Wild When Amphibians Are Absent

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Once common in the southern Rocky Mountains of North America, sharp declines in Boreal Toad (*Anaxyrus boreas boreas*) populations precipitated their listing as a state endangered species in Colorado, USA (Loeffler 2001) and consideration for listing under the Endangered Species Act (U.S. Fish and Wildlife Service 2005). The amphibian chytrid fungus (*Batrachochytrium dendrobatidis*, hereafter *Bd*) has been implicated in these declines (Livo 2000; Muths et al. 2003; Scherer et al. 2005). Interest in reintroducing *A. b. boreas* into historical habitats (Loeffler 2001) has spurred the need to develop a test for the presence of *Bd*. Reintroduction efforts are time consuming and costly, and their success may hinge on the occurrence of *Bd* at a potential site. As such, it is imperative that disease status be considered when evaluating potential reintroduction efforts.

Currently our ability to detect *Bd* at a site relies on resident amphibians being present, yet they are not at many promising potential reintroduction locations. Since *Bd* can persist at a location even in the absence of amphibian species (Longcore et al. 1999; Rowley et al. 2007; Speare et al. 2001), we suspect that amphibians may not be the only host, and that infection can be maintained through other alternate hosts or environmental reservoirs. We hope that by testing these non-amphibian sources, the *Bd* status at potential reintroduction sites can be evaluated. Rowley et al. (2007) did not detect *Bd* in retreat sites of rain forest stream frogs, while Lips et al. (2006) did find *Bd* DNA on stream boulders but not in filtered water samples. Others have detected *Bd* in filtered water samples (Kirshtein et al. 2007; Walker et al. 2007), but their approaches do not always perform well in waters carrying high organic loads that rapidly clog filters (Cossel and Lindquist 2009) or cause PCR inhibition (Kirshtein et al. 2007). Our initial efforts toward finding alternative *Bd* hosts focused on insects, because they are readily available and chytrid fungi can degrade chitin, a component of aquatic insect exoskeletons (Johnson and Speare 2003; Powell 1993). These early surveys were unable to confirm the presence of *Bd* in samples of Dytiscidae, Coenagrionidae, Hydrophilidae, or Notonectidae from two ponds known to harbor the fungus (Rogers et al. 2004). Samples of Corixidae, algae, snails, and clams taken from a third pond with infected Boreal Chorus Frogs (*Pseudacris maculata*) were also negative for *Bd* DNA (Rogers and Wood 2005). In an effort to establish a more rigorous examination of potential alternate hosts, we initiated a study to explore the feasibility of using sentinel cages and fish following reports that *Bd* could be found on the scales of Fathead Minnows (*Pimephales promelas*) that were exposed to *Bd* in the laboratory (R. Retallick, pers. comm., GHD, Australia). Feathers and keratin were included

in this field study as well when others demonstrated the ability to culture *Bd* on sterile duck feathers (Johnson and Speare 2005) or 1% keratin agar (Piotrowski 2004) *in vitro*.

Methods.—Sentinel experiments were conducted in both a mid-elevation site in the town of Steamboat Springs, Colorado, and a high elevation site on the Grand Mesa, Colorado after the spring thaw in 2005 when prevalence of *Bd* infection was greatest (K. Rogers, unpubl. data). This occurred in May for the low elevation site in Steamboat Springs, and in July for the high elevation sites on the Grand Mesa. *Bd* presence at both sites was confirmed by swabbing resident *P. maculata* following Livo (2004). DNA was extracted from the samples using a standard spin column protocol. All sample DNA preparations were assayed for the presence of the *Bd* ribosomal RNA Intervening Transcribed Sequence (ITS) region by 45 cycle single-round PCR amplification (Annis et al. 2004) that was modified for greater specificity and sensitivity at Pisces Molecular, Boulder, Colorado.

Cages (0.125 m^3) were constructed of 4 × 4 cm pine boards and 3 mm mesh to house sentinel animals. Cages were deployed in water less than 60 cm deep, and secured to the bottom with metal stakes. A protective hardware cloth (25 mm mesh) was attached to the outside of each cage to protect them from predators. Sentinel fish were sampled for *Bd* at 1, 3, 7, and 14 days following introduction to the cages, and mortalities were noted. Fish were swabbed on their right flanks one day after exposure. After 3, 7 and 14 days of exposure, 10 fish of each species from each pen were euthanized with MS-222, then swabbed, scraped, and fin clipped. A cotton swab (Puritan cotton-tipped applicators, VWR International, West Chester, Pennsylvania), was stroked 20 times unidirectionally across the left flank of each sentinel fish, then preserved in 70% ethanol (Livo et al. 2004) for subsequent PCR screening. The skin scrapes followed a similar protocol but used a sharpened wooden dowel (Livo 2004). Paired and caudal fins were removed and preserved in 70% ethanol.

In addition to sampling sentinel fish, six mallard (*Anas platyrhynchos*) flank feathers were taped together at the stalk and suspended in the surface film with a string attached to the outside of the cage. A feather was collected on each sampling day by clipping the exposed end of the feather and placing the complete piece in a 2-mL microcentrifuge tube containing 70% ethanol, then processed with the same PCR procedure.

The first study was conducted in a small temporary spring-flooded pond (Trafalger Pond) next to the Yampa River within the city limits of Steamboats Springs, Colorado (2051 m elev.; 40.47445°N, 106.83017°W). Skin swabs from 20 resident adult *P. maculata* collected during the breeding season suggest this pond has harbored *Bd* since at least 2004 (30% prevalence, K. Rogers, unpubl. data). Thirty Rainbow Trout (*Oncorhynchus mykiss*), 30 *P. promelas*, and 30 Goldfish (*Carassius auratus*) were used as sentinel fish in each of four cages spread throughout the pond, in addition to six Mallard flank feathers suspended outside of each cage.

The second study was conducted in the Kannah Creek drainage on the Grand Mesa near Grand Junction, Colorado (3268 m elev.; 39.04420°N, 108.02992°W). Dozens of small ponds in this drainage are home to robust populations of *P. maculata*. Ponds with perennial water also support Tiger Salamanders (*Ambystoma tigrinum*). *Bd* was first detected in this drainage in 2003 in *P. maculata* collected from a 1.0 ha pond (Pond 4) used in this study (Rogers and Banulis 2004). One cage with 30 *P. promelas* was deployed in each of two additional 0.5 ha ponds, hereafter referred to as Lands End and Cow Camp. Pond 4 received two cages, each with 30 *P. promelas*. Six Mallard flank feathers were installed outside of each of the four cages. In addition, we explored baiting *Bd* with pure keratin (VWR International, West Chester, Pennsylvania). Keratin tea bags were constructed from paper coffee filters, cut in half and sewed together. Five bags were fastened to each cage with 3 g of keratin per bag. A bag was removed from each cage on every sampling occasion, and a portion of the contents preserved in 70% ethanol. Skin swabs from 20 adult *P. maculata* were collected from each of these three ponds the day after this 14-day experiment to evaluate the prevalence of *Bd* in 2005.

Results.—In an effort to reduce assay costs in the first study, only the feathers collected at 1, 3, 7, and 14 days following exposure along with fish skin swabs collected one day following exposure on *O. mykiss* and three days following exposure on *P. promelas* and *C. auratus* were submitted for analysis. None of these 16 feather samples or 120 fish samples suggested that *Bd* was present. Because the ability to use sentinel organisms at this site did not appear promising and processing samples was costly, the remaining samples were archived.

In the second study, despite a substantial number of *Bd*-positive samples from the *P. maculata* collected at the end of our experiment (prevalence of *Bd* ranging from 25–30% in all three ponds), only six of 350 fish swab, scrape, and fin samples were *Bd* positive. These included five swabs collected one day after exposure on *P. promelas* in Cow Camp and a single swab from Lands End, also collected one day after exposure that returned a very weak positive signal. None of the fish swabs, scrapes, or fin clips collected 3, 7, or 14 days after exposure yielded positive results. Feathers and raw keratin were equally ineffective, as all 32 samples failed to register any evidence of *Bd* over the course of the experiment.

Discussion.—Caged fish, feathers, and keratin were ineffective at sampling *Bd* in ponds known to have amphibians with the disease. Although swabbing the flanks of *P. promelas* exposed for one day in a *Bd*-positive environment yielded Bd-positive results, fish sampling was clearly much less sensitive than sampling *P. maculata* in the same environment. The fact that the majority of the positive results came from the single cage at Cow Camp, and that positives were found after only one day of exposure but not after a week or two weeks makes the use of *P. promelas* as sentinel organisms problematic. Rather than *Bd* actually infecting the host, this suggests that the cage was fortuitously deployed in an area with *Bd* zoospores, and that they simply adhered to the fish when sampled on that first day. Chytrid spores have a short-lived free-swimming stage that only lasts about 24 hrs before encysting (Piotrowski et al. 2004). Even with this 24 hr active period the spore can only swim 2 cm (Piotrowski et al. 2004). Thus we may have simply been lucky in our placement of the Cow Camp cage in particular. There does not appear to be any particular affinity by the zoospores toward *P. promelas*, as subsequent samples revealed no indication of *Bd* presence. Given the inconsistent nature of the results, it is doubtful that using sentinel *P. promelas* would be a viable approach for screening potential amphibian reintroduction sites for the presence of the fungus. Although sentinel fish have been used to test for pathogens like whirling disease (Koel et al.

2006; Thompson et al. 1999), the construction and deployment of cages remains labor intensive, particularly in sites that are difficult to access. This is an additional consideration, given the apparently low sensitivity of *P. promelas* as a sentinel to detect *Bd*.

Because the majority of positive samples came from the same cage on the same day, contamination of the samples is a concern. The frog samples used to confirm the presence of the fungus were collected following the experiment, and stored in a different location making them an unlikely source of contamination. Using latex gloves between samples, and sterilizing equipment with an open flame further minimized contamination risk. Contamination occurring in the original source stock of *P. promelas* was also ruled out, as most positive signals came from a single cage, and only early in the study. Samples collected after 3, 7, and 14 days were all *Bd*-negative.

Given that others have been successful growing chytrid fungi on a 1% keratin agar (Piotrowski et al. 2004) or on feathers (Johnson and Speare 2005) *in vitro*, we were surprised that none of the keratin or feather samples yielded a positive PCR result. It was suggested that perhaps the *Bd* fungus did not colonize the interior of the keratin bags, but rather just the outside, which was not sampled. Subsequent tests using agar-impregnated swabs rolled in raw keratin however also failed to bait in *Bd* following three days of exposure (K. Rogers, unpubl. data).

If *Bd* has a patchy distribution in a pond environment, it would be difficult to sample with fixed organisms or objects. A more effective approach would be to release amphibians targeted for a reintroduction effort, then subsequently collecting survivors the following year to sample for *Bd*. Using a non-tethered organism allows the target to move through the environment as it would following a repatriation effort, encountering pathogens along the way. Repatriation efforts require the ability to produce large numbers of offspring for subsequent release; a portion of this captive production could be used to assay potential field sites for *Bd*. If a captive broodstock is not available, fertilized eggs could be secured from the wild, washed to minimize risk of *Bd* transfer, then raised to the larval stage for release (Rogers and Banulis 2004). This approach requires that target amphibians be produced during pilot studies prior to implementing full repatriation efforts to determine the suitability of potential translocation sites.

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First Report of *Ranavirus* Infecting Lungless Salamanders

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Ranaviruses are a group of pathogens belonging to the genus *Ranavirus* (Family Iridoviridae) that have been linked to catastrophic die-offs of larval amphibians in North America and elsewhere (Daszak et al. 2003). They also have been identified as the etiologic agent in the mass mortality of adult Common Frogs (*Rana temporaria*) and Common Toads (*Bufo bufo*) in the United Kingdom (Cunningham et al. 1996; 2007a,b). In the United States, ranaviruses are responsible for the majority of disease-related mortality events in amphibians (Green et al. 2002; Muths et al. 2006). There is evidence that ranaviruses may be an emerging infectious disease (Storfer et al. 2007), possibly due to novel strain introduction (Picco and Collins 2008) or increased occurrence of anthropogenic stressors on the landscape (Forson and Storfer 2006; Gray et al. 2007). Recognizing the potential threat of ranaviruses to global amphibian biodiversity, the World Organization for Animal Health (OIE) recently listed this pathogen as a notifiable disease, requiring proof of *Ranavirus*-negative results before commercial shipment of amphibians (OIE 2008). The OIE identifies field surveillance as a critical component of risk assessment for ranaviruses (OIE 2008). Although surveillance for the amphibian pathogen *Batrachochytrium dendrobatidis* has become widespread (e.g., Chatfield et al. 2009; Rothermel et al. 2008), testing amphibians for *Ranavirus* occurs less frequently.

The Southern Appalachian Mountain Range of North America represents a global hotspot for salamander biodiversity (Dodd 2004; Petranka 1998). In particular, lungless salamanders (Family Plethodontidae) occur in high abundance and biomass (Peterman et al. 2008; Petranka and Murray 2001) and are important components of the ecosystem (Davic and Welsh 2004). Known die-offs of Eastern Newts (*Notophthalmus viridescens*), Spotted Salamanders (*Ambystoma maculatum*), Pickerel Frogs (*Lithobates palustris*), and Wood Frogs (*L. sylvaticus*) occurred in the Southern Appalachian Mountains due to ranaviruses in 1999 and 2001 (Converse and Green 2005; Green et al. 2002). Despite these mortality events, surveillance for *Ranavirus* in Southern Appalachian amphibians has been nonexistent. Our goal was to test for the presence of *Ranavirus* in lungless salamander communities located in the Southern Appalachian Mountains. We tested for *Ranavirus* in salamander communities at three sites that differed in elevation and report prevalence by species and for each site.

Methods.—We captured adult lungless salamanders for *Ranavirus* testing on 21 April 2007 at three locations in the Great Smoky Mountains National Park, Tennessee: 1) Ash Hopper Branch (456 m elev.; 35.6836°N, 83.5375°W); 2) Chimney Tops Seeps (831 m elev.; 35.6367°N, 83.4928°W); and 3) Indian Gap Seeps (1537 m elev.; 35.61°N, 83.45°W). At all sites, we searched 1 h for salamanders in streams, seeps, and under terrestrial ground cover items (e.g., logs, rocks). We placed captured salamanders in individual 1-L plastic containers and processed up to 10 individuals per species per site. We swabbed the oral cavity and the cloaca twice each. We wore disposable gloves and changed them between animals to minimize the likelihood of cross contamination among samples. We put each swab in separate microcentrifuge tubes, placed the tubes on dry ice, and froze the swabs at -70°C within 10 h of collection. We swabbed 21, 21, and 27 salamanders at Ash Hopper Branch, Chimney Tops, and Indian Gap sites, respectively. All salamanders were released at their approximate capture location within 1 h of capture, and containers, footwear, and equipment were disinfected with 2% Nolvasan® prior to moving between sites (Bryan et al. 2009). We shipped frozen swabs overnight on dry ice to the University of Georgia Veterinary Diagnostic and Investigational Laboratory for *Ranavirus* testing.

We used conventional polymerase chain reaction (PCR) to test for the occurrence of *Ranavirus*. We extracted genomic DNA from swabs using a QIAamp DNA Mini Kit (Qiagen Inc., Valencia, California). A heminested PCR targeting a 500-bp region of the major capsid protein (MCP) gene was used following the protocol by Kattenbelt et al. (2000). The PCR products were resolved by gel electrophoresis for determination of *Ranavirus* occurrence. We randomly chose one sample per species with a distinct PCR-positive band, cut the band from the gel, and submitted the isolated product to SeqWright DNA Technology Services, Houston, Texas, for automated sequencing in the forward and reverse directions. We then performed a GenBank BLAST search (http://www.ncbi.nlm.nih.gov/Genbank.html) on the sequences to verify that positive PCR results were *Ranavirus*. Additionally, real-time quantitative PCR (qPCR) was performed following the procedure by Picco et al. (2007) on samples used for sequencing to further support our findings.

We summarized the positive test results for each species, and tallied *Ranavirus* prevalence among species for each sampling

TABLE 1. Prevalence of *Ranavirus* detected from oral and cloacal swabs using PCR for 10 species of adult lungless salamander, Plethodontidae, in the Great Smoky Mountains National Park, Tennessee, USA, April 2007.

Species	No. Infected/ Tested	Prevalence	Accession Number[1]
Desmognathus conanti	13/14	0.93	GQ326559
D. imitator	11/13	0.85	GQ326560
D. monticola	1/1	1.0	GQ326561
D. ocoee	2/2	1.0	GQ326562
D. quadramaculatus	7/8	0.88	GQ326563
D. santeetlah	11/13	0.85	GQ326564
D. wrighti	1/2	0.5	NS
Eurycea wilderae	8/12	0.67	GQ326565
Gyrinophilus porphyriticus	1/2	0.5	GQ326566
Plethodon jordani	1/2	0.5	NS
Total	56/69	0.81	

[1]GenBank accession number of the DNA sequence used for *Ranavirus* determination; NS = not sequenced because insufficient genomic DNA was amplified for sequencing.

site. We tested for the differences in *Ranavirus* prevalence among sites using logistic analysis and calculated odds-ratio statistics to estimate the likelihood of *Ranavirus* infection for each site (Stokes et al. 2000). All analyses were performed using the SAS® system (SAS Institute, Cary, North Carolina) with $\alpha = 0.05$.

Results.—We captured 10 species of lungless salamanders and all species included individuals that tested positive for *Ranavirus*. The qPCR results matched the conventional PCR results. We were able to sequence the PCR products from eight of the infected species. GenBank BLAST searches on the sequences revealed identities of 94–96% and 97–100% with ATV and FV3, respectively. Overall prevalence was 81% among species and sites (Table 1). *Ranavirus* prevalence differed among sites ($\chi^2 = 7.14$, $P = 0.028$; Fig. 1). Salamanders were 10 and 3 times more likely to be infected at Ash Hopper Branch (odds ratio = 0.1) and Chimney Tops Seeps (odds ratio = 0.3), respectively, compared to the Indian Gap Seeps.

Discussion.—We report the first documentation of *Ranavirus* infecting salamander species in the family Plethodontidae. We documented *Ranavirus* infecting 10 species of lungless salamander at an overall prevalence of 81% among species. The high prevalence of *Ranavirus* in adult lungless salamanders may indicate that they are tolerant of infection. Brunner et al. (2004) reported that postmetamorphic Tiger Salamanders (*Ambystoma tigrinum*) could be asymptomatic carriers of ranaviruses. However, no studies have quantified the pathogenicity of ranaviruses for lungless salamanders or whether virulence differs among developmental stages. Studies with anurans and ambystomatid salamanders suggest that adult stages are less susceptible to *Ranavirus* than larval stages (Collins et al. 2004; Gantress et al. 2003), thus adult amphibians have the greatest likelihood of serving as a *Ranavirus* reservoir. It also is possible that the high *Ranavirus* prevalence was evidence that a die-off was occurring or imminent. Laboratory studies with ranaviruses have shown that infection and mortality rates typically track each other in highly susceptible species (Brunner et al. 2007; Cunningham et al. 2007b). None of the individuals that we swabbed had gross signs of ranaviral disease (e.g., edema, erythema) and dead salamanders were not observed. However, it is important to note that diseased individuals often do not exhibit external signs and die-offs in the wild are rarely observed (Green et al. 2009). Inasmuch as this is the first documentation of ranaviruses infecting lungless salamanders, more research is needed to determine the threat that ranaviruses pose to this diverse group of amphibians.

Although positive results from swab specimens can be an indication of virus infection (Driskell et al. 2009), they also may reflect virions attached to skin surfaces (Green et al. 2009). In a separate controlled study with tadpoles, we determined that PCR test results for *Ranavirus* from swabs have about a 10% false-positive rate for systemic infection when compared with test results from liver tissue (Miller, Gray, and Hoverman, unpubl.

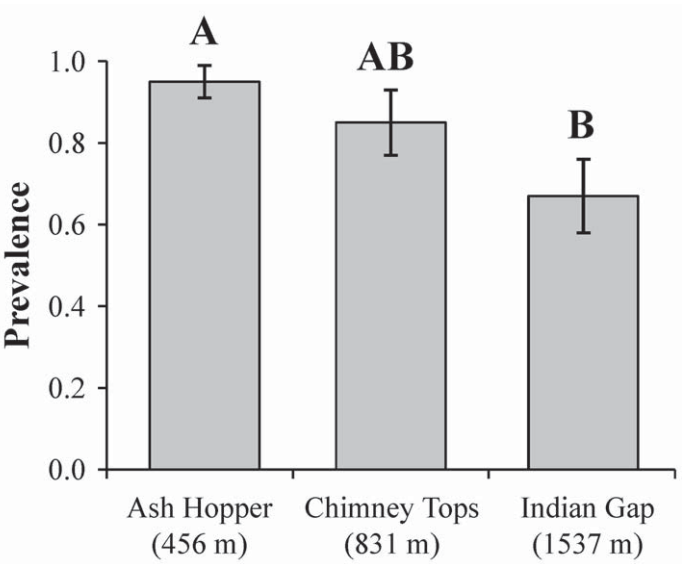


FIG. 1. *Ranavirus* prevalence in lungless salamanders (Plethodontidae) among three sampling locations that differed in elevation, Great Smoky Mountains National Park, Tennessee, USA, April 2007. Bars with unlike letters are different ($P = 0.03$) by Wald's chi-square test; standard error bars calculated as: $\hat{p} \pm \sqrt{\hat{p}(1-\hat{p})/n}$

data). We did not euthanize salamanders in our study so it is unknown if positive swabbed individuals had systemic infections. Nonetheless, given the high prevalence of *Ranavirus* across species, systemic infection of some individuals was possible.

Pathogen prevalence differed among sites, with prevalence increasing with decreasing site elevation. Salamanders at 456 m above sea level were 10 times more likely to be infected with *Ranavirus* than those at 1537 m elev. Greater pathogen prevalence at lower elevation is opposite of the trends reported by previous studies with *Ranavirus* and *Batrachochytrium dendrobatidis* (Brem and Lips 2008; Gahl and Calhoun 2008), which have related differences in infection among elevations to changes in temperature. Inasmuch as stream temperature is relatively constant among elevations in the Southern Appalachian Mountains (Swift and Clinton 1997), more optimal temperature for virus replication or temperature-induced stress probably were not factors responsible for higher prevalence at lower elevation. Higher prevalence at low-elevation sites may reflect greater human access. All sites could be accessed by trails but the sampling location for Ash Hopper Branch was <200 m from the U.S. National Park Service Sugarlands Visitor Center and a campground was <100 m from the Chimney Tops Seeps. In contrast, the Indian Gap seeps were approximately 400 m from a minor parking lot. Greater human access could increase the likelihood of infection by increasing the level of stressors in the environment or by introducing *Ranavirus* virions that are attached to footwear or recreational gear (Green et al. 2009). It also is possible that greater infection at low-elevation sites was a result of watershed position. Most of the salamanders that we collected were in or adjacent to flowing streams. *Ranavirus* virions transmit effectively in water (Harp and Petranka 2006), and they probably remain active outside the host for several months (Langdon 1989). Thus, greater prevalence of *Ranavirus* at lower elevation may be a consequence of cumulative downstream transport of virions and higher contact rates with the pathogen. The possible impacts of factors associated with elevation and human access on exposure frequency and susceptibility of lungless salamanders to ranaviruses need to be explored.

Our results indicate that plethodontid salamanders are suitable hosts for ranaviruses. The pathogenicity of ranaviruses to plethodontid salamanders remains unknown and is a part of ongoing experimental challenges (Gray, Miller, and Hoverman, unpubl. data). Given the high prevalence of *Ranavirus* in Southern Appalachian salamanders, we recommend that surveillance efforts be expanded in this region and perhaps elsewhere. Future efforts should include isolating and molecularly characterizing ranaviruses infecting plethodontid salamanders to determine if they are phylogenetically similar to previous isolates. Given the possible threat of ranaviruses to lungless salamanders, we recommend that researchers take biosecurity precautions to reduce the likelihood of transporting *Ranavirus* virions among watersheds. Bryan et al. (2009) reported that 1% Nolvasan®, 1% Virkon S®, and 3% bleach were effective at inactivating *Ranavirus* after 1 min contact duration. Mud and debris should be removed from footwear and gear prior to applying disinfectant (Green et al. 2009).

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Amphibian Chytrid Fungus in Western Toads (*Anaxyrus boreas*) in British Columbia and Yukon, Canada

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The amphibian chytrid fungus, *Batrachochytrium dendrobatidis* (*Bd*), appears to have a patchy pattern of occurrence, particularly at the northernmost extent of its distribution (Aanensen et al. 2009). In northwestern North America, *Bd* has been detected in Western Toads, *Anaxyrus boreas*, in southeast Alaska, USA (Adams et al. 2007), the Peace River district in northeast British Columbia, Canada (Raverty and Reynolds 2001), and in southwest British Columbia (Deguise and Richardson 2009). *Bd* also was found in Wood Frogs, *Lithobates sylvaticus*, in Kenai National Wildlife Refuge, Alaska (Reeves and Green 2006, Reeves 2008), and in Northern Red-legged Frogs, *Rana aurora*, from Vancouver Island, British Columbia (Adams et al. 2007). Conversely, *Bd* was not detected in Columbia Spotted Frogs (*Rana luteiventris*), Wood frogs, or Western Toads collected at several locations including the Chilkoot Trail National Historic Site, northwest British Columbia (Adams et al. 2007). Likewise, *Bd* was not found in Wood Frogs in Denali National Park (Chestnut et al. 2008), Innoko National Wildlife Refuge, or Tetlin National Wildlife Refuge, Alaska (Reeves 2008). However, small sample sizes and low prevalence may have affected detection at some sites (see Skerratt et al. 2008).

Amphibians within a large portion of the range of Western Toads at its northern limit in northern British Columbia (Matsuda et al. 2006) and the southeast Yukon Territory, Canada (Slough and Mennell 2006) have not been sampled for *Bd*. To address this gap, I sampled amphibians for *Bd* from 4 distinct populations in this region in 2007 and 2008, including Tutshi Lake, Atlin Lake and the Nakina River in northwest British Columbia, and the Coal River in the southeast Yukon Territory (Table 1).

Amphibians were located using visual encounter surveys and were captured by hand or dip net, which had been cleaned and dried between captures and disinfected with bleach between sites. Each animal was held separately prior to swabbing and was handled with a new pair of vinyl medical examination gloves and swabbed with a sterile 15 cm cotton-tipped swab (AMG Medical Inc., Montréal, QC) 5-times each below the throat, between the toes of the front feet, along the belly, thighs, around the drink patch and cloaca and between the toes of the hind feet. Each swab was air-dried for 5 min and placed tip down in a 1.5 ml microcentrifuge tube. Excess handle-length of the swab was broken off and the tube was sealed and stored frozen. Swabs were analyzed for *Bd* with a real-time PCR assay at either the British Columbia Ministry of Agriculture, Fisheries and Food, Animal Health Centre (2007 samples) or the University of Victoria, British Columbia (2008 samples) using the technique described by Boyle et al. (2004).

In 2007, seven of 20 toads from Atlin Lake and the Nakina River tested positive for *Bd*, and the Tutshi Lake samples were *Bd*-negative (Fig. 1). A Wood Frog from Atlin Lake and two Long-toed

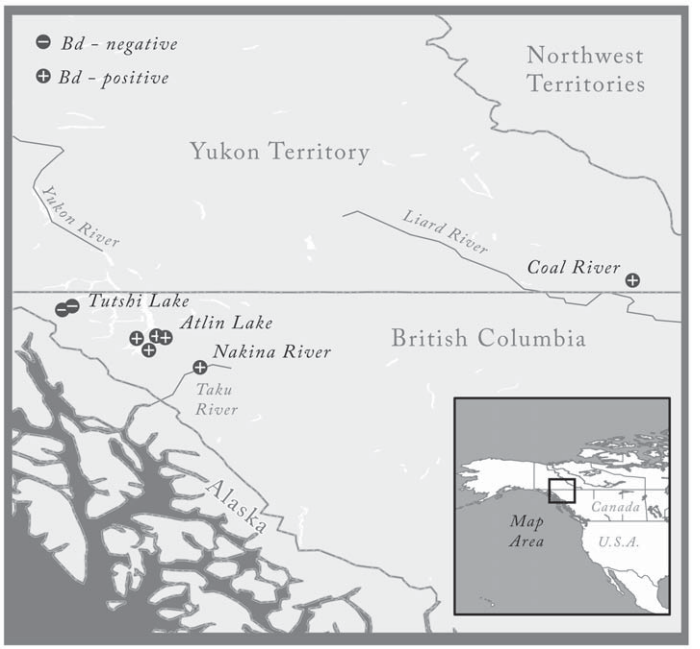


FIG. 1. Locations in British Columbia and Yukon, Canada where amphibians were sampled for the presence (+) of *Batrachochytrium dendrobatidis* (*Bd*) in 2007 and 2008. "–" indicates locations where *Bd* was not detected.

Salamanders (*Ambystoma macrodactylum*) from the Nakina River also tested negative. One of the *Bd*-positive Western Toads from Atlin Lake had sloughing skin on a thigh; otherwise no other individuals had visual signs of the disease such as lethargy or redness on the legs. In 2008, all 10 toad metamorphs from Atlin Lake, an adult toad, and six Wood Frogs from the Coal River, Yukon Territory, tested *Bd*-positive. Western Toad tadpoles from the Coal River were *Bd*-negative.

The pattern of patchy *Bd* occurrence at high northern latitudes is supported by these additional data from northern British Columbia and Yukon Territory. *Bd* was present in three Western Toad populations sampled in northwestern British Columbia and Yukon Territory but was not detected at Tutshi Lake (Fig. 1), the northwestern-most site surveyed, which coincidentally is only 10 km east of the Chilkoot Trail National Historic Site where amphibians previously sampled also were *Bd*-negative (Adams et al. 2007).

There is concurrent Western Toad breeding site monitoring at one of the study sites, the Atlin Warm Springs, at Atlin Lake, where there were eggs, larvae or metamorphs present demonstrating breeding activity in survey years 1988, 1996, 1998, 1999, 2001, 2005 and 2008, but no breeding activity or adults were observed in 2006, 2007 and 2009 (B. Slough, unpubl. data). This is a small population, with no more than 25 adults and 8 egg clutches observed at one time, however it has demonstrated long-term persistence. Other observations of toads at this site were made in 1924 (Slevin 1928; MVZ 9478–9483, Museum of Vertebrate Biology, University of California, Berkeley), 1952 (Cook 1977), 1962 (RBCM 1273, Royal British Columbia Museum, Victoria), 1979 (CMNAR 21852, Canadian Museum of Nature, Ottawa), 1980 (RBCM 1389) and 1993 (Mennell 1997). These data indicate that the breeding population may have suffered recent losses, and although *Bd* may be contributing to this, several alternative or interacting factors warrant consideration (e.g., climate change; Slough 2009), especially due to the location of this area at the margin of the species' range. The general status rank of the Western Toad is *Sensitive* in British Columbia and the Yukon (Canadian Endangered Species Conservation Council 2006), and it is protected under the federal *Species at Risk Act* after being designated *Special Concern* (COSEWIC 2002). The effect of *Bd* on northern amphibian populations, especially

TABLE 1. Incidence of *Batrachochytrium dendrobatidis* (*Bd*) in amphibians sampled in northwest British Columbia and Yukon, Canada. The species examined were *Anaxyrus boreas* (ANBO), *Lithobates sylvaticus* (LISY), and *Ambystoma macrodactylum* (AMMA).

Location	Date	Latitude °N, Longitude °W	Positive *Bd* Samples	Negative *Bd* Samples
Tutshi River uplands	20 June 2007	59.772, -134.931	0	1 juvenile ANBO
Tutshi Lake	3 June 2007	59.817, -134.799	0	8 adult ANBO
Atlin Lake, Torres Channel	23 June 2007	59.398, -133.951	1 adult ANBO	0
Atlin Lake, near Griffith Island	23 & 28 June 2007	59.286, -133.824 59.284, -133.823	2 adult ANBO	1 adult ANBO
Atlin Lake, 12-Mile Point, Teresa Island	28 June 2007	59.436, -133.695	2 juvenile 1 adult ANBO	1 adult ANBO
Atlin Lake, Warm Springs Homestead	19 April 2007	59.406, -133.579	0	1 adult ANBO
Atlin Lake, Warm Springs Homestead	26 June 2007	59.406, -133.579	0	1 adult LISY
Atlin Lake, Warm Springs	10 May 2008	59.404, -133.573	10 metamorph ANBO	0
Nakina River, near confluence with Sloko River	1 July 2007	59.011, -133.141 59.008, -133.151	1 adult ANBO	1 adult ANBO 2 adult AMMA
Coal River Springs and Coal River	23–24 July 2008	60.156, -127.435	1 adult ANBO 6 adult LISY	30 ANBO larvae

Western Toads, warrants further investigation.

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Chytridiomycosis-Associated Mortality in a *Rana palustris* Collected in Great Smoky Mountains National Park, Tennessee, USA

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Batrachochytrium dendrobatidis (*Bd*) has been associated with global amphibian population declines and occasionally with species extinctions (Daszak et al. 1999). Further, recent evidence suggests that surviving amphibian communities may persist with sublethal infections (Rettalick et al. 2004). Although *Bd* has been detected in amphibians in Great Smoky Mountains National Park (GSMNP; Chatfield et al. 2009), USA, mortality associated with chytridiomycosis has not been reported.

The Southern Appalachian Mountain Range, where GSMNP occurs, is known for its amphibian species richness (Dodd 2004). Within the GSMNP, Cades Cove, Tennessee, is one of the most highly visited sites by tourists, and thus an area where anthropogenic stressors (e.g., introduction of chemical agents or novel pathogens) may impact native species. Although amphibian mortality was observed in Cades Cove from 1999 to 2001, these mortality events were attributed to pathogens other than *Bd* (Dodd 2004; Rothermel et al. 2008). On 5 April 2009, a recently deceased adult male *Rana palustris* was found in a pond in Cades Cove (35.606667ºN, 83.816944ºW) while conducting field surveillance for *Ranavirus*. The animal was collected and shipped overnight on ice to the University of Georgia, Veterinary Diagnostic and Investigational Laboratory for diagnostic evaluation.

Gross examination revealed only mild (ca. 48 h under refrigeration post field collection) postmortem autolysis. Grossly there was diffuse erythema (reddening) on the ventromedial legs and random petechia (pin-point hemorrhages), ecchymosis (red blotches), and irregular patches of discoloration elsewhere on the ventral body (Fig. 1A). Vascular congestion was noted in the kidneys but other organs appeared normal. Sections of all organs were collected and fixed in 10% phosphate-buffered formalin, embedded in paraffin, cut at 4 μm sections, stained with hematoxylin and eosin, and examined microscopically. Additionally, sections of skin lesions and toes were collected for qPCR and conventional PCR for *Bd*, and sections of skin lesions, liver and kidney were collected for

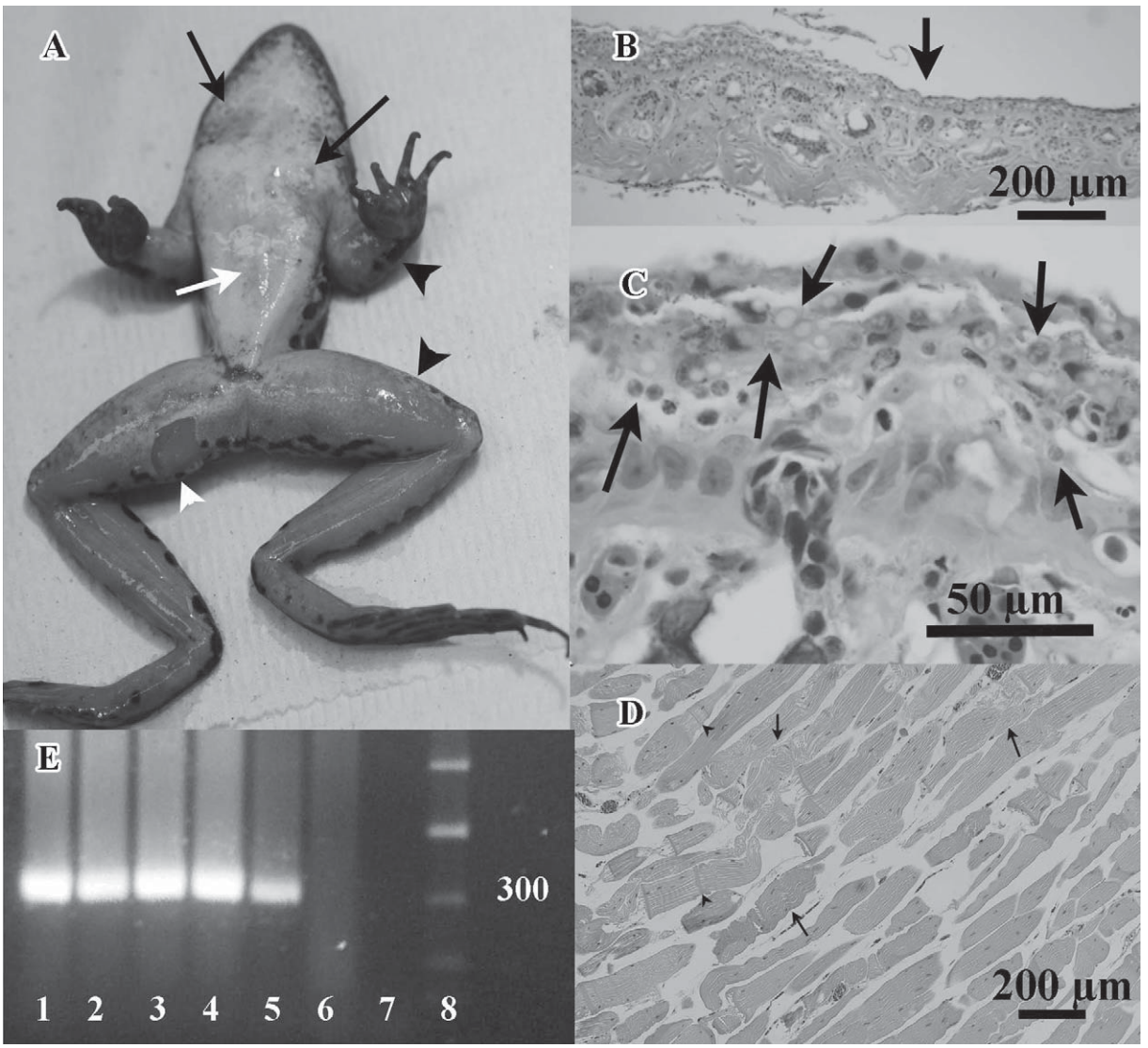


FIG. 1. A) Gross changes observed in *Rana palustris* found dead in Great Smoky Mountains National Park, Tennessee, USA. There is diffuse erythema on the ventromedial legs (black arrowheads) and random petechia, ecchymosis (white arrow), and irregular patches of discoloration (black arrows) elsewhere on the ventral body. The white arrowhead indicates an area of post-mortem tissue sampling. B) Photomicrograph of a hematoxylin and eosin (H&E) stained section of skin from the frog showing epidermal proliferation. The area to the left of the arrow is more proliferative and the area to the right is more normal. C) Closer view of the proliferative skin area in B (H&E stain), showing the organisms consistent with *Batrachochytrium dendrobatidis* zoospores (arrows). D) Photomicrograph of an H&E stained section of skeletal muscle subjacent to the skin lesions, and showing swollen fibers that had lost cross-striations and were often fragmented (arrows), and occasional contraction bands (arrowheads). E) Gel electrophoresis of the PCR products isolated from skin and toe samples collected from the frog pictured in A. The 300-bp products were consistent with *Bd*. Lanes 1 and 2 are Frog Sample 1, Lanes 3 and 4 are Frog Sample 2, Lane 5 is the Positive *Bd* Control, Lane 6 is the Negative Tissue Control, and 7 is Negative Control, Lane 8 is the molecular weight marker.

qPCR and conventional PCR for *Ranavirus*. Chytrid qPCR was performed using the method described by Boyle et al. (2004), and conventional PCR was performed following the protocol by Annis et al. (2004). *Ranavirus* qPCR was performed using the protocol by Picco et al. (2007), and conventional PCR was performed following the protocol by Mao et al. (1997).

Histologically, the epidermis was multifocally thickened (2–4 cell layers; Fig. 1B) with intracytoplasmic 3–5 μm round organisms (Fig. 1C) consistent with *Bd* organisms (thalli). This type of lesion was consistently found in the epidermis overlying the digits and in the skin lesions observed grossly. The skeletal muscles subjacent to the skin lesions had swollen fibers and patches of myofiber disarray, fragmentation, and loss of cross-striations (Fig. 1D). Conventional PCR was positive for *Bd* (Fig. 1E), but negative for *Ranavirus*. Likewise, qPCR was positive for *Bd*, but negative for *Ranavirus*.

The histological and molecular findings were consistent with chytridiomycosis caused by the amphibian pathogen *Bd*. Sensitivity to *Bd* varies by amphibian species (Blaustein et al. 2005), and may be partially attributed to differences in skin antimicrobial properties (Woodhams et al. 2004). Ultimately, chytridiomycosis is believed to interfere with osmoregulation (Voyles et al. 2007), which leads to muscular degeneration and eventually death (Miller et al. 2008). Other factors (e.g., environmental contaminants,

climate change) are hypothesized to exacerbate the effects of or make amphibians more susceptible to this pathogen (Bosch et al. 2007; Davidson et al. 2007).

We are uncertain what factors contributed to this *R. palustris* developing chytridiomycosis. Rothermel et al. (2008) found that 23 of 35 *R. palustris* collected from the southeastern United States were positive for *Bd*; however, chytridiomycosis was not found. In a Canadian survey, *Bd* prevalence in *R. palustris* was found to be low (3%; Ouellet et al. 2005). Given the findings from these studies and the lack of detection of other pathological changes in the *R. palustris* in our study, an exogenous stressor or combination of stressors (e.g., chemical exposure, habitat change, breeding) may have contributed to the development of chytridiomycosis in this case.

The finding of chytridiomycosis in this *R. palustris* verifies the need for continued surveillance and testing of amphibian populations in the GSMNP. Given the wealth of amphibian biodiversity in the GSMNP, this location serves as an ideal place to study the variation in pathogen prevalence and species susceptibility of amphibian populations. The co-occurrence of two emerging amphibian pathogens (*Ranavirus* [Dodd 2004] and *Bd*) in Cades Cove warrants continued monitoring of amphibian breeding ponds in this highly visited area of GSMNP.

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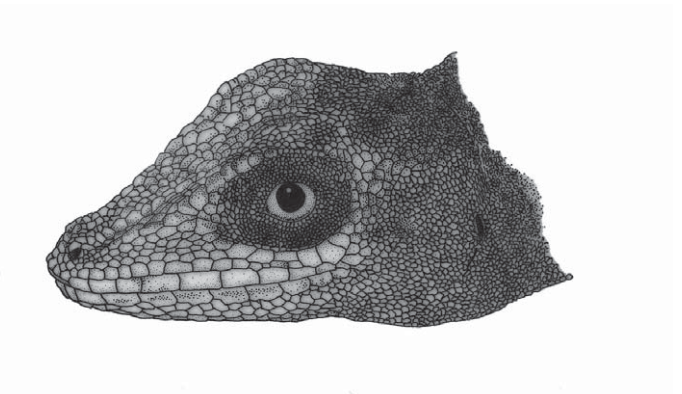
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Anolis fraseri (Polychrotidae). Reserva Forestal Bosque de Yotoco, Department of Valle del Cauca, Colombia. Illustration by Fernando Vargas Salinas, based on a photograph by FVS.

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Nutrient Composition of Whole Crayfish (*Orconectes* and *Procambarus* Species) Consumed by Hellbender (*Cryptobranchus alleganiensis*)

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Hellbenders (*Cryptobranchus alleganiensis*) are one of the largest salamanders in North America, averaging 29–51 cm in total length, but reaching up to 70 cm (Nickerson and Mays 1973; Conant and Collins 1998; Johnson 2000). The Eastern Hellbender (*C. a. alleganiensis*) ranges from New York State south to Georgia, and west to Missouri, whereas the Ozark subspecies (*C. a. bishopi*) is only found in a few locations in south central Missouri and northern Arkansas (Firschein 1951; Pfingsten 1990; Petranka 1998). Serious population declines have targeted the Ozark Hellbender as a conservation priority species by numerous institutions (e.g. government agencies, universities, zoos, etc.). These institutions have spent considerable effort to recover the species in Missouri (Wheeler et al. 2003; Briggler et al. 2007). Due to the drastic decline in number of wild Hellbenders in Missouri, captive propagation was one necessary component to the recovery of the species in which the Ron Goellner Center for Hellbender Conservation at the Saint Louis Zoo was created. Numerous Hellbenders were removed from the wild and moved to their new artificial stream raceway to facilitate long-term propagation efforts. As with many propagation efforts, various aspects of Hellbender biology are being investigated in detail at the St. Louis Zoo, including ecological nutrition and digestive physiology, to better address long-term health needs of this captive breeding stock. Hellbenders are fully aquatic, spending most of their life under flat rocks in stream bottoms (Nickerson and Mays 1973; Johnson 2000). Diet consists of a variety of aquatic prey including small fish and insects, but a majority of the diet comprises whole crayfish, consumed in their entirety (Nickerson and Mays 1973; Peterson et al. 1989; Petranka 1998).

The primary purpose of this study was two-fold: 1) to obtain details on a preferred food item of Hellbenders, for which no nutritional composition data exist (crayfish plus shell) as a basis for assessing nutritional status in the wild; and 2) to compare native food composition with substitute food items used in captivity. A secondary goal was to investigate possible factors that may underlie any differences noted in chemical composition. These initial data might provide useful information for optimizing nutritional health and dietary management of Hellbender and other crayfish-eating species (e.g., storks; Negro and Garrido-Fernandez 2000).

Samples.—Three species of native crayfish were used in this study. Long-pincered Crayfish (*Orconectes longidigitus*), Spothanded Crayfish (*O. punctimanus*), and Ringed Crayfish (*O. neglectus*) were opportunistically collected from two locations in close proximity on the North Fork of the White River, Missouri, USA in August 2006 and September 2007 (N = 21 total samples). Crayfish were transported in buckets of stream water and maintained overnight before being identified to species, weighed, measured, and processed for nutrient analysis. Three individual crayfish were not positively identified and were included in samples as unidentified.

Feeder crayfish obtained locally in 2005 and 2006 comprised a single species, Northern Crayfish (*Orconectes virilis*), from Paul's Bait Shop (PBS, N = 9; St. Louis, Missouri, USA) or directly from Ozark Fisheries (OF, N = 7; Stoutland, Missouri USA). In 2007, *Procambarus paeninsulanus* (Peninsula Crayfish) from Florida (FL, N = 9) were added as a substitute feeder species, and *O. virilis* were also collected for analysis from ponds on the grounds of the Saint Louis Zoo as part of a larger population study for potential sustainable harvest (SLZ, N = 21). SLZ crayfish of three body sizes (see below) were sampled from two sites (North and South Lakes) during either summer (Jun–Aug) or fall (Sep–Oct) 2007. Purchased crayfish were shipped or transported in water overnight, and processed within 24 h of receipt. Crayfish acquired on zoo grounds were collected in the morning from traps set the previous day using canned cat food as bait, and sampled within 24 h. Because Hellbenders consume crayfish in toto, an additional subset of trapped crayfish from SLZ (N = 24) were dissected to determine percent contribution of nutrients from shell vs. remainder of the body by weighing and analyzing portions separately, and water and substrate samples were taken for chemical analysis at the two sites.

Laboratory Processing/Analyses.—Animals were weighed to the nearest 0.1 g, and carapace and tail-to-rostrum length (TR) measured to the nearest 0.01 cm with calipers. Crayfish were categorized as small (<2.5 cm total length), medium-sized (2.5 to 5 cm total length), or large (>5 cm). All crayfish were euthanized by decapitation, then head and body were homogenized together in a food processor (Toastmaster Chopster). Subsamples of homogenate (0.5 g in duplicate) were taken immediately and extracted via previously described methods for meat samples (Barker et al. 1998) to determine vitamin A (as retinol), E (as α-tocopherol), and total carotenoids. Extracts were sealed in cryovials, stored in an ultracold freezer (-20°C), and sent to Arizona State University for analysis via HPLC following the methods

of McGraw et al. (2006). Pigment extracts were resuspended in 200 µl mobile phase (42:42:16% (v/v/v) methanol : acetonitrile : dichloromethane) and injected into a Waters Alliance 2695 HPLC system (Waters Corporation, Milford, MA) fitted with a Waters YMC Carotenoid 5.0 µm column (4.6 mm × 250 mm) and a built-in column heater set at 30°C. A three-step gradient solvent system was used to analyze both xanthophylls and carotenes in a single run, at a constant flow rate of 1.2 ml min-1: first, isocratic elution with the aforementioned mobile phase for 11 min, followed by a linear gradient up to 42:23:35% (v/v/v) methanol : acetonitrile : dichloromethane through 21 min, held isocratically at this condition until 26 min, and finishing with a return to the initial isocratic condition from 26 to 29.5 min. Data were collected from 250 to 600 nm using a Waters 2996 photodiode array detector. Pigments were identified by comparing their respective retention times and absorbance maxima (λmax) to those of reference carotenoids run as external standards.

Subsamples (1.0 g) from 10 randomly-selected farmed crayfish (*Orconectes virilis*) were frozen for determination of fatty acid content at the University of Missouri-Columbia; a frozen Pacific Krill (*Euphasia pacifica*) sample was also sent for comparison since krill are often used in feeding very small salamanders (J. Ettling, pers. comm.). Total lipids were extracted with chloroform: methanol (2:1 v/v) after samples were homogenized in 10 mM EDTA. Lipids were methylated with freshly made 5% methanolic HCl. Fatty acid methyl esters were extracted with hexane. Pigments and residual water were removed from each sample with the addition of 0.1 g each of anhydrous sodium sulfate and activated charcoal. Methyl esters were analyzed by gas chromatography using an HP 5890A instrument with a 30-meter capillary column (Omegawax 250; Supelco, Bellefonte, PA) according to the methods of Sukhija and Palmquist 1988. Individual fatty acids were identified using retention times of standards (i.e., Omegawax, PUFA-II, PUFA-I; Supelco).

Remaining sample homogenates were freeze-dried (Labconco Freezone 4.5) to determine water content, and dried, ground samples were sent for proximate analysis (crude protein, crude fat, fiber fractions, ash) and minerals to Dairy One Forage Lab (Ithaca, NY). Substrate mineral content was determined at the Amino Acid Laboratory, University of California (Davis, California; data not presented). Differences in nutrient composition by species (stream-caught) or source/location within species (pond-reared) were evaluated with Mann-Whitney tests at a significance level of 0.05 (Snedecor and Cochran 1967). For the STZ crayfish samples only, percentage data were arcsine transformed to approximate normal distribution, and seasonal, body size, and sampling location differences in nutrient composition were compared by analysis of variance.

Wild-captured crayfish sampled from Hellbender habitats varied widely in size compared to those utilized as food for captive salamanders at the Saint Louis Zoo (Table 1). Regardless of species, size ranges encompassed the small and medium body size criteria preferred by zoo managers. Specific preferences of crayfish prey size have not been determined for Hellbenders; presumably crayfish must be suitably sized to trigger a feeding response, yet not too large to defend themselves against ingestion. Although similar in carapace length to those obtained from commercial suppliers, Northern Crayfish from the zoo ponds in this study contained ash-free dry weight (AFDW) similar to that reported from wild-caught Virginia *O. virilis* (~3.7 g vs. 3.8 g, respectively; Mitchell and Smock 1991) and almost twice the AFDW calculated for the fisheries-reared crayfish (~2.0 g from PBS, ~1.5 g from OF).

Body sizes did not differ between *O. virilis* samples collected for dissection at the two STZ sites, hence data were combined (mean weight = 25.2 ± 5.4 g). Of total body composition, shell comprised 61.5 ± 5.7% of whole body mass, whereas meat and body fluids reflected the remaining 38.5 ± 5.7% (wet basis). Shells averaged 31.2 ± 4.3% dry matter (DM) (or 68.8% water), and meat averaged 17.8 ± 2.1% DM, approximately 82.2% water.

Proximate Composition.—Overall, crayfish provided crude protein concentrations in excess of the requirements determined for domestic carnivores, fish and shellfish (ca. 15 to ~40% of DM; Zootrition 2006). Protein and fat, as fractions of whole body mass, are typically inversely related when evaluating composition of whole vertebrate prey. This pattern was not apparent in crayfish, possibly due to the much greater contribution of both ash and carbohydrate fractions (from shells) in crayfish compared to vertebrate prey species. Total ash reported in whole vertebrate prey DM ranges from 7.5 (juvenile hamsters) to 17.5% (snowshoe hare) as opposed to 30–45% in crayfish, whereas carbohydrate content is generally negligible (Dierenfeld et al. 2002). Additionally, the crude fat content of most whole prey (range 5–45% of DM, but typically 15–35%, depending on species and age of prey; Dierenfeld et al. 2002) is considerably higher than recommended minimum dietary levels (~5 to 10% of dry matter, DM) for domestic carnivores (NRC 2006). Crayfish contained some of the lowest fat concentrations measured across a wide variety of whole prey consumed by carnivores, with both wild-caught and farmed crayfish averaging <5% fat (DM basis, Tables 2 and 3). This may be important for overall energetics and nutritional balance, as amphibians and other poikilotherms have a lower metabolic rate than homeotherms, hence require fewer calories per unit body mass. Thus low-fat, lower nutrient density dietary ingredients may be entirely appropriate for Hellbenders, but actual nutritional requirements remain uncharacterized for amphibians and most reptiles. As with all species—but perhaps particularly so for low-energy amphibian species—the feeding of higher-fat dietary ingredients in captive management programs should be carefully controlled to minimize risk of obesity or health conditions associated with excess body condition.

Nonetheless, some fat, and particularly essential fatty acids (EFAs) are required in the diet, hence our analysis provides baseline information on fatty acid content of whole crayfish (Table 4). Fatty acids are the primary constituent of most lipids, and can be deposited in animal tissues with minimal modification from diets; fatty acid signatures are often used to differentiate and understand trophic interactions in aquatic ecosystems (Iverson et al. 2002). Although the essential fatty acid (EFA) requirements of salamanders have not been determined to our knowledge, minimum dietary recommendations of domestic carnivores for two of the omega-6 EFAs, linoleic acid (18:2n6) and arachidonic (20:4n6), have been set at 0.5 and 0.2% of dietary DM, respectively (NRC 2006). Crayfish in this study contained 9% of total FA as linoleic, and 6.5% as arachidonic acid (see Table 4). Converting FA data reported here to a comparable dietary DM basis yields 0.3%

TABLE 1. Size (mean ± SD; range in parentheses) parameters of crayfish sampled to determine nutrient composition of whole crayfish available as food to Ozark Hellbender (*Cryptobranchus alleganiensis bishopi*). nd = not determined.

Species	N	Mass (g)	Carapace Length (cm)	Tail–Rostrum Length (cm)
Wild-Caught				
Longpincered Crayfish (*Orconectes longidigitus*)	7	53.20 ± 20.33 (14.54–75.14)	8.00 ± 3.79 (4.6–13.6)	11.22 ± 2.04 (8.00–13.40)
Ringed Crayfish (*Orconectes neglectus*)	7	10.80 ± 3.45 (3.18–14.56)	3.00 ± 0.48 (2.23–3.37)	6.19 ± 1.01 (4.53–7.17)
Spothanded Crayfish (*Orconectes punctimanus*)	4	23.12 ± 6.31 (13.62–31.04)	5.96 ± 2.91 (3.57–9.70)	7.97 ± 0.47 (7.60–8.50)
Unidentified (*Orconectes* species)	3	8.35 ± 5.33 (3.95–14.27)	2.69 ± 0.55 (2.11–3.20)	5.46 ± 1.11 (4.26–6.43)
Farmed				
Northern Crayfish - Local bait shop (*Orconectes virilis*)	9	12.11 ± 3.56 (6.19–16.69)	7.68 ± 0.82 (6.0–8.9)	nd
Northern Crayfish - Ozark Fisheries (*Orconectes virilis*)	7	9.64 ± 2.13 (5.42–16.88)	7.14 ± 0.50 (6.0–8.4)	nd
Northern Crayfish - SLZ ponds (*Orconectes virilis*)	21	21.04 ± 8.77 (7.74–38.64)	7.39 ± 2.27 (3.93–18.19)	10.41 ± 2.71 (6.88–15.00)
Peninsula Crayfish - Florida (*Procambarus paenenisulanus*)	9	6.13 ± 2.85 (2.92–9.66)	2.94 ± 0.83 (2.10–4.83)	5.55 ± 0.79 (4.26–6.43)

linoleic acid (3% crude fat (Table 3) * 0.09), and 0.2% arachidonic (3% fat *0.065). Assuming that amphibian carnivores have similar fatty acid requirements as domestic animals, and since fat has ~2 times the caloric value of carbohydrates or protein, crayfish would provide about 0.5% of dietary energy as linoleic acid, a value that would be considered borderline for meeting EFA requirements in the absence of any preformed arachidonic acid (AA). However, the presence of 0.2% AA determined in the crayfish should be sufficient to meet the requirements for omega-6 polyunsaturated FA for most animals that might be consuming crayfish as a primary food source. Marine krill, however, appear to provide insufficient levels of both EFAs (Table 4). Both whole crayfish and whole krill contained relatively high concentrations of polyunsaturated fatty acids (PUFA) (22–32% of total fatty acids as PUFA). PUFA can be more prone to oxidative degradation compared with more saturated fats, thus may require higher levels of dietary antioxidants. By comparison, saturated fats were much higher in the marine krill (45.4%) compared with fresh water crayfish (32.4%), comprising almost half of total fatty acids quantified. Additionally, the omega-3:omega-6 fatty acid ratios measured in crayfish compared with krill vary considerably (Table 4), with omega-6 fatty acids about 10-fold higher in crayfish compared with krill; these two feed types are not nutritional equivalents. In particular, omega-3:omega-6 ratios/composition may have health implications for captive feeding programs of Hellbenders, particularly regarding immune function (Fritsche 2006), which should be investigated further. Interestingly, meat from farmed crayfish contained higher concentrations of all fatty acids compared with meat from wild crayfish reported in the USDA Nutrient Database (USDA 2009), further suggesting that captive dietary management may certainly influence composition, and should be considered when raising species as food for other animals.

Regarding carbohydrate (CHO), fractions, while most vertebrate whole prey are not considered to contain substantial concentrations of simple sugars, dietary fiber (measured as crude fiber, acid detergent fiber, and/or neutral detergent fiber), may be measurable in gastrointestinal contents of herbivorous prey species. In the case of crayfish, the chitinous exoskeleton is a chemical matrix comprising polysaccharide units (similar to plant cellulose) and protein. It is unclear whether the exoskeleton provides a source of dietary nutrients to Hellbenders; chitinase enzyme activity has not been reported, and digestibility trials have not been performed. Hellbenders have the ability to regurgitate exoskeleton fragments—identification of such samples is a technique routinely used for feeding ecology studies (Peterson et al. 1989). The dietary fiber (CHO) measured in crayfish samples (~14 to 24–30% of DM, depending on fraction considered from Tables 2 and 3) derives from the exoskeleton, and likely provides physical fill and/or a source of mineral nutrition to Hellbenders consuming whole crayfish, rather than readily available calories.

Mineral Content.—In general, the wild-caught crayfish (Table 2) contained more inorganic constituents (ash) compared with commercially-reared crayfish (Table 3; 47.16 versus 36.81%, respectively) and thus may provide better dietary mineral levels. The shell contributed 79.6% of measured ash, ~90% of Ca, and 31–64% of other minerals (with the exception of S, where 80% was present in meat). Northern Crayfish sampled from SLZ were more similar to wild-captured crayfish than were those sampled from either PBS or OF, and differed significantly ($P < 0.05$) in

TABLE 2. Nutrient composition (mean ± SD) of wild captured crayfish collected from two locations in close proximity on the North Fork of the White River, Missouri, Aug 2006 and Sept 2007. Data represent whole crayfish; all nutrients except water presented on a dry matter basis.

Species	*Orconectes longidigitus*	*Orconectes neglectus*	*Orconectes punctimanus*	*Orconectes* species
N	7	7	4	3
Nutrient				
Water, %	67.40 ± 10.07	65.84 ± 10.31	64.25 ± 3.59	71.59 ± 1.57
Crude Protein, %	41.53 ± 3.95	38.33 ± 4.17	38.08 ± 1.83	34.45 ± 1.77
Crude Fat, %	4.47 ± 1.51	4.44 ± 1.32	3.38 ± 1.33	2.75 ± 1.20
Crude Fiber, %	14.25 ± 0.49	15.20 ± 0.14	14.20 (N = 1)	na
Neutral Detergent Fiber, %	23.36 ± 4.00	23.02 ± 5.33	24.42 ± 2.78	20.95 ± 2.62
Acid Detergent Fiber, %	14.70 ± 2.28	14.41 ± 2.47	16.01 ± 3.08	15.42 ± 0.73
Ash, %	42.77 ± 5.09	46.11 ± 5.15	47.43 ± 4.02	52.33 ± 1.59
Minerals				
Calcium, %	15.65 ± 2.23	20.27 ± 5.07	15.96 ± 4.51	19.49 ± 0.59
Chloride, %	0.73 ± 0.01	0.57 ± 0.10	0.64 (N = 1)	na
Magnesium, %	0.33 ± 0.05	0.26 ± 0.02	0.30 ± 0.03	0.28 ± 0.02
Phosphorus, %	0.96 ± 0.15	0.93 ± 0.14	0.77 ± 0.08	0.78 ± 0.04
Potassium, %	0.52 ± 0.05	0.51 ± 0.09	0.53 ± 0.07	0.54 ± 0.07
Sodium, %	0.50 ± 0.04	0.55 ± 0.15	0.47 ± 0.08	0.53 ± 0.11
Sulfur, %	0.35 ± 0.05	0.31 ± 0.07	0.30 ± 0.05	0.24 ± 0.01
Cobalt, mg/kg	0.49 ± 0.03	0.58 ± 0.05	0.41 (N = 1)	na
Copper, mg/kg	38.86 ± 8.40	27.57 ± 5.09	27.00 ± 7.70	39.00 ± 11.31
Iron, mg/kg	59.29 ± 26.31	71.57 ± 34.98	73.00 ± 37.72	38.50 ± 6.36
Manganese, mg/kg	82.29 ± 23.94	85.57 ± 15.13	93.50 ± 38.52	86.50 ± 23.33
Molybdenum, mg/kg	0.47 ± 0.28	0.40 ± 0.35	0.20 ± 0.14	0.20 ± 0.00
Zinc, mg/kg	75.86 ± 8.30	78.57 ± 6.32	65.25 ± 11.09	84.50 ± 3.54
Fat-Soluble Vitamins				
Vitamin A, mg/kg, as retinol	95.57 ± 143.25	123.43 ± 124.61	160.14 ± 164.89	10.36 ± 5.34
Vitamin A, IU/kg	318,567± 477,500	411,433 ± 415,367	533,800 ± 549,633	34,533 ± 17,800
Vitamin E, mg/kg, α-tocopherol	267.72 ± 129.08	261.98 ± 141.30	248.26 ± 83.33	162.21 ± 66.62
Total Carotenoids, mg/kg	30.90 ± 12.96 [ab]	26.43 ± 19.35 [ab]	43.52 ± 11.74[a]	21.14 ± 3.08[b]

[ab] Means in the same row without a common superscript letter differ (Mann-Whitney test; $P < 0.05$).

total ash, Ca, Cu, and Fe from those groups (Table 3). Other significant differences between the SLZ-pond and fishery-pond reared crayfish (Mg, K, S levels) may reflect differences in water or substrate quality, and/or result from unspecified holding and feeding schedules at the bait shop. Macromineral requirements (as a percentage of dietary DM) for growing mammal and bird species (Ca, 0.4 to 1.2%; Mg, 0.03 to 0.1%; P, 0.3 to 0.6%; K, 0.2 to 1.4%; and Na, 0.05 to 0.4%; Zootrition 2006) appear to be met by any of the crayfish analyzed in this study.

Wide variability among and within samples in trace element composition is evident and likely due to multiple factors including limited sample size, differing original dietary trace mineral levels, and possibly habitat/substrate variability. Mineral concentrations in water and substrate did not differ between sampled sites at SLZ (data not shown), but neither water, substrate, nor food samples were obtained from any other crayfish group, so source of variation is unknown at this time. Dietary requirements for Cu range from about 3 to 5 mg/kg DM for domestic carnivores (NRC 2006); and high levels can be toxic. In particular, the high Cu level documented in some crayfish (>100 mg/kg) is of potential health concern. Although LC50 is not directly comparable to LD50, toxicity (based on survival) has been determined between 40 and ~800 µg/L for *Ambystoma* spp. salamanders (Sparling et al. 2000), a magnitude lower than dietary levels measured in this study. While Cu LD50 has not been reported for salamanders, dietary tolerance of this nutrient is 15 and 40 mg/kg for sheep and cattle, respectively, and 100 mg/kg for fish (NRC 2005). Northern Crayfish could have been exposed to copper from commercial fish foods and fish wastes in confined ponds, which may have affected their overall composition. Copper sulfate is often added as an algaecide and may contribute to crayfish body composition (38% of Cu was found in the shell); hence, aquatic environmen-

TABLE 3. Nutrient composition (mean ± SD) of pond-reared crayfish consumed by Ozark Hellbender (*Cryptobranchus alleganiensis bishopi*) at the Saint Louis Zoo (2005–2007). Data represent whole crayfish; all nutrients except water presented on a dry matter basis.

Species	*Orconectes virilis*	*Orconectes virilis*	*Orconectes virilis*	*Procambarus paeninsulanus*
N	9	7	21	9
	Paul's Bait Shop	Ozark Fisheries	St. Louis Zoo	Florida
Nutrient				
Water, %	74.31 ± 4.16	77.58 ± 3.23	68.02 ± 5.08	70.71 ± 4.57
Crude Protein, %	54.08 ± 4.14	54.80 ± 5.68	42.00 ± 4.98	47.84 ± 5.29
Crude Fat, %	2.96 ± 1.47	3.70 ± 0.80	3.03 ± 1.41	4.90 ± 1.62
Crude Fiber, %	20.04 ± 7.38[a]	13.78 ± 2.79[b]	na	na
Neutral Detergent Fiber, %	17.27 ± 0.95	21.70 ± 4.70	28.98 ± 3.31	31.94 ± 14.19
Acid Detergent Fiber, %	13.70 ± 0.66[a]	11.55 ± 0.64[b]	13.79 ± 1.53 [ab]	15.44 ± 3.84
Ash, %	35.69 ± 4.42[a]	31.90 ± 3.69[a]	45.36 ± 5.71[b]	34.27 ± 3.20
Minerals				
Calcium, %	12.00 ± 1.79[a]	11.85 ± 1.87[a]	16.31 ± 2.31[b]	12.25 ± 0.88
Chloride, %	1.22 ± 0.20	1.29 ± 0.01	na	na
Magnesium, %	0.40 ± 0.04[a]	0.28 ± 0.07[b]	0.37 ± 0.04[a]	0.35 ± 0.02
Phosphorus, %	1.16 ± 0.04	1.11 ± 0.06	1.07 ± 0.16	0.92 ± 0.06
Potassium, %	0.68 ± 0.11[a]	0.96 ± 0.15[b]	0.64 ± 0.14[a]	0.81 ± 0.08
Sodium, %	0.73 ± 0.06	0.78 ± 0.10	0.62 ± 0.09	0.60 ± 0.09
Sulfur, %	0.44 ± 0.06[ab]	0.47 ± 0.03[a]	0.33 ± 0.07[b]	0.40 ± 0.08
Cobalt, mg/kg	0.99 ± 0.29	1.22 ± 0.12	na	na
Copper, mg/kg	107.44 ± 12.19[a]	110.57 ± 18.38[a]	34.24 ± 13.51[b]	46.75 ± 9.74
Iron, mg/kg	133.78 ± 53.60[a]	104.00 ± 34.79[a]	315.71 ± 134.60[b]	89.25 ± 84.13
Manganese, mg/kg	108.44 ± 101.15	55.29 ± 13.34	43.19 ± 23.56	9.88 ± 2.17
Molybdenum, mg/kg	0.17 ± 0.08[a]	0.53 ± 0.23[b]	0.67 ± 0.46[b]	0.20 ± 0.08
Zinc, mg/kg	87.78 ± 6.04	84.86 ± 11.32	71.81 ± 9.45	66.38 ± 4.27
Fat-Soluble Vitamins				
Vitamin A, mg/kg, as retinol	482.23 ± 70.95[a]	878.22 ± 206.11[b]	7.97 ± 2.51[c]	8.30 ± 2.69
Vitamin A, IU/kg	1,607,433 ± 236,500[a]	2,927,400 ± 687,033[b]	26,567 ± 8,367[c]	27,667 ± 8,967
Vitamin E, mg/kg, α-tocopherol	320.16 ± 118.80[a]	485.65 ± 190.76[b]	353.84 ± 136.49[ab]	252.07 ± 116.61
Total Carotenoids, mg/kg	55.37 ± 15.29	56.18 ± 38.79	32.35 ± 15.32	48.75 ± 17.41

[ab] Means in the same row without a common superscript letter differ (Mann-Whitney test; $P < 0.05$).

tal quality is critical both directly and indirectly to the health of the Hellbender. Similarly, iron requirements for carnivores range from ~30 to ~100 mg/kg DM (NRC 2006), and excessive levels may interfere with bioavailability of other trace minerals. Recommended levels of bioavailable Mn and Zn (5 mg/kg, and 10 to 50 mg/kg, for cats and dogs, respectively; NRC 2006) would likely be met by crayfish as a dietary staple, but nutrient requirements and dietary interactions in salamander nutrition remain to be investigated.

Fat-Soluble Nutrients.—Vitamin A levels tend to increase with age/maturity in vertebrate prey through accumulation in body stores, particularly liver. Body size and vitamin A content were uncorrelated in our study; however, vitamin A levels were exceptionally high in farmed (OF) and baitshop (PBS) sourced crayfish (Table 3; 1.6 to 2.9 million IU/kg DM [0.3 μg retinol = 1 IU]) as well as in 3 of 4 wild crayfish species (~300,000 to 500,000 IU vitamin A/kg DM). The unidentified species and the SLZ pond-caught crayfish contained vitamin A concentrations ranging between ~26,000 and 40,000 IU/kg DM. Dietary requirements for vitamin A in domestic carnivores are approximately 4000 to 11,000 IU/kg DM (NRC 2006); presumed upper safe limits of this nutrient range from 33,000 IU/kg (dogs) to 100,000 IU/kg DM (cats) (NRC 1987). Clearly more information is needed on safe levels of this nutrient for salamanders (and crayfish), but it appears likely that diets fed to the farmed animals may have contributed to the high body levels found in this study.

Vitamin E concentrations were quite high in all crayfish sampled; crayfish meat has been previously shown to be a good source of this nutrient (USDA 2009) and may provide an important dietary antioxidant. Vitamin E levels in crayfish (160–486

TABLE 4. Fatty acid composition (mean ± SD) of whole Missouri native crayfish (Northern Crayfish, *Orconectes virilis*), compared with whole Pacific Krill (*Euphasia pacifica*).

Fatty Acid Name	Fatty Acid*	Crayfish (N = 10)	Krill (N = 1)
		% of total fatty acids	
Lauric acid	12:0	4.8 ± 1.0	2.5
Myristic acid	14:0	3.6 ± 0.9	15.6
Palmitic acid	16:0	19.0 ± 3.6	25.6
Palmitoleic acid	16:1	6.6 ± 3.2	10.6
Stearic acid	18:0	5.0 ± 1.3	1.7
Oleic acid	18:1n9	24.8 ± 3.8	20.3
Linoleic acid	18:2n6	9.0 ± 2.9	1.9
γ-linolenic acid	18:3n6	0.7 ± 0.3	0.3
α-linolenic acid	18:3n3	4.0 ± 2.6	0
Dihomo- γ -linolenic acid	20:3n6	1.0 ± 1.0	0
Arachidonic acid	20:4n6	6.5 ± 1.9	0.3
Eicosapentaenoic acid (EPA)	20:5n3	8.1 ± 1.9	13.5
Docosahexaenoic acid (DHA)	22:6n3	2.6 ± 1.3	6
	%PUFA	31.9	22.0
	n3:n6	0.85:1	7.8:1

* First number denotes the # of carbons in the fatty acid; 2nd # denotes the total # of double bonds; the number following "n" refers to the position of the first double bond relative to the methyl- or "omega"–end of the fatty acid.

mg/kg DM, calculated 240–729 IU/kg) consistently exceeded dietary requirements established for domestic carnivores (30–50 IU/kg; 1 mg natural source vitamin E = ~ 1.5 IU) fed diets containing moderate levels of polyunsaturated fats (PUFAs). High dietary PUFA (as found in crayfish), however, may increase the vitamin E requirement up to 5-fold due to the high oxidative potential of these fats; vitamin E can be depleted as it is utilized as a biological antioxidant. Vitamin E deficiency has been shown to adversely impact reproduction and immune function in other species (Dierenfeld and Traber 1992). Hence these high concentrations of vitamin E may be beneficial to health of Hellbenders, but require further investigation.

The only nutrient category that differed significantly among wild-caught crayfish species was total carotenoid concentration (Table 2), and unfortunately, this was compared with the species that remains unidentified. Carotenoid content measured is likely an artifact of small sample size, but may reflect real differences in feeding habits among crayfish species. *O. punctimanus* appears much broader in its habitat and possibly feeding requirements compared to other species, (MOFWIS 2008) and thus may be able to consume a diet containing higher levels of carotenoid pigments, but must be quantified further in more controlled studies. Diets fed in the fisheries pond(s) quite likely also contributed to the high levels of vitamins and carotenoids measured in the crayfish. It remains unclear, however, whether these higher nutrient levels are beneficial or detrimental to the salamanders consuming crayfish, as both vitamin A toxicity and deficiency can negatively impact health and reproduction. Vitamin A concentrations are lower in native crayfish or pond-captured crayfish compared with those sampled from farm-reared populations, but ranges varied by levels of magnitude, and, in general were higher than documented dietary requirements for carnivorous species in all samples – regardless of origin. Some of these concentrations are in ranges considered toxic for other species; to date, salamander dietary vitamin A nutrient requirements are unknown. Controlled feeding trials should be conducted and/or tissue levels of fat-soluble nutrients should be monitored to determine nutrient interactions and evaluate status. One potentially negative factor associated with low-fat diets (as found in crayfish) may be lower absorption of fat-soluble vitamins; this possibility should be investigated in future studies with Hellbenders.

Sources of variability in nutrient parameters measured in the SLZ crayfish found season (summer vs. fall) to be significant only in crude fat content ($P < 0.01$); location significantly impacted Cu ($P < 0.01$), Zn ($P < 0.01$), and P ($P < 0.001$) levels, even though trace mineral and water phosphate levels did not vary between the two sites (data not shown). Body size (hence, age/particular molt) had the greatest impact on both proximate and mineral nutrient composition of Northern crayfish at the Saint Louis Zoo, affecting crude protein ($P < 0.001$), ash ($P < 0.001$), Ca ($P < 0.05$), K ($P < 0.001$), Na ($P < 0.05$), P ($P < 0.05$), Cu ($P < 0.001$), Mn ($P < 0.05$), and Zn ($P < 0.01$) content. Larger crayfish contained higher levels of proximate nutrients (protein, fat, and ash) as well as macrominerals Ca, K, and Na compared to smaller animals. Phosphorus content, however, was higher in smaller crayfish, as were levels of trace minerals (Cu, Mn, and Zn). Locally harvested crayfish represented a nutritionally superior food for captive Hellbender compared to fisheries-reared individuals, and were closer in chemical composition to species found in native habitats. Sustainable local harvest should be explored as a viable alternative feeding option and as a way of reducing fossil fuel (transportation) costs.

These data provide preliminary detail on the nutrient composition of whole crayfish eaten by Hellbender, but clearly species, size, and habitat of origin impact the nutritional content of crayfish (and likely other aquatic prey species) eaten by Hellbenders. The chemical composition of native, as well as substitute, food items must be considered integral to the development of optimal diets for this species, and monitoring prey composition can provide strong bioindicators of habitat quality. In addition to crayfish, Hellbenders also eat small fish, lamprey, worms, insects, snails, mollusks, tadpoles, and fish entrails in nature (Nickerson and Mays 1973; Peterson et al. 1989; Petranka 1998); in captivity, they are fed black worms, krill, and fish along with crayfish (J. Ettling, pers. comm.). Intake, utilization, growth response trials, and health assessments to these varied whole prey items, and mixed diets, should provide valuable management guidelines that can assist in captive propagation, habitat evaluation, conservation and ultimate recovery of these unique and threatened salamanders. Characterization of both ex situ and in situ diets remains a critical component underlying health, reproduction, and recovery program management.

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NATURAL HISTORY NOTES

The Natural History Notes section is analogous to Geographic Distribution. Preferred notes should 1) focus on observations in the field, with little human intrusion; 2) represent more than the isolated documentation of developmental aberrations; and 3) possess a natural history perspective. Individual notes should, with few exceptions, concern only one species, and authors are requested to choose a keyword or short phrase which best describes the nature of their note (e.g., Reproduction, Morphology, Habitat, etc.). Use of figures to illustrate any data is encouraged, but should replace words rather than embellish them. The section's intent is to convey information rather than demonstrate prose. Articles submitted to this section will be reviewed and edited prior to acceptance.

Electronic submission of manuscripts is requested (as Microsoft Word or Rich Text format [rtf] files, as e-mail attachments). Figures can be submitted electronically as JPG files, although higher resolution TIFF or PDF files will be requested for publication. Please DO NOT send graphic files as imbedded figures within a text file. Additional information concerning preparation and submission of graphics files is available on the SSAR web site at: http://www.ssarherps.org/HRinfo.html. Manuscripts should be sent to the appropriate section editor: **Charles W. Painter** (amphibians; charles.painter@state.nm.us); **James Harding** (turtles; hardingj@msu.edu); **Jackson D. Shedd** (crocodilians, lizards, and *Sphenodon*; Jackson.Shedd@gmail.com); and **John D. Willson** (snakes; willson@uga.edu); and.

Standard format for this section is as follows: SCIENTIFIC NAME, STANDARD ENGLISH NAME (if available, for the United States and Canada as it appears in Crother [ed.] 2008. *Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico*. SSAR Herpetol. Circ. 37:1–84, available from SSAR Publications Secretary, ssar@herplit.com; for Mexico as it appears in Liner and Casas-Andreu 2008, *Standard Spanish, English and Scientific Names of the Amphibians and Reptiles of Mexico.* Herpetol. Circ. 38:1–162), KEYWORD. DATA on the animal. Place of deposition or intended deposition of specimen(s), and catalog number(s). Then skip a line and close with SUBMITTED BY (give name and address in full—spell out state names—no abbreviations). (NCN) should be used for common name where none is recognized. References may be briefly cited in text (refer to this issue for citation format). One additional note about the names list (Crother 2008) developed and adopted by ASIH-HL-SSAR: The role of the list is to standardize English names and comment on the current scientific names. Scientific names are

hypotheses (or at least represent them) and as such their usage should not be dictated by a list, society, or journal.

Recommended citation for notes appearing in this section is: Medina, P., and R. L. Joglar. 2008. *Eleutherodactylus richmondi*: reproduction. Herpetol. Rev. 39:460.

CAUDATA — SALAMANDERS

AMBYSTOMA CALIFORNIENSE (California Tiger Salamander). **COLORATION AND PATTERN.** During the winter of 2003–2004, we conducted a survey for California Tiger Salamanders on farm lands owned by the City of Santa Rosa and two private properties in Sonoma County, California, USA. We used 17 pit-fall drift fence arrays (1360 pitfalls) to capture salamanders. During the course of our survey we captured 114 adult (57 male, 57 female) and 65 subadult California Tiger Salamanders on the city-owned Kelly Farm, an adjacent property on Duer Road, and another property at the north end of the former Santa Rosa Air Center. Animals were not marked and some may have been recaptured during the course of the study. Here we report on observations of the color and color pattern of the salamanders we captured.

California Tiger Salamanders typically have a black ground color with distinctive rounded or irregular yellowish to whitish spots and bars (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, D.C. 587 pp.; Stebbins 2003. Western Reptiles and Amphibians 3rd ed. Houghton Mifflin Co., Boston, Massachusetts, 533 pp.). All the individuals captured in our survey, however, had a chocolate brown ground color with no gray or black tones (Fig. 1A). One subadult individual captured in our survey completely lacked pale spots or bars and was a uniform dark brown above and below (Fig. 1B); all other subadults captured during our study exhibited a typical spotting pattern. To the best of our knowledge California Tiger Salamanders with a chocolate brown ground color have not been described in the literature. Individuals of this species completely lacking a pale spotting pattern similarly have not been reported.



Fig. 1. (A) Adult male *Ambystoma californiense* (SVL 103 mm; TL 225 mm) exhibiting spotted color pattern typical of the Sonoma County population. (B) Subadult (SVL 70 mm; TL 105 mm) lacking typical spotted pattern.

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TARICHA RIVULARIS (Red-bellied Newt). **ENDOPARASITES.** *Taricha rivularis* occurs in northern coastal California from Sonoma and Lake counties north to Humboldt County (Stebbins 2003. A Field Guide to Western Reptiles and Amphibians, 3rd ed. Houghton Mifflin, Boston, Massachusetts. 533 pp.). To our knowledge there are no reports of helminths in *T. rivularis.* The purpose of this note is to establish the initial helminth list for *T. rivularis*.

One adult male *T. rivularis* hand collected by MDD in Mendocino Co., California (123.8058°N, 39.4416°W, WGS 84, elev. 26 m) on 23 March 2009 was sacrificed and the digestive tract removed, opened, and examined under a dissecting microscope. Fourteen nematodes were found in the intestine, which were fixed in alcohol, cleared in glycerol on a microscope slide under a coverslip, and studied using a compound microscope. Of these, six were female nematodes from the small intestine identified as *Oswaldocruzia pipiens* and eight (five male, three female) from the large intestine were identified as *Cosmocercoides variabilis.* Nematodes were deposited in the United States National Parasite Collection (USNPC), Beltsville, MD: *Oswaldocruzia pipiens* (USNPC 101993); *Cosmocercoides variabilis* (USNPC 101992). The *T. rivularis* was not accessioned.

Cosmocercoides variabiis is a cosmocercid nematode found in North American salamanders, frogs, lizards, snakes, and turtles (Baker 1987. Occas Paps. Biol. Memor. Univ. Newfoundland 11:1–325). Some uncertainty exists for its hosts because of confusion between *C. variabilis* and *C dukae*, a molluscan parasite. Vanderburgh and Anderson (1987. Can. J. Zool. 65:1662–1665) demonstrated that the two species are distinct. The major difference in morphology for the two species is the number of rosette papillae in the male: *C. dukae* with 12 pairs, *C. variabilis* with 14–20 pairs. We have assigned these specimens to *C. variabilis* because males have 16 pairs of papillae. Infection occurs by skin penetration (Baker 1978. J. Parasitol. 64:765–766). All North American specimens of *Oswaldocruzia* have been referred to *O. pipiens* by Baker (1977. Can. J. Zool. 55:104–109). *Oswaldocruzia pipiens* is a strongylid nematode that is widely distributed and has been reported from frogs, toad, salamanders, lizards, and tortoises (Baker 1987, *op. cit.*). In the case of amphibians, transmission occurs by skin penetration (Baker 1978. Can. J. Zool. 56:1026–1031). *Taricha rivularis* represents a new host record for *O. pipiens* and *C. variabilis*.

Specimens were collected under authority of California state fishing license 029486-09 issued to Murray D. Dailey.

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ANURA — FROGS

LIMNONECTES IBANORUM (Rough-backed River Frog). **DIET.** *Limnonectes ibanorum* is endemic to the island of Borneo, where it occurs in rainforest at elevations between 50 and 900 m (Inger 1966. Field. Zool. 52:1–402). Although this large frog (SVL to 13 cm) is common along clear, rocky streams of intermediate width (10–30 m) (Inger and Stuebing 2005. A Field Guide to the Frogs of Borneo. Natural History Publications [Borneo], Kota Kinabalu. 201 pp.), almost nothing is known about its ecology. According to Inger and Stuebing (2005, *op. cit.*), *L. ibanorum* feeds on large insects, crabs, and small lizards. The diet of its large (SVL > 9 cm) Bornean congeners, i.e. *Limnonectes ingeri, L. leporinus*, and *L. malesianus*, also includes frogs (Inger and Stuebing 2005, *op. cit.*; Malkmus et al. 2002. Amphibians and Reptiles of Mount Kinabalu [North Borneo]. Koeltz Scientific Books, Königstein. 424 pp.), but there are no reports of predation of frogs by *L. ibanorum*.

On 20 Sept 2007 at 2045 h, I observed an adult *L. ibanorum* (SVL 11.5 cm) catching and devouring an adult *Hylarana raniceps* (Fig. 1). The prey was ingested head first. The specimen of *L. ibanorum* was caught afterwards, measured, and released. The observation took place on the bank of the Nyipa River, Camp 1, Gunung Mulu National Park, Sarawak, Malaysia (ca. 150 m elev.).

I thank the Sarawak Forest Department for permission to conduct research in Gunung Mulu National Park. Fieldwork was supported by a grant from the German Academic Exchange Service (DAAD).



FIG. 1. *Limnonectes ibanorum* ingesting *Hylarana raniceps*, Gunung Mulu National Park, Sarawak, Malaysia.

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TESTUDINES — TURTLES

CHRYSEMYS PICTA BELLII (Western Painted Turtle). **AS INTRODUCED PREDATOR.** The Western Painted Turtle occurs naturally in the central and northwestern United States and adjacent southern Canada but has been widely introduced to water bodies outside its natural range. Established populations and individual records in California presumably are introduced (Lever 2003. Naturalized Reptiles and Amphibians of the World. Oxford University Press; Stebbins 2003. A Field Guide to Western Reptiles and Amphibians. Houghton Mifflin Co., Boston, Massachusetts).

At 1600 h on 15 February 2007 an adult (782.8 g) *Chrysemys picta bellii* was found in Tracy Lake, San Mateo Co., California. When first observed, the turtle was in shallow water with a dead Pacific Chorus Frog (*Pseudacris regilla*) in its mouth. The condition of the frog suggests it was captured alive, rather than scavenged. It is perhaps significant that this turtle was eating a native frog in Tracy Lake, which supports a breeding population of the threatened California Red-legged Frog *(Rana draytonii)*. The Western Pond Turtle (*Actinemys marmorata*), which is listed by California as a Species of Concern, has also been observed in this lake. The introduced Red-eared Slider *(Trachemys scripta elegans)* has been established in this area for years, but to our knowledge this is the first report of *C. p. bellii* for this area. The impact of introduced turtles on native amphibians through direct predation remains unknown. The impact of Painted Turtles as a competitor of Western Pond Turtles is also unknown, but the latter are also known to feed on native anurans (Bury 1986. J. Herpetol. 20:515–521). Frogs have been previously noted in the diet of *C. picta* (Ernst et al. 1994. Turtles of the United States and Canada. Smithsonian Inst. Press, Washington, DC) but may not be a significant food source. No frogs were detected in the stomachs of 46 *C. picta* collected in Michigan (Knight and Gibbons 1968. Am. Midl. Nat. 80[2]:558–562).

The turtle and frog were collected under California Department of Fish and Game Scientific Collecting Permit 008139 and deposited in the collections at the California Academy of Sciences.

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EMYDOIDEA BLANDINGII (Blanding's Turtle). **PREDATION.** Neonate turtles, including *Emydoidea blandingii*, are known to have many predators. The dissection of Bullfrog (*Lithobates [= Rana] catesbeianus)* stomachs occasionally reveals the remains of hatchling turtles of various species, and *L. catesbeianus* has previously been observed in unsuccessful pursuit of hatchling *E. blandingii* (Bleakney 1963. Can. Field Nat. 77:67–76). Herein we report evidence of the successful predation of a hatchling *E. blandingii* by an adult *L. catesbeianus*.

On 28 August 2006, 12 hatchling *E. blandingii* emerged from

a protected nest at Winous Point Marsh, Ottawa County, Ohio, USA. The hatchlings were outfitted with 0.5 g radio transmitters and released at the nest site the following day. On 11 September we tracked one of these hatchlings to an agricultural ditch ca. 440 m W of the nest. Over several minutes we followed this individual's signal as it evaded our capture by rapidly moving back and forth across the flooded ditch. The submerged animal then emerged onto land revealing itself as an adult *L. catesbeianus*. We proceeded to track the frog over land, by sight and telemetry, through thick multi-flora roses until it disappeared into a large animal burrow. We tracked the radio signal back to the frog the next day, but our attempts to capture the animal proved unsuccessful. We were unable to pick up the radio signal the following day due to presumed exhaustion of the transmitter's battery. The radio transmitter included a thin vinyl coated antenna measuring ca. 9 cm long. The antenna was not observed protruding from the mouth of the frog and it is uncertain what effect it may have ultimately had on the predator. Although *L. catesbeianus* is known to consume nearly any animal it can fit into its mouth, this is believed to be the first report of *E. blandingii* having been consumed by this voracious and often abundant species.

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EMYDOIDEA BLANDINGII (Blanding's Turtle). **HATCHLING DIET.** The behavior of hatchling *Emydoidea blandingii* in the wild is poorly understood. Previous studies have focused on the movements and habitat use of hatchlings after nest emergence (Butler and Graham 1995. Chelon. Conserv. Biol. 1:187–196; McNeil et al. 2000. Chelon. Conserv. Biol. 3:661–664). Herein, we report an observation of feeding behavior by a hatchling *E. blandingii* during its first weeks post emergence from the nest.

On 18 September 2007, six hatchling *E. blandingii* emerged from a protected nest at Winous Point Marsh, Ottawa Co., Ohio, USA. We attached radio transmitters to the hatchlings and released them at the nest site the same day. We tracked the hatchlings daily and GPS points were taken at each location. One hatchling tracked over the course of 29 days moved an average of 20 m/day. During this time it spent three days in a shallow, muddy agricultural ditch. The animal then exited this ditch and moved a short distance to a small vernal pool where it spent another three days along the shallow margins. The ditch and vernal pool were both located along a narrow strip of shrubby, wooded land between two agricultural fields.

On 15 October we tracked this individual to the top of a dike adjacent to the vernal pool. The animal appeared lethargic and did not move again. We found it dead and intact in the same location two days later. No obvious indication of the cause of death was observed, but a tear in the skin was noted anterior to the left front leg where fly eggs had recently been deposited. Dissection of the digestive tract of this animal revealed the chitinous remains of a small adult dytiscid beetle located within the colon along with some other unidentified material. The remains of the beetle measured ca. 5 mm long when articulated. The stomach contained an unidentified pink gelatinous material. Small perforations were observed in the wall of the stomach which were not believed to be due to researcher handling. The cause of these perforations and whether they resulted in the death of this animal could not be determined with certainty. However, it seems possible that they were associated with the death of this animal and may have occurred during consumption of the observed food item. Two additional hatchlings salvaged after predation and partial consumption (in 2006 and 2007) were also dissected and material was observed within the colon of each individual. The stomach was missing from both individuals and was presumably removed when the head of each had been consumed during predation. The colonic material included small bits of vegetation, grains of sand, and some unidentifiable material. Specimens will be deposited at The Cleveland Museum of Natural History.

Observations of narrow growth annuli on juvenile *E. blandingii* have previously hinted at hatchling feeding activity (Pappas et al. 2000. Chelon. Conserv. Biol. 3:557–568), but this is believed to be the first confirmation of post-emergence feeding activity by hatchling *E. blandingii* prior to their first winter dormancy.

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GLYPTEMYS INSCULPTA (Wood Turtle). **ECTOPARASITES.** Although freshwater turtles are known to be parasitized with leeches of the genus *Placobdella* (e.g., Watermolen 1996. J. Fresh. Ecol. 11:211–217), several families of biting flies (Diptera) are ectoparasites of turtles as well. For example, biting midges in the genus *Culicoides* (Diptera: Ceratopogonidae) are well-known pests of vertebrates, including humans. Females of most *Culicoides* species require blood meals in order to produce one or more clutches of eggs [Blanton and Wirth 1979. Sand Flies (*Culicoides*) of Florida (Diptera: Ceratopogonidae), (in) Arthropods of Florida & Neighboring Land Areas. 10. 204 pp]. Currently, there are some 1300 known species of *Culicoides* [Borkent and Wirth 1997. World Species of Biting Midges (Diptera: Ceratopogonidae). Bull. Amer. Mus. Nat. Hist. 233:1–237.]. However, only one of the 152 Nearctic species (*Culicoides testudinalis*) is known to obtain blood meals from turtles. Herein, we report eight instances of *C. testudinalis* parasitizing the semi-aquatic turtle, *Glyptemys insculpta* in June of 2003 and 2004.

On 5 June 2003 at 0835, one of us (JM) observed two adult male *G. insculpta* (# 138 and # 1009) feeding on an unidentified species of slug, within 4 m of each other, at an undisclosed study site in Nova Scotia, Canada. Both of these turtles were noted to have many midges on their carapaces. Later, at 1110, an adult female *G. insculpta* (# 1011) that was covered with hundreds of small midges on its carapace, head, and limbs was observed and photographed (Figs. 1–2). At 1151, another adult female (# 1012) was found to be parasitized as well. On 17 June 2003 at 1230, an adult female (# 1113) was noted to have 13 midges; all but three were swollen with blood meals. On 19 June 2003 at 1125, another adult female (# NT39) was reported to be parasitized by midges, but no additional details were recorded.

Two additional observations were made in 2004. On 16 June 2004 at 0905, an adult female (#1194) was noted to have hundreds

of midges, many of which were on the carapace engorged with blood . Several midges were feeding upon the tissues surrounding the eyes as well. A final adult female (# 1177) was observed to be parasitized on 17 June 2004 at 0945. Although approximately 10 midges were associated with this *G. insculpta*, only one was engorged with blood. The mean carapace length (range) of the aforementioned eight *G. insculpta* was 195 mm (183–213 mm). The estimated minimum age of these turtles, based on carapacial growth annuli, ranged from 20–26 years.

Several dozen of the midges from one *G. insculpta* (# 1011) were collected and subsequently sent to WLG for identification. Nine unengorged midges were cleared in phenol-alcohol and mounted on microscope slides in phenol-Canada balsam by the methods of Wirth and Marston (1968. Ann. Entomol. Soc. Amer. 61: 783–784). Voucher specimens of slide-mounted *C. testudinalis* will be deposited in the Canadian National Collection of Insects (Ottawa, Ontario) and Florida State Collection of Insects (Gainesville, Florida). All slide-mounted midges are identical to three other females that were collected, mounted, and identified as *C. testudinalis* by Wirth; a paratype from Falls Church, Fairfax Co., VA, and two others from Prince Georges and Montgomery counties, Maryland in the synoptic collection of ceratopogonids maintained by WLG. The female holotype of *C. testudinalis* was collected on 6 June 1953 by Neill Richmond while it fed upon a Wood Turtle (*G. insculpta*) in Coburn, Centre County, Pennsylvania (Wirth and Hubert. 1962. Ann. Entomol. Soc. Amer. 55:182–195). Of the 78 female paratypes of this ectoparasitic midge, two were found biting *Terrapene carolina* at Patuxent Wildlife Refuge, Prince Georges County, Maryland by John Scanlon on 12 July 1958; whereas, three others were found "feeding on turtle" by R.C. Shannon on 23 May 1939 at Dead Run, Fairfax County, Virginia.

Notably, of the several hundred *C. testudinalis* observed on the turtles, most individuals appeared to have pierced the sulci between carapacial scutes or the margins of growth annuli with their fine-toothed mandibles in order to reach capillaries with their tubular mouthparts. This is consistent with observations of the biting midge *Leptoconops bezzii* feeding on the sulci between the scutes of



FIG. 1. Posterior portion of adult Wood Turtle (*Glyptemys insculpta*) infested with female biting midges (*Culicoides testudinalis*). Note that most of the midges are feeding in the sulci of successive scute layers and several engorged midges are resting on vegetation.



FIG. 2. Adult Wood Turtle (*Glyptemys insculpta*) from Fig. 1 infested with hundreds of adult female biting midges (*Culicoides testudinalis*) on its carapace, head, neck, and front leg. The swollen, reddish abdomens of some midges are engorged with blood from the turtle.

Testudo graeca in western Syria and Lebanon (Široký et al. 2007. Parasitol. Res. 101:485–489). Moreover, the leech, *Placobdella ornata*, is also known to obtain blood from the sulci between the scutes that overly the carapace bones (Siddall and Gaffney 2004. J. Parasitol. 90:1186–1188). Approximately 100 midges on one *G. insculpta* (# 1011) appeared to be fully engorged with blood, and a few that had completed feeding were resting on vegetation (Fig. 1). The highest densities of midges occurred between marginal and costal scute interfaces (Fig. 1); however, a much greater proportion of the midges on the anterior portion of the carapace were engorged (Fig. 2). Midges might initially be attracted to the head of a turtle, the source of exhaled CO_2. It is unknown if turtles suffer significant ill effects from the bites of *Culicoides*, but the *G. insculpta* in question were not observed attempting to dislodge any midges with forelimbs or engaged in any other erratic movements.

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GLYPTEMYS MUHLENBERGII (Bog Turtle). **LONGEVITY.** Between May 1969 and June 1982, William Kimmich conducted mark recapture surveys of Bog and Spotted Turtles (*Clemmys guttata*) at several sites in southeastern Pennsylvania to gain information about population dynamics of these turtles. (The northern populations of the Bog Turtle were listed as a Threatened species by the U.S. Fish and Wildlife Service in November 1997.) During

this time period Kimmich marked approximately 100 Bog Turtles with small drill holes in the marginal scutes at one of these sites. Kimmich worked independently on this study, but provided his data and volunteer services to The Nature Conservancy after it acquired this property in 1989. Carl Ernst conducted research on Bog Turtles at this site between May 1982 and May 1989 and marked several additional Bog Turtles with square and triangular notches. Ernst also contributed data to the Conservancy for this analysis. In 1992 the Nature Conservancy, using staff and contractors, reinitiated mark/recapture surveys and conducted a short radio telemetry study at the site in 1992. Turtles marked during and after 1992 were marked exclusively with triangular notches in the marginal scutes. Turtles were sexed, and measurements of the carapace length and width, plastron length and width, and shell height were recorded. Shell wear and injuries were also noted at subsequent captures. These characteristics, as well as the configuration of markings on the marginal scutes, were used for the data comparison. At least 29 turtles (9 males and 20 females) that were marked as adults prior to 1982 were recaptured after 1992. Positive identification of some of these turtles has not been made because of erosion of holes to the edges of the scutes, the possible addition of marks to some turtles, predator damage to the marginal scutes, and drill holes filling with mud, making their detection difficult. Fourteen turtles were confirmed to be positive matches between the two data sets. Three of these turtles were recaptured in 1993, 1994 and 1997 respectively, and eleven of these turtles were recaptured after 2000. The most recent of these captures was made during the 2008 field season.

The average annual growth rate of Bog Turtles is rapid during the first years after hatching, and gradually decreases as the turtle ages. Ernst (1977. Herpetologica 33: 241-246) documented annual growth rates of 34.6 percent at hatchling with a gradual decline to 5.2 percent at age twelve, indicating that Bog Turtles reach their maximum size at some time after age 12. Comparison of Kimmich's data and that collected by The Nature Conservancy reveals an average size variation of 0.56 mm between initial and subsequent captures, indicating that these turtles were fully grown adults when first captured, and were presumed to be at least thirteen years old at first capture. Counting the number of scute annuli appears to be a reasonable method of determining approximate ages of Bog Turtles up to about 10 to 15 years, after which time growth may nearly cease and their burrowing habit will begin to wear away the annuli. While young Bog Turtles have distinct annuli, the annuli on the shells of turtles that were calculated to be more than 40 years old had been worn completely smooth. The earlier data did not note annuli count or wear and it is possible that several of these turtles are considerably older than the calculated ages. Many factors influence the speed and amount of wear on the shell, and shell wear may vary greatly between sites.

The ages of turtles in these studies were estimated using the aforementioned criteria. One turtle is estimated to be at least 25 years old, two turtles to be at least 35 years old, seven turtles to be at least 38 years old, three turtles to be at least 45 years old, and one turtle is estimated to be at least 49 years old. Notably, one female whose age is calculated to be more than 48 years old had all toes missing on both left feet at both captures, and thus had survived for at least 35 years in the wild in this condition.

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GOPHERUS AGASSIZII (Desert Tortoise). **MORTALITY.** In 1990, populations of *Gopherus agassizii* in the Mojave Desert were listed as Threatened under the US Endangered Species Act (Fish and Wildlife Service 1990. Federal Register 55:12178–12191). This action was deemed necessary because of the increase in habitat loss and degradation in the Mojave Desert due to the rapid growth of many cities and suburban communities (Boarman and Beaman 2002. The Sensitive Plant and Animal Species of the Western Mojave Desert. U.S. Geological Survey, Western Ecological Research Center, Sacramento, California). Although anthropogenic activities undoubtedly contribute to *G. agassizii* mortality, many natural causes of mortality have also been reported. Many of the natural dangers to *G. agassizii* appear to affect young tortoises more than older individuals. Among the many threats are predation, parasites, disease, dehydration, and being crushed when dens collapse (Luckenbach 1982. *In* R. B. Bury [ed.], North American Tortoises: Conservation and Ecology, pp. 1–37. Wildl. Res. Rep. 12, U.S. Fish and Wildlife Service, Washington, DC). Here we report the first observations of *G. agassizii* mortality caused by individuals falling into and being trapped in rock fractures on a basalt flow.

The habitats where *G. agassizii* can be found in the Mojave Desert vary from sandy valleys filled with Creosote Bush (*Larrea tridentata*), to rocky bajadas and hillsides (Riedle et al. 2008. Copeia 2008:414–420). Studies of *G. agassizii* in the Sonoran Desert suggest that preferred den sites may occur in rugged terrain with high densities of boulders (Barrett 1990. Herpetologica 46:202–206). Several reserves have been established with the aim of protecting critical tortoise habitat. The Red Cliffs Desert Reserve, Washington Co., Utah, was established in 1996 to protect a large tract of desert habitat suitable for *G. agassizii* and other desert wildlife. This reserve contains a diverse suite of habitats, from Blackbrush (*Coleogyne ramosissima*) covered mesas, to sandstone and basalt rock outcrops, to creosote bush flats.

On two occasions on separate basalt flows in the Red Cliffs Desert Reserve, carcasses of adult *G. agassizii* were found. These individuals had apparently fallen headfirst into fractures in the rocks, become stuck, and died from exposure, likely from overheating. Both individuals had their hind legs in the air and their forelegs and head dangling down into the crack. No noticeable marks were found on the tortoise carcasses that would suggest they were killed and placed in the cracks by predators. It is unknown what caused the tortoises to wander onto the basalt flows.

This finding is interesting because tortoises in the Red Cliffs Desert Reserve often traverse steep sandstone outcrops with little difficulty (pers. obs.). It is likely a rare event for a tortoise to be trapped by falling into a crack in the rocks, yet given that two individuals were trapped and died in a similar manner, this may be a more common event than previously thought.

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HYDROMEDUSA MAXIMILIANI (Brazilian Snake-necked Turtle). **ALGAL COLONIZATION.** Algae of the genus *Basicladia* (Chlorophyta, Cladophoraceae) are often noted growing on the shells of freshwater turtles, which offer the algae an attractive substrate for colonization (Edgren et al. 1953. Ecology 34:733–740; Ducker 1958. Hydrobiology 10:157–174; Semir et al. 1988. Cienc. cult. 40:885–888). The relationship between algae and turtles has been described as commensal (assuming the turtles receive little or no benefit from the algae) or mutualistic (the turtle using the algae as camouflage, perhaps while foraging, and the algae using the turtle as a safe and mobile substrate) (Edgren et al., *op. cit*.; Niel and Allen 1954. Ecology 35:581–584; Proctor 1958. Ecology, 39:634–645; Dixon 1960. Texas J. Sci. 12:36–38).

In November 2004 we captured seven *Hydromedusa maximiliani* in Reserva Biológica Municipal Santa Cândida (21.6888889°S, 43.3444444°W, 770 m elev.), Juiz de Fora, Minas Gerais state, Brazil. Algae on the turtle's shells were collected with a scalpel and fixed in Transeau and formaline 4% solution. Biometric analysis suggested that six of these specimens were adults, with an average maximum carapace length of 150.60 ± 12.51 mm, and one was considered a juvenile, with a carapace length of 128.60 mm. All specimens had *B.* cf. *chelonum* adhering to their carapaces, on the vertebral plates, principally on the anterior and posterior regions, and on the marginal plates. The same distribution of algae was also noted for the chelids *Phrynops geoffroanus* and *Hydromedusa tectifera* from Brazil (Semir et al. 1988. Cienc. Cult. 40:885–888). The algae occurred mainly in the anterior and posterior regions of the carapace on the marginal scutes, there being little algae on the costal and central scutes.

A possible correlation between the feeding habits of turtles and frequency of epizoophyte growth is supported by the observation that carnivorous species that ambush or actively hunt their food may be more often subject to algal growth. Examples include include the chelydrids *Macrochelys* and *Chelydra*, kinosternids *Sternotherus* and *Kinosternon*, and the emydids *Deirochelys* and *Emys*. all of which hunt active prey, such as frogs, fish and aquatic insects (Niel and Allen 1954. Ecology 35:581–584). *H. maximiliani* has similar predatory feeding habits (Souza and Abe 1995. Chel. Cons. Biol. 1:320–322). The presence of algae on the carapace of this species may serve as protection against predators but would also decrease detection by prey. This record of *B.* cf. *chelonum* colonizing *H. maximiliani* is apparently the first report of the algae growing on this turtle species and supports a possible mutualistic relationship between the algae and the turtle host.

This work was licensed by IBAMA (Process nº 02015.003546/04-11), and was performed under the principles adopted by COBEA (Brazilian School of Animal Experimentation), which were approved by the Committee of Ethics in Animal Experimentation (Pro-Rectory of Research) of the Federal University of Juiz de Fora, in a meeting which took place on 04/12/2004 (Protocol nº 011/2005-CEA).

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MACROCHELYS TEMMINCKII (Alligator Snapping Turtle). **AERIAL BASKING.** *Macrochelys temminckii* is rarely observed out of the water. Terrestrial activity is typically limited to nesting females and hatchlings traveling from nest to water. Only two dead-on- road individuals are known (Ewert et al. 2006. *In* Meylan [ed.], Biology and Conservation of Florida Turtles, pp. 58–71. Chelon. Res. Monogr. No. 3, 376 pp.). Apparently, only four instances of observed or inferred aerial basking have been reported: on a log in Texas (Ewert 1976. Herpetologica 32:150–156; also see Ewert et al., *op. cit*.), on a fallen tree in Texas (Farr et al. 2005. Herpetol, Rev. 36:168), on a basking trap in Mississippi (Shelby and Jenson 2002. Herpetol. Rev. 33:304), and an adult basking on a river bank, also in Mississippi (Selman et al. 2009. Herpetol. Rev. 40:79). Here I report aerial basking of *M. temminckii* on land in Florida.

The observation was made as part of a long-term (since 2003) ecological study of *Macrochelys temminckii* in northern peninsular Florida. On 19 October 2008 at 1300 h, I found a juvenile (18.6 cm CL, 1.68 kg) *M. temminckii* on the northern bank of the Santa Fe River, Columbia Co. Florida, 1.7 km upstream from the US 27 bridge. This turtle was basking in partial sunlight at least 2 m from the water's edge. The turtle was found on sandy soil and appeared completely dry. Air temperature and water temperature (10 cm depth) were 23.3 and 22.5°C, respectively. Upon capture, this turtle was found to have been originally marked with a passive integrated transponder (PIT) on 9 July 2008, and had traveled ca. 2.5 km from the initial capture site. Additionally, I counted over 100 leeches that were attached to the turtle. This is the first report of aerial basking in Florida. Aerial basking in this species is certainly rare, but may occur sporadically in response to thermoregulatory needs of individual turtles.

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PHRYNOPS HILARII (Hilaire's Side-necked Turtle). **FEEDING BEHAVIOR.** The freshwater chelid turtle *Phrynops hilarii* is one of the most abundant chelonians in Rio Grande do Sul state, Brazil. Research by the Chelonia-RS Project in the lake at Moinhos de Vento Park, Porto Alegre city (30.0269444°S, 51.2011111°W) has been carried out intermittently since 2003. Between August and December 2008, 29 *P. hilarii* were captured and marked. Straight-line carapace length ranged between 113 and 387.2 mm (mean = 280.21; SD = 81.2). In the lake, which is ca. 4675 m^2 in area and has a maximum depth of 1.5 m, there are four other chelonian

species (*Trachemys dorbigni*, *T. scripta*, *Acanthochelys spixii*, and *Hydromedusa tectifera*). This note provides additional data about the diet and feeding behavior of *P. hilarii* at this location.

Predation of waterfowl and other birds by chelonians has been reported for the Snapping Turtles, *Chelydra serpentina*, and the Red-eared Slider, *Trachemys scripta elegans* (Ernst et al. 1994. Turtles of the United States and Canada. Smithsonian Inst. Press, Washington, D.C.; Ligon 2007. Herpetol. Rev. 38:201–202; Pryor 1996. Wilson Bull. 108:190–192). However, predation of non-aquatic birds by *P. hilarii* has not been previously described.

Pigeons (*Columba livia*) are abundant in the park and capture of the species by *P. hilarii* was observed by Daniel Borba Rocha and co-workers in 2004. On 9 October 2007, I described (field notes of the Chelonia-RS Project) the predation of a pigeon by a *P. hilarii* while the bird was drinking water at the margin of the lake. The turtle, without leaving the water, grabbed the bird by the neck with its jaws, and pulled it to the bottom of the lake, while other turtles (*T. scripta* and *P. hilarii*), also bit at the bird. On 22 January 2009, pictures and a report about pigeon predation by the Hilaire's Side-necked Turtle were published in a local newspaper (Zero Hora newspaper 2009. 15849:42). In this situation, the capture occurred on land as pigeons foraging on the margins of the lake were ambushed by a *P. hilarii*. When the birds got close to the margin of the lake, the turtle left the water and quickly attacked one of the birds (Fig 1A). The prey, at different times, was captured by the legs (Fig. 1B, C) or by the base of the neck (Fig. 1D). After the capture, the turtle brought the prey into the water and submerged with it (Fig. 1E). In the water, other turtles, presumably attracted by the movement and by the chance of obtaining food, also attacked the prey (Fig. 1F, G). A video showing what was reported here is available at http://csbujes.blogspot.com/.



FIG. 1. Sequence of predation by Hilaire's Side-necked Turtle on pigeons in Moinhos de Vento Park, Porto Alegre City, Rio Grande do Sul, Brazil.

The predation of small aquatic birds by turtles is apparently occasional, and/or opportunistic in nature, however, the behavior of leaving water displayed by *P. hilarri* suggests an intentional act of capture not previously described.

I thank the photographer of Zero Hora, Ronaldo Bernardi, for making photographic material and videos available. Thanks to the administration of the Moinhos de Vento Park; to the biologist Soraya Ribeiro; to the wildlife management group of the Secretaria de Meio Ambiente de Porto Alegre; and to the researchers in the Chelonia-RS Project of the Departamento de Zoologia da Universidade Federal do Rio Grande do Sul.

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PSEUDEMYS RUBRIVENTRIS (Northern Red-bellied Cooter). **HATCHLING BEHAVIOR.** We observed the locomotion and behavior of hatchling *Pseudemys rubriventris* that emerged and departed from a nest at Jug Bay Wetland Sanctuary, Anne Arundel County, Maryland, USA (38.7858333°N, 76.7136111°W). At Jug Bay, Red-bellied Cooters nest in open, sunny areas 100–225 m from a large freshwater tidal wetland bordering the Patuxent River (Swarth 2004. *In* Swarth et al. [eds.], Conservation and Ecology of Turtles of the Mid-Atlantic Region, pp. 73–84. Bibliomania!, Salt Lake City, Utah). Turtle hatchlings often disperse quickly from the nest and may move directly to water or to dense vegetation or under leaves where they are difficult to observe. Tuttle and Carroll (2005. Northeast. Nat. 12:331–348) tracked hatchling Wood Turtles (*Glyptemys insculpta*) as they moved from nests to water in New Hampshire; researchers in New Jersey found that hatchling Wood Turtles did not travel directly to water, but remained in a field for days to weeks (Castellano et al. 2008. Chelon. Conserv. Biol. 7:113–118).

Here we describe the post-emergence movements and behavior of Red-bellied Cooter hatchlings under natural field conditions. The hatchlings under observation emerged from a nest discovered at 0900 h on 27 June 2007 when the female was observed laying eggs. The nest was immediately covered with a screened predator exclusion cage and was checked daily after 1 September 2007 to determine the date of hatchling emergence. The nest was in well-drained, sandy substrate next to a tractor shed, about 90 m from a large tidal wetland. The nest was partially shaded by the shed canopy roof and there was no vegetation within several meters.

Following a 98-day incubation period, eight hatchlings emerged from the nest at 1715 h on 3 October 2007. Air temperature was 27°C and there had been no rain for more than six days. The hatchlings were contained at the nest under the predator exclusion cage until the next morning. (Upon excavation, the nest held five dead,

under-developed hatchlings and three intact, unfertilized eggs).

On 4 October, we released four hatchlings at 1000 h and four at 1100 h. Air temperature during the observations varied from 21°C to 26°C. We glued a yellow, 10 cm long bristle in an upright position to the carapace of each hatchling to help us observe them as they moved through the grass. However, we removed the bristles when they became entangled in vegetation a short distance from the nest. We then affixed a thin, 10 cm long strip of colored plastic flagging to the rear of each shell. We observed the hatchlings from a distance of 25 m in order to minimize observer effect. We noted the hatchlings' rate of movement and behavior as they crossed the field heading for the shrub/sapling area where we lost sight of them in the leaf litter.

The terrain between the nest and the wetland consisted of 30 m of open mowed field; 30 m of level, shady shrub/sapling habitat with ample leaf litter; and 30 m of sloping forest-covered bluff extending downhill to the wetland. The hatchlings alternated between short bursts of rapid walking and periods of rest and concealment. As they walked across the 30 m of mowed field most of the hatchlings moved steadily for 5–10 min., then rested in taller grass clumps before moving on. Prior to reaching the forest edge, two of the hatchlings burrowed into the ground for several hours before moving on.

For six hatchlings, we measured path length, amount of time required to cover the distance from nest to forest edge, rate of movement, and maximum speed. All walking paths were N or NW away from the nest site directly toward the wetland. Mean path length across the mowed field for each of the six hatchlings walking from nest to forest was 29.7 m (SD = 6.8 m, range: 21.9–40.8 m). Mean travel time to cross the field was 134 min. (SD = 73 min., range: 40–244 min.). Mean rate of movement was 17.6 m/h (range 6.6–38.7 m/h). Maximum speed was 38.7 m/h.

For aquatic turtle species that deposit eggs in upland areas, hatchlings are quite vulnerable to predation as they move from the nest toward water. Hatchlings minimize this risk by moving quickly across exposed fields or lawns. Upon emergence, Red-bellied Cooter hatchlings in our study area generally leave the nest site immediately and invariably walk directly toward the tidal wetlands. However, predators may also be alerted to the movement of a rapidly walking hatchling. Hatchlings may minimize the risk of predation by alternating between bursts of relatively rapid movement followed by periods of rest where they are immobile. Additionally, the variability in the pattern of movement and stasis that we observed, wherein some hatchlings crossed the field quickly while others spent several hours making the journey, suggests that behavioral heterogeneity among nest mates might reduce predation risk.

Each hatchling under observation walked in almost the same direction towards the wetlands. It is possible that hatchlings move towards bright light from the sky that is visible on the horizon and avoid moving toward areas that are dark or shady. The sky was visible and bright at ground level through the trees and shrubs to the northwest of the nest. A sky that is visible through vegetation may be a cue to hatchlings that the terrain drops off towards lower elevations. By walking in this direction hatchlings would travel downhill, eventually reaching the safety of a stream, pond, or wetland.

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TERRAPENE CAROLINA MAJOR (Gulf Coast Box Turtle). **SWIMMING**. With the exception of *Terrapene coahuila* (Cohuilan Box Turtle), members of the genus *Terrapene* have been considered to be primarily terrestrial (Ernst et al. 1994. Turtles of the United States and Canada. Smithsonian Institution Press, Washington, D.C., pp. 250–265). The occasional use of aquatic habitats, perhaps for drinking or thermoregulation, is often noted (Bonin et al. 2006. Turtles of the World. John Hopkins Univ. Press, Baltimore, Maryland. 416 pp; Dodd 2001. North American Box Turtles: A Natural History. Univ. Oklahoma Press, Norman, Oklahoma. 231 pp.), but instances of actual swimming are less common (McCauley 1945. The Reptiles of Maryland and the District of Columbia. Privately printed, Hagerstown, Maryland. 194 pp.; Stickel 1950. Ecol. Monogr. 20:361; Tyler 1979. Southwest. Nat. 24:189–190; McDowell et al. 2004. Herpetol. Rev. 35:265–266). *Terrapene c. major* occupies coastal wetland or near-wetland habitats in the southeastern USA and will walk and forage on the bottoms of ponds and canals (Bartlett and Bartlett 1999. A Field Guide to Florida Reptiles and Amphibians. Gulf Publ., Houston, Texas. 280 pp.). Here we report a long-distance swimming event for this subspecies.

On 28 June 2008, at ca. 0900 h, we observed a male *T. c. major* swimming across the East Fowl River in Mobile Co., Alabama, USA. The turtle was sighted by boat in the center of the river, swimming in a northwesterly direction away from the south bank. The turtle was swimming at the surface with its head up and approximately two-thirds of its carapace above the water line. Upon approach, the turtle ceased swimming and began to float. We collected the turtle to verify the identification and sex. The turtle was photographed and then returned to the water. As we moved away, the turtle continued to swim towards the north bank. The width of the river at this location was measured, using ArcGIS, to be ca. 320 m. We observed the turtle for 15 minutes until it came within 20 m of the north bank, at which time we continued up the river.

Swimming and river crossings have been previously reported for subspecies of *T. carolina* (references, *op. cit.* from above), and *T. ornata* is capable of swimming (Richtsmeier et al. 2008. Chelon. Conserv. Biol. 7:3–11), but the distances reported for these events are generally short (< 20 m), and large rivers have been considered as possible barriers to dispersal and gene flow (Richtsmeier et al., *op. cit.*). In the instance described above, the circumstances resulting in this animal swimming such a long distance are unknown. However, the ability to swim across large bodies of water has implications for gene flow between populations that would otherwise be considered geographically isolated.

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SQUAMATA — LIZARDS

AMEIVA AMEIVA (Green Lizard). **ATTEMPTED PREDATION OF AMPHISBAENIAN**. *Ameiva ameiva* (Teiidae) is a moderate-sized (to 190 mm SVL), terrestrial lizard that occurs in nearly all tropical habitats of South America (Pianka and Vitt 2003. Lizards: Windows to the Evolution of Diversity. University of California Press, Berkeley, California. 333 pp.). It is an active forager with a generalist diet that includes plants and vertebrates, though dominated by arthropods (Vitt and Colli 1994. Can. J. Zool. 72[11]:1986–2008).

On 19 October 2004 at 1438 h, in an area of Cerrado in the municipality of Bauru, São Paulo State, Brazil (22.340690°S 49.018190; datum: WGS84; elev. 580 m) we observed an adult *A. ameiva* (ca. 150 mm SVL) attacking a Spade-snouted Worm-Lizard (*Leposternon microcephalum*) ca. 300 mm total length (Fig. 1). During a period of 20 minutes, we observed the *Ameiva* repeatedly shake the *L. microcephalum* from side to side, occasionally releasing its grip and then biting again. Eventually, the *Ameiva* released the *L. microcephalum* and retreated to a hole in a shaded ravine. We examined the amphisbaenian and noted small bite marks but the skin was not torn; it seemed exhausted and moved slowly. The latter was collected and added to collection of the House of Reptiles of Bauru Zoo.

Records of predation of *L. microcephalum* include a coralsnake (*Micrurus corallinus*) and a mammal (*Nasua nasua*) (Marques and Sazima 1997. Herpetol. Nat. Hist. 5:88–93; Oliveira et al. 2004. Herpetol. Rev. 35:170–171). This is the first report of predation of *L. microcephalum* by *A. ameiva* and the first occurrence of predation by this species on an amphisbaenian.



FIG. 1. Green Lizard (*Ameiva ameiva*) attacking a Spade-snouted Worm-Lizard (*Leposternon microcephalum*). Photo by F. K. Ubaid.

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ASPIDOSCELIS COSTATA (Western México Whiptail). **CANNIBALISM**. Cannibalism is common among reptiles (Mitchell 1986. SSAR Herpetol. Circ. No. 15, 37 pp.) and has been recorded in a number of lizard species (e.g., Castilla and Van Damme 1996. Copeia 1996:991–994; Moll and Koenig 2003. Sonoran Herpetologist. 16:90–91; Keren-Rotem et al. 2006. Behav. Ecol. Sociobiol. 59:723–731). The teiid genus *Aspidoscelis* includes insectivorous lizards (Anderson 1993. *In* Wright and Vitt [eds.], Biology of Whiptail Lizards (Genus *Cnemidophorus*), pp. 83–116. Oklahoma Mus. Nat. Hist., Norman; Vitt and Pianka 2004. *In* Pérez-Mellado et al. [eds.], The Biology of Lacertid Lizards, pp. 139–157. Evolutionary and Ecological Perspectives. Institut Menorquí d'Estudis, Recerca. Lesvos, Greece). Though the diet of *Aspidoscelis* spp. is often characterized as comprising mainly insects, some records exist of cannibalistic behavior, especially among temperate zone species (Etheridge and Wit 1982. Herpetol. Rev. 13:19; Mitchell 1979. Can. J. Zool. 57:1487–1499). However, as no reports of cannibalism exist for *A. costata*, we report an instance of cannibalism in this species.

On 18 October 2008 (rainy season), MAGR captured a juvenile male *A. costata* (60 mm SVL, 6.6 g) at Mezcala, Guerrero (17.9101°N, 99.6148°W, datum: WGS84; 548 m elev.) in southern México. Dominant vegetation is tropical dry forest with a wet season from July to October and a dry season from November to June. Examination of its stomach contents revealed a conspecific hatchling (35 mm SVL, 1.0 g). The hatchling had been swallowed headfirst and showed little evidence of digestion, indicating that it had been consumed just before the juvenile's capture. In short-lived animals such as small lizards, population dynamics appear to be particularly sensitive to fluctuations in annual recruitment and survival of eggs and juveniles (Castilla and Vand Damme 1996. Copeia 1996:991–994). In that sense, cannibalism of hatchlings could be a mechanism to reduce intraspecific competition or a form of population regulation (Fox 1975. Ann. Rev. Ecol. Syst. 6:87–106).

Both specimens (predator and prey) were deposited in Colección Nacional de Herpetología, Instituto de Biología, Universidad Nacional Autónoma de México (IBH 20202 and 20209, respectively).

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ASPIDOSCELIS MARMORATA (Western Marbled Whiptail). **FACULTATIVE FRUGIVORY**. *Aspidoscelis marmorata* inhabits semiarid environments in southern New Mexico and Texas, and in northern México in Coahuila, Chihuahua, and

Durango (Stebbins 2003. A Field Guide to Western Reptiles and Amphibians. Houghton Mifflin, Boston, Massachusetts. 533 pp.). Previous studies of stomach contents have shown that insects comprise most of the diet, and that some plant material may be taken in very low quantity (Gadsden and Palacios-Orona 2000. Acta Zool. Mex. 79:61–76; Lemos-Espinal and Smith 2007. Amphibians and Reptiles of the State of Coahuila, Mexico. UNAM and CONABIO. 550 pp.) but frugivory has not been documented. This is the first observation of intentional fruit ingestion in the species.

On 2 November 2004 around 1300 h, we observed an adult *A. marmorata* at Mapimí Biosphere Reserve in central Chihuahuan Desert, Durango, México (26.6662°N, 103.7471°W, WGS84, elev. 1150 m) consuming a fleshly, juicy, red fruit of *Opuntia leptocaulis* (Cactaceae). The lizard picked up the fruit from the ground in its mouth and consumed most of. *Opuntia leptocaulis* (Desert Christmas Cholla) occurs throughout the Chihuahuan Desert. Their fleshy, highly attractive fruits are common and ripen during winter, and are frequently consumed by a variety of vertebrates, especially birds and small mammals (Goettsch and Hernández 2006. J. Arid Environ. 65:513–528).

In xeric habitats, food availability is frequently unpredictable and scarce, so opportunistic feeding could shape the diets of many lizard species (Whiting and Greeff 1997. Copeia 1997:811–818). Fruiting *O. leptocaulis* are food resources that are widely available in late fall. Fruit consumption by *Aspidoscelis* lizards could be an interesting issue for the study of facultative frugivory.

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ASPIDOSCELIS TESSELATA (Checkered Whiptail) × ***ASPIDOSCELIS SEXLINEATA VIRIDIS*** (Prairie Racerunner). **REPRODUCTIVE POTENTIAL**. Pattern class E (Zweifel 1965. Am. Mus. Novit. 2235:1–35) of diploid (Lowe et al. 1970. Syst. Zool. 19:114–127) parthenogenetic *Aspidoscelis tesselata* (*sensu* Reeder et al. 2002. Am. Mus. Novit. 3365:1–61), derived from hybridization between *A. marmorata* (= *tigris*) *marmorata* × *A. gularis septemvittata* (Parker and Selander 1976. Genetics 40:245–252; Cordes and Walker 2006. Copeia 2006:14–26), is syntopic with gonochoristic *A. sexlineatus viridis* and parthenogenetic *A. neomexicana* near the railroad depot in the city of Fort Sumner, De Baca Co., New Mexico, USA (34.47389°N, 104.23944°W; datum: WGS84; elev. 1250 m). On 12 July 2002, GJM collected a male lizard (University of Arkansas Department of Zoology, UADZ 7619) at this site possessing characters of scutellation and components of the dorsal and ventral color patterns that appeared to be phenotypically derived from hybridization between *A. tesselata* and *A. sexlineata viridis*. Analyses of morphological characters in the apparent hybrid and samples of the putative parental species from Fort Sumner (Manning and Walker 2006. Am. Midl. Nat. 2006. 155:411–416) confirmed that UADZ 7619 resulted from a haploid sperm of *A. sexlineata viridis* (1n = 23) fertilizing an unreduced egg of *A. tesselata* (2n = 46). Though this is the first reported example of this hybrid combination, *A. tesselata* E (= pattern class EC of Taylor et al. 2003. Am. Mus. Novit. 3424:1–40) has been identified as a participant in frequent hybridizations with its maternal progenitor *A. marmorata marmorata* at a site in New Mexico (Taylor at al. 2001. Am. Mus. Novit. 3345:1–65).

Based on Walker et al. (1989. Copeia 1989:1059–1064; 2006. Herpetol. Rev. 37:344–345) and Taylor et al. (2001, *op. cit.*), JMW described the gross reproductive morphology of the preserved hybrid (UADZ 7619). Based on Goldberg and Beaman (2003. Herpetol. Rev. 34:143), SRG histologically examined the left testis and left epididymis of the hybrid and assessed its previous reproductive functionality.

The hybrid was 70 mm in SVL. Compared to males of *A. sexlineata viridis* of similar size from Fort Sumner, its testes (mean dimensions of both = ca. 3.8 × 6 mm), epididymides, and hemipenes were of expected size and structure. Histology of the left testis indicated that UADZ 7619 was undergoing early spermiogenesis when collected. As reported for other teiid lizards (Lowe and Goldberg 1966. J. Morphol. 119:277–281); a circumtesticular tunic 1–3 Leydig cells thick surrounded the left testis. Clusters of metamorphosing spermatids were present and tails of spermatozoa projected into the lumina of the seminiferous tubules. Sperm were also present in the sectioned epididymis.

This *A. tesselata* × *A. sexlineata viridis* hybrid would have been deemed fertile based on cytological characteristics of testes in species such as *A. tigris* (Lowe and Goldberg, *op. cit.*). However, though it seemed capable of producing sperm and inseminating females of *A. tesselata*, *A. neomexicana*, and *A. sexlineata viridis* at Fort Sumner, its ability to produce a stable haploid chromosome complement from a triploid number of 69 is dubious. Nevertheless, the hybrid likely would have interfered with normal reproduction in some females of these three species should any of them have been inseminated. Taylor et al. (2001, *op. cit.*) provided morphological and histological descriptions of gonads and ducts of both male and female hybrids of *A. tesselata* × *A. marmorata* collected at Macho Draw, Chaves Co., New Mexico, and provided indirect evidence that some hybrid males (N = 12) may have inseminated congeneric females at this site.

Collection of UADZ 7619 was made under authority of Permit No. 3118 issued to GJM in 2002 by the New Mexico Department of Game and Fish.

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CALOTES "VERSICOLOR" (Burmese Garden Lizard). **GLIDING**. During surveys of the Burmese herpetofauna (NSF DEB-9971861, DEB-0451832), we periodically sampled the components

of the Hlawga Wildlife Park fauna (17.043°N, 96.1271667°E; Yangon Division, Myanmar). On 28 February 2009, we focused on the lizard *C. "versicolor"* (Quotes indicate the population is a member of this species group; true *C. versicolor* does not occur in Myanmar.), and discovered that members of the Hlawga population glide. Hlawga *C. "versicolor"* are wary and typically take evasive action when a person approaches within 4–5 m of "their" tree. These lizards are sit-and-wait predators, and typically cling to the sides of trees, usually 1–2 m from the tree base. When a potential predator approaches, evasive action begins with a slight upward movement around the tree, apparently in an effort to escape detection. If pursued, even slowly, they continue to circle the tree trunk, constantly moving upward. Our observation concerns an adult on a tree isolated in a grassy patch. As we approached, the lizard immediately climbed to nearly 3 m. Being the dry season, the tree was leafless. A park ranger decided to aid capture by climbing the tree. The lizard continued to the top (about 12 m); at about 10 m, the tree was too slender for the ranger to reach the lizard, so he chopped off the tree top and moved slowly and held the top horizontal. We expected the lizard to simply drop directly downward; instead it leaped outward and descended at roughly 45°, landing in a brush pile and eluding capture. The descent angle alone does not imply gliding, but in association with the lizard's deliberate vertical outward leap and its posture of straight body and head with outstretched fore- and hindlimbs, dorsoventrally flattened trunk, and tail held straight backward (rigidly so, i.e., no movement), the controlled descent can be defined as gliding behavior.

Gliding is certainly not an unknown agamid behavior owing to the spectacular gliding performance of the various species of *Draco*, but it has not been reported in other agamid taxa except *Bronchocela cristatella* (Allen 1957. Malayan Nat. J. 11:81; Reid 1958. Malayan Nat. J. 12:119). Both of these reports note that the lizard was observed to leap outward and descent vertically from its origin at a roughly 40–45° angle. We suggest that these and other species of lighter-bodied arboreal agamids may use this mode of escape, but that it would be rarely seen and uncommonly used because these lizards are often successful at eluding capture by climbing, hiding, or jumping short distances to other trees.

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CELESTUS CURTISSI (Curtis' Galliwasp). **REPRODUCTION.** *Celestus curtissi* is restricted to Hispaniola where it is known from Haiti and the Dominican Republic (Schwartz and Henderson 1991. Amphibians and Reptiles of the West Indies. Descriptions, Distributions, and Natural History. Univ. Florida Press, Gainesville. 720 pp.). It is ovoviviparous with brood sizes of 2–5 (Schwartz and Henderson 1991, *op. cit.*). The purpose of this note is to report a new minimum brood size for *C. curtissi*.

Two female *C. curtissi* from the Dominican Republic collected August 1976, were examined from the herpetology collection of the Natural History Museum of Los Angeles County (LACM). Both (LACM 125351, SVL 63 mm; LACM 125354, SVL 64 mm) were from Pedernales Province, 5 km NE of Oviedo (17.7833°N, 71.3666°W, datum: WGS 84; elev. 3 m).

A mid-ventral incision was made in the lower abdomen and the ovaries were examined. One well-developed embryo was observed in LACM 125354 and one oviductal egg was in LACM 125351. Ober (1970. Herpetol. 26:275) reported one *C.* (as *Diploglossus*) *curtissi* gave birth to five young in September. One embryo represents a new minimum brood size for *C. curtissi*.

I thank Christine Thacker (LACM) for permission to examine *C. curtissi*.

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CYCLURA CYCHLURA INORNATA (Allen Cays Rock Iguana). **CAUSE OF MORTALITY**. Jetsam, flotsam, and other discarded material has been shown to be a source of mortality for reptiles (e.g., Laist 1997. *In* Coe and Rogers [eds.], Marine Debris: Sources, Impacts, and Solutions, pp. 99–139. Springer-Verlag, New York; Benedict and Billeter 2004. Southeast. Nat. 3:371–377; Mascarenhas et al. 2004. Mar. Poll. Bull. 49:354–355). We report on jetsam-related sources of mortality for the *Cyclura cychlura inornata*.

The Allen Cays Rock Iguana is a CITES-listed species restricted to a few small cays in the Exuma Islands of the Bahamas (Iverson et al. 2005. Cat. Amer. Amphib. Rept. 810:1–9). It has few, if any, natural predators as adults, and relatively high adult and juvenile survivorship (Iverson et al. 2006. Biol. Conserv. 132:300–310; Iverson 2007. Copeia 2007:740–744). Documented sources of mortality include accidental death (Iverson et al. 2005. Herpetol. Rev. 36:175), and there is some concern about the possibility of poaching or other human- or tourism-related stressors (Iverson et al. 2006. Biol. Conserv. 132:300–310; Smith and Iverson 2006. Can. J. Zool. 84:1522–1527). We observed another possible cause of mortality related to oceanic refuse of jetsam causing the death of four juvenile Allen Cays Iguanas.

On 15 May 2008, three juvenile iguanas were found dead inside a large 50-gallon (189 liter) plastic drum on a cay near the Allen Cays (exact location not provided for conservation purposes). The drum had apparently washed up on the coastline, probably within the previous year. There were two small openings on the top of the drum through which the juveniles apparently entered (Fig. 1A). All three iguanas were about the same size (SVL ≈ 14 cm, 20 cm, 21 cm) and at a similar state of decomposition (Figs. 1B, 1C), suggesting that they may have been using the drum as a communal retreat until wind or waves reoriented the drum and prevented the lizards' escape. The three iguanas were all clearly juveniles based upon their size (Fig. 1C).

One juvenile iguana was found dead in a small upright freezer half filled with rain water on Southwest Allen's Cay (U Cay) (24.75°N, 76.84°W; see Iverson et al. 2004. Herpetol. Monogr.

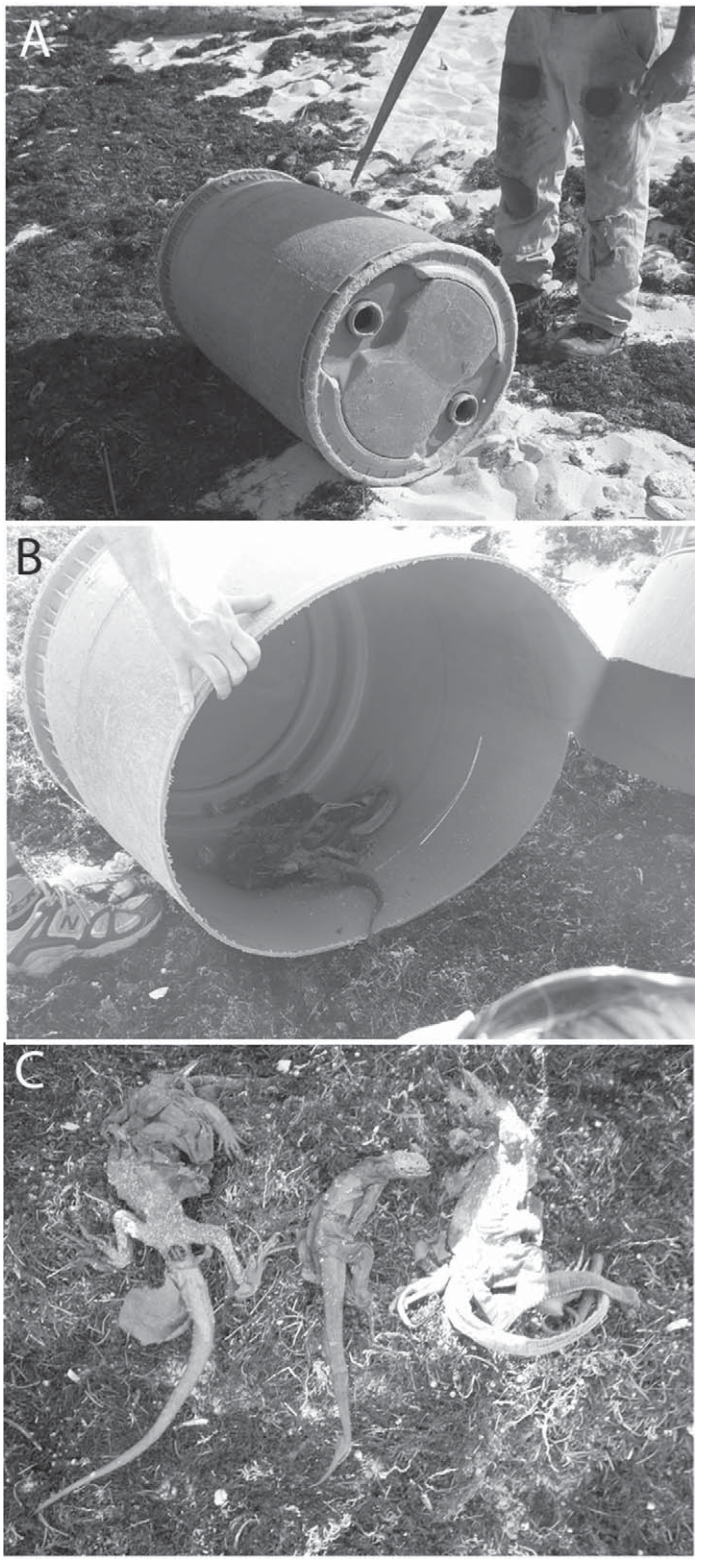


FIG. 1. A) The 50-gallon barrel as originally discovered; B) the remains of the three juvenile Allen Cays Iguana (*Cyclura cychlura inornata*) as found inside the barrel; and C) the remains of the three iguanas after removal from the barrel. Photos by Kirsten Hines (A), Lynne Pieper (B), and Stesha Pasachnik (C).

18:1–36 for a detailed description) on 16 May 2008 (Fig. 2A). The iguana had apparently fallen into the water and drowned. Few remains were found, but based on their size, it is highly probable

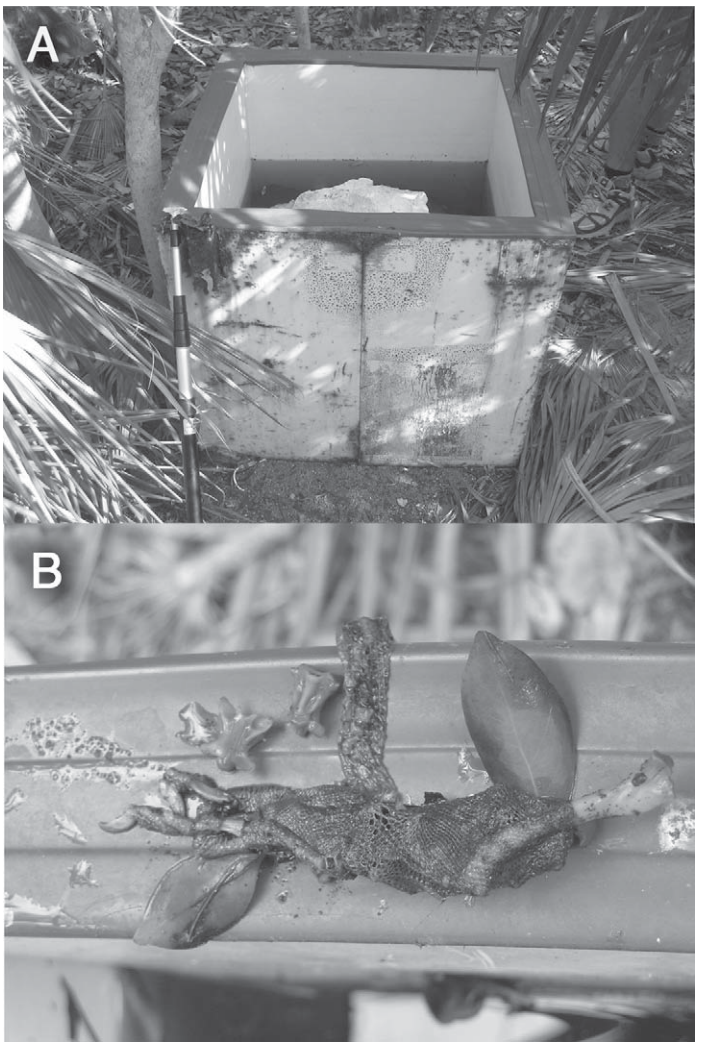


FIG. 2. A) The upright freezer partially filled with rain water; and B) the remains of one juvenile Allen Cays Iguana (*Cyclura cychlura inornata*) found in the water inside the freezer. Photos by Lynne Pieper.

that the individual was a juvenile (Fig. 2B).

Although the mortality events that we observed are likely rare, it does suggest that material washing up on the shores of these small cays can be an additional source of mortality, especially for smaller and younger iguanas, and potentially other native wildlife.

We thank Bruce Dunham and Will McLean of the M/V Bahama Star for help opening the barrel. Funding for this project was provided by Earlham College, the Cope Museum Fund, and the Test Fund. Permits for research on the Allen Cays Iguana were provided by the Bahamas Department of Agriculture to JBI.

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EUTROPIS CARINATA (Common Skink), ***EUTROPIS MACULARIA*** (Rock Skink). **ENDOPARASITES.** *Eutropis carinata*, a terrestrial, diurnal skink, occurs in a wide variety of habitats in Sri Lanka, India, Bangladesh, and Nepal (Das and De Silva 2005. A Photographic Guide to Snakes and Other Reptiles of Sri Lanka. Ralph Curtis Publ., Sanibel Island, Florida. 144 pp.). *Eutropis macularia*, a semi-fossorial skink, occurs in Sri Lanka, India, Pakistan, Nepal, Bangladesh, Bhutan, east to mainland southeast Asia (Das and de Silva, *op. cit.*). There are, to our knowledge, no published records of helminths from these species. The purpose of this note is to establish the initial helminth lists for *E. carinata* and *E. macularia*.

One male *E. carinata* (SVL = 110 mm, Christopher C. Austin = CCA 2364, collected August 2002 at Buttala, Monaragala District, Central Province, Sri Lanka [6.6813°N, 81.2705°E, datum: WGS84], elev. 125 m) and one female *E. macularia* (SVL = 68 mm, CCA 1771, collected November 2002 at Batamdomba Cave, Rathapura District, Central Province, Sri Lanka [6.7797°N, 80.3969°E, WGS84], elev. 114 m) were examined for helminths. Lizards were sacrificed within 12 h of capture, preserved in 10% formalin and stored in 70% ethanol. The digestive tract was later removed, opened, and searched for helminths under a dissecting microscope. The three female nematodes found in their stomachs (1 in *E. carinata* and 2 in *E. macularia*), were removed, cleared in a drop of glycerol on a glass slide, cover-slipped, studied under a compound microscope and identified as *Physalopteroides dactylurus*. Nematodes were deposited in the United States National Parasite Collection, Bethesda, Maryland, USA as: *E. carinata* (USNPC 101175) and *E. macularia* (USNPC 101176). Lizards were deposited in the herpetology collection of the National Museum of Sri Lanka, Colombo, Sri Lanka.

Physalopteroides dactylurus is a member of the Physalopertidae, which utilizes insects as intermediate hosts (Anderson 2000. Nematode Parasites of Vertebrates. Their Development and Transmission. CABI Publishing, Oxford, UK. 650 pp.). *Eutropis* likely become infected through diet. *Eutropis carinata* and *E. macularia* are new host records for *P. dactylurus*, which is also known from *Calotes versicolor, Hemidactylus flaviviridis*, both collected in India, and *Eumeces taeniolatus* (currently *Eurylepis taeniolatus*) collected in Turkmenistan (Baker 1987. Synopsis of the Nematoda Parasitic in Amphibians and Reptiles. Memorial University of Newfoundland Occas. Pap. Biol., St. John's Newfoundland, Canada. 325 pp.)

We thank the Department of Wildlife Conservation, Sri Lanka, for scientific collecting permit (number WL/3/2/1/14/12). This research was funded in part by the People's Trust for Endangered Species and National Science Foundation grant DEB 0445213 to CCA. Sarah Goldsberry assisted with dissections.

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HELODERMA SUSPECTUM (Gila Monster). **DIET AND PREDATORY BEHAVIOR.** *Heloderma suspectum* is a strict carnivore and nest-raiding specialist that shows geographic variation in its diet. Typical prey selection includes eggs of ground-nesting birds and lizards, as well as small mammals, commonly the neonates of rodents (reviewed by Beck 2005. Biology of Gila Monsters and Beaded Lizards. University of California Press, Berkeley and Los Angeles. 247 pp.; Geiger and Tracy 2008. Herpetol. Rev. 39:225–226.).

Here, we provide additional information on the diet and predatory behavior of adult *H. suspectum* from a population in the Sonoran Desert of south-central Arizona, USA. The individuals we discuss herein were subjects of a radio-telemetric study in which various features of their behavior, physiology, and spatial ecology have been investigated since March 2001 (e.g., Kwiatkowski et al. 2008. J. Zool. doi:10.1111/j.1469-7998.2008.00495.x).

The present study site, located in Pinal County, is 40 km SSE of the city of Florence, 8 km W of State Route 79, and encompasses an area of ≈ 3 km^2 at the extreme western edge of the Suizo Mountains (Iron Mine Hill). The region is ecologically designated as Arizona Upland Desertscrub subdivision (Brown 1994. Biotic Communities of the American Southwest—United States and Mexico. University of Utah Press, Salt Lake City. 342 pp.). Annual precipitation (chiefly rain) patterns are bimodal, with slight to moderate storms occurring during winter and early spring (December to March), and the strongest activity occurs from mid- to late summer (early July to mid-September), which is termed the North American monsoon (Brown 1994, *op. cit.*; Phillips and Comus 2000. A Natural History of the Sonoran Desert. The University of California Press, Berkeley and Los Angeles. 628 pp.). The area lacks permanent freestanding water, a common feature of the Sonoran Desert; at the present site, collection of rainwater in surface rocks and soil, as a rule, is transitory, and persists for only minutes to several hours. However, artificial alterations of the habitat (e.g., deep tire tracks in narrow dirt roads) occasionally provide a substantive reservoir for the collection and storage of rainwater, but even under these situations it is ephemeral, especially in summer.

On 27 April 2003, at 0923 h, in an area interfacing bajada (Phillips and Comus 2000, *op. cit.*) and desert flats, a female *H. suspectum* (HS-2: SVL = 320 mm; TL = 135 mm; body mass = 573 g) was radio-tracked and located. This individual was originally collected on 1 April 2001, and had been studied regularly since that time. She was found (Site 55, 813 m elev.) beside an active nest of Gambel's Quail; 8 clustered, normal-sized eggs were present (Fig. 1A). The nest was a shallow soil depression, located centrally in a network of Engelmann's Prickly Pear, *Opuntia engelmannii* (200 L × 100 W × 80 H cm). Nearby (3 m diam.

from nest) vegetation was sparse and limited to Triangle Bursage and Pincushion. Her core body temperature (obtained via an implanted 11.0 g temperature-sensitive radio-transmitter; Holohil Systems Ltd., Ontario, Canada) was 30.5ºC. Ambient temperature (1 m above the ground in shade) was 29.5ºC. Cloud cover was ≈ 10%, relative humidity was ≈ 15%, and wind speed was slight (0–5 kph) and intermittent.

The eight clustered eggs were inspected by HS-2 via nose-rubbing and tongue-flicking. From 0923 h to 0937 h, seven eggs were consumed at a seemingly rapid rate (0.5 eggs/min), and from 0937 h to 0947 h, the last egg was consumed. From the time the first egg was secured in her jaws, the eight eggs were consumed in 24 minutes. None of the eggs were broken prior to swallowing; each egg was slowly and gently secured in her jaws (Fig. 1A) without the aid of forelimbs. During ingestion, when the eggs were no longer visible in her mouth, cracking sounds were audible from a distance up to 3 m. When ingestion of the eggs was completed, she moved away from this site and was not re-located for 7 days. The previous day (26 April 2003), at 1800 h, HS-2 was located at Site 2 (elev. 826 m), a large triangular rock slab, which was located in the western-most area of the Suizo Mountain complex (Iron Mine Hill); she demonstrated fidelity to Site 2 on multiple occasions since using it first on 13 April 2001. The minimum distance traveled between the two sites (2 and 55) was 215 m and accomplished in < 15 h.

On 11 May 2004, at 1831 h, in bajada, a male *H. suspectum* (HS-7: SVL = 334 mm; TL = 151 mm; body mass = 673 g) was radio-tracked and located (Site 19, elev. 821 m). This individual

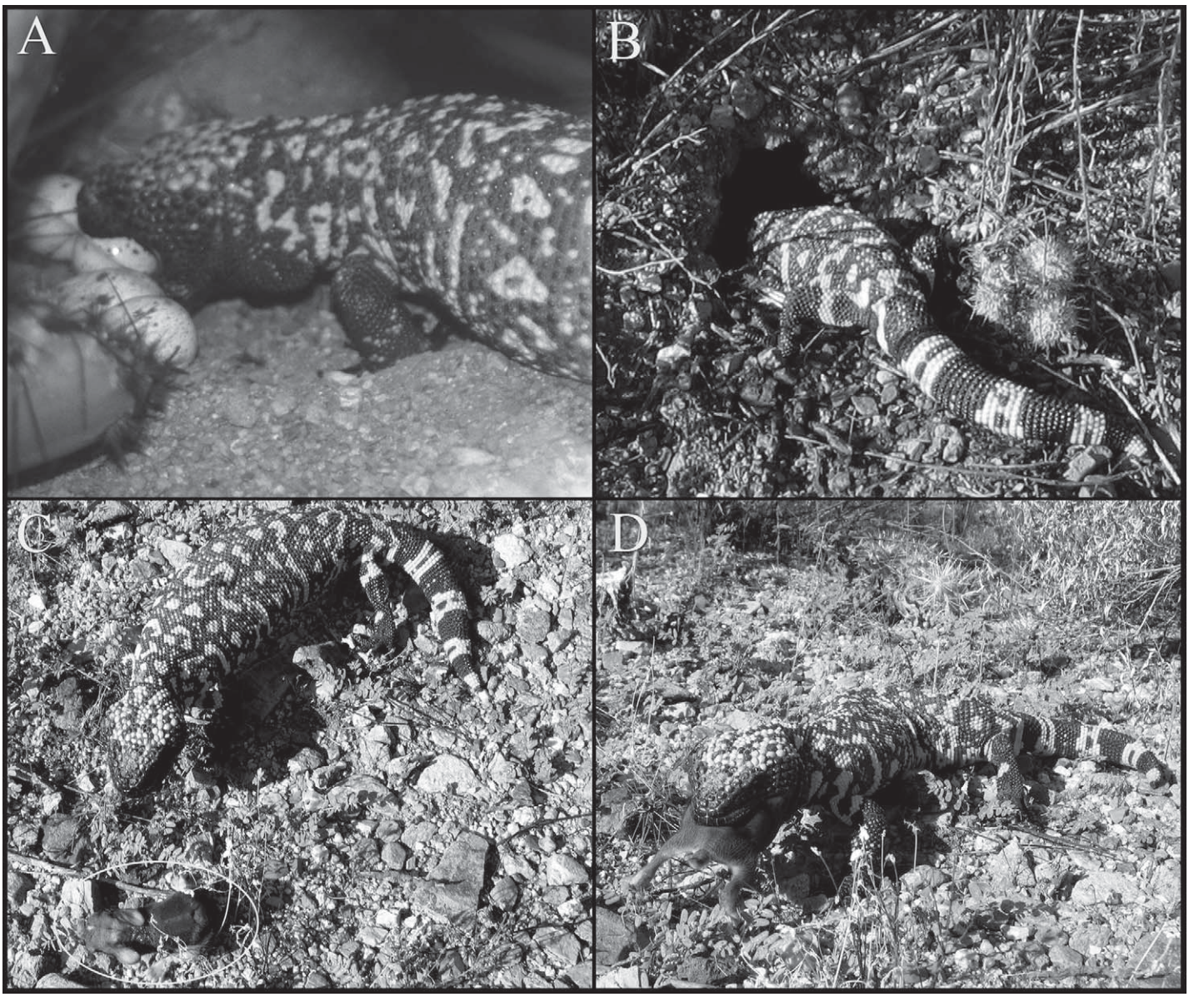


FIG. 1. Predation by adult wild-living Gila Monsters, *Heloderma suspectum*. A) An adult female (HS-2) at the nest of a Gambel's Quail in the process of securing an egg to ingest. Eight eggs were observed at the nest and all were ingested. B–D) An adult female (HS-13) in various stages of consuming neonates of Desert Cottontails (*Sylvilagus audubonii*). B) Female HS-13 was first located entering a burrow. C) Female HS-13 is next to the first neonatal rabbit (within the yellow ellipse). Note the extensive torn skin in the area of the neck. D) The neonate in Fig. 1C is being consumed head-first. All photographs by R. A. Repp.

was originally collected on 23 February 2003, and had been studied regularly since that time. He was found 30 cm W of an active Gambel's Quail nest; 6 clustered, normal-sized eggs were present. He appeared to be moving away from the nest at our approach, likely as a result of our sudden presence. The nest was located on the west side of a stand of Engelmann's Prickly Pear, which was circular-shaped (110 H cm × 200 cm in diam.). Nearby (3 m diam. from the nest) vegetation was Triangle Bursage, Buckhorn Cholla (*Opuntia acanthocarpa*), and Pincushion. His core body temperature (obtained via a 11.0 g temperature-sensitive radio-transmitter; Holohil Systems Ltd) was 31.3ºC. Ambient temperature was 30ºC, and ground temperature in the sun ("hot spot") was 34.0ºC. Cloud cover was 0%, relative humidity was ≈ 10%, and wind speed was slight to moderate (5–20 kph) and intermittent. Because our presence seemed to distress HS-7, we promptly left this site.

At 1947 h, we radio-tracked HS-7 a second time; he was re-located at a previously used location (Site 18, elev. 826 m) on the western edge of Iron Mine Hill, which was 37 m NW of Site 19. His core body temperature was 28.8ºC. Ambient temperature was 25ºC. Wind speed was slight (0-5 kph) and intermittent. At 1956 h, we returned to Site 19 and inspection revealed that all 6 eggs were gone; we thus presumed they had been consumed by HS-7. Similar to our observations of HS-2, we found no signs that the eggs had been broken during feeding (e.g., no yolk or shell fragments).

On 9 August 2008, at 0820 h, in bajada, a female *H. suspectum* (HS-13: SVL = 310 mm; TL = 146 mm; body mass = 466 g) was radio-tracked and located (Site 9, elev. 825 m). This individual was originally collected on 24 May 2008, and had been studied regularly since that time. She was found with her head and midbody in a north-facing burrow (Fig. 1B) that was 75 mm diameter. The burrow was situated between two clumps of Triangle Bursage (each ≈ 400 m height). Nearby plants included Pincushion. Her core body temperature (obtained via an implanted 11.0 g temperature-sensitive radio-transmitter; Holohil Systems Ltd) was 35.5ºC. Ambient temperature was 29.5ºC and the hot spot was 41.0ºC. Cloud cover was ≈ 10 %, relative humidity was ≈ 30%, and wind speed was slight (0–5 kph) and intermittent.

Muffled vocalizations (repetitious cat-like mews, 1 sec apart, presumed from a single individual) were heard emanating from the burrow; these calls were distinctive and could be heard several meters from the site. At 0821 h, her tail was grabbed, and she was quickly removed from the burrow and placed on the ground ≈ 1 m from the burrow. During this transfer, a neonatal Desert Cottontail (*Sylvilagus audubonii*), estimated to be 40–50 g, was gripped in her jaws but was dropped as she was placed on the ground. For about 1 min, the neonate was writhing and rapidly vocalizing while HS-13 re-located and inspected it; the neonate had severe lacerations with oozing fluids (Fig. 1C). At 0822 h, HS-13 began ingesting the neonate headfirst (Fig. 1D), which was completed in 3 min. At 0825 h, HS-13 returned to and stayed at the nest; she entered to midbody. Muffled vocalizations from a single neonate were heard; at 0830 h, the vocalizations stopped. Apparently, the neonate producing the vocalizations had been consumed. At 0831 h, with no further signs of predatory activity, HS-13 was gently removed from the burrow a second time, and it was noted that she had rabbit fur clinging to her jaws. The nest was gently and non-invasively inspected at 0832 h. It was shallow (120 mm), the cavity was larger than the entrance, and the substrate was lined with fur (presumably of the mother) and grasses (Bowers et al. 2004. Mammals of North America. Houghton Mifflin Co., New York. 352 pp.). During this assessment, no further neonates were detected. HS-13 re-entered the nest at 0833 h, inspected it for several minutes, then exited at 0837 h, traveling N of the burrow; she was not re-located until a later date (16 August 2008).

We cannot determine whether HS-13 bit and envenomated the first neonate prior to our grabbing and removing her from the burrow/nest (see Beck 2005, *op. cit.*). Clearly, she was startled by this procedure, and there is little doubt that the neonate was damaged (and possibly envenomated) by this intrusion. Nonetheless, based on the presence of vocalizations prior to our disturbances, it is possible that biting and envenomation occurred prior to our arrival. Similarly, the second neonate we heard vocalizing from the burrow/nest might have been bitten and envenomated. Furthermore, although we show that HS-13 consumed at least two neonates, it is possible that there were others eaten because litter size in *S. audubonii* is typically greater than two (Beck 2005, *op. cit.*).

Support for our field studies at the Suizo Mountains are from Arizona State University, Zoo Atlanta, Georgia State University, and David L. Hardy, Sr. Since 2001, many individuals provided assistance in radio-tracking, but most noteworthy are Hans-Werner Herrmann and Ryan Sawby. Also, Ryan Sawby provided invaluable assistance with photography and identification of plants and invertebrates. This study was approved by the animal care committee (IACUC) of Arizona State University (98-429R), and appropriate scientific permits were obtained from the Arizona Game and Fish Department.

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HEMIDACTYLUS FRENATUS (Common House Gecko). **BROOD**. On 9 February 2008, two gravid female *Hemidactylus frenatus* (SVL = 49.19 mm, tail length = 40.62 mm, mass = 2.365 g; SVL = 44.06 mm, tail length = 52.12 mm, mass = 2.360 g) were obtained from Poza Larga, Municipio Espinal Veracruz, Mexico (20.1608333°N, 97.5094444°W), and brought to the laboratory. Specimens were maintained in separate plastic boxes measuring 32 × 21 × 15 cm with newspaper as substrate, fresh water, and an ambient temperature of 28.5ºC.

On the morning of 10 February 2009, each female produced a clutch of two eggs, which were placed in an incubator at 28–30ºC with 50–70% humidity in plastic boxes with agrolite substrate. The first hatchling emerged on 17 March (37 days post oviposition [dpo]) and measured 19.6 mm SVL, 18.8 mm tail length, 0.19 g. The second hatchling emerged on 19 March (39 dpo) and measured 13.1 mm SVL, 14.1 mm tail length, 0.16 g. The third hatchling emerged on 25 March (45 dpo), and measured 16.1 mm SVL, 20.9 mm tail length, 0.21 g. The fourth hatchling emerged on 2

April (53 dpo), and measured 18.7 mm SVL, 19.6 mm tail length, 0.21g. Mean incubation period lasted 43.5 days, shorter than those presented in Krysko et al. (2003. Amphibia-Reptilia 24:390–396), who reported incubation times of 48–55 days at 28–29ºC.

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IGUANA IGUANA (Green Iguana). **AGGRESSIVE BEHAVIOR**. Male green iguanas are reported to defend small territories in which variable numbers of females and sub-adults males reside (Muller 1972. Zool. Beitr. 18:109–131). Dominant males use varied displays to defend their territory. These displays involve vertical head and body movements (head bob) as well as tail slapping, often accompanied by dewlap extensions (Dugan 1982. Anim. Behav. 30:327–338). Reports in literature on display behavior of *I. iguana* are common, but descriptions of males engaging in contact fights are rare. We report here on aggressive behavior in which two males were observed fighting violently and biting each other.

At 1300 h on 28 May 2008, we observed two male *I. iguana* of approximately the same size (120 cm from snout to tip of tail) fighting on a ranch near the Abobral River in the Pantanal of Mato Grosso do Sul, Brazil (56.9177111°W, 19.4762333°S, datum: WGS84, elev. 60 m). Both males were on the ground in an open grassland ca. 10 m away from trees bordering a marsh. The males were seen lunging, biting each other and thrashing on the ground (Figs. 1A–B). They interlocked for less than five minutes, until finally one male escaped. The remaining male displayed, using vertical head movements while extending the dewlap for ca. 5 min before retreating to the forested area near the marsh (Fig. 1C). Both males sustained superficial wounds on their flanks and one male's front right leg was injured.

Iguana iguana has an annual reproductive cycle and maximum testicular development in the Pantanal occurs between June and September with a peak in June (Ferreira et al. 2002. Brazil. J. Morphol. Sci. 19:23–28). Oviposition occurs between September and December (Campos 2004. Herpetol. Rev. 35:169). Hence, this behavior may be related territorial defense for access reproductive females.

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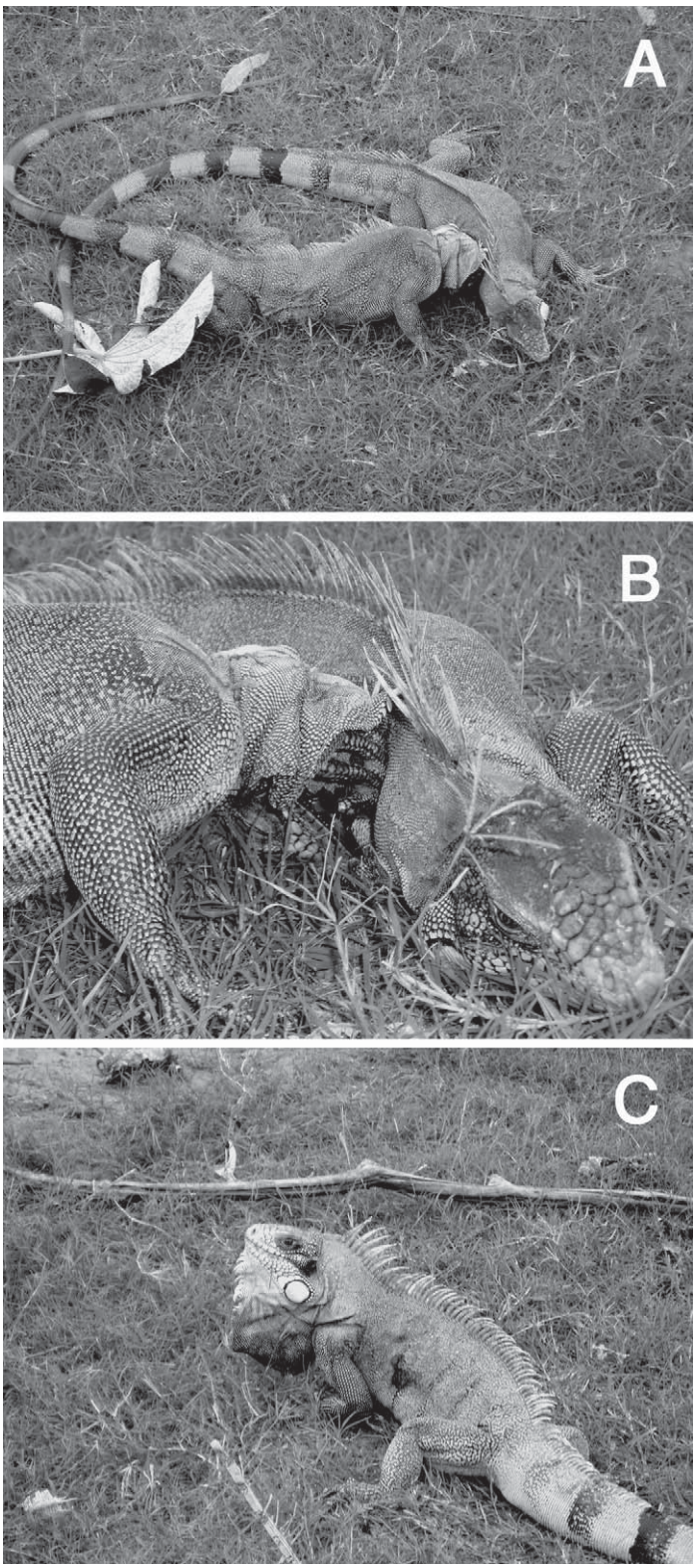


FIG. 1. A–B. Male *Iguana iguana* engaging in interlocking biting behaviors in the Brazilian Pantanal, May 2008. C) Victorious male iguana displaying after the fight. Note the superficial wound on the animal's flank.

LYGOSOMA PUNCTATA (Spotted Supple Skink). **ENDOPARASITES.** *Lygosoma punctata* is a diurnal, fossorial skink that is widepread in Sri Lanka, India, Bangladesh, and Pakistan (Das and de Silva 2005. A Photographic Guide to Snakes and Other Reptiles of Sri Lanka. Ralph Curtis Publ., Sanibel Island, Forida. 144 pp.). To our knowledge, the only helminth recorded from *L. punctata* is the nematode, *Thelandros* sp. (Lakshimi et al. 1985. Ind. J. Helminthol. 2:115–125). The purpose of this note is to add the nematode *Parapharyngodon adamsoni* to the helminth list of *L. punctata*.

Two female *L. punctata* (SVL = 60 mm, Christopher C. Austin = CCA 2367 collected at Tampataya, Ampara District, Eastern Province [7.5996°N, 81.4272°E, WGS 84], elev, 20 m; and SVL = 49 mm, CCA = 2400 collected 2 km N central Puttalam, Puttalam District, North Western Province, Sri Lanka [8.0742°N, 79.7956°E, WGS 84], elev. 0 m) were examined for helminths. Lizards were sacrificed within 12 h of capture, preserved in 10% formalin, and stored in 70% ethanol. The digestive tract was removed, opened, and searched for helminths. The five nematodes found (CCA 2367 1 m, 2 f; CCA 2400 2 f) in their stomachs were removed, cleared in a drop of glycerol on a glass slide, cover-slipped, studied under a compound microscope, and identified as *Parapharyngodon adamsoni*. Nematodes were deposited in the United States National Parasite Collection, Bethesda, Maryland as (USNPC 101177). Lizards were deposited in the herpetology collection of the National Museum of Sri Lanka, Colombo, Sri Lanka.

Parapharyngodon adamsoni was described from *Chalcidoceps thwaitesi*, *Nessia smithi* (currently *Nessia bipes*), and *N. burtoni* by Crusz and Daundasekera (1988. Ann. Parasitol. Hum. Comp. 63:439–447.). *Parapharyngodon adamsoni* is in the family Oxyuridae which has a direct life cycle with no intermediate host (Anderson 2000. Nematode Parasites of Vertebrates. Their Development and Transmission. CABI Publishing, Oxford, UK. 650 pp.). Infection likely occurs through ingestion of eggs. *Lygosoma punctata* represents a new host record for *P. adamsoni*.

We thank the Department of Wildlife Conservation, Sri Lanka for permission (number WL/3/2/14/12). This research was funded in part by the People's Trust for Endangered Species and National Science Foundation grant DEB 0445213 to CCA. Sarah Goldsberry assisted with dissections.

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MESOSCINCUS MANAGUAE (Managua Skink). **ENDOPARASITES.** *Mesoscincus managuae* is known from southern Honduras to Costa Rica (Köhler 1999. The Amphibians and Reptiles of Nicaragua. A Distributional Checklist with Keys. Cour. Forsch.-Inst. Senckenburg, Frankfurt a. M. 213:1–121). To our knowledge, there are no reports of helminths from *M. managuae*. The purpose of this note is to establish an initial helminth list for *M. managuae*.

One female *M. managuae* from the herpetology collection of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California collected in December 1964 in Nicaragua, Granada Department, near Isletas (11.7500°N, 85.3333°W, WGS84; elev. 10 m) was examined for endoparasites (LACM 37975; SVL = 85 mm). The body cavity was opened and the digestive tract examined under a dissecting microscope. Found in the large intestine were one fourth stage female and one male nematode which were cleared in a drop of glycerol on a glass slide, cover-slipped, and identified using a compound microscope as *Parapharyngodon alvarengai*. Nematodes were deposited in the United States National Parasite Collection, Beltsville, Maryland as *Parapharyngodon alvarengai* (USNPC 101743).

Parapharyngodon alvarengai was originally described from *Mabuya maculata* from Brazil (Freitas 1957. Mem. Institut. Oswaldo Cruz 55:21–45) and later reported in *Ameiva ameiva* (Vicente et al. 1993. Rev. Brasil. Zool. 10:19–168) and *Rhinella icterica* (Luque et al. 2005. Acta Parasitol. 50:215–220), both hosts from Brazil. It was also reported from the lizards *Anolis nebulosus*, *Phyllodactylus lanei*, and *Sceloporus nelsoni* collected in Mexico (Moravec et al. 1997. J. Helminthol. Soc. Washington 64:240–247; Mayén-Peña and Salgado Maldonado 1998. J. Helminthol. Soc. Washington 65:108–111). *Parapharyngdon alvarengai* is a member of the Oxyuridae, which do not utilize intermediate hosts (Anderson 2000. Nematode Parasites of Vertebrates: Their Development and Transmission, 2nd ed. CABI Publishing, Oxfordshire, UK. 650 pp.). Infection of *M. managuae* presumably occurred via exposure to *P. alvarengai* eggs in fecally contaminated substrate. *Mesoscincus managuae* represents a new host record for *P. alvarengai*. Nicaragua is a new locality record.

We thank Christine Thacker (LACM) for permission to examine *M. managuae* and Cecilia Nava (Whittier College) for assistance with dissections.

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PHRYNOSOMA ASIO (Giant Horned Lizard). **DIET**. *Phrynosoma asio* is the largest member of the genus, occurring along the Pacific Coastal forests of Colima, Mexico south to northern Guatemala (Baur and Montanucci 1998. Krötenechsen. Herpeton, Offenbach. 158 pp.; Sherbrooke 2003. Introduction to Horned Lizards. Univ. California Press, Berkeley. 178 pp.). Little is known of the natural history of *P. asio*, but previous reports on the diet of this species show that it is more of a generalist and less myrmecophagous than congeners (Lemos-Espinal et al. 2004.

Herpetol. Rev. 35:131–134; Montanucci 1989. Herpetologica 45:208–216; Pianka and Parker 1975. Copeia 1975:141–162).

On 3 August 2008, Ian M. Recchio, Chris M. Rodriguez, Brett Baldwin, and Carlos Martinez collected 4 male and 2 female sub-adult (mean SVL = 50.0 mm) *P. asio* in tropical deciduous forest in Municipio de Ixtlahuacan, Colima, Mexico (19.03°N, 103.779°W). All six individuals were observed in late afternoon between 1400 and 1700 h, associated with secondary growth clearings adjacent to primary tropical deciduous forest, resting near or underneath bunchgrass. Fecal samples were obtained while the lizards were held prior to export. While being transported for export, the feces from the lizards were preserved for content analysis. Fecal samples were preserved in 75% isopropyl alcohol and examined for contents. The grouped fecal samples contained the remains of the following insect taxa: 56 *Aphaenogaster ensifera* (Formicidae, Myrmicinae), 23 larvae of an undetermined species of tortoise beetle (Chrysomelidae, Cassidinae), over 400 termites (Isoptera), three toad bugs (Gelastocoridae, *Nerthra fuscipes*), a single dung beetle (Scarabaeidae, Scarabaeinae, *Canthon* sp.), and several pieces of unidentifiable insect material. Our sample shows *P. asio* feeds on a variety of terrestrial insects including, but not limited to, ants and termites. This is consistent with previous studies.

All research and collecting were done under the authority of SEMARNAT scientific research permit SGPA/DGVS/03804 issued to IR.

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PHRYNOSOMA CORNUTUM (Texas Horned Lizard). **REPRODUCTION.** We observed copulation between *Phrynosoma cornutum* on multiple occasions. On 3 May 2008 at 1250 h in Oklahoma Co., Oklahoma, USA, while conducting radiotelemetry observations on a male (61.0 mm SVL) *P. cornutum*, one of us (MTC) observed copulation with a radio-transmittered female (62.9 mm SVL) (Fig. 1). Both individuals were fitted with Holohil model BD-2 transmitters (0.9 g, male; 1.5 g, female), with transmitters attached to the dorsal surface using silicone sealant and secured around the neck by an elastic collar. The same male was observed copulating with another female (70.0 mm SVL) on 16 May 2008 at 0715 h and with a third female (69.5 mm SVL) on 20 May 2008. The latter two females were not fitted with transmitters.

These observations are significant in that they confirm that our technique of transmitter attachment does not prevent coitus in our study animals, and also provides direct evidence for the polygynous mating strategy of male *P. cornutum*.

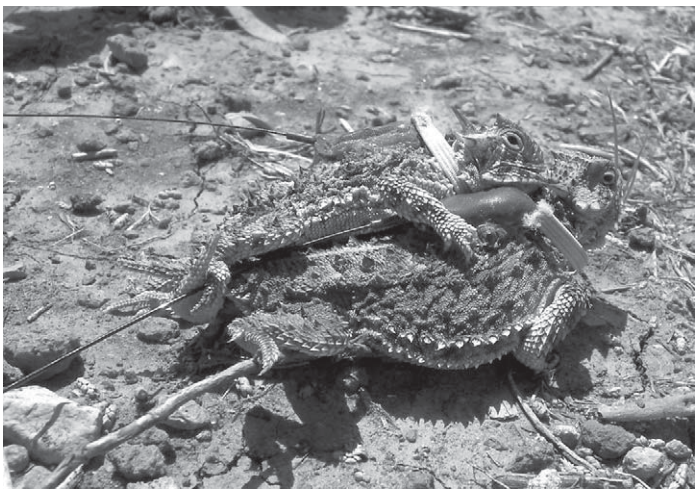


FIG. 1. Copulating pair of radio-transmittered *Phrynosoma cornutum*. Photograph by Megan T. Cook.

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PODARCIS BOCAGEI (Bocage's Wall Lizard). **SPINAL FRACTURE**. Pathologic spinal fractures can occur in reptiles as the result of metabolic bone disease (Bennett and Mehler 2006. *In* Mader [ed.], Reptile Medicine and Surgery, 2nd ed., pp. 244–245. Saunders Elsevier, St. Louis, Missouri), but in some cases they have also been reported to result from spinal osteopathies (Bennett and Mehler, *op. cit.*; Fitzgerald and Vera 2006. *In* Mader [ed.], *op. cit.*, pp. 909–910 and periosteal newbone formation due to undetermined causes (Fitzgerald and Vera, *op. cit.*). Reptiles with spinal cord fractures may present paralysis (Mader 2006. *In* Mader [ed.], *op. cit.*, p. 847) and reptiles with spinal cord injury generally have a loss of panniculus response caudally to the site of injury and a loss of tail or vent stimulation reflex (Bennett and Mehler, *op. cit.*). In some cases, hypertonia occurs cranial to the site of the injury (Bennett and Mehler, *op. cit.*). A reptile with paralysis and spinal fracture can loose its ability to urinate and defecate (Mader, *op. cit.*). Here, we report on a case of spinal fracture in a wild lacertid lizard from Portugal.

During the radiographical examination of specimens of *Podarcis* undergoing experiments on locomotor performance, we detected an adult female *P. bocagei* (55.9 mm SVL) with a conspicuous spinal fracture. The lesion affected the thoracic vertebrae, next to the front limbs (Fig. 1) and we observed evidence of reossification of the vertebrae cranially and caudally the fracture.

This female had been collected 26 days earlier in São Mamede do Coronado, near Trofa, northwestern Portugal (41.2853°N, 8.5745°W; datum: WGS 1984 ; elev. 50 m), in a habitat consisting of agricultural fields separated by granite formations where lizards found refuge and attained high densities. The female displayed no obvious locomotor deficiencies before or after the radiographies. In fact, before being submitted to the x-ray revealing the malformation, this individual had participated in several

experiments consisting of different locomotion trials. Nonetheless, during preliminary analysis of the data (video footage), a slight difference in this individual's running pattern was noted, consisting of a "wriggling" or undulating movement different from all other specimens (N = 26) included in the study. Currently, detailed quantification of the locomotion parameters is being carried out, which may provide more information on the exact impact of the injury on the locomotor capacities of the lizard. While the lizard was kept in the laboratory (for total period of 27 days), we detected no differences in drinking, feeding, defecating, or urinating habits between this individual and remaining lizards. Radiographs of the 26 other specimens (14 males, 12 females) from the same population revealed no fractures or anomalies of any kind. X-rays from a previous study that included 162 *P. bocagei* and 168 *P. carbonelli* (Kaliontzopoulou et al. 2008. Amphibia-Reptilia 29:288–292) also revealed no individuals with fractures or malformations.

Though other kinds of vertebral malformations have frequently been observed in lizards, mostly are related to the metabolic bone disease suffered by many captive bred reptiles and usually result in either scoliosis/lordosis or bone demineralization (Grogan 1976. J. Herpetol. 10:262–263; Ahboucha and Gamrani 2001. Metabolic Brain Dis. 16:219–226; Mitchell and Georgel 2005. Herpetol. Rev. 36:183–184). The fracture we observed could be a case of spinal osteopathy or trauma, but we can not assess these hypotheses through radiography (all the individuals used were released to their place of capture after the experiment was completed). However, independent of its exact cause, this represents an exceptional case of recovery from a fracture that typically would have become lethal, either directly by causing a fracture in the spinal cord or indirectly by causing paralysis and consequently making the lizard unable to carry on its normal activities. The low frequency with which such a fracture was observed (only one out of more than 300 individuals of two closely related species of the genus) might indicate that such fractures typically are lethal and rarely seen in free-ranging animals.

Special thanks to H. Fernandes from Park & Zoo Santo Inácio who provided X-rays, and W. Grogan for providing references related to vertebral anomalies in reptiles.

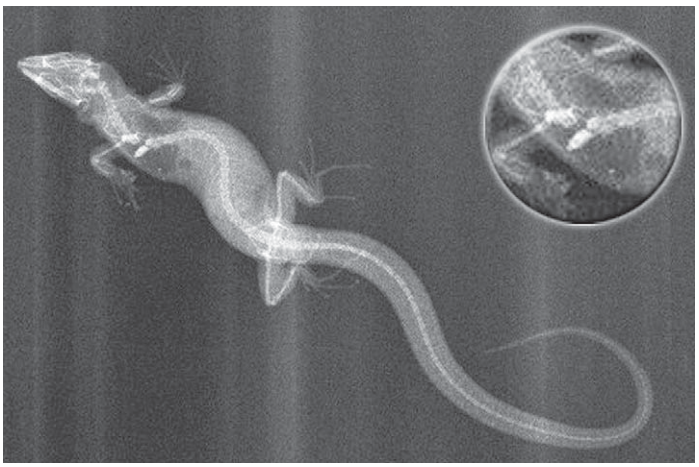


FIG. 1. X-ray of an injured female *Podarcis bocagei*. Detail of the fractured vertebral area can be seen in the round inset at upper right. The 36 Kv X-ray was taken with an exposure of 3mA/sec for 0.03 sec.

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PRISTIDACTYLUS SCAPULATUS (NCN). **SAUROPHAGY**. *Pristidactylus* are generally considered to be insectivorous (Cei1993. Reptiles del Noroeste, Nordeste y Este de la Argentina. Mus. Reg. Sci. Nat. Torino Monogr. 14:1–949), but specific diet data are lacking for most species. Hence, here we report an observation of saurophagy in *P. scapulatus*.

At 1213 h on 13 December 2007, we observed an adult male *P. scapulatus* (100 mm SVL; 26 mm mouth width) attack and start to eat an adult (51 mm SVL) male *Liolaemus ruibali* at the Reserva Uso Multiple Don Carmelo, Sierra de la Invernada, Departamento Ullum, San Juan, Argentina (30.5862°S, 69.0964°W; datum: WGS84; elev. 3100 m). The habitat where the observation was dominated for shrubs of *Adesmia subterranea*, *Adesmia horrida* and *Licyum chañar*, this is vegetation typical to the Puna (M. Almirón, pers. comm.). When captured, the *P. scapulatus* released the *L. ruibali*, which was unable to move and died soon thereafter. To our knowledge, this is the first record of attempted saurophagy for any species of *Pristidactlyus*.

We thank M. Jordán for permission to conduct research at the Reserva Don Carmelo (permit Nº 1204-2235-070), R. Espinoza and F. Lobo for assistance in the field, and M. Almirón for identification of the vegetation.

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SCELOPORUS MAGISTER (Desert Spiny Lizard). **PREY.** Members of the *Sceloporus magister* species group (Schulte et al. 2006. Mol. Phylogen. Evol. 39:873–880) are often reported to be generalized feeders (Parker and Pianka 1973. Herpetologica 29:143–152; Vitt and Ohmart 1974. Herpetologica 30:410–417). However, studies show that invertebrates are far more representative in the diet than vertebrates. Documented prey items include insects (especially Hymenoptera [mostly ants], Coleoptera, Hemiptera, and various larvae), spiders, and other invertebrates (Hotton 1955. Am. Midl. Nat. 53:88–114; Johnson 1966. Am. Midl. Nat. 76:504–509; Parker and Pianka 1973, *op. cit.*; Tanner and Krogh 1973. Great Basin Nat. 33:133–146; Vitt and Ohmart 1974, *op. cit.*). Vegetation is also reported in the diet in these studies, but it

is not clear how much plant material is secondarily ingested along with invertebrate prey.

Vertebrate prey, especially lizards, is widely reported in general literature, but is based on relatively few records in the primary literature (Cardwell 1994. Herpetol. Rev. 25:121–122). Parker and Pianka (1973, *op. cit.*) reported a single unidentified vertebrate in their sample of the stomach contents of 123 specimens in the *S. magister* complex (*S. magister* + *S. bimaculosus* + *S. uniformis*, *fide* Schulte et al. 2006, *op. cit.*) and Vitt and Ohmart (1974, *op. cit.*) reported a single *Aspidoscelis tigris* from the sample of stomach contents of 66 specimens (*S. magister* + *S. uniformis*, *fide* Schulte et al. 2006, *op. cit.*). Perkins et al. (1997. Herpetol. Rev. 28:89) reported *Xantusia vigilis* in the diet of these lizards in the Mojave Desert (hence, *S. uniformis*, *fide* Schulte et al. 2006, *op. cit.*). Intraspecific predation upon neonates has also been reported (Tanner and Krogh 1973, *op. cit.*; Cardwell 1994, *op. cit.*). Jones and Schwalbe (2009. *In* Jones and Lovich [eds.], Lizards of the American Southwest: A Photographic Field Guide, pp. 226–229. Rio Nuevo Publishers, Tucson, Arizona) report "nestlings" in the diet of *S. magister*, but the details are not reported. However, we are aware that the source of this report comes from a reliable personal observation by R. Smith, Tucson, Arizona, of an adult *S. m. magister* feeding on a nestling Gambel's Quail (*Callipepla gambelii*) in a Tucson suburb.

To our knowledge, there are no records of *S. magister* (or any species of the complex) attempting to feed on mammalian prey. At 0900 h on 13 October 2008, one of us (WBG) heard squeals that were coming from the direction of an outside wall of a house in Tucson, Pima Co., Arizona. An adult *S. m. magister* had the left wing of a Western Pipistrelle Bat (*Pipistrellus hesperus*) in its mouth. The lizard and the bat were under a wooden false shutter next to a window on a south-facing wall (Fig. 1). The bat struggled for ca. 15 min before freeing itself and dropping to the ground. The bat remained on the ground for at least 15 more minutes, the duration of the observation. The lizard stayed in place and did not attempt to interact with the bat again during that time. The next morning the bat was gone, but the lizard was not. It seems likely this event was an attempt at predation, but other behavioral traits (e.g., territorial aggression) cannot be completely ruled out.

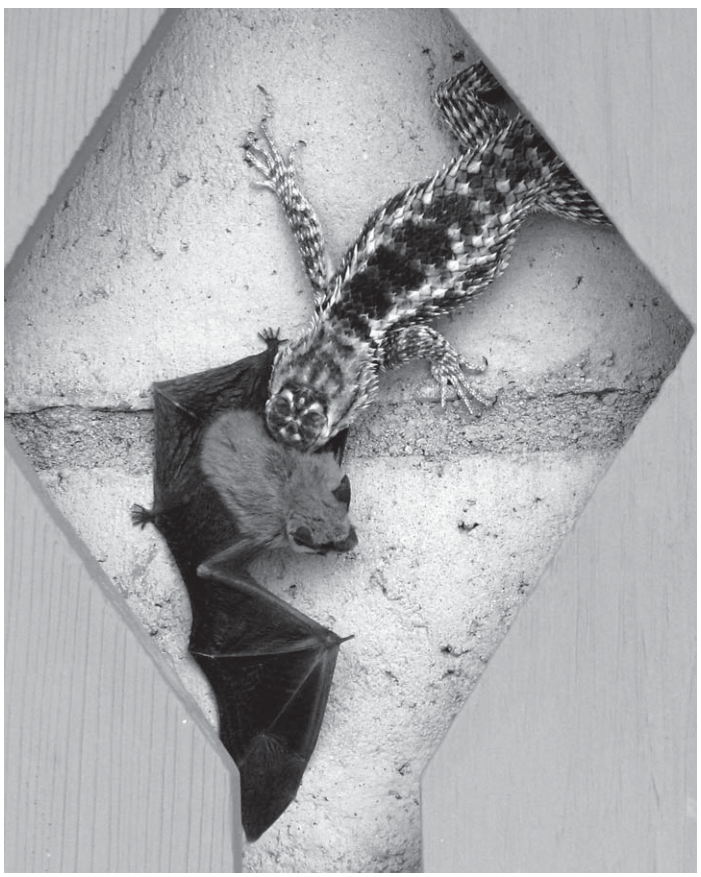


FIG. 1. Adult *Sceloporus m. magister* apparently attempting to prey on a bat, *Pipistrellus hesperus*. Photograph by W. B. Gillespie.

The identity of the lizard was verified by Cecil Schwalbe (U.S. Geological Survey, Tucson, Arizona) and the bat's identity was verified by Tim Snow and Angie McIntire (Arizona Game and Fish Department) and Ronnie Sidner (University of Arizona).

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TROPIDURUS HISPIDUS (NCN). **MINIMUM SIZE AT MATURITY; MAXIMUM BODY SIZE**. *Tropidurus hispidus* has a broad distribution from central-eastern and northeastern Brazil to Venezuela (Rodrigues 1987. Arq. Zool. 31:105–230). The minimum size at sexual maturity is ≥ 70 and ≥ 71 mm, for females and males, respectively based on a series from northeastern Brazil (Vitt 1995. Occ. Pap. Oklahoma Mus. Nat. Hist. 1:1–29). Vitt (1995, *op. cit.*) also reported the maximum body size for adult female and male *T. hispidus*, respectively, as 107 and 129 mm. Herein, we report a new record for minimum size at maturity and for maximum body size for both sexes of this species in a caatinga at the Estação Ecológica do Seridó (ESEC Seridó), Serra Negra do Norte municipality, Estado do Rio Grande do Norte, Brazil.

To study the reproductive ecology of *Tropidurus* in rocky habitats at ESEC Seridó (06.57672°S, 37.25575°W, datum: WGS84; elev. 192 m), we collected a large series of *T. hispidus* (nine juveniles, 75 adults). Of the 75 adult lizards (25 males, 50 females), three females (collected on 6 February 2007 and 23–24 January 2008, respectively) with SVLs of 67.8, 65.5, and 65.0 mm had vitellogenic follicles. Also, one male (SVL = 68 mm) collected on 7 February 2007 had testes and epididymides containing mature spermatozoa in the lumen, and showed secondary sexual characteristics (a black stripe on the ventral aspect of each thigh and a black compact spot in the pre-cloacal flap.; Vanzolini et al. 1980. Répteis das Caatingas. Acad. Bras. de Ciênc., Rio de Janeiro, Brazil. 161 pp.). Thus, for the purpose of our study, we regarded the SVL of the smallest reproductive female as the minimum size for sexual maturity and all females ≥ 65 mm were considered adults. Also, all males with SVL ≥ 68 mm were regarded as adults. These sizes at sexual maturity precede the previous minima for females by 5 mm and for males by 3 mm. With relation to the maximum body size, we recorded a 113 mm SVL adult female on 21 November 2007, and a 139 mm SVL adult male on 13 December 2007. These sizes exceed the previous maxima for females by 6 mm and for males by 10 mm.

Specimens of *T. hispidus* (CHBEZ 1589, 1592, 1961, 1974, 1983, 1987) were deposited in the herpetological collection of Universidade Federal do Rio Grande do Norte, Natal City. We thank the Programa PELD/CNPq – Caatinga: Estrutura e Funcionamento for logistic support, and R. Hansen for helpful comments on this note. This study was supported by a grant from the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) to L. Ribeiro (Process 141993/2006-5), and IBAMA provided a permit (Permit 206/2006 and Process 02001.004294/03-15).

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TROPIDURUS MONTANUS (Calango-da-Montanha; Montane Collared Lizard). **ESCAPE BEHAVIOR**. Some knowledge of behavior is crucial for understanding an animal's ecology, yet for many vertebrates, we lack even anecdotal information is lacking (Greene 1986. *In* Feder and Lauder [eds.], Predator-Prey Relationships, pp. 99–108. University of Chicago Press, Chicago, Illinois; Greene 2005. Trend. Ecol. Evol. 20:23–27). Lizards are known to present diverse defensive behaviors to avoid predation, including crypsis, immobility, mimicry, chemical defense, tail or skin shedding, social and aggressive displays, and use of retreats or escape routes (Pianka and Vitt 2003. Lizards: Windows to the Evolution of Diversity. University of California Press, Berkeley. 348 pp.). *Tropidurus montanus* is a small, diurnal, terrestrial lizard, endemic to the open, montane habitats of southern Espinhaço range (Rodrigues 1987. Arq. Zool., São Paulo 31:105–230). The defensive behavior of *T. montanus* was recently studied (Machado et al. 2004. S. Am. J. Herpetol. 2:136–140) and the primary strategy of defense is the predator avoidance through crypsis associated with immobility. When disturbed, locomotor escape was the tactic employed by this species (Machado et al., *op. cit.*). Here, we describe an unreported defensive behavior in *T. montanus*, and a novelty among *Tropidurus* lizards.

At 1210 h on 16 March 2008, we observed an adult male *T. montanus* (80.6 mm SVL, 117.4 mm tail length) dive into a small stream after being chased by one of us. The observation occurred in Serra do Cabral, Augusto de Lima municipality, Espinhaço range, Minas Gerais State, Brazil (17.999500°S, 44.337028°W; datum: WGS84; elev. 1016 m). After having been disturbed, the lizard fled on the rocks and dove to a depth of ca. 10 cm into a small stream and remained underwater over 3.5 min. Throughout this time, the animal kept its head partly oriented toward the surface and its eyes partially opened, presumably observing the surface and our movements. Three minutes after the observation began, the animal was visibly experiencing difficulties remaining under water, and bubbles escaped through its nostrils. Just over 3.5 min after the observation began, it tried to escape sideways on the rock where it was submerged, and was captured.

Diving behavior would allow *T. montanus* opportunity to escape a predator during a risky chase. Lizards in many families are known to use water bodies as escape routes from potential predators (Pianka and Vitt, *op. cit.*). The majority of the reports on this defensive behavior in neotropical lizards is related to lowland rainforest or flooded-field species, especially semi-aquatic or river-associated lizards (Martins 1991. Faun. Environ. 26:179–190; Ávila-Pires 1995. Zool. Verh. Leiden 299:1–706; Pianka and Vitt, *op. cit.*).

To date, the only known tropidurid for which water-escape has been described is the Amazonian *Uranoscodon superciliosus*. This semi-arboreal species relys largely on crypsis to avoid detection by predators, but when disturbed readily jumps to water, often running across the water surface, but in some cases, diving into the water, and remaining underwater for minutes before emerging (Howland et al. 1990. Can. J. Zool. 68:1366–1373). This represents of the first report of water-based escaped behavior in the genus *Tropidurus*, and a second report for such behavior among tropidurid lizards.

The specimen was deposited in the herpetological collection of the Museu de Zoologia da Universidade de São Paulo, São Paulo, Brasil (MZUSP 98259, José Cassimiro field number JC 1358).

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XENOSAURUS GRANDIS (Knob-scaled Lizard). **ENDOPARASITES.** *Xenosaurus grandis* is known from the Mexican states of Chiapas, Oaxaca, and Veracruz (Flores Villela and Gerez 1994. Biodiversidad y Conservación en México: Vertebrados, Vegetación y Uso del Suelo. Comision Nacional para el Conocimiento y Uso de la Biodiversidad, Universidad Nacional Autónoma de México, Destricto Federal, 439 pp.). To our knowledge, there are no reports of endoparasites from *X. grandis*. The purpose of this note is to establish an initial helminth list for *X. grandis*.

Eleven *X. grandis* (mean SVL = 110.0 mm ± 17.0 SD, range = 78–130 mm) from Cuautlapan, Veracruz, Mexico (18.8666°N, 97°0166°W, WGS84; elev. 1000–1200 m) collected in 1969, 1970–1972 and deposited in the herpetology collection of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California were examined: LACM 75689, 75692–75694, 120051, 120060, 120065, 120071, 120077, 120083, 120086. The body cavity was opened and the digestive tract was removed and examined under a dissecting microscope. Only nematodes were found. These were cleared in a drop of glycerol on a glass slide, coverslipped, and identified using a compound microscope as *Spauligodon xenosauri* infection site: large intestine *(*prevalence = number infected/number examined × 100 = 91%; mean intensity = mean number helminths per infected individual =13.9 ± 12.7 SD. range = 1–36), *Physaloptera* sp. as 3rd stage larvae (the lack of adult specimens makes species identification imprudent, however, *P. retusa* is commonly reported in lizards of Mexico),

infection site: stomach, small intestine (prevalence = 9%, 5.0) and Seuratoidea gen. sp. (larvae in cysts), infection site: stomach wall (prevalence = 36%, mean intensity = 12.8 ± 12.6, range = 2–26). Voucher nematodes were deposited in the United States National Parasite Collection, (USNPC), Beltsville, Maryland as: *Spauligodon xenosauri* (USNPC 101562); *Physaloptera* sp. as 3rd stage larvae (USNPC 101563), and Seuratoidea gen. sp. (USNPC 101564).

Spauligodon xenosauri was described from *Xenosaurus platyceps* from Tamaulipas, Mexico by Bursey et al. (2007. Zootaxa 1501:65–68). *Xenosaurus grandis* is the second host known to harbor it. *Spauligodon xenosauri* is a member of the Oxyuroidea, which infect hosts directly (Anderson 2000. Nematode Parasites of Vertebrates. Their Development and Transmission. CABI Publishing, Oxfordshire, UK, 650 pp.). Infection likely occurs when lizards lick substrate on which eggs are present (see Goldberg and Bursey 1992. J. Parasitol. 78:539–541). *Physaloptera retusa* is a common parasite in lizards of Mexico and North America and requires an insect intermediate host (Bursey et al. 2007. Comp. Parasitol. 74:108–140). Bursey and Goldberg (1991. J. Wildlife Dis. 27:710–715), in a study of *P. retusa* in the lizard *Sceloporus jarrovii*, suggested that approximately 10% of 3rd stage larvae ingested by a host survive to maturity and that those found in the small intestine were dead at time of host capture. Goldberg et al. (1993. Bull. South. California Acad. Sci. 92:43–51) reported hosts for physalopteran larvae; teiid and xenosaurid lizards were absent from that list which suggests that some lizards may not be suitable hosts for this nematode. In this case, these physalopteran larvae should be considered to be artifacts of diet. The life cycles of the Seuratoidea are largely unknown (Anderson 2000, *op. cit.*) but it is thought that insects serve as intermediate hosts. In this study, the cysts were in early granuloma formation perhaps indicating re-encystment of larvae in an inappropriate host. *Xenosaurus grandis* represents a new host record for *Spauligodon xenosauri*, *Physaloptera* sp. (3rd stage) and larvae of Seuratoidea gen. sp.

We thank Christine Thacker (LACM) for permission to examine specimens and Cecilia Nava (Whittier College) for assistance with dissections.

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SQUAMATA — SNAKES

BOTHROPS ASPER (Terciopelo). **SCAVENGING BEHAVIOR.** We ecountered a *Bothrops asper* as it scavenged a frog at La Selva Biological Station in Costa Rica (10.4333333ºN, 83.9833333ºW) on 20 April 2008 at dusk (1747 h local time). The *B. asper* (ca. 60 cm long and missing part of its tail) slid onto the cement trail to a dead, rotting frog. The snake grasped the frog in its mouth, dragged it to the leaf litter adjacent to the trail, let go of the frog, then re-approached and consumed it. The frog was decayed beyond identification and attracting flies (Fig. 1).

Scavenging behavior has been documented in 12 species of Crotalinae under field conditions (DeVault and Krochmal 2002, Herpetologica 58:429-436). Sazima and Strüssman (1990. Rev. Brasil. Biol. 50:463–468) suggest that habitat and diet can influence carrion encounter rates. They expect terrestrial snakes with diverse diets to be "occasional" scavengers. As a dietary generalist, the terrestrial *B. asper* meets their prediction (Martins et al. 2002. *In* Schuett et al. [eds.], Biology of the Vipers, pp. 307–328. Eagle Mountain Publishing, Eagle Mountain, Utah). We speculate that scavenging is a prevalent opportunistic foraging strategy for many snakes (A. Solórzano, pers. comm.) that has gone unnoticed due to the difficulty of observing such behaviors under field conditions.



FIG. 1. *Bothrops asper* consuming a scavenged frog at La Selva Biological Station, Costa Rica.

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CLELIA SCYTALINA (Mexican Snake Eater). **DIET**. *Clelia scytalina* is a large terrestrial snake whose distribution is apparently unclear and disjunct, occurring at low elevations from southern Mexico to Costa Rica (Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna Between Two Continents, Between Two Seas. Univ. Chicago Press. Chicago, Illinois. 934 pp.). Natural history of this species is poorly known. In the Los Tuxtlas region of Veracruz, Mexico diet records include frogs and lizards (Pérez-Higareda et al. 2007. Serpientes de la Región de Los Tuxtlas, Veracruz, México. Guía de Identificación Ilustrada. Universidad Nacional Autónoma de México. 189 pp.), but there are no previous records of snakes as prey in this area.

On 17 May 2006 at 1700 h we observed a *C. scytalina* (ca. 120 cm total length) preying on a Parrot Snake (*Leptophis ahaetulla*) of similar length. The event occurred in a dry creek in the tropical rainforest reserve at Los Tuxtlas Field Station (Lote 67, Vigia Hill, 18.5851°N, 95.08055°W, 178 m elev., WGS84). The *C. scytalina* surprised the *L. ahaetulla* at rest, biting its head and starting to

swallow without releasing. When approached to within 3 m, the *C. scytalina* detected our presence, released the prey, and fled into nearby vegetation. The *L. ahaetulla* was still alive but died shortly after the attack.

This is the first report of a *C. scytalina* preying on a *L. ahaetulla* and it suggests that *C. scytalina* is an opportunistic and generalist feeder. This is consistent with other *Clelia* species (Campbell 1998. Amphibians and Reptiles of Northern Guatemala, the Yucatán, and Belize. Univ. Oklahoma Press. 380 pp.; da Costa Pinto and de Lema 2002. Iheringia, Ser. Zool. 92[2]:9–19; Vitt and Vangilder 1983. Amphibia-Reptilia 4:273–296).

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CROTALUS ATROX (Western Diamond-backed Rattlesnake). **ADULT PREDATION ON LIZARDS.** The prey of adult *Crotalus atrox* consists of a wide range of mammalian (endothermic) taxa, primarily rodents and lagomorphs. Occasionally, birds are subjugated and consumed (Klauber 1972. Rattlesnakes. Their Habits, Life Histories, and Influence on Mankind. Two vols., 2nd ed. University of California Press, Los Angeles and Berkeley. 1533 pp.; Cundall and Greene 2000. *In* K. Schwenk [ed.], Feeding, Form, Function, and Evolution in Tetrapod Vertebrates, pp. 293–333. Academic Press, San Diego, California; Campbell and Lamar 2004. The Venomous Reptiles of the Western Hemisphere. Cornell University Press, Ithaca, New York. 870 pp.).

Here, we provide further information on the diet and predatory behavior of adult *C. atrox* from a population in the Sonoran Desert of south-central Arizona. Specifically, we show that adults of a large species of a North American temperate pitviper (Viperidae: Crotalinae) do not exclude relatively small, ectothermic prey from their diet (e.g., Sherbrooke 2003. Introduction to Horned Lizards of North America. University of California Press, Berkeley and Los Angeles. 178 pp.; Nowak et al. 2008. Biol. Rev. 2008: 83:601–620). The individuals of *C. atrox* we discuss were the subjects of a radio-telemetric study in which various aspects of their behavior, physiology, and spatial ecology have been investigated since March 2001 (e.g., Repp and Schuett 2008. Southwest. Nat. 53:108–114).

The present study site, located in Pinal County, is 40 km SSE of Florence and encompasses an area ≈ 3 km^2 at the western perimeter of the Suizo Mountains. This region is ecologically designated as Arizona Upland Desertscrub subdivision (Brown 1994. Biotic Communities of the American Southwest — United States and Mexico. University of Utah Press, Salt Lake City. 342 pp.). Annual precipitation (chiefly rain) patterns are bimodal, with slight to moderate storms occurring during winter and early spring (December–March); the strongest activity occurs from mid- to late summer (early July to mid-September), which is termed the North American monsoon (Brown 1994, *op. cit.*; Phillips and Comus 2000. A Natural History of the Sonoran Desert. The University of California Press, Berkeley and Los Angeles. 628 pp.). The area lacks permanent freestanding water, a common feature of the Sonoran Desert; at the present site, collection of rainwater in surface rocks and soil, as a rule, is transitory, and persists for only minutes to several hours. However, artificial alterations of the habitat (e.g., deep tire tracks in narrow dirt roads) occasionally provide a substantive reservoir for the collection and storage of rainwater, but even under these situations it is ephemeral, especially in summer.

On 10 July 2004, at 2042 h, in an area interfacing bajada (Phillips and Comus 2000, *op. cit.*) and desert flats, an adult male *C. atrox* (CA-32: SVL = 110 mm, TL = 9.5 mm, body mass = 745 g) was radio-tracked and located (Site 21, 822 m elev.) partially coiled beside an adult (SVL ≈100 mm; body mass ≈ 40 g) Regal Horned Lizard, *Phrynosoma solare*. The core body temperature of CA-32 (obtained via an implanted 11.0 g temperature-sensitive



FIG. 1. Predation by adult wild-living Western Diamond-backed Rattlesnakes (*Crotalus atrox*). A) An adult male *C. atrox* (CA-32) beside an adult Regal Horned Lizard (*Phrynosoma solare*) that presumably was envenomated by CA-32. Note the two blood spots (within the yellow ellipses) that most likely resulted from fang punctures of the present snake. Photograph by R. Villa. B) An adult male *C. atrox* (CA-55) beside an adult Desert Spiny Lizard (*Sceloporus magister*) that it presumably subjugated; also, note that the lizard is gaping with its tongue protruding. This lizard was subsequently consumed by CA-55. Photograph by R. Repp.

radio-transmitter; Holohil Systems Ltd, Ontario, Canada) was 32.7ºC. The ambient temperature (1 m above the ground) was 29.0ºC. Cloud cover was ≈ 10%, relative humidity was ≈ 20%, and wind speed was slight (0–5 kph) and intermittent. Upon closer inspection, the *P. solare* was sluggish and had been (presumably) bitten by the present snake; at least two presumptive fang punctures were present on both left and right left sides of the posterior body, and from these wounds oozing dark-colored blood (within yellow ellipses) was detected (Fig. 1A).

From 2042 h to 2111 h, CA-32 was directly facing the lizard and periodically (N = 8 episodes) nudged it, presumably to determine whether it was dead or fully immobilized. During these nudging episodes, the lizard exhibited anti-predator behavior, primarily rearing and directing its head obliquely downward toward CA-32 (see Sherbrooke 2003, *op. cit.*). At 2211 h, the lizard was still alive, and we departed to avoid possible interference. At 2300 h, we re-located CA-32; he was about 10 m from Site 21 and had a food bolus, undoubtedly the *P. solare*.

On 24 July 2004, at 0643 h, 14 days following consumption of the *P. solare*, we radio-tracked male CA-32 and located him (Site 19, 821 m elev.) in bajada; he was coiled 1 m from of an active *Neotoma albigula* midden. An obvious large food bolus (documented via photography) was present; given his location, it was possibly an adult *N. albigula*. His core body temperature was 26.4ºC. The ambient temperature was 25.0ºC and ground temperature in direct sunlight ("hot spot") was 28.0ºC.

On 14 June 2008, from 0630 to 0733 h, in bajada, an adult male *C. atrox* (CA-55: SVL: 99 mm, TL: 80 mm, mass: 687 g) was radio-tracked and located (Site 52, 826 m elev.) beside an adult male (SVL ≈ 140 mm, body mass ≈ 40 g) Desert Spiny Lizard (*Sceloporus magister*). First inspection of the pair revealed that CA-55 was sprawled lengthwise, with the front one-third of his body positioned in a small area of shade in open ground, and his rear two-thirds was beneath a cluster of Triangle Bursage beneath the canopy of a 1.5 m tall Creosote Bush. The snake's chin rested on the tail of the lizard, which was positioned directly in front of and facing away from CA-55. Neither subject was moving; the lizard's eyes were slightly open. Minutes after locating CA-55, his core body temperature was 23.8ºC. The ambient temperature was 25ºC and hot spot was 32ºC. Cloud cover was 0%, relative humidity was ≈ 10%, and wind speed was slight (< 5 kph). Both ambient and hot spot temperatures changed rapidly as sunrise progressed.

At 0648 h, CA-55 slowly crawled lengthwise beside the left side of the lizard, he occasionally rubbed the lizard with his mouth, and then started rubbing his snout on the snout of the lizard. At that point, the lizard flinched and CA-55 slowly withdrew to resume his position behind the lizard. The core body temperature of CA-55 was 26.7ºC. The pair was temporarily left to radio-track another *C. atrox* subject; CA-55 was re-tracked at 0711 h. At that time, CA-55 was on the right side of the lizard, which gaped widely three times, at ≈ 30 sec intervals (Fig. 1B). Following the first gape, the lizard shuddered violently; he also shuddered after the third gape. The third gape and subsequent shudder were the last obvious movements of the lizard. Both subjects were in full sunlight; the body temp of CA-55 was 31.3ºC. The ambient temperature was 29ºC and hot spot was 35ºC.

Because CA-55 appeared disturbed, other subjects of *C. atrox* were subsequently radio-tracked; ca. 20 min later, CA-55 was re-tracked at 0733 h and neither the snake nor the lizard were present at the original site (Site 52). The snake had moved 2 m N of Site 52 into a heavily vegetated arroyo. Inspection revealed that a minor food bolus was present, and it was assumed he had consumed the lizard. Again, CA-55 appeared startled by the observer and quickly coiled in 100% shade under a downed canopy of wolfberry (*Lycium* sp.) branches on the south side of the arroyo. His core body temperature at the conclusion of the observations was 35.5ºC. The ambient temperature was 32ºC and hotspot was 44.5ºC.

In both of the above cases, body masses of the two species of lizards, estimated based on SVL, were ≈ 40 g; this represents 5% (CA-32, 745 g) and 6% (CA-55, 687 g) of the body masses of the respective snakes. Moreover, the resultant food boluses, as expected, were not highly discernible compared to larger prey such as commonly consumed mammals (e.g., ground squirrels, woodrats); owing to their size, it is likely that the present food items would have been overlooked under most situations. Hence, this suggests that predation attempts and feeding frequency in certain large rattlesnakes (and other vipers) are underestimated (Nowak et al. 2008, *op. cit.*). Also, we show that adult *C. atrox* can successfully feed on adult horned lizards (*Phrynosoma* spp.) without (apparent) subsequent injury (see comments by Sherbrooke 2003, *op. cit.*).

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EPICRATES CENCHRIA (Brazilian Rainbow Boa). **DIET.** On 27 February 2008, at 2350 h, during a radiotracking study at Floresta River (22.5275°S, 42.5516667°W), Reserva Botânica Águas Claras, Silva Jardim, Brazil, we located a female (280 g) radio-collared Neotropical Water Rat (*Nectomys squamipes*) inside an *Epicrates cenchria* (ca. 2 m total length). The snake was <1 m from the river's edge and active. We observed it again two days later in a shelter at the base of a large tree (3.55 m perimeter at breast height), at 5.1 m above the river level and 0.5 m from the river. This shelter had three openings, the measures were: 16×14×66; 20×7×56 and 22×18×49 cm (biggest diameter, perpendicular diameter and depth, respectively). The radiotransmitter was found one month later in what appeared to be regurgitations of the snake

in the same shelter.

Epicrates cenchria is widely distributed in Central and South America, from Costa Rica to Argentina (Tolson 1987. Occas. Pap. Mus. Zool., Univ. Michigan 715:1–68; Vanzolini et al. 1980. Répteis das Caatingas. Academia Brasileira de Ciências, Rio de Janeiro. 161 pp). All *Epicrates* are nocturnal and most eat exclusively endotherms, with most diet records consisting of bats and rodents (*Mus, Rattus*) (Nellis et al. 1983. J. Herpetol. 17:413–417). To the best of our knowledge, this is the first record of *E. cenchria* predation on *N. squamipes*, the largest and most adapted to semi-aquatic life among sigmodontine rodents.

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FARANCIA ERYTROGRAMMA (Rainbow Snake). **HABITAT**. *Farancia erytrogramma* is a secretive, nocturnal species occurring in southeastern USA (Gibbons and Dorcas 2005. Snakes of the Southeast. University of Georgia Press, Athens, Georgia. 253 pp.). In North Carolina, this species can be found throughout the coastal plain (Palmer and Braswell 1994. Reptiles of North Carolina. University of North Carolina Press, Chapel Hill, North Carolina. 412 pp.) and usually inhabits clear, fluvial water systems with low turbidity, neutral pH, and standing vegetation for cover (Neill 1964. Amer. Midl. Nat. 71:257–295). However, past research revealed this species can occur in standing freshwater habitats, such as Carolina bays (Gibbons et al. 1977. Herpetologica 33:276–281).

During a study of the reptile and amphibian community at Bull Neck Swamp (35.96667°N, 076.41667°W), one *F. erytrogramma* was captured with an aquatic funnel trap. Bull Neck Swamp (BNS) is a 2428-ha pocosin wetland located 28 km E of Plymouth, North Carolina, USA, and is managed by the Fisheries and Wildlife Sciences Program at North Carolina State University.

The highly turbid canals of tannic flows and thick bottom debris that meander throughout BNS were an unexpected habitat to discover *F. erytrogramma*, which prefer clear, moving water (Neill 1964, *op. cit.*). Neill (*op. cit*.) maintained that consistent temperatures of stream habitats were important for thermoregulation. Also, fluvial habitats provide cover for American Eels (*Anguilla rostrata*) and Neill (*op. cit*.) suggested the predominant diet on *A. rostrata* further supported the constraint of *F. erytrogramma* to these habitats. However, steep, sandy canal banks prevented the growth of standing vegetation, which likely reduced refuge and staging habitats for nocturnal foraging. Further, Beaver (*Castor canadensis*) dams reduced what little flow existed in some canals to standing quagmires more representative of the habitat selected by Eastern Mudsnakes (*Farancia abacura*; Neill 1964, *op. cit.*). Interestingly, one *A. rostrata* was observed near BNS, but none was captured within the swamp. It is possible that Rainbow Snakes leave bordering fluvial habitats in pursuit of young eels that wandered into canals and swamp habitats.

Capturing such a secretive and uncommon species as *F. erytrogramma* in unexpected habitat encourages consideration of their delicate ecological niche. Declining population indices for American Eels along the eastern United States are attributed to overfishing, parasitism, habitat loss, pollution, and changes in major currents related to climate change (Hightower and Nesnow 2006. Southeast. Nat. 5:693–710). Eel declines could negatively impact population sizes and distributions of Rainbow Snakes, especially in inland areas. We believe future studies based on confirmed Rainbow Snake occurrences from museum records or North Carolina GAP data could better delineate the range within North Carolina. Additionally, sampling for American Eels to determine their population status and distribution in North Carolina could augment population and distribution data for Rainbow Snakes.

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HELMINTHOPHIS FRONTALIS (Northern Antsnake). **FEEDING BEHAVIOR**. Fossorial blind worm snakes are frequently found under debris in lowland moist and premontane forests in Costa Rica and Panama (Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna Between Two Continents, Between Two Seas. University of Chicago Press, Chicago, Illinois. 934 pp.). The habits of these snakes are nearly unknown because of their burrowing and secretive lifestyle, though it is known that the diet of *Helminthophis frontalis* (Anomalepididae) consists of ants, termites and their larvae (Solórzano 2004. Serpientes de Costa Rica. Instituto Nacional de Biodiversidad (INBio). Heredia, Costa Rica. 792 pp.). How blind worm snakes prey upon ants and termites without being attacked by these colonial insects has not yet been described.

Leptotyphlops dulcis (Leptotyphlopidae), another blind burrowing snake that feeds on termites, preys on immature stages of colonial insects (e.g., ants and termites), apparently without being attacked. This blind snake covers itself with feces and a viscous odoriferous liquid that is secreted by the cloaca prior to crawling into the colony. This substance repels the ants and prevents their attack (Gehlbach et al. 1968. Bioscience 18:784–785). This information is missing for most fossorial blind worm snakes, though there are a few reports of some species using this strategy (Zug et al. 2001. Herpetology: An Introductory Biology of Amphibians and Reptiles. 2nd ed. Academic Press. California,. 630 pp.).

On 21 July 2004, we observed a *Helminthophis frontalis* entering an ant colony in San José City, Costa Rica. As the snake attempted

to enter, it was immediately attacked and expelled by the ants. The attack eventually ceased and the snake was able to enter the colony and remain inside, preying upon adult ants and their larvae. After 5 minutes, we removed the snake from the colony and observed that it was covered by an odoriferous viscous substance. Presumably such material repelled the ants and protected the snake from being attacked. A few minutes later, we placed the snake back into the colony and noted that the substance was produced from the cloaca and seemed to allow the snake to feed, undisturbed by ants.

Despite the phylogenetic association of the families Leptotyphlopidae and Anomalepididae, this specialized feeding-related behavior has not been reported for species of the latter (Savage, *op. cit*.).

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LEPTODEIRA SEPTENTRIONALIS (Cat-eyed Snake). **PREY.** Many neotropical snakes feed primarily on anurans (Vitt 1983. Herpetologica 39:52–66) but information regarding their individual prey species is scarce. On 15 November 2004 at 21 h, in the Refugio de Vida Silvestre, Golfito (Costa Rica, Puntarenas Province, 8.65°N, 83.18°W, ca. 5 m elev.), I observed an adult *Leptodeira septentrionalis* swallowing a *Leptodactylus bolivianus* (Fig. 1). The frog was ingested head first. *L. bolivianus* represents a hitherto unreported prey item for *L. septentrionalis.*



FIG. 1. *Leptodeira septentrionalis* swallowing a *Leptodactylus bolivianus.*

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LEPTOPHIS AHAETULLA PRAESTANS (Green Parrot Snake). **PREDATION ATTEMPT.** *Leptophis ahaetulla* is a large, diurnal, and arboreal species, occurring in different vegetation types from southern Mexico to Brazil and Argentina (Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna Between Two Continents, Between Two Seas. Univ. Chicago Press. Chicago, Illinois. 934 pp.). It has been reported that *L. ahaetulla* forages in trees and shrubs for sleeping or resting frogs, and to a lesser extent, arboreal lizards (Oliver 1948. Bull. Am. Mus. Nat. Hist. 92:157–280; Pérez-Higareda et al. 2007. Serpientes de la Región de Los Tuxtlas, Veracruz, México. Guía de Identificación Ilustrada. Universidad Nacional Autónoma de México. 189 pp.). There are no reports for prey items for *L. ahaetulla* in Mexico, so here we record a feeding attempt observed in Veracuz.

On 18 April 2007 at ca. 1000 h on bare soil adjacent to buildings belonging to Los Tuxtlas Tropical Biology Station (18.5851°N, 95.0752°W, 119 m elev., WGS84), we observed a *L. ahaetulla* (ca. 150 cm total length) feeding on a Baudin's Treefrog (*Smilisca baudini*, ca. 60 mm snout–vent length). The snake held the frog in its mouth for a minute but when we approached to a distance of 2 m, the snake released the frog and fled. The frog was alive though motionless, and died some minutes later.

Frogs (especially hylids) have been recorded as the main food items for *L. ahaetulla* elsewhere in its range (e.g., Campbell 1998. Amphibians and Reptiles of Northern Guatemala, the Yucatán, and Belize. Univ. Oklahoma Press. 380 pp.; De Albuquerque and Di-Bernardo 2005. Herpetol. Rev. 36:325; Lopez et al. 2003 Herpetol. Rev. 34:68–69). Other reported prey for *L. ahaetulla* are birds, bird's eggs, and grasshoppers (Oliver 1948, *op. cit;* Lopez et al., *op. cit*).

We thank Lindley McKay for improving the English language in this note.

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LIOPHIS VITTI (NCN). **DIET**. The colubrid snake *Liophis vitti* is known from the western Andean slopes in northern Ecuador at elevations between 1070–1650 m (Dixon 2000. Copeia 2000:482–490). A specimen collected "one meter high on leaf in forest at night" is all the natural history data available in the literature for this species (Dixon, *op. cit*.). On 24 February 2009, we collected a male *L. vitti* (QCAZ 8708, SVL = 368 mm, TL = 110 mm) in northwestern Ecuador, Carchi Province, Chilmá Bajo (0.8647222°N, 78.0497222°W, 2071 m elev.). This specimen had recently eaten, as indicated by an anterior swelling at about one fourth its SVL. The forced-out prey was a specimen of an undescribed species of the bufonid toad *Osornophryne* (QCAZ 40028, SVL = 30.4 mm). No records of *Osornophryne* are known from this locality. Moreover, this is the first record of predation of *Osornophryne* by any vertebrate. Both specimens are deposited in the

herpetological collection of Museo de Zoología QCAZ, Pontificia Universidad Católica del Ecuador.

Submitted by **OMAR TORRES-CARVAJAL** (e-mail: omartorcar@gmail.com), **JUAN M. GUAYASAMIN, ELICIO TAPIA**, and **SILVIA ALDÁS**, Escuela de Biología, Pontificia Universidad Católica del Ecuador, Apartado Postal 17-01-2184, Quito, Ecuador.

MASTIGODRYAS MELANOLOMUS (NCN). **PREY.** Information on the trophic ecology and individual prey species of certain tropical snakes is scarce. *Mastigodryas melanolomus* is a moderately-sized colubrid snake that forages on the ground and preys on lizards, small snakes, reptile eggs, nesting birds, and small mammals (Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna Between Two Continents, Between Two Seas. University of Chicago Press, Chicago, 994 pp.). On 14 October 2004 at 1530 h, in the Reserva Biológica Hitoy Cerere (Costa Rica, Limón Province, 9.66°N, 83.03°W, ca. 200 m elev.), I observed a *M. melanolomus* with a total length of about 1.2 m that had entered a hole in the ground up to about the anterior third of its body. When it reappeared, it was holding an adult *Ameiva festiva* in its mouth (Fig. 1). Although *M. melanolomus* is known to prey on other species of *Ameiva* (Seib 1984. J. Herpetol. 18:412–420), *A. festiva* has not yet been reported as a prey item of *M. melanolomus*.



FIG. 1. *Mastigodryas melanolomus* preying on *Ameiva festiva*.

Submitted by **DAVID MATTHIAS DEHLING**, Department of Ecology, Animal Ecology, Faculty of Biology, Philipps-University Marburg, Karl-von-Frisch-Straße 8, D-35032 Marburg, Germany; e-mail: Dehling@students.uni-marburg.de.

OXYRHOPUS CLATHRATUS (NCN) **PREY.** Species of *Oxyrhopus* are known to prey on small lizards (Bernarde and Machado 2000. Herpetol. Rev. 31:247–248.). On 2 September 2004, during fieldwork in Teresópolis municipality, Rio de Janeiro State, southeastern Brazil (22.448442°S, 42.983542°W), we collected a recently deceased juvenile *Oxyrhopus clathratus* (312 mm total length), that contained an adult *Placosoma cordyline* (153.3 mm total length). The cause of death of the snake is unknown. This is the first report of predation of *P. cordyline* by *O. clathratus*. Both specimens are deposited in the herpetological collection of the Universidade Federal do Estado do Rio de Janeiro, Brazil, under the accession numbers ZUFRJ 1650 (*Oxyrhopus clathratus*) and 1651 (*Placosoma cordyline*).

We thank Universidade Federal do Estado do Rio de Janeiro for transport logistics, and Henrique C. Costa and Paulo Sérgio Bernarde for suggestions on the manuscript.

Submitted by **VICTOR G. DILL ORRICO,** Departamento de Zoologia, UNESP - Universidade Estadual Paulista Júlio de Mesquita Filho, Av. 24-A, num 744, Bela Vista, Departamento de Zoologia, I.B.; Cx. P. 199, CEP: 13506-900 - Rio Claro, SP – Brazil (e-mail: victordill@gmail.com); and **PAULO NOGUEIRA DA COSTA**. Laboratório de Anfíbios e Répteis - Universidade Federal do Rio de Janeiro, Departamento de Zoologia, Caixa Postal 68.044, CEP 21944-970, Rio de Janeiro, RJ, Brazil (e-mail: nogpj@yahoo.com.br).

OXYRHOPUS GUIBEI (False Coralsnake). **DIET.** *Oxyrhopus guibei* is a terrestrial, crepuscular-nocturnal pseudoboine snake in southeastern Brazil (Sazima and Abe 1991. Stud. Neotr. Fauna Environ. 26:159–164). Reported prey items include rodents, lizards (Andrade and Silvano 1996. Rev. Bras. Zool. 13[1]:143–150; França et al. 2008. Copeia 2008:23–38), and birds (Sazima and Abe 1991. Stud. Neotr. Fauna Environ. 26:159–164).

We dissected 17 specimens of *O. guibei* from the vicinity of the Irapé Power Plant (16.75°S; 42.53°W), Minas Gerais state, Brazil, collected between February 2004 and July 2006 during a faunal monitoring program. We found 10 prey items in the stomachs of three males (total length: 404, 629, and 811 mm), two females (total length: 599 and 1016 mm), and three juveniles (total length: 289, 306, and 363 mm). Prey consisted of rodents (70%) and lizards (30%). Nonetheless, one adult female *O. guibei* (1016 mm total length) had digested parts of an individual *Oxymycterus* sp. (Cricetidae) in its stomach. This snake also contained 10 vitellogenic follicles (> 10 mm, following Pizzatto and Marques 2002. Amphibia-Reptilia 4:495–504). Rodents of the genus *Oxymycterus* have semi-fossorial habits and are endemic to South America (Hershkovitz 1994. Fieldiana Zool. 79:1–43; Câmara and Murta 2003. Mamíferos da Serra do Cipó. Ed. PUC Minas. Belo Horizonte. 129 pp.). The rodent body parts had a volume of 5478.7 mm^3 and seemed derived from an adult individual. To our knowledge this is the first record of the semi-fossorial rodent *Oxymycterus* as a food item of *O. guibei*. Furthermore, another two species of rodents belonging to the Cricetidae family were found: four *Necromys lasiurus* in three specimens and two *Calomys tener* in one. Three unidentified tails of lizards were found in three juvenile specimens.

Representative specimens are deposited in the Herpetological Laboratory of Museu de Ciências Naturais of Pontifícia Universidade Católica de Minas, Minas Gerais, Brazil (MCNR 915, 1718, 1847, 1923, 2511). We thank Sônia A. Talamoni for identifying the rodents and FAPEMIG for financial support to LBN.

Submitted by **LAURA RODRIGUES VIEIRA DE ALENCAR**, Departamento de Ecologia, Instituto de Biociências, Universidade de São Paulo, Rua do Matão, Travessa 14, Cidade Universitária, São Paulo, SP, Brazil, CEP 05508-090 (e-mail: laura.alencar@globo.com); **CONRADO A. B. GALDINO**, present address: Departamento de Biologia, Universidade Federal do Ceará, Campus do Pici, Bloco 906, Fortaleza, Ceará, CEP 60455-760 (e-mail: galdinoc@gmail.com); and **LUCIANA BARRETO NASCIMENTO**, Programa de Pós-graduação em Zoologia de Vertebrados, Laboratório de Herpetologia, Museu de Ciências Naturais, Pontifícia Universidade Católica de Minas Gerais, Avenida Dom José Gaspar, n. 290, Bairro Coração Eucarístico, Campus PUC Minas, Belo Horizonte, Minas Gerais, Brazil, CEP 30535-610 (e-mail: luna@pucminas.br).

PHILODRYAS CHAMISSONIS (Long-tailed Snake) and ***LIOLAEMUS NITIDUS*****. PREDATION DETERMINED BY PIT TAG**. As part of a multi-species capture-recapture study in central Chile (31.9861°S, 71.1696167°W, 820 m elev., datum Prov SudAm 56) during October 2007, we collected a *Philodryas chamissonis* (68 cm total length, 24 g) that contained a secondarily-ingested PIT tag in its stomach. The PIT tag originally had been placed in a juvenile *Liolaemus nitidus* (5.0 cm SVL, 4.6 g) in December 2006 (10 months earlier). Thus, the minimum prey/predator ratio is 19.2%, exceeding the mean value of 7.7 ± 3.1% reported by Greene and Jaksic (1992. Rev. Chil. Hist. Nat. Santiago, Chile 65:485–493) for museum specimens of *P. chamissonis*. Our observation suggests the potential utility of PIT tags in long-term studies of predation.

Submitted by **GABRIEL LOBOS**, Centro de Estudio de Vida Silvestre, Facultad de Ciencias Veterinarias y Pecuarias, Universidad de Chile, Casilla 2 correo 15, Santiago, Chile (e-mail: galobos@yahoo.com); **MARTÍN A. H. ESCOBAR**, **ROBERTO F. THOMSON** (e-mail: rthomsonsaa@gmail.com), Laboratorio de Ecología de Vida Silvestre, Facultad de Ciencias Forestales, Universidad de Chile, Casilla 9206, Santiago, Chile; and **ALEJANDRA ALZAMORA**, Centro de Estudio de Vida Silvestre, Facultad de Ciencias Veterinarias y Pecuarias, Universidad de Chile, Casilla 2 correo 15, Santiago, Chile, Casilla 2 correo 15, Santiago, Chile.

RHINOCHEILUS LECONTEI (Long-nosed Snake). **CANNIBALISM.** The diet of *Rhinocheilus lecontei* consists mainly of lizards, small mammals, and squamate eggs (Rodríguez-Robles et al. 1999. J. Herpetol. 33:87–92; Rodríguez-Robles and Greene 1999. J. Zool. Lond. 248:489–499). Although general references to predation on snakes have appeared (e.g., Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. Univ. New Mexico Press, Albuquerque. 431 pp.; Stebbins 2003. A Field Guide to Western Reptiles and Amphibians, 3rd ed., revised. Houghton Mifflin Co., Boston, Massachusetts. 533 pp.; Werler and Dixon 2000. Texas Snakes: Identification, Distribution, and Natural History. Univ. Texas Press, Austin. 437 pp.), specific reports are lacking and thus it is unclear if *R. lecontei* preys on snakes in the wild. Klauber (1941. Trans. San Diego Soc. Nat. Hist. 9[29]:289–332) reported feeding on *Chionactis occipitalis* in captivity. Here I document an instance of predation on a juvenile conspecific.



FIG. 1. Adult *Rhinocheilus lecontei* ingesting a juvenile conspecific, Alameda Co., California.

On 17 May 2009 at 2307 h, I observed an adult *R. lecontei* (estimated total length 90 cm) ingesting a juvenile conspecific (ca. 32 cm TL) (Fig. 1). Although ingestion had commenced before my arrival, the sequence I observed was completed in ca. 2 minutes. The smaller snake did not display any obvious injuries. This observation took place 24 km by air SE of Livermore, Alameda Co., California, USA.

Submitted by **CHAD M. LANE**, 426 Swallow Ct, Manteca, California 95336, USA; e-mail: ChadMLane@aol.com.

THAMNOPHIS ELEGANS VAGRANS (Wandering Gartersnake). **DEFENSIVE BEHAVIOR**. Several species of snakes have been observed to enlarge or triangulate the head as a defensive response to a predator (Greene 1988. *In* C. Gans and R. B. Huey [eds], Biology of the Reptilia, Volume 16, Ecology B, pp. 1–152. Alan R. Liss, New York). In June 2007, I observed this behavior as a defensive response in three specimens of *Thamnophis elegans vagrans* (ca. 45 cm total length) in a residential area of Springville, Utah, USA (40.1529°N, 111.5960°W). Sexes were not determined.

Defensive responses in the snakes were elicited by a peck on the head by a nest-guarding American Robin (*Turdus migratorius*). The nest was located 1.75 m above ground in a cherry tree (*Prunus cerasus*). The robin attacked up to 4.6 m from its nest. The original observation occurred with no manipulation on my part. However, after the initial observation, I captured two other *T. e. vagrans* within 200 m of the nest site and placed them individually under the same robin nest. The bird responded in the same manner to these new snakes (i.e., flying from nest to ground and pecking at the snake's head). Upon being attacked, the snakes quickly coiled and exhibited head triangulation, accompanied by aggressive posturing, i.e. in a stance poised to strike, and repeated striking with mouth open. Once the snakes exhibited this defensive behavior, attacks by the bird ceased.

Head triangulation as a defensive response has been documented for many colubrid species (Greene 1988, *op. cit.*), and has apparently evolved independently multiple times (Young et al. 1999. J. Zool., Lond. 248:169–177). However, to the best of my knowledge this is the first report of head triangulation in *Thamnophis*. Werner

(1983. Israel J. Zool. 32:205–228) postulated that this behavior can be classified as Batesian mimicry of sympatric venomous snakes. *Crotalus viridis* (Western Rattlesnake) is broadly sympatric with *T. e. vagrans* over most of its range (Stebbins 2003. A Field Guide to Western Reptiles and Amphibians. Houghton Mifflin Co., Boston, Massachusetts. 533 pp.).

Special thanks to Caleb, Shiloh, Jubal, Micah, and Cyrus Rasmussen for help in catching and observing the snakes.

Submitted by **JOSH E. RASMUSSEN**, Department of Biology, Brigham Young University, Provo, Utah 84663, USA; e-mail: josh_rasmussen@byu.edu.

Cover Images for *Herpetological Review*

We are looking for photographic images to appear on future covers of *HR*. To be considered, preferred images should have the following qualities:

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Images for consideration should be submitted as low-resolution jpg or pdf files. Do not send full resolution images via email. All submissions or questions should be directed to the Editor (herpreview@gmail.com).

GEOGRAPHIC DISTRIBUTION

Instructions for contributors to Geographic Distribution appear in Volume 40, Number 1 (March 2009, p. 106). Please note that the responsibility for checking literature for previously documented range extensions lies with authors. Do not submit range extension reports unless a thorough literature review has been completed.

CAUDATA – SALAMANDERS

AMBYSTOMA MACULATUM (Spotted Salamander). USA: ARKANSAS: Searcy Co.: Off AR 14, ca. 2 km down Ramblewood Trail in a small pool of water (36.0568°N, 92.6044°W; WGS 84). 20 February 2009. M. B. Connior. Verified by S. E. Trauth. Arkansas State University Museum of Zoology Herpetology Collection (ASUMZ 31298). This adult male is a new county record filling a distributional hiatus between previous records in Marion, Stone, Van Buren, and Newton counties in northern Arkansas (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville. 421 pp.).

Submitted by **MATTHEW B. CONNIOR,** Department of Biological Sciences, Arkansas State University, P.O. Box 599, State University, Arkansas 72467, USA; e-mail: matthew.connior@smail.astate.edu.

AMBYSTOMA MACULATUM (Spotted Salamander). USA: TENNESSEE: Van Buren Co.: Ephemeral pond near entrance to paved field just prior to Fall Creek Falls Inn parking lot (35.6561ºN, 85.3711ºW: datum NAD 27). Matthew L. Brown. Verified by A. Floyd Scott. One adult located, photographed and catalogued at Austin Peay State University Center for Field Biology (APSU 18953). First county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Internet version [http://www.apsu.edu/amatlas] contains links to information regarding Tennessee distribution of amphibians recorded since 1996; accessed 05 February 2009). Extends range approximately 15 km SW of nearest recorded occurrence.

Submitted by **MATTHEW L. BROWN**, Fall Creek Falls State Park, Pikeville, Tennessee 37367, USA; e-mail: matthew.brown@state.tn.us.

AMBYSTOMA TIGRINUM (Eastern Tiger Salamander). USA: OKLAHOMA: McCurtain Co.: 1.2 km E Pollard Community on Ferguson Road (33.47640°N, 94.42591°W; WGS84). 18 March 2009. J. Ferguson. Verified by S. E. Trauth. Arkansas State University Herpetological Museum (ASUMZ photographic voucher 31306). First record for the county (Oklahoma Biological Survey DOKARRS Search; http://www.biosurvey.ou.edu/dbsrch/dokalist.php); adult male with swollen vent found crossing gravel road in early morning.

Numerous *A. tigrinum* from the state are in the collection of the Sam Noble Oklahoma Museum of Natural History of Oklahoma; one specimen (SNOMNH 25011) is from adjacent Pushmataha Co. The species occurs immediately southward across the Red River in Red River Co., Texas (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. Texas A&M University Press, College Station, Texas. 421 pp.). However, *A. t. tigrinum* has not yet been reported

north of the Red River from any counties along the southwestern tier in Arkansas (Trauth et al. 2004. Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.).

Submitted by **CHRIS T. McALLISTER**, RapidWrite, 102 Brown Street, Hot Springs National Park, Arkansas 71913, USA (e-mail: drctmcallister@aol.com); **HENRY W. ROBISON**, Department of Biology, Southern Arkansas University, Magnolia, Arkansas 71754, USA (e-mail: hwrobison@suddenlink.net); **DAVID ARBOUR**, De Queen, Arkansas 71832, USA (e-mail: arbour@windstream.net); **JACKYE FERGUSON**, United States Forest Service, HC 60, Box 430, Haworth, Oklahoma 74740, USA; and **TERRY STUART**, Oklahoma Department of Wildlife Conservation, HC 60, Box 160, Haworth, Oklahoma 74740, USA.

AMBYSTOMA TIGRINUM (Eastern Tiger Salamander). USA: TEXAS: Lee Co.: 6.1 km W of the junction of Farm-Market Roads 116 and 696, on FM 696 (30.5725º N, 97.0888889ºW). 25 March 2009. Philip Ralidis. Verified by Heather Prestridge. Texas Cooperative Wildlife Collection (photo voucher) TCWC-PV001. The large adult female (total length 175.5 mm, tail 80 mm) was captured alive about 2100 h, crossing FM 696 during a heavy rain. New county record (Dixon 2000. Amphibians and Reptiles of Texas. 2nd ed. Texas A&M University Press, College Station, Texas).

Submitted by **PHILIP RALIDIS**, 3003 Loveland Cove, Austin, Texas 78746, USA; **JAMES R. DIXON** (e-mail: jrdixon5@verizon.net) and **TOBY J. HIBBITTS** (e-mail: thibbitts@tamu.edu), Texas Cooperative Wildlife Collections, Department of Wildlife and Fisheries Sciences, Texas A&M University, 2258 Tamu, College Station, Texas 77843-2258, USA.

CRYPTOBRANCHUS ALLEGANIENSIS (Hellbender). USA: TENNESSEE: Rutherford Co.: J. Percy Priest Reservoir, Spring Creek branch (36.0353ºN, 86.4467ºW; NAD83). 20 April 1990. Mark Hodge. Verified by M. L. Niemiller. An adult female gravely injured by a fisherman's attempts to retrieve baited hook from stomach. Deposited in the Herpetology Collection at Middle Tennessee State University (MTSU 422C). First record for county and for the Stones River watershed, ca. 60 km SE of historical record for the Cumberland River in Davidson Co., Tennessee (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Internet version [http://www.apsu.edu/amatlas] contains links to information regarding Tennessee distribution of amphibians recorded since 1996; accessed 03 March 2009).

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NOTOPHTHALMUS VIRIDESCENS LOUISIANENSIS (Central Newt). USA: ARKANSAS: Dallas Co.: 5.6 km S Sparkman off St. Hwy 7 at Brushy Creek (Sec. 15, T10S, R17W). 07 May 1986. Henry W. Robison. Verified by S. E. Trauth. Arkansas State University Herpetological Museum (ASUMZ 30829). New county record filling a distributional gap between Clark and Cleveland counties (Trauth et al. 2004. Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.), and leaving only Lafayette Co. without documentation of *N. v. louisianensis* for all of south Arkansas.

Submitted by **HENRY W. ROBISON**, Department of Biology, Southern Arkansas University, Magnolia, Arkansas 71754, USA (e-mail: hwrobison@saumag.edu); and **CHRIS T. McALLISTER**, Department of Physical and Life Sciences, Chadron State College, Chadron, Nebraska 69337, USA (e-mail: cmcallister@csc.edu).

PSEUDOTRITON MONTANUS (Mud Salamander) USA: ALABAMA: Bibb Co.: 18.0 km WSW of Eoline (32.90679ºN, 87.39313ºW, WGS84). 14 November 2008. Heather Cunningham, Walter H. Smith, and Joseph J. Apodaca. Verified by Leslie J. Rissler. University of Alabama Herpetological Collection (UAHC 16175, 16178). Two adult *Pseudotriton montanus* were found under leaf litter along the margin of a beaver-impounded wetland in the Talladega National Forest (Oakmulgee District) of west-central Alabama. This wetland was located along an unnamed tributary of Fivemile Creek in a mixed bottomland hardwood/yellow pine forest, with extensive canopy cover. This site is located ca. 60 km outside of the currently accepted range for *P. montanus* and is 94 km from the nearest catalogued voucher for the species (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, DC). The presence of a disjunct portion of the range of *P. montanus* in eastern Mississippi (Petranka, *op. cit*.) presents several possible implications for this new locality. It is possible that the contiguous range of *P. montanus* extends westward at least to the Alabama locality described here. Because this Alabama locality is centered between the recognized contiguous range and the disjunct Mississippi population it may also be possible that the range of *P. montanus* extends westward across the Gulf Coastal Plain to encompass the Mississippi population.

Submitted by **HEATHER CUNNINGHAM**, **WALTER H. SMITH**, and **JOSEPH J. APODACA**, Department of Biological Sciences, Ecology, Evolution, and Systematics Section, Box 870345, University of Alabama, Tuscaloosa, Alabama 35487, USA.

TARICHA GRANULOSA (Rough-skinned Newt) USA: CALIFORNIA: Butte Co.: North Fork Feather River, ca. 1.4 mi. upstream from Poe Powerhouse, west bank (39.72273ºN, 121.47105ºW; datum: WGS 84); 286 m elev.; adult (California Academy of Sciences 241781) captured on 13 March 2008 at 1300 h underwater in a pool tail-out; water temperature 21.5ºC; K. D. Wiseman. Verified by Ricka Stoelting. A second specimen (CAS 234628) was found at 39.80197ºN, 121.44695ºW, 404 m elev. on 15 June 2006. Specimen verified by Jens Vindum. CAS 241781 extends the known distribution of *T. granulosa* in the Sierra Nevada of California ca. 7.7 miles SE, while CAS 234628 extends the distribution ca. 9.1 miles E of specimens previously regarded as the southern extent of their distribution in the Sierra Nevada (MVZ 56784–56798; Hayes and Cliff 1982. Herpetol. Rev. 13[3]:85–87; Koo and Vindum 1999. Amphibians and Reptiles of the Plumas National Forest: Historical Collections and California Academy of Sciences 1998 and 1999 Surveys; Koo et al. 2004. Results of 02-CS-11050650-029, the California Academy of Sciences Survey: Amphibians and Reptiles of the Lassen National Forest). These specimens are also significant as they document *T.*

granulosa occupying the North Fork Feather River watershed, a distinct watershed from the West Branch Feather River watershed, previously considered the southern extent of the species range in the Sierra Nevada of California (Hayes and Cliff, *op. cit.*). *Taricha granulosa* is found in sympatry with *Taricha torosa* at localities provided herein.

Submitted by **KEVIN D. WISEMAN,** Garcia and Associates (GANDA), 2601 Mission Street, Suite 600, San Francisco, California 94110, USA; Department of Herpetology, California Academy of Sciences, 55 Music Concourse Drive, Golden Gate Park, San Francisco, California 94118, USA; e-mail: kwiseman@garciaandassociates.com.

ANURA – FROGS

AGALYCHNIS SPURELLI (Gliding Treefrog). COSTA RICA: SAN JOSE: Distrito Carara, El Sur de Turrubares, (9.4339ºN, 84.34038ºW; WGS84), 385 m elev. 19 August 2006. A. Vega, J. M. Robertson, and G. Chaves. Verified by Federico Bolaños. Museum of Zoology, Universidad de Costa Rica, San Jose (UCR 19214). New province record and a 114 km NW range extension from the closest previous record at Palmar Norte, Puntarenas, expanding its distribution along the Pacific versant on the Cordillera de Talamanca (Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna Between Two Continents, Between Two Seas. Univ. Chicago Press, Chicago, Illinois. xx + 934 pp.). The frog was calling from a tree-lined temporary pool in an agricultural field once covered by lowland rainforest, along with a large breeding congregation of *Agalychnis callidryas*.

Submitted by **ANDRES VEGA**, AMBICOR, 400 E., 75 S., 75 E. de la Municipalidad de Tibas, Tibas, Costa Rica (e-mail: avegak@hotmail.com); **JEANNE M. ROBERTSON**, Department of Ecology and Evolutionary Biology, Cornell University, Ithaca, New York 14853, USA (e-mail: jmr79@cornell.edu); and **GERARDO CHAVES**, Museum of Zoology, University of Costa Rica, San Jose (e-mail: cachi@biologia.ucr.ac.cr).

ANAXYRUS DEBILIS DEBILIS (Eastern Green Toad). USA: TEXAS: Stephens Co.: N of Eolian (32.68165ºN, 99.03378ºW; 370 m elev.). 21 March 2009. J. Meik, J. Streicher, and S. Schaack. Verified by C. J. Franklin. University of Texas at Arlington, UTA A-59175. Collected under a rock adjacent to a gravel road in Post Oak savannah. First known county record of the species, which fills a distributional gap in north-central Texas (Dixon 2000. Amphibians and Reptiles of Texas. 2nd ed. Texas A&M Univ. Press, College Station). Collected under Texas Parks and Wildlife permit number SPR-0707-1387.

Submitted by **JEFFREY W. STREICHER** (e-mail: e-mail: streicher@uta.edu.), **JESSE M. MEIK**, and **SARAH SCHAACK**, Department of Biology, The University of Texas at Arlington, Arlington, Texas 76019, USA.

HYLA CINEREA (Green Treefrog). USA: TENNESSEE: Van Buren Co.: Fall Creek Falls State Park Golf Course Pond (35.65ºN, 85.3606ºW: datum NAD 27). 11 July 2008. Matthew L. Brown and Leigh Ann Brown. Verified by A. Floyd Scott. One adult photographed and catalogued at Austin Peay State University Center for Field Biology (APSU 19959). Only specimen found in park. Calls have been audible for at least two years at the Fall Creek Falls State Park Golf Course pond. Possible introduction, 62.2 km N of nearest recorded occurrence (Miller et al. 2007. Herpetol. Rev. 38:97). First county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Internet version [http://www.apsu.edu/amatlas] contains links to information regarding Tennessee distribution of amphibians recorded since 1996; accessed 17 January 2009).

Submitted by **MATTHEW L. BROWN**, Fall Creek Falls State Park, Pikeville, Tennessee 37367, USA; e-mail: matthew.brown@state.tn.us.

GASTROPHRYNE CAROLINENSIS (Eastern Narrow-mouthed Toad). USA: ARKANSAS: Boone Co.: 3.2 km SE of Harrison off US 65 (36.122014°N, 93.039479°N; NAD83). 10 June 1995. H. W. Robison. Verified by S. E. Trauth. Arkansas State University Herpetological Museum (ASUMZ 31305). New county record partially filling a distributional hiatus in northern Arkansas between Benton and Marion counties (Trauth et al. 2004. Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.). This frog has now been documented in 69 of 75 (92%) Arkansas counties.

Submitted by **CHRIS T. McALLISTER**, RapidWrite, 102 Brown Street, Hot Springs National Park, Arkansas 71913, USA (e-mail: drcmcallister@aol.com); and **HENRY W. ROBISON**, Department of Biology, Southern Arkansas University, Magnolia, Arkansas 71754, USA (e-mail: hwrobison@suddenlink.net).

KALOULA PULCHRA (Painted Bull Frog): MALAYSIA: SARAWAK: MIRI DIVISION: Kuala Lutong, nr. Lutong Town (4.4708333ºN, 114.0038889ºE). From beach forest, within a patch of *Casuarina* with blackwater pools. 25 October 2007. I. Das. USDZ 1.12153. Verified by Kelvin K. P. Lim. First record for Sarawak. Bornean records from Sinkawang, Kalimantan (Indonesia) by Inger (1966. Fieldiana Zool. 52:1–402), Sabah East Malaysia, without locality (Inger and Tan 1996. Raffles Bull. Zool. 44:551–574), Crocker Range, Sabah (Das 2006. Amphibian and Reptile Conservation 4[1]:3–11), and Bandar Seri Begawan, in Brunei Darussalam (Charles 2008. Herpetol. Rev. 39:462–463). Sarawak locality is ca. 115 km W of Brunei record, and choruses of breeding males heard during late afternoons and nights of 25–26 October 2007 indicate species is established locally. Considered introduced by anthropogenic activities in Borneo and is currently spreading west along north coast, and widespread in Southeast Asian mainland (Inger 1999. *In* W. E. Duellman [ed.], Patterns of Distribution of Amphibians: A Global Perspective, pp. 445–482. The John Hopkins University Press, Baltimore and London).

I thank Lee Nyanti, Andrew Alek Tuen, and Matteo Veronesi for supporting field work in Lutong under Project Kuala for Shell Sarawak Berhad and Environmental Resources Management Sdn. Bhd.

Submitted by **INDRANEIL DAS**, Institute of Biodiversity and Environmental Conservation, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia; e-mail: idas@ibec.unimas.my.

LITHOBATES GRYLIO (Pig Frog). USA: TEXAS: Chambers Co.: Highway 124, 5 km N of High Island (29.61379ºN, 94.38073ºW; WGS 84). 25 June 2008. Collected by Paul Crump. Verified by Carl J. Franklin. University of Texas Arlington (UTADC 3691–3698), and tissue deposited at the MRJ Forstner Frozen Tissue Collection at Texas State University (MF 27033).

Submitted by **PAUL CRUMP** (e-mail: pcrump@houstonzoo.org), **RACHEL ROMMEL**, Department of Conservation and Science, Houston Zoo, 1513 North Macgregor Way, Houston, Texas 77030, USA (e-mail: rrommel@houstonzoo.org); and **JAIME GONZALEZ**, Katy Prairie Conservancy, Katy Prairie Conservancy, Waller, Texas 77098, USA (e-mail: jaimegonzalez72@gmail.com).

LITHOBATES PALUSTRIS (Pickerel Frog). USA: ARKANSAS: Searcy co.: Off AR 14, ca. 2.2 km down Ramblewood Trail in small drainage creek (UTM 15N 0536006E, 3990296N; WGS 84). 26 March 2009. M. B. Connior. Verified by S. E. Trauth. Arkansas State University Museum of Zoology Herpetology Collection (ASUMZ 31312). Adult female caught by hand. First county record filling a distributional gap among surrounding Stone, Marion, and Newton counties (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. Univeristy of Arkansas Press, Fayetteville. 421 pp.).

Submitted by **MATTHEW B. CONNIOR,** Department of Biological Sciences, Arkansas State University, P.O. Box 599, State University, Arkansas 72467, USA; e-mail: matthew.connior@smail.astate.edu.

LITHOBATES SYLVATICUS (Wood Frog). USA: TENNESSEE: Van Buren Co.: Flooded pit near Piney Falls at Fall Creek Falls State Park (35.67278ºN, 85.375ºW: datum NAD27). 06 January 2009. Matthew L. Brown and Thomas P. Solomon. Verified by A. Floyd Scott. Twenty-two adults and egg masses located, two adults photographed and catalogued at Austin Peay State University Center for Field Biology (APSU 18954).. First county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Internet version [http://www.apsu.edu/amatlas] contains links to information regarding Tennessee distribution of amphibians recorded since 1996; accessed 17 January 2009). Extends range from nearest documented occurrence by approximately 25 km west.

Submitted by **MATTHEW L. BROWN**, Fall Creek Falls State Park, Pikeville, Tennessee, 37367, USA; e-mail: matthew.brown@state.tn.us

PHYSALAEMUS KROYERI (Kroyer's Dwarf Frog). BRAZIL: PIAUÍ: Municipalidade de Piracuruca: Parque Nacional de Sete Cidades (03.978ºS, 41.556ºW; datum SAD69; 110 m elev.). April 2007. B. B. Annunziata, I. S. Castro, and W. M. Fontenele. February 2009. B. B. Annunziata, M. R. A. Mendes and D. Cisne. Verified by D. Silvano and P. Valdujo. Herpetological Collection of Universidade Estadual do Piauí, Parnaíba (UESPI 0062, 0394–0404). This species ranges from the northern part of the State of Minas Gerais and from the central part of the State of Bahia, north to São José do Bonfim and Mamanguape in State of Paraíba, occurring up to 240 m elev. (Frost 2009 Amphibian Species of the World http://research.amnh.org/herpetology/amphibia/index.php IUCN 2009 Global Amphibian Assessment). First state record, extends distribution ca. 588 SE from the city of São José do Bonfim, Paraíba state (Arzabe et al. 1998 Herpetol. J. 8:111–113), and a new elevation range of the species, up to 110 m.

Submitted by **BRUNO B. ANNUNZIATA**, Departamento de Zoologia, Coleção Herpetológica, Universidade de Brasília (UnB), CEP 70.855-160, Brasília, Distrito Federal, Brazil; **IRISMAR S. CASTRO**, Departamento de Biologia, Universidade Estadual do Piauí (UESPI), CEP 64.202-220, Parnaíba, Piauí, Brazil; **WOLNEY M. FONTENELE**, Departamento de Biologia, Universidade Estadual do Piauí (UESPI), CEP 64.202-220, Parnaíba, Piauí, Brazil; and **DANIEL CISNE**, Departamento de Biologia, Universidade Estadual do Piauí (UESPI), CEP 64.202-220, Parnaíba, Piauí, Brazil; e-mail: barcellos.ba@gmail.com.

PSEUDACRIS CRUCIFER (Spring Peeper). USA: ARKANSAS: Carroll Co.: 3.2 km S Berryville off St. Hwy 21 (36.201993°N, 93.340094°W; NAD83). 23 March 1996. H. W. Robison. Verified by S. E. Trauth. Arkansas State University Herpetological Museum (ASUMZ 31320). New county record completely filling a distributional gap in northwestern Arkansas among Benton and Boone counties (Trauth et al. 2004. Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.). This frog has now been reported from all but six counties of the state (Trauth et al. *op. cit*.).

Submitted by **CHRIS T. McALLISTER**, RapidWrite, 102 Brown Street, Hot Springs National Park, Arkansas 71913, USA (e-mail: drcmcallister@aol.com); and **HENRY W. ROBISON**, Department of Biology, Southern Arkansas University, Magnolia, Arkansas 71754, USA (e-mail: hwrobison@suddenlink.net).

RHACOPHORUS PSEUDOMALABARICUS (False Malabar Tree Frog). INDIA: KERALA STATE: Western Ghats: Sakkulathumedu (9.8830556ºN, 77.2330556ºE), Idukki District, 1080 m elev., 10 km N of Periyar Tiger Reserve. 2100 h, 19 April 2008. G. Srinivas and Suganthan R. Sakthivel. Digital image voucher, USDZ (IMG) 1.27. Verified by Karthikeyan Vasudevan. Metamorphs observed 12 June 2008. Including type locality, currently known from two sites in Andiparai shola, 1190 m elev., Indira Gandhi National Park, Tamil Nadu, India (Vasudevan and Dutta 1998. Hamadryad 25[1]:21–28). Appears to be distributed in narrow elevational range. First report for Kerala State, 60 km S of type locality.

Submitted by **G. SRINIVAS** (e-mail: sriniherp@gmail.com), **S. BHUPATHY** (e-mail: bhupathy.s@gmail.com), Salim Ali Centre for Ornithology and Natural History, Anaikatty, Coimbatore 641 108, Tamil Nadu, India; and **SUGANTHAN R. SAKTHIVEL**, Kerala Forest Research Institute, Peechi 680 653, Kerala, India.

SPHAENORHYNCHUS PRASINUS**:** BRAZIL: PERNAMBUCO: Municipality of São Lourenço da Mata: Estação Ecológica do Tapacurá (08.03333ºS, 35.18333ºW, WGS 84, elev. 140 m). 10 January 2000. E. Maranhão dos Santos. Coleção Herpetologica da Universidade Federal Rural de Pernambuco, Unidade Acadêmica de Serra Talhada, Serra Talhada, Pernambuco, Brazil (CHUFRPE 966, adult specimen SVL 26.8 mm). Verified by M. Trefault Rodrigues. Previously known from states of Bahia (Centro de Pesquisa

do Cacau, Ilheus municipality (type locality); Teixeira de Freitas municipality, and Mata de São João municipality), and Minas Gerais (Parque Estadual do Rio Doce), Brazil (Bokermann 1973. Brasil. Biol. 33[4ª]:589–594; Silvano and Pimenta 2003. CD-ROM, Ilhéus, IESB/CI/CABS/UFMG/UNICAMP; Juncá 2006. Biota Neotropica May/Aug 2006 6[2], http://www.biotaneotropica.org.br 2006; Feio et al. 1999. Herpetol. Rev. 30:56–57). First state record, extends the known distribution 860 km NE from type locality and 600 km NE from Mata de São João municipality.

Submitted by **EDNILZA MARANHÃO DOS SANTOS**, Unidade Acadêmica de Serra Talhada, Universidade Federal Rural de Pernambuco, 56900-000, Serra Talhada, PE, Brazil; and **GERALDO JORGE BARBOSA DE MOURA**, Post-graduate Program in Biological Sciences, Universidade Federal da Paraíba, 58059-900, Cidade Universitária, João Pessoa, PB, Brazil.

TRACHYCEPHALUS NIGROMACULATUS (Black-spotted Casque-headed Treefrog). BRAZIL: BAHIA: Municipality of Potiraguá: Cedro Farm (0414551ºS, 8265887ºW), 188 m elev. 20 January 2008. M. A. Freitas, T. O. Lima, and T. F. Miranda. Museu de Zoologia da Universidade Federal da Bahia, Salvador, Brazil (MZUFBA 7825, collected at night below terrestrial bromeliads). Verified by I. Nunes. Previously known from coastal regions of southern Brazil. First state record extends distribution ca. 380 km N from Fundão Municipality, Espírito Santo State (Ramos and Gasparini 2004. Anfíbios do Goiapaba-Açu, Fundão, estado do Espírito Santo. Fundão. 75 pp.).

Submitted by **MARCO ANTÔNIO DE FREITAS,** Programa de pós-graduação em zoologia, UESC (Universidade Estadual de Santa Cruz), CEP 46.500-000 Rodovia Ilhéus/Itabuna, Ilhéus, Bahia, Brazil **(**e-mail: philodryas@hotmail.com); and **TIAGO DE OLIVEIRA LIMA,** Rua São Joaquim n 11, Sagrada Família, CEP 31-700-000, Belo Horizonte, Minas Gerais, Brazil (e- mail: tiagoboidae@yahoo.com.br).

TESTUDINES – TURTLES

TERRAPENE CAROLINA CAROLINA (Eastern Box Turtle). USA: OHIO: Summit Co.: Bath Township, corner of Kemery and Glengary Roads (41.18437ºN, 81.60213ºW). 10 July 2006. Scott and Alice Mason. Verified by Jeffrey G. Davis. Cincinnati Museum Center (CMC Herpetology Photodocumentation Collection HP 245–247). New county record (Wynn and Moody 2006. Ohio Turtle, Lizard, and Snake Atlas. Ohio Biological Survey Misc. Contrib. No. 10, Columbus).

Submitted by **JOHN W. FERNER**, Department of Biology, Thomas More College, Crestview Hills, Kentucky 41017, USA (e–mail: john.ferner@thomasmore.edu); and **VERNA VANDER KOOI**, 1903 Glengary Rd., Akron, Ohio 44333, USA.

TRACHEMYS SCRIPTA ELEGANS (Red-eared Slider) USA: TEXAS: Eastland Co.: 1.7 miles S of Cisco on TX 183, (32.35350˚N, 98.96579˚W; datum WGS84). 05 April 2009. Collected by D. J. Leavitt. Verified by T. J. Hibbitts. Texas Cooperative Wildlife Collection (TCWC 93636). One individual found dead on the road. New county record fills gap within adjacent counties (Dixon 2000. Reptiles and Amphibians of Texas. Texas A&M Univ. Press, College Station. 500 pp.).

Submitted by **DANIEL J. LEAVITT,** Texas Cooperative Wildlife Collection, Department of Wildlife and Fisheries Sciences, Texas A&M University, College Station, Texas 77843, USA.

TRACHEMYS SCRIPTA SCRIPTA (Yellow-bellied Slider) × ***T. S. ELEGANS*** (Red-eared Slider). USA: VIRGINIA: Chesterfield Co.: City of Petersburg (Virginia State University, Randolph Farm), 4415 River Road (3722881°N, 77.43800°W; WGS84). 22 September 2008. Christian A. d'Orgeix and Edward N. Sismour. Verified by Jeffrey C. Beane. North Carolina State Museum (NCSM 74672–74675). Intergrades between native *T. s. scripta* and introduced *T. s. elegans* occur in southeastern Virginia (Mitchell 1994. The Reptiles of Virginia. Smithsonian Institution Press, Washingon, DC. 352 pp.). This new county record is ca. 75 km NW from the nearest known intergrade population in James City Co., Virginia (Mitchell 1994, *op. cit.*). An adult female, adult male, and two juveniles were caught in floating (1.2 m L × 1.2 m W × 1.2 m H), 0.6 cm^2 mesh, black polyethylene fish aquaculture cages in two 0.1 ha artificial aquaculture ponds located ca. 430 m N of the Appomattox River. These individuals represent a range of markings on the head and plastron (i.e., amount and pattern of red and yellow pigment on the head and black spots on the plastron) between the two parental species. Backcrossing of intergrades with parental subspecies or among themselves would explain the range of observed phenotypic variation in the intergrades. We hypothesize that original colonization of these ponds occurred through immigration of the parental subspecies and possibly intergrades from the Appomattox River.

Field work supported through S. Newton (Evans-Allen program, USDA/CSREES, P. L. 95-113, Sec. 1445) and through Virginia General Assembly appropriations for the Virginia State University Agricultural Research Station.

Submitted by **CHRISTIAN A. D'ORGEIX,** National Evolutionary Synthesis Center, 2024 West Main Street, Durham, North Carolina 27701, USA; Department of Biology, Virginia State University, Petersburg, Virginia 23806, USA (e-mail: cdorgeix@vsu.edu); and **EDWARD N. SISMOUR,** Agricultural Research Station, School of Agriculture, Virginia State University, Petersburg, Virginia 23806, USA (e-mail: esismour@vsu.edu).

SQUAMATA – LIZARDS

ANOLIS CHLOROCYANUS (Hispaniolan Green Anole). USA: FLORIDA: Palm Beach Co.: 1301 Summit Boulevard, West Palm Beach, The Palm Beach Zoo (26.667731°N, 80.068944°W, WGS84; elev. < 1m). 16 February 2009. Brian J. Camposano and Mark D. Halvorsen. Verified by Joseph Burgess. Florida Museum of Natural History (UF 154683–84). New county record and extends the range ca. 42 km NE of the closest known locality in Parkland, Broward Co. (Butterfield et al. 1994. Herpetol. Rev. 25:77–78).

Submitted by **BRIAN J. CAMPOSANO**, Division of Herpetology, Florida Museum of Natural History, Dickinson Hall, University of Florida, Gainesville, Florida 32611, USA (e-mail: biscuit1@ufl.edu); **MARK D. HALVORSEN,** Curator of Herpetology, The Palm Beach Zoo, 1301 Summit Boulevard, West Palm Beach, Florida 33405, USA (e-mail: mhalvorsen@palmbeachzoo.

org); and **KENNETH L. KRYSKO**, Division of Herpetology, Florida Museum of Natural History, Dickinson Hall, University of Florida, Gainesville, Florida 32611, USA (e-mail: kenneyk@flmnh.ufl.edu).

ANOLIS DISTICHUS (Bark Anole). USA: FLORIDA: COLLIER CO.: 722 16th Avenue South, Naples (26.12797°N, 81.79576°W; WGS84; elev. < 1 m). 12 April 2008. Steve A. Johnson and Sam Logue. Verified by Kenneth L. Krysko. Florida Museum of Natural History (UF 152789). New county record and extends the range ca. 150 km NW of the closest known locality at SR 997 & SW 300 Street, Homestead, Miami-Dade Co. (UF 147676, Meshaka et al. 2004. The Exotic Amphibians and Reptiles of Florida. Krieger Publ. Co., Malabar, Florida. 155 pp.).

Submitted by **BRIAN J. CAMPOSANO**, Division of Herpetology, Florida Museum of Natural History, Dickinson Hall, University of Florida, Gainesville, Florida 32611, USA (e-mail: biscuit1@ufl.edu); and **STEVE A. JOHNSON**, Wildlife Ecology and Conservation, UF/IFAS Plant City Campus, 1200 North Park Road, University of Florida, Plant City, Florida 33563, USA (e-mail: tadpole@ufl.edu).

PHELSUMA MADAGASCARIENSIS (Madagascar Day Gecko). USA: FLORIDA: MONROE CO.: Sugarloaf Key, 19580 Mayan Street (24.6682797ºN, 81.5277097ºW; WGS84; elev. < 1 m). 31 March 2009. Andrew P. Borgia. Verified by Kevin M. Enge. Florida Museum of Natural History (Photographic voucher UF 155282). First voucher specimen and seventh known island in the Florida Keys to which this species has been introduced (Krysko and Sheehy 2005. Caribbean J. Sci. 41:169–172, Krysko and Hooper 2007. Gekko 5:33–38).

Submitted by **KENNETH L. KRYSKO**, Division of Herpetology, Florida Museum of Natural History, Dickinson Hall, University of Florida, Gainesville, Florida 32611, USA (e-mail: kenneyk@flmnh.ufl.edu); and **ANDREW P. BORGIA**, P.O. Box 4346, Key West, Florida 33041, USA.

PSEUDOCALOTES MICROLEPIS (Small-scaled Montane Forest Lizard). THAILAND: CHIANG RAI PROVINCE: Wieng Pa Pao District, Tambon (= Subdistrict) Pagnew, Moo. 7.6 km S of Ban Pa Miang Mae Hang (19.3505556ºN, 99.5341667ºE). 18 November 2007. K. Kunya. Korat Zoo Museum (KZM 002) and Queen Saovabha Memorial Institute, Bangkok (QSMI 1001). Verified by M. Sumontha (Ranong Marine Fisheries Station). First provincial record based on the rejection by Pauwels et al. (2003. Nat. Hist. J. Chulalongkorn Univ. 3[1]:23–53) of a record from Phetchaburi Province in west Thailand. Species known in Thailand from northern provinces of Chiang Mai and Chiang Rai and northeastern provinces of Chaiyaphum and Loei (Nabhitabhata et al. "2000" 2004. Checklist of Amphibians and Reptiles in Thailand. Office of Environmental Policy and Planning, Bangkok. 152 pp.). We thank L. Chanhome (QSMI) for providing working facilities.

Submitted by **OLIVIER S. G. PAUWELS**, Département des Vertébrés Récents, Institut Royal des Sciences naturelles de Belgique, Rue Vautier 29, 1000 Brussels, Belgium (e-mail: osgpauwels@yahoo.fr); and **KIRATI KUNYA**, Korat Zoo, Muang District, Nakhon Ratchasima, Thailand (e-mail: kkunya2006@yahoo.com).

SQUAMATA – SNAKES

BOA CONSTRICTOR (Boa Constrictor). MÉXICO: HIDALGO. Municipality of Huehuetla, Barrio Aztlán (98.0836°N, 20.43125°W; WSG 84), 496 m elev. 28 August 2008. Froylán Ramírez, Alejandro Ramírez, Adriana López, Nallely Morales, Arely Penguilly, and Arely Flores. Verified by Norma Manríquez-Morán. Colección Herpetológica, Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo (CIB-UAEH 1623). First record for the municipality, extending the range in Hidalgo ca. 99 km S from Tepehuacán de Guerrero (Mendoza et al. 2006. *In* A. Ramírez-Bautista et al. [eds.], Inventarios Herpetofaunísticos de México: Avances en el Conocimiento de su Biodiversidad, pp. 99–109. Publ. Soc. Herpetol. Mex. No. 3. México, D.F.). The snake was found in tropical deciduous forest. Fieldwork was funded by CONACyT- 43761.

Submitted by **IRENE GOYENECHEA** (e-mail: ireneg@uaeh.edu.mx), **JESÚS M. CASTILLO, FROYLÁN RAMÍREZ-RESÉNDIZ,** and **ALEJANDRO RAMÍREZ-PÉREZ**, Centro de Investigaciones Biológicas (CIB), Universidad Autónoma del Estado de Hidalgo, A.P. 1-69 Plaza Juárez, Pachuca, Hidalgo, México.

BUNGARUS SLOWINSKII (Red River Krait). VIETNAM: QUANG NAM PROVINCE: Tay Giang District: B Ha Lee Commune (16.0086111ºN, 107.521666ºE), 750 m elev. 27 April 2006. Doan Van Kien. IEBR 2978. Verified by David Kizirian. Adult male. Previously known from Lao Cai and Yen Bai provinces (Kuch et al. 2005. Copeia 2005:818–833). Third and southernmost record from Vietnam, and ca. 750 km from type locality in Yen Bai Province.

Submitted by **DOAN VAN KIEN** (e-mail: doanvankien@yahoo.fr) and **NGUYEN QUANG TRUONG** (e-mail: NQT2@YAHOO.COM), Institute of Ecology and Biological Resources, 18 Hoang Quoc Viet, Hanoi, Vietnam.

COLUBER (= MASTICOPHIS) FLAGELLUM FLAGELLUM (Eastern Coachwhip). USA: GEORGIA: CHARLTON CO.: ~16 km SSW of St. George (straight distance from town center) (30.39450°N, 82.11297°W; WGS84). 16 June 2004. Nathan H. Nazdrowicz. Verified by John Jensen. Georgia Museum of Natural History photographic voucher (GMNH 50108). Photographed and released. New county record (Jensen et al. [eds.] 2008. Amphibians and Reptiles of Georgia. Univ. Georgia Press, Athens, 575 pp.).

Submitted by **NATHAN H. NAZDROWICZ**, Department of Entomology and Wildlife Ecology, University of Delaware, Newark, Delaware 19716, USA; e-mail: spinifer@aol.com.

COLUBER* (= *MASTICOPHIS*) *FLAGELLUM (Coachwhip). USA: GEORGIA: EMANUEL CO.: Ohoopee Dunes Natural Area, Hall's Bridge Tract, just south of Hall's Bridge Rd., 2.33 km NW of intersection with Frank Wimberly Rd. (32.530277°N, 82.4516861°W; WGS 84). 13 December 2007. Kerry T. Nelson and Andrew M. Durso. Verified by Kenneth L. Krysko. FLMNH 154856. New county record (Jensen et al. [eds.] 2008. Amphibians and Reptiles of Georgia. Univ. Georgia Press, Athens, 575 pp.). A juvenile *M. flagellum* was found on a sandhill under a log at ca. 1230 h. This record is ca. 27.6 km NW of a 2008 record from

Candler Co., Georgia (FLMNH 154400), and ca. 32 km S of a 1994 record from Jefferson Co., Georgia (SSM 13101).

Submitted by **KERRY T. NELSON**, University of Georgia, Warnell School of Forestry and Natural Resources, Athens, Georgia 30602, USA (e-mail: kerrytnelson@gmail.com); and **ANDREW M. DURSO**, University of Georgia, Odum School of Ecology, Athens, Georgia 30602, USA (e-mail: amdurso@gmail.com).

FARANCIA ERYTROGRAMMA ERYTROGRAMMA (Common Rainbow Snake). USA: GEORGIA: Charlton Co.: west bank of St. Marys River at Earnest A. Bell Bridge, Moniac Rd. (Hwy 94) near St. George (30.52438°N, 82.01898°W; WGS84). 31 March 2006. Nathan H. Nazdrowicz and Nigel Watson. Verified by John Jensen. Georgia Museum of Natural History photographic voucher (GMNH 50107). Found under rock on steep bank of river. New county record (Jensen et al. [eds.] 2008. Amphibians and Reptiles of Georgia. Univ. Georgia Press, Athens, 575 pp.).

Submitted by **NATHAN H. NAZDROWICZ** (e-mail: spinifer@aol.com) and **NIGEL WATSON** (e-mail: nigelgwatson@yahoo.com), Department of Entomology and Wildlife Ecology, University of Delaware, Newark, Delaware 19716, USA.

HYDRODYNASTES GIGAS (False Water Cobra). BRAZIL: PIAUÍ: Municipality of Ilha Grande: 2.8219°S, 41.8245°W; datum WGS84, 4 m elev. 23 December 2008. Pedro da Costa Silva. Instituto Butantan, São Paulo (IBSP 77245). Verified by V. J. Germano. Species widely distributed in South America with recognized records from Suriname, French Guyana, Venezuela, Peru, Bolivia, Paraguay, Argentina, and Brazil (Giraudo and Scrocchi. 2002. Smithson. Herpetol. Inf. Serv. 132:1–53). In Brazil, the species has been recorded mainly in the northern, southeastern, and central western states (Franco et al. 2007. Zootaxa. 1613:57–65), however, there is a unique record for northeastern Brazil in Paraíba State (Pereira Filho and Montingelli. 2006. Herpetol. Rev. 37:497). This is the first record for the state of Piauí, extending the distribution previously known as follow: ca. 900 km NW from the municipality of João Pessoa, Paraíba, Brazil (Pereira Filho and Montingelli, *op. cit.*); ca. 1000 km NE from the municipality of Mateiros, Tocantins, Brazil (Vitt et al. 2005. Occas. Pap. Sam Noble Oklahoma Mus. Nat. Hist. [2]:1–24); and ca. 340 km E from the municipality of Perim-Mirim, Maranhão, Brazil (Franco et al. 2007, *op. cit.*).

Submitted by **ROBERTA ROCHA SILVA-LEITE**, Universidade Federal do Piauí, Campus Ministro Reis Velloso, Av. São Sebastião nº 2819, Parnaíba, Piauí, Brazil, CEP 64202-020 (e-mail: roberta.ufpi@gmail.com); **DANIEL LOEBMANN**, Departamento de Zoologia, Instituto de Biociências, Universidade Estadual Paulista, Rio Claro, São Paulo, Brazil, Caixa Postal 199, CEP 13506-970; **PEDRO DA COSTA SILVA**, Associação de Guias e Condutores de Turismo de Ilha Grande, Centro, Ilha Grande, Piauí, Brazil, CEP 64224-970.

LAMPROPELTIS TRIANGULUM (Milksnake). USA: TEXAS: Nacogdoches Co.: Stephen F. Austin Experimental Forest (31.49726°N, 094.78005°W; WGS 84). Stephen F. Austin State University Vertebrate Collection 4916. 01 April 2008 by T. B. Cotten. Verified by T. J. Hibbitts. New county record (Dixon 2000. Amphibians and Reptiles of Texas. Texas A&M Univ. Press, College Station. 129 pp.).

Submitted by **TAYLOR B. COTTEN**, Department of Biology, Stephen F. Austin State University, P.O. Box 13003, S.F.A. Station, Nacogdoches, Texas 75962-3003, USA.

MICRURUS FULVIUS (Harlequin Coralsnake). USA: ALABAMA: Coosa Co.: Cahaba and Columbiana Forever Wild Tract, Coosa Wildlife Management Area (32.8°N, 86.4°W; WGS84). 20 April 2009. Nicholas W. Sharp and Josh D. Landrum. Verified by Robert Mount. Alabama Herpetological Atlas Project AHAP-D-203. Photographed and released. Previously believed to be extirpated in the county. Although range maps typically depict a disjunct population in the Alabama Piedmont north of the Fall Line (Mount 1975. Reptiles and Amphibians of Alabama. Agricultural Experiment Station, Auburn University. 347 pp.), this is the only record of such in 40 years. Auburn University holds only one specimen from Coosa Co., lacking a date and locality; collected sometime before 1975 near Strickland Crossroads, ca. 13 miles N of the current specimen (R. Mount, pers. comm.). Adult captured traversing open ground at 1040 h after heavy rains the previous evening. Habitat was mature Longleaf Pine over well-drained, sandy loam ridges and steep slopes.

Submitted by **NICHOLAS W. SHARP**, Alabama Department of Conservation and Natural Resources, State Lands Division, 64 North Union Street, Montgomery, Alabama 36104, USA; e-mail: nicholas.w.sharp@gmail.com.

MICRURUS FULVIUS (Harlequin Coralsnake). USA: GEORGIA: Talbot Co.: Manchester, ca. 10.8 km E (32.865223ºN, 84.493107ºW; NAD83), 252 m elev. 13 October 2008. Nathan A. Klaus. UF 153883. Verified by Kenneth Krysko. First county record and only the fifth documented specimen from the Pine Mountain/Piedmont physiographic region (Stevenson and Moulis 2008. *In* Jensen et al. [eds.], Amphibians and Reptiles of Georgia, pp. 421–423. Univ. Georgia Press, Athens. 575 pp.). Not seen in this area since 1977 (Pike Co. specimen, AUM 32733). Found on surface along a ridgetop in an area of old growth montane Longleaf Pine (*Pinus palustris*) and Chestnut Oak (*Quercus montana*) forest with rocky/gravelly soil.

Submitted by **NATHAN A. KLAUS** (e-mail: nathan.klaus@gadnr.org), and **JOHN B. JENSEN**, Georgia Department of Natural Resources, Nongame Conservation Section, 116 Rum Creek Drive, Forsyth, Georgia 31029, USA.

MICRURUS FULVIUS (Harlequin Coralsnake). USA: GEORGIA: Telfair Co.: Horse River Wildlife Management Area (31.83007°N, 82.85688°W; WGS84). 29 March 2008. Nigel Watson and Nathan H. Nazdrowicz. Verified by John Jensen. Georgia Museum of Natural History photographic voucher (GMNH 50106). One adult observed crossing a dirt road at night. New county record (Jensen et al. [eds.] 2008. Amphibians and Reptiles of Georgia. Univ. Georgia Press, Athens, 575 pp.).

Submitted by **NATHAN H. NAZDROWICZ** (e-mail: spinifer@aol.com) and **NIGEL WATSON** (e-mail: nigelgwatson@yahoo.com), Department of Entomology and Wildlife Ecology, University of Delaware, Newark, Delaware 19716, USA.

MICRURUS LEMNISCATUS LEMNISCATUS (Guiana's Ribbon Coralsnake). BRAZIL: CEARÁ: MUNICIPALITY OF UBAJARA: Ubajara National Park (03.830417°S, 40.900278°W; datum WGS84), 445 m elev. 13 November 2008. D. Loebmann. Verified by F. L. Franco. Coleção Instituto Butantan, São Paulo, Brazil (IBSP 77079). Species recorded for the Amazon Rainforest Biome with distribution in Guyana, Suriname, French Guyana, Colombia, Bolivia, Ecuador, Peru, Venezuela, and Brazilian states of Acre, Amapá, Amazonas, Pará, Maranhão, Rondônia, and Roraima (Cunha and Nascimento 1993. Bol. Mus. Para. Emílio Goeldi, sér. Zool. 9[1]:1–191; Roze 1996. Coral Snakes of the Americas: Biology, Identification, and Venoms. Krieger Publishing Company, Malabar, Florida. 328 pp.; Campbell and Lamar 2004. The Venomous Reptiles of the Western Hemisphere. Cornell University Press, Ithaca, New York. 1032 pp.; Feitosa 2006. Unpubl. thesis. Universidade Federal do Pará, Belém, Pará. 170 pp.). First record for Ceará state and the Caatinga biome, extending distribution ca. 350 km E from state of Maranhão, in surroundings of municipality of Coroatá, Brazil (Campbell and Lamar 2004, *op. cit.*).

Submitted by **DANIEL LOEBMANN**, Departamento de Zoologia, Instituto de Biociências, Universidade Estadual Paulista, Rio Claro, São Paulo, Brazil, Caixa Postal 199, CEP 13506-970; e-mail: contato@danielloebmann.com.

OXYRHOPUS MELANOGENYS ORIENTALIS (Black-headed Calico Snake). BRAZIL: CEARÁ: MUNICIPALITY OF UBAJARA: 3.8450°S, 40.9344°W (datum WGS84), 857 m elev. 10 February 2008. D. Loebmann. Coleção Instituto Butantan, São Paulo, Brazil (IBSP 77061); MUNICIPALITY OF GUARAMIRANGA: 04.2723°S, 38.9492°W, 844 m elev. 10 December 2006. T. Pinto, C. Albano, and I. J. Roberto (IBSP 76979); MUNICIPALITY OF PACOTI: 04.2208°S, 38.9259°W, 758 m elev. 15 April 2006. C. Albano and I. J. Roberto. (IBSP 77980). All verified by F. L. Franco. Subspecies distributed in the Brazilian states of Pará and Maranhão (Cunha and Nascimento 1993. Bol. Mus. Para. Emílio Goeldi, sér. Zool. 9[1]:1–191). First state records represented by two isolated populations in the relict rain forests of the plateau of Ibiapaba and Baturité Hills. Also the first records in the Caatinga biome, extending distribution ca. 480 km E (Plateau of Ibiapaba) and ca. 710 km E (Baturité Hills) from municipality of Santa Inês, state of Maranhão, Brazil (Cunha and Nascimento 1983. Bol. Mus. Para. Emílio Goeldi, sér. Zool. [122]:1–42).

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PANTHEROPHIS GUTTATUS (Red Cornsnake). USA: GEORGIA: EMANUEL CO.: DOR adult male on Hall's Bridge Rd. (CR 160), ~10.75 km SW of Swainsboro (straight distance from town center) (32.54500°N, 82.43683°W; WGS84). 02 April 2002. Nathan H. Nazdrowicz and Shawn T. Dash. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50109). New county record (Jensen et al. [eds.] 2008. Amphibians and Reptiles of Georgia. Univ. Georgia Press, Athens, 575 pp.).

Submitted by **NATHAN H. NAZDROWICZ,** Department of Entomology and Wildlife Ecology, University of Delaware, Newark, Delaware 19716, USA; e-mail: spinifer@aol.com.

RAMPHOTYPHLOPS BRAMINUS (Brahminy Blindsnake). USA: TEXAS: HIDALGO CO.: McAllen (26.261983°N, 98.210933W; WGS 84). 15 March 2009. John Merino. Verified by Frank W. Judd. University of Texas – Pan American Vertebrate Museum (UTPA) 03092. Female (11.3 cm total length and 0.5879 g) found under flat landscaping stones alongside ant colonies in a residential area. This is the first county record and third known locality in the state. Previously reported in adjacent Cameron Co. (Dixon 2000. Amphibians and Reptiles of Texas. 2nd ed. Univ. of Texas A&M Press, College Station. viii + 421 pp.; Godwin et al. 2007. Herpetol. Rev. 38:356; Wallach. 2008. Bull. Chicago Herpetol. Soc. 43[5]:80–82.). Our record lies ca. 88 km WNW of the nearest (= Cameron Co.) published record. On the same day, another was captured at a residence in Edinburg, also in Hidalgo Co. (26.287050°N, 98.175717°W; WGS 84). This individual was found underneath an established plant in a flowerbed. On 19 March 2009 a third individual was captured by G. Martinez and J. M. Cantu in Brownsville, Cameron Co. in a different locality (University of Texas – Brownsville campus) from the previous Cameron Co. record. From 20–30 March 2009 an additional 13 specimens were captured at the two Hidalgo Co. locations. After its first mention in the area over 20 years ago, it appears that *R. braminus* is now well established in the Lower Rio Grande Valley.

Submitted by **JOHN MERINO**, Department of Biology, University of Texas – Pan American, Edinburg, Texas 78539, USA; **LEE BAINES**, Department of Biology, South Texas College, 3201 W. Pecan Blvd., McAllen, Texas 78501, USA; and **FREDERIC ZAIDAN III,** Department of Biology, University of Texas – Pan American, Edinburg, Texas 78539, USA (e-mail: fzaidan@utpa.edu).

SCOLECOPHIS ATROCINCTUS (Black-Banded Snake). HONDURAS: CORTÉS: Sierra de Omoa, Parque Nacional El Cusuco, Buenos Aires Village (15.499722ºN, 88.176667ºW; WGS84), 1120 m elev. 27 July 2007. Jonathan E. Kolby and Douglas Fraser. Verified by Larry D. Wilson. (USNM Herp Images 2685–2688). First record for Cortés, extending the range ca. 111 km N of Lempira, Gracias (FMNH 28559). It is also a 420 m upward extension in elevation from the highest previous record of 700 m reported by Kohler (2003. Reptiles of Central America. Herpeton Verlag Elke Kohler. 367 pp.). The snake was found DOR in a deforested region converted to coffee cultivation.

Submitted by **JONATHAN E. KOLBY**, The Conservation Agency, 6 Swinburne Street, Jamestown, Rhode Island 02835, USA (e-mail: J_Kolby@hotmail.com); and **DOUGLAS FRASER**, Operation Wallacea, Wallace House, Old Bolingbroke, Lincolnshire PE23 4EX, United Kingdom.

SIBON NEBULATUS (Cloudy Snail-eating Snake). MÉXICO: JALISCO: MUNICIPALITY OF SAN SEBASTIÁN DEL OESTE: on the road from Mascota to Ixtapa (20.78017°N, 104.92650°W; WGS84), 917 m elev. 14 June 2007. U. O. García-Vázquez and R. C. Jadin. Both verified by E. N. Smith. Museo de Zoología, Facultad de Ciencias UNAM (MZFC 22051). First verified municipality record that

bridges a distribution gap between Tepic, Nayarit (80 km N) and Chamela, Jalisco (140 km S) (Zweifel 1959. Amer. Mus. Novit. 1953:1–13; Ramirez-Bautista 1994. Manual y Claves Ilustradas de los Anfibios y Reptiles de la Región de Chamela, Jalisco. UNAM, Cuadernos del Inst. de Biol. 23:1–127). Another individual was found nearby on the same road and date (20.81104°N, 104.95510°W, 710 m elev.; UTA R-55780). The vegetation at the capture site was a patch of pristine tropical deciduous forest, although much of what remained was in the process of being burned for agriculture and other developmental purposes.

Submitted by **ROBERT C. JADIN,** Amphibian and Reptile Diversity Research Center and Department of Biology, University of Texas at Arlington, Arlington, Texas 76019, USA (e-mail: snakeman1982@hotmail.com); and **URI OMAR GARCÍA-VÁZQUEZ,** Museo de Zoología, Facultad de Ciencias, Universidad Nacional Autónoma de México, A.P. 70-399, México D.F. (e-mail: urigarcia@gmail.com).

SPILOTES PULLATUS (Tropical Rat Snake). MÉXICO: HIDALGO: Municipality of Huehuetla: El Paraíso (98.13972°N, 20.43125°W, WGS 84), 498 m elev. 28 August 2008. Adán Martínez Sosa. Verified by Norma Manríquez-Morán. Colección Herpetológica, Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo (CIB-UAEH 1622). First municipality record, extending the range in Hidalgo ca. 92 km S from 2.3 km E of San Felipe Orizatlán, Orizatlán (Mendoza-Quijano and Hernández 2001. Herpetol. Rev. 32:279). The snake was found in a coffee field surrounded by tropical deciduous forest. Fieldwork was funded by CONACyT- 43761.

Submitted by **IRENE GOYENECHEA** (e-mail: ireneg@uaeh.edu.mx), **JESÚS M. CASTILLO, FROYLÁN RAMÍREZ-RESÉNDIZ,** and **ALEJANDRO RAMÍREZ-PÉREZ**, Centro de Investigaciones Biológicas (CIB), Universidad Autónoma del Estado de Hidalgo, A.P. 1-69 Plaza Juárez, Pachuca, Hidalgo, México.

STORERIA DEKAYI TEXANA (Texas Brownsnake). USA: TEXAS: Stephens Co.: S of State Highway 180 and E of Ranch Road 717 near Caddo (32.64668ºN, 98.61677ºW). 05 April 2008. Collected by J. W. Streicher. Verified by Carl J. Franklin. Deposited in the herpetological collection of the University of Texas at Arlington (UTA R-56675, field ID: JWS 053). Adult (SVL = 225 mm, TL = 33 mm) found under a roadside log represents first county record. This account is a local range extension W (ca. 4 km) and fills in a longitudinal gap (ca. 50 km) within the known distribution of *S. d. texana* (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. Texas A&M University Press, College Station. 421 pp.; Werler and Dixon 2000. Texas Snakes. University of Texas Press, Austin. 437 pp.). Collected under Texas Parks and Wildlife scientific permit number SPR-0707-1387.

Submitted by **JEFFREY W. STREICHER**, Amphibian and Reptile Diversity Research Center, Department of Biology, The University of Texas at Arlington, Arlington, Texas 76019, USA; e-mail: streicher@uta.edu.

STORERIA DEKAYI WRIGHTORUM (Midland Brownsnake). USA: ARKANSAS: Lincoln Co.: 1.6 km E Palmyra (33.552712°N, 91.563533°W; NAD83). 05 May 2001. M. B. Gannet. Verified by S. E. Trauth. Arkansas State University Herpetological Museum (ASUMZ 31321). New county record filling a distributional hiatus among Arkansas and Cleveland counties (Trauth et al. 2004. Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.). Since the publication of Trauth et al. (*op. cit.*), no fewer than seven new county records in various parts of the state have been documented for this snake.

Submitted by **CHRIS T. McALLISTER**, RapidWrite, 102 Brown Street, Hot Springs National Park, Arkansas 71913, USA (e-mail: drctmcallister@aol.com); and **HENRY W. ROBISON**, Department of Biology, Southern Arkansas University, Magnolia, Arkansas 71754, USA (e-mail: hwrobison@suddenlink.net).

VIRGINIA VALERIAE ELEGANS (Western Smooth Earthsnake). USA: ARKANSAS: Howard Co.: 9.7 km NW Center Point off US 278 (34.025766°N, 93.571243°W; NAD83). 10 June 2004. S. Fowler. Verified by S. E. Trauth. Arkansas State University Herpetological Museum (ASUMZ 31322). New county record filling a distributional hiatus in southwestern Arkansas south of previous records in Polk Co. (Trauth et al. 2004. Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.).

Submitted by **CHRIS T. McALLISTER**, RapidWrite, 102 Brown Street, Hot Springs National Park, Arkansas 71913, USA (e-mail: drctmcallister@aol.com); and **HENRY W. ROBISON**, Department of Biology, Southern Arkansas University, Magnolia, Arkansas 71754, USA (e-mail: hwrobison@suddenlink.net).

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One Hundred and One New County Records for Alabama Amphibians and Reptiles

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The distribution of Alabama's herpetofauna was treated thoroughly in Mount's (1975) regional field guide. Since its publication, few additional distribution contributions for Alabama

(mostly in the form of single-taxon notes) have appeared. Although most counties in Alabama have numerous recorded taxa, a few counties have not been sampled extensively and have fewer than 18 species recorded. To address this situation, we began road cruise surveys on rainy nights in counties with few records. In addition, we have included new records discovered during class field trips and other related activities. Here we report 101 new county records for Alabama. These new records include at least one new county record for 48 species. All new records were verified by Craig Guyer.

Caudata – Salamanders

Ambystoma opacum (Marbled Salamander). DALE CO.: Found AOR 0.3 km W of Judy Creek on Dale County Rd. 36 (31.462594°N, 85.574776°W; WGS 84). 29 December 2007. S. Graham and S. Hoss. AHAP-D 77. LOWNDES CO.: Found AOR on Lowndes County Rd. 40 (32.324877°N, 86.676382°W; WGS 84). 18 October 2007. S. Graham. AHAP-D 64.

Ambystoma talpoideum (Mole Salamander). LOWNDES CO.: Lowndes WMA. Captured by dipnet in shallow marsh (32.357364°N, 86.731320°W; WGS 84). 20 September 2008. S. Graham and K. Gray. AHAP-D 154–155.

Ambystoma tigrinum (Eastern Tiger Salamander). BULLOCK CO.: Collected AOR in Union Springs, crossing US Hwy 29 in historic district at intersection with Hunter St. (32.15068°N, 85.713527°W; WGS 84). 10 December 2008. S. Graham, R. Birkhead, and K. Gray. AHAP-D 176.

Cryptobranchus alleganiensis (Hellbender). LIMESTONE CO.: Caught on fishing line in Sugar Creek at Buck Island Road (State Rt. 99) bridge (34.944524°N, 87.155586°W; WGS 84). 09 March 1990. H. Bloodworth. Photograph of H. Bloodworth and specimen appeared in *Athens News Courier* 25 March 1990; locality and additional information verified by M. Bailey and R. Mount. Newspaper clipping with photo and other information entered into AUM as AHAP-P182. This represents a new county record and one of the most recent verified records for a hellbender in Alabama.

Eurycea cirrigera. (Southern Two-lined Salamander). HALE CO.: Payne Lake Recreational Area, Talladega National Forest. In spring W of Lake. (32.886059°N, 87.445250°W; WGS 84). 20 September 2008. S. Graham and K. Gray. AHAP-D 167.

Eurycea guttolineata (Three-lined Salamander). CRENSHAW CO.: In Threemile Cr. floodplain ~ 25 m E of US Hwy 29 (31.520517°N, 86.335433°W; WGS 84). 18 March 2008. S. Graham. AHAP-D 105. HALE CO.: Payne Lake Recreational Area, Talladega National Forest. In swampy area S. of dam. (32.878206°N, 87.443716°W; WGS 84). 20 September 2008. S. Graham and K. Gray. AHAP-D 157.

Hemidactylium scutatum (Four-toed Salamander). LAMAR CO.: Found AOR Lamar County Rd. 12 .64 km W of Mud Creek Rd. intersection (33.577378°N, 88.144967°W; WGS 84). 29 November 2008. S. Graham and K. Gray. AHAP-D 163. MARENGO CO.: 5.8 km (air km) NE of Dixon's Mill. 1 January 1977. J. Autery. AUM 29664.

Notophthalmus viridescens (Eastern Newt). BULLOCK CO.: Found DOR on Bullock County Road 102 (32.22618°N, 85.4796052°W; WGS 84). 29 December 2007. S. Graham and S. Hoss. AUM 37612. CRENSHAW CO.: Found AOR Crenshaw County Rd. 59 NE of Luverne (31.751883°N, 86.232050°W; WGS 84). 10 December 2008. S. Graham, R. Birkhead, and K. Gray. AHAP-D 168. LAMAR CO.: Found AOR on State Rt. 17 N of Millport 10m N of bridge over Luxapalilla Cr. (33.575406°N, 88.083639°W; WGS 84). 29 November 2008. S. Graham and K. Gray. AHAP-D 162. LOWNDES CO.: Collected AOR on Brownshill Rd. ~ 200m W of Lowndes County Rd. 40 (32.314128°N, 86.584818°W; WGS 84). 21 September 2007. S. Graham, S. Hoss, D. Steen, V. Johnson. AHAP-D 97. WILCOX CO.: Near dam of large beaver marsh along Howard Steen Rd. 3.86 km SW of Wilcox County Rd. 4 (31.884343°N, 86.913055°W; WGS 84). 5 May 2008. S. Graham and R. Birkhead. AHAP-D 99.

Plethodon grobmani (Southeastern Slimy Salamander). CRENSHAW CO.: In Floodplain of Threemile Cr. ~ 25 m E of US Hwy 29 (31.520517°N, 86.335433°W; WGS 84). 18 March 2008. S. Graham. AHAP-D 106. LOWNDES CO.: Collected AOR on Lowndes County Rd. 40 (32.325749°N, 86.731768°W; WGS 84). 18 November 2007. S. Graham and K. Gray. AHAP-D 68. These specimens were not assigned to this taxon using molecular methods; they were assumed to be *P. grobmani* based on existing range maps (Lannoo, 2005) and in any event represent new county records for a species of the *P. glutinosus* complex.

Pseudotriton ruber (Southern Red Salamander). CRENSHAW CO.: In seepage S of Threemile Cr. floodplain ~ 25 m E of US Hwy 29 (31.520517°N, 86.335433°W; WGS 84). 18 March 2008. S. Graham. AHAP-D 104. LOWNDES CO.: Collected in spring just S of Lowndes County Rd. 40 (32.325966°N, 86.681629°W; WGS 84). 10 February 2008. S. Graham and S. Hoss. AUM 37643.

Anura – Frogs

Acris crepitans (Northern Cricket Frog). BULLOCK CO.: Collected AOR Bullock County Road 14 at the Conecuh River (32.010724°N, 85.740373°W; WGS 84). 29 December 2007. S. Graham and S. Hoss. AUM 37613. LAMAR CO.: Collected DOR on Lamar County Rd. 12 (33.579901°N, 88.0989721°W; WGS 84). 12 February 2008. S. Graham and S. Hoss. AUM 37644.

Acris gryllus (Southern Cricket Frog). CRENSHAW CO.: Collected DOR on Crenshaw County Rd. 1200 m NW Crenshaw County Rd. 7 (31.700153°N, 86.375061°W; WGS 84). At least one male also heard calling at this locality on this night (large beaver marsh N of road). 10 December 2008. S.Graham, R. Birkhead, and K. Gray. AHAP-D 180–181.

Anaxyrus fowleri (Fowler's Toad). CRENSHAW CO.: Found at US Hwy 331 at the Conecuh River (31.574056°N, 86.253057°W; WGS 84). 02 October 2008. S. Graham, D. Steen, and K. Gray. AHAP-D 149.

Anaxyrus terrestris (Southern Toad). CRENSHAW CO.: Collected DOR on State Rt. 106 (31.604150°N, 86.414700°W; WGS 84). 10 December 2008. S. Graham, R. Birkhead, and K. Gray. AHAP-D 173. MONROE CO.: Collected AOR on Monroe County Rd. 47 (31.815335°N, 86.959945°W; WGS 84). 22 September 2007. S. Graham and S. Hoss. AHAP-D 80

Gastrophryne carolinensis (Eastern Narrow-mouthed Toad).

Conecuh Co.: In seepage 5m N of State Rt. 106 (31.707310°N, 86.929000°W; WGS 84). 5 May 2008. R. Birkhead and S. Graham. AHAP-D 190. Crenshaw Co.: Found at US Hwy 331 at the Conecuh River (31.574056°N, 86.253057°W; WGS 84). 2 October 2008. S. Graham, D. Steen, and K. Gray. AHAP-D 150. Lowndes Co.: Collected AOR Lowndes County Rd. 40 (32.327441°N, 86.743206 °W; WGS 84). 03 September 2007. S. Graham AHAP-D 75.

Hyla avivoca (Bird-voiced Treefrog). Lowndes Co.: Collected DOR on Lowndes County Rd. 40, 0.64 km E of Cypress Cr. bridge (32.331069°N, 86.669781°W; WGS 84). 18 October 2007. S. Graham. AUM 37570.

Hyla chrysoscelis (Cope's Gray Treefrog). Bullock Co.: Collected AOR on Bullock County Rd. 23, 0.8 km NW of US Hwy 82 (32.17664122°N, 85.7088937°W; WGS 84). 10 July 2008. S. Graham. AHAP-D 130–131. Crenshaw Co.: Collected DOR State Rt. 59 N of Patsburg (31.790033°N, 86.229567°W; WGS 84). 10 December 2008. R. Birkhead, S. Graham, and K. Gray. AHAP-D 179. Cullman Co.: Found along millpond at Clarkson-Legg covered bridge (34.207298°N, 86.990100°W; WGS 84). 11 July 2008. S. Graham, M. Connell, D. McMoran, K. Gray. AHAP-D 141. Lamar Co.: Collected DOR on Lamar County Rd. 12 (33.572793°N, 88.212234°W; WGS 84). 29 November 2008. S. Graham and K. Gray. AHAP-D 165.

Hyla cinerea (Green Treefrog). Butler Co.: Collected DOR on State Rt. 106, 0.8 km W of Butler County Rd. 7 (31.665940°N, 86.856180°W; WGS 84). 18 October 2007. S. Hoss and A. Liner. AUM 37581. Crenshaw Co.: Collected AOR on State Rt. 106 (31.589400°N, 86.396317°W; WGS 84). 10 December 2008. S. Graham, R. Birkhead, and K. Gray. AHAP-D 172. Cullman Co.: Found along millpond at Clarkson-Legg covered bridge (34.207298°N, 86.990100°W; WGS 84). 11 July 2008. S. Graham, M. Connell, D. McMoran, K. Gray. AHAP-D 140. Lowndes Co.: Collected DOR Lowndes County Rd. 29/40 intersection (32.33260°N, 86.646066°W; WGS). 3 September 2007. S. Graham. AUM 37476. Lamar Co.: Collected AOR Lamar County Rd. 12 (33.578240°N, 88.111256°W; WGS 84). 10 January 2008. S. Graham. AHAP-D 101.

Hyla femoralis (Pine Woods Treefrog). Marengo Co.: Collected on Marengo County Rd. 30 200m W of railroad at Magnolia Terminal. 1 August 1976. J. Autery. AUM 29665.

Hyla gratiosa (Barking Treefrog). Crenshaw Co.: Collected AOR on US Hwy 29 SW Brantly (31.577350°N, 86.281700°W; WGS 84). 10 December 2008. S. Graham, R. Birkhead, and K. Gray. AHAP-D 173. Lowndes Co.: Collected AOR on Lowndes County Rd. 40 (32.326992°N, 86.702447°W; WGS 84). 18 October 2007. S. Graham AHAP-D 66.

Hyla squirella (Squirrel Treefrog). Lowndes Co.: Collected AOR on Lowndes County Rd. 40 (32.331811°N, 86.657170°W; WGS 84). 21 September 2007. S. Graham, S. Hoss, D. Steen, V. Johnson. AHAP-D 79. Monroe Co.: Collected DOR on State Rt. 21 6.12 km N of State Rt. 47 bypass (31.570260°N, 87.285750°W; WGS 84). 18 October 2007. S. Hoss and A. Liner. AUM 37580.

Lithobates catesbeianus (American Bullfrog). Lowndes Co.: Collected AOR on Lowndes County Rd. 40 (32.331925°N, 86.649499°W; WGS 84). 21 September 2007. S. Graham, S. Hoss, D. Steen, and V. Johnson. AHAP-D 78.

Lithobates clamitans (Green Frog). Colbert Co.: Along Cane Creek in Cane Creek Canyon Nature Preserve (34.626323°N, 87.805596°W; WGS 84). 13 September 2008. D. Steen, S. Graham, C. Guyer, and K. Bakkegard. AHAP-D 144. Cullman Co.: Found along millpond at Clarkson-Legg covered bridge (34.207298°N, 86.990100°W; WGS 84). 11 July 2008. S. Graham, M. Connell, D. McMoran, K. Gray. AHAP-D 188. Dale Co.: Collected DOR on Dale County Road 19 100m from State Rt. 123 (31.5711208°N, 85.6722654°W; WGS 84). 29 December 2007. S. Graham and S. Hoss. AHAP-D 185–186. Hale Co.: Found AOR on Hale County Rd. 50 ~ 2km E of intersection with Hale County Rd. 44 (32. 966308°N 87.546789°W; WGS 84). 20 September 2008. S. Graham and K. Gray. AHAP-D 161. Lamar Co.: Collected DOR on Lamar County Rd. 12 adjacent to Fernbank Baptist Ch. (33.578645°N, 88.140127°W; WGS 84). 12 February 2008. S. Graham and S. Hoss. AUM 37645. Lowndes Co.: Collected AOR on Lowndes County Rd. 40 (32.331842°N, 86.648872°W; WGS 84). 3 September 2007. S. Graham. AHAP-D 76.

Lithobates palustris (Pickerel Frog). Cullman Co.: Found under Clarkson-Legg covered bridge (34.207298°N, 86.990100°W; WGS 84). 11 July 2008. S. Graham, M. Connell, D. McMoran, K. Gray. AHAP-D 143.

Lithobates sphenocephalus (Southern Leopard Frog). Bullock Co.: Found DOR Bullock County Road 14 at the Conecuh River (32.010724°N, 85.740373°W; WGS 84). 29 December 2007. S. Graham and S. Hoss. AUM 37610. Crenshaw Co.: Collected along west bank of Conecuh River at Crenshaw County Rd. 77 (31.487593°N, 86.361388°W; WGS 84). 4 October 2008. S. Graham, D. Steen, and K. Gray. AHAP-D 152. Lamar Co. Collected AOR St. Route 96 SW of Belk, AL (33.616678°N, 87.954633°W; WGS 84). 10 January 2008. S. Graham. AHAP-D 102. Lowndes Co.: Found AOR on Lowndes County Rd. 40 (32.327348°N, 86.710297°W; WGS 84). 18 October 2007. S. Graham. AHAP-D 65. Pike Co.: Collected DOR on US Hwy 231, 0.16km N of intersection with State Rt. 125 (31.681467°N, 85.824700°W; WGS 84). 10 December 2008 S. Graham, R. Birkhead, and K. Gray. AHAP-D 182.s

Pseudacris crucifer (Spring Peeper). Bullock Co.: Found AOR Bullock County Road 35 (32.029348°N, 85.588407°W; WGS 84). 29 December 2007. S. Graham and S. Hoss. AHAP-D 183. Coffee Co.: Collected AOR on State Rt. 189 0.5 km E of Crenshaw County Line (31.524867°N, 86.189500°W; WGS 84). 10 December 2008. S. Graham, R. Birkhead, and K. Gray. AHAP-D 174. Conecuh Co.: Collected DOR on State Rt. 106 0.1 km E of Conecuh County Rd. 37 and State Rt. 106 intersection (31.706196°N, 86.921304°W; WGS 84). 17 October 2008. S. Graham and K. Gray. AUM 37828. Dale Co.: Found AOR Dale County Road 36 E of Ozark, AL (31.461183°N, 85.579572°W; WGS 84). 29 December 2007. S. Graham and S. Hoss. AHAP-D 184. Fayette Co.: Collected DOR Fayette County Rd. 12 at the Sipsey River (33.543883°N, 87.784320°W; WGS 84). 12 February 2008. S. Graham and S. Hoss. AUM 37646. Lamar Co. Collected AOR St. Route 96 SW of Belk, AL (33.616678°N, 87.954633°W; WGS 84). 10 January 2008. S. Graham. AHAP-D 100. Lowndes Co.: Collected AOR on Lowndes County Rd. 40 (32.326603°N, 86.680310 °W; WGS 84). 18 November 2007. S. Graham and K. Gray. AHAP-D 67. Pickens Co.: Collected DOR State Rt. 17 N of Reform (33.511498°N,

87.980888°W; WGS 84). 29 November 2008. S. Graham and K. Gray. AHAP-D 166.

Pseudacris feriarum (Upland Chorus Frog). Crenshaw Co.: Collected in roadside ditch along Bradleyton Rd. (31.880455°N, 86.250700°W; WGS 84). Several males heard chorusing. 10 December 2008. R. Birkhead, S. Graham, and K. Gray. AHAP-D 171. Dale Co.: Collected in roadside ditch off Dale County Rd. 59 0.6 km NW of Choctawhatchee River (31.478963°N, 85.537040°W; WGS 84). Several males heard chorusing. 29 December 2007. S. Graham and S. Hoss. AHAP-D 187. Lamar Co.: Collected AOR on Lamar County Rd. 12 .80 km E of Mississippi State Line (33.574091°N, 88.262090°W; WGS 84). 29 November 2008. S. Graham and K. Gray. AHAP-D 164.

Scaphiopus holbrookii (Eastern Spadefoot). Bullock Co.: Collected AOR on Bullock County Rd. 40 3.22 km E of Union Springs (32.167561°N, 85.612993°W; WGS 84). 10 July 2008. S. Graham. AHAP-D 132. Dale Co.: Found DOR Dale County Road 36 (31.462133°N, 85.576611°W; WGS 84). 29 December 2007. S. Graham and S. Hoss. AUM 37611.

Testudines – Turtles

Chelydra serpentina (Snapping Turtle). Covington Co.: Found AOR on US Hwy 29 (31.455568°N, 86.433406°W; WGS 84) 3.56 km SW of Covington County Line. 18 March 2008. S. Graham. AHAP-D 107. Lauderdale Co.: Found in Little Cypress Cr. at Lauderdale County Rd. 8 (34.949325°N, 87.694589°W; WGS 84). 12 July 2008. S. Graham, M. Connell, D. McMoran, and K. Gray. AHAP-D 143. Macon Co.: Captured in hoop trap in large beaver marsh in Tuskegee National Forest (32.428926°N, 85.647345°W; WGS 84). 19 June 2008. S. Graham and M. Connell. AHAP-D 129.

Terrapene carolina (Eastern Box Turtle). Cullman Co.: Found under Clarkson-Legg covered bridge (34.207298°N, 86.990100°W; WGS 84). 11 July 2008. S. Graham, M. Connell, D. McMoran, K. Gray. AHAP-D 142.

Squamata – Lizards

Anolis carolinensis (Green Anole). Crenshaw Co.: Collected DOR on Crenshaw County Rd. 59 (31.751883°N, 86.232050°W; WGS 84). 10 December 2008. R. Birkhead, S. Graham, and K. Gray. AHAP-D 177–178.

Plestiodon laticeps (Broad-headed Skink). Crenshaw Co.: Found at US Hwy 331 at the Conecuh River (31.574056°N, 86.253057°W; WGS 84). 2 October 2008. S. Graham, D. Steen, and K. Gray. AHAP-D 146-148.

Scincella lateralis (Little Brown Skink). Hale Co.: Payne Lake Recreational Area, Talladega National Forest. Near spring W of Lake. (32.886059°N, 87.445250°W; WGS 84). 20 September 2008. S. Graham and K. Gray. AHAP-D 160.

Squamata – Snakes

Agkistrodon contortrix (Copperhead). Crenshaw Co.: In Threemile Creek floodplain ~ 25 m E of US Hwy 29 (31.520517°N, 86.335433°W; WGS 84). 04 October, 2008. S. Graham, K. Gray, and D. Steen. AHAP-D 153. Cullman Co.: Found DOR on Cullman County Rd. 1043 100 m E of Winston County Line (34.228753°N, 87.109102°W; WGS 84). 12 April 2008. S. Graham. AHAP-D 121.

Carphophis amoenus (Eastern Wormsnake). Conecuh Co.: In seepage 5 m N of State Rt. 106 (31.707310°N, 86.929000°W; WGS 84). 05 May 2008. R. Birkhead and S. Graham.

Coluber constrictor (North American Racer). Lowndes Co.: Collected DOR Lowndes County Rd. 40 (32.327227°N, 86.762491°W; WGS 84). 03 September 2007. S. Graham. AUM 37480. Wilcox Co.: Collected in small branch 5 m S of Howard Steen Rd. (31.884617°N 96.922506°W; WGS 84). 5 May 2008. R. Birkhead and S. Graham. AHAP-D 98.

Crotalus horridus (Timber Rattlesnake). Lowndes Co.: Collected DOR Lowndes Wildlife Management Area, 200 m W of Check Station turnoff (32.364884°N, 86.740857°W; WGS 84). 03 September 2007. S. Graham. AUM 37478.

Diadophis punctatus (Ring-necked snake). Hale Co.: Payne Lake Recreational Area, Talladega National Forest. In swampy area S of dam (32.878206°N, 87.443716°W; WGS 84). 20 September 2008. S. Graham and K. Gray. AHAP-D 158. Lowndes Co.: Collected AOR Lowndes County Rd. 40 (32.326305°N, 86.680024°W; WGS 84). 21 November 2007. S. Graham. AHAP-D 71.

Lampropeltis getula niger (Eastern Black Kingsnake). Limestone Co.: Found along Limestone Cr. 5 m S of Interstate Hwy 565 (34.648517°N, 86.822358°W; WGS 84). 12 July 2008. S. Graham, M. Connell, D. McMoran, and K. Gray. AHAP-D 189.

Masticophis flagellum (Eastern Coachwhip). Elmore Co.: DOR State Rt. 229, 4.83 km S of Tallassee (32. 493624°N, 85.892708°W; WGS 84). 05 May 2009. R. Birkhead. AHAP-D 204.

Nerodia erythrogaster (Plain-bellied Watersnake). Lowndes Co.: Collected DOR Lowndes County Rd. 40 (32.326305°N, 86.680024°W; WGS 84). 21 November 2007. S. Graham. AHAP-D 70.

Opheodrys aestivus (Rough Greensnake). Lowndes Co.: Collected DOR 8.85 km W of Montgomery County line at Tallawassee Creek bridge over Lowndes County Rd. 40 (32.329826°N, 86.557229°W; WGS 84). 18 October 2007. S. Graham. AUM 37572.

Pantherophis guttatus (Red Cornsnake). Covington Co.: Found DOR on US Hwy 331 at mile marker 10. 2 October 2008. S. Graham, D. Steen, and K. Gray. AHAP-D 151. Elmore Co.: Found DOR Elmore County Road 4 (32.451117°N, 86.075117°W; WGS 84). 17 September 2008. S. Graham and R. Birkhead. AHAP-D 191.

Pantherophis spiloides (Gray Ratsnake). Chilton Co.: Found DOR on US Hwy 82 3.22 km N of Autauga County Line (32.683793°N, 86.791322°W; WGS 84). 30 November 2008. S. Graham. AHAP-D 164. Lowndes Co.: Collected DOR in Lowndes WMA 0.8 km E of Check Station (32.350679°N, 86.725180°W; WGS 84). 21 September 2007. S. Graham, V. Johnson, D. Steen and S. Hoss. AUM 37491.

Storeria dekayi (DeKay's Brownsnake). Bullock Co.: Found AOR on US Hwy 82 N of Union Springs (32.175567°N, 85.709517°W; WGS 84). 10 December 2008. S. Graham, R. Birkhead, and K. Gray. AHAP-D 175. Conecuh Co.: Collected DOR on State Rt. 106 1.45 km E of County Rd. 29 intersection (31.707533°N, 86.933592°W; WGS 84). 17 February 2008. S. Hoss. AUM 37650. Hale Co.: Payne Lake Recreational Area, Talladega National Forest. In spring W of lake. (32.878206°N, 87.443716°W; WGS 84). 20 September 2008. S. Graham and K. Gray. AHAP-D 159. Lowndes Co.: Collected AOR Lowndes County Rd. 40 (32.327649°N, 86.743344°W; WGS 84). 03 September 2007. S. Graham. AHAP-D 74. The Conecuh and Lowndes county records fill a substantial distribution gap from the nearest documented populations to the N (Bibb County) and NE (Montgomery County) to those to the SW (Washington County; Mount 1975).

Storeria occipitomaculata (Redbelly Snake). Henry Co.: Collected in swamp S of Hutto Pond, 4.61 air km W of Laurenceville (31.660815°N, 85.317152°W; WGS 84). 13 May 2009. S. Graham and D. Laurencio. AUM 34915.

Thamnophis sauritus (Eastern Ribbonsnake). Crenshaw Co.: Collected DOR on Crenshaw County Rd. 1, 200m NW Crenshaw County Rd. 7 (31.700153°N, 86.375061°W; WGS 84). 10 December 2008. S.Graham, R. Birkhead, and K. Gray. AHAP-D 169. Lowndes Co.: Collected DOR on Lowndes County Rd. 40 (32.331976°N, 86.594544 °W; WGS 84). 21 September 2007. S. Graham, S. Hoss, D. Steen, V. Johnson. AUM 37490. St. Clair Co.: Found under rock next to small creek along US Hwy 231 ~ 10 km S of Ashville (33.754353°N, 86.275546°W; WGS 84). 2 March 2008. S. Graham and S. Hoss. AHAP-D 103.

Thamnophis sirtalis (Common Gartersnake). Lowndes Co.: Collected DOR on Brownshill Rd. 100 m W of Lowndes County Rd. 40 (32.318552 °N, 86.577542 °W; WGS 84). 3 September 2007. S. Graham AUM 37477.

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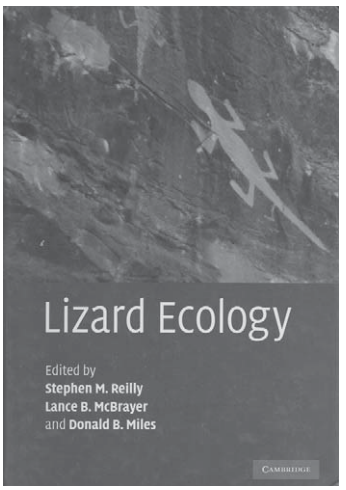
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BOOK REVIEWS

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Lizard Ecology: The Evolutionary Consequences of Foraging Mode, edited by Stephen M. Reilly, Lance B. McBrayer, and Donald B. Miles. 2007. Cambridge University Press, Cambridge, New York. xiv + 531 pp. Hardcover. US $142.00. ISBN 978-0-521-83358-5.

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Lizards have become a model group for research spanning a wide range of biological disciplines, including: morphology, physiology, ecology, behavior, and evolution. Over the past 40 years, many of the advances in lizard ecology have been periodically summarized in books beginning with the title *Lizard Ecology*. These include: *Lizard Ecology: A Symposium* (Milstead 1967), *Lizard Ecology: Studies of a Model Organism* (Huey et al. 1983), and *Lizard Ecology: Historical and Experimental Perspectives* (Pianka and Vitt 1994). The most recent addition, *Lizard Ecology: The Evolutionary Consequences of Foraging Mode* adds to this lineage and provides further evidence of the importance of lizards in understanding the evolutionary complexity and trade-offs inherent in the way animals forage for their food. At its core, *Lizard Ecology* focuses on the sit-and-wait (SW)/ambush mode of foraging versus the active, widely-foraging (WF) dichotomy (analogous to the r-K dichotomy of life history theory), where species are lumped into one or other foraging mode (FM). In the latest release, researchers have tested an immense range of hypotheses from the fields of ecology, evolutionary biology, and animal behavior using species with an equally diverse range of natural histories. The goal of the book is to review research on FM and assess its influence on the biology of squamates that has accumulated over the past 40 years. The book is divided into two parts: I. Organismal patterns of variation in FM, and II. Environmental influences of FM. The first 11 chapters make up Part I and include relationships between FM and various aspects of squamate biology, such as physiology, morphology, anatomy, performance, behavior, diet and life history. Part II centers around the influence of nocturnality (geckos) on FM, plasticity in FM in response to environmental variation, and habitat use and its relationship to food acquisition.

To begin, Ray Huey and Eric Pianka provide interesting insight into the emergence of the term FM (Pianka 1966). Following on in one of the most important chapters (Chapter 1), particularly

in terms of data collection and quality, Gad Perry examines and identifies the all-too-often neglected issues of methodology and terminology of foraging behavior. This is followed by theoretical predictions of foraging theory. Measuring foraging behavior, and the qualitative versus quantitative measures of speed, moves per minute and percentage time spent moving has often been problematic and there has rarely been consensus on how such foraging behaviors should be measured. Perry examines various taxonomic groups to determine the number of observations necessary to reliably estimate foraging behavior. In general, we find that, with the exception of gekkonid lizards, relatively few samples (≥15) are needed to reliably estimate a species' movement rates.

Early predictions of foraging mode suggested "SW" foragers should have high sprint speed and low endurance, highlighting an evolutionary trade-off. In the longest chapter of the book (Chapter 2; 45 pages), Miles et al. use published data on sprint speed, endurance and FM to examine these hypotheses, and provide a macroevolutionary perspective on whether morphology and locomotor performance correlates with FM, using size-corrected data for the majority of lizard groups. Finally, they examine data within *Anolis* to provide a microevolutionary perspective using field data on foraging behavior and locomotor performance in the field. Nonetheless, their ancestral reconstruction reveals that shifts in FM from SW-WF occurred early in the evolution of squamate reptiles, probably at the node of scleroglossans, as other studies have suggested (e.g., Vitt and Pianka 2005). One result to emerge is that SW species have greater sprint speeds than WF species. In closing, the authors warn against categorizing SW-WF as end points of a continuum, but instead encourage the collection of additional data to develop a clearer picture of the differences in foraging behavior.

In Chapter 3, correlates of lizard foraging mode, Kevin Bonine highlights known and potential correlations between physiology and performance traits that relate primarily to FM. Using Arnold's (1983) paradigm (morphology → performance → behavior → fitness) he presents results within a phylogenetic context to explore the link between morphology and performance. In addition, Bonine provides a thorough introduction to FM and physiology, and whole-animal performance measures, including energy balance, sprint speed, endurance, temperature, water loss, aerobic capacity, anaerobic scope, and the sub-organismal physiological traits of respiration and muscle physiology.

Chapter 4 (Brown and Nagy) addresses the fundamental ecological question: do WF species have greater energetic costs than SW species? The authors use published data on field metabolic rates (FMR), and doubly labeled water (DLW) for 46 lizard species, develop allometric equations for members of each FM, which they use to assess the position of new species, and to predict, develop and test bioenergetic hypotheses. They begin by reviewing older studies that examined distantly related SW-FW species, and move onto more recent studies which focus on more closely related species. Next, they examine DLW studies in an attempt to detect general patterns among SW and FW species, before examining the phylogenetic effects of energy use among lacertilians. While their results for the FMR data support the SW-FW dichotomy they suggest that as more foraging behavior data become available, it may be possible to use a continuous predictor (e.g., MPM) to investigate patterns in FM and energy use.

In Chapter 5 the modern-day fathers of lizard ecology, Laurie Vitt and Eric Pianka begin with the admission that… "the foraging mode paradigm is more complex than originally envisioned" (page 141). Fittingly, their chapter sets out to highlight major evolutionary and non-evolutionary factors that affect the prey types consumed by lizards, using diet data for 184 lizard species from Africa, Australia, North America and the New World Tropics. They begin by presenting factors likely to influence the prey consumed by lizards in addition to foraging mode, including; body size, biomechanics of feeding structures, thermoregulatory behavior, times of activity, sensory capabilities, physiological constraints, and resource availability. The results of their phylogenetic analyses revealed that variation among lizard diet is reduced by 80%, suggesting many of the differences are nested deep within the evolutionary history of lizards. The emergence of chemical prey discrimination, jaw prehension, and the use of a WF mode of locomotion to find prey, no doubt led to an increase in prey types that were unavailable previous to iguanians. The sheer number of extant scleroglossans (snakes and lizards; 6000) to iguanians (1230) provides ample evidence for the success of these evolutionary innovations.

In Chapter 6 Shine and Wall examine the reasons for the dramatic degree of intraspecific niche divergence in body size and sex observed in snakes compared to lizards. To begin, the authors highlight a series of mechanisms that may drive observed patterns of: size-dependent shifts in prey consumption, and intersexual niche divergence, including other factors that may cause variation in foraging traits within a species. In the final part of their chapter, the authors highlight the difference between lizards and snakes (e.g., snakes consume a wider range of prey sizes), and follow this with a series of hypothesis that test these ideas. The authors suggest that the functional basis for the intraspecific shift in dietary niche frequently observed in snakes relates mainly to differences in the anatomy, physiology, ecology and behavior observed between snakes and lizards.

Anthony Herrel (Chapter 7) aims to identify those traits (ecological, morphological and performance) in lizards that are typically associated with the two foraging modes, and compares these with the traits typically associated with an herbivorous lifestyle. One of the highlights of this chapter is the finding that ancestry appears not to have constrained the dietary mode of lizards. Regardless of FM the shift to herbivory has led to the evolution of flat, blade-like teeth, high bite force, large size and a longer colon. Moreover, given that these traits are present within omnivorous species, it suggests that the evolutionary shift to herbivory has occurred via an omnivorous diet. Given this, Herrel poses the question of why are their so few scleroglossan herbivores? Clearly, this is one question requiring additional data!

In Chapter 8, William Cooper describes the morphology and physiology of lizard chemosensory systems, the evidence for prey chemical discrimination, and how lizard FMs have influenced these relationships. Evidence is presented in the form of correlated evolution between the lingual-vomeronasal system, food chemical discrimination, and FM. We find that differences in FM have influenced the evolution of diet, and this has then affected the responsiveness of species to the different chemicals of specific food types. In closing, Cooper discusses the role of the lingual-vomeronasal system and foraging mode, for prey chemical discrimination, and

in driving the evolutionary diversification of lizards.

In Chapter 9 McBrayer and Corbin examine patterns of head shape variation in response to FM, in order to establish the existence of trade-offs between head shape, biting force, and FM using 22 species of lizard representing 12 families. Here we find that head length and width has evolved in concert with FM, but that much remains to be learned. In particular, it is unclear whether head shape is changing in response to foraging mode alone, or whether other forces play a part. Following on, Reilly and McBrayer (Chapter 10) examine the convergence and divergence in prey capture and processing behavior and the evolution of lingual and sensory traits in lizards. In general, three distinct patterns of FM emerge: two distinct SW predators, one mixed forager, and thee distinct WFs. They suggest that despite the similar prey processing behaviors of the Iguania and Gekkota, it is achieved via fundamentally different forms of tongue use when capturing prey. The mixed FM and retention of primitive Autarchoglossan features and tongue prehension place the Scincoidea midway. Indeed, the evolution of a tongue with chemosensory abilities appears to have been a pre-determinate of a widely-foraging strategy and is probably a key component of the WF vs. SW FM dichotomy.

Beaupre and Montgomery (Chapter 11) change gear by focusing on the FM of snakes, with reference to interspecific and broad-scale patterns among snakes. They point out that the foraging modes of snakes differ from that of lizards by being strongly determined by phylogeny: species within the same family tend to forage in a similar way, with relatively few exceptions. The authors consider an impressive range of factors likely to influence snake foraging mode. There is evidence, however, that snake foraging modes conform to the "syndrome hypothesis" by being sufficiently variable. Results from a bioenergtic model suggest that within snakes the dichotomous classes of FM may represent adaptive peaks, with intermediate FMs favored only under certain conditions. In closing, it becomes clear that a suitable definition of FM for snakes is lacking.

In Chapter 12 Aaron Bauer examines a group that appears to be an exception to the SW–WF dichotomy, the Gekkota. The Gekkota contain some 1100+ species representing 106 genera from essentially three families. A large summary table (7 pages) provides details of the genera, number of species and FM. The Gekkota display a mixed foraging strategy, and provide some evidence that WF evolved with the Scleroglossa, and was probably facilitated by the development of chemosensory abilities. Thus, despite similar chemosensory abilities as autarchoglossans, the Gekkotans moved along an alternative evolutionary pathway for foraging, having retained visual predation and SW foraging. However, apart from this generality little more can be concluded. Thus, while geckos do not fall neatly into the dichotomous foraging paradigm, Bauer concedes that more data (movement patterns, additional lineages, etc.) are necessary to provide greater confirmation on this placement.

In Chapter 13 Martin Whiting examines plasticity in FM using the lizard *Platysaurus broadleyi* – a member of a clade of SW foragers which shows considerable variation in FM. For instance, juveniles move more in order to hunt insects, while adults move less often making short movements, but switch to active "herbivory" in order to increase the likelihood of encountering figs when available. This provides a clear fitness benefit in situations where a high quality resource becomes available, but which requires a different FM then that which is typically employed. Indeed, whether lizards experience a trade-off between the amount of time spent foraging and courtship/reproducetive behavior, or simply increase energy intake, is unknown—and a question in need of study. In closing, Whiting posses two questions highlighted by the *Platysaurus* system: 1. how widespread is FM plasticity and what is the effect of a spatially and temporally variable high energy resource on FM? and 2. what effect on FM does having traits common to both ambush and active foragers? Clearly, there awaits considerable research potential for such a system!

In Chapter 14 Vanhooydonck et al. provide insight into the relationship between locomotor performance, bite performance and head morphology of lacertid lizards. They investigate how endurance and sprint performance affect an organism's feeding ecology, and whether there is a trade-off between species that rely on sprint performance to acquire prey versus species that are reliant on increased stamina for prey capture. The results suggest endurance and the proportion of soft-bodied prey consumed is co-evolved in lacertid lizards. However, speed is not correlated with evasive prey, but rather with the proportion of intermediate prey in the diet. In males, body flattening and climbing trade-off is due to a reduction in head height, which is likely to be beneficial for maintaining the center of mass close to the substrate (Aerts et al. 2003), and reducing the possibility of the animal lifting off the substrate. Conversely, there iss no trade-off between body flattening and climbing in females, possibly because of differential selection on head shape in males versus females.

In Chapter 15 Roger Anderson examines FM from the perspective of the principal ecological features required by any organism to survive: finding food, avoiding becoming food, avoiding abiotic extremes (e.g., temperature), and reproducing. Anderson examines how food acquisition mode (FAM), as opposed to FM *per se*, varies among lizards, and among habitats. Unfortunately, the message from this chapter is that we still know too little to conclude much regarding the role of FAM on the evolution of lizard FM. Nonetheless, Anderson proposes promising possibilities for future research, such as the use of laboratory microcosms and semi-natural mesocosms for conducting experimental tests of FAM, prey types, competitors and predators.

In the shortest chapter (Chapter 16) Vitousek et al. examine the Galapagos Marine Iguana, whose short, intense bouts spent foraging on macrophytic marine algae are unique among reptiles, and more reminiscent of a SW foraging style. They the marine iguana as a model system to test how natural and sexual selection drive morphological and behavioral adaptation, including the physiological and environmental constrains that act as intense selective pressures on this species. We find that in response to the strong selective pressures of their energetically costly grazing bouts, marine iguanas have evolved a blunt head, salt glands, and dark coloration allow for maximal energy intake.

In Chapter 17 McBrayer et al. summarize by highlighting those studies to emerge since Huey and Pianka (1981). They point out that while many traits relate to foraging mode, there remain many areas in need of additional research attention. The authors suggest that because FM span both physiological and morphological parameters there is a need for more integrative approaches and thinking; only in this way can both general patterns and variation in lizard foraging biology be understood.

In closing, *Lizard Ecology* brings together a diverse range of information, offering a great starting point for anyone contemplating lizard studies likely to incorporate aspects of food acquisition and foraging behavior. Presumably, this is because it achieves its main goal by determining the influence of FM on the biology of squamate reptiles. Overall, the book contains few errors, a complement to the three editors. While some may lament the lack of color images, the text is well complemented with numerous tables (37), and figures (90). On the downside, however, the book is highly priced (US $142), and may be out of reach for students or people with just a general interest in lizard ecology. Price not withstanding, this work is a worthy acquisition for anyone interested in lizard ecology and behavior. As stated by Kevin Bonine in Chapter 3, the success of books of the *Lizard Ecology* series (Milstead 1967; Huey et al. 1983; Pianka and Vitt 1994), and the recent *Lizards: Windows to the Evolution of Diversity* (Pianka and Vitt 2003) highlight the appeal of lizard biology to scientists and a wider audience alike.

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Erratum

In two recently published geographic distribution notes, the name of one of the coauthors (Paulo Nogueira da Costa) was printed incorrectly. The citations, with correct author names, are:

Silva-Soares, Thiago, Paulo Nogueira da Costa, and Rodrigo B. Ferreira. 2009. Geographic distribution: *Chiasmocleis carvalhoi* (Central Humming Frog). Herpetological Review 40:107.

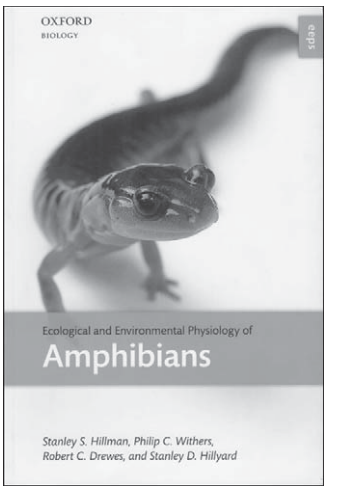
Silva-Soares, Thiago, Rodrigo B. Ferreira, and Paulo Nogueira da Costa. 2009. Geographic distribution: *Ischnocnema oea* (Espírito Santo Robber frog). Herpetological Review 40:108.

Herpetological Review, 2009, 40(3), 374–376.

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Ecological and Environmental Physiology of Amphibians, by Stanley S. Hilman, Philip C. Withers, Robert C. Drewes, and Stanley D. Hilyard. 2009. Oxford University Press (www.oup.com). xii + 469 pp. Softcover. US $65.00. ISBN 978–0–19–857032–5.

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The new book *Ecological and Environmental Physiology of Amphibians* provides an up-to-date and relatively concise summary of comparative research on amphibian physiology. This is the first volume in the Ecological and Environmental Physiology Series published by Oxford University Press; similar volumes are in the works for reptiles, fishes, birds, insects, and crustaceans (http://www.eeps-oxford.com). One may wonder whether this review is necessary following the relatively recent synthesis edited by Feder and Burrgren (1992). However, this new book fills a different niche and is more appropriate for those looking for a concise review, especially students. This multi-authored book provides a relatively well-integrated and cohesive view of the topic that should prove accessible to researchers, graduate students, and those teaching courses in physiology or amphibian biology. While Hillman and co-authors touch on many aspects of amphibian physiology, the book places a particular emphasis on water balance, an obviously important topic for amphibians and a dominant area of expertise of the authors. This book will serve as a useful and up-to-date addition to the much larger volume by Feder and Burggren (1992).

Most importantly, this book will serve as an entry point for students and researchers interested in integrating a physiological component into their comparative and phylogenetic studies. While not as all encompassing as Feder and Burggren (1992), Hillman et al. succeed in producing a work is perhaps a more engaging introduction to amphibian physiology. This book provides references to and short summaries of relevant literature published since 1992, especially for some topics such as metabolic depression. It also provides gems for young physiologists and comparative biologists interested in unusual features of amphibians, such as the sections dealing with cutaneous water exchange (including "waterproof" frogs in *Chiromantis* or *Phyllomedusa*), the physiology of the "pelvic" or "seat" patch, cocoon formation, dehydration tolerance, and hypoxia.

The book is organized into six chapters: an introduction with a discussion of diversity, phylogeny, and basic physiological challenges faced by amphibians; two chapters summarizing both basic and specialized aspects of amphibian physiology; a chapter on the

physiology of species living in "extreme" environments; and two final short chapters, one detailing approaches and techniques and the other on future directions. I found the separation of chapters into basic, specialized, and "extreme" physiology to be a useful division that highlights the physiology of unusual taxa living in deserts or regions with freezing soils. The section concerning techniques in amphibian physiology provides a quick introduction to oft-used methods and the inclusion of some historical background for some methods is a nice touch.

The section on cardiovascular oxygen and carbon dioxide exchange (2.6) is probably my favorite. In many ways, it is representative of the many positive aspects of this book and its utility for those requiring an informed yet brief introduction. This section includes reviews of cardiovascular anatomy and basic physiology, and has a number of short, readable passages on topics such as arterial pressure, mixing of pulmocutaneous and systemic flows, and cardiac output.

This basic summary and introduction to the relationship between physiology and ecology will be of interest to audiences other than physiologists, such as those interested in ecological niche modeling. The chapter on physiological adaptations to extreme environments provides interesting food for thought for those considering how environmental variables contribute to determining species distributions. There is a general lack of knowledge about where amphibians actually spend their time (e.g., in trees, under ground, and high up or far down), but this book engenders an appreciation that this likely has important physiological consequences. There is also a fair amount of physiological variation between species, for instance in the ability to "supercool" which would effect species distributions. Basic data on the relationship between physiology and ecology is also important to evolutionary studies of the relationship between morphology and the environment, which, for example, has been relatively little explored in frogs, especially the Neobatrachia.

In a relatively short review of a topic as large and varied as amphibian physiology, there are inevitably many areas that receive little attention; examples include endocrinology, development, or locomotory and behavioral energetics. Despite the focus on the relationship between physiology and the environment, the mention of phenotypic plasticity is limited to an exceedingly brief discussion of developmental rates. Studies on plasticity and reaction norms can form a beneficial basis for many research programs (e.g., Schlichting and Pigliucci, 1998; West-Eberhard, 2003), including those on amphibian physiology. There are several short sections on larval physiology (e.g., energy budgets, skin morphology), but, in general, there is little attention paid to larvae or metamorphosis. For those interested in these topics, I suggest turning to the thorough review by Burggren and Just (1992).

I appreciated that many of the flow charts summarizing available data contain references pointing to appropriate literature. Summary tables, such as Table 2.2, are very useful and help to drive home the lack of knowledge for most species. Many of the plots and flow charts will prove useful as teaching aids, though some drawings and photographs could be of higher quality (e.g., Figs. 2.37, 3.41, 4.6A, 5.10).

The first chapter of this work lays out a comparative framework that aims to encapsulate all living amphibian diversity, including a lengthy section titled "Habitats and Morphotypes." While some discussion does appear in the literature (e.g., Emerson, 1988), to my knowledge, such a detailed and explicit discussion of amphibian morphotypes has not been published previously in a form that is easily accessible to students. The authors state that the discussion of morphotypes is intended to refine the traditional categories of aquatic, fossorial, terrestrial, and arboreal. However, the categories proposed by the authors will need further scrutiny as some are separated by few substantial differences. For example, imagine trying to teach the difference between "semi-aquatic" and "semi-terrestrial (mesic)"; the only character state given that differs between these morphotypes is the amount of webbing (fully webbed vs. not fully webbed). This is a good start, but further quantitative studies of morphotypes will be necessary. One drawback is that the relationship between morphotypes and environment is not adequately explored using comparative methods. Morphotypes are summarized by family in Table 1.1 (with the number of species examined in parentheses; R. Drewes, pers. comm.), but it is only much later in the book (p. 377) that the often extensive variation within families and genera is clearly pointed out. However, this review of morphotypes still provides a concise summary for students and is a satisfactory start at dissecting ecomorphological diversity within the three orders of living amphibians.

At the time of the last thorough synthesis of environmental physiology of amphibians (i.e., 1992), the described diversity of amphibians was considerably less (~ 70% of the diversity recognized at the time of writing this review; D. Frost, pers. comm.) and a central problem confounding comparative research was the lack of phylogenetic data. Yet descriptions of new species and the accumulation of phylogenetic data now far outpace comparative morphological and physiological studies, which can be labor-intensive for obtaining data for a few, or even just one, species. While limited, comparative data do exist for some topics and could be analyzed using comparative methods to investigate correlations between physiological features or examine character evolution over the phylogeny. In fact, the authors do make some claims regarding the change or conservation of traits across phylogeny. For example, the authors state that the energy source underlying metamorphic climax varies "interspecifically with little phylogenetic inertia" (p. 110), though this appears to be based on only four species from three families. It seems that the authors intended to use comparative analyses to make use of recent phylogenetic data. However, the only example that I could find of using comparative data in a phylogenetic context is the analysis of standard metabolic rate that appears in the sections on phylogeny and environmental physiology and on comparative methods. The authors might have missed an opportunity by not combining available data from recent phylogenetics research with that from either comparative physiology or the morphotypes that they describe. The text is peppered with comparisons between "aquatic" and "terrestrial" species, though usually with little mention of phylogenetic relationships. By couching these arguments in a phylogenetic context, the authors could have made an even stronger case concerning the environmental correlates of observed physiological diversity.

Perhaps most importantly, this review by Hillman and co-authors underscores that the vast majority of living amphibians still remains to be studied in physiological research. We know little of the physiology of most amphibian larvae, exceedingly little about caecilians, not much about the relationship of physiological

phenotypes with genotype × environment interactions, and without better studies of interspecific variation we will lack the insight into the "hows and whys" underlying physiological variation. With appropriate estimates of the amphibian tree of life in hand, we now need to integrate these with ecological and physiological data to understand "how environmental differences have shaped intra- and interspecific variation in amphibians' physiological performance" (p. 376). A book such as this one is poised to inspire students to do exactly that.

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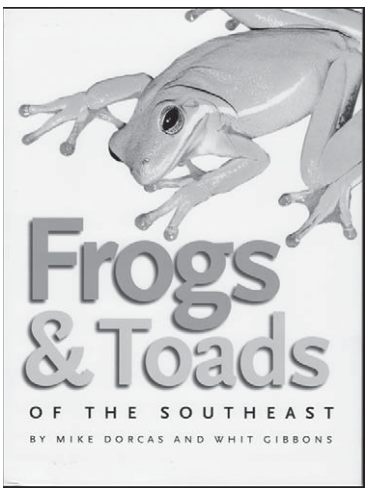
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Frogs and Toads of the Southeast, by Mike Dorcas and Whit Gibbons. 2008. The University of Georgia Press (www.ugapress.uga.edu). US $22.95. viii + 238 pp. Flexible cover. ISBN-978-0-8203-2922-2.

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This book is the third in a series on amphibians and reptiles of the Southeast published by the University of Georgia Press. It closely follows the format of the two previous volumes on snakes (Gibbons and Dorcas 2005) and turtles (Buhlmann et al. 2008), and covers the same nine-state region (Virginia, Tennessee, the Carolinas, Georgia, Florida, Alabama, Mississippi, and Louisiana) defined as the Southeast in the other volumes. Like the others in this series, it was written with a broad and general readership in mind, but it will also be highly useful to professional herpetologists and seasoned naturalists.

Species accounts are included for all 42 (38 native and four introduced) species known from the region. Each account is divided into sections on "Description," "What do the tadpoles look like?," "Similar species," "Distribution and habitat," "Behavior and activity," "Food and feeding," Description of call," "Reproduction," "Predators and defense," "Conservation," and "Comments." Each also contains several photographs, shaded distribution maps of the species' range within the region as well as its overall range, a sidebar with quick identification tips, and a bar chart with peak calling months indicated by shading. In addition, the book includes a thorough introductory section, a glossary, a table of calling months for all species, a quick-reference table of species found in each state, a list of further reading, indices of scientific and common names, and a closing section on human-anuran interactions. The pages throughout are punctuated with "Did you know?" sidebars featuring interesting facts on frogs and toads. The book carries a strong conservation message throughout, and I have only praise for this conservation-oriented approach.

The more than 300 color photographs range in quality from adequate to excellent. Virtually all serve their purpose of showcasing anuran beauty and diversity, pointing out important identification features, and illustrating intraspecific variation. This last is an especially important feature — too many works allow only a single photograph or illustration of each species covered and fail to adequately cover the often extensive range of variation exhibited by most species. In a few cases, the choices of included photographs could have been improved upon. For example, all the included images of *Hyla squirella* show similarly-colored bright green individuals. As this frog is, color-wise, one of the most variable species in the Southeast, it would have been helpful to have included more images of individuals in gray, brown, and heavily spotted liveries. Several photographs are included more than once. While there is certainly nothing wrong with that *per se*, it may present an illusion that the book has more photos than it actually does, and considering the cost of color printing and the great array of quality anuran photographs available, any such repetition seems unnecessary.

Most of the errors I noticed are ones I would regard as minor. To cite a few examples, on pages 10 and 78 (one of the aforementioned instances of an image being included more than once) a ribbon snake is misidentified as a common garter snake. I also believe the metamorphs identified as green treefrogs at the bottom of page 13 are probably squirrel or possibly pine woods treefrogs. "Brumation" is misspelled in the glossary and "Pine Barrens" is misspelled twice ("Pine Barren" and "Pine barrens") on page 82. The green treefrog account (page 76) states that "no other southeastern treefrog has small, bright orange or gold spots" (in fact, the barking treefrog also frequently has such spots). Page 142 shows "a river frog transforming from a tadpole into an adult" (". . . into a juvenile" would be more accurate). There are a number of errors in the index. For example, the index lists a nonexistent reference to squirrel treefrogs on page 211, and page 207 and 212 feature photographs of a southern toad and a barking treefrog, respectively, but these are not listed in the index. I also found the variable fonts and type sizes, and inconsistent use of italics among the listed page numbers in the index to be slightly confusing. Finally, I am inclined to question the statement (page 44): "Southern and northern cricket frogs occasionally interbreed in areas where

both occur and can produce hybrids that are difficult to identify." While Mount (1975) and Jensen (2005) mentioned possible hybrids between these two species, and Mecham (1964) was able to produce laboratory hybrids, there is apparently scant, if any, solid evidence to support natural hybridization. Mette (2008) and Micancin and Mette (2009) suggested that specimens thought to be hybrids may be merely indicative of the difficulty in identifying these two species morphologically.

I was pleased to see each species account include a brief description of the tadpole, as well as photographs of tadpoles for some species; this is another feature sorely lacking in many anuran field guides. I did feel that some of the tadpole descriptions could have been a bit more accurate, thorough, or clear. While some might argue that tadpoles are often so variable that short verbal descriptions, or even photographs, could potentially be more misleading than useful, I view them as generally helpful, especially for species with particularly distinctive tadpoles (river frog, eastern narrowmouth toad, cricket frogs).

At 7¾" x 10¼", the book's size may hinder its use somewhat as a field guide, but the flexible cover may compensate enough for it to fit into a backpack or otherwise be more easily transported than would a hardback of the same dimensions.

Overall, this volume is an excellent and welcome addition to the series. As the only published work covering exclusively the anurans occurring in the nine-state Southeast region, it will be a valuable addition to the library of anyone interested in the natural history of that region.

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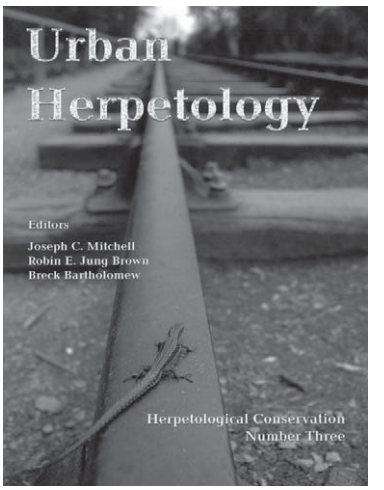
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Urban Herpetology (Herpetological Conservation, Number 3), edited by Joseph C. Mitchell, Robin E. Jung Brown, and Breck Bartholomew. 2008. Society for the Study of Amphibians and Reptiles, Salt Lake City (www.SSARherps.org). Hardcover. xvii + 586 pp. US $75.00. ISBN 978–0–916984–79–3.

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Urban Herpetology is a brick. At 40 chapters and 13 case studies, this is not the type of tome one moves casually between office and home. My 20 minute morning walk to work with this bad boy in my rucksack buckled my knees several times and cracked the casing of my lap top. I've successfully blocked ravaging graduate students from entering my office by leaning it against my closed office door. Be forewarned. Also be forewarned that there's useful information in this book. Although I've had some experience with its effects…..the type locality for the Italian agile frog, *Rana latastei*, with which I have worked for several years, is located somewhere in the heart of downtown Milano, where the species is no longer to be found…..I had little familiarity with the specific topic of urban herpetology before agreeing to review this book. I was laboring under the delusion that the study of herps in cities and related areas fell under the old standards of habitat loss and modification, pollution, invasive species and other IUCN-type threats (although even the IUCN has modified their categories: anyone ever heard of transportation and service corridors?). I was pleased to see some familiar words in the section headings and my readings made me realize more clearly how urbanization can bring specific, new and worrying takes on the old IUCN standards. Reading this book has persuaded me that there is a need for me to reconsider how urbanization does and will impact amphibian and reptile populations. I can envision how I may use the information contained within it to some effect, and the chapters I gave short shrift to will be subject to a more thorough reading in the very near future. In the age of narrow focus topical books or superficial undergraduate text books, it is a pleasure to hold a substantial book that covers a fairly broad bit of ground with some depth on a topic that is moving rapidly up the research priority list.

The book opens with a list of contributors, a forward and a preface, followed by an opening overview chapter. This chapter I found exceptionally useful, as it provided me with a tidy historical and geographic overview of urban herpetology. Mitchell and Jung Brown have spent some time collating a valuable list of relevant

references, restricted to English language reference sources, and synthesized their contents neatly. I found their definitions of urban environments most useful, although there is some scope for further refinement. Multiple definitions for exurban are provided, summarized as 1 house per 0.4–16 ha in a matrix that may include native landscapes. This does suggest that Caiapó settlements could be viewed as urbanized, while most would treat the Brazilian forest within which they live as natural.

The rest of the book is broken into sections dealing with various types of habitat alteration (Section I: Direct and Indirect Effects of Habitat Loss and Alteration; Section II: Effects of Roads, Trails and Railroad Tracks; Section IV: Stormwater Ponds, Swimming Pools, Urban Lakes and Golf Courses), pollution (Section III: Chemical and Light Pollution), introduced species (Section V: Introduced Species, Urbanophiles, and Urbanophobes), reviews (Section VI: State, Regional, and Country Reviews), policy (Section VII: Management and Regulations) and outreach (Section VIII: Education and Citizen Involvement). Michael Lannoo provides the afterword. Each section contains up to eight chapters and case studies. Most of the papers specialized on a single or a few species focus on amphibians or chelonians, with a few snake, lizard and crocodilian papers. There are also several papers that attempt to cover both amphibians and reptiles.

I found the papers varied widely in content. Ignoring reviews, quantitative studies ranged from excellent examples of population ecological studies that examined how human-driven habitat change affected population dynamics over time (Chapter 7, Plummer and Mills) to a two-page 'case study' consisting of a collection of anecdotes containing no new empirical data (Case Study 2, Vandeman). In addition, I am unsure that the weight afforded each section was justified. While the number of chapters and case studies in Section I was certainly warranted, why were there only five state, regional, and country reviews? Was it really necessary to have eight chapters and case studies in Section IV, or three chapters outlining the welfare issues of roads? Having said that, I applaud Andrews and Gibbons (Chapter 10) for presenting some rare empirical evidence of possible ecological costs of road mortality to snake populations. As discussed by Andrews, Gibbons and Jochimsen (Chapter 9), most studies of road mortality simply present counts of animals found dead on roads and extrapolating this animal welfare issue to actual population regulation and conservation is fraught with assumptions. While counting dozens or even hundreds of dead reptiles and amphibians on roads is appalling from a welfare point of view, if such a level of slaughter is maintained over time, this suggests that road mortality may not be increasing the likelihood of population extirpation. I encourage other researchers to go and determine if road mortality actually has the ability to regulate populations.

The organization and classification of papers is, on occasion, confusing. Hayes et al.'s study (Chapter 31), arguably one of the best of the book, reviews the ecology of *Rana aurora* in depth and puts it in context of existing legislation, making recommendations as to where legislation fails this species. Even the authors consider it a case study for the species however the paper has been classified as a chapter and put in the section on state, regional and country reviews, even though it is a species review. This chapter is an exception: overall, papers are correctly categorized. The book does have a large number of unreplicated studies that rely on comparisons with previously published data to make conclusions as to the 'health' status of urbanized populations. Not ideal, and any such conclusion must be taken with a grain of salt, even though I do acknowledge the manpower and funding limitations imposed on research groups that dictate how much new data can be collected at any one time. Perhaps this may serve as a call for different research teams studying the same species in urban versus rural versus 'natural' habitats to join forces and develop broader, more comparative studies?

I have three major issues with this book. First, the editors claim that *Urban Herpetology* encapsulates a global perspective, stating their hope that the book will "....set the stage for future research and conservation efforts around the world…." Clearly overblown: Mitchell and Jung Brown cite numerous recent and empirical studies from Africa, Europe, Canada and Australia in their opening chapter, along with some additional studies from Asia and Latin America, yet most chapters and case studies are based on studies of herps in the United State. There is a smattering of data chapters from Europe, Canada and Australia, along with two review articles representing Russia and the West Indies, but these come across as sops when compared to the number of U.S. studies included in the book versus the spectrum of available published literature tabulated and cited in Chapter 1. This bias narrows the insight into urban herpetology afforded readers of the book because the contents do not reflect the distribution of research effort on the topic. As stated by Mitchell and Jung Brown "….much of the available herpetofaunal literature on the impacts of urbanization……is based on work done in Europe. The only serious long-term studies have been conducted (t)here." Further: "A growing body of literature on urban amphibians and reptiles continues to be produced in Australia." The bias extends to the selection of section headings and their contents, to the detriment of herpetologists in other parts of the world. I find it unlikely that researchers in much of Africa, Asia and Latin America will find the section on stormwater ponds, swimming pools, urban lakes and golf courses valuable. Researchers studying how urbanization affects herps in the U.S.A. would certainly benefit from understanding how advanced and long-term urbanization in areas such as Europe, Africa, the Fertile Crescent and some parts of Asia has impacted herps in those regions. Imagine studying the ecology of urbanized herps in Tokyo, the focus of Imperial Japanese power since the shogun of Edo won a civil war in the 16th century and subject to increasing levels of urbanization ever since! Are there any herps to be found in Greater Tokyo? Urban Herpetology doesn't answer this question, but a quick Google hunt returns a study by Kusano and Inoue (2009) on the breeding phenology of three Japanese amphibian species in the suburbs of Tokyo, rather ironically published in the *Journal of Herpetology*. Of course, SSAR is an organization based in the United States, but once claims of a global perspective are made, a lack of attention to it grates.

My second issue is with the complete lack of a genetics perspective. Habitat alteration, fragmentation and pollution, to name a few relevant urbanization processes, are known to influence genetic structure, and there is a wealth of genetic studies on urbanized herps to support this (e.g., Madsen et al. 1996, 1999; Hitchings and Beebee 1997; Andersen et al. 2004; Johansson et al. 2005; Lesbarrères et al. 2006; Ficetola et al. 2007; Noël et al. 2007; see Beebee 2005 for a review of genetics applications that are applica-

ble to studies of urbanized herps). These studies consistently show how habitat fragmentation due to urbanization decrease genetic variability and gene flow among populations, often with associated population-averaged or individual fitness costs. Quantitative genetics have been used to explore amphibian responses to acid stress, providing insight into the potential for a species to adapt in the face of increasing chemical pollution (Merilä et al. 2004). Recent developments in Bayesian population genetics approaches have been successfully used to reveal demographic processes that were not detected using standard field ecology methods (e.g., Jehle et al. 2005). Many of the studies included in Urban Herpetology describe demographic processes that should elevate genetic drift, such as low migration rates, and populations exposed to factors that should impose selection, yet the editors did not think the topic worthy of a single chapter or case study. Why the omission?

My third issue is the decidedly mechanistic perspective evinced throughout the book. Urbanization is set to increase and more species will be forced to exist in human-modified habitat, thus identifying the circumstances that allow species to persist over long time scales is crucial for herpetological conservation. Where is the evolutionary perspective that would facilitate managing urbanized populations? In fact, where is the section on adaptive management, briefly discussed by Hayes et al in Chapter 31? Important questions that can only be addressed using evolutionary concepts are not addressed in *Urban Herpetology*. How can we expect urbanization and climate change to interact and what are the consequences for amphibians and reptiles? Some chapters do take a more dynamic approach to urban herpetology and herpetological conservation, but by and large species and populations are treated as static units and conservation applications as one-off responses to interpretations of current data and trends.

In the end, if you can stump up US $75, the book is worth buying after you determine if the range of topics, taxa, and geographic regions are relevant to your research program. My hope is that this first book on urban herpetology will generate follow-ups, along the lines of Seigel and Collins' snake ecology books or, better yet, Krebs and Davies' series on Behavioral Ecology, that take this decent, but limited, first effort into as yet unexplored aspects of urban herpetology.

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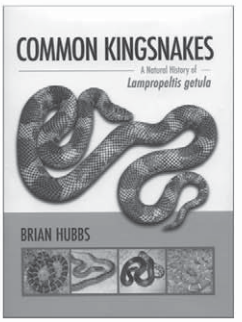
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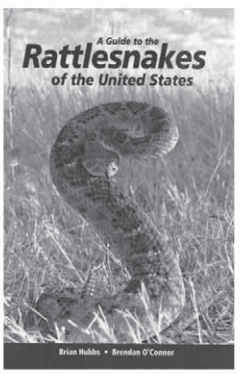
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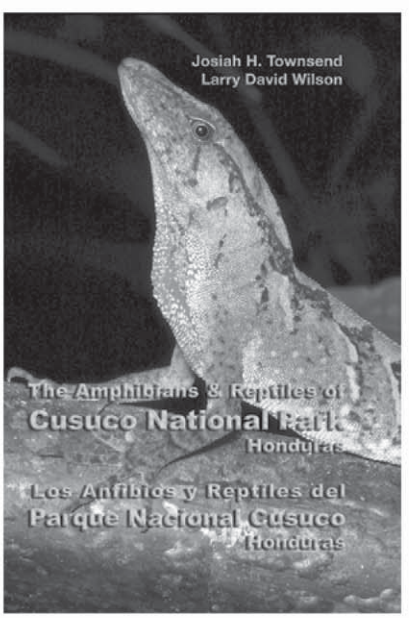
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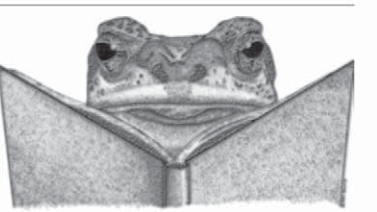
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About Our Cover: *Sceloporus minor*



The spiny lizards of the genus *Sceloporus* range throughout much of the United States south into Central America and number approximately 90 species (Bell et al. 2003. Acta Zoológica Mexicana [n.s.] [90]:103–174). The genus reaches its greatest diversity in central Mexico, with as many as 9 or 10 species co-occurring in many places. They occupy a diversity of habitats and niches, and range in size from the diminutive *Sceloporus parvus* (SVL ~50 mm) to the relatively large *S. serrifer* (≥ 150 mm SVL).

Of particular interest are populations within the *S. jarrovii* complex, a group of closely related species (Wiens et al. 1999. Evolution 53[6]:1884–1897; Wiens and Penkrot 2002. Sysematic Biology 51[1]:69–91; Martínez-Méndez and Méndez-de la Cruz 2007. Zootaxa 1609:53–68), the males of which exhibit high levels of variation in dorsal coloration, presumably the result of sexual selection (Wiens et al., *op. cit.*). Certainly this is true for *S. minor*, a species associated with rocky. mountainous terrain from northeastern Zacatecas, central Nuevo Leon, and western Tamaulipas south though San Luis Potosi to Guanajuato, Querétaro, and Hidalgo. In some locations, this lizard occurs in extremely high densities, and males display a variety of dorsal colors—gray, gold, or red, often with blue highlights on the head, legs, and tail. On some individuals, this blue coloration can be extremely bright, and may cover the entire dorsum.

Our cover features a young adult male *Sceloporus minor* photographed by **Troy Hibbitts** in August 2008 in the Sierra Madre Oriental of central Nuevo Leon, Mexico. Individuals of this population display unusually gaudy colors, with some specimens exhibiting a complete dorsal suffusion of blue. To record this image, Troy used a Nikon D50 and a Sigma 17–70mm lens set at a focal length of 17mm (ISO 800, F22, 1/60th second exposure) with a Nikon SB600 as fill flash. Hibbitts is a high school science teacher in Texas, and often travels to Latin America to photograph herpetofauna.



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SSAR Grants-in-Herpetology 2009 Annual Report

An award in the amount of US $500 was made to each of the following individuals:

Conservation.—**Rosalinda Palomo-Ramos**, New Mexico State University, "Foraging ecology and nutritional requirements of the Bolson Tortoise (*Gopherus flavomarginatus*) in the northern and southern Chihuahuan Desert."

Field Research.— **Jeanine Refsnider**, Iowa State University, "Can maternal nest-site choice compensate for the effects of global climate change on reptiles with temperature-dependent sex determination? A common-garden experiment using a model species."

Laboratory Research.—**Brittany S. Barker**, University of New Mexico, "Phylogeography of a montane endemic and its widespread congener: *Eleutherodactylus portoricensis* and *E. antillensis* in the Caribbean."

Travel.—**Arley Camargo**, Brigham Young University, "Species boundaries and phylogeny of the *Liolaemus darwinii* species group (Squamata: Liolaemini)."

International.—**Carlos Miguel Del Valle-Useche**, Universidad Nacional de Colombia, "Conservation and management of the Colombian slider turtle (*Trachemys callirostris*) based on mtDNA sequences."

Education.—**Dan Costel**, Lowry Park Zoo, "Amphibian Crisis Education Project."

2009 Grants-in-Herpetology Committee.—Co-chairs: Erik R. Wild and Josh Kapfer. Reviewers: Jeffrey Parmelee, Eli Greenbaum, Rebecca Christoffel, Rich King, Melissa Pilgrim, Jerry Husak, Greg Haenel, Mike Pauers, John Maerz. SSAR congratulates the 2009 GIH recipients and thanks the committee members for their efforts.

SSAR Silent Auction Donations

The SSAR announces the Thirteenth Annual Silent Auction to be held at the 2009 Joint Meeting of Ichthyologists and Herpetologists (JMIH) in Portland, Oregon, July 22–27. In previous years, items for the Silent Auction have been limited to frameable art. However, this year, we are glad to accept any herp-related donations, including, but not limited to, frameable art (photographs, paintings, and line illustrations), books, music, glassware, jewelry, clothing and gift certificates for Portland area services/events during the meeting week. The SSAR Student Travel Committee organizes the Annual Silent Auction to raise money to fund the student travel awards to the JMIH. Your donations help provide opportunities for students to attend and present their research. If you are interested in donating an item or two (tax deductible for U.S. residents), please contact Matthew D. Venesky (mvenesky@memphis.edu) for more information.

MEETINGS

Meetings Calendar

Meeting announcement information should be sent directly to the Editor (HerpReview@gmail.com) well in advance of the event.

18–20 July 2009— 5th Meeting of the Snake Ecology Group, Donnelly, Idaho, USA. Registration and information: http://www.projectorianne.org/SEG_5.html.

22–27 July 2009— 52nd Annual Meeting, Society for the Study of Amphibians and Reptiles; 89th Annual Meeting, American Society of Ichthyologists and Herpetologists; 67th Annual Meeting, The Herpetologists' League. Portland, Oregon, USA. Information: http://www.dce.ksu.edu/jointmeeting/.

5–8 August 2009— 7th Annual Turtle Survival Alliance Symposium on Chelonian Conservation and Biology, St. Louis, Missouri, USA. Information: http://www.turtlesurvival.org.

12–17 September 2009— Association of Zoos and Aquariums Annual Conference, Portland, Oregon. Information: http://www.aza.org/AnnualConference/index.html.

2–4 October 2009— Symposium on *Anolis* Biology, Harvard University, Cambridge, Massachusetts, USA. Information: http://anolis.oeb.harvard.edu.

16–17 October 2009— Texas Herpetological Society Fall Symposium, Texas A&M University, College Station, Texas, USA. Information: www.kingsnake.com/ths.

17–19 October 2009— Gaffney Chelonian Fossil Symposium, Drumheller, Alberta, Canada. Information: http://www.tyrrellmuseum.com/events/turtlesymp09.php

CURRENT RESEARCH

The purpose of Current Research is to present brief summaries and citations for selected papers from journals other than those published by the American Society of Ichthyologists and Herpetologists, The Herpetologists' League, and the Society for the Study of Amphibians and Reptiles. Limited space prohibits comprehensive coverage of the literature, but an effort will be made to cover a variety of taxa and topics. To ensure that the coverage is as broad and current as possible, authors are invited to send reprints to the Current Research section editors, Joshua Hale or Ben Lowe; postal and e-mail addresses may be found on the inside front cover.

The current contents of various herpetological journals and other publications can be found at: http://www.herplit.com/contents.

Different Male Color Morphs Display Alternate Mating Strategies in a Lizard

Sexual selection may operate both pre- and post-mating and may involve a number of different mechanisms. Typically, males of the same species demonstrate similar reproductive strategies; however this is not always the case. The Australian Painted Dragon, *Ctenophorus pictus*, consists of three male head color morphs: red, yellow, and orange. In a previous study, it was shown that red males outcompete yellow males in staged encounters for females. Furthermore, red males emerge and establish territories in the wild earlier than yellow males. In this study, the authors measured relative testes size of the color morphs and conducted a number of mating experiments in which females were allowed additional matings with males of different colors, both within the same and across different ovarian cycles. Yellow males had larger testes relative to body size than red males, and were observed to copulate for a shorter time. Microsatellite loci were used to determine paternity, with the authors demonstrating that females are able to store sperm, with males able to sire offspring in an ovarian cycle subsequent to the mating event. Furthermore, these analyses revealed that yellow males sired three times more offspring per copulation than red males (evidence for numerical sperm competition). The authors conclude that the color morphs may be associated with different reproductive tactics, with the yellow morphs able to adopt a "sneaker" strategy due to their larger testis size.

Olsson, M., T. Schwartz, T. Uller and M. Healey. 2009. Effects of sperm storage and male colour on probability of paternity in a polychromatic lizard. Animal Behaviour 77:419–424.

Correspondence to: M. Olsson, School of Biological Sciences, University of Wollongong, Northfields Avenue, Wollongong, NSW 2522, Australia; e-mail: molsson@uow.edu.au

A Review of the Success of Translocations in Amphibians and Reptiles

Translocations are widely used to aid species conservation; however, their usefulness is still keenly debated. In this study, the authors have reviewed the results of amphibian and reptile translocation studies published between 1991 and 2006. In all, 85 translocation projects were examined, 38 of which involved amphibians and 47 involved reptiles. The success rate of translocations was independent of taxonomic class (amphibian or reptile) and was twice that observed pre-1991. The success of amphibian translocations was tightly linked with the number of individuals involved. Translocations in which greater than 1000 individuals were released were more successful than smaller introductions. Translocations most often failed due to poor release site habitat and migration of introduced individuals. Although the authors suggest that the increased success of recent introductions is encouraging, more work is needed, especially research into stress responses of released animals.

Germano, J. M. and P. J. Bishop. 2009. Suitability of amphibians and reptiles for translocation. Conservation Biology 23:7–15.

Correspondence to: Jennifer M. Germano, Department of Zoology, University of Otago, P.O. Box 56, Dunedin 9054, New Zealand; e-mail: jen.germano@otago.ac.nz

Living on Rocks Determines Patterns of Morphological and Performance Evolution in Lizards

Worldwide, lizards occupy a wide array of habitats, yet there remain few cases where habitat use, morphology, and performance,

are clearly related. The best known cases include an increase in limb length in response to increased perch diameter in arboreal anoles. Rocky habitats impose strong natural selection on specific morphological characteristics, which differ markedly from those imposed on terrestrial and arboreal species. Using comparative phylogenetic methods, the authors examined the habitat use, morphology, and performance (sprinting, climbing, clinging and jumping) of 23 populations of skinks representing 19 species from tropical Australia. These populations occupy habitats with considerable variation in rock availability. This study revealed that the occupation of rock-dominated habitats was correlated with the evolution of increased limb length, relative to species from forest habitats that predominantly occupied leaf litter. Moreover, increased limb length directly affected performance, with species from rocky habitats having greater sprinting, climbing, and clinging ability than their relatives from less rocky habitats. The authors conclude that the degree of rock use is correlated with both morphological and performance evolution in this group of tropical lizards.

Goodman, B. A., D. B. Miles, and L. Schwarzkopf. 2008. Life on the rocks: habitat use drives morphological and performance evolution in lizards. Ecology 89:3462–3471.

Correspondence to: Brett A. Goodman, School of Marine and Tropical Biology, James Cook University, Townsville 4812, Queensland, Australia; e-mail: Brett.Goodman@jcu.edu.au

Phylogenetic Placement of Lacertidae in the Squamate Mitochondrial Tree

Representatives of the lizard family Lacertidae have proven to be useful model organisms in a number of studies; however the phylogenetic position of Lacertidae within Squamata has remained controversial. In this study, the authors completed sequencing of the entire mitochondrial genome for three lacertid lizard species (*Podarcis siculus*, *Podarcis muralis* and *Phoenicolacerta kulzeri*), and together with 16 previously published complete mtDNA genomes, conducted phylogenetic analyses (Maximum Parsimony [MP], Bayesian Inference [BI]) in an attempt to reconstruct the mtDNA relationships within Squamata. In concordance with results from previous analyses of molecular data, the results of these analyses confirmed Amphisbaenia as the sister taxon of Lacertidae. Interestingly, in contrast to previous studies (based both on morphological and molecular data), a well supported clade consisting of Gekkota and Lacertidae/Amphisbaenia was recovered in one of the analyses (BI); the MP analysis placed Gekkota as sister to remaining sampled squamates, in line with other recent studies. Finally, analysis of the mtDNA genes commonly used for phylogenetic analyses within Lacertidae revealed extremely high levels of divergence, suggesting an ancient divergence within *Podarcis*.

Podnar, M., W. Pinsker and W. Mayer. 2009. Complete mitochondrial genomes of three lizard species and the systematic position of the Lacertidae (Squamata). Journal of Zoological Systematics and Evolutionary Research 47:35–41.

Correspondence to: Martina Podnar, Croatian Natural History Museum, Department of Zoology, Demetrova 1, 10000 Zagreb, Croatia; e-mail: martina.podnar@zg.t-com.hr

Influence of Landscape on Population Genetic Structure of a Salamander

In this study, the authors have examined the population genetic structure of the spotted salamander, *Ambystoma maculatum*, in northeastern Ohio, a landscape fragmented by natural features such as the Cuyahoga River, but also human-induced alterations such as roads, urbanization and agricultural development. The authors used 8 polymorphic microsatellite loci to investigate population genetic structure of 407 individuals across 17 populations. In contrast with the findings in a number of other taxa, no effect of geographical distance or landscape barriers on dispersal was observed. The authors suggest that this pattern may have been observed because insufficient time has passed since anthropogenic fragmentation for the detection of a change in population structure. Alternatively, dispersal interruptions caused by fragmentations could be compensated for by more effective dispersal via alternative routes. The authors suggest that the high level of connectivity between ponds, despite apparent barriers and hostile inter-pond landscape, could be related to dispersal pathways which run along the network of riparian corridors linked with the Cuyahoga River.

Purrenhage, J. L., P. H. Niewiarowski, and F. B.-G. Moore. 2009. Population structure of spotted salamanders (*Ambystoma maculatum*) in a fragmented landscape. Molecular Ecology 18:235–247.

Correspondence to: Jennifer L. Purrenhage, Department of Zoology, Miami University, Oxford, Ohio 45056, USA; e-mail: purrenjl@muohio.edu

Parental Care in a Tropical Skink in the Face of Different Predation Risks

Reptiles rarely demonstrate parental care, and if they do, it is usually restricted to egg-guarding. Despite egg-guarding behavior representing an extremely primitive form of parental care, the influence of predators on this behavior remains relatively unknown. In this study, the authors have investigated parental care in a tropical skink from Taitung County, Taiwan, *Mabuya longicaudata*, in the face of different predation risks. The authors manipulated encounters between different predators and female skinks in naturally occurring nests shortly following oviposition. When presented with the egg-predating snake *Oligodon formosanus*, skinks reacted aggressively, attacking the predator on each occasion and increasing the amount of time egg-guarding. In contrast, when presented with non egg-predating sympatric skinks, *Sphenomorphus incognitos* and *Japalura swinhonis*, female *M. longicaudata* skinks did not behave aggressively or change their egg-guarding behavior. When presented with the skink-predating snake *Elaphe carinata*, female skinks escaped and did not return to the original nest. The authors suggest that egg-guarding in this species reflects precise and complex behaviors adapted to specific reptile predators.

Huang, W-S., and H-Y. Wang. 2009. Predation risks and anti-predation parental care behavior: An experimental study in a tropical skink. Ethology 115:273–279.

Correspondence to: Wen-san Huang, Department of Zoology, National Museum of Natural Science, 1 Kuan-Chien Road, Taichung 404, Taiwan; e-mail: wshuang@mail.nmns.edu.tw

Giant Prehistoric Snake Used to Estimate Past Climate

In this study, researchers describe a prehistoric boid snake, *Titanoboa cerrejonensis*, from northeastern Colombia, which is estimated to be about 58–60 million years old. Fossilized vertebrae found in the Cerrejón Coal Mine indicate that *Titanoboa* is the largest snake ever discovered, measuring 13 m in length and weighing 1135 kg. The extremely large size of this prehistoric snake provides interesting clues as to the environmental conditions of the time period, and has allowed the authors to use *Titanoboa* to reconstruct the climate of the neotropics in the Paleocene. Based on the size of *Titanoboa* in comparison to *Eunectes murinus*, the largest extant snake in the neotropics, the authors estimated that *Titanoboa* would require a mean minimum annual temperature of 30–34ºC to survive. This estimation is consistent with independent climate models, which predict hot Paleocene temperatures and high atmospheric concentrations of CO_2. Similarities between the deposits in which *Titanoboa* were found and the habitat of the extant *Eunectes* and inferences about prey taxa, including crocodyliforms, suggest *Titanoboa* had an ecology similar to modern anacondas.

Head, J. J., J. I. Bloch, A. K. Hastings, J. R. Bourque, E. A. Cadena, F. A. Herrera, P. D. Polly and C. A. Jaramillo. 2009. Giant boid snake from the Palaeocene neotropics reveals hotter past equatorial temperatures. Nature 457:715–717.

Correspondence to: Jason Head, Department of Biology, University of Toronto, Mississauga, Ontario L5L 1C6, Canada; e-mail: jason.head@utoronto.ca

A Novel Species of Land Iguana from the Galápagos

On Charles Darwin's visit to the Galápagos, he encountered both marine (*Amblyrhynchus*) and yellow land (*Conolophus*) iguanas, but not the rare, pink land iguana referred to as "rosada." Despite the considerable scientific focus on the Galápagos subsequent to Darwin's expedition, the rosada form, which occurs only on an Isla Isabella volcano named Volcan Wolf, was first observed only in 1986. In this study, the authors used mtDNA and microsatellite genotyping to investigate the taxonomic status of the rosada form. The rosada iguanas were found to form a well supported clade sister to a clade containing all remaining *Conolophus* (comprising two named species and the natural inhabitants of six islands including Isla Isabella, where they occur in sympatry with members of the rosada clade). Interestingly, this result places the timing of divergence of the rosada lineage to a point before all of the present day islands had formed. The rosada is also morphologically distinct; in addition to their color, they can be distinguished by flat dorsal head scales and a characteristic nuchal crest. Furthermore, differences are present in head-bobbing behavior, which is thought to be important in territory defense and courtship. Finally, the authors propose that their analysis suggests that the rosada form should be elevated to full-species status and a conservation program should be initiated in order to protect it from extinction.

Gentile, G., A. Fabiani, C. Marquez, H. L. Snell, H. M. Snell, W. Tapia, and V. Sbordoni. 2009. An overlooked pink species of land iguana in the Galápagos. PNAS 106:507–511.

Correspondence to: Gabriele Gentile, Dipartimento di Biologia, Univeristà Tor Vergata, 00133 Rome, Italy; e-mail: gabriele.gentile@uniroma2.it

Impact of Predation Risk on Larval and Post-Metamorphic Phenotypes in a Frog

Phenotypic responses to environmental pressures may constrain the future phenotype, reducing the fitness of the individual at later life-stages. In this study, the authors investigated the phenotypic response of tadpoles of the Common Frog, *Rana temporaria*, to perceived predation risk and how this impacted the post-metamorphic phenotype. Egg masses collected near Glasgow, Scotland were reared through to metamorphosis in the laboratory, either in the presence or absence of a predator, larvae of the odonate *Aeshna juncea*. Predators were housed with the tadpoles, but were kept separate in a cage, ensuring that no actual predation could occur. Tadpoles raised in the presence of the predator developed deeper tail fins and muscles, and swam further than tadpoles reared with no predator. At metamorphosis, tadpoles reared under predator and control treatments did not differ morphologically. However, 12 weeks post-metamorphosis, frogs that developed in the predator treatment had narrower femurs and swam more slowly and less far than control frogs. The authors suggest that this trade-off indicates that phenotypic adaptations made early in development can have consequences in later life-stages.

Stamper, C. E., J. R. Downie, D. J. Stevens, and P. Monaghan. 2009. The effects of perceived predation risk on pre- and post-metamorphic phenotypes in the common frog. Journal of Zoology 277:205–213.

Correspondence to: Clare E. Stamper, School of Biosciences, University of Exeter, Cornwall Campus, Penryn TR10 8EZ, UK; e-mail: c.e.stamper@exeter.ac.uk

Low MHC Variation in Long Surviving Populations of Newts

Major histocompatibility complex (MHC) genes are an important component of immune response, and a reduction in polymorphism is predicted to limit a population's ability to counter novel disease threats. Understanding amphibian responses to pathogens is particularly important in the face of the global amphibian declines. In this study, the authors investigated MHC class II variation in a number of populations of the Great Crested Newt, *Triturus cristatus*. Refugial populations from Romania were sampled, as well as postglacial expansion populations from Germany, Poland, and the UK. Refugial populations demonstrated extremely high levels of adaptive variation with 24 expressed alleles. In contrast, areas colonized during the postglacial expansion possessed very low levels of variation, with only two expressed alleles. Despite the low level of MHC variation in these areas, these populations have survived 10,000 years, suggesting that low levels of MHC variation may not be a critical problem for long-term population persistence in Great Crested Newts.

Babik, W., M. Pabijan, J. W. Arntzen, D. Cogălniceanu, W. Durka and J. Radwan. 2009. Long-term survival of a urodele amphibian despite

depleted histocompatibility complex variation. Molecular Ecology 18:769–781.

Correspondence to: W. Babik, Department of Community Ecology, Helmholtz Centre for Environmental Research – UFZ, Theodor-Lieser-Str 4, 06120 Halle/Saale, Germany; e-mail: wieslaw.babik@uj.edu.pl.

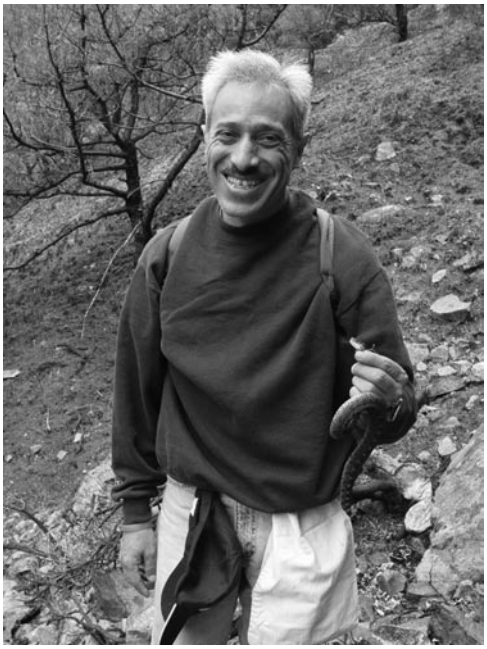
OBITUARIES

Herpetological Review, 2009, 40(2), 133–134.
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Fernando Mendoza Quijano (1957–2008)

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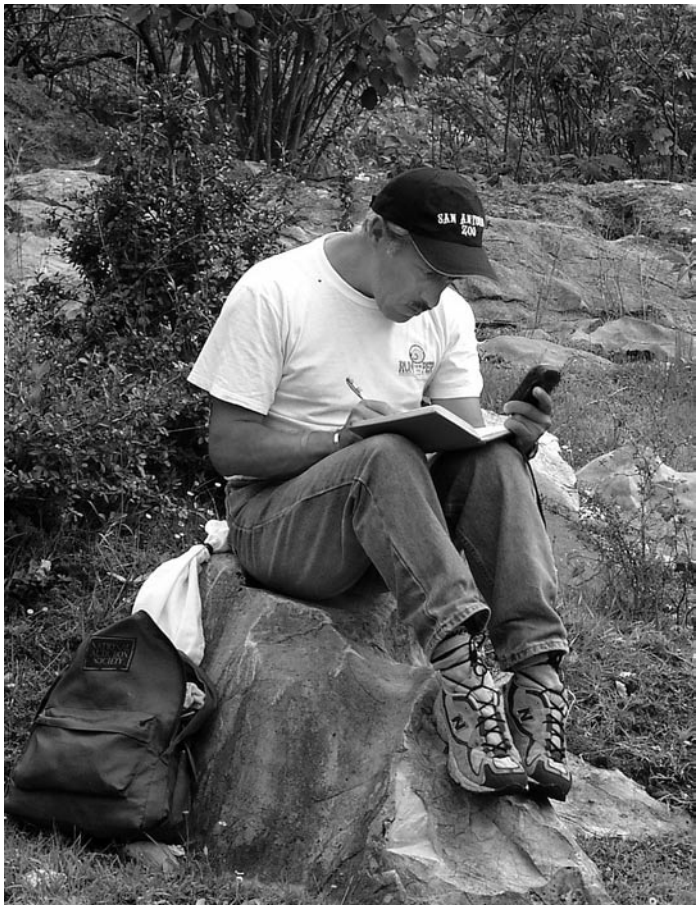
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Fernando Mendoza holding a *Crotalus aquilus*, 16 July 2005, at El Calicanto in the Sierra de Pachuca, Hidalgo, México. Photo by Alan Kardon.

On 14 September 2008, Fernando Mendoza Quijano was tragically killed, at the age of 51, in an automobile accident northwest of Gómez Palacio while on his way to Casas Grandes, Chihuahua, to obtain a collection of books from an American collaborator for his students in Hidalgo, México. Also dying instantly in the crash, caused by an oncoming pickup truck swerving into their lane of travel, was his wife and collaborator Giselda Quijano Manilla. He is survived by seven children: Fernando Ricardo Mendoza Paz, Claudio Alberto Mendoza Paz, Orlando Mendoza Paz, Mónica Mendoza Cabrera, Cecilia Mendoza Cabrera, Daniela Mendoza Cabrera, and Julio Mendoza Mehenes. An eighth child, Mario Alejandro Mendoza Paz, died in 2006.

Fernando Mendoza Quijano was born on 3 April 1957, in Mexico City to Napoleón Mendoza Hernández and Esperanza Quijano Simón and attended primary school at Instituto Liceo de México for six year, where he was recognized for excellence, at the top of his class. He then attended high school at the Escuela Secundaria Técnica No. 3 "Héroes de Chapultepec," followed by studies at the national preparatory school, Miguel E. Schultz No. 8 (1973–1975). His professional training as a biologist was at the Escuela Nacional de Estudios Profesionales-Iztacala at the Universidad Nacional Autónoma de México (UNAM) in Tlalnepantla. He completed his degree in 1991 with a thesis titled "Estudio herpetofaunístico en el transeco Zacualtipán-Zoquizoquipan-San Juan Mextitlán, Hidalgo" followed by a master's degree in the Facultad de Ciencias of UNAM in 1995, titled "Variación genética y distribución geográfica de las lagartijas del grupo *variabilis* del género *Sceloporus* (Squamata: Phrynosomatidae)."



Fernando Mendoza, in a characteristic pose, recording his precise field notes, 24 July 2005, Valle de los Fantasmas, San Luís Potosí, México. Photo by Robert W. Hansen.

Fernando found a calling for his many inspirational talents in teaching, first at the Escuela de Biologia at the Benemérita Universidad Autónoma de Puebla, Puebla, México (1996–1997), and then (1997–2008) as Profesor Asociado "C", Instituto Technológico Agropecuario No. 6, Huejutla de los Reyes, Hidalgo, México. He maintained a close relationship with herpetologists at UNAM (as Investigador Asociado, Colección Nacional de Anfibios y Reptiles), and served on many thesis committees at UNAM (including as thesis director) as well as at Huejutla (nearly 40 in all). Although mostly herpetological, Fernando facilitated the interests of his students in other areas of vertebrate biology, ethnobiology, and conservation. But his teaching talents

were not confined to the classroom as he radiated his knowledge of and enthusiasm for Mexican herpetology to all those around him, in the field, at Mexican and U.S. herpetological conferences, in symposia, and in special courses and seminars that he attended or arranged—at least 75 (1984–2005).

Fernando has been well known to herpetologists throughout Mexico and the United States for over two decades through his broad herpetological interests, publications, and personal contacts and collaborations he made with colleagues at meetings and in the field in both countries (as well as in Costa Rica). He read the herpetological literature widely and carefully, and always encouraged his students in their efforts at learning English. Fernando was dedicated to the importance of collections and was an active member of the Museo de Zoología "Alfonso L. Herrera" at UNAM and the Museo de Biodiversidad del Mundo Maya at the Universidad Autónoma de Campeche. He played important roles in the Sociedad Herpetológica Mexicana. He wrote widely on species distributions and regional faunas, having published over 90 papers, scientific notes, and book chapters in 18 journals and 6 books, and having left many manuscripts in press, submitted, and in preparation. He was keenly aware of and deeply concerned about the impacts of ecological changes, due to human activities throughout Mexico, on reptiles and amphibians as well as on the natural world. Fernando was always interested in taxonomic questions and in learning to utilize the best modern methods available to him for resolving them. The number of his collaborators from Mexico and the United States listed in his curriculum vitae on herpetological projects, well over a hundred, is truly impressive, and it speaks deeply to Fernando's ability to engage others with his passion for reptiles and amphibians.

Shortly after his death Fernando was remembered on 7 October 2008 at the 10th Annual Meeting of the Sociedad Herpetologica de México in Pachuca, Hidalgo. In a slide tribute ("One Man Made a Difference: Tribute to Fernando Mendoza Quijano," arranged by Robert W. Bryson, Jr. and David Lazcano), many friends and associates of Fernando shared their thoughts, a few of which we share here: "I have known Fernando for six years. Never have I met a more selfless, passionate, and giving person…. He always retained a positive outlook on life despite a life full of hardships, and he served as an inspiration for Mexicans and non-Mexicans alike. His friendship was one of the most rewarding and fulfilling experiences that I have ever had" (Bryson); "Fernando fue sin duda uno de los herpetologos más notables que he conocido. Para mí sobresalen entre sus cualidades su gran capacidad, habilidad y tesón para el trabajo de campo… que nunca dejó de trabajar por la herpetologia a pesar de no estar en las mejores circunstancias para ello; sin duda, hizo mucho más con pocos recursos que otros con mayor recursos …. Siempre estuvo dispuesto a ayudar y a enseñar a otros y fue un hombre sencillo y generoso." (Adrián Nieto Montes de Oca); "Mexico has lost one of its best herpetologists, and I have lost a dear friend and valued colleague." (Robert W. Hansen); "Esa combinación de poseer un olfato previlegiado para encontrar anfibios y reptiles en el campo, tener la resistencia y el empuje para sobreponerse a la adversidad y al mismo tiempo ser optimista y entregado es la que te hace única Fer…." (Georgina Santos); "I can remember Fernando from … my lab…. He worked long hours, and was grateful … he was always in a good mood … a delight to be around … and he genuinely enjoyed the cultural diversity of our group … yet managed to tolerate my errors (in Spanish) with the right mix of humor and politeness." (Jack Sites).

Mexican herpetology has lost a great native contributor and a unique person of inspirational ability. He will be missed in the classroom, laboratory, and field by his students and by innumerable herpetologists who have collaborated on studies with him and whose lives have been moved by his energy, perseverance, charm, and dedication to high ideals.

Acknowledgments.—For assistance in compiling information about Fernando's life we thank Fernando Ricardo Mendoza Paz and Robert W. Bryson, Jr.

ZOO VIEW

Herpetological Review, 2009, 40(2), 134–142.
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Updating the Bookshelves Part IV: Important Herpetological Books Appearing During the Last Two Decades

CHELONIANS — CROCODILIANS — AMPHIBIANS
CAPTIVE & MEDICAL MANAGEMENT— ZOO HISTORY

"What shall I do with all my books?" was the question; and the answer, "Read them," sobered the questioner. "But if you cannot read them, at any rate handle them and, as it were, fondle them. Peer into them. Let them fall open where they will. Read on from the first sentence that arrests the eye. Then turn to another. Make a voyage of discovery, taking soundings of uncharted seas. Set them back on their shelves with your own hands. Arrange them on your own plan, so that if you do not know what is in them, you at least know where they are. If they cannot be your friends, let them at any rate be your acquaintances. If they cannot enter the circle of your life, do not deny them at least a nod of recognition."

—*Thoughts and Adventures*, Winston S. Churchill, 1932

CHELONIANS

Turtles & Tortoises of the World / / David Alderton. QL666 .C5A43 1988X
Imprint: New York: Facts on File, 1988.

Loggerhead Sea Turtles / / edited by Alan B. Bolten and Blair E. Witherington. QL666.C536 L65 2003
Imprint: Washington DC: Smithsonian Books, 2003.

Diamonds in the Marsh: A Natural History of the Diamondback Terrapin / / Barbara Brennessel. QL666.C547 B74 2006
Imprint: Lebanon NH: University Press of New England, 2006.

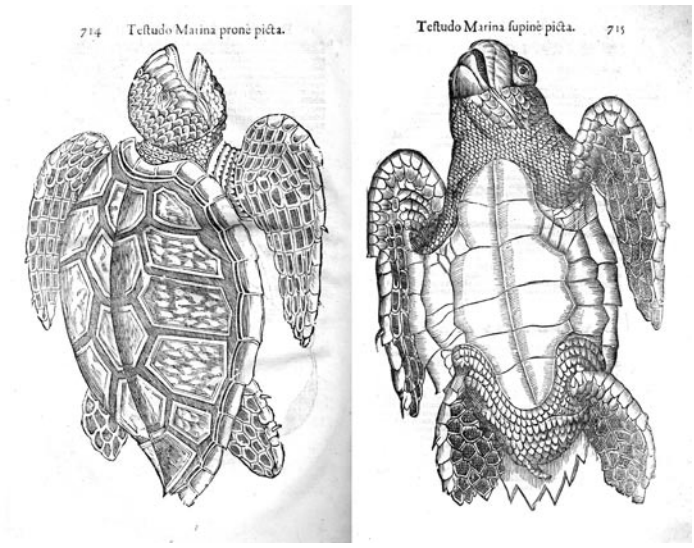
Australian Freshwater Turtles / / John Cann. q QL666.C5 .C333 1998
Imprint: [S.l.: J. Cann?]; Singapore: Beaumont, 1998.

A Sheltered Life: The Unexpected History of the Giant Tortoise / / Paul Chambers. QL666.C584 C42 2004
Imprint: London: John Murray, 2004.

The World of Turtles and Crocodiles / / Indraneil Das and Zai and Rom Whitaker; photographs, Rom Whitaker; drawings, Indraneil Das. QL666.C5 W685 1993
Imprint: New Delhi: National Book Trust, 1993.

North American Box Turtles: A Natural History / / C. Kenneth Dodd, Jr. QL666.C547 D63 2001X
Imprint: Norman OK: University of Oklahoma Press, 2001.

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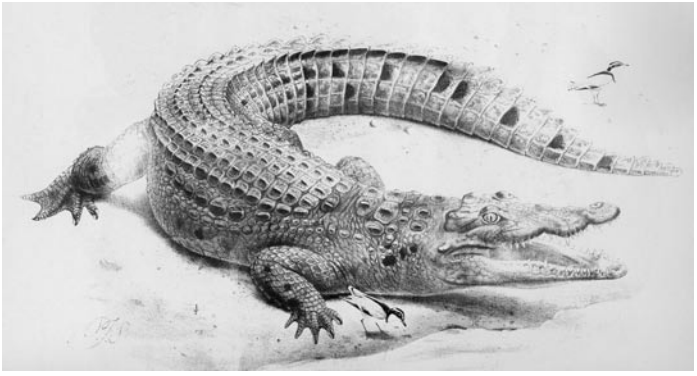


Two views of sea turtles from *De quadrupedibus digitatis viviparis libri tres et De quadrupedibus digitatis oviparis libri duo. Bartholomaeus Ambrosinus ... collegit ... Bonon., Apud Nicolaum Tebaldinum, sumptibus M. Antonii Berniae* by Ulisse Aldrovandi in 1645.
Credit: Collections of Ernst Mayr Library, Museum of Comparative Zoology, Harvard University.

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In my opinion, this is one of the finest drawings of a crocodilian ever rendered by artist P. J. Smit. Pictured is a Nile Crocodile (*Crocodylus niloticus*) with so-called crocodile birds from John Anderson's *Zoology of Egypt* in 1898.

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An elegantly dressed Raymond L. Ditmars (right) thrusting a rabbit down the gullet of a Reticulated Python in the reptile house at the Bronx Zoo on 9 April 1913. In early days, snakes were often fed forcibly since they refused to feed on their own, due to medical problems and improper husbandry protocols. Credit: Wildlife Conservation Society, headquartered at Bronx Zoo.

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London Zoo keeper with Indian Python (*Python molurus*) ca. 1872. Credit: photograph by Frederick York, provided by John Edwards.

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Articles from *Bulletin of Philadelphia Herpetological Society*

Contact me at jbmurphy2@juno.com if you wish to get copies:

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CONCLUDING REMARKS

I hope that, after reading this series, zoo and aquarium workers will have been convinced that a personal reference library is an essential tool for learning about the animals entrusted to their care. Also, through the illustrations utilizing spectacular art found in earlier publications, readers will note their connection to important herpetological books and papers of the past twenty or so years. In my opinion, some of this herpetological artwork compares favorably with the finest works hanging in our art museums. Stunningly beautiful and arresting lithographs such as those created by Sowerby and Lear, as well as George H. Ford, Auguste Sonrel, P. J. Smit, Robert Mintern, James Green, C. Berjeau, and John Green during the 19th century, disappeared as the newer and cheaper method of photo-engraving became the technology of choice in the 20th century. Today, even with the advent of digital cameras and computer-enhanced images, the inspiring work of these talented craftsmen can not be matched.

When I talk with some of my younger colleagues, they ask why it is necessary to build a library at all when the internet is available to search for information at great speed and at much lower cost. In fact, a few have accused me of being out of touch with mainstream technology. Many years ago, I asked the late Roger Conant about the advent of computers and how our profession would change. He became agitated and told me that many of the current group of young herpetologists were spoiled by mostly depending on this new technology; in fact, he called them "whiners" when they complained that they occasionally had to do research the "old way" in a library without access to a computer. When Conant began writing his classic *Agkistrodon* monograph with Howard K. Gloyd over 60 years earlier, there were no word-processing programs with spell-check and thesaurus, no bibliographic programs to download references, no statistical or spreadsheet software, and no scanners or copiers to duplicate literature. Each reference was either examined in a library, provided by colleagues, borrowed, or purchased. All requests for information from colleagues and early drafts were typed on a manual typewriter. Every citation with notations was initially hand-written on an index card, then sorted and collated.

In my defense of actual books, I can say that there is something therapeutic, uplifting, and often unexpectedly rewarding about paging through a work written long ago, especially when remembering that authors like Gloyd and Conant had to overcome formidable odds to finish their magnum opus. They examined the phylogeny and zoogeography of the *Agkistrodon* (sensu lato) complex the "old-fashioned way" and explained their approach, "There are no cladistics, no cladograms, no variances, and no divergence events, or any of the other newer approaches and terminology currently in use by phylogenetic systematists." Supercomputers and the new analytical software to drive them were not available to Gloyd and Conant but their conclusions remain robust nonetheless. In defense of libraries, I can add that browsing the stacks often turns up something of value. It must be said here that I do not dislike computers; rather my argument is that books are important too and should not be viewed as unnecessary relics from the past. Although there is a trend to digitize books and make them accessible to a wider audience via the internet, I do not enjoy reading a book from a computer screen. The defense rests!

As our natural world shrinks around us, the content of herpetological books has changed dramatically. Virtually every new title addresses conservation and some accounts are pretty alarming. Three recent examples really caught my attention. The first is *The Amphibians & Reptiles of Cusuco National Park Honduras / Los Anfibios y Reptiles del Parque Nacional Cusuco Honduras,* by Josiah H. Townsend and Larry David Wilson. A chapter is devoted to the subject including a table summarizing conservation assessment criteria.

The second—*The Ecology and Behavior of Amphibians*, by Kentwood D. Wells—devotes an entire chapter, over 70 pages, to the conservation status of amphibians and the news is not good.

The last one—Michael Lannoo's *Malformed Frogs: The Collapse of Aquatic Ecosystems*—is devastating.

Why zoo biologists must publish their observations: Permit me to use one example of how an old text can be more correct than would have been expected. True chameleons fascinate zoo patrons—elaborate ornamentation and rapid color changes, independently rotating eye turrets, zygodactyl feet, extensible prey-catching tongues, and prehensile tails. When I started in the zoo business more years ago than I care to remember, many chameleon species often lived only a few years in captivity. We read all of the literature available and tried a number of different techniques to keep them but only a precious few (Veiled, Panther and Jackson's Chameleons) did well for even a short time.

In 1925, Major Stanley Smyth Flower explained it this way, "As far as the evidence goes, Chameleons appear to be the only short-lived Reptiles, not attaining to even five years. Lizards present varying lengths of life not correlated with their bodily size." Flower found that chameleons rarely lived one year in captivity and in his survey of 55 years, only 15 chameleons out of nearly 770 survived over one year, except the South African Dwarf Chameleon (*Bradypodion pumilum*) which has live young. We read Flower and tried to improve upon the statistics he compiled through the early part of the 20th century. Many of us thought that the failure to thrive was due to our improper husbandry practices and, in fact, zoos have improved their techniques and kept chameleons for longer periods. As field studies trickled in, we read them and eagerly applied the information, and subsequently we published our results (e.g., Ferguson et al. 2004; Murphy 2005).

A new challenge is the recent study by Karsten and associates which explains why some imported animals could probably never have been successfully kept in captivity for extended periods. They found that Labord's Chameleon (*Furcifer labordi*), from arid southwestern Madagascar, is an "annual" lizard living mostly as an egg for about nine months and then only four or five months outside the egg. These lizards reach sexual maturity in two months. This may mean that the brief life span of chameleons in captivity might, for some species, actually represent the natural adult life span. So questions are asked and suggestions given by the authors in their abstract: "Consequently, a new appraisal may be warranted concerning the viability of chameleon breeding programs, which could have special significance for species of conservation concern. Additionally, because *F. labordi* is closely related to other perennial species, this chameleon group may prove also to be especially well suited for comparative studies that focus on life history evolution and the ecological, genetic, and/or hormonal determinants of aging, longevity, and senescence."

As we just learned about Labord's Chameleon, Flower's statement about chameleons being short-lived reptiles written over 80 years ago was prophetic.



Fig. 6a. Illustration of chameleons in *Animate Creation; Popular Edition of "Our Living World" a Natural History, by the Rev. J. G. Wood. Revised and Adapted to American Zoology, by Joseph B. Holder* by J. G. Wood in 1885. Credit: From the collections of the Ernst Mayr Library, Museum of Comparative Zoology, Harvard University.

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—James B. Murphy, Section Editor

LETTERS TO THE EDITOR

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Considerations and Recommendations for Raising Live Amphibians in Classrooms

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Pinou et al. (2009) outlined a first-grade scientific education program that included live amphibian larvae collected from the wild, maintained and studied in the classroom, and then released into their natal pond. The reality of emerging infectious diseases as a primary threat to amphibian populations prompted us to consider carefully some recommendations made by those authors, and also the general notion of reducing disease risks associated with keeping living amphibians in K–12 classrooms—although the same concerns apply to living amphibians in all *ex-situ* situations (see Pessier 2008; Zippel et al. 2006). The sad reality is that the world is no longer a simple place and seemingly innocent acts like catching tadpoles and releasing them later are now much more complex, with regard to conservation imperatives. In general, we applaud the schoolchildren's program outlined by Pinou et al. (2009), as it appears to be an engaging exercise that brings together qualitative

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data, the scientific method, and a wonderful element of amphibian natural history. However, a specific recommendation by them raised some initial concern, and led us to engage in some (hopefully) fruitful discussions related to amphibians in classrooms and the potential for spread of diseases. Pinou et al. (2009:33) suggest:

> *"Schools that are interested in participating in similar activities can contact the Herpetologists Education Committee of the Society for the Study of Amphibians and Reptiles (SSAR) at www.ssarherps.org. Ask for a partnering herpetologist that can provide eggs of regional species of amphibians that can be released back into their native habitat once hatched—preventing the disruption of the natural biodiversity."*

We first learned of the publication when, in fact, a number of teachers from around the US began contacting various SSAR officers, looking for leads to "partnering herpetologists." The officers were initially mystified as to the sudden flurry of similar requests, but a bit of investigating revealed the primary inspiration to be from Pinou et al. (2009). We read it with great interest and all quickly agreed that the authors have outlined an insightful and engaging educational activity. The only problem is the line "*….amphibians that can be released back into their native habitat….*" Emerging infectious diseases (e.g., amphibian chytrid fungus and ranaviruses) are now acknowledged as a leading cause of amphibian declines and extinctions (Daszak et al. 2003; Skerratt et al. 2007) and there is increasing recognition that important amphibian pathogens have been disseminated to new locations by anthropogenic means (Jancovich et al. 2005; Picco and Collins 2008; Weldon et al. 2004). As a result, biosecurity becomes an essential consideration as amphibians are being moved between locations, be they any combination of natural habitats and/or captive facilities. The model proposed by Pinou et al. (2009) raises a real potential risk of transferring non-native pathogens back into the natal pond of the amphibians included in the classroom exercise.

It was of primary importance to us not to simply squelch this classroom exercise for reasons of risk avoidance. To us, this exercise is a great example of the spirit of encouraging a collective public conscience of "bioliteracy" outlined so eloquently by Ehrlich and Pringle (2008:11584):

> *"The earlier in the developmental process comes exposure to nature, the better the odds of inspiring devotion to biodiversity and its conservation. It is a rare conservationist who did not encounter nature as a child. Every one of us can go to elementary schools to show pictures of animals and plants and tell funny stories about ecology. The teachers will be happy to have us. More ambitious people might think about how to finance and institutionalize school field trips to natural areas."*

We put authors Pinou, Flanigan, and Drucker (2009) in this latter "ambitious" category, as their program brings salamanders to first-graders, and wraps it all in a solid framework of quantified science. So, how can we encourage programs like this without adding to the already horrendous problem of pathogens and amphibian survival in the wild? We believe that one simple precaution may solve the problem:

> Proceed with the program of Pinou et al. (2009) verbatim, but with the important caveat that absolutely *no other live amphibians are also maintained in the classroom, or that the amphibians cannot come into contact with any other materials shared with other amphibians (e.g., re-used aquaria that have not been sterilized), or that at the time any amphibians are brought into the classroom, they should be maintained in isolation from all other aquatic organisms and their potential pathogens. Setting up the specimens in new or sterilized enclosures will insure this*. This is the simplest, surest, way to eliminate the risk of introducing foreign pathogens back into the pond with those newly hatched amphibians.

We make this simple, but stark, recommendation in full realization that it will limit the diversity of amphibian-related natural experiences that may be presented in the classroom. In other words, we understand that any teacher receptive to the program of Pinou et al. (2009) is likely to be the same teacher who also has a tank full of metamorphosing leopard frog tadpoles, some fire-bellied toads, or perhaps a poison dart frog or two in the same classroom. We certainly experienced (and appreciated) like-minded teachers in our school days—but, sadly, the world has changed and the specter of emerging infectious diseases as a real conservation threat to wildlife no longer makes such activities acceptable. The seriousness of the threat of the amphibian chytrid fungus was made clear by its recent classification as a 'notifiable' disease by the World Organisation for Animal Health (OIE); the full text of the listing is available at http://www.oie.int/eng/normes/fcode/en_chapitre_2.4.1.htm#rubrique_batrachochytrium_dendrobatidis). This means member countries will have to declare annually the status of these diseases in their country and what they are doing to control them.

We also add the reminder that activities such as those described by Pinou et al. (2009) are likely to require collection permits from the appropriate governmental agency. Additionally, if school groups will be moving among field sites, the stringent sanitation protocols of Speare (2001) should be followed. That document is available online (http://www.jcu.edu.au/school/phtm/PHTM/frogs/adrecommendations.htm). Enclosures, gravel, nets, and other items that come in contact with amphibians or their water in the classroom must be disinfected between usages. We recommend a solution of household bleach (usually a 5–6% solution of sodium hypochlorite) that can be made using one part bleach to 3 parts water; a minimum contact time of one minute is necessary.

A related concern about amphibians in the classroom involves animals that are readily available in pet stores, with *Bombina* (fire-bellied toads), *Hymenochirus* (African dwarf frogs), *Litoria* (Australiasian treefrogs), and *Xenopus* (African clawed frogs) seeming to be especially common among the larger retail chains. Additionally, numerous ready-made kits are available so that families and classrooms can watch together the marvel of amphibian metamorphosis. Some retailers and online outlets provide literature advising against release of the tadpole or froglet, some do not. Regardless of the literature accompanying the purchased amphibian, we reiterate here that:

> No amphibian purchased or received from any commercial or informal (e.g., a neighbor) source may be released into the wild. This recommendation applies whether the species is technically "native" to the region of release, or not.

Families or teachers considering the purchase of commercially available amphibian adults or larvae must realize that they are embarking on a commitment for the natural life of that amphibian. We found one online testimonial for a commercial tadpole kit where the family raised the "Bullfrog" for 33 years; this is longer than the careers of some teachers. We recommend the useful pamphlet produced by Partners in Amphibian and Reptile Conservation (PARC) entitled "Don't Turn it Loose" as a guide. It is available on the web (http://www.parcplace.org/DontTurn.pdf). Alternatively,

euthanasia by a licensed veterinarian should be considered. We also note that some amphibian species are small and relatively simple to maintain in good health, but that others—e.g., American Bullfrog (*Lithobates catesbeianus*)—are large and decidedly not so simple to maintain. It is important to note that some diseased amphibians may appear to be completely healthy, showing no signs of illness whatsoever. We pose the scenario that watching chicks hatch from commercially available fertile eggs would also be a wonderful classroom experience, but how many teachers would go on to release those chickens into nearby fields, and how many poultry farmers would accept them (being of unknown genetic lines and veterinary history) into their operations? We present this, at the risk of overstatement, because we have all met teachers, parents, and students of all ages who have released the amphibians from their in-home or classroom experiences into the "pond down the road." They did so with good intentions, but the practice cannot continue and is, in fact, illegal in some US states. As we endeavor to be as supportive as possible of introducing children to amphibians, especially via a strong science curriculum, we suggest the following well-executed resources for teachers to consider bringing into their classrooms:

- *The Amphibian Project* http://www.helpafrog.org/toolkit.htm
- *Amphibians*. 35 min. (by EyeWitness Videos; SKU WW73872M27) Describes amphibian life cycle and anatomy; behaviors and adaptations; and amphibian characteristics. Grades 5-12
- *Caterpillar and the Polliwog* (by Jack Kent ISBN 0-671-66281-3). Book and video that describe metamorphosis of caterpillars and frogs. Grades K-3
- *Tale of a Tadpole* (Eyewitness Level I by Karen Wallace ISBN 0-7894-3437-7). Follows the life of a frog with simple, yet excellent photographs. Grades Pre-2

In closing, as we learn more about the devastating effects that emerging infectious diseases are having on amphibians globally (Daszak et al. 2003; Stuart et al. 2004), we are realizing that various commercial activities by humans are increasingly spotlighted as the culprit in spreading the disease. We know better now, and we hope our simple recommendations will allow innovative programs like that of Pinou et al. (2009) to continue to bring the wonder of amphibians to the classroom, and to do so without risking the very same amphibians we seek to admire.

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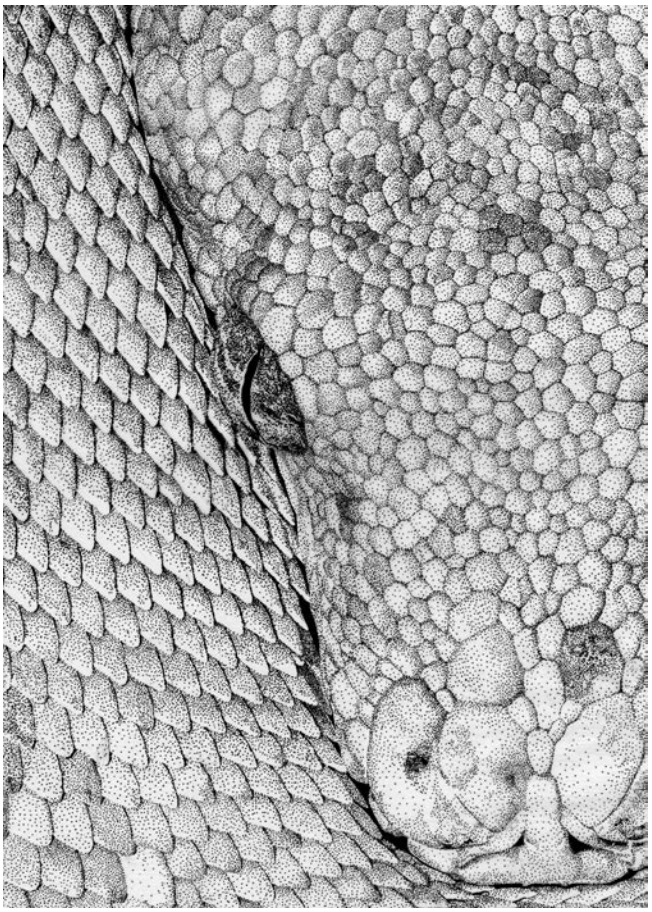
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Morelia viridis (Green Tree Python), Biak Island form. Pen and ink illustration by Will Brown (http://www.blueridgebiological.com/).

ARTICLES

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Guidelines for the Safe Use of Disposable Gloves with Amphibian Larvae in Light of Pathogens and Possible Toxic Effects

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Prior to the discovery and widespread recognition that pathogens such as *Batrachochytrium dendrobatidis* (*Bd*) and ranaviruses can lead to the decline and even extinction of amphibian populations around the world, few herpetologists used gloves when handling amphibians. Disposable gloves, along with disinfection protocols (Webb et al. 2007), quarantine (Young et al. 2007), and reports by Daszak et al. (2001) and Lynch (2001) have since become an important tool in our arsenal for preventing the spread of pathogens between individuals and among populations or habitats.

Cashins et al. (2008) recently reported that latex, vinyl, and nitrile gloves can be lethal to tadpoles of several species (*Litoria genimaculata*, *L. nannotis*, and *Bufo marinus*), even after short-term exposures during routine handling. Two previous studies had also found that latex and nitrile gloves (or water in which gloves had been soaked) could be lethal to *Xenopus laevis* and *Rana temporaria* tadpoles (Sobotka and Rahwan 1994, Gutleb et al. 2001). In an unrelated study aimed at developing hygiene protocols to prevent the spread of *Bd* among animals, Mendez et al. (2008) reported that bare hands that are washed between animals may be

TABLE 1. Glove related contact and associated morbidity and mortality for larval amphibians involved in laboratory experiments. All experimental animals were examined for signs of morbidity or mortality daily.

Species	Origin	N	Frequency of contact	Contact type[1]	Contact duration	Type of gloves used[2]	Response[3]	Reference
Wood Frog (*Rana sylvatica*)	Ontario, Canada	240	weekly for 6 weeks	SVL STAGE HUS	2–3 min	P-LTX	None observed	Greer et al. (2005)
Arizona Tiger Salamander (*Ambystoma tigrinum nebulosum*)	Lab bred, Arizona, USA, stock	1038	weekly for 4 weeks	VIE CLIP HUS	45 s	P-LTX N-LTX	None observed	Greer et al. (2008)
	Arizona, USA	335	weekly for 8 weeks	HUS	30 s	P-LTX	None observed	Brunner et al. (2005)
Gray Tiger Salamander (*Ambystoma tigrinum diaboli*)	Saskatchewan and Manitoba, Canada	397	weekly for 16–20 weeks	HUS SVL STAGE	1 min	P-LTX	None observed	D. Schock, pers. comm.

[1] SVL = snout–vent length measurement, STAGE = developmental stage, CLIP = tissues sample, SWAB = swab for DNA, VIE = visible implant elastomer tag marking, HUS = animal husbandry/water changes
[2] P-LTX = powdered latex, N-LTX = non-powdered latex, P-NIT == powdered nitrile
[3] Based on description of morbidity and mortality described by Cashins et al. (2008)

preferable to repeatedly using the same pair of gloves in some situations. Although both Mendez et al. (2008) and Cashins et al. (2008) conclude that using new pairs of gloves for each handled animal is important for preventing the inadvertent transmission of pathogens, we have become aware that some organizations and researchers are interpreting these studies as cause, or even justification, for not using gloves. We wish to emphasize that discontinuing glove use may unnecessarily lead to increased spread of harmful pathogens.

Although these studies indicate limitations and potential pitfalls of disposable gloves, their safe use remains an essential component of amphibian care and research. A variety of disposable gloves have been used extensively in the handling and care of larval amphibians in laboratory experiments (Table 1), in the field (Table 2), and in zoo settings (Table 3) without any adverse effects under conditions where morbidity or mortality would have been noticed. Additional examples documenting the non-injurious use of gloves appear in Cashins et al. (2008). These results make it clear that many glove types do not negatively affect many species of amphibian larvae. Given that the use of a new pair of gloves to handle each individual is a good method for preventing the transmission of pathogens, best practice should clearly be to handle larval amphibians using a new pair of gloves for each individual, of a type known to have no negative effects on that species. This can easily be done by initially determining which species are susceptible to which types or brands (or even batches) of gloves. Researchers can take a few simple steps to ensure that the gloves they use are not toxic to the amphibians they handle. We recommend a two-phase approach. If researchers have been handling larvae with disposable gloves in captivity or in a situation where individual larvae have been observed for 24 hours following contact and no adverse effects have been seen, then researchers should continue using those same gloves. However, they should remain vigilant for any unusual mortality by following the second phase of the following protocol.

First, researchers should conduct a simple experiment in which tadpoles or salamander larvae of a given species are handled using the gloves in question and then observed for 24 h for signs of morbidity or mortality. Sample sizes do not need to be especially large. Cashins et al. (2008) found that when gloves are toxic, ≥ 40% of the individuals were affected. Using 10% as a more conservative figure for the maximum number of individuals that may experience negative effects, a sample size of 29 provides a 95% probability of observing at least one morbid or dead animal if the gloves under examination have deleterious effects on the species being tested. For rare and endangered species, replicate individuals could be handled and observed sequentially so that individuals are not unnecessarily killed; a single death would suggest a problem with the gloves. It is important that each animal be handled with new gloves and housed in a separate container so that individuals are independent replicates. Note that plastic containers can leach bioactive contaminants (McDonald 2008), so it is worth scrutinizing containers too. Researchers should also use controls, in this case individuals handled with clean bare hands or with gloves that have been demonstrated to be safe with the species in question. Since there is no way to predict *a priori* which species will be affected

TABLE 2. Glove related contact and associated morbidity and mortality for amphibian larvae handled in field settings where the observation periods post-handling would have permitted detection of effects described by Cashins et al. (2008). These results are from ponds where animals could 1) be easily observed in the pond shallows for a period of time (>6 hours) post-glove contact (OBS); 2) where animals were resampled over the course of the season with a high recapture probability (RCAP); or 3) where the protocol requ□

Species	Origin	N	Contact type[1]	Contact duration	Type of gloves used[2]	Monitoring	Response[3]	Reference
Wood Frog (*Rana sylvatica*)	Northwest Territories, Canada	32	SVL CLIP SWAB	1–2 min	P-LTX P-NIT	OBS	None observed	D. Schock (pers. comm.)
Western Toad (*Bufo boreas*)	Northwest Territories, Canada	98	SVL CLIP SWAB	1–2 min	P-LTX P-NIT	OBS	None observed	D. Schock (pers. comm.)
Boreal Chorus Frog (*Pseudacris maculata*)	Northwest Territories, Canada	4	SVL CLIP SWAB	1–2 min	P-LTX P-NIT	OBS	None observed	D. Schock (pers. comm.)
Arizona Tiger Salamander (*Ambystoma tigrinum nebulosum*)	Arizona, USA	2309	VIE CLIP	2 min	P-LTX N-LTX	RCAP HOLD	None observed	Greer et al. (2009)

[1] SVL = snout–vent length measurement, STAGE = developmental stage, CLIP = tissues sample, SWAB = swab for DNA, VIE = visible implant elastomer tag marking,
[2] P-LTX = powdered latex, N-LTX = non-powdered latex, P-NIT == powdered nitrile
[3] Based on description of morbidity and mortality described by Cashins et al. (2008)

by which gloves, this experiment should be conducted with every species to be handled using each type (e.g., latex, nitrile, or vinyl) and brand of glove that will be used. If it is impossible to hold individuals of a given species for 24 h, a sister species may be used. Given the potential for batch-to-batch variation in the manufacturing process, it may be preferable to order large batches of gloves after finding one that does not seem to cause mortality.

Second, once a suitable type and brand of glove are identified, experiments should be used intermittently to test new batches of these gloves for safety. As confidence in the safety and quality control of the product is established then the testing could be less frequent.

There are several other simple steps that researchers should take to minimize the risk to amphibians. Cashins et al. (2008) found that rinsing vinyl gloves in water reduced their toxicity, so any protocol should include rinsing gloves in fresh water prior to handling animals. The water used for this purpose could be collected on site but should be discarded terrestrially. We also recommend researchers pay attention to where gloves are stored to avoid unnecessary risks of gloves coming within close proximity of volatile toxic substances. While we cannot control how and where gloves are stored before we receive them, we can avoid storing them near disinfectants, insecticides, or laboratory chemicals. Lastly, we as a community should watch for and report morbidity and mortality associated with handling tadpoles and larvae in the lab or field. These findings should be openly shared with others who work on amphibians in order to avoid unnecessary morbidity and mortality. Disposable gloves are an essential component of any animal hygiene protocol and by taking these simple steps researchers can ensure that they help, rather than harm, the animals we study.

TABLE 3. Amphibian species at the Detroit Zoo that have been repeatedly handled using gloved hands and otherwise exposed to gloves during husbandry and veterinary care while in the larval lifestage. All animals are checked daily as part of routine care and husbandry. For several years, powdered latex gloves have been primarily used although infrequently non-powdered nitrile gloves are used. In no instance has glove-related morbidity or mortality as described by Cashins et al. (2008) ever been detected. Reference for all information in Table 3 is R. Johnson and D. Schock, personal observations.

Species	Origin[1]	N[2]
Puerto Rican Crested Toad (*Bufo lemur*)	CAPT-DZ	TENS
Wyoming Toad (*Bufo baxteri*)	CAPT-DZ	TENS
Panamanian Golden Frog (*Atelopus varius zeteki*)	CAPT-DZ	TENS
Vietnamese Mossy Frog (*Theloderma corticale*)	CAPT-DZ	TENS
Hourglass Treefrog (*Hyla ebraccata*)	CAPT-DZ	TENS
Red-eyed Treefrog (*Agalychnis callidryas*)	CAPT-DZ	TENS
African Clawed Frog (*Xenopus laevis*)	CAPT-DZ	TENS
Golfodulcean Dart Frog (*Phyllobates vittatus*)	CAPT-DZ	ONES
Green and Black Dart Frog (*Dendrobates auratus*)	CAPT-DZ	ONES
Blue Dart Frog (*Dendrobates azureus*)	CAPT-DZ	ONES
Emperor Newt (*Tylototrition shanjing*)	CAPT-DZ	TENS
Anderson's Newt (*Echinotrition andersoni*)	CAPT-DZ	TENS
Axolotl (*Ambystoma mexicanum*)	CAPT-DZ	TENS
Marbled Salamander (*Ambystoma opacum*)	CAPT-DZ	TENS
Texas Blind Salamander (*Eurycea rathbuni*)	CAPT-DZ	TENS
Texas Salamander (*Eurycea neotenes*)	CAPT-DZ	TENS
Red-spotted Newt (*Notophthalmus v. viridescens*)	CAPT-DZ	TENS

[1]CAPT-DZ = captive bred at the Detroit Zoo

[2]Dependent upon the breeding biology of the species. TENS = 10's to 100's of tadpoles surviving through metamorphosis and beyond per breeding event for multiple years, ONES = 1–2 eggs laid per animal's breeding event with several adults producing tadpoles that survive beyond metamorphosis for multiple years.

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Microhabitat Selection of Bullsnakes (*Pituophis catenifer sayi*) at a Site in the Upper Midwestern United States

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The presence of suitable habitat is an important factor in the conservation of rare species (Loehle and Li 1996; Primack 2002; Smith 1996; Tilman et al. 1994). As such, in order to effectively work toward wildlife conservation, it is important to understand the habitat requirements of the species in question. Recent studies have suggested that landscape-level habitat factors, or macrohabitat, may be critical to determine the distribution of snake species native to Midwestern prairies (Cagle 2008). Alternatively, past research has shown that microhabitat selection is of greater importance than landscape-level habitat selection in a non-prairie species; the eastern Massasauga, *Sistrurus catenatus catenatus* (Harvey and Weatherhead 2006). Other studies have shown that certain snake species select habitat at several scales (Blouin-Demers and Weatherhead 2001; Reinert 1993; Row and Blouin-Demers 2006; Sperry and Weatherhead 2009; Wund et al. 2007).

Bullsnakes (*Pituophis catenifer sayi*) are considered a species of conservation concern in most upper Midwestern states. Thorough studies on the habitats selected by members of the genus *Pituophis*, including Bullsnakes, are rare. Much of the existing information on Bullsnakes in the upper Midwest comes from field guides, which report that it associates primarily with open-canopied, xeric habitats such as prairies and grasslands (Oldfield and Moriarty 1994; Phillips et al. 1999; Vogt 1981, *but see* Kapfer et al. 2008a, b, c). Although anecdotal observations of Bullsnake habitat associations can offer insight into their habitat preferences, this type of information does not support a thorough understanding of ecology. Rigorous, multi-year research on habitat selection at multiple scales is necessary to achieve this. The lack of detailed information is a significant hindrance to understanding the ecology of this species.

Bullsnakes have recently been reported to show a strong preference for open, south- to west-facing bluff slopes, rather than prairie or grassland (Kapfer et al. 2008c). This habitat is characterized by significant topographic relief, rocky soils and outcroppings, no overstory vegetation, and ground vegetation consisting of mostly short, herbaceous species, with occasional clumps of taller woody species. Although landscape-level habitat preferences have been reported for this species in the upper Midwest (Kapfer et al. 2008c), preferred microhabitat parameters remain largely unknown. Therefore, the main objective of this research was to use radiotelemetry to determine the microhabitat preferences, if any, of Bullsnakes in the upper Midwestern United States. We predicted that selection on a microhabitat scale would occur in Bullsnakes and that, based on previous research of macrohabitat preferences in this species (Kapfer et al. 2008c), selection would correspond with characteristics typical of preferred macrohabitats. As such, we predicted that favored microhabitats would likely have high rock cover, open canopy, and mostly herbaceous vegetation. Because this previous research on macrohabitat also found little difference between male and female preferences, we also predicted that males and females would not differ in microhabitat selection. We did, however, believe the microhabitat variables favored by males and females would differ from that measured at randomly selected locations.

Methods.—The study site, located in southwestern Wisconsin, was ca. 8943 ha in size. This area consisted of a mosaic of natural, managed, fallow, agricultural and residential habitats (Kapfer et al. 2008c). Managed habitat (mostly sand prairie, savanna, and open bluff sides) was kept in an early state of vegetative succession through a combination of herbicide application, removal of aggressive or invasive plant species and a prescribed burning regimen. Although open bluff sides comprised only a small portion of the managed property, it was the preferred macrohabitat of Bullsnakes (Kapfer et al. 2008c). The unmanaged habitat within the study area was dominated by closed-canopy bluff side forest and agriculture (row crop and pasture), with small components of non-bluff deciduous woodlots and residential property also sporadically present on the landscape.

We captured adult Bullsnakes opportunistically by hand during emergence from winter dormancy. We surgically implanted radio transmitters (models SI-2 or AI-2; Holohil Systems; Carp, Ontario, Canada) following the methods of Reinert and Cundall (1982). We released radio-tagged individuals approximately 48 h post-surgery and relocated them at least weekly throughout the duration of their active season (early-April to mid-October, 2003–2005) via radio receiver and three-element Yagi antenna (Advanced Telemetry Systems, Isanti, Minnesota, USA). Fieldwork was conducted from 0900 h to 1700 h. The amount of time spent tracking snakes within a given day varied widely, as did the times at which snakes were relocated.

Each time we located individuals, we measured several structural microhabitat variables within a 1.0 m^2 area centered on the location of snakes. These included the percent area covered with exposed rock, non-woody vegetation, woody vegetation, leaf litter, and woody vegetative debris. Vegetation height was also measured at four random positions within the same 1.0 m^2 area and averaged per snake location. We used a convex densiometer to measure canopy closure (Ben Meadows, Atlanta, Georgia, USA). We selected these microhabitat parameters based on past studies of snake habitat selection, but modified them to suit this study (Blouin-Demers and Weatherhead 2001; Blouin-Demers et al. 2007; Reinert 1984; Reinert 1993). We took care to ensure that

radio-tagged snakes were not disturbed while recording habitat information. On occasions where an individual snake was disturbed, we recorded microhabitat parameters at the location it had been observed prior to disturbance. If this could not be determined, we did not collect microhabitat data for that particular observation. We recorded data for both male and female snakes. Because we discovered that all female Bullsnakes were gravid during each year, we did not further separate them into "females" and "gravid females" for analyses.

We measured microhabitat parameters at 100 random locations, determined via Geographical Information Systems (GIS). We placed random data points only in habitats where snakes had been previously located during the first year of tracking, which included all habitats available within the designated study area. We then compared microhabitat data from random locations to microhabitat variables measured in association with male and female snake observations via discriminant function analysis (DFA, alpha to enter of 0.001) as in other studies (Blouin-Demers and Weatherhead 2001; Reinert 1984; Reinert 1993; Wund et al. 2007). In addition, a multiple analysis of variance (MANOVA) was conducted on the DFA scores, followed by a post-hoc pair-wise comparison with a Bonferroni correction to determine if differences existed among males, females and random locations in microhabitat variables preferred (Reinert 1984; Wund et al. 2007). We conducted all statistical analyses in Systat v. 10.0 (Point Richmond, California).

Results.—The number of snakes tracked in each year varied (2003 = 12 males, 8 females; 2004 = 9 males, 5 females; 2005 = 10 males, 5 females). We collectively located radio-tagged Bullsnakes a total of 310 times in 2003, 189 times in 204, and 291 times in 2005, and the mean number of locations recorded annually for an individual was 16.1 (± 3.8 SD). Conditions suitable to record microhabitat data occurred on 740 of these occasions (females, N = 281; males, N = 459).

Of the habitat variables associated with snake observations, the most common were consistent with open bluff sides. For example, the mean percentage of non-woody vegetation was largest among variables measured (41–47.6%), while mean vegetation height (35.5–37.3 cm) and tree canopy closure (~18%) associated with snake locations were small compared to the rest of the landscape (Table 1). The DFA revealed that males, females, and randomly sampled points could be distinguished using the microhabitat variables measured at each location (Wilk's $\lambda = 0.949$, $F = 3.176$, df = 14, 1684, $P = <0.001$). However, discriminant function 1 was a stronger discriminator (eigenvalue = 0.053) than discriminant function 2 (eigenvalue = 0.001). Several of the variables along the first discriminant axis influenced the distribution of male and female snakes, and also differed from random locations: percent rock, percent woody debris, and percent woody vegetation (Table 2; Fig. 1). In general, males exhibited a moderate preference for rock, woody debris and woody vegetation cover, which did not occur in females or random locations (Fig. 1). The MANOVA performed on the DFA scores indicated that males, females and random locations differed in their habitat association along the first discriminant axis, but not along the second (Wilk's $\lambda = 0.949$, $F = 11.182$, df = 4, 1694, $P = <0.001$). A Post-hoc, pair-wise comparison among groups with a Bonferroni correction indicated that, along the first discriminant axis, females differed from males (P = <0.001), females differed from random locations (P = 0.005) and males differed from random locations (P = <0.001). No significant difference was found among groups along the second discriminant axis (all comparisons P = 1.000). We recommend caution when interpreting our results, as a low percentage of jackknifed classification cases were predicted correctly by this analysis, particularly for females (females = 6%, males = 47% and random locations = 71%).

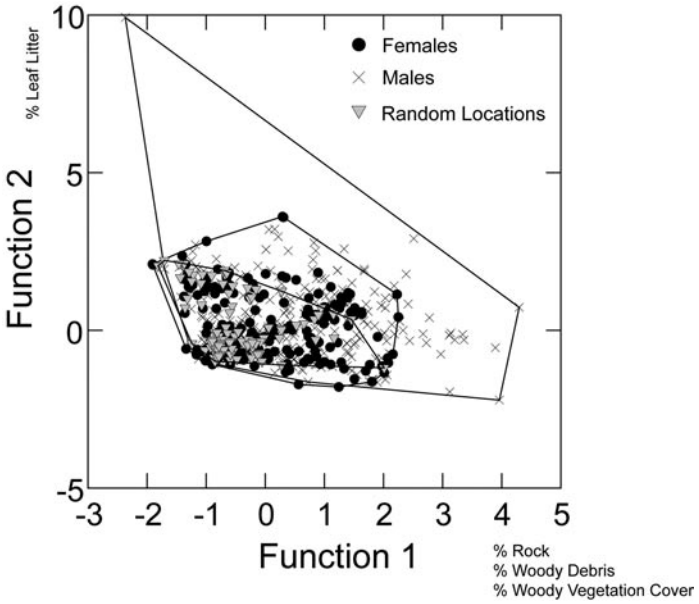


FIG. 1. Discriminant function plot of male and female Bullsnake (*Pituophis catenifer sayi*) and random location scores in southwestern Wisconsin, with convex hulls delineating the data clusters for each group.

Discussion.—These findings are the first, to our knowledge, to specifically address Bullsnake microhabitat selection. Some of our findings support the hypothesis that Bullsnakes

TABLE 1. Microhabitat parameters (% of 1.0 m^2 area centered on snake location ± 1 SD) recorded in association with male and female Bullsnake (*Pituophis catenifer sayi*) observations in southwestern Wisconsin.

	Males	Females	Random Locations
Rock	20.9 (± 34.4)	16.1 (± 31.9)	9.8 (± 23.2)
Leaf Litter	18.4 (± 36.7)	17.9 (± 33.71)	20.1 (± 36.4)
Non-woody Vegetation Cover	40.8 (± 38.2)	46.9 (± 39.7)	53.2 (± 37.1)
Woody Debris	13.5 (± 26.5)	9.6 (± 22.7)	4.6 (± 13.3)
Woody Veg. Cover	16.9 (± 26.9)	12.2 (± 23.9)	7.7 (± 16.2)
Ave. Vegetation Height (cm)	37.3 (± 32.6)	35.4 (± 35.2)	34.3 (± 30.0)
Canopy Closure	19.2 (± 34.1)	18.9 (± 33.2)	21.6 (± 38.4)

TABLE 2. Summary statistics for the two canonical discriminant functions, standardized by within variances, for microhabitat variables measured while radio tracking Bullsnakes (*Pituophis catenifer sayi*) in southwestern Wisconsin.

Variable	Function 1	Function 2
% Rock	0.661	0.356
% Leaf Litter	-0.179	0.946
% Non-woody veg. cover	0.049	-0.175
% Woody debris	0.698	-0.244
% Woody veg. cover	0.479	-0.277
Vegetation Height	0.159	0.377
Canopy Closure	-0.129	0.017
	Canonical Scores of Group Means	
	Function 1	Function 2
Females	-0.104	-0.040
Males	0.182	0.014
Random Locations	-0.487	0.044
Eigenvalues	0.053	0.001

select microhabitat characteristics typically found in preferred macrohabitats (open bluff sides; Kapfer et al. 2008c). For example, non-woody herbaceous vegetation often found on open bluff sides was abundant compared to other habitat variables (Table 1). On average, 40% to nearly 50% of the 1.0 m^2 area immediately associated with snakes consisted of non-woody vegetation (Table 1). In addition, a positive association by males with rock cover was observed in the DFA, which is expected based on the prevalence of exposed rock outcroppings and rocky substrate on open bluff sides.

Males also exhibited a preference for woody debris and woody vegetation cover, which are not typically abundant on managed open bluff sides. Yet, woody debris does occur sporadically in this macrohabitat, and is occasionally used as cover by some snake species. The reason females do not exhibit preferences for these same microhabitat variables is unknown, as males and females were not found to substantially differ in their macrohabitat selection (Kapfer et al. 2008c), although females were found to prefer one additional habitat to males (savanna) in one of three years. However, gravid females have greater mean body temperatures than males (Kapfer et al. 2008a). To achieve this, females may seek out warmer microhabitats and less often use cover from woody vegetation or debris. Our prediction that males and females would prefer similar microhabitats was not supported, while our prediction that snakes would differ significantly from random locations was supported. In general, due to low eigenvalues and low percentages of correctly predicted jackknifed classification scores, the ability of our analyses to discriminate between these groups based on microhabitat variables was relatively low. Therefore, our analysis indicates that, although the DFA results support the prediction that Bullsnakes exhibit selection at the microhabitat scale, this selection is not strong. Therefore, it appears that microhabitat variables may not substantially influence habitat selection in this species. If true, it may be adequate to measure only macrohabitat preferences (or landscape level preferences) to effectively understand the Bullsnake's habitat needs. This also suggests that habitat management for Bullsnakes should focus on habitat communities rather than microhabitat composition. Other recently published studies have also suggested that effective snake conservation efforts in prairies of the midwestern United States should focus on determining landscape-level habitat preferences (Cagle 2008).

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Attributes of Rock Crevices Selected by Green Salamanders, *Aneides aeneus,* on the Blue Ridge Escarpment

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The Green Salamander, *Aneides aeneus*, is a federal species of concern and in North Carolina it is listed as endangered (LeGrand et al. 2006). The importance of suitable rock crevices to Green Salamanders has been noted by many researchers (e.g. Bruce 1968; Gordon 1952; Gordon and Smith 1949; Netting and Richmond 1932; Petranka 1998). Green Salamanders generally use two types of rock crevices, which have been described by Gordon (1952) as "breeding" and "transitory" crevices. Breeding crevices are used primarily by gravid females for egg laying and brooding eggs and hatchlings (Canterbury and Pauley 1994; Gordon 1952; Petranka 1998). Transitory crevices are used by juveniles, males, and non-breeding females and are thought to serve as refuges that provide stable microclimatic conditions (Cupp 1980; Gordon 1952). Cupp (1980) postulated that these specialized rock crevices form the basis of a Green Salamander's territory, as most males and females he observed occupied and defended individual crevices throughout much of the year.

Currently, very little published data are available on the characteristics of rock crevices used by Green Salamanders. To our knowledge, Gordon (1952) provided the only comprehensive data on rock crevices used by Green Salamanders. In his study, he quantified 17 attributes of breeding (N = 16) and transitory crevices (N = 30) used by two populations of Green Salamanders in North Carolina. However, only limited inferences on the relative importance of selected attributes can be drawn from Gordon's (1952) study because no comparisons were made to an attribute's availability in the surrounding environment. In this study, we quantified the attributes of rock crevices used by a population of Green Salamanders on the Blue Ridge Escarpment and investigated whether the attributes selected differed from those available in the surrounding environment.

Materials and Methods

Study Site.—We conducted our study at a rock complex at Heady Mountain Gap in the Highlands District of the Nantahala National Forest, Jackson County, North Carolina (elevation 1036 m). The site was chosen because it had an abundance of Green Salamanders (L. Williams, unpubl. data) and it was accessible. The rock complex was part of the Biotite gneiss unit of the Alligator Back Formation, which was metamorphosed to Amphibolite Facies in the Blue Ridge Belt (North Carolina Geologic Survey 1985). Temperatures of the Blue Ridge Escarpment are considered mild and annual precipitation is the highest in eastern North America, ranging from 215–250 cm (White et al. 1998).

The rock complex consisted of three separate outcrops (96 m^2, 50 m^2, and 35 m^2) approximately 15 m apart. The site was located on a southwest-facing slope surrounded by relatively mature mixed-hardwood forest, with a closed canopy and thick shrub layer. Dominant canopy species included Northern Red Oak (*Quercus rubra*), Chestnut Oak (*Q. prinus*), Red Maple (*Acer rubrum*), and Tulip Poplar (*Liriodendron tulipifera*). Rhododendron (*Rhododendron maximum*) and Mountain Laurel (*Kalmia latifolia*) comprised the shrub layer.

Crevice surveys and measurements.—We conducted four diurnal and three nocturnal searches for crevices occupied by Green Salamanders from 12 May to 3 June 2006. Searches were generally conducted every 6 d. Diurnal searches were conducted between 1200–1500 h, and nocturnal searches were conducted between 2000–2200 h. All crevices in each rock outcrop were systematically searched using a flashlight. Searches typically occurred on partly cloudy to clear days with the exception of one diurnal search that occurred during a rain event. Air temperatures during searches ranged from 18–24°C. We measured the distance of each crevice occupied by a Green Salamander (and each corresponding unoccupied crevice, see details below) to a marked reference point on each rock outcrop in order to track and identify all crevices used in the study.

We restricted our study to those crevices most likely used as transitory crevices, because crevices used for breeding may have dif-

ferent characteristics (Gordon 1952). Green Salamanders in the southern Appalachians mate in late May and early June (Canterbury and Pauley 1994; Gordon 1952), with male-gravid female pairs occupying breeding crevices for 3–7 d (Canterbury and Pauley 1994). Eggs are laid during the first two weeks of June (Canterbury and Pauley 1994; Gordon 1952). Therefore, we only quantified crevices that contained one occupant and no evidence of eggs. We visually categorized the age of individuals in crevices as either juvenile (< 45 mm snout to vent length, SVL) or adult (> 45 mm SVL; Juterbock 1989). We did not determine the sex of individuals because of the difficulty and invasiveness of capturing animals (Gordon 1961; Netting and Richmond 1932).

For each occupied crevice, we measured the total length (measured using a string placed along the bottom edge of the crevice opening on the rock face), maximum depth (measured using a flattened wooden probe), maximum opening width (measured using a tape measure), mean depth and mean opening width (calculated using measurements at three equidistant points along the crevice), drip-edge (horizontal distance of cover provided by the closest overhanging ledge above the crevice, measured using a plumb bob and tape measure), slope (angle of crevice above horizontal estimated using a protractor and level), and height above the ground (measured from the lowest point of the crevice opening on the rock face).

For each occupied crevice, we identified a corresponding unoccupied crevice located 1 m from each occupied crevice to determine whether the attributes of occupied crevices differed from those available on the rock outcrops. We used a random numbers table to determine the direction (0–360°) an unoccupied crevice would be located from an occupied crevice. An unoccupied crevice was determined suitable if its opening was at least 0.3 cm wide and large enough for a juvenile Green Salamander to use. If a suitable crevice was not located at the 1 m point, we continued along the random direction until a suitable crevice was found. In the event there was no suitable crevice along the random direction, we generated a new random direction and repeated the procedure until a suitable crevice was located. Once an unoccupied crevice was selected, data were recorded as described above. We tracked all unoccupied crevices throughout the study and none were found to be occupied during any of the searches.

Analyses.—We conducted a conditional logistical regression analysis for matched pairs to examine which characteristics increased the probability that a salamander would select the occupied crevices instead of the unoccupied ones (Allison 1999). We analyzed attributes separately to avoid over-fitting. We excluded crevice height from the analysis because height of unoccupied crevices was dependent on height of occupied crevices. We used the likelihood-ratio chi-squared statistic to test the null hypothesis on no selection based on a given attribute with a significance level of 0.05. The PHREG procedure in Statistical Analysis System (SAS) was used for all calculations (SAS Institute Inc. 2004). To examine whether Green Salamanders used crevices at particular heights, a t-confidence interval for the mean height of the occupied crevices at each rock outcrop was calculated and compared to the middle height of each rock.

Table 1. Means (SD) of attributes of 15 occupied and 15 unoccupied rock crevices in a population of Green Salamanders at Heady Mountain Gap, Nantahala National Forest, North Carolina.

Attribute	Occupied	Unoccupied	χ^2	P-value[1]
Length (cm)	18.2 (8.9)	13.2 (6.1)	2.35	0.13
Mean opening width (cm)	1.8 (1.4)	2.6 (1.8)	4.14	0.04
Mean depth (cm)	6.1 (2.9)	5.5 (3.0)	0.27	0.60
Maximum opening width (cm)	2.1 (1.5)	3.7 (3.2)	5.95	0.01
Maximum depth (cm)	7.2 (2.8)	6.7 (3.4)	0.24	0.63
Drip-edge (cm)	19.0 (23.0)	24.9 (41.2)	0.42	0.52
Slope (°)	24.5 (27.7)	23.3 (28.8)	0.02	0.89

[1]Likelihood-ratio chi-square tests were used to compare attributes of occupied and unoccupied crevices (P-value < 0.05 was considered significant for all tests).

Results

We identified fifteen occupied crevices during our study, with a maximum of six occupied crevices during any one search. All crevice occupants were adults. Nine crevices were occupied during diurnal searches, and six were occupied during nocturnal searches. Of the fifteen crevices, five were occupied during at least one diurnal and one nocturnal search. Occupied crevices had smaller mean opening widths ($P = 0.04$) and smaller maximum opening widths ($P = 0.01$) than unoccupied crevices (Table 1). No other differences were found between any of the other attributes compared (all $P > 0.12$; Table 1).

Outcrop 1 (total height of 701 cm) had four occupied crevices, with a mean crevice height of 82.6 cm (95% CI = 18.2, 146.9). Outcrop 2 (total height of 274 cm) had ten occupied crevices, with a mean crevice height of 133.3 cm (95% CI = 103.0, 139.3). Outcrop 3 (total height of 264 cm) had a single occupied crevice at a height of 172.2 cm.

The confidence interval for Outcrop 2 contained the middle height of the outcrop, but the upper limit of the confidence interval for Outcrop 1 was significantly lower than the middle height of the rock ($P = 0.0009$).

Discussion

Transitory crevices have been characterized as refuges used by Green Salamanders to avoid periods of low humidity (Cupp 1980; Gordon 1952). Many researchers have suggested that narrow crevices are a primary component of suitable Green Salamander habitat (Bruce 1968; Gordon 1952; Gordon and Smith 1949; Netting and Richmond 1932; Petranka 1998). In our study, Green Salamanders selected crevices with smaller openings than were available in the surrounding habitat, supporting the importance of narrow crevices to Green Salamanders. Crevices with narrow openings may be preferred by Green Salamanders because they are more efficient at maintaining high relative humidity levels and constant temperatures than crevices with larger openings. Crevices used by Green

Salamanders have been found to maintain high relative humidity levels and moderate extreme temperature fluctuations relative to conditions outside the crevices (Canterbury 1991; Gordon 1952; Snyder 1971). Green Salamanders also may select narrow crevices to avoid direct competition with other salamanders that occasionally inhabit rock crevices such as woodland salamanders (*Plethodon* spp.; Gordon 1952). Green Salamanders are uniquely adapted for inhabiting narrow crevices because of their flattened bodies (Conant and Collins 1998; Petranka 1998).

It has been suggested that Green Salamanders select higher crevices on rocks because their greater climbing ability allows them to avoid competition when other crevice-dwelling plethodontid salamanders are present (Cliburn and Porter 1986; Cliburn and Porter 1987; Pauley and Watson 2005). This is supported by field observations and laboratory tests by Cliburn and Porter (1987) that found Green Salamanders stratified vertically in the presence of *Plethodon glutinosus*, with Green Salamanders selecting significantly higher crevices. Our findings comparing the confidence intervals of the heights of occupied crevices to the middle height of each rock outcrop suggest that Green Salamanders in our study did not vertically stratify, and on Outcrop 1 used crevices lower on the rock than expected by chance. The lack of vertical stratification is further supported by the fact that no other species of salamander were found during our study. It should be noted, however, that these results assume that suitable crevices were distributed evenly at all heights of the rocks. Although we did not quantify the heights of all suitable crevices, observations indicated that they were available throughout the entire rock faces.

The dimensions of occupied crevices in our study (e.g., length, mean opening width, and depth) were comparable to those reported by Gordon (1952) for two populations in North Carolina, highlighting the specialized and specific habitat requirements of this species. Many of the attributes examined in our study did not differ from those available in the surrounding habitat, suggesting that these attributes may not be as important to Green Salamanders choosing crevices. However, because of our small sample size, these findings should be viewed tentatively until a broader range of habitats are sampled.

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Diet of *Amphiuma means* from Cumberland Island, Georgia, USA

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Amphiuma means is common on Cumberland Island, the largest and southernmost barrier island off the coast of Georgia. A number of Two-toed Amphiumas have been preserved over the years by CR, and provided a source for examination of their food habits. Knowledge of the diet is basic to understanding their biology and natural history. The purpose of this paper is to examine the food of *Amphiuma means* on Cumberland Island, Georgia, and to compare the results with those of previous studies on this species elsewhere.

Most reports on the diet of *A. means* have been generalized into broad categories of food items such as crayfish, frogs, earthworms, and salamanders (Martof et al. 1980; Mount 1975) or involve few individuals (Duellman and Schwartz 1958; Enge 1998). Hamilton (1950) provided a detailed account of the major food groups of 36 individuals from Florida and South Carolina. Machovina (1994) identified food items from 94 *Amphiuma* from the Everglades, and also reported on seasonality of the diet. Duellman and Schwartz (1958) examined 11 individuals, but only 6 provided information on food.

Materials and Methods.—Cumberland Island is a barrier island with freshwater sloughs occurring behind the beach dune complex. The sloughs are relics of the primary dune system and may be extensive, although shallow and frequently dry. The water in these systems reflects groundwater level, the recharge of which is provided solely by rainwater. During periods of drought, aquatic flora and fauna are supplanted by *Eupatorium capillifolium* (dog fennel), grasses, and other terrestrial species, and blowing sand may block the usual drainage to the sea, especially where the dune system is compromised by feral cattle or horses (pers. obs.). Storms or heavy rainfall may cause the water level to rise above the confining sand dunes. In that case, the water may breach the dunes and increase in velocity as it deepens its channel to the sea. This flush of usually fairly stagnant water may catch animals unaware or they may deliberately take advantage of it to disperse. Many animals end up in the sea. For several days after such a breach, freshwater animals (mostly fish but including *A. means*) may be found stranded at the wrack line. Osmoregulation of *Amphiuma means* is unable to cope with exposure to saltwater (pers. obs.) and they usually die quickly; thus, the gut contents of stranded individuals reflect normal feeding in their freshwater environment.

All individuals of *Amphiuma means* included in this study were collected between 1983 and 1996, and all were associated with temporary fresh water systems. Many (N = 62) were salvaged from the ocean beach after exposure to salt water and others were mortalities of modified funnel traps during a behavior study. Feces were collected from four live animals. Male snout–vent length averaged 544 mm (range 383–735, N = 38), and total length averaged 675 mm (range 490–935, N = 36). Female snout-vent length averaged 513 mm (range 295–641, N = 27) and total length averaged 628 mm (range 385–828, N = 26). Measurements were taken from both the preserved and live animals. Tails had been mutilated in some cases; therefore the numbers measured for total length are less than those measured for snout-vent length. The specimens are preserved in the Cumberland Island Museum.

Stomach and intestinal contents were collected separately from 65 preserved specimens. All were treated as separate samples. Twelve individuals had materials in the stomach only, 37 had food in the intestines only, and 12 had food in both the stomach and the intestines. Feces were collected from four live animals. This totaled 77 samples. We also examined five individuals that had nothing in either the stomach or intestines. Food items were identified with the aid of a dissecting microscope to the lowest possible taxon. The percent volume of each component in each sample was visually estimated (Whitaker 1988), and the data were averaged for a total percent volume for each item recorded. Percent frequency represents the number of animals which contained each item, calculated as a percentage of the total. Calculating only percent frequency has the potential to be misleading especially when there is great diversity in prey numbers and size. Seasons were defined as spring: March–May, N = 11; summer: June–August, N = 23; autumn: September–November, N = 43; and winter: December–February, N = 0.

Results.—The items identified (35) in 77 Two-toed Amphiuma food samples from Cumberland Island, Georgia (Table 1) were insects (16), other invertebrates (6), vertebrates (12), and plant materials (1). Six different plant items were actually identified, but were presumed to have been incidentally ingested. The three most predominant foods both in percent volume and percent frequency were: crayfish, *Procambarus paeninsulanus* (46.0% volume, 59.7% frequency), insects (31.4% volume), and amphibians (11.0% volume).

The most predominant insect groups represented were: Coleoptera (11.5% volume), including unidentified adults; Hemiptera (5.1%); Diptera (4.9%), Lepidoptera (3.4%); Orthoptera (0.7%); Odonata (0.2%). Other invertebrates included Chilopoda (0.5%), Araneae (0.1%), Annelida (1.6%), and Mollusca (0.2%).

Vertebrates (16.6% volume) were represented by Amphibia (11.0%), Reptilia (1.8%), and Osteichthyes (2.2%). The majority of the amphibians consumed were salamanders *Amphiuma means* (6.9% volume, 11.7% frequency), *Notophthalmus viridescens* (Eastern Newt) (1.4%, 2.6%), and shed skin (0.1%, 2.6%), probably of *Amphiuma* (Brode and Gunter 1959). The remainder included *Rana grylio* (Pig Frog) (1.9% volume) and tadpoles (0.6%).

Among the reptiles consumed were *Nerodia fasciata* (Southern Watersnake), which contributed the greatest volume (1.3%) and was more frequently captured (2.6%) than unidentified lizards (0.3% volume), lizard eggs (0.1%), or turtle eggs (0.1%). The fishes identified were all mosquitofish, *Gambusia affinis*.

The percentage of food items changed seasonally (Table 2). Crayfish were the most important food item by volume in spring (60.5%)

TABLE 1. Food of the Two-toed Amphiuma, *Amphiuma means*, from Cumberland Island, Camden County, Georgia (N = 77).

Food item	% Volume	% Frequency
Invertebrates other than insects	(48.4)	
Crustacea (*Procambarus paeninsulanus*)	46.0	59.7
Chilopoda	0.5	1.3
Araneae	0.1	1.3
Oligochaeta	1.0	3.9
Hirundinea	0.6	1.3
Mollusca (*Physa heterostropha*)	0.2	1.3
Insects	(31.4)	
Unidentified insects	5.6	10.4
Diptera	4.9	15.6
Coleoptera: adult	3.3	9.1
Coleoptera: pupae	0.9	2.6
Hydrophilidae	2.9	7.8
Dytiscidae: adult	0.5	3.9
Dytiscidae: larvae	0.6	2.6
Carabidae: adult	2.2	2.6
Scarabaeidae: adult	0.3	1.3
Scarabaeidae: larvae	0.8	1.3
Unidentified Hemiptera	2.1	5.2
Nepidae	3.0	10.4
Lepidoptera: adult	1.8	5.2
Lepidoptera: larvae	1.6	3.9
Orthoptera (Gryllidae)	0.7	1.3
Odonata: adult	0.2	2.6
Vertebrates	(16.6)	
Unidentified vertebrates	1.6	2.6
Amphibian shed skin	0.1	2.6
Unidentified amphibian	0.1	1.3
Amphiumidae (*Amphiuma means*)	6.9	11.7
Salamandridae (*Notophthalmus viridescens*)	1.4	2.6
Tadpole intestine	0.6	1.3
Ranidae (*Rana grylio*)	1.9	2.6
Testudinata (turtle egg)	0.1	1.3
Lizard	0.3	1.3
Lizard egg	0.1	1.3
Serpentes (*Nerodia fasciata*)	1.3	2.6
Poeciliidae (*Gambusia affinis*)	2.2	7.8
Miscellaneous plant material	3.8	100.2

TABLE 2. Main foods of *Amphiuma means* from Cumberland Island by season (% volume).

Food item	Spring (N = 11)	Summer (N = 23)	Fall (N = 43)	Total (N = 7)
Crayfish	60.5	65.2	32.5	46.3
Insects	9.9	14.1	45.5	31.1
Amphibians	13.5	15.2	9.9	12
Fish	0	3	2.3	2.2
Reptiles	9.6	0	0.8	1.8
Earthworms	0	0	1.8	1
Leeches	0	0	1	0.6
Centipedes	0	0	0.8	0.5
Unid. vertebrate	3.6	0	0	0.5
Mollusks	1.1	0	0	0.2
Spiders	0	0	0.1	0.1
Vegetation	1.9	2.4	5.2	3.9
	100.1	99.9	99.9	100.2

and summer (65.2%), but were much lower in fall (32.5%). Insects were low in spring (9.9%) and summer (14.1%) but increased greatly in fall (45.5%), apparently being much more heavily eaten at that time perhaps because they were more abundant. Reptiles were eaten in spring (9.6%), but not much later. Amphibians were the second most eaten item in spring (13.5%) and summer (15.2%), third after insects and crayfish in autumn.

Data on sex were not available for all the amphiumas, but we did have information on 35 males and 28 females. The greatest difference was in the amounts of crayfish eaten by males (57.4% volume) and by females (37.8%). However, larger individuals ate more crayfish, and males averaged larger than females which could account for that difference. Data on other of the more important foods were Diptera (5.6% males, 5.5% females), Carabidae (4.4%, 0%), Hydrophilidae (4.6%, 0%), vegetation (3.6%, 3.9%), Nepidae (1.7%, 4.1%), *Amphiuma* (6.6%, 10.5%), Lepidopteran larvae (2.4%, 0.9%), *Rana* (0%, 2.9%), Scarab larvae (0%, 2.1%), and Chilopoda (2.3%, 0%). There are some differences, especially a few cases where members of one sex had eaten an item, and the other none (Carabidae, Hydrophilidae, *Rana*, and scarabaeid larvae), but the samples were too small to mean much.

Discussion.—Hamilton (1950) found insects most important in volume (33.8%) and frequency (52.8%) in his sample, with crayfish second in frequency (25.0%) but fifth in percent volume (12.8%). Other items were amphibians (19.7% volume, 19.4% frequency), reptiles (12.4%, 16.7%), fish (17.6%, 19.4%), molluscs (2.4%, 11.1%), and arachnids (1.3%, 2.8%). Machovina (1994) found crayfish to be first in frequency (57.0%) followed by insects (49.1%), amphibians (8.3%), reptiles (4.0%), fish (20.0%), and vegetation (9.4%) with no estimate of percent volume provided. The greatest differences in the findings of these studies and the present one is the reduced use of amphibians by the Everglades population (8.3% frequency) compared with that of Hamilton (1950) from widely separated geographic areas (Charleston, South Carolina, and Fort Myers, Florida, 19.4%) and ours on Cumberland Island, Georgia (22.1%). The consumption of reptiles was more similar between the Cumberland Island sample (6.5%) and the Everglades collection (4.0%) than Hamilton's (16.7%), and the use of fish was greatly reduced on Cumberland Island (7.8%) compared with the other localities (Hamilton 19.4%, Machovina 20.0%). This is because freshwater fish are uncommon on Cumberland Island and usually include primarily *Gambusia* in the sloughs and temporary ponds of amphiuma habitats.

Hamilton (1950) did not calculate values for the insect groups he recorded, but he did rank them. Midges (Chironomidae) were found by Hamilton but not represented in the other studies. Machovina (1994) calculated percent frequency of the groups but found less diversity than in our study. He found Belostomatidae (Hemiptera) in his Everglades sample but it was not found in the

other studies, and two of the three top-ranking insect categories in our study, Nepidae (Hemiptera) and miscellaneous Lepidoptera and lepidopteran larvae, were not found in the other studies. The majority of the insects consumed by amphiuma in all three studies were beetles (Order Coleoptera) with the families Dytiscidae and Hydrophilidae most prominent. The only other group represented in all three studies was Orthoptera, with a low occurrence. Some plant material was present, but we think that most of it was ingested incidentally, in or with other foods. Data from Duellman and Schwartz (1958) are few but similar to ours. Six individuals had food as follows: one had 4 syrphid larvae, one had 2 dragonfly naiads, one had 5 aquatic beetles (Dytiscidae, Hydrophilidae), one had eaten fish, *Mollienesia latipinna*, and one had eaten crayfish. It is interesting that the fish found were also in the family Poeciliidae, the same as ours.

Availability and size of both predator and prey are important factors contributing to *Amphiuma* diet (Dundee and Rossman 1989), yet few reports have specifically correlated size of animal with type of prey. Hamilton (1950) provided the range of sizes of his individuals but not the average length, while Machovina (1994) found a change in diet from insects to fish and crayfish in larger animals (over 350 mm SVL). In our individuals with a total length of less than 500 mm, the volume and frequency of crayfish in the diet was 5%, but the number of animals available for analysis was low (N = 4). Insects and fish were the two most important items of the smaller *Amphiuma*. Crayfish (76%) were slightly more predominant than insects (62%) in frequency in animals over 700 mm in total length (N = 21), but crayfish (57.2%) composed a much greater percent volume than insects (16.0%).

Collecting methods and season of capture may bias a sample for animal size. All our animals below 400 mm total length (N = 7) were taken in autumn. Size of trap mesh and vulnerability of small animals to predators on the ocean beach could have biased our collections. Machovina (1994) did not find a seasonal change in diet in the Everglades, but seasonal changes in diet are more likely to occur in the northern part of the animal's range where temperature changes are more pronounced.

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Field Body Temperature, Diet, and Reproduction of *Homonota andicola* (Gekkonidae) in Catamarca, Argentina

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Homonota andicola is a small (45 mm maximum SVL), terrestrial, nocturnal gecko of the mountainous regions of west-central Argentina (Cei 1986). Because the species has been virtually unstudied it is currently defined as a species for which "insufficient knowledge" exists (Lavilla et al. 2000). In fact, the only ecological information available about *H. andicola* are the comments in the original species description (Cei 1978), which simply state that it is a saxicolous lizard. Here, we provide the first ecological data for this species including aspects of its thermal ecology, diet, and reproduction. Fieldwork was conducted in January 2001 and January and March 2005 in the Valle de Chaschuil, Departamento Tinogasta, Provincia de Catamarca, Argentina (27.72777°S, 68.15305°W, WGS 84; 3200 m elev.). The habitat at our field site is characterized as Puna (Cabrera 1994) with rocky hillsides and sparse herbaceous and shrubby vegetation growing among the rock outcrops. The climate is generally cool and semiarid with broad daily thermal amplitude and high solar radiation (Boretto and Ibargüengoytía 2006).

We captured lizards by hand from under rocks. Lizard cloacal temperature (T_b), substratum temperature (T_s), and air (T_a) temperature were measured (± 0.1°C) within 5 seconds of capture with a rapid-reading mercury thermometer (Miller-Weber, New York, USA). For each capture, we recorded T_s at the point of observation, and T_a 1 cm above the surface of the substratum. We measured snout–vent length (SVL) with Vernier calipers (± 0.02 mm) and determined the sex of each specimen via visual inspection of enlarged swelling at the base of the tail. Thermal data were obtained on 1 January and 1 March 2005 between 0900 and 1900 h.

The lizards were fixed in 10% formalin and preserved in 70% ethanol no more than 4 hours from the time they were captured. Thereafter, the geckos were dissected and their gut contents and gonads were examined with the aid of a dissecting magnifying lens. Our diet analysis only considered items found in the stomachs and small intestines. Insects were identified to taxonomic order, and the maximum length and width of all items were measured with calipers (± 0.1 mm) to estimate their volume. We determined the relative importance of each item using the relative importance index (Pianka et al. 1971).

For females, we recorded the states of developing follicles (vitellogenic or non-vitellogenic) and the condition of the oviducts (enlarged or not enlarged).

We collected 27 *H. andicola* (16 males, 11 females). Mean SVL

TABLE 1. Diet composition in *Homonota andicola* (N = 27), with prey categories expressed as percentage by number (# = number of prey per category and percentage of the total number of prey), frequency of occurrence (percentage of lizards whose guts contained one or more prey), volume (in mm^3 and percentage of total volume) and IRI (index of relative importance).

Items	# (%)		Frequency (%)		Volume in mm^3 (%)		IRI	
	Male	Female	Male	Female	Male	Female	Male	Female
Diptera	3(5.5)	3(8.1)	6.2	27.2	42.4 (3.4)	42.4 (4)	55.9	330.1
Lepidoptera	17(31.3)	5(13.5)	62.5	27.2	534.1(42.8)	157.1(14.8)	4642	772.7
Coleoptera	10(18.5)	12(32.4)	50	72.7	98.5(7.9)	103.7(9.7)	1321	3070
Isoptera	3(5.5)	—	6.2	—	0.4(0.0)	—	34.8	—
Orthoptera	2(3.7)	1(2.7)	12.5	9.1	251.3(20.2)	125.6(11.8)	298.6	132.3
Mollusca	1(1.8)	—	6.2	—	5.2(0.4)	—	14.2	—
Hemiptera	1(1.8)	—	6.2	—	108.9(8.7)	—	66.2	—
Hymenoptera	3(5.55)	5(13.5)	18.7	27.3	1.6(0.1)	2.6(0.2)	106.4	375.1
Homoptera	1(1.8)	2(5.4)	6.2	18.2	5.2(0.4)	10.5(1)	14.2	116.2
Larvae								
Diptera	7(12.9)	3(8.1)	18.7	27.27	0.4(0.03)	0.2(0.0)	243.7	221.4
Lepidoptera	1(1.8)	3(8.1)	6.2	18.2	196.3(15.7)	589.1(55.6)	110.1	1158
Coleoptera	—	2(5.4)	—	9.1	—	28.3(2.7)	—	73.3
Aranea	5(9.2)	1(2.7)	18.7	9.1	0.6(0.05)	0.1(0.0)	174.4	24.65
Plants	—(50)	—(45.4)	—	—	—	—	—	—

was 39.9 mm (SD = 7.9, range: 24–47 mm) for males and 42.8 mm (SD = 2.8, range: 39–47 mm) for females. The sexes were dimorphic in body length (t = -1.15; P = 0.002). Mean body temperature of 18 *H. andicola* was 13.0ºC (SD = 5.3, range: 7.0–22.5ºC). Mean air temperature was 13.2ºC (SD = 2.7, range: 10.0–17.9ºC). Mean substrate temperature was 11.7ºC (SD = 3.8, range: 8.0–18.0). Body size was unrelated to T_b (Spearman rank correlation: r_s = -0.18, P = 0.46), but T_b was correlated with both T_s and T_a (r_s = 0.75, P = 0.002; r_s = 0.90, P < 0.0001, respectively). The mean T_b of *H. andicola* is lower than that recorded for other *Homonota* species: *H. fasciata* (T_b = 27.2°C; Aun and Martori 1994), *H. underwoodi* (T_b = 26.3°C; Marinero et al. 2003), and *H. darwinii* (T_b = 21.7°C, Ibargüengoytía et al. 2007). *Homonta andicola* appears to be to thermoconforming and highly dependent on the air and substratum temperatures.

We registered a total of nine prey item categories for both sexes. We analyzed diet separately for each sex because we found differences in the gut contents of males and females (Kolmogorov-Smirnov two sample test: D_{max} = 0.08; P = 0.005). The diet consisted predominantly of arthropods, with Lepidoptera and Coleoptera being the most important items for males and Coleoptera and larval Lepidoptera for females (Table 1). It is possible that these differences result from resource partitioning between the sexes, but we cannot affirm this due to the low number of our sample. Plants, including leaves and stems of *Ephedra breana*, were also eaten frequently by both sexes (Table 1). By contrast, other *Homonota* species studied to date do not eat plants (*H. fasciata*: Aun and Martori 1994; *H. fasciata* and *H. whitti*: Martori et al. 2002). Yet other Andean lizards in this region (e.g., *Pristidactylus scapulatus*: Acosta et al. 2004; *Liolaemus ruibali*: Villavicencio et al. 2005; and *Phymaturus antofagastensis*: Acosta et al. 2008) also eat *Ephedra* sp.

Reproductive females ranged from 40–47 mm in SVL. All the females sampled had nonvitellogenic follicles, 80% had enlarged oviducts in January 2001, and 25% in January and March 2005. These observations suggest that the female reproductive cycle ends by March.

All specimens were deposited in the Herpetology Collections of the Instituto y Museo de Ciencias Naturales of Universidad Nacional de San Juan (IMCN-UNSJ 4276–4302).

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Scientific and Traditional Conceptions of Snakes in Kenya: Herpetologists as Teacher Mentors

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"We all have a duty to protect our environment and conserve biological diversity for posterity."
—Mwai Kibaki, President of the Republic of Kenya

The conservation of herpetofauna (reptiles and amphibians) through the teaching and understanding of biology, ecology, and environmental studies hinges on the ability of teachers to impart factual information about this misunderstood and sometimes feared group of animals. Unfortunately, knowledge about herpetofauna is too often based on misinformation or presented by individuals with limited knowledge who perpetuate misconceptions and superstitions (Gibbons 1983). Snakes, in particular, are one of the most feared and abused taxa within this group of animals (Gibbons et al. 2000; Greene 1997; Ricciuti 2001). Many people are simply unaware that most species of snakes are completely harmless and many species are ecologically beneficial.

Environmental education has been charged with integrating the aforementioned subject areas while fostering informed decision making abilities in school children and the population at large. Environmental education is defined as:

> A learning process that increases people's knowledge and awareness about the environment and associated challenges, develops the necessary skills and expertise to address the challenges, and fosters attitudes, motivations, and commitments to make informed decisions and take responsible action.
>
> (UNESCO, Tbilisi Declaration, 1978).

Conserving Earth's biodiversity is a longstanding goal of environmental education (Kenya Organization of Environmental Education [KOEE] 2006; North American Association For Environmental Education 2006). The United States and Kenya both recognize the need for environmental education and agree that biodiversity conservation is necessary to ensure a sustainable environment for all (American Association for the Advancement of Science 1993; KOEE 2006; National Science Teachers Association 2003). Conservation education can be considered a subset of environmental education and is frequently acknowledged as one of the primary antecedents of environmental education (Nash 1976). However, environmental education has treaded lightly when it comes to promoting action due to the fear of blurring the lines between teaching ecologically sound science and politically motivated or special interest group advocacy (see Tanner 1974; van Weelie and Wals 2002).

Over the last 30 years the term conservation has evolved from a resource management term to one that includes concern for the protection of the world's biodiversity, which agrees with the interests of environmental education. However, in this regard, conservation education takes concern for biodiversity one step further than environmental education by the admission of advocacy for, and the protection of, animals, plants and the necessary environments to sustain them. Museums and zoos worldwide have adopted a conservation education mission (Carr 2005). For example, according to the National Museums of Kenya's Director-General, Dr. Iddle Farah, "…our Museums' mission has expanded from one of passive collection and specialized scholarship to include active participation and commitment in meeting today's many needs of Kenyan society" (Accessed 2007 Oct 13 from: http://www.naturekenya.org/museums.htm). As an advocate for herpetofauna conservation, this study was based on a conservation education philosophy and also influenced why I chose teachers for my participants. I felt teachers would continue a positive message for snake conservation long after I had left. (My return in the spring of 2008 has born this out, as the primary participants are still teaching snake conservation lessons in their classrooms.)

I conducted a three-month descriptive qualitative study mid-September through mid-December 2005 to investigate conceptions of snakes among 60 rural southeast Kenyan teachers from five villages surrounding Mt. Kasigau. I used a narrative inquiry approach (Clandinin and Connelly 2000). I chose teachers as participants for this study as local community elders informed me that educators would have impunity from stigmatization from imparting scientific viewpoints about snakes and handling live snakes. The following research questions were used to guide this study:

1. How do Kasigau teachers conceptually relate to snakes?
2. How might Kasigau teachers' conceptual relationship with snakes change following exposure to scientific perspectives and experiences?

Three herpetologists and I traveled to the village of Bungule to facilitate herpetofauna conservation education opportunities for the teachers of Kasigau; the herpetologists were Patrick Malonza and Beryl Bwong of the National Museums of Kenya, and John Measey of the University of Antwerp. We conducted a herpetofauna professional development institute in order to facilitate encounters between Kasigau teachers, herpetologists and snakes; the institute consisted of all workshops and scientific experiences conducted by the visiting herpetologists or myself during the study period. During the course of this study 23 species of snakes were captured and kept temporarily for use during the aforementioned workshops

and additional in-depth training for the primary participants (see Table 1).

Visits by the herpetologists included one full-day (six-hour) workshop for 24 of the 60 teachers from the Kasigau area held in the village of Bungule during the beginning of the project, and three subsequent five-day visits by Patrick and John to mentor the principal participants. Additional half-day (three-hour) workshops were conducted at each of the five primary schools for those teachers who did not attend the first workshop. Therefore, all 60 teachers eventually received the same basic information about local herpetofauna. Of these, seven teachers (five males and two females) who showed the greatest interest in the study were invited to be primary participants, and received more exposure to scientific information as a result of the amount of time spent with the herpetologists and me. Of the seven, two teachers (hereafter referred to as principal participants) experienced the most opportunities to learn about snakes and spend time with visiting herpetologists and me. The primary participants spent additional time with me hunting for snakes and learning about snake identification and collecting techniques [i.e., one morning checking drift fences (4 h) and one full day searching for snakes and visiting at my banda handling live harmless snakes (six hours)]. The principal participants also read the book *Their Bood Runs Cold: Adventures with Reptiles and Amphibians* by Gibbons (1983) and one principal participant presented snake talks with live harmless snakes at each of the primary schools and the Taita Discovery Center (a nearby ecotourism lodge) during the last week of the study.

Workshop topics included: how to conduct a Visual Encounter Survey of microhabitats; the construction, maintenance, and monitoring of drift fences; identification of the various reptiles and amphibians indigenous to the region, including use of dichotomous keys and field guides; and methods museums use for preserving and cataloging reptile and amphibian specimens. Workshop facilitators modeled the use of such apparatus as snake sticks and snake tongs using live snakes. Experienced facilitators modeled how one should handle a venomous snake (puff adder; *Bitis arietans*) using a snake stick and snake tongs, as well as harmless snakes. Live nonvenomous snakes used for modeling purposes were the Speckled Green Snake (*Philothamnus punctatus*), Kenyan Sand Boa (*Eryx colubrinus*), Brown House Snake (*Lamprophis fuliginosus*), and the Cape Wolf Snake (*Lycophidion capense*). We stressed use of obvious morphological characteristics for identifying the different snake species, especially ways to distinguish venomous snakes from nonvenomous snakes.

Generally speaking, the traditional conceptions of the Wakasigau about snakes included fear, aversion, and loathing (Wakasigau refers to the people living in the five villages surrounding Mt. Kasigau; Bungule, Jora, Rukanga, Kiteghe and Makwasinyi). Snakes encountered by the Wakasigau are usually killed.

I collected narratives describing the conceptions of snakes from seven rural Kenyan teachers and other influential community members living in Kasigau, Kenya, regarding snakes and observational notes of teachers' interactions with live snakes. Further, the study explored the relationship between teachers and snakes and the teachers' change of perspective toward snakes during a three-month period after exposure to the workshops.

During the first three weeks prior to the first workshop, 100% of the teachers I spoke with (N = 60) were suspicious of why I would have an interest in snakes, as anyone who handles snakes in this area is believed to have *juju* (magic). Both principal participants confessed later that they thought my ability to handle snakes may have been enhanced by a talisman or some other metaphysical empowerment when viewed through their cultural lenses, however, each professed that magic does not really exists, when viewed as teachers using a scientific perspective (Jegede 1997). Before the workshops, most of the people I encountered in Kasigau, Kenya shared stories with me depicting snakes as bad, evil, unpleasant, or disgusting, while relating emotions of fear and hatred. The only exceptions were three out of the five medicine men I interviewed who did not view snakes as evil, "...but dangerous creatures that one could not take chances with." However, many teachers said that some types were *tazamika* (pleasant to look at). I was told many times that a snake could be attractive, but that did not make that particular snake any less deadly, and I witnessed villagers killing snakes while expressing apparent fear and hatred.

During initial interviews, 100% of the 60 teachers interviewed professed a fear of snakes and believed that all snakes were dangerous and capable of delivering a "poisonous" (venomous) bite. No one I spoke to, including the local high school biology teacher, differentiated between venomous, mildly venomous and nonvenomous snakes. One noticeable exception was the python, as six teachers (10%) expressed awareness that pythons were supposed to be "nonpoisonous," but all teachers agreed that pythons should still be feared and killed because they are capable of crushing a person to death and also preyed on livestock.

As a result of exposure to scientific perspectives, the two principal participants exhibited an amazing transformation; to a lesser extent, so did the other five primary participants. These teachers' ideas about snakes changed from complete negativity toward all snakes to respect, interest, and an increased understanding of the ecological role of snakes. Still, all the teachers expressed concern about having venomous snakes near their houses or in their *shambas* (family farms) and expressed their conviction that they would kill a Puff Adder (*Bitis arietans*) or other dangerous snake if they found it near areas they frequented or where children played. However, harmless snakes, for example the Brown House Snake (*Lamprophis fuliginosus*), were to be spared in order to eat the rodents that plagued villagers' homes and fields. Exit interviews and post workshop observations of teacher participants in classrooms indicated that the other Kasigau teachers' conceptions of snakes (N = 53) were also changed as a result of the herpetofauna institute. 98% showed an increased interest in snakes and exhibited an alternative perspective while teaching about snakes during subsequent science lessons observed by me in all six schools within the five villages surrounding Kasigau.

Several important factors contributed to the teachers' change in attitude towards snakes, including their newly acquired ability to differentiate between harmless and dangerous snakes, their ability to ask different questions about snakes, and their experiences with a modeled positive-appropriate response to nonvenomous snakes by both male and a female herpetologists. 98% of the participants said that knowing there were harmless snakes was the first step in allowing an alternative perspective to be considered and the ability to positively identify harmless versus venomous snakes

TABLE 1. Scientific (Family, genus, species), Kitaita (with translations), and English names for snake species indigenous to the Kasigau region.

Scientific name	Kitaita name	English name	EDS
Family: Typhlopidae			
Typhlops lineolatus	Ngomu = moves forwards and backwards	Lineolate Blind Snake	Y
Rhinotyphlops unitaeniatus	Ngomu = moves forwards and backwards	Yellow Striped Blind Snake	Y
Family: Leptotyphlopidae			
Leptotyphlops scutifrons	Ngomu = moves forwards and backwards	Peter's Worm Snake	Y
Family: Boidae			
Python natalensis	Are	African Rock Python	Y
Eryx colubrinus	Kivuvu = serpentine movement	Kenya Sand Boa	Y
Family: Colubridae			
Lamprophis fuliginosus	Mwawaya = shy	Brown House Snake	Y
Lycophidion capense		Cape Wolf Snake	Y
Mehelya capensis		Cape File Snake	N
Mehelya nyassae		Dwarf File Snake	N
Coluber smithii	Nguluku = red	Smith's Racer	Y
Prosymna stuhlmanni		East African Shovel Snout	N
Hemirhagerrhis kelleri	Zagho	Striped Bark Snake	Y
Hemirhagerrhis nototaenia		Bark Snake	N
Rhamphiophis rostratus†	Choka Ya Nganga Nganga = snake that resembles a guinea fowl	Rufous Beaked Snake	Y
Rhamphiophis rubropunctatus†	Nguluku = red	Red-spotted Beaked Snake	N
Psammophis sudanensis†	Zagho	Northern Striped-bellied Snake	Y
Psammophis mossambicus†	Zagho	Olive Sand Snake	Y
Psammophis punctulatus†	ndezi ya ng'ombe = walks among cattle	Specked Sand Snake	Y
Psammophis biseriatus†	Kisikiria Maza = listens to stories	Linked-marked Sand Snake	Y
Psammophis tansanicus†	Kisikiria Maza = listens to stories	Tanganyika Sand Snake	N
*Atractaspis microlepidota**		Small-scaled Burrowing Asp	Y
Aparallactus jacksoni†		Jackson's Centipede-eater	N
Aparallactus guentheri†		Black Centipede-eater	N
Aparallactus lunulatus†		Plumbeous Centipede-eater	N
Micrelaps boettgeri†		Desert Black-headed Snake	Y
Micrelaps bicoloratus†	Zagho	Two-coloured Snake	N
Meizodon semiornatus		Semi-ornate Snake	N
Philothamnus battersbyi	Ikumbo = green	Battersby's Green-snake	Y
Philothamnus punctatus	Ikumbo = green	Speckled Green-snake	Y
Philothamnus semivariegatus	Ikumbo = green	Spotted Bush Snake	Y
Dasypeltis medici	Nguluku = red (red phase only)	Rufous/East African Egg-eater	N
Dasypeltis scabra		Common/Rhombic Egg-eater	N
Crotaphopeltis hotamboeia		White-lipped Snake	N
Telescopus semiannulatus†	Nguluku = red (reddish or pink phases only)	Large-eyed Snake	N
*Dispholidus typus**	Vunjarere (green/black "kivuensis" phase) Bafwe (black phase)	Boomslang	N
*Thelotornis capensis**	Ifurudi	Savannah Vine Snake	Y
Family: Elapidae			
*Naja nigricollis**	Bafwe (black phase) Ilimanjighu = eats hyrax (brown phase)	Black-necked Spitting Cobra	N
*Naja pallida**	Nguluku = red	Red Spitting Cobra	Y
*Naja haje**		Egyptian Cobra	N
*Dendroaspis polylepis**	Ilimanjighu = eats hyrax	Black Mamba	Y
Family: Viperidae			
*Causus rhombeatus**	Kili = (from English "kills")	Rhombic Night Adder	N
*Bitis arietans**	Kili = (from English "kills")	Puff Adder	Y

The list presented is a synthesis from regional maps from Spawls et al. (2004) and the Taita Discovery Center's unpublished Reptile Checklist assembled by E. Selempo (2002). EDS = Encountered During Study: Y = Yes / N = No *Venomous snakes. †Mildly venomous snakes.

was a key component in forming their new perspectives toward snakes. This new attitude was also dependent on myriad other factors, such as teachers' views of science, trust in the facilitator, and pride within the community.

Educational experiences can have a significant impact on teachers' conceptions of snakes within the environmental/conservation education realm. The majority of previous studies involving human-snake relations have been attitude surveys using quantitative methodology (e.g., Kellert 1996; Öhman and Mineka 2003) or short-duration intervention, i.e., snake talks with brief exposure to live specimens (e.g. Morgan and Gramann 1989; Gomez et al. 2004). Although quantitative survey methods may be helpful in establishing baseline data and brief exposure interventions may afford short durational change in attitude, neither allow for an understanding of more complex conceptions of snakes nor the situational influence of human-snake interactions. Herzog and Burghardt (in Rowen 1988) suggested, "there are many important questions that can only be investigated by studying subjective reports of conscious experience, a position referred to as phenomenology" (p. 91). The current study emphasizes that peoples' conceptions of snakes are not just negative or positive. Teachers in this study exhibited complex reactions depending on the type of snake encountered, the situation and their own level of confidence and knowledge of snake identification. As part of qualitative research studies involving human-animal interactions, opportunities for teacher transformative learning can take place (Loucks-Horsley et al. 2003).

Having been an advocate of snake conservation education for the last twenty-five years, it was gratifying to witness the change in behavior of teachers who were once convinced that all snakes were dangerous and deserved to die and scoffed at the very idea of touching a snake. The teachers who held snakes during snake talks expressed how proud they were at having overcome their fear and were very pleased that they now had a new understanding of snakes. For them the phrase "a snake is a snake" was no longer true. Their traditional conception of "snake" had now been broadened by their willingness to participate in experiential opportunities involving live snakes and from taking the time to learn the important ecological niche of snakes. The teachers told me that now that they understood that some snakes were indeed harmless and important controllers of rodents, they would include snake conservation lessons in their classrooms and refrain from killing harmless species they could positively identify.

Another avenue for future research is the influence of gender on perspectives toward snakes within specific cultural settings. A study which explored the differing view of how males perceive females during snake interactions versus how females actually interact with snakes during snake encounters when men are not present would be an important contribution to the field of human-animal relations.

Conversely, I was also affected by my experiences in Kenya. Up until my trip to Kasigau I had never met anyone who had lost a loved one to snakebite nor had I met anyone who had lost a limb due to snake envenomation. Although I am still very adamant concerning the need for snake conservation, I am much more understanding of those who do not like snakes or have a desire to kill snakes. Kasigau has a rich diversity of snakes but, with so many dangerous species present, I have a newfound respect for those persons who would prefer to have nothing to do with snakes. During the short time I was living in the village of Bungule I witnessed much suffering due to snake encounters, for example, the 'three-legged' man who lived in Jora who was bitten by a Puff Adder on his calf and had to have the leg amputated above the knee because of the lack of antivenin, the Kasigau Subchief who had lost his daughter from the bite of a Black Mamba, and the ACK Minister whose sister died from a snakebite when he was a boy.

Lastly, it is imperative that we protect ecosystems, not just charismatic megafauna. The only hope for biodiversity is to conserve complete ecosystems and snakes play an important role in many such systems. Additional studies that integrate education, herpetology, and human-animal interactions are vital for the increased understanding of herpetofauna conservation efforts.

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TECHNIQUES

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A Piece-Wise Linear Model of Sound Pressure Level of Male *Eleutherodactylus coqui* Overnight Chorus

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A frog chorus offers the opportunity for evaluating reproductive or territorial activity remotely, and sound pressure level (SPL) has been used to investigate the behavior and nocturnal activity of *Eleutherodactylus* frogs (Drewry 1970; Woolbright 1991; Stewart and Bishop 1994; Narins 1995; Woolbright et al. 2006). As data logging SPL meters have become prevalent, compact, and economical, overnight recording and analysis of SPL is readily accessible. The Coqui Frog chorus SPL exhibits distinct overnight patterning. We developed a piece-wise linear model of the overnight chorus SPL derived from recordings of *Eleutherodactylus coqui* in Hawaii. From this simple model, standardized parameters can be calculated that may be used to correlate frog behavior with environmental variables and to monitor frog populations.

Materials and Methods.—SPL was recorded with a Rion model NL-32 (IEC 61672-1 2002 Class 1) data logging meter. Equivalent continuous sound level, $L_{Aeq\ (1\ sec)}$ measurements were made at 1 sample per second in the A-frequency weighting mode. Each 1 second sample was averaged internally by the SPL meter at intervals of 20.8 μ sec. Bandpass filtering was targeted specifically for the *E. coqui* audio spectrum by using a Rion model NX-21VA universal filter card, configured as a third-order Butterworth bandpass filter. This filter offered discrete lower and upper cutoff frequencies selected at respectively 1 KHz and 3.15 KHz, bounding the Coqui audio emission spectrum. A Rion model EC-04A microphone extension cable, 5m in length, was used in conjunction with a waterproof enclosure to protect the SPL meter from weather. The microphone outfitted with a windscreen ball was mounted on a tripod at approximately 1.7 m above ground, simulating the typical height of the human ear. The tripod mounting was sheltered from rain and other elements by an umbrella suspended from an overhead line 0.5 m above the microphone. The SPL meter was calibrated prior to the start of recordings using a Rion model NC-74 Sound Calibrator (IEC 60942 1997 Class 1). The SPL meter was outfitted with higher capacity external batteries to maintain power requirements for continuous overnight recordings.

Concurrent with SPL measurements, audio recordings were also made using an RCA model RP5035A digital voice recorder in close proximity to the SPL microphone. Bandwidth and upper frequency limit was approximately 3 KHz. Data were stored in MP3 format running at Standard Play (SP), 16K bits per second. Audio recordings were utilized simply to identify and verify occurrences of man-made, meteorological, and other noise interference that may have occurred during SPL measurements. Examples include cars passing by, birds, dogs, wind, and rain. Identification of noise interference from the audio recordings validated selectively editing relatively short segments of SPL data when deemed necessary.

Overnight recordings of the male Coqui chorus were collected between approximately 1700 and 0800 h on Hawaii Island at various forested locations in the vicinity of Hilo (52 data sets) during August 2006–July 2007. SPL data sets were reduced by selecting samples at 2-sec intervals and twice applying a 15 min running average smoothing of the raw data. To facilitate accurate averaging of logarithmic data, raw SPL data (L_{raw}) were first exponentially transformed to raw sound pressure units (P_{raw}) by the formula:

$$P_{raw} = [10^{(L_{raw}/10)}]/10^6 \quad (1)$$

The constant factor 10^6 was used to scale down the otherwise relatively large numbers to preserve accuracy of computer calculations. The raw pressure data (P_{raw}) were then filtered twice using a time domain midpoint, 451 data points (i.e., a 15 minute), moving average smoother by the formula:

$$P_{smooth}(i) = {}_{1/451}\sum_{j=-225}^{+225} P_{raw}(j) \quad (2)$$

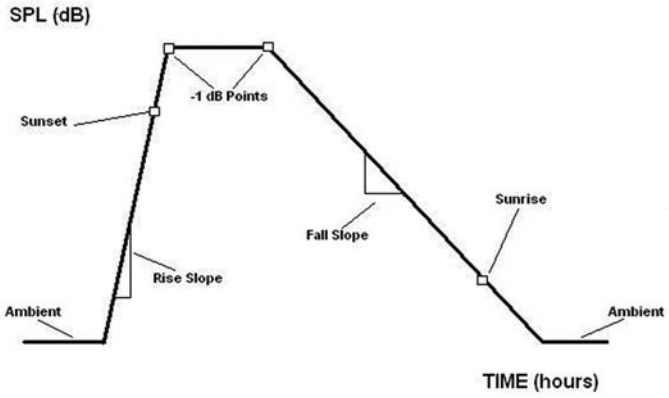


FIG. 1. Piece-wise linear model of the male *Eleutherodactylus coqui* overnight chorus. The parameters defining the model phases are indicated.

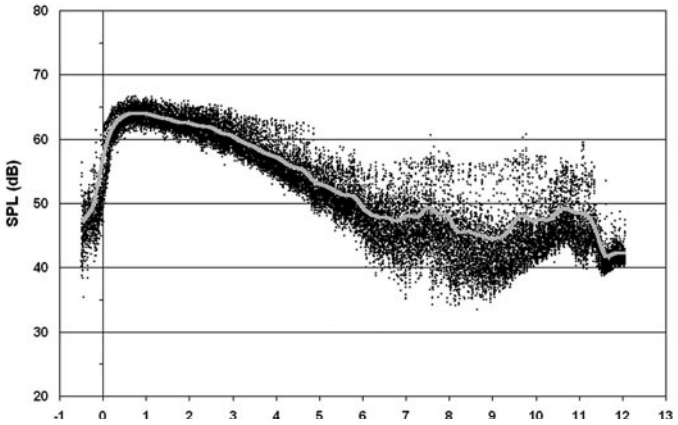


FIG. 2. Typical raw data overnight record of male Coqui frog chorus from Hawaii with moving average smoothed data trace superimposed. There were neither rainfall events contributing to the SPL nor any individual frogs very near the microphone to dominate the signal.

where i = ith data point (i.e., the j = 0 midpoint), and j = jth data point for summation.

Finally, twice-smoothed pressure data (P_{smooth}) were transformed back to smooth SPL data (L_{smooth}) by the formula:

$$L_{smooth} = 10 \text{ Log}_{10} [10^6 (P_{smooth})] \quad (3)$$

Data for this study were analyzed using Microsoft Excel 2002.

We represented the typical male Coqui overnight chorus as a piece-wise linear SPL model (Fig. 1). In addition to the expected ambient day time SPL just prior to sunset and soon after sunrise, the SPL model consists of the following characteristic phases:

Rise: a relatively rapid increase in SPL from a daytime ambient until a plateau is reached where male Coqui chorus is relatively constant (the time of sunset occurs during the rise phase).

Plateau: a period in time when the average SPL is fairly constant (the endpoints were chosen such that double-smoothed SPL data lie within -1 dB of the maximum double-smoothed SPL value).

Fall: a relatively slow decline in SPL from the plateau phase back down to ambient SPL (the time of sunrise occurs either near the end of the fall phase or during the ambient following the fall phase).

Ambient phases before sunset and after sunrise were not further analyzed in this study as these periods included only an occasional frog vocalization. The slope of the rise phase (dB/minute) was calculated using a first order least squares fit of the raw SPL data (L_{raw}). The period of interest was the most linear portion of the rise segment, typically starting approximately 10 minutes prior to sunset and terminating prior to the first -1 dB point (derived from the double smoothed SPL data L_{smooth}), which marks the start of the plateau phase.

The period or duration of the plateau phase was derived from the smooth SPL data (L_{smooth}). First, the maximum SPL was found, next the -1 dB points occurring prior to and following the maximum SPL were located. The difference in time between the two -1 dB points established the plateau phase width in units of hours. Other plateau parameters of interest were calculated from the raw SPL data (L_{raw}) defined in time by the previously established -1 dB points in the smooth SPL data, including L_{raw} (dB) mean and standard deviation. The slope of the fall phase (dB/minute) was calculated using a first order least squares fit of the raw SPL data. The period of interest was the most linear portion of the fall segment selected starting after the second -1 dB point from maximum obtained from the smooth SPL data and terminated when the raw SPL data reached ambient, or when noise interference as described above was encountered. Other model parameters of interest included the ratio of rise to fall slopes, the time in hours of maximum SPL and the first and second -1 dB points referenced to sunset and derived from the smooth SPL data.

TABLE 1. Parameter values of the piece-wise linear SPL model (Fig. 1) of the overnight chorus of *Eleutherodactylus coqui*. Data are values from N = 52 data sets recorded. For plateau converted P_{raw} SPL, statistics were derived in the sound pressure domain, then logarithmically converted to SPL dB (see Methods). For plateau maximum SPL and timing parameters, data were derived from moving average smoothed sound pressure domain data converted to SPl dB (L_{smooth}).

Model Parameter	Mean	Standard Deviation	Minimum	Maximum
Rise (dB/min)	0.379	0.212	0.073	1.020
Fall (dB/min)	-0.036	0.014	-0.081	-0.014
Ratio (rise/fall)	-11.20	6.03	-25.0	-1.80
Plateau Mean SPL (dB)	66.4	2.98	60.5	73.5
Plateau Maximum SPL (dB)	67.1	2.95	61.2	74.0
Plateau Timing Relative to Sunset of:				
1. Maximum SPL (h)	0.90	0.32	0.34	1.80
2. First -1 dB from maximum SPL (h)	0.44	0.24	0.11	1.07
3. Second -1 dB from maximum SPL (h)	1.65	0.48	0.54	2.68
Plateau Width (h)	1.23	0.49	0.23	2.18

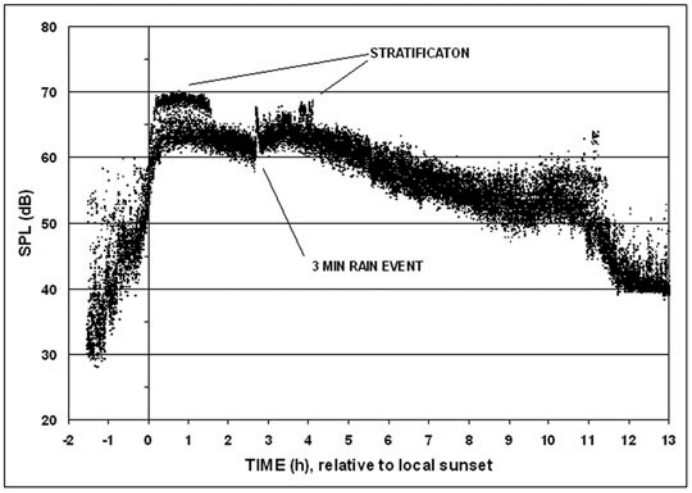


FIG. 3. A raw data overnight record of a Coqui chorus showing stratification episodes likely due to a calling frog positioned near the microphone. The spike-like elevation in the signal during the falling phase was a brief episode of heavy rain and was followed by elevation of the frog chorus SPL.

Results.—A typical overnight record of raw SPL data superimposed by its associated doubly-smoothed running average data set from shortly before sunset until sunrise is shown in Fig. 2. Model parameters calculated from the collected SPL data sets are shown in Table 1. The evening rising SPL chorus was typically more rapid than the late-night decline of the falling phase by a factor of approximately 11. The plateau phase started and ended on an average 0.44 h and 1.65 h after reference sunset, respectively. The plateau phase lasted an average of 1.23 h. We also observed some variable patterns in the SPL data. For example, during the early portion of the chorus rise phase, there were often scattered high level SPL data points appearing as outliers to the predominant upward trend (Figs. 2 and 3). After reviewing corresponding audio recordings during the same period, the phenomenon was found to be the result of one or two frogs initiating vocalization in relatively close proximity to the SPL instrument microphone. As the overall upward trend of SPL catches up, these points are absorbed into the composite SPL. Various other sources of sound were also identified, such as early evening vocalization of birds and distant barking dogs, passing cars, or overhead aircraft during the rise segment; however, most contributed only to the lower level background SPL. During the plateau phase, if one or more male Coqui call from sites very near the SPL microphone, the resultant SPL signal appears stratified as shown in Fig. 3. This source proximity effect was also occasionally observed during the late night falling phase of data sets.

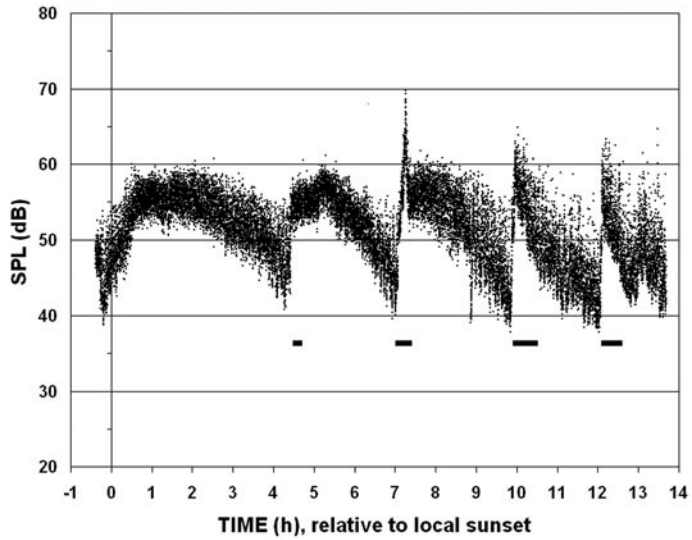


FIG. 4. A raw data record of a Coqui chorus involving several successive heavy rainfall events during the falling chorus phase. The horizontal bars show the timing of rainfall.

Rain, especially brief heavy downpours, was manifested in the SPL data as a sudden spike-like increase in SPL followed by a slower decrease as the rain subsided (Fig. 3). Of the 52 SPL data sets analyzed, over 50% contained one or more heavy rain events as revealed by the corresponding audio recordings. After the SPL spike due to rain subsided, the SPL due to male Coqui vocalization appeared several dB higher compared to the SPL prior to the associated rain event (Fig. 3). In addition to heavy episodes of rain, light to moderate rain events occurred in approximately 15% of the 52 data sets analyzed. In these cases, the onset of rain was not distinguished from the subsequent male Coqui chorus as a spike in SPL, however, concurrent audio recording verified presence of rain, along with a corresponding rise in SPL (Fig. 4). When multiple rain events occurred late at night, the result was a saw-tooth-like pattern of SPL as the generally declining male Coqui chorus level was successively re-elevated, apparently stimulated by the occurrence of each new rain shower (Fig. 4).

Discussion.—SPL recordings of the male Coqui chorus show temporal events that are useful for understanding the behavior and activity of the frogs, as well as for monitoring their recent colonization of the Hawaiian Islands. From the SPL model (Fig. 1), the plateau phase affords the best opportunity for researchers to study Coqui behavior that is consistent with the highest level of activity as indicated by male Coqui vocalization during a given night. SPL data reduction to 1 sample every 2 seconds was more than adequate to provide useful analyses of pattern characteristics of male Coqui SPL. The two-pass moving average smoothing filter applied directly to the raw pressure domain data is widely considered as one of the most optimum data analysis techniques for use on temporal data (Smith 2003). A smoothing parameter of 15 minutes was selected as a tradeoff to account for both slow-moving trends during the rise and fall phases of the SPL data and the relatively fast changing transition from the rise to the plateau phases of the SPL. In addition to plateau mean SPL, the slopes of the rise and fall phases and their ratio may serve as another measure of the intensity of reproductive activity of a frog population. Steeper rise slopes are expected from more rapid emergence and recruitment of males to the chorus after sunset, and shallower (less negative) fall phase slopes may represent individual frogs extending calling activity or additional frogs recruited to the chorus later at night.

Coqui frogs behaviorally reduce signal interference with near neighbors by patterning their vocalizations to avoid overlap in time and space (Brush and Narins 1989; Narins 1983; Stewart and Bishop 1994). These behaviors tend to stabilize the temporal, spatial, and frequency variation of the chorus. However, if one or more frogs perch very close to the microphone, their individual

calls will dominate the SPL signal producing the stratification observed in Fig. 3, and this proximity effect is an important consideration for microphone placement. Assuming a homogeneous spatial distribution of male Coqui, the SPL meter should be strategically positioned near the centroid of a typical frog density cell. An on-site observer with a hand-held SPL meter can avoid recording from positions with nearby calling frogs and make multiple recordings from several positions. For remote longer-term recording, a position should be selected with no immediate adjacent vegetation that offers perch sites to recruit calling frogs near the microphone.

Other important sources of variation in the pattern of frog SPL are temperature and rainfall. Temperature is well known to affect calling behavior of frogs including *E. coqui* (Drewry 1970; Drewry and Rand 1983). We observed a strong influence of brief rain showers that subsequently raised frog SPL within a single night of recording (Figs. 3 and 4). Penna et al. (2005) observed increases in call rate and duration of individual *Eusophus calcaratus* (Leptodactylidae) frogs during exposure to natural and synthetic rain, wind, creek, and sea surf noise. This evoked response could be a mechanism of coping with potential vocal signal interference, however the *E. coqui* chorus SPL response to rain continued to build following brief rain events occurring up to 7 h after sunset (Figs. 3 and 4). Rainfall during the night as well as the immediate past history of rainfall influences the availability of liquid water in the habitat. These factors affect frog evaporative water loss and potential for re-hydration by water uptake across the skin. In turn, they influence the time frogs can be active abroad. In the present study, it is not clear whether rain events wetting the vegetation and floor of the forest during the night stimulated recruitment of additional new frogs to the chorus or stimulated formerly calling frogs to resume calling activity.

While more dense populations of calling frogs are expected to be louder, Drewry (1970) showed in a theoretical model of *E. coqui* sound fields that the relationship between overall SPL and frog density is non-linear. At relatively high calling densities with SPL > 60 dB, the male Coqui chorus SPL is expected to exhibit an increasing, yet asymptotic upper bounded trend in SPL as calling frog density is increased. Based on the model and data presented here, auto recording of SPL from approximately 0.5 h–1.5 h after sunset with selection of the most level or plateau portion of the data segment for averaging, is the best time to characterize the maximum levels of the nighttime vocalization of *E. coqui*.

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Methods for Inexpensive, Non-Intrusive Detection of Skeletal Elements in Small Zoological Specimens Using Micro-Computed Tomography

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Biological disciplines such as palaeontology and comparative anatomy have long embraced computed tomography (CT) as a non-intrusive way of visualizing bone (Conroy and Vannier 1984; for an extensive CT-scan database visit http://www.digimorph.org/index.phtml). However, most of these studies are conducted on large specimens using low-resolution medical CT scanners, or on expensive specialized scanners accessible to few researchers. However, "general purpose" micro-CT scanners are increasingly common (Holdsworth and Thornton 2002; Kalender 2006) and can be accessed, for reasonable fees or through collaborations, in hospitals or university departments that own scanners. In addition, easy-to-operate sophisticated reconstruction programs, some of them free of charge, exist. Micro-CT allows determination of existence, shape and structure of mineralized tissue; it is non-intrusive, fast, reproducible and can provide images of microscopic detail. As such, micro-CT has significant advantages over destructive techniques such as clear-staining or maceration and does not require

specialized laboratory equipment. This is particularly useful for herpetological research, which frequently targets ossifications in small specimens. Micro-CT has already been successfully applied in herpetological studies of ontogeny (e.g., Boughner et al. 2007) and comparative skeletal morphology (e.g., Kley 2006; Maisano et al. 2001) but would also be useful for assessing phylogenetically relevant osteological information (e.g., Nuin and do Val 2005). Nevertheless, this technique remains little utilized by the broader herpetological community. This may be because the accessibility of Micro-CT scanners is not widely perceived, and usage of the equipment and reconstruction requires a certain degree of procedural expertise. The following is a short introduction to micro-CT with an overview over the most important procedures and parameter settings for CT scanning of small vertebrate specimens.

To scan a specimen, it is placed between an X-ray source and a radiation detector. The source exposes the specimen to X-rays at a specified voltage and current and for a given exposure time. Most micro-CT scanners are cone-beam scanners which return a projection image of the rays attenuated by the specimen as a two-dimensional image, with increasing darkness (or lightness, if projection image "negatives" are preferably viewed) signifying increasing density (Fig. 1); however, fan-beam scanners return so-called sinograms that contain all information but are not directly interpretable. A simple evaluation of some projection images can provide all information needed within minutes (e.g., presence and approximate shape of a bone; Fig. 1), which makes this a very fast and inexpensive process. For full image acquisition to enable 2D-slice reconstruction and 3D-modelling, the specimen or the source/detector system (depending on the scanner) is rotated by a specified small angle and the next image is acquired, until images of the specimen have been taken throughout at least 180° (360° rotation yields larger datasets but also provides better reconstruction quality).

Maximum micro-CT resolutions are constantly increasing and vary depending on the scanner and detector model used. Resolutions of up to 3 μm are possible (some "Nano-CT scanners" also work at a nanometer-scales). However, since resolution is inversely related to specimen size, such resolutions are generally only achieved at very high magnifications (usually above 100x) and with pin-head-sized specimens. Magnification and resolution for visualizing whole specimens will typically be upwards of 10 μm. Maximum scannable specimen size also depends on scanner characteristics and varies from 30 mm to human head size. It is constrained by specimen impedance (large specimens may be too dense for the radiation to penetrate), chamber volume, and source distance (as the source approaches the specimen with increasing magnification, there is a danger of the two colliding). Magnification can be increased to scan only specific components within a specimen (Fig. 1 inset).

For full acquisition of wet specimens, retention of moisture must be ensured using wrapping materials with as little impedance as possible (Fig. 2). Non-PVC food wrapping film and stretching lab tape (e.g., parafilm; Fig. 2) are excellent wrapping materials because they keep specimens moist and have low impedance (faint shadows produced by plastic film can be seen in Fig. 1 inset). For obtaining clear specimen outlines, specimens can be placed in oil to increase the density contrast between the specimen and the surrounds (Boyde et al. 2000), but this may not be an option for museum specimens. Immobilization of the specimens is crucial because even slight movement during scanning precludes the reconstruction of cross-sectional slices. Delicate specimens can be fixed in a narrow cleft cut into a cube of radio-translucent material such as styrofoam (a faint styrofoam shadow can be seen in the lower half of Fig. 1), which is attached to the mounting surface using tape (double-sided tape is very useful) or plasticine. It is also common to slot specimens into blocks of agarose gel (Claeson et al. 2007), and simple plastic vials attached to the mount using plasticine are also useful



Fig. 1. Projection image of *Choerophryne rostellifer* (South Australian Museum A3779) taken on a SkyScan 1072 micro-CT scanner at 80 kV, 100μA, and 2.9 s exposure time, frame averaged over two images. Scale bar: 3 mm. Inset: Detail of the wrist of the same specimen at increased magnification. The line across indicates the position of the slice reconstructions in Fig. 3.

For slice reconstruction and 3D modelling, the structure to be reconstructed must be fully in camera view at all angles of rotation. To prevent the specimen from going out of view, and to reach optimum magnification, the specimen should be positioned exactly in the centre of rotation. If possible, it is advisable to preview projection images at various angles to ensure proper positioning of the specimen.

Most acquisition parameters involve modifying the x-ray spectrum to suit the attenuation properties of the specimen scanned. High voltage increases x-ray penetration and is suited for dense objects such as fossils or dense bone. In small wet specimens or if bone is thin, voltage reduction and current increase, if possible, can yield better distinction of soft tissue features (Kalender 2005). Metal filters (e.g., aluminium or copper) modify the energy spec-



FIG. 2. Some wrapping materials (single or double-sided sticky tape, plasticine, plastic vial) and an example of an arrangement for fixing delicate specimens and retaining its moisture (bottom left). The specimen (not shown) is slotted into a styrofoam cleft and parafilm is folded around it. Note that the fold on the right side of the cube should not be too thick to avoid interference with the 2D reconstruction quality.

trum emitted and are commonly applied to reduce noise in dense materials such as fossils or rock (Kalender 2006; Ketcham and Carlson 2001). Exposure time, if not optimized automatically, is also an important parameter. It should be set for good contrast between background and bone, but if parts of the projection image are purely white or black, some grey values are beyond the signal perception limits of the detector, which results in loss of image information (Kalender 2005). Frame averaging reduces noise by acquiring and averaging several projection images at the same angle, thereby providing clearer images.

Acquisition time and dataset size depend on rotation angle per acquisition, frames averaged, and exposure time. In all cases, the faster or less memory-demanding option is traded off for lower resolution or image quality.

Reconstruction of 2D "slices" perpendicular to the axis of rotation is achieved by an algorithm which processes the projection images previously taken (Fig. 2; e.g., Kalender 2006; Zollikofer and Ponce de Leon 2005). Slice reconstruction software is generally available at the scanning facilities and slice reconstructions are sometimes provided. If reconstruction needs to be done separately, some settings need to be considered optimum image quality. This involves adjusting the settings to ensure that the slices are not misaligned, which can occur through slight movement of the specimen during the scan; typical symptoms of misalignment include "tails" (Fig. 2B), double lines, and blurry images. Artifacts such as beam hardening (where the outer areas of the object appear to

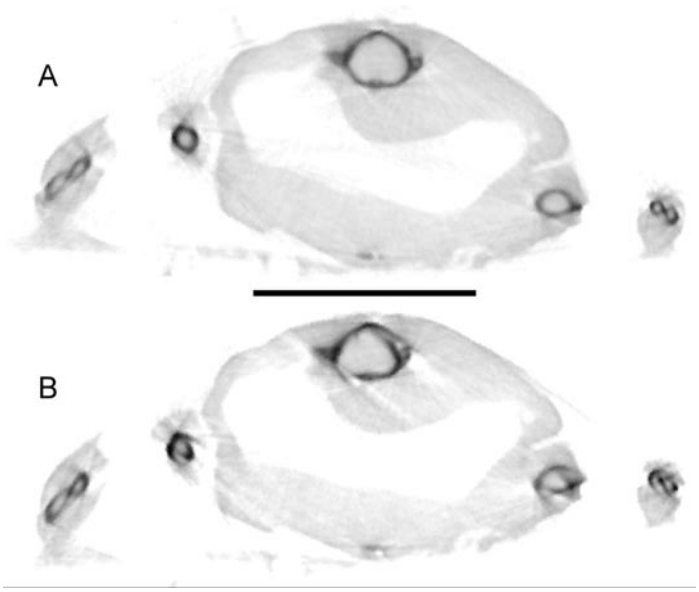


FIG. 3. 2D slice reconstructions of *Choerophryne rostellifer*, taken at 80 kV, 100μA, and 2.9 s, 0.23°rotation per acquisition, frame averaged over two images. A, Optimally reconstructed slice; B, Badly aligned reconstruction. The arrow points out the "tails" typical for a misaligned 180° reconstruction. Scale bar: 3 mm.

be denser) and ring artifacts (where concentric rings occur in the image) can also be remediated to some degree by the reconstruction algorithms. Reconstruction times and sizes vary depending on how many slices are reconstructed and how fine the angle of rotation was. Dataset sizes of 1 GB upwards are common. Slice reconstructions are generally in a common image file format which can be viewed conveniently by programs that allow the playing of the images as a movie (a useful free program is DataViewer, which also allows measuring distances in 3D; Sasov 2007). However, often the reconstruction software returns so-called DICOM images, which are viewable with special DICOM viewers (e.g., the freeware DicomWorks; Puech and Boussel 2008); the free image viewing program IrfanView (Skiljan 2007) also allows batch-conversion of DICOM files into more common image files.

There is a range of possible applications for 2D slices, including tissue density determination, morphometrics, volumetrics, or discrimination of trabecular vs. cortical bone (for more details, see Kalender, 2005; Zollikofer and Ponce de Leon, 2005). The most popular application for visualization of 2D slices is 3D reconstruction. This is achieved by thresholding out that portion of grey values in the 2D slices which correspond to the density of the elements to be reconstructed. The 3D reconstruction can also be restricted to a particular region of interest (ROI). All image components within the chosen grey values are then "stacked together" by the reconstruction algorithm to yield a three-dimensional structure. Note that morphometric measurements of three-dimensional objects are influenced by the threshold chosen, which can lead to inconsistent measurements (Coleman and Colbert 2007). Sophisticated three-dimensional reconstruction programs are often available with the processing software at scanning facilities (e.g., Disect, VGStudioMax, Amira, Mimics). However, reconstructions can be made using freely downloadable 3D-reconstruction programs (e.g., ImageJ, Abramoff et al. 2004; Drishti, Limaye 2006) on any computer with enough memory. The reconstruction in Fig. 3 was



FIG. 4. Ventral view of a 3D reconstruction of a scan of *Oreophryne brevirostris (*South Australian Museum A8589) using Drishti. Scale bar: 3 mm.

made with Drishti (Limaye, 2006). The quality of 3D reconstructions depends on the quality of the 2D slices and the graphical rendering capabilities of the reconstruction program used. However, considerable computer and graphics card memory are required in order for the programs to run at sufficient speed.

The limitation of CT for biological specimens is that it only differentiates bone, water, air, and fat (e.g., Ritman 2002). "Desktop" cone-beam micro-CT scanners in particular do not show non-mineralized tissue elements very well (Kalender, 2005). A number of approaches using stains for discrimination between various tissues are rapidly being developed (e.g., Palmer et al. 2006; Ritman 2004; Uzun et al. 2006), but these can only be used on destructible specimens. Since the field of high-resolution CT scanning is still developing rapidly, scanner capabilities regarding specimen size, resolution, or magnification are continuously being improved so that considerable improvement to this already fast and effective method can be expected within the next few years.

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A Safe and Efficient Technique for Handling *Siren* spp. and *Amphiuma* spp. in the Field

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Siren spp. and *Amphiuma* spp. are large eel-like salamanders distributed throughout the coastal plain of the southeastern United States (Conant and Collins 1998). Much has been reported on capture methods for these species. Common methods include minnow and crayfish traps (Sorensen 2004), hoop nets (Snodgrass et al. 1999), dip nets (Fauth and Resetarits 1991), and baited hooks (Hanlin 1978). Recently, a trap capable of sampling these species at depths up to 70 cm was developed (Luhring and Jennison 2008). Because of their slippery skin and irritable nature, *Siren* spp. and *Amphiuma* spp. are difficult to handle. Little has been published on methods to aid in field-handling of these species. Sorensen (2004) used a modified squeeze box to restrain individuals (Cross 2000). Luhring (2005) restrained individuals by wrapping them in a damp cloth. Frese et al. (2003) anesthetized individuals prior to marking and measuring.

We found snake restraining tubes (King and Duvall 1984) to be a safe and effective device for restraining *Siren texana* (Dixon 2000) in the field (Fig. 1). The set we used included nine clear plastic tubes obtained from Forestry Suppliers Inc. (Jackson, Mississippi), measuring 609.6 mm in length and ranging in diameter from 9.5 to 50.8 mm. This allowed all *S. texana* encountered (N = 31), ranging from 84 to 443 mm snout–vent length, to be restrained effectively. An opening at each end of the tube allowed constant airflow to be maintained, and water was trapped in the tube with the *S. texana* which prevented desiccation.

Captured individuals were initially placed in holding bags so that they could be manipulated into entering the tubes. However, we found it more efficient to house the *S. texana* in a large cooler containing enough pond water to cover their bodies prior to handling. Individual *S. texana* were easily disturbed by touch and swam directly into tubes placed in the water in front of them when disturbed. This allowed us to minimize contact with *S. texana*, decreasing the potential for handling injuries to both salamander and worker. Typically, a large individual would attempt to back out of the tube when it was between one third and half way in. In such cases, we held the tube vertical to the ground, with the posterior end of the *S. texana* facing up, and pushed the body into the tube until only the tail was free. The individual was then less able to move within the tube, facilitating accurate measurements, tail-clips, and photographs. *S. texana* were ejected from the tubes directly into damp perforated laundry sacks to be weighed by holding the tubes vertically, with the anterior portion of the individuals facing up, and pulling lightly on the tail.

We found that a single person could restrain and obtain all necessary data on a given individual in under ten minutes. A potential drawback of this method is that the salamanders will never be perfectly linear due to the necessity of having enough space to facilitate movement into the tube. However, once an individual is placed in a given tube, a smaller tube can be inserted at the anterior end and the salamander can be coerced into it by touching its tail, resulting in a tighter fit and more accurate measurements. The handling method we used was effective for collecting standard data and facilitating tail-clips. This method may not be useful when extremely accurate measurements are required or when investigating some morphological characters, such as bite-marks (Fontenot and Seigel 2008; Godley 1983). However, the tubes may be useful for restraining individuals prior to administering anesthetic vapor.

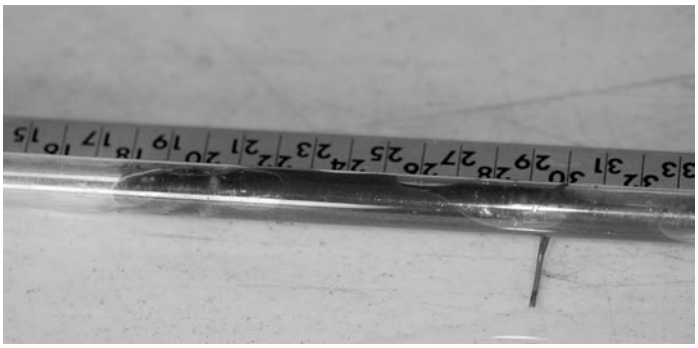


FIG. 1. *Siren texana* being restrained for measurements using a snake tube.

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Using PIT Tags to Evaluate Non-Individual-Specific Marks Under Field Conditions: A Case Study with Greater Siren (*Siren lacertina*)

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Mark-recapture models used in estimating population size require the capture, marking, and recapturing of marked animals (Donnelly and Guyer 1994). Although several methods are available for marking amphibians (see Ferner 1979), sirenids and Greater Siren (*Siren lacertina*), in particular, present several problems for marking schemes. Sirenids have fewer total toes (6 or 8) than most salamanders and this limits the applicability of toe clipping schemes. Additionally, the dark skin of Greater Sirens prevents marks made by tattooing and injectable dyes from being easily read (Sorensen 2003). The only known test of multiple marking techniques on *S. lacertina* was conducted on two captive animals (Sorensen 2003). The marking techniques used on the two captive animals included cyano-acrylic, tail-notching, heat-branding and Passive Integrated Transponders (PIT tags). Of these, only PIT tags were successful in creating a lasting mark and were later used in field studies. While it was not deemed applicable for Greater Siren, previous studies on Lesser Siren (*Siren intermedia*) used heat branding to create marks that lasted for up to 96 months (Frese 2000; Gehlbach and Kennedy 1978; Raymond 1991).

The required level of identity (e.g., individual, cohort) and persistence (e.g., permanent, month, day) for a mark is dependent on the specific goals of a mark-recapture study. I tested two types of non-individual-specific marks on *S. lacertina* in an isolated herbaceous bay wetland to determine their permanence and readability. Passive integrated transponder (PIT) tags are effective at providing a permanent individual mark in *S. lacertina* (Crabill 2007; Sorensen 2003). Their proven persistence as a mark for *S. lacertina* allowed me to use them as a redundant mark to test other marking techniques used in this study.

There are several individual marking schemes for toe clipping amphibians (see Donnelly et al. 1994). However the utility of toe clipping for individually marking *Siren* is fairly limited as they only have eight total toes (most toe-clipping schemes are designed for amphibians with 18 total toes). For this reason, toe-clipping in this study was considered to be a cohort mark (i.e., different toe-clip combinations can be used in order to separate animals into smaller groups by a pre-defined criterion such as period of capture). Tail notching has been successfully used as a marking technique for larval anurans (Turner 1960). Sirens often have minor damage to their tailfins that can resemble a tail notch (pers. obs.). To avoid confusion with naturally occurring tailfin damage, I used an elongate arc or "tail scoop" (see Luhring 2008) as a tailfin mark on each marked animal. Because there is not an effective way to vary the appearance of a tail scoop, this method was considered to be a non-specific capture mark.

Methods and Materials.— All animals were captured from September 2006 to September 2007 as part of an on-going study on greater siren and two-toed amphiuma at Dry Bay, a 5-ha fishless Carolina bay located on the Department of Energy's Savannah River Site in Aiken County, South Carolina, USA (Luhring 2008). A sampling period occurred each month for ten consecutive days (for a total of 130 nights of trapping over 13 months) with a fyke net, and multiple arrays of hoop nets, trashcan traps (Luhring and Jennison 2008; Luhring, *in press*), and plastic and steel minnow traps (see Luhring 2008 for details of trapping design). Upon return to the laboratory, animals were weighed to the nearest 0.1 g on a Mettler PC 440 electronic scale (Mettler Instrument Corporation, Hightstown, New Jersey), measured on a meter stick for snout–vent length (SVL) and total length to the nearest 1.0 mm, and were then marked. Animals were photographed with a Nikon D70 (model# 25218) or Nikon D200 (model# 25235) camera with a Nikon 18–70 mm f/3.5-4.5G ED IF AF-S DX Nikkor Zoom Lens (model#2149) mounted on a Bogen TC-2 copy stand (Bogen Imaging Incorporated, Ramsey, New Jersey) to document mark regeneration and for later use in morphometric measurements. Animals were restrained for marking by placing them on a wet cloth. The cloth was folded over the animal's head and then the side of the cloth was folded over the animal. The animal and cloth were then rolled together to the opposite end of the cloth (see Luhring 2008). This technique of restraining the siren permitted access to the area immediately posterior to the vent for injecting a PIT tag (AVID Marketing, Incorporated, Norco, California) and administering a tail scoop while restraining the siren. Sirens did not need to be restrained for toe-clipping as they typically did not react to this type of mark. Larger sirens (>300 mm SVL) also typically did not react to receiving a PIT tag, however, all animals were restrained in the cloth for PIT tagging and tail scooping.

All PIT tags were injected towards the distal end into the ventral side of the tail 1–3 cm posterior to the vent. This is the same area used by Sorensen (2003); however, I injected the PIT tag ventrally as the ventral aspect at this point was wider and doing so negated having to avoid the spinal column. Tail scoops were made with dissection scissors on the dorsal side of the tail fin. The scoop usually started at the widest part of the tail fin and was cut ~5–7mm deep in larger animals (>400mm SVL) and 2–5mm deep in smaller animals (<400mm SVL). The general rule of thumb in deciding tail scoop depth was that no cut should be deeper than a quarter of the tail depth (i.e., halfway to the middle of the tail). Tail tissue was easier

to cut if making an initial cut at a 60–90° angle and then cutting towards the distal end of the tail in a shallow arc for 25–35mm (variable with body size of animal). Tissue from tail scoops was saved for genetic analysis and thus scissors were cleaned with a 10% bleach solution (to degrade any remnant DNA), run under tap water (to wash off any bleach), and then submerged in 70% isopropyl alcohol between the marking of each animal. Syringe needles were stored in 70% isopropyl alcohol prior to being used on PIT tag applicators. All PIT tag applicators and needles were wiped with a paper towel (to remove tissue residue) and 70% isopropyl alcohol between animals to minimize cross-contamination.

Markings on recaptured animals were given a four-stage rating based on a combination of photographic records and notes taken during laboratory measurements. Toe clips and tail scoops were given a 1 if they were freshly clipped and did not show any evidence of regrowth. They were given a 2 if there was only minor regrowth. A toe clip was given a 3 if it was partially re-grown (more than half the original size but less than ¾ the size of a full grown toe). Tail scoops were given a 3 if the tissue had healed and the site of the mark was obviously discolored. Toes and tails that were fully regenerated were given a rating of 4. If a mark was considered to be borderline between categories, it was given the higher numerical rating to provide a conservative estimate of mark retention (for photos of marks at different stages, see Luhring 2008).

Toe clips were taken from the siren's second innermost toe (the longest toe) on the right foot by using a pair of sharp scissors to cut the toe at the base where it meets the hand. A few animals had deformities (not associated with toe-clipping) on their designated hand, in which case a toe was taken from the left hand. While toe clipping was administered from the beginning of the experiment, tail scooping was initiated in January of 2007 at which time all animals received a toe-clip, a tail scoop and a PIT tag. Animals recaptured within the same ten-day trapping period were recorded and released at the site of capture without taking additional measurements.

Mark ratings were tested for significant correlations to the age of the mark, and changes in SVL, total length, and mass since the original mark. Regressions were tested with an analysis of variance (ANOVA) with a lack-of-fit test. Statistical analyses were run in Statgraphics (Centurion XV Version 15.2.06.).

Results.—A total of 102 recaptures of 72 toe-clipped animals and 94 recaptures of 58 tail scooped animals were analyzed for mark durability and readability. These data were grouped into 30-day intervals to represent monthly sampling efforts (Table 1). Days between captures ranged from 20 to 332 days for toe clips (100.2 ± 65.5 SD) and tail scoops (92.1 ± 57.3 SD). Most marks began showing signs of regeneration at around 30 days (Figs. 1, 2). Toe clips remained fresh or had only minor regeneration three times longer than tail scoops (61–90 days versus 20–30 days). Marks were readable (i.e., classified as a 1, 2, or 3) 180 days after they were given, however this is at the uppermost bound of tail scoop readability. The first observed loss of mark for a toe clip occurred 127 days after being administered. The first observed loss of mark for a tail scoop occurred 61 days after being administered. While the majority of toe clips were still readable within the 332 day maximum between captures (both recorded marks over 300 days were ranked as 3's) and one mark was a 1 at 216 days, most tail scoops were unreadable beyond 180 days.

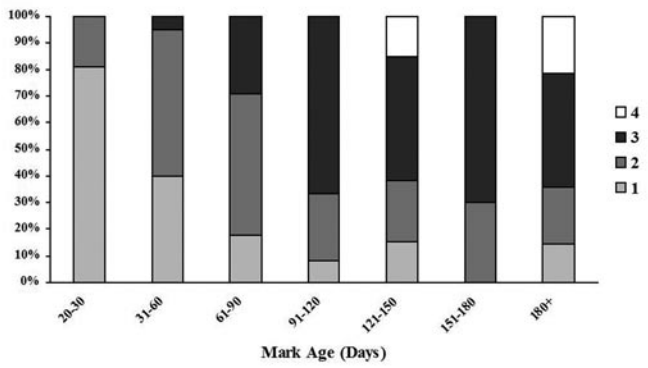


FIG. 1. Proportion of toe clip ratings by mark age of recaptured animals. 1 = fresh, 2 = minor regeneration, 3 = partial regeneration, 4 = loss of mark.

Toe clip and tail scoop mark readability were correlated to mark age, and change in SVL, TL, and mass ($p<0.05$). While tail scoop regeneration was best explained by mark age ($F_{1,87} = 144.59$, $p<0.0001$, $r^2 = 0.79$), toe clip regeneration was explained slightly better by change in SVL ($F_{1,98} = 96.15$, $p<0.0001$, $r^2 = 0.70$) than by mark age ($F_{1,98} = 89.65$, $p<0.0001$, $r^2 = 0.69$; see Luhring 2008 for complete ANOVA tables). A Fisher's least significant difference (LSD) test was used to compare the mean mark age (days) to mark rating (1–4) within toe clips and tail scoops and between toe clips and tail scoops (Table 2). Two outliers were removed from the toe clip statistical analyses to create a better fit for the model without affecting significance. The outliers belonged to the same animal that did not regenerate any toe tissue after 194 and 216 days. One outlier was removed from the tail scoop analyses for similar reasons (no tail tissue regeneration in 63 days) and did not affect significance. All three outliers are included in non-statistical figures and tables (Figs. 1, 2; Tables 1, 2).

Discussion.—Toe clips lasted longer than tail scoops and can also be used to create a finer level of distinction between groups

TABLE 1. Breakdown of toe clip (c) and tail scoop (s) mark readability (1–4) by mark age (days) for recaptured animals.

Readability	Mark Age 20–30 C	S	31–60 C	S	61–90 C	S	91–120 C	S	121–150 C	S	151–180 C	S	180+ C	S
1	13	4	8	0	3	1	1	0	2	0	0	0	2	0
2	3	11	11	5	9	2	3	0	3	0	3	0	3	0
3	0	1	1	13	5	10	8	10	6	7	7	5	6	1
4	0	0	0	0	0	3	0	2	2	3	0	4	3	9
Total	16	16	20	18	17	16	12	12	13	10	10	9	14	10

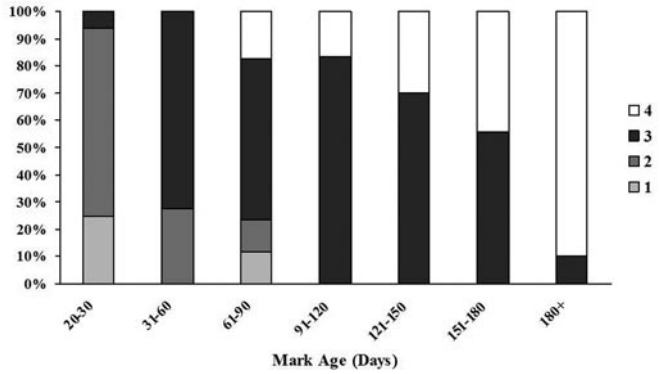


FIG. 2. Proportion of tail scoop ratings by mark age of recaptured animals. 1 = fresh, 2 = minor regeneration, 3 = partial regeneration, 4 = loss of mark.

of animals (cohorts). Most toe clips were still readable through the end of the study and one animal that was caught outside of the study period on 31 January 2008 had a readable toe clip that was 353 days old. Although there were five "lost marks" (a rating of 4) of toe clips, most of these were actually still distinguishable marks that surpassed the ¾ of original length threshold between a rating of 3 and 4. However, they were not easy to distinguish and may have only been distinguishable to someone familiar with what that specific toe should look like.

Toe clips would be best suited for mark-recapture studies lasting for a field season (January to September) and provide an opportunity for a cohort marking scheme. Toe clipping may also be used in conjunction with studies on skeletochronology (Bruce and Castanet 2006; Halliday and Verrell 1988) or for any studies needing tissue samples. The number of toes on *S. lacertina* (8) limits toe-clipping schemes. Additionally, I caution against removing multiple toes on the same foot because *S. lacertina* use their feet as much, if not more than, their tail (Schalk and Luhring, unpubl. data) to pull themselves through the water, vegetation, and organic debris, and the extent to which the loss of multiple toes would impact their survival is not known.

Although one tail scoop was readable 332 days later, 11 out of the 12 tail scoop marks that were over 165 days old were completely regenerated and no longer visible. After 63 days, all tail scoops were healed and only discolored tissue (a rating of 3) in the area of the original mark distinguished these animals as having been given a tail scoop. Of all the techniques tested, tail scoops might have had the shortest-lived effects on sirens. Tail scoops would be ideal for marking efforts that last for a short period of time (<60 days) and do not require a specific mark. The tissue taken from tail scoops is sufficient for quality DNA extraction (pers. obs.) and the rapidity of tailfin regeneration suggests that there are not any likely long-term effects of tail scoops. While mark age, and change in SVL, TL, and mass were significantly correlated to the quality of marks, these correlations were not directly tested for causation of mark regeneration. Future studies that test mark regeneration as it relates to the growth rates of aquatic salamanders may show differences for regeneration rates of different types of tissue. Greater Sirens show a reduced growth rate upon reaching a length of 400 mm SVL (Luhring 2008), and toe regeneration may be retarded in these animals (pers. obs.).

TABLE 2. Results of a 95% Least Significant Difference (LSD) test on the mean ages of mark type readability. Letters in homogenous groups column denote significantly different groups.

Mark Type-Readability	No. Ind.	Mean Age	Homogeneous Groups
Tail Scoop-1	4	25.0	A
Tail Scoop-2	18	35.5	A
Toe Clip-1	27	47.0741	A
Toe Clip-2	35	87.1429	B
Tail Scoop-3	47	94.2553	B
Toe Clip-3	33	143.242	C
Tail Scoop-4	21	160.095	CD
Toe Clip-4	5	193.6	D

There are still several other types of marking techniques available for testing on sirens and other permanently aquatic salamanders (e.g., visible implant alpha-numeric tags). While PIT tags work well for permanent individual identification, they cannot be used in larva and small juveniles of *S. lacertina* because of the large gauge needle needed to insert the tag into the tail (Sorensen 2003; pers. obs.). The golden flecking on *S. lacertina* is highly variable in respect to the amount present, as well as the shapes and sizes of individual flecks. This variation is possibly unique and might be useable for individual identification with photo-identification programs (see Gamble et al. 2008).

Until the validity of other such techniques are tested on *S. lacertina* in the field, I suggest using PIT tags for long-term studies or those requiring individual identification and either toe clipping or tail scooping for short-term studies not requiring individual identification. The use of a PIT tag as a permanent individual-specific mark was essential for determining the applicability of non-individual-specific marking techniques in the field. Field-testing marking techniques would presumably be the best indicator of how well those techniques would work in the field on the species or groups of species of interest.

The initial investment of time and money required to establish the validity of cost-effective marking techniques enables long-term savings through cheaper marking schemes. Many population level studies on animals are cost-prohibitive. For example, only two published mark-recapture studies are available for *S. lacertina* and more information on population monitoring is unavailable at this time. Prior to this study, only PIT tags were proven to work as a marking scheme and the cost of PIT-tagging a population of sirens would prevent many investigators from being able to conduct even a simple population estimate. Now that there are two cheap, quick, simple, and field-proven marking techniques for sirens, population monitoring is cheaper and more realistically achievable.

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Marking Lizards by Heat Branding

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During a mark-recapture study on island populations of the lacertid lizard *Podarcis sicula* (Rafinesque-Schmaltz 1810), we needed to provide large numbers of lizards with individual, permanent marks. Toe clipping was not an option, because of the high incidence of natural toe loss in our study populations (see e.g., Schoener and Schoener 1980; Vervust et al., unpubl.). In addition, preliminary observations suggested that toe clipping may influence locomotor abilities and thereby reduce survival in this saxicolous species (Vervust et al., unpubl.). Techniques involving color banding or painting were discarded because they are insufficiently durable and/or might affect the lizards' visibility to predators. Passive integrated transponders (PIT tags) could not be used due to the small size of the lizards, especially the juveniles and subadults. Decimal coded wire tags (Northwest Marine Technology, Inc.) and visible implant elastomers (Northwest Marine Technology, Inc.) are not clearly visible in lizards and/or require sedation and later sometimes euthanization of the study animals.

Heat branding has been used to mark anurans (Taber et al. 1975; Thomas 1975; Daugherty 1976), salamanders (Taber et al. 1975; Bull et al. 1983; Woolley 1962), turtles (Woodbury and Hardy 1948; Clark 1971), lizards (Clark 1971) and snakes (Clark 1971; Lewke and Stroud 1974; Winne et al. 2006). Typically, marking-irons in the shape of numerals or alphabetic characters are combined to obtain different recognition codes. However, the total number of individuals that can be given a distinct code this way is limited by the number of shapes and is more cumbersome than necessary, especially in small animals. We decided to use a heat branding method and coding technique employed by Winne et al. (2006) to successfully mark snakes. The technique consists of marking specific combinations of ventral scales with disposable medical cautery units (Aaron Medical Change-A-Tip cautery high power units; Aaron Medical, St. Petersburg, Florida 33710, USA; www.aaronmed.com). We modified the coding system slightly for use in our study species. A first mark (R0) was burned on one of the first ventral scales on the right side of each individual, to act as a reference point. Second, third and fourth marks were then burned into other ventral scales. Each of these marks was given a name reflecting its position with regard to the reference point (Figs. 1, 2). For instance, a mark at the right side of the body, 5 scale rows below R0 would be called R5; a mark at the left side of the body, 3 scale rows below R0, would be L3. These marks were made on the outer ventral scale rows. These names could then be combined into an individual lizard's code (R5L3). The number of unique combinations that can be produced in this way is:

$$\sum_{k\,(0\to 3)} \frac{n!}{k!\,(n-k)!}$$

with k = the number of dots applied, exclusive of R0 and n = the number of ventralia available, exclusive of R0. In our study species, 24 rows of ventralia could be used for burning; the ventralia adjacent to the collaria and preanalia were often too small to allow proper marking. Hence, 48 lizards could be coded individually with one dot; 1,129 with two dot combinations, 17,344 with three dot combinations and 195,709 with four dot combinations (plus the reference dot). Since our study populations have estimated population sizes between 3000 and 9000 lizards (Vervust et al. 2007), we used a maximum of four dots per lizard (inclusive of R0).

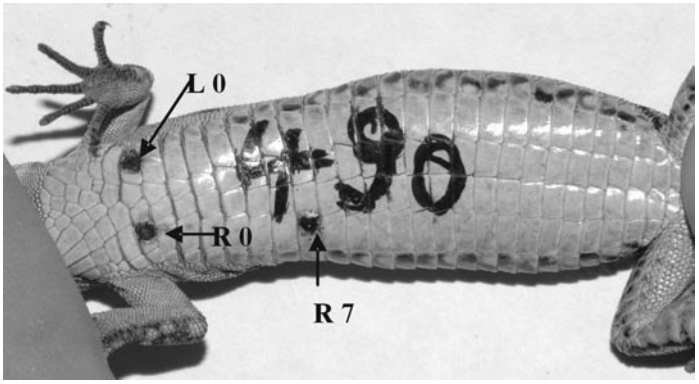


FIG. 1. Lizard from the islet Pod Kopište, with burn mark R7L0, after 48 h.

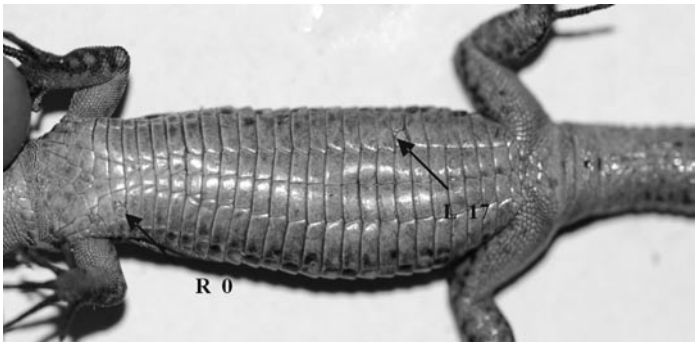


FIG. 2. Lizard from the islet Pod Mrčaru, with burn mark L17, after 465 days.

To date we have marked over 1000 lizards, including juveniles, with this technique. All lizards were kept and observed in captivity for 48 hours after marking. None showed any obvious negative effects and all lizards resumed their normal activities within minutes after the treatment. Not a single lizard died during this period. The markings remained clearly visible over a period of at least 485 days during which the lizards resided in their natural habitat (Fig. 2) and could be readily distinguished from natural scars.

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AMPHIBIAN DISEASES

This section offers a timely outlet for streamlined presentation of research exploring the geographic distribution, host range, and impact of emerging amphibian pathogens, especially the amphibian chytrid fungus *Batrachochytrium dendrobatidis* (*Bd*) and ranaviruses. *Bd* is an emerging pathogen linked to mass mortality and declines of amphibians worldwide, yet Bd has also been detected in amphibians without disease. Ranaviruses also cause mass mortality, but have not yet been linked to large-scale declines. We know relatively little about their global distribution, host range, or impacts on host populations. To improve our understanding of the scope of this issue, we encourage submission of studies that illuminate the geographic distribution, host ranges, and impact of these pathogens on amphibian populations, including research on individual species or groups of species, wild or captive animals, native or non-native species, live animals or museum specimens, environmental samples, and, provided there is sufficient sampling[1], reports of non-detections.

We ask authors to: 1) restrict the Introduction of their paper to a **maximum** of two paragraphs to highlight the context of their study; 2) briefly include both field and laboratory Methods; 3) present Results in a Table, although a map might also be useful, and limited text; and 4) have a short discussion of a **maximum** of three paragraphs to touch upon key findings. Please include the following information in submissions as appropriate: coordinates and description of sampling areas (or please note if locations are extremely sensitive to reveal, and provide general area instead); species name(s) and life history stages examined, as well as other species present; whether samples were collected randomly or just from dead or moribund animals; date of specimen collection; evidence of unusual mortality; numbers of positive and negative samples; disposition of voucher specimens; name of collaborative laboratory or researcher conducting histological sections or PCR analyses; and names of cooperative land owners or land management agencies. We encourage researchers to conduct post-mortem examinations when possible to identify the cause of death when reporting mortalities. We aim to expedite the review and publication process! Please e-mail submissions directly to Associate Editor, Dr. Dede Olson: dedeolson@fs.fed.us.

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Batrachochytrium dendrobatidis in Argentina: First Record in *Leptodactylus gracilis* and Another Record in *Leptodactylus ocellatus*

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In the last few decades, rapid declines and extinctions of populations have been reported in more than 400 amphibian species all over the world. A pathogen that has received attention relative to these losses is the chytridiomycete *Batrachochytrium dendrobatidis* (*Bd*). Ron (2005) identified potentially suitable regions for *Bd* establishment in the New World. In South America, Ron predicted suitable regions included the Brazilian Atlantic forest, the temperate forest in Chile and western Argentina (south to 30ºS), northeastern Argentina, Uruguay, and Paraguay. Thus far in Argentina, *Bd* has been reported in four anuran species at three geographic locations: 1) Barrionuevo and Mangione (2006) found *Bd* in *Telmatobius pisanoi* and *T. atacamensis* (Anura: Leptodactylidae) in mountainous areas of Northern Argentina; 2) Arellano et al. (2006) and Herrera et al. (2005) reported *Bd* in adult specimens of *Leptodactylus ocellatus* (Anura: Leptodactilidae) in Buenos Aires province; and 3) in North Patagonia, Fox et al. (2006) found *Bd* in *Atelognathus patagonicus* (Anura: Leptodactilidae). We present *Bd* detections in central Argentina: a new occurrence in the Striped Thin-toed Frog (*Leptodactylus gracilis*) and another occurrence in the Spotted Thin-toed Frog (*Leptodactylus ocellatus*).

Dead specimens of the two leptodactilids were found during field surveys and were deposited in the collection of Centro de Zoologia Aplicada (Universidad Nacional de Córdoba, Argentina). A specimen of *Leptodactylus ocellatus* (CZA a-00011) was collected on May 2005 (31.3967ºS, 64.5936ºW) and a specimen of

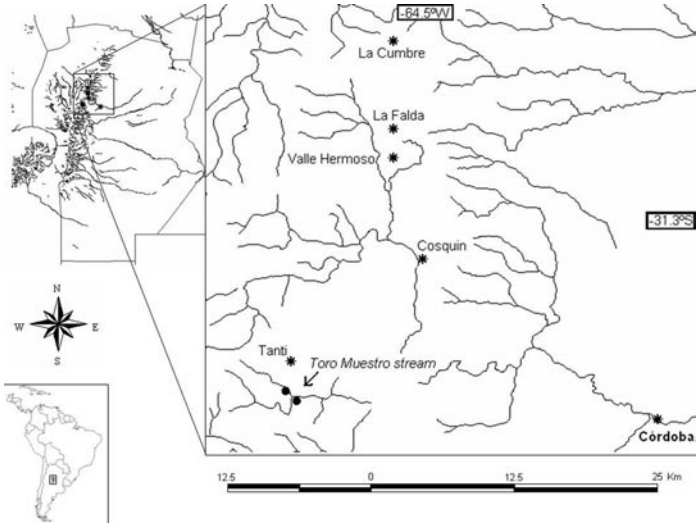


FIG. 1. Location of dead *Leptodactylus gracilis* and *L. ocellatus* specimens infected with the amphibian chytrid fungus, *Batrachochytrium dendrobatidis*, in central Argentina (black dots). Stars represent nearby localities.

Leptodactylus gracilis (CZA a-00010) was collected on March 2006 (31.3855ºS, 64.6057ºW), on the banks of the Toro Muerto stream, in the locality of Villa Flor Serrana, in a mountainous area of Córdoba province, Central Argentina, at 800 m elevation. The stream had a mean depth of 70 cm and flowed intermittently over granitic rock. The physiognomy of the surrounding vegetation was that of serrano secondary forest and thorny shrublands, typical of the Chacoan region (Cabrera 1976). Annual rainfall is 950 mm and is mainly concentrated in spring and summer. Mean annual temperature is 18.9°C, ranging from peak values in summer that may exceed 38°C to winter frosts (Capitanelli 1979).

The specimens were fixed in the field in 10% neutral formaldehyde solution and then were transferred to 70% ethanol. In the laboratory, abdominal and hind limb ventral skin patches (~5 x 10 mm) were excised from the anurans, stored in 70% ethanol and dehydrated to embed in paraffin. Then, tissues were sectioned at 5-μm thickness with a Reitcher microtome for histology, and stained with hematoxylin & eosin. With a stereomicroscope, we looked for spores and sporangia in the corneous epithelium of the tissue samples following Berger et al. (1999) and Pessier et al. (1999).

We identified *Bd* in the two specimens analyzed. Zoosporangia at different developmental stages, empty or containing rounded basophilic zoospores, were identified in the stratum corneum. With those results, we increase the geographic distribution of *Bd* in *Leptodactylus ocellatus*, and report the first record of infection in *L. gracilis*. These two species are widespread in a broad region of Argentina, supporting the need to conduct further studies of *Bd* to investigate the status of these populations and the risk to sympatric species. The first case of *Bd* in Argentina was detected in 2002 in a dead specimen (Herrera et al. 2005), and until now eleven specimens (include our two) belonging to five different species have been found infected (Arellano et al. 2006, Barrionuevo and Mangione 2006, Fox et al. 2006, Herrera et al. 2005). Our finding expands the known distribution of *Bd* to the wilderness area of the Chacoan phytogeographic region of Argentina, Chaco Serrano district (Cabrera 1976) (Fig. 1). Although Ron's (2005) prediction map of potentially suitable regions for *Bd* establishment

has constituted a helpful tool for orientating explorations for *Bd* infections detection, these prediction have been made on the bases of only 44 points over the New World, and none of these points was either from Argentina or neighboring countries, resulting in a low precision. Further information is needed about the prevalence and habitat requirements of *Bd* infecting anurans inhabiting Argentina for modeling an actualized and more precise *Bd* distribution map. An increase in the number of amphibian species monitored will help us to estimate the health of wild populations. The collection of environmental and biological data will provide us with valuable tools to predict new scenarios and implement adequate and specific conservation policies in order to manage disease outbreaks in Argentina.

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Detection of *Batrachochytrium dendrobatidis* in Amphibians from the Great Smoky Mountains of North Carolina and Tennessee, USA

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Amphibians in the southern Appalachian Mountains of the United States comprise a diverse and globally significant biological resource (Dodd 2004). There are ample reasons to be concerned about the welfare of amphibian populations in the Southern Appalachians, given expected changes in environmental conditions with climate change (Bernardo and Spotila 2006; Corser 2001; Dodd 1997) and reports of population declines (Corser 2001; Highton 2005). Furthermore, the pathogenic fungus, *Batrachochytrium dendrobatidis* (hereafter called *Bd*), has been detected in many sites throughout the southeastern U.S. (e.g., Daszak et al. 2005; Rothermel et al. 2008). Although Rothermel et al. (2008) detected *Bd* infection in 10 species within the families Ranidae, Hylidae, and Salamandridae, none of the 143 amphibians collected in Great Smoky Mountains National Park in 1999–2001 were infected. Importantly, this sample included only two individuals in the family Plethodontidae. Other studies have reported *Bd* infections in wild-caught plethodontid salamanders of two terrestrial species (*Plethodon neomexicanus*, Cummer et al. 2005; *P. cinereus*, Lauer et al. 2007) and three stream-associated species (*Eurycea cirrigera*, Byrne et al. 2008; *E. bislineata* and *Desmognathus fuscus*, Grant et al. 2008). Researchers have also collected morbid terrestrial plethodontid species (*Oedipina* spp. and *Bolitoglossa* spp.) during mass mortality events in Mexico and Panama (Lips et al. 2003; Parra-Olea et al. 2005). Therefore, there is an urgent need for more information regarding *Bd* occurrence and susceptibility within the range of the many endemic species of salamanders in the Southern Appalachians.

Three methods have been used to detect the presence of *Bd* in amphibians: histological examination, conventional polymerase chain reaction (PCR), and quantitative (real-time) PCR (qPCR). The relative benefits of histological examination versus the more sensitive molecular methods have been described previously (Smith 2007). Since the publication of Boyle et al. (2004), qPCR has become widely adopted in studies seeking to detect or quantify the presence of *Bd* in amphibians. A recent study has supported the increased sensitivity of qPCR over conventional PCR in detecting *Bd* (Kriger et al. 2006), but there are few empirical tests

comparing the two methods (Kriger et al. 2006). The objectives of this study were: 1) to determine the presence of *Bd* in the Great Smoky Mountains of North Carolina and Tennessee; 2) to compare the incidence of *Bd* in groups of amphibians with different life history strategies (i.e., pond-breeding, stream-breeding, and fully terrestrial); and 3) to assess repeatability of *Bd* detection by verifying a subset of our conventional PCR results using qPCR.

Methods.—Field surveys for amphibians were conducted in Great Smoky Mountains National Park, located in western North Carolina and eastern Tennessee. We sampled pond-breeding amphibians from 10 sites in April and May 2007, and collected 377 larval and 60 post-metamorphic samples. We sampled stream-breeding and fully terrestrial salamanders from 25 sites in May–July 2006 and April–July 2007, and collected one larval and 221 post-metamorphic samples. Larvae were euthanized by immersion in a concentrated solution of MS-222, which does not destroy *Bd* (Webb et al. 2005). The sampling method for post-metamorphic amphibians entailed swabbing the ventral skin (and hind-toe webbing of anurans) 15–20 times, following the protocol of Livo (unpubl.; http://wildlife.state.co.us/NR/rdonlyres/710BBC95-2DCF-4CF9-8443-D4561DBC3B69/0/PCRsampling2004.pdf). Euthanized larvae and swab samples were preserved in 70% ethanol for subsequent genetic assays.

DNA isolation techniques for pond-breeding amphibians varied depending on whether the sample was a whole larva or a skin swab. For larvae, oral discs were excised and DNA was isolated using standard phenol-chloroform techniques. Briefly, oral discs were initially incubated in 100 μl of 1 mg/ml collagenase (Sigma-Aldrich Chemical Company, St. Louis, Missouri) in phosphate buffered saline (PBS) for 4 h at 37°C followed by an additional incubation using 100 μl of proteinase K for 16 h at 37°C. After incubation, the digested tissue samples were triturated to disrupt cellular matrixes and an equal volume of a 1:1 ratio of phenol:chloroform was added. The sample was vortexed thoroughly for 10 sec and allowed to set at room temperature for approximately 5 min. The sample was then centrifuged at 10,000 × g for 5 min and the top, aqueous layer was moved to a new tube. Approximately five volumes of 100% ethanol and 100 μl of 3 M sodium acetate were added to the sample for DNA precipitation. The samples were allowed to sit at -80°C for 5 min and then centrifuged at 10,000 × g for 10 min. The resulting DNA pellet was washed once in 80% ethanol and subsequently centrifuged at 10,000 × g for 5 min. The DNA pellet was air dried and resuspended in 20 μl of molecular grade water.

Larvae collected in the field were either kept separate for individual analysis or pooled. The oral discs of separated individuals (N = 90) were kept isolated and processed separately throughout. However, some pooled samples (N = 293 individuals) of larvae were large (as many as 73 tadpoles per jar) and had to be divided into subsamples of three to seven oral discs per tube (N = 66 reactions). Pooled samples of pond-breeding amphibian larvae consisted of only a single species. In addition to testing the oral discs, we also retained and tested the ethanol from each pooled sample of larvae (N = 8). The ethanol was passed through a 0.22 μm filter to collect possible free-floating *Bd* zoospores. The cellular debris was reverse-osmosed to collect the debris in a new tube. The sample was then boiled in a hot water bath and the resulting cell lysate was frozen until further DNA analysis. To isolate DNA from skin swabs (N = 199), we pressed the swab against the sides of its 2-ml vial to remove most of the retained ethanol (and any *Bd*) from the cotton. The tubes containing ethanol were then centrifuged to create pellets of swab-debris and possible zoospores. The swab-debris pellet was re-suspended in water and boiled. The resulting cell lysate was frozen until used directly for PCR analysis; cell lysates of *Bd* were not found inhibitory to PCR reactions (C. S. Brooks, unpubl. data). All pond-breeding amphibian samples were analyzed using conventional PCR following Annis et al. (2004). As controls, the above procedures were repeated using *Bd*-free swabs and frog tissues intentionally inoculated with serially diluted zoospores to determine minimum detection limits. These controls indicated that as few as 10 zoospores could be detected using the described procedures (C. S. Brooks, unpubl. data).

DNA was extracted from swabs collected from stream-breeding and fully terrestrial salamanders following the methodology of Hyatt et al. (2007). Swab samples were tested for the presence of *Bd* DNA using qPCR Taqman assays and species-specific primers developed by Boyle et al. (2004). With our limited funding, we chose to use this more expensive (and presumably more sensitive) analytical method for only the samples of plethodontids. Plethodontids are of greater concern from a conservation standpoint and use of qPCR ensured a high degree of confidence in negative results. An internal control (VIC_{TM} dye, Applied Biosystems) was added to every sample well of the assay, and was used to determine the presence of PCR inhibitors, which may result in false negatives (Hyatt et al. 2007). Additionally, a sample known to contain *Bd* was run concurrently as a positive control. To avoid the high costs associated with qPCR, samples from identical locations (but not necessarily the same species) were pooled, with up to three samples per reaction well (Hyatt et al. 2007). To further avoid high costs, all assays were performed in singlicate (following Kriger et al. 2006) rather than the widespread method of performing assays in triplicate (following Boyle et al. 2004). Actual detection probability is not expected to decline significantly with these cost-cutting measures (Kriger et al. 2006; Hyatt et al. 2007).

To assess repeatability of *Bd* detection, 15 samples from the pond-breeding group that tested positive and 20 that tested negative using conventional PCR were rerun using qPCR. Five positive controls of differing concentrations (undiluted and dilution factors of 1/20, 1/400, 1/8000 and 1/160000) were also run using qPCR. Samples were run in triplicate at 1/10 and 1/100 dilution factors (for a total of six replicates per sample). Samples were scored as negative if all six of the replicates tested negative, positive if three to six replicates tested positive and equivocal if one or two of the replicates tested positive. These tests were conducted blindly, such that the number and identity of samples that tested positive using conventional PCR was not known during the qPCR analysis.

Results.—Using conventional PCR, we detected *Bd* in samples from four of the 10 localities where pond-breeding amphibians were collected. All positive samples using this method were larval anurans, with five to 116 infected Wood Frog (*Lithobates sylvaticus*) larvae, one infected toad (*Anaxyrus* sp.) larva, and one to seven chorus frog (*Pseudacris* sp.) larvae being detected (Table 1). The above ranges of infected *Lithobates* and *Pseudacris* larvae are large because it is impossible to determine how many individuals within a pooled set of samples were infected. At sites where *Bd* was detected, prevalence was apparently very low. We can

TABLE 1. Post-metamorphic (P) and larval (L) amphibians tested for *Batrachochytrium dendrobatidis* (*Bd*) infection in Great Smoky Mountains National Park, North Carolina and Tennessee, USA, in 2006–2007.

Species	Life Stage	N*	*Bd* Detected
Pond-breeding			
Ambystoma maculatum	P	3 (3)	No
Hemidactylium scutatum	P	3 (3)	No
Notophthalmus viridescens	P	37 (37)	Yes
Anaxyrus sp.	L	122 (11)	Yes
Anaxyrus sp.	P	6 (6)	No
Pseudacris sp.	L	7 (2)	Yes
Pseudacris crucifer	P	6 (6)	No
P. feriarum	P	1 (1)	No
Lithobates catesbeianus	P	1 (1)	No
L. clamitans	L	4 (4)	No
L. clamitans	P	3 (3)	No
L. sylvaticus	L	244 (45)	Yes
Stream-breeding			
Cryptobranchus alleganiensis	P	1 (1)	No
Desmognathus sp.	P	4 (4)	No
D. imitator	P	1 (1)	No
D. imitator/*D. ocoee*	P	6 (4)	No
Eurycea sp.	L	1 (1)	No
E. wilderae	P	11 (10)	No
Pseudotriton ruber	P	1 (1)	No
Fully terrestrial			
D. wrighti	P	5 (5)	No
Plethodon jordani	P	35 (15)	No
P. metcalfi	P	23 (8)	No
P. serratus	P	12 (11)	No
P. teyahalee	P	17 (7))	No
P. jordani x *P. metcalfi*	P	94 (32)	No
P. jordani x *P. metcalfi* x *P. teyahalee*	P	11 (6)	No

* Numbers in parentheses indicate number of samples tested after pooling.

infer prevalence from samples in which large numbers of larvae were collected from a given site on the same date, and individual larvae were preserved and analyzed separately. At Finley Cane Sinkholes (35.61027°N, 83.74388°W), only 1.6% of toad larvae were infected. At Stupka's Sinkhole (35.58972°N, 83.84777°W), 3.7% of Wood Frog larvae were infected. Likewise, the one positive subsample of Wood Frog larvae from Finley Cane Sinkholes contained three larvae (out of a total of 72), which suggests prevalence was ≤ 4%. These sites are in, or within 10 km of, the heavily visited Cades Cove area in the western section of the park.

According to the qPCR assays, every stream-dwelling and terrestrial salamander swab sample was negative for the presence of *Bd* (Table 1). By determining the presence of *Bd* in the positive control, we confirmed that the reactions worked. However, the standard dilution of 1/10 (Hyatt et al. 2007) of the swab extract yielded a mere 20% success rate in internal control reactions, indicating PCR inhibition was a significant problem. To overcome the presence of PCR inhibitors, all samples were rerun with a 1/100 dilution. The success rate of internal control reactions was 100% following the increased dilution factor.

Results of samples analyzed using both conventional PCR and qPCR were largely discordant. Of the 35 samples that were run using conventional PCR and subsequently rerun using qPCR, 14 were discordant with the original result, 13 were concordant and 8 were equivocal. In total, seven additional samples unequivocally tested positive using qPCR: two *Lithobates sylvaticus* larvae from The Sinks (35.66944°N, 83.66138°W; ca. 14 km from Cades Cove), one *L. sylvaticus* larva from Finley Cane Sinkhole, one *L. sylvaticus* larva from Tremont Road (35.65222°N, 83.69722°W; ca. 10 km from Cades Cove), and three post-metamorphic *Notophthalmus viridescens* from Stupka's Sinkhole (Table 1). Importantly, *Bd* infection would not have been detected in *N. viridescens* had the samples not been retested using qPCR. Conversely, 7 samples that tested positive using conventional PCR tested negative using qPCR. It is also important to note that positive controls had predictable results. The undiluted positive control and the control diluted to 1/20 tested positive, the control diluted to 1/400 was equivocal (consistent with a very low concentration) and the controls diluted to 1/8000 and 1/160000 tested negative (consistent with concentrations too low to detect).

Discussion.—Our sampling revealed the presence of *Bd* in a limited number of sites and species within Great Smoky Moun-

tains National Park. The detection of *Bd* in the Park is one of a growing list of occurrences in the southeastern U.S. For example, recent surveys have also found *Bd*-infected amphibians at Congaree National Park in South Carolina, Chattahoochee River National Recreation Area in Georgia, and sites in the Blue Ridge Mountains of North Carolina and Georgia (Rothermel et al. 2008).

Another goal of this study was to provide preliminary information regarding *Bd* prevalence and which species are infected. We detected *Bd* in the larval stages of pond-breeding anurans in the genera *Anaxyrus*, *Lithobates*, and *Pseudacris*, as well as in post-metamorphic pond-breeding salamanders (*Notophthalmus*). Overall prevalence in the park appears to be low (1–4%), but exact measures of prevalence are not possible because we had low sample sizes for many sites and individual larvae were often pooled by species and site. We could not assess the influence of elevation on *Bd* occurrence because elevation and taxonomic associations were confounded; that is, samples (including positives) of pond-breeding species tended to be from lower-elevation sites and samples (all negative) of stream-dwelling and terrestrial salamanders tended to be from higher-elevation sites. Woodland salamanders that are direct-developing may have a low likelihood of infection simply because they do not inhabit streams and other aquatic habitats where *Bd* occurs. However, at least one species (*Plethodon metcalfi*) has been shown to be susceptible to chytridiomycosis following experimental exposure to *Bd* (V. M. Vazquez and B. B. Rothermel, unpubl. data). Resistance to *Bd* in some species derives from antimicrobial peptides produced by skin glands (Rollins-Smith et al. 2005) or cutaneous bacteria that inhibit growth of fungi, in some cases (Harris et al. 2006; Lauer et al. 2007). Different species and populations possess various combinations of these inhibitory factors, resulting in variation in resistance to chytridiomycosis.

The simplest explanation for the discordance in conventional PCR versus qPCR results is that *Bd* occurs with such low prevalence in the Great Smoky Mountains that repeated tests on the same sample yield only occasional positives. The implications of this finding are: 1) that large sample sizes may be necessary to detect the presence of *Bd* where present; and 2) current estimates of prevalence may be underestimates. Our comparative tests also suggest that conventional PCR detection rates may not be significantly lower than those of qPCR, although additional studies with larger sample sizes are needed.

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Amphibian Chytrid (*Batrachochytrium dendrobatidis*) in Post-Metamorphic *Rana boylii* in Inner Coast Ranges of Central California

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In California, USA, the amphibian chytrid fungus, *Batrachochytrium dendrobatidis* (*Bd*), has been reported to infect many species of native ranids (Nieto et al. 2007; Padgett-Flohr 2007) with particular attention being focused on dramatic *Bd*-related declines of the Sierra Nevada Yellow-legged Frog (*Rana sierrae*) in the Sierra Nevada mountains (Davidson et al. 2007; Fellers et al. 2001; Rachowicz et al. 2006). The Foothill Yellow-legged Frog (*R. boylii*) is a close relative of *R. sierrae* that occurs in streams over much of California, but at lower elevations (<1940 m) than *R. sierrae* (Fellers 2005). In 2006, *Bd* was found in *R. boylii*, Pacific Treefrogs (*Pseudacris sierra* sensu Recuero et al. 2006a, b), and Western Toads (*Anaxyrus boreas*) at Pinnacles National Monument, managed by the US Department of Interior - National Park Service, and in nearby streams on lands managed by the US Department of Interior - Bureau of Land Management (BLM) in San Benito and Fresno counties (P. Johnson, pers. comm.). The BLM in California recognizes *R. boylii* as a sensitive species, and it is a California Species of Concern (http://www.dfg.ca.gov/wildlife/species/ssc/amphibians.html). I surveyed *R. boylii* from nine streams in this region and tested them for *Bd* to better understand the geographic distribution of the pathogen. Incidental captures of *P. sierra* also were tested. In addition, I conducted a preliminary investigation of potential differences in habitat associations of infected and non-infected *R. boylii*.

Methods.—Between 5 July and 14 September 2006, post-metamorphic *R. boylii* and *P. sierra* were opportunistically caught during abundance counts conducted using visual encounter surveys (Fellers and Freel 1995) along streams in the Inner Coast Ranges of central California (Fig. 1). During abundance counts, frogs were recorded as adults or subadults subjectively based on size. Skin swabs were collected from each captured frog and screened for *Bd* presence using PCR amplification (Pisces Molecular LLC, Boulder, Colorado, USA). Sterilized equipment and disposable gloves were used for each frog handled. Snout–vent length (SVL), weight, and sex were recorded for each frog. For each capture location, microhabitat variables were recorded including water temperature, water depth, stream width, water velocity, stream habitat unit type (riffle, run, pool, step-pool), dominant substrate size (modified from Platts et al. 1983; sand [<2 mm diam], gravel [2–63 mm], cobble [64–256 mm], boulder [>256 mm]), dominant riparian vegetation, and location by Universal Transverse Mercator. Two-sample t-tests were used to compare continuous variables (SVL, weight, SVL-to-weight ratio, water temperature, water depth, and stream width) between *Bd*-negative and *Bd*-positive samples using NCSS 2000 statistical software. To assess frog condition between those animals with and without *Bd*, SVL-to-weight ratios were compared. Categorical variables (sex, stream habitat unit, substrate, and vegetation) did not yield adequate within-group samples sizes for statistical analysis, hence summaries for these variables are given.

Results.—Forty-nine *R. boylii* were tested for *Bd* from nine streams, and seven *P. sierra* were tested from three streams and a BLM vehicle wash facility. Nine of 49 (18%) *R. boylii* and one of seven (14%) *P. sierra* tested positive for *Bd*. Five of nine (56%) streams supporting *R. boylii* had at least one frog testing positive for *Bd* (Fig. 1, Table 1). Different streams were tested during different months of the year. All streams tested in July had *Bd*-positive frogs, as did half the streams tested in August, but no streams tested in September had *Bd*-positive frogs. Frogs at one stream, White Creek, tested positive for *Bd* during pilot sampling in May but tested negative in September. *Bd*-positive frogs occurred in streams with low *R. boylii* densities (e.g., 41 post-metamorphic frogs/km) to high *R. boylii* densities (e.g., 527 post-metamorphic frogs/km, Table 1). The single *Bd*-positive *P. sierra* was captured at Sawmill Creek where one *R. boylii* was also *Bd*-positive. The remaining *P. sierra*, including two captured from the vehicle wash facility, tested negative for *Bd*.

Rana boylii of all size classes (15–75 mm SVL) were tested, but only smaller frogs (<41 mm SVL) tested positive for *Bd* (Fig. 2). Although there was no significant difference in SVL between *Bd*-positive and *Bd*-negative groups ($p = 0.1260$, $t = 1.558$), *Bd*-positive frogs weighed less (mean *Bd*+ = 3.4 ± 0.6 SE, N = 8;

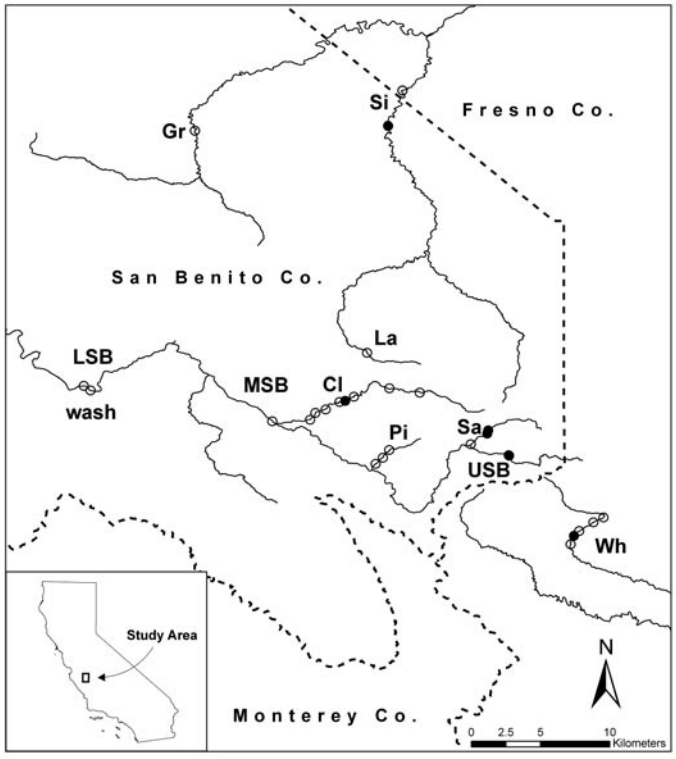


FIG. 1. Locations of positive (black circles) and negative (open circles) test results for *Batrachochytrium dendrobatidis* in *Rana boylii* and *Pseudacris sierra* in Griswold Creek (Gr), Silver Creek (Si), Larious Creek (La), lower San Benito River (LSB), vehicle wash facility (wash), middle San Benito River (MSB), Clear Creek (Cl), Picacho Creek (Pi), Sawmill Creek (Sa), upper San Benito River (USB), and White Creek (Wh), California, USA.

TABLE 1. Streams surveyed for *Rana boylii* density (frogs/km) and results of *Batrachochytrium dendrobatidis* (*Bd*) tests in 2006 in southern San Benito and western Fresno counties, California, USA.

Stream Name	Adult Density	Sub-adult Density	No. Frogs Tested for *Bd*	No. *Bd*-Positive Frogs	Date of Samples
White Creek	92	435	11	0[a]	8 Sept
Clear Creek	54	205	14	1	27 July
San Benito River (upper)	53	54	6	4	12 July
Picacho Creek	25	153	5	0	1,5 Sept
Larious Creek	14	0	2	0	9 Aug
Sawmill Creek	12	9	2	1[b]	5,7 July
Silver Creek	8	33	6	3	17 Aug
San Benito River (lower)	2	3	2	0	7 Sept
San Benito River (middle)	0	9	1	0	7 Sept

[a] Although negative for *Bd* in September, a pooled sample of 10 *Rana boylii* from White Creek tested positive for *Bd* during pilot sampling on 9 May 2006.
[b] One *Pseudacris sierra* from Sawmill Creek was *Bd*-positive.

mean *Bd*- = 8.8 ± 1.2 SE, N = 39; p = 0.0282, t = 1.958). Smaller frogs (< 41 mm SVL) testing positive for *Bd* had higher SVL-to-weight ratios than frogs of the same size class testing negative for *Bd* (mean *Bd*+ = 8.0 ± 0.5 SE, N = 5; mean *Bd*- = 6.9 ± 1.0 SE, N = 16; p = 0.0174, t = -2.274). Frogs > 41 mm SVL were not included in this analysis. Because of their small sizes, none of the nine *R. boylii* testing positive for *Bd* could be sexed. Frogs that tested positive were not symptomatic for chytridiomycosis, and no frogs seen during abundance counts appeared abnormal in any way. However, one sub-adult *R. boylii* was found dead at the bottom of White Creek being consumed by a stink bug (Pentatomidae).

Bd-positive frogs were found in streams with various types of riparian vegetation (e.g., Brewer's Willow [*Salix breweri*], Salt Cedar [*Tamarix ramosissima*], and California Sagebrush [*Artemisia californica*]) and in various aquatic habitat conditions, but primarily in pools with fine substrates and cooler than average water. Eight of the nine (89%) *Bd*-positive *R. boylii* and the *Bd*-positive *P. sierra* were caught in pools, even though pools made up only 43% of the frog capture locations. The other *Bd*-positive *R. boylii* was captured in a high-velocity riffle with a gravely substrate from Clear Creek. All the *Bd*-positive pools had sandy substrates except those on the upper San Benito River, which had cobble-dominated substrate. Water temperatures were lower at *Bd*-positive sites (mean *Bd*+ = 20.0 ± 1.6 SE, N = 9; mean *Bd*- = 23.7 ± 0.5 SE, N = 40; p = 0.0102, t = 2.678). When riffles and runs are taken out of the analysis to compare water temperatures of pools only, the pattern of cooler temperatures at sites with *Bd*-positive animals remains significant (mean *Bd*+ = 20.2 ± 1.8 SE, N = 8; mean *Bd*- = 23.3 ± 0.8 SE, N = 13; p = 0.0475, t = 1.757). Stream width (range 0.5–4.5 m) and water depth (4–68 cm) did not differ between sites with *Bd*-positive and *Bd*-negative frogs (p = 0.7421, t = 0.3310; p = 0.4668, t = 0.7337, respectively).

Discussion.—I detected *Bd* in 18% of the *R. boylii* sampled, and in 5 of 9 streams in southern San Benito and western Fresno counties, California. The small sample size from some streams might explain lack of detection, given the relatively low prevalence rate across all sampled frogs. Interestingly, none of the streams sampled in September resulted in *Bd*-positive results even though one of these was known to have *Bd*-positive frogs in May. Other studies have shown that higher prevalence and mortality rates of *Bd* are detected in winter and early spring than in late summer and early fall (Berger et al. 2004; Kriger and Hero 2006, 2007). Streams in the present study were sampled during various months of the summer, and a seasonal effect may have confounded analyses. If a seasonal effect resulted in false negatives for frogs tested in September, then the pattern of *Bd* distribution in the study area and the overall prevalence rate described here could be underestimated.

I found that only *R. boylii* less than 41 mm SVL and weighing less than 4.0 g tested positive for *Bd*. Frogs of this size are young-of-the-year or sub-adults in their second post-metamorphic year (Stebbins 1962; Storer 1925; Zweifel 1955). These younger age classes had reduced body condition (as estimated by SVL-to-weight ratio) if they tested positive for *Bd*. No adults in this population tested positive for *Bd*, which might indicate a difference in *Bd* susceptibility between these life history stages. Desiccation and temperatures over 30ºC are known to be lethal to Bd (Daszak et al. 2000; Drew 2006; Johnson et al. 2003), and *R. boylii*, especially adults (pers. obs.), are known to bask on open

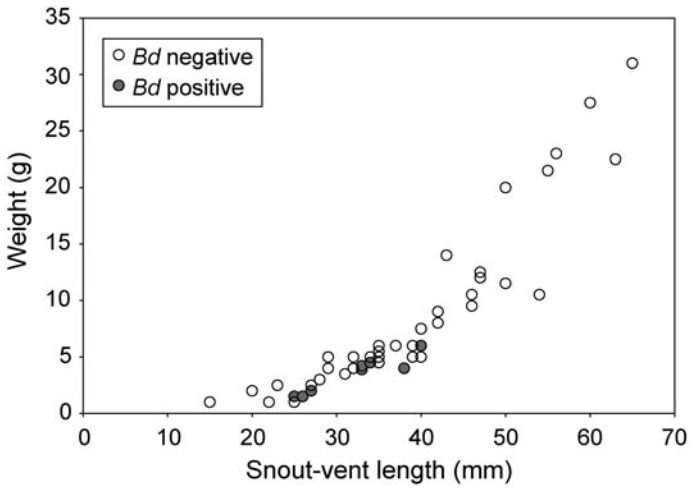


FIG. 2. Sizes of 48 *Rana boylii* tested for *Batrachochytrium dendrobatidis* (*Bd*) in California, USA. *Bd*-positive individuals (N = 8) are shown in black. One *Bd*-positive frog (33 mm SVL) was not weighed.

sunny stream banks with less than 20% canopy cover (Fuller and Lind 1992; Stebbins 1962). This behavior might prevent *Bd* from infecting *R. boylii* adults or help them to shed the fungus if infected, especially in the foothills of California where summer air temperatures commonly exceed 35ºC. Although, mortality of *Bd*-infected adults cannot be ruled out, no evidence for adult chytridiomycosis or mortality was seen in this study.

Pool habitats and cooler water temperatures were the only habitat variables that were significantly associated with the presence of *Bd*. Pools provide rearing habitat for *R. boylii* larvae, and in one study, *R. sierrae* larvae have been shown to transmit *Bd* to post-metamorphic frogs (Rachowicz and Vredenberg 2004). The preponderance of *Bd*-positive frogs sampled from pools where larvae tend to congregate appears to support Rachowicz's suggestion that larvae and thus their habitats might serve as reservoirs for the fungus. It is uncertain whether the finding that *Bd*-positive frogs were sampled from areas with cooler water temperatures than *Bd*-negative frogs has any biological significance because the difference in water temperatures between these groups was small (20ºC versus 24ºC respectively) and within *Bd*'s optimal growth range of 17–25ºC (Daszak et al. 2000; Piotrowski et al. 2004).

Populations of *R. boylii* appear to be stable in streams involved in this study (BLM, unpubl. data, 2005–2007). The fact that large populations of *R. boylii* are present in streams with *Bd*-infected animals without showing declines or symptoms of chytridiomycosis is encouraging. However, if *Bd* is causing reduced body condition in younger age classes, population sizes might eventually be affected. This study was conducted over only one year, with small sample sizes, and might have been confounded by seasonal effects. I suggest future sampling be temporally stratified across seasons and years, with greater sample sizes of frogs tested. Furthermore, population monitoring to determine the lethality of *Bd* on various life history stages, prevalence rates, and population-level effects in various streams over time is warranted given the sensitive status of the species and the effects the disease has had on its close relative *R. sierrae*.

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How Relevant is Opportunistic *Bd* Sampling: Are We Ready for the Big Picture?

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Understanding the distribution of chytridiomycosis, both at global and local scales, is important to controlling its impacts on host species (e.g., biocontrol or eradication) and to managing host amphibian populations (e.g., reintroduction and habitat management). In response to this, efforts to map observations of *Batrachochytrium dendrobatidis* (*Bd*) are underway to better understand its distribution and impact on amphibian populations (e.g., www.spatialepidemiology.net\Bd).

While there are many legitimate reasons to sample opportunistically for this pathogen, we question the validity of continuing this sort of exercise without a more cohesive and directed effort to apply the information to management of *Bd*. We use a recent example (Scalera et al. 2008) and some additional data from Denmark to discuss this question.

Scalera et al. (2008) published data from frogs (*Rana esculenta* [now *Pelophylax esculentus*], and *R. temporaria*) at sites in Denmark on the islands of Zealand (1 of 7 positive for *Bd*) and Fyn (1 of 4 positive for *Bd*). Two sites on the Jutland mainland of Denmark were negative according to Scalera et al. (2008) and a single positive record is known from the island of Bornholm, the most eastern portion of Denmark (www.spatialepidemiology.net). To these published data we add information from the island of Lolland where we tested 10 adult *R. esculenta* (three female and seven male) for *Bd* (sensu Berger et al. 2005). These animals were from a single pond in the backyard of a private residence on the outskirts of Nakskov (54.85°N, 11.01°E). Swabs were analyzed using PCR (Annis et al. 2004) at Pisces Molecular (Boulder, Colorado, USA) and *Bd* was detected on 0 of 10 animals.

Our data increase the range of sampling in Denmark to include four of six of the major islands (Zealand, Lolland, Fyn, and Bornholm). To date, there are no samples from Mon, Falster and the smaller islands of Als, Aero, and Langeland. The information reported here and by Scalera et al. (2008) is interesting because it is from a region lacking in data and provides the most northerly published records of this fungus in Europe (www.spatialepidemiology.net\Bd). However, there are serious constraints to these data.

Sampling in both reports (Scalera et al. [2008] and the present one) was ad hoc, sample sizes were low, and most sites yielded negative results. Scalera et al. (2008) tested a maximum of four adults or three juveniles per site. We tested 10 adults at one site. Skerratt et al. (2008) provides a good example of necessary sample sizes that contrast with those reported here and in many other reports (e.g., Zellmer et al. 2008, N = six per site; Adams et al. 2007, N = 2–17 per site). For example, if we assume perfect specificity of the PCR, and use an apparent prevalence ≥ 5%, 59 individuals must be sampled to be 95% certain of detecting *Bd* on at least one animal (Skerratt et al. 2008). This suggests that the sample sizes from locations in Denmark need to be at least six times greater to be confident in the negative reports. Alternatively, small sample sizes can be informative at high prevalence rates, but given reported sample sizes, prevalence rates would have to be 30% in our work, and at least 75% in the work by Scalera et al. (2008), to be 95% certain of detecting *Bd* on at least one animal. In populations that are not declining, we would expect the prevalence of *Bd*, if it is present, to be low in contrast to high values reported in amphibian communities where *Bd* is causing extinctions (e.g., 98% prevalence, Lips et al. 2006).

Clearly, neither the data presented by Scalera et al. (2008) nor our data are adequate to determine if the amphibian chytrid is absent from portions of Denmark. Additionally, these data cannot speak to the prevalence of the disease where it was detected (Skerratt et al. 2008). These reports beg the question, "What do we really know about the presence of the amphibian chytrid fungus in Denmark?" We submit that these reports tell us very little. Specifically, the information does not provide a clear direction or purpose for further testing because we are uncertain about the applicability (area of inference) and the degree of confidence we should attribute to the results. This hampers our ability to discuss the relationship of these data to other *Bd* occurrences in northern Europe, an exercise that has the potential to be relevant to at-risk amphibians in northern Europe and amphibian declines in general.

As observations of *Bd* are published and added to existing databases, it is tempting to try to interpret the "patterns" that begin to emerge which can be at best heuristic and at worst seriously misleading. Because of the well-known impact of chytridiomycosis on amphibians, the relative ease of sampling for the disease and the awareness level in the herpetological community, sampling and testing for *Bd* is often undertaken. Such opportunistic sampling is generally motivated by goals other than determining the distribution of *Bd* in a particular region or country. It can be quite useful to know whether *Bd* is present at a particular study site. For example, testing surrogate local amphibians or testing the environment for *Bd* (Kirshstein et al. 2007, Walker et al. 2007) is likely to be a critical element in translocation programs involving susceptible species (Walker et al. 2008). There is some utility to reporting the ad hoc testing of amphibians and locations for *Bd*, even when results are negative, especially when reports: 1) come from areas with no information at all; or 2) can be combined to present a picture of an area where a more concerted effort is unfunded or logistically difficult. Perhaps the real utility of these data lies in the archiving and mapping realm effectively implemented at www.spatialepidemiology.net\Bd.

On the other hand, we can argue that by continuing to report on isolated instances of positive and negative results, we are losing focus on the bigger issue of a single pathogen with global impacts. Two main issues surface, first, sample sizes are often low and ad hoc reports generally lack details on assay specificity, and laboratory and collection conditions. Second, much of the opportunistic sampling occurs in portions of the world where amphibians are already declining, the *Bd* "hot spots" of South and Central America and Australia. Are other locales being neglected because there is no globally coordinated sampling plan? Northern Europe is far

removed from typical *Bd* "hot spots" where species are highly impacted by this fungus and it is possible that declines in amphibian populations, caused or exacerbated by *Bd*, could go unnoticed in countries such as Denmark. While data exist on *Bd* for almost every biome in the world, including the temperate zone (e.g., Bosch et al. 2001 [Spain], Muths et al. 2003 [U.S.], Ouellet et al. 2005 [Canada]), there are information gaps where no scientists or funded projects exist, especially in regions where the perceived threat from *Bd* is low (i.e. northern regions).

There is no global amphibian authority to provide direction for coordinated sampling or to enforce collaboration, however, the Amphibian Conservation Action Plan (Gascon et al. 2007) calls specifically for more coordinated research into this disease. Perhaps an effort by the amphibian research community to follow a standard sampling plan is a first step. For example, Skerratt et al. (2008) have laid out a *Bd* sampling protocol using systematic sampling and taking into consideration time of year, accessibility, likelihood of infection, life stage, potential for pooling samples, and the specificity of the assay. This protocol was designed for the large land mass of Australia, but is applicable to any regional or country-wide effort in the rest of the world and offers the potential for a great deal of consistency in efforts to map and understand the distribution of *Bd*.

There is a significant challenge to moving ahead toward an understanding of the spatial epidemiology of chytridiomycosis and continued ad hoc additions to the existing databases are unlikely to yield answers. A systematic approach to building and testing hypotheses and bridging data gaps is necessary. Fortunately the substantial body of knowledge about the geographical distribution of this pathogen gained from coordinated regional efforts, as well as opportunistic sampling, provides the data necessary to develop such an approach.

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Seasonal Variation in the Detection of *Batrachochytrium dendrobatidis* in a Texas Population of Blanchard's Cricket Frog (*Acris crepitans blanchardi*)

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Blanchard's Cricket Frog (*Acris crepitans blanchardi*) is a small anuran with a broad distribution in North America (Conant and Collins 1998), and recently has been suggested for elevation to full species (Gamble et al. 2008). Cricket Frog populations are in decline throughout much of the northern portion of their range, although causes for these declines are unclear (Lannoo 2005). However, *A. c. blanchardi* is often the most abundant and conspicuous member of anuran breeding assemblages throughout much of the year in eastern and central Texas. Central Texas supports a particularly robust population, with Cricket Frogs found in virtually any natural or artificial aquatic environment, including ephemeral streams and pools, spring outflows, stock tanks, roadside ditches, and along riverbanks. At the eastern edge of the Edward's Plateau, *A. c. blanchardi* is sympatric with a number of endangered, threatened, or endemic amphibians including the Houston Toad (*Bufo* [*Anaxyrus*] *houstonensis*) (Hillis et al. 1984) and several species of plethodontid salamanders (*Eurycea nana*, *E. neotenes*, *E. pterophila*, *E. rathbuni*, *E. sosorum*) (Chippindale et al. 2000) each with increasing conservation concern in this rapidly developing region.

Amphibian populations are declining at an alarming rate world-

wide (Houlahan et al. 2000; Stuart et al. 2004), and infection by *Batrachochytrium dendrobatidis* (*Bd*) is frequently implicated as a factor in documented cases of population decline (Daszak et al. 1999; Daszak et al. 2000). *Bd* seems to be widespread in North America (Ouellet et al. 2005), and has been detected in both captive and wild populations of *A. c. blanchardi* in several states in the midwestern United States (Steiner and Lehtinen 2008; Zippel and Tabaka 2008). Detection of *Bd* on individuals of *A. c. blanchardi* was not restricted to regions with declining populations, and also not accompanied by any mortality or signs of chytridiomycosis (Steiner and Lehtinen 2008). Previous studies indicate that *Bd* can have variable effects on amphibian populations, with potential impacts ranging from no mortality to mass die-offs without recovery as the most extreme effects (Daszak et al. 1999; Daszak et al. 2003). The susceptibility of amphibians to *Bd*, however, can vary across species, developmental stage, and temperature regimes (Berger et al. 2004; Daszak et al. 2004; Davidson et al. 2003; Lamirande and Nichols 2002). In addition, seasonal variation in prevalence and severity of infection by *Bd* within individual populations has been noted (Bradley et al. 2002; Woodhams and Alford 2005; Kriger and Hero 2007), suggesting effects of environmental conditions on the severity of infection.

The purpose of this study was to determine the rate of infection by *Bd* within a population of *A. c. blanchardi* at the headwaters of Barton Creek, located ca. 11 km W of Dripping Springs and 30 km W of Austin, Texas (30.2248611°N, 98.1687306°W), adjacent to habitat for several endemic and endangered salamanders (Chippindale et al. 2000; Sweet 1982). We conducted a second sampling and subsequent analysis of frogs captured later in the season at the same site during times with higher mean temperature and lower water availability and we examined seasonality of the infection across a relatively narrow time scale.

Frog sampling was conducted on 18 May and on 18 July 2008. Weather data collected for the 30 days preceding sampling differed significantly between sampling events, with a mean temperature of 21.6 ± 0.6ºC and total precipitation of 57.1 mm for the May sampling date, and a mean temperature of 27.6 ± 0.4ºC and total precipitation of 18.8 mm for the July sampling date (Fig. 2). In May, the creek was flowing and several pools of considerable size (10 m^2–50 m^2) provided habitat for large numbers of cricket frogs. In July, sampling sites along the creek were virtually dry, with only a few predominantly mud-filled patches of habitat remaining. Frogs were much less abundant than in May, and two weeks after the July sampling frogs were completely absent from the sample site.

For the May sampling, which was part of a larger population genetics study of *Acris*, 30 frogs were captured by hand and uniquely marked using a series of toe clips (Hero 1989). These toes as well as toes from 27 individuals obtained in July were retained and stored in 95% EtOH until used for DNA extraction. DNA extracts were tested for the presence of *Bd* using a nested PCR approach that has shown high sensitivity of detection and is outlined in detail in Gaertner et al. (*in press*). This procedure uses primers ITS1f (5'-CTT GGT CAT TTA GAGC GAA GTA-3') and ITS4 (5'-TCC TCC GCT TAT TGA TAT GC-3') to amplify the 5.8S rRNA gene and the flanking internal transcribed spacers (ITS) within conserved regions of the 28S and 18S rRNA genes of all fungi (White et al. 1990). A portion of this reaction was then used as a template in a subsequent PCR using primer set Bd1a (5'-CAG TGT GCC ATA TGT CAC G-3') and Bd2a (5'-CAT GGT TCA TAT CTG TCC AG-3') (Annis et al. 2004) which amplified fragments of about 300 bp that included the 5.8S rRNA and flanking ITS regions of *Bd* (Annis et al. 2004). A *Bd*-positive DNA sample from a previous study (Gaertner et al., *in press*) and sterilized distilled water were used as positive and negative controls in all reactions, respectively.

Agarose gel electrophoresis (2% agarose in TAE buffer) (Sambrook et al. 1989) of the nested PCR revealed that 83% of the samples obtained in May were positive for *Bd*. None of the samples collected in July, however, tested positive for *Bd* even though the positive controls amplified. Individuals collected in July included one recapture (AD03, marked 3 using the method of Hero 1989) that tested positive for *Bd* in May. The clipped toe was almost fully healed and showed no evidence of regrowth. Additional toes were removed for the second *Bd* test, resulting in a new unique mark for this individual (8093; Hero 1989). In order to verify the detection of *Bd*, six randomly selected 300-bp-fragments were sequenced using the CEQ 8800 Quickstart Kit (5% DMSO added to the reaction mix) on a CEQ 8800 sequencer (Beckman Coulter, Fullerton, CA). These sequences (GenBank accession numbers FJ373880–FJ373885) were validated against the GenBank/EMBL databases using BLASTn (Pearson and Lipman 1988) and were identical to the published sequence of the 5.8S rRNA gene, and virtually identical to the published flanking ITS regions of *Bd* (AY997031). These data demonstrate *Bd* infection of large numbers of individuals of *A. c. blanchardi* in late spring (May), and absence of infection in the same population including a previously positive recapture in summer (July). Because sampling times differed with respect to basic environmental conditions (temperature and water availability), the data suggest seasonal effects of environmental conditions on the infection of *A. c. blanchardi* by *Bd*.

Seasonal variation in the prevalence of disease is not uncommon, as documented for several diseases of both humans and wildlife (Hosseini et al. 2004; Kriger and Hero 2007; Pascual and Dobson 2005). For *Bd,* significantly higher detection rates have been reported in winter than in summer (McDonald et al. 2005; Ouellet et al. 2005; Retallick et al. 2004). Kriger and Hero (2007) detected *Bd* infection in a population of stony creek frogs (*Litoria wilcoxii*) in up to 60% of samples collected in winter and spring, but at much lower rate (0–13%) in summer for the same population. As in our study, *L. wilcoxii* that were positive for *Bd* initially were shown to be negative for this pathogen upon subsequent recapture (Kriger and Hero 2006).

The effects of temperature on *Bd* are well documented in laboratory studies. *Bd* can grow *in vitro* in the lab from 6–28ºC, with an optimum at 23ºC (Longcore et al. 1999). Frogs in laboratory studies have shown large differences in susceptibility to the fungus as a function of temperature, with the highest mortalities occurring at 23ºC and with decreasing pathogenicity at higher temperatures (Berger et al. 2004; Lamirande and Nichols 2002). Infected frogs could be cured of *Bd* in the laboratory at temperatures above 32ºC (Johnson et al. 2003; Woodhams et al. 2003). The laboratory results suggest that the disappearance of *Bd* from the *A. c. blanchardi* population in the headwaters of Barton Creek during the season could very well be a function of increasing temperatures. However, currently we have no direct evidence for a causal relationship between the disappearance of *Bd* and higher temperature. Other seasonally variable environmental conditions such as microhabitat

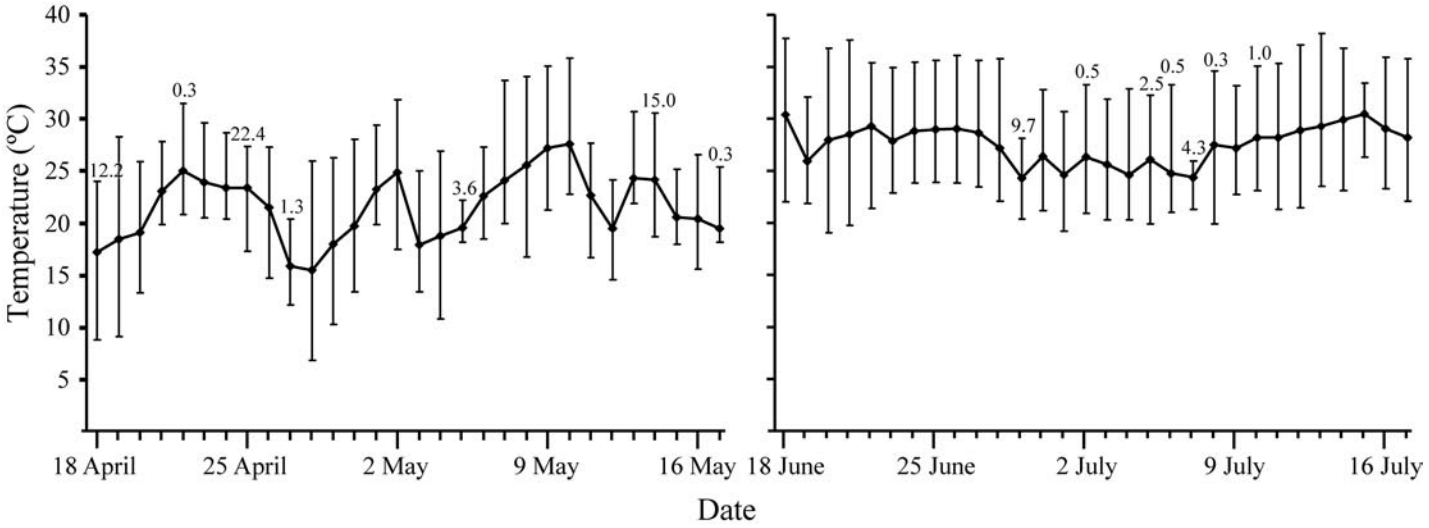


FIG. 1. Average temperature for each day with error bars showing the minimum and maximum daily temperatures for the 30 days preceding each sampling event (18 May and 18 July 2008) at the headwaters of Barton Creek near Dripping Springs, Texas, USA. Numbers adjacent to error bars depict total daily precipitation in millimeters.

temperature differences, relative humidity, and precipitation/water availability are closely related to temperature, and synergistic effects of these factors are difficult to quantify.

Although it is well known that *Bd* is spread via aquatic zoospores and prefers moist environments (Longcore et al. 1999; Ron 2005), a significant inverse relationship between precipitation and prevalence of *Bd* has been found (Kriger and Hero 2007). These authors acknowledge that this finding is counterintuitive to the life history of this pathogen, and suggest that this negative relationship may be an artifact of seasonal weather patterns in southeastern Queensland, Australia (warm wet summers, cool dry winters), with a positive relationship between precipitation and *Bd* infection being more the global norm. Our results support the latter hypothesis, in that *Bd* detection was 0% in the samples collected during drier conditions.

The overall pattern in *Bd* detection with respect to temperature is the same in our study as has been found in previous work in wild amphibian populations (e.g., Kriger and Hero 2007; decreasing prevalence of infection with increasing temperature). However, the mean 30-day temperature for our May sampling date (21.6ºC) was within the range of highest 30-day mean temperatures recorded in Kriger and Hero (2007). These authors found that *Bd* prevalence ranged from 0–13.3% when temperatures ranged from 19.5–22.2ºC, a temperature range that our data suggest could be optimal for infection in central Texas. This lack of concordance emphasizes the need for studies that carefully consider multiple environmental variables in examining seasonal variation in *Bd* prevalence within populations.

Our findings indicate that high temperature, drying of aquatic habitats, or an interaction between these factors may reduce *Bd* prevalence in semi-aquatic amphibians to very low levels in ecosystems characterized by hot, dry summers and/or ephemeral water sources. The diurnally active *A. c. blanchardi* sampled in this study may have been exposed to temperatures in excess of 30ºC (Fig. 2), approaching the thermal range known to cure *Bd* in laboratory studies (Johnson et al. 2003). This hypothesis might explain the decline of populations of *A. c. blanchardi* in the northern parts of the range where populations experience temperatures that are amenable to *Bd* for a much larger part of the year than further south where infections may be regularly cleared by higher temperatures and the lack of water which have both been suggested to limit the distribution of *Bd* (Skerratt et al. 2008).

Further research is necessary to determine whether the sharp declines in *Bd* prevalence observed in cricket frogs are mirrored in the entirely aquatic plethodontid salamanders that occur in the region, and thereby the utility of these frogs as a proxy or indicator of *Bd* in central Texas aquatic ecosystems.

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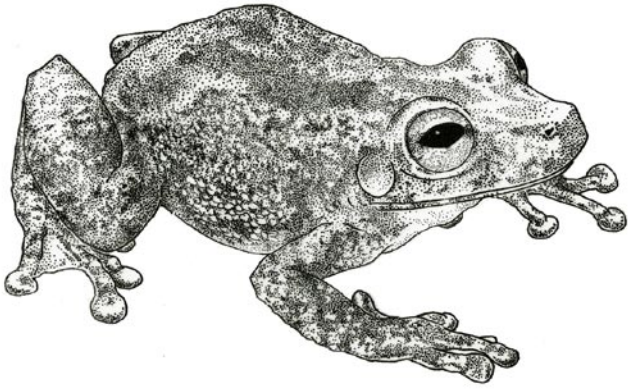
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Hybsiboas crepitans. Colombia: Department of Casanare: Orocue. Illustration by Fernando Vargas Salinas based on a picture by Luis Alberto Rueda & Fernando Vargas S.

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The Chytrid Fungus in the Red Salamander, *Pseudotriton ruber*, in South Carolina, USA

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The chytrid fungus, *Batrachochytrium dendrobatidis* (*Bd*), has been implicated in mass mortality, population declines, and apparent extinctions of anuran amphibians worldwide (Berger et al. 1998). To date, this pathogen has been detected in 233 of 422 (55%) anuran species in 17 of 25 families and 24 of 36 (67%) of caudate species in 5 of 5 families (Olson and Ronnenberg 2008). In South Carolina, USA, *Bd* has been detected in anurans at three locations (Daszak et al. 2005; Rothermel et al. 2008). Speare and Berger (2004) reported *Bd* in the Red Salamander, *Pseudotriton ruber*, in South Carolina from a personal communication (Donald K. Nichols, National Zoological Park, Washington D.C.). However, that record was listed erroneously under Salamandridae, and the specific region within South Carolina was not indicated. Herein, I report the details of the case and its significance.

On 12 March 2002, a female *Pseudotriton ruber* was collected while crossing SC Route 130, ca. 6.6 road km N of SC Route 11 (34.94606°N, 83.01564°W), Oconee County, South Carolina, USA. The salamander was returned to the laboratory and maintained alone in a plastic shoebox with paper towels and ca. 2.5 cm of water. The salamander was not fed, but weekly water changes were made. On 13 April 2002, multiple molts were noticed in the container. Unlike the shed skins of healthy salamanders that are a translucent white in color, these sheds were dark black. On 20 April, another water change was made, and again, at least one black molt was found. The salamander was inspected daily from 20–24 April, and continued to produce black molts. On 24 April it was found dead and was immediately preserved in 70% ethanol.

After consulting my laboratory notes, I found a second specimen of *P. ruber*, a small metamorph from near Oconee Station Falls (Station Cove Falls) (34.84933°N, 83.08531°W), Oconee County, South Carolina, that had displayed similar symptoms, e.g., frequent ecdysis in which the molts were dark in color. This specimen had been collected on 10 Sept 2001 and was euthanized and preserved on 24 Nov 2001.

On 8 May 2002, both specimens were sent to pathologist Donald K. Nichols at the National Zoological Park, Washington, DC, for histological examination. On 14 June 2002, I received word from Dr. Nichols concerning the two specimens. The small metamorph had scattered areas of mild inflammation of its epidermis, but there was no evidence of chytrid fungus. Samples of skin and internal organs had been taken from the large female. According to Nichols, there was nothing remarkable about the internal organs, but the epidermis had hyperkeratosis with an abundance of chytrid thalli. The case histories of two other *P. ruber* collected by me in adjacent Pickens County, South Carolina, suggested infection with chytrid fungus. However, the two specimens were not available for histological examination.

The Southern Appalachian region has long been recognized for its high salamander biodiversity (Bruce et al. 2000; Hairston 1949). To my knowledge, this is the first published report of chytridiomycosis in *Pseudotriton ruber* and represents the second caudate species known to be infected with this fungal pathogen from the Blue Ridge Physiographic Province of the Southern Appalachian Mountains. Rothermel et al. (2008) previously reported *Bd* in *Notophthalmus viridescens* from the Upper Tallulah River, in northern Georgia. The authors also sampled *Plethodon metcalfi* and *Desmognathus monticola* from near the Highlands Biological Station in western North Carolina; the two species tested negative for *Bd*. Additionally, Timpe et al. (2008) surveyed 19 frogs and 28 salamanders (including *P. ruber*) from five physiographic regions in Georgia; *R. clamitans, R. palustris*, and *R. sphenocephala* and *Desmognathus conanti* tested positive for *Bd*, but none of the positive sites were in the Blue Ridge Physiographic Province. My collection site for *P. ruber* is situated near the Jim Timmerman Natural Resources Area; the property is managed by the state of South Carolina and supports a diverse amphibian fauna (Montanucci 2006). The positive finding of *Bd* in *P. ruber* emphasizes the need to initiate a comprehensive survey of all amphibian species in the region for chytridiomycosis.

Acknowledgments.—I am grateful to Donald K. Nichols for histological examination of the two *P. ruber* specimens. Corey Roelke and Barbara Foster helped with field collecting. H. Lee Mitchell, South Carolina Dept. of Natural Resources, Clemson Office, provided the GPS information. I also thank Dede Olson for assistance with the manuscript preparation.

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First Reported Detection of *Batrachochytrium dendrobatidis* in Florida, USA

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The fungal pathogen *Batrachochytrium dendrobatidis* (*Bd*) has been linked to amphibian population declines around the world (Daszak et al. 2003; Ron 2005). Within the United States, *Bd* appears to have high prevalence in western states and in the northeast (Longcore et al. 2007; Schlaepfer et al. 2007). Infected anurans also have been found throughout the southeast, but, to my knowledge, not as of yet, in Florida (Green and Dodd 2007; Peterson et al. 2007; C.K. Dodd, Jr., pers. comm.). Ecological niche modeling demonstrated high suitability for *Bd* in Florida, and very high suitability along the Lake Wales Ridge in central Florida (Ron 2005). Here, I report the results of surveys of 7 amphibian species on Walt Disney World's Wildlife Management and Conservation Area (WMCA).

The WMCA is a network of primarily forested wetlands with interspersed upland spanning 3380 ha in Orange and Osceola counties designed as a buffer area for Reedy Creek and managed by the Reedy Creek Improvement District (Fig. 1). The Reedy Creek basin includes a significant portion of the headwaters of the Kissimmee River. Sampling for this study was restricted to the northern portion of the WMCA, centered approximately at 28.39929703°N, 81.60801927°W. Amphibians were captured using plywood coverboards, minnow traps, and during incidental encounters. Seventeen coverboard arrays were placed 500 m apart with each array checked once a month. Ten minnow traps were placed in canals, marsh, and a pond for 3 days each month. Clean disposable gloves were worn when handling each animal. Live amphibians were swabbed along the ventral surface and legs 25 times with cotton-tipped swabs (Puritan, Guilford, Maine). Swab tips were stored at room temperature in 2-ml screw cap microcentrifuge tubes (Fisher #02-681-343) containing 1 ml of 70% ethanol. Because optimal pathogen growth in culture occurs at 23ºC (Daszak et al. 2003), sample collection was restricted to cooler months in Florida, November 2007–April 2008, to increase the probability of *Bd* detection, if present. Maximum daily temperature during sample days ranged from 17.8–29.4°C. Samples were sent in May 2008 to Pisces Molecular (J. Wood, Boulder, Colorado, USA) for analysis using a polymerase chain reaction to detect *Bd* presence (Annis et al. 2004).

Two additional samples were included in the analysis. One dead American Bullfrog tadpole (*Lithobates catesbeianus*, formerly *Rana catesbeiana*) was found in a minnow trap. The keratinized region around the mouth was submitted for analysis. An adult bullfrog (non-collection animal) was found in an exhibit within Disney's Animal Kingdom® Theme Park. It had abrasions on its snout and was brought to the veterinary hospital for treatment, where a swab sample was collected. The cause of the abrasions was unknown. The snout was medicated with Nolvasan® solution and the frog was released where it was found. None of the animals in this study exhibited clinical signs of infection by *Bd*.



FIG 1. Location of Walt Disney World Wildlife Management and Conservation Area, Florida, USA, where amphibians were sampled for presence of *Batrachochytrium dendrobatidis* (*Bd*). Dashed box indicates study area. *Bd*-positive sample locations are indicated by an X.

Although a representative sampling of all amphibian species was desired, samples were biased heavily towards Greenhouse Frogs (*Eleutherodactylus planirostris*) because they were the most abundant species underneath coverboards. Eighty-one samples

TABLE 1. Prevalence (no. animals testing positive/total sampled) of *Batrachochytrium dendrobatidis* in amphibians in Walt Disney World's Wildlife Management and Conservation Area, Florida, USA. Number of sites sampled indicates the number of coverboard and/or trap locations where species were encountered.

Species	No. sites sampled	Prevalence
Florida Cricket Frog (*Acris gryllus dorsalis*)	1	1/5
Southern Toad (*Anaxyrus terrestris*, formerly *Bufo*)	4	0/7
Greenhouse Frog (*Eleutherodactylus planirostris*)	10	0/59
Green Treefrog (*Hyla cinerea*)	2	0/6
Cuban Treefrog (*Osteopilus septentrionalis*)	1	0/1
American Bullfrog (*Lithobates catesbeianus*)	2	1/2
Two-toed Amphiuma (*Amphiuma means*)	1	0/1

from 7 species were submitted for analysis (Table 1). *Bd* was detected in the adult bullfrog found within Disney's Animal Kingdom® and one Florida Cricket Frog (*Acris gryllus dorsalis*) in the WMCA. This appears to be first detection of *Bd* in Florida. Due to small sample sizes and potentially low Bd prevalence rates, it is premature to rule out the presence of *Bd* in these other species.

This study has documented the occurrence of *Bd* in central Florida. *Bd* was not detected in northern Florida, despite extensive sampling (C. K. Dodd, Jr., pers. comm.), and few samples have been tested elsewhere in the state (D. Green, pers. comm.). *Bd* does not appear to have had a negative impact on the amphibian population in the central Florida region as evidenced by apparently stable populations and no observed die-offs. Bullfrogs are a likely carrier of *Bd* because they show resistance to infection, and may be important in the spread of the pathogen (Daszak et al. 2004). Bullfrogs are abundant in Florida; therefore, the presence of *Bd* in Florida is not unexpected.

Audio recordings suggest there are hundreds of Florida cricket frogs occupying the pond where the positive sample was found. With a small sample size, it is not known whether this is another species that is effectively resistant to infection by *Bd* (Woodhams et al. 2007); more testing is required. An alternative explanation is that this was an early detection within the population, because Northern Cricket Frogs (*A. crepitans*) and Blanchard's Cricket Frogs (*A.c. blanchardi*) are susceptible to infection (Pessier et al. 1999; Steiner and Lehtinen 2008; Zippel and Tabaka 2008). Monitoring of cricket frogs and species not yet tested at this site will continue. Continued monitoring for the presence of *Bd* in Florida is recommended. As most waters in Florida flow south towards the Everglades, monitoring for the presence of this disease in biologically-rich south Florida should be a priority, given its occurrence in central Florida and also in Cuba (Díaz et al. 2007).

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Detection of *Batrachochytrium dendrobatidis* in Amphibians from the Forest Floor to the Upper Canopy of an Ecuadorian Amazon Lowland Rainforest

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During the last two decades significant declines and extinctions of amphibians have been observed worldwide (Blaustein and Wake 1995; Houlahan et al. 2000; Stuart et al. 2004). The Neotropics are among the most impacted areas, with sudden losses of anuran species noticed during the 1980s in Costa Rica, Ecuador and Venezuela (Pounds and Crump 1994; Pounds et al. 1997; Young et al. 2001; Ron et al. 2003). Population declines and losses have been more significant at high elevation (above 1000 m) with one study showing all species of *Atelopus* with sufficient data (N = 28) declining and 75% disappearing (La Marca et al. 2005). A serious contributor to amphibian declines worldwide is the fungus *Batrachochytrium dendrobatidis* (*Bd*), which was present in the Neotropics before declines were noticed in the 1980's (Berger et al. 1999; Speare and Berger 2000; Bosch et al. 2001; Bradley et al. 2002; Lips et al. 2005; Ron and Merino 2000). *Bd* is now implicated as one of the causes of the extinction of several species of anurans from these regions (Ron et al. 2003; La Marca et al. 2005; Merino-Viteri et al. 2005). While *Bd* has been detected in amphibians from many high elevation sites in the Neotropics (e.g., Ron and Merino 2000; Young et al. 2001; Lips et al. 2003),

low elevation sites in the Neotropics have received comparatively little attention and thus reports on the detection of *Bd* at these sites are less common (Puschendorf et al. 2006; Oliveira de Queiroz Carnaval et al. 2006).

The aim of this study was therefore to examine the occurrence of *Bd* in amphibian species of a Neotropical lowland rainforest, i.e., at sites in the Upper Amazon Basin of eastern Ecuador at low elevation (about 200 m). This study included analyses of amphibians occupying ecological niches above the forest floor and shrub layers, specifically the mid- to upper canopy, because the upper strata of Amazonian rainforests plays an integral role in ecosystem function and data are missing for the interaction of *Bd* with amphibians in this important microhabitat.

Methods.—Samples were collected from sites surrounding Tiputini Biodiversity Station – Universidad San Francisco de Quito (0.6384694°S, -76.1490806°W, 217 m elev.), at the border of Yasuni National Park in the eastern lowlands of Ecuador (Fig. 1) during May–August of 2004 and 2006. The vegetation of the region has been defined as Amazonian Evergreen Lowland Forest, where annual rainfall averages 2425–3145 mm, temperature averages 25°C (range is 15°–38°C), and average humidity is 88% (Balslev et al. 1987; Blandin Landívar 1976; Duellman 1978). This area is part of the Napo refugium, a subset of the Amazonian system, and it is likely to represent some of the oldest undisturbed forests and greatest biodiversity in the system (Prance 1982). Amphibians from the forest floor and shrub layer were collected near the banks of the Rio Tiputini at elevations between 190–250 m during visual encounter surveys. Amphibians occupying higher strata were collected during bromeliad patch sampling following the procedure outlined by McCracken and Forstner (2008).



FIG. 1. Schematic presentation of the sampling site within the Yasuni National Park near Tiputini Biodiversity Station (TBS) – Universidad San Francisco de Quito, in the Upper Amazon Basin of eastern Ecuador used for collection of amphibians to be tested for infection by *Batrachochytrium dendrobatidis*.

Toe clips and skin from thigh muscle samples were used to test for the presence of *Bd* (Table 1). Samples were grouped into three categories (fossorial/forest floor, shrub/sub-canopy, and upper canopy) along the vertical axis based on historical and current collection locations for each species tested. Species placed in the fossorial/forest floor category are those which utilize subterranean habitat such as burrows and holes or typically occur amongst the forest floor leaf litter. Thirty-six individuals of 15 species in the order Anura were tested from the fossorial/forest floor category. The second category contains species which occupy the forest understory (shrub/sub-canopy). Whereas some of these amphibians may occasionally be found on the forest floor, they are most commonly found on low vegetation (< 2 m); a few animals which were tested and placed in this category have been found up to 4 m. Twenty-nine individuals of 12 species in the orders Anura and Caudata were tested from the shrub/sub-canopy category. The final category contains species found in the upper canopy occupying tank bromeliad habitat above 4 m (4–38 m). Twenty-one individuals of 4 species in the order Anura were tested from the upper canopy layer.

Water temperature was collected in three tank bromeliads of the species *Aechmea zebrina* located in the upper canopy of an emergent tree, *Parkia multijuga*, at 32, 34, and 35.5 m vertical height and within 2 m horizontal distance from the tree bole. One Thermochon iButton (model DS1922L) temperature logger was placed in an outer leaf bract of each bromeliad a minimum of 8 cm below the water level. Data loggers were set to collect water temperature every 30 minutes (35.5 m) and every 60 minutes (32 m, 34 m) at a resolution of 0.5°C with an accuracy of ±1°C from -30°C to +70°C. Duration of total data collection varied from 43 to 142 days from 31 March 2008 to 24 August 2008. Water pH was taken during bromeliad patch sampling according to McCracken and Forstner (2008) for five *A. zebrina* in each of 18 trees for a total of 90 bromeliads during field seasons in 2006 and 2008. An Oakton pHTestr 30 was used to collect water pH at a resolution of 0.01 pH with an accuracy of ±0.01 pH; a three-point calibration was performed before each tree sampled.

A nested PCR approach that has shown increased sensitivity of detection in samples with low template numbers and is outlined in detail in Gaertner et al. (*in press*) was used for detection of *Bd*. This approach used primers ITS1f (5'CTT GGT CAT TTA GAGC GAA GTA-3') and ITS4 (5'TCC TCC GCT TAT TGA TAT GC-3') targeting conserved regions of the 28S and 18S rRNA to amplify the 5.8S rRNA gene and the flanking internal transcribed spacer (ITS) of all fungi (White et al. 1990). PCR products from this reaction were purified and then used as a template for the subsequent PCR reaction using the *Bd*-specific primer set Bd1a (5'CAG TGT GCC ATA TGT CAC G-3') and Bd2a (5'CAT GGT TCA TAT CTG TCC AG-3') (Annis et al. 2004). The product from this reaction was examined by gel electrophoresis (2% agarose in TAE buffer) (Sambrook et al. 1989) for a fragment of approximately 300 bp (Annis et al. 2004). DNA from a sample positive for *Bd* from a previous study (Gaertner et al., *in press*) and sterilized distilled water were used as positive and negative controls, respectively. PCR products from samples showing the 300 bp amplicons were then sequenced using the CEQ 8800 Quickstart Kit with the addition of 5% DMSO to the reaction mix on a CEQ 8800 sequencer (Beckman Coulter, Fullerton, California). The sequences were

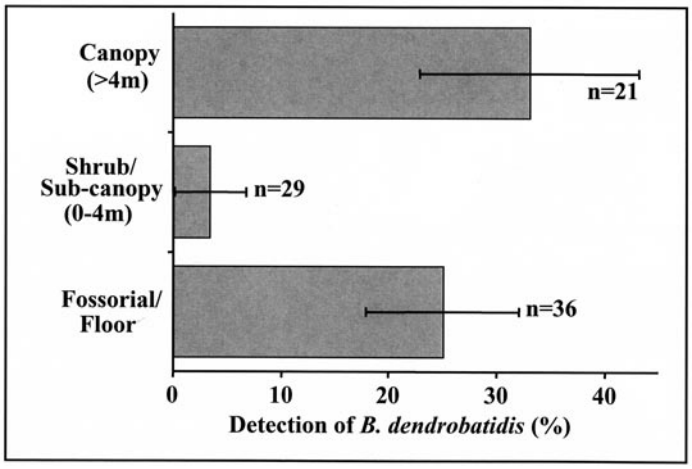


FIG. 2. Detection of *Batrachochytrium dendrobatidis* (% ± 95% confidence intervals, calculated in Microsoft Office Excel) in samples from amphibians collected within the Yasuni National Park, Ecuador, at three different vertical strata groups (fossorial/floor; shrub/sub-canopy, 0–4 m; and canopy, > 4 m).

validated against the GenBank/EMBL databases using BLASTn (Pearson and Lipman 1988).

Results.—Eighty-six amphibians of two orders (Anura N = 84, and Caudata N = 2) belonging to 7 families and 31 species were screened (Table 1) using nested PCR analysis (Gaertner et al., *in press*). Of those tested, 17 individuals (20%) representing eight species were positive for *Bd*. *Bd* was detected from within each of the strata, with the fossorial/floor group consisting of nine positive from 36 individuals tested (25%), shrub/sub-canopy group consisting of one positive from 29 tested (3%), and the canopy group consisting of seven positive of 21 tested (33%) (Fig. 2). Comparative sequence analysis of all 17 amplicons retrieved from PCR amplification with existing sequences of *Bd* available in GenBank/EMBL databases confirmed the detection of *Bd*. All sequences exhibited more than 99% similarity, with all sequences of the 5.8S rRNA gene being identical to the published sequence of *Bd* (AY997031), and those of seven amplicons displaying small differences in the ITS regions (Table 2).

Water temperatures recorded inside *A. zebrina* bromeliads at 32 m were 20.5–30.5°C (23.8 ± 1.9 [$\bar{x}$ ± SD], N = 1369), at 34 m they were 20.0–31.0°C (24.1 ± 1.9, N = 3422), and at 35.5 m were 20.5–32.5°C (24.5 ± 2.5, N = 2017). The mean pH recorded was 4.48 ± 0.67 (N = 90).

Discussion.—The presence of *Bd* was demonstrated in amphibians of the Upper Amazon Basin of eastern Ecuador. *Bd* has been detected from several high altitude sites in the Neotropics (Lips et al. 2003; Ron and Merino 2000; Young et al. 2001), however, detections at low elevation sites are less common (Oliveira de Queiroz Carnaval et al. 2006). Our results have shown that *Bd* is present in Amazonian lowland rainforests at elevations less than 300 m. This finding is significant because even though amphibian declines are not as prevalent at low elevations (Oliveira de Queiroz Carnaval et al. 2006; Puschendorf et al. 2006), *Bd* is present and could be contributing to declines. Amphibians may also be serving as a reservoir for *Bd* which could then move to and infect amphibians at higher elevation sites.

Another important finding of this study is the demonstration of clinical signs of chytridiomycosis and a positive detection for *Bd* by one individual (*Leptodactylus pentadactylus*) included in the study. In laboratory experiments, *Bd* grew best and was most lethal under cool (22ºC), moist conditions (Piotrowski et al. 2004; Woodhams et al. 2003) suggesting that montane species should be the most likely candidates for declines. This scenario is certainly supported by studies in the area with one study failing to find even a single apparently healthy population of *Atelopus* at elevations above 1000 m (La Marca et al. 2005). Despite the apparent virulence of *Bd* at high elevation sites, there are very few accounts of population declines caused by *Bd* infection at low elevations. The discovery of *L. pentadactylus* at this elevation showing clinical signs suggests that *Bd* might play a more important role in lowland declines than previously thought.

TABLE 1. Amphibian species collected from three vegetation strata (canopy, shrub/sub-canopy, fossorial/floor) in Yasuni National Park, Ecuador, and analyzed for *Batrachochytrium dendrobatidis* (*Bd*).

Amphibian species	Number of samples analyzed	Number of *Bd*-positive samples
Canopy		
Hypsiboas boans	1	0
Osteocephalus taurinus	4	0
Pristimantis aureolineatus	7	4
Pristimantis waoranii	9	3
Total	21	7
Shrub/sub-canopy		
Dendropsophus parviceps	2	0
Hypsiboas cinerascens	1	0
Hypsiboas geographicus	1	0
Hypsiboas lanciformis	2	0
Osteocephalus planiceps	2	0
Scinax cruentommus	2	0
Scinax ruber	1	0
Pristimantis acuminatus	3	0
Pristimantis altamazonicus	6	0
Pristimantis ockendeni	6	1
Pristimantis peruvianus	1	0
Bolitoglossa equatoriana	2	0
Total	29	1
Fossorial/floor		
Rhinella margaritifera	2	0
Rhinella marina	2	0
Engystomops petersi	6	1
Leptodactylus andrea	1	0
Leptodactylus discodactylus	5	2
Leptodactylus hylaedactyla	1	0
Leptodactylus pentadactylus	5	4
Leptodactylus rhodomystax	1	1
Leptodactylus wagneri	1	0
Chiasmocleis bassleri	3	0
Oreobates quixensis	2	0
Pristimantis lanthanites	1	1
Pristimantis malkini	2	0
Strabomantis sulcatus	2	0
Total	36	9

TABLE 2. Base pair differences of sequences generated from nested PCR reactions of samples collected from Yasuni National Park, Ecuador, using existing GenBank entry AY997031 for reference positions.

Accession Number	Difference
FJ232005	1 bp insertion at base 68 (A)
FJ232006	1 bp insertion at base 68 (A), deletion of positions 80–86
FJ232007	1 bp insertion at base 68 (A)
FJ232009	SNP at position 47 (G to T)
FJ232019	deletion of positions 13–20, SNP at position 55 (T to A)
FJ232020	deletion of positions 36–39, SNP at position 51 (A to G)
FJ232021	deletion of positions 31–33

All previous studies on *Bd* have used amphibians caught at or near ground level. This allows for testing of only the portion of amphibians contained in the lower strata of a structurally complex system. We detected *Bd* on amphibians inhabiting all strata of the forest which demonstrates that searches not including vertical strata may be lacking important data on the system. Furthermore, we found evidence that the occurrence of *Bd* infection on amphibians along a vertical axis is non-random in this system. Infection by *Bd* was found to be significantly higher in the fossorial/floor and canopy groups, showing 25% and 33% of individuals infected, respectively, than in the shrub/sub-canopy group with only one individual (3%) infected. Each of the strata of the rainforest has unique microclimate characteristics that could potentially affect *Bd* infections. In this case the availability of water may play a role in the prevalence of infection in each of the groups. Amphibians of the fossorial/floor group have water available in the form of streams and standing pools and the canopy group has access to water captured in phytotelmata, primarily tank bromeliads. Because *Bd* is transmitted via aquatic zoospores (Longcore et al. 1999), the absence of an abundance of standing water available to amphibians of the shrub/sub-canopy group may be reducing their exposure to the fungus. Previous studies have demonstrated that environmental conditions at the landscape level can have strong effects on host-pathogen dynamics (Woodhams et al. 2006), and future studies should include the investigation of interactions of *Bd* with environmental conditions, including water availability, on both the landscape and microhabitat level.

Environmental parameters for *Bd* have been found to have a significant influence on its pathogenicity (Andre et al. 2008; Piotrowski et al. 2004). Piotrowski et al. (2004) found isolates of *Bd* to grow and reproduce (in culture) between 4–25ºC and pH 4–8. Optimal growth of *Bd* zoospores occurred at temperatures of 17–25ºC and pH 6–7 (Piotrowski et al. 2004). Mortality rates in studies of *Bd*-infected frogs exposed to ambient temperatures of 17–25ºC have been >50%, although several studies show increased survival and decreased infection rates with temperatures >22ºC (Andre et al. 2008; Berger et al. 2004; Carey et al. 2006; Kriger and Hero 2007; Woodhams et al. 2003). Exposure to temperatures >25ºC has been shown to kill *Bd* zoospores and cure infected frogs (Berger et al. 2004; Kriger and Hero 2006; Piotrowski et al. 2004; Woodhams et al. 2003). While *Bd* prefers a near neutral pH, swimming zoospores were found in cultures at pH 4 and a temperature of 23ºC for 14 days (Piotrowski et al. 2004).

In our study, basic environmental water parameters collected from *A. zebrina* tank bromeliads indicate optimal temperature conditions for the persistence of *Bd* in the canopy. While pH levels were lower than previously reported as optimal conditions in fungal culture experiments, it remains unclear what effect this has *in situ*. *Pristimantis aureolineatus* and *P. waoranii* are known permanent inhabitants of *A. zebrina* bromeliads and with 44% of those individuals screened in this study testing positive it seems evident that *Bd* is present in canopy phytotelmata. However, definite proof of this assumption requires detection of *Bd* directly in water of the bromeliads. Many other species of anurans utilize bromeliad habitat for egg and tadpole deposition sites and may act as a reservoir for transferring the pathogen between sites. Several species of Dendrobatidae are of particular concern since they transfer tadpoles from terrestrial deposition sites to bromeliads in the canopy for final development. This broad traverse of habitats may facilitate the movement of *Bd* between terrestrial and canopy water sources, additional studies are needed to track potential movement of *Bd* along the vertical axis.

Four ecological traits are commonly associated with amphibian populations in decline including: aquatic mode of life, occurrence at mid to high altitudes, low fecundity and endemic distribution (Laurance et al. 1996; Lips 1998; Lips et al. 2003; Williams and Hero 1998). The observation of clinical signs of chytridiomycosis at a low elevation site and the characteristics of microhabitat utilized by permanent canopy anuran inhabitants infected by *Bd* demonstrate that the threat of chytridiomycosis may still be significant at sites even in the absence of those traits.

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NATURAL HISTORY NOTES

Instructions for contributors to Natural History Notes appear in Volume 40, Number 1 (March 2009, p. 66) and also are available online at: http://www.ssarherps.org/pages/HRinfo.php

CAUDATA — SALAMANDERS

AMBYSTOMA MACULATUM (Spotted Salamander). **OCCURRENCE.** *Ambystoma maculatum* is a wide ranging mole salamander found from Nova Scotia and southern Ontario through Georgia and eastern Texas (Conant and Collins 1998. Reptiles and Amphibians of Eastern/Central North America, 3rd ed., expanded. Houghton Mifflin, Boston, Massachusetts. 616 pp.). It is most commonly associated with lowland wetlands (Thompson and Gates 1982. Oikos 38:273–279.). In the 75+ years of ecological research at Mountain Lake Biological Station (MLBS, Salt Pond Mountain, Giles County, Virginia, USA, 37.37485°N, 80.52413°W, NAD 83; 1160 m elev.), this species has never been recorded (H. Wilbur and J. Murray, pers. comm.). Herpetological research over the last 20 years has included regular sampling of amphibian breeding locations; therefore, presence of this species without detection during the past two decades is highly unlikely.

A single adult male *A. maculatum* was captured at a drift fence surrounding Horton Pond on MLBS property on 6 April 2008 (mass = 16.31 g). It was captured exiting the pond on 12 April 2008. The drift fence was opened in May 2005 and has been run from March–October each year since. The 2007–2008 winter was mild in southwestern Virginia and this first capture *of A. maculatum* at MLBS might indicate that changes in weather conditions could make upper elevation ponds more conducive for this species. Observations such as these are important as researchers study the effects of climate change on the abundance and distribution of species.

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CRYPTOBRANCHUS ALLEGANIENSIS ALLEGANIENSIS (Eastern Hellbender). **MULTIPLE CLUTCHES.** *Cryptobranchus alleganiensis alleganiensis* are unique in that unlike most salamanders, fertilization occurs externally, with males defending the nest until the eggs are hatched (Petranka 1998. The Salamanders of the United States and Canada. Smithsonian Inst. Press. Washington, DC. 587 pp.). Males typically establish nesting sites under large, flattened rocks and a female will enter the chamber to expel her eggs (Alexander 1927. Buffalo Soc. Nat. Sci. 7:13–18; Bishop 1941. The Salamanders of New York. New York State Mus. Bull. 324. Albany, New York; Nickerson and Mays 1973. The Hellbenders: North American "Giant Salamanders." Milwaukee Public Mus. Pub. Biol. Geol. 1:1–106). Smith (1912. J. Morphol. 23:61–157) observed that the number of eggs a female could lay in one season was limited, and that these would all be deposited at the same time. Based on the large number of eggs commonly observed in a nest, the variability of developmental stage of eggs in the same nest, and the noticeable difference in the color of eggs (which varies between females but is constant for eggs from one individual), Smith (1912, *op. cit.*) suggested that multiple females would lay their eggs in the same nest, to be fertilized and guarded by the attending male. Bishop (1941, *op. cit.*) also inferred joint clutches based upon a comparison of the number of eggs in females' ovaries with the total number of eggs commonly found in nests. To our knowledge, this is the first study to prove through genetic means that multiple females deposited eggs in a single nest.

On 15 Oct 2007, KML and JTB found a male *C. a. alleganiensis* guarding a nest of eggs in the Big Piney River, Missouri under a large rock. The eggs appeared to be from two different clutches due to developmental stages. Some of the eggs were beginning to hatch while others appeared to be several weeks from hatching. All of the eggs were removed and transported to Shepherd of the Hills Hatchery, Branson, Missouri to be hatched and captive-reared for future propagation. Eggs from one clutch hatched an average of 16 days earlier than those from the other clutch. This suggested that the eggs were laid at different times, and thus by two different females. Developmental time may be a suitable method of identifying eggs from multiple mothers, although simultaneous hatch dates would not reveal nest heterogeneity. In this case, genetic testing could provide insight into clutch maternity.

Polymerase chain reaction, with the universal primers L15926 and 12SAR-H, was used to amplify and sequence a 525bp fragment of the control region of the mitochondrial genome. Initial screening suggested that the larvae had two different haplotypes that varied by a single base pair difference. The two haplotypes corresponded to the two putative clutches. To confirm this interclutch variation, eleven additional larvae (five from one clutch and six from the other) were tested in a blind experiment. All eleven larvae exhibited one of the two previously observed haplotypes, providing correct assignment to their respective clutches.

Thus, based upon stage of development and genetic confirmation, we have documentation of the deposition of clutches by multiple female *C. a. alleganiensis* in a single male nest. To investigate the possibility of multiple paternities in a single nest site, microsatellite profiles are being developed to identify males in the general locality.

This work was funded by the Missouri Department of Conservation. We thank numerous Missouri Department of Conservation staff at Shepherd of the Hills Hatchery for care of the eggs and larval hellbenders. Research was conducted in compliance with applicable animal care guidelines and appropriate permits were obtained.

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DESMOGNATHUS FUSCUS (Northern Dusky Salamander). **ALBINISM.** On 3 July 2007, I collected a xanthic *Desmognathus fuscus* along Dead Stream east of Boyd Lake, Orneville, Piscataquis County, Maine, USA (catalogued into the Yale Peabody Museum as YPM A12540). The specimen measured 51 mm SVL and 104 mm TL. In life its color was a light yellow-orange, similar to those illustrated from Connecticut (Klemens 1993. Amphibians and Reptiles of Connecticut and Adjacent Regions. State Geological and Natural History Survey of Connecticut Bull. No. 112. 318 pp.) and Quebec (Desroches and Rodrigue 2004. Amphibiens et Reptiles du Quebec et des Maritimes. Editions Michel Quintin, Waterloo, Quebec. 288 pp.). Xanthic or so-called "yellow albino" specimens of *D. fuscus* have also been reported from West Virginia (Channell and Valentine 1972. J. Herpetol. 6:144–146) and Massachusetts (Tyning 1977. Herpetol. Rev. 8:118), and a leucistic larva was reported from Maryland by Harris (1970. Bull. Maryland Herpetol. Soc. 6:21–27; cited in Dyrkacz 1981. Recent Instances of Albinism in North American Amphibians and Reptiles. SSAR Herpetological Circular No. 11. 31 pp.). This is the first report of such an individual from Maine. During a brief survey at the collection site, I also observed a single typically pigmented (i.e., nearly black) *D. fuscus*, as well as ten *Eurycea bislineata*. All, including the xanthic individual, were found under rocks at the edge of the stream.

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HEMIDACTYLIUM SCUTATUM (Four-toed Salamander). **DISTANCE FROM NESTING SITE**. *Hemidactylium scutatum* is a terrestrial salamander that inhabits deciduous and mixed forests of northeastern North America. Females migrate to nesting sites in early spring just before ovipositing. Nesting sites can vary in appearance, but sphagnum/mosses clumps hanging over small vernal pools are characteristic (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press. Washington, DC. 587 pp.). In every case that we studied, the nesting site was of small dimension, not locatable using 1:50000 nor 1:20000 maps, but they can easily be mapped in the field as a nesting polygon using GPS locality data. Working on conservation of this "special concern" species in the province of Québec (Canada), we need to know how far from the nesting site, in the surrounding terrestrial system, should we protect *H. scutatum*. Considering the lack of such information, we searched for individuals in the vicinity of nesting polygons, just before oviposition (early spring) or during fall and measured the distance between the individual and the periphery of the nesting polygon. We report our 11 measurements below to share this information and promote similar works, as it is essential to protect a portion of the terrestrial habitat surrounding nesting site to ensure local conservation of this species.

A: August 2001, Parc de la rivière Batiscan (46.6°N, 72.6°W), sex unk., 32 m; B: 8 Sept 2001, Tourbière de Saint-Narcisse (46.6°N, 72.6°W), sex unk., 25 and 72 m (individual nearby 2 known nesting polygons); C: 11 May 2002, Québec City (46.75°N, 71.316°W), female, 15 m; D: 21 April 2005, Québec City (46.75°N, 71.316°W), female, 41 m; E: 21 April 2005, Québec City (46.75°N, 71.316°W), female, 41 m; F: 21 April 2005, Québec City (46.75°N, 71.31666°W), female, 20 m; G: 26 August 2007, Trois-Rivières (46.316°N, 72.65°W), sex unk., 45 m; H: 10 Sept 2007, Trois-Rivières (46.316°N, 72.65°W), male, 11 m; I: 10 Sept 2007, Trois-Rivières (46.316°N, 72.65°W), male, 10.5 m. J: 11 Sept 2007, Trois-Rivières (46.316°N, 72.65°W), male, 5.5 m. Mean distance from nesting polygon: 33.6 m SD = 18.8 m. All GPS locality data were collected using the datum NAD 83.

We thank M. Savard (Obs. A) and J.-M. Vallières (Obs. G and J) for useful comments.

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LYCIASALAMANDRA LUSCHANI FINIKENSIS (NCN). **HABITAT AND ALTITUDE.** Two adult and two juvenile individuals *Lyciasalamandra luschani finikensis* were located on the central Gölcük Tepesi (36.3°N, 30.08333°W; WGS 84; 800 m elev.) northwest of Finike, southwestern Turkey, on 20 Feb 2007 at 1400 hr. The weather was cloudy, air temperature was 16ºC. Individuals were found under stones. The habitat was characterized by a dense mixture of maquis (*Arbutus arachne* and *Quercus coccifera* dominated) and *Cedrus libani*. The occurrence of this subspecies was previously reported from 750 m elev. at an inland location near Arif, where the habitat is dominated by dry maquis and *Pinus brutia* (Veith et al. 2001. Zool. Middle East 22:67–82). Previously, the occurrence of *L. l. finikensis* in a dense maquis-*Cedrus libani* dominated vegetation community was unknown. This locality also represents an altitude record for the subspecies. The occurrence of *L. l. finikensis* is known south (were it occurs at sea level in coastal maquis) and north of Finike (Veith et al. 2001, *op. cit.*) at the base of the Gölcük Tepesi, which consists of karstic limestone, similar to the entire southern Lycian area. Therefore, *L. l. finikensis* might be expected to occur along the entire mountain chain northward from Finike to Arif (Veith et al. 2001, *op. cit.*).

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PHAEOGNATHUS HUBRICHTI (Red Hills Salamander). **RECORD SIZE**. On 2 Dec 2007 at 0515 h, we captured a large adult female *Phaeognathus hubrichti* on a mesic hillside in Monroe County, Alabama (exact locality withheld), which measured (anesthetized) 135.19 mm SVL and 268.15 mm total length (19.72 g). This salamander exceeded the previous maximum size for *P. hubrichti* reported by Schwaner and Mount (Auburn Univ. Museum 11381; 134 mm SVL; 256 mm total length; Copeia 1970. 1970:571–573). *Phaeognathus hubrichti* is a federally threatened species, and therefore the salamander was photographed, received a Passive Induced Transponder (PIT tag), and was released at its home burrow.

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PHAEOGNATHUS HUBRICHTI (Red Hills Salamander). **LEUCISM**. On 19 Oct 2007 at 1900 h, on a mesic hillside in Monroe County, Alabama, USA (exact locality withheld), we captured a leucistic adult female *Phaeognathus hubrichti* (121.55 mm SVL; 113.2 mm TL). This is the first report of an aberrant color morph in this narrowly distributed genus. This individual lacked integumentary pigment and appeared pink overall (Fig. 1). Iris pigmentation was present. This individual appeared gravid based on the presence of enlarged follicles clearly visible through the body wall. We have observed and/or captured > 150 individuals at this site with typical pigmentation, indicating a low prevalence of these morphs in the population. The salamander was processed, photographed, received a Passive Induced Transponder (PIT tag), and returned to its home burrow.



FIG. 1. Leucistic female *Phaeognathus hubrichti* (top) compared to a typically-colored female.

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PLETHODON ALBAGULA (Western Slimy Salamander). **DIET**. On 22 March 2008, cave cricket (*Ceuthophilus* spp.) exit counts were performed using a red light at a cave entrance (Flintridge Cave, Travis County, Texas, USA) for two hours immediately following sunset, which occurred at 1944 h. At 2005 h I noticed the front portion of the head of a *Plethodon albagula* emerging from under a ledge near the cave entrance. I observed the salamander slowly ease out from under the ledge to capture cave cricket nymphs as they exited the cave. After each capture the salamander retreated to the crack and would remain there until another cricket nymph passed close to the ledge. At no time did the salamander emerge farther than one body length out from under the ledge. After about one hour of feeding on cricket nymphs the salamander retreated into the crack beyond view and did not come out again during the observational period, which ended at 2145 h.

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PLETHODON CINEREUS (Eastern Red-backed Salamander). **COLORATION**. Two common color morphs are known for *Plethodon cinereus*. In the striped morph a straight-edged reddish stripe extends from the base of the head down the trunk to the tail. Dark gray or black borders the dorsal stripe on both sides. In some individuals the stripe may be orange, tan, yellow, or light gray. The unstriped morph, often referred to as the "leadback" phase, is dark gray or black on the back and sides. Some individuals may have brassy or silver flecking. The ventral surface is mottled with white and gray. There is usually more white than gray. A third color morph, the erythristic phase, lacks any dark pigment. Its back and sides are bright red and its ventral surface is white. The erythristic phase is known from scattered localities in the northeastern United States and southeastern Canada (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Inst. Press, Washington D.C. 587 pp.). It has been reported from eight counties in northeast Ohio (Pfingsten and Downs [eds.] 1989. Salamanders of Ohio. Ohio Biol. Surv. Bull. New Series 7:2, Columbus, Ohio, 315 pp.).

On 13 April 2007 an adult amelanistic *P. cinereus* was collected from beneath a limestone rock in a second growth deciduous woodlot along Greenville Creek in Darke County, Ohio, USA (40.14134°N, 84.78422°W; WGS 84). Dyrkacz (1981. Recent Instances of Albinism in North American Amphibians and Reptiles. SSAR Herpetol. Circ., No. 11) discussed a *P. cinereus* collected in Maryland but did not distinguish it as albino or one of the five other degrees of albinism he described. In this individual the top of the head, the limbs, sides, the underside, and other surfaces that typically are black or gray were pink with white flecks. The dorsal stripe was evident and rather than the reddish color typical of the striped color morph, it was salmon in color and extended from the nape to ca. 1/3 the length of the tail where it faded to the pink color of the rest of the body. The pupils reflected red in the flash of a camera. Color photographs of the specimen have been accessioned into the Herpetological Photodocumentation Collection at the Cincinnati Museum Center (CMC HP 441–447). Other *P. cinereus* found at the site were all the redback phase. I thank Greg Lipps Jr. for reviewing this note.

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PLEURODELES WALTL (Spanish Ribbed Newt)**. ALBINISM**. The genus *Pleurodeles* ranges over North Africa and the Iberian Peninsula, whereas *P. waltl* is restricted to the Iberian Peninsula and western Morocco (Carranza and Arnold 2004. Syst. Biodiversity 1:327–337). This is the most common newt in the Iberian lowlands, where it inhabits both natural and artificial ponds (Salvador and García-París 2001. Anfibios Españoles. Canseco Eds. Talavera de la Reina. 269 pp.). The usual color is an olive green, brown, or yellowish grey spotted pattern. The yellowish, pink, or orange-colored belly also may show grey spots (Salvador and García-París 2001, *op. cit.*). Larvae show a grey or brown dark body with small black spots and greenish or metallic gleams (Díaz-Paniagua and López-Jurado 1981. Bol. Est. Cent. Ecol. 10:27–34).

An albino larva, 43 mm SVL and 82 mm TL, was captured on 19 April 2006, in a semi-natural permanent pond in Santa Marta

village (Albacete, Spain; 39.14944°N, 2.29027°W, ED50 datum; 740 m elev). The pond is almost circular with an average diameter of 45 m. Non-irrigated agricultural lands surrounds the pond and natural Mediterranean shrubland can be found 800 m distant. Aquatic vegetation was abundant, but shoreline vegetation was absent. Overall coloration of the larva was soft pink and the muscular bands were visible along the body. The caudal crests were transparent and the eyes were red.

Records of true albinism have not been reported in *P. waltl*. It has been twice described for this species (Fontanet et al. 1992. Herpetol. Rev. 23:79; Schreitmüller 1934. Zool. Anz. 108:95), although these records should be classified as partial albino or hypomelanistic specimens (Bechtel 1995. Reptile and Amphibians Variants. Colors, Patterns and Scales. Krieger Publ. Co., Malabar, Florida. 206 pp.; Rivera et al. 2001. But. Soc. Cat. d'Herp. 15:59–75). This is the first record of true albinism in the genus and the species.

The albino individual was found two weeks later showing abnormal behavior and died in the following hours. Death could be due to the high levels of solar radiation in the pond together with the absence of melanin. The specimen is deposited in the Centro de Rescate de Anfibios y Reptiles, Alcalá la Real, Spain (ref. 19/10/06-06)

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ANURA —FROGS

ACRIS GRYLLUS (Southern Cricket Frog). **PREDATION**. A variety of arthropods are known to capture and feed upon anurans. A recent review (Toledo 2005. Herpetol. Rev. 36:395–400) made available an exhaustive list of arthropod predators and their anuran prey. According to this review, only one spider (*Dolomedes* sp.) has been documented to feed on *Acris gryllus*. On 20 Sept 2007 at 1920 h, a movement attracted our attention to the substrate of a large drying beaver pond in Tuskegee National Forest, Macon County, Alabama, USA (32.43014°N, 85.64678°W; WGS 84). For the next few minutes we witnessed a large *Dolomedes triton* grasping and attempting to subdue an adult male *A. gryllus* (Fig. 1). Both animals were captured and preserved. It is assumed that the spider would have successfully fed upon the frog. The spider's identification was made by D. Folkerts and confirmed by N. Burkett-Cadena (deposited in the Auburn Univ. Insect Museum). The *A. gryllus* was verified by C. Guyer and deposited in the Auburn University Museum (AUM 37607). Although this genus of spider was noted to feed upon *A. gryllus*, the species was not identified by Goin (1943. Proc. Florida Acad. Sci. 6:143–153). *Dolomedes* is a common genus throughout the Northern Hemisphere and is known to feed upon other small anurans including *Hyla cinerea*, *H. japonica*, *H. minuta*, and *Pseudacris feriarum* (Toledo 2005, *op. cit.*).

We thank D. Folkerts and N. Burkett-Cadena for identifying the spider, and C. Guyer for assistance on this note. This observation was made while conducting research funded by NIH grant R01-A149724 under ADCNR Permit 4268.



FIG. 1. *Dolomedes triton* subduing *Acris gryllus*.

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ATELOGNATHUS PATAGONICUS (NCN). **AQUATIC HABITAT.** An improved understanding of the aquatic ecology of semi aquatic amphibian is not only important from a conservation perspective, but it is vital to our understanding of population dynamics. *Atelognathus patagonicus* is an endemic frog to an endorrheic wetland system in Laguna Blanca National Park and surroundings, Northwest Patagonia, Argentina (Cei and Roig 1968. Physis 27:265–284; Gallardo 1962. Neotropica 8:45–68). Two morphological forms have been described for *A. patagonicus*: an "aquatic form" which has large interdigital membranes, highly developed cutaneous folds on its trunk and thighs, and a "littoral form" with fewer of these features (Cei and Roig 1968, *op. cit.*). For this semi-aquatic frog few data are available regarding its biology (Cuello 2002. Licenciature thesis, Universidad Nacional del Comahue, Bariloche, Argentina. 87 pp.; Fox et al. 2005. Copeia 2005:920–928) and no data regarding habitat use and activity are available, especially in areas where macrophytes are abundant.

The frog is now extinct in Laguna Blanca as a result of unauthorized introductions of predatory fishes (two trout species, *Oncorhynchus mykiss* and *Salmo trutta,* and *Perichthys colhuapiensis*). Currently the known distribution is restricted to 21 neighboring water bodies (between 0.5 ha and 60 ha), smaller than Laguna Blanca (1780 ha). Because of its extinction from Laguna Blanca, the species was listed as Endangered (IUCN, Conservation International, and Nature Serve. 2004. Global Amphibian Assessment. <www.globalamphibians.org> 13 Dec 2004). Also, with the introduction of perch in Laguna Blanca, limnological changes have been observed including: i) a drastic decrease of birds, and ii) a reduction of macroinvertebrates and macrophyte cover (largely *Myriophyllum quitense*). All of these changes have resulted in changes to the habitat complexity (Ortubay et al. 2005. Aquatic Conserv. Mar. Freshw. Ecosyst. 15). The objectives of our study

were to determine: 1) habitat use of *A. patagonicus* in areas with abundant macrophytes, and 2) the distribution of *A. patagonicus* at different depths in the lagoon.

This study was carried out during January, February, and April 2005 at a permanent lagoon, Laguna Verde, in Laguna Blanca National Park (39.00777°S, 70.38527°W; WGS 84, elev. 1250 m). The lagoon has a 17 ha surface and a 1.70 km perimeter, and constitutes an aquatic ecosystem with high abundance and diversity of aquatic birds including Andean Flamingo, Black-necked Swan, and grebes. These birds depend on the macrophyte vegetation (largely *M. quitense*) for food and nesting. The predation by grebes of larval and postmetamorphic *A. patagonicus* in the deeper vegetated area has been reported (Cuello et al. 2005. Herpetol. Rev. 36:298).

Frogs were captured with aquatic funnel traps (11 cm diameter, 30 cm long), one plastic funnel and a rubber band (Smith and Retting 1996. Herpetol Rev. 27:190–191) placed at three different depths: surface (20 cm), middle (70 cm) and maximum depth (ca. 350–450 cm), in vegetated and non-vegetated areas. Fifteen traps were set for 12 h during the night during Jan, Feb, and April at three different depths. Amphibian larvae and postmetamorphic individuals were collected; the tadpole stage (Gosner 1960. Herpetologica 16:183–190) and postmetamorphic body length were recorded. All individuals were returned unharmed to the original place of capture.

Atelognathus patagonicus was found at all water depths sampled. During the study we captured 85 *A. patagonicus*: 83 tadpoles (stage 28–39), one juvenile, and one "aquatic form" female. The captures were more abundant in vegetated areas (N = 74; mean/per trap = 3.5 ± 1.49) than in non-vegetated areas (N = 11; mean/per trap = 0.45 ± 0.15). Significant differences were found in the number of individuals by strata (Kruskal-Wallis, $H_2 = 7.14$, $p = 0.0281$). The difference was between the deeper and the middle strata (Dunn's test, $p < 0.05$). No differences were found in the number of individuals captured per month (Kruskal-Wallis, $H_2 = 1.99$, $p = 0.370$). The "aquatic form" female (body length = 4.5 cm) was found at 4.5 m in an area with a high abundance of *M. quitense*.

Our preliminary results show that larval and postmetamorphic *A. patagonicus* select deeper areas of the lagoon. The larger captures in deeper zones characterized by presence of aquatic vegetation suggest that the frog prefers *M. quitense* as refuge and/or as foraging habitats. According to our results, the resulting extinction of *A. patagonicus* at Laguna Blanca would be associated with the disappearance of *M. quitense* and also by the predation pressure and competition imposed by the presence of introduced fishes (Cuello et al. 2006. Phyllomedusa 5[1]:67–76; Cuello and Perotti, unpubl. data).

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BOMBINA VARIEGATA (Yellow Fire-bellied Toad). **MATING BEHAVIOR**. Various authors have provided evidence for male toads attempting to amplex male conspecifics (Marco et al. 1998. Anim. Behav. 55[6]:1631–1635; Marco and Lizana 2002. Ethol. Ecol. Evol. 14:1–8), as well as for interspecific amplexus (Brown 1977. J. Herpetol. 11:92–94; Reading 1984. J. Zool. (Lond.) 203:95–101; Marco and Lizana 2002, *op. cit.*) and even for amplexus between males and inanimate elastic objects of similar size to a female toad (Ishii and Itoh 1992. Gen. Comp. Endocr. 86:36–42). However, evidence for males amplecting dead females is sparse. Herein I report the first record of a male *Bombina variegata* amplecting a dead female.

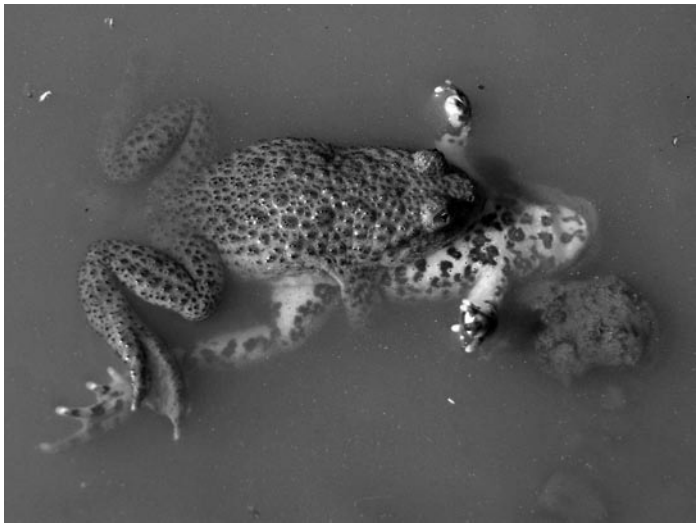


FIG. 1. Male *Bombina variegata* in amplexus with deceased female conspecific, Bukovec Mountains, Slovakia.

On 10 June 2008 at ca. 1630 h, I observed a male *Bombina variegata* in amplexus with a dead female conspecific in a wheel-rut temporary pond in the Bukovec Mountains, northeastern Slovakia (49.0872°N, 22.4086°E; WGS 84; 680 m elev.). The amplexus was inguinal, typical for the family Bombinatoridae, however the female was upside down, with the male on the female's belly rather than on her back (Fig. 1). The amplexus was observed for 5 minutes, during which time the male was immobile. When disturbed (slight pushes on the back), it swam away with difficulty for a total distance of ca. 30 cm without releasing the female. The pair was then separated and the female examined. The female's tongue was protruding out of its mouth, but no external damage was apparent and the cause of death was not determined. Although it is possible that death occurred during amplexus, this seems unlikely given the position of the female, suggesting that the male clasped the already-dead female.

This observation provides additional evidence suggesting that male *B. variegata* do not assess females carefully before clasping them, occasionally making obvious mistakes. The benefits of being first to encounter a female probably outweigh the costs of this type of error.

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BUFO DEBILIS (Green Toad). **BREEDING HABITAT SELECTION.** Breeding site selection in *Bufo debilis* is poorly understood beyond the general knowledge that they use temporary, fishless water sources including desert playas, earthen stock tanks, and any other depressions that will temporarily hold water. Herein, I report

breeding pond selection by *B. debilis* in southwestern rangelands as modified by livestock use.

I made observations of *B. debilis* calling at ephemeral pools in an arid southwestern desert in southern New Mexico, west of Las Cruces. The survey area was in the Chihuahuan Desert on Bureau of Land Management grazing allotment 3013. During the monsoon season, approximately July 1 through late August, I surveyed earthen livestock tanks and desert playas for breeding amphibians. I conducted amphibian vocalization surveys between 2200 and 0200 h in areas that received rain that day or the previous day. Most available breeding sites on these allotments are livestock watering tanks that dry up on a yearly basis and were dry in the spring of 2007. I did not find *B. debilis* at tanks that received heavy livestock use as measured by the cover of livestock feces within 10 m of the earthen tank high water line. However, while surveying at three of these heavily used tanks I detected *B. debilis* calling from small ephemeral sites located remotely from the tank. Upon investigation, I found *B. debilis* males calling from seven small pools of water associated with washes or erosion sites created by wildlife and cattle trails. As described below, these small wetlands desiccated much more quickly than the larger tanks, but they may not have received as much livestock use as the larger tanks.

The first earthen cattle tank, Marijuana Tank contained no calling amphibians on 21 July 2007 or on any other survey day (32.40060°N, 107.11543°W; WGS 84; elev. 1402 m) (30 × 40 × 1.25 m deep). The tank water, measured with a Hydrolab MS 5 (Hach Environmental), had pH 7.42, 41.2% dissolved oxygen (DO), turbidity of 125 NTU , salinity of 0.14 ppt , and conductivity of 0.2973 mS/cm. This tank retained water into the fall. Three temporary sites close to the tank had calling amphibians including *B. debilis*. The first small wetland close to Marijuana Tank had ca. 20 calling *B. debilis* males (071) (32.40148°N, 107.12139°W; WGS 84; elev. 1408 m) (1 × 3 × 0.75 m deep). The wetland had pH 8.41, 23.3% DO, turbidity of 1969 NTU, salinity of 0.06 ppt, and conductivity of 0.1424 mS/cm, and retained water past 15 Aug 2007. The second small wetland close to Marijuana Tank had ca. 5 calling males (072) (32.40060°N, 107.11987°W; WGS 84; elev. 1407 m) (3 × 4 × 1.0 m deep). The wetland had a pH 8.43, 23.0% DO, turbidity of 1899 NTU, salinity of 0.06 ppt, and conductivity of 0.1424 mS/cm, and dried before 15 August 2007. The third site close to Marijuana Tank had ca. 50 calling males (073) (32.40203°N, 107.11522°W; WGS 84; elev. 1401 m) (2 × 4.5 × 1.25 m deep). The wetland had a pH 8.56, 21.8% DO, turbidity of 1463 NTU, salinity of 0.07 ppt, and conductivity of 0.1645 mS/cm, and was almost completely dry by 15 August 2007.

The second earthen cattle tank was unnamed, contained no calling amphibians 21 July 2007 or on any other survey day and retained water past September 2007 (32.39798°N, 107.11569°W; WGS 84; elev 1419 m) (15 × 20 × 1.25 m deep). I did not record measurements of water quality at this set of wetlands. Two small temporary water bodies close to the tank had calling amphibians including *B. debilis*. The first small wetland close to the unnamed tank had ca. 5 calling males and retained water until late August (74/82) (32.41933°N, 107.09922°W; WGS 84; elev 1432 m) (1 × 4 × 1 m deep). The second water body close to the unnamed tank had 4 calling males and dried by 15 August 2007 (070) (32.41933°N, 107.09922°W; WGS 84; elev 1432 m) (1 × 3 × 0.75 m deep).

The third cattle tank, North Kimbel, contained no calling amphibians 29 July 2007 or on any other survey date (32.33181°N, 107.07601°W; WGS 84; elev. 1396 m) (60 × 30 × 2.0 m deep) (Fig. 1 A). The tank water had a pH 8.62, 76.3% DO, turbidity of 1316 NTU, salinity of 0.17 ppt, and conductivity of 0.3535, and retained water past September 2007. Two temporary water bodies close to the tank had calling amphibians including *B. debilis*. The first site close to North Kimbel Tank had ca. 40 calling males (077)(32.33132°N, 107.07897°W; WGS 84; elev. 1394 m) (1 × 4 × 1.0 m deep) (Fig. 1 B). The wetland had a pH 7.71, 20.2% DO, turbidity of 2447 NTU, salinity of 0.08 ppt, and conductivity of 0.1882 mS/cm, and was dry by 16 August 2007. The second wetland close to North Kimbel Tank had ca. 20 calling males (079) (32.33132°N, 107.07885°W; WGS 84; elev. 1395 m) (1 × 3 × 1.0 m deep). The water had a pH 7.68, 24.7% DO, turbidity of 2945 NTU, salinity 0.08 ppt, and conductivity of 0.1858 mS/cm, and dried before 15 August 2007.

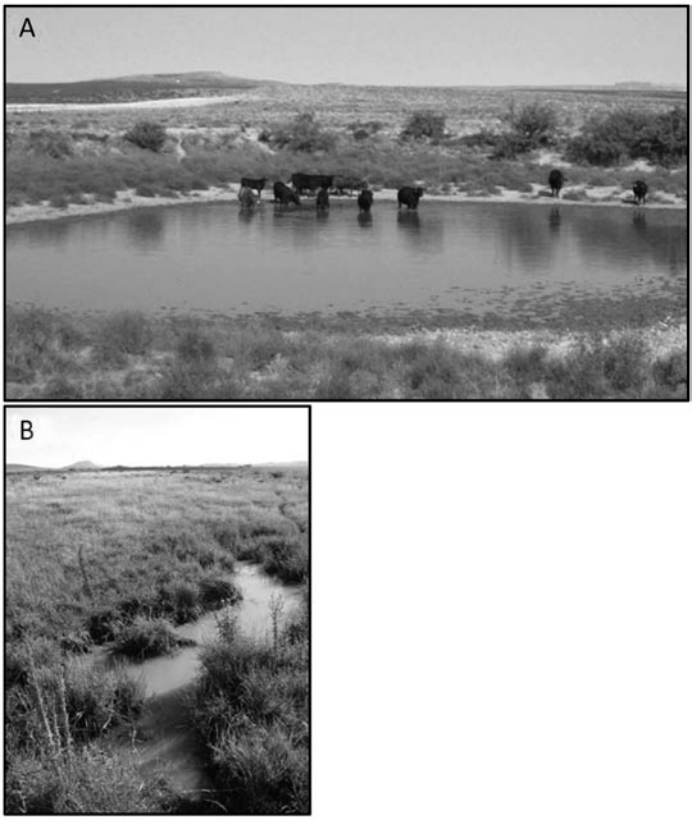


FIG. 1. Calling *Bufo debilis* were not detected at (A) North Kimbel livestock tank, which receives heavy livestock use; however, male *B. debilis* were calling from (B), a small ephemeral wetland created by erosion in a wildlife and livestock trail. These sites are 283 m apart, west of Las Cruces, New Mexico, USA.

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BUFO FOWLERI (Fowler's Toad). **DIET**. It is well known that larval toads will consume injured, dead (Heinen and Abdella 2005. Am. Midl. Nat. 153:338–347), and live conspecifics (Bragg 1964. Herpetologica 20:17–24; Fox 2008. Herpetol. Rev. 39:151–154).

The increased nutrient uptake that results from larval grazing on moribund cohorts and conspecific carcasses is advantageous because it facilitates rapid larval growth and metamorphosis (Heinen and Abdella 2005, *op. cit.*). In *Bufo americanus* this process is probably triggered by chemical cues associated with decomposition of dead conspecifics and is more likely a form of scavenging than cannibalism (Heinen and Abdella 2005, *op. cit.*).

Though rare, isolated cases of active interspecific cannibalism have been documented in non-invasive (i.e., excluding cases of cannibalism in *B. marinus*), non-larval *Bufo*. To the best of our knowledge, non-larval conspecific scavenging and active conspecific cannibalism is unknown in *B. fowleri*. In fact, larger *B. fowleri* can apparently differentiate between the movements of invertebrate prey and newly metamorphosed toadlets, thus avoiding active conspecific cannibalism (Clarke 1974. Am. Midl. Nat. 91[1]:140–147). Additionally, Klimstra and Myers (1965. Trans. Illinois Acad. Sci. 58[1]:11–26) found that only 0.4% of non-invertebrate matter in *B. fowleri* stomach contents was animal in origin, 0% of which was amphibian.

Here we report an unusual case of conspecific scavenging in *Bufo fowleri*. On 3 July 2008 at 2315 h on Provincelands Road (42.05058°N, 70.22184°W; NAD 83) in Provincetown, Massachusetts, USA, we observed a terrestrial subadult *B. fowleri* (ca. 50 mm snout–urostyle length [SUL]) consuming a flattened, dried, road-killed conspecific (Fig. 1). The remains of the road-killed toad measured ca. 57 mm SUL. Because the road-killed individual broke as we removed it from the mouth of the live toad, we estimated the carcass to be a few millimeters longer than we report here, making the specimen slightly larger than the scavenging toad. We observed two live ants (Formicidae), a known prey item for *B. fowleri* (Clarke 1974, *op. cit.*; Klimstra and Myers 1965, *op. cit.*), on the carcass after we removed it from the mouth of the live toad. The live toad may have inadvertently picked up the road-killed individual, along with the more commonly consumed ants. However, we are unsure if the ants were in or on the carcass and visible to the toad during consumption. Though non-invertebrate material of animal origin has been documented in stomach contents of non-larval *B. fowleri*, our observation represents what is likely the only documented case of conspecific scavenging, active, passive, or unintentional, in non-larval *B. fowleri*.



FIG. 1. Juvenile *Bufo fowleri* consuming a road-killed conspecific.

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CRAUGASTOR RANOIDES (NCN). **PREDATION**. Although a variety of predators are likely to feed on *Craugastor ranoides*, there are no cases of predation documented. On 15 April 15 at 2130 h, we observed a spider of the species *Ancylometes bogotensis* (Ctenidae) eating a juvenile C. *ranoides* at the Quebrada Grande, Guanacaste National Park, Costa Rica (10.90111°N, 85.74138°W; WGS 84). Except for the head, the frog was completely consumed in ca. 3 h. To confirm our observation, photographs were taken. After the predation event, the spider was collected for identification. The spider was identified by Diana Silva-Davila and deposited at the California Academy of Sciences (CASENT 9025506). A digital photograph of the event was deposited at the Museo de Zoología, Universidad de Costa Rica.

We thank Enrique González for taking the pictures and Mark Budworth for comments on this note.

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CYCLORAMPHUS FULIGINOSUS (Tschudi's Button Frog). **SAUROPHAGY.** *Cycloramphus fuliginosus* is a poorly known frog associated with streams of the Atlantic coastal forest from Rio de Janeiro to southeastern Bahia, Brazil (Heyer 1983. Arq. Zool., S. Paulo 30:235–339; Heyer 1988. Proc. Biol. Soc. Washington 10:151–154; Verdade 2005. Unpubl. PhD thesis, Universidade de São Paulo, São Paulo, Brazil). In general, natural history data for *Cycloramphus* species are scarce and anecdotal. Little is known of their reproduction and defensive behavior, and there are virtually no data on the diet of these frogs. In turn, *Ecpleopus gaudichaudii* is a rare forest-litter dweller lizard, endemic to the Atlantic Forest of southeastern Brazil (Uzzel 1969. Postilla 135: 1–23). This lizard is difficult to observe and remains poorly known, with only the description, and a single note on its diet available in literature (Eisemberg et al. 2003. Herpetol. Rev. 35:336–337). Herein, we make the first report of saurophagy for the frog genus *Cycloramphus*.

While dissecting a specimen of *Cycloramphus fuliginosus* (52 mm SVL), we found a partially digested *Ecpleopus gaudichaudii* (30 mm SVL). The specimen was collected on 24 May 1952 at Tijuca, Rio de Janeiro municipality (22.94°S, 43.24°W), Rio de Janeiro state, Brazil. *Cycloramphus fuliginosus* is a large territorial frog, with all life stages strictly associated with streams (Lutz 1929. Mem. Inst. Oswaldo Cruz 22:5–25; Heyer 1983, *op. cit.*; Izecksohn and Carvalho-e-Silva 2001. Anfíbios do Município do Rio de Janeiro, Editora UFRJ, Rio de Janeiro), whereas *E. gau-*

dichaudii is an active forest litter forager (Eisemberg et al. 2003, *op. cit.*). This observation suggests *C. fuliginosus* is a generalist predator, as are most large species of frogs (Duellman and Trueb 1994. Biology of Amphibians. Johns Hopkins University Press, Baltimore, Maryland. 670 pp.). The frog and its prey are deposited at the herpetological collection of the Museu de Zoologia da Universidade de São Paulo, São Paulo, Brazil (MZUSP 9836).

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DENDROBATES AURATUS (Green and Black Dart-poison Frog). **DIEL ACTIVITY.** Variation of diel activity of *Dendrobates auratus* has been studied in Panama (Dunn 1941. Copeia 1941:88–93) and Cost Rica (Graves 1999. J. Herpetol. 33:375–381), however no such studies exist for the introduced population on O'ahu, Hawai'i. We examined activity patterns in adults and compared this with temperature, time, and humidity in the field to identify the primary determinant of activity.

We examined activity patterns of adult *D. auratus* on the leeward side of the island of O'ahu, Hawai'i at and around the Harold B. Lyon Arboretum (21.33166°N, 157.8°W; WGS 84; 137–164 m elev.) during summer 2005. Three plots were established via natural and unnatural barriers. The first plot, the "arboretum" was ca. 0.375 km^2. Terrain consisted of paved area, mowed lawn, greenhouse structures, living quarters, and gardens. Vegetation included bromeliads (Bromeliaceae), pothos (*Scindapsus*), bird-of-paradise (Strelitziaceae), and *Heliconia* sp. (Heliconiaceae). The second plot, the "park" shared a paved border with the "arboretum" on the east and a stream border to the west. Total area was ca 0.125 km^2. Terrain consisted of undeveloped secondary forest, unmaintained paved area, and small (uninhabited) buildings. Vegetation consisted primarily of bamboo (Bambusoideae) and pothos, coconut (Arecaceae), and *Heliconia*. The third plot, the "farm" shared a border to the west with the "park" that consisted of a small (ca. 3 m across) stream. Total area was ca. 0.25 km^2. Terrain consisted of existing (but not frequented) dirt trails through secondary forest and uninhabited living quarters. Vegetation consisted of bamboo, pothos, and *Heliconia*.

Each plot was hiked and visually examined on random days by two observers for the duration of the experiment. Number of frogs observed was noted, as was time of day, temperature, and weather conditions. These observations were considered an indication of activity level as behaviors consisted of active foraging and courting.

Average daily rain data were collected from a rain gauge located on the Harold B. Lyon Arboretum grounds, owned by the National Weather Service Forecast Office (http://www.prh.noaa.gov/hnl/pages/hydrology.php).

The number of *D. auratus* observed ranged from 0 to 14 during an hour session. Activity gradually increased starting at sunrise and peaked at 3 h past sunrise, decreasing again in midday and increasing again in the early evening. Temperatures at which *D. auratus* were observed ranged between 23.5ºC and 30ºC (mean 26.13ºC ± 1.51ºC). Time and temperature did not appear correlated (R^2 = 0.146652), nor did daily rain totals and frogs observed (R^2 = 0.0057). To determine whether or not there was a correlation between plot and number of observed frogs, an ANOVA was performed and found not to be significant (df = 2, Q = 0.2240).

Our field study occurred throughout the breeding season, during which activity is at its highest (pers. obs). Dunn (1941, *op. cit.*) observed highest activity in the mornings and after rains in Panama. Graves (1999, *op. cit.*) observed highest activity midday. Our observations did not show a correlation between weather and activity but showed that time and activity correlated when examined as a bimodal function. Our time and temperature did not appear correlated. This is likely due to our temperature collection methods. Temperature was collected at the exact location where the frog was first detected using an electronic thermometer and thus, represents a highly variable microclimate reading which we would not expect to follow the parabolic relationship that intradaily air temperatures typically follow. Our observations suggest that the primary contributor to activity in *D. auratus* is temperature in its introduced habitat on the island of O'ahu, Hawaii.

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ELEUTHERODACTYLUS ALTAMAZONICUS (NCN). **REPRODUCTION**. *Eleutherodactylus* species undergo direct development, forgoing an aquatic larval stage. It is generally assumed that species deposit eggs in trees within cavities or bromeliads, or on the ground amid moisture-retaining leaf litter or under rotting logs. However, records of oviposition by most species of *Eleutherodactylus* are rare.

On 26 May 2005, at 0830 h we encountered a male (22.3 mm SVL, 0.66 g) and female (34.5 mm SVL, 2.03 g) *Eleutherodactylus altamazonicus* in amplexus at the base of a large tree in primary, terra firme forest within Yasuní National Park in Ecuador (Provincia de Orellana). The pair was positioned over a small depression in the ground. The cavity was circular in shape, devoid of leaf litter, and roughly 3 cm in diameter and 1 cm deep. The pair was captured, placed together in a plastic bag and taken to the laboratory so measurements could be taken. Overnight, the female deposited 38 unpigmented eggs ca. 3.5 mm in diameter inside the bag. The eggs were returned to the depression from which the frogs were originally taken the next day. The study period ended 4 days after the pair was found, therefore we were unable to observe whether the eggs hatched. On 27 May, we encountered a second gravid *E. altamazonicus* female (32.1 mm SVL, 2.78 g) less than 100 m from the spot the first two individuals were encountered. These findings support suggestions that the beginning of the rainy season marks the onset of breeding in this species (Duellman 1978. Misc. Publ. Univ. Kansas, Mus. Nat. Hist. 65:1–352).

To our knowledge, only three other clutches have been described for *E. altamazonicus*. The clutch size reported here is much greater and the eggs larger than those clutches (mean number of eggs in other clutches = 18.7, mean size = 2.8 mm) (Duellman 1978, *op. cit.*). This difference may be attributable to the large size of the female or geographic variation in reproduction in this species.

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port and Amo Enomenga for field assistance. This observation was made during dissertation research supported by grants from the Conservation, Food, and Health Foundation and the Louisiana Governor's Office of Environmental Education.

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ELEUTHERODACTYLUS ATKINSI (NCN). **DIURNAL RETREATS.** *Eleutherodactylus atkinsi* is endemic to Cuba. It is widely distributed throughout Cuba, Isla de la Juventud, and some keys of the Sabana-Camagüey archipelago (Estrada and Ruibal 1999. *In* Crother (ed.), Caribbean Amphibians and Reptiles). It inhabits scrub, mesic woods, and forests as well as coffee, cacao, and banana plantations and the edges of cornfields. During the day it occupies refuges in small caves, pastures, under trash and fallen palm thatch; it is often found near human habitations (Schwartz and Henderson 1991. Amphibians and Reptiles of the West Indies: Descriptions, Distributions, and Natural History. Florida Univ. Press, Gainesville, 720 pp.). In this note we report an opportunistic and unusual retreat of this Cuban endemic frog.

During the morning of 25 Jan 2007, we found a great density of sticky mounds (ca. 90 m^2) (Fig.1A) near a shallow stream in a heavily altered area of secondary vegetation in Baitiquirí, Guantánamo province (20.03090°N, 74.8704°W; NAD 27 for Cuba). The mounds had a central burrow dug as shelter by a fiddler crab, *Uca* sp. (Ocypodidae). During the night (ca 2030 h) we observed male, female (including gravid individuals), and juvenile *E. atkinsi* emerge from the crab burrows to vocalize and forage (Fig. 1B).

During two consecutive nights (between 2000–2200 h) we observed the frogs' behavior. On the second night, we counted the number of frogs observed in each mound and characterized the crab burrows by measuring the following: height of the mound (HB), diameter of the opening (DB), temperature near to the opening (TB), soil humidity (Dry/Moist), and aperture condition (Open/Close). Below we present the mean and standard deviation (mean ± SD) of each mound characteristic measured and the mode of the number of frogs in each mound.

We inspected 64 crab burrows and found frogs in 48. The number of frogs in each mound (1.22 ± 0.87) ranged from 0–4 (mode = 1, N = 37 burrows, 57.8%). The crab burrows used by *E. atkinsi* had DB = 40.2 ± 14.2 mm, average HB = 10.8 ± 4.8 mm; temperature near the opening varied less than 1ºC among burrows (22.8 ± 0.81ºC).

Some species of frogs have been observed using the shelters of spiders and crabs as a regular daytime retreat, apparently coexisting with the original inhabitants (Cocroft and Hambler 1989. Biotropica 21:2–8; Dundee 1999. Herpetol. Rev. 30:91–92; McIntrye 2003. Herpetol. Rev. 34:52–53). We noted the presence of active crabs in the area, new burrow construction between nights, tracks, and other evidence suggesting coexistence between frogs and crabs. Our observations of the opening/humidity conditions of the burrows on the second night indicate that the frogs occurred in higher frequency in dry conditions (37 of 41 dry burrows had frogs), independent of opening condition. This suggests that frogs preferred mounds not recently disturbed by crabs. The only report



FIG. 1. A. Density of crab burrows at study site in Baitiquirí, Guantánamo Province (the white arrow indicates the mound shown in (B). B. Mound with four *Eleutherodactylus atkinsi* (white circles) emerging from their diurnal retreat.

of crabs preying on frogs in Cuba is that of Fong and Hero (2005. Tech. Rept., DAPTF) who reported the freshwater crab *Epilobocera cubensis* preying on an adult *Eleutherodactylus cuneatus* in La Gran Piedra, Eastern Cuba.

Some species of anurans are opportunistic burrowers and often use natural holes, crevices, or tunnels made by other animals (Wells 2007. The Ecology and Behavior of Amphibians. Univ. of Chicago Press, Chicago, Illinois). The use of these pre-existing burrows as diurnal refuge provide more stable conditions of temperature and humidity than do more exposed locations, and also provide protection from desiccation and diurnal predators (Wells 2007, *op. cit*). To our knowledge this is the first report of the opportunistic use of pre-existing burrows by *E. atkinsi* and the second for Cuban amphibians. An individual *Peltophryne peltacephala* was observed using the nest of a Burrowing Owl (*Speotyto cunicularia*) as a diurnal retreat (Valdés de la Osa 1978. Misc. Zool. Acad. Cien. Cuba. 7:4).

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ELEUTHERODACTYLUS DIMIDIATUS (NCN) **AND *ELEUTHERODACTYLUS INTERMEDIUS*** (NCN). **PREDATOR/PREY**. On 18 Sept 2005 (ca. 2300 h) we witnessed an adult *Eleutherodactylus dimidiatus* (26.1 mm SVL) eating an adult *E. intermedius* (18.6 mm SVL). The frogs were observed among leaf litter in secondary vegetation in montane rainforest at La Gran Piedra (20.0°N, 75.61666°W; WGS 84; elev. 1100 m), Santiago de Cuba Province, Cuba.



FIG. 1. Adult *Eleutherodactylus dimidiatus* eating an adult *E. intermedius*, La Gran Piedra, Santiago de Cuba, Cuba. Photograph by R. Alonso.

When first observed, the *E. dimidiatus* was grasping the hind legs of the *E. intermedius*, with the head and the front legs of the prey emerging from its mouth (Fig. 1). We observed the frogs' interaction with headlamps and took pictures using flashes for ca 10 min. We then removed the leaf litter around the frogs, but the predator never changed its behavior and only moved a few centimeters from its initial position.

Our observation represents the first record of a predator/prey relationship between wild *Eleutherodactylus* frogs in Cuba, although Valdés de la Osa and Ruiz-García (1977. Misc. Zool. 6:4) reported cannibalism in captive *E. riparius* (identified as *E. cuneatus*). Specimens were deposited in the herpetological collection of BIOECO, Santiago de Cuba (Field number AFG 2946).

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ELEUTHERODACTYLUS LEBERI (NCN). **CLUTCH SIZE AND PARENTAL CARE.** *Eleutherodactylus leberi* is an endemic Cuban frog of the subgenus *Eleutherodactylus* (Hedges 1989. *In* Woods (ed.), Biogeography of the West Indies: Past, Present and Future, pp. 305–370. Sandhill Crane Press, Gainesville, Florida). The species is restricted to the northern slope of the Sierra Maestra in eastern Cuba (Estrada and Ruibal 1999. *In* Crother (ed.), Caribbean Amphibians and Reptiles, pp. 31–62. Academic Press, San Diego, California). During a herpetological expedition to the Sierra Maestra in June 2003, several calling male *E. leberi* were collected among the rocks and vegetation surrounding La Tabla (20.204194°N, 76.39588°W; NAD 27 Cuba datum). Voucher specimens were verified by L. V. Moreno and were deposited in the Instituto de Ecología y Sistemática, Colección Zoológica de la Academia de Ciencias de Cuba (CZACC 14.11530–36). One of the calling males was vocalizing at 2055 h from a small cavity in the rocky wall of "diente de perro," the karstic landscape typical of this region, and was observed in close contact with a clutch of eggs. This individual remained close to the clutch when disturbed by our headlamps, and escaped only when we attempted to photograph the cavity. The clutch of 27 spherical eggs (one measured 5.8 mm diameter) was at the end of the cavity (1.8 cm diameter, 6.4 cm deep). The eggs were contained in a jelly cluster adhered to a rock; seven were dark and seemed infertile, the rest were creamy-white. Air temperature measured inside the cavity was 23.3ºC; outside was 22.6ºC. To the best of our knowledge these are the first data regarding clutch size of *E. leberi*, a feature that is largely unknown for most of the Cuban *Eleutherodactylus*. Additionally, the behavior of this male provides the first evidence of parental care in this species in the form of egg attendance, a behavior reported in other Cuban *Eleutherodactylus*: *E. albipes*, *E. atkinsi*, *E. dimidiatus*, *E. guantanamera*, *E. intermedius*, *E. tetajulia,* and *E. varleyi* (Wells 2007. The Ecology and Behavior of Amphibians. University of Chicago Press, Chicago, Illinois. 1148 pp.).

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HYLA CINEREA (Green Tree Frog) and ***PSEUDACRIS TRISERIATA*** (Western Chorus Frog). **CALLING IN AMPLEXUS**. Anurans are known for their large breeding choruses in which males gather to attract mates. Females approach these choruses and phonotactically evaluate and respond to males whose voice qualities are believed to communicate fitness (Ryan 1985. The Tungara Frog: A Study in Sexual Selection and Communication. Univ. Chicago Press, Chicago, Illinois). Because females enter the choruses over the entire breeding chorus, rather than simultaneously, competition between males is severe. Consequently, males that amplex the first available female "choosing" them should be at a selective advantage to males that reject less favorable females.

On 23 Feb 2000 at ca. 2130 h in Craighead County, Arkansas, USA (T13N, R2E, Sec. 12), ca. 2.4 km S of U.S. Hwy 49 on CR 204, we observed a chorus of *Pseudacris triseriata*. Several specimens were collected and returned to the Arkansas State University Herpetology Museum for examination. Upon return to the museum, two of the frogs had paired in amplexus. This pair was isolated to collect the eggs. At 0130 hr in amplexus, the male began calling. The male continued calling sporadically for about one hour. Eggs were recovered the next morning, but none hatched.

On 29 May 2000 at ca. 2030 h a chorus of *Hyla cinerea* was visited in a rice field in Craighead County, Arkansas, USA (T13N, R4E, Sec. 31) at the junction of CR 452 and Arkansas Highway 1, ca. 11.2 km S of Jonesboro. While collecting calling males, one male was found calling while in amplexus with a female. The pair was captured, and they quickly separated. Both frogs were deposited in a 1-liter plastic bag with five other males. After

returning from the field at 0200 h, a male was observed amplexed with the female again. It is unknown whether this was the same male as before, but there was only one female in the bag. The pair was removed and placed in their own bag to recover the eggs. At ca. 0215 h the male in amplexus began calling and continued for at least 15 minutes. He then ceased and did not call again before 0245 h when observations ceased. In the morning, a clutch of eggs was present, and the frogs were no longer in amplexus. The calls were typical breeding calls and bore no resemblance to aggression or release calls observed in both species.

Apparently, there are no previous reports of males producing breeding calls while in amplexus, but this is a very significant adaptation for a male. Obviously, the implications of amplectant calling behavior are quite dramatic. Because the pairs observed were isolated, there is no way to know if the males would switch mates. Nevertheless, the selective advantage that could be incurred by participating in such an action cannot be ignored.

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KALOPHRYNUS INTERLINEATUS (Striped Sticky Frog)**. DIET.** The information on amphibian diets suggests that all adult amphibians are carnivores; most feed principally on insects, although many species eat a wide variety of invertebrates (Duellman and Trueb. Biology of Amphibians 1986. McGraw-Hill Book Co., New York. 670 pp.). Here we report prey of *Kalophrynus interlineatus* from the Trat Agroforestry Research Station, Muang District, Trat Province, southeastern Thailand. A frog was caught at 2030 h on 23 Jan 2008 in dry, evergreen secondary forest (12.40129°N, 102.67195°E; WGS 84; 20 m elev.). It was kept overnight in a plastic bag. Later the next morning, we collected a fecal pellet (field no. Y 0373) from the bag and the frog was released into its natural habitat.

The pellet was dominated by ants (Formicidae), which comprised 13 of 14 identifiable prey items. These included eight *Camponotus* sp., two *Odontomachus* sp., one *Pheidole* sp., one *Pheidologeton affinis*, one *Polyrhachis* sp., and one unidentified beetle belonging to the family Scarabaeidae. This information provides preliminary data on the diet of *K. interlineatus* in Thailand.

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KALOPHRYNUS INTERLINEATUS (Striped Sticky Frog)**. ANTIPREDATOR BEHAVIOR.** Here we report antipredator behavior of *Kalophrynus interlineatus* from southeastern Thailand. The frog was caught at 2030 h on 23 Jan 2008 in dry, evergreen secondary forest (12.40129°N, 102.67195°E; WGS 84; 20 m elev.), Trat Agroforestry Research Station (Muang District, Trat Province). It was kept overnight in a plastic bag. When touched near the vent the following morning (similar to Chuaynkern et al. 2007. Herpetol. Rev. 38:321–322), the individual inflated its lungs and elevated the body, especially the pelvic region, thereby presenting the ocelli-like marks on the pelvic region (Fig. 1). A somewhat similar defensive posture—lowering the head and elevating inguinal glands—is shown by *Physalaemus nattereri* (Duellman and Trueb 1986. Biology of Amphibians. McGraw-Hill Book Co., New York. 670 pp.), However, we did not observe lowering of the head in *K. interlineatus*. Presentation of the ocelli-like marking on the pelvic region has been interpreted as "eyespots" with the suggestion that the broad pelvic region with elevated "eyes" gives the image of a much larger organism (Duellman and Trueb 1986, *op. cit.*). Chan-ard 2003. (A Photographic Guide to Amphibians in Thailand. Darnsutha Press Co., Ltd., Bangkok. 175 pp.) suggested *Kalophrynus* used ocelli-like markings to present an image of a snake with open mouth.



FIG. 1. Defensive posture by *Kalophrynus interlineatus*, inflating of lungs and elevating of body. Photograph by Prateep Duengkae.

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LIMNONECTES MEGASTOMIAS (Big-mouthed Frog). **DIET and ORNITHOPHAGY**. The recently described frog, *Limnonectes megastomias*, is currently known from only two localities in northeastern Thailand (McLeod 2008. Zootaxa 1807:26–46).

On 27 June 2003, a series of *L. megastomias* was collected from the type locality, a dry evergreen forest at Sakaerat Environmental Research Station, Nakhon Ratchasima Province, Wang Nam Khieo District, Thailand (14.49°N, 101.87°E; Indian-Thailand Datum; 645 m). During collecting, an adult male *L. megastomias* was found to have recently ingested an adult male *L. gyldenstolpei*, the only other anuran known to co-occur with *L. megastomias* at this site. On 15 March 2005, another series of 13 specimens (11 males, 2 females) was collected at the same locality and maintained in captivity until 17 March 2005. Feces from these frogs, containing feathers and other prey items, were preserved as a dietary voucher. Feathers were identified as those of a Leaf Bird, *Chloropsis* sp. Invertebrate remains were identified as belonging to species of Coleoptera (Carabidae; Scarabidae, 2 spp.; 1 undetermined taxon), Hemiptera (2 undetermined taxa), Hymenoptera (Meliponinae; Formicidae), Isoptera (Termitidae), and Lepidoptera (2 undetermined taxa).

Based on personal observations, *L. megastomias* seems to be a sit-and-wait predator, often found partially submerged in water at the edge of a waterway with only eyes and snout exposed. Occasionally, individuals are seen on the stream bank. These frogs, males in particular, have a relatively large gape, and it is conceivable that a bird landing on the bank of the stream might be consumed in the same opportunistic manner that a conspecific *L. gyldenstolpei* would be.

There are infrequent examples in the literature of anurans preying on birds (Duellman and Trueb 1994. Biology of Amphibians. The John Hopkins University Press, Baltimore, Maryland. 670 pp.). This represents the only account that I am aware of documenting an Asian anuran preying on birds.

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LITHOBATES CATESBEIANUS (American Bullfrog)**. PREDATION ON CLIFF SWALLOWS.** The American Bullfrog is known to have a broad, omnivorous diet that includes plant material, aquatic and terrestrial invertebrates, and vertebrates (Bury and Whelan 1986. Ecology and Management of the Bullfrog. USFWS Res. Publ. 155. Washington, DC). During a 25-year study of Cliff Swallows (*Petrochelidon pyrrhonota*) in southwestern Nebraska, we observed *Lithobates catesbeianus* prey on, or attempt to prey on Cliff Swallows. Cliff Swallows feed exclusively on insects caught in flight. They are quick, agile fliers and rarely alight on the ground (Brown and Brown 1996. Coloniality in the Cliff Swallow: The Effect of Group Size on Social Behavior. University of Chicago Press, Chicago, Illinois), thus they are very unlikely prey for *L. catesbeianus*.

As we were mist-netting Cliff Swallows at a 10-nest colony on 7 July 1998, a *L. catesbeianus* attempted to eat a Cliff Swallow that was caught in the net. We were dropping the net over the side of a road culvert (Brown and Brown 1996, *op. cit.*; Lueschen 1962 Eastern Bird-Banding Association News 25:109) in which the birds' nests were built, near Roscoe, Keith County, Nebraska, USA (41.11931°N, 101.57523°W; NAD 83). When the net was lowered into place, the top was ca. 45–60 cm above the ground. The birds were caught in the net when they flew out of the culvert. The net was lowered over the culvert entrance for, at most, 10 seconds. A wet, marshy area, with ca. 20–25 cm of standing water, was situated at the mouth of the culvert. On one drop, with 3 adult swallows in the mist-net, a large (36–41 cm SVL) *L. catesbeianus* jumped up into the net from the standing water and caught a swallow by the head. We immediately raised the net. In the 15–20 seconds it took to raise and secure the net, the frog had swallowed the bird as far down as the bird's legs. The bird was still alive although seemingly stunned, and its feathers were matted with saliva when removed from the frog's mouth. The *L. catesbeianus* was released unharmed.

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OSTEOPILUS SEPTENTRIONALIS (Cuban Treefrog). **PREY.** The Cuban Treefrog is a large (to 165 mm SVL; Meshaka 1996. Herpetol. Rev. 27:74), predominantly nocturnal frog native to Cuba, the Isla de Pinos, the Cayman Islands, and the Bahamian Archipelago (Duellman and Crombie 1970. Cat. Amer. Amphib. Rept. 92:1–4). It commonly preys on invertebrates but has been observed feeding on small vertebrates including conspecifics (Peters 1974. Mitt. Zool. Mus. Berlin 50:299–322), small snakes, and hatchling birds (Bartlett and Bartlett 1996. Frogs, Toads, and Treefrogs. Barrons Publ., Hauppauge, New York). Here I report a diurnal predation attempt on an adult bird.

While working as a guide at Tiamo Resorts, a lodge on South Andros Island in the Bahamas in April 2006, I witnessed an adult Bananaquit (*Coereba flaveola*) ca. 110 mm long alight on a wooden handrail within 50 mm of a sleeping *O. septentrionalis* of comparable size; the frog awoke and attempted to catch the bird, succeeding only in grasping its retrices (tail feathers), which were shed in the ensuing struggle after which the bird escaped. The frog then retreated and closed its eyes with the feathers still protruding from its mouth. After ca. 3 min., still with eyes closed, the frog proceeded to push the feathers into its mouth with its forelimbs and consume them. This is the first recorded predation attempt by a Cuban Treefrog on an adult avian. I thank Bob Powell and Bob Henderson for providing comments on this note.

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OSTEOPILUS SEPTENTRIONALIS (Cuban Treefrog). **REPRODUCTION.** *Osteopilus septentrionalis* is native to Cuba, the Cayman Islands, and the Bahamas, including the Exumas, but has been extensively introduced or accidentally released outside its native range (Schwartz and Henderson 1988. Milw. Publ. Mus. Contrib. Biol. Geol. 74:1–264). However, its need for standing freshwater to reproduce has likely limited the ability of Cuban Treefrogs to colonize and successfully reproduce on small cays in the Bahamas because standing freshwater is often at a premium on these islands. Herein we report successful reproduction of *O. septentrionalis* on Southwest Allen's Cay (U Cay) in the Exumas in the central Bahamas (24.75°N, 76.84166°W; WGS 84; see Iverson et al. 2004. Herpetol. Monogr. 18:1–36 for a detailed description).

The presence of adult *O. septentrionalis* was first detected on U Cay in May 2001 (GRS and JBI, pers. obs.). Standing freshwater on U Cay is very limited, and frequently non-existent, except for short-term rain puddles. However, the presence of jetsam has created more permanent freshwater habitats on this island, and indeed the first adult *O. septentrionalis* was associated with an upright freezer found in the interior of the island (GRS and JBI, pers. obs.). We report on our observation of successful production of metamorphs from this upright freezer-based freshwater habitat. Metamorphs were observed on 14 May 2008, as well as numerous tadpoles ranging across several developmental stages and sizes. Our observation suggests that human-derived habitats may allow *O. septentrionalis*, and other amphibians, to colonize previously uncolonized islands and cays. Indeed, in Florida *O. septentrionalis* has been extremely successful at exploiting human-associated habitats, including reproducing in a variety of human-created habitats (e.g., cisterns, birdbaths, etc.; Meshaka 2001. The Cuban Treefrog in Florida: Life-history of a Successful Colonizing Species. University Press of Florida, Gainesville. 191 pp.), and its ability to colonize Anguilla appears to be tied to the use of cisterns (Townsend et al. 2000. Caribb. J. Sci. 36:326–328). The effect of such human-mediated colonization and reproduction on these small cays is not clear, and warrants further investigation.

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PHYLLOMEDUSA CAMBA (NCN). **MAXIMUM SIZE.** *Phyllomedusa camba* is distributed throughout the southwestern Amazon of South America from southeastern Peru and western Brazil to eastern Bolivia (De la Riva 1999. Rev. Esp. Herpetol. 13:123–31). Previous studies have reported the maximum snout–vent length (SVL) of the species to be 84.0 mm for females and 73.3 mm for males; the maximum mass record for the largest female is 22.5 g and 18.5 g for the largest male (De la Riva 1999, *op. cit.*; De la Riva et al. 1995. J. Herpetol. 29:113–18; Duellman 2005. Cusco Amazónico. Cornell University Press, New York, pp. 253–254; Duellman and Thomas 1996. Univ. Kansas Nat. Hist. Mus. Occ. Pap. No. 180:1–34). Here we report a new size record for the species.

Reserva Amazónica, previously known as Cuzco Amazónico (ca. 12.541666°S; 69.052777°W, WGS 84; 195 m elev.) is located in Provincia Tambopata, ca. 12 km E Puerto Maldonado on the north shore of the Rio Madre de Dios in southeastern Peru. On 27 Dec 2007 (2300 h), an adult *Phyllomedusa camba* was observed on a branch ca. 1 m above the ground. The branch extended over Trail-A ca. 200 m from the beginning of the trail. Although the frog was not collected, photographs and measurements were taken in the field at the time of capture and deposited at the University of Texas at Arlington (UTADC 1924–26). Measurements were taken with digital calipers and Pesola scales. Although we did not determine the sex of the frog, its large size (87.3 mm SVL; 42.5 g) suggests it was a female. Our record is the first for Reserva Amazónica since January and February 1990, when eight specimens (SVL range 68.9–73.9 mm; mass range 15.0–22.5 g) of this frog were found (Duellman 2005, *op. cit.*).

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POLYPEDATES LEUCOMYSTAX (Java Whipping Frog). **PREDATION.** Although invertebrate predators are known to feed on larval and metamorph anurans, predation of adult anurans by invertebrates are rarer, although regularly reported (see McCormick and Polis 1982. Biol. Rev. 57:29–58 for review). Here we report the first observation of predation upon an adult male *Polypedates leucomystax* by the Giant Water Bug, *Lethocerus deyrollei*, a commonly encountered belostomatid in Southeast Asia. The observation was made during the evening of 19 July 2006 in a buffalo pond in Sopchoun, Luang Prabang Province, Laos (19.7°N, 102.5333°E; WGS 84), a small village close to the Nam Kham River, a tributary of the Mekong River. *Polypedates leucomystax* is arboreal and builds foam nests on branches overhanging water. However, some populations lay eggs in a foam nest on the ground near the pond edge. This is the case of this population where the predated frog was disturbed by us and dove into the water. Predation on this species by the Giant Water Bug should be exceptional as these frogs have no aquatic phase. We caught the frog and water bug as soon as the observation was made, and the frog was already badly injured. Both specimens were deposited in the Muséum National d'Histoire Naturelle, Paris under the collection numbers MNHN 2006.3401 (*Polypedates leucomystax*) and MNHN 2006.3402 (*Lethocerus deyrollei*).

We thank Annemarie Ohler for the time shared in the field with one of us (SG).

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POLYPEDATES LEUCOMYSTAX (Common Tree Frog). **SAUROPHAGY**. On 27 June 2006 at 2104 h, in the Philippines (island: Luzon, province: Cagayan, municipality: Gattaran, barangay: Nassiping; 17.97001°N, 121.65598°E, WGS84), I collected an adult female *Polypedates leucomystax* in the process of consuming an adult male *Cosymbotus platyurus* (Sauria: Gekkonidae). The encounter occurred after ca. 2 h of heavy afternoon rain at the Nassiping Reforestation Project (NRP), an area of ca. 200 ha consisting of natural secondary growth, agricultural areas, and artificial forest with introduced species (e.g., *Eucalyptus* sp.). Both the frog and the lizard were collected and deposited at the University of Kansas Natural History Museum and Biodiversity Research Center (*P. leucomystax*: KU 307625; *C. platyurus*: KU 307448).

When I first observed the pair, the frog was on the ground with the gecko's hind legs and tail protruding from its mouth (Fig. 1) a few meters from an open-walled, thatch-roofed gazebo at the main compound of the NRP. Geckos were common on nearby buildings and active after nightfall; *C. platyurus* was predominant, with *Gehyra mutilata*, *Hemidactylus frenatus*, and *Gekko monarchus* also present.

The average to slightly larger-than-average size of both individuals (*P. leucomystax*: 72.1 mm SVL, 20.5 g; *C. platyurus*: 60.3 mm SVL, 6.1 g), as well as their commonness and tolerance for disturbed, anthropogenic habitat, suggest that adult *P. leucomystax* may be a frequent predator on *C. platyurus* and other small, common geckos. Large geckos (e.g., *G. monarchus*) are not likely to be preyed upon as adults, but neonates may be vulnerable. For these two individuals, prey/predator ratios of length and weight were 0.84 and 0.30.

Although large anurans (e.g., *Ceratophrys ornata*, *Discodeles guppyi*, *Pyxicephalus adspersus*, and *Rana catesbeiana*) are known to consume large prey items, predation by anurans on vertebrates is considered a general exception (Duellman and Trueb 1994. Biology of Amphibians. Johns Hopkins University Press, Baltimore, Maryland. 670 pp.) The diet of *P. leucomystax* in the Philippines has previously been reported to include solely invertebrates (Alcala and Brown 1998. Philippine Amphibians: An Illustrated Field Guide. Bookmark, Inc., Makati City, Philippines. 116 pp.). Saurophagy also has been reported for the large New World treefrog, *Osteopilus septentrionalis* (Campbell 2007. Herpetol. Rev. 38:440).



FIG. 1. Adult female *Polypedates leucomystax* consuming an adult male *Cosymbotus platyurus* on Luzon Island, Philippines, 27 June 2006. Note the everted hemipenis of the gecko. Photo by KH.

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RANA AURORA (Northern Red-legged Frog). **EGG MASS DISTURBANCE**. The negative effects of exotic organisms on amphibians, usually via predation and/or competition, are well documented, both globally (Kats and Ferrer 2003. Divers. Distrib. 9:99–110) and in the Pacific Northwest (Adams 2000. Ecol. Appl. 10:559–568; Kiesecker and Blaustein 1997. Ecology 78:1752–1760; Kiesecker and Blaustein 1998. Conserv. Biol. 12:776–787). Nutria (*Myocastor coypus*), a South American species introduced to Oregon in the 1930s for fur-farming, is known to damage vegetation and physical habitat, which has diverse indirect ecological effects (Sheffels and Sytsma 2007. Report on Nutria Management and Research in the Pacific Northwest. Portland State University Center for Lakes and Reservoirs, Portland, Oregon. 49 pp.). However, its effects on Pacific Northwest amphibians are unaddressed. Hence, here we describe disturbance to and disappearance of *Rana aurora* egg masses attributable to the foraging of Nutria.

In January–March 2005, TRC conducted visual encounter surveys (Crump and Scott 1994. *In* Heyer et al. (eds.), Measuring and Monitoring Biological Diversity: Standard Methods for Amphibians, pp. 84–92. Smithsonian Press, Washington, DC) for amphibian egg masses in a seasonal pond in a palustrine wetland complex on the Willamette River floodplain ca. 16 km N of Portland, Oregon, USA (45.66°N, 122.86°W; WGS 84; elev 4 m). Black Cottonwood (*Populus trichocarpa*), Oregon Ash (*Fraxinus latifolia*), and invasive Reed Canary Grass (*Phalaris arundinacea*) dominate the site, which is managed by the Oregon Department of Fish and Wildlife (ODFW). As part of a larger study, each egg mass was assigned a unique mark and monitored weekly. Two *R. aurora* egg masses initially detected on 10 February were missing on 3 March, when TRC found a vegetation platform at their former location constructed of the Common Rush (*Juncus effusus*) to which the egg masses had been attached. The platform, which included the bamboo stakes and flagging used to mark these masses, was littered with Nutria scat. Nutria, Beaver (*Castor canadensis*), Muskrat (*Ondatra zibethicus*), and a suite of waterfowl species are all recorded from this site, but the only sign near or on the damaged vegetation was that of Nutria. Thorough search of the area failed

to reveal the missing masses. TRC had last observed these masses on 24 February; at that time, both were intact and in Gosner Stage 17 (Gosner 1960. Herpetologica 16:183–190). Twenty-five other marked masses detected on the same initial date (10 February) were in Stages 13–17 on 24 February. Of these masses, 13 were in the process of hatching on 3 March, and eight had not yet begun to hatch, but even the hatching masses had remained mostly intact. Nutria commonly build platforms of compacted vegetation for resting, feeding, and grooming (Burt and Grossenheider 1980. A Field Guide to the Mammals, 2nd ed. Houghton Mifflin, Boston, Massachusetts. 289 pp.). We do not know the ultimate fate of the disturbed egg masses, but based on the chronology of nearby *R. aurora* egg masses that TRC first observed on the same date at the same developmental stage, hatching and total disintegration by 3 March was unlikely. During the first half of embryonic development, *R. aurora* egg masses are typically denser than the water in which they are laid, and they sink if detached from their brace (MPH, unpubl. data). Klaus Richter (pers. comm.) has experimentally shown that mortality increases in *R. aurora* egg masses artificially relocated to greater depth. Moreover, simply mechanically disturbing amphibian egg masses has been shown to decrease embryonic survival (Licht 1971. Ecology 52:116–124.; Garwood et al. 2007. Northwest. Nat. 88:95–97). In this study, *R. aurora* egg masses occasionally became detached from attachment vegetation on their own, but typically only as they aged and neared hatching, when they typically float. Moreover, in the absence of high wind or other substantial disturbance, such detached egg masses generally remained near the original oviposition site. Hence, *M. coypus* foraging has the potential to affect *R. aurora* reproduction both directly by displacement of egg masses, and indirectly by altering the availability of braces for attachment of eggs.

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RANA CAPITO (Gopher Frog). **BURROW COHABITATION.** Gopher Frogs seek refuge in the burrows of Gopher Tortoises (*Gopherus polyphemus*), crayfish, and several species of small mammals, as well as in stump holes (Jensen and Richter 2005. *In* Lannoo [ed.], Amphibian Declines: The Conservation Status of United States Species, pp. 536–538. Univ. California Press, Berkeley). Although Gopher Frogs are difficult to locate and observe in terrestrial habitats because they spend much of their lives underground, adults are not thought to share burrows with conspecifics (Jensen and Richter 2005, *op. cit.*; Wright and Wright 1949. Handbook of Frogs and Toads of the United States and Canada. Comstock Publishing Co., Ithaca, New York. 640 pp.). Here we report observations of at least two, and possibly three, adult Gopher Frogs occupying a Gopher Tortoise burrow simultaneously.

During a radio-telemetry study on Gopher Frogs conducted in the Ocala National Forest, Marion and Putnam counties, Florida, USA, we observed one transmitter-equipped adult Gopher Frog (Frog 1) sitting beside a large Gopher Tortoise burrow on 8 Oct 2007 at 2030 h. We also observed a second adult Gopher Frog (Frog 2), which was not equipped with a transmitter, sitting in the entrance to the same burrow (Fig. 1). Frog 1 had left a breeding pond within the previous 24 h, which was located 112 m from the burrow. Gopher Frogs can occasionally be observed sitting beside burrows at night and often create distinctive resting areas, consisting of soil cleared of vegetation (Richter et al. 2001. J. Herpetol. 35:316–321). Thus, although only one frog was actually inside the burrow, the two frogs probably shared the burrow diurnally.



FIG. 1. Two adult Gopher Frogs (*Rana capito*) observed at a Gopher Tortoise (*Gopherus polyphemus*) burrow in the Ocala National Forest, Florida. One frog (left) was in the burrow entrance, while the other frog (right) was sitting beside the burrow.

On 11 Oct at 2100 h, following a prescribed fire earlier that day, Frog 1 and a second transmitter-equipped adult Gopher Frog (Frog 3) were both located inside the same Gopher Tortoise burrow described above. Frog 1 had remained in the burrow since 8 Oct, and Frog 3 was located in leaf litter 22 m from the burrow during the previous day. Although no frogs were visible, Frog 2 may have also remained in the burrow since 8 Oct and thus may have been a third frog occupying the burrow. The two frogs with transmitters (Frogs 1 and 3) cohabited this burrow for 11 days until 22 Oct when Frog 3 moved 30 m into a stump hole.

Although adult Gopher Frogs have not been previously reported to cohabit burrows with conspecifics, they may only share them temporarily during fires or migrations to and from breeding ponds, or cohabitation may be more common than previously thought, but rarely observed due to the difficulty in monitoring individuals at burrows.

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RHINELLA JIMI (Cururu Toad) and ***LEPTODACTYLUS VASTUS*** (Northeastern Pepper Frog). **PREDATION ON BATS.** Anurans are primarily sit-and-wait foragers, and capture primarily insect prey (Toft 1981. J. Herpetol. 15:139–144). The predation of bats by two anuran species, *Rhinella jimi* and *Leptodactylus vastus*, was observed at the entrance of the Casa de Pedra cavern in Itabaiana, in the Brazilian state of Sergipe (10.833°S, 37.450°W; SAD 69). The cave is ca. 200 m long and has an internal temperature of ca. 39ºC. The entrance is ca. 5 m wide × 1.5 m high. The predation of a bat by *L. vastus* was first observed in 1998, and additional observations involving *L. vastus* and *R. jimi* were recorded in 2006 and 2008.

As night falls, individuals of both species position themselves close to the cave entrance to wait for the "explosive" (Fenton et al. 1994. Anim. Behav. 48:9–18) exit of the resident bats, which fly outside to forage between 1730 h and 2200 h. As they crowd through the narrow opening, some of the bats collide with each other and may fall to the ground, where the anurans are waiting. As soon as a bat falls to the ground, one of the anurans pounces rapidly forward to seize the animal directly in its mouth, without using its tongue (Fig. 1).

Although anurans are known to prey on many types of vertebrates (Duellman and Trueb 1986. Biology of Amphibians. McGraw-Hill, NewYork. 670 pp.), this appears to be the first record of feeding on bats, and might be related to specific circumstances. Analysis of stomach contents revealed the predation of Wagner's Mustached Bat (*Pteronotus personatus*) by both anurans. *Leptodactylus vastus* was also observed preying on a Mexican Funnel-eared Bat (*Natalus stramineus*). As records now span a decade, it is clear that a foraging "tradition" has been established in these anuran populations, although more observations are required to assess the importance of this behavior in ecological terms.

We thank Celso Morato de Carvalho for identification of the anurans, Renato Gomes Faria, João Pedro Souza Alves, Fábio Nascimento dos Santos, and Stephen Ferrari for revision of the text.



FIG. 1. Two toads (*R. jimi*) at the entrance of the Casa de Pedra cave (A). One of the toads pouncing on (B), seizing (C) and ingesting (D) a bat. Photographs by PAR.

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RHINELLA ORNATA (NCN). **PREDATION**. *Rhinella ornata* is a small bufonid found in the states of São Paulo, Rio de Janeiro, Espírito Santo, and Paraná, Brazil (Baldisscra et al. 2004. Nat. Mus. Rec. 62:255–282). In the region of Botucatu, SP, Brazil (22.8495°S, 48.4284°W; WGS 84), the species breeds in permanent ponds next to the forest during the dry season, between May and September. The males vocalize from the shallowest edges of the pond, but it is common to see them moving throughout the pond searching for females. In August 2005, a *Salminus brasiliensis* (Characidae) was captured in a pond in the Aquaculture Division of the School of Veterinary and Animal Science in the Paulista State University of Botucatu. This fish had a recently ingested *R. ornata* in its stomach. The anuran was a female with mature eggs in its ovary and was swallowed headfirst (Fig. 1). There are few reports of adult frogs being eaten by fish. The presence of toxic secretions on the skin and especially in the parotid glands, protects the toads from predators. The poison glands of *R. ornata* are not big and the quantity of poison stored can be very small or the poison toxicity can be very low, thus not affecting the fish (Cardoso and Sazima 1977. Cic. Cult. 29[10]:1130–1132).

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FIG. 1. Female *Rhinella ornata* eaten by *Salminus brasiliensis*.

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SCAPHIOPHRYNE CALCARATA (NCN). **TADPOLE BIOLOGY**. *Scaphiophryne* tadpoles are unique in their morphology as they are intermediate between the ranid and microhylid types. They possess neither keratinized teeth nor horny beaks, but are equipped with rows of oral papillae. This morphology allows them to filter-feed as well as to use their papillae as instruments to wipe particles off the substrate or to churn up particles from the bottom.

In the dry deciduous forest of Western Madagascar, *S. calcarata* tadpoles occasionally form aggregations where members may benefit from feeding as a group. On several occasions from 1999 to 2002 I observed dense aggregations of 20–100 tadpoles in small puddles (surface area 1–3 m^2, no tadpole predators present) within the Kirindy/CFPF Forest, a 10,000 ha remnant of the deciduous dry forest of Western Madagascar. In each of these aggregations, a few (5–10) tadpoles were digging with their mouthparts into the muddy substrate, ingesting it, and thereby churning it up. The majority of tadpoles in such an aggregation, however, were clumped behind these digging tadpoles, and were obviously filtering the stirred-up substrate. These tadpoles likely profit from the action of the others by increasing their ingestion rate without increasing their feeding costs. This observation supports the view that a feeding benefit, in addition to predation avoidance, is a factor leading to the formation of social aggregations in tadpoles.

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SCAPHIOPUS HOLBROOKII HOLBROOKII (Eastern Spadefoot). **MAXIMUM SIZE.** The maximum body size reported for *Scaphiopus h. holbrookii* is 7.3 cm SVL (Conant and Collins 1998. A Field Guide to Reptiles and Amphibians of Eastern and Central North America, 3rd ed., expanded. Houghton Mifflin Co., Boston, Massachusetts. 616 pp.; Wasserman 1968. Cat. Am. Amphib. Rept. 70:1–4). Herein we report a record SVL for *S. h. holbrookii*.

A male *S. h. holbrookii* was captured in a box trap on 23 Oct 2007, following a 9.5 cm rain event the previous evening on the Camp Shelby Joint Forces Training Center, Perry Co., Mississippi, USA. The mean SVL of this individual was 7.8 cm (SE = 0.03, N = 5). The SVL was measured from the tip of the snout to the posterior edge of the vent with the anuran placed on its back. The mean SVL was determined from independent measurements by five herpetologists; this reduced possible biases in individual measuring techniques and provided a measure of dispersion (standard error) for SVL. All measurements were made to the nearest millimeter with either a standard metric ruler or digital calipers.

The *S. h. holbrookii* was deposited into the herpetological collection of the Mississippi Museum of Natural Sciences (MMNS 16000). We thank Matthew Hinderliter, Aaron Holbrook, and Thomas Radzio for their measurements.

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SYRRHOPHUS NITIDUS (Shiny Peeping Frog). **DEATH FEIGNING**. Many anurans rely on escape behavior to avoid predation, but some, especially species incapable of rapid escape, have developed various defensive behavior in response to encounter by predators (Duellman and Trueb 1986. Biology of Amphibians. McGraw-Hill, New York. 670 pp.). Death feigning is a common anti-predator behavior in amphibians, and has been observed in several species of anurans (Fatorelli and Duarte 2005. Herpetol. Rev. 36:301; Kokubum 2005. Herpetol. Rev. 36:299). Herein, death feigning is reported in *Syrrhophus nitidus*, a species endemic to Mexico.

On 2 Aug 2006, along a creek in Quilamula, Morelos, México, a *S. nitidus* was observed on the ground. One of us (CAMS) lifted it gently with the hand to identify it. At the moment of opening the hand, the frog was found lying on its back with the eyes closed with one of the hind legs extended, feigning death. The frog kept that position for 40 sec., after which it turned quickly and tried to jump to the ground. A couple of days later the same behavior was observed in three more individuals. All of them displayed the death feigning behavior when lifted from the ground. Some of the frogs stayed still on the palm of the hand from 40 seconds to one minute. All were video-taped and released where found. We believe this to be the first published report of death feigning in *Syrrhophus nitidus*.

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CROCODYLIA — CROCODILIANS

CROCODYLUS MORELETII (Morelet's Crocodile). **NESTING ECOLOGY.** Nesting season for *Crocodylus moreletii* begins with clutch deposition between May and mid-July, though laying maxima occur between mid-June and mid-July. Hatching occurs between August and October (Casas-Andreu and Rogel-Bahena 1986. An. Inst. Cienc. Mar Limnol., Univ. Nac. Auton. México. 13:323–330; Platt et al. 2008. J. Zool. 275:177–189). *Crocodylus moreletii* is regarded as a species that builds a mound nest, composed of vegetation, soil, leaves, and woody debris (Álvarez del Toro and Sigler 2001. Los Crocodylia de México. 1ª Edición, Imernar, Profepa, México. 134 pp.; Platt et al. 2008. J. Zool. 275:177–189). However, few data exist on nesting habitat and the material for nesting across the range of *C. moreletii*. Hence, here we present observations on its nesting ecology during 2007–2008

On 20 June 2007, we discovered a nest of *C. moreletii* at the precise moment of hatching in El Cuyo, Campeche, México (19.99806°N, 90.46528°W, datum WGS84; elev. <1 m). The nest was built on a sandbank along the exposed seashore on the edge of a mangrove forest (*Rhizophora mangle* and *Avicennia germinans*). Nest materials consisted of a mix of mollusk shells, rocks, sand, vegetation, and Mayan archeological remains (pottery fragments). Based on the mean incubation period estimated by Platt et al. (2008. J. Zool. 275:177–189: incubation period: 75 ± 11 days, range: 61–100 days), laying in the El Cuyo nest likely ocurred in early April 2007. Clutch size was 32: mean egg length was 74.4 ± 3.1 mm (range: 71.1–77.9 mm, N = 5), and mean egg width was

47.3 ± 0.5 mm (range: 46.5–47.8 mm). Only one hatchling had hatched, and it was 27.3 cm total length and weighed 100 g.

During nocturnal surveys on the road El Remate–Isla Arena, Campeche (20.53500°N, 90.37250°W, datum:WGS84; elev. <1 m.) in July 2008, we captured five *C. moreletii* hatchlings, one with the egg-tooth still present. Ferguson (1985. *In* Gans [ed.]. Biology of the Reptilia Vol. 4, pp. 329–341. John Wiley & Sons, New York) observed that the egg-tooth usually drops off during the first or second week of post-hatching development. Mean total length of hatchlings was 30.7 ± 2.3 cm (range: 28.9–34.7 cm) and mass was 70.4 ± 10.3 g (range: 60.0–90.0 g). Using the model of Platt et al. (2003. Herptol. Rev. 34:121–122) to calculate the age of *C. moreletii*, we estimated the incubation period at 92 ± 11 days. Thus, if these hatchlings belonged to aforementioned observed nest, oviposition would have been close to 11 April 2008.

Oviposition timing of *C. moreletii* we observed in Campeche is similar to that observed for *C. acutus*. Clutch deposition in *C. acutus* in México occurs from March to May, and hatching from June to August (Casas-Andreu 2003. Acta Zool. Mex. [n.s.] 89:111–128). In Belize, *C. acutus* also deposits eggs from March to May, and hatching occurs from June to July (Platt and Thorbjarnarson 2000. Copeia 2000:869–873). Based on habitat and oviposition date, our observations may represent at least one nest of a *C. moreletii* × *acutus* hybrid (Platt et al. 2008. J. Zool. 275:177–189). In the Yucatán Peninsula, the distribution of *C. acutus* remains poorly defined. Ernst et al. (1999. Cat. Amer. Amphib. Rept. 700:1–17) state that the distribution of *C. acutus* in the Gulf of Mexico begins in Tabasco, and hence, *C. acutus* may occur in Campeche and hybridize with *C. moreletii*. Ray et al. (2004. Cons. Genet. 5:449–462) determined that a region of hybridization between these two species exists in Belize, and Cedeño-Vázquez et al. (2008. J. Exp. Zool. 309A, *in press*) found an area of hybridization in Quintana Roo, México. These data may indicate that the Yucatán Peninsula represents a general zone of hybridization between *C. moreletii* and *C. acutus*.

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TESTUDINES — TURTLES

ACTINEMYS* (= *CLEMMYS*) *MARMORATA (Western Pond Turtle)**. COURTSHIP BEHAVIOR.** Little has been published on the courtship behavior of *A. marmorata*. Here I contribute to the growing body of observations documenting courtship behavior with additional observations of courtship display and presumed mating in the wild accompanied by a series of photographs.

On 18 April 2008, while conducting herpetological surveys along Vaqueros Creek, a tributary to the Arroyo Seco River in Monterey County, California, J. Henricks and I observed two *A. marmorata* engaged in courtship activity in the depths of a ca. 1.5 m pool. Both turtles were located at the base of a bedrock slab that extended above water from the pool's rock/gravel substrate. The pair was first observed in the bottom of the pool facing each other. The female was facing away from us and had retracted her legs, but was anchored in place by her partially extended hind-limbs. The male was facing toward us, and was observed actively scraping/waving his forelimbs at the anterior marginal shields of the female's carapace, alternating between limbs and pausing briefly between bouts. At approximately 1446 h, the male noticed our presence and abandoned the female to surface, where he floated for several seconds to inspect us, head fully extended and making eye contact before diving and returning to the pool bottom where he resumed his courtship display. This ritualized courtship display was reinitiated for 35 seconds before the female attempted to reorientate herself away from the male, at which time the male swam around and repositioned himself to face the female, who resumed her earlier posture. This ritual of limb-waving (male), reorientation (female), and repositioning (male) continued several times until, at approximately 1452 h, the female had reorientated herself 180 degrees from her original position to face us. As soon as the female noticed our presence, she abandoned the male's advances and fled downstream, followed shortly by the male. The entire encounter lasted at least 6 minutes, 30 seconds (Figs. 1a–1d). These observations are loosely in accordance with *A. m. marmorata* courtship activity described in detail by Ashton (2007. Herpetol. Rev. 38:327–328), who described similar instances of ritualized behavior.

On 19 April 2008, while continuing herpetological surveys along a downstream portion of Vaqueros Creek, Henricks and I observed two *A. marmorata* in the act of mating. A third uninvolved *A. marmorata* was observed ca. 1 m upstream of the pair. The pair was first observed at 1412 h in the shallow waters (~ 10 cm) of

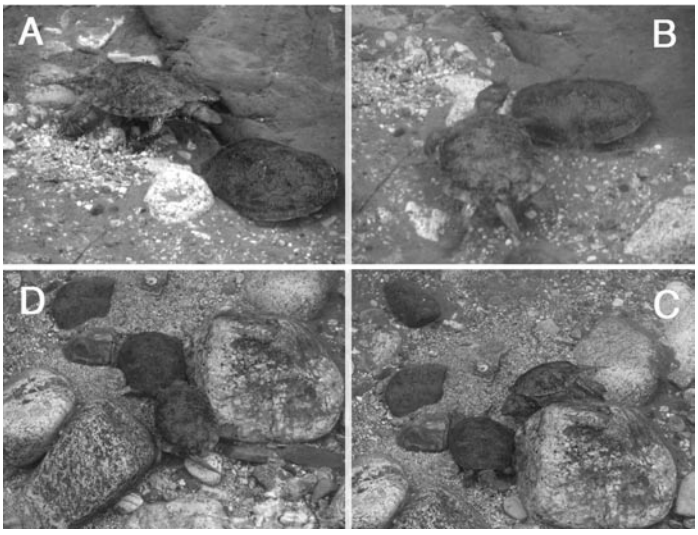


FIG. 1. Time-lapse series detailing ritual courtship display of *Actinemys marmorata*, depicting limb-waving (Fig. 1a), reorientation, and repositioning (Fig. 1b–1d).

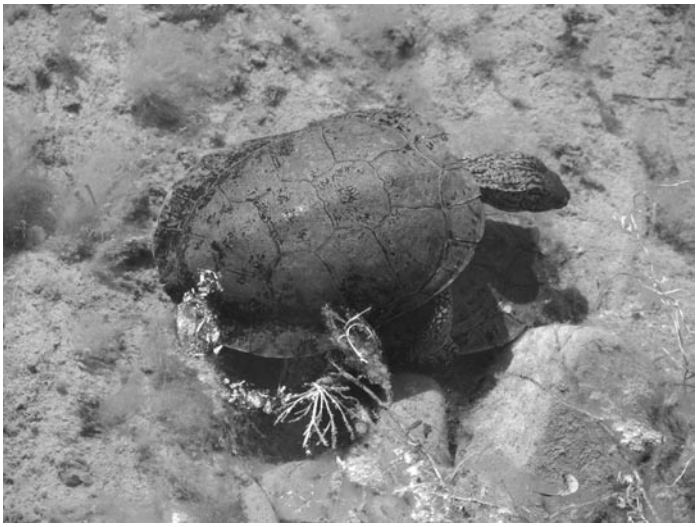


FIG. 2. *Actinemys marmorata* pair in the act of mating.

a bedrock and cobble-lined section of the creek, within 30 cm of the shoreline. The male had mounted the female at a ca. 45° angle; his forelimbs were firmly grasping the female's carapace near the fifth marginal shields, and his head was extended downward at a right angle toward the creekbed (Fig. 2). The male's tail was not visible from our elevated vantage point. The pair was observed so entwined for ca. 20 seconds before the male noticed our presence and extended his head above water to inspect us. Several seconds passed before, undeterred, the male lowered his head underwater and resumed mating until the female noticed our presence several seconds later and disengaged the male. All three turtles fled to the near bank and took cover beneath an algal mat.

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BRAZILIAN AMAZONIAN TURTLES. HABITAT. Very little is known about the habitat or distribution of the small non-riverine freshwater turtles that inhabit the Brazilian Amazon (Rueda-Almonacid et al. 2007. Las Tortugas y Cocodrilianos de los Países Andinos del Trópico. Conserv. Intern. Bogotá, D.C. – Colombia. 467 pp.). Although the ecology of some of these species is known for other parts of their wide distribution (e.g., *Kinosternon scorpioides* in Mexico, Colómbia, and coastal Brazil) their ecology and distribution within the Amazon Basin has been an enigma. There are records for single captures of *K. scorpioides* on a road in Roraima, near the Solimões River near Manaus, and in the Mamirauá Reserve near Tefé, but no populations were found. Similarly *Rhinoclemmys punctularia* has appeared sporadically on the road to Boa Vista from Manaus in Roraima, near Mindu igarapé in Manaus and near the Trombetas Reserve in Pará, but again no populations have been documented. We have collected *Phrynops gibbus* from shallow permanent forest pools in several different forests in the Amazon and can say with some confidence that they prefer shallow forest pools associated with buriti palms (*Mauritia* sp.), one of the principal fruits in their diet (Vogt et al., this report). It is also established (e.g., Pritchard and Trebbau. 1984. The Turtles of Venezuela. SSAR Contr. Herpet. 2, Ithaca, New York) that *Platemys platycephala* forages in ephemeral rain-filled forest pools throughout their range, and they are typically the only chelonian species found in these pools. Until now we have found only one species at any one time in the pools they inhabit.

On 22 April 2008 we visited forest wetlands 4000 m from the shore of the Amazon River within high evergreen rainforest near Tucumanduba, Municipality of Barreirinhas, Amazonas, Brazil (2.94575°N, 57.02408°W). We searched for turtles in seven different ponds ranging from 7 m to 50 m in diameter. The water was transparent and 20–30 cm deep. The substrate was covered with either grasses and/or decomposing leaves. The ponds were scattered within the rainforest and only a limited amount of light passed through the canopy to the ponds. The ponds are never connected, even at the height of the rainy season, and the flood waters of the Amazon River do not extend this far into the forest. However, water in the ponds filters out or evaporates in the dry season, and presumably the turtles either aestivate in the bottom of the ponds, in the forest, or move overland to a small forest stream (Sr. Bicó, pers. comm.). Turtles were collected by muddling with help of a local collector (Sr. Bicó). In addition to the turtles we captured, we also examined turtles that Sr. Bicó had previously taken in these ponds. We recorded the straight-line carapace length and mass of each turtle captured. This survey resulted in 27 *K. scorpioides*: seven adult males (mean CL 130.27 mm ± 10.55 and mean mass 288.57 g ± 71.05), 16 adult females (CL 129.24 mm ± 24.26 and 263.13 g ± 113.77) and four immatures (CL 65.05 mm ± 10.52 and 41.25 g ± 19.31); five *R. punctularia*: three immatures (CL 86.49 mm ± 11.84 and 105 g ± 47.67), one adult female (CL 113.63 mm and 280 g) and one male (CL 188 mm and 600 g); six *P. gibbus*: one immature (CL 85.61 mm and 70 g), one male (CL 181.41 mm and 530 g) and four females (mean CL 148.94 mm ± 27.67 and mean mass 500 g ± 247.11) and five *P. platycephala*: two immatures (mean CL 87.73 mm ± 28.74 and mass of 75 g) and three females (mean CL 129.97 mm ± 15.58 and mean mass of 260 g ± 98.49). All species reported were caught together in at least one of the ponds, and there was no evidence that any of these species was using one pond more than another. Analyzing fecal samples we observed that three of the four species had fed on plant material (fruits, seeds, leaves, and algae) while the *P. platycephala* had consumed only animal foods.

We thank Joelza for help with the fieldwork. This research was conducted under the auspices of CNPq and IBAMA's permit nº 14029-1.

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CHRYSEMYS PICTA (Painted Turtle)**, *GRAPTEMYS GEOGRAPHICA*** (Northern Map Turtle)**, *TRACHEMYS SCRIPTA*** (Pond Slider). **AURAL ABSCESSES**. The incidence of aural

abscesses in turtles may be linked to various environmental factors such as organochlorine contamination via its effects on Vitamin A metabolism (Holladay et al. 2001. Ecotoxicol. Environ. Safety 48:99–106; Brown et al. 2004. J. Wildl. Dis. 40:704–712) or climatic conditions (e.g., excessive rainfall; Dodd and Griffey 2004. Herpetol. Rev. 35:233–235). Thus, aural abscesses may be an indicator of environmental stressors on turtle populations. It is therefore important to obtain a baseline for aural abscess prevalence in turtle populations to understand if changes in aural abscess frequencies are occurring and what might drive variation in their frequency over time or among populations (see also Gamble 2007. Chel. Conserv. Biol. 6:293–295).

We used a long-term mark-recapture dataset on a community of turtles from a lake in northern Indiana to examine aural abscess prevalence in three species, Painted Turtles (*Chrysemys picta*), Northern Map Turtles (*Graptemys geographica*), and Pond Sliders (*Trachemys scripta*). In addition, we were able to look for evidence of recovery from aural absesses.

Since 1979 we have nearly annually surveyed the turtle community in Station Bay in Dewart Lake, Kosciusko Co., Indiana, USA (41.37°N, 85.77°W) using box traps, fyke nets, basking traps, and dip nets (see Smith et al. 2006. J. Herpetol. 40:180–185 for details). Over the course of the study we have examined 1994 individually-marked Painted Turtles, 346 individually-marked Northern Map Turtles (plus 157 captures not marked), and 143 individually-marked Pond Sliders. Of the 1994 Painted Turtles, we observed four turtles with aural abscesses (0.2%). No Northern Map Turtles and Pond Sliders were observed with aural abscesses. All four of the Painted Turtles with aural abscesses were recaptured after the initial observation of the abscess. Three of these turtles were subsequently recaptured and the abscesses were gone.

Our observations suggest the incidence of aural abscesses is quite low in the Dewart Lake turtle community, and that turtles can recover from aural abscesses. The frequency of aural abscesses in *C. picta* that we observed is similar to the frequencies found in several populations of *C. picta* from Minnesota (Gamble 2007, *op. cit.*) and Iowa (Christiansen et al. 2004. J. Herpetol. 37:293–298). The only previous observations of aural abscesses in *T. scripta* and *G. geographica* also found no aural abscesses (Christiansen et al. 2004. J. Herpetol. 37:293–298). It thus appears that for many aquatic emydids, the natural frequency of aural abscesses is very low, and populations with higher frequencies of aural abscesses, as observed in some of the populations in Minnesota studied by Gamble (*op. cit.*), might indicate some sort of external stressor upon those populations.

We thank the many students, colleagues, and family members who have helped catch turtles at Dewart Lake. Funding was provided by Earlham College, Denison University, and our families. We thank Quaker Haven Camp (particularly T. and J. Dain) for housing, the Neffs and Mullens for storing equipment, and the late B. Haubrich for use of his pier.

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EMYDOIDEA BLANDINGII (Blanding's Turtle). **CLUTCH SIZE.** Maximum clutch size for *Emydoidea blandingii* has been variously listed as 19 eggs (Congdon et al. 2008. Chel. Res. Monogr. No. 5, pp. 015.1–015.12), 21 eggs (Harding 1997. Amphibians and Reptiles of the Great Lakes Region. University of Michigan Press, Ann Arbor, Michigan. 378 pp.), or 22 eggs (Rowe 1992. Can. J. Zool. 70:1690–1695). Sajwaj et al. (1998. Final report to Non-game Wildlife Office, Minnesota Department of Natural Resources, Brainerd, Minnesota) lists 24 eggs and a maximum total clutch wet mass of 310 g in a central Minnesota population. Here, we report an observation of a female Blanding's Turtle from Anoka County, Minnesota that produced a single clutch of 23 eggs and a total clutch wet mass of 316.7 g.

On 28 June 2008 at 2145 h we observed an adult female *E. blandingii* (carapace length = 217.4 mm, plastron length = 198.5 mm) constructing a nest. The nest was constructed in sandy soil, ca. 185 m from water, and completed by 0300 h on 29 June 2008 (total lapsed time = 2 h 45 min). Nest depth was 172.0 mm, with an opening diameter of 133.5 mm at the top and 98.0 mm width near the bottom. Eggs at the top of the nest were covered by approximately 10 mm of sand. Mean egg mass was 13.8 g (SD = 0.6 g, range = 12.5–14.8 g), mean egg length was 35.36 mm (SD = 0.97 mm, range = 33.78–37.40 mm), and mean egg width was 24.78 mm (SD = 0.54 mm, range = 23.65–25.69 mm).

Clutch size of *E. blandingii* is highly variable (DePari et al. 1987. Can. Field-Nat. 101:440–442); mean clutch size differs geographically and ranges between 8.3–17.7 eggs (Sajwaj et al. 1998, *op. cit.*; Gibbons 1968. Can. J. Zool. 46:288–290). In *E. blandingii*, clutch size may increase with body size (Congdon et al. 2008, *op. cit.*), although Rowe (1992. Can. J. Zool. 70:1690–1695) and DePari et al. (1987. Can. Field-Nat. 101:440–442) did not observe this in Nebraska and Massachusetts populations, respectively. In a large southeastern Minnesota population (Weaver Dunes), mean clutch size was 9.8 and body mass of females averaged 1080 g; carapace length (CL) averaged 197.0 mm and mean egg size was 37.5 mm (length) × 23.5 mm (width). Eggs from this population averaged 12.7 g; mean total clutch wet mass was 112 g. Sajwaj et al. (1998, *op. cit.*) reported that adult Blanding's Turtles in a central Minnesota population (Camp Ripley) are substantially larger than other known populations (males = 2440 g, 260.3 mm CL; females = 2210 g, 244.6 mm CL,) and this population has produced the largest mean clutch size (17.7), several large clutches of 23–24 eggs, and a maximum single clutch mean egg weight of 16.3 g. The current nesting site, near Carlos Avery Wildlife Management Area, is 151 km SE of Camp Ripley and 135 km NW of Weaver Dunes. Despite the moderate size of the nesting female and typical egg dimensions described herein, this female apparently produced the largest total clutch wet mass recorded for *E. blandingii*.

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GRAPTEMYS OCULIFERA (Ringed Map Turtle). **FORAGING BEHAVIOR**. Species in the emydid turtle genus *Graptemys* are highly aquatic, yet dietary studies indicate occasional consumption of terrestrial insects to complement the more typical aquatic prey, which may include insect larvae, snails, clams, mussels, sponges, bryozoans, and algae (e.g., Kofron 1991. Amphibia-Reptilia 12:161–168; Lindeman 2000. Can. J. Zool. 78:992–1008; Lindeman 2006. Chel. Cons. Biol. 5:25–31; Shealy 1976. Bull. Florida St. Mus. Biol. Sci. 21:47–111; Webb 1961. Amer. Midl. Nat. 65:193–214). Insects may be taken after they fall to the water's surface, but terrestrial feeding by *Graptemys* has not been described. Here I detail observations of one or more male *G. oculifera* repeatedly searching for and taking insects from their terrestrial perches on a floating log.

On the morning of 25 May 2008 I observed a group of *G. oculifera* basking on a floating log lodged behind erosion-control structures beneath the Interstate 59 crossing of the West Pearl River (St. Tammany Parish, Louisiana, USA). From a shaded location on shore ca. 25 m from the log, I used a spotting scope with 30× magnification and built-in digital camera to observe basking by at least six different individuals. Initially, a male was observed straddling the log in a typical basking orientation with neck extended and head up, facing the shore. A small (ca. 1 cm long) winged insect crawled toward the male, made brief contact with the anterior edge of his plastron, and retreated. The male appeared to take no notice of the insect until this contact, then it looked down and quickly grasped the insect in its mouth and re-entered the water. In subsequent observations, a turtle (possibly the same male) was observed facing the log, holding its head above the level of the log. The turtle sometimes sat in this position for several seconds before either submerging or pulling itself up on the log with its forelimbs. On six occasions I observed the turtle pull itself up partway onto the log as if initiating a basking session, but then quickly dropping back into the water before coming completely out of the water; on two of these occasions, it was observed to make quick strikes to take insects from the log, presumably consuming them under water. The insects were unidentified but may have been wasps, based on constrictions observed at their abdomens.

Cagle (1953. Zoologica 38:137–144) observed two *G. oculifera* swimming against the current and straining to extend their mouths toward a log, at a point above the waterline, apparently to feed. Carr (2008 Southeast. Nat. 7:748–752) described repeated brief terrestrial foraging forays made by *G. pseudogeographica* along a riverbank in Louisiana. He interpreted those turtles' actions as directed at eating herbaceous plants. My observations suggest that terrestrial insects might also have been a target of their foraging behavior. Cagle's and Carr's observations and those detailed here document terrestrial feeding behavior that might explain the origin of some of the terrestrial insects included in dietary samples from species of *Graptemys*. I thank W. Selman for comments on the manuscript.

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MALACLEMYS TERRAPIN TERRAPIN (Northern Diamondback Terrapin). **CONJOINED INDIVIDUALS**. On 13 September 2007, two conjoined Northern Diamondback Terrapin hatchlings were found at Jamaica Bay Wildlife Refuge, a unit of the Gateway National Recreation Area, Queens County, New York, USA (Fig. 1). They were found on a trail, lying on their carapaces, apparently unable to right themselves. The timing and location of this find suggests that they came from one of the few nests in this area to avoid predation, incubated naturally, successfully emerged from the nest, and walked at least a short distance.



FIG. 1. Photograph of conjoined *Malaclemys t. terrapin* on 13 September 2007, the day they were discovered by a visitor of Jamaica Bay Wildlife Refuge Queens New York. Photo by ELR.

They are being raised at Cold Spring Harbor Fish Hatchery in Cold Spring Harbor, New York. The hatchlings each have two forelimbs, but share hindlimbs. There are also two tails, one larger than the other. Radiographs indicated that the terrapins are joined at the pelvis or just anterior to the pelvis (Fig. 2). The right hatchling seemed underdeveloped and was the weaker of the two. They weighed 6.19 g. The right individual had a 21.9 mm carapace length (measured from nuchal to the shared pygial);

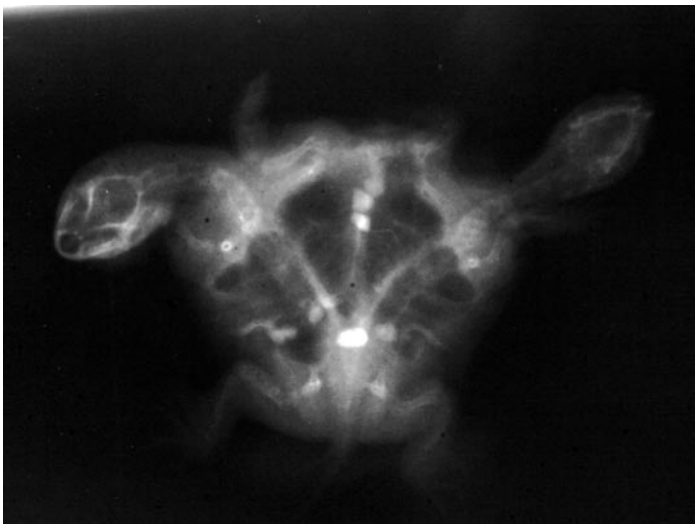


FIG. 2. Radiograph of conjoined *Malaclemys t. terrapin* on 22 July 2008, illustrating attachment at or just anterior of the pelvis.

20.1 mm plastron length; head width of 6.5 mm; and 7 left and 12 right marginal scutes. The left individual had an 18.9 mm carapace length; 20.1 mm plastron; head width of 7.7 mm; and 6 right and 12 left marginal scutes. Combined, measured down the middle, the carapace length was 22.6 mm; the plastron was 24.0 mm; the two tails measured 9.8 and 5.0 mm, respectively.

Approximately a month after they were discovered, 11 November 2007, the right hatchling had developed more and was starting to take more control in combined movements. They were alive and feeding on 11 August 2008.

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MAUREMYS RIVULATA (Balkan Terrapin). **TOURIST HABITUATION AND DIET**. Although *Mauremys rivulata* is known to tolerate human-modified habitats, and remains locally abundant, it is generally wary and most easily observed from a distance. The species is omnivorous, and bread has been noted in diet summaries since 1899 (Loveridge and Williams 1957. Bull. Mus. Comp. Zool. Harvard, 115, 557 pp.; Valakos et al. 2008. The Amphibians and Reptiles of Greece. Ed. Chimaira, Frankfurt am Main, 463 pp.).

On 24 June 2008, I witnessed several dozen Balkan Terrapins converge just below the downstream side (on the in-bound lane of the roadway above) of the bridge on the western outskirts of Skala Eresou on Lesvos Island, Greece, in response to the stopping of a tour bus on the bridge above the water course. The tour bus had paralleled the water course for several kilometers prior to stopping on the bridge, and appropriate aquatic habitat for this species was clearly available for some distance upstream. When, however, the driver tossed bread fragments into the water below, terrapins began to arrive in substantial numbers (Fig. 1) from both up- and downstream. Competition for the bread was, at times, violent and often involved several terrapins. Uwe Fritz (Museum of Zoology, Dresden, pers. com.) reported seeing similar behavior in western Crete and had heard of similar tourist habituation in this species in areas along the south coast of Turkey. These observations suggest that this behavior probably occurs at a number of tourist sites within the range of *M. rivulata*, but has gone unreported until now.

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PSEUDEMYS GORZUGI (Rio Grande Cooter). **KYPHOSIS.** Kyphosis (abnormal convex curvature of the spine) has been reported in several chelonian families, including several emydids, and may result from a variety of environmental factors and ontogenetic miscues (Plymale et al. 1978. Southwest. Nat. 23:457–462). On 17 June 2008, I captured a distinctly kyphotic adult *P. gorzugi* (Fig. 1) in the Black River at Black River Village, Eddy County, New Mexico, USA (32.22327°N, 104.21791°W; WGS 84). The apex of the carapace was slightly left of the midline at the junction of the second and third vertebral scutes, suggesting kyphoscoliosis similar to that reported for *Trachemys g. gaigeae* in New Mexico (Stuart and Painter 2008. Herpetol. Rev. 39:218–219). Scutellation was abnormal with regard to shape of vertebral and costal scutes, and two extra left costals were present posterior to C3. The ratio of shell height to carapace length was 0.54, shell height to carapace width was 0.68, and carapace width to carapace length was 0.80. The cooter appeared to be healthy and was released alive. This is the first report of kyphosis in *P. gorzugi*.

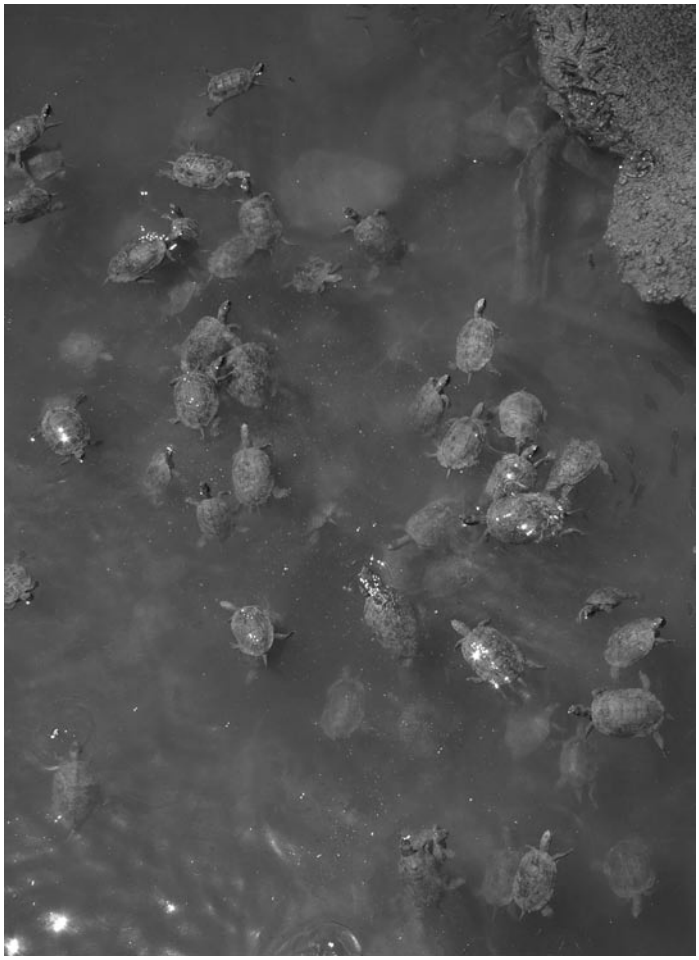


FIG. 1. *Mauremys rivulata* aggregation in response to tourist-provided bread.

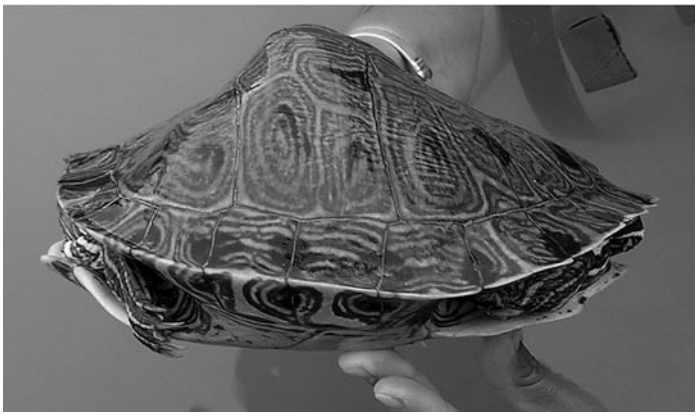


FIG. 1. Kyphotic *Pseudemys gorzugi* from Eddy County, New Mexico.

I thank Charles Painter and James Stuart for their helpful advice.

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TERRAPENE CAROLINA (Eastern Box Turtle) and ***GOPHERUS POLYPHEMUS*** (Gopher Tortoise). **INTERSPECIFIC INTERACTION**. *Terrapene carolina* has been documented to use burrows constructed by *Gopherus polyphemus* (e.g., Brodie 1959. Herpetologica 15:101–102; Landers and Speake 1980. Proc. Ann. Conf. Southeast. Assoc. Fish Wildl. Agencies 34:515–529; Brandt et al. 1993. Herpetol. Rev. 24:4). However, we are unaware of any field reports describing social interactions between these two species.

Using a video camera and an automated time-lapse VHS tape recorder, we observed an interaction between an Eastern Box Turtle and a Gopher Tortoise at the Camp Shelby Joint Forces Training Center (CSJFTC) in Forrest County in southern Mississippi, USA. On 2 August 2006 at 8:48:11 h (CST; ambient air temperature = 30ºC), an adult female Gopher Tortoise (carapace length = 267 mm) that was sitting in front of her burrow rapidly (~1 sec) retreated into it as if she had been disturbed. Seven seconds later, an adult Eastern Box Turtle entered into camera view, ~0.5 m behind the burrow entrance. After briefly pausing just behind the burrow, the Box Turtle walked onto the bare soil in front of the burrow entrance and faced the burrow mouth from a distance of ~0.5 m. The Box Turtle then incrementally advanced toward the burrow. Shortly after reaching the burrow mouth, the Box Turtle made several backward and forward movements starting at 8:54:56. At this point, the front of the Box Turtle was partially inside the burrow and out of camera view, making it difficult to determine what the turtle was doing. At 8:56:00, or about 64 sec after the Box Turtle started moving backward and forward in the burrow entrance, the female Gopher Tortoise emerged from her burrow as she pushed the Box Turtle with her gular. For the next 17 sec, with her head withdrawn, the tortoise repeatedly rammed and nudged the box turtle, pushing it backward and against the side of the burrow entrance. However, even as the tortoise pushed against it, the Box Turtle appeared to try to enter the burrow. During this exchange, both animals moved forward and backward, but it was unclear whether the Box Turtle was actually pushing the tortoise or whether the tortoise's backward movements were voluntary or partially due to the slope of the burrow entrance. The Gopher Tortoise then backed slightly into her burrow, and the movements of both turtles briefly decreased in intensity. About 25 sec later, the physical aggression resumed in much the same manner and intensity as before (but mostly with the tortoise further inside her burrow and out of camera view). The camera observed this aggressive bout for ~50 sec until the Box Turtle completely entered the burrow at 8:57:32 h, or about 2 min and 36 seconds after the physical interaction appeared to begin (based on the Box Turtle's initial backward and forward movements before the tortoise emerged into camera view). At 10:38:30 h, the tortoise emerged and sat on her apron for 40 min before going back into her burrow. The tortoise emerged once again at 12:19:01 h, sat on her apron for 37 min and again reentered her burrow. At 13:31:20 h, while the tortoise was still in its burrow, the box turtle emerged and then left the filmed area. Events such as this one are probably infrequent and/or difficult to observe, as Gopher Tortoises tend to flee into their burrows when humans approach. It is unclear why the Box Turtle was so determined to enter this particular Gopher Tortoise burrow, but tortoise burrows may provide Box Turtles with foraging opportunities (Landers and Speake, *op. cit.*) or shelter from temperature extremes and arid conditions (Dodd 2005. Iguana 12:153–159). Although we have no evidence to support this, it is possible that the Gopher Tortoise was simply defending its burrow, a structure that is a key feature in the species' daily activities. Interestingly, although we are unaware of any previous accounts describing naturally occurring aggression between these two species, Wailes (1854. Report on the Agriculture and Geology of Mississippi. E. Barksdale, State Printer, Jackson, Mississippi) describes how hunters in Mississippi would capture Gopher Tortoises by exploiting the aggressive response of tortoises toward Box Turtles placed into their burrows. He writes: "A common box terrapin [turtle] is used for the purpose, being sent into the gopher's [tortoise] hole, from which he is speedily driven out; but, in the eagerness of pursuit, the gopher frequently follows him so far above ground as to be cut off from his retreat and captured by the waiting hunter." Together, Wailes' (*op. cit.*) account and our observation suggest that Gopher Tortoises may respond aggressively with some regularity to Box Turtles that visit their burrows.

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TERRAPENE ORNATA (Ornate Box Turtle). **HABITAT.** *Terrapene ornata* is found from southern Wyoming to western Indiana, south to Louisiana and southeastern Arizona into north-central Mexico (Degenhart et al. 1996. Amphibians and Reptiles of New Mexico. University of New Mexico Press, Albuquerque, New Mexico. 431 pp.). In southeastern Arizona, the species is found primarily in flatlands and low valleys within Semidesert Grassland, Chihuahuan Desertscrub, and lower Madrean Evergreen Woodland (Brennan and Holycross 2006. Amphibians and Reptiles in Arizona. Arizona Game and Fish Department, Phoenix, Arizona. 150 pp.). Within these communities, it seeks sites where the soil is sandy or otherwise suitable for burrowing (Stebbins 2003. A Field Guide

to Western Reptiles and Amphibians. Houghton Mifflin, Boston, Massachusetts. 336 pp.). According to Degenhart et al. (*op. cit.*), *T. ornata* does not typically occupy dense woodlands.

We have noted an apparently disjunct population of *T. ornata* along the lower San Pedro River near the town of Dudleyville, Arizona, inhabiting riparian woodland consisting primarily of an overstory of Fremont Cottonwood (*Populus fremontii*) and Goodding's Willow (*Salix gooddingii*). In 2004, we discovered box turtles inhabiting a non-native dominated plant community within the floodplain of the Gila River, ca. 14.5 km downstream and north of Dudleyville (UTM 12S 0514736, 3651967). This area is predominately dense saltcedar (*Tamarix* sp.) with interspersed Mesquite (*Prosopis velutina*) at the ecotone with the Sonoran Desert upland community. Isolated cottonwoods and willows can be found along the active channel of the Gila River. Overall, canopy cover measured with a hand-held densiometer was 88.4%. Based on ocular estimates, ground cover was 29.4% silt/sand, 34.5% saltcedar duff, 29.7% downed branches and logs, 5.6% herbaceous material, and trace amounts of rock. Saltcedar tree height was >6 m. We subsequently captured and affixed radio transmitters to seven turtles (2 females, 5 males) for a home range study. Vegetation density made it extremely difficult to walk through the area and record locations. Dens and forms were easily constructed in the sandy substrate and often were under dense piles of downed saltcedar branches or covered with duff. We know of no other reports of Ornate Box Turtles inhabiting extensive, dense stands of this non-native plant. It is widely believed that the regulated flows from the upstream Coolidge Dam resulted in conditions favorable to invasion by saltcedar. The lower San Pedro River is free flowing.

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TRACHEMYS ADIUTRIX **(**Capininga). **DIET.** The diet of *Trachemys adiutrix* is not known. We examined stomach contents of specimens collected on Curupu Island, Maranhão State, Brazil, (2.4025°S, 44.11444°W) situated about 30 km off of São Luís in the inner part of São José Bay. This species frequently inhabits the small freshwater lagoons that occur between dune systems.

Trachemys adiutrix were captured from September 2003 to June 2005 with handcrafted traps, which are manufactured locally using wood stems and are similar to lobster traps. Every 15 d, one baited trap (containing small pieces of chicken and beef) was placed in each of the lagoons for two consecutive daylight hours. We verified sex by measuring tail length and palpating the inguinal region, and carapace length (CL) was measured with calipers to the nearest 0.1 cm. As the relationship between age and size is unknown for *T. adiutrix*, two size classes were arbitrarily established (after Balensiefer 2003. Unpubl. master's thesis, Departamento de Ecologia. INPA/UFAM. Manaus, Amazonas. 60 pp.): small (7.4–11.5 cm CL) and large (11.6–19.0 cm CL). Individuals within each size class were then subdivided into males and females.

Stomach contents were collected from 63 individuals; seven individuals were excluded from analyses because their stomachs contained only unidentified material. Stomachs were flushed within a few minutes of capture and afterwards all individuals were released at their point of capture. The extracted material was collected with forceps, placed in a plastic fine-woven sieve, and then removed with a brush and fixed with 70% ethanol. Food items were first categorized as either plant or animal material. Plant material was further subcategorized as leaves, roots, seeds, macroalgae, or bryophytes. Animal material was subdivided into fishes, insects, or arachnids. All unidentifiable material was categorized as "unidentified." We measured the volume of the stomach contents using volumetric displacement in a graded test tube.

We observed that about 50% of total stomach content volume was plant material and 50% was animal material. For the females (N = 28), total percent volume was 22% of animal material and 31% of plant material. For the males (N = 28), total percent volume was 25% of animal material and 22% of plant material. Small turtles, ranging from 7.4–11.5 cm CL, consumed primarily fish and plant matter. Individuals in the large class (11.6–19 cm CL) consumed more vegetation than animal matter. Plant material comprised 31% of consumed food items for female *Trachemys adiutrix* compared to 22% for that of males. Animal matter was observed in 22% and 25% of female and male stomachs respectively, consisting of fish, insects and arachnids. However, our study was not conclusive with respect to selective feeding in natural habitats because we did not measure food availability in the ponds.

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SQUAMATA — LIZARDS

ALEXANDRESAURUS CAMACAN (Alexandre's Lizard; Calanguinho do Alexandre). **REPRODUCTIVE BEHAVIOR**. Reports on lizard mating behavior are relatively scarce and most such data come from observations recorded in captivity. Data are even less frequent for secretive lizards. Such is the case for the Gymnophthalmidae, an assemblage of >200 Neotropical species representing 43 genera and four subfamilies (Rodrigues et al., Amer. Mus. Novit., *in press*; Rodrigues and Silva 2008. Zootaxa 1873:50–60). One of the latter, the subfamily Gymnophthalminae, comprises 16 genera of mostly secretive fossorial lizards living in forested or open areas (Pellegrino et al. 2001. Biol. J. Linn. Soc. 74:315–338; Rodrigues et al. 2005. Amer. Mus. Novit. 3565:1–27). Hence, we provide the first report of the copulatory behavior in the gymnophthalmine *Alexandresaurus camacan*, which occurs along the Atlantic Rainforest state of Bahia, from São Sebastião do Passé in the north (Freitas et al. 2007. Herpetol. Rev. 38:481) to Una in the south (Rodrigues et al. 2007. Amer. Mus. Novit. 3565:1–27).

At ca. 1250 h on 15 February 2006, we observed and photographed a mating pair of *A. camacan* in the forest surrounding experimental fields of the Cacao Research Center, CEPEC/CEPLAC, at Ilhéus, state of Bahia, Brazil (14.75°S, 39.22°W; datum WGS84; near sea level). The pair was concealed under a fallen large bromeliad (genus *Aechmea*) in a cacao plantation shaded by



FIG. 1. A mating pair of *Alexandresaurus camacan*, Bahia, Brazil.

Erythrina and other large trees of the remnant primary forest. The lizards were copulating in the leaf litter under the leaves of the bromeliad and remained immobile after exposure and during the next 5 min when we took pictures of the mating pair. The male mounted the female on the latter's left side grasping her with his right hind leg and biting the dorsal part of her neck. Fig. 1 reveals the right hemipenis still everted, likely the one used. The right side of female cloaca was visibly swollen. The figure reveals that the tails of both specimens were intact, that the male was larger and much more brightly colored than his mate, having yellowish flanks mottled with black and an irregular longitudinal series of white dots, whereas the female had almost homogeneous brown flanks.

The belly-to-back copulatory position with the male biting and gripping the skin of female´s neck was reported for several lizards like *Phrynosoma* and is apparently widespread in lizards (Sherbrooke et al. 2005. Herpetol. Rev. 36:64–65), but has never previously been reported among the Gymnophthalmidae.

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AMEIVA FUSCATA (Dominican Ground Lizard). **ARBOREAL ACTIVITY AND DIET.** Lizards in the genus *Ameiva* are generally terrestrial and facultatively omnivorous (Henderson and Powell 2009. Natural History of West Indian Reptiles and Amphibians. University Press of Florida, Gainesville; *in press*). From 4–23 June 2008, near the mouth of the Batali River on the leeward (western) coast of Dominica (15.452°N, 61.446°W), we observed three small *A. fuscata* (SVL 70–100 mm) climb to heights in excess of 1.5 m on trees. One arboreal *A. fuscata* appeared to be stalking an *Anolis oculatus*. Arboreal activity was described previously for *A. alboguttata* and *A. pleii* (Powell and Censky 2002. Herpetol. Rev. 33:50), the former tracking a trail of ants up a tree trunk.

Ameiva fuscata fed regularly on the pulp of fallen mangoes, but did not feed on the carcass of a dead *A. fuscata* adjacent to an area of intense activity. That lizards ate fallen mangoes confirmed descriptions that *Ameiva* are dietary generalists (e.g., Powell et al. 2005. The Reptiles and Amphibians of the Dutch Caribbean. St. Eustatius National Parks Foundation, Gallows Bay, St. Eustatius, Netherlands Antilles. 192 pp.). That they did not feed on the carcass of a dead *Ameiva* was surprising, as *A. fuscata* is known to eat eggs, embryos, and hatchlings of *Iguana delicatissima* (Breuil 2002. Patr. Nat., Paris 54:1–339; Knapp 2007. Iguana Spec. Grp. Newsl. 10[2]:13–14; A. Mitchell in Henderson and Powell, *op. cit.*), hatchling *Eretmochelys imbricata* (Knapp and Prince 2008. Herpetol. Rev. 39:213–214), and scavenge carrion and meat scraps (Malhotra and Thorpe 1999. Reptiles & Amphibians of the Eastern Caribbean. Macmillan Educ. Ltd., London. ix + 134 pp.; L. A. White and R. W. Henderson in Henderson and Powell, *op. cit.*).

Arlington James, Forest Officer, Forestry, Wildlife, and Parks Division, Ministry of Agriculture & the Environment, Commonwealth of Dominica, was instrumental in issuing permits to conduct research in Dominica and facilitated our efforts in myriad ways. Protocols were approved by the Avila University Animal Care and Use Committee. Fieldwork was funded by a grant from the National Science Foundation (USA) to Robert Powell (DBI-0242589).

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ANOLIS CRISTATELLUS (Crested Anole). **AVIAN PREDATION**. The Pearly-eyed Thrasher (*Margarops fuscatus*) opportunistically feeds on eggs and chicks of parrots and other forest birds (Arendt 2000. Ornithol. Neotropical 11:13–63; Lazell 2005. Island: Fact and Theory in Nature. Univ. California Press, Berkeley), and is an important predator of *Anolis* lizards (Waide and Reagan 1983. Amer. Nat. 121[1]:133–138). In a review of avian predators of West Indian reptiles, Powell and Henderson (2008. Iguana 15[1]:9–11) recorded only two birds taking *A. cristatellus*, both falconiform raptors. Here I report Pearly-eyed Thrasher predation on the Crested Anole on Guana Island, British Virgin Islands (18.46666°N, 64.58333°W; WGS 84).

On 23 Oct 2007 ca. 1800 h, a young male *A. cristatellus* jumped onto a roof (3 m long, 1 m wide, 2.5 m above ground, and in contact with the vegetation canopy alongside) often used by the species for basking. Unusually, it made a noisy landing. Anoles use flight behavior to deter snake predation (Leal and Rodriguez-Robles 1997. Anim. Behav. 54:1147–1154). This anole quickly ducked under the eve of the roof, followed within 5 sec by the arrival of a thrasher. The bird appeared to be searching for the lizard, located it, but was not able to catch it. In the next few seconds, the bird ran quickly along the roof edge back and forth twice, head looking down, neck cocked sideways, and beak extended below the eve.

It was apparently following the lizard under the eve. It eventually drove the anole out onto the wall. Whether the anole was herded or stopped from escaping by the bird was not clear because I could not see under the eve. Once in the open, the bird caught the lizard in its beak. The lizard struggled and the thrasher took at least 5 min to subdue and swallow it. In addition to falconiform raptors, the snake (*Alsophis portoricensis*) and mongoose (*Herpestes javanicus*) also prey on the Crested Anole (Platenberg and Boulon 2006. J. Appl. Herpetol. 3[3]:215–235; Schwartz and Henderson 1991. Amphibians and Reptiles of the West Indies: Descriptions, Distributions, and Natural History. Univ. Press Florida, Gainesville. 720 pp.).

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CNEMIDOPHORUS OCELLIFER (Spix's Whiptail). **ATTEMPTED PREDATION**. The *Cnemidophorus ocellifer* complex is a widespread group of teiid lizards found in open habitats in Brazil south to the Amazon (Peters and Donoso-Barros 1970. Catalogue of the Neotropical Squamata. Part II. Lizards and Amphisbaenians. Bull. U.S. Natl. Mus. 297:1–293; Vanzolini et al. 1980. Répteis da Caatinga. Acad. Brasil. Ciênc., Rio de Janeiro, Brazil. 161 pp.). Though at least six species from this complex have been recently described (e.g., Feltrim and Lema 2000. Biociências, Porto Alegre 8:103–114; Colli et al. 2003. Occ. Pap. Oklahoma Mus. Nat. Hist. 14:1–14; Colli et al. 2003. Herpetologica 59:76–88), the epithet *ocellifer* continues to be applied as a general tag to populations in the complex. Mesquita and Colli (2003. J. Herpetol. 37:498–509) studied the diet of *C. ocellifer* and reported termites, spiders, grasshoppers, and insect larvae as the most frequent prey. These results generally agreed with Vitt (1991. J. Herpetol. 25:79–90), who found termites to be the most important prey. Here, we add to dietary data on *C. ocellifer* with the observation of an attempt at saurophagy.

On 20 March 2006, we observed a predation attempt by an adult *C. ocellifer* (53.3 mm SVL) on a small juvenile *Tropidurus hygomi* in Mata de São João municipality, Bahia State, Brazil (12.5406°S, 37.9986°W; datum WGS84; elev. 20 m). Vegetation consisted of xeromorphic coastal forest, a type of restinga, an ecosystem characterized by medium-sized trees and shrubs adapted to dry, sandy, acidic, and nutrient-poor soils. RMLS was pursuing the *T. hygomi* when the *C. ocellifer* attacked it and bit off a 31.9 mm piece of its tail. After autotomizing its tail, the *T. hygomi* escaped. The *C. ocellifer* was captured, euthanized, and dissected. Besides the tail of *T. hygomi*, we found the following partly digested prey: two adult spiders (Arachnidae) belonging to different species, an adult ant (Formicidae), an adult grasshopper (Acrididae), and one larval ant lion (Myrmeleontidae). This is the first record of saurophagy in *C. ocellifer*.

The *C. ocellifer* and its prey were deposited in the herpetological collection of the Museu de Zoologia da Universidade de São Paulo, São Paulo, Brazil (MZUSP 98027, Miguel T. Rodrigues field number MTR 12557).

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COLEODACTYLUS NATALENSIS (NCN). **CLUTCH SIZE; HATCHLING SIZE.** *Coleodactylus natalensis* is a small lizard endemic to the Atlantic Forest of Rio Grande do Norte, Brazil (Freire 1999. Bol. Mus. Nac. 399:1–14). Clutch size is not known, but its geographically proximate congener, *C. meridionalis*, has a one-egg clutch (Vanzolini et al. 1980. Répteis das Caatingas. Acad. Bras. de Ciênc. Rio de Janeiro, Brazil. 161 pp.). Here, we provide an observation of clutch size and hatchling size in *C. natalensis*.

At 1630 h on 24 January 2006, PAGS collected two eggs of *C. natalensis* ca. 1 m apart among leaf litter in a 30-cm deep cavity in a rock (1 m^2) at the Estação Experimental Rommel Mesquita de Faria (Mata do Jiquí; 05.9305ºS, 35.1814ºW, datum: WGS84; elev. 40 m), an Atlantic Forest fragment on an EMPARN (Empresa de Pesquisas Agropecuárias do Rio Grande do Norte) farm of 79 ha in the of municipality Parnamirim. These data and field observations of females carrying one egg (CMCAL, pers. obs.) indicates that this species likely has a fixed clutch size of one egg.

The eggs were placed in a terrarium (20 × 12 × 20 cm) with a substrate of sand and leaf-litter, and maintained at Laboratório de Herpetologia, in the Departamento de Botânica, Ecologia e Zoologia in Universidade Federal do Rio Grande do Norte) at an ambient temperature averaging about 25ºC, but which varied between 24ºC and 32ºC over the incubation period. On 6 March 2006 (41 days after collection), one juvenile emerged. Measurements were SVL: 11 mm; tail length: 0.8 mm; foreleg length: 3.1 mm; fourth finger: 0.4 mm; hindleg length: 3.6 mm; fourth toe: 0.7 mm; head length: 2.9 mm; head width: 2.0 mm; jaw length: 1.6 mm; head height: 1.1 mm; body width: 2.2 mm; pelvis width; 1.3 mm; axilla-groin length: 4.4 mm; and mass: 0.024 g. This is the first record of hatchling size in *C. natalensis*.

The specimen was deposited in the Herpetological Collection of Universidade Federal do Rio Grande do Norte (CHBEZ 1504), municipality of Natal. We thank two anonymous reviewers for suggestion on the manuscript. Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) provided research grants to LBR (process 141993/2006-5) and to PAGS (process 107762/2006-4).

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DIPLOGLOSSUS BILOBATUS (O'Shaughnessy's Galliwasp). **REPRODUCTION.** *Diploglossus bilobatus* is a diurnal, secretive anguid known from lowlands and adjacent premontane slopes of Costa Rica and Panama (Savage 2002. The Amphibians and Reptiles of Costa Rica. A Herpetofauna Between Two Continents, Between Two Seas. University of Chicago Press, Chicago, Illinois. 934 pp.). Taylor (1956. Univ. Kansas Sci. Bull. 38:3–222) reported clutches of six and 15 eggs. The purpose of this note is to provide additional information on reproduction of *D. bilobatus*.

Five males (mean SVL = 82.4 mm ± 3.1 SD, range = 78–86 mm, LACM 130923, 148115, 116, 121, 122); three females (mean SVL = 68.0 mm ± 7.0 SD, range = 61–75 mm, LACM 148114, 119, 120) and five presumed neonates (mean SVL = 27.6 mm ± 2.1 SD, range = 25–30 mm, LACM 148117, 123, 124, 126, 127) collected 1962 to 1994 in Costa Rica (10°N, 84°W, datum: WGS84) were examined from the herpetology collection of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California.

An incision was made on the lower portion of the abdomen and one gonad was removed. Histological slides were prepared using conventional methods (Presnell and Schriebman 1997. Humason's Animal Tissue Techniques. Johns Hopkins University Press, Baltimore, Maryland. 572 pp.). One clutch of oviductal eggs was counted. Slides are deposited in LACM.

All five males were undergoing spermiogenesis = sperm formation: January (N = 2), March (N = 1), July (N = 1), August (N = 1). One female from June (LACM 148114, SVL = 75 mm) contained five oviductal eggs. One female each from February and July had quiescent ovaries (no yolk deposition). Presumed neonates were collected in spring: March (N = 1), April (N = 1), May (N = 1), June (N = 2).

The presence of males undergoing spermiogenesis in widely separated months suggests *D. bilobatus* has an extended period of spermiogenesis. Continuous spermiogenesis has been reported for other lizards from Costa Rica (Smith 1968. Biol. Bull. 134:325–331; Goldberg 2008a. Bull. Maryland Herpetol. Soc. 44:42–45; 2008b. Bull. Chicago Herpetol. Soc. 43:130–131). Five eggs is a new minimum clutch size for *D. bilobatus*.

I thank Christine Thacker (LACM) for permission to examine *D. bilobatus* which are part of the CRE (Costa Rica Expeditions) collection donated to LACM by Jay M. Savage in 1998.

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GONATODES HUMERALIS (NCN). **DEFENSIVE BEHAVIOR.** Curling the tail over the back is a defensive strategy some lizards use to reduce predation (Pianka and Vitt 2003. Lizards: Windows to the Evolution of Diversity. Univ. California Press, Berkeley, California. 333 pp.). By performing this behavior, a lizard may mimic a scorpion and/or expose its tail to predators (diverting attention from more vulnerable areas) (Pianka and Vitt, *op. cit.*). Among Brazilian geckos, this behavior is reported only for *Gymnodactylus carvalhoi* (= *G. geckoides amarali*) (Colli et al. 2003. J. Herpetol. 37:694–706), and *Coleodactylus brachystoma* (Brandão and Motta. 2005. Phyllomedusa 4:139–145), both from the Cerrado biome. Here, we report an observation of similar behavior in the gecko *Gonatodes humeralis*.

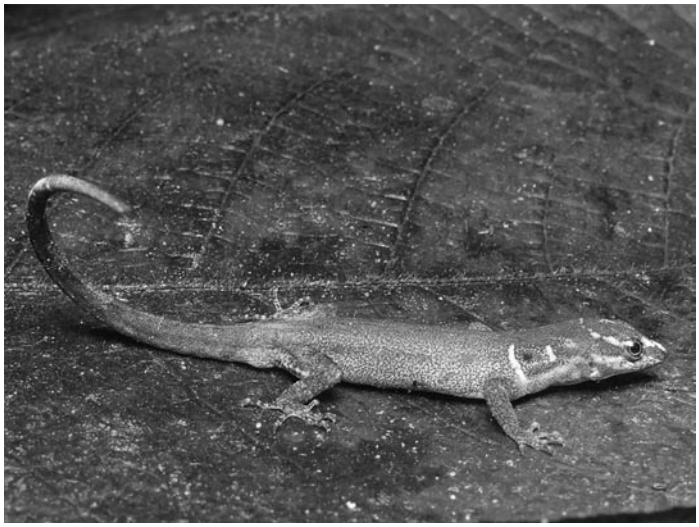


FIG. 1. *Gonatodes humeralis* exhibiting its defensive tail display. Photo by D. J. Santana.

At ca 2000 h On 6 March 2008 during fieldwork in Aripuanã, Estado do Mato Grosso, Brazil, VASP and DJS collected an adult male *G. humeralis* (35.85 mm SVL) sitting on the leaf of a small tree ca. 1.0 m above the ground at the edge of an altered submontane tropical rainforest near human settlement (10.1650°S; 59.4392°W; datum: WGS84; elev. 176 m). The following day, while being photographed, the gecko exhibited a display in which its tail was lifted and held still (Fig. 1), a defensive behavior reported for the first time in this species. This behavior may have one or both of the following causes: 1) Scorpion mimicry (Pianka and Vitt, *op. cit.*), considering that scorpions are common in the study area; and/or 2) Tail exposure as geckos possess particularly fragile tails that detach easily (Pianka and Vitt, *op. cit.*; Brandão and Motta, *op. cit.*).

The collected *G. humeralis* (MZUFV 647) was deposited in the herpetological collection of Museu de Zoologia "João Moojen," Universidade Federal de Viçosa, in Viçosa, Minas Gerais. We thank Energética Águas da Pedra S.A. for financial support; IBAMA for collection permits (029/2006-COFAN and 50/2007-SUPES/MT, process number 02001.003069/2004-42; Permanent License for Collecting Zoological Material (10504-1) to Renato N. Feio, IBAMA registration number 491048); J. Dergam and M. Hayes for suggestions on the manuscript.

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GONATODES HUMERALIS (NCN). **HABITAT OCCURRENCE; ESCAPE BEHAVIOR.** *Gonatodes humeralis*, a broadly

distributed gekkonid lizard, occurs from gallery forests of rivers in Brazilian Cerrado across the entire Amazon and Orinoco Basins, east to foothills of the Andes and north to Panamá (Pianka and Vitt 2003. Windows to the Evolution of Diversity. Univ. California Press, Berkeley, California. 346 pp.). In Amazonian Brazil, *G. humeralis* is among the most common lizards, occurring in all kinds of forest, such as terra firme, várzea or igapó, primary or secondary, gallery forests, and patches of forest in savanna areas (Ávila-Pires 1995. Zool. Verhandel. 299:1–706). Here, we report a previously unrecognized pattern of habitat use in *G. humeralis* and an escape behavior not previously mentioned in the literature.

During fieldwork in a mangrove forest, we found two individuals of *G. humeralis* (a male 33.5 mm SVL; a female 23.3 mm SVL). This mangrove forest is basically comprised of *Avicennia germinans*, *Rhizophora mangle*, and *Laguncularia racemosa*, and is flooded by daily tides, resulting in high water salinities (41) during the dry season. This mangrove area is located on the Ajuruteua Peninsula, in the municipality of Bragança, State of Pará, Brazil, and is 6 km from the terra firme to the north and ca. 30 km from the mainland to the south. To our knowledge, *G. humeralis* has not been reported as a part of the typical mangrove fauna. Insects represent a major food source for predators in mangroves (Hogarth 1999. The Biology of Mangroves. Oxford University Press Inc., New York. 240 pp.), and we found insects in the stomachs of both lizards, including gryllids (Orthoptera), chalcidid wasps (Hymenoptera), termites (Isoptera), and nematocerid and pharid flies (Diptera). A number of microhabitats available on the ground in non-flooded tropical forests, such as decayed logs, dead leaves, spaces among roots or else stones, tunnels of termite nests or even axils of terrestrial bromeliads are unavailable to *G. humeralis* for foraging, nesting, or refuge in flooded mangrove areas (Ávila-Pires, *op. cit.*; Maciel et al. 2005. Herpetol. Rev. 36:178). During capture, the *G. humeralis* attempted to escape running around the tree trunk, a characteristic behavior for this species (Ávila-Pires, *op. cit.*). Some attempts at capture resulted in their diving into the brackish mangrove water and submerging 10–15 cm, an escape behavior not previously reported. Study of *G. humeralis* in mangrove forests is needed to clarify how this species copes with this inhospitable environment.

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LEPOSOMA PERCARINATUM (NCN). **AQUATIC HABITAT USE**. Lizards of the genus *Leposoma* are conspicuous members of leaf litter herpetofauna in Neotropical forests (Pellegrino et al. 1999. Hereditas 13:15–21; Rodrigues 1997. Herpetologica 53:383–389). The *Leposoma parietale* species group, which occurs from Amazonia to Costa Rica (Rodrigues and Borges 1997. Herpetologica 53:1–6; Uzzell and Barry 1971. Postilla 154:1–39), currently contains 10 species (Rodrigues and Avila-Pires 2005. J. Herpetol. 39:541–546). One, *L. percarinatum*, is parthenogenetic (Pellegrino et al., *op. cit.*; Uzzell and Barry, *op. cit.*) and is probably the most widespread species of *Leposoma* in the Amazon (Avila Pires 1995. Zool. Ver. 299:1–706). The species has been reported to occur either close to the water (near creeks or in várzea and igapó forests) or in terra firme forest (Avila-Pires, *op. cit.*; Crump 1971. Occ. Pap. Mus. Nat. Hist. Univ. Kansas 3:1–62; Martins 1991. Stud. Neo. Fauna Env. 26:179–190; pers. obs.), but aquatic habitat use is unreported. Here, we report an instance of aquatic habitat use.

At 2015 h (at night) on 3 July 2008, SMS observed an adult of *L. percarinatum* active in a pool associated with a small forest creek in a forest fragment near Candeias do Jamari (09.7792°S, 063.6696°W, datum SAD69; elev. 87 m), state of Rondônia, Brazil. The animal was moving at the water surface through floating algae and dead leaves ca. 0.5 m from the edge of the pool. The animal was not collected as it escaped after two capture attempts in the water. Identification was only possible due to the previous experience of the senior author with *Leposoma* in the field (Souza 2007. MSc thesis, Instituto Nacional de Pesquisas da Amazônia, Manaus, Amazonas, Brazil. 73 pp.). This is the first report of *L. pericarinatum* using aquatic habitat.

This observation reinforces the idea of relationship between *L. percarinatum* and *L. ferreirai*, hypothesized as closely related (Rodrigues and Avila-Pires, *op. cit.*). *Leposoma ferreirai*, the only *Leposoma* with a clearly aquatic habit, is restricted to Arquipélago das Anavilhanas, a fluvial archipelago of more than 400 islands that are inundated several months annually by the Rio Negro and is ca. 750 km from Candeias do Jamari.

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LIOLAEMUS AUSTROMENDOCINUS (NCN). **SAUROPHAGY**. *Liolaemus austromendocinus* is a medium-sized liolaemid lizard found in northwestern Patagonia from the Andean mountains of Departamento San Carlos, Mendoza Province (34.00°S latitude) to rocky outcrops of the Añelo Basin, Departamento Añelo, northern Neuquén Province (38.50°S latitude). Dietary data are sparse, but the species is reported to feed on insects (Cei 1986. Reptiles del Centro, Centro-Oeste y Sur de la Argentina. Monogr. IV, Mus. Reg. Sci. Nat. Torino, Italy. 527 pp.). Here we report an observation of interspecific saurophagy by an adult *L. austromendocinus* on an adult *L. bibronii*.

On 7 February 2008 during a field trip to Auca Mahuida volcano (37.6932ºS, 68.8241ºW; datum WGS84; elev. 1348 m, Departamento Añelo, Neuquén Province, northwestern Patagonia, Argentina), we observed an adult *L. austromendocinus* (86.9 mm SVL, 228.9 mm tail) basking on a rock in shrub-steppe habitat. When we

chased it, the lizard ran under a rock where we captured it by hand. One hour after we had temporarily placed this lizard in a plastic container, it regurgitated the remains of a female *L. bibronii* (35 mm long × 10 mm wide). We estimated the original size of the *L. bibronii* by comparison with other preserved *L. bibronii* to be ca. 50 mm SVL. These two lizard species are synoptic in this area of Patagonian steppe and usually share similar habitats. Saurophagy has not been previously documented for *L. austromendocinus*.

Nicolas Frutos verified the identifications and the *L. austromendocinus* (LJAMM 10340) and the *L. bibronii* (LJAMM 10483) were deposited in the Herpetological Collection LJAMM (Luciano Javier Avila Mariana Morando) of the Centro Nacional Patagónico (CENPAT), Puerto Madryn, Chubut.

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LIOLAEMUS BAGUALI (NCN). **SPINAL INJURY.** *Liolaemus baguali* is an uncommon liolaemid lizard endemic to Patagonian steppe environments of western Santa Cruz Province, southern Patagonian, Argentina. During field work on 17 January 2008, along the margins of Ruta Nacional (National Highway) 40, 72.8 km N of its junction Ruta Provincial (Provincial Highway) 288 (49.1040°S, 71.1985°W; datum WGS84; elev. 525 m), Rio Chico Department, Santa Cruz Province, we collected an adult male *L. baguali* (66.4 mm SVL) that appeared to exhibit a scoliosis as had been recently reported for another Patagonian lizard (Frutos et al. 2006. Herpetol. Rev. 37:468–469). After we x-rayed the lizard, we realized that the supposed scoliosis was in fact severe spinal trauma (Fig. 1). The radiograph revealed vertebral displacement and an apparent disconnection between bones. Apparently, the injury had not yet affected the nervous system because the lizard was able to move and run normally. Externally, no evidence of a wound was visible: scales and scale rows were complete and no scars were noticeable. Only a humpback appearance with slight displacement to the right side was evident. Absence of external evidence of injury likely means that it cannot be attributed to a predator. The lizard was found in the west edge of an unpaved road between small to medium rounded rocks periodically disturbed by grazers. The injury may be attributable to crushing between rocks during disturbance by grazers or vehicular traffic. Our observation reveals an unusual ability to survive severe internal injury.

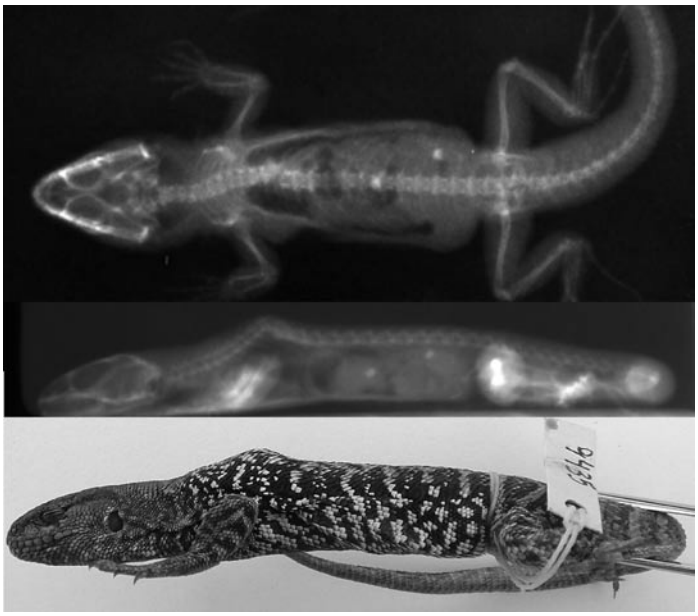


FIG. 1. Top and middle panels: Dorsal and lateral radiographs of the injured *Liolaemus baguali*, arrow indicates the spinal injury. Lower panel: External view, no injury is visible in the dorsal scales.

The lizard was deposited in collection Luciano Javier Avila Mariana Morando (LJAMM) now housed in CENPAT-CONICET (LJAMM 9435).

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MICROACONTIAS LITORALIS (Coastal Legless Skink). **COPULATION.** Few ecological and natural history data exist for many fossorial herpetofaunal species, including the skink *Microacontias litoralis*. During the late afternoon of 25 October 2007, a pair of *M. litoralis* was discovered in the process of copulating in white sand dunes near Noup, on the Namaqualand Coast, Northern Cape, South Africa (30.10832°S; 17.21752°E; datum WGS84; elev. 43 m). The lizards were partly exposed in the sand with less than 50% of their bodies obscured from view. Their bodies were entwined, crossing over each other in three places. Temperature of the sand was 28.3ºC; air temperature was 22.2ºC. On closer inspection, the lizards attempted to escape but were captured. The male's hemipenes were exposed. The male measured 108 mm SVL (26 mm tail, 1.4 g) and showed orange and brown coloration as described by Branch (1998. Field Guide to the Snakes and Other Reptiles of Southern Africa. Struik Publishers, Cape Town, South Africa. 399 pp.). The female measured 111 mm SVL (30 mm tail, 1.4 g) and was an overall orange color with some fine dark speckling over the entire dorsum. These data represent the first on copulation for this species. Both specimens were killed, preserved, and deposited at Bayworld (Port Elizabeth Museum: PEM R17456–57).

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OPHISAURUS COMPRESSUS (Island Glass Lizard). **PREDATION**. Known predators of glass lizards (*Ophisaurus* spp.) include colubrid, elapid, and viperid snakes (e.g., Schmidt 1932. Copeia 1932:6–9; Palis 1993. Herpetol. Rev. 24:59, 62; Palmer and Braswell 1995. Reptiles of North Carolina. Univ. North Carolina

Press, Chapel Hill, North Carolina. 412 pp.; Himes 2004. Herpetol. Rev. 35:123–128), several species of birds (Fitch and Bare 1978. Trans. Kansas Acad. Sci. 81:1–13; Fogarty and Hetrick 1973. Auk 90:268–280; Moore et al. 2005. Herpetol. Rev. 36:182), and armadillos and raccoons (Stains 1956. Misc. Publ. Mus. Nat. Hist. Univ. Kansas 10:1–76; Wirtz 1985. *In* G. G. Montgomery [ed.], The Evolution and Ecology of Armadillos, Sloths, and Vermilinguas, pp. 439–451. Smithsonian Inst. Press, Washington, DC). Predators of *O. compressus* have been suspected but not documented (Moler 2008. *In* J. Jensen et al. [eds.], Amphibians and Reptiles of Georgia, pp. 283–284. Univ. Georgia Press, Athens, Georgia).

CR found skeletal remains of an adult *O. compressus* (FMNH 153660) in Bobcat (*Lynx rufus*) scat collected on 23 November 1997 on the north end of Cumberland Island, Camden County, Georgia (30.9292°N, 81.4097°W; NAD27; elev. 3 m). Following elimination of feral cattle, the area has been in a transitional phase between open savannah-like interdune habitat and a more forested community. Bobcats were the only large, roaming predators on the island at the time. The scat also included remains of a young raccoon and a small, unidentified bird. Preferred prey of Bobcats that occur on the island are Marsh Rabbits (*Sylvilagus palustris*) and Cotton Rats (*Sigmodon hispidus*) (Whitaker and Hamilton 1998. Mammals of the Eastern United States, Cornell Univ. Press, Ithaca, New York. 583 pp.). However, they are also known to kill and eat several species of snakes (e.g., Fritts and Sealander 1978. J. Wildl. Manage. 42:533–539; King et al. 1983. Brimleyana 9:111–122) and at least two species of lizards, *Sceloporus poinsetti* and *Phrynosoma* sp. (Young 1958. The Bobcat of North America, Stackpole Books, Harrisburg, Pennsylvania. 193 pp.; Delibes and Hiraldo 1987. Southwest. Nat. 32:457–461). Previous records of Bobcat prey on Cumberland Island include seven species of mammals and one unidentified bird but no reptiles (Baker et al. 2001. Amer. Midl. Nat. 145:80–93). Our observation is the first report of a mammalian predator of *O. compressus* and a third prey lizard species for the bobcat.

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PHYLLODACTYLUS HOMOLEPIDURUS (Sonoran Leaf-toed Gecko). **ENDOPARASITES.** Endoparasitic helminths from *Phyllodactylus homolepidurus,* which is known from western Sonora, México and the Isla San Pedro Nolasco (Grismer 2002. Amphibians and Reptiles of Baja California, including its Pacific Islands and the Islands in the Sea of Cortés. Univ. California Press, Berkeley. 399 pp.), are unreported. Hence we present the first information on its helminths.

Five *P. homolepidurus* (4 females, 1 male, mean SVL = 60.0 mm ± 4.6 SD, range 54–66 mm) obtained from the herpetological collection of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California, USA were examined for helminths. Lizards were from Isla San Pedro Nolasco (27.96667°N, 111.38333°W, datum WGS84; elev. 152 m; LACM 25086, collected 1964) or the vicinity of Hermosillo, Sonora, México (29.06667°N, 110.96667°W, datum WGS84; elev. 210 m; LACM 37565, 93784, 93785, collected 1967; 122509, collected 1975). The lizards were opened by a mid-ventral incision and the gastrointestinal tract removed and opened. The esophagus, stomach, small and large intestines and body cavity were searched for endoparasites using a dissecting microscope. One species of Nematoda was found in the large intestines of LACM 25086, 37565, 93785 and 122509 (mean number of helminths = 18.0 ± 15.9 SD, range = 1–36). They were cleared in a drop of glycerol, cover-slipped, studied as wet mounts and identified as *Spauligodon oxkutzcabiensis*. Voucher nematodes were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland as USNPC (100789). *Spauligodon oxkutzcabiensis* was initially described as *Pharyngodon oxkutzcabiensis* from the gecko *Thecadactylus rapicaudus* taken in the Yucatan (Chitwood 1938. Publ. Carnegie Inst. Wash. 491:51–66). Skrjabin et al. 1960 (Oxyurata of Animals and Man, Part 1. Israel Program of Scientific Translation, Jerusalem. 526 pp.) relocated it to its current genus. *Spauligodon oxkutzabiensis* has previously been reported in *Phyllodactylus reissii* from Peru (Goldberg and Bursey 2004. Herpetol. Rev. 35:395), *Sceloporus malachiticus* from Costa Rica (Goldberg and Bursey 1992. J. Helminthol. Soc. Wash. 59:125–126), *Tropidurus guarani* from Paraguay (Goldberg and Bursey 2004. Comp. Parasitol. 71:203–207) and *Sceloporus formosus, S. grammicus, S. megalepidurus, S. mucronatus* and *S. torquatus* from Distrito Federal, Hidalgo, Oaxaca, Puebla and Querétaro, México (Goldberg et al. 2003. Southwest. Nat. 48:208–217). *Phyllodactylus homolepidurus* is the third species of gecko reported to harbor *S. oxkutzcabiensis*. Sonora, Mexico is a new locality record.

We thank T. Doleck (Whittier College) for assistance with dissections and C. Thacker (LACM) for permission to examine specimens.

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PODARCIS HISPANICA **COMPLEX** (North African Wall Lizard). **ARBOREAL BEHAVIOR.** Lacertids of the genus *Podarcis* surround the Mediterranean Basin, where they inhabit a broad range of habitats, including coastal dunes, open grassy areas, human-developed environments, Mediterranean maquís and mountain forests (Arnold 1987. J. Zool. (B) 1:739–782). In these habitats, *Podarcis* utilize diverse microhabitats, such as stony walls and rocky surfaces, ruins, scrub, paths and road sides, bushes and numerous anthropogenic structures (Arnold and Ovenden 2002. A field guide to the reptiles and amphibians of Britain and Europe. Harper-Collins. London, United Kingdom. 272 pp). Members of the *Podarcis hispanica* species complex (hereafter *P. hispanica**), a group whose systematics remains unresolved (Harris and Sá-Sousa.

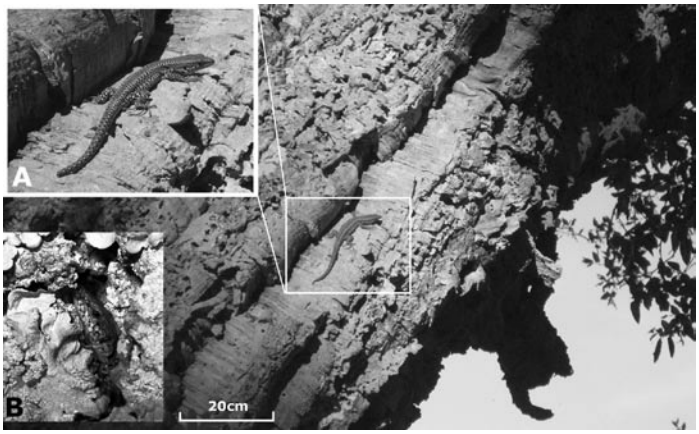


FIG. 1. North African Wall Lizard, *Podarcis hispanica**, A) basking on a Cork Oak (*Quercus suber*), and B) using its surface as a refuge in Cape Negro, Tunisia.

2002. Mol. Phylogenet. Evol. 23:75–81), have been characterized as principally saxicolous, climbing on rocks, walls, parapets and other anthropogenic structures, at least in the Iberian Peninsula, which represents the center of its geographic distribution (Arnold and Ovenden, *op. cit.*). Hence, here we report on the arboreal habit of *Podarcis hispanica** from Tunisia.

During a field-trip to northern Tunisia in May 2008, we repeatedly observed *P. hispanica** climbing on tree trunks, either spontaneously in order to bask and feed or in response to our presence, presumably to seek refuge (Fig. 1). We recorded this behavior at all sites where we encountered *P. hispanica**, including El Feidja National Park (36.5045°N, 8.3137°E, datum: WGS84), the vicinity of Ain Draham (36.7227°N, 8.6775°E) and Cap Negro (37.0685°N, 9.0465°E). *Podarcis hispanica** used primarily Cork Oaks (*Quercus suber*), but European Chestnuts (*Castanea sativa*) were also used. Both adult males and females displayed this behavior, but we never observed subadults on trees. When adults fled to the trees, the lizards first climbed to roughly one meter in height, then progressively further up if they continued to feel threatened, reaching heights up to 8 m above the ground. When directly approached by one of us, they used complex tree surfaces as refuge, hiding in holes beneath the bark (Fig. 1). Additionally, after releasing two non-resident lizards on a cork oak, we observed agonistic behavior toward these individuals by resident lizards. This implies use of trees that may encompass part of individual territories and refuge sites.

Though scattered observations exist of at least three *Podarcis* utilizing trees (i.e., *P. hispanica*, *P. muralis* and *P. sicula*; Arnold and Ovenden, *op. cit.*), this is the first report of extensive arboreality in the genus. Other members of the *P. hispanica* species complex (*sensu* Harris and Sá-Sousa, *op. cit.*) have been observed to use downed trees as shelter or to climb palm trees in human-developed habitats (pers. obs.). However, use of trees by *P. hispanica** in the Iberian Peninsula has been exclusively mentioned as incidental (Barbadillo et al. 1999. Anfibios y Reptiles de la Península Ibérica, Baleares y Canarias. Editorial GeoPlaneta. Barcelona, Spain. 419 pp.; Pérez-Mellado 1998. *In* Salvador [coord.], Fauna Ibérica, vol. 10, Reptiles, pp. 258–272. Museo Nacional de Ciencias Naturales, CSIC. Madrid, Spain) and we have never observed its regular use of trees in the Iberian Peninsula, even though oaks and other large trees are often available. In contrast, we found arboreal behavior frequent in Tunisian *P. hispanica**. This may reflect available habitat within the range of wall lizards in Tunisia, where they are confined to the northwestern part of the country, and correspond to the distribution of dense, humid Mediterranean forests (Kaliontzopoulou et al. Can. J. Zool., *in press*). In such closed habitats, stony and rocky which provide potential terrestrial refuges, are infrequent and terrestrial basking opportunities are very limited. Consequently, lizards may take advantage of the higher branches of big trees in order to find light and thermoregulate, and use the bark of trunks as a refuge. Similar behavior has also been incidentally observed in *P. hispanica** in Algeria (MAC, JCB, pers. obs.), but not in *P. vaucheri* in Morocco, even though long-term studies have been carried out on this recently recognized species (Busack et al. 2005. Amphibia-Reptilia 26: 239–256).

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PRISTIDACTYLUS SCAPULATUS (NCN). **SAUROPHAGY**. *Pristidactylus scapulatus* inhabits the eastern slope of the Andean Cordillera from north of San Juan in San Guillermo Provincial Reserve to Chubut Province (Cei 1986. Museo Regionale di Scienze Naturali Torino. Monografie IV. Torino, Italia. 527 pp.). Its diet includes scarab (Scarabaeidae), darkling beetles (Tenebrionidae), and fruits of *Lycium chanar* and *Ephedra breana* (Acosta et al. 2004. Herpetol. Rev. 35:171–172), but saurophagy is unreported. Hence, here we report an observation of interspecific saurophagy by an adult *P. scapulatus* on a juvenile *Phymaturus punae*.

On 5 December 2004 during the course of Project "Estudio de Línea de Base San Guillermo" in the Parque Nacional San Guillermo, Departamento Iglesia, Provincia de San Juan (29.25°S, 69.48°W; datum: WGS84; elev. 3400 m), we collected an adult female *P. scapulatus* (98 mm SVL) by hand. Its stomach contents were examined and found to contain a juvenile of *Phymaturus punae* (51 mm SVL). The *P. scapulatus* female was gravid with three eggs in the oviduct.

Saurophagy has been documented in other *Pristidactylus* (e.g., *P. nigroiugulus* preying on juvenile *Liolaemus fitzingerii* and *L. boulengeri*; Cei et al. 2004. Boll. Mus. Reg. Sci. Nat. Torino 21:159–192). *Pristidactylus scapulatus* and *P. punae* are both common in Parque Nacional San Guillermo and both use similar

microhabitats. Juvenile *P. punae* may represent important prey for gravid female *P. scapulatus*.

The female *P. scapulatus* (IMCN-UNSJ4303) and its *P. punae* prey (IMCN-UNSJ4304) were deposited in the collection of the Facultad de Ciencias Exactas, Físicas y Naturales, Universidad Nacional de San Juan

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SCELOPORUS JARROVII (Yarrow's Spiny Lizard). **AQUATIC ESCAPE BEHAVIOR**. Use of aquatic habitats to evade predators is well documented in terrestrial lizards (Bauer and Jackman 2008. Hydrobiologia 595:581–586; Daniels and Heatwole 1990. Mem. Queensland Mus. 29:374–387; Greene 1988. *In* Gans and Huey [eds.], Biology of Reptilia, Volume 16, pp. 136–143, Alan R. Liss, New York, New York). However, this behavior is not reported for *Sceloporus jarrovii*. Here, we report four observations of three adult *S. jarrovii* entering water to escape.

All observations were made in the Peloncillo Mountains, Hidalgo Co., New Mexico, USA (109.017°W, 31.483°N, WGS84; elev. 1726 m) at an artificial impoundment formed by a reinforced concrete dam (13–15 m × 2 m) built into a canyon streambed. On 3 September 2007, water depth of the impoundment was < 0.5 m and the exposed surface area of the dam wall was ca. 19–23 m^2. On 6–7 September 2007, heavy monsoon rains increased the impoundment water depth to 2 m and decreased the exposed surface area of the dam wall to ca. 2 m^2, with water reaching 13 cm from the top of the dam.

On 11 September 2007, we observed an adult *S. jarrovii* perched on top of the dam. KJL unsuccessfully attempted to capture the lizard by hand. Suspecting that he had knocked the lizard into the water, we searched the flooded terrestrial vegetation and water adjacent to the dam, but only caught sight of a sinking detached tail. While searching, BDS observed the tailless lizard perched vertically on the dam 15–20 cm below the water surface, where we photographed it from above. After ca. 2 min, KJL attempted to nudge the lizard. The lizard ran ca. 1–2 m along the wall underwater, then exited the water and retreated into a pile of debris at the end of the dam. In the following days, during separate episodes, we observed similar behavior by the same lizard (recognized by its lost tail), and another adult that remained submerged for 80 sec and 20 sec, respectively. The lizards appeared to have no difficulty entering the water and running along the dam wall while submerged. We also observed a third adult leap from the dam and swim ca. 1.5 m to an adjacent willow tree (*Salix* spp.). Unfortunately, we were unable to sex any of the lizards involved in aquatic escape behaviors.

This represents the first report of *S. jarrovii* utilizing an aquatic habitat in any context. Aquatic escape behavior is rare among sceloporine lizards, but *S. spinosus floridanus* uses the aquatic environment for escape as a last resort (Strecker 1928. Contr. Baylor Univ. Mus. 15:3–9). In the Peloncillo Mountains, aquatic escape behavior seems odd given the dearth of standing water. However, populations faced with intense predation pressure are predicted to evolve more diverse escape tactics (Schall and Pianka 1980. Am. Nat. 115:551–566). In the nearby Chiricahua Mountains at a similar elevation (1675 m), *S. jarrovii* have several potential predators and cope with high predation pressure (Ballinger 1979. Ecology 60:901–909). Stomach content analyses from the region indicate that *S. jarrovii* compose 45% of prey taken by banded rock-rattlesnakes (*Crotalus l. klauberi*; Holycross et al. 2006. J. Herpetol. 36:589–597). Considering the geographic similarities of these studies, *S. jarrovii* may encounter high predation pressure in the Peloncillo Mountains. Hence, aquatic escape may be an occasionally used escape tactic with important anti-predator benefits.

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SCELOPORUS PYROCEPHALUS (Mexican Boulder Spiny Lizard). **DIET**. *Sceloporus pyrocephalus*, a phrynosomatid lizard endemic to México, occurs in tropical dry forest in coastal areas of the states of Jalisco, Colima, Michoacán and Guerrero, including the lowlands of the Río Balsas Basin (Smith and Taylor 1950. U.S. Nat. Mus. Bull. 199:1–253). Information on its biology is sparse. Here we report the first data on its diet.

The study was conducted at Rancho Las Bermejas (18.5833°N, 101.2136°W; datum WGS84; elev. 215 m) ca. 30 km W of the town of Huetamo and 6 km N of the Río Balsas, Michoacán, México. Vegetation consists of tropical dry forest. Lizards were caught opportunistically. Fourteen animals were collected during the wet season (July) and 7 during the dry season (November) of 2000. Individuals were assigned to two age classes (adults ≥ 45 mm SVL; juveniles < 45 mm SVL, Ramirez-Bautista and Olvera-Becerril 2004. J. Herpetol. 38:225–231). Lizards were frozen to arrest digestion, and stomachs were dissected to evaluate their contents. Food items were preserved in 70% ethanol and identified to the lowest possible taxonomic level. We calculated the relative abundance of food items by volume (%V), and their frequency among stomachs examined (%F). Estimates of dietary diversity and overlap were based on %V. We calculated the Shannon-Wiener Index (H') to estimate dietary diversity. Dietary diversity values were compared using Hutcheson's t-test. We used the percent overlap index of Schoener (1970. Ecology 51:408–418) to describe seasonal and ontogenetic changes in diet.

We found 28 different terrestrial arthropod taxa in the 21 lizard stomach samples (Table 1). Five groups were dominant: flies (Diptera), true bugs (Hemiptera), beetles (Coleoptera), and wolf spiders (Lycosidae) collectively constituted more than 70% of the diet by volume, and ants (Formicidae) were the most frequent prey items (95% of the stomachs). Dietary diversity (H') for the entire sample was 2.37. Eleven prey taxa recorded during wet season were not recorded during the dry season, whereas 6 groups present during dry season were absent during the wet season (Table

TABLE 1. Stomach contents of *Sceloporus pyrocephalus* in wet and dry season. Variation in prey taxa is described as the percentage of stomachs in which the taxon was found (%F), and percentage of stomach volume (in mm^3) represented by that taxon (%V).

Prey Taxon	Wet Season %F	Wet Season %V	Dry Season %F	Dry Season %V
Acari	—	—	14	< 1
Araneae	14	< 1	29	2
Amaurobiidae	7	< 1	—	—
Lycosidae	36	21	29	< 1
Pholcidae	7	1	—	—
Salticidae	21	< 1	—	—
Coleoptera	100	5	71	25
Brentidae	—	—	14	< 1
Buprestidae	—	—	14	3
Carabidae	7	< 1	14	< 1
Chrysomelidae	7	< 1	—	—
Curculionidae	—	—	14	< 1
Dytiscidae	—	—	14	< 1
Elateridae	21	< 1	29	5
Staphylinidae	7	< 1	—	—
Diptera	57	19	29	6
Stratiomyidae	7	< 1	—	—
Hemiptera	57	20	71	29
Scutelleridae	7	5	—	—
Homoptera	36	1	29	1
Flatidae	14	3	—	—
Hymenoptera	29	8	—	—
Formicidae	86	6	100	11
Isoptera	—	—	43	< 1
Odonata	14	< 1	—	—
Orthoptera	29	1	57	14
Gryllotalpidae	36	9	14	2
Trichoptera	7	< 1	—	—

1). Inter-seasonal dietary overlap was 41.5% and dietary diversity was significantly greater in wet (H' = 2.11) versus dry (H' = 1.89) seasons ($t = 2.24$, $df = 37$, $P < 0.05$). During the dry season, the most important prey were true bugs and beetles, whereas dipterans and wolf spiders dominated wet-season diet (Table 1). During the dry season, we found ants in all the stomachs, whereas during wet season, beetles were present in all the stomachs. The reduction in the dietary diversity index during dry season suggests that prey abundance and availability of arthropods declines during that season.

We found a moderate level of dietary overlap (39.5 %) between juvenile and adult lizards, and dietary diversity differed between juvenile (H' = 2.21) and adult (H' = 1.77) lizards ($t = 4.60$, $df = 33$, $P < 0.05$). For juveniles the most important prey (by volume) were true bugs (21%), beetles (19%) and ants (17%), whereas wolf spiders (26%), true bugs (22%) and dipterans (24%) dominated adult diet. Based on frequency of occurrence, ants dominated the diet of both adult (100%) and juvenile lizards (94%).

Relatively high dietary diversity and the fact that no prey taxon contributed more than 25% by volume to the diet may indicate either that *S. pyrocephalus* is a dietary generalist or that high variability exists among individuals in their dietary preferences. Considering the markedly seasonal environment in which this species is found, an opportunistic diet may be an advantageous foraging strategy for coping with temporal fluctuations in prey diversity, levels of activity, and availability, as predicted by optimal foraging theory (Pianka and Vitt 2003. Lizards: Windows to the Evolution of Diversity. Univ. of California Press, Berkeley, California. 333 pp.).

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SCELOPORUS UNDULATUS (Eastern Fence Lizard). **DEFLECTION DISPLAY.** Many squamate species attempt to deflect predation attacks toward their tails. For instance, Ringneck Snakes coil their tails to show the bright underside in an apparent deflection display (McCallum et al. 2006. Herpetol. Nat. Hist. 10:91–94). Better known are display tactics among lizards with autotomous tails. Broad-headed Skinks may undulate their tail just prior to fleeing (Cooper 1998. Behav. Ecol. 9:598–604; Cooper 1998. Can. J. Zool. 76:1507–1510). Some geckos may also display their tail to distract predators away from the head or body (Congdon et al. 1974. Science 184:1379–1380). These displays are intended to improve chances of escape. Here, we provide an observation of such a deflection display in *Sceloporus undulatus*.

At ca. 1530 h on 18 March 2004, JWS noticed an adult female *S. undulatus* on a split-face concrete block building at a private residence in Chester County, Tennessee, USA (35.47576°N, 88.56750°W; datum WGS84; elev. 165 m). The lizard was chased for 2–3 min until cornered. At that point, it remained still except that it began undulating its entire tail at a frequency of ca. 1 undulation every 1–2 sec. It did not try to flee but remained motionless even as it was picked up. When released, the lizard still did not try to escape; rather, it began undulating its tail once more. As JWS backed away the undulations would slow down and then would intensify when JWS re-approached. The lizard still did not flee when JWS moved out of its line-of-sight; when JWS returned ca 5 min later, it renewed its tail display while the rest of its body continued to remain motionless. JWS again left for ca. 5 min with parallel results upon return. Only after JWS had been out of sight for > 15 min did the lizard finally leave.

We have never previously witnessed this behavior in *S. undulatus* and are unaware of presumptive deflection displays reported for this species in the scientific literature.

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TROPIDURUS HISPIDUS (NCN). **FROG PREDATION**. As with most *Tropidurus,* the diet of *T. hispidus* is mainly arthropods (e.g., *T. oreadicus* and *T. spinulosus*, Colli et al. 1992. J. Herpetol. 26:66–69; *T. torquatus*, Fialho et al. 2000. J. Herpetol. 34:325–330; *T. montanus*, Van Sluys et al. 2004. J. Herpetol. 38:606–611). Ants, beetles, insect larvae and termites comprise the numerical majority of *T. hispidus* diet in rock outcrops in Brazilian Amazonia (Vitt et al. 1996. J. Trop. Ecol. 12:81–101). Plant material (e.g., leaves, flowers and fruits) is also an important portion of the total volume ingested in different *T. hispidus* populations: one from a caatinga biome (Vitt 1995. Occ. Pap. Oklahoma Mus. Nat. Hist. 1:1–29) and one from "campos rupestres" (rocky meadow) habitats (Van Sluys et al., *op. cit.*). Besides invertebrates and plant material, *T. hispidus* occasionally eat small vertebrates, such as frogs (Vitt et al. 1996, *op. cit.*) and other lizards (Vitt 1995, *op. cit.*). Here, we report a frog previously unreported as prey for *T. hispidus* in a caatinga biome at the Estação Ecológica do Seridó (ESEC Seridó), Serra Negra do Norte municipality, Estado do Rio Grande do Norte, Brazil.

During an ecological study of *Tropidurus* in rocky habitats at ESEC Seridó (06.5767°S, 37.2558°W, datum: WGS84; elev. 192 m) a total of 84 stomachs of *T. hispidus* were analyzed. The stomach contents of an adult female (99 mm SVL) captured on a rock surface on 14 February 2008, included an adult hylid frog *Scinax x-signatus* (30.0 mm in length [SVL], 20.0 mm in width and 6,280 mm^3 in volume).

Based on stomach analysis of 74 *T. hispidus* by Vitt et al. 1996 (*op. cit.*), 11 frogs were found as prey in 6 lizards. The microhylid *Elachistocleis ovalis* was the only anuran identified to species among these frogs. However, in contrast to our observation, all the frogs recorded by Vitt et al. 1996 (*op. cit.*) were juveniles and comprised a relatively small total volume (1,473 mm^3).

The *T. hispidus* (CHBEZ 1994) was deposited in the herpetological collection of Universidade Federal do Rio Grande do Norte, Natal City. We thank the Programa PELD/CNPq - Caatinga: Estrutura e Funcionamento for logistic support, U. Caramaschi for identification of the frog, and M. Hayes for helpful comments on this note. A grant from the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) to L.B. Ribeiro (process 141993/2006-5) supported this study, and IBAMA provided a permit (Permit 206/2006 and Process 02001.004294/03-15).

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TROPIDURUS SEMITAENIATUS (NCN). **DRINKING BEHAVIOR**. Many reptiles drink water (Minnich 1982. *In* Biology of the Reptilia, pp. 325–395. Academic Press, New York, New York), and many use behavioral strategies and adaptations in morphology and physiology associated with living in habitats with little water (Minnich 1979. *In* Comparative Physiology of Osmoregulation in Animals, pp. 391–641. Academic Press, London, UK). One such behavior, drinking water, has been recorded relatively infrequently among lizards dwelling in arid habitats (e.g., Meyer 1966. Copeia 1966:126–128; Fusari 1985. Copeia 1985:981–986; Sherbrooke 1993. J. Herpetol. 27:270–275; Sherbrooke 2004. Amphibia-Reptilia 25:29–39). Hence, we describe drinking behavior in the tropidurid lizard *Tropidurus semitaeniatus* for the first time.

Tropidurus semitaeniatus is broadly distributed in the rocky habitats of the semi-arid caatingas of northeastern Brazil (Vanzolini et al. 1980. Répteis das Caatingas. Acad. Bras. de Ciênc., Rio de Janeiro, Brazil. 161 pp.). High temperatures, low humidities, and low, often-irregular precipitation concentrated in 2–3 months of each year characterize these caatingas (Nimer 1972. Rev. Bras. Geog. 34:3–51; Reis 1976. Ann. Acad. Bras. de Ciênc. 48:325–335; Andrade-Lima 1981. Rev. Bras. Bot. 4:149–153).

Our observations were made at a caatinga at the Estação Ecológica do Seridó (Ecological Station of the Seridó [ESEC Seridó]; 6.5767°S, 37.2558°W, datum: WGS84; elev. 192 m), Serra Negra do Norte municipality, Estado do Rio Grande do Norte, Brazil.

At 0810 h and 0930 h, respectively, on 7 and 8 October 2007, LBR observed the drinking behavior in 8 *T. semitaeniatus* to which he experimentally offered water in the course of making focal animal observations of foraging behavior. Water was offered to lizards by dripping it directly on a rock surface (~1 m^2) and on dry leaves at a distance ~1 m from the animals using a 20-ml syringe. Lizards rapidly demonstrated interest in water offered as soon as they located it visually or heard the sound of the drops on dry leaves. During this month of heavy drought, air temperature and humidity at the time of observations on the first day was 33.2ºC and 38.6%, whereas at the time of observations on the second day, air temperature was 32.3ºC and humidity was 36.1%.

To drink the water from warm rock surfaces, each *T. semitaeniatus* kept its forelegs flexed such that its belly did not contact the substrate. With the head oriented down, their snout touched the accumulated water in the rock fissures of the rock (Fig. 1) and based on contractions of the throat, they seemed



FIG. 1. *Tropidurus semitaeniatus* drinking water in the rock fissure of the rock at the Estação Ecológica do Seridó, Brazil.

to swallow it. Where water was in a thin laminar layer on rock surfaces, the lizards tongue-flicked rapidly in an apparent attempt to maximize their intake before the water evaporated from warm surfaces (> 40°C). Lizards also alternating quickly among fissures holding water also seemed to be an attempt to maximize intake. Water offered in dry leaves appeared to allow more time to access than that offered on warm rocks, and water on dry leaves also seemed to be more easily consumed.

Given the scarce precipitation on caatingas, *T. semitaeniatus* are thought to acquire most of their water from animal prey, mainly termites (Vitt 1995. Occ. Pap. Oklahoma Mus. Nat. Hist. 1:1–29), because vegetation becomes completely dry during drought. The drinking behavior we described may be used opportunistically by *T. semitaeniatus* as soon as the annual rains appear in northeastern Brazil.

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UTA STANSBURIANA (Side-Blotched Lizard). **NOCTURNAL ACTIVITY; FORAGING BEHAVIOR.** *Uta stansburiana* is a small (up to 6.3 cm SVL) sceloporine lizard common throughout much of the arid western United States (Stebbins 2003. A Field Guide to Western Reptiles and Amphibians. Houghton Mifflin, New York, New York. 533 pp.) that is typically associated with mixed fine substrate and rock habitats below elevations of ca. 1,850 m (St. John 2002. Reptiles of the Northwest. Lone Pine, Auburn, Washington, USA. 256 pp.). Its diel activity pattern is typically bi-modal, occurring during the morning (beginning at 0900 h) or early evening (1730–1830 h), and centered around foraging or mate searching behavior (Parker and Pianka 1975. Copeia 1975:615–632). Reports of crepuscular activity exist for *Sceloporus jarrovi* and *S. virgatus* in southeast Arizona (Duncan et al. 2003. Southwest. Nat. 48:218–222), but reports of nocturnal activity among sceloporine lizards are rare. Hence, here I report an observation of nocturnal behavior in *U. stansburiana*.

At 0115 h on 18 May 2008, I observed 3 adult *U. stansburiana* on Huntzinger Road in eastern Kittitas County, Washington (46.86305°N, 119.97155°W, datum: WGS84; elev. ca. 185 m). Two individuals appeared to be basking (via thigmothermy) on the road. Their limbs were splayed out and each had a flattened appearance. A third animal was observed actively pursuing insects on the road ca. 3 m away (the road was illuminated via a full moon). Air temperature at the time of observation was 28°C, and the daytime high in the area, recorded at 1530 h 1.0 m above the surface in the shade, approached 43.5°C. Surrounding habitat was shrub-steppe characteristic of much of central Washington (Daubenmire 1970. Steppe Vegetation of Washington. Washington Agric. Exp. Station Tech. Bull. 62, Pullman, Washington. 131 pp.), dominated by big sagebrush (*Artemesia tridentata*), rabbitbrush (*Chrysothamnus* spp.), various annuals, and in some areas, a few invasive exotics (*Bromus* sp. and *Centaurea* sp.).

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SERPENTES — SNAKES

BOA CONSTRICTOR (Boa Constrictor). **DIET.** *Boa constrictor* is a widely distributed, large-bodied dietary generalist that consumes a wide taxonomic diversity of prey including invertebrates, fish, lizards, birds, and mammals (Quick et al. 2005. J. Herpetol. 39:304–307). Though dietary habits of continental *B. constrictor* are well-documented, less data exist concerning the diet of populations inhabiting neotropical islands. Iguanas of the genus *Ctenosaura* have been documented in the diet of *B. constrictor* inhabiting the Bay Islands of Honduras (Gutsche 2005. Herpetol. Rev. 36:317; Reed et al. 2006. Herpetol. Rev. 37:84) and Green Iguanas (*Iguana iguana*) have been reported in the diets of individuals inhabiting Aruba (Quick et al., *op cit*.). Here we report an additional iguana prey item for *B. constrictor* from the island of Dominica in the Lesser Antilles, West Indies.

On 13 July 2004, MG observed a dead *B. constrictor* (ca. 2 m total length) on the main road passing through Desirade (15.58333°N, 61.31667W°) in Woodford Hill on the northeastern coast of Dominica. An adult female *Iguana delicatissima* (Lesser Antillean Iguana; ca. 27 cm SVL) was protruding through a laceration in the snake's body. Eggs from the iguana were strewn along the road and a broken and a rotten branch of a White Cedar (*Tabebuia pallida*) was discovered next to the specimen. It is assumed that the snake captured and ingested the iguana in the White Cedar and its excessive mass caused the rotten tree limb to break. Another *B. constrictor* (ca. 2 m TL) was discovered by CRK and LP on 24 August 2007 in the Batalie Beach area (15.45027°N, 61.44694°W) located on the west coast of Dominica. The snake was resting on the ground in a shallow cave along a rock wall 12 m from the ocean. A single scat (16 × 3 cm) was discovered 1 m from the snake. The scat contained skeletal elements, crest scales, and six eggs of *I. delicatissima*. These observations augment the list of prey items for *B. constrictor* and suggest that large-bodied iguanas may be more common prey than previously documented.

We thank the Center for Conservation and Research for Endangered Species (CRES) of the Zoological Society of San Diego for support.

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BOTHROPS ASPER (Mapanare, Lancehead). **PREY.** *Bothrops asper* is a large neotropical lancehead that grows to more than 1500 mm TL. It is common in lowland and premontane moist forest up to about 1000 m elev., and is a major source of medically significant human envenomations. Available data indicate that *B. asper* feeds predominantly on rodents, but also feeds on birds, frogs, lizards, snakes (Campbell and Lamar 2004. The Venomous Reptiles of the Western Hemisphere. Cornell University Press, Ithaca, New York. 870 pp.), and arthropods (Boada et al. 2005. Herpetozoa 18 [1/2]:77–79).

Here we report for the first time fish as prey for *B. asper*, and two additional findings we recovered from stomachs of specimens from Venezuela. An adult male *B. asper* (SVL = 1180 mm; MIZA 505) collected on 21 August 2006 near Estación Ecológica Guáquira, 10 km ESE of San Felipe, Estado Yaracuy, Venezuela (10.2975°N, 68.6554°W, 100 m elev.) contained an eel (*Synbranchus marmoratus*). Martins et al. (2002. *In* Schuett et. al. [eds.], Biology of the Vipers, pp. 307–328. Eagle Mountain Publishing, Eagle Mountain, Utah) examined stomach contents from 1055 specimens representing 22 species of *Bothrops* and did not record a single case of fish as prey.

MN examined the stomachs of two adult *B. asper* in the museum at the Biological Station Rancho Grande. An adult male collected at the Estación de Fauna de El Limón on 8 November 1999 (EBRG 3716) had eaten a small wren (*Troglodytes* sp.). An adult female *B. asper* (EBRG 3215) collected on 25 October 1995 at the same locality contained an amphisbaenian (*Amphisbaena alba*).

We are grateful to Carlos Rivero-Blanco, Róbert Sóliz, and Orlando Escalante for making our stay at the Estación Ecológica la Guáquira possible. SL received financial support by the German Academic Exchange Service (DAAD). Collecting permission (N 01-02-03) for La Guáquira was issued to Douglas Mora by Marcos Luis Cardozo Uzcategui, general director of the administrative bureau for permissions in the Ministerio del Ambiente y los Recursos Naturales Renovables.

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IMANTODES CENCHOA (Blunt-headed Tree Snake). ***IMANTODES GEMMISTRATUS*** (Central American Tree Snake), ***IMANTODES INORNATUS*** (Western Tree Snake). **ENDOPARASITES.** Species of *Imantodes* occur in lowlands and premontane slopes from Sonora and southern Tamaulipas, Mexico south to northwestern Ecuador, Bolivia, Paraguay, and northeastern Argentina (Savage 2002. The Amphibians and Reptiles of Costa Rica. A Herpetofauna Between Two Continents, Between Two Seas. University of Chicago Press, Chicago, Illinois. 934 pp.). To our knowledge there are no reports of endoparasites from any species of *Imantodes*. The purpose of this note is to establish the initial helminth lists for *Imantodes cenchoa*, *I. gemmistratus*, and *I. inornatus* from Costa Rica.

Nineteen *I. cenchoa* (SVL = 725.2 mm ± 98.2 *SD*, range = 503–843 mm); 12 *I. gemmistratus* (SVL = 597.3 mm ± 89.7 *SD*, range = 447–805 mm); 10 *I. inornatus* (SVL = 586 mm ± 47.4 *SD*, range = 502–657 mm) were borrowed from the herpetology collection of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California and examined for helminths. The posterior third of the body cavity was opened by a longitudinal incision and organ surfaces and mesenteries were visually examined for parasites. Nematodes were identified after clearing in glycerol. Cestodes and acanthocephalans were stained in hematoxylin, mounted in Canada balsam and studied as whole-mounts. Found were: *I. cenchoa*, 5 oligacanthorhynchid cystacanths in (LACM 150789, 150791, 151332, 151339), prevalence = 21% (number infected/number examined × 100), mean intensity = 1.3 ± 0.50 SD (mean number infected individuals), range = 1–2, and 1 *Mesocestoides* sp. tetrathyridium in (LACM 151377) (prevalence = 5%); *I. gemmistratus*, 1 oligacanthorhynchid cystacanth in (LACM 150773) (prevalence = 8%); *I. inornatus*, 4 *Porrocaecum* sp. (larva in cysts) in LACM 114141, 150578 (prevalence = 20%, mean intensity = 2.0 ± 1.4 *SD*, range = 1–3) and 4 oligacanthorhynchid cystacanths in (LACM 114143, 150754) (prevalence = 20%, mean intensity = 2.0 ± 1.4 *SD*, range = 1–3). Voucher endoparasites were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland: *I. cenchoa*, *Mesocestoides* sp. (USNPC 101518), cystacanth (USNPC 101519); *I. gemmistratus*, cystacanth (USNPC 101520); *I. inornatus*, *Porrocaecum* sp. (USNPC 101520), cystacanth (USNPC 101521). All of the above helminths have been previously found in other colubrid snakes from Costa Rica (Goldberg and Bursey 2004. Carib. J. Sci. 40:62–69).

The genus *Mesocestoides* contains cestodes in which a larval form (tetrathyridium) is infective to a predatory definitive host (Roberts and Janovy 2005. Gerald D. Schmidt & Larry S. Roberts' Foundations of Parasitology, McGraw-Hill, New York. 702 pp.). Adults of *Porrocaecum* occur in the intestines of birds; eggs are ingested by earthworms to commence development (Anderson 2000. Nematode Parasites of Vertebrates. Their Development and Transmission. CABI Publishing, Oxfordshire, UK. 650 pp.). Acanthocephalans have larvae (cystacanths) which occur in arthropod intermediate hosts (Kennedy 2006. Ecology of the Acanthocephala. Cambridge University Press, Cambridge, UK. 249 pp). The helminths found in this study do not develop beyond the larval stage in reptiles. Species of *Imantodes* presumably acquire these helminths by ingesting infected frogs (Savage 2002, *op. cit.*). *Imantodes cenchoa* represents a new host record for cystacanths and *Mesocestoides* sp.; *I. gemmistratus* a new host record for cystacanths; and *I. inornatus* a new host record for larvae of *Porrocaecum* sp. and cystacanths.

We thank C. Thacker (LACM) for permission to examine *Imantodes* sp. which are part of the CRE (= Costa Rica Expeditions) collection donated to LACM by J. M. Savage in 1998.

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LAMPROPELTIS GETULA NIGRA (Black Kingsnake). **OPHIOPHAGY**. Ophiophagy has been commonly documented for many kingsnake (*Lampropeltis*) species. For example, Black Kingsnakes have been documented to prey mainly on species of *Nerodia* and *Regina*, but also *Agkistrodon contortrix* (Copperhead) (Tilley and Huheey 2001, Reptiles and Amphibians of the Smokies, 2nd edition. Great Smoky Mountains Natural History Association, Gatlinburg Tennessee, 143 pp.).

Recently, we observed the predation of an *A. contortrix* by a *L. g. nigra* during an ongoing radiotelemetry study of Copperhead habitat use at the Bankhead National Forest, Alabama, USA. On 23 July 2006, we captured a large male Copperhead (snout–vent length 755 mm; total length 858 mm; mass 326 g) in a drift-fence trapping array located in a recently thinned pine-hardwood forest stand. We surgically implanted the snake with a transmitter (Model SI-2, 9 g, Holohil Systems Ltd., Carp Ontario) following procedures described in Reinert and Cundall (1982. Copeia. 1982:702–705). The snake was released after 48 h and relocated every three days for a total of 11 unique locations. The last visual location was on 4 September 2006 in a large stream management zone next to the thinned forest stand. For two weeks following the 4 September 2006 location, the snake was located three separate occasions; twice inside a large rockpile and once underground at the edge of a wildlife management plot. On 21 September 2006, the snake was tracked inside the base of a newly downed *Quercus alba* (White Oak) (diameter at breast height 18 cm; length 690 cm; distance from ground 25 cm), ca. 500 m from the 4 September 2006 location. The radio signal remained in the downed tree for two weeks, during which we were unable to visually confirm its status. On 5 October 2006, we detected the radio signal in the adjacent stream management zone. When approached, we found a large male Black Kingsnake (SVL 1230 mm; total length 1370 mm; mass 699 g) basking under herbaceous cover and *Fagus grandifolia* (American Beech) saplings. Radio signals emanated from the kingsnake indicating that it had consumed the Copperhead. We captured the kingsnake and brought it back to the laboratory for further observations and to retrieve the transmitter. The transmitter was palpated to the mouth and then slowly removed using tweezers. The kingsnake was returned to the point of capture after three days in captivity and behaved normally upon release.

We believe that the kingsnake predated the Copperhead prior to 21 September 2006, and sought shelter in the downed White Oak to digest the large prey. This idea is supported because the only remains of the Copperhead were a small section of ribs stuck to the transmitter surface, indicating that digestion occurred for a considerable amount of time. Our observation of snake predation not only confirms the proclivity of Black Kingsnakes for Copperheads, but also illustrates the potentials of using radiotelemetry to identify predation rates of focal species during traditional radiotelemetry studies.

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LEIOPYTHON ALBERTISII (Northern White-Lipped Python). **BEHAVIOR**. Little is known about the diet and behavior of this species in the wild, and it has received little attention by scientists. One record on the diet of this species in the wild suggests that it primarily preys on rats (Slip and Shine 1990. Herpetologica 46:283–290), but it is assumed that juvenile pythons also prey on skinks (O'Shea 1996. A Guide to the Snakes of Papua New Guinea. Independent Publishing, Papua New Guinea. p. 80). *Leiopython albertsii* exhibits some interesting behaviors in captivity: it regularly regurgitates fur balls (Froesch 1966. DATZ 19:255); juveniles and sub-adults build persistent tunnel systems in the substrate (D. G. Barker, pers. comm.; pers. obs.) through which they move; and individuals undergo a dramatic physiological color change (pers. obs., see http://leiopython.de for details and photographs). Additionally, individuals often sleep with the head resting laterally on the body coils (pers. obs., see http://leiopython.de for details).

Here I report an unusual and interesting behavior repeatedly shown by two of my long-term captive female *L. albertisii* (12 and 15 years old), caught in the vicinity of Sorong, West Papua. Approximately three weeks after feeding an adult rat each and one week after defecating and regurgitating fur balls, the snakes were observed raising their head and neck (about ¼ of the body) as well as their tail (including the cloacae). The mouth was opened wide and the glottis was shut. Within seconds, the snake's mid-body inflated, and then deflated again accompanied by flatulence-like noise and minimum cloacal outcast of a mucilaginous substance. This was repeated four and five times, respectively. It looked as though the snakes were pumping air into their stomach, and then almost immediately releasing it through the cloaca.

To my knowledge, nothing has been reported on the digestive behavior of this species. Taking into consideration that ambush predators such as large pythons, which feed infrequently, are able to down-regulate their gastrointestinal tract after finishing digestion (Ott and Secor 2007. J. Exp. Biol. 210:340–356), this action might be a means of clearing the gastrointestinal tract prior to down-regulation. However, feces were found in other snake species in which the gastrointestinal tract already downregulated (S. Secor, pers. comm.). To the best of my knowledge, this is the first report of gastrointestinal ventilation behavior in snakes.

I thank David G. Barker and Stephen M. Secor for discussion and sharing unpublished observations.

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GEOGRAPHIC DISTRIBUTION

Instructions for contributors to Geographic Distribution appear in Volume 40, Number 1 (March 2009, p. 106). Please note that the responsibility for checking literature for previously documented range extensions lies with authors. Do not submit range extension reports unless a thorough literature review has been completed.

CAUDATA — SALAMANDERS

AMBYSTOMA LATERALE (Blue-spotted Salamander). CANADA: ONTARIO: Kenora District: Wunnummin Lake (52.9335 °N, 89.2976 °W; WGS84). 17 May 2006. Ralph Winter. Verified by Robert W. Murphy (Royal Ontario Museum) and James P. Bogart (University of Guelph). Royal Ontario Museum (ROM 45416). One adult male (10.3 cm total length, 5.6 cm SVL) found dead adjacent to a pond in the Wunnumin Lake First Nation community just after spring thaw. The range of members of the Jefferson's Salamander complex in northern Ontario is poorly documented, and not well understood (Oldham and Weller 2000. Ontario Herpetofaunal Atlas. Natural Heritage Information Centre, Ontario Ministry of Natural Resources, Peterborough, Ontario, Canada. < http://www.mnr.gov.on.ca/MNR/nhic/herps/ohs.html > (updated 15 January 2001). This record extends the documented range limit for this complex at this longitude in Ontario northward by 327 km from Burnt Island (ROM 11981) in Lake Nipigon (50.0419°N, 88.4367°W). The nearest adjacent documented records for specimens of this complex are 151 km to the west at Highway 808/McCauley River Road, Kenora District (52.4515 °N, 91.3985°W; Canadian Museum of Nature, CMNAR 24489 [formerly National Museum of Canada, NMC 24489]), and 618 km to the east at Moosonee, Cochrane District (51.2833 °N, 80.6500 °W; J.P. Bogart, JPB 19712). This record suggests that the southward dip in the range in northern Ontario depicted in published maps (Conant and Collins 1998. A Field Guide to Reptiles and Amphibians of Eastern and Central North America. 3rd ed., expanded. Houghton Mifflin Co., Boston, Massachusetts. 616 pp.; Petranka 1998. Salamanders of the United States and Canada, Smithsonian Press, Washington. 587 pp.; MacCulloch 2002. The ROM Field Guide to Amphibians and Reptiles of Ontario. Royal Ontario Museum, and McClelland & Stewart, Toronto, Ontario. 168 pp.) might be an artifact of insufficient sampling in northern Ontario. In addition, ROM 45416 represents the most northern locality of Jefferson's Salamander complex salamanders identified as LL (Lowcock et al. 1987. Syst. Zool. 36:328–336) using isozyme electrophoresis (Bogart and Klemens 2008. Am. Mus. Novitates No. 3627:1–58), and is one of only five other localities for electrophoretically-determined LL in Ontario north of 48°N latitude (southwest of Thunder Bay, Thunder Bay District [JPB 23715–25, 23934, 24384–85]; Moosonee, Cochrane District [JPB 19712]; north of Harmon Generating Station, Mattagami River, Cochrane District [JPB 39596–97]; north of Kapuskasing, Mattagami River, Cochrane District [JPB 39598]; and, near New Liskeard, Timiskaming District [JPB 24172, 24175]).

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AMBYSTOMA MACULATUM (Spotted Salamander). USA: ILLINOIS: Gallatin Co.: Shawnee National Forest, vernal pond ca. 1 km from Pounds Hollow Rd. on York Lane Rd. (38.603889°N, 88.262778°W; NAD 83). 08 March 2008. Cy L. Mott. SIUC H-8762. Hamilton Co.: Hamilton County State Fish and Wildlife Area, vernal pond ca. 500 m S of the Dolan Lake spillway parking lot (38.051389°N, 88.402222°W; NAD 83). 08 March 2008. Cy L. Mott. Egg mass. SIUC H-8763. Saline Co.: Saline County State Fish and Wildlife Area, forested pond ca. 100 m E of Glen Jones Road (37.691944°N, 88.378611°W; NAD 83). 08 March 2008. Cy L. Mott. Egg mass. SIUC H-8764. All specimens verified by Ronald A. Brandon. All specimens represent new county records (Phillips et al. 1999. Field Guide to Amphibians and Reptiles of Illinois. Illinois Nat. Hist. Surv. Manual 8, Champaign, Illinois. xii + 282 pp.). This research was funded by a grant from the Chicago Herpetological Society.

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DESMOGNATHUS AENEUS (Seepage Salamander). USA: GEORGIA: Haralson Co.: 5.79 km E of Buchanan along State Rt. 120. 23 April 1968. G. Folkerts and R. Estridge. Verified by Craig Guyer. AUM 18833–18840. New county record. Talbot Co.: Sprewell Bluff Wildlife Management Area. Seepage on the N slope of Rockhouse Mountain near the Flint River (32.88055° N, 84.50418° W; WGS 84). 15 February 2009. S. Graham and K. Gray. Verified by John Jensen. AUM 37837. New county record. Although *D. aeneus* was mentioned to occur in Haralson County (Folkerts 2004. *In* Mirarchi et al. [eds.], Alabama Wildlife Vol. 3: Imperiled Amphibians, Reptiles, and Mammals. University of Alabama Press. 225 pp.), there were no specifics or verification provided, and the locality did not appear in a recent regional guide (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens, Georgia. 575 pp.). The Haralson County locality is ~ 70 km from nearest documented population to the NE (Cherokee County, Georgia), and probably contiguous with nearby Alabama populations to the west (Cleburne County).

The Talbot County locality is ~ 100 km SE of the nearest documented population in Carroll County, Georgia (Williamson and Moulis 1994. Distribution of Amphibians and Reptiles in Georgia. Savannah Sci. Mus. Spec. Publ. 3:1–172), and is potentially disjunct, unless additional localities await documentation along the Talladega Uplands/Pine Mountain Ridges in western Georgia. The Talbot County record is the first for this species from the Pine Mountain Ridges ecoregion, an area within the Piedmont physiographic province (Wharton 1978. The Natural Environments of Georgia. Georgia Department of Natural Resources Bull. 113. 227 pp.; Graham et al., *in review*). The specimen was found under leaf litter near the head of a ~ 20–30 m seepage run which flows directly into the Flint River.

This collection trip was partially supported by NIH grant #R01-A149724 to T. Unnasch under Georgia collection permit

#29-WBH-08-8.

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HEMIDACTYLIUM SCUTATUM (Four-toed Salamander). USA: GEORGIA: Madison Co.: John Seginak's property, off Waggoners Grove Church Rd. (34.03504722° N, 83.170877° W; WGS84). 31 January 2006. Collected during undergraduate herpetology class survey by E. Adair, P. Barnett, A. Durso, K. Holcomb, N. Hyslop, N. Loftin, A. Ruiz, J. Seginak, D. van Dijk, D. Sollenberger. Verified by Kenneth L. Krysko. UF 154325. New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. The University of Georgia Press. 575 pp.). An adult *H. scutatum* was found under coarse woody debris adjacent to a tributary of Beaverdam Creek.

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ANURA — FROGS

ACRIS GRYLLUS (Southern Cricket Frog). USA: TENNESSEE: Hamilton Co.: Volunteer Army Ammunition Plant site (35.10437°N, 85.13053°W; WGS 84). 01 November 2008. Joseph F. Simpson, Evan Collins, Thomas P. Wilson. Verified by C. Manis. UT Chattanooga Natural History Museum (TPW/UTCHERP 4656). Specimen collected using a drift fence/pitfall array surrounding an ephemeral wetland. First record for Hamilton County (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee, 19 pp. Hard copy and Internet [http://www.apsu.edu/amatlas/]. Accessed 30 November 2008). Voucher collected under Tennessee Wildlife Resources Agency Permit #3082 and UTC AUP No. 0408TPW-04.

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ANAXYRUS AMERICANUS (American Toad). USA: ILLINOIS: Gallatin Co.: Shawnee National Forest, vernal pond ca. 1 km from Pounds Hollow Rd. on York Lane Rd. (37.603889°N, 88.262778°W; NAD 83). 26 March 2008. Cy L. Mott. Verified by Ronald A. Brandon. SIUC R-8765. New county record (Phillips et al. 1999. Field Guide to Amphibians and Reptiles of Illinois. Illinois Nat. Hist. Surv. Manual 8, Champaign, Illinois. xii + 282 pp.). This research was funded by a grant from the Chicago Herpetological Society.

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ANAXYRUS* (*=BUFO*) *WOODHOUSII (Woodhouse's Toad). USA: TEXAS: Castro Co.: 0.4 miles N of Highway 60 on FM 1057 (34.7427778ºN, 102.513055ºW), 3936 feet elev. 06 September 2008. Collected by James R. Dixon and Bob L. Tipton in an agricultural area. Verified by Toby Hibbitts. Texas Cooperative Wildlife Collections (TCWC 93122). The large male specimen was found alive on the road at 0017 h, 59ºF, adjacent to an agricultural area, about 100 yards south of the Deaf Smith County sign. Deaf Smith Co.: 12.0 miles W of Hereford on Highway 1058W (34.825833ºN, 102.608888ºW), 3969 feet elev. 05 September 2008. Verified by Toby Hibbitts. (TCWC 93121). The small male specimen was found alive at 2117 h, 65 ºF, on the road. Both specimens represent new county records (Dixon 2000. Amphibians and Reptiles of Texas. 2nd edition. Texas A&M University Press, College Station, Texas. 421 pp.).

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COLOSTETHUS CAERULEODACTYLUS. BRAZIL: AMAZONAS: Canutama Municipality (06.9468333ºS, 64.2003611ºW). 24 January 2004. A. M. Batistella, A. C. Cordeiro, and O. S. Pereira, Instituto Nacional de Pesquisas da Amazônia - INPA, Manaus, Brazil, Amphibian and Reptile Collection (INPA-H 11.451–65). Verified by A. Lima. The specimens were found in the leaf litter in forest that is periodically flooded, on the right bank of Igarapé Trufarí, a black water tributary of the Purus River. This is the third known locality for this species which is endemic to the Brazilian Amazon Basin. Extends the distribution 665 km SW of the population located ca. 40 km S Manaus, elev. 50 m, Amazonas, Brazil (03.61955ºS, 60.45511ºW), in the municipality of Castanho (Lima and Caldwell 2001. Herpetologica 57:180–189).

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GASTROTHECA PULCHRA. BRAZIL: BAHIA: Municipality of Amargosa, Timbó farm (13.2739ºS, 39.2835ºW), 850 m elev. 13 January 2007. P. Fonseca, T. Figueiredo Santos Silva, and M. A. de Freitas. Museu de Zoologia da Universidade Federal da Bahia, Bahia, Brazil (MZUFBA 6457). Municipality of Elíseo Medrado, Jequitibá farm (12.5214ºS 39.2830ºW) 570 m elev. 09 January 2008. M. A. de Freitas, (MZUFBA 7826). All verified by I. Nunes. Extends known distribution ca 100 km N from nearest previous locality: Municipality of Itamari, Bahia, Brazil (Caramaschi and Rodrigues 2007. Boletim do Museu Nacional, nova série, Rio de

Janeiro, Zoologia 525:1–19.).

Submitted by **MARCO ANTÔNIO DE FREITAS,** Programa de pós-graduação em zoologia, UESC (Universidade Estadual de Santa Cruz) CEP 46.500-000 Rodovia Ilhéus/Itabuna, Ilhéus, Bahia, Brazil (e-mail: philodryas@hotmail.com); **THAÍS FIGUEIREDO SANTOS SILVA** (e- mail: thaisfsilva@hotmail.com); and **PATRÍCIA MENDES FONSECA,** Biogeographia publicações e consultoria ambiental, Rua E quadra D lote 11, Jardim Aeroporto, CEP 42700-000, Lauro de Freitas, Bahia, Brazil; (e-mail: patriciamfonseca@yahoo.com.br).

LITHOBATES CLAMITANS (Green Frog), USA: ILLINOIS: Calhoun Co.: McCully Heritage Project. 0.12 km S of Crawford Creek Hollow Rd., 0.80 km W of Hwy 100 (39.2804ºN, 90.6187139ºW; datum WGS84), 23 May 2008. C. E. Montgomery and P. J. Muelleman. Verified by Lori B. White. Southern Illinois University at Carbondale Fluid Vertebrate Collection (H-7934). One individual was captured on the edge of a small stream. This record fills a single-county hole in the range of *L. clamitans* in Illinois and Missouri (Philips et al. 1999. Field Guide to Amphibians and Reptiles of Illinois. Illinois Natural History Survey, Champagne, Illinois. 282 pp.; Johnson 2000. The Amphibians and Reptiles of Missouri. Missouri Dept. of Conservation, Jefferson City, Missouri. 369 pp.). Permits issued by the Illinois Dept. of Natural Resources (NH08.5174; NH08.5173). We thank the McCully Heritage Project and the National Great Rivers Research and Education Center.

Submitted by **PETER J. MUELLEMAN** and **CHAD E. MONTGOMERY**, Department of Biology, Truman State University, Kirksville, Missouri 63501, USA; e-mail: chadmont@truman.edu.

PLEURODEMA GUAYAPAE. ARGENTINA: SAN JUAN: Department Valle Fértil: Astica (30.5817°S, 67.5339°W; WGS 84). December 2008. L. Quiroga, E. Borghi, S. Carta, and G. Moreira. Herpetological Collection, Instituto y Museo de Ciencias Naturales, Universidad Nacional de San Juan, Argentina, (IMCN-UNSJ 5336–5337) Two males collected calling in a temporary pond after the rain. Verified by Julián Valetti. Previously known for Argentinean central provinces of Córdoba, La Rioja, Catamarca, Santiago del Estero (Barrio 1964. Physis 24:471–489) and San Luis, Sierras Quijadas National Park (Guerreiro et. al. 2003 Herpetol. Rev. 34[3]:259) and Department of Santa Cruz, Bolivia (Gonzales 1998. Ecología en Bolivia 31:45–52; de la Riva and Gonzales 1998. Alytes 16:68–76). First province record, extends known distribution ca. 100 km W from the nearest locality (La Rioja province) and 142 km NW from Sierras Quijadas National Park (San Luis province).

Submitted by **LORENA B. QUIROGA** (e-mail: quiroga_lore@gmail.com), and **EDUARDO A. SANABRIA**, Departamento de Biología, F.C.E.F. y N., Universidad Nacional de San Juan, Avenida España 400 (N) C.P. 5400, San Juan, Argentina.

PRISTIMANTIS TANTANTI. PERU: MADRE DE DIOS: Cocha Cashu Field Station (ca. 11.85°S, 71.3166°W, 400 m elev.; WGS84), Manu National Park. October/November 1989. L. Rodríguez. Museo de Historia Natural Universidad Nacional Mayor de San Marcos, Lima, Peru (first females known: MUSM 3848, SVL 29.9 mm and contained 13 ovarian eggs; and MUSM 9119, SVL 28.8 mm). Verified by C. P. Torres. The description of *Pristimantis tantanti* was based on two males from Myaria (Department of Cusco) the only known locality (Lehr et al. 1997. Herpetologica 63:94–99). First record for Region Madre de Dios, extending the distribution to 175 km (airline) southeast of the type locality.

Submitted by **EDGAR LEHR**, Senckenberg Natural History Collections Dresden, Koenigsbruecker Landstrasse 159, 01109 Dresden, Germany; e-mail: edgar_lehr@yahoo.de.

PSEUDACRIS CRUCIFER (Spring Peeper).USA: TENNESSEE: Benton Co.: McIllwain Road, (35.853030ºN, 88.065970ºW; WGS84). 31 March 2006, H. A. Messer and L. D. Bennie, APSU 18245. Frogs were recorded calling from a woodland area adjacent to the road. APSU 18246. Additional Benton County locations (APSU 18246, APSU 18247) were also recorded. Carroll Co.: Cutlip Road (36.031727ºN, 88.601635ºW; WGS 84). 08 March 2006, H. A. Messer and L. D. Bennie, APSU 18248. Frogs were recorded calling from flooded grassland adjacent to the road. An additional Carroll County location (APSU 18249) was also recorded. Davidson Co., Luster Road (36.335686ºN, 86.782390ºW; WGS84) 14 April 2006, H. A. Messer and L. D. Bennie, APSU 18251. An additional Davidson County location (APSU 18252) was also recorded. Decator Co.: Bath Springs, Red Walnut Road at Red Walnut Church of Christ, (35.469461ºN, 88.181546ºW; UTM 84). 11 March 2006, B. P. Butterfield, K. L. Butterfield, and J. B. Butterfield, APSU 18253. Frogs were recorded calling from flooded bottomland hardwoods near North Prong of Stewman Creek. Gibson Co.: Hwy 425, (35.936590ºN, 88.736626ºW; WGS84). 08 March 2006, H. A. Messer and L. D. Bennie, APSU 18256. Frogs were recorded calling from a drainage ditch running along a railroad track that intersects with Hwy 425. An addition Gibson County location (APSU 18257) was also recorded Haywood Co.: Hatchie National Wildlife Refuge, Hillville, (35.468613ºN; 89.143466ºW;WGS84). 15 February 2005, J. Stanley, APSU 18225. Frogs were recorded calling from edge of cornfield with rain-filled depressions adjacent to woodland habitat.Henderson Co.: Hwy 100 (35.493744ºN, 88.402690ºW;WGS84). 21 February 2005, H.A. Messer and L.D. Bennie, APSU 18260. Frogs were recorded calling from a flooded area adjacent to woodlands. Additional Henderson County locations (APSU 18261 – APSU 18263) were also recorded Hickman Co.: Nunnelly Road (35.891005ºN, 87.606087ºW;WGS84). 05 April 2006, H.A. Messer and L.D. Bennie, APSU 18264. Frogs were recorded calling from a woodland adjacent to the road. Additional Hickman County locations (APSU 18265, APSU 18266) were also recorded. Humphreys Co.: Seed Tick Road (35.838549º N, 87.800247ºW;WGS84). 12 April 2006, H.A. Messer and L.D. Bennie, APSU 18267. Frogs were recorded calling from a flooded grassy area surrounded by woodlands. An additional Humphreys County location (APSU 18268) was also recorded. Lauderdale Co.: South end of Open Lake adjacent to Hwy 19 (35.779218ºN, 89.690994ºW; WGS84). 06 March 2006, H. A. Messer and L. D. Bennie, APSU 18269. Frogs were recorded calling from woodland adjacent to Open Lake. Additional Lauderdale County locations (APSU 18270, APSU 18271 andAPSU 18272) were also recorded. Lawrence Co.: 35.419429ºN, 87.476543ºW;WGS84. 13 March 2006, H. A. Messer and L. D. Bennie, APSU 18273. Several additional Lawrence County locations (APSU 18274, APSU 18275

and APSU 18276) were also recorded. LEWIS CO.: 35.429092ºN, 87.475025ºW; WGS84. 13 March 2006, H. A. Messer and L. D. Bennie, APSU 18277. Frogs were recorded calling from a pond in field adjacent to woodland. Two additional Lewis County locations (APSU 18278, 18279) were also recorded. MADISON CO., Pinson, Ozier Road (35.496319ºN, 88.712942ºW; WGS84). 03 February 2005, H. A. Messer and L. D. Bennie, APSU 18280. Frogs were recorded calling from flooded woodland. One additional Madison County location (APSU 18281) was recorded. MAURY CO.: Leaper's Creek Road (35.6996392 ºN, 87.198301W: NAD83), 05 April 2006, H. A. Messer and L. D. Bennie, APSU 18282. Frogs were recorded calling from woodland surrounding Leaper's Creek. A second Maury County location (APSU 18283) was also recorded. MCNAIRY CO.: 35.228975ºN, 88.405480ºW; WGS84. 21 February 2005, H. A. Messer and L. D. Bennie, APSU 18284. Frogs were recorded from a farm pond. Several additional McNairy County locations (APSU 18285 –APSU 18290) were also recorded. PERRY CO.: Hwy 412 next to Coon Creek (35.620755ºN, 87.734145ºW,WGS84). 13 March 2006, H.A. Messer and L.D. Bennie, APSU 18291. One additional Perry County location (APSU 18292) was also recorded. TIPTON CO.: 35.452477ºN, 89.568174ºW;WGS84. 25 February 2005, H. A. Messer and K. A. Dassatt, APSU 18293. Frogs were recorded calling from a wetland. A second Tipton County location (APSU 18294) was also recorded. WAYNE CO.: Hwy 64, 35.288515ºN, 87.980692ºW; WGS84, 13 March 2006, H. A. Messer and L. D. Bennie, APSU 18295. Frogs were recorded calling from woodland. A second Wayne County location (APSU 18296) was also recorded.

Pseudacris crucifer has a near continuous distribution throughout much of the eastern United States and southeastern Canada (Conant and Collins 1998. A Field Guide to Reptiles and Amphibians of Eastern and Central North America. 3rd ed. Houghton Mifflin Co., Boston, Massachusetts). However, this common species has not been reported from many counties in central and west Tennessee (Butterfield et al. 2005. *In* M. Lannoo (ed.), Amphibian Declines: The Conservation Status of United States Species, pp. 472–474. University of California Press, Berkeley). The purpose of this study was to determine if the distribution map provided by Butterfield et al. (*op. cit.)* accurately reflects the distribution of *P. crucifer* in Tennessee or is the result of inadequate sampling. Sampling was conducted during the breeding seasons of 2004, 2005, and 2006. Topographic maps were used to identify likely breeding sites within each county.

All voucher specimens (audio recordings and/or photographs) are deposited in the Austin Peay State University Museum of Zoology (APSU) and were verified by A. Floyd Scott. Collections were made under the authority of TWRA permit 1494 to BPB. All records, represent new county records for *P. crucifer* in Tennessee (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee).We thank A. Floyd Scott for verifying recordings and Freed-Hardeman Research Center and Freed-Hardeman University Honors College for providing funding.

Submitted by **BRIAN P. BUTTERFIELD,** Department of Biology, Freed-Hardeman University, Henderson, Tennessee 38340, USA (e-mail: bbutterfield@fhu.edu); **HELEN A. MESSER**, Reelfoot Lake State Park, 3120 State Route 213 Tiptonville, Tennessee 38079, USA; and **LAURIE D. BENNIE, JONATHAN W. STANLEY**, Department of Biological Sciences, Arkansas State University, PO Box 599, State University, Arkansas 72467, USA.

TESTUDINES — TURTLES

APALONE MUTICA MUTICA (Midland Smooth Softshell). USA: WISCONSIN: DANE CO.: Blackhawk Unit – Lower Wisconsin State Riverway (43.249667°N, 89.747833°W; WGS 84). 30 June 2007. One individual captured by hand (TM) on gravel bar and photographed. Photographs verified by Gary Casper (University of Wisconsin-Milwaukee Field Station). Photograph voucher, Illinois Natural History Survey catalogue number INHS 2008. k. New county record. Extends range of species in Wisconsin (Casper 1996. Geographic Distributions of the Amphibians and Reptiles of Wisconsin. Milwaukee Public Museum, 87 pp.). Vogt (1981. Natural History of Amphibians and Reptiles of Wisconsin. Milwaukee Public Museum. 208 pp.) reported this species from adjacent counties (Columbia and Sauk), which lie along the same major river system—the Wisconsin River.

Submitted by **TIM MUEHLFELD**, We Energies, 333 W. Everett St., Milwaukee, Wisconsin 53203, USA; **JOSHUA M. KAPFER**, Natural Resources Consulting, Inc., 209 Commerce Parkway, PO Box 128, Cottage Grove, Wisconsin 53527, USA.

KINOSTERNON SCORPIOIDES (Scorpion Mud Turtle): AMAZONAS: Barreirinha (2.9457ºS, 57.0239ºW; WGS84). 08 May 2008. C. Ferrara, L. Schneider, R. C. Vogt, and L. B. Santos-Junior. Verified by L. Bonora. Coleção de Repteis e Anfibios, Instituto Nacional de Pesquisas da Amazonia. INPAH 19955. The 14 *K. scorpiodes,* including mature males, females, and juveniles, captured at this site represent the first breeding population known from the central Amazon. Closest record is in Itapiranga, Amazonas (2.9457ºS, 58.0239ºW; WGS84) MZUSP 2181, 117 km W from the new record (Pritchard and Trebbau 1984. The Turtles of Venezuela. Society for the Study of Amphibians and Reptiles, Oxford, Ohio. 403 pp.).

Submitted by **CAMILA FERRARA** (e-mail: ferrara@terra.com.br), **LARISSA SCHNEIDER, RICHARD C. VOGT**, **LADISLAU B. SANTOS-JUNIOR**, Instituto Nacional de Pesquisas da Amazônia (INPA). Caixa Postal 478. CEP 69011-970, Manaus, Amazonas, Brazil.

MESOCLEMMYS VANDERHAEGEI. BRAZIL: MINAS GERAIS: Municipality of João Pinheiro: Fazenda Serra Morena, in short stream tributary of Prata River (17.823056ºS, 46.196389ºW; datum SAD-69, 730 m elev.). 15 December 2004. A. L. Silveira. Museu Nacional / UFRJ, Rio de Janeiro, RJ, Brazil (MNRJ 15341). Dirt road near Cachoeira do Garimpo in Garimpo River (17.700556ºS, 46.041389ºW; datum SAD-69, 715 m elev.). 18 December 2008. D. V. Valinhas and A. L. Silveira. MNRJ 15770. Verified by Ronaldo Fernandes. The localities are in the area of Cerrado biome in São Francisco River basin. First record for the State of Minas Gerais and for the São Francisco River basin, ca. 275 km SE from the closest previous record (Brazil, Distrito Federal, Municipality of Brasília, Estação Ecológica do Jardim Botânico de Brasília – CHUNB 24694; Brandão et al. 2002. Biol. Asoc.

Herpetol. Esp. 13[1–2]:1115).

Submitted by **ADRIANO LIMA SILVEIRA**, Setor de Herpetologia, Departamento de Vertebrados, Museu Nacional / Universidade Federal do Rio de Janeiro, Quinta da Boa Vista, São Cristóvão, CEP 20940-040, Rio de Janeiro, RJ, Brazil; e-mail: biosilveira@yahoo.com.br.

PHRYNOPS GIBBUS (Gibba Turtle). BRAZIL: AMAZONAS: Barreirinha (02.9457ºS, 57.0239ºW; WGS84). 08 May 2008. L. Schneider, C. Ferrara, R. C. Vogt, L. B. Santos-Junior. Verified by L. Bonora. Coleção de Repteis e Anfibios, Instituto Nacional de Pesquisas da Amazonia INPAH 19956. The range of this secretive species is poorly documented, known from throughout the Guianas and the Brazilian northern coastal plain as well as the Amazon drainage of Colombia, Venezuela, and Peru (Vogt 2008. Tortugas Amazónicas. Grafica Biblos, Lima, Peru 104 pp.). This is the first state record, and extends the range 740 km W from the nearest location in Breves, Para state (01.6825ºS, 50.48ºW; WGS84) based on MZUSP 2684–5 (Pritchard and Trebbau. 1984. The Turtles of Venezuela. Society for the Study of Amphibians and Reptiles, Oxford, Ohio. 403 pp.). Extends the range of this species into the central Amazon Basin in Brazil. The turtles were hand captured in 20–30 cm deep, clear water, forest pools.

Submitted by **LARISSA SCHNEIDER** (e-mail: laribio@terra.com.br), **CAMILA FERRARA**, **RICHARD C. VOGT**, **LADISLAU B. SANTOS-JUNIOR**, Instituto Nacional de Pesquisas da Amazônia (INPA), Caixa Postal 478, CEP 69011-970, Manaus, Amazonas, Brazil.

PLATEMYS PLATYCEPHALA (Twist-necked Turtle). BRAZIL: AMAZONAS: Barreirinha (02.9457ºS, 57.0239ºW; WGS84). 08 May 2008. C. Ferrara, L. Schneider, R. C. Vogt, and L. B. Santos-Junior. Verified by L. Bonora. Coleção de Repteis e Anfibios, Instituto Nacional de Pesquisas da Amazonia INPAH 19957. Turtle was in a shallow forest pool (20–30 cm deep) in the middle of the high evergreen rain forest. First record for this municipality. The closest record is in Maués, Amazonas (03.54ºS, 57.6916ºW; WGS84), based on AMNH 89782, 100 km SW from this new record (Ernst 1983. J. Herpetol. 17:345–355). This record fills in the gap between Santarem, Para, and Maués, Amazonas, adding another locality south of the Amazon River in the Central Amazon Basin.

Submitted by **CAMILA FERRARA** (e-mail: ferrara@terra.com.br), **LARISSA SCHNEIDER**, **RICHARD C. VOGT**, **LADISLAU B. SANTOS-JUNIOR**, Instituto Nacional de Pesquisas da Amazônia (INPA), Caixa Postal 478, CEP 69011-970, Manaus, Amazonas, Brazil.

RHINOCLEMMYS PUNCTULARIA (Spot-legged Turtle). AMAZONAS, Barreirinha. (02.9457ºS. 57.0239º W; WGS84). 08 May 2008. L. Schneider, C. Ferrara, R. C. Vogt, L. B. Santos-Junior. Verified by L. Bonora. Coleção de Repteis e Anfibios, Instituto Nacional de Pesquisas da Amazonia. INPAH 19958. This is the fourth record for the Amazonas state (Vogt 2008. Tartarugas da Amazônia. Grafica Biblos, Lima, Peru. 104 pp.). This new record extends the range for this species 236 km SW from the closest record in Santarém, Pará (MZUSP 39) (02.5455ºS, 54.9688ºW; WGS84) (Pritchard and Trebbau 1984. The Turtles of Venezuela. Society for the Study of Amphibians and Reptiles, Oxford, Ohio. 403 pp.). Turtle was captured in Tucumanduba village by muddling with help of a local collector, Sr. Bico.

Submitted by **LARISSA SCHNEIDER** (e-mail: laribio@terra.com.br), **CAMILA FERRARA, RICHARD C. VOGT, LADISLAU B. SANTOS-JUNIOR**, Instituto Nacional de Pesquisas da Amazônia (INPA), Caixa Postal 478, CEP 69011-970, Manaus, Amazonas, Brazil.

TRACHEMYS SCRIPTA ELEGANS (Red-eared Slider). USA: OHIO: Delaware Co.: Liberty Township: Pond at Columbus Zoo and Aquarium (40.156799°N, 83.119469°W; WGS 84). 12 March 2007. Jeffrey E. Dawson. Verified by Jeffrey G. Davis. Photo voucher in Cincinnati Museum Center, Geier Collections and Research Center (CMC HP 588). New county record (Wynn and Moody 2006. Ohio Turtle, Lizard, and Snake Atlas. Ohio Biol. Surv. Misc. Contr. No. 10, Columbus. iv + 81 pp.). *T. s. elegans* have been released into scattered localities around Ohio; the nearest previous record is ca. 60 km E in Licking County (Wynn and Moody, *op. cit.*). During the 1970s and early 1980s, *T. s. elegans* that were donated to the Columbus Zoo by visitors were released into an unenclosed pond by zoo keepers. Although this practice no longer continues, a number of individuals are still present in the pond. Hatchling *T. s. elegans* have been seen on multiple occasions in recent years, suggesting that this population is successfully reproducing, but whether any offspring survive to maturity is currently unknown. Most recently, a hatchling was found 6 May 2008 on zoo grounds near the Scioto River (less than 200 m straight-line distance from the pond). We thank Mike Brittsan, Curator of Shores at the Columbus Zoo and Aquarium, for bringing the recent hatchling to our attention.

Submitted by **JEFFREY E. DAWSON** (e-mail: jeff.dawson@columbuszoo.org) and **RONNIE E. HATCHER** (e-mail: ron.hatcher@columbuszoo.org), Reptiles/Shores Region, Columbus Zoo and Aquarium, 4850 W. Powell Road, P. O. Box 400, Powell, Ohio 43065, USA.

SQUAMATA – LIZARDS

ANOLIS CAROLINENSIS CAROLINENSIS (Northern Green Anole). USA: ARKANSAS: Johnson Co.: Clarksville, 1.6 km N Clark Rd. (34.192672°N, 94.064072°N; NAD 83). 04 November 2008. T. Kremers. Verified by S. E. Trauth. Arkansas State University Herpetological Museum (ASUMZ 31281). Specimen is an adult female, 60 mm SVL. New county record and first locality in the state north of the Arkansas River and west of the boundary separating the Interior Highlands/Gulf Coastal Plain (Trauth et al. 2004. Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.). Most importantly, we document the northernmost record for *A. c. carolinensis* in the United States west of the Mississippi River (Conant and Collins 1998. Reptiles and Amphibians of Eastern and Central North America. 3rd ed., expanded. Houghton Mifflin Co., Boston, Massachusetts. 616 pp.).

Submitted by **CHRIS T. McALLISTER**, RapidWrite, 102 Brown Street, Hot Springs National Park, Arkansas 71913, USA (e-mail: drcmcallister@aol.com); **HENRY W. ROBISON**, Department of Biology, Southern Arkansas University, Magnolia, Arkansas 71754, USA (e-mail: hwrobison@suddenlink.net); and **JOE KREMERS**, 2019 W. Clark Road, Clarksville, Arkansas

72830, USA (e-mail: skremers@suddenlink.net).

ANOTOSAURA VANZOLINIA. BRAZIL: BAHIA: Municipality of Rui Barbosa, Quixadá farm (12.2708ºS, 40.3731ºW), 550 m elev. 20 June 2003. L. E. Moisés. Museu de Zoologia da Universidade Estadual de Santa Cruz, Ilhéus, Bahia, Brazil (MZUESC 4119). Collected during daylight hours, on the ground of the estacional forest. Verified by M. Rodrigues. Previously known from northeastern Brazil in Agrestina and Serra Negra municipality, Pernambuco state (Delfin and Freire 2007. Oecol. Bras. 11[3]:365–382). First state record, extends distribution ca. 750 km S from Pernambuco state (Delfin and Freire 2007, *op. cit.*).

Submitted by **MARCO ANTÔNIO DE FREITAS,** Programa de pós-graduação em zoologia, Universidade Estadual de Santa Cruz, CEP 46.500-000 Rodovia Ilhéus/Itabuna, Ilhéus, Bahia, Brazil (e-mail: philodryas@hotmail.com); and **LUIZ EDUARDO MOISÉS,** Pituba, Salvador, Bahia, Brazil, CEP 42-700-000 (e-mail bioengen@yahoo.com.br).

ASPIDOSCELIS XANTHONOTA (Red-backed Whiptail). MÉXICO: SONORA: Caborca: Sierra La Gloria-Cerro El Alamo, (30.5055°N, 112.051°W; WGS84), 521 m elev. 27 August 2008. UAZ 57076-PSV, 57077-PSV. Sonoyta: Sierra Cubabi (31.4333°N, 112.5038°W; WGS 84), 755 m elev. 02 August 2008. UAZ 57078-PSV. Philip C. Rosen and Adrian Quijada-Mascareñas. All verified by George Bradley. New records for México and a range extension of ca. 120 km S (airline) from the closest known locality in Arizona (Brennan and Holycross 2006. A Field Guide to Amphibians and Reptiles in Arizona. Arizona Game and Fish Department, Phoenix. 150 pp.). Liner (2007. Louisiana State Univ. Occ. Pap. Mus. Nat. Sci. 80:1–60) lists *A. xanthonota* as occurring in Mexico, but museum searches and queries to curators have not revealed any previous records. The lizards were found in Arizona Upland Sonoran Desert scrub on rocky slopes, confirming a widespread occurrence in this vegetation formation (Rosen 2007. *In* R. S. Felger and B. Broyles [eds.], Dry Borders: Great Natural Reserves of the Sonoran Desert, pp. 310–337. Univ. Utah Press, Logan).

Submitted by **PHILIP C. ROSEN** and **ADRIAN QUIJADA-MASCARENAS**, School of Natural Resources, University of Arizona, 316 Biosciences East, Tucson, Arizona 85721, USA; e-mail: pcrosen@email.arizona.edu.

SQUAMATA — SNAKES

CARPHOPHIS AMOENUS (Eastern Wormsnake). USA: GEORGIA: Madison Co.: John Seginak property, off Waggoners Grove Church Rd. (34.035047°N, 83.170878°W; WGS 84). 02 April 2006. Collected during undergraduate herpetology class survey by E. Adair, P. Barnett, A. Durso, K. Holcomb, N. Hyslop, N. Loftin, A. Ruiz, and D. van Dijk. Verified by Kenneth L. Krysko. UF 154592. New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. The University of Georgia Press. 575 pp.). An adult *C. amoenus* measuring 182 mm SVL was found inside a log adjacent to a riparian wetland. This record is ca. 18.82 km SSE of three 1953 records from Oglethorpe County, Georgia (GMNH 254).

Submitted by **ANDREW M. DURSO**, University of Georgia, Odum School of Ecology, Athens, Georgia 30602, USA (e-mail: amdurso@gmail.com); **KERRY L. HOLCOMB**, 1207 Somerton Place, Cumming, Georgia 30040, USA (e-mail: holcombkerryl@gmail.com); and **PARKER G. BARNETT**, 119 Ashley Way, Jefferson, Georgia 30549, USA (e-mail: barnettp@warnell.uga.edu).

CHIRONIUS FLAVOLINEATUS (Cipó Snake). BRAZIL: CEARÁ: Barbalha Municipality: RPPN Parque do Arajara. (7.328774ºS, 39.408052ºW; WGS84). June–July1997. D.A.N. Machado. Collection of Herpetology of Núcleo Regional de Ofiologia (NUROF) - Universidade Federal do Ceará, Fortaleza, Brazil (CHUFC 2127). Verified by F. L. Franco. First state record; extends known distribution ca. 512 km airline W of João Pessoa municipality, Paraíba (7.439143ºS, 34.913502ºW; WGS84) Paraíba (Santana et al. 2008. Biotemas 21[1]:75–84; Sousa and Nóbrega 2007. Herpetofauna Terrestre de Áreas Sobre Influência da Linha de Transmissão (LT) 230 KV PE/PB, circuito 3. Anais do VIII Congresso de Ecologia do Brasil); also is the first record from Atlantic forest relicts on highlands on the State of Ceará.

Submited by **DIVA MARIA BORGES-NOJOSA**, Universidade Federal do Ceará, NUROF-UFC, Campus do Pici, Bloco 905, 60455-760, Fortaleza, Ceará, Brazil (e-mail: dmbnojosa@yahoo.com.br); and **DANIEL CASSIANO LIMA**, Universidade Estadual do Ceará, Av Mons. Tabosa s/n, 62500-000, Itapipoca, Ceará, Brazil (e-mail: dancassiano@yahoo.com.br).

COLUBER CONSTRICTOR (North American Racer). USA: ILLINOIS: Hamilton Co.: Illinois Route 142, ~3 km S of McLeansboro, DOR. (38.068056°N, 88.534167°W; NAD 83). 09 August 2008. Cy L. Mott. Verified by Ronald A. Brandon. SIUC R-3459. New county record (Phillips et al. 1999. Field Guide to Amphibians and Reptiles of Illinois. Illinois Nat. Hist. Surv. Manual 8, Champaign, Illinois. xii + 282 pp.). This research was funded by a grant from the Chicago Herpetological Society.

Submitted by **CY L. MOTT**, Cooperative Wildlife Research Laboratory, Department of Zoology, Southern Illinois University, Carbondale, Illinois 62901, USA; e-mail: cm8755@siu.edu.

COLUBER CONSTRICTOR FLAVIVENTRIS (Eastern Yellow-bellied Racer). USA: TEXAS: Van Zandt Co.: DOR 78 cm SVL snake was found at the junction of Van Zandt County Roads 2708 and 2705, 22 May 2008. R. Michael Burger. Verified by Carl J. Franklin. Color digital photo vouchers, University of Texas at Arlington - Amphibian and Reptile Diversity Research Center (UTADC 2608–2611). New county record (Dixon 2000. Amphibians and Reptiles of Texas. 2nd ed. Univ. of Texas A&M Press, viii + 421 pp.).

Submitted by **R. MICHAEL BURGER**, 510 VZCR 2721, Mabank, Texas 75147, USA; e-mail: mvburger@dctexas.net.

CROTALUS VIRIDIS (Prairie Rattlesnake). USA: TEXAS: Parmer Co.: Found on Hwy 2298 at jct with Texas 214 (34.7275ºN, 102.725277ºW), 4066 feet elev. 05 September 2008. Verified by Toby Hibbitts. Texas Cooperative Wildlife Collection-Texas A&M University (TCWC 93123). New county record. (Dixon 2000. Amphibians and Reptiles of Texas. 2nd ed. Texas A&M University Press, College Station, Texas. 421 pp.). The snake was a male (SVL 652 mm, tail 54 mm) and was found DOR at 2202 h, 63ºF.

Submitted by **BOB L. TIPTON** (e-mail: btipton39@comcast.net) and **JAMES R. DIXON** (e-mail: jrdixon5@verizon.net), Texas Cooperative Wildlife Collections, Department of Wildlife and Fisheries Sciences, Texas A&M University, 2258 Tamu, College Station, Texas 77843-2258, USA.

DIADOPHIS PUNCTATUS (Ring-necked Snake). USA: ILLINOIS: Gallatin Co.: Shawnee National Forest, ca. 1 km from Pounds Hollow Rd. on York Lane Rd. (37.603889°N, 88.262778°W; NAD 83). 07 June 2008. Cy L. Mott. Verified by Ronald A. Brandon. SIUC R-3460. New county record (Phillips et al. 1999. Field Guide to Amphibians and Reptiles of Illinois. Illinois Nat. Hist. Surv. Manual 8, Champaign, Illinois. xii + 282 pp.). This research was funded by a grant from the Chicago Herpetological Society.

Submitted by **CY L. MOTT**, Cooperative Wildlife Research Laboratory, Department of Zoology, Southern Illinois University, Carbondale, Illinois 62901, USA; e-mail: cm8755@siu.edu.

EUNECTES MURINUS (Anaconda). BRAZIL: CEARÁ: Aquiraz Municipality: Tupuiu Mangroove. (03.52806°S 38.234661°W; WGS84). 22 October 2008. S. V. Mendonça. Collection of Herpetology of Núcleo Regional de Ofiologia (NUROF) - Universidade Federal do Ceará, Fortaleza, Brazil (CHUFC 3054). Verified by D. M. Borges-Nojosa. First state record; extends known distribution ca. 490 km airline E of previously known range within Maranhão (02.390187°S, 43.524319°W; WGS84), and 680 km airline northwest from Paraíba (07.136732ºS, 34.860413ºW; WGS84). This species was previously known from Amazon Forest, Atlantic Forest, Pantanal and coastal areas of much of northern South America (Cunha and Nascimento 1978. Publicações Avulsas do Museu Paraense Emílio Goeldi 31:1-218; Henderson et al. 1995. Herpetological Natural History 3:15-27; Marques et al. 2005. Serpentes do Pantanal. Holos, Ribeirão Preto. 184 pp.). The specimen was found on *gamboa* area of mangrove environment, inter dunes. Another individual was photographed on 14 May 2007 by S.V. Mendonça in this same locality. The name *sucurijuba* is used by the local peoples living in the coastal areas of Ceará with descriptive references clearly related to the *Eunectes murinus*, where some people have skins of this species hanging in their homes.

Submitted by **SANJAY VEIGA MENDONÇA** (e-mail: sanjaydomato@hotmail.com), **HUGO FERNANDES-FERREIRA** (e-mail: hugofernandesbio@gmail.com), and **RONO LIMA CRUZ** (e-mail: ronolc@gmail.com), Universidade Federal do Ceará, NUROF-UFC, Campus do Pici, Bloco 905, 60455-760, Fortaleza, Ceará, Brazil.

LEPTOTYPHLOPS BORAPELIOTES (NCN). BRAZIL: CEARÁ: Aratuba (04.411111ºS, 39.039722ºW; WGS84). 30 August 2007. S. Veiga. Instituto Butantan, São Paulo, Brazil (IBSP 76987). Verified by F. Franco. First state record, extends distribution ca. 390 km NW from of the nearest locality, Junco do Seridó in Paraíba (Vanzolini 1996. Pap. Avul. Zool. 39[15]:281–291).

Submitted by **IGOR JOVENTINO ROBERTO**, Aquasis –Associação de Pesquisa e Preservação de Ecosssistemas, Praia de Iparana s/n (Sesc Iparana), 61627-010, Caucaia, Ceará, Brazil (e-mail: igorjoventino@yahoo.com.br.); and **SANJAY VEIGA**, Sítio Vashana, Aratuba, Ceará, Brazil.

LEPTOTYPHLOPS BRASILIENSIS (Blind Snake). BRAZIL: CEARÁ: Crato Municipality: Floresta Nacional do Araripe. (7.394083°S, 39.499883°W; WGS84). 15 April 1998. D. M. Borges-Nojosa, C. A. Oliveira and A. P. B. Maia. Collection of Herpetology of Núcleo Regional de Ofiologia (NUROF) - Universidade Federal do Ceará, Fortaleza, Brazil (CHUFC 3122, adult, 146 mm SVL, 12.75 mm TL, 194 dorsals, and 18 subcaudals). Verified by F. L. Franco and U. Caramaschi. *L. brasiliensis* is considered rare, and only four previous records are known. First state record, extends the distributional range ca. 798 km NE of Barreiras-BA (12.148250°S, 44.993660°W; WGS 84) (Rodrigues and Puorto 1994. J. Herpetol. 28: 393–394). The specimen was found at Chapada do Araripe in an area of transition between habitats of Cerrado and Caatinga in a phytofisionomy designated as Carrasco.

Submitted by **DIVA MARIA BORGES-NOJOSA** (e-mail: dmbnojosa@yahoo.com.br), **CACIANA DE ALENCAR OLIVEIRA** and **ANA PATRÍCIA BEZERRA MAIA,** Universidade Federal do Ceará, NUROF-UFC, Campus do Pici, Bloco 905, 60455-760, Fortaleza, Ceará, Brazil.

NERODIA RHOMBIFER (Diamondback Watersnake). USA: TEXAS: Garza Co.: 6.84 air km S, 5.59 air km E of jct US 84 and US 380 (33.104950°N, 101.264250°W; WGS 84). 09 August 2008. Michael L. Treglia and Oswaldo Ramirez. Verified by Toby J. Hibbits. Texas Cooperative Wildlife Collection, TCWC 93119. New county record (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. Texas A&M University Press, College Station, Texas. 421 pp.). Voucher specimen found dead at south edge of a pond, coiled against a log. Six live individuals were also observed.

Submitted by **MICHAEL L. TREGLIA** (e-mail:mlt35@tamu.edu) and **OSWALDO RAMIREZ**, Department of Wildlife and Fisheries Sciences, 2258 TAMU, Texas A&M University, College Station, Texas 77843-2258, USA.

NERODIA SIPEDON (Northern Watersnake). USA: MINNESOTA: Olmsted Co.: North Branch Root River, upstream from County Road 116 crossing (91.44.0789909°N, 91.6828156°W; NAD 83). 27 July 2006. Philip Cochran, Bridget Emmett, Amanda Frost, and Stephen Schmitt. James Ford Bell Museum (JFBM R15179). Verified by Kenneth H. Kozak. One of two individuals observed. Not documented in this county since prior to 1960 (Oldfield and Moriarty 1994. Amphibians & Reptiles Native to Minnesota. University of Minnesota Press, Minneapolis, Minnesota. 237 pp.); the specimen listed for this county by Gibbons and Dorcas (2004. North American Watersnakes: A Natural History. University of Oklahoma Press, Norman, Oklahoma. 438 pp.) was collected in 1938, also from the North Branch Root River (Benjamin Lowe, James Ford Bell Museum, pers. comm.).

Submitted by **PHILIP A. COCHRAN** (e-mail: pcochran@smumn.edu), **BRIDGET M. EMMETT,** and **STEPHEN J. SCHMITT**, Biology Department, Saint Mary's University of Minnesota, 700 Terrace Heights, Winona, Minnesota 55987, USA.

NERODIA SIPEDON SIPEDON (Northern Watersnake). USA: WISCONSIN: Adams Co.: Petenwell Wildlife Area (44.06096113ºN, 89.9914377ºW; WGS84). One juvenile captured on 15 May 2008 (JMK), three juveniles captured and photographed on 12 July 2008 (TM, SM, JMK). Photographs verified by Gary

Casper (University of Wisconsin-Milwaukee Field Station). Photograph voucher, Illinois Natural History Survey catalogue number: INHS 2008.j. New county record. Fills gap in currently known range of species in Wisconsin (Casper 1996. Geographic Distributions of the Amphibians and Reptiles of Wisconsin. Milwaukee Public Museum, 87 pp.). Vogt (1981. Natural History of Amphibians and Reptiles of Wisconsin. Milwaukee Public Museum. 208 pp.) reported this species from adjacent Juneau County, which also lies along the Wisconsin River.

Submitted by **JOSHUA M. KAPFER**, Natural Resources Consulting, Inc., 209 Commerce Parkway, PO Box 128, Cottage Grove, Wisconsin 53527, USA; **TIMOTHY MUEHLFELD** and **SIENNA MUEHLFELD**, 123 N. 87th St., Wauwatosa, Wisconsin 53226, USA.

STORERIA DEKAYI (Dekay's Brownsnake). USA: OHIO: Logan Co.: Jefferson Township: Camp Myeerah, 7405 State Route 540, ca. 9.5 km E of Bellefontaine (40.384023°N, 83.634835°W; WGS 84). 03 May 2008. Jeffrey E. Dawson. Verified by Jeffrey G. Davis. Photo vouchers in Cincinnati Museum Center, Geier Collections and Research Center (CMC HP 474–476). The individual was observed and photographed as it crossed a gravel road inside the camp. New county record, ca. 22 km from the nearest previous records in Champaign, Hardin, and Union counties, filling a distributional gap in western Ohio (Conant 1951. Reptiles of Ohio. 2nd ed. Univ. Notre Dame Press, Notre Dame. 284 pp.; Wynn and Moody 2006. Ohio Turtle, Lizard, and Snake Atlas. Ohio Biol. Surv. Misc. Contr. No. 10, Columbus. iv + 81 pp.).

Submitted by **JEFFREY E. DAWSON**, Reptiles/Shores Region, Columbus Zoo and Aquarium, 4850 W. Powell Road, P.O. Box 400, Powell, Ohio 43065, USA; e-mail: jeff.dawson@columbuszoo.org.

STORERIA DEKAYI (Dekay's Brownsnake). USA: MISSOURI: Perry Co.: Red Rock Landing Conservation Area, ca. 400 m ESE of primitive camping area, ca. 5 m N of area access trail. (37.74715°N, 89.666111°W; NAD 83). 26 October 2008. Cy L. Mott, Michael A. Steffen, Scott E. Albert. Verified by Ronald A. Brandon. Color photo voucher. SIUC R-3458. New county record (Edmond and Daniel 2008. Atlas of Missouri Amphibians and Reptiles for 2007. <http://atlas.moherp.org/pubs/atlas07.pdf>).

Submitted by **CY L. MOTT**, Cooperative Wildlife Research Laboratory, Department of Zoology, Southern Illinois University, Carbondale, Illinois 62901, USA (e-mail: cm8755@siu.edu); **MICHAEL A. STEFFEN** (e-mail Bass2187@aol.com); **SCOTT E. ALBERT** (e-mail ilherps@siu.edu), Department of Zoology, Southern Illinois University, Carbondale, Illinois 62901, USA.

STORERIA OCCIPITOMACULATA (Red-bellied Snake). USA: MINNESOTA: Olmsted Co.: Rock outcrops along north side of County Highway 9, 1.2 km W of State Highway 74 (44.0789909°N, 91.6828156°W; NAD 83). 18 October 2005. Two specimens collected by Philip Cochran and William Martin. James Ford Bell Museum (JFBM R15180, R15181). Verified by Kenneth H. Kozak. Oldfield and Moriarty (1994. Amphibians & Reptiles Native to Minnesota. University of Minnesota Press, Minneapolis, Minnesota. 237 pp.) list no museum record for this county but plotted its occurrence there with a symbol used for sightings or literature records.

Submitted by **PHILIP A. COCHRAN** (e-mail: pcochran@smumn.edu), **WILLIAM R. MARTIN**, and **JONERIC DUDEN**, Biology Department, Saint Mary's University of Minnesota, 700 Terrace Heights, Winona, Minnesota 55987, USA.

THAMNODYNASTES ALMAE. BRAZIL: CEARÁ: Milagres (07.253611ºS, 38.976389ºW; WGS84). 12 September 2008. I. Joventino Roberto, J. C. Lima Melo, and S. Cardozo Ribeiro. Instituto Butantan, São Paulo, Brazil (IBSP 76969 female SVL 64.3 cm; TL 14.4 cm; collected at night in dry forest vegetation, near a pond). Verified by F. Franco. The species was previously known only from the municipality of Rodelas in the state of Bahia (type locality, Franco and Ferreira 2002. Phyllomedusa 1[2]:57–74). First state record, extends known distribution ca. 175 km N from type locality.

Submitted by **IGOR JOVENTINO ROBERTO** (e-mail: igorjoventino@yahoo.com.br), Aquasis – Associação de Pesquisa e Preservação de Ecosssistemas, Praia de Iparana s/n (Sesc Iparana), 61627-010, Caucaia, Ceará, Brazil; **SAMUEL CARDOZO RIBEIRO,** Universidade Regional do Cariri – URCA, Departamento de Ciências Biológicas, Laboratório de Zoologia. Rua Cel. Antônio Luiz, n.1161, 63105-000 Crato, Ceará, Brazil; and **JULIO CESAR LIMA MELO,** Eduardo Bezerra 85, São João do Tauape, Fortaleza, Ceará, Brazil.

THAMNODYNASTES SERTANEJO. BRAZIL: CEARÁ: Jati (07.629167ºS, 39.043889ºW; WGS84). 15 September 2008. I. Joventino Roberto, P. T. Pinto de Brito, S. Cardozo Ribeiro, and J. C. Lima Melo. Instituto Butantan, São Paulo, Brazil (IBSP 76971, male, SVL 57.8 cm; TL 22.9 cm; collected at night in shrub vegetation). Verified by F. Franco. This species was previously known from the Brazilian states of Bahia (municipalities of Jaguarari and Paulo Afonso), Pernambuco (municipality of Exú), and Minas Gerais (municipality of Jaíba) (Bailey et al. 2005. Phyllomedusa 4 [2]:83–101; Silveira and Cotta, Herpetol. Rev. 37:364). First state record, extends known distribution ca. 75 km E from the nearest locality, Exú in Pernambuco (Bailey et al. 2005, *op. cit.)*.

Submitted by **IGOR JOVENTINO ROBERTO** and **PAULO THIERES PINTO DE BRITO,** Aquasis – Associação de Pesquisa e Preservação de Ecosssistemas, Praia de Iparana s/n (Sesc Iparana), 61627-010, Caucaia, Ceará, Brazil; **SAMUEL CARDOZO RIBEIRO,** Universidade Regional do Cariri – URCA, Departamento de Ciências Biológicas, Laboratório de Zoologia. Rua Cel. Antônio Luiz, n.1161, 63105-000, Crato, Ceará, Brazil; and **JULIO CESAR LIMA MELO,** Eduardo Bezerra 85, São João do Tauape, Fortaleza, Ceará, Brazil (e-mail [IJR]: igorjoventino@yahoo.com.br).

VIRGINIA VALERIAE (Smooth Earthsnake). USA: GEORGIA: Elbert Co.: River Rd., ca. 1.2 mi. E intersection with GA-77 (34.0084944ºN, 82.8607111ºW; WGS 84). 28 August 2008. Collected while roadcruising by KTN, AMD, and EDO. Verified by Kenneth L. Krysko. FLMNH 154401. New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. The University of Georgia Press. 575 pp.). An adult *V. valeriae* was found crossing a paved road at ca. 2100 h. This record is ca. 20.5 km NE of a 1953 record from Oglethorpe County, Georgia (GMNH 176) and 37.3 km

SE of three 1992 records from Madison County, Georgia (GMNH 23187–23189). Additionally, a 2002 record from Sumter National Forest in Abbeville County, South Carolina (Carolina Herp Atlas 24289), lies 48.0 km NE of our finding, across the Savannah River, which presumably represents a substantial dispersal barrier for these small, terrestrial snakes.

Submitted by **ANDREW M. DURSO**, University of Georgia, Odum School of Ecology, Athens, Georgia 30602, USA (e-mail: amdurso@gmail.com); **KERRY T. NELSON**, University of Georgia, Warnell School of Forestry and Natural Resources, Athens, Georgia 30602, USA (e-mail: kerrytnelson@gmail.com); and **ERNEST D. OSBURN**, University of Georgia, Odum School of Ecology, Athens, Georgia 30602, USA (e-mail: ernieo@uga.edu).

XENOPHOLIS UNDULATUS. BRAZIL: CEARÁ: Planalto da Ibiapaba, Tianguá Municipality: Fazenda Gameleira (3.729994°S, 40.925979°W; WGS84). 18 January 1998. D. M. Borges-Nojosa. Ubajara Municipality: Murimbeca (3.820750°S, 40.904496°W; WGS84). 10 February 1999. D. M. Borges-Nojosa. Collection of Herpetology of Núcleo Regional de Ofiologia (NUROF) - Universidade Federal do Ceará, Fortaleza, Brazil (CHUFC 3030–3031). Verified by F. L. Franco.

First state record; extends known distribution ca. 1535 km airline E of previously known range within Santarém Municipality, State of Pará (Martins and Oliveira 1999. Herpetol. Nat. Hist. 6[2]:78–150; Bernarde and Abe 2006. S. Amer. J. Herpetol. 1[2]:102–113), 1313 km airline NE from Brasília, Distrito Federal (França et al. 2008. Copeia 2008:23–38) , and 860 km airline NW from Maceió Municipality, State of Alagoas (Silva et al. 2006. *In* F. B. P. Moura [org.], A Mata Atlântica. EDUFAL; Argolo 2001. Unpubl. thesis. Universidade Estadual de Santa Cruz, UESC). The species was found in a municipality located on Ibiapaba Plateau, one of the relicts of montane Atlantic Forest in Ceará.

Submited by **DIVA MARIA BORGES-NOJOSA**, Universidade Federal do Ceará, NUROF-UFC, Campus do Pici, Bloco 905, 60455-760, Fortaleza, Ceará, Brazil (e-mail: dmbnojosa@yahoo.com.br); and **DANIEL CASSIANO LIMA**, Universidade Estadual do Ceará, Av Mons. Tabosa s/n, 62500-000, Itapipoca, Ceará, Brazil (e-mail: dancassiano@yahoo.com.br).

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New Distributional Records of Amphibians in Quebec and Labrador

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Fieldwork during July and August 2004 yielded new distributional records in Quebec and Labrador at the northern range limits of two amphibians. These findings represent new county records in remote regions of Northeastern Canada, where herpetofaunal distributions are poorly documented (Bider and Matte 1996; Maunder 1983, 1997; Petranka 1998). The new localities are from rivers and streams that cross under roads, with deciduous trees and shrubs along the banks and surrounding forest consisting primarily of Black Spruce (*Picea mariana*). Amphibians were found along the margins of these waterways or on the seepage slopes just above them.

Northern Two-lined Salamanders, *Eurycea bislineata*, were located underneath various sized cover objects, including rocks and logs, and were captured by hand. In Labrador, several individuals of *E. bislineata* were commonly found under the same cover object. In one instance, 12 mature salamanders were found under a single rock measuring 40 × 30 × 30 cm. These new records of *E. bislineata* help to clarify the northern extent of its range and bridge together known populations in Labrador and Quebec. Previously, known populations were separated by upwards of 300 km (Cook and Preston 1979; Maunder 1983, 1997). The new records indicate that the distribution of *E. bislineata* is continuous from Quebec through to Labrador and along the 53°N parallel.

A gap in the distribution of *E. bislineata* still appears to exist, however, in an area extending from 16 km E of Labrador City to 29 km E of Churchill Falls. Intensive sampling in this area did not uncover any salamanders. In this area, Black Spruce dominates the forests nearly exclusively, and peat bogs cover much of the landscape. East of Churchill Falls, however, there is a dramatic change in landscape as deciduous trees often outnumber Black Spruce, the ground is noticeably rockier and there is greater elevational variation.

In northwestern Quebec, a population of *E. bislineata* was also found along Highway 113 in Jamésie Territory. This new locality is ca. 110 km SW of the nearest known population in Chibougamau and falls well within the large distribution gap noted by Bider and Matte (1996).

During this work, a single American Toad, *Anaxyrus americanus,* was found near the edge of a rocky river in Labrador, ca. 75 km from the closest previously recorded population of this species. This record is significant as the site occurs in the middle of an apparent distribution gap on the map presented by Maunder (1997). The finding connects two otherwise disjunct pockets of

populations on either side of Labrador and might indicate that *A. americanus* is present across the region.

All field collections were made by T. M. Markle and sanctioned by permits from the Province of Quebec and the Province of Newfoundland and Labrador. Collections were documented with voucher specimens. The toad was further documented with a photograph. All voucher specimens are deposited in McGill University's Redpath Museum (RM), Montreal, Quebec, Canada. Voucher identifications were verified by Shavonne Meyer. Common nomenclature follows that of Crother et al. (2008) in accordance with Frost et al. (2006).

Caudata — Salamanders

Eurycea bislineata (Northern Two-lined Salamander). CANADA: QUEBEC: Caniapiscau Regional County Municipality (RCM): 64 km S of Labrador City (80 km S of nearest recorded population in Labrador), Hwy 389 (52.669358°N, 67.40975°W). 11 July 2004. T. Markle. RM 4904. Caniapiscau RCM: 86 km S of Labrador City, Hwy 389 (52.49675°N, 67.43175°W). 11 July 2004. T. Markle. RM 4905. Caniapiscau RCM: 172 km S of Labrador City, Hwy 389 (52.059778°N, 68.64325°W). 11 July 2004. T. Markle. RM 4906, 4907. Manicouagan RCM: 337 km S of Labrador City, Hwy 389 just N of Manic 5 (50.890722°N, 68.64325°W). 11 July 2004. T. Markle. RM 4897 (larvae). Manicouagan RCM: Hwy 389, river between two lakes, ca. 100 km N of Baie-Comeau, (49.852692°N, 68.746472°W). 06 July 2004. T. Markle. RM 4896. Manicouagan RCM: Hwy 138, small stream between two lakes flowing under hwy, ca. 7 km E of turnoff to Godbout, (49.390972°N, 67.600556°W). 04 July 2004. T. Markle. RM 4893. Sept-Rivières RCM: Reserve Faunique de Port-Cartier-Sept-Iles, 7 km inside entrance to reserve, off of Hwy 138 by Port-Cartier, (50.093806°N, 67.037278°W). 05 July 2004. T. Markle. RM 4894 & 4895. Jamésie Territory: Hwy 113, small stream 7 km S of Waswanipi (49.640056°N, 76.004889°W). 29 August 2004. T. Markle. RM 6004.

Eurycea bislineata (Northern Two-lined Salamander). CANADA: NEWFOUNDLAND AND LABRADOR: Central Labrador: 29 km west of HVGB town limits (60 km from nearest known population), Hwy 500, "Lower Brooke" (53.268528°N, 60.894222°W). 10 July 2004. T. Markle. RM 4928. Central Labrador: 195 km W of HVGB (40 km from nearest known population), Hwy 500, "East Wilson River" (53.309333°N, 62.919528°W). 10 July 2004. T. Markle. RM 4930.

Anura — Frogs

Anaxyrus americanus (American Toad). CANADA: NEWFOUNDLAND and LABRADOR: Central Labrador: 195 km W of Happy Valley Goose Bay, Hwy 500, "East Wilson River" (53.309333°N, 62.919528°W). 10 July 2004. T. Markle. RM 4980 (photographic voucher).

Acknowledgments.—We thank Erin King for field assistance and John Maunder for advice. All work with animals conformed to McGill University Animal Use Protocol No. 8569 issued to DMG. This work was supported by a Discovery Grant to DMG from NSERC Canada.

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Amphibian and Reptile Records from Southeastern Illinois, USA

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The geographic distribution of amphibian and reptile species in Illinois has been well documented by Smith (1961), Phillips et al. (1999), and by numerous notes and articles published in *Herpetological Review*. However, southeastern Illinois has received less attention by herpetologists than other parts of the state. A lack of large universities, natural history museums, and the area's rural nature are all likely factors that have affected herpetological collecting in this region. Two natural divisions encompass southeastern Illinois, the Southern Till Plain Natural Division and the Wabash Border Natural Division. The Southern Till Plain Natural Division is divided into two sections. Originally mostly prairie, the Effingham Plain Section is a flat plain drained by the Embarras, Kaskaskia and Little Wabash rivers; uplands of this section are characterized by Post Oak (*Quercus stellata*) flatwoods (Schwegman et al. 1973) and upland oak–hickory

forests. The Mount Vernon Hill Country Section has rolling, hilly topography and historically was covered with upland forest (Schwegman et al. 1973). The Wabash Border Division includes the bottomlands of the Wabash River and its major tributaries and the loess-covered uplands bordering the Wabash River (Schwegman et al. 1973). The Wabash Border Division is divided into three sections; two of these sections are pertinent to the present article. The Bottomlands Section encompasses the bottomland forests, sloughs, marshes, and oxbow lakes in the floodplains of the Wabash River, the Ohio River, and their major tributaries (Schwegman et al 1973). The Southern Uplands Section of the Wabash Border Division contains the dry-mesic and mesic upland forests on the deep loess bluffs along the Wabash River (Schwegman et al. 1973).

Herein, we report amphibian and reptile records from the counties of Clay, Crawford, Hamilton, Jasper, Lawrence, Marion, and Wayne in southeastern Illinois. All specimens are new county records unless otherwise indicated (e.g., photographic voucher updated with voucher specimen) and all specimens are deposited in the Illinois Natural History Survey (INHS) Amphibian and Reptile collection. County records were determined by consulting Phillips et al. (1999), checking databases located at the Illinois Natural History Survey, and checking issues of *Herpetological Review* (March 1998–June 2008). All georeferenced localities are based on NAD83 datum. Identifications were confirmed by C. A. Phillips. Scientific and standard English names follow Crother et al. (2008).

Caudata – Salalmanders

Ambystoma maculatum (Spotted Salamander). Hamilton Co.: Hamilton County Conservation Area (38.065°N, 88.3918°W). 27 March 2008. T. L. Esker. INHS 20860. An adult collected in shallow pond. A second Hamilton County specimen (INHS 20862) was also collected. Wayne Co.: Sam Dale Lake Conservation Area (38.5432°N, 88.5928°W). 20 March 2007. T. L. Esker. INHS 20493–20494. Two males collected in a woodland pond. Two additional adults (INHS 20508–20509) were collected at a second Wayne County location.

Ambystoma opacum (Marbled Salamander). Crawford Co.: SW of Hardinville, forest E of Big Creek, N of the Embarras River, and W of Co. Rd. 400E (38.8963°N, 87.8726°W). 03 October 2006. J. E. Petzing and T. L. Esker. INHS 20144. Adult male under log in floodplain forest; Hamilton Co.: Hamilton County Conservation Area (38.0606°N, 88.3921°W). 30 March 2005. T. L. Esker. INHS 19811. Young of the year collected from a vernal pond. Mott (2008) recently reported *A. opacum* from Hamilton County. We report this specimen as an addition to Mott's county record; our collection date precedes Mott's county record by nearly three years. Lawrence Co.: NW of Russellville (38.8340°N, 87.5535°W). 14 October 2005. T. L. Esker, J. E. Petzing, and B. R. Edgin. INHS 19665. Adult male collected under log in dry, forested wetland basin.

Ambystoma texanum (Small-mouthed Salamander). Hamilton Co.: Ten Mile Creek State Fish and Wildlife Area (38.0687°N, 88.6198°W). 20 April 2005. T. L. Esker. INHS 19810. Larva collected from vernal pond in upland oak-hickory forest, raised through metamorphosis. Wayne Co.: ca. 2.35 km NW of Golden Gate, IL Rt. 15 bridge at the Little Wabash River (38.3724°N, 88.2305°W). 20 March 2007. T. L. Esker. Two adults. INHS 20560 –20561.

Ambystoma tigrinum (Tiger Salamander).Wayne Co.: Sam Dale Lake Conservation Area (38.5365°N, 88.5787°W). 2006. T.L. Esker. Larva collected from shallow pond and reared through metamorphosis. INHS 20810.

Plethodon glutinosus (Northern Slimy Salamander). Clay Co.: Martin T. Snyder Memorial Nature Preserve (38.6375°N, 88.5278°W). 31 March 2006. T. L. Esker. INHS 19948–19949. Two individuals collected in upland oak-hickory forest.

Anura — Frogs

Anaxyrus (=*Bufo*) *fowleri* (Fowler's Toad). Lawrence Co.: Robeson Hills Nature Preserve (38.7093°N, 87.5348°W). 15 August 2006. T. L. Esker and T. Buhnerkempe. INHS 20239. Individual collected in wet/mesic beech-maple forest.

Pseudacris crucifer (Spring Peeper). Hamilton Co.: Ten Mile Creek State Fish andWildlife Area (38.0680°N, 88.6176°W). 10 July 2006. J. E. Petzing, T. L. Esker, and T. Buhnerkempe. INHS 20856. Adult collected in forest.

Rana clamitans (Green Frog). Lawrence Co.: NW of Russellville (38.8335°N, 87.5544°W). 14 October 2005. B. R. Edgin, J. E. Petzing, and T. L. Esker. INHS 19666. Juvenile (possible young of the year) collected under log in dry, forested wetland basin.

Testudines — Turtles

Chelydra serpentina (Snapping Turtle). Crawford Co.: SW of Hardinville, NNE of confluence Big Creek and the Embarras River (38.9012°N, 87.8708°W). 12 June 2006. T. L. Esker. INHS 20201. Individual collected in floodplain forest with bottomland sloughs.

Trachemys scripta (Pond Slider). Jasper Co.: Sam Parr State Park (39.0309°N, 88.1164°W). 15 August 2006. T. L. Esker and T. Buhnerkempe. INHS 20659. Male collected in upper cove of Sam Parr Lake. This specimen upgrades the photographic record reported in Petzing et al. (2000); Lawrence Co.: Red Hills State Park (38.7288°N, 87.8378°W). 16 August 2006. T. L. Esker and T. Buhnerkempe. INHS 20150. Immature male collected in man-made lake.

Sternotherus odoratus (Eastern Musk Turtle). Clay Co.: 22.5 km E of Salem, Greendale Reservoir (= Greendale Lake). 11 June 1971. G. McNaughton. INHS 9846. Adult female found on shore. The locality information for this specimen was entered in the hard copy catalog as "near Iuka" in Marion County. McNaughton's field notes were found on file at the Illinois Natural History Survey with the Greendale Reservoir information. Greendale Lake is just east of the Marion County line in neighboring Clay County; Hamilton Co.: Hamilton County Conservation Area. Female collected in spillway pool of L. P. Dolan Lake/Lick Creek (38.0563°N, 88.4042°W). 10 July 2006. J. E. Petzing, T. Buhnerkempe, and T.L. Esker. INHS 20116. Jasper Co.: Sam Parr State Park (39.0113°N, 88.1195°W). 16 August 2006. T. L. Esker and T. Buhnerkempe. INHS 20151. Male collected in creek below dam. This specimen upgrades the photographic record reported by Olson (1999); Marion Co.: Stephen A. Forbes State Park (38.7093°N, 88.7458°W). 11 March 2006. T. L. Esker. INHS 19968. Hatchling collected from man-made pond on Illinois Natural History Survey Fish Research Laboratory.

Squamata — Lizards

Plestiodon (=*Eumeces*) *fasciatus* (Common Five-lined Skink). Crawford Co.: SW of Hardinville, forest E of Big Creek, N of the Embarras River, and W of County Rd. 400E (38.8957°N, 87.8723°W). 16 June 2006. T. Buhnerkempe. INHS 20041. Subadult/young adult collected in floodplain forest.

Plestiodon (=*Eumeces*) *laticeps* (Broad-headed Skink). Hamilton Co.: E of Dahlgren, Karcher's Post OakWoods Nature Preserve (38.2072°N, 88.6176°W). 10 July 2006. T. Buhnerkempe, J. E. Petzing, and T. L. Esker. INHS 20086. Adult collected on downed tree.

Squamata — Snakes

Heterodon platirhinos (Eastern Hog-nosed Snake). Marion Co.: Stephen A. Forbes State Park (38.7358°N, 88.7738°W). 07 May 2005. T. L. Esker. INHS 19586. DOR adult; head and neck vouchered.

Storeria occipitomaculata (Red-bellied Snake). Crawford Co.: Crawford County Conservation Area (39.0987°N, 87.6983°W). 4 April 2006. T. L. Esker. INHS 19954. Juvenile collected in upland mesic oak forest.

Thamnophis sauritus (Eastern Ribbonsnake). Crawford Co.: NE of Green Brier and W of Big Creek on County Rd. 450N (38.9162°N, 87.8884°W). 03 October 2006. T. L. Esker and J. E. Petzing. INHS 20143. DOR adult male. Wayne Co.: ca. 6.75 km NE of Mount Erie (38.5476°N, 88.1640°W). 23 April 2007. T. L. Esker. INHS 20532. Adult collected in floodplain forest.

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New Records of Amphibians and Reptiles from Florence County, South Carolina, USA

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Florence County lies in the Coastal Plain of South Carolina and has, to some degree, been overlooked for its amphibian and reptile diversity in comparison with the rest of the Coastal Plain. Only a handful of species have physical vouchers to document their occurrence in the county, and a number of common species have never been published. Searches of museum collections were performed via the HerpNet data portal, and additional universities were contacted for records. The species in the following list have never been published from Florence County; nevertheless, vouchers for these species do exist and are presented below. Museum acronyms follow Leviton et. al. (1985): *Ambystoma opacum* [MSU SH.4291], *Desmognathus auriculatus* [CU 5936; MSU HE.13479–85], *Eurycea cirrigera* [CU 5935], *Plethodon chlorobryonis* [USNM 463847–55], *Plestiodon* (*Eumeces*) *fasciatus* [CUSC 592; INHS 9063], *Plestiodon* (*Eumeces*) *laticeps* [INHS 9064], *Nerodia erythrogaster* [CUSC 381, 538], *Nerodia fasciata* [USNM 91416], *Kinosternon subrubrum* [INHS 9062], and *Sternotherus odoratus* [CUSC 115]. The only published record that could be found was for *Masticophis flagellum* (Camper and Brooks 2005).

The majority of aforementioned specimens were collected in or before 1971; however, Erskine College Vertebrate Collection (ECVC) contains recent (≤ 5 years) vouchers of most of these species for Florence County, documenting their continued occurrence in this area, as well as new records. New county records are presented below. Many of these species are commonly encountered in the county; we simply provide a voucher specimen for documentation of its occurrence. Geocoordinates are based on datum WGS 84. Scientific and English names follow Crother (2008) and all species identifications (physical and photo vouchers) were verified by Mary Lang Edwards unless otherwise stated. All specimens and photographs are deposited in the ECVC and Photo Voucher Collection (ECPVC) in Abbeville County, South Carolina.

Caudata — Salamanders

Siren intermedia (Lesser Siren). S. Cartersville Hwy., Timmonsville. 34.2764ºN, 79.5891ºW. 15 September 2005. J. Broach. ECVC 229. Taken from temporary pool of water branching off of a swamp area.

Anura — Frogs

Anaxyrus terrestris (Southern Toad). S. Cartersville Hwy., Timmonsville. 34.2240ºN, 79.5752ºW. 26 August 2006. C. McMahan and J. Broach. ECVC 314. Collected at night among debris alongside of pond. Numerous individuals were out. The most commonly encountered toad of the area.

Gastrophryne carolinensis (Eastern Narrow-mouthed Toad). S. Cartersville Hwy., Timmonsville. 34.2247ºN, 79.5752ºW. 15 April 2006. C. McMahan, J. Broach, and J. Wicker. ECVC 270. Found under rock in middle of dirt trail at night.

Hyla chrysoscelis (Cope's Gray Treefrog). S. Cartersville Hwy., Timmonsville. 34.1447ºN, 78.5813ºW. 24 June 2007. J. Broach. ECVC 624. Found at night along edge of puddle after late rain in afternoon.

Hyla cinerea (Green Treefrog). Twin Bridge Rd., Timmonsville. 34.3319º N, 79.5548ºW. 16 July 2007. J. Broach. ECVC 588. Collected on rainy night crossing road near Sparrow Swamp.

Hyla femoralis (Pine Woods Treefrog). Young Rd., Timmonsville. 34.3527ºN, 79.5572ºW. 16 July 2007. J. Broach. ECVC 587. Collected during rainy night 100 m from intersection with S. Hill Rd.

Hyla squirella (Squirrel Treefrog). S. Cartersville Hwy., Timmonsville. 34.2314ºN, 79.5753ºW. 26 August 2006. C. McMahan and J. Broach. ECVC 335. Found at night on side of building. Numerous individuals of this species were found on sides of buildings near lights.

Lithobates catesbeianus (American Bullfrog). S. Cartersville Hwy., Timmonsville. 34.2240ºN, 79.5752ºW. 24 June 2007. J. Broach and J. Wicker. ECVC 591. Caught along edge of a fish pond during day.

Lithobates clamitans (Green Frog). S. Cartersville Hwy., Timmonsville. 34.2240ºN, 79.5752ºW. 26 August 2006. C. McMahan and J. Broach. ECVC 334. Collected at night alongside edge of pond.

Lithobates sphenocephalus (Southern Leopard Frog). S. Cartersville Hwy., Timmonsville. 34.1424ºN, 79.5813ºW. 03 June 2007. J. Broach. ECVC 593. Collected at night alongside Lynches River. Found in tall grasses and shrubs along river edge.

Scaphiopus holbrookii (Eastern Spadefoot Toad). S. Cartersville Hwy., Timmonsville. 34.2954ºN, 79.5758ºW. 23 March 2007. C. McMahan, J. Broach, J. Gladden, J. Durham, D. Camak, and J. Wicker. ECVC 442. Collected while crossing small wooded path at night after heavy rain. Several individuals were observed along side of and on path.

Testudines — Turtles

Clemmys guttata (Spotted Turtle). S. Cartersville Hwy., Timmonsville. 34.1575ºN, 79.5843ºW. 06 April 2007. J. Broach and C. McMahan. ECPVC 008. Found alongside of water-edge in swamp habitat.

Squamata — Lizards

Aspidoscelis sexlineata (Six-lined Racerunner). S. Cartersville Hwy., Timmonsville. 34.2126ºN, 79.5757ºW. 10 June 2007. J. Broach. ECVC 585. Caught while running to shrubs in an open field among a forested lot.

Sceloporus undulatus (Eastern Fence Lizard). S. Cartersville Hwy., Timmonsville. 34.2126ºN, 79.5757ºW. 14 June 2007. J. Broach. ECVC 584. Caught on pine tree along margin of a field.

Scincella lateralis (Little Brown Skink). S. Cartersville Hwy., Timmonsville. 34.2170ºN, 79.5754ºW. 25 September 2006. J. Broach, J. Wicker, and C. McMahan. ECVC 337. Found during the day under log in middle of grassy field near small growth of shrubs.

Squamata — Snakes

Agkistrodon contortrix (Copperhead). Second Loop Rd., Florence. 34.9583ºN, 79.4740ºW. 07 June 2007. J. Broach. ECVC 575. Caught in debris on lot being cleared for housing development.

Agkistrodon piscivorus (Cottonmouth). S. Cartersville Hwy., Timmonsville. 34.1526ºN, 79.5867ºW. 7 July 2006. J. Broach. ECVC 306. Found around base of tree in swamp.

Coluber constrictor (North American Racer). State Hwy. 403 ca. 100 m S of Timmons Rd., Timmonsville. 34.4308ºN, 79.5766ºW. 13 June 2007. J. Broach. ECVC 576. DOR.

Crotalus horridus (Timber Rattlesnake). Young Rd., Timmonsville. 34.3411ºN, 79.5520ºW. 31 July 2007. J. Broach. ECVC 634. DOR within 50 m of intersection with S. Hill Rd.

Farancia abacura (Red-bellied Mudsnake). S. Cartersville Hwy., Timmonsville. 34.1533ºN, 79.5865ºW. 04 June 2007. J. Broach. ECVC 636. Caught in late afternoon crossing dirt path after a brief rain.

Nerodia taxispilota (Brown Watersnake). Twin Bridge Rd., Timmonsville. 34.3339ºN, 79.5545ºW. 24 June 2007. J. Broach and J. Wicker. ECVC 626. Captured out of tree extending over water where Twin Bridge Rd. crosses Sparrow Swamp.

Pantherophis alleghaniensis (Eastern Ratsnake). Old Sansburry Rd., Timmonsville. 34.4102ºN, 79.5540ºW. 14 June 2007. J. Broach. ECVC 577. Found crossing road ca. 30 m from intersection with Young Rd.

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Additional Geographic Distribution Records of Amphibians and Reptiles in Arkansas, USA

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Trauth et al. (2004) provided a much-needed summation of records on 59 species of amphibians and 78 species of reptiles in Arkansas. Since then, numerous individual as well as compilations of records have been documented for the state (Caldwell and Tumlison 2005; Robison and McAllister 2007b, 2008b). Here we provide eight additional geographic (new county) records for six amphibians (one salamander, five frogs) and two snakes from various sites in Arkansas. Specimens were verified by Stanley E. Trauth, and voucher specimens were deposited in the Arkansas State University Herpetological Museum (ASUMZ), State University, Arkansas. Current common names follow Crother (2008).

Caudata – Salamanders

Notophthalmus viridescens louisianensis (Central Newt). ARKANSAS CO.: Bayou Meto at St. Hwy. 152 (34.2107°N, 91.4224°W). 6 May 1976. M. Evans. ASUMZ 31224. New county record that partially fills a distributional gap between Lincoln (Robison and McAllister, 2008a) and Monroe counties.

Anura – Frogs

Hyla chrysoscelis/versicolor sibling species complex (Gray Treefrog). SEARCY CO.: Middle Fork Little Red River at US 65, S of Leslie (35.4927°N, 92.3312°W). 04 May 2002. H. W. Robison. ASUMZ 31230. New county record that fills a hiatus between Van Buren (Robison and McAllister 2007a) and Marion counties.

Hyla cinerea (Green Treefrog). SCOTT CO.: Waldron (34.5357°N, 94.0529°W). 15 April 1999. H. W. Robison. ASUMZ 31229. New county record. Fills a distributional gap in extreme west-central Arkansas among Polk and Sebastian counties.

Pseudacris crucifer (Spring Peeper). ARKANSAS CO.: De Witt (34.1729°N, 91.2013°W). 2 March 1978. M. Evans. ASUMZ 31228. New county record filling distributional gap between Desha and Lincoln counties.

Pseudacris fouquettei (Cajun Chorus Frog). JOHNSON CO.: Clarksville, 458 Co. Rd. 3411 (35.2954°N, 93.2957°W). 14 March 2008. T. Kremers. ASUMZ 31227. New county record filling a distributional gap in the Arkansas River valley between Franklin and Pope counties. This species, formerly known as *P. feriarum*, was recentlydescribed by Lemmon et al. (2008) with a range that includes all of Arkansas.

Lithobates (= *Rana*) *palustris* (Pickerel Frog). JOHNSON CO.: Clarksville, 458 Co. Rd. 3411 (35. 2954°N, 93.2957°W). 16 March 2008. ASUMZ 31225. LOGAN CO.: 1.6 km E Magazine on St. Hwy 10 (35.0959°N, 93.4746°W). 14 April 2007. D. Powell. ASUMZ 31226. New county records. Fills distributional gaps north and south of the Arkansas River valley, respectively.

Squamata — Snakes

Cemophora coccinea copei (Northern Scarletsnake). LAFAYETTE CO.: Stamps (33. 2134°N, 92.5234°W). 15 January 1974. B. Lindsay. ASUMZ 31231. New county record. This snake is sporadically distributed in Arkansas and we provide an additional record for the extreme part of the state adjacent to previous record in Columbia County.

Diadophis punctatus sticogenys (Mississippi Ring-necked Snake). LAFAYETTE CO.: Stamps (33.2134°N, 92.5234°W). 15 September 1986. B. Lindsay. ASUMZ 31232. New county record partially filling a distributional gap in the extreme southern tier of counties in the state.

Acknowledgments.—Many thanks to S. E. Trauth for curatorial assistance and specimen verification, and M. Evans, T. Kremers, B. Lindsay, and D. Powell for providing vouchers. Specimens were collected under the authority of Arkansas Scientific Collecting Permits issued to HWR by the Arkansas Game and Fish Commission.

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New and Updated County Records for Amphibians and Reptiles in North Dakota, USA

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Little attention has been paid to the herpetofauna of North Dakota beyond the publications of Wheeler and Wheeler (1966) and Jundt (2000). Field work conducted by us on three trips in 2008 yielded a number of new and updated county records for North Dakota. We felt it significant to include updated county records because the latest published record for any species we collected was 1977. Records were obtained by road cruising, search and seizure, and hoop trapping. To the best of our knowledge, the *Apalone spinifera* record represents the first specimen of this species from North Dakota to be deposited in an official collection or institution. Voucher specimens and photographic records were deposited in the James Ford Bell Museum of Natural History (JFBM). Specimen numbers preceded by the letter "P" are cataloged in the photo collection. All specimens and photos were verified by Kenneth Kozak and Ben Lowe. Geocoordinates are based on datum WGS 84. Field work was conducted under permit number GNF02465468.

Anura — Frogs

Anaxyrus (= Bufo) cognatus (Great Plains Toad). Barnes Co.: NW of Valley City (46.9823000°N, 98.0889500°W). 25 July 2008. Updated county record. J. B. LeClere, C. E. Smith, and R. E. Blasus. JFBM P267. Foster Co.: Hwy 281 NW of Melville (47.4238800°N, 99.1386000°W). 25 July 2008. New county record. J. B. LeClere, C. E. Smith, and R. E. Blasus. JFBM 15862.

Anaxyrus (= Bufo) woodhousii (Woodhouse's Toad). McKenzie Co.: Theodore Roosevelt National Park, North Unit (47.6126600°N, 103.3768000°W). 30 August 2008. Updated county record. J. B. LeClere and C. E. Smith. JFBM P268.

Lithobates (= Rana) pipiens (Northern Leopard Frog). Barnes Co.: CR 19 NW of Valley City (46.9700900°N, 98.0470300°W). 25 July 2008. Updated county record. J. B. LeClere, C. E. Smith, and R. E. Blasus. JFBM P280. Eddy Co.: CR 15 E of New Rockford (47.6870600°N, 98.7282400°W). 25 July 2008. Updated county record. J. B. LeClere, C. E. Smith, and R. E. Blasus. JFBM 15880. Logan Co.: CR 34 SW of Gackle (46.5293100°N, 99.2199800°W). 26 July 2008. Updated county record. J. B. LeClere, C. E. Smith, and R. E. Blasus. JFBM P281. McIntosh Co.: Hwy 13 E of Wishek (46.2574500°N, 99.4243800°W). 26 July 2008. New county record. J. B. LeClere, C. E. Smith, and R. E. Blasus. JFBM P282. Morton Co.: CR 1806 S of Bismarck (46.6913800°N, 100.8038600°W). 29 August 2008. Updated county record. J. B. LeClere and C. E. Smith. JFBM P272. Richland Co.: CR 11 W of Hankinson (46.0663600°N, 96.9984900°W). 27 July 2008. Updated county record. J. B. LeClere, C. E. Smith, and R. E. Blasus. JFBM P283.

Lithobates (= Rana) sylvaticus (Wood Frog). Barnes Co.: 29th St. SE, NW of Valley City (46.9941200°N, 98.1179200°W). 25 July 2008. Updated county record. J. B. LeClere, C. E. Smith, and R. E. Blasus. JFBM 15881.

Spea bombifrons (Plains Spadefoot). Eddy Co.: 74th Ave NE, E of New Rockford (47.6592900°N, 98.9690600°W). 25 July 2008. New county record. J. B. LeClere, C. E. Smith, and R. E. Blasus. JFBM 15868.

Testudines — Turtles

Apalone spinifera (Spiny Softshell). Morton Co.: Tributary stream of the Missouri River S of Bismarck (46.6913600°N, 100.8039900°W). 31 August 2008. New county record and the first specimen of this species from North Dakota to be entered into a recognized collection. J. B. LeClere and C. E. Smith. JFBM 16054.

Chelydra serpentina (Snapping Turtle). Morton Co.: Tributary stream of the Missouri River S of Bismarck (46.6913900°N, 100.8038900°W). 31 August 2008. New county record. J. B. LeClere and C. E. Smith. JFBM P275.

Chrysemys picta (Painted Turtle). Eddy Co.: New Rockford (47.6853600°N, 99.1350600°W). 25 July 2008. New county record. J. B. LeClere, C. E. Smith, and R. E. Blasus. JFBM P271. Logan Co.: Burnstad (46.3794400°N, 99.6191800°W). 26 July 2008. New county record. J. B. LeClere, C. E. Smith, and R. E. Blasus. JFBM P270. McIntosh Co.: 26th Ave SE N of Zeeland (46.1133900°N, 99.8367600°W). 26 July 2008. New county record. J. B. LeClere, C. E. Smith, and R. E. Blasus. JFBM 16052. Morton Co.: Tributary stream of the Missouri River S of Bismarck (46.6913900°N, 100.8038900°W). 29 August 2008. Updated county record. J. B. LeClere and C. E. Smith. JFBM P296. Richland Co.: Hwy 11 W of Lidgerwood (46.0787900°N, 97.2196700°W). 27 July 2008. Updated county record. J. B. LeClere, C. E. Smith, and R. E. Blasus. JFBM P274. Sargent Co.: Hwy 11 NW of Rutland (46.0795700°N, 97.5853000°W). 27 July 2008. New county record. J. B. LeClere, C. E. Smith, and R. E. Blasus. JFBM 15865.

Graptemys pseudogeographica (False Map Turtle). Morton Co.: Tributary stream of the Missouri River S of Bismarck (46.6913900°N, 100.8038900°W). 31 August 2008. New county record. J. B. LeClere and C. E. Smith. JFBM P297.

Squamata — Snakes

Coluber constrictor (North American Racer). McKenzie Co.: Theodore Roosevelt National Park (47.5955900°N, 103.2826000°W). 30 August 2008. Updated county record. J. B. LeClere and C. E. Smith. JFBM 16055. Morton Co.: CR 84 N of Flasher (46.5836700°N, 101.2704800°W). 20 September 2008. Updated county record. J. B. LeClere, C. E. Smith, and R. E. Blasus. JFBM P276.

Opheodrys vernalis (Smooth Greensnake). Billings Co.: Hwy 85 N of Fairfield (47.1985000°N, 103.2230700°W). 19 September 2008. New county record. J. B. LeClere, C. E. Smith, and R. E. Blasus. JFBM P285. Eddy Co.: Hwy 20 N of McHenry (47.5954700°N, 98.5857700°W). 25 July 2008. New county record. J. B. LeClere, C. E. Smith, and R. E. Blasus. JFBM 15878. Foster Co.: Hwy 20 SE of McHenry (47.5612600°N, 98.5684000°W). 25 July 2008. Updated county record. J. B. LeClere, C. E. Smith, and R. E. Blasus. JFBM 15870. Logan Co.: Hwy 30 N of Lehr (46.3065300°N, 99.3513000°W). 27 July 2008. New county record. J. B. LeClere, C. E. Smith, and R. E. Blasus. JFBM 15875. McIntosh Co.: Hwy 13 W of Wishek (46.2591900°N, 99.5731400°W). 27 July 2008. New county record. J. B. LeClere, C. E. Smith, and R. E. Blasus. JFBM 15869. Morton Co.: I-94 NE of Glen Ullin (46.8636800°N, 101.6880400°W). 20 September 2008. Updated county record. J. B. LeClere, C. E. Smith, and R. E. Blasus. JFBM 16056. Slope Co.: Hwy 85 NE of Amidon (46.5257000°N, 103.1961200°W). 20 September 2008. New county record. J. B. LeClere, C. E. Smith, and R. E. Blasus. JFBM 16060.

Pituophis catenifer (Gophersnake). Billings Co.: Theodore Roosevelt National Park (46.9310900°N, 103.4318900°W). 19 September 2008. Updated county record. J. B. LeClere, C. E. Smith, and R. E. Blasus. JFBM 16059. Grant Co.: Hwy 21 SW of Carson (46.4005700°N, 101.6002200°W). 20 September 2008. Updated county record. J. B. LeClere, C. E. Smith, and R. E. Blasus. JFBM P286. Morton Co.: CR 1806 S of Bismarck (46.6952100°N, 100.8072400°W). 29 August 2008. Updated county record. J. B. LeClere and C. E. Smith. JFBM 16057. Stark Co.: Hwy 85 N of Belfield (46.9121400°N, 103.1897700°W). 30 August 2008. New county record. J. B. LeClere and C. E. Smith. JFBM P287.

Storeria occipitomaculata (Red-bellied Snake). Barnes Co.: CR 19 NW of Valley City (46.9888300°N, 98.0822300°W). 25 July 2008. New county record. J. B. LeClere, C. E. Smith, and R. E. Blasus. JFBM P288. LaMoure Co.: Hwy 281 N of Nortonville (46.5887000°N, 98.7044700°W). 26 July 2008. New county record. J. B. LeClere, C. E. Smith, and R. E. Blasus. JFBM 15876. Logan Co.: CR 34 SE of Streeter (46.4567400°N, 99.3516100°W). 27 July 2008. New county record. J. B. LeClere, C. E. Smith, and R. E. Blasus. JFBM 15861. McIntosh Co.: Hwy 13 E of Wishek (46.2590000°N, 99.4892900°W). 27 July 2008. New county record. J. B. LeClere, C. E. Smith, and R. E. Blasus. JFBM 15872. Sargent Co.: CR 11 W of Cogswell (46.1097000°N, 97.9582200°W). 27 July 2008. Updated county record. J. B. LeClere, C. E. Smith, and R. E. Blasus. JFBM 15863.

Thamnophis radix (Plains Gartersnake). Barnes Co.: Hwy 22 E of Eckelson (47.6870300°N, 98.7762000°W). 25 July 2008. Updated county record. J. B. LeClere, C. E. Smith, and R. E. Blasus. JFBM P289. Eddy Co.: CR 15 E of New Rockford (47.6873400°N, 99.0530800°W). 25 July 2008. Updated county record. J. B. LeClere, C. E. Smith, and R. E. Blasus. JFBM 15879. Foster Co.: Hwy 20 S of McHenry (47.5580400°N, 98.5651700°W). 25 July 2008. Updated county record. J. B. LeClere, C. E. Smith, and R. E. Blasus. JFBM 15864. Hettinger Co.: Mott (46.3737900°N, 102.3312100°W). 20 September 2008. Updated county record. J. B. LeClere, C. E. Smith, and R. E. Blasus. JFBM P290. LaMoure Co.: Hwy 281 NE of Nortonville (46.5691700°N, 98.7044800°W). 26 July 2008. New county record. J. B. LeClere, C. E. Smith, and R. E. Blasus. JFBM 15873. Logan Co.: Hwy 34 SW of Gackle (46.5293300°N, 99.2058200°W). 26 July 2008. Updated county record. J. B. LeClere, C. E. Smith, and R. E. Blasus. JFBM P291. McIntosh Co.: Hwy 13 E of Wishek (46.2590000°N, 99.4829200°W). 27 July 2008. New county record. J. B. LeClere, C. E. Smith, and R. E. Blasus. JFBM 15871. Richland Co.: Hwy 11 W of Lidgerwood (46.0782600°N, 97.1611300°W). 27 July 2008. Updated county record. J. B. LeClere, C. E. Smith, and R. E. Blasus. JFBM 15867. Sargent Co.: Hwy 11 W of Cogswell (46.1097300°N, 97.9399900°W). 27 July 2008. New county record. J. B. LeClere, C. E. Smith, and R. E. Blasus. JFBM 15866.

Crotalus viridis (Prairie Rattlesnake). Billings Co.: NE of Medora (47.0513500°N, 103.3779000°W). 30 August 2008. Updated county record. J. B. LeClere and C. E. Smith. JFBM P278. Grant Co.: Hwy 21 W of Lark (46.4149100°N, 101.5500900°W). 20 September 2008. Updated county record. J. B. LeClere, C. E. Smith, and R. E. Blasus. JFBM 16062. McKenzie Co.: Theodore Roosevelt National Park (47.5927500°N, 103.3000700°W). 30 August 2008. Updated county record. J. B. LeClere and C. E. Smith. JFBM P279.

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New Distributional Records for Georgia Amphibians and Reptiles

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The recent publication of a thorough treatment of the herpetofauna of Georgia (Jensen et al. 2008) provides a basis for documenting new county records. Herein, we document new county records for Georgia amphibians and reptiles, provide voucher specimens for several counties lacking museum records, and provide a county record update. Unless otherwise noted,

all specimens were verified by Lance D. McBrayer and were deposited in the Georgia Southern University (GSU) collection, Statesboro, Georgia. New county records and county updates were determined by consulting Williamson and Moulis (1994) and Jensen et al. (2008). Records are the first for each county unless otherwise indicated. Geocoordinates are approximations derived from Google Earth.

Caudata — Salamanders

Ambystoma talpoideum (Mole Salamander). Camden Co.: 15.0 km ESE Woodbine (30.943056°N, 81.597222°W). 06 February 2008. J. G. Palis and D. Stevenson. Adult dipnetted from depressional wetland within mixed pine-oak hammock. GSU 20000. First museum voucher specimen for county (John B. Jensen, pers. comm., 2008)

Amphiuma means (Two-toed Amphiuma). Brooks Co.: 1.5 km NW Nankin in roadside swamp at State Hwy. 333 (30.673056°N, 83.478056°W). 26 June 2008. D. Stevenson. GSU 20001. Glynn Co.: 7.4 km SW Darien (31.333889°N, 81.513611°W). 3 March 2008. D. Stevenson. Mucky swamp south of the Altamaha River. GSU 20002.

Eurycea guttolineata (Three-lined Salamander). Ben Hill Co.: Mobley Bluff Road boat landing on the Ocmulgee River (31.774858°N, 83.00805°W). 17 November 2008. D. Stevenson. GSU 20050.

Eurycea quadridigitata (Dwarf Salamander). Appling Co.: 0.2 km NW Eason Bluff Landing in Altamaha River floodplain swamp (31.904444°N, 82.205°W). 04 July 2008. D. Stevenson. GSU 20003. First museum voucher specimen for county.

Notophthalmus perstriatus (Striped Newt). Camden Co.: 15.0 km ESE Woodbine (30.943056°N, 81.597222°W and 30.940833°N, 81.5975°W). 06 February 2008. J. G. Palis and D. Stevenson. Adults and larvae dipnetted from two depressional wetlands within mixed pine-oak hammock. GSU 20008 (photo). Only the second record for the county for this state-listed (Threatened) species, and the first record for the county since 1953. Extends range ca. 8.0 km closer to the Georgia coast.

Notophthalmus viridescens (Eastern Newt). Brooks Co.: 1.5 km NW Nankin in roadside swamp at State Hwy. 333 (30.673056°N, 83.478056°W). 26 June 2008. D. Stevenson; depressional wetland adjacent to and E of State Hwy. 333, 0.3 km S of jct. with Cty. Rte. 100 (30.7075°N, 83.506111°W). 26 June 2008. D. Stevenson. GSU 20004–06. First museum voucher specimens for county. Camden Co.: 15.0 km ESE Woodbine (30.943056°N, 81.597222°W). 06 February 2008. D. Stevenson and J. G. Palis. Adult dipnetted from depressional wetland within mixed pine-oak hammock. GSU 20007. Wheeler Co.: 5.6 km E of State Hwy. 19 on Cty. Rte. 95 (31.972947°N, 82.578653°W). 19 January 2009. D. Stevenson. Adult dipnetted from roadside wetland. GSU 20051.

Pseudotriton montanus (Mud Salamander). Glynn Co.: 7.4 km SW Darien (31.333889°N, 81.513611°W). 03 March 2008. D. Stevenson. Adult from under log in mucky swamp S of the Altamaha River. GSU 20009.

Siren intermedia (Lesser Siren). Appling Co.: 0.2 km NW Eason Bluff Landing in Altamaha River floodplain swamp (31.904444°N, 82.205°W). 04 July 2008. D. Stevenson. GSU 20010.

Siren lacertina (Greater Siren). Wayne Co.: 1.9 km N of Brantley County line on State Hwy. 301 (31.362778°N, 81.946111°W). 11 March 2008. D. Stevenson. Adult dropped by Great Blue Heron (*Ardea herodias*) at edge of deep, vegetated ditch adjacent to the W side of State Hwy. 301. GSU 20011.

Anura — Frogs

Acris crepitans (Northern Cricket Frog). Tattnall Co.: 19.7 km S Reidsville; county boat landing on the E side of the Ohoopee River at its confluence with the Altamaha River (31.896667°N, 82.109167°W). 02 May 2008. D. Stevenson. GSU 20014. Wheeler Co.: 3.0 km E Lumber City; Little Ocmulgee River at State Hwy. 19 (31.935278°N, 82.670556°W). 02 May 2008. D. Stevenson. GSU 20012–13.

Hyla gratiosa (Barking Treefrog). Brooks Co.: 0.3 km S of jct. with County Rte.100; depressional wetland adjacent to and E of State Hwy. 333 (30.7075°N, 83.506111°W). 26 June 2008. D. Stevenson. Tadpoles dipnetted from isolated depressional wetland. GSU 20017; Coffee Co.: Broxton Rocks Natural Area Preserve (31.733611°N, 82.8625°W). 06 July 2008. D. Stevenson, F. Snow, and B. Brody. Recent metamorph dipnetted from borrow pit. GSU 20018.

Lithobates capito (Gopher Frog). Camden Co.: 18.0 km ESE Woodbine (30.940833°N, 81.581111°W). 13 February 2008. D. Stevenson and J. G. Palis. Adult captured in a funnel trap placed at the entrance to a Gopher Tortoise (*Gopherus polyphemus*) burrow in sandhill habitat. GSU 20015 (photo); Wheeler Co.: 4.6 km NNE Lumber City (31.965278°N, 82.683611°W). 21 March 2008. J. Jensen and D. Stevenson. Adult observed in Gopher Tortoise (*Gopherus polyphemus*) burrow in xeric sandhill habitat. Verified by L. McGee. GMNH 50093 (photo).

Pseudacris ocularis (Little Grass Frog). Baker Co.: 12 km SW Newton, Joseph W. Jones Ecological Research Center at Ichauway (31.248889°N, 84.495278°W). 16 April 2004. G. Miller. Adult caught at drift fence encircling seasonal pond. GSU 20043.

Testudines — Turtles

Apalone spinifera (Spiny Softshell). Ben Hill Co.: Mobley Bluff Road boat landing on the Ocmulgee River (31.7751°N, 83.007956°W). 17 November 2008. D. Stevenson. GSU 20052. Telfair Co.: Altamaha River at Horse Creek Wildlife Management Area (31.815278°N, 82.839444°W). 17 August 2008. D. Stevenson. GSU 20042. Toombs Co.: 10.7 km SE Uvalda; Gray's Landing at the Altamaha River (31.966389°N, 82.428889°W). 02 May 2008. D. Stevenson. GSU 20019.

Clemmys guttata (Spotted Turtle). Brantley Co.: State Hwy. 32 at Needmore (31.333333°N, 81.903889°W). 21 May 2000. A. Walde. Adult found in blackwater creek swamp near State Hwy. 32. GSU 20021 (photo). Glynn Co.: 6.4 km SW Darien (31.346667°N, 81.510833°W). 03 April 2008. D. Stevenson and E. Grunwald. Adult male found in freshwater swamp. GSU 20020 (photo).

Deirochelys reticularia (Chicken Turtle). Toombs Co.: 1.8 km W of Tattnall County line on County Rte. 188 (31.953333°N, 82.231667°W). 15 March 2008. D. Stevenson and B. Willis-Stevenson. Adult female found AOR. Verified by L. McGee. GMNH 50096 (photo).

Kinosternon baurii (Striped Mud Turtle). Long Co.: 21.1 km WNW Ludowici (31.785833°N, 81.9475°W). 28 February 1998. R.A. Moulis and J.B. Blue, Jr. Adult captured in cypress pond wetland in sandhills. GSU 98.0548. First museum voucher specimen for county.

Pseudemys concinna floridana (Coastal Plain Cooter). Toombs Co.: State Hwy. 147 at Zigman Whonic Rd. (31.972503°N, 82.295192°W). 15 October 2008. D. Stevenson. Subadult DOR at beaver (*Castor canadensis*) pond wetland. GSU 20053.

Trachemys scripta (Pond Slider). Appling Co.: 4.5 km NW Davis on Moody Forest Natural Area Preserve (31.930833°N, 82.283333°W); 04 July 2008. D. Stevenson. GSU 20023 (photo). Jeff Davis Co.: Hazlehurst, Hollingsworth Blvd. at railroad tracks (31.86033°N, 82.589722°W). 21 June 2008. D. Stevenson. Adult found DOR. GSU 20024.

Squamata — Lizards

Anolis carolinensis (Green Anole). Telfair Co.: 16.0 km SW Lumber City, Mopani Preserve; N shore of the Ocmulgee River. (31.845756°N, 82.792647°W). 02 December 2008. D. Stevenson. GSU 20054.

Aspidoscelis (= *Cnemidophorus*) *sexlineatus* (Six-lined Racerunner). Wayne Co.: 7.4 km N Mt. Pleasant; Sansavilla Bluff at Altamaha River; Sansavilla Wildlife Management Area (31.494444°N, 81.647778°W). 03 July 2008. D. Stevenson. GSU 20044 (photo).

Ophisaurus attenuatus (Slender Glass Lizard). Elbert Co.: 5.5 km E Bell on River Road (33.993333°N, 82.715278°W). 31 May 2008. J. Oguni. GSU 20025 (photo).

Squamata — Serpentes

Agkistrodon contortrix (Copperhead). Bulloch Co: County Rte. 364 (Old River Road), 2.9 km NW of jct. with State Hwy. 24-W (32.5075°N, 81.650833°W). 23 March 1995. R. A. Moulis and G. K. Williamson. GSU 98.0980.

Cemophora coccinea (Scarletsnake). Wayne Co.: 7.6 km E Gardi; Penholoway Swamp Wildlife Management Area (31.549167°N, 81.714722°W). 05 July 2008. D. Stevenson and M. Wallace. Dug from six-lined racerunner (*Aspidoscelis* (*Cnemidophorus*) *sexlineatus*) burrow system in sandy soil. GSU 20026.

Coluber (=*Masticophis*) *flagellum* (Coachwhip). Brooks Co.: 5.8 km E Nankin (Nankin Road at jct. with Cty. Rte. 83) (30.670833°N, 83.399167°W). 22 June 2008. D. Stevenson. Adult found DOR. GSU 20029. Irwin Co.: 15.8 km SW Ocilla, Alapaha River sandhill located S of State Hwy. 319 (31.525128°N, 83.364961°W). 31 October 2008. A. Safer and D. Stevenson. Juvenile found at Gopher Tortoise (*Gopherus polyphemus*) burrow. GSU 20056 (photo).

Crotalus horridus (Timber Rattlesnake). Dade Co.: 3.5 km SE of U.S. Hwy. 11/58 on State Hwy. 136 (34.8475°N, 85.499444°W). 21 July 2002. J. G. Palis. Adult male found DOR. Verified by L. White. SIUC R03454. First museum voucher specimen for county. Tattnall Co.: Baxter Durrence Road at Mushmelon Creek (9.2 km SSW Glennville, by air). Adult DOR (31.864556°N, 81.965542°W). 26 October 2008. D. Stevenson and B. Willis-Stevenson. GSU 20055. White Co.: Chattahoochee National Forest at State Hwy. 348 (34.724722°N, 83.842222°W). 22 August 2008. D. Stevenson and B. Willis-Stevenson. GSU 20045 (photo).

Farancia abacura (Red-bellied Mudsnake). Toombs Co.: 0.2 km S of State Hwy. 147 on Laura Dixon Road (31.978889°N, 82.276944°W). 17 August 2008. D. Stevenson. Adult found DOR. GSU 20046. Wheeler Co.: 0.5 km S of County Rte. 68 on State Hwy. 126 (32.110278°N, 82.691389°W). 10 June 2008. D. Stevenson. DOR adult male. GSU 20027.

Lampropeltis triangulum elapsoides (Scarlet Kingsnake). Baker Co.: 12 km SW Newton, Joseph W. Jones Ecological Research Center at Ichauway (31.284722°N, 84.471944°W). 25 April 2007. A. Heupel. Adult female caught in snake trap. GSU 20047 (photo). Burke Co.: 9.7 km E Girard. (33.052778°N, 81.612778°W). 13 April 2007. R. Redmond, M. Wallace, and D. Stevenson. GSU 20028 (photo).

Micrurus fulvius (Harlequin Coralsnake). Bacon Co.: Alma, near Hurricane Creek (31.594306°N, 82.485047°W). 23 May 2008. D. Deen. Adult. GSU 20057.

Nerodia erythrogaster (Plain-bellied Watersnake). Toombs Co.: Old River Road at Larry Dickerson Road (31.984167°N, 82.436389°W). 17 August 2008. D. Stevenson. Adult found DOR. GSU 20048. Wayne Co.: Doctortown, Jaycee's boat landing; floodplain forest adjacent to the Altamaha River (31.666667°N, 81.846389°W). 03 May 2008. D. Stevenson and D. Beamer. GSU 20030.

Nerodia taxispilota (Brown Watersnake). Coffee Co.: 9.2 km NE Relee; Flat Tub Wildlife Management Area (31.801667°N, 82.838889°W). 06 July 2008. D. Stevenson, F. Snow, and B. Brody. Juvenile found in river swamp. GSU20031.

Pituophis melanoleucus (Pine Snake). Brantley Co.: State Hwy. 32 at Popwellville (31.315833°N, 81.744444°W). 21 May 2000. A. Walde. Adult found AOR. GSU 20032 (photo). Wayne Co.: Madray Springs: on State Hwy. 169 at mile marker 14 within city limits (31.733503°N, 81.978233°W). 30 March 1997. J. Blue. DOR subadult. GSU 97.0085.

Storeria occipitomaculata (Red-bellied Snake). Baker Co.: 12 km SW Newton, Joseph W. Jones Ecological Research Center at Ichauway (30.191667°N, 84.483333°W). 24 October 2002. D. Temple. Adult dead on farm road. GSU 20049.

Virginia striatula (Rough Earthsnake). Appling Co.: 5.5 km NW Davis on Moody Forest Natural Area Preserve (31.940556°N, 82.2925°W). 30 March 2008. D. Stevenson and B. Cash. Adult under debris in floodplain forest along the Altamaha River. GSU 20033.

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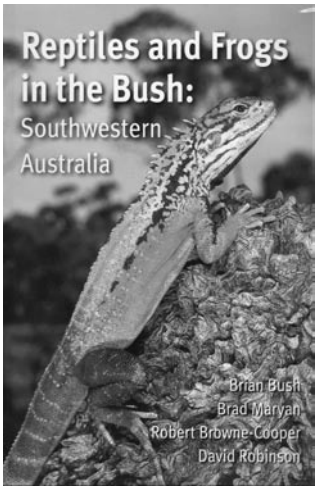
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BOOK REVIEWS

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The state of Western Australia, encompassing a third of continental Australia, has a human population largely concentrated around the southwestern fringe, and that same area represents two adjacent biogeographic and climatic zones, the South-Western and Eucla Divisions, regions extensively used by the late Glen Storr in his numerous taxonomic studies of the Western Australian herpetofauna (e.g., Storr 1974). Although there are already several guides to the Western Australian herpetofauna, including the taxon-based guides to the entire state produced by the Western Australian Museum (Storr et al. 1983, 1990, 1999, 2002; Tyler et al. 2000) and a regional guide to the capital city, Perth (Bush et al. 1995), there has been no comprehensive guide to the southwest in its entirety. But is this any more than just a regionally much expanded version of the previous Perth field guide by the same authors and publisher? It is indeed.

The core of the book (Section Four, Frogs, and Section Five, Reptiles) is the usual series of colour photos, distribution maps/statements and listings of diagnostic characters, as in most modern field identification guides. But the authors have gone beyond this in trying to enthuse their audience, with numerous personal stories of catching reptiles and amphibians in the south-west. These are provided firstly as a series of tales of field trips to particular habitats, liberally illustrated with photographs, that constitute Section Three of the book ("In the Bush" [for non-Australian readers, the "Bush" is the Australian vernacular for the non-urban parts of the continent]), and which in other field guides would take the less entertaining form of photographs and descriptions of habitat types. Secondly, there are more specific notes accompanying the photographs in the identification section, detailing how the photographed individuals were found (e.g., p. 126, "headtorched on wattle tree at Ellenbrook"; p. 163, "raked from leaf litter on coastal dune at False Entrance Well"; p. 168, "found under piece of old iron in banksia woodland at Waterman"; p. 255, "found basking outside rabbit burrow on Lort River Station"). There are also tales of recent Australian herpetological history, such as the rediscovery of the skink *Tiliqua adelaidensis* (p. 20), the discovery of the frog *Spicospina flammocaerulea* (p. 94), the search for a potential new species of the skink genus *Glaphyromorphus* (p. 198), and the search for extant south-western populations of the python *Aspidites ramsayi* (p. 237), all emphasizing the thrill of exploration and discovery. All of this, together with an engaging writing style and a vast number of color photographs (there are few pages without at least one photograph of animals or people in the field) gives this book a unique flavor, guaranteed to entertain as well as educate an audience that potentially ranges from the member of the general public, through the keen amateur, to the professional herpetologist seeking to explore a new fauna.

The book opens with a map of the region covered (from Shark Bay on the west coast, in a sweeping arc to Eucla at the South Australian border on the south coast), with many of the localities mentioned later in the text labelled, as well as the major settlements for orientation. Section One (26 pages) provides general information on a wide range of topics, with recommendations on how to use the book, the basics of nomenclature and taxonomic method, methods for recognizing the presence of amphibians and reptiles, amphibian declines, a brief personal view of the inadequacies of wildlife conservation, the importance of taking field notes, methods of handling, transporting, and preserving amphibians and reptiles, the value of examining roadkilled reptiles, photography, dealing with problem snakes in urban environments, and insular populations. Section Two (13 pages) describes methods of locating and catching amphibians and reptiles, including triangulating calls, raking leaf litter and loose soil, turning rocks and logs, "fishing" for active lizards with insects, noosing fast-moving or wary lizards, headtorching and spotlighting, pit-trapping, and temporarily fencing around the spikey spinifex (*Triodia*) clumps that are so widespread in arid Australia (and home to so many reptiles). The habitat/field trip accounts of Section Three (27 pages) cover six areas: the dry stony habitats of the Murchison in the north-west, the swamps and forests of the far south-west, the degraded, now-fragmentary woodlands and granite outcrops of the Wheat Belt, the heathlands of the west coastal plain, the mining country and woodlands of the Eastern Goldfields, and the chenopod steppes of the Nullarbor Plain in the east. My only significant concern with these preliminary parts of the book is the lack of emphasis on the legal requirements needed to permit the activities the authors so enthusiastically espouse. It is only a single paragraph on page 16 that notes the need to obtain a permit from the Western Australian Department of Environment and Conservation before any of the activities in the book can be carried out.

The next two sections, the identification core, consist of brief accounts arranged taxonomically by class, family, genus and species/subspecies. Each species/subspecies account provides a common name (largely based on those coined by Ehmann [1992], though not always), taxonomic name, a brief diagnostic statement noting features to differentiate the species from similar species (many illustrated in the accompanying photographs, or in a few cases with line drawings), a verbal description of the call (for frogs), a size measurement, and a statement of distribution and habitat. Each species account is illustrated by one or more color photographs, almost all of high quality, though mostly small (54 mm wide), and a very small map identifying the overall range of

the species in Western Australia. Although small, the use of color and arrows on the maps, the latter highlighting tiny patches of distribution, makes the distribution readily recognizable. There are no keys. While some would argue that this decreases the value of the book, keys for the same fauna are available in the Western Australian Museum field guide series, and non-professionals rarely use them anyway (or if they do, they often misuse them). The identification format in this book is useful once the reader has got a rough match from the photos, but offers little help in getting to the right photo to start the process, other than flicking through the 197 pages of species accounts. This still results in the physical separation of the superficially similar and confusing pygopod lizards (pp. 129–142) and snakes (pp. 226–268), and separates the numerous small brown skinks into generic groupings arranged alphabetically (although at least the alphabet kept the elongate burrowing skinks of the genera *Hemiergis* and *Lerista* adjacent). The diagnostic statements (except for monotypic genera) are mostly only useful in differentiating between congeners. But having reached the correct genus, I found the diagnostic statements usually worked effectively (noticeable exceptions were the diagnostic statements for *Ctenotus pantherinus pantherinus*: "As for Eastern Leopard Skink" [*Ctenotus pantherinus ocellifer*], and *Ctenotus euclae*: "As for Centralian Wedge-snout Ctenotus" [*Ctenotus brooksi*]). I did not find any obvious errors in photographic identifications, although the photograph of the "yellow-eyed" *Strophurus spinigerus spinigerus* did not show an eye noticeably different from that of the "orange-eyed" *Strophurus spinigerus inornatus*.

The identification section terminates in a brief general account of marine reptiles that might be encountered as beach strandings. Atypically, this is not arranged by species and lacks identification aids, although two species of turtle and three of sea snakes are photographed.

The book closes with first aid treatment for snake bite (pp. 274–275), then a series of lists, first (pp. 276–282) species lists by island or archipelago (the southwest coastline has large numbers of continental islands), including references to the literature on each island, then mainland bioregion listings for each species (pp. 283–292), and finally a brief list of other general herpetological books and websites that may be of interest to readers ("Useful Books"). The index is brief and largely designed to locate only photographs, species accounts and broader topics. It certainly does not provide every citation of a species in the text.

Although a paperback, the production values are good. The book is printed on quality glossy paper, the binding is robust, both stitched signatures and glued, and the cover protected by a thick clear plastic protector, all of which facilitate the intended use of this book in a field setting.

Apart from the few criticisms noted, this book is a worthwhile and unique addition to the plethora of Australian herpetological field guides, and entertaining reading for those yearning for fieldwork in the southwest.

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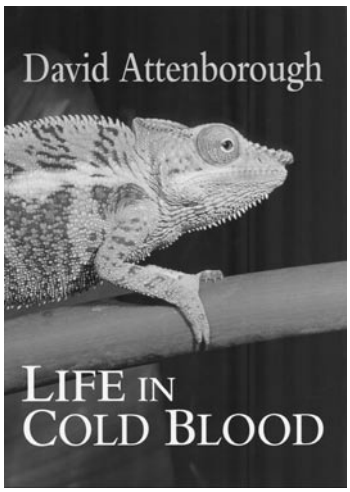
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Life in Cold Blood, by David Attenborough. 2008. Princeton University Press (www.press.princeton.edu). 288 pp. Hardcover. US$ 29.95. ISBN 978-0691137186; and **Life in Cold Blood** (DVD). 2008. BBC Warner. 250 minutes. US $34.98. ASIN B0018F0QS2.

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The British have somehow long been able to achieve something that has eluded television in most other countries: quality programming. Perhaps the best examples of this are provided by BBC nature documentaries, some accompanied by a book providing more details for those wanting to delve further. With exquisite photography and an attention to detail, those associated with David Attenborough have for decades been the gold standard in the field. As a result, our expectations from their newest offering, *Life in Cold Blood*, were high. Both the video (two DVDs containing five, 50-minute episodes) and the book (some 280 pages, plus an index of common and scientific names) generally met our expectations.

The book offers a nice balance of pictures and text. It reads like

a large-scale overview of the diversity of herpetofauna, presented in four taxonomic chapters: amphibians; turtles and tortoises; crocodilians; and lizards and snakes. It concludes with a final chapter discussing ectothermic life as a whole. The video follows a similar organization. Drawing from decades of personal observation and study, Attenborough attempts to demonstrate the sophistication these groups evolved to fill seemingly every available niche. Topics ranging from life history and evolutionary theories to foraging and reproductive strategies are addressed through detailed accounts of example species, illustrated with brilliant photos or scintillating video. Several major themes run through the series: the dependence of amphibians and reptiles on outside temperature; the move from the water to progressively drier land, providing an illustration of the evolutionary process without being pushy; conservation, especially of amphibians; and the complexity of behaviors and adaptations shown by creatures that most consider primitive, such as parental behavior and pairing for life. The inclusion of the Panamanian golden frog (*Atelopus zetecki*), which went extinct in the wild during the production period, effectively drives the point home. The latter is interwoven throughout the series, but is inserted with a light touch, so that the message is one of wonder, rather than gloom-and-doom. This is enhanced by Mr. Attenborough, who is often openly delighted by what he reports. Delightfully, and unlike the new breed of television nature show hosts, the show isn't about him; Attenborough's presence and verbiage is not testosterone laden and overbearing, but rather informative and enlightening.

As products aimed at the non-specialist, both the book and the video do a superb job. Instead of being bogged down by scientific jargon, the average reader will easily follow the text. The numerous photos, many taken from the DVDs, provide for entertaining pauses along the way. The videography tends to be excellent. Some shots are taken inside nests and burrows, showing hatching behavior and other events that we have never seen displayed in this way before. Segments shot using infrared cameras offer enlightening views into nighttime activity and other events that transpire in the dark. Thermal imaging helps illustrate some points about the thermal relations of various species. Novel behavioral observations abound, and many can be witnessed first-hand in the DVDs. Attenborough gently and without preaching tells the stories of numerous species, engaging the lay person in the life of a creature they may have never heard of before, or even previously thought of as "gross" or "frightening." The flowery language and repeated projections of human characteristics may irritate the scientist. For example, an Australian sleepy lizard remaining by a mate that has been run over by a car is said in the video to be "grieving." Professional herpetologists may find statements such as "lizards, with their watertight skins, are immune to" dehydration when swimming in sea-water (p. 146) overly simplistic, but will still learn a fact or two about an unfamiliar species.

Although the book offers more detail, the video provides more pizzazz. It also offers something new: each episode is followed by a ten-minute "under the skin" section which offers much more than the "making of" segment promised on the dust jacket. As in his previous shows, Attenborough does not share the screen with other humans in this series. In these little snippets, however, the viewer is introduced to some of the scientists who aided in the research and filming, and gives a sense of the process of science and how long acquiring knowledge can take. This adds a dimension that is extremely valuable for those intending to use these videos in teaching. In addition, it is in these segments that conservation issues are often most directly addressed. Over the course of a week, we showed the DVDs to a group of about twenty people, ranging in age from four to 84 and in experience from none to retired biology professors. Every single viewer, regardless of age or experience level, learned new things. The show was a bit much for the younger children, and probably is most appropriate for those over 8. However, the feedback we received was enthusiastic. Younger viewers mostly liked the more dramatic scenes, such as a constrictor struggling to swallow a large deer. Older spectators noted the color quality, cinematography, and engaging delivery. Several said they were going to buy the series for home. Their only complaint was minor: Madagascan chameleons showed up in too many episodes. Our complaints are likewise few, and may be of little concern for most viewers. The first episode spends some time on digitally-created dinosaurs, something we could have done without.

Sir David Attenborough and the BBC have once again succeeded in taking a substantial academic subject and making it approachable to the general populace, while reminding scientists why they chose their careers in the first place. Aside from being an enjoyable experience for anyone interested in nature, *Life in Cold Blood* can provide discussion material for high school level biology or even a college-level animal behavior course. Public outreach programs can utilize the strong conservation message from this series to inspire interest in herpetological conservation from the general public as well. Though not really suited to the professional herpetologist as a reference book, the book may inspire future herpetologists as it provides wonderful insights into the lives of these fascinating creatures.

This year marks the 200th birthday of Charles Darwin and the 150th anniversary of the publication of his *Origin of Species* – perhaps the most influential biology book ever published. Amazingly, even as the scientific community has embraced the concept of evolution as the core of biology, the public in some countries has remained intractable. Less than half of Britons surveyed recently agree that evolution is the best explanation for the development of life (Williams 2006), and a British government report indicates that teachers there tend to avoid controversial topics such as the Crusades and Holocaust for fear of offending students (Vasagar 2007). In the US, many high-school biology teachers avoid the topic of evolution or downplay it because of public pressure, personal belief, or lack of sufficient exposure to the topic in college (Berkman et al. 2008). Polls consistently show that more Americans believe that human were created in their present form within the last 10,000 years than are comfortable with the idea that we slowly evolved from less advanced forms of life. Clearly, we are doing a poor job of reaching even our biology teachers, let alone our general public. Against this background, it is a pleasure to see a new product that is aimed at the general public, focuses on herpetology, and provides a matter-of-factly evolutionary perspective without being technical, boring, or preachy.

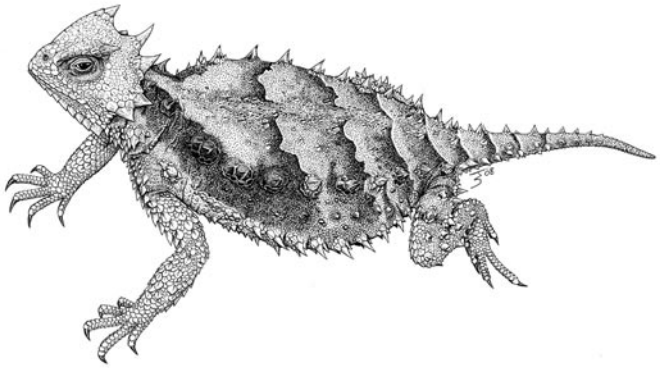
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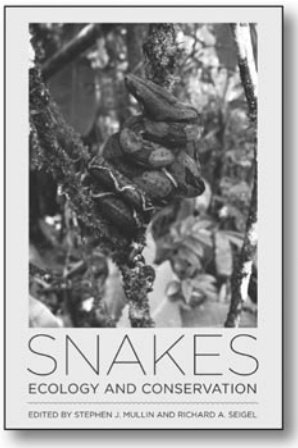
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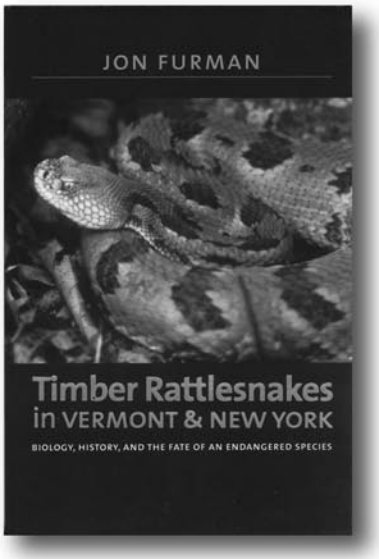
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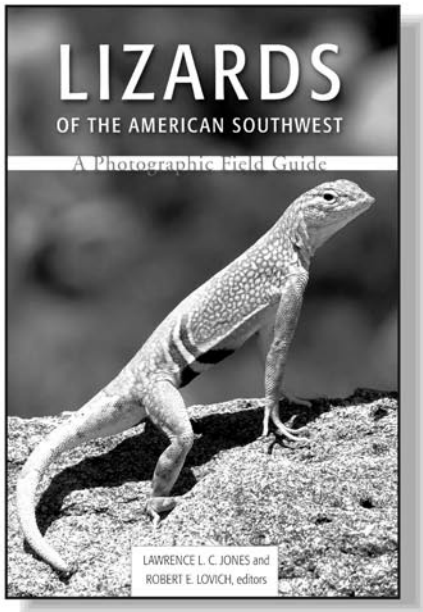
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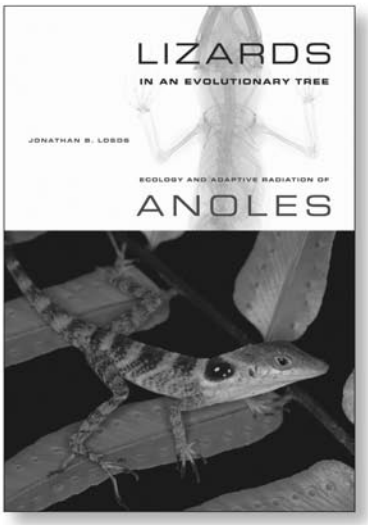
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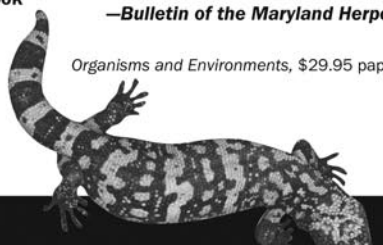
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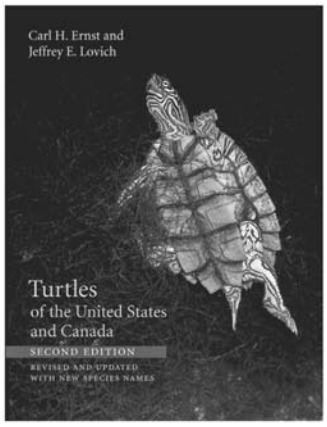
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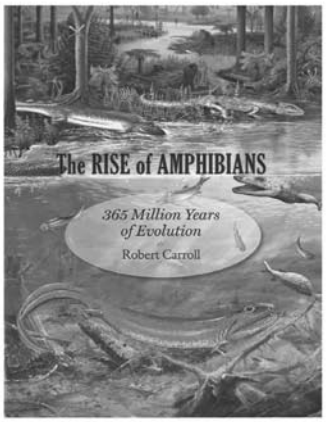
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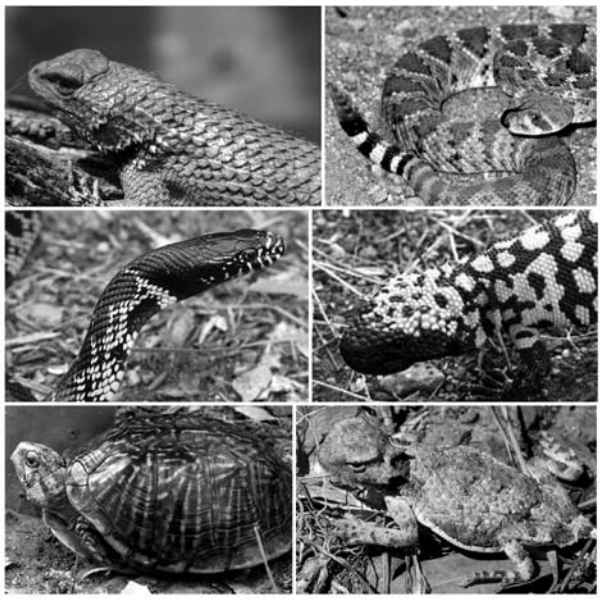
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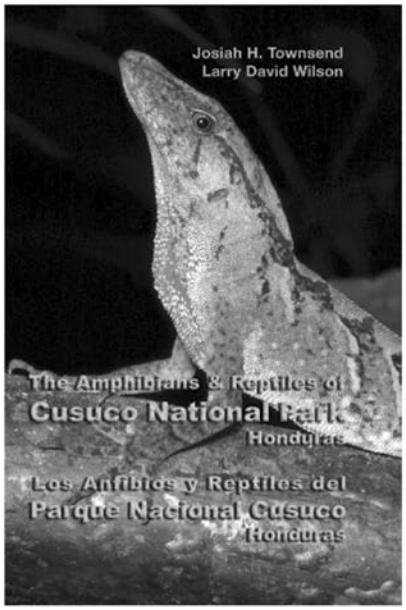
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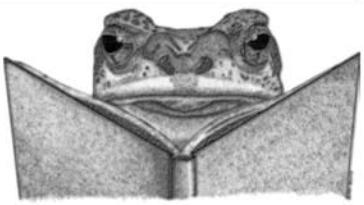
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The Society for the Study of Amphibians and Reptiles, the largest international herpetological society, is a not-for-profit organization established to advance research, conservation, and education concerning amphibians and reptiles. Founded in 1958, SSAR is widely recognized today as having the most diverse society-sponsored program of services and publications for herpetologists. Membership is open to anyone with an interest in herpetology—professionals and serious amateurs alike—who wish to join with us to advance the goals of the Society.

All members of the SSAR are entitled to vote by mail ballot for Society officers, which allows overseas members to participate in determining the Society's activities; also, many international members attend the annual meetings and serve on editorial boards and committees.

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Future Annual Meetings

2009 — Portland, Oregon, 22–27 July (with ASIH, HL)
2010 — Providence, Rhode Island, 7–12 July (with ASIH, HL)

About Our Cover: *Ranitomeya fantastica*



With brilliant colors and accompanying toxicity, fascinating parental behaviors, and convenient diurnal activity, dart-poison frogs in the family Dendrobatidae (*sensu lato*) have long attracted the attention of researchers. Arguably the most influential body of work resulted from the productive partnership of Charles Myers and John Daly (see p. 53 of this issue for a herpetological biography of Daly). For almost forty years, their collaboration yielded numerous new species, addressed taxonomic issues, and advanced the new field of anuran biochemical research. The work of Daly and his colleagues resulted in the discovery of over 800 chemical compounds isolated from dendrobatids, many novel and important in understanding broader physiological mechanisms beyond the herpetological realm.

More recent research has seen advances in our understanding of pattern polymorphisms, parental care, biogeography, and evolutionary theory. In 2006, Taran Grant and colleagues published a major systematic treatise (Grant et al. 2006. Bulletin of the American Museum of Natural History 299:1–262). New species continue to be described each year, with the total in late 2008 standing at over 260 (for the families Aromobatidae and Dendrobatidae combined; Frost 2008. Amphibian Species of the World: an Online Reference. Version 5.2 [15 July 2008]. Electronic database accessible at http://research.amnh.org/herpetology/amphibia/index.php. American Museum of Natural History, New York). An excellent source for additional information can be found at: www.dendrobates.org.

This issue's cover features *Ranitomeya fantastica*. Even for a veteran dendrobatid hunter, *R. fantastica* can be an extremely difficult frog to catch. They are very quick and have an amazing ability to completely disappear within leaf litter. This species is found in the Departments of San Martin and Loreto in central Peru and frequently is sympatric with *R. ventrimaculata* and *R. imitator*. *R. imitator* and *R. fantastica* are wildly polymorphic; our cover frog is representative of a population found adjacent to the city of Tarapoto, Peru. Recently, Brown et al. (2008. Zootaxa 1823:1–24) showed that *R. fantastica* consists of a complex of three species, two of which they described as new: *R. benedicta* and *R. summersi*. Our cover frog was photographed by **Tim Paine** in October 2006 using a Nikon D2x and a Nikkor 105mm macro lens (ISO 100, f/20). Lighting was accomplished using an SB800 flash (1/60 s) off-camera and Nikon's wireless R1C1 macro lighting set. Paine is a police officer with the San Francisco Police Department, and oftens travel to Latin America to photograph herpetofauna.



PHOTO BY BETH GOUDREAU

NEWSNOTES

Kansas Herpetological Society Annual Meeting

The Kansas Herpetological Society held its 35th Annual Meeting at Friends University in Wichita, Kansas, on November 8–9, 2008. Over 100 participants attended scientific paper sessions presented by scientists and students from across the nation. Featured speaker was Ronald Bonett (University of Tulsa).

Ashley Inslee, student at Fort Hayes State University, received the 2008 Howard K. Gloyd/Edward H. Taylor Scholarship, honoring the memory of two great biologists with strong ties to Kansas. The 2008 Alan H. Kamb Grant for Research on Kansas Snakes was made to Page Klug, Kansas State University, Manhattan. Dustin J. Wilgers, University of Nebraska, Lincoln, was chosen as the eleventh recipient of "The Suzanne L. & Joseph T. Collins Award for Excellence in Kansas Herpetology." Steve D. Grant, West Texas A&M University, was presented with the George Toland Award for the best student paper given at the meeting. In 2009, the Society will meet at Overland Park, Kansas.

MEETINGS

Meetings Calendar

Meeting announcement information should be sent directly to the Editor (rwh13@csufresno.edu) well in advance of the event.

17–19 April 2009—Texas Herpetological Society Spring Field Meet, Rolling Plains Quail Research Ranch, near Roby, Texas, USA. Information: http://www.kingsnake.com/ths/2009_Spring%20Meet.htm.

19–23 April 2009—16th International Conference on Aquatic Invasive Species, Fairmont Queen Elizabeth Hotel, Montreal, Canada. A forum on Bullfrog Eradication and Control will be part of the program. Registration: http://www.icais.org/; information: www.bullfrogcontrol.com.

23–25 April 2009—56th Annual Meeting of the Southwestern Association of Naturalists, Monterrey, Mexico. Information: www.biosurvey.ou.edu/swan/annualm09.html.

6–7 June 2009—Southwestern PARC (Partners in Amphibian and Reptile Conservation) meeting and Herpetofauna Conservation Training (4–5 June), St. George, Utah, USA. Information: http://chelydra.unm.edu/swparc/.

17–20 June 2009—33rd International Herpetological Symposium, Monterrey, Mexico. Information: www.kingsnake.com/ihs.

18–20 July 2009—5th Meeting of the Snake Ecology Group, Donnelly, Idaho, USA. Registration and information: http://www.projectorianne.org/SEG_5.html.

22–27 July 2009—52nd Annual Meeting, Society for the Study of Amphibians and Reptiles; 89th Annual Meeting, Amercian Society

of Ichthyologists and Herpetologists; 67th Annual Meeting, The Herpetologists' League. Portland, Oregon, USA. Information: http://www.dce.ksu.edu/jointmeeting/.

16–17 October 2009—Texas Herpetological Society Fall Symposium, Texas A&M University, College Station, Texas, USA. Information: www.kingsnake.com/ths.

CURRENT RESEARCH

The purpose of Current Research is to present brief summaries and citations for selected papers from journals other than those published by the American Society of Ichthyologists and Herpetologists, The Herpetologists' League, and the Society for the Study of Amphibians and Reptiles. Limited space prohibits comprehensive coverage of the literature, but an effort will be made to cover a variety of taxa and topics. To ensure that the coverage is as broad and current as possible, authors are invited to send reprints to the Current Research section editors, Joshua Hale or Ben Lowe; postal and e-mail addresses may be found on the inside front cover.

The current contents of various herpetological journals and other publications can be found at: http://www.herplit.com/contents.

Looking for Commonalities in Amphibian Declines

Amphibian species across the globe are suffering from population declines and extinctions, many of which are due to the *Batrachochytrium dendrobatidis* (Bd) pandemic. Focusing on anurans, the authors used existing phylogenetic data and data on amphibian declines to look for factors that make some taxa particularly susceptible to rapid population declines. They compiled a dataset consisting of ecological, life history, and environmental data for 553 species (spanning 32 of 33 families and six continents). Additionally, the taxa were coded for IUCN status (e.g., threatened, endangered), if they have experienced rapid declines (RD) and the suspected cause of the declines (based on information from the Global Amphibian Assessment), and if Bd infection has been found (Bd+ and Bd-, respectively). The cause of decline was divided into three categories: habitat loss, over-exploitation, and "enigmatic" (which includes Bd, as well as UV exposure, climate change, etc.). Tests were conducted to determine if RD species were different from other threatened species, if enigmatic RD species were different from species experiencing RD caused by other factors, if Bd+ species experiencing RD differ from Bd+ species not experiencing RD, and if Bd+ species suffering from RD differ from Bd- species experiencing RD. For these tests, the confounding effects of phylogeny were accounted for by using a Generalized Estimating Equation. An aquatic life-stage was found to be strongly correlated with RD, relative to other threatened species. Relative to threatened species, species suffering enigmatic RD are significantly associated with both habitats experiencing low annual temperature variation and an aquatic life-stage. Furthermore, for Bd+ species, those experiencing RD exhibit a strong association with small distributions and high elevation. Finally, no associations were found for Bd+ species experiencing RD relative to Bd- species experiencing RD. This study shows that the connections between Bd, RD, and threatened status are complicated, with different factors leading to different results in anuran species.

Bielby, J., N. Cooper, A. A. Cunningham, T. W. J. Garner, and A. Purvis. 2008. Predicting susceptibility to future declines in the world's frogs. Conservation Letters 1:82–90.

Correspondence to: Jon Bielby, Division of Biology, Imperial College London, Silwood Park Campus, Ascot, U.K., SL5 7PY; e-mail: jon.bielby04@imperial.ac.uk.

Quantifying the Nutrient Contributions of Salamanders to Terrestrial Ecosystems

As organisms that develop as larvae in aquatic ecosystems, then emerge and move as adults to terrestrial ecosystems, many amphibian species potentially contribute greatly to the transfer of nutrients between these two environments. While this has been examined extensively in other systems, few studies have explicitly addressed the roll of amphibians in these types of biomass transfers. The authors sought to quantify this transfer in three species of *Ambystoma* (*A. tigrinum*, *A. opacum*, and *A. maculatum*) occurring sympatrically in four ponds (two temporary and two permanent) in Illinois. Using *A. opacum*, food-specific assimilation efficiencies were determined for three prey types: zooplankton (cladocerans and copepods), larval midges (*Chironomus*), and hatchling *A. maculatum*. Larval diets of the three species were determined through gut content analysis of ethanol-preserved specimens; prey numbers and sizes were also quantified. Using these data and species-specific population density data, the volume of food consumed by the larval salamanders (prey production), the amount assimilated, and amount of biomass transferred by each species to the terrestrial environment (all in g AFDM [ash-free dry mass] × m^{-2} [pond area] × $year^{-1}$) were calculated. In different pond types, the various prey species were found to contribute differently to the biomass transported to terrestrial ecosystems via metamorphosed salamanders. Different prey species were also found to contribute differently to the biomass of the various salamander species. In the three ponds in which salamander cohorts survived to metamorphosis, between 0.3 and 0.85 g AFDM m^{-2} $year^{-1}$ of biomass was delivered to terrestrial ecosystems by emerging salamanders, representing between 3.4% and 8.4% of prey production. This "emergence production" is considerably higher than has been found in most studies of similar systems, indicating that amphibians with both aquatic and terrestrial life-stages are very important contributors to the transfer of aquatic biomass to terrestrial ecosystems.

Regester, K. J., M. R. Whiles, and K. R. Lips. 2008. Variation in the trophic basis of production and energy flow associated with emergence of larval salamander assemblages from forest ponds. Freshwater Biology 53:1754–1767.

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Comparative Biogeography Spanning the Strait of Gibraltar

The field of comparative phylogeography aims to understand the

effects of geography on biodiversity. One particularly interesting geographic feature, the Strait of Gibraltar, which separates the Iberian Peninsula from North Africa at the western terminus of the Mediterranean Sea, has long been of interest to evolutionary biologists. It currently is an effective barrier to dispersal to most terrestrial animals but was connected roughly 5.5 million years ago. Since that vicariant event, quantifiable morphological and/or molecular differentiation in taxon pairs occurring on either side of this feature may have accrued due to different selective pressures, founder's effects, or continued gene flow. To investigate this, the authors collected morphological and molecular data on eight taxon pairs divided by the Strait of Gibraltar spanning anurans, testudines, and squamates. The molecular data (mitochondrial DNA [mtDNA] and allozyme) is presumed to not be under selection and therefore give estimates of gene flow and degree of isolation between northern and southern populations. The morphological data is presumed to be under selection and therefore reflects the degree of differentiation due to selection attributable to the different environmental conditions existing in the two regions. Results suggest that the vicariant event led to different outcomes in the various taxon pairs. Three pairs (a hylid, a testudine, and a snake) exhibit low levels of genetic differentiation, suggesting continued gene flow between the two regions or recent colonization; however, discriminant analysis of the morphological variation revealed that the intercontinental morphological variation in the testudine was low while it was high in the anuran and the squamate. Two lacertid taxon pairs exhibited moderate to high morphological and mtDNA differentiation but low allozyme differentiation; this was attributed to limited gene flow during the formation of the isthmus via islands. Finally, the ranid, alytid, and, amphisbaenid taxon pairs exhibited moderate to high levels of morphological differentiation coupled with high levels of molecular differentiation, indicating the pairs diverged at, if not before, the formation of the isthmus and at least moderately different selective pressures are acting in the two regions.

Busack, S. D., and R. Lawson. 2008. Morphological, mitochondrial DNA and allozyme evolution in representative amphibians and reptiles inhabiting each side of the Strait of Gibraltar. Biological Journal of the Linnean Society 94:445–461.

Correspondence to: Stephen Busack, North Carolina State Museum of Natural Sciences, 11 West Jones Street, Raleigh, North Carolina 27601–1029, USA; e-mail: sbusack348@aol.com.

Potential Effects of Climate Change on an Arid Lands Lizard

With the threat of climate change on the horizon, understanding its effect on wild populations is imperative. While initially it may seem that the increased global temperatures and longer growing seasons predicted by most climate models might be beneficial, studies have shown that climate change frequently triggers unforeseen detrimental effects. The author investigated the effects of extended growing season and milder winter temperatures in a northern population of side-blotched lizards (*Uta stansburiana*), a taxon that could potentially benefit from such changes. Eggs from wild caught females were hatched in captivity and hatchlings were measured, uniquely toe clipped, and either returned to the source population or released into one of twelve 100 m^2 enclosures located 38 km north of the source population. The enclosures were designed to encompass suitable habitat, complete with overwintering sites and potential mates and predators. The enclosures were populated on four dates, with the later dates allowing the lizards less time to accumulate fat reserves, simulating a shorter growing season. Lizards were recaptured at the end of the growing season and again the following spring (source population only) to ascertain survivorship and to make measurements. Additional lizards were collected from the source population at the end of the growing season and maintained in the laboratory at either 2.0° C or 7.7° C to ascertain winter survivorship. Lizards provided with longer growing periods were larger than lizards experiencing truncated growing seasons, lizards maintained at higher temperatures during winter experienced increased rates of mortality, and winter survivorship was found to be correlated with body size. These results reveal that while the lizards exhibit increased fitness with an increased growing season, this is offset by the lower survivorship of milder winters, attributable to an increased metabolism during hibernation.

Zani, P. A. 2008. Climate change trade-offs in the side-blotched lizard (*Uta stansburiana*): effects of growing-season length and mild temperatures on winter survival. Physiological and Biochemical Zoology 81:797–809.

Correspondence to: Peter Zani, Department of Biology, Lafayette College, Easton, Pennsylvania 18042; e-mail: zanip@lafayette.edu.

Chytrid Epidemic in Wild Population Traced to Captive Bred Frogs

For many anuran species, captive breeding programs represent the only remaining option for reestablishing wild populations. However, *Batrachochytrium dendrobatidis* (Bd) has surfaced in a number of captive populations, leading to the possibility of Bd being introduced into wild populations by captive bred frogs. The authors document an unintentional Bd introduction in a population of *Alytes muletensis*, a critically endangered alytid endemic to the Mediterranean island of Malorca. Known wild populations were assayed for Bd, as were frogs that had died in the captive breeding program over the last two decades. Data on captive die-offs and introduction attempts were also gathered. Four of 21 populations tested positive for Bd, as did several captive frogs that had died between 1991 and 1995. Multilocus genetic analyses revealed the Bd in both the captive specimens and the wild populations belonged to the same strain, one unrelated to Bd strains known from mainland Europe. Furthermore, records revealed that in 1991 a *Xenopus* was brought into the breeding center; it was also found to have been infected with the same strain of Bd and it was only shortly thereafter that a large die-off of captive *Alytes* occurred. This unfortunate inadvertent introduction of Bd into a wild population underscores the importance of adhering to the IUCN guidelines for captive breeding.

Walker, S. F., J. Bosch, T. Y. James, A. P. Litvinsteva, J. A. O. Valls, S. Piña, G. García, G. A. Rosa, A. A. Cunningham, S. Hole, R. Griffiths, and M. C. Fisher. 2008. Invasive pathogens threaten species recovery programs. Current Biology 18:R853–R854.

Correspondence to: Susan Walker, Imperial College Faculty of Medicine, Dept of Infectious Disease Epidemiology, St Mary's Campus, Norfolk Place, London, W2 1PG, UK; e-mail: susan.walker03@imperial.ac.uk.

Tracking the Evolution of Limb Reduction in Squamates

The growing number of well-supported phylogenies calibrated with a molecular clock has allowed researchers to answer questions regarding not only how many times a particular trait has originated within a clade, but also the timing of the change and how many different pathways have led to the derived state. Taking advantage of the recent availability of a robust, fossil-calibrated phylogeny for squamate reptiles, the authors investigated the evolution of a snake-like body form, which occurred no fewer than 26 times across the phylogeny. Data on eight morphological characters were collected for the 258 species included in the phylogeny on which regression analyses of independent contrasts were conducted to determine which traits were associated with limb reduction and to look for common patterns. Additionally, the terminal taxa in the phylogeny were coded for their forelimb and hind limb digit numbers and ancestral states were reconstructed across the phylogeny using a novel likelihood-based framework. Overall, forelimb and hind limb digit number were strongly correlated and reduction in limb lengths and digit numbers were strongly correlated with an increase in snout-vent length (SVL) and tail length (TL). Within some clades (Gymnophthalmidae and Scincidae), the correlation with TL dropped off; this was attributed to the discrepancy between the two different reduced-limb ecomorphs (long-tailed surface-dweller and the short-tailed burrower). Thresholds were found for limb lengths, SVL, and TL which when crossed a reduction in digit number invariably occurred. The median length of time between an ancestor with five digit limbs and a descendant missing at least one pair of limbs was found to be ~50 million years (My) and as short as ~16 My; lineages with extant members exhibiting morphologies intermediate between these two extremes have persisted for as long as ~63 My. Finally, instances of digit loss drastically outnumbered instances of digit gain and digit gain was found to occur more frequently in the forelimb than the hind limb.

M. C. Brandley, J. P. Huelsenbeck, and J. J. Wiens. 2008. Rates and patterns in the evolution of snake-like body form in squamate reptiles: evidence for repeated re-evolution of lost digits and long-term persistence of intermediate body forms. Evolution 62:2042–2064.

Correspondence to: Matthew Brandley, Museum of Vertebrate Zoology, University of California, Berkeley, California 94270, USA; e-mail: brandley@berkeley.edu.

Thamnophis Pupil Diameter Changes with Water Submersion

The eye's pupil allows for adjustment to light conditions by widening and shrinking under low and high light conditions, respectively. Previous studies have shown that despite a reduction in available light, *Thamnophis* (North American garter snakes) submerged underwater experience reductions in pupil diameter. Potential benefits conveyed by a reduced aperture size underwater include an increased depth of field and an adjustment to the altered refractive index encountered in the different medium. Therefore, pupil diameter controlled by aqueous submersion (as opposed to light level) may allow aquatic snakes to better take advantage of underwater resources and variation in influence in light versus submersion control may allow for niche partitioning among sympatric species. To investigate this, the author examined pupil size response to light and submersion in three species of *Thamnophis* that occur sympatrically in southern California and exhibit different ecologies: *T. sitralis* (terrestrial), *T. hammondii* (aquatic), and *T. atratus* (intermediate). Light was found to have no impact on pupil aperture size. Additionally, while all species exhibited a reduced pupil size when submerged, *T. sirtalis* showed the largest magnitude of change (which was contrary to the prediction that the more aquatic species should show the greatest response to submersion). An explanation for this phenomenon lies in the absolute pupil size (which is smallest in *T. hammondii*); perhaps the aquatic specialists have abandoned pupil size flexibility and adequate but suboptimal vision both terrestrially and underwater (as seen in *T. sirtalis*) for an eye optimized for underwater vision at the expense terrestrial vision. This finding supports the hypothesis of niche partitioning.

Fontenot, C. L., Jr. 2008. Variation in pupil diameter in North American gartersnakes (*Thamnophis*) is regulated by immersion in water, not by light intensity. Vision Research 48:1663–1669.

Correspondence to: Clifford Fontenot Jr., Department of Biological Sciences, Southeastern Louisiana University, Hammond, Louisiana 70402, USA; e-mail: cfontenot@selu.edu.

Sea Turtle Evolutionary Relationships Obscure Origin of Spongivory

Studies examining the evolutionary relationships among extant sea turtles have offered conflicting results. The placement of the Australasian flatback turtle (*Natator*) has been particularly problematic; previous analyses have placed it as the sister taxon to a clade containing hawksbill (*Eretmochelys*), loggerhead (*Caretta*) and ridley (*Lepidochelys*) turtles. This relationship would have the unique spongivorous diet of *Eretmochelys* arising from an ancestral carnivorous condition. To address this question, the authors generated sequence data for two mitochondrial and five nuclear loci for all the extant sea turtles, including Pacific and Atlantic green turtles (*Chelonia*). Their analyses found *Natator* forming a clade with *Chelonia*, which in turn was sister to a clade containing all remaining sea turtles with the exception of leatherbacks (*Dermochelys*). This obscures the origin of spongivory, making it equally likely that it, the herbivorous diet of *Chelonia*, and the jellyfish diet of *Dermochelys* are derived from either a carnivorous or an omnivorous ancestral diet.

Naro-Maciel, E., M. Le, N. N. FitzSimmons, and G. Amato. 2008. Evolutionary relationships of marine turtles: A molecular phylogeny based on nuclear and mitochondrial genes. Molecular Phylogenetics and Evolution 49:659–662.

Correspondence to: Eugenia Naro-Maciel, Sackler Institute for Comparative Genomics, American Museum of Natural History, Central Park West at 79th Street, New York, New York 10024, USA; e-mail: enmaciel@amnh.org.

Recent Fossil Discovery Sheds Light on Amphibian Relationships

With a growing fossil record, it is clear that Amphibia is comprised of two clades, Temnospondyli and Lepospondyli. However, deciphering the origins of, and relationships among, the three extant amphibian lineages (Lissamphibia) has been problematic. Current hypotheses involve extant lineages forming a clade within Temnospondyli, forming a clade within Lepospondyli, or arising independently within Temnospondyli (Anura + Caudata) and Lepospondyli (Apoda). The authors describe a recent fossil from the early Permian and using morphological data, construct a phylogeny incorporating other known fossil amphibians. Their analysis reveals the new fossil is sister to the node-based clade defined by Anura and Caudata. Furthermore, Anura and Caudata are shown to be derived from within Temnospondyli while Apoda is derived from within Lepospondyli, rendering Lissamphibia paraphyletic. This phylogenetic reconstruction places the divergence between Temnospondyli and Lepospondyli within the Carboniferous, which is much more in line with molecular estimates than the monophyletic Lissamphibia hypotheses.

Anderson, J. S., R. R. Reisz, D. Scott, N. B. Fröbisch, and S. S. Sumida. 2008. A stem batrachian from the Early Permian of Texas and the origin of frogs and salamanders. Nature 453:515–518.

Correspondence to: Jason Anderson, Department of Comparative Biology and Experimental Medicine, Faculty of Veterinary Medicine, University of Calgary, 3330 Hospital Drive, Calgary, Alberta T2N 4N1, Canada; e-mail: janders@ucalgary.ca.

Fossil Reveals Morphological Evolution and Ecology of Early Turtles

Previously, early testudinate material indicated a terrestrial origin for modern turtles (= Testudines). The recent discovery from China of the earliest testudinate calls this hypothesis into question. *Odontochelys semitestacea*, from the early Carnian (mid Triassic; ~220 million years ago), appears to have inhabited the terrestrial-marine interface and superficially resembles extant aquatic turtles. In collaboration with other unique osteological features, the presence of teeth on most bones defining the oral cavity firmly places this taxon as the most basal testudinate (*Proganochelys*, the next most basal testudinate, possess teeth on a subset of those bones; later testudinates are toothless). *Odontochelys* exhibits a fully developed plastron but a rudimentary carapace; this sequence of shell evolution mirrors shell development seen in embryonic Testudines. Further examination of the carapace reveals the presence of axial skeleton elements with no osteoderm contribution. Finally, the addition of *Odontochelys* into a phylogenetic analysis of reptiles finds increased support for the placement of Testudinata within Diapsida.

Li, C., X. C. Wu, O. Rieppel, L. T. Wang, and L. J. Zhao. 2008. An ancestral turtle from the Late Triassic of southwestern China. Nature 456:597–501.

Correspondence to: Chun Li, Laboratory of Evolutionary Systematics of Vertebrates, Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, PO Box 643, Beijing 100044, China; e-mail: lichun@ivpp.ac.cn.

OBITUARIES

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Harlan D. Walley
November 7, 1932 – June 20, 2008

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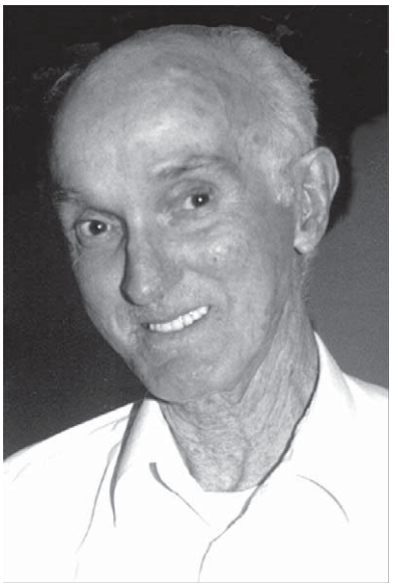


Fig. 1. Harlan D. Walley, ca. 2000.

Harlan Walley (Fig. 1) exhibited energy for life and love of natural history that began during his childhood in rural Sandwich, Illinois and continued throughout adulthood. He was a fixture in the Northern Illinois University Department of Biological Sciences, supervising the department's animal care facility from 1968 until his retirement in 1998 and curating its natural history museum until his death. Harlan's academic interests centered on herpetology, mammalogy, and Illinois natural history and he was a valuable, respected, and generous source of information to faculty, students, the community, and the state.

Harlan's formal training in biology was cut short by the Korean War, during which he served as a Navy medic (1951–1959), and by health problems associated with psoriasis which began during his years in Korea. Harlan suffered with this disease and a range of ineffective and sometimes harmful treatments for more than a decade before he found hydrocortisone ointments that allowed him to manage his symptoms. Time-consuming treatments, often at facilities far from home, interrupted his course work so frequently that he abandoned formal education beyond undergraduate classes at Waubonsee Community College and Northern Illinois University.

A true curator, Harlan became obsessed with natural history books and papers at an early age and went on to build a personal

collection of more than 60,000 reprints and 3,000 bound volumes. He developed his museum skills through time spent as a technician in the Departments of Entomology and Herpetology at the Smithsonian Institution and through an informal association with the Illinois Natural History Survey. At the INHS, Harlan established a lifelong relationship with two eminent figures of North American herpetology, Philip W. Smith, who in 1961 authored *The Amphibians and Reptiles of Illinois*, and Hobart M. Smith, who has continued to contribute to the scientific literature into his 90s. It was with Phil Smith that in 1951 Harlan published his first scientific paper—a note documenting the occurrence of the Marbled Salamander, *Ambystoma opacum*, in Michigan (Copeia 1951:309). Harlan was 18 at the time! Harlan went on to publish over 100 professional papers, many focused on amphibian, reptile, and mammal natural history and distribution. More than 30 of these appeared in *Herpetological Review* alone. He also put his reprint collection to good use, regularly contributing entries to the *Catalogue of American Amphibians and Reptiles*. The literature cited sections of his entries are encyclopedic—a soon to be published entry on the Northern Watersnake includes over 1,000 references! Harlan was an avid reader and supported this habit and his penchant for book collecting by authoring more than 100 book reviews, many of which can be found in the *Bulletin of the Maryland Herpetological Society*, *Bulletin of the Chicago Herpetological Society*, and *Wilson Bulletin.* Though focused on amphibians and reptiles, included among Harlan's publications are papers on fish, birds, mammals, and even freshwater jellyfish. For complete publication list, email rbking@niu.edu.

Harlan contributed to natural history education and conservation in many ways. He was an officer in local and state chapters of the Audubon Society, served a term as index editor for the American Society of Ichthyologists and Herpetologists, was a member of the Illinois Endangered Species Protection Advisory Board, and served on the Indiana Bat Recovery Plan panel. Perhaps one of Harlan's greatest, if unrecognized, contributions was the informal mentorship he provided to NIU biology graduate students. Harlan was a resource, lunch companion, and field-trip guide to students with interests in any aspect of biology. He was generous with his reprint collection and often helped start students' publishing careers by urging submission of a life history or distributional observation or including them as coauthors on papers he initiated. He enriched all our lives in unfathomable ways and will be missed!

ZOO VIEW

Herpetological Review, 2009, 40(1), 6–18.
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Updating the Bookshelves Part III: Important Herpetological Books Appearing During the Last Two Decades

GENERAL— REGIONAL WORKS— SNAKES— LIZARDS

FOR HIM THAT STEALETH, OR BORROWETH AND RETURNETH NOT, THIS BOOK FROM ITS OWNER, LET IT CHANGE INTO A SERPENT IN HIS HAND AND REND HIM. LET HIM BE STRUCK WITH PALSY, AND ALL HIS MEMBERS BLASTED. LET HIM LANGUISH IN PAIN CRYING ALOUD FOR MERCY, AND LET THERE BE NO SURCEASE TO THIS AGONY TILL HE SING IN DISSOLUTION. LET BOOKWORMS GNAW HIS ENTRAILS . . . AND WHEN AT LAST HE GOETH TO HIS FINAL PUNISHMENT, LET THE FLAMES OF HELL CONSUME HIM FOREVER.

—*A Gentle Madness*, Nicholas A. Basbanes, 1995.

I have selected books, mostly from my library, which have been helpful as sources of information and, in my view, deserve a place in every zoo herpetologist's reference collection. Each entry includes title, author(s), call number or ISBN, place of publisher, name of publisher, and date of publication. Titles are listed alphabetically by author. Due to space limitations, I have decided not to include books covering a single genus, e.g., *Phelsuma*, *Rhacodactylus*, *Eublepharis*, which are geared toward the herpetoculturist. Books mentioned in Parts I and II are not listed here. Part IV will appear in the next issue.

GENERAL

Contributions to the History of Herpetology / / edited by Kraig Adler.
QL26 .C76 1989
Imprint: Oxford OH; Society for the Study of Amphibians and Reptiles, 1989.

Herpetology: Current Research on the Biology of Amphibians and Reptiles: Proceedings of the First World Congress of Herpetology / / edited by Kraig Adler; with a foreword by H.R.H. Prince Philip.
World Congress of Herpetology (1st: 1989: Canterbury, England).
QL640 .H56 1992
Imprint: [England]: Society for the Study of Amphibians and Reptiles, 1992.

Contributions to the History of Herpetology. Vol. 2 / / edited by Kraig Adler.
QL26 .C65 2007
Imprint: St. Louis MO: Society for the Study of Amphibians and Reptiles, 2007.

Reptile and Amphibian Variants: Colors, Patterns, and Scales / / H. Bernard Bechtel.
QL645.5 .B43 1995X
Imprint: Malabar FL: Krieger Pub. Co., 1995.

The Phylogeny and Classification of the Tetrapods / / edited by M. J. Benton.
QL607.5 .P49 1988X
Imprint: Oxford [Oxfordshire]: Published for the Systematics Association by the Clarendon Press; New York: Oxford University Press, 1988.

Ecophysiology of Desert Reptiles / / S.D. Bradshaw.
QL669.2 .B73 1986X
Imprint: Sydney; Orlando: Academic Press, 1986.

Homeostasis in Desert Reptiles / / S. Donald Bradshaw.
QL669.2 .B74 1997X
Imprint: Berlin; New York: Springer Verlag, 1997.



Reptilian panorama from A. E. Brehm's *Les Merveilles de la Nature. Les Reptiles et les Batraciens* (Librairie J.-B. Baillière et Fils, Paris, 1883).

The Genesis of Animal Play: Testing the Limits / / Gordon M. Burghardt.
QL763.5 .B87 2005
Imprint: Cambridge MA: MIT Press, 2005.

Encyclopedia of Reptiles & Amphibians / / consultant editors, Harold G. Cogger & Richard G. Zweifel; illustrations by David Kirshner.
q QL641 .E53 1998
Imprint: San Diego CA: Academic Press, 1998.

Amphibians, Reptiles, and their Conservation / / Marty Crump.
QL644.2 .C78 2002X
Imprint: North Haven CN: Linnet Books, 2002.

Reptilian Incubation: Environment, Evolution and Behaviour / / edited by D.C. Deeming.
QL665 .R46 2004
Imprint: Nottingham: Nottingham University Press, 2004.

A Complete Guide to Scientific and Common Names of Reptiles and Amphibians of the World / / Norman Frank and Erica Ramus.
QL645 .F82 1995
Imprint: Pottsville PA: N G Pub. Inc., 1995.

Firefly Encyclopedia of Reptiles and Amphibians / / edited by Tim Halliday and Kraig Adler.
q QL640.7 .F57 2002
Imprint: Toronto; Buffalo NY: Firefly Books, 2002.

The New Encyclopedia of Reptiles and Amphibians / / edited by Tim Halliday and Kraig Adler.
q QL640.7 .N49 2002
Imprint: Oxford: Oxford University Press, 2002.

Molecular Systematics // edited by David M. Hillis, Craig Moritz, and Barbara K. Mable.
QH83 .M665 1996
Imprint: 2nd ed., Sunderland MA: Sinauer Associates, 1996.

The World's Most Spectacular Reptiles & Amphibians / / text by William W. Lamar; photographs by Pete Carmichael and Gail Shumway.
q QL643 .L36 1997
Imprint: Tampa FL: World Publications, 1997.

Island: Fact and Theory in Nature / / James Lazell.
QH109.V55 L39 2005
Imprint: Berkeley CA: University of California Press, 2005.

A Field Guide to Reptiles and the Law / / John P. Levell.
KF5645.R4 L65 1995
Imprint: Excelsior MN: Serpent's Tale Natural History Book Distributors, 1995.

Vertebrate Ecology and Systematics: A Tribute to Henry S. Fitch / / edited by Richard A. Seigel ... [et al.].
QL640.5 .V48 1984
Imprint: Lawrence KS: Museum of Natural History, University of Kansas, 1984.

The Manual of Lizards & Snakes / / Marc Staniszewski.
SF459 .R4S78 1990
Imprint: Morris Plains NJ: Tetra Press, 1990.

Life, Love, and Reptiles: An Autobiography of Sherman A. Minton, Jr., M.D. / / foreword by Kraig Adler.
QL31.M625 A3 2001
Imprint: Malabar FL: Krieger Pub. Co., 2001.

Society for the Study of Amphibians and Reptiles: A Fifty Year History, 1958 to 2007 / / John J. Moriarty and Breck Bartholomew.
QL640 .M77 2007



Two vipers from *Histoire naturelle de Lacépède, comprenant les cétacés, les quadrupèdes ovipares, les serpents et les poissons* by Bernard Germain Etienne de La Ville sur Illon La Cépède (Count de Lacepède) in 1860.
Imprint: Paris, Furne, 1860.

Imprint: Salt Lake City UT: Society for the Study of Amphibians and Reptiles, 2007.

Herpetology / / F. Harvey Pough ... [et al.].
QL641 .H47 1998X
Imprint: Upper Saddle River NJ: Prentice Hall, 1998.

Studies in Herpetology: Proceedings of the European Herpetological Meeting (3rd Ordinary General Meeting of the Societas Europaea Herpetologica), Prague, 1985 / / edited by Zbynek Roček.
QL640 .S62 1985X
Imprint: Prague: Published by Charles University, Prague for the Societas Europaea Herpetologica; Praha, Czechoslovakia: ARTIA, Foreign Trade Corp. [distributor], 1986.

Reptile Egg-Shells: SEM Atlas / / H. Hermann Schleich and Werner Kästle.
q QL665 .S34 1988X
Imprint: Stuttgart; New York: G. Fischer, 1988.

Temperature-Dependent Sex Determination in Vertebrates / / edited by Nicole Valenzuela and Valentine Lance.
QP278.5 .T46 2004
Imprint: Washington DC: Smithsonian Books, 2004.

Phylogenetic Analysis of Morphological Data / / edited by John J. Wiens.
QH351 .P58 2000X
Imprint: Washington DC: Smithsonian Institution Press, 2000.

Herpetology: An Introductory Biology of Amphibians and Reptiles / / George R. Zug, Laurie J. Vitt, Janalee P. Caldwell.
QL641 .Z84 2001X
Imprint: San Diego CA: Academic Press, 2001.

REGIONAL WORKS—Eastern Hemisphere

Colored Atlas of the Reptiles of the North Eurasia / / Ananjeva, N. B., et al.
ISBN 5-98092-007-2
Imprint: Nature Conservation, Environment and Wildlife Health Committee under Administration of St. Petersburg [in Russian].

Reptiles and Amphibians of Europe / / E. N. Arnold.
ISBN 0-691-11413-7
Imprint: Princeton, Oxford: Princeton University Press, 2002.

Bill Branch's Field Guide to the Snakes and Other Reptiles of Southern Africa.
QL662 .A356B816 1988
Imprint: London: New Holland, 1988.

Amphibians and Reptiles: A Natural History of the British Herpetofauna / / Trevor J.C. Beebee & Richard A. Griffiths.
QL658.G7 B39 2000
Imprint: London: HarperCollins, 2000.

Amphibiens et reptiles du Maroc (Sahara Occidental compris): atlas biogéographique = Anfibios y reptiles de Marruecos (incluido Sáhara Occidental): atlas biogeográfico = Amphibians & Reptiles of Morocco (including Western Sahara): biogeographical atlas / / Jacques Bons et Philippe Geniez ; [editores, Albert Montori y Vicente Roca].
QL662.M8 B72a 1996
Imprint: Barcelona: Asociación Herpetológica Española, 1996.

Handbuch der Reptilien und Amphibien Europas / / hrsg. von Wolfgang Böhme unter mitarbeit von Natalija B. Ananjeva ... [et al.].
QL658.A1 B67
Imprint: Wiesbaden: Akademische Verlagsgesellschaft, 1981–

Reptiles and Amphibians of Australia / / Harold Cogger.
QL663.A1 C63 2000
Imprint: Chatswood, N.S.W. Australia: Reed; London: New Holland, 2000.

The Snakes of Thailand and Their Husbandry / / Merel J. Cox.
SF515.5 .S64C68 1991X
Imprint: Malabar FL: Krieger Pub. Co., 1991.

Biogeography of the Reptiles of South Asia / / Indraneil Das.
QL661.S64 D37 1996X
Imprint: Malabar FL: Krieger Pub., 1996.

The Serpent's Tongue: A Contribution to the Ethnoherpetology of India and Adjacent Countries / / Indraneil Das.
QL661.I4 D37 1998
Imprint: Frankfurt am Main: Ed. Chimaira, 1998.

An Introduction to the Amphibians and Reptiles of Tropical Asia / / Indraneil Das; photographs by the author.
QL661.S64 D375 2002
Imprint: Kota Kinabalu: Natural History Publications (Borneo), 2002.

Amphibians and Reptiles of the Hashemite Kingdom of Jordan: An Atlas and Field Guide / / Ahmad M. Disi ... [et al.].
QL661.J6 A47 2001
Imprint: Frankfurt am Main: Edition Chimaira, 2001.

A Fieldguide to the Amphibians and Reptiles of Madagascar / / Frank Glaw, Miguel Vences.
QL662 .M28G55 1994
Imprint: Köln, Germany: M. Vences & F. Glaw Verlags, 1994.

The Reptiles of Japan / / Richard C. Goris.
QL661 .J3G66
Imprint: Tokyo: Ikuei Technical College, 1966.

Biology of Australasian Frogs and Reptiles / / edited by Gordon Grigg, Richard Shine and Harry Ehmann.



This spectacular drawing is from the paper by Osbert Salvin (On the Reptiles of Guatemala) of a Yellow-blotched Palm Pit Viper (*Thamnocenchris aurifer*, now *Bothriechis aurifer*) feeding on Morelet's Leaf Frog (*Hyla holochlora*, now *Agalychnis moreletii*), published in the *Proceedings of the Zoological Society of London* in 1860.

q QL663 .A1B61 1985
Imprint: Chipping Norton, N.S.W., Australia: Surrey Beatty, in association with the Royal Zoological Society of New South Wales, 1985.

Amphibians and Reptiles of Madagascar and the Mascarene, Seychelles, and Comoro Islands / / Friedrich-Wilhelm Henkel and Wolfgang Schmidt, with the collaboration of Michael Knöthig, Klaus Liebel, and Roland Zobel; final translation and technical edit by Hinrich Kaiser.
QL662.M28 H4613 2000X
Imprint: Malabar FL: Krieger Publishing Co., 2000.

The Natural History of Amphibians and Reptiles in Sabah / / Robert F. Inger and Tan Fui Lian.
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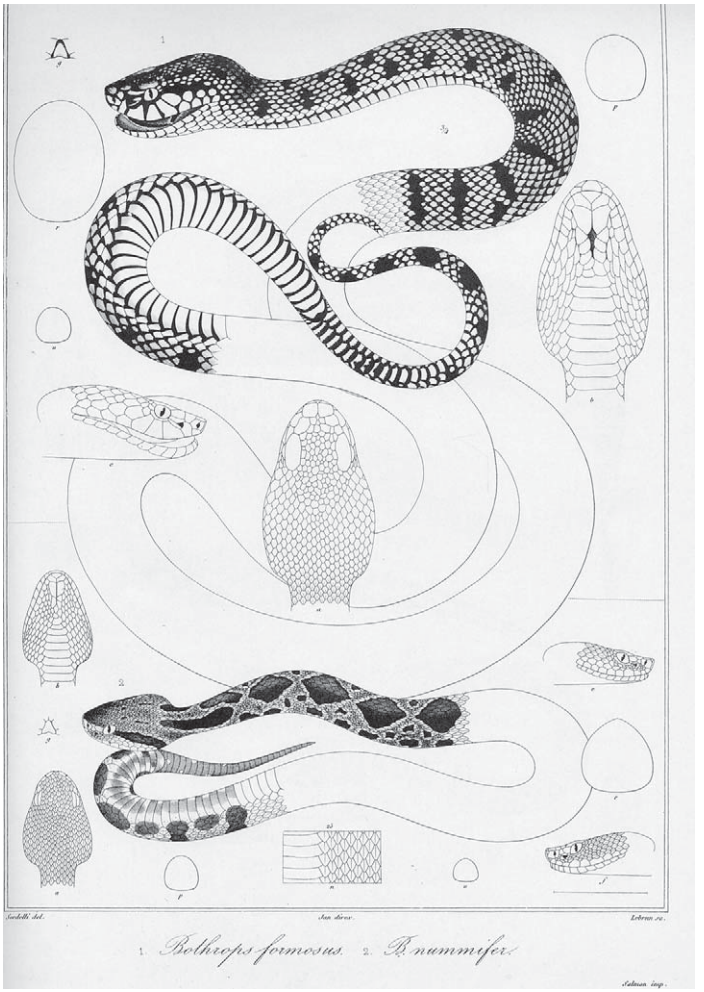
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In addition to its journal and news-journal, the Society for the Study of Amphibians and Reptiles (SSAR) has five continuing series: *Catalogue of American Amphibians and Reptiles*, *Herpetological Conservation*, *Contributions to Herpetology*, *Facsimile Reprints in Herpetology*, and *Herpetological Circulars*. A complete list of titles may be found at the back of any book published by SSAR.

The Herpetologists' League publishes *Herpetological Monographs* in addition to the journal *Herpetologica*.

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Imprint: Melbourne; New York: Oxford University Press, 1994.

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Imprint: Oxford: published for the Zoological Society of London by Clarendon Press; New York: Oxford University Press, 1997.

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Three views of monitor lizards from the genus *Varanus*. The lizards pictured from left to right: Desert Monitor (*V. griseus*) from John Anderson's *Zoology of Egypt* in 1898; Water Monitor (*V. salvator*) from R. Lydekker's *The Royal Natural History* in 1896; and George Shaw's "Dracæna Lizard" in *General Zoology* may be the Bengal Monitor (*V. bengalensis*) in 1802.

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Imprint: Malabar FL: Krieger Publ. Co., 1995.

Biology, Husbandry, and Medicine of the Green Iguana / / edited by Elliott R. Jacobson; foreword by Thomas Huntington Boyer.
SF515.5.I38 B56 2003
Imprint: Malabar FL: Krieger Pub. Co., 2003.

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QL666.L29 K56 1999
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Imprint: Bloomington IN: Indiana University Press, 2004.

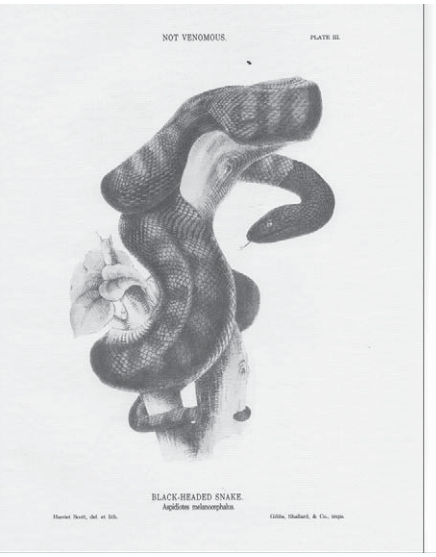
Lizards: Windows to the Evolution of Diversity / / Eric R. Pianka and Laurie J. Vitt; with a foreword by Harry W. Greene.
QL666.L2 P54 2003X
Imprint: Berkeley CA: University of California Press, 2003.

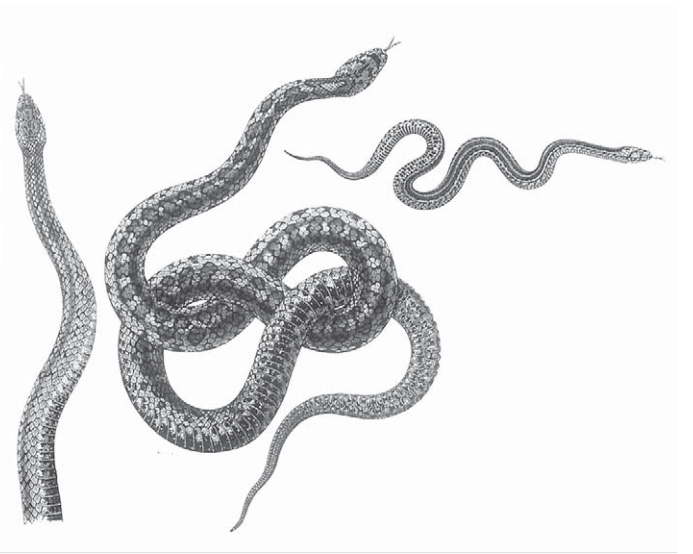
Lizard Ecology: The Evolutionary Consequences of Foraging Mode / / edited by Stephen M. Reilly, Lance D. McBrayer, and Donald B. Miles.
QL666.L2 L585 2007
Imprint: Cambridge; New York: Cambridge University Press, 2007.

Lizards, 2 Vols. / / Manfred Rogner; translated from the original German by John Hackworth.
SF459.L5 R6313 1997
Imprint: Malabar FL: Krieger Pub. Co., 1997.

Anolis Lizards of the Caribbean: Ecology, Evolution, and Plate Tectonics / / Jonathan (Joan) Roughgarden.
QL666 .L25R68 1995X
Imprint: New York: Oxford University Press, 1995.

The Iguanid Lizards of Cuba / / edited by Lourdes Rodríguez Schettino;





One definition of a dictionary is any alphabetically arranged list of words or articles related to a special subject. Here are two lovely plates of snakes ranging from A (*Aspidites*) to Z (*Zamenis*).

Left: Black-Headed Python (*Aspidites melanocephalus*) from *The Snakes of Australia; An Illustrated and Descriptive Catalogue of all the Known Species,* by Gerard Krefft.
Imprint: Sydney, T. Richards, Government Printer, 1869.

Right: European or Leopard Ratsnake (*Zamenis situla*, formerly *Coluber leopardinus*) from *Iconografia della fauna italica per le quattro classi degli animali vertebrati, principe Bonaparte, principe di Canino* by Charles Lucian Bonaparte. ,
Imprint: Roma, Tip. Salviucci, 1834.

contributing editors, Alberto Coy Otero ... [et al.].
QL666.L25 I383 1999X
Imprint: Gainesville FL: University Press of Florida, 1999.

Chamaeleo calyptratus: the Yemen Chameleon / / Wolfgang Schmidt; translated from the original German by John Hackworth.
SF459.C45 S3413 2001
Imprint: Münster: Matthias Schmidt, 2001.

Introduction to Horned Lizards of North America / / Wade C. Sherbrooke.
QL666.L25 S48 2003
Imprint: Berkeley CA: University of California Press, 2003.

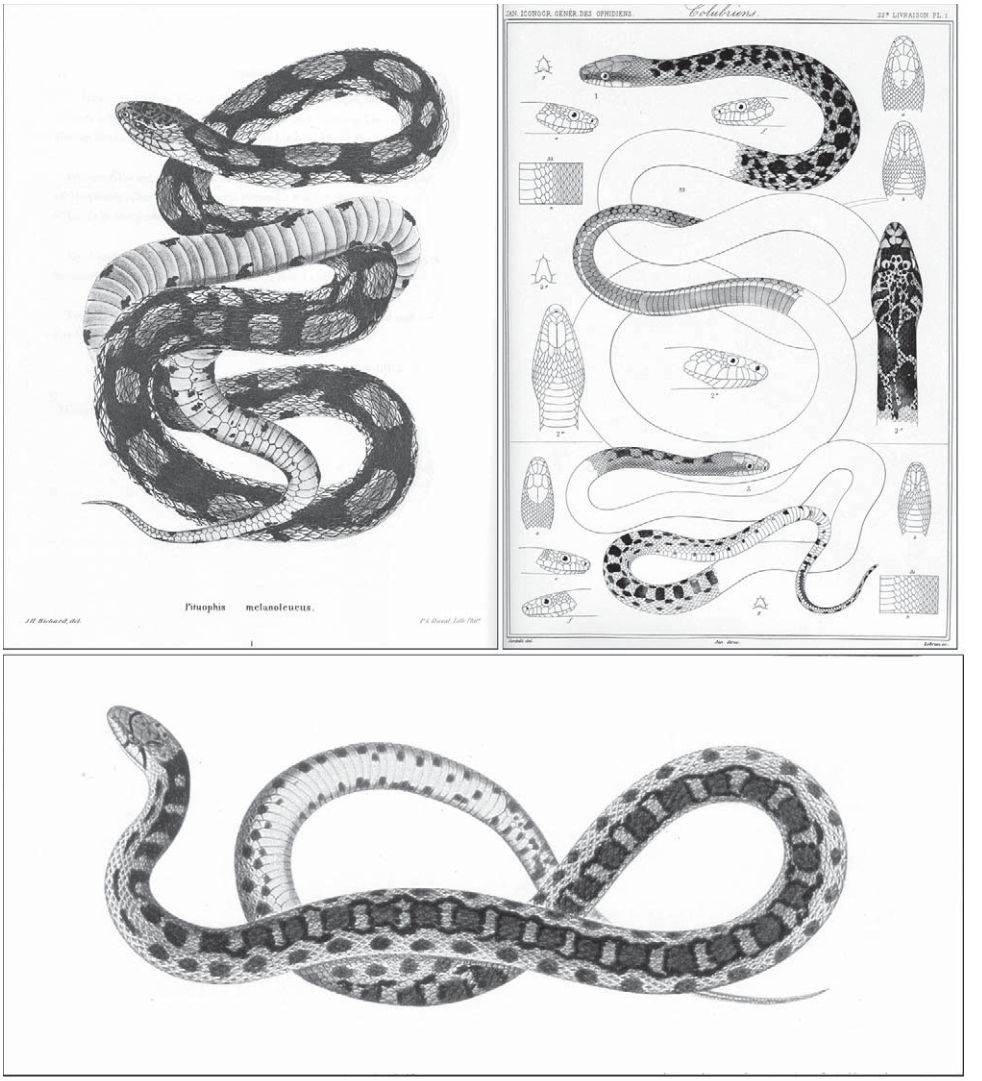
Giant Lizards / / Robert G. Sprackland.
SF515.5 .L58S65 1992X
Imprint: Neptune City NJ: T.F.H. Publications, 1992.

Lizards of Western Australia / / G.M. Storr, L.A. Smith, and R.E. Johnstone.
QL666.L2 S86 1999Y
Imprint: Perth: Western Australian Museum, 1999.

Lizard Ecology: Historical and Experimental Perspectives / / edited by Laurie J. Vitt and Eric R. Pianka.
QL666.L2 L57 1994X
Imprint: Princeton N.J: Princeton University Press, 1994.

Biology of Whiptail Lizards: Genus *Cnemidophorus* / / editors, John W. Wright and Laurie J. Vitt.
QL666 .L285B615 1993
Imprint: Norman OK: Oklahoma Museum of Natural History and University of Oklahoma, 1993.

The Lizards of Fiji: Natural History and Systematics / / George R. Zug.
QL666 .L2Z94 1991
Imprint: Honolulu: Bishop Museum Press, 1991.



Three views of the Pine or Bull Snake (*Pituophis melanoleucus* sensu lato) and varieties from the 19th century—*North American Herpetology; or, A Description of the Reptiles Inhabiting the United States*, by John Edwards Holbrook in 1842; *United States Exploring Expedition: during the years 1838, 1839, 1840, 1841, 1842, under the command of Charles Wilkes, U.S.N.; [v. 20]*, by Charles Girard, 1858; *Iconographie générale des ophidiens / par M. le professor Jan . . .*[*en collaboration avec Mr. F. Sordelli*.]. . . , 1860–1881.

Herpetology from A to Z

In 1964, James A. Peters wrote *Dictionary of Herpetology: A Brief and Meaningful Definition of Words and Terms Used in Herpetology*. Since my memory is not stellar, I used this book constantly until my copy was worn and tattered. Forty-four years later, my recall has certainly not improved but at least I can turn to a new source to refresh and refine my recollection of biological and herpetological terminology—*Dictionary of Herpetology* by Harvey B. Lillywhite (2008, Krieger Publ. Co., Malabar FL; Hardcover, 8.5 x 11, 384 pages; ISBN 1-57524-023-8). Lillywhite's book will be useful for decades: 11,358 readable definitions related to anatomy, physiology, systematics, evolution, and other disciplines in an alphabetical format.

Lillywhite's book contains over three times the number of entries found in the dictionary by Peters. One important element is the inclusion of recent terminology which updates the tools, methods and concepts from a variety of biological disciplines relevant to the study of amphibians and reptiles. Of particular value is the provision of a literature citation(s) accompanying many terms so the reader can go to the original source. For instance, the definition of the word species almost fills an entire page and identifies dozens of titles. In Peters, that word is not listed.

There are three tables: geologic time; International System of units, conversions, constant, and definitions; and metric prefixes and multipliers. This dictionary includes 41 figures to complement the text. Another feature is inclusion of the new taxonomic arrangements proposed in 2006 by Darrel Frost and 18 coauthors—The Amphibian Tree of Life (Bull. Amer. Mus. Nat. Hist. No. 297:1–370).

Some may complain that the list price of US $112.50 is pretty steep but that translates to around 1¢ a word in United States currency. That seems like a pretty good deal to me, especially since the value of the dollar is shrinking.

"Today, the only chance one has to see a Rim Rock Crowned Snake is on a public or private wildlife reserve. The days of finding this species in a suburban Miami backyard or under a piece of limestone at the side of a roadway spanning a rural zone between south Florida towns are gone. One day soon this will be the case for most of the species highlighted in these pages."

—Steven B. Reichling, 2008

Steven B. Reichling, Curator of Reptiles and Aquarium at the Memphis Zoo and adjunct professor of biology at the University of Mem-

TABLE 1. Chapters in *Biology of the Reptilia* series of particular importance to the zoo biologist. Publishers are Academic Press (AP), Wiley-Interscience (W-I), Alan R. Liss, Inc. (AL), University of Chicago Press (UCP), and Society for Study of Amphibians and Reptiles (SSAR).

Volume	Year	Publisher	Author(s)	Topic
1	1969	AP	Carroll	Origin of Reptiles
			Zangerl	Turtle Shell
2	1970	AP	Parsons	Nose, Jacobson's Organ
			Barrett	Pit Organs
			Gans & Parsons	Taxonomic Literature
3	1970	AP	Dessauer	Blood Chemistry
4	1973	AP	Walker	Locomotor Apparatus of Testudines
5	1976	AP	Gans & Dawson	Physiology
			McDonald	Study of Physiology
			Bennett & Dawson	Metabolism
			Bentley	Osmoregulation
			Dunson	Salt Glands
6	1977	AP	Fox	Urogenital System
7	1977	AP	Pianka	Species Diversity
			Schoener	Competition & the Niche
			Heatwole	Habitat Selection
			Turner	Dynamics of Populations
			Stamps	Social Behavior & Spacing Patterns
			Carpenter & Ferguson	Stereotyped Behavior
			Burghardt	Learning
8	1978	AP	Gans	Venoms
			Kochva	Oral Glands
			Latifi	Production of Anti-Snakebite Serum
9/10	1979	AP	Various Authors	Neurology
11	1981	AP	Various Authors	Musculo-Skeletal System
12	1982	AP	Gans & Pough	Physiological Ecology
			Pough & Gans	Vocabulary of Thermoregulation
			Huey	Temperature, Physiology, Ecology
			Avery	Field Studies of Body Temperatures & Thermoregulation
			Bartholomew	Physiological Control of Body Temperatures
			Firth & Turner	Sensory, Neural & Hormonal Aspects of Thermoregulation
			Tracy	Biophysical Modeling
			Various Authors	Water Relations
13	1982	AP	Seymour	Physiological Adaptations to Aquatic Life
			Gregory	Hibernation
			Bennett	Energetics of Activity
			Duvall et al.	Environmental Control of Reproductive Cycles
			Congdon et al.	Energy Budgets & Life History
			Andrews	Growth
14	1985	W-I	Billet et al.	Development
			Hubert	Origin & Development of Oocytes
			Ewert	Embryology of Turtles
			Miller	Embryology of Marine Turtles
			Ferguson	Reproductive Biology & Embryology of Crocodilians
			Moffet	Reproductive Biology & Embryology of Tuatara
			Maderson	Integument
			Cooper et al.	Immunity
15	1985	W-I	Hubert	Embryology of Squamates
			Darevsky et al.	Parthenogenesis
			Yaron	Placentation & Gestation
			Shine	Viviparity

TABLE 1. Continued.

Volume	Year	Publisher	Author(s)	Topic
16	1981	AL	Greene	Antipredator Mechanisms
			Pough	Mimicry
			Arnold	Caudal Autonomy
			Dunham et al.	Study of Populations
			Wilbur & Morin	Life History Evolution of Turtles
			Dunham et al.	Life History Patterns in Squamates
			Packard & Packard	Physiological Ecology of Eggs & Embryos
17	1992	UCP	Peterson	Retinal Structure
			Granda & Sisson	Retinal Function in Turtles
			Reperant et al.	Comparative Analysis of Primary Visual System of Reptiles
			Ulinski et al.	Optic Tectum
			Molenaar	Infrared Receptors
			Crowe	Muscle Spindles, Tendon Organs and Joint Receptors
			ten Donkelaar & Bangma	Cerebellum
			Reiner	Neuropeptides in Nervous System
18	1992	UCP	Whittier & Tokarz	Physiological Regulation of Sexual Behavior in Female Reptiles
			Moore & Lindzey	Physiological Regulation of Sexual Behavior in Male Reptiles
			Mason	Reptilian Pheromones
			Underwood	Endogenous Rhythms (circadian and circannual)
			Cooper, Jr. & Greenberg	Coloration of Reptiles
			Halpern	Nasal Chemical Senses in Reptiles: structure and function
19	1998	SSAR	Various Authors	Visceral Organs (pulmonary, cardiovascular, hepatic systems; spleen)

phis in Tennessee, has written a book on the herpetofauna found in the southeastern United States. The book is well written, clearly organized, and filled with excellent photographs but reading through this book was a bittersweet experience. I have traveled periodically to some of these places since I was a child and have watched many of them disappear before my eyes. When I saw the type locality (depicted in plate 7.3 in the book) for the Rim Rock Crowned Snake (*Tantilla oolitica*) strewn with trash and surrounded by buildings and a chain link fence in Miami, it was a reminder of how ravaged the land has become in southern Florida. But enough of this maudlin recollection—most herpetologists can say the same when thinking about changes to their favorite haunts.

Reichling's book—*Reptiles & Amphibians of the Southern Pine Woods* (2008, University Press of Florida, Gainesville, softbound, ISBN 978-0-8130-3250-4)—covers the pine woods from Texas to North Carolina, south to the Gulf of Mexico and north to the Appalachians. Twenty-six species or subspecies are highlighted and each account includes Description, Distribution Notes, Habitat, Ecology and Natural History, Conservation, and a Summary. Twenty-six distribution maps are included. Species are grouped by habitat types: pine woods generalists, flatwoods specialists, savanna specialists, ridge specialists, rockland specialists, and others. In the epilogue, Reichling passionately describes the daunting conservation task ahead: "What happens—or fails to happen—during the next four crucial decades will determine whether the species accounts and habitat descriptions in the preceding pages are still relevant and accurate, or have become an historical record of times and places lost to future generations."

He is well-qualified for writing this book as he has extensive experience with some of the prominent denizens of these forests: the endangered pine snakes of the Gulf Coast. His studies include reproduction in captive Black Pinesnakes, *Pituophis melanoleucus lodingi*; as well as reproductive biology, taxonomic status and its relevance to the evolutionary species concept, and current status of the endangered Louisiana Pinesnake, *P. ruthveni*. He has published the AZA's North American Regional Studbook for both of these taxa. Reichling has published other herpetological papers: dystocia in snakes, habits of the Mangrove Snake in captivity, reproduction in captive Dumeril's Boas, conservation status of the Lesser Antillean Iguana, and phenotypic consequences of incubation environment on cobra eggs in the African elapid genus *Aspidelaps*. He is also author of a book on tarantulas of Belize.

Biology of the Reptilia

The first volume of the series entitled *Biology of the Reptilia* was published in 1969. The general editor for the entire project was Dr. Carl Gans, now an adjunct professor at the University of Texas at Austin. His plan was to produce a timely and comprehensive series of books dealing with all aspects of reptilian biology; he solicited specialists to prepare chapters reflecting their areas of expertise. Gans invited co-editors versed in morphology, embryology and physiology, or ecology and behavior.

Twenty-one volumes have been published which represent the most complete coverage of these topics ever assembled. These books represent the highest scholarship and are essential for advanced zoo herpetologists who wish to go beyond current husbandry literature in an effort to understand the principles and dynamics of the processes which reflect the complexities of captive reptiles.

The final two text volumes (20, 21), published as a set, are available from SSAR and contain the following chapters: "The Skull of Lizards and Tuatara" by Susan E. Evans; "The Snake Skull" by David Cundall and Frances Irish; "The Appendicular Locomotor Apparatus of *Sphenodon* and Normal-limbed Squamates" by Anthony P. Russell and Aaron M. Bauer; "The Skull of Serpentes" by Samuel B. McDowell; "An Atlas of Amphisbaenian Skull Anatomy" by Carl Gans and Ricardo Montero.

—James B. Murphy, Section Editor

ARTICLES

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The Importance of Herpetological Survey Work in Conserving Malagasy Biodiversity: Are We Doing Enough?

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Madagascar is internationally recognized as being of high biodiversity conservation concern due to high levels of endemism, habitat destruction and predicted extinctions (Brooks et al. 2002; Myers 1988; Myers et al. 2000). The herpetofauna of Madagascar in particular is extremely species-rich and diverse with high levels of endemism (Glaw and Vences 2007).

Conservation strategies are in place to protect this unique biodiversity, including identification of priority areas in Madagascar for threatened or overall species diversity and their inclusion in protected nature reserves (Ganzhorn et al. 1997; ANGAP 2001). In theory these protected nature reserves are an effective means to protect tropical biodiversity (Bruner et al. 2001) and they can be successful at stopping land clearing, and to a lesser degree effective at mitigating logging, hunting, fire, and grazing (Bruner et al. 2001). However, in practice the identification and protection of priority areas globally is constrained by a lack of information regarding the distribution, abundance, and habitat requirements of threatened species and the size, condition, and threats to survival of forest remnants (Smith et al. 1997). This type of baseline information is needed to integrate information relevant to existing conservation and development programs and guide the course of future management strategies (Balmford and Gaston 1999; Kremen et al. 1994; Andreone et al. 2008; Kremen et al. 2008).

Furthermore, the regions in Madagascar where conservation management is most needed are also the regions where biological information is most limited (i.e., primary habitats located within non-protected areas [Andreone et al. 2003; D'Cruze et al. 2006; Kremen et al. 2008]). As a result, decisions affecting biodiversity often have to be taken without all the necessary information (data may be unavailable, incomplete, or unreliable [Funk and Richardson 2002]). This is partly because many surveys, in Madagascar and elsewhere, are conducted over a fairly short period of time, and often within sites that are already been designated as protected areas (e.g., Bildstein 1998; Gaston and Rodrigues 2003; Goodman 1999; Raxworthy and Nussbaum 1994). It is widely accepted that there are major financial, labor, and time-related constraints associated with conducting such work (Bildstein 1998).

Given the necessity for adequate baseline information to conserve this important region of biological endemism, we conducted a literature review of herpetological surveys published for Madagascar. We chose reptiles and amphibians as focal taxa because in Madagascar these vertebrate groups are highly endemic, species-rich, currently under threat, and often serve as excellent indicator species (Raxworthy 1988). We focused on papers published between 1994 and 2007 because prior to 1994 the knowledge of most Malagasy amphibians and reptiles was largely based on the studies of a few herpetologists who often provided comprehensive accounts and revisions (e.g., Blanc, Blommers-Schlosser, Brygoo and Domergue; Glaw and Vences 2007). Since 1994, a new research era has started in Madagascar, stimulated by the publication of a new field guide (Glaw and Vences 1994). Large-scale surveys and species inventories have subsequently been carried out by a new generation of more numerous researchers, operating in a much more collaborative manner, in many areas of Madagascar, including well-known sites and hitherto unexplored remote regions (Glaw and Vences 2007; Vences et al., *in press*).

We undertook this study to: 1) characterize the types of herpetological survey work conducted over the past two decades; 2) use this information to identify any biases in survey work conducted to date to guide future herpetological research initiatives; and 3) highlight any weaknesses so as to provide potential solutions to limiting factors which might be inhibiting such work.

Methods

Literature Review.—We conducted a literature review of peer-reviewed scientific journals to compile a comprehensive list of herpetological survey-based published manuscripts. This type of information can be embedded in manuscripts focused on ultimate function (i.e., "why" something happens [Timbergen 1963]) making the data difficult to identify. Therefore, we specifically searched for manuscripts that included a detailed species inventory or list. However, any attempt to document survey/inventory-based manuscripts will have a degree of subjectivity involved (McCallum and McCallum 2006), and this study is no different. Still we made every effort to accurately portray what is and what is not a survey-based manuscript and to take the most inclusionary and liberal approach possible to classify manuscripts.

Following the completion of this review we subjected tabulated data to simple regression analysis using Systat statistical software (version 10.0, Systat Software Inc., San Jose, California, USA). We analyzed publications to reveal the number of papers published per year over the selected study period. We chose to ignore the duration of each survey as we were unable to determine the number of staff actively participating during fieldwork and ensure an unbiased comparison. In addition, we assembled a data set that included the protective status and dominant vegetation types of each survey site (we designated four categories for the purpose of this study: rainforest, dry deciduous forest, savanna, and spiny forest). We also tabulated various aspects of the survey methodology, including focal taxa, season, and capture methods used. Finally, when possible we recorded the primary funding source as listed in the acknowledgments section of each manuscript.

Results

We found 37 herpetological survey-based published manuscripts (Table 1), based on surveys conducted in 31 different locations by 19 different primary authors. Five of these primary authors (26%) are Malagasy nationals. The remaining 14 (74%) are non-Malagasy nationals. Twelve (32%) of these 37 publications included Malagasy nationals as either a primary or co-author. Between 1994 and 2007 the number of survey-based manuscripts varied between 1 and 5 publications per year, with an average of 2.6. Linear trends analysis revealed that the number of survey-focused manuscripts published per year has remained relatively constant ($R^2 = 0.01$, $P = 0.738$) (Fig. 1).

Protected areas have been subject to more survey effort than unprotected areas (Table 1), as 22 surveys (59%) were conducted in areas currently awarded full protection (Strict Nature Reserve 3%, Special Reserve 8% and National Park 49%; Table 2). The remaining 15 sites (41%) are currently unprotected or have only been recently awarded Temporary Protected Status (Unprotected 38%, Temporary Protected Area 3%). However, it is important to note that despite this preference for protected areas only 17 of the 49 (35%) fully protected areas in Madagascar have been subject to published herpetological survey work.

The different vegetation types in Madagascar have also not been subject to equal survey effort (Table 1), as 26 (70%) of these 37 studies involved survey work in rainforest habitat, 13 (35%) involved survey work in dry deciduous habitat, 4 (11%) involved survey work in spiny forest habitat and one (3%) involved survey work in savanna habitat. With regards to focus taxa, we found that 32 publications (86%) focused on both reptiles and amphibians, three (8%) focused just on amphibians, and two (6%) focused solely on reptiles.

We also extracted information from our literature review regarding the seasonal aspect of each survey. We classified surveys as 1) dry season (May–October); 2) wet season (November–April); or 3) wet and dry (some field work conducted during both of the aforementioned periods). Seventeen (46%) of these 37 surveys involved field work conducted in the wet and dry season. Of the remaining surveys, 15 (41%) only involved field work conducted in the wet season, two (5%) only involved field work conducted in the dry season and three (8%) provided no information.

We also extracted information on the survey techniques used in each survey. Active searching was utilized in all of the surveys, while pitfall trapping was used in 29 (78%) to capture specimens. We were able to glean information regarding funding (from the acknowledgment sections) from 22 of the 37 manuscripts. All but three studies involved some form of research grant from a scientific or industrial benefactor, and five studies used volunteers in some capacity during field work.

Discussion

Herpetological survey work trends in Madagascar.—A prior analysis of a list of almost 1400 publications focused on Malagasy amphibians and reptiles revealed a clear trend of increasing research intensity from the year 1838 until the present day with maximum levels reached for the periods of 1990–1999 and 2000–2009 (Vences et al., *in press*). In contrast, we found that the number of published manuscripts focused on herpetological survey work appear to have remained relatively constant during the period 1994–2007. Initially, one might assume that a similar marked increase in this particular type of scientific research has not occurred as it is not required. For example, it may be that already there is sufficient information available in the existing literature (detailing the composition, geographical, ecological, and seasonal distribution of the herpetofauna in Madagascar) and that the majority of these surveys are monitoring efforts conducted to observe changes in population dynamics or community structure. However, unfortunately this is not the case and this is exemplified by the number of new species which continue to be described each year (Glaw and Vences 2007; Vences et al., *in press*) and by the fact that our study shows that the existing data currently available as a result of herpetological survey work is far from comprehensive. We estimate that it will take approximately another 20 years before even a preliminary herpetological species list is available for all of the current protected areas in Madagascar.

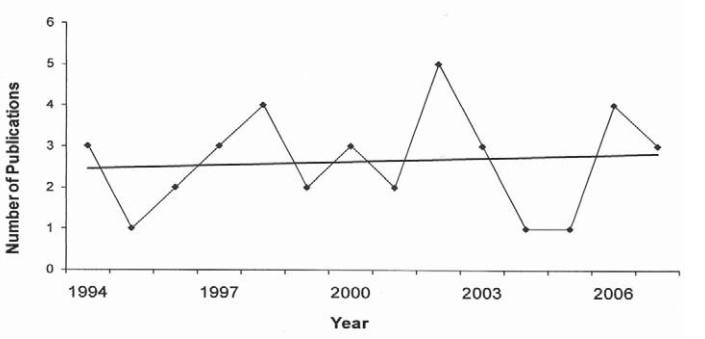


Fig. 1 Publication of herpetological survey-based manuscripts 1994–2007. Points are observed values and the line represents the trend.

It is important to note that this observed trend might not be a direct reflection of the amount of field work that has actually being conducted over this time period. It is more than likely that researchers have been gathering these sorts of data without publishing their findings in a peer-reviewed format (Vences et al., *in press*). Either way, despite their recognized value (Greene and Losos 1988; Greene 1994, 2005), we suspect that the number of peer-reviewed survey-based studies published over this period might have been restricted because of the strong natural history component which is present in this type of manuscript (studies have indicated that the publication frequency of natural history studies has gradually declined over recent decades [Bury 2006; McCallum and McCallum 2006]). Explanations for these kinds of restrictions are complex but might be related to the fact that conservation and science are driven by different agendas (a lot of conservation science published in respectable journals will be of little use to practical conservation, while much good conservation practice would never get into a scientific journal). Peer-reviewed journal editorial strategies are driven by scientific agendas which are often subject to fads and fashions (R. Griffiths, pers. comm.). Therefore, factors affecting the publication trends of survey-based manuscripts will include less grant funding, editorial decisions, additional competition from other journals, and the rise of molecular and genetic studies (McCallum and McCallum 2006).

Unequal sampling effort.—In their prior analysis of a list of almost 1400 publications Vences et al. (*in press*) found that research on Malagasy amphibians has been less intensive as compared to reptiles. In contrast, we found that the majority of survey-based

TABLE 1. Details of the herpetological survey-based manuscripts found during this study. Habitat abbreviations: RF = rainforest, DF = dry deciduous forest, SP = spiny forest, SV = savanna.

Number	Authors	Publication Date	Survey Location	Protective Status	Survey Habitat Type
1	Andreone	1994	Ranomafana	National Park	RF
2	Raxworthy & Nussbaum	1994	Montagne d'Ambre	National Park	RF, DF
3	Raxworthy et al.	1994	Zombitse	National Park	DF
4	Emanueli & Jesu	1995	Tsingy de Bemaraha	National Park	DF
5	Bloxam et al.	1996	Kirindy Forest	National Park	DF
6	Raxworthy & Nussbaum	1996	Andringitra	National Park	RF
7	Andreone & Randriamahazo	1997	Andohahela	National Park	RF
8	Schimmenti & Jesu	1997	Tsingy de Bemaraha	National Park	DF
9	Langrand & Goodman	1997	Isoky-Vohimena	National Park	DF
10	Raxworthy et al.	1998	Anjanaharibe-Sud	Special Reserve	RF
11	Goodman et al.	1998	Ambositra	Unprotected Area	RF
12	Raselimanana	1998	Andranomay Anjozorobe	Unprotected Area	RF
13	Rasilamanana et al.	1998	Tampolo	Unprotected Area	RF
14	Nussbaum et al.	1999	Andohahela	National Park	RF, SP
15	Raselimanana	1999	Ivohibe/Andringitra	Special Reserve/National Park	RF
16	Andreone et al.	2000	Ambolokopatrika	Unprotected Area	RF
17	Raselimanana et al.	2000	Marojejy	National Park	RF
18	Vallan	2000	Ambohitantely	Special Reserve	RF
19	Andreone et al.	2001	Berara Forest	Unprotected Area	RF, DF
20	Rakatomalala et al.	2001	Ranomafana/Andringitra	National Park	RF
21	Rakotomalala	2002	Manongarivo	Special Reserve	RF
22	Ramanamanjato & Rabibisoa	2002	Ankarafantsika	National Park	DF
23	Vences et al.	2002	Ankaratra	Unprotected Area	RF
24	Ramanamanjato et al.	2002	Malahelo Forest	Unprotected Area	RF, SP
25	Goodman et al.	2002	Tsimanampetsotsa	National Park	SP
26	Andreone et al.	2003	Nosy Be	Strict Nature Reserve	RF
27	Glos	2003	Kirindy Forest	National Park	DF
28	Lehtinen et al.	2003	Mandena & Sainte Luce	Unprotected Area	RF
29	Vallan et al.	2004	An'Ala	Unprotected Area	RF
30	D'Cruze & Sabel	2005	Ranobe	Unprotected Area	SP
31	D'Cruze et al.	2006	Manondro	Unprotected Area	DF
32	Mori & Ikeuchi	2006	Ankarafantsika	National Park	DF
33	Rakotondravony	2006	Daraina	Unprotected Area	RF, DF
34	Lehtinen & Ramanamanjato	2006	Mandena & Sainte Luce	Unprotected Area	RF
35	Andreone et al.	2007	Antoetra	Unprotected Area	RF, SV
36	Bora et al.	2007	Befotaka-Midongy	National Park	RF
37	D'Cruze et al.	2007	Montagne des Francais	Temporary Protected Area	RF, DF

manuscripts published over the last 14 years (86%) provide information for both reptiles and amphibians. This is more than likely because traditional survey techniques used to target either reptiles or amphibians (e.g., visual encounter surveys [Campbell and Christman 1982] and pitfall trapping [Raxworthy and Nussbaum 1994]) typically result in the capture of species belonging to both of these vertebrate groups (Raxworthy 1988).

However, it appears that this survey work has not been so equally distributed throughout Madagascar with regards to the protective status of study areas. For example, we found that the majority of published survey work has been conducted in protected areas. This is understandable as only 35% of protected areas have been surveyed and this information is needed to manage them correctly. However, this means that the designation of future protected areas is greatly compromised. Furthermore, at least from a herpetological point of view, our study confirms prior claims that there have been lower conservation efforts in the dry deciduous forests, spiny forest and savanna areas of Madagascar when compared to those undertaken in Madagascar's evergreen rainforest (Ganzhorn et al. 2001). Explanations for this type of site bias are difficult to qualify;

TABLE 2. Details of the current ANGAP protected areas and related herpetological survey effort.

Province	Number of Surveys Conducted in non-ANGAP Protected Areas	Number of Surveys Conducted in ANGAP Protected Areas	Number of ANGAP Protected Areas	% ANGAP Protected Areas Surveyed
Toamasina	2	0	9	0
Mahajanga	0	4	12	17
Fianarantsoa	2	4	7	43
Antsiranana	5	5	10	50
Toliara	4	8	10	60
Antananarivo	2	1	1	100
Madagascar	15	22	49	35

however, this might be because these rainforest sites are more accessible, because more preliminary research has been conducted in this type of habitat or because the majority of protected areas are composed of rainforest habitat. Additionally this may be because of the perceived greater biological richness of this habitat type or because this type of habitat is not characterized by such pronounced seasonal variation (meaning that researchers do not have to worry about associated decreases in herpetological activity). Finally, it is also important to note that the relative area for each of the habitat types is different and might also be an influencing factor that is partly responsible for this observation.

Addressing the limitations of current survey work.—One important first step to address this situation would be to encourage and facilitate the further participation of Malagasy researchers. For a long time the participation of Malagasy researchers in the exploration work and publications of Madagascar's flora and fauna remained marginal, largely reflecting colonial history (Vences et al., *in press*). Although it has now been recognized Malagasy scientists can (and have in recent decades) strongly contribute to advancing the knowledge on Madagascar's biota (there is an increasing trend in the participation of Malagasy researchers in the process of publishing research results [Vences et al., *in press*]), we found that only 33% of the survey-based manuscripts published in the last 14 years included Malagasy researchers as either primary or co-author. In a similar study, researchers also found that more than 80% of all studies on Malagasy amphibians are published without the participation of Malagasy researchers (Vences et al., *in press*).

Another key step that could be made to address this situation would be to foster the participation of non-specialist, self-funded volunteer researchers (hereafter referred to as volunteers). Volunteers have been seen as a viable option by host countries with financial, labor, or training constraints (Mumby et al. 1995) which is apparent from their increasing contribution to conservation biology and wildlife management over the past 20 years (e.g., Bildstein 1998; Easa et al. 1997; Fore et al. 2001; Foster-Smith and Evans 2003; Gill 1994; Newman et al. 2003). However, our study indicates that over the last 14 years in Madagascar only four studies (Andreone et al. 2003; D'Cruze et al. 2005; D'Cruze et al. 2007; Raxworthy and Nussbaum 1994) utilized volunteers and only two of these (D'Cruze et al. 2005; D'Cruze et al. 2007) were solely reliant on them as a source of funding. We suggest that the under-utilization of volunteers in Madagascar is due to the fact that their use in scientific research is often criticized. A major problem is that data that they generate are considered unreliable both because many volunteers lack a high level of biological knowledge and training, and due to inconsistencies through the use of many different observers (Bildstein 1998; Darwall and Dulvy 1996). Another worry relating to the use of volunteers is that they may be seen as a solution to the issue of under-funding, leading to further reductions in research funds.

In our opinion both of these groups should be viewed as key collaborators that have the potential to help in addressing the financial, labor, and time-related constraints associated with conducting modern survey work. We highly recommend that researchers should seek to increase collaboration and initiate capacity-building exercises to ensure the systematic collection of reliable and comparable data. This should include the collation of digital photos, morphological data, molecular tissue samples, call recordings, specimens, and associated ecological data.

Making survey data accessible.—The accessibility of data generated by modern survey work is also of fundamental importance. For example, it is possible that survey-based studies resulting in peer-reviewed manuscripts might have limited utility for practical conservation because a) many conservation practitioners do not have access to peer-reviewed manuscripts, and b) unpublished (i.e., "grey literature") reports might be more accessible to those who need to utilize these data (e.g., park management authorities). However, at the same time, because grey literature reports have typically not been subject to peer review their scientific and technical accuracy can be brought into question, and they are not always accessible to other external stakeholders (e.g., international NGOs).

A general change in the way that survey data are distributed might be required to ensure that data are made available to relevant stakeholders. To achieve this, several researchers (Rhee 2004; Vences et al., *in press*) have proposed to make data available through appropriate cyber structure and an electronically connected network of knowledge. Specifically, they propose that data should be published electronically and made instantly available on a seamless connection of community databases, public repositories, and journals. As a result, the data collected during herpetological survey work would no longer remain isolated in specialized papers and grey reports. The Réseau de la Biodiversité de Madagascar (REBIOMA) project (which aims to make validated, up-to-date biodiversity data available for conservation planning in Madagascar and to provide conservation tools and map products to facilitate identification of conservation priorities)

TABLE 3. Additional details of the herpetological survey-based manuscripts found during this study. Abbreviations: Focal Species A = amphibian, R = reptile; Survey Techniques AS = active searching, PT = pitfall trapping.

Number	Authors	Focal Species	Survey Season	Survey Technique	Funding Source
1	Andreone 1994	A & R	Wet & Dry	AS & PT	Research Grant
2	Raxworthy & Nussbaum 1994	A & R	Wet	AS & PT	Research Grant & Volunteers
3	Raxworthy et al. 1994	A & R	Wet	AS & PT	?
4	Emanueli & Jesu 1995	A & R	Wet	AS	?
5	Bloxam et al. 1996	R	Wet	AS	Research Grant
6	Raxworthy & Nussbaum 1996	A & R	Wet & Dry	AS & PT	Research Grant
7	Andreone & Randriamahazo 1997	A & R	Wet & Dry	AS & PT	Research Grant
8	Schimmenti & Jesu 1997	R	Wet	AS & PT	?
9	Langrand & Goodman 1997	A & R	Wet	AS & PT	?
10	Raxworthy et al. 1998	A & R	Wet & Dry	AS & PT	?
11	Goodman et al. 1998	A & R	Wet	AS & PT	?
12	Raselimanana 1998	A & R	Wet	AS & PT	?
13	Rasilamanana et al. 1998	A & R	Wet	AS & PT	?
14	Nussbaum et al. 1999	A & R	Wet & Dry	AS & PT	Research Grant
15	Raselimanana 1999	A & R	Wet	AS & PT	?
16	Andreone et al. 2000	A & R	Wet & Dry	AS & PT	Research Grant
17	Raselimanana et al. 2000	A & R	Wet & Dry	AS & PT	Research Grant
18	Vallan 2000	A	Wet	AS	Research Grant
19	Andreone et al. 2001	A & R	Wet	AS & PT	?
20	Rakatomalala et al. 2001	A & R	Wet & Dry	AS & PT	?
21	Rakotomalala 2002	A & R	Wet	AS & PT	?
22	Ramanamanjato & Rabibisoa 2002	A & R	?	AS & PT	?
23	Vences et al. 2002	A & R	?	AS	?
24	Ramanamanjato et al. 2002	A & R	Wet	AS & PT	Research Grant
25	Goodman et al. 2002	A & R	?	AS & PT	?
26	Andreone et al. 2003	A & R	Wet & Dry	AS & PT	Research Grant & Volunteers
27	Glos 2003	A	Wet & Dry	AS	Research Grant
28	Lehtinen et al. 2003	A & R	Wet & Dry	AS	Research Grant
29	"Vallan et al., 2004"	A	Wet	AS	Research Grant
30	D'Cruze & Sabel 2005	A & R	Wet & Dry	AS & PT	Volunteers
31	D'Cruze et al. 2006	A & R	Dry	AS & PT	Volunteers
32	Mori & Ikeuchi 2006	A & R	Wet & Dry	AS & PT	Research Grant
33	Rakotondravony 2006	A & R	Wet & Dry	AS	Research Grant
34	Lehtinen & Ramanamanjato 2006	A & R	Wet & Dry	AS & PT	Research Grant
35	Andreone et al. 2007	A & R	Wet & Dry	AS & PT	Research Grant
36	Bora et al. 2007	A & R	Dry	AS & PT	Research Grant
37	D'Cruze et al. 2007	A & R	Wet & Dry	AS & PT	Volunteers

could serve as the "embryo" for such an online resource. Progress towards this vision will require a high degree of collaborative effort. However, it appears that research on Malagasy amphibians is already a collaborative endeavor (exemplified by the increasing number of authors and nationalities involved in the publication of such papers [Vences et al., *in press*]) and therefore this is a feasible potential future strategy.

CONCLUSION

It appears that time, personnel, and financial resources have limited the amount of herpetologically-focused survey work conducted in Madagascar, which unlike other fields of herpetological biology, such as taxonomy, has remained relatively constant over the past two decades. The rapid and increasing rates of habitat loss make protective management and reserve selection in Madagascar an urgent task. Therefore, we recommend that more surveys should be conducted in Madagascar (both in protected and unprotected areas) and that researchers should look to work in habitat types that have been traditionally overlooked. Research programs should increase collaboration with Malagasy researchers and self-funded volunteers, as both groups provide the means by which comprehensive data sets can be collected and both can

effectively contribute to long-term surveys. We also support the increasingly collaborative nature of research on Malagasy herpetofauna by utilizing approaches that speed up data availability via appropriate cyber infrastructure.

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Eyes Bigger than Stomach: Prey Caching and Retrieval in the Saltwater Crocodile, *Crocodylus porosus*

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Some animals store surplus food for later consumption (reviewed in Smith and Reichman, 1984; Vander Wall, 1990). For example, herbivores such as squirrels cache nuts for consumption during winter when food is less abundant (Smith and Follmer 1972). Long-term caching is possible for carnivores in cold climates, but predators can cache prey for several days in any climate. For example, leopards cache prey in trees to reduce competition from other scavengers (Kruuk 1972). Prey caching in carnivores is known for felids, hyenas, canids, bears, mustelids, shrews, birds of prey, and seals (Ingram 1942; Kim et al. 2005; Kruuk, 1972; McCord 1974; Michener 2000; Oksanen 1983; Phillips et al. 1990; Schaefer et al. 2007; Smith and Reichman 1984). The general explanation for this behavior is that a predator caches when its prey is too large to consume in one feeding bout (Smith and Reichman 1984), although surplus killing of smaller prey may also occur when predators are already satiated (Kruuk 1972; Oksanen et al. 1985).

Crocodilians are capable of killing prey much larger than their stomachs, and Webb and Manolis (1989) report that Saltwater Crocodiles (*Crocodylus porosus*) cache their recent kills underwater or in mangroves. *Crocodylus porosus* is a large crocodilian inhabiting rivers, estuaries, and swamps from northern Australia through to southeast Asia and eastern India (Webb and Manolis 1989). Like other crocodiles it is a generalist carnivore, feeding on a variety of invertebrates, fish, amphibians, reptiles, birds, and mammals (Taylor 1979; Webb and Manolis 1989; Webb et al. 1991). Larger individuals are known to capture medium to large terrestrial prey such as wallabies, cattle, and water buffalo (Doody et al. 2007; Pye 1976; Shield 1994; Webb and Manolis 1989).

Crocodylus porosus is relatively common in the Daly River, Northern Territory, Australia, where in recent years we have studied anti-predator behavior in Agile Wallabies, *Macropus agilis*, in response to the threat of crocodile predation (Doody et al. 2007; Steer 2007). During the dry seasons (May–October) of 2001–2007 my colleagues and I made a number of observations of prey caching by crocodiles in freshwater reaches between Oolloo Crossing (14.005ºS, 131.2402778°E) and Daly River Township (13.7747222°S, 130.7211111°E). We located crocodile kills via boat. Our evidence for kills was generally indirect or circumstantial (e.g., wallabies with missing heads or limbs, or with obvious crocodile bite marks). These kills were considered to be caches when there was evidence of manipulation by crocodiles (e.g., carcasses placed above water on snags, or on riverbanks with associated crocodile tracks). Cache retrieval was documented opportunistically using remote camera systems. I used Trailmaster® camera systems, which consist of an infrared emitter box, a receiver with LED, and a 35mm camera. The system was employed such that a crocodile retrieving a carcass would break the infrared beam, triggering the camera mounted above. Herein, I summarize the findings and discuss a previously unpublished behavior in crocodiles—above-water prey caching. I also report a possible case of surplus killing in *C. porosus* associated with prey caching.

Thirty-eight prey caches of *C. porosus* were discovered during 2001–2007, including mammals, reptiles, a fish, and a bird (Table 1). The most common prey item cached was the Agile Wallaby (*Macropus agilis*), for which 28 carcasses were found. Individuals were usually found floating, either at the river's edge or lodged on woody snags, but in eight instances wallabies were dragged onto the riverbank (Fig. 1). For example, in 2001 an adult female wallaby carcass was found 5 m up a steep sand bank and footprints and marks in the sand revealed that the carcass had been dragged there by a large (~3 m) crocodile. I employed a camera system just below the carcass in an attempt to photograph the crocodile returning, but the carcass was dragged further up the slope by unknown predators, possibly dingos. However, in the same year, a camera system did reveal a ~3 m crocodile returning for a wallaby cache (Fig. 1). The carcass was found the previous day at the river's edge with puncture wounds to the neck and head, and I employed a camera trap that afternoon. The crocodile retrieved the carcass at 0440 h the following morning (Fig. 1).

Two days later I discovered the carcass of a Northern Quoll (*Dasyurus hallicatus*) on a nearby vegetated riverbank, 2 m from the river. Crocodile tracks in the sand suggested that a ~3 m crocodile had cached the quoll. I employed a camera system that afternoon, and a crocodile retrieved the carcass at 0537 h the next morning (Fig. 2). Interestingly, the quoll was found < 100 m from where the abovementioned wallaby had been killed, cached, and retrieved, suggesting that the same crocodile was responsible for both kills. This could explain why such a small prey item was cached rather than immediately consumed.

Other mammals found cached were Water Buffalo (*Bubalus bubalis*), one of which was found floating but lodged against a snag, with obvious 'towing' teeth marks at the base of the tail, and a feral pig, in which a front quarter was lodged on a snag just above water. Reptile caches found were snakes and turtles (Table 1). A Pig-nosed Turtle (*Carettochelys insculpta*) cache with crocodile teeth marks was located on a snag just above the water. A Black-headed Python (*Aspidites melanocephalus*) was cached on a riverbank next to tracks of a ~2.5 m crocodile (the carcass was gone the next day). A an adult Water Python (*Liasis fuscus*) carcass with crocodile teeth puncture marks was also found cached on a snag in water (Fig. 2; D. Steer, pers. comm.). The snake was gone the next day. A Freshwater Crocodile (*Crocodylus johnstoni*) was found cached on a snag in water. The carcass had clear crocodile bite marks on its body and was attended by a 2.5 m *C. porosus*. The next day the carcass was half its previous size, missing the head and two limbs. The single fish cache was a ~1 m long Bull Shark (*Carcharhinus leucas*) found on a riverbank in 2001. A 4.5 m crocodile was observed several times at this exact location, which was a flat, muddy area with abundant cover provided by a fallen tree. The single bird cache was a Great-billed Heron (*Ardea*

sumatrana) found on a riverbank and attended by a 4 m crocodile in 2006. The crocodile was sighted at the same location the next day, but the cache was gone.

Prey caching by carnivores often occurs when predators kill prey too large to consume in one feeding bout (McDonald 1976; Smith and Reichman 1984). For example, Bobcats (*Lynx rufus*) cache White-tailed Deer (*Odocoileus virginianus*) and return to the carcass for further feeding (Labisky and Boulay 1998; McCord 1974). Similarly, *C. porosus* apparently cached and recovered a wallaby and a quoll (Fig. 1). It is important to distinguish between caching a carcass vs. simply returning to a carcass to feed. Although in a few cases floating carcasses could have lodged themselves against snags, many were clearly placed above, or partly above water (Table 1; Fig. 1; Fig. 2). Thus, at least some *C. porosus* kills were manipulated, presumably to facilitate further feeding and reduce the probability of competition. It is likely that other crocodilian species cache their food, especially large species and those known to capture prey too large to consume in one feeding bout. I could find no published reports of prey caching in crocodiles other than the report by Webb and Manolis (1989) that *C. porosus* will cache prey underwater or in mangroves. However, there have been a number of unpublished observations of individual *C. porosus* attending their kills. For example, in 2002 a *C. porosus* killed a tourist in a billabong in northern Australia, and authorities discovered the body later that night ~2 km from the attack site with the crocodile in attendance (C. Manolis, pers. comm.). In addition

TABLE 1. Prey caches of *Crocodylus porosus* discovered on the Daly River, Northern Territory, Australia, during the dry season.

Prey item	N	Location
Agile Wallaby (*Macropus agilis*)	28	water (20), riverbank (8)
Feral Water Buffalo (*Bubalus bubalis*)	2	against snag in water
Feral Pig (*Sus scrofa*)	1	snag just above water
Northern Quoll (*Dasyurus hallicatus*)	1	riverbank
Black-headed Python (*Aspidites melanocephalus*)	1	riverbank
Water Python (*Liasis fuscus*)	1	snag in water
Pig-nosed Turtle (*Carettochelys insculpta*)	1	snag just above water
Freshwater Crocodile (*Crocodylus johnstoni*)	1	snag in water
Bull Shark (*Carcharhinus leucas*)	1	riverbank
Great-billed Heron (*Ardea sumatrana*)	1	riverbank



FIG. 1. Agile Wallabies (*Macropus agilis*) cached by Saltwater Crocodiles (*Crocodylus porosus*). Top: A headless wallaby carcass cached on the riverbank. Bottom: Wallaby cache retrieved by a crocodile.



FIG. 2. Top: A Northern Quoll (*Dasyurus hallicatus*) cached on a riverbank is retrieved by a crocodile. Bottom: A Water Python (*Liasis fuscus*) cached on a snag in water by a crocodile. Note the puncture marks inflicted by the crocodile.

to those reported in Table 1, numerous additional wallabies were found floating down the river, of which most showed signs of crocodile attacks, including missing heads, front limbs, or injuries to the head and neck (see also Doody et al. 2007). In an unrecorded number of instances the carcasses were attended by a crocodile. I could not accurately determine the proportion of caches with a crocodile in attendance because our approach via motorboat often caused the crocodiles to submerge before being sighted (pers. obs.). However, in three cases we observed crocodiles towing wallaby carcasses across the river, although these particular carcasses were not known to be cached. There is currently no evidence that crocodiles defend their caches against scavengers, but this occurs in other carnivores known to cache (Smith and Reichman 1984).

Prey caching is sometimes associated with 'surplus killing', whereby a satiated predator makes another kill (DelGuidice 1998; Kruuk, 1972; Oksanen et al. 1985). In this case prey size is not necessarily important, but recent feeding leads to 'killing on a full stomach'. This appears to be the case with my observations of the quoll cache. This kill was unlikely to be too large for the crocodile to consume (Fig. 1), but the crocodile had apparently taken a wallaby two nights before the cache was found (pers. obs.).

Above-water caching has not been reported for crocodiles, but 12 of the 38 caches I found were above water (Table 1). Why cache above water, when more effort would generally be required to cache there? Smith and Reichman (1984) contend that the defensibility of the cache should be the primary consideration in the decision of where to cache, and some carnivores are known to defend their caches (e.g., Kim et al. 2005). Crocodiles may have learned to cache above water to avoid losing carcasses that are stolen, eaten, or incidentally dislodged by scavengers. We frequently found wallaby carcasses floating down the river that were previously attached to snags, or floating but lodged against the riverbank. These carcasses were apparently dislodged by other scavengers—most wallaby carcasses we observed were accompanied by scavenging pig-nosed turtles (pers. obs.), and water levels do not fluctuate during the dry season. The smaller, freshwater crocodiles were also attracted to the carcass, as were other *C. porosus* (pers. obs.). However, above-water caches are also scavenged. I have observed scavenging of above-water caches by monitor lizards (*Varanus panoptes*), Sea Eagles (*Haliaeetus luecogaster*), Wedge-tailed Eagles (*Aquila audax*), Whistling Kites (*Haliastur sphenurus*), Black Kites (*Milvus migrans*), and Grey Goshawks (*Accipiter novaehollandiae*). The diverse suite of scavengers at a site may influence a crocodile's decision of whether to cache prey in, or above water.

It is not surprising that Agile Wallabies were the most common prey cached by crocodiles. The species is abundant in the area, and thrives in nearby paddocks and open savannah. During the dry season free water is restricted to the river and a few permanent billabongs, bringing wallabies into contact with predatory crocodiles (Doody et al. 2007). Drinking wallabies exhibit a number of anti-predator behaviors, including increased apprehension and the excavation of drinking holes in the sand just out of reach of crocodiles (Doody et al. 2007; Steer 2007). There are a few anecdotal reports of wallabies or kangaroos falling prey to *C. porosus* (Pye 1976; Shield 1994). Those findings, combined with the present observations, indicate that agile wallabies are a significant prey item for *C. porosus*, at least during the dry season on the Daly River.

In summary, observations herein of crocodiles retrieving carcasses, combined with evidence that the prey were initially killed by crocodiles and manipulated thereafter, offer strong indirect evidence for prey caching in *C. porosus*. Although it is possible that these prey were killed by one crocodile and retrieved by another, in some instances the carcasses showed clear signs of being cached there by a crocodile. Caches are sometimes attended, but cache defense is unknown. I agree with Webb and Manolis (1989) that the commonly evoked idea that prey is cached because crocodiles prefer decomposed flesh over fresh kills is an unlikely explanation (see also Shield 1994). Indeed, predators may prefer fresh kills; some caching predators exhibit behaviors that may inhibit microbial action, such as burying, drying, and covering with 'antiseptic' sphagnum (Michener 2000; reviewed in Smith and Reichman 1984). It is more likely that large prey are cached due to constraints imposed by stomach size in the predator (about the size of a soccer ball in an adult *C. porosus*; Webb and Manolis 1989). However, evidence of latency to cache retrieval relative to decomposition rates is needed to determine why crocodiles cache their prey. Further research is also required on the potential defense of caches, their relative importance to energy uptake, and the relative costs to caching above water vs. in the water by *C. porosus*. Data from other crocodilians are also needed to evaluate the generality of the behavior in this group.

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Movement and Habitat Use of the Endangered Australian Frog *Nyctimystes dayi*

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The Australian Lacelid, *Nyctimystes dayi*, is an endangered, stream-breeding hylid frog endemic to rainforests in the wet tropics of northeastern Queensland, Australia. During the 1990s, populations of *N. dayi* declined dramatically, with the species disappearing from all upland (>300 m) areas, where they were once common (Richards et al. 1993; Northern Queensland Threatened Frogs Recovery Team 2001; Trenerry et al. 1994). The proximate cause of these population declines and disappearances was the amphibian disease chytridiomycosis (Berger et al. 1998). This disease had similar effects on several other species sympatric with *N. dayi* (Berger et al. 1998). Habitat modification and fragmentation are also potential stressors for *N. dayi* populations, since approximately 20% of the wet tropics region has been clear cut since 1880 (Winter et al. 1987), and smaller-scale clearing still occurs in non-protected areas (e.g., for pastures, human settlement and associated infrastructure; Department of Natural Resources and Water 2007).

In order to make informed management decisions aimed at species conservation, it is necessary to have species-specific information on movement and habitat use, information that is lacking for the vast majority of amphibians (Johnson et al. 2007; Semlitsch and Bodie 2003; Trenham and Shaffer 2005). This is especially true for stream-breeding species such as *N. dayi*.

The study of *N. dayi* in the field has been hampered by several factors. First, the species is cryptic in both appearance and behaviour, and inhabits complex, densely vegetated habitats. Only males calling along streams in the breeding season are readily detectable. Second, males weigh less than 4 g, making them too small to track remotely using either radio-telemetry or harmonic direction finding (see Rowley and Alford 2007a), and females are rarely encountered (Czechura 1987; Hodgkison and Hero 2002), with male *N. dayi* 24 times more common than females along stream transects (Czechura 1987). As a result, the only information available on the ecology and habitat use of *N. dayi* is on males, and is derived from nocturnal surveys along streams or in riparian vegetation within 10 m of the stream (Czechura 1987; Hodgkison and Hero 2002).

Our objective was to track to track *N. dayi* females in the field, obtaining information on their movement and habitat use. The study was conducted at Tully Falls Forest Reserve (145.68ºE, 17.80ºS; 70 m elev.), in northern Queensland, Australia. Individuals were initially captured along a low-gradient stream containing pools, riffles, and a number of waterfalls. The stream was surrounded by relatively undisturbed rainforest vegetation, except for a sealed, two-lane road, which crosses the stream via a bridge approximately 20 m above the stream bed.

The study was conducted during the warm/wet season from 22 February to 8 March 2005 and the cool/dry season from 25 August to 8 September 2005. Tracking methodology followed that of Rowley and Alford (2007b). Each frog was captured by hand, weighed, fitted with radio transmitters (model BD-2NT; Holohil Systems Ltd., Ontario, Canada; weighing ca. 0.67 g including silicone tubing harness) *in situ* and released at point of capture within five minutes. Frogs did not carry more than 6% of their total body weight (the recommended maximum relative weight for an attached tag is 10% of the body weight; Richards et al. 1994). We tracked each frog using a HABIT Research HR2500 Osprey VHF Receiver (HABIT Research, Victoria, B.C., Canada), fitted with a three-element folding Yagi antenna (A.F. Antronics, Urbana, Illinois, USA).

The location of each frog was determined during two surveys per 24-h period, once during the day (0700–1900 h) and once at night (1900–0700 h) over the duration of the study. We established a marked transect along the stream edge to serve as a reference for frog locations, and when we located a frog, we recorded its three-dimensional position in meters as its location along the transect, its horizontal distance from the stream, and approximate elevation above stream. Distances were measured using tape measures, range finders and transect markers. If the frog was more than 20 m from the stream, distance from the stream was recorded to the nearest 5 m. We also recorded the environmental substrate frogs were using: bare ground, dry rock, leaf litter, vegetation, wood, on wet rock in stream, and under rock in stream.

TABLE 1. Movement patterns and habitat use of female *Nyctimystes dayi*. Values represent medians (and ranges) of data obtained using individual frogs as replicates.

Individual ID	Season	Total number of relocations	Percent of observations individuals moved between surveys	Distance moved between surveys (m)	Elevation above stream (m)		Horizontal distance from stream (m)	
					Diurnal	Nocturnal	Diurnal	Nocturnal
Frog 1	Cool/dry	24	60.9	8 (0–91.3)	3 (0–12)	3 (0–10)	8 (0–50)	3 (0–50)
Frog 2	Cool/dry	28	33.3	0 (0–27.1)	13 (0–20)	13 (0–20)	0 (0–3)	0 (0–3)
Frog 3	Cool/dry	15	64.3	4.2 (0–91.3)	0 (0–3)	0.75 (0–3)	0 (0–4)	0 (0–4)
Frog 4	Warm/wet	28	55.6	0 (0–20.6)	5 (0–10)	6 (0–10)	5 (0–20)	2.5 (0–10)
Frog 5	Warm/wet	19	66.7	4.7 (0–17.1)	5 (0–12)	5 (0–12)	4 (0–5)	5 (0–5)

We used individuals as replicates and compared summary statistics calculated for each animal, in order to avoid pseudoreplication and biasing our results by including more data on frogs that were located more often (Rowley and Alford 2007b). Due to obvious differences between the diurnal and nocturnal behavior of *Nyctimystes dayi*, we examined diurnal and nocturnal data on habitat use separately.

Five female *N. dayi* were tracked during the study period, three in the cool/dry season and two in the warm/wet season (Table 1). Our sample size was limited by the low availability of females for initial capture. We successfully relocated all frogs on every attempt, resulting in between 15–28 relocations per frog, and a total of 117 relocations for the species.

Tracked frogs moved to a new position between 33.3–66.7% of surveys (Table 1). The median distance moved between surveys (over ca. 12 h) ranged from 0–8 m, however two individuals moved more than 90 m between surveys (Table 1). The elevation of frogs above the stream during surveys varied from 0–20 m and their horizontal distance from the stream ranged from 0–50 m (Table 1). Individual movement patterns were variable; one frog remained within 5 m of the stream in both elevation and horizontal distance, while others moved extended distances vertically and horizontally from the stream for several days at a time (Fig. 1). No frogs were observed to have moved during the day. Tracked *N. dayi* were always relocated in rainforest. A single individual, "Frog 1," traversed the sealed, two-laned road twice during the study period.

During both diurnal and nocturnal observations, tracked frogs were most often located in vegetation (Table 2), typically in the canopy of large trees (>10 m height). When we were able to visually locate tracked frogs in the canopy, all were on the leaves of trees. During a single instance in which we opportunistically sighted a male *N. dayi* during the day, it was also located in vegetation, on leaves overhanging the stream. Frogs also spent up to several days at a time under rocks in the stream, and were occasionally observed during the night on wet rocks in the stream (Table 2). A single frog was observed on leaf litter during the study (Table 2).

We observed three of our tracked frogs in amplexus; two in the cool/dry season and one in the warm/wet season. "Frog 2" spent between 24–36 h in amplexus, on vegetation 1–2 m above the stream and 2 m in horizontal distance from the stream. "Frog 3" spent <12 h in amplexus on 3 m high vegetation, 4 m from the stream, and "Frog 5" was found in amplexus under a rock in the middle of the stream when we removed its transmitter at the end of the study.

Nyctimystes dayi females made relatively large (up to 50 m), extended journeys away from streams, spent a high proportion of their time in canopy vegetation, and were always observed in rainforest. Similar behavior has been recorded in females of the sympatric hylid *Litoria genimaculata* (Rowley and Alford 2007b). Although we did not track male *N. dayi*, due to their small size, we can make predictions about their behavior, based on the behavior of females. First, it is likely that the frequency and distance of movements in male *N. dayi* is lower than for females, as it is in many species, especially when males are smaller in size than females (Bartelt et al. 2004; Bellis 1965; Johnson et al.

TABLE 2. Substrate use of female *Nyctimystes dayi*. Values represent proportions of observations each frog was on each substrate type during diurnal and nocturnal surveys.

Individual ID	Season	Nocturnal				Diurnal			
		Vegetation	Under rock in stream	Leaf litter	On wet rock in stream	Vegetation	Under rock in stream	Leaf litter	On wet rock in stream
Frog 1	Cool/dry	0.73	0.18	0.09	0	0.69	0.23	0	0.08
Frog 2	Cool/dry	0.77	0.23	0	0	0.8	0.13	0	0.07
Frog 3	Cool/dry	0.29	0.71	0	0	0.5	0.5	0	0
Frog 4	Warm/wet	0.85	0.15	0	0	0.87	0	0	0.13
Frog 5	Warm/wet	0.78	0.22	0	0	0.8	0.1	0	0.1

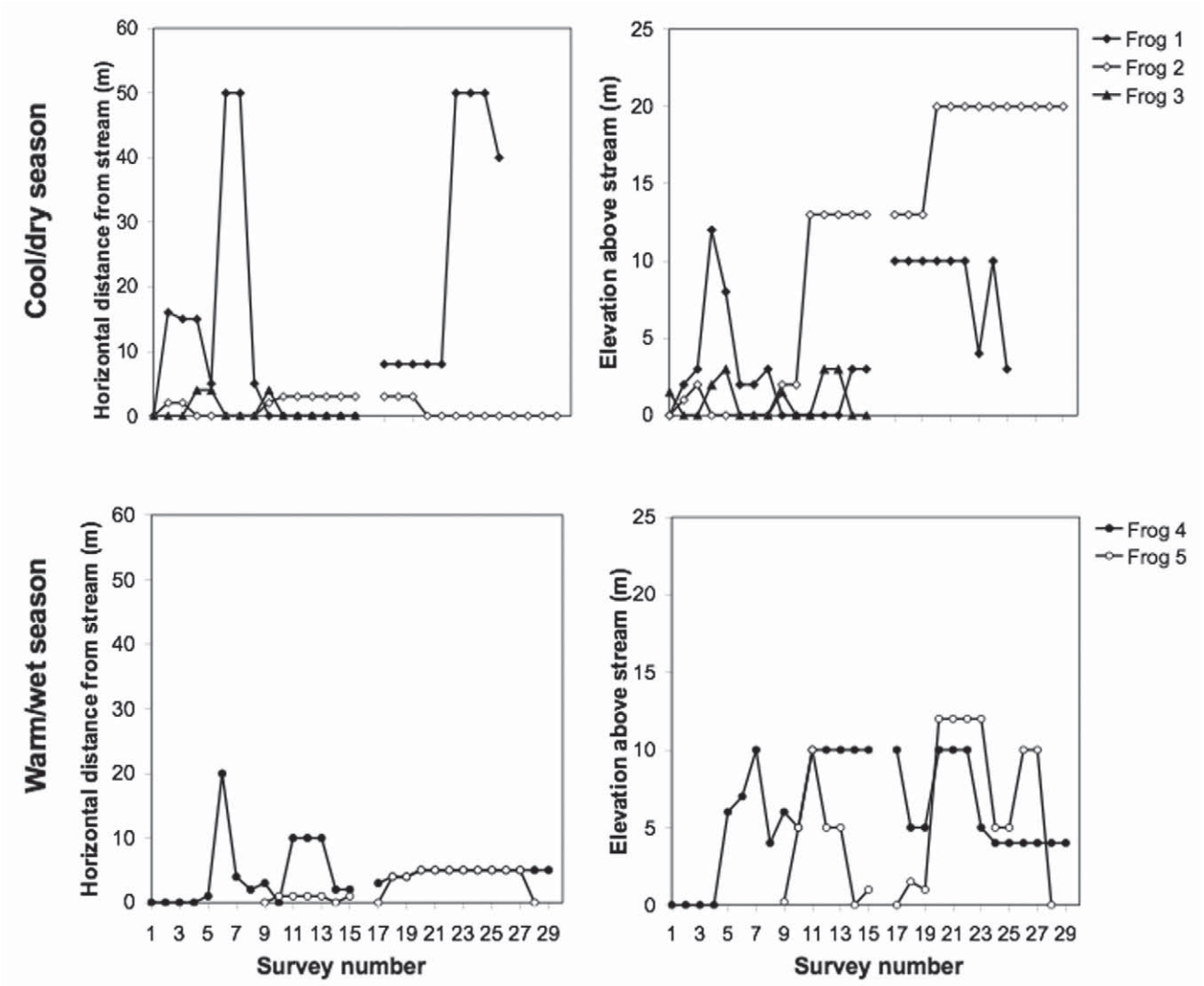


FIG. 1. Individual movement patterns of female *Nyctimystes dayi* during the cool/dry and warm/wet seasons. Values represent position of single frogs in terms of horizontal distance from stream (m) and elevation above stream (m) during successive surveys. Even numbered surveys represent diurnal surveys and odd numbered surveys represent nocturnal surveys.

2007; Miaud et al. 2000; Muths 2003; Ovaska 1992; Rowley and Alford 2007b). It is also likely that male *N. dayi* are more stream-restricted, especially considering their high relative abundance along streams, fidelity to calling-sites along streams (Hodgkison and Hero 2002; Rowley and Alford, unpubl. data), and inter-male aggression (Rowley 2007) during the breeding season.

Results of this study have important consequences for population censuses of *N. dayi* using techniques such as mark-recapture. The large movements of *N. dayi* both along and away from streams are likely to make it difficult to distinguish between mortality and emigration from fixed sites, an issue previously recognized for several other amphibian species (Rowley and Alford 2007b; Schmidt et al. 2007). In addition, it is likely that the high relative abundance of male *N. dayi* encountered during population surveys is simply a reflection of greater detectibility, with females spending large proportions of time farther away from the stream in terms of both horizontal distance and in elevation. This is probably exacerbated by the cryptic behavior of females. When they were adjacent to streams at night, they were often concealed from sight from the stream itself, and would have remained undetected had they not been fitted with tracking devices.

As *N. dayi* were always observed in rainforest, and used habitat at relatively large distances from streams, management actions aimed at conserving the species should maintain terrestrial vegetation buffer zones along streams and habitat corridors between streams. Although a single *N. dayi* successfully traversed a sealed road during the study, we do not know how common these movements are, whether male *N. dayi* are capable of traversing such potential barriers, and how great the risk presented by such traversals is. Until further research is carried out, it should be assumed that roads and other habitat disturbances are barriers to movement for *N. dayi*.

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Cross-Species Amplification of Emydid Microsatellite Loci in Three *Graptemys* Species and Their Utility as a Conservation Tool

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Microsatellites are a powerful set of highly variable molecular markers gaining widespread use in population genetics (Avise 2004) and increasingly in studies with a conservation focus (e.g., Beaumont and Bruford 1999; Jehle and Arntzen 2002). However, one drawback of microsatellites is that the development of these markers for use *de novo* typically involves the costly and time-consuming process of creating a genomic library, isolating microsatellite-containing clones, designing primers for the loci, and then optimizing the primers (Selkoe and Toonen 2006). Fortunately, the priming sites within the flanking sequences of microsatellite loci are sometimes conserved across species (e.g., Engel et al. 1996; Holman et al. 2005; Primmer et al. 1996; Primmer et al. 2005; Rico et al. 1996), including turtles (FitzSimmons et al. 1995). This allows the primers designed for one species (the focal species; Hutter et al. 1998) to successfully amplify loci in other species. In fact, many authors routinely test novel microsatellite loci on closely related species, usually within the same genus.

Turtles are considered one of the most endangered animal taxa, with 129 of the 205 species assessed by the World Conservation Union (IUCN) listed as critically endangered, endangered or vulnerable (http://www.iucnredlist.org/info/tables/table4a; accessed 27 May 2007). Genetic studies are playing an increasing role in the conservation of chelonians including the use of microsatellites, either alone (Pearse et al. 2006; Roberts et al. 2005; Schwartz and Karl 2005) or in combination with other genetic markers (Bowen et al. 2005; Sites et al. 1999). Interest in genetic studies of several species within the family Emydidae has been indicated by the recent publication of papers describing microsatellite loci for the Diamondback Terrapin (*Malaclemys*

terrapin; Hauswaldt and Glenn 2003), the Bog Turtle (*Glyptemys muhlenbergii*; King and Julian 2004) and the Blanding's Turtle (*Emydoidea blandingii*; Libants et al. 2004; Osentoski et al. 2002).

The imperiled nature of members of the genus *Graptemys* (family Emydidae) makes the use of genetic studies increasingly important. The genus *Graptemys* has a broad distribution across North America, but seven of twelve species in the genus are endemic to specific drainages east of the Mississippi River along the northern coast of the Gulf of Mexico (Ernst et al. 1994). Presumably this complex evolutionary history is the product of the fluctuating sea levels in the Gulf of Mexico during the Pleistocene (Lamb et al. 1994; Lovich and McCoy 1992; Wood 1977). Like many freshwater species, this genus appears to be extremely sensitive to human modifications and perturbations of the river and surrounding habitats (reviewed by Bulhmann and Gibbons 1997; Moll and Moll 2004).

The combination of such restricted distributions and apparent recent population declines has led to the listing of six species of *Graptemys* as either imperiled (G2) or vulnerable (G3) (NatureServe 2006). Two of the coastal species, *G. flavimaculata* and *G. oculifera*, have state endangered and federally threatened status (U.S. Fish and Wildlife Service 1988 and 1993). Furthermore, *G. barbouri*, *G. ernsti*, *G. nigrinoda nigrinoda*, *G. nigrinoda delticola*, and *G. pulchra* (all coastal species) are considered state protected in Alabama (Alabama Natural Heritage Program 2006). *Graptemys nigrinoda nigrinoda* is also considered state endangered in Mississippi (Mississippi Natural Heritage Program 2002). Developing effective management and recovery plans has been complicated by a general paucity of ecological information for *Graptemys* species (Bulhmann and Gibbons 1997), although there is a growing body of literature for *G. flavimaculata* (Horne et al. 2003; Jones 1996; Lindeman 1998; Shelby et al. 2000; Shelby and Mendonça 2001) and *G. oculifera* (Jones 2006; Jones and Hartfield 1995; U.S. Fish and Wildlife Service 1988). However, no published studies of genetic variation and population structure in the context of conservation issues exists for any of the *Graptemys* species. The goal of this project was to identify a suite of previously published microsatellite loci that would be useful for population and conservation genetic studies of *G. gibbonsi*, *G. flavimaculata*, and *G. oculifera*. Given the potential for cross-species amplification of microsatellite loci among related species, the loci we tested were selected from those developed for species within the family Emydidae. Loci found to be useful for the three *Graptemys* species in this study would also likely be useful for other members of the genus as well.

TABLE 1. Microsatellite loci tested in this study along with the repeat motif and optimal annealing temperature for each locus that was successfully amplified. Loci that were not successfully or reliably amplified are indicated by a –.

		Species Tested & Annealing Temperature (°C)		
Locus and Focal Species	Repeat Motif	*G. gibbonsi*	*G. flavimaculata*	*G. oculifera*
Malaclemys terrapin				
TerpSH1	$(AGAT)_{15}$	56	56	56
TerpSH2	$(AGAT)_{12}$	60	56	56
TerpSH3	$(CAAA)_{14}$	–	–	58
TerpSH5	$(CTAT)_{12}$	56	56	56
TerpSH7	$(AGAT)_{13}$	60	56	56
TerpSH8	$(GA)_{19}$	56	56	–
Glyptemys muhlenbergii				
*Gmu*B08	$(TAC)_{10}$	–	56	56
*Gmu*D28	$(ATCT)_{15}$	52	–	–
*Gmu*D51	$(ATCT)_{52}$	60	56	–
*Gmu*D70	$(ATCT)_{8}$	60	56	56
*Gmu*D79	$(ATCT)_{10}$	56	56	56
*Gmu*D87	$(ATCT)_{22}$	53	–	56
*Gmu*D88	$(ATCT)_{18}$	60	56	56
*Gmu*D90	$(ATCT)_{9}$	56	58	56
*Gmu*D93	$(ATCT)_{18}$	56	56	56
*Gmu*D114	$(ATCT)_{13}$	56	56	56
*Gmu*D121	$(ATCT)_{8}$	56	56	53
Emydoidea blandingii				
Eb15	$(CA)_{18}$	–	56	–
Eb17	$(AAT)_{11}$	56	–	56
BTGA3	$(GA)_{11}$	–	–	–
BTCA7	$(CA)_{12}$	56	56	56

From April 2005 to November 2006 turtles were collected using basking traps or by hand during periods of low flow. *Graptemys gibbonsi* was collected from the Chickasawhay River (Pascagoula drainage) at Leakesville, Mississippi. *Graptemys flavimaculata* was collected from the Leaf River (Pascagoula drainage) north of Hattiesburg, Mississippi. *Graptemys oculifera* was collected from the Pearl River at Columbia, Mississippi. Approximately 1 mL of blood was drawn from the coccygeal vein using a heparinized 26.5-gauge needle and a 1 mL syringe. All individuals were released at the site of capture following sample collection. Samples were stored on ice for 4–6 h while in the field, centrifuged to separate plasma and blood cells and then stored at –20°C. All collections were made under permits from the Mississippi Department of Wildlife, Fisheries and Parks.

We selected a total of 21 loci for testing in *G. flavimaculata*, *G. oculifera* and *G. gibbonsi* (Table 1). All six loci for *Malaclemys terrapin* (Hauswaldt and Glenn 2003) were tested since each suc-

TABLE 2. Characteristics of the 21 microsatellite loci as reported for the focal species or as observed in the *Graptemys* species tested in this study: size range of alleles (in base pairs), the number of alleles (N_a) for each locus, and the observed and expected heterozygosity (H_O/H_E). NA means no amplification, and NR means not resolved. The number (N) of individuals tested for the focal species and each species of *Graptemys* is also reported.

	Focal Species			*G. gibbonsi* (N = 34)			*G. flavimaculata* (N = 20)			*G. oculifera* (N = 20)		
Locus	Size	N_a	H_O/H_E	Size	N_a	H_O/H_E	Size	N_a	H_O/H_E	Size	N_a	H_O/H_E
Malaclemys terrapin (N = 18–21)												
TerpSH1	254–302	12	0.571/0.913	239–255	5	0.655/0.589	266–276	5	0.545/0.550	269–295	6	0.833/0.736
TerpSH2	171–227	12	1.00/0.902	157–161	2	0.029/0.028	155–175	6	0.714/0.709	158–190	5	0.474/0.594
TerpSH3	283–311	8	0.857/0.803	NA	–	–	NR	–	–	265–273	3	0.444/0.568
TerpSH5	157–189	8	0.905/0.825	131–135	2	0.529/0.484	133–165	8	0.833/0.795	129–157	6	0.688/0.727
TerpSH7	97–137	10	0.722/0.872	97–125	7	0.765/0.780	102–126	7	0.667/0.784	102–134	7	0.800/0.764
TerpSH8	193–221	14	0.895/0.913	193–199	4	0.375/0.433	174–182	2	0.077/0.074	NA	–	–
Glyptemys muhlenbergii (N = 37)												
*Gmu*B08	NA	–	–	221–224	2	0.406/0.359	218–224	3	0.625/0.588	219–223	2	0.389/0.461
*Gmu*D28	208–236	6	0.917/0.789	197–221	4	0.300/0.345	NA	–	–	NA	–	–
*Gmu*D51	307–359	10	0.545/0.843	320–380	13	0.875/0.878	201–273	9	0.889/0.819	NA	–	–
*Gmu*D70	185–205	5	0.676/0.725	185–241	9	0.710/0.714	202–280	10	0.846/0.855	215–303	9	0.636/0.781
*Gmu*D79	164–192	3	0.459/0.487	152–152	1	0.000/0.000	153–153	1	0.000/0.000	152–152	1	0.000/0.000
*Gmu*D87	260–292	8	0.892/0.843	220–268	10	0.903/0.852	NR	–	–	220–240	6	0.947/0.684
*Gmu*D88	154–178	17	0.730/0.753	115–135	6	0.600/0.627	113–157	9	1.000/0.838	119–147	8	0.833/0.813
*Gmu*D90	122–134	3	0.568/0.520	115–119	2	0.514/0.431	121–121	1	0.000/0.000	119–119	1	0.000/0.000
*Gmu*D93	185–389	10	0.730/0.843	183–191	3	0.059/0.058	185–185	1	0.000/0.000	161–189	2	0.111/0.105
*Gmu*D114	92–128	6	0.757/0.738	87–87	1	0.000/0.000	97–101	2	0.167/0.153	99–99	1	0.000/0.000
*Gmu*D121	138–154	5	0.703/0.678	126–142	4	0.629/0.504	127–147	2	0.053/0.051	130–142	2	0.211/0.266
Emydoidea blandingii (N = 100 & 12)												
Eb15	147–186	34	0.920/0.950	NA	–	–	166–166	1	0.000/0.000	NA	–	–
Eb17	94–109	5	0.690/0.690	87–87	1	0.000/0.000	NA	–	–	87–87	1	0.000/0.000
BTGA3	108–108	1	0.000/0.000	NA	–	–	NA	–	–	NA	–	–
BTCA7	154–158	2	0.333/0.290	158–164	2	0.324/0.271	86–88	2	0.389/0.313	165–165	1	0.000/0.000

cessfully amplified in *Chrysemys picta*. Two loci from each of the *Emydoidea blandingii* papers were also chosen based on their broad applicability in the species tested or the degree of polymorphism in *C. picta*. From Osentoski et al. (2002) we selected Eb15 and Eb17, and from Libants et al. (2004) we selected BTCA7 and BTGA3. Twenty–seven loci were reported for *Glyptemys muhlenbergii* (King and Julian 2004), and thirteen of these amplified in *Graptemys geographica*. We tested all but *Gmu*A18 and *Gmu*D89, since only a few alleles were reported in *G. geographica*.

Total genomic DNA was extracted with the DNeasy Tissue Kit (QIAGEN Inc.). Although heparin can sometimes have an inhibitory effect on the polymerase chain reaction (Beutler et al. 1990), this extraction method yielded good quality DNA that amplified well for most individuals. Amplifications were conducted in a total volume of either 12.5 µl or 25 µl using 50 mM KCl, 10 mM Tris-HCl (pH 8.3), 0.01% gelatin, 200 µM dNTPs, 2 mM $MgCl_2$ (4 mM for TerpSH3 & TerpSH7 and 1.5 mM for TerpSH8 in *G. oculifera*) 0.5 units of *Taq* polymerase (Promega Co.), 0.3 µM of the M13 tailed forward primer (Boutin-Ganache et al. 2001), 0.3 µM of the reverse primer, 0.1 µM of the labeled M13 primer (LICOR Co.), 20–150 ng of template DNA, and water to the final volume. PCR cycling conditions consisted of an initial denaturing step of 94°C for 2 min followed by 35 cycles of 30 sec at 94°C, 1 min at 52–60°C, and 1 min at 72°C. A final elongation step of 10 min at 72°C ended the cycle. Locus specific annealing temperatures are provided in Table 1. Microsatellite alleles were visualized on acrylamide gels using a LICOR 4200 DNA analyzer and scored using Gene Imag-IR v. 3.55 (LICOR Co.). We tested 20–34 individuals per species (Table 2). For polymorphic loci, summary statistics were generated using GENALEX 6 (Peakall and Smouse 2005). Tests for Hardy-Weinberg equilibrium and linkage disequilibrium were both conducted using randomization tests implemented in GENEPOP v 3.3 (Raymond and Rousset 1995). Statistical significance was adjusted using sequential Bonferrroni procedures (Rice 1989) for all multiple tests. We performed statistical comparisons of several properties of each locus (number of alleles, expected heterozygosity levels, smallest allele size, and largest allele size) to determine if the values for our study species were different from those reported for the focal species, and whether there were differences among our study species. To do this, we used one-factor analyses of variance, and for tests that showed a significant difference among the four groups we also performed post–hoc comparisons (Tukey's HSD) to test for differences between each pair (SAS Institute 2002). All analyses were performed using JMP 5.0 software.

Eighteen loci were reliably amplified in *G. gibbonsi*, and 16 loci were amplified in both *G. flavimaculata* and *G. oculifera* (Table 2). Of these loci, 15 were polymorphic in *G. gibbonsi*, 12 were polymorphic in *G. flavimaculata* and 11 loci were polymorphic in *G. oculifera*, with 2–13 alleles per locus per species. Two other loci (TerpSH3 and *Gmu*D87) amplified inconsistently in *G. flavimaculata* but appeared to be polymorphic and may yet prove useful after further optimization. Observed heterozygosity values ranged widely across species with values of 0.029–1.0, however most loci exhibited observed heterozygosity values greater than 0.500 (Table 2). No loci exhibited significant departure from Hardy-Weinberg equilibrium expectations or demonstrated linkage disequilibrium after applying a Bonferroni correction.

A common observation in studies testing cross-species amplification of microsatellite loci is that alleles are typically longer and more numerous in the focal species (e.g., Ellegren et al. 1995; FitzSimmons et al. 1995). Hutter et al. (1998) tested two hypotheses for this observation by performing a reciprocal test of microsatellite loci designed for two species of *Drosophila*. They found no difference in mean PCR fragment length, but there was greater variation in the focal species as measured by the number of alleles and expected heterozygosity. The statistical tests of our data revealed the same pattern. We found no significant differences among groups in length of the largest ($F = 0.877$; $df = 3,66$; $P = 0.458$) and smallest ($F = 0.274$; $df = 3,66$; $P = 0.844$) alleles. Reduced genetic variability was observed compared to the focal species. The number of alleles differed significantly among the focal and study species ($F = 6.73$; $df = 3,80$; $P = 0.0004$), and post-hoc comparisons showed that this was due to significantly higher numbers of alleles in the focal species than in the three study species. Number of alleles did not differ among the three *Graptemys* species. Likewise, expected heterozygosity values differed significantly among the four groups ($F = 4.65$; $df = 3,65$; $P = 0.005$), and post-hoc comparisons showed that values for all three *Graptemys* species were significantly smaller than those reported in the focal species. Heterozygosity levels did not differ among the three study species. Differences in sample sizes and the geographical range of samples are unlikely to account for the higher genetic variability in the focal species. Only Libants et al. (2004) sampled a large number of individuals from a broad geographic range. Our samples sizes (Table 2) were comparable to, or larger than, all of the other studies.

We have identified a set of microsatellite loci designed for species in the Emydidae that amplify in *G. gibbonsi*, *G. flavimaculata*, and *G. oculifera*. Somewhat reduced levels of genetic variability compared to the focal species does not appear to affect their usefulness as a conservation genetic tool. We have already employed these loci to document genetic differentiation between *G. gibbonsi* populations from the Pearl and Pascagoula Rivers (unpublished data). Our lab is also using these loci to measure connectivity among populations of *G. flavimaculata* within the mainstem Pascagoula River and its tributaries. The loci identified here (Table 2) may likewise prove useful in population genetics studies of other *Graptemys* species or even other species within the Emydidae.

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The Use of Vehicle-Portable Scanners for Obtaining Morphological Data on Small- to Medium-sized Reptiles

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Rapidly and accurately recording morphological characters from live lizards and snakes can be difficult, especially for small and/or venomous species. Ventral scale numbers and belly color patterns can be particularly difficult to record from live specimens, despite their importance for determining vertebral numbers (Alexander and Gans 1966; Kerfoot 1970), sexual dimorphism trends (Shine 1993), environmental conditions (Castellano et al. 1994), and correlations with body size, growth rate, and survivorship (Lindell et al. 1993).

Body length is another important part of any study of reptiles and amphibians (Measey et al. 2003) and snout–vent length (SVL) is the most commonly reported measure of linear body size (Fitch 1987). However, measuring the SVL of a snake can be problematic, especially for venomous species (Bertram and Larsen 2004).

Fitch (1987) stated that stretching a conscious snake to its full length for a SVL measurement may set back growth by several weeks. We observed similar results during a previous study of *Sinonatrix* snakes (Mao, unpubl.). Measurements from stretched snakes have been demonstrated to be significantly longer than measurements obtained by other methods (Bertram and Larsen 2004). In addition, squeeze boxes must be turned upside-down or used following the methods of Bertram and Larsen (2004) in order to obtain ventral characteristics or tail lengths.

Animals can be anesthetized in order to reduce injury to both study animals (e.g., tail autonomy) and investigators and to increase measurement precision (Blouin-Demers 2003; Setser 2007). However, anesthesia can increase potential risk of mortality, can be time consuming, and may be impractical when processing large numbers of individuals at one time (Setser 2007). Anesthesia also requires experienced personnel and specialized equipment, and is subject to legal constraints in many countries (Beaupre et al. 2004, Bennett 1999). In addition, anesthetized snakes can stretch considerably and do not necessarily provide more accurate measurements (Blouin-Demers 2003).

Schuett (1997) used photocopiers for measuring snakes, following Quinn and Jones' methods, and other researchers have used digital images from cameras (Measey et al. 2003; Perera and Pérez-Mellado 2004). In 1999, we developed a technique that employs a modified flatbed scanner to gather morphological data on *Sinonatrix annularis* and *Sinonatrix percarinata suriki*. This approach provided high quality images of ventral characteristics and body length of small to medium sized reptiles in a safe and rapid manner. Unlike large photocopiers, the scanner method can be used in the field by using a notebook PC with a scanner, while drawing power from a vehicle or generator. Compared to images taken with digital cameras, which often suffer from spherical distortion, the scanner provides a standardized platform that eliminates problematic biases such as angle and distance from the subject.

Materials and methods.—We originally used Hewlett Packard (HP) Scan Jet 3300C and Epson Perfection 1650 scanners, with maximum image resolution of 600 and 1650 dpi (dots per inch) respectively. We later used a HP Scanjet 4670 scanner because of its faster scanning speed, higher image quality, compact design, and lighter weight. A squeeze labyrinth (L × W × H = 30.3 × 22.3 × 5 cm) was designed to keep the body of the animal being scanned extended (Fig. 1). To prevent the subjects from moving while being scanned, the labyrinth has a plastic cover, onto which six strips of sponge are glued (each sponge being L×W×H = 20 × 4.2 × 5.2 cm, respectively). Larger lizards like *Plestiodon elegans* can be placed in the labyrinth, while lizards such as geckoes or the brown anole (*Norops sagrei*), as well as very small snakes, can be scanned by manually restraining the animal under a white cloth on top of the scanner. Very small characters such as the enlarged post-cloacal scales of male *N. sagrei* can be scanned by selecting the area and scanning it at 200–300% with a resolution of 300–400 dpi. We saved all scanned images to both the computer's hard drive and to CD or DVD.

In addition to the two above *Sinonatrix* species, we tested the method on 16 additional snake species: *Amphiesma sauteri*, *A. stolatum*, *Bungarus m. multicinctus*, *Enhydris chinensis*, *E. plumbea*, *Elaphe c. carinata*, *Lycodon r. ruhstrati*, *Oligodon formosanus*, *Oreocryptophis porphyracea kawakamii*, *Pseudoxenodon s. stejnegeri*, *Ptyas korros*, *Rhabdophis tigrinus formosanus*, *Rhadinophis frenatum*, *Trimeresurus gracilis*, *Viridovipera stejnegeri stejnegeri*, and *Xenochrophis piscator*. The largest and smallest snakes tested were 1350 mm SVL (adult *E. c. carinata*) and 90 mm SVL (neonatal *E. plumbea*), respectively. We also tested the method on 12 lizard species: *Eutropis longicaudata*, *Gekko hokouensis*, *Hemidactylus bowringii*, *H. frenatus*, *H. stejnegeri*, *Japalura swinhonis*, *N. sagrei*, *P. elegans*, *Sphenomorphus indicus*, *Takydromus formosanus*, *T. kuehnei*, and *T. stejnegeri*. The largest



FIG. 1. The scanner platform module (the main figure) from left to right clockwise; the PC notebook, cover glued with six sponge strips, the white labyrinth with one transparent side for animal observations, and a HP-4670 scanner. The upper right insert is the ventral image of an *Enhydris chinensis* with a tag number, indicating the collection and measurement data.

and smallest lizards tested were 120 mm SVL (*E. longicaudata*) and 18.5 mm SVL (neonatal *T. formosanus*), respectively.

To examine the accuracy and precision of the proposed method, we accumulated the body axis measurements (e.g., SVL, and tail length) of a single adult male *X. piscator* by using the following methods: 1) conscious—stretching the snake and directly measuring it by tape ruler—repeated five times; 2) scanning the snake with the HP-3300C, at 150 and 200 dpi resolutions, and measuring those lengths with a digital map-reader on a full size printout and directly from the screen by using GIS software—repeated five times; 3) same as no. 2 but using the HP-4670 as scanner platform at 200 and 600 dpi resolutions; 4) anesthetizing the snake and measuring once with a tape ruler.

Results.—We compared the measurements from the anesthetized snake against the other nine treatments (Table 1; based on the precision study results of Blouin-Demers [2003] and Setser [2007] this measurement was considered the standard value). Both the standard value and measurements from the stretched conscious snake resulted in longer measurements for total length (TL; ca. 4.2% longer) and SVL (ca. 6.2% longer) when compared to measurements from scanned images, irrespective of being calculated by map-reader or GIS software. In addition, most measurements from images scanned at 150, 200, and 600 dpi resolutions, and measured with the map-reader, were significantly smaller that the standard value of the snake length, especially for the images acquired with the HP-4670 scanner. Of the tail length measurements from different procedures, those acquired from scanner images were much closer to standard value than the ones from the stretched conscious snake. Although the TL measurements from stretched conscious snakes appeared to be very similar to that of the standard measurement, it resulted in a longer Tail-L and a relatively shorter SVL compared to the anesthetized snake (Table 1).

Most ventral characters can be easily counted from images on the computer screen. Unclear or small characters can be seen and counted after being magnified. Between 1999 and 2005 more than 400 different images have been recorded from *E. chinensis*, *E. plumbea*, *S. annularis*, *S. percarinata suriki*, and *X. piscator* for population monitoring. Ventral characters, including ventral scale number, gular region (Dowling 1951), subcaudals, chin-shield, and anal plate have been successfully scanned from every live snake, and we have successfully used ventral color patterns to identify individual snakes.

The scanned image also provides a record of the ventral markings and coloration. Ventral images of lizards scanned at a resolution of 300–600 dpi provides several additional characters in so far as the shape and number of the infra-labial scales, subdigital scales, posterior anal scales, tail-margin structure and, if present, groin

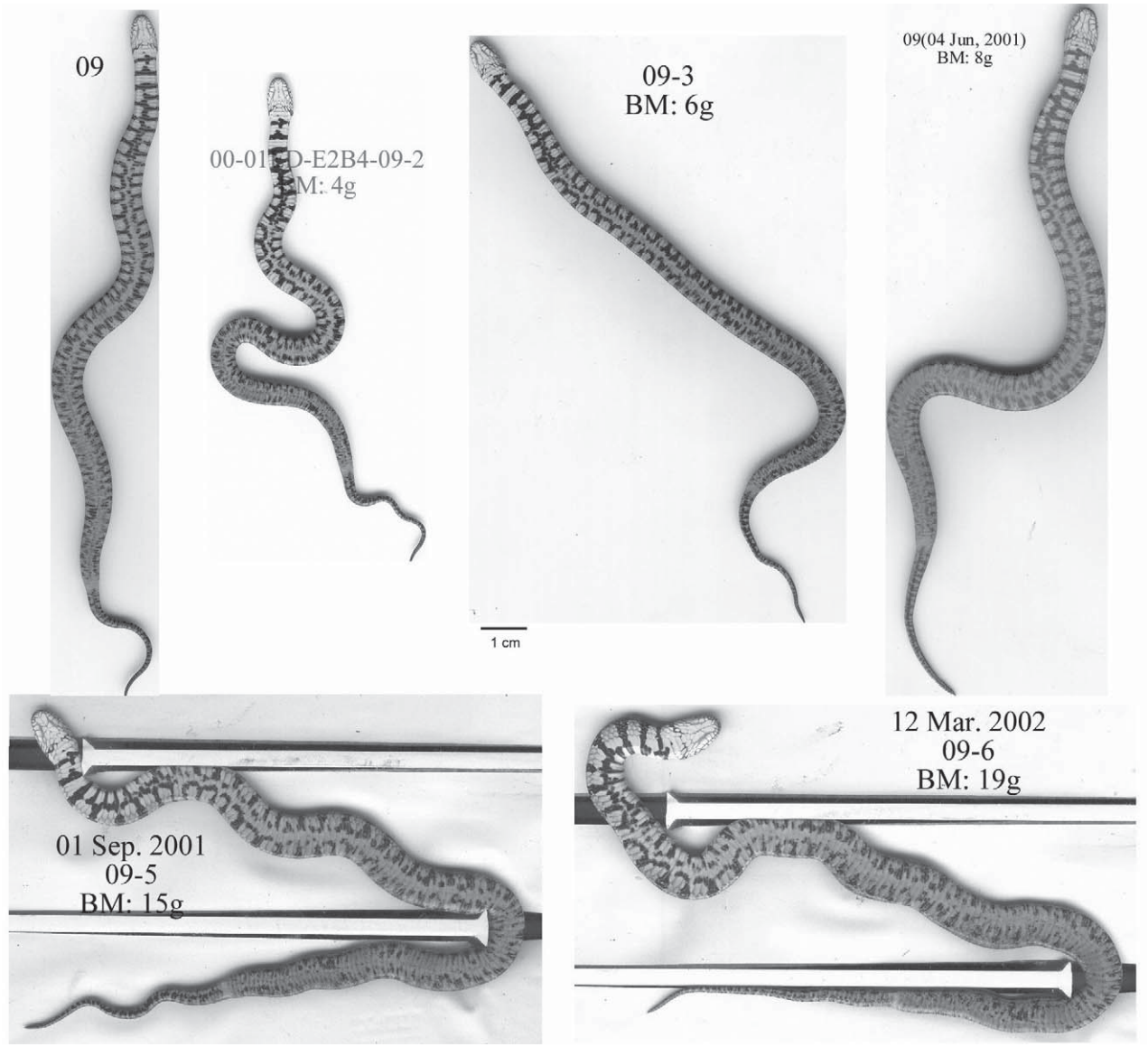


FIG. 2. The monitored ventral pattern and growth of a *Sinonatrix annularis* newborn over an 18 month period; (left to right, top to bottom) new born, 3 months old, 6 months old, 9 months old, 12 months old and 18 months old.

pores.

Our method has already been utilized to great effect in our field and laboratory studies. In 2000 the growth rate of a litter of newborn *S. annularis* was regularly recorded with this method in a field enclosure in a semi-aquatic Cape-lily (*Crinum* sp.) paddy, Yangminshan, Taipei (Mao 2003). For a period of nearly two years the seven neonatal *S. annularis* individuals were scanned every three months (Fig. 2).

Discussion.—Setser (2007) explained at length the problems associated with stretching snakes during measuring procedures, and although our proposed method does overcome this, it has some considerations that should be taken into account. The snake should be extended in the labyrinth, with as little kinking as possible, since these may result in slightly shorter measurements. In addition, the length measurements determined by GIS software were slightly closer to the standard value (anesthesia snake measurement), when compared to map-reader calculations, which may be due to multiple causes. First, the scanner models employed different image collection devices; for example the HP-3300C acquired images by optical reflection while the HP-4670 uses CCD. The efficiency of these two devices will differ slightly, especially when the image is printed out on paper (HP technical support, Taipei, pers. comm.). Moreover, the length and distance on the image must be defined *a priori*, and some size rectification must be done by a length scale before GIS software measuring. This is not necessary with the printout measurements, but it must be taken into consideration that the snake's posture (coiled taut or loose) and anthropogenic operating biases may result in variation, especially when the map-reader must calculate the continually linear curves of a snake. However, a size rectification by verifying if the object size is 1:1 by checking certain length scales on the image (e.g., labyrinth trail width) can greatly reduce these problems, whether lengths are determined using software such as Image Tool (Measey et al. 2003), on the computer screen using GIS software (e.g., ArcView), or via a map-reader or proportional divider on a printout.

Natural markings were used in a Swedish *Natrix natrix* population (Carlström and Edelstam 1946) to identify individuals,

TABLE 1. Results of the length measurements taken from a male *Xenochrophis piscator* by four different methods and image resolutions. The asterisk indicates significant differences among the nine length measuring treatments compared to anesthesia of the snake (two tailed *t*-distribution test, P = 0.01, 4 df).

Input tool	Measuring method	TL in cm (mean ± SD)	t-value	SVL in cm (mean ± SD)	t-value	Tail-L in cm (mean ± SD)	t-value
	Anesthesia (N = 1)	63.6	—	43.9	—	19.7	—
Conscious—stretching the snake (N = 5)		63.62 ± 0.42	-0.048	42.98 ± 0.30	3.033	20.64 ± 0.23	-0.483
HP-3300C (150 dpi)	Map-reader (N = 5)	60.37 ± 0.69	4.667*	40.62 ± 0.84	3.916	19.74 ± 0.22	-0.204
	GIS software (N = 5)	61.64 ± 1.02	1.934	41.53 ± 1.03	2.301	20.11 ± 0.12	-3.380
HP-3300C (200 dpi)	Map-reader (N = 5)	60.30 ± 0.78	4.265	40.63 ± 0.87	3.780	19.67 ± 0.13	0.250
	GIS software (N = 5)	61.89 ± 0.78	2.203	41.85 ± 0.72	2.830	20.04 ± 0.18	-1.871
HP-4670 (200 dpi)	Map-reader (N = 5)	60.38 ± 0.43	7.566*	40.80 ± 0.39	7.871*	19.58 ± 0.10	1.234
	GIS software (N = 5)	61.31 ± 0.50	4.576	41.50 ± 0.39	6.099*	19.81 ± 0.16	-0.691
HP-4670 (600 dpi)	Map-reader (N = 5)	60.57 ± 0.35	8.700*	41.02 ± 0.37	7.910*	19.55 ± 0.08	1.875
	GIS software (N = 5)	60.95 ± 0.78	3.404	41.19 ± 0.56	4.524	19.76 ± 0.22	-0.258

and this method was also proposed for studies involving some lizards and amphibians (Ferner 1979). However, it had only limited applications for some species because this method was based on color pattern permutation. A snake "fingerprinting" digital system was developed by Hailey and Davies in 1985, and was based on a combination of natural markings and ventral scale blotch patterns, recorded by photographing *Natrix maura*. Photo identification has also been shown to have good potential as a non-invasive identification technique for some amphibians such as *Eurycea bislineata wilderae* (Bailey 2004). Digital cameras can be used for recording characteristics of individuals and could aid in taking various measurements (Measey et al. 2003; Perera and Pérez-Mellado 2004). Bender (2001) proposed the use of natural markings to identify individual reptiles, especially for the registration of pets. In our opinion, images of the ventral views of lizards and snakes from digital cameras may be out-of-focus or exhibit insufficient image quality if using the technique proposed by Bender (2001). Measey et al. (2003) also stated that the digital cameras are prone to un-repairable error in the field. During previous observations it was found that photographs could not always reflect a clear ventral pattern image of the snake, especially, when the individual being photographed was small or under conditions of multiple light sources (Mao and Norval, pers. obs.). In addition, there was the problem of restraining the snake in an upside-down position. Mertens (1995) used xerographic copies to recognize individual juvenile *Natrix natrix*, but bulky xerographic equipment is difficult to transport and is costly to acquire and maintain. Furthermore, when a large number of fingerprinting files are required for resources management purposes, locating the correct fingerprinting pattern from the huge number of images in the database can be a time consuming process. Although some of the commercially available software does not fully satisfy our requirements of image database sorting and comparison, it is our opinion that by incorporating the proposed scanner method with some commercial digital camera software (e.g., Visual Similarity Duplicate Image Finder), the process can be greatly simplified, and could be an invaluable tool in dealing with herpetological fieldwork involving identification of individual animals. We believe our proposed method not only aids in measuring small reptiles, but can also have broad application in population studies.

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A Novel Aquatic Thermal Mosaic for Assessing Preferred Body Temperature in Semi-Aquatic Snakes

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Reptiles maintain their body temperature (T_b) at or near a preferred level that is generally referred to as the thermoregulatory set-point range (T_{set}; Hertz et al. 1993). Knowledge of T_{set} is useful as an indicator of the T_b that an organism tries to achieve and maintain during thermoregulation (Angilletta and Werner 1998). Careful regulation of T_b increases the time spent at physiologically favorable temperatures (Huey et al. 1989). It is often assumed that T_{set} is the optimal temperature range since an animal would strive to maintain a T_b at which it performs and/or functions optimally (Bartholomew 1977).

Measuring T_{set} is significant in studies of ectotherms because it provides a yardstick against which field or operative temperatures (T_e) can be compared and the effects of environmental or physical conditions on thermal performances can be evaluated (Al-Johany and Al-Sadoon 1996; Van Damme et al. 1986). T_{set} is measured in the laboratory using thermal gradients or mosaics, which have been used in studies of thermal preferences in a wide variety of reptiles (e.g., see Al-Johany and Al-Sadoon 1996; Blouin-Demers et al. 2000; Firth and Belan 1998; Gvoždik and Castilla 2001; Patterson and Davies 1978; Stapley 2006; Tosini et al. 1995). While thermal gradients are useful in thermal studies on reptiles, thermal mosaics are preferable because they provide multiple thermal gradients and therefore create more choices for the reptile. Thermal gradients are generally constructed as a box with one end heated and the other end cooled creating a thermal gradient from one end to the other, which results in only one location for any particular temperature. In thermal mosaics, two opposite corners are heated and the other two corners are cooled, which establishes multiple gradients across the floor of the box. In a mosaic, the reptile is therefore able to choose among different areas that are the same temperature.

For semi-aquatic reptiles, the ability to regulate T_b within T_{set} may vary considerably between aquatic and terrestrial habitats. Water has a higher thermal inertia than air and is therefore more thermally stable than many terrestrial habitats. Although a terrestrial mosaic is useful in measuring T_{set} in a terrestrial environment, the thermoregulatory abilities and/or preferences of semi-aquatic reptiles in water may vary due to the different thermal properties of water. Owing to limitations with the design and construction of thermal mosaics, studies of thermal preference have been conducted primarily on terrestrial species.

Thermal preferences in fish are commonly measured using shuttleboxes. The shuttlebox usually consists of two chambers connected by a channel. The difference in the water temperature between the chambers is constant and the fish is able to move freely between the chambers. The temperature in the chambers is usually increased or decreased depending on whether the fish chooses the warmer or cooler chamber. The preferred temperature is measured as the actual chamber temperature (e.g., see Mortenson et al. 2007) or determined by the time spent in each chamber (e.g., see Larsson 2005). Thermal gradients are also used in some studies measuring thermal preferences in fish. These thermal gradients generally comprise a large box divided into zones or lanes with varying temperatures along the length of the box to create a temperature gradient (e.g., see Lafrance et al. 2005; Podrabsky et al. 2008). Tamplin (2006) successfully used an aquatic thermal gradient (similar to those used in fish studies) to investigate the thermal preferences of hatchling Wood Turtles (*Glyptemys insculpta*), but, to the best of our knowledge, there have been no studies of semi-aquatic or aquatic reptiles using an aquatic mosaic.

Here, we provide a description of a novel aquatic mosaic we successfully used in investigating thermal preferences in juvenile Yellow Anacondas (*Eunectes notaeus*; SVL 0.5–0.6 m, mass ca. 180 g; N = 8; McConnachie, Greene and Perrin, unpublished data) and Common Brown Water Snakes (*Lycodonomorphus rufulus*; SVL 0.4–0.6 m, mass ca. 60 g; N = 5; McConnachie and Perrin, unpubl. data).

The aquatic thermal mosaic (1.2 x 1.2 x 0.5 m) was constructed from 10 mm marine plywood with a transparent acrylic fitted lid. The plywood box was divided into 16 three dimensional (300 x 300 x 200 mm) compartments with 10 mm marine plywood partitions and the interior walls were coated with fiberglass. Each compartment contained an immersion heater (500 W – reconfigured to run at 250 W), earthing rod (for the safety of researcher and reptiles in case of a short circuit), temperature sensor and air stone (Fig. 1).

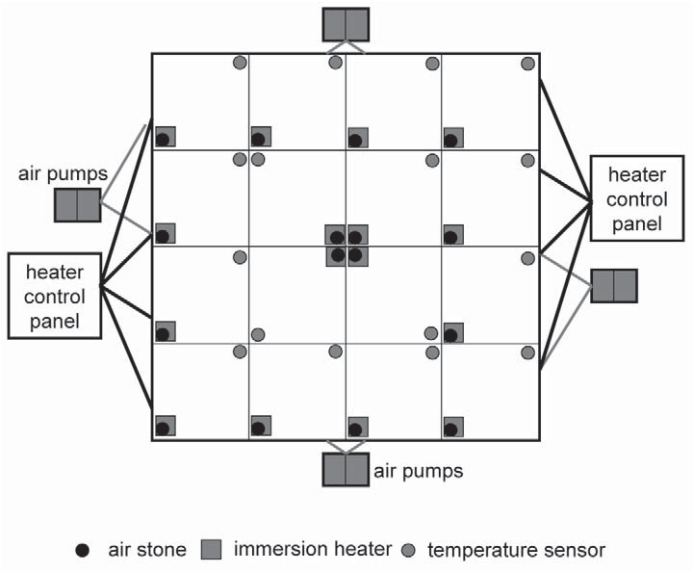


FIG. 1. Layout of the aquatic thermal mosaic. The immersion heater and temperature sensor were placed in opposite corners of compartments to ensure even heating of the water in each compartment.

Each immersion heater and corresponding temperature sensor was connected to a thermostat (-40–50ºC, resolution 0.1ºC) located in one of two control panels. Eight standard dual tube aquarium air pumps (Jumbo Jet 7800) powered the 16 air stones to circulate heated water. All wiring and tubing was glued and/or taped to the partitions or sides of the mosaic and each heater was enclosed in plastic mesh to avoid influencing or interfering with snake movement (Fig. 2). Each compartment was filled with water to within 5 mm of the top of the partitions and randomly assigned a temperature between 10ºC and 45ºC at 5ºC increments. We decided on a random placement of temperatures to create numerous gradients between the different compartments and to provide the snakes with as heterogeneous an environment as possible. The mosaic was set up in a constant environment (CE) room with T_a of 10ºC to maintain low temperatures and to encourage snakes to remain in the water. (Very little is known about Yellow Anacondas or Common Brown Water Snakes in the wild, but both occur in areas which experience environmental temperatures below freezing. A T_a of 10ºC is likely to be at the lower end of range of T_es usually available to both species in the wild.) The range of aquatic T_es available to the snakes (17-44ºC) was measured using 100 iButtons (Dallas Semiconductor, Texas) spread throughout the mosaic.

In order to avoid a build up of condensation on the acrylic lid of the aquatic mosaic, we raised each side of the lid to an angle of approximately 30º. A bracket was made for each side and the gap was covered in 30% shade cloth to allow moisture out, but keep snakes in. Although the modification resulted in some evaporative water loss, particularly from the warmer compartments, we were able to run a full trial (36 h; 12 h acclimation, 24 h recorded trial) without having to add water.

The design and construction of the aquatic thermal mosaic allowed us to establish the T_{set} for juvenile Yellow Anacondas (ca. 28ºC) and Common Brown Water Snakes (ca. 21ºC; calculated as the range of T_bs selected over the 24 h recorded trial; data from these experiments to be published elsewhere). Similar to a terrestrial thermal mosaic, the aquatic thermal mosaic provided multiple thermal gradients over a wide range of temperatures, which were easily adjusted. Because our mosaic allowed for such a wide range of temperatures, it should be suitable for determining T_{set} (and other thermal preference measurements) for species with different thermal requirements.

We encountered a variety of problems during construction and running of the aquatic mosaic. In the aquatic mosaic, snakes were observed resting on the partitions between compartments, with parts of their bodies in one or more compartments. Although completely aquatic species may spend all their time submerged in one compartment or another, semi-aquatic species can be expected to spend some time out of the water. Our compartments may have been too deep for the snakes to rest comfortably while submerged in the water. The snakes may also have preferred the support of the compartment wall because there were no resting points within the compartments. A stone or small branch submerged in each compartment would provide a shallower resting point within the compartment, which may encourage the snakes to remain in the compartment.

The immersion heaters we used initially were designed to heat water in coffee cups and often malfunctioned or burned out. While the immersion heaters were suitable for our study on juvenile Yellow Anacondas, they were replaced with 100 W aquarium heaters (Resun). The aquarium heaters were more stable and efficient and were used successfully for the study on Common Brown Water Snakes. The built-in temperature control mechanism was bypassed and each heater was controlled using the temperature sensors and controllers. The aquarium heaters proved superior to the immersion heaters, particularly because they can be more finely controlled. In addition, the original heaters in the middle four compartments could only be mounted in the centre of the mosaic. The aquarium heaters could be mounted identically in each compartment, which meant that each compartment was structured identically and was less likely to affect snakes' movements or preferences based on compartment structure. The original heaters also resulted in substantial amounts of evaporative water loss, particularly in the warmer compartments, and the snakes had a tendency to perch

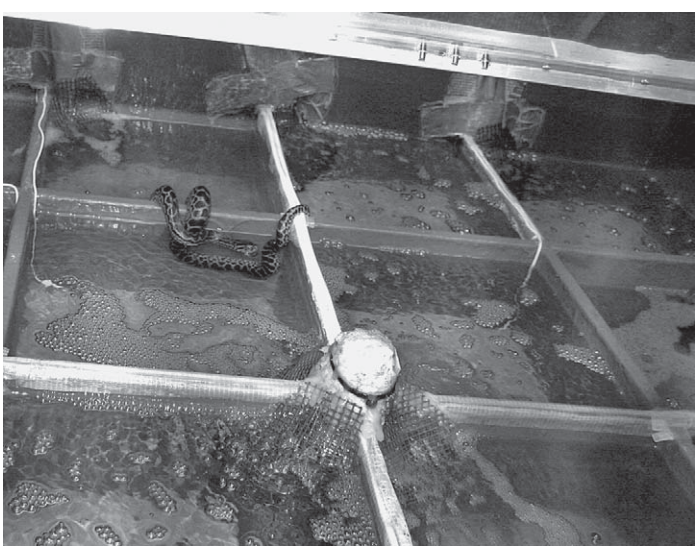


FIG. 2. Juvenile Yellow Anaconda (*Eunectes notaeus*) in the aquatic thermal mosaic. Wiring and tubing were glued and/or taped to the partitions or sides of the mosaic and each heater was enclosed in plastic mesh.

out of the water on the compartment partitions. Heating with the aquarium heaters resulted in less evaporative water loss, so the snakes tended to remain submerged instead of perching out of the water on the partitions.

Temperature in the aquatic thermal mosaic was easily adjusted using the temperature controllers. In addition, the temperature of the CE rooms where the mosaics were housed could also be adjusted. Adjusting both CE room and heater temperatures allow for a wide range of temperatures. Also, temperatures in individual compartments in the aquatic thermal mosaic could be individually controlled, so temperatures for compartments could be randomly or structurally organized. While we were able to maintain stable temperatures in most compartments, we were not able to maintain the lowest temperatures because warm compartments adjacent to coldest compartments often warmed them. There was no insulation between adjacent compartments other than the marine plywood partitions. Additional insulation may be necessary to maintain distinct temperature differences between compartments.

Overall, the aquatic thermal mosaic worked well for determining thermal preferences of juvenile Yellow Anacondas and Common Brown Water Snakes, and is suitable for use with other semi-aquatic reptile species. Despite the problems we experienced with the immersion heaters, they worked sufficiently to complete the Yellow Anaconda study, but the aquarium heaters used in the Common Brown Water Snake study are better suited. The ability to adjust the temperatures of both heating and cooling systems (directly through heaters or indirectly through changing T_a) suggests that the aquatic mosaic is suitable for use in studies on other aquatic and semi-aquatic snakes and potentially other aquatic and semi-aquatic ectotherms. Fine-tuning the mosaic for the requirements of each species will enhance the success of the apparatus while investigating thermoregulation in aquatic and semi-aquatic animals.

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SSAR Student Travel Awards — Call for Applications

Ten awards of US $400 each are available to students to help defray the cost of traveling to the 2009 Joint Meeting of Ichthyologists and Herpetologists (JMIH). An applicant for a travel award must be a student and a current member of SSAR, must not have previously received a travel award from SSAR, and must be the first author of a paper or poster to be presented at the 2009 JMIH. The application package must include: 1) a letter signed by his/her major advisor or department chair that states that he/she is not completely funded for travel from another source and, if the research is co-authored, that the work was primarily the product of the applicant; 2) a copy of the abstract that was submitted for either poster or oral presentation. The qualified applicants will be pooled and the winners will be drawn at random. Students from the immediate vicinity of the JMIH, as well as current members of the SSAR Travel Awards Committee, are excluded from applying for a travel award. Award checks will be disbursed at the SSAR Business Meeting to be held during the JMIH. Application materials are preferred in electronic form (either PDF or Microsoft Word) and should be sent to Matthew Venesky by 15 April 2009 (mvenesky@memphis.edu); however, hard copies can be mailed to Matthew Venesky, The University of Memphis, Department of Biology, Memphis TN USA, 38152. Hard copies sent via postal mail must be postmarked prior to 15 April 2009 to be considered.

For more information, contact: Cari-Ann Hickerson (chickerson@jcu.edu) or Matthew Venesky (mvenesky@memphis.edu).

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A New View from a Novel Squeeze Box Design

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Obvious risks are associated with measuring venomous snakes. Herpetologists have employed several methods for restraining venomous snakes while taking measurements, including, but not limited to holding the snake behind the head by hand, anesthesia, tubing, and squeeze boxes (Fitch 1987; King and Duvall 1984; Quinn and Jones 1974). The squeeze box method may be considered among the safest options because it does not require direct contact with the animal. Squeeze boxes generally consist of a wooden box with a foam insert that fits snuggly inside the box and a Plexiglas® sheet that fits inside the box on top of the foam insert (Quinn and Jones 1974). The clear sheet permits general morphological measurements such as snout-vent length (SVL) and tail length (TL) (Quinn and Jones 1974). However, the traditional squeeze box design only allows a dorsal view of the snake. Here we present a new variation on the traditional squeeze box design that permits both a dorsal and ventral view of the study animal.

Traditionally, tongs are used to place snakes between the Plexiglas® top and foam rubber base, permitting a safe estimation of snout-vent length from a dorsal view (Quinn and Jones 1974). Little has changed in the squeeze box design, although modifications have been made with lightweight materials for field use (Cross 2000). Our squeeze box design maintains the general shape of the traditional box. Size during construction will vary according to the animals being investigated. The sides are constructed of wood with a foam pad placed inside. In addition to a Plexiglas® top, our squeeze box also has a Plexiglas® bottom secured to the sides with screws (Fig. 1). Holes are drilled through the center of the opposing sides of the box allowing a dowel rod to pass across the top piece of the Plexiglas®, which locks the removable Plexiglas® lid in place while viewing the animal's venter. Large boxes may require holes on each side of the box and two dowel rods to ensure a secure hold on the animal. Holes are drilled at varying levels to allow for variation in the robustness of different species. In order to view the venter, the animal is placed in the box on top of the Plexiglas® bottom, with the foam pad and Plexiglas® lid placed on top of the animal. Therefore, the snake can be safely viewed from above, like the traditional box, and from below.

Some snake measurements depend on ventral markers, such as the cloacal vent, ventral pattern and scale counts. Using a traditional squeeze box to estimate ventral markers from a dorsal view may lead to significant error in measurements (Bertram and Larsen 2004). To compare measurements, the SVL of 10 watersnakes (*Nerodia fasciata*) were traced from both the ventral and dorsal views. Each trace was measured three times with a flexible tape measure and the means of the ventral and dorsal measurements were compared using a one-tailed paired t-test. Bertram and Larsen (2004) found the accuracy of this measuring method equal to more rigorous methods and with less stress to the animal. From the dorsal view, SVL was significantly overestimated relative to the ventral view ($\text{mean}_{\text{dorsal}} = 45.45$, $\text{mean}_{\text{ventral}} = 43.99$; d.f. = 9, $P = 0.0038$), and the average standard deviation was less for the ventral view ($SD_{\text{ventral}} = 0.231$, $SD_{\text{dorsal}} = 0.369$).

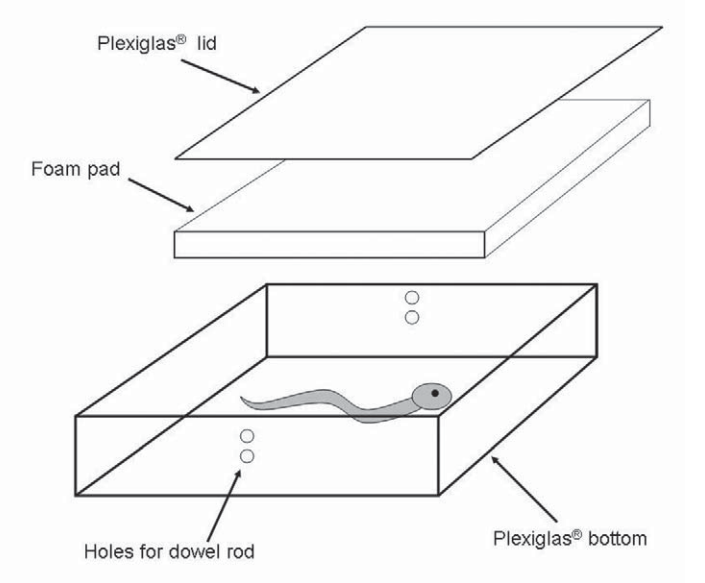


FIG. 1. Diagram showing the method for viewing the venter of snakes in the novel squeeze box.

With the use of the new squeeze box design, the dowel rod secures the lid at a chosen height, lightly squeezing the study snake between the Plexiglas® bottom and the foam insert. When turned over the snake remains in place, permitting confident measurements of SVL and TL. In addition to improved measurement accuracy, the new design allows a ventral view of the snake for photography or studies involving patterns or coloration. Further, with both dorsal and ventral views, scale counts can be taken safely on live individuals.

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AMPHIBIAN DISEASES

This section offers a timely outlet for streamlined presentation of research exploring the geographic distribution, host range, and impact of emerging amphibian pathogens, especially the amphibian chytrid fungus *Batrachochytrium dendrobatidis* (*Bd*) and ranaviruses. *Bd* is an emerging pathogen linked to mass mortality and declines of amphibians worldwide, yet Bd has also been detected in amphibians without disease. Ranaviruses also cause mass mortality, but have not yet been linked to large-scale declines. We know relatively little about their global distribution, host range, or impacts on host populations. To improve our understanding of the scope of this issue, we encourage submission of studies that illuminate the geographic distribution, host ranges, and impact of these pathogens on amphibian populations, including research on individual species or groups of species, wild or captive animals, native or non-native species, live animals or museum specimens, environmental samples, and, provided there is sufficient sampling[1], reports of non-detections.

We ask authors to: 1) restrict the Introduction of their paper to a **maximum** of two paragraphs to highlight the context of their study; 2) briefly include both field and laboratory Methods; 3) present Results in a Table, although a map might also be useful, and limited text; and 4) have a short discussion of a **maximum** of three paragraphs to touch upon key findings. Please include the following information in submissions as appropriate: coordinates and description of sampling areas (or please note if locations are extremely sensitive to reveal, and provide general area instead); species name(s) and life history stages examined, as well as other species present; whether samples were collected randomly or just from dead or moribund animals; date of specimen collection; evidence of unusual mortality; numbers of positive and negative samples; disposition of voucher specimens; name of collaborative laboratory or researcher conducting histological sections or PCR analyses; and names of cooperative land owners or land management agencies. We encourage researchers to conduct post-mortem examinations when possible to identify the cause of death when reporting mortalities. We aim to expedite the review and publication process! Please e-mail submissions directly to Associate Editor, Dr. Dede Olson: dedeolson@fs.fed.us.

[1]If a sample of 30 individuals of a particular life history stage of a particular species yields no positive results, and the diagnostic test is highly sensitive, one can conclude that the prevalence of infection is less than 10% with 95% confidence. With a sample of 10 an infection in one of four individuals could go undetected. We encourage researchers to collect sufficient samples that negative results are meaningful.

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Batrachochytrium dendrobatidis in Arboreal and Lotic Water Sources in Panama

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Chytridiomycosis caused by the pathogenic fungus *Batrachochytrium dendrobatidis* (*Bd*) has been implicated as a cause for many widespread amphibian declines (Berger et al. 1998; Bosch et al. 2001; Briggs et al. 2005; Ron and Merino 2000; Skerratt et al. 2007). Amphibians of Central America have experienced substantial declines involving 30 genera and nine families (Young et al. 2001) and *Bd* has been implicated in a number of these declines (Lips et al. 2006). For example, about 50 percent of the amphibian species at Las Tablas, Costa Rica, have declined or disappeared apparently due to *Bd* infection (Lips et al. 2003). A more thorough understanding of the natural history and ecology of *Bd* is still needed, and knowledge of the geographic distribution of this fungal pathogen is important for biological conservation (Adams et al. 2007; Young et al. 2001). Recently described techniques allow for the rapid detection of *Bd* DNA from skin swabs (Boyle et al. 2004) and environmental water sources (Kirshtein et al. 2007; Walker et al. 2007). To gain insight into the spatial distribution of *Bd* within a neotropical cloud forest habitat we utilized water filtering and quantitative PCR techniques to: 1) determine the presence of *Bd* in lotic water sources at a site where historic die-offs were attributed to *Bd* mortalities; and 2) determine if *Bd* was present in water collected in arboreal, epiphytic bromeliads.

Methods.—Our study was conducted in the cloud forests of the Los Quetzales Preserve (8.876389°N, 82.547222°W, 2200 m elevation), a private land holding adjacent to Parque Nacional Volcan Barú, Chiriquí Province, Panamá. We used the US Geological Survey (USGS) Backcountry Chytrid-water Field Protocol (C. Anderson, pers. comm.), similar to that described by Kirshtein et al. (2007), to detect and quantify the presence of *Bd* zoospores in water between 4 and 7 January 2008. Using vinyl examination gloves, we processed one sterile water control, as well as samples from a headwater stream (N = 3) and bromeliads (N = 5). Zoospores in sampled water were trapped by using sterile 60 cc syringes with Leur-lok® ends to pump water through 0.22 µm Sterivex™-GP filters. The volume of pumped water necessary to nearly occlude each filter was recorded. Filters were rinsed with 50 ml of sterile buffered phosphate saline (Sigma-Aldrich P5368). Filters, with retained particulates, were preserved with 0.9 ml of cell lysis solution (Fisher Scientific FP2301320). Cell lysis accommodated sample storage under variable field temperatures until subsequent laboratory analysis (Kirshtein et al. 2007). Sterile Leur-lok® caps were used to seal filter inlets, while a hematocrit sealant was used for outlets of each Sterivex™ filter. All sample filters were labeled and sealed individually in plastic zippered bags.

Stream samples were obtained from a 1st-order tributary of Río Chiriquí Viejo. This permanent stream was ca. 1 m wide and maximum depth was approximately 0.1–0.3 m. Water clarity was high and the primary substrates were gravel and cobble, with small areas of sand and silt accumulation in low velocity pools and along stream edges. Stream temperature at the time of sampling was a mean of 13.1°C. There was little aquatic vegetation and only slight amounts of organic debris, with low levels of suspended and dissolved organic matter. During sample collection, the weather was overcast with a light drizzle and air temperature was 8.5°C. Water was collected from riffle zones near the stream margin at 25 m, 75 m and 125 m upstream from the river confluence. We filtered 4.0 L, 4.2 L and 4.0 L respectively (see Table 1). These quantities were roughly double the maximum filtered volumes from lentic waters reported by Kirshtein et al. (2007), owing to the lack of suspended material in the stream.

Bromeliads at heights of less than 1.75 m were sampled from the ground, while those located higher in the canopy (from 2 to 11 m) were accessed using both single and doubled rope techniques. Water was collected by pulling down exterior bromeliad leaves, re-

TABLE 1. Quantitative PCR analyses were used to detect the presence of the amphibian chytrid fungus *Batrachochytrium dendrobatidis* (*Bd*) in water samples collected from a first-order stream and from arboreal sources (bromeliads) at Los Quetzales Reserve, Guadalupe, Panamá, in 2008. *Bd* zoospore equivalents per liter are reported for each of two replicate samples analyzed (rep) and their means. NA = Not applicable; ND = Not detected.

Water Source	Upstream from confluence (m)	Bromeliad Height and Number Sampled (N)	Water Volume Filtered (L)	*Bd* Zoospore Eq/L rep 1	*Bd* Zoospore Eq/L rep 2	Mean (SD) *Bd* Zoospore Eq/L
stream	25	—	4	6.3	4.2	5.3 (1.4)
stream	75	—	4.2	6.6	3.6	5.1 (2.1)
stream	125	—	4	9.0	6.0	7.5 (2.2)
bromeliads	-	0.9m (5), 1.2m (2), 1.5m (6), 1.8m (2)	0.066	ND	ND	NA
bromeliads	-	0.9m (3), 1.2m (3), 1.5m (2), 2.1m (5), 2.4m (2), 2.7m (2)	0.16	ND	ND	NA
bromeliads	-	0.m1 (1), 0.6m (2), 0.9m (1), 1.2m (2), 1.5m(1), 1.8m (3), 2.1m (1), 2.4m (2), 2.7m (1)	0.025	ND	ND	NA
bromeliads	-	1.2m (1)	0.035	6,840	6,720	6,780 (85)
bromeliads	-	11m (1)	0.084	3,580	3,920	3,750 (240)
field control	NA	NA	1.0	ND	ND	NA
lab control	NA	NA	0.15	ND	ND	NA

leasing stored water from leaf axils. As water was released it was captured in clean, 3.78-L plastic zippered bags. Underlying leaves on one side of the bromeliad (the lowest side if the bromeliad was growing at an angle) were successively bent down releasing additional water that dripped off the leaf tip. Individual bromeliads were sampled by this method until sufficient water had been obtained for a filter sample (~1 L). The amount of water from each bromeliad varied due to varying water holding capacities of the plants. Approximately 25–50 ml of water was obtained from each bromeliad. Three of the arboreal bromeliad water samples contained water from multiple bromeliads, ranging from 7 to 17 plants, and from heights of <1 to 6 m off the ground (Table 1). Two arboreal water samples were from a single bromeliad each, at heights of 1.75 m and 11 m. Bromeliad water ranged in temperature from 12.0 to 13.9°C. The five bromeliad samples had filtered water volumes ranging from 25 to 160 ml (Table 1). Because of the large amount of suspended organic material, we let each sample settle at ambient temperatures (< 17°C) for 2–7 h before extracting water for filtering. The high organic content of bromeliad water resulted in rapid clogging of the filters. All filters were labeled and placed in their own labeled plastic bag. Copies of data forms and bagged samples were shipped to the USGS laboratory in Virginia, USA, where they were analyzed using qPCR techniques (Boyle et al. 2004; Kirshtein et al. 2007).

Results.—Quantitative PCR analyses detected the presence of *Bd* in 5 of 9 water samples (Table 1). There were no *Bd* zoospores detected in the control sample. All three stream samples were positive for *Bd* zoospores, and two of the five bromeliad water samples tested positive for *Bd* zoospores (Table 1). The two positive bromeliad water samples were from plants that had the canopy-dwelling tree frog, *Isthmohyla picadoi* (Hylidae), in the plant or nearby (~1 m away).

Discussion.—These findings are significant because they confirm the presence of *Bd* at a site where declines of the local amphibian fauna have occurred (pers. observ.). Mortalities now believed to be caused by *Bd* were first observed in this area (Cerro Pando) in July 1994 (pers. obs.). Mortalities were directly observed in two species, *Atelopus chiriquiensis* and *Rana warszewitschii* (single dead individual of each species). Neither of these species was observed at our study site during three weeks of field research in January 2008. The apparent decade-long persistence of *Bd* has sobering implications for the prospects of repatriating susceptible amphibian species (Fellers et al. 2007).

In addition, while water filtering has been used to detect the presence of *Bd* zoospores in temperate, lentic waters (Kirshtein et al. 2007; Walker et al. 2007), to our knowledge this is the first published report of environmental testing using this technique in neotropical regions and lotic waters. The levels of *Bd* zoospore equivalents in our lotic samples were within the lower range of levels reported from temperate, lentic systems (Kirshtein et al. 2007; Walker et al. 2007; C. Anderson, pers. comm.). Tropical stream-dwelling amphibian species from moderate to high elevations in Central America have experienced inordinate levels of decline (Lips et al. 2003; Pounds et al. 2006), and Kriger and Hero (2007) found a greater prevalence of *Bd* infection among stream breeding amphibians in Australia. Consequently, the ability to detect the presence of *Bd* in lotic waters should prove vital to better understanding *Bd* ecology (Walker et al. 2007). The technique described herein is suitable even when low amphibian abundance prohibits skin swab sampling.

Although there are no known published accounts of *Bd* in arboreal water sources, a study by Longcore (2005) documented the presence of the fungal groups Chytridiomycota, Oomycota, and Hypochytridiomycota from canopy detritus samples obtained in New Zealand and Australia. Twelve of the species detected by Longcore (2005) were chytrids. We report the first published account of *Bd* in arboreal water sources. Our values are ~10x higher than any published samples acquired via these techniques. For example, Kirshtein et al. (2007) reported a range of 19–454 zoospore equivalents/L, and Walker et al. (2007) described ranges from 0.5 to 262 zoospore equivalents/L. Filtering water as soon as possible is advised, since Hyatt et al. (2007) reported declines in zoospore abundance in water samples that are allowed to settle for longer than 8 h. In addition, Hyatt et al. (2007) indicated that zoospores appear to attach to water containers. Consequently, an improved technique may include rinsing sample bags and filtering the rinsate. The presence and abundance of *Bd* in our arboreal samples suggest that arboreal sites may serve as additional environmental reservoirs,

facilitating the persistence of *Bd*.

Various hypotheses have been proposed to explain how *Bd* persists in the environment, including the presence of a saprophytic form (Johnson and Speare 2003; Longcore et al. 1999) although none has been described for *Bd*. Di Rosa et al. (2007) suggested that we still do not understand the entire life cycle of *Bd*, and they described a new growth form that may represent a persistent encysted-form. Non-vertebrate hosts have been proposed and Rowley et al. (2006) initially asserted that freshwater shrimp were *Bd* vectors, although subsequent studies failed to verify this hypothesis (Rowley et al. 2007). Regional persistence may be explained by reservoir species of amphibians that are not lethally infected (Briggs et al. 2005), and such species are known to occur in some areas (Daszak et al. 2004; Garner et al. 2006; Woodhams et al. 2007). While we have not yet identified a specific amphibian host, it is possible that infected individuals of two canopy-dwelling amphibian species occurring at this site are responsible for shedding *Bd* zoospores into bromeliad water. Work is currently under way to analyze skin swabs of *Isthmohyla picadoi* and *Bolitoglossa* sp. from this study site for the presence of *Bd*.

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Presence of *Batrachochytrium dendrobatidis* at the Headwaters of the Mississippi River, Itasca State Park, Minnesota, USA

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The disease caused by the pathogenic fungus *Batrachochytrium dendrobatidis* (*Bd*), chytridiomycosis, is one of several factors driving the global decline of amphibian populations (Blaustein and Kiesecker 2002; Lips et al. 2006; Muths et al. 2003). *Bd* has been found in amphibians at sites across North America including Minnesota, USA (Ouellet et al. 2005; Woodhams et al. 2008). The prevalence of *Bd* in wild anuran populations in Minnesota is unknown, and motivated the work described herein.

We investigated the occurrence of *Bd* at the University of Minnesota's Itasca Biological Station and Laboratories in Itasca State Park, site of the headwaters of the Mississippi River. Our research objectives were to: 1) verify if *Bd* is present in the park; 2) determine which anuran species are affected by the fungus; and 3) test if there are differences in infection rate among species.

Methods.—We collected frogs in Itasca State Park, Clearwater County, Minnesota in June and July 2008. We collected frogs by hand and with nets at night in breeding ponds and during the day near ponds and wetlands. We rinsed nets with 95% ethanol between outings and wore latex gloves in the field and the laboratory to prevent potential transfer of *Bd* among individuals. A subsample of frogs was toe-clipped and released in the field, but most were vouchered. Toe-clips were collected in individual plastic bags and we extracted genomic DNA immediately upon return to the laboratory. We kept frogs individually in plastic bags from time of capture until they were euthanised in the laboratory. Frogs were humanely euthanised with MS-222 (tricaine methanesulfonate) or topical application of benzocaine (Simmons 2002). MS-222 does not appear to inhibit growth or detection of *Bd* (Webb et al. 2005) and was the preferred method of euthanasia. We clipped one toe and a portion of adjacent webbing to obtain tissues. We stored tissues in 95% ethanol at 4°C until processing. All vouchers were deposited in the Bell Museum of Natural History, University of Minnesota (JFBM).

We extracted genomic DNA from tissues using the Qiagen extraction kit (Qiagen, Valencia, CA, USA) following the manufacturer's instructions. We used polymerase chain reaction (PCR) to amplify a 300-bp fragment consisting of part of internal transcribed spacer 1 (ITS1), ribosomal rRNA 5.8S, and part of internal transcribed spacer 2 (ITS2) using *B. dendrobatidis* specific primers (Bd1a and Bd2a; Annis et al. 2004). PCR was performed in 12.5 μl reaction volumes under the following conditions: an initial denaturation of 94°C for 5 min; 30 cycles of denaturation (94°C for 45 sec), annealing (50°C for 45 sec) and extension (72°C for 1 min); followed by a final extension of 72°C for 5 min. All PCR reactions contained a negative control. PCR products were run on a 1% agarose gel, stained with ethidium bromide and visualized under ultraviolet light. Presence of a strong, defined band approximately 300 bp was considered a positive result.

We sequenced two positive samples to ensure that we had amplified *Bd* rather than non-target DNA. We purified PCR products using Exonuclease I and Shrimp Alkaline Phosphatase (Hanke and Wink 1994). Sequencing was performed using Big Dye (Perkin Elmer, Boston, MA, USA) terminator cycle sequencing on an ABI 3730xl at the Advanced Genetic Analysis Center, University of Minnesota. We used BLAST (Altschul et al. 1990) to verify that sequences were *Bd*.

We tested whether infection rates of *Bd* were significantly different among sampled species and among sampled families of frogs using a Chi-square contingency test. All statistical analyses

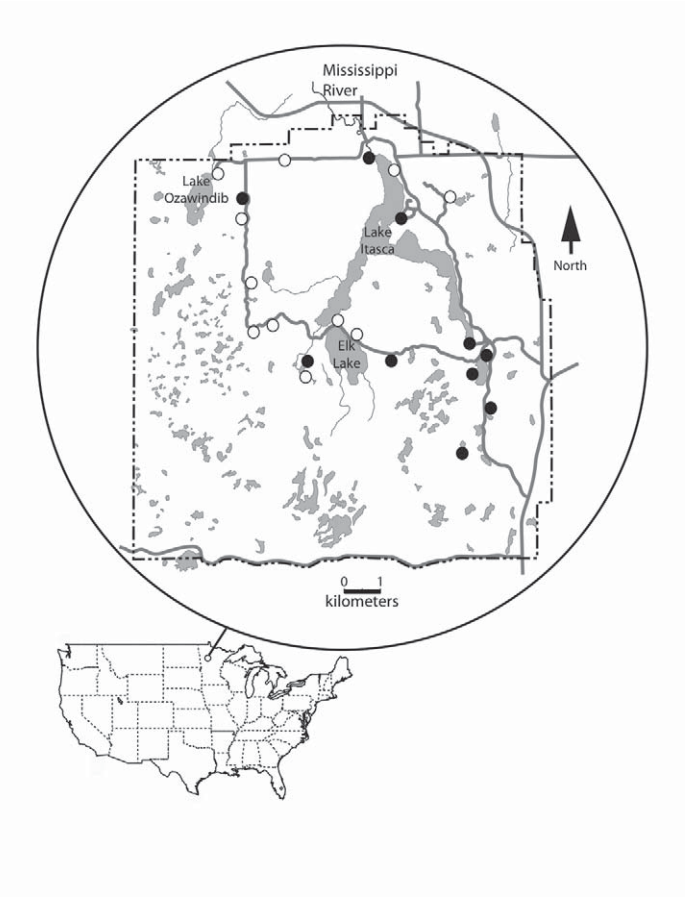


FIG. 1. Collecting locations (circles) of anurans examined for *Batrachochytrium dendrobatitis* (*Bd*) at Itasca State Park, Minnesota, USA. Localities with *Bd*-positive specimens indicated by filled cirlces, localities with no *Bd*-positive specimens indicated by open circles. Park boundaries shown by a dashed line. Light gray areas are water.

were conducted using JMP 7.0 (SAS 2007).

Results.—We collected tissues from 147 frogs and toads of three families from around Itasca State Park (Fig. 1), consisting of 133 vouchered specimens and 14 toe-clips of released frogs. Thirty-four of 147 (23%) individuals were *Bd*-positive. None of our negative controls produced bands on agarose gels. *Pseudacris maculata* had the highest percentage of positive individuals, 50% (Table 1), although it is difficult to interpret this given the small number of individuals captured. *Lithobates pipiens* had the second highest infection rate with 33.3% of samples being *Bd*-positive. *Hyla versicolor* and *Pseudacris crucifer* had no positive samples. We collected one dead *Lithobates sylvaticus* (JFBM 15957) at the Mississippi River headwaters on the North end of Lake Itasca that tested positive for *Bd.* No other dead animals were found, and no animals were observed with symptoms of illness.

TABLE 1. Prevalence of *Batrachochytrium dendrobatidis* in seven frog species collected in Itasca State Park, Minnesota, USA, in 2008.

Species	Family	No. *Bd*-Negative Animals	No. *Bd*-Positive Animals	% Positive (95% C.I.)
Anaxyrus americanus	Bufonidae	20	1	4.8 (0–24.4)
Hyla versicolor	Hylidae	19	0	0 (0–19.8)
Pseudacris crucifer	Hylidae	2	0	0 (0–70.1)
Pseudacris maculata	Hylidae	1	1	50 (9.5–90.6)
Lithobates pipiens	Ranidae	14	7	33.3 (17.1–54.8)
Lithobates septentrionalis	Ranidae	13	3	18.8 (5.8–43.8)
Lithobates sylvaticus	Ranidae	78	22	22 (14.9–31.2)

Rates of *Bd* infection differed among species ($\chi^2 = 16.505$, $P < 0.0113$) and among families ($\chi^2 = 9.673$, $P < 0.0079$). Frogs in the family Ranidae had a higher infection rate than Bufonidae and Hylidae (Table 1).

We confirmed that DNA fragments amplified using PCR were *Bd* by sequencing two of our positive PCR products. Both sequenced samples, one from *Lithobates sylvaticus* (JFBM 15884, Genbank accession number FJ229469) and the other from *Lithobates pipiens* (JFBM 15918, Genbank accession number FJ229470) had an identical sequence. We compared our sequences to *Bd* sequences on Genbank using BLAST, confirming our samples as *Bd.* Our samples had 100% identity with the following *Bd* sequences from Genbank: EU779867, EU779864, EU779863, EU779862, EU779860, EU779859. Our samples had a 98 % identity with *Bd* sequences AY997031 and EU779866.

Discussion.—Rates of *Bd* infection in Itasca State Park varied among species and families. This variance is similar to observations from other North American sites for the same species (Longcore et al. 2007; Ouellet et al. 2005). North American hylid frogs, for example, typically have had low *Bd* infection rates (Longcore et al. 2007; Ouellet et al. 2005; Pearl et al. 2007) and we found no evidence of *Bd* in the hylid species *Hyla versicolor* and *Pseudacris crucifer*. *Pseudacris maculata* and *Acris blanchardi* appear to be exceptions to this rule (Ouellet et al. 2005; Steiner and Lehtinen 2008) and we found one infected *P. maculata* in the Park. We found the highest rates of infection in the three ranid species examined, *L. sylvaticus, L. pipiens* and *L. septentrionalis.* Several hypotheses have been proposed to explain the species-specific variance in *Bd* infection rates. Because *Bd* can persist in aquatic environments (Johnson and Speare 2003), species that spend more time in the water are thought to be at greater risk of infection than species spending less time in the water (Hero et al. 2005; Lips et al. 2003). *Bd* is prevalent in species breeding in permanent wetlands and streams (Kriger and Hero 2007) and in species that overwinter in aquatic environments (Longcore et al. 2007). There is also, potentially, a phylogenetic component to *Bd* (Corey and Waite 2008) with some amphibian lineages showing greater susceptibility to chytridiomycosis than others.

The presence of *Bd* in multiple frog species in Itasca State Park highlights the pathogen's pervasiveness in North America. North American amphibian populations have been exposed to *Bd* since the early 1960s and have been found across the continent (Ouellet et al. 2005). Presence of *Bd* does not always lead to mortality or population declines (Retallick and Miera 2007) but, given its potential as a pathogen, the presence of the fungus is cause for further monitoring of infected populations.

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Chytridiomycosis in Woodhouse's Toad (*Anaxyrus woodhousii)* in Colorado

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As scientists in the 1990s became aware that amphibian populations were experiencing population declines on a number of continents, the most perplexing mortalities were those observed in relatively pristine environments in which man-made habitat destruction, introduction of invasive species, or direct application of toxicants were not evident. Mass mortalities of amphibians in these relatively untouched environments, such as wilderness areas of the American West and tropical rainforests in Australia and Central America, shared a number of similarities that suggested a common proximate cause. These similarities were: 1) mass mortalities were observed principally in metamorphosed amphibians; 2) populations experienced severe declines in size, and, in some cases, total extinction; 3) only some of the amphibian species in a given locality experienced declines; and 4) population declines were more pronounced at higher elevations or in cooler regions than in lower/warmer areas (Lips 1998; Carey et al. 1999). Many of the mass mortalities sharing this pattern have now been attributed to a chytrid fungal pathogen, *Batrachochytrium dendrobatidis* (hereafter *Bd*; Berger et al. 1998; Skerratt et al. 2007). The observations that *Bd* is more likely associated with mass mortalities of amphibians at higher elevations in mountain ranges than in the adjacent lowlands have been replicated on several continents. For instance, numerous mass mortalities have been noted above approximately 400 m in Costa Rica and Panama (Lips 1998; Lips 1999; Young et al. 2001) but, even though *Bd* has been documented histologically on a number of species living at lower elevations in these countries, no mass mortalities have been observed (Puschendorf et al. 2006). Die-offs are most pronounced at elevations over 400 m in Australia (McDonald and Alford 1999 and above ca. 2000 m in Spain (Bosch et al. 2001; Bosch and Martinez-Solano 2006).

Woodhouse's Toads *(Anaxyrus woodhousii)* (formerly *Bufo woodhousii*; Crother 2008) are widely distributed in the US throughout the western central plains and Rocky Mountain states, from Montana and South Dakota south to Arizona and Louisiana. In Colorado, this species generally occurs at lower elevations up to ca. 2100 m. It is replaced at higher elevations by Western Toads (*Anaxyrus boreas*) (formerly *Bufo boreas*; Crother 2008) which range from about 2500–3550 m (Livo and Yackley 1997). Only one area of sympatric occurrence of the two species has been reported in Colorado (Hammerson 1999; Harris 1963). Western Toads are very susceptible to *Bd* (Carey et al. 2006). Beginning in the 1970s, Western Toad populations have experienced numerous mass mortalities that have extirpated breeding populations from about 85–90% of their historical habitats (Carey 1993; Corn et al. 1989). Some of these mass mortalities have been attributed to *Bd* (Carey et al. 1999; Muths et al. 2003). In a few instances, Woodhouse's Toad carcasses have been observed in the wild, but the deaths could not be attributed to *Bd*. Some carcasses were observed during one study in Arizona, but the carcasses were too decomposed to analyze for the presence or absence of *Bd* (Sredl 2000). Additionally, one of us (LL) found a dead Woodshouse's Toad in Canyonlands National Park, Utah (17 August 1992, ca. latitude 38.06814, longitude 109.76871) and two dead Woodhouse's Toads at Colorado National Monument, Colorado (24 June 1999, latitude 39.01993, longitude 108.64672). Toads at both of these locations were very decomposed and observed before a PCR test for *Bd* was developed. However, to our knowledge, no observations of mass mortalities of Woodhouse's Toads attributed to *Bd* have been recorded in the literature (see Sullivan 2005). Therefore, the goal of this study was to determine whether or not *Bd* is present on Woodhouse's Toads in Colorado.

A total of 86 Woodhouse's Toads were collected at a number of sites, the elevations of which ranged from 1096 to 2032 m (Table 1). Elevation for each sampling site was determined by plot-

ting the GPS coordinate as decimal degrees (WGS84 datum) with National Geographic TOPO! software (Version 3.4.3). When two or more individuals were sampled within a 10 km distance on the same date and the same drainage complex, the individual sites were combined into a single locality for which the mean elevation and latitude/longitude were calculated. We selected a 10 km distance because Woodhouse's Toads in our sampling areas would encounter fewer barriers to movement within a drainage complex than Western Toads in the mountains of Colorado. This latter species has been reported to move straight-line distances of at least 7–8 km between breeding sites (Lambert and Gaughan 2007), which, when following drainages rather than traversing intervening mountains, would result in movement estimates of more than 15 km.

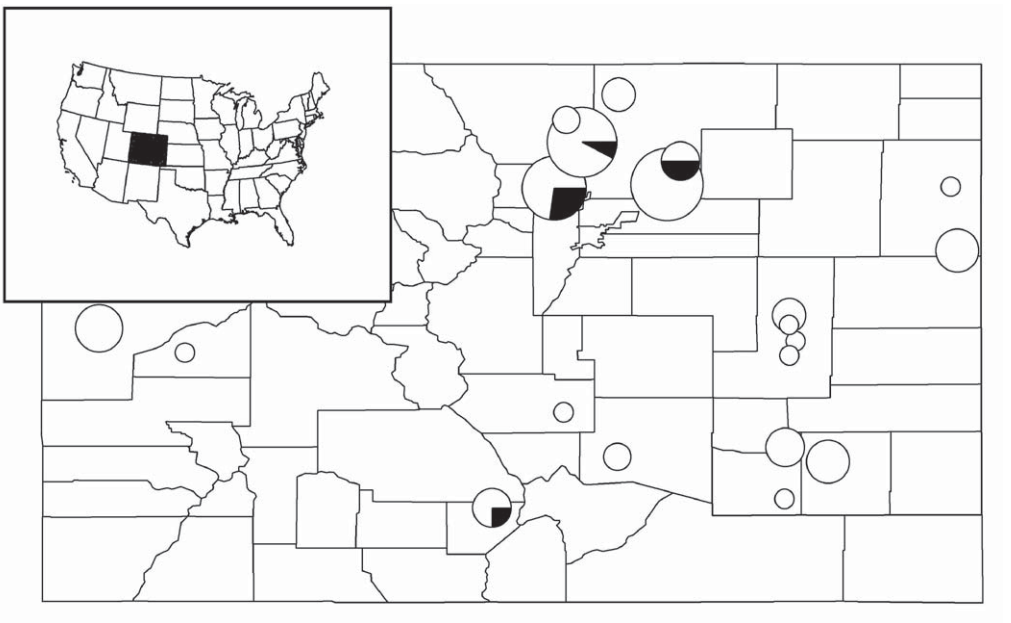


FIG. 1. *Anaxyrus woodhousii* sampling localities (circles) within counties in Colorado, USA. Within circles, open areas represent PCR-negative and black areas represent PCR-positive *Batrachochytrium dendrobatidis* samples. The relative size of each circle is proportional to the total sample size of Woodhouse's Toads. Circles are centered on the localities they represent. In one case, two circles are superimposed: samples were taken at the same location in two separate years.

Each animal was handled with a fresh pair of latex gloves. The ventral pelvic area and back legs were swabbed according to the method of Livo (2004). Swabs were placed in 2-ml vials with 70% ethanol and analyzed for *Bd* DNA by Pisces Molecular LLC, Boulder, Colorado.

Woodhouse's Toads tested positive for *Bd* at several sites in Colorado (Table 1; Figure 1). Unfortunately, we have been unable to revisit the sites with sufficient frequency to determine whether population sizes are declining at the *Bd*-positive sites. At several localities at which one or more Woodhouse's Toads tested posi-

TABLE 1. *Anaxyrus* (*Bufo*) *woodhousii* that tested positive (P) and negative (N) for *Batrachochytrium dendrobatidis* (*Bd)* in Colorado, USA. *Bd*/Other Species indicates whether individuals of other amphibians sampled on the same date at the same locality were all *Bd* negative (N) or any were *Bd* positive (P). ANCO = *Anaxyrus cognatus*; PSTR = *Pseudacris triseriata*; LIBL = *Lithobates blairi*; LIPI/LIBL = *L. pipiens* x *blairi* hybrids; SPBO = *Spea bombifrons*; HYAR = *Hyla arenicolor.*

Date	Latitude	Longitude	Elev. (m)	County	Locality	No. *Bd*-N	No. *Bd*-P	*Bd*/Other Species
25 June 06	37.69439	105.69515	2302	Alamosa	GSDNPP	3	1	P (PSTR) N (ANCO)
9 Aug. 05	38.03862	103.18978	1187	Bent	Las Animas	5	0	N (SPBO)
2 July 04	40.08556	105.21889	1578	Boulder	Boulder Reservoir	2	1	
6 June 05	40.07306	105.23222	1578	Boulder	Boulder Reservoir	8	3	
30 Aug. 00	38.85037	107.98515	1714	Delta	Orchard City	1	0	
15 Aug. 01	38.40592	105.16198	1594	Fremont	Florence	1	0	
24 Aug. 01	40.58122	105.14067	1559	Larimer	Ft. Collins	2	0	N (PSTR)
15 May 05	40.41556	105.02389	1559	Larimer	Boyd Lake	12	1	
23 July 01	38.93520	103.43145	1533	Lincoln	Kinney	1	0	N (LIBL/LIPI)
12 May 03	39.12771	103.47991	1540	Lincoln	Hugo	3	0	P (PSTR)
27 May 03	38.82899	103.47807	1485	Lincoln	Rush Creek	1	0	
27 May 03	39.05677	103.47984	1589	Lincoln	Liberty	1	0	
1 Sept. 00	39.02957	108.62410	1511	Mesa	Echo Canyon	6	0	N (HYAR)
1 Sept. 01	37.76095	103.51485	1308	Otero	Vogel Canyon	1	0	P (LIBL)
10 June 05	38.14518	103.50906	1266	Otero	Cheraw	4	0	
16 Aug. 01	38.07464	104.76079	1601	Pueblo	St. Charles River	2	0	N (SPBO)
29 April 01	40.27450	104.28940	1380	Weld	Painter Road	2	2	P (PSTR)
22 Aug. 01	40.76870	104.75088	1612	Weld	Dover	3	0	
3 Aug. 05	40.10047	104.38910	1461	Weld	Prospect Valley	14	0	N (SPBO, LIPI)
30 July 01	40.08368	102.27472	1096	Yuma	Stalker Lake	1	0	N (LIBL)
12 April 03	39.60908	102.22553	1127	Yuma	Republican River	5	0	N (PSTR)

tive, other amphibian species also tested positive. In two cases (locations: Hugo, Lincoln County; Vogel Canyon, Otero County), another species tested positive but the Woodhouse's Toad samples were negative. While the presence of *Bd* on a single animal is sufficient to indicate that a locality is *Bd*-positive, small sample sizes at the localities at which all samples tested negative for *Bd* preclude judging whether or not *Bd* is actually present.

Some of the Woodhouse's Toads that were PCR positive for *Bd* were taken to our laboratory at the University of Colorado and subsequently died within 2–3 weeks after capture with many of the signs of chytridiomycosis (i.e., abnormal shedding patterns, lassitude, and decreased blood ionic concentrations; Carey and Livo, unpubl. data), although the presence of and severity of infection have not yet been histologically verified. Additionally, when newly captured Woodhouse's Toads have been experimentally exposed to *Bd* using standardized methods, they all died and were PCR positive for *Bd*. We tentatively conclude that Woodhouse's Toads are at least mildly susceptible to *Bd* infection and that the infection can prove lethal under laboratory conditions. However, whether or not *Bd* causes declines in Woodhouse's Toad populations in the wild deserves more research.

The effect of temperature on *Bd* growth may explain, in part, observations that amphibians living at lower elevations do not experience population declines due to *Bd* (cf. Puschendorf et al. 2006), whereas adjacent high elevation populations do. Exposure of an infected animal to 30°C can control or even kill *Bd* (Woodhams et al. 2003; Carey and Livo, unpubl. data). Amphibians living at higher elevations do not achieve such high temperatures for sufficiently long times to kill *Bd* (Carey 1978; Carey et al. unpubl. data) and, as a result, are unable to shed the fungus once they become infected.

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HERPETOLOGICAL HISTORY

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Memories of John William Daly (1933–2008): A Biographical Sketch and Herpetological Bibliography

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John Daly—pioneering chemist, pharmacologist, and field herpetologist—died from sepsis associated with pancreatic cancer on March 5, 2008, in Rockville, Maryland. This brief history celebrates a career that fundamentally advanced basic and applied research in biology and medicine. We see frogs and birds and tiny creatures on the jungle floor in new light because of his enthusiastic study of things small and wonderful.

John was born on June 8, 1933 to John E. Daly and Hilda Daly in Portland, Oregon. He received degrees in Biochemistry (B.S., 1954) and Organic Chemistry (M.A., 1955) at Oregon State College, and a Ph.D. (1958) in Organic Chemistry at Stanford University. This was followed by a two-year postdoctoral appointment (1958–1960) at the National Institutes of Health (NIH), in what was then called the National Institute of Arthritis and Metabolic Diseases.

John's appointment was to Bernhard Witkop's Laboratory of Chemistry. Witkop allowed a degree of freedom to his postdoctoral chemists, and John spent time studying catecholamine neurotransmitters under the mentorship of Julius Axelrod, a section chief in a different NIH institute (Mental Health). Axelrod, who received a Nobel Prize for his work on catecholamines in 1970, later remembered (in 1998) that "John somehow drifted to our lab, and I was struck by his intense interest in research."

John was to spend all his professional life at the NIH institute that eventually became (in 1986, after two previous names) the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK). He was appointed to the permanent staff as Research Chemist in Witkop's Laboratory in 1960, became Chief of the Section on Pharmacodynamics in 1969, and became founding Chief of his own Laboratory of Bioorganic Chemistry in 1981.

John became a NIH Scientist Emeritus in January 2003 and enthusiastically continued his research on frog toxins nearly to the week of his death. He is survived by his daughters, Kathryn Daly and Shannon Ostrander, his sister, Hildred Powers, four grandchildren, and his life partner Kathleen McKnight.

During five decades at NIH, John's research spanned several disciplines. The isolation, structural determination, and synthesis of novel natural products was only one interest. He also was especially keen on elucidating the pharmacodynamics of such products, with emphasis on receptors, ion channels, and second messenger formation in the nervous system. Some high points in his career included major discoveries and co-discoveries such as the "NIH Shift"—a surprising molecular mechanism that occurs during conversion of the amino acids phenylalanine and tryptophan to the crucial neurotransmitters dopamine, norepinephrine, and serotonin; the finding that forskolin, from the plant *Coleus*, directly activates adenylyl cyclase, an enzyme responsible for the formation of the intracellular messenger cyclic adenosine monophosphate (cyclic AMP) from ATP; the introduction of a prelabeling technique for investigation of cyclic AMP generation in intact cells; the introduction of a variety of selective agonists and antagonists as probes and radio ligands for adenosine receptors; discovering that the stimulant effects of caffeine in the central nervous system result from blockade of adenosine receptors; the finding that maitotoxin (the most potent marine toxin, produced by a dinoflagellate) stimulates breakdown of metabolically important phosphoinositide; that the anti-diarrhea drug loperamide is a unique modulator of a capacitative calcium influx pathway and that *N*-substituted dihydropyridines are selective blockers of such channels.

John's work on "frog alkaloids" ("dendrobatid alkaloids") led to a series of equally impressive discoveries after he and his associates worked their way through formidable analytical problems. Up to the 1960s, plants generally were considered to be the sole source of alkaloids (bioactive organic nitrogenous ring compounds). Typical plant alkaloids historically were obtained in quantity and structures determined through classic techniques of chemical degradation; alkaloids in frog skin, however, were to be measured in micrograms rather than milligrams. Thin-layer chromatography, electron-impact and chemical-ionization mass spectrometry combined with gas chromatography were used by the 1970s to separate and characterize small samples of "frog alkaloids." And, fortunately, some frogs occurred in exceedingly dense populations that could be harvested without harm to the species, yielding sufficient material for X-ray crystallography of key structures. Before the end of the century, increasingly sophisticated analytical techniques and improved instrumentation were allowing precise determination of many compounds even in a few mg of skin from a single frog.

Hundreds of previously unknown compounds were discovered and assigned to more than 20 structural classes of alkaloids. Many of the new alkaloids have remarkable pharmacological activity, and some of the new classes are characterized by chemical structures unprecedented in nature. Some of these have become widely used as research tools: batrachotoxin as a selective activator of sodium channels; histrionicotoxins as blockers of nicotinic channels; pumiliotoxins as sodium channel agents with biomedical potential as cardiotonic agents; and epibatidine as a nicotinic agonist with potent analgesic activity 200 times stronger than morphine. Many of these alkaloids became targets of synthetic research in laboratories around the world, and synthetic analogues of epibatidine are in clinical trials for treatment of chronic pain from neuropathies, cancer, and arthritis.

Considering his extraordinarily successful career in the laboratory, few of John's numerous collaborators could have been truly cognizant of his proficiency as a tropical field biologist. But, for over four decades, he was *extensively* involved in fieldwork leading to the discovery of over 800 different alkaloids in frog skin.

John himself identified two factors in the genesis of his tropical work. First, his lab chief Bernhard Witkop had studied curare arrow poisons as a student of Nobelist Heinrich Wieland in Germany and was intrigued by reports of a South American "arrow" (dart) poison derived from frogs. Witkop's curiosity led to an important initial

paper with Fritz Märki, a postdoctoral chemist who returned to Switzerland. John was then drawn into the project, eventually becoming lead scientist in the isolation and characterization of the batrachotoxin alkaloids. The second event was a letter from me, as mused by John in various articles and published interviews: e.g., "Our research at the NIH on further alkaloids from frog skins might have ended with batrachotoxin were it not for a news release [that] drew the attention of a herpetologist ..." (Daly 1998a: 165).

This all started in December 1963, when Witkop first sent the young chemist to Colombia to obtain additional skin extracts from a frog used for poisoning blowgun darts. John's involvement came to my attention in the July 16, 1965 issue of *Medical World News*, in a note titled "Deadly Frogs May Yield Therapeutic Agent." At the time, I was on leave from graduate school for a three-year assignment as Visiting Scientist at the old Gorgas Memorial Laboratory in Panama City (funded by an NIH grant with W. E. Duellman and myself as co-investigators). I had recently discovered a remarkable complex of small, brightly colored toxic frogs in the Bocas del Toro region of northwestern Panama, all or most of which seemed to represent a single species, *Dendrobates* (*Oophaga*) *pumilio*. Colors in different micropopulations collectively encompassed the visible spectrum from red to blue, except for one population of achromatic black-and-white frogs.



FIG. 1. John Daly and one of our pack horses in the western Andes, on the 1970 Colombian expedition. This trip of 43 days was intended to close out a five-year survey of dendrobatid skin alkaloids. Instead, it stimulated further work by Daly that continued until his death in 2008.

I mentioned this "exceedingly common" frog in a letter written on September 7, 1965; John responded on September 22 and made his first of many trips to Panama the following January, during a stop-over on his second excursion to Colombia. Our earliest fieldwork together was limited to a few areas accessible by four-wheel drive near Panama City, but we started collaborating immediately on the *pumilio* project. I sent my assistant with John to several of my collecting sites in Bocas del Toro; they obtained some frog-skin samples in methanol and I mailed additional samples a month later.

It was during our early Panama work that John and I initiated what was to become our field "taste test" for presence of pharmacologically active substances in frog skin. I had mentioned (in my 1965 letter) being puzzled as to why small, brightly colored toxic frogs should have no taste when put in one's mouth. We found that some poison frogs first had to be stressed before toxins are released from granular glands; foot-pinching or skin piercing (as by snake teeth) would do the trick. Touching a stressed frog to the tongue (or frog–finger–tongue) provided a fairly accurate field bioassay for presence of alkaloids. Indeed, the human tongue sometimes seemed more sensitive than early analytical techniques then available at NIH. (Presence of "trace-trace" quantities of a powerful toxin in some specimens of Panamanian *Phyllobates lugubris* was suggested by taste when John's earliest lab tests were negative. Years later, it probably was fortunate that we did *not* taste the new, aptly named *Phyllobates terribilis*.)

A bond was established with my wife Joan and me in Panama, where John became a kind of visiting uncle to our young children, Charles and Tracy. When the time came in 1967 for us to drive back to the U.S., John flew down to travel (and collect) with us as far as San José, Costa Rica. Most of the southern part of the Pan American Highway was a rough, unpaved road in those days and we had scarcely entered Costa Rica when a gear broke in our four-wheel drive carryall. We found a mechanic who had an open-air, dirt-floor garage under a thatched roof. John and I spent anxious hours sitting on boxes, apprehensively watching our cheerfully confident mechanic figure out how to get into the transfer case and fabricating his own tool for one process. That done, he took a bus to the nearest Chevrolet dealership back in Panama and the next day smuggled the needed gear under his belt in order to circumvent Costa Rican customs.

While waiting for our mechanic's return, John and nine year-old Charles and I took a ride in a *cazadora* (a "hunter"), the name then applied to tiny country buses. We got off at a good section of forest

to look for poison frogs. We found two species along a stream that also harbored a surprisingly large population of fer-de-lance snakes. But most of our day was spent waiting for *cazadoras*, with no inkling that John and I were to do a lot of waiting together in coming years—waiting sometimes days at a stretch when bad weather kept planes or helicopters from reaching us at a backcountry landing strip or on some mountain top.

We published the results of our early Panama work in *Science* in 1967. The new alkaloids were mistakenly characterized as "steroidal," but never mind, John was to work on that amazing complex of frogs on-and-off for the next 40 years. But it was early days in 1967 and we were wondering about the extent of variation in skin alkaloids of dendrobatid frogs generally. After a field trip to Venezuela, we innocently decided that one trip to Colombia would allow us to wrap up the work started a few years earlier in Panama. The taxonomic diversity of poisonous frogs in Colombia would be sufficient for testing our hypothesis. The brightly colored species would all contain skin toxins that would be found to vary, but all the toxins probably would prove to be steroidal alkaloids—variations on a common theme. How wrong we were about the last part of that! Instead of finalizing the work, we caught the tail of the proverbial tiger and were unable to let go. Well, I might have let go, but John's enthusiasm could not be quelled.

Our first joint trip to Colombia lasted some 40 days in early 1970, during which time John and I covered thousands of kilometers by jeep, on foot, and by dugout canoe. We drove over much of highland and lowland northern and western Colombia and south nearly to Ecuador and into the Amazon basin. We drove to the end of an unpaved road in the western Andes, left our jeep and trekked a day-and-a-half with a few men and pack horses down to the Pacific lowlands, where we traveled by dugout to a collecting site (Fig. 1).

That was to have been our final trip, but back at NIH the field samples yielded dozens of new compounds in new classes of alkaloids. The tiger was running and over the next 30 years John and I worked together in eight tropical countries in the New World, with each of us also making independent trips to several of those countries. An annual field trip was not enough. Two or three trips a year were not uncommon in the 1970s and 80s, and the new alkaloids multiplied into the hundreds. It was an intensive program of discovery, with each new trip yielding treasures of new compounds and often new amphibians and reptiles as well, including a fearsomely toxic frog used by Emberá Chocó Indians as a source of poison for blowgun darts (Figs. 2, 3).



FIG. 2. John Daly at the front steps of a 1973 base camp, an Emberá Chocó house in the Pacific lowlands of western Colombia. This was the general type locality of the dangerously toxic new dart-poison frog that we later named *Phyllobates terribilis*.



FIG. 3. John skinning *Phyllobates terribilis* for methanolic extraction of batrachotoxin alkaloids (1973); in addition to surgical gloves, he is wearing eye and respiratory protection. Batrachotoxin and homobatrachotoxin are among the most potent of all naturally occurring nonprotein toxins. These alkaloids are present in largest quantities (700–1900 μg) in skin of wild-caught *P. terribilis*—the world's most poisonous frog.

During the early work in Colombia we wondered aloud whether the "dendrobatid toxins" were synthesized by the frogs or sequestered from dietary sources. To test the last possibility, we extracted fresh stomach contents of a few common species of dendrobatids into methanol, but John was unable to detect alkaloids or potential precursors in those samples and we came to assume that the frogs themselves were inventive chemists. However, neither was he able to demonstrate biosynthetic pathways in a 1971 experiment with David Johnson; there was no incorporation of radioactive cholesterol, acetate, or mevalonate into the steroidal batrachotoxins of *Phyllobates* or the bicyclic or tricyclic alkaloids of *Dendrobates* (although cholesterol had been recently claimed as a precursor of

certain toad toxins and salamander alkaloids). And F_1 progeny of dart-poison frogs raised at the American Museum lacked detectable alkaloids, although they retained an altered sodium-channel that made them immune to their parents' toxins.

We continued to publish as though the frogs were making their own toxins, as seemed consistent with the absolute novelty of many of the alkaloids and the absence of toxicity in stomach contents. But it was a vexing problem in the back of John's mind, renewed by conversations with colleagues and by growing evidence that ants (a major food source) also were a source of interesting alkaloids. I recall John and the late A. Stanley Rand idly talking in Panama about how one might set about doing a "natural" feeding experiment using captive-raised frogs. That idea eventually bore fruit in 1994, when John and Stan and associates demonstrated uptake of alkaloids by froglets raised in outdoor screened enclosures provided with leaf litter from native habitats; some alkaloids also were obtained from a sampling of leaf-litter insects.

Also in 1994, John and colleagues demonstrated the presence of an efficient uptake system for sequestering dietary alkaloids in some (aposematic) dendrobatid frogs. These events suggested that the granular ("poison") glands may be primarily storage sites in some anurans rather than (or as well as) the chemical factories we had supposed. John doggedly pursued the sequestering evidence in a series of collaborative papers interspersed among publications on chemistry and pharmacology. The 1990s and first years of the 21st century saw a constant flow of discoveries emanating from what had become "the alkaloid program" in John's Laboratory of Bioorganic Chemistry. He depended greatly on chemists H. Martin Garraffo and Thomas F. Spande, the mainstays of the program who became involved in most aspects of John's later research.

Among John's numerous collaborators who figured importantly in the early frog studies, special mention should be made of Edson X. Albuquerque (School of Medicine, University of Maryland), who helped pioneer the pharmacology of anuran alkaloids; Isabella L. Karle (Naval Research Laboratory, Washington, D.C.), responsible for most of the X-ray crystallographic characterization of key structures; and Takashi Tokuyama (Department of Chemistry, Osaka City University), who continued collaborating for many years in the chemical studies. Many other talented chemists and pharmacologists became involved at various times, as shown by a reading of coauthors in the Bibliography.

I gradually withdrew from the dendrobatid work in the 1990s to give time to other long-term projects, but John tried to keep me abreast of the alkaloid program and joined me in several Venezuelan expeditions ending in 2000. Our young colleague Taran Grant expanded the systematic work and revised all dendrobatoid frogs in a masterful Ph.D. dissertation that, with John's assistance, made appropriate use of published and unpublished alkaloid data. (Grant's dissertation was published in 2006, with a number of honorary coauthors.)

My former postdoc Maureen A. Donnelly (Florida International University) and her student Ralph A. Saporito became associated with the alkaloid program at century's end. They collaborated with John's group on an important series of papers in 2002–2007 that determined major arthropod sources of dietary alkaloids in *Dendrobates* (*Oophaga*) *pumilio*—the Central American poison frog that John had started studying in 1963, on his first trip to Panama.

John's wondrously multifaceted and productive program at NIH serendipitously came to include birds as well as frogs and arthropods. Knowing that John thrived on the improbable, I called him in early April 1991, with news just received by phone from Jack Dumbacher (then a graduate student at the University of Chicago), who had evidence of toxicity in a bird. A few days later, Dumbacher wrote, "The same day that we spoke ... John Daly called and agreed to run some initial tests." The resulting collaboration between Dumbacher and Daly and their associates led to the extraordinary discovery of batrachotoxins on the feathers of some New Guinea birds; these highly toxic alkaloids theretofore had been known *only* from the Neotropical dart-poison frogs (*Phyllobates* s.s.). Two high-profile papers in 1992 and 2000 were followed in 2004 by the report that batrachotoxin had been found in *Choresine* beetles (Melyridae). Such beetles, known to be eaten by the birds, were also suggested as the putative source for batrachotoxin in frogs.

In the 1990s, John was on the road to convincing himself that *all* frog alkaloids must be sequestered. He sometimes would call me (always early morning) when there was new evidence of an arthropod origin for one class of alkaloids or another. I would tease that he could not yet rule out lack of biosynthesis for batrachotoxins, histrionicotoxins, or some other major class. But one morning he called with the news of early evidence that an Australian frog was manufacturing one of its own alkaloids. This was supported in print in 2002, with the added evidence that the frogs (*Pseudophryne*) were synthesizing one class of alkaloids (pseudophrynamines) while sequestering another (pumiliotoxins). Furthermore, biosynthesis of pseudophrynamines appeared reduced in the presence of high levels of dietary pumiliotoxins! As revealed by electron microscopy (Neuwirth et al. 1979), the granular secretory glands of amphibians are morphologically (and physiologically) complex structures, and generalized assertions about their evolution and function cannot yet be made with confidence.

Nonetheless, John and various associates collectively have shown that dietary sequestration, especially from mites and ants, is the principal source of what we originally termed the "dendrobatid alkaloids." The demonstration in 2007 that mites are a particularly major source of dietary *and other* alkaloids was a striking finding, particularly since the aposematic dendrobatids are generally regarded as ant-mite specialists (based on terrarium observations, they are physically unable to swallow prey as large as taken by many other frogs their size). However, one cannot yet justify stating categorically that all alkaloids in all genera and species of dendrobatid frogs are of dietary origin. A secondary dietary origin was shown for a few species, in which a precursor dietary alkaloid can be hydroxylated to a more potent compound in the frog.

The ultimate source of the myriad dietary alkaloids remains an open question. Some eventually may prove to be synthesized by the arthropods, but John fretted for years that symbiotic microorganisms may be involved (as in some marine occurrences of tetrodotoxin). The tropical forest floor has never been a simple place, but now I imagine it as a molecular jungle swarming with amazingly diverse alkaloids of astounding bioactivity—or, as envisioned by John in 1977, "a virtually untapped source of new pharmacologically active agents from the world's rain forests."

Fortunately, such complexity was not foreseen when we started our explorations. Given the state of analytical chemistry at the time, the thought of surveying alkaloids in microscopic mites would have been discouraging even to John. The frogs then seemed to be chal-

lenge enough, and in their pursuit we were enticed onto memorable journeys. Much of our travel involved wilderness expeditions by dugout or on foot with a few local packers and guides. John and I worked comfortably together in the forest and early on I quit worrying about him after realizing that he had a built-in compass and untapped stores of resourcefulness and common sense. He did not take his sense of direction for granted, however, and did carry a compass, being always appropriately cautious. After starting off collecting together, we commonly got separated in the forest, only to meet up again when it was time for a trail lunch. Neither of us fully understood how that worked.

Taran Grant coined the dendrobatid genus-group name *Adelphobates*, in honor of two "scientific brothers." However, Joan called us "The Odd Couple" after a popular TV series. But we seldom disagreed, although it happened one time during a trip from one place to another along the Colombian coast. We had hired a dugout with a small outboard motor, but it rode only a few inches above water once loaded. John loved boats and was unhappy when I insisted that for safety we travel up-coast through mangrove channels; John was an enthusiastic boatman and wanted us off coast, with the wind and salt spray in his face. Once the tide went out we were stranded for hours with some very poor folks, who were living off seafood easily gathered at a river mouth. Biting flies were so unimaginably bad that their daylight hours were mostly spent in close proximity to smoke pots. They kindly lent smoke pots for us to huddle over until the tide filled the mangrove channels, giving me time to contemplate my cautious stubbornness.

Over the years we were to spend much time living for a few days or a week or so with impoverished people in rural tropical America. We rented their porches for hanging our hammocks and some families came to expect our return in following years. I remember one isolated house at the edge of a jungle, where several fierce-looking men were sharing a single machete; there were tears of gratitude when John handed each a new machete. John enjoyed people and many came to adore him, except at one Indian settlement where small children ran screaming from us. They had been told that we were witches who would carry them away if they disobeyed their parents.

We conducted our back-country work with circumspection and little fanfare. Nonetheless, our interest in dart-poisons and other toxins did not go unnoticed at home or abroad. For example: John and I each received a few curiously probing calls from inquisitors with unconvincing cover; a pleasant, curious gentleman managed an assignment to the seat between us on a nearly empty flight that had vacant window and aisle seats in abundance (we pretended not to notice that he had been seated prior to boarding); colleagues in one foreign capital were questioned by officials about our poison work. Such interest was different from that of the occasional military patrol that sought out our camps in remote areas. We thought that it related to the global publicity and paranoia following disclosure that our Central Intelligence Agency had had a secret cache of exotic poisons (e.g., the paralytic shellfish poison saxitoxin) and methods of using them (e.g., suicide pills and the poison-dart pistol unwisely displayed to Congress in 1975). Not all bioweapon material had been destroyed as ordered by President Nixon in 1969; the CIA's supply of saxitoxin was transferred to NIH in the 1970s and ended up in John's lab.

John and I had separate but overlapping research objectives, both heavily dependent on fieldwork and general collecting. The discovery of new species of frogs and new alkaloids often coincided. But we collected amphibians and reptiles generally, often with great enthusiasm on his part. I have vivid memories of this world-renown scientist unceremoniously hurling himself at some small lizard or snake that was trying to scurry or slither into the leaf litter. However, he acceded to my early request that he not catch by hand any brightly-ringed snake. On one of our last trips, John called out that he was standing on a thrashing snake that he optimistically suggested was a coral-snake mimic, to which I soon replied, "It's not a mimic, but keep your foot on it until I decide which end is the head"—another rare specimen bagged thanks to John!

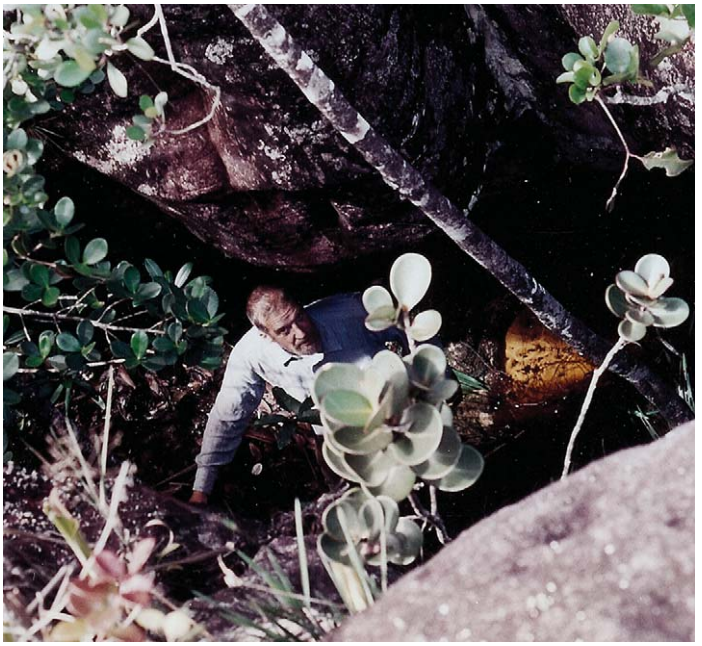


FIG. 4. John in 1994, exploring a sandstone crevasse on the summit of Auyantepui, one of Venezuela's "Lost Worlds."

Fortunately for me and for the American Museum, John was interested from the start in sampling skin secretions of as many kinds of frogs as possible. Many amphibians and reptiles are nocturnal and nighttime collecting therefore is essential. With a powerful light strapped to his head, John joined the ranks of truly accomplished collectors. He was enthralled when the wet tropical forest came alive at night. In the early days I might rush to his side when hearing some exclamation of wonderment, only to find him exchanging stares with some gigantic insect and not the rare frog or snake for which I had hoped. After a day searching for diurnal poison frogs, we often were in the forest until after midnight, resulting in discovery of many previously unknown species of amphibians and reptiles.

John became a global collector, gathering frog-skin samples also in Africa, Thailand, and Australia—sometimes in conjunction with a symposium to which he had been invited. In later years John developed a major field program in Madagascar. But his heart was in the wild places in South America, and from 1989 to 2000 he participated when possible in the American Museum's helicopter-supported expeditions to the Venezuelan *tepuis* (the isolated sandstone mesas such as the one in Sir Arthur Conan Doyle's *The Lost World*). There was little of professional interest to John



FIG. 5. John (left) arriving at camp on a remote Venezuelan table mountain in 2000, for our last fieldwork together.

on these wild, uninhabited mountains, but he loved exploring and was easily persuaded to come lend a hand in the general collecting (Figs. 4, 5). He told me that he came only out of old friendship, but I noticed that his face seemed to light up and his "yes" would come quicker if I slyly mentioned that he might be able to fish in some virgin stream along the way. He usually carried at least a telescoping rod. Fishing in every kind of water was a passion and even the landing of a small piranha seemed fulfilling.

John's research touched many fields and attracted global attention. "During the 1980's [he] was among the 100 most-cited scientists worldwide as documented in *Current Contents*" (fide *NIH Record* August 25, 1998), and for the period 1993–2003, he was 41st among the 100 (of 2,081) most-cited scientists in Pharmacology & Toxicology. Recently, he was said to rank among the 10 most-cited government scientists (*The Pharmacologist* 50:118, June 2008). His work garnered many honors, including: the Hillebrand Award from the American Chemical Society in 1978; the Presidential Rank Meritorious Award, 1989; the Washington Academy of Sciences Award for Outstanding Achievement in the Biological Sciences, 1996; the Japanese Society Fellowship for the Promotion of Science, 1996; the Research Achievement Award from the American Society of Pharmacognosy, 1997; the Karl Wilhelm Scheele Award from the Swedish Academy of Pharmaceutical Sciences, 1999; and the American Chemical Society's Ernest Guenther Award in the Chemistry of Natural Products, 2002. John seemed especially proud of his appointment as Research Associate in Herpetology at the American Museum of Natural History in 1983, and his election to the National Academy of Sciences, USA, in 1997.

John Daly will be missed by the global scientific community. I miss him in ways unforeseen, and he continues to surprise me. Although always generous in his published comments, I was taken aback by his recent, last acknowledgment to me. I did not see it until after his death and for that reason it read like a final farewell. He expressed gratitude for "years of guidance from … his mentor both in the field of herpetology and on their many expeditions to Panama, Colombia, Ecuador, Peru, Venezuela, Suriname, Trinidad, and Brazil." That statement, from an experienced and accomplished field man, says much about John. As one close colleague said, "John was always very kind, even when he should not have been." He was a good friend, a great scientist, and one of the most unpretentious people I have ever known.

Memories and melancholy can be a potent mix. The years of traveling with John have left me with an ever-changing kaleidoscope of remembrances that sometimes come unannounced:

> A certain light at the break of dawn reminds me of John just out of his hammock in back-country Suriname, grumbling at a small scorpion that had taken up overnight residence in the crotch of his trousers.
>
> An exceptionally hard rain might recall the two of us alone in a Colombian cloud forest—in an area where annual rainfall is measured in meters—where we succeeded in having a fire and in keeping our jungle hammocks dry during 13 hours of drenching rain.
>
> A howling gale in the night brings back the montane storm that pushed the side of our tent down across our faces and which would have blown away the tent itself had we not been in it.
>
> Smoke wafting over trees can be reminiscent of the roadless frontier between Venezuela and Brazil, where we helplessly bore witness to a

small missionary plane that crashed and burned in the jungle far below our mountain-top camp.

Sound of a fast boat at night summons our exhilarating, frightening ride in a small speedboat caught after dark between Pebas and Iquitos, racing upriver without life jackets on a flooded Amazon, with logs and uprooted trees coming downstream. One boatman in back running the big outboard motor at full throttle, and one standing in front with a handheld search light spotting the on-coming obstacles and flinging an arm right or left, meaning turn! turn!

Sight of a Boy Scout pocket knife raises the memory of John being arrested during a police raid in a tough Colombian bar. He looked like a sailor and the Scout knife in his pocket a concealed weapon.

I seldom drink beer nowadays. When I do I sometimes remember beers shared with John at the ends of long dusty drives. And perhaps I see the Andean town where we had to hold tight our glasses and raise our legs so that fighting drunks could roll past our table, tumbling out the door and into the horses tied to the rail alongside our jeep.

Treasures of jewel-like frogs at the ends of tropical rainbows. And, along the way, wild towns at the ends of long roads, yes—and wild rivers—and wild places empty of people at the ends of long trails. All that and more did we share, but all trails come to an end. Goodbye old friend, our ways are severed and the jungle has never seemed so dark.

Acknowledgments.—For providing new bibliographic information and for reading and commenting on these "memories," I am deeply grateful to H. Martin Garraffo and Thomas F. Spande, John's long-time colleagues at the National Institutes of Health.

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"Herpetological" Bibliography

John's "List of Publications" maintained by his lab contained 655 entries at the time of his death; some additional manuscripts (published, submitted, or in press) bring the minimal total to 666. By my count, at least 213 of these derive from his work on alkaloids and other compounds in the integument of frogs (especially) and other nonmarine animals. Herpetologists and other biologists have started mining data and ideas from some of these publications, but the interdisciplinary tangle and sheer bulk of the work do present a challenge. Many of his publications cannot easily be sorted into categories such as chemistry, pharmacology, biology, or systematics. Some papers span two or more of these disciplines.

This "herpetological" bibliography represents only about 32% of the total of John's published work. It is relevant primarily to amphibians, especially frogs, but some birds and arthropods also are represented, usually because of shared or similar alkaloids.

John's numbering system for the non-steroidal "dendrobatid alkaloids" needs to be understood. When it was realized that such alkaloids were too numerous (now > 800) for each to be given a name such as histrionicotoxin or pumiliotoxin, individual compounds were designated by nominal molecular weight (Myers and Daly 1976a), with identifying letters added to differentiate compounds with identical weights (Myers and Daly 1976b). The system was formalized a few years later (Daly et al. 1978) and the alkaloid designations were then set in boldface for emphasis and to avoid ambiguity when molecular weights are mentioned in discussion. This convention now is widely followed owing to the magnitude of John's work; it has not been used for the small number of steroidal batrachotoxins. For consistency in the bibliography, I have silently bolded molecular-weight/letter designations in a few titles where the practice was not followed.

Pharmacological papers are included in which specific "frog alkaloids" were used along with other molecular probes at one receptor or another. I doubtless have missed some papers in which such alkaloids are not singled out in the title. For practical purposes, such experimental studies may seem irrelevant to whole-animal biology. However, pharmacologic targets of the alkaloids must play a role in the evolutionary dance between prey and predators. John Daly pioneered discovery of an amazing new world of animal alkaloids, whose astonishingly diverse bioactivity is yet to be placed in broad ecological and evolutionary context. It is a new world awaiting further exploration.

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NATURAL HISTORY NOTES

The Natural History Notes section is analogous to Geographic Distribution. Preferred notes should 1) focus on observations in the field, with little human intrusion; 2) represent more than the isolated documentation of developmental aberrations; and 3) possess a natural history perspective. Individual notes should, with few exceptions, concern only one species, and authors are requested to choose a keyword or short phrase which best describes the nature of their note (e.g., Reproduction, Morphology, Habitat, etc.). Use of figures to illustrate any data is encouraged, but should replace words rather than embellish them. The section's intent is to convey information rather than demonstrate prose. Articles submitted to this section will be reviewed and edited prior to acceptance.

Electronic submission of manuscripts is requested (as Microsoft Word or Rich Text format [rtf] files, as e-mail attachments). Figures can be submitted electronically as JPG files, although higher resolution TIFF or PDF files will be requested for publication. Please DO NOT send graphic files as imbedded figures within a text file. Additional information concerning preparation and submission of graphics files is available on the SSAR web site at: http://www.ssarherps.org/HRinfo.html. Manuscripts should be sent to the appropriate section editor: **Marc P. Hayes** (crocodilians, lizards, and *Sphenodon*; mhayesrana@aol.com); **Charles W. Painter** (amphibians; charles.painter@state.nm.us); **Andrew T. Holycross** (snakes; AndrewHolycross@gmail.com); and **James Harding** (turtles; hardingj@msu.edu).

Standard format for this section is as follows: SCIENTIFIC NAME, COMMON NAME (for the United States and Canada as it appears in Crother [ed.] 2008. *Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico*. SSAR Herpetol. Circ. 37:1–84, available from SSAR Publications Secretary, ssar@herplit.com; for Mexico as it appears in Liner and Casas-Andreu 2008, *Standard Spanish, English and Scientific Names of the Amphibians and Reptiles of Mexico.* Herpetol. Circ. 38:1–162), KEYWORD. DATA on the animal. Place of deposition or intended deposition of specimen(s), and catalog number(s). Then skip a line and close with SUBMITTED BY (give name and address in full—spell out state names—no abbreviations). (NCN) should be used for common name where none is recognized. References may be briefly cited in text (refer to this issue for citation format).

Recommended citation for notes appearing in this section is: Medina, P., and R. L. Joglar. 2008. *Eleutherodactylus richmondi*: reproduction. Herpetol. Rev. 39:460.

CAUDATA — SALAMANDERS

***AMBYSTOMA* SP. HABITAT USE.** On 17 May 2007, we observed an ambystomatid salamander inhabiting an unoccupied Gopher Tortoise (*Gopherus polyphemus*) burrow in Baker Co., Georgia, USA. The salamander was observed 3.5 m inside the burrow using a Sandpiper Technologies, Inc. (Manteca, CA) Peeper Video Probe System with a black and white monitor. The nearest potential breeding wetland, a cypress/tupelo swamp, was approximately 1100 m from the burrow. The individual was identified to genus using body size and type, however, species level identification could not be determined. Ambystomatid salamanders occurring in this region include *Ambystoma tigrinum*, *A. talpoideum*, *A. opacum*, and *A. bishopi* (Smith et al. 2006. Southeast. Nat. 5[4]:599–620). At least 60 vertebrate species inhabit gopher tortoise burrows for various reasons (Jackson and Milstrey 1989. Gopher Tort. Reloc. Sym. Proc. 86 pp). To our knowledge, however, ambystomatid salamanders have not previously been reported using Gopher Tortoise burrows. These salamanders spend much of their time underground in burrows they dig themselves or in small mammal burrows (Semlitsch 1983. Can. J. Zool. 61:616–620). We do not know if the salamander inhabited the burrow or was just passing through, although, the presence of leaf litter and the depth of the burrow suggest that the burrow would likely offer suitable shelter for ambystomatids.

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DESMOGNATHUS CONANTI (Spotted Dusky Salamander). **HABITAT.** *Desmognathus conanti* is one of the more widely distributed members of the genus, ranging across much of the Southeast and inhabiting a variety of moist environments from stream margins and seepages to muddy swamp edges and mesic forests associated with lowland streams (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington. 576 pp.). To this date, however, many aspects of the ecology and distribution of the salamander remain poorly understood. Here I provide a record for a new type of habitat utilized by *D. conanti* in the Appalachian Plateau region of northern Alabama.

On 15 Sept 2007, individuals of *D. conanti* were encountered on moist talus slopes below several sets of large sandstone bluffs near the Sipsey Fork, near the river's confluence with Borden Creek (34.29222°N, 87.39972°W; WGS84), Winston County, Alabama, USA. The bluffs were ca. 10 m high and ranged in distance from 50–75 m from the stream, situated very high above the water by thick stands of hardwood forest. The talus slopes were extensive beneath each set of bluffs, with available rock cover of varying sizes at each site, and were not directly associated with any type of lotic habitat or pools of standing water. No salamanders were encountered on the forest floor between the bluffs and Sipsey Fork. All individuals were adults and ranged between 47–51 mm SVL.

To my knowledge, this is the first record for this type of habitat use by *D. conanti;* nearly all other recorded habitats involve streamside environments or those directly contiguous to them. However, this species and a congener with similar microhabitat requirements have been found to inhabit crevices in wet cliff environments directly associated with mountain streams (Tilley 1980. Copeia 1980:806–821). It is important to note that individuals of *D. conanti* were also found in several small order tributaries of Sipsey Fork and Borden Creek at sites further upstream from these sandstone bluffs, and with the current drought in the region several other tributaries closer to the bluffs were found to be completely dry with no running water and dry substrate. It has been suggested that extreme drought or flood conditions may cause short-term migrations of *D. conanti* to areas of more suitable habitat. Given that these talus slopes remain shaded all day and were still relatively moist despite extreme drought conditions and dry streambeds nearby suggests that this migratory phenomenon may provide an explanation for our observations. However, a definitive explanation deserves further investigation.

Collected individuals were deposited in the University of Alabama Herpetological Collection (UAHC 15882 and 15883).

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GYRINOPHILUS PORPHYRITICUS PORPHYRITICUS (Northern Spring Salamander). **REPRODUCTION**. Few accounts of the nesting activity of *G. p. porphyriticus* exist. Green (1925. Copeia 1925:32) observed a female in attendance of 15 eggs in a spring in Pennsylvania on 8 August. Organ (1961. Herpetologica 17:53–56) observed two nests with females, one with 41 eggs on 14 July and the other with 66 eggs on 6 August in a small spring in southwestern Virginia. Eggs were attached singly in a monolayer to the underside of a rock at least partially submerged in both reports. Bruce (1978. Herpetologica 34:53–64) and Bishop (1924. New York St. Mus. Bull. 253:87–96) both observed similar nests of the Blue Ridge Spring Salamander (*G. p. danielsi*) in North Carolina. Because of the paucity of observed nests, most females probably oviposit in deep underground recesses (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press. 587 pp.); however, nests have not been documented from cave streams. Here, we report a nest of the Northern Spring Salamander from a cave stream located in the Valley and Ridge of east Tennessee.

We observed a female *G. p. porphyriticus* in attendance of a nest on 30 Sept 2007 in Cruze Cave (Tennessee Cave Survey No. TKN24) located in Knox County, Tennessee. The nest consisted of at least 15 eggs attached in a monolayer to the underside of a medium-sized (ca. 30 cm length) rock partially impeded in the cave stream ca. 120 m from the cave entrance. Observable eggs were in a late stage of development. The female was positioned just underneath the nest. We did not have a camera during this trip, and subsequently decided not to disturb the female and nest further. MLN returned a week later on 07 Oct 2007, and only eight eggs near hatching remained and two hatchlings with yolk sacs were observed. The female was no longer in attendance and could not be relocated. The remaining eggs were still attached to the underside of the rock and were submerged in a 4.4 cm deep depression. The hatchlings also were found in the depression and measured 18 and 20 mm TL.

Our observation is consistent with the reports of others that *G. p. porphyriticus* oviposits in summer followed by later summer to autumn hatching (Green 1925, *op. cit.*; Organ 1961, *op. cit.*; Petranka 1998. *op. cit.*). Nests in cave streams have not been reported previously; however, adults and larvae are commonly encountered in cave streams suggesting such habitat is utilized for oviposition.

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RHYACOTRITON OLYMPICUS (Olympic Torrent Salamander). **MAXIMUM LARVAL SIZE**. Data on larval size of torrent salamanders (*Rhyacotriton*) are relatively few. Based on a sample of well over 1000 torrent salamander larvae taken from two sites, one of each of which now falls within the range of *R. variegatus* and *R. cascadae*, Nussbaum and Tait (1977. Amer. Midl. Nat. 98:176–199) reported larval size ranges, respectively, of 13.5–38.6 mm, and 15.8–44.7 mm. Data on variation in larval size are lacking for *R. olympicus*. Here we report an observation of a large *R. olympicus* larva.

On 24 Sept 2007, JAT and KAD made these observations on upper Miller Creek, Mason County, Washington, USA (47.43531°N, -123.15615°W, WGS84; elev. ca. 216 m). Upper Miller Creek is a small (2–4 m wide), third-order perennial stream underlain by Pleistocene glacial till containing interbedded sand, silt, and gravel; however the basalt-based Crescent Formation upstream also contributes large-clast material. Riparian overstory consisted of Red Alder (*Alnus rubra*) and Vine Maple (*Acer circinatum*) with a thin understory of Salmonberry (*Rubus spectabilis*) and Devil's Club (*Oplopanax horridus*); adjacent uplands were second-growth Douglas-fir (*Pseudotsuga menziesii*) managed for timber. At ca. 1000 h, JAT found a *R. olympicus* larva along the shallow (< 2 cm) channel margin. The salamander measured 45.4 mm SVL, 36.8 mm tail length (SVL and tail measured to the anterior end of the vent [*fide* Nussbaum and Tait 1977, *op. cit.*]), and weighed 2.5 g. Though larval, as indicated by its fully developed gills, non-protruding lidless eyes, and tail fins, this animal was probably male as it displayed the distinctive square vent lobes that distinguish post-metamorphic adult males (Good and Wake 1992. Univ. California Publ. Zool. 126:1–91). In the course of sampling for *R. olympicus* in this stream and 12 additional nearby streams over the last three years, this represents the largest *R. olympicus* larva among over 500 animals measured. This animal was also just slightly larger (by 0.7 mm) than the largest *Rhyacotriton* larva previously measured (Nussbaum and Tait 1977, *op. cit*.). After measurement, we released the larva at the location of capture.

We deposited a photographic voucher of this *R. olympicus* at the University of Washington Burke Museum (UWBM 2318). Work was done under a programmatic Washington Department of Fish and Wildlife handling permit provided to employees in the course of their work; conditions of this permit require adherence to the guidelines for use of live amphibians and reptiles in the field (Beaupre et al. 2004. Guidelines for Use of Live Amphibians and Reptiles in Field and Laboratory Research, 2nd ed. Herpetological Animal Care and Use Committee, American Society of Ichthyologists and Herpetologists). This is contribution No. 17 of the Forests and Fish Section of the Washington Department of Fish and Wildlife Habitat Program Science Division.

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ANURA — FROGS

ANAXYRUS AMERICANUS (American Toad). **EGG CANNIBALISM**. Cannibalism by tadpoles on conspecifics may be advantageous when tadpoles occur at high densities in ephemeral breeding sites (Crump 1983. Am. Nat. 121:281–287; Petranka and Kennedy 1999. Oecologica 120:621–631; Dayton and Wapo 2002. J. Herpetol. 36:531–532). Under these conditions, cannibalistic

oophagy may yield especially high payoffs, including not only reduced competition but also an easily accessed source of lipids, proteins, and calcium. Abundant nutrients can promote a decreased time to metamorphosis in an evaporating environment (Heinen and Abdella 2005. Am. Midl. Nat. 153:338–347), thereby increasing odds of survival.

While reports of cannibalistic oophagy are becoming more common for tropical, and especially arboreal anurans, few occurrences have been reported for *Anaxyrus* (reviewed in Petranka and Kennedy 1999. Oecologia 120:621–631; see also Babbitt 1995. Herpetol. Rev. 2:30). To my knowledge, there are no records for cannibalistic oophagy in *Anaxyrus americanus*. Heinen and Abdella (2005. Am. Midl. Nat. 153:338–347) found no evidence for active cannibalism by *A. americanus* tadpoles on conspecifics of same or smaller sizes, but suggested that such cannibalism may be facultative and occur under more stressful environmental conditions (e.g., higher tadpole densities and/or water temperatures) than were encountered by tadpoles in that study.

On 21 May 2006 at Big Creek trailhead (35.4198°N, 82.6755°W; WGS84) in Henderson Co., North Carolina, USA, I observed three pairs of amplexed *Anaxyrus americanus* in a shallow streamside pool at the confluence of Big and Fletcher creeks. Two of the females were laying eggs. All three pairs of adults were surrounded by a very high density of *A. americanus* tadpoles. Tadpoles were congregated on egg strings that were emerging from ovipositing females and many were actively feeding on the eggs (Fig. 1).

Although Petranka and Kennedy (1999, *op. cit*.) suggested diverse feeding strategies for generalized tadpoles, there is still a prevailing paradigm of pond tadpoles as obligate omnivorous suspension feeders. Oophagy on conspecifics greatly complicates current ecological theory and models by expanding the roles of tadpoles in temporary pond communities, the guild of predators faced by maturing conspecifics, and the strategic challenges faced by females selecting breeding sites.

I thank T. G. Forrest for photographs, J. W. Petranka for positive identification of the tadpoles, and R. B. Cocroft, T. G. Forrest, G. Hoebel, and J. W. Petranka for helpful comments.

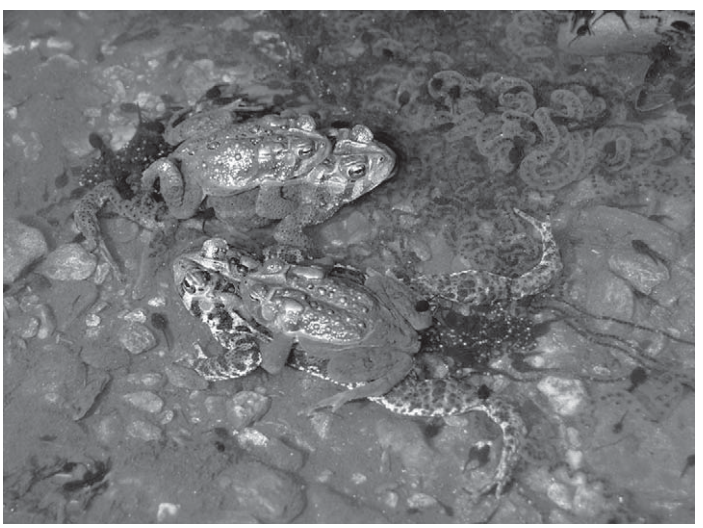


FIG. 1. *Anaxyrus americanus* tadpoles feeding on egg masses from ovipositing female conspecifics in a shallow pool at the confluence of Big and Fletcher creeks (Henderson County, North Carolina, USA). Photo taken 21 May 2006 by T. G. Forrest.

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BUFO BOREAS BOREAS (Boreal Toad). **PREDATION**. Olson (1989. Copeia 1989:391–397) reported Raven (*Corvus corax*) predation on adult *Bufo boreas* at three breeding aggregations in the central Cascade Mountains of Oregon (USA). However, carcass condition prevented Olson (1989, *op. cit.*) from identifying the gender of predated animals. Here, we provide additional observations of *B. boreas* predation attributable to *C. corax* from another population in the Oregon Cascades. In these, we were able to distinguish the gender of predated toads, providing novel insight into this phenomenon.

MPH and RFP made these observations at Horse Lake, Douglas County, Oregon (43.1266°N, 122.1533°W; datum WGS84, elev. 1586 m) in 2007. However, MPH had also collected observations at this site over four additional years since 1997. The latter observations were always made over a 2–3 day period during snowmelt (May) when *B. boreas* breeding was at its peak. Horse Lake is a small (1.5 ha) lake underlain by a pumice-dominated volcanic lithology and surrounded by mature Lodgepole Pine (*Pinus contorta*) with a thin understory. It has two subequal lobes positioned northwest–southeast that are connected at high water; though maximum depth is ~1.5 m, 80% of the lake is <1 m deep.

During an extensive visual encounter survey of Horse Lake and vicinity between 1145 and 1540 h on 11 May 2007, we found the remains of 8 *B. boreas*, 7 at Horse Lake and an 8th individual in a small (0.1 ha) sedge-filled pond ca. 150 m south of Horse Lake. In each case, remains included a near-complete skin. Based on the sizes of 39 live adult toads measured at Horse Lake (males: N = 37, mean = 96.9 mm SVL, SD = 6.2; females: N = 2, mean = 113 mm SVL, SD = 6.2), all belonged to adults ca. 90–110 mm SVL. These skins were remarkable in that except for one in which a forearm bone and a little flesh remained, all had been pulled inside out, often down to the digits, and were thoroughly cleaned of flesh and bone. All skins seemed fresh; they were moist, pliable, and displayed coloration we could not distinguish in quality from that of living adult toads. Each skin was also notable in that the severed margin was always on the ventral side; the skin across the entire back and sides (including the parotoid glands) was always intact, making it easy to observe the toad's original dorsal color pattern by laying the skin flat. We found 6 of the 8 skins on downed Lodgepole Pine logs bordering Horse Lake; the remaining two were in water. In addition to the skins, fragments of toad ovaries were found within 1 m of five of the six skins. Notably, we saw no well-developed eggs in any discarded ovaries. As individual toad skins were scattered (all were >5 m apart), discarded ovaries helped determine gender. However, presence (or absence) of nuptial pads on toad skins (easily viewed on fresh skins by inverting the skin of the digits on an anterior limb) was the definitive criterion for gender determination. In every case, at least one anterior limb had some intact digits. Male Western Toads at Oregon Cascade sites where we have collected data develop nuptial pads on the dorsolateral surface of digits 1, 2, and 3 on the anterior limbs (MPH, unpubl. data), so only one of these digits needed to be intact for gender determination. Color pattern of the dorsal skin also helped confirm

gender since females tend to have a more complex or blotched pattern than the more uniformly colored males (Blair 1963. Evolution 17:1–16; Schueler 1982. Can. Field Nat. 96:329–332).

During our 2007 survey, we also found toad egg strings that we estimated as representing the complement of at least 29 egg masses (i.e., we counted at least 58 separate egg strings; each female deposits one pair of separate strings: see Kagarise Sherman 1980. Ph.D. dissert., University of Michigan, Ann Arbor, Michigan. 394 pp.), and observed 15 additional adult toads that were not measured. Because each female is assumed to lay eggs once per breeding season (Kagarise Sherman 1980, *op. cit.*) and the two living females we found appeared gravid, we observed evidence of at least 91 adult toads during our survey, 9% (N = 8) of which were dead. This would overestimate mortality if live adults contributing to this aggregation were missed, or underestimate it if we missed dead adults; both are possible.

We attributed the dead toads to *C. corax* predation because we observed a Raven fly away from the *B. boreas* breeding aggregation as we approached it, and the pattern of predation was nearly identical to that which Olson (1989, *op. cit.*) described. However, we cannot unequivocally exclude other predators. We observed at least two pairs of Gray Jays (*Perisoreus canadensis*) during our 2007 survey, and MPH has recorded Clark's Nutcrackers (*Nucifraga columbiana*), a known toad predator (Mulder et al. 1978. Condor 80:449–451; Kagarise Sherman and Morton 1993. J. Herpetol. 27:186–198), on previous visits. However, in five years of visits to this breeding aggregation, this is the first time we recorded predation on adult toads. Two further aspects merit comment. Given the high visibility of nearly constantly moving male *B. boreas* in the breeding aggregation, we were surprised to find that most dead adults we encountered were female. This is especially true given our general experience that female toads are far less conspicuous (to the human eye) in breeding aggregations, a pattern consistent with other observations (Olson et al. 1986. Oecologia 70:351–356; Kagarise Sherman 1980. *op. cit.*). Lack of developed eggs in discarded ovaries also raises questions regarding the female toads that were prey. These could represent either post-breeding or non-gravid females, but given apparent female-biased predation, such females may exhibit unrecognized vulnerability to predators.

Work was done under an Oregon Department of Fish and Wildlife scientific handling permit 031-07 to C. Rombough, under which MPH was a permitee; conditions of this permit require adherence to the guidelines for use of live amphibians and reptiles in the field (Beaupre et al. 2004. Guidelines for use of live amphibians and reptiles in field and laboratory research, Second edition. Herpetological Animal Care and Use Committee of the American Society of Ichthyologists and Herpetologists). We thank C. Rombough and D. Olson for valuable comments. This is contribution No. 15 of the Forests and Fish Section of the Washington Department of Fish and Wildlife Habitat Program Science Division.

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BUFO BUFO (Commond Toad). **PARASITISM**. The distribution of *Bufo bufo* covers the whole of Europe, northeastern Africa, and western Asia (Nöllert and Nöllert 1992. Los Anfibios de Europa. Omega Editions. 399 pp.). It breeds mainly in permanent water (Lizana 1997. *In* Pleguezuelos (ed.), Distribución y Biogeografía de los Anfibios y Reptiles de España, pp. 152–154. Asociación Herpetológica Española, Universidad de Granada, Granada), where it may be parasitized by different species of leech (Hoffmann 1960. Notules Hirundinologiques. Archieves de la Section des Sciences Naturalles, Physiques et Mathematiques de L´Intitut Grand-Ducla de Luxembourg [new series] 27:285–291; Fontaneto et al. 1998. *In* Miaud and Guyétant [eds.], Current Studies in Herpetology, pp. 121–124. Societas Europaea Herpetologica, Le bourget du lac, France). Parasitism of adult *Bufo bufo* by the leech *Hirudo medicinalis* has been reported in previous studies (Hoffmann 1960, *op. cit.*; Fontaneto et al. 1998, *op. cit.*), although its attack on other *B. bufo* developmental stages has not been described.

On 30 July 2007, a larval *B. bufo* (total length = 26 mm; Gosner Stage 37) (Gosner 1960. Herpetologica 16:183–190.) was found being parasitized by *H. medicinalis* in a permanent cistern located in Sierra Espuña Regional Park (Province of Murcia, southeastern Iberian Peninsula, 37.86873°N, 1.52032°W; European 1950 datum; 772 m elev.). The leech was attached to the back of the larva, which was forced to swim in a supine position (Fig. 1). Because both larva and the leech were preserved immediately after capture, the consequences of this parasitism on natural history traits, such as locomotion, feeding, and survival of the affected larva, could not be assessed.

We thank the Consejería de Desarrollo Sostenible y Ordenación del Territorio de la Región de Murcia for providing the corresponding permits.

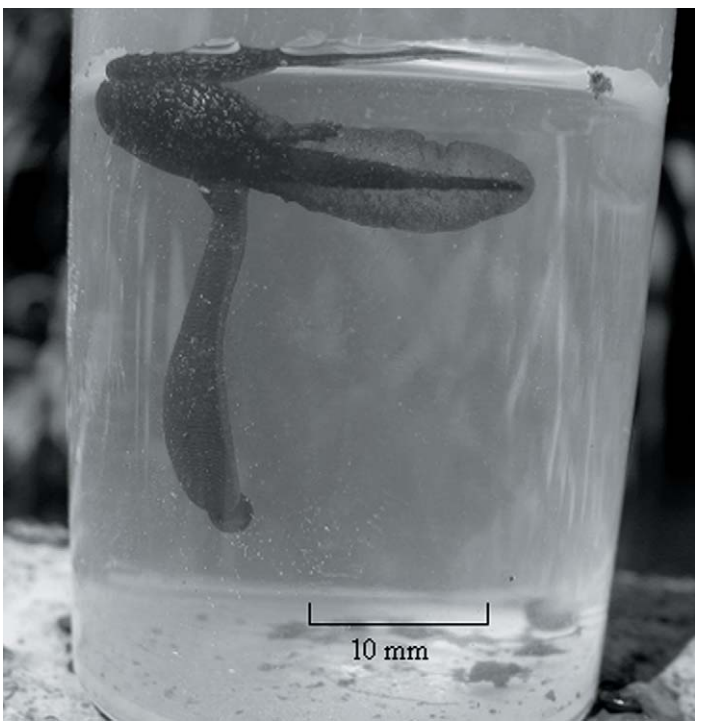


FIG. 1. Lateral photo of *Bufo bufo* larvae, showing *Hirudo medicinalis* on its back.

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BUFO MELANOSTICTUS (Spectacled Toad). **ARBOREAL BEHAVIOR**. *Bufo melanostictus* is a typical ground dwelling toad; based on its relatively short hind limbs. This species naturally occurs in the Himalayas, India, Indochina, Indo-Australian Archipelago, Malaysia, Myanmar, southern China (Nutphund 2001. Amphibians of Thailand. Amarin Printing and Publishing, Thailand.192 pp. [in Thai]) and Taiwan, including Orchid Island and Green Island (Lue et al. 2002. The Transition World—Guidebook of Amphibians and Reptiles of Taiwan. SWAN, Taipei. 350 pp. [in Chinese]; Yang 1998. A Field Guide to the Frogs and Toads of Taiwan. Taipei. Nature and Ecology Photographer's Society. 144 pp.).

At 0954 h on 03 Aug 2007, a sub-adult male *Bufo melanostictus* (47 mm SVL) was found 1.6 m above ground, on the trunk of a *Macaranga tanarius* that was growing at a 45º angle out of an embankment in a secondary forest in Santzepu, Sheishan District, Chiayi County (23.42666°N, 120.48583°E; WGS84; elev. 90 m). The habitat consisted of *Tetrastigma formosanum*, *Alocasia macrorrhiza*, *Alpinia zerumbet*, *Brachiaria mutica*, *Christella acuminata*, *Cinnamomum camphora*, *Clerodendrum paniculatum*, *Costus speciosus*, *Dimocarpus longans*, *Ichnanthus vicinus*, *Lantana camara*, *Lygodium japonicum*, *Macaranga denticulata*, *Machilus thunbergii*, *Maesa perlaria* var. *formosana*, *Mangifera indica*, *Mikania micrantha*, *Miscanthus sinensis*, *Morus australis*, *Passiflora foetida* var. *hispida*, *Smilax ocreata*, and *Stephania japonica*. The canopy cover, created by the crowns of *C. camphora* and *M. denticulata*, was 80%.

No possible prey or refuge was observed on the trunk, so it is not clear why the *B. melanostictus*, which is a nocturnal terrestrial species, was in an arboreal location during the day. We believe the arboreal behavior of the toad could relate to its thermal requirements. The highest air temperature (36.3ºC) for Chiayi County for 2007 was recorded on the same day, and was 8.4ºC higher than the mean air temperature (27.9ºC) of August (Central Weather Bureau. 2007. Monthly Report on Climate System. Ministry of Transportation and Communications, Taipei. [in Chinese]). Arboreal relocation probably offered better air circulation and reduced thermal stress for the toad. This appears to be the first description of arboreal behavior in *B. melanostictus* from Taiwan.

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CRAUGASTOR BRANSFORDII (Bransford's Rain Frog). **REPRODUCTION AND NEST SITE.** The genus *Craugastor* contains 111 currently recognized species of Neotropical direct-developing brachycephalid frogs (Frost 2007. Amphibian Species of the World. Vers. 5.1. http://research.amnh.org/herpetology/amphibia/index.php). While all species in this genus are presumed to exhibit direct development of eggs and many species exhibit parental care, few reports of reproduction have been documented within the genus (Townsend 1996. *In* Powell and Henderson [eds.], Contributions to West Indian Herpetology, a Tribute to Albert Schwartz, pp. 229–239. SSAR Conrib. Herpetol. Vol. 12. Ithaca, New York). We are aware of no documentation of reproduction for *C. bransfordii*, nor for any other member of the *bransfordii* species group. Herein, we report the first description of reproduction in *C. bransfordii* from primary forest within La Selva Biological Station (10.42°N, 84.00°W; WGS84, ca. 60 m elev), Heredia Province, northeastern Costa Rica.

On 23 Aug 2007, we encountered a female *C. bransfordii* (22.4 mm SUL) perched on top of a clutch of eggs at ca 1300 h. The nest site was on bare soil from which leaf litter had been removed, between the stilt roots at the base of a small (10 cm diam) palm. We observed the female rotating the longitudinal axis of her body over the clutch, keeping her mid-venter positioned directly over the center of the clutch as her head and legs rotated around the periphery of the nest cavity. She was observed performing this unusual behavior intermittently for approximately one hour. We returned at ca 1900 h on the same day to conduct a closer inspection of the nest site. The female was still present in the same location, but was perched on bare soil, and no eggs were visible at that time. We removed the female and located the clutch under ca 5 mm of soil. The egg mass measured ca 15 × 14 × 12 mm, and consisted of ten eggs. Four individual eggs from the clutch measured 3.7, 3.9, 4.1, and 4.4 mm in diameter, but the other six eggs were not measured. Using a staging table developed for another species of brachycephalid frog (Townsend and Stewart. Copeia 1985:423–436), we estimated the developmental stage of these eggs to be stage 1—the yolks were featureless and cream-colored and were surrounded by a thin clear covering. While the staging table we used is species-specific and was developed for *Pristimantis coqui*, *Pristimantis* and *Craugastor* are presumed to share a common evolutionary origin of direct-development, and Townsend and Stewart (1985, *op. cit.*) provide the only staging table for direct-developing embryos of which we are aware. We returned to the nest site on 24 Aug 2007 at ca 1130 h, and on several occasions thereafter, but did not detect the female within a 3 m radius of the nest site despite a careful examination of the surrounding area. We checked the status of the nest on 3 Sept 2007 by carefully removing the soil covering the nest, and the clutch appeared intact. We returned to the nest site once again on 20 Sept 2007. At this time, there were no eggs present in the nest site, nor was there any evidence of disturbance surrounding the nest cavity.

Within the genus *Craugastor*, nests are often constructed in shallow depressions excavated by the parent, but we are not aware of burial of eggs by any species in this genus. We presume that the unusual rotating behavior we observed was a behavior of the female to draw soil from the edges of the nest depression to cover the eggs. While many species of *Craugastor* are characterized by parental care by either the male or female parent (Townsend, *op. cit.*), we detected nest attendance by the female only for a short time after the eggs were presumably laid. However, because we disturbed the female parent, we cannot objectively evaluate whether further

parental behaviors would have occurred. Finally, we are also unable to determine whether the nest in the field failed or hatched, or whether our disturbance of the nest played any significant role in its fate.

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ELEUTHERODACTYLUS* cf. *PARVUS (Girard's Robber Frog). **PREDATION.** Predation on anuran amphibians by spiders has been reported many times in the literature and appears to be a common phenomenon in the neotropics (Menin et al. 2005. Phyllomedusa 4:39–47; Costa et al. 2006. Herpetol. Rev. 37:337–338; Pazin 2006. Herpetol. Rev. 37:336). Herein, we present another case of predation of an anuran by a spider, adding another neotropical frog species to the list of amphibians known to be preyed upon by spiders.

On 18 Aug 2005, at the Reserva Ecológica de Rio das Pedras (22.98333°S, 44.1°W; 370 m elev, SAD 69), municipality of Mangaratiba, State of Rio de Janeiro, Brazil, one of us (JALP) captured a spider, *Oligoctenus medius* (Ctenidae) with a live frog, *Eleutherodactylus* cf. *parvus*, being held between its chelicerae. The spider and its prey were found on the leaf litter at 1910 h. The frog, which was being held by the abdominal region in the spider's chelicerae, was released when the spider was picked up by the observer, and remained alive for about 15 h afterwards, until being euthanized. The spider (female; body length = 31 mm; mass = 2.7 g) was later deposited at the arachnological collection of the Museu Nacional, Rio de Janeiro (MNRJ 03085), whereas the frog (unsexed; SVL = 15.4 mm; mass = 0.37 g) was deposited in the herpetological collection (MNRJ 40177).

Members of the families Ctenidae, Pisauridae, Sparassidae, Lycosidae, and Theraphosidae (especially the first two) appear to be the most common arachnid predators of neotropical anurans (Brescovit et al. 2004. *In* Marques and Duleba [eds.], Estação Ecológica Juréia-Itatins. Ambiente Físico, Flora e Fauna, pp. 198–221. Holos Editora, Ribeirão Preto; Menin et al. 2005, *op. cit.*; Costa et al. 2006, *op. cit.*), and the present report agrees with this trend. Menin et al. 2005. (*op. cit.*) observed a trend for spiders preying on frogs in the neotropics to be about the same size or slightly smaller than its prey, but our report does not concur with the apparent trend, as the spider was considerably larger than its anuran prey. Since the frog remained alive and apparently in good health after being released by the spider, it is possible that the spider had not yet injected it with venom by the time it was captured, as the venom of ctenid spiders is frequently quite potent and can cause paralysis and death in small vertebrates within a short time (Massary 1999. Herpetol. Rev. 30:167; Teixeira et al. 2003. Herpetol. Rev. 34:368–369; Menin et al. 2005, *op. cit.*).

We thank C. A. G. da Cruz and J. P. Pombal Jr. for identifying the frog and E. Winskonski for identifying the spider. Fieldwork at the Reserva Ecológica de Rio das Pedras was financed by the Critical Ecosystems Partnership Fund (CEPF).

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HYLA ARBOREA (Tree Frog). **BLOWFLY PARASITISM**. *Lucilia*-fly parasitism on *Bufo bufo* in Europe is well documented and most often concerns the blowfly *Lucilia bufonivora* which seems to favor *B. bufo*. Incidentally, infections by maggots in the nostrils of other amphibians, including *B. calamita, B. viridis, Alytes obstetricans, Pelobates fuscus, Rana arvalis, R. esculenta, R. temporaria*, and *Salamandra salamandra* are reported (Koskela et al. 1974. Ann. Zool. Fennici. 11:105–106; Garanin and Shaldybin 1976. Parazitologiia 10:286–288; Krous 2007. J. Nat. Hist. 41:1863–1874). There is one report on the presence of *Lucilia* eggs on *Hyla arborea* in Switzerland (Meisterhans and Heusser 1970. Mt. Schweiz. ent. Ges. 43:41–44). This frog was kept in captivity to study the development of the *Lucilia* infection. After Day 3 the eggs were gone, and on Day 10 the *H. arborea* was healthy with no sign of *Lucilia* maggots in the nostrils or other forms of myiasis. The authors suggested the eggs were less strongly attached to the frogs' skin, as compared to earlier observations on bufonids.

On 13 August 2007, an infected *H. arborea* (Fig. 1) was found in De Doort, middle part of Limburg, The Netherlands. This is the first documented report of a *Lucilia* infection on *H. arborea*. The frog or maggots were not collected and thus the species of *Lucilia* remains uncertain.

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FIG. 1. *Hyla arborea* infected by *Lucilia* blowfly; maggots are visible in the nostrils. Photograph by Jan Vandewall.

LEPTOBRACHIUM SMITHII (Smith's Litter Frog). **DEFENSE AND PIGMENTATION**. The megophrid frog, *Leptobrachium smithi* has been described from Thailand (Matsui et al. 1999. Japan J. Herpetol. 18:19–29), Myanmar (Das and Chanda 2004. Asiatic Herpetol. Res. 10:245–246), India (Sengupta et al. 2001. J. Bombay Nat. Hist. Soc. 98[2]:289–291), and Laos (Stuart 2005. Herpetol. Rev. 36:473–479). Chuaynkern et al. 2007 (Herpetol. Rev. 38:323–324) noted its distribution in Bangladesh, citing Asmat et al. 2003. (Univ. J. Zool. 22:141–143); however, Asmat et al. 2003, *op. cit*.) did not actually report its occurrence in Bangladesh.

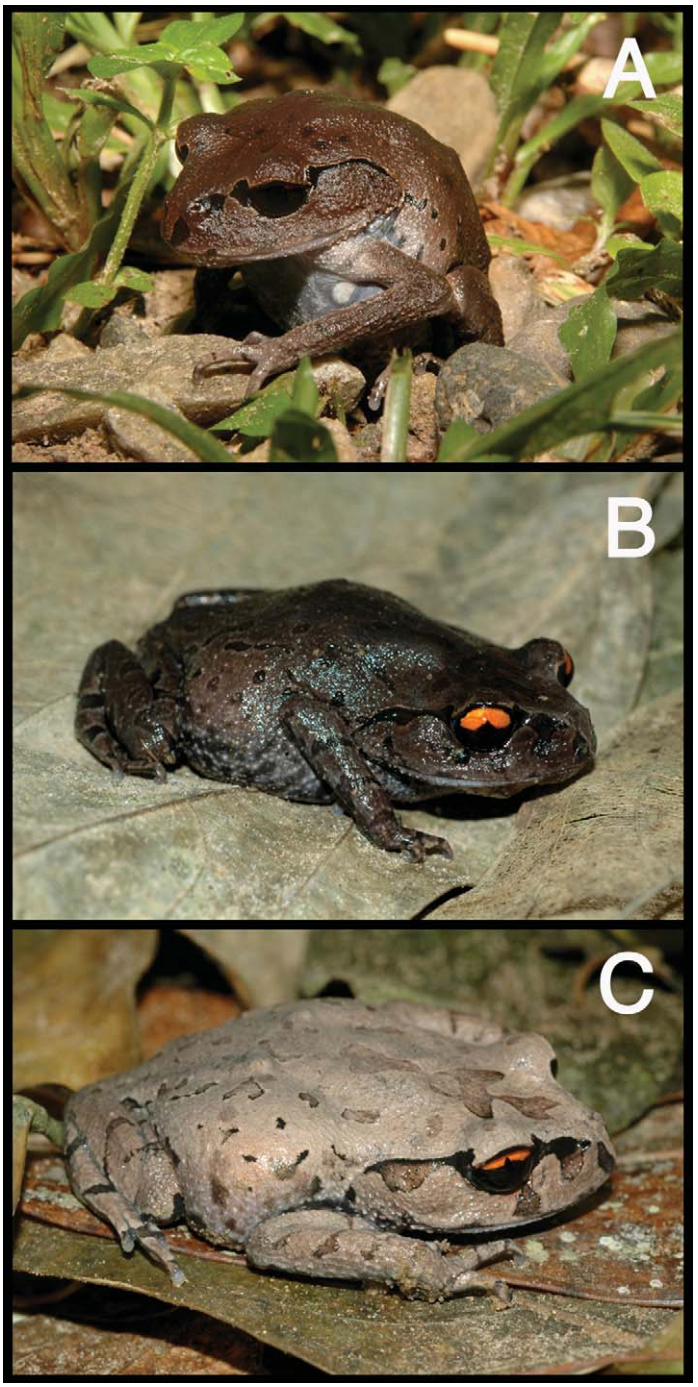


FIG. 1. A) *Leptobrachium smithi*, with its head arched (ca. 90°) towards the vent. B) Adult *L. smithi* with the true color and distinct red-eye before being manipulated. C) The same *L. smithi* completely loses its color after being held in a plastic jar for 30 min.

Defensive behavior has been described in *L. smithi* but defending its body by arching its head towards the vent and by changing its color has not been previously reported.

On 27 June 2007, an adult *L. smithi* (Jahangirnagar University; JU 0058) was found stalking prey at about 2230 h on a rail-way line in the middle of a hilly evergreen forest of Lawachara National Park (24.316°N, 91.783°E; WGS84, 144–150 m elev.), Moulvibazar District of northeastern Bangladesh. When approached and disturbed with a strong camera flash, the frog arched its head towards the vent (ca. 90°) while pushing its body into the rocky ground and remaining motionless (Fig. 1A). Similar behavior has been described in *L. smithi* but with a head arched ca. 90° elevated in opposite direction (Chuaynkern et al. 2007, *op. cit*.) which reveals the capability of the species to bend its head both ways up to 180°. While carrying the frog in a plastic jar for less than an hour, its body color changed completely into a light-ash color (Fig. 1C) from its original dark color with contrasting orange and black eye (Fig. 1B). When the ash-colored frog was taken out of the jar, it remained motionless for several minutes and then tried to escape by moving backwards.

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***PROCERATOPHRYS* SP.** (NCN). **PREDATION.** The Cerrado species of the genus *Proceratophrys* belong to the *cristiceps* group, and are found in open grasslands and gallery forests (Reuber Brandão, pers. comm.). On 12 March 2002, four adult White-eared Puffbirds (*Nystalus chacuru*, Bucconidae) were captured in mist nets in a "campo cerrado" area at Fazenda Água Limpa, Distrito



FIG. 1. White-eared Puffbird captured in a mist net carrying a *Proceratophrys* sp.

Federal, Brazil. One was holding a *Proceratophrys* sp. in its beak (Fig. 1). The White-eared Puffbird digs in the ground or in banks to construct a gallery as an entrance for the nest chamber, and could have captured the frog in its diurnal retreat on the soil. It is a common Cerrado bird that is mostly insectivorous, although other food items including lizards and vegetable matter have been reported (Del Hoyo et al. 2002. Handbook of the Birds of the World. Cotingas to Pipits and Wagtails. Lynx Edicions, Barcelona). This is the first record of a White-eared Puffbird predating a frog.

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SCAPHIOPUS COUCHII (Couch's Spadefoot). **PREDATION**. Predation upon larval *Scaphiopus couchii* by vertebrate and invertebrate predators has been well documented (Duellman and Trueb 1986. Biology of Amphibians. McGraw–Hill, New York. 670 pp.). Predation upon adults is likely common as well, especially during active periods such as the breeding season. However, there are few comprehensive studies detailing predation upon adult *S. couchii*. On 3 Aug 2006 at ca. 2400 h during a trip through Bottomless Lake State Park (Chaves Co., Roswell, New Mexico, USA: 33.31583°N, 104.32307°W; WGS84) we found a single adult male *S. couchii* on a road being consumed by an adult Common Barn Owl (*Tyto alba*). The owl had pinned down the toad with one talon piercing the midsection and had already created a large wound on the toad's back using its beak. The owl immediately flew away when our vehicle headlights illuminated the area from ca. 10 m away. The toad was still alive when collected, but expired shortly thereafter. The specimen was deposited in the University of Texas at Arlington Amphibian and Reptile Diversity Research Center (UTA–A57962).

To our knowledge, this is the first documented instance of predation upon *Scaphiopus couchii* by an avian predator. Common Barn Owls prey heavily upon small mammals, but have been known to eat other prey, including frogs (del Hoyo et al. 1999. Handbook of Birds of the World: Volume 5: Barn-owls to Hummingbirds. Lynx Edicions, Barcelona). This observation suggests that Common Barn Owls living in arid regions may utilize *S. couchii*, or desert breeding anurans in general, as a seasonally abundant food resource. *Scaphiopus couchii* adults may be attractive prey items during the breeding season owing to their large numbers, increased activity, and conspicuous advertisement calls.

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SCINAX FUSCOMARGINATUS (NCN). **PREDATION**. Batracophagy between adult anurans is not frequently documented. Cardoso and Sazima (1977 Ciência e Cultura 29:1130–1132) reported predation of *Chaunus granulosus* by *Leptodactylus labyrinthicus* in Parque Nacional de Sete Cidades, in state of Piauí, Brazil. Cannibalism of nests and tadpoles of other species has been reported by *Leptodactylus labyrinthicus* tadpoles (Silva et. al. 2005. J. Nat. Hist. 39:555–566). On 13 Dec 2006, at 1000 h (air temp. 21°C; water temp. 24°C) we observed an adult *Scinax fuscomarginatus* (20.5 mm SVL), being captured by a adult *Leptodactylus furnarius* (30.7 mm SVL). This observation occurred beside a pond, located in Botucatu (22.923°S, 48.458°W, 800 m elev, WGS84), State of São Paulo, Brazil. The pond was filled with water, the soil around the pond was sandy, and there were small grasses along the shoreline. The *S. fuscomarginatus* was captured by its posterior left leg as it walked close to the L. *furnarius* (Fig. 1). Both individuals were collected and deposited at the Departamento de Zoologia, Instituto de Biociências da UNESP-Botucatu (*S. fuscomarginatus* CCJJ 7816; *L. furnarius* CCJJ 7817).



FIG. 1. An adult *Scinax fuscomarginatus*, captured by a adult *Leptodactylus furnarius*.

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TESTUDINES — TURTLES

CHELYDRA SERPENTINA SERPENTINA (Common Snapping Turtle). **NESTING BEHAVIOR AND SITE SELECTION.** On 31 May 2008, we observed a ca. 36 cm CL C*helydra serpentina serpentina* in unexpected nesting circumstances. Observations were made from 0908 to 1027 h on clear day with ambient temp ca 24°C. The nest site near Longmont, Colorado, USA (40.1599528°N, 105.1259861°W; WGS84) was 4.3 m from a seasonal ditch running north-south to connect two lakes, one on either side of a busy road. The intriguing aspect of the nest location was that it was immediately adjacent to a heavily traveled concrete sidewalk that bordered a road with a high volume of traffic. The frequent foot traffic on the sidewalk and virtually constant vehicle traffic on the adjacent road did not deter the turtle from the particular nest loca-

tion, even though virtually identical soils, gradients, and directional aspects were available equidistant from the ditch, but away from constant human activity. In fact, aside from the potential for nesting disruption, the particular nest location might hold incubation advantages. The position adjacent to the sidewalk might yield thermal advantages from radiant heat from the sidewalk, both above and below ground. The depth of the nest was ca. 15 cm, similar to the thickness of the sidewalk, and probably allowing the entire depth of the nest to be warmed by heat stored in the concrete. The nest was also on a west-facing side of the ditch, allowing it to receive maximal effect of solar radiation during the summer. Altitude is a limiting factor in Colorado for the range of C. *s. serpentina*, with the species only distributed below 1680 m elev. (Hammerson 1999. Amphibians and Reptiles in Colorado. 2nd ed. University Press of Colorado, Niwot). At 1518 m, the elevation of the nest site might be high enough such that any thermal advantages could be important.

Assuming the turtle lives in the pond on the same (south) side of the road as the nest, and can only use the ditch, which connects the ponds on the north and south sides of the road on a seasonal basis (spring only), then there are ca. 3–4 ha of open area for nest building. Unlike turtles that live in city parks where the body of water is often surrounded by sidewalks or bike paths, this turtle had >99% chance to choose a less traveled location to lay her eggs. Using the ditch to gain access to her nesting site provided many opportunities to exit the ditch anywhere along its ca 30 m length to lay her eggs in a non-traveled and secluded area. The ditch embankments are such that they would not inhibit her ability to climb out of the ditch at any location along the way.

At the time observations were initiated, ca. 20 eggs appeared to have already been deposited in the nest. Egg laying was completed at 0932 h. During the 24 min from initiation of observations, 15 additional eggs were added to the clutch already in the nest (average inter-egg interval: 1 min. 36 sec). By 1025 h (53 min after final egg was laid), the turtle had completed covering the nest to the extent it could not be distinguished from the neighboring ground. By 1027 h the turtle had re-entered the ditch.

Unfortunately, this nest was destroyed by a Raccoon (*Procyon lotor*) on 30 August 2008 (predator identification based on tracks and scat), so we were unable to determine if the nest would have produced viable hatchlings. The adjacent ditch, which is often dry by late summer, had been filled during an unusual heavy rain event, so it seems possible that hatchlings might have successfully dispersed if the nest had not been predated.

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CLEMMYS GUTTATA (Spotted Turtle). **DISPLACEMENT.** *Clemmys guttata* utilizes a wide variety of shallow wetland habitats including streams, marshlands, and swamps (Ernst et al. 1994. Turtles of the United States and Canada. Smithsonian Institution Press, Washington, DC. 578 pp.). Juveniles of this species (≤ 6 cm carapace length) tend to be secretive and are observed less often than adults (Ernst 1976. J. Herpetol. 10:5–33). On 16 May 2008, I observed a juvenile *C. guttata* (carapace length 5 cm, with 3–4 annuli) swimming westward across the Patuxent River (38.7839222°N, 76.7093278°W) in Maryland. The river at this location is ca. 110–120 m wide, with a depth of 3 m. On the east side of the river, a 400-m wide freshwater tidal marshland dominated by Spatterdock (*Nuphar advena*) separates the main channel from the adjacent floodplain, where adult *C. guttata* are commonly sighted. The juvenile was captured while swimming close to the water's surface and was photographed for verification.

This unusual occurrence might be explained by a major flood that took place on 14 May 2008. A late northeastern storm caused the river's channel to expand significantly, with strong currents that deposited large amounts of debris along the banks. This turtle might have been displaced by the effects of the storm, and was possibly attempting to return to its place of origin. Other species of semi-aquatic and terrestrial turtles were also sighted adjacent to or swimming across the Patuxent River following the storm, suggesting that the displacement of turtles as a result of major weather events is not uncommon. Previous investigators have found that strong current velocity associated with floods might displace turtles from their home ranges (MacCulloch and Secoy 1983. J. Herpetol. 17:283–285; Moll and Legler 1971. Bull. Los Angeles Co. Mus. Nat. Hist. 11:1–102). Moll and Moll (2004. The Ecology, Exploitation, and Conservation of River Turtles. Oxford University Press, pp. 23–24) suggest that displacement as a result of flooding is more likely to affect juvenile age class individuals of semi-aquatic turtle species. Ernst (1968. Herpetologica 24:77–78) reported that of 25 adult *C. guttata* relocated a distance of 310 m from the original capture point, 14 were later recaptured within 27 m of their capture point, suggesting that this species might have some homing ability.

This observation was made while conducting research at the Jug Bay Wetlands Sanctuary in Lothian, Maryland. Chris Swarth, Sanctuary Director, assisted in identifying and measuring *C. guttata*, and provided additional local observational records of the species.

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GLYPTEMYS INSCULPTA (Wood Turtle). **DIET.** North American Wood Turtles are omnivores that feed on a variety of sources, including green leaves, fruits, algae, moss, fungi, insects, slugs, snails, and earthworms (Ernst et al. 1994. Turtles of the United States and Canada. Smithsonian Institution Press, Washington D.C. 578 pp.; Harding 1997. Amphibians and Reptiles of the Great Lakes Region. University of Michigan Press, Ann Arbor, Michigan. 378 pp.). Wood Turtles feed opportunistically, as the abundance and availability of food items changes seasonally, and are known to scavenge animal carcasses, including fish (Harding 1997, *op. cit.*; Farrell and Graham 1991. J. Herpetol. 25:1–9). As part of a population genetics study, we collected morphometric data and DNA samples from 47 *Graptemys insculpta* in Berkeley County, West Virginia during May 2008 and noted feeding events and food items when possible. Wood Turtle food sources in Berkeley County (listed in order of frequency of observation) included grasses,

green leaves, berries, moss, and a dried Scarlet Oak leaf (*Quercus coccinea*). On 21 May 2008, we noted evidence of ophiophagy in two adult female Wood Turtles from Berkeley County. At 1335 h, an adult female Wood Turtle (mass = 1050.0 g; carapace length = 189.59 mm) defecated a 27.2 x 19.7 mm section of intact, previously shed snake skin. The skin section was undigested, clearly a shed specimen, and appeared to be from a gartersnake (*Thamnophis* sp.). At 1501 h, another adult female (mass = 986.0 g; carapace length = 181.75 mm) defecated a 62.4 x 11.1 mm section of partially digested Ring-necked Snake (*Diadophis punctatus*) while cloacal temperature was being recorded. This specimen had intact skin and muscle, and several vertebrae and ribs emerging from one end. Snake material, including exuviae, has not been reported as a food item for *G. insculpta*.

Thamnophis and *Diadophis punctatus* are both abundant in Berkeley County, although all *D. punctatus* we observed were found well hidden under rocks and logs during daylight hours, when Wood Turtles typically forage. *Diadophis punctatus* is nocturnal, but may be active diurnally during the breeding season (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Institution Press, Washington D.C. 668 pp.). We have no evidence to suggest whether the *D. punctatus* specimen was taken as carrion or predated. The worm-like appearance of *D. punctatus* might have elicited predation by *G. inscuplta*, or the snake might have been taken as carrion, possibly as the remnant of another predator's meal. Although a wide variety of vertebrates have been reported to prey on *D. punctatus*, the only reptile predators recorded are squamates (Ernst and Ernst 2003, *op. cit.*).

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GOPHERUS AGASSIZII (Desert Tortoise). **BURROW ASSOCIATE**. Desert Tortoises are semi-fossorial and construct burrows that are a unique environment that provides shelter from the extreme heat and are generally more humid, both features which aid in reducing water loss (Bulova 2002. J.Therm. Biol. 27:175–789; Zimmerman et al. 1994. Herpetol. Monogr. 8:45–59). It would be expected that numerous other species would make use of this structure; however, in a review of burrow associates, Luckenbach (1982. *In* Bury [ed.], North American Tortoises: Conservation and Ecology, pp. 1–38. Wildl. Res. Report 12, U.S. Fish and Wildlife Service, Washington, D.C.) lists only 31 species observed in Desert Tortoise burrows. From this list we can conclude that virtually all desert vertebrates will use or modify a Desert Tortoise burrow for shelter, while only a few arthropods have been noted. This is rather surprising as more than 350 animals have been observed using burrows of the Gopher Tortoise (*Gopherus polyphemus*), with roughly 300 of these being invertebrates (Jackson and Milstrey 1989. *In* Diemer et al. [eds.], Gopher Tortoise Relocation Symposium Proceedings, pp. 86–98. State of Florida Game and Fresh Water Fish Commission Nongame Wildlife Program Technical Report No. 5). It is likely that part of this large discrepancy between the two species of tortoises' burrow associate fauna is based on the fact that the southwestern deserts of the United States are less diverse than the southeast, where the Gopher Tortoise is found. However, we believe that more invertebrates should be making use of Desert Tortoise burrows, despite the conclusions of Grant (1936. Zoologica 21:225–229) that burrow associates of the Desert Tortoise are not important.

On 13 November 2007 at 1200 h at a study site in the west Mojave Desert northeast of Barstow, San Bernardino County, California (Walde et al. 2007. West. N. Am. Nat. 67:147–149) we observed a tarantula (Araneae, Mygalomorphae, Theraphosidae) in a Desert Tortoise burrow. The tarantula was brown with a carapace of ca. 25 mm and was considered to be a male because of the relatively small abdomen. There are two species of tarantula in this area, *Aphonopelma mojave* and *A. iodius* (Prentice 1997. J. Arachnol. 25:137–176). These two species are easily distinguished as *A. mojave* is black and small, while *A. iodius* is larger and has a light to medium brown carapace with variably colored legs from medium to dark brown, to black (Prentice, *op. cit.*). Therefore, we can conclude that the tarantula observed in the burrow was *A. iodius*. These species are both fall breeders, a time when males go in search of females (Prentice, *op. cit.*), therefore it is likely that this *A. iodius* took refuge in the burrow during its mate searching, although it may have been looking for food. The burrow was an overwintering burrow for an adult female Desert Tortoise.

Previously, an unknown species of tarantula was documented in a Desert Tortoise burrow during a study in Nevada (Burge 1978. *In* Trotter [ed.], Desert Tortoise Council Proceedings of 1978 Symposium. pp. 80–111). To our knowledge, the only other spider documented in Desert Tortoise burrows is the Black-widow Spider (*Lactrodectus mactans*) which has been observed in California and Nevada (Burge, *op.cit.*; Luckenbach, *op. cit.*). The presence of these highly effective predators in the burrows of Desert Tortoises suggests that additional species of invertebrates are likely utilizing the burrows as well.

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GOPHERUS AGASSIZII (Desert Tortoise). **PREDATION BY MOUNTAIN LION**. During a long-term study on tortoise growth within three fenced 9-ha enclosures in Rock Valley, Nevada Test Site (NTS), Nye County, Nevada, USA, tortoises have been captured annually since 1964 (Medica et al. 1975. Copeia 1975:630–643; Turner et al. 1987. Copeia 1987:974–979). Between early August and mid October 2003 we observed a significant mortality event. The Rock Valley enclosures were constructed of 6 x 6 mm mesh 1.2 m wide hardware cloth, buried 0.3 m in the soil with deflective flashing on both sides on the top to restrict the movement of small mammals and lizards from entering or leaving the enclosures (Rundel and Gibson 1996. Ecological Communities and Process in a Mojave Desert Ecosystem: Rock Valley, Nevada, Cambridge University Press, Great Britain. 369 pp.).

On 6 August 2003, the carcass of an adult female Desert Tortoise #1411 (carapace length 234 mm when alive) was collected while adult male tortoise #4414 (carapace length 269 mm) was observed alive and in good health on the same day. Subsequently, the carcass of #4414 was found on 16 October 2003. Between 16–17 October 2003, the remains of six (five adult and one juvenile) Desert Tortoises were found, some within each of the three enclosures in Rock Valley. A seventh adult tortoise was found on 26 September 2006, its death also attributed to the 2003 mortality event based upon the forensic evidence. Each of the seven adult Desert Tortoises had the central portion of their carapace broken open approximately to the dorsal portion of the marginal scutes while the plastron was still intact (Fig. 1A). Adjacent to seven of the eight remains, we located numerous bone fragments including parts of the carapace and limbs as well as dried intestinal content in nearby Range Rhatany (*Krameria parvifolia*) shrubs (Fig. 1B). The significance of the frequent use of this shrub is puzzling. Three of the Desert Tortoise shell remains possessed distinctive intercanine punctures measuring 55–60 mm center to center indicating that this was an adult sized Mountain Lion (*Puma concolor*). By comparison, a two-year old male Mountain Lion salvaged on NTS had an upper intercanine bite width of 45 mm, and a six-month old kitten measured 35 mm, respectively. The Mountain Lion is the only predator that exists in southern Nevada that could possibly have a bite with such a large gap between its upper canine teeth (Murmann et al. 2006. J. Forensic Sci. 51:846–860).

The appearance of the shell remains in Fig. 1A is similar to that depicting Jaguar (*Panthera onca*) predation on the Amazonian Red-footed Tortoise (*Geochelone denticulata*) as illustrated by Emmons (1989. J. Herpetol. 23:311–314), with the majority of the carapace broken open and the plastron still intact. Predation of Desert Tortoises by Mountain Lions was also documented in 1993 in southern Arizona (Little Shipp Wash Plot), where seven of eight carcasses found were attributed to Mountain Lion predation (Averill-Murray et al. 2002. *In* T. R.Van Devender [ed.], The Sonoran Desert Tortoise: Natural History, Biology, and Conservation, pp. 109–134. University of Arizona Press and Arizona-Sonora Desert Museum, Tucson, Arizona). Similarly, predation by a Mountain Lion has been reported on the Argentine Tortoise (*Chelonoidis chilensis*) in Argentina (Acosta et al. 2004. Herpetol. Rev. 35:53–54), and a Mountain Lion kitten was observed to kill and consume a portion of the carapace of a Texas Tortoise (*Gopherus berlandieri*) in west Texas (Adams et al. 2006. Southwest. Nat. 51:581–582).

Over the past 45 years this Desert Tortoise population has been monitored yearly, with no prior evidence of predation to tortoises within the fenced enclosures. On several occasions other predators such as Bobcats (*Lynx rufus*) have been observed within the study enclosures for as long as a week. Evidence of Kit Fox (*Vulpes macrotus*) sign has been observed on numerous occasions, and a Spotted Skunk (*Spilogale putorius*) and Longtail Weasels (*Mustela frenata*) have been captured and released (Medica 1990. Great Basin Nat. 50:83–84; B. G. Maza, pers. comm.), while Coyotes (*Canis latrans*) were never observed within the fenced enclosures. Prior to this predation event in Rock Valley, 17 Desert Tortoises were alive between 2000 and 2002, only 7 were known to be alive in 2004, while 2 tortoises have not been seen since 2002. Predation studies of Mountain Lions indicate that these events may be an example of a learned behavior of individual animals developing

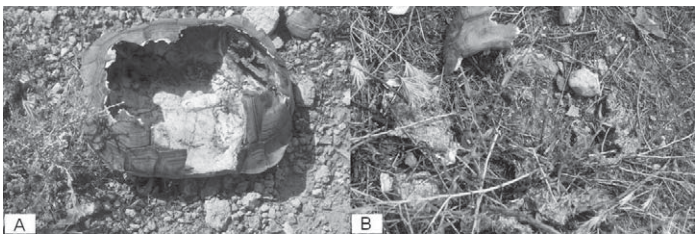


FIG. 1. A) Shell remains of an adult female Desert Tortoise (#1411) characteristic of Mountain Lion predation. B) Pieces of Desert Tortoise carapace and remnants of intestinal content found in a *Krameria parvifolia* shrub.

a preference for a prey (Logan and Sweanor 2001. Desert Puma: Evolutionary Ecology and Conservation of an Enduring Carnivore. Hornocker Wildlife Institute, Island Press, Washington. 463 pp.; Creeden and Graham 1997. Desert Bighorn Council Transactions, pp. 37–43), or the plight of a large predator locating an available source of food while passing through low elevation Mojave Desert habitat in late summer or early fall. Several Mountain Lion sightings were recently recorded in late summer and early spring (5 and 26 July 2006; 15 March 2007) at lower elevations (1300 m) in *Larrea*/*Ambrosia* habitat on the NTS, 8–10 km NE of Rock Valley in canyons near the base of Skull Mountain. Predation upon Desert Tortoises and their nests is also perpetrated by smaller carnivores, e.g., Coyotes, Kit Foxes, and Badgers (Grover and DeFalco 1995. Desert Tortoise (*Gopherus agassizii*): Status-of-knowledge Outline with References. U.S. Department of Agriculture, Forest Service Report INT-GTR-316, pp.76–79). Predation by these smaller carnivores generally leaves the carapace intact and the head and legs are gnawed off, sometimes leaving the upper portions of the appendages still connected to the carcass. The carcass of an adult male tortoise #1212 (carapace length 289 mm when last captured alive) was found in this condition on 15 October 2004. Such predation events upon alternate prey such as the Desert Tortoises appear to take place toward the end of the summer season and coincide with a combination of drought years and the reduced density of typical prey such as small mammals. Localized predation events by a large predator such as Mountain Lions can have a significant impact upon on a small population of prey, e.g., the reduction of the population of bighorn sheep in the Granite Mountains during drought 1989–1991 (Wehausen 1996. Wildl. Soc. Bull. 24:471–479). The Mountain Lion predation event that took place in Rock Valley during 2003 was likely a chance happening but has had a profound impact upon the local population. The presence of Bighorn Sheep (*Ovis canadensis*) in the adjacent Specter Range since their introduction in the fall of 1990 may have influenced the distribution of Mountain Lions.

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GOPHERUS POLYPHEMUS (Gopher Tortoise). **EMERGENCE BEHAVIOR**. Female Gopher Tortoises often place their nests in a mound of soil or bare area (referred to as the "apron") located immediately in front of their burrows (studies reviewed in Mushinsky et al. 2006. *In* Meylan [ed.], Biology and Conservation of Florida Turtles, pp. 350–375. Chelonian Research Foundation, Lunenburg, Massachusetts). However, observations of nest emergence and subsequent behavior of hatchling Gopher Tortoises are few. To our knowledge, Ashton and Ashton (2008. The Natural History and Management of the Gopher Tortoise. Krieger Publishing Company, Malabar, Florida) provide the only account of a hatchling Gopher Tortoise entering an active adult burrow immediately following nest emergence. We observed a hatchling Gopher Tortoise emerge from a nest located on a female tortoise burrow apron while an adult male courted the resident female and document the hatchling's emergence, the male's response, and the hatchling's post-emergence use of the active adult burrow.

We made our observation using an automated video system focused on an adult female burrow at the Camp Shelby Joint Forces Training Center in southern Mississippi, USA. On 26 August 2006 at 1229 h (CST; overcast skies; ambient air temperature [T_a] = 30ºC), an adult male was on a burrow apron courting an adult female that was inside her burrow as a hatchling Gopher Tortoise emerged from its nest, located about ~10 cm in front of the male. The female, which entered her burrow earlier, did not emerge while the hatchling was present. The male head bobbed intermittently before, during, and after the emergence event. Although he was directly facing the hatchling and head bobbing in its direction, he was probably directing this behavior toward the female's burrow, which was also in front of him. The male extended his head toward the hatchling three times. All but the third head extension could easily have been part of the courtship ritual, but the third appeared to be clearly in response to the hatchling as the male extended his head far forward and touched the small turtle with its nose for several seconds. To our knowledge, this is the first report of an adult Gopher Tortoise responding to the presence of a hatchling. We did not identify any other unambiguous response by the adult toward the hatchling. The hatchling moved toward the male, and the male also moved slightly toward it (and the female burrow) until the hatchling was just in front of the male's gular and left forelimb. The two tortoises appeared to repeatedly make random contact before the hatchling walked away.

The male then proceeded toward the burrow, inadvertently pushing the hatchling that was still in his path with his forelimb and shell as he walked by. The hatchling, now behind the male, followed. The male continued to head bob toward the female's burrow and disappeared into the burrow at 1241 h. The hatchling appeared to enter the burrow at 1242 h, but it is unknown if it completely entered the burrow because the camera was positioned slightly behind the burrow entrance. The hatchling intermittently appeared in the burrow entrance until 1246 h, when it was no longer visible. A short while later, a small tortoise, possibly the same hatchling, emerged from the burrow entrance before going back inside. At 1255 h, shortly after it started to rain, the male emerged from the burrow and left the apron and the video-taped area. At 1305 h (T_a = 27ºC), while it was still raining, a small tortoise (possibly the same hatchling) emerged from the burrow entrance. After beginning to leave the apron, it turned around and somehow, perhaps due to the slope of the terrain, overturned onto its carapace. Thirty seconds later, the hatchling righted itself, left the apron, and went into some dense vegetation before going out of view for the final time at 1329 h. Neither the male nor the hatchling returned to the burrow later that day before the video system stopped recording at 2030 h.

Ashton and Ashton (*op. cit*.) report an event in which a hatchling entered an active adult burrow immediately upon emerging from its nest. It is unknown whether a hatchling that is at the surface can determine whether a burrow contains an adult tortoise. Our observation of a hatchling following an adult tortoise into a burrow entrance is notable because it provides unambiguous evidence that upon emergence, some hatchlings use adult burrow entrances (and probably deeper portions of burrows also) regardless of activity status or adult presence at the burrow mouth. Adult Gopher Tortoise burrows may provide newly-emerged hatchlings with a convenient, temporary refuge from hot and dry surface conditions from which they can leave to construct their own burrows when conditions are favorable for extended above ground activity.

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GOPHERUS POLYPHEMUS (Gopher Tortoise). **NESTING.** *Gopherus polyphemus* is endemic to the Longleaf Pine ecosystems of the Gulf Coastal Plain of the southeastern USA. Oviposition in this species usually occurs between May and early July when eggs are deposited in a nest cavity usually located on the apron of

the burrow. In the DeSoto National Forest (DNF), female tortoises construct nest cavities on average 55 cm from the mouth of the burrow, 17 cm deep, and containing 5 eggs (Noel 2006. Unpubl. MS thesis, University of Southern Mississippi, Hattiesburg). During the summer of 2008, we searched burrow aprons in the DNF for clutches of eggs on a daily basis. Each clutch that was found was excavated and removed from the nest cavity and moved to man-made nests at different burrows, as part of an experiment to evaluate environmental influences on hatching success. Following excavation and egg removal, nest cavities were re-filled with the loose soil that had been earlier removed. Because of the soil composition and hard-setting nature of most burrow aprons (mean soil composition of nests: 83.2% sand, 12.7% silt, and 4.1% clay), these nest cavities often remain detectable by feel (i.e., a hard-sided cavity filled with loose, friable soil) for several weeks or longer.

On 24 May 2008, a clutch (N = 5 eggs) was found and excavated at a burrow (#7032 in the DNF database) at our McLaurin site (31.14992 Nº, 89.2005 Wº) that was ca. 70 cm from the burrow mouth and 17 cm deep. Ten days later on 3 June 2008, a second clutch (N = 6) was discovered within the same nest cavity, with only minor modifications to the original shape. A third clutch (N = 5) was excavated from the same nest cavity just two days later on 5 June 2008 with slightly more substantial modifications to the original cavity. The final clutch (N = 5) was discovered on 16 June 2008 at the original cavity location; however the cavity was highly modified from the original shape and size. To our knowledge, this is the first report of multiple clutches being laid not only at the same burrow but also in the same nest cavity within a given year. We presume that these four clutches were oviposited by four different females, since there are no published accounts of multiple clutches in one season for *G. polyphemus*, and it seems highly unlikely that a female could produce a subsequent clutch in as few as two to eleven days. This is perhaps not a naturally occurring phenomenon, since we removed each previous clutch, the presence of which may have prevented subsequent females from excavating and ovipositing in the same location. Alternatively, it is possible that subsequent females may have used the same location even without our alterations, perhaps destroying the prior clutch(es) during their excavation of a nest cavity. During our five years (2003–2007) of searching for nests at the same sites, we have never found a nest cavity utilized more than once but have found, on several occasions, two clutches oviposited in the same apron. These observations suggest that particular burrow aprons could be more favorable, and nesting *G. polyphemus* may exhibit preference for these locations.

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GRAPTEMYS FLAVIMACULATA (Yellow-blotched Map Turtle). **UNUSUAL BASKING DISTURBANCE.** Members of the genus *Graptemys* are noted for their proclivity to bask aerially and wariness while basking on emergent deadwood (Boyer 1965. Ecology 46:99–118). Basking disturbances for this species have been studied, but focused on human recreational disturbance (Moore and Seigel 2006. Biol. Cons. 130:386–393). Here we report multiple observations of *G. flavimaculata* basking disturbances caused by unnatural floating debris.

On 23 June 2007, three male *G. flavimaculata* (West Pascagoula River, Jackson County, Mississippi) were observed to flee their basking locations in response to a large piece of polystyrene foam (ca. 90 x 90 x 90 cm) floating downstream at 1755 h. One of these turtles was basking in a fallen tree crown and two were basking on the trunk portion of the same fallen tree. Also, on 22 April 2008 (same locale), two female, one male, and one juvenile female *G. flavimaculata* were not disturbed by a medium-sized piece of floating polystyrene foam (122 x 45 x 20 cm) floating downstream at 1339 h. However, this floating debris got caught in an eddy current and began moving back upstream and only then (1343 h) did all four individuals evacuate their basking locations on trunk portions of fallen trees. Later that afternoon at 1730 h, three female *G. flavimaculata* were disturbed by a small piece of Styrofoam (45 x 15 x 10 cm) floating downstream.

On 20 April 2008, a large female *G. flavimaculata* (same locale) was disturbed from her basking location because of a large television floating downstream at 1304 h. Further, it was also noted that two *G. flavimaculata* males basking downstream were not disturbed by the same floating television at 1310 h.

Within the Lower Pascagoula River, there are many floating houseboats and these usually have large blocks of polystyrene foam that are used for floatation. Following Hurricane Katrina, many of these houseboats were destroyed (by wind and storm surge) and there was a plethora of floating debris including plywood, couches, polystyrene foam, and other items. For all observations, objects passed within 5–10 m of the basking turtles, and therefore, it is unknown if objects floating at greater distance would elicit the same response. However, it is clear from these observations that this species is quite wary of unnatural floating items in the river.

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GRAPTEMYS FLAVIMACULATA (Yellow-blotched Map Turtle). **BASKING AND PARASITE REMOVAL**. Aerial basking in turtles is thought to be primarily for thermoregulatory reasons (Boyer 1965. Ecology 46:99–118). However, a recent observation (Selman et al. 2008. Herpetol. Rev. 39:216) supports the secondary role of basking as a method to rid turtles of ectoparasites (Cagle 1950. Ecol. Monogr. 20:31–54; Neill and Allen 1954. Ecology 35:581–584; Vogt 1979. Auk 96:608–609). Here, we provide a second observation of voluntary leech removal from a different species in the genus *Graptemys*.

On 27 May 2008 (1127 h), WS observed a juvenile female *Graptemys flavimaculata* (~10 cm, 200 g) basking on a branch of a fallen tree-crown (West Pascagoula River, Jackson Co., Missis-

sippi, USA). It was unknown how long the individual had been emerged from the water, but the shell was completely dry when first observed. Also, a large leech (*Placobdella* sp.) was noted on the posterior right portion of the carapace and it was in a ball shaped posture, presumably for water conservation. After 6 minutes of observation (1133 h), the leech terminated the ball-shape and moved slowly toward the posterior of the carapace. Over the next minute, the leech removed one end of its body from of the turtle and began to 'search' below toward the branch, while the other end was still attached at the rear margin of the carapace. The leech tried to reach for the branch multiple times to remove itself, but was unsuccessful because the turtle was 'swiping' her hind legs, preventing the leech from attaching to the log. At 1134 h, the leech began to 'search' again for the branch and the turtle flipped the leech off its shell with a swipe of its right hindlimb into the water.

At the time of basking, the air temperature was 27.2°C and log surface temperature was 28.2°C. Therefore, the carapace temperature of the *G. flavimaculata* juvenile female was likely hot enough to induce the leech to voluntarily release itself from its host organism. It is unlikely that the leg swiping was related to the leech's presence, but instead a normal behavior associated with basking in other turtle species (Auth 1975. Bull. Florida St. Mus. 20:1–45). We assume that the leech eventually would have removed itself in a manner similar to our previous observation (Selman et al. 2008, *op. cit*.) had the turtle not assisted. This is the second documented observation of voluntary parasite release during basking and first observation for this species.

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MACROCHELYS TEMMINCKII (Alligator Snapping Turtle). **ADULT BASKING BEHAVIOR**. *Macrochelys temminckii* is the largest freshwater turtle in North America, inhabiting rivers and associated waters (e.g., cypress swamps and smaller tributaries) that drain into the Gulf of Mexico (Ernst et al. 1994. Turtles of the United States and Canada. Smithsonian Institute Press, Washington, D.C. 578 pp.). Little is known concerning the behavior of this secretive turtle, but there have been reports of *M. temminckii* hatchlings and juveniles basking aerially (Ewert 1976. Herpetologica 32:150–156; Farr et al. 2005. Herpetol. Rev. 36:168; Shelby and Jenson 2002. Herpetol. Rev. 33:304). Here we report the first known aerial basking observation of an adult *M. temminckii*.

On 3 April 2008 (1400 h), WS and BD observed an adult *M. temminckii* (ca. 40–50 cm carapace length) basking on a bank of the Leaf River (Forrest County, Mississippi, USA). The individual was observed via spotting scope (ca. 100 m distant), ca. 1.8 m above the water's surface on the opposite, cut bank side of the river. The individual was facing upslope and appeared lifeless, with head extended completely and resting on the sand bank (to the extent that we could seeing the complete dorsal profile of the head). The sandy bank was fully exposed to sun, non-vegetated, had a slope of ca. 45–60°, and faced to the southwest. Conditions were mostly sunny, with a water temperature of 22°C and an ambient air temperature of 28°C (31°C in direct sunlight). After observation of this turtle basking for ca. 5 minutes, it turned around and retreated to the water. The route back to the water seemed to be a "controlled fall" on the steep slope and the turtle hesitated slightly before re-entering the water.

It is unlikely that this behavior was associated with female reproductive activity because reports indicate that nesting of *M. temminckii* occurs in Florida during late April to early May (Ewert and Jackson 1994. Unpubl. report to Florida Game and Freshwater Fish Commission) and in Georgia until early June (Powders 1978. Copeia 1978:134–140). Furthermore, subsequent searches did not reveal any nest sites at the basking location. It is difficult to determine what initiated this behavior because there are no other reports for adult basking behavior. We could not determine how long the individual had been basking before our initial observation or why the turtle was basking so far and high from the water's edge on a steep inclined river bank, as opposed to near the water's edge. However, we presume that basking behavior could have been initiated due a combination of factors. The day of observation was mostly sunny, preceded by three days of cloudy conditions. Water temperatures were relatively low, and river flows peaked during the day of observation, preceded by two days of rising water levels following heavy rains. Additionally, the individual might have had an injury or illness and might have been basking to increase body temperature to fight infection.

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PSEUDEMYS CONCINNA (River Cooter). **MAXIMUM BASKING TIME.** *Pseudemys concinna* is a large, herbivorous, freshwater turtle that is found predominantly in the southeastern United States (Ernst et al. 1994. Turtles of the United States and Canada. Smithsonian Inst. Press, Washington, D.C. 578 pp.). It is prone to aerial basking and this behavior has been observed in West Virginia populations from March to September (Buhlman and Vaughan 1991. J. Herpetol. 25:72–78), with basking peaking during midday (1200 h) for Florida populations (Pritchard and Greenhood 1968. Int. Turtle Tortoise Soc. J. 2:20–25, 34). Even though it is known that basking behavior is common in this species, the maximum amount of time an individual will spend once emerged from the water is unknown. Here we report a maximum basking time for this species.

On 15 April 2008 (Leaf River, Forrest County, Mississippi, USA), a *P. concinna* (ca. 15–20 cm CL) was noted emerging onto a branch at 0950 h, which was the first favorable sunlight conditions for basking. This individual basked without re-entering the water until 1755 h (8 h, 5 minutes). At the time of emergence, the water temperature was 16.3°C and the ambient air temperature was 12°C (26.6°C in sunlit conditions). At submergence, water temperature was 20.0°C and ambient air temperature was 17.4°C (33.7°C in sunlit conditions). Furthermore, it was sunny throughout the day; the water temperature peaked at 20.0°C and ambient air temperatures peaked at 18.1°C (sunlit temperatures at 34.7°C).

Throughout the day, many *P. concinna* were observed basking

for extended periods of time (4–6 h). Also, 44 *P. concinna* were noted basking at 1400 h along a 310-m section of river. This was the most observed during any hourly count at this location throughout the year (April–October). Therefore, early spring, when water temperatures are cool and air temperatures are warming, is apparently highly conducive to *P. concinna* basking for long periods of time.

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TERRAPENE ORNATA LUTEOLA (Desert Box Turtle). **CARRION FEEDING**. *Terrapene ornata* is known to eat a variety of food items, although its diet mainly consists of insects under natural conditions (Ernst et al. 1994. Turtles of the United States and Canada. Smithsonian Inst. Press, 578 pp.; Legler 1960. Univ. Kansas Publ., Mus. Nat. Hist. 11:527–669). Included in the diet of the species is carrion (Dodd 2001. North American Box Turtles: A Natural History. Univ. of Oklahoma Press, Norman, 231 pp.). *Terrapene ornata luteola* occurs in desert habitats of New Mexico, Texas, Arizona, and adjacent parts of Mexico. Most information on the diet of *T. ornata* has been gathered on the grassland-inhabiting subspecies *T. o. ornata*. Here I report on an instance of carrion feeding in *T. ornata luteola*.

On 22 July 2008 at 0716 h, at the Sevilleta National Wildlife Refuge (ca. 67 km S of Albuquerque, New Mexico, USA), I found an adult female *T. ornata luteola* (130 mm straight-line carapace length, 583 g) on a dirt road with the head of a recently deceased Round-tailed Horned Lizard (*Phrynosoma modestum*) in its mouth. When I drove up to the turtle, she started to move off the road with the lizard still in her grasp. The female held onto the lizard for about 30 s as I tried to photograph her. Once she dropped the lizard, I placed turtle and lizard in a holding box. A small (about 4 mm) chunk of the anterior portion of the head of the lizard had been removed. The horned lizard (58 mm snout–vent length, 6.2 g) was still pliable and may have been a recent roadkill. However, a caged *T. o. ornata* was found to have partially eaten a living Texas Horned Lizard (*P. cornutum*) caged with it (Eaton 1947. Copeia 1947:270). Under natural conditions, though, it seems unlikely that a turtle could catch a living horned lizard.

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TRACHEMYS SCRIPTA ELEGANS (Red-eared Slider). **MAXIMUM BASKING DURATION.** *Trachemys scripta* is a large, omnivorous, freshwater turtle that is found predominantly in the southeastern and central United States (Ernst et al. 1994. Turtles of the United States and Canada. Smithsonian Inst. Press, Washington, D.C. 578 pp.), although it has been introduced to many places worldwide via the pet and food trades (Emer 2004. Herpetol. Rev. 35:34–35; Lever 2003. Naturalized Reptiles and Amphibians of the World. Oxford University Press, Oxford; Perry et al. 2007. Applied Herpetol. 4:88–89). Aerial basking is highly developed in this species with peak basking time occurring around 1400 h; maximum basking duration also has been noted at over 200 minutes during the fall months (Auth 1975. Bull. Florida St. Mus. 20:1–45). Here we report a new maximum basking time for this species.

On 15 April 2008 (Leaf River, Forrest County, Mississippi, USA), a *T. s. elegans* (ca. 20 cm CL) was noted emerging onto a branch at 0955 h—the first favorable sunlight conditions for basking. This individual basked without re-entering the water until 1705 h (7 h, 10 minutes). At the time of turtle emergence, water temperature was 16.4°C and the ambient air temperature was 12.4°C (26.4°C in sunlit conditions). At submergence, water temperature was 19.9°C and ambient air temperature was 17.5°C (33.6°C in sunlit conditions). Further, it was sunny throughout the day; water temperature peaked at 20.0°C and ambient air temperatures peaked at 18.1°C (sunlit temperatures at 33.6°C).

Throughout the day, many turtles of several species were noted to bask for extended periods of time (4–6 h). Therefore, early spring, when water temperatures are cool and air temperatures are warm, appear highly conducive to extended basking in *T. s. elegans* and other co-occurring turtle species.

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CROCODYLIA — CROCODILIANS

CAIMAN CROCODILUS **(**Spectacled Caiman**). OPPORTUNISTIC FORAGING.** We document opportunistic foraging behavior by *Caiman crocodilus* in a post-inundation forest at Estacíon Biologíca Caño Palma, Costa Rica. Estacíon Biologíca Caño Palma is a 40-ha reserve located on the northeast coast of Costa Rica, south of Barra del Colorado. This reserve and the surrounding area is lowland tropical wet forest (*fide* Holdridge 1967. Lifezone Ecology, Tropical Science Center, San José, Costa Rica. 206 pp.) comprised predominantly of *Manicaria* swamp forest (Myers 1990. *In* Lugo et al. [eds.], Ecosystems of the World, pp. 267–278. Elsevier, Oxford, UK). Bounded by large catchment rivers to the north, south, and west with a blackwater channel to the east, the forest inundates seasonally (November–December and May). *Manicaria* forests typically exhibit a prominent biannual polymodal inundation during the wettest season (Junk et al. 2000. The Central Amazon Floodplain: Actual Use and Options for a Sustainable Management, Backhuys Publishers, Leiden, Holland. 584 pp.). The seasonal inundation event that engulfs Estacíon Biologíca Caño Palma is also coupled with local tidal flow patterns (Kelso 1967. Unpubl. M.Sc. thesis, Univ. Florida, Gainesville. 156 pp.). Once inundation subsides, numerous temporal pools remain in the forest; these generally disappear during the warmer (and drier) months of the year.

In December 2002 and again in January 2004, during three months of weekly diurnal visual-encounter transects of post-inundation *Manicaria* forest, 5 adult and 7 juvenile caiman (2002) and 4 adult and 3 juvenile caiman (2004), respectively, were located well into (often > 100 m) the forest. Once disturbed, they retreated terrestrially toward the channel associated with riparian habitat, rapidly slipping in and out of temporary pools as they headed in an easterly direction toward the main blackwater channel bordering the property.

Caiman reproduction, which generally occurs during the rainy season in this region of Costa Rica (November–February), involves construction of vegetation mounds in forested environments to incubate the eggs (Allsteadt 1994. J. Herpetol. 22:12–19). As in other crocodilians, caiman exhibit well-developed parental care and will defend nests from predators, the primary threat to their eggs (Leenders 2001. A Guide to Amphibians and Reptiles of Costa Rica. Zona Tropical, Miami, Florida. 305 pp.). We detected no evidence of nests or nest-guarding behavior in the areas where we sighted caiman. However, these areas, still saturated by water, were frequently found to be full of suffocating fish trapped in desiccating flood pools or anurans utilizing these ponds for breeding. Fish species present included: *Archocentrus nigrofasciatus* and *Parachromis managuensis* (Cichlidae), *Rhamdia guatemalensis* and *Rhamdia rogersi* (Pimelodidae), and *Astyanax aeneus* (Characidae). *Atractosteus tropicus* (Order: Semionotiformes) were also hunting in these pools and may have constituted prey. That caiman were feeding on the diverse prey within these seasonally restricted environments seems likely. Fish are an important prey species for many crocodilians (Magnusson 1987. J. Herpetol. 21:85–95) and can make up over 25% of total prey items in sub-adult and mature adult caiman (Thorbjarnarson 1993. Herpetologica 49:108–117; Velasco et al. 1994. Crocodile Specialist Group Newsletter 13:20–21). In tropical blackwaters Cichlidae, Pimelodidae, and Characidae can make up 10–27% of the composition of fish species consumed (Santos et al. 1996. Herpetol. J. 6:111–117; Thorbjarnarson 1993. Herpetologica 49:108–117) and possibly more when increases in water level like that which occurred along the Caño Palma allow more fish access to greater volumes of water and increased predation susceptibility (Silveira and Magnusson 1999. J. Herpetol. 33:181–192).

Caiman now occur in diverse habitats such as marshes, rivers, channels, and lakes in both the Caribbean and Pacific lowlands of Costa Rica, particularly as a result of the now-diminished ranges of sympatric competitors (*Crocodylus acutus*) (Magnusson 1982. Crocodiles, pp. 108–116. Proc. 5th IUCN/SSC Croc. Spec. Group, Gland, Switzerland). They are commonly found in the canals, dykes, and channel networks in forested floodplain habitats (Allsteadt and Vaughan 1992. Brenesia 38:65–69; Guyer 1994. *In* McDade et al. [eds.], La Selva: Ecology and Natural History of a Neotropical Rain Forest, pp. 210–216. Univ. Chicago Press, Chicago, Illinois; Guyer and Donnelly 2005. Amphibians and Reptiles of La Selva, Costa Rica and the Caribbean Slope. Univ. California Press, Berkeley, California. 299 pp.; Ouboter and Nanhoe 1988. J. Herpetol. 22:283–294; Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna Between Two Continents, Between Two Seas. Univ. Chicago Press, Illinois. 934 pp.). This species is known to establish territories in local channel networks where they exhibit high site tenacity (Savage, *op. cit.*), especially in areas that provide a sustainable food resource. Opportunistic seasonal shifts in habitat use has not been widely reported in *Caiman crocodilus*. Our observations imply that these habitat shifts provide enhanced feeding opportunities that may be unavailable the rest of the year. We present two models that may explain these habitat shifts. In the first, caiman may periodically abandon their territories within the permanent channel network during episodic inundation to specifically forage for trapped fish within temporary pools in the forest. The second model proposes that caiman along with other fauna advance into the forest during inundation following the expanding shoreline. As the water recedes, some aquatic animals are trapped in pools where they are vulnerable to amphibious predators, such as caiman. Caiman are able to escape back to traditional channel-margin habitat as the pools disappear. Which is correct provides an interesting question for further research.

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LACERTILIA — LIZARDS

AMEIVA FESTIVA (Middle American Ameiva). **ENDOPARASITES.** *Ameiva festiva*, a diurnal forest species, occurs in humid lowlands from Tabasco, Mexico to northern Colombia (Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna Between Two Continents, Between Two Seas. University of Chicago Press, Chicago, Illinois. 934 pp.). To our knowledge, only one report exists of helminths in *A. festiva*; Bursey et al. (2006. J. Parasitol. 92:350–353) reported the nematode *Oswaldocruzia nicaraguensis*, physalopterid (nematode) larvae and an acanthocephalan cystacanth from *A. festiva* collected in Nicaragua. The purpose of this note is to add the nematode *Physaloptera retusa* to the list of endoparasites for *A. festiva*.

Only the stomach of one *A. festiva* female (90 mm SVL) deposited in the Natural History Museum of Los Angeles County, Los Angeles, California, USA as LACM 72804 (from Colombia, Chocó Province, upper Rio del Valle, 06.7572°N, 77.5636°W, WGS84; elev. 50 m) collected in 1971 was opened and examined for helminths. Found were 5 adult (4 male, 1 female) nematodes, which were cleared in a drop of glycerol on a glass slide, cover-slipped and identified using a compound microscope as *Physaloptera retusa.* Nematodes were deposited in the United States National Parasite Collection, Beltsville, Maryland as: *Physaloptera retusa* (USNPC 101082).

Physaloptera retusa is widely distributed among lizards in the western hemisphere (Baker 1987. Mem. Univ. Newfoundland, Occas Pap. Biol. 11:1–325; Goldberg et al. 2007. Comp. Parasitol. 74:327–342). Physalopterid nematodes utilize insects as intermediate hosts; lizards become infected by ingesting insects containing infective larvae (Anderson 2000. Nematode Parasites of Vertebrates: Their Development and Transmission, 2nd ed. CABI Publishing, Oxfordshire, UK. 650 pp.). *Ameiva festiva* represents a new host record for *P. retusa*. Colombia is a new locality record.

We thank Christine Thacker (LACM) for permission to examine *A. festiva.*

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AMEIVA UNDULATA (Rainbow Ameiva). **ENDOPARASITES.** *Ameiva undulata* is known from Tamualipas and Nayarit, Mexico, south to Nicaragua (Savage 2002. The Amphibians and Reptiles of Costa Rica; A Herpetofauna Between Two Continents, Between Two Seas. University of Chicago Press, Chicago, Illinois. 934 pp.). To our knowledge, only one report exists of an endoparasite from this species. Caballero (1951. Ann. Instit. Biol. Univ. Nac. Aut. Mexico 20:141–158) reported the nematode *Physaloptera retusa*. The purpose of this note is to add the nematode *Physalopteroides venancioi* and an acanthocephalan (Oligacanthorhynchidae) cystacanth to the list of endoparasites from *A. undulata*.

The coelomic cavities of 28 *A. undulata* from Guanacaste Province, Costa Rica in the herpetological collection of the Natural History Museum of Los Angeles County were examined for helminths. The body cavity was opened and the coelomic cavity and visceral organs were examined. Three female nematodes were found, two from LACM 166050 (male, 76 mm SVL) and one from LACM 166081 (male, 68 mm SVL) both collected 1964 (vic. Liberia, 10.6333°N, 85.4333°W, WGS84; elev. 176 m) and one acanthocephalan cystacanth was found in LACM 166089 (male, 103 mm SVL) collected 1983 (vic. Bagaces, 10.3333°N, 85.3333°W; elev. 400 m). Nematodes were cleared in a drop of glycerol on a glass slide, cover-slipped and identified using a compound microscope as *P. venancioi*. The acanthocephalan was regressively stained in hematoxylin, mounted on a glass slide in a drop of Canada balsam, cover-slipped and identified using a compound microscope as a cystacanth belonging to the Oligacanthorhynchidae. Endoparasites were deposited in the United States National Parasite Collection, Beltsville, Maryland as: *P. venancioi* (USNPC 101073) and (Oligacanthorhynchidae) cystacanth (USNPC 101074).

Physalopteroides venancioi was described from *Bufo paracnemis* (currently *Rhinella schneideri*) from Paraguay (Lent et al. 1946. Mem. Instit. Oswaldo Cruz. 44:195–214) and is also known from anurans and lizards from Peru as well as lizards from Brazil (Bursey et al. 2005. Comp. Parasitol. 72:50–68). It is in the family Physalopteridae which typically utilize insect intermediate hosts (Anderson 2000. Nematode Parasites of Vertebrates; Their Development and Transmission, 2nd ed. CABI Publishing, Oxfordshire, UK. 650 pp.). The cystacanth, a larval acanthocephalan, also requires an arthropod intermediate host (Kennedy 2006. Ecology of the Acanthocephala. University Press, Cambridge, UK. 249 pp.). *Ameiva undulata* represents a new host record for *P. venancioi* and oligacanthorhynchid cystacanth.

We thank Christine Thacker (LACM) for permission to examine *A. undulata* which is part of the CRE collection donated to LACM in 1998 by Jay Savage.

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AMPHIBOLURUS MURICATUS (Jacky Dragon). **AVIAN PREDATION**. The Jacky Dragon, a medium-sized agamid lizard (100 mm SVL; tail length: ~200% SVL), is common in heathland regions of southeastern coastal Australia. As with many agamids, they rely heavily on their motion vision system for survival. They adopt a sit-and-wait strategy to identify insect prey, waiting for movement to attract their attention. They also respond to the movement of larger animals that may pose a threat, including birds, larger reptiles, and mammals. While Jacky Dragons are abundant and detailed knowledge of their behavior and reproductive biology exists (e.g., Harlow and Taylor 2000. Austral Ecol. 25:640–652; Peters et al. 2007. Curr. Biol. 17:1231–1234; Warner and Shine 2008. Nature 451:566–568), scant data exist on predation. To our knowledge, there is only a recent note on predation by varanid lizards *Varanus rosenbergi* and *V. varius* (Warner 2007. Herpetol. Rev. 38:449). That report describes predation following raids on nests that were likely identified using chemical cues. Though larger reptiles such as varanid lizards and snakes may feed opportunistically on agamid lizards (e.g., Shine 1977. Can. J. Zool. 55:1118–1128), our observations in the field suggest that Jacky Dragons are particularly responsive to potential aerial predators. Indeed, raptors such as Australian (Nankeen) Kestrels (*Falco cenchroides*) and White-bellied Sea-eagles (*Haliaeetus leucogaster*) frequently hover and circle above our outdoor field enclosures and are watched intently. Dietary analyses of many Australian raptors provide evidence that agamid lizards are preyed upon (Marchant and Higgins 1993. Handbook of Australian, New Zealand and Antarctic Birds. Vol 2. Raptors to Lapwings. Oxford University Press, Melbourne, Australia. 984 pp.), but identification of remains has not reached the species level. Here we document predation on a Jacky Dragon by another common Australian bird, the Laughing Kookaburra (*Dacelo novaeguineae* – hereafter Kookaburra).

The Kookaburra is an ambush predator and, although primarily insectivorous, they will take vertebrates, including snakes of more than twice their weight (Blomberg and Shine 2000. Behav. Ecol. Sociobiol. 48:484–489). Small prey are swallowed whole, whereas larger prey are first killed by being beaten against the ground or a tree branch. During the afternoon of 14 September 2006, we observed a Kookaburra manipulating a live adult Jacky Dragon in



FIG. 1. A Jacky Dragon (*Amphibolurus muricatus*) in the beak of a Laughing Kookaburra (*Dacelo novaeguineae*).

its beak at Tura Head Coastal Reserve, New South Wales, Australia (36.82°S, 149.93°E; elev. 20 m) (Fig. 1). The kookaburra remained on the same perch, occasionally beating the Jacky Dragon against the tree branch, and consuming it over the following two hours.

Jacky Dragon color patterns ensure that they remain cryptic while basking motionless in dense habitats; territorial defense behavior, however, quickly disrupts their camouflage. This suggests a direct cost for intra-species aggression. Like many lizards, Jacky Dragons make use of their motion vision system by relying on movement to communicate. In response to potential rivals, they perform a stereotyped display comprising several motor patterns, including tail flicking, foreleg waves and push ups (Peters and Ord 2003. Austral Ecol. 28:499–506). Bouts of these displays are often repeated after moving to a new location. While their displays attract the attention of conspecifics, they can also attract the attention of potential predators.

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ASPIDOSCELIS COSTATA BARRANCARUM (Barranca Whiptail). **DIET**. Little is known about the diet of any of the subspecies of *Aspidoscelis costata* (*sensu* Duellman and Zweifel 1962. Bull. Am. Mus. Nat. Hist. 123:155–210; Wright 1993. *In* Wright and Vitt [eds.], Biology of Whiptail Lizards [genus *Cnemidophorus*], pp. 27–81. Oklahoma Mus. Nat. Hist., Norman, Oklahoma). We describe prey items removed from specimens of *A. costata barrancarum*, a subspecies described as *Cnemidophorus sacki barrancorum* from 28 specimens from adjacent parts of Sonora and Chihuahua, México (Zweifel 1959. Bull. Am. Mus. Nat. Hist. 117:57–116). The 14 individuals used in this study were collected by JALE in southwestern Chihuahua, México and transferred to the University of Colorado. They were then shipped to the University of Arkansas by HMS, their stomach contents were removed by JMW and identified by MAP, and they were catalogued into the Herpetological Collection of Unidad de Biología, Tecnología y Prototipos (UBIPRO) as follows: N of Batópilas at km 50.5 on Chihuahua Hwy 75 from Samachique to Batópilas (27.1149°N, 107.6646°W, WGS84; elev. 687 m, 16 June 2001 [UBIPRO 7316]; 17 June 2001 [UBIPRO 7318]); Satevo (26.9905°N, 107.7647°W, 567 m, 18 June 2001 [UBIPRO 7328–7330]); Arroyo El Camuchil (27.0261°N, 107.7625°W, 435 m, 19 June 2001 [UPIBRO 7369]); Ejido Gorojaki (27.4266°N, 108.5550°W, 450 m, 21 July 2003 [UPIBRO 11475, 11476, 11478, 11479, 11505]); Chínipas (27.3944°N, 108.5360°W, 469 m, 23 July 2003 [UPIBRO 11528, 11530, 11533]). Lemos-Espinal et al. 2003. (Herpetol. Rev. 34:365–366) provided a description of habitat in which *A. costata barrancarum* forages and engages in other activities; mean SVL of 10 gravid females was 82.7 ± 2.9 (range 67–97); mean SVL of 4 males was 101.5 ± 4.6 (range 97–104). Stomach contents were dissected from each specimen and preserved in separate vials containing 70% ethanol until analyzed. Each prey item was identified to at least order (often family) and its length and width measured to the nearest 0.1 mm to estimate prey item volume using the formula $V = 4/3\ (0.5\ \text{length}) \times (0.5\ \text{width})^2$ (Vitt et al. 2003. J. Zool. 71:2391–2400).

TABLE 1. Diet of 14 *Aspidoscelis costatus barrancarum* collected from southwestern Chihuahua, México. Arthropod orders are capitalized. Three hundred fifty-two prey items comprising 18,060 mm^3 total volume were recorded.

Prey Taxon	% by Number	% by Volume	% of Stomachs Containing
ARANEAE	4.8	6.4	35.7
ORTHOPTERA			
Acrididae	1.7	5.3	35.7
Gryllidae	0.6	3.5	14.3
Tetrigidae	0.3	0.3	7.1
Blattidae	0.3	2.1	7.1
ISOPTERA	6.5	0.5	28.6
COLEOPTERA			
Adults	5.4	10.4	42.9
Larvae	3.7	6.0	42.9
LEPIDOPTERA			
Adults	0.6	0.8	7.1
Larvae	9.1	26.2	78.6
NEUROPTERA	0.3	0.2	7.1
DIPTERA	0.3	0.6	7.1
HYMENOPTERA			
Formicidae	63.9	9.2	50.0
PUPAE	1.7	28.3	21.4
Unidentifiable	0.9	0.1	21.4

Ants (Formicidae) were the numerically dominant prey taxon as one lizard consumed 92, a second consumed 80, and a third consumed 31 (together comprising more than half of all the prey items identified; Table 1). The dominant prey by volume were insect pupae, caterpillars (Lepidoptera larvae), beetles (Coleoptera adults), and ants. Caterpillars were the only prey taxon consumed by a majority of lizards surveyed (though ants were consumed by half the lizards). The only other study of *A. costata* diet of which we are aware, Brooks and Mitchell (1989. Southwest. Nat. 34:541–546), which was based on lizards collected from the Alamos Region of Sonora, México, reported termites as the numerically dominant prey. However, similar to our study, they found that beetles, caterpillars, and ants made up most of the volume of lizard prey consumed. Having ants constitute such a large part of the diet is unusual for a whiptail lizard (Mitchell 1979. Can. J. Zool. 57:1487–1499; Paulissen et al. 2003. Southwest. Nat. 38:377–381).

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CTENOSAURA SIMILIS (Black Spiny-Tailed Iguana), ***GOPHERUS POLYPHEMUS*** (Gopher Tortoise). **CONCURRENT BURROW USE.** *Ctenosaura similis* is exotic to Florida (Meshaka et al. 2004. The Exotic Amphibians and Reptiles of Florida, Krieger Publ. Co., Malabar, Florida. 155 pp.), whereas *Gopherus polyphemus* is listed as a species of special concern by the state of Florida (Florida Wildlife Code Chap. 39 F.A.C.), and as a threatened species by the Florida Committee on Rare and Endangered Plants and Animals (FCREPA) (Moler 1992. Rare and Endangered Biota of Florida: Volume III, Reptiles and Amphibians. University Press of Florida, Gainesville, Florida. 291 pp.). Three *C. similis* were introduced to Gasparilla Island (Charlotte and Lee counties) ca. 30–35 years ago, where the species is now abundant (Krysko et al. 2003. Florida Sci. 66:141–146). Among the many concerns about the high density of ctenosaurs on Gasparilla Island are their impacts to threatened and endangered species (Krysko et al. 2003. Florida Sci. 66:141–146). *C. similis* is well-known to occupy *G. polyphemus* burrows, but apparently *G. polyphemus* cohabitation has not been observed following their occupation by ctenosaurs (McKercher 2001. Unpubl. M.Sc. thesis, Univ. Florida, Gainesville, Florida. 117 pp.). We report here observations of ctenosaur usage of active *G. polyphemus* burrows and the effects on *G. polyphemus*.

From 14–28 February 2008 we made a series of observations on Gasparilla Island, Florida at a 0.1-ha site of undeveloped habitat surrounded by a neighborhood of homes with manicured landscaping. Approximately 14 adult *G. polyphemus* resided in this small area, with a similar number of adult *C. similis*. As part of an invasive species removal effort, and to avoid impacting tortoises during the invasive species removal operations, observations on burrow usage were made on 12 days during the time span.

Ctenosaurs would actively move among the burrows (created by *G. polyphemus*), appearing to purposefully investigate other burrows holding other ctenosaurs. Ctenosaurs would readily enter burrows already occupied by a tortoise (or another ctenosaur). If a tortoise was situated at the burrow entrance, an iguana would not hesitate to scramble over or around the tortoise to enter the burrow, without causing the tortoise to exit. Typically, a tortoise would readily enter a burrow already holding a ctenosaur. However, we observed that a burrow which appeared to be regularly occupied by four ctenosaurs was not observed, either directly or from tracks, to be entered by a tortoise. Once 12 *C. similis* were removed from the site (and only one or two adult *C. similis* remained on the entire site), that burrow no longer was occupied by ctenosaurs and *G. polyphemus* resumed using it. Thus, some low level of burrow sharing appears to be tolerated by *G. polyphemus*, but they also seem to be repelled from burrows at some level of *C. similis* activity.

Our observations relate only to the willingness to share burrows. Other potentially negative aspects of *C. similis* activity such as *G. polyphemus* nest destruction was not addressed. Examination of the stomach contents of *C. similis* removed from Gasparilla Island will be examined for *G. polyphemus* eggs and examination of *G. polyphemus* burrow aprons for *G. polyphemus* nests that were intentionally (e.g., predation) or accidentally (e.g., byproduct of ctenosaur nesting) disturbed or destroyed by *C. similis* will help identify other negative aspects of their activities.

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CTENOSAURA SIMILIS (Black Spiny-Tailed Iguana), ***COLUBER CONSTRICTOR PRIAPUS*** (Southern Black Racer). **NON-PREDATORY KILLING.** *Ctenosaura similis* is exotic to Florida (Meshaka et al. 2004. The Exotic Amphibians and Reptiles of Florida. Krieger Publ. Co., Malabar, Florida. 155 pp.). In particular, three individuals were released on Gasparilla Island (Charlotte and Lee counties) ca. 30–35 years ago, where they are now abundant (Krysko et al. 2003. Florida Sci. 66:141–146). This species may pose a threat to a number of endemic threatened and endangered species on Gasparilla Island such as eggs and young of nesting shorebirds, beach mice, hatchling sea turtles and Gopher Tortoises (*Gopherus polyphemus*) (Krysko et al., *op. cit.*). We report evidence that *C. similis* may also pose a threat to snakes.

On 10 November 2007, MK observed a ca 60 cm (total length) adult male *C. similis* attack a similarly long *Coluber constrictor priapus*. The iguana was basking on a rock at 1400 h on a warm (ca. 28°C) afternoon, when it attacked the racer as it approached within 2 m of the lizard's position. The ctenosaur rushed the snake and grabbed it in its mouth and shook it vigorously, much as dogs are prone to do. Once the snake was limp and appeared dead, the lizard dropped it and backed off 30–40 cm. When it noticed the snake's body twitching, it again rushed it and shook it, and again dropped it and backed off 30–40 cm. Further twitching of the snake's body resulted in another rush and even more vigorous shaking of the snake with the lizard backing off about 2 m this time, but additional twitching triggered another rush and shaking. Once the racer ceased to move, the iguana ignored it. The scene was observed for 20 min more to see if the ctenosaur would eat the racer, but it did not. The next morning its carcass was in the same spot.

We cannot clearly explain the ctenosaur's behavior towards the racer, but a defense mechanism towards snakes seems plausible. Janzen and Brodie (1995. J. Herpetol. 29:132–136) studied color cues in ctenosaur foraging by using different color patterns on snake replicas. They found brightly colored replica snakes (red, yellow, black) elicited the most attacks, but concluded the lizards

perceived the replicas as colored flowers or fruits because snakes were unknown in ctenosaur diet studies and snakes with such coloration could pose a hazard to the lizards (Janzen and Brodie, *op. cit.*). Our observation clearly shows the willingness of a ctenosaur to attack a snake, even though the racer most closely resembled the monotone color pattern that elicited the fewest attacks in the Janzen and Brodie study. More importantly, this behavior may have implications regarding the potential for *C. similis* to impact threatened or endangered species. If this behavior is innate in *C. similis*, juvenile *Drymarchon corais couperi* (Eastern Indigo Snakes), a threatened species (Moler 1992. Rare and Endangered Biota of Florida, Vol III, Amphibians and Reptiles. University Press of Florida, Gainesville, Florida. 291 pp.), could be severely impacted. A high-density population of *C. similis*, such as found on Gasparilla Island, could negatively affect snake recruitment through such behavior.

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DIPLOLAEMUS DARWINI (NCN). **SAUROPHAGY**. *Diplolaemus darwini* is a poorly known leiosaurid lizard found in Patagonia south of 44°S latitude. Data on the diet of this species is sketchy, though some authors mention it to be insectivorous (Cei 1986. Reptiles del Centro, Centro-Oeste y Sur de la Argentina, Mus. Reg. Sci. Nat. Torino, Monogr. IV:1–527). Here we report an observation of interspecific saurophagy by an adult *D. darwini* on an adult *Liolaemus lineomaculatus*.

On 17 January 2008 during a field trip to Sierra del Bagual (49.40ºS, 71.83ºW; WGS84; elev. 601 m), Lago Argentino Department, Santa Cruz Province, southern Patagonia, Argentina; we observed an adult female *D. darwini* (92.9 mm SVL, 61.6 mm tail) basking on a rock in shrub-steppe habitat. When we chased it, the lizard ran under a rock where we captured it by hand. A few hours after we had temporarily placed this lizard in a plastic container, it regurgitated the remains of a female *L. lineomaculatus* (26.6 mm long × 12.5 mm wide). We estimated the original size of the *L. lineomaculatus* by comparison with other preserved *L. lineomaculatus* to be ca. 60 mm SVL. We also examined the remaining stomach contents of the *D. darwini* and found it to contain two tenebrionid beetles (*Nyctela* sp.). These two lizard species are synoptic in this area of Patagonian steppe and usually share similar habitats. Saurophagy has not been previously documented in the field for *D. darwini*.

D. R. Perez verified the identifications and the *D. darwini* (LJAMM 9390) and the *L. lineomaculatus* (LJAMM 7292) were deposited in the Herpetological Collection LJAMM (Luciano Javier Avila Mariana Morando) of the Centro Nacional Patagónico (CENPAT), Puerto Madryn, Chubut.

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GAMBELIA COPEI (Cope's Leopard Lizard). **ENDOPARASITES.** *Gambelia copei*, a near-endemic to Baja California, ranges from extreme southern San Diego County, California, south to the northern Cape Region, Baja California Sur, Mexico (Grismer 2002. Amphibians and Reptiles of Baja California Including its Pacific Islands and the Islands in the Sea of Cortés. Univ. California Press, Berkeley, California. 399 pp.). To our knowledge, no reports of helminths exist for this species. The purpose of this note is to document the nematode *Thubunaea iguanae* from *G. copei*.

One *G. copei* female (108 mm SVL) collected in 1949 and deposited in the Natural History Museum of Los Angeles County (LACM), Los Angeles County, California, USA (LACM 4005, vic. Cerro Elefante, Vizcaino Desert, 27.2966°N, 114.3750°W, WGS84; elev. 335 m) was examined for helminths. The body cavity was opened and the coelomic cavity and visceral organs were examined. One nematode was found. It was cleared in a drop of glycerol on a glass slide, cover-slipped and identified as an adult female *T. iguanae* and deposited in the United States National Parasite Collection, Beltsville, Maryland as USNPC 101071.

Thubunaea iguanae is widely distributed among lizards from the southwestern United States and Mexico and has been reported from crotaphytids, gekkonids, phrynosomatids, teiids, and xantusiids (Telford 1965. Jpn. J. Exp. Med. 35:111–114) as well as colubrid snakes (Goldberg and Bursey 2001. Bull. South. California Acad. Sci. 100:109–116). It is in the family Physalopteridae, which utilize insect intermediate hosts (Anderson 2000. Nematode Parasites of Vertebrates: Their Development and Transmission, 2nd ed. CABI Publishing, Oxfordshire, UK, 650 pp.). *Gambelia copei* is a new host record for *T iguanae*.

We thank Christine Thacker (LACM) for permission to examine *G. copei*.

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GLAPHYROMORPHUS NIGRICAUDUS (NCN). **PREY PIRACY.** Prey piracy, the opportunistic theft of prey from another predator or another indirect source, is known for a broad range of diurnal reptilian taxa. In this note I report on an incidence of prey piracy in the skink *Glaphyromorphus nigricaudus*.

Glaphyromorphus nigricaudus is a secretive species restricted to tropical northeast Queensland, Australia. Like most of its genus, it prefers shaded moist habitats and is reported to be nocturnal-

crepuscular, but is sometimes active during the day (Cogger 2000. Reptiles and Amphibians of Australia, Reed Publishing, Sydney, Australia. 808 pp.). While conducting fieldwork at Trinity Beach in north-eastern Australia (145.6978°E, 16.7861°S; WGS84; elev. 3 m) at 1453 h EST on the 17 February 2001, I observed an adult *G. nigricaudus* patrolling 5–10 cm from a well-established Green Ant (*Oecotsylla smaragolia*) column oriented in an eastward direction. Many of the ants were transporting prey back to a nest located in a nearby tree. Over a period of 18 min, I observed the lizard lunge quickly at individual ants carrying specific prey. Following each successful lunge, the lizard would retreat a short distance from the column (20–40 cm) to consume the prey. From a nearby vantage point, I determined that the majority of prey items targeted by the lizard were lepidopteran larvae.

The cryptic nature and high diversity of Australian skinks (Cogger, *op. cit*.) implies that the frequency with which prey piracy occurs among Australian skinks may be substantially underestimated. Nonetheless, at least four other cases of skink species opportunistically stealing prey (directly or indirectly) from other predators have been reported. Three of these records involve cases of direct piracy from ant columns by the diurnal species *Carlia munda* (Bedford 1995. Herpetol. Rev. 26:99–100), *Cryptoblepharus virgatus* (Greer 1989. The Biology and Evolution of Australian Lizards. Surrey Beatty and Sons, Chipping Norton, Sydney. 264 pp.), and *Morethia boulengeri* (as *Ablepharus lineoocelatus*) (Chisholm 1923. Aust. Zool. 3:60–71). A fourth observation was the theft of arthropod prey from eumenid mud-wasp nests involving *Cryptoblepharus virgatus* (Phillips 2005. Herpetofauna 35:120). Members of the genus *Glaphyromorphus* are almost entirely terrestrial, crepuscular and secretive in habit (Greer, *op. cit*.), suggesting that high energy prey, such as lepidopteran larvae, may be only infrequently available. If this is indeed the case, instances of prey piracy, as I report here, may provide such species with an additional and energetically favorable form of prey.

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GLAPHYROMORPHUS PUNCTULATUS (NCN). **ENTRAPMENT.** At 0847 h (EST) on 22 March 2008 while observing a heliothermic skink assemblage (*Carlia rhomboidalis, Eulamprus brachysoma*) at Cape Hillsborough Nature Reserve, Queensland, Australia (20.9217°S, 149.0453°E; WGS84; elev. 10 m), we observed a small skink moving in a conspicuous hapless manner through the leaf litter substrate. The lizard was making considerable noise for an animal of its small size. Closer inspection revealed the skink to be a juvenile *G. punctulatus* with a seed casing of the fruit of the Peanut Tree (*Sterculia quadrifida*) completely enclosing the anterior portion of its head. Initial attempts to loosen and remove the seed casing failed and it appeared the casing had been on the skink's head for a couple of days and had dried to some degree, contracting over its head and neck. The thickness of the seed casing and the absence of holes (apart from the one in which the lizard inadvertently inserted its head) suggests the lizard had no ability to see while the seed casing was on its head. This was further evident by the lizard's abnormal and risk-prone activity, such as wandering through exposed areas of the open forest. As the seed casing was likely to tighten due to further drying, it seemed unlikely that the lizard would have been able extricate itself from the casing on its own, which ultimately would have resulted in the skink's death, directly or indirectly (predation). Careful work made it possible to fracture the casing along three small cracks to allow removing it from the lizard's head. After removal, the lizard was examined for injuries. Minor injury existed to the scales, presumably from rubbing contact with the seed, and minor cuts existed around the lizard's head and neck. Following removal, the lizard was weighed (to ± 0.1 g) and measured (± 0.1 mm) prior to release at the site of capture. The skink weighed 0.5 g and was 36.1 mm SVL with a total unbroken tail length of 46.7 mm. When released, the lizard moved and behaved as typical for a member of this genus. Head trapping by a plant seed casing similar to that reported here was observed in a specimen of *Lampropholis guichenoti* (Langkilde et al. 2002. Herpetofauna 32:131), implying that such entrapment might be more widespread than realized, but rarely observed in nature.

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HEMIDACTYLUS PALAICHTHUS (Spiny House Gecko). **EGG AGGREGATION**. *Hemidactylus* geckos lay clutches of only one or two eggs (Krysko et al. 2003. Amphibia-Reptilia 24:390–396; Fitch 1970. Misc. Pub. Univ. Kansas Mus. Nat. Hist. 52:1–247), but several clutches may be produced annually, greatly elevating reproductive capacity. As many as 20 clutches have been reported to be produced annually (Hernández et al. Especies Exóticas Invasoras. http://www.geocities.com/otecbio_especies/ [consulted 22 February 2006]). Further, egg aggregations (communal nesting and/or repeated use of oviposition site by single females) that locally increase the number of eggs that may offer other advantages, e.g., predator-satiation (Eckrich and Owens 1995. Herpetologica 51:349–354) or thermoregulation (Booth and Astill 2001. Austr. J. Zool., 49:71–48). Large numbers of eggs are typically interpreted as communal nesting, but larger aggregations of gecko eggs may also represent repeated use of oviposition site by individual females or some combination of both (Bock 1996. Herpetol. Rev. 27:181–183).

Large egg aggregations are known for several species of *Hemidactylus*: *H. mabouia*, 6–60 eggs (Dixon and Soini 1986. The Reptiles of the Upper Amazon Basin, Iquitos Region, Peru. Milwaukee Public Museum, Milwaukee. 154 pp.; FitzSimons 1943. The Lizards of South Africa. Transvaal Mus. Mem.,1:1–528; Krysko et al. 2005. Carib. J. Sci. 41:169–172; Rivas et al. 2005. Herpetol. Rev. 36:121–125); *H. turcicus* with up to 20 eggs (Selcer 1986. Copeia 1986:956–962); and *H. brookii* with 16 eggs (Shanbhag 1999. Herpetol. Rev. 30:166). However, we are unaware of any literature recording this or any other aspect of the reproductive biology of *H. palaichthus*.

On 2 February 2006 at 0800 h, during field work on the herpetofauna of north Amazonas, Venezuela (12 km S of Puerto Ayacucho, road to Gavilán, Estado Amazonas, Venezuela; 5.5741667°N, 67.5358333°W, datum: La Canoa; elev. ± 80 m), a pair of adult

H. palaichthus (female: 60 mm SVL; male: 65 mm SVL) were encountered inside a small abandoned doghouse. Next to these animals was 23 apparently viable eggs. Shell fragments of two other eggs that had already hatched and one older-appearing damaged egg were also found. Eight eggs from the aggregation contained embryos in the final stages of development (evident from shell translucency and intense pigmentation of the embryos). The remaining 15 eggs had white or light pink shells and lacked distinguishable embryos. Additionally, we found an apparent recent hatchling (26 mm SVL) next to the nest.

The nest was located on the ground, in a narrow space (ca. 1 cm) under a cement brick inside the dog-house. The eggs were surrounded by scattered leaf litter and the remains of a plastic bag. Air temperature in the nest was of 28.9°C and relative humidity was 76%.

Presence of an adult pair (male and female) near the nest, and the absence of other females nearby, may indicate that this site is repeatedly used by this female rather than as a communal nest (i.e., at least two females). The large number of eggs may also indicate a high annual fecundity. Bock (*op. cit.*) established (in *H. mabouia*) that aggregations of up to 10 incubating eggs likely result from both communal nesting and repeated use of the same site by individual females; additional observation would be needed to identify the basis of the large number of eggs we found. Finally, the finding of shells of only two eggs suggests that *H. palaichthus* eggs tend to hatch in pairs, implying that the female lays both eggs of a single clutch simultaneously.

The geckos were released after taking measurements and photographs. J. Celsa Señaris verified the species identification. We gratefully acknowledge funding provided by the National Science Foundation (grant no. DEB-0416160) to Eric N. Smith. We also thank Gabriel Ugueto for suggestions on this note.

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HOPLOCERCUS SPINOSUS (NCN). **ENDOPARASITES.** *Hoplocercus spinosus* is a poorly known lizard distributed from the Mato Grosso and Mato Grosso do Sul region of Brazil to adjacent Bolivia (Wiens and Etheridge 2003. Herpetologica 59:375–398). To our knowledge, no parasite records have been published for *H. spinosus*. Hence, here we report the presence of *Cruzia rudolphii* in *H. spinosus.*

We examined 5 adult *H. spinosus* (mean = 80.4 mm SVL, ± 12.3 mm SD) deposited in the Coleção Zoológica de Referência, Laboratory of Zoology, Campus of Corumbá, Universidade Federal de Mato Grosso do Sul (UFMS) (CEUCH 2888, 2892, 3374, 3375, and 3460) for endoparasites. Lizards were captured in November 2003 and February 2004 in pitfall traps with drift fences in a remnant fragment of Cerradão (forest savanna-like vegetation) of Dois Irmãos do Buriti and Terenos (55.30ºW, 20.50ºS; WGS84; elev. 300 m) between the municipality of Aquidauna and Campo Grande, Mato Grosso do Sul, Brazil. Lizards were euthanized and the body cavity, esophagus, stomach, lungs, small and large intestines were opened and separately examined for helminths under a stereomicroscope. Endoparasites were cleared in phenol, identified and deposited in the Coleção Helmintológica do Instituto de Biociências da Unesp de Botucatu as *C. rudolphii* (CHIBB 1052). Three adult females of *C. rudolphii* were recovered and the observed prevalence (infected lizards/examined lizards × 100) was 20%.

Species of *Cruzia* have been reported in many taxa, such as mammals (Quintão e Silva and Costa 1999. J. Wildl. Dis. 35:371–374) and reptiles (Vicente et al. 1993. Rev. Bras. Zool. 10:1–183). *Cruzia rudolphii* was originally described from the colubrid snake *Erythrolamprus aesculapii* in southeastern Brazil (Ruiz 1947 in Vicente et al. 1993, *op. cit.*). *Hoplocercus spinosus* represents a new host record for *C. rudolphii* and Mato Grosso do Sul, Brazil is a new locality for the parasite.

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LEIOCEPHALUS CARINATUS ARMOURI (Northern Curlytail Lizard). **MORTALITY.** *Leiocephalus carinatus armouri* is a well established, exotic species in Florida (Meshaka et al. 2004. The Exotic Amphibians and Reptiles of Florida. Krieger Publ. Co., Malabar, Florida. 155 pp.; Meshaka et al. 2005. Southeast. Nat. 4:521–526; Smith and Engeman 2004a. Florida Field Nat. 32:107–113); but few causes of mortality, including vertebrate predators, have been documented within its introduced range (Smith and Engeman 2003. Herpetol. Rev. 34:245–246; Smith and Engeman 2004a. *op cit.*; Smith and Engeman 2004b. Herpetol. Rev. 35:169–170; Dean et al. 2005. Herpetol. Rev. 36:451; Smith et al. 2006a. Herpetol. Rev. 37:224). Only surface paving (Smith and Engeman 2004a, *op. cit.*), vehicle-related road-kill (Smith et al. 2006b. Herpetol. Rev. 37:87), and entanglement in persistent human-made debris (Dean et al. 2005. Herpetol. Rev. 36:179–180) have been reported as abiotic sources of mortality. Here, we quantify extensive mortality to an entire *L. c. armouri* colony resulting from parking lot sealing and repaving.

At ca. 1300 h on 10 July 2006, surface sealing and repaving of a parking area off Woolbright Road was initiated at the location of a colony of *L. c. armouri* in Boynton Beach, Florida (see Smith and Engeman 2003, *op. cit.*; Smith and Engeman 2004a, *op. cit.* for site descriptions of this colony). On the two previous days (8–9 July), a total of 81 active *L. c. armouri* burrows had been located

within the proposed work area. As with standard Gopher Tortoise (*Gopherus polyphemus*) surveys (Cox et al. 1987. Ecology and Habitat Protection Needs of Gopher Tortoise [*Gopherus polyphemus*] Populations on Lands Slated for Large-scale Development in Florida. Nongame Wildlife Program Tech. Rept. No. 4, Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida), active lizard burrows were similarly identified by fresh dirt piled outside their entrances, and tail drags and/or lizard footprints entering them. Lizards were also observed fleeing into several burrows during the survey. The 10 July repaving work affected the entire south side of the study area colony, which contained 43 active burrows. On the morning of 11 July, 39 of these 43 burrows (91%) were either flooded with liquid sealer/tar or had the substance at least partially extending into the burrow entrance. No lizards were observed at the entrances, or around, these 39 burrows. The 4 unimpacted burrows appeared active. Repaving continued throughout 11 July to include the additional south and east areas, and on 12 July the colony was resurveyed. The 12 July survey revealed that 45 of 51 burrows (88%) in those areas were now entombed. The 4 active burrows found on 11 July were still active for a total of 6 active burrows in those areas. Surveys were not conducted on the mornings of 13–14 July, but by 15 July, the north side of the colony had now been repaved. A survey on that morning revealed 56 of 65 burrows (86%) entombed. Nine burrows were active, including the 6 found on 11 and 12 July. By Sunday 16 July, the treatment had been completed on the west side of the colony and 71 of the 81 burrows (88%) were now entombed, and ten were active. Additional construction and curb painting at the site on 18 July forced an end to all surveys when most burrow markers were lost.

Burrow collapse and entombment of animals is recognized as a factor in animal mortality by off-road vehicle use (Brock and Kelt 2004. Biol. Cons. 118:633–640; Luckenbach and Bury 1983. J. Appl. Ecol. 20:265–286). While entombment of burrowing animals during road construction or repaving may be acknowledged as a cause of animal mortality in many environmental assessments, impact statements, and federal rulings (USFWS 2000. Federal Register 65:57242–57264.; USFWS 2003. Federal Register 68:13498–13520.), the actual numbers of animals in an impacted area are frequently unknown.

Biotic factors impacting exotic herpetofauna populations (e.g.; predation, disease, parasites) are often described in the literature (see extensive species accounts in Meshaka et al. 2004, *op. cit.*). However, abiotic sources of mortality for exotic herpetofauna remain poorly known, or underreported, especially at the colony-site or deme level. Meshaka et al. (2005, *op. cit*.) noted that for some invasive species such as *L. c. armouri*, which utilizes heavily human-modified coastal habitat to provide "**…**open sunny conditions and cement analogues to the rocky substratum to which it is adapted," abiotic mortality factors may likewise be more of a limiting factor to exotic populations than biotic factors.

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LEIOCEPHALUS CARINATUS ARMOURI (Northern Curly-tail Lizard). **PREDATION.** Although several avian predators are documented (Smith and Engeman 2004a. Herpetol. Rev. 35:169–170; Smith et al. 2006a. Herpetol. Rev. 37:224; Smith et al. 2006b. J. Kansas Herpetol. 19:9), virtually nothing is known about the mammalian predators and scavengers of *Leiocephalus carinatus armouri* within its introduced range in Florida. To date, only one mammalian predator, feral cat (*Felis catus*) (Smith and Engeman 2004b. Florida Field Nat. 32:107–113), and one mammalian scavenger, Gray Squirrel (*Sciurus carolinensis*; Smith et al. 2006c. Herpetol. Rev. 37:87) have been verified. Here we report the predation of a juvenile *L. c. armouri* by a second mammalian predator in Florida, the domestic dog (*Canis familiaris*).

At 1435 h on 17 December 2006 (a warm [ca.75°F] sunny day), HTS observed an unleashed ca. 10-kg mixed-breed dog chase a juvenile (ca. 5 cm SVL) *L. c. armouri* through the south side of the Woolbright Road colony of *L. c. armouri* located in Boynton Beach, Florida (see previous site descriptions in Smith and Engeman 2003. Herpetol. Rev. 34:245–246; Smith and Engeman 2004b, *op. cit.*). The chase was a rapid, straight-line run of about 10 m with the dog gaining ground. The *L. c. armouri* reached the south wall of a building, could not find its burrow entry quickly enough, and was captured in the dog's jaws. The dog then thoroughly macerated the lizard for 30–45 sec before swallowing it.

Feral cats were frequent predators of *L. c. armouri* at this colony (Smith and Engeman 2004b, *op. cit.*) from 1993 until property management changed in 2005 at which time free-living feral cats were aggressively removed, and pet dogs were allowed to condominium residents. Observations of domestic dogs preying on other iguanid lizard species have been reported (Iverson 1978. Biol. Conserv. 14:63–73; Henderson 1992. Carib. J. Sci. 28:1–10). The effects of domestic dog predation on *L. c. armouri* colony population dynamics and recruitment are unknown.

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LEIOCEPHALUS PSAMMODROMUS (Turks and Caicos Curly-Tailed Lizard). **CONSPECIFIC NECROPHAGY**. At 1200 h on 6 December 2007 on Big Ambergris Cay in the Turks and Caicos Islands (21.299°N, 71.633°W; elev. 11 m), I documented a young adult female *Leiocephalus psammodromus* (ca. 60 mm SVL) feeding on the carcass of a road-killed adult male conspecific (ca. 85 mm SVL). The condition of the carcass, considerably flattened and dried out, indicated that the male was likely recently killed by construction traffic and repeatedly run over. The observation, which lasted 4 min, was made at a distance of 4 m from the carcass, which lay on the side of a small dirt road. During this time, the female tilted her head sideways and down to take quick bites of the carcass, rapidly returning to a vigilant head-up position to swallow small pieces. I observed a total of six feeding motions during the observation period, which ended when another male entered the area and the female retreated.

Little has been reported on the diet of *L. psammodromus*, though it has been assumed to resemble that of other members of the genus in the Bahamian Archipelago. Other *Leiocephalus* species have been reported to feed on hymenopterans, lepidopteran larvae, coleopterans, blattarians, a substantial amount of plant matter such as fruits and buds, as well as demonstrate heterospecific saurophagy (Schoener et al. 1982. Oecologia 53:160–169) and cannibalism (Jenssen et al. 1989. Anim. Behav. 38:1054–1061), but conspecific necrophagy was previously unreported in this genus. *Leiocephalus* are known to have highly opportunistic food habits (Schoener et al., *op. cit*.), and recently deceased conspecifics may provide an easily accessible source of protein for young adults of this species.

I thank the Turks and Caicos Sporting Club at Ambergris Cay for logistical support and M. Hayes for suggestions. Financial support provided by the Department of Ecology and Evolutionary Biology, University of Tennessee, Knoxville.

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LEIOSAURUS BELLI (NCN). **PREDATION**. Birds are often reported to prey on lizards (e.g., Pérez and Avila. 2005. Herpetol. Rev. 36:451–452; Terres 1991. The Audubon Society Encyclopedia of North American Birds. Wing Books, New York, New York, USA. 1109 pp.; Trejo et al. 2003. Herpetol. Rev. 34:145), but such predation events typically occur rapidly so that the field observation of the event is rarely recorded. Hence, we report an observation of White-throated Cacholote (*Pseudoseisura gutturalis*) preying on *Leiosaurus belli* from southeast Argentina.

Observations were made near Puerto Madryn, Biedma Department, Chubut province (42.34ºS, 64.09ºW, WGS84; elev. 20 m) using 8 × 30 binoculars. At ca. 1315 h on 23 October 2007, CHFP observed an adult male *P. gutturalis* arriving at the nest carrying remains of the hind leg of *L. belli* in its bill. Within 5 min, both members of the pair brought the remainder of the tail. Both birds hesitated briefly before entering the nest to feed the nestlings, presumably due to the presence of the observer close to the nest (less than 3 m). This allowed identification of the lizard and photography. Based on photographs of the leg, the size of the *L. belli* was estimated to be ca. 85 mm SVL. The nest contained four nestlings about 8 days old weighing 31–46 g.

Leiosaurus belli is a moderate-sized (<100 mm SVL) diurnal and relatively aggressive lizard inhabiting shrubby areas in Monte and Patagonian steppe of the Mendoza, Neuquén, La Pampa, Río Negro and Chubut provinces, Argentina (Cei 1986. Museo Regionale di Scienze Naturali Torino, Monographie 4:1–528). The only a report of its bird predators is based on remains found in pellets (Udrizar Sauthier et al. 2007. Herpetol. Rev. 38:78–79). The White-thoated Cacholote is an active diurnal bird weighing 63–79 g, endemic to the Monte and Patagonia steppes in Argentina (Remsen 2003. *In* del Hoyo et al. [eds.], Handbook of the Birds of the World, vol 8, pp. 162–357. Lynx Edicions, Barcelona, Spain). To date, small vertebrates were not known to be part of the diet of the White-throated Cacholote or any other member of the genus *Pseudoseisura*, which are regarded as predators primarily on invertebrates (Remsen, *op. cit*.).

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LIOLAEMUS ROTHI (NCN). **CANNIBALISM**. *Liolaemus rothi* is a stout, medium-sized liolaemid lizard found in northern Patagonia (Neuquén, Río Negro, and Chubut provinces) in steppe or steppe-Monte ecotone habitats on rocky substrates. Though some authors mention it to be insectivorous, dietary data are scarce (Cei 1986. Reptiles del Centro, Centro-Oeste y Sur de la Argentina, Monogr. IV, Mus. Reg. Sci. Nat. Torino, Italy. 527 pp.). Here, we report an observation of intraspecific saurophagy in *L. rothi*.

Around 1100 h on 20 February 2008, during an ecological study of this species at a location 20 km N of Gan Gan (42.4071°S, 68.2634°W; datum: WGS84; elev. 1071 m), Departamento Telsen, Chubut, Argentina, we observed and filmed (for 3 min) an adult (81 mm SVL) male *L. rothi* eating a conspecific juvenile. When first observed, the adult was swallowing the juvenile. Only the hindlimbs and tail of the juvenile were visible, but enough features could be observed for accurate identification.

In the genus *Liolaemus*, cannibalism has been only reported for *L. darwinii* (Ripoll and Acosta 2007. Herpetol. Rev. 38:459). The causes of this behavior in liolaemid lizards merit investigation.

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OPHIODES FRAGILIS (Cobra-de-Vidro). **CANNIBALISM**. *Ophiodes fragilis*, a medium-sized anguid (228 mm max SVL) distributed in southern and southeastern Brazil and northeastern Argentina (Misiones Province), inhabits forested areas (Borges-Martins 1998. Unpubl. Ph.D. dissertation. Pontifícia Universidade Católica do Rio Grande do Sul, Porto Alegre, Rio Grande do Sul, Brazil. 239 pp.). Though anguids are generally recognized as carnivorous and are known to feed on insects, small mammals, other lizards, and molluscs (Smith 1946. Handbook of Lizards. Comstock Publ. Associates, Ithaca, New York. 557 pp.; Pough et al. 2001. Herpetology, 2nd ed. Prentice Hall, Upper Saddle River, New Jersey. 612 pp.; Pianka and Vitt 2003. Lizards: Windows to the Evolution of Diversity. University of California Press, Berkeley, California. 333 pp.), little is known about the diet of *O. fragilis*. The only existing dietary study recorded only small arthropods (Marques and Sazima 2004. *In* Marques and Duleba [eds.], Estação Ecológica Juréia-Itatins: Ambiente Físico, Flora e Fauna, pp.

257–277. Editora Holos, Ribeirão Preto, São Paulo, Brazil.). Here, we report the first record of cannibalism in *O. fragilis.*

In January 1994, Ivan Rubens Brum found an already dead adult male *O. fragilis* (184 mm SVL), at Canela, Rio Grande do Sul, Brazil (29.3638°S, 50.8100°W; WGS84; elev. 835 m), that contained four almost undigested conspecific juveniles (110 mm total length).

The adult male *O. fragilis* (MCP 5987) and juveniles (MCPAN 1856) it had eaten were deposited in the collection of Museu de Ciências e Tecnologia da Pontifícia Universidade Católica do Rio Grande do Sul.

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PHELSUMA MADAGASCARIENESIS GRANDIS (Madagascar Day Gecko). **PREY**. *Phelsuma madagascarienesis grandis* is native to northern Madagascar (Henkel and Schmidt 2000. Amphibians and Reptiles of Madagascar and the Mascarene, Seychelles, and the Comoro Islands. Krieger Publ. Co., Malabar, Florida. 319 pp.) and has been introduced into the United States in Hawaii (Kraus 2002. Bishop Mus. Occ. Pap. 69:48–52) and Florida (Krysko et al. 2003. Florida Sci. 66:222–225). *Phelsuma m. grandis* is diurnal and arboreal, and feeds primarily on nectar, pollen and arthropods (Krysko et al., *op. cit.*; Krysko and Hooper 2007. Gekko 5:33–38; Tytle 1992. Vivarium 2:15–19, 29), but adults occasionally eat hatchling *Phelsuma* (Krysko et al., *op. cit.*) and *Hemidactylus* geckos (García and Vences 2002. Herpetol. Rev. 33:53–54; Krysko and Hooper, *op. cit.*). Herein, we report *P. m. grandis* preying upon the nonindigenous Northern Curly-tailed Lizard (*Leiocephalus carinatus*) in Florida.

At 1420 h on 30 August 2008, an adult male *Phelsuma m. grandis* was observed in Lake Worth, Palm Beach County (26.625634°N, -80.05083°W, WGS84, elev. <1 m) on a building wall. Upon closer examination, the gecko was holding a neonate (ca. 30 mm SVL) *Leiocephalus carinatus* in its mouth. After being photographed (photographic voucher UF 153515) the gecko retreated into a stand of *Heliconia* sp., and ca. 1 h later the gecko reemerged and appeared fat. This is the first record of *Phelsuma m. grandis* consuming *Leiocephalus carinatus*, and the first record of this gecko in Palm Beach County, Florida.

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PHRYNOSOMA CORNUTUM (Texas Horned Lizard). **NESTING; HATCHLING BEHAVIOR; PREDATION**. At 1245 h CDT on 3 June 2008, we observed a young female (37.6 g; ca. 65 mm SVL) *Phrynosoma cornutum* digging a first nest in caliche soil in Randall County, Texas (vicinity of 34.98°N, 101.93°W, NAD27; elev. 1080 m). The nest was completed by 1100 h on 4 June on a 9.5° slope facing SW. The lizard weighed 20.7 g after oviposition, having lost 44.9% of her pre-oviposition weight (similar to reports by Allison and Cepeda (2009. Southwest. Nat. 54[2]: *in press*) and Sherbrooke 2002. Herpetol. Rev. 33:206–208). Twenty-four hatchlings (of 25 total eggs recovered from excavating the nest on 18 August) emerged between 2000 h on 6 August and 1400 h on 7 August from one exit hole 3 cm × 2 cm. We weighed 14 of the hatchlings (mean = 0.71 g, ± 0.11 SD), and variation in mass was similar to that reported by Sherbrooke (2002).

Emerging hatchlings were more alert and active than those we have previously observed from other nests. At times, several hatchlings waited to emerge from the nest, climbing over one another to exit. One ate tiny ants (<4 mm) before and while exiting the nest opening. Several hatchlings were seen sand-diving at the exit or immediately after exiting the nest, or when dispersing further when a threat was perceived. At 1136 h on 7 August, a Blue Jay (*Cyanocitta cristata*) flew low to the ground over the nest site. At 1148 h, the jay landed at the site and a hatchling that had just emerged immediately crouched at the approach of the bird. The crouching hatchling was snatched up by the jay, and 3 other hatchlings inside the exit hole immediately froze. The jay wrestled the first hatchling in its beak for 10 sec, and manipulated the now apparently dead hatchling into its beak over the next 12 sec. The other 3 hatchlings remained motionless. With the first hatchling still in its beak, the jay stood out of sight of the remaining hatchlings, appeared to listen for activity inside the nest and, within 3 sec, snatched a second hatchling head-first from within the exit hole. The 2 hatchlings left at the exit hole remained motionless.

At the time of the predation episode, 18 hatchlings had emerged, and 10 hatchlings were within 2 m of the nest site. A period of sunshine during a mostly cloudy morning may have initiated a period of greater hatchling activity that caught the attention of the jay. In contrast to the hatchlings freezing at the jay's approach, our arrival at the nest caused one hatchling to dive back into the nest and the other to bury itself inside the exit hole.

Lizards were weighed, measured, and immediately released in accordance with permit SPR-0294-659 issued by the Texas Parks and Wildlife Department.

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SPHENOMORPHUS CHERRIEI (Striped Litter Skink, Chirbala Lisa). **ENDOPARASITES.** *Sphenomorphus cherriei* is a litter-dwelling skink known from central Veracruz, México to extreme western Panama (Savage 2002. The Amphibians and Reptiles of Costa Rica; A Herpetofauna Between Two Continents Between Two Seas. Univ. Chicago Press, Chicago, Illinois. 934 pp.). To our knowledge, only one report of endoparasites for *S. cherriei* exists;

Goldberg and Bursey (2007. Herpetol. Rev. 38:83–84) reported one species of Digenea *Mesocoelium monas* and three species of Nematoda *Oswaldocruzia nicaraguensis*, *Physaloptera* sp., and acuariid larvae.

The coelomic cavity of one mature female *S. cherriei* (64 mm SVL) from the herpetological collection of the Natural History Museum of Los Angeles County (LACM 162570) collected in Puntarenas Province, Costa Rica (9.22246°N, 83.84309°W, WGS84; elev. 50 m) in 1973 was examined for helminths. The body cavity was opened and the visceral organs examined under a dissecting microscope. One larva was found encysted in the liver. It was excised, cleared in a drop of undiluted glycerol on a glass slide, examined under a compound microscope and assigned to the genus *Porrocaecum*. The larva was deposited in the United States National Parasite Collection, Beltsville, Maryland as USNPC 100569.

Adults of *Porrocaecum* live in the intestines of birds; eggs pass with the feces and are eaten by earthworms in which they hatch (Anderson 2000. Nematode Parasites of Vertebrates: Their Development and Transmission, 2nd Ed. CABI Publishing, Oxfordshire, UK, 650 pp.). Vermivorous vertebrates may act as paratenic (= transport) hosts; larvae mature when ingested by an appropriate host (Anderson, *op. cit.). Sphenomorphus cherriei* represents a new paratenic host record for *Porrocaecum* sp. and can be added to the list of poikilothermic Costa Rican vertebrates serving as paratenic hosts in Goldberg and Bursey (2008. Herpetol. Rev. 39:350).

We thank Christine Thacker (LACM) for permission to examine the *S. cherriei* that is part of the CRE collection donated in 1998 by Jay M. Savage.

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TILIQUA ADELAIDENSIS (Pygmy Bluetongue Lizard). **MATING BEHAVIOR.** *Tiliqua adelaidensis* is an endangered scincid lizard found exclusively in remnant fragments of native grassland habitat in mid-north South Australia (Armstrong et al. 1993. Rec. S. Austral. Mus. 36:53–55; Hutchinson et al. 1994. Trans. Roy. Soc. Ser. A. 118:217–226). The smallest member of the genus *Tiliqua* (adult SVL ca. 95 mm), males have shorter body lengths and longer, wider heads than females (Hutchinson et al., *op. cit.*). The lizards live in burrows constructed by lycosid and mygalomorph spiders, which they use for both shelter and vantage points for ambushing passing prey (Milne et al 2003. Wildl. Res. 30:523–528). Mating occurs in late October to early November and 2–4 live young are born in late January to mid March (Hutchinson et al., *op. cit.*; Milne et al., *op. cit.*).

Milne et al (*op. cit.*) video-recorded burrow entrances and filmed one episode of mating where a male entered a female burrow and dragged her from the burrow by her head. At the surface, the lizards rolled vigorously until the male eventually grasped the female, and proceeded to mate, copulation lasting 30 sec. The female then entered her burrow and the male remained at the burrow entrance for 30 min, making occasional attempts to pull the female out again. During another study that involved filming the behavior of wild *T. adelaidensis* on closed circuit video cameras (CCTV), we recorded a second mating event that differed from the first observation by Milne et al (*op. cit.*). The purpose of this note is to detail these observations.

At 1000 h on 11 November 2007, we were recording a adult (ca. 85 mm SVL) male *T. adelaidensis* at his burrow entrance. The view frame for the camera was about 1 m^2. A adult (ca. 85 mm SVL) female entered the frame of view and within 5 sec the male had left his burrow and grasped the female on the left shoulder with his jaws. The male appeared to try and subdue the female who was attempting to escape the grasp of the male. The initial struggle lasted 35 sec, until the male managed to move his body on top of the female, while vigorously waving his rear left leg as if trying to raise the female tail. By this time, the female was in a 'C' position with the male on top, also in a 'C' position over her. The male eventually raised the tail of the female and aligned his cloaca with hers. He appeared to lock the female tail between his tail and body to hold his position for 37 sec while mating. The male maintained his grasp of the female shoulder throughout the mating. The female started struggling vigorously towards the end of the mating and the male eventually released his grasp. The entire mating sequence lasted 77 sec. Both the male and female then ran into the male burrow where they remained. After 10.5 min, a second adult (ca. 90 mm SVL) male lizard entered the frame of view from the same direction as the female had. This male tongue flicked about 20 times as it moved towards the burrow. At 1012 h, this male partially (to mid-body) entered into the burrow and the posterior part of its body could be seen thrashing around. The second male then emerged, dragging the female out of the burrow with him, grasping her by the left rear leg. When she was completely outside the burrow, he flung her to one side, briefly releasing his grip. She sat motionless near the burrow entrance for 5 sec before moving rapidly away in the opposite direction from where she had come and away from the burrow. The second male re-entered the burrow after 5 sec and remained completely inside the burrow for 70 sec before re-emerging. He then circled once around the burrow tongue flicking about 38 times in 30 seconds, before re-entering the burrow for a third time. He emerged once more after 10 sec, and slowly (50 sec to move 50 cm) left the area in the same direction he had come, tongue flicking 16 times on the way. The original male emerged from the burrow after another 70 sec and basked at the burrow entrance with his head and forearms exposed. Seventy-six min later, the second male (or one of similar size and appearance) returned to the burrow. The first male retreated into the burrow followed by the second male, who remained in the burrow for 15 sec. The second male then emerged and left the frame 20 sec later. After another 15 sec, the first male emerged and continued to bask as before. No further interactions were observed over the 3 h of filming.

Though the copulation time of ca. 30 sec was similar to that reported by Milne et al (*op. cit.*), our observation of mating differed in one major aspect. In the former episode, a male initiated mating by entering a burrow occupied by a female. Here, the first male was at his burrow entrance and seized a passing female. The second male behaved in a manner similar to the episode described by Milne et al. (*op. cit.*), though no mating occurred. However, the appearance of a second male in the current observation implies that

pheromone trailing or some other olfactory cue may be being left by receptive females. Our observation also suggests that at least two mating strategies exist for *T. adelaidensis*, the first more selective (when a male approaches a female) and the second more opportunistic. However, both observations suggest that females have little choice in mate selection. Understanding the mating behavior of threatened species is crucial, as it enables better management and conservation strategies to be developed, particularly for captive breeding programs and translocations and reintroductions.

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TUPINAMBIS MERIANAE (White Tegu), ***TUPINAMBIS TEGUIXIN*** (Golden Tegu). **PREDATION ON SNAKES.** Lizards of the genus *Tupinambis* are omnivores; their diet includes invertebrates, vertebrates, eggs, and diverse fruits (Presch 1973. Copeia 1973[4]:740–746; Sazima and Haddad 1992. *In* L.P.C. Morellato (ed.), Répteis da Serra do Japi: Notas Sobre a História Natural, pp. 212–235. Unicamp/FAPES: Campinas, SP, Brazil). These diurnally active lizards are known to be ophiophagous, but few data exist on the species of snakes upon which they feed. Here, we report two events of predation by *Tupinambis* where the snakes were identified from the Brazilian Pantanal and southern Brazil.

At 1252 h on 22 September 2006, we observed an adult *Tupinambis merianae* near a small lake on a restinga located on the coastal plain of the State of Santa Catarina, southern Brazil (27.83°S, 48.62°W; elev. 5 m). The tegu was regurgitating its stomach contents and fled quickly upon our approach. In the stomach contents we found remains of plants, insects, and an intact adult male *Sordellina punctata* (total length of 30 cm). We deposited the *S. punctata* in the herpetological collection of the Universidade Federal de Santa Catarina (CHUFSC) (Kunz et al. 2007. Biotemas 20:127–132).

At 1310 h on 27 November 2007, we observed an adult *T. teguixin* preying on an adult *Leptophis ahaetulla* (ca. 1 m TL), on the shore of the Vermelho River, Pantanal, State of Mato Grosso do Sul (19.60°S, 56.90°W; elev. 200 m). We observed the event for 98 sec. During this period, the *T. teguixin* caught and bit the snake ca. 30 cm from the end of its tail. The *T. teguixin* had a short struggle with its prey, which tried to bite the tegu three times. After this, the lizard left rapidly with the snake in its mouth.

Our data indicate that both *Tupinambis* species have the ability to subdue aglyphous adult snakes with semi-aquatic (*S. punctata*) and arboreal habits (*L. ahaetulla*).

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VARANUS VARIUS (Lace Monitor). **PREDATION**. *Varanus varius*, Australia's largest lizard based on mass, is widespread over eastern continental Australia and selected offshore islands (Cogger 2000. Reptiles and Amphibians of Australia, 6th ed.. Reed New Holland, Frenchs Forest, Australia. 808 pp.). A large terrestrial and arboreal carnivore taking a broad range of prey, *V. varius* is similar to most varanids in being regarded as strictly diurnal (Cogger, *op. cit*.). Here we report a nocturnal observation of arboreal predation by *V. varius* on an adult Common Brushtail Possum, *Trichosurus vulpecula*.

On two occasions between 3 and 17 January 2008, JR observed a very large *V. varius* (ca. 1 m SVL, ca. 30 cm across the dorsum at widest point) active by day foraging and scavenging food scraps left by campers at Tathra Beach Motor Village, Andy Poole Drive, a caravan park located ca. 1 km N of Tathra, on the south coast of New South Wales, Australia. This individual, likely a female, is a well-known long-term resident of the area recognizable from a cataract in its left eye; this animal has often been observed in previous years during the holiday season. A population of *T. vulpecula* were also locally resident, and their noisy vocalizations and movements across roofs of cabins and recreational vehicles were frequently heard at all times of the night. At ~0030 h (EST) on 13 December 2007 (a warm, humid, and starlit but moonless night), JR heard the typical *T. vulpecula* advertisement call, but it soon changed to a loud alarm call. When JR looked out through cabin window, he observed the aforementioned *V. varius* in a ~6 m high *Eucalyptus* sp. tree (36.71829°S, 149.97608°E; WGS84; elev. 1 m) located ~6 m E of the cabin. The *V. varius* was situated on a major lateral branch above the main fork of the trunk, which was ~4.5 m above the ground at the base of the canopy, with an adult *T. vulpecula* situated among foliage at the end of the same branch. At this point, JR went to retrieve a camera with a nightscope function (Panasonic Lumix™), during which time the alarm call was abruptly cut off. Upon his return, JR observed the *V. varius* through the camera with the *T. vulpecula* in its mouth, in the process of swallowing it, a process completed in ~5 min. Whether the lizard was actively hunting, or had opportunistically seized the *T. vulpecula* while resting in the tree when the latter was moving about is unknown. Habitat consisted of an open cleared area with several permanent cabins and scattered *Eucalyptus* trees (either remnant or planted), located adjacent to a remnant ~20 m-wide strip of dense coastal heath/dry sclerophyll woodland. This strip of woodland was located on the west side of a paved road, which had another ~40 m wide strip of similar woodland on its east side behind the edge of the beach. The eastern edge of this camping area was located ~150 m inland from the high tide mark.

Varanus varius is a diurnal predator on a wide range of reptiles, birds, and mammals, including *T. vulpecula* captured by day in tree-hollow refugia and is a well-known scavenger of roadkills, farm animal mortalities, and food scraps left by humans (Cogger, *op. cit.*; DM, pers. obs.), but predation at night has been hitherto unreported. More observations will be needed to determine whether noctural predation by *V. varius* represents an active hunting strategy.

We thank M. Hayes for editorial suggestions.

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XENOSAURUS PHALAROANTHEREON (NCN). **DIET**. Few data exist on the feeding habits of knob-scaled lizards (genus *Xenosaurus*). Lemos-Espinal et al. (2003. Southwest. Nat. 48:119–122) indicated that *Xenosaurus grandis*, *X. platyceps*, and *X. newmanorum* consume primarily insects, though they found remains of a mammal in one *X. newmanorum*. Here, we report a second instance of mammal predation among xenosaurine lizards.

On 16 May 2004, we captured an adult (102.7 mm SVL) male *Xenosaurus phalaroanthereon* 6.1 km SW by road of San Juan Acaltepec, (16.2478°N, 95.9607°W, WGS84; elev. 2160 m) the type locality of this species in the Sierra Madre del Sur, Oaxaca, México. We obtained a fecal sample and released the animal at the point of capture. Using the technique of Arita and Aranda (1987. Técnicas para el Estudio y Clasificación de los Pelos. Inst. Nal. de Inv. Sobre Rec. Bióticos, Xalapa Veracruz. 21 pp.) and data from Baca (2002. Catálogo de Pelos de Guardia Dorsal en Mamíferos Terrestres del Estado de Oaxaca, México. México D.F. 100 pp.), we identified hair from the fecal sample as belonging to an unidentified species of harvest mouse (genus *Reithrodontomys*).

We cannot distinguish whether the mouse eaten was the result of the lizard capturing a live animal or scavenging a dead one. As the only small mammal previously reported is from the diet of *X. newmanorum* (Lemos-Espinal et al. 2003, *op. cit.*) and no other dietary data exist for *X. phalaroanthereon* (Lemos-Espinal and Smith 2005. Phyllomedusa 4:133–137), more information on *X. phalaroanthereon* diet will be necessary to properly evaluate our observation.

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SERPENTES — SNAKES

AGKISTRODON PISCIVORUS LEUCOSTOMA (Western Cottonmouth). **DIET**. *Agkistrodon piscivorus leucostoma* eats a wide variety of prey including rodents, birds, bird eggs, snakes, frogs, and numerous species of fish (Werler and Dixon 2000. Texas Snakes: Identification, Distribution, and Natural History, University of Texas Press, Austin, Texas. 437 pp.). We add a new species of lizard to this list. On 14 September 2006, a recently killed juvenile *A. p. leucostoma* (239.0 mm SVL, 289.0 mm TL, 13.1 g; TNHC 67394) was turned in to the San Angelo Nature Center from a residence on the shores of Lake Nasworthy, Tom Green County, Texas. Although the snake was beheaded, both the body and head were vouchered. Upon further examination, the snake's stomach contained a juvenile *Sceloporus olivaceus* (48.0 mm SVL, 113.0 mm TL, 3.42 g; cataloged separately as TNHC 67395), swallowed headfirst.

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BOGERTOPHIS SUBOCULARIS (Trans-Pecos Ratsnake). **ARBOREALITY.** *Bogertophis subocularis* inhabits the Chihuahuan Desert of west Texas, New Mexico, and northern Mexico (Werler and Dixon 2000. Texas Snakes: Identification, Distribution, and Natural History. University of Texas Press, Austin). Within this region, it is known to occupy subterranean and terrestrial habitats with most field-collected specimens found amongst rocky slopes and outcrops (Werler and Dixon, *op. cit.*). Although these snakes are known to be adept climbers in rocky habitat, similar climbing activity has not been reported from arboreal settings. Here we report on two observations of arboreal activity in this species.

On 1 July 2007, we observed two male *B. subocularis* at approximately 1378 m elevation in Box Canyon, Sierra Vieja, Presidio County, Texas. The first (790 mm SVL, 920 mm TL, 146 g) was found at 0005 h crawling amongst the outer branches of an *Acacia greggii* (Catclaw Acacia) ca. 1.75 m above the ground. This acacia was one of several in a bunch ca. 2 m from the edge of a dry wash (30.5501°N, 104.6592°W). Twenty minutes later and ca. 150 m from the first snake, we found a second *B. subocularis* (724 mm SVL, 839 mm TL, 112 g) crawling down a ca. 10 cm diameter branch of a *Quercus emoryi* (Emory Oak) ca. 4 m above the ground. The *Q. emoryi* is near the confluence of Box Canyon and Fox Hollow (30.5498°N, 104.6588°W) and equidistant (ca. 4 m) from the edge of each wash. Although previous authors note that most *B. subocularis* are active between sunset and midnight on nights with little moonlight (Tennant 1984. The Snakes of Texas. Texas Monthly Press, Austin; Werler and Dixon, *op. cit.*), these two individuals were observed after midnight during the full moon. Additionally, the snake found in the oak tree was parasitized by a single tick, which we presume was *Aponomma elaphensis*, whose only known host is *B. subocularis* (Degenhardt and Degenhardt 1965. Southwest. Nat. 10:167–178).

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BOIGA SIAMENSIS (Grey Cat Snake). **DIET**. Pauwels et al. (2005. Russ. J. Herpetol. 12:102–106), recently placed *Boiga ocellata* (Grey Cat Snake) in the synonymy *Boiga siamensis*. The species is known from Bangladesh, northeast India (westwards up to Bengal), Myanmar, Thailand, Cambodia, Laos, and Vietnam (Orlov and Ryabov 2002. Russ. J. Herpetol. 10:217–240; Teynié et al. 2004. Hamadryad 29:33–62; Stuart and Emmett 2006. Fieldiana Zool. new ser. 109:1–27; Teynié and David 2007. Russ. J. Herpetol. 14:39–44). *Boiga siamensis* is known to consume birds and their eggs (Cox et al. 1998. A Photographic Guide to Snakes and other Reptiles of Peninsular Malaysia, Singapore and Thailand. Ralph

Curtis Publishing, Inc., Sanibel Island, Florida).

On 23 May 2004 at ca. 1940 h we found a *B. siamensis* (1600 mm total length) attempting to consume a *Acridotheres tristis* (Common Myna) within the branches of a *Leucaena leucocephala* (White Popinac) behind the research house in Huay Khayenk Village (14.607889ºN, 98.582167ºE), Huay Khayenk Subdistrict, Thong Pha Phum District, Kanchanaburi Province, Thailand. The snake bit the bird at the wing and tried to kill it by constricting it. At ca. 2000 h the snake was disturbed and it released the bird. The snake was photographed and released.

We thank G. Vogel for assistance.

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BOTHROPS ASPER (Fer-de-lance)**. DEFENSIVE BEHAVIOR.** *Bothrops asper* is an abundant pitviper widespread throughout much of Central America (Campbell and Lamar 2004. The Venomous Reptiles of the Western Hemisphere. Cornell Univ. Press, Ithaca, New York), and is the species responsible for most snakebite fatalities in the region (Hardy 1994. Biotropica 26:198–207; Saborío et al. 1998. Toxicon 36:359–366). However, published accounts of the circumstances surrounding such snakebites are rare, and the majority of such cases occur when the snake is accidentally grabbed or trod upon (Hardy 1994. Herpetol. Nat. Hist. 2:67–82). Here we report a case of defensive behavior by an unmolested adult *B. asper* at La Selva Biological Station, Puerto Viejo de Sarapiquí, Herédia Province, Costa Rica (10.4313°N, 84.0036°W).

At 2110 h on 6 March 2005, we were radiotracking *B. asper* and encountered a non-telemetered female (1.7 m total length). The animal was moving slowly through undergrowth when encountered and showed no obvious response when cautiously approached to a distance of ca. 2.5 m. After being quietly observed for about 3 min and continuing to move away, the snake suddenly recoiled as if startled, although no stimulus was observed. It immediately turned 180˚ and began to advance rapidly with the head slightly raised towards us, causing us to quickly retreat. The snake proceeded to follow the exact nonlinear retreat path of one of us (JBL) for ca. 4 m, at which point it stopped, lowered its head, and did not immediately retreat but after ca. 30 sec resumed gradual slow movement in its original direction of travel. This sequence appeared similar to the "type I offensive advance" described for elapids (Whitaker and Shine 1999. Wildl. Res. 26:689–704).

Although the species is often depicted in popular literature and folklore as highly prone to unprovoked aggression, no similar reactions or attempted strikes were witnessed by DKW over more than 4500 similar observations of adult *B. asper*. A nocturnal ambush predator, fer-de-lance tended to flee in response to human approach at night, and usually displayed no visible reaction at all during the day, relying instead on crypsis. The present case seems atypical in that the snake was neither handled nor restrained, stimuli which can elicit defensive behavior in other pitvipers that otherwise appear similarly hesitant to strike (Gibbons and Dorcas 2002. Copeia 2002:195–198; Prior and Weatherhead 1994. J. Herpetol. 28:255–257). Factors influencing the described event remain unclear, although the fact that the snake was moving when encountered should be considered.

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BOTHROPS ASPER (Terciopelo). **DIET**. *Bothrops asper* occupy an important position in the food chain of tropical ecosystems. At Los Tuxtlas region (Veracruz, Mexico) adult *B. asper* feed on medium to large food items such as rodents (*Rattus* sp., *Didelphis* sp.), small birds, and juvenile conspecifics, whereas juveniles feed on smaller prey such as anurans (*Craugastor rhodopis*, *Smilisca baudini*), lizards (*Ameiva undulata*), and arthropods (Buttenhoff and Vogt 1997. *In* Gonzáles-Soriano et al. [eds.], Historia Natural de Región se Los Tuxtlas, pp. 478–480. Universidad Nacional Autónoma de México, Districto Federal, México; Pérez-Higareda et al. 2007. Serpientes de la Región de Los Tuxtlas, Veracruz, México. Universidad Nacional Autónoma de México, D.F., México). Herein I report the first record of *B. asper* eating a *Lepidophyma tuxtlae* (Tuxtla Tropical Night Lizard).

On 12 April 2005 at 2210 h, I found at Los Tuxtlas rainforest (18.53°N, 95.1°W) two subadult of *B. asper* approximately one meter apart and 20 m from the forest edge. One of these individuals fled but the other (ca. 835 mm SVL) had a half-swallowed *L. tuxtlae* (ca. 73 mm SVL) in its mouth. A color photographic voucher (MZFC-ID 1603) has been deposited in the herpetological collection of Museo de Zoología, Facultad de Ciencias, Universidad Nacional Autónoma de México.

I thank V. H. Reynoso and U. O. García-Vazquez for assistance.

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CARPHOPHIS AMOENUS HELENEA (Midwest Worm Snake). **DEFENSIVE BEHAVIOR**. Very little is known about the defensive behaviors of small fossorial snakes, including *Carphophis amoenus*. Most noted behaviors, other than escaping, include prodding with the pointed tail-tip and a flattened body posture with a partially buried head under coils (Clark 1970. Univ. Kansas Publ. Mus. Nat. Hist. 19:85–194).

On 10 May 2007 at Beech Fork State Park in Wayne County, West Virginia (38.28488°N, 082.41875°W), a non-gravid female *C. amoenus* was found under a large dome shaped rock. After handling the specimen, it was placed on the ground and proceeded to remain still in a loosely coiled pattern with its head partially buried under part of its body. The tail was positioned on top of the coils and the tail-tip oriented vertically as if it were mimicking the head. The tail tip remained motionless, as did the rest of the main

body, for the duration of the time photographed after which it was replaced under the cover object. This is the first report of a worm snake species exhibiting this type of defensive behavior.

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CORONELLA AUSTRIACA (Smooth Snake). **PARAPHIMOSIS.** Paraphimosis is a common condition in captive reptiles (Bennet 1996. *In* Mader [ed.], Reptile Medicine and Surgery, pp. 355–357. W.B. Saunders Co., Philadelphia, Pennsylvania) and occurs as a result of inflammation of the hemipenis, or hemipenes, making retraction through the cloaca impossible (DeNardo 1996. *In* Mader, *op. cit*., pp. 212–224). Although common in captivity, this condition has not, to our knowledge, been recorded in a wild snake. Here, we report a wild *Coronella austriaca* showing clinical signs of paraphimosis.

On 10 August 2006 at 1159 h an adult male *C. austriaca* (433 mm SVL, 138 mm tail length [TL], 42 g) was captured at a lowland heath site in Dorset, United Kingdom. While collecting morphometric data as part of an ongoing mark-recapture study, we noticed that the blackened and necrotic left hemipenis was extruding from the cloaca (Fig. 1). The snake was in an otherwise healthy condition and showed no outward signs of any secondary infection that commonly accompany physical traumas (Cooper and Jackson 1981. Diseases of the Reptilia, Academic Press, London). The snake had been previously captured on 31 May 2006 (433 mm SVL, 138 mm TL, 45 g) when paraphimosis was not evident. The animal was released at the point of capture following data collection and subsequently recaptured on 2 August 2007 at 0957 h near the original locality. The necrotic mass was absent and there was minimal scar tissue present at the scales surrounding the cloaca. The snake was in a healthy condition (471 mm SVL, 140 mm TL, 54 g) and was again released at the point of capture.



FIG. 1. Lateral and ventral views of a necrotic prolapsed hemipenis observed on a wild *Coronella austriaca*.

The most common injuries observed in *C. austriaca* are physical traumas and damage to tails (Cooper and Davies 1997. Herpetol. J. 7:19–22), which can reduce survival and predispose individuals to infection (Cooper and Jackson, *op. cit*.). Paraphimosis did not appear to produce secondary infection in this instance and is unlikely to prevent the individual from reproducing, since the reproductive organs on each side of the body are morphologically and functionally separate. Contralateral hemipenis use in successive reproductive events has been observed in both kingsnakes (*Lampropeltis getula*; Zweifel 1997. J. Herpetol. 31:459–461) and gartersnakes (*Thamnophis sirtalis*; Shine et al. 2000. Behav. Ecol. 11:411–415) which, if present in *C. austriaca*, may place individuals such as this at a competitive disadvantage in future breeding seasons.

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CROTALUS SCUTULATUS SCUTULATUS (Mojave Rattlesnake). **DEFENSIVE BEHAVIOR/SALTATION AND HEAD HIDING**. Head hiding/coiling defensive behavior has not been previously documented in *Crotalus scutulatus scutulatus*. On 21 April 1994, several unusual behaviors were exhibited by an adult male *C. s. scutulatus* ca. 850–900 mm SVL (snout–vent length) in Fenner Valley, San Bernardino County, California, USA. At 0840 h (air temperature 27°C), a resting, fully coiled, slightly buried, adult male was observed in a gravelly wash, partially shaded by a large shrub (Fig.1A). After I took numerous photos from different compass directions, the snake remained motionless until it struck at me without rattling or moving into an aggressive striking position, and became airborne. The snake struck directly at me from the position facing 90° to my left (Fig.1A), a distance greater than its full body length. As the snake struck, it came completely off the ground (at least 15–20 cm) and propelled itself forward landing between my feet. A similar type of saltation behavior was

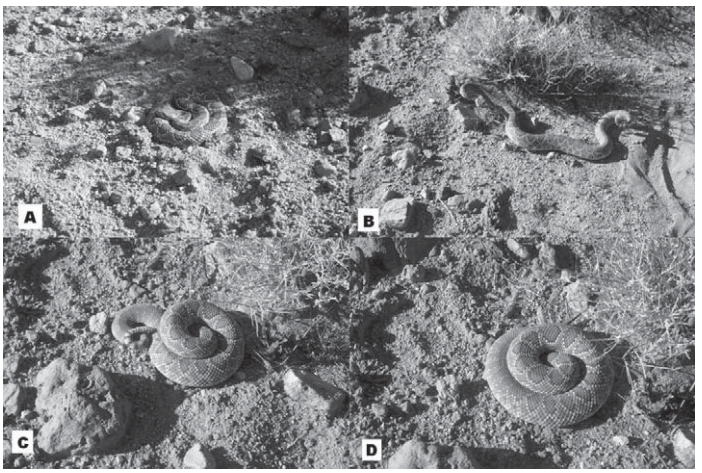


FIG. 1. Male Mojave Rattlesnake (*Crotalus s. scutulatus*) behavioral sequence of head-hiding: A) resting coil; B) saltation and aggressive behavior; C) head hidden and coiling; D) coiling completed, rattle extended upward but not vibrating.

described by Bartholomew and Nohavec (1995. Great Basin Nat. 55:282–283) in reference to flight behavior of a *C. s. scutulatus* from Mohave County, Arizona. Additionally, this type of saltation behavior has been observed in *C. scutulatus salvini* (Armstrong and Murphy 1979. The Natural History of Mexican Rattlesnakes. Univ. Kansas Mus, Nat. Hist., Spec. Publ. No. 5. 88 pp.): "This rattlesnake is one of the most aggressive species we encountered. Several struck so violently that their entire body appeared to be momentarily air borne." The present observation parallels that of Armstrong and Murphy (1979, *op. cit.*). In my observations of hundreds of active rattlesnakes, the distance they could strike is about 2/3 of its body length; B. H. Brattstrom (pers. comm.) corroborated this estimate as well. Klauber (1982. Rattlesnakes. Their Habits, Life Histories, and Influence on Mankind. Abridged edition, p. 93. University of California Press, Berkeley, California) stated: "A rattler can strike only a short distance from its resting coil—only the distance involved in straightening the S-shaped section of the neck;" and Klauber (*op. cit.*) p. 96. "From my own experience I should say that a rattler will rarely strike more than half its length, measured from the front of the anchor coil, and almost never beyond three-quarters of that length." Mattison (1996. Rattler! A Natural History of Rattlesnakes. Sterling Publ. Co. Inc., New York. 144 pp.) notes "A rattler's strike is rapid—about 2–3 m (6–10 ft) per second—and can reach a distance of about half its body length. The strike is sometimes so violent that its whole body slides forward and, under exceptional circumstances, it may completely leave the ground." This particular male Mojave Rattlesnake did not follow the distance axioms estimated above.

Following the active saltation display, the snake became agitated and began body bridging, looping coils, rattling violently, and repeatedly striking in any direction as I tried to lift it with a stick to move it to a safe location. Most rattlesnakes are easily picked up near midbody with a stick and balance themselves well so they can safely be moved. This particular snake would not stay balanced on the stick and repeatedly fell off and continued to act aggressively, striking and rattling violently (Fig. 1B). This aggressive behavior continued for several minutes, with each attempt to pick up the snake eliciting continued striking, thrashing, and falling to the ground. On my final attempt to pick up the rattlesnake it began to display an unusual coiling behavior, placing its head on the ground and initiating a clockwise coiling motion on top of its head (Figs. 1D, 1E). In this position the snake's head was on the ground and completely buried under the center of its coils with the rattle erect and not vibrating. The snake stayed motionless in this position for approximately 5 minutes. Then I reached out with the stick to pick the snake up and attempt to move it again, this time the snake became docile while I moved it to a nearby wash 100 m west and released it next to a rodent burrow, into which it rapidly crawled.

A second head-hiding observation was made on 18 May 1999 of a smaller *C. s. scutulatus* (female ca. 650–700 mm SVL) in Piute Valley, Clark County, Nevada, USA. I attempted to move this snake from where I had set up some equipment. The snake repeatedly fell off the stick with which I had attempted to move it and was not striking violently as described earlier. After a number of attempts to move this snake it behaved similarly to the male specimen and hid its head (Fig. 2A), attempted to coil its body over the head, though not quite concealing it as well as the male specimen described earlier (Fig. 2B).

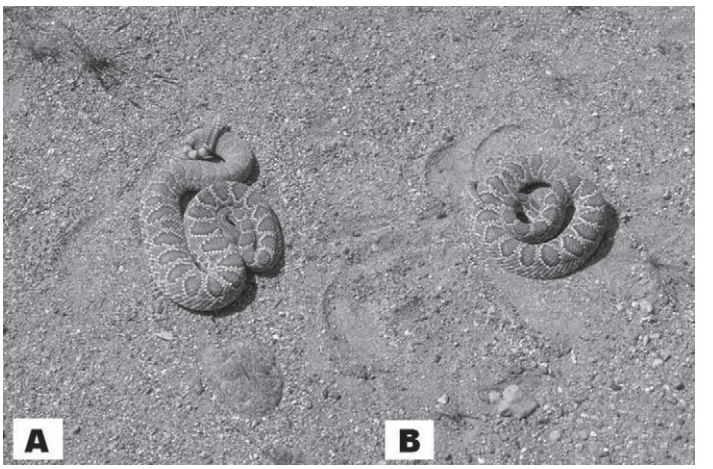


FIG. 2. Female Mojave Rattlesnake (*Crotalus s. scutulatus*) behavioral sequence of head-hiding: A) initiating head-hiding behavior; B) coiling completed, rattle silent.

Head hiding in rattlesnakes is apparently uncommon and was not documented in Carpenter and Ferguson (1977. *In* C. Gans and D. W. Tinkle [ed.], Biology of the Reptilia Vol. 7. pp. 335–554. Academic Press, New York). Subsequently, several instances of head hiding have been recorded as a result of human or predator interaction with rattlesnakes. An account of intimidation of a Western Diamondback Rattlesnake (*Crotalus atrox*) was reported (Cowles 1977. Desert Journal: A Naturalist Reflects on Arid California. Univ. California Press, Berkeley. 263 pp.) where several snakes were individually intimidated by placing a flattened hand into the face making the snake lower its head and hiding it under a coil. This behavior apparently is an attempt to avoid an attacker by escaping and to protect its head from imminent danger. A slightly different posture of head hiding behavior has been documented in *C. atrox* as an escape from predation after being confronted by a Roadrunner (*Geococcyx californianus*). After the snake struck numerous times at a Roadrunner and became exhausted, it protected its head by tucking it under its coils (Cornett 2001. The Roadrunner. Nature Trails Press, Palm Springs, California. 64 pp.; Meinzer 1993. The Roadrunner. Texas Tech Univ. Press, Lubbock, Texas. 104 pp.; Sherbrooke and Westphal 2006. Southwest Nat. 51:41–47). Head-hiding behavior has also been documented in the Prairie Rattlesnake (*Crotalus viridis viridis*) in response to human interaction (Duval et al. 1985. Nat. Geogr. Res. 1:80–111; Alcock 1998. Animal Behavior: an Evolutionary Approach. Sinauer Associates, Inc. Sunderland, Massachusetts. 640 pp.); and in the Red Diamond Rattlesnake (*Crotalus ruber*) by Rubio 1998. Rattlesnake: Portrait of a Predator. Smithsonian Institution Press, Washington, D.C. 240 pp.). Head-hiding behavior in conjunction with defensive tail displays is widespread in snakes (Greene 1973. J. Herpetol. 7:143–161). The significance of head hiding behavior in rattlesnakes and lack of rattle vibration appear to simply be a defensive measure to protect the snake and its head from human intimidation and/or possible predation.

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DINODON RUFOZONATUM RUFOZONATUM (Asian King Snake). **DIET AND BEHAVIOR**. *Dinodon rufozonatum rufozonatum* occurs in parts of eastern China, Korea, Japan (Szczerbak 2003. Guide to the Reptiles of the Eastern Palearctic. Krieger Publishing Company, Florida. 260 pp.) and Taiwan (Lue et al. 2002. The Transition World – Guidebook of Amphibians and Reptiles of Taiwan. Swan, Taipei. 350 pp. [In Chinese]). Previously reported prey include: a chick, *Bufo bankorensis*, *Bufo melanostictus*, *Rana adenopleura*, skinks, snakes, and a beetle (Lee and Lue 1996. Biol. Bull. Natl. Taiwan Normal University 31:119–124. [In Chinese]; Lee and Lue 1996. J. Taiwan Mus. 49:137–138; Lin et al. 1995. Newsletter of Wildlifers 3:19–21 [In Chinese]; Norval and Mao 2004. Herpetol. Rev. 35:65; JJM, unpubl. obs.).

On the evening of 21 September 2007, an adult male *D. r. rufozonatum* (775 mm SVL, 169 mm tail length [TL], 198.8 g) was observed on a branch, ca. 2 m above the ground, overhanging a small concrete reservoir on the edge of a secondary forest in Santzepu, Sheishan District, Chiayi County, Taiwan (23.43ºN, 120.48ºE, WGS84). Our presence disturbed the snake and as it tried to flee it was captured. After it was measured we released it at the capture site. On 27 January 2008 at 2212 h, another adult male *D. r. rufozonatum* (729 mm SVL, 207 mm TL, 186.2 g) was observed at the reservoir, but this time on the reservoir wall. Again, our presence disturbed the snake and it tried to seek shelter under a fallen palm leaf that was lying on the wall. Numerous *Rhacophorus moltrechti* were calling from inside the reservoir, and there were some bubble-foam nests on the inside of the reservoir wall, as well as on the coconut palm leaf. The snake was captured and it was noted it had an enlarged abdominal region. After gentle palpation of the stomach region, the snake regurgitated two intact *R. moltrechti* (male: 50 mm SVL, 5.1 g; female: 56 mm SVL, 8.1 g) and ova, as well as an unidentifiable anuran (5.9 g) that was in an advanced digested state. In July 1997 in one night, we encountered several frogs and five *D. r. rufozonatum* in a large concrete reservoir in Donhe Dsitrict, Taitung County. We believe that *D. r. rufozonatum* have learned that these reservoirs provide a reliable food resource when *R. moltrechti* are breeding. To our knowledge this is the first report of *D. r. rufozonatum* predation on *R. moltrechti*.

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DRYMARCHON COUPERI (Eastern Indigo Snake). **NESTING HABITAT AND EGG DEPREDATION.** Little is known about the nesting ecology of *Drymarchon couperi* in the wild. In southern Georgia, *D. couperi* females are known to lay eggs from May through early June (Moulis 1976. Bull. New York Herpetol. Soc. 12:14–23; R. Moulis, pers. comm., 2006), but there is scant information detailing where the eggs are laid. In this note, we report the discovery of a *D. couperi* nest found in southern Georgia, USA.

On 3 June 2003, one of us (SLN) found a *D. couperi* nest (N = 10 eggs) near an active, adult *Gopherus polyphemus* (Gopher Tortoise) burrow in xeric sandhill habitat, Telfair County, Georgia. Evidently, the nest had recently been excavated and depredated (in part) by a predator when discovered. The shells of four *D. couperi* eggs that had been consumed by the predator, as well as three intact eggs, were found on the sandy surface of the tortoise burrow apron. Three additional intact eggs were found in the nest cavity, which was located ca. 10 cm deep in the sand beneath and beside a rotten *Quercus laevis* (Turkey Oak) log; numerous fresh *Procyon lotor* (raccoon) tracks were observed on the burrow apron. The intact *D. couperi* eggs (N = 6) were subsequently incubated in captivity where they all hatched on 3 October 2003 . We believe that SLN or his dog may have disturbed or frightened away the nest predator (probably a raccoon) before it had time to consume the entire clutch.

The few other published observations of *D. couperi* nests also suggest that *G. polyphemus* burrows are important sites for oviposition. In southern Georgia, a *D. couperi* that had been implanted with a radio transmitter and then released nested ca. 1 month later (N = 6 eggs; between 23–29 May) in an inactive tortoise burrow (burrow width = 12.7 cm) located in an open *Pinus elliottii* (Slash Pine) plantation (Speake et al. 1978. *In* Odum and Landers [eds.], Proc. Rare and Endangered Wildlife Symposium, pp. 64–73. Georgia Dept. Nat. Res., Game and Fish Tech. Bull. WL4, Atlanta). Smith (1987. Unpubl. master's thesis. Auburn University, Auburn, Alabama. 129 pp.) reported that three radio-transmittered gravid female *D. couperi* translocated to sandhill habitat on St. Marks NWR, Wakulla County, Florida, laid eggs in tortoise burrows soon after release. The discovery of a *D. couperi* eggshell on the apron of an active tortoise burrow in southern Georgia is also circumstantial evidence that tortoise burrows or burrow aprons are used by nesting *D. couperi* (Williamson and Moulis 1979. Survey of Reptiles and Amphibians on Fort Stewart and Hunter Army Airfield. Rept. to United States Army, Fort Stewart, Georgia. 343 pp.).

Our observation bolsters the limited available information regarding *D. couperi* nesting habitat and strongly suggests that raccoons may sometimes depredate nests. A possible risk for *D. couperi* nesting inside or immediately nearby an active *G. polyphemus* burrow would be disturbance or damage to the eggs by the digging activities or regular movements of the resident tortoise. Conversely, *D. couperi*, a federally threatened species, may benefit in its apparent nesting relationship with Gopher Tortoises and their burrows by virtue of having readily available refuges and recovery shelters for post-nesting adult females, as well as for the vulnerable hatchlings.

We thank N. Hyslop for assistance.

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EUNECTES MURINUS (Green Anaconda). **DIET**. *Eunectes murinus* is known to prey on a variety of species, including capybaras, white-tailed deer, and spectacled caiman as well as smaller anacondas (Rivas 1999. Life History of the Green Anaconda [*Eunectes murinus*] with Emphasis on its Reproductive Biology. Ph.D. dissertation. University of Tennesee at Knoxville. 235 pp.; Rivas and Owens 2000. Herpetol. Rev. 31:45–4).

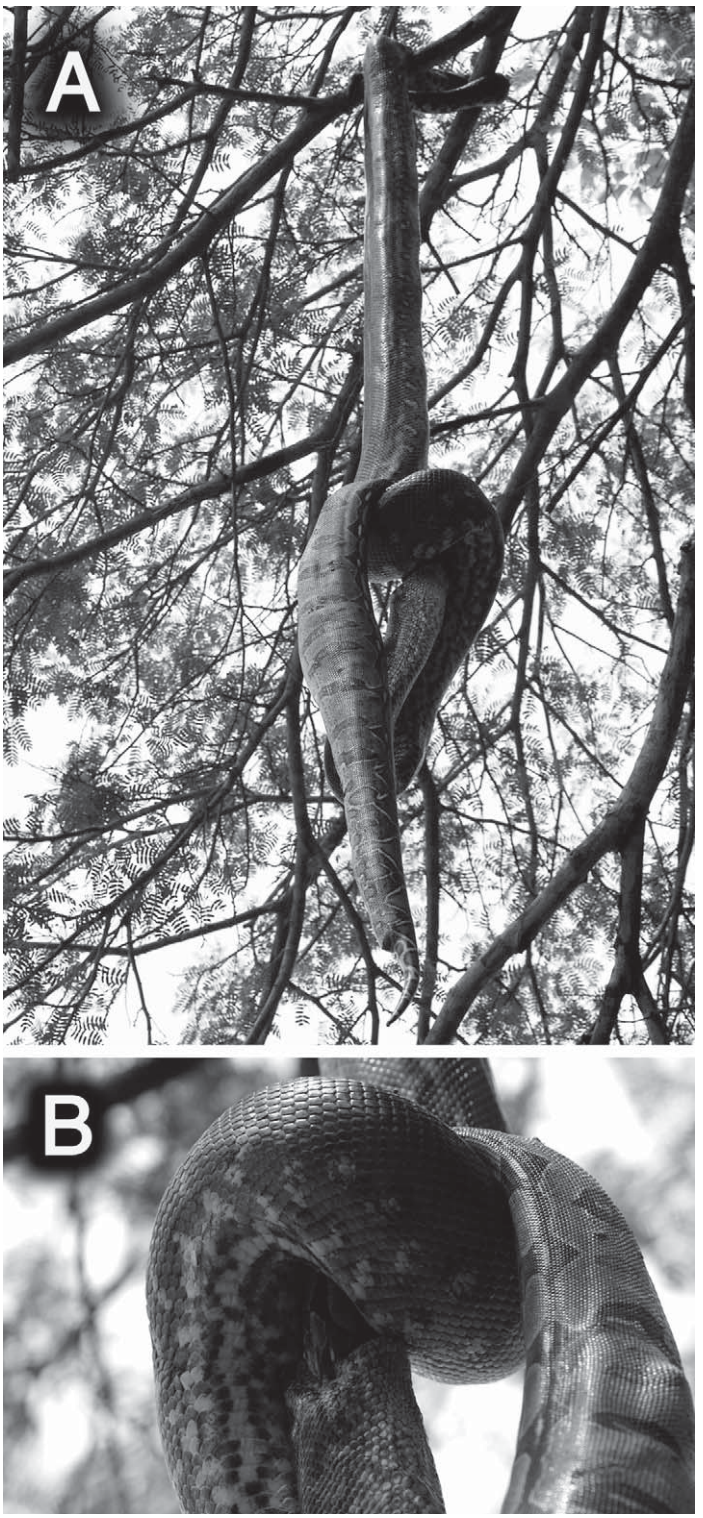


FIG. 1. A) Green Anaconda (*Eunectes murinus*) devouring Boa Constrictor (*Boa constrictor*) in gallery forest canopy. B) Close-up showing a bulge in the boa's body from a recently-ingested Green Iguana (*Iguana iguana*).

In this note we report an observation made on 16 July 2006 of a large *E. murinus* (ca. 5 m total length) attempting to eat an adult *Boa constrictor* in the South Rupununi savannas of Guyana about 7 km N of Dadanawa Ranch (2.88°N, 59.53°W). From a boat on the Rupununi River, we spotted a large adult *E. murinus* hanging by its tail from the canopy of a tree in the gallery forest ca. 5 m above the river (Fig. 1A). The anaconda had partially ingested an adult *Boa constrictor* head-first, and was supporting its prey by doubling it over a coil in the anaconda's body (Fig. 1B). After 10 minutes of observation from a distance, we approached more closely, whereupon the anaconda attempted to regurgitate its prey, first by shaking the boa from its mouth and then by wrapping its coils behind its head to forcibly push its prey loose. After 15 minutes, the anaconda dropped the boa into the river and retreated up into the canopy.

We recovered the dead boa (1.78 m total length) from the river and it had the tail of a Green Iguana (*Iguana iguana*) protruding from its mouth. The anaconda likely encountered the boa in the tree while it was in the process of digesting the recent kill and in a vulnerable condition. It is interesting that the observation was made at the height of the rainy season when it is rare to spot anacondas.

Submitted by **DUANE DE FREITAS**, Dadanawa Ranch, South Rupununi, Region #9, Essequibo, Guyana, South America; e-mail: defreitasduane@yahoo.com.

LAMPROPELTIS CALLIGASTER CALLIGASTER (Prairie Kingsnake). **DIET**. *Geomys bursarius ozarkensis* (Ozark Pocket Gopher) is an endemic that has only been reported in two counties in Arkansas (Elrod et al. 2000. J. Mammal. 81:852–864). Ozark Pocket Gophers maintain a closed underground burrow system and are rarely seen above ground. They inhabit pastureland, which is also favorable habitat for *Lampropeltis calligaster calligaster* (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp).

On 16 May 2007 at 1530 h, we discovered that a male *G. b. ozarkensis* (186 mm body length, 43.7 mm tail length, 84 g) that we were radiotracking had been consumed by a male *L. c. calligaster* (890 mm SVL, 298 g). The snake was ca. 1 m from the gopher's burrow system in a hay field off County Road 3 (36.0236°N, 91.9150°W) in Izard County, Arkansas. We did not observe the snake feeding, thus we do not know whether the snake preyed on the pocket gopher inside its burrow or above ground. The snake regurgitated the gopher and radio transmitter in captivity, ca. 3 hours later. Although small mammals, including *Geomys* sp., are common prey for *L. calligaster* (Ernst and Ernst 2003. Snakes of the United States and Canada, Smithsonian Books, Washington, DC. 668 pp; Fitch 1999. A Kansas Snake Community: Composition and Changes Over 50 Years, Krieger Publ. Co., Malabar, Florida. 165 pp; Trauth and McAllister 1995. Proc. Arkansas Acad. Sci.49:188–192), to the best of our knowledge *G. bursarius* has never been recorded in its diet.

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LEPTODEIRA SEPTENTRIONALIS (Cat-eyed snake). **DIET.** *Leptodeira septentrionalis* is widely distributed in the Americas. It is found at low and moderate elevations on the Atlantic and Pacific slopes from southern Texas and Sinaloa, south to Peru (Lee 1996. The Amphibians and Reptiles of the Yucatan Peninsula. Comstock Publishing Associates, Cornell University Press, Ithaca, New York).

On 21 July 2006 at 2109 h we observed a juvenile *Leptodeira septentrionalis polysticta* (247 mm SVL, 323 mm total length) on a plant on low vegetation, swallowing a female Leaf Litter Frog, *Craugastor* cf. *loki* (ca. 36 mm SVL). These observations took place in a tropical rainforest fragment (6.6 ha) at Los Tuxtlas, Veracruz, Mexico (18.5953°N, 95.1208ºW, 433 m elev., WGS84). The snake was collected after feeding and deposited in Colección Nacional de Anfibios y Reptiles, Instituto de Biología, Universidad Nacional Autónoma de México (CNAR-IBH 21139).

Leptodeira septentrionalis consumes a broad range of anurans (and anuran eggs) and hunts on the ground, in low vegetation, in trees, and in water (Duellman 1963. Univ. Kansas Publ. Mus. Nat. Hist. 15:205–249; Henderson and Hoevers 1977. Copeia 1977:349–355; Lee, *op. cit*.; Pérez-Higareda et al. 2007. Serpientes de la Región de Los Tuxtlas, Veracruz, México. Guía de Identificación Ilustrada. Universidad Nacional Autónoma de México, Mexico City; Schmidt and Andrews 1936. Field. Mus. Nat. Hist. Publ. Zool. Ser. 20:167–187; Stuart 1948. Misc. Publ. Mus. Zool. Univ. Michigan 69:109). This is the first record of *Craugastor* in the diet of *L. septentrionalis*. Frogs of the genus *Craugastor* are the most abundant amphibian species living on leaf litter at Los Tuxtlas.

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LIOPHIS POECILOGYRUS (Yellow-bellied Liophis). **DIET**. *Liophis poecilogyrus* is a widely distributed colubrid snake found in South America (Dixon 1989. Smithson. Herpetol. Infor. Serv. 79:1–40). Its diet includes amphibians, lizards, insects, fishes, and rodents (Achaval and Olmos 2003. Anfíbios y Reptiles del Uruguay. 2nd ed. Graphis Impresora, Montevideo, Uruguay, 136 pp.). On 15 April 2007 at 1745 h a young *L. poecilogyrus* (220 mm SVL, 40 mm tail length) was found under a branch at the border of a lake in Campo Belo do Sul municipality, Santa Catarina State, Brazil (27.5651ºS, 50.4128ºW, 972 m elev., SAD 69). After a few minutes of handling for photographs, it regurgitated a partially ingested anuran, the semi-fossorial *Elachistocleis ovalis* (Common Oval Frog). The anuran was collected and the snake liberated after photographs.

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LYCODON RUHSTRATI RUHSTRATI (Mountain Wolf Snake). **ENDOPARASITES**. The pentastomid *Raillietiella orientalis* naturally occurs in Taiwan and has been recorded as an endoparasite of *Amphiesma stolatum*, *Bungarus multicinctus multicinctus*, *Deinagkistrodon acutus*, *Elaphe carinata*, *Elaphe taeniura friesei*, *Naja atra*, *Protobothrops mucrosquamatus*, and *Ptyas mucosa* (Kuo 1999. Helminths and Pentastomids of Snakes in Taiwan. Master's thesis, Veterinary School, National Chung Hsing University, Taichung [in Chinese]).

On 18 February 2006 at 1038 h a DOR *Lycodon ruhstrati ruhstrati* (626 mm SVL, 153 mm tail length [TL], 46.3 g prior to dissection) was found on a road in Santzepu, Sheishan District, Chiayi County (23.43ºN, 120.48ºE, WGS84). On 21 April 2006 we captured another *L. r. ruhstrati* (587 mm SVL, 178 mm TL, 22.3 g prior to dissection) in the same area and maintained it in captivity until its death on 30 May 2006. Both specimens were dissected and inspected for parasites. Parasites were found in the vicinity of the trachea, lungs, liver, and fat reserves. All of the parasites were identified as *R. orientalis* and deposited in the United States Parasite Collection, Beltsville, Maryland (USNPC 100468). To our knowledge this is the first report of *R. orientalis* parasitizing *L. r. ruhstrati*.

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MICRURUS ANCORALIS (Regal Coralsnake). **DIET**. Snakes of several phylogenetic groups and some raptorial birds are known to prey on caecilians (Taylor 1968. The Caecilians of the World. A Taxonomic Review. University of Kansas Press, Lawrence. 848 pp.). Specimens of *Micrurus corallinus* and *M. ancoralis* with caecilians in their stomachs have been reported (Boulenger 1913. Proc. Zool. Soc. London 1913:1019–1038). There are also reports of caecilian consumption by colubrids and other fossorial elapids (Gower et al. 2004. Afr. J. Ecol. 42:83–87). According to Roze (1996. Coral Snakes of the Americas: Biology, Identification, and Venoms. Krieger Publishing Co., Malabar, Florida. 328 pp.), at least nine species of coralsnake prey upon caecilians, and some appear to be caecilian specialists (e.g., *M. mipartitus* and *M. bocourti*). Here we present two additional observations of coralsnakes (*Micrurus*, Elapidae) feeding on caecilians.

On 2 May 2002 at 1530 h one of us (JFF) along with J. A.

Chaves observed a *Micrurus ancoralis ancoralis* (ca. 1300 mm TL) struggling with a *Caecilia* cf. *nigricans* at Bilsa Biological Station (0.46°N, 79.8°W, 400 m elev.), Esmeraldas Province, Ecuador. The *M. ancoralis* was biting the caecilian by the latter's lower jaw, while the caecilian had a hold of the snake's upper jaw. The pair struggled for over an hour. When we left the site both animals were still entangled. The tail of the caecilian was in a burrow but we estimate the caeclian's total length to be longer than the coral snake (ca. 1500 mm TL).

Campbell and Lamar (2004. The Venomous Reptiles of the Western Hemisphere. Volume I. Comstock Publishing Associates, Ithaca, New York. 898 pp.) suggest that *M. ancoralis* feeds on small snakes. Our observations and those of Boulenger (*op. cit.*) suggest that caecilians may comprise an important component of *M. ancoralis* diet. Direct observation of coralsnake predation upon caecilians is rare (Burger 1997. Bull. Chicago Herpetol. Soc. 32:145., Kupfer et al. 2003. Amphibia-Reptilia 24:212–215.). Our observation of headfirst ingestion is consistent with the inference that this is the most common pattern (Gower et al., *op. cit.*). Nevertheless, we believe this is the first observation of a caecilian struggling with a coralsnake after it appeared to have been envenomated.

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NERODIA ERYTHROGASTER (Yellow-bellied Watersnake). **DIET.** The diet of *Nerodia erythrogaster* consists almost entirely of fish and amphibians, with this species consuming more amphibians than other watersnake species (Gibbons and Dorcas 2004. North American Watersnakes: A Natural History. University of Oklahoma Press, Norman. 438 pp.). Moreover, a Louisiana population exhibited an ontogenetic shift in which snakes under 500 mm SVL largely consumed fish whereas individuals over 500 mm SVL largely consumed anurans (Mushinsky et al. 1982. Ecology 63:1624–1629). Here, we report a new anuran prey species for *N. erythrogaster* that was consumed by a snake under 500 mm SVL.

On 18 July 2006 at ca. 0020 h we collected a male *N. erythrogaster* (342 mm SVL, 536 mm total length, 23.4 g after prey removal) in a flooded, temporary wetland on the north side of Farm-to-Market Road 253, 2.0 road miles W of Texas Highway 87, Newton Co., Texas (30.4275°N, 93.8369°W). Numerous *Hyla squirella* were calling in the wetland. The abdominal region of the snake was noticeably distended, and later examination of the stomach contents revealed five adult male *H. squirella* with some decomposition to the head and forelimbs of the most posteriorly positioned treefrog. The combined mass of the five *H. squirella* was 10.5 g yielding a combined relative prey mass of 0.45. Although *H. chrysoscelis* and *H. cinerea* have been reported as prey items of *N. erythrogaster,* to the best of our knowledge this is the first time *H. squirella* has been reported as a prey item. All specimens were deposited in the Texas Natural History Collection (TNHC 65206).

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NOTECHIS SCUTATUS (Australian Tiger Snake**). INJURIES.** Carnac Island in Western Australia hosts a large population of *Notechis scutatus* (Bonnet et al. 1999. Behav. Ecol. Sociobiol. 46:267–272). Adult *N. scutatus* in this population feed primarily on *Larus novaehollandiae* (Silver Gull) chicks. Adult *L. novaehollandiae* defend their progeny by pecking at the snake's head. Consequently, many snakes sustain head injuries, and of the estimated 400 adult snakes that appear to thrive on Carnac Island, 7.5% are totally blind and 6.6% half blinded. However, sight does not appear to be critical to the capture of their primary prey, abundant and sessile *L. novaehollandiae* chicks (Aubret et al. 2006. Austr. J. Zool. 303:894–903). This may explain why these injured snakes survive, eat and reproduce just as well as their intact counterparts (Bonnet et al., *op. cit*.). Here we present evidence of comparable injuries in two other island populations of *N. scutatus*.

In July 2007, an adult female *N. scutatus* with a large (ca. 2.5 x 2.5 cm), healed scar on the left side of her head was captured on Hopkins Island, South Australia (34.964°S, 136.060°E). A large area of tissue and bone as well as the left eye were missing. The left fang was embedded in scar tissue and non-functional. The snake had a low body mass for its length (1130 mm SVL, 356 g), however this was the case for most of the snakes on the island (pers. obs.). The injury appeared to be quite old, indicating that this snake has continued to survive despite its severe head injuries. A large adult male *N. scutatus* with a large, healed scar at mid-body was also captured on Hopkins Island. We presume that such injuries are due to attacks by large predatory birds. No other terrestrial snake predators occur on Hopkins Island. *Haliaeetus leucogaster* (White-breasted Sea Eagle) and *Aquila audax* (Wedge-tailed Eagle) are both present on Hopkins Island and both appear capable of attacking adult *N. scutatus* and inflicting severe injuries.

Furthermore, on a recent (January 2008) trip to Christmas Island (39.687°S, 143.831°E) off the coast of King Island, Tasmania, we captured and measured 33 adult *N. scutatus* (17 males, 16 females) and found that three large adult males presented injuries to their heads. Such injuries were characteristic and recognized (from numerous observations on Carnac Island tiger snakes) as being attacks from nesting birds defending their chicks. Many bird species nest on Hopkins islands, including *Puffinus tenuirostris* (Short-Tailed Shearwater), *Eudyptula minor* (Little Penguin), and *L. novaehollandiae*. Chicks of all three of these species are preyed upon by *N. scutatus*. However there is no evidence that shearwaters or penguins defend their hatchlings from the snakes, whereas *L. novaehollandiae* have been observed defending their hatchlings (Bonnet et al., *op. cit.*).

These observations further demonstrate the surprising ability of wild snakes to withstand large injuries and survive despite the loss of sensory (eye) or predatory (fang) equipment.

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OXYBELIS AENEUS (Narrow-Headed Brown Vine Snake). **BEHAVIOR.** *Oxybelis aeneus* diet consists of lizards, frogs, birds, and mammals (Savage 2002. The Amphibians and Reptiles of Costa Rica. University of Chicago Press, Chicago, Illinois. 934 pp.). Here we report a possible predation event by *O. aeneus* upon the non-native gecko, *Hemidactylus frenatus* (House Gecko).

On 20 July 2007, we found an *O. aeneus* perched on a wall with a *H. frenatus* in its mouth on the Gandoca-Manzanillo Wildlife Refuge, Limón Province, Costa Rica (9.637889°N, 82.705222°W, WGS84; 3 m elev.). The snake was in a vertical, head down position and had seized the gecko's left hindlimb; the gecko was simultaneously biting the snake on the head (Fig. 1). The snake moved up and out of sight while the two were interlocked. Although not confirmed, we assume that the snake consumed the gecko. *Hemidactylus frenatus* has recently invaded Costa Rica and is commonly encountered in buildings, it is an abundant accessible prey for a variety of predators. However, only *Troglodytes aedon* (House Wren) has been reported preying on *H. frenatus* in Costa Rica (Barquero and Hilje 2005. Wilson Bull. 117:204–205). Our observation is noteworthy because it is the first report of apparent predation by a native reptile on non-native *H. frenatus* in Costa Rica.



FIG. 1. *Oxybelis aeneus* attempting to consume *Hemidactylus frenatus* at Gandoca-Manzanillo Wildlife Refuge, Limón Province, Costa Rica.

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PORTHIDIUM HESPERE (Western Hognose Pitviper). **DIET**. *Porthidium hespere* is a rare pitviper known only from two specimens collected in the coastal plain of Colima and Michoacan, México (Campbell and Lamar 2004. Venomous Reptiles of the Western Hemisphere. Cornell University Press, Ithaca, New York. 898 pp.). Very little is known about its ecology or natural history. On the night of 11 August 2005, a specimen (MZFC 19742) was found DOR in the vicinity of El Faro de Bucerias, Municipality of Aquila, Michoacan, Mexico (Goldberg et al. 2008. Herpetol. Rev. 39:99). Posterior examination of stomach contents revealed the remains (hind legs and vertebrae) of an *Ameiva undulata* (Rainbow Ameiva). Other members of the genus *Porthidium* prey on *Ameiva* and other lizards (Campbell and Lamar 2004, *op. cit.*). This is the first reported prey of *P. hespere* and only the third known specimen with precise locality data.

I thank C. Grünwald, E. Dugan, and J. Collins for assistance.

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PSEUDONAJA TEXTILIS (New Guinea Brownsnake). **ATTEMPTED OPHIOPHAGY.** *Pseudonaja textilis* is a widely distributed and commonly encountered medically important elapid in eastern Australia. It was first collected in Papua New Guinea (PNG) in 1953, by the 4th Archbold Expedition to northern Milne Bay Province, (McDowell 1967. J. Zool. 151:497–543), and assumed to represent a WWII or post-war introduced population (Slater 1968. A Guide to the Dangerous Snakes of Papua. 2nd ed. V. P. Bloink, Port Moresby. 22 pp.). Additional records exist for Milne Bay, Oro and Central Provinces (O'Shea 1996. A Guide to the Snakes of Papua New Guinea. Independent Group, Port Moresby. 239 pp.; Williams et al. 2008 Zootaxa 1703:47–61), but it is uncommon in PNG. It has been reported as common in southeastern West Papua (Indonesia) (Kuch and Yuwono. 2002 Herpetozoa 15:75–78.). Recent work on the zoogeographical history and distribution of *P. textilis* in New Guinea suggests a natural origin rather than an introduction (Williams et al., *op. cit.*).

This note constitutes the first field-based feeding record for *P. textilis* from PNG and also represents deviation from the typical prey preferences of adult *P. textilis*. Australian *P. textilis* exhibit catholic diets, summarized as 9% frogs, 49% reptiles (3.7% snakes), 1% reptile eggs, 2% birds, and 39% mammals (Shine 1991. Australian Snakes: A Natural History. Reed, Sydney. 223 pp.), although an ontogenetic shift in diet preferences exists (Shine 1989. Herpetologica 45[2]:195–207). Snakes up to 600 mm SVL prey on ectotherms, while endotherms are the preferred prey of adult snakes. Most reptiles in the diet are lizards, with occasional reports of elapids being taken: *Denisonia devisi* (x1), and *P. textilis* (x2), and unidentified elapids (x3) in New South Wales (Shine 1989, *op. cit.*) and *P. textilis* (x1) in captivity (Neindorf, pers. comm.).

Between 21–23 October 2003, MOS visited Heropa oil-palm mini-estate, near the Popondetta to Buna road (8.75°S, 148.39°E) and part of Higaturu Plantations, Oro Province, PNG, to collect live *P. textilis* for a snakebite and venom research project, under the auspices of the Australian Venom Research Unit (AVRU), University of Melbourne. Six *Pseudonaja* were sighted and three



FIG. 1. *Candoia paulsoni mcdowelli* (top), succumbed to envenomation during a predation attempt by a *Pseudonaja textilis*. The *Candoia* had previously consumed a *Sphenomorphus jobiensis* (bottom). Photograph by Mark O'Shea.

captured, the first Oro Province specimens collected since the mid-1960s.

One specimen, a female (981 mm SVL, 1210 mm TTL), was sighted at 1100 h, following a period of light rain, lying alongside and parallel with a low 'frond-row' of dead palm fronds, between oil-palms. It was in the process of swallowing a *Candoia paulsoni mcdowelli* (McDowell's Bevel-nosed Ground Boa) that had been envenomed but was still alive. Although Australian *P. textilis* are reported to use constriction to subdue prey, the *Pseudonaja* was lying almost full length and was not constricting or restraining the *Candoia*, two thirds of which protruded from its mouth. Disturbed, the *Pseudonaja* regurgitated the *Candoia* and attempted to flee, but was caught. The *Candoia*, a female (445 mm SVL, 525 mm TTL) was also collected, but rapidly succumbed to the venom. It contained a *Sphenomorphus jobiensis* (Jobi Skink; 85 mm SVL, 180 mm TTL) (Fig. 1).

Snakes are representative of the limbless, elongate 'Type IIb' prey taken by many elapids (Cundall and Greene 1999. *In* Schwenk [ed.], Feeding: Form, Function, and Evolution in Tetrapod Vertebrates, pp. 293–333. Academic Press, San Diego, California) but adult Australian *P. textilis* are not noted to be especially ophiophagous, showing a preference for 'Type III' prey such as small mammals. All three New Guinea *P. textilis* collected by MOS fed readily on rat pups within 10 days of captivity. This record of ophiophagy is the first wild feeding record for PNG *Pseudonaja* and the first record of a *Pseudonaja* preying on a boid, although the endemic New Guinea elapid *Micropechis ikaheka* has previously been reported to prey on *Candoia aspera* (O'Shea 1994. Herpetol. Rev. 25:70).

We thank Wolfgang Wüster, Graham King, John Hula, Gabby Chris, Rick Shine, and Rex Neindorf.

Submitted by **MARK O'SHEA** (e-mail: osheam@unimelb.edu.au) and **DAVID WILLIAMS** (e-mail: d.williams4@pgrad.unimelb.edu.au), Australian Venom Research Unit, Department of Pharmacology, University of Melbourne, Parkville, Victoria, 3010, Australia.

PSEUSTES POECILONOTUS (Bird-eating Treesnake). **PREDATORS.** The diet of *Pseustes poecilonotus* is known to include birds and bird eggs (Campbell 1998. Amphibians and Reptiles of Northern Guatamala, the Yucatan, and Belize. University of Oklahoma Press, Norman. 380 pp.). However, other than antbirds (Thamnophilidae), interactions with specific avian prey species appear to be lacking in the literature (Oniki 1979. Biotropica. 11:60–69; Weatherhead and Blouin-Demers 2004. J. Avian Biol. 35:185–190; Willis 1972. Ornithol. Monogr. 10:1–162).

On 11 August 1996 at approximately 1400 h I watched two adult *Ramphastos swainsonii* (Chesnut-mandibled Toucans) dive repeatedly at a nest hole cavity located ca. 15 m high in the trunk of a dead tree near the 300 meter mark of the Sendero Oriental Trail at La Selva Biological Station, Costa Rica (10.43°N, 83.98°W). Observation with binoculars revealed that a *P. poecilonotus* (ca. 1.4 m total length) was clinging to the tree trunk just outside the nest hole opening. The two *R. swainsonii* continued to dive at and harass the snake for several minutes before the snake fell from the tree and landed on a log a few meters from where we were standing. I could not tell whether the snake had lost its grip or whether it had been knocked off the tree by the *R. swainsonii*. The snake's head had blood on it, but it wasn't clear if its injuries were sustained from the fall, or from the toucans. The *P. poecilonotus* was momentarily stunned, and I grabbed it by the tail, whereupon it spread its neck and began striking at me. I released the *P. poecilonotus* at the capture site.

I could find no records in the literature of *P. poecilonotus* attempting to prey on *R. swainsonii* or any other toucan species. Further, foraging observations documented in the literature seem to indicate that *P. poecilonotus* is most often seen foraging in lower level vegetation (Willis, *op. cit.*), so seeing one attempting to predate a nest high in the canopy may represent an unusual event (D. Graham, pers. comm.). Alternatively, it may be that human observations of *P. poecilonotus* tend to be limited to lower vegetation, missing possible foraging by the snake at higher levels of the canopy.

I thank D. Graham for assistance.

Submitted by **DONALD LYMAN, JR.**, Biology Department, Merrimack College, North Andover, Massachusetts, 01845, USA; e-mail: donlyman@ix.netcom.com.

RHINOCHEILUS LECONTEI TESSELATUS (Texas Longnosed Snake). **LONGEVITY.** On 25 June 1980, I collected a male *Rhinocheilus lecontei tesselatus* (ca. 260 mm SVL) at a public camping ground adjacent to the Pecos River (Jim White Campground, now Lake Carlsbad Recreation Area), Carlsbad, Eddy County, New Mexico. I maintained this animal in captivity until its death on 12 August 2007. From the time of its capture until August 1989, the snake was fed a diet of *Sceloporus occidentalis* (Western Fence Lizard), *Uta stansburiana* (Side-blotched Lizard), and *Eumeces skiltonianus* (Western Skink). Refused prey items included *S. occidentalis* eggs and subadult *Elgaria multicarinata* (Southern Alligator Lizard). From August 1989 until its death, the snake was fed weanling *Mus musculus* and neonate *Rattus nor-*

vegicus. At time of death, the snake measured 645 mm SVL and 105 mm tail length. The size at time of collection, indicates that it likely hatched in 1978 or earlier, making this snake at least 29 years old when it died. Previous records for this species (Slavens 1981. Inventory of Live Reptiles and Amphibians in North American Collections, Current January 1, 1981. Woodland Park Zoological Gardens, Seattle, Washington; Snider and Bowler 1992. Longevity of Reptiles and Amphibians in North American Collections, 2nd ed. Herpetol. Circ. 21) do not indicate a specimen older than 22 years. The specimen is deposited in the Texas Natural History Collections (TNHC 66571).

Submitted by **STEPHEN J. MULLIN**, Department of Biological Sciences, Eastern Illinois University, Charleston, Illinois 61920, USA; e-mail: sjmullin@eiu.eiu.

SIBON LONGIFRENIS (Drab Snail-eater). **REPRODUCTION.** The genus *Sibon* is one of four groups of neotropical snake specialized for foraging on snails, slugs, and also amphibian eggs (Montgomery et al. 2007. Herpetol. Rev. 38:343). *Sibon longifrenis* is a small nocturnal and arboreal species previously found in Honduras, Costa Rica, and Panama. In Costa Rica it inhabits undisturbed Atlantic Lowland Wet and Moist Forests, Premontane Wet Forests, and Rainforest. It is a seldom seen snake that inhabits deep shady forest (Leenders 2001. A Guide to the Reptiles and Amphibians of Costa Rica. Zona Tropical, Miami, Florida. 305 pp.; Savage 2002. Amphibians and Reptiles of Costa Rica. University Chicago Press, Chicago, Illinois. 934 pp.).

On 14 November 2002, while conducting transect-based surveys, I found a female *S. longifrenis* (288 mm SVL, 135 mm tail, 9.7 g) in the forests of Caño Palma Biological Station, Tortuguero, Limón Province. The snake was moving across a palm tree leaf (*Manicaria saccifera*) at a height of ca. 2 m in an area of wet primary swamp forest (25.4°C, 97%RH). I captured the snake and held it overnight in order to verify identification and measure it. During the night the snake laid two elongate, white eggs (10.0 x 26.1 mm, 1.24 g; 10.1 x 24.8 mm, 1.25 g) in a terrarium. After laying her eggs, the snake weighed 7.1 g. The eggs were placed inside a small terrarium in conditions intended to mimic natural circumstances. Unfortunately by 25 December 2002 both eggs had brown fungi on their surfaces and inspection revealed partially developed dead embryos inside.

Guyer and Donnelly (2005. Amphibians and Reptiles of La Selva, Costa Rica and the Caribbean Slope. University of California Press, Berkeley. 367 pp.) reported *S. longifrenis* as 'presumably an egg-layer.' To the best of my knowledge, this is the first report of clutch size in *S. longifrenis*. Egg-laying has been reported for only a handful of *Sibon* species, but all previously reported clutch sizes range from 2–9 eggs (Kofron 1987. J. Herpetol. 21:210–225; McCoy 1990. Carib. J. Sci. 26:162–166; Campbell 1998. Amphibians and Reptiles of Northern Guatemala, the Yucatan, and Belize. University of Oklahoma Press, Norman, Oklahoma. 380 pp.). November and December are wetter periods for the Tortuguero region and Caño Palma Biological Station receives most of its rainfall around this time.

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Submitted by **TODD R. LEWIS**, 4 Worgret Road, Wareham, Dorset, BH20 4PJ, United Kingdom; e-mail: biotropical@gawab.com.

THAMNOPHIS ATRATUS ATRATUS (Santa Cruz Gartersnake). **DIET**. The interaction between the newt *Taricha granulosa* and the gartersnake *Thamnophis sirtalis* provides a model system for the study of predator-prey coevolution (e.g., Brodie and Brodie 1999. Bioscience 49:557–568). Newts of the genus *Taricha* possess tetrodotoxin (TTX) in their skin and other tissues (Mosher et al. 1964. Science 144:1100–1110; Wakely et al. 1966. Toxicon 3:195–203), which acts as a powerful chemical defense against nearly all potential predators (Brodie 1968. Copeia 1968:307–313). Despite the fact that TTX is a potent neurotoxin, *T. sirtalis* in a number of California and Oregon populations prey on *T. granulosa* (Brodie and Brodie 1990. Evolution 44:651–659; Brodie and Brodie 1991. Evolution 45:221–224). In fact, concentrations of TTX in *T. granulosa* and levels of resistance in *T. sirtalis* generally covary over much of the West Coast in a pattern consistent with an evolutionary arms-race of adaptation and counter-adaptation (Brodie et al. 2002. Evolution 56:2067–2082; Hanifin et al. 2008. PLoS Biol. 6:e60). Until recently, this TTX-mediated coevolution was thought to include only two ecological partners, *T. sirtalis* and *T. granulosa*. However, a similar interaction between gartersnakes and newts was recently discovered in the Sierra Nevada Mountains of California; *T. couchii* prey on both *T. torosa* (Brodie et al. 2005. J. Chem. Ecol. 31:343–356) and *T. sierrae* (Wiseman and Pool 2007. Herpetol. Rev. 38:344–345) and are resistant to TTX at levels concordant with toxicity in sympatric *T. torosa* (Brodie et al. 2005, *op. cit.*). Here we detail a field observation of a *T. atratus* preying on a *T. granulosa*. Our report is significant because it is the first to document predation by *T. atratus* on metamorphosed *Taricha* in the wild, and hints at yet a third arms-race between gartersnakes and newts.

On 13 October 2006 at 1411 h, at Monte Bello Pond (MB05) in the Santa Cruz Mountains, Santa Clara County, California (37.32108°N, 122.18548°W; 576 m elev.), RRG observed an adult *T. atratus atratus* (~ 75 cm SVL) swim ashore with a subadult *T. granulosa* (~ 5 cm SVL) firmly held in its mouth (Fig. 1). The snake settled on the south edge of the pond, characterized by a gentle grade and only sparse vegetation, where it held the newt high off the substrate (~ 15 cm) but kept the majority of its own body anchored in the shallows. The snake gripped the newt through the midsection and proceeded to manipulate the prey deeper into its mouth. The newt struggled to free itself and appeared to exude a milky white liquid along its dorsal surface (glandular secretions including TTX; Cardall et al. 2004. Toxicon 44:933–938), but by 1414 h (3 min) the snake had already succeeded in swallowing the newt tail-first. The snake briefly rested (1 min) before turning back into the pond and slowly swimming away, apparently unaffected by its prey.

Taricha larvae have been reported in the diet of *T. atratus* (Fitch 1940. Univ. California Publ. Zool. 44:1–150; Fitch 1941. California Fish Game 27:2–32; Fox 1951. Univ. California Publ. Zool. 50:485–530; Kuchta 2005. *In* Lannoo [ed.], Amphibian Declines: The Conservation Status of United States Populations



FIG. 1. An adult Santa Cruz Gartersnake (*Thamnophis atratus atratus*) consuming a subadult Rough-skinned Newt (*Taricha granulosa*) in Monte Bello Pond, Santa Clara County, California (MVZ 257750).

Vol. 2, pp. 904–908. Univ. California Press, Berkeley, California). However, newts possess little if any TTX before metamorphosis (Twitty and Johnson 1934. Science 80:78–79), so predation of newt larvae may occur commonly by sympatric gartersnakes and probably does not indicate physiological resistance to TTX. The only account that mentions consumption of transformed *Taricha* by *T. atratus* suggests this occurred in captivity and provides no information on the source of the specimens (Fox 1951, *op. cit.*). Even naïve gartersnakes that do not co-occur with some toxic amphibians will attempt to eat such deadly prey in the laboratory (e.g., Brodie at al. 1991. Biotropica 23:58–62), so captive observations are not especially revealing. Furthermore, because of extensive geographic variation in newt potency (Hanifin et al. 2008, *op. cit.*), locality information is critical in understanding the complex pattern of match and mismatch (hotspots and coldspots) between newt toxicity and TTX resistance across the landscape (Brodie et al. 2002, *op. cit.*). Our account of a natural predation event by *T. atratus* on a transformed *T. granulosa* suggests another parallel arms-race between gartersnakes and newts and could lead to a number of exciting evolutionary and ecological investigations. We hope other naturalists will continue to add pieces to this fascinating and unfolding coevolutionary puzzle (e.g., Fellers et al. 2007. Herpetol. Rev. 38:317–318).

We thank E. D. Brodie, Jr for verifying newt species, and C. L. Spencer for accessioning photo vouchers (MVZ 257749–257754).

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TROPIDOPHIS PAUCISQUAMIS (Brazilian Dwarf Boa)**. DIET AND CAUDAL LURING**. *Tropidophis paucisquamis* is a semi-arboreal snake typically found in bromeliads in the Atlantic forests of Brazil (Carvalho 1951. Rev. Bras. Biol. 11:239–248). However, basic aspects of its biology remain unknown, since it is rarely observed and specimens are rare in collections (Amaral 1930. Bol. Mus. Nac. 4; Hedges 2002. Bull. Nat. Hist. Mus. Lond. [Zool.] 68:83–90). Feeding and behavioral information are restricted to captive specimens or are speculative (Amaral 1978. Serpentes do Brasil: Iconografia Colorida. Brazilian Snakes: a Color Iconography. Melhoramentos/EDUSP, São Paulo, Brazil; Carvalho, *op. cit.*). Here, we present the first report of feeding and tail displays by two wild *T. paucisquamis* recorded on the same night and location.

On 17 December 2004 at 2030 h at Pilar do Sul Municipality, São Paulo State, Brazil (23.93ºS, 47.67ºW, 780 m elev.) we watched as an adult *T. paucisquamis* (315 mm SVL, 42 mm tail length) left the shelter of a leaf (*Bathyza* sp., ca. 1.5 m above ground) and defecated. The snake stayed perched and immobile we collected it at 0230 h on 18 December 2004. Upon collection, the snake regurgitated a *Hypsiboas caipora* (33 mm SVL, 2.5 g) which it had swallowed headfirst. It was raining and the air temperature was 18–19°C. The following day the snake was found coiled in a ball. The snake was photographed and released and the treefrog (CFBH 9336) was deposited in Célio Fernando Baptista Haddad collection, Laboratório de Herpetologia, Instituto de Biociências, Universidade Estadual Paulista, Rio Claro, São Paulo State, Brazil.

A second snake was foraging a few m away and we observed it from 2000 h on 17 December 2004 until 0230 h on 18 December 2004. This snake stopped on two occasions and lured with its tail. On the first occasion, the snake was stretched out on a leaf of *Calathea communis* (Marantaceae), except for the tail, which was elevated and undulated in a sinusoidal manner for ca. one minute. On the second occasion, the body was again stretched out. However, in this case the sinusoidal undulations of the tail were made while the tail was in contact with the plant stem, and the tail was dragged along the stem for ca. 30 seconds. In both cases tail movements were made from a stationary position and in the presence of two male *Hypsiboas caipora* (ca. 3 m from the snake). The contrasting color of the tail (with the body) and the observations of tail displays in the presence of prey by *T. paucisquamis* indicate that the species uses its tail as a lure, although additional observations are necessary to confirm this hypothesis.

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TYPHLOPS BRONGERSMIANUS (Blindsnake). **OWL PREDATION**. *Typhlops brongersmianus* is relatively small (ca. 300 mm total length as adults) and occurs from Uruguay to Venezuela (Lema 1982. Iheringia 61:3–7.; Lema 1987. Acta Biologica Leopoldensia 9:225–240). The fossorial *T. brongersmianus* occurs in different enviroments, but primarily in sandy soils. In this habitat, it feeds on small terrestrial invertebrates (Freitas 2003. Serpentes Brasileiras. Bahia, Brazil. 119 pp.).

On 3 February 2007, I encountered a road-killed adult (sex not determined) Tropical Screech Owl (*Megascops choliba*) south of Rodovia do Sol at kilometer 32 on route ES 060. The area around

kilometer 32 is transitional between salt marsh and mangroves (Venturini et al. 1996. Aves e Mamíferos na Restinga Parque Estadual Paulo César Vinha Setiba. Guarapari, Espírito Santo. Secretaria de Estado do Desenvolvimento Sustentável. Governo do Estado do Espírito Santo, Vitória). During examination of the stomach contents of the owl on 7 November 2007, I found an adult male *T. brongersmianus* severed into two pieces. The anterior piece was 6.8 mm long, whereas the posterior one was 8.3 mm. Besides the *T. brongersmianus*, the stomach also contained two leptodactylid frogs (not further identifiable because of the degree of digestion), 14 ants, and two orthopterans.

Megascops choliba, a small (97–134 g) crepuscular owl, inhabits open habitats such as forest edges, Cerrado, rural fields, and sometimes urban localities. It feeds on insects, especially orthopterans and beetles, and may also capture small rodents, snakes, lizards, and anurans (Motta-Junior 2002. J. Raptor Res. 36:332–334; Sick 1997. Ornitologia Brasileira. Ed. Nova Fronteira, Rio de Janeiro, Brazil. 862 pp.). Among the seven stomachs of *M. choliba* analyzed, only one had vertebrate prey. This is the first record of *T. brongersmianus* in the diet of *M. choliba*.

The *T. brongersmianus* specimen (MBML 2203) was deposited in the Herpetological Collection of the Museu de Biologia Prof. "Mello Leitão." I thank Concessionária Rodosol S.A. for permits, Flávia Araújo for help in analysis, Thiago Maciel de Castro for species identification, Gustavo Machado Prado for valuable suggestions on the manuscript, and Luisa Maria Sarmento Soares for English translation.

Submitted by **MIKAEL MANSUR MARTINELLI**, Setor de Zoologia, Museu de Biologia Prof. "Mello Leitão," Avenida José Ruschi, 4, CEP 29650-000, Santa Teresa, Espírito Santo, Brazil; e-mail: mansurmartinelli@yahoo.com.br.

VIRGINIA PULCHRA (Mountain Earth Snake). **LONGEVITY, REPRODUCTION, AND GROWTH.** Longevity and growth data are lacking for *Virginia pulchra* (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Institution Press, Washington, D.C.; Slavens and Slavens 1997. Reptiles and Amphibians in Captivity: Breeding, Longevity, and Inventory Current January 1, 1996. Slaveware, Seattle, Washington; Snider and Bowler 1992. Longevity of Reptiles and Amphibians in North American Collections. 2nd ed. SSAR Herpetol. Circ. No. 21). Herein I report, to my knowledge, the first longevity record for *V. pulchra* as well as observations on reproduction and growth.

On 4 June 2004 a gravid female *V. pulchra* (225 mm SVL; 265 mm total length; 10 g) was found under rocks, on a sparsely vegetated slope at State Game Land 86, Warren County, Pennsylvania, USA. The snake was maintained in captivity and produced a litter of five young on 9 August 2004. This date is earlier than the earliest parturition date of 18 August observed by Pisani (1971. J. Herpetol. 5:207–208). All neonates were female, 88–93 mm total length, and the litter totaled 2.75 g (34.4% of female's postpartum mass). Richmond (1954. Ann. Carnegie Mus. 33:251–260) also reported an all-female litter born to a captive female *Virginia* sp. Furthermore, Bothner and Moore (1964. Copeia 1964:709–710) noted two of nine litters that contained skewed sex ratios (7 F:1M; 5F:1M). On 14 July 2007, after 3 years, 1 month, and 10 days in captivity the specimen was found dead in her enclosure. During that time, she had increased in length by 13.3% (255 mm SVL, 300 mm total length) and weighed 11 g. Because this species matures during its second year (Ernst and Ernst 2003, *op. cit.*), it is reasonable to assume that this snake was at least five years old at the time of its death.

The specimen (TREC R-025) is deposited in the collection of the Tom Ridge Environmental Center, Erie, Pennsylvania. A shed skin (MHP 11835) obtained from the specimen is deposited in the Sternberg Museum of Natural History, Fort Hays University, Lawrence, Kansas.

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Submitted by **BRIAN S. GRAY**, 1217 Clifton Drive, Erie, Pennsylvania 16505, USA; e-mail: brachystoma@hotmail.com.

ZAOCYS DHUMNADES (Big-Eye Rat Snake). **DIET.** *Zaocys dhumnades* is a large diurnal snake from China and Taiwan that has been reported to eat amphibians, rodents, small fish, and lizards (Kuntz 1963. Snakes of Taiwan. Quart. J. Taiwan Mus. 16:15–17; Zhou and Jiang 2004. Cons. Biol. 18:1386–1394).

On 9 May 2007, a DOR male *Z. dhumnades* (1206 mm SVL, 599 mm tail length, 526 g) was found on the roadside, where it appeared to have been trapped on the road by a barrier in the Ilan section of the North Crossroad, Taiwan (24.6439ºN, 121.5119ºE, 600 m elev.). A partially digested female *Buergeria robustus* (Brown Treefrog) was protruding from the snake. According to previous dietary records, *Z. dhumnades* preys mainly on lentic anurans (e.g., *Bufo* or *Rana*; Pope 1935. Natural History of Central Asia. Volume X: The Reptiles of China. American Museum of Natural History, New York). *Buergeria robustus* typically inhabit trees and can be found up to 7 m above ground (Hou and Kuo 1996. Notes and Newsletter of Wildlifers 4:6–7). However, during the breeding season (late April–early June) they aggregate along mountain creek banks at elevations below 1000 m. *Trimeresurus stejnegeri* has been observed to use these localities as ambush sites (JJM, unpubl. obs.). Our observations suggest that seasonal breeding aggregations of some arboreal frogs on the ground provide an occasional food source for opportunistic ophidian predators. We believe this to be the first reported instance of *Z. dhumnades* predation on *B. robustus*.

Submitted by **JEAN-JAY MAO** (e-mail: jjmao@niu.edu.tw) and **WUN-BIN KUNG,** Department of Natural Resources, National Ilan University. No. 1, Sec. 1, Shen-Lung Rd., Ilan, Taiwan 260; and **GERRUT NORVAL**, Applied Behavioural Ecology & Ecosystem Research Unit, Department of Nature Conservation, UNISA, Private Bag X6, Florida, 1710, Republic of South Africa.

GEOGRAPHIC DISTRIBUTION

Herpetological Review publishes brief notices of new geographic distribution records in order to make them available to the herpetological community in published form. Geographic distribution records are important to biologists in that they allow for a more precise determination of a species' range, and thereby permit a more significant interpretation of its biology.

These geographic distribution records will be accepted in a **standard format** only, and all authors *must* adhere to that format, as follows: SCIENTIFIC NAME, COMMON NAME (for the United States and Canada as it appears in Crother [ed.] 2008. *Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico*. SSAR Herpetol. Circ. 37:1–84, available from SSAR Publications Secretary, ssar@herplit.com; for Mexico as it appears in Liner and Casas-Andreu 2008, *Standard Spanish, English and Scientific Names of the Amphibians and Reptiles of Mexico*. Herpetol. Circ. 38:1–162), LOCALITY (use metric for distances and give precise locality data, including lat/long coordinates in **decimal degrees** and cite the map datum used), DATE (day-month-year), COLLECTOR, VERIFIED BY (*cannot* be verified by an author; curator at an institutional collection is preferred), PLACE OF DEPOSITION (where applicable, use standardized collection designations as they appear in Leviton et al. 1985, *Standard Symbolic Codes for Institutional Resource Collections in Herpetology and Ichthyology*, Copeia 1985[3]:802–832) and CATALOG NUMBER (required), COMMENTS (brief), CITATIONS (brief and must adhere to format used in this section; these should provide a geographic context for the new record), SUBMITTED BY (give name and address in full—spell out state or province names—no abbreviations). Please include distance from nearest previously known record (provide a citation or refer to existing vouchered material to substantiate your report). If publishing specific locality information for a rare or endangered species has the potential to jeopardize that population, please consult with the Section Editor at time of record submission. If field work and/or specimen collection occurred where permits were required, please include permit number(s) and authorizing agency in the text of the note.

Some further comments. This geographic distribution section does not publish "observation" records. Records submitted should be based on preserved specimens which have been placed in a university or museum collection (private collection depository records are discouraged; institutional collection records will receive precedence in case of conflict). A good quality photograph (print, slide, or digital file) may substitute for a preserved specimen *only* when the live specimen could not be collected for the following reasons: it was a protected species, it was found in a protected area, or the logistics of preservation were prohibitive (such as large turtles or crocodilians). Photographic vouchers *must* be deposited in a university or museum collection along with complete locality data, and the photographic catalog number(s) must be included in the same manner as a preserved record. Before you submit a manuscript to us, check Censky (1988, *Index to Geographic Distribution Records in Herpetological Review: 1967–1986*; available from the SSAR Publications Secretary), subsequent issues of *Herpetological Review*, and other sources to make sure you are not duplicating a previously published record. The responsibility for checking literature for previously documented range extensions lies with authors. **Do not submit range extensions unless a thorough literature review has been completed.**

Please submit any geographic distribution records in the **standard format only** to one of the Section Co-editors: **Alan M. Richmond** (USA & Canada records only); **Jerry D. Johnson** (Mexico and Central America, including the Caribbean Basin); **Indraneil Das** (all Old World records); or **Gustavo J. Scrocchi** (South American records). Short manuscripts are discouraged, and are only acceptable when data cannot be presented adequately in the standard format. **Electronic submission of manuscripts is required** (as Microsoft Word or Rich Text format [rtf] files, as e-mail attachments)**.** Refer to inside front cover for e-mail addresses of section editors.

Recommended citation for new distribution records appearing in this section is: Schmitz, A., and T. Ziegler. 2003. Geographic distribution: *Sphenomorphus rufocaudatus*. Herpetol. Rev. 34:385.

CAUDATA – SALAMANDERS

AMBYSTOMA TIGRINUM (Eastern Tiger Salamander). USA: INDIANA: Pike Co.: Madison Township: ca. 0.4 km W of Bowman on Hwy 56 (38.48867ºN, 87.35124ºW, NAD 83). 31 March 2008. Nathan Engbrecht. Verified by Chris Phillips. Photo voucher in Illinois Natural History Survey (INHS 2008.d). Adult female found on road at night. New county record (Minton 2001. Amphibians and Reptiles of Indiana. 2nd ed., revised. Indiana Acad. Sci. 404 pp.)

Submitted by **NATHAN ENGBRECHT (**e-mail: nengbrecht@dnr.in.gov), **ANGIE GARCIA, BETHANY GEBOY,** and **ZACK WALKER**, Wildlife Diversity Section, Indiana Department of Natural Resources Division of Fish and Wildlife, 553 E. Miller Drive, Bloomington, Indiana 47401, USA.

EURYCEA BISLINEATA (Northern Two-lined Salamander). USA: MICHIGAN: Tuscola Co.: Murphy Lake State Game Area (43.2813291°N, 83.45363036°W). 12 April 2008. Nicole Soderberg, Ernest Szuch, and Teresa Yoder. Verified by James Harding. University of Michigan Museum of Zoology (UMMZ i7, photo voucher). Individual was gravid; therefore, she was photographed and released at site of capture. Three additional specimens were recorded from Tuscola County; UMMZ i10, i11, i12, i13 photo vouchers; UMMZ i1, i2; photo vouchers and UMMZ 239001. First state record (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, D.C. 587 pp.).

Submitted by **NICOLE SODERBERG**, **TERESA YODER,** and **ERNEST SZUCH**, Department of Biology, University of Michigan-Flint, Flint, Michigan 48502-1950, USA.

HEMIDACTYLIUM SCUTATUM (Four-toed Salamander). USA: MARYLAND: Somerset Co.: 5.0 km W of Princess Anne off Pine Pole Rd. (38.21102°N, 75.74951°W; WGS 84). 18 April 2008. Nathan H. Nazdrowicz. Verified by Traci Hartsell. USNM 565980. One female found under sphagnum moss around a clutch of 28 eggs, and one unattended clutch of eggs observed in a semi-open canopy, grassy wetland. New county record (White and White 2007. Amphibians and Reptiles of Delmarva. Revised ed. Tidewater Publishers, Centreville, Maryland. 243 pp.).

Submitted by **NATHAN H. NAZDROWICZ**, Department of Entomology and Wildlife Ecology, University of Delaware, Newark, Delaware 19716, USA; e-mail: spinifer@aol.com.

NECTURUS MACULOSUS LOUISIANENSIS (Red River Mudpuppy). USA: OKLAHOMA: McCurtain Co.: N side of Forest Road 53000 at Glover River (34.1009°N, 94.5445°W). 25 November 2008. P. Taggart. Verified by S. E. Trauth. Arkansas State University Herpetological Museum (ASUMZ photographic voucher 31277). New county record; known previously from adjacent LeFlore and seven other eastern Oklahoma counties [Sam Noble Oklahoma Museum of Natural History, Division of Herpetology, Amphibians Database, http://129.15.20.101/collections-research/db/FMPro). Has also been reported immediately eastward from adjacent Little River and Sevier counties, Arkansas (Trauth et al. 2004. Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.).

Submitted by **CHRIS T. McALLISTER**, RapidWrite, 102 Brown Street, Hot Springs National Park, Arkansas 71913, USA (e-mail: drctmcallister@aol.com); **HENRY W. ROBISON**, Department of Biology, Southern Arkansas University, Magnolia, Arkansas 71754, USA (e-mail: hwrobison@suddenlink.net); **DAVID ARBOUR**, De Queen, Arkansas 71832, USA (e-mail: arbour@windstream.net); and **ROBERT BASTARACHE**, Okla-

homa Ranger District-Ouachita National Forest, Route 4, Box 2900, Broken Bow, Oklahoma 74728, USA (e-mail: rbastarache@fs.fed.us).

ANURA – FROGS

ACRIS CREPITANS (Northern Cricket Frog). USA: TENNESSEE: Rhea Co.: East side of Broyles Branch, 0.25 km downstream from Blythe Ferry Road, Dayton (35.4847667ºN, 85.01695ºW; WGS84). 12 October 2008. David Hedrick. Austin Peay State University Museum of Zoology (APSU 18942, color photo). Verified by A. Floyd Scott. New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Hard copy and Internet versions, the latter [http://www.apsu.edu/amatlas/ accessed 11 November 2008] including links to data on amphibians in Tennessee having appeared since 1996).

Submitted by **DAVID HEDRICK**, 207 Hillcrest Avenue, Chattanooga, Tennessee 37411, USA; e-mail: d.hedrick@hotmail.com.

CERATOPHRYS JOAZEIRENSIS. BRAZIL: PERNAMBUCO: Municipality of Triunfo: Café do Brejo (07.83819ºS, 38.10183SºW, WGS 84), 1004 m elev.). 14 April 2008. E. Maranhão dos Santos, G. Limeira da Silva, T. Freitas Campos, and A. M. Siqueira Quirino. Coleção Herpetologica da Universidade Federal Rural de Pernambuco, Unidade Acadêmica de Serra Talhada, Serra Talhada, Pernambuco, Brazil (CHUFRPE 902 adult specimen SVL 69.4 mm). Verified by M. Trefault Rodrigues. Previously known from Juazeiro municipality (type locality), Bahia (Mercadal 1986. Amphibia-Reptilia 7[4]:313–334); Araruna municipality, Paraiba, and Passa and Fica, Rio Grande do Norte (Vieira et al. 2006. Check List 2:28–29). First state record, fills the distributional gap and extends the known distribution 317 km NE from type locality and 299 km from Araruna municipality.

Submitted by **EDNILZA MARANHÃO DOS SANTOS**, Unidade Acadêmica de Serra Talhada, Universidade Federal Rural de Pernambuco, 56900-000, Serra Talhada, PE, Brazil; **GEANE LIMEIRA DA SILVA**, **THAMIRES FREITAS CAMPO & ANA MARIA SIQUEIRA QUIRINO**, Unidade Acadêmica de Serra Talhada, Universidade Federal Rural de Pernambuco, 56900-000, Recife, PE, Brazil.

CHIASMOCLEIS CARVALHOI (Central Humming Frog). BRAZIL: ESPÍRITO SANTO STATE: Setiba, Municipality of Guarapari (20.601900ºS, 40.429192ºW, 2 m elev., datum: Córrego Alegre). July 2004. T. Silva-Soares. Amphibian Collection, Universidade Federal do Rio de Janeiro, Departamento de Zoologia, Rio de Janeiro (ZUFRJ 9894–9899 five males, one female with eggs). Verified by C. A. Gonçalves da Cruz. Previously known only from Brazil, in the states of São Paulo, Rio de Janeiro, and Bahia, (Cruz et al. 1997. Alytes 15[2]:49–71; Pimenta et al. 2002. Herpetol. Rev. 33:219). First state record extends range ca. 360 km N from Magé municipality, Rio de Janeiro state (Cruz et al., *op. cit.*) and ca. 608 km S from Una municipality, Bahia state (Pimenta et al., *op. cit.*).

Submitted by **THIAGO SILVA-SOARES** (e-mail: thiagossoares@ufrj.br) and **PAULO NOGUEIRA DAS COSTAS** (e-mail: nogpj@yahoo.com.br), Universidade Federal do Rio de Janeiro, Departamento de Zoologia, Lab. de Anfíbios e Répteis, Caixa postal 68.044, CEP 21944-970, Cidade Universitária, Rio de Janeiro, Brazil; and **RODRIGO BARBOSA FERREIRA**, Museu de Biologia Mello Leitão, Av. José Ruschi, Nº 4, CEP 29.650-000, Santa Teresa, Espírito Santo, Brazil (e-mail: rodrigoecologia@yahoo.com.br).

CRAUGASTOR COFFEUS (Coffee Rain Frog). HONDURAS: CORTÉS: Sierra de Omoa: Parque Nacional El Cusuco, Santo Tomas Village (15.561111°N, 88.291667°W; WGS84), 674 m elev. 20 June 2007. Jonathan E. Kolby. Verified by Larry D. Wilson. USNM Herp Images 2689–2696 (one specimen). New department record and a ca. 100 km range extension NE of the type locality in Copan, Honduras, which is the only other viable population of this species known to exist (McCranie and Wilson 2002. The Amphibians of Honduras. SSAR Contr. Herpetol. 19: x + 625 pp.). The adult frog was found under a log in wet broadleaf forest ca. 2 km from approaching agricultural clearing activities.

Submitted by **JONATHAN E. KOLBY**, The Conservation Agency, 6 Swinburne Street, Jamestown, Rhode Island 02835, USA; e-mail: j_kolby@hotmail.com.

ELEUTHERODACTYLUS CYSTIGNATHOIDES (Rio Grande Chirping Frog). USA: TEXAS: Dallas Co.: Dallas, Great Trinity Forest southeast of downtown Dallas. 28 April 2008.Verified by Corey E. Roelke. Amphibian and Reptile Diversity Research Center at the University of Texas Arlington. UTA A-58153. New county record (Dixon 2000. Amphibians and Reptiles of Texas. Texas A&M University Press, College Station, Texas. 421 pp.).

Submitted by **CARL J. FRANKLIN (**e-mail: Franklin@uta.edu) and **ERICK A. P. CATALÁN**, Amphibian and Reptile Diversity Research Center at the University of Texas Arlington, 501 S. Nedderman, Arlington, Texas 76019, USA.

GASTROPHRYNE CAROLINENSIS (Eastern Narrow-mouthed Toad). USA: ALABAMA: Chilton Co.: 6.3 km S of CR 25 on CR 73 (33.01960°N, 87.52418°W; WGS84). 01 October 2007. J. Burling and J. Wicknick. Verified by Joseph R. Mendelson III. University of Montevallo Collection of Vertebrates (UMCV-AA0075). County record; fills a gap among Shelby, Bibb, and Perry counties and the Coosa River (Mount 1975. The Reptiles and Amphibians of Alabama. The University of Alabama Press, Tuscaloosa, 347 pp.). The Auburn University Museum Reptile and Amphibian collection contains one Chilton County specimen, unpublished to our knowledge and not listed on HerpNet, AUM 3398 collected on 20 June 1963 (online database accessed 19 September 2008 (http://www.auburn.edu/cosam/collections/reptiles_amphibians/index.htm#holdings). Collection made under Alabama Department of Conservation and Natural Resources collecting permit 4368 (JAW).

Submitted by **JILL A. WICKNICK**[1] and **JOHN W. BURLING**[2], Departments of Biology[1] and Psychology[2], University of Montevallo, Montevallo, Alabama 35115, USA (e-mail: wicknickja@montevallo.edu).

HYLA CINEREA (Green Treefrog). USA: ARKANSAS: Dallas Co.: roadside ditch off St. Hwy 8 in Manning (34.011120°N, 92.472411°W; NAD83). 05 June 1997. T. R. Davis. Verified by S. E. Trauth. Arkansas State University Herpetological Museum

(ASUMZ 31274). New county record filling a distributional gap between Cleveland (Robison and McAllister 2007. Herpetol. Rev. 38:245–246) and Clark counties (Trauth et al. 2004. Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.).

Submitted by **CHRIS T. McALLISTER**, RapidWrite, 102 Brown Street, Hot Springs National Park, Arkansas 71913, USA (e-mail: drctmcallister@aol.com); and **HENRY W. ROBISON**, Department of Biology, Southern Arkansas University, Magnolia, Arkansas 71754, USA; e-mail: hwrobison@suddenlink.net.

HYLA GRATIOSA (Barking Treefrog). USA: TENNESSEE: Gibson Co.: Milan Army Ammunition Plant (35.8675°N, 88.7331°W). 08 October 2008. Eric Johansen, Nathan Parker, Seth McCormick, and Nathalie Smith. Verified by A. Floyd Scott. David H. Snyder Museum of Zoology, Austin Peay State University (APSU 18943 [juvenile] and APSU 18944 [metamorph]). Collected in fishless pond at 1100 h. New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Hard copy and Internet [http://www.apsu.edu/amatlas/] versions, the latter accessed 02 June 2008).

Submitted by **ERIC PAUL JOHANSEN** (e-mail: ejohansen14@apsu.edu), **NATHALIE SMTIH**, and **SETH McCORMICK**, Department of Biology and Center of Excellence for Field Biology, Austin Peay State University, Clarksville, Tennessee 37044, USA.

HYLA WRIGHTORUM (Arizona Treefrog). MEXICO: SONORA: Los Fresnos Ciénega, ca. 44 km NW Cananea (31.30845^{0}N, 110.42915^{0}W)**,** 1534 m elev. 25 August 1990. Peter L. Warren. Verified by T. C. Brennan. Arizona State University voucher photograph (ASU HP.59). Northernmost record for this species in Sonora and a 235 km NNW range extension from the closest record at El Chorro, 8 km NE of Nacori Chico, Sonora (UAZ 45595), although the closest out-of-country record is ca. 13 km N in Arizona (Gergus et al. 2004. Copeia 2004:758–769). A locality dot pictured on a map in Duellman (2001. Hylid Frogs of Middle America, Vol. 2. SSAR Contrib. to Herpetol. 18:i–x, 695–1159), which appears close to Los Fresnos Ciénega, was an apparent misplacement for a record from Yécora, Sonora (W. E. Duellman, pers. comm.). Additional individuals were observed by us during August and October 2006 in surrounding wetlands situated within the grassland ecosystem characteristic of the Los Fresnos Ciénega region. Typical habitat for this species was reported to be in meadows or slow-moving streams within pine-oak and pine-fir forest (Gergus et al. 2005. *In* M. J. Lannoo [ed.], Amphibian Declines: The Conservation Status of United States Species, pp. 461–463. University of California Press, Berkeley).

Submitted by **BARUK G. MALDONADO LEAL**, Biodiversidad y Desarrollo Armónica, Calle Guadalupe Victoria #46 Int. 5 entre Veracruz y Tamaulipas, Col. Benito C.P., Hermosillo, Sonora, Mexico, 83190 (e-mail: baruk23@gmail.com); **PETER L. WARREN,** The Nature Conservancy, 1510 E Fort Lowell Rd, Tucson, Arizona 85719, USA (e-mail: PWarren@tnc.org); **THOMAS R. JONES** and **VALERIE L. BOYARSKI**, Arizona Game and Fish Department, 5000 West Carefree Highway, Phoenix, Arizona 85086, USA (e-mail: TJones@azgfd.gov; VBoyarski@azgfd.gov); and **JAMES C. RORABAUGH**, U.S. Fish and Wildlife Service, 201 N. Bonita Ave., Suite 141, Tucson, Arizona 85745, USA (e-mail: Jim_Rorabaugh@fws.gov).

INCILIUS MELANOCHLORUS (Wet Forest Toad). PANAMÁ: BOCAS DEL TORO: Distrito de Changuinola: Quebrada Caña de Laosa, El Guayabal, Río Changuinola (09.2075°N, 82.48023°W; WGS84), 164 m elev. 11 June 2007. César A. Jaramillo A., Andrew J. Crawford, Fidel E. Jaramillo A., Daniel Medina, Jhoana De Alba, and Eladio Quintero. Museo de Vertebrados de la Universidad de Panamá (MVUP 2041). Trail to Changuinola Arriba, Río Changuinola (09.19798°N, 82.47188°W; WGS84), 119 m elev. 12 June 2007. César A. Jaramillo A., Fidel E. Jaramillo A., Daniel Medina, Jhoana De Alba, and Eladio Quintero. Círculo Herpetológico de Panamá (CH 6222, 6225). Cerro Alto, El Guayabal, Río Changuinola (9.208051°N, 82.473504°W; WGS84), 165 m elev. 14 June 2007. César A. Jaramillo A., Fidel E. Jaramillo A., Daniel Medina, Jhoana De Alba, and Eladio Quintero. CH 6258. All specimens verified by Jay M. Savage. These specimens represent the first records for Panamá, extending the geographic range ca. 81 km (airline) SE of the nearest locality in Costa Rica (Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna Between Two Continents, Between Two Seas. University of Chicago Press, Chicago, Illinois. xx + 934 pp.). To view photographs of of all live specimens visit the Smithsonian Tropical Research Institute - Digital File Manager at http://biogeodb.stri.si.edu/bioinformatics/dfm. We thank the MWH company for field support.

Submitted by **CÉSAR A. JARAMILLO A.**[1,2,3] (e-mail: jaramilc@si.edu), **ANDREW J. CRAWFORD**[1,3], and **ROBERTO IBÁÑEZ D.**[1,3,4], [1]Smithsonian Tropical Research Institute, Apartado 0843-03092, Balboa, Ancón Panamá, República de Panamá; [2]Departamento de Histología y Neuroanatomía Humana, Facultad de Medicina, Universidad de Panamá, Panamá, Rep. de Panamá; [3] Círculo Herpetológico de Panamá, Apartado 0824-00122, Panamá, Rep. de Panamá; [4]Departamento de Zoología, Universidad de Panamá, Panamá, Rep. de Panamá.

ISCHNOCNEMA OEA (Espírito Santo Robber Frog). BRAZIL: RIO DE JANEIRO: Sophronitis Farm, River of the Flowers headwaters, Macaé de Cima, Municipality of Nova Friburgo (22.391378ºS, 42.477525ºW, 935 m elev., datum: Córrego Alegre). 20 April 1989. S. Lucena Mendes. Zoology Collection, Museu de Biologia Mello Leitão, Espírito Santo (MBML 212). Verified by J. P. Pombal Jr. and C. A. Gonçalves da Cruz. Previously known only from the type locality, Municipality of Santa Teresa, Espírito Santo, Brazil (Heyer 1984. Smithson. Contrib. Zool. 402:1–42). First state record and first record outside of the type locality, extending range ca. 335 km NW from Santa Teresa Municipality, Espírito Santo.

Submitted by **THIAGO SILVA-SOARES**, Universidade Federal do Rio de Janeiro, Departamento de Zoologia, Lab. de Anfíbios e Répteis, Caixa postal 68.044, CEP 21944-970, Cidade Universitária, Rio de Janeiro, Brazil (e-mail: thiagossoares@ufrj.br); **RODRIGO BARBOSA FERREIRA**, Museu de Biologia Mello Leitão. Av. José Ruschi, Nº 4, CEP 29.650-000, Santa Teresa – Espírito Santo, Brazil (e-mail: rodrigoecologia@yahoo.com.br); and **PAULO NOGUEIRA DAS COSTAS**, Universidade Federal do Rio de Janeiro, Departamento de Zoologia, Lab. de Anfíbios e

Répteis, Caixa postal 68.044, CEP 21944-970, Cidade Universitária, Rio de Janeiro, Brazil (e-mail: nogpj@yahoo.com.br).

LITHOBATES CATESBEIANUS (American Bullfrog). USA: TENNESSEE: Jefferson Co.: 12.7 km W of Jefferson City (36.1084°N, 83.6247°W). 11 July 2008. Ted M. Faust. Verified by Floyd A. Scott. Austin Peay State University Museum of Zoology (APSU 18933 [color photo]). This individual was found in a small pool of standing water in a culvert. The air temp was 30.3°C at 1625 h. Four more individuals were found nearby. All individuals were juveniles. New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Hard copy and Internet versions, the latter [http://www.apsu.edu/amatlas/ accessed 09 September 2008] including links to data on amphibians in Tennessee that have appeared since 1996.

Submitted by **TED M. FAUST**, 11828 Couch Mill Road, Knoxville, Tennessee 37932, USA; e-mail: tmfaust21@gmail.com.

LITHOBATES CLAMITANS MELANOTA (Northern Green Frog). USA: TENNESSEE: Jefferson Co.: 12.7 km W of Jefferson City (36.1061°N, 83.6246°W). 12 July 2008. Ted M. Faust. Verified by Floyd A. Scott. Austin Peay State University Museum of Zoology (APSU 18932 [color photo]). Three individuals were found at 1110 h in a small stream that was not flowing. New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Hard copy and Internet versions, the latter [http://www.apsu.edu/amatlas/ accessed 09 September 2008] including links to data on amphibians in Tennessee that have appeared since 1996).

Submitted by **TED M. FAUST**, 11828 Couch Mill Road, Knoxville, Tennessee 37932, USA; e-mail: tmfaust21@gmail.com.

OLLOTIS NEBULIFER (Gulf Coast Toad). USA: TEXAS: Tom Green Co.: Private residence along USH87 (31.4178333ºN, 100.4388333ºW). 1838 ft elev. 25 September 2007. M. S. Price and N. M. Price. Verified by Travis LaDuc. Texas Natural History Collection (TNHC 68557, photo voucher). New county record (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. Texas A&M University Press, College Station, Texas. 421 pp.)

Submitted by **MICHAEL S. PRICE,** San Angelo Nature Center, 7409 Knickerbocker Road, San Angelo, Texas 76904, USA; e-mail: michael.price@sanangelotexas.us.

PSEUDACRIS FOUQUETTEI (Cajun Chorus Frog). USA: ARKANSAS: Howard Co.: roadside ditch off US 278 in Umpire (34.192672°N, 94.064072°N; NAD83). 20 March 1987. W. Cox. Verified by S. E. Trauth. Arkansas State University Herpetological Museum (ASUMZ 31275). New county record completely filling a distributional gap in southwestern Arkansas between Sevier and Pike counties (Trauth et al. 2004. Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.). We follow the recent taxonomic suggestions of Lemmon et al. (2008. Zootaxa 1675:1–30) for Arkansas chorus frogs (formerly *P. feriarum*).

Submitted by **CHRIS T. McALLISTER**, RapidWrite, 102 Brown Street, Hot Springs National Park, Arkansas 71913, USA (e-mail: drctmcallister@aol.com); and **HENRY W. ROBISON**, Department of Biology, Southern Arkansas University, Magnolia, Arkansas 71754, USA (e-mail: hwrobison@suddenlink.net).

PRISTIMANTIS ASHKAPARA (NCN). BOLIVIA: DEPARTMENT SANTA CRUZ: Manuel Maria Caballero Province: Abra de la Cruz (17.8566°S, 64.3616°W; 2360 m elev.), Amboró National Park. 12 December 2007. D. Ramos. Threatened species, observed and photographed climbing 2 m high at a rocky wall almost completely covered by moss, adjacent to a small stream, around midnight, at 13.5°C air temperature; photograph deposited in Museo de Historia Natural Noel Kempff Mercado (MNKA-F 120), Santa Cruz, Bolivia. Verified by J. Köhler. Previously known only from the type locality, Department Cochabamba, Chapare Province, ca. 47 km on the "old" road from Paractito via El Palmar to Cochabamba, 17.1327778ºS, 65.615ºW; 2100 m elev. (Köhler 2000. Copeia 2000:516–520). First department record extends known distribution 155 km SE from the known locality in Parque Nacional Carrasco; also extends maximum known elevational distribution for 200 m.

Submitted by **DANIEL RAMOS GUTIERREZ** (e-mail: daniel_ramosg@yahoo.com) and **LUCINDO GONZALES ALVAREZ** (e-mail: bichos10@hotmail.com), Museo de Historia Natural Noel Kempff Mercado, Casilla postal 2489, Santa Cruz-Bolivia.

SCAPHIOPUS HOLBROOKII (Eastern Spadefoot). USA: INDIANA: Gibson Co.: White River Township: ca. 0.5 km W of Highway 41 on County Road 350 (38.40626°N, 87.60250°W; NAD 83, Zone 16). 31 March 2008. Nathan Engbrecht. Illinois Natural History Survey (INHS 2008.b photo voucher). New county record for the state of Indiana. Female found on road at night. Males were heard chorusing in a nearby field. Pike Co.: Madison Township: ca. 0.6 km E of Bowman (38.49646°N, 87.34070°W; NAD 83, Zone 16). 01 April 2008. Nathan Engbrecht. INHS 2008.c photo voucher. Adult male found on road at night. Specimens verified by Chris Phillips. Both are new county records that partially fill a gap in the known distribution of this species in southwest Indiana (Minton 2001. Amphibians and Reptiles of Indiana. 2nd ed., revised. Indiana Acad. Sci. 404 pp.).

Submitted by **NATHAN ENGBRECHT (**e-mail: nengbrecht@dnr.in.gov), **ANGIE GARCIA**, **BETHANY GEBOY,** and **ZACK WALKER**, Wildlife Diversity Section, Indiana Department of Natural Resources Division of Fish and Wildlife, 553 E. Miller Drive, Bloomington, Indiana 47401, USA.

SCAPHIOPUS HOLBROOKII (Eastern Spadefoot). USA: TENNESSEE: Hamilton Co.: Back yard of 8308 Pine Ridge Road, Ooltewah, Tennessee. (35.0396833ºN, 85.0948ºW; WGS84). 05 November 2003. David Hedrick. Austin Peay State University Museum of Zoology (APSU 18941, color photo). Verified by A. Floyd Scott. Individual found alive, submerged in a water dish. New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Hard copy and Internet versions, the latter [http://www.apsu.edu/amatlas/ accessed 03 November 2008] including links to data on amphibians in Tennessee having appeared since 1996).

Submitted by **DAVID HEDRICK**, 207 Hillcrest Avenue, Chattanooga, Tennessee 37411, USA; e-mail: d.hedrick@hotmail.com.

SCINAX FUSCOMARGINATUS (Brown-bordered Snouted Treefrog). BRAZIL: PIAUÍ: Piracuruca (03.978ºS, 41.556ºW; datum SAD69). April 2007. B. B. Annunziata, I. S. Castro, and W. M. Fontenele. Verified by D. Silvano and P. Valdujo. Herpetological Collection of Universidade Estadual do Piauí, Parnaíba (UESPI 0040, 0063, 0064, 0069, 0077). This species occurs in southern, central, and eastern Brazil, eastern Bolivia, Paraguay, and northwestern Argentina (Frost 2008 Amphibian Species of the World. http://research.amnh.org/herpetology/amphibia/index.php). First state record, extends distribution ca. 881 km S from the city of Mateiros, Tocantins state (Vitt et al. 2002. Sam Noble Oklahoma Museum of Natural History 1:1–17), ca. 651 km SW from the city of Açailândia, Maranhão state (Brasileiro et al. 2008. Check List 4[2]:185–197), and ca. 920 km SE from Chapada Diamantina, Bahia state (Juncá 2005. Biodiversidade da Chapada Diamantina, BA. 1ª ed. 436 pp.).

Submitted by **BRUNO B. ANNUNZIATA**, Departamento de Zoologia, Coleção Herpetológica, Universidade de Brasília (UnB), CEP 70.855-160, Brasília, Distrito Federal, Brazil; **IRISMAR S. CASTRO**, Departamento de Biologia, Universidade Estadual do Piauí (UESPI), CEP 64.202-220, Parnaíba, Piauí, Brazil; and **WOLNEY M. FONTENELE**, Departamento de Biologia, Universidade Estadual do Piauí (UESPI), CEP 64.202-220, Parnaíba, Piauí, Brazil (e-mail: barcellos.ba@gmail.com).

SPEA MULTIPLICATA (Mexican Spadefoot). USA: TEXAS: Irion Co.: 0.1 rd mi E jct of TX SH 163 on TX SH 67 (31.1293167ºN, 101.16945ºW). 2562 ft elev. 20 September 2007. M. S. Price, N. M. Price, S. G. Price, and N. R. Price. Verified by Travis J. LaDuc. Texas Natural History Collection (TNHC 66566). New county record, filling distributional gap (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. Texas A&M University Press, College Station, Texas. 421 pp.).

Submitted by **MICHAEL S. PRICE,** San Angelo Nature Center, 7409 Knickerbocker Road, San Angelo, Texas 76904, USA; e-mail: michael.price@sanangelotexas.us.

CROCODILIA – CROCODILIANS

ALLIGATOR MISSISSIPIENSIS (American Alligator). USA: TEXAS: Tarrant Co.: Fort Worth Nature Center. Near secondary spillway for Eagle Mountain Lake. 32.869535ºN, 97.496719ºW. 185 m elev. 21 June 2008. Verified by Jeff Streicher. Amphibian and Reptile Diversity Research Center at the University of Texas Arlington (UTADC 2062, photo voucher). New county record (Dixon 2000. Amphibians and Reptiles of Texas. Texas A&M University Press. 421 pp.).

Submitted by **CARL J. FRANKLIN (**e-mail: Franklin@uta.edu) and **ERICK A. P. CATALÁN**, Amphibian and Reptile Diversity Research Center at the University of Texas Arlington, 501 S. Nedderman, Arlington, Texas 76019, USA.

TESTUDINES – TURTLES

APALONE SPINIFERA ASPERA (Gulf Coast Spiny Softshell). USA: GEORGIA: Miller Co.: Spring Creek, 0.4 km S of White's Bridge Rd. (31.0776893ºN, 84.71716945ºW; NAD83). 24 June and 17 July, 2008. Sean C. Sterrett and Andrew M. Grosse. Verified by John Jensen. (UF 153971). New county record (Buhlmann 2008. *In* Jensen et al. [eds.], Amphibians and Reptiles of Georgia, pp. 520–522. University of Georgia Press, Athens, Georgia). Five turtles (1 male, 4 females) were captured by hoop trapping. One additional juvenile was also found dead on this stretch likely due to stress of low flows.

Submitted by **SEAN C. STERRETT,** Joseph W. Jones Ecological Research Center, Route 2, Box 2324, Newton, Georgia, USA (e-mail: ssterret@jonesctr.org); and **ANDREW M. GROSSE,** D. B. Warnell School of Forestry and Natural Resources, University of Georgia, Athens, Georgia 30602, USA (e-mail: frog14@uga.edu).

GRAPTEMYS BARBOURI (Barbour's Map Turtle). USA: GEORGIA: Miller Co.: Spring Creek, 0.4 km S of White's Bridge Rd. (31.1558503ºN, 85.433684°W; NAD83). 24 June, 16 July, and 6 October, 2008. Sean C. Sterrett and Andrew M. Grosse. Verified by John Jensen. (UF 153970). New county record (Moulis 2008. *In* Jensen et al. [eds.], Amphibians and Reptiles of Georgia, pp. 478–480. University of Georgia Press, Athens, Georgia). Four turtles (1 male, 1 female, 2 juveniles) were captured by hoop trapping and snorkeling in a highly agriculturally affected portion of Spring Creek during low flow periods. One additional male was observed during the summer of 2008.

Submitted by **SEAN C. STERRETT,** Joseph W. Jones Ecological Research Center, Route 2, Box 2324, Newton, Georgia, USA (e-mail: ssterret@jonesctr.org); and **ANDREW M. GROSSE,** D. B. Warnell School of Forestry and Natural Resources, University of Georgia, Athens, Georgia 30602, USA (e-mail: frog14@uga.edu).

GRAPTEMYS GEOGRAPHICA (Common Map Turtle). USA: ARKANSAS: Izard Co.: Twin Creek, off Co. Rd. 1, 4 km E of St. Hwy 9 (35.5804°N, 92.0202°W; WGS84). 6 May 2007. M. B. Connior, I. Guenther. Verified by S. E. Trauth. Arkansas State University Museum of Zoology Herpetology Collection (ASUMZ photographic voucher 31266). Adult female observed digging nest. First county record (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville. 421 pp.).

Submitted by **MATTHEW B. CONNIOR** (e-mail: matthew.connior@smail.astate.edu), **IDUN GUENTHER**, and **THOMAS S. RISCH**, Department of Biological Sciences, Arkansas State University, P.O. Box 599, State University, Arkansas 72467, USA.

MACROCHELYS TEMMINICKII (Alligator Snapping Turtle). USA: TEXAS: Franklin Co.: North of Mt. Vernon in White Oak Creek near state highway 37. 16 May 1986. Verified by Jonathan A. Campbell. Amphibian and Reptile Diversity Research Center at the University of Texas Arlington. UTA R-16661. New county record (Dixon 2000. Amphibians and Reptiles of Texas. Texas A&M University press. 421 pp.).

Submitted by **CARL J. FRANKLIN (**e-mail: Franklin@uta.edu), and **ERICK A. P. CATALÁN**, Amphibian and Reptile Diversity Research Center at the University of Texas Arlington, 501 S. Nedderman, Arlington, Texas 76019, USA.

PELUSIOS GABONENSIS (African Forest Turtle). REPUBLIC OF CONGO: CONKOUATI DEPARTMENT: NZAMBI DISTRICT: Tchibenda Lake and unnamed wetland, 3 km W Conkouati Village. 27 September 2008. California Academy of Sciences photo vouchers (CAS HPV44–47). Verified by Hallie Brignall. Only known records for Republic of Congo located in central Congo along Congo River and inland within the Cuvette and Plateaux Regions, > 480 km NE of our localities (Iverson 1992. A Revised Checklist with Distribution Maps of the Turtles of the World. Privately published. Richmond, Indiana. xiii+363 pp.). Three adults captured accidentally on fish hooks by local fisherman in July 2008. Fourth specimen captured by hand in Tchibenda Lake and eaten by local family on 27 September 2008.

Submitted by **PIERRE FIDENCI**, ESI, 79 Brady St., San Francisco, California 94108, USA (e-mail: pfidenci@endangeredspeciesinternational.org); and **JEROME MARAN**, L'Association du Refuge des Tortues, 26, place du Souvenir, 31660, Bessières, France (e-mail: jerome.maran@wanadoo.fr).

TERRAPENE ORNATA ORNATA (Ornate Box Turtle). USA: TEXAS: CROCKETT CO.: 2.8 rd mi N jct of TX SH190 on TX SH163 (30.9515167ºN, 101.16795ºW). 2659 ft elev. 20 September 2007. M. S. Price, N. M. Price, S. G. Price, and N. R. Price. Verified by Travis J. LaDuc. Texas Natural History Collections photo voucher, TNHC 66535. New county record and fills distributional gap (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. Texas A&M University Press, College Station, Texas. 421 pp.).

Submitted by **MICHAEL S. PRICE**, San Angelo Nature Center, 7409 Knickerbocker Road, San Angelo, Texas 76904, USA; e-mail: michael.price@sanangelotexas.us.

TRACHEMYS EMOLLI (Moll's Slider). EL SALVADOR: LA UNIÓN: Golfo de Fonseca: Municipio de Meanguera del Golfo: east-central shore of Pirigallo Island (13.1020°N, 87.4103°W; datum WGS 84), 0 m elev. 29 August 2007. Enrique Barraza and Ricardo Ibarra Portillo. Verified by John L. Carr. Museo de Historia Natural de El Salvador, San Salvador collection (MUHNES C-301654). Municipio de Intipucá: Playa El Icacal (13.1675°N, 88.005256 W; WGS84), 0 m elev. 11 May 2008. Carlos Funes. Verified by John L. Carr. The University of Kansas Natural History Museum Digital Archive (KUDA 002402–002405). New records for El Salvador (Köhler et al. 2006. The Amphibians and Reptiles of El Salvador. Krieger Publ. Co., Malabar, Florida. ix + 238 pp.), extending the species' range ca. 140 km NW of closest known localities in Lakes Managua and Nicaragua, in streams connecting the two lakes, and in Río San Juan near the Nicaragua-Costa Rica border (Legler 1990. *In* J. W. Gibbons [ed.], Life History and Ecology of the Slider Turtle, pp. 82–105. Smithson. Inst. Press, Washington, D.C.). The adult male from Pirigallo Island was found dead, lodged between rocks at 2 m depth in sea water. Because Pirigallo Island does not contain suitable freshwater habitat for *Trachemys*, it is likely that the specimen was blown out to sea from a nearby lagoon in the Gulf of Fonseca or from the Río Choluteca during a storm. The Playa El Icacal, male specimen was collected as it was swimming in an estuary near Río El Encantado. Legler (1990, *op. cit.*) noted the absence of *Pseudemys* (= *Trachemys*) records from suitable habitat in the lowland corridor from the Gulf of Fonseca to Lake Managua, but our records suggest that *T. emolli* occurs throughout this corridor in El Salvador, Honduras, and Nicaragua. However, we cannot eliminate the possibility that the species was introduced by the illegal wildlife trade that is rampant in the Gulf of Fonseca (O. Komar, pers. comm.).

Submitted by **RICARDO IBARRA PORTILLO**, Ministerio de Medio Ambiente y Recursos Naturales (MARN), Calle y Colonia Las Mercedes, km 5 y ½ carretera a Santa Tecla, San Salvador, El Salvador (e-mail: ribarra@marn.gob.sv); **VLADLEN HENRÍQUEZ,** Programa de Ciencias para la Conservación, SalvaNATURA, 33 Ave Sur #640, Colonia Flor Blanca, San Salvador, El Salvador (e-mail: vhenriquez@salvanatura.org); and **ELI GREENBAUM,** Department of Biological Sciences, University of Texas at El Paso, 500 West University Ave., El Paso, Texas 79968, USA (e-mail: egreenbaum2@utep.edu).

TRACHEMYS SCRIPTA ELEGANS (Red-eared Slider). USA: FLORIDA: GILCHRIST CO.: Santa Fe River, 2.5 km upstream from Suwannee River (29.9030667ºN, 82.8672583ºW, datum WGS84). 27 February 2008. Travis M. Thomas. UF 153059. Verified by Kenneth L. Krysko. New county record and 37.6 km downstream from the closest known *T. s. elgans* (UF 153056–57) in Columbia County. Adult male (carapace length 150 mm, plastron length 140 mm) captured using baited hoop trap.

Submitted by **TRAVIS M. THOMAS**, Florida Museum of Natural History, Division of Herpetology, University of Florida, Gainesville, Florida 32611, USA (e-mail: tthomas@flmnh.ufl.edu); and **GERALD R. JOHNSTON**, Department of Natural Sciences, Santa Fe Community College, Gainesville, Florida 32606, USA (e-mail: jerry.johnston@sfcc.edu).

TRACHEMYS SCRIPTA ELEGANS (Red-eared Slider). USA: FLORIDA: SUWANNEE CO.: Ichetucknee Springs State Park, Devil's Eye Spring, Ichetucknee River (29.9737194ºN, 82.7600556ºW; datum WGS84). 19 April 2008. Anthony Lau. Florida Museum of Natural History (UF 153060). Verified by Kenneth L. Krysko. New county record. Adult male (carapace length 140 mm, plastron length 127 mm) captured by hand while snorkeling. First known *T. s. elegans* collected in the Ichetucknee River, a tributary to the Santa Fe River, where multiple individuals of non-native *T. s. elegans* have been collected (Lau et al. 2008. Herpetol. Rev. 39:236–237).

Submitted by **ANTHONY LAU**, Department of Wildlife Ecology and Conservation, University of Florida, Gainesville, Florida 32611, USA (e-mail: alau0924@ufl.edu); and **GERALD R. JOHNSTON**, Department of Natural Sciences, Santa Fe Community College, Gainesville, Florida 32606, USA (e-mail: jerry.johnston@sfcc.edu).

SQUAMATA – LIZARDS

AMEIVA AMEIVA (Giant Ameiva). USA: FLORIDA: MONROE CO.: Grassy Key, jct Morton Street and Lemon Avenue (24.7629ºN, 80.9603ºW, WGS84). 21 September 2008. Renée Anderson. Two individuals observed foraging among leaves on ground. Florida Museum of Natural History photographic voucher (UF 153706). Verified by Kenneth L. Krysko. First record from the Florida Keys and a new county record. Extends range ca. 106 km SSW of the nearest known population at a reptile dealer's facility in Miami,

Miami-Dade Co. (UF 137671). Other *A. ameiva* were observed in the vicinity, suggesting an established population.

Submitted by **SCOTT HARDIN**, Florida Fish and Wildlife Conservation Commission, 620 South Meridian Street, Tallahassee, Florida 32399, USA (e-mail: scott.hardin@myfwc.com); **RENÉE ANDERSON**, Signs by Renée, 72 Coco Plum Drive, Marathon, Florida 33050, USA; and **KEVIN M. ENGE**, Florida Fish and Wildlife Conservation Commission, 1105 SW Williston Road, Gainesville, Florida 32601, USA.

ANOLIS ALLISONI (Green Anole). HONDURAS: ATLÁNTIDA: Hotel Rotterdam, La Ceiba (15.4730°N, 86.4720°W; WGS84), near sea level. 13 May 2007. Alexander Gutsche and James R. McCranie. Verified by Steve Gotte. USNM 570550. First mainland record for this species in Honduras (McCranie et al. 2005. Amphibians & Reptiles of the Bay Islands and Cayos Cochinos, Honduras. Bibliomania!, Salt Lake City, Utah. xiii + 210 pp.). The specimen was captured at 1135 h on a small palm tree in the hotel garden. Observations of about ten additional specimens, including adult males and females and a subadult, indicate an established population that was likely introduced from nearby Islas de la Bahía, Honduras. Fieldwork of A. Gutsche was supported by German Research Fondation (DFG 444 HON 111/1/07).

Submitted by **JAMES R. McCRANIE,** 10770 SW 164th Street, Miami, Florida 33157-2933, USA (e-mail: jmccrani@bellsouth.net); and **ALEXANDER GUTSCHE**, Humboldt-Universität zu Berlin, Institut für Biologie, Abteilung Sinnesbiologie, Invalidenstr. 43, D-10115 Berlin, Germany (e-mail: alexander-gutsche@web.de).

ANOLIS EQUESTRIS (Knight Anole). USA: FLORIDA: Highlands Co.: 101 Green Dragon Drive, Lake Placid (27.295233°N, 81.370525°W, WGS84; elev. 36.5 m). 27 September 2005. Florida Museum of Natural History (UF 153968). New county record and extends the range ca. 78 km NE of the closest known locality at 5207 Palm Beach Boulevard, Fort Myers, Lee County (UF 145694). Polk Co.: 3832 Avenue Q NE, Winter Haven (28.03906°N, 81.72411°W, WGS84; elev. 44 m). 15 December 2007. UF 153967. New county record and extends the range ca. 86 km north of the closest known locality in Highlands County above (Camposano et al. 2008. Iguana 15[4]:24–31). Found dead in swimming pool. Specimens collected by Daniel Parker and verified by Kevin M. Enge.

Submitted by **DANIEL J. PARKER**, Division of Herpetology, Florida Museum of Natural History, Dickinson Hall, University of Florida, Gainesville, Florida 32611, USA (e-mail: sunshineserpents@earthlink.net); and **KENNETH L. KRYSKO**, Division of Herpetology, Florida Museum of Natural History, Dickinson Hall, University of Florida, Gainesville, Florida 32611, USA (e-mail: kenneyk@flmnh.ufl.edu).

COLEONYX VARIEGATUS (Western Banded Gecko). USA: NEVADA: Esmeralda Co.: Cuprite Hills, northwest of U.S. Highway 95 and State Route 266 intersection (37.52292°N, 117.20111°W, WGS84), 1500 m elev. 11 March 2008. Polly Conrad. University of Nevada at Reno (UNR 7725). A second specimen (UNR 7724) was found nearby in the Palmetto Mountains. Verified by Chris R. Feldman. Northernmost record for the species. These records extend the range of *C. variegatus* by 44.2 km NNE of UNR 7002 in Nye County, Nevada and 62.8 km ENE of MVZ 227787 in Inyo County, California. Two desiccated specimens were found inside hollow mine claim marker posts. There was no evidence of predation, thus the idea of birds dropping the lizards into the posts was ruled out. Along with several hundred individuals of many other lizard species, the geckos likely accessed the plastic hollow mine claim posts through perforations slightly above ground level, turning the posts into traps.

We thank Chris Feldman for assistance with museum records.

Submitted by **PAULETTE M. CONRAD,** Nevada Department of Wildlife, Diversity Division, 4747 Vegas Drive, Las Vegas, Nevada 89108, USA (e-mail: pconrad@ndow.org); and **PETER V. BRADLEY**, Nevada Department of Wildlife, Diversity Division, 60 Youth Center Drive, Elko, Nevada 89801, USA.

CTENOSAURA PECTINATA (Mexican Spiny-tailed Iguana). USA: FLORIDA: Broward Co.: Hollywood, N 56th Avenue (26.03661°N, 80.2005°W; WGS84; elev. <1 m). 22 October 2008. Raymond A. Mendez. Verified by Kevin M. Enge. Florida Museum of Natural History photographic voucher (UF 153801). New county record and extends known range of this species ca. 50 km N of closest known record near Old Cutler Road along Biscayne Bay, Miami-Dade County (Townsend et al. 2003. Herpetozoa 16:67–72). Adult male found in yard at residence.

Submitted by **KENNETH L. KRYSKO**, Florida Museum of Natural History, Dickinson Hall, Division of Herpetology, University of Florida, Gainesville, Florida 32611, USA; e-mail: kenneyk@flmnh.ufl.edu.

HEMIDACTYLUS GARNOTII (Indo-Pacific Gecko). USA: FLORIDA: Clay Co.: Keystone Heights, near Keystone Lake (29.78324°N, 82.032246°W; WGS84). 05 November 2008. B. K. Atkinson. Verified by M. A. Nickerson and K. L. Krysko. Florida Museum of Natural History (UF 153892). Juvenile gecko collected in private residence garden. New record for Clay County, extends the known range 17.3 km NE of the closest known specimen (UF 134315) in Bradford County, Florida (Krysko and Daniels 2005. Carib. J. Sci. 41[1]:28–36).

Submitted by **BENJAMIN K. ATKINSON** (e-mail: bka@ufl.edu), and **JAMES C. NIFONG (**e-mail: ncboy@ufl.edu), Florida Museum of Natural History, University of Florida, Gainesville, Florida 32611, USA.

HEMIDACTYLUS MABOUIA (Wood Slave). HONDURAS: ISLAS DE LA BAHÍA: Isla de Guanaja, Savannah Bight (16.29078°N, 85.50300°W; WGS84), 14 m elev. 09 May 2007. Alexander Gutsche and James R. McCranie. Verified by Steve Gotte. USNM 570548–49. First record of this introduced species for Islas de la Bahía (McCranie et al. 2005. Amphibians & Reptiles of the Bay Islands and Cayos Cochinos, Honduras. Bibliomania!, Salt Lake City, Utah. viii + 210 pp.). The specimens were captured at night on concrete walls and a ceiling of the Savannah Hotel. The presence of subadults and adults indicate an established population. Fieldwork of A. Gutsche was supported by German Research Foundation (DFG 444 HON 111/1/07).

Submitted by **ALEXANDER GUTSCHE,** Humboldt-Universität zu Berlin, Institut für Biologie, Abteilung Sinnesbiologie,

Invalidenstr. 43, D-10115 Berlin, Germany (e-mail: alexander-gutsche@web.de); and **JAMES R. McCRANIE**, 10770 SW 164th Street, Miami, Florida 33157-2933, USA (e-mail: jmccrani@bellsouth.net).

HEMIDACTYLUS TURCICUS (Mediterranean Gecko). USA: LOUISIANA: Washington Parish: 1730 Sullivan Dr., Bogalusa, 3.5 km S of intersection of Highways 10 and 21 (30.75871ºN, 89.84551ºW; WGS 84). 17 July 2007. Beau B. Gregory and Aran C. Meyer. Verified by Jeff Boundy. LSUMZ 90434–90435. Two individuals captured on wall of building. First parish record (Dundee and Rossman 1989. The Amphibians and Reptiles of Louisiana. Louisiana St. Univ. Press, Baton Rouge. 300 pp.).

Submitted by **BEAU B. GREGORY** and **ARAN C. MEYER**, Coastal and Nongame Resources Division, Louisiana Department of Wildlife and Fisheries, P.O. Box 98000, Baton Rouge, Louisiana 70898, USA.

SCELOPORUS JARROVII (Yarrow's Spiny Lizard). USA: NEW MEXICO: Grant Co.: Gila River, 2.0 km W, 0.8 km E Gila Hot Springs (33.17675°N, 108.20131°W, WGS84). 02 August 2006. Randy D. Jennings and Jan L. Frye. Two juveniles, one collected (43 mm SVL, WNMU 14779). Found on sycamore trunk by large rock outcrop near river. Vouchers from two additional sites were also collected (WNMU 14780, 14781) in 2007. All three locations are along 2.9 km of Gila River corridor; 0.8 air km separate two distant-most sites. All verified by C. W. Painter. Deposited in Western New Mexico University, Gila Natural History Collection. First verified collections in Grant County, an extension of ca. 160 km from known localities in neighboring Hidalgo County (Degenhardt 1996. Amphibians and Reptiles of New Mexico. Univ. New Mexico Press, Albuquerque. 431 pp.).

Submitted by **RANDY D. JENNINGS**, Western New Mexico University, P.O. Box 680, Silver City, New Mexico 88062, USA (e-mail: jenningsr@wnmu.edu); **BRUCE L. CHRISTMAN,** 736 Cardenas SE, Albuquerque, New Mexico 87108, USA (e-mail: nattybrew@hotmail.com); and **JAN L. FRYE**, P.O. Box 92, Silver City, New Mexico 88062, USA (e-mail: janlf@hotmail.com).

SQUAMATA – SNAKES

ARIZONA ELEGANS ELEGANS (Kansas Glossy Snake). USA: TEXAS: Irion Co.: 1.6 rd mi E of jct of TX SH163 on RM 2469 (31.2993ºN, 101.14035ºW). 2596 ft elev. 07 July 2007. M. S. Price, and N. M. Price. Verified by Travis J. LaDuc. Texas Natural History Collections (TNHC 66534 photo voucher). New county record and fills a distributional gap (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. Texas A&M University Press, College Station, Texas. 421 pp.).

Submitted by **MICHAEL S. PRICE**, San Angelo Nature Center, 7409 Knickerbocker Road, San Angelo, Texas 76904, USA; e-mail: michael.price@sanangelotexas.us.

BOGERTOPHIS SUBOCULARIS (Trans-Pecos Ratsnake). USA: TEXAS: Upton Co.: 1.3 rd mi N of U.S. Hwy 67 on CR 405 (31.1586333ºN, 102.20145ºW). 2692 ft elev. 12 June 1996. M. S. Price and J. Garza. Verified by Travis LaDuc. Texas Natural History Collections (TNHC 66555). New county record (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. Texas A&M University Press, College Station, Texas. 421 pp.).

Submitted by **MICHAEL S. PRICE,** San Angelo Nature Center, 7409 Knickerbocker Road, San Angelo, Texas 76904, USA; e-mail: michael.price@sanangelotexas.us.

CORALLUS CANINUS (Emerald Tree Boa) COLOMBIA: CALDAS: Municipio de Victoria, Vereda San Lorenzo (05.3394ºN, 74.9467ºW; WGS84), 800 m elev. 20 September 2008. J. D. Sánchez-L and A. Arias Alzate. Verifed by R. W. Henderson. Museo de Herpetología Universidad de Antioquia, Medellín, Colombia (MHUA 14625). The species has a wide distribution in the Amazon Basin occurring in Brazil, Peru, French Guiana, Suriname, Guyana, Venezuela, and Ecuador (Henderson 1993. Cat. Amer. Amp. Rept. 574:1–3). The only confirmed records for the species outside of the Amazon River basin are two documented vouchers from the Choco-Magdalena region in Colombia (Renjifo and Lundberg 1999. Anfibios y Reptiles de Urrá. Ed. Colina, Medellín, Colombia; Daza-R. and Henderson 2005. Herpetol. Rev. 36:338–339). This is first record for the Department of Caldas and extends the known distribution in the Magdalena River valley region ca. 248 km to the south.

Submitted by **JUAN DAVID SÁNCHEZ-L.,** Instituto de Biología, Universidad de Antioquia, AA. 1226, Medellín, Colombia (e-mail: jdavids21@gmail.com); **JUAN M. DAZA**, Department of Biology, University of Central Florida, Orlando, Florida 32816, USA (e-mail: jdaza@mail.ucf.edu); and **ANDRÉS ARIAS ALZATE.,** Instituto de Biología, Universidad de Antioquia, AA. 1226, Medellín, Colombia (e-mail: andresarias3@yahoo.es).

CROTALUS VIRIDIS (Prairie Rattlesnake). USA: TEXAS: Crockett Co.: 3.1 road miles S of junction of CR131 on CR209 (31.0743ºN, 100.9745ºW). 2497 ft elev. 24 May 2007. M. S. Price and S. G. Price. Verified by Travis LaDuc. Texas Natural History Collections (TNHC 66855 photo voucher). New county record (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. Texas A&M University Press, College Station, Texas. 421 pp.)

Submitted by **MICHAEL S. PRICE**, San Angelo Nature Center, 7409 Knickerbocker Road, San Angelo, Texas 76904, USA; e-mail: michael.price@sanangelotexas.us.

DIADOPHIS PUNCTATUS EDWARDSII (Northern Ring-necked Snake). USA: WISCONSIN: Monroe Co.: Fort McCoy United States Army Installation Facility, (44.121430˚N, 90.723391˚W). 21 June 2008. Matthew Heeter and Luke Breitenbach. Verified by Robert Hay. Illinois Natural History Survey (INHS 2008.h photo voucher). New county record. Fills gaps in range map in Wisconsin (Casper 1996. Geographic Distributions of the Amphibians and Reptiles of Wisconsin. Milwaukee Public Museum, 87 pp.), and complements four prior unverified Monroe County records from: T16N, R2W (Fort McCoy, Eric W. Spadgenske, 1993), T18N, R3W, Sec. 35 SE ¼ (Fort McCoy, Dan Nedrelo, 1992), T19N, R2W, Sec. 1 or 2 (Rich King, 1998), and T19N, R2W, Sec. 6 SE ¼ of SW ¼ (Rich King, 1995)—data from Wisconsin Herp Atlas, Univ. Wisconsin Field Station, accessed Oct. 2008. Two individuals found under a rotting log on 21 June 2008 (MH and LB).

Submitted by **TIMOTHY T. WILDER,** Department of the Army, Directorate of Public Works, IMNE-MCY-PWEN, 2171

South 8th Avenue, Fort McCoy, Wisconsin 54656-5136, USA; **MATTHEW HEETER**, 106 ½ Clinton Street, La Crosse, Wisconsin 54603, USA; **LUKE BREITENBACH**, 2505 Elmwood Road, Hartford, Wisconsin 53027, USA; **GARY S. CASPER**, University of Wisconsin-Milwaukee Field Station, 3095 Blue Goose Rd, Saukville, Wisconsin 53080, USA; and **JOSHUA M. KAPFER**, Natural Resources Consulting, Inc., 209 Commerce Parkway, PO Box 128, Cottage Grove, Wisconsin 53527, USA.

FARANCIA ABACURA (Red-bellied Mudsnake). USA: TENNESSEE: Fayette Co.: Wolf River Wildlife Management Area (35.02909ºN, 89.26639ºW; WGS84). 18 May 2008. J. Ream and E. Johansen. Verified by A. Floyd Scott. Austin Peay State University's David H. Snyder Museum of Zoology (APSU 18940). Voucher photographs taken of specimen found at 1530 h in graveled parking lot along Beasley Drive. New county record (Scott and Redmond 2008. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available from http://apsu.edu/reptatlas/, ver. 03 October 2008, accessed 14 October 2008).

Submitted by **JOSHUA TAYLOR REAM (**e-mail: jream14@apsu.edu), and **ERIC PAUL JOHANSEN**, The Center of Excellence for Field Biology, Austin Peay State University, Clarksville, Tennessee 37044, USA.

HETERODON NASICUS (Western Hog-nosed Snake). USA: TEXAS: Schleicher Co.: 1.3 rd mi W of jct. of Crockett County line marker on TX SH190 (30.9072167ºN, 100.9415833ºW). 2514 ft elev. 19 August 2006. M. S. Price and Ben Vanecek. Verified by Travis J. LaDuc. Texas Natural History Collections (TNHC 66536, photo voucher). Sterling Co.: 5.4 rd mi W of U.S. Hwy 87 on TX SH 158. (31.8505833ºN, 101.1268833ºW). 2353 ft elev. 27 April 2007. M. S. Price and K. Conder. TNHC 66560. New county records (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. Texas A&M University Press, College Station, Texas. 421 pp.).

Submitted by **MICHAEL S. PRICE**, San Angelo Nature Center, 7409 Knickerbocker Road, San Angelo, Texas 76904, USA; e-mail: michael.price@sanangelotexas.us.

LACHESIS MELANOCEPHALA (Black-headed Bushmaster). PANAMÁ: CHIRIQUÍ: Cantón Racimiento, Finca Hartmann, 20 km W of Volcán (ca. 8.51ºN, 82.54°W, map estimation), ca. 1200 m elev. 1965 (no other information available). Ratibor Hartmann. Verified by J. A. Campbell. University of Texas at Arlington Digital Collection (UTADC 1039). First verified locality record from Panamá, although there is an old record (MVZ 27231) with inexact data that implied the species' presence in Chiriquí. The closest known locality is about 30 km W at San Vito in adjacent Puntarenas, Costa Rica (Campbell and Lamar 2004. The Venomous Reptiles of the Western Hemisphere, Vol. 1. Comstock Publ. Assoc., Cornell Univ. Press, Ithaca, New York. 476 pp.).

Submitted by **QUETZAL DWYER** and **MONICA PEREZ**, Parque Reptilandia, Platanillo, Pérez Zeledón, San José, Costa Rica; e-mail: Reptilandia_cr@racsa.co.cr.

LAMPROPELTIS CALLIGASTER CALLIGASTER (Prairie Kingsnake). USA: ARKANSAS: Searcy Co.: ca. 0.5 km W of jct. AR 14 and AR 263 (35.5925°N, 92.2458°W; NAD 83). 26 October 2008. M. B. Connior, I. Guenther. Verified by S. E. Trauth. Arkansas State University Museum of Zoology Herpetology Collection (ASUMZ 31273). Adult found DOR on AR 14. First county record (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville. 421 pp.).

Submitted by **MATTHEW B. CONNIOR** (e-mail: matthew.connior@smail.astate.edu), and **IDUN GUENTHER**, Department of Biological Sciences, Arkansas State University, P.O. Box 599, State University, Arkansas 72467, USA.

LAMPROPELTIS CALLIGASTER RHOMBOMACULATA (Mole Kingsnake). USA: ALABAMA: Chilton Co.: 9.0 km S of CR 25 on CR 73 (33.00685°N, 86.52074°W; WGS84). 25 May 2000. J. Burling. Verified by Joseph R. Mendelson III. University of Montevallo Collection of Vertebrates (UMCV-RS0083). Female with five eggs found dead on road. County record; fills a gap among Shelby, Bibb, and Coosa counties (Mount 1975. The Reptiles and Amphibians of Alabama. University of Alabama Press, Tuscaloosa. 347 pp.).Specimen was collected under Alabama Department of Conservation and Natural Resources collecting permit number 1044 (JWB).

Submitted by **JOHN W. BURLING[1]** and **JILL A. WICKNICK[2]**, Departments of Psychology[1] and Biology[2], University of Montevallo, Montevallo, Alabama 35115, USA (e-mail: wicknickja@montevallo.edu).

LAMPROPELTIS MEXICANA (Mexican Kingsnake). MEXICO: JALISCO: Sierra del Laurel near La Ciénega, along border with Aguascalientes (ca. 21.72970°N, 102.69890°W; WGS84), elev. 2435–2440 m. 26–27 July 2006. B. Alexander, R. W. Hansen, C. Heim, B. McGregor. Verified by David Lazcano. University of Texas at Arlington Digital Collection (UTADC 2602–2604, photo vouchers); Universidad Autónoma de Nuevo Leon (UANL, three specimens, uncatalogued). First records for Jalisco and ca. 33 km S of closest known locality from the Mesa Montoro region of Aguascalientes (Quintero-Díaz et al. 2001. Herpetol. Rev. 32:278). Snakes were collected under rocks or in crevices within rock outcrops that were surrounded by montane woodland dominated by oaks (*Quercus* spp.) and manzanita (*Arctostaphylos* sp.).

Scientific collecting permits were issued to us by SEMARNAT (OFICIO NUM.SGPA/DGVS/03382/06, OFICIO NUM.SGPA/DGVS/02100).

Submitted by **ROBERT W. HANSEN**, 16333 Deer Path Lane, Clovis, California 93619, USA (e-mail: rwh13@csufresno.edu); and **ROBERT W. BRYSON, JR.**, School of Life Sciences, University of Nevada-Las Vegas, 4505 Maryland Parkway, Las Vegas, Nevada 89154-4004, USA (e-mail: brysonjr@unlv.nevada.edu).

LAMPROPELTIS MEXICANA (Mexican Kingsnake). MEXICO: DURANGO: Municipality of Canatlán, ca. 30 km (air) WNW of Canatlán (24.5814167°N, 104.9354833°W; WGS 84), 2306 m elev. Summer 2007. Ron Savage. Verified by Carl Franklin. University of Texas Arlington Digital Collection (UTADC 2599, photo voucher). New municipality record, extending range northward by ca. 70 km (LACM 107230–31; Garstka 1982. Breviora 466:1–35) and brings *L. mexicana* to within 90 km of *L. alterna* on the eastern flank of the Sierra Madre Occidental (Ingrasci et al. 2008. Herpetol. Rev. 39:371–372). The snake was found in a rock crevice surrounded by

Madrean woodland, which appears to span the range gap between *L. alterna* and *L. mexicana* in unbroken fashion.

Submitted by **RON SAVAGE**, 609 Edmonston Street, Rockville, Maryland 20851, USA (e-mail: Ronsavage@yahoo.com); and **ROBERT W. HANSEN**, 16333 Deer Path Lane, Clovis, California 93619, USA (e-mail: rwh13@csufresno.edu).

LAMPROPELTIS TRIANGULUM TRIANGULUM (Eastern Milksnake). USA: GEORGIA: White Co.: Wildcat Mountain, 9.7 km WNW Helen (34.7270ºN, 83.8419ºW), 1064 m elev. 13 September 2008. Bryan Hudson and Carlos D. Camp. Verified by Kenney Krysko. Florida Museum of Natural History (UF 153761, photo voucher). Hatchling. New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. Univ. Georgia Press, Athens. 575 pp.).

Submitted by **BRYAN HUDSON**, 101 Nancy Trail, Roswell, Georgia 30075, USA (e-mail: Yoitsbry142@aol.com); **CARLOS D. CAMP**, Department of Biology Piedmont College, PO Box 10, Demorest, Georgia 30535, USA (e-mail: ccamp@piedmont.edu); and **JOHN B. JENSEN**, Georgia Department of Natural Resources, Nongame-Endangered Species Wildlife Program, 116 Rum Creek Drive, Forsyth, Georgia 31029, USA (e-mail: John_Jensen@dnr.state.ga.us).

LIOPELTIS FRENATUS (Günther's Stripe-necked Snake). VIETNAM: THUA THIEN-HUE: Bach Ma. Collected before August 1998. Hoang Xuan Quang and students. Verified by Wolfgang Böhme. Zoologisches Forschungsmuseum Alexander Koenig, Bonn, Germany (ZFMK 83105). *Liopeltis frenatus* was previously reported in Vietnam from Lao Cai Province in the north and from the provinces of Quang Binh, Da Nang, and Gia Lai in central and southern Vietnam (Nguyen et al. 2005. A Checklist of Amphibians and Reptiles of Vietnam. Nha xuat ban nong nghiep, Hanoi, 180 pp.; Szyndlar and Nguyen 1996. The Snake 27:91–98; Orlov et al. 2003. Russian J. Herpetol. 10:217–240; Ziegler et al. 2007. Zootaxa 1493:1–40). Our finding represents the first record for Thua Thien-Hue Province, which borders Da Nang Province in the south. Besides coloration and pattern, the specimen has 15 smooth scale rows around midbody, 141 ventrals, 72 divided subcaudals, divided anal scale, seven supralabials (third and fourth in contact with eye), eight infralabials, single loreal, one preocular, and two postoculars that are characteristic of *L. frenatus*. The specimen is a female (SVL 340 mm; tail 128 mm) that contained four eggs of 25–28 mm length and 7–9 mm width.

Submitted by **THOMAS ZIEGLER**, Cologne Zoo, Riehler Str. 173, D-50735 Köln, Germany (e-mail: ziegler@koelnerzoo.de), and **HOANG XUAN QUANG**, University of Vinh, Nguyen Du Str., Vinh - Nghe An, S. R. Vietnam.

MICRURUS TENER (Texas Coralsnake). USA: TEXAS: Schleicher Co.: Eldorado, 7.0 rd mi SW (30.8270167ºN, 100.7056833ºW). 2433 ft elev. 07 April 2007. M. S. Price and N. M. Price. Verified by Travis J. LaDuc. Texas Natural History Collection (TNHC 66564). New county record (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. Texas A&M University Press, College Station, Texas. 421 pp.).

Submitted by **MICHAEL S. PRICE,** San Angelo Nature Center, 7409 Knickerbocker Road, San Angelo, Texas 76904, USA; e-mail: michael.price@sanangelotexas.us.

NERODIA SIPEDON (Northern Watersnake). USA: TEXAS: Dallas Co.: Dallas, White Rock Creek near northeast quadrant of Forest Lane and Hillcrest Road. 32.916482ºN, 96.776481ºW, 151 m. 28 April 2008. Specimens were collected from White Rock Creek from 1200–1545 h. Verified by Corey E. Roelke. Amphibian and Reptile Diversity Research Center at the University of Texas Arlington (UTA R- 55906–913). New county record (Dixon 2000. Amphibians and Reptiles of Texas. Texas A&M University Press. 421 pp.).

Submitted by **CARL J. FRANKLIN (**e-mail: Franklin@uta.edu), and **ERICK A. P. CATALÁN**, Amphibian and Reptile Diversity Research Center at the University of Texas Arlington, 501 S. Nedderman, Arlington, Texas 76019, USA.

PITUOPHIS CATENIFER SAYI (Bullsnake). USA: ILLINOIS: Kane Co.: Collected on property of a private residence in Geneva (41.900090 °N, 88.315087 °W; WGS84). 26 June 2008. Jace Robinson. Verified by Chris Phillips. Illinois Natural History Survey (INHS 2008.20, photo voucher). New county record (Phillips et al. 1999. Field Guide to Amphibians and Reptiles of Illinois. Illinois Nat. Hist. Surv. Manual 8, 300 pp.).

Submitted by **JACE W. ROBINSON**, Department of Biology, Harper College, Palatine, IL, 60067, USA; Department of Biological Sciences, Northern Illinois University, DeKalb, IL, 60115, USA; e-mail: jrobinso@harpercollege.edu.

PROTOBOTHROPS CORNUTUS (Smith's Horned Pit Viper). VIETNAM: HA GIANG: Khau Ca area (22.49º–22.51ºN, 105.05º–105.09ºE). October to November 2002. Photographed by Le Khac Quyet. Verified by Wolfgang Böhme. Zoologisches Forschungsmuseum Alexander Koenig, Bonn, Germany (ZFMK color slides 0210–11). Previously known from type locality "Fan-si-pan Mts., Tong-king" (Lai Chau/Lao Cai provinces) in northern Vietnam, as well as from localities in central Vietnam (Nghe An, Ha Tinh, Quang Binh, and possibly Thua Thien-Hue provinces: Ziegler and Herrmann 2002. Mitt. Zool. Ges. f. Arten u. Populationsschutz e.V. 18:24–26; Herrmann et al. 2004. Herpetologica 60:211–221; Orlov et al. 2003. Russian J. Herpetol. 10:217–240). New photographic reports from Ha Giang Province in northern Vietnam, close to border with Yunnan and Guangxi Zhuang Autonomous provinces (China), represent northernmost records in Vietnam, extending known distribution in northern Vietnam by ca. 200 km airline distance to NE. Besides coloration and pattern (brownish-black pattern on light brownish-gray head and body, reddish-brown tail tip), its distinctly raised, horn-like, enlarged supraocular scales are characteristic of *P. cornutus*. Both specimens were found between 1200–1500 h in sunny weather on tree trunk and in branches in limestone forest. Most recently, the species was recorded from China (Nanling Mountains), ca. 980 airline km distance from type locality (David et al. 2008. Asiatic Herpetol. Res. 11:17–23).

Submitted by **LE KHAC QUYET**, Fauna & Flora International—Vietnam Programme, IPO Box 78, 55 To Hien Thanh, Hanoi, S. R. Vietnam; and **THOMAS ZIEGLER**, Cologne Zoo, Riehler Str. 173, D-50735 Köln, Germany (e-mail: ziegler@koelnerzoo.de).

REGINA SEPTEMVITTATA (Queen Snake). USA: WISCONSIN: Rock Co.: Turtle Creek Watershed (42.59376821°N, 88.79786439°W; WGS84). Verified by Robert Hay. Illinois Natural History Survey (INHS 2008.i, photo voucher). New county record. Extends confirmed Wisconsin range ca. 6.4 km downstream from nearest confirmed Turtle Creek records (Casper 1996. Geographic Distributions of the Amphibians and Reptiles of Wisconsin. Milwaukee Public Museum, 87 pp.; Wisconsin Herp Atlas, Univ. Wisc. Field Station, accessed Oct. 2008). One gravid female captured and photographed on 25 July 2008 (JMK and WPM). Complements two other unverified Rock County records: Carver's Rock Park off Turtle Creek, T2N, R14E, Sec. 27 (George Bachay, 1960) and Turtle Creek, T2N, R14E, Sec. 32 NE ¼ (Robert Parker Hodge, 1956) (Wisconsin Herp Atlas, *op. cit.*). Although this species prefers clear streams with rocky shores and substrates (e.g., Vogt 1981. Natural History of Amphibians and Reptiles of Wisconsin. Milwaukee Public Museum, 205 pp.), this individual was found in a wet meadow, ca. 30 m from flowing water. The nearby stream was turbid, with muddy banks and likely a silt substrate. It is possible that the significant flooding that occurred in this area the month prior carried this individual downstream from known Walworth County sites into a habitat-type that was not normally preferred. The snake regurgitated a molted crayfish (species unidentifiable) while it was being manipulated for photographs.

Submitted by **JOSHUA M. KAPFER**, **WILLIAM P. MUELLER**, and **MEGHAN M. PORZKY**, Natural Resources Consulting, Inc., 209 Commerce Parkway, PO Box 128, Cottage Grove, Wisconsin 53527, USA; and **GARY S. CASPER**, University of Wisconsin-Milwaukee Field Station, 3095 Blue Goose Rd, Saukville, Wisconsin 53080, USA.

RAMPHOTYPHLOPS BRAMINUS (Brahminy Blindsnake). HONDURAS: ISLAS DE BAHÍA: Utila, near Iguana Station (16.619°N, 86.5393°W; WGS84), 30 m elev. Collecting dates and collector name unavailable. Verified by Konrad Klemmer. SMF 79882, 82718. First records for Honduras and Islas de Bahía (McCranie et al. 2005. Amphibians and Reptiles of the Bay Islands and Cayos Cochinos, Honduras. Bibliomania, Salt Lake City, Utah. 210 pp.), and first record of this introduced species on the Atlantic versant of Central America (Köhler 2003. Reptiles of Central America. Herpeton, Verlag E. Köhler, Offenbach, Germany. 368 pp.).

Submitted by **MILAN VESELY**, Department of Zoology, Faculty of Natural Sciences, Palacký University, tř. Svobody 26, 77146 Olomouc, Czech Republic (e-mail:veselym@prfnw.upol.cz); and **GUNTHER KÖHLER**, Forschungsinstitut und Naturmuseum Senckenberg, Senckenberganlage 25, 60325 Frankfurt a.M., Germany.

RHADINOPHIS PRASINUS (Green Bush Ratsnake). VIETNAM: QUANG NAM: Dong Giang District, Macoih Commune, Axo Village. March 2004. Vu Ngoc Thanh. Zoological Museum, Vietnam National University Hanoi (VNUH 12.3.04–1). Verified by Wolfgang Böhme. *R. prasinus* (see Burbrink and Lawson 2007. Mol. Phyl. Evol. 43:173–189 for generic assignment) was previously known from a few provinces in northern Vietnam (Cao Bang, Lao Cai, Bac Kan, Thai Nguyen, and Vinh Phuc: Nguyen and Ho 1996. Danh luc bo sat va ech nhai Viet Nam. Ha Noi; Nguyen et al. 2005. A Checklist of Amphibians and Reptiles of Vietnam. Nha xuat ban nong nghiep, Hanoi, 180 pp.), as well as from Quang Binh and Gia Lai provinces in central and southern Vietnam (Orlov et al. 2003. Russian J. Herpetol. 10:217–240; Ziegler et al. 2007. Zootaxa 1493:1–40). In addition, Schulz 1996 (A Monograph of the Colubrid Snakes of the Genus *Elaphe* Fitzinger. Koeltz Scientific Books, Havlickuv Brod, 439 pp.) mentions two records for southern Vietnam "in the coastal buttresses of the northern Annam Highlands (Annam) and Plateau du Kontum." Thus, our finding represents the first record for Quang Nam Province in southern Vietnam. Specimen caught resting at noon on primary forest path at ca. 600 m elev. Besides coloration and pattern, 19 (dorsally keeled) scales across midbody, 209 ventrals, 107 divided subcaudals, undivided anal scale, nine supralabials (IV–VI in contact with eye), single loreal and preocular scale, and two postoculars are characteristic of *R. prasinus*. Specimen is female (SVL 800 mm; tail 275 mm), containing nine eggs of dimensions 31–39 mm x 16–19 mm.

Submitted by **VU NGOC THANH**, Vietnam National University, Hanoi, University of Science, Faculty of Biology, Department of Vertebrate Zoology, Zoological Museum, 334 Nguyen Trai Str., Thanh Xuan, Hanoi, S. R. Vietnam; and **THOMAS ZIEGLER**, Cologne Zoo, Riehler Str. 173, D-50735 Köln, Germany (e-mail: ziegler@koelnerzoo.de).

SISTRURUS MILIARIUS STRECKERI (Western Pigmy Rattlesnake). USA: ARKANSAS: Newton Co.: Found on County Road 78, E of AR 7. 28 September 2008. I. Guenther. Verified by S. E. Trauth. Arkansas State University Museum of Zoology Herpetology Collection (ASUMZ 31262). DOR. First county record (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. Univeristy of Arkansas Press, Fayetteville. 421 pp.).

Submitted by **IDUN GUENTHER** and **MATTHEW B. CONNIOR (**e-mail: matthew.connior@smail.astate.edu), Department of Biological Sciences, Arkansas State University, P.O. Box 599, State University, Arkansas 72467, USA.

SISTRURUS MILIARIUS STRECKERI (Western Pigmy Rattlesnake). USA: OKLAHOMA: Love Co.: Hickory Creek Wildlife Management Area (34.00464˚N, 97.06274˚W; WGS84). Collected by C. E. Roelke and C. L. Cox. Verified by C. J. Franklin. The University of Texas at Arlington Amphibian and Reptile Diversity Research Center (UTA R 56342). New county record (Webb 1970. Reptiles of Oklahoma. Univ. Oklahoma Press, Norman, Oklahoma. 370 pp; Distribution of Oklahoma Amphibians and Reptiles by Recorded Sightings [http://www.biosurvey.ou.edu/dokadesc.html], Accessed on 10/15/2008.) The specimen was found dead on main road leading through Wildlife Management Area. This record extends the known range of the species westward in Oklahoma, even though it is found slightly further west in Montague and Wise counties, Texas (Dixon 2000. Amphibians and Reptiles of Texas. Univ. Texas A&M, Univ. Press College Station. 421 pp.: Werler and Dixon 2000. Texas Snakes: Identification, Distribution, and Natural History. Univ. Texas Press, Austin. 437 pp.).

Submitted by **COREY E. ROELKE (**e-mail: croelke@uta.edu), and **CHRISTIAN L. COX,** University of Texas at Arlington, Department of Biology, 501 S. Nedderman Dr., Arlington, Texas 76019, USA.

STORERIA OCCIPITOMACULATA OCCIPITOMACULATA (Northern Red-bellied Snake). USA: IOWA: Chickasaw Co.: Newell Road 0.2 km N of State Hwy 24 (43.0616°N, 92.2797°W; WGS84). 04 October 2007. Terry J. VanDeWalle. Verified by James L. Christiansen. DOR specimen deposited in the Drake University Research Collection (DRUC 7298). New county record. Although species is known from a number of adjacent counties, this specimen fills a gap in the distributional data in this portion of the state (J. L. Christiansen, pers. comm.; http://www.herpnet.net/Iowa-Herpetology/). The closest record for this species found in the DRUC is from Bremer County 32.3 km to the south.

Submitted by **TERRY J. VANDEWALLE** (e-mail: tvandewalle@nrc-inc.net), and **STACEY J. CARLSON,** Natural Resources Consulting, Inc., 2300 Swan Lake Blvd., Suite 200, Independence, Iowa 50644, USA.

TANTILLA HOBARTSMITHI (Smith's Black-headed Snake). USA: TEXAS: Irion Co.: 2.2 air miles SW of Barnhart on CR311 (31.1134667ºN, 101.2040667ºW). 2600 ft elev. 03 April 2007. M. S. Price and J. T. Fisher. Verified by Travis LaDuc. Texas Natural History Collections (TNHC 68556, photo voucher). New county record (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. Texas A&M University Press, College Station, Texas. 421 pp.).

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XENOPHOLIS UNDULATUS (Jensen's Ground Snake). BRAZIL: CEARÁ: Municipality of Ubajara, Ubajara National Park (03.840278°S, 40.907500°W; WGS84), 896 m elev. 09 September 2008. Coleção Instituto Butantan, São Paulo, Brazil (IBSP 76832). Municipality of Ubajara, Ubajara National Park (03.838346°S, 40.911467°W; WGS84), 829 m elev. 07 November 2008. IBSP 77110. Both specimens were collected by D. N. Lima, and verified by F. L. Franco. The species was recorded for Paraguay and Brazilian states of Goiás, Maranhão, Mato Grosso do Sul, Minas Gerais, Pará, Paraná, São Paulo, and Tocantins (Cunha and Nascimento 1993. Bol. Mus. Para. Emílio Goeldi, sér. Zool. 9[1]: 1–191; França et al. 2006. SNOMNH Occas. Pap. [17]:1–13). These new records represent an isolated population in the rainforests of Ibiapaba's plateau and also are the first report for the genus in Ceará state and from the Caatinga biome. Extends distribution ca. 770 km NE from Porto Franco municipality, Maranhão state, Brazil, and ca. 1220 km E from Carajás municipality, Pará state, Brazil (Cunha et al. 1985. Publ. Avul. Mus. Para. Emílio Goeldi 40:9–85).

Submitted by **DANIEL LOEBMANN**, Departamento de Zoologia, Instituto de Biociências, Universidade Estadual Paulista, Rio Claro, São Paulo, Brazil, Caixa Postal 199, CEP 13506-970; e-mail: contato@danielloebmann.com.

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New State Records for Amphibians and Reptiles from Colima, Mexico

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The herpetofauna of Colima, México, has not been thoroughly sampled. There have been only two published inventories for the state, but both appeared during the middle of the last century. Oliver (1937) reported on a collection from Colima and recorded 61 species of amphibians and reptiles from the state. Later, Duellman (1958) reported 85 non-marine species, and of those, 80 are still considered valid, although many have experienced taxonomic name changes. Since 1958, another 21 species were added to the state's list from a variety of publications revising specific groups, describing new taxa, or reporting new discoveries due to expanded field work. Therefore, 101 species of non-marine reptiles and amphibians were known to occur in Colima prior to the survey reported on herein.

Between January 2004 and October 2006, we surveyed the mainland herpetofauna from every municipality in the state of Colima and documented 94 of the 101 terrestrial species previously recorded. We did not sample marine species and three of the terrestrial forms are endemic to islands that were not visited. We also discovered 21 species that had never been reported from the state, including two salamanders, one caecilian, four anurans, five lizards, and nine snakes. Although we sampled every major habitat present on mainland Colima, our efforts were primarily focused in four areas: 1) tropical deciduous forest and tropical thorn scrub in the Municipality of Ixtlahuacán; 2) tropical thorn scrub, tropical deciduous forest, tropical semi-deciduous forest, and mixed tropical deciduous/oak woodland along México Hwy. 98 between the cities of Colima and Manzanillo, in the Municipalities of Comala, Manzanillo, Minatitlán, and Villa de Álvarez; 3) pine-oak woodland and cloud forest in the Sierra de Manantlán, Municipality of Minatitlán; and 4) tropical thorn scrub and mixed mesquite grassland/tropical thorn scrub at higher elevations above the city of Colima in the Municipalities of Colima, Comala, Cuauhtemoc, and Villa de Álvarez. See Fig.

1 for a map depicting collecting localities for individuals listed in the species accounts. Those accounts may include only one voucher for a larger series observed within a given locality. All four authors were involved in collecting voucher specimens and taking digital photographs. Preserved specimens were deposited in the Museo de Zoología, Facultad de Cinecias (MZFC) and verifying photographs were placed in the Digital Collection, University of Texas at Arlington (UTADC). Vouchers deposited in MZFC were verified by Edmundo Perez-Ramos and those placed in UTADC by Fernando Mendoza-Quijano. Coordinates and elevations were taken with a GPS device using map datum WGS84. New state records for the 21 species of amphibians and reptiles from Colima are as follows.

Anura

Dendropsophus sartori (Taylor's Yellow Treefrog). Municipality of Colima: 1.6 km E of México Hwy. 110 on road to Tepames (19.105727°N, 103.405559°W), 476 m elev. 6 July 2004. UTADC 1020. Municipality of Manzanillo: 3 km NE Tepehuajes on México Hwy. 98 446 m elev. (19.153846°N, 104.101999°W), 446 m elev. 28 June 2004. UTADC 1021. These records fill a significant gap in the known distribution of this species between the Chamela-Cuixmala region of southwestern Jalisco and the coast of central Guerrero (Duellman 2001). Both samples were males found calling in flooded agricultural fields surrounded by tropical deciduous forest.

Hyla arenicolor (Canyon Treefrog). Municipality of Colima: 5 km (by air) SW of Tepames (19.0816°N, 103.666°W) 870 m elev. 7 January 2005. UTADC 1018. This record is a range extension of ca. 90 km S of the two nearest published records, 4 km NE Ciudad Guzman, Jalisco, and 14.4 km NE Union de Tula, Jalisco (Duellman 2001). Numerous males were found calling from rocks next to an intermittent stream in tropical deciduous forest.

Hyla eximia (Mountain Treefrog). Municipality of Villa de Alvarez: El Naranjal (19.243741°N, 103.392046°W), 1443 m elev. 23 September 2006. UTADC 1019. The record represents a range extension of 40 km SW of the closest known locality in southern Jalisco (Duellman 2001). Frogs were found calling in a flooded field within an ecotone between tropical thorn scrub and mesquite grassland.

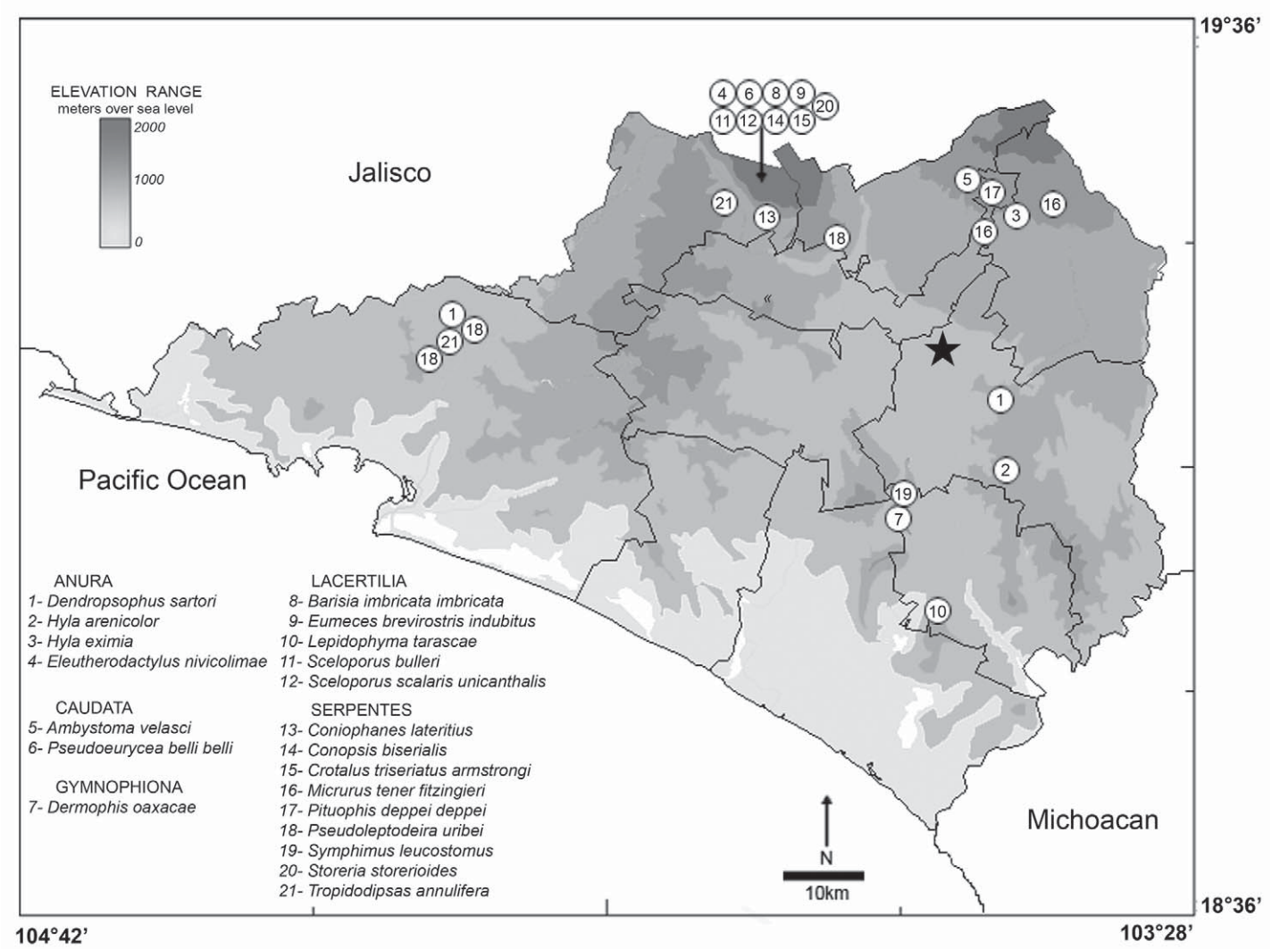


FIG. 1. Map of Colima, México showing collection localities reported in the text and a list of species collected from those localities. The star indicates the city of Colima.

Eleutherodactylus nivicolimae (Nevado de Colima Chirping Frog). Municipality of Minatitlán: Sierra Manantlán: 2.3 km SW (by road) of El Terrero (19.261686°N, 103.573144°W), 2040 m elev. 11 July 2004. UTADC 1033. This record represents a range extension of approximately 46 Km SW of the closest known localities on Nevado de Colima, in Jalisco (Dixon and Webb 1966). The frog was calling at 2200 h from the base of a tree in oak forest.

Caudata

Ambystoma velasci (Plateau Tiger Salamander). Municipality of Comala: 13 km NNE of Comala (19.251511°N, 103.405721°W), 1520 m elev. 9 February 2007. UTADC 1037. This record is a range extension of 60 km S from the closest known locality 2.68 km E Tapalpa, Jalisco (McKnight and Shaffer 1997). The series is composed of larvae captured in a flooded grassy field, two of which were kept in captivity until metamorphosis to facilitate identification, and then released. Surrounding vegetation was a mix of tropical thorn scrub and mesquite grassland.

Pseudoeurycea bellii bellii (Bell's False Brook Salamander). Municipality of Minatitlán: 2.5 km SE of El Terrero (19.25528°N, 103.54510°W), 2164 m elev. 11 July 2004. MZFC19769. This locality is a range extension of ca. 8 km SE of El Tepeixtle, Tolimán, Jalisco, which was initially recorded erroneously from Colima by Mendoza-Quijano et al. (1995) The salamander was found under a log in cloud forest. It is noteworthy that the species is presently abundant at this site.

Gymnophiona

Dermophis oaxacae (Oaxacan Caecilian). Municipality of Ixtlahuacan: 2.8 km (by road) SW of La Salada (19.01816°N, 103.47446°W), 297 m elev. 24 June 2006. UTADC 1016. This record represents a range extension of ca. 150 km S from the closest reported locality, 50 NE Autlan, Jalisco (Savage & Wake 2001). The specimen was found AOR on a rainy night in tropical deciduous forest.

Lacertilia

Barisia imbricata imbricata (Imbricate Alligator Lizard). Municipality of Minatitlán: Sierra de Manantlán: 2.5 km SE of El Terrero (19.255454°N, 103.56444°W), 2200 m elev. 15 August 2004. UTADC 1012. This record represents a range extension of ca. 37 km ESE from the nearest reported locality on the Sierra de Manantlán in adjacent Jalisco (Guillette and Smith 1982). Several juveniles and the reported adult were seen crawling in leaf litter on a hillside covered by oak woodland.

Eumeces bevirostris indubitus (Mexican Shortnose Skink). Municipality of Minatitlán: Sierra de Manantlán: El Terrero, 2183 m elev. (19.2540°N, 103.9388889°W). 11 July 2004. UTADC 1017. This record represents a 43 km SW range extension from the nearest reported locality near Atenquique, Jalisco (Dixon 1969). Individuals of the species were commonly observed at the site in pine-oak woodland under rocks and in leaf litter.

Lepidophyma tarascae (Tarascan Tropical Night Lizard). Municipality of Ixtlahuacán: 1 km NW of San Gabriel (18.55339°N, 103.44016°W), 538 m elev. 3 July 2005. UTADC 1022. This record extends known distribution 95 km WNW from closest reported locality in the Municipality of Aguililla, Michoacán (Guzmán-Villa et al. 1998). The specimen was found at dusk in a crack of a limestone wall in tropical deciduous forest, which is the same plant formation reported by Bezy et. al. (1982) at the type locality. Guzmán-Villa et al. (1998) erroneously suggested that the species is restricted to pine-oak woodland.

Sceloporus bulleri (Buller's Spiny Lizard). Municipality of Minatitlán: Sierra de Manantlán: 1.7 km SW of El Terrero (19.2604°N, 103.5740°W), 2098 m elev. 11 July 2004. UTADC 1029. This record represents a range extension of ca. 65 km SE of the closest know locality in SW Jalisco (Webb 1967). The species was commonly observed on dead trees and under rocks at this site, which is situated in pine-oak woodland.

Sceloporus scalaris unicanthalis (Smith's Bunch Grass Lizard). Municipality of Minatitlán: Sierra de Manantlán: 3.5 km SE El Terrero (19.252494°N, 103.543354°W), 2160 m elev. UTADC 1030. 3 August 2005. This record represents a range extension of ca. 40 Km SW of other known localities in Jalisco on Nevado de Colima and vicinity of Ciudad Guzmán (Smith et. al. 1997). The lizard was found among bunch grass in an open mountain meadow surrounded by pine-oak woodland.

Serpentes

Coniophanes lateritius (Cope's Stripeless Snake). Municipality of Minatitlán: 6.4 km W of junction of México Hwy. 98 and road to El Sauz (19.225443°N, 103.57704°W), 750 m elev. 9 August 2005. UTADC 1013. This record represents a SE range extension of 110 km from the nearest reported locality in Jalisco (Ponce-Campos & Smith 2001). The specimen was found AOR at ca. 1500 h in tropical deciduous forest.

Conopsis biserialis (Two-lined Mexican Earth Snake). Municipality of Minatitlán: 2.5 km SE of El Terrero (19.135838°N, 104.12384°W), 2200 m elev. 15 August 2004. UTADC 1014. This record represents a SW range extension of 40 km from the nearest locality on Nevado de Colima in Jalisco (Goyenechea & Flores-Villela 2006). Numerous other samples were found under rocks in pine-oak forest.

Crotalus triseriatus armstrongi (Armstrong's Dusky Rattlesnake). Municipality of Minatitlán: Sierra de Manantlán: 1.7 km SW El Terrero (19.2604°N, 103.5740°W), 2098 m elev. 15 August 2004. UTADC 1015. This expected record extends the known range ca. 12 km N of other localities on the Serra de Manantlán in adjacent Jalisco (Campbell and Lamar 2004). The snake was found crossing a dirt road at 1900 h in oak forest. It is noteworthy to mention that the species was locally abundant in the vicinity of this site, as over 30 individuals have been found there during the past three years.

Micrurus tener fitzingeri (Fitzinger's Coral Snake). Municipality of Cuauhtémoc: vicinity of Montitlán, 30 km (airline) NNW of Colima, (19.244323°N, 103.361477°W), 1480 m elev. 13 February 2004. MZFC 19743. Municipality of Villa de Alvarez: vicinity of El Carrizal, 17.5 km (airline) N of Colima (19.233248°N, 103.402168°W), 1291 m elev. 23 November 2005. MZFC 19746. These records represent a 350 km range extension W of the closest known localities in western Queretaro (Campbell and Lamar 2004). Both snakes were found in tropical thorn scrub.

Pituophis deppei deppei (Mexican Bullsnake). Municipality of Comala: Laguna Carrizalillos: 19.5 km N of Colima (19.244553°N, 103.402534°W), 1492 m elev. 3 August 2005. UTADC 1026. This record represents a range extension of 60 km S from the nearest known locality at Tapalpa, Jalisco (Campbell 1979). The area is in an ecotone between tropical thorn scrub and oak forest.

Pseudoleptodeira uribei (Uribe's False Cat-eyed Snake). Municipality of Comala: 4 km SW of Juluapan, on México Hwy. 98 (19.182966°N, 103.511855°W), 494 m elev. 14 May 2004. MZFC 19752. Municipality of Manzanillo: 2 km SW Tepehuajes, on México Hwy. 98 (19.181829°N, 103.513089°W), 482 m elev. 8 May 2004. MZFC 19775. 3 km NE Tepehuajes, on México Hwy. 98 (19.152967°N, 104.101939°W), 453 m elev. 29 June 2004. UTADC 1028. These records help fill a 190 km distributional gap between Estación de Biologia Chamela, Jalisco, the type locality (Ramirez-Bautista and Smith 1992), and Ejido Maquili, Michoacán (Mijangos et al. 2007). All three specimens were found DOR in tropical deciduous forest.

Storeria storerioides (Mexican Brown Snake). Municipality of Minatitlán: Sierra de Manantlán: 2.5 km SE of El Terrero (19.255454°N, 103.56444°W), 2200 m elev. 11 June 2004. UTADC 1031. This record fills a distributional gap between localities at Chinicuila, Michoacán (Ponce-Campos et al. 2003) and Tapalpa, Jalisco (Campbell 1979). The snake was found under leaf litter in oak forest.

Symphimus leucostomus (Isthmian White-lipped Snake). Municipality of Ixtlahuacán: 1.7 km NE of La Salada (19.0653306°N, 103.7819833°W), 448 m elev. 11 October 2004. UTADC 1032. This record fills a distributional gap between 14.2 km S of La Huerta, Jalisco (Rossman and Shaefer 1974) and 23 km NW of Punta San Telmo, Michoacán (Alvarez and Diaz-Pardo 1982). The snake was found DOR in tropical deciduous forest.

Tropidodipsas annulifera (Western Snailsucker). Municipality of Minatitlán: 1.5 km W of exit to El Sauz on México Hwy. 98 (19.251908°N, 103.594542°W), 1042 m elev. 28 May 2004. UTADC 1034. Municipality of Manzanillo: 1 km SW Tepeguajes (Puertecito de Lajas) on México Hwy. 98 (19.135838°N, 104.12384°W), 430 m elev. 11 September 2006. UTADC 1035. These records fill a large distributional gap between SW Jalisco and central Guerrero (Kofron 1988). Both specimens were found DOR in tropical deciduous forest.

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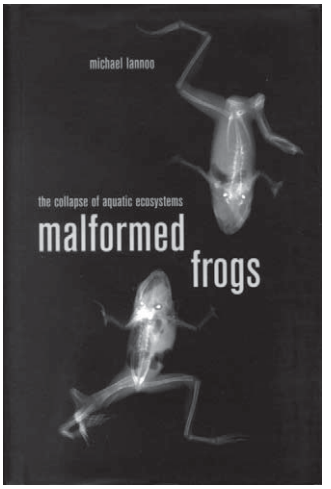
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BOOK REVIEWS

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Malformed Frogs, the Collapse of Aquatic Ecosystems, by Michael Lannoo. 2008. University of California Press, Berkeley (www.ucpress.edu). Hardcover. xvi + 270 pp. US $65.00. ISBN 978-0-520-25588-3.

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I remember the phone call from an official at the regional EPA research lab in Duluth, Minnesota. A group of students from a charter school had found some abnormal frogs during a field trip to a local wetland. The frogs exhibited mainly hind limb deformities, including twisted, missing, or even duplicated hind limbs. The teacher immediately realized that this was a great opportunity to get her students involved in a genuine scientific puzzle, and they reported their discovery to the Minnesota Pollution Control Agency (MPCA). The MPCA helped the kids put together a web page concerning deformed amphibians and what it possibly signified. The web page mentioned something about chemical pollution (who wouldn't think of that?), which generated a firestorm in the media. Soon stories began appearing in major newspapers about a "froggy love canal" with the implication that there might be some contaminant in Minnesota ground water causing thalidomide-like limb "malformations" and worse. I can easily imagine a Minnesota farmer sitting down to breakfast, picking up the newspaper and spitting out his coffee as he reads the headlines: Minnesota ground water may cause birth defects. Soon, state authorities were distributing bottled water to all who asked for it. Inevitably, the US Environmental Protection Agency would become involved. The EPA official called me because I had published a paper on deformed amphibians five years earlier providing an "explanation" for the deformities, and he invited me to an emergency deformed frog workshop at the EPA lab in Duluth.

The Duluth workshop was infused with a sense of urgency and excitement. I watched with amazement as slide after slide of frogs with astonishing deformities elicited audible gasps from the audience. Multilegged frogs drew the most attention as the oddest deformities, and soon became the "poster child" for deformed frogs. My presentation focused on the research I had done with colleague Steve Ruth in California on populations of deformed Pacific Treefrogs and Long-toed Salamanders, most of which had hind limb duplications but a wide range of other deformities as well, including missing limbs (Sessions and Ruth 1990). We showed that the deformities were caused by a parasitic flatworm (trematode) that disrupts limb development in young tadpoles. My intention was to present "the parasite hypothesis" as the one to exclude before searching for more elusive and (in my view) less likely causes such as chemical pollution. In fact, chemical pollution seemed very unlikely as a cause for multi-limbed frogs in particular, since toxic chemicals are far more likely to kill cells and halt limb development than to induce cells to build extra structures. To my amazement, my presentation seemed to help divide the group of researchers into two opposing camps, setting the stage for a decade of controversy: those who favored the chemical pollution hypothesis, and those who favored the parasite hypothesis.

It was at the meeting in Duluth that I first met Mike Lannoo, a well-known and highly respected herpetologist from the Indiana University School of Medicine. A somewhat reserved man, Lannoo played the role of a sort of deformed frog diplomat. Impressed with the strength of the parasite evidence (in fact, he was responsible for my being invited to the workshop), he also saw merit in other hypotheses, including chemical pollution, UV-B radiation, and even predation. In the ensuing controversy and associated media craziness and follow-up workshops and conferences, Mike continued to keep a relatively low profile, focusing his energies on editing multi-authored compendia on declining and deformed amphibians. His "behind the scenes" role is described in William Souder's book "A Plague of Frogs" (Souder 2000). Lannoo patiently waited 10 years for all the fuss to die down before coming out with his own definitive statement about deformed amphibians: *Malformed Frogs, the Collapse of Aquatic Ecosystems*.

Lannoo's book is a solid, handsome little volume, 23.5 cm tall, 16 cm wide, and 2 cm thick, with excellent quality paper, narrow margins, and an attractive, easy-to-read font. Most of the illustrations are black and white and of excellent quality, as are the few pages of beautiful color plates. Physically, it is a high quality book, as expected from the University of California Press (even if, at US $65.00, a bit on the expensive side). After a brief introduction, personal preface and acknowledgment sections, the contents of the book are sorted into seven chapters. The first chapter addresses the issue of what is an amphibian "malformation." Beginning with a quote about symmetry (as a sign of health), Lannoo defines malformation as "bad form" and "unintended" lack of symmetry that arises through one of three mechanisms: genetic flaws, epigenetic perturbation of gene expression, and trauma due to injury or disease. After a brief discussion of each of these mechanisms, Lannoo concludes that the most likely cause is "epigenetic disturbance of gene expression." Lannoo then presents evidence that most malformations involve anurans rather than urodeles. This chapter also presents important background information including a primer on frog skeletal anatomy and limb development, with some brief comments on jaw and eye development, and ends with some comments about when in development certain malformations are likely to arise.

The second chapter covers "malformed frog types" and presents the main kinds of malformations seen including high quality x-ray photographs of over 50 specimens representing the different types. A handy-dandy table provides a description of each of the types, most of which are designated by medical terminology; for example, *microphthalmia* (small eye), *amelia* (missing limb),

taumelia (bent bone), *polymelia* (complete extra limb), and so forth. Some malformations do not have a Latinized medicinal moniker (e.g. "bloated body"). Some of these main types can be broken down into subtypes, for example *unilateral amelia* (too few hind limbs) or *unilateral hemimelia* (short limb on one side). Most of the examples are *Rana pipiens*, but a few other species are included, such as *Acris crepitans* and *Bufo americanus*. The examples are meticulously assembled and presented along with collection locality, collectors, and sometimes a Field Museum specimen number.

Chapter Three focuses on "hotspot" localities, mostly in Minnesota and nearby regions in the Midwest that have yielded a large number, and especially percentage, of malformed amphibians. Here we are presented with a map, showing the overall distribution of the hotspots in Minnesota, and then each hotspot locality (designated with an abbreviation for convenient cross-referencing) is described with an accompanying photograph of the site. The entries include a brief description of the physical aspects, some of the major vegetation present, what types of deformities were found at each one, and how many animals were sampled. In most cases, brief mention is made of any other obvious organisms encountered at the locality, including insects, snails, crustaceans, fishes, and other species of amphibians.

Chapter Four ("Causes") reviews the main causes of amphibian malformations that have been proposed or confirmed over the years. Here Lannoo first divides the causes into two broad categories (following Ouellet 2000): Natural causes and Manmade causes. Natural causes include wounding (failed predation attempts), fish excrement (involving the mysterious "*anomalie P*"; you'll have to read the book and/or Ouellet 2000), crowding, sweet pea extracts (lathyrogens), nutritional deficiencies, UV-B radiation, disease, temperature extremes, genetics, and parasitic cysts. Manmade causes include acidification, radioactive contamination, ozone depletion (UV-B radiation), heavy metals, retinoids, agricultural chemicals (e.g., pesticides), and other chemicals (especially xenobiotics). The brief (four page) descriptive list of causes in Chapter Four is followed by two of the most interesting sections in the book: "synergisms and neutralizations," discussing the possible (probable) interaction of multiple factors in the generation of malformations, and especially "determining cause from malformation type: the search for morphological signatures" in which we are assured that there are, as yet, no morphological signatures in the deformities that point to a particular cause.

Finally we come to probably the most important (or, at 65 pages, at least the largest) chapter of the whole book: Chapter Five, which is devoted to resolutions. The chapter begins with a brief and somewhat scolding diatribe about "bitter personality clashes" that warped the scientific process of discovery into one of competition and simplification, thereby interfering in a resolution of the problem, and warnings about falling into the trap of adaptationist ("just so") thinking (I get a slap on the hand here). Most of the rest of the chapter is devoted to a "deconstruction" of the major hypotheses presented to explain amphibian malformations, and ends with an overall summary of where we stand, in the form of Lannoo's answers to Frequently Asked Questions about amphibian malformations.

Chapter Six covers human malformations and causes (which I mostly skipped), and then we come to the last chapter, Chapter Seven: "Solutions." If Chapter Five was the pièce de résistance of the book, Chapter Seven appears to be the raison d'etre. After another brief diatribe, scolding fellow researchers for tending to reduce the problem to one or two main causes, Lannoo comes, finally, to his shocker conclusion (presented as a kind of unfunny joke): The solution to the malformed frog phenomenon is largely independent of specific cause. Here is the reasoning: After all is said and done, given the complexity of wetland ecology and environmental science, including parasites, predators, UV-B radiation, and various kinds of chemical pollution, it is obviously unlikely that there is a single cause for all malformations in natural populations of amphibians. Instead, the malformed frog problem largely consists of local, site-specific issues. The important thing, according to Lannoo, is that we identify the correct *solution*, and luckily we already know what that is! All vectors point towards one gigantic ultimate problem: general environmental degradation, in this case, collapse of wetland ecosystems. Thus the solution is obvious: ecosystem remediation.

In terms of overall organization of the book, I like it with one exception: Lannoo references his comments with notes that are listed numerically at the end of the book. Thus, to look up a footnote or citation, you must flip to the back of the book and search around for the correct chapter and then find the corresponding number. Because some of the entries contain a large number of references, this is more difficult that it sounds. I found this to be a nuisance. Many will appreciate a section at the end of the book called "species affected," which lists all known species of amphibians with those involved in reported deformities indicated in bold.

My overall take of this book is that it is a very useful summary of the most important issues and research involved in the problem of deformed amphibians. It should be on every herpetologist's bookshelf, and is also of use to anyone who is interested in environmental issues and controversies, and even how science works in the context of such human foibles as competition for attention and grants. Having said that, and being intimately involved in some of the controversy and privy to some of the fascinating stories that have emerged (see Souder's book, *A Plague of Frogs*, for a taste), I do take issue with some of Lannoo's conclusions. Here I will give just a few main examples.

The very first chapter should have served as a warning for me that working my way through the rest of the book was going to involve a struggle with semantics and specific terminology. Definitions are important, and anyone who has kept track of the deformed frog controversy has noticed that some people refer to the abnormalities as "malformations" while others refer to them as "deformities." In the world of medical terminology, the difference in meaning between these two terms is highly significant. Malformation implies an *intrinsic* developmental defect of developing tissues (Winter et al. 1988; MedicineNet.com 2008) whereas deformity refers to *extrinsic* (environmental) factors disrupting the development of *otherwise normal* tissues. Because all of the suggested and known causes of morphological abnormalities in amphibians involve extrinsic factors (e.g., parasites) disrupting the development of otherwise normal tissues, the more precise term for these abnormalities is "deformity."

The question is why does Lannoo use the term malformation rather than deformity? My opinion is that in the world of deformed amphibian research, these terms have become ideological, or

politicized, and the term malformation is usually used to imply disruption of biochemical processes in developing systems, such as endocrine disruption. In this sense, malformation implies disruption of biochemical signaling pathways, for example in the developing limb. Scary stuff indeed! So much is now known about the biochemistry and developmental genetics of limb development that it is easy to construct a detailed scenario by which small biochemical perturbations (via retinoids, for example) could generate monstrocities. One problem here is that I think Lannoo has a very simplistic (deterministic) view of limb development, as exemplified by his statement that "…developmental biology is largely a chemical phenomenon" (p. 193). In actuality, developmental biology is largely a *cellular* phenomenon, and this is critical in understanding how various kinds of deformities are generated. For example, it is only by understanding limb pattern formation as the outcome of interacting cells in an undifferentiated limb bud that you can fully appreciate how parasites can generate massive limb deformities using nothing but mechanical perturbation (Stopper et al. 2002).

Likewise, Lannoo does not seem to understand *amphibian* limb development, specifically in anurans, and this colors his assessment of various cause hypotheses. A dirty little secret (just emerging in recent years) of the deformed frog controversy is that multilegged frogs, the oddest-looking deformities which (understandably) became the poster child of the deformed frog issue (featured in several articles and on the covers of several books) actually represent a small minority of reported cases of deformed amphibians, at least in number of reported hotspots. By far the most common deformities are frogs with *missing* hind limbs and missing hind limb segments and, while less dramatic looking than multilegged frogs, these have turned out to be far more difficult to explain. Anyone who picks up a limbless frog should first think of predation as the most likely explanation. This is Ocam's razor at work. However, Lannoo spends a considerable amount of book space debunking the role of predation, based mainly (as far as I can tell) on assumptions and logical inferences derived from various anatomical and morphological characteristics of deformed frog specimens (ironic given his previous debunking of "morphological signatures"). For example, he sees no obvious signs of wounding or wound repair, he sees pigment malformations in most of the specimens, he sees damaged limb girdles as well as limbs, he finds no evidence of likely predators, etc. Most of these objections are invalidated by one key characteristic of anuran limb development of which Lannoo appears to be unaware: Regenerative decline (Muneoka et al. 1986). Young tadpoles with early limb buds can completely regenerate their limbs, but this ability gradually diminishes to zero as they approach metamorphosis and the limbs complete their development. At intermediate stages, amputation of a limb results in a range of incomplete limb development represented by a panoply of idiosyncratic abnormalities including bent bones, cellular accumulations, cartilaginous spikes, and pigment abnormalities. I feel that this is a major omission in the book and a serious flaw in Lannoo's overall analysis of the most common types of deformed amphibians.

To understand how limb development works you need to think like a developmental biologist, who is used to contemplating the cellular basis of pattern formation and morphogenesis in four dimensions, and small things early on having big final ramifications. Developmental thinking is necessary to appreciate how trematode cysts, located at the base of fully developed limbs, could be responsible for massive deformities located distally. I found the lack of developmental thinking in the book frustrating, because it is so necessary for understanding how various deformities can arise from disparate causes, but not from others. I feel that this is how Lannoo could assert the absence of "morphological signatures" that would point to particular causes. For example, over a century of research in limb development has shown, via simple grafting experiments, that mechanical disruption of the spatial organization of cells in a developing or regenerating amphibian limb is all that parasite cysts need to do to cause the outgrowth of different kinds of mirror-image limb duplications (French et al. 1971). Retinoids can cause a subset of these, but not all of them (Sessions et al. 1999). On the other hand, a true signature of retinoids is a proximal-distal duplication (e.g., two elbows; Bryant and Gardiner 1992). Likewise, the presence of a cartilaginous bump or spike on the end of a limb stump indicates traumatic amputation near the end of regenerative decline (late tadpole stages; Muneoka et al. 1986). Thus, in Chapter 2 where deformed frog types are described and illustrated, I was able to identify the *most likely* causes of the deformities in over 80% of the cases. Out of a total of 63 specimens, 23 were almost certainly parasite-induced and 28 were almost certainly trauma-induced. Nine of the remainder appeared to be trauma, one appeared to be parasite-induced, and only two of them seemed completely ambiguous. Of course, the most important morphological signature of all is the fact that the vast majority of deformities involve the hind limbs, with the rest of the frog (including the front limbs) appearing perfectly normal.

Finally, I cannot agree with Lannoo's conclusion that wetland ecosystem remediation is the solution to the problem of deformed amphibians regardless of the specific causes. What if it turns out (as seems likely to me) that parasites and predation together account for the vast majority of deformities (or "malformations") in natural populations of amphibians? As Lannoo's parasitologist friend, the late Dan Sutherland (to whom the book is dedicated), pointed out to him (and to me), parasites are even more sensitive to environmental pollution than amphibians….. so we should worry when the parasites disappear! Likewise, predator diversity is, if anything, negatively affected by habitat degradation. So if we follow Lannoo's advice (which seems like good advice under any circumstances), ignoring the causes of amphibian deformities and focusing on *the solution* (wetland remediation), we might actually expect an *increase* in the incidence of amphibian deformities! I call this the "perverse hypothesis."

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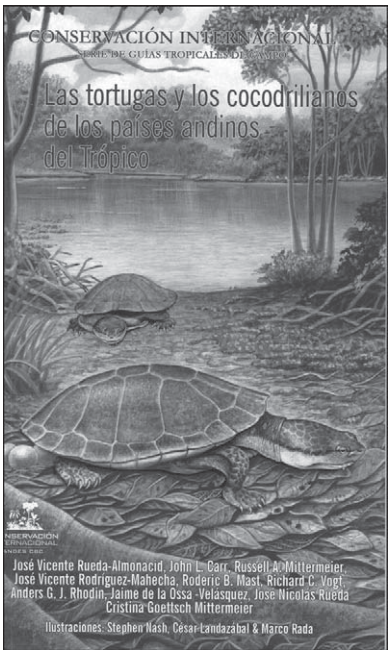
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Las Tortugas y Cocodrilianos de los Países Andinos del Trópico, by José Vicente Rueda-Almonacid, John L. Carr, Russell A. Mittermeier, José Vicente Rodríguez-Mahecha, Roderic B. Mast, Richard C. Vogt, Anders G. J. Rhodin, Jaime de la Ossa-Velásquez, José Nicolás Rueda, Cristina Goettsch Mittermeier. 2007. Conservación Internacional, Bogotá, Colombia (www.conservation.org/publications/). 538 pp. Softcover. US $25.00. ISBN 978-1-934151-10-5.

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Lovers of Neotropical turtles and crocodilians are lucky. This new book fills the enormous vacuum of information that exists with respect to these two orders, gathering information that was previously scattered in many publications, some with quite limited circulation. Until now, the most comprehensive books that treated these animals were Pritchard and Trebbau's (1984) masterpiece, *The Turtles of Venezuela*, (required reading for anyone interested in any aspect of South American turtles, not just Venezuelan ones) and Federico Medem's two classics (1981, 1983) about Colombian and South American crocodilians, respectively. Those interested in the last quarter century of new data, however, have had to search through mountains of diverse primary sources and regional and national publications.

The work of the multiple authors of this book, supported by three formidable illustrators (Stephen Nash, César Landazábal, and Marco Rada), and an endless list of collaborators, has yielded an extraordinary result that will certainly become a herpetological classic both because of the quality of information presented and because of its fine illustrations. The text is entirely in Spanish but, as I have previously argued (Barrio-Amorós 2006a, b), anyone with a serious interest in working with Neotropical species should master Spanish, at least to the level of competent reading comprehension.

The book, of small size (20 x 12 cm) and ideally suited for the field, is unusually beautiful, showing on its front cover an illustration of the rare species *Mesoclemmys dahli*, and on its back the threatened Orinoco Crocodile, along with the logos of sponsoring institutions. Two maps of South America, one physiographic, another showing major vegetation types, are on the inside covers. The book is dedicated to the Latvian herpetologist Federico Medem, who arrived in Colombia after the Second World War and became the most important investigator on turtles and crocodiles of that country. He died in 1984, leaving the most comprehensive information to date on the Colombian species of these two orders. Reminiscences by Russell Mittermeier (current president of Conservation International) and Anders Rhodin (president of the group of the IUCN Terrestrial and Freshwater Turtle Specialist Group), both of whom were influenced by Medem in their youth, provide a suitable tribute. This is followed by a foreword, brief resumés of the authors and illustrators, acknowledgments, and a table of contents.

The introduction highlights aspects of the conservation of chelonians and crocodilians in the region. A guide for handling marine turtles injured by fishing hooks, which has also been published as a separate pamphlet, is included in this section. The introduction to the general characteristics of chelonians is extremely complete and well-illustrated. There is also a section on how to record field data (valid for all types of vertebrates), how to mark shells, how to take different measurements, how to capture turtles using different methods, etc. There are very well illustrated keys at both the family and species level. The text for each species account is complete and accompanied by color photos and/or illustrations of the animal and very accurate distribution maps. In some cases, however, the origin of the photographed specimen is not noted.

The comparable section dealing with the Crocodylia is equally valuable, with extensive and informative text, high quality photos and illustrations, useful keys (including one for eye shines and another for skins), and many other features.

Following the main text a further 70 plates with multiple photos and illustrations each are provided. These show, amongst other things, sexual, ontogenetic, and geographic variation of the included species. It would have seemed preferable to have these illustrations placed in the relevant sections of text, particularly since the book has color throughout anyway, but clustered as they are they do permit easy visual comparisons of similar or related species.

A glossary with the most important terms, a bibliography, and an index to species complete the book. The bibliography, although useful, is not as complete as it might be and some references are lacking although, based on the updated information presented in the text, it seems they were consulted (e.g., Barrio 2001; Barrio-Amorós and Manrique 2006).

There are a number of seeming inconsistencies in the book, but these do not detract significantly from the work as a whole. The title, although correct, may surprise readers not familiar with the Neotropics, since it may seems that the species are restricted to the countries usually understood as Andean. These, for most of the people, are only Bolivia, Peru and Ecuador. The word "Andean" may also be surprising, since no turtle or crocodile species live in the Andes proper (the highest are found in the Andean foothills at no more than 1000 m). However, the tropical Andean countries also include Venezuela and Colombia (but exclude Argentina and Chile, which are Andean but not tropical). So the context is that of the species inhabiting these five countries, and extending the information to other countries where the same species also occur — although these are not Andean (Brazil, Paraguay, the Guianas, Trinidad and Tobago). The presence, for example, of *Mesoclemmys vanderhaegei* in the book is due to the possibility that it may occur in Bolivia. The treatment of Galapagos tortoises in a book with this title may also seem out of place, but of course, the islands belong to Ecuador. The map for *Chelus fimbriatus* is actually correct, but a spot in the southern part of Lake Maracaibo in Venezuela, represents a reported, but unconfirmed record that might have been more appropriately designated with a question mark. Another point to highlight is that the section of common and indigenous names, which is often incomplete, gives the common names in use Colombia, since the book was originally going to be dedicated only to that country. In any case, it is difficult to come to an agreement on the appropriate common name of a species that goes by several names in each country or region. It is even more confusing that the general name in Colombia and Venezuela for the two species of *Crocodylus* (*C. acutus* and *C. intermedius*) is "caiman," while the true caimans of the genus *Caiman* are called "babos" or "babillas" in these countries.

Lastly, I consider that with only a little more effort, it would have been possible to include the rest of the species that occur in South America (those of the southern cone: *Hydromedusa maximiliani, H. tectifera, Platemys pallidipectoris, P. macrocephala, P. radiolata, P. spixii, Mesoclemmys hogei, M. perplexa, M. tuberculata, M. nasuta, Phrynops hilarii, P. williamsi, Trachemys dorbigni*), thereby making the work truly comprehensive.

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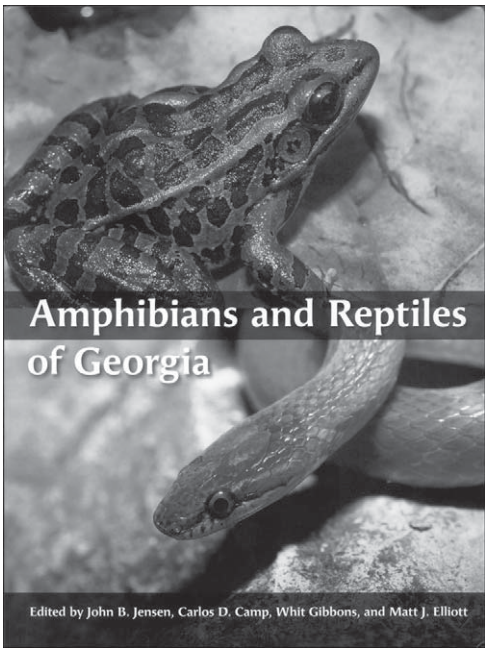
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Amphibians and Reptiles of Georgia, Edited by John B. Jensen, Carlos D. Camp, Whit Gibbons, and Matt J. Elliott. 2008. University of Georgia Press (www.ugapress.uga.edu). xvii + 575 pages. Flexible cover. US $39.95. ISBN-13 978-0-8203-3111-9

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The Amphibians and Reptiles of Georgia has been long awaited and is much needed. Georgia as a diverse herpetofauna of 170 species and there has been no statewide treatment of its amphibians and reptiles since Martof's (1956) key and checklist.

The Introduction starts with a detailed explanation of the physiography, climate, and habitats of Georgia. The various maps showing changes in temperature and moisture from the northwest to the southeast are very helpful in explaining the variation in herp diversity across the state.

The taxonomy section is a basic primer on scientific names and Linnaean nomenclature. There is no discussion of the recent name changes in many genera and the associated publications (Frost et al. 2006; Crother 2008; Collins and Taggart 2008) are not even listed. The numerous new names for genera listed in Crother (2008) are problematic to some. I wish the authors had either provided a better explanation for or against the name changes or not included them at all. The way they are presented adds to the ongoing confusion. This will surely be a recurrent issue with other state and regional publications over the next several years as the dust settles.

The editors brought together 54 regional experts and the Georgia Herp Atlas Project to write the species accounts, which comprise the majority of the book. The accounts provide detailed descriptions of adult and larval stages. A taxonomy and nomenclature section provides useful information on relationships to other species and subspecies, although as noted above, newer scientific names are used without discussion. The distribution and habitat, reproduction and development, and habitats sections provide good information on each species. It would have been nice to have more details in these sections, but I understand that with 170 species there has to be a limit. The conservation section is nice to see for even for the

more widespread and abundant species. The county distribution maps show the most recent data collected by the Georgia Herp Atlas. In addition, the map shading shows the expected range within each county when habitat requirements are added. The color photos of the adults and larval stages with each species account are an important feature. The selection of photos, of which all but a few very rare species are of Georgia specimens, is excellent. Photos are of high quality and appropriately sized and the inclusion of images showing pattern variety and color phases provides valuable information.

The Amphibians and Reptiles of Georgia omits a dichotomous key to the species. While this is a common feature in many state works, the lack of a key is probably not a significant drawback as most general users tend to flip through the photos and do not use keys when they are provided.

The inclusion of a county map in the introduction and back inside cover is very handy for those of us not from Georgia. It would be a task to remember all 159 counties.

The references are arranged by topic and species. I find it cumbersome, but a more general reader looking for info on one species would probably find it convenient.

The listings of amphibian and reptile (frogs and alligators) calls on the University of Georgia Press website is an innovative way of accessing acoustic information. I have never used the CDs that are found in the back of some state books, but I have already visited the web to listen to the calls. My one concern is the University of Georgia Press's ability to maintain the website for years to come.

The Amphibians and Reptiles of Georgia is a tremendous resource to herpetologists and naturalists working in Georgia and throughout the southeastern United States and should be on every bookshelf. The flexible cover makes it suitable to use in the field, even though the size may limit some people from putting it in their pack.

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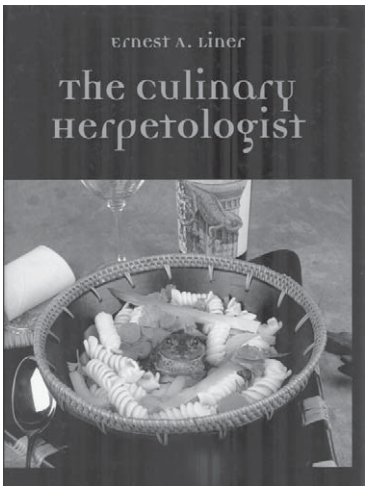
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The Culinary Herpetologist, by Ernest A. Liner. 2005. Bibliomania! (www.herplit.com). vii + 382 pp. Hardcover. US$ 37.95. ISBN 1-932871-05-5 (Paperback US$ 29.95. ISBN 1-932871-06-3).

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Gastronomy and herpetology being two of my main Epicurean passions, I have to confess that I was awaiting my copy of Ernie Liner's book with much impatience and salivation. One of my favorite hobbies, certainly shared with millions of people, is to look at the pictures in cookbooks. The satisfaction is often not as great as eating the illustrated dishes, but the principle is the same as visiting an art gallery. Seeing Liner's book for the first time, I examined its front cover, illustrated by a photograph of a live frog bathing in an Italian noodle soup, which I found of dubious humor, and its back cover, showing *Leiolepis* lizards being prepared, which reminded me some marvellous meals I had in northern Thailand. My disappointment was great when I opened the book and realized that these are the only photographs that the book includes.

This reasonably priced, well-bound book is printed on a good quality glossy paper, and is of a large size (8.5 x 11 inches) that is practical for culinary use, with characters big enough to be read while busy cooking. It includes a brief introduction (4 pages), followed by 952 recipes arranged in successive chapters (with 103 additional auxiliary recipes, especially for accompanying sauces and marinades), respectively on salamanders (26 recipes), frogs and toads (193), crocodiles (379), turtles (281), lizards (9), snakes (34), and recipes of indigenous people (30). The book closes after a glossary, an index, and a short biography of the author, who is a renowned specialist on the herpetofauna of Mexico. A few references to published works are made in the main text, but there is no literature cited section. 'Deep fried brandied Amphiuma,' 'Seafood stuffed frog legs,' 'Crumbed toad legs,' 'Alligator cabbage rolls,' 'Snapping Turtle in a pot,' 'Florida Green Turtle soup,' 'Cayenne Iguana stew,' and 'Baked snake with berries' are a few randomly-selected examples of the proposed recipes.

The recipes are generally short, and the ingredients are often not very specific ('frog,' 'mushroom,' 'beer,' 'white wine,' etc., without mentioning the species, the variety or the brand). This gives much space for improvisation and is actually an encouragement to apply the recipes to what ingredients are available and create personal and local versions of the recipes. The recipes are designed for a

variable number of persons, sometimes one, sometimes many more (I noted that the 'Wild game sauce piquant,' proposed for use with alligator or turtle meat, was designed for 60 persons, and that the 'Bayou Alligator sauce piquant' recipe was intended for 100+ persons). The units of measurement used and brands cited make the book practical mostly for the American public.

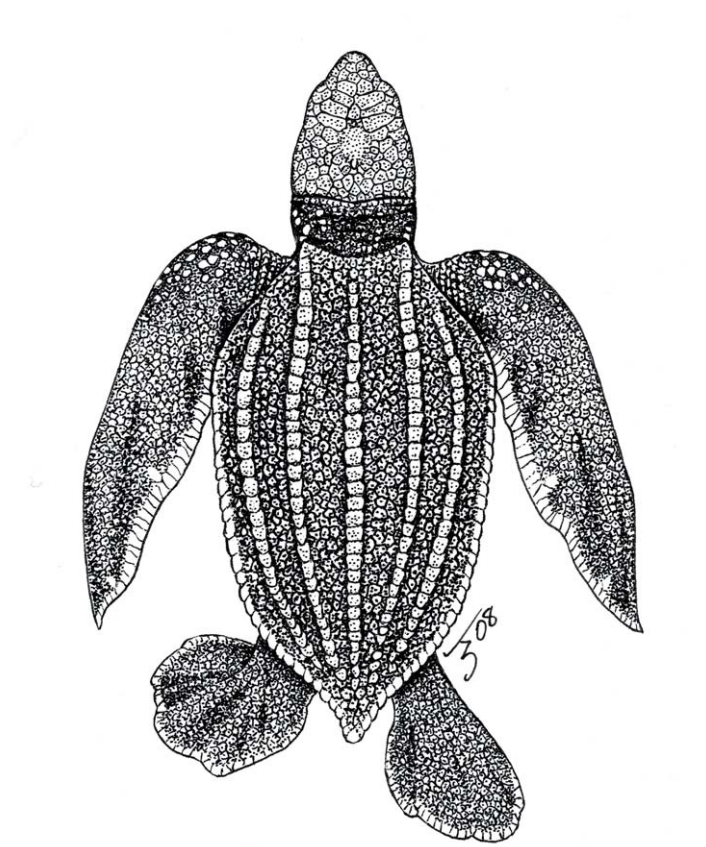
The publisher's note at the beginning of the book stresses the contradiction between herp conservation and the publication of a reptile and amphibian cookbook, with a hope that readers will replace the proposed herps in the various recipes with chicken. I disagree. First, many herp species are not endangered, especially those easily farmed (such as some crocodiles, softshell turtles, etc.), and their controlled consumption as food does not endanger them. Second, you do not replace a recipe's main ingredient by another without dramatically altering the result. By experience, I know for example that a ranid and a pipid do not taste the same, and that a ranid and a chicken do not taste the same at all. The recipes in the book most often do not specify which exact herp species has to be used, except in a few cases, where even highly endangered species are proposed, such as Leatherback Turtle, etc. (the Index does not list the scientific names used in the book, and only some of them are in the Glossary). It is a question of common sense and civic responsibility on the part of readers to use taxa that are currently not endangered or protected in their area, and the author is right to mention all species used in the original recipes he collected without obscuring the use of currently endangered species. In several cases the author stresses the fact that one species or another is protected.

Besides the absence of photographs, my main disappointment was that there is only rarely an indication of the geographical or cultural origin of the recipes. Gastronomy is in my opinion one way to discover other peoples' cultures, and a way to mentally travel while comfortably sitting at one's home dinner table. Even the section on indigenous people's recipes most often does not specify the country or ethnic group of origin. Moreover, I do not understand what the author meant by 'indigenous' and 'native,' and what were the criteria for putting these recipes in a distinct section. Outside this indigenous section, a series of 15 recipes are given in Spanish, i.e. the original language in which the author received them, 'to add to their historical value' says the author, but without mentioning from which country they originate! The author explains in the introduction that he gathered the recipes over decades, from various sources including anonymous ones, with no intention to be exhaustive. Whether the given recipes were born in the imaginative mind of a single person or are part of the gastronomy of a whole cultural or ethnic group is not specified. The recipes in the present book are thus a compilation of recipes the author heard of or encountered about preparing herps, with no scientific nor cultural pretention.

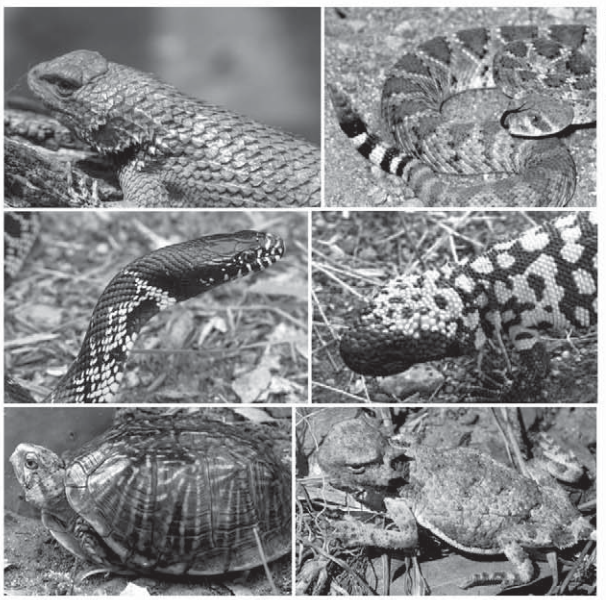
The author mentions (page 347) that 'only the larger species of lizards are of any value as food,' and the only lacertilians in the recipes he provides are *Iguana*, *Ctenosaura* and *Varanus* (there is one recipe using *Tiliqua* in the indigenous section). The back cover however shows the preparation of *Leiolepis*, a genus lizards of modest size, but there is no mention of that genus inside the book. But the author clearly specifies that there are many cookbooks and published recipes that he did not consult, especially from Asian, Australian, European, and South American sources.

Reading the text it is obvious that the author has a wide experience in herp cooking, and knows his subject very well. He provides useful tips for the best ways to cut meat and the most savory parts in turtles and crocodiles. Besides the cover photographs, the book contains a single figure (page 92), very schematic, showing Alligator meat cuts. Given the author's experience, one would have hoped to get such drawings for the other kinds of animals treated in the book, at least at the level of order.

Due to the general lack of information on the species used and the countries where they are used, the book provides a too limited an ethnoherpetological content to belong to a strictly herpetological library. It is, however, an excellent addition to any kitchen bookshelf. I recommend it not only for the numerous delicious recipes presented, but also for a number of other sakes. For instance, it should be shown to your neighbor, whose pet turtles are growing too big and who envisages releasing them in the wild. Or, it may be of special value if you live in an area where many herps are found dead on the road. Or it can help to creatively combat exotic invasive species, as the author himself suggests (the book contains nice recipes to cook *Bufo marinus*, *Rana catesbeiana*, etc.); this answers, in part, the publisher's worries regarding conservation. Many recipes, some of them very appetizing, are proposed for preparing rattlesnakes, which can in some aspects pose real safety issues. The book gives ideas for the use of alternative, cheaper, protein resources that are often neglected, even in periods of economic crisis. This book is, in general, an invitation to remind to the omnivorous species we are that there is more to eat than the few hormone-grown, warm-blooded animal species on sale at the corner supermarket.



Dermochelys coriacea (Leatherback Sea Turtle). Illustration by Jackson Shedd (www.jacksonshedd.com).



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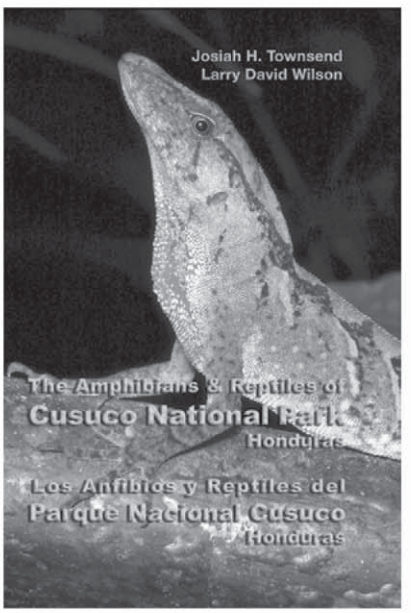
We welcome scientists and students from all parts of the U.S. and from abroad to carry out research projects. We offer comfortable cabins and a common dining room. The station also serves as a site for advanced training courses and workshops.

The SWRS Student Intern program offers students in biological sciences outstanding opportunities to observe and become involved with scientists conducting field research.

For information on research, course/workshop descriptions, the student intern program, and our bibliography of research, check out our website: http://research.amnh.org/swrs/

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The Amphibians & Reptiles of Cusuco National Park, Honduras
Los Anfibios y Reptiles del Parque Nacional Cusuco, Honduras

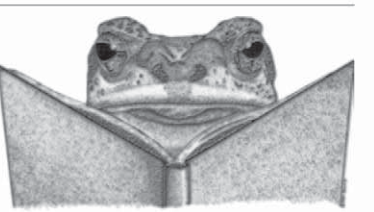
Josiah H. Townsend and Larry David Wilson

Cusuco National Park in northeastern Honduras is home to 50 species of amphibians and reptiles, nine of which are endemic to the park. This book, in English and Spanish, is an in-depth guide to the park's herpetofauna.

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SOCIETY FOR THE STUDY OF AMPHIBIANS AND REPTILES

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The Society for the Study of Amphibians and Reptiles, the largest international herpetological society, is a not-for-profit organization established to advance research, conservation, and education concerning amphibians and reptiles. Founded in 1958, SSAR is widely recognized today as having the most diverse society-sponsored program of services and publications for herpetologists. Membership is open to anyone with an interest in herpetology—professionals and serious amateurs alike—who wish to join with us to advance the goals of the Society.

All members of the SSAR are entitled to vote by mail ballot for Society officers, which allows overseas members to participate in determining the Society's activities; also, many international members attend the annual meetings and serve on editorial boards and committees.

ANNUAL DUES AND SUBSCRIPTIONS: Annual membership dues for the year 2009 in the Society for the Study of Amphibians and Reptiles are as follows: **REGULAR** membership US$70 (Student $35)—includes *Journal of Herpetology* and *Herpetological Review*; **PLENARY** membership US$95 (Student $50)—includes *JH*, *HR*, and annual subscription to the *Catalogue of American Amphibians and Reptiles*; **INSTITUTIONAL SUBSCRIPTION (BASIC)** $140—includes *JH* and *HR*. **INSTITUTIONAL SUBSCRIPTION (COMPREHENSIVE)** $170—includes *JH*, *HR*, and *Catalogue*. Additional fee for airmail postage outside USA $35 for one year. Additional membership categories available on the SSAR webpage: http://www.ssarherps.org/pages/membership.html.

All members and institutions receive the Society's primary technical publication, the *Journal of Herpetology,* and its newsjournal, *Herpetological Review*; both are published four times per year. Members also receive pre-publication discounts on other Society publications, which are advertised in *Herpetological Review*.

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Future Annual Meetings

2009 — Portland, Oregon, 22–27 July (with ASIH, HL)
2010 — Providence, Rhode Island, 7–12 July (with ASIH, HL)

About Our Cover: *Ceratophora tennentii*



The family Agamidae is represented in Sri Lanka by six genera, of which *Ceratophora*, *Cophotis*, and *Lyriocephalus* are endemic to the island. *Ceratophora* contains five species; collectively, these occupy three regional uplifts (massifs). The cover species, *C. tennentii*, is restricted to the Knuckles Massif, where it is a denizen of cool, montane cloud forests. These are slow-moving, diurnal lizards associated with moss and lichen-covered tree trunks. Rainfall in prime habitat ranges from 2540–5080 mm/year. The flattened, leaf-like appendage (better developed in males) distinguishes this species from congeners. Adults of both sexes attain SVLs of 60–90 mm. Gravid females have been recorded during June–August, with hatchlings observed in November and January; the latter tend to be more terrestrial than adults and are cryptic on forest floor litter. As with many species characterized by small, relictual distributions, the range of *C. tennentii* is compromised by habitat conversion for agriculture (tea and cardamom plantations) and invasion by exotic species. Given its status as a cool cloud forest species, it may face threats from warming temperatures as has been documented in another agamid, *Cophotis ceylanica*. Information for this account was obtained from de Silva et al. (2005 [2006]. Lyriocephalus 5:55–62).

The cover photo was taken by **Paul Freed**, retired Herpetology Supervisor from the Houston Zoo. Paul's career at the zoo spanned 25 years, resulting in numerous scientific and popular articles being published in national and international journals. Just prior to his retirement, Paul wrote a book, *Of Golden Toads and Serpents' Roads* (Texas A&M University Press), chronicling his world travels to observe amphibians and reptiles in the wild. Paul has relocated to the Pacific Northwest where he currently is focusing on the expansion of his herpetological photographic library.

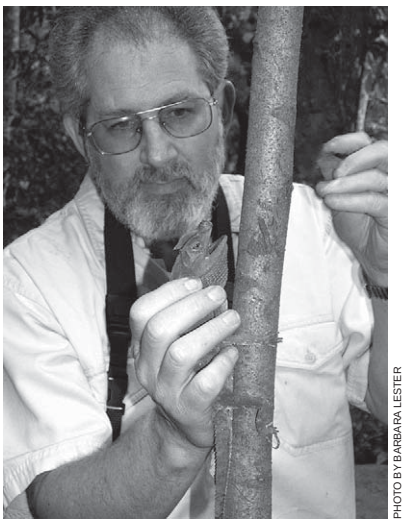


PHOTO BY BARBARA LESTER

While touring the island of Sri Lanka in March 2007 with prominent local herpetologist Anslem de Silva, Freed photographed the adult pair (male left, female right) of *Ceratophora tennentii* at Pitawala in the North Knuckles Massif. He used a Canon F-1 with a 100mm f/4 macro lens along with a Vivitar 4600 flash, recording the image on Fuji Provia 100 ISO slide film.

SSAR BUSINESS

SSAR Election Results

Results of the 2008 SSAR election are as follows:

President-Elect: .....Joseph Mendelson, III
Treasurer: .....Kirsten Nicholson
Secretary: .....Marion Preest
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.....David Cundall, Kevin de Queiroz, Ann Paterson
Board Member (non-US):.....Patrick Gregory

All proposed amendments to the bylaws were approved. Thanks to all of the nominees who agreed to stand for positions and to Dan Noble, Elector.

—Marion Preest, SSAR Secretary

Seibert Award Winners for 2008 Announced

The 17th annual Seibert Awards were presented at the 51st Annual Meeting of the SSAR in Montréal, Québec, 23–28 July 2008. These awards are named in honor of Henri C. Seibert, an early and tireless supporter of SSAR (having served as an officer for over 20 years). In recognition of outstanding student presentations at the annual meeting, a single award was given in each of the following categories: Evolution/Systematics (5 eligible presentations), Ecology (7 eligible presentations), and Conservation (9 eligible presentations). There were no presentations in Physiology/Morphology. All awardees will receive a check for US $200 and a book from Chuck Crumly at University of California Press.

The Winners—Systematics/Evolution: **Julienne Ng**, University of Rochester, "Dewlap color and reproductive isolation in *Anolis distichus*." Ecology: **Forrest Brem**, University of Memphis, "Environmental transmission: a mechanism of disease-induced amphibian extinctions." Conservation: **David Pike**, Jonathan Webb, and Richard Shine, University of Sydney, "Landscape-scale reptile conservation: experimentally manipulating canopy cover to restore a reptile assemblage."

Honorable Mention—Ecology: **April Barreca** and Jason T. Irwin, Central Washington University, "Seasonal habitat use and movement of Cascades frogs (*Rana cascadae*) in Washington." Conservation: **Brian Todd**, Thomas Luhring, Betsie Rothermel, and Whit Gibbons, Savannah River Ecology Lab, Austin Peay State University, "Interspecific effects of upland forest clearing on amphibian migrations: implications for habitat and population connectivity."

The judges were Catherine Bevier (Colby College), Gerardo Carfagno (College of Wooster), Nirvana Filoramo (Clark University), Colleen Ingram (American Museum of Natural History), Eric Juterbock (The Ohio State University at Lima), Patrick Owen (The Ohio State University at Lima), and Emily Taylor (California Polytechnic State University).

SSAR Grants-in-Herpetology 2009 Call for Proposals

Proposals are now being accepted for the 2009 SSAR Grants-in-Herpetology Program. This program is intended to provide financial support for deserving individuals or organizations involved in herpetological research, education, or conservation. Application deadline is 28 February 2009. Grant application details are available at: http://www.ssarherps.org/pages/GIH.php.

2008 Annual Meeting, Montréal, Canada

The Annual Meeting of SSAR took place from 23–28 July, 2008 at the Le Centre Sheraton Hotel, Montréal, Canada. In addition to SSAR members, participants included members of the American Elasmobranch Society, the American Society of Ichthyologists and Herpetologists, The Herpetologists'League, Canadian Amphibian and Reptile Conservation Network, and Canadian Association of Herpetologists. The meeting was hosted by McGill University, Concordia University, Environment Canada, and Ministère des Ressources Naturelles et de la Faune. The local hosts were David Green, Andrew Hendry, Lauren Chapman, Grant Brown, David Marcogliese, Andrée Gendron, Alain Branchaud, Jacques Jutras, Heather Gray, Ronald Javitch, and Ray Saumure. The hard work of the local hosts, the staff of the Kansas State University Division of Continuing Education (especially Heide Burke and Sharon Brookshire), and over 30 volunteers ensured that we had another smooth-running meeting.

Numbers were down somewhat at this year's meeting. There were 862 herpetologists and ichthyologists from 22 countries (including Australia, Belize, Brazil, France, Japan, Norway, Poland, and Taiwan) and 15 exhibitors. Approximately 45% of attendees were students and around 480 papers and 250 posters were presented. Close to 40% of the papers and posters were herpetological. Two graduate student workshops and six symposia were held. One symposium was sponsored by SSAR: "Is Management of Sustainable Commercial Harvest of Long-Lived Organisms Possible?" Willem Roosenburg, Justin Congdon, Henry Mushinsky, and Rich Seigel were the co-organizers and SSAR thanks them for their efforts. The Henri Seibert Competition attracted 21 students in three categories this year.



Joe Mendelson, III (left) and Greg Watkins-Colwell (right) enjoying a break between paper sessions. Photo by M. Preest.



Participants in the SSAR-sponsored symposium "Is Management of Sustainable Commercial Harvest of Long-Lived Organisms Possible?" Top row (L to R): Willem Roosenburg, Ron Brooks, Justin Congdon, Jack Musick, Rich Seigel, Wade Smith, Earl McCoy; Bottom row (L to R): Tony Gamble, Paul Moler, Henry Mushinsky. Photo by M. Preest.

Most participants were in the Conservation category.

The Annual Meeting began officially at 0830 h on Thursday, July 24th with warm welcomes from David Green (chair of the Local Host Committee) and Rachel Leger (Directrice, Biodôme de Montréal). Joseph Mendelson, III from Zoo Atlanta then spoke about "Research, Conservation, and the 2008 Year of the Frog Campaign." Joe presented some truly alarming statistics relating to amphibian declines and extinctions that will be familiar to many SSAR members. He indicated that research as usual and conservation as usual are not a sufficient response to the crisis and that innovative, cross-disciplinary research is needed. Some of this research is outlined in the Amphibian Conservation Action Plan (http://www.amphibianark.org/pdf/ACAP.pdf).

Pat Gregory then presented David Green with the 2008 Distinguished Herpetologist Award from the Canadian Association of Herpetologists. Stevan Arnold was the recipient of the 2008 Fitch Award for Excellence in



This year's President's Travelogue was presented by Board Member Jimmy McGuire. Photo by M. Preest.



Attendees at the SSAR Student Reception held on July 24th listening to President McDiarmid welcoming them to the meeting. Photo by M. Preest.

Herpetology and Al Savitzky was presented with a plaque for receiving the Robert K. Johnson Award in 2007. Rick Mayden gave the ASIH plenary address on "A New Paradigm on Biological Species: the Nexus of Theory and Operationalism Essential to Biodiversity Studies." Pat Gregory, the 2008 Herpetologists' League's Distinguished Herpetologist, spoke about "Northern Lights and Seasonal Sex: Reproductive Ecology of Cool-Climate Viviparous Snakes." Kenneth Goldman then made a presentation on the past, present, and future of the American Elasmobranch Society.

Social Events

Jimmy McGuire (Museum of Vertebrate Zoology, UC Berkeley) was a good choice for the President's Travelogue and this event (on July 24th) was attended by around 60 people. These presentations are always a treat and this year was no exception! Jimmy spoke on "Herpetological Diversity and Biogeography of Sulawesi, Indonesia—the World's Coolest K-Shaped Island."

The Joint Meeting Reception was held the next evening in the Biodôme de Montréal (formerly an Olympic velodome). Inside was a journey through five ecosystems; tropical rainforest, Laurentian forest, the St Lawrence marine, Arctic, and Antarctic.

This year SSAR offered two special social events for our student members. We hosted a very successful Student Reception on the evening of July 24th and invited all attending students and a number of professional herpetologists. This was intended as an opportunity for the students to meet professionals in their field, to make useful contacts, and to encourage their participation and contributions. A variety of items provided by Kraig Adler and Dawn Wilson were offered as door prizes.

We also held a Pizza Lunch offsite on July 25th for students particularly interested in becoming more involved



Perry Wood, one of the lucky winners of a door prize at the SSAR Student Reception. Photo by M. Preest.



Dawn Wilson, Carola Haas, and Al and Barb Savitzky (from L to R) waiting for the Joint Meeting Picnic held at McGill University. Photo by M. Preest.



Jen Germano and Samantha Wisniewski were two of the many student volunteers at the highly successful joint SSAR/HL auction on the evening of July 27th. Photo by M. Preest



The San Luis Obispo crowd at the Joint Meeting Banquet. L to R: Craig Lind, Peter Jackson-Tooby, Amber Branske, Emily Taylor. Photo by M. Preest.

in the Society. We talked about various ways of increasing their involvement and generated a number of interesting ideas to raise funds to support student attendance at the Annual Meeting.

Following the group photograph, the Joint Meeting Picnic had to be held indoors. For the past five years, three of our picnics (Norman, Tampa, and now Montréal) have been driven indoors because of inclement weather. We were however rewarded with lively traditional Québécois music and dance by Les Bons Diables. Most then took advantage of the close proximity of the Redpath Museum and spent some time wandering through the exhibits. There was also a live collection of local amphibians and reptiles.

The SSAR/HL Live Auction occurred on July 27th and, although the turnout seemed low, we raised an impressive $5,200. Several hard-working and dedicated graduate students (including Mallory Eckstut, Rocky Parker, Alison Hamilton, and Devin Bloom) resurrected the Silent Auction at the last minute (literally a week before the meeting began). This was a joint SSAR/ASIH effort and it raised over $2000 for graduate student support.

The Joint Meeting Banquet was held on the last evening of the meeting, and Pat Gregory served as Master of Ceremonies. Pat acknowledged Past-Presidents of the participating Societies. Three of SSAR's Past-Presidents attended the Banquet (Al Savitzky, David Green, and Darrel Frost) and there were certainly others at the meeting this year. HL and ASIH made various awards and ASIH announced the results of their recent election. Carl Ferraris issued an invitation to attend the 2009 Joint Meeting of Ichthyologists and Herpetologists in Portland, Oregon, 22–27 July).

Board Meeting and Business Meeting Summaries

Society President Roy McDiarmid called the board meeting to order at 0803 h on July 23rd, 2008 in the Le Centre Sheraton Hotel, Montréal, Canada. In attendance were eight members of the Board of Directors and 12 editors, committee chairs, or members of the society. Minutes of the 2007 Board of Directors Meeting (St. Louis) were approved.

Annual reports for 2007/2008 were submitted by all officers, editors, and committee chairs. President McDiarmid reported devoting much time since the 2007 meeting to dealing with various issues raised in St. Louis. For example, he has been involved in discussions with Henry Mushinsky (SSAR representative on the Joint Meeting Committee [JMC] and incoming ASIH President) and Brian Crother (SSAR President-Elect) on the functioning of the JMC, the perceived dominant role of ASIH in that activity, and the role of SSAR and other societies (e.g., HL, AES). Additionally, he has been working on initiatives designed to respond to concerns expressed by several student members at the annual business meeting and at other social venues in St. Louis that many did not feel that they were an integral part of the society and did not always have a positive and welcoming experience at our meetings. Following receipt of a letter of resignation from Geoff Smith (Editor, *Journal of Herpetology*), Brian Crother and Roy reviewed the duties and current structure of the editorial office. As a result of this review and subsequent discussions with Geoff Smith and a former editor (Brian Sullivan), they identified and interviewed a candidate for the position; he is Matt Parris, University of Memphis, and is currently an associate editor of the journal. Roy appointed Raul Diaz as new web czar and arranged for Catherine Bevier and Alan Savitzky to represent SSAR at an AAAS/AIBS NSF funded Education Summit and for Jimmy McGuire to present the President's Travelogue at the 2008 Annual Meeting.

Treasurer Kirsten Nicholson reported that the society's expenses were well within the approved budget limits, but they exceeded revenues by $15,403. This was due in large part to a significant shortfall in membership income. The shortfall may be offset ultimately by an increase in membership (new and renewing) early in 2008. The society's Membership Office is currently being managed by Allen Marketing and Management (AM&M), which assumed responsibility in May 2007. The transition to AM&M's handling of membership has been somewhat rocky. However, overall, Kirsten is pleased with the service provided. This service is not inexpensive and Cecelia Widdison (in the Publication Secretary's office) has indicated that she is interested in resuming membership duties and could do so at a substantially lower cost. The board decided to ask Cecelia for a formal proposal and will reconsider this matter at the 2009 board meeting.

The society's investments performed well and the entire portfolio increased by $46,390 with nearly $3,000 in realized investment income. The society's investment objective is to maximize return on investment while preserving the original principal amount of all restricted funds. Towards this end, the portfolio was rebalanced in March 2006, and has been performing well. Income shortfalls necessitated cashing in $40,000 from our investments to pay society bills. For easier financial management, Kirsten plans to consolidate several bank accounts into an account established by Allen Press. Most of the President's Fund was used to support SSAR's 50th Anniversary celebration last year. Kirsten presented summaries of the Book Initiatives and Student Awards Funds. The Roger Conant library, which was picked up in Albuquerque several years ago and is now in Salt Lake City, will be auctioned in the near future.

In the past year, Secretary Marion Preest prepared board and business meeting agendas and minutes for officers, editors, and committee chairs. Additionally, she prepared a summary of the 2007 meeting for publication in *Herpetological Review* and prepared the Annual Report for this year's board meeting. Ongoing duties include updating SSAR letterhead and material on the website, answering or forwarding numerous emails, and ensuring that reports from committee chairs are submitted for publication. Marion was involved in the student activities planned for the Montréal meeting, Nominations Committee duties, and she headed an effort to increase email contact with members. She made copies of photographs taken at the 50th Anniversary celebration in 2007 available for purchase at the Annual Meeting (Raul Diaz is working on making photographs available via the website). She has also been working on compiling a list of international herpetological societies so that SSAR can acknowledge significant events (e.g., anniversaries) as they occur in our sister societies.

Breck Bartholomew (Publications Secretary) reported that total income from the Publications Office in 2007 was $93,720. This included $49,564 in membership dues collected before AM&M assumed membership duties.

Andy Price (Editor, *Catalogue of American Amphibians and Reptiles*) reported that 20 accounts were published in 2007. He is revising the *CAAR* "Instructions for Authors." He brought two issues to the board's attention.

(1) For a variety of reasons the *CAAR* Board of Editors has been unable to maintain an annual publication schedule of 20 accounts. Andy therefore recommended that *CAAR* adopt an 'as ready' publication schedule; that is, when 20 accounts are ready they are published regardless of the time frame involved. Subscribers will then renew for the next issue of 20 accounts.

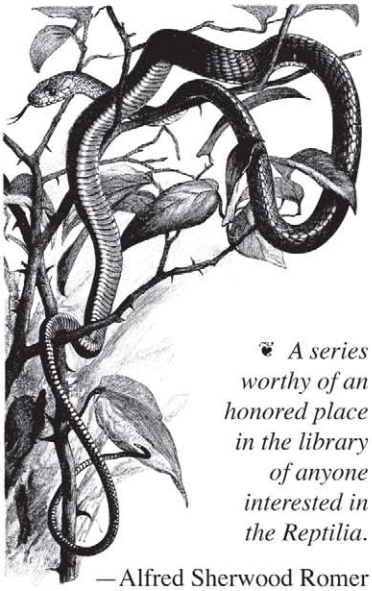
(2) Andy plans to ask the *CAAR* Board of Editors to begin soliciting authors to prepare revisions of existing accounts. He believes this step will be of benefit to the *Catalogue* for reasons including changes in taxonomy, significant changes in geographical ranges, substantial increases in the body of literature pertaining to given taxa, and our ability to publish color illustrations.

There was discussion of the implications of an "as ready" publication schedule for SSAR members who receive copies of *CAAR* as part of their membership (e.g., Plenary members, *CAAR*-only members). A suggestion was made that *CAAR* not be included in certain membership categories, but that individuals indicate when they renew if they wish to receive *CAAR* (which they would then be billed for). Plenary memberships would no longer be available.

The board approved Andy's suggestion that he ask authors to prepare revisions of existing accounts. The board was clear that it is the editor's prerogative to replace section editors should they not be performing adequately.

Kraig Adler (Editor, *Contributions to Herpetology*) reported that a number of books in this series were published recently. *Contributions to the History of Herpetology*, Volume 2 was distributed *gratis* to the del-

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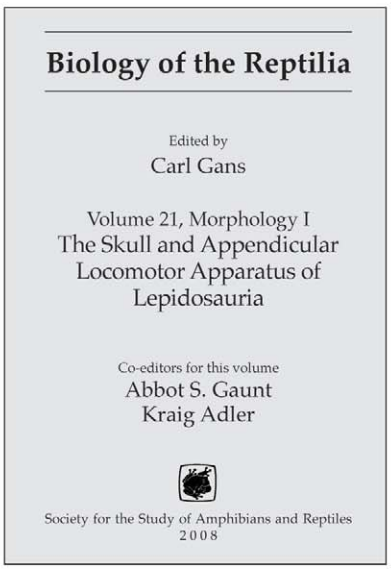
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—Garth Underwood (*British Journal of Herpetology*)

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• VOLUMES 20 AND 21: TO BE PUBLISHED AS A SET (DECEMBER 2008) •

Morphology, Volumes H and I: Edited by Carl Gans, Abbot S. Gaunt, and Kraig Adler

Topics and authors: *The Skull of Lizards and Tuatara,* by Susan E. Evans; *The Snake Skull,* by David Cundall and Frances Irish; *The Appendicular Locomotor Apparatus of* Sphenodon *and Normal-limbed Squamates,* by Anthony P. Russell and Aaron M. Bauer; *The Skull of Serpentes,* by Samuel B. McDowell; *An Atlas of Amphisbaenian Skull Anatomy,* by Carl Gans and Ricardo Montero.

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Specifications: *Volume 20*: 770 pages, 214 figures, indices (ISBN 978–0–916984–76–2); *Volume 21*: 792 pages, 151 figures, indices (ISBN 978–0–916984–77–9). Both volumes will be clothbound with dust jackets. To be published 1 December 2008.

***Price per set of two volumes*:**	***Shipping cost per set*:**
SSAR members *before 31 March 2009* . . . . US$120	Shipping will be charged at cost.
Institutions and Non-members . . . . . US$140	Insurance is extra, on request.

Send orders to: Breck Bartholomew, SSAR Publications Secretary, P. O. Box 58517, Salt Lake City, Utah 84158–0517, USA (*telephone*: area code 801, 562–2660; *e-mail*: ssar@herplit.com). Make checks payable to "SSAR." Overseas customers may make payment in USA funds using a draft drawn on American banks or by International Money Order. All persons may charge to MasterCard, American Express, Discover Card, or VISA (please provide account number and expiration date). SSAR membership details and a complete list of all Society publications can be obtained on request to the Publications Secretary (address above). For details, check the Society's webside at www.ssarherps.org.

NOTE: Copies of Volume 19 (Morphology G, 660 p.) are available at $58.00. SSAR did not publish and does not sell volumes 1–18 in the series.

egates at the St. Louis meeting. *Tasks and Problems in Studying the Life of Reptiles in Zoos*, by Hans-Günter Petzold was published in May 2008 and *Biology of the Reptilia*, Volumes 20–21 are expected in September, 2008. A number of books are planned beyond 2008, including *Biology of the Reptilia*, Volume 22 (a cumulative index of the series).

Editor of *Facsimile Reprints in Herpetology*, Aaron Bauer, reported that a softcover version of *The Life and Herpetological Contributions of August Friedrich Schweigger* is being printed in Manaus, Brazil, and the book will be given to all attendees of the 6th World Congress of Herpetology (WCH) thanks to a donation from Ronald Javitch. This will be coupled with a membership drive at the meeting (the new membership brochures will be available). A hardcover edition will be printed by September, 2008. Publication of *Gray's Catalogues of the Specimens of Amphibians and Reptiles in the Collection of the British Museum* was postponed due to the need to complete the Schweigger volume for the WCH. Other works are in various stages of completion.

Herpetological Circulars Volume 37 was printed in January, and John Moriarty (Editor) indicated that Volume 38 would be printed by the Annual Meeting. The use of print-on-demand for recent *Circulars* keeps the original printing costs and inventory to a minimum, but requires the reprinting of better selling *Circulars*. This printing technique allows for short run reprints at reasonable prices. There previously was no budget item to allow for the reprints. John would like to start budgeting for anticipated reprints.

The Editors of *Herpetological Conservation* (Joe Mitchell and Robin Jung Brown) reported that Volume 3 (*Urban Herpetology*, edited by J. C. Mitchell and R. E. Jung Brown) is nearing completion and is scheduled for publication in Fall, 2008. Joe will continue as editor for one more volume, but Robin is stepping down. Meredith Mahoney suggested that Joe might consider publishing the proceedings of an upcoming SSAR-sponsored symposium ("Headstarting Turtles—Learning from Experience").

Robert Hansen (Editor) reported that *Herpetological Review*, Volume 38 was slightly smaller than Volume 37 and that submission rates appear to have leveled off. There were several staff changes during 2007. Managing Editor Tom Tyning ended his long-running tenure with *Herpetological Review* at the end of 2007. Meredith Mahoney (Illinois State Museum) became an Associate Editor in late 2007, Michael Burger concluded his stint as Section Editor for Herpetological Husbandry and was replaced by Brad Lock (Zoo Atlanta), thus ending the Dallas Zoo's multi-decade long staffing of this position. Michele Johnson (Section Editor, Current Research) resigned and was replaced by Ben Lowe (San Diego State University). A new section, Amphibian Chytridiomycosis Geographic Distribution, appeared in the final issue of 2007. The board continued its ongoing discussion of making *Herpetological Review* available online and voted unanimously to support this change. Effects on membership will need to be considered. Roy will ask Bob to pursue this and contact BioOne to discuss the possibility and implications of this change.

Geoff Smith, Editor of *Journal of Herpetology*, submitted his letter of resignation and reported a number of staff changes in the past year (two new Associate Editors). He supports appointing Matt Parris as his replacement. Submission rates for *Journal of Herpetology* continue to increase and the rejection rate remains stable at around 60%. The 2007 budget was overspent by approximately $11,500 due to an increase in the average length of papers published and this increase in manuscript size continues in 2008. To deal with this, Geoff has reduced the number of papers that will appear in the September and December issues.

Journal of Herpetology will continue with its use of color images on the front cover. The paper used for printing the journal for several years was recently officially certified by the Forest Stewardship Council. Geoff plans to work with his replacement to revise the current "Guidelines for Authors" on the website. Geoff is recommending that the table of contents revert from its subject category arrangement to the original undivided layout and that all papers and notes be published with author-generated keywords that would be searchable and used by an indexing service. The majority of the board voted to do away with categories and suggested using symbols that would appear on the legend on the back cover to show the cross-categorization of papers.

Joe Mendelson, III expressed some concern that the *Journal* might be losing potential authors because of the slow turn around time for submissions. The problem appears to be due to delinquent reviewers. The editor needs to remind reviewers of how important timely reviews are. It might be necessary to increase the number of reviewers to whom each paper is sent and then accept the reviews of the first two or three that are received.

Matt Parris was introduced by Roy and then talked about his experience with *Journal of Herpetology* and what his philosophy as an editor would be. Matt was asked what support he would receive from his home institution (University of Memphis). He indicated that he will receive release from service responsibilities and access to an assistant funded out of a budget for teaching assistants. Matt was excused from the room, and, following brief discussion, the Board voted unanimously to approve Matt's appointment as Editor of *Journal of Herpetology*.

The 50th Anniversary Celebration Committee was composed of Bob Aldridge, Janalee Caldwell, Jonathan Losos, Henry Mushinsky, Kirsten Nicholson, and Al Savitzky (Chair), with Robin Andrews and Roy McDiarmid serving as *ex officio* members. The 50th Anniversary celebration was held during calendar year 2007, with primary emphasis on events at the annual meeting in St. Louis. The committee acknowledges with gratitude the support and assistance of many individuals, particularly Roy McDiarmid and Kraig Adler for their tireless efforts to ensure that this important milestone in society history was celebrated in a manner befitting the magnitude of the occasion. Major items extending throughout the year included the production of special covers for the *Journal of Herpetology*, a special banner on the cover of *Herpetological Review*, a highly successful celebratory banquet at the St. Louis meeting with elegant commemorative wine glasses etched by Ronn Altig with a modified society logo of his own design provided to all banquet attendees, and a special edition of the SSAR Auction with Joe Collins reprising his role as auctioneer. SSAR provided several items *gratis* to all meeting participants. These included *Contributions to the History of Herpetology, Vol. 2* by Kraig Adler, John S. Applegarth, and Ronald Altig (supported by a generous gift from Ron Javitch), a beautiful photographic poster by Dave Dennis (with production assistance from Breck Bartholomew), and a history of the society by John Moriarty and Breck Bartholomew.

Over the past year, the Conservation Committee (Stephen Richter and Betsie Rothermel, co-chairs) worked toward a long term goal of collaborating more with other professional committees (e.g., ASIH Conservation Committee) and with conservation organizations (e.g., Partners in Amphibian and Reptile Conservation, PARC). The committee was asked to lend its support to a planned symposium on the effects of roads on herpetofauna, to be held at the 2009 Joint Meeting in Portland. The Conservation Committee agreed that this was an important issue and so has joined with ASIH and other organizations in endorsing and promoting this event. In February 2008, committee member John Jensen played an active role as an organizer and moderator for the Southeast PARC meeting held in Athens, Georgia. He reported that the meeting was well attended and addressed many pressing concerns of interest to members of both SSAR and PARC, including emerging diseases, land acquisition and protection, and outreach and education. Stephen Richter intends to phase out of his role as co-chair of the committee this year and Betsie Rothermel and Joe Mendelson, III will serve as co-chairs.

Seven proposals of high quality were submitted for the Dean Metter Award this year (Joe Beatty, Committee Chair). The committee requested permission from President McDiarmid to make two awards this year and that request was granted. The first awardee is Emilie Throop of Kansas State University. She is working on a Masters degree under the direction of Kimberly With in the Division of Biology and wrote an outstanding proposal entitled "Habitat Suitability and Metapopulation Dynamics of a Native Tallgrass Prairie Reptile." The other equally impressive proposal was put together by Fernanda Werneck who is working on her Ph.D. under the supervision of Jack Sites in the Department of Integrative Biology

at Brigham Young University. Her proposal deals with South American lizards (two gekkonids and a gymnophthalmid) and is entitled "Phylogeography and Conservation of Lizards from Seasonally Dry Tropical Forests of South America."

Erik Wild and Josh Kapfer (co-Chairs, Grants-in-Herpetology Committee) reported that 62 proposals from 23 US states and eight countries (including the United States) were received in 2008. The "Laboratory" category received the most applications (16). The following winners will each receive $500:

Conservation: Sara M. Maxwell, University of California Santa Cruz
Field Research: Sarah Becker, Southern Illinois University
Laboratory Research: William T. McLamb, Florida Institute of Technology
Travel: Kyna M. Hogg, University of North Dakota
International: Michael Hailu, Addis Ababa University, Ethiopia
Education: Mike Hickel, Rolling Hills Wildlife Adventure, Salina, Kansas

Co-Chairs of the Henri Seibert Award, Lora Smith and Margaret Gunzberger announced the winners of the 16th annual Seibert Award at the meeting in St. Louis, 2007 (published in *Herpetological Review* 38:380). SSAR wishes to thank Chuck Crumly (UC Press) for once again providing books for the winners. There was some discussion of whether a student could enter another Seibert category after they have won previously, e.g. if they have won the Conservation category can they enter the Morphology/Physiology category. The board decided that strict interpretation of the guidelines would not permit this. Pat Owen has replaced Lora and Margaret as chair of this committee.

Cathy Bevier (Chair, Herpetological Education Committee, HEC) reported that members of this committee continue activities that are in line with their mission, including fielding questions from community members and students about herps and conducting outreach programs to local groups and schools. These informal educational pursuits are noteworthy, but expanding the reach of the HEC to a greater section of the public could happen with a more extensive web page that is linked with the herpetology society web pages. This will be a major project over the next year, and information will potentially include teaching modules, curriculum suggestions, and links with websites from different states that contain information on amphibian and reptile species diversity. Several potential initiatives that HEC can pursue have grown from Cathy's attendance at a recent meeting, "NSF Conversation in Undergraduate Biology – AAAS/AIBS Biology Education Summit." Part of the meeting focused on identifying the needs of resources and knowledge for successful biology students in the 21st century.

The board discussed various projects the HEC could consider to raise the profile of herpetologists, e.g., creating a "How to Become a Herpetologist" webpage, including herpetology-related laboratory teaching modules on the webpage, posting herpetology data sets that could be used by classes for analysis, making back issues of *Journal of Herpetology* and *Herpetological Review* available either free or deeply discounted to students in Herpetology or Vertebrate Biology classes as a recruitment tool. Cathy will talk with Breck Bartholomew about the possibility of this last suggestion.

Lynnette Sievert (Chair, Kennedy Award Committee) announced that the winning paper for 2007 is by Guohua Yu, Junxing Yang, Mingwang Zhang, and Dingqi Rao: "Phylogenetic and Systematic Study of the Genus *Bombina* (Amphibia:Anura: Bombinatoridae): New Insights from Molecular Data," *Journal of Herpetology* 41:365–377. Guohua will receive a check for US $200 or $400 in SSAR publications.

Henry Mushinsky reported that he was resigning from his role as representative for SSAR and HL on the Meeting Management Committee (MMGC). He suggested that each society should elect or select an individual to represent their society on this committee. He intends to serve on the committee for one more year as a representative of ASIH. During April, members of the MMGC and the Meeting Planning Committee met in Montréal and spent three days reviewing the conference facilities and developing the overall schedule including business meetings, workshops, social events, and poster and oral presentations. The deadline for abstract submission was extended for the 2008 meeting because the meeting was undersubscribed at the original deadline. Henry provided a reminder that each person can only submit one oral paper and one poster for presentation at the annual meeting. The MMGC feels that their efforts to better coordinate and organize symposia have been well-received and worthwhile. Symposia organizers have formatted their symposia to fit within a predetermined schedule and have been responsive to requests to be sure all participants are properly registered and have submitted their abstracts in a timely manner.

Meetings are planned for Portland in 2009 and Providence in 2010. The MMGC is aware that a World Congress of Herpetology has been proposed for Vancouver, British Columbia, Canada for 2012. Henry suggested that every effort should be made to integrate the four JMIH sponsoring societies into the WCH meeting plans.

Kirsten Nicholson (Chair, Nominations Committee) reported that no elections were held in 2007. In 2008, the society needs to elect a president-elect, three regular board members, and one non-US board member. Kirsten Nicholson and Marion Preest are willing to run again for the positions of treasurer and secretary, respectively. For the first time, voting will be carried out electronically. AM&M will post the list of candidates and their biographical sketches online, then will email the membership and provide instructions on how to login and vote. An Election Officer (Dan Noble, University of Guelph) has been appointed.

In the context of discussion about society resolutions, a suggestion was made that, annually, the president writes personal letters acknowledging those who have served the Society in the previous year (e.g., editors, committee chairs and members, etc). Those who have provided the society with special service could additionally be acknowledged with a brief paragraph and photograph in *Herpetological Review*. Brian Crother and Kraig Adler agreed to work on this with help from Marion Preest.

The 6th edition of the Standard English and Scientific Names List has been published. Brian Crother (Chair) is working with Anne Maglia and Raul Diaz to put an edited 6th edition on the web. This will not be a simple static pdf of the hard copy, but a changeable document for easy updating. The 6th edition has attracted attention because of certain name usage and there are two items that Brian brought to the board's attention. One is the authority of the list. This list is called the "Official Names List" for SSAR, ASIH, and HL. This means that these are the *standard English names* to be used, at least for SSAR journals. This rule is simply meant to differentiate among competing English names lists. As for scientific names, these are hypotheses and in no way does this list dictate the use of scientific names published in SSAR journals or any other journals. The second item discussed related to the review of this list prior to publication. The publication editor, John Moriarty, sends the entire document out for review prior to publication. These reviews have always yielded a number of issues to which the committee has had to respond. Brian wondered whether the list should undergo a more expansive review process. The board did not think this was necessary. A suggestion was made that a description of the review process could be included on the cover of the issue in which the list is published.

At the board meeting in St. Louis, Dawn Wilson resigned as chair of the Silent Auction Committee (a service she has provided for many years). This committee raises funds for student travel. Dawn suggested that SSAR come up with other ways to raise funds. She was subsequently appointed as chair of the new Student Participation Committee. There was discussion of increasing the size and/or number of Travel Awards given each year. The board voted unanimously to double the size of the budget for these awards, i.e., ten awards of US $400 each will be given out in 2009. Dawn reported that the number of applicants for Travel Awards continues to be low (16 applications for 10 awards in 2007).

Anne Maglia (Chair, Web Oversight Committee) thanked Zack Walker for his valuable service as webmaster for several years and announced

that he has been replaced by Raul Diaz. Among other changes, Raul has added the SSAR logo to the URL address bar, updated contact information, text, and available PDFs, fixed links on the History of Herpetology page and PDFs that open within the browser page, added an SSAR PUBLICATIONS link on the drop menu under "PUBLICATIONS" for a link to the publications available through HerpLit, updated the annual meetings section as well as other society's conferences, and increased monthly bandwidth by 33%.

Al Savitzky (SSAR Representative to AIBS and BioOne) reported that he attended the annual BioOne Publishers and Partners meeting in April and the annual meeting and associated activities of the AIBS in May, 2008. AIBS continues to serve its member societies in two major areas, public policy and education. Both of these offices were again consumed during the year with issues surrounding the teaching of evolution. Anti-evolution bills appeared in several state legislatures under the new guise of "academic freedom" bills, with the tag line "teach the controversy." Such bills are simply an attempt to re-introduce "intelligent design" curricula where they have previously been defeated or ruled unconstitutional. The Public Policy Office and elected officers of AIBS were active in providing authoritative arguments for their defeat. Other public policy activity by AIBS was directed toward monitoring and supporting the funding of biological research by NSF, which continues to lag far behind support for NIH under the present administration.

Two members of the AIBS Public Policy Office, Holly Menninger and Robert Gropp, published a booklet in 2008 entitled *Communicating Science: A Primer for Working with the Media*, which is available from the AIBS. As usual, the annual meeting of AIBS centered around a single major theme. This year's meeting was devoted to Climate Change and Human Health and featured internationally prominent speakers. The AIBS meetings were followed by an Education Summit, which consisted primarily of presentations on a range of subjects, e.g., threats to the teaching of evolution, increasing the involvement of under-represented groups, the future of textbook publishing in biology. A representative of McGraw-Hill said that he is informing his authors that they should plan on having only one or two more editions published in print, before textbooks become exclusively electronic. Another important element of the Summit was discussion of the pros and cons of establishing national standards for undergraduate programs in biology.

BioOne held its annual one-day meeting of representatives from publishers (primarily professional societies), academic libraries, and a few commercial presses. The program included updates on BioOne activities and presentations on several related topics. The major development in the coming year will be the migration of BioOne to a new platform. In addition to giving BioOne itself a new look, the new platform will provide important advantages for publishers (societies), libraries, and users.

Catherine Norton, Deputy Director of the Biodiversity Heritage Library (www.biodiversitylibrary.org), provided a detailed update on that project, which is an element of the broader Encyclopedia of Life that was launched in May, 2007 with major funding from foundations and several large biodiversity institutions. The goal of the BHL is to produce an open-access digital library of the biodiversity literature, which includes about 5.4 million books dating back to 1469, as well as 800,000 monographs, and 40,000 journal titles (12,500 of them current).

Al Savitzky suggested that SSAR consider approaching the Biodiversity Heritage Library about scanning back issues of *Herpetological Review*. Alternatively, or in addition, SSAR might consider the benefits of publishing *Herpetological Review* through BioOne. Al will work with Bob Hansen to investigate this. A concern was expressed regarding the color photos and complicated formatting of *Herpetological Review* and the searchability of the material in the publication.

During the discussion period, a question arose regarding the transition from print to online-only publication. The answer from a staff member of BioOne was that such a transition was indeed still coming, and sooner than we expect. The impact of online-only publication on the size of society memberships is now a matter of immediate concern and should be the subject of pro-active planning.

Richard Durtsche (Symposium Coordinator) did not receive any symposium proposals by the February 1 deadline. Dick reported being contacted by HL regarding co-sponsorship as they had received three proposals (two requesting funding). In working with the HL symposium committee chair, Rafael de Sá, it was agreed that the societies (SSAR and HL) would co-sponsor both symposia requesting funding. The first symposium, with lead sponsorship by HL, is entitled "Reproductive Biology of the Ophidia." The second symposium, with lead sponsorship by SSAR, is entitled "Headstarting Turtles—Learning from Experience." The second symposium was later withdrawn, although plans are to resubmit a proposal next year.

This concluded discussion of reports submitted, and the board then turned to new business. The Zoo Liaisons Committee has been defunct for a number of years. It was originally intended to try to bridge the gulf in herpetology between the "zoo people" and those in academia. Joe Mendelson, III led a discussion of this committee and suggested that this gulf does not exist to the degree it did years ago and that herpetologists in the zoo community typically do not attend meetings like the JMIH, not because they don't feel welcome, but, rather, because they have their own meetings. Joe offered to spearhead a membership drive among the zoo community. He suggested, and the board approved, that student membership rates be made available to zoo keepers. The board voted unanimously to abolish the Zoo Liaisons Committee.

This year the society ran out of an issue of *Journal of Herpetology* and had to print an expensive rerun. Partly this was due to interpreting Article VII, Section 3 from our bylaws (see below) such that individuals who failed to renew their memberships would still receive copies of our journals in March and June of the year in which they were delinquent.

Article VII. Dues

Section 3. A member in arrears for payment of dues for a period of 6 months after conclusion of the current membership year shall be dropped from the role after due notice from the Secretary.

The board voted to ask the membership to approve rewording Article VII, Section 3 of the bylaws (as below) so as to avoid this problem in the future. This will be included in the 2008 ballot.

"A member in arrears for payment of dues for a period of 2 months after conclusion of the current membership year shall be dropped from the role after due notice."

Earlier in 2008, Roy and Brian approved a request for $1000 towards publication of a book titled "Lizards of the American Southwest: A Photographic Field Guide." In this agreement they arranged for SSAR to get four *gratis* copies and the opportunity to buy copies of the book at $13 (45% of retail). Roy and Brian agreed to look at a draft of the book, as well as other works produced by the publisher, and decide whether it is appropriate for the SSAR logo to appear on the book. Decisions like this could be made at the level of the board rather than solely by the president.

There is some inconsistency in the membership dues listed in various places, e.g., on the website, in *Journal of Herpetology*, in the new membership brochure, etc. In order to prevent this from occurring in the future, membership pricing will only be included on the website and any changes to the dues structure will be made there. Following a consideration of past dues increases and comparison with dues for ASIH and HL, the board voted unanimously to increase individual dues by 15% (rounded up) and institutional dues by 20% (rounded up). Thus, a regular membership will increase from $60 to $70 and a student membership will increase from $30 to $35. This change will take effect immediately.

Aaron Bauer conveyed some information about the 2012 WCH in Vancouver (Aug 8–14). The first formal announcement will be made in January, 2011. Aaron indicated that accommodation at a variety of prices ($30–$170 per night) would be available and that registration fees would likely be $350–450 depending on the number of registrants. SSAR has previously indicated that it will participate in this meeting.

There was discussion of implementing page charges for non-members publishing in SSAR journals. Effectively, members are underwriting

the costs of publication by nonmembers. According to Geoff Smith, approximately 40% of papers submitted to *Journal of Herpetology* include at least one author who is a member of SSAR. There was concern that instituting page charges would affect submission rate from nonmembers from outside the United States. The board decided not to impose page charges on nonmembers. Rather, the editor or president would send a copy of the new membership brochure with a letter encouraging joining SSAR to nonmember authors once a manuscript has been accepted for publication.

There was discussion of various ways of encouraging students to participate more in SSAR and of ways to raise funds to support students. One proposal was that we could run a raffle, e.g., for a trip. This will be discussed further with students.

Several minor amendments to the bylaws are necessary because of the switch to electronic voting. The board agreed to send these amendments to the members along with the 2008 ballot.

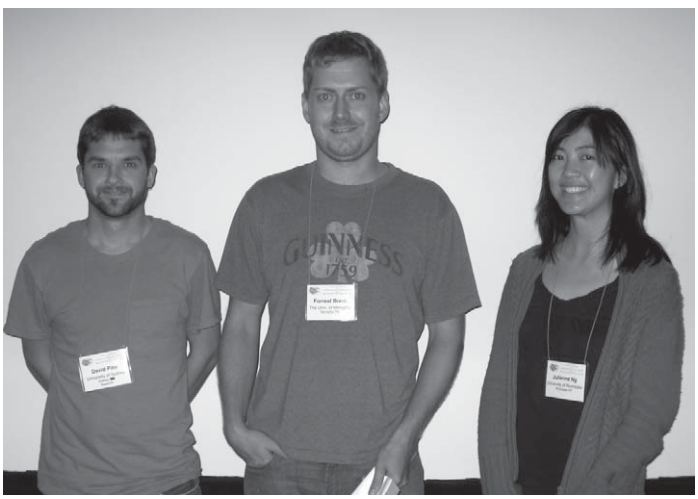
The proposal to formalize the planning, management and financing of the JMIH was rejected outright by the ASIH Executive Committee earlier in the day, and thus was not considered further by SSAR. The board however recognizes that this is a very important issue and must be addressed.

A balanced budget for 2009 of $277,860 was approved. The meeting was adjourned at 1630 h.

The Annual SSAR Business Meeting was called to order by President McDiarmid at 1618 h on July 26th. Approximately 41 SSAR members were in attendance. In contrast to recent business meetings, each officer, editor, and committee chair in attendance then presented their own annual reports (rather than the president summarizing reports) and relevant information from the board meeting.

Winners of the 2008 Dean Metter Award, Kennedy Award, Henri Seibert Student Awards, Grants in Herpetology Awards, and Student Travel Awards were announced.

Richard Wassersug (Resolutions Chair) then acknowledged a number of individuals who have served SSAR in a variety of ways. Robin Jung Brown is stepping down as co-editor of *Herpetological Conservation* Vol. 3. Richard mentioned that anyone lucky enough to see a copy of *Urban Herpetology* will appreciate the great effort that went into producing this volume. Richard also acknowledged Breck Bartholomew's contributions to *Herpetological Conservation*, Vol. 2 (*Ecology, Conservation, and Status of Reptiles in Canada*). Breck was instrumental in finalizing and seeing this volume through to press. Managing Editor Tom Tyning was



2008 Henri Seibert Award winners (from L to R) David Pike (Conservation Category), Forrest Brem (Ecology Category), and Juliet Ng (Systematics/Evolution Category). The winners each receive a check for $200 and a book of their choice from UCPress kindly donated by Chuck Crumly. Photo by M. Preest.



The traditional passing of the gavel from President McDiarmid (left) to President-Elect Crother (right) at the end of the Business Meeting. Photo by M. Preest.

thanked for his many years of involvement with *Herpetological Review*. Among other services to SSAR, Tom (along with George Pisani) was instrumental in the conversion to electronic composition of *Herpetological Review* in early 1990s. Michael Burger (Section Editor, Herpetological Husbandry) and Michele Johnson (Section Editor, Current Research) were also thanked, and Richard acknowledged Sarah Bouchard who resigned as Associate Editor for *Journal of Herpetology*. Margaret Gunzburger and Lora Smith, who served as co-chairs of the Seibert Award committee for several years, are stepping down. They were thanked for continuing the tradition of acknowledging papers of high quality presented at the Annual Meetings.

Richard acknowledged on behalf of the society the 50th Anniversary Celebration Committee: Al Savitzky (Chair), Bob Aldridge, Robin Andrews, Jan Caldwell, Jonathan Losos, Roy McDiarmid, Henry Mushinsky, and Kirsten Nicholson. Kraig Adler, Ron Altig, John Applegarth, Breck Bartholomew, Joe Collins, Marty Crump, David Dennis, Bob Hansen, Julian Lee, John Moriarty, Jim Murphy, John Simmons, Geoff Smith, and many, many others also contributed to making this celebration such a success. SSAR wishes to thank Ron Javitch who has been, and continues to be, a major benefactor for our Society activities. He has been a major supporter of SSAR's many publications, including books, the Facsimile series, and *Herpetological Circulars*. He supports the society auctions by donating and bidding on many items.

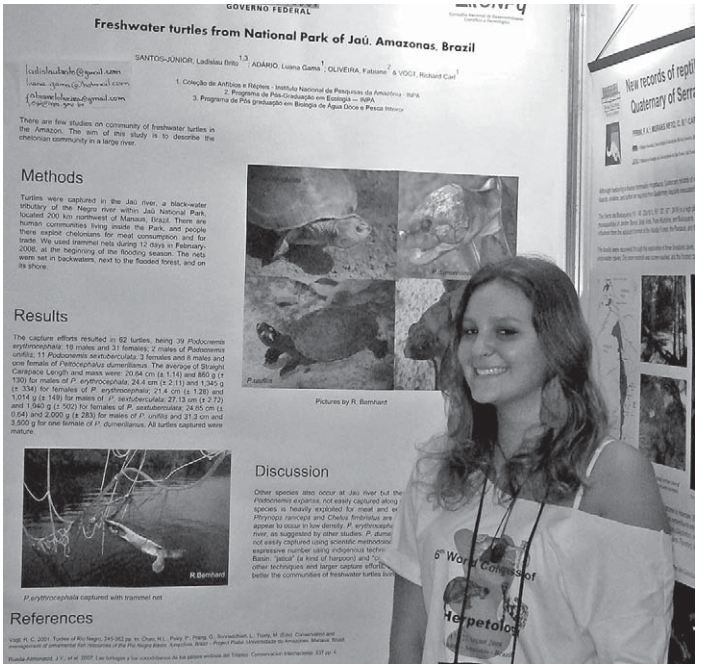
Henry Mushinsky is stepping down as SSAR representative on the Meeting Management Committee, having served this role for several years. Richard commented that members who have been attending meetings for a couple of decades or so, know that Henry's efforts on behalf of SSAR in regards to meetings extend back beyond his service on this committee. Henry's work on behalf of SSAR (much of which is behind the scenes) is greatly appreciated and the success of these meetings owes much to his labors. SSAR owes a debt of gratitude to Dawn Wilson who guided the Silent Auction for many years (often single-handedly). Although she officially resigned this year as coordinator, she will continue to provide input and guidance to student fund raising activities. Zack Walker recently resigned after serving as webmaster for several years. His designs and efforts greatly improved the web page and raised the society's image. Everyone who worked either directly or indirectly with Zack found him a pleasure to work with. Jim McGuire was thanked for presenting the President's Travelogue on the first evening of the meeting. Richard noted that SSAR depends entirely on volunteers, and the Society as a whole

thanks the many people whose hard work keep SSAR running: the officers, members of the board, chairs and members of various committees, editors of journals plus the associate and section editors they rely on. In regards to our journals, the society also thanks individuals who review the many manuscripts we receive and those who help with the presubmission review of manuscripts by non-English speakers. Finally, Richard thanked those in attendance for coming to the meeting. He noted that it is because of the dedication and hard work of both students and professionals that SSAR is as strong a society as it is.

On a personal note, I would like to acknowledge what a pleasure it has been for me to work with Roy McDiarmid (as it was with previous presidents Janalee Caldwell and Robin Andrews). My job and those of other officers, plus editors and committee chairs, are made so much easier when we have someone as dedicated to the society as Roy is at the helm. Roy is just the tip of the iceberg, however, and as Richard noted, this society has a fantastic group of volunteers many of whom I interact with on a weekly basis. I look forward to working more with Brian Crother when he officially assumes the president's position and I hope SSAR continues to elect presidents who are as committed to the society's future and best interests as those with whom I have had the opportunity to work.

The business meeting ended with the traditional passing of the gavel from outgoing President McDiarmid to President-Elect Crother and was adjourned at 1747 h.

—Respectfully submitted by Marion Preest, SSAR Secretary



Luana, student from Manaus, presenting her turtle poster.

The Sixth World Congress of Herpetology Manaus, Amazonas, Brazil

The Sixth World Congress of Herpetology in Manaus, Amazonas, Brazil took place 17–22 August 2008 and was attended by 565 delegates from 43 countries—greater attendance than for either of the last two World Congresses. North America was represented by 117 (21%) registrants, South and Central America with 256 (45%), Europe with 98 (17%), Asia and Oceania with 83 (15%), and Africa 11 (2%). This cosmopolitan group of herpetologists included 270 professionals, 164 students, 18 accompanying persons, and 110 local committee and support staff. We obviously did not need such a large local committee; however, when I asked for volunteers, the local students from Manaus universities came out in force, willing and eager to participate. I was able to bring them into the participation of the event through grant monies obtained from local, state, and federal Brazilian governmental agencies as well as a generous grant from Conservation International.

The quality of the scientific presentations was outstanding. There were 293 oral presentations including the 15 distinguished plenary lectures, 15 symposia, and contributed oral paper sessions. The poster presentations were held at the end of each day in the book and equipment exhibition room complete with bar service, providing the exchange between the authors and audience in a more relaxed atmosphere. Each day a different group of 50 posters was presented following various themes, most notably genetics, conservation, and ecology. The abstracts were available on line prior to the meeting on the 6WCH web site and also distributed on CD at the meeting in accordance with my ideas initiated at the Joint meeting in 2003 that we do not have to have printed abstracts. However I was forced by the Secretary General of the EC of the WCH to make available some printed abstract books as well. Copies of the 421-page tome are available from me at a 50% discount while they last for US $40 plus shipping.

The meeting got underway early, at 1230 h on Sunday August 17, with the Conservation International sponsored Amphibian Conservation Workshop. The event got a send off pitch from Claude Gascon and Jim Collins, followed by 13 reports from around the world. This well attended event was followed by the first two Plenary Lectures, Bill Magnusson speaking on the evolution of herpetological studies in the Brazilian Amazon and Russ Mittermeier delineating priorities for global reptile and amphibian conservation. This was followed by the opening social in and around one of the swimming pools in Hotel Tropical.

Throughout the week each morning and afternoon session was initiated by a Plenary Presentation followed by six papers in five different lecture rooms simultaneously. One of the most exciting plenary lectures was that of Peter Narins, who enlightened us about the ultrasonic vocalizations that some species of Bornean frogs are making in their mating calls given amidst the din of waterfalls. Thus opening up an entire new dimension in anuran communication studies. How many times have you been sitting next to a silent frog that was actually calling?

Monday afternoon at the poster session we had a 400 capirinha send off for the presentation of two Conservation International financed books: *Las Tortugas y Los Cocodrilianos de Los Paises Andinos del Tropico*, by Jose Vicente Rueda Almonacid et al., and *Field Guide to the Anurans*



Camila Ferrara, James Parham, and Brian Horne with *Podocnemis erythrocephala*.



John Legler mobbed by appreciative students.

of the Pantanal and Surrounding Cerrados, by Masao Uetanabaro et al. Some of the et al. authors of the books were present to sign copies: Russ Mittermeier, John Carr, Dick Vogt, and Domingos de Jesus Rodrigues. At the same time, Vogt also introduced his new books on Amazon turtles published in English, Spanish, and Portuguese as well as *Rainforests*.

Ian Swingland, a meeting Sponsor and the Director of the First World Congress of Herpetology in 1989, invited all of the turtle biologists to his presidential suite for cocktails and munchies on Tuesday evening, it was well attended by professors and students alike.

The rain gods smiled down on the meeting and we were able to have both the picnic on the beach of the Rio Negro complete with live native folkloric dancers and the banquet as well under the stars with no hint of rain.

Meeting participants ventured out on post meeting field trips to Reserva Ducke, Jau Nacional Park, Virua Nacional Park, turtle farms, and up the Rio Negro. A number of turtle biologists accompanied Camila Ferrara and me up the Rio Negro to the Rio Itu and Rio Jaupiri. Here we were able to collect and release a few dozen *Podocnemis erythrocephala* and *P. sextuberculata*, showing our guests the differences between the turtles inhabiting black water and white water habitats. It was a stellar group with three plenary speakers: John Legler, Oscar Flores Villela, and James Parham. Also on board to help lead stimulating discussions about turtle conservation and biology were Brian Horne, Andrew Walde, Gerald Kuchling, Joanna Burger, Glen Gerber, Chuck Schaffer, and Rick Hudson. Juliette Velosoa came all the way from Madagascar to join our trip to compare the habitat of *Peltocephalus* to that of the similar *Erymnochelys* from her native land. The group also had the opportunity to swim with and feed wild pink dolphins in the Rio Negro.

The editors of the electronic journal *Herpetological Conservation and Biology* are soliciting all those who presented posters at either the WCH in Manaus or the Joint Meeting in Montreal to submit notes to be published essentially as presented in the poster. These notes will, of course, have to be submitted to the review process, but most of them should be publishable. Contact Malcolm McCallum for details (e-mail: Malcolm.McCallum@tamut.edu). The plenary speakers are also writing down their thoughts to be published as a volume of the HCB as well. Some of the symposia speakers are organizing their presentations for private publication in hard copy while others will be published in HCB.

I thank you all for attending and making this meeting one of the great ones to remember!

—Dick Vogt, Director 6WCH

NEWSNOTES

Slowinski Award Announced for 2008

The Center for North American Herpetology is pleased to announce that the recipient of The Joseph B. Slowinski Award for Excellence in Snake Systematics for 2008 is Frank T. Burbrink of the College of Staten Island/City University of New York.

On 12 September 2001, the world lost one of its premier herpetologists, a loss that went virtually unnoticed in the wake of the tragedy that befell the United States the previous day. Joseph Bruno Slowinski, the 39 year old curator of herpetology at the California Academy of Sciences in San Francisco, died in the jungles of Burma from the bite of a venomous snake. Joe was bitten on 11 September and succumbed to the effects of the bite the next day. Eventually, the world took notice and media outlets throughout the U.S. and beyond chronicled Joe Slowinski's exemplary career, cut so tragically short.

A distinguished committee, comprised of Simon Creer (University of Wales, Bangor), Hussam Zaher (Museu de Zoologia da Universidade de Sao Paulo, Brazil), and Christopher L. Parkinson (committee chairperson, University of Central Florida, Orlando), has deemed the paper "How and when did Old World ratsnakes disperse into the New World?" published in volume 43 of *Molecular Phylogenetics and Evolution*, as the most distinguished paper on snake systematics to appear during 2007. The paper was co-authored with Robin Lawson (California Academy of Sciences, San Francisco).

As senior author of the paper, Dr. Burbrink becomes the sixth recipient of The Slowinski Award, and will receive a check from The Center for North American Herpetology for US $500 along with a commemorative memento in recognition of his achievement.

2008 Sabin Award for Amphibian Conservation

Sathyabhama Das Biju has been selected from a pool of outstanding candidates from around the world to receive the 2008 Sabin Award for Amphibian Conservation. This award, which is in its second year, was instigated by the Amphibian Specialist Group of IUCN/SSC (http://www.amphibians.org) to recognize an individual or group that has made a significant contribution to amphibian conservation and/or research.

This award recognizes Biju's extreme dedication to discovering and conserving the amphibian fauna of the rapidly vanishing Western Ghats biodiversity hotspot.

For fifteen years, S. D. Biju has been tirelessly working to document the amphibians of the Western Ghats, often using his personal earnings to fund his explorations. His mission: to document and propose conservation priorities through scientific methods. When he started his self-funded research project, he worked as a plant systematist in Tropical Botanic Garden and Research Institute in Kerala. Later, he quit this job to fully focus on frog research, and transferred to the Vrije Universiteit Brussel to obtain a PhD on amphibians of the Western Ghats. He is now leading a research group at the University of Delhi as an associate professor.

When he initiated his research in the Western Ghats, there was very little objective evidence for assessing conservation priorities of the amphibian fauna. Biju conducted over 1000 field visits throughout the Western Ghats and documented over 850 distinct populations of amphibians. Through directed field expeditions, he tracked and re-discovered rare species which were known only from century old descriptions.

After 15 years of exploration and research, Biju has gathered evidence for about 100 species new to science. The discovery and description of an entirely new frog family (Nasikabatrachidae, 'the purple frog'), sent ripples through the entire scientific community and also caught international attention of the popular press. This species was described as 'the coelacanth of frogs' and 'a once in a century find.' Biju's prolific outputs brought a fresh fascination for amphibians among many Indian scientists and forest officials, and provided the push needed to increase the pace of amphibian research in India. The burrowing purple frog also has important conservation implications. Inundation of large chunks of valley forests in the Western Ghats by dam projects could spell disaster to this ancient amphibian and many other endemic taxa. India now has *Nasikabatrachus* to use as a flagship to promote the conservation of important habitats in the region.

SSAR congratulates Dr. Biju on this important recognition.

ICZN Proposal Regarding Electronic Publication of New Names

The International Commission on Zoological Nomenclature (ICZN) rules governing availability of animal names require publication in a durable medium. To date, that has been interpreted as including paper and 'hard' digital media such as CD-ROMs, but this has become increasingly problematic as electronic publication becomes more common. To address this issue the Commission is considering an amendment to the Code that will permit electronic publication of new names and nomenclatural acts. A draft has been published in *Zootaxa*, and will be followed by publication in other journals, including the *Bulletin of Zoological Nomenclature*. This initiates a year-long period for community input, after which a final amendment will be drafted and voted upon by the Commission.

The published draft may be downloaded from the ICZN website (www.iczn.org) or the *Zootaxa* website http://www.mapress.com/zootaxa/.

The summary points are 1) electronic-only publications should be allowed, if mechanisms can be found that give reasonable assurance of the long-term accessibility of the information they contain; 2) some method of registration should be part of the mechanism of allowing electronic publication of names and nomenclatural acts; and 3) works that are not paper-based (e.g., CD-ROMs, DVDs) should be disallowed.

Comments may be addressed to the ICZN through Dr. Ellinor Michel, Executive Secretary (iczn-em@nhm.ac.uk).

MEETINGS

Meetings Calendar

Meeting announcement information should be sent directly to the Editor (rwh13@csufresno.edu) well in advance of the event.

27–29 March 2009—32nd Annual Herpetology Conference (with 6th Annual Southeastern Ecology and Evolution Conference), Paramount Plaza Hotel and Suites Conference Center, Gainesville, Florida, USA. Sponsored by the University of Florida, Florida Museum of Natural History, and the Reptile and Amphibian Conservation Corps. Information: Benjamin Atkinson (e-mail: bka@ufl.edu).

19–23 April 2009—16th International Conference on Aquatic Invasive Species, Fairmont Queen Elizabeth Hotel, Montreal, Canada. A forum on Bullfrog Eradication and Control will be part of the program. Registration: http://www.icais.org/; information: www.bullfrogcontrol.com.

22–27 July 2009—52nd Annual Meeting, Society for the Study of Amphibians and Reptiles; 89th Annual Meeting, Amercian Society of Ichthyologists and Herpetologists; 67th Annual Meeting, The Herpetologists' League. Portland, Oregon, USA. Information: http://www.dce.ksu.edu/jointmeeting/.

CURRENT RESEARCH

The purpose of Current Research is to present brief summaries and citations for selected papers from journals other than those published by the American Society of Ichthyologists and Herpetologists, The Herpetologists' League, and the Society for the Study of Amphibians and Reptiles. Limited space prohibits comprehensive coverage of the literature, but an effort will be made to cover a variety of taxa and topics. To ensure that the coverage is as broad and current as possible, authors are invited to send reprints to the Current Research section editors, Joshua Hale or Ben Lowe; postal and e-mail addresses may be found on the inside front cover.

The current contents of various herpetological journals and other publications can be found at: http://www.herplit.com/contents.

Aquatic and Terrestrial Egg Laying in a Panamanian Treefrog

Adaptations that have allowed terrestrial oviposition, especially with regard to oxygen uptake and water retention, broadly conflict with the requirements for aquatic egg laying, ensuring that few species are known to display variable reproductive modes. In this study, the authors described the first example of a vertebrate that is able to lay eggs both in the water and on land, the neotropical treefrog, *Dendropsophus ebraccatus* (formerly *Hyla ebraccata*), from Panama. This species was originally thought to lay eggs terrestrially, however, of the 148 clutches laid near a pond at the site of a former gravel quarry, 28% were completely submerged, 48% were laid at the water surface, and 24% were laid terrestri-

ally. This contrasted with exclusively terrestrial egg laying at two nearby ponds. By exposing breeding pairs from each pond to shaded and unshaded breeding sites in a series of experiments, the authors demonstrated that aquatic egg laying was a response to a lack of shade availability, which presumably increases the risk of desiccation. Furthermore, mating pairs could lay both aquatic and terrestrial eggs on the same night, highlighting the plasticity of this response. As this species is basal to a clade of terrestrial breeders within a large lineage of aquatic breeders, the authors conclude that this plastic response is an intermediate form in the evolution of terrestrial egg laying.

TOUCHON, J. C., AND K. M. WARKENTIN. 2008. Reproductive mode plasticity: Aquatic and terrestrial oviposition in a treefrog. PNAS 105:7495–7499.

Correspondence to: Justin Touchon, Department of Biology, Boston University, 5 Cunnington Street, Boston, Massachusetts 02215, USA; e-mail: jtouchon@bu.edu.

Male Moor Frogs do not Lek with Kin

Although most commonly associated with birds, lekking behavior is observed in a number of diverse taxa, including amphibians. A subordinate male may secure relatively more mating opportunities at a lek, simply by being close to more preferred male, or by being in areas that are favored by females. Alternatively, if a subordinate male is closely related to the top males in a lek and large leks attract more females than smaller ones, then kin selected benefits can accrue, without the subordinate male securing matings. In this study, the authors examined the importance of kin selection on lek formation in the Moor Frog, *Rana arvalis*, in Scania, southern Sweden. Eight microsatellite loci were used to determine genetic relatedness of 203 males from seven leks across two populations. The degree of relatedness between males in a lek was found to be low, with leks containing closely related males no more often than would be expected by chance. The authors suggest that lek formation in this species may be a result of two types of female choice. The first type is female choice for breeding aggregations, which due to the high levels of male-male competition characteristic of leks may maximize her chance of mating with a desirable male. The second type is female choice for habitat that is suitable for oviposition.

KNOPP, T., M. HEIMOVIRTA, H. KOKKO, AND J. MERILÄ. 2008. Do male moor frogs (*Rana arvalis*) lek with kin? Molecular Ecology 17:2522–2530.

Correspondence to: Theresa Knopp, Ecological Genetics Research Unit, Department of Biology and Environmental Sciences, PO Box 65 FIN-00014, University of Helsinki, Finland; e-mail: Theresa.knopp@helsinki.fi.

Threatened Tuatara Species has Reduced MHC Variation

Genes of the major histocompatibility complex (MHC) are an important component of the vertebrate immune system. Due to the way in which these MHC genes function, heterozygotes are thought to be more fit due to their capacity to provide a greater diversity of antigens than homozygotes. The genetic consequences of population bottlenecks at neutral genetic loci have been well studied, however, little work has been done on the impact of bottlenecks on fitness-related genes. Of the two extant species of tuatara, *Sphenodon punctatus* is comprised of two genetic groups divided among several islands, while the only remaining natural population of *Sphenodon guntheri* is on North Brother Island (NBI) in eastern Cook Straight off the coast of New Zealand. Previous work on these populations has shown that *S. guntheri* has low levels of microsatellite diversity compared to *S. punctatus*. In this study, the authors determined the impact of a population bottleneck on fitness-related genes by sequencing regions of the MHC class I exon 2. The NBI population demonstrated significantly reduced MHC variation when compared to a population of *S. punctatus* on nearby Stephens Island. Only three MHC sequences and three (out of a possible six) genotypes were present on NBI, compared to 15 sequences and 21 genotypes in a similar sample size from Stephens Island. The authors conclude that the low MHC diversity observed in NBI tuatara could severely reduce this population's capacity to respond to new diseases.

H. C. MILLER, K. A. MILLER AND C. H. DAUGHERTY. 2008. Reduced MHC variation in a threatened tuatara species. Animal Conservation 11:206–214.

Correspondence to: Hilary C. Miller, Allan Wilson Centre for Molecular Ecology and Evolution, School of Biological Sciences, Victoria University of Wellington, PO Box 600, Wellington, New Zealand; e-mail: hilary.miller@vuw.ac.nz.

Ecological Separation in a Polymorphic Salamander

Polymorphic species provide a unique opportunity to investigate the importance of reproductive isolation in sympatric speciation. In this study, the authors examined a polymorphic population of the Red-backed Salamander, *Plethodon cinereus*, in the Cuyahago Valley National Park, Ohio (USA), which is composed of striped and unstriped morphs. Previous studies in this species have demonstrated a correlation between climate and color morphology, however, no studies have examined whether diet and mate choice vary between the color morphs. Mate choice was determined by examining the composition of adult pairs cohabitating beneath ceramic wall tiles placed on the forest floor. Based on the findings of a previous study, cohabitating adults were assumed to be mated pairs. In total, 94 mated pairs were observed, of which 68 were same-color pairs, and 26 were non-matching pairs. Gut analysis was used to determine diet composition, with striped morphs consuming a more varied and profitable diet than unstriped morphs. Additionally, in agreement with previous studies in this species, the authors found that unstriped morphs withdrew from the forest floor when temperatures fell earlier than striped morphs. Despite the observed ecological separation, and the observed incidence of selective mating, the authors suggest that due to the level of intermorph matings, they are unlikely to be undergoing divergence. However, as the morphs respond differently to environmental conditions, climate warming may open new niches which could encourage future divergence in this species.

C. D. ANTHONY, M. D. VENESKY, AND C. M. HICKERSON. 2008. Ecological separation in a polymorphic terrestrial salamander. Journal of Animal Ecology 77:646–653.

Correspondence to: Carl Anthony, Department of Biology, John Carroll University, University Heights, Ohio 44118, USA; e-mail: canthony@jcu.edu.

Impact of Agriculture on Reproduction in the Toad, *Bufo marinus*

Studies of the impact of pollutants on wildlife commonly have compared polluted and unpolluted sites. However, as pollutants can be transported hundreds of miles from the point of application, essentially no site can be considered completely pollutant free. In this study, the authors examined gonadal function and abnormalities in *Bufo marinus* from south Florida, USA, from five sites that differed in intensity of agricultural land use. There was an increased frequency of intersex individuals (specimens exhibiting both female and male reproductive tissue) from the two most agricultural sites. By examining the extent of male and female reproductive tissue within intersex toads, the authors were also able to quantify the severity of the intersexed condition, and found that toads became more intersexed as agriculture increased. Furthermore, secondary sexual traits, such as skin color, nuptial pad number and forearm width were all altered in toads from the highly agricultural sites. The authors suggest that these intersex toads are feminized and demasculinized male toads. Finally, they conclude that as agricultural chemicals are distributed globally, and appear to illicit a dose dependent response on reproductive function, they may be linked to amphibian population declines.

K. A. McCoy, L. J. Bortnick, C. M. Campbell, H. J. Hamlin, L. J. Guillette jr, and C. M. St. Mary. 2008. Agriculture alters gonadal form and function in the toad *Bufo marinus*. Environmental Health Perspectives doi: 10.1289/ehp.11536.

Correspondence to: Krista A. McCoy, Smithsonian Tropical Research Institute, Unit 0948, APO AA 34002 USA; e-mail: kristam@bu.edu.

Male Responses to Aggressive and Submissive Signals in the Jacky Dragon

Intraspecific conflict over resources can be costly for both winners and losers, both in terms of energy expended as well as increased risk of injury or vulnerability to predation. These significant costs have led to the evolution of non-combative conflict resolution, a common example of which involves an individual dynamically signaling their fighting ability and motivation. The Australian jacky dragon, *Amphibolurus muricatus*, displays a number of signaling behaviors, with males commonly performing a stereotyped push-up display, which has been shown to play a part in opponent assessment. Previous research has also demonstrated that two other behaviors, slow arm-waves and slow head-bows, signal submission in conflict situations. In this study, the authors used interactive video playback of an animated stimulus lizard, which allowed them to examine responses to these different behaviors while controlling for signaler morphology. Five display animations were produced, each starting with a series of push-up displays. In the control treatment, the animated lizard then displayed a number of substrate licks. In the "aggressive" treatment, the animated lizard responded to all behaviors of the focal male with push-up displays. In the "submissive" treatment, all behaviors were matched with slow arm-waves. A "matching" treatment, where the behavior of the focal male was matched by the animation, and an "opposite" treatment were also produced. The aggressive treatment failed to suppress attacks as compared to the control treatment, and the submissive treatment actually increased the rate of attack. Interestingly, attacks were frequent when the animated male responded to a submissive display by the focal male, suggesting that behaviors are monitored closely and are sensitive to social contingencies.

D. A. Van Dyk and C. S. Evans. 2008. Opponent assessment in lizards: examining the effect of aggressive and submissive signals. Behavioral Ecology 19:895–901.

Correspondence to: Daniel Van Dyk, Centre for the Integrative Study of Animal Behaviour, Macquarie University, New South Wales 2109, Australia; e-mail: daniel@galliform.bhs.mq.edu.au.

Boldness Linked to Foraging Success in an Invasive Gecko

Lepidodactylus lugubris, a parthenogenetic gecko that arose from the hybridization of two sexual species from the Marshall Islands, is now widespread throughout the Pacific Islands. There are four major clone lineages that differ ecologically, and are thought to have arisen from independent hybridization events. Since the mid-1990s, *A-clones* have become the most common clone, increasing in both abundance and distribution. In this study, the authors investigated whether *A-clones* are displacing *B-clones* due to behavioral differences related to foraging success and aggression. *A-* and *B-clones* were selected from a laboratory-reared population that had been captured one generation previously from Oahu, Hawaii. Geckos were placed in one of two experimental enclosures, one which, in addition to a shelter, contained a number of opaque plastic barriers designed to add to the structure of the environment. The other enclosure was of equal size, but contained only a shelter. A number of behavioral variables were measured, including foraging attempts, total consumption and activity. *A-clones* were superior foragers, having greater consumption and a reduced time to first successful foraging attempt, and did so at the expense of *B-clones*. Interestingly, *A-clones* displayed lower levels of activity than *B-clones* overall; however, *B-clones* used and defended shelters more frequently. The complexity of the habitat affected foraging, aggression and activity levels in both clones, with *A-clones* remaining superior foragers in both treatments. The authors conclude that the increased use and defense of shelters by *B-clones* may explain their persistence in structurally complex habitat, such as forests. In contrast, *A-clones* have an advantage in structurally simple environments, such as human landscapes, due to their innate boldness perhaps enabling them to exploit scarce food resources.

Harfmann Short, K., and K. Petren. 2008. Boldness underlies foraging success of invasive *Lepidodactylus lugubris* geckos in the human landscape. Animal Behaviour 76:429–437.

Correspondence to: Kristen Harfmann Short, Department of Biological Sciences, University of Cincinnati, Ohio 45221-0006, USA; e-mail: harfmaka@email.uc.edu.

Uncovering the Introduction History of Australian Bell Frogs into New Zealand

Two species of Australian bell frogs, *Litoria raniformis* and *L. aurea*, were introduced into New Zealand in the late 1800s to control mosquito larvae and provide food for ducks. Despite these two species now being threatened in Australia, they are widespread and abundant in New Zealand. As both the precise release locations and the source populations for introduced frogs are unknown, the authors of this study have used molecular techniques to investigate the introduction history of bell frogs in New Zealand. Partial sequences of the mitochondrial DNA region cytochrome oxidase I were obtained from across the native range of both species. Results of the molecular analyses indicated that *L. aurea* was introduced from two areas of Australia, northern and southern coastal New South Wales, and into the North Island of New Zealand. *L. raniformis* was introduced from the vicinity of Melbourne, Victoria, and into New Zealand's South Island, from which they dispersed to the North Island. Previously, it was thought the *L. raniformis* was introduced into New Zealand from Tasmania, however this hypothesis was rejected. Finally, the authors observed extremely diverse mitochondrial lineages in *L. raniformis* within mainland Australia, perhaps pointing to the existence of a cryptic species.

Vörös, J., A. Mitchell, B. Waldman, S. Goldstien and N. J. Gemmell. 2008. Crossing the Tasman Sea: Inferring the introduction history of *Litoria aurea* and *Litoria raniformis* (Anura: Hylidae) from Australia into New Zealand. Austral Ecology 33:623–629.

Correspondence to: Judit Vörös, Department of Zoology, Hungarian Natural History Museum, Baross u. 13, Budapest H-1088, Hungary; email: jvoros@nhmus.hu.

Horned Lizards Use Mucus to Incapacitate Dangerous Prey

Horned lizards, genus *Phrynosoma*, feed almost exclusively on ants, in particular, the venomous harvester ants (genus *Pogonomyrex*). Unlike most other lizard species that consume dangerous prey, horned lizards do not incapacitate their prey by biting or chewing. Instead, they combine prey capture, transport and swallowing into a single stage. In this study, the authors examined how horned lizards are able to consume dangerous prey without first incapacitating them mechanically. It was found that horned lizards possess unique pharyngeal papillae that secrete mucus which incapacitates and immobilizes prey. More mucus secreting folds exist in the esophagus which the ants pass through as they are consumed. Ants examined from the gut of horned lizards were bound in mucus and curled into balls. The authors suggest that by using mucus to incapacitate dangerous prey, horned lizards are able to consume a larger number of ants in a single feeding bout. This reduces the chance of being attacked by predators while feeding or being detected by the ant colony and being mobbed by aggressive worker ants. The authors suggest that this feeding adaptation may be one result of an ongoing co-evolutionary relationship between harvester ants and horned lizards.

Sherbrooke, W. C., and K. Schwenk. 2008. Horned lizards (*Phrynosoma*) incapacitate dangerous ant prey with mucus. Journal of Experimental Zoology 309A:447–459.

Correspondence to: Kurt Schwenk, Department of Ecology and Evolutionary Biology, University of Connecticut, Storrs, Connecticut 06269-3043, USA; e-mail: kurt.schwenk@uconn.edu.

Lizards from Rocky Habitats Evolve a Flatter Body Plan

The occurrence of similar morphological traits among unrelated organisms from similar habitats has often been used as evidence of convergent evolutionary change. For example, many unrelated lizard species display head and body flattening that appears associated with the use of vertical rocky habitats. However, whether this morphology is solely the result of the occupation of rocky habitats has never been rigorously tested. Using phylogenetic comparative methods, the authors examined 18 tropical skink species from northeast Queensland that occupy three broad habitat categories (generalist, leaf litter, rock-dwelling) to test whether the observed patterns of morphological convergence in this lizard clade are related to the use of rocky habitats. This work revealed that despite relatively few morphological differences overall, rock-using species have consistently and repeatedly evolved a dorsoventrally flattened body and head. This study highlights the role of rocky habitats in driving adaptive shifts in morphology that is likely associated with increased selection on enhanced running and climbing performance, movement into and within rock crevices, and improved camouflage of species from rocky habitats.

Goodman, B. A., and J. L. Isaac. 2008. Convergent body flattening in a clade of tropical rock-using skinks (Scincidae: Lygosominae). Biological Journal of the Linnaean Society 94:399–411.

Correspondence to: Brett A. Goodman, School of Marine and Tropical Biology, James Cook University, Townsville, QLD 4819, Australia; e-mail: brett.goodman@jcu.edu.au.

Amphibians: On the Leading Edge of a Sixth Mass Extinction

The history of life on earth has been punctuated by periodic extinction events that saw as many as 95% of all species become extinct. Many researchers have suggested that we are currently experiencing a biodiversity crisis on par with past extinction events. The authors set out to examine this hypothesis from an amphibian perspective. Amphibian species are widely understood to be disproportionately threatened relative to other taxonomic groups. As of 2004, 32.5% of known amphibian species were "globally threatened," as calculated by the Global Amphibian Assessment. In this article, the authors detail amphibian declines in California's Sierra Nevada and the Central American Highlands. These case studies exemplify how numerous factors, climate change and infectious disease (chytridiomycosis) in particular, are acting in concert to push amphibian species to the brink of extinction and beyond. The tropics are of special concern as they are high in amphibian richness, are home to species with smaller distributions relative to temperate species, and are experiencing extreme rates of habitat conversion. The authors conclude that we are in the midst of an amphibian mass extinction event, as current extinction rates are 221 times higher than background rates. Furthermore, they conclude that humans are ultimately responsible for this mass extinction event.

WAKE, D. B., AND V. T. VREDENBURG. 2008. Are we in the midst of the sixth mass extinction? A view from the world of amphibians. PNAS 105:11466-11473.

Correspondence to: David Wake, Museum of Vertebrate Zoology and Department of Integrative Biology, University of California, Berkeley, California 94720-3160, USA; e-mail: wakelab@berkeley.edu.

OBITUARIES

Herpetological Review, 2008, 39(4), 400–401.
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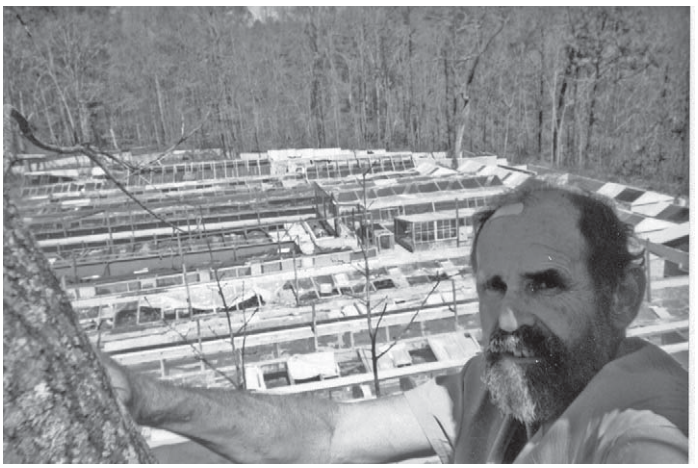
Bert Langerwerf (1944–2008): Lizard Breeder Extraordinaire

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Renowned herpetoculturist Bert Langerwerf passed away on 11 August 2008 following a courageous battle with cancer. Bert was born on 28 February 1944 in Waspik, Netherlands, on his father's birthday. Bert's father, Wilhelmus Langerwerf, was a farmer; his mother, Coralie, was the youngest daughter of a boatman. Various aunts and uncles lived on boats that transported goods, mostly coal and other raw materials, along the Rhine River from Basel to Rotterdam.

Although Bert was formally educated at the University of Amsterdam and subsequently taught physics at Dr Mollercollege in Waalwijk, his passion was lizards. He recalled catching his first lizard as a nine-year-old during a break from a soccer game at school: "It was a nice warm day in May and there was a dry ditch at the northern edge of the soccer field. I went to look for animals in that dry ditch. Rush…there ran a lizard! A real lizard being chased by me on the sunny southern slope of that dry ditch. Out of excitement I did not hear the shouting boys anymore, but rather a kind of music, when I found my first lizard. I followed the lizard and caught it without breaking its tail. I reached for my shoe, took off a sock, and put the shoe on again. The lizard went inside the sock and I was rushing home, forgetting everything else. I guess they may have missed me the rest of that school day. A few months later the lizard, a *Zootoca vivipara*, died in a glass jar, and with that I learned that I did something wrong, because I wanted to keep the lizard alive."



Bert Langerwerf, up a tree, surveying the hundreds of outdoor terraria at Agama International, in 2000.

Bert built his first outdoor terrarium in 1954 and joined the Dutch Club for Terrarium Keepers in 1958. Since these early days, he has maintained memberships in herpetological societies around the world, and has spoken to local reptile clubs, as well as scientific herpetological societies in the U.S. and Europe.

Aside from lizards, Bert's other passions were music and languages; he was fluent in English, Dutch, German, French, Spanish, Italian, Danish, Finnish, Swedish, and Russian, and still learning more. He enjoyed the music of the exotic places associated with his searches for lizards, often treating his traveling companions to the music of Morocco, Egypt, Russia, Finland, and elsewhere—played loudly given his near-deafness in recent years.

Bert's early love of lizards grew into his life's work. Over the years, he traveled the world searching for lizards to establish in captivity. Although best known for his work with Argentine Tegus, Australian Water Dragons, Prehensile Tailed Skinks, and Chinese Crocodile Lizards, he successfully bred over 135 species of lizards, turtles, and amphibians, and for some time he was the only private individual to maintain tuatara in captivity.

In 1982, Bert made his first trip to the U.S. to speak at the annual meeting of SSAR in Raleigh, North Carolina. There he met many herpetologists, including long-time friends Sean McKeown and RLT, who would later be influential in Bert's decision to move to the States.

In 1985, Bert took his family from their native Netherlands to Gran Canaria, Canary Islands, where he dreamed of building a lizard breeding facility and zoo. Within two years, Reptilandia—the world's first reptile park—was born. Soon thereafter, however, the Langerwerf family moved again, traveling to New Zealand.

By 1989, at the urging of friends, Bert and family moved to a seven-acre farm near Birmingham, Alabama, where he established Agama International Herpetocultural Institute. Here, he was able to reach full stride, as his lizards thrived in the warm, humid climate of Alabama. Bert constructed over 400 outdoor terraria and numerous outbuildings, all built with his own two hands and simple tools. But the daily operation of the facility was a family affair and a path that few people will ever fully know.

Over the course of his career, Bert made several important discoveries. These included his observations of Temperature-dependent Sex Determination (TSD) in a number of lizard species. He was among the first to recognize the critical role of ultraviolet light in successful husbandry of diurnal lizards. And he was a pioneer in the captive breeding of numerous lizard species. In recent years, Bert spent a great deal of time traveling to conferences and speaking about his advancements and discoveries in lizard behavior, nutrition, lighting, thermoregulation, and reproduction. His travels found him in the company of the world's leading herpetologists and herpetoculturists, many of whom called him friend and col-

league for decades.

Bert is survived by his mother, Coralie Poppelier Langerwerf (age 100), Hester, his wife of 39 years, and sons Aleksis and Timo.

Bert was a truly unique character—brilliant, obsessively focused, innovative, generous, and funny. Surely there will not be another like him. His passion has been an inspiration to us all.

ZOO VIEW

Herpetological Review, 2008, 39(4), 401–407.
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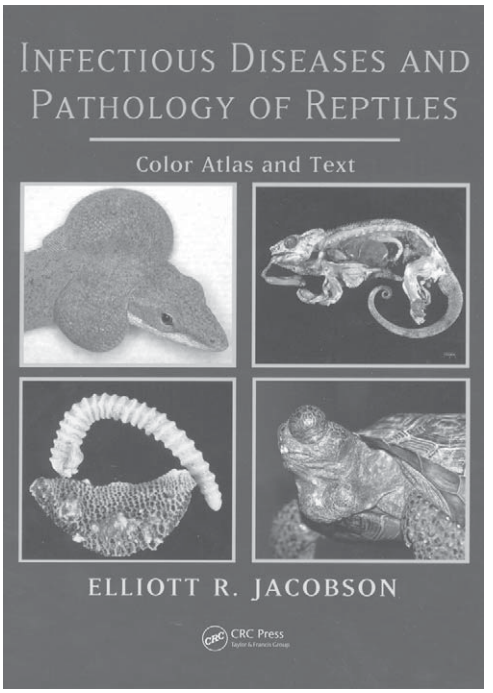
Updating the Bookshelves Part II: Medical and Captive Management, Conservation, Biographies, Regional Books, History

WHAT WILD DESIRES, WHAT RESTLESS TORMENTS SEIZE
THE HAPLESS MAN, WHO FEELS THE BOOK -DISEASE . . .
THE BIBLIOMANE EXCLAIMS, WITH HAGGARD EYE,
"NO MARGIN!" TURNS IN HASTE, AND SCORNS TO BUY . . .
AT EV'RY AUCTION, BENT ON FRESH SUPPLIES,
HE CONS HIS CATALOGUE WITH ANXIOUS EYES:
WHERE'ER THE SLIM ITALICS MARK THE PAGE,
"CURIOUS AND RARE" HIS ARDENT MIND ENGAGE.

DR. JOHN FERRAIR DESCRIBING BIBLIOMANIA IN *A GENTLE MADNESS: BIBLIOPHILES, BIBLIOMANES, AND THE ETERNAL PASSION FOR BOOKS*, BY NICHOLAS A. BASBANES, 1995.

Medical Management

Every so often, a book arrives on the scene that is destined to become a classic and that time has come again. Elliott R. Jacobson, professor of zoological medicine in the Department of Small Animal Clinical Services in the College of Veterinary Medicine at the University of Florida, has compiled a book of such scope and magnitude that it will likely grace the reference library collection of virtually every veterinarian and pathologist working with reptiles. The first chapter on biology, anatomy, and histology is particularly valuable for the herpetologist as there are many pictures of skulls and a variety of skeletal preparations with major bones identified. Jacobson's book, *Infectious Diseases and Pathology of Reptiles: Color Atlas and Text* (2007, CRC Press, Boca Raton, Florida, ISBN 10:0-8493-2321-5, ISBN 13:978-0-8493-2321-8), is truly awesome: 716 pages, with approximately 1400 high-quality color images. The thirteen chapters, some written by other experts, cover the following topics: reptile biology, anatomy, and histology; immunology; circulating inflammatory cells; necropsy techniques; host response to infectious agents and identification of pathogens in tissue section; identifying pathogens using electron microscopy; molecular diagnostics; serodiagnostics; viruses and viral diseases; bacterial diseases; mycotic diseases; parasites and parasitic diseases; and isolation of pathogens.



Elliott Jacobson's new book is the most detailed reference on infectious diseases and pathology.

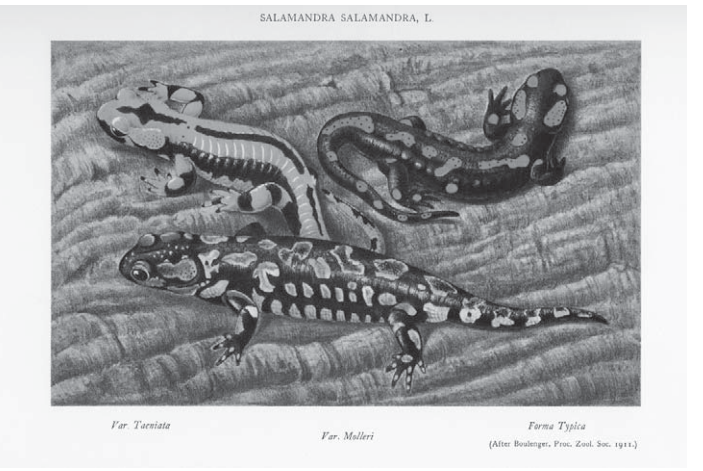
Captive Management of Salamanders

On 20 September 2005, a meeting was held at Conservation International in Washington, DC to explore the need to develop assurance colonies for imperiled amphibians. One of the presenters was Jean Raffaëlli, recognized as one of the world's leading authorities on the captive management of salamanders and newts. I was impressed by his talk, accompanied by photos of breeding urodeles living in state-of-the-art enclosures. Later, he contributed to the captive breeding chapter of the Amphibian Conservation Action Plan (ACAP), headed by Joe Mendelson of Zoo Atlanta.

Written in French, Raffaëlli's book *Les Urodèles du Monde* (2007; Penclen Edition; ISBN 978-2-9528246-0-6) has now appeared and sets the standard for a book of this type. In my view, it is the best multispecies salamander book available, covering all species described at the time of publication.

In the first part, Raffaëlli describes his travels around the globe, relating his field experiences and the number of prominent amphibian biologists he encountered. In the next part, his detailed study of some 650 forms of urodeles appears which includes almost all temperate taxa and several tropical species—304 pages of descriptions of families, genera, and species—featuring maps (over 500) and species accounts describing their taxonomy, biology, ecology, behavior, and sections on maintenance and breeding in captivity (Notes d´ élevage). The book has 515 photographs, most in color. The bibliography alone is worth the price of the book. This guide will be of immense value to serious amateurs, such as those in the French Urodela Group (FUG), and professionals alike who wish to learn more about taxonomy, biology, and ecology of salamanders and also how to keep these amphibians alive and well.

The book can be purchased directly from the author (e-mail: jean.



Each of these three examples of Fire Salamander *Salamandra salamandra* was drawn from a living specimen by artist John Green. This was originally a colored illustration from *Anatomy of the Salamander* by Eric T. B. Francis in 1934, slightly modified from Edward G. Boulenger's paper in Proc. Zool. Soc. London 1911. Boulenger was curator of reptiles at the London Zoo beginning in 1911.

raffaelli@laposte.net or via post: PENCLEN 56420-Plumelec, France) or from Bibliomania (http://herplit.com/Urodeles/).

Conservation

Believing that virtually all large mammals throughout Asia and Africa are inevitably going to become extinct during this century, Donlan et al. (2005. Re-wilding North America. Nature 436:913–914) proposed a plan to restore predators and prey that disappeared 13,000 years ago from Pleistocene North America. They proposed using extant representatives as genetic reservoirs of ancestral stock to bring about this new radiation—African Lions, African Cheetahs, Asian and African elephants, horses, asses, and Bactrian Camels, but also the endangered Bolson Tortoise (*Gopherus flavomarginatus*)—a taxon which lived across the Chihuahuan Desert in North America during the Late Pleistocene. Presently, Bolson Tortoises are restricted to a limited area in northern Mexico. In the view of Donlan et al., North America offers the best option for establishing these colonies, comprising both predators and prey, on public lands and private game ranches.

If zoo workers are going to ever be asked to embrace the plan to produce hundreds of Bolson Tortoises—or other herps related to ancestors long gone—to populate protected tracts of land in order to support this alternative conservation strategy, this handy reference might help—*Rewilding North America: A Vision for Conservation in the 21st Century*, by Dave Forman (2004, Island Press; Washington, Covelo, London; ISBN 1-55963-060-4 [cloth]; ISBN 1-55963-061-2 [paper]), divided into three main parts: bad news, good news, and taking action.

The Wildlife Conservation Society (WCS), headquartered at the Bronx Zoo, was long led by William G. Conway, who retired as Director of the then New York Zoological Society. WCS has long supported a number of field researchers engaged in studies focused on conservation and habitat protection throughout the world. Conway is internationally known for his leadership and vision, writing one of the classic works in zoo philosophy in 1973: "How to exhibit a bullfrog: a bed-time story for zoo men." (Int. Zoo Yearb. 13:221–226).

In *Act III in Patagonia: People and Wildlife* (2005, Island Press, Washington, Covelo CA, London; ISBN 1-55963-518-5 [hardbound]), Conway explores 12,000 years in Patagonia (Act I), describes Hunting's High Tide (Act II), and summarizes The Road to Conservation (Act III). This is an important and graceful read written by one of the pillars of zoo conservation.



William Conway holding a James's Flamingo in the Chilean Andes at 14,800 feet in 1960. *From Gathering of Animals: An Unconventional History of the New York Zoological Society*, by William Bridges, 1974.

Imprint: New York, Harper & Row.

Credit: Wildlife Conservation Society, headquartered at Bronx Zoo.

I admire Michael Lannoo. He is certainly one of the most productive and influential herpetologists in highlighting amphibian declines and the need for dramatic conservation measures. In 1998, he edited *Status and Conservation of Midwestern Amphibians* (Iowa City: University of Iowa Press; ISBN 0-87745-631-3). Seven years later, he produced a volume of such scope that it will clearly be the definitive reference for years to come: *Amphibian Declines: The Conservation Status of United States Species* (2005, Berkeley: University of California Press, ISBN 0-520-23592-4 [hardbound]). Imagine coordinating 215 contributing authors, reviewing over 50 chapters, and compiling species accounts for all of the US taxa—resulting in a volume of nearly 1100 pages. He succeeded brilliantly at this monumental task.

Most herpetologists would sit back and enjoy the fruits of their labor but not Lannoo. He has produced yet another volume—*Malformed Frogs. The Collapse of Aquatic Ecosystems* (2008, Berkeley: University of California Press; ISBN 978-0-520-25588-3). Using data from ecology, parasitology, and other disciplines, he outlines the possible causes of these deformities, identifies which amphibians have been affected, and addresses questions about what these malformations might mean to human populations. Lannoo paints a grim picture, identifying the particulars in the usual litany of causes: chemical, nutrient, and pesticide runoff into wetlands. If this book's title and content are not terrifying enough to attract the attention of citizens, politicians, and policy-makers globally, then one must wonder what type of ecological disaster it will take for humans to pay attention to the perilous state of our world and begin to take steps to remediate the inevitable disasters looming.

Deformed anurans have been reported from Europe as well. Jean Rostand described and pictured a number in the book *Les anomalies des amphibiens anoures* (Paris, Société d'edition d'enseignement supérieur, 1958). The species depicted were Midwife Toad (*Alytes obstetricans*), Edible Frog (*Rana esculenta*), European Common Frog (*Rana temporaria*), and Common European Toad (*Bufo bufo*). Some of the most grotesque anomalies imaginable are shown in figures 12–14, 22, 29, 31, 34, and 37.

In his book *The Windward Road*, the late Archie Carr tells us of his fondness for frogs: "I have always liked frogs. I liked them since before I ever took up zoology as a profession; and nothing I have had to learn about them since has marred the attachment. I like the 'looks' of frogs and their outlook, and especially the way they get together in wet places on warm nights and sing about sex." If Carr would have had the opportunity to read Lannoo's books before he died, he would be saddened to learn that there are far fewer places where he could hear frogs sing.

Is it too late for amphibians? Every zoo biologist must immediately read this paper: Wake, D. B., and V. T. Vredenburg. 2008. Are we in the midst of the sixth mass extinction? A view from the world of amphib-



As aquatic ecosystems collapse around us, the Mudpuppy (*Necturus maculosus*) is particularly at risk, although malformations have not been reported for this taxon. This amphibian has a broad geographical range but populations have declined in Maryland, Indiana, North Carolina, and Iowa, due in part to chemical pollutants, increased siltation, and widespread use as fish bait. Illustration from Georges-Louis Duvernoy's *La Règne Animal par Georges Cuvier, Reptiles volume. Disciple edition. Paris 1842*. This image (plate 41 in vol. 6.) is from the Disciple's edition of Cuvier, published in Paris after his death by his students (i.e., disciples). The herpetology volumes (text plus atlas) are by Duvernoy. Credit: Courtesy of Kraig Adler.

ians. PNAS 105 (suppl.1):11466–11473. (pdf available at: http://web.me.com/vancevredenburg/Vances_site/Publications.html)

Biographies

In a book entitled *The Remarkable Life of William Beebe: Explorer and Naturalist* (2004, Island Press, Washington, Covelo CA, London; ISBN I-55963-858-3 [softbound]), author Carol Grant Gould has written an account equal to Beebe's extraordinary personal and professional life. In 1899, he began working at the Bronx Zoo (New York Zoological Society). The relationship among the three famous department heads at that time, J. Alden Loring (mammalogy), Raymond L. Ditmars (herpetology), and Beebe (ornithology), was described by Gould: "Despite vast differences in their educational backgrounds, the three young assistant curators got along well. They shared powerful common interests, and each had idiosyncratic skills and areas of special knowledge to share."

Ornithologist Beebe, although most often associated with the Society's Tropical Research Station in South America, published a number of papers in herpetology. Some of the subjects included preparation of snake skins, his unsuccessful attempts to collect lizards with a net in St. Thomas until a young girl taught him how to use a noose, encounter with a bushmaster in South America, Amphibia and Reptilia of the Bartica District, reptiles of the Galápagos Islands, habits of garter and ribbon snakes, development of the toad, sea snakes, and field notes on the lizards and snakes of British Guiana and Venezuela.



William Beebe dressed in expedition garb in British Guiana in 1917. From *Gathering of Animals; An Unconventional History of the New York Zoological Society*, by William Bridges, 1974.

Credit: Wildlife Conservation Society, headquartered at Bronx Zoo.

Albertus Seba: In the 1500s, wealthy Europeans had large collections of preserved animals, including many herpetological treasures. Explorers were traveling the world to bring artifacts to Europe. Collectors searched for examples of rare and wondrous objects to place in these cabinets that exemplified the Renaissance search for knowledge and understanding of the world. These collections were called "cabinets of curiosities"—also known as Wunderkammern, or cabinets of wonder—reflecting both the trait of curiosity that drives human search for knowledge, and the extraordinary qualities of the objects in the cabinets. These private cabinets held biological treasures, arranged in no particular order, to excite wonder—monsters or other natural oddities such as a two-headed calf, animals with extra or missing legs, human birth defects, or a horned horse.

A reasonably priced book presents the collection of Albertus Seba in *Cabinet of Natural Curiosities: Locupletissimi rerum naturalium thesauri 1734–1765: based on the copy in the Koninklijke Bibliotheek, The Hague* (2006, published by Barnes & Noble, Inc. by arrangement with Taschen GmbH, Köln; London; ISBN 13:978-0-7607-8204-0; ISBN 10:0-7607-8204-0). Although it is believed by some that zoo workers are notoriously well-paid, a hand-colored original is likely beyond reach—according to Kraig Adler, the last copy offered fetched a sum of nearly US $500,000! This is a fine reproduction of one of the classic natural history books of all time, with nearly 450 plates shown in color. In the introduction, Seba's life and collection of natural history specimens are described.

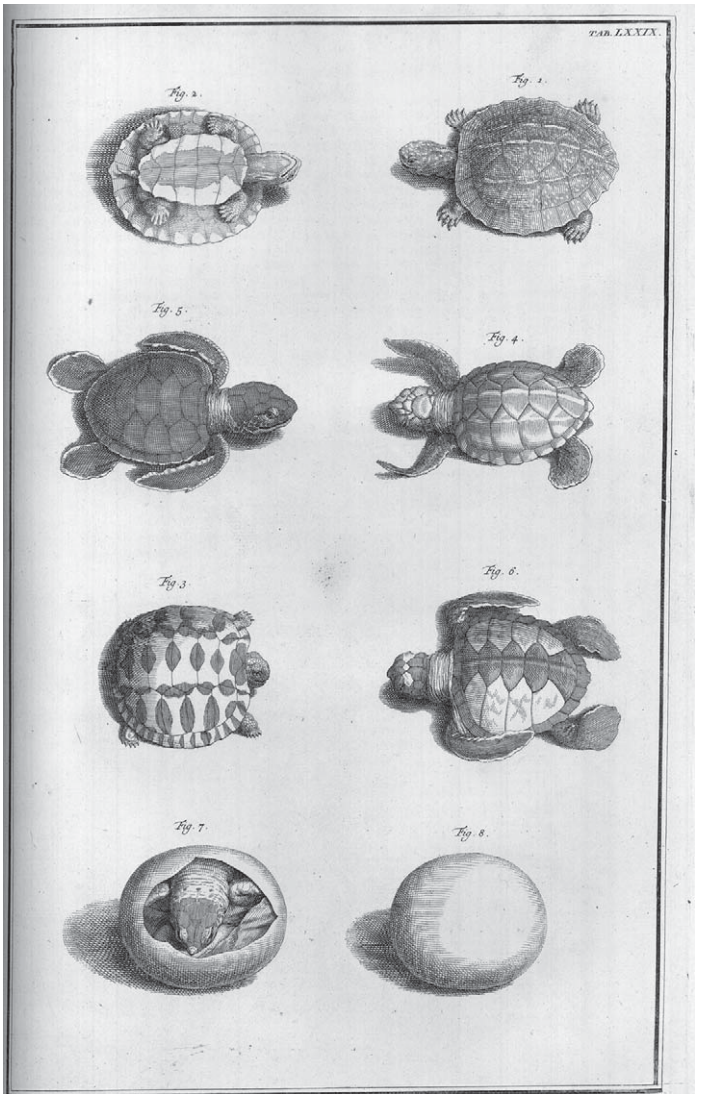


Illustration of chelonian neonates and eggs from Albertus Seba's *Locupletissimi rerum naturalium thesauri accurata descriptio, et iconibus artificiosissimis expressio, per universam physices historiam : Opus, cui, in hoc rerum genere, nullum par exstitit / / Ex toto terrarum orbe collegit, digessit, descripsit, et depingendum curavit Albertus Seba ….*

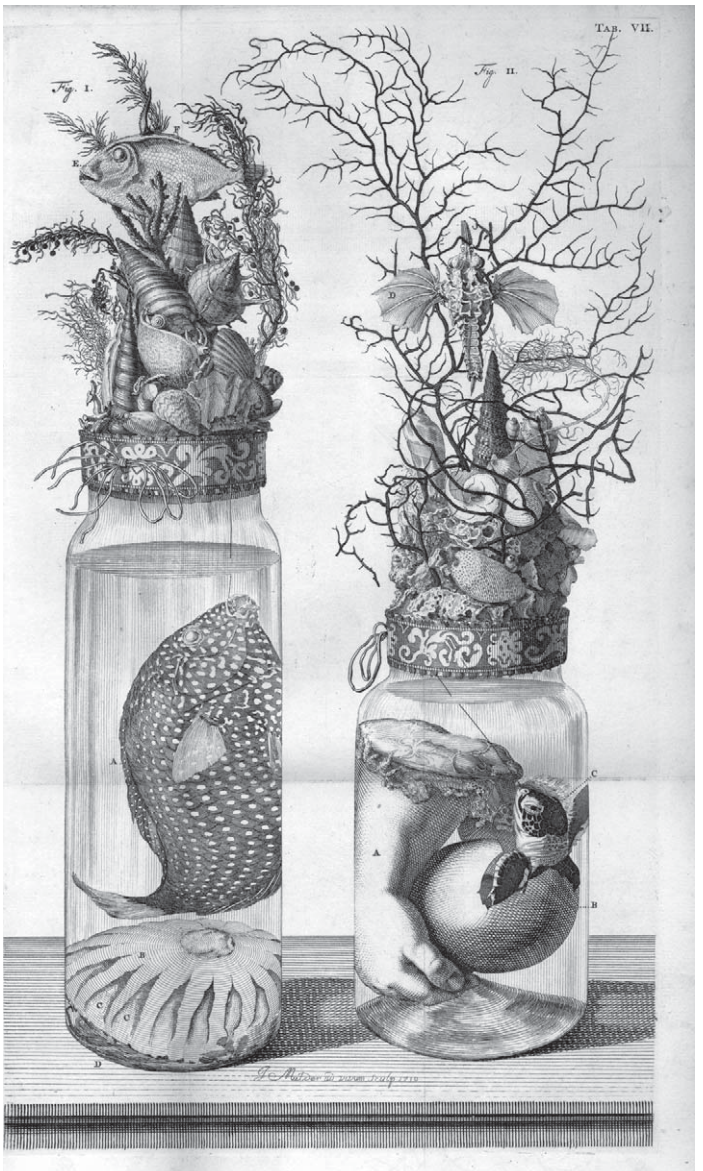
Imprint: Amstelaedami: Apud J. Wetstenium, & Gul. Smith, & Janssonio-Waesbergios, 1734–1765.

Credit: Collections of Ernst Mayr Library, Museum of Comparative Zoology, Harvard University.

Joseph Bruno 'Joe' Slowinski: Slowinski, an American herpetologist who worked extensively with elapid snakes, died in an isolated region in northern Burma (Myanmar) after being bitten by a small Multi-Banded Krait (*Bungarus multicinctus*) in 2001. A detailed account of his life and career has recently been published in a book by Jamie James entitled *The Snake Charmer: A Life and Death in Pursuit of Knowledge* (2008,

Hyperion Press, New York; ISBN 13:978-1-4013-0213-0). James' narrative begins with Slowinski's early childhood, development of interest in natural history, and subsequent career as a postdoctoral student working at the National Museum of Natural History and Louisiana State University. He eventually took a position as professor of biology at Southeastern Louisiana University until his dream job opened—curator for the Department of Herpetology for the California Academy of Sciences.

The account of his envenomation and the heroic measures taken by his companions to try and save him for 30 hrs was tough reading, certainly not to be used as a light bedtime distraction before sleeping. James does a masterful job of treating Joe as the complex person he was, especially about his approach to catching venomous snakes. I am not sure how I feel about Joe and his escapades—clearly he was a gifted, productive person but, oh, so careless and reckless with venomous snakes. Because



In this peculiar image from Frederik Ruysch's natural history cabinet in 1710, a human's severed arm and hand holding a sea turtle emerging from an egg in a bottle of preservative is displayed—*Frederici Ruischii . . . Thesaurus animalium primus = / Het eerste cabinet der dieren / van Frederick Ruysch . . .*

Imprint: Amstelædami: apud J. Wolters.

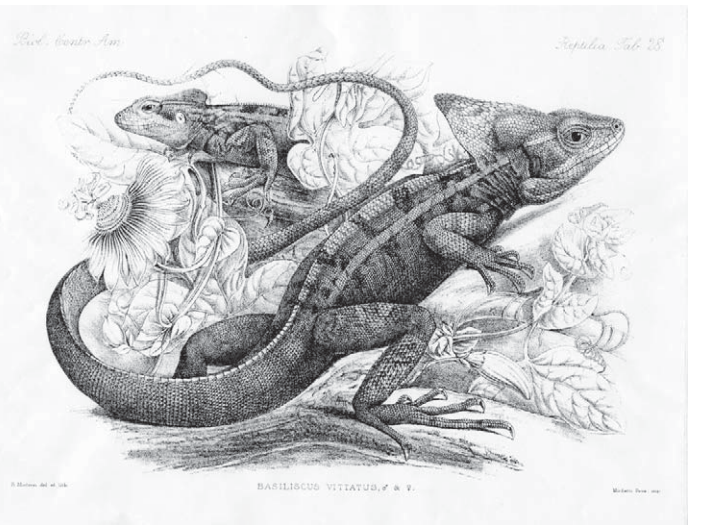
Credit: Collections of Ernst Mayr Library, Museum of Comparative Zoology, Harvard University.



This hand-colored woodcut is reproduced from the first illustrated surgical book, *Buch der C[h]irurgia* (Book of Surgery), published in 1497 by Hieronymus Brunschwig. Three doctors are attending to a victim bitten by a viper encircling the leg. Credit: provided by Kraig Adler.

I worked with dangerous snakes in a zoo for over 30 years without a bite, I am amazed at how cavalier he was about the dangers; in fact, we talked several times at herpetological meetings about the danger of working with venomous snakes, especially elapids, and the precautions needed to work safely with them. Although Joe suffered eight bites and many close calls, he continued to free-handle them.

This statement in Joe's article in *California Wild* in 2000 was pro-



Drawing by R. Mintern of Common Basilisk (*Basiliscus vittatus*) from Albert Carl Ludwig Gotthilf Günther's *Biologia Centrali-Americana*. [vol. 7], Reptilia and Batrachia, 1885–1902.

Imprint: London, Pub. for the editors by R. H. Porter.

phetic, "Neurotoxic proteins are extremely effective at bringing about death with minimal disturbance to the body. Viperid venoms, on the other hand, are messy—tearing apart tissue and literally melting cells. So an elapid venom is more likely to kill you but will leave a far prettier corpse." The picture facing page 180 with Joe next to the Burmese Spitting Cobra (*Naja madalayensis*), a taxon he described, pretty much sums it up—why wasn't he wearing a welder's mask or goggles to protect his eyes instead of those small sunglasses, especially because he had experienced several episodes when snakes had directed a stream of venom toward him?

For anyone working with dangerous reptiles, use this book as a cautionary tale and be bloody careful—that juvenile krait was less than 10 inches long!

Herpetofauna of Honduras

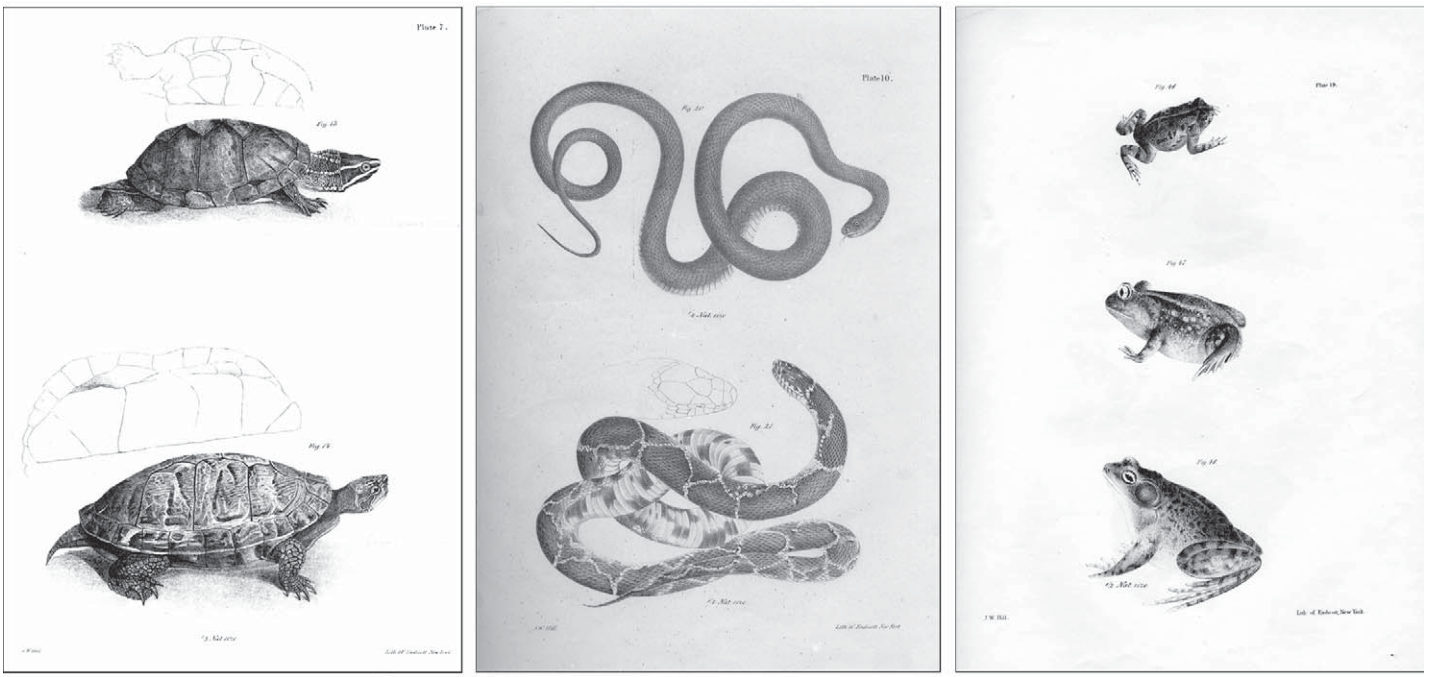
In 1969, John R. Meyer finished his dissertation, *A Biogeographic Study of the Amphibians and Reptiles of Honduras*. Thirteen years later, a book appeared called *The Snakes of Honduras* by Larry David Wilson and Meyer (Milwaukee Public Museum, Milwaukee, Wisconsin; followed by a second edition in 1985). From that time on, the amphibians and reptiles of Honduras and surrounding islands have been featured in a number of papers, mostly written by Wilson, Meyer, James R. McCranie, and Gunther Köhler.

Four excellent books have been published on Honduras in the new millennium. The first is *The Amphibians of Honduras* (2002, Society for the Study of Amphibians and Reptiles; Salt Lake City, Utah; ISBN 0-916984-57-5 [hardbound]) by James R. McCranie and Larry David Wilson with a foreword by Jay M. Savage. This is a large book—625 pages, 126 maps and figures, 33 tables and 20 color plates.

The next year, Gunther Köhler's *Reptiles of Central America* (Herpeton Verlag, Offenbach, Germany; ISBN 3-936180-02-4 [hardbound]) became available with a foreword by Wilson. A prolific author, most of Köhler's work has centered in Central America and this book covers the reptiles occurring from the Isthmus of Tehuantepec in Mexico to the southern extent of the Panamanian isthmus.

The next book is *The Amphibians & Reptiles of the Bay Islands and Cayos Cochinos, Honduras* (2005, Bibliomania, Salt Lake City, Utah; ISBN 1-932871-07-1 [hardbound]) by James R. McCranie, Larry David Wilson, and Gunther Köhler with a foreword by John R. Meyer.

The latest book is *The Amphibians & Reptiles of Cusuco National Park Honduras / Los Anfibios y Reptiles del Parque Nacional Cusuco Honduras*, by Josiah H. Townsend and Larry David Wilson (2008, Bibliomania, Salt Lake City, Utah; translated by Pauline M. Kulstad; ISBN 978-1-932871-12-8). Like so many other cloud forest herpetofaunal assemblages, this one is at risk. The authors put it this way, "…we predict that with continued human population growth, Cusuco National Park will come under increasing pressure from subsistence farming and urbanization." Each taxon account in Spanish and English includes common name, holotype specimen and type locality, similar species, description, distribution, localities in Cusuco, natural history, conservation status, remarks, and references. Rather than using a map to identify all named localities, a gazetteer is provided. Again, this fine book matches the qualities of the other books on Honduras except for maps—illustrated keys, readable text, splendid color photographs, and glossary.



The University of Georgia Press has published several books since 2005 which cover the amphibians and reptiles of the southeastern United States and some representatives are pictured here. These plates are by artist J. W. Hill from James Ellsworth De Kay's *Zoology of New York, or the New-York Fauna: comprising detailed descriptions of all the animals hitherto observed within the state of New York, with brief notices of those occasionally found near its borders, and accompanied by appropriate illustrations*, 1842–1844.

Imprint: Albany, New York, W. and A. White and J. Visscher.

Series: Natural history of New York.

Plate 7 shows the Musk Tortoise (*Sternothœrus odoratus*, now *Sternotherus odoratus*) above and Red-Bellied Tortoise (*Emys rubriventris*, now *Pseudemys rubriventris*); Plate 10 depicts the Black Snake (*Coluber constrictor*) above and Chain Snake (*Coluber getulus*, now *Lampropeltis getula*); Plate 19 includes Common Toad (*Bufo americanus*, now *Anaxyrus americanus*), Hermit Spade-Foot (*Scaphiopus solitarius*, now *Scaphiopus holbrookii*) and Bullfrog (*Rana pipiens*, now *Lithobates catesbeianus*) from top to bottom.

Amphibians and Reptiles of the Southeastern United States

The University of Georgia Press has published four exquisite books on the herpetofauna of the southeastern United States since 2005. The first is *Snakes of the Southeast*, by J. Whitfield Gibbons and Michael E. Dorcas (Athens, Georgia and London, ISBN 13 978-0-8203-2652-8). Three years later, three other books have appeared—*Turtles of the Southeast*, by Kurt. A. Buhlmann, Tracey D. Tuberville, and Whit Gibbons (ISBN 13: 978-0-8203-2904-4; ISBN 10: 0-8203-2902-9); *Amphibians and Reptiles of Georgia*, edited by John B. Jensen, Carlos D. Camp, Whit Gibbons, and Matt J. Elliott (ISBN 10: 0-8203-3111-2; ISBN 13: 978-08203-3111-9); and *Frogs and Toads of the Southeast*, by Michael E. Dorcas and Whit Gibbons (ISBN 13: 978-0-8203-2922-2; ISBN 10: 0-8203-2922-3).

All are of uniformly high-quality, clearly written, with an attractive layout. Each has solid introductory information, detailed species descriptions, excellent range maps and color photographs, line drawings showing defining features, and a strong conservation message. There is an explanation as to how to use the species accounts which will be of value to the lay reader. Several of the books also use "Did You Know?" sidebars to briefly explain interesting facts. One feature, used in the turtle and snake books, is the use of an illustrated sidebar for each taxon to help the non-herpetologist identify an unknown reptile.

Whit Gibbons, now retired Professor of Ecology at the University of Georgia (since 1989) and Senior Research Ecologist, Savannah River Ecology Lab, has written three other books: *Their Blood Runs Cold: Adventures with Reptiles and Amphibians* (ISBN 0-8173-0133-X, University, Alabama: University of Alabama Press, 1983), *Keeping All the Pieces: Perspectives on Natural History and the Environment* (ISBN 1-56098-224-1, Washington, DC: Smithsonian Institution Press, 1993), and *Ecoviews. Snakes, Snails, and Environmental Tales* (ISBN 0-8173-0919-5, University, Alabama: University of Alabama Press, 1998). These books are for a broad audience.

Bon Appétit

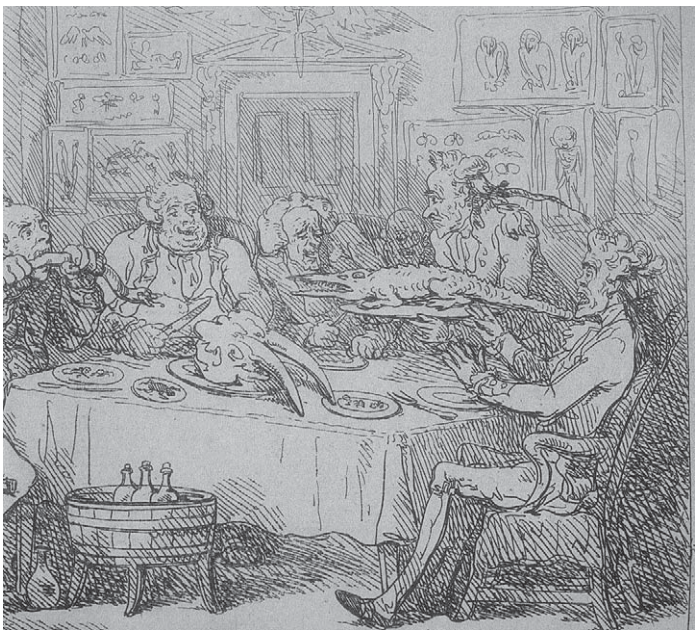
Imagine this scenario. You invite that very special someone to your home for a romantic, candlelit dinner. To prepare for the occasion, you pull out your best china, linen, crystal, and silver. When your guest arrives, the lights are turned down and soft music plays in the background. A lovely bottle of wine is opened. After a pleasant interlude of stimulating conversation, dinner is served. You bring the entree in a silver serving dish, remove the cover and plop a Deep Fried Brandied Amphiuma on your guest's plate. Could anyone imagine a more pleasant evening!

Even if this approach does not appeal to you, you must have *The Culinary Herpetologist* (2005, Bibliomania: Salt Lake City, Utah; ISBN 1-932871-05-5 [hardbound]; ISBN 1-932871-06-3 [paper]), by Ernest A. Liner. The book features over 950 recipes using amphibians and reptiles, though Liner does not recommend exploiting these for food. Rather, he stresses that these recipes are mostly listed for historical purposes.

I have enjoyed Ernie's cooking on several occasions. One of the most memorable followed the SSAR meeting in New Orleans in 1990 where dozens of guests were invited to a Cajun cookout. A huge grill on wheels was rolled into his front yard where roasted meats were prepared. Libations flowed freely and a merry time was had by all. Mercifully, as far as I know, Roasted Poison Dart Frog (Campa Indian Style) was not served.

The Bartlett Society

Abraham Dee Bartlett (1812–1897) was the great nineteenth century Superintendent of the Zoological Society of London from 1859–1897. Two of his books mention herps: *Wild Animals in Captivity Being an Account of the Habits, Food, Management and Treatment of the Beasts and Birds at the 'Zoo'*. . . (1899) and *Bartlett's Life Among Wild Beasts at the 'Zoo'* . . . (1900). The first book covered the habits of tortoises, including a charming story about a museum curator, alone at night when a loud commotion was heard. One of the tortoises, varnished and properly labeled, revived and knocked the other preserved chelonians all over the museum.



Banquet scene from Peter Pindar's *PETER'S PROPHECY … or, An important epistle to Sir J. Banks, on the approaching election of a president of the Royal Society. With an etching by an eminent artist. Third edition. London: printed for G. Kearsley, 1788*. Reproduced from *Slithy Toves: Illustrated Classic Herpetological Books at the University of Kansas in Pictures and Conversations*, by Sally Haines.

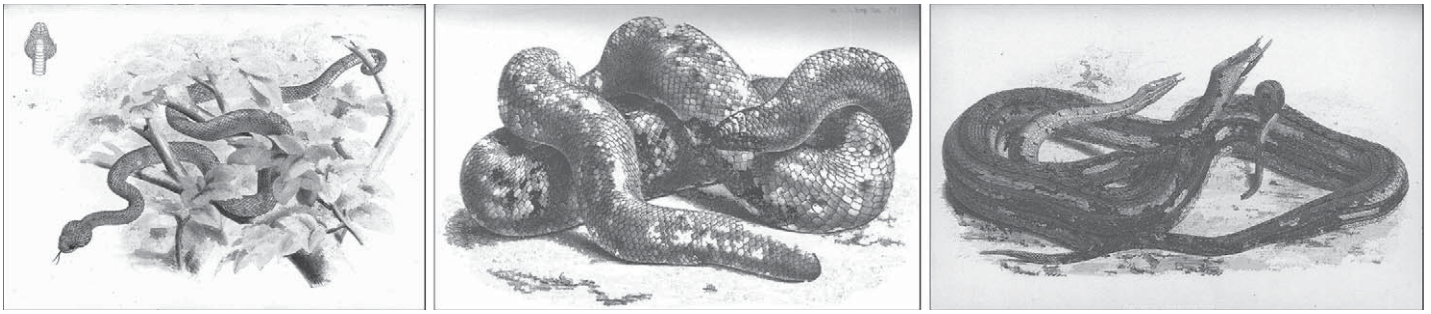
Imprint: [Ithaca, New York]: Society for the Study of Amphibians and Reptiles, in cooperation with the Kenneth Spencer Research Library at the University of Kansas, 2000.

In honor of his name, the Bartlett Society was formed for individuals who have an interest in the history of zoos, aquariums, and wild animal husbandry. Clinton Keeling and others founded the Bartlett Society in England on 27 October 1984 (the birthday anniversary of A. D. Bartlett). Soon after this an independent but corresponding branch was formed in North America, covering the United States and Canada.

The Bartlett Society in Britain, which accepts international members,



Force-feeding python at Central Park Zoo in New York. Credit: undated postcard, possibly around 1913, provided by Brint Spencer.



Sampling of snake art from the *Proceedings of the Zoological Society of London* between 1858–1863 (left to right): African Bush Viper (*Atheris burtonii*, now *A. squamigera*); African Burrowing Python (*Calabaria fusca*, now *C. reinhardtii*); Tentacled Snake (*Herpeton tentaculatum*, now *Erpeton tentaculatum*). Credit: collections of the Smithsonian Institution libraries, Washington, D.C.

produces bi-monthly newsletters, annual journals, and occasional special publications, as well as maintaining a zoo history website and holding meetings. There is an annual membership subscription and conditions for membership apply.

The North American branch publishes its own newsletter, and there is no subscription fee, although they do not hold meetings or produce additional publications.

For those interested in zoo history there is also the unrelated Indian organization—The Society for Promotion of History of Zoos and Natural History in India and Asia.

For more information about the Bartlett Society—admin@zoohistory.co.uk or http://zoohistory.co.uk or write to Paul D. Murphy, 81 St James Avenue, Upton, Chester, CH2 1NN. UK.

The founder of the Bartlett Society, the late Clinton Harry Keeling, published many books on British zoos, menageries, aquariums, and wild animal collecting: *Year of Janus* 2000*; Where the Leopard Lazed* 1999; *Where the Macaw Preened* 1993; *Where the Penguin Plunged* 1995; *Wonderful Year* 1995; *Chessington Story: The Story of the Chessington Zoological Garden* 1996; *One Man and His Animals* 1994; *Little Acorns Grow: The Early History of the Linton Zoological Garden . . .* 2003; *Where the Elephant Walked* 1991; *Where the Peacock Screamed. . .* 2002; *Sir Peter's Way: An Account of the Crucial First Year of Whipsnade. . .* 1999; *Where the Zebu Grazed: A Further Study and Discussion on Forgotten Animal. . .* 1989; *Where the Crane Danced: More about Zoological Gardens of the Past* 1985; *and Where the Lion Trod: A Study of Forgotten Zoological Gardens 1984.* Several are particularly relevant to herpetology: *A Short History of British Reptile Keeping* 1992; *Here, There and Regent's Park* 1992; *The Life and Death of Belle Vue* 1987; *Remember Belle Vue* 1997; *Belle Vue Bygones: A Farewell to the Manchester Zoological Garden* 1990; and *They All Came Into the Ark: A Record of the Zoological Society of London in . . .* 1988. All were privately published by Keeling (Clam Publications, Guilford, England).

The Zoological Society of London (ZSL) developed four important serials. The *Proceedings of the Zoological Society of London*, begun in 1833 and later changed to *Journal of Zoology, Series A*, was the vehicle for publishing scientific papers, many in herpetology. The *Transactions* were absorbed into *Journal of Zoology, Series B*. In 1987, *Series A* and *Series B* were merged to form *Journal of Zoology*.

The annual *International Zoo Yearbook*, launched in 1960, is the premier publication for research by zoo and aquarium personnel worldwide. In 1864 the first volume of *The Record of Zoological Literature* was edited by Albert C. L. G. Günther and this series remains a valuable bibliographic reference over 140 years later. The ZSL Symposia series was started in 1960 and many of the volumes are devoted to topics of interest to zoo professionals: captive and medical management, conservation, and other relevant issues.

Art was an important component in the *Transactions* and *Proceedings* of the ZSL, detailed in two excellent books—*Transactions of the Zoological Society of London: An Index to the Artists, 1835–1936*, compiled by Nina J. Root and Bryan R. Johnson. New York: Garland Publishing, 1986; and *Proceedings of the Zoological Society of London: An Index to the Artists, 1848–1900*, compiled by Nina J. Root and Bryan R. Johnson. New York: Garland Publishing, 1986.

Acknowledgments.—I am grateful to Emily Becker, Dana Fisher, and James Hanken from the Museum of Comparative Zoology, Harvard University, for providing most of the illustrations. All colored originals have been converted to a black-and-white format. Thanks are also due to Kraig Adler, Danté Fenolio, Marla Krauss, Polly Lasker, Paul Murphy, Robert Olley, Leslie Overstreet, Jennifer Pramuk, Brint Spencer, and Daria Wingreen. My wife Judith Block read early drafts and made critical changes to make my articles comprehensible.

Part III will appear in the next issue.

—James B. Murphy, Section Editor

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Hanzaki Pilgrimage: A Visit to the Home of the Giant Amphibian

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The Japanese Giant Salamander, *Andrias japonicus*, is a huge aquatic salamander that occurs on southwestern Honshu Island and two southern islands—Shikoku and Kyushu. The species is commonly known in Japanese as "hanzaki" or "hanzake," literally "cut in half," in reference to a false belief that it is able to regenerate itself even if cut in half (Goris et al. 2004). Studies on this indigenous amphibian by Japanese scientists began in 1887 with an account by Prof. Chujiro Sasaki (Kobara 1985; Kuwabara 2007). Captive breeding was first recorded in the Amsterdam Aquarium in 1903 (van Bruggen 2003). More recently, groups of researchers left the familiar zoo and aquarium boundaries for field research. Dr. Jiro Kobara of Asa Zoo, Hiroshima (opened in 1971) was the first of these workers; by 1973 their work was well under way. In 1975, Takeyoshi Tochimoto, Director of Himeji City Aquarium, began fieldwork (Kawata 2006; Murphy 2007). Based on data from the field, Asa Zoo formulated a captive breeding program, and larvae hatched in 1979 (Kuwabara et al. 1989), more than three-fourths of a century after Amsterdam's first breeding.

Hanzaki is protected by Japanese national law. In 1951 the species as a whole (with no specific geographical distributions, as in many other protected species) was designated as a Natural Monument by the Japanese government. In the following year it was upgraded to Special Natural Monument (SNM) status, which placed hanzaki under stricter protective measures. Interestingly, the government agency in charge is the Agency for Cultural Affairs, not the Ministry of the Environment, as one would expect. Thus, in theory the species is regarded as a cultural heritage, rather than a part of nature. The SNM designation adds charisma and potential political clout to the presence of the species. For instance, under the provision of the law a research project that could alter the existing conditions (physical manipulations, capture, transport or invasive surgical procedures) requires a special permit issued by the Agency for Cultural Affairs.

In practice, the process of permit issuance is handled by the board of education of a prefecture. (Japan is divided into four dozen or so administrative and political units called prefectures, similar to provinces or states.) Because of the perceived aura attached to the SNM status, bureaucrats in the prefectural governments within the range of hanzaki tend to guard hanzaki as *their* heritage. This could easily lead to increased political and territorial control. As a result, every step of permit application and implementation requires jumping through hoops, which handicaps researchers. Moreover, there is hardly any communication among prefectural officials. There existed an urgent need for those involved in hanzaki conservation to meet in person. Mr. Tochimoto organized a national annual conference, Asa Zoo staff assisted in administrative aspects, and the first conference was held in 2004. Fifty enthusiasts and experts gathered, an attendance figure which exceeded expectations, to open a communication channel. The attendance grew to 90 for the second conference, and for the third meeting, 150 assembled for technical sessions on a variety of topics. The fourth conference in 2007 was attended by about 100 delegates. With growing interest and concern over the threats to *in situ* populations, hanzaki continues to carry a larger-than-life image, which I was about to explore.

In April 2008, I made a trip to western Japan, into the range prefectures of hanzaki. The trip was prompted by an invitation to a college class reunion, and as a retired zoo man I took this opportunity to visit zoological collections. Also, a part of the itinerary was set aside for paying tribute to those who are associated with the study of this legendary animal. On 6 and 7 April the pilgrimage began at Asa Zoo in Hiroshima. In the science museum of the zoo was a huge preserved specimen, 150.5 cm long and weighing 27.6 kg at the time of its death on 14 July 2002 (it had been maintained elsewhere in Hiroshima Prefecture). There were leaflets and flyers about hanzaki for children, and live specimens, including adults and larvae, were on exhibit at the zoo. I also visited the off-premises breeding area (Fig. 1). It is here that the four-chamber breeding tank was built, designed after the breeding dens in the wild. In 2007, full second-generation hanzaki in captivity were born, three decades after the beginning of the zoo's field study.

After the zoo visit it was time to leave the bustling city, and early on 9 April, Dr. Kuwabara of Asa Zoo picked me up. As he drove through country roads, we reached a pastoral area that can best be described as *satoyama*: for centuries, the center of

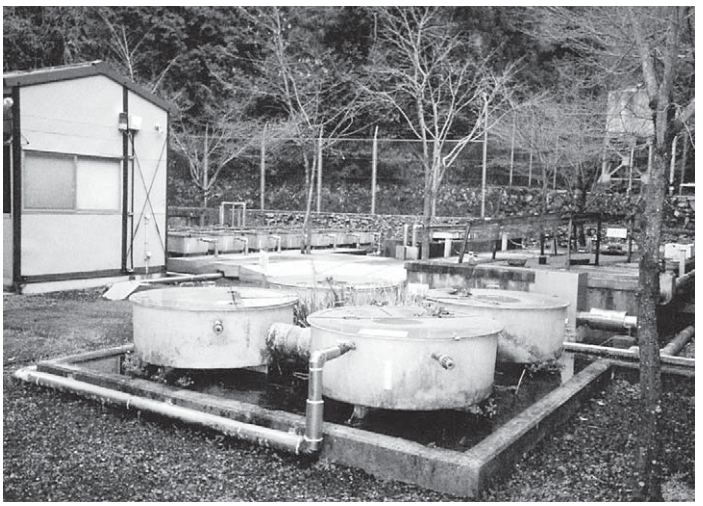


FIG. 1. Off-exhibit hanzaki propagation area, with breeding tanks, Asa Zoo, Hiroshima.

Japan's rural life was represented by an environment consisting of a paddy system (often terraced), streams, ponds, and woods, interconnected with a village where rice farmers lived. This is called *satoyama*, a stable habitat for many wildlife species. (Recently, *satoyama* has been vanishing at a rapid pace due to development.) The car pulled up behind a gasoline station and Kuwabara said, "This is it, the habitat, our study site." I got out of the car. There was nothing exotic or special about this piece of the land for wet cultivation of rice. A stream named Matsuzaigawa flows through paddies and bamboo bushes along houses and a country highway (Fig. 2). But a large sign by the stream, with a cartoon-like hanzaki, clearly states, "Where culture and nature richly intermingle: Forest and river in which hanzaki babies grow." Abruptly, a long-held romantic myth from childhood crashed into flame. For decades, written accounts have convinced us that hanzaki, a mysterious monster, lives in pure streams high up in remote mountains. In reality the pure stream water makes a poor habitat, and hanzaki often live side by side with rural people,



FIG. 2. On the surface it appears to be a typical Japanese pastoral scene; it also represents a hanzaki habitat and the Asa Zoo study site, in Hiroshima Prefecture. A stream (Matsuzaigawa), 1–2 m wide, flows through rice paddies; under the shed lies an artificial breeding den.

as well as in remote mountainous areas.

We met with Mr. Fukunaga, the local representative of the hanzaki program. We then walked across the highway. Before arriving at a Buddhist temple we passed a bridge over a stream which included a hanzaki breeding den. Mrs. Asaeda, the monk's wife, and their daughter greeted us; Mrs. Asaeda was the director of a kindergarden on the temple grounds. The kindergarden was not in session but we walked in, and noticed cloth models of hanzaki, more educational material, newsletters, and other publications. The curriculum centered on hanzaki, and special events are held to celebrate the life of hanzaki. The word "conservation" was largely absent, yet the educational approach no doubt leaves a strong impression on the children's minds. It is essential that local citizens participate in the wildlife research and conservation effort, and a grassroots environmental movement is evident in this small rural community. The villagers have been a vital part of the zoo's research team. For example, the egg-laying season constitutes the most crucial period for researchers, during which they conduct a minute-by-minute, around the clock observation. The temple offers lodging for biologists, who take six-hour shifts for a week to 10 days.

The community participation has its roots in the culture and history of the region. In some parts of Japan, hanzaki is regarded as a delicacy and still is being poached, but that is not the case here. Hanzaki has long been regarded as the mythical master of the river. The zoo group introduced the study of biology and a new meaning for the species to this traditional view. Villagers take pride in their heritage, as noted in the curriculum of the kindergarden. That also explained why the community leaders welcomed this expatriate, who came from New York to see the study site. The community-based effort, however, represents an exceptionally bright spot; hanzaki is lucky to have influential allies in the form of community leaders on its side. After the temple visit we were back to the stream, a habitat that had already gone through a major alteration. Even this serene *satoyama* could not dodge the marching force named progress.

Whatever a visitor sees in Japan could be peculiarly deceiving. The maximum protection by law does not interfere with the devastating act of habitat destruction, which jeopardizes the very survival of hanzaki. Herein lies the ultimate irony concerning the protection of wild hanzaki populations. The construction of weirs and dams, the so-called "reinforcement" of river banks and bottoms with concrete, and the alteration of rivercourses prevent migration, access to nest sites, and limit food supply. The altering of the environment has increasingly fragmented hanzaki's suitable habitats. The relentless destruction of Japan's natural environments, little known to the West, has been chronicled eloquently by Kerr (2001). Should the current course continue, "The future of these magnificent animals, which may be the largest living amphibians, still remains bleak (Goris et al. 2004)." In fact a fleet of bulldozers descended upon the zoo's study site for a project to restructure paddies for mechanized farming. By the time a plan was underway in 1984, the zoo staff had accumulated enough data as a conservation tool.

The stream (Matsuzaigawa) had a population density of 50 hanzaki/km. The stream gradient was about 4 m for a 290-m segment that required, according to the plan, 12 weirs. At this juncture the zoo staff made four recommendations to the civil engineers: 1) avoid straight lines when altering the water course, because floods will push hanzaki downstream; 2) banks may be concreted, but leave the bottom as natural as possible; 3) weirs must have ladders with footholds, properly spaced out to enable climbing by the animals; and 4) build artificial dens. All recommendations were incorporated and the work was completed in March 1985 with the first artificial dens in Japan (Fig. 3). In September of the same year, egg-laying was noted in an artificial den, thus hanzaki's adaptability to a changing environment came as a pleasant surprise for everyone. Villagers continue to participate in the hanzaki project. They patrol the area to ensure that sand and gravel do not block the entrance and the tube to the artificial den after a flood. Through a narrow footpath between rice paddies I reached an artificial den and stared into dark water, imagining how a den master would defend eggs during the breeding season.

It was time to hit the road again. Already into the afternoon Dr. Kuwabara was moving fast, and I was unaware that we had left Hiroshima into another prefecture, Shimane. Soon, the car slowed and two red-slate-roofed buildings were awaiting us. We stepped in the Hanzake Field Museum (opened in 2000), a richly interpretive facility with an auditorium, exhibit halls with graphics, panel displays, preserved and live animals, and a gift shop (Fig. 4). I purchased picture postcards, and picked up attractive leaflets and an excellent booklet on hanzaki (all in Japanese, as usual). The museum is also keen on natural history of the region, in addition to the giant salamander. There are events such as after-dark observation workshops (giant salamanders are mostly nocturnal). There is even a children's song about the giant amphibian; in a nearby township there are a trail and a building over a stream for observation.

However, wandering through the exhibits and chatting with the staff, I could not shake off a question. For this rural area, the museum and other facilities appeared to be a luxury. Well, almost. The town is so far away from any major city, away from hordes of tourists. It must be costly for them to build and operate such a disproportionately large facility, particularly featuring a

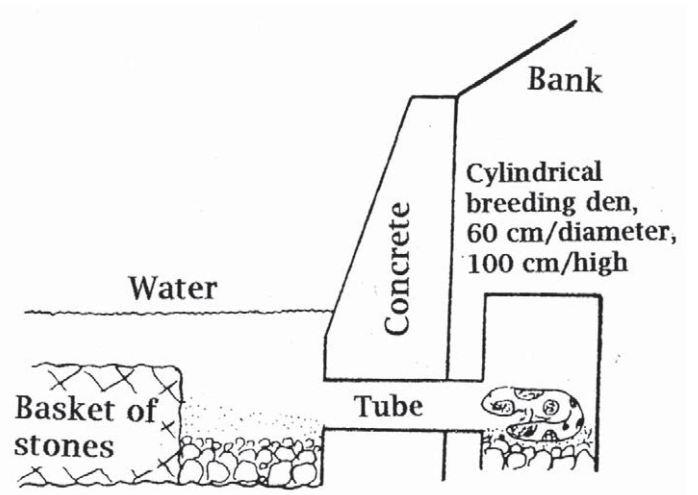


FIG. 3. A cross-section of an artificial breeding den, designed by Asa Zoo staff, patterned after an in situ model. A tube, 15 cm in diameter and 70 cm long, leads to a cylindrical concrete den. Modified after Kuwabara (2004).



FIG. 4. Hanzake Field Museum, Shimane Prefecture.

creature that is not cute and cuddly. The grass-roots enthusiasm must be infectious, but promoting it requires funds and a political will. (Without my asking the question, Ms. Shabana, the museum director, later wrote to me, explaining that the museum was built as a base for an eco-museum concept, and actively being utilized for environmental education.)

As we began our long drive back to Hiroshima, we talked about a new threat to hanzaki. According to IUCN (2008): "It might also be facing competition from the introduced Chinese Giant Salamander (*Andrias davidianus*). Genetic uniformity in this species is high, which increases its vulnerability to threatening processes." A newspaper account noted that Prof. Masafumi Matsui of the University of Kyoto surveyed hanzaki populations in various rivers in 2005 and 2006, and found a large population in Kansai district (west-central Japan). A DNA test revealed that four out of 22 specimens turned out to be *davidianus,* which may have established a breeding population. These four were found in the entrance area of a breeding den during the egg-laying season. The professor commented that *davidianus* could present a serious threat to the conservation of the indigenous *japonicus.* These alien salamanders can be traced back to some 800 *davidianus* that were imported by a dealer in Okayama Prefecture in 1972, and were distributed to restaurants (Anon. 2007). Apparently, the intended culinary delight never caught on, and some of them found their way into local freshwater systems, such as the Kamogawa River in Kyoto.

Also, *A. davidianus* is sporadically found in Japan, after possible release by (or escape from) individuals who imported them. One such example was noted by a Westerner who watched a large specimen in an aquarium in Hakone, Shizuoka Prefecture. "I would have liked to know things like how long it's been at this aquarium and where it came from, but the staff there were few in number and pretty clueless, to say the least. At a couple of other facilities I've seen in Japan, the *A. davidianus* were all 'wild-caught' by fishermen after having been released into local rivers—either having escaped from the menu or having been released after becoming too big and troublesome to be kept in captivity (Johnson 2007)."

From Hiroshima, I headed east and arrived at Hyogo Prefecture, skipping Okayama Prefecture in between. Early in the morning of 12 April, Kakinoki, a young biologist from the Japan Hanzaki Institute, picked me up in front of the train station in Himeji, a city known for the grandest of Japan's remaining feudal castles. After leaving the city, the car started to climb a series of highways into mountainous regions. The higher we climbed, the more desolate the landscape became and soon, a river loomed on the left side of the highway. Up on the steep hillside were tall cedar trees, forming an economically feasible, artificially nurtured forest. What caught my eye, however, was an orange-colored piece of heavy equipment scraping up the riverbed in a repetitive motion (Fig. 5). A layer of vegetation had largely been peeled off of the hillsides, replaced with panels of square concrete frames, possibly for bank reinforcement, as if postage stamp sheets have been slapped upon a naked surface of mucous membrane. This view reminded me of the book by Alex Kerr (2001), which vividly portrays how rivers and streams get violated with emotional impunity. Then the river departed, and our journey to Japan Hanzaki Institute continued. It takes about an hour by car from Himeji, but using public transportation is a different story. It requires a train ride from Himeji, changing trains once, and after one hour one takes a local bus ride for 30 minutes.

After retirement from the directorship of Himeji City Aquarium in April 2005, Takeyoshi Tochimoto established the Japan Hanzaki Institute (Fig. 6). It is located in his study site in this mountainous area, some 470 m above sea level. Surrounded by steep canyons and valleys, this small community typifies a dilemma facing remote agricultural and forestry regions in Japan. Younger generations

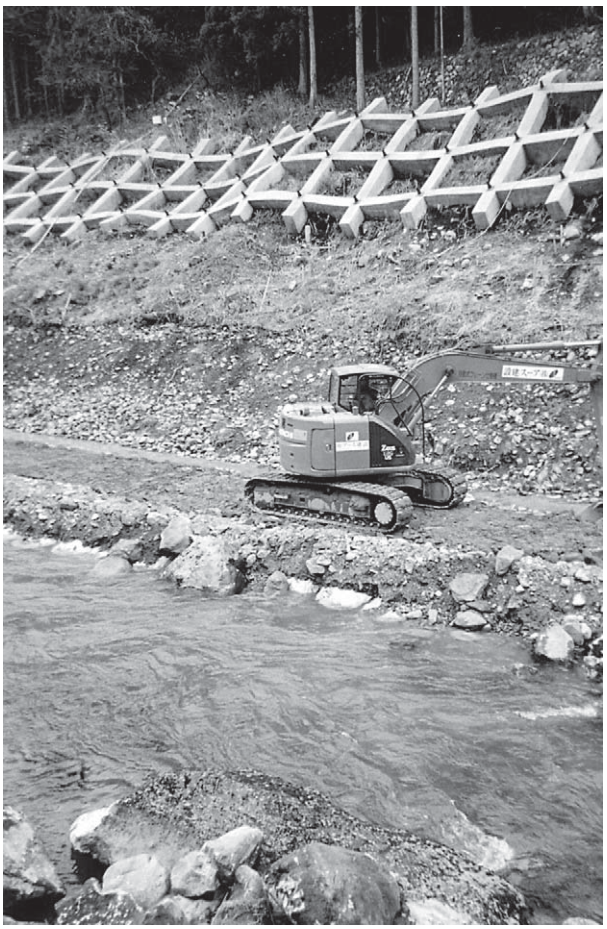


FIG. 5. Rivers and streams are being altered at a rapid pace, a common sight in Japan, Hyogo Prefecture.



FIG. 6. Japan Hanzaki Institute; underneath the bridge flows a river, another hanzaki habitat. Hyogo Prefecture.

depart for cities, leaving behind aging and shrinking populations, cut off from the economic prosperity of urban areas. There was an elementary school that had been closed for over a decade. Located by the river, it consisted of a classroom building, a gymnasium, a principal's residence, and a swimming pool. Mr. Tochimoto rented this facility and converted it into the institute. He gave me a tour of the facility. The images that I had seen earlier in the institute's newsletters began to blend into reality. The classroom building houses a library, lecture rooms, a depository of natural history specimens and artifacts, and his office. The children's swimming pool has become a temporary holding station for hanzaki during river "reinforcement" projects (at my visit he had 60 hanzaki in modified tanks). The foundation is here for the formation of a natural history museum.

Field research is by far the primary mission for the institute. Thus far, 1350 hanzaki have been individually identified in the area. Tagging and recording the pattern of blotches on the tail constituted the initial methods. It became evident, however, that tags fall off, and illustrating the color patterns of so many individuals proved to be an unrealistic approach. Transponders offered a solution, and about 750 animals have been identified by this approach. The long-term goal is to trace their lives in the natural habitat. Hanzaki have a long generation time; sexual maturity takes 16–17 years in captivity. Thus, it might take several generations of researchers to determine the natural life span of hanzaki. Another task for the institute is environmental education. Through classes and other activities, children are taught the importance of hanzaki in their own surroundings. The institute also plans to help to revive the declining village community. By nurturing increased awareness, hanzaki can become the theme for this endeavor and hopefully will attract tourists. At this time the institute is largely a one-man operation, and a step has been taken toward incorporation into a non-profit organization. Currently the institute is open to visitors by advance appointment.

The wholesale destruction of freshwater environments, which has swept the Japanese archipelago, is at work even in this remote region. In a nearby river a flood flushed down a large number of hanzaki below a dam, and 100 of them were seen at the bottom, trying in vain to move back upstream. At the institute I saw a



FIG. 7. Stones chained and strung together, to function as a ladder for aquatic animals from crabs to hanzaki. At the Japan Hanzaki Institute.

photo of one of them with injured feet, as a result of a desperate attempt to climb a concrete wall. More recently, at the urging of biologists, civil engineers and government agents have responded. Mr. Tochimoto showed me some of the remedial measures that construction companies have devised. One was the "shelter block" to be installed on the concreted riverbank. There are various types, but they all have entry holes and cavities for aquatic creatures from invertebrates to fish and hanzaki. Another one resembles a bunch of grapefruits, but instead is made of large stones chained and strung together (Fig. 7). This can be bolted by a weir or dam to enable hanzaki and other creatures such as crabs to climb over.

Mr. Kakinoki's next stop was the site of a large-scale civil engineering project at the Izushigawa River. But we first reviewed commercial trout ponds. During the project hanzaki had to be captured and held, and the civil engineering firm rented rainbow trout ponds for them. At one time Mr. Kakinoki held 400 hanzaki. With the project nearing its end, hanzaki were now being returned to the river. We left the trout ponds for the river, climbed on the riverbank and walked down to stand on top of an artificial hanzaki breeding den. I scanned the panoramic waterscape; it was concreted and reshaped, so far removed from the gentle and embracing image



FIG. 8. Notice the shelter blocks installed (to the left) on the concreted riverbanks. Izushigawa River, Hyogo Prefecture.

of a river. I noted many shelter blocks in use, and Mr. Kakinoki told me that 49% of the 15-km stretch had been treated with shelter blocks (Fig. 8). That constituted quite an effort. It was late in the afternoon, we had to drive back to Himeji and I turned around to take a good look. There is hope, but can hanzaki continue its life cycle in an altered new environment? The jury is still out.

Acknowledgments.—I express my sincere appreciation to Drs. Yukio Fukumoto, Director, and Kazushi Kuwabara, Administrative Director, Asa Zoological Park, and Mr. Takeyoshi Tochimoto, President, Japan Hanzaki Institute, for cordially making arrangements, hosting my visits, and providing literature and information. In two trips, Messrs. Kuwabara and Shunsuke Kakinoki patiently drove through rural areas to introduce me to the animal's habitats, local institutions, and residents. Thanks also go to Dr. Kuwabara for critically reviewing the manuscript.

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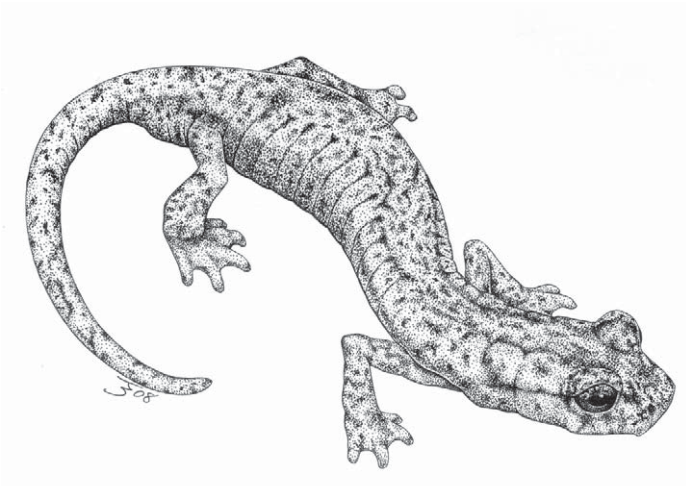
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Hydromantes shastae (Shasta Salamander). USA: California: Shasta Co., vic. Shasta Reservoir. Illustration by Jackson D. Shedd.

LETTERS TO THE EDITOR

Herpetological Review, 2008, 39(4), 412–413.
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Essential History of Herpetological Societies: Origins of the ASIH, HL, and SSAR

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Recent publication of the new *Dictionary of Herpetology* (Lillywhite 2008) has evoked reassessment of the historical origins of the North American-based herpetological societies: ASIH, HL, and SSAR. Notices about the new book have appeared in emails distributed by the Center for North American Herpetology, and specific references to the entries for these societies in the *Dictionary* require some expanded comments. Here I provide historical details from the published record to clarify the situation.

ASIH

The new *Dictionary* entry for the American Society of Ichthyologists and Herpetologists (ASIH) states that the society was established in 1913 by J. T. Nichols. This is not strictly correct if one refers to the official chronology published by ASIH (Berra 1984). In 1916 a publication committee was established for *Copeia* and consisted of John T. Nichols, Henry Fowler, and Dwight Franklin, who collectively organized the American Society for the Study of Fishes and Reptiles. In the same year bylaws were adopted, and the name of the society was changed to American Society of Ichthyologists and Herpetologists, which held its first official meeting on March 8, 1916 at the American Museum of Natural History. Previously, in December of 1913, John T. Nichols had published the first issue of *Copeia*, named in memory of Edward D. Cope. During these early years the journal was published privately by John T. Nichols. There is no mention of ASIH in the early issues of *Copeia* through 1916.

It is a common confusion that the journal *Copeia* and the society of ASIH began at the same time, but this is not true. However, some herpetologists consider the history of the Society "as one continual event dating back to 1913," and there is little historical information available to judge the definitive history of the Society during its early formative years (Berra 1984). While some may consider the publication of *Copeia* as the rudimentary origin of the ASIH, it seems best to mark the formal birth of the Society as 1916 when the name was officially designated by a duly empowered body.

The Herpetologists' League

With respect to the The Herpetologists' League, the organization's past (but not current) website stated that the HL was established in 1936, as does the entry for "Herpetologists' League" in the new *Dictionary of Herpetology*. To the contrary, this is the year marking the first publication of the journal *Herpetologica*,

founded by C. Grant, W. L. Necker, and H. K. Gloyd. Grant and Necker edited the first issue with the essential support of Gloyd, who was Director of the Chicago Academy of Sciences and allowed Necker to have free access to the printing facilities of the Academy. During these early years the journal was published privately by Chapman Grant. As a society, the HL was started later in 1946 (Smith 1986). There is no mention of The Herpetologists' League in early issues of *Herpetologica* prior to 1946. It is of interest to note that the HL was founded originally as an affiliate of AAAS, and the society met jointly with AAAS for many years until the latter organization terminated meetings with all smaller societies at its annual meetings. As with the ASIH, there is obvious confusion or difference of historical interpretation concerning the origins of the HL being separate from the journal that has been published by that society. Hobart M. Smith (1986) wrote:

> The strangest fact in the history of the Herpetologists' League is that it was born, in 1946, of its journal, *Herpetologica*, established in 1936; the reverse is normal for societies, popular and scientific, and their publications…. A somewhat similar history (Grant, 1947:146) exists in a sister journal, *Copeia*, founded in 1913 by John Treadwell Nichols; the journal was later (1924, No. 126) adopted by the American Society of Ichthyologists and Herpetologists (already in existence for eight years) as its official organ (Dunn, 1924; Nichols, 1923).

As a further complicating historical note, the apostrophe in The Herpetologists' League did not appear anywhere in the League's publications until 1960 (Grant, cited in Smith 1986).

SSAR

There is further misunderstanding concerning the beginnings of SSAR. The new *Dictionary of Herpetology* states the origin of this society as being founded in 1967, but the origins of the SSAR can be traced to 1958 when The Ohio Herpetological Society was founded by Kraig Adler and David M. Dennis (Preest 2007). At the birth of the OHS, the early officers felt a need to form a regional society at a time when the ASIH and HL were already in existence. However, the OHS grew to 75 members and 10 institutions, representing 11 states and four countries, within its first year. In 1967 the OHS changed its name from The Ohio Herpetological Society to the Society for the Study of Amphibians and Reptiles, while retaining the same officers, publications, and constitution. The change of name was made to reflect the increasingly international membership and mission of the Society, which had grown to exceed the regional identity of the organization. Thus, while strict interpretation of the origin of the named society (SSAR) may be problematic to some, OHS and SSAR are one and the same organization, in spite of the name change in 1967. The Society itself regards the SSAR as a "continuation" of the OHS, as recorded in its official silver and golden anniversary publications (Ford and Collins 1983; Moriarty and Bartholomew 2007). Indeed, SSAR celebrated its 50th anniversary meeting last year in Saint Louis, thus recognizing 1958 as its year of founding.

There is an important distinction between the founding of the SSAR and the other two societies. Both *Copeia* and *Herpetologica* were started and run privately by individuals for many years before the two later-associated societies came into being. The OHS, however, began as a society with journal and newsletter from its inception in 1958. What occurred later in 1967 was a mere change of name (to SSAR).

For all three societies discussed here, a few persons have argued for different years, modes of origin, and founders of the organizations and/or with journals that have become the respective central arms of these societies. This statement is important, because I do not wish for the society entries in the 2008 *Dictionary of Herpetology* to be cited as a final authority. It should be up to each society to record its own history. Disagreement will likely continue in spite of the suggestions here favoring the stringent interpretations stated, which are based on the published record.

Acknowledgments.—This communication is published with the approval and support of the Presidents of each of the societies that are discussed: Henry Mushinsky (ASIH), David Cundall (HL), and Roy McDiarmid (SSAR). I am also grateful to Harry Greene, Kraig Adler, and David Cundall for relevant comments and improvements to the manuscript.

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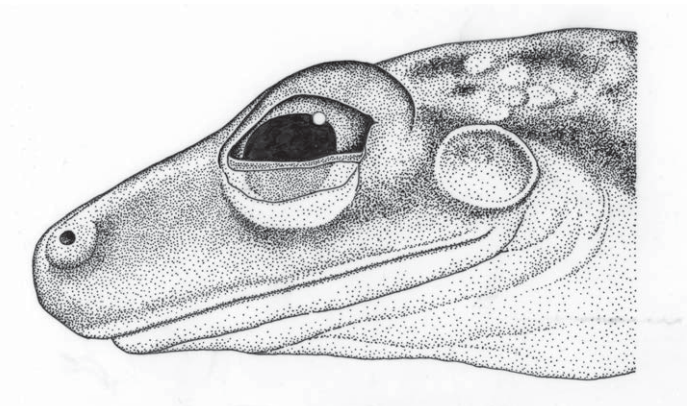
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Scinax staufferi. México: Yucatán (UJRC 79-291). Illustration by Julian C. Lee.

ARTICLES

Herpetological Review, 2008, 39(4), 414–419.
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Ecology and Natural History Observations of the Salamander, *Siren intermedia nettingi* (Western Lesser Siren), in Northern Indiana

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The Lesser Siren (*Siren intermedia*) is an unusual two-legged salamander with external gills retained into adulthood. They inhabit shallow semi-permanent and permanent wetlands, sloughs and ponds that have abundant aquatic vegetation and deep mucky to sandy sediment that provides burrowing sites (Petranka 1998; Smith and Minton 1957). Lesser Sirens are able to survive droughts by using crayfish burrows or burrowing into mud to depths from 8 cm to 1 m where they aestivate until the pool refills (Blatchley 1900; Cagle 1942; Harding 1997).

The Lesser Siren also has an unusual distribution, inhabiting the Atlantic and Gulf Coastal Plains with a northern extension through the mid-Mississippi, Illinois, and Wabash Vallies (Leja 2005; Petranka 1998). The western subspecies (*S. i. nettingi*) is found in Indiana throughout the Wabash and Kankakee drainages with isolated populations in the Lake Michigan drainage in extreme northwestern Indiana (Atkinson 1896; Minton 2001). The northern populations in Indiana are often fragmented and isolated (Brodman 2003; Brodman and Kilmurry 1998; Leja 2005; Petranka 1998).

Because these amphibians are highly secretive and difficult to observe, relatively few ecological studies have been conducted on Lesser Sirens (Petranka 1998), and, moreover, very few of these studies have been on northern populations. Ecological studies and natural history observations of northern populations of Lesser Sirens should provide useful information for conservation and increase the understanding of the ecology of species distributed along a north-south axis. Herein field and laboratory observations of population trends, body size, diet, habitat preference, and aestivation for Lesser Siren populations in northern Indiana over an eleven-year period are provided.

Methods

Lesser Sirens were sampled from 1998–2008 from 21 sites at Jasper-Pulaski Fish and Wildlife Area in Indiana. These populations are among the most northern extant populations known for this species (Fig. 1). The sites consisted of 11 seasonal to semi-permanent wetlands, two permanent wetlands, five shallow lakes and three drainage ditches. Each site was visited several times a year in May, June, and October after sundown to search for active sirens by flashlight. However the primary method for sampling sirens was using un-baited metal minnow traps in March, April, June, September, October, and November. Minnow traps were placed in shallow areas near aquatic vegetation. The number of traps and the number of days that traps were set varied among sites and among years because ponds dried at different times and could no longer be surveyed. I recorded the number of animals caught per trap-day for each site and year to standardize the data.

All traps were checked within 24 h of being set and all of the animals caught by traps were identified and released. The sirens were measured (TL) and inspected for scars and malformities before being released. Sirens were not sexed or marked. Sirens greater than 18.0 cm in TL were recorded as adults (Petranka 1998). A small number of sirens escaped before being measured and another small number of sirens were found dead in the minnow traps. All of the dead sirens were preserved as vouchers in 70% isopropyl alcohol and deposited in the Saint Joseph's College Zoology collection. Sirens were later dissected to determine stomach contents. Prey items were identified to family using Pennak (2001).

Habitat characteristics of each site (depth, vegetation type, hydroperiod) were recorded. In 2003 samples of the substrate where minnow traps were placed were collected and analyzed to determine soil characteristics and pH.

In 1998 half of the minnow traps were baited with sardines and half were un-baited to determine if bait would increase the number of sirens caught in traps. In 1999 half of the minnow traps were plastic and half were metal to determine if one type was more effective in capturing sirens. In 2004 half of the minnow traps were altered by increasing the opening from 3 to 5 cm to determine



Fig. 1. The distribution of the Lesser Siren (indicated in gray), adapted from Minton (2001) and Lannoo (2005). The black area indicates the location of the study sites at Jasper-Pulaski Fish and Wildlife Area.

if a larger opening would increase the maximum size of sirens captured.

Six adult sirens in fall 1998 and 18 sirens (nine juveniles and nine adults) in fall 2004 were collected from one site and kept in aquaria for observations of behavior and feeding. In 1998 pairs of similar sized sirens were kept in three 56.8-liter glass aquaria filled with 40 liters of un-chlorinated well water over a 3 cm layer of aquarium gravel. The sirens were observed in captivity for four weeks and then released at the site of capture. The sirens were fed a variety of live prey including earthworms, *Tubifex* worms, aquatic insects, crustaceans, snails, clams, tadpoles, fish, and also processed food such as shrimp pellets, mussels, and sardines. Each siren was observed a number of times during the day and after sundown with 1-lux lights covered with red cellophane filters.

In 2004 individual sirens were kept in eighteen 17.9-liter plastic containers measuring 26.5 cm H × 32.5 cm L × 23.5 cm W to study aestivation. A control group (three adults and three juveniles) had a 13 cm layer of sediment from the natural pond and 7.5 liters of pond water added to the container which resulted in a layer of standing water 10.5 cm above the surface of the pond substrate. To prevent aestivation in the control group, pond water was periodically added to these containers to maintain the water level. Two treatment groups were set up to simulate pond drying. The slow drying treatment (three adults and three juveniles) had 4.5 liters of pond water added to the containers resulting in a 7.5 cm layer of standing water over a 13 cm layer of pond substrate. The fast drying treatment (three adults and three juveniles) had 3.0 liters of water added to containers resulting in 6 cm of standing water over a 13 cm layer of pond substrate. The drying treatments were allowed to dry to initiate aestivation of sirens. Until sirens initiated aestivation, they were fed live earthworms and observed daily after sundown with 1-lux lights covered with red cellophane filters. The position of each siren was recorded (water column, on substrate, body inside borrow but with head out, inside burrow with opening unplugged, inside burrow with opening plugged with mud) during each observation. Sirens were considered to be aestivating when they were buried in the substrate with the burrow opening plugged with mud for an extended number of days. The experiment was terminated after four months when aestivating sirens were removed from the dry mud. The presence of a secreted cocoon around an inactive siren was used to confirm aestivation. Aestivating sirens were then re-hydrated with un-chlorinated well water. Surviving sirens were released at the site of capture.

Regression was performed as exploratory analyses to determine if there were any relationships among abundance, TL, size class, diet, substrate (soil type and pH), coexisting species, habitat and recovery from aestivation. ANOVA was used to determine if minnow trap treatments (altered vs. unaltered opening, plastic vs. metal, baited vs. un-baited) affected the number or size of sirens captured. MANOVA was performed to test the effects of drying treatments and age class on siren behavior and survival.

Results

Population trends.—From 1998–2008 a total of 167 sirens were captured in 2633 trap-days. This is a mean of 15.2 sirens captured in 239 trap-days per year. The number of sirens captured per trap-day fluctuated from year to year with spikes in abundance in 1998, 2001, and 2007 followed by declines over the following two years (Fig. 2). There were no significant differences ($\alpha = 0.05$) in the number of sirens captured in baited traps, plastic traps or traps with enlarged openings compared to un-baited, metal, unaltered minnow traps.

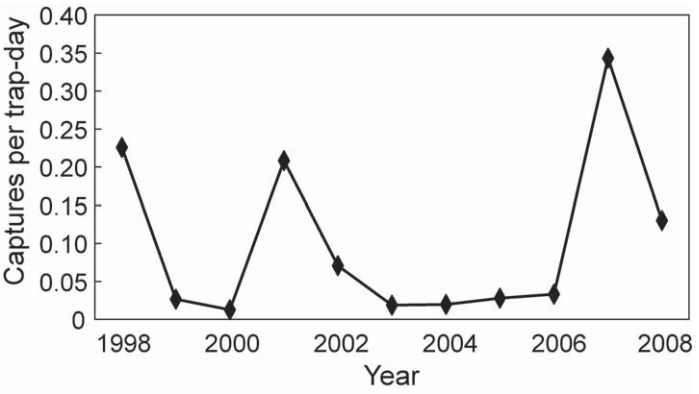


Fig. 2. Population trends of Lesser Sirens at Jasper-Pulaski Fish and Wildlife Area. Values are the number of sirens caught per trap-day of effort from 1998–2005.

The mean and SE of the TL of sirens captured in minnow traps was 26.5 cm ± 1.1 (range 13.0–43.2 cm, N = 118) and has increased significantly over time (Regression; $F_{1,10} = 28.138$, $P < 0.001$, $r = 0.870$). The mean and SE of the TL of adults was 32.3 cm ± 0.9 and the mean and SE of the TL of juveniles was 15.9 cm ± 0.4. Overall 66% of the sirens captured were adults and 34% were juveniles. The proportion of adults to juveniles (Fig. 3) has increased significantly over time (Regression; $F_{1,10} = 10.884$, $P = 0.009$, $r = 0.740$). Adults made up 75% of the sirens captured from 2002–2008 but only 41% of the sirens captured from 1998–2001. There was no significant difference in the TL of sirens captured in altered traps (5 cm openings) compared to unaltered traps (3 cm openings). Sirens captured from a given site in a given year were typically of the same size class.

In addition to sirens, 9779 individuals of other taxa were captured in the minnow traps. These included 249 large aquatic insects (predaceous diving beetles, Dysticidae; dragonfly naiads, Anisoptera; water scorpions, Nepidae; giant water bugs; Belostomatidae), 344

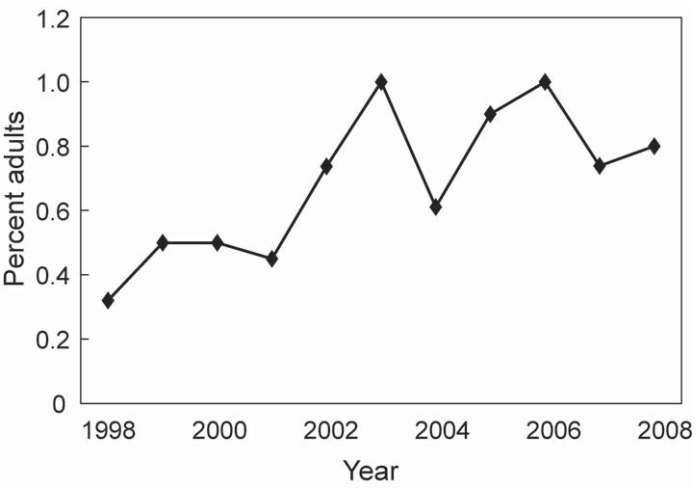


Fig. 3. The percentage of Lesser Sirens caught each year that were adults.

crayfish, five Eastern Newts (*Notophthalmus viridescens*), 5353 larval and adult anurans (Spring Peeper, *Pseudacris crucifer*; Western Chorus Frog, *P. triserata*; Eastern Gray Treefrog, *Hyla versicolor*; American Bullfrog, *Rana catesbeiana*; Green Frog, *R. clamitans*), six snakes (Eastern Ribbon Snake, *Thamnophis sauritus*; Western Fox Snake, *Elaphe vulpina*; Northern Watersnake, *Nerodia sipedon*), and 1028 fish (Central Mudminnow, *Umbra limi*; Black Bullhead, *Ameiurus melas*; Pickerel, *Esox americanus*; Green Sunfish, *Lepomis cyanellus*; Lake Chub, *Couesius plumbeus*; Pugnose Minnow, *Opsopeodus emiliae*). There was a positive relationship between the number of sirens caught and the number of fish and crayfish caught (Regression; $F_{1,21}$ = 13.04, P = 0.002, r = 0.638).

Habitat.—Sirens were found in 6 (28.6%) of the 21 surveyed sites. Three of these sites were shallow lakes, two were semi-permanent wetlands, and one was a drainage ditch. Sirens were not significantly more abundant in lakes and ditches than wetlands (Regression; $F_{1,20}$ = 3.337, P = 0.084, r = 0.387). The lakes and wetlands with siren populations all had more than 50% of the surface area with abundant emergent vegetation and the ditch had more than 50% of its surface area covered with large mats of green algae.

A few of the sirens that were observed by flashlight at night were swimming in the water column, but usually sirens were observed motionless on the substrate with a portion of the tail and body hidden in the vegetation or under an algal mat. When disturbed sirens would either swim into the cover of vegetation or algal mats, or into the substrate under rocks or logs.

The sites with sirens all had very poorly drained, loamy, fine sand substrates with near neutral pH (6.0–7.5) and water with high turbidity while substrates from sites that lacked sirens had silty acidic substrate soils and clear acidic water (5.1–6.0). Siren abundance was significantly greater at sites with higher substrate pH (Regression; $F_{1,5}$ = 10.140, P = 0.033, r = 0.847).

Diet.—Sirens kept in captivity were observed to eat a wide variety of prey. They readily ate live earthworms (Oligochaeta), *Tubifex* worms (Oligochaeta), dragonfly naiads (Odonata: Anisoptera), damselfly naiads (Odonata: Zygoptera), crawling water beetles (Coleoptera: Haliplidae), water boatmen (Hemiptera: Corixidae), isopods (Crustacea: Isopoda), crayfish (Crustacea: Decapoda), spire snails (Lymnaeidae), fingernail clams (Sphaeriidae), tadpoles (*Pseudacris triseriata* and *Rana clamitans*), and Central Mudminnows (*Umbra limi*). Sirens reacted to prey by fanning their heads from side to side to orient and move toward prey in such a way that vision is unlikely to be the primary sense used to find food. They primarily ate smaller prey, such as worms, aquatic insects, spire snails, fingernail clams and isopods, by suction feeding. However for prey that was too large to be swallowed whole, the sirens would kill and eat the prey by taking bites out of it. For example, sirens would bite off the viscera of mudminnows and *R. clamitans* tadpoles or the carapace of crayfish. Some of the adult sirens (TL = 29–33 cm) were able to kill and eat relatively large (TL up to 10 cm) crayfish in this manner. After eating the viscera, sirens would often leave the carcass alone and then scavenge on it the next evening. I also observed sirens scavenging dead fish and mussels and also eating commercial fish food such as shrimp pellets.

Some of the sirens captured in 1998, 1999, and 2001 in deeper water (≥1 m) during hot weather in September died in the trap. Starting in 2002, minnow traps were kept in shallower water with the top of the trap just above the surface when temperatures were higher than 25ºC. I dissected 17 sirens (N = 11 adults, six juveniles; mean TL = 24.7 ± 1.9 cm, range TL 14.0–33.0 cm) that were found dead in minnow traps to analyze stomach contents. A total of 128 prey items of 13 taxa were found in the stomachs and identified (Table 1). All sirens had at least two prey items and as many as 23. Dragonfly naiads were the most abundant prey item (29% of prey items) and found in the most sirens (52%). Four prey taxa (dragonfly naiads, caddisflies, aquatic beetles, and ostracods) made up 75% of the prey items. Dragonflies, aquatic beetles, ostracods, and tadpoles were eaten by the most sirens. Minor constituents of the diet included clams, tadpoles (*Pseudacris* and *Rana*), oligochaetes, chironomid larvae, damselfly naiads, dobsonfly larvae (Megaloptera), crayfish and *Daphnia* (Cladocera). The TL of the sirens significantly affected the diet. Juveniles ate significantly more caddisflies (Regression; $F_{1,16}$ = 4.765, P = 0.045, r = -0.50), ostracods (Regression; $F_{1,16}$ = 6.966, P = 0.019, r = -0.57), and snails (Regression; $F_{1,16}$ = 6.666, P = 0.021, r = -0.56) and significantly fewer tadpoles (Regression; $F_{1,16}$ = 9.571, P = 0.007, r = 0.41) than adults. One juvenile and one adult siren

TABLE 1. The diet of Lesser Sirens from examination of stomach contents (N = 17). Data are the mean number of prey items for each prey taxon per siren, the percentage of sirens that ate each taxa, and the mean number of prey items per juveniles (N = 6) compared to adults (N = 11).

Prey taxa	prey items	% of sirens	juvenile	adult
Dragonfly naiads	2.18	53	2.17	2.18
Caddisfly larvae	1.59	12	4.50	0
Crawling water beetles	1.06	47	1.33	0.91
Ostracods	0.82	29	2.00	0.18
Snails	0.47	18	1.33	0
Clams	0.29	18	0.50	0.18
Tadpoles	0.24	24	0	0.36
Oligochaetes	0.24	18	0.17	0.27
Chironomid larvae	0.24	12	0.50	0.09
Damselfly naiads	0.18	6	0	0.27
Dobsonfly larvae	0.12	6	0.33	0
Cladocerans	0.06	6	0	0.09
Crayfish	0.06	6	0	0.09
Total Prey Items	**7.53**	**100**	**12.83**	**4.63**
Additional stomach contents				
Nematodes	0.76	24	0	1.18
Algae	0.12	12	0.17	0.09

had algae in their stomach and a total of 13 Ascaridida nematodes were found in four of the adult sirens. The nematodes ranged in size from 1.5–1.7 cm in length and unlike other taxa they showed no signs of being digested.

Aestivation.—Sirens that were placed in containers with mud and water were observed to dig burrows into the mud. The sirens were often observed either lying on the substrate or with their heads and forebodies in the water while their hindbodies and tails were in the burrow. Sirens were observed to initiate aestivation when the depth of standing water was 1–5 cm. On day 22 of the experiment the mean depth of water in the slow drying treatment (4.08 ± 0.13 cm) was significantly greater (MANOVA; $F_{1,12} = 23.021$, $P = 0.001$) than the fast drying treatment (1.80 ± 0.20 cm), and half of the sirens in both treatments were buried in the substrate with the opening of the burrow plugged with mud. No sirens in the fast drying treatment were observed out of the substrate after day 22 and no sirens in the slow drying treatment were observed out of the substrate after day 32. After those dates, all of the sirens were buried in the substrate with the burrow openings plugged with mud. On day 36 of the experiment, all of the fast drying treatment containers had no standing water and on day 53 of the experiment, all 12 containers in the drying treatments had no standing water. From day 33 to completion of the experiment on day 120, all 12 sirens in the drying treatments remained burrowed into the substrate. None of the control sirens ever buried themselves with a plugged opening and were observed to be active throughout the experiment. There was a significant effect of age class on the number of days that sirens were active before entering aestivation (MANOVA; $F_{1,17}$, $F = 6.640$, $P = 0.024$). Juveniles (28.33 ± 0.13 days) were active significantly longer than adults (22.83 ± 0.83 days). Drying treatment had no significant effect on the mean number of days that sirens were active.

Drying treatments had a significant effect on the survival of sirens (MANOVA; $F_{2,17} = 6.333$, $P = 0.013$). All six control sirens survived throughout the experiment. All six sirens in the slow drying treatment had secreted cocoons surrounding the animal. However, one juvenile and one adult were found dead. Only two sirens, one adult and one juvenile, survived the fast drying treatment. Most of the dead sirens were desiccated but each had a secreted cocoon layer indicating that they went into aestivation before dying. One of the dead adults in the fast drying treatment was in similar body condition to the sirens that survived but it did not revive after 24 h of re-hydration. All of the surviving sirens became active within an hour after being re-hydrated.

Discussion

This is the first report of population trends of the Lesser Siren. Populations fluctuated over an eight-year period with two peaks in abundance followed by two declines. Siren density is likely to be high during the peak abundance years. Mean density can be as high as 1.3 sirens/m^2 (Gehlbach and Kennedy 1978). The abundance of Lesser Sirens was positively associated with the abundance of crayfish and fish.

It has been concluded that it is difficult to determine adundance of sirens because of their secretive nature and difficulty catching them with dip nets (Leja 2005; Petranka 1998). However, other observations that Lesser Sirens are easily caught at various times of the year by un-baited minnow traps (Gehlbach and Kennedy 1978; Gibbons and Semlitsch 1991; Raymond 1991; Sever et al. 1996) were confirmed. For the sites in which sirens were present, they were captured at a mean rate of about 1 siren per 12 trap-days.

The range of TL of adult sirens in this study fits the range of 18–50 cm for other populations (Petranka 1998). However during the first year of the study most sirens captured were juveniles and small adults that were similar in size to Indiana specimens reported by Minton (2001). Minton (2001) found that the mean TL of 13 adult Lesser Sirens from Indiana was 23.1 cm with a range of 18.3–28.4 cm. It is possible that northern populations are a smaller race. However Smith (1961) found that there were no trends in geographic variation in TL of specimens captured in four regions of Illinois, and larger sirens were observed after the first year of this study in northwest Indiana.

Samples from other populations show aggregations of 2–4 size classes within a population (Cagle and Smith 1939; Gehlbach and Kennedy 1978; Petranka 1998). Samples in this study best fit two size classes (juveniles 13–18 cm and adults 23–43 cm) with a small percentage (< 6%) of individuals intermediate (19–22 cm) between these size classes. Often, nearly all of the individuals from a specific site in a specific season were from the same size class. It is possible that same-aged cohorts aggregate in a habitat resulting in fluctuations from year to year in TL and juvenile to adult ratio at a particular sampling site.

In this study sirens were found to be more abundant in habitats with soft sandy loam bottoms and in habitats with abundant emergent vegetation and leaf litter. Juveniles live in burrows or in thick mats of aquatic vegetation (Petranka 1998) and adult sirens hide in individual retreats in burrows, beneath logs or in thick vegetation (Asquith and Altig 1987; Bennett and Taylor 1968; Davis and Knapp 1953). The habitats in this study where sirens were abundant would allow for burrowing into soft substrates and refuge in thick vegetation. Sirens were observed to forage on pond bottoms at night, often with the tail end of the body hidden in vegetation or leaf litter as has been reported elsewhere (Fauth et al. 1990; Minton 2001; Noble and Marshall 1932). All of the sites with sirens present were either semi-permanent or permanent bodies of water that held water for at least six months of the year. Sirens have never been seen or captured in any of the many temporary and seasonal wetlands at Jasper-Pulaski that have been observed to dry for more than six months of the year (Brodman 2003; this study). These observations support the hypothesis that Lesser Sirens are restricted to wetlands that hold water at least six months a year (Snodgrass et al. 1999). Southern populations of Lesser Sirens have been associated with acidic conditions (Carr 1940; McAllister et al. 1994). However, the northern populations in this study were associated near neutral pH and were absent from sites where the pH was below 6.0.

There has been some disagreement over whether Lesser Sirens feed on small fish (Altig 1967; Davis and Knapp 1953; Hurter 1911; Pope 1964; Scroggin and Davis 1956). It has been hypothesized that Lesser Sirens feed by filter feeding through bottom material or within the burrow (Altig 1967; Reilly and Altig 1996) and are not capable of catching larger or more mobile prey (Davis and Knapp 1953). Stomach contents from the study population indicate that Lesser Sirens primarily eat small benthic aquatic invertebrates but also eat larger more mobile prey such as tadpoles. Captive Lesser

Sirens were observed to use suction feeding when foraging on small prey, but adults also predated and scavenged prey that was too large to swallow whole, such as mudminnows, tadpoles, and crayfish.

Juveniles have been reported to feed mostly on zooplankton and small macroinvertebrate prey such as amphipods, craneflies and lumbriculid worms (Carr 1940). In this study juveniles ate more ostracods, caddisflies, and spire snails than adults while adults were more likely to eat tadpoles than juveniles. Adults have been reported to eat a wide variety of small aquatic invertebrates such as crustaceans, insect larvae, snails, clams as well as some larger prey such as crayfish, tadpoles, and salamander larvae (Davis and Knapp 1967; Fauth 1999; Fauth and Resetarits 1991; Fauth et al. 1990; Scroggin and Davis 1956). Cladocerans, ostracods, snails, sphaeriid clams, and mayflies have been reported to be the most important prey, often making up more than 80% of the diet (Altig 1967; Davis and Knapp 1953; Scroggin and Davis 1956). Dragonflies, caddisflies, crawling water beetles, ostracods, spire snails, sphaeriid clams, and aquatic oligochaetes were the most important prey items in the diet of the study population. These observations and reports confirm that Lesser Sirens eat a wide variety of prey and the diet is likely dependent on prey availability in the habitat.

Nematode parasites, including intestinal parasites in the order Ascaridida, have been documented in Lesser Sirens (Dyer 1973; McAllister and McDaniel 1992; McAllister et al. 1994). Ascaridida were found in about a quarter of the dead specimens examined in this study. Ascaridida are hypothesized to infect sirens from ingestion of minnows (McAllister and McDaniel 1992). Observation of sirens preying upon mudminnows in the lab and the fact that nematodes were only present in the digestive tract of adult sirens that are large enough to eat small fish make this hypothesis plausible.

Filamentous algae have been documented from dietary studies of Lesser Sirens (Bennett and Taylor 1968; Davis and Knapp 1953; Noble and Marshall 1932; Scroggin and Davis 1956) and were confirmed in some specimens in this study. Algae and plant debris pass through the gut undigested and are likely to be accidentally swallowed along with prey while foraging among vegetation (Davis and Knapp 1953; Petranka 1998).

When the habitat dries, Lesser Sirens retreat to depths of 0.45–1 m into crayfish burrows (Cagle 1942; Pope 1964) or burrow into mud to aestivate (Harding 1997). It has been hypothesized that the western edge of the range of Lesser Sirens is limited by dry conditions (Gehlbach et al. 1973). Under laboratory conditions juvenile and adult Lesser Sirens were able to aestivate in a shallow (13 cm) layer of pond substrate and survive for 2–3 months. However survivorship was dependent upon the drying regime. Aestivation can last from several weeks to > 1 year (Gehlbach et al. 1973). In Indiana, Lesser Sirens were found aestivating at a depth of 8–10 cm in the dry mud of a pond bottom that had been dry for 8 months (Blatchley 1900). In the lab, small sirens are reported to starve 12–14 weeks after initiating aestivation, but large sirens survive at least 16 weeks (Gehlbach et al. 1973; Petranka 1998). Adults initiated aestivation sooner than juveniles. However there was no difference in mortality between size classes over a 12–14 week period of aestivation.

Loss of habitat and habitat fragmentation are threats to Lesser Siren populations (Bury et al. 1980; Petranka 1998). They are possibly extirpated from the Great Lakes drainage basin because of habitat loss and rotenone treatment (Harding 1997). Loss of extensive wet prairie in Illinois and Indiana (Brodman and Kilmurry 1998; Prince 1997) has likely reduced siren populations in the lower Midwest (Leja 2005). Ecology and natural history information will be needed for the conservation of threatened Lesser Siren populations. Future studies need to be conducted on dispersal and colonization to understand how habitat fragmentation and the geographic isolation of northern populations affect the long-term survival of this species in the lower Midwest.

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A Data Aggregation Problem in Studies of Upper Respiratory Tract Disease of the Gopher Tortoise

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Conservation efforts could be improved markedly by involving health professionals (e.g., Deem et al. 2001; Kock 1996) and, conversely, disease control efforts could be improved markedly by involving ecologists (e.g., Kazura and Bockarie 2003; Wasserburg et al. 2002). The role of ecologists in dealing with disease threats to wildlife is destined to grow, in response to increasing recognition that local (e.g., Ross 2002) and global (e.g., Chan et al. 1999) environments influence disease transmission and prevalence, and, in turn, that environmental improvement can mitigate the consequences of disease (e.g., Woodroffe 1999). As ecologists become more involved in studying disease threats and other risks to individuals, they are likely to encounter data aggregation problems that, although familiar to researchers in a wide variety of other disciplines, seem not to be familiar to many ecologists. Ecologists must become more aware that these serious, but difficult to recognize, problems can arise any time one infers individual attributes from population-level attributes. I present a detailed illustration of one such data aggregation problem, involving studies of upper respiratory tract disease (URTD), an emergent disease of turtles.

Emergent diseases are those whose incidences have increased within the past two decades or threaten to increase in the near future (Lederberg et al. 1992), and they are recognized in wildlife, as well as in humans and domesticated animals (Daszak et al. 2000; Williams et al. 2002). The principal causal agent of URTD is the bacterium *Mycoplasma agassizii* (Baseman and Tully 1997; Brown et al. 1994; McLaughlin 1997; Schumacher et al. 1993). *Mycoplasma agassizii* was unknown until the early 1990's, when it was recorded from the Desert Tortoise, *Gopherus agassizii*, in the southwestern U.S. (Jacobson et al. 1991, 1995), and from the Gopher Tortoise, *G. polyphemus*, in the southeastern U.S. (Beyer 1993), but URTD has become a major concern for researchers studying North American tortoises. *Mycoplasma agassizii* is easily transmitted by direct contact between individuals (Brown et al. 2002; McLaughlin 1997), and URTD is potentially lethal (e.g., Berry 1997; Jacobson et al. 1991; Seigel et al. 2003 and references therein). *Gopherus polyphemus* researchers have speculated that URTD may not affect individuals of all sizes equally, because of size-specific differences in encounter rates, which, in turn, result in size-specific differences in the probability of infection or re-infection with *M. agassizii*.

A study by Seigel et al. (2003) addressed the question of whether the risk of death from upper respiratory tract disease (URTD) is related to body size. The study compared the mean size of individuals found dead, as a direct or indirect consequence of URTD, to the mean size of live individuals in the same population. The authors concluded that the mean sizes of dead and live individuals could not be distinguished for either sex,

TABLE 1. Mean sizes (carapace length) of live (two studies) and dead (four studies) individuals of the Gopher Tortoise, and one-way ANOVA comparisons of the mean sizes of live and dead individuals.

	LIVE (mm)	DEAD (mm)	F	df	P
Seigel et al. (2003)*					
Females	263 ± 28.6 (N = 51)	261 ± 35.3 (N = 9)	0.05	1, 58	0.82
Males	259 ± 25.3 (N = 71)	244 ± 34.2 (N = 11)	3.02	1, 80	0.09
McCoy et al. (unpubl. data)					
Females	265 ± 11.8 (N = 11)	244 ± 15.5 (N = 7)	6.52	1, 16	0.02
Males	248 ± 11.0 (N = 10)	246 ± 16.0 (N = 7)	0.04	1, 15	0.85
Blihovde (unpubl. data)					
Females	—	246 ± 24.6 (N = 41)			
Males	—	240 ± 15.1 (N = 25)			
Gates et al. (2002)					
Females	—	262 ± 19.7 (N = 16)			
Males	—	246 ± 20.6 (N = 39)			

* Used plastron length as the measure of size, which, when plotted against carapace length, displays a slope close to 1 for the individuals in a population.

although "live males were somewhat larger than males found dead, and the difference bordered on statistical significance" (Table 1). I compared the mean size of individuals found dead to the mean size of live individuals at a site where intact shells of dead individuals were found during transect surveys (McCoy et al. 2006, 2007). The mean size of dead males could not be distinguished from the mean size of live males, but the mean size of dead females was smaller than the mean size of live females (Table 1).

The fact that similarly designed studies reached different conclusions will not surprise many ecologists: they would likely attribute the difference simply to natural variation. However, careful examination of the experimental design employed in these studies suggests another possible reason for the difference. The question of interest is whether risk of death per individual is independent of body size. Because direct information on individual risk is not available, the size distribution of dead individuals is used as surrogate data. The test then applied to the surrogate data is a comparison of the mean size of dead individuals to the mean size of live individuals. This experimental design requires, therefore, that both the risk of death per individual and any difference in mean sizes of dead and live individuals have the same cause, namely URTD. The difference in mean sizes of dead and live individuals depends on the size distribution of live individuals in a population, however, which varies among populations for reasons that could have little or nothing to do with URTD, such as differences in individual growth rates (Mushinsky et al. 1994). If the experimental design is inappropriate for the reason I have suggested, then these two studies have not addressed the question of interest.

Comparison of the data (Table 1) strongly suggests that the two studies indeed are not addressing the question of interest. The mean sizes of dead males were similar between studies (244 and 246 mm), as expected if URTD actually was targeting individuals by size. At our study site, more shells of dead individuals than expected from the size distribution of live individuals were intermediate in size (156–263 mm; $\chi^2 = 8.67$, $P < 0.01$). The mean sizes of dead males in two other studies that reported only sizes of dead individuals (Table 1) also were < 246 mm. So, there is reason to suspect that relatively small males are affected more severely by URTD. The difference between the mean sizes of dead and live was insignificant for the population with the mean size of live males (248 mm) more similar to that of dead males (McCoy et al., unpubl. data), but "bordered on statistical significance" for the population with the mean size of live males (259 mm) less similar to that of dead males (Seigel et al. 2003). In other words, the size distributions of live males are driving the conclusions, and obscuring whatever connection between body size and URTD that may exist. For females, the mean sizes of live individuals are similar between studies (263 and 265 mm), but the mean sizes of dead individuals are not as similar (261 and 244 mm). Consequently, the conclusions depend on the nature of the size distributions of dead individuals: comparison of the means sizes of dead and live females indicated a significant difference for the population with a relatively small mean size of dead individuals (McCoy et al., unpubl. data), but not for the population with a relatively large mean size of dead individuals (Seigel et al. 2003). Perhaps no size-specific effects of URTD exist for females; perhaps URTD affects females differently than males; perhaps the larger mean sizes of dead females (261 and 262 mm) in two of the four studies may be a simple consequence of the populations and/or sexes being in different phases of the progression of the disease. The available data do not offer any insight into these possibilities.

Data aggregation problems may occur whenever population-level attributes, such as size distributions, influence assessment of individual attributes, such as risk of death. These problems apparently are not commonly recognized in ecology (but see Levins and Lewontin 1985), although they are well recognized in a variety of other disciplines (King 1997). For example, public health researchers have long considered data aggregation problems a serious impediment to their research (Greenland 2004; Koopman 1977; Rose 1992; Schwartz and Carpenter 1999), and have dubbed the resulting inferential error "Type III

statistical error" (Schwartz and Carpenter 1999; but see Crawford et al. 1998; Leventhal and Huynh 1996; Marascuilo and Levin 1970). These problems are insidious because one actually finds a correct answer, but it is not for the question of interest (Schwartz and Carpenter 1999). Furthermore, these problems could bear substantial associated costs (Shrader-Frechette and McCoy 1992). For the gopher tortoise/URTD interaction, they could prevent increased understanding of the transmission of URTD. Additional studies employing the same design could not be employed as replicates to strengthen the answer to the question of interest, for example (see Johnson 2002; Palmer 2000; Underwood 1999). Worse, these problems could be detrimental to the well-being of the Gopher Tortoise. For example, one might infer from the very different conclusions of the two studies that no general relationship between risk of death from URTD and body size exists, when, in fact, URTD may selectively target relatively small adults. The ultimate result of this false inference could be failure to prevent the deaths of some of the most demographically valuable individuals. Data aggregation problems such as the one illustrated here probably are more common in ecological research than often recognized, but they may become more noticeable as ecological studies increasingly focus on the management of relatively small numbers of individuals in disturbed and fragmented landscapes.

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Frequency and Phenotypic Differences of Melanistic and Normally Colored Common Lizards, *Lacerta* (*Zootoca*) *vivipara* of the Southern Pyrenees (Spain)

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Since the nineteenth century, melanism has attracted the attention of evolutionary biologists, who have focused their research on its evolutionary significance (Cook et al. 2005). Recent studies on mammals and birds corroborate the hypothesis that melanism has a genetic basis and that it is a powerful driver of species evolution (Eizirik et al. 2003; Mundy 2005). Nachman et al. (2003) provided a good example of the adaptive importance of melanism in Rock Pocket Mice, *Chaetodipus intermedius*, which, depending on the background, exhibits different colorations. In order to improve crypsis, light-colored mice live on light-colored rocks while melanistic mice live on dark lava rocks. Nachman et al. (2003) also demonstrated that melanism evolved independently in several mice populations and they found that different mutations located on different genes were responsible for melanism.

As in mammals and birds, melanism is quite common in reptiles (Jandzik 2004; Korsos and Nagy 2006; Mateo and López-Jurado 1994; Pérez-Mellado 1984; Trocsanyi and Korsos 2004; Zuffi 1986). Partial melanism is frequent and partially melanistic individuals typically have ventral scales, which are not completely black coloured (Trocsanyi and Korsos 2004). In some cases the populations of certain lizards and snakes are formed by a mixture of melanistic and normally coloured animals (Bittner and King 2003), while in other cases entire populations consist only of melanistic or only of normally colored animals (Daniels et al. 2004; Pearse and Pogson 2000). Melanism in *Lacerta* (*Zootoca*) *vivipara* has been described in central and northern Europe, but not in the Pyrenees nor in Spain (Cavin 1993; Kuranova 1989; Malkmus 1976; Petzold 1978; Westrin 1985, 1986). In comparison to other species (Thiesmeier 2002), melanistic Common Lizards occur at very low frequencies, indicating that melanism in the Common Lizard might be a rare rather than a well-established polymorphism. An explanation for its rarity might be high selective pressures acting against melanistic individuals (Andrén and Nilson 1981; Husak et al. 2006). Contrary to the rock pocket mice, melanistic and normally colored Common Lizards are usually observed in the same habitat and on the same background (Gvozdik 1999). Given that melanistic individuals lose the cryptic dorsal patterns, their dorsal coloration contrasts more with the background (Forsman 1995), making them more visible for predators (Husak et al. 2006). This suggests that melanistic individuals may suffer from increased predation risk (Andrén and Nilson 1981), potentially explaining their low frequency. Additionally, high predation risk may also result in decreased foraging efficiency and in increased physiological stress both negatively affecting body condition (Pérez-Tris et al. 2004; Rands and Cuthill 2001).

On the other hand, it is suggested that the potentially negative effects of melanism on viability and reproduction may be compensated, for example, through increased thermoregulatory capabilities (Gibson and Falls 1979; Rosenblum et al. 2004). This hypothesis is known as the "thermal melanism hypothesis" (Ellers and Boggs 2002; Parkash and Munjal 1999; Vences 2002). It has been shown to play an important role in many species, including eight lizard species (Daniels et al. 2004). The thermal melanism hypothesis predicts that melanistic individuals should have an advantage under conditions of low temperature since they heat up faster than light-coloured individuals (Clusella Trullas et al. 2007). This indicates that the advantage of melanism should increase with decreasing temperature and thus, that the frequency of melanism should increase with altitude (Clusella Trullas et al. 2007).

To test these hypotheses we used data from several Common



FIG. 1. Photograph of the melanistic *Lacerta vivipara* found in the Southern Pyrenees, Spain.

TABLE 1. Traits of the melanistic male and 54 adult males of the same population of *Lacerta vivipara*. Given are the mean ± SE, as well as the median of the 54 males and the measurements of the melanistic male. We further show to which percentile of the distribution the measurement of the melanistic male corresponds and we give Wilcoxon signed-ranks tests to test for differences between the melanistic male and the other 54 males.

characters	mean ± SE (range)	median	melanistic male	percentiles	z	P
body weight (g)	3.7049 ± 0.6304 (4.8390–2.7140)	3.739	3.3890	20	-0.66144	0.5083
body condition	-0.0026 ± 0.0396 (-0.7345–0.6967)	-0.0064	0.1402	70	0.72443	0.4688
SVL (mm)	55.8333 ± 0.3 (61–52)	56	53	10	-1.30307	0.1926
total length (mm)	137.5741 ± 1.82 (162–113)	138.5	125	20	-0.94568	0.3443
tail length (mm)	81.7407 ± 1.7609 (102–57)	83	72	20–40	-0.75649	0.4494
head length (mm)	10.3611 ± 0.0753 (11.5–9)	10.5	10.5	50–70	0.29572	0.7674
head width (mm)	6.9639 ± 0.0417 (7.6–6.2)	6.95	6.8	30	-0.98198	0.3261
number dorsal scale rows	32.6852 ± 0.3115 (38–27)	32.5	32	40	-0.12781	0.8983
number transverse ventral scale rows	20.7963 ± 0.1358(23–19)	21	21	50–70	0.19958	0.8418
number supralabial scales	6.3889 ± 0.0811 (8–5)	6	6	10–60	-0.66406	0.5066
number infralabial scales	5.4815 ± 0.0825 (6–4)	6	4	0–10	-1.77265	0.0763
number chin shields	4.9259 ± 0.0446 (6–4)	5	5	10–90	0.1264	0.8994
number gular scales	18.2222 ± 0.1786 (22–16)	18	19	70–80	0.77874	0.4361
number collar scales	8.5185 ± 0.1513 (11–6)	9	6	0–10	-1.65811	0.0973
number subdigital lamellae	17.9074 ± 0.157 (21–16)	18	17	10–30	-0.8488	0.396
number femoral pores	10.9815 ± 0.1226 (13–10)	11	11	40–60	0.06652	0.947

Lizard populations to estimate the frequency of melanistic lizards and we compared body condition and several morphological traits between melanistic and typically colored adult male Common Lizards of the same population.

On 19 April 2007, we found a completely melanistic male Common Lizard, *Lacerta (Zootoca) vivipara*, at the Puerto de Ibañeta, Navarra (Southern Pyrenees, Spain, 43.02158889ºN, 1.320416667ºW, elev. 1062 m). Although melanism has already been described in Europe for *L. vivipara*, this is the first time a melanistic individual has been described in the Pyrenees and also the first record for Spain. Thus it is the first record of a melanistic Common Lizard belonging to the oviparous clade, which mainly inhabits the Pyrenees and the Cantabrian mountains (Surget-Groba et al. 2001) and which may belong to a new species that hardly interbreeds with the Common Lizard (Heulin et al. 1989; Heulin et al. 1999). The melanistic adult male showed a uniformly black coloration (dorsally and ventrally), with a slightly blacker vertebral line (Fig. 1). The melanistic male was captured in a pre-alpine meadow whose predominant vegetation consists of *Ulex gallii* and *Erica vagans*. We discovered him in a small bush (*U. gallii*), in which we saw and captured several other conspecific lizards. To compare the melanistic individual with typically colored individuals of the same population, we captured an additional 54 adult males. Subsequent to the capture, all lizards were measured following Pérez-Mellado and Gosá (1988). For the analyses of body condition we used the residuals of the regression with SVL as the independent variable and body mass as the dependent variable (Wilson 1991). In order to compare the measurements of the melanistic individual with the other males of the same population, we applied Wilcoxon signed-ranks tests.

To estimate the frequency of melanistic individuals we analyzed data from the population where the melanistic lizard was captured and from six other populations from the Spanish Pyrenees (Provincia de Aragón) that we sampled during spring and summer 2007. The six populations were located at an average elevation of 1453 ± 94 m (range: 1140–1700 m). We captured a total of 515 *L. vivipara* and only one of these individuals was melanistic. Taking into account that not all observed lizards could be captured (captured to not-captured ratio is at most 1:3), we estimate that the frequency of melanistic individuals is maximally 1 per 2000 individuals. This estimate corresponds to a very conservative measurement because melanistic individuals are easier to detect, given that they stand out more against the surrounding vegetation (Andrén and Nilson 1981), and because in population censuses conducted in 2005 and 2006 (ranging from Vielha, Llerida, to Guipuzcoa) no melanistic lizards were observed.

The melanistic male did not significantly differ from the other males in body size, tail length, body condition, or in the number of scales (Table 1). Only the number of infralabial and collar scales was in the lowest percentile (0–10% percentile). Our results on body weight and snout–vent length agree with those obtained by Gvozdik (1999), who did not find differences between melanistic and typically colored common lizards.

The frequency estimation clearly shows that melanistic *L. vivipara* are rare in the Spanish Pyrenees. A potential explanation for the rarity might be provided by the thermal melanism hypothesis (Ellers and Boggs 2002; Parkash and Munjal 1999; Vences 2002). This hypothesis predicts that melanism should provide an advantage in cold climates. For example, in the Western Cape (South Africa) melanistic populations of cordylid lizards are associated with zones of upwelling cold water in the coast, or with mountainous zones with high incidence of fog and cloud cover (Mouton and Oelofsen 1988; Mouton et al. 2002). This hypothesis would also predict that melanism should be more frequent in mountainous habitats. However, our observations do not support this given that the observed melanistic individual was found in the Puerto de

Ibañeta population, which is located at the lowest elevation (1062 m), and no melanistic lizards were found in populations located at higher altitudes and thus in colder habitats. Further, capture effort was higher in the six other populations, which indicates that the frequency of melanistic individuals is likely much lower than in the Puerto de Ibañeta population. Consequently, it is unlikely that thermal advantages explain the observed frequencies. Furthermore, heating rates did not differ between melanistic and normally colored *L. vivipara* (Gvozdik 1999). It is also unlikely that melanism may have other advantages in the oviparous clade of the *L. vivipara*: i) melanism was rare; ii) melanism is genetically determined (King 2003; Majerus and Mundy 2003; Mundy 2007; Rosenblum et al. 2004); iii) slight selective advantages should rapidly translate into increased frequencies (Falconer 1960), in short-lived species such as *L. vivipara*. Alternately, the low frequency might be the result of strong selective pressures against melanistic individuals (Andrén and Nilson 1981). Given that the melanistic male was observed in the same habitat and on the same background as typically colored individuals, he should also be more conspicuous than normally colored individuals (Andrén and Nilson 1981; Forsman 1995). In comparison to typically colored individuals, detection of the melanistic male was markedly easier. However, we could not find evidence that higher conspicuousness might have resulted in decreased body condition (Forsman 1995; Perez-Tris et al. 2004). Further, most of the measured traits were in the 10–90% percentile and only two of fourteen morphological measurements were in the 0–10% percentile. This suggests that the observed melanistic male did not differ from typically colored males in traits other than coloration. Melanism usually results from mutations (Majerus and Mundy 2003; Mundy 2007; Rosenblum et al. 2004) and it has been suggested that in some species melanism is controlled by neutral alleles (Nahrung and Allen 2005), which are maintained at a constant low level. Given that we found no evidence for positive or negative selection, our results are in line with the neutral allele hypothesis, which states that black alleles are not eliminated by natural or sexual selection because black alleles are neither favorable nor unfavorable to survival or reproduction (Nahrung and Allen 2005). This hypothesis might also explain why the frequency of melanistic animals is very low in the Spanish Pyrenees. However, to understand the reasons why melanistic Common Lizards might be very rare, further sampling needs to be carried out to increase the sample size and thus the analytical power.

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Diet Composition of Bullfrogs, *Rana catesbeiana* (Anura: Ranidae) Introduced into the Venezuelan Andes

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Large size, generalist eating habits, and high reproductive capacity have made the Bullfrog (*Rana catesbeiana*) an extremely successful invader and important competitor with native species of amphibians (Hecnar and M'Closkey 1997). Increased specialization, competitive inferiority, and predation by Bullfrogs make native species susceptible to declines (Mayuri et al. 2004). Introduction of Bullfrogs has contributed to the decline of native species of *Rana* in western North America (Bury and Luckenbach 1976; Clarkson and DeVos 1986; Hammerson 1982; Moyle 1973). *Rana catesbeiana* is a recently introduced species to the Andean region of Mérida, Venezuela (Barrio 2001) although anecdotal evidence suggests this species has has been present since the mid-1980s. Further, in this introduced population, the pathogen *Batrachochytrium dendrobatidis*, the agent for chytridomycosis, has been identified in 96% of healthy individuals (Hanselman et al. 2004). This infectious fungal disease is responsible for mass mortality in amphibian species worldwide (Ron and Merino 2000).

Because introduced Bullfrogs have proven to negatively impact native frog populations in other regions, the discovery of Bullfrogs in the Andes of Venezuela prompted us to undertake a variety of studies on their ecology to determine the extent of their impacts on native frog populations. Here, we report the diet of Bullfrogs from a recently established population.

This study was conducted at a 1 km^2 pond in a location known as "La Carbonera" (8.6148333°N, 71.3630556°W, 2360 m elev.), 30 km NW of Mérida city, located in the "Cordillera de Mérida" in the Andes of Venezuela. The surrounding habitat consists mostly of secondary forest (Díaz de Pascual and Chacón-Ortíz 2001).

The Bullfrog was the most common frog in the pond, and was found extensively throughout and around the pond. Fieldwork was conducted monthly from March to November 2002. Large Bullfrogs were captured by air-rifle and small ones by hand and net. Immediately after capture, we measured snout–vent length (SVL; to the nearest 0.1 mm) and mass (to the nearest 0.1 g). Frogs were dissected, the stomachs were removed and the contents placed in 10% formalin for later analysis. Bullfrogs that contained at least one prey item in their stomachs (N = 338) were divided into four categories based on size and morphological characters: 1) Recently-metamorphosed: legs fully developed and tail partially absorbed; 2) Juveniles: tail completely absorbed, 51–69 mm SVL; 3) Sub-adults: 70–103 mm SVL; and 4) Adults: 104–180

mm. In the sample of 338 individuals, we had 90 recently metamorphosed, 92 juveniles, 77 sub-adults, and 79 adults.

Organisms in the stomach analysis were classified as adults or immature stages to the family level according to Smith and Silva (1983). Diet was quantified as the number and volume of prey individuals and then was scored to order level. Prey length was also measured with a dial caliper to the nearest 0.01 mm. Prey volume was determined by use of the water displacement method (precision of 0.1 cc). We determined volumetric and numeric percentages of each prey per frog size category as follows: % volume = (Total volume of diet item) × 100 ÷ (Total volume of all items). % N = (Number of samples containing diet item) × 100 ÷ (Total number of all items). These two measurements provide different insights into the feeding habits. To integrate them we calculated an index of relative importance of each prey as the average of numeric and volumetric percentages of prey items per each frog size-category.

Food niche width, which characterizes the food resource spectrum used by Bullfrogs in each size category, was calculated based on the index of relative importance described above. Niche overlap among frog size categories was calculated using the program "Niche Measures" (Krebs 2002). A one-way ANOVA and a post-hoc Bonferroni test were performed to examine differences among frog size categories and prey size. Pearson correlation analysis was used to examine the relationship between frog size (SVL) and prey size. Statistical analyses were performed using SPSS statistical package ver. 10 for Windows (User's Guide, Cary, SPSS Inc., NC, 1999).

We identified 474 prey items from stomach contents. Means and standard deviation of all measurements obtained from all frogs in each size category are given in Table 1. Terrestrial prey constituted a greater proportion of the diet for recently metamorphosed individuals and juveniles, compared to sub-adults and adults (Table 2). This may be a result of differential habitat use among the age classes as adults are known to use more aquatic habitats than juveniles (Werner et al. 1995). Vertebrates found in the stomach contents were mainly *Poecilia reticulata*, *Rana catesbeiana*, *Leptodactylus meridensis*, and *Hyla meridensis*. Juvenile Bullfrogs were the largest diet item and were common in adults and sub-adults. The frequencies of occurrence of conspecifics in the stomach contents were less in sub-adults (5%) and higher in adults (32%). Most conspecifics were smaller individuals (SVL < 50 mm).

Niche breath decreased from 0.93 for recently metamorphosed to 0.77 for adults (Table 2), indicating a tendency for less generalized feeding as bullfrogs grow. Juveniles had a higher diet overlap with recently metamorphosed and sub-adults 64% and 60%, respectively. Lower overlap of 54% was obtained between sub-adults and adults (Table 3).

Following log-transformations, variable variances among groups were not homogeneous (Levene statistic = 12.38, p = 0.000). However, we chose to use parametric statistical methods because of large sample sizes (Zar 1999). ANOVA detected significant differences among prey size and frog size category ($F_{3, 334}$ = 45.02,

TABLE 1. Snout–vent length (SVL) and mass of 338 *Rana catesbeiana* from the Andes of Venezuela and the corresponding morphological variables of the prey items.

Class Size	SVL (mm) Mean ± SD	Mass (g) Mean ± SD	Prey Number Mean ± SD	Prey length (mm) Mean ± SD	Prey volume (mm^3) Mean ± SD
Rec. Met.	56.54 ± 4.54	28.20 ± 2.97	1.74 ± 1.49	10.61 ± 2.79	0.14 ± 0.06
Juveniles	60.62 ± 7.24	30.67 ± 8.60	1.85 ± 1.71	11.10 ± 5.26	0.34 ± 0.32
Sub-adults	85.26 ± 10.58	74.47 ± 26.41	2.59 ± 1.86	15.48 ± 8.51	1.95 ± 6.44
Adults	142.65 ± 15.08	415.39 ± 117	1.39 ± 0.85	34.21 ± 22.09	13.94 ± 15.59

TABLE 2. Importance index of prey found in the stomach content of *Rana catesbeiana* size groups. Prey habitat types are in parenthesis as follows: A = aquatic, T = terrestrial. Rec. Met. = recently metamorphosed.

	Rec. Met.	Juvenile	Sub-Adult	Adult
INSECTA				
Coleoptera(T)	11.81	30.49	36.11	10.83
Orthoptera(T)	4.67	6.14	7.68	1.76
Odonata(T)	28.41	19.68	13.91	10.38
Diptera(T)		24.95	10.55	0.73
Homoptera(T)		16.84	2.58	0.81
Hymenoptera(T)	30.96	31.59	15.46	4.59
Isoptera(T)		1.93	1.83	
Lepidoptera(T)				
Larval Lepidoptera(T)		2.47	4.15	1.67
Larval Coleoptera(T)				1.33
Larval Diptera(A)	22.17	19.73	0.79	
ARACHNIDA				
Araneae (T)		3.33	2.58	
MOLLUSCA				
Gastropoda(A)	8.11	5.60	0.96	
CRUSTACEA				
Branchiopoda(A)		4.09		
Malacostrata(T)	3.12	4.82		
Diplopoda(T)	4.36	5.83	1.13	
VERTEBRATA				
Pisces(A)		10.59	7.66	6.94
Anura(A)			21.75	64.25
Aquatic prey	27.67	11.55	67.50	67.74
Terrestrial prey	72.33	91.03	33.97	31.84
Niche breadth /	0.93	0.92	0.87	0.77
95% Confidence Limits	(0.88-0.96)	(0.87-0.95)	(0.82-0.92)	(0.69-0.83)
Sample size	90	92	77	79

TABLE 3. Diet overlap index among *Rana catesbeiana* size class groups and overlap percentages (in parentheses). Rec-met. = recently metamorphosed.

Size Class	Rec-met.	Juveniles	Sub-adults	Adults
Rec-met.	-	0.79 (64%)	0.54(39%)	0.18 (27%)
Juveniles		-	0.76 (60%)	0.20 (36%)
Sub-adults			-	0.64 (54%)

P = 0.000) and pos-hoc Bonferroni test found significant mean differences between adults and all other categories ($\alpha = 0.05$). There was significant and positive relationship between Bullfrog length (SVL) and prey length (r = 0.578, N = 338, P = 0.01). Bullfrog size explained only 33% of the prey size variability. The remainder of the variation is probably due to other factors including behaviour, physiological needs, prey availability and habitat use.

Rana catesbeiana has a generalist diet, but probably has a preference for some prey items such as Odonata, Coleoptera, Hymenoptera, and vertebrates (fish and frogs). There was a tendency to increase vertebrate consumption as bullfrog size increased. It was observed mainly in large frogs (sub-adults and adults). Cannibalism can have strong effects on reducing population size and community structure (Fox 1975).

The diet of Bullfrogs introduced into Colombia mostly consisted of insects (56%), with vertebrates constituting only 2% of the diet (Daza and Castro 1999). However, in Japan it was found that adults fed mainly on crayfish (49.6%) with vertebrates not represented in the diet (Hirai 2004).

Our results confirmed that *R. catesbeiana* is an opportunistic species, with both invertebrates and vertebrates comprising the diet. Differences in diet are related to differences in body size and microhabitat selection (Wu 2005). This invasive species may affect native amphibians as predators, competitors, agents of habitat change, and disease reservoirs. Therefore, management and control should be attempted.

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Absence of Cloacal Shedding of *Salmonella* in Wild Red-eared Sliders (*Trachemys scripta elegans*)

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Salmonella is a zoonotic bacterium that causes gastrointestinal disease in humans and can be carried asymptomatically by animals (Chiodini and Sundberg 1981). While most human infections are caused by the consumption of contaminated food (Tauxe 1991), reptiles are also a source of infection and may cause as many as 70,000 human cases annually in the United States (Mermin et al. 2004). Public health concerns have led to studies to identify the rate of *Salmonella* shedding in captive turtles from zoos (Otis and Behler 1973), commercial turtle farms (Siebeling et al. 1984), and private collections (Abalem de Sá and Solari

2001). Comparatively little is known, however, about *Salmonella* infections in wild, free-ranging turtles. Generally, wild turtles are believed to shed *Salmonella* at lower rates than captive turtles because they either lack exposure to stressors that increase shedding rates or because they are not natural carriers of the bacterium (Du Ponte et al. 1978; Richards et al. 2004; Saelinger et al. 2006). A few recent studies on wild chelonians have, however, reported a high prevalence of *Salmonella* in turtles (Chambers and Hulse 2006; Gaertner et al. 2008), with wild turtles having similar prevalence of *Salmonella* infection to captive turtles (Gaertner et al. 2008).

We examined the prevalence of *Salmonella* in wild Red-eared Sliders (*Trachemys scripta elegans*). Red-eared Sliders are common in the pet trade, and numerous studies have quantified *Salmonella* shedding rates in this species in captivity (Abalem de Sá and Solari 2001; Chassis et al. 1986; McCoy and Seidler 1973; Otis and Behler 1973; Pasmans et al. 2002a). They are also notorious as a globally invasive species, and they inhabit a variety of aquatic habitats. Our goal was to estimate the prevalence of *Salmonella* in wild Red-eared Sliders in Illinois where they inhabit a variety of natural water bodies and man-made agricultural ponds. We hypothesized that the prevalence of *Salmonella* in turtles would differ among habitat types because turtles might have experienced persistent stressors in man-made habitats, which might have increased shedding rates, or because man-made habitats might have increased infection risk directly. Such a result would have public health implications, and might help to explain variation in shedding rates observed among previous studies of wild turtles.

Turtles were sampled from water bodies in southern Illinois, a region characterized primarily by a mosaic landscape of forest, grassland, and intensive row crop agriculture. Five natural ponds (37.0688°N–37.1080°N, 88.5934°W–88.4677°W; NAD83) and five artificial ponds were sampled (37.4622°N–37.4089°N, 88.6900°W–88.6508°W; NAD83). Natural ponds, oxbow lakes along the Ohio River floodplain, were large (mean ± S.E.: 28.4 ± 11.5 ha), and supported a high diversity of fishes (Readel, unpubl. data) as well as diverse turtle assemblages (Dreslik et al. 2005). Artificial ponds, built in the 1970s as agricultural retention ponds, were small (1.1 ± 0.3 ha), contained only common lentic turtle species, and have been stocked with game fish (Readel, unpubl. data). Both habitat types were used as public or semi-public fishing grounds, and Red-eared Slider turtle abundance (trap-hours required to capture one turtle) was similar between sites (natural: 33.8 ± 9.5; manmade: 41.5 ± 13.7; Readel, unpubl. data).

Turtles were captured using baited hoop traps and were held in individual bleach-decontaminated tubs up to 4 h until sampling. Cloacal swabs were collected from turtles by rubbing a sterile polyester swab against the inner cloacal lining to obtain fecal material. Each swab was then agitated into 10 mL of selenite cystine broth (Edge Biologicals, Memphis, Tennessee, USA) that was incubated for 18 h at 37°C and then plated on xylose lysine desoxycholate (XLD) agar (Edge Biologicals, Memphis, Tennessee, USA) to isolate individual bacterial colonies. Plates were incubated at 37°C for 24 h and suspect colonies (colonies morphologically consistent with *Salmonella*) were inoculated into 0.2 ml tubes containing tryptic soy agar (Becton, Dickinson and Company, Sparks, Maryland, USA) for transport to the laboratory. If suspect colonies were not present after 24 h, plates were incubated at room temperature for an additional 24 h. Colonies were re-streaked on XLD agar and re-isolated in the laboratory.

All suspect colonies were subjected to a diagnostic PCR for *Salmonella*. Isolated colonies were inoculated into 0.5 ml of Luria-Bertani broth (Becton, Dickinson and Company, Sparks, Maryland, USA), which was incubated for 18 h at 37°C. Bacterial cells were then pelleted by centrifugation, and DNA was extracted using the DNeasy Mini Kit (Qiagen, Valencia, California, USA) eluted in a 100 μl volume, according to the manufacturer's protocol. The *Salmonella* specific primer pair invA-1 (5'- ACAGTGCTCGTTTACGACCTGAAT) and invA-2 (5'- AGACGACTGGTACTGATCGATAAT) was used to amplify a 243-bp segment of the *Salmonella* invA gene, which has been shown to be both sensitive and specific for this bacterial genus (Chiu and Ou 1996). As an internal control for DNA extraction and amplification, another published PCR primer pair of 16S-F (5'- AGACTGCTACGGGAGGCAGCAGT) and 16S-R (5'- GTTGCGCTCGTTGCGGGACTTAA) was used to amplify a 755-bp fragment of the 16S ribosomal RNA subunit gene, which is present in all bacteria (Villalobo and Torres 1998). PCRs were conducted in 12.5 μl volumes containing 1X DyNAzyme EXT buffer (Finnzymes OY, Finland), 3.5 mM MgCl2, 200 μM dNTPs, 0.3 μM each of primers 16S-F and 16S-R, 0.06 μM each of primers invA-1 and invA-2, and 0.125 units of DyNAzyme EXT DNA polymerase (Finnzymes OY, Finland). Reactions were cycled in an i-Cycler thermocycler (BioRad Inc, Hercules, California, USA) at 94°C for 2 minutes, then for 30 cycles at 94° C for 30 seconds, 57°C for 30 seconds, and 72°C for 45 seconds, followed by a final 72°C 4-minute extension step and an indefinite 4°C soak. A sample of wild-type *Salmonella typhimurium* DNA from the University of Illinois Veterinary Diagnostic Laboratory was used as a positive control, and sterile, distilled water was used as a negative control. Amplicons were visualized by electrophoresis in 1.5% agarose /TAE buffer followed by ethidium bromide staining and digital imaging under ultraviolet light. Samples were considered positive only if PCR produced both the 243-bp invA band and the 755-bp internal control 16S rRNA band. To confirm amplification of the correct gene, one invA PCR product from the positive control isolate was purified using the Zymoclean Gel DNA Recovery Kit (Zymo Research, Orange, California, USA) and submitted to the University of Illinois, Biotechnology Center for sequencing. The resulting sequence was compared to published sequence data (BLAST tool from the National Center for Biotechnology Information).

One hundred wild Red-eared Sliders were captured between June 18–29, 2006. Fifty turtles were captured from natural ponds and an equal number were captured from artificial ponds. Suspect colonies (colonies that were morphological consistent with *Salmonella* on XLD agar) were recovered from nine of 50 turtles in natural ponds and 12 of 50 turtles in artificial ponds.

PCR testing of suspect colonies failed to yield amplicons of the invA gene in any suspect colony, although amplifications of the internal control 16S rRNA fragment yielded positive results in all cases. Our *Salmonella* positive control yielded amplicons of both invA and 16S, and DNA sequencing confirmed that we had indeed amplified invA. These results demonstrated that DNA extraction and PCR were universally successful. The prevalence of

Salmonella spp. in the turtles sampled was therefore 0%, with an upper 95% confidence limit of 4.4% for the entire population of 100 turtles (calculated using the modified Wald method; Agresti and Coull 1998). All suspect colonies were, therefore, likely to be normal enteric organisms that produce hydrogen sulfide.

The absence of *Salmonella* in wild turtles in our study was consistent with findings of other studies on wild turtles in the United States that have reported a prevalence of 0–8% (Brenner et al. 2002; Harwood et al. 1999; Jackson et al. 1969; Richards et al. 2004; Saelinger et al. 2006), but was lower than those reported from Spain (12–15%; Hidalgo-Vila et al. 2006), Pennsylvania (100%; Chambers and Hulse 2006), and Texas (51%; Gaertner et al. 2008). Studies on captive turtles have reported *Salmonella* in 12–41% of *T. scripta* (Abalem de Sá and Solari 2001; Chassis et al. 1986; McCoy and Seidler 1973; Otis and Behler 1973; Pasmans et al. 2002a), and in 3–72% of all turtle species (Abalem de Sá and Solar 2001; Cambre et al. 1980; Corrente et al. 2004; Geue and Löschner 2002; Jackson and Jackson 1971; Nakadai et al. 2005; Onderka and Finlayson 1985; Otis and Behler 1973; Pasmans et al. 2002a). Our results supported the conclusion that the prevalence of *Salmonella* is low in wild compared to captive turtles.

Turtles might be natural carriers of *Salmonella*, but rarely shed the bacterium unless physiologically stressed (Du Ponte et al. 1978; Richards et al. 2004; Saelinger et al. 2006). In this study, artificial habitats were not associated with increased shedding in wild Red-eared Slider turtles. The habitats in which our turtles resided might not have experienced stress levels high enough to activate shedding. Alternatively, wild turtles may not be natural carriers of *Salmonella*, but rather only become infected through their environment (Richards et al. 2004; Saelinger et al. 2006). For instance, wild turtles admitted to a veterinary hospital were not shedding *Salmonella* upon entrance or after three weeks in captivity, and gastrointestinal mucosal samples from dead or euthanized wild turtles were also negative (Saelinger et al. 2006), suggesting that these turtles were not carriers of *Salmonella* before capture (Saelinger et al. 2006). Our results were consistent with another study that found no effect of habitat on the prevalence of *Salmonella* in aquatic turtles (Gaertner et al. 2008).

Our methods might have limited our ability to detect turtles with occult *Salmonella* infection, because we did not sacrifice turtles and sample regions of their gastrointestinal tracts where *Salmonella* can reside (Pasmans et al. 2002b). However, we used methods that were similar to previous studies (Corrente et al. 2004; Saelinger et al. 2006). Corrente et al. (2004), for example, showed that the quantity of feces on swabs was not correlated with a greater recovery rate, because of the efficiency of the enrichment step. Repeated culture with several media over time may have increased our chance of detecting intermittently shed organisms like *Salmonella* (Smith et al. 2002). Nevertheless, our failure to detect *Salmonella* in any of the 100 turtles indicated that, if the bacterium existed in this population, its point prevalence was below 4.4%.

Overall, our results were consistent with previous observations that wild turtles have low prevalence or shedding rates of *Salmonella*, and that these rates are lower than in captive turtles. To the extent that our results can be generalized, the public health problem of zoonotic salmonellosis of turtle origin may be largely characteristic of farmed and otherwise captive turtle populations; wild turtles may not represent an important source of the bacterium, even in habitats that are artificial and/or impacted by human activity. Red-eared Sliders, a notoriously ecologically plastic (and globally invasive) species, may be able to adapt to areas of high human impact without serious health-related consequences. It remains to be seen whether other, less adaptable turtle species show similar patterns.

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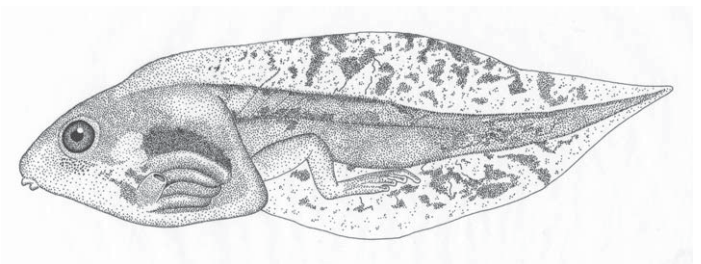
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Scinax staufferi tadpole. México: Quintano Roo (KU 157690). Illustration by Julian C. Lee.

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Diet and Reproduction of the Lizard *Tropidurus etheridgei* in Rocky Areas of Central Brazil

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Lizards of the genus *Tropidurus* occur throughout South America, mainly in open habitats such as Caatinga and Cerrado, occupying a wide variety of microhabitats (Rodrigues 1987). Many *Tropidurus* species (e.g., *T. oreadicus*, *T. hispidus*, *T. torquatus*, and *T. etheridgei*) are abundant, widespread, and ecologically diverse (Rodrigues 1987). *Tropidurus* are diurnal, heliophilous, sit and wait predators, consuming a wide variety of arthropods and occasionally vertebrates (Bergallo and Rocha 1993; Colli et al. 1992; Rocha and Siqueira 2008). With few exceptions, reproduction of *Tropidurus* species is non-continuous, occurring during the dry-wet season (Van Sluys et al. 2002) and involves a sexual dimorphism, both in color and size (Wiederhecker et al. 2002).

Although several aspects of life history of some *Tropidurus* species have been studied (e.g., Bergallo and Rocha 1994; Carpenter 1977), little is known about geographic variation in ecological attributes of the widely distributed species *T. etheridgei*.

Wide-ranging lizards often exhibit geographic variation in life-history and ecological traits (Qualls and Shine 1997). Understanding sources of this variation is essential for understanding the success and evolution of lizard species (e.g., Vitt and Colli 1994). Moreover, modification or the maintenance of ecological attributes between different populations of the same species may indicate the influence of historical or ecological factors on the structure of lizard communities (Vitt et al. 1998).

Tropidurus etheridgei is a medium-sized lizard distributed in the dry habitats of the Chaco, the Cerrado and the Pantanal regions, in Brazil, Paraguay, Bolivia and Argentina (Cei 1993; Rodrigues 1987). In spite of following the same patterns of other *Tropidurus* with a seasonal reproductive cycle, sexual dimorphism in color and shape and a generalized diet, there are some differences in the biology of *T. etheridgei* between the Chaco (Cruz 1997; Cruz et al. 1998) and the Cerrado (Vitt 1991) populations, mainly with respect to diet, reproduction and habitat use. However, information about populations in these two regions is limited. Herein, we describe the reproduction and diet of *T. etheridgei* in rocky areas of the Pantanal, Western Brazil. In addition, we compare reproductive and feeding data to those reported for *T. etheridgei* in the Chaco and the Cerrado regions.

Materials and Methods.—The study was conducted in three rocky areas (19.1802778°S, 57.5381111°W; 19.1672222°S,

57.5573056°W; 19.0709167°S, 57.4858889°W) in the municipality of Ladário, Mato Grosso do Sul state, Brazil. The area is characterized by rock substrate covered mainly by bromeliads (*Deuterochomia* sp. and *Bromelia balansae*) and patches of dry forest. The climate is characterized by an Aw type of Köppen classification, with mean precipitation of 1120 mm, concentrated in October–March (Soriano 1997).

Lizards were captured from July 1997 to June 1998 by noose or hand, with a sampling effort of 36 h/month. The following variables were measured for each lizard: snout–vent length (SVL), head length (HL), head width (HW), head height (HH), body width (BW), body height (BH), tail length (TL), foreleg length (FL) and hind leg length (LL) using an electronic caliper (Mitutoyo®; ± 0.1 mm). Lizard body mass was measured with Pesola® spring scales (± 0.2 g).

To examine morphological variation due to sex, we log-transformed all morphometric variables of adult individuals and made separate regressions of all variables with log10 SVL. We then used a multivariate analysis of variance (MANOVA) on the residuals of the regressions, with the sex as factor. The differences in SVL of males and females were tested by a Mann-Whitney Z test.

For diet analysis, the lizards were with an injection of Thiopental® dissected, stomachs removed, and prey items identified to the lowest taxonomic level possible. The length (l) and width (w) of intact prey were recorded with electronic calipers and prey volume (V) was estimated as an ellipsoid:

$$V = \frac{4}{3\pi\left(\frac{1}{2L}\right)\left(\frac{1}{2W}\right)^2}$$

where L is the prey length and W is the prey width.

Numeric and volumetric percentages of each prey categories were calculated for allow comparisons with other studies and for calculations of niche breadths, which were computed using the inverse of Simpson's diversity index (Simpson 1949):

$$\beta = \frac{1}{\sum_{n=1} pi^2}$$

where *p* is the numeric or volumetric proportion of prey category *I*, and *n* is the number of categories. In addition, a standardized niche breadth (niche breadth divided by number of prey categories) was calculated for comparisons between the populations of *T. etheridgei* from Chaco (Cruz et al. 1998) and Cerrado (Vitt 1991). To investigate the relationship between lizard SVL and mean prey length we performed a Pearson correlation.

Lizards were sexed by dissection and gonads were examined. Males (N = 8) were considered reproductive if they contained convoluted epididymides. Females (N = 17) with vitellogenic follicles (N = 14) or oviductal eggs (N = 3) were considered reproductively active. Simultaneous presence of vitellogenic follicles and eggs was considered as an indication of production of more than one clutch per reproductive season.

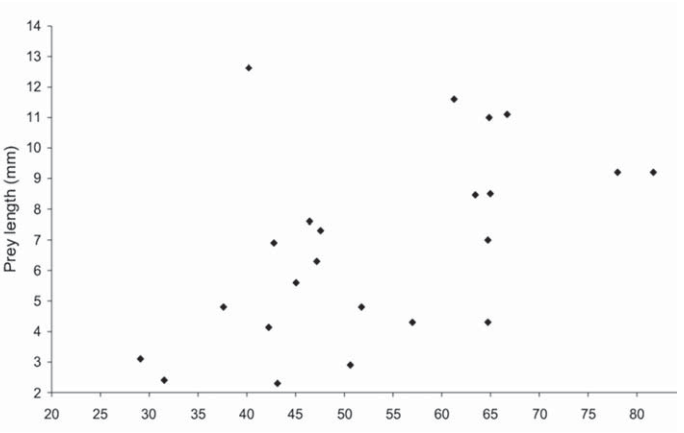


FIG. 1. Relationship between mean prey length and snout–vent length (SVL) of the lizard *Tropidurus etheridgei* in rocky areas of central Brazil.

Size at sexual maturity was estimated as the smallest female containing vitellogenic follicles and the smallest male with convoluted epididymides. Length and width of testes and follicles and/or eggs were recorded with a digital caliper and volume was estimated using the ellipsoid formula described above.

Results.—Reproduction and diet of *T. etheridgei* are based on 31 individuals: 8 adult males, 17 adult females and 6 juveniles. No sexual dimorphism in SVL for 8 adult males (54.70 ± 12.86 mm) and 17 adult females was detected (54.29 ± 13.95 mm) (Mann-Whitney U test = 62, P = 0.75). Likewise, no sexual dimorphism for body shape between the sexes was verified (Wilks $\lambda = 0.50$; $F_{8,16} = 1.99$; P = 0.11; N = 25), although some variables, such as tail length were different (Table 1). The smallest mature male was 47.6 mm in SVL and the smallest mature female was 42.8 mm. Mean clutch size based on three females was 4.33 ± 2.08, and mean egg volume was 186.02 ± 108.21 mm^3 (N = 13 eggs). None of these females contained evidence of production of more than one clutch. Females with oviductal eggs (N = 3) were captured from October–December and skin in the gular region was dark, in contrast to the grayish gular region of non-gravid females from January–September.

Of the 31 stomachs of *T. etheridgei* dissected, 25.8% (8) were empty. We identified 17 prey types (N = 779 items) that were

TABLE 1. Summary of descriptive statistics (range) of 17 adult female and 8 adult male *Tropidurus etheridgei* from rocky habitats of the Pantanal, Brazil. Means are ± 1 standard deviation.

Variables	Males	Females
SVL	54.70 ± 12.86 (47.57–81.57)	54.29 ± 13.95 (42.79–78.01)
Body width	13.52 ± 4.05 (10.44–19.66)	14.25 ± 4.3 (10.44–20.29)
Body height	8.13 ± 2.32 (7.65–12.57)	9.08 ± 3.62 (5.54–16.03)
Head width	15.86 ± 3.68 (9.96–18.22)	15.31 ± 3.27 (8.76–13.29)
Head length	11.04 ± 2.97 (13.91–23.48)	10.27 ± 2.27 (12.68–20.48)
Head height	7.92 ± 1.74 (6.76–11.18)	7.86 ± 2.20 (6.03–11.99)
Foreleg	25.55 ± 7.32 (18.86–41.86)	24.50 ± 5.52 (18.24–31.32)
Hind leg	38.31 ± 9.47 (31.89–61.91)	38.40 ± 9.55 (28.21–49.54)
Tail	78.44 ± 27.72 (71.54–144.01)	84.66 ± 18.40 (64.68–118.49)

TABLE 2. Numbers, proportion of number (P/N), total volume and percent volume of prey types in the diet of *Tropidurus etheridgei*, with respective percentages and niche breadth.

	N	P/N	VOLUME (mm^3)	% VOLUME
INSECTA				
Blattaria	2	0.26	65.00	1.09
Coleoptera	35	4.49	1163.84	19.56
Diptera	1	0.13	0.15	0.00
Insect larvae	34	4.36	894.98	15.04
Hemiptera	13	1.67	182.45	3.07
Homoptera	4	0.51	61.77	1.04
Hymenoptera				
Ants	586	75.22	454.96	7.64
Other	4	0.51	37.73	0.63
Isoptera	24	3.08	22.29	0.37
Orthoptera	14	1.80	2098.50	35.26
Phasmatodea	2	0.26		
CHILOPODA	4	0.51	66.36	1.12
ARACHNIDA				
Aranae	40	5.13	599.36	10.07
Others	3	0.39	213.17	3.58
PLANT MATERIAL	9	1.16	83.08	1.40
STONES	3	0.39	7.39	0.12
SHED SKIN	1	0.13	0.27	0.00
TOTAL	779	100	5951.32	100
NICHE BREADTH		1.74		4.90

mainly insects (83.7% in volume), although arachnids comprised 13.65% of the total volume and spiders were the second most frequent prey type in number (5.13%). Ants were the most frequent in number (75.22%) and Orthoptera was greatest in volume (35.26%; Table 2).

Niche breadth of *T. etheridgei* was 1.74 in number and 4.90 in volume. Mean number of prey was 28 ± 22.53 (4–89), with a mean length of 3.39 ± 2.75 mm (N = 639), mean width of 1.14 ± 1 mm and a mean volume of 9.94 ± 42.27 mm^3. Mean prey length was significantly correlated with lizard SVL ($r = 0.29$, $P < 0.001$; Fig. 1).

Discussion.—Many aspects of the ecology of *T. etheridgei* in the Pantanal were similar to those of the Chaco and Cerrado populations (Table 3). However, some differences regarding reproduction were apparent. Clutch size of *T. etheridgei* from the Pantanal is smaller than that of lizards of the Chaco and the Cerrado regions. Furthermore, the Cerrado and Chaco populations produce multiple clutches (Cruz 1997; Vitt 1991). However, absence of multiple clutches and the low clutch sizes in the present study may be due to our sample size. Environmental factors, such as rainfall, strongly affect reproductive characteristics of lizard populations at the local level (Colli 1991; Van Sluys et al. 2002). Mesquita and Colli (2003) found that populations of *Cnemidophorus* in highly seasonal biomes (Cerrado and Amazonian Savannas) produce larger clutches and have a shorter reproductive season than in habitats with unpredictable climates (Caatinga). This may partially explain the cyclical reproductive season in the Pantanal (with a highly seasonal climate), but not clutch size. Clutch size is influenced by female body size and microhabitat preferences (Vitt 1981). Rocky habitats may also constrain the availability of prey, which ultimately can affect energy invested in reproduction (Vitt et al. 1996).

Dark gular patches in gravid females were reported for the second time for a *Tropidurus* species. These occur in *T. chromatops* (a species that resembles *T. etheridgei*) from Serrania de Huanchaca, Bolívia (Harvey and Gutberlet 1998). Dichromatism most likely provides signals in social interactions. The lack of sexual size dimorphism found here may result from our small sample size, since many larger males were observed in the field. Male *Tropidurus* generally have larger SVL than females (Vitt 1993; Vitt et al. 1996). This includes the Chaco populations, where males are considerable larger than females (Cruz 1997).

The diet of *T. etheridgei* in the Pantanal consisted almost exclusively of arthropods, with a high percentage of ants. However, lizards from the Chaco population (Cruz et al. 1998) also feed on vertebrates. Similarly to the Chaco lizards, we did not find flowers in the diet of *T. etheridgei*, in contrast to the diet of the Cerrado population where this was an important item, although we collected year-round (Vitt 1991). In spite of this, the diet is similar among populations, being ants, beetles and larvae the most important prey items. Differences in diet between populations may reflect geographic variation in prey availability, seasonality and dietary preferences (Mesquita and Colli 2003). Moreover, the diet of *T. etheridgei* follows the general pattern found in many species of *Tropidurus*, with a consumption of a great variety of prey, especially a lot of ants (Vitt et al. 1997). They also occasionally prey on vertebrates, including conspecifics (Kiefer and Sazima 2002). This can be confirmed by the high values of niche breadth found in many *Tropidurus* species, although in our study the niche breadth values, both numerically and volumetrically resembles the Chaco populations studied by Cruz et al. (1998).

With the exception of differences related to clutch size and few

TABLE 3. Ecological comparisons of *Tropidurus etheridgei* in three different biomes of South America: Chaco (Cruz 1997; Cruz et al. 1998; Fitzgerald et al. 1999), Cerrado (Vitt 1991), and Pantanal (this study). Sample sizes are in parentheses.

	CERRADO	PANTANAL	CHACO
Mean SVL (mm)	68.9 (71)	62.0 (31)	68.9 (150)
% volume of ants in diet	36.6	7.64	27.11
Mean prey length (mm)	4.7 (117)	3.39 (639)	9.14 (386)
Numeric niche breadth	0.21	0.10	0.16
Volumetric niche breadth	0.47	0.29	0.27
Mean clutch size	4.9 (45)	4.3 (3)	6.2 (15)
Multiple clutches	yes	no?	yes

prey types, the biology of *T. etheridgei* is similar in three different biomes of South America. However, further studies are necessary to identify the influences of historical and ecological factors in the differences.

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TECHNIQUES

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Denaturing Gradient Gel Electrophoresis for the Determination of Bacterial Species Diversity in the Gastrointestinal Tracts of Two Crotaline Snakes

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Vertebrate gastrointestinal tracts (GITs) are complex ecosystems inhabited by hundreds of microbial species (Bäckhed et al. 2004; Lu and Walker 2001). Vertebrates have coevolved with commensal and mutualistic microbes and microbiota is now considered an essential component of mammalian physiology (Dethlefson et al. 2007).

Microbial cells living in and on the human body are estimated to outnumber human cells by a factor of ten (Turnbaugh et al. 2007). The use of molecular techniques to study the human microbiota is revolutionizing the study of human biology (Dethlefsen et al. 2007). Bacteria of the GIT have an important influence on nutritional, physiological, and immunological processes of their hosts and provide multiple benefits (Turnbaugh et al. 2006; Zoetendal et al. 2004). In humans, beneficial bacteria synthesize vitamins, break down indigestible substances, and provide protection from the colonization of pathogenic bacteria by competing for food and living space or by producing antimicrobial substances (Xu and Gordon 2003). Mutualistic and commensal bacteria play a key role in educating the immune system to provide tolerance and reduce allergic responses (Braun-Fährlander et al. 2002). The intestinal microbiota also has a profound affect on nutrient acquisition. Mouse GIT microbiota suppress gene expression of factors produced by the intestinal epithelium and promote absorption of monosaccharides resulting in increased fat storage (Bäckhed et al. 2004). Turnbaugh et al. (2007) recently wrote, "To understand the range of human genetic and physiological diversity, the microbiome and the factors that influence the distribution and evolution of the constituent microorganisms must be characterized." Surely the importance of microorganisms is not restricted to humans and an understanding of microbe host relationships in vertebrates is critical to understanding their biology and ecology.

Snakes, especially pitvipers, are useful organisms for studies of vertebrate energy budgets (Beaupre 1996, 2002). Microbiota of the GIT are likely to play an integral role in nutrient and energy acquisition in snakes, yet very little is known about the microbial communities of snake GITs and nothing is known about the function of microorganisms for nutrient acquisition in snakes. An understanding of the diversity and function of intestinal flora of snakes is likely to increase our knowledge of nutrient acquisition and energy budgets in these animals.

Gastrointestinal microbiota have been relatively well studied in humans (Hooper et al. 2001; Wang et al. 2003), lab mice (Bäckhed et al. 2004), and agriculturally important animals (Leser et al. 2002; Simpson et al. 2002). Less is known about the GIT microbiota of non-human and non-agricultural taxa and the implications of GIT microbiota for studies of ecophysiology have yet to be explored. Despite their importance to ecophysiological research, virtually nothing is known about the structure and function of microbial communities in reptile GITs. To date, only the microflora of the mouth, esophagus, and feces of snakes have been characterized using traditional microbiological (culturing) techniques (Graves et al. 1988; Grupka et al. 2006; Lutterschmidt et al. 2007). Because culture-based techniques fail to cultivate many microbial species (Raskin et al. 1997; Ricke and Pillai 1999), their use may drastically underestimate microbial diversity. Furthermore, to fully understand the structure and function of the microbial communities in reptilian guts, all organs of the digestive tract should be studied. From an energy acquisition standpoint the small intestine is especially important because nutrient absorption occurs there.

Molecular techniques for identifying complex microbial communities can alleviate problems associated with traditional culturing techniques because selective cultivation and isolation conditions are not needed. Denaturing gradient gel electrophoresis (DGGE) is a commonly used culture-independent technique for modeling complex microbial communities (Ercolini 2003). To determine bacterial species diversity of a sample using DGGE, DNA is extracted from the sample. The polymerase chain reaction (PCR) is then used to amplify the 16s rRNA gene, present in all bacteria, and produce products of the same size but with different sequences (Muyzer et al. 1993). The products are subsequently separated on a denaturing gel with an increasing gradient to produce a banding pattern unique to each bacterial community sampled. Individual bands obtained during electrophoresis may be excised and sequenced. Sequences

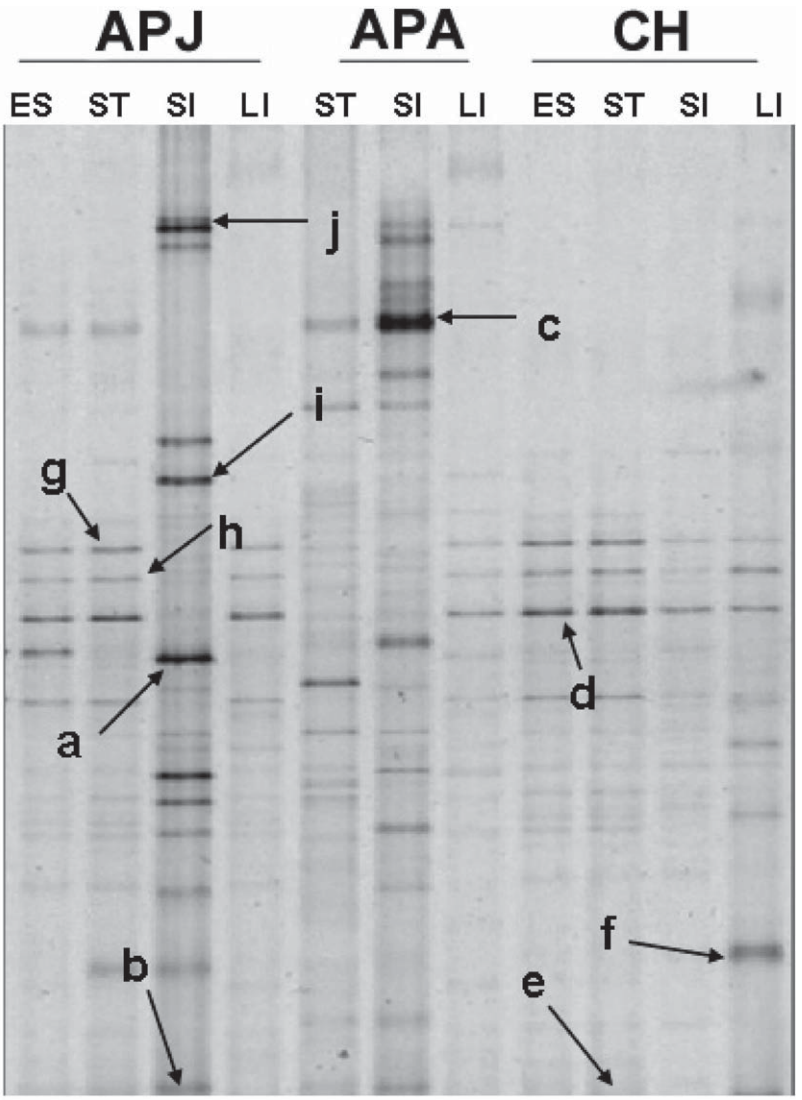


FIG. 1. DGGE gel electrophoresis band patterns of bacteria samples isolated from organs of the gastrointestinal tract of a juvenile *Agkistrodon piscivorus* (APJ), an adult *A. piscivorus* (APA), and an adult *Crotalus horridus* (CH). ES = esophagus; ST = stomach; SI = small intestine; LI = large intestine. Lettered bands were excised, sequenced, and identified to the most closely related bacterial taxa using GenBank. a) *Parabacteroides* sp., b) *Fusobacterium* sp., c) *Bacteroides* sp., d) *Lactobacillus fermentum*, e) *Lactobacillus lactis*, f) Firmicutes, g) *Lactobacillus* sp., h) *Lactobacillus hammesii*, i) *Bacteroides* sp., j) *Bacteroides fragilis*.

TABLE 1. List of bacterial taxa identified from gastrointestinal tract organs of snakes. Juvenile *Agkistrodon piscivorus* (APJ), adult *A. piscivorus* (APA), and adult *Crotalus horridus* (CH). ES – esophagus, ST – stomach, SI – small intestine, LI – large intestine. * – Digesta present in the organ. X – Bacterial taxa present. Total bands refers to the number of bands in the gel from each sample.

Bacterial Taxa	APJ-ES	APJ-ST	APJ-SI*	APJ-LI	APA-ST*	APA-SI*	APA-LI*	CH-ES	CH-ST	CH-SI	CH-LI
Bacteroides fragillis			X			X	X				
Bacteroides											
? Species 1					X	X					
Bacteroides											
? Species 2			X			X	X				
Parabacteroides											
? Species		X	X		X	X					
Firmicutes											
? Species											X
Lactobacillus fermentum			X			X	X	X	X	X	X
Lactobacillius lactis		X		X			X	X	X	X	
Lactobacillus hammesii	X	X	X	X			X				
Lactobacillus											
? Species	X	X		X	X	X					
Fusobacterium											
? Species			X			X					
Total Bands	13	18	25	12	24	27	12	13	12	8	11

can be compared to known sequences of bacterial taxa which are published in the GenBank database to identify bacteria (Altschul et al. 1990). The number of bands from a sample provides a close estimate of the number of bacterial species in the sample but may not directly correspond to the number of bacteria species present (Nübel et al. 1996; von Wintzingerode et al. 1997) and bacteria present in low numbers may not be detected by PCR/DGGE (Muyzer et al. 1993).

To the best of our knowledge, no published studies have utilized PCR/DGGE to determine the bacterial diversity in the GIT of any reptile. The objective of this research was to determine the usefulness of PCR/DGGE for determining the bacterial diversity of snake GITs. We used PCR/DGGE to analyze samples from different organs in the GIT of two species of viperid snake and sequenced electrophoretic bands to identify some of the bacterial species present. Our results provide the first data on bacterial species diversity of reptilian stomachs and small intestines.

Materials and Methods.—One Timber Rattlesnake (*Crotalus horridus*) and two Western Cottonmouths (*Agkistrodon piscivorus leucostoma*) were captured opportunistically in Madison County, Arkansas in August and October of 2006, respectively. Specimens were held in captivity for less than 24 h, euthanized, measured for snout–vent length (SVL), total length (TL), weighed using an electronic balance, and dissected. During dissection, tissue from the esophagus, stomach, small intestine, and large intestine was removed, placed in sterile plastic bags, and frozen at -80°C. The esophagus was not sampled from the adult *A. piscivorus* due to financial limitations.

We used a QIAamp DNA stool mini kit (Qiagen, Valencia, CA) to extract bacterial DNA from 180–220 mg of tissue from the mucosa of the dissected gastrointestinal tract samples. The V2–V3 region of the 16s rRNA gene, corresponding to positions 339–539 of the *Eschericia coli* genome, was amplified by PCR using previously published primers (Fasoli et al. 2003; Johansen et al. 2006) and reaction conditions (Hume et al. 2003). Electrophoresis and gel staining were carried out according to the protocol of Johansen et al. (2006). Gels were viewed under UV transillumination and total number of bands and band comparison among electrophoretic lanes were analyzed using Quantity One gel analysis software (Bio-Rad, Richmond, California).

Twenty-five of the most brightly stained bands were excised from the gel for sequencing. Excised gel fragments were disrupted by forcing gel through a pin hole in the bottom of a 0.5 ml microcentrifuge tube, centrifuged at 14,000 rpm for 5 minutes, and collected in a 1.7 ml microcentrifuge tube. Disrupted gels were suspended in 300 µl of TE buffer, vortexed, and incubated at 65°C for 15 minutes. Contents were filtered through a 0.2µm filter (Pall Life Sciences, East Hills, New York) and the filtrate was mixed with 1333 µl of NH_4OAc in EtOH (10% vol/vol 7.5M NH_4OAc; 90% EtOH) and 1 µl of glycogen (20mg/ml) (EMD Biosciences). The sample was vortexed and stored at -80°C for 10 minutes then centrifuged at 14,000 rpm for 15 minutes. The supernatant was discarded and the pellet washed twice in cold 70% EtOH and resuspended in 4.5 µl of TE. DNA was sequenced with the same primers as used for amplification but without the GC clamp. Sequencing was carried out on an ABI 3100 capillary analyzing system and sequences were compared with the GenBank database using the BLAST algorithm (Altschul et al. 1990).

The gastrointestinal tract profiles were compared using the Quantity One software (Bio-Rad). Similarities were compared based on the Dice similarity coefficient which uses an arithmetic determination to analyze the degree to which banding patterns are alike. Dendrograms were created based on the grouping and relatedness between samples (each lane) and the amount of relatedness is indicated by the percentage bar above each dendrogram. A chicken ceca intestinal sample was used as an out-group to root

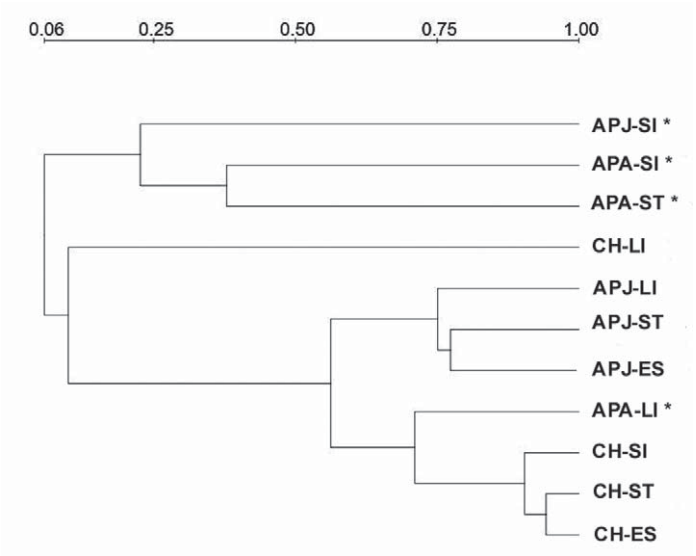


FIG. 2. A comparison of the similarity of the DGGE gel electrophoresis patterns of intestinal bacteria isolated from the esophagus (ES), stomach (ST), small intestines (SI), and large intestines (LI) of a juvenile *Agkistrodon piscivorus* (APJ), an adult *A. piscivorus* (APA), and an adult *Crotalus horridus* (CH). Relative similarity of banding pattern is indicated by the grouping on the dendrogram and the percent of similarity coefficient (bar). * - organ contained digesta.

the tree for this analysis.

Results.—Gastrointestinal tract samples were obtained from one adult female *C. horridus* (69.0 cm SVL, 73.5 cm TL, 218.6 g), one adult female *A. piscivorus* (56.2 cm SVL, 75.0 cm TL, 171.6 g), and one juvenile female *A. piscivorus* (32.0 cm SVL, 37.6 cm TL, 37.4 g). All the digestive organs of the adult *C. horridus* specimen were devoid of digesta. The stomach, small intestine, and large intestine of the adult *A. piscivorus* contained digesta. The juvenile *A. piscivorus* specimen had digesta in the small intestine and the remaining organs were devoid of digesta.

Electrophoretic gel lanes from individual snake GIT organ samples contained from 8 to 27 bands (Fig. 1, Table 1). When all GIT organ samples were combined the *C. horridus* specimen contained a total of 18 bands, the juvenile *A. piscivorus* specimen contained 57 bands, and the adult *A. piscviorus* specimen contained 46 bands. A total of 66 different bands were present from all three snakes and 12 were in common to all three specimens.

Of the 25 bands excised from the gel for sequencing, 10 were successfully sequenced and assigned to a species, genus, or higher taxa by the GenBank database using the BLAST algorithm (Fig. 1, Table 1). Insufficient DNA was present in the remaining 16 bands for sequencing. Bands identified as *Parabacteroides*, *Bacteroides*, and *Fusobacterium* were only found in *A. piscivorus* (Table 1). Bands identified as *Bacteroides* and *Fusobacterium* were found in the small intestines and stomachs of both *A. piscivorus* specimens but not in the esophagus and large intestines. *Lactobacillus fermentum* and *Lactobacillus lactis* were found in one or more organs of all three snakes (Table 1).

Similarity comparisons of the samples indicate several trends (Fig. 2). Three of the four samples which contained digesta had less than 40% homology with each other and the other samples. Most of the samples that did not contain digesta were 75% or more homologous but the *C. horridus* large intestine sample was quite unique (<10% homology). Aside from the above trends, the samples roughly grouped by individual.

Discussion.—The total number of unique electrophoretic bands observed for each of our specimens was similar to totals found in other vertebrates for which data are available. A PCR/DGGE analysis of chicken ceca found 26 bands (Hume et al. 2003). Samples from the ilea and ceca of chickens contained 17 bands (Lu et al. 2003). Rumen of steer guts showed approximately 12 bands (Simpson et al. 2002).

Lutterschmidt et al. (2007) detected nine bacterial species in the mouth and esophagus of wild *A. piscivorus* using culture based techniques. Our two esophageal samples both contained 13 bands. Our study did not identify any of the species found by Lutterschmidt et al. (2007) but we only sequenced 10 bands out of the 66 present in our samples. The nine species found by Lutterschmidt et al. (2007) might be present in our samples but were not among the bands we selected for sequencing. It is also possible the nine species found by Lutterschmidt et al. (2007) are indigenous to the oral cavity, a region we did not sample.

Variation in bacterial species diversity among our samples might be attributable to interspecific differences related to diet (Dethlefsen et al. 2007; Lutterschmidt et al. 2007), the presence or absence of digesta in the organ (Simpson et al. 2002), the developmental stage of the individual (Lu et al. 2003; Lentle et al. 2006), or the functional role and environmental conditions of the specific GIT organ (Lu et al. 2003; Wang et al. 2003). We lacked sufficient samples to test any of these possibilities statistically and future studies should be conducted to investigate these issues. We speculate that microbial diversity in our individual GIT organs was influenced by the presence or absence of digesta. Organs without digesta were generally more similar to one another than those with digesta and organs containing digesta appeared to show higher microbial diversity than those devoid of digesta (Table 1). The presence of digesta in an organ might increase microbial diversity because bacteria are introduced into the gut upon ingestion of prey or because resident bacteria, that were undetectable in empty organs, increase to detectable numbers in the presence of digesta.

All of the bacterial taxa identified from the GITs of our snake specimens are typical gut flora found in other vertebrate hosts (Lu et al. 2003; Xu and Gordon 2003; Sakamoto et al. 2007). *Lactobacillus*, *Bacteroides*, and *Fusobacterium* were among the ten genera which comprise 99% of the microbiota in human intestines (Xu and Gordon 2003). The small intestine of both *A. piscivorus* specimens contained *B. fragilis*, and an unidentified *Bacteroides* species. Bacteria in the genus *Bacteroides* affect nutrient uptake and fat accumulation in lab mice (Turnbaugh et al. 2006) and are likely to affect nutrient uptake in our snake specimens as well. All the snakes in our study were found to be carrying *Lactobacillus fermentum* and *L. lactis* in one or more organs. Because these *Lactobacilli* were found in both snake species having such different diets, they are also likely to be indigenous flora. *Lactobacilli* are common in the GIT of humans and other vertebrates and are considered health promoting or "probiotic" flora because they produce antimicrobial compounds that inhibit the growth of pathogens (Amit-Romach et al. 2004; Soomro et al. 2002). *Lactobacillus lactis* produces the antimicrobial agent nisin which is also produced commercially to prevent food spoilage (Vandenbergh 1993). Additional studies

will be required to determine the functional role of bacteria in the GIT of snakes.

Results of this study demonstrate that DGGE is a useful approach for studying bacterial diversity in snake GITs. With this tool we characterized bacterial communities present in different GIT organs of individual snakes and identified some likely indigenous species. Application of this technique to snake microbial gut ecology could provide valuable insight into the interactions of snakes with GIT bacteria and would likely increase our understanding of nutrient acquisition in snakes and other reptiles.

Alternative molecular methods for characterizing microbial communities include Terminal Restriction Fragment Length Polymorphism (T-RFLP, Osborn et al. 2000) and pyrosequencing (Liu et al. 2007; Luna et al. 2007). Both T-RFLP and DGGE have problems with PCR introduced bias but additional bias is introduced with T-RFLP because PCR products are enzymatically digested—adding significant bias towards certain products (Hartmann and Widmer 2008). Also, because T-RFLP is a fluorescence-based analysis some peaks represent artifacts and not bacteria (Hartmann and Widmer 2008). Pyrosequencing aims at identification of all bacterial species in a sample and is typically used in a clinical setting for analysis of microbial communities with minimal diversity (Luna et al. 2007). Our objective was to compare microbial communities and identify some bands of interest. Therefore, DGGE was a more appropriate and cost effective method than pyrosequencing for this study.

A number of interesting questions regarding snake GIT microbiota could be addressed using PCR/DGGE and similar techniques. For example, when snakes consume whole animal prey allochthonous microbes are introduced to their guts. How does the snake GIT cope with such an assault? Snake GITs are subject to large variations in activity level and environmental conditions. Because many snakes feed infrequently on large meals the gastrointestinal tract is upregulated during feeding and downregulated during periods of non-feeding (Secor and Diamond 1995). Does microflora contribute significantly to the increase in gut biomass which occurs during up-regulation? What happens to the GIT microflora during periods of non-feeding in the active season and during low temperature hibernation? How is the microflora reestablished when feeding ensues? How does temporal variation in the GIT microbial community influence a snake's ability to obtain energy and nutrients from its environment? Molecular techniques for the analysis of complex microbial communities will be useful tools for answering these and other important questions that will increase our understanding of how reptiles obtain energy and materials from their environments.

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Density Estimation of Larval *Eurycea wilderae*: A Comparison of Mark-Recapture and Depletion Sampling

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Salamanders often are considered to be the most abundant vertebrate organisms in headwater-riparian ecosystems, contributing a significant amount of biomass to ecological and ecosystem processes (Burton and Likens 1975; Davic and Welsh 2004; Peterman et al. 2008). Research has shown that salamanders can exert significant top-down limitations on ecosystem processes, acting as predators of detrivorous organisms (Davic 1983; Wyman 1998), but larval salamanders are susceptible to bottom-up limitations of leaf litter in largely allochthonous-based headwater ecosystems (Johnson and Wallace 2005). Though salamanders are thought to be integral components to fishless headwater streams, acting as predators and prey, actual quantification of their importance has been limited by accurate estimation of population sizes and densities (Bailey et al. 2004; Dodd and Dorazio 2004).

Eurycea wilderae (Blue Ridge Two-lined Salamander) is the most abundant larval species encountered in many Appalachian headwater streams (WEP, unpubl. data). Like a number of other species, two-lined salamanders exhibit a variable activity pattern (Hairston 1949; Orser and Shure 1972; Petranka 1984). During the day, larval two-lined salamanders seek refuge under rock cover or in interstitial spaces in the gravel streambed and at night move about the stream feeding (Petranka 1984). These variable activity patterns can result in drastically different measures of abundance and habitat use (Crawford 2007). Previous estimates of larval salamander abundance and density have employed a variety of techniques that include passive sampling using leaf litter bags, drift nets, or funnel traps (e.g., Bruce 1986; Waldron et al. 2003; Willson and Dorcas 2003), daytime visual encounter surveys that include lifting of cover objects (e.g., Barr and Babbitt 2001; Lowe and Bolger 2002; Smith and Grossman 2003; Welsh and Ollivier 1998), active dipnetting (Willson and Dorcas 2003), or a combination of methods (Nowakowski and Maerz, *in press*). Data collected through these various methods have been analyzed using mark-recapture techniques (Johnson and Wallace 2005; Lowe 2003), removal equations (Jung et al. 2005; Spight 1967), or using replicated counts (Dodd and Dorazio 2004).

Though there are a variety of sampling and estimation options available, researchers are often restricted by time and resources in conducting surveys. In this study, we assess two population estimation techniques: passive trapping with mark-recapture and active depletion sampling. We compare both the time and resources involved with each of these techniques and population estimates

calculated from each method.

Methods.—Surveys for larval two-lined salamanders were conducted at four headwater streams in the southern Appalachian Mountains near Highlands, North Carolina, USA during June and July of 2007. All streams were located within 5 km of Highlands, and were separated by at least 300 m. The four study sites did not differ substantially with regards to habitat characteristics, which were measured at each trap location and then averaged across all sites; values are reported as means (± SD). All four of the gravel substrate streams were fishless headwater streams (i.e., first or second order) that flowed through mixed hardwood forests. *Rhododendron* spp. dominated the understory along the stream banks. Width and depth were measured with a meter tape and ruler, and were 3.21 m (± 0.72) and 105 mm (± 9.43), respectively. Canopy cover averaged 91.9% (± 1.78) and was measured from the center of the stream using a spherical crown densiometer. The area of streambed covered by surface sedimentation averaged 28% (± 3.18) and was measured using a 0.25 m^2 sampling grid divided into 25 sections. The average elevation of study streams was 1044 m (± 151).

Passive trapping of larval salamanders was done using leaf litter traps (Nowakowski and Maerz, *in press*), which differ from leaf bags in that they are generally easier to search (WEP, pers. obs.) and they cover a greater area of stream while utilizing less material than leaf bags. Traps were constructed from 53 × 26 × 6 cm plastic plant pallets. Each trap was covered with 1.9 cm^2 garden mesh, which was held in place using 10 cm plastic cable ties on three sides. Traps were then filled with leaf litter and the fourth side was secured with a metal binder clip. Three traps were deployed at each stream, at least 5 m apart. Each trap was placed on the streambed and weighted with one or two rocks to keep it in place and tied to a secure branch or root on the stream bank to prevent loss from drift. Traps were set for ten days prior to checking to allow for colonization by invertebrates and salamanders. Leaf traps were checked once every three days for a total of four sample periods (nine days between first and last sample). Though it is possible to make population estimates after just two sampling events (e.g., Lincoln-Peterson; Lincoln 1930), three or more samples are generally recommended (Mazerolle et al. 2007) and we chose to use four sample periods for this study with the goal of obtaining more precise estimates and narrower confidence intervals.

To check for larvae, one researcher would quickly remove the leaf trap from the water and place it over a 60 × 40 × 22 cm Rubbermaid® container. Immediately after the trap was lifted from the streambed, a second researcher would use a 15 × 20 cm baitnet with <1 mm mesh to sweep directly under the trap (an area approximately 0.75 × 0.50 m). One researcher would then shake and agitate the trap over the large container while another poured approximately 35 liters of water over the trap. The resulting water and sediments were then poured from the large container through the 15 × 20 cm baitnet. The consolidated contents were then transferred into a white tray (40 × 30 × 8 cm) and sorted. Larvae were identified, counted, and given a cohort mark by clipping the tail fin at a 45° angle. All salamanders were then released at the upstream edge of the trap after it was reset. Following the fourth and final trapping period, all salamanders were released at the trap location after traps were removed from the stream.

Depletion sampling was conducted in plots centered on the area where leaf traps were previously set (i.e., three plots per site). Flags were placed in the stream bed to delineate the search area (0.75 m × 0.75 m) for depletion sampling. Depletion sampling began three days after the last trapping session. Each site was searched twice a night by two researchers (at least 45 minutes between searches) for three consecutive nights (six total samples). Sites were sampled in a different order each night to accommodate potential temporal variation in surface activity. Surface active larvae were captured using dipnets and turkey basters. No rocks or other cover objects were lifted or disturbed during depletion sampling. Following each sample, larvae were released at least 15 m downstream from the most downstream sample location. This distance effectively removed larvae from the depletion plots as most larval salamander movement occurs in the downstream direction, and movements upstream are generally less than 3 m (Johnson and Wallace 2005).

Mark-recapture data collected from trapping were analyzed using a Schumacher-Eschmeyer estimator (Seber 1982). Data from the three traps were pooled together for a single abundance estimate for each site. Abundance estimates were converted into density•m^{-2} estimates, assuming that the total area covered by each trap was 0.375 m^2 (0.75 × 0.50 m per trap). This area is greater than the trap size to account for the area searched with the dipnet. Removal data were analyzed in Program CAPTURE using Pollock and Otto's closed population estimator (Pollock and Otto, 1983) and abundance estimates were converted to density•m^{-2} estimates by dividing by the depletion plot area (0.75 × 0.75 m) .

Results.—We caught a total of 211 larvae with leaf litter traps and 237 were captured using active depletion sampling. Most of the captured larvae (93% and 92% for trapping and depletion, respectively) were smaller than 15 mm snout–vent length and are likely representative of the new cohort of two-lined salamanders, which generally have a larval period lasting about a year. The vast majority of larval captures in traps were two-lined salamanders, but traps captured a low number of larval Red Salamanders (*Pseudotriton ruber*) and larval Black-bellied Salamanders (*Desmognathus quadramaculatus*) at some sites. Density estimates could not be made using depletion sampling at Site 2 because of a lack of captures; nor could estimates be made using mark-recapture at Site 4 because of a severe storm and high water that disturbed the traps. For all other sites, density estimates calculated using mark-recapture and depletion sampling did not differ significantly (Table 1, Fig. 1). Estimates made through mark-recapture ranged from 75 larvae•m^{-2} (95% CI = 69.34–79.58) to 137 larvae•m^{-2} (95% CI = 113.87–160.80) and estimates from depletion sampling ranged from 50 larvae•m^{-2} (95% CI = 40.30–73.48) to 99 larvae•m^{-2} (95% CI = 83.83–128.43; Table 1, Fig. 1).

During the course of data collection, the time needed to complete a sample was recorded, where a sample is equal to the time needed to check three traps at a site or search three plots during depletion sampling. Both methods required about 0.50 h per site per sample period (two researchers per site per sample period; ~1 total man h; Table 2). More sample periods (six samples) were required to get estimates using depletion methods than for the mark-recapture methods (four samples; Table 2), as population estimation via depletion is dependent on reducing the population size (i.e. capturing fewer animals in each subsequent sample period). Following four sample periods, capture numbers at each site

were only reduced 55% on average, but were reduced 83% following six sample periods. As a result of our use of six sample periods, the total effort for depletion sampling was substantially greater and the cost in time per salamander was lower using depletion sampling (Table 2).

Discussion.—We successfully obtained density estimates for larval two-lined salamanders using two different closed capture techniques. In order for the results obtained from these techniques to be valid, four assumptions needed to be met: 1) the population was closed from immigration or emigration; 2) all animals had the same chance of being caught in a sample (i.e., must be a non-biased sample); 3) marking animals did not affect their catchability or survivability; and 4) animals did not lose marks between sampling periods (White et al. 1982). We are confident that these assumptions were satisfactorily met, as both studies (once started) were completed in nine days or less. The marks could not be lost over such a short time period and movement into or out of sample populations was likely minimal. Survivability and catchability are harder to estimate, but these same techniques have been used in longer term studies (WEP, unpubl. data) without apparent adverse effects on survivability.

Justifying all the assumptions of closed population models is difficult as few detailed, long-term studies of larval salamanders have been conducted. Johnson and Wallace (2005) found that only 35.7% of larvae moved more than one meter from the point of capture and the mean movement for all marked salamanders at their reference stream was 2.38 m (N = 122). These data were collected while conducting an 18-month mark-recapture study using monthly sampling. Taking the results of Johnson and Wallace (2005) into consideration, movement into or out of our seemingly confined sample plots was likely minimal.

Trapping with mark-recapture and depletion sampling provided estimates of population density that were not significantly different, though success per hour effort was about 33% less using depletion sampling. Confidence intervals and estimates for both techniques could likely be refined with the inclusion of more sample periods. Trapping and mark-recapture of larval salamanders proved to be relatively cost effective, time efficient, and required no previous experience in locating and effectively capturing salamanders. All of these are important and attractive attributes for implementing replicated studies using minimally trained personnel. One drawback to this method is the initial cost in getting materials to make and check traps. The plant pallets can be purchased from plant nurseries for ~ US $0.40 each, while garden mesh can be purchased from the hardware store in bulk (65 m^2) for ~$30.00. The Rubbermaid® container, white sorting tray, and dipnet cost an additional $18.00. Also, it is difficult to quantify the extra time involved with having to set traps and waiting to check them (10 days in this study).

Nighttime depletion sampling required only a dipnet, a turkey baster (~$10.00 total) and a headlamp, but there is a significant amount of researcher effort and experience required, which are also hard to objectively quantify. In

TABLE 1. Reported larval *Eurycea* densities from fishless 1st and 2nd order headwater streams. Passive Trapping (PT) with leaf litter traps, Area Constrained Dipnetting (ACD), Area Constrained (AC) searches, and Time Constrained (TC) searches have been used to estimate population sizes using Counts, Mark-Recapture (M-R), and Depletion estimation methods.

Species	Larvae•m-2	95% CI	Capture Method	Est. Method	Site Characteristics	Location	Reference
E. cirrigera	1.11–3.81	2.63–4.99	PT & ACD	Count	70% substrate embededness[a]	GA	Nowakowski and Maerz, *in press*
E. cirrigera	10.75–72.81	6.77–108.23	PT & ACD	M-R	70% substrate embededness[a]	GA	Nowakowski and Maerz, *in press*
E. bislineata	0.5–0.76	0.29–1.16	AC (pool)	M-R	Extensive organic detritus, cobble / boulder substrate	NH	Burton and Likens (1975)
E. bislineata	0.7–1.30[b]	N/A	AC (quadrat) & TC (pool / riffle)	Count	Cobble dominate (64–256 mm)	NH, ME	Barr and Babbitt (2002)
E. wilderae	1.16[c]	0.74–1.75	AC	M-R	1.25 m wide, 80% mixed substrate, 20% bedrock[a]	NC	Johnson and Wallace (2005)
E. wilderae	75–137	69.34–160.80	PT & ACD	M-R	3.2 m wide, gravel substrate, 28% surface sedimentation[a]	NC	This study
E. wilderae	50–99	40.30–128.43	AC (quadrat)	Depletion	3.2 m wide, gravel substrate, 28% surface sedimentation[a]	NC	This study

[a] Mean values from all sites included in study
[b] Estimates from fishless streams only.
[c] Study included nutrient manipulations of streams; the reported value is from the unaltered reference site.

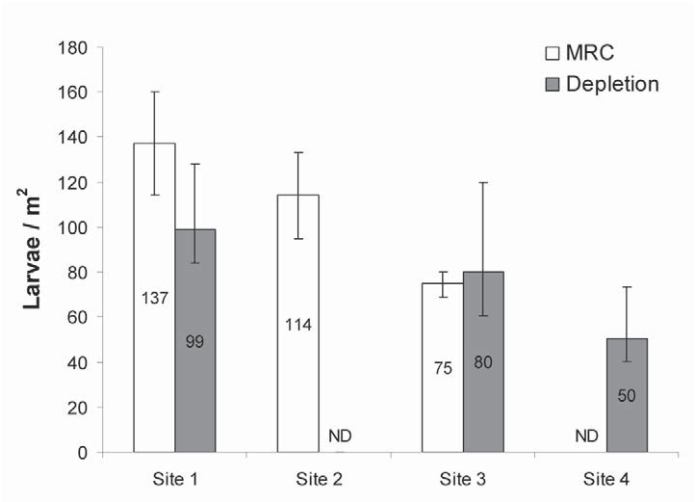


FIG. 1. Estimated larval density and 95% confidence intervals for the four study sites and the two estimation methods. No data were available to make estimates at Sites 2 and 4 using depletion and mark-recapture sampling, respectively.

order to get accurate estimates from depletion sampling, sample sizes need to show a steady, progressive decline over time (White et al. 1982), which can be variable depending on weather conditions, stream conditions, or time of sample period (Barr and Babbitt 2002; Hairston 1949; Orser and Shure 1972; WEP, pers. obs.). After four sample periods in this study, capture numbers were only 55% lower than the first sample, but decreased 83% after the sixth sample.

Estimated densities for larval salamanders are rare in the literature. Previous density estimates for larvae of the *Eurycea bislineata* complex have varied substantially with nearly all studies reporting densities less than 5 larvae•m^{-2} (Table 1). The lone exception to this is the study of Nowakowski and Maerz (*in press*), on which our leaf trapping methodologies were based. It is hard to determine whether this variation is attributable to geography, species, or the quality of habitat. Some likely factors contributing to the variable density estimates include the area of stream surveyed (i.e., selected quadrats vs. entire pools or reaches), the presence of fish or other predators, and whether or not surveys were conducted during the day or night (e.g., Barr and Babbit 2002; Burton and Likens 1975; Johnson and Wallace 2005). The costs in time and effort among the different studies listed in Table 1 are difficult to quantify, but search time would largely be affected by the complexity and amount of suitable, searchable habitat. In order to gain a greater understanding of how larval densities differ among species and regions, standardized sampling needs to be conducted. We have shown that *E. wilderae* densities in North Carolina are comparable to *E. cirrigera* densities in Georgia using similar techniques. Future research on *E. bisleanata* in northern regions utilizing leaf traps and area constrained dipnetting may provide clarity to the question of larval density in headwater streams as well as explain or alleviate the variability in density estimates currently in the literature.

Our estimates of 75 (95% CI = 69.34–79.58) to 137 (95% CI = 113.87–160.80) *E. wilderae*•m^{-2} using passive trapping are among the highest reported, and support claims that salamanders are likely important and influential organisms in headwater streams (Burton and Likens 1975; Davic and Welsh 2004; Peterman et al. 2008). Though high in comparison to previous studies, we feel our density estimates are describing the three-dimensional nature of headwater streams. As suggested by Ward (1989), there are four dimensions to lotic systems: the lateral, longitudinal, vertical, and time dimensions, and it is the vertical dimension within streambed interstices that larval salamanders often inhabit. It is widely understood that terrestrial salamanders are fossorial in nature, and Petranka and Murray (2001) demonstrated that only a small fraction of the population is surface active at any point in time, thus requiring several successive sample periods to adequately deplete population numbers. Similarly, only a fraction of the larval salamanders were surface active or inhabiting our traps during a given sample period, and only with repeated sampling and marking of animals could accurate estimates be made.

The importance of salamanders to headwater stream communities is becoming more evident (Peterman et al. 2008), further reinforcing their ecological importance (Davic and Welsh 2004). From the results of our study, we suggest that larval salamanders can be effectively sampled passively using either a leaf litter trapping technique with mark-recapture or by active depletion sampling, but there are costs and benefits to both. The quality and resolution of the subsequent results are largely dependent upon the number of sample periods used. Here we have demonstrated that four sample periods can be sufficient to get estimates using simple cohort marking and Schumacher-Eschmeyer estimation methods, while six sample periods were sufficient for removal sampling. The number of samples needed is likely to vary, depending on several factors and may be more or less dependent on one's study design and research objectives, but we feel that there is much less variability involved with trapping, allowing for a more equitable comparison among study sites. With refined sampling techniques and estimation capabilities, future research should address ecological and ecosystem processes that include both larval and adult salamanders.

TABLE 2. Estimated effort involved with each sampling method. The mark-recapture study was concluded after four sample periods; depletion was concluded after six sample periods. Time per sample is the time needed for two researchers to search three traps or three depletion plots at a single site; time per site is the cumulative time needed to sample a site (time per sample x number of samples); total effort is the cumulative time needed to collect data for abundance estimates at four sites (time per site x number of sites); and salamanders per hour are the total number of salamanders that were captured divided by the hours of total effort.

Method	Time per sample (h)	Time per site (h)	Total Effort (h)	Salamanders/h
Mark-recapture	0.48	1.92	7.68	27.47
Depletion	0.54	3.24	12.96	18.29

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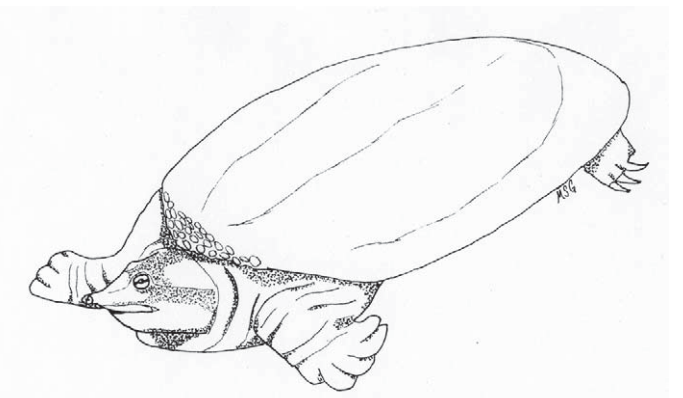
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Apalone ferox (Florida Softshell). Illustration by Margaret S. Gunzburger.

AMPHIBIAN CHYTRIDIOMYCOSIS GEOGRAPHIC DISTRIBUTION

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Presence of the Amphibian Chytrid Fungus (*Batrachochytrium dendrobatidis*) on Hellbenders (*Cryptobranchus alleganiensis*) in the Ozark Highlands

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Amphibian chytrid fungus *Batrachochytrium dendrobatidis* (*Bd*) presence in anurans is well documented, both nationally and globally, resulting in population declines and/or extinctions (Berger et al. 1998; Carnaval et al. 2006; Garner et al. 2005; Lips et al. 2006; Skerratt et al. 2007). Recent increased *Bd* sampling in North American wild amphibian populations has resulted in its documentation in numerous species and demonstrated its widespread geographic distribution (Adams et al. 2007; Briggler et al. 2007a; Longcore et al. 2007; Ouellet et al. 2005; Pearl et al. 2007; Reeves and Green 2006). When compared to anurans, reports of *Bd* in populations of North American caudates are limited. In North America, the presence of *Bd* has previously been reported in ambystomatids in Arizona, California, and Canada (Davidson et al. 2003; Ouellet et al. 2005; Padgett-Flohr and Longcore 2005), salamandrids in California and Canada (Ouellet et al. 2005; Padgett-Flohr and Longcore 2007) and cryptobranchids in Missouri (Briggler et al. 2007a).

In Missouri and Arkansas, *Cryptobranchus alleganiensis alleganiensis* (Eastern Hellbender) and *C. a. bishopi* (Ozark Hellbender) have experienced severe population declines (Wheeler et al. 2003). Causes of Hellbender decline are mainly linked to habitat degradation or alteration, chemical contaminants, introduced species, commercial exploitation, and diseases and pathogens, such as *Bd* (Briggler et al. 2007b). These large, aquatic salamanders live in cold, spring-fed rivers and streams in the Ozark Highlands of Missouri and Arkansas (Nickerson and Mays 1973) that provide ideal conditions for supporting *Bd* (Piotrowski et al. 2004). *Bd* was first reported in *C. a. bishopi* from the North Fork of the White River, Ozark County, Missouri (Briggler et al. 2007a). This initial detection of *Bd* in conjunction with known Hellbender population declines and optimal conditions for supporting *Bd* in other Ozark rivers prompted us to sample additional

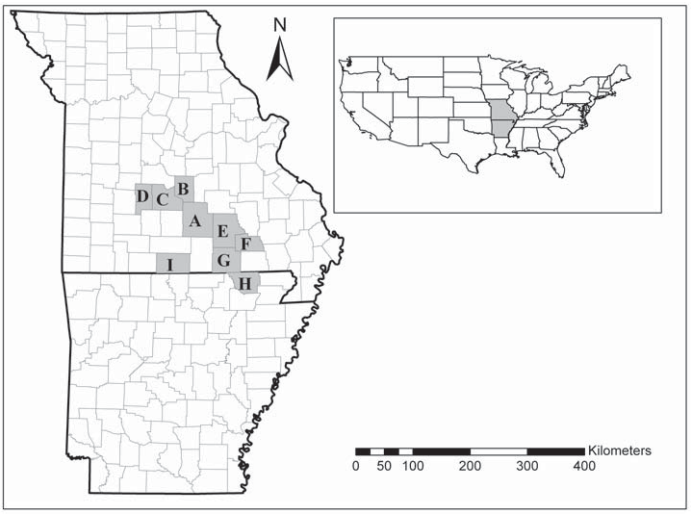


FIG. 1. Counties where *Cryptobranchus alleganiensis alleganiensis* (Areas A, B, C, and D) and *C. a. bishopi* (Areas E, F, G, H, and I) tested positive for *Batrachochytrium dendrobatidis* in Missouri and Arkansas, USA.

Hellbender populations. Herein, we report additional distribution records of Bd in wild Hellbender populations in the Ozark Highlands of Missouri and Arkansas. Both subspecies are listed as critically imperiled in Arkansas and Missouri, and state endangered in Missouri. In addition, *C. a. bishopi* is a candidate for federal listing under the U.S. Endangered Species Act (NatureServe 2008). Because of the sensitive nature of this declining species we do not provide specific locations or sample sizes, and thus, only report to the river system level within each county.

Hellbenders captured during annual surveys in 2006 and 2007 were tested for *Bd* by swabbing with a cotton-tipped wooden shaft applicator over the ventral surface of each foot, the belly, and around the thigh and vent area. Both the cotton swab end and the posterior wooden tip end of the swab were rubbed back and forth over each of these regions approximately 10 times. The wooden tip end was used to better scrape the skin layer. Once collected, the two ends of the swab were cut or broken off the applicator and placed in a 2.0-ml screw-cap tube with 1 ml of 70% ethanol and shipped to Pisces Molecular, Boulder, Colorado, for PCR (polymerase chain reaction) assay.

Positive *Bd* test results were detected in five rivers in nine counties in Missouri and Arkansas (Fig. 1; Table 1). *Bd* was detected in *C. a. alleganiensis* in the Big Piney and Niangua Rivers in four counties and in *C. a. bishopi* in five counties in the Current River, Eleven Point River, and North Fork of the White River (Table 1). Both male and female *C. alleganiensis* tested positive for *Bd*. *Cryptobranchus a. alleganiensis* had an average (± SD) total length of 47.9 ± 3.7 cm, snout–vent length of 31.9 ± 2.9 cm, and mass of 778.8 ± 151.5 g compared to an average (± SD) total length of 43.3 ± 2.0 cm, snout–vent length of 29.5 ± 1.4 cm, and mass of 528.0 ± 81.6 g for *C. a. bishopi* (Table 1).

Our results not only document the first report of *Bd* in *C. a. alleganiensis* but also show that *Bd* is geographically widespread in *C. alleganiensis* in the Ozark Highlands. With the decline of *C. alleganiensis* throughout most of its range, further sampling for *Bd* to determine the geographic extent and prevalence of this pathogen in wild Hellbender populations is warranted. Addition-

TABLE 1. Locations and associated Hellbender data where *Cryptobranchus alleganiensis alleganiensis* and *C. a. bishopi* tested positive for *Batrachochytrium dendrobatidis* in Missouri and Arkansas, USA. County designations correspond to Fig. 1. TL = total length; SVL = snout–vent length.

County Designation	County, State	River Name	Subspecies	Date	Gender	TL (cm)	SVL (cm)	Mass (g)
A	Texas, MO	Big Piney	*C. a. alleganiensis*	22 May 07	Male	46.0	30.5	867
B	Pulaski, MO	Big Piney	*C. a. alleganiensis*	15 Oct. 07	Female	52.5	34.5	932
C	Laclede, MO	Niangua	*C. a. alleganiensis*	19 Sept. 07	Male	44.0	28.5	593
D	Dallas, MO	Niangua	*C. a. alleganiensis*	23 Oct. 07	Female	49.0	34.0	723
E	Shannon, MO	Current	*C. a. bishopi*	25 Sept. 07	Female	44.5	30.5	544
F	Carter, MO	Current	*C. a. bishopi*	29 June 06	Unknown	45.0	30.0	638
G	Oregon, MO	Eleven Point	*C. a. bishopi*	31 Aug. 06	Male	41.0	28.0	455
H	Randolph, AR	Eleven Point	*C. a. bishopi*	20 Aug. 07	Male	41.5	28.0	440
I	Ozark, MO	North Fork	*C. a. bishopi*	17 Aug. 06	Male	45.0	31.0	563

ally, further research is needed to understand the effects *Bd* may have on these animals, and whether or not its occurrence has bearing on recent population declines.

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Amphibian Chytrid Infection in *Melanophryniscus moreirae* (Bufonidae) in the Brazilian Atlantic Rainforest

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Amphibian population declines driven by chytridiomycosis, a fungal disease caused by *Batrachochytrium dendrobatidis* (*Bd*), have become a major concern worldwide (Berger et al. 1999; Lips et al. 2006). Although there is evidence that not all reported amphibian declines were caused by *Bd* (Daszak et al. 2005), the disease chytridiomycosis has been linked to species declines and extinctions on several continents (Lips et al. 2006; Mendelson et al. 2006; Schloegel et al. 2006; Weldon and du Preez 2004). Ecological niche modeling based on point distribution data of *Bd* predicts it to be widely distributed, occurring under a wide variety of temperature and precipitation regimes (see figures 1–2, Ron 2005, for details). The Brazilian Atlantic rainforest was listed as one of the most suitable areas in the Neotropics for the occurrence of *Bd* (Ron 2005).

In Brazil, most amphibian population declines have been reported in the Atlantic rainforest of southeastern Brazil (Eterovick et al. 2005; Guix et al. 1998; Heyer et al. 1988; Weygoldt 1989) and, more recently, in the Cerrado at Serra do Cipó (Eterovick et al. 2005). In the Atlantic rainforest, *Bd* appears to be widely distributed, as it has been detected in histological samples of several frog species, from Rio Grande do Sul (southernmost state) to Pernambuco (northeastern) (Carnaval et al. 2006; Toledo et al. 2006a, b). However, there is not sufficient evidence linking this pathogen to population declines in this region.

Melanophryniscus moreirae is a small bufonid (mean SVL < 20 mm) found above 1800 m on the Mantiqueira mountain range (Itatiaia Plateau) in southeast Brazil (Bokerman 1967; Marques et al. 2006; Weber et al. 2007) (Fig. 1). Guix et al. (1998) reported population declines for this species although no systematic monitoring has ever been conducted. Previous histological screenings of species from several localities showed *Bd* to be widely distributed in the Atlantic Rainforest of eastern Brazil, including the Itatiaia/ Mantiqueira mountain chain (Carnaval et al. 2006; Toledo et al. 2006a, b). Considering that histology is less precise than molecular techniques such as real-time PCR in the detection of *Bd* (Boyle et al. 2004; Hyatt et al. 2007; Kriger et al. 2006), the number of positive cases found by Carnaval et al. (2006) and Toledo et al. (2006a, b) might be underestimated. We examined *M. moreirae* for the presence of *Bd* using PCR assays.

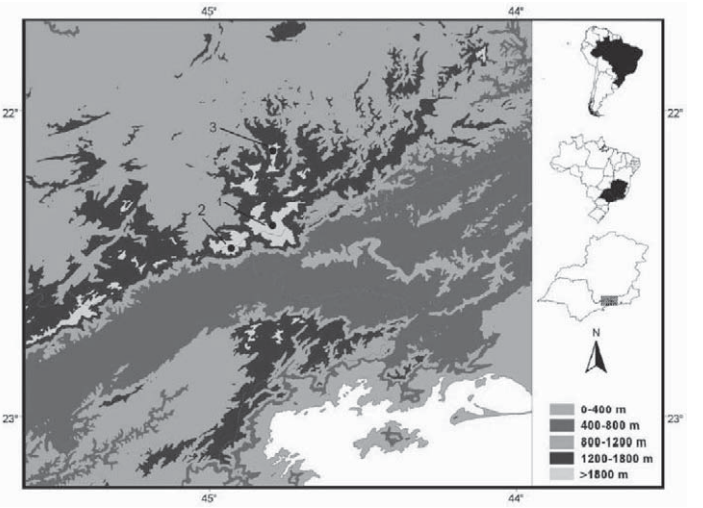


FIG. 1. Distribution of *Melanophryniscus moreirae* in southeastern Brazil, in the Itatiaia Plateau municipalities: 1) Itamonte/ MG; 2) Queluz/ SP; and 3) Aiuruoca/ MG (modified from Weber et al. 2007).

Methods.—The study was conducted along the Rio Campo Belo Valley in the Itatiaia National Park (22.27ºS, 44.57ºW to 22.46ºS, 44.7ºW), within the states of Rio de Janeiro, Sao Paulo, and Minas Gerais. This is a mountainous region with high plateau vegetation characterized by humid subalpine grasslands ("campos de altitude") (Safford 1999).

In 2006, 50 adult male *Melanophryniscus moreirae* were captured during October–November, when toads were breeding in shallow puddles (Bokerman 1967; Guido-Castro 2006; Starrett 1967). Toads were captured in individual plastic bags and measured for snout–urostyle length (± 0.1 mm). A swab was run ten times over the body's ventral surface, the sides—from groin to armpit, and the thigh's ventral surface (Kriger et al. 2006). Additionally, we performed five outward strokes on the undersides of each toad's feet. Swabs were initially stored in ice, and within 24 h transferred to -19.0°C. Toads were marked by toe-clipping to avoid resampling.

We analyzed swabs using quantitative (real-time) PCR techniques in a single assay: all 50 samples plus a set of four standards and three negative controls were run on a single plate. Subsequently, positive samples were run in triplicate assays with a new set of standards and controls (Boyle et al. 2004; Kriger et al. 2006). DNA was extracted from swabs using Prepman™ Ultra (Applied Biosystems, California) according to manufacturer instructions as previously described (Boyle et al. 2004). Real-time Taqman PCR assays were performed using an Applied Biosystems Prism 7000 Sequence Detection System according to Boyle et al. (2004). We classified each sample as positive or negative for infection with *Bd*. We used the number of *Bd* zoospores present on the swab as a measurement of toad's intensity of infection. The concentration of each sample was estimated by comparison with a standard curve of the four serial dilution points (100, 10, 1, and 0.1) of *Bd*-zoospore equivalents. Our estimate of the number of zoospores in infected individuals was given by the mean value of *Bd e*quivalents detected in the PCR assay run in triplicate based on the standard curve.

Results.— Of 50 adult males examined, only two (4%) were in-

fected with *Bd* (SUL = 24.9 mm and 26.1 mm). One was collected on 23 October (22.37°S, 44.7°W) and the other on 23 November 2006 (22.37°S, 44.41°W). The numbers of zoospore equivalents were low (14 and 15 zoospore equivalents). No evident clinical or abnormal signs were observed in these toads.

Discussion.—This is the first report of *Bd* in *M. moreirae* and the first for the genus. Even though the prevalence and the severity of infection were low, these results suggest precautionary measures should be taken considering the restricted geographic range of *M. moreirae*.

Our work adds to the few other studies of *Bd* infection in Brazilian anurans (Carnaval et al. 2006; Toledo et al. 2006a, b). However, few inferences on the epidemiological status of the fungus in Brazilian anuran communities can be made because very little information is available. At this point, we have no data on the impact *Bd* might have on individual toads, populations, or communities in the studied area. We found no indication that the toads we sampled showed symptoms of the disease. There have been reported cases of *Bd* presence with no apparent impact on infected populations (e.g., Retallick et al. 2004) and reservoir hosts are known for many diseases. In general, whenever a species is considered to be the reservoir host for a given pathogen, its prevalence of infection is maintained at high rates, once the pathogen has little or no effect on the reservoir species (McCallum and Dobson 1995). The prevalence of 4% found here was rather low. Monitoring of *M. moreirae* should contribute to our current understanding of the dynamics of this disease and to determine and try to avoid possible impacts of *Bd* on this endemic species.

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Occurrence of the Fungal Pathogen *Batrachochytrium dendrobatidis* in Georgia's Amphibian Populations

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To date, few surveys for the presence of the fungal pathogen *Batrachochytrium dendrobatidis* (*Bd*) have been conducted or published on amphibian populations in the southeastern United States (Daszak et al. 2005; Green and Dodd 2007). This may be due in part to a lack of concern because amphibian mass mortalities attributable to *Bd* have not been reported. Georgia hosts one of the country's richest and most diverse amphibian faunas, including 55 described species of salamanders and 31 species of frogs (Jensen et al. 2008). The goal of this study was to conduct a baseline survey for *Bd* in a large number of amphibian taxa in a variety of physiographic regions and ecosystems in Georgia.

From June 2006 to June 2008, we captured and swabbed adult amphibians of as many species as we could locate in each of the five major physiographic regions in Georgia (Cumberland Plateau, Ridge and Valley, Blue Ridge, Piedmont, and Coastal Plain; Wharton 1978). Survey methods included visual encounter surveys and road cruising, both of which were conducted in conjunction with other research (Graham 2007; Graham et al. 2007). We swabbed each amphibian captured per Brem et al. (2007) and samples were analyzed via PCR by one of two laboratories (Veterinary Pathology Laboratory of M. Levy, North Carolina State University; Wildlife Disease Laboratory of A. Pessier, Zoological Society of San Diego, CA).

Bd-specific real-time Taqman (Applied Biosystems, Foster City, CA) PCR was performed according to the method of Boyle et al. (2004). Briefly, dried swabs were processed by adding 30–40 mg of 1.0 mm glass beads (Research Products International Corp, Mt. Prospect, IL) and 100 µl Prepman Ultra (Applied Biosystems, Foster City, CA) and processed for 1 min in a Mini Beadbeater (Biospec Products, Bartlesville, OK) at 5000 rpm. Following 10 min in a boiling water bath the tubes were cooled for 2 min at room temperature and centrifuged at 13,000 rpm in a Marathon 16km centrifuge (Fisher Scientific, Pittsburg, PA). Twenty microliters (µl) of liquid was removed, used immediately or stored at 4°C for later analysis. One µl of this mixture was used as template for the PCR assay. Positive controls consisted of *Bd* isolate 197 (Longcore et al. 1999) cultured on 1% tryptone agar at 23–25°C, and negative controls consisted of deionized water and/or pond water from a *Bd*-free site.

Our results offer baseline information regarding the presence and prevalence of *Bd* in Georgia (Fig. 1). In terms of number of species (N = 47) and geographic scope (> 400 km and 43 localities), to our knowledge this study represents one of the most comprehensive surveys to date for *Bd* in eastern North America. We sampled 10 of the 12 families (83%) of amphibians in Georgia, including 18 of 22 genera (82%) and 47 of 86 species (55%) (Table 1). Of 533 samples taken from amphibians throughout the state from June 2006 to June 2008, 10 were *Bd*-positive, suggesting a low overall prevalence (1.88%). Eight of these positive results were taken from three Green Frogs (*Rana clamitans*), three Pickerel Frogs (*R. palustris*) and two Spotted Dusky Salamanders (*Desmognathus conanti)* from the same site (Crockford-Pigeon Mountain WMA) located on Pigeon Mountain in the Cumberland Plateau of northwest Georgia (34.7100°N, 85.3750°W) on 27 July 2006. Pigeon Mountain is an ecologically unique area of Georgia, thus the detection of *Bd* may be cause for concern. Not only is this site and the surrounding areas home to protected amphibian species (e.g., Green Salamander, *Aneides aeneus*; Tennessee Cave Salamander, *Gyrinophilus palleucus*), it is the sole location of the endemic Pigeon Mountain Salamander (*Plethodon petraeus*). Our finding of *Bd* in the plethodontid salamander *D. conanti* heightens concern for these other plethodontids. The remaining positive samples were taken from two Southern Leopard Frogs *(R. sphenocephala*) from a site in the Coastal Plain of eastern Georgia (4.0 km N of Matthews; 33.2380°N, 82.2979°W) on 10 June 2006. All of the *Bd*-positive individuals appeared healthy and did not exhibit physical or behavioral symptoms of chytridiomycosis (Daszak et al. 1999).

Our study supports the findings from other surveys, confirming that *Bd* is present in southeastern North America (Daszak et al. 2005; Green and Dodd 2007; B. Rothermel, pers. comm.). Due to the low number of individuals from each taxon sampled, we can-

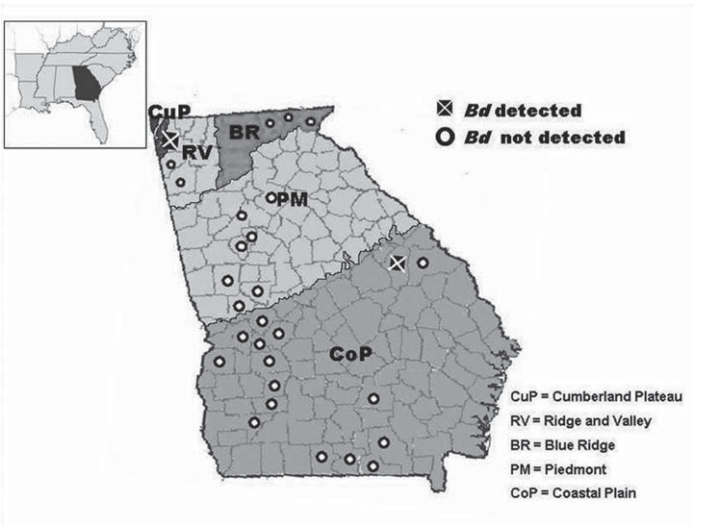


FIG. 1. Counties within five physiographic provinces of Georgia, USA, where amphibians were sampled for the presence of *Batrachochytrium dendrobatidis* from 2006–2008.

TABLE 1. Number of individuals per amphibian species surveyed for *Batrachochytrium dendrobatidis* (Bd) in five physiographic regions of Georgia, USA. ( ) represents number of individuals that tested positive for Bd. CuP = Cumberland Plateau; RV = Ridge and Valley; BR = Blue Ridge; PM = Piedmont; CoP = Coastal Plain.

Frogs	Physiographic Region					Salamanders	Physiographic Region				
	CuP	RV	BR	PM	CoP		CuP	RV	BR	PM	CoP
Acris crepitans	0	1	0	10	0	*Ambystoma maculatum*	0	0	0	3	0
A. gryllus	0	0	0	0	7	*A. opacum*	0	0	0	4	0
Bufo americanus	0	0	0	2	0	*A. talpoideum*	8	0	0	0	0
B. fowleri	0	0	0	1	3	*Amphiuma means*	0	0	0	0	1
B. terrestris	0	0	0	0	2	*Desmognathus aeneus*	0	0	3	0	0
Gastrophryne carolinensis	0	0	0	1	1	*D. apalachicolae*	0	0	0	13	16
Hyla chrysoscelis	0	0	1	4	0	*D. conanti*	39 (2)	11	0	24	12
H. cinerea	0	0	0	0	1	*D. marmoratus*	0	0	7	0	0
Pseudacris crucifer	1	0	0	1	0	*D. monticola*	0	20	40	0	0
P. feriarum	0	0	0	1	0	*D. ocoee*	0	0	57	0	0
P. ornata	0	0	0	0	1	*D. quadramaculatus*	0	0	22	0	0
Rana capito	0	0	0	0	3	*Eurycea chamberlaini*	0	0	0	1	0
R. catesbeiana	2	1	0	2	3	*E. cirrigera*	23	2	0	17	5
R. clamitans	15 (3)	5	0	2	3	*E. guttolineata*	0	0	0	3	8
R. heckscheri	0	0	0	0	1	*E. longicauda*	4	4	0	0	0
R. palustris	5 (3)	1	0	0	0	*E. lucifuga*	3	0	0	0	0
R. sphenocephala	0	0	0	6	2 (2)	*E. quadridigitata*	0	0	0	0	12
R. sylvatica	0	0	0	2	0	*E. wilderae*	0	0	4	0	0
Scaphiopus holbrookii	0	0	0	2	2	*Gyrinophilus porphyriticus*	1	0	3	2	0
						Hemidactylium scutatum	0	0	0	1	0
						Necturus beyeri	0	0	0	0	1
						Notophthalmus viridescens	4	0	0	5	6
						Plethodon glutinosus complex	5	1	3	3	7
						P. serratus	2	0	0	0	0
						P. ventralis	6	0	0	0	0
						P. websteri	0	0	0	2	0
						Pseudotriton montanus	0	0	0	1	3
						P. ruber	3	1	1	7	5

not estimate the prevalence of *Bd* for individual species. Similar to statewide *Bd* studies in the northeastern United States (Longcore et al. 2007), our survey indicates that the overall prevalence of *Bd* is low (1.88%). Hence, rigorous sampling of many individuals and many localities may be needed in some cases to detect the presence of this pathogen in certain species or areas. It is important to know the distribution of amphibian populations that contain *Bd*-positive individuals in order manage them to prevent the spread of *Bd* from the southeastern United States to other regions of the world (e.g., via fisheries or wildlife management or studies, transfer of untreated water between sites, pet and food trade), because elsewhere, chytridiomycosis is linked to population declines and extinctions.

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Batrachochytrium dendrobatidis in Venezuela

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Venezuela is among the ten most biodiverse countries in the world, particularly in terms of amphibians (IUCN et al. 2006). However, 18 amphibian species endemic to this country are critically endangered (IUCN et al. 2006; Rodríguez and Rojas-Suárez 1995); seven of these have not been observed in their natural habitats since the early 1990s despite intensive sampling efforts during the last decade (La Marca and Lötters 1997; La Marca and Reinthaler 1991; Manzanilla and La Marca 2004). Although the causes for most of these declines are not well understood, the high prevalence of the chytrid fungus *Batrachochytrium dendrobatidis* (*Bd*) in museum specimens of species collected just before their disappearance lead us to question whether chytridiomycosis was linked to the declines of some Venezuelan amphibians (Bonaccorso et al. 2003; Lampo et al. 2006b).

In Venezuela, the Cordillera de Mérida and the Cordillera de La Costa harbor most of the critically endangered species, including nine *Atelopus* species, a neotropical genus severely affected by declines (IUCN et al. 2006; La Marca et al. 2005; Lötters et al. 2004). As with other regions, most declines occurred at high altitudes in relatively pristine habitats. Other high-elevation pristine habitats where unusual mortalities of frogs were reported during the 1980s are the remote tepuis (tabletop mountains) of the Guianan Basin. This area is particularly interesting in light of hypotheses about human-mediated translocation of *Bd*, because human contact has been very limited on these tepuis (Lampo and Señaris 2006). Therefore, *Bd* should be absent from these remote and isolated areas.

To assess the risk that *Bd* represents to Venezuelan amphibian biodiversity, several studies have been conducted aiming to detect *Bd* in anuran species, identify hosts and reservoirs, quantify prevalence or identify variables affecting the prevalence and intensity of infection (Hanselmann et al. 2004; Lampo et al. 2006b; Lampo et al. 2006a; Lampo and Señaris 2006; Nicolás 2007; Rodríguez-Contreras et al. 2008; Sánchez et al. 2008). Based on these studies and one new host species reported here, we summarize the species and geographic distribution of *Bd* in Venezuela. Samples were taken from live wild frogs or museum specimens collected from three montane regions: the Cordillera de Mérida, the Cordillera de la Costa, and the Guianan tepuis (Table 1). In all these localities species have suffered declines (Bonaccorso et al. 2003; Lampo et al. 2006b; Lötters et al. 2004; Manzanilla and La Marca 2004) or unusual mortalities have been reported (Ayarzagüena et al. 1992; Gorzula and Señaris 1998). Detection of *Bd* from museum specimens was conducted using histology (Berger et al. 1999). Except for all infected bullfrogs reported in Hanselmann et al. (2004), all live specimens were diagnosed by conventional PCR (Annis et al. 2004) and real time PCR assays (rt-PCR) (Boyle et al. 2004) (Table 1). Standards for zoospore quantification in rt-PCR assays were provided by the Animal Health Laboratory (Australia). We adopted the species nomenclature published in the Amphibian Species of the World (Frost 2007) and listed the geographic coordinates for all sampling locations, except for that of *A. cruciger*. Whenever samples from a species included more than two locations, we provided the upper left and bottom right geographic coordinates for the distribution polygon (Table 1). Except for the two localities in the remote tepuis of the Guianan Basin, species with only negative records were not included; some were the result of small sample sizes and others had no geographic coordinates associated in the original publications.

In Venezuela, *Bd* has been detected in species that have suffered population crashes in the past (Bonaccorso et al. 2003), and also in many other common species showing no evidence of declines (Table 1). This pathogen appears to be widespread in amphibian communities of the Cordillera de Mérida between 8.50ºN, 71.25ºW and 8.67ºN, 71.50ºW, in altitudes from 120 to 2600 m (Fig. 1). Therein, *Bd* infects 17 species in six families found in ephemeral and permanent ponds, streams and terrestrial habitats of cloud forests or highly disturbed areas (Table 1) (Lampo et al. 2006b; Lampo et al. 2006a; Sánchez et al. 2008). Among infected species in the Cordillera de Mérida, the American Bullfrog (*Lithobates catesbeianus* [formerly *Rana catesbeiana*]) appears to be a key

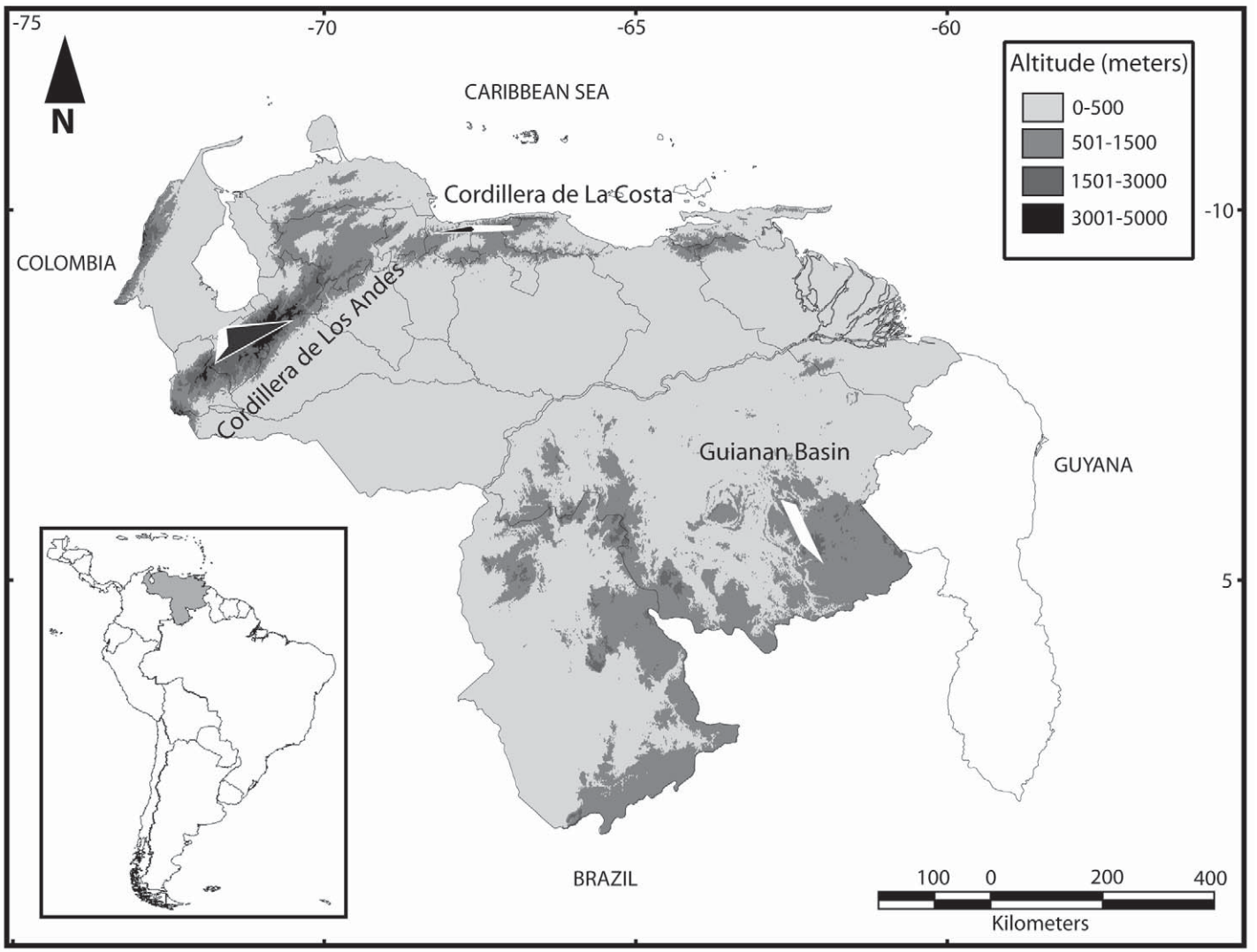


FIG. 1. Geographic distribution of the amphibian chytrid fungus *Batrachochytrium dendrobatidis* (*Bd*) in Venezuela. White polygons contain all sampling locations (positive and negative) and represent the areas sampled for *Bd*. Black polygons are subsets of the white polygons that contain all positive samples and delimit the areas for which we have evidence of infection. Polygons were constructed using the minimum convex method adopted by the IUCN for determining extent of occurrence (http://www.iucnredlist.org/info/categories_criteria1994).

reservoir; it has the highest prevalence of infection (80–96%) but no apparent clinical signs (Hanselmann et al. 2004; Sánchez et al. 2008). Although *L. catesbeianus* currently occupies an area less than 50 km^2, its geographic distribution is expanding. Thus, the exposure of endemic species to *Bd* is likely to increase as bullfrogs invade new geographic areas.

Most critically endangered species of the Cordillera de Mérida have not been observed since the early 1990s. Nontheless, *Bd* appears to persist in remnant populations of some of these species. For example, it was detected in the only Andean *Atelopus* frog seen since 1994 (*Atelopus mucubajiensis*) (Lampo et al. 2006a), and in one *Aromobates meridensis*, a species with a few known populations (IUCN et al. 2006). Although it is not well understood why some species have suffered crashes while many others coexist with *Bd* with no apparent effect, increasing evidence suggests that species-specific responses (Blaustein et al. 2005; Carey et al. 2006; Daszak et al. 2004; Lampo et al. 2006a; Nichols et al. 2001) and environmental stressors are important in determining the relationship between infection and disease (Alford et al. 2007; Berger et al. 2004; Daszak et al. 2004; Di Rosa et al. 2007; Pounds et al. 2006).

In the Cordillera de la Costa, two sympatric frogs, *Atelopus cruciger* and *Mannophryne herminae*, tested positive for *Bd* (Nicolás, 2007; Rodríguez-Contreras et al. 2008) (Fig. 1; Table 1). *Atelopus cruciger* is a critically endangered species that occurs in this region whose disappearance for almost two decades was associated with *Bd* (Bonaccorso et al. 2003). Before 1986, its altitudinal distribution ranged from sea level to 2400 m, however, all recently discovered populations are located below 500 m (Rodríguez-Contreras et al. 2008). In these populations the prevalence and intensity of infection appears to be low. However, one adult male was found morbid with excessive sloughing and severe infection (244,484 zoospores in 1–3 mg of tissue) (Rodríguez-Contreras et al. 2008). This evidence suggests that *A. cruciger* could be recovering only in those locations where *Bd* growth is limited by high temperatures. *Mannophryne herminae*, on the contrary, is a widely distributed frog of the Cordillera de La Costa whose habitat overlaps extensively with that of *A. cruciger*. The presence of *Bd* in this species could affect

TABLE 1. Geographic and species distribution of the amphibian chytrid fungus *Batrachochytrium dendrobatidis* (Bd) in Venezuela. IUCN red list categories (see http://www.iucnredlist.org/info/categories_criteria2001): CR = critically endangered; NT = Near Threatened; EN = Endangered; LC = Least Concern; VU = Vulnerable. MHNLS = Museo de Historia Natural La Salle (voucher specimen number indicated).

Region/State/ Location	Species (Red list categories)	*Bd* detection (No. specimens)	Specimens examined	Method of detection	Date of occurrence
Cordillera de la Costa, Aragua					
1. Extremely sensitive to reveal	*Atelopus cruciger* (CR)	4	24	rt-PCR	2006 (Rodríguez-Contreras et al. 2008)
2. 10.40°N, 67.74°W 10.32°N, 67.65°W	*Mannophryne herminae* (NT)	27	209	rt-PCR	2006–2007 (Nicolás 2007)
Cordillera de la Costa, Carabobo					
3. 10.3°N, 68.22°W	*Atelopus cruciger* (CR)	1	59	Histology	1986 (Bonaccorso et al. 2003)
Cordillera de Los Andes, Mérida					
4. 08.62°N, 71.47°W	*Aromobates meridensis* (CR)	1	5	rt-PCR	2006 (Present study, MHNLS 18995)
5. 08.65°N, 71.39°W	*Atelopus carbonerensis* (CR)	1	18	Histology	1988 (Lampo et al. 2006b)
6. 08.85°N, 70.71°W	*Atelopus mucubajiensis* (CR)	2	14	Histology	1988 (Lampo et al. 2006b)
7. 08.84°N, 70.73°W	*Atelopus mucubajiensis* (CR)	1	1	rt-PCR	2004 (Lampo et al. 2006a)
8. 08.26°N, 71.72°W	*Atelopus sorianoi* (CR)	4	17	Histology	1988 (Lampo et al. 2006b)
9. 8.69°N, 71.47°W 8.57°N, 71.33°W	*Dendropsophus meridensis* (EN)	28	105	rt-PCR	2003–2004 (Sánchez et al., *in press*)
10. 8.82°N, 71.46°W	*Engystomops pustulosus* (LC)	2	3	rt-PCR	2003, 2005 (Sánchez et al., *in press*)
11. 8.70°N, 71.44°W	*Gastrotheca nicefori* (LC)	1	1	rt-PCR	2004 (Sánchez et al., *in press*)
12. 8.69°N, 71.42°W	*Gastrotheca nicefori* (LC)	1	1	rt-PCR	2005 (Sánchez et al., *in press*)
13. 8.58°N, 71.33°W	*Hyloscirtus platydactylus* (VU)	1	1	rt-PCR	2005 (Sánchez et al., *in press*)
14. 8.58°N, 71.37°W 8.51°N, 71.31°W	*Hypsiboas crepitans* (LC)	1	20	rt-PCR	2003–2006 (Sánchez et al., *in press*)

TABLE 1. Continued.

Region/State/ Location	Species (Red list categories)	*Bd* detection (No. specimens)	Specimens examined	Method of detection	Date of occurrence
15. 08.49°N, 71.53°W	*Leptodactylus* sp.	1	1	Histology	1996 (Lampo et al. 2006b)
16. 08.60°N, 71.36°W	*Lithobates catesbeianus* (NT)	44	48	Histology	2002 (Hanselmann et al. 2004)
17. 8.65°N, 71.38°W 8.58°N, 71.31°W	*Lithobates catesbeianus* (NT)	279	408	rt-PCR/PCR	2003–2005 (Sánchez et al., *in press*)
18. 8.50°N, 71.55°W	*Mannophryne collaris* (EN)	1	2	rt-PCR	2005 (Sánchez et al., *in press*)
19. 08.88°N, 70.64°W	*Mannophryne cordilleriana* (VU)	1	1	Histology	2002 (Lampo et al. 2006b)
20. 8.78°N, 71.55°W	*Pseudis paradoxa* (LC)	1	1	rt-PCR	2005 (Sánchez et al., *in press*)
21. 8.61°N, 71.62°W 8.51°N, 71.31°W	*Rhinella marina* (LC)	2	20	rt-PCR	2003–2004; 2006 (Sánchez et al., *in press*)
22. 8.78°N, 71.58°W 8.51°N, 71.31°W	*Scarthyla vigilans* (LC)	4	35	rt-PCR	2004–2005 (Sánchez et al., *in press*)
Guianan Basin, Bolívar (Auyán-tepui Massif)					
23. 6.03°N, 62.67°W 5.95°N, 62.42°W	*Tepuihyla edelcae* (LC)	0	13	Histology	1983–1984 (Lampo and Señaris 2006)
Guianan Basin, Bolívar (Chimantá Massif)					
24. 5.33°N, 62.34°W 5.00°N, 61.98°W	*Tepuihyla edelcae* (LC)	0	24	Histology	1984–1986 (Lampo and Señaris 2006)]

the dynamics of chytridiomycosis in *A. cruciger*, depending on the relative magnitude of interspecific transmission (Nicolás 2007). Therefore, *in situ* conservation efforts for *A. cruciger* must necessarily include the monitoring of *Bd* infection in *M. herminae*.

The remote highlands of the Guianan tepuis is the only area in Venezuela were unusual mortalities were reported between 1984 and 1986, but no evidence of *Bd* was found in 37 museum specimens collected during those years (Fig. 1) (Lampo and Señaris 2006). No detection of *Bd* from museum specimens from this area do not necessarily indicate the absence of the pathogen. However, the accumulation of evidence from this and other secluded areas will be important in evaluating the hypothesis of human-mediated translocation of *Bd* (Lampo and Señaris 2006).

Conserving endangered amphibian species is a major environmental challenge. Rates of extinction in the Neotropics are among the highest in the world, yet data to inform conservation efforts remain scarce. Although several factors likely contribute alone and synergistically to amphibian declines in the Neotropics (La Marca et al. 2005; La Marca and Reinthaler 1991; Lampo et al. 2006b; Pounds and Puschendorf 2004; Pounds et al. 1999; Pounds et al. 2006; Pounds and Crump 2004), amphibian chytridiomycosis appears to be a key factor (Bonaccorso et al. 2003; La Marca et al. 2005; Lampo et al. 2006b; Lips et al. 2003; Lips et al. 2005a; Lips et al. 2005b; Lips et al. 2006; Pounds et al. 2006; Pounds and Crump 2004; Puschendorf et al. 2006a; Rodríguez-Contreras et al. 2008). *Bd* also seems to be widespread among species for which there is no evidence of declines (Beard and O´Neill 2005; Kriger and Hero 2007; Nicolás, 2007; Ouellet et al. 2005; Puschendorf et al. 2006b; Sánchez et al. 2008; Woodhams and Alford 2005). A comprehensive map of pathogen distribution in relation to species declines as well as a thorough understanding of the relationship between infection and disease under different ecological and climatic scenarios are necessary before we can asses the risk associated with this emerging disease.

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NATURAL HISTORY NOTES

Instructions for contributors to Natural History Notes appear in Volume 39, Number 1 (March 2008).

CAUDATA — SALAMANDERS

ANEIDES AENEUS (Green Salamander). **DIGIT MORPHOLOGY.** Green Salamanders are known to have unique digits that are thought to be an adaptation to a climbing lifestyle on rock outcrops and trees (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington D.C. 587 pp.). Although the complete osteology of the genus *Aneides* shows that *A. aeneus* has a curved terminal phalanx (Wake 1963. J. Morphol. 113:77–118), no studies have been done to determine

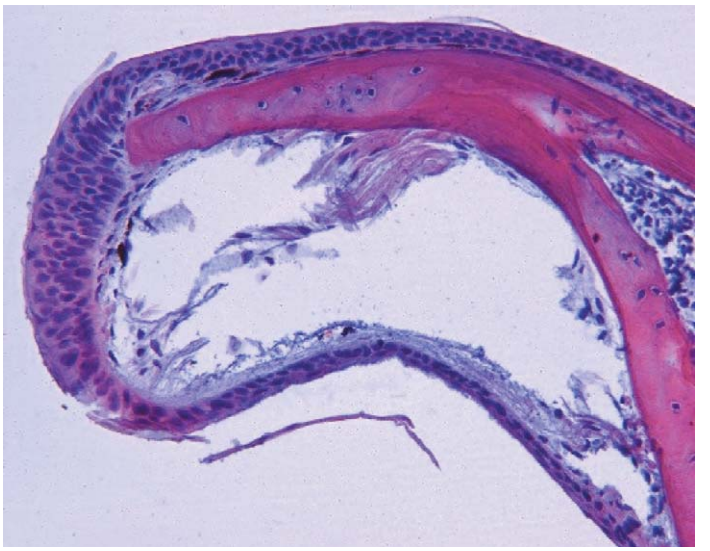


Fig. 1. Sagittal section showing terminal phalanx (TP), squamous tissue layer (Sq), and ventral position (V). 200x.

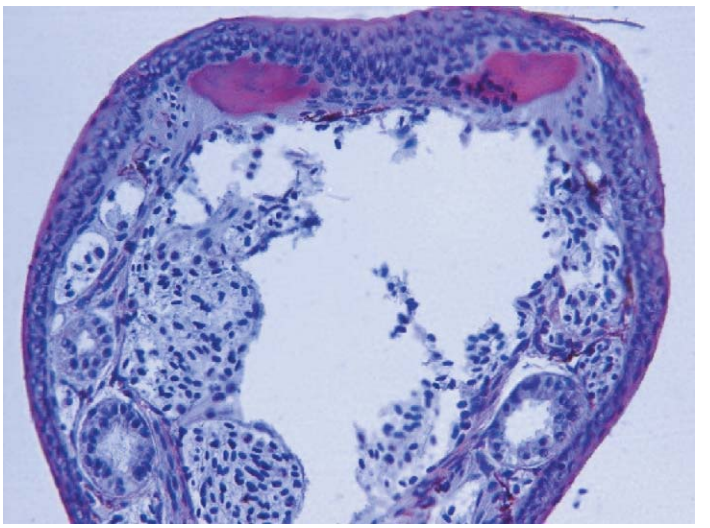


Fig. 2. Horizontal section showing doublet tips of terminal phalanx (TP), glandular cells (G), squamous tissue layer (Sq), and distal (Di) orientation. 200x.

what cellular structure(s) comprise the digits on the distal end of each digit. Here, we report the cellular morphology of the digit structure using light micrographs and stained histological preparations.

Digits (N = 60) were amputated from preserved *A. aeneus* from the West Virginia Reptile and Amphibian Museum at Marshall University. Digits were decalcified, dehydrated in ethyl alcohol and xylene, immersed in melted paraplast overnight, and embedded in fresh melted paraplast in embedding molds. Digits were oriented in molds to produce sagittal and horizontal sections. Digits were then sectioned at 10μm with a microtome and stained with hematoxylin and eosin Y.

Sagittal sections (Fig. 1) revealed an increased thickening of squamous cell layers from two cell layers at the crest of the terminal phalanx, to four or more layers thick at the tip of the terminal phalanx. This thickness remains through the distal portion of the digit tapering sharply to two cell layers thick on the ventral portion of the digit. Horizontal sections (Fig. 2) expose glandular cells lining the perimeter of the digit just underneath the squamous tissue layer. Glandular cells appear in clusters of 9–20 ovular shaped cells arranged in a spherical profile. The number of squamous cell layers was also shown to increase around the doublet tip of the distal most part of the terminal phalanx.

It is unknown how the terminal phalanx influences the climbing ability of *A. aeneus*. With the degree of dermal thickening and glandular cells associated with the terminal phalanx, it is possible that these structures act as a simple friction-based mechanism. The thick dermis and glandular structures could lend to the shape while allowing the distal portion of the digit to be flexible enough to grip irregularities on the substrate surface. It is also unknown to what extent the glandular cells secrete mucous that might aid in the adhesive capabilities of the digit, effectively allowing *A. aeneus* to cling to different substrates. To our knowledge, this is the first report disclosing the cellular morphology and possible adhesive mechanism of *A. aeneus* digits.

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EURYCEA BISLINEATA (Northern Two-lined Salamander). **HABITAT USAGE.** *Eurycea bislineata* is a streamside salamander that lays eggs and passes through its larval stage in cool running waters throughout its broad range (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, D.C., 587 pp.). In New York State, the species is abundant and widely distributed, and generally occupies the same habitats as elsewhere, with adults found along streams and in surrounding forests, and eggs and larvae occurring in lotic systems (Gibbs et al. 2007. The Amphibians and Reptiles of New York State. Oxford University Press, New York, 422 pp.). A single, startling exception is found in Lake Minnewaska, Ulster Co., New York, where adults, larvae, and eggs of this species are found within the lake to depths exceeding 10 m (Bahret 1996. J. Herpetol. 30:399–401). Herein, we report another important exception—an established population of *E. bislineata* occupying semi-permanent marl ponds in central New York State.

The salamanders live along and within a chain of ten, glacier-created kettle ponds surrounded by mixed deciduous forest and agriculture in Cortland Co., New York. The ponds range in size from 0.14 to 1.2 ha in surface area with depths to 3 m, and are separated by 10–30 m. Their substrates are calcareous and their waters clear and oligotrophic. Hydroperiods vary among the ponds and range from drying completely every year, to drying during late summer one in every four or five years, to never drying completely during the 17 years of our observation. The two streams nearest to the ponds are 1.2 and 1.6 km away and separated from the ponds by busy multi-lane roads and commercial buildings with large parking lots. Adult *E. bislineata* are abundant beneath stones and logs surrounding and within each of the ponds in the chain. The dominant vegetation in the ponds is the alga, Chara. Some or all of the ponds support populations of other salamanders (*Ambystoma jeffersonianum* complex, *A. maculatum*, *Notophthalmus viridescens*), frogs (*Bufo americanus, Pseudacris crucifer, Hyla versicolor, Rana clamitans, R. palustris, R. pipiens*, and *R. sylvatica*), and turtles (*Chelydra serpentina* and *Chrysemys picta*).

One pond (0.14 ha surface area), which dries about once every five years, was part of repeated herpetological surveys in the area over the last 17 years. We found adult *E. bislineata* each year at this pond and have captured newly metamorphosed juveniles there in five different years. Larvae have been seen in the pond in summer and fall, and captured in dip nets. Because the surveys did not include disturbing the stones deep within the ponds, eggs have not been observed.

Taken together, the high abundance of adult *E. bislineata*, the presence of many newly metamorphosed individuals, the observation of larvae, and the significant distance to the nearest lotic system, suggest that this is an isolated population of this species successfully reproducing within a series of semi-permanent marl ponds. Voucher specimens are held in Bowers Science Museum, SUNY at Cortland.

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PLETHODON GLUTINOSUS (Northern Slimy Salamander). **REFUGIA FROM DROUGHT.** *Plethodon glutinosus* is considered to be a strictly terrestrial salamander (Petranka 1998. Salamanders of the United States and Canada, Smithsonian Inst. Press, Washington, DC. 587 pp.). Rare cases exist where individuals have been removed from the stomachs of fish presumably after being washed into lotic environments by storms (Sorrell et al. 2005. Herpetol. Rev. 36:429). Under normal rainfall conditions *P. glutinosus* has been observed to occupy small (< 9 m) home ranges (Wells and Wells 1976. Herpetologica 32:156–162). Documented responses to drought include aggregating in large numbers under logs (Wells and Wells 1976, *op. cit*.) or migrating from surrounding forests into caves (Humphries 1956. Copeia 1956:122–123). It has not been previously documented that these salamanders use cover objects in dry streambeds during droughts to avoid desiccation.

The summer of 2007 was historically dry in Alabama with rainfall well below normal (National Climate Data Center 2007. [http://www.ncdc.noaa.gov/oa/ncdc.html]). On 9, 11, and 12 Sept 2007, 7 *P. glutinosus* were found under flat stones in the riffles of a first order stream. At this time epigean flow had been reduced to isolated pools leaving riffles and runs dry. This stream is located in a mixed hardwood forest of secondary growth in the Talladega National Forest (WGS 84, 33.5469°N, 85.8224°W). Searches of cover objects in the streambed were performed only during daylight hours. As the microhabitat under logs and in leaf litter on the surrounding hillsides were extremely dry it is thought that these individuals were seeking refuge from desiccation under moist rocks in the streambed. An additional individual was found drowned in an isolated stream pool that was ~ 7 cm deep. The presence of this drowned individual may attest to the terrestriality of these animals and how extreme the conditions were to force this species to move to such a perilous environment.

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PSEUDOTRITON MONTANUS MONTANUS (Eastern Mud Salamander). **HABITAT USE.** Habitat use by adult *Pseudotriton montanus* has been reported as mesic habitats along rivers or swamps (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Press, Washington, D.C. 587 pp.). As part of a herpetofaunal survey of Hobcaw Barony in Georgetown County, South Carolina, I set up a plus-shaped drift fence array in Longleaf Pine (*Pinus palustris*)/ Turkey Oak (*Quercus laevis*) habitat at WGS 84 33.30682°N, 79.26372°W. The drift fence array was made of silt fencing with each arm ca. 16.5 m in length and four funnel traps along each of the four arms. On 10 May 2007 two adult *P. m. montanus* were found in the funnel traps. The previous evening 39.6 mm of rain fell at nearby Georgetown, 7.5 km NNW of Hobcaw Barony (www.wunderground.com/weatherstation/WXDailyHistory.asp) and there was evidence of precipitation at the trapping site. This is the first report that I am aware of *P. m. montanus* using a xeric habitat. One of the specimens (JDC-2137) will be deposited in the Charleston Museum, Charleston, South Carolina, USA.

I thank the Belle W. Baruch Foundation for funding the survey access to the study site.

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RHYACOTRITON KEZERI (Columbia Torrent Salamander). **LARVAL DIET.** Bury and Martin (1967. Copeia 1967:487) reported on the stomach contents of 36 post-metamorphic *R. variegatus* from northwestern California, the only diet study for any species of *Rhyacotriton*. Data on larval diet are lacking entirely. Herein, we report on larval diet for *R. kezeri*.

TLH made one observation in a small (< 2 m wide), 2nd-order (Strahler 1952. Geol. Soc. Am. Bull. 63:923–938) tributary of Minnie Creek, off the South Fork Willapa River, Willapa Hills, southwestern Washington State, USA (WGS 84, 46.580°N, 123.726°W, elev. 224 m). This site was in 2nd-growth forest managed for timber by the Washington Department of Natural Resources (WDNR). Western Hemlock (*Tsuga heterophylla*) with interspersed Western Red Cedar (*Thuja plicata*) dominate the overstory; Sword Fern (*Polystichum munitum*) is prominent in the understory.

At 1549 h on 9 July 2007, during measurement of a larval *R. kezeri* (31 mm SVL, 18 mm tail) in a clear polyethylene bag partly filled with water, TLH observed the animal regurgitate two *Neodiprion* sawfly larvae. The larvae were immediately preserved in 95% ethanol for subsequent examination. The *R. kezeri* had been found in sand beneath a 10 cm cobble in a riffle in the non-fish-bearing portion of the stream (126 m above the point where the last fish was recorded).

Both sawfly larvae had a narrow (1 mm wide) pale mid-dorsal stripe and one dark stripe (2 mm wide) running dorsolaterally the length of each side, typical of the Hemlock Sawfly, *N. tsugae* (Hard et al. 1976. Hemlock Sawfly. USDA Forest Service, Forest Insect and Disease Leaflet. Online at: http://www.fs.fed.us/r6/nr/fid/fidls/fidl31.pdf). The relatively intact larger of the two larvae (ca. 20 mm total length [TL]), was pale green, had a black head capsule with a lighter dorsal patch, and matched the size of the last larval (= pre-pupal) instar of *N. tsugae* (Hard et al. 1976, *op. cit.*). The smaller larva (15 mm TL), consisted of only a head and outer skin, but we could not distinguish whether this was from digestion or simply represented a previously shed larval skin consumed by the salamander.

At 1056 h on 11 July 2007, DEM made a second observation while sampling at the same site. A larval *R. kezeri* (30 mm SVL, 16 mm tail), found beneath a cobble in a riffle 282 m upstream from the first observation, had a *Neodiprion* larva (ca. 10 mm TL) sticking out of its mouth. As previously, the larva was immediately preserved. This larva was similar to the previous two, but the striping was less pronounced, and the head capsule was mostly white with black shading.

Sawflies are hymenopterans known for their phytophagous larvae (Smith 1993. *In* Wagner and Raffa [eds.], Sawfly Life History and Adaptations to Woody Plants, pp. 3–32. Academic Press, Inc., San Diego, California). Members of *Neodiprion* feed exclusively on conifers, tend toward monophagy (feed on but one host species), and several species are well known for eruptions in larval numbers that can defoliate large areas (Haack and Mattson 1993. *In* Wagner and Raffa [eds.], *op. cit.*, pp, 503–545). Given *Neodiprion* life history and that mature *N. tsugae* larvae are active from late June through August (Hard et al. 1976, *op. cit.*), opportunity exists for sawfly larvae to serve as an important seasonal food source for forest-dwelling species. Prepupal migration is not well understood, but if *N. tsugae* larvae fall from the canopy and initiate pupation, typically in August, either terrestrially or in low shrubs (Hard et al. 1976, *op. cit.*), those that drop into aquatic habitats may become prey for torrent salamanders.

Fieldwork was supported by the Forests and Fish Adaptive Management Program, Washington Department of Fish and Wildlife (WDFW). WDNR facilitated work on their land. Studies were done under a programmatic WDFW handling permit provided to employees in the course of their work. David R. Smith, research entomologist (retired, Systematic Entomology Labo-

ratory, Agricultural Research Service, U.S. Dept. Agriculture, Beltsville, Maryland) identified both larvae collected on 09 July 2007 as *Neodiprion*. R. Bruce Bury provided helpful comments. This is contribution No. 20 of the WDFW Habitat Program Amphibian Research Group.

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ANURA — FROGS

ALSODES PEHUENCHE (NCN). **LARVAL BIOLOGY.** *Alsodes pehuenche* is a telmatobiine frog known only from the type locality, the Pehuenche Valley in the Central Andes of Argentina, on the border with Chile (Cei 1976. Atti. Soc. Ital. Sci. Nat. Museo Civ. Stor. Nat. Milano 117[3–4]:159–164). Its tadpole was described as belonging to *Telmatobius montanus* (Cei and Roig 1965. Copeia 1965[4]:421–425), but was later re-assigned to *Alsodes pehuenche* (Cei 1976, *op. cit.*). The species was described from mountain snowmelt streams with stony banks covered in herbaceous vegetation, near permanent snow, and from ponds of spring water, probably thermal, rich in sulphurous deposits (Cei 1965. Publ. Occ. Inst. Biol. Univ. Nac. Cuyo 7:1–4; Cei and Roig 1965, *op. cit.*; Cei 1976, *op. cit.*). Since the species was first described (Cei 1976, *op. cit.*), no contributions have been made to the knowledge of its biology, and its current population status is unknown. The species has been categorized as Data Deficient (IUCN et al. 2004. Global Amphibian Assessment. <www.globalamphibians.org>). This note provides life history information on the larval population structure and larval habitat of the species.

During February 2007 (austral summer) two visits were made to the type locality in the Pehuenche Valley (WGS 84, 35.97342°S, 7038181°W, 2523 m elev.), in western Mendoza Province, Malargüe Department, Argentina. Habitat is a high mountain, steep, desert landscape, with wet meadows and snowmelt streams. The climate is harsh and is characterized by a long winter and a short favorable season. Average precipitation (mainly in the form of snow) is 800 mm annually. The area is inaccessible from May to November (Cei and Videla 2003. Bol. Mus. Reg. Sci. Nat. Torino 20[2]:275–290). Following Cei's 1964 itinerary, we travelled ca. 30 km along Provincial Route Nº 224 towards Paso Pehuenche along the Pehuenche Valley (1900–2530 m elev) in search of *Alsodes pehuenche* tadpoles in streams, meadows, and temporary pools. Of nine streams visited, *A. pehuenche* tadpoles were found only in the four located nearest to the International Pass, between 2491 and 2523 m elev, in agreement with Cei (1965, *op. cit.*). The frog *Pleurodema bufoninum* was found in temporary pools, and no anurans were found in the meadows.

Streams with *A. pehuenche* tadpoles are in very steep areas, although they have long stretches with gentle gradients and numerous waterfalls, and are surrounded by wet meadows. They have a maximum width of 2 m, carry a low volume of water and are exposed to strong summer radiation, with water temperature reaching 19°C at midday. Streambeds are stony, with fine organic sediment; periphyton and bacteria form a conspicuous reddish brown layer on the bottom. Snowmelt water in the streams is pure and contains a low concentration of ions, having very low conductivity (28–41μS/cm) and low hardness ($CaCO_3$ 11.68–15.01 mg/l). The concentration of sulphur is also very low (sulphides 0.3–2.44 mg/l). The pH was 5.9–7. No sulphur springs were found in the area. Midday air temperature was ca. 22°C. The tadpoles observed were concentrated in backwater sections of the streams. Groups were found ranging from 12–15 tadpoles occupying a surface area of 0.3 × 0.5 m or 0.5 × 0.8m, to groups of 50 tadpoles occupying surface areas of 1 × 1 m, giving density estimates ranging from 30 to 80 individuals/m^2. In all the streams, we found different cohorts of tadpoles of different sizes and stages (Gosner 1960. Herpetologica 16:183–190) living together, including newly hatched tadpoles (< 20 mm, Stage 25), medium-sized tadpoles (40 mm, Stage 26), large tadpoles (54–58 mm, Stages 31–34), and tadpoles near metamorphosis (62 mm, Stage 41; 57 mm, Stage 42).

Alsodes pehuenche tadpoles seem to prefer backwater sections of the streams, as they have no morphological adaptations to fast-flowing waters. None of the streams where *A. pehuenche* was found had characteristics of thermal waters with sulphurous deposits, nor any sign of volcanic activity. Cei and Roig (1965, *op. cit.*) mentioned finding adults and tadpoles in a "natural sulphur spring." There are two possible explanations for this statement. They may have mistaken the reddish-brown sediments (characteristic of these streams that drain wet meadows), for sulphurous deposits, perhaps influenced by the fact that the Termas de Cajón Grande hot springs, with their sulphurous pools, are located 20–30 km E of the area. The other possible explanation is that in 1964 there may have been an upwelling of sulphurous water that later disappeared as a result of the dynamics of volcanism itself.

Of the 17 species of the genus *Alsodes*, only *A. pehuenche*, *A. gargola*, *A. tumultuosus*, and *A. montanus* inhabit high mountain bodies of water in the Andes Range with similar environmental restrictions. The type locality of *A. pehuenche* has snowmelt streams with low conductivity and hardness, a long winter period with snow cover seven months a year, and an abrupt transition to summer with strong radiation and high temperatures, as do the high elevation localities of *Alsodes gargola* (Logares and Úbeda 2004. Herpetol. Rev. 35:368–369; Logares and Úbeda 2006. Amphibia-Reptilia 27[2]:263–267), *A. tumultuosus*, and *A. montanus* (Díaz and Valencia 1985. Oecologia 66:353–357). In this type of environmental scenario, the *A. pehuenche* tadpole development pattern bears similarities with the other three species.

The cohort of small, Gosner Stage 25 tadpoles found in February indicate a recent hatch during the summer that samples were taken. Similarly, for *A. montanus* and *A. tumultuosus*, early tadpoles (Stages 25–26) were reported in December–January (Díaz and Valencia 1985, *op. cit.*), and it was suggested that spawning occurred early in the favorable season. Similarly, *A. gargola* tadpoles hatch during a limited period in mid-summer (January–February) (C. Úbeda, pers. obs.). Cei and Roig (1965, *op. cit.*) mentioned the coexistence of *A. pehuenche* tadpoles of all stages and assumed that this could be due to repeated ovipositions during the summer season. Nevertheless, the large differences in size and development stage found among cohorts show that they belong

to ovipositions of different summers, as reported for *A. gargola*, for which there are up to three simultaneous cohorts of tadpoles, each cohort having hatched during a different summer (Logares and Úbeda 2004, *op. cit*.).

Cei (1965, *op. cit*.) suggested that tadpoles probably do not complete metamorphosis in a single period, but their larval life extends over two annual cycles. Our field observations support a long larval period in *A. pehuenche* and tadpole overwintering for at least two winters. It has now been shown that *A. gargola* tadpoles overwinter in high Patagonian Andean aquatic environments subject to a long winter season with snow cover (Logares and Úbeda 2004, 2006, *op. cit*.). An extended larval stage, tadpoles that overwinter, and a similar pattern of sizes and stages have also been found for *A. montanus* and *A. tumultuosus* (Díaz and Valencia 1985, *op. cit*.).

Our finding of *A. pehuenche* tadpoles nearing transformation in the middle of the favorable season matches the date recorded for *A. gargola* (Logares and Úbeda 2004, *op. cit*.), *A. tumultuosus*, and *A. montanus*, which had large metamorphosing larvae at the beginning of the favorable season, and recently transformed froglets during summer (December–March) (Díaz and Valencia 1985, *op. cit*.).

The habitat of *A. pehuenche* may soon be altered when the road through the Andes between Argentina and Chile is paved. Traffic is expected to increase over the following years, along with the consequent impact on the only known populations of the species. The streams occupied by *A. pehuenche* cross the road, and tadpoles have been found just a few meters upstream and downstream from the road. Although this contribution provides new information on basic aspects of larval natural history and microhabitat, further studies are needed. Because of this species' restricted range and the lack of information on its biology, we believe that further studies are urgently needed to develop conservation plans.

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ASCAPHUS TRUEI (Coastal Tailed Frog). **ATYPICAL AMPLEXUS.** Cross-species amplectic behavior has been reported with some frequency among anurans, but reports are limited to lentic-breeding amphibians (Brodie 1968. Herpetologica 24:86; Brown 1977. J. Herpetol. 11:92–94; Storm 1952. Herpetologica 8:108). Herein, we report the first observed case of inter-species amplexus involving the stream-breeding *Ascaphus truei*.

This observation was made on a small (< 1 m wide), 1st-order (Strahler 1952. Geol. Soc. Am. Bull. 63:1117–1142), seasonally intermittent, non-fish-bearing stream, a tributary of the South Fork Willapa River, Pacific County, Washington, USA (WGS 84, 46.585°N, 123.731°W, elev. 248 m). This site, located in a 50-year old second-growth forest managed for timber by the Washington Department of Natural Resources (WDNR), is dominated by Western Hemlock (*Tsuga heterophylla*) with Sword Fern (*Polystichum munitum*) and Oregon Oxalis (*Oxalis oregona*) in the understory.

On 15 May 2007, KMP and TRC found an adult (38 mm SVL) male *A. truei* in amplexus with a dead juvenile (45 mm SVL) *Rana aurora* in a small (0.8 m long, 11 cm deep) gravel-dominated pool. Both frogs were encountered ventral side up with the *A. truei* clasping the waist of the *R. aurora*. The *R. aurora*, dead, was slightly bloated, had its digestive track partly everted through its mouth, its left hand missing, and only one digit on its right hand. The male tailed frog's "tail" appendage was erect, directed anteriorly, and visibly engorged. Notably, the *A. truei* made no obvious response when picked up with the *R. aurora* from the pool, becoming active only after it was carefully removed for measurement from its firm grip on the dead *R. aurora*. The *A. truei* was released at the point of capture and the *R. aurora* was discarded.

Whether the *R. aurora* died before or after being clasped is unclear. The typical amplectic posture by the male *A. truei* (Slater 1931. Copeia 1931:62–63; Wemz 1969. J. Herpetol. 3:167–169) involves hand clasping from an inguinal position. This appeared to direct pressure on the mid-abdomen, and may have resulted in the partial eversion of the digestive track we observed. Moreover, if the *R. aurora* was alive when clasped, as a juvenile, it would not have responded. Noble and Aronson (1942. Bull. Am. Mus. Nat. Hist. 80:127–142) showed experimentally that frog girth represents a primary amplectic inducement for male frogs, so the *A. truei* may have perceived the juvenile *R. aurora* as a key stimulus; the juvenile *R. aurora* was about the size and shape of a gravid female *A. truei*.

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BOKERMANNOHYLA CIRCUMDATA (Espirito Santo Treefrog). **PREDATION.** Amphibians are commonly preyed upon by spiders and snakes (Neill 1948. Herpetologica 4:158; Rowe

et al. 2000. Herpetol. Nat. Hist. 7:145–152; Aucone and Card 2002. Herpetol. Rev. 33:48). The treefrog *Bokermannohyla circumdata* occurs in the Cerrado and Atlantic Forest of Brazil. This terrestrial, nocturnal treefrog is associated with forested areas and is usually found on tree trunks or branches close to water bodies (Eterovick and Sazima 2004. Amphibians from the Serra do Cipó. PUC Minas, Belo Horizonte; Izecksohn and Carvalho-e-Silva 2001. Anfíbios do Município do Rio de Janeiro. Editora Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil). *Xenodon neuwiedii* is a terrestrial and diurnal snake species that feeds strictly on anurans (Jordão 1996. Master´s thesis. Instituto de Biociências, Universidade de São Paulo, São Paulo. 93 pp.; Silva and Rodrigues 2001. Herpetol. Rev. 32:188). Herein, we report predation of an adult *B. circumdata* in Atlantic High Montane Forest in the Duas Barras Farm, Santa Maria do Salto (10.7693°N, 41.3501°W, SAD 69; 950 m elev.), Minas Gerais, southeastern Brazil. On 2 May 2005, between 1000 and 1040 h, one of us (AS) observed an adult *Xenodon neuwiedii* (ca. 450 mm TL) on a fallen tree near the permanent stream's edge (Fig. 1) preying on a adult *B. circumdata* (ca. 80 mm SVL). The snake used its jaws to support and ingest the treefrog headfirst, while maintaining its tail curled in a thin branch.



FIG. 1. *Bokermannohyla circumdata* preyed upon by *Xenodon neuwiedii*, Minas Gerais, southeastern Brazil, May 2005.

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DENDROPSOPHUS LEUCOPHYLLATUS (Bereis' Tree Frog). **PREDATION.** Spiders are known to prey on frogs, including species of *Dendropsophus* (Pramuk and Alamillo 2002. Herpetol. Rev. 33:46). Herein, we provide the first record of a spider of the genus *Ancylometes* (Araneae: Ctenidae) feeding on *D. leucophyllatus*. On 8 Jan 2006 at 2310 h AS observed an adult *D. leucophyllatus* being eaten by an adult spider near a small temporary pond located on the Hacienda San Sebastian, Provincia Ñuflo de Chavez, Dept. Santa Cruz, Bolivia (WGS 84, 16.383°S, 62.010°W, 566 m elev.) (Fig. 1). At the time of observation, the spider was observed motionless in the grass 25 cm from the pond's border. When the frog jumped nearby, the spider caught it and immediately began feeding.

Spider identification was verified by H. Hoefer (Staatliches Museum für Naturkunde, Karlsruhe, Germany) by photographs.



FIG. 1. A spider (*Ancylometes* sp.) feeding on an adult *Dendropsophus leucophyllatus* at the Hacienda San Sebastian, Department of Santa Cruz, Bolivia. Photograph by A. Schulze.

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ELEUTHERODACTYLUS COQUI (Coquí). **PREDATION**. This endemic frog from Puerto Rico is distributed along the island, concentrated mainly in two distinct large populations (Velo-Antón et al. 2007. Mol. Phylogenet. Evol. 45:716–728). Many natural predators are known for this frog, including scorpions, spiders, frogs, lizards, birds, and mammals (Joglar 2005. *In* Joglar [ed.], Biodiversidad de Puerto Rico, Vertebrados Terrestres y Ecosistemas, Serie de Historia Natural, pp. 37–96. Editorial del Instituto de Cultura Puertorriqueña). Sympatric tarantulas and spiders (Sprassidae, genera *Olios* and *Stasina*) have been documented as important predators (Formanowicz et al. 1981. Herpetologica 37[3]:125–129; Stewart 1985. J. Herpetol. 19[3]:391–401). Ctenidae and Ctenizidae spiders have also been reported as predators (Formanowicz et al., *op. cit.*; Stewart and Woolbright 1996. *In* Reagan and Waide [eds.], The Food Web of a Tropical

Rain Forest, pp. 302–309. University of Chicago Press, Chicago, Illinois).

On 5 July 2006 we observed a ground spider (Corinnidae) attacking a juvenile *E. coqui* (Fig. 1). This event took place at 2227 h (27°C) in Las Casas de la Selva, Patillas, a rainforest reserve in the southern central highlands of Patillas, Puerto Rico (WGS 84, 18.067°N, 66.033°W). The attack took place on the forest floor over leaf litter. A sequence of 12 photographs taken in ca. 1 minute intervals revealed that the spider struck the frog by sticking its chelicerae in the dorsal pelvic girdle region, presumably injecting venom to the sciatic nerves of the frog. Once the frog was subdued, the spider released it, and walked away. The frog remained immobile with both legs paralyzed, and died about 1 min later; unfortunately, the spider escaped without capture. Because the SVL of the frog was comparable to the spider's cephalothorax + abdomen length, we think it is unlikely that the spider could have engulfed its prey whole. Instead, we suggest that this spider's foraging strategy is to stun its prey with venom, and later return to suck the juices of a partially digested protein-rich meal.

We are grateful to the Tropic Ventures staff at Las Casas de la Selva for allowing us to work in their property, to G. Muriente-Pastrana for the photographs, to N. I. Platnick, D. R. Smith, J. Mercado, and A. Bonaldo for speculating on the identity of the spider, and to R. L Joglar for comments on earlier versions of this note.



FIG. 1. Photograph taken in the field of a ground spider (Corinnidae) attacking a juvenile *Eleutherodactylus coqui*.

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ELEUTHERODACTYLUS RICHMONDI (Coquí Caoba). **REPRODUCTION.** *Eleutherodactylus richmondi* is a medium-sized frog (female max SVL 43.5 mm), found in the interior uplands of Puerto Rico; females are usually found on the forest floor and males call from the lower vegetation up to 1.5 m above ground (Joglar 1998. Los Coquíes de Puerto Rico: Su Historia Natural y Conservación, Editorial de la Universidad de Puerto Rico, San Juan. 232 pp.). Herein, we offer the first report of reproduction in *E. richmondi* since 1962 and include information on nesting site, parental care, clutch and egg size, and SVL of newly hatched juveniles.

Two egg clutches were found on 31 Jan 07 in the Carite Forest Reserve in eastern Puerto Rico. Both clutches were found inside a fallen tree-fern log on the forest floor and were separated from each other by a distance of 25 cm. An adult female *E. richmondi* was found inside the log, suggesting some degree of parental care. There are previous reports suggesting parental care for this species but it was unknown which parent provides such care (Joglar 1998, *op. cit.*). One of the clutches (UPRRP 6394) was in an advanced stage of development and contained 29 eggs (mean = 5.76 mm diameter; range = 5.4–6.3; N = 5). Fully formed embryos were readily observed and exhibited the typical brown and brick color pattern of the adult. This characteristic facilitates clutch identification at advanced stages. Eggs began hatching on 1 Feb 07 and in less than 24 h, 20 of 29 eggs hatched. Mean SVL of newly hatched juveniles was 7.7 mm (7.5–8.0; N = 20). By 4 Feb, only 21 of 29 eggs hatched. The second clutch (UPRRP 6393) was comprised of more recently deposited eggs and contained 29 eggs (mean = 5.26 mm diameter; 5.0–5.5; N = 5).

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GASTROPHRYNE CAROLINENSIS (Eastern Narrow-mouthed Toad). **HIND LIMB MALFORMATION**. Amphibian malformations are one of the major concerns in the loss of global amphibian biodiversity. Some abnormalities are a result of mutation, developmental errors, or trauma; however, these occurrences are thought to be uncommon and most often result in missing digits or parts of a limb (Blaustein and Johnson 2003. Front. Ecol. En-

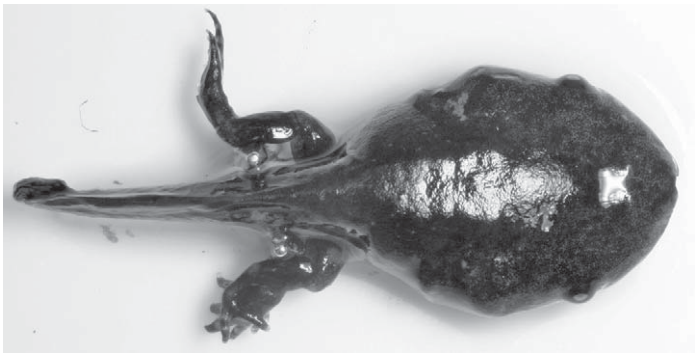


FIG. 1. Dorsal surface of *Gastrophryne carolinensis* tadpole with malformed right hind limb.

viron. 1:87–94). Other causes of amphibian malformations are UV radiation, chemical contamination, and parasitic infection (Blaustein and Johnson 2003, *op. cit.*). These types of exposures can result in a wide range of malformations from whole body abnormalities to missing limbs and/or digits to extra limbs and/or digits. Although it is known that UV radiation, chemical contamination, and parasitic infection can cause malformations, it is likely these variables interact with each other. Because the complex interaction of all three is unclear, we can better understand the mechanisms that cause deformities by adding to the growing breadth of knowledge on amphibian malformations.

We collected 200 larval *Gastrophryne carolinensis* from a permanent manmade wildlife pond in the Davy Crockett National Forest, Houston County, Texas, USA on 8 Aug 2007. The pond was created in 1992 and is located in a 72-acre Short-leaf Pine (*Pinus echinata*) stand. The stand was planted in 1990 and received a prescribed burn in 2003 and 2005 and has not been treated with herbicides or pesticides. Upon observation we noticed that one of the larvae had a malformed right hind limb. The lower portion of the right hind limb is enlarged (Fig. 1); however, it is unclear if the tibiafibula is duplicated. Also, the right hind foot has 13 digits that are oriented ventrally (Fig. 2A, 2B). The left hind limb is normal and the left hind foot has 5 normally positioned digits (Fig. 2A, 2C). The larva is Gosner Stage 41 (Gosner 1960. Herpetologica 16:183–190) and has a broken tail. After close examination we concluded that the type of malformation could be polymelia, polydactyly, or polyphalangy (Meteyer 2000. Biological Science Report USGS/BRD/BSR-200-0005), or some combination of the three. Of the 200 individuals that were collected at this site this was the only one that had malformations. To our knowledge this is the first record of hind limb malformations in *G. carolinensis*. The larva was deposited in the Texas Cooperative Wildlife Collections, TCWC 92886.

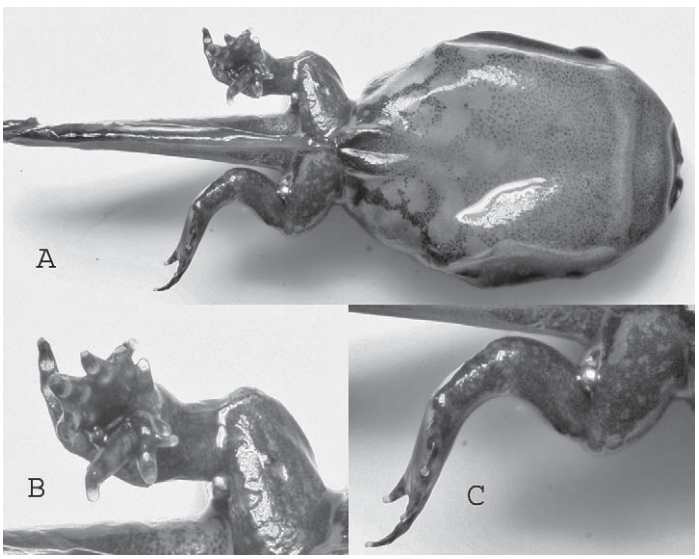


FIG 2. (A) Ventral surface of *Gastrophryne carolinensis* tadpole with malformed right hind limb. (B) Right hind limb of *Gastrophryne carolinensis* with 13 digits. (C) Normal right hind limb of same individual.

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LEPTODACTYLUS DIPTYX (Tropical Bullfrog). **ENDOPARASITES**. *Leptodactylus diptyx* occurs in the Lower Chaco and oriental region of Paraguay; eastern lowlands of Santa Cruz (Bolivia), and northern Argentina (IUCN 2007. Conservation International and NatureServe. Global Amphibians Assessment. http://www.globalamphibians.org. Accessed 22 Oct 2007). To our knowledge, no previous report of parasitism exists for *L. diptyx*. The purpose of this note is to report *Catadiscus* sp. (Trematoda) and *Centrorhynchus* sp. (Acanthocephala) in *Leptodactylus diptyx* from Argentina. Two adult *Catadiscus* sp. in large intestine and five acanthocephalan larvae *Centrorhynchus* sp. in the coelomic cavity were found in a female *L. diptyx* (27.6 mm SVL) from the herpetological collection of Universidad Nacional del Nordeste (UNNEC 9000) collected 22 Nov 2006, Corrientes (city), Corrientes Province (WGS 84, 27.466°S, 58.783°W, elev. 65 m). In Argentina, species of *Catadiscus* are known from the anurans *Leptodactylus latinasus*, *Leptodactylus ocellatus*, *Pseudopaludicola boliviana*, *Lysapsus limellus*, *Pseudis minuta*, *Pseudis paradoxa*, and *Hypsiboas pulchellus* (Lunaschi and Drago 2007. Zootaxa 1476:51–68). *Centrorhynchus* sp. has been documented from several South American amphibians (Smales 2007. Zootaxa 1445:49–56; Smales 2007. J. Parasitol. 93[2]:392–398), but only two species from Argentina: *Leptodactylus latinasus* and *Leptodactylus bufonius* from Corrientes Province (Hamann et al. 2006. Acta Parasitol. 51[4]:294–299; González and Hamann 2006. Rev. Esp. Herpetol. 20:39–46).

Leptodactylus diptyx represents a new host record for *Catadiscus* sp. and *Centrorhynchus* sp. We thank L. Lunaschi for verification of the organisms.

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LITORIA RANIFORMIS (Southern Bell Frog). **CLUTCH SIZE.** Currently, there is no documented assessment of the clutch

size of *Litoria raniformis*. A recent review of the biology of *L. raniformis* suggested that the number could range from several hundred, as indicated by dissections, up to thousands as in the closely related *L. aurea* (Pyke 2002. Austral. Zool. 32:32–48). Five amplecting pairs of *L. raniformis* were caught in Central Otago, South Island, New Zealand on the night of 30 Oct 2007. These pairs were housed in separate containers until they laid eggs, after which the frogs were removed and the eggs counted. The five clutches contained the following numbers of eggs: 2448, 3090, 3191, 3644, and 4563. *Litoria aurea* is known to lay an average of 5000 eggs with large clutches reaching over 11,000 eggs (van de Mortel and Goldingay 1996. Austral. Zool. 30:398–404). This suggests that the clutch sizes of *L. raniformis* are smaller than that of similarly-sized *L. aurea*.

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OOPHAGA PUMILIO (Strawberry Poison Frog). **PARENTAL CARE.** Parental care is complex in dendrobatid frogs, all of which are diurnal and transport tadpoles (Duellman and Trueb 1994. Biology of Amphibians. Johns Hopkins Univ. Press. Baltimore, Maryland. 670 pp.). On 5 July 2007 at 1047 h at Popa Island, in the Bocas Del Toro Archipelago, Panama, I observed a male *Oophaga pumilio* carrying a wriggling tadpole on his back (Fig. 1). The frog was observed on the southern part of the island, in an open area adjacent to the coast. The male was discovered while it was calling among numerous calling males at the same site. The male moved when the chorus stopped, but when the chorus began again the male stopped moving and started to call. The behavior continued for ca. 20 minutes, after which the male climbed up the tree until lost from sight. This is the first report of a male *O. pumilio* transporting tadpoles in the field since the first report from captive individuals (Weygoldt 1980. Behav. Ecol. Sociobiol. 7:329–332).



FIG. 1. *Oophaga pumilio* male carrying a tadpole up a *Ficus* sp., 5 July 2007, at Popa Island, Bocas Del Toro Province, Panama.

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RANA BOYLII (Foothill Yellow-legged Frog). **NECROGAMY.** Necrogamy has not been reported in *Rana boylii*. Here we report on a male *R. boylii* attempting to amplex with a dead female *R. boylii*. During *R. boylii* egg mass surveys on Canyon Creek, Trinity County, California, USA conducted on 20 June 2006, an adult male *R. boylii* was photographed in amplexus with a long-deceased female *R. boylii* at 1328 h. (Fig. 1.). The deceased female was badly decomposed and covered with a film of fungal hyphae. Measurements of animals were not taken to avoid disturbing the mating event. This behavior may have negative implications with disease transmission of pathogens such as *Batrachochytrium dendrobatidis* or iridoviruses.



FIG. 1. Male *Rana boylii* in amplexus with deceased female conspecific in Canyon Creek, Trinity County, California.

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RANA CATESBEIANA (American Bullfrog). **PREDATION.** Although predation on amphibians by Western Burrowing Owls (*Athene cunicularia hypugaea*) has been previously documented (Bond 1942. Condor 44:183; Clark 2008. Herpetol. Rev. 39:80–81; Green et al. 1993. Northwest Sci. 67[2]:88–93; Hoetker and

Gobalet 1999. J. Raptor Res. 33[4]:333–335; Munro 1929. Condor 31[3]:112–116; Scott 1940. Amer. Midl. Nat. 24[3]:585–593; Thomsen 1971. Condor 73:177–192), published documentation of predation on *Rana catesbeiana* is lacking. We observed numerous dead *R. catesbeiana* at the entrance of a Western Burrowing Owl burrow adjacent to a cattle stock pond within a vernal pool complex near Roseville, Placer County, California, USA (NAD 83, 38.8222°N, 121.3847°W) on 23 Sept 2003. Forty-three late-stage tadpoles and subadult *R. catesbeiana*, ranging from ca. 30–80 mm SVL, were collected at the burrow entrance. All of the frogs were desiccated and were missing brain cases or their entire head. Although this is the first published report of Western Burrowing Owl predation on *R. catesbeiana* of which we are aware, similar instances of predation, including brain case consumption, have been observed on other amphibians including California Tiger Salamander (*Ambystoma californiense*), Couch's Spadefoot (*Scaphiopus couchii*), and Great Plains Toad (*Bufo cognatus*) (C. Conway, pers. obs.; L. Rugge, pers. comm.).

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TELMATOBIUS OXYCEPHALUS (NCN). **PREDATION.** Herein I report two cases of predation on juvenile and adult *Telmatobius oxycephalus*. The observations were made during 15–17 Aug, 18–21 Dec, 27–30 Dec, 2006 and 29 Jan–1 Feb 2007 at two branches of a small stream tributary of the Huasamayo River 10 km from the city of Tilcara, province of Jujuy, northern Argentina.

On 31 Jan 2007 at 2110 h, a non-adult wolf spider (*Lycosa cf. thorrelli*; Lycosidae) was observed hidden under a small rock at the margin of a branch of the stream (max width 1 m) preying upon a juvenile *T. oxycephalus*. Only the hindlegs of the frog were distinguishable because the spider covered the rest of the specimen with its body. When found the frog was dead and a large area of necrotic tissue existed in the dorsal area; the whole body was a pallid color. The spider remained motionless for ca. 10 min. and then left the prey when it was disturbed during an attempt to collect it.

On 12 Dec 2006 at 2000 h, a Rainbow Trout (*Oncorhynchus mykiss*) was collected from a pool ca. 30 cm from the stream. The pool was ca. 150 × 80 cm, 50 cm deep, and had clear water; water temp. was 9°C, and air temp. was 17°C. As the pond did not have direct connection with the stream it is possible that the trout got there during a flood that occurred a week prior to the observations. Searching under the stones around the pool yielded a live female *T. oxycephalus* (SVL = 44.8 cm). Upon dissection of the trout, an adult *T. oxycephalus* (SVL = 45 cm) in an intermediate state of digestion was found in the stomach. The inhabitants of the area reported that Rainbow Trout have been released in the area annually for at least three years. However, they indicated that the summer floods cause high mortality and drive the adult trout downstream where they likely die because of water turbidity. Additional searches were conducted at the site but no other trout were found. These observations indicate that introduced salmonids do prey on *Telmatobius*. Although suspected (Merino-Viteri et al. 2005. Monog. Herpetol. 7:9–37), I am unaware of any published report of predation, although trout are known to prey on other anurans (e.g., Bradford et al. 1993. Cons. Biol. 7[4]:882–888; Fox et al. 2005 Copeia 2005:921–929; Katz et al. 2003. Div. Distrib. 9:99–110; Lips et al. 2005. Biotropica 37[2]:222–226). Whether this predation occurs at a scale that could drive local populations to extirpation, as suggested for *Telmatobius ceiorum* (Barrionuevo and Ponssa 2008. Herpetologica 64:47–62), remains to be studied.

The specimens of *T. oxycephalus*, the stomach of *O. mykiss*, and the spider are deposited at the Museo Argentino de Ciencias Naturales "Bernardino Rivadavia" División Herpetología.

I thank Julian Faivovich for provide helpful comments on this manuscript and L. Piacentini for identification of the spider.

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TURTLES

ACTINEMYS MARMORATA (Western Pond Turtle). **PREDATION ATTEMPT.** *Actinemys marmorata* inhabits a variety of aquatic habitats from western Washington, USA south to northwestern Baja California, Mexico (Stebbins 2003. Western Reptiles and Amphibians. Third Ed. Houghton Mifflin. New York, New York. 533 pp.) and is a California Species of Special Concern (Jennings and Hayes 1994. Amphibian and Reptile Species of Special Concern in California. Report to the California Department of Fish and Game, Rancho Cordova, California. 260 pp.). Among the predators that are known to feed on *A. marmorata* is the North American River Otter (*Lontra canadensis*). Manning (1990. Northwest. Nat. 71:38–42) observed cracked and chewed *A. marmorata* shells as well as a live individual with all four legs bitten off, which was attributed to predation by *L. canadensis*. However, no direct observations of *L. canadensis* feeding on *A. marmorata* have been documented.

On the morning of 31 May 2006 I observed eight *A. marmorata* basking on a large boulder along the edge of the Klamath River near Yreka, California (41.861315°N, 122.566127°W) from the opposite bank using binoculars. As I watched these turtles at ca. 0845 h, three *L. canadensis* leaped from the water, in unison, onto the rock. One *L. canadensis* came onto the rock from the downriver side, one from the upriver, and one from the middle. Each *L. canadensis* grasped an individual basking *A. marmorata* with their forelimbs and rolled back into the water. A fourth *L. canadensis* leapt onto the rock and made attempts to capture another escaping *A. marmorata*, but was unsuccessful. As the attack ensued, the remaining five *A. marmorata* quickly fled into the river. Shortly after, the three successful predator otters returned to the rock, and all four otters scrambled around the boulder appearing to search for *A. marmorata*. All four otters then returned to the river channel and disappeared. After the attack, a boulder

on the same bank ca. 45 m upstream had two other basking *A. marmorata* that were undisturbed.

Many populations of *A. marmorata* are sensitive to factors that affect reproduction and recruitment such as habitat loss, non-native predators, disturbance, water quality, and natural predation. Though actual predation on *A. marmorata* by *L. canadensis* was not confirmed during this observation, the cooperative hunting strategy utilized by *L. canadensis* during this observation provides insight into predator/prey interactions between these species.

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PSEUDEMYS CONCINNA (Eastern River Cooter). **MOVEMENT**. On 24 July 2007 a female *Pseudemys concinna* (carapace length = 329 mm; mass = 4020 g), was uniquely marked by drilling holes in the marginal scutes (ID = 655) and released from a baited hoop trap at 1000 h. Later that same day (1500 h), it was recaptured 1470 m downstream during snorkeling surveys. Capture locations were determined with a Trimble Geo3 Explorer GPS (accuracy 1–5 m). To our knowledge, this is the longest daily movement recorded for *P. concinna*. On 6 July 2008 another female *P. concinna* (carapace length = 383 mm; mass = 5610g), was also uniquely marked (ID = 946) and released from a baited hoop trap at 0900 h. On 9 July 2008 at 1315 h, the same female was recaptured during a snorkel survey 6280 m downstream. A female and male *P. concinna* were observed to move a maximum distance of 358 and 321 m in a Virginia population over the course of a two-month study (Buhlmann and Vaughan 1991. J. Herpetol. 25:72–78). Dreslik et al. (2003. Chelon. Cons. Biol. 4:706–710) found *P. concinna* in an Illinois pond to move 336.9 m ± 200.9 m, with females moving 321.9 m ±197.3 m during the day. Marchand (1942. M.S. thesis, Univ. Florida, Gainesville. 113 pp.), during a two-year study, found that 14 *P. c. suwanniensis* moved, on average, > 640 m between recaptures and observed one movement of 8.9 km. It was mentioned that these movements may be attributed to extended handling and releasing groups of turtles at the same place. Long, linear movements of riverine turtle species have been attributed to nesting voyages by females (Moll and Moll 2005. The Ecology, Exploitation, and Conservation of River Turtles. Oxford University Press. New York). In the southern United States, *P. concinna* generally nest in May and June (Ernst et al. 2004. Turtles of the United States and Canada. Smithsonian Institution Press. Washington, D.C. 578 pp.). The two movements we observed may have been associated with either nesting or disturbance from handling, although attempts were made to minimize handling disturbance in the field.

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TERRAPENE ORNATA (Ornate Box Turtle). **PREDATION ON CLIFF SWALLOWS**. Turtles are known to have broad, omnivorous diets that include plant material, aquatic and terrestrial invertebrates, and vertebrates (Klimstra and Newsome 1960. Ecology 41:639–647). During a 25-year study of Cliff Swallows (*Petrochelidon pyrrhonota*) in southwestern Nebraska, we observed *Terrapene ornata* prey, or attempt to prey, on swallows. Cliff Swallows feed exclusively on insects caught in flight. They are quick, agile fliers and rarely alight on the ground (Brown and Brown 1996. Coloniality in the Cliff Swallow: The Effect of Group Size on Social Behavior. University of Chicago Press. Chicago, Illinois). Consequently, they are very unlikely prey for turtles.

On 4 July 2002, one of us (MBB) was netting Cliff Swallows with a stationary mist-net placed near the entrance of a culvert underneath a railroad embankment near Keystone, Keith County, Nebraska, USA (41.3841667°N, 101.7988889°W). The colony consisted of 200 swallow nests. On one occasion as large numbers of birds flushed and hit the net, the weight of the birds pulled the net down to ground level. One *T. ornata*, which was seen regularly at the colony, approached one adult Cliff Swallow that was very low in the net and killed it by biting and eating its head. After killing the bird, the turtle walked away carrying the head. Nesting at Cliff Swallow colonies is usually quite synchronous (Brown and Brown 1996, *op. cit*.). Most colonies are initiated in mid-May, incubation lasts until mid-June, and most nestlings have fledged by mid-July. It is not uncommon for nestling Cliff Swallows to fall out of their nests (or jump out in response to nest parasites). Because these birds are too young to fly back to their nest and parent swallows do not attend nestlings on the ground, these nestlings become chilled, starve, and die. During peak periods of nesting synchrony, relatively large numbers of doomed nestlings can be found on the ground underneath nests at large colonies. From 2002–2007, at one large (1000–1800 nests) Cliff Swallow colony near Keystone, Keith County, Nebraska, USA (41.3555556°N, 101.6286111°W), we regularly observed two *T. ornata* patrolling the ground underneath the nests, killing and eating the moribund nestlings and scavenging dead nestlings. The turtles would walk up to nestlings that were alive and bite their heads, usually grabbing the nestlings by the front part of the head (in the beak and mouth area). Based on unique markings on their carapaces, we are confident that the same two turtles were present at this colony throughout the nesting season, and we suspect that the same two turtles returned to this colony site to feed for several consecutive years. *T. ornata* are known to be most active during June, which coincides with the swallow's nestling period (D. Ferraro, pers. comm.). *T. ornata* are rarely seen at colonies during the birds' incubation period or after most of the nestlings have fledged. Our observations are anecdotal in nature, but it appears that *T. ornata* recruit to and remain at Cliff Swallow colonies during the nestling period, when a reliable food resource is available.

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SQUAMATA — SNAKES

AGKISTRODON CONTORTRIX MOKESON (Northern Copperhead). **MID-WINTER THERMOREGULATION.** On 6 January 2007, I found two adult *Agkistrodon contortrix mokeson* thermoregulating at their hibernacula (41.35°N, 74.27°W, 244 m elev.) Chester, New York, USA. The latest date this species has been observed above ground in New York is 4 November and the earliest reported emergence is 2 March. *Agkistrodon c. mokeson* was considered to be inactive during the brumation period in the winter (Conant and Collins 1998. A Field Guide to Reptiles and Amphibians of Eastern and Central North America, 3rd edition. Houghton Mifflin, Boston. 450 pp.). Unusual warm weather probably contributed to this facultative basking. The average high temperature for 6 January is 1.7°C and the average low –7.8°C compared with the recorded high temperature of 21.1°C and the actual low temperature of 11.1°C on the day of this observation. This observation suggests that *A. c. mokeson* facultatively thermoregulates during winter months and appear to be able to detect external temperatures while in hibernacula.

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AGKISTRODON PISCIVORUS LEUCOSTOMA (Western Cottonmouth). **SCAVENGING**. Scavenging by wild snakes is thought to be rare, and has been documented in only 26 species (reviewed in DeVault and Krochmal 2002. Herpetologica 58:429–436). Scavenging may actually be quite common, but rarely documented, because typical diet analysis makes it difficult to determine whether prey items were dead or alive when encountered. On 31 May 2004 at 2125 h, I observed a juvenile *A. piscivorus leucostoma* (~ 350 mm SVL) scavenge an adult, road-killed *Hyla cinerea* (~ 50 mm SVL) from County Road 1985, 3.4 rd mi W of Texas State Highway 124, in Chambers County, Texas, USA. The posterior end of the frog was stuck to the road, so that the snake had to pull several times in order to peel the frog off the road. After removing the frog from the road, the snake traveled into the grassy shoulder as it swallowed the frog. The road passes through marshy coastal plain, where there is a high density of amphibians, especially *Hyla cinerea* and *Rana sphenocephala*, and a variety of amphibian-eating snakes including five species of *Nerodia* and two species of *Thamnophis*, in addition to *A. piscivorus*. Road-killed amphibians are common after rains in this area, thus providing ample opportunity for scavenging of amphibians by snakes. This is only the second documented case of amphibian scavenging by a viperid in the wild (see DeVault and Krochmal, *op. cit*.). It is interesting that the species observed here was *A. piscivorus*, as Savitzky (1992. *In* Campbell and Brodie, Jr. [eds.], Biology of the Pitvipers, pp. 347–368. Selva, Tyler, Texas) suggests that the Cottonmouth is primarily a scavenger.

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ALSOPHIS PORTORICENSIS ANEGADAE (Racer). **CANNIBALISM.** Feeding on conspecifics is an uncommon but broadly observed phenomenon in snakes (e.g., Loveridge 1944. Copeia 1944:254; Lourdais et al. 2005. Biol. J. Linn. Soc. 84:767–774). However, it has not been previously reported in *Alsophis portoricensis* (Henderson and Powell. *In press*. Natural History of West Indian Amphibians and Reptiles. University Press of Florida, Gainesville). Here we report on several such cases observed on Guana Island, British Virgin Islands, in 2006.

The most definitive evidence for cannibalism occurring in nature was obtained on 12 October 2006, when staff alerted us to the presence of a dead snake at the dump. We found an adult male (596 mm SVL, 229 tail length [TL], MCZ R-184654) with the posterior end of a smaller female (545 SVL, 177 TL, MCZ R-184655) emerging from its mouth. Because the two snakes may have tried to swallow a single prey item, we dissected the specimen but found no prey item. The larger snake had abundant fat deposits and appeared in good condition. A second case occurred in captivity on 7 October, when two snakes were placed in a single cloth bag. Two days later, only the larger animal (female, 440 SVL, 247 TL, MCZ R-184643) could be found. Upon dissection it was found to contain the other individual, a hatchling (241 SVL, 116 TL, also MCZ R-184643). Hotel staff brought a third instance to our attention. They had observed two snakes "fighting" and photographed the event. Unfortunately, they did not allow the interaction to continue, but the photograph is inconsistent with known snake combat behavior, which has never been observed in this species. Instead, the larger individual had grasped the smaller snake behind the head, presumably in an attempt to subdue it for ingestion. The smaller snake was bleeding profusely, according to the report.

We are surprised that a behavior not noted in the past, despite extensive work on the species (e.g., Barun et al. 2007. Copeia 2007:93–100), appeared to be common this year. The past year had been unusually wet on Guana Island, vegetation is abundant, and anoles, the principal prey of *A. portoricensis*, are common. Consequently, the prevalence of cannibalism is difficult to explain. However, if cannibalism occurs frequently, that could explain why smaller animals were relatively uncommon in the sample examined by Barun et al. (*op. cit*.).

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ATROPOIDES OLMEC (Tuxtlan Jumping Pitviper). **REPRODUCTION and PARASITES.** *Atropoides olmec* is a terrestrial viviparous pitviper distributed as disjunct populations in the Sierra de Los Tuxtlas (Veracruz), Cerro Baúl (Oaxaca), and Ocozocuautla (Chiapas) in México and in Baja Verapaz, Guatemala. It occurs in upper tropical rainforest and cloud forest from elevations of 530–1100 m and probably higher (Campbell and Lamar 2004. The Venomous Reptiles of Western Hemisphere. Comstock Publishing

Associates, Ithaca, New York; Castoe et al. 2003. Herpetologica 59:421–432; Pérez-Higareda et al. 1985. Bull. Maryland. Herpetol. Soc. 21:97–106).

On 28 July 2006 we collected two gravid *A. olmec* females (580 mm SVL, 645 mm total length(CNAR 12230); 582 mm SVL, 644 mm total length) on El Bastonal, Santa Marta volcano, Catemaco, Veracruz, México (18.333°N, 94.89°W, WGS 84). Both were under rocks in a secondary forest at 1100 m elevation. The snakes were captured in order to obtain venom samples and were individually housed in cages at Instituto de Biotecnología, Universidad Nacional Autónoma de México (UNAM).

One of the snakes (CNAR 12230) never fed in captivity and died on 8 August 2006. Upon dissection we found 18 partially developed embryos (CNAR 12231–12248), ranging from 93–105 mm SVL (mean SVL = 101.9, SD = 3.3). We also found 23 adult hookworm nematodes *Kalicephalus inermis* (CNHE 5617) parasitizing her intestine and stomach. Nineteen of these were females ranging in length from 9.73–12.55 mm and four were males ranging in length from 8.23–10.02 mm. The other snake was maintained in captivity and gave birth to 15 live offspring on 15 October 2006. Neonates ranged from 161–186 mm SVL (mean SVL = 168.6 mm, SD = 8.3). This snake and two snakes of the litter are still alive in captivity at the Miguel Alvárez del Toro Zoo, Chiapas, México.

The only other report of litter size in this species is of a gravid female found at Los Tuxtlas in late May that birthed 12 offspring in mid-June (Pérez-Higareda et al. 2007. Serpientes de la Región de Los Tuxtlas, Veracruz, México. Guía de Identificación Ilustrada. Universidad Nacional Autónoma de México, Mexico City). Based on these three litters, mean litter size is 15 and falls within the range reported for other, closely related, *Atropoides* species (Campbell and Lamar, *op. cit.*; Solórzano-López 1989. Rev. Biol. Trop. 37:133–137, Solórzano-López 1990. Copeia 1990[4]:1154–1157).

Kalicephalus spp. nematodes have been reported from a broad spectrum of reptile hosts worldwide, mostly from snake species but also from several lizard species (Baker 1987. Occas. Pap. Biol., Memorial University of Newfoundland, St. John, Newfoundland; Schad 1962. Can. J. Zool. 40:1035–1165). *Kalicephalus inermis* has been described as a parasite of other genera of pitvipers (*Agkistrodon, Bothrops, Crotalus*) in America, including México (Baker 1987, *op. cit.*; Grego et al. 2004. Vet. Rec. 154:559–562; Pfaffenberger et al. 1989. J. Wildl. Dis. 25:305–306; Schad 1962, *op. cit*.). The life cycle of *K. inermis* is unknown, but direct development is suspected, with free living larvae and parasitic adults. Snakes can be infected experimentally by oral inoculation of third-stage larvae which invade the stomach or intestinal wall and become encapsulated in the mucosa where development to the fourth stage takes place. How snakes become infected under natural conditions is unknown. Because this reptile group tests their environment with their tongues, it is suggested that larvae might attach to the latter. There is also the possibility that infective larvae could invade soft-bodied animals such as snails, slugs and amphibians cohabiting with the snakes. There is no evidence that skin penetration occurs in snakes so ingestion is the most probable mechanism for infection (Anderson 2000. Nematode Parasites of Vertebrates. Their Development and Transmission. 2nd ed. CABI, International Publishing, New York; Schad 1956. Can. J. Zool. 43:425–452).

It has been reported that juvenile *Atropoides mexicanus* and *Atropoides occiduus* feed on orthopterans and lizards. Adults of these species (as well as *Atropoides nummifer*) feed on small rodents (Campbell and Lamar, *op. cit.*). No data on the natural diet of *A. olmec* are available, but in captivity both juvenile and adults fed on rodents (newborn and adult mice) and frogs (Pérez-Higareda et al. 2007, *op. cit*.).

The ecology of *A. olmec* has been poorly studied, and its habitat is fragmented, isolated, and dangerously subject to increasing pressure from human use. A better understanding of the species' natural history is necessary to help in conservation of the remaining populations. Specimens were deposited in the Colección Nacional de Anfibios y Reptiles (CNAR) and the Colección Nacional de Helmintos (CNHE), Instituto de Biología, Universidad Nacional Autónoma de México.

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BOA CONSTRICTOR (Boa Constrictor)**. DIET**. *Boa constrictor* is a widely-distributed generalist predator that is abundant throughout many neotropical systems and is known to consume a wide variety of reptiles, mammals, and birds (Greene 1983. *In* Janzen [ed.], Costa Rican Natural History, pp. 380–383. University of Chicago Press, Chicago, Illinois). Avian prey taken by *B. constrictor* includes a diversity of ground- and canopy-dwelling species (Boback et al. 2000. Herpetol. Rev. 31:244–245; Sironi et al. 2000. Amphibia-Reptilia 21:226–232), yet the actual number of documented prey species remains relatively small. Here we report predation on an additional species of passerine bird, *Hylocichla mustelina* (Wood Thrush), at La Selva Biological Station, Puerto Viejo de Sarapiquí, Herédia Province, Costa Rica (10.4313°N, 84.0036°W). On April 6, 2005 at 1320 h, DLR was radio-tracking adult Wood Thrushes that had been equipped with external transmitter backpacks, and found that one bird (60–65 g, 20 cm long including tail feathers) had been consumed by a female *B. constrictor* (1203 mm SVL, 772.3 g). At the time of capture, the snake was resting on a 70 cm high branch, and had rectrices protruding from its mouth. We believe this to be the site of actual predation, because additional feathers were visible on the ground directly below the snake and tracked *H. mustelina* typically foraged in similar understory habitat. The snake was returned to the lab for data collection. Six days later it defecated 7.5 g of feathers, one partially-digested tarsus, the maxilla and mandible, and the 2 g intact transmitter, and subsequently was released at point of capture.

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BOTHROPS JARARACUSSU (Jararacussu). **OPHIOPHAGY**. Ophiophagy in the wild has been reported for many species of the genus *Bothrops* (Martins et al. 2002. *In* Schuett et al. [eds.], Biology of the Vipers, pp. 307–328. Eagle Mountain Publ., Eagle Mountain, Utah). On March 2007 at 1130 h, we watched a *B. jararacussu* (ca. 500 mm TL) prey upon an adult of *Liophis miliaris* (Common Water Snake; ca. 500 mm TL) at Alto Ribeira State Park (24.583°S, 48.583°W), Iporanga, São Paulo, Brazil. The prey was partially inside of a crevice on the banks of a small stream and was swallowed head first. Marques et al. (2004. Herpetol. Rev. 35:58) reported *B. jararacussu* preying on *Chironius bicarinatus*.

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BOTHROPS MOOJENI (Brazilian Lancehead). **PREDATION.** *Bothrops moojeni* is a large pitviper from riparian areas in Central and Southeastern Brazil (Nogueira et al. 2003. J. Herpetol. 37:653–659). On 23 Nov 2006 at 0723 h we found a juvenile *B. moojeni* (315 SVL) being eaten by a Tarantula (*Acanthoscurria* sp., Theraphosidae) above a rock in a semideciduous forest (18.0922222ºS, 57.4755556°W, WGS84 datum, 117 m elev.) in the Reserva Natural Engenheiro Eliezer Batista, Serra do Amolar, Brazilian Pantanal, Mato Grosso do Sul. The spider was holding the snake with its chelicerae. When disturbed, the spider fled while carrying the snake and attempted to hide under rocks. We captured the pair and released the spider. The snake was fixed in formalin and deposited at the Coleção Zoológica de Referência do Campus de Corumbá, Universidade Federal de Mato Grosso do Sul (CEUCH 3761). Invertebrates are known to prey on small, secretive snakes and juveniles of larger species (Greene 1997. Snakes: The Evolution of Mystery in Nature. University of California Press, Berkeley. 351 pp.), however most predators on pitvipers are vertebrates (e.g., Valdujo and Nogueira 2000. Herpetol. Rev. 31:45; Martins et al. 2003. Herpetol. Rev. 34:148; Oliveira and Santori 1999. Stud. Neotr. Fauna Environ. 34:72–75; Rodrigues 2005. Herpetol. Rev. 36:68). To the best of our knowledge this is the first published record of predation on *B. moojeni*.

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CACOPHIS CHURCHILLI (Northern Crowned Snake). **REPRODUCTION.** *Cacophis churchilli* is the only snake endemic to the Wet Tropics of Australia. A small cryptozoic elapid, it occurs in a range of habitats from rainforest to well-vegetated urban gardens, from sea level to 1000 m (Covacevich and McDonald 1993. Mem. Queensland Mus. 34:189–1999; pers. obs.). Very little is known of the natural history of this species beyond its present distribution and diet. Currently there is no published information on reproduction.

On 15 December 2006, a female was collected in the township of Atherton on the Atherton Tablelands (North Queensland) from an urban garden (17.2618°S, 145.4865°E). At the time the snake was "rescued" from the depredations of a domestic cat (*Felis catus*). Judging by the size and shape of the snake (330 mm SVL; 38 mm tail length; 12.8 g) it was thought to be gravid, an observation that was confirmed later in the day when the snake deposited four oblong eggs into a cloth bag in which the animal was being held prior to release. The eggs were 21.2 × 10.1 mm; 23.1 × 9.6 mm; 23.7 × 9.7 mm and 24.7 × 9.1 mm. An attempt was made to hatch the eggs with no success.

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CONOPHIS LINEATUS (Road Guarder). **DIET**. *Conophis lineatus* is a medium-sized snake that feeds on vertebrates, especially lizards of the genus *Aspidoscelis* and rodents (Lee 1996. The Amphibians and Reptiles of the Yucatán Peninsula. Cornell Univ. Press, Ithaca, New York, 500 pp.; Wellman 1963. Univ. Kans. Publ. Mus. Nat. Hist. 15[6]:251–295). At ca. 1300 h on 13 October 1996 on Isla Mujeres Quintana Roo, México (21.2472°N, 86.7417°W), one of us (OH-G) observed a *C. lineatus* on a sand beach below a shrub (*Suriana maritima*). The snake was in the process of constricting a juvenile *Ctenosaura similis*, which was later ingested head first (photographic vouchers, CNAR-RF 21 a–b).

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CROTALUS ADAMANTEUS (Eastern Diamond-backed Rattlesnake). **PREY**. Known prey items for *C. adamanteus* include rodents, squirrels, rabbits, and a few species of birds. The latter group includes several passerines, Northern Bobwhite (*Colinus virginianus*), juvenile Wild Turkey (*Meleagris gallopavo*), and Pileated Woodpecker (*Dryocopus pileatus*) (Timmerman 1995. Bull. Florida Mus. Nat. Hist. 37:127–158; Timmerman and Martin 2002. Herpetol. Circ. 32:1–70; Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Inst. Press, Washington, DC. 668 pp. and references therein; D. B. Means, pers. comm.). We note here another species of passerine bird captured by *C. adamanteus* in the field and one accepted in captivity.

At 0700 on 4 October 2007 one of us (CR) found a *C. adamanteus* (ca. 1500 mm TL) lying under a 60 cm^2 wooden feeding platform in a 2.4 × 7.3 m welded wire chicken coop on the north end of Cumberland Island, Camden County, Georgia (30.9226°N, 81.4361°W) that was eating an adult Cardinal (*Cardinalis cardinalis*). The habitat adjacent to the coop has an open canopy of pecan trees and a sparse understory that is part of a small settlement of houses. The snake had apparently killed but did not eat a 2/3 grown domestic chicken the day before. Upon discovery, the adult male Cardinal was in the same place as the chicken and being swallowed by the snake. The snake finished swallowing the bird in a plastic cooler after capture. It also ate a dead Carolina Wren (*Thryothorus ludovicianus*) offered to it in a cage on 16 October 2007. Captive *C. adamanteus* has been reported to eat Goldfinches, Chipping Sparrows, and warblers in captivity (Williams 1892. Science 20:345). Our observations add one new species of bird to the natural diet of this rattlesnake (Cardinal) and one new species accepted by a captive individual (Carolina Wren).

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CROTALUS CATALINENSIS (Santa Catalina Island Rattlesnake). **ARBOREALITY**. *Crotalus catalinensis* is generally considered an adept climber (Grismer 2002. Amphibians and Reptiles of Baja California, Including Its Pacific Islands and the Islands in the Sea of Cortés, University of California Press, Berkeley, California. 409 pp.), however, there are few data to support this assumption. Here I present field observations that corroborate the presumed proclivity for arboreality. During an ecological study in 2003–2004 we visited Santa Catalina Island on seven occasions: thrice between March and June (dry season), and four times between July and October (rainy season). We spent a total of 276 person-hours searching for snakes over 32 days. We searched for snakes between 1900 and 2400 h and recorded sex, snout–vent length (SVL), color phase, place of capture (on ground or on vegetation) and height above ground level. Seventeen of 45 *C. catalinensis* were found on vegetation during the dry season and three of 159 were found on vegetation in the rainy season. Of the twenty snakes (mean SVL = 527 ± 128 mm, range = 276–733 mm, N = 20) found on vegetation, twelve were males and eight were females, and of these, eleven were gray phase and nine were brown phase. Mean height above ground level was 36 ± 19 cm (range = 10–75 cm). Plant species used included Cardon Cactus (*Pachycereus pringlei*; N = 5), Copal (*Bursera hindsiana*; N = 4), Elephant Tree (*Bursera microphylla*; N = 3), Palo Verde Tree (*Cercidium microphyllum*; N = 2), Cholla Cactus (*Opuntia cholla*; N = 1), Jojoba (*Simmondsia chinensis*; N = 1), and four not registered.

According to Klauber (1982. Rattlesnakes: Their Habits, Life Histories, and Influence on Mankind. University of California Press, Berkeley. 350 pp.) this behavior is common among some rattlesnakes and can be related to foraging activities. Santa Catalina Island Deer Mice (*Peromyscus slevini*), the main prey of *C. catalinensis* (Avila-Villegas et al. 2007. Copeia 2007:80–84), are also frequently found climbing in shrubs (pers. obs.), lending credence to the notion that *C. catalinensis* uses vegetation as hunting sites. However, I have also observed *C. catalinensis* traveling considerable distances (e.g., 3.0 m) in a straight line through vegetation at heights of 0.6 m in January 2005 (Avila-Villegas 2006. Herpetol. Rev. 37:476), which may suggest that frequent presence in vegetation is due to transit upon it.

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CROTALUS MOLOSSUS NIGRESCENS (Mexican Black-tailed Rattlesnake). **BEHAVIOR.** Snakes present a broad variety of defensive behaviors when confronted with potential predators. The most common include fleeing, vibrating the tail, gaping the mouth, cloacal discharge, hissing, and biting (Martins 1996. Anais de Etologia 14:185–199). Some elapids gape their mouths and spit venom at potential predators (Young et al. 2004. J. Exp. Biol. 207:3483–3494). Anti-predator behaviors also vary with the level of menace perceived by the snake (Whitaker and Shine 1999. Wildl. Res. 26:689–704). Herein, we report venom spitting by *Crotalus molossus.*

On 12 January 2005, at the Laboratory of Biodiversity (Dirección General de Divulgación de la Ciencia-Universidad Nacional Autónoma de México), an adult *C. molossus* (890 mm SVL) was temporarily placed in a plastic container, while its cage was cleaned. When the snake was returned to its cage it adopted a defensive posture, arching the body in an "S" form, opening the mouth widely, and hissing loudly. Immediately, the handler (CAMS) moved approximately a meter away. The snake lunged forward with its mouth agape and ejected venom into the handler's eyes, resulting in a feeling of intense heat and momentary blindness over the course of the next 3 min. The handler's eyes were immediately flushed with copious amounts of water and over the remainder of the day the handler didn't present any other symptoms. However, at ca. 0730 h the next morning, the handler experienced nausea, tachycardia, and a decrease of arterial pressure. He also fainted several times over a period of ca. 5 min. Under medical supervision, the patient was treated with Meticortelone® corticosteroid and completely recovered over the course of seven days.

Current evidence suggests that the ability to spit venom has evolved multiple times within the cobras (Wüster 1996. Toxicon 34:399–406; Keogh 1998. Biol. J. Linn. Soc. 63:177–203). Multiple appearances of this defensive behavior in the evolutionary history of elapids suggests it has broad adaptive value. While this observation appears to be an isolated observation, it may represent a latent behavior in Crotalidae that presents irregularly or only under certain conditions. Interestingly, one of us (CJBV) has observed similar behavior in *Crotalus atrox*. Alternatively, agitated pitvipers might accidentally and prematurely eject venom in some circumstances.

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CROTALUS RAVUS (Mexican Pygmy Rattlesnake). **DIET**. There are few reports regarding the feeding habits of *Crotalus ravus*. However, lizards (*Sceloporus grammicus*, *S. megalepidurus*), mammals (*Mus musculus*, *Microtus mexicanus*), and insects (Hemiptera and Orthoptera) have been reported in the diet of this species (Uribe-Peña et al. 1999. Anfibios y Reptiles de las Serranías del Distrito Federal, México. Instituto de Biología, Universidad Nacional Autónoma de México. 119 pp.; Mendoza-Hernández et al. 2004. Herpetol. Rev. 35:63).

In May 2001 we found a *C. ravus* at the base of a cactus (*Opuntia* sp.) near La Preciosa Lake (19.3678°N, 97.3867°W, WGS84; 2040 m), Las Minas, Puebla State, México. The snake was eating an adult *Sceloporus spinosus*. Photographic vouchers (MZFC 1604–05) are in the Herpetological Collection of Museo de Zoología, Facultad de Ciencias, Universidad Nacional Autónoma de México.

Furthermore, on 12 May 2007 we collected an adult female *C. ravus* (167 mm SVL, 186 mm TL), in Delegación Magdalena Contreras (19.2879°N, 99.2670°W, WGS84; 2580 m) in the southern mountains of Distrito Federal, México. The specimen (MZFC 20902) was found crossing a trail in oak forest. A fragment of a snake tail was found in the snake's stomach. We identified the prey as *Thamnophis scalaris*, by comparing the tail fragment to the tails of other snakes collected in the same area. This is the first report of a snake in the diet of *C. ravus*.

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EUNECTES MURINUS (Green Anaconda). **LONGEVITY**. Anacondas and other large reptiles tend to live many years and grow slowly later in life. However, long-term data on growth rates for wild snakes are in short supply. Here we report recapture of a *Eunectes murinus* after 13 years. These observations were made in the course of conducting an on-going mark-recapture project (running since 1992) in the Venezuelan llanos, Distrito Muñoz, Apure State (7.5ºN, 69.3ºW). All snakes were marked using scale clipping and by copying the ventral pattern covering the first 15 subcaudal scales (Rivas et al. 2007. *In* Henderson and Powell [eds.], Biology of the Boas and Pythons, pp. 128–138. Eagle Mountain Publishing Company, Eagle Mountain, Utah).

On 27 August 1994 we captured a female (E548, 324 cm SVL, 21 kg). Thirteen years later on 19 March 2007, we caught E548 again and although the scale clipping mark was difficult to read, we were able to identify the individual unequivocally by comparing the subcaudal pattern with our records. Upon recapture E548 measured 366 cm SVL and 25 kg. E548 was wounded, weakened, and had a subcutaneous nematode (possibly *Dracunculus* sp.) which has been found in other individuals in this population (Calle et al. 1994. J. Zoo. Wild. Med. 25:53–64).

This may be the longest recapture record of any individual snake in the wild. Twelve-year recaptures have been reported by Madsen and Shine (2000. J. Anim. Ecol. 69:952–958). It is surprising that in 13 years E548 only grew 42 cm. It is expected that the growth rate of large reptiles will decrease towards older age (e.g., Madsen and Shine, *op. cit*.), but E548 is still far from the largest size recorded for this region (exceeding 500 cm, Rivas et al., *op. cit*.) and even further from other literature records. Cursory evaluation of our mark/recapture data suggest that anacondas in the wild may take more than a decade to reach 320 cm SVL, so E548 could be in her mid-twenties or perhaps even older.

The harvest of anacondas have been present for more than two decades driven largely by demand for luxury snakeskin products in the global market (Waller et al. 2007. *In* Henderson and Powell [eds.], Biology of the Boas and Pythons, pp. 340–362. Eagle Mountain Publishing Company, Eagle Mountain, Utah). However, rural populations may also be increasing their harvest in response to changes associated with macroeconomic packages that are affecting much of South America (Rivas 2007. Iguana. 14:10–21). Nevertheless, a recent three-year study monitored the experimental harvest of wild *Eunectes noteus* (Yellow Anaconda) and concluded that harvest could be sustainable based primarily on high reproductive rates, large distribution, and low human density (Waller et al., *op. cit.*). However, if the extremely slow growth rate presented here is the norm, we believe that the notion of sustainability is suspect in regions with high harvest/mortality (see Rivas, *op. cit*.; Rivas et al. 1999. Herpetol. Rev. 30:101; Rivas 2000. Unpubl. Ph.D. dissertation, University of Tennessee. 287 pp.; Rivas et al. 2001. Herpetol. Rev. 32:107–108).

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FARANCIA ABACURA (Mud Snake). **PREDATION**. Few records exist regarding predators of *Farancia*. Palmer and Braswell (1995. Reptiles of North Carolina. University of North Carolina Press, Chapel Hill) reported that American Alligators (*Alligator mississippiensis*) and Cottonmouths (*Agkistrodon piscivorus*) consumed *Farancia abacura* and these appear to be their only documented predators. It has been suggested that birds of prey and wading birds predate mud snakes (Ernst and Ernst 2004. The Snakes of the United States and Canada. Smithsonian Press, Washington, D.C.) and birds have been used experimentally to elicit death feigning (Doody et al. 1996. Herpetol. Rev. 27:82–83). However, there are no records of birds preying upon Mud Snakes *in situ*.

On 2 March 2008 at ca. 1830 h a Barred Owl (*Strix varia*) was observed attacking a juvenile *F. abacura* (238 mm SVL, 6.8 g) on a road at Lake Martin, St. Martin Parish, Louisiana, USA (30.214°N, 91.898°W). The owl fled when approached leaving the snake behind. The snake was collected alive without conspicuous external injuries although it expressed a slow righting response and locomotor difficulties. The snake died approximately one hour later. Ambient temperature was 20.9°C with 59% humidity.

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LAMPROPELTIS TRIANGULUM (Milksnake). **DIET**. Although *L. triangulum* is known to prey on snakes, *Arizona elegans* (Glossy Snake) has not been previously reported as prey (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Institution Press, Washington, D.C. 668 pp; Williams 1978. Systematics and Natural History of the American Milksnake, *Lampropeltis triangulum*. Milwaukee Public Mus. Publ. Biol. Geol. [2]:1–258). At 2355 h on 1 June 2006, we encountered an adult male *L. triangulum* (622 mm SVL, 63 mm tail, 83 g) in the process of swallowing an adult female *A. elegans* (561 mm SVL, 89 mm tail, 61 g) that was 74% of its mass at the Caprock Wildlife Area, Chaves County, New Mexico, USA (33.4541667°N, 103.7923611°W, WGS84). We monitored this interaction from discovery to complete ingestion which occurred at 0130 h on 2 June 2006. This is the first documentation of *L. triangulum* preying on *A. elegans*. Both individuals were collected and deposited in the University of New Mexico Museum of Southwestern Biology (MSB 72600, 72601).



FIG. 1. Adult male *Lampropeltis triangulum* ingesting an adult female *Arizona elegans*. Chaves County, New Mexico. Photo taken on 1 June 2006.

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LAMPROPELTIS TRIANGULUM TRIANGULUM (Eastern Milksnake). **DICEPHALISM.** A dicephalic neonate *Lampropeltis triangulum* collected 26 September 2004 by Glen Tricarico beneath a rock in a rock wall surrounding a backyard in Winthrop, Maine (44.3356°N, 69.9850°W) measured 200 mm total length (TL) and weighted 4.0 g. The snake shed for the first time on 7 October 2004. Since then it has shed 35 times and currently measures 735 mm TL and weighs 98 g. After continued refusal of various invertebrate prey, it readily fed upon *Scincella lateralis* on 5 November 2004. It was weaned onto pinkie mice for its second meal and has eaten 303 since then. Of those feedings, 200 were by the right head and 103 by the left. Initially both heads fought over food but they have learned to cooperate in feeding.

Previously published records of dicephaly in *L. triangulum* include Bancroft (1769. An Essay on the Natural History of Guiana, in South America. Becket and De Hondt, London, 214 pp.) for a New York specimen, W. Smith (1882. Rep. U.S. Geol. Surv. Ohio 4:690) for a Michigan specimen, Blatchley (1906. Proc. Acad. Nat. Sci. Philadelphia 58:421) for an Indiana specimen, Hyde (1925. Natural History 25:187) for another New York specimen, and Ernst (1960. Trans. Kentucky Acad. Sci. 26:67) for a Pennsylvania specimen. This is the sixth documented case of *L. triangulum* although three unverified reports exist (Cunningham 1937. Axial Bifurcation in Serpents. Duke Univ. Press, Durham, North Carolina. 91 pp.).

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LEPTODEIRA ANNULATA **(**Banded Cat-Eyed Snake). **DIET.** *Leptodeira annulata* is a nocturnal, arboreal colubrid snake which habits primary and secondary forests (Vitt 1996. Herpetol. Nat. Hist. 4:69–76). The dissection of 260 *L. annulata* specimens originally collected in southeastern and midwestern Brazil and deposited in the Instituto Butantan (IB) collection, revealed 22 prey items consumed by 17 snakes (three individuals consumed two prey each and one individual consumed three). Hylid, leptodactylid, and bufonid anurans constituted 77% of these prey items. Other identified prey include one *Hemidactylus mabouia* (ingested by a 449 mm SVL juvenile female), beetles and plant material (probably ingested incidentally), and two colubrid snakes. The colubrids were an *Atractus zebrinus* (318 mm SVL, 41 mm tail length [TL]) consumed by a female *L. annulata* (612 mm SVL, 25.1 mm head length [HL]) and an *Oxyrhopus guibei* (195 mm SVL, 55 mm TL) consumed by a male *L. annulata* (526 mm SVL, 19.7 mm HL). Prey were consumed head-first excepted by the *A. zebrinus*, which was consumed tail first. Our observations are consistent with previously published data suggesting that anurans comprise the majority of prey items consumed by this species (Martins and Oliveira 1999. Herpetol. Nat. Hist. 6:78–150) and that small lizards can be occasionally eaten as well (Amaral 1978. Serpentes do Brasil. Iconografia colorida. Melhoramentos/Univ. São Paulo, Brazil; Vitt 1996. Herpetol. Nat. Hist. 4:69–76; Cunha and Nascimento 1978. Ofídios da Amazônia. Museu Paraense Emilio Goeldi, Brazil). However, these are the first records of ophiophagy in this species. *Atractus zebrinus* is a terrestrial and fossorial snake, sympatric with *L. annulata* while *O. guibei* is a terrestrial snake which inhabits semi-deciduous forests, open,

and disturbed areas. There are no records of *O. guibei* in the area where *L. annulata* was collected. This suggests that *O. guibei* may have been consumed opportunistically after its collection while transported with other snakes or even in the captivity if it was kept with other specimens before it was preserved. Furthermore, our data suggest that this arboreal snake may forage both on the vegetation and on the ground.

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MASTICOPHIS MENTOVARIUS (Neotropical Whipsnake). **ATTEMPTED PREDATION AND DIET.** *Masticophis mentovarius* is a large diurnal species distributed from Sonora, México to Colombia (Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna Between Two Continents, Between Two Seas, University of Chicago Press, Chicago. 934 pp.). Little is known regarding the biology of northern populations and few predators or predatory attacks have been documented for the species.

On 1 August 2005 at 2219 h we observed a large adult (ca. 1070 SVL) Common Kingsnake (*Lampropeltis getula*) writhing on the road after being struck by a passing vehicle near Navajoa, Sonora. A large section of snake's gut was exposed revealing the partially digested remains of a recently consumed juvenile *M. mentovarius*.

On 3 August 2005 at 2249 h we observed a large adult *M. mentovarius* (ca. 1700 mm SVL) crawling rapidly onto a paved road between Navajoa and Minas Nuevas, Sonora. Upon stopping, we noticed the snake being chased by a small adult American Badger (*Taxidea taxus*). The badger repeatedly bit the snake and in one instance shook it at mid-body. Our presence caused the badger to retreat into the vegetation. Upon inspection we noticed that the snake was injured and bleeding from several sections of its body. The snake contained a large food bolus, which might have hindered its escape. The snake voluntarily regurgitated the prey item, an adult Norway Rat (*Rattus rattus*).

Masticophis mentovarius has been reported as a prey of both the Great Black Hawk (*Buteogallus urubitinga*) in Guatemala (Gerhardt et al. 1993. Biotropica 25:349–352), and the White Tailed Hawk (*Buteo albicaudatus*) in Colombia (Smith 1942. Copeia 2:85–88). Our observations provide novel information regarding the predators of this species in Sonora, Mexico.

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MICRURUS BRASILIENSIS (Brazilian Coralsnake). **DIET.** On 7 January 2005 we found what we believe to be an *Apostolepis assimilis* (500 mm SVL, 40 mm TL, 15 g) in the stomach of a DOR adult *Micrurus brasiliensis* (610 mm SVL, 40 mm TL, 32 g) collected at Fazenda Floryl (13.95ºS 46.01ºW), near the municipality of Correntina, Bahia. Specific identification of the prey species was not possible as the head was missing. The snakes were deposited in the Coleção Herpetológica da Universidade de Brasília, Brasília, Brazil (*M. brasiliensis* - CHUNB 39081 and *A.* cf. *assimilis* - CHUNB 39079). Martins and Oliveira (1998. Herpetol. Nat. Hist. 6:78–150) recorded predation of *Apostolepis* sp. by *Micrurus spixii* in Manaus region, Central Amazon, Brazil. However, our observation is the first record of *Apostolepis* in the diet of *M. brasiliensis.*

We thank F. Floryl/Jatobá and D. F. Silva for assistance.

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MICRURUS CORALLINUS (Painted Coralsnake)**. DIET.** *Micrurus corallinus* is a fossorial and diurnal coralsnake that ranges from Rio Grande do Norte to Rio Grande do Sul states in Brazilian Atlantic Forest (Campbell and Lamar 2004. The Venomous Reptiles of the Western Hemisphere. Cornell University Press, Ithaca, New York). This species feeds primarily on elongate ectothermic prey such as snakes, lizards, and amphisbaenians (Cunha and Nascimento 1978. Mus. Par. Emílio Goeldi Publ. Avuls. 31:1–218; Marques and Sazima 1997. Herpetol. Nat. Hist. 5:88–93).

On 27 May 2007 at 1230 h, I observed an adult male of *M. corallinus* (MNRJ 15119; 430 mm SVL, 31 mm tail length [TL]) feeding on an adult male *Tantilla melanocephala* (Crowned Snake; MNRJ 15120; 205 mm SVL, 62 mm TL) above a rock at Boqueirão, Pontal do Atalaia, Arraial do Cabo, Brazil (22,5899°S, 41,9999°W, 28 m elev.). The *M. corallinus* was swallowing the *T. melanocephala* headfirst before I interrupted. Marques and Sazima (*op. cit*.) reported a positive correlation between prey total length and predator SVL in *Micrurus corallinus*. Prey length ranged from 21–93% of the snake SVL. This is the first record of *M. corallinus* preying on *T. melanocephala*.

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NERODIA SIPEDON (Northern Watersnake). **MORTALITY CAUSED BY MUSSEL.** Interactions between freshwater mollusks and aquatic vertebrates are not uncommon. Freshwater bivalves are prey items for many vertebrates (muskrats, fish, turtles, etc.) and many freshwater mollusks have larval stages that parasitize vertebrates. Freshwater mussels of the family Unionidae have larvae, "glochidia," which are ectoparasites on vertebrates, generally fish species although one species parasitizes the Mudpuppy, *Necturus maculosus* (Parmalee and Bogan 1998. The Freshwater Mussels of Tennessee. The University of Tennessee Press, Knoxville, Tennessee. 328 pp.). Freshwater mussels have evolved different methods of attracting their host to increase their reproductive success, the most dramatic example being species that produce an extension of their mantle that resembles small fish, complete with eye-spots and tails. Furthermore, brooding freshwater mussels will flap and wave these mantle displays to mimic



FIG. 1. *Nerodia sipedon* caught in grasp of a Rabbitsfoot Mussel, *Quadrula cylindrica*.

fish movements, all the while attracting the piscivorous fish that are the host for their larvae (Haag and Warren 1999. Freshwater Biol. 41:1–6). However, these species interactions rarely end in the death of the vertebrate.

On 13 July 2006 we found a *Nerodia sipedon* that might have attempted to strike at a displaying rabbitsfoot mussel (*Quadrula cylindrica)* at a site in the Little River in southeast Oklahoma, USA. The snake's jaw was caught in the grasp of the mussel's valves (Fig. 1), and the snake was dead, likely from drowning in the several inches of water where they were found. Given that *Q. cylindrica* larvae parasitize small fish in the genus *Cyprinella*, and that they have been reported to brood larvae and display from May to July (Parmalee and Bogan 1998, *op. cit.*), we believe that the mussel's display behavior was in part responsible for the snake's death. Because northern *N. sipedon* are known to feed on small fish (Sievert and Sievert 1993. Reptiles of Oklahoma. Oklahoma Department of Wildlife Conservation, Oklahoma City, Oklahoma. 104 pp.), we think it is possible that the snake was striking at a fish that was attracted to the displaying mussel. Alternatively, the snake could have thought that the mussel's display itself was an appropriate food item, and struck at the display. Somewhat less likely is the possibility that the snake thought the whole mussel could have been its prey. When any foreign object is thrust into the opening of a mussel shell, the mussel almost always closes its valves. To our knowledge this is the first report of a snake being killed by a mussel and the first time any of us have seen anything like this in our 30+ years of experience of field work in rivers and streams.

We thank the Oklahoma Department of Wildlife Conservation for financial assistance.

Submitted by **DANIEL C. ALLEN** (e-mail: dallen@ou.edu), **DANE M. MORRIS**, and **CARYN C. VAUGHN,** Oklahoma Biological Survey, University of Oklahoma, 111 E. Chesapeake Street, Norman, Oklahoma 73069, USA.

NERODIA TAXISPILOTA (Brown Watersnake). **DIET**. *Nerodia taxispilota* is known to feed primarily on fish, particularly catfish (Ictaluridae; Camp et al. 1980. J. Herpetol. 14:301–304). Herein, we report *N. taxispilota* feeding on an invasive catfish previously undocumented as a prey species.

On 17 May 2007 at 1730 h, one of us (AT) observed an adult *N. taxispilota* (ca. 80 cm total length) on the bank of the Ichawaynochaway Creek at the Joseph W. Jones Ecological Research Center, Baker County, Georgia, USA. The snake was holding the anterior end of a live *Pylodictis olivaris* (Flathead Catfish, ca. 20 cm TL). Over the course of ca.1 h, the *N. taxispilota* swallowed half the catfish. *Pylodictis olivaris* is an introduced invasive in the Flint River and its tributaries, including Ichawaynochaway Creek.

Submitted by **ALEX TYSON, DAVID A. STEEN**, and **LORA L. SMITH**, Joseph W. Jones Ecological Research Center, Route 2 Box 2324, Newton, Georgia 39870, USA (e-mail: LexTyson@AOL.com)

PLIOCERCUS ELAPOIDES AEQUALIS (Variegated False Coralsnake). **DIET.** *Pliocercus elapoides* is a wide ranging and variable mimic of venomous coralsnakes. It inhabits rainforest and cloud forest slopes in México and Central America.

On 24 June 2007 at 0900 h we observed a male *P. elapoides aequalis* (287 mm SVL, 496 mm total length) feeding on a ca. 28 mm SVL *Gastrophryne elegans* (Microhylidae; Elegant Narrow-mouthed Toad). The observation was made on a narrow dirt path at the edge of tropical rainforest near Laguna Escondida, Los Tuxtlas, Veracruz, Mexico (18.5908ºN, 95.0882°W, 150 m elev., WGS84). The snake held the anterior body portion of the dead frog inside its mouth and spent ten minutes to swallow it completely. The event was photographed and the snake was measured and released.

It is known that *P. elapoides* feed on amphibians. Stuart (1948. Misc. Publ. Mus. Zool. Univ. Michigan 69:1–109) and Duellman (1963. Univ. Kansas Publ. Mus. Nat. Hist. 15:205–249), mentioned that in Guatemala *P. elapoides* diet consists of salamanders of the genus *Bolitoglossa*. Also, Seib (1985. Unpubl. Ph.D. dissertation, Univ. California, Berkeley. 229 pp.) reported *Bolitoglossa* and *Eleutherodactylus* parts and terrestrial amphibian eggs in Chiapas (southern México) and adjacent Guatemala as stomach contents. This is the first record of *Gastrophryne elegans* in the diet of this species.

Submitted by **ELISA CABRERA-GUZMÁN, MARCO ANTONIO MÁRQUEZ,** and **VÍCTOR HUGO REYNOSO,** Colección Nacional de Anfibios y Reptiles, Instituto de Biología, Departamento de Zoología, Universidad Nacional Autónoma de México, Circuito exterior, Ciudad Universitaria, México D.F., C.P. 04510 (e-mail: anfisbenido@yahoo.com).

SIPHLOPHIS COMPRESSUS (Red-eyed Liana Snake)**. CANNIBALISM.** *Siphlophis compressus* is a rare, primarily nocturnal and often arboreal forest colubrid occurring from Costa Rica south to Brazil, including Trinidad (Martins and Oliveira 1999. Herpetol. Nat. Hist. 6:78–150; Boos 2001. Snakes of Trinidad and Tobago. Texas A&M University Press, College Station, Texas; Solórzano 2005. Snakes of Costa Rica. Instituto Nacional de Biodiversidad, Costa Rica). Data on the diet of *S. compressus* indicate that the species is primarily a lizard specialist

(Cunha and Nascimento 1993. Boletim do Museu Paraense Emilio Goeldi 9:1–191; Martins and Oliveira, *op. cit.*), and there have been no previous reports of *S. compressus* consuming snakes of any species. In this note, we report the first case of *S. compressus* preying upon another snake, and the first case of cannibalism for this species.

On 30 January 2007 at ca. 1000 h, on the Soconusco Estate, Santa Cruz, Trinidad and Tobago (10.716°N, 61.483°W), we observed two *S. compressus* among leaf litter in a forested area dominated by Balisier (*Heliconia bihai*). One snake (ca. 1 m total length) was in the last stages of ingesting another, similarly sized conspecific. A dead, apparently regurgitated *Anolis* sp. (ca. 15–20 cm total length) was ca. 1.5 m from the two *S. compressus*.

Although the initial interaction between the snakes was not observed, it is likely that this observation was a case of accidental cannibalism. *Anolis* are a common prey item for *S. compressus* (Cunha and Nascimento, *op. cit;* Martins and Oliveira, *op. cit.*) and it may be that one *S. compressus* encountered the other while in the process of ingesting the lizard, eventually resulting in accidental cannibalism.

We thank H. W. Greene for assistance.

Submitted by **JAHSON B. ALEMU I.**, 827 East 2nd Street Crescent, Edinburgh 500, Chaguanas, Trinidad and Tobago (e-mail: jahsonb@gmail.com); and **JODI J. L. ROWLEY**, Conservation International Indo-Burma, PO Box 1356, Phnom Penh, Cambodia (e-mail: jodi.rowley@gmail.com).

SISTRURUS MILIARIUS BARBOURI (Dusky Pigmy Rattlesnake). **DIET**. *Sistrurus miliarius* has been recorded feeding on frogs, lizards, snakes, small mammals and birds, insects, spiders, and centipedes (Campbell and Lamar 2004. The Venomous Reptiles of the Western Hemisphere. Comstock Publishing Associates, Ithaca and London, 898 pp.; Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Books, Washington, 668 pp.). Only the Western Pigmy Rattlesnake (*S. m. streckeri*) is known to feed on shrews (*Blarina brevicauda*) (Jacob 1981. Report for the Tennessee Wildlife Resources Agency (project #E-1-2). Herein, we document *S. m. barbouri* consuming Short-tailed Shrews (*Blarina carolinensis*).

Two *Sistrurus m. barbouri* (UF 146057, 23.0 cm snout–vent length [SVL], 3.1 cm tail length [TL]; UF 146951, 49 cm SVL, 7.5 cm TL) were collected DOR on 27 October 1985 and 4 March 1987, respectively, on Long Pine Key, Research Road, 0.5 km E of the Daniel Beard Research Center in Everglades National Park (25.3893°N, 80.6742°W, datum: WGS84; elev. < 1 m). Both of these snakes had a single *B. carolinensis* in their stomach, augmenting diet data for this native species in Florida.

Submitted by **SCOTT L. TRAVERS, KENNETH L. KRYSKO, SARAH J. ALLRED,** and **LUIS R. TIRADO,** Florida Museum of Natural History, Division of Herpetology, University of Florida, Gainesville, Florida 32611, USA.

SISTRURUS MILIARIUS MILIARIUS (Carolina Pigmy Rattlesnake) **MORPHOLOGY**. On 28 August 2005 at 1839 h I found a newborn *Sistrurus miliarus miliarius* (127 mm SVL, 152 mm total length, 4 g) crossing an asphalt road in Chesterfield County, South Carolina. The snake's head appeared short and the eyes appeared to be incompletely developed and bulged out laterally. Some features appeared normal; the pit and naris were present. Although a superficial examination suggested that this might be a case of brevicephaly (shortening of the skull), this was merely an illusion created by a head that is disproportionately wide across the eyes. The specimen's head measured 12.1 mm from the snout to the posterior margin of the jaws. Head length of the specimen is 8.2% of the total body length, which is not remarkably different from six other juvenile specimens that I measured (mean = 8.3%). The width of the head, across the eyes, measured 11.3 mm. On the other juveniles I measured, a line transecting the venom glands represented the widest part of the head and the average width across the eyes was 86% of the width across the venom glands. In the present case, the width of the head across the eyes was 136% of the width across the venom glands. Furthermore, head width (across the eyes) on the typical juveniles averaged 52.8% of head length. On this specimen, the width of the head across the eyes is 93.4% of the head length. The snake is deposited in the North Carolina Museum of Natural Sciences (NSM 68554).



FIG. 1. Juvenile *Sisturus miliarus miliarius* with abnormal head morphology.

Submitted by **KEVIN MESSENGER**, 2715 Vanderbilt Ave, Raleigh, North Carolina 27607, USA.

STILOSOMA EXTENUATUM (Short-tailed Snake). **DIET AND PREDATION**. *Stilosoma extenuatum* is known to feed on small, smooth-scaled colubrid snakes and rarely on lizards, both in the wild and in captivity (Rossi and Rossi 1993. Herpetol. Rev. 24:100–101, and literature cited therein]. On 14 March 2007, a partially eaten (tail and posterior to gall bladder), adult *S. extenuatum* was found in the garage at 4085 Ramona Drive, Spring Hill, Florida. The snake appeared to have been killed by a dachshund. Gut contents of the snake contained a partially digested, adult *Ramphotyplops braminus* (Brahminy Blind Snake), the first record of this introduced typhlopid in the diet of *S. extenuatum* and a new county record for *R. braminus*. Both specimens were deposited in the National Museum of Natural History under the same catalog number (NMNH 563619).

Submitted by **J. STEVE GODLEY**, **SHANNON M. GONZALEZ**, and **MARY C. GONZALEZ**, Biological Research Associates, 3905 Crescent Park Drive, Riverview, Florida 33578, USA.

TANTILLA GRACILIS (Flathead Snake). **COURTSHIP**. *Tantilla gracilis* is a small, semi-fossorial, saxicolous snake that occurs in Arkansas, Kansas, Louisiana, Missouri, Oklahoma, Texas, and southwestern Illinois (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville). In Louisiana and Texas, most individuals are collected from beneath rocks in spring or early summer, with gravid females found in June and July and oviposition (clutch size of 2–3 eggs) occurring in these months (Dundee and Rossman 1989. The Amphibians and Reptiles of Louisiana. Louisiana State University Press, Baton Rouge; Cobb 1990. Southwest. Nat. 35:222–224). Relatively little is known about courtship in this species or when it occurs.

On 15 March 2008 at 1530 h CST, we captured an adult male (157 mm total length) and female (226 mm total length) together beneath a large sandstone rock (50 x 25 x 6 cm) in the Kisatchie Ranger District of Kisatchie National Forest, Natchitoches Parish, Louisiana (31.476611°N, 93.076361°W, 34 m elev., WGS84). The male was lying in a loose coil on top of the female with the posterior third of his body partially intertwined with hers. The vegetation of this habitat is dominated by Longleaf Pine and the area is actively managed for Red-cockaded Woodpeckers and had been recently burned (within a week of our observation). The terrain had a moderate slope, the ground was covered by a loose assortment of sandstone rocks, and there were a series of streams and springs that occurred at irregular intervals. Our observation is the first report of courtship behavior for this species and indicates that mating occurs as early as March in the southern portion of its range.

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THAMNOPHIS SIRTALIS FITCHI (Valley Gartersnake). **HABITAT AND BEHAVIOR**. *Thamnophis sirtalis* is the most widely distributed snake in North America and is typically found near both lentic and lotic waters in meadows, farms, and damp woodlands up to 1800 m (Behler and King 1991. The Audubon Society Field Guide to North American Reptiles and Amphibians. Alfred A. Knopf, New York. 743 pp.). Here we describe *Thamnophis sirtalis fitchi* using the nest of *Neotoma fuscipes annectens* as a shelter.

On 27 September 2007, we disassembled four *N. f. annectens* nests in a willow (*Salix*) riparian woodland along the banks of Uvas-Carnadero Creek, Santa Clara County, California (36.9167°N, 121.5333°W, NAD27). From a nest built around a willow tree, we removed one adult *T. s. fitchi* and four juveniles from the lower level of the nest containing decomposing vegetation and relocated them to a leaf litter layer near the creek. Woodrat nests are probably attractive shelters and retreats for reptiles. Whereas larger snake species (e.g., *Crotalus* and *Pituophis*), might prey upon woodrats or their young while using the burrows, this is unlikely to be true of *T. sirtalis*. In this case, use of the burrows represents a commensal relationship in that the gartersnakes benefit from the use of the woodrat burrows, but the woodrats are largely unaffected by the interaction.

We thank N. R. Sisk, D. P. Newman, and S. I. Hagen for assistance. Permits and support provided by the California Department of Fish and Game, and the Santa Clara County Water District provided additional support.

Submitted by **HOWARD O. CLARK, JR.**, H. T. Harvey and Associates, Fresno, California, USA (e-mail: hclark@harveyecology.com); and **JENNIFER R. GWOREK**, H. T. Harvey and Associates, Los Gatos, California, USA.

TROPIDOPHIS WRIGHTI (NCN). **NEONATES**. On 11 April 2001 an adult female *Tropidophis wrighti* (385 mm SVL, 50 mm tail length [TL], 17 g) was found in submontane rainforest in Altiplanicie El Toldo, Moa municipality, Holguín province, Cuba (20.45°N, 74.90°W). The female was held in captivity, provided water *ad libitum*, and was fed *Anolis sagrei*, *Eleutherodactylus* spp. and small *Bufo peltocephalus*. The snake shed on 21 May and 6 August 2001. On 27 August 2001, the female gave birth to three neonates: two live (124 mm SVL, 22 mm TL and 127 mm SVL, 21 mm TL) and one dead (136 mm SVL, 21 mm TL). I could not determine if the dead neonate had died before or after parturition. Two additional yolk masses (10 x 6 mm and 9 x 6 mm) found on 8 September 2001 indicated that two additional ova failed to develop. The female's mass after parturition was 15.5 g. On 29 September 2001, another female (ca. 40 mm total length) maintained in captivity and of unknown origin, gave birth to five neonates.

Our observations of litter size in *T. wrighti* fall within the range reported for other species of this genus (Schwartz and Henderson 1991. Amphibians and Reptiles of the West Indies: Descriptions, Distributions and Natural History. Univ. Florida Press, Gainesville; Powell et al. 1992. Bull. Chicago Herpetol. Soc. 27:116–117; Fong 2005. Herpetol. Rev. 36:118–119) and neonatal sizes reported here are similar to the only other record (Fernandez and Alonso 2005. Herpetol. Rev. 36:330).

I thank Luis M. Diaz and Josefina Blanco for assistance.

Submitted by **ANSEL FONG G.**, Centro Oriental de Ecosistemas y Biodiversidad (BIOECO), Museo de Historia Natural "Tomás Romay," Enramadas #601, Santiago de Cuba 90100, Cuba; e-mail: ansel@bioeco.ciges.inf.cu.

VIRGINIA STRIATULA (Rough Earth Snake). **AGGREGATION AND URBAN HABITAT**. Snakes form aggregations in social and non-social contexts, such as courtship (e.g., Luiselli 1996. J. Zool. 239:731–740; Shine et al. 2005. Anim. Behav. 69:1251–1258), thermoregulation (Graves and Duvall 1987. Herpetologica 43:259–264), hibernation (Cobb et al. 2005. Southeast. Nat. 4:723–730), and refuge use (Gregory 2004. Herpetologica

60:178–186). Individuals of at least one species (*Crotalus horridus*) preferentially aggregate with siblings, indicating that some species may engage in complex social behavior by forming family groups (Clark 2004. Proc. Royal Soc. Biol. Sci. Ser. B 271 (Suppl. 4):S243–S245). Natricine snakes, including *Virginia striatula*, frequently exhibit complex sociality during the reproductive season. Several males may simultaneously court a single female, forming a "ball" of mating snakes (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Inst. Press, Washington, DC. 668 pp.). The natural habitat of *V. striatula* is typically under logs and loose bark in forests and fields; however, individuals may occur in abundance in areas disturbed by humans, such as in the plant litter of flower gardens adjacent to houses (Dundee and Rossman 1989. The Amphibians and Reptiles of Louisiana. Louisiana St. Univ. Press, Baton Rouge. 295 pp.). Mating occurs in March and April in southern regions of its range as individuals emerge from hibernation (Dundee and Rossman, *op. cit.*).

On 11 March 2006, we observed six individual *Virginia striatula* in close spatial proximity in a highly urbanized landscape in a subdivision of Lafayette, Louisiana (30.2091ºN, 92.0755ºW). At 1900 h, we observed these and one other individual within a 2.5 x 3 m^2 area in close-cropped Bermuda grass between a sidewalk and a townhouse. The largest individual was a female (230 mm SVL, 33 tail length, 7.6 g), whereas all others were males (177–218 mm SVL, 25–44 mm tail length, 2.8–4.6 g). The subdivision was a series of town houses around which yards and public areas were maintained in short grass and manicured sidewalks. The location in which the snakes were found was across the sidewalk to a small yard maintained as a flower garden watered frequently by the owner. We assumed that these snakes use the garden as a refugium during dry conditions. The snakes were active on the surface during dry weather and appeared to be scent trailing.

We interpret the sex ratio of one female to five males, their close proximity, and apparent scent trailing behavior as a mating aggregation. The date of observation is the earliest known for reproductive behavior in Louisiana (Dundee and Rossman, *op. cit.*). This report documents that *V. striatula* populations can occupy small, highly urbanized areas if moist gardens and other landscaped areas are maintained nearby. This observation has implications for management and restoration of this small colubrid in urban habitats.

Submitted by **JOSEPH C. MITCHELL** (e-mail: dr.joe.mitchell@gmail.com) and **SUSAN C. WALLS,** Mitchell Ecological Research Service LLC, P.O. Box 5638, Gainesville, Florida 32627-5638, USA (e-mail: dr.susan.walls@gmail.com); and **JAMES W. BECK**, 100 Aurelien Loop #101, Broussard, Louisiana 70518, USA (e-mail: agkistrodon@worldnet.att.net).

VIRGINIA VALERIAE (Smooth Earth Snake). **THREAT DISPLAY**. *Virginia valeriae* is a wide-ranging and diminutive natricine snake found in the southeastern United States (maximum reported total length: 393 mm). Many colubrid snakes, especially natricines, will gape, vibrate the tail, and eventually strike to ward off predators if unable to flee. However, it is less common to see such threat displays among small-bodied semi-fossorial or "leaf-litter" snakes, possibly because such behaviors are non-threatening and ineffectual deterrents due to the small size and lack of serious consequence to predators that results from encounters with such undersized snakes. Nevertheless, one small-bodied natricine, *Storeria occipitomaculata*, is known to exhibit an unusual threat display known as "lip-curling" when molested, whereby the lips are curled back and the teeth are revealed (Amaral 1999. J. Zool. (London) 248:289–293). A similar "lip-curling" display has also been described for one female *V. valeriae* observed in Ohio (Conant 1951. Reptiles of Ohio. Notre Dame Press). On 22 April 2007, I observed a threat display in a male *V. valeriae* (111 mm SVL) while photographing the animal *in situ* in an open canopy pine forest in the early morning in Barnwell County, South Carolina. The snake faced me and repeatedly gaped, open-mouthed, in a strike position when approached closely with the camera. During the approximate two minutes of repeated display, the snake accompanied its gaping on two occasions with lively tail vibrations that lasted 3–5 seconds. At no time did the snake strike. To my knowledge, this is the first report of a threat display involving tail-vibrations and gaping in any species of *Virginia*, a seldom reported or apparently rare behavior among small-bodied snakes. It is unclear whether this threat display is distributed more widely among species than previously assumed, is a product of phylogenetic conservatism and the natricine heritage of *V. valeriae*, or was an atypical occurrence resulting from a highly agitated individual.

Submitted by **BRIAN D. TODD**, University of Georgia, Savannah River Ecology Laboratory, Drawer E, Aiken, South Carolina 29802, USA; e-mail: btodd@uga.edu.

WAGLEROPHIS MERREMI (False Yarara) **DIET**. *Waglerophis merremi* is a medium-sized colubrid that occurs in a variety of habitats in Argentina, Paraguay, Bolivia, Brazil, and Guayanas (Campbell and Lamar 1989. The Venenous Reptiles of the Latin America. Cornell Univ. Press, Ithaca, New York; Peters and Orejas Miranda 1970. Catalogue of Neotropical Squamata. Part. I. Snakes. Bull. U.S. Natl. Mus. 297). The majority of prey consumed by this snake are amphibians.

In Novembrer 2006 we captured and euthanized six specimens from Pago Largo (29.97ºS, 58.28ºW), Curuzú Cuatiá, Corrientes, Argentina. Dissection of the stomach and intestine showed remains of *Rhinella* (= *Chaunus*) *schneideri* (Rococo Toad) and also ribs and scales of characid fishes in one snake. The snakes and their prey were deposited in the Laboratorio de Herpetológica of the Universidad Nacional del Nordeste Argentina (UNNEC 09413, 09432–435, 09411). To our knowledge, this is the first published record of fish in the diet of *W. merremi*.

Submitted by **ADRIANA AROZTEGUI** (e-mail: adrianam2003@hotmail.com), **BEATRIZ ÁLVAREZ** (e-mail: balvarez@exa.unne.edu.ar), and **JORGE CÉSPEDEZ** (e-mail: cespedez2003@yahoo.com.ar), Laboratorio de Herpetología, Anatomía Comparada de los Cordados, Departamento de Biología. Facultad de Ciencias Exactas y Naturales y Agrimensura, Universidad Nacional del Nordeste, Campus Universitario, Corrientes. Cp 3400, Av. Libertad 5740, Argentina.

GEOGRAPHIC DISTRIBUTION

Instructions for contributors to Geographic Distribution appear in Volume 39, Number 1 (March 2008, p. 102). Please note that the responsibility for checking literature for previously documented range extensions lies with authors. Do not submit range extension reports unless a thorough literature review has been completed.

CAUDATA – SALAMANDERS

AMBYSTOMA LATERALE (Blue-spotted Salamander). USA: WISCONSIN: Richland Co.: Lone Rock Unit – Lower Wisconsin State Riverway (43.1815333ºN, 90.2118833ºW). 24 June 2008. Tim Muehlfeld and Mathew Muehlfeld. Photographs verified by Robert Hay (Wisconsin Department of Natural Resources-Bureau of Endangered Resources) and Gary Casper (Great Lakes Ecological Services). Illinois Natural History Survey catalogue number: INHS 2008.e. New county record. Extends range of species in Wisconsin (Casper 1996. Geographic Distributions of the Amphibians and Reptiles of Wisconsin. Milwaukee Public Museum, 87 pp.). One individual captured by hand under abandoned railroad tie.

Submitted by **TIM MUEHLFELD**, We Energies, 333 W. Everett St., Milwaukee, Wisconsin 53203, USA; **MATTHEW MUEHLFELD**, 4116 Knollcrest Circle N., Martinez, Georgia 30907, USA; **JOSHUA M. KAPFER**, Natural Resources Consulting, Inc., 209 Commerce Parkway, PO Box 128, Cottage Grove, Wisconsin 53527, USA.

AMBYSTOMA MACULATUM (Spotted Salamander). USA: TEXAS: Houston Co.: 1.4 rd km SE Jct TX 21 on FR 511, Davy Crockett National Forest compartment 19 (31.55835863ºN, 95.16437ºW). 13 February 2007. Terry L. Hibbitts. Verified by James R. Dixon. Texas Cooperative Wildlife Collections, TCWC 91796. New county record and first record east of the Neches River in Texas. The specimen collected is a partial egg mass. Two egg masses were observed. (Dixon 2000. Amphibians and Reptiles of Texas. Second Ed. Univ. of Texas A&M Press, viii + 421 pp.).

Submitted by **TOBY J. HIBBITTS,** Texas Cooperative Wildlife Collections, Department of Wildlife and Fisheries Sciences, Texas A&M University, 2258 Tamu, College Station, Texas 77843-2258, USA (e-mail: thibbitts@tamu.edu); **TERRY L. HIBBITTS,** 484 CR 396, Camp Wood, Texas 78833, USA; **DANIEL SAENZ**, **CORY ADAMS**, and **JOSH PIERCE** Wildlife Habitat and Silviculture Laboratory, Southern Research Station, USDA Forest Service, Nacogdoches, Texas 75965, USA.

AMBYSTOMA TALPOIDEUM (Mole Salamander). USA: TENNESSEE: Carroll Co.: Milan Army Ammunition Plant (35.9081°N, 88.6947°W). 22 June 2008. Eric Johansen. Verified by A. Floyd Scott. David H. Snyder Museum of Zoology, Austin Peay State University (APSU 18846). Three larvae taken in fishless pond at 0830 h. New county record (Redmond and Scott. 1996. Atlas of Amphibians in Tennessee. Misc. Publ. 12:1–94;The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Hard copy and Internet [http://www.apsu.edu/amatlas/] versions, the latter accessed 02 June 2008).

Submitted by **ERIC PAUL JOHANSEN**, Department of Biology and Center of Excellence for Field Biology, Austin Peay State University, Clarksville, Tennessee 37044, USA; e-mail: ejohansen14@apsu.edu.

EURYCEA CHAMBERLAINI (Chamberlain's Dwarf Salamander). USA: ALABAMA: Bullock Co.: Collected crossing Bullock County Rd. 35 (32.121311°N, 85.566736°W; WGS 84). 29 December 2007. S. Graham and S. Hoss. Verified by Craig Guyer. AUM 37614. Clarke Co.: Fred T. Stimpson Nature Sanctuary. In sphagnum seep draining into bay swamp tributary of Salt Creek (31.607766°N, 87.9637951°W; WGS 84). 1 February 2008. G. Sorrell and C. Raimond. Verified by Craig Guyer. AUM 37648–37649. Conecuh Co.: Collected crossing Conecuh County Rd. 106 1.9 km E of Conecuh County Rd. 29 intersection (31.707097°N, 96.925850°W; WGS 84). 20 December 2007. S. Hoss. Verified by Craig Guyer. AUM 37600. Lee Co.: Keisel Park (Lee County Rd. 51). Across nature trail from small pond (32.585351°N, 85.544435°W; WGS 84). 23 September 2008. A. Dunn. Verified by Craig Guyer. AUM 37825. Lowndes Co.: Collected crossing Lowndes County Rd. 40 (32.331481°N, 86.652537°W; WGS 84). 18 November 2007. S. Graham and K. Gray. Verified by Craig Guyer. AUM 37591–37594. Macon Co.: Tuskegee National Forest. Collected along edge of pond near intersection of Forest Service Rd. 906 and 900 (32.485284°N, 85.607894°W; WGS 84). 06 February 2002. R. Birkhead. Verified by Craig Guyer. AUM 35594. These represent the first state records of *Eurycea chamberlaini* in Alabama. Their presence in these counties suggests a fairly widespread distribution in Alabama from the Fall Line Sandhills to the Red Hills physiographic regions and a contiguous distribution from nearby populations in Georgia (Means 2008. *In* J. Jensen et al. [eds.], Amphibians and Reptiles of Georgia. University of Georgia Press, Athens and London. 595 pp.). Older range maps (Mount 1975. Amphibians and Reptiles of Alabama. Auburn University Agricultural Experiment Station, Auburn, Alabama. 347 pp.) illustrate a similar range for *E. quadridigitata* and were no doubt based on collections of both *E. quadridigitata* and *E. chamberlaini*. However, after our recent, extensive explorations of the Alabama Coastal Plain, we have only found *Eurycea quadridigitata* (*sensu stricto*) in extreme southeasternmost Alabama (Houston County). We have also found other forms of the *E. quadridigitata* complex (of uncertain taxonomic assignment) in Covington, Escambia, and Baldwin counties; identity of this form awaits detailed phylogenetic and systematic analyses which are currently underway (Means 2008, *op. cit.*).

GGS thanks J. Grand, A. Silvano, F. Pringle, and C. Nettles for logistical support. SPG thanks A. Dunn for collecting salamanders for this note and C. Guyer for verifying these records. These collection trips were supported in part by an ALDCNR SWG to J. Grand, and by NIH grant R01-A149724 to T. Unnasch, under ALDCNR Permit 4268.

Submitted by **SEAN P. GRAHAM, GEOFFREY G. SORRELL, ROGER D. BIRKHEAD, SHANNON K. HOSS,** Department of Biological Sciences, Auburn University, 331 Funchess Hall, Auburn University, Alabama 36849, USA (e-mail: grahasp@auburn.edu); and **COREY RAIMOND** (e-mail: corey.raimond@gmail.com).

GYRINOPHILUS PORPHYRITICUS (Spring Salamander). USA: GEORGIA: Meriwether Co.: F. D. Roosevelt State Park. Captured in seepage at the headwaters of Sparks Creek along the Pine Mountain Trail (32.861189°N, 84.727916°W; WGS 84). 21 November 2007. S. Graham. Verified by Craig Guyer. AHAP-D 90. New county record.

Submitted by **SEAN P. GRAHAM**, Auburn University Department of Biological Sciences, 331 Funchess Hall, Auburn University, Alabama 36849 USA; e-mail: grahasp@auburn.edu.

NECTURUS MACULOSUS (Mudpuppy) USA: INDIANA: Parke Co.: 39.89840ºN, 87.23302ºW. 18 September 2001. John O. Whitaker, Jr, and Vertebrate Zoology Class. ISUVC 4036. Verified by Dale W. Sparks. New county record (Minton 2001. Amphibians and Reptiles of Indiana. Second Ed. Indiana Acad. Sci. 404 pp.)

Submitted **by B. JAGGER FOSTER**, Indiana State University, Biology Department, 600 North 6th St. Terre Haute, Indiana 47809-1905, USA.

NECTURUS MACULOSUS (Mudpuppy). USA: MINNESOTA: Dodge Co.: Salem Creek upstream from County Road 13 crossing (92.7367630°W, 43.9624329°N; NAD 83). 29 May 2008. Philip A. Cochran and Jacob D. Zanon. James Ford Bell Museum (JFBM P-266). Verified by Kenneth H. Kozak. Single specimen captured by electrofishing in area of fractured slab bedrock; no other specimens were observed during three previous samples at this location and two other sites on Salem Creek during 2008. First county record (Oldfield and Moriarty 1994. Amphibians & Reptiles Native to Minnesota. University of Minnesota Press, Minneapolis, Minnesota. 237 pp.).

Submitted by **PHILIP A. COCHRAN** (e-mail: pcochran@smumn.edu) and **JACOB ZANON,** Biology Department, Saint Mary's University of Minnesota, 700 Terrace Heights, Winona, Minnesota 55987, USA (e-mail: jdzano05@smumn.edu).

NOTOPHTHALMUS VIRIDESCENS (Eastern Newt). USA: TENNESSEE: Carroll Co.: Milan Army Ammunition Plant (35.8403°N, 88.6761°W). 09 November 2007. Eric Johansen and Nathan Parker. Verified by A. Floyd Scott. David H. Snyder Museum of Zoology, Austin Peay State University (APSU 18819). One gilled female adult taken in fishless pond at 1120 h. New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Hard copy and Internet [http://www.apsu.edu/amatlas/] versions, the latter accessed 2 June 2008).

Submitted by **ERIC PAUL JOHANSEN** (e-mail: ejohansen14@apsu.edu) and **NATHAN LEIGH PARKER**, Department of Biology and Center of Excellence for Field Biology, Austin Peay State University, Clarksville, Tennessee 37044, USA.

PSEUDOTRITON MONTANUS (Mud Salamander). USA. TENNESSEE: Hawkins Co.: Near Stone Mountain School (36.43603°N, 83.11426°W). 28 April 2007. Justin Crisp and John E. Copeland. Verified by A. Floyd Scott. David H. Snyder Museum of Zoology, Austin Peay State University (APSU 18598). One specimen caught within leaf litter of ephemeral stream. First record for Hawkins County. (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. 12:1–94;The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Hard copy and Internet [http://www.apsu.edu/amatlas/] versions).

Submitted by **JOHN E. COPELAND** (e-mail: john.copeland@lmunet.edu) and **JUSTIN CRISP**, Department of Mathematics and Natural Sciences, Lincoln Memorial University, Harrogate, Tennessee 37752, USA.

SIREN INTERMEDIA (Lesser Siren). USA: TEXAS: San Augustine Co.: 2.3 air km S and 4.7 air km W Jct TX 103 and TX 147, Angelina National Forest compartment 13 (31.37253226ºN, 94.24970428ºW). 29 June 2007. Toby J. Hibbitts. Verified by James R. Dixon. Texas Cooperative Wildlife Collections, TCWC 92440. USA: TEXAS: Trinity Co.: 0.5 air km N and 2.3 air km W Jct FM 2262 and FM 357 south, Davy Crockett National Forest compartment 114 (31.14958055˚N, 94.90181944˚W). 20 April 2007. David Laurencio. Verified by James R. Dixon. Texas Cooperative Wildlife Collections, TCWC 91992–93. New county records (Dixon 2000. Amphibians and Reptiles of Texas. Second Ed. Univ. of Texas A&M Press, viii + 421 pp.).

Submitted by **TOBY J. HIBBITTS (**e-mail: thibbitts@tamu.edu) and **DAVID LAURENCIO,** Texas Cooperative Wildlife Collections, Department of Wildlife and Fisheries Sciences, Texas A&M University, 2258 Tamu, College Station, Texas 77843-2258, USA; **DANIEL SAENZ**, **CORY ADAMS**, and **JOSH PIERCE** Wildlife Habitat and Silviculture Laboratory, Southern Research Station, USDA Forest Service, Nacogdoches, Texas 75965, USA.

ANURA – FROGS

ACRIS CREPITANS (Northern Cricket Frog). USA: MINNESOTA: Winona Co.: Prairie Island Park at spillway of Mississippi River 5A dam (44.0789909°N, 91.6828156°W; NAD 83). 26 August 2008. Philip A. Cochran. James Ford Bell Museum (JFBM P-292-293). Verified by Kenneth H. Kozak. Multiple specimens observed along shoreline both upstream (Pool 5A) and downstream (Pool 6) of spillway. I first observed this species here on 18 September 2006, and I have heard calling males along a backwater channel across Straight Slough from this spot. Another population was located 2.4 km away (JFBM P-294-295). The recovery of a Cottonmouth (*Agkistrodon picivorus*) in this vicinity from a barge originally loaded in Louisiana (Cochran 2008. Northeast. Nat. 15:461–464) suggests the possibility that *Acris crepitans* might also have been transported north. Recent summaries of geographic distribution do not include Winona Co. (Gray et al. 2005. *In* M. J. Lannoo [ed.], Amphibian Declines: The Conservation Status of United States Species, pp. 441–443. Univ. California Press, Berkeley). Although some natural resource agency personnel are aware of Northern Cricket Frogs in the Winona area and their occurrence was mentioned in a newspaper article (Dankert 2006. *Winona Daily News*, Nov. 9, p. 1A), it is not clear that the species has been formally documented or that its geographic extent within the county has been assessed.

Submitted by **PHILIP A. COCHRAN,** Biology Department, Saint Mary's University of Minnesota, 700 Terrace Heights, Winona, Minnesota 55987, USA; e-mail: pcochran@smumn.edu.

ANAXYRUS FOWLERI (Fowler's Toad). USA: TENNESSEE: Campbell Co.: Norris Dam State Park (36.24461°N, 84.12098°W). 15 May 2006. John E. Copeland. Verified by A. Floyd Scott. David H. Snyder Museum of Zoology, Austin Peay State University (APSU 18596). One specimen caught on Rock Creek Trail. First record for Campbell County. (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp.).

Submitted by **JOHN E. COPELAND** Department of Mathematics and Natural Sciences, Lincoln Memorial University, Harrogate, Tennessee 37752, USA; e-mail: john.copeland@lmunet.edu.

DUTTAPHRYNUS MELANOSTICTUS (Common Asian Toad). BRUNEI DARUSSALAM: BRUNEI MUARA DISTRICT: Bandar Seri Begawan, Jalan Muara (04.95ºN, 14.9666667ºE); 16 December 2006. J. K. Charles and I. Das. From grassy edge of ditch in an urbanized area. Brunei Museum (BM 2006.23). First report for Brunei Darussalam (Das 2007. A Pocket Guide. Amphibians and Reptiles of Brunei. Natural History Publications [Borneo] Sdn Bhd. Kota Kinabalu. viii + 200 pp.), and previously known from Sabah, Sarawak, and Kalimantan, and other parts of South and Southeast Asia (Inger and Tan 1996. Raffles Bull. Zool. 44:551–574.). We thank Awang Mahdi bin Abdullah, Brunei Museum, for curatorial assistance.

Submitted by **JOSEPH K. CHARLES**, Department of Biology, Universiti Brunei Darussalam, Jalan Tunku Link, Gadong, Bandar Seri Begawan 2028, Brunei Darussalam (e-mail: jcharles@fos.ubd.edu.bn); and **INDRANEIL DAS,** Institute of Biodiversity and Environmental Conservation, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia (e-mail: idas@ibec.unimas.my).

ELEUTHERODACTYLUS (=SYRRHOPHUS) CYSTIGNATHOIDES CAMPI (Rio Grande Chirping Frog). USA: TEXAS: Bee Co.: Intersection of State Highway 181 and State Highway 59 on the outskirts of Beeville (29.09114°N, 97.29095°W). 28 June 2008. Romey Swanson, Vincent Farallo, Jeff Troy, and Glen Hood. Verified by James R. Dixon, Texas Cooperative Wildlife Collection (TCWC 93074). A single adult was found and captured by hand under a piece of plywood near a drainage ditch running parallel with the east bound frontage of Highway 59. New county record (Dixon 2000. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Publ. Texas A&M University Press. 421 pp.).

Submitted by **ROMEY L. SWANSON (**e-mail: rs56761@txstate.edu), **VINCENT R. FARALLO**, **JEFF R. TROY**, **GLEN R. HOOD**, and **MICHAEL R. J. FORSTNER**, Department of Biology, Texas State University, San Marcos, Texas 78666, USA.

HYLA ARENICOLOR (Canyon Treefrog). USA: NEW MEXICO: San Miguel Co.: along Gallinas River above Montezuma; ca. 122 m upstream of USGS gauging station; 2095 m elev; 35.6519ºN; 105.3183ºW; datum NAD 27. 10 June 2003. Chris Cudia. Verified by Tomas Giermakowski. University of New Mexico Museum of Southwestern Biology (MSB 71908). New county record and the first specimen of this species from the Pecos River drainage in New Mexico (Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. Univ. New Mexico Press, Albuquerque. 431 pp.).

Submitted by **CHRIS CUDIA**, 1031 6th Street, Las Vegas, New Mexico 87701, USA (e-mail: chris-cudia@nmenv.state.nm.us); and **CHARLES W. PAINTER**, Endangered Species Program, New Mexico Department of Game and Fish, 1 Wildlife Way, Santa Fe, New Mexico 87507, USA (e-mail: charles.painter@state.nm.us).

HYLA VERSICOLOR / CHRYSOSCELIS **SIBLING SPECIES COMPLEX** (Gray Treefrog / Cope's Gray Treefrog). USA: TENNESSEE: Anderson Co.: 324 Bland Road, Clinton (36.14701°N, 84.10603°W). 12 June 2006. John E. Copeland. Verified by A. Floyd Scott. David H. Snyder Museum of Zoology, Austin Peay State University (APSU 18596). One specimen caught on trunk of a tree. First record for Anderson Co. (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp.).

Submitted by **JOHN E. COPELAND** Department of Mathematics and Natural Sciences, Lincoln Memorial University, Harrogate, Tennessee 37752, USA; e-mail: john.copeland@lmunet.edu.

HYLA VERSICOLOR (Gray Treefrog). USA: WISCONSIN: Jefferson Co.: Watertown (43.18094506°N, 88.71355654°W; NAD83, Garmin III Plus). 12 July 2008. Collected by JMK and JJK. Verified by Christopher Phillips, INHS 2008.g (MPEG video clip of calling males). Numerous males heard calling in ornamental shrubs near a commercial property. New county record, filling gap in Wisconsin distribution (Casper 1996. Geographic Distributions of the Amphibians and Reptiles of Wisconsin. Milwaukee Public Museum, 87 pp.). JMK also heard calling males in a wetland ca. 0.4 km SW of this location in June 2008. A prior specimen record (MPM 16168) cataloged as "*Hyla verisicolor* complex," collected 21 May 1974 by B. Dudiak at Koshkonong, T5N R13E, could be *H. chrysoscelis*.

Submitted by **JOSHUA M. KAPFER**, Natural Resources Consulting, Inc., 209 Commerce Parkway, PO Box 128, Cottage Grove, Wisconsin 53527, USA; **GARY S. CASPER**, University of Wisconsin-Milwaukee Field Station, 3095 Blue Goose Rd, Saukville, Wisconsin 53080, USA; and **JENNIFER J. KAPFER**, 512 S. 10th St., Watertown, Wisconsin 53094, USA.

GASTROPHRYNE CAROLINENSIS (Eastern Narrow-mouthed Toad). USA: ALABAMA: Chilton Co.: 6.3 km S of CR 25 on CR 73 (33.01960°N, 87.52418°W; WGS84). 01 October 2007. J. Burling and J. Wicknick. Verified by Joseph R. Mendelson III. University of Montevallo Collection of Vertebrates (UMCV-AA0075). New county record; fills a gap among Shelby, Bibb, and Perry counties and the Coosa River (Mount 1975. The Reptiles and Amphibians of Alabama, The University of Alabama Press, Tuscaloosa. 347 pp.). Alabama Department of Conservation and Natural Resources collecting permit number 4368 (JAW).

Submitted by **JILL A. WICKNICK[1]** and **JOHN W. BURLING[2]**, Departments of Biology[1] and Psychology[2], University of Montevallo, Montevallo, Alabama 35115, USA; e-mail: wicknickja@montevallo.edu.

KALOULA PULCHRA (Painted Bull Frog). BRUNEI DARUSSALAM: BRUNEI MUARA DISTRICT: Bandar Seri Begawan,

Universiti Brunei Darussalam Campus, Gadong (4.9666667ºN, 114.8833333ºE). From a toilet. Collected by J. K. Charles. 10 January 2007. Brunei Museum (BM 2007.01). Verified by Indraneil Das. First record for Brunei Darussalam (see Das 2007. A Pocket Guide. Amphibians and Reptiles of Brunei. Natural History Publications [Borneo] Sdn Bhd. Kota Kinabalu. viii + 200 pp.). Previous Bornean records were from Sabah (Inger and Tan 1996. Raffles Bull. Zool. 44:551–574); the species generally is widespread in Southeast Asia (Inger 1999. *In* W. E. Duellman [ed.], Patterns of Distribution of Amphibians. A Global Perspective, pp. 445–482. The John Hopkins University Press, Baltimore and London). I thank Awang Mahdi bin Abdullah, Brunei Museum, for curatorial assistance.

Submitted by **JOSEPH K. CHARLES**, Department of Biology, Universiti Brunei Darussalam, Gadong, Tungku Link, Bandar Seri Begawan, Brunei Darussalam; e-mail: jcharles@fos.ubd.edu.bn.

LITHOBATES CATESBEIANUS (American Bullfrog). MALAYSIA: JOHOR: Gunung Ledang Recreational Forest (02.34°N, 102.63°E). La Sierra University Herpetological Collection LSUHC 8968. 07 June 2008. Juvenile, SVL 46 mm. Chan K. O., P. L. Wood Jr., and J. L. Grismer. Verified by L. L. Grismer. Currently known from N America, north to Nova Scotia, New Brunswick, S Quebec, and S Ontario (Canada), west to the central plains and south to Veracruz (Mexico); introduced on Cuba, Isla de Juventud (= Isla de Pinos), Puerto Rico, Hispaniola, and Jamaica in the Antilles; Europe, in Netherlands, Bordeaux region of France, Belgium, northern Italy, western Spain; Asia, in Java, Bali, Japan, northern Thailand, Korea, and Taiwan (Lever 2003. Naturalized Reptiles and Amphibians of the World. Oxford University Press, Oxford. 318 pp.). Specimen collected 2010 h from muddy drain by main trail. Another observed on the same night on rock besides main stream. The two juveniles in a natural habitat are suggestive of a local breeding population, and a cause for concern as this invasive species presents a danger to native anurans. Gunung Ledang is situated at least 8 km from the nearest town and is surrounded by oil palm and rubber estates. Because of its isolated location, specimens found are considered naturalized and not escapees from pet or food industry. First report in the wild from Peninsular Malaysia.

Submitted by **CHAN KIN ONN,** Institute for Environment and Development (LESTARI), Universiti Kebangsaan Malaysia, 43600 Bangi, Selangor Darul Ehsan, Malaysia (e-mail: kin_onn@yahoo.com); **PERRY L. WOOD, JR.**, Department of Biology, Villanova University, Villanova, Pennsylvania 19085, USA (e-mail: perry.wood@villanova.edu); and **JESSE L. GRISMER,** Department of Biology, Villanova University, Villanova, Pennsylvania 19085, USA (e-mail: jesse.grismer@villanova.edu).

LITHOBATES CATESBEIANUS (American Bullfrog). MÉXICO: HIDALGO: Municipality of Mineral el Chico, Ejido La Estanzuela (20.1088°N, 98.45255°W, WGS 84), 2734 m elev. 03 November 2007. Christopher Duifhuis Rivera. Verified by Luis Canseco Márquez. Colección Herpetológica del Museo de Zoología Alfonso L. Herrera, UNAM (MZFC-21372). First precise locality for Hidalgo, extending the known range ca. 80.23 km SW from the nearest known records in the Sierra Norte de Puebla (Smith and Smith 1976. Synopsis of the Herpetofauna of Mexico: Source Analysis and Index for Mexican Amphibians, IV. J. Johnson, North Bennington, Vermont. 1–9, A-A 1-G 12 pp.). The species was reported from Hidalgo by Canseco-Marquez et al. (2004. *In* Luna et al. [eds], Biodiversidad de la Sierra Madre Oriental, pp. 417–437. Las Prensas de Ciencias, México, D.F.), but with no specific locality. The specimen was found around the marshy edge of La Estanzuela's municipal water source located in pine forest.

Submitted by **CHRISTOPHER DUIFHUIS RIVERA (**e-mail: christopherduifhuis@gmail.com), **URI OMAR GARCIA VAZQUEZ,** and **GASTÓN ZAMORA HEBREGO**, Museo de Zoología, Facultad de Ciencias, UNAM, A.P. 70-399, México D.F.04510, México.

LITHOBATES CATESBEIANUS (American Bullfrog). USA: NEW MEXICO: Mora Co.: Wind River Ranch, farm pond along the Mora River, ca. 2.5 km N NM Hwy 161, ca. 8 air km NW Watrous, (35.84121°N, 105.05317°W; NAD 27, 1992 m). 15 August 2008. Theresa Lorraine McInnes and Andrea F. Currylow. Verified by J. Tomas Giermakowski. University of New Mexico, Museum of Southwestern Biology (MSB 74454). Specimen represents a new county record and the first record of the species from the Mora River (Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. Univ. New Mexico Press, Albuquerque. 431 pp.). Approximately 30 juvenile and 10 adult *R. catesbeiana* were encountered during the nocturnal survey.

Submitted by **THERESA LORRAINE MCINNES**, 1500 15th Street, Albuquerque, New Mexico 87109, USA; **ANDREA F. CURRYLOW**, 7225 Cristobal Avenue, Atascadero, California 93422, USA; **CHARLES W. PAINTER** and **JAMES N. STUART**, Endangered Species Program, New Mexico Department of Game and Fish, P.O. Box 25112, Santa Fe, New Mexico 87504, USA.

LITHOBATES CATESBEIANUS (American Bullfrog). USA: TENNESSEE: Gibson Co.: Bradford (36.05871ºN, 88.79968ºW; datum WGS 84). 25 April 2008. Joshua M. Hall. Verified by A. Floyd Scott. David H. Snyder Museum of Zoology, Austin Peay State University (APSU 18902 [color photo]). Numerous individuals found calling from a small pond. One adult male photographed and released. New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. 12:1–94; Center for Field Biology, Austin Peay State University, Clarksville, Tennessee; hard copy and Internet [http://www.apsu.edu/amatlas/] versions).

Submitted by **JOSHUA M. HALL**, 4105 Caldwell Drive, Milan, Tennessee 38358, USA.

LITHOBATES SPHENOCEPHALUS (Southern Leopard Frog). USA: TENNESSEE: Gibson Co: Milan (35.87669º N, 88.76290ºW: datum WGS 84). 22 July 2008. Joshua M. Hall. Verified by A. Floyd Scott. Austin Peay State University's David H. Snyder Museum of Zoology (APSU 18930 [color photo]). Numerous individuals found at edge of a small pond. One adult specimen photographed and released. New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. 12:1–94; Center for Field Biology, Austin Peay State University, Clarksville, Tennessee; hard copy and Internet [http://www.apsu.edu/amatlas/] versions).

Submitted by **JOSHUA M. HALL**, 4105 Caldwell Drive, Milan, Tennessee 38358, USA.

OLLOTIS (=BUFO) NEBULIFER (Gulf Coast Toad). USA: TEXAS: San Augustine Co.: 4.5 air km N, 1.0 air km jct TX 103 and TX 147, Angelina National Forest compartment 13 (31.43484098°N, 94.19057968°W). 29 June 2007. Toby J. Hibbitts. Verified by James R. Dixon. Texas Cooperative Wildlife Collections, TCWC 92441. New county record (Dixon 2000. Amphibians and Reptiles of Texas. Second Ed. Univ. of Texas A&M Press, viii + 421 pp.).

Submitted by **TOBY J. HIBBITTS,** Texas Cooperative Wildlife Collections, Department of Wildlife and Fisheries Sciences, Texas A&M University, 2258 Tamu, College Station, Texas 77843-2258, USA (e-mail: thibbitts@tamu.edu); **DANIEL SAENZ**, **CORY ADAMS**, and **JOSH PIERCE,** Wildlife Habitat and Silviculture Laboratory, Southern Research Station, USDA Forest Service, Nacogdoches, Texas 75965, USA.

OSTEOPILUS SEPTENTRIONALIS (Cuban Treefrog). USA: FLORIDA: Clay Co.: Orange Park, 2884 Golden Pond Boulevard (30.18358°N, 81.78956°W; WGS84). 15 March 2008. Kenneth Beyerly. Florida Museum of Natural History, University of Florida (UF 152919). Adult female. New county record. In their map of Cuban Treefrog distribution in Florida, Meshaka et al. (2004. The Exotic Amphibians and Reptiles of Florida. Krieger Publ. Co., Malabar, Florida. 155 pp.) show a record from Clay Co. and cite Meshaka (1996. Herpetol. Rev. 27:37–40), who does not mention this county. A search of museum databases failed to find any specimens from this county. Franklin Co.: Carrabelle, 312 East Meridian Avenue (29.8518ºN, 81.661ºW). 5 July 2006. Rod Fasche. UF 151399. New county record and only the third voucher from the panhandle (Johnson 2004. Herpetol. Rev. 35:405; Krysko et al. 2005. Herpetol. Rev. 36:85–87). Lake Co.: Fruitland, U.S. Highway 441, 1.6 km S of Lake Griffin State Park (28.8440ºN, 81.8975ºW). 28 June 2005. John W. Strawbridge. UF 152458. New county record. Pasco Co.: New Port Richey, 5824 Baker Road (28.2440ºN, 82.6995ºW). 14 October 2002. David DeWitt. UF 134614–15. New county record. Putnam Co.: Hastings, County Road 13, 0.6 km S of State Road 207 (29.7085ºN, 81.5082ºW). 11 April 2006. John R. Rossi. UF 146299–300. Found in leaf of palm tree. New county record. Sumter Co.: Lake Panasoffkee, 2095 County Road 416N (28.7862ºN, 82.1454ºW). 28 May 2008. Nancy Dwyer. UF 152955–56. Found on house. New county record. Identification of all UF specimens was verified by Max A. Nickerson. *Osteopilus septentrionalis* has now been documented from 40 of 51 counties in peninsular Florida. It has not been reported yet from Baker, Bradford, Dixie, Gilchrist, Hamilton, Lafayette, Madison, Nassau, Suwannee, Taylor, and Union counties, all of which are located in the northern peninsula and have relatively low human population densities. Human-mediated dispersal of this species has been rapid and discontinuous via transport on cultivated palm trees, ornamental plants, vehicles, and trailers (Meshaka 1996, *op. cit.*). According to Meshaka (1996, *op. cit.*), *O. septentrionalis* was recorded from most counties in the southern two-thirds of the peninsula; since then, it has been recorded from 13 counties in the northern one-third of the peninsula and three of 16 counties in the panhandle. Reproducing populations are known to be present in Alachua, Levy, and Duval counties in the northern peninsula.

Submitted by **KEVIN M. ENGE**, Florida Fish and Wildlife Conservation Commission, 1105 SW Williston Road, Gainesville, Florida 32601, USA (e-mail: kevin.enge@myfwc.com); **STEVEN A. JOHNSON**, Department of Wildlife Ecology and Conservation and Gulf Coast Research and Education Center, University of Florida — IFAS Plant City Campus, 1200 North Park Road, Plant City, Florida 33563, USA (e-mail: tadpole@ufl.edu); and **KENNETH L. KRYSKO**, Florida Museum of Natural History, Division of Herpetology, University of Florida, Gainesville, Florida 32611, USA; e-mail: kenneyk@flmnh.ufl.edu.

SCAPHIOPUS HOLBROOKII (Eastern Spadefoot). USA: INDIANA: Parke Co.: 39.68113ºN, 87.37843ºW. 05 July 2008. Tim Thomas, Kelly Thomas, and B. Jagger Foster. ISUVC 4113. Verified by John Crawford. New county record (Minton 2001. Amphibians and Reptiles of Indiana. Second Ed. Indiana Acad. Sci. 404 pp.)

Submitted **by B. JAGGER FOSTER**, Indiana State University, Biology Department, 600 North 6th St., Terre Haute, Indiana 47809-1905, USA.

GYMNOPHIONA — CAECILIANS

DERMOPHIS OAXACAE (Oaxacan Caecilian). MÉXICO: MICHOACÁN: Municipality of Aquila: Federal Road 120, 2.5 km NE Aquila (18.5996°N,103.486°W; WGS84), 406 m elev. 18 July 2005. Jacobo Reyes-Velasco, Tim Burkhardt, and Jason Jones. UTA Digital Collection (UTADC 1016). Verified by Marvalee H. Wake. Second record for the state of Michoacán, filling a gap in the distribution of the species between Autlán, Jalisco (160 km NW) and Zitacuaro, Michoacán (320 km NE) (Wake 1998. Cat. Amer. Amph. Rept. 661:1–2).

Submitted by **JACOBO REYES-VELASCO**, Centro Universitario de Ciencias Biológicas y Agropecuarias, Carretera a Nogales Km. 15.5. Las Agujas, Nextipac, Zapopan, Jalisco, México (e-mail: jackobz@gmail.com); **TIM BURKHARDT**, 2941 Benton St. Wheat Ridge, Colorado 80214, USA (e-mail: triprionco@aim.com); and **JASON M. JONES**, 16310 Avenida Florencia, Poway, California 92064, USA (e-mail: jjones@switaki.com).

CROCODILIA – CROCODILIANS

CAIMAN CROCODILUS (Common Caiman). BRAZIL: CEARÁ: Crateús Municipality: District of Ibiapaba, Poty River (5.048579°S, 40.912588°W; WGS84). 24 April 2003. D. M. Borges-Nojosa. Collection of Herpetology of Núcleo Regional de Ofiologia (NUROF) - Universidade Federal do Ceará, Fortaleza, Brazil (CHUFC C044, adult, skin and bones). Verified by L. M. Verdade. Other specimen was observed walking on the road (5.116674°S, 40.804554°W; WGS84) between the local lagoons, showing the same habit registered by Olmos and Souza 1991 (Herpetol. Rev. 22:28–29). The species was previously known from Colombia, Peru, Bolivia, and in the Brazilian states of Amazonas, Pará, Maranhão, Mato Grosso, and Piaui (at Serra da Capivara National Park and basin river Parnaíba) (Carvalho 1951. Arquivos do Museu Nacional, XLII:127–152; King and Burke 1989. Crocodilian, Tuatara, and Turtle Species of the World. Association of Systematics Collections, Washington. 216 pp.). First state record; extends known distribution ca. 400 km airline NE of previously known range within Serra da Capivara National Park

(Arruda 1997. Conservação, Ecologia Humana e Sustentabilidade na Caatinga: Estudo da Região do Parque Nacional da Serra da Capivara - PI. IBAMA, Brasília. 96 pp.), and ca. 440 km airline from Lagoa do Muqueri (8.406687°S, 42.369043°W; WGS84), and Fazenda Veneza (8.751346°S, 42.265451°W; WGS84) (Olmos and Souza, *op. cit.*).

Submitted by **DIVA MARIA BORGES-NOJOSA**, Universidade Federal do Ceará, NUROF-UFC, Campus do Pici, Bloco 905, 60455-760, Fortaleza, Ceará, Brazil (e-mail: dmbnojosa@yahoo.com.br); and **DANIEL CASSIANO LIMA**, Universidade Estadual do Ceará, Av Mons. Tabosa s/n, 62500-000, Itapipoca, Ceará, Brazil (e-mail: dancassiano@yahoo.com.br).

TESTUDINES – TURTLES

CARETTA CARETTA (Loggerhead Sea Turtle). TRISTAN DA CUNHA: near Edinburgh (37.04°S, 12.18°W), 6 May 2008. Verified by Bruce L. Wing, Curator, Reference Collections, NMFS Auke Bay Marine Station, Juneau, Alaska. Photographs and correspondence archived (AB 2008-0025) in herpetological collections of NMFS Auke Bay Marine Station. Edinburgh is on the north shore of Tristan da Cunha, ca. 4000 km E of South America, 2700 km W of South Africa, and 1100 ± km N of Antarctic Convergence. Juvenile female washed ashore on rocky coastline during a storm, tangled in discarded fishing net. Turtle had minor injuries as a result of struggle with netting and rocks, but was alert, vigorous, and apparently healthy. Released in waters off a sandy beach. First record from Tristan da Cunha.

Submitted by **ROBERT PARKER HODGE**, ME2, POB 1521, Gig Harbor, Washington 98335, USA; and **ERIK MACKENZIE**, Edinburgh, Tristan da Cunha.

DERMOCHELYS CORIACEA (Leatherback Sea Turtle). TRISTAN DA CUNHA: Nightingale Island (37.24°S, 12.29°W), March 1979. Verified by Denise Hamerton, Natural History Collection Manager, Iziko Museum: SA Museum. Nightingale Island is 38 km SSW of Tristan da Cunha, which is ca. 4000 km E of South America, 2700 km W of South Africa, and 1100 ± km N of Antarctic Convergence. Adult male, accessioned as SAM ZR 44953 on 24 February 1982 at Iziko Museum: South Africa Museum, Cape Town. First record from Tristan da Cunha.

Submitted by **ROBERT PARKER HODGE**, ME2, POB 1521, Gig Harbor, Washington 98335, USA; and **ERIK MACKENZIE**, Edinburgh, Tristan da Cunha.

GOPHERUS BERLANDIERI (Texas Tortoise). USA: TEXAS: ARANSAS CO.: Aransas National Wildlife Refuge (28.309478ºN, 96.803242ºW). 20 November 2007. Russell Jackson. Voucher images were taken by Darrin Welchert. Verified by Jonathan Campbell. Amphibian and Reptile Diversity Research Center UTADC 1974–1980. New county record (Dixon 2000. Amphibians and Reptiles of Texas, 2nd Edition. Texas A&M Univ. Press, College Station, Texas. 421 pp.). The captured adult male presented a heavy keratinous fungal infection on the marginal and costal scutes of the carapace, and the entire plastron. The specimen was marked and released in the Aransas National Wildlife Refuge.

Submitted by **AKIKO FUJII**, Department of Biology, Texas State University, San Marcos, Texas 78666, USA (e-mail: af@txstate.edu); **DARRIN WELCHERT**, Aransas National Wildlife Refuge, Victoria, Texas 77904, USA (e-mail: darrin_welchert@fws.gov); and **MICHAEL R. J. FORSTNER**, Department of Biology, Texas State University, San Marcos, Texas 78666, USA (e-mail: mf@txstate.edu).

GRAPTEMYS PSEUDOGEOGRAPHICA KOHNII (Mississippi Map Turtle). USA: TEXAS: MILAM CO.: Hatchling captured in the Little River (30.84188°N, 96.71916°W; NAD 83). 11 July 2008. James R. Dixon. Verified by Toby Hibbitts. Trapping conducted for the Texas Parks and Wildlife Department freshwater turtle assessment (Permit No. SPR-0102-191). Specimen deposited in the Texas Cooperative Wildlife Collection (TCWC 93025) at Texas A&M University College Station. New county record (Dixon 2000. Amphibians and Reptiles of Texas. 2nd Edition. Texas A&M Univ. Press, College Station. 421 pp.).

Submitted by **DONALD J. BROWN** and **MICHAEL R.J. FORSTNER**, Department of Biology, Texas State University – San Marcos, San Marcos, Texas 78666, USA; and **JAMES R. DIXON**, Department of Wildlife and Fisheries Sciences, Texas A&M University, College Station, Texas 77843, USA.

MACROCHELYS TEMMINCKII (Alligator Snapping Turtle). USA: TENNESSEE: HAMILTON CO.: Collegedale, Spalding Road, Wolftever Creek (35.0316°N, 85.0313°W). 03 June 2003. David B. Ekkens. Verified by A. Floyd Scott. Austin Peay State University photo archive, APSU 17486. New county record. Female turtle, exhibiting 8 annuli. Turtle trapped in a downstream-facing 0.94-m hoop trap baited with sardines. Paul Moler, Florida Fish & Wildlife Conservation Commission, performed analysis of the mitochondrial DNA from a tail-clipped tissue sample. The results showed that the turtle belonged to Haplotype A, commonly found in the Tennessee River system. Therefore, it is not clear if this animal is a natural occurrence or one that has been translocated, given that the nearest record on the Tennessee River is 550 river km from the present location.

Submitted by **DAVID B. EKKENS**, Biology Department, Southern Adventist University, Collegedale, Tennessee 37315, USA (e-mail: dekkens@southern.edu); and **DAVID COLLINS**, Curator of Forests, Tennessee Aquarium, Chattanooga, Tennessee 37401, USA (e-mail: dec@tennis.org).

PSEUDEMYS NELSONI (Florida Red-bellied Cooter). USA: FLORIDA: BRADFORD CO.: Starke, SR 16, 1.6 km W Clay County line (29.95483°N, 82.06454°W). 13 March 2008. J. M. Butler. Verified by M. A. Nickerson. UF 152531. Sub-adult male found DOR. A second specimen UF 153667 was found DOR on 30 August 2008. New county record (Jackson 2006. *In* P. A. Meylan [ed.], Biology and Conservation of Florida Turtles, pp. 313–324. Chelonian Research Monographs No. 3.

Submitted by **BENJAMIN K. ATKINSON** (e-mail: bka@ufl.edu) and **J. MICHAEL BUTLER**, Department of Herpetology, Florida Museum of Natural History, University of Florida, Gainesville, Florida 32611, USA.

TERRAPENE ORNATA (Ornate Box Turtle). USA: ILLINOIS: SCOTT CO.: 7.4 km WSW of Winchester, and 8.9 km WNW of Alsey, crossing 700E (Hillview Road), 0.08 km S of jct with 500N (Lashmett Road) (39.59365ºN, 90.52889ºW). 01 June 2008. Veri-

fied by Chris Phillips, Illinois Natural History Survey. Photographic voucher INHS 2008.13. New county record (Phillips 1999. Field Guide to Amphibians and Reptiles of Illinois. Illinois Natural History Survey Manual 8:xv, 1–282). Adult female collected by John K. Tucker. Turtle was returned alive to collecting locality after tissue sample was obtained.

Submitted by **JOHN K. TUCKER,** Illinois Natural History Survey, 8450 Montclair Ave, Brighton, Illinois 62012, USA; **CHAD R. DOLAN,** Iowa Department of Natural Resources, Lake Darling Station, 110 Lake Darling Road, Brighton, Iowa 52540, USA; and **JAMES T. LAMER,** Western Illinois University, 1 University Circle, Macomb, Illinois 61455, USA.

TRACHEMYS SCRIPTA TROOSTII (Cumberland Slider). USA: NORTH CAROLINA: Madison Co.: 7.1 km NW Hot Springs, French Broad River near Huff Island (35.933477°N, 82.886194°W, WGS84). 07–08 August 2008. Jeffrey C. Beane, Robert A. Davis, and L. Todd Pusser. Two juveniles taken in hoop-style turtle trap baited with sardines. Verified by William M. Palmer. North Carolina State Museum of Natural Sciences (NCSM 74447–74448). A third subadult was observed basking in the French Broad River at 4.8 km NW Hot Springs (35.924467°N, 82.86235°W, WGS84) on 08 August 2008. New county records and first confirmed records for North Carolina (Palmer and Braswell 1995. Reptiles of North Carolina. University of North Carolina Press, Chapel Hill. 412 pp.). Extends range ca. 50 km SE of nearest records in Tennessee (Iverson 1992. A Revised Checklist with Distribution Maps of Turtles of the World. Privately published, Richmond, Indiana. xiii + 363 pp.).

Submitted by **JEFFREY C. BEANE**, North Carolina State Museum of Natural Sciences, Research Laboratory, MSC# 1626, Raleigh, North Carolina 27699-1626, USA (e-mail: jeff.beane@ncmail.net); **ROBERT A. DAVIS**, 413 West Aycock Street, Raleigh, North Carolina 27608, USA (e-mail: radavis413@msn.com); and **L. TODD PUSSER**, P.O. Box 122, West End, North Carolina 27376, USA (e-mail: tpusser@nc.rr.com).

SQUAMATA – LIZARDS

AGAMA AGAMA AFRICANA *(*African Rainbow Lizard*)*. USA: FLORIDA: Hillsborough Co.: Apollo Beach: NE corner U.S. 41 and county road 672 (27.793155°N, 82.383603°W; WGS84). 26 December 2007. J. Steve Godley. Verified by Kenneth L. Krysko, Florida Museum of Natural History (FLMNH), Gainesville, Florida (UF 152540, color photo; USNM 565101, specimen). New county record (Enge et al. 2004; Florida Sci. 67:303–310). Population of 12–15 individuals first detected at 7-11 store on road corner noted above. On this same day one adult female and three juveniles observed at an abandoned building 180 m to the N and ca. 30 observed 365 m to the NE at the 2.0-ha compound of Segrest Farms #1 (complete search not possible), all within NE quadrant of road intersection. A follow-up survey on 06 June 2008 showed similar numbers of active agamas at the 7-11 store and Segrest; the abandoned building had been removed with none observed. Three adult males, two females, and two juveniles also seen from outside the south fence of a Cemex Ready-Mix plant 200 m E of Segrest. Searches of other likely edificarian sites within 1.6 km of this intersection failed to detect the species on either day. Both sexes and multiple size classes observed at 7-11 store, Segrest Farms, and Cemex plant suggests an established, breeding population that may total 100 adults. The owner of Segrest Farms (Jack Brandon, pers. comm.), an exotic fish and reptile dealer, acknowledged they had sold *A. a. agama* up to 3–4 years ago, and despite multiple security fences "some may have escaped." Additional Hillsborough County populations are catalogued in the Florida Museum of Natural History (FLMNH UF 152788 and 153456–153457, photo vouchers; UF 153458, specimen)..

Submitted by **TODD S. CAMPBELL**, Department of Biology, University of Tampa, 401 W. Kennedy Blvd., Tampa, Florida 33606, USA (e-mail: tcampbell@ut.edu); **STEVE GODLEY**, Biological Research Associates, a Division of Entrix, Inc., 3905 Crescent Park Drive, Riverview, Florida 33578, USA; **DAVID SANDMANN**, Department of Information Technology, University of Tampa, 401 W. Kennedy Blvd., Tampa, Florida 33606, USA; and **JEREMY HOROWITZ**, Department of Biology, University of Tampa, 401 W. Kennedy Blvd., Tampa, Florida 33606, USA.

ANOLIS CAROLINENSIS (Green Anole). USA: TEXAS: DeWitt Co.: State Highway 183 in the town of Cuero (29.09114°N, 97.29095°W; WGS84). 28 June 2008. Romey Swanson, Vincent Farallo, Jeff Troy, and Glen Hood. Verified by James R. Dixon, Texas Cooperative Wildlife Collection (TCWC 93071). A single adult was found and captured by hand on the sidewalk of the town square. This individual represents the first recorded occurrence of this species in DeWitt County (Dixon 2000. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Publ. Texas A&M University Press. 421 pp.).

Submited by **ROMEY L. SWANSON** , **VINCENT R. FARALLO**, **JEFF R. TROY**, **GLEN R. HOOD**, and **MICHAEL R. J. FORSTNER**, Department of Biology, Texas State University, San Marcos Texas 78666, USA (e-mail: rs56761@txstate.edu).

BASILISCUS VITTATUS (Brown Basilisk). USA: FLORIDA: Hendry Co.: Clewiston, 0.5 km SE of Evercane Road on Old U.S. Highway 27 (26.7449°N, 80.8979°W; WGS84). 17 May 2008. Tom Crutchfield. Florida Museum of Natural History, University of Florida (UF 152897). Juvenile collected along canal on S side of road; all age classes observed. Verified by Kenneth L. Krysko. New county record and extends range 59 km W of nearest known population in Palm Beach Co. (Krysko et al. 2005. Herpetol. Rev. 36:85–87).

Submitted by **TOM E. CRUTCHFIELD**, 4681 SW 33rd Avenue, Fort Lauderdale, Florida 33312, USA (e-mail: tomcrutchfield@hotmail.com); and **KEVIN M. ENGE**, Florida Fish and Wildlife Conservation Commission, 1105 SW Williston Road, Gainesville, Florida 32601, USA (e-mail: kevin.enge@myfwc.com).

HEMIDACTYLUS FRENATUS (Common House Gecko). VANUATU: MALEKULA: Nabelchel Bungalows, Norsup (16.073679ºS, 167.398024ºE). Philip de Pous. Verified by Wouter Beukema. Specimen (http://calphotos.berkeley.edu, digital image voucher 0000 0000 0908 0035) found on wall of dining room on 29 July 2007. Besides Efate and Esperitu Santo (Case et al. 1991. Evol. Ecol. 5:272–290), Malekula is the third island invaded in Vanuatu Archipelago.

Submitted by **PHILIP E. DE POUS**, Department of Animal Management, University of Applied Sciences Van Hall Larenstein, 8934 CJ Leeuwarden; e-mail: phillip.depous@wur.nl.

LEIOCEPHALUS CARINATUS (Northern Curly-tailed Lizard). USA: FLORIDA: Alachua Co.: Gainesville, University of Florida campus, McCarty Hall (29.646487ºN, 82.34582ºW, Datum WGS84). 25 September 2008. Kenneth L. Krysko, Michael C. Granatosky, and Tina M. Bouse. UF 153707. Verified by Steve A. Johnson. New county record, and extends known range of this species ca. 177.5 km SW of closest known record in Jacksonville, Duval County (Krysko and Burgess 2008. Herpetol. Rev. 39:368). Collected on limestone boulder.

Submitted by **KENNETH L. KRYSKO** (e-mail: kenneyk@flmnh.ufl.edu) and **MICHAEL C. GRANATOSKY**, Florida Museum of Natural History, Division of Herpetology, University of Florida, Gainesville, Florida 32611, USA; **TINA M. BOUSE**, Florida Department of Environmental Protection, GTM NERR, Ponte Vedra, Florida 32082, USA; and **STEVE A. JOHNSON**, Department of Wildlife Ecology and Conservation, Gulf Coast Research and Education Center, University of Florida-IFAS Plant City Campus, 1200 N. Park Road, Plant City, Florida 33563, USA (e-mail: mgranato@ufl.edu).

LYGOSOMA BOWRINGII (Bowring's Supple Skink) MALAYSIA: PENANG: PULAU PINANG: Su Batu Pea (05.16ºN, 100.14ºE) (La Sierra University Herpetological Collection. LSUHC 8986 male, LSUHC 8985 female). 12 June 2008. P. L. Wood Jr. and J. L. Grismer. Verified by L. L. Grismer. Collected at 1540 h from under logs and debris on beach. Currently known to range from Andaman and Nicobar Islands of India, Peninsular Malaysia (including offshore islands of Pulau [= P.] Aceh, P. Aur, P. Besar, P. Harimau, P. Ibol, P. Lima Besar, P. Mawar, P. Mensirip, P. Mentigi, P. Mertang Tengah, P. Mertang Timur, P. Nangka Kecil, P. Papan, P. Pemanggil, P. Rawa, P. Sembilang, P. Seribuat, P. Setidan, P. Sibu, P. Sibu Tengah, P. Tengah, P. Tinggi, P. Tioman, and P. Tunas Seletan), Singapore, and possibly Sumatra, Indochina, and China (Grismer 2005. Amphibians and Reptiles of the Tioman Archipelago, Malaysia. Forestry Department of Peninsular Malaysia, Kuala Lumpur. 224 pp.). First report from Pulau Pinang.

Submitted by **PERRY L. WOOD, Jr.** (e-mail: perry.wood@villanova.edu) and **JESSE L. GRISMER (**e-mail: jesse.grismer@villanova.edu), Department of Biology, Villanova University, Villanova, Pennsylvania 19085, USA; and **MUIN, M. A.**, School of Biological Sciences, Universiti Sains Malaysia, 11800 Penang, Malaysia.

MABUYA ALTAMAZONICA (NCN). COLOMBIA: META: "Finca Santa Teresita 15 km NE Villavicencio" (04.1533°N, 73.635°W; WSG 84, Fallingrain Gazetteer) University of Texas at Arlington (UTA R-3304), 14 June 1969, W. F. Pyburn; "Near Caño Blanco, ca. 15 km WSW Vista Hermosa" (03.0864°N, 73.7514°W,WSG 84, Fallingrain Gazetteer), (UTA R-3358), J. R. Glidewell, 10 March 1971; Lomalinda (not traced; UTA R-3546 and R-5027), respectively 16 September, 1971 by J. K. Salser, Jr., and 21 June 1974 by W. F. Pyburn. VAUPÉS: Timbó (approximately 01.10°N, 69.92°W, elev. 168 m, fide Campbell and Clarke 1998. Herpetologica 54:301–317; UTA R-3586), J. K. Salser, Jr., 25 June 1972; Wacará (this locality is located east of Mitú near the Brazilian border at approximately 1.15°N, 69.92°W, elev. 213 m, fide Campbell and Clarke 1998, *op. cit.*; UTA R-3944–46), J. K. Salser, Jr., 4–19 September 1973. ECUADOR: PASTAZA: "Río Cononaco." This specimen was found about 4 m above ground in the thatched roof hut in primary rainforest in a small village of Auca Indians (1–2°S, 76.5–75.5°W), M. B. Harvey, June, 1984. Verified by E. N. Smith.

These records are the first reports of *Mabuya altamazonica* from Colombia and Ecuador. Reported from Peru in the original description (Miralles et al. 2006. Zootaxa 1188:1–22), this species extends south in rainforests along the Andes to Buenavista, Santa Cruz, Bolivia (Harvey et al. 2008. Zootaxa 1828:43–56).

Submitted by **MICHAEL B. HARVEY**, Department of Biology, Broward College, 3501 S.W. Davie Road, Davie, Florida 33314, USA; e-mail: mharvey@broward.edu.

PHELSUMA MADAGASCARIENESIS GRANDIS (Madagascar Day Gecko). USA: FLORIDA: Monroe Co.: Key West, 1225 South Street (24.552797ºN, 81.787325ºW, WGS84; elev. < 1 m). 7 May 2008. Phyllis Rose. Verified by Kevin M. Enge. Florida Museum of Natural History (photographic voucher UF 152814). New island and most southern record in the United States (Krysko and Hooper 2007. Gekko 5:33–38). Palm Beach Co.: Lake Worth, 820 North O Street (26.625634ºN, 80.05083ºW, WGS84; elev. < 1 m). 30 August 2008. Carl D. May. Verified by Kevin M. Enge. Florida Museum of Natural History (photographic voucher UF 153515). New county record and extends the range ca. 190 km N of the closest known locality on Plantation Key, Monroe County (Krysko and Hooper 2007, *op. cit.*).

Submitted by **KENNETH L. KRYSKO**, Division of Herpetology, Florida Museum of Natural History, Dickinson Hall, University of Florida, Gainesville, Florida 32611, USA (e-mail: kenneyk@flmnh.ufl.edu); **ANDREW P. BORGIA**, P.O. Box 4346, Key West, Florida 33041, USA; and **CARL D. MAY**, 1311 N Lakeside Drive, Lake Worth, Florida 33460, USA.

PLESTIODON (=EUMECES) EGREGIUS (Mole Skink). USA. FLORIDA. Walton Co.: Nokuse Plantation, 3.5 km NE of Bruce and 57 m E of SR 81 (30.495867ºN, 85.930457ºW). 14 April 2008. Matthew J. Aresco. Verified by Jason Butler, Florida Museum of Natural History, Gainesville, Florida (UF 153017). New county record (Ashton and Ashton 1991. Handbook of Reptiles and Amphibians of Florida. Part II. Lizards, Turtles & Crocodilians. Second Edition. Windward Publishing, Miami, Florida. 191 pp.). Adult found dead on surface following prescribed burn.

Submitted by **MATTHEW J. ARESCO**, **FRANK N. CUCHENS**, **SANTIAGO H. CRUZ**, and **ROBERT N. WALKER**, Nokuse Plantation, 13292 Co. Hwy 3280, Bruce, Florida 32455, USA (e-mail: aresco@nokuse.org).

SCELOPORUS SUGILLATUS (Variable Yarrow's Spiny Lizard). MÉXICO: DISTRITO FEDERAL: Delegación Magdalena Contreras, Cuarto Dínamo, área de Coconetla (19.259°N, 99.302°W, WGS 84), 3385 m elev. 19 January 2006. Uri Omar García Vázquez. Verified by Edmundo Pérez Ramos. Museo de Zoología, Facultad de Ciencias, Universidad Nacional Autónoma de México (MZFC 19893). First record for Distrito Federal, extending the

known range ca. 23 km N from Parque Nacional Lagunas de Zempoala, Huitzilac, Morelos (Smith 1942. Proc. U.S. Nat. Mus. 92:349–395). The specimen was under a rock in fir forest. Field work funded by "Manejo de Ecosistemas y Desarrollo Humano" UNAM (SDEI-PTID-02).

Submitted by **ANDRÉS ALBERTO MENDOZA-HERNÁNDEZ** (e-mail: andalmeher@ yahoo.com), **URI OMAR GARCÍA-VÁZQUEZ** (e-mail: urigarcia@hotmail.com), and **ADRIÁN NIETO-MONTES DE OCA,** Museo de Zoología, Facultad de Ciencias, Universidad Nacional Autónoma de México, Apartado Postal 70-399, México, Distrito Federal 04510, México.

SQUAMATA – SNAKES

AGKISTRODON CONTORTRIX CONTORTRIX (Southern Copperhead). USA: ARKANSAS: Searcy Co.: ca. 0.5 km E of jct AR 14 and Searcy Co. Rd. 61 (36.0153°N, 92.3231°W; NAD 83). 11 August 2008. M. B. Connior. Verified by S. E. Trauth. Arkansas State University Museum of Zoology Herpetology Collection (ASUMZ 31240). Adult found DOR on Searcy Co. Rd. 61. First county record (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. Univeristy of Arkansas Press, Fayetteville. 421 pp.).

Submitted by **MATTHEW B. CONNIOR,** Department of Biological Sciences, Arkansas State University, P.O. Box 599, State University, Arkansas 72467, USA; e-mail: matthew.connior@smail.astate.edu.

CLONOPHIS KIRTLANDII (Kirtland's Snake) USA: INDIANA: Hendricks Co.: 39.67542ºN, 86. 34102ºW. 02 August 2004. B. Jagger Foster and the Indianapolis Airport Authority Bat Crew. ISUVC 3893. Verified by Dale W. Sparks. New county record (Minton 2001. Amphibians and Reptiles of Indiana. Second Ed. Indiana Acad. Sci. 404 pp.)

Submitted **by B. JAGGER FOSTER**, Indiana State University, Biology Department, 600 North 6th St. Terre Haute, Indiana 47809-1905, USA.

COLUBER CONSTRICTOR FLAVIVENTRIS (Eastern Yellow-bellied Racer). USA: TEXAS: McMullen Co.: Hwy 72, 6 km E of jct with Hwy 16 (28.46025°N, 098.49085°W; WGS 84). 28 June 2008. Vincent Farallo, Romey Swanson, Jeff Troy, and Glen Hood. Verified by James R. Dixon, Texas Cooperative Wildlife Collection (TCWC 93076). The snake was found crossing the road at ca. 0100 h and represents the first recorded specimen for McMullen County (Dixon 2000. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 421 pp.).

Submitted by **VINCENT R. FARALLO (**e-mail: VF1030@txstate.edu), **ROMEY L. SWANSON**, **JEFF R. TROY**, **GLEN R. HOOD**, and **MICHAEL R.J. FORSTNER**, Department of Biology, Texas State University, San Marcos, Texas 78666, USA.

COLUBER CONSTRICTOR LATRUNCULUS (Black-masked Racer). USA: TENNESSEE: Fayette Co.: Wolf River Wildlife Management Area, Yager Drive just south of Yager Bridge (35.0313889°N, 89.2469444°W). May 2007. Eric P. Johansen and Joshua T. Ream. Verified by A. Floyd Scott. David H. Snyder Museum of Zoology, Austin Peay State University (APSU 18934). Adult found dead on road. New county record (Thomas et al. 2000. Herpetol. Rev. 31:54).

Submitted by **ERIC PAUL JOHANSEN (**e-mail: ejohansen14@apsu.edu) and **JOSHUA TAYLOR REAM**, Department of Biology and Center of Excellence for Field Biology, Austin Peay State University, Clarksville, Tennessee 37044, USA.

CONOPSIS ACUTA (NCN). MÉXICO: GUERRERO: Municipality of Malinaltepec: Ejido Tres Marías (17.07357°N, 98.41424°W, WGS 84), 2331 m elev. 29 June 2006. Uri García Vázquez and Itzel Durán Fuentes. Verified by Luis Canseco Márquez. Museo de Zoología, Facultad de Ciencias, UNAM (MZFC 20906). First record for Guerrero, extending its known range ca. 83.21 km (airline) E from the closest locality, 3 mi SE of Tlaxiaco, Oaxaca (Goyenechea and Flores-Villela 2006. Zootaxa 1271:1–27). The snake was found under a rock in pine-oak forest.

Submitted by **URI OMAR GARCÍA-VÁZQUEZ (**e-mail: urigarcia@gmail.com), **EDMUNDO PÉREZ-RAMOS,** and **ITZEL DURÁN-FUENTES,** Museo de Zoología, Facultad de Ciencias, UNAM, A.P. 70-399, México D.F. 04510, México.

CROTALUS HORRIDUS (Timber Rattlesnake). USA: TEXAS: Montague Co.: Hwy 677 (33.845ºN, 97.489ºW), large adult male DOR. 21 May 2008. Jesse M. Meik and Felipe Avila. Verified by Carl Franklin. University of Texas at Arlington Collection of Vertebrates (UTA R-55989). First county record (Werler and Dixon 2001. Texas Snakes: Identification, Distribution, and Natural History. Univ. Texas Press, xv + 437 pp.). *Crotalus horridus* has a fragmented distribution throughout the eastern third of Texas; UTA R-55989 represents the northwestern-most locality for the state. Habitat at the time of collection consisted of a mosaic of rural/agricultural lands and Post Oak (*Quercus stellata*)/Blackjack Oak (*Q. marilandica*) woodlands.

Submitted by **JESSE M. MEIK (**e-mail: jmeik@uta.edu) and **FELIPE AVILA**, Department of Biology, The University of Texas at Arlington, Arlington, Texas 76019, USA.

CROTALUS TRANSVERSUS (Cross-banded Mountain Rattlesnake). MÉXICO: DISTRITO FEDERAL: Delegación Magdalena Contreras, Cerro Panza, Valle del Tezontle (19.13155°N, 99.1782°W; datum WGS 84). 3430 m elev. 20 May 2007. Uri Omar García Vázquez. Museo de Zoología, Facultad de Ciencias, Universidad Nacional Autónoma de México (MZFC 20521). Verified by Oscar Flores Villela. First record for Distrito Federal, extending the known range of the species ca. 21.4 km N from Parque Nacional Lagunas de Zempoala, Huitzilac, Morelos (Campbell and Lamar 2004. Venomous Reptiles of the Western Hemisphere. Cornell Univ. Press, Ithaca, New York. 870 pp.). The specimen was found crawling on a road in pine forest. Field work funded by Manejo de Ecosistemas y Desarrollo Humano, UNAM (SDEI-PTID-02).

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CROTALUS WILLARDI MERIDIONALIS (Southern Ridge-nosed Rattlesnake). MÉXICO: DURANGO: Municipality of Tepehuanes: 24 km SW Tepehuanes (25.1°N, 105.8°W; WGS84), 2600 m elev. 31 July 2007. Jason M. Jones. UTA Digital Collection (UTADC 1088). 28 km SSE Tepehuanes (25.1°N, 105.5°W, WGS84), 2600 m. elev. 1 August 2007. Chris I. Grünwald, Jacobo Reyes-Velasco and Ginny N. Weatherman. UTA Digital Collection (UTADC 1089). Both specimens verified by Robert W. Bryson, Jr. Northernmost records for *Crotalus willardi meridionalis* and extends known range ca. 150 km N from localities near El Salto, Durango (Armstrong and Murphy 1979. Univ. Kansas Publ. Mus. Nat. Hist. Spec. Publ. No. 5:1–88). The locality is also ca. 300 km SE from the southernmost locality for *C. willardi silus*, located between Urique and Cerocouhui, Chihuahua (Tanner 1985. Great Basin Nat. 45:615–676).

Submitted by **JACOBO REYES-VELASCO**, Centro Universitario de Ciencias Biológicas y Agropecuarias, Carretera a Nogales Km. 15.5, Las Agujas, Nextipac, Zapopan, Jalisco, México (e-mail: jackobz@gmail.com); **CHRISTOPH I. GRÜNWALD**, 450 Jolina Way, Encinitas, California 92024, USA (e-mail: cgruenwald@switaki.com); **JASON M. JONES**, 16310 Avenida Florencia, Poway, California 92064, USA (e-mail: jjones@switaki.com); and **GINNY N. WEATHERMAN**, 1812 Arkansas, Lawrence Kansas 66044, USA (e-mail: ginnykansas@gmail.com).

HELICOPS ANGULATUS (Water's snake). BRAZIL: CEARÁ: Aquiraz Municipality: Batoque Lagoon. (03.995253°S, 38.241394°W; WGS84). 11 June 2008. V. Lima-Verde, P. C. M. D. Mesquita, and H. Fernandes-Ferreira. Collection of Herpetology of Núcleo Regional de Ofiologia (NUROF) - Universidade Federal do Ceará, Fortaleza, Brazil (CHUFC 2961). Verified by C. Strüssmann. The species was previously known from Amazon Forest (Ecuador, Venezuela, Colombia, Bolivia, Peru, French Guiana, Trinidad, and Brazil (states of Acre, Amazonas, Maranhão, Pará, and Rondonia) (Cunha and Nascimento 1978. Publicações Avulsas do Museu Paraense Emílio Goeldi 31:1–218; Jorge-da-Silva 1993. Herpetol. Nat. Hist. 1:37–86; Frota 2005. Phyllomedusa 4[1]:61–67), Pantanal (State of Mato Grosso) (Marques et al. 2005. Serpentes do Pantanal. Holos, Ribeirão Preto. 184 pp.), and Atlantic Forest (State of Paraíba) (Santana et al. 2008. Biotemas 21[1]:75–84). First state record; extends known distribution ca. 510 km airline E of previously known range within Nova Vila (Maranhão; 03.768042°S, 45.164173°W, WGS84), and 770 km airline NW from João Pessoa (Paraíba; 07.136732°S, 34.860413°W, WGS84). This specimen and a *H. leopardinus* were found in a lacustrine environment (freshwater marshes and dunes). This is the first record for this species from the coastal environment.

Submited by **DIVA MARIA BORGES-NOJOSA** (e-mail: dmbnojosa@yahoo.com.br), **PAULO CESAR MATTOS DOURADO DE MESQUITA** (e-mail: paulocmdm@gmail.com), and **HUGO FERNANDES-FERREIRA,** Universidade Federal do Ceará, NUROF-UFC, Campus do Pici, Bloco 905, 60455-760, Fortaleza, Ceará, Brazil (e-mail: hugofernandesbio@gmail.com).

LAMPROPELTIS CALLIGASTER RHOMBOMACULATA (Mole Kingsnake). USA: ALABAMA: Chilton Co.: 9.0 km S of CR 25 on CR 73 (33.00685°N, 86.52074°W; WGS84). 25 May 2000. J. Burling. Verified by Joseph R. Mendelson III. University of Montevallo Collection of Vertebrates (UMCV-RS0083). Female containing five eggs found dead on road. New county record; fills a gap among Shelby, Bibb, and Coosa counties (Mount 1975. The Reptiles and Amphibians of Alabama. Univ. Alabama Press, Tuscaloosa. 347 pp.). Alabama Department of Conservation and Natural Resources collecting permit number 1044 (JWB).

Submitted by **JOHN W. BURLING[1]** and **JILL A. WICKNICK[2]**, Departments of Psychology[1] and Biology[2], University of Montevallo, Montevallo, Alabama 35115, USA; e-mail: wicknickja@montevallo.edu.

LETHEOBIA CROSSI (Crosse's Blind Snake). TOGO: CENTRAL REGION: Fazao (08.42°N, 00.48°E). Between June and December 2007. Collector unrecorded. Institut de Recherche pour le Développement at Dakar (IRD 92-T). Verified by Youssouph Mané. First record for Togo. Extension of range by ca. 600 km W from closest known locality at Wushishi in Nigeria (Butler and Reid 1990. Nigerian Fld. 55:19–40). The genus *Letheobia* was recently revived (Broadley and Wallach 2007. Zootaxa 1515:31–68). Species also obtained from a farmer at Alédjo Kadara (09.15°N, 01.13°E) (IRD 102–T). Before these records, *L. crossi* was known from Nigeria, including Asaba (type locality: 06.11°N, 06.45°E), Agweri (06.20°N, 06.53°E), Wushishi (09.44°N, 06.04°E), and Calabar (04.48°N, 08.21°E) (Butler and Reid 1990. Nigerian Fld. 55:19–40; Roux-Estève 1974. Mém. Mus. Nat. Hist. Nat., Ser. A, 87:1–313).

Submitted by **JEAN-FRANÇOIS TRAPE**, Institut de Recherche pour le Développement (IRD), Laboratoire de Paludologie et Zoologie médicale, B.P. 1386, Dakar, Sénégal (e-mail: trape@ird.sn); and **GABRIEL HOINSOUNDE SEGNIAGBETO**, Département de Zoologie et Biologie animale, Faculté des Sciences, Université de Lomé, B.P. 1515, Lomé, Togo (e-mail: h_segniagbeto@yahoo.fr).

MICRURUS DISTANS OLIVERI (Western Mexican Coral Snake). MÉXICO: MICHOACÁN: Municipality of Aquila: 1.8 km N Maruata, on road to Pomaro, 26 m elev. (18.2903°N, 103.346°W; WGS84), 26 m elev. 15 August 2007. Brendan O'Connor and Richard L. Gassaway. Verified by Jonathan A. Campbell. UTA digital collection (UTADC 1086). First state record for this subspecies. All other records for the species in Michoacán come from the arid Balsas-Tepalcatepec Basin and represent *M. d. michoacanensis* (Campbell and Lamar 2004. Venomous Reptiles of the Western Hemisphere, Vol. 1. Comstock Publ. Assoc., Cornell Univ. Press, Ithaca, New York. 476 pp.). The snake was found AOR at night in tropical deciduous forest.

Submitted by **JACOBO REYES-VELASCO**, Centro Universitario de Ciencias Biológicas y Agropecuarias, Carretera a Nogales Km. 15.5. Las Agujas, Nextipac, Zapopan, Jalisco, México (e-mail: jacobz@gmail.com); **CHRISTOPH I. GRÜNWALD**, 450 Jolina Way. Encinitas California 92024, USA (e-mail: cgruenwald@switaki.com); and **JASON M. JONES**, 16310 Avenida Florencia, Poway, California 92064, USA (e-mail: jjones@switaki.com).

PANTHEROPHIS EMORYI (Great Plains Ratsnake). USA: NEW MEXICO: Sierra Co.: found at residence ca. 21.7 rd km S Hillsboro, 1.0 rd km W NM Hwy 27; 1621 m elev., 32.768ºE, 107.554ºW; datum NAD 27. 29 June 2008. Randall L. Gray. University of Kansas Photo Archive (KUDA 002399). Verified by James N. Stuart. Specimen photographed and released at capture site. New county record (Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. Univ. New Mexico Press, Albuquerque. xix + 431 pp.).

Submitted by **RANDALL L. GRAY**, 62 Black Range Road, Hillsboro, New Mexico 88042, USA (e-mail: randygray1@msn.com); and **CHARLES W. PAINTER**, New Mexico Department of Game and Fish, 1 Wildlife Way, Santa Fe, New Mexico 87507, USA (e-mail: charles.painter@state.nm.us).

PITUOPHIS CATENIFER SAYI (Bullsnake). USA: WISCONSIN: Trempeleau Co.: Northeast of Perrot State Park (44.02334226°N, 91.41473959°W)**.** 10 May, 1 June, and 12 June 2008. Mary Wanatka. Photographs verified by Gary Casper (Great Lakes Ecological Services). Photograph voucher, Illinois Natural History Survey catalogue number INHS 2008.f. New county record. Fills gaps in currently known range of species in Wisconsin (Casper 1996. Geographic Distributions of the Amphibians and Reptiles of Wisconsin. Milwaukee Public Museum, 87 pp.). Single individual seen near residence on 10 May 2008 and near road on 1 June 2008 (MW). Two individuals seen near residence on 12 June 2008 (MW).

Submitted by **JOSHUA M. KAPFER**, Natural Resources Consulting, Inc., 209 Commerce Parkway, PO Box 128, Cottage Grove, Wisconsin 53527, USA; **ROBERT HAY**, Wisconsin Department of Natural Resources-Bureau of Endangered Resources, PO Box 7921, Madison, Wisconsin 53707, USA; **MARY WANATKA**, N12798 Drieslien Road, Trempealeau, Wisconsin 52661, USA.

PYTHON RETICULATUS (Reticulated Python). PHILIPPINES: BATANES PROVINCE: Itbayat Island (20.75ºN, 121.8333333ºE). 10 February 2001. Specimen released alive. Photograph verified by M. Auliya (MCZ R-186014). A widespread and commonly encountered species, being found throughout mainland Southeast Asia and the Indo-Malay-Philippine archipelago but the true limits of its range are more difficult to determine because most authors are satisfied to list countries rather than exact localities. The southeastern limits of the range are the islands to the west of New Guinea, i.e., Seram and Tanimbar Islands (Rooji 1917. The Reptiles of the Indo-Australian Archipelago. Vol. II. Ophidia. E. J. Brill, Leiden. xiv + 334 pp; Kopstein 1927. Zool. Meded. [Leiden] 9:71–112; de Haas 1950. Truebia 20:511–625). The northern limits of the range are more difficult to determine. This species is not believed to occur in China even though de Haas (*op. cit.*) records "S. China?", Zhao and Adler (1993. Herpetology of China. Society for the Study of Amphibians and Reptiles, Oxford, Ohio. 522 pp. + 48 pl. + 1 folding map) omitted the species, and Pope (1935. The Reptiles of China. Natural History of Central Asia. Vol. 10. American Museum of Natural History, New York. li + 604 pp.; 27 pl.) stated that despite earlier reports, it is unlikely that *P. reticulatus* is part of the Chinese herpetofauna, further suggesting that occasional specimens might have been deliberately transported into the country by travelers. Neither has *P. reticulatus* been recorded from Taiwan (Kuntz 1963. Snakes of Taiwan. US Naval Research Unit No. 2:1–80). de Haas (*op. cit.*) recorded *P. reticulatus* from "Burma; Siam as far north as lat. 18°; Indochine." Taylor (1965. Univ. Kansas Sci. Bull. 45[9]:609–1096) stated that the species is found throughout Thailand "except perhaps the northern parts." Smith (1943. Fauna of British India: Reptilia and Amphibia. Vol. III. Serpentes. Taylor and Francis, London. xii + 583 pp. + 1 map) listed "Tenasserim" in southern Burma (Myanmar), Siam (Thailand) as far north as lat. 18°, and French Indo-China (Vietnam) as far north as "Yen-Bai in Tong-King." Yen-Bai is both a province and provincial capital located at 21°45'N, 104°50'E. Khan (1982. Wildlife of Bangladesh: A Checklist. Univ. Dhaka, Dhaka. 173 pp.) records *P. reticulatus* from Sylhet Division, between 24°00' and 25°10'N and includes a plate of an identifiable processed skin, this being the northernmost record for Bangladesh, the earlier report from the Shishak River on the border with northeastern India (Mountfort 1969. The Vanishing Jungle: The Story of the WWF Expedition to East Pakistan. Houghton Mifflin, New York. 286 pp.), being a misidentified *P. molurus* (Funk 1979. Bull. Chicago Herpetol. Soc. 14[3]:92).

All the major islands of the Philippines fall within the known range of *P. reticulatus*. Alcala (1986. Guide to Philippine Flora and Fauna. Vol. X. Amphibians and Reptiles. Natural Resources Management Centre, Ministry of Natural Resources and University of the Philippines, Manila. xiv + 195 pp.) records it as "Found all over the Philippines."

In the process of filming a documentary in the Philippines, we visited Itbayat, the northernmost inhabited island in the Batanes Islands, 320 km N of Luzon and 200 km SE of Taiwan. The herpetofauna of Itbayat is low in diversity and we recorded only *Hemidactylus frenatus* (Common House Gecko) and *P. reticulatus*, the latter as two specimens. One was a 2.0–3.0 m captive specimen in Mayan town. It had been captured in a chicken coop and offered to us for sale. Ownership of the python was negotiated, without payment, before it was photographed extensively and released. A second specimen, killed near a goat paddock, was much larger. A large part of its skin was preserved as a tanned roll and some had been used on a local banjo. These two Itbayat specimens constitute the northeasternmost, possibly also the northernmost, records for *P. reticulatus*.

We thank YAP Films and Animal Planet for support of the project.

Submitted by **MARK O'SHEA**, West Midland Safari Park, Bewdley, Worcestershire, DY12 1LF, England (e-mail: oshea@snakemos.demon.co.uk); and **JAMES D. LAZELL, JR**, The Conservation Agency, 6 Swinburne Street, Jamestown, Rhode Island 02835, USA (e-mail: hq@theconservationagency.org).

RAMPHOTYPHLOPS BRAMINUS (Brahminy Blind Snake). VANUATU: AMBRYM: Wakon village, Lake Fanteng Conservation area (16.221831ºS, 167.923889ºE). Two specimens found by Philip de Pous and Diederik Dingemans. Verified by Wouter Beukema. The specimens (see http://calphotos.berkeley.edu, digital image voucher 0000 0000 0908 0036 and 0000 0000 0908 0037) were found under bark of two dead trees, ca. 1 m from ground on 11 July 2007. *R. braminus* is widespread along the coast of the island and became established before 1990 (Jessy Saksak, pers. comm., 2007). After Efate (Medway and Marshall 1974. Philos.

Trans. R. Soc. Lond. B. Biol. Sci. 272:423–465) and Esperitu Santo (Shea and Wallach 2000. Pacific Sci. 54:70–74), Ambrym is third island invaded in Vanuatu Archipelago.

Submitted by **PHILIP E. DE POUS**, Department of Animal Management, University of Applied Sciences Van Hall Larenstein, 8934 CJ Leeuwarden (e-mail: phillip.depous@wur.nl); and **DIEDERIK J. DINGEMANS**, Department of Animal Management, University of Applied Sciences Van Hall Larenstein, 8934 CJ Leeuwarden (e-mail: diederik.dingemans@wur.nl).

RHINOCHEILUS LECONTEI (Long-nosed Snake) USA: UTAH: Box Elder Co.:15 airline km NE town of Lucin, 1362 m elev. (41.4843806ºN, 113.6217056ºW). 12 June 2002. T. A. Scott Newbold and Nathan E. Welch. University of Kansas Natural History Museum color transparency (KU-CT 11933). Verified by John E. Simmons. This record extends the distribution of this species northward by ca. 137 km, beyond the northern margin of the Great Salt Lake (Cox and Tanner 1995. Snakes of Utah. Brigham Young University Press, Provo, Utah. 91 pp.). Two other, unvouchered individuals of this species were seen in the immediate vicinity of this site (23 May 2001, 24 June 2003). There is an additional, previously unreported record from further south in Box Elder Co. (BYU 47356). Considered together, these records suggest a continuous distribution along the western side of the Great Salt Lake.

Submitted by **T. A. SCOTT NEWBOLD** (e-mail: scott@biology.usu.edu), **JOSEPH R. MENDELSON III**, Department of Biology and the Ecology Center, Utah State University, Logan, Utah 84322-5305, USA; and **NATHAN E. WELCH,** Department of Biology, Duke University, Durham, North Carolina 27708, USA.

STORERIA DEKAYI WRIGHTORUM (Midland Brownsnake,) USA: INDIANA: Hendricks / Morgan Co. line: 39.63066ºN, 86.38850ºW. 22 July 2004. B. Jagger Foster. ISUVC 3894. Verified by John O. Whitaker, Jr. New county record (Minton 2001. Amphibians and Reptiles of Indiana. Second Ed. Indiana Acad. Sci. 404 pp.).

Submitted **by B. JAGGER FOSTER**, Indiana State University, Biology Department, 600 North 6th St. Terre Haute, Indiana 47809-1905, USA.

THAMNOPHIS PROXIMUS PROXIMUS (Orange-striped Ribbonsnake). USA: ARKANSAS: Sevier Co.: off US 70, vic. Cossatot Community College, De Queen (34.025°N, 94.216°W). 28 April 2008. D. Arbour. Verified by S. E. Trauth. Arkansas State University Herpetological Museum (ASUMZ photographic voucher 31238). New county record filling a distributional hiatus in extreme southwestern Arkansas near a previous record in Howard County (Trauth et al. 2004. Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.).

Submitted by **CHRIS T. McALLISTER**, RapidWrite, 102 Brown Street, Hot Springs National Park, Arkansas 71913, USA (e-mail: drctmcallister@aol.com); **HENRY W. ROBISON**, Department of Biology, Southern Arkansas University, Magnolia, Arkansas 71754, USA (e-mail: hwrobison@saumag.edu); and **DAVID ARBOUR**, De Queen, Arkansas 69337, USA (e-mail: arbour@windstream.net).

THAMNOPHIS PULCHRILATUS (Mexican Highland Gartersnake). MÉXICO: TLAXCALA: Municipality of Santa Cruz Tlaxcala; 1.5 km N of Santa Cruz (19.2201°N, 98.0858°W; datum WGS 84), 2404 m elev. 20 July 2007. Uri Omar García Vázquez and Omar Gabriel Salvatierra García. Verified by Luis Canseco Márquez. Colección Herpetológica, Facultad de Ciencias, UNAM (MZFC 20901). First record for the municipality and second record for Tlaxcala, extending the known range 44.14 km SW (airline) from Mimiahuapan, Tlaxco, Tlaxcala (Fernández et al. 2006. Acta Zool. Mex. [n.s.] 22:159–162). The specimen was collected under a rock in pine forest.

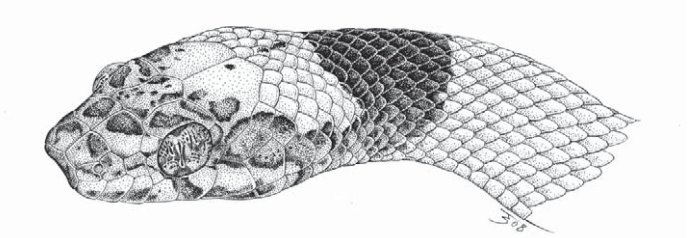
Submitted by **URI OMAR GARCÍA-VÁZQUEZ,** Museo de Zoología, Facultad de Ciencias, UNAM, A.P. 70-399, México D.F. 04510; e-mail:urigarcia@gmail.com.

THAMNOPHIS SIRTALIS SIRTALIS (Eastern Gartersnake). USA: ARKANSAS: Searcy Co.: Off AR 14, ca. 1.5 km down Ramblewood Trail (36.0642139ºN, 92.5971056ºW). 05 May 2008. M. B. Connior. Verified by S. E. Trauth. Arkansas State University Museum of Zoology Herpetology Collection (ASUMZ 31140). This adult female is the first county record (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. Univeristy of Arkansas Press, Fayetteville. 421 pp.).

Submitted by **MATTHEW B. CONNIOR,** Department of Biological Sciences, Arkansas State University, P.O. Box 599, State University, Arkansas 72467, USA; e-mail: matthew.connior@smail.astate.edu.

TROPIDODIPSAS ANNULIFERA (Western Snailsucker). MÉXICO: MICHOACÁN: Municipality of Chinicuila: 8 km (by air) SSE Villa Victoria (18.6927°N, 103.328°W; WGS84), 1357 m elev. 9 June 2005. Christoph I. Grünwald and Jason M. Jones. Verified by Jonathan A. Campbell. UTA Digital Collection (UTADC 1036). First record from Michoacán, filling a large gap between localities in SW Jalisco and central Guerrero (Kofron 1988. Amphibia-Reptilia 9:145–168). The snake was found DOR in a tropical deciduous forest/oak forest ecotone.

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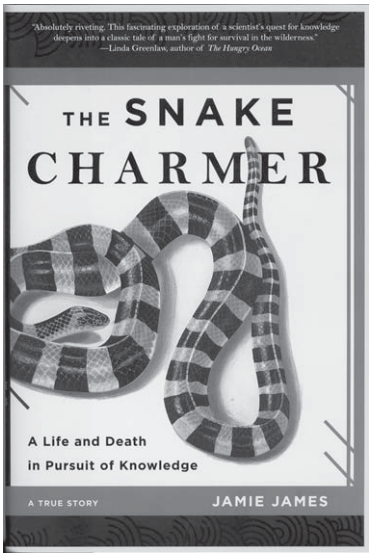
Pseudoleptodeira latifasciata. México: Guerrero; vic. Zihuatanejo. Illustration by Jackson D. Shedd.

BOOK REVIEWS

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The Snake Charmer: A Life and Death in Pursuit of Knowledge, by Jamie James. 2008. Hyperion, New York, New York (www.hyperionbooks.com). 272 pp., 16 pp. pls. Hardcover. US $24.95. ISBN-13: 9781401302139

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It seems nearly impossible that a person could write a credible biography of someone they never met and accurately capture the subject's personality and the intimate details of their life. Jamie James has not only done this with his biography of Joe Slowinski in the new book, *The Snake Charmer: a Life and Death in the Pursuit of Knowledge*, but he has actually done it well and given us an entertaining read to boot. I anticipated the release of this book for sometime and am very pleased with the final product. I will admit that my review of this book is somewhat biased as Joe Slowinski was a very good friend of mine and I was interviewed extensively by James for this book. Nevertheless, I think it is not only an important document for the layperson interested in the process of science, snakes, and adventure, but also a fantastic contribution to the history of herpetology. Ultimately, James admits that he wrote this book to question what drives a person to spend their life investigating snake evolution at the expense of health, finances, relationships, and personal comfort. Obviously, for most readers of *Herpetological Review*, the answer to this question is obvious—it's what we do for fun and we can't help it. Jamie James traces the life of Joe Slowinski in order to get an even better understanding of how to frame such a question and I'll not spoil the book by giving my impression of that.

Beyond exploring this somewhat nebulous question, the real charm in *The Snake Charmer* is that it explores and documents the life of Joe Slowinski, with an emphasis on his academic development, life as a field researcher, personal relationships, and the social nature of herpetologists. For those who did not know Joe, I can honestly say that James' writing captures Joe's personality and passion for herpetology well. So, how is it that James, who never met Joe, was able to provide us with such a good characterization of Slowinski's personality and abilities as a scientist? James thoroughly examined all of Joe's personal journals and correspondence with friends and researchers—Joe was meticulous and kept most written interactions with everyone he encountered. Additionally, James conducted numerous (and very long) interviews with family, friends, and fellow researchers to provide even more detail on Joe's life to relay a real sense of his mannerisms and rough but loveable personality. The result is a pretty detailed journey through Joe's life that is seasoned with quotes and stories from his family, friends, and (importantly for our crowd) luminaries in herpetology and evolutionary biology.

For many people curious about this book, I am sure that a primary motivation for purchasing it is to read the gruesome events documenting Joe's final tragic collecting expedition near Rat Baw, Burma. Certainly much of Joe's life has been boiled down in the popular press to his final 36 hours and his struggle for life after being bitten by a krait (*Bungarus*). The last events of Slowinski's life are definitely covered here, in fact nearly a third of book describes every aspect of this grim event—including funding, preparation, hardships in the field, inefficiency of the Burmese government, tensions among the field crew, Joe's bite, resuscitation efforts, his death, handling the remains, and subsequent grief for all those who cared about him. Thankfully, *The Snake Charmer* covers much more of Slowinski's life and personal achievements.

The Snake Charmer is broken into 13 unnumbered chapters and one epilogue. Each chapter is named after a single snake species and is prefaced by an illustration and an accompanying discussion of various aspects of the biology of the particular serpent. Most of these snakes are in some way tied to particular events in Joe's life in said chapter. I thought this was a clever way to introduce different events or facets of Joe's life and, excluding *Oxyuranus microlepidotus*, I am certain Slowinski collected all of these snakes. The book also provides two sections of photos—the first are shots capturing Joe's childhood with friends and family (and some herps) and the second is composed mostly of pictures of Joe and colleagues in Burma. I wish a section of photographs had been included showing reptiles and amphibians that Joe would have encountered or worked on throughout his life (or at least the ones named in his honor).

The Snake Charmer opens with a discussion of venomous snake mimicry (emphasizing the model/mimicry system in *Dinodon* and *Bungarus*), krait venom, and Joe's fatal encounter with this snake. The following chapters detail Joe's life chronologically and do not return to the fatal encounter with the krait until the last section of the book, entitled 'The Expedition.' In between, James traces Joe's interest and academic development in general science, geology, and ultimately herpetology. Along with descriptions of his keen intellect, we are also given a fairly accurate depiction of the warmth, humor, generosity, debauchery, and rough and rowdy ways that characterized Slowinski's personality. Joe's early life in Manhattan, Tokyo, and Kansas City are thoroughly explored through interviews with his family and it clearly shows how an inherently curious kid, capturing a rat snake (*Pantherophis obsoletus*) at the age of five, was encouraged and aided by his mother to study natural history. Eventually, this would develop into a passion for snakes. As an undergraduate at the University of Kansas, we learn about Joe's passion for evolution, paleontology, and snakes. In these chapters covering Joe's early life, it is evident that he was completely fascinated with collecting snakes and venomous ones in particular—leading to two crotaline envenomations.

The book then turns to Joe's career as a doctoral student at the University of Miami, where he was mentored by Jay Savage, and his early contributions to herpetology and evolutionary biology. For herpetologists interested in the social aspects of our field, the book becomes particularly important for documenting the personality of other major players in the field. For me, a quote by Savage on page 73 about why scientists build phylogenies when we know they may be incorrect is classic and completely worth the price of this book. After completing his doctorate on the taxonomy of New World coral snakes, the book traces Joe's life through his postdoc years researching krait evolution at the National Museum of Natural History and Louisiana State University Museum of Natural Science, where he was again envenomated by another crotaline (*Sistrurus miliarius*). As the book correctly describes, these were tough days for Slowinski—he had great difficulty obtaining a professorial position at a university and was living on a very meager salary. Although these aspects of his life may seem somewhat dry, I can assure you they are not. These sections are laced with some pretty spicy and exciting stories that illustrate Joe's wild side, including some run-ins with the law.

The last portion of the book describes his curatorial position at the California Academy of Sciences, research in Burma and China, and his success at obtaining a massive NSF grant to fund expeditions in Burma. With funds for research, a new romance, and respect in the field, we learn how life was certainly looking up for Joe. And then the book turns to his last trip to Burma. James relates in excruciating detail Joe's final collecting trip to northern Burma and the hardships faced by him and his crew on this adventure. I think anyone reading this will find the end of the book difficult to stomach. The account of Joe's fatal bite, the impossibilities faced by his crew to sustain his life, and Slowinski's eventual passing is pretty rough stuff. Hopefully, this last episode will teach scientists working with venomous snakes to proceed with caution. 'The Expedition' section is appropriately followed by an epilogue that frames life at the California Academy after Joe's death and discusses the species named in his honor.

The Snake Charmer is a quick read, well written, and should be of great interest to readers of this journal. In fact, I doubt many books reviewed here contain as much drama, action, and adventure—peppered with a host of romantic and villainous characters (you can figure out who the villains are). Other than a few errors about Joe being the only academic herpetologist killed in the field from a venomous snake bite (although Schmidt and Mertens were envenomated in their labs, it could be argued that Fred Shannon was an academic herpetologist and certainly he died in the field from the bite of a *Crotalus scutulatus*), and some half-baked theories on why *Boa constrictor* does not lay eggs and a prediction of impending infertility for dwarf members of this same species in Cozumel, the text is thorough and well-researched. At a cover price of US $24.95, even the most frugal herpetologist should be able to afford it. This book sits on my shelf right next to other stalwart classics in the history of herpetology (or herpetological biographies): *Snakes and Snake Hunting* (Kauffeld 1957), *Snakes*: *the Keeper and the Kept* (Kauffeld 1969), *Edward H. Taylor: Recollections of a Herpetologist* (Taylor et al. 1975), *A Field Guide to the Life and Times of Roger Conant* (Conant 1997), and *Contributions to the History of Herpetology* (Adler 1989, 2007). As the artist Jack Kirby used to say "Don't ask, just buy it!"

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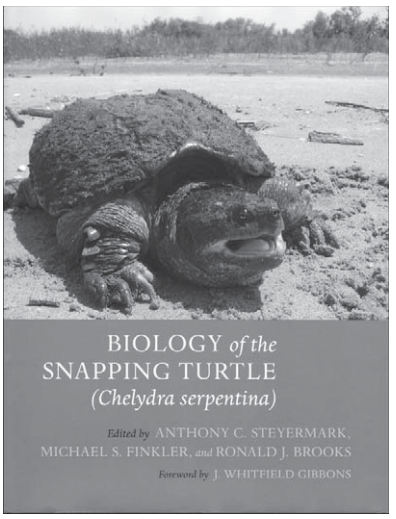
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Biology of the Snapping Turtle (*Chelydra serpentina*), edited by Anthony C. Steyermark, Michael S. Finkler, and Ronald J. Brooks. 2008. The John Hopkins University Press, Baltimore, Maryland (www.press.jhu.edu). x + 225 pp. Hardcover. $US 75.00. ISBN 0-8018-8724-0.

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This volume is a comprehensive review of research on snapping turtles. In the tradition of Gibbons' (1993) volume on slider turtles, Steyermark, Finkler, and Brooks have assembled an impressive roster of turtle biologists to write individual chapters relating to all aspects of snapping turtle biology. The book begins with an introduction by Whit Gibbons. The majority of the book is divided into three sections. The first, containing Chapters 1–4, covers taxonomy and systematics. The second section, containing Chapters 5–11, covers physiology, energetics, and growth. The third section, with Chapters 12–17, covers life history and ecology. The book concludes with a list of references and an index.

Chapter 1, by Carl Ernst, is a taxonomic overview of chelydrid turtles. Distribution, characteristics, geographic variation, and recorded fossils are provided for all extant chelydrid taxa including the alligator snapping turtle (*Macrochelys temminckii*) and the central and South American snapping turtles (*Chelydra rossignonii*

and *C. acutirostris*).

J. Howard Hutchison reviews fossil chelydrids in Chapter 2. Prior to reading this chapter I was unaware of the broad geographic distribution of fossil chelydrids and was surprised to learn of early Eocene snapping turtle fossils from Ellesmere Island in Canada! This chapter presents a phylogenetic analysis of fossil chelydrids although it could be easily overlooked as there is no discussion of the methods used and the resulting phylogenetic tree is only about 3 cm wide, part of an eight-panel, quarter page figure.

Chapter 3, by Eugene Gaffney, provides an overview of the snapping turtle skull and a summary of the literature pertaining to snapping turtle morphology. A large amount of descriptive and comparative work has been published concerning snapping turtle morphology in the past and Gaffney does an outstanding job summarizing that literature. The chapter is illustrated with several line drawings of snapping turtle skulls. There are, however, some missing citations pertinent to snapping turtle skeletal morphology such as Zangerl (1939) and recent papers by Sheil and Greenbaum (2005) and Jamniczky and Russell (2007). These omissions though do not detract from the thoroughness and usefulness of this chapter.

Shaffer, Starkey, and Fujita use Chapter 4 to examine several long-standing systematic issues of chelydrid turtles. The authors focus on the following questions using molecular data: i) Are *Macrochelys* and *Chelydra* sister taxa? ii) Does current taxonomy reflect the evolutionary diversity present in *Chelydra*? iii) Is the Asian big-headed turtle (*Platysternon*) allied with the Chelydridae? The authors do a good job explaining why these are important systematic questions and put forward satisfactory answers. The chapter ends with some taxonomic recommendations and identification of areas needing additional research.

Chapter 5, by Nigel West, covers respiratory and cardiovascular physiology. Much of the emphasis is on gas exchange and ties in nicely with chapter nine on overwintering.

Mahmoud and Alkindi review snapping turtle reproductive physiology in Chapter 6. Gonadal cycles and hormone levels in both male and female snapping turtles are discussed. Much of the information covered in this chapter is taken from papers co-authored by the senior author.

Chapter 7, by Spotila and Bell, is about thermoregulation and feeding biology. Much of the chapter is spent discussing thermoregulation in turtles generally and comparing snapping turtles to other turtle species. As in other chapters, I was struck by how little is known about snapping turtle thermal biology and the great need for further study in this field.

Robert Gatten, in Chapter 8, covers metabolism and energetics of eggs and turtles. Gatten does a good job showing the relevance of energy use to major life history characteristics such as incubation environment, sex determination, growth, and overwintering.

Ultsch and Reese discuss overwintering in Chapter 9. The adaptations needed to survive in low oxygen environments and at cold temperatures are fascinating and this chapter is a great overview of this topic. The authors also mention the importance of protecting hibernating turtles. This is wise advice particularly as commercial harvesters in Minnesota and other northern states are known to collect overwintering snapping turtles through holes in the ice.

Chapter 10, by Michael Ewert, is about embryos and incubation with a strong focus on energy utilization and latitudinal variation. Importantly, this chapter utilizes previously unpublished data in new analyses in a comparison of snapping turtle egg incubation from Tennessee and Minnesota. Ewart's results suggest a suite of physiological adaptations of snapping turtles eggs to the shorter growing seasons of northern latitudes.

Anthony Steyermark writes about snapping turtle growth patterns in Chapter 11. The chapter is generally written and serves as a good introduction to the importance of growth to individuals and species. Growth, and the factors affecting it, are discussed for both embryos and juvenile/adult stages. Like most chapters, there is a section on directions for future research.

Justin Congdon, Judith Greene, and Ron Brooks review the nesting behavior and reproductive ecology of female snapping turtles in Chapter 12. This chapter has some overlap with several other chapters in the book but it is different enough so that it doesn't seem repetitive. Additionally, much of the information presented in this chapter is unpublished having being collected at the long-term study sites of the authors: Savannah River in South Carolina; E. S. George Reserve in Michigan; and Algonquin Provincial Park in Ontario. This chapter is very well written and offers a clear and concise overview of snapping turtle life history and reproduction.

Chapter 13 by Ackerman, Rimkus and Lott overviews water relations of snapping turtle eggs. The authors state, "It is probable that what we think that we understand about the role and importance of egg and embryonic water exchange for reptile eggs rests largely on the study of the eggs of *C. serpentina*." If this statement is true then this chapter provides not only a thorough introduction to water exchange in snapping turtle eggs but in reptile eggs as a whole. The chapter is well written and does indeed offer a thorough and concise introduction and summary to this important field.

Snapping turtles have been important models in the study of temperature-dependant sex determination (TSD), the topic of Chapter 14 by Fred Janzen. Understanding the adaptive significance of TSD is key to understanding the evolution of sex-determining mechanisms and the maintenance of TSD. Janzen provides a thorough overview of these topics as well as some of the functional aspects of TSD. A comprehensive compilation of snapping turtle incubation data from the literature provides a sort of meta-analysis on the influence of temperature on hatchling gender. Janzen writes a concise introduction to TSD that will serve as an important entry into the field of sex determination in snapping turtles specifically and reptiles as a whole.

Ecology and physiology of hatchling turtles is outlined in Chapter 15. Michael Finkler and Jason Kolbe review in great detail what is known about snapping turtles in the period from hatching through the first year. The chapter highlights the interactions between hatchling turtles and their environment during hatching, overland migration from the nest to the water and finally, interactions once in the water. The topics covered in this chapter have similarities with other chapters in the book but, as with Chapter 12, it is not repetitive, and highlights the integrative nature of the volume.

Chapter 16 by David Galbraith examines population biology and population genetics of snapping turtles. The chapter is divided roughly into thirds, with a portion devoted to age estimations in snapping turtles, a section on life history characteristics and demography, and finally a thorough section on population genetics. Within the last section on genetics, Galbraith poses eight predic-

tions regarding snapping turtle genetic structure based on the snapping turtle's unique life history characteristics. These predictions provide a defined series of testable hypotheses to future researchers making this chapter one of the most useful in the whole book.

Chapter 17 by Don Moll and John Iverson covers geographic variation and life-history traits. The content is an extension of Iverson et al. (1997) and uses the data presented in that paper, as well as results of studies conducted since then, to examine how morphological and reproductive characteristics vary across the large geographic range of *C. serpentina*. Despite numerous studies involving snapping turtles, there is still much more work needed to fully understand the range of life-history variation and its possible causes.

The book appears well put together although the margins, particularly at the top of the page, are a bit tight. I noticed few print errors: one spelling mistake in the References section, on page 220, "ski" instead of "skin" in the title of Yntema 1974b; and "Brooks 1992," cited on page 169 in Chapter 16, is not listed in the Literature Cited. As mentioned before, figure 2.3 is too small and could have easily filled an entire page.

Overall the editors and authors did a good job integrating the subject matter to provide a very complete picture of snapping turtle biology. That said, some minor inconsistencies occur where a statement made in one chapter contradicts information presented in another. For example, in both chapters 5 and 16, *C. serpentina* is said to occur throughout North and Central America south to Ecuador. The first and fourth chapters of the book make clear that the Central and South American *Chelydra* are not *C. serpentina* but *C. acutirostris* or *C. rossignonii*. These mistakes appear to be oversights by the authors and editors and not a rejection of current snapping turtle taxonomy. There are additional inconsistencies in Chapter 1. Discussing relationships of the Chelydridae to other turtles, Ernst says "… all other extant cryptodirans are their sister group." While this relationship has been proposed, Chapter 4 makes a strong case that chelydrid turtles are nested well within the Cryptodira. Similarly, Chapter 1 states there are two fossil species of *Macrochelys* while Chapter 2 lists three species. Finally, Chapter 1 states that the earliest *Chelydra* fossil is from the Pliocene, citing Chapter 2 of the same volume, instead of the Miocene as correctly listed in Chapter 2.

One topic missing, sadly, is a chapter on conservation and management. While snapping turtles are relatively abundant throughout their range, they are harvested in large numbers in some areas (Brooks et al. 1988), suffer from high levels of road mortality (Steen and Gibbs 2004), and accumulate elevated levels of environmental contaminants (Helwig and Hora 1983; Ashpole et al. 2004). Snapping turtles are considered vulnerable in two U.S. states and two Canadian provinces (NatureServe 2008). Conservation and management are briefly mentioned in the chapters by Congdon, Greene, and Brooks (Ch. 12) and Galbraith (Ch 16), as well as the introduction by Whit Gibbons. Nonetheless, a dedicated chapter for reviewing the threats to snapping turtles and their management would have been a worthwhile addition.

Summarizing what we know about a species makes obvious our gaps in scientific knowledge. Publication of a book like *Biology of the Snapping Turtle* can help guide future research in filling those gaps. Most chapters in *Biology of the Snapping Turtle* have a section detailing potential directions for future research. Chelonian biologists should consult this volume when designing research plans involving snapping turtles, or any turtle species for that matter. One obvious gap in knowledge repeatedly mentioned throughout the book relates to intraspecific variation across the species' distribution. Almost all of the authors comment on how we only have data from a few populations, representing a fraction of the snapping turtle's continent-wide range. Additionally, many of these data are from the northern portions of the distribution. It is obvious after reading *Biology of the Snapping Turtle* that conducting research across the full range of the snapping turtle's distribution, particularly involving populations in the southern United States and Mexico, should be a priority.

Biology of the Snapping Turtle is a well-executed volume filled with useful information. The strong emphasis on physiology is particularly welcome and anyone conducting physiological research on reptiles and reptile eggs is advised to get this book. While the publisher's list price is a bit steep, wildlife managers, fisheries biologists, herpetologists, and vertebrate physiologists will find it a handy reference to this widespread turtle species.

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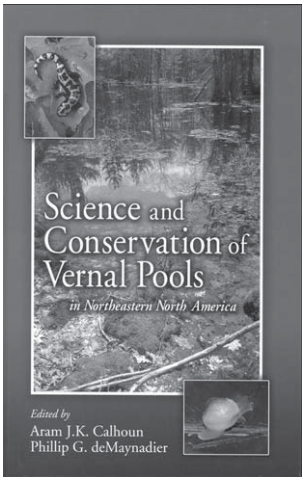
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Science and Conservation of Vernal Pools in Northeastern North America, edited by Aram J.K. Calhoun and Phillip G. de Maynadier. 2008. CRC Press, Boca Raton, Florida (www.crcpress.com). xxvii + 363 pp., 12 pp. pls. Hardcover. $US 99.95. ISBN 978-0-8493-3675-1.

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This is a comprehensive consideration of vernal pools of the Northeast—here defined as the area that was glaciated during the Late-Wisconsin glaciation (35,000–11,000 years B.P.) and bounded on the west by the forest-prairie interface and in the north by the current tree line. The region encompasses the states and provinces from Minnesota and Manitoba east to New England and the Atlantic provinces of Canada and south to the terminal moraines of New York, Pennsylvania, Ohio, Indiana, Illinois, and Missouri.

The book is divided into three sections dealing with 1) the physical (geomorphology, hydrology, remote and field identification of vernal pools), and 2) biological setting (flora and fauna) of vernal pools, and 3) aspects of conservation in the human modified landscapes that dominate in much of the region covered by the book. Each of the 16 chapters by 33 authors is self-standing, with its own set of references. The book is a companion to an earlier volume by Colburn (2004), which concentrated on the plants, invertebrates, and microorganisms of these wetlands. In contrast, this volume has a strong herpetological component, with five chapters (totaling 114 pages) devoted largely to amphibians and reptiles. In addition, the 12 color plates illustrating the book include eight images of vernal pool-associated amphibians and reptiles.

"Ecology and Conservation of Pool-Breeding Amphibians" by Semlitsch and Skelly deals with the life cycles, distribution, population and community dynamics, and spatial ecology of the 27 species that breed in the vernal pools of the northeast, along with the conservation implications of these parameters. Although only *Scaphiopus holbrookii* and *Rana sylvatica* (as well as *Pseudacris triseriata* in parts of its range) use vernal pools as their principle breeding habitats, nine of ten salamanders, including eight ambystomatids, *Hemidactylium*, and *Notophthalmus viridescens*, use them commonly.

In "The Importance of Vernal Pools to Reptiles, Birds, and Mammals," Joe Mitchell and colleagues report on the uses, mostly facultative, of vernal pools made by amniotes. Although as many as half of regional reptiles occasionally make use of these wetlands, only *Clemmys guttata*, *Emydoidea blandingii*, and, to a lesser extent, *Glyptemys insculpta* among the turtles, and *Nerodia erythrogaster* and *Thamnophis sauritus* among the snakes, can be considered to commonly use vernal pools and their edges for activities such as foraging, thermoregulation, nesting, and aestivation.

In "Population and Genetic Linkages of Vernal Pool-Associated Amphibians" by Gibbs and Reed, drift, inbreeding, extinction, and migration distance relative to the clustering of vernal pools are considered. Because of low population sizes and local fluctuations inbreeding and drift may be particularly important. The authors highlight the general lack of population structure data, which are necessary in order to develop intelligent conservation strategies.

The remaining herpetological chapters, "Conserving Vernal Pool Amphibians in Managed Forests" and "Spatial Tools for Conserving Pool-Breeding Amphibians," are grouped in the conservation section of the book. The first of these highlights the importance of forest management practices for conserving amphibians. It stresses the need for a high percentage of canopy cover to maintain amphibian abundance and the importance of complex life cycles and philopatry in planning tree harvesting operations in areas with vernal pools. This is particularly critical in areas such as Maine and New Brunswick, where forests cover more than 85% of the landscape.

The second chapter advocates a landscape species approach to conservation. Landscape species are those that require habitats in multiple ecosystems within a landscape in order to survive. Using the example of *Rana sylvatica* in Maine, the authors demonstrate how gap analysis can be used to identify focal landscapes of conservation concern where landscape elements of high value to amphibians intersect with human landscape elements that threaten amphibians.

Other chapters in this section of the book include those on conservation policy, chemical contamination, conservation in urbanizing environments, vernal pools as outdoor laboratories for education, and community-based conservation initiatives. The book concludes with a detailed subject index that also includes taxa discussed, but only by common name (except in the case of certain key plants, such as *Sphagnum*).

Vernal pools are disproportionately significant in ecological terms because of the high diversity of organisms they support. Their small size is a double-edged sword; their ubiquity in the glaciated landscape, as well as their manageable dimensions makes them especially amenable to study, but also leaves them vulnerable to destruction and in particular need of conservation. Amphibians, because of both their varied uses of vernal pools and associated habitats during the course of their complex life cycles and their sensitivity to environmental perturbations, have been particularly valuable in the interpretation of complex ecological interactions in vernal pools and influential in the practical implementation of conservation strategies in the glaciated landscapes of the Northeast.

Collectively, the contributions in this volume present the physical and biological data that explain the structure of vernal pool communities and explore the ways in which an understanding of vernal pools can inform land, water, and wildlife management decisions and guide conservation priorities. Although of broad relevance to herpetologists, ecologists, and other biologists working in the northeastern United States and eastern Canada, the high cost of the book may limit its distribution. However, it will be of particular value to natural resource managers and conservation biologists,

for whom the investment may well be justified.

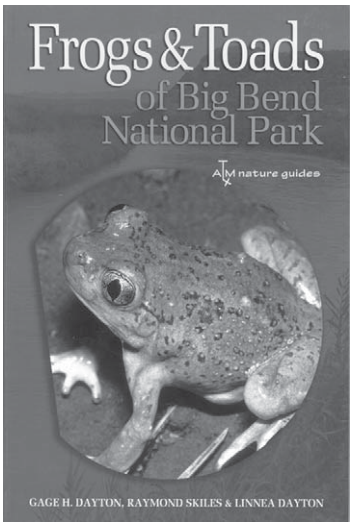
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Frogs and Toads of Big Bend National Park, by Gage H. Dayton, Raymond Skiles, and Linnea Dayton. 2007. Texas A&M University Press, College Station, Texas (www.tamu.edu/upress). xi + 51 pp. Softcover. US $12.95. ISBN 1-58544-574-2.

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Big Bend National Park (BBNP) is not only the largest national park in Texas, it is also located in one of the most herpetologically diverse regions of the state (Owen 1989). Available literature regarding field identification of the amphibians of BBNP can be found in two distinct categories—locally specific and state or national. Locally specific nature guides appeal to naturalists with general interests in the Big Bend region but often are not descriptive enough with respect to amphibian lifestyles and distributions (e.g., Wauer and Fleming 2002), whereas state or national guides lack local appeal and are too generalized to provide relevant information regarding regional variation or natural history (e.g., Garrett and Barker 1987; Conant and Collins 1998). This leaves visitors, biologists, and wildlife enthusiasts to identify what they see at Big Bend with suboptimal, or even misleading (e.g., Eifert and Eifert, 2007), nature guides. *Frogs and Toads of Big Bend National Park* provides a welcome alternative.

Few national parks have received such taxon-specific attention with respect to any group of organisms, let alone amphibians. BBNP, and West Texas in general, has lower amphibian diversity than eastern portions of the state (Owen 1989). Regardless, the species present in BBNP include some interesting and unique anurans. Considering the remoteness of this region, the diversity of the taxa present in the park, and the book's applicability to its surrounding vicinity, this guide is fully warranted. Specialized regional field guides like this one will provide useful information to park and regional visitors, naturalists, and herpetologists, and have the potential to spur the production of more locally specialized field guides.

It is obvious that a great deal of care went into designing the layout of this book from cover to cover. The book is field-ready—it is extremely easy to handle (it could fit in a big pocket) and the plasticized soft-cover binding can handle the elements. The contents go far beyond those of most other field guides. The authors present this guide as a culmination of a seven-year amphibian survey in BBNP. Every species account provides identification tips and natural history, as well as a brief description of where in the park the species has been found. The authors describe 11 of the 12 known amphibian species from the park in great detail—*Hyla cinerea*, a recent addition to the park checklist (Leavitt et al. 2007), is excluded. The traditional field guide format of species accounts is abandoned to describe recent population trends and life history traits unique to these desert amphibians.

Many high-quality color photographs are presented for each species, although a few are used more than once. Many of these species have variable patterns and unique behavioral or ecological characteristics, and a few more photographs representing this morphological and biological diversity could have been provided. The photos work well in conjunction with the authors' useful dichotomous key to the species, greatly facilitating field identification of the frogs and toads of BBNP. Specialized terms relating to amphibians and the desert environment that are used in the key and elsewhere in the book are defined in a two-page glossary. It is unfortunate that page numbers of species accounts are not provided in the key, as this would simplify the identification process. Another minor issue is that authors refer to *Spea multiplicata* as the Mexican Spadefoot in the text and as the New Mexico Spadefoot in the key. Although such minor problems hardly detract from such a well-executed book, they should be considered for improvement in future editions. The book closes with a literature referenced section—for the studious, and an index—for the forgetful.

Overall, *Frogs and Toads of BBNP* has a very strong appeal for both scholars and naturalists. Throughout the species accounts the authors integrate their knowledge of, and concern for, conservation of BBNP anurans with field identification basics, providing a field guide that will be a great addition to the library of anyone interested in Big Bend or the frog fauna of the southwest.

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PUBLICATIONS RECEIVED

The Frog-Biting Midges of the World (Corethrellidae: Diptera), by Art Borkent. 2008. Zootaxa 1804:1–456. Online publication (www.mapress.com/zootaxa/). ISBN 978-1-86977-211-3 [also available in paper copy edition].

This monograph on dipteran insects is of direct relevance to herpetologists because females of corethrellid midges are attracted by the calls of male frogs and feed on their blood. Immature stages of the midges may be associated with terrestrial habitats or phytotelmata. At least some species are known to transmit *Trypanosoma* to the frogs they feed upon. This major treatment of the group recognizes 97 extant species—52 of them new, and seven fossil forms, of which two are described as new. In addition to species accounts and descriptions *per se*, the work includes a cladistic analysis of the Corethrellidae as well as maps and keys for all of the recognized taxa. Biogeography of the group should be of special interest to herpetologists because of the close association between fly and midge—at least some taxa are host-specific in their feeding preferences. The author concludes that the frog feeding lifestyle of these insects dates from the early Cretaceous and considers that some patterns of affinity and distribution are reflective of Gondwanan origins. Abstracts of this, as well as many taxonomic papers and monographs dealing with amphibians and reptiles (as well as all other animal groups), can be accessed at the Zootaxa website. Some Zootaxa publications are open access, others are available for purchase in hardcopy or electronically through personal or institutional library subscription.

Don't Touch That! The Book of Gross, Poisonous, and Downright Icky Plants and Critters, by Jeff Day. 2008. Chicago Review Books (available through Independent Publishers Group; www.ipgbook.com). [iv] + 108 pp. Softcover. US $9.95. ISBN 978-1-55652-711-1.

This book is intended for children aged seven to nine. It presents for its young readers an overview of the poisonous, venomous, and otherwise dangerous plants and animals of North America (with vignettes dealing with some exotic taxa). The book is humorously written and illustrated by numerous cartoons depicting the relevant wildlife and their effects on humans. The information presented is fundamentally sound and clearly presented. The author, who is both a pediatrician and cartoonist, has creatively taken advantage of children's love of all things that most adults find disgusting to present a quite practical primer. In addition to amphibians and reptiles, the book considers plants (poison ivy, stinging nettle, mushrooms, etc.), insects (bees, wasps, ants, fleas, lice, mosquitoes), spiders (as well as scorpions and ticks), mammals (porcupines and skunks as well as domestic and wild mammal bites and their associated complications—rabies, tetanus, etc). The herpetological section of the book discusses amphibian skin secretions in general, *Salmonella*, pit vipers, and gila monsters. It provides basic information about the identification of venomous snakes, the venom apparatus, effects of venom on the body, snakebite treatment, production of antivenin, and tips for avoiding snakebites. The philosophy of the book is that learning about potentially dangerous organisms in their surroundings will allow kids not only to avoid trouble but to confidently explore and enjoy nature. *Don't Touch That!* should make a good gift for budding naturalists.



HERPETOLOGICAL CONSERVATION VOLUME 3

URBAN HERPETOLOGY

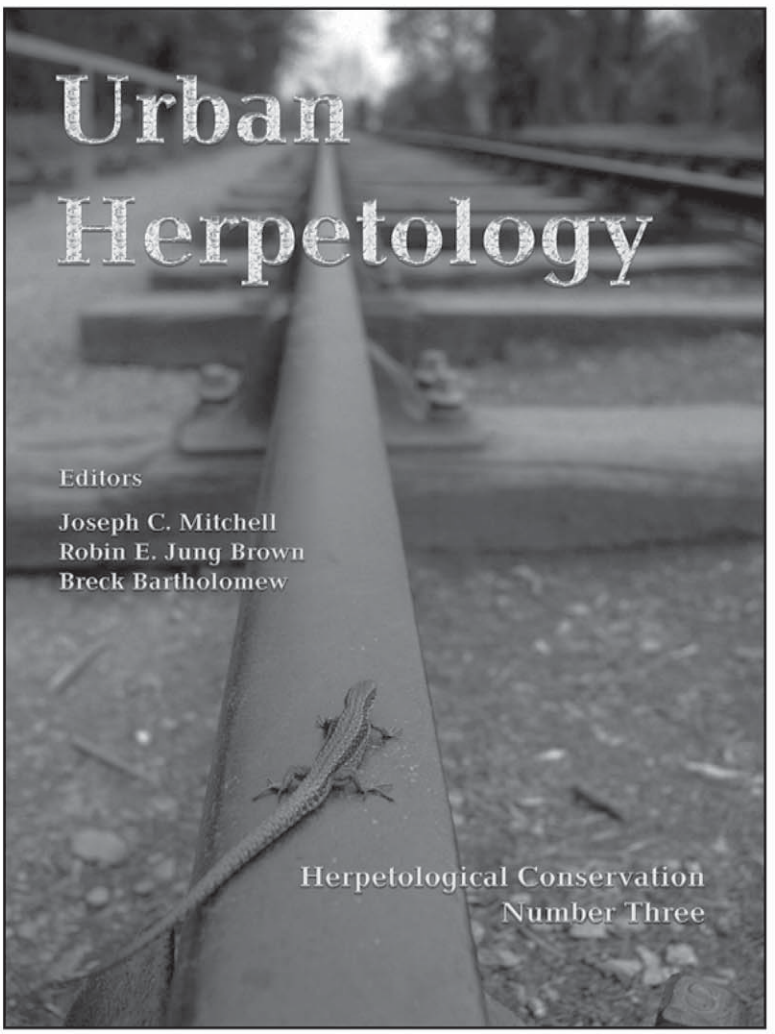
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Foreword by John M. Marzluff

Afterword by Michael J. Lannoo

Illustrations by Carel P. Brest van Kempen

120 contributing authors from around the world



Herpetologists in some parts of the world, notably Europe and Russia, have long engaged in studies of amphibians and reptiles in urban environments. Urbanization is progressing at such a rapid pace that herpetofaunal populations are becoming extirpated and species continue to decline. This book shows how studies of amphibians and reptiles in urban systems have much to offer scientists, conservation biologists, and land managers, and how important conservation, education, and management efforts are to the continued persistence of amphibians and reptiles in urban settings.

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A New Facsimile Reprint from the Society for the Study of Amphibians and Reptiles

THE LIFE AND HERPETOLOGICAL CONTRIBUTIONS OF
AUGUST FRIEDRICH SCHWEIGGER (1783–1821)



August Friedrich Schweigger (1783–1821) was best known to the world as a botanist, but his contributions to herpetology were of great importance. In his major work, *Prodromus Monographiae Cheloniorum*, published in Latin in 1812, Schweigger provided a comprehensive overview of the chelonians of the world, giving accounts for 84 nominal taxa in six genera. Of these, 24 were described as new; 14 of these species remain valid today. Among the taxa authored by Schweigger are such well known species as *Melanochelys trijuga*, *Pelusios castaneus*, *Mauremys leprosa*, *Podocnemis expansa*, and *Chersina angulata*, as well as the generic name *Chelydra*. In addition to this 157 page paper, the facsimile includes Schweigger's later (1814) chelonian monograph (66 pages), with some corrections and changes to his 1812 paper, and a never-before published manuscript (72 pages) from 1809, representing the earliest version of his classification of turtles.

The facsimiles are accompanied by a detailed 79 page bilingual (English/French) introduction by Roger Bour. It details Schweigger's early research in Paris, his academic successes in East Prussia, and his tragic murder in Sicily while on a collecting trip. Taxonomic and bibliographic comments on the reprinted works are also provided, as is a 200+ word Latin-English-French lexicon to facilitate use of the original Latin papers.

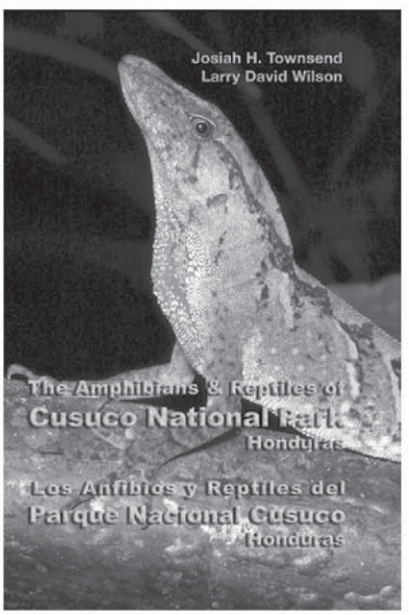




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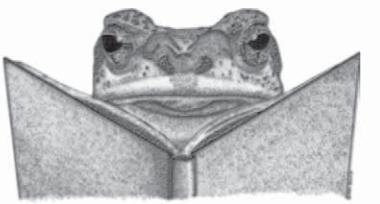
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Josiah H. Townsend and Larry David Wilson

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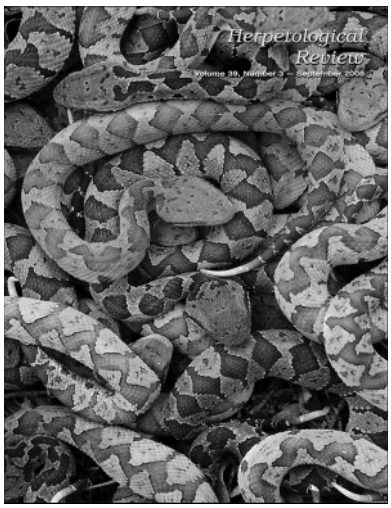
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About Our Cover: *Atropoides mexicanus*



The Central American Jumping Viper, *Atropoides mexicanus*, is one of five species assigned to the genus *Atropoides*. Exceptionally stout snakes with heavily keeled scales, the taxonomy of this morphologically similar group of pitvipers is not well resolved. Recent phylogenetic analysis suggests undescribed taxonomic diversity within the genus (Castoe et al. 2005. Molecular Phylogenetics and Evolution 37:881–898). Ranging from southern Mexico to central Panama, *A. mexicanus* is essentially a sedentary, mostly terrestrial species inhabiting tropical moist to wet forests at 40–1600 m in elevation. Adults average 50–70 cm TL, but can occasionally reach lengths of over 90 cm.

What's in a name? Throughout Central America this species is commonly referred to as "Mano de Piedra," in reference to its resemblance to a stout implement used in grinding corn in the making of tortillas. The vigorous striking ability of this species has led to grossly exaggerated claims that it is capable of launching itself a distance equal to or greater than to its own body length, hence the common English name of "Jumping Viper." Even the late Raymond Ditmars suggested that this snake may be able to jump as much as a yard if given "good purchase to lurch its coils" (Ditmars 1931. Snakes of the World. Macmillan, New York. 270 pp.). In reality, the striking distance of this snake might possibly cover a distance of half of its own body length.

Solórzano (1989. Revista Biología Tropical 37[2]:133–137) found that *A. mexicanus* reproduction in Costa Rica was distinctly seasonal depending on geography. Females from the Pacific versant gave birth in the late dry to early rainy season (March–June), whereas females from the Atlantic versant and areas of the Central Plateau gave birth during the rainy season (August–November). From five to thirty-seven young have been reported in single litters, with the smallest gravid female being just 38 cm in total length (March 1929. Bulletin of the Antivenom Institute of America 3[1]:27–29).

The 22 juveniles featured on the cover were born on 31 August 2007 from a captive 65 cm (TL) Honduran female. Considerable polymorphism exists even within single litters, as evidenced by the variation in color in these juveniles. Young are reported to feed primarily on orthopterans and lizards in the wild (Campbell 1998. The Amphibians and Reptiles of Northern Guatemala, Yucatán, and Belize. University of Oklahoma Press, Norman. 367 pp.); however, captive born individuals will readily consume small mice. Although born with cream-to-yellow tail tips, caudal luring has not been reported in this species.

The rather calm juveniles were photographed using a Nikon D50 digital SLR camera with a Sigma 90mm macro lens the day following their birth. The image was recorded using natural light with fill flash from the camera. Photographer **R. Michael Burger** has been involved with amphibians and reptiles for four decades. His articles have appeared in a variety of North American and European publications, including recent issues of *Zoo Biology*, *Herpetological Journal*, *Reptiles Magazine*, as well as in the recently published book *Biology of the Boas and Pythons*. Michael lives with his understanding wife on a small ranch in Mabank, Texas.



PHOTO BY VERONICA BURGER

SSAR BUSINESS

Kennedy Student Award Committee

The Kennedy Award Committee (Carl Anthony, Bill Lutterschmidt, Terry Schwaner, Wayne VanDevender, Lynnette Sievert, Chair) has completed its work for Volume 41 of the *Journal of Herpetology*. The Committee has selected "Phylogenetic and Systematic Study of the Genus *Bombina* (Amphibia: Anura: Bombinatoridae): New Insights from Molecular Data" by **Guohua Yu**, Junxing Yang, Mingwang Zhang, and Dingqi Rao (Vol. 41:365–377). The Kennedy Award carries with it a cash prize of US $200 or the winner's selection of any SSAR publications valued at twice that amount.

The committee invites all student members of the Society to submit their work to the Journal, and encourages regular members who supervise the work of students to draw this award to the attention of those students.

Annual Report (2008)
Grants-in-Herpetology Committee

An award in the amount of US $500 was made to each of the following individuals:

Conservation.—Sara M. Maxwell, University of California, Santa Cruz. Project title: "Conservation of olive ridley sea turtles in Central Africa."

Field Research.—Sarah Becker, Southern Illinois University. Project title: "Hanging out with cool frogs: Microhabitat temperatures' effect on disease susceptibility."

Laboratory Research.—William T. McLamb, Florida Institute of Technology. Project title: "Molecular and physiological characterization of infrared thermosensation in boid and crotaline snakes."

Travel.—Kyna M. Hogg, University of North Dakota. Project title: "Landscape level distribution and effects of landscape configuration and habitat on several anurans of three river drainages in North Dakota."

International.—Michael Hailu, Addis Ababa University, Ethiopia. Project title: "Status, social organization and conservation of the vulnerable African spurred tortoise, in East Rift Valley, Ethiopia."

Education.—Mike Hickel, Rolling Hills Wildlife Adventure, Salina, Kansas. Project title: "Public Herpetological Field Guide."

2008 Grants-in-Herpetology Committee.—Co-chairs: Erik R. Wild and Josh Kapfer. Reviewers: Jeffrey Parmelee, Rich Seigel, Vince Cobb, Brian Smith, Brian Greene, Matt Rowe, Rebecca Christoffel, Rich King, David Wake, Stephen Richter, Jerry Husak, Michael Pauers, Chirstopher Beachy. SSAR congratulates the 2008 GIH recipients and thanks the committee members for their efforts.

NEWSNOTES

Amphibian Ark's Amphibian Population Management Guidelines Released

In December 2007, a group of population biologists, amphibian husbandry experts, and software developers gathered for two days in San Diego, California. The goal of the workshop was to develop a series of population management guidelines that would cover all species of amphibians, and be useful for a wide-ranging audience, from population biologists to amphibian breeders.

The *Amphibian Population Management Guidelines* are now available for download at: http://www.amphibianark.org/

MEETINGS

Meetings Calendar

Meeting announcement information should be sent directly to the Editor (rwh13@csufresno.edu) well in advance of the event.

3–4 October 2008—Annual Meeting of the Gopher Tortoise Council, Jekyll Island, Georgia, USA. Refer to meeting announcement above.

7–9 November 2008—35th Annual Meeting of the Kansas Herpetological Society, Wichita, Kansas, USA. Information: http://www.cnah.org/khs/AnnualMeetingInfo.html.

24–29 November 2008—VIII Latin-American Congress of Herpetology (VIII Congreso Latinoamericano de Herpetologia), Topes de Collantes, Sancti Spiritus, Cuba. Information: Roberto Alonso Bosch (e-mail: 8voclah@fbio.uh.cu or ralonso@ecologia.cu).

CURRENT RESEARCH

The purpose of Current Research is to present brief summaries and citations for selected papers from journals other than those published by the American Society of Ichthyologists and Herpetologists, The Herpetologists' League, and the Society for the Study of Amphibians and Reptiles. Limited space prohibits comprehensive coverage of the literature, but an effort will be made to cover a variety of taxa and topics. To ensure that the coverage is as broad and current as possible, authors are invited to send reprints to the Current Research section editors, Joshua Hale or Ben Lowe; postal and e-mail addresses may be found on the inside front cover.

The current contents of various herpetological journals and other publications can be found at: http://www.herplit.com/contents.

Adaptive Significance of Temperature-Dependent Sex Determination

It has been known for some time that for many species sex is determined by the temperature that the eggs are exposed to during development. It has long been thought that temperature-dependent sex determination (TSD) is advantageous when the temperature experienced during development differentially influences the fitness of males and females. However, experiments to test for the adaptive significance of TSD have been elusive. By treating the eggs of Jacky Dragons (*Amphibolurus muricatus*) with hormones, the authors of this study generated males at temperatures that would normally produce females. Some males generated under typical male-producing temperatures were also treated with the hormones to ensure that the hormones themselves had no effect on fitness. They then compared the fitness (measured in reproductive output) of males generated under the different temperatures over the next 3.5 years. As predicted, males produced under typical male-generating conditions exhibited a significantly higher fitness than the hormone-treated males.

Warner, D. A., and R. Shine. 2008. The adaptive significance of temperature-dependent sex determination in a reptile. Nature 451:566–568.

Correspondence to: Dan Warner, 234 Bessey Hall, Department of Ecology, Evolution and Organismal Biology, Iowa State University, Ames, Iowa 50011, USA; e-mail: dwarner@iastate.edu.

Impact of Saltcedar Removal on Lizards

Saltcedar (*Tamarax* spp.) has invaded many riparian ecosystems in the American Southwest, often to the detriment of native fauna and flora. However, to date, no study has documented the effects of saltcedar removal on reptiles. In this study, the authors attempted to document the impact of saltcedar control methods on communities of lizards along the Rio Grande in central New Mexico, habitats historically dominated by cottonwood (*Populus deltoides*). The relative abundances of the six most frequently encountered lizard species was monitored at twelve sites for seven years. For every three sites that experienced saltcedar removal, one was left untreated as a control. Analyses revealed an increase in abundance for two species and no significant decrease in abundance for any species after non-native plant removal. The authors suggest that removing non-native understory plants allows more opportunities for lizards to bask in areas where light penetrates the canopy.

Bateman, H. L., A. Chung-MacCoubrey, and H. L. Snell. 2008. Impact of non-native plant removal on lizards in riparian habitats in the southwestern United States. Restoration Ecology 16(1):180–190.

Correspondence to: Heather Bateman, USDA Forest Service, Rocky Mountain Research Station, 333 Broadway SE, Suite 115, Albuquerque, New Mexico 87102, USA; e-mail: heather.bateman@gmail.com.

Effects of Thyroxine on Salamander Metamorphosis

Many studies have examined amphibian metamorphosis; however little is known about the patterns of gene expression that transpire during salamander metamorphosis. In this study, the authors attempted to document how thyroxine (T_4; a thyroid

hormone) concentrations affect metamorphosis and gene expression in the Mexican Axolotl (*Ambystoma mexicanum*), an obligate paedomorph that can be induced to metamorphose when exposed to thyroid hormones in the laboratory. Individuals were exposed to two different concentrations of T_4 and the subsequent metamorphosis was observed. Different concentrations of T_4 were found to affect the timing of the onset of the metamorphosis but not the duration. While many of the genes found to be expressed during metamorphosis were also known to be activated during anuran metamorphosis, there were also some differences, highlighting the importance of studying metamorphosis in diverse amphibian taxa.

PAGE, R. B., S. R. VOSS, A. K. SAMUELS, J. J. SMITH, S. PUTTA, AND C. K. BEACHY. 2008. Effect of thyroid hormone concentration on the transcriptional response underlying induced metamorphosis in the Mexican axolotl (*Ambystoma*). BMC Genomics 9:78 (17 pp.).

Correspondence to: Robert Page, Deptartment of Biology, University of Kentucky, Lexington, Kentucky 40506, USA; e-mail: robert.page@uky.edu.

Use of Forked Tongue for Edge Detection in Snakes

It has been hypothesized that the deeply forked tongue of some squamates functions as a chemical "edge detector," where cues gathered by each tine are kept separate to provide the central nervous system with two points of lateral odor assessment via the vomeronasal nerve. While following a chemical trail, one tine can be on the trail, the other off, and such differential information prompts the snake to turn back to the trail. It has been shown that in snakes, complete disruption of the vomeronasal nerve severely impairs the ability to track prey; however, no study has attempted to unilaterally disrupt the vomeronasal nerve to determine the impact on tracking ability. The authors of this study compared the tracking ability of Western Rattlesnakes (*Crotalus oreganus*) before and after severing one side of the vomeronasal nerve. The authors found no change in the seven separate trailing parameters measured. They suggest instead that deeply forked tongues may represent a chemosensory specialization to increase odor-sampling area.

PARKER, M. R., B. A. YOUNG, AND K. V. KARDONG. 2008. The forked tongue and edge detection in snakes (*Crotalus oreganus*): An experimental test. Journal of Comparative Psychology 122(1):35–40.

Correspondence to: M. Rockwell Parker, Department of Zoology, Oregon State University, 3029 Cordley Hall, Corvallis, Oregon 97331-2914, USA; e-mail: parkermi@science.oregonstate.edu.

Massive Scale Turtle Farming in China

As the demand for turtle products has increased over the past 20 years, entrepreneurs in China have initiated large-scale commercial breeding facilities for profit. However, due to the secrecy of these operations, it has been difficult to fully appreciate the magnitude of Chinese turtle farming, and it is often assumed that most turtles in food markets and the pet trade come from the wild. Therefore, understanding the scale and scope of Chinese turtle farms is an important step towards understanding China's role in the Asian turtle crisis. The authors surveyed Chinese turtle farms with questionnaires in 2002 that included questions about which species were being farmed and their estimated annual yield. The results indicated that most native species of freshwater turtles are bred in Chinese turtle farms. Additionally, based on the responses and accounting for the percentage of farms that failed to respond, the authors estimate that the Chinese captive turtle trade generates annual revenue of US $1.3 billion. They stress that these extrapolations are conservative estimates because most farms operate illegally. Finally, the authors state that the farms do not serve as potential conservation resources and instead advocate the establishment of protected natural areas to preserve the few remaining populations of wild Chinese turtles.

HAITAO, S., J. F. PARHAM, F. ZHIYONG, H. MEILING, AND Y. FENG. 2008. Evidence for the massive scale of turtle farming in China. Oryx 42(1):147–150.

Correspondence to: Shi Haitao, Department of Biology, Hainan Normal University, Haikou, 571158, Hainan Province, China; e-mail: haitao-shi@263.net.

Amphibians Do Not Follow Bergmann's Rule

Bergmann's Rule, the pattern where organisms tend to be larger in cooler climates, has historically been thought to apply to endothermic and possibly ectothermic vertebrates, including amphibians. The authors tested this hypothesis by measuring 96,996 adult *Plethodon* salamanders from the eastern United States, belonging to 40 species, 3974 populations, and 3213 geographic locations. Typical adult body size and mean climate metrics were generated for both species and populations within species. Relationships between latitude and size were examined at both the inter- and intraspecific levels. The authors accumulated data from other studies of salamanders, frogs, and caecilians to look for Bergmann's Rule at higher levels. Of the 40 *Plethodon* species examined, only 3 exhibited a pattern concordant with Bergmann's Rule. Additionally, no relationship was found between body size and temperature among species of *Plethodon*. Finally, the meta-analysis revealed no support for Bergmann's Rule at either the order (Caudata) or class (Amphibia) levels.

ADAMS, D. C., AND J. O. CHURCH. 2008. Amphibians do not follow Bergmann's Rule. Evolution 62(2):413–420.

Correspondence to: Dean Adams, Department of Ecology, Evolution, and Organismal Biology, Iowa State University, Ames, Iowa 50011, USA; e-mail: dcadams@iastate.edu.

Character Clines Across a Recent Secondary Contact Zone in a Hispaniolan *Ameiva*

Within species, character clines at areas of secondary contact between morphologically differentiated lineages are maintained by the relative strengths of endogenous (selection against hybrid genotypes) and exogenous (differential selection across an environmental gradient) forces. While they superficially resemble each other, clines maintained by exogenous factors

should be strongly correlated with an ecotone (a transitional area between two ecosystems), while clines maintained by endogenous factors should be independent of the environment and instead display spatial clustering. The author examined a secondary contact zone in the teiid *Ameiva chrysolaema* that occurs near an environmental transition zone that runs east–west along the southern coast of Hispaniola. Morphological (measurements and scale counts; treated separately), mitochondrial DNA, nuclear DNA, and climactic data were collected from nine localities across the ecotone. A canonical variates analysis was performed on the measurement data and mean values were generated for all data types for each locality. The means were then plotted against distance along the transect and tested for concordance. The analyses revealed that the clines were not coincident, with the mitochondrial DNA cline being located quite far from the morphological and nuclear DNA clines. Additionally, the shape and location of the scale cline is coincident with the environmental data cline. Therefore, it is likely that the transition zone is primarily maintained by exogenous factors and there is little selection against hybrid genotypes.

GIFFORD, M. E. 2008. Divergent character clines across a recent secondary contact zone in a Hispaniolan lizard. Journal of Zoology 274:292–300.

Correspondence to: Matthew Gifford, Department of Biology, Campus Box 1137, Washington University, Saint Louis, MO 63130, USA; e-mail: gifford@biology2.wustl.edu.

Urosaurus nigricaudus Phylogeography

Historically, maternally-inherited mitochondrial (mt)DNA has been relied upon to infer intraspecific relationships; however, a growing importance has been placed on incorporating bipaternally-inherited nuclear DNA in phylogeographic analyses. In this study, the authors compared a mtDNA phylogeny generated in this study to previously published allozyme data in an attempt to elucidate the historical biogeography of the Black-tailed Brush Lizard (*Urosaurus nigricaudus*), a species that ranges throughout Mexico's Baja California peninsula. The existing allozyme data suggest moderate genetic divergences exist along the peninsula, with the deepest divergence occurring at mid-peninsula. Many researchers have attributed the various genetic breaks observed along the peninsula in this and other codistributed taxa to seaways that in the past have isolated northern and southern populations. The recovered mtDNA breaks were found to be discordant with respect to the allozyme data, with the deepest genetic break at the southern end of the peninsula. This incongruence is interpreted as ongoing gene flow following a past vicariant event, possibly in conjunction with sex-differential dispersal patterns.

LINDELL, J., F. R. MÉNDEZ-DE LA CRUZ, AND R. W. MURPHY. 2008. Deep biogeographical history and cytonuclear discordance in the black-tailed brush lizard (*Urosaurus nigricaudus*) of Baja California. Biological Journal of the Linnean Society 94:89–104.

Correspondence to: Johan Lindell, Department of Evolutionary Biology, Evolutionary Biology Centre, Uppsala University, Norbyvägen 18D, SE-752 36 Uppsala, Sweden; e-mail: johan.lindell@ebc.uu.se.

Sphenodon Tail Autotomy

Tail autotomy occurs in most major Squamata lineages as well as Rhynchocephalia (*Sphenodon*). However, relative to squamates, little attention has been paid to tail autotomy and regeneration in rhynchocephalians. In this study, the authors examined > 200 preserved, skeletonized, and live *Sphenodon* in an attempt to characterize the nature of tail-loss and regrowth in this taxon. Their anatomical findings regarding tail autotomy in general, and in particular tail loss via intravertebral autotomy, largely corroborate previous studies. Interestingly, unlike the typical condition in squamates, both the frequency of tail autotomy and the length of intact tail was found to be equivalent in both sexes. As is common in squamates, left-side dominant individuals showed statistically elevated injury rates, including rates of tail autotomy. While the precise cause of this difference between left- and right-side dominant individuals in injury rate is unknown, the authors suggest that it is potentially related to escape capacity, in particular, speed. Additionally, tail-keeping and tail-losing males exhibited morphological differences echoing the sexual dimorphism observed between males and females, with tail-losing males resembling females.

SELIGMANN, H., J. MORAVEC, AND Y. L. WERNER. 2008. Morphological, functional and evolutionary aspects of tail autotomy and regeneration in the 'living fossil' *Sphenodon* (Reptilia: Rhynchocephalia). Biological Journal of the Linnean Society 93:721–743.

Correspondence to: Yehudah Werner, Department of Evolution, Systematics and Ecology, The Hebrew University of Jerusalem, 91904 Jerusalem, Israel; e-mail: yehudahw@vms.huji.ac.il.

Lungless Frog Discovered in Borneo

Until recently, the only extant tetrapods known to have undergone a complete loss of lungs belonged to two salamander families and a single species of caecilian. The authors describe the first species of lungless anuran, *Barbourula kalimantanensis* (Discoglossidae), recently discovered in the highlands of Borneo. This species, which inhabits cold, fast-flowing streams, was initially known from two specimens collected in the 1970s and 1980s. The original collection locality was subsequently rendered uninhabitable by illegal gold mining operations. A recent expedition rediscovered the species upstream from the original locality. Examination of the additional specimens led to the discovery of its lack of lungs. This loss of respiratory structures extends to the loss of the glottis, allowing for an enlarged esophageal opening. An anatomical examination of the only other member of the genus, *B. busuangensis* from the Philippines, revealed an intact and functioning respiratory system. As its habitat is rapidly being degraded, immediate actions must be undertaken to ensure the survival of this enigmatic aquatic frog.

BICKFORD, D., D. ISKANDAR, AND A. BARLIAN. 2008. A lungless frog discovered on Borneo. Current Biology 18(9):R374–R375.

Correspondence to: David Bickford, National University of Singapore, 14 Science Drive 4, 117543 Singapore; e-mail: rokrok@nus.edu.sg.

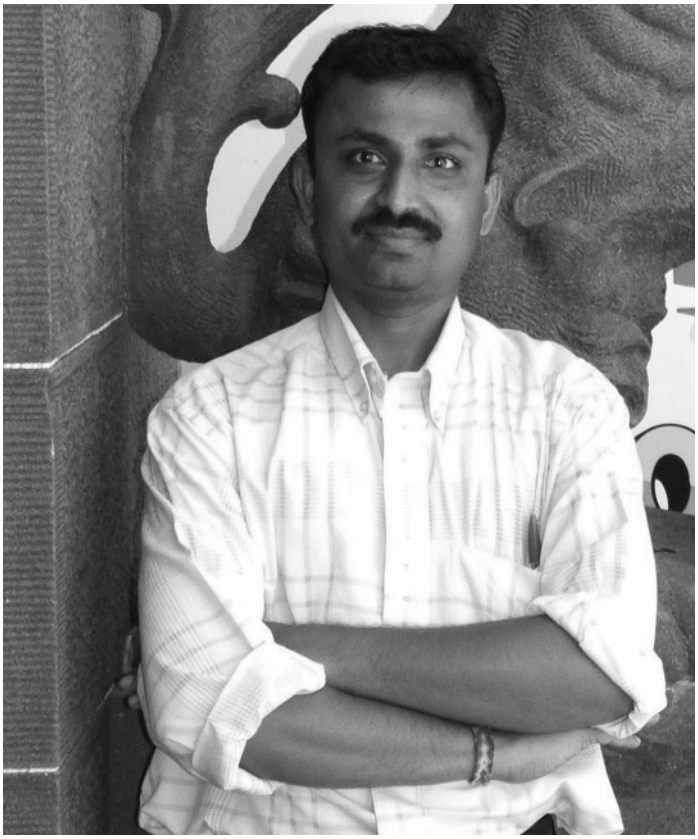
OBITUARIES

Herpetological Review, 2008, 39(3), 261–262.
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Rajkumar Shivappa Radder (1973–2008)

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Dr. Rajkumar S. Radder, popularly known as 'Raju,' passed away on 31 May 2008 due to cardiac arrest at his home at Mulawad (India) at the age of 34. Raju was born in a small village in the Bijapur district of Karnataka State, India. He was the second of four children of Mr. Shivappa R. Radder, a retired high school Head-Master, and mother Anusuya. Raju was schooled at his village and obtained first place in the final secondary school public examination in the district. During his school days, Raju was active in a variety of extracurricular aspects that included participation in Scouts and Guides. Indeed, Raju received an award as the Best Scout, at state level. He was also an accomplished and enthusiastic cricketer.

Raju obtained his bachelor's degree in science at Bijapur and joined Karnatak University, Dharwad, India in 1994 for his Master's degree in Zoology. His professors recall Raju as a very impressive student, always eager to learn diverse aspects of biology. Raju completed his degree, with top ranking, in the year 1996. He remained in the same department for his doctoral work, under the supervision of Prof. B. A. Shanbhag and with Prof. S. K. Saidapur as co-guide. Raju conducted original research on the garden lizard, *Calotes versicolor* and discovered many interesting phenomena. For example, he found embryonic diapause, and an ability for long-term oviductal retention of eggs (up to 6 months: Radder et al. 1998). Raju also identified a possible mechanism for prolonged egg retention (maternal selection of lower body temperatures). He also explored and refined a wide range of methodologies, including manipulation of egg and clutch sizes by "allometric engineering" methods.

As well as his facility at laboratory studies, Raju enjoyed working in the field—even under difficult conditions. He conducted pioneering demographic studies on the fan-throated lizard, *Sitana ponticerana* and the rock lizard, *Psammophilus dorsalis* (Radder et al. 2005; Shanbhag et al. 2003). Raju began publishing papers in major international journals, and soon achieved significant national recognition as an upcoming herpetologist and evolutionary biologist. He was honored with the prestigious 'Young Scientist Award' by the Indian Science Congress (2002) and the 'Young Scientist Medal' by the Indian National Science Academy, New Delhi (2003). These are the two most prestigious such awards in India, and winning both was a remarkable achievement.

Raju rapidly built up an international as well as national reputation. In 2001 he approached Rick Shine at the University of Sydney about postdoctoral studies; and in 2003 Raju obtained a postdoctoral position funded by the Australian Research Council, to work on the adaptive significance of sex-determining systems in lizards. Raju arrived in Sydney early in 2004, and was employed by that institution until his untimely death in 2008. During his time at the University of Sydney, Raju initiated a wide range of collaborative projects with many people and on a diverse array of topics. Although the central theme of his research was sex determination, he found time to collaborate in studies on embryonic heart rates, ovarian morphology, yolk steroids, sex-based hatching asynchrony, the role of residual yolk for hatchling lizards, and the evolutionary significance of communal nesting (e.g., Radder 2007; Radder & Shine 2006, 2007a,b,c,d; Radder et al. 2007a,b,c, 2008a,b,c). All of these studies resulted in publications in major journals. Rick recalls a meeting of his research group, not too long after Raju first arrived, where Rick asked his people to briefly summarize their current projects. Just about everyone—students, postdocs, and research assistants—finished their summaries with "And also, Raju and I are doing a small study on …." The combination of Raju's infectious enthusiasm, his creative thinking, his willingness to discuss any aspect of science, his superb technical skills, and his mastery of a diverse array of analytical techniques, made him an extraordinary collaborator.

Raju's central project at the University of Sydney was to explore the complex sex-determination mechanism of a montane scincid lizard species. He showed that the conventional

division into "genetic sex determination" and "environmental sex determination" simply didn't work. These lizards have heteromorphic sex chromosomes (males are XY, females XX) but remarkably, incubation temperatures also influence offspring sex. Using genetic markers developed in collaboration with researchers at the University of Canberra, Raju's work demonstrated unambiguously that low incubation temperatures—temperatures often recorded in natural nests at high elevations—could turn genetically female offspring into phenotypic males (Radder et al. 2008c). He also pioneered methods for transferring yolk from one egg to another, and found strong evidence that such yolk transfer could determine the sex of the offspring: a truly novel sex-determination system. It is truly tragic that, having come so far on the path to understanding that system, Raju never had the chance to put the final pieces of the puzzle into place.

Through his time in both India and Australia, Raju was a wonderful colleague. A truly gentle human being, always respectful and polite, Raju nonetheless had a delightful sense of humor. At one conference of the Australian Society of Herpetologists, a particular delegate insisted on tapping away noisily at his laptop computer during student talks. Raju was deeply offended by this rudeness, so arranged for he and several friends to bring their laptops to that delegate's own talk—and to sit in the front row, all tapping away noisily, throughout the presentation. Raju had a superb skill at getting his point across without confrontation.

One of Raju's most impressive qualities was his ability to transcend cultural barriers in the course of his career in international science. For a man who grew up in a small village in India, Raju's ease in mixing on the international stage was truly impressive. During his time at the University of Sydney, Raju not only worked closely with people from many countries, but enthusiastically enmeshed himself in an Australian culture that at times must have seemed truly bizarre. During summers he spent many Sunday afternoons at a hotel near the University, watching cricket on TV and talking for hours with the local old-timers about their lives and experiences.

In his short life, Raju touched many of us very deeply. We have no doubt that he would soon have risen to be an international leader in his field, and his death is a great loss to evolutionary biology in general, as well as to herpetology in particular. We are enormously saddened at his death, but feel privileged to have had the opportunity to learn and laugh by his side.

A more detailed account of Raju's achievements, and a list of his publications (with downloadable PDFs) is available via the website http://www.bio.usyd.edu.au/Shinelab/.

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Erratum

In the recently published article, "Analysis and Comparison of Three Capture Methods for the Eastern Hellbender (*Cryptobranchus alleganiensis alleganiensis*)," by Foster et al. (2008. vol. 39, pp. 181–186), an incorrect version of Table 2 appeared due to a printing error. The correct version of this paper is available as a pdf from the corresponding author, Amy McMillan (e-mail: mcmillam@buffalostate.edu).

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Proposals are now being accepted for the 2009 SSAR Grants-in-Herpetology program. This program is intended to provide financial support for deserving individuals or organizations involved in herpetological research, education, or conservation. Application deadline is 31 December 2008. Grant application details are available at:

http://www.ssarherps.org/pages/GIH.php

ZOO VIEW

Updating the Bookshelves
Part I: Chelonians, Snakes, Amphibians

. . . interest in zoology is almost as much a physical part of the topography of reptile keepers' work as cleaning after animals. One of the ingredients that typifies a reptile keeper is nagging curiosity, and curiosity is something that cannot be taught. Answers to questions in zoology are tucked away in tons of technical literature. Popular sources of information— television, the warm glow of the Internet or entertaining articles for the lay audience with a generous dose of large color photos— are often too inadequate. A search for hard-core data requires a trip to the science section of a major library and hours of digging through hundreds of journals and volumes, in your own time. Unglamorous and tedious no doubt, but that is expected of professionals.

—Ken Kawata, 2005

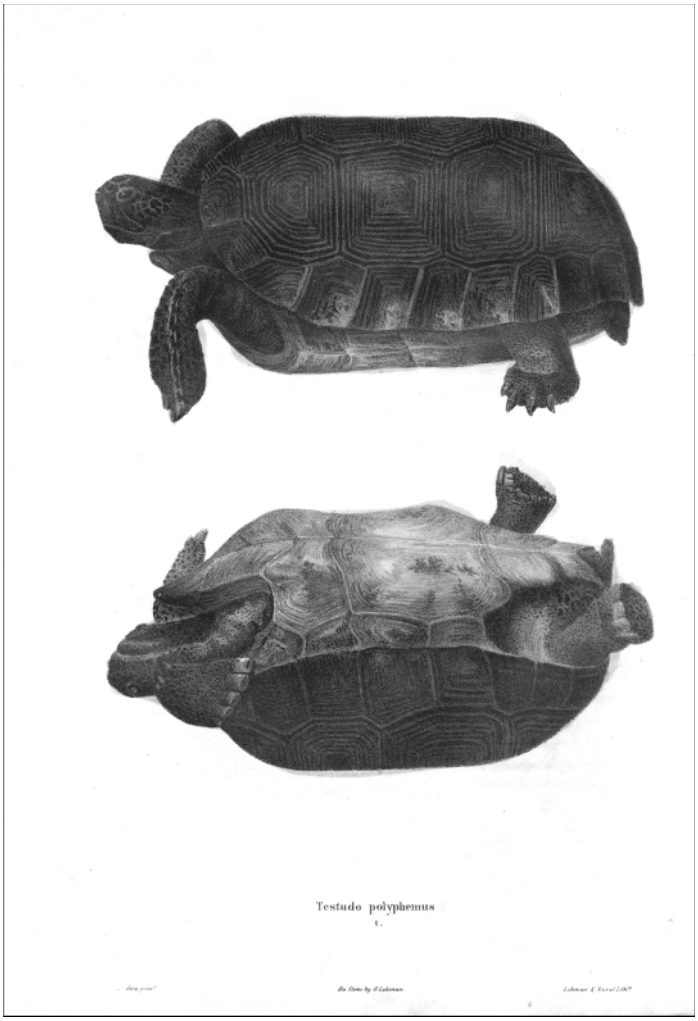
In William Shakespeare's *The Tempest* (Act 1, Scene 2), Prospero told us about the importance of a library when he said, "Me, poor man, my library was dukedom large enough." For anyone who dreams of building a working herpetological library, a number of books and papers have appeared in the past few years which will prove to be important references. I have selected some particularly useful ones below and paired them with historical images relevant to the publications. Part II will appear in the next issue.

Books and Papers on Chelonians

They select dry and sandy places, are generally found in troops, and are very abundant in pine barren countries. They are gentle in their habits, living entirely on vegetable substances. They are fond of the sweet potato, (Convolvulus batatas,) and at times do much injury to gardens, by destroying melons, as well as bulbous roots &c. &c. In the wild state they are represented as nocturnal animals, or as seeking their food by night: when domesticated, and I have kept many of them for years, they may be seen grazing at all hours of the day. When first placed in confinement, they chose the lowest part of the garden, where they could most easily burrow; this spot being once overflowed by salt water in a high spring tide, they migrated to the upper part, nearly eighty yards distant, and prepared anew their habitations. They seldom wandered far from their holes, and generally spent part of the day in their burrows. They delighted in the sun in mild weather, but could not support the intense heat of our summer noons; at those hours they retreated to their holes, or sought shelter from the scorching rays of the sun under the shade of broad-leaved plants. A tanyer, (Arum esculentum,) that grew near their holes, was a favourite haunt. They could not endure rain, and retreated hastily to their burrows or to other shelter at the coming on of a shower. As winter approached they confined themselves to the immediate neighborhood of their holes, and basked in the sunshine. As the cold increased, they retired to their burrows, where they became torpid; a few warm days, however, even in winter, would again restore them to life and activity. The adults are remarkably strong, sustaining and moving with a weight of two hundred pounds or more. The female is generally larger than the male, with the sternum convex; the sternum of the male is concave, especially on its posterior part. The eggs are larger than those of a pigeon, round with a hard calcareous shell: they are much esteemed as an article of food.

—John Edwards Holbrook on the Gopher Tortoise, 1842

Zoo workers have implemented a number of tortoise conservation initiatives, both in their institutions and in the wild. In a new book by Ray E. Ashton and Patricia S. Ashton called *The Natural History and Management of the Gopher Tortoise* Gopherus polyphemus *(Daudin)* (2008, Krieger, Malabar FL, ISBN 13:978-1-57524-162-3; ISBN 10:1-57524-162-5), the authors provide an excellent template as to how a thorough tortoise study should be designed and accomplished. They run the Ashton Biodiversity Research & Preservation Institute in Florida, where they are now comparing various savannah and semi-desert species from all over the world. In this book, the authors demonstrate the insights gained by studying tortoises for many years in the field versus short term observations. The forage chapters are extremely important in understanding tortoise dietary needs and behavior, especially the fact that the animals eat not only selective plants each season but also eat only certain parts of the plants. Various age classes chose almost entirely different plants. Secondly, the book goes into great detail about natural history, including seasonal patterns. Chapter 10 defines an often ignored element in a successful conservation undertaking—the complexity of not just knowing the natural history but also economics, community support, and the need for a long-term commitment. This book will likely set a benchmark as to what knowledge is necessary about tortoises and other amphibian and reptile species if we are going to manage them over time and beyond that, also enter into any form of *in situ* conservation.

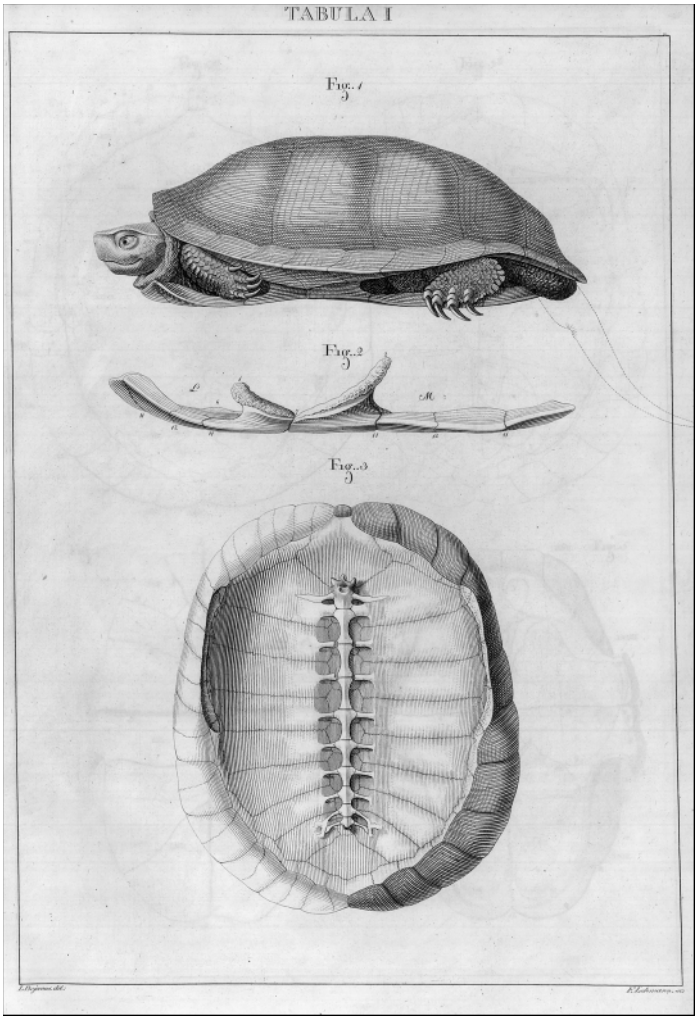


Drawing of Gopher Tortoise (*Testudo polyphemus*, now *Gopherus polyphemus*) in *North American herpetology; or, A description of the reptiles inhabiting the United States* by John Edwards Holbrook in 1842.

Imprint: Philadelphia, J. Dobson. [vol. 1, plate I]

Credit: Collections of Ernst Mayr Library, Museum of Comparative Zoology, Harvard University.

In 1819–1821 Ludwig Heinrich Bojanus published *Anatome testudinis Europaeae. Vols. 1, 2.* This rare atlas was issued in an original edition of 80 copies, reprinted in 1902, and again in 1970 by SSAR. Written in Latin, the magnificent folio contains arguably the finest anatomical drawings of a turtle ever produced. The subject was the European Pond Turtle (*Testudo europaea*, now *Emys orbicularis*). There is no detailed text but extensive descriptions of the 30 numbered plates.



Exquisite rendition of anatomical features in the European Pond Turtle (*Testudo europaea*, now *Emys orbicularis*) in *Anatome testudinis Europaeae. Vols. 1, 2* by Ludwig Heinrich Bojanus in1819–1821.

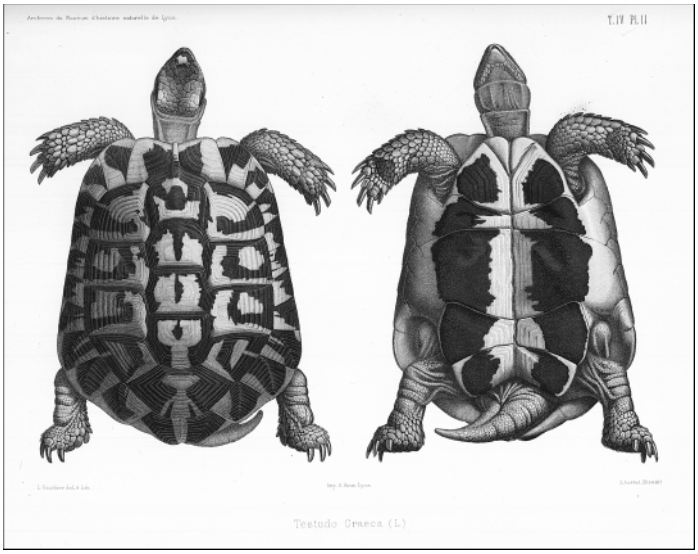
Imprint: Wilno (Vilna, Lithuania), published by the author.

Credit: Collections of Ernst Mayr Library, Museum of Comparative Zoology, Harvard University.

Over a century later, J. Stuart Thomson studied the gross morphology of the Spur-Thighed Tortoise (*Testudo graeca*, now *T. g. graeca*) and Iberian Tortoise (*Testudo ibera*, now *T. g. ibera*). His contribution—published in *1932 Scientific Proceedings of the Royal Dublin Society* 20(28):359–462, plates 19–43—was called *The Anatomy of the Tortoise* and appeared after his death. This high-quality reprinted edition (2006, Bibliomania, Salt Lake City UT; ISBN 10:932871-10-1; ISBN 13:978-1-932871-10-4) includes an introduction by Gabe S. Bever and Christopher J. Bell covering Thomson's life, career, and importance to herpetology.

A new book called *Biology of Turtles*, edited by Jeanette Wyneken, Matthew H. Godfrey, and Vincent Bels, provides the first comprehensive review of the Testudinata in and out of the shell (2008, CRC Press, Boca Raton FL; ISBN 978-0-8493-3339-2). The book covers the turtle body plan in detail; physiological and ecological consequences, evolutionary novelties, and their importance. Some of the topics are of importance to veterinarians and pathologists: bone growth, bone strength and aging, cervical anatomy, skeletochronology, and cardiopulmonary structure. For the turtle keeper, the chapters on locomotion, feeding behavior, reproduction and mixed and uniform brood sex ratio strategy are important.

Chelonian Research Foundation: Anders G. J. Rhodin has been the driving force in creating this organization dedicated to research and conservation. The Foundation has published four Chelonian Research Monographs—one on Galápagos tortoises, another on the horrifying Asian turtle trade, and a third called *Biology and Conservation*

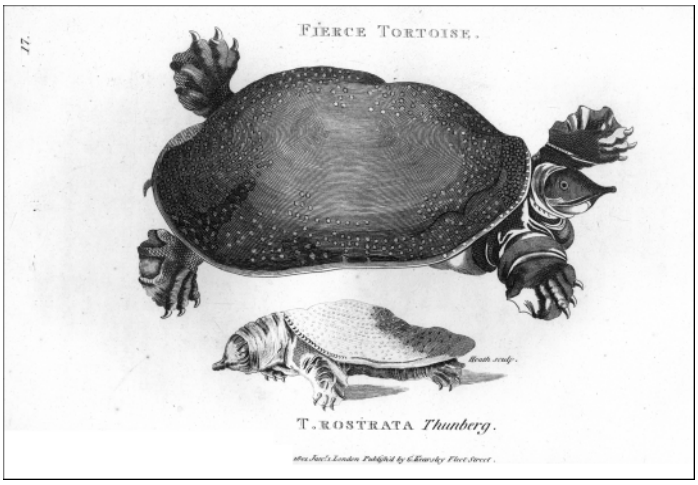


In his book, L. Lortet provided beautifully colored figures of the Spur-Thighed Tortoise and other Mediterranean tortoises.

Lortet, L. 1886. *Observations sur les tortues terrestres et paludines du bassin de la Mediterranée.*

Imprint: Lyon, Libraire de la Faculté de médecine et de la Faculté de droit.

Credit: Collections of Ernst Mayr Library, Museum of Comparative Zoology, Harvard University.



George Shaw was the creator of the encyclopedic fourteen volume set called *General Zoology*. One important innovation by Shaw was the inclusion of common names, and his plates are labeled with common names throughout Volume 3 (part I). Here is plate 17 named Fierce Tortoise, now called Florida Softshell Turtle. The taxon was designated *Testudo Ferox* by Shaw and is now *Apalone ferox*. The name *Testudo rostrata*, now suppressed, may be a variation of the Florida Softshell Turtle.

Shaw, George. 1800–1826. *General zoology, or Systematic natural history . . .; with plates from the first authorities and most selected specimens, engraved principally by Mr. Heath.*

Imprint: London, Printed for G. Kearsley . . .

Credit: Collections of Ernst Mayr Library, Museum of Comparative Zoology, Harvard University.

of Florida Turtles, edited by Peter A. Meylan. Each species account in this latter monograph treats the following subjects: species recognition and taxonomic history, distribution, habitat relations, growth and reproduction, population biology, interspecific interactions, threats, status, and conservation options and solutions.

The fourth monograph is *Defining Turtle Diversity. Proceedings of a Workshop on Genetics, Ethics, and Taxonomy of Freshwater Turtles and Tortoises. Cambridge, Massachusetts, 8–12 August 2005.* This book was edited by H. Bradley Shaffer, Nancy N. FitzSimmons, Arthur Georges, and Rhodin and was published in 2007. There are several important chapters for captive managers: review of genetics studies during past 70 years, taxonomy, genetic considerations for captive breeding and translocation for conservation, internet resources, and an annotated list of modern terminal taxa, with comments on areas of instability and recent change.

Twice a year, the Foundation also prints a peer-reviewed journal of the highest quality—*Chelonian Conservation and Biology*—and a newsletter. In a recent issue, there is a review article by Dean Williams and Matthew Osentowski called, "Genetic considerations for the captive breeding of tortoises and freshwater turtles" (2007, 6[2]:302–313).

No zoo herpetologist should be without these publications. The journal is available by subscription from Chelonian Research Foundation, c/o Allen Press, P.O. Box 7065, Lawrence KS 66044 (phone: 785-843-1235, ext. 296; Fax: 785-843-1274; e-mail: crf@allenpress.com) or Chelonian Research Foundation, 168 Goodrich Street, Lunenburg MA 01462 (phone: 978-582-9668; Fax; 978-582-6279; e-mail: RhodinCRF@aol.com). Books may be ordered from the latter address.

THE FLESH OF THIS TURTLE IS USED FOR FOOD, LARGE NUMBERS OF ANIMALS BEING SOLD IN THE MARKETS OF OUR LARGE CITIES. THERE IS A STRONG ODOR OF MUSK, HOWEVER, WHICH DETRACTS FROM ITS VALUE, FOR IT COMMANDS ONLY A SMALL PRICE. USED IN A SOUP THE FLAVOR IS SAID TO BE EXCELLENT. IT IS CAPTURED MOSTLY WITH A BAITED HOOK WHICH IT TAKES MOST READILY, OFTEN TO THE EXASPERATION OF FISHERMEN. FORMERLY IN COUNTRY DISTRICTS IT WAS A COMMON CUSTOM TO KEEP A SNAPPING TURTLE IN A SWILL BARREL, WHERE IN THE COURSE OF TIME, IT GREW EXCEEDINGLY FAT, VERY TENDER, AND LOST MOST OF ITS MUSKY ODOR. IT WAS THEN KILLED AND EATEN. MR. S. W. DENTON OF WELLESLEY, MASS., TELLS ME HE KNEW OF A TURTLE KEPT UNDER SUCH CONDITIONS WHICH REACHED A WEIGHT OF EIGHTY-SIX POUNDS.

—HAROLD L. BABCOCK ON THE COMMON SNAPPING TURTLE, *THE TURTLES OF NEW ENGLAND*, 1919

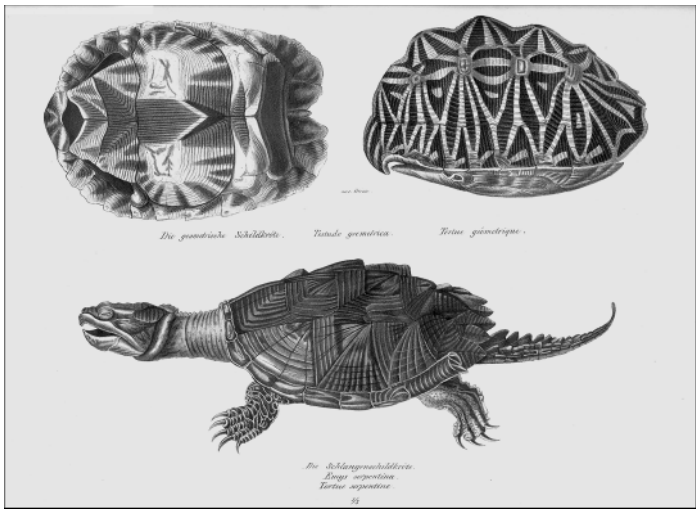
The Biology of the Snapping Turtle (Chelydra serpentina) is the first broad biological treatment of the Common Snapping Turtle. Edited by Anthony C. Steyermark, Michael S. Finkler, and Ronald J. Brooks, this is the definitive reference for anyone working with or interested in this fascinating reptile. The book is published by The Johns Hopkins University Press (2008; The Johns Hopkins University Press, Baltimore MD; ISBN 13: 978-0-8018-8724-6 [hardcover]; ISBN 10:0-8018-9724-0 [hardcover]) and in it a number of prominent turtle biologists synthesize all that is known about this chelonian by providing an up-to-



In plate 89 called *Testudo* by Ernst Haeckel, the somewhat stylized taxa appear to be (left top, clockwise): leatherback and hawksbill sea turtles, mata mata, giant tortoise, snapping turtle, star tortoise, and snake-necked turtle. From *Kunstformen der Natur* (Art forms in nature) by Ernst Heinrich Philipp August Haeckel in 1899–1904.

Imprint: Leipzig, Wien, Verlag des Bibliographischen Instituts.

Credit: Collections of Ernst Mayr Library, Museum of Comparative Zoology, Harvard University.



Heinrich Rudolf Schinz was professor of natural history in Zürich. Many illustrations in his book include a variety of herps: developmental series of newts, lizards in naturalistic poses, caecilians, breeding behavior and development of anurans, complete drawings and skulls of caimans, gavials, and crocodiles, and a large series on snakes. Shown here is Common Snapping Turtle (bottom).

Schinz, Heinrich Rudolf. 1833. *Naturgeschichte und Abbildungen der Reptilien. Nach den neuesten Systemen zum gemeinnützigen Gebrauche entworfen und mit Berücksichtigung für den Unterricht der Jugend bearbeitet, / von H.R. Schinz. Nach der Natur und den vorzüglichsten Originalien gezeichnet, von K.J. Brodtmann.*

Imprint: Schaffhausen, in Brodtmanns lithographischer Anstalt.

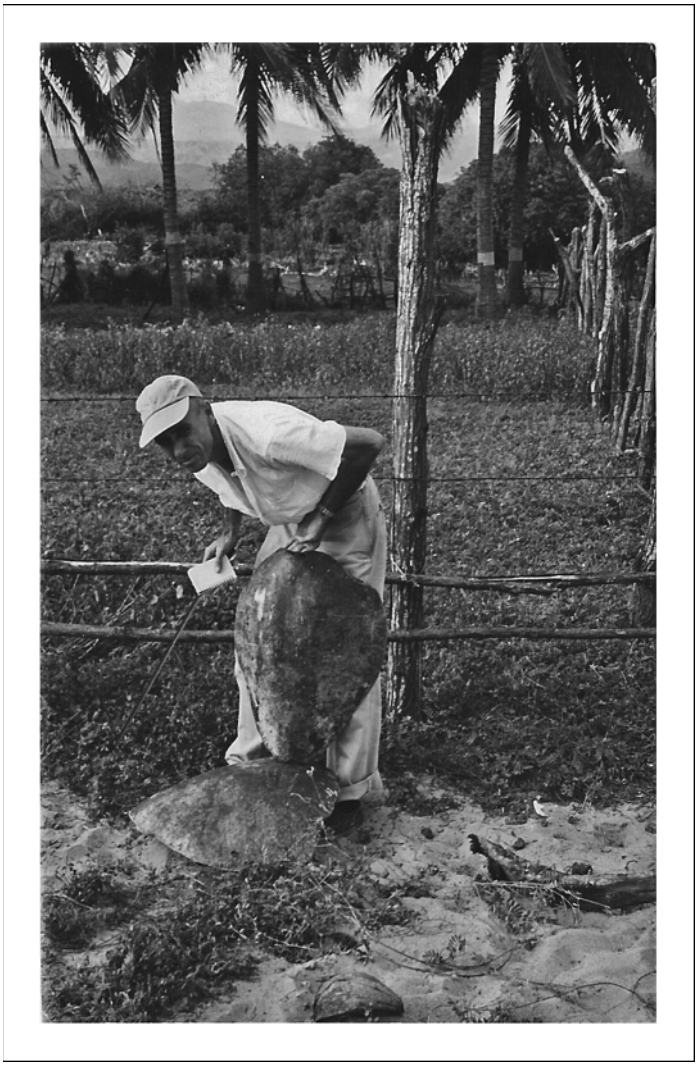
Credit: Collections of Ernst Mayr Library, Museum of Comparative Zoology, Harvard University.

date comprehensive resource on the species' evolution, taxonomy, and systematics; physiology, energetics, and growth; and life history and ecology. There are several chapters which are particularly relevant to captive managers working with other chelonians from temperate climates: thermal ecology and feeding, ecology and physiology of overwintering, embryos and incubation period, sex determination, physiology and ecology of hatchlings, and geographic variation in life history traits.

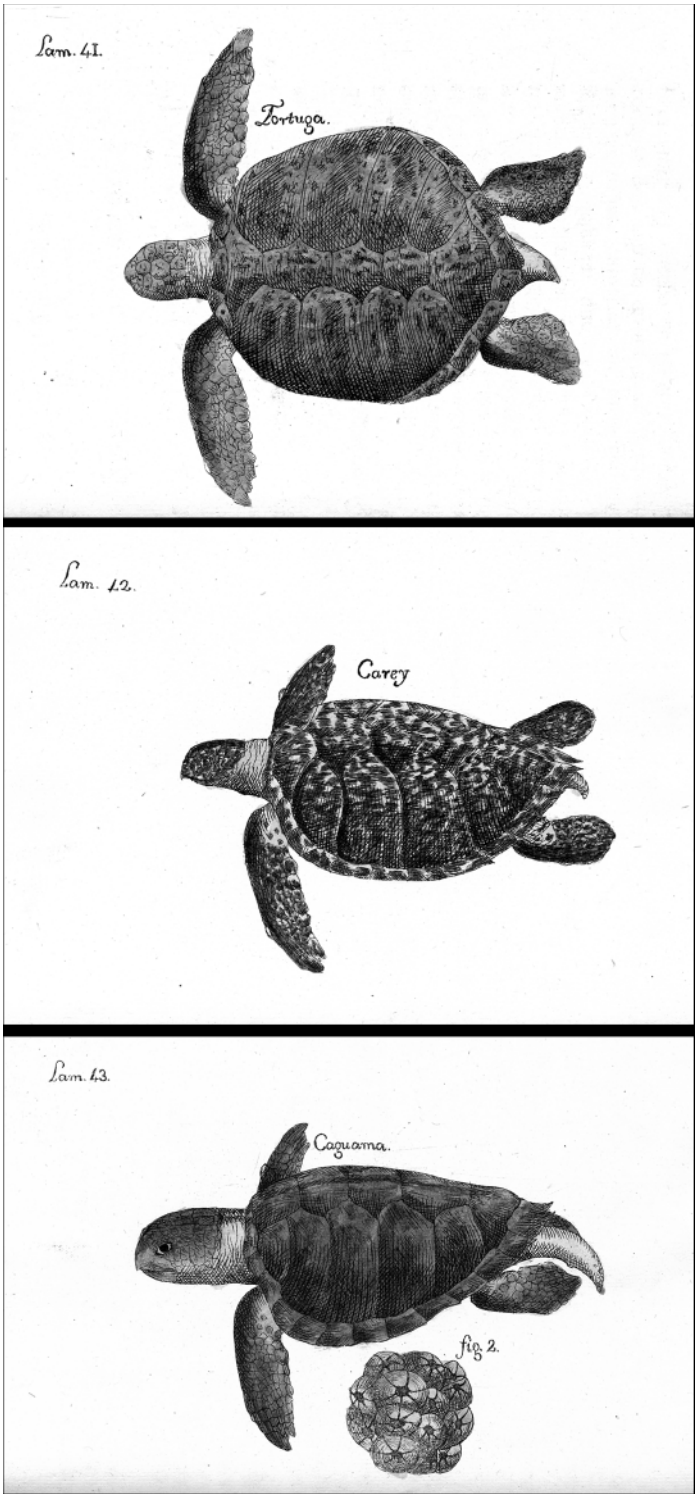
The Johns Hopkins University Press published another important book on chelonians: *Turtles of the World* by Franck Bonin, Bernard Devaux, and Alain Dupré (2006, translated from French by Peter C. H. Pritchard, ISBN 0-8018-8496-9). Species accounts include distribution, description, natural history, and protection and all are accompanied by maps and excellent color photographs.

Archie Fairly Carr Jr.: One of our most prominent turtle biologists, the late Archie Carr, is the subject of two recent books. The first, by his former graduate student Peter C. H. Pritchard, is called *Tales from the Thébaïde. Reflections of a Turtleman* (2007, Krieger, Malabar, Florida; ISBN 1-57524-277-X). In the first chapter titled "The master turtler," Pritchard provides an overview of Carr's life, details his many contributions to science, and presents a moving account of the time he spent with Carr.

The second book is *The Man Who Saved Sea Turtles. Archie Carr and the Origins of Conservation Biology* by Frederick Rowe Davis (2007, Oxford University Press, Oxford, New York; ISBN 978-0-19-531077-1). Carr began writing about sea turtles in 1942 and was passionate about



Photograph of Archie Carr with turtle shells was taken at Pie de la Cuesta, Guerrero, Mexico in 1951 by Charles M. Bogert. Credit: courtesy of Kraig Adler.



Archie Carr studied Green (plate 41), Hawksbill (plate 42), and Loggerhead (plate 43) Sea Turtles, beautifully pictured in *Descripcion de diferentes piezas de historia natural las mas del ramo maritimo : representadas en setenta y cinco laminas / su autor don Antonio Parra* by Antonio Parra (Parra y Callado) in 1787.

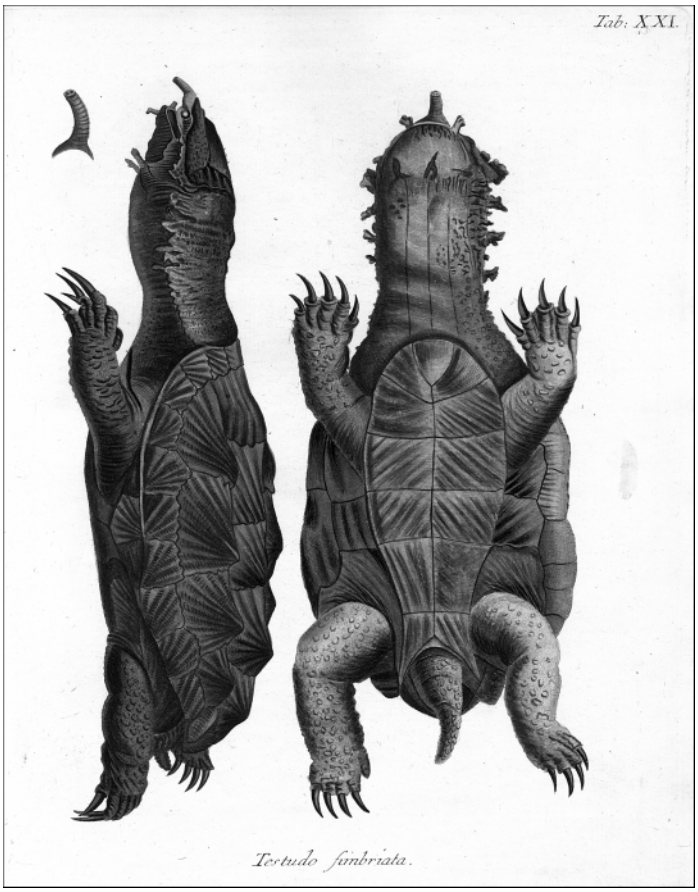
Imprint: En La Havana : En la Imprenta de la Capitania General.

Credit: Collections of Ernst Mayr Library, Museum of Comparative Zoology, Harvard University.

their protection throughout his life. He was a gifted writer and author of many important books: *A Contribution to the Herpetology of Florida* (1940); *Handbook of Turtles* (1952); *High Jungles and Low* (1953); *The Windward Road* (1956); *The Reptiles* (1963); *Ulendo* (1964); *Africa* (1964); *So Excellent a Fische* (1967); and *A Naturalist in Florida* (1994). When Carr was asked why he liked turtles by a newspaper reporter a month before he died in 1987, he replied, "I just liked the looks on their faces. There is an old, wise, sort of durable aboriginal look about turtles that fascinates people." (in Pritchard, 2007:10).

Fines- Mundi Verlag has reprinted three classic works on chelonians of the highest quality. I have compared these reprinted plates with the originals and there is no essentially no difference between the two.

The first is by Johann David Schöpf, a German medical doctor, zoologist and botanist whose only herpetological contribution was this atlas written in Latin and German —*Ioannis Davidis Schoepff Historia testudinum iconibus illustrata* and *Naturgeschichte der Schildkröten*. Schöpf died at age 48 before his contribution was completed. Shown here is the Mata Mata.



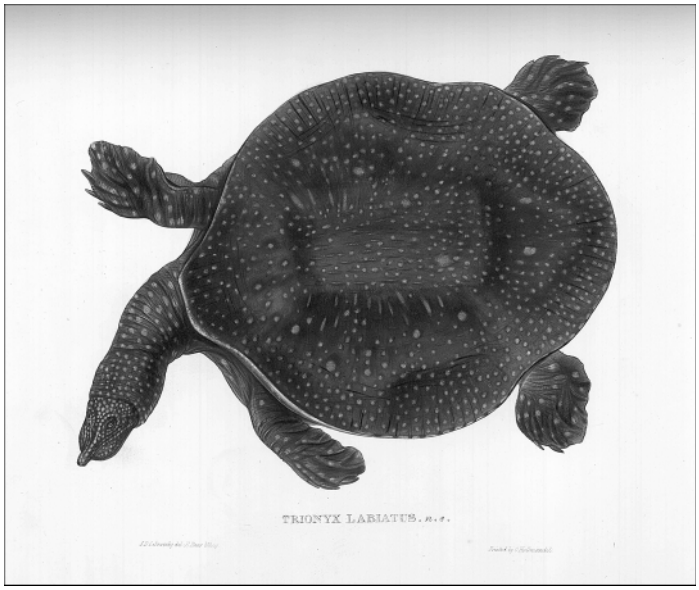
Drawing of Mata Mata called *Testudo fimbriata* (now *Chelus fimbriatus*) in *Ioannis Davidis Schoepff Historia testudinum iconibus illustrata* by Johann David Schöpf in 1792 [–1801].

Imprint: Erlangae [Erlangen], Sumtibus Ioannis Iacobi Palm.

German edition *Naturgeschichte der Schildkröten* (Erlangen, J. J. Palm, 1792 [–1801]).

Credit: Collections of Ernst Mayr Library, Museum of Comparative Zoology, Harvard University.

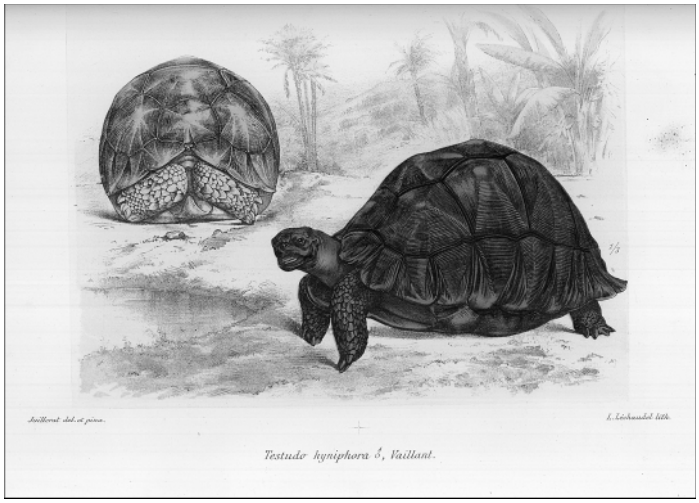
Artist James de Carle Sowerby and lithographer Edward Lear mostly used living specimens as models to create 41 extraordinary plates which were first published in Thomas Bell's folio work *A Monograph of the Testudinata* in 1832–36. Forty years later, the plates were reissued, along with additional ones, and a short text by John Edward Gray from the British Museum of Natural History called *Tortoises, Terrapins, and Turtles Drawn from Life*, by James de Carle Sowerby and Edward Lear. One of the most magnificent pictures in the Bell volume is the Nile Softshell Turtle pictured here.



Nile Softshell Turtle (*Trionyx labiatus*, now *Trionyx triunguis*) from Thomas Bell's *A Monograph of the Testudinata*. London : s.n., in 1832–36.

Credit: Collections of Ernst Mayr Library, Museum of Comparative Zoology, Harvard University.

The Menagerie of the Museum of Natural History in Paris was created in 1793 and was the first of the national menageries. It has a rich history as a center for experimental zoology. Many French herpetologists used



Due to human impact, two of the rarest species on the planet are nearly extinct: Madagascan Big-Headed Turtle (*Erymnochelys madagascariensis*) and Northern Madagascan Spur Tortoise (*Geochelone* (*Astrochelys*) *yniphora*) pictured here from *Histoire physique, naturelle, et politique de Madagascar*.

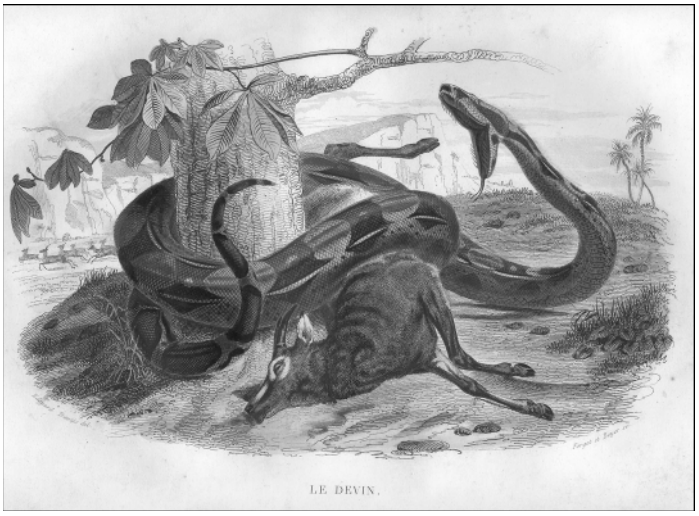
Credit: Collections of Ernst Mayr Library, Museum of Comparative Zoology, Harvard University.

the Menagerie to observe living animals. In addition to his regular duties in the museum, Léon Vaillant was in charge of the reptile menagerie and aquarium. He published *Muséum d'histoire naturelle Guide à la ménagerie des Reptiles. Laboratoire d'Herpétologie, Paris* in 1898. In 1910, Vaillant and Guillaume Grandidier published *Histoire physique, naturelle, et politique de Madagascar* publiée *par Alfred et Guillaume Grandidier. Volume XVII Histoire Naturelle des Reptiles*, presenting 27 of the most exquisite herpetological plates ever produced.

All of these superb facsimiles (and other rare herpetological tomes from the past) are available from Fines- Mundi GmbH, Die Lach 4, 66121 Saarbrücken, Germany; info@fines-mundi.de; www.fines-mundi.de.

Snakes

In a comprehensive and lavishly illustrated book called *Biology of the Boas and Pythons* (2007, Eagle Mountain Publishing, Eagle Mountain UT; ISBN 978-0-9720154-3-4), editors Robert W. Henderson and Robert Powell have solicited chapters covering a wealth of topics from many experts: ecology, natural history, and evolution; behavior; physiology, neurology, and reproductive biology; and conservation. One of the most interesting sections deals with the problems caused by introduced populations, now reproducing, of Boa Constrictors (*Boa constrictor*) and Burmese Pythons (*Python molurus bivittatus*) in southern Florida. Recently, there have been a number of sensational newspaper stories in response to a press release issued in mid-February 2008 by the United States Geological Survey (USGS) about invasive alien pythons in Florida and the possibility of this taxon extending its range to other parts of the United States. Two of the book's authors, David G. Barker and Tracy M. Barker, were stimulated to write two subsequent articles in response: "Comments on a flawed herpetological paper and an improper and damaging news release from a government agency." (Bull. Chicago Herpetol. Soc. 43(3):45–47) and "Review: *An ecological risk assessment of nonnative boas and pythons as potentially invasive species in the United States* by Robert N. Reed. 2005. Risk Analysis 25(3):753–766." (Bull. Chicago Herpetol. Soc. 43(4):63–67).

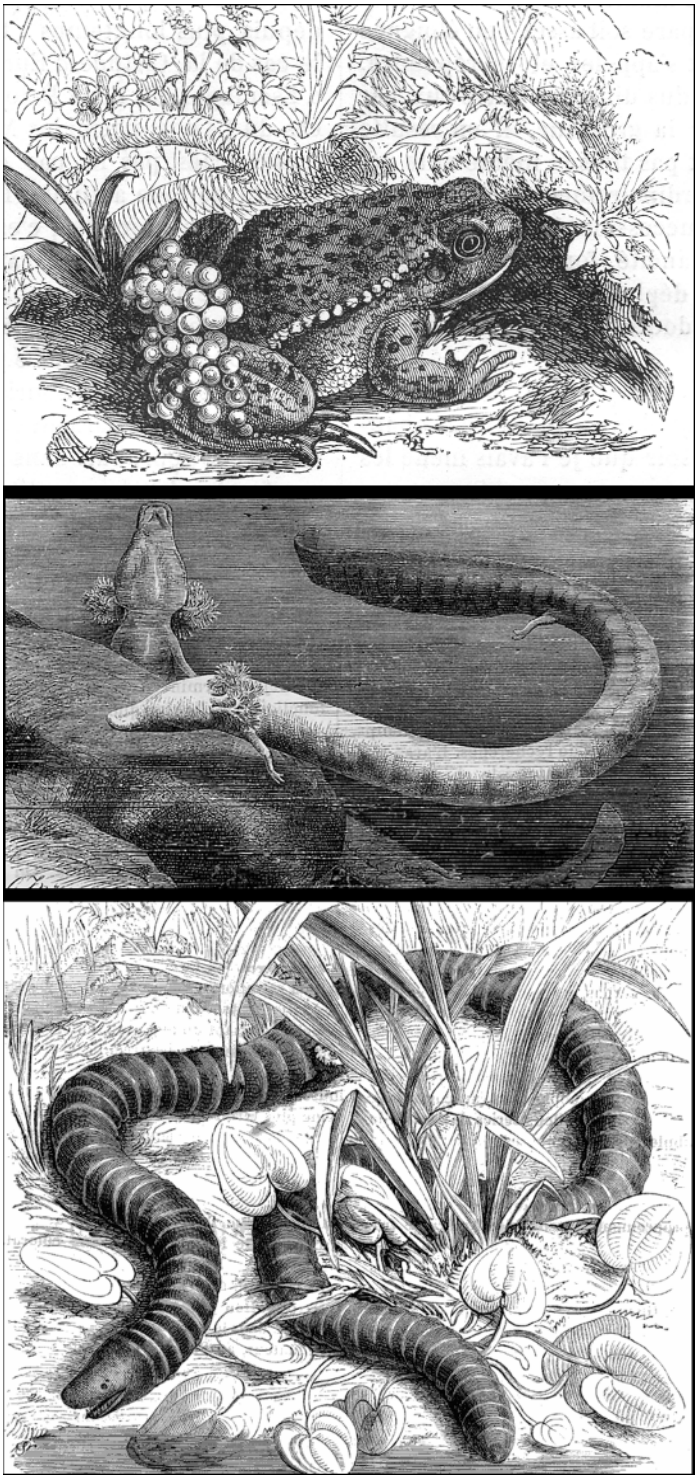


Boa Constrictor (*Boa constrictor*) from *Histoire naturelle de Lacépède, comprenant les cétacés, les quadrupèdes ovipares, les serpents et les poissons* by Bernard Germain Etienne de La Ville sur Illon La Cépède (Count de Lacepède**)** in 1860.

Imprint: Paris, Furne, 1860.

Amphibians

For the zoo professional working with living amphibians, Kentwood D. Wells has written a splendid book detailing their biology—*The Ecology and Behavior of Amphibians* (2007, The University of Chicago Press, London, Chicago; ISBN 13:978-0-226-89334-1 [cloth], ISBN 13:978-



In his book, Kentwood Wells describes the diversity of amphibians including the Midwife Toad (*Alytes obstetricans*), European Olm (*Proteus anguinus*), and Ringed Caecilian (*Siphonops annulatus*). These beautiful plates are in A. E. Brehm's *Les Merveilles de la Nature. Les Reptiles et les Batraciens* (Librairie J.-B. Baillière et Fils, Paris, 1883).

0-226-89335-8 [paper]). Topics explained in detail include phylogeny, classification, and morphological evolution; temperature relations, respiration, metabolism and energetics; movements and orientation; anuran vocal communication; mating systems and sexual selection in anurans; communication and social behavior of urodeles and caecilians; natural history of amphibian reproduction; parental care; ecology and behavior of amphibian larvae; complex life cycles and ecology of amphibian metamorphosis; predation upon amphibians; ecology of amphibian communities; and conservation. Wells describes the plight of amphibians in the last chapter and his words reflect future challenges for the zoo community—"Clearly much more needs to be done. We cannot save all species of amphibians, and we are going to lose some pretty spectacular products of evolution, particularly in the tropics. Many frogs with strange and unusual breeding habits, especially those adapted to the interiors of tropical forests, are likely to be lost, as are some species equipped with arsenals of chemical weapons in their skins, some of which might be used to fight human diseases in the future. In many cases, we may lose species of amphibians before we even know they exist. Yet there is some hope."

International Zoo Yearbook: In volume 42 (2008), there is a special section on amphibian conservation covering many topics—Conservation (role of zoos and aquariums, "Amphibian Conservation Action Plan," "Amphibian Ark" and "2008 Year of the Frog Campaign," status of Taipei Frog *Rana taipehensis* [=*Hylarana*], status of Farmland Green Tree Frog *Rhacophorus arvalis* in Taiwan, Axolotyl *Ambysoma mexicanum* at Lake Xochimilco, Mexico, Afrotropical anurans in zoos, South Asian, South African, Panamanian, and Colombian amphibians); Captive management (disease, water quality, automatic waste-water disinfection system); Behavior and reproduction (Kingsbury's Rocket Frog *Allobates kingsburyi*, Colombian Magdalena River Poison-Dart Frog *Dendrobates truncatus*, Rocket Frog *Hyloxalus toachi*, Romer's Tree Frog *Chirixalus romeri* [=*Chiromantis*]). Although disquieting, Tim Halliday's article on why amphibians are important is an excellent review of accelerating human effects threatening the global ecosystem.

Try to find a copy of a spectacular picture book entitled *Oo-sansho-uo (Giant Salamander)* showing the life history of the Japanese Giant Salamander (*Andrias japonicus*) throughout the four seasons in the wild by Ryu Uchiyama, published by Biburosu, Tokyo, 10 November 2003 (ISBN4-8352-1498-6). The Japanese text is minimal but the photos are eloquent.



Japanese Giant Salamander (*Andrias japonicus*) from a lithograph drawn from life by the Dutch natural history artist, A. Saagmans Mulder (from Philipp Franz de Siebold's *Fauna Japonica*, Reptilia part 3, Leiden, 1838). Credit: provided by Kraig Adler.

In 2006, Darrel Frost and 18 coauthors published *The Amphibian Tree of Life* (Bull. Amer. Mus. Nat. Hist. No. 297:1–370); the purpose was to construct a new taxonomy of living amphibians to correct the deficiencies of the old one. Such a massive undertaking was bound to generate criticism; for example—Wiens (2007, book review: the amphibian tree of life, Q. Rev. Biol. 82:52–55). In a subsequent paper titled "Is *The Amphibian Tree of Life* really fatally flawed?" Frost et al. (2008, Cladistics 24:385–395) responded to the criticisms elucidated by Wiens. I mention these publications here, not to evaluate the evidence but rather to alert zoo biologists that change is coming. Are you ready to modify the scientific name on your American Bullfrog exhibit from *Rana catesbeiana* to *Lithobates catesbeianus*?

Herps

In 2005, The University of Chicago Press published two books which covered reptiles as well as amphibians. The first, by Marty Crump, was called *Headless Males Make Great Lovers & Other Unusual Natural Histories* (ISBN 0-226-12199-2 [cloth], ISBN 13: 978-0-226-12202-1 [paper]), filled with charming descriptions of the behaviors of a host of creatures ranging from sponges to mammals. There is plenty here to entice the zoo herpetologist: unusual parental behaviors of poison dart and rocket frogs, marsupial frogs, gastric brooding frog, gladiator frogs, and other anurans; salamander courtship; snake and turtle mating and the production of eggs; snakebites and venom; American Alligator parental care, and many others.

The other book is the definitive treatment of the state of herpetological investigation in the tropics and it is fitting that the remarkable achievements of our colleague Jay M. Savage were highlighted and celebrated throughout this volume. Edited by Maureen A. Donnelly, Brian I. Crother, Craig Guyer, Marvalee H. Wake, and Mary E. White, the book called *Ecology & Evolution in the Tropics. A Herpetological Perspective* (ISBN 0-226-15657-5 [cloth]; ISBN 0-226-15658-3 [paper]), encompasses two parts—evolution and biogeography; ecology, biogeography, and faunal studies. Twenty-eight contributors, known for their expertise in tropical biology, authored eighteen chapters. Of the 32 Savage students listed in Altig (2007), sixteen were involved in the production of this book—S.-H. Chen, B. I. Crother, M. A. Donnelly, S. B. Emerson, C. Guyer, W. R. Heyer, A. G. Kluge, K. L. Lips, R. W. McDiarmid, K. E. Nicholson, N. J. Scott Jr, J. B. Slowinski, D. B. Wake, M. H. Wake, S. D. Werman, and M. E. White. In the foreword, Luis D. Gómez summarizes the Savage impact beautifully, "After his monumental opus, *The Amphibians and Reptiles of Costa Rica* (2002), this low-profile humble man with the textbook diastema and his perennial jovial disposition, precipitates a deluxe array of authors who celebrate his accomplishments by giving us, and several generations to come, the blue-print of what is known of the tropical herpetofauna and what would be desirable to know in the near future. That is Savage, the engine, at his best."

—James B. Murphy, Section Editor

ARTICLES

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Diversity, Endemism, and Conservation of the Amphibians and Reptiles of Southern Peninsular Malaysia and its Offshore Islands

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For many years, the Malay Peninsula has been a focal point for herpetological investigations (e.g., Berry 1975; Boulenger 1912; Butler 1904; Cantor 1847; Chan-ard et al. 1999; Das and Norsham 2007; Kloss 1915, 1921; Lim and Das 1999; Denzer and Manthey 1991; Flower 1896, 1899; Manthey and Grossmann 1997; Smith 1930; Tweedie 1983; Wood et al. 2008b) and the complex biogeographical history of its fauna has only recently begun to emerge (Inger 1999; Pauwels et al. 2003). It is one of the world's longest peninsulas, extending roughly 1660 km from Samut Songkhram, Thailand in the north, southward to the southern coast of Singapore. Its topography is sculpted by a discontinous series of mountain ranges that begin in the highlands of central Indochina and run nearly its entire length (Fig. 1). In Peninsular Malaysia (= West Malaysia), these ranges trifurcate

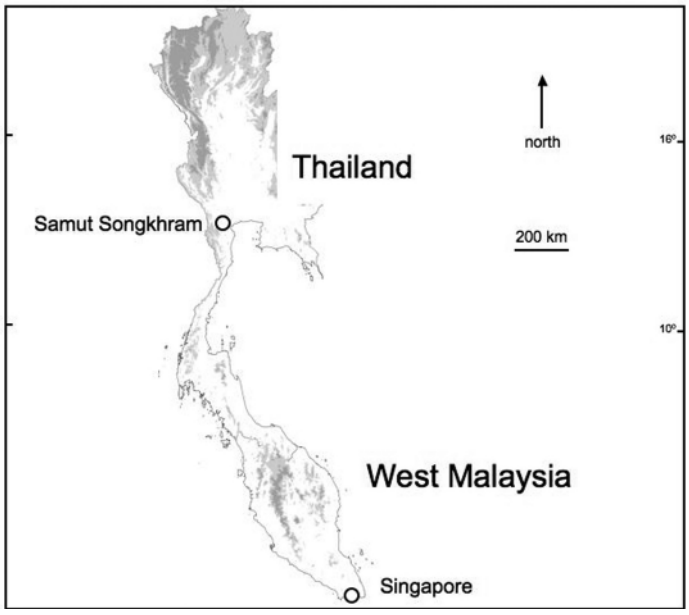


FIG. 1. Location map showing the extent of the Malay Peninsula.

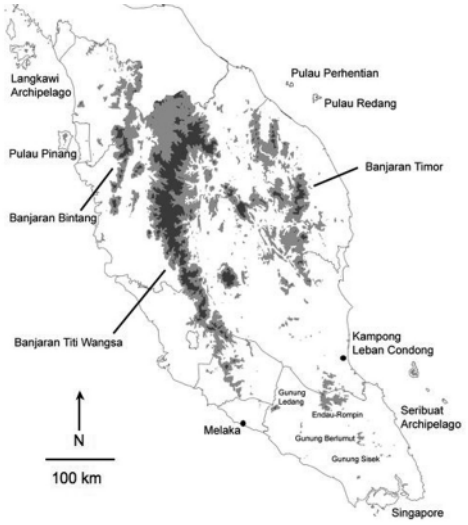


FIG. 2. Map of Peninsular Malaysia showing its three major mountain ranges, its major archipelagos, and the extent of and topographical features of southern West Malaysia (SPM) discussed in the text.

in the north, fan out, and extend southward as the expansive and fragmented Banajaran Timor in the east, the Banjaran Bintang in the west, and the longest and centrally positioned Banjaran Titi Wangsa (Fig. 2). Paralleling these mountain systems are a series of shallow-water archipelagos and islands whose geological origins are tied to those of the adjacent peninsular mountains. Despite the growing tourism industry generated by the aesthetic appeal of these insular systems, their mountainous interiors for the most part, remain covered with relatively unexplored, pristine rainforest. The Langkawi Archipelago and Pulau Pinang are the most prominent island groups along the west coast of Peninsular Malaysia, whereas Pulau Rendang, Pulau Perhentian and several smaller islands scattered in their general vicinity dominate the waters off the northeast coast (Fig. 2). Off the southeast coast of Peninsular Malaysia lies the extensive Seribuat Archipelago (commonly referred to as the Tioman Islands) with 62 islands extending along the northern and southern shores of the states of Johor and Pahang, respectively (Fig. 2).

It has been known for many years that the mountain ranges of Peninsular Malaysia are regions of high herpetological diversity and endemism (e.g., Boulenger 1900; Das et al. 2004; Das and Norsham 2003; Dring 1979; Grandison 1972; L. L. Grismer et al. 2004a; Grismer 2006b, 2007a, 2008a; Hallerman and McGuire 2001; Leong and Lim 2003; Lim et al. 2002; Matsui and Ibrahim 2006; McLeod and Norhyati 2007; Norsham and Lim 2002; Sanders et al. 2004; Smedley 1931; Smith 1922, 1935; Vogel et al. 2004; Wood et al. 2008a). Recent studies are now beginning to reveal that an equally, if not more impressive degree of diversity and endemism occurs in the offshore archipelagos. This becomes germane as the results from ongoing expeditions on Pulau Langkawi (Grismer 2008b; Grismer et al. 2006b) and especially in the Seribuat Archipelago (see Grismer 2006c; Grismer et al. 2006a and references therein) continue to emerge and consistently report new island records and species previously unknown to science. With the exception of Singapore, which has a rich history of herpetological research (e.g., Leong and Chou 1997, 1999; Leong et al. 1996; Lim 1989a,b; Lim and

Chou 1990; Lim and Lim 1992; Lim and Yang 1991; Sworder 1922, 1924a,b, 1925), herpetological studies in the lowlands of southern Peninsular Malaysia—roughly that area from Endau-Rompin National Park (Endau-Rompin) in southern Pahang and northern Johor, southward throughout the state of Johor (Fig. 2)—have been few (Sworder 1925). Recent work, however, focused in Endau-Rompin and surrounding areas has significantly increased the herpetofaunal diversity of southern Peninsular Malaysia (SPM) in both the number of newly reported species and the discovery of new species (Bhaarathyraja 2006; Daicus and Hashim 2004; Grismer 2006a, 2007b; Grismer and Leong 2005; Grismer et al. 2007b; Juliana 2001; Kiew 1987; Lim, 1989c; Norhayati and Dionysius 2004; Norhayati et al., 2004; Wood et al. 2008b). The same is true for the Seribuat Archipelago where recent studies have contributed to a tremendous increase in this region's diversity and endemism (see Grismer 2006c; Grismer et al. 2006a and references therein). The intent of this essay is to 1) highlight the diversity and high levels of endemism of the herpetofauna of SPM; 2) establish the importance of this region in efforts to conserve tropical biodiversity; 3) indicate the major current threats to its herpetofauna; and 4) to underscore the urgent, ongoing need for field-based, systematic research in this understudied region of the Malay Peninsula.

Southern Peninsular Malaysia

As delineated here, SPM occupies approximately 1620 km^2. It extends from the city of Melaka, Melaka (2.1991667°N, 102.2544444°E) on the west coast to Kampong Leban Condong, Pahang (2.8719444°N, 103.4341667°E) on the east coast, and southward through Singapore (1.2513889°N, 103.8256667°E; Fig. 2). In Peninsular Malaysia, this is roughly the entire state of Johor and the southern section of the state of Pahang and includes all low-lying areas below 150 m as well as the mountainous areas encompassing Gunung Ledang (1276 m) in northeastern Johor; Endau-Rompin in southern Pahang and northern Johor, reaching 1036 m at Gunung Besar; and a system of mountains in central Johor dominated by Gunung Berlumut (1010 m) in the north and extending southward ca. 57 km to Bukit Sisek (430 m) in the south (Fig. 2). Also, included in this region are the 62 islands of the Seribuat Archipelago lying off the east coast of SPM (Fig. 2) that extend ca. 100 km from Pulau Cebeh off the coast of southern Pahang, southward to Pulau Tokong Yu off the coast of central Johor.

Originally, continental SPM was an expansive region of lowland rainforest punctuated by isolated mountains and mountain ranges. Currently, the majority (~65%) of the lowland rainforest has been converted into agricultural fields supporting rubber tree and oil palm plantations. This is especially true of the western half and southern third. Continuous lowland rainforest remains in the northeastern third of continental SPM as well as a few scattered patches in the west. Peat swampforests are found in isolated patches in the east and west and freshwater swampforests dominate the southeastern corner. Fringing the coastal areas are isolated stands of mangrove swamps, which are particularly noteworthy in the south. Intact montane forest exists in all areas above 300 m, most notably in Endau-Rompin, Johor, the Gunung Berlumut system, and Gunung Ledang.

The environmental diversity of the Seribuat Archipelago off the east coast of SPM is unparalleled by any other island groups of Peninsular Malaysia (Grismer 2006c, 2008b; J. L. Grismer et al. 2004; L. L. Grismer et al. 2006b; Tamblyn 2005). This is paramount to the generation and maintenance of its herpetofaunal diversity and its broad array of adaptive types (Grismer et al. 2006a). The large islands (> 4.0 km^2) such as Aur, Babi Besar, Pemanggil, Tinggi, Tioman, and Sibu generally maintain extensive tracts of primary dipterocarp forest (Fig. 3). The largest of these islands, Tioman and Tinggi, also maintain significant sources of permanent fresh water in the form of streams, which harbor aquatic and riparian species not found on the other islands. Pulau Tioman even has a small river system, S. Mentawak (Fig. 4) which serves as the only locality in the archipelago for the frog *Rana picturata*. Conversely, many of the very small islands (< 0.03 km^2) such as the "Tokongs" are little more than wind-blown, arid, rocky outcrops rising precipitously out of the ocean, supporting only grasses and low-growing shrubs (Fig. 5). But here too, potentially endemic species have been found which occur nowhere else in the archipelago (Grismer 2006a, b). The intermediate-sized islands may be barren (P. Layak), forested (P. Babi Hujong), or combinations of both such as in the Seribuat group (sensu Grismer et al. 2006a) and may or may not support ephemeral bodies of fresh water. Many of the islands in the archipelago, both large and small, are fringed with broad stands of mangroves.

The Herpetofauna

Like other regions within tropical, megadiversity hotspots (Myers et al. 2000), the flora and fauna of SPM are extremely rich (Shaharuddin et al. 2004; Sham 1998; Yong 1998), and in regards to the herpetofauna, the documented diversity is experiencing a sharp increase as a result of recent and ongoing field work (Table 1). Focused efforts in continental SPM since 2005 have led to the discovery of at least four species previously unknown to science, the re-discovery of an extremely rare species (Daicus and Hashim 2004; Grismer 2006a, 2007b, Grismer and Leong 2005; Grismer et al. 2007b; Wood et al. 2008b), and an increase in the diversity of the herpetofauna of Endau-Rompin by at least 33% (Wood et al. 2008b). This trend has been particularly evident (not to mention surprising) in the Seribuat Archipelago where, since 2001, 186 new insular species records were added (Grismer 2006c; Grismer et al. 2006a and references therein) and at least 13 new species were discovered and described (Table 1), increasing the total diversity of the archipelago by 60% since the major contributions of Lim and Lim (1999) and Hien et al. (2001). Such dramatic increases in diversity over such a relatively short period clearly indicate that these regions remain significantly understudied and their actual diversity has yet to be realized.

To date, five families of frogs representing at least 53 species, and one family of caecilian representing an unknown number of species (see below), are confirmed for SPM (Berry 1975; Grismer 2006c; Wood et al. 2008b; Table 1). Not including caecilians, this represents ca. 59% of all the species of amphibians known from Peninsular Malaysia (based on Das and Norsham 2007) in less than 14% of the total area of the country. The reptilian fauna is even more diverse with three families of terrestrial and



FIG. 3. Pulau Tioman, Pahang; a) dipterocarp forest canopy, b) understory vegetation, and c) rocky streamside habitat.

freshwater turtles representing 11 species, eight families of lizards representing 60 species, eight families of non-marine snakes representing 90 species, and one crocodilian species (Table 1). Collectively, this represents ca. 65% of the reptilian fauna of Peninsular Malaysia (based on Das and Norsham 2007).

Perhaps of greater importance, however, is the role SPM plays in harboring endemic species. Since the description of *Cyrtodactylus sworderi* (Smith 1925), two new species of frogs (Grismer 2006a; Grismer 2007b) and a new species of lizard (Grismer and Leong 2005) have been described from continental SPM. Additionally, there is another species of snake (*Macrocalamus* sp.) in the

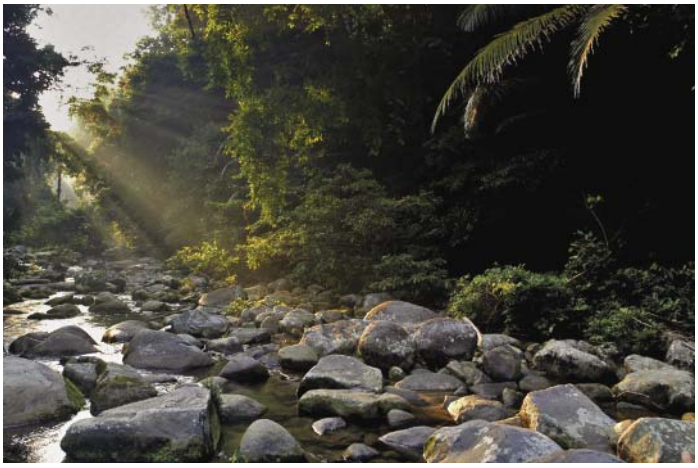


FIG. 4. Sungai Mentawak, Pulau Tioman, Pahang.

process of being described. This recent increase in the level of endemism has been particularly noteworthy in the Seribuat Archipleago. Prior to 1967, only one endemic species, *Ansonia tiomanica* Henderson 1966 (Hendrickson 1966a,b) was known and occurred only on Pulau Tioman. From 1999–2006, one new caecilian, one new frog, 10 new lizards, and four new snakes were described (see Grismer 2006c and references therein; Table 1), increasing the level of endemism by a factor of 16.

ENDEMIC SPECIES OF SOUTHERN PENINSULAR MALAYSIA

Apoda (Caecilians)

Ichthyophiidae.—Most recently *Ichthyophis monchrous* Bleeker 1858, *I. glutinosus* (Linneaus, 1758), *I. singaporensis* Taylor 1960, and *I. paucisulcus* Taylor 1960 have been reported from SPM (Boulenger 1912; Daicus and Hashim 2004; Kiew 1987; Lim and Lim 1992). However, there are several striped putative species known from the Malay Peninsula (Berry 1975; Manthey and Grossmann 1997, Lim and Lim 1992; Taylor 1968) and all have an extremely conserved morphology, making it difficult to distinguish one species from another, resulting in a confusing and unstable taxonomy (Gower et al. 2002). Until the completion of ongoing molecular analyses (D. Gower, pers. comm. 2006), assignment of any population to species cannot be done with confidence.



FIG. 5. Pulau Tokong Burong, Johor.

Anura

Bufonidae.—There are at least 10 species of bufonids confirmed for SPM, of which three are endemic (Table 1). *Ansonia tiomanica* Hendrickson 1966 (Fig. 6) is known only from Pulau Tioman in the Seribuat Archipelago. It was originally reported to occur at elevations above 800 m (Hendrickson 1966a) in close association with large boulders not associated with streamside habitat. Another population was subsequently discovered along a stream course below 300 m (Grismer et al. 2006a). This population, however, was extirpated with the modification of the stream to form a water catchment basin in 2004. *Ansonia endauensis* Grismer 2006 (Fig. 7) was recently discovered and described from Endau-Rompin, Johor. Specimens were found perched on leaves and rocks at the water's edge in some of the small tributaries of the Sungai Endau in the Peta region. *Ingerophrynus gollum* Grismer 2007 (Fig. 8) is a small toad also recently discovered and described from the Peta region of Endau-Rompin. Three males were heard calling from a small, swampy area cloaked in thick vegetation beneath a closed-canopy in lowland dipterocarp forest.

Megophryidae.—There at least four species of megophryids confirmed for SPM, one of which, *Leptolalax kajagensis* Grismer, Grismer, and Youmans, 2004 (Fig. 9), is endemic to Pulau Tioman (Table 1). L. L. Grismer et al. (2004b) reported this species to occur above 400 m on Gunung Kajang. On steep slopes at higher elevations where streams do not occur, *L. kajangensis* breeds in subterranean watercourses found beneath giant granite boulders. Tadpoles here develop in complete darkness and lack integumentary pigments (Grismer 2006c; Fig. 9).

Squamata (Lizards)

Dibamidae.—There is only one dibamid confirmed for SPM, *Dibamus tiomanensis* Diaz, Leong, Grismer, and Norsham 2004 (Fig. 10), which is known only from Tulai and Tioman islands. Like most other dibamids, *D. tiomanensis* occurs beneath surface debris, leaf litter, and within loose soils (Grismer 2006c). Given the secretive, fossorial nature of dibamids in general and their widespread, fragmented occurrence throughout Southeast Asia (see Das and Lim 2005 for review), it would be unlikely for *Dibamus* not to occur in continental SPM.

Gekkonidae.—Gekkonids have been very successful in SPM with at least 22 confirmed species of which eight from the genera *Cnemaspis* Strauch, 1887 and *Cyrtodactylus* Gray, 1827 are endemic (Table 1). *Cnemaspis* is represented by four species in SPM, of which three are endemic to the Seribuat Archipelago. *Cnemaspis baueri* Das and Grismer, 2003 (Fig. 11) occurs only on Pulau Aur. Like many other species of *Cnemaspis*, it is scansorial but restricted to the shaded surfaces of large boulders and within cave-like situations formed by piles of large boulders (Grismer 2006c). *Cnemaspis limi* Das and Grismer, 2003 (Fig. 12) is known only from Tulai and Tioman islands and has a lifestyle very similar to that of *C. baueri*. *Cnemaspis pemanggilensis* Grismer and Das, 2006 (Fig. 13) is endemic to Pulau Pemanggil. Its lifestyle is generally more restrictive than that of *C. limi* and *C. baueri* in that it rarely leaves the shelter of its cave-like habitats.

The genus *Cyrtodactylus* is represented in SPM by eight species, of which five are endemic. Three of these, *C. aurensis* Grismer 2005, *C. seribuatensis* Youmans and Grismer, 2005, and *C. tiomanensis* Das and Lim, 2000 are restricted to the Seribuat Archipelago, whereas *C. semenanjungensis* Grismer and Leong, 2005 and *C. sworderi* (Smith, 1925), are known only from the state of Johor. *Cyrtodactylus aurensis* (Fig. 14) is endemic to Pulau Aur and has a relatively restricted lifestyle in that it primarily occurs on large boulders and trees situated beneath closely overhanging vegetation (Grismer 2005, 2006c). *Cyrtodactylus seribuatensis* (Fig. 15) has the most extreme life style of any of Malaysia's gekkonids. On the seven small islands on which it is found (Youmans and Grismer 2005), it is restricted to the hypersaline intertidal zone where it takes refuge and forages for food (Grismer 2006c). *Cyrtodactylus tiomanensis* (Fig. 16) is endemic to Pulau Tioman and is more typical in *Cyrtodactylus* behavior, being common on the trunks of trees and large boulders. *Cyrtodactylus semenanjungensis* (Fig. 17) is most likely widespread throughout Johor (Grismer and Leong 2005) in lowland forests where it is found on the sides of trees and on leaves. The newly re-discovered *C. sworderi* (Fig. 18) seems at this point, to be associated with lowland forest in the vicinity of central Johor (Daicus and Hashim 2004; Grismer et al. 2007b; Smith 1925). Here, lizards have been found on the ground, on leaves, 3 m above the ground on tree trunks, and in shrubs. All sightings in Endau-Rompin, Johor were in association with stream courses (Grismer et al. 2007b).

Scincidae.—Like the gekkonids, skinks constitute a significant portion of the lizard fauna of SPM, although endemism in this group is far less than that in gekkonids. There are 15 species of skinks confirmed for SPM of which three—*Larutia seribuatensis* Grismer, Leong, and Norsham, 2003, *Sphenomorphus ishaki* Grismer, 2006, and *S. sibuensis* Grismer, 2006—are endemic to the Seribuat Archipelago (Table 1). *Larutia seribuatensis* (Fig. 19) occurs on Tulai and Tioman islands where it is a leaf-litter specialist and emerges to forage above ground shortly following periods of rain (Grismer 2006c). *Sphenomorphus ishaki* (Fig. 20) is a small, leaf-litter inhabitant endemic to the upper elevations of Pulau Tioman and emerges only on cool, overcast days. *Sphenomorphus sibuensis* (Fig. 21), conversely, is found at sea level in the vicinity of mangrove swamps where ambient temperatures are much higher. Both species are rare and virtually nothing is known of their life history (Grismer 2006c).

Squamata (Snakes)

Colubridae.—Despite the relatively high diversity of colubrid snakes (~68 species) in SPM, they are represented by a surprisingly low number of endemics (Table 1), especially when compared to groups like geckos and skinks. Additionally, all the endemic species, except for perhaps one, are restricted to Pulau Tioman of the Seribuat Archipelago. *Calamaria ingeri* Grismer, Kaiser, and Norsham, 2004 (Fig. 22) is known from only two specimens. Both were collected from pitfall traps at 98 m in elevation in lowland dipterocarp forest. *Gongylosoma mukutense* Grismer, Das, and Leong, 2003 (Fig. 23) is a terrestrial, diurnal species that ranges from sea level to near 400 m in elevation in coastal vegetation and lowland dipterocarp forests (Grismer 2006c). *Oligodon booliati* Leong and Grismer, 2004 (Fig. 24) is a terrestrial, leaf litter species that is both diurnal and nocturnal and found primarily in lowland dipterocarp forests (Grismer 2006c). *Macrocalamus* sp. is likely an undescribed species from Endau-Rompin, Johor known only from two, high-quality photographs







FIGS. 6–8, above, from top to bottom. FIG 6. *Ansonia tiomanica*, Pulau Tioman, Pahang. FIG. 7. *Ansonia endauensis*, Endau-Rompin, Johor. FIG. 8. *Ingerophrynus gollum*, Endau-Rompin, Johor.



FIG. 9. *Leptolalax kajangensis*, Pulau Tioman, Pahang. Adult and tadpole.

given to me by park personnel. The specimen has a color pattern unique to all other known *Macrocalamus*, is the only lowland member of the genus, and represents a southern range extension for the genus of ca. 180 km (David and Pauwels 2004). Based on this, we believe it to be an undescribed species.

Viperidae.—There are seven species of viperids in SPM but the only endemic species, *Popeia buniana* Grismer, Grismer, and McGuire 2006 (Fig. 25), is restricted to Pulau Tioman (Table 1). It is an arboreal, nocturnal species restricted to upland regions of the island above 300 m (Grismer 2006c). It is apparently unique among arboreal pitvipers in that it may be an active forager rather than an ambush predator as inferred from its morphology and anecdotal field observations of its behavior (Grismer et al. 2006c).



FIG. 10. *Dibamus tiomanensis*, Pulau Tioman, Pahang.

FIGS. 11–14, Opposite page, left column, from top to bottom. FIG. 11. *Cnemaspis baueri*, Pulau Aur, Johor. FIG. 12. *Cnemaspis limi*, Pulau Tioman, Pahang. FIG. 13. *Cnemaspis pemanggilensis*, Pulau Pemanggil, Johor. FIG. 14. *Cyrtodactylus aurensis*, Pulau Aur, Johor.



FIGS. 15–18, above, from top to bottom. FIG. 15. *Cyrtodactylus seribuatensis*, Pulau Nangka Kecil, Johor. FIG. 16. *Cyrtodactylus tiomanensis*, Pulau Tioman, Pahang. FIG. 17. *Cyrtodactylus semenanjungensis*, near Jemaluang, Johor. Photo by Heok Hui. FIG. 18. *Cyrtodactylus sworderi*, Endau-Rompin, Johor.

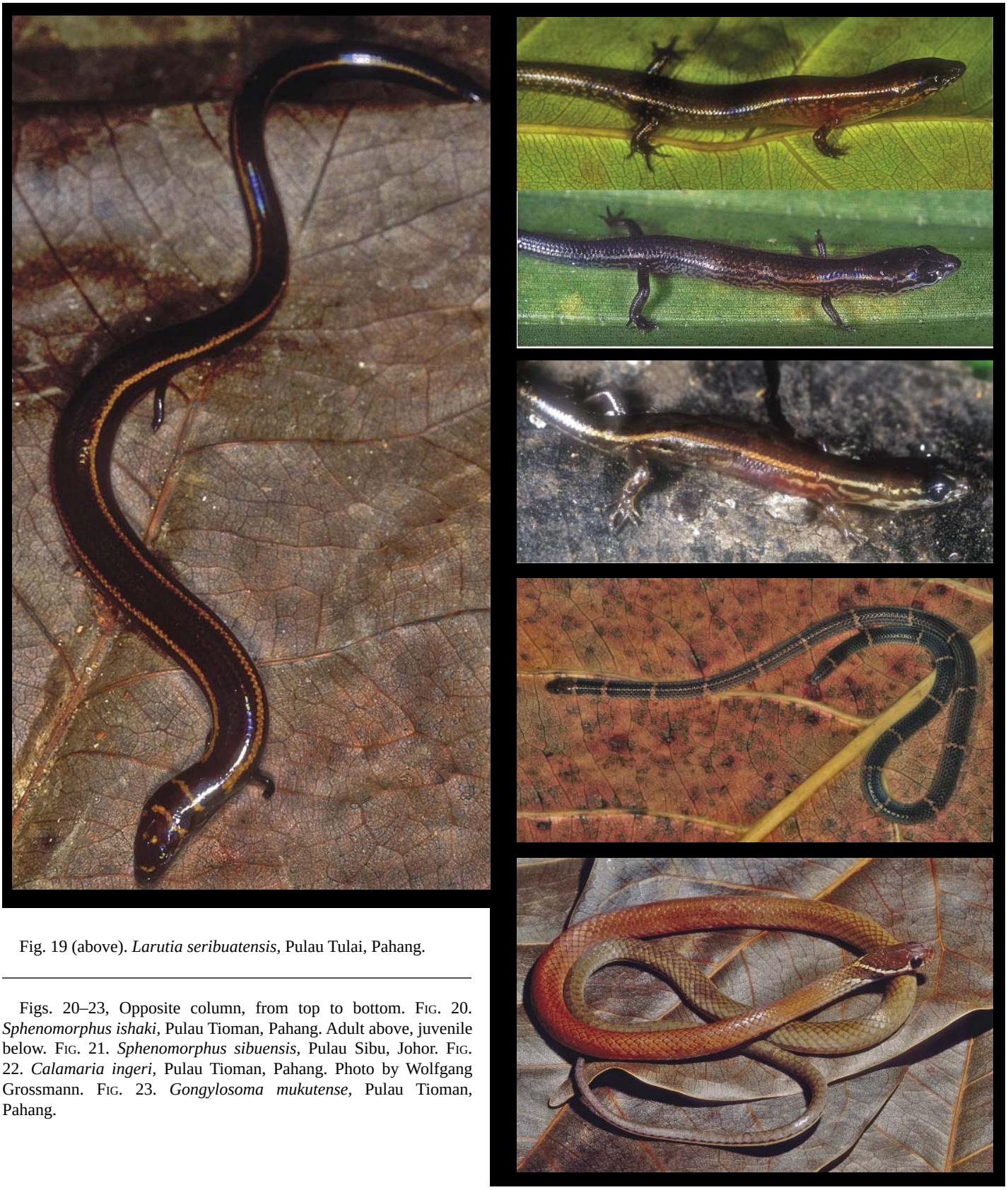


Fig. 19 (above). *Larutia seribuatensis*, Pulau Tulai, Pahang.

Figs. 20–23, Opposite column, from top to bottom. FIG. 20. *Sphenomorphus ishaki*, Pulau Tioman, Pahang. Adult above, juvenile below. FIG. 21. *Sphenomorphus sibuensis*, Pulau Sibu, Johor. FIG. 22. *Calamaria ingeri*, Pulau Tioman, Pahang. Photo by Wolfgang Grossmann. FIG. 23. *Gongylosoma mukutense*, Pulau Tioman, Pahang.

CONSERVATION

As noted above, it is clear that the herpetofauna of SPM is understudied and the region incompletely surveyed as underscored by the recent addition of so many new records and the discovery of so many new species in such a relatively short period of time. Although the level of endemism (4%; 5 of 134 species) for continental SPM is low, three of the five endemics were discovered only within the last two years. On the other hand, endemism in the Seribuat Archiplelago is much greater (15%; 17



FIG. 24. *Oligodon booliati*, Pulau Tioman, Pahang. Adult above, juvenile below.

of 111) and like continental SPM, most of its endemics (14 of 17 species) were described only within the last three years.

Based on the results of over a century of field work in montane regions of central and northern continental Malaysia (Boulenger 1900; Das et al. 2004; Das and Norsham 2003; Dring 1979; Grandison 1972; Grismer 2006b, 2007a, 2008a; L. L. Grismer et al. 2004a; Hallerman and McGuire 2001; Leong and Lim 2003; Lim et al. 2002; Matsui and Ibrahim 2006; McLeod and Norhayati



FIG. 25. *Popeia buniana*, Pulau Tioman, Pahang. Adult male above, adult female below (photo by P. Hien).

TABLE 1. Checklist of the herpetofauna of southern Peninsular Malaysia. E = endemic.

	Continental Southern Peninsular Malaysia	Seribuat Archipelago
AMPHIBIA		
Apoda		
Ichthyophiidae		
Ichthyophis sp.	X	X
Anura		
Bufonidae		
Ansonia endauensis	E	
Ansonia tiomanica		E
Bufo asper	X	X
Bufo melanostictus	X	X
Ingerophrynus parvus	X	X
Ingerophrynus gollum	E	
Ingerophrynus quadriporcatus	X	
Leptophryne borbonica	X	
Pedostibes hosii	X	
Pelophryne brevipes	X	X
Megophryidae		
Leptobrachium hendricksoni	X	
Leptobrachium nigrops	X	
Leptolalax kajangensis		E
Megophrys nasuta	X	X
Microhylidae		
Chaperina fusca	X	X
Kalophrynus palmatissimus	X	
Kalophrynus pleurostigma	X	X
Kaloula baleata	X	X
Kaloula pulchra	X	X
Metaphrynella pollicaris	X	
Microhyla annectens	X	
Microhyla berdmorei	X	
Microhyla butleri	X	
Microhyla fissipes	X	
Microhyla heymonsi	X	
Microhyla mantheyi	X	X
Micryletta inornata	X	
Phrynella pulchra	X	
Ranidae		
Amolops larutensis	X	
Fejervarya cancrivora	X	X
Fejervarya limnocharis	X	
Limnonectes blythii	X	X
Limnonectes kuhlii	X	
Limnonectes laticeps	X	
Limnonectes malesianus	X	
Limnonectes paramacrodon	X	
Limnonectes plicatellus	X	
Occidozyga laevis	X	
Occidozyga martensii	X	
Rana erythraea	X	X
Rana glandulosa	X	
Rana hosii	X	X
Rana laterimaculata	X	
Rana miopus	X	
Rana nicobariensis	X	
Rana picturata	X	X
Rana raniceps	X	X
Taylorana hascheana	X	X
Rhacophoridae		
Nyctixalus pictus	X	X
Philautus petersi		X
Polypedates colletti	X	
Polypedates leucomystax	X	X
Polypedates macrotis	X	
Rhacophorus appendiculatus	X	
Rhacophorus cyanopunctatus	X	
Rhacophorus nigropalmatus	X	

TABLE 1. Continued.

	Continental Southern Peninsular Malaysia	Seribuat Archipelago
Rhacophorus pardalis	X	
Rhacophorus tunkui	X	
Theloderma horridum		X
Reptilia		
Chelonia		
Bataguridae		
Callagur borneoensis	X	
Cuora amboinensis	X	
Cyclemys dentata	X	
Heosemys grandis	X	
Heosemys spinosa	X	
Notochelys platynota	X	
Orlitia borneensis	X	
Siebenrockiella crassicollis	X	
Testudinidae		
Manouria emys	X	
Trionychidae		
Amyda cartilaginea	X	
Dogania subplana	X	X
Squamata (Lizards)		
Agamidae		
Acanthosaura armata	X	X
Aphaniotis fusca	X	X
Bronchocela cristatella	X	X
Calotes versicolor	X	
Draco blanfordii	X	
Draco fimbriatus	X	X
Draco formosus	X	X
Draco haematopogon		X
Draco maximus	X	
Draco melanopogon	X	X
Draco quinquefasciatus	X	
Draco sumatranus	X	X
Gonocephalus abbotti	X	
Gonocephalus chamaeleontinus		X
Gonocephalus grandis	X	X
Gonocephalus liogaster	X	
Eublepharidae		
Aeluroscalabotes felinus	X	
Dibamidae		
Dibamus tiomanensis		E
Gekkonidae		
Cnemaspis baueri		E
Cnemaspis kendallii	X	X
Cnemaspis limi		E
Cnemaspis pemanggilensis		E
Cyrtodactylus aurensis		E
Cyrtodactylus consobrinus	X	
Cyrtodactylus pulchellus	X	
Cyrtodactylus quadrivirgatus	X	X
Cyrtodactylus semenanjungensis	E	
Cyrtodactylus seribuatensis		E
Cyrtodactylus sworderi	E	
Cyrtodactylus tiomanensis		E
Gehyra mutilata	X	X
Gekko gecko	X	
Gekko monarchus	X	X
Gekko smithii	X	X
Hemidactylus craspedotus	X	X
Hemidactylus frenatus	X	X
Hemidactylus platyurus	X	X
Hemiphyllodactylus typus	X	X
Lepidodactylus lugubris		X
Ptychozoon kuhli	X	X
Ptychzoon lionatum		X

TABLE 1. Continued.

	Continental Southern Peninsular Malaysia	Seribuat Archipelago
Scincidae		
Dasia grisea	X	
Dasia olivacea	X	X
Emoia atrocostata		X
Eutropis longicaudatus	X	X
Eutropis macularius	X	
Eutropis rugiferus	X	
Eutropis multicarinatus	X	X
Larutia seribuatensis		E
Lipinia surda		X
Lipinia vittigera	X	X
Lygosoma bowringii		X
Sphenomorphus ishaki		E
Sphenomorphus scotophilus	X	X
Sphenomorphus sibuensis		E
Sphenomorphus sp.	X	
Leiolepididae		
Leiolepis belliana	X	
Varanidae		
Varanus nebulosus	X	X
Varanus rudicollis	X	
Varanus salvator	X	X
Squamata (Snakes)		
Typhlopidae		
Ramphotyphlops albiceps		X
Ramphotyphlops braminus	X	X
Typhlops muelleri	X	
Cylindrophiidae		
Cylindrophis ruffus	X	
Xenopeltidae		
Xenopeltis concolor	X	
Pythonidae		
Python reticulatus	X	X
Acrochordidae		
Acrocordus granulatus	X	
Acrocordus javanicus	X	
Colubridae		
Ahaetulla fasciolata	X	
Ahaetulla mycterizans	X	
Ahaetulla prasina	X	X
Asthenodipsas laevis	X	
Asthenodipsas vertebralis		X
Bitia hydroides	X	
Boiga cynodon		X
Boiga dendrophila	X	X
Boiga drapiezii	X	X
Boiga jaspidea	X	
Boiga nigriceps	X	X
Calamaria albiventer	X	
Calamaria ingeri		E
Calamaria lovii	X	X
Calamaria lumbricoidea	X	X
Calamaria pavimentata		X
Calamaria prakkei	X	
Calamaria schlegeli	X	
Cantoria violacea	X	
Cerberus rhynchops	X	X
Chrysopelea paradisi	X	X
Chrysopelea pelias	X	X
Coelognathus flavolineatus	X	X
Coelognathus radiatus	X	
Dendrelaphis caudolineatus	X	X
Dendrelaphis formosus	X	X
Dendrelaphis hasi	X	X
Dendrelaphis kopsteini	X	
Dendrelaphis pictus	X	X
Dendrelaphis striatus	X	X

TABLE 1. Continued.

	Continental Southern Peninsular Malaysia	Seribuat Archipelago
Dryocalamus subannulatus	X	X
Dryophiops rubescens	X	X
Enhydris enhydris	X	X
Enhydris plumbea	X	X
Enhydris punctata	X	
Fordonia leucobalia	X	X
Gerarda prevostiana	X	
Gongylosoma balodeirum	X	
Gongylosoma mukutense		E
Gonyophis margaritatus	X	
Gonyosoma oxycephalum	X	X
Homalopsis buccata	X	
Liopeltis tricolor		X
Lycodon albofuscus		X
Lycodon capucinus		X
Lycodon effraenis	X	
Lycodon subcinctus	X	
Macrocalamus sp.	E	
Macropisthodon rhodomelas	X	
Oligodon booliati		E
Oligodon octolineatus	X	
Oligodon purpurascens	X	X
Oligodon signatus	X	
Oreophis porphyracens	X	
Orthriophis taeniurus	X	X
Pareas margaritophorus	X	
Psammodynastes pictus	X	
Psammodynastes pulverulentus	X	X
Pseudorhabdion longipes	X	X
Ptyas carinata	X	X
Ptyas fuscus	X	
Ptyas korros	X	
Rhabdophis chrysargos	X	X
Sibynophis melanocephalus		X
Xenelaphis hexagonotus	X	
Xenochrophis piscator	X	
Xenochrophis trianguligerus	X	
Xenochrophis vittatus	X	
Xenodermus cf. *javanicus*	X	
Elapidae		
Bungarus candidus	X	
Bungarus flaviceps	X	X
Calliophis bivirgata	X	
Calliophis gracilis	X	
Calliophis intestinalis	X	X
Naja sumatrana	X	
Ophiophagus hannah	X	X
Viperidae		
Cryptyletrops purpureomaculatus	X	
Parias hageni	X	
Parias sumatrana	X	
Popeia buniana		E
Popeia fucata	X	
Trimeresurus wiroti	X	
Tropidolaemus wagleri	X	X
Crocodilia		
Crocodylidae		
Crocodylus porosus	X	

2007; Norsham and Lim 2002; Sanders et al. 2004; Smedley 1931; Smith 1922, 1935; Vogel et al. 2004; Wood et al. 2008a), it is almost certain that field surveys in the montane regions of continental SPM will result in the discovery of additional species, many of which are likely to be endemic, and may raise endemism of these habitat-islands to levels comparable to those of the islands in the adjacent Seribuat Archipelago. What makes the need for field work particularly urgent in continental SPM is that this area has only ca. 35% of its native lowland forest intact and some of this is currently threatened by agricultural expansion. Additionally, some of the islands in the Seribuat Archipelago are threatened by partial deforestation. Pulau Tioman, the largest and most environmentally diverse island in the archipelago, with the highest herpetofaunal diversity and endemism (Grismer 2006c), has suffered a loss of some of its coastal forests to support development of an increasing international tourism industry. The island also has been bisected by a wide, trans-island road that traverses the crest of the island from the west coast at Kampong Tekek to the east coast at Kampong Juara. The road cuts through large tracts of virgin rainforest, making the rainforest interior accessible to other potentially destructive activities. Plans are also in place to construct a runway on the west coast of Pulau Tioman long enough to accommodate large passenger jets. This, and its attendant infrastructure, will have a major negative impact on the coastal and offshore ecosystems. Other islands such as Rawa, Sibu, Tinggi, Aur, and Pemanggil also support a growing tourism industry and its associated environmental degradation.

The herpetofauna of SPM is also under a growing threat of commercialization. Commercial dealers and collectors are hiring native Orang Asli in Johor to collect large quantities of amphibians and reptiles for export and sale abroad. They are also collecting endemics from Pulau Tioman which bring very high prices in the illegal pet trade. One of us (LLG) is often contacted by Malaysian and Indonesian commercial collectors trying to get information about the endemic pitviper *Popeia buniana,* specimens of which are sold for as much as US $400 each.

The documented herpetofaunal diversity of SPM will undoubtedly increase as a result of the ongoing efforts of field biologists working in this area. These increases will be most dramatic in the severely understudied areas of continental SPM as suggested by the recent findings from Endau-Rompin, Johor (Grismer 2006a, 2007b; Grismer et al. 2007b; Wood et al. 2008b). Surveys will also begin in earnest in the upland areas of Endau-Rompin, Gunung Berlumut, and Gunug Ledang and it is expected that many additional records and potentially new species will be discovered here as well. All these areas should be set aside for purposes of studying and preserving the biodiversity of SPM in an effort to protect the natural heritage of Malaysia. Importantly, protected areas such as these can be immensely useful for serving as model systems in evaluating the myriad of complex nuances involved in efficient and cost effective ecosystem management which can subsequently be applied to other imperiled regions of Southeast Asia.

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Note added in proofs: LLG and associates recently discovered two additional undescribed species of the gekkonid genus *Cyrtodactylus* from SPM—one from central Johor and another from a small island off the coast of the state of Melaka. Both are currently being described as new species.

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The Hemipenis and External Morphology of a New Specimen of *Calamodontophis paucidens* (Amaral, 1935) (Serpentes: Colubridae, Dipsadinae, Tachymenini) from Uruguay

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Calamodontophis paucidens (Amaral, 1935) is a rare, slug-eating snake of southern Brazil and Uruguay (Franco et al. 2006). Only twelve specimens were included in the generic summary of Franco et al. (2006). A detailed description of the hemipenis of *C. paucidens* has never been published. Franco (1999) described the species' hemipenial morphology in his doctoral thesis based on one specimen from Cachoeira do Sul, Vila Barro Vermelho (Museu de Ciências e Tecnologia da PUCRS, Porto Alegre, RS, Brazil [MCP] 8607), and a cursory description, based on two males (MCP 7834, 8607), was used by Franco et al. (2006) to compare general characters among other genera of Tachymenini.

Calamodontophis paucidens is scarce throughout its distribution, and only two males are known (Franco et al. 2001; Carreira 2006; Carreira and Meneghel 2004). A detailed description of the hemipenis is an important addition to the knowledge of this scarce species, and can provide useful data to support phylogenetic analyses examining the species' taxonomic position in the Tachymenini.

Materials and Methods

A new male specimen (ZVC-R 6303) from Departamento Rocha, Uruguay, made possible the fresh extraction the left hemipenis and measurements of the position of the right organ *in situ*. The left hemipenis was everted, extracted from the specimen, and injected with a 10% formalin solution. The base was tied off. The hemipenis was maintained in a 10% formalin solution. We used the methods of Zaher (1999) and Dowling (2002).

Results

Specimen information.—Colección Zoología Vertebrados, Reptiles, Secc. Zoología Vertebrados, Facultad de Ciencias, Universidad de la República, Montevideo, ZVC-R 6303: Ruta 109, Camino de las Sierras, 20 km from Rocha city, Departamento Rocha. 16-II-2005. Col.: Gerardo Feijóo (Rocha). Specimen external characters (left/right): supralabials 7(3,4)/7(3,4); preoculars 1/1; postoculars 2/2; temporals 1+2/1+2; infralabials 7(1–3)/8(1–4); ventrals 128; subcaudals 38/39; anal plate divided; scale rows 15/15/15; SVL = 317 mm; tail length = 65 mm; head length = 13.7 mm. Coloration identical to other specimens illustrated in Franco et al. (2001) and Carreira et al. (2005).

Hemipenial description.—The *in situ* organ is 9 subcaudals long, counting from the anal plate. The muscle insertion is at the level of the 28th subcaudal. The organ is slightly bilobed, semicalyculate, and non-capitate, with a spinulate body (Fig. 1). The asulcate surface has spines, smallest on the apical region and slightly enlarged and homogeneous on the body and basal region. The lateral surfaces of the hemipenial body have enlarged lateral spines in the basal region. The *sulcus spermaticus* divides approximately in the middle of the hemipenial body. The intrasulcar region is formed by calyces partially covered with spinulate flounces. These calyces extend outside the intrasulcar region, morphing to spines in the apical zone of the asulcate surface. Flounces weakly differentiated and without spines are observed in the *sulcus spermaticus* division. Calyces extend outside the arms of the *sulcus* on the lobes but never reach the lateral surface. Flounces weakly differentiated are observed in the upper region of the body, on the lateral sides of the *sulcus spermaticus*. The spines on the sulcate surface increase in size towards the basal region, with the exception of the homogeneous row parallel to the sides of the *sulcus*. In the region of the undivided *sulcus*, spines increase in size towards the lateral sides of the hemipenial body. The biggest spines are in the basal region.

Discussion

In his doctoral thesis, Franco (1999) partially described and illustrated the hemipenial morphology of *C. paucidens*. From the drawing in Franco (1999), we can see that the organ in MCP 8607 is not totally everted, because the lobes are largely in contact, and because of the presence of a deep constriction in the middle of the organ that we did not observe in our material. The capture of ZVC-R 6303, the third male known, makes possible the correct preparation and description of the hemipenis and its *in situ* examination.

Franco (1999) recorded 124, 127 (N = 2) male ventrals and

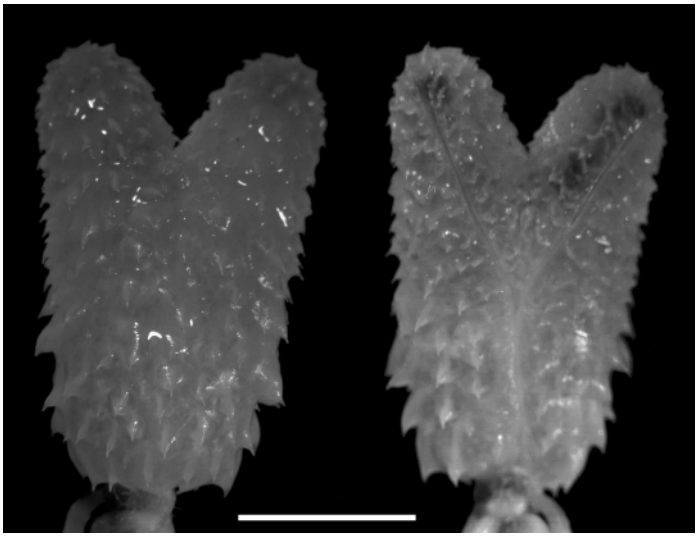


Fig. 1. Hemipenis of *Calamodontophis paucidens* (ZVC-R 6303; scale = 5 mm). Asulcate (left) and sulcate (right) views.

131–137 (N = 9) female ventrals, 32, 39 (N = 2) male subcaudals and 29–32 (N = 9) female subcaudals. Because of only two males, he did not comment on sexual dimorphism. Franco et al. (2001) and Carreira and Meneghel (2004) have data from additional specimens. Carreira and Meneghel (2003) recorded 147 ventrals and 24 subcaudals in the female ZVC-R 5710; we reexamined the specimen and the correct information is 137 ventrals and 32/31 subcaudals. With all of the additional information, we have the following ranges: males (N = 3), ventrals 124–128, subcaudals 32–39; and females (N = 11), ventrals 131–137, subcaudals 29–34. Actually the difference in subcaudal counts is proportionally greater (~12%) than in the ventral counts (~6%).

Acknowledgments.—We are grateful to Gerardo Feijóo for the specimen. We thank Norman Scott for revision of English text and suggestions.

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Diet of *Kinosternon scorpioides* in Serra dos Carajás, Eastern Amazonia

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The New World genus *Kinosternon* includes 19 species of small to medium-sized (< 300 mm) aquatic turtles, occurring from southern Canada to Argentina (Ernst and Barbour 1989). The biology of many species of *Kinosternon* has been studied (e.g., Frazer 1991; Gibbons 1983; Iverson 1991; Loben Sels et al. 1997; Morales-Verdeja and Vogt 1997; Vogt and Guzman 1988), but little is known of the biology of *K. scorpioides*. Studies on this species have focused mostly on morphology and information on diet, behavior, and reproduction is limited (Acuña-Mesen 1992; Cabrera and Colantonio 1997; Marquez 1995; Pritchard and Trebbau 1984; Moll 1990).

Current evidence suggests that *K. scorpioides* is a visually oriented omnivore that feeds on fish, amphibians (tadpoles and adults), dead vertebrates, invertebrates, algae and plant material, but with the exception of Moll (1990), most of these data are anecdotal (Cunha 1970; Vanzolini et al. 1980) or based on observation of captives (Monge-Nágera and Moreva-Brenes 1987; Pritchard and Trebbau 1984). In this paper, we describe the diet of *K. scorpioides* at Serra Sul, Floresta Nacional de Carajás, eastern Amazonia.

Materials and Methods.—Serra Sul (6°20'S, 5°25'W) is a narrow plateau (600–800 m above sea level) developed upon a "banded iron formation" at Serra dos Carajás, eastern Amazonia, Brazil (Sifeddine et al. 1994). Climate is seasonal, with most annual rains (1500–2000 mm) falling from November to May. Mean annual temperature is 24°C. Vegetation on the plateau consists mostly of open and shrub savannas ("canga vegetation"), while the steep borders and surrounding lowlands are covered by rainforest. The plateau is covered with many shallow lakes at various stages of silting.

We conducted our sampling in March and April 2005, at the end of the rainy season, when a large part of the study area was flooded. Turtles were captured in lakes, marshes and slow-moving streams, by hand or in Tomahawk live traps (model 202, 47 × 15 × 15 cm) baited with meat and placed partially submerged in water. Traps were checked at 1–6 h intervals. Turtles were sexed, mass was measured with spring scales, and straight-line carapace length (CL) was measured with vernier calipers. All turtles were marked and kept in damp cloth bags for 6 h before release at their capture site. Turtles usually defecated in the bags and these fecal samples were collected and stored in 70% alcohol. We identified each food item to the lowest possible taxon (usually order) and

TABLE 1. Summary of food items found within fecal samples from 23 *Kinosternon scorpioides* (NUM = Sum of individual prey recorded in all feces; IND = Number of individual fecal samples containing a particular prey category; Prey habitat: A = aquatic, T = terrestrial, ? = habitat unknown).

TAXON	NUM	IND	HABITAT
PLANT MATERIAL			
Fam. Graminae			
Echinocloa sp.	1138	16	A
Unidentified Graminae	711	9	?
Unidentified plant material	—	16	?
INVERTEBRATES			
Class Insecta			
Order Coleoptera	1	1	T
Order Diptera	1	1	T
Order Hemiptera			
Limnocoris sp.	55	20	A
Order Hymenoptera			
Fam. Formicidae	5	2	T
Order Isoptera	8	6	T
Order Lepidoptera	2	2	T
Order Odonata			
Adults	16	9	T
Naiads	19	13	A
Order Orthoptera	3	3	T
Unidentified invertebrate	2	2	T
VERTEBRATES			
Class Anura	—	2	T, A
Class Reptilia			
Fam. Colubridae (scales)	1	1	?
Class Aves (eggshell)	1	1	T
Class Mammalia (fur)	1	1	T

counted the total number of each. The number of each prey type present in each sample was considered as the minimum number of individuals that could have contributed to the disarticulated parts (Lima et al. 1997).

Results and Discussion.—We captured 36 *K. scorpioides* a total of 42 times. Our sample included 17 males (mean CL = 123.4 mm, SD = 8.4, range = 96–134 mm; mean mass = 262.7 g, SD = 39.2, range = 150–320 g), 17 females (mean CL = 126.5 mm, SD = 5.8, range = 96.5–135 mm; mean mass = 284.4 g, SD = 62.2, range = 125–385 g), and two unsexed juveniles.

Twenty-eight fecal samples were obtained from 23 turtles. Feces from the same individuals were pooled for the analysis (thus, N = 23). Consistent with previous studies, *K. scorpioides* used a wide range of animal and plant resources (Moll 1990; Monge-Nágera and Moreva-Brenes 1987; Pritchard and Trebbau 1984; Vanzolini et al. 1980). We found 16 different prey taxa in the fecal samples including invertebrates, vertebrates and plant material (Table 1). The most common item was grass seeds (mostly *Echinocloa* sp.), followed by aquatic Hemiptera (*Limnocoris* sp.) and Odonata naiads and adults (Table 1). The most common prey types were aquatic, but some were terrestrial. However, terrestrial prey species were probably consumed in the water, after falling in and becoming trapped (e.g., adult dragonflies; Pritchard and Trebbau 1984). Seeds and other plant material passed undigested through the digestive tract. We do not know if these food items were consumed accidentally or intentionally. However, aquatic plants have been reported in the diet of *K. scorpioides* from Belize (Moll 1990). Captive *K. scorpioides* have been reported to consume vertebrates, including fish, reptiles, and rodents (Pritchard and Trebbau 1984). The rarity of vertebrates in our samples suggested opportunistic feeding, however, we were unable to determine if vertebrates were eaten alive or as carrion. Amphibians were recorded only in three samples, despite being very common within *K. scorpioides* habitat. But our results may have been misleading because amphibians, particularly tadpoles, are easily digested and leave few remains in feces (Daltry et al. 1998).

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Nomenclatural Status of the Malagasy Snake Genus *Bibilava* Glaw, Nagy, Franzen, and Vences, 2007: Resurrection of *Thamnosophis* Jan and Designation of a Lectotype for *Leptophis lateralis* Duméril, Bibron, and Duméril (Serpentes: Colubridae)

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The new generic name *Bibilava* was recently applied to an assemblage of colubrid snakes from Madagascar that had previously been associated with the genus *Liopholidophis* (Glaw et al. 2007; Glaw and Vences 2007), but we here show that the earlier name *Thamnosophis* Jan (1863) is the appropriate name for this group. In addition, we designate a lectotype for *Leptophis lateralis* Duméril, Bibron, and Duméril, the type species of *Thamnosophis*, to resolve some ambiguity in the application of this name.

Mocquard (1904) erected the snake genus *Liopholidophis* to accommodate snakes from Madagascar placed in *Tropidonotus* by Boulenger (1893), primarily because the Malagasy snakes have hemipenes dissimilar to those of *Tropidonotus* with which Boulenger had associated them. Mocquard (1904, 1909) also recognized that several species he included in the genus had an unusually exaggerated sexual dimorphism in tail length (reviewed by Cadle 1996 and Glaw et al. 2007). Apart from the subset of species that shared this unusual sexual dimorphism, *Liopholidophis* came to include other generalized Malagasy colubrids that lacked derived characters linking them to other named Malagasy colubrid genera.

Mocquard (1904) explicitly included the following taxa in *Liopholidophis*: *Leptophis lateralis* Duméril, Bibron, and Duméril, 1854; *Dromicus stumpffi* Boettger, 1881a; *Dromicus sexlineatus* Günther, 1882; *Dromicus dolicocercus* Peracca, 1892; and the new species *Liopholidophis grandidieri* Mocquard, 1904. Subsequent authors (e.g., Cadle 1996; Guibé 1958; Mocquard 1909; Parker 1925) have used Mocquard's name *Liopholidophis* for this assemblage. Williams and Wallach (1989) designated *L. grandidieri* Mocquard (1904) as the type species of *Liopholidophis*; Glaw et al. (2005: 83) erroneously stated that the type species was *L. sexlineatus* (Günther).

Parker (1925) defined two species groups within *Liopholidophis*, which were amplified by Cadle (1996): the *sexlineatus* group for the species having the exaggerated sexual dimorphism in tail length, and the *stumpffi* group for the species lacking that extreme dimorphism. After accommodating subsequently described species and nomenclatural adjustments (Cadle 1996, 1998; Glaw et al. 2005), Parker's *sexlineatus* group comprised the nominal species *sexlineatus*, *dolicocercus*, *grandidieri*, *rhadinaea*, and *varius*, whereas his *stumpffi* group included the nominal species *stumpffi*, *epistibes*, *infrasignatus*, *lateralis*, and *martae*. Cadle (1996) found evidence to support the monophyly of each of the species groups but he suspected that *Liopholidophis* was non-monophyletic because he found no characters to support the monophyly of the genus as a whole. Several authors (e.g., Boulenger 1893; Cadle 1996; Domergue "1972" [1973]; Guibé 1954, 1958; Williams and Wallach 1989), recognized the relevance of the name *Thamnosophis* Jan, 1863 (type species: *Leptophis lateralis* Duméril, Bibron, and Duméril, 1854) to the nomenclature of "*Liopholidophis*" by including the name in the synonymies of *L. lateralis* and *L. stumpffi*. Being the earlier name, *Thamnosophis* has priority over *Liopholidophis* when the two names are applied to the same taxon. However, because Cadle (1996) questioned the relationship of the two species groups of *Liopholidophis* to one another, and the type species of *Liopholidophis* and *Thamnosophis* are in different species groups (*sexlineatus* and *stumpffi* groups, respectively), he chose to leave the generic nomenclature alone until stronger evidence bearing on the systematics of the species groups accrued.

Glaw et al. (2007) provided evidence for the partition of *Liopholidophis* in a molecular phylogenetic analysis of eight species of *Liopholidophis* (three species of the *sexlineatus* group and five species of the *stumpffi* group) along with other representative Malagasy colubrids. They found that each species group was monophyletic. However, species of the *L. sexlineatus* group were more closely related to several species of *Liophidium* than to species of the *L. stumpffi* group, thus making *Liopholidophis* sensu lato non-monophyletic. In revising the nomenclature to conform to their phylogenetic hypothesis, Glaw et al. (2007) restricted the name *Liopholidophis* to the former *sexlineatus* group (which includes the type species, *L. grandidieri*) and described a new species, *Liopholidophis dimorphus*. Glaw et al. (2007) also named a new genus, *Bibilava*, to accommodate species of the former *stumpffi* group and designated, as its type species, *Leptophis lateralis* Duméril, Bibron, and Duméril, 1854.

Thus, Glaw et al. (2007) overlooked the available generic name, *Thamnosophis* Jan, for the *stumpffi* species group. Its type species

(by subsequent designation: Wall 1923:604) is also *Leptophis lateralis* Duméril, Bibron, and Duméril, 1854. *Bibilava* Glaw, Franzen, Nagy, and Vences is thus an objective junior synonym of *Thamnosophis* Jan, which has nomenclatural priority. We resurrect this name, whose nomenclatural history is summarized herewith:

Thamnosophis Jan, 1863

Thamnosophis: Jan 1863:79, 82. Included taxa: *Leptophis lateralis* Duméril, Bibron, and Duméril, 1854; *Leptophis vertebralis* Duméril, Bibron, and Duméril, 1854; *Leptophis bivittatus* Duméril, Bibron, and Duméril, 1854; *Herpetodryas margaritiferus* Schlegel, 1837; *Thamnosophis delesserti* Jan, 1863. Jan and Sordelli 1869: Livr. 31, pl. VI, fig. 3; 1879: Livr. 49, pl. II, fig. 2.

Ahaetulla Gray, part: Boettger 1879:33. Referred species: *A. lateralis* (= *Thamnosophis* Jan).

Philothamnus Smith, part: Boettger 1881b:526. Referred species: *P. lateralis* (= *Thamnosophis* Jan).

Tropidonotus Kuhl, part: Boulenger 1893:193. Referred species: *Tropidonotus stumpffi* (= *Thamnosophis stumpffi*) and *Tropidonotus lateralis* (= *Thamnosophis lateralis*).

Drymobius Fitzinger, part: Boulenger 1894:9, 15, 17. Günther 1885–1902:125. Referred species: *D. margaritiferus* (= *Thamnosophis margaritiferus*) and/or *D. bivittatus* (= *Thamnosophis bivittatus*). See Smith and Smith 1976 for additional citations of *Thamnosophis* in connection with these Neotropical species.

Rhabdophis Fitzinger, part: Wall 1923:604. Referred species: *R. lateralis* (= *Thamnosophis* Jan). [*Leptophis*] *lateralis* Duméril, Bibron, and Duméril, 1854 designated as type species of *Thamnosophis* Jan.

Liopholidophis Mocquard, part: Guibé, 1954:243. Guibé 1958:213. Domergue "1972" [1973]:1397. Williams and Wallach 1989:146. Cadle 1996:416, 421. Referred species: *L. lateralis* (= *Thamnosophis lateralis*) and/or *L. stumpffi* (= *Thamnosophis stumpffi*).

Natrix Laurenti, part: Romer 1956:579. *Thamnosophis* listed as a synonym.

Bibilava Glaw, Nagy, Franzen, and Vences, 2007:294. Glaw and Vences 2007: 438. **New synonymy**.

The name *Thamnosophis* has been used in the combination *Thamnosophis lateralis* (Duméril, Bibron, and Duméril) as a synonym of the Malagasy snakes *Leptophis lateralis* Duméril, Bibron, and Duméril and/or *Dromicus stumpffi* Boettger by the following authors: Boulenger (1893:247–248), Cadle (1996:416, 421), Domergue ("1972" [1973]:1397), Guibé (1954:243; 1958:213), Jan (1863:82), and Jan and Sordelli (1879: Liv. 49, pl. II, fig. 2).

The resurrected genus *Thamnosophis* Jan (1863) has the following content (all endemic to Madagascar): *Thamnosophis lateralis* (Duméril, Bibron, and Duméril 1854) (type species); *Thamnosophis epistibes* (Cadle 1996), new combination; *Thamnosophis infrasignatus* (Günther 1882), new combination; *Thamnosophis martae* (Glaw, Franzen, and Vences 2005), new combination; and *Thamnosophis stumpffi* (Boettger 1881a), new combination. Diagnoses of these taxa are found in Cadle (1996) and Glaw et al. (2005). Characters given by Cadle (1996:417 [Table 2], 436–443, 450–452) for the "*Liopholidophis stumpffi* group" and Glaw et al. (2007:294) for "*Bibilava*" serve as a diagnosis and description of *Thamnosophis*. *Thamnosophis* is diagnosed by unique hemipenial characters, including unusual depressions at the tips of each lobe of the bilobed organs, and lobes set off from the base of the organ by a nude gap, giving the false impression of capitation (Cadle 1996:436–443).

There has been ambiguity in the application of the name *Leptophis lateralis* Duméril, Bibron, and Duméril, the type species of *Thamnosophis*, owing in part to color variation in the type series and confusion about the identity of several nominal taxa we refer to *Thamnosophis*. Resurrection of *Thamnosophis* and reexamination of the syntypes of *L. lateralis* presents an opportunity to resolve this confusion by designating a lectotype for *L. lateralis*. *Leptophis lateralis* was originally described from four syntypes (three females and one male) with the catalogue number 7312 in the Muséum National d'Histoire Naturelle, Paris (MNHN). In a subsequent renumbering, one specimen retained "7312" and the other three were distinguished by letters: 7312A, 7312B, and 7312C. Later, the three specimens with letter designations were given individual catalogue numbers, 1999.8232–8234, corresponding to the letters A–C, respectively.

TABLE 1. Scutellation characters and measurements of the four syntypes of *Leptophis lateralis* Duméril, Bibron, and Duméril. The current identity of each syntype is given below the MNHN number; data for the lectotype are in the first column. Measurements are in mm.

	MNHN 1999.8232 (*Thamnosophis lateralis*) Lectotype	MNHN 7312 (*Thamnosophis lateralis*)	MNHN 1999.8233 (*Thamnosophis lateralis*)	MNHN 1999.8234 (*Thamnosophis epistibes*)
Sex	Female	Female	Female	Male
Total length (SVL)	791 (564)	688 (492)	643+ (503)	680+ (493)
Tail length	227	196	140+	187+
Dorsal scale rows	19–19–17	20–19–17	19–19–17	19–19–17
Ventrals + Preventrals	165 + 1	158 + 2	158 + 2	164 + 2
Subcaudals	95	90	59+	75+
Supralabials (touching eye)	8 (4-5)/8 (4-5)	8 (4-5)/8 (4-5)	8 (4-5)/8 (4-5)	8 (4-5)/8 (4-5)
Infralabials	10/10	10/10	11/10	10/10

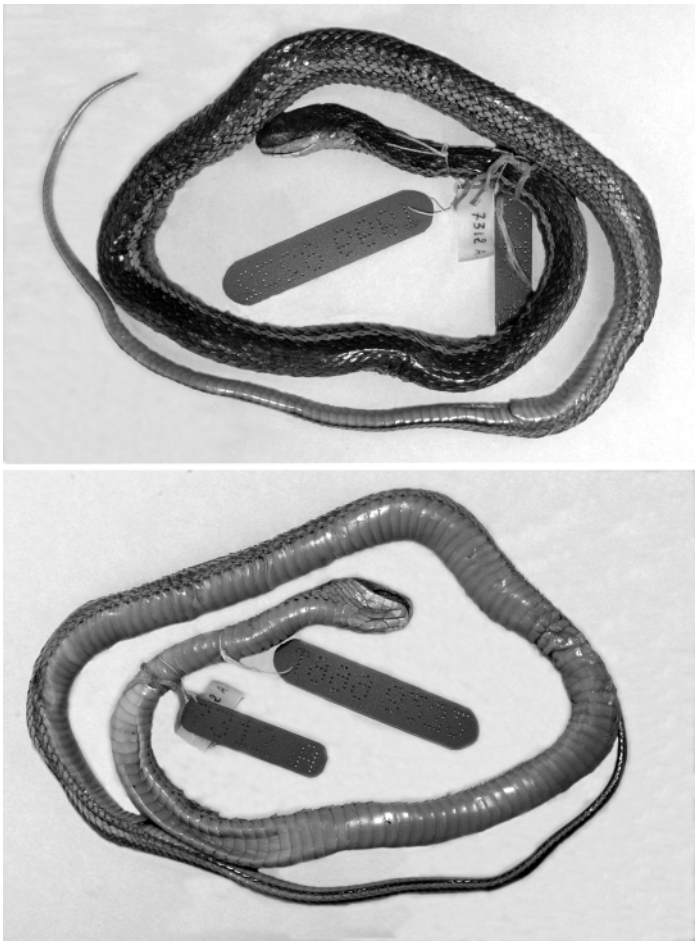


FIG. 1. Lectotype of *Leptophis lateralis* Duméril, Bibron, and Duméril (1854), MNHN 1999.8232, in dorsal and ventral views.

Hereafter, we refer to the specimens by the last numbers. Their scutellation and other traits are summarized in Table 1.

Since its description the name *Leptophis lateralis* has been universally applied to a Malagasy species having a diagnostic color pattern of vivid pale (yellowish to white in life) dorsolateral stripes from the neck to the tip of the tail against a primarily black dorsal ground color. Descriptions and/or illustrations of this form are found in Cadle (1996), Glaw and Vences (1994, 2007), Guibé (1954, 1958), and Jan and Sordelli (1879: Liv. 49, pl. II, fig. 2), among others. However, Duméril et al. (1854:545) indicated that the stripes in one of the syntypes were not so extensive: "The most prominent trait in the disposition of the colors is the presence of a yellowish white band on each side which, in all our specimens with one exception, extend from the head to the tip of the tail." The exceptional specimen is the male syntype (MNHN 1999.8234), in which the dorsolateral stripes are evident on only the anterior quarter of the body. In addition, the male syntype has median black markings on many of the ventral scales (also noted by Guibé [1958:214]), which occasionally form more extensive irregular markings across the anterior edge of individual ventral scales. Neither incomplete dorsolateral stripes nor extensive black ventral markings are characteristic of *T. lateralis*. On the other hand, pale dorsolateral stripes on only the anterior half of the body and/or black ventral markings are characteristic of the other species referred to *Thamnosophis* (i.e., *T. epistibes*, *T. infrasignatus*, *T. martae*, and *T. stumpffi*; see Cadle 1996, Glaw et al. 2005).

The variation in the extent of the dorsolateral stripes among the syntypes of *Leptophis lateralis* has led to some nomenclatural confusion. Some authors have placed *L. lateralis*, in part, in the synonymy of the nominal species *Dromicus stumpffi* Boettger or *Ptyas infrasignatus* Günther (e.g., Boulenger 1893; Cadle 1996) or have considered these species identical (e.g., Guibé 1954, 1958; Mocquard 1904). Guibé (1954, 1958) placed these names and several other nominal taxa in the synonymy of *L. lateralis*, thinking that there was a single, wide-ranging species exhibiting extensive variation in color pattern. This confusion persisted until it was partially sorted out by Domergue ("1972" [1973]) and further resolved by Cadle (1996; see footnote 10). Until now, the syntypes have not been reexamined.

Our study of the syntypes of *Leptophis lateralis* shows that three (MNHN 7312 and 1999.8232–8233) represent the taxon *Thamnosophis lateralis* as universally understood (diagnosis in Cadle 1996). The male syntype (MNHN 1999.8234) is *T. epistibes*, as suspected by Cadle (1996: footnote 10), and has the diagnostic characters of scutellation and color pattern of that species (e.g., ventral spotting, postocular and dorsolateral stripe configurations) (Cadle 1996:386). Although similar to *T. martae*, MNHN 1999.8234 has fewer ventrals than the only known male of *T. martae* (185; Glaw et al. 2005).

We select MNHN 1999.8232 as the lectotype of *Leptophis lateralis* because it is the largest specimen and apparently the one for which Duméril et al. (1854) gave measurements (Fig. 1). The specimen is an adult female in good condition with a midventral slit in the base of the tail. Scutellation and proportions are given in Table 1. The pale dorsolateral stripe of MNHN 1999.8232 extends from the neck to the tail tip. Anteriorly, it is centered on dorsal row four but encompasses adjacent parts of rows three and five; it broadens posteriorly, occupying row four, most of row three, and part of row five. The venter of MNHN 1999.8232 is uniform whitish. Resolution of the identity of the syntypes of *Leptophis lateralis* Duméril, Bibron, and Duméril and selection of a lectotype clarifies the application of this name. Accordingly, the name should be removed from the synonymy of *T. stumpffi* and *T. infrasignatus* (e.g., Cadle 1996) and placed, in part, in the synonymy of *T. epistibes* (Cadle).

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The Mud Dwelling Tadpole of the Long-toed Tree Frog, *Leptopelis xenodactylus* (Arthroleptidae)

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The genus *Leptopelis* includes many terrestrial species (Schiøtz 1999), such as *L. bocagii* and *L. bufonides*. All species studied share a terrestrial breeding system with eggs deposited in nests away from water. The tadpoles wriggle to the water to continue development (Wager 1986, as *Hylambates natalensis*). The tadpoles of many species are found in shallow muddy water.

The Long-toed Tree Frog *Leptopelis xenodactylus* Poynton 1963, is endemic to the midlands of KwaZulu Natal Province, South Africa. Although it was described from a single specimen (Poynton 1963), subsequent specimens (Burger 2004; Van Dijk 1978) have increased the known range to about 120 × 150 km. The species has been placed in the Endangered category of the IUCN, based on its limited and fragmented area (Harrison et al. 2001). This study aimed to locate and describe the tadpole of *L. xenodactylus*, in order that further monitoring and range extensions could be undertaken based on larvae.

The description is based on three specimens collected at Mpur Forest, near Franklin in KwaZulu-Natal Province, South Africa (30°19'56"S, 29°31'04"E). They were collected from soft mud covered by a few mm of water, between grass polls, 15 January 2007, by A. Schmitz and A. Channing. Adults of *Leptopelis xenodactylus* have been collected at this site (Burger 2004; Van Dijk 1978). The habitat was described as a hammock bog and was illustrated in color (Photo 30) by Minter et al. (2004).

Tadpole identification is based on the characteristic low fins and labial tooth row formula, as well as the muddy habitat, characteristic for *Leptopelis* tadpoles. There is only one species of tree frog known from the habitat.

I use the terminology of Altig and McDiarmid (1999), and the morphometric ratios proposed by Van Dijk (1966). Tadpoles were staged according to Gosner (1960). A digital caliper accurate to 0.01 mm was used with a stereo microscope to take the measurements. Measurements were rounded to 0.1 mm. I measured total length, tail length, maximum height of fins, distance from highest point on fin to tail tip, snout tip to spiracle distance, snout tip to nostril distance, internarial distance, distance between eyes, distance between lateral limits of eyes, head width at level of eyes, snout tip to eye distance, nostril to eye distance, width of oral disc, and head width at level of disc.

The three tadpoles were deposited in the Natural History Museum of Geneva, MHNG 2691.53. They have total lengths of 40.2, 38.2, and 20.7 mm, the larger two representing Stage 38 and the smallest tadpole Stage 37. The largest specimen served as the model for the description (Fig. 1). Proportions are given as the range from smallest to largest.

The mouth is positioned ventrally. The oral disc is 59–68% of the width of the head at the level of the disc. The marginal papillae



FIG. 1. Stage 38 tadpole of *Leptopelis xenodactylus*. Scale bar = 10 mm.

are in a double posterior row, with the outer papillae longer, extending well clear of the disc when viewed from the front. The anterior gap in the papillae is 61–71% of the width of the oral disc. The papillae are about twice as long as wide, scattered in the angle of the jaw. The anterior and posterior jaw sheaths are heavy, fully pigmented in the larger specimens, but only the marginal half pigmented in the small tadpole. The jaw sheaths are finely serrated. The labial tooth row formula is 4(2-4)/3 in the larger specimens (Fig. 2), but 2(2)/3 in the small tadpole. The nostrils are rounded with the proximal margin forming a small protuberance. Internarial ratio: width of nostril/internarial distance = 0.17 to 0.33. Longitudinal position of nostrils: rostronasal distance/ orbitonasal distance = 1.29–1.83. There is no orbitonasal line, but a small pineal spot is present midway between the anterior margins of the eyes. Extraocular proportion: width of head minus distance between lateral limits of eyes/distance between lateral limits of eyes = 0.16–0.32.

The spiracle opening is not attached to the body wall, rounded, smaller than the spiracular tube, positioned 70–74% posteriorly along trunk. The vent opening is dextral, confluent with the ventral fin margin. The tail muscle is two thirds as high as the body, with the low dorsal fin only reaching half the height of the tail, and the ventral fin about half the height of the dorsal fin. The tail tip is acutely tapered. The dorsal fin originates just anterior to the junction of the tail and body, rising gradually to a high point 41–48% posteriorly along tail. The extrapolated tail axis passes dorsal to the eyes. Tail length/ length of head and trunk = 2.3–2.7.

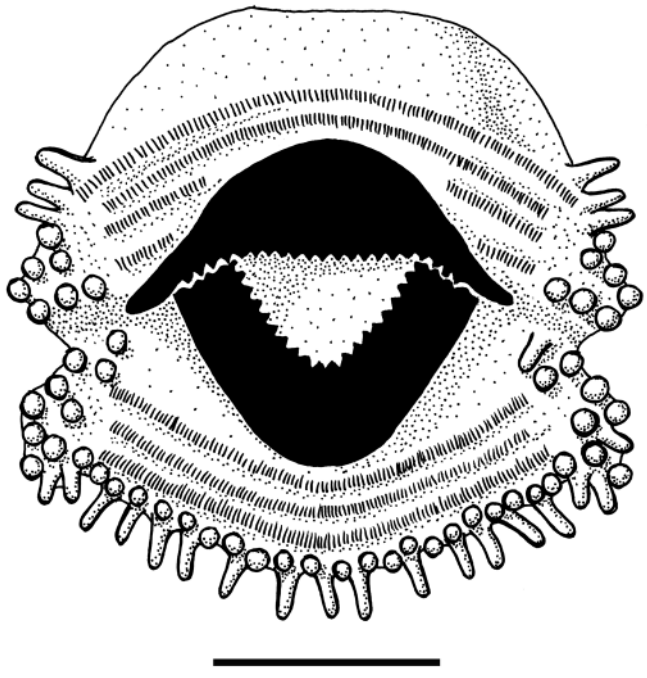


FIG. 2. Mouthparts of Stage 38 tadpole of *Leptopelis xenodactylus*. Scale bar equals 1 mm.

The tadpole is pale with translucent skin, on which very fine black stippling is present, forming irregular clumps over the tail, fins, and lateral and dorsal surfaces of the body. Dark pigment is present over the terminal 25% of the fins, where it forms a black margin on the dorsal and ventral fin margins. The ventral surface of the body is unpigmented.

The measurements of the larger Stage 38 tadpole are: total length 40.2, tail length 29.2, maximum fin height 5.5, highest point on fin to tail tip 15.3, snout tip to spiracle 8.1, snout tip to nostril 2.3, snout tip to eye 3.8, internarial distance 1.7, interocular distance 3.6, width of oral disc 2.4.

Body shape is similar in all known *Leptopelis* tadpoles, which have long tails with low fins. The largest recorded tadpoles are found in *L. gramineus* (Schiøtz 1999) and are 64 mm long, while the smallest are those of *L. hyloides* which are only 34 mm in total length (Oldham 1977).

The labial tooth row formula is known to change as the tadpoles grow, and more rows are added, as documented in *L. calcaratus* (Schiøtz 1999) and *L. nordequatorialis* (Perret 1966). This is apparent in the specimens of *L. xenodactylus*, with the smallest tadpole having two anterior rows of labial teeth, and the larger specimens four rows. The jaw sheaths of *L. xenodactylus* are heavy, resembling those of *Kassina* in build, suggesting that they are able to feed on the tough vegetation.

Previously described tadpoles of *Leptopelis* are all darkly pigmented, such as *L. viridis* (Rödel 2000) although the pigmentation in this species does not extend to the ventral surfaces of the head (Inger 1968). The ventral fins are unpigmented in other species of the genus (e.g., *L. natalensis*, *L. mossambicus*, and *L. oryi* (Inger 1968; Oldham 1977; Wager 1986).

The tadpole of *Leptopelis xenodactylus* can be distinguished from *L. natalensis*, the only other species in the genus likely to be sympatric, by the presence of the dark tail tip.

Tadpoles are useful for monitoring the presence of amphibians. The distinctive tadpole of *L. xenodactylus* is much easier to find than the burrowing adults, which may even vocalize from below ground level. Searching for tadpoles would be an appropriate means of discovering additional localities of this highly cryptic and endangered species.

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Intraspecific Combat Behavior of *Phyllomedusa boliviana* (Anura: Hylidae) and the Possible Origin of Visual Signaling in Nocturnal Treefrogs

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Social communication in anuran amphibians is predominantly mediated by acoustic signals. However, visual displays have been observed in several species in variable behavioral contexts. Some visual displays were interpreted as part of courtship and/or territorial behavior, especially in diurnal stream dwelling frogs, where the noisy environment hampers acoustic communication (see Grafe and Wanger 2007; Haddad and Giaretta 1999; Hödl and Amézquita 2001; Lindquist and Hetherington 1996; Narvaes and Rodrigues 2005). The functional role of visual displays is so far not well understood, especially in cases where it occurs in nocturnal species and/or in forest dwelling species (e.g., Amézquita and Hödl 2004). As demonstrated recently by various authors (e.g., Giasson and Haddad 2006; Hartmann et al. 2004), visual signaling in nocturnal frogs seems to be more common and is found in many more species than previously thought.

Within the Hylidae, visual displays have been observed in several nocturnal species (e.g., Amézquita and Hödl 2004; Hartmann et al. 2004; Toledo et al. 2007; Zina and Haddad 2007). Frogs of the genus *Phyllomedusa* engage in male-male combat (e.g., De Jesus et al. 2003; Matos et al. 2000; Wogel et al. 2004), and in some species visual signals were reported during combats: *P. hypochondrialis* has been observed to display "hand-waving" (Laurent 1973); leg signals and pedal luring were observed in *P. burmeisteri* (Abrunhosa and Wogel 2004; Bertoluci 2002; Haddad and Giaretta 1999), and foot flagging was reported for *P. distincta* (Castanho 1994) and *P. sauvagii* (Halloy and Espinoza 2000). *Phyllomedusa boliviana* occurs along the dry eastern slopes of the Andes and lowlands of eastern Bolivia to northern Argentina, western Mato Grosso and Rôndonia, Brazil, occupying an altitudinal range of approximately 200–2000 m elev. (Köhler 2000). Its breeding biology has been reported in detail by Vaira (2001). We here report for the first time on visual signaling in *P. boliviana* during male-male interaction and discuss the possible origin of leg stretching behavior in nocturnal anurans.

Materials and Methods.—Observations were made by MJ in an inter-Andean dry valley at Pampagrande (18°05.257'S, 64°06.842'W, 1298 m elev.), Province of Florida, Department of Santa Cruz, Bolivia, on 29 November 2005 (2330 h, 19.7°C air temperature, 60% air humidity). For characters of the general study area see Azurduy et al. (2004) and Ibisch et al. (2004). Males of *P. boliviana* called at a small artificial pond within the small village. Photos and short movie sequences of the behavior, as well as recording of calls were taken with a Minolta Dimage X50 digital camera. A short video sequence was later analyzed on computers. We used the time scale of the Windows Media Player for counting of seconds of leg stretching behavior. Similar observations were done immediately before and during crepuscular light but without torch light. Due to lack of recording we were not able to analyze them adequately.

Results.—Around the pond several males of *P. boliviana* were calling (together with *Pleurodema cinereum*). The behavior of two males observed in a shrub might be classified by the following phases:

Approaching Phase: One male (here called resident, Male A) was calling ca. 150 cm above the water body. The apparent intruder (here called Male B) was sitting less than 10 cm distance from the first, ca. 140 cm above the water body (Fig. 1-1). Male A continued calling, whereby the call type was in agreement with advertisement calls described for *P. boliviana* by Köhler (2000).

Signaling Phase: Nine visual displays were recorded. Male A stretched legs in an alternating manner, whereby stretch displays of one leg had a duration of 5–25 seconds (mean 12.75 ± 8.8; N = 4). The signaling phase itself can be subdivided into four sections: lifting of leg (section I); stretching (section II); movement in an arc backwards and above the body (section III; Fig. 1-2); and bringing back the leg alongside the body (section IV). In the cases where all phases were realized, the total duration of the leg stretching behavior was 13–25 seconds (N = 2). Section III, in which the leg was kept fully stretched and then brought back



FIG. 1. Sequence of male-male interaction and visual display in *Phyllomedusa boliviana* (A, resident male; B, intruding male). 1) Approaching Phase; 2) Signaling Phase (showing leg stretching behavior); 3) Wrestling Phase; 4) Grasping Phase. Photos by M. Jansen.

alongside the body, lasted for 12–19 seconds (N = 2). After a short interval of only 2–4 seconds (N = 2), the other leg was lifted. Calling of Male A continued during visual signaling. Leg movement did not always consist of all the sections described above. In some cases, Male A lifted and stretched the leg entirely without doing an arc, then brought the leg alongside the body (sections I + II + IV; N = 2). This movement was very slow and lasted for about 6 seconds from beginning of the movement to full stretching. Just before wrestling, Male A only lifted the leg, but did not stretch it entirely, then brought it alongside the body (section I + IV; 6 second duration; N = 1).

Wrestling Phase: As Male B slowly continued approaching Male A, the latter initiated a physical combat with a jump forward. This physical encounter consisted of a slow wrestling movement, each male trying to grab the opponent´s head and body with fore and hind limbs (Fig. 1-3). This wrestling lasted for 2:25 minutes, before Male A managed to climb on top of Male B. During wrestling, both males emitted a different call type consisting of short series of pulsed notes, much softer than the advertisement call. This call lasted 400–418 milliseconds (mean = 407 ± 96; N = 3).

Grasping Phase: Wrestling ended in an axillary amplexus with Male A on top (Fig. 1-4). Just after Male A reached the back of its opponent, it was stretching the left leg for 5 seconds, followed by three short, not totally stretched leg-movements, starting with the right foot. The first of these movements lasted 3 seconds, the following were much shorter (about one second). Both males stopped calling, Male B did not try to escape.

Release Phase: Unfortunately, observations ended before Male B was released, but obviously this phase has to follow the grasping phase. Loosening of the grip of the superior male might be triggered by emission of some kind of release call by the inferior male, as reported for *P. sauvagii* by Halloy and Espinoza (2000).

Discussion.—Territorial behavior has been documented for various species of nocturnal hylids, among them several species of the genus *Phyllomedusa*: physical combats appear in *Phyllomedusa boliviana* (Vaira 2001; this study), *P. burmeisteri* (Abrunhosa and Wogel 2004), *P. hypochondrialis* (M. Jansen, pers. obs.; Matos et al. 2000), *P. sauvagii* (De Jesus et al. 2003; Halloy and Espinoza 2000), and *P. rohdei* (Wogel et al. 2004). Our observations are most similar to those described for *P.*

burmeisteri by Abrunhosa and Wogel (2004) or *P. sauvagii* by Halloy and Espinoza (2000).

As stated by various authors (e.g., Haddad and Giaretta 1999; Hödl and Amézquita 2001), the selective pressures leading to the evolution of visual communication in nocturnal anurans are more difficult to understand than in diurnal species. Visual signaling may have evolved in order to avoid physical combat between males and could be as important for the maintenance of spacing among males, to assure well-positioned leaves or facilitate male location by females, as it occurs in the genus *Hyalinobatrachium* (see Hartmann et al. 2005). From our observation, it can be summarized that intraspecific visual signaling in *Phyllomedusa boliviana* occurred in the context of aggressive behavior, was used directionally and displayed toward a target individual, and was accompanied by acoustic signaling. It can be postulated that in a multimodal display of visual and acoustic signals, the acoustic part directs the receiver's attention to the location of the subsequent more informative signal (compare Grafe and Wanger 2007). Furthermore, it can be assumed that the presence of a conspecific competitor triggers the frequency of visual signaling displayed in a directed mode toward the target individual (see Lindquist and Hetherington 1998). These predicted functions of visual and acoustic signals have not been tested in *P. boliviana*.

In the case of *Phyllomedusa* species, such as *P. burmeisteri*, and *P. sauvagii*, visual signaling can be understood as an aggressive display to defend good calling positions and therefore is strongly related to high-quality territories (Abrunhosa and Wogel 2004; Halloy and Espinoza 2000). Defense of an advantageous calling position is known for many arboreal frogs and occurs in several families, e.g., Centrolenidae and Hyperoliidae (Bolivar et al. 1999; Guayasamin and Barrio-Amorós 2005; Passmore and Telford 1981; pers. obs.). One common character in these male-male interactions is some kind of wrestling with close contact of bodies, connected with kicking movements of the hindlimbs, targeted at pushing the competitor from its position. In most of these cases, wrestling and kicking is connected with intense calling activity (e.g., Köhler and Böhme 1996). Thus, it might be postulated that the behavior of foot flagging (sensu Hödl and Amézquita 2001) used as visual signal in arboreal and nocturnal anurans is a derived behavior, originating from a more plesiomorphic kicking movement in male-male combats. It is possibly only a small step from trying to kick a competitor from the twig in direct body contact to "ritualized" leg stretching triggered by the visual and acoustic presence of a conspecific competitor.

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Scalation of Morelet's Crocodile (*Crocodylus moreletii*) from Northern Belize

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Morelet's Crocodile (*Crocodylus moreletii*) is a large crocodilian (total length [TL] to 416 cm; Perez-Higareda et al. 1991) inhabiting the Atlantic and Caribbean lowlands from northern Mexico southwards to Guatemala and Belize (Groombridge 1987). The scalation of *C. moreletii* has previously been described (Brazaitis 1973; Fuchs 1974; King and Brazaitis 1971; Ross and Mayer 1983; Ross and Ross 1974; Ross and Ross 1987; Smith and Smith 1977), but these accounts are based on samples of specimens collected from widely scattered localities in various range countries, or of unspecified (or unknown) provenance. Additionally, some descriptions are based on small numbers of specimens, perhaps reflecting the overall paucity of large reptiles in museum collections (Barker and Barker 2008). Consequently, published descriptions of *C. moreletii* are of little use for assessing intraspecific geographic variation in meristic characters, such as scalation. This situation is not unique to *C. moreletii* as phenotypic variation in scalation remains undetermined for most species of crocodilians (Ross and Roberts 1979). Indeed, with a few notable exceptions (Hall 1989; Ross and Roberts 1979) there has never been a comprehensive systematic analysis of geographic variation published for any species of crocodilians (Busack and Pandya 2001). Such analyses may identify geographically distinct populations that qualify for taxonomic or legal recognition (Busack and Pandya 2001; Hall 1989; Smith et al. 1997). Furthermore, studies of intraspecific phenotypic variation are an essential prerequisite to our understanding of biogeography, evolution, and ecology (Storer 1982).

Here we describe scalation in a large sample (N = 102) of *C. moreletii* collected in freshwater wetlands of northern Belize (Belize, Cayo, Corozal, and Orange Walk Districts) from 1994 through 1997. Detailed descriptions of this region and our study sites are provided elsewhere (Johnson 1983; Platt 1996; Platt and Thorbjarnarson 2000; Rainwater et al. 1998). We captured crocodiles in conjunction with population surveys (Platt and Thorbjarnarson 2000; Rainwater et al. 1998), and studies of reproduction (Platt 1996), diet (Platt et al. 2002, 2006), and ecotoxicology (Rainwater 2003; Rainwater et al. 2007, 2008). Crocodiles were captured at night with the aid of a spotlight; smaller crocodiles (TL ≤ 100 cm) were taken by hand or dip-net, and a noose-pole was used to capture larger individuals (TL > 100 cm). Each crocodile was permanently marked for future identification by notching the dorsal edge of a unique series of caudal scutes (Jennings et al. 1991) and released at the site of capture within 12 to 24 hours. We also examined two crocodiles that were found dead from unknown causes. The crocodiles in our sample ranged from 34.5 to 260 cm TL. *Crocodylus moreletii* occurs sympatrically with the morphologically similar American crocodile (*C. acutus*) in coastal mangrove habitats of northern Belize and Mexico (Quintana Roo and Yucatán states) and the two species are known to hybridize (Cedeño-Vázquez et al. 2008; Hekkala 2004; Ray et al. 2004; Rodriguez et al. 2008). Although individuals with characteristics of both species have occasionally been reported (Abercrombie et al. 1980; Powell 1972; Schmidt 1924), only crocodiles exhibiting the irregular subcaudal scale groups that are typical of *C. moreletii* (Platt and Rainwater 2005; Ross and Ross 1974) were included in our study. It is important to note that in reptiles, meristic characters such as the number of scales are determined during embryonic development (Ferguson 1985; Kerfoot 1970; Ross and Mayer 1983), and other than increasing in size, scales do not exhibit postembryonic ontogenetic change (Busack and Pandya 2001).

Scale counts and nomenclature follow Brazaitis (1973), King and Brazaitis (1971), and Ross and Ross (1987). We counted the following scale groups on each captured *C. moreletii*: post occipital scales, nuchal scales, dorsal scale rows (counted from posterior edge of nuchal cluster to posterior margin of hind limbs), continuous scales in each dorsal scale row, ventral scale rows (counted from the first row posterior to the ventral collar to the last complete row anterior to the cloaca), double-crested caudal

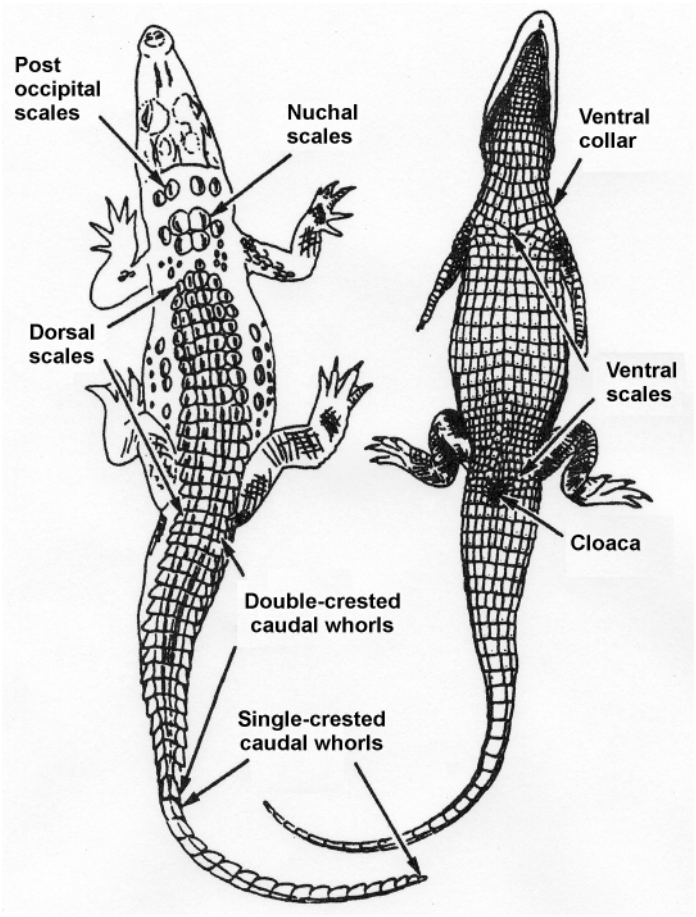


FIG. 1. Generalized dorsal (left) and ventral (right) view of a crocodile showing major scale groups, ventral collar, and cloaca. Transverse dorsal scale rows are counted from the first row posterior to the nuchal cluster to the posterior margin of hind limbs. Ventral scale rows are counted from the first transverse row posterior to the ventral collar to last complete row anterior to the cloacal margin. (Drawing modified from Brazaitis 1973).

whorls, and single-crested caudal whorls (Fig. 1). We calculated the mean number of dorsal scales for individual crocodiles as the sum of the scales in each row divided by the number of rows. To calculate the overall mean number of dorsal scales for our sample, we summed the total number of dorsal scales and divided this value by the total number of transverse rows. Mean values are presented as ± 1SD and results were considered significant at $P \leq 0.05$.

We found little variation in the number of post-occipital scales among our sample of *C. moreletii* (mean = 4.0 ± 0.4; range = 3–6); 92 (90.1%) crocodiles had four scales, while two (2.0%) were missing an element, and eight (7.8%) had either one (4) or two (4) extra elements. The range of post-occipital scales that we found is slightly greater than the range of four to six reported by others (Brazaitis 1973; Fuchs 1974; Smith and Smith 1977). However, post occipital scalation was considerably more variable among a sample of 100 specimens from throughout the geographic distribution of *C. moreletii*; 64 crocodiles had four post-occipital scales, while 36 had additional elements (range = 4–7) (Ross and Ross 1987). Using data from Ross and Ross (1987), we calculated a mean of 4.5 ± 0.8 post-occipital scales for this sample. This value is significantly greater than the mean number of post-occipital scales among *C. moreletii* from Belize (One-tailed *t*-test, $t = 5.03$, $df = 152$, $P < 0.001$).

With a single exception, the nuchal scale group in our sample of *C. moreletii* consisted of two tandem pairs of enlarged scales flanked by a smaller scale on each side. One crocodile in our sample lacked the two smaller flanking scales, and flanking scales were present, although considerably reduced in two other crocodiles. The number and arrangement of nuchal scales in *C. moreletii* from Belize is consistent with most published accounts (Brazaitis 1973; Fuchs 1974; Ross and Ross 1987; Smith and Smith 1977). Ross and Ross (1987) report a slightly larger range (4–8) in the number of neck shield (= nuchal) scutes, although only 11% of their sample deviated from the modal value of 6.

The mean number of transverse dorsal scale rows among *C. moreletii* from northern Belize was 15.9 ± 0.3 (range = 15–17). The same range is given by others (Brazaitis 1973; King and Brazaitis 1971; Smith and Smith 1977), but mean values are unavailable for comparison with our data. The mean number of dorsal scales in each transverse row ranged from 3.4 ± 0.6 to 5.0 ± 1.1 (N = 102 crocodiles). The overall mean number of dorsal scales in each transverse row was 4.3 ± 0.9 (N = 1624 dorsal scale rows). The minimum and maximum number of scales in any single dorsal row ranged from 1 to 4 and 4 to 6, respectively (frequency distribution in Table 1). The maximum number of scales in each dorsal row is given as 3–6 by others (Brazaitis 1973; Ross and Mayer 1983; Smith and Smith 1977). To our knowledge, comparable data on the minimum number of scales in each dorsal row have not been published.

The mean number of transverse ventral scale rows among the *C. moreletii* that we examined was 31.5 ± 1.5 (range = 28–37). Mean values for ventral scalation have not been previously reported for *C. moreletii*; however, the range that we found is somewhat greater and encompasses the range of 29–33 given by Brazaitis (1973). The mean number of double- and single-crested caudal whorls among *C. moreletii* from Belize was 17.3 ± 0.6 (range = 16–19) and 20.0 ± 1.0 (range = 16–22), respectively.

TABLE 1. Frequency distribution of the minimum and maximum number of scales in each dorsal scale row of *Crocodylus moreletii* (N = 102) collected in northern Belize (1994–1997). Number of crocodiles followed by percent of N in parentheses.

	Number of scales					
	1	2	3	4	5	6
Minimum	2 (1.9)	34 (33.3)	38 (37.2)	28 (27.4)	0	0
Maximum	0	0	0	1 (0.9)	13 (12.7)	88 (86.2)

Mean values for double- and single-crested caudal whorls are unavailable for comparison with our data. The range of 17–20 double-crested caudal whorls reported elsewhere for *C. moreletii* (Brazaitis 1973; Smith and Smith 1977) is somewhat greater than we found in Belize. According to Brazaitis (1973), *C. moreletii* is characterized by 19 (range not given) single-crested caudal whorls, the median value of our sample. The distal-most single-crested caudal whorls appeared to be missing or deformed (probably as a result of past injuries; Webb and Messel 1978) in many of the *C. moreletii* that we examined making comparisons of this character among populations problematic.

In conclusion, our study constitutes the first quantitative description of scalation among *C. moreletii* from a specific, well-defined geographic region. A comparison of our data with the few published accounts suggest that interpopulational differences in scalation may exist among *C. moreletii*, although whether populations can be identified on the basis of scalation remains to be determined. Differences between our data and published descriptions were noted among post occipital, dorsal, and ventral scale groups. Interestingly, a cursory examination by SGP and TRR of a small number of *C. moreletii* at a crocodile farm in Villahermosa, Mexico, suggests that at least in dorsal scalation, these animals differed from conspecifics in Belize. However, a complete analysis of geographic variation in scalation among *C. moreletii* must await the publication of comparable data from other range countries.

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Herpetofauna of the Pulau Banggi Group of Islands off Northeastern Borneo

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The limestone islands of the Pulau Banggi (ca. 07°14–19'N, 117°5–10'E) group are situated off the northeast coast of the island of Borneo, and due south of the Philippines islands of Balabac and Palawan (Fig. 1). In geographical terms, they lie between the basins of the South China Sea and that of the Sulu Sea, and cover a total land area of 699 km^2. Banggi, the largest of these islands, is ca. 700 km^2 in area and has a coastline of 420 km (Teh et al. 2005). Other important islands of the group include Balambangan and Malawali, the former island with extensive limestone formation, with outcrops reaching 120 m (Tuen et al. 2002). Administratively, these islands fall under Kudat District of Sabah (East Malaysia), and are included in the proposed (in 2003) Tun Mustapha Marine Park, designated primarily to protect the rich marine life of the surrounding seas. The archipelago comprises about 70 islands, 33 of which are inhabited by an estimated 80,000 people of various ethnic origins (Biusing 2001).

The first naturalist recorded to have collected on these islands is Francis Henry Hill Guillemard (1852–1933), in 1883, on board the 420-ton auxillary screw yacht 'The Marchesa,' which visited islands of eastern Asia and New Guinea on a natural history expedition. Although the purpose of the stop at Banggi was to obtain fresh water, Guillemard also made a collection of birds (Chasen and Boden Kloss 1930). In 1886, Alfred Hart Everett (1849–1898), then Resident of Trusan, Sarawak, and formerly with the British North Borneo Company, an important collector of Bornean fauna, visited these islands, and again made ornithological collections. The earliest herpetological collection took place on these islands in 1927, organized and led by Cecil Boden Kloss (1877–1949) of the Raffles Museum, Singapore, in collaboration with Henry Maurice Pendlebury (1893–1945), systematic entomologist with the Federated Malay States Museum. Besides the archipelago, the Expedition also worked in adjacent mainland, in what was then the Residencies of Sandakan and Kudat. Material from these collections is extant in the collection of the ZRC. However, little has been published on the herpetofauna of the region, apart from the citation of a specimen of *Bronchocela cristatella* in Tan (1993).

We report here the results of two separate inventories, undertaken in 2003 by the first author on Pulau Balambangan in the month of June, and by the second author on Pulau Banggi, in July. Lowland limestone forests characterize these islands, and include forests of tall trees of the Dipterocarpaceae, besides *Calophyllum* spp. and *Ficus* spp., growing sometimes on steep cliffs, besides limestone cliffs and coastal, sandy beaches (descriptions in Rahman and Abdullah 2002). As sampling periods were short (2–5 days), we employed opportunistic collection methods, such as collections along established trails and adhesive traps, rather than pit-fall trapping, searches in leaf-litter plots, and time constrained searches. We also examined specimens in museum collections to augment our list.

Abbreviations used include:

BOR.– The Borneensis Collection of Universiti Malaysia Sabah (including collections of Universiti Kebangsaan Malaysia, UKMS), Kota Kinabalu, Sabah, Malaysia,

ID.– The field collection number of the first author,

SSM.– Sabah State Museum and Archives, Kota Kinabalu, Sabah, Malaysia, and

ZRC.– Zoological Reference Collection, Raffles Museum of Biodiversity Research, National University of Singapore, Singapore (USDZ in Leviton et al. 1985). For one specimen, the voucher specimen (prefixed with ZRC [IMG]) is a digital image.

Nomenclature of amphibians follows Frost et al. (2006) as revised by Frost (2007); that of the Pythonidae follows Rawlings et al. (2008).

AMPHIBIANS

FAMILY DICROGLOSSIDAE

***Limnonectes kuhlii*:** BOR 12409–12411, BOR 12413–12418, Sungai Kepitan, Kampung Kalangkaman, Pulau Banggi (07°18'N, 117°5.2'E), 27 July 2007.

***Limnonectes leporinus*:** BOR 12408, Sungai Kepitan, Kampung Kalangkaman, Pulau Banggi (07°18'N, 117°5.2'E), 27 July 2007; ZRC 1.12152 (*ex* ID 7779), west coast of Pulau Balambangan (07°12'N, 116°45'E), 18 June 2003.

FAMILY MICROHYLIDAE

***Kalophrynus pleurostigma*:** ZRC 1.12151 (*ex* ID 7772), bank of an unnamed freshwater stream on west coast of Pulau Balambangan (07°12'N, 116º45'E), 18 June 2003.

***Microhyla borneensis*:** BOR 12402, Kampung Kalangkaman, Pulau Banggi (07º18.5'N, 117º5.16'E), 26 July 2003.

FAMILY RHACOPHORIDAE

***Polypedates macrotis*:** ZRC 1.10885, *ex* ID 7773, west coast of Pulau Balambangan (07º12'N, 116º45'E), 18 June 2003.

***Rhacophorus appendiculatus*:** BOR 12405–07, BOR 12412, Forest path nr. Kampung Kalangkaman, Pulau Banggi (07º18'N, 117º5'E), 27 July 2007.

***Rhacophorus pardalis*:** BOR 12401, BOR 12404, Forest path nr. Kampung Kalangkaman, Pulau Banggi (07º18'N, 117º5.1'E), 26 and 27 July 2007, respectively.

FAMILY RANIDAE

***Hylarana raniceps*:** BOR 12403, BOR 12419, Sungai Kepitan, Kampung Kalangkaman, Pulau Banggi (07º18'N, 117º5.2'E), 27 and 28 July 2007, respectively.

REPTILES

FAMILY AGAMIDAE

***Bronchocela cristatella*:** BOR 02721, Pulau Balambangan (cited by Tan 1993:2) (no further sampling data).

FAMILY GEKKONIDAE

***Gekko gecko*:** SSM 0383, Pulau Balambangan; ZRC 2.5732 (*ex* ID 7948), west coast of Pulau Balambangan (07º12'N, 116º45'E), 19 June 2003; UKMS (at present BOR) Re. 443, ZRC 2.1018–1023, "Pulau Banggi" (no further sampling data).

***Gekko monarchus*:** ZRC 2.6557 (*ex* ID 7776) and ZRC 2.6558 (*ex* ID 7778), west coast of Pulau Balambangan (07º12'N, 116º45'E), 18 June 2003.

FAMILY SCINCIDAE

***Apterygodon vittatum*:** ZRC 2.6559 (*ex* ID 7774), west coast of Pulau Balambangan (07º12'N, 116º45'E), 18 June 2003.

***Emoia atrocostata*:** ZRC 2.1564, Pulau Banggi (no further sampling data); west coast of Pulau Balambangan (07º12'N, 116º45'E; I. Das, field sighting, 21 June 2003).

***Eutropis multifasciata*:** UKMS (at present BOR) Re. 391, Wak Wak, Pulau Banggi, Kudat District (07º08'N, 117º06'E); UKMS (at present BOR) Re. 402, Selamat Darat, Pulau Balambangan, Kudat District (07º15'N, 116.56'E) (no further sampling data).

FAMILY ELAPIDAE

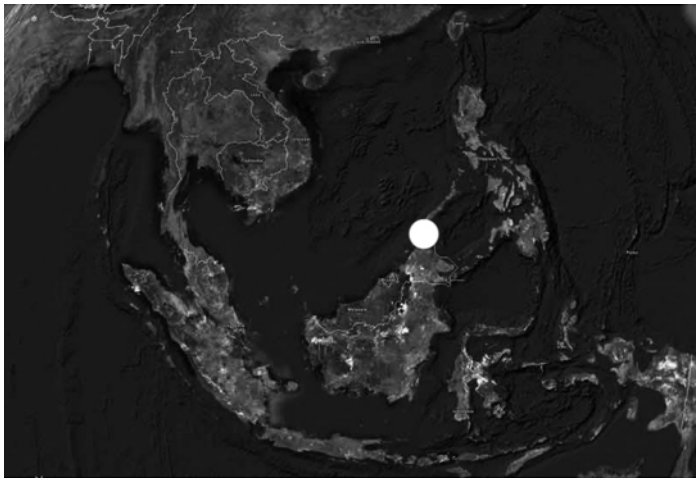
***Laticauda colubrina*:** Tan (2008) recorded this species from Pulau Banggi.

FAMILY PYTHONIDAE

***Broghammerus reticulatus*:** ZRC 2.3143–3147, Pulau Banggi (no further sampling data).

FAMILY COLUBRIDAE

***Boiga dendrophila*:** ZRC [IMG] 2.64, west coast of Pulau Balambangan (07º12'N, 116º45'E), 20 June 2003. Tan (2008)



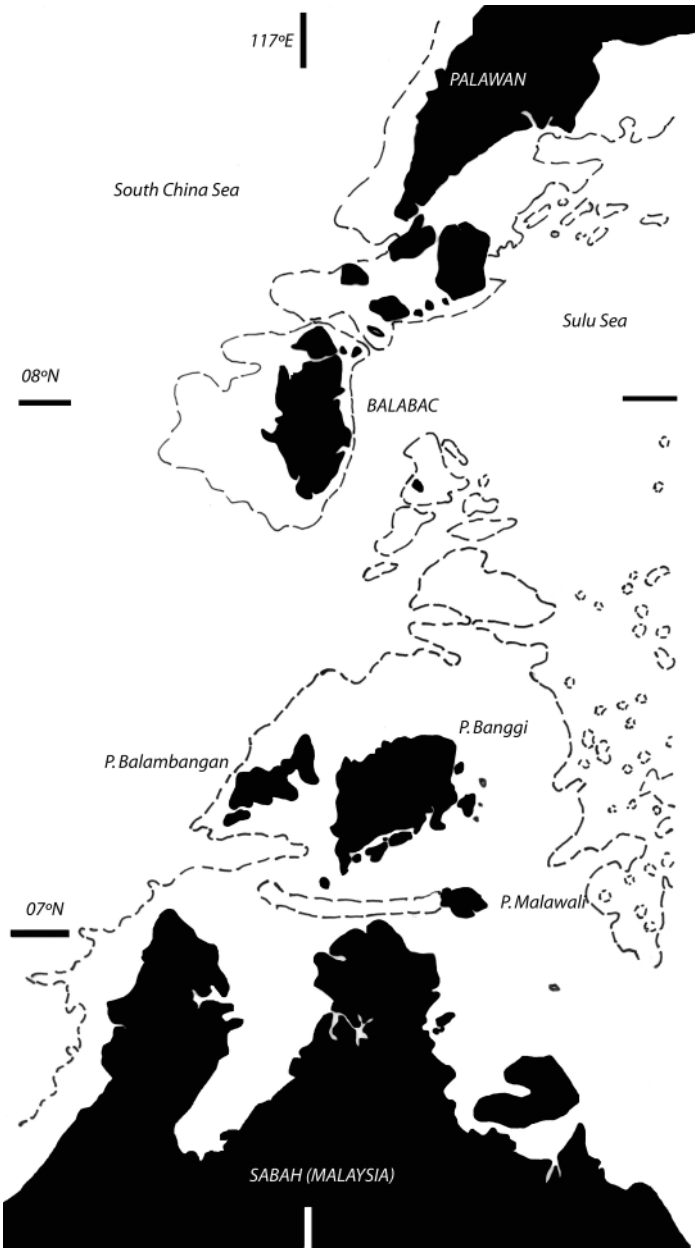


FIG. 1. Maps (on left) of Borneo and (on right) of the Pulau Banggi group of islands, Kudat District, Sabah, off the northeast coast of Borneo, and the islands of southern Philippines. Broken lines indicate 40 m contour.

presented an image of this species from Pulau Malawali.

***Chrysopelea paradisi*:** ZRC 2.3599, Pulau Banggi (no further sampling data).

***Dendrelaphis caudolineatus*:** ZRC 2.6560 (*ex* ID 7777), west coast of Pulau Balambangan (07º12'N, 116º45'E), 18 June 2003.

FAMILY CROCODYLIDAE

***Crocodylus porosus*:** Not collected, but reported by the local Bajau tribesmen as occurring off the waters of Pulau Balambangan.

Excluding marine turtles, for which no data are currently available, Pulau Banggi and adjacent islands are home to at least eight species of amphibians and 12 species of reptiles. All, save one (*Gekko gecko*), are widespread across the lowlands of Borneo, a distributional pattern similar to that shown by the island group's avifauna (Chasen and Boden Kloss 1930). The sole reptile not known from Borneo is widely distributed in the Philippine Archipelago, and may either be a recent emigrant via the Palawan-Balabac corridor, or competitively excluded on the main island by the closely related and presumably ecologically similar *Gekko smithii*. The islands to the north of the Pulau Banggi group lie within the jurisdiction of the Philippines, and the herpetofaunas of Palawan and Balabac has been enumerated by Mocquard (1890) and Boulenger (1894).

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Lethal Effect of Latex, Nitrile, and Vinyl Gloves on Tadpoles

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Tadpoles are studied in a variety of fields including husbandry, developmental physiology, toxicity testing, and basic biological and ecological research. In many instances it is necessary to use gloves when handling tadpoles or during water changes to protect the experimenter (e.g. teratology research) or to promote hygiene and prevent the transfer of pathogens between tadpoles (Retallick et al. 2006; Sobotka and Rahwan 1999). While investigating aspects of the virulent amphibian fungal pathogen *Batrachochytrium dendrobatidis*, we discovered that a variety of gloves can be lethal to tadpoles. We present here two case studies, one in the lab and one in the field, and two experiments, all demonstrating the lethal effect of gloves on tadpoles. Following exposure to the

various glove treatments, all tadpoles were categorized as either fine, listless, or dead.

Case Study 1: Laboratory

Batrachochytrium dendrobatidis infects the skin of frogs, but only the mouthparts of tadpoles (Knapp and Morgan 2006; Marantelli et al. 2004). During a laboratory experiment investigating *B. dendrobatidis* infection in *Litoria genimaculata* and *Litoria nannotis* tadpoles, each tadpole was to be measured, weighed, and its mouthparts swabbed with a sterile cotton swab to test for *B. dendrobatidis* by diagnostic PCR (Boyle et al. 2004). A new pair of latex gloves (SuperMax, low powder) were worn when handling each tadpole to prevent transmission of *B. dendrobatidis* between individuals and to prevent DNA contamination of swab samples. Each tadpole was scooped out of its container with a gloved hand. The tadpole was secured, ventral surface up, in between the index and middle fingers by gently depressing the thumb to the base of the tail. A swab was gently passed over the mouthparts repeatedly to collect *B. dendrobatidis* DNA on the cotton fibers. Each tadpole was in hand for approximately 30–90 seconds before being returned to its container.

Thirty-six *L. genimaculata* had been processed in this way when we observed that some of the earliest handled tadpoles appeared listless, could not remain upright, and had difficulty using their tails for locomotion. Upon closer inspection, the tails of the listless tadpoles were gray and dead in appearance at the locations where gloved fingers held them in place during swabbing. At that time, we suspended tadpole handling. Within 24 h, 26 of the 36 tadpoles died. The surviving ten tadpoles did not appear listless, showed no overt adverse effects and survived 4–6 weeks to metamorphosis (Fig. 1A). Although care was taken to handle tadpoles gently, the observed mortality could possibly have been due to mechanical damage, so we initiated a series of experiments. Based on the results of these experiments (see below), we switched from latex to vinyl gloves for the remainder of the lab study. Ten unhandled *L. genimaculata* and *L. nannotis* tadpoles were processed as previously described except with vinyl instead of latex gloves. Following 24 h of observation, no mortality or ill effects were noted. Satisfied that vinyl gloves were safe for tadpoles of these species, the remaining 13 *L. genimaculata* and 22 *L. nannotis* tadpoles were processed using vinyl gloves (Fig. 1A). All tadpoles appeared unaffected after handling. In total, 26/36 *L. genimaculata* died following handling with latex gloves, while 0/23 *L. genimaculata* and 0/32 *L. nannotis* died following contact with vinyl gloves.

Experiment 1: Glove Soak

To determine the best gloves for handling tadpoles, we conducted an experiment testing the three most common glove types: latex (SuperMax, low powder), vinyl (Livingstone, clear, low powder), and nitrile (Livingstone, low powder). Forty non-native *Bufo marinus* tadpoles were captured from a local pond and allowed to rest in individual 1000 mL containers with 500 mL of collected rainwater and a pinch of powdered tadpole chow (3:1 alfalfa pellets:fish food, ground and passed through a 250 μm sieve). After 24 h, one of each glove type was draped over the edge of the container for five minutes so that the five fingers of each glove were submerged. Ten control containers had no contact with a glove. The condition of each tadpole was recorded at 2, 12, 24, and 72 h following removal of the glove, however, tadpole condition did not change beyond the two hour post-exposure point. One of ten tadpoles exposed to the latex gloves died and two more were listless and floating awkwardly within two hours of glove exposure. One of the tadpoles exposed to nitrile gloves was listless while all of the vinyl and control treatments appeared unaffected (Fig. 1B). The listless tadpoles remained in an impaired state for the full 72 h of observation and appeared permanently affected. These listless tadpoles were euthanized and preserved in 70% ethanol. Although three of the ten *B. marinus* tadpoles exposed to latex gloves experienced deleterious effects, the rate of mortality was lower than we expected given the high level of mortality we previously observed in *L. genimaculata*. We hypothesized this difference was related to the different methods of glove exposure. The *L. genimaculata* in "Case Study 1" were in direct physical contact with the gloves during measuring and swabbing while the *B. marinus* in "Experiment 1" were in water in which gloves were soaked. This indirect glove contact may have yielded a lower dose of the toxic compound(s).

Experiment 2: Glove Contact

To determine whether direct glove contact increases mortality, we ran a second experiment in which *B. marinus* tadpoles were handled in the same manner as previously described for *L. genimaculata* and *L. nannotis*. Each tadpole was gently held in place at the base of the tail between the thumb and index finger for 60 seconds with one of the three types of gloves as treatments or with an ungloved hand as a control. A new glove was worn for each tadpole and the treatments were interspersed, with each glove type and the bare hand treatment applied in succession. Prior to the no glove treatment, hands were rinsed in tap water and dried with a paper towel to remove any residual powder from the previous glove treatment.

Within two hours of handling, all tadpoles that had been in contact with latex or nitrile gloves were dead or listless. Those that were listless died within 24 h (Fig. 1C). Listless tadpoles had little to no tail function and the usually dark black tail had a discolored, dead-looking, gray appearance. This discoloration was most pronounced where direct contact with the gloves occurred. Particles in the water soon began to attach to the epidermis of the dying tail, giving it a fuzzy appearance. None of the tadpoles handled with either vinyl gloves or bare hands suffered noticeable ill effects and all survived to metamorphosis (Fig. 1C).

Case Study 2: Field

We applied our conclusion that vinyl is the safest glove material to "Case Study 1: Lab" (described above) as well as a field study monitoring *B. dendrobatidis* in the wild. Individual tadpoles were to be captured, handled with vinyl gloves, measured, swabbed for *B. dendrobatidis* infection, and returned to the stream unharmed. During initial field sampling, individuals were processed and kept temporarily in a holding tray to monitor condition following swabbing. Unexpectedly, of the first ten *L. nannotis* tadpoles processed, four became listless and died within one hour (Fig. 1D). The remaining six tadpoles appeared normal and did not develop signs over the following 24 h. As a test, the next ten captured tadpoles were processed with bare hands and suffered

no ill effects, suggesting the gloves and not the handling were the cause of mortality. The next ten captured tadpoles were processed with vinyl gloves that were rinsed in a bucket of water prior to handling. All of these tadpoles survived and appeared normal suggesting that a substance on the outside of the vinyl glove was toxic and that rinsing successfully removed it. All tadpoles were held for 24 h for observation. From this point on we incorporated the rinsing of vinyl gloves into the standard field protocol. Vinyl gloves were rinsed in a 10 L bucket of water which was changed after at most ten tadpoles. This was adequate to ensure the glove-wash residue did not attain a high enough concentration to cause harm. To date over 2500 tadpoles have been handled with washed vinyl gloves with no ill effects. On a few occasions, the rinsing step was accidentally skipped and many of these tadpoles became listless and died.

The fact that the same type and brand of vinyl glove did not cause mortality in *L. nannotis* tadpoles in the laboratory trials but did cause mortality in the field suggests that the presence or level of the toxic compound(s) may vary among boxes of gloves. This may be a result of varying conditions during glove fabrication. During production of disposable gloves, a large number of chemicals are added including vulcanizers, accelerators, colorants, preservatives, stabilizers, and antistatic agents (Boman et al. 2004). These chemicals are typically the cause of glove sensitivity in humans. The type and quantity of these compounds can vary widely among manufacturers and possibly even production runs (Boman et al. 2004).

Our results show that unwashed latex, nitrile, and vinyl gloves can be toxic to tadpoles. Unwashed latex and nitrile gloves caused up to 100% tadpole mortality following only 30–90 seconds of direct contact (Fig. 1C). Rapid, localized necrosis of tissue at the point of contact was observed grossly. Even five minutes of partial glove submersion was sufficient to cause mortality in the latex and nitrile treatments (Fig. 1B).

Despite a thorough literature search, only two references to the toxic effects of gloves on tadpoles were found and both of these were published in toxicological journals, likely to have low readership by herpetologists. In a letter to the editor, Sobotka and Rahwan (1999) reported that water from unwashed latex gloves (American Dental Association, Safeskin brand) and washed latex gloves (Baxter Pharmaseal Flexam) soaked for 24 h caused mortality in *Xenopus laevis* tadpoles. However, water from washed vinyl gloves (Baxter Triflex) did not. Gutleb et al. (2001) reported 100% mortality in *X. laevis* and *Rana temporaria* tadpoles exposed to water from unwashed latex gloves (Becton-Dickinson) soaked for 24 h. Even very dilute solutions of glove-soaked water (0.29% for *X. laevis* and 0.15% for *R. temporaria*) caused 100% mortality. Gutleb et al. (2001) found that vinyl gloves (Becton-Dickinson) soaked for 24 h also killed tadpoles, but only at relatively high concentrations: 33% and above. Mortality was 100% at or above this concentration but 0% below this concentration.

Our results, together with the results from these published studies, demonstrate the potentially high toxicity of latex gloves to tadpoles. Different brands of latex gloves, different exposure methods, and tadpoles of different species were used in each study. Sobotka and Rahwan (1999) tested washed and unwashed latex gloves. The end result, however, was the same: significant

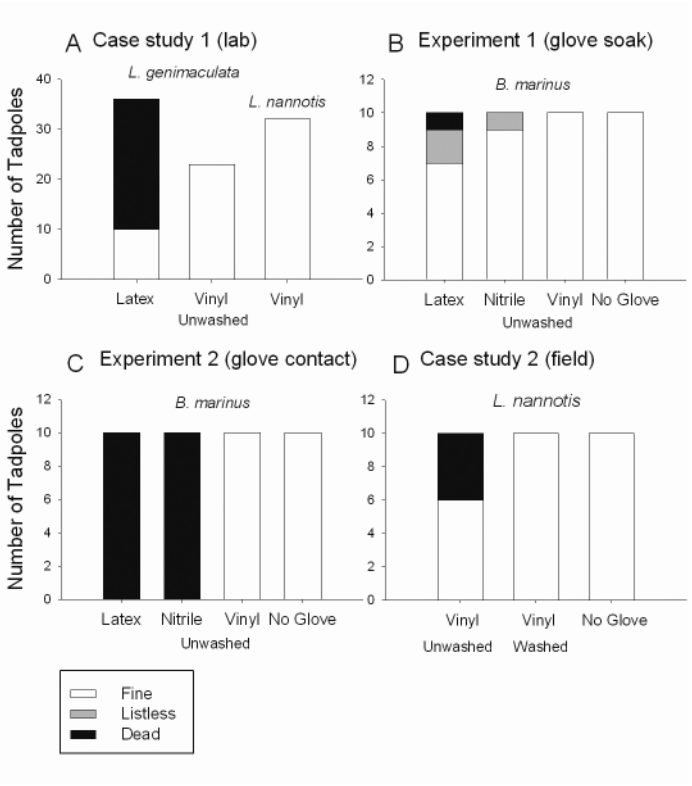


FIG. 1. A) Case Study 1: Laboratory. Number of *Litoria genimaculata* and *Litoria nannotis* tadpole deaths within 24 h following contact with latex or vinyl gloves for 30–90 seconds. B) Experiment 1: Glove Soak. Number of *Bufo marinus* tadpole deaths within 72 h following contact with water containing latex, vinyl, and nitrile gloves soaked for 5 minutes. C) Experiment 2: Glove Contact. Number of *B. marinus* tadpole deaths within 24 h following direct contact with latex, vinyl, and nitrile gloves and bare hands for 60 seconds. D) Case Study 2: Field. Number of *L. nannotis* deaths within 24 h following direct contact with unwashed vinyl gloves, washed vinyl gloves, and bare hands for 30–90 seconds.

tadpole mortality. This suggests that glove toxicity may be associated with many different brands of disposable latex glove and tadpoles of many different species are likely to be affected. Ours is the first report that nitrile gloves can also be extremely toxic to tadpoles, producing 100% mortality in *Bufo marinus* following direct glove contact.

We found that unwashed vinyl gloves can also cause mortality, however, at a lower rate than either latex or nitrile gloves. This finding is supported by Gutleb et al. (2001) who found that vinyl glove-soaked water caused mortality only at dilutions over 110 times more concentrated than latex glove soaked water. Importantly, by rinsing the vinyl gloves in water we eliminated any obvious toxicity.

As a result of the apparently more toxic nature of latex and nitrile gloves compared with vinyl, and the ability to eliminate toxicity in vinyl gloves through rinsing, we recommend the use of well rinsed vinyl gloves when handling tadpoles or cleaning aquaria. However, all glove brands and types are potentially toxic and should not be used until proven safe with tadpoles of the particular species being handled. Even then, handled tadpoles should be observed carefully as toxicity may vary between production runs.

It is important to note that gloves have not been found to affect juvenile or adult amphibians negatively. The use of gloves to handle amphibians is widespread in the field and lab. Changing gloves between amphibians remains an important hygiene measure to prevent transmission of infectious agents such as *B. dendrobatidis* and ranaviruses between individual amphibians and aquaria. However, given our tadpole results, it would be useful to investigate potential non-lethal effects of gloves on adult and juvenile amphibians to ensure that gloves really are entirely non-injurious.

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TECHNIQUES

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Visible Implant Fluorescent Elastomer: A Reliable Marking Alternative for Snakes

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Studies in population ecology require use of reliable marking techniques to estimate various parameters (e.g., population size, density, demographics, movement, or behavior; Penney et al. 2001; Perret and Joly 2002; Walsh and Winkelman 2004; Woods and Martin-Smith 2004). However, it is imperative that marking techniques meet standard assumptions: 1) marks must remain visible for the duration of the experiment, 2) marks are correctly recorded, 3) marks do not affect the survival of the animal, and 4) marks do not affect the recapture probability of animals (Goldsmith et al. 2003; Otis et al. 1978).

Visible implant fluorescent elastomer (VIE; Northwest Marine Technology, Inc., Shaw Is., Washington, USA) was initially developed for batch marking migratory fish, but has recently been used to mark amphibians and lizards (Bailey 2004; Losos et al. 2004; Nauwelaerts et al. 2000; Nishikawa and Service 1988; Penney et al. 2001). Visible implant fluorescent elastomer consists of a liquid polymer added to a curing agent to create a flexible plastic mark. Color kits are available, capable of marking 15,000 individuals depending on the number of colors used and marking design. Our objective was to determine if VIE was an appropriate marking technique for snake research based on the marking assumptions of Otis et al. (1978) and Goldsmith et al. (2003). We hypothesized that VIE would be a reliable marking technique for snakes. To our knowledge, our study is the first to apply VIE to snakes.

We conducted this empirical study in a laboratory setting at North Carolina State University, Raleigh, North Carolina, USA. We marked Red Cornsnakes (*Pantherophis guttatus*; N = 18) between 19 and 29 April 2006. Each snake received three doses (1, 2, and 3 μl) of yellow VIE randomized to the general area of three locations (neck, midbody, and pre-caudal). We injected marks subcutaneously and dorsolaterally on left sides using a graduated 1cc Luer-lok syringe with a 25-gauge needle (Becton-Dickinson, Franklin Lakes, New Jersey, USA). We used 1cc syringes to better approximate volumes, which required the 25-gauge needle for a secure fit. We injected additional *P. guttatus* (N = 4) and Common Kingsnakes (*Lampropeltis getula*; N = 6) with

blue and red to examine VIE color, ground color, and species effects, but did not quantify results from these 10 snakes.

All snakes were captive-raised and housed individually at a constant 26.6°C with food, water, and substrate provided regularly. We checked snakes for marks every two weeks using a UV-B light. We collected shed skins to record shedding frequency and expulsion of marks. Our study concluded on 4 May 2007 after 370 days.

We calculated retention time as the number of days we detected a mark until the median date between when a mark was last detected and the following examination. We derived mean retention times for each mark volume (1, 2, and 3 μl). To discern the effects of mark volume or individual variation on retention time, we analyzed retention time as a dependent variable with mark volume and individuals as independent variables in an additive, 2-factor analysis of variance (ANOVA). Similarly, we employed two 1-factor ANOVAs with retention time as the dependent variable and shedding frequency (i.e., number of sheds/individual) or mark location (i.e., neck, midbody, and pre-caudal) as independent variables. We performed analyses using PROC GLM (SAS 9.1, Cary, North Carolina, USA). We calculated the percentage of marks retained to demonstrate mark performance by volume.

All 18 *P. guttatus* used in the experiment were of similar length (mean = 990.39 ± 79.41 mm snout–vent length) and weight (mean = 370.33 ± 81.93 g). After 370 days, 94, 83, and 100% of low (mean = 354 days), medium (mean = 333 days), and high (mean = 370 days) mark volumes were retained. A 2-factor ANOVA revealed no differences in retention time between mark volumes ($F_{2, 34} = 1.27$, P = 0.2940) or individuals ($F_{17, 34} = 0.88$, P = 0.6045). Shedding frequency (mean = 5.05 ± 1.21 sheds/snake) did not have a significant effect on mark retention time at low ($F_{1, 16} = 0.79$, P = 0.3860), medium ($F_{1, 16} = 0.00$, P = 0.9501), or high mark volumes (100% retention). Analysis of mark location revealed a 13% lower mean retention time for marks located pre-caudally (mean = 321 days) compared to neck (mean = 366 days) and midbody (mean = 370 days) mark locations. However, we did not detect a significant difference in mark retention among mark locations ($F_{2, 51} = 3.00$, P = 0.0588).

Our results indicated that VIE was a reliable marking technique for snakes, with 94, 83, and 100% retention for low, medium, and high volumes after 370 days and no mortalities recorded. Elastomer marks were easy to identify and record due to fluorescent colors. We observed a lower retention time for pre-caudal marks. In fact, three of the four marks lost (1-low and 2-medium volume) were located in the pre-caudal region and were lost through expulsion within the first few examinations. If we removed these early loses from our analyses, retention times would be 100, 94, and 100% for low, medium, and high volumes, respectively.

Our results demonstrated that VIE marks last at least 370 days and satisfy the marking assumptions proposed by Otis et al. (1978) and Goldsmith et al. (2003). Branding and scale clipping have been reported to last ≥ 3 years (Brown and Parker 1976; Winne et al. 2006) and elastomer marks have been reported lasting well over a year in amphibians (Davis and Ovaska 2001) and are capable of permanence (Kinkead et al. 2006). We acknowledge our short study duration (370 days), but believe VIE satisfies assumptions for correct recording, and survival and recapture effects (Davis and Ovaska 2001; Kinkead et al. 2006) and is a reliable marking technique for snakes. Equipment costs were initially higher for VIE (US $465) compared to scale clipping (i.e., scissors) or branding (i.e., cautery units ~US $20–25; Winne et al. [2006]), but marking costs per snake were small (~$0.10– $0.29 for marks of 1– 3 μl). Further, our retention of all mark volumes suggested the usefulness of VIE in snakes of any size; small marks can be applied to small-bodied species and individuals (≤ 26 cm), which may be too small for PIT tags or scale clipping (Spellerberg 1977). However, problems were encountered with the technique. Pre-caudal marks had a 13% lower retention time and accounted for 75% of marks lost. Mark losses occurred from 23 days to 310 days, and were likely due to expulsion from the site of injection. Similarly, fragmentation of marks into several pieces could cause detection problems. The application of a liquid bandage product would likely deter expulsion and pathogen introduction.

We recommend future studies evaluate the use and efficacy of VIE in snakes, both in lab and field settings. Future studies should evaluate using VIE in different species of snakes with various ground colors and at various mark locations. Anecdotally, we can report that yellow, blue, and red VIE colors were detectable in Red Cornsnakes at all volumes, but blue VIE was difficult to detect in Common Kingsnakes due to the dark ground color of this species. Mark volume should be studied in the field to better understand mark retention under natural conditions and field and laboratory research should focus on survival and recapture rates for VIE over longer periods. Future research should evaluate the effects of growth on mark detectability and compare stress levels incurred by traditional and VIE marking techniques.

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Monitoring Non-breeding Habitat Activity by Subterranean Detection of Ambystomatid Salamanders with Implanted Passive Integrated Transponder (PIT) Tags and a Radio Frequency Identification (RFID) Antenna System

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Pond breeding amphibians require terrestrial habitat during the non-breeding season in addition to aquatic reproductive habitat. Ambystomatid salamanders such as spotted (*Ambystoma maculatum*) and marbled salamanders (*Ambystoma opacum*) have been previously studied to determine migration movements and terrestrial habitat requirements. Several migration studies have estimated the "life" or buffer zones required for terrestrial non-breeding habitat. Estimates of habitat area that encompass 95% of the population have ranged from 159 m to 370 m (Faccio 2003; McDonough and Paton 2007; Rittenhouse and Semlitsch 2007; Semlitsch 1998; Semlitsch and Bodie 2003). Few studies have examined migration and non-breeding home range of *Ambystoma* species over multiple years because of the difficulties of long term tracking and monitoring of these animals. Recent studies have shown that vertebrates with implanted passive integrated transponder (PIT) tags are detectable subterraneously (Cabarle et al. 2007; Kuhnz 2000). The purpose of this study was to examine the utility of PIT tags and a multidirectional radio frequency identification (RFID) antenna system (FS 2001 Destron reader and Biomark triangle antenna) for tracking and monitoring ambystomatid salamanders during the non-breeding season.

Identifying and locating individual salamanders is important in determining terrestrial home range and migration. Several methods of identification have been used including: photographs of spot patterns (Stenhouse 1985), toe clips (Ott and Scott 1999), radiotelemetry (Faccio 2003; Madison 1997; McDonough and Paton 2007), PIT tags (Blackwell et al. 2004; Gibbons and Andrews 2004; Ott and Scott 1999), and subcutaneously implanted reflector tags (Moseley and Castleberry 2005). Drift fences have been frequently used to monitor migrants to and from breeding pools (Kleeberger and Werner 1983; Sexton et al. 1990). Concentric circles of drift fences spaced at regular intervals allow researchers to determine the approximate area in which salamanders establish a home range. However, drift fences only capture salamanders moving on or just below the surface. Radiotelemetry studies can track animals underground, but transmitters have a short (< 5 months) battery life and can have high cost (> US $150 each). Radioisotopes were used to determine the home range and summer movements of *A. maculatum* (Kleeberger and Werner 1983), *A. talpoideum* (Semlitsch 1983), *Plethodon jordani* (Madison and Shoop 1970), and *Desmognathus fuscus* (Ashton 1975), but do not allow for individual specific identification.

Materials and Methods.—In this study we attempted to locate and track ambystomatid salamanders using RFID antenna systems with animals that had been marked during previous reproductive seasons with PIT tags. The study area was a constructed vernal pool on the Tennessee Valley Authority's (TVA) South Holston Weir Dam property (36.5239°N, 82.1100°W) in Sullivan County, Tennessee, USA. The floodplain forest at this location supports populations of both *A. maculatum* and *A. opacum*, with the population of *A. opacum* being distinct and disjunct in eastern Tennessee (Hamed et al. 2007). A two-lane paved road (Holston View Dam Road) bisects the property and salamanders living on the north side of the vernal pool must cross the road to reach the pool. The forested area (0.79 ha) north of the road consists mainly of Virginia Pine (*Pinus virginiana*), Boxelder (*Acer negundo*), and Sycamore (*Plantus occidentalis*). A mixed deciduous forest composed mainly of Sweetgum (*Liquidambar stryaciflua*), Sycamore, White Oak (*Quercus alba*), and a 0.5 ha patch of non-native bamboo (*Phyllostachys aureosulcata*) border the south side of the vernal pool.

Previous studies have reported variable detection distances of PIT tagged vertebrates beneath the soil surface (12–22 cm) in both *in situ* (Kuhnz 2000) and experimental (Cabarle et al. 2007) conditions. The observed variability was a result of antenna sensitivity and environmental conditions. We first used a preserved specimen of *A. maculatum* obtained from the East Tennessee State University teaching collection to determine the sensitivity of subterranean detection of PIT tags specific to our study site in a series of ten location accuracy trials. A TX-1411-SST PIT tag (Biomark, Idaho) was injected into the body cavity of the preserved specimen anterior to the rear limbs. To

test detectability of location with the antenna we placed a PIT tag implanted preserved salamander on the forest floor in the leaf litter where it was not visible. The specimen was also buried 5 cm, 10 cm, 15 cm, 20 cm, 25 cm, 27.5 cm, and 30 cm below the surface at the same location. All soil initially removed for burial of the specimen was replaced so as to maintain the naturally occurring soil density. The soil type at this location was well drained Pettyjon loam in a floodplain, derived from limestone and shale (USDA 2008). A waterproof twelve inch triangular, multi-directional, RFID antenna with 10' pole and Destron FS 2001 PIT tag reader with attenuation control box (model AN-TN-04 Biomark) was used to locate the specimen. Biomark technical representatives reported that 25 cm was the maximum detection distance under factory conditions. In order to determine movement patterns of individual animals correctly, it was necessary to identify the actual position of the marked animal and to determine the accuracy of the detection system under the given soil and environmental conditions. The observer moved the antenna in a side to side motion at a rate of ca. 0.5 m/sec. Following initial detection of the transponder the observer then attempted to mark the correct position of the salamander by noting the location at which the specimen was first and last detected as the antenna was moved horizontally across the forest floor. The middle of this range was marked as the location of the specimen. The specimen was then uncovered and the distance from the marked location determined. Ten successive trials at each depth were conducted. In four of these trials using a PIT tagged preserved specimen, the maximum distance above the ground that the antenna could detect the buried specimen was measured using a tape measure before the specimen was unearthed. In these four trials the antenna was held immediately above the identified point and slowly raised until the signal was no longer detected. This measurement provided an estimate of the depth of the specimen below the surface by subtracting the measured height of the antenna above the soil surface from the antenna's maximum detection depth (27.5 cm).

On 20 October 2006, 30 *A. opacum* salamanders were captured by hand as they crossed Holston View Dam Road during the return migration from the vernal pool, and in drift fences in the forest bordering the south side of the pool. On 28 February 2006 and 16 March 2007, 18 and 94 *A. maculatum* respectively were captured along the Holston View Dam Road. On 16 March 2007, an additional 78 *A. maculatum* were captured in pitfall traps in an area south of the vernal pool. These 78 salamanders were not expected to be found in the PIT tag study area to the north of the vernal pool in subsequent surveys. Overall a total of 220 individuals were tagged, of which 190 were *A. maculatum*. All animals were subsequently immersed in a 1% solution of MS-222 (tricaine methanesulfonate) buffered to pH 7.0 at room temperature until anesthetized, and a 12-gauge sterile syringe was used to insert a TX–1411–SST PIT tag (Biomark) into the body cavity of the salamander just anterior to the rear limbs. The wound was sealed with VetBond™. Animals were subsequently released in the center of the vernal pool. All animals appeared healthy at the time of release.

One-quarter of a hectare of the forested area north of Holston View Dam road was divided into a grid of 5 m × 5 m quadrats on 27 July 2007. This area is 36 m from the release site at the center of the vernal pool and is bordered on one side by the road, on two sides by parking areas, and by the South Holston River on the fourth side. These barriers create a discrete patch of useable habitat. The entire search area falls within the terrestrial buffer zone of 164 m recommend for amphibians (Semlitsch 1998) and therefore all PIT tagged individuals were potentially present throughout the area. Each 5 m × 5 m quadrat was completely searched with overlapping sweeps of the antenna to insure that the entire 0.25 ha grid was covered. Surveys were conducted on five separate dates resulting in a total of 11 h of effort. Downed logs were turned over and areas under the logs were searched. When PIT tags were detected the location and depth of the salamander was estimated by the same method used in the previous trails with a preserved specimen. Location was determined by noting the point at which the antenna initially detected the PIT tag and then the point at which the antenna no longer detected the PIT tag as the antenna was moved horizontally across the surface. Depth was estimated by measuring the maximum distance above the ground at which the antenna could detect the PIT tag and then subtracting this distance from the maximum 27.5 cm depth detection distance determined for the antenna under these conditions in the previous trials using a preserved specimen. Exact locations of individual animals were then marked with numbered surveyors flags. Each marked location of an identified salamander was then checked during subsequent surveys and any change in position was marked and measured as a straight line distance relative to the most recent known position of that animal. Distance to the edge of the vernal pool was measured for each *A. maculatum* detected. Four PIT tag detection points were examined for the presence of a live salamander. The leaf litter was searched and a shovel then used to carefully remove soil at the detection point. The soil was scanned with the antenna until the salamander or transponder was found. Salamanders were returned to a small mammal runway adjacent to the disturbed area and covered with leaf litter after discovery. The remaining tag detection points were not examined because of the potential negative effects of stress and desiccation on animals disturbed during the then prevailing extreme drought conditions (NOAA 2008).

Results.—The PIT tag in the preserved *A. maculatum* was detected in all ten trials up to 27.5 cm below ground. One trial located the tag at 30 cm below the surface. The mean deviation between the actual location and the predicted location at different depths varied from 11.7 cm to 21.3 cm. In unobstructed, open-air conditions above the tag, the antenna detected the tag a mean of 29.7 cm above the tag (range = 27.7–38.6 cm) (95% CI = 26.2–33.3) (Table 1).

Eleven percent (12 of 112) of the PIT tagged *A. maculatum* were detected in the study area. Eleven of the 12 A. *maculatum* were individuals that had originally migrated to the vernal pool from the north side of the pool. The twelfth individual was originally captured in drift fences to the south of the vernal pool. After being released in the pool this individual apparently migrated 142 m in the opposite direction (north) from its original capture location. For *A. maculatum* the recapture rate of marked salamanders was 9.8% (discounting the twelfth individual that migrated from the south side of the vernal pool). For *A. opacum* the recapture rate of PIT tagged salamanders was 3.3% (1 of 30). A total of eleven hours of surveying time was expended in locating the 13 PIT tags recovered in the study area with a resulting detection rate of

1.18 individuals per hour of surveying effort. The mean distance from the edge of the vernal pool to non-breeding habitat traveled by *A. maculatum* was 58.7 m (range = 41.1–72.3 m; 95% CI = 51.0–66.4). The mean estimated depth of *A. maculatum* was 6.8 cm below the forest surface (range = 2.0–15.0 cm; 95% CI = 4.02–9.61).

Three of four excavated PIT tags revealed a living *A. maculatum*. The fourth tag had been originally placed in a living *A. opacum* and was recovered without the salamander being found. The three excavated *A. maculatum* moved an average of 8.4 m from their original locations, after being excavated and then placed in a small mammal runway close to the point of capture. Tracking of *A. maculatum* with PIT tags over a seven-week period suggested a very limited home range in late summer (< 0.5m^2) within the restrictions of PIT tag antenna location distance and within the confines of this study. The 12 *A. maculatum* observed within the 0.25 ha surveyed were using a total of 0.24% of the available habitat. Eight of the 12 salamanders were found in two separate groups of four clustered in an area of 8 m^2 each.

Discussion.—The FS 2001 PIT tag reader and triangle RFID antenna were shown to detect a preserved *A. maculatum* with a PIT tag 27.5 cm below the surface in 100% of the ten location accuracy trials. On only one occasion could the tagged preserved specimen be detected at 30 cm below the surface, so 27.5 cm was considered the maximum depth of PIT tag detection at the study site. Previous studies involving PIT-tagged fossorial vertebrates were able to locate the California Legless Lizard (*Anniella pulchra*) under field conditions at depths of up to 12 cm with less sensitive RFID antenna systems (Kuhnz 2000), and Tiger Salamanders (*Ambystoma tigrinum)* under controlled conditions where specimens in cloth bags were covered with soil up to 22 cm deep using the same RFID antenna system as in this study (Cabarle et al. 2007). Radioactive tags injected into *Plethodon jordani* have been detected at depths of up to 50 cm (Madison and Shoop 1970) but could only be detected in *A. maculatum* at depths of 25–30 cm using Cobalt 60 (Kleeberger and Werner 1983). Radioactive tags do not allow for individual specific identification of salamanders. The 27.5 cm maximum depth detected in this study would have located most *A. talpoideum* from a previous study, which ranged in depth from 2.5–7.5 cm (Semlitsch 1981). *A. maculatum* are thought to inhabit similar depths (Semlitsch and Bodie 2003). Studies using radio-implanted transmitters did not report a depth but salamanders were found in shallow small mammal runways underground and in leaf litter (Madison 1997). With the possible exceptions of deep winter burrows used by *A. maculatum* (Faccio 2003), PIT tagged ambystomatid salamanders seem to inhabit soil depths that can be surveyed throughout the summer and during breeding migrations.

In this study the "recapture rates" (i.e., detection of RFID signals) of PIT tagged *A. maculatum* was 9.8% and *A. opacum* was 3.3%. There were 1.18 captures per hour of effort in covering an area of 0.25 ha during 13 h of surveying. Previous studies of ambystomatid salamanders using other marking techniques had recapture rates during the first year of 35.7% for PIT tag studies using drift fence recapture (Blackwell et al. 2004), and 52.6% to 75% for radiotelemetry studies (Faccio 2003; Madison 1997; McDonough and Paton 2007; Montieth and Paton 2006) , and 17% after 100 days for radioisotope based studies (Semlitsch 1981). The lower rates of detection of marked individuals in this study are likely attributable firstly to the difficulty of detection in summer habitat without the use of drift fences and secondly to exceptional drought conditions present during the time of this study (NOAA 2008) that may have driven the salamanders to unusually deep depths beneath the soil surface and beyond the range of the RFID antenna (> 27.5 cm).

The preserved PIT-tagged *A. maculatum* specimen was identified a mean distance of 11.7–21.3 cm from its actual location in our location accuracy trials, depending on the depth at which the specimen was buried. This degree of accuracy would allow individual specific daily or weekly movements to be reliably observed. Radioactive tags allowed *A. talpoideum* to be detected with 10 cm accuracy (Semlitsch 1981) as could radio-implanted transmitters used to locate *A. maculatum* (Madison 1997).

The cost of PIT tagging and tracking individual *A. maculatum* using the latest generation RFID triangular antenna may be more overall cost effective than other options for many applications. PIT tags cost ≤ US $5.00 each (Biomark, Idaho) when purchased in bulk. Radio tags used in other studies cost US $160 each (BD-2 model Holohil Systems, Ontario, Canada). The triangular RFID antenna and tuning box for PIT tags cost approximately US $4,900 (Biomark) compared to antennas for tracking radio transmitters that cost US $650 (Holohil). The total cost to tag and track 200 *A. maculatum* with PIT tags would be about US $5,900, while the total cost to mark and track the same number of *A. maculatum* with radio transmitters would be about US $32,000.

Radioisotopes require an extensive regulatory infrastructure and have a limited effective lifespan compared to PIT tags. Radio transmitters typically have a battery life of 5–6 months which requires recapture, transmitter removal, battery replacement, and transmitter reimplantation (Faccio 2003; Madison 1997; McDonough and Paton 2007). However, PIT tags function for over 10 years and can be detected after the salamander dies

TABLE 1. Mean linear accuracy from the point of detection of the PIT tagged preserved specimen to the actual location, and mean predicted depth below the soil surface of the PIT tagged preserved specimen based on the height above the identified location that a PIT tag signal was detectable.

Pit Tag Depth	Mean Linear (95% CI) Accuracy (cm)	Mean Predicted Depth (95% CI) Below Surface (cm)
Leaf Litter	12.6 (10.7–14.4)	+0.7 (+8.7–7.32)
5 cm	13.1 (11.4–14.8)	2.9 (+0.7–6.5)
10 cm	13.2 (11.7–14.7)	7.6 (3.2–12.1)
15 cm	15.1 (11.9–18.4)	8.9 (2.4–15.3)
20 cm	11.7 (9.1–14.2)	14.1 (5.8–22.5)
25 cm	13.7 (11.4–16.0)	18.5 (15.7–21.3)
27.5 cm	16.7 (11.9–21.4)	19.6 (17.9–21.4)
30 cm	21.3 (10.9–31.6)	18.4 (16.4–20.4)

(Gibbons and Andrews 2004).

The mean distance *A. maculatum* migrated from the breeding pond was 58.7 m. Movements greater than 150 m were not possible because of a barrier created by the South Holston River. Previous studies have produced variable estimates of mean post reproductive migration distances: 64 m (Williams 1973), 92 m (Kleeberger and Werner 1983), 113 m (Faccio 2003), 118 (Madison 1997), and 145 m (Montieth and Paton 2006).

Based on the distance above the surface that PIT tagged *A. maculatum* were detected, the mean estimated depth occupied in summer habitat was 6.8 cm (range = 2.0–15.0 cm; 95% CI = 4.02–9.61 cm). Other studies have shown that *A. maculatum* can be found as deep as 1.3 m (Gordon 1968) and at this depth these salamanders could not be detected by any current tracking method. *A. talpoideum* has been shown to inhabit burrows that averaged 4.7 cm below the surface (Semlitsch 1981). The 12 salamanders we followed for seven weeks showed little detectible change in location or depth. This lack of activity could have been the result of extreme drought conditions (1.5 cm total rainfall) during the seven-week study period (NOAA 2008).

In our study *A. maculatum* has a non-breeding home range of less than 0.5 m^2. This limited home range could have been because of drought conditions, but other studies have also shown limited movements in summer habitat with *A. maculatum* staying in the same location for several weeks (Madison 1997). However, one study of non-breeding habitat of *A. maculatum* estimated a home range of 16–20 m^2 with frequent movements (Faccio 2003). *Ambystoma talpoideum* has been shown to have a variable home range (0.11–23.2 m^2) and variable amounts of daily movement also (Semlitsch 1981).

The results of this study show that PIT tags and new multidirectional RFID antenna technology can be a useful tool for tracking and individual identification of *Ambystoma* species during fossorial periods of their yearly activity cycle. Because of the exceptional drought conditions present during this study (NOAA 2008) we feel that future work may yield higher recapture rates of marked individuals. PIT tags allow for individual identification, have a lifespan of at least 10 years, are relatively affordable, can be detected up to 27.5 cm below the soil surface, have a linear accuracy equivalent to other methods, and have the potential for increased relative distance and depth detection based on further improvements in antenna technology.

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Comparison of Two Diet Collection Methods in the Lizards, *Sceloporus jarrovii* and *Sceloporus virgatus*

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The diet of the Striped Plateau Lizard (*Sceloporus virgatus)* has been described as insectivorous (Cole 1963; Smith 1996, 1999), although a conclusive diet analysis has not been done. Several experimental studies have shown the lizard's willingness to eat mealworms (*Tenebrio*), crickets (*Acheta*), and acridid grasshoppers in both laboratory and field-based feeding experiments (Ballinger and Holscher 1983; Phelan and Niessen 1989; Weiss 2001). A stomach content analysis on individuals from Sonora, Mexico showed a high percentage of the diet composed of Hymenoptera (ant: 52%, non-ant: 18%) and adult Coleoptera (14%) (G. R. Smith, unpubl. data). Smith (1999) noted anecdotally that *S. virgatus* has also been observed attempting to eat a centipede (30–40 mm in length).

The diet of the Yarrow's Spiny Lizard (*Sceloporus jarrovii*) is much more extensively known than that for *S. virgatus*. *Sceloporus jarrovii* feeds on a wide variety of insects, spiders, and plant matter. Stomach content analyses have shown that adults eat more Coleoptera, large Heteroptera (formerly Homoptera), and Lepidoptera, whereas neonates feed predominantly on small Heteroptera and Hymenoptera (ants). Both age classes eat approximately equal amounts of Orthoptera, Heteroptera (formerly Hemiptera), Diptera, Hymenoptera, and Arachnida (Bursey and Goldberg 1993). In a separate study, Barbault et al. (1985) observed that the bulk of adult stomach contents were made up of Coleoptera, Orthoptera, and Lepidoptera. There were also observed differences in the size of prey items present between neonates and adults; however, it has been suggested that this could result from differences in gape size and microhabitat use (Bursey and Goldberg 1993). These differences in prey size captures may help to reduce competition among different ages and sizes of *S. jarrovii* (Simon 1976).

A diet analysis based on behavioral observations has not been completed on either *S. virgatus* or *S. jarrovii*. All previous diet studies of *S. jarrovii* have been conducted by stomach content analysis via dissection (Ballinger and Ballinger 1979; Barbault et al. 1985; Bursey and Goldberg 1993; Goldberg and Bursey 1990; Simon 1975, 1976; Simon and Middendorf 1985). Diet studies of *S. virgatus* have not been completed by any method. Diet analysis of other *Sceloporus* species have also only been completed using stomach contents (Barbault et al. 1985; Ballinger et al. 1977; Rose 1976). In order to test the validity of determining diet through behavioral observations, I compared prey selection in observations with stomach contents as part of a long-term study of foraging behavior.

Methods

The foraging study was conducted at two sites (Herb Martyr and John Hands Campgrounds) near the American Museum of Natural History's Southwestern Research Station (SWRS), located outside Portal, Arizona (USA) inside the Coronado National Forest of the Chiricahua Mountains from May to July in 2004 and 2005. Both sites are located in seasonally dry creek beds adjacent to two USDA Forest Service Campgrounds a few miles from SWRS and have ample sympatric populations of both *S. jarrovii* and *S. virgatus*.

The Herb Martyr (HM) site was located at 31.8724167°N, 109.2352667°W (elev. 1787 m). This study area was 200 m long and spanned the width of the creek bed (3–7 m) and ca. 7 m on each side of the creek bank. The transect was demarcated at the northwest end by a barbed wire fence, delineating the end of the campground property, and on the southeast end by a dam. The John Hands (JH) study area was 320 m in length and was located at 31.8782333°N, 109.22295°W (elev. 1714 m). The site was bordered by a 0.5 m tall concrete dam at the top and a 5 m tall dam at the lower end. The width of the creek bed varied between 10 and 15 m, and up to 20 m of creek bed bank was also used. Within the first few weeks of the study, the creek beds located at both sites were dry, with no water flowing. Both sites had an upper canopy primarily of Alligator Juniper (*Juniperus deppeana*), Arizona Sycamore (*Platanus wrightii*), and Ponderosa Pine (*Pinus ponderosa*), with an understory of willow (*Salix* sp.), *Yucca* sp., and seedlings of the larger trees.

Behavioral Assays.—During the first week of research in both 2004 and 2005, up to 30 individuals of each age class and species at both sites were caught by handheld nooses. Captured lizards were identified to species, sexed, and placed into an age category (neonate or adult). Neonate and adult *S. jarrovii* were easily distinguishable based on size because the neonates were less than half the size of the adults. Lizards were individually marked using toe clips (Tinkle 1967) and paint markers (Jones and Ferguson 1980; Simon and Bissinger 1983) and then released.

Feeding behavioral assays were then conducted May to July. Lizards were observed daily from 0830 h to 1200 h, and often from 1400 h to 1600 h, in half-hour increments. Observations were conducted from at least a 1 m distance to avoid disturbing the lizards. I recorded the size and type (description and taxonomic classification) of prey captured. A total of 106 *S. jarrovii* adult, 70 *S. jarrovii* neonate, and 73 *S. virgatus* adult successful foraging observations were made. At least one observation was made per marked lizard, and in some cases, up to four observations were made per lizard.

Stomach Content Collection.—Stomach flushes, using the methods of Legler (1977), Legler and Sullivan (1979), and James (1990), were performed on ten unmarked lizards of each group (*S. jarrovii* adults, *S. jarrovii* neonates, and *S. virgatus* adults) at each site to compare behavioral observations of prey choice with stomach content analysis. Lizards captured for stomach flushing were collected in creek beds, upstream and downstream of the boundaries of each site to avoid disrupting the study populations. All lizards were collected between 1100 h and 1200 h and returned to the sites by 1700 h the same day. Stomach flushing was done in a laboratory at the Southwestern Research Station.

Stomach contents were collected using the following method. The lizard's mouth was propped open using a stiff plastic ring. Then a thin catheter (inner diameter = 1.19 mm, outer diameter = 1.70 mm) was passed down the esophagus until reaching the end of the stomach, as felt by external palpation (Legler and Sullivan 1979). To further reduce the risk of over-insertion, the length of the tube was measured against the outside of the lizard body to just before the forelimbs, which corresponds to the midpoint of the stomach (James 1990). Once the tube was inserted it was connected to a 10cc hypodermic syringe and enough room-temperature water was pumped into the stomach to enable the food to rise to the mouth. Early trials suggested that cold water was more likely to put the lizard into shock during stomach flushing. Food was removed either by forceps or by suspending the lizard upside-down over a fine mesh net to let the items flow out with the water (James 1990; Legler 1977; Legler and Sullivan 1979). While the stomach was full of water, the abdomen was gently massaged to break up the food bolus (Middendorf 2005). This entire flushing process was repeated until no food came out of the stomach (2–4 times total).

After stomach flushing completion, the lizards were held in small plastic terraria and monitored for any adverse effects for at least one hour. If the lizard stopped breathing after the procedure was completed, it was briefly immersed in a bucket of ice water to "jump-start" its system (James 1990). Any lizards that did not survive the procedure were dissected to determine cause of death and any residual stomach contents were removed and preserved (N = 18). These contents were combined with the prey items obtained through stomach flushing for analysis.

All food items were collected in a fine mesh net, transferred to a 45 ml sample vial, and stored in 75% ethanol until analysis in Fall 2005. Stomach contents were sorted and identified to the lowest classification level possible, usually to the Order level (Bland and Jaques 1978; Jackman 1997; Milne and Milne 1980; Roth 1985). The abundance of prey items was identified by counting the number of complete organisms or by using the number of heads, legs, or wings to estimate total number of items eaten of each prey type.

Results

Diet content in 2004 and 2005 foraging assays differed from that of stomach content analysis (Table 1). The predominantly observed prey types for *S. jarrovii* adults were Formicidae (2004: 27%, 2005: 63%), Diptera (24%, 23%), and Isoptera (44%, 2004 only). In contrast, the stomach contents for this lizard group primarily consisted of Formicidae (55%) and Hymenoptera (16%). The stomach contents contained several taxa that were never observed in the behavioral observations: Hymenoptera (as stated previously), Arachnida (3%) and Heteroptera (8%). Also, the high prevalence of Diptera in the observed diet was not confirmed by stomach content analysis, as Diptera were not present in any stomachs of *S. jarrovii* (Table 1).

Neonates of *S. jarrovii* showed similar differences in diet based on the source of the data. The dominant prey taxa in behavioral assays were Formicidae (2004: 27%, 2005: 77%) and Diptera (2004: 62%, 2005: 16%). Diptera were not found in any neonate stomachs and the most prominent prey types were Formicidae (38%) and Heteroptera (35%), a taxon not observed in the foraging assays. Several additional taxa found in the stomach contents, but lacking in the behavioral data were Arachnida (6%), Hymenoptera (non-ant; 6%), Scorpiones (1%), Isopoda (3%), and unidentifiable fleshy larvae (4%) (Table 1).

Diet comparisons of stomach contents and behavioral observations for *S. virgatus* revealed similar differences to both adult and neonate *S. jarrovii*. The dominant prey items from behavioral observations were again Formicidae (2004: 54%, 2005: 52%) and Diptera (2004: 34%, 2005: 31%). Dipterans were notably absent from stomach contents. The dominant food items found in the stomachs were: Formicidae (36%), Heteroptera (19%), and Coleoptera (23%). Heteroptera was not present in the behavioral diet and Coleoptera were only present in small amounts in 2005 (5%). Arachnida were not present in the behavioral diet, but made up 8% of the stomach content diet (Table 1).

Discussion

Observations of prey attacked revealed that the dominant food items in the diet of adult *S. jarrovii* were Formicidae, Diptera, and Isoptera (Table 1). This contrasts somewhat with the stomach content diet, which consisted predominantly of Formicidae and Hymenoptera (non-ant) (Table 1). Previous stomach content analyses have shown that the adult *S. jarrovii* eat mainly Coleoptera, Heteroptera, Lepidoptera, and Orthoptera (Barbault et al. 1985; Bursey and Goldberg 1993). Differences in dominant food items between this study and previous work may be due to the differences in study locations, which undoubtedly have differing available prey bases. The Bursey and Goldberg (1993) study occurred in Pima Co., Arizona (southwest of Tucson) and the Barbault et al. (1985) study occurred in northern Mexico, whereas this study was limited to the early summer in the Chiricahua Mountains (southeast of Tucson). In addition, the high incidence of Isoptera in the observational diet was an isolated incident in 2004. A single individual that I was observing found a hole in the ground from which reproductive termites were emerging, enabling the lizard to eat a large number of termites (32) with very little effort.

For neonate *S. jarrovii*, the diet was very similar to adult *S. jarrovii* in that it was dominated by Formicidae and Diptera in the behavioral observation diet (Table 1). The stomach content diet was high in Formicidae, but also Heteroptera (Table 1). For *S. virgatus* the dominant prey items in the observational diet are Formicidae and Diptera, similar to both age classes of *S. jarrovii* (Table 1). The stomach contents, however, are made up mainly Formicidae, Heteroptera, and Coleoptera (Table 1).

Observed diet analysis discrepancies may be an artifact of the methodology surrounding stomach content analysis in general. The stomach flushing technique may not be as exhaustive as dissection, as some prey items may not be successfully removed from the lizard's stomachs. It is possible that the items least likely to be removed were large-bodied organisms that could not be washed out by water. Of the 18 individuals (3 *S. jarrovii* adults, 11 *S. jarrovii* neonates, and 4 *S. virgatus*) that died during the procedure and were later dissected, only one individual (an adult *S. virgatus*) had a completely empty stomach, so it appears that this method did not disgorge all items. Although not all prey items were extracted from the stomachs, those items that were extracted

are still useful for comparison with the behavioral observations.

A second explanation for the diet discrepancy is that many prey items may have been partially digested due to the length of time since eating, resulting in an underestimate of easily digested organisms (Vitt and Zani 1998). All of the lizards in this study were kept for a minimum of two hours before stomach flushing. Lepidopterans, which are known to be dominant in the diet of adult *S. jarrovii* (Barbault et al. 1985; Bursey and Goldberg 1993), were not present in high numbers in the stomach samples (Table 1), possibly because these soft-bodied organisms are digested fairly quickly (Bullock et al. 1993). The only evidence of Lepidoptera in the stomach contents were wings, which I counted to get an estimate of the number of individuals eaten. This technique may have resulted in an underestimate of the number of Lepidoptera present in the diet, though behavioral observations were consistent with this low prevalence (Table 1). Perhaps completing stomach flushes immediately upon capture would alleviate some of these issues, however, it still does not resolve the problem of lizards that have been foraging for hours prior to capture.

Diptera were a major dietary component for all three lizard groups according to the behavioral observations, but were not present in any of the stomach contents (Table 1). Diptera are soft-bodied, with very little chitin, making them an easily digested prey source. However, unlike the Lepidoptera, there was no evidence of Diptera wings or other identifiable body parts in the stomach contents. Unpublished data of *S. virgatus* stomach contents also show no evidence of Diptera eaten, though "unidentifiable" organisms made up 9% of the diet and perhaps partially digested Diptera were contained therein (G. R. Smith, unpubl. data). Another alternative is that no Diptera were actually ingested, although this conflicts with the behavioral observations, and seems very unlikely due to heavy prevalence of Diptera at the site (pers. obs.).

The contradiction between the diet sources within this study may also be an artifact of observer bias. Since behavioral observations occurred at a distance of over one meter, and often over two meters, it is entirely possible that what the observers thought was a "fly" may simply have been another small flying insect that could not be distinguished at that distance. This bias may also explain why Heteroptera and Hymenoptera were either rare or completely lacking in the observational diet of all three lizards groups, yet are common in the stomach contents of this study (Table 1) and other previous studies (Bursey and Goldberg 1993). However, I am confident that the behavioral methodology was sound and may need only further refinement to improve accuracy.

While both the stomach flushing method and behavioral observations provide valuable insight into the diet of *S. jarrovii* and *S. virgatus*, it is unclear which method is truly representative of their diets. Likely, both methods are only pieces of the whole picture, but by looking at the data from both methods together, we gain a much greater understanding of the diet of these two lizard species. Further research comparing behavioral observations and stomach contents will need to be conducted in order to determine if an observational method alone can be used as a representation of lizard diet. This experiment is also the first time that this particular behavioral methodology has been used, so repetition of

TABLE 1. Total diet composition from stomach contents and behavioral observations. Data for each prey item are represented as the percentage of the entire diet from that source.

Lizard Group	Data Source	N	Arachnida	Chilapoda	Coleoptera	Diptera	Formicidae	Heteroptera	Hymenoptera	Isoptera	Lepidoptera adult	Orthoptera	Scorpiones	Unidentified larvae
Sceloporus jarrovii adult	stomach	20	3.3	0.7	9.8	0	54.9	8.5	15.7	0	3.3	0	0	2.6
	behavior 04	76	0	0	0	24.7	27.3	0	0	44.2	0	0	0	1.3
	behavior 05	30	0	0	6.7	23.3	63.3	0	0	0	6.7	0	0	0
Sceloporus jarrovii neonate	stomach	20	6.1	0	6.1	0	37.8	35.0	5.6	0	1.7	0	1.1	3.9
	behavior 04	27	0	0	0	61.5	26.9	0	0	7.7	3.9	0	0	0
	behavior 05	43	0	0	7.0	16.3	76.7	0	0	0	0	0	0	0
Sceloporus virgatus adult	stomach	20	8.8	0	23.4	0	35.8	19.0	4.4	0	5.8	0	0	2.9
	behavior 04	38	0	0	0	34.3	54.3	0	0	0	2.9	2.	0	2.9
	behavior 05	35	0	0	5.6	30.6	52.8	0	2.8	0	0	5.6	0	2.8

the methodology may be necessary. Other than keeping lizards in enclosures and feeding them all possible prey items, the two methods in this study are our best hope of determining lizard diets while providing minimum impact. In addition, it is important to develop a method to determine diet through behavioral observations, since this is the only method by which we can also record prey species-specific data on pursuit time, search time, handling time, or prey capture success rate in the field.

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Finding a Needle in a Haystack: New Methods of Locating and Working with Rhinoceros Vipers (*Bitis rhinoceros*)

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Large snake species are important predators in their ecosystems (Dodd 1987; Greene 1997; Lawson and Klemens 2001). Rhinoceros Vipers (Viperidae: *Bitis rhinoceros*, Schlegel, 1855) are among the biggest and most massive venomous snakes (Phelps 1981). Taxonomically they are closely related to the Gaboon Viper, *Bitis gabonica* (Duméril et al. 1854), and were long considered to be only a subspecies of the latter. A sister species to these two taxa is the Nose-horned Viper, *Bitis nasicornis* (Calvete et al.

2007; Lenk et al. 1999; Lenk et al. 2001). Although there is no ecological study on the Rhinoceros Viper, they are likely to have a very similar ecological niche to the Gaboon Viper. Therefore, we herein compare our data to *B. gabonica*. *Bitis rhinoceros* occurs in Western Africa from Guinea to Togo (e.g., see Chippaux 2001), while *B. gabonica* ranges from Nigeria to central, eastern, and southern Africa (e.g., see Spawls and Branch 1995).

These two vipers can reach 1.80 m (Chippaux 2001; FitzSimons 1962; Pitman 1974; Spawls and Branch 1995) and weigh up to 10 kg (Greene 1997). Their size and strong venom enable them to kill and feed on a wide variety of prey, including medium-sized mammals (Bodbijl 1994; FitzSimons 1962; Luiselli 2006b; Mallow et al. 2003; Marsh and Whaler 1984; Perrin and Bodbijl 2001; Pitman 1974; Spawls and Branch 1995). Both viper species may be very abundant in some habitats (Ionides and Pitman 1965, Luiselli and Akani 1998; Rödel and Mahsberg 2000); for example, Lawson (1993) documented especially high densities of *B. gabonica* in altered habitats like farms and plantations in Cameroon. In Côte d'Ivoire, Doucet (1963) found 282 *B. rhinoceros* on only a few km^2. This indicates that these large forest vipers might play an important functional role in their ecosystems. Unfortunately, knowledge about abundances and ecology of this species is rather anecdotal and stems mostly from extrapolations of *B. gabonica*. In general, there are little data on the ecological role of huge vipers (Greene 1997; Schuett et al. 2002).

Because of their camouflage coloration combined with a sit and wait hunting strategy, it is very time intensive to ascertain the presence of these snakes (even when radio-tracked, Lawson 2006) and almost impossible to estimate exact abundances (see Kéry 2002). There are no studies that investigated the ecology of *B. rhinoceros* and few on *B. gabonica*. Research on *B. gabonica* was conducted in outdoor enclosures (Akester 1979; 1989) and in the wild. The latter was done by applying radio-tracking (Angelici et al. 2000; Bodbijl 1994; Perrin and Bodbijl 2001a; Lawson 2006; Linn et al. 2006) and visual encounter surveys (Luiselli and Akani 1998, 2003; Luiselli et al. 1998; Luiselli 2006a, b; Perrin and Bodbijl 2001b). Numbers of snakes studied varied strongly between studies but were mostly low, ranging from two (Lawson 2006), four (Angelici et al. 2000), six (Linn et al. 2006) to nine (Bodbijl 1994; Luiselli and Akani 1998; Luiselli et al. 1998; Perrin and Bodbijl 2001a) individuals. Numbers increased to 57 (Perrin and Bodbijl 2001a), 81 (Luiselli 2006a), 97 (Perrin and Bodbijl 2001b), 524 (Luiselli and Akani 2003) and 586 (Luiselli 2006b) when i) search effort was strongly elevated (e.g., through high manpower, visiting bush meat markets), ii) secondary habitats were searched, and/or iii) data were pooled over several years, sites, habitats, or supplemented with museum specimens.

In addition to the difficulty of detecting large forest vipers, they are also dangerous and difficult to handle. They have the longest fangs of all snakes (Pough and Groves 1983) and their large venom glands (Grasset 1946; Pezzano 1986) produce a huge amount of highly haemotoxic venom (Brown 1973; Broadley et al. 2003; Chippaux 2002; Grasset 1946; Phelps 1981; Wildi et al. 2001). Most untreated bites probably are fatal (Chippaux 2002; Mallow et al. 2003; Marsh and Whaler 1984; Marsh et al. 1997, 2007; Spawls and Branch 1995). Though these snakes are considered to be of a docile nature (e.g., Angelici et al. 2000; Broadley et al. 2003; Isenmonger 1962; Lawson 2006; Wildi et al. 2001),

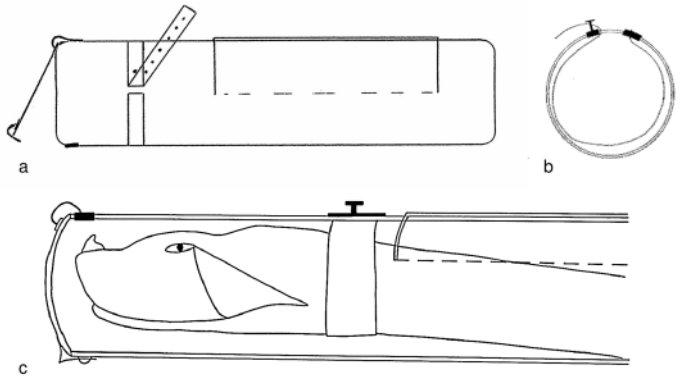


FIG. 1. Transparent Plexiglas tube used for handling Rhinoceros Vipers. a) and c) illustrate how the left side can be closed. The leather belt to fix the snakes' head was attached with a screw on the outside of the tube. a) View of the whole tube, indicating the window that can be opened on the tube's side. b) Cross section of the tube, illustrating the attachment of the belt. c) The belt should be fastened around the neck of the snake.

handling *Bitis* species poses a severe danger to researchers. This is an important point because medical services in many areas in Africa are generally not well prepared for dealing with snake bite victims (Chippaux 1998; Chippaux 2005; Theakston and Warrell 2000; Theakston et al. 2003; Stock et al. 2007). Additionally, many research areas are too remote to reach proper medical services within an acceptable time span. Hence the personal risk while investigating these snakes has to be minimised.

In order to investigate the role and importance of these large predators in an undisturbed West African rainforest, we tested a new method of finding Rhinoceros vipers and developed a new secure handling method.

Study site.—Our study site was situated in the Taï National Park, which is located in the southwest of Côte d'Ivoire (5°08'–6°07'N, 6°47'–7°25'W), close to the southeastern border of Liberia. It is one of the largest remaining blocks of the Upper Guinean rainforest (Vooren and Sayer 1992). The study area comprised roughly 770 ha of natural forest around the "Station de Recherche en Ecologie Tropicale" (SRET; 5°50'03"N, 7°20'536"W), maintained by the University of Abobo-Adjamé, Abidjan. Rainfall around the SRET is ca. 1800 mm annually, with peaks from March to July and from September to December (Rödel and Mahsberg 2000).

Methods.—Because of their cryptic coloration and secretive lifestyle it is very difficult to record Rhinoceros Vipers with methods like visual encounter surveys on transects, plots, or random searches in particular habitats. Other methods such as cover boards, artificial dens, or different kinds of traps are not applicable for this species, possibly because of their assumed high underground activity, as observed in Nigeria (Angelici et al. 2000) but not confirmed for South Africa (Linn et al 2006; Perrin and Bodbijl 2001a), and presumed low daily movement rates (Alexander and Marais 2007; Linn et al. 2006; Mallow et al. 2003). Previous studies suggest that *B. gabonica* relies rather on its cryptic camouflage than on shelters (Lawson 2006; Linn et al. 2006; Perrin and Bodbijl 2001a; Pitman 1974). Hence these methods could yield few vipers but not in a reliable manner.

The new method for tracking forest vipers we developed employs following monkeys habituated to humans, Sooty

Mangabeys (*Cercocebus torquatus atys*). During the day, these monkeys forage about 80% of the time on the ground (Berggmüller 1998; Rutte 1998). When encountering a snake, they usually seem to ignore it. However, snakes of the genus *Bitis* are treated differently. The monkeys jump aside and give loud, distinct alarm calls (Range and Fischer 2004), which attracts other monkeys to the site, facing the snake and giving alarm calls as well. In the Taï Monkey Project a habituated mangabey group was followed on a daily basis (Range and Noe 2002). This group consisted of 100–120 individuals of all age classes. Researchers and field assistants followed the monkeys and marked all places with flagging tape where vipers had been indicated. Subsequently, we located the snakes and took the geographic position of these places and photographs of the snake's heads. The latter were used to ascertain individual identification (see Ferner 2007). To assure long-term identification some snakes were additionally marked with a PIT tag (Passive Integrated Transponder; Trovan©) injected subcutaneously, laterally in front of the tail on the right side of the body. For that purpose we had to capture and handle the snakes.

For handling the vipers safely we used custom-made transparent Plexiglas tubes (wall of the tubes 3–4 mm thick) which were open at one end and lockable on the other. Close to the lockable end a loop of leather belt was fed into the pipe. The leather belt was fixed to the outside of the tube in one position and slides through a slot with a locking mechanism in the other (Fig. 1). We had six different sizes of tubes (diameters ranging from 5 to 30 cm; length ranging from 50 to 100 cm), which enabled us to handle various sizes of vipers. If the snake was covered with leaves and/or wood, the cover was first removed. The snake was then gently lifted or pushed into an open area with a long hook (1.80 m) and the head subsequently pinned to the ground using the same hook. The open end of the tube was then placed over the snake's head by a second person. Either the snake started crawling further into the pipe on its own or was still pinned down by the first person, while the second was pushing the tube further ahead. When the head finally passed through the leather belt, the belt was pulled and fixed on the outside of the tube. Due to the triangular head shape, the snake subsequently was not able to move backwards, even when the belt was not too tight. A very tight belt has to be prevented in order to avoid strangulation and because it is suggested that the common procedure of gripping heavy-bodied venomous snakes (e.g., *Lachesis muta*) by their necks can cause serious injuries to the snakes (Ripa 2002). A removable lid on the side of the tube allowed us close examination of the snake's body for detection of ectoparasites, counting scales, inserting PIT tags, etc. (see Fig. 1). After recording data (e.g., pattern, length, weight) the belt was loosened and the tube slowly lifted. The person holding the hook followed the movement of the tube so that the part of the snake outside the tube was always pinned until the head could be reached with the hook. The person holding the tube retreated and the hook was removed afterwards.

Results.—The handling method proved to be effective and safe. No snake under restraint got out of the tube (N = 5). However, the belt had to be fixed at the locking mechanism because some snakes tried to squeeze themselves backwards through the belt. It was also necessary that one person was always holding the hind part of the snake's body in order to prevent the snake from turning around. Both implementations are necessary because due to the large girth, the small neck and the ability of changing the girth dramatically by moving ribs or inflating, no tube will prevent efforts of squeezing around the own axis backwards without injuring the skin. Afterwards these lesions might become entry points for parasites, infections, etc.

Sooty Mangabeys were followed during 429 days (3110 observation hours) from October 2001 to September 2002. We recorded a total of 43 Rhinoceros Vipers (0.01 snake/h). Two snakes were encountered twice. The 41 individuals were registered in an area of 770 ha (1 snake / 18.8 ha). Viper locations were randomly spaced (Nearest Neighbor Analysis R = 0.75, Donnelly Modification for Clark and Evans Test z = -3.44) within the mangabeys' home range (770 ha). Most Rhinoceros Vipers were found between 1000 h and 1400 h (28 snakes). A seasonal peak was registered in October 2001 (12 snakes). During a parallel study on leaf litter anurans (Ernst and Rödel 2005; Rödel and Ernst 2004), we employed 382.5 h of transect walks, thereby carefully investigating the forest floor. During this time, we recorded one Rhinoceros Viper (0.002 snake/h). During additional random visual encounter surveys for litter frogs (without accompanying monkeys, 1999–2002; total time not recorded), we found two more vipers. Unfortunately, we had to interrupt all studies in October 2002 due to the start of a civil war.

Discussion.—To our knowledge our capture protocol is the safest method for the human observer and large vipers alike. The tubes prevent snakes from breaking free through violent and sudden head jerking as has been observed in other vipers, e.g., *Bitis arietans* (Visser and Chapman 1980). The tubes are easily fabricated and can be customized to any size and modified for specific needs, such as the removable window on the side of the tube which we employed for the insertion of PIT tags (Lang 1992).

Although the monkeys clearly showed fear of big vipers, the respective reasons remained unclear and were not addressed in our study. It is long known that various species of monkeys react with specific alarm calls ("conceptual semantics") towards snakes (Coss et al. 2007; Crockford and Boesch 2003; Fichtel et al. 2005; Range and Fischer 2004; Struhsaker 1967; Seyfarth et al. 1980a, b), especially if the snakes are moving. However, we observed that they react towards stationary snakes and that reactions towards Rhinoceros Vipers (and Nose-Horned vipers, *Bitis nasicornis*) differ from those toward other snakes such as Forest Cobras (*Naja melanoleuca*). This is contrary to observations on Vervet Monkeys (*Chlorocebus aethiops*), where monkeys reacted with specific alarm calls towards Puff Adders (*Bitis arietans*) and Egyptian Cobras (*Naja haje*) (Struhsaker 1967). We hypothesize that large vipers are capable of killing and subsequently devouring such large prey (Angelici et al. 2000). Large prey items are rare (Luiselli and Akani 2003; Luiselli 2006b; Perrin and Bodbijl 2001b), but a Royal Antelope (*Neotragus pygmaeus*) has been recorded for *B. rhinoceros* (Cansdale 1965). A Large Spotted Genet (*Genetta tigrina*) (Perrin and Bodbijl 2001b) and monkeys (Broadley and Cock 1975; *Chlorocebus pygerythrus*, J. Newby quoted in Broadley et al. 2003) have been noted for *B. gabonica*. We never observed any encounters with Rock Pythons (*Python sebae*), which do occur in the area and elicit alarm calls in three other monkey species (Starin and Burghardt 1992) and are easily capable of feeding on Sooty Mangabeys (e.g., see Cowlishaw

1994; Starin and Burghardt 1992; Struhsaker 1967). Other snakes, although capable of killing monkeys with their venom (*Naja* spp.), are smaller and their gape limitation does not allow them to feed on monkeys. An additional hypothesis assumes that the monkeys warn other members of their group when encountering vipers (Cheney and Seyfarth 1992; Struhsaker 1967) to not accidentally step on the snake, thereby avoiding a defensive bite. Neither of the two viper species will flee immediately when detected by a group of mangabeys, allowing the behavior of habituated mangabeys to be exploited to locate large forest vipers.

The peaks of snake records between 1000 h and 1400 h were most likely due to peaks in foraging activity of the monkeys during that same time period. Similarly, a seasonal peak of snake records was coincidental with fruiting (October–December and May–June) of one major fruit tree used by the mangabeys (*Saccoglottis* sp.). During these periods the monkeys covered a larger foraging area than during other periods, therefore increasing the chance to encounter more snakes. The observed density of 0.053 snakes per hectare is at the lower limit known for comparable sized species (see review by Parker and Plummer 1987) and lower than modelled densities of the sister species *B. gabonica* in southern Nigeria (mean: 0.22/ha; min.: 0.014/ha; max.: 0.372/ha; Luiselli 2006a). However, we would have needed a much higher recapture rate to calculate real densities. The monkeys did not equally use all parts of their home range and although a Nearest Neighbor Analysis of the Rhinoceros Viper records revealed a random distribution in the forest, we cannot exclude the possibility that the snakes could be much more abundant in parts were monkeys forage rarely.

Our results showed that, by using the monkey's specific warning system, we have identified a highly valuable method to detect large vipers in West Africa. Data from our study revealed more vipers per unit time compared to visual encounter surveys. Our refined method of tubing snakes is highly recommended for safe handling of large vipers.

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Infection with the Fungus *Batrachochytrium dendrobatidis* in a Non-native *Lithobates berlandieri* Below Sea Level in the Coachella Valley, California, USA

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The amphibian fungal disease chytridiomycosis caused by *Batrachochytrium dendrobatidis* (*Bd*) has been found in several parts of the world including Africa, Australia, Europe, Central, South, and North America (e.g., Berger et al. 1998; Skerratt et al. 2007), yet its geographic distribution is not fully known. Based on current patterns, the great majority of species and populations that have been affected have occurred in montane habitats or areas characterized by relatively moist climates (Stuart et al. 2004; Longcore et al. 2007). In North America, *Bd* has been reported from numerous species, with the earliest recorded incidence of infection dating back to 1961 (Ouellet et al. 2005; Longcore et al. 2007; AmphibiaWeb 2007). *Bd* is recorded from latitudes as far north as Alaska, USA (e.g., Adams et al. 2007; Reeves 2008), and at elevations extending from near sea-level at Point Reyes, California, USA, to 3550 m in the Sierra Nevada, California (Fellers et al. 2001; Morgan et al. 2007; Spatialepidemiology.net 2008).

Recently, *Bd* has been confirmed in native, desert frog species *Lithobates* [=*Rana*] *yavapaiensis*, *L. chircahuensis*, *L. tarahumarae* and *Hyla arenicolor* in Arizona (Bradley et al. 2002; Hale et al. 2005) and is hypothesized to be a key factor in the extirpation of populations of these species. Locally in southern California, *Bd* is known to occur in the native species *Anaxyrus* [=*Bufo*] *californicus* (Mendelsohn et al. 2005), and *Rana draytonii* (Ervin et al. 2001). Individuals from established populations of the introduced frog species *L. catesbeianus* and *L. berlandieri* in the southwestern United States have been reported to be infected with *Bd* (Sredl 2002). Consequently, the concern now is that infected individuals from these populations, and other undiagnosed populations, may serve as vectors for *Bd* to naïve populations of native frogs (Hanselmann et al. 2004, Sredl et al. 2002). *Lithobates berlandieri* is native to Texas and New Mexico but has been introduced to Arizona and California within the last 35 years (Rorabaugh et al. 2002).

On 23 January 23 2007, one of us (BC) collected a dead *L. berlandieri* in Coachella Valley, California, USA (33.5352722°N, 115.9883278°W), south of the town of Mecca, and ~1 km N of the Salton Sea. The animal was found in an agricultural ditch (~2 × 35 m) filled with 5– 20 cm of standing water and with lush emergent vegetation and a dense mat of green algae, at –58 m below sea level. The specimen was photo documented (LACM PC1457–1460), and examination revealed bright red coloration on the ventral surface of the legs that is uncharacteristic of the natural coloration for this species. Museum acronyms used follow Leviton et al. (1985). Subsequent searches of the area were made, and on 13 March 2007 one of us (MJR) collected an additional living specimen from the same agricultural ditch. Upon capture the frog was moribund and unable to right itself when placed on its back. The ventral surfaces of its legs were reddened similar to the frog that was found dead. The second frog perished within a day of capture, despite efforts to maintain it in captivity until it could be prepared as a museum specimen. It was preserved in 95% ethanol and a complete necropsy was performed on the fixed carcass. Sections of the dorsal and ventral skin, heart, lung, liver, kidney, pancreas, tongue, stomach, small and large intestine, brain, eye, skeletal muscle, bone, and bone marrow were post-fixed in 10% neutral buffered formalin and processed routinely for histology. When hematoxylin- and eosin-stained sections were examined by light microscopy, lesions were limited to the skin and other tissues were histologically normal. Histologic findings included: near diffuse mild to moderate epidermal hyperplasia with multifocal epidermal erosion; scattered single cell necrosis of keratinocytes; moderate to marked congestion of dermal capillaries: and a mild multifocal lymphohistiocytic dermatitis. Occasionally, within the superficial keratin layers (*stratum corneum*) there were small numbers of spherical fungal thalli with evidence of internal septation (colonial thalli) morphologically typical of *Bd* (Berger et al. 2005; Longcore et al. 1999). Based on these findings, death was attributed to chytridiomycosis. A swab obtained from the skin was processed following previously described methods for a Taqman® polymerase chain reaction (PCR) assay to detect *Bd* DNA (Boyle et al. 2004; Hyatt et al. 2007). PCR results were positive, confirming the morphologic identification of *Bd* on histologic examination. The frog is vouchered as SDSNH 72858.

This observation of *Bd* infection is notable for several reasons. First, it represents the first record of *Bd* in *L. berlandieri* in California. *Lithobates berlandieri* is expanding its range in the deserts of the American southwest (Rorabaugh et al. 2002), and also occurs in sympatry with other native aquatic amphibian species such as *Anaxyrus punctatus, A. woodhousei*, and *A. alvarius*, *Pseudacris hypochondriaca* (pers. obs.). The determination that *Bd* is now known to occur in this region highlights the need for other local native species to be monitored to investigate the impacts of this pathogen in a region otherwise characterized by extreme heat and low humidity. Second, this is the first incidence of

Bd below sea level in one of the hottest and driest locations in the western hemisphere (Klauber 1931). Occurrence of *Bd* in arid, desert environments is significant because desert anurans tend to be reliant on water bodies more so than species of more mesic environments resulting in higher local densities (Degenhardt et al. 1996) which may allow *Bd* to more virulently move through a population (Rowley and Alford 2007; Ryan et al. 2008). Although the prevailing environmental conditions at the sampling locations seem unsuitable to survival of *Bd*, microhabitat use (water bodies, retreat sites) and behaviors used by *L. berlandieri* (thermoregulation) could counteract the prevailing conditions by keeping the frog and thus the *Bd* at temperatures and humidities more conducive to both, because these frogs are obviously not exposing themselves to the extremes of the environment. *Lithobates berlandieri* is known to tolerate high salinities (McCoid 2005), similar to those conditions along the Salton Sea where the specimens were documented and collected. Interestingly, in laboratory culture *Bd* has been shown to survive, but grow poorly, at a pH of less than 6 (Piotrowski et al. 2004). The historically desert environs of the Coachella Valley have undergone urban and rural development to such an extent that extremely widespread agriculture, golf courses, and residential and private artificial landscaping have resulted in an elevated humidity and the expansion of mesic spatial and temporal conditions. Humidity is also greater along the shores of California's largest inland body of water, the Salton Sea, where the specimens were found. *Bd* is thought to be intolerant of extremely warm, dry conditions, and the occurrence of *Bd* in this type of environment is novel (Piotrowski et al. 2004).

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Preliminary Surveys for *Batrachochytrium dendrobatidis* in Taiwan

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Batrachochytrium dendrobatidis (*Bd*) is a chytrid fungal pathogen of amphibians that has been implicated in numerous amphibian extinctions and declines (Berger et al. 1998; Lips et al. 2006). The geographic distribution of this novel pathogen, however, is poorly known. While a number of reports are available from Africa (Goldberg et al. 2007; Smith et al. 2007; Weldon et al. 2004), Australia (Berger et al. 1998; Woodhams and Alford 2005), Europe (Bosch et al. 2007; Garner et al. 2005) and the Americas (Lips et al. 2006; Ouellet et al. 2005), we are aware of only two published reports from Asia. The first study (Garner et al. 2006) found no evidence of *Bd* in introduced populations of North American Bullfrogs (*Lithobates catesbeianus*, formerly *Rana*; Crother 2008; Frost et al. 2006) in Japan. The second study (Rowley et al. 2007) found no evidence of *Bd* in four native species or in frogs imported to Hong Kong, China. Herein, we provide preliminary data from surveys for *Bd* in Taiwan.

Methods.—On 3 October 2006, skin swabs were collected from 20 wild-caught adult frogs (representing 12 species in four families, taxonomy following Frost et al. 2006). Frogs were collected from ponds, streams, and roadside ditches in the vicinity of the Taiwan Forestry Research Institute's experimental forest at Lien Hua Chih Station (23.92°N, 120.87°E, Nantou County, elevation range of collection sites 600–700 m). Skin swabs were obtained by running a sterile cotton swab along the skin of the captured frog for approximately 30 seconds, focusing on the hands, feet, and pelvic region. A new pair of sterile gloves was used when capturing and handling each frog. Frogs were released immediately after the swabbing procedure. During collection, air temperatures ranged from 17–21°C. Skin swabs were preserved in 70% ethanol in 2.0 ml screw-capped microcentrifuge tubes and stored at room temperature. All samples were transported to the University of Michigan where they were tested for the presence of *Bd*.

The 20 swab samples and a total of 100 negative controls were randomized and tested for *Bd* using Taqman diagnostic quantitative PCR (q-PCR; Boyle et al. 2004). DNA was extracted from each sample and negative control following Hyatt et al. (2007) and q-PCR assays were performed in triplicate following Boyle et al. (2004). Samples containing PCR inhibitors were detected using VIC_{TM} Exogenous Internal Positive Controls (Applied Biosystems) and inhibition was overcome by dilution following Hyatt et al. (2007). Samples were considered positive if all three replicates indicated the presence of *Bd*. Samples testing positive in one or two replicates were re-assayed once.

Results.—One of the 100 negative controls tested positive for *Bd*, indicating a false positive rate for DNA extraction and *Bd* assay of 1%. All of the skin swab samples tested negative for *Bd* DNA in all three replicates except for one (from *Huia swinhoana*, Table 1). This sample initially tested positive for *Bd* in two out of three replicates. However, when this sample was re-extracted and three additional assays were performed, none of these replicates tested positive for *Bd* DNA. No dead or obviously diseased frogs were found at the study sites.

Discussion.—Taken together, the false positive rate of 1% for q-PCR and the lack of amplification in a second assay, it seems likely that the amplification of *Bd* DNA from the first assay of the *Huia swinhoana* sample was a result of cross-contamination (i.e., a false positive). While these data are from a relatively small sample in a small geographic area, they suggest that either *Bd* is absent from these sites in central Taiwan or that it occurs at such a low frequency that it was not detected.

Although we found no convincing evidence of *Bd*, it would be presumptuous to claim that it is absent from Taiwan. In fact, there have been unpublished reports of *Bd* from North American Bullfrog farms in southern Taiwan (L. Schloegel, pers. comm.). With relatively high levels of endemicity (27%; Yang 1998) and much of its land area at moderate to high elevations (where conditions for *Bd* would likely be optimal), Taiwan might be vulnerable to the kind of amphibian declines and extinctions that have been noted elsewhere. Additional surveys for *Bd* are urgently needed island-wide to assess the danger this pathogen may pose to Taiwan's amphibian fauna.

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TABLE 1. List of species tested for *Batrachochytrium dendrobatidis* infection from Lien Hua Chih Forestry Station, Nantou County, Taiwan. * indicates endemic species. Ecological data from Chou and Lin (1997).

Family	Species	No. Infected / No. Tested	Breeding Habitat	Elevation Range (m)
Bufonidae	*Bufo bankorensis**	0 / 2	ponds, ditches	0–2700
	Duttaphrynus melanostictus	0 / 1	ponds	0–1500
Dicroglossidae	*Limnonectes kuhlii*	0 / 2	streams, ditches	300–600
Ranidae	*Babina adenopleura*	0 / 1	ponds	0–2000
	Huia swinhoana	0 / 2	streams	150–1700
	Pelophylax plancyi	0 / 2	ponds	0–1000
	Rana sauteri	0 / 3	streams	170–2600
	Staurois latouchii	0 / 2	ponds, ditches	0–1000
Rhacophoridae	*Buergeria japonica*	0 / 2	ditches, streams	175–1200
	*Buergeria robustus**	0 / 1	streams	175–800
	*Kurixalus idootocus**	0 / 1	ponds, ditches	50–1200
	*Rhacophorus moltrechi**	0 / 1	ponds, cisterns	150–2500
Total		0 / 20		

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Occurrence of *Batrachochytrium dendrobatidis* in Southwestern Tennessee, USA

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There is evidence that amphibian chytridiomycosis, caused by the pathogenic fungus *Batrachochytrium dendrobatidis* (*Bd*), is widespread throughout Mexico (Lips et al. 2004), New Zealand (Waldman et al. 2001), and South America (Ron and Merino 2000). Additionally, reports have documented *Bd* in parts of the USA (reviewed in Longcore et al. 2007), yet the full extent of its current geographical distribution in the United States remains unclear. *Bd* infections can cause mortality in metamorphosed amphibians, however pathogenicity varies among species (Davidson et al. 2003). More information about the distribution and effects of *Bd* will impact current management strategies and assist in the understanding of how *Bd* is spread. These data are especially important for amphibian populations which are not currently undergoing disease-related declines. Herein, we document *Bd* infections of two adult Southern Leopard Frogs (*Rana sphenocephala*) collected from Shelby County, Tennessee, USA.

During March 2008, multiple anurans (*Acris gryllus, Pseudacris triseriata, Scaphiopus holbrooki,* and *R. sphenocephala*) began breeding choruses following rain events in Tennessee. On 14 and 31 March 2008, we surveyed six ponds throughout Shelby County, Tennessee, in search of *R. sphenocephala* egg masses for a separate research project. On 14 March, we found two dead/moribund adult female *R. sphenocephala* within 2 m of each other along the east margin of one of the ponds (35.33861°N, 90.03944°W). The first specimen was heavily colonized by filamentous fungi and appeared to be dead for approximately 2–3 days. The second specimen was extremely moribund and was found with its ventral side facing up, with petechial hemorrhaging on the venter and feet. In addition to the hemorrhaged tissue, skin sloughs were present on the venter and all four appendages of the individual. On 31 March, we found a moribund adult male *R. sphenocephala* at a second locality (35.36278°N, 90.02194°W). This individual was also found ventral side facing up with hemorrhaged tissue. At each locality, we collected the moribund frogs from the water with forked sticks and placed each frog into a clean plastic container and into a cooler for transport to the laboratory at The University of Memphis. During transport to the laboratory, both frogs died (ca. 3 h after collection).

Batrachochytrium dendrobatidis can be diagnosed in fresh tissue by examining a piece of skin under a light microscope for *Bd* thalli (Longcore et al. 2007). Using latex gloves and sterile equipment, we collected a sample of sloughed skin from the venter of each frog and prepared a wet-mount slide of the freshly sloughed tissue and viewed it under 40×. After determining that the frogs were heavily infected with *Bd*, we fixed them in 10% formalin and preserved each entire specimen in 70% ethanol for additional photographs of the *Bd* infections. We then collected two additional, formalin-fixed, skin sloughs from the pelvic portion of each leg of the frogs. These sloughs were examined and photographed under 40×.

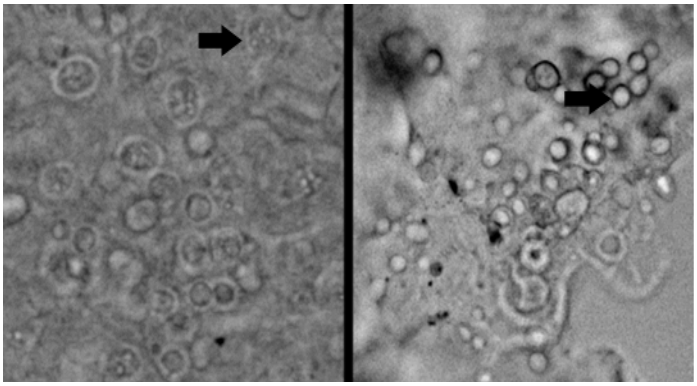


FIG. 1. Photographs, taken at 40×, of two skin sloughs from a female *Rana sphenocephala* with *Batrachochytrium dendrobatidis* thalli present, collected in Shelby County, Tennessee, USA. Left: arrow pointing to a thallus filled with zoospores; right: arrow pointing to a group of empty thalli.

Throughout each of the skin sloughs, we found heavy infections of *Bd* (Fig. 1). Additionally, on each skin sample, we found multiple life stages of *Bd*, ranging from empty thalli with discharge papillae to thalli filled with zoospores.

Transmission of *Bd* between individuals can occur by the spread of free-swimming zoospores (Pessier et al. 1999). Although data are lacking on how far zoospores can travel and infect a susceptible host, Johnson and Speare (2003) found that zoospores were viable after 3–6 weeks in water. Although it was not possible to determine the infection status of the other dead *R. sphenocephala*, we suspect that it was also infected with *Bd* because of the close proximity to the infected individual we collected. In addition, we did not perform necropsies on the *Bd* infected frogs and cannot say for certain that *Bd* infections were the cause of death of the two individuals. To our knowledge, this is the first published account of an infected metamorph anuran in Tennessee.

Acknowledgments.—K. Kramer provided the photomicroscope for images of the skin scrapes presented in this paper. T. Wilcoxen and an anonymous reviewer assisted with revising an earlier version of this manuscript. We complied with all applicable IACUC guidelines and obtained the appropriate scientific collection permits required to conduct this research.

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Batrachochytrium dendrobatidis in *Ambystoma jeffersonianum* Larvae in Southern Indiana

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The amphibian chytrid fungus *Batrachochytrium dendrobatidis* (*Bd*) has been associated with amphibian declines and mass mortality (Berger et al. 1998; Bosch et al. 2001; Daszak et al. 2003; Lips et al. 2006). Infection is usually associated with the keratinized skin of post-metamorphic amphibians and keratin jaw sheaths of anuran tadpoles, however deaths have only been associated with post-metamorphic frogs (Berger et al. 1998; Daszak et al. 2003; Ouellet et al. 2005). Infections are sometimes associated with subtle skin lesions (Ouellet et al. 2005).

To our knowledge, *Bd* has not been associated with salamander mortality, salamander skin lesions, or detected in salamander larvae (Davidson et al. 2003; Pasmans et al. 2004; Speare and Berger 2000), although *Bd* was detected in several species of adult salamanders (Crummer et al. 2005; Davidson et al. 2003; Frias-Alvarez et al. 2008; Ouellet et al. 2005; Padgett-Flohr and Longcore 2005; Pasmans et al. 2004; Speare and Berger 2000). Most salamander larvae, such as ambystomatids, do not have keratinized jaw sheaths and only develop keratin in the skin late in development. Here we report our detection of *Bd* in pond-breeding salamander larvae with associated skin lesions.

On 28 May 2007, a random sample of 20 *Ambystoma jeffersonianum* (Jefferson Salamander) larvae was collected by dip-net from a pond in Morgan-Monroe State Forest in southern Indiana, USA (39.328°N, 86.423°W). The larvae were transferred to Saint Joseph's College in a single 8-L container filled with 4-L of pond water, for use in another study. The larvae were post-Harrison Stage 46 (Harrison 1969) with four toes developed on the front limbs and 3–5 toes developed on the hind limbs. The mean ± SD of TL was 43.3 mm ± 6.4 mm (range 33.1–56.7 mm). Examination of the larvae in the lab under 10× magnification revealed that 17 of 20 (85%) larvae had red skin lesions, usually on the hind limbs or the ventral surfaces of the jaw line, throat, body, or base of the tail; the two larvae with the largest lesions died during transit and were preserved in 70% isopropyl alcohol (Figs. 1a and 1b). The *A. jeffersonianum* larvae were kept in individual 500-ml containers with unchlorinated tap water that was changed twice weekly, at 13°C in an environmental chamber separated from other species in the lab. Larvae were maintained on brine shrimp nauplii and *Tubifex* worms following a protocol that has been successful in raising *Ambystoma* larvae (Brodman 1999, 2004; Brodman and Jaskula 2002). The three larvae without lesions survived through metamorphosis. The other 15 larvae with lesions or hemorrhages died 6–16 days after collection and were preserved in 70% isopropyl alcohol. In the most extreme cases two larvae lost parts of their feet and limbs (Fig. 1c and 1d).

PCR assay was used on five randomly selected larvae that had lesions and died to test for the presence of *Bd*. Two of the samples were whole larvae (smallest larvae) and a piece of the tail and one foot was removed from the remaining three (larger specimens). A portion of the tissue of each larva was transferred with clean forceps to 2.0 ml microfuge tubes, and tissue lysis buffer of 70% ethanol was added. Samples were shipped to Pisces

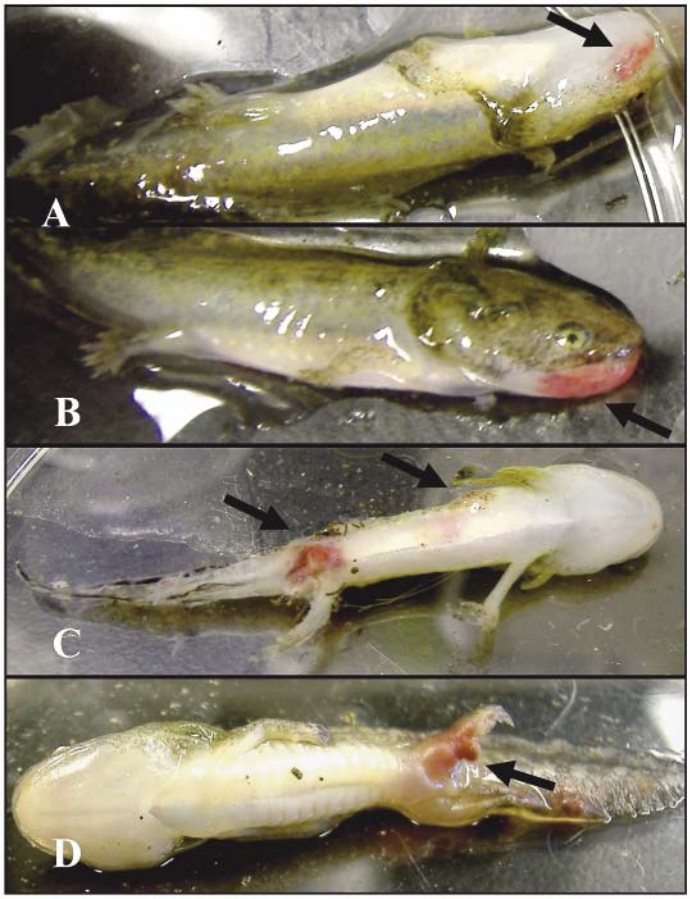


Fig. 1. *Batrachochytrium dendrobatidis* was detected in *Ambystoma jeffersonianum* larvae with skin lesions from southern Indiana, USA. Arrows indicate the following lesions: A and B show lesions on the upper and lower jaws, C shows foot and limb loss, and D shows lesion on hindlimb.

Molecular Laboratory (J. Wood, Boulder, Colorado, USA) for PCR (polymerase chain reaction) assay. Three of the five samples were *Bd* positive. The voucher specimens are deposited in the Saint Joseph's College zoology collection.

Annual larval surveys at the study site indicate that *A. jeffersonianum* and *A. opacum* (Marbled Salamander) populations have declined over the past ten years (R. Brodman, unpubl. data). Disease could be a cause of decline; however, we have not found dead or moribund larvae in previous years. To our knowledge, this is the first published case of *Bd* on larval salamanders. It should be noted that we have not determined the direct cause of mortality of these larval salamanders, nor the cause of the physical lesions, and it is possible that *Bd* and/or the associated physical lesions could be the cause of mortality.

Acknowledgments.—We thank J. Wood from Pisces Molecular, Boulder, Colorado, for analyzing tissue samples for *Bd*. We complied with all applicable institutional animal care guidelines and state permit regulations.

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Geographic Distribution of *Batrachochytrium dendrobatidis* in Puerto Rico

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Amphibian declines and extinctions have been reported across the world and infection by a pathogenic chytrid fungus, *Batrachochytrium dendrobatidis* (*Bd*), is one of the factors associated with this biodiversity loss (Berger et al. 1998; Stuart et al. 2004; Lips et al. 2006). *Bd* was first diagnosed in the West Indies in 2000, from histological studies of skin from declining populations of *Eleutherodactylus coqui* and *E. portoricensis* at El Yunque, Puerto Rico (Burrowes et al. 2004). Histological studies on seven different species of *Eleutherodactylus* collected between 1961 and 1978, revealed that 1976 was the earliest record of chytridiomycosis on the island, and this record corresponded to the last known individual of *E. karlschmidti* collected from El Yunque (Burrowes et al. 2004).

The purpose of this paper is to provide a geographical and taxonomic overview of the current distribution of *Bd* in Puerto Rico. This type of information, with corresponding sampling dates, represents a baseline for further research on the pathogen's origin, potential points of introduction, movement trends, and ecological requirements. In addition, it allows us to identify amphibian species that may be at greater risk from infection or extinction, and to develop appropriate management strategies.

Methods.—Frogs sampled in the wild for *Bd* were captured in individual plastic bags worn as gloves and inverted to prevent cross contamination. All native Puerto Rican amphibians, with the exception of *Bufo lemur,* were sampled. Individuals were examined for physical condition and sampled for *Bd* by swabbing their ventrum, feet and toes as described by Kriger et al. (2006), or toe-clipped following a modification of Twitty (1966) that allowed us to take tissue from different limbs of the frog. A fresh pair of powder-free nitrile gloves was worn every time a different frog

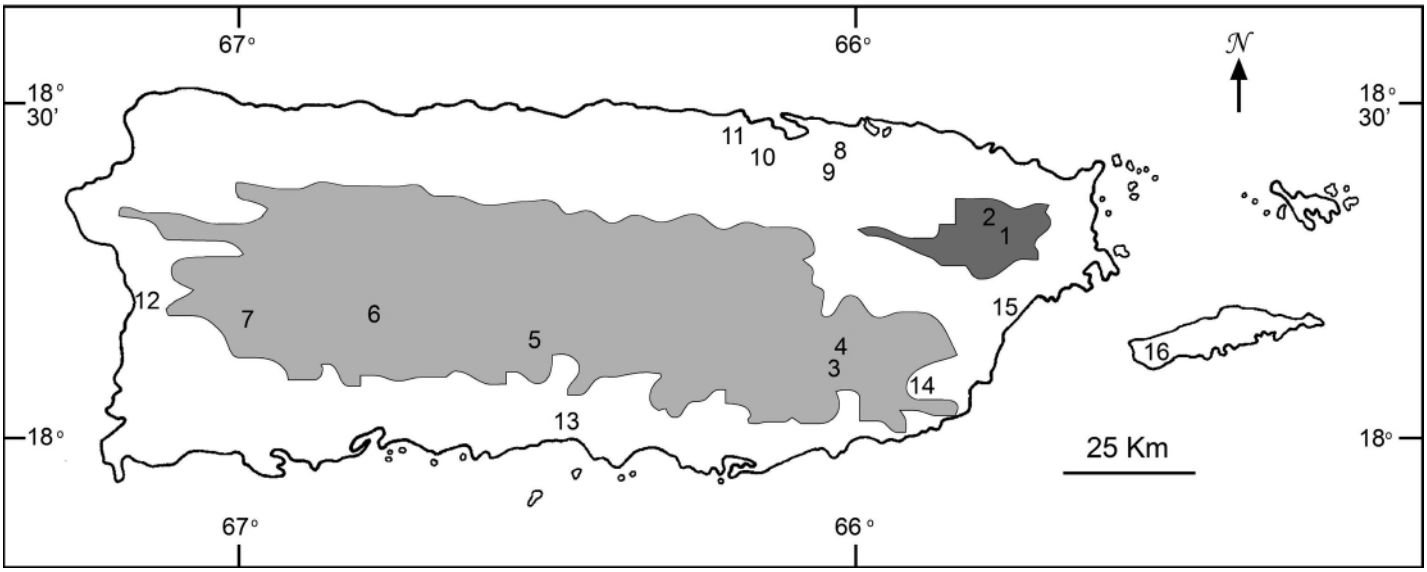


FIG. 1. Map of Puerto Rico showing locations of frogs sampled for *Batrachochytrium dendrobatidis* with the exception of Mona Island. Location numbers correspond to those described in Table 1. The light-shaded area represents the Central Cordillera and the dark-shaded area is The Sierra de Luquillo.

was manipulated. Survey sites were determined opportunistically according to other studies conducted by some of the authors. The number of frogs sampled per species and the timing in which species were sampled varied across this study (Table 1). Some species were sampled only once and *Bd* diagnosis is reported as positive or negative for that year only. Other species were sampled continuously during the dry and wet seasons in Puerto Rico, and for those, we use a dash next to the year to indicate ongoing *Bd* status until present (i.e., 2008; see Table 1).

Bd diagnostics was done by one of the following methods: histology of the skin performed by D.E. Green at the U.S.G.S. National Wildlife Health Center on wild-caught animal tissues collected in the year 2000, and on museum specimens from prior dates obtained from the University of Kansas Natural History Museum, University of Puerto Rico at Mayagüez, and the private collections of Richard Thomas and Rafael Joglar; Polymerase Chain Reaction (PCR) performed by Pisces Molecular (Boulder, Colorado, U.S.A.), following Annis et al. (2004); and Taqman quantitative PCR according to Boyle et al. (2004) at Zoological Society of London and University of Puerto Rico facilities. PCR methods were used for tissues from wild-caught animals from 2002 until present (Table 1).

Results.—A total of 2439 frogs were examined for *Bd* infection across Puerto Rico including two of its off-shore islands, Mona and Vieques. *Bd* was detected at seven of 17 locations sampled, in nine *Eleutherodactylus* species and one species of *Leptodactylus* (Table 1). *Bd* was not detected in another eight species of *Eleutherodactylus*, *Bufo marinus*, and *Rana catesbeiana*. For a few species that were examined from museum or private collections, geographic data was reported only as a region, or nature reserve. These species are reported within the closest locality sampled in our studies.

Discussion.—Previous studies suggested that *Batrachochytrium dendrobatidis* was introduced to Puerto Rico in the mid 1970s, in years characterized by cooler than average temperatures and a greater number of periods with more than five consecutive days without rain (Burrowes et al. 2004). Considering the advanced road infrastructure on the island, the disease could have spread easily and rapidly by humans to all environments that were suitable for its growth. As an epidemic pathogen during 1976–1981, *Bd* probably drove to extinction two species, *Eleutherodactylus karlschmidti* and *E. jasperi*, that were more dependent on water than any of the other 15 congenerics. *Eleutherodactylus karlschmidti* was a stream-dweller with fully webbed toes (Rivero et al. 1963), and *E. jasperi* was an obligate bromeliad dweller, considered more aquatic because it occurred within the inner axils, always flooded with water (Drewry 1986). At present the pathogen seems to be endemic above 600 m, occurring from the eastern Luquillo Mountains (El Yunque), throughout the Central Cordillera up to Maricao (Table 1 and Fig. 1). Species that are widespread in the island, such as *E. coqui*, *E. antillensis*, *E. brittoni* and *Leptodactylus albilabris*, are infected only at high elevations (Table 1). The absence of *Bd* from lower elevations in Puerto Rico may be explained by the high diurnal temperatures which are often above the thermal tolerance (17–25°C) reported for this fungus (Piotrowski et al. 2004). This suggests that high ambient temperatures may serve as a limiting factor for this disease in terrestrial, direct-developing anurans of the genus *Eleutherodactylus*, and point conservation efforts to the more vulnerable highland endemics in Puerto Rico. Nonetheless, in Costa Rica some lowland amphibians seem to cope well with low-level *Bd* infections (Pushendorf et al. 2006), and in Dominica, *Bd* has been associated with the drastic decline of *Leptodactylus fallax* at sea level (García et al. 2007). This suggests that *Bd* can infect amphibians at higher ambient temperatures, and that other factors such as behavior (Rowley and Alford 2007), reproductive mode, (Lips et al. 2003), or strain virulence (Berger et al. 2005) may influence vulnerability to chytridiomycosis among amphibian taxa.

It is evident that the range of responses of amphibians to infection by *Bd* varies among taxa, environmental conditions, climatic regimes and *Bd* strains (Berger et al. 2005; Retallick and

TABLE 1. Geographical distribution of *Batrachochytrium dendrobatidis* in Puerto Rico. Species names are followed by year of first diagnosis and sample size; a dash after a year indicates persistence until present. An asterisk denotes species for which exact localities were not available and, thus, have been reported within closest locality in their geographical range. The number in the first column corresponds to localities in the map (Fig. 1).

Map No.	Location	Coordinates	Elevation (m)	*Bd* positive (date, No. detected/No. sampled)	*Bd* negative (date, No. sampled)	Method of Detection
1	El Yunque (Palo Colorado Forest	18.3006°N 65.785389°W	671	*E. coqui* (1978, 2/9; 2000-, 430/784) *E. portoricensis* (2000-, 8/15) *E. karlschmidti* (1976, 2/2)* *E. wightmanae* (2005, 1/1)	*E. eneidae* (1961-1965, 8) *E. hedricki* (2006, 1) *E. locustus* (1961-1965, 8) *Leptodactylus albilabris* (2003-,5)	Histology PCR qPCR
2	El Yunque (Elfin Forest)	18.301867°N 65.794583°W	850–907	*E. coqui* (2003-, 154/532) *E. portoricensis* (2003-, 204/375) *E. unicolor* (2007-, 3/6)	*E. gryllus* (2005-, 5)	Histology PCR qPCR
3	Patillas (Casas de la Selva)	18.079483°N 66.034972°W	623	*E. coqui* (2004-, 19/95) *E. brittoni* (2004-, 3/25) *E. wightmanae* (2004-, 53/147) *Leptodactylus albilabris* (2004-, 4/6)		PCR qPCR
4	Carite	18.0916°N 66.034233°W	686	*E. coqui* (2005-, 6/6) *E. locustus* (2005-, 17/18) *E. portoricensis* (2005-, 1/1) *E. richmondi* (2005-, 6/11)	*E. jasperi* (1976, 3)* *E. brittoni* (2005, 5) *Leptodactylus albilabris* (2005, 1)	Histology PCR qPCR
5	Toro Negro	18.172367°N 66.358022°W	851–1178	*E. coqui* (2005-, 20/39) *E. antillensis (2005-, 20/20)* *E. brittoni* (2005-, 3/3) *E. wightmanae* (2005-, 10/12) *Leptodactylus albilabris* (2005-, 6/6)	*Bufo marinus* (2005, 1)	PCR qPCR
6	Adjuntas	18.173231°N 66.772531°W	733	*E. coqui* (2006, 4/10) *E. brittoni* (2006, 3/5)		qPCR
7	Maricao	18.14455°N 66.9801°W	800	*E. coqui* (2005-, 14/48) *Leptodactylus albilabris* (2005-, 4/10)	*E. wightmanae* (2005-, 5)	PCR qPCR
8	San Juan (UPR)	18.406644°N 66.041414°W	17		*E. coqui* (2005-, 107) *E. cochranae* (2007-, 5) *Leptodactylus albilabris* (2005-,11)	PCR qPCR
9	San Juan (Bosque San Patricio)	18.411578°N 66.094417°W	64		*E. coqui* (2005-, 6)	PCR
10	Bayamón	18.369414°N 66.18205°W	45		*E. coqui* (2005-, 10)	PCR qPCR
11	Toa Baja	18.431847°N 66.200644 °W	10		*E. juanariveroi* (2006, 5) *E. coqui* (2006, 5)	qPCR
12	Mayagüez	18.210536°N 67.138144°W	32		*E. coqui* (2004-, 6) *Leptodactylus albilabris* (2004-, 4)	qPCR
13	Juana Díaz	18.135083°N 66.358022°W	215		*E. coqui* (2005-, 7) *Leptodactylus albilabris* (2006-, 8)	PCR qPCR
14	San Lorenzo	18.081281°N 65.989544°W	407		*E. cooki* (2004-, 10)	PCR qPCR
15	Humacao	18.166667°N 65.766667°W	3		*Bufo marinus* (2000, 4) *Rana catesbeiana* (2000, 3)	Histology
16	Vieques	18.116892°N 65.560786°W	2.5		*E. antillensis* (2006, 10) *Leptodactylus albilabris* (2006, 2)	PCR
17	Mona Island	18.088508°N 67.935914°W	10		*E. monensis* (2006, 8)	qPCR

Miera 2007; Morgan et al. 2007). Puerto Rico is not an exception to these observations. Species extinctions, population extirpations from certain geographical areas, and population fluctuations in species that seem to resist the disease, have occurred on the island. Our data (Table 1) provides a valuable research tool to compare future changes in *Bd* spread, test for evolution of genetic strains, and study environment-specific variation in prevalence of this disease in amphibian communities.

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Batrachochytrium dendrobatidis in Amphibian Populations in Italy

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The pathogen responsible for the disease chytridiomycosis is the fungus *Batrachochytrium dendrobatidis* (*Bd*) (Berger et al. 1998), which has been detected in numerous localities around the world (Skerratt et al. 2007). In Italy, it has been detected in *Bombina pachypus*, *Rana latastei*, and *Rana catesbeiana* populations in the north (Stagni et al. 2004; Garner et al. 2006; T. Garner, pers. comm. 2008) and in a *Rana* kl. *esculenta/Rana lessonae* population in Umbria (Simoncelli et al. 2005; Di Rosa et al. 2007). *Bd* has also been detected on Sardinia (the second largest Italian island) in endemic populations of *Euproctus platycephalus* (Bovero et al. 2008). Here, we report surveys for the pathogen in 13 species of amphibian at 15 locations in Italy in 2007.

We hand captured individual amphibians and sampled them for *Bd* by rubbing a cotton-tipped swab over the body of each individual. Frogs were held separately prior to swabbing and technicians wore a new pair of gloves for each individual handled. As the frog was restrained, the swab was firmly rubbed back and forth 25 times over the drink patch and was also rubbed over the mouth and webbing between each toe. The swab was

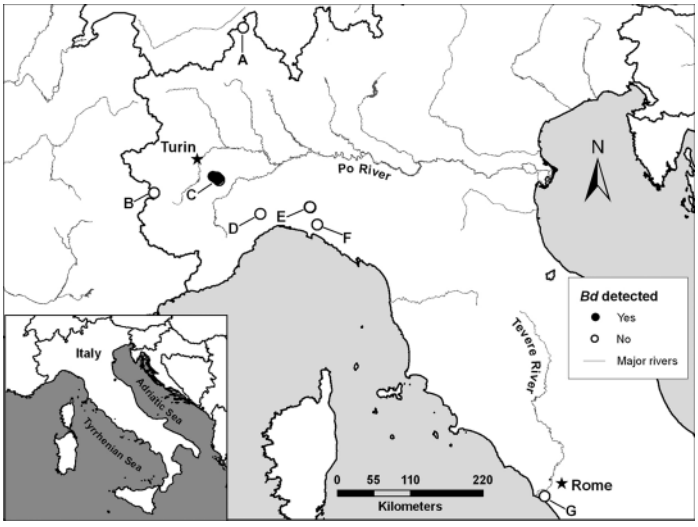


FIG. 1. Location of six study areas (A–G) in northern Italy where we sampled amphibians for the presence of *Batrachochytrium dendrobatidis* in 2007.

immediately inserted, cotton side down, into a 2-mL screw-cap tube containing 1 mL of 70% ethanol and stored upright. Vials were shipped to the laboratory for analysis, and each swab was analyzed individually for the presence of *Bd* DNA using PCR. The PCR assay was based on Annis et al. (2004), but modified to run for 45 cycles. Total DNA was extracted from swab samples using Qiagen DNeasy spin columns, amplified with *Bd*-specific primers targeting the ITS1 and ITS2 regions of the ribosomal DNA locus, and visualized with agarose gel electrophoresis. Samples were scored as negative or positive for *Bd* based on the absence or presence, respectively, of the expected 296 base pair amplicon. Known *Bd* DNA was used as a positive control in all PCR runs (J. Wood, Pisces Molecular, Boulder, CO, USA, pers. comm.). All field gear was cleaned with a brush and water and then sterilized using a dilute bleach solution between each sampling location.

We swabbed 45 amphibians and of these, 4 were positive for *Bd* (Table 1). We found *Bd* on all 3 *Rana catesbeiana* captured in a small farm pond near Turin (Fig. 1, Study Area C). *Rana catesbeiana* is a North America species introduced to Italy more than 50 years ago (Lanza 1962). It is less susceptible to chytridiomycosis-induced mortality than some other species of amphibian and may serve as a reservoir for *Bd* (Daszak et al. 2004; Garner et al. 2006). Out of 41 native amphibians tested, we only found one individual that was positive for *Bd.* The positive individual was 1 of 10 *R. esculenta* tested at 5 ponds in Study Area C. We did not find any frogs that were dead or that appeared to be sick. While only a small haphazard sample, this is the largest survey for *Bd* in Italy reported to date.

TABLE 1. Anurans that tested positive or negative for the presence of *Batrachochytrium dendrobatidis* in Italy in 2007. See Fig. 1 for the locations of the study areas A–G.

Study Area	Latitude	Longitude	Species	Stage	No. negative	No. positive
A	46.319660	8.282630	*Rana temporaria*	adult	2	0
B	44.742830	7.075300	*Rana temporaria*	adult	1	0
B	44.742830	7.075300	*Salamandra lanzai*	adult	3	0
C	44.864000	7.955000	*Bufo bufo*	adult	1	0
C	44.885300	7.921520	*Bufo viridis*	juvenile	1	0
C	44.885300	7.921520	*Rana catesbeiana*	adult	1	0
C	44.901360	7.874620	*Rana catesbeiana*	adult	0	3
C	44.864100	7.956000	*Rana esculenta*	adult	2	0
C	44.868700	7.955700	*Rana esculenta*	adult	1	0
C	44.874920	7.947880	*Rana esculenta*	adult	2	1
C	44.864000	7.955000	*Rana esculenta*	juvenile	1	0
C	44.864100	7.956000	*Rana esculenta*	juvenile	1	0
C	44.868700	7.955700	*Rana esculenta*	juvenile	1	0
C	44.891340	7.924450	*Rana esculenta*	juvenile	1	0
C	44.864100	7.956000	*Triturus carnifex*	adult	1	0
D	44.539290	8.516300	*Rana ridibunda*	adult	2	0
E	44.602730	9.194440	*Rana italica*	adult	2	0
E	44.605420	9.192030	*Rana italica*	juvenile	3	0
E	44.606240	9.187160	*Rana italica*	juvenile	1	0
E	44.602730	9.194440	*Salamandra salamandra*	adult	1	0
E	44.606240	9.187160	*Salamandra salamandra*	adult	1	0
E	44.602730	9.194440	*Speleomantes ambrosii*	adult	2	0
F	44.436440	9.287520	*Bombina pachypus*	adult	5	0
G	41.732778	12.376111	*Rana* kl. *hispanica*	adult	5	0

Acknowledgments.—We complied with all applicable US animal care guidelines. Use of trade names does not constitute endorsement.

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HERPETOLOGICAL HISTORY

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Historical Evidence for the Type Locality of *Sauromalus ater* Duméril, 1856

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The holotype of *Sauromalus ater* (MHNP 813) was collected during a circumnavigational voyage of the French corvette, *La Danaïde*, and presented, without locality, to the Muséum National d'Histoire Naturelle in Paris by Lieutenant M. Jaurès (Brygoo 1989). The lack of a type locality for *S. ater* has remained, ever since, a problem for taxonomists interested in *Sauromalus* (Hollingsworth 1998; Schmidt 1922; Shaw 1945).

Unable to study the holotype due to political conditions in Europe, Shaw (1945) believed he had uncovered clues in the literature as to its provenance. The details in a redescription of the type by Duméril and Bocourt (1870) as well as reference to traces of an interbrachial band mentioned by Mocquard (1899), suggested that the holotype might have originated from one of the islands off the southern gulf coast of the Baja California peninsula. However, Shaw (1945:284) did not restrict the type locality, but stated: "Not definitely known but undoubtedly one of the several islands in the southern part of the Gulf of California where this species is known to occur." Five years later, Smith and Taylor (1950) restricted the type locality to Isla Espíritu Santo without explicit justification (de Queiroz 1995). Perhaps Smith and Taylor (1950) selected this island because it is the largest one close to the port settlement of La Paz.

In Hollingsworth's (1998) systematic revision of the genus *Sauromalus*, he re-evaluated the meristic and color pattern characters of the holotype of *S. ater*, to determine its likely origin. Using a univariate statistical approach, Hollingsworth (1998) ruled out a number of populations as the potential source of the holotype because the holotype's character value fell outside the range limits of each sample. He concluded that the holotype was most similar to individuals from southern Sonora. Hollingsworth's (1998) also used multivariate approaches: a multivariate classification analysis placed the type specimen with the sample from southern Sonora, but using a discriminant function analysis, the holotype fell within the dispersion polygon for Isla San Francisco, adjacent to the boundary for Isla San Marcos, and farther away from the southern Sonora sample. Hollingsworth (1998) considered that the weight of the evidence supported the conclusion that southern Sonora was the likely origin of the holotype and he restricted the type locality to somewhere between Guaymas northward to the southern extent of the Llanuras de San Juan Bautista at Estero de Tastiota.

Montanucci (2000) reviewed Hollingsworth's (1998) methods for determining the type locality of *Sauromalus ater*, citing the problem of small sample sizes of the reference samples, the

intrinsic weakness of the univariate approach, and contradictions in the results of the multivariate analyses (see Montanucci 2000 for further discussion). Montanucci (2000) determined, using prediction intervals (Hahn and Meeker 1991), that most insular and southern coastal mainland sites dismissed by Hollingsworth (1998) could not be ruled out as the source of the holotype. He therefore argued that Hollingsworth (1998) had not conclusively demonstrated that southern Sonora was the type locality to the exclusion of the southern Baja California peninsula or adjacent gulf islands. Montanucci (2000) acknowledged that southern Sonora was a possible source for the holotype, but that without additional evidence, the question of the type locality remained unsettled.

Historical information has now come to light that provides convincing evidence as to the provenance of the holotype of *Sauromalus ater*. In 1945, noted historian Abraham P. Nasatir published a volume entitled *French Activities in California: an Archival Calendar-Guide.* According to Nasatir (1945), historians familiar with California history were well aware that in the mid-1800s the Pacific Region was an area of rivalry for power and influence by several nations including England, Russia, Spain, and the United States. What was not generally appreciated was the extent of the role played by France in this ongoing rivalry. In the preface of his book, Nasatir (1945) states that in 1924 he was awarded a traveling fellowship by the Sons of the Golden West to examine and catalog documents pertaining to the activities of France in California prior to statehood. He spent four months in 1924, and one month in 1925, working in the libraries and archives of Paris, and discovered an "immense amount of material" pertaining to California.

In the Ministry of Foreign Affairs, Nasatir studied the series "Correspondence Politique" containing letters between French officials and those of several other nations including États-Unis and Mexique. He also worked in the Archives du Service Hydrographique de la Marine, which contained reports of voyages, logbooks, and inventories. Relevant maps were stored in the Bibliotheque du Dépot des Cartes et Plans located in an adjacent building. Among the letters, manuscripts, reports, and maps listed by Nasatir (1945), I noted several that are relevant to the circumnavigational voyage (1839–42) of the French corvette *La Danaïde* under the command of Joseph de Rosamel. In early 1840, *La Danaïde* reached the west coast of México where it conducted nautical and hydrographic investigations, much to the dismay of Mexican officials. A letter dated 18 May 1840, from M. Baron Alleye de Cyprey, French Ambassador to México, to Maréchal Duc de Dalmatie, French Foreign Minister, states that His Majesty's corvette *La Danaïde* has raised the suspicions and fears of Mexican authorities by its work on that coast. De Cyprey further mentions that on the previous day, he received a note from M. de Cañedo, Mexican Minister of Foreign Relations, demanding an explanation for the activities of the corvette and expressing his astonishment that the ship is taking the liberty of charting the coasts of México without previously having obtained permission.

A 10.5-page manuscript entitled "á bord *La Danaïde*" listed in Nasatir (1945:313) includes a table of latitudes and longitudes, and observations and notes made at many places including the west coast of México, Lower California (Cabo San Lucas), Upper California (Monterey), as well as localities visited after the ship left the Pacific Coast area (e.g., Honolulu, Manila). Information about the ship's itinerary was found in the "Extrait du Journal de navigation de *La Danaïde* par de Rosamel." For Mexican localities where the ship anchored, it lists Acapulco, San Blas, Mazatlán, and Guaymas (Nasatir 1945:313). These records indicate that with the exception of Guaymas, Sonora, none of the localities known to be inhabited by *Sauromalus ater* was visited by *La Danaïde*.

The ship dropped anchor in the Bay of Guaymas during March of 1840, and two of the ship's men, Fisquet (sub-lieutenant of the vessel) and Garnault (a naval cadet), conducted a detailed survey to map the bay and its vicinity. Nasatir (1945:338) lists the Guaymas map under Portefeuille 171 bis, Division Number 6, as follows: No. 18 "Plan de la Rade de Guaymas et ses Environs, Levée en Mars, 1840 by M. Fisquet, Enseigne de Vaisseau." MS. Original "Voyage of *La Danaïde*" [Rosamel, rubric, — in Volume II of "Documents of *La Danaïde*."]. Rosamel et al. (2005:23) provide a general itinerary for *La Danaïde* and indicate the date of arrival at Guaymas as 14 March 1840. Although Nasatir (1945) lists only Fisquet for the preparation of the map of the Guaymas area, other sources (e.g., Orozco y Berra 1871; Uricoechea 1860) credit the naval cadet Garnault as well.

On the basis of official correspondence as well as the abbreviated contents of manuscripts and other documents (e.g., maps) listed by Nasatir (1945), it can be inferred that the French were very interested in charting the west coast of mainland México, probably for strategic reasons. However, the peninsula of Lower California was apparently of little or no concern to the French at that time. There is no record of *La Danaïde* having visited any of the islands in the Gulf of California or the port settlement of La Paz. The only peninsular locality listed is Cabo San Lucas (see below). The itinerary depicted by Rosamel et al. (2005:23) shows that *La Danaïde*, after reaching and then departing Guaymas, backtracked southward along the Sonoran coast to Mazatlán.

According to Shepard (1958), *La Danaïde* was stationed at Mazatlán from 19 April to 7 May 1840. While there and preparing to set sail for the Sandwich Islands (Hawaiian Islands), de Rosamel was informed by the crew of a schooner arriving from Santa Barbara that two Frenchmen had been killed and several others wounded during an incident (later known to historians as the "Graham Affair") at Monterey, the capital of Upper California. The governor of Upper California, Don Juan Bautista Alvarado, fearing a plot to seize control of the country, had ordered the general arrest of all foreigners, including 47 alleged conspirators (Americans and Englishmen among them), led by Isaac Graham from Tennessee. With news of this incident, de Rosamel decided to set sail immediately for Monterey to ascertain the veracity of this report, and if necessary, to avenge the deaths and protect any remaining compatriots. It can be inferred that while en route to Monterey, *La Danaïde* anchored at Cabo San Lucas, but spent little time there due to the urgency of the matter. Alternatively, the cape area could have been visited earlier while the vessel was charting the west coast of México, but this seems less likely as it would have diverted the ship away from its northward route along the coast.

According to Shepard (1985), de Rosamel arrived in the Bay of Monterey on 11 June 1840; the French corvette trained its cannons

on the capital and was prepared to reduce the small settlement to "a pile of adobe dust and splinters." But through discussions with local customs officials and a handful of French residents, de Rosamel quickly learned that the report of deaths and injuries to French citizens was erroneous. De Rosamel remained in Monterey for nearly a month to establish amicable relations with the residents and provision his vessel. On 8 July 1840, he drafted letters to Governor Alvarado and Baron de Cyprey recounting the circumstances of his visit to Monterey as well as related matters (Nasatir 1945:154–157). The following day (9 July 1840) de Rosamel set sail for Honolulu (Shepard 1985).

On the basis of the aforementioned information, it is clear that de Rosamel had an interest in charting the west coast of mainland México. The extended reconnaissance of the Bay of Guaymas and its vicinity by the officers and crew of *La Danaïde* provided the opportunity to collect *Sauromalus ater*. As indicated previously, no other localities occupied by this species are listed among the ports visited by the French vessel. It is my conclusion that the type specimen of *Sauromalus ater* was collected near Guaymas, and I therefore further restrict the type locality to the vicinity of Guaymas Bay, with the date of collection being sometime in mid-March 1840.

The classification analysis based on meristic data of the holotype of *Sauromalus ater* (Hollingsworth 1998) and the historical record presented here support the type locality restriction by Hollingsworth (1998) and its further restriction here. The specific epithet *ater* can now be assigned to the continental chuckwalla populations with confidence, thereby negating the need to designate a neotype with an arbitrary type locality. With regard to future research directions, it is not clear that all continental and insular populations are conspecific (see Petren and Case 2002). Molecular genetic studies should focus on the populations from the Baja California peninsula (Vizcaíno region southward), and the southern gulf islands to reassess their taxonomic status.

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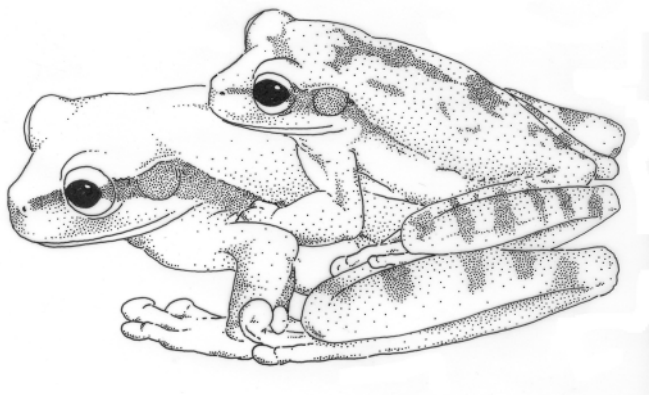
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Smillisca phaeota (Hylidae). Locality: Vereda El Danubio, Región de Anchicayá, Valle del Cauca, Colombia. Illustration by Fernando Vargas Salinas.

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Catalogue of American Amphibians and Reptiles: The Beginnings

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Early in 1960 several people came together in my office at the American Museum of Natural History and discussed what we thought of as an impending crisis. An amateur herpetologist had announced his intention to publish an updated version of Karl P. Schmidt's 1953 Check List of North American Amphibians and Reptiles, Sixth Edition. My feeling was that the proposal would be unlikely to yield a publication of high quality. Also, I had serious concerns about the form and content of any new checklist. The others present shared my concerns to a greater or lesser extent: Herndon G. Dowling (New York Zoological Society), William J. Riemer (University of Florida), and Philip W. Smith (Illinois Natural History Survey) were there, and possibly James Anderson (Rutgers University) and others whom I cannot now recall.

The Schmidt (1953) checklist had much the same format as the Fifth Edition (Stejneger and Barbour 1943), but with significant additions. Accounts of genera included synonymies more inclusive than in the earlier checklists, species and subspecies accounts (rather than species alone) each comprised of a brief synonymy with type localities incorporated, a generalized statement of range, and a "Common Name." Apart from some broad references cited in an opening section, bibliographic information was restricted to abbreviated citations in the synonymies.

The Schmidt checklist was a personal and idiosyncratic document. He stated (1953:2) "when [type localities] are vague, I have restricted them." He dropped the second *i* of *ii* endings in species names, or substituted *ei*. Most inconvenient for subsequent taxonomists, he introduced 29 new name combinations "[New comb.]," throughout the publication without explanation and without a means for the reader to find them other than by searching through the checklist. He dropped the convention of "enclosing the names of the authors of specific (trivial) names in parentheses when these names have been transferred from one generic combination to another" (1953:4). Apart from these technical matters, the range statements were often quite vague and occasionally erroneous, even given the state of knowledge when the manuscript was written.

It was apparent (at least to most of us) that a new single-authored checklist would suffer from many of the deficiencies of the Sixth Edition, even allowing for more input from other herpetologists than had that edition. Multiple authorship had potential advantages, but these might be more than offset by communication and editorial complications that could increase exponentially with the number of authors. Also of concern was the "engraved-in-stone" aspect of a hard-bound volume revised only every decade or so.

A possible solution that occurred to me was to publish a checklist incrementally in the form of individual accounts that could be assembled by the subscribers in a loose-leaf fashion. Among the many potential advantages were diversity of authorship, space to expand the sorts of information that had been restricted to a few lines of text in the earlier checklists, and room to add categories of information not previously covered. The loose-leaf format would have the additional virtue of permitting revisions of individual accounts without awaiting the production of an entirely new checklist. The suggestion was favorably received.

At the June 1960 annual meeting of the American Society of Ichthyologists and Herpetologists, I recommended to the Board of Governors that the Society consider replacing the hardbound, single-author checklist with a loose-leaf edition (Anon. 1960:393). President Norman Hartweg appointed a Committee "to investigate the desirability of issuing a new checklist of North American amphibians and reptiles." He instructed the Committee "to ascertain the support of the Society membership; to suggest the scope, content, and format of a new edition, if such is deemed desirable; and to determine the most economically feasible manner of producing a new checklist" (Anon. 1960:393). Subsequently, "Dr. Philip W. Smith presented a summary of comments from herpetologists on a proposed seventh edition of the check list of North American amphibians and reptiles. There were numerous opinions, but the consensus was that preparation should be made of a seventh edition or that a supplement, to be called a seventh edition, be made to the current sixth edition." "[Subsequent to the meetings, President Hartweg appointed the following persons to serve as a Committee on a North American herpetological checklist: Philip W. Smith, Chairman, Herndon G. Dowling, Alan E. Leviton, William J. Riemer, Hobart M. Smith, and Richard G. Zweifel]" (Conant 1960:398).

Hence, we began designing a format for the individual accounts, keeping in mind the need to expand upon both the categories in the Checklist's accounts and the variety of information provided. We decided that a typical species account should have the following eight sections: 1) Synonymy (incorporating type locality, catalog number of type specimen, deposition site, collector, and date of collection; 2) Content (names of subspecific taxa recognized); 3) Definition (descriptive statements characterizing the taxon); 4) Descriptions (citations to significant morphological descriptions); 5) Illustrations (citations to selected references with illustrations; 6) Distribution (a statement more detailed than the generalized ones in earlier checklists, always accompanied by a map with individual localities plotted); 7) Pertinent Literature (citations to sources of information not covered elsewhere in the account; 8) Etymology (derivation of the scientific name); and, of course, 9) Literature Cited. If subspecies were recognized, each would have a synonymy, definition, and (if needed) a Remarks paragraph. Wherever possible, accounts of anuran taxa would include an audiospectrogram. This format could be adapted as needed for accounts treating higher categories. A strict condition to be imposed on authors would be that no novel taxonomic conclusions could be advanced in an account. Where controversy existed, however, this should be recognized and documented.

We realized that such a publication would not be a checklist in the usual sense, but a catalog. The catalog would be made available by subscription in the hope that this would provide income to support the project. Initially a grant would be needed

as seed money. (The need for checklists of the less inclusive sort would eventually be filled by publications from the Society for the Study of Amphibians and Reptiles, The Herpetologists' League, and other organizations.)

At the April 1961 annual meeting of the ASIH a sample species account (marked "NOT PUBLISHED" to avoid future bibliographic complications) was distributed to the attendees for their comments, acting on President Hartweg's charge to the Committee in 1960. At this meeting, "The Committee of the Herpetological Check List, William Riemer, Chairman, received permission from the Board of Governors to proceed with plans for the check list, and was authorized to submit a proposal to the National Science Foundation for financing the check list on a three-year basis" (Anon. 1961:511). In addition to William J. Riemer being appointed Chairman, Wilfred T. Neill was added to the Committee.

Committee Chairman William Riemer was the person most responsible for getting the project moving. From his base at the University of Florida, he wrote the grant proposal to the National Science Foundation, and at the June 1962 ASIH meeting, "President Conant announced that the National Science Foundation had approved a two-year grant to the society, designated for the purposes of publication of the Herpetological Catalogue" (Peters 1962:868).

The first six Catalogue accounts were published in December 1963, followed by eight in September 1964, and eight in October 1965—all edited by Riemer. At the June 1966 ASIH annual meeting he reported that 8 accounts were in press, 12 at the printers, 34 being edited or reviewed, and 80 in preparation by authors. Clearly, the tasks involved in preparing manuscripts for the printer had become too varied and time-consuming to be done efficiently by one editor. In order to spread the work load, Richard Zweifel and James D. Anderson were appointed as Section Editors for Salientia and Caudata, respectively. The Section Editors would be responsible for editing manuscripts in their respective fields, leaving the Editor to see the accepted manuscripts through the press and distribution stages. These three edited 81 of the first 100 accounts. As the need developed in subsequent years, additional Section Editors were appointed and in later years editorial functions were further dispersed.

At the 1968 ASIH annual meeting Herndon Dowling, Chairman of the Herpetological Catalogue Committee, reported that the NSF grant supporting the Catalogue project was due to expire and that an extension of the grant period had been applied for. The extension was granted to 1970 but without additional funding. With about 600 subscribers by 1969 and 74 accounts published, the Catalogue was still not self-supporting. Although the ASIH Board of Governors was complimentary about the Catalogue project—"The Committee was highly commended for the work they have done on the Catalogue and were urged to continue this excellent project," (Highton 1970:799)—they declined to devote ASIH funds to its continuance.

Fortunately, the younger and more far-sighted board of the Society for the Study of Amphibians and Reptiles was willing to take a chance. "In 1970, the editors of the *Catalogue of American Amphibians and Reptiles* voted unanimously to request transfer to SSAR sponsorship from that of the American Society of Ichthyologists and Herpetologists which had supported the Catalogue since its beginning in 1963. That transfer was effected in 1971." (Moriarty and Bartholomew 2007:6).

William Riemer, who contributed so much to the establishment of the Catalogue, resigned his membership on the Catalogue Committee in 1969 and left the University of Florida for a position with the National Science Foundation in Washington. At that time Herndon Dowling became General Editor of the Catalogue and the editorial offices moved to the American Museum of Natural History, where his NSF-supported bibliographic project was quartered.[1] This project, however, was unable to become self-supporting and was terminated by the NSF in 1972 (Myers 2000:168). In 1974, I became General Editor of the Catalogue, while also keeping my position as Section Editor for Salientia. I continued as General Editor until 1981 and as Section Editor until 1986 when I resigned with retirement on the horizon.

The Catalogue has continued to grow and prosper. The inclusion of "American" in the name was not done lightly but implied an intention of including all the Americas, indeed the entire Western Hemisphere, in its scope; this intention has been realized. The penny-pinching days of trying to restrict as many accounts as possible to a single sheet have given way to more liberal funding, allowing multi-paged accounts, often with color illustrations. The Catalogue has become the "first stop" for anyone seeking information on the species and genera covered, with 840 accounts published by 2007. Itzchak Gilboa compiled a list (not published) of references cited in the first 400 accounts (through 1986), with no titles duplicated. I estimate that this list includes nearly 15,000 references.

Acknowledgments.—Kraig Adler, Charles W. Myers, and Itzchak Gilboa helped greatly in the preparation of this manuscript. Last but certainly not least, I thank my wife, Frances Zweifel, for her heroic efforts over 23 years (1963–1986) in producing all the more than 400 maps published from the very first account up to the time of our mutual retirement.

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[1]Variously called "The Genera of Reptiles and Amphibians," "Bibliographic Service in Herpetology," and "Herpetological Search Systems (HISS)."

HERPETOLOGICAL HUSBANDRY

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Positive Reinforcement Training of Aldabra Tortoises (*Geochelone gigantea*) at Zoo Atlanta

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In an effort to improve the care and management of exotic animals there has been an increased interest in applying training in captive animal facilities. The training of captive animals has many advantages and has recently become more widespread. In one survey, 139 AZA accredited institutions reported performing at least some training with their animals (Good 2000). Additionally, most institutions that had formal training plans had formed them within the 15 years prior to the Good study.

Reinforcement training has been used successfully in captive animal facilities with such diverse groups as hoofstock (Phillips et al. 1998), marine mammals (Anderson et al. 2003), birds (Martin 2007) and even fish (Losey and Margule 1974). Despite the diversity of taxa in which these techniques have been found to be successful, the majority of published, objective training reports are focused on nonhuman primates (i.e. Laule et al. 2003; Prescott and Buchanan-Smith 2003; Schapiro et al. 2003). Conversely, reptiles, though capable of learning tasks, as shown in the basic learning literature (for a review see Burghardt 1977), are rarely the subject of published, applied learning accounts (for an exception see Weiss and Wilson 2003).

Training has been used to deal with various issues that arise with the management and display of captive exotic animals. Positive reinforcement training has been used successfully to increase animal activity (Myers 1977), facilitate breeding (Colahan and Breder 2003), decrease aggression (Bloomsmith et al. 1994), and even to elicit novel behaviors (Pryor et al. 1969). More commonly, animals have been trained to comply with basic husbandry and veterinary procedures (Basset et al. 2003; Laule et al. 2003). Some basic behaviors include "targeting" (the animal touches a target in response to a verbal cue), "shifting" from one place to another and "holding".

Training for these purposes has proven advantageous in several ways. For example, compliance training can decrease the stress of a procedure. In a study by Phillips et al. (1998) two groups of Bongo (*Tragelaphus eurycerus*) were subjected to a veterinary procedure. The group of Bongo that had been crate trained showed lower cortisol levels than the Bongos that were physically restrained for the procedure. Additionally, training can allow for other, more invasive, veterinary procedures to be performed without chemical or physical immobilization (Weiss and Wilson 2003). Positive reinforcement training may be particularly important in large and/or skittish animals (Pryor 1995). Training an animal to comply with a procedure in response to a cue rather than physically forcing it to comply prevents stress and possible injury for both keeper and animal.

The two main objectives for this project were to maintain a behavior that had previously been trained "target" and to train a new behavior of "hold" in a group of Aldabra Tortoises (*Geochelone gigantea*). "Target" is defined as having the animal touch a target stick, often a rod with a ball on the end of it, with their nose. "Hold" is defined as having the animal follow the target stick onto a platform and stand there without shifting their weight for 30 seconds. Targeting training officially started a year prior to this project for the purpose of facilitating moving the tortoises between sections of their exhibit. Problems occurred when staff attempted to weigh the tortoises. The "target" behavior, that had been used successfully to move tortoises between parts of the exhibit, failed in this new context. The target was used to try and guide the tortoises onto the weighing platform but this met with limited success. One animal refused to participate, one was spooked by the platform and had to be manually lifted onto it, and two would walk over the platform but not stop on it correctly. Only one tortoise successfully stepped on the platform and held long enough to get an accurate weight. Weighing these animals without their cooperation is particularly difficult because not only they are hard to move physically (as they often weigh hundreds of pounds), but trying to coerce them to move can be hazardous (animal care staff have been injured in the past). By specifically training a "hold" behavior, it was hoped accurate weights could be safely, quickly, and reliably obtained for all five tortoises.

Materials and Methods.—Subjects were two male and three female Aldabra Tortoises (*Geochelone gigantea*) housed at Zoo Atlanta. The two males each weigh ca. 136 kg and the three females ca. 91 kg each. Exact ages of the tortoises are unknown but they are all estimated to be over 50 yrs old. The tortoise exhibit consists of two outside yards and a heated indoor solarium.

Target sticks consisted of a dowel (1.07 m long, 6.4 mm diameter) attached to a blue-and-white pool float. The blue-and-white float was chosen as a target because it was too large to be swallowed by the tortoises. Additionally, blue and white are colors not typically associated with tortoise food items. Times were recorded with a stopwatch, and a thermometer was used to track the temperature during training sessions. The scale platform used for the weighing was a 1.2 × 1.2 m piece of wood which was 8.9 cm thick. Primary reinforcers used were mostly sticks of carrot and sweet potato, but also included melon and banana. Carrot and sweet potato sticks were used most often because they would not stick to debris, could be easily administered, and the tortoises responded well to orange-colored food. Orange was a salient color for these subjects. This was illustrated by the tortoises' repeated interest in orange colored items (e.g., colorful shoelaces) no matter how many times they encountered them and found them inedible. Although this species has not been tested for color vision, reports on related taxa show that color vision is likely (Liebman and Grada 1971; Ohtsuka 1985).

Design and Procedure.—Training sessions were held two or three times a week for three months. Sessions were ca. 45 min. in duration, and occurred at either 1400 or 1600 h. Training was

held indoors unless weather permitted the tortoises to be outside. Although the entire session was 45 min., each animal was worked with individually for only 5–10 min. Animals that were not being worked with individually had the behavior of "not interfering" reinforced. In this context, this consisted of placing food items that took longer for the animals to process (e.g., lettuces) at the edges of the exhibit. Thus, while the other tortoises were engaged with eating the freely available low preference items an individual could be worked with using the higher preference training food items.

Training was conducted by DB while observations and times were recorded by DEG. Training consisted of maintaining the "target" behavior and shaping the behavior of "hold." A clicker was used as a bridging stimulus during the training sessions; the clicker had been established as a secondary reinforcer prior to the initial target training. Training was initiated by placing the target in the subjects view and giving a verbal command in the form of "animal's name, command." Targeting was reinforced on a variable ratio schedule with an average ratio of two (VR2), meaning the behavior of targeting was reinforced after a random number, averaging two and with a range of one to three, of successful targets. Holding was reinforced for each successful hold of 30 seconds. The clicker was used when an animal successfully targeted or intermittently during the hold behavior.

Food items used for training were not part of the tortoises' general diet; they were only given in the context of training. The tortoises were fed daily, although in an attempt to keep motivational levels constant the tortoises were generally not fed until after the training session had ended. All food items not used during training were given out after the session was completed.

Scoring.—Hold times were measured from the moment when the subject first touched the target stick until it shifted its weight.

Results.—The criterion for successful training of the "hold" behavior was set at four consecutive successful holds of 30 seconds each. All five subjects achieved criterion within 25 trials with a mean of 15.8 (Fig. 1). At the end of the study, a mock weighing session was conducted. This procedure consisted of having the subjects step on the scale platform and hold there, without shifting their weight, for 30 seconds. The scale platform was novel to the tortoises when the weighing took place. Four of the subjects were successfully mock-weighed on a scale platform. The remaining subject, M2, was unavailable because of illness that caused him to cease eating and responding to the trainer. Before this project had taken place only one tortoise had been weighed successfully using a similar procedure.

Discussion.—This study demonstrates the practicality of training tortoises in compliance behaviors. All subjects were successfully trained to hold in a relatively short period of time (less than three months with only 10–30 min. a week of training per animal). The rapidity of the training was probably most attributable to the fact that the subjects had been target trained for the previous year.

These results may support the hypothesis that training of new behaviors can proceed more rapidly if the subject has had experience with training previously (Pryor 1999). Although these tortoises initially took months before even approaching the target, much less reacting to it appropriately (unpubl. data), shaping the target behavior into a 30-second hold was accomplished in a much shorter period of time. The concept of "learning to learn" is a well established one (Harlow 1949). However, to conclusively support this idea, a similar set of subjects who are naïve to training would need to be trained on the "hold" behavior. It is also important to note that other variables such as trainer experience, the animal's history and even temperature (especially for reptiles) can affect training results (Krekorian et al. 1968; Pryor 1999). However, institutions might consider training animals in the collection on at least one basic behavior, if not just for current purposes, but to possibly facilitate training of new behaviors in the future.

Additionally, it may be important to train flexibility into new behaviors. Problems with weighing these animals stemmed from the static way in which the target stick had been used in past training. Prior to this study, while target training, the keeper was always moving with the target stick (pers. obs.). Additionally, the target had only been presented at a height of about 7–8 cm off the ground. Thus, the tortoises had a reinforcement history only at one height and would not respond if target was held in any other position. Accordingly, the tortoises had acquired a fixed response of moving towards the target only when it was held at that height. They would not respond when the target was higher or lower and they would continue walking even if they had already encountered the target (they would push through the target instead of stopping). During this study, varying the height at which the target was presented and reinforcing the tortoises only for contacting the target, not walking through it, helped overcome these issues.

Reptiles can learn and this has implications in both applied and pure research areas. In the applied field, training can prove helpful in areas of animal husbandry (Laule et al. 2003). Animals can be trained to endure veterinary procedures without potentially harmful physical restraint or the risks associated with chemical immobilization. Additionally, they can be trained to shift from one part of the enclosure to another, facilitating cleaning of the exhibit as well as isolating the animal should a potentially threatening situation arise. Resistance to the idea of training reptiles may exist due to misconceptions of the time required to train a reptile to a useful task. However, training in turtles and lizards, given daily sessions, can be accomplished in only a matter of weeks (Ishida and Papini 1997; pers. obs.). The current results further support the hypothesis of the feasibility of training reptiles.

In addition to teaching captive animals useful behaviors, the application of positive reinforcement training techniques may provide other, broader benefits for these animals (Laule 1992). Training can also be considered a form of environmental enrichment (Laule 2003). Environmental enrichment can be defined as attempting to increase the mental and physical well-being of a captive animal. Training accomplishes this aim by allowing the animal to have a choice in their daily routine. At the very least, the animal can choose whether or not to participate in the training. Having such a choice may be good for captive animals, improving physical, and potentially psychological, health (Coe 1995; Mineka et al. 1986). Therefore, training animals presents an opportunity to increase an animal's well-being while making physical examination of its condition by staff much easier.

Training may have several other benefits. Positive reinforcement training may improve keeper-animal relationships and allow the animals to experience extra stimulation beyond that provided in

an otherwise highly static environment. Additionally, they have the opportunity to work for food, which may have benefits for animals as well by increasing a captive animal's opportunities for choice and stimulation through interaction (Laule and Desmond 1998). Training may also function as an indicator of general health, or expose health issues which may not otherwise be obvious. Markowitz et al. (1978) describe one such example where a Serval (an African cat), which had been trained to leap to obtain food, suddenly stopped responding. Upon physical examination, it was found that the Serval had developed a hernia, which in other circumstances might have gone undiagnosed. In the current study, subject M2 stopped responding to training sessions prior to the mock weighing. Later, the subject was diagnosed with a bleeding gastric ulcer.

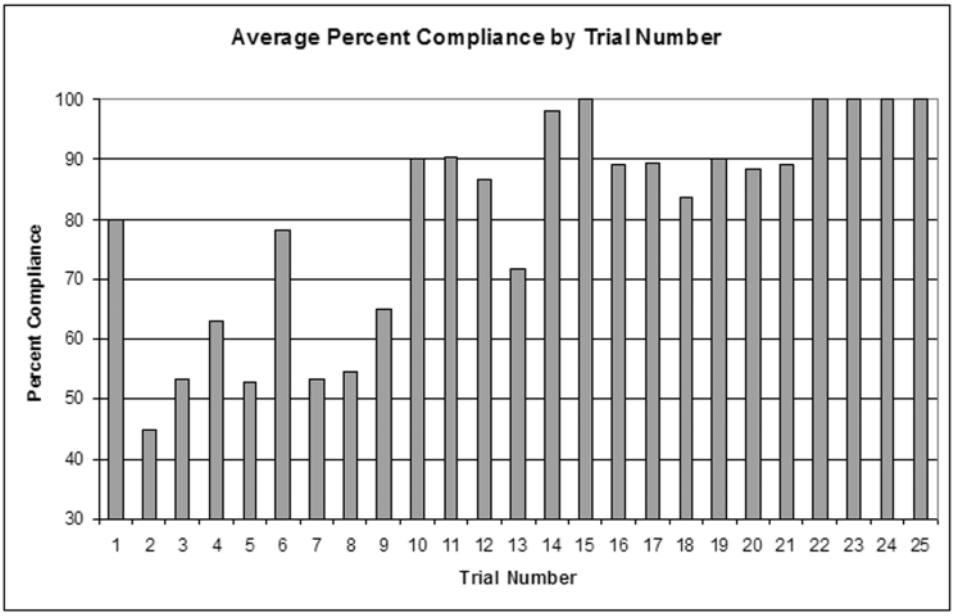


FIG. 1. Percent compliance with "hold" command averaged across five tortoises by trial number.

Another possible benefit of training concerns interactions between zoo staff and zoo visitors. Anderson et al. (2003) found that public animal training had several benefits. Visitors, after experiencing the public training, stayed at the exhibit longer and expressed more positive views on their zoo experiences when compared to visitors who only passively viewed the exhibit. In the current study, training sessions were often held during keeper talks where zoo visitors are encouraged to ask the keeper questions about the tortoises. This gave the keeper a chance to educate the public about positive reinforcement techniques, and their application in the zoo, while demonstrating those concepts first hand.

Having animals trained in basic husbandry behaviors can also be beneficial for research. For example, animals can be trained to voluntarily comply with blood draws, which can facilitate tracking hormones such as cortisol in blood levels (Phillips et al. 1998). Additionally, researchers can shape previously learned behaviors to facilitate behavioral testing. Kelling et al. (2006) shaped a previously trained "present paw" behavior into a "push" behavior that allowed for the behavioral testing of color vision in Giant Pandas (*Ailuropoda melanoleuca*). While many of these possible benefits described above are untested, if even some are actually beneficial, training should be considered as a valuable tool in captive animal management.

Although many examples of training have been published, rarely are they reported in a way that would allow for useful comparison. Several recent publications have noted this deficiency (Schapiro et al. 2003; Young 2002). These studies called for quantitative reports on both training and the effect of training, including details about the individual animals as well as the trainers and the training sessions. Although knowing that it is possible to train a particular species to perform a certain behavior is useful knowledge, details about the time required to implement a specific training protocol are essential to allow animal staff to determine the feasibility and utility of such a course of action. This report has included this information in an attempt to facilitate future comparisons. Additionally this report can serve as a guide to other facilities in how they might begin implementing training programs for their reptiles.

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NATURAL HISTORY NOTES

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CAUDATA — SALAMANDERS

EURYCEA LONGICAUDA MELANOPLEURA (Dark-sided Salamander). **COLOR ABERRATION**. On 8 Sept 1999 during a rainstorm, a single female *Eurycea longicauda melanopleura* displaying an unusual color pattern was collected along with two normally patterned male individuals, 10 normal *Plethodon albagula* and two normal *Hyla cinerea* as they crossed the access road to the Mammoth Spring State Fish Hatchery 5 km S of Mammoth Spring, Fulton Co., Arkansas. The percent of aberrant pattern was determined by cutting the animal out of the photograph (Fig. 1) then cutting the patterned and unpatterned portions apart. The clippings were weighed separately on an analytical balance and the percent distributions determined. The same procedure was performed with a normally patterned individual for comparison. The colors present were the usual black speckling with yellow background. The normally patterned individual was unpatterned on 11.9% of its body, being patterned on 88.5% of its body (total = 100.4%, there was a 0.4% error in weighing). The aberrant individual was 45.9% unpatterned and 54% patterned (total = 99.9%, there was a 0.1% error in weighing). The aberrant salamander had 35.4% less patterning than the normal individual. This cause of this color aberration is unknown. Observations such as this further solidify the importance of using an array of diagnostic characteristics in addition to color and patterning whenever possible to identify species and/or subspecies. The specimen was deposited in the Arkansas State University Museum of Zoology herpetological collection (ASUMZ 23406).



FIG. 1. Aberrant color pattern in a female *Eurycea longicauda melanopleura* from Fulton County, Arkansas, USA. Photograph by Stan Trauth.

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PLETHODON DORSALIS (Northern Zigzag Salamander). **REPRODUCTION**. Few accounts of the nesting activity of *P. dorsalis* exist and are limited to those of Mohr (1952. Natl. Speleol. Soc. Bull. 14:59–60) and Miller et al. (1998. Herpetol. Rev. 29:38–39). Mohr (1952, *op. cit.*) reported 12 nests during three visits over a nine-year period to Mammoth Onyx Cave in Kentucky. All nests were observed in small cavities associated with fluted cave formations 1.5 m above the cave floor. Miller et al. (1998, *op. cit.*) found seven nests in a cave within the Central Basin of Rutherford County, Tennessee. Unlike the report of Mohr (1952, *op. cit.*), these nests were found in a series of fissures in the clay floor and not within cavities in the cave wall proper. Nests in both reports were found during the summer from 29 June to 02 August. Here, we report a nest of the Northern Zigzag Salamander found in a cave located in the Western Highland Rim of Tennessee.

An aggregation of *P. dorsalis* was found on 22 July 2006 in association with a series of fissures and crevices in the limestone wall of Cave Branch Cave (Tennessee Cave Survey No. HI3) located in Hickman County, Tennessee. The aggregation consisted of at least 23 adults dispersed within the fissures and crevices and exposed on rock faces ca. 30.5 m from the cave entrance and past the twilight zone. A single female (89 mm SVL) was found in attendance of a lone egg within a cavity behind a loose rock in this area ca. 75 cm above the clay/mud floor (Fig. 1). The ca. 4–5 mm egg was attached via the outer envelope to the floor of the cavity and the developing embryo lacked pigmentation and a tail bud indicating that oviposition occurred recently. Seven smaller adults including two males were in the immediate vicinity of the nest. The female and egg were transported to the laboratory to monitor development; however, the egg succumbed to a fungal infection eight days later.

Our observation supports the claims that females move underground in late spring or early summer to nest (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn Univ. 347 pp.; Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, DC. 587 pp.). Although clutch size is reportedly small in *P. dorsalis*, ranging from 2–5 eggs in Kentucky (Mohr 1952, *op. cit.*) and 4–7 eggs in Tennessee (Miller et al. 1998, *op. cit.*), the single egg clutch reported here is unusually small. Enlarged ova were not visible through the abdomen of the attending female suggesting that all ova had been laid at the time of observation. If the clutch initially contained additional eggs, these eggs either succumbed to predation or infection.



FIG. 1. A female (89 mm SVL) *Plethodon dorsalis* in attendance of a lone egg within a cavity behind a loose rock in the wall of Cave Branch Cave, Hickman Co., Tennessee, USA.

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PLETHODON NETTINGI (Cheat Mountain Salamander). **HABITAT USE AND OVIPOSITION**. *Plethodon nettingi* is a federally threatened species endemic to high-elevation forests in the Allegheny Mountains of eastern West Virginia (Green and Pauley 1987. Amphibians and Reptiles in West Virginia. Univ. Pittsburgh Press, Pittsburgh, Pennsylvania. 241 pp.). Existing roads and trails are believed to serve as barriers to salamander movements and may fragment existing populations (USFWS 1991. Cheat Mountain Salamander Recovery Plan. U.S. Fish and Wildlife Service, Newton Corner, Massachusetts. 35 pp.). Presumably the microclimatic, vegetation, and structural characteristics that occur in and adjacent to trails during creation and maintenance (e.g., reduced overhead canopy and ground cover, higher soil temperatures) create unsuitable conditions for *P. nettingi* and other woodland salamanders. Moreover, individuals moving across trails are subject to disturbance from foot and mountain bike traffic. Therefore, management guidelines in the species recovery plan (USFWS, *op. cit.*) include the "establishment of a buffer zone of at least 300 feet around known *P. nettingi* populations within which trees and other vegetation should not be removed," and/or "re-routing of trails or other barriers to go around rather than through known populations."

On 9 June 2006 we observed a single *P. nettingi* under a small rock in the middle of the Railroad Grade Trail within the Monongahela National Forest near Davis, Tucker County, West Virginia, USA (39.0656ºN, 79.5239ºW; NAD 83). Similarly, on 10 June 2006 we observed a single *P. nettingi* under a rock in the middle of the Pointy Knob Trail, also within the Monongahela National Forest near Davis, (39.0364ºN, 79.4894ºW; NAD83). On the same trail, ca. 30 m away, we observed another *P. nettingi* in the middle of the trail attending 7 eggs (mean diameter 4.3 mm) attached to the underside of a small rock. At all locations, trail width was ca. 1–2 m and consisted of abundant small surficial rocks along with leaf litter, small woody debris, and moss/lichen. Dominant overstory vegetation included American Beech (*Fagus grandifolia*), Eastern Hemlock (*Tsuga canadensis*), Yellow Birch (*Betula alleghaniensis*), and Red Maple (*Acer rubrum*). Rosebay Rhododendron (*Rhododendron maximum*) and Red Spruce (*Picea rubens*) were present in the understory. Canopy closure at all sites was >75%. Our observations are significant as they document not only the presence of three *P. nettingi* on recreational trails used for a variety of purposes (e.g., hiking, mountain biking, skiing), but also the use of surface rock on a recreational trail as an

oviposition site. Our observations suggest that recreational trails may not necessarily inhibit movements by *P. nettingi*, and in fact may serve as suitable habitat when abundant cover objects (e.g., small rocks) and shaded ground conditions exist. However, if use of trail habitats by *P. nettingi* is more widespread than previously believed, recreational activities on these trails may constitute take, which is prohibited under the Endangered Species Act. We urge the appropriate regulatory agencies, i.e., U.S. Fish and Wildlife Service and West Virginia Department of Natural Resources, to both review the current status of *P. nettingi* and work with the U.S. Forest Service to mitigate possible impacts from the use of recreational trails on this species.

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TARICHA GRANULOSA (Roughskin Newt**). SYMPTOMS OF POISONING.** *Taricha granulosa*, a salamander endemic to the moist coastal regions of the Pacific states, is known to manufacture and store the neurotoxin tetrodotoxin as an anti-predator defense (Stebbins 2003. Field Guide to Western Reptiles and Amphibians. Houghton Mifflin, New York, New York. 519 pp.). Tetrodotoxin ($C_{11}H_{17}N_3O_8$), which is toxic to humans, blocks sodium-ion channels in nerve cells, causing hypotension and respiratory arrest (Torda et al. 1973. Med. J. Australia 1973:599–602; Sims and Ostman 1986. Ann. Emerg. Med. 1986:1094–1098). Symptoms of tetrodotoxin poisoning in humans as a result of puffer fish (Tetraodontiformes) ingestion are well-known (Torda et al. 1973, *op. cit.*, Sims and Ostman et al.1986, *op. cit.*), but only two accounts of tetrodotoxin poisoning from ingestion of *T. granulosa* have been reported (Brodie et al. 1974. Copeia 1974:506–511; Bradley and Klika 1981. J. Amer. Med. Assoc. 246:247). Alcohol consumption might have complicated symptoms in both cases, so accounts of newt poisoning in which tetrodotoxin acts alone are needed. Hence, I here provide a first-hand account of newt-induced tetrodotoxin poisoning.

At 1600 h on 09 Aug 2006, an assistant (Brendan Currey) and I captured an adult male *T. granulosa* (76.5 mm SVL, 102.0 mm tail, 15.0 g) in a bedrock-bottomed pool along a western Oregon stream (44.22927°N, 122.38838°W, WGS 84; elev. 211 m). The newt exhibited typical aquatic morphology (smooth skin, well-developed tail fin, and dark sides) characteristic of breeding males of this species (Stebbins 2003, *op. cit.*). While Brendan took a gag picture of me pretending to lick the newt, the shutter click caused the newt to flinch; as a consequence, its body just barely brushed the tip of my tongue, and I immediately noticed a bitter taste. Subsequently, I experienced a tingling, then burning sensation on the tip of my tongue. For the next 2 min, I flushed my mouth and tongue with copious amounts of water, at which point the burning subsided. At this point, I continued to survey. Eight minutes later, I experienced a sensation of dizziness with such rapid onset that it felt as if someone had hit me in the head, causing me to stumble to the ground. The sensation was that of my surroundings spinning; I found it extremely difficult to coordinate my speech or form coherent thoughts. My eyelids drooped involuntarily, and my vision was blurry and unfocused (Brendan indicated that my pupils were fixed dilated). This state of dizziness, coupled with a general loss of feeling (numbness over most of my body) lasted for a full 20 min. Thirty minutes after the event, I had regained some feeling in my body, and had enough muscle control to walk and talk, though I was still unable to coordinate my thoughts. My eyelids still drooped, and my vision was still blurry. Interestingly, I had previously sustained a significant back injury and had been in considerable pain prior to the newt-licking event; as the dizziness passed, I noticed that my back was totally numb, and it remained so for almost an hour. Brendan also indicated that my eyelids continued to droop for ca. 90 min, and my vision remained blurry and unfocused (with dilated pupils) for ca. 2.5 h. Following cessation of these symptoms, I had a headache that lasted several hours.

The symptoms I experienced in this case, including dizziness, numbness, and dilated pupils, are similar to those previously reported (Bradley and Klika 1981, *op. cit.*), and thus appear representative of tetrodotoxin poisoning from *T. granulosa*. Besides illustrating its potentially serious consequences, this account provides clues to consider in cases where *Taricha* poisoning may be suspected.

I thank Brendan Currey for his assistance in making observations and Marc P. Hayes for suggestions.

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TARICHA GRANULOSA (Rough-skinned Newt)**. REPRODUCTION.** *Taricha granulosa*, one of three salamandrids native to the Pacific Coast of North America, generally exhibits a biphasic life history, with aquatic larvae developing into terrestrial forms which return to the water to breed (Stebbins 2003. Field Guide to Western Reptiles and Amphibians. Houghton Mifflin, New York. 519 pp.; Nussbaum et al. 1983. Amphibians and Reptiles of the Pacific Northwest. Univ. Press of Idaho, Moscow. 332 pp.). In lowland regions, such as the Willamette Valley of Oregon, the breeding period is reported as February through July (Chandler 1918. Oregon Ag. Coll. Exp. Bull. 152:1–24; Pimentel 1960. Am. Midl. Nat. 63:470–496). In this note, we increase the known reproductive interval with an observation of breeding by *T. granulosa* in November from western Oregon.

At 1430 h on 8 Nov 2006, we collected six adult *T. granulosa* in the water-filled concrete fish ladder at the Alsea Fish Hatchery, Benton Co. (44.422°N, 123.551°W; WGS 84; elev. 116 m), Oregon, USA. Based on the presence of secondary sexual characteristics (well-developed tail fin, smooth skin, swollen vent, and rough clasping patches on feet and limbs) in the males and a gravid condition (evidenced by a swollen abdomen, indicating the presence of well-developed eggs) in the females, five of these

were in breeding condition. Of these five newts, four were two amplectic pairs (Pair 1: male 104.8 mm SVL, female 63.5 mm SVL; Pair 2: male 88.9 mm SVL, female 66.7 mm SVL), and the fifth was an unpaired male (85.7 mm SVL). The portion of the ladder in which we observed the newts had no visible flow, was partially covered with duckweed (*Lemna* sp.), and ranged in depth from 45–60 cm. Water temperature was ca. 15°C. Both amplectic pairs were swimming slowly near the water's surface when caught; occasionally, they would investigate a floating log or swim towards the bottom of the pool. The male of Pair 2 was observed "chin-rubbing" the snout of the female with which he was paired prior to capture. The male of Pair 1 had an extremely swollen vent, from which a whitish secretion was issuing when captured. Though actual egg deposition was not observed, the female newts' abdomens were enlarged to a degree similar to that of others observed by CJR in the Willamette Valley which deposited eggs < 48 h after courtship (amplexus and fertilization).

Notably, 14 recently transformed *T. granulosa* were also captured in the pool. Mean size of 3 of these metamorphs was 27 mm SVL; most had stubby (1 mm) gill remnants. These animals were either resting on floating debris, attempting to climb the concrete sides of the outflow, or were swimming awkwardly, attempting to make contact with an object on which they could climb out of the water. The presence of these metamorphs is significant because it indicates successful breeding earlier in the year (neither larvae or adults can overwinter in the fish ladder due to the high flow present in this structure during winter months).

Taricha granulosa in montane situations (particularly in the case of neotenic forms) are known to breed in fall, depositing eggs as late as October (Marangio 1978. NW Sci. 52:343–350; Garber and Garber 1978. J. Herpetol. 12:59–64). However, this represents the first record of lower-elevation breeding in western Oregon between July and February, possibly following breeding earlier in the year. Further investigation is needed to determine the extent of this phenomenon and its significance to *T. granulosa* life history.

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ANURA — FROGS

CHAUNUS JIMI (NCN). **ENDOPARASITES**. Parasites may exert negative impacts on their hosts, such as morphological modifications, decrease in growth and fecundity, disturbance on feeding habits, even causing death of hosts (Marcogliese 2004. Ecohealth 1:151–164). *Chaunus jimi* (Stevaux 2002. Rev. Bras. Zool. 19:235–242), occurs in northeastern Brazil (Frost 2007. Online Reference. Version 5.0 http://research.amnh.org/herpetology/amphibia/index.php). We examined 37 *C. jimi* from the Universidade Regional do Cariri: (LZ-URCA 469–500, 503, 504. 506–508) from five municipalities of Cariri region, Caririaçu (7.033°S, 39.283°W), Crato (7.233°S, 39.4°W), Mauriti (7.38°S, 38.766°W), Várzea Alegre (6.783°S, 39.283°W) in the state of Ceará, and Exú (7.5°S, 39.716°W) in the state of Pernambuco. Body size (SVL) was measured to the nearest 0.1 mm, and the respiratory tract removed and examined for parasites under a stereomicroscope. The parasites were mounted on glass slides, identified, and preserved in 70% ETOH. We found *Rhabdias fuelleborni* (Nematoda: Rhabdiasidae) in the lungs of these toads. The overall prevalence was 81.1% (30/37) and the mean intensity of infection was 18.7 ± 25.9 (range: 1–97). There was no relation between SVL and intensity of infection (spearman rank correlation, $r_s = 0.15$; $t = 0.80$; $p = 0.43$). Species of *Rhabdias* are common pulmonary parasites of bufonids (Vicente et al. 1990. Rev. Bras. Zool. 7[4]:549–626), however *C. jimi* represents a new host record for *R. fuelleborni*. Voucher specimens of the parasites were deposited as LZ-URCA 600–697.

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LEPTODACTYLUS DIPTYX (Tropical Bullfrog). **ENDOPARASITES**. *Leptodactylus diptyx* occurs in the Lower Chaco and oriental region of Paraguay, the eastern lowlands of Santa Cruz (Bolivia), and northern Argentina (IUCN 2007. Conservation International and NatureServe. Global Amphibians Assessment. http://www.globalamphibians.org. Accessed 22 Oct 2007). To our knowledge, no previous reports of parasites exist for *L. diptyx*. Herein we report *Catadiscus* sp. (Trematoda) and *Centrorhynchus* sp. (Acanthocephala) in *L. diptyx* from Argentina. Two adult *Catadiscus* sp. were found in the large intestine and five acanthocephalan larvae *Centrorhynchus* sp. in the coelomic cavity of a female *L. diptyx* (27.6 mm SVL) from the herpetological collection of Universidad Nacional del Nordeste (UNNEC 9000) collected 22 Nov 2006, Corrientes (city), Corrientes Province (27.466°S, 58.783°W, datum: WGS 84; elev. 65 m). *Leptodactylus diptyx* is a new host record for *Catadiscus* sp. and *Centrorhynchus* sp.

We thank L. Lunaschi for verification of the identification of the organisms.

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LEPTODACTYLUS PODICIPINUS (Pointedbelly Frog). **PREDATION.** Amphibians are common prey for a great variety of vertebrates, arthropods, and even carnivorous plants (Duellman and Trueb 1986. Biology of Amphibians. McGraw-Hill, New York; Pough et al. 1998. Herpetology. Prentice-Hall, New Jersey). The fishes known locally as "lambaris" or "tambiús" live strictly in fresh water, and have the greatest number of species



FIG. 1. Adult female *Leptodactylus podicipinus* wounded, showing exposed intestines and eggs in a stream at the Parque Ecológico do Baguaçú, Araçatuba municipality, state of São Paulo, Brazil.

in the family Characidae. *Astyanax* is the most common genus in the state of São Paulo (Nomura 1975. Rev. Brasil. Biol., Rio de Janeiro, 35[4]:775–798). Many characids are nocturnal, have good visual acuity (Orsi 2001. Dissertação mestrado. Instituto de Biociências, Universidade Estadual Paulista, Botucatu), and forage in an opportunistic fashion (Bennemann et al. 2000. Peixes do Rio Tibagi: Uma Abordagem Ecológica. Londrina, Ed. Universidade Estadual de Maringá. 62 pp.). Here we report the predation of an adult female *Leptodactylus podicipinus* by a shoal of "lambaris" (*Astyanax altiparanae*).

On 3 Oct 2007 at 1600 h, in a stream at the Parque Ecológico do Baguaçú, Araçatuba municipality, state of São Paulo, Brazil, an adult female *Leptodactylus podicipinus* was observed wounded, showing exposed intestines and eggs (Fig. 1). When the frog was disturbed by our presence, it jumped into the water. At the same instant, a shoal of *A. altiparanae* attacked and consumed the wounded frog.

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LITHOBATES CATESBEIANUS (American Bullfrog) **PREY.** *Lithobates catesbeianus* is one of the most harmful invasive species in the world, being introduced in the Caribbean Basin, South America, Europe, and Asia (Lowe et al. 2000. 100 of the World's Worst Invasive Alien Species. The Invasive Species Specialist Group, 12 pp.; IUCN, CI, and NatureServe 2006. Global Amphibian Assessment. <www.globalamphibians.org>, accessed on 09 April 2008). This species was introduced in Brazil in the 1930s for commercial breeding, where, due to poor management practices and high survival of individuals in wild habitats, feral populations became established in many regions, especially in the Atlantic Rainforest (Giovanelli et al. 2007. Biol. Invasions 9:1–6).



FIG. 1. Dissected stomach of Bullfrog (*Lithobates catesbeianus)* containing a juvenile *Bothrops jararaca*.

There are few records of predation on snakes by *L. catesbeianus* and these mostly involve species that occur within the frog's native range (but see: Silva et al. 2007. Herpetol. Rev. 38:443). On 12 Jan. 2008, during fieldwork in Ponte Nova municipality, Minas Gerais state, southeastern Brazil (20.3710667°S, 42.9250028°W; datum WGS 84; 412 m elev.), CBCF collected a *L. catesbeianus* (female, SVL 15.93 mm, 429.9 g), which contained in its stomach a juvenile *Bothrops jararaca* (305 mm SVL, 5.9 g), and a partially digested treefrog (Fig. 1), probably an adult *Hypsiboas crepitans*.

The juvenile *B. jararaca* (MZUFV 1514) was deposited in the herpetological collection of Museu de Zoologia "João Moojen," Universidade Federal de Viçosa, in Viçosa, Minas Gerais. We thank Universidade Federal de Viçosa for transport logistics, Jorge Dergam for English translation assistance, and Robert Hansen for suggestions on the manuscript.

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OSTEOCEPHALUS OOPHAGUS (NCN). **TERRESTRIAL BEHAVIOR.** *Osteocephalus oophagus* is one of seven *Osteocephalus* species known to occur in the Brazilian Amazon, and one of three found at the Biological Dynamics of Forest Fragments Project (BDFFP) in the state of Amazonas (Zimmerman and Simberloff 1996. J. Biogeog. 23:27–46). *Osteocephalus oophagus* is a phytotelm breeder with oophagous tadpoles; adults spend most of their time in the canopy. The breeding season for

O. oophagus, as with other *Osteocephalus*, generally coincides with the rainy season (Jungfer and Weygoldt 1999. Amphibia-Reptilia 20:235–249). Individuals of this species have only previously been observed near the ground when reproducing in terrestrial bromeliads (Jungfer and Weygoldt 1999, *op. cit.*). Here I report terrestrial behavior previously undescribed for *O. oophagus*, but that has been observed in two other *Osteocephalus* species in the Ecuadorian Amazon (Deichmann and Williamson 2007. Herpetol. Rev. 38:189).

While searching 5 × 5 m quadrats for leaf litter herpetofauna in continuous forest during the wet season at Fazenda Dimona (BDFFP), we found 2 *O. oophagus* females hidden in the leaf litter. The first individual (56.8 mm SVL, 8.51 g) was found on 9 May 2007 on the ground in terra firme forest at ca. 1030 h, buried well under the litter layer. The second female (56.7 mm SVL, 9.81 g) was found the same day at 1400 h in a position similar to the first. When encountered, both were seemingly asleep. Upon handling, they became aroused and attempted to escape. Both frogs were photographed and released on site later the same day.

The leaf litter habitat has largely been ignored in studies of *Osteocephalus* because of the traditional view that the genus is strictly arboreal. However, the observations presented here, as well as accounts of this same behavior in *O. planiceps* and *O. yasuni* (Deichmann and Williamson 2007, *op. cit.*), suggest that the leaf litter might be an integral habitat for females during the breeding season and should be searched by investigators. Further research is needed to determine why females of these generally arboreal species spend time on the ground, whether other species of *Osteocephalus* show similar behavior, and whether individuals utilize leaf litter habitat in the dry season as well as the wet season.

I thank the staff of the BDFFP for logistical support and João de Deus Fragata Farias for field assistance. This observation was made during dissertation research supported by grants from the Conservation, Food, and Health Foundation, Louisiana Governor's Office of Environmental Education and Biograds. Work in Brazil was conducted with permits from CNPq (EXC 006-06-C) and IBAMA (n 222/2006).

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OSTEOPILUS SEPTENTRIONALIS (Cuban Treefrog). **DIET**. *Osteopilus septentrionalis* is a large, invasive hylid in Florida, where it has become common throughout the central and southern portions of the peninsula. In Florida, *O. septentrionalis* is known to feed on squamates, including three species of introduced lizards (Meshaka 2001. The Cuban Treefrog in Florida. Univ. Press of Florida, Gainesville. 192 pp.) and the native Florida Brownsnake, *Storeria victa* (Maskell et al. 2003. Herpetol. Rev. 34:137). Here we report the predation of a native lizard by *O. septentrionalis*.

At 1542 h on 4 Jan 2007, while checking PVC pipe refugia for a study at Wekiwa Springs State Park, Apopka, Florida, USA, we discovered a 40 mm SVL *O. septentrionalis* depredating a 39 mm SVL adult male *Anolis carolinensis* (Green Anole). The frog was facing downwards within the pipe using its forearms to force the lizard head-first into its mouth, while using its half-extended rear legs to support itself on the inside surface of the pipe. We removed the pipe from the ground to photograph the predation event from the end of the pipe to which the frog and lizard were closest. We used a "plunger" to chase the frog from the pipe, and upon capture it dropped the lizard, which appeared stressed but relatively unharmed. We released the Green Anole into palmetto adjacent to the pipe.

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PHYSALAEMUS CUVIERI (Dwarf Frog). **ENDOPARASITES.** Vicente et al. (1991. Rev. Brasil. Zool. 7:549–626), in an inventory of the nematode parasites of amphibians in Brazil, reported the occurrence of *Cosmocerca* sp. in the digestive tracts of Hylidae, Bufonidae, and Leptodactylidae. Between Sept 2002 and Feb 2003, 286 individual *Physalaemus cuvieri* (mean SVL = 284 ± 3.04 mm; range 157–354 mm) were collected in two areas of Brasília and were deposited in the Coleção da FTB (Brasília, DF). The body cavity was opened and the stomach, small, and large intestine were removed and examined; 17 adult nematodes were found (prevalence: 4.2% and mean intensity: 1.42). Only female *Cosmocerca* were found, thus making species determination very difficult. This note reports the first occurrence of *Cosmocerca* sp. in *Physalaemus cuvieri* in Brazil. Nematodes were deposited in the Coleção Helmintológica do Instituto de Biociências de Botucatu, Botucatu, São Paulo, Brazil (CHIBB 1428).

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RANA CATESBEIANA (American Bullfrog). **TADPOLE GIGANTISM and DEFORMITY**. On 11 Dec 2007, individuals from Arizona State University (ASU) and Arizona Game and Fish Department (AZGF) harvested roundtail chub *Gila robusta* from a stock pond at Bubbling Ponds State Fish Hatchery (BPFH) in Cornville, Yavapai Co., Arizona, USA. The pond (0.7 ha, 1.4 million gal.) was completely drained and seined for fish removal. *Rana catesbeiana* tadpoles also occupied the pond and were abundant (most were 40– 80 mm TL). One extraordinary specimen was discovered measuring 195 mm TL (197 mm prior to preservation in alcohol) (Fig. 1A) and was preserved for deposition into ASU Natural History Collections (ASU 35975). Bolek and Janovy (2004. Herpetol. Rev. 35:376–377) reported a 190 mm specimen as the largest of its kind.

The ponds at BPFH are fed from an artesian spring and pond temperature annually ranges from 11–22°C. Pond was stocked with 750 adult *G. robusta* on 26 Jul 2006. At harvest, the pond contained Chara (*Chara* sp.) and Eurasian Water-milfoil (*Myriophyllum spicatum*). Fish were fed pelleted catfish diet enriched with spirulina and krill (Rangen®) dispensed at a rate of 2.25 kg twice daily. Additionally, fish were curatively treated for illness once with potassium permanganate and twice with a copper sulfate / citric acid solution (independent treatments, each at 0.75 ppm).

The tadpole appears to have stalled at Gosner Stage 25, as no hind-limb buds are externally evident (Gosner 1960. Herpetologica 16[3]:183–190; Fig. 1B). Subsequently, the specimen was x-rayed to investigate any skeletal basis for deformities. Inspection of the lateral x-ray indicated possible hind-limb development (Fig. 2A), but inadequate resolution made it difficult to determine whether markings were real or an artifact of the superimposition of intestinal tissues. Additionally, the specimen is lacking a right eye and x-ray imaging shows that the tadpole's skull, though not completely calcified, appears asymmetrical in density (Fig. 2B).

Other investigators have shown that metamorphic deformities and gigantism in tadpoles are thyroid-related (Rocek et al. 2006. Paleobio. 32[4]:666–675; Rot-Nikcevic and Wassersug 2003. Dev. Growth Different. 45[4]:321–325). Thyroid hormone levels are subject to disruption by parasites, UV radiation, and chemical or metal contamination, among other stressors (Bridges et al. 2004. Env. Sci. Pollution Res. 11[4]:233–239; McDaniel et al. 2004. Water Qual. Res. J. Canada 39[3]:160–174). Specifically, copper contamination in both aqueous and solid forms has been implicated as contributing to deformities in amphibians (McDaniel et al. 2004, *op. cit.*). Given that that the pond was treated with copper sulfate, it likely represents a chemically unnatural environment for tadpole development.

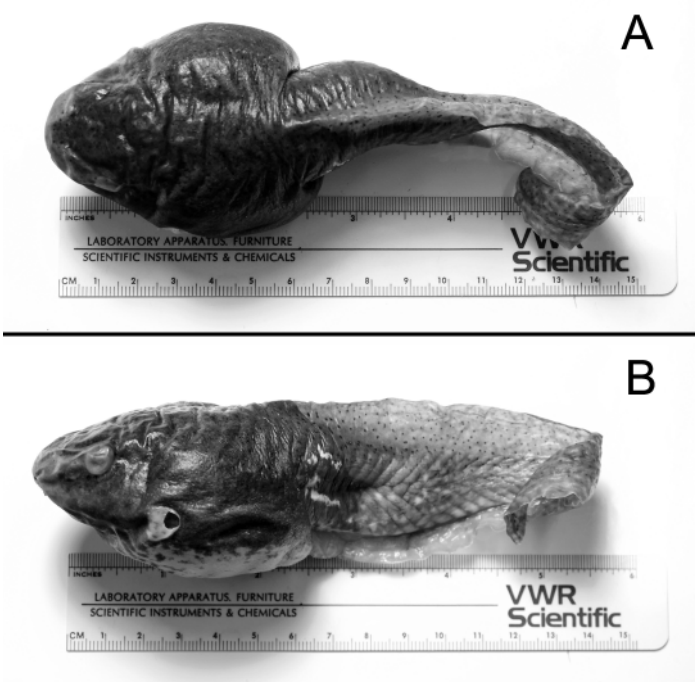


FIG. 1A. Gigantic *Rana catesbeiana* tadpole taken from fish hatchery pond in Cornville, Arizona, USA, Dec 2007. 1B. Metamorphosis appears to have stalled at Gosner Stage 25, as no limb buds are evident.

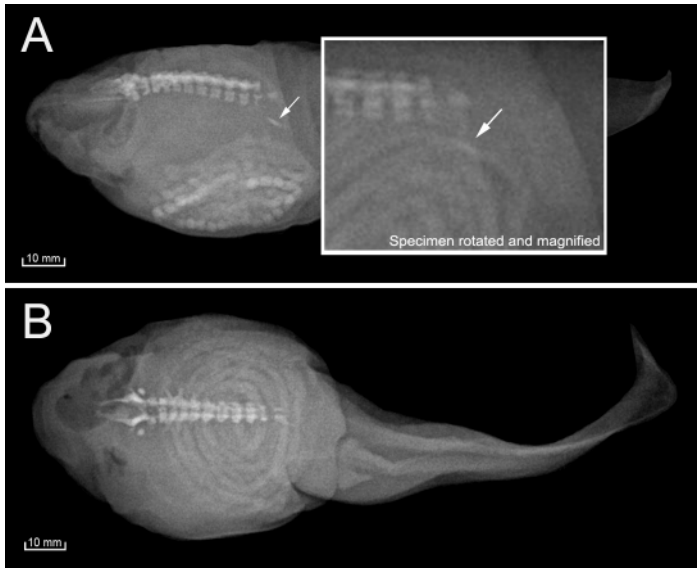


FIG. 2A. Lateral x-ray of gigantic *Rana catesbeiana* tadpole. Arrow indicates a suspected pelvic girdle calcification. Further examination (via rotational x-ray; inset) provided some support that this apparent contrast was actually superimposition of intestinal coils. 2B. Dorsal x-ray.

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RANA PRETIOSA (Oregon Spotted Frog). **REPRODUCTION**. Endangered in the state of Washington (Washington Dept Fish and Wildlife 2007. Sensitive species list. WDFW, Olympia), Canada (COSEWIC 2000. Assessment and Status Report on the Oregon Spotted Frog in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa. 22 pp.), and a candidate for federal listing in the United States (USFWS 2001. Fed. Reg. 66:1295–1300), *Rana pretiosa* has been a focus of recent study (Hayes et al. 2006a. Herpetol. Rev. 37:209–210; Rombough et al. 2006. Herpetol. Rev. 37:210). Despite significant efforts at quantifying reproduction (Hayes et al. 2006b. Northwest. Nat. 87:171), reproductive behavior, particularly during oviposition, remains undescribed. Hence, we provide a preliminary description of oviposition in *R. pretiosa* from Washington State, USA.

Observations were made during surveys for *R. pretiosa* egg masses on the Troh area of Conboy Lake National Wildlife Refuge (Klickitat Co.) during March 2007 (45.9873°N, 121.2665°W, WGS 84; elev. ca. 555 m). We provided general descriptions of this site elsewhere (Hayes et al. 2006a, *op. cit.*; Rombough et al.

2006, *op. cit.*). The area where these observations were made is a historical oviposition site for *R. pretiosa* at Conboy Lake NWR; calling males and egg masses have been observed annually over the last 10 years.

At 1315 h on 12 March 2007, CJR encountered two pairs of amplectic *R. pretiosa* (Pair 1: female ~88 mm SVL, male ~68 mm SVL; Pair 2: female 86.3 mm SVL, male ~67 mm SVL). Both pairs were on the bottom of 20-cm deep water among clumps of *Carex* in a seasonally flooded meadow, and were sitting next to a freshly laid (< 2 h old) egg mass. The two pairs were facing away from each other, < 8 cm apart. When first encountered, Pair 1 immediately swam beneath the sedges, presumably because of the appearance of CJR, and were not seen again. At the same time, the female of Pair 2 had just begun laying eggs, which were visible as they issued from her body as a mixed black-and-white mass. Based on subsequent observation, the female had extruded about 20% of her eggs when first encountered. Over the next ~2 min, this female laid her remaining eggs in one fluid motion except for the final 10%, which were expelled via a series of short pulses. Based on the rate of oviposition, the entire time required for egg deposition was likely < 3 min. Several seconds after the female had finished laying, the male frog released his hold and floated to the surface, at which point he spotted CJR and swam away. The female, which now had a distinctly baggy appearance, was captured, measured, weighed (37.0 g), and released at the capture site.

As first laid, the egg mass measured ca. 45 × 15 × 15 mm. The embryos were randomly oriented, with the light (vegetal) pole of some eggs positioned upwards. After ca. 30 min, the mass had nearly doubled in volume, to ca. 75 × 30 × 30 mm, and most embryos were re-oriented so that the dark (animal) pole faced upward. After 75 min, the mass measured ca. 95 × 70 × 70 mm, and all of the embryos were now oriented with the animal pole up. By 90 min post-oviposition, the mass was roughly spherical, ca. 100 mm in diameter, and similar in size to the older (now ~3.5 h old) egg mass next to it.

Observations were made within a group of calling male *R. pretiosa*; 12 males were visible within a relatively small (ca. 3 m^2) area. These male frogs were either floating quietly at the water's surface or were calling from either floating or submerged positions. Audible calls consisted of a series of 3–7 (usually 5) note, "knocking" sounds, consistent with that described for the species (Nafis 2006. Sounds of *Rana pretiosa*. online: http://www.californiaherps.com/noncal/northwest/nwfrogs/pages/r.pretiosa.html). At least two other unpaired females, both apparently gravid and measuring ca. 87 and 89 mm SVL, were also present. Unlike the males, which could be approached rather closely (within 1 m and hand captured), these females were wary and dove seconds after seeing CJR.

Few descriptions of oviposition among ranid frogs in a field setting exist. The process we describe here is similar to that seen in *Rana boylii* in that most eggs were extruded at a constant speed over a short time (ca. 1.5 min. for *R. boylii*; Rombough and Hayes 2005. Northwest Nat. 87:157–160) and overall oviposition duration was < 10 min (Wheeler et al. 2003. Herpetol. Rev. 34:234). A brief oviposition interval might be related to deposition of all eggs in one mass (the method of all western North American ranids), as ranid frogs with smaller clutch sizes (than western North American species) which partition their eggs into several packets have longer oviposition intervals (Tsuji and Lue 1998. Copeia 1998:769–773). Further, though the process of egg deposition in the laboratory is well known (Fankhauser 1948. Ann. New York Acad. Sci. 49:684–708; Sype 1975. Breeding Habits, Embryonic Thermal Requirements and Embryonic and Larval Development of the Cascade Frog. Ph.D. Diss., Oregon State Univ., Corvallis. 113 pp.), the post-fertilization reorientation of embryos is almost never reported. Detailed observations are needed to understand variation in the timing of this phenomenon.

Work, conducted under a programmatic permit from the WDFW, adhered to the guidelines for the care and handling of amphibians in the field as detailed in Beaupre et al. (2004. Guidelines for Use of Live Amphibians and Reptiles in Field and Laboratory Research, 2nd ed. HACC, American Society of Ichthyologists and Herpetologists). This is a contribution from the Habitat Program of the WDFW.

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SCINAX EURYDICE (Maracas Snouted Treefrog). **PREDATION**. Aquatic invertebrates, especially belostomatids, are often cited as predators of tadpoles (Eterovick and Barata 2006. Herpetologica 62:363–377; Eterovick and Sazima 2000. Amphibia-Reptilia 21:439–461) and adult frogs (Bastos et al. 1994. Herpetol. Rev. 25:118; Brasileiro et al. 2003. Herpetol. Rev. 34:137; Haddad and Bastos 1997. Amphibia-Reptilia 18:295–298; Toledo 2003. Phyllomedusa 2[2]:105–108). *Scinax eurydice* occurs in Brazil from the northern state of Bahia to São Paulo (Ribeiro et al. 2005. Biota Neotropica 5[2]:1–15). This species occurs in open, wet areas, being common in the Atlantic Forest fragments in the municipality of Mariana, Minas Gerais State, southeastern Brazil (43.50025°W, 20.24916°S; WGS 84; ca. 900 m elev). On 24 Jan 2007 at ca. 2200 h we found a female *S. eurydice* (49.6 mm SVL), with eggs inside its oviducts, being preyed upon by the belostomatid, *Lethocerus annulipes* (62.4 mm body length, 25 mm body width). The adult male belostomatid was on the water surface of a temporary pond holding the frog with its raptorial forelimbs. We captured and preserved both animals. *Scinax eurydice* calls and lays it eggs on water bodies that usually have high densities of belostomatids and thus is vulnerable to these aquatic invertebrate predators. The *S. eurydice* (LZV 877) is deposited in the Laboratório de Zoologia dos Vertebrados of Universidade Federal de Ouro Preto, MG, Brazil; the belastomatid (IC 5052) is deposited in the Invertebrate Collection of Universidade Federal de Minas Gerais, MG, Brazil.

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Gerais, 30123-970, Belo Horizonte, MG, Brazil; and **FELIPE SÁ FORTES LEITE**,Classe Construções e Meio Ambiente, Rua Almirante Tamandaré, 438, CEP 30430-120, Belo Horizonte, MG, Brazil.

SCINAX GRANULATUS (NCN). **REPRODUCTION**. The reproductive strategy described for the species of the genus *Scinax* agrees with the strategy of most species of Hylinae, which consists of laying egg masses adhered to submerged vegetation (Cei 1980. Amphibians of Argentina. Monitore Zool. Ital., N. S., Monogr. 2. 609 pp.; Gallardo 1987. Anfibios Argentinos. Guía para su Identificación. Biblioteca Mosaico, Bs. As., Agropecuaria 1. 98 pp.; Lavilla and Cei 2001. Amphibians of Argentina A Second Update, 1987–1997. Mus. Reg. Scien. Natur. Torino 28. 177 pp.; Lavilla and Rouges 1992. Reproducción y Desarrollo de Anuros Argentinos. Asociación Herpetológica Argentina 5:1–61; Duellman and Trueb 1986. Biology of Amphibians. McGraw-Hill Book Co., New York. 670 pp.). This note describes egg deposition for *Scinax granulatus* in its natural environment.

The observations were made in the vicinity of La Plata city, Buenos Aires province, Argentina (36.0182°S, 57.8591°W; WGS 84) between September 2003 and February 2006 as part of a more comprehensive study of the reproductive behavior of this species. The following description is based on four clutches observed in the field. After oviposition we noted the spatial arrangement of eggs, and counted between 300–700 eggs in each clutch, with pigmented animal pole, 1.3 mm ± 0.04 diameter embryos and 1.7 mm ± 0.05 capsules with jelly coat (mean ± 95% confidence limits, N = 35).

Scinax granulatus disperses its eggs on the bottom of water bodies, and the eggs adhere to submerged objects and/or the bottom individually or in small clusters of 2–3 eggs. The clutches observed were scattered over an average surface area of 3616 cm^2, which represented a small portion of the water body. To our knowledge, this is the first report of this egg deposition mode for a species of Hylinae.

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GASTROPHRYNE PICTIVENTRIS (Nicaragua Narrowmouth Toad), ***HYPOPACHUS VARIOLOSUS*** (Sheep Frog). **ENDOPARASITES.** Herein we report endoparasites of two microhylid frog species from Costa Rica. *Gastrophryne pictiventris* is known from southeastern Nicaragua and the Atlantic slope of Costa Rica; *Hypopachus variolosus* occurs from southern Texas to Costa Rica (Savage 2002. The Amphibians and Reptiles of Costa Rica. A Herpetofauna Between Two Continents, Between Two Seas. Univ. Chicago Press, Chicago, Illinois. 934 pp.). We know of no reports on the helminths of these species.

Two *G. pictiventris* adult males (mean SVL = 27 mm ± 1.4 SD, range: 26–28 mm) collected in 1966 from Heredia Province (LACM 155965, 155967) and four *H. variolosus* adult males (mean SVL = 36 mm ± 1.4 SD, range: 35–38 mm) collected in 1963 from Guanacaste Province (LACM 156792–156795) were examined for endoparasites. The frogs were opened by a mid-ventral incision and the lungs, stomach, small and large intestines, urinary bladder, liver, and body cavity were searched for endoparasites using a dissecting microscope. Each nematode was cleared in a drop of glycerol, coverslipped, and studied as a temporary wetmount. The pentastome was cleared in cedarwood oil and studied under a dissecting microscope.

Found in *G. pictiventris* were two species of Nematoda: four *Cosmocerca podicipinus* (mean: 2.0 ± 1.4 SD, range: 1–3) small and large intestines; one *Oswaldocruzia costaricensis* in the small intestine. One Pentastomida nymph was found in the body cavity. Found in *H. variolosus* were two species of Nematoda: 17 *Cosmocerca podicipinus* (mean 5.7 ± 3.2, range: 2–8) in the small and large intestines; three *Oswaldocruzia costaricensis* (mean: 1.5 ± 0.7, range 1–2) in the small intestines. Voucher helminths were deposited in the United States National Parasite Collection, USNPC, Beltsville, Maryland, USA as: *G. pictiventris, Cosmocerca podcipinus* (USNPC 98743), *Oswaldocruzia costaricensis* (USNPC 98744), Pentastomida (USNPC 98745); *H. variolosus, Cosmocerca podicipinus* (USNPC 98758), *Oswaldocruzia costaricensis* (USNPC 98759).

Oswaldocruzia costaricensis was described from *Rana* cf. *forreri* from Costa Rica by Bursey and Goldberg (2005. J. Parasitol. 91:600–605). It has also been found in *Lithobates warszewitschii* and *Lithobates taylori* from Costa Rica (Goldberg and Bursey 2007. Carib. J. Sci. 43:1–10; Goldberg and Bursey 2007. Carib. J. Sci. 43:65–72). *Cosmocerca podicipinus* is a generalist nematode with a wide distribution in Central and South America and has been reported in bufonid, dendrobatid, hylid, leptodactylid, and ranid frogs as well as one bony fish (Goldberg et al. 2007. Comp. Parasitol. 74:327–342). Infection by *Oswaldocruzia* and *Cosmocerca* are direct with no intermediate host involved (Anderson 2000. Nematode Parasites of Vertebrates. Their Development and Transmission, CABI Publishing, Oxon, U.K. 650 pp.). With few exceptions, pentastomids mature in reptiles; various vertebrates serve as intermediate hosts and when eggs ingested by an intermediate host hatch the larvae penetrate the intestine to migrate randomly in the body, finally becoming quiescent and metamorphosing into a nymph (Roberts and Janovy 2005. Gerald D. Schmidt and Larry S. Roberts' Foundations of Parasitology, McGraw Hill, Boston.702 pp.) We consider *G. pictiventris* to be an intermediate host for the pentastome; *Cosmocerca podicipinus* and *O. costaricensis* represent new host records for *G. pictiventris* and *H. variolosus.*

We thank Christine Thacker for permission to examine frogs which are part of the Costa Rica Expeditions (CRE) collection donated to LACM in 1998 by Jay M. Savage. Sean Kirk assisted with dissections.

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TESTUDINES — TURTLES

CARETTA CARETTA (Loggerhead Sea Turtle). **DIGESTION TIME**. Sea turtles feed on a wide variety of food items, depending on the turtle species, growth stage, and other factors. Digestive processes have been investigated largely in the herbivorous Green Sea Turtle, *Chelonia mydas* (Bjorndal 1997. *In* Lutz and Musick [eds.], The Biology of Sea Turtles. CRC Press, Boca Raton, Florida) and these studies are not necessarily applicable for other marine species. Determining digestion time (i.e., the time necessary for natural food items to pass through the gastrointestinal tract) would help in understanding feeding behavior and nutrition in wild turtles. Given the capacity of sea turtles for long-range movement, knowing time and spatial range of turtle feeding is important for interpreting results on diet composition. Further, knowledge of digestion time can help determine how long turtles should be kept in captivity for studies investigating diet through examination of fecal samples.

Until now, few studies have investigated digestion time of Loggerhead Sea Turtles (Birse and Davenport 1987. Herpetol. J. 1:170–175; Peiter 2005. Master's thesis. Bremen University), and mostly in individuals just a few months old, using artificial diets. It is likely that turtle size and prey type can affect digestive functions. For this reason, the present study attempted to provide information on digestion time for medium-sized juvenile Loggerhead Sea Turtles feeding on wild prey.

A total of 30 live turtles caught by trawlers were kept under observation at the WWF's Turtle Rescue Center in Lampedusa Island, Italy (42.67°N, 16.83°E), during May–September 2005. Turtles captured by trawlers are usually healthy and without hooks or lines in the digestive tract (however all turtles were radiographed to ascertain the absence of hooks). Furthermore, bottom trawlers are assumed to catch turtles in the neritic stage, mainly feeding upon benthic prey, which tend to have hard, non-digestible body parts easily recognized in the feces (in contrast to pelagic prey); thus, these turtles are particularly suitable for investigating digestion time by monitoring defecation. Turtles were kept in captivity for a variable period of time and their tanks were checked four times a day for presence/absence of feces. If present, feces were collected and examined to distinguish species ingested in the wild (e.g., gastropods, crabs, sea urchins) from those given as food in captivity (fish). Only feces assumed to be evidence of wild prey were considered in the analysis.

For each turtle we recorded or calculated Curved Carapace Length notch-to-tip (CCL), number of defecations (ND), interval between the arrival at the center and the first defecation (AFD); interval between the arrival at the center and the last defecation (ALD), defecation frequency (DF), calculated as ND/ALD, mean defecation interval (MDI), calculated as (ALD-AFD)/(ND-1) (only for turtles with minimum two defecations), and water temperature.

The mean ND was 2.7 (SD: 1.5; range: 1–6), AFD was 0.7 days (SD: 0.5; range: 0–1.8), DF was 2.6 days^{-1} (SD: 5.7; range: 0.6–32.0), and MDI was 1.1 days (SD: 0.6; range: 0.3–2.2). The mean ALD was 2.4 days (SD: 1.5; range: 0–5.2), which is likely to be an underestimation due to the unknown time lag between the last feeding in the wild and the arrival at the center. For instance, considering the capture at 00.00, ALD would be 2.8 days. This indicates that digestion of benthic prey items such as those found in the corresponding feces (e.g. gastropods, crabs, sea urchins) takes around 2.5–3 days in turtles of the observed size (mean: 60.2 cm CCL; SD: 9.4; range: 41–80.3) and at the observed temperature (mean 25.0°C; SD: 2.0; N = 21).

Result indicate that feces collected in captivity from turtles caught in the wild, and specifically turtles feeding upon benthic prey, probably correspond to several different meals spanning a period of 2–3 days. This is significant for studies that investigate diet through fecal collection or necropsy, suggesting that such samples can provide good information on the diet covering multiple meals during movement among different sea bottom types. Moreover, maximum ALD suggests that studies investigating diet through fecal samples should keep turtles under observation for a period of at least six days to collect the entire gut content.

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CARETTA CARETTA (Loggerhead Sea Turtle). **PREDATION**. Sea turtle hatchlings are eaten by a variety of predatory fishes while departing from natal beaches. However, observations beyond the near shore zone are sparse because post-hatchling stages in offshore habitats are cryptic while hiding among *Sargassum* rafts or in drift line debris at current boundaries. Herein, we report a predation event by an endangered fish species upon a threatened turtle species, which involved a juvenile Loggerhead Sea Turtle (*Caretta caretta*) eaten by a Goliath Grouper (*Epinephelus itajara*) off the southwestern Florida coast.

On 14 December 2006, the crew of the R/V Eugenie Clark retrieved a drum line during surveys for large coastal sharks conducted by the Center for Shark Research at Mote Marine Laboratory. The drum line was 13 km offshore from Sarasota, Florida, USA (27.1470°N, 82.6150°W) in depths of about 12 m. Mid-water column temperature was 18.8°C and salinity was 36.0 ppt. The retrieved line yielded a *E. itajara* (length = 1.7 m) which upon its ascent regurgitated a partly digested but intact *C. caretta* carcass. The turtle specimen was photographed from dorsal, ventral, and lateral aspects adjacent to a landing net of known diameter. The photos provided multiple diagnostic features (number and color of costal scutes, inframarginal pores, carapace shape, and cranial scales) even though the flesh and muscle tissue were partially digested. Image measurements of the landing net compared to the turtle gave an estimate of 30–35 cm straight carapace length. Due to permit restrictions, the turtle carcass was not collected and was returned to the water. The grouper was de-hooked and also released in good condition.

The event is noteworthy given the paucity of information regarding grouper predation on young sea turtles. Groupers

reportedly consume Hawksbill Sea Turtles (*Eretmochelys imbricata*) in the West Indies (Randall 1967. Studies Trop. Ocean., Univ. Miami No. 5:665–847) and Green Sea Turtles (*Chelonia mydas*) in Hawaii (Balazs 1984. Univ. Hawaii Sea Grant Misc. Rep. 84-01(Vol. II), 321 pp.), the Kingdom of Tonga (Witzell 1981. Bull. Mar. Sci. 31:935–936), and the Great Barrier Reef in Australia (Gyuris 1994. Coral Reefs 13:137–144). However, studies of grouper species of the Florida Gulf coast have not yet reported sea turtles in the diet (Bullock and Smith 1991. Mem. Hourglass Cruises, Vol. 8, Pt. 2, 243 pp.) and studies of predators of Florida Atlantic coastal Loggerhead Sea Turtle hatchlings do not record this grouper species (Whelan and Wyneken 2007. Copeia 2007:745–754).

Both *E. itajara* and *C. caretta* receive protection from state and federal agencies within the United States. Recent assessments for *E. itajara* have suggested that the Gulf of Mexico populations may be recovering. This predatory event raises a question as to whether recovery of one protected species might be impacting the recovery of its prey, also a protected species, since top-down trophic cascades can occur in marine ecosystems. The observation also suggests that *E. itajara* in Florida waters are, at the very least, opportunistic consumers of juvenile sea turtles.

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GOPHERUS POLYPHEMUS (Gopher Tortoise). **COYOTE PREDATION.** Hatchling and juvenile *Gopherus polyphemus* are known to have many predators, including mesomammalian, ophidian, raptor, and invertebrate species (see Epperson and Heise 2003. J. Herpetol. 37:315–324, and references therein). However, known published accounts of predation on adult *G. polyphemus* are limited to Dog (*Canis familiaris*) attacks (Douglass and Winegarner 1977. J. Herpetol. 11:236–238; Causey and Cude 1978. Herpetol. Rev. 9:94–95). Here I report an incidence of a Coyote (*C. latrans*) depredating an adult *G. polyphemus*.

On 15 June 2007 at 1225 h, I arrived at artillery firing point 136 on the Camp Shelby Joint Forces Training Center, Perry County, Mississippi, USA to search for Gopher Tortoise nests. Upon exiting the vehicle, I heard crunching noises coming from the edge of the field, and approached slowly to investigate. When I got within ca. 30 m of the disturbance, I scared off an adult *C. latrans* that had been eviscerating an adult female *G. polyphemus*. The Coyote had ripped open a large hole in the plastron, and had removed the tail and most of the intestines (Fig. 1). The head, limbs, and carapace were all intact, and the damage was presumably done immediately prior to my arrival, since I could see the tortoise's heart still beating. The tortoise died 10 minutes later. I examined all nearby burrows, and did not find any signs of excavation, nor did I find signs of attempted or interrupted oviposition; therefore I assumed that this tortoise had been attacked while out of its burrow. This supports observations by R. E. Ashton (unpubl. data, in Mushinsky et al. 2006. *In* P. A. Meylan [ed.], Biology and Conservation of Florida Turtles, pp. 350–375. Chelonian Research Monographs No. 3) that Coyotes will wait



FIG. 1. Remains of an adult female *Gopherus polyphemus*, eviscerated by a coyote (*Canis latrans*) at the Camp Shelby Joint Forces Training Center, Perry County, Mississippi.

until a Gopher Tortoise leaves its burrow before attacking it. This particular tortoise had been measured the previous summer, and at 283 mm carapace length and a weight of 4.4 kg, it exceeded the averages for adult female *G. polyphemus* at Camp Shelby (ca. 267 mm carapace length and 3.8 kg; N = 281).

Coyotes have been expanding their range across the southeast for decades, partially due to releases by man and extirpation of native predators (Hill et al. 1987. Wildl. Soc. Bull. 15:521–524; Lovell et al. 1998. Wildl. Soc. Bull. 26[3]:552–556). An analysis of annual predator harvest data in Mississippi (Lovell et al., *op. cit*.) found that the numbers of Coyotes increased 7.5-fold from 1980 to 1995 (unlike Bobcat, Red Fox, and Grey Fox numbers, which remained relatively unchanged during that same period). The increased numbers of Coyotes in the area represent a relatively new predation pressure for *G. polyphemus*, adding to the growing list of threats (including habitat conversion and fire exclusion) already facing this federally-protected species.

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HYDROMEDUSA MAXIMILIANI (Brazilian Snake-necked Turtle)**. HATCHLING SIZE AND BODY MASS.** The chelid turtle *Hydromedusa maximiliani* is endemic to eastern and southeastern Brazil (Minas Gerais, Espírito Santo, Rio de Janeiro, and São Paulo states) and in parts of southern Bahia, and is associated with mountainous regions (Souza 2004. Reptilia 53:51–55). On 30 May 2005 at 1100 h we hand-captured, measured, and released one post-hatchling juvenile *H. maximiliani* in Reserva Biológica Muncipal Santa Cândida (21.6888889°S, 43.3444444°W; 770 m elev.), Juiz de Fora, Minas Gerais state, Brazil. The carapace length (CL) of this juvenile was 43 mm, plastron length (PL) was 28.5 mm, and the body mass was 7.8 g. Guix et al. (1992. Bol. Assoc. Herpetol. Esp. 3:23–25) reported the minimum CL of one (presumably post-hatchling) specimen as 40 mm, but did not provide data on body mass. The minimum body mass for a juvenile *H. maximiliani* previously reported was

15 g (Souza. 1995. Herpetol. Rev. 26:34), though the CL of this specimen was 47.3 mm. The specimen here reported, probably a recent post-hatchling, represents a new record for minimum body mass and plastron length for a juvenile *H. maximiliani*.

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HYDROMEDUSA MAXIMILIANI (Brazilian Snake-necked Turtle)**. DIET.** Adult *Hydromedusa maximiliani* are primarily carnivorous, feeding on aquatic invertebrates, including insect larvae and crustaceans (Souza 2004. Reptilia 53:51–55; Souza and Abe 1995. Chelon. Conserv. Biol. 1:320–322; Souza and Abe 1998. J. Herpetol. 32:106–112). This diet is complemented by terrestrial invertebrates that fall into the water, anurans, and carrion (Souza 2004, *op. cit*.). Here we report on *H. maximiliani* feeding on *Trichodactylus fluviatilis*, a freshwater decapod native to South America.

We gathered data on the feeding habits of *H. maximiliani* from October 2004 to May 2005, in the Reserva Biológica Municipal Santa Cândida (21.6888889°S, 43.3444444°W; 770 m elev.), Juiz de Fora, Minas Gerais state, Brazil. The stomach contents of 10 specimens of *H. maximiliani* were sampled by flushing (Legler 1977. Herpetologica 33:281–284). The decapod was identified in accordance with Magalhães (2003. *In* Melo [ed.], Manual de Identificação dos Crustáceos Decápodos de Água Doce do Brasil, pp. 143–287. São Paulo, Edições Loyola). Six samples of stomach contents revealed parts of the carapace, pereiopod, and cheliped of *T. fluviatilis*. Freshwater decapods previously reported as prey of *H. maximiliani* are *Aegla odebrechi*, *A. paulensis*, and *Hyalella pernix* (Yashimita 1990. Herpetol. Rev. 21:19; Souza and Abe 1995, *op. cit*.; Souza and Abe 1998, *op. cit*.; Souza and Abe 1997. Bol. Asoc. Herpetol. Esp. 8:17–20). This is the first report of *T. fluviatilus* being consumed by *H. maximiliani*.

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KINOSTERNON SONORIENSE (Sonoran Mud Turtle). **DIET.** *Kinosternon sonoriense* is generally considered a carnivore, but occasionally consumes plant material when benthic fauna are limited (Hulse 1974. J. Herpetol. 8:195–199). Over the last decade, we have documented several observations of Sonoran Mud Turtles feeding on vertebrates in ephemeral canyon pools in the Peloncillo Mountains, Hidalgo Co., New Mexico (Ligon and Stone 2003. Herpetol. Rev. 34:241–242*;* Stone et al. 2005. Herpetol. Rev. 36:312). Here, we add the House Finch (*Carpodacus mexicanus*) to the list of vertebrate species *K. sonoriense* has consumed in this setting. On 17 July 2007, ca.1200 h, we approached an isolated canyon pool (ca. 20 cm in depth and 1.5 m^2 in area) and observed a dead House Finch floating near the edge. Just before we began to search the pool, we noticed the dead bird gently rippling on the surface. We examined the bird and noted its breast and belly were missing and much of the sides and flanks had been picked clean of meat, with only the head, wings, and legs remaining intact. A female *K. sonoriense* (MCL = 100.8 mm) was found on the bottom of the pool directly underneath the bird. After identifying and measuring the turtle, we placed the turtle and bird back into the pool and then quietly waited and observed. After a few minutes the bird again began to gently ripple, presumably due to the turtle feeding on the carcass.

Stone et al. (2005, *op. cit.*) reported a similar observation involving a Mockingbird (*Mimus polyglottus*), and Ligon and Stone (2003, *op. cit.*) reported two instances of Sonoran Mud Turtles feeding on toads (*Bufo punctatus*). These are the only birds and only anurans we have found dead in canyon pools during a long-term field study (Stone 2001. Southwest. Nat. 46:41–53). Stone et al. (2005, *op. cit.*) also observed a Sonoran Mud Turtle kill and eat a garter snake (*Thamnophis cyrtopsis*). Although observations involving birds and anurans could represent instances of scavenging, the accumulated observations suggest that *K. sonoriense* opportunistically preys on vertebrates in canyon pools. Regardless, it is clear that canyon pools provide unique feeding opportunities for Sonoran Mud Turtles, and that vertebrates likely comprise a more significant portion of this species' diet than previously reported.

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CROCODYLIA — CROCODILIANS

CAIMAN CROCODILUS **(**Spectacled Caiman**). OPPORTUNISTIC FORAGING.** We document opportunistic foraging behavior by *Caiman crocodilus* in a post-inundation

forest at Estacíon Biologíca Caño Palma, Costa Rica. Estacíon Biologíca Caño Palma is a 40-ha reserve located on the northeast coast of Costa Rica, south of Barra del Colorado. This reserve and the surrounding area is lowland tropical wet forest (*fide* Holdridge 1967. Lifezone Ecology, Tropical Science Center, San José, Costa Rica. 206 pp.) comprised predominantly of *Manicaria* swamp forest (Myers 1990. *In* Lugo et al. [eds.], Ecosystems of the World, pp. 267–278. Elsevier, Oxford, UK, 527 pp.). Bounded by large catchment rivers to the north, south, and west with a blackwater channel to the east, the forest inundates seasonally (November–December and May). *Manicaria* forests typically exhibit a prominent bi-annual polymodal inundation during the wettest season (Junk et al. 2000. The Central Amazon floodplain: Actual Use and Options for a Sustainable Management. Backhuys Publishers, Leiden, Holland. 584 pp.). The seasonal inundation event that engulfs Estacíon Biologíca Caño Palma is also coupled with local tidal flow patterns (Kelso 1967. A Contribution to the Ecology of a Tropical Estuary. M.Sc. Thesis, Univ. Florida, Gainesville. 156 pp.). Once inundation subsides, numerous temporal pools remain in the forest; these generally disappear during the warmer (and drier) months of the year.

In December 2002 and again in January 2004, during three months of weekly diurnal visual-encounter transects of post-inundation *Manicaria* forest, 5 adult and 7 juvenile caiman (2002) and 4 adult and 3 juvenile caiman (2004) respectively were located well into (often > 100 m) the forest. Once disturbed, they retreated terrestrially toward the channel associated with riparian habitat, rapidly slipping in and out of temporary pools as they headed in an easterly direction toward the main blackwater channel bordering the property.

Caiman reproduction, which generally occurs during the rainy season in this region of Costa Rica (November–February), involves construction of vegetation mounds in forested environments to incubate their eggs (Allsteadt 1994. J. Herpetol. 22:12–19.). As in other crocodilians, caiman exhibit well-developed parental care and will defend nests from predators, the primary threat to their eggs (Leenders 2001. A Guide to Amphibians and Reptiles of Costa Rica. Zona Tropical, Miami, Florida. 305 pp.). We detected no evidence of nests or nest-guarding behavior in the areas where we sighted caiman. However, these areas, still saturated by water, were found to frequently be full of suffocating fish trapped in desiccating flood pools or anurans utilizing these ponds for breeding. Fish species present included: *Archocentrus nigrofasciatus* and *Parachromis managuensis* (Cichlidae), *Rhamdia guatemalensis* and *Rhamdia rogersi* (Pimelodidae), and *Astyanax aeneus* (Characidae). *Atractosteus tropicus* (Order: Semionotiformes) were also hunting in these pools and may have constituted prey. That caiman were feeding on the diverse prey within these seasonally restricted environments seems likely. Fish are an important prey species for many crocodilians (Magnusson 1987. J. Herpetol. 21:85–95) and can make up over 25% of total prey items in sub-adult and mature adult caiman (Thorbjarnarson 1993. Herpetologica 49:108–117; Velasco et al. 1994. Crocodile Specialist Group Newsletter 13:20–21). In tropical blackwaters Cichlidae, Pimelodidae, and Characidae can make up 10–27% of the composition of fish species consumed (Thorbjarnarson 1993, *op. cit.*; Santos et al. 1996. Herpetol. J. 6:111–117) and possibly more when increases in water level like that which occurred along the Caño Palma allow more fish access to greater volumes of water and increased predation susceptibility (Silveira and Magnusson 1999. J. Herpetol. 33:181–192).

Caiman now occur in diverse habitats such as marshes, rivers, channels, and lakes in both the Caribbean and Pacific lowlands of Costa Rica, particularly as a result of the now-diminished ranges of sympatric competitors (*Crocodylus acutus*) (Magnusson 1982. Proc. 5th IUCN/SSC Croc. Spec. Group, pp. 108–116. Gland, Switzerland). They are commonly found in the canals, dikes, and channel networks in forested floodplain habitats (Allsteadt and Vaughan 1992. Brenesia 38:65–69; Guyer 1994. *In* McDade et al. [eds.], La Selva: Ecology and Natural History of a Neotropical Rain Forest, pp. 210–216. Univ. Chicago Press, Chicago, Illinois; Guyer and Donnelly 2005. Amphibians and Reptiles of La Selva, Costa Rica and the Caribbean Slope. Univ. California Press, Berkeley, California. 299 pp.; Ouboter and Nanhoe 1988. J. Herpetol. 22:283–294; Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna Between Two Continents, Between Two Seas. Univ. Chicago Press, Illinois. 934 pp.). This species is known to establish territories in local channel networks where they exhibit high site tenacity (Savage 2002, *op. cit.*), especially in areas that provide a sustainable food resource. Opportunistic seasonal shifts in habitat use has not been widely reported in *Caiman crocodilus*. Our observations imply that these habitat shifts provide enhanced feeding opportunities that might be unavailable the rest of the year. We present two models that might explain these habitat shifts. In the first, caiman might periodically abandon their territories within the permanent channel network during episodic inundation to specifically forage for trapped fish within temporary pools in the forest. The second model proposes that caiman, along with other fauna, advance into the forest during inundation following the expanding shoreline. As the water recedes, some aquatic animals are trapped in pools where they are vulnerable to amphibious predators, such as caiman. Caiman are able to escape back to traditional channel-margin habitat as the pools disappear. Which is correct provides an interesting question for further research.

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CROCODYLUS MORELETII (Morelet's Crocodile). **SALINITY TOLERANCE**. Salinity and temperature are the major abiotic factors limiting crocodile distribution and abundance (Duson and Mazzotti 1989. B. Mar. Sci. 44:229–244; Mazzotti et al. 2007. J. Herpetol. 41:122–132; Richards et al. 2004. Ecol. Model. 180:371–394). *Crocodylus moreletii* lacks excretory (salt)

glands, so it is typically considered freshwater-dwelling (Platt and Thorbjarnarson 2000. Biol. Conserv. 96:21–29). Hence, here we provide observations indicating that *C. moreletii* may be more salinity tolerant than previously recognized.

During nocturnal crocodile surveys of La Mancha Lagoon, Veracruz, Mexico (19.5689°N, 96.3872°W; datum: NAD27; elev. 0 m.) in March 2007, we recorded the size range of *C. moreletii* in relation to water salinity. We measured salinity using a multi-parameter YSI85. Following Platt and Thorbjarnarson (*op. cit.*), we classified crocodiles based on total length (TL) as hatchlings (TL < 29.9 cm), yearlings (TL = 30–50 cm), juveniles (TL = 51–100 cm), subadults (TL = 101–150 cm), and adults (TL > 150 cm). We observed 10 crocodiles, four yearlings, three juveniles, two subadults and one adult. Hatchlings were observed in 3.4 parts per thousand (ppt), juveniles in 10.8 ppt, subadults in 22.7 ppt, and adults in 21.4 ppt.

Taplin (1988. Biol. Rev. 63:333–377) suggested that *C. moreletii* tolerantes heavily brackish water (> 20.0 ppt). However, in coastal Mexico and Belize where Morelet's and American crocodiles (*C. acutus*) occur in macrosympatry, the former is generally confined to freshwater, whereas the latter is found in saline habitats (Cedeño-Vázquez et al. 2006. Herpetol. Nat. Hist. 10:17–30). Our observations compliment the earlier report of Meerman (1992. Occ. Pap. Belize Nat. Hist. Soc. 1:1–5) from Chetumal Bay where fisherman captured an adult *C. moreletii* in heavily brackish water (22 ppt). Collectively, these data suggest that *C. moreletii* is physiologically capable of tolerating moderately saline conditions. Hence, its general absence from brackish coastal habitats may arise from conditions other than a limiting saline environment, such as those resulting from the poorly understood interspecific interactions with *C. acutus*.

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RHYNCHOCEPHALIA — TUATARAS

SPHENODON PUNCTATUS (Common Tuatara). **PREY DETECTION.** *Sphenodon punctatus* are generally regarded as nocturnal visual hunters that rely on movement to detect and capture prey (Dawbin 1962. Endeavour 21:16–24; Walls 1981. New Zealand J. Ecol. 4:89–97). They feed primarily on orthopterans, beetles, and arachnids (Ussher 1999. New Zealand J. Zool. 26:117–125), but are also known to eat the eggs (Gaston and Scofield 1995. Notornis 42:27–41) and chicks (Walls, *op. cit.*) of Fairy Prions (*Pachyptila turtur*), small burrowing seabirds that occur at high densities on many *S. punctatus*-inhabited islands. As *S. punctatus* and *P. turtur* often use the same burrows (Newman 1987. Herpetologica 43:336–344), *S. punctatus* are likely to occasionally encounter prion chicks when entering a burrow, and they may opportunistically consume them as well as any eggs present in the burrow. However, in the absence of movement cues, detection of certain food items such as carrion or isolated eggs may be more readily accomplished via olfaction (Walls, *op. cit.*). Here we report an observation of a male *S. punctatus* feeding on a *P. turtur* egg during which time it displayed behavior consistent with olfaction.

At ca 1200 h on 28 November 2006, an intact *P. turtur* egg was observed on a concrete slab at the base of a small bank on Stephens Island, Cook Strait, New Zealand (40.67°S, 174.00°E; elev. 215 m). The egg had likely been laid in one of the burrows dug into the side of the bank, and may have been displaced by the burrowing activity of a *S. punctatus* or seabird, whereupon it rolled out of the burrow and onto the slab. Though the eggshell was intact, it had evidently not been viable for some time as its odor was easily detectable to human observers. Importantly, we observed no flies near the egg at this point. At 1400 h, a male *S. punctatus* was observed and video-recorded consuming the egg. He broke the eggshell in his jaws and then proceeded to chew up and swallow the shell fragments. During this process, yolk dripped onto the concrete slab and spread out in a thin layer over about 5 cm^2, attracting numerous flies that swarmed around the yolk and the face of the *S. punctatus*. After having eaten all of the shell fragments, the *S. punctatus* proceeded to probe at the ground with his snout and the tip of his lower jaw and appeared to be searching for additional matter that could be consumed. He probed first in the vicinity of the spilled yolk, and then moved in a zig-zag pattern, first outward from the yolk and then down the side of the concrete slab, before returning to probe again at the site of the yolk. The nose-probes were interspersed by motions in which the *S. punctatus* dragged his snout along the ground without breaking contact with the substrate. At no point did he display any tongue-flicking or mouth-opening behavior consistent with vomeronasal detection. In addition, the flies attracted to the broken egg were landing on the spilled yolk but not the surrounding area, and a search pattern by the *S. punctatus* based on the movement of the flies should have kept his attention on the flies at the spilled yolk. Instead, upon consuming the last of the eggshell, the *S. punctatus* searched the area independently of the location of the flies. Moreover, the *S. punctatus* immediately swatted with a forelimb at any flies that landed on his face, even during an agonistic encounter with an approaching male conspecific. The *S. punctatus* remained in the vicinity for ca. 35 min.

Although *S. punctatus* are active primarily at night, they spend much of the day basking at their burrow entrances (Goetz and Thomas 1994. New Zealand J. Zool. 21:473–485; Walls 1983. New Zealand J. Zool. 10:309–318). As sit-and-wait predators, it is not surprising that they would also feed during the day if the opportunity arose, as it did in this observation. The behavior displayed here is consistent with prey detection via olfaction because we could identify no movement cues at the time the prey item was first detected by the *S. punctatus*; subsequent motion by flies was ignored; and the *S. punctatus*'s probing was consistent with olfactory, but not vomeronasal, detection.

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Island, and Fulbright New Zealand and the Allan Wilson Centre for Molecular Ecology and Evolution for funding. Victoria University of Wellington Animal Ethics Committee in consultation with Te Ngati Koata no Rangitoto ki te Tonga Trust and the New Zealand Department of Conservation provided ethics approval and permits.

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SQUAMATA — LIZARDS

ANOLIS UNIFORMIS (Lesser Scaly Anole). **DIET.** *Anolis uniformis* is a small lizard widely distributed in wet tropical rain forests from southern Tamaulipas, México through northern Guatemala and Belize to northern Honduras. It occurs in forest understory from near sea level to about 900 m (Campbell 1998. Amphibians and Reptiles of Northern Guatemala, the Yucatán, and Belize. University of Oklahoma Press, Norman, Oklahoma. 380 pp.; Campbell et al. 1989. Biotropica 21:237–243; Lee 1996. The Amphibians and Reptiles of the Yucatan Peninsula. Comstock Publishing Associates. Cornell University Press, Ithaca, New York. 500 pp.). The most observable lizard at Los Tuxtlas tropical rain forest, Veracruz, México, *A. uniformis* is thought to be a diurnal insectivore across its geographic range (Duellman 1963. Univ. Kansas Publ. Mus. Nat. Hist. 15:205–249; Villarreal 1997. *In* González et al. [eds.], Historia Natural de los Tuxtlas, pp. 495–500. Universidad Nacional Autónoma de México, México, D.F.; Villarreal and Heras 1997. *In* González et al. [eds.], *op. cit*., pp. 476–478). Here we report predation by *A. uniformis* on an anuran.

At 2315 h on 3 September 2003 during a nocturnal herpetofaunal survey, we observed a young male *A. uniformis* (29 mm SVL) swallowing a very small (ca. 9 mm SVL) leaf litter frog (*Craugastor* sp.). The event occurred on the leaf of a medium-sized plant in a small bamboo and tropical rain forest remnant in the Los Tuxtlas region, Veracruz, México (18.6072°N, 95.1437°W; datum: WGS84; elev. 650 m). The anole was collected and deposited in Colección Nacional de Anfibios y Reptiles, Instituto de Biología, Universidad Nacional Autónoma de México (CNAR IBH 21138).

From September 2006 to July 2007, we also collected and dissected 30 *A. uniformis* adults at the Laguna Escondida rainforest remnant at Los Tuxtlas region (18.5909°N, 95.0883°W; elev. 150 m) as a part of a parasitological study. Examination of stomach and intestinal contents revealed only arthropod remains, mostly terrestrial and flying insects (flying Diptera, Hymenoptera, Hemiptera; terrestrial Orthoptera) and a few spiders. We found no amphibian remains in this sample.

Previous diet records for *Anolis uniformis* (Stuart 1948. Misc. Publ. Mus. Zool. Univ. Michigan 69:1–109; Villarreal, *op. cit.*; Villarreal and Heras, *op. cit.*) indicate that it preys on insects and litter-dwelling invertebrates, especially soft-bodied arthropods. Our 2003 observation indicates that *A. uniformis* can prey on small amphibians and that it may sometimes feed at night.

We thank to F. Bertoni, M. Márquez, R. Paredes, H. Reyes, and M. Sánchez for assistance in the field.

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CTENOSAURA PECTINATA (Spiny-tailed Iguana). **POPULATION STATUS**. *Ctenosaura pectinata* is native to the west coast of Mexico and ranges from mid-Sinaloa to south Oaxaca, at elevations below 1000 m (Burghardt and Rand 1982. Iguanas of the World: Their Behavior, Ecology, and Conservation. Noyes Publ., Park Ridge, New Jersey. 504 pp.). During the last century, *C. pectinata* was introduced into Brownsville, Texas as well as south Florida (Conant and Collins 1998. A Field Guide to the Reptiles and Amphibians, Eastern / Central North America. Houghton Mifflin Co., Boston, Massachusetts. 616 pp.). Both populations have been established for nearly 40 years (Smith and Kohler 1978. Trans. Kansas Acad. Sci. 80:1–24; Meshaka et al. 2004. Exotic Amphibians and Reptiles of Florida. Krieger, Malabar, Florida. 155 pp.). The population in south Florida has been discussed in the literature numerous times (see Meshaka et al., *op. cit*. for a review) but little has been published about the Brownsville population. Here, we document the persistence of *C. pectinata* in Brownsville and their use of artificial microhabitat.

From 6–16 June 2007, we conducted eight searches for *C. pectinata* at the Gladys Porter Zoo (GPZ), Brownsville, Texas, USA (97.4952°W, 25.8831°N; datum: WGS84; elev. 6 m) and vicinity. Searches were conducted between 0800–1400 h, when iguanas would be basking. We searched the GPZ by slowly walking along exhibits, alleys, and buildings for ca. 3 h during each search. We also chose areas of the surrounding neighborhood that were within 0.5 km of the GPZ, and searched them by slowly walking along sidewalks and alleys for ca. 1 h. We used binoculars and digital photo equipment to find, observe, and record observations of *C. pectinata.* Photos and videos were reviewed to distinguish multiple sightings of an individual from sightings of several individuals based on coloration, markings, and head shape. Captures could not be made due to facility restrictions. We used a Garmin eTrex Vista C GPS unit to georeference *C. pectinata* locations (accurate to within ~5 m). GPZ staff assisted us in locating areas where *C. pectinata* were known to occur.

Though the GPZ staff has received reports of *C. pectinata* elsewhere in south Texas, the only known breeding population is centered at the GPZ in Brownsville. The GPZ (est. 1971) is a 10.5-ha facility dominated by open-area exhibits bordered by fences and artificial rivers and lagoons, and interconnected by artificial rock walls and sidewalks. Nine islands, some with artificial rock structures, have been built to exhibit zoo animals.

Reviews of photographs, videos, and GPS waypoints revealed a total of nine adult (ca. 1 m TL) *C. pectinata* and one juvenile (ca. 20 cm TL) within the zoo grounds. These individuals were located near or inside exhibits that were bordered with artificial

rock walls (2–4 m in height); three adults were observed entering holes in these structures. On 8 June, we observed an adult perched 3 m up on a rocky peak within an exhibit (Fig. 1, pt 1). On 9 June, we observed an adult and a juvenile perched less than 3 m apart on an artificial rock wall in the rear of the same exhibit, shaded by vegetation (pt 2). On 9 June, we also observed an adult entering a hole in the wall, behind an exhibit (pt 3). On 9 June, we observed an adult basking on a level rock surface that was elevated 2 m above an artificial lagoon within a different exhibit (pt 4). This adult was again observed on 15 June, emerging from a crack in the concrete surface of the exhibit floor, 20 m from where it was previously observed (pt 5). On 12 June, two adults were observed simultaneously occupying the same large (4 m × 4 m × 7 m) rock structure on an island (pt 6). These iguanas were separately observed on 6, 10, and 15 June occupying the same structure. On 16 June, we observed two other adults, one missing half its tail, perched within 2 m of each other, on a rocky peak (2.5 m) that was shaded by vegetation (pt 7). This peak was part of a wall separating two exhibits. On 16 June, we observed an adult perched 4 m up on a rock wall within a different exhibit (pt 8).

Two individuals were also observed outside the zoo. One (ca. 0.5 m TL) was observed on Belvedere Drive, a road that separates the zoo from the surrounding neighborhood (pt 9). This individual fled into the zoo as our vehicle approached. The total length and bright green tail coloration indicated that it was a juvenile. The other individual (ca. 0.5 m TL) was observed in a grassy neighborhood alley, ca. 60 m from the zoo (pt 10). This individual was predominantly green, and due to the similarity between hatchling *C. pectinata* and *Iguana iguana*, could have been an *I. iguana*. GPZ staff have observed at least 5 juveniles in the zoo over the past three years, including an individual that was ca. 20 cm TL, seen on 30 June 2007 in an exhibit barn.

Though the population at GPZ has been established for nearly 40 years, we found few individuals (N = 12) despite intensive search efforts. Apparently, population growth has been limited, possibly by low overwinter survival, predation, or both. The lowest average annual minimum temperature (i.e., the coldest temperature experienced each winter) for extreme south Texas for the period 1960–1990 was –1.8°C to –3.8°C (Cathey and Jordan 2001. USDA Plant Hardiness Zone Map. U.S. National Arboretum, Agricultural Research Service, USDA, Washington, DC). In contrast, the lowest average annual minimum temperature for the native range of *C. pectinata* ranged from 1.7°C to about 4.5°C during the period 1960–1990 (Cathey and Jordan 2001, *op. cit.)*, thus, the colder temperatures in south Texas may have affected survivability. Some authors (e.g., Iverson 1978. Biol. Conserv. 14:63–73) have also suggested that predation by cats and dogs may cause populations of ground-dwelling iguana species to decline. Cats and dogs are infrequently encountered inside the GPZ, but their predation could potentially limit populations in surrounding neighborhoods. Besides these potential predators, the GPZ has a large, diverse avian community; birds such as egrets (free-ranging) and hornbills (exhibited) may also be potential predators.

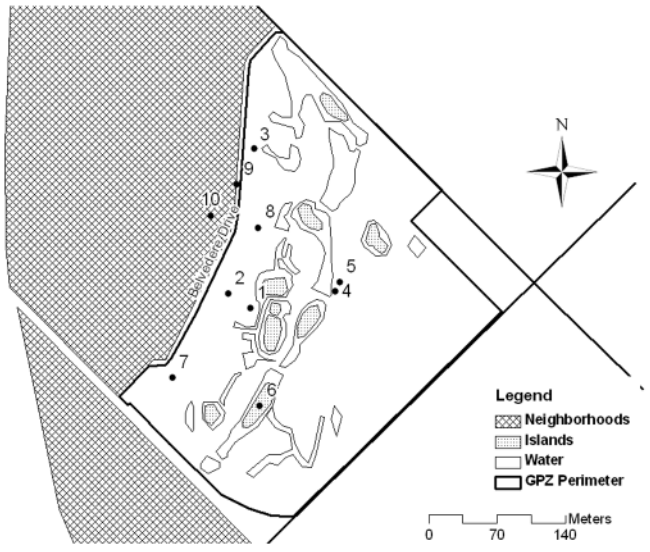


FIG. 1. Map of the Gladys Porter Zoo. Numbered points correspond to sightings of *Ctenosaura pectinata* referred to in the text.

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GLAPHYROMORPHUS NIGRICAUDUS (NCN). **PREY PIRACY.** Prey piracy, the opportunistic theft of prey from another predator or another indirect source, is known for a broad range of diurnal reptilian taxa. In this note I report on an incidence of prey piracy in the skink *Glaphyromorphus nigricaudus*.

Glaphyromorphus nigricaudus is a secretive species restricted to tropical northeast Queensland, Australia. Like most of its genus, it prefers shaded moist habitats and is reported to be nocturnal-crepuscular, but is sometimes active during the day (Cogger 2000. Reptiles and Amphibians of Australia, Reed Publishing, Sydney, Australia. 808 pp.). While conducting fieldwork at Trinity Beach in northeastern Australia (145.6978°E, 16.7861°S; datum: AGD66; elev. 0.9 m) at 1453 h EST on the 17 February 2001, I observed an adult *G. nigricaudus* patrolling 5–10 cm from a well-established Green Ant (*Oecotsylla smaragolia*) column oriented in an eastward direction. Many of the ants were transporting prey back to a nest located in a nearby tree. Over a period of 18 min, I observed the lizard lunge quickly at individual ants carrying specific prey. Following each successful lunge, the lizard would retreat a short distance from the column (20–40 cm) to consume the prey. From a nearby vantage point, I determined that the majority of prey items targeted by the lizard were lepidopteran larvae.

The cryptic nature and high diversity of Australian skinks (Cogger, *op. cit.*) implies that the frequency with which prey piracy occurs among Australian skinks may be substantially underestimated. Nonetheless, at least four other cases of skink species opportunistically stealing prey (directly or indirectly) from other predators have been reported. Three of these records involve cases of direct piracy from ant columns by the diurnal species *Carlia munda* (Bedford 1995. Herpetol. Rev. 26:99–100.), *Cryptoblepharus virgatus* (Greer 1989. The Biology

and Evolution of Australian Lizards. Surrey Beatty and Sons, Chipping Norton, Sydney. 264 pp.) and *Morethia boulengeri* (as *Ablepharus lineoocelatus*) (Chisholm 1923. Aust. Zool. 3:60–71). A fourth observation was the theft of arthropod prey from eumenid mud-wasp nests involving *Cryptoblepharus virgatus* (Phillips 2005. Herpetofauna 35:120). Members of the genus *Glaphyromorphus* are almost entirely terrestrial, crepuscular, and secretive in habit (Greer, *op. cit.*), suggesting that high energy prey, such as lepidopteran larvae, might be available only infrequently. If this is the case, instances of prey piracy, as I report here, might provide such species with an additional and energetically favorable form of prey.

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LEPIDOBLEPHARIS XANTHOSTIGMA (NCN). **ENDOPARASITES.** *Lepidopblepharis xanthostigma* is a small gecko that inhabits leaf litter and occurs from southeastern Nicaragua and northwestern Costa Rica to northern Colombia (Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna Between Two Continents, Between Two Seas. University of Chicago Press, Chicago, Illinois. 934 pp.). To our knowledge, only one report of an endoparasite from this species exists; Goldberg and Bursey (2004. Herpetol. Rev. 35:268) reported acanthocephalan (Oligacanthorhynchidae) cystacanths from this host. The purpose of this note is to add the nematode *Porrocaecum* sp. to the list of endoparasites of *L. xanthostigma.*

The coelomic cavity of one mature female *L. xanthostigma* (28 mm SVL) from the herpetology collection of the Natural History Museum of Los Angeles County (LACM 114228) collected in Puntarenas Province, Costa Rica (8.7167°N, 83.4667°W; datum: WGS84; elev. 38 m) in May 1971 was examined for helminths. The body cavity was opened and the visceral organs were examined under a dissecting microscope. Two larvae were found in cysts in the liver. They were cleared in a drop of undiluted glycerol on a glass slide, examined with a compound microscope and assigned to the genus *Porrocaecum.* The larvae were deposited in the United States National Parasite Collection, Beltsville, Maryland as (USNPC 100467).

Adults of *Porrocaecum* live in the intestines of birds; eggs pass with the feces and are eaten by earthworms in which they hatch (Anderson 2000. Nematode Parasites of Vertebrates: Their Development and Transmission, 2nd ed. CABI Publishing, Oxfordshire, UK, 650 pp.). Vermivorous verebrates may act as paratenic (= transport) hosts; larvae mature when ingested by an appropriate host (Anderson, *op. cit.*). *Lepidoblepharis xanthostigma* represents a new paratenic host record for *Porrocaecum* sp. and can be added to the list of poikilothermic Costa Rican vertebrates serving as transport hosts: *Amastridium veliferum, Chironius carinatus, Dendrophidion pericarinatus, Dendrophidion vinitor, Erytholamprus bizonus, Liophis epinephelus, Oxybelis brevirostris, Micrurus nigrocinctus* (Goldberg and Bursey 2004. Carib. J. Sci. 40:62–69); *Coniophanes fissidens, Rhadinaea decorata, Plicocercus euryzonus* (Goldberg and Bursey 2007. Phyllomedusa 6:69–72); *Lithobates taylori, Lithobates vaillanti* (Goldberg and Bursey 2007. Carib. J. Sci. 43:65–72); and *Lithobates warszewitschii* (Bursey and Goldberg 2007. Carib. J. Sci. 43:1–10).

We thank Christine Thacker (LACM) for permission to examine the *L. xanthostigma* that is part of the CRE collection donated in 1998 by Jay Savage.

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LIOLAEMUS CUYANUS (NCN). **CLUTCH SIZE.** *Liolaemus cuyanus*, a medium-sized sand lizard belonging to the "*darwinii*" complex (Abdala 2007. Zootaxa 1538:1–84), has a wide distribution, living in dunes in Neuquén, La Pampa, Mendoza, San Juan, La Rioja, and Catamarca provinces. This species occurs in habitats dominated by xerophyllous vegetation (primarily *Larrea divaricata*, *Bulnesia retama*, and *Opuntia*, *Trichocereus*, and *Echinopsis* cacti species). Other than a description of it being oviparous (Cei 1986. Reptiles del Centro, Centro-oeste y Sur de la Argentina. Herpetofauna de Zonas Áridas y Semiáridas. Monografie IV. Museo Regionale di Scienze Naturali Torino, Italy. 527 pp.), few data exist regarding its reproductive biology (Blanco et al. 2002. XVI Reunión de Comunicaciones Herpetológicas. La Plata, Argentina. 32 pp.). Hence, we report the first data on clutch size in *L. cuyanus*.

On 4 November 2007, we captured a gravid female (71 mm SVL) *L. cuyanus* at Los Baldecitos, Valle Fértil Department, San Juan Province (30.22°S, 67.68°W; datum: WGS84; elev. 1239 m) in the shade of a *Larrea cuneifolia* shrub on reddish sandy that matched its dorsal coloration. We placed this female in a 120 cm × 60 cm × 40 cm terrarium with abundant sand and gravel, and provided larval beetles and water *ad libitum*. On 2 December 2007, the female laid 7 eggs. We measured the length and width of each egg with Vernier calipers to the nearest 0.1 mm. The volume of each egg was calculated using the formula of an ellipsoid sphere (Dunham 1983. *In* Huey et al. [eds.], Lizard Ecology, pp. 261–280. Harvard University Press, Cambridge, Massachusetts). Eggs averaged 14.2 mm (s = 1.1) long; 8.3 mm (s = 0.2) wide; and 292.4 mm^3 (s = 31.4) in volume. This clutch size may approximate what is typical for this species. *L. cuyanus* females from Médanos Grandes (Caucete Department), located 178 km SW of the Baldecitos population were reported to have a mean clutch size of 7.9 (Blanco et al., *op. cit.*). These authors mentioned that *L. cuyanus* displays follicular activity over a lengthy season (September–March) and commonly lays two clutches annually.

We deposited the eggs in the herpetological collection of the Instituto y Museo de Ciencias Naturales, Universidad Nacional de San Juan. We thank Y. Heredia and V. Pesce for help in the field and G. Blanco for generously providing reproductive data on *L. cuyanus*.

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LIOLAEMUS INACAYALI (NCN). **MAXIMUM SIZE.** *Liolaemus inacayali*, a recently described species, inhabits Provincia de Rio Negro, Argentina (Abdala 2003. Cuad. Herpetol. 17:3–32). Available size data from the species description indicate that 10 individuals measured ranged from 57.3 to 75.3 mm SVL (mean = 63.7 mm). Here, we report on an additional *L. inacayali* that considerably exceeds the known maximum size.

In the Juan Carlos Acosta (JCA) herpetological collection, we discovered an adult male *L. inacayali* (no number collection) collected by Graciela Blanco in December 1991 in Ingeniero Jacobacci, Departamento 25 de Mayo, Provincia de Río Negro (41.28°S, 69.57°W; elev. 894 m) with a SVL of 77.3 mm. This individual, like others of its species, was collected from a very arid habitat with high daily and seasonal temperature variation and low annual precipitation (< 200 mm.), principally as snow. The soil is composed of sand derived from interspersed volcanic and sedimentary rocks. Vegetation consists of low spiny shrubs typical of central Patagonia.

The specimen is deposited in the Universidad Nacional de San Juan herpetological collection (IMCN-UNSJ-3015).

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SCELOPORUS OCCIDENTALIS (Western Fence Lizard). **PREDATION**. Invertebrate predators such as spiders, scorpions, and mantids occasionally feed on immature lizards (Jehle et al. 1996. Herpetozoa 9:157–160; Pianka and Vitt 2003. Lizards: Windows to the Evolution of Diversity. University of California Press, Berkeley, California. 333 pp.; Prete et al. [eds.] 1999. The Praying Mantids. Johns Hopkins University Press, Baltimore, Maryland. 400 pp.). However, documentation of such events is sparse. Here, I report an observation of predation on *Sceloporus occidentalis* by the European mantid, *Mantis religiosa*, an introduced species previously reported to prey on lizards in Europe (Jehle et al., *op. cit.*), and that is now widespread in the United States.

At 1220 h on 2 September 2006 (air temperature 25.3ºC), I observed a female *M. religiosa* (73 mm body length) feeding on a hatchling *S. occidentalis* (ca. 32–35 mm SVL, Fig. 1) 24.6 km SW of Idaho City, Boise Co., Idaho, (43.6367°N, 115.9975°W, datum: WGS84; elev. 995 m). When discovered, the mantid momentarily stopped feeding, but it had already consumed the head, neck, left foreleg, and some of the upper left trunk region of the lizard. Without further disturbance, the mantid resumed feeding another 15–20 min, and photographs were taken during this time. After feeding, the mantid left the carcass remnant and climbed into adjacent *Rudbeckia* flowers. The mantid was not collected, but was identified as *M. religiosa* by the occurrence of a large black-ringed spot on the anteroventral surface of the forecoxa, near the base (Helfer 1987. How to Know the Grasshoppers, Crickets, Cockroaches and their Allies. Dover Publications, New York, New York. 363 pp.).



FIG. 1. *Mantis religiosa* feeding on *Sceloporus occidentalis*, Boise Co., Idaho, 2 September 2006.

I made the observation in a ca. 60 ha unincorporated residential subdivision located in the foothill shrublands-grasslands ecoregion of Boise County (McGrath et al. 2002. Ecoregions of Idaho. USGS. Reston Virginia. U.S. Geological Survey map, scale 1:1,350,000) and surrounded by thousands of hectares of similar habitat. *Sceloporus occidentalis* have been observed in this subdivision for more than 25 years (pers. obs.). However, *M. religiosa* was likely introduced to the subdivision less than 15 years ago (DRB, unpubl. data) and has since become abundant; on 6 August 2007, I observed 14 mantids in ca. 66 m^2 of unmowed largely graminoid vegetation 106 m ENE from the aforementioned site of observation. Areas with high densities of generalist invertebrate predators, such as *M. religiosa*, may increase the likelihood of small vertebrates becoming prey.

I thank Jack W. Sites, Jr. (Brigham Young University) for identifying the lizard. It was deposited in the BYU herpetological collection (BYU 4426). William H. Clark (Orma J. Smith Museum of Natural History, College of Idaho, Caldwell) provided helpful suggestions on this note.

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TROPIDURUS ITAMBERE (Rock Lizard). **SOCIAL INTERACTIONS.** Visual signals are used in many different social contexts, incluing territory advertisement, courtship, and intrasexual interactions (Bradbury and Vehrencamp 1998. Principles of Animal Communication. Sinauer Associates, Sunderland, Massachusetts. 882 pp.). Nearly all lizard species display some form of intraspecific aggression ranging from specific site defense (e.g., basking sites or burrows) to home range defense (Stamps 1977a. *In* Gans and Tinkle [eds.], Biology of the Reptilia: Volume 7. Social Behavior and Spacing Patterns in Lizards, pp. 265–334. Academic Press, New York). Herein, we provide the first description of courtship and territorial behavior for the saxicolous lizard *Tropidurus itambere*. This is a medium-sized lizard (mean adult SVL = 71.8 mm) that commonly occurs in open, sometimes rocky, areas in central and southeastern Brazil (Rodrigues 1987. Arq. Zool. São Paulo 31:105–230). Females

have a seasonally distinct reproductive cycle from the end of the dry season to the end of the rainy season (October–March), whereas some males are reproductive year-round (Van Sluys 1993. J. Herpetol. 27:28–32).

We made field observations in August and December 2007 (end of the dry season and rainy season, respectively) in a rocky open area at Parque Estadual do Ibitipoca, state of Minas Gerais, southeastern Brazil (21.67°–21.73°S and 43.87°–43.92°W; elev. 1200 m). We first observed courtship behavior (Fig. 1) at 1330 h on 13 August on a rock substrate. An adult female (73.8 mm SVL) was on the rock raised up on four legs, arching her back with her tail raised when a large male (84.4 mm SVL) approached her and bit her neck just once (Fig. 1A). The female moved away from male while he remained in place and both lizards then inflated their gular regions while head bobbing. The female arched her back and again presented her raised tail to the male (Fig. 1B) while he continued to perform head bobs with the gular region inflated. The lizards remained this way for ca. 20 sec, then the male approached the female and pushed her cloacal region, sometimes successively, with his nose (Fig. 1C). Subsequently, the two lizards arched their backs and inflated their gular regions while the female remained with her tail raised. The male then rushed the female once more, attempting to bite her neck twice, and the female again moved away. We did not observe copulation.

At 1500 h on 16 August, we observed an aggressive interaction between two males. For a few seconds, a larger male (86.9 mm SVL) was on a rock with the gular region inflated and head bobbing with the forelimbs extended toward a smaller male (75.8 mm SVL). The larger male then jumped off rock and chased the smaller male, who fled to nearby vegetation. A few minutes later, the larger male was observed copulating with a smaller female (67.8 mm SVL) near to where the smaller male had been chased.

At 1000 h on 1 December, we observed a similar agonistic interaction, but between two females. The larger female (76.8 mm SVL) was on a rock when a smaller female (63.6 mm SVL) approached her. Soon after, the larger female arched her back and began to head bobbing with the forelegs extended. She then jumped off the rock and approached the other female with the gular region inflated while head bobbing and chased smaller female, who fled to nearby vegetation. Subsequently, the aggressive female returned to the same rock.

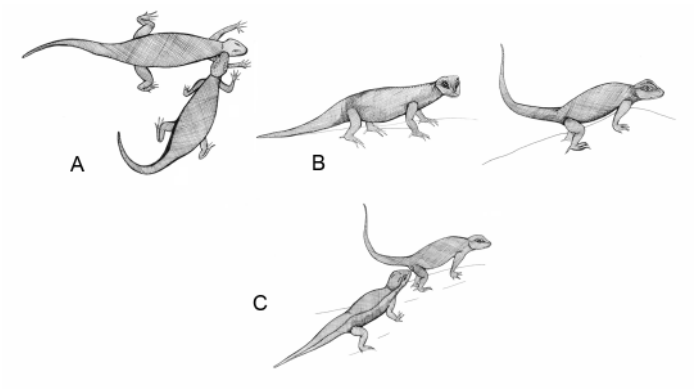


FIG. 1. Courtship behavior of *Tropidurus itambere* observed in a rocky open area situated at Parque Estadual do Ibitipoca, in Minas Gerais, southeastern Brazil.

Courtship behavior we describe for *T. itambere* was similar to that reported for others *Tropidurus* (Àvila and Cunha-Avellar 2006. Herpetol. Rev. 37:473; Carpenter 1977. Herpetologica 33:285–289). Tail raising has been attributed to play a role in courtship interactions and female rejection behavior (Carpenter 1977. Herpetologica 33:285–289; Martins 1991. Anim. Behav. 41:403–416; Martins 1993. Anim. Behav. 45:25–36). According to Stamps (1977a., *op. cit.*) and Fitch (1981. Misc. Publ. Mus. Nat. Hist. Univ Kansas 70:l–72) males and females in the Tropiduridae generally show home-range defense or are territorial. Van Sluys (1997. Copeia 1997:623–628) found that the overlap between home ranges within sexes in *T. itambere* is low and suggested that both sexes are territorial, but no descriptions of aggressive behaviors were provided. Our observations revealed that male and female *T. itambere* display aggressive behaviors when defending their areas, as has been observed for *T. albemarlensis* (Stebbins et al. 1967. Ecology 48:839–851) and *T. delanonis* (Werner et al. 1978. Z. Tierpsychol. 47:337–395). Field studies performed by Stamps (1977b. Ecology 58:349:358) using the lizard *Ano1is aeneus* as a model may indicate that females compete for food and males for mates.

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SQUAMATA — SNAKES

ATRACTUS TORQUATUS (Rusty Earth Snake). **DIET**. Based on reports available in the literature, this Amazonian snake preys primarily on earthworms; however mites, beetles, and flies have also been reported as prey (Martins and Oliveira 1993. Zool. Meded. 67:21–40). Here we report the first evidence of this species feeding on a vertebrate. On 20 November 2002, at 1414 h, we collected an adult male *Atractus torquatus* (INPA-H 10932; 472 mm total length, 28.29 g) at Reserve Adolpho Ducke, in the municipality of Manaus, Amazonas state, Brazil (2.950°S, 59.917°W, WGS 84, 60 m elev.). We found a single amphibian—the caecilian *Rhinatrema bivittatum* (INPA-H 16057; 238 mm total length; 8.3 g)—in the digestive tract. This observation gives evidence that *A. torquatus* is capable of feeding on caecilians and possibly other limbless, fossorial vertebrates and invertebrates of comparable sizes. Additional evidence of the ability to consume large, limbless prey is a report of an *A. torquatus* preying on a giant earthworm (180 mm total length; Martins and Oliveira 1998. Herpetol. Nat. Hist. 6:78–150).

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BOTHROCOPHIAS HYOPRORA (Amazonian Hog-nosed Pit Viper). **DIET**. *Bothrocophias hyoprora* is a forest-dwelling terrestrial snake with a diet that includes centipedes, frogs, lizards, marsupials, and rodents (see Martins et al. 2002. *In* Schuett et al. [eds.], Biology of the Vipers, pp. 307–328. Eagle Mountain Publishing, Eagle Mountain, Utah; Cisneros-Heredia et al. 2006. Herpetozoa 19:17–26). There are few specific reports of this species' diet in the literature. On 11 March 2003 at 0700 h a juvenile *B. hyoprora* (298 mm SVL, 15 g after prey removal) was captured in a forest at Reserva Biológica do Jaru (10.1447222°S, 61.9075°W), Ji-Paraná, Rondônia, Brazil. Upon dissection, we discovered a frog *Allobates femoralis* (Aromobatidae; 32 mm SVL, 2.3 g) in the snake's stomach that had been ingested head-first. This is the first report of *A. femoralis* in the diet of *B. hyoprora*. The snake was deposited in the herpetological collection of Universidade Federal do Acre, Campus Floresta (UFACF 216) in Cruzeiro do Sul, State of Acre, Brazil.

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BOTHROPS ATROX (Amazonian Lancehead). **DIET**. *Bothrops atrox* is a euryphagous pitviper that feeds on centipedes, fishes, frogs, lizards, snakes, birds, and small mammals (see Martins et al. 2002. *In* Schuett et al. [eds.], Biology of the Vipers, pp. 307–328. Eagle Mountain Publishing, Eagle Mountain, Utah and citations therein; Oliveira and Martins 2003. Herpetol. Rev. 34:61–62; Macedo-Bernarde and Bernarde 2005. Herpetol. Rev. 36:456). On 16 March 2006 at 2030 h we captured an adult *B. atrox* (620 mm SVL, 334 g after prey removal) in a pasture near Parecis (12.18°S, 61.60°W), Rondônia, Brazil. Upon dissection, we found a *Taraba major* (Aves: Passeriformes: Thamnophilidae; 88 g) in the snake's stomach that had been ingested head-first. Birds are infrequent in the diet of this pitviper (Martins and Gordo 1993. Herpetol. Rev. 24:151–152; Martins et al. 2002, *op. cit.*). This is the first report of *T. major* in the diet of *B. atrox*. The snake was deposited in the herpetological collection of Universidade Federal do Acre, Campus Floresta (UFACF 215) in Cruzeiro do Sul, State of Acre, Brazil.

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CROTALUS RAVUS (Mexican Pygmy Rattlesnake). **DIET.** *Crotalus ravus* is a small rattlesnake restricted to the temperate montane regions of the Mexican Plateau southward to the Mesa del Sur in Oaxaca and the Sierra Madre del Sur in Guerrero (Campbell and Lamar 2004. Venomous Reptiles of the Western Hemisphere. Cornell Univ. Press, Ithaca, New York. 870 pp.). *Crotalus ravus* has been documented to consume a variety of vertebrate and invertebrate prey, including crickets, anurans, lizards, and rodents (Campbell and Armstrong 1979. Herpetologica 35:304–317; Sánchez-Herrera 1980. Bull. Maryland Herpetol. Soc. 16:9–18; Mendoza-Hernández et al. 2004. Herpetol. Rev. 35:63–64). Here we document the consumption of a snake by *C. ravus*.

On 21 July 2002 we collected a juvenile *C. ravus* in pine-oak forest near Colonia Zacamulpa, Municipality of Huixquilucan, Estado de México, Mexico (19.4141667°N, 99.3055556°W, elev. 2750 m). This snake was deposited in the herpetological collection of Instituto Tecnológico de Huejutla (ITAH 1412). Upon dissection, we found that the snake (SVL 308 mm, mass 19.8 g) had ingested a medium-sized colubrid snake, *Storeria storerioides* (ITAH 1412b; SVL 225 mm, tail length 60 mm, mass 10.7 g), head-first (Fig. 1). The approximate prey/predator mass ratio was 0.54. This is the first report of ophiophagy in *C. ravus*, and extends our knowledge about the diet of this rattlesnake.

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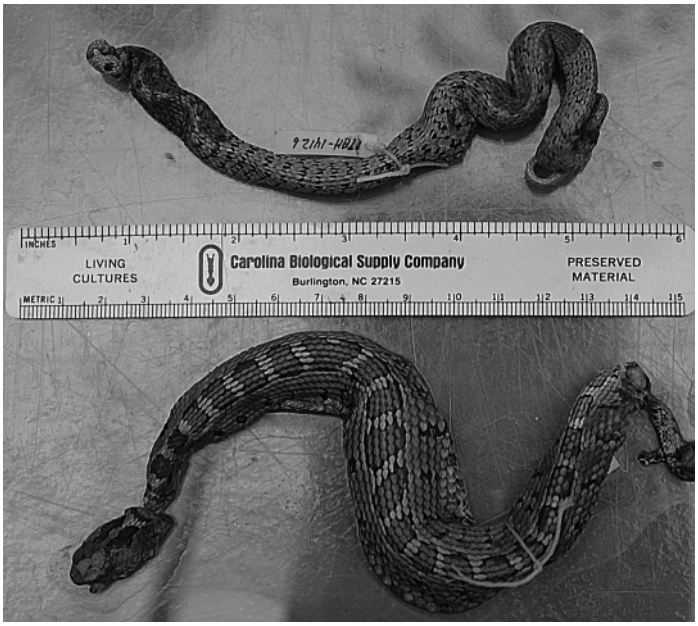


FIG. 1. A juvenile *Crotalus ravus* and prey (*Storeria storerioides*); approximate prey/predator mass ratio 0.54.

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HETERODON NASICUS (Western Hog-nosed Snake). **PREDATION.** Although predation on *H. nasicus* by avian predators has been reported in the literature (Ernst and Ernst. 2003. Snakes of the United States and Canada. Smithsonian Institution Press, Washington, D.C. 668 pp.) few instances have been documented, and we know of no accounts of predation on *H. nasicus* by Loggerhead Shrikes (*Lanius ludoviscianus*). Loggerhead shrikes are known to prey on a wide array of vertebrates including reptiles (Lefranc 1997. Shrikes. A Guide to the Shrikes of the World. Yale University Press, New Haven and London. 192 pp.). On 23 May 2005 we found a small male *H. nasicus* (171 mm SVL, 33 mm tail, 4.8 g) that was dead and draped over a branch at ground level under a soapberry tree (*Sapindus saponaria*) at the Caprock Wildlife Area, Chaves County, New Mexico, USA (33.4418653°N, 103.8165683°W, NAD 83). The snake had a 7 mm long by 3 mm wide wound on the right side of the body, between 43 and 50 mm from the snout near the snake's heart. We presumed predation by a Loggerhead Shrike due to the nature of the wounds, the position of the snake on the branch, and the presence of shrikes in the immediate area for weeks before and after the incident described above. The specimen was deposited at the Texas Cooperative Wildlife Collection, Texas A&M University (TCWC 89794).

Submitted by **MICHAEL T. HILL** and **LEE A. FITZGERALD**, Department of Wildlife and Fisheries Sciences, Texas A&M University, 2258 TAMU, College Station, Texas 77843, USA.

LAMPROPELTIS CALLIGASTER (Prairie Kingsnake). **ACTIVITY**. At high elevations snakes are known to emerge from winter hibernacula to bask on warm winter days (Hansknecht et al. 1999. Herpetol. Rev. 30:104), but information on snake activity away from hibernacula during cold temperatures is rare or lacking. On 27 December 2006, I encountered a recently killed female *Lampropeltis calligaster* (864 mm SVL, 101 mm tail) on the center dividing line of East Clarksville Road (Clark County Road 8), ca. 3 km NW of Marshall, Illinois, USA (39.4136111°N, 87.7275°W, WGS84; 180 m elev.). The cause of death was obviously by automobile, but the snake appeared in good physical condition otherwise. The temperature at the time of this encounter was ca. 1°C. It is possible that the snake was hibernating on a bank adjacent to or underneath the road, emerging to bask on the road. Because the snake was in the center of the road, however, it is likely that the snake was actively crossing the road. Furthermore, although December 2006 was warmer than typical Decembers (2006 mean high and low temperatures = 7.00°C and –1.94°C, respectively; normal mean high and low temperatures = 3.89°C and –4.61°C, respectively), days immediately prior to and the day of this encounter were not particularly warm. The mean high and low temperatures for the three days prior to encountering the animal were 4.07°C (± 0.19) and –0.56°C (± 0.64**)**, respectively. On 27 December 2006, the high and low temperatures were 2.22°C and –2.22°C, respectively.

I thank J. Angel for providing climatological data from a local weather station.

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LICHANURA ORCUTTI (Rosy Boa). **PREDATION**. The most common natural source of mortality for snakes is predation by various vertebrates (Greene 1997. Snakes: The Evolution of Mystery in Nature. Univ. California Press, Berkeley. 351 pp.). In arid western North America, some bird species in particular are known to prey heavily on snakes (e.g., Roadrunners, *Geococcyx californicus*; Red-tailed Hawks, *Buteo jamaicensis*, Golden Eagle, *Aquila chrysaetos*; Terres 1991. The Audubon Society Encyclopedia of North American Birds. Wing Books, New York, New York. 1109 pp.; Steenhof and Kochert 1988. J. Anim. Ecol. 57:37–48). We report here evidence of raptor predation on *Lichanura orcutti* (= *Lichanura trivirgata roseofusca*, Coastal Rosy Boa; see Wood et al. 2008. Mol. Phylogenet. Evol. 46:484–502) in southern California.

On 7 May 1999, an adult male *L. orcutti* implanted with a transmitter was radiotracked at the Santa Margarita Ecological Reserve, Riverside County, as part of an ongoing telemetry study in southern California (Diffendorfer et al. 2005. J. Herpetol. 39:24–36). On day five of the tracking effort for this snake, we recovered the skeletal remains (along with transmitter) from a raptor nest ca. 400 m upstream from the last point of capture. Ten additional *L. orcutti* were radiotracked along San Pasqual Valley, San Diego County, California. On 07 February 2000 (after 214 days of monitoring), an adult male implanted with a transmitter was found dead (with transmitter intact) within an agricultural field ca. 300 m from the last point of capture. The snake bore several puncture wounds across the length of the body. The distance moved by this individual greatly exceeded distances traveled per move for individuals (N = 10) of this population (distance per move ranged from 15.8–63.2 m; Diffendorfer et al., *op. cit.*). We presume this incidence represents an attempted predation event by a raptor, but was subsequently dropped while in flight and never recovered.

Although we were not able to determine the species of raptor for either observation, Red-tailed Hawks (*Buteo jamaicensis*) and Golden Eagles (*Aquila chrysaetos*) occur at both of these study sites, although Red-tailed Hawks were observed more frequently. To our knowledge, these are the first reports of predation on *Lichanura* by raptors, although we cannot rule out the possibility

of scavenging by raptors given that the act of predation was not observed.

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MORELIA SPILOTA SPILOTA (Diamond Python). **REPRODUCTION**. *Morelia spilota spilota* is a medium-sized (up to 3 m and 6 kg) boid inhabiting rocky outcrops, scrub, woodland, and disturbed urban areas of coastal southeastern Australia (Shine and Fitzgerald 1996. Biol. Cons. 76:113–122; Slip and Shine 1988a. Aust. Wildl. Res. 15:515–531). Sexual maturity is reached at 150 cm snout–vent length with breeding occurring in spring (late September to early November). Breeding aggregations of one female and several males are often formed which can last several months (Slip and Shine 1988b. Herpetologica 44:396–404). Here we report an unusual reproductive event involving a captive female *M. s. spilota* and wild male *M. s. spilota* that occurred prior to the recognized breeding season.

On 23 August 2007, a wild male *M. s. spilota* (1460 mm SVL; 1691 mm TL; 1.30 kg) entered a house in Berry (34.7652778°S, 150.6780556°E), NSW, Australia, through an open window at night. The male was discovered on the wire mesh screen top of a glass tank attempting to access a captive-born virgin female *M. s. spilota* (1525 mm SVL; 1890 mm TL; 1.79 kg) housed inside. The male was captured and released the following day ca. 500 m away on a nearby nature reserve (34.7616667°S, 150.6811111°E). On 28 August 2007, the same male *M. s. spilota* (identifiable by a distinctive missing tail tip) was again discovered on top of the tank attempting to access the captive female. At this time, CHB removed the screen top, the male python entered the cage, the screen top was replaced, and the pair began copulating within minutes. The pythons remained entwined and appeared to copulate multiple times until 6 September 2007, although it was often difficult to ascertain intromission depending on how the snakes were situated. On 6 September, the male appeared to lose interest and was released.

For a number of snake species, it appears that pheromones are substrate-bound substances (Aldridge et al. 2005. Amphibia-Reptilia 26:576–582; Carmichael et al. 2007. *In* Henderson and Powell [eds.], Biology of the Boas and Pythons, pp. 227–240. Eagle Mountain Publishing, Eagle Mountain, Utah). This has also been suggested for *M. s. spilota*, with females depositing pheromone trails to attract males (Slip and Shine 1988b, *op. cit.*). However, this reproductive encounter between a captive female *M. s. spilota* and wild male *M. s. spilota* indicates that pheromones could perhaps be airborne in *M. s. spilota*. We do not discount the possibility that the male python entered the house following non-pheromonal cues as part of its normal activity range, or that the male used spatial mapping or some other form of orientation to return to the house after being relocated. However, we suspect that the male was following pheromonal cues when he gained his first entry because: a) the window through which the male entered had been closed for three months during the winter and the male entered within three days of the window being opened; and b) no pythons had been seen previously in the vicinity of the house during > 7 years of occupancy by CHB. We suggest that more controlled investigations of the volatility of boid pheromones could have potential management applications, such as pheromone traps for invasive *Python molurus* or *Boa constrictor* in south Florida, USA.

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NERODIA CLARKII (Saltmarsh Watersnake). **PREDATION**. To our knowledge, there are no published observations of predation on *Nerodia clarkii*. Several authors have suggested that potential predators might include any large vertebrate or invertebrate such as fish, crabs, wading birds, snakes, alligators, or crocodiles (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Institution Press, Washington D.C. 218 pp.); Gibbons and Dorcas 2004. North American Watersnakes. University of Oklahoma Press, Norman, Oklahoma. 438 pp.). *Nerodia clarkii* is the most salt tolerant member of its genus and presumably is exposed to more marine predators than its congeners. Of these predators, *Callinectes sapidus* (Blue Crab) represents a more formidable invertebrate predator than those that would be typically encountered by most species of *Nerodia*.

During a herpetological survey of the Gulf Islands National Seashore, Mississippi District, Mississippi, USA, we observed an apparent predation attempt on *N. c. clarkii* on West Ship Island (30.2091667°N, 88.9783333°W [NAD83]). On 30 March 2006 at 1226 h we captured a *N. c. clarkii* (404 mm SVL) in a small, isolated pool in a *Juncus* sp. saltmarsh. After processing, we released the snake onto the bank where it remained for about five minutes. The snake then entered the pool where it was quickly grasped both at mid-body and just posterior to the head by a large female *C. sapidus*. With the *N. c. clarkii* firmly secured, the crab moved toward the deeper middle section of the pool pulling the snake's head just below the water surface. Once the head was submerged, the crab remained motionless for approximately two minutes, while the *N. c. clarkia* fully extended its body, stretching toward the surface. While attempting to photo-document this event, we disturbed the crab, subsequently causing the release of the snake. However, it seemed unlikely that the snake would have escaped without this intervention. Although crabs have been hypothesized as a potential predator of *N. clarkii* (Gibbons and Dorcas 2004, *op. cit.*), this is the first published report of crab predation on *N. clarkii*.

We thank the National Park Service, Mississippi State Museum, and Mississippi Division of Marine Resources for permissions or assistance.

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OPHEODRYS AESTIVUS (Rough Green Snake). **PREDATION**. Known avian predators of *O. aestivus* include four species of hawks (*Buteo*), Cattle Egret (*Bubulcus ibis*), Loggerhead Shrike (*Ludius ludovicisnus*), Blue Jay (*Cyanocitta cristata*), Florida Scrub Jay (*Aphelocoma coerulescens*), American swallow-tailed kite (*Elanoides forficatus*), and two species of owls (*Otus, Steotyto*) (Hammerson. 1988. Herpetol. Rev. 19:85; Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Inst. Press, Washington, DC. 668 pp. and references therein). We report here an observation of yet another avian predator of *O. aestivus*.

On 15 May 2007, we observed an Osprey (*Pandion haliaetus*) catch an adult *O. aestivus* while the snake was swimming on the surface of Chickahominy Lake, about 3–4 m north of the southern shoreline, New Kent County, Virginia (37.4095°N, 76.9395°W). The Osprey carried the snake to the top of a cypress tree where it apparently killed and partially ate it before dropping the snake and flying off. The snake fell out of the tree and died. The only obvious external injury was a lesion at the snake's midbody. *Opheodrys aestivus* has been observed swimming in fresh water (Raun 1965. A Guide to Texas Snakes. Texas Mem. Mus., Mus. Notes (9):1–85) making them easy targets for Ospreys that search for fish and other aquatic prey at or just below the surface. This is the first report of an Osprey as a predator of *O. aestivus*.

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OXYBELIS AENEUS (Brown Vine Snake). **ENVENOMATION**. On 1 June 2004 at 1205 h, I encountered an *Oxybelis aeneus* (ca. 920 mm total length) swimming eastward in a freshwater canal ca. 80 m northeast from the port at Moin, Limón Province, Costa Rica. Diving attacks at a thread-like serpentine movement by a *Pitangus sulphuratus* (Great Kiskadee) initially alerted my group to the snake's presence. The boat was driven to shore within 1 m of the snake's exit from the water. I grabbed the snake mid-body and was bitten between my left thumb and index finger. The snake chewed vigorously for at least 1 min before I was able to gently release its mouth. After several photographs, it was released unharmed near its capture site. After 5 min, I experienced a slight to moderate burning sensation in the area of the bite. This subsided considerably after ca. 10 min. There was no evidence of swelling or excessive bleeding, but a slight dark discoloration began to appear at the site of the bite. After 20 min, my left thumb, left index finger, and the surrounding portion of my hand were completely numb but exhibited normal range of motion. Approximately 45 min later, feeling had returned to the entire left hand, but there was still slight pain at the point of envenomation. The pain was completely gone by the following morning. The discoloration at the area of the bite faded gradually and was completely gone by 6 July 2004. No further complications were experienced.

I thank C. Fielitz, C. Puttock, A. Riley, W. T. Heath, and C. C. Green for assistance.

Submitted by **GREGORY J. McCONNELL**, Department of Biology, Emory and Henry College, PO Box 947, Emory, Virginia 24327, USA; e-mail: gjmcconn@ehc.edu.

OXYRHOPUS RHOMBIFER BACHMANNI (False Coral Snake). **PREDATION/SCAVENGING**. On 7 March 2004, HMC found an apparently road-killed Geoffroy's Cat (*Oncyfelis geoffroyi*) with remains of a snake in its stomach. Based on coloration, pattern, and body shape, we identified the snake as *Oxyrhopus rhombifer bachmanni*, a medium-sized colubrid. The snake was too digested to determine sex, but we estimate its size to be at least 480 mm SVL. The cat was found on Ruta Nacional 3, 9 km S of junction Ruta Provincial 60, Biedma Department, Chubut Province, Argentina. The cat remains were discarded but the snake is deposited in Museo de La Plata herpetological collection (MLP.S 2597). We are unaware of any published accounts of predation on *O. r. bachmanni* by Geoffroy's Cat. An interesting issue is the fact that *O. r. bachmanni* is not reported for northern Chubut Province (Cei 1986. Museo Regionale di Scienze Naturali Torino, Monographie 4:1–527). The nearest reported locality is in northern Rio Negro Province, ca. 450 airline km distant. Thus, our observation may constitute a new locality for *O. r. bachmanni*, which is infrequently encountered even within its known distribution. Alternately, this is a case of introduction by human activities (e.g., in a cargo truck), as has been reported previously in another region of Argentina (Gomez and Acosta 1998. Multequina 7:73–75). We cannot be sure if the snake was dead or alive before the cat ate it, but its body was nearly flat, suggesting that the cat scavenged the snake from the roadway.

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PANTHEROPHIS GLOYDI (Eastern Foxsnake). **BEHAVIOR.** *Pantherophis gloydi* is a large constrictor found only in parts of Ontario, Michigan, and Ohio (Conant and Collins 1998. A Field Guide to Reptiles and Amphibians. Houghton Mifflin, New York. 616 pp.), with adults usually growing larger than 910 mm TL (Wright and Wright 1957. Handbook of Snakes of the United States and Canada. Comstock Publishing Associates, Ithaca, New York. 564 pp.). Much of what we know about this species' life history has been learned from radiotelemetry studies of adults (e.g. Willson and Brooks 2006. J. Herpetol. 40:285–289; MacKinnon et al. 2005. Can. J. Zool. 84:9–19). Because hatchlings and juveniles are seldom encountered in the wild (C. MacKinnon, A. Lawson, and R. Willson, pers. comm.), and because their small size precludes radiotransmitter implantation, relatively little is known about the life history of these younger age classes. Here, we report an elevated frequency of observation of young *P. gloydi*

on roads in the early fall in southern Ontario, Canada.

Data from 72 hatchling *P. gloydi* (≥ 3 clutches) indicate that the length of Pelee Island hatchlings ranges from 210 to 305 mm SVL (mean = 265.1 ± 21.8 mm [SD], N = 72, mean TL = 314.4 mm, range 252–367 mm; R. Willson, pers. comm.). Other reported *P. gloydi* hatchling lengths range from 254 to 356 mm TL (Wright and Wright 1957. *op. cit.*). Although little is known regarding the size at which *P. gloydi* attains sexual maturity, the shortest *P. gloydi* observed courting, mating, or gravid in the wild (Georgian Bay) measured 928 mm SVL for females (N = 58) and 1000 mm SVL for males (N = 54; A. Lawson, pers. comm.). Based on these data, we refer to snakes < 370 mm TL as young-of-year (YOY), snakes between 370 and 980 mm TL as juveniles, and to snakes ≥ 980 mm TL as adults (the presumed minimum adult total length assumes they have a tail length of at least 52 mm).

During a bicycle survey of wildlife on roads (118 trips total) conducted between 7 May and 26 October 2005 in both Point Pelee National Park and Rondeau Provincial Park, Ontario, we recorded 23 *P. gloydi* on roads (N = 14 Point Pelee; N = 9 Rondeau). Sixteen of these snakes (N = 10 Point Pelee; N = 6 Rondeau) were found between 28 September and 21 October, and all were YOY and juveniles (250–440 mm TL; Fig. 1). Seven larger snakes were observed prior to 10 August, with one snake eluding capture and measurement, three snakes measuring 650, 890 and 910 mm TL, and three adults exceeding 990 mm TL (Fig. 1). Although some of these large snakes were shorter than our 980 mm TL adult cutoff length, we believe that all were mature adults, given that their observed coloration was consistent with the pool of adults, rather than with the paler YOY and juveniles. In addition to our own observations, park staff and visitors at Point Pelee reported 10 *P. gloydi* on the road, including 6 small snakes (≤ 390 mm TL) found between 3 October and 17 October and four larger snakes found prior to 24 September (Figure 1; one adult unmeasured).

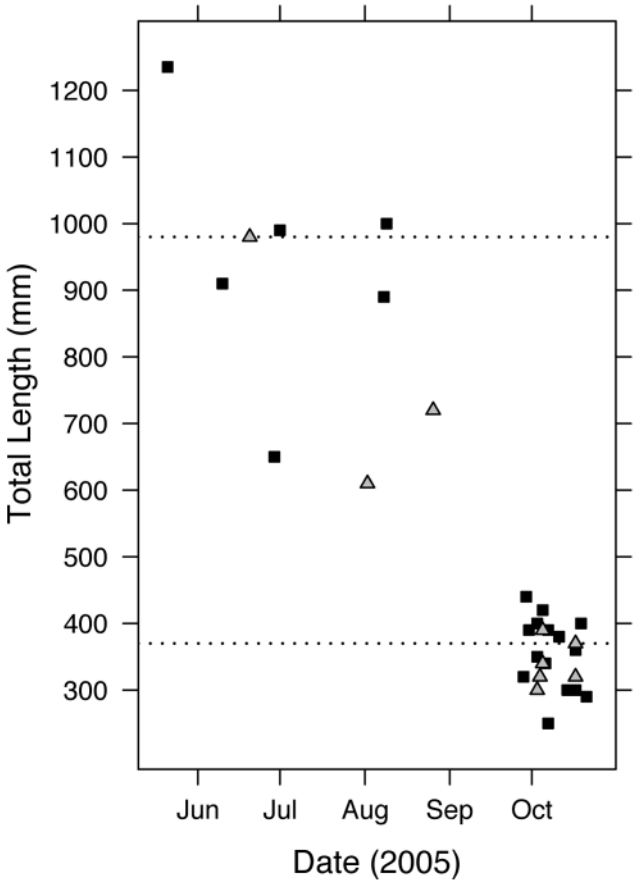


FIG. 1. Total lengths of *Pantherophis gloydi* encountered on Point Pelee National Park and Rondeau Provincial Park area roads between 7 May and 26 October, 2005. Black boxes correspond to sightings by the principal investigators and assistants; gray triangles correspond to anecdotal reports from park visitors and staff. Dotted lines define the narrowest (most conservative) estimated boundaries for the total length of juveniles of this species.

Pooling our observations and the anecdotal observations, we observed a cluster of exclusively small snakes within a period roughly coincident with expected hatching times (mid-August to October; Wright and Wright, *op. cit.*). Nine of the 16 small (≤ 440 mm) snakes formally observed during this time had lengths consistent with a YOY age class (< 370 mm). Our concurrent encounters with the remaining 7 slightly larger, but still sub-adult snakes could indicate that rapid post-hatching growth occurs among neonates in the wild, or alternatively that there is an increase in activity by juvenile age classes at the same time as neonate hatching and movement. We recommend that more intensive surveys be conducted during the late summer and early fall to explore whether increased encounters with juvenile age classes are the result of a seasonal dispersal event.

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PITUOPHIS RUTHVENI (Louisiana Pinesnake). **REPRODUCTION.** There are almost no data available on reproduction in wild *Pituophis ruthveni* (Werler and Dixon 2000. Texas Snakes: Identification, Distribution, and Natural History. University of Texas Press, Austin, Texas. 437 pp.).

On 4 July 2003 I observed an adult *P. ruthveni* in the possession of a private collector. The collector had captured the snake mid-day on approximately 22 June 2003 crossing a sand road in Bienville Parish near Sparta, Louisiana, USA. The snake appeared gravid and manual palpation indicated the presence of six eggs. The snake had not undergone ecdysis since capture. Because egg deposition appeared imminent, the snake was offered a plastic box tightly packed with damp sphagnum moss. The snake immediately entered the plastic shoe box and hollowed out an area near the bottom of the container. During the night (approximately 8–10 h after the plastic shoe box was made available), oviposition occurred. A total of six eggs were laid, but one was identified as infertile and did not hatch. The six eggs were incubated at 26–28ºC for ca. 9 weeks in a dampened mixture (3:2) of perlite and vermiculite. One male and four females hatched from the viable eggs.

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SENTICOLIS TRIASPIS (Green Rat Snake)**. MAXIMUM SIZE**. The maximum size attained by *Senticolis triaspis* is 1147 mm TL for females and 1213 mm TL for males (Lemos-Espinal and Smith 2007. Amphibians and Reptiles of the State of Chihuahua, México. Universidad Nacional Autónoma de México–Comisión Nacional para el Conocimiento y Uso de la Biodiversidad. 613 pp.). However, Vázquez and Quintero (2005. Anfibios y Reptiles de Aguascalientes. Comisión Nacional para el Conocimiento y Uso de la Biodiversidad. 318 pp.) comment that this species exceeds 1500 mm TL, though they do not provide an exact length or cite a specimen.

On 29 June 2007 we captured an adult female *Senticolis triaspis* in Ejido El Tepeyac (18.4877°N, 96.8535°W; WGS84; 94 m), Tlacotepec de Díaz, Puebla, Mexico. The snake was found above a rock in Tropical Semideciduous forest. The specimen was deposited in the Museo de Zoología, Facultad de Ciencias, Universidad Nacional Autónoma de México (MZFC 20574). The specimen measured 1500 mm SVL and 1830 mm TL and represents the maximum size recorded for this species.

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SISTRURUS CATENATUS CATENATUS (Eastern Massasauga). **DIET.** Several studies report an ontogenetic dietary shift in *Sistrurus catenatus catenatus* with young age classes consuming snakes and older classes consuming small mammals (Holycross and Mackessy 2002. J. Herpetol. 36:454–464, and citations therein). Shepard et al. (2004. Am. Midl. Nat. 152:360–368) report that snakes were consumed by captive young of the year (YOY) *S. c. catenatus* in every case in which they were offered, but were not found in the stomach contents of free ranging YOY *S. c. catenatus* examined in southern Illinois. The following observations were made in the course of conducting a radio-telemetry study of YOY *S. c. catenatus* along the Upper Wapsipinicon River, Bremer County, Iowa, USA.

On 4 September 2007 at 1025 h, we captured a YOY male *S. c. catenatus* (188 mm SVL; 10 g) consuming a small snake, with only the tail still visible. The *S. c. catenatus* was retained for transmitter attachment and ca. three hours later it regurgitated an intact and undigested YOY *Opheodrys vernalis* (100 mm SVL; 2 g). On 15 September 2007, a second young of the year male *S. c. catenatus* (254 mm SVL; 35 g) was captured and also retained for transmitter attachment. Prior to release, it defecated and the feces contained snake skin, which we later identified as *O. vernalis* based on the presence of smooth scales (*O. vernalis* is the only snake species present at the study site possessing smooth scales). On 9 May 2006 at 1535 h, we found a previously marked subadult female *S. c. catenatus* (434 mm SVL; 100 g) basking in full sunlight with a large bulge at mid-body. While collecting morphological data, she regurgitated an intact and undigested *Microtus pennsylvanicus* (155 mm total length, 55 g). The relative prey mass (RPM; prey mass/ snake mass) was 0.55, similar to the mean mass ratio of 0.47 reported by Shepard et al. (2004. *op. cit*.) for free-ranging YOY *S. c. catenatus* in Illinois.

Mauger and Wilson (1999. *In* Johnson and Wright [eds.] Second International Symposium and Workshop on the Conservation of the Eastern Massasauga Rattlesnake, pp. 110–124. Toronto Zoo, Ontario) previously reported *O. vernalis* in the diet of two subadult (50–150 g) *S. c. catenatus* from northeastern Illinois. Ours is the second report of *O. vernalis* in the diet of *S. c. catenatus* (Holycross and Mackessy 2002, *op. cit*.) and the first in this size class. The observations reported here provide further evidence of an ontogenetic dietary shift in *S. c. catenatus*.

We thank the U.S. Fish and Wildlife Service and the Iowa Department of Natural Resources for funding.

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SISTRURUS CATENATUS CATENATUS (Eastern Massasauga). **LEIOMYOMA**. Leiomyomas are benign, smooth muscle tumors usually arising from the gastrointestinal or female reproductive tract. We know of no report of this tumor in snakes although one of us has seen leiomyosarcoma in *Bogertophis subocularis* (Trans Pecos Ratsnake; ERJ, unpubl.). Leiomyosarcoma has been reported in a *Drymarchon corais erebennus* (Texas Indigo Snake) by Barten (1981. J. Amer. Vet. Med. Assoc. 179:1292–1295) and leiomyoma has been reported in a *Chelonia mydas* (Green Turtle) where it caused intestinal stricture (Helmick et al. 2000. J. Zoo Wildl. Med. 31:221–227). Here we report a large leiomyoma that appears to have caused the death of a captive *Sistrurus catenatus catenatus* (Eastern Massasauga). This appears to be the first report of any form of leiomyoma in a crotalid snake.

This 11-year-old snake (Drake University Research Collection, DURC 3913) was born 12 August 1972 shortly after the mother (DURC 3912) was captured by JLC on 25 June 1972 in Bremer County, Iowa. The specimen ate well until two months before its death approximately 2 January 1983 and appeared to be robust. Upon its death, the snake was preserved and placed in the Drake University Research Collection. Upon examination (during the course of conducting a reproductive study) the snake (ca. 570 mm TL) was found to have a large (ca. 154 × 27 mm) mass paralleling the atrophied intestinal tract and had almost no fat.

The mass was sectioned at both ends and routinely processed for light microscopy. Paraffin embedded 7 μm sections were stained with hematoxylin and eosin and examined. The mass consisted of interlacing bundles of spindle-shaped cells with an eosinophilic staining cytoplasm; cells were oriented in different planes. The nuclei were often elongate and had round to blunt ends and a distinct nucleolus was present. Sections stained with Mallory's trichrome stain did not show connective tissue (collagen) and no mitotic figures were seen. Scattered among the tumor cells were cross sections of blood vessels. There was no evidence of necrosis, invasion, or metastasis (Fig. 1).

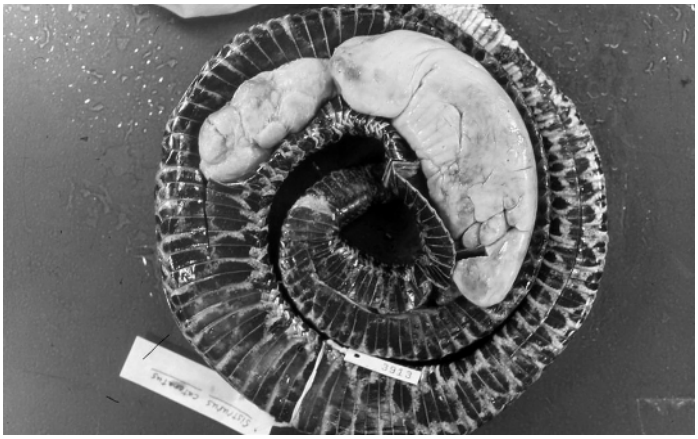


FIG. 1. *Sistrurus catenatus catenatus*, DURC 3912, with very large exposed leiomyoma that apparently caused the death of the snake.

The presentation is consistent with a leiomyoma. Origin of the tumor is uncertain because of local tissue atrophy and poor tissue preservation in the region, but we suspect it arose from the gastrointestinal tract. Although the mass was submitted for immunohistochemical staining for actin to further confirm the diagnosis, it was lost in shipment and special staining was not possible. We suspect that the tumor eventually disrupted passage through the intestine resulting in intestinal atrophy.

In addition to the tumor, scattered ovarian tissue was found attached to the coleomic wall in several places. This too was sectioned and found to consist of multiple vitellogenic and atretic follicles. The ovarian tissue was surrounded with a mix of macrophages, small round cells, and heterophils. This condition, yolk peritonitis, is not uncommon in reptiles and is seen when yolk is released from the reproductive tract or when follicles rupture and release yolk into the coelomic cavity (Mader 2006. *In* D. R. Mader [ed.], Reptile Medicine and Surgery, pp. 581–630. Sauders, Elsevier. St Louis, Missouri).

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THAMNOPHIS ELEGANS ELEGANS (Mountain Garter Snake). **PREDATION**. *Thamnophis elegans* has one of the largest geographic ranges of any *Thamnophis* (Stebbins 2003. Field Guide to Western Reptiles and Amphibians. Houghton Mifflin, New York, New York. 519 pp.). As a consequence, it takes a wide variety of prey, including mammals, birds, reptiles, amphibians, fishes, and invertebrates, including annelids and mollusks (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Institution Press, Washington, D.C. 668 pp., and citations therein). Reflecting this diverse range of prey are the methods used to procure it (Drummond and Burghardt 1983. Behav. Ecol. Sociobiol. 12:43–48). Though *T. elegans* typically swallows its prey alive, as do other *Thamnophis*, alternate methods of killing prey, such as constriction, have been reported (Peterson 1978. Am. Zool. 18:649; Gregory et al. 1980. Herpetologica 36:87–93; de Queiroz and Groen 2001. J. Herpetol. 35:450–460). One infrequently reported method of killing prey is envenomation. Here, we report the apparent envenomation of an Oregon Vole (*Microtus oregoni*; Ingles 1995. Mammals of the Pacific States. Stanford University Press, Stanford, California. 506 pp.) by a *T. e. elegans*.

At 1200 h on 19 September 2007, we were searching the bank of the North Santiam River (Marion County, Oregon, USA; 44.7580°N, 122.3927°E, 277 m elev.; WGS84) for snakes when we heard squeaking coming from a clump of sedges (*Carex* sp.) at the river's edge. Investigation revealed an adult female *T. e. elegans* (564 mm SVL, 726 mm total, 90 g) attacking an adult (ca. 90 mm) *M. oregoni*. At first, the snake's head and the vole were hidden, though movement of the sedges revealed their position. The snake's body and tail were wrapped around stems, presumably to improve its grip. Within 90 sec, the squeaking stopped, and the snake pulled the now lifeless vole out of the sedges. The snake, which had a firm grip on the vole's back, just above the hind legs, began swallowing it tail first. Swallowing took 80 minutes and once it was completed, the snake was captured, measured, and held for six days. It then defecated and was released. Examination revealed the upper and lower mandibles (with teeth) to be the only undigested parts of the vole.

Besides documenting an unrecorded prey species for *T. e. elegans*, two aspects of this observation merit comment: 1) the way in which the snake captured the vole; and 2) the rapidity with which the vole succumbed. The fact that the snake's body was stretched out during the capture and handling of the vole eliminates constriction as a possibility. The undisturbed condition of the vole's fur suggests that the snake did not shift its hold during the encounter. In field observations of Common Garter Snakes (*Thamnophis sirtalis*) capturing and consuming rodents (*Microtus* spp.) under similar situations, the rodents were simply swallowed whole and remained alive while being consumed (C. Rombough, pers. obs.). Therefore, considering the relatively rapid death (< 90 sec) of the vole in this situation, as well as the circumstances under which it was captured and consumed, it seems most likely that the snake's saliva was the cause of mortality. *T. elegans* is known to produce toxic saliva (Kardong 1980. Amer. Zool. 20:269–282; Vest 1981. Toxicon 19:831–839; Jansen 1987. J. Herpetol. 21:81–83), and in at least one other instance, has been observed envenomating mammal prey (St. John 2002. Reptiles of the Northwest. Lone Pine, Auburn, Washington. 272 pp.). The diversity of prey taken, along with the regional variation in foraging and methods of prey capture by *T. elegans*, suggest that envenomation may be a locally important means of taking prey, although more observations are needed to clarify its significance.

We thank B. Coblentz, D. Knutsen, M. Hayes, and A. St. John for assistance.

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THAMNOPHIS ELEGANS (Western Terrestrial Gartersnake). **ELEVATION.** The high elevation record for *Thamnophis elegans* is often reported as ca. 3990 m (13,100 ft) based on two specimens (MCZ 62473 and 62474), both collected 15 August 1960 in San Miguel County, Colorado (Stebbins 2003. A Field Guide to Western Reptiles and Amphibians. 3rd edition. Houghton Mifflin Company, Boston, Massachusetts. 533 pp.; Hammerson 1999. Amphibians and Reptiles in Colorado. University Press of Colorado, Niwot, Colorado. 484 pp.; Rossman et al. 1996. The Garter Snakes: Evolution and Ecology. University of Oklahoma Press, Norman, Oklahoma. 332 pp.). There are no field notes associated with these specimens. However, catalog records indicate that the collector traveled through Utah, Colorado, Wyoming, and New Mexico during July and August of 1960. These two specimens are the only specimens he collected in Colorado. Although the catalog entry states "13,100 +/-," the fairly explicit collection locality associated with both specimens is "Colorado: Old Ophir nr. Telluride." The town site of Old Ophir (37.8566°N, 107.8319°W) is in a high valley at ca. 2974 m (9756 ft) elevation. The only road through Old Ophir reaches its highest elevation in nearby Ophir Pass at 3593 m (11,789 ft). In our view, the elevation associated with these specimens is somewhat questionable.

Hendricks (Herpetol. Rev. 27:89) obtained a more reliable record than those above with his report of a *T. elegans* (Idaho Museum of Natural History Photofile, IMNHP 001) at 3182 m (10,440 ft) on the Beartooth Plateau in Park County, Wyoming that was 155 m above tree line and within Alpine Tundra habitat. At 1612 h on 01 September 2007 we found a *T. elegans* at 3658 m (12,002 ft) on Humphrey's Peak, San Francisco Peaks, Coconino County, Arizona, USA. The snake was found in Alpine Tundra (ca. 150 m above treeline) along the ridgeline (35.339056°N, 111.683878°W) between Humphrey's Peak and the saddle with Agassiz Peak. A photographic voucher is deposited at the University of Arizona (UAZ 56926-PSV). This observation might represent the high elevation record for *T. elegans* throughout its range and it is the highest elevation reported for any reptile in Arizona (A. T. Holycross, pers. comm.).

We thank J. Rosado for providing information on the specimens deposited in the Museum of Comparative Zoology at Harvard University.

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GEOGRAPHIC DISTRIBUTION

Instructions for contributors to Geographic Distribution appear in Volume 39, Number 1 (March 2008, p. 102). Please note that the responsibility for checking literature for previously documented range extensions lies with authors. Do not submit range extension reports unless a thorough literature review has been completed.

CAUDATA – SALAMANDERS

AMBYSTOMA MACULATUM (Spotted Salamander). USA. ARKANSAS: Lee Co.: Found under decaying log on hillside near Highway 44 at Bear Creek Lake Bridge (34.70547ºN, 90.69319ºW). 18 April 2008. Jacob A. Sawyer. Verified by Benjamin Wheeler. Arkansas State University Museum of Zoology Herpetological Collection (ASUMZ 31093). New county record (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. Univ. of Arkansas Press, Fayetteville. 421 pp.).

Submitted by **JACOB A. SAWYER, PHILLIP JORDAN, TRACY KLOTZ, ROBERT G. NEAL, COREY SHAFFER,** and **STAN TRAUTH,** Department of Biological Sciences, Arkansas State University, State University, Arkansas 72467, USA (e-mail: jacob.sawyer@smail.astate.edu).

AMBYSTOMA MACULATUM (Spotted Salamander). USA: TENNESSEE: Gibson Co.: Milan Army Ammunition Plant (35.9098°N, 88.7232°W). 29 February 2008. Eric Johansen and Joshua Ream. Verified by A. Floyd Scott. David H. Snyder Museum of Zoology, Austin Peay State University (APSU 18895, color photo). Under cover object (roofing tin) near fishless pond at 1155 h. New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Hard copy and Internet [http://www.apsu.edu/amatlas/versions, the latter accessed 25 March 2008]).

Submitted by **ERIC PAUL JOHANSEN** and **JOSHUA TAYLOR REAM**, Center of Excellence for Field Biology, Austin Peay State University, Clarksville, Tennessee 37044, USA (e-mail: ejohansen14@apsu.edu).

AMBYSTOMA TALPOIDEUM (Mole Salamander) USA: TENNESSEE: Fayette Co.: Wolf River Wildlife Management Area, Mineral Slough (35.02878ºN, 89.26570ºW). 12 March 2008. J. Ream and E. Johansen. Verified by A. Floyd Scott. David H. Snyder Museum of Zoology, Austin Peay State University (APSU 18903, color photo). Two adults collected by minnow trap in a vernal pool adjacent to a water tupelo/cypress swamp adjoining the Wolf River. One specimen, a 62-mm SVL metamorphic female, photographed for voucher. New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 37 pp. Hard copy and Internet versions, the latter [http://www.apsu.edu/amatlas/ accessed 15 March 2008] containing links to data on amphibians in Tennessee that have appeared since 1996.)

Submitted by **JOSHUA TAYLOR REAM** and **ERIC PAUL JOHANSEN**, Center of Excellence for Field Biology, Austin Peay State University, Clarksville, Tennessee 37044, USA (e-mail: jream14@apsu.edu).

HEMIDACTYLIUM SCUTATUM. (Four-toed Salamander). USA. TENNESSEE: Hardeman Co.: Chickasaw State Forest and Wildlife Management Area 1.2 miles W of Fire Tower road on north side of Highway 100 in the Medon Quad (35.37762°N, 88.85367°W; NAD 83). 12 May 2008. Daniel Stanfield. Austin Peay State University Museum of Zoology (APSU 18906). Verified by A. Floyd Scott. One juvenile captured in drift fence within bottomland hardwoods along Cypress Creek (Hatchie River drainage). New county record that extends the range of the species in Tennessee into the northeast portion of Hardeman County. Tennessee (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Hard copy and Internet versions, the latter of which includes links to information on Tennessee herpetology having appeared since 1996, [http://www.apsu.edu/amatlas/] accessed 22 May 2008).

Voucher collection made under the authority of the Tennessee Wildlife Resources Agency; field work supported by State Wildlife Grant (SWG) funding under the authority of the U.S. Fish and Wildlife Service.

Submitted by **CHAD HARDEN**, Tennessee Wildlife Resources Agency Region I, 200 Lowell Thomas Drive, Jackson, Tennessee 38301, USA; e-mail: chad.harden@state.tn.us.

NECTURUS MACULOSUS MACULOSUS (Common Mudpuppy). USA: NORTH CAROLINA: Madison Co.: 7.1 km NW Hot Springs, French Broad River near Huff Island (35.9322°N, 82.8847°W; WGS84). 17 April 2008. Wayne C. Starnes and Stephen J. Fraley. Verified by William M. Palmer. North Carolina State Museum of Natural Sciences (NCSM 73916). New county record (NCSM files). Extends range ca. 11 km E of nearest record in Cocke County, Tennessee (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Austin Peay State University, Clarksville, Tennessee. v + 94 pp.) and fills part of range hiatus shown in Petranka (1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, D.C. xvi + 587 pp.) and in Conant and Collins (1998. A Field Guide to Reptiles and Amphibians of Eastern and Central North America. Third Edition, Expanded. Houghton Mifflin Co., Boston, Massachusetts. xviii + 616 pp.).

Submitted by **JEFFREY C. BEANE** (e-mail: jeff.beane@ncmail.net) and **WAYNE C. STARNES** (e-mail: wayne.starnes@ncmail.net), North Carolina State Museum of Natural Sciences, Research Laboratory, 4301 Reedy Creek Road, Raleigh, North Carolina 27607, USA; **STEPHEN J. FRALEY** (e-mail: fraleysj@bellsouth.net), North Carolina Wildlife Resources Commission, 50 Trillium Way, Clyde, North Carolina 28721, USA; and **LORI A. WILLIAMS,** North Carolina Wildlife Resources Commission, 177 Mountain Laurel Lane, Fletcher, North Carolina 28732, USA (e-mail: lori_williams@earthlink.net).

TYLOTOTRITON VERRUCOSUS (Crocodile Newt). THAILAND: UTTARADIT PROVINCE: Nam Paad District: Phu Soi Dao National Park, Lan Son (17.44ºN, 100.60ºE), 1594 m elev. Collected with a deep net by day at a small (ca. 2.5 m width, 1.2 m depth) stream. Y. Chuaynkern, C. Inthara, and R. Songchan. 20 June 2006. USDZ photographic archive, ZRC (IMG).1.25a–c. Specimen released as species is protected by Thai law. Verified by Jarujin Nabhitabhata. First provincial record. Previously known from northern and northeastern Thailand, in Chiang Mai, Chiang Rai, Loei, Mae Hong Son, Nan, and Phitsanulok provinces (Pomchote et al. 2008. Nat. Hist. J. Chulalongkorn Univ. 8[1]:35–43).

Field work conducted during the project "Biodiversity Hot Spot of Thailand" supported by funding from the Office of Environmental Policy and Planning (OEPP) (Bangkok, Thailand) to PD. We especially thank Watcharapon Saejia (Phu Soi Dao National Park) for assisting in the field.

Submitted by **YODCHAIY CHUAYNKERN**, Thailand Natural History Museum, National Science Museum, Technopolis, Khlong 5, Khlong Luang, Pathum Thani 12120 Thailand (e-mail: ychuaynkern@yahoo.com); **CHANTIP INTHARA**, Department of Biology, Faculty of Science, Khon Kaen University, Muang, Khon Kaen 4002, Thailand (e-mail: ichant@kku.ac.th); **RUTHAIRAT SONGCHAN** (e-mail: pry_vana@hotmail.com) and **PRATEEP DUENGKAE** (e-mail: prateep.du@ku.ac.th), Department of Biology, Faculty of Forestry, Kasetsart University, Jatujak, Bangkok 10900, Thailand.

ANURA – FROGS

ANAXYRUS AMERICANUS (American Toad). USA: TENNESSEE: White Co.: Cane Hollow, near Center Hill Lake. (36.03283°N, 85.61719°W). 11 April 2008. Ted M. Faust. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 18901, color photo). A group of more than five calling individuals were found in a large puddle after a heavy rain between 2030 h and 2245 h. Many others were heard calling in the immediate area during this time period. New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Hard copy and Internet versions, the latter [http://www.apsu.edu/amatlas/ accessed 13 April 2008] including links to data on amphibians in Tennessee that have appeared since 1996).

Submitted by **TED M. FAUST**, 11828 Couch Mill Road, Knoxville, Tennessee 37932, USA; e-mail: tmfaust21@gmail.com.

BOKERMANNOHYLA CARAMASCHII (NCN). BRAZIL: BAHIA: Municipality of Camacan, Serra Bonita Reserve (15.3916667ºS, 39.5652778ºW) 850 m elev. 15 March 2008. M. Solé. Verified by J. Faivovich and A. C. C. Lourenço. Coleção Célio Fernando Baptista Haddad, Departamento de Zoologia, Universidade Estadual Paulista, Rio Claro, SP, Brazil (CFBH 19561–62) and Coleção Herpetologica do Museu Nacional, Rio de Janeiro, RJ, Brazil (MNRJ 51716). This species has only been previously recorded from the northern sector of the Serra da Mantiqueira in Espírito Santo and Minas Gerais States, Brazil (Napoli 2005. Herpetologica 61[1]:63–69). First record for the state of Bahia, extending the previously known distribution 510 km N from Santa Teresa, Espírito Santo state (type locality)

Submitted by **VICTOR GOYANNES DILL ORRICO**, Departamento de Zoologia, Instituto de Biociências, Universidade Estadual Paulista, CEP 13506-900, Rio Claro, SP, Brazil (e-mail:

victordill@gmail.com); and **MIRCO SOLÉ**, Departamento de Ciências Biológicas, Universidade Estadual de Santa Cruz, Rodovia Ilhéus-Itabuna, km 16, CEP 45662-000, Ilhéus, BA, Brazil (e-mail: mksole@uesc.br).

CHIASMOCLEIS ALBOPUNCTATA (NCN). PARAGUAY: CENTRAL DEPARTMENT: Municipality of Mariano Roque Alonso, Surubií Urbanization (25.18667ºS, 57.513889ºW, WGS 84). 07 March 2008. S. Vargas. Colección Biológica Arnoldo da Winkelried Bertoni-Instituto de Investigación Biológica del Paraguay (IIBP-H 600). Verified by E. O. Lavilla. This is the first record with voucher for the Central Department and southernmost locality for this species, which was previously known from the Department of Santa Cruz in eastern Bolivia (De la Riva et al. 2000. Rev. Esp. Herpetol. 14:19–164; Frost 2007. Amphibian Species of the World: An Online Reference. V 5.1 [March 2008]. http://research.amnh.org/herpetology/amphibia/index.php); and from the states of Goiás, Mato Grosso, Mato Grosso do Sul, Minas Gerais, and São Paulo in Brazil (Frost, *op. cit.*). In Paraguay it has been registered in the Departments of Alto Paraguay, Amambay, Canindeyú, and Concepción (Brusquetti and Lavilla 2006. Cuad. Herpetol. 20[2]:3–79) in the northern part of the country. Two authors previously cited this species from Asunción in the Central Department as *Engystoma albopunctatum*, but without vouchers (Boulenger 1894. Ann. Mag. Nat. Hist. 13[6]:342–348; Bertoni 1939. Rev. Soc. Cient. Paraguay 4[4]:42–43). The present locality is in the Humid Chaco ecorregion (following Dinerstein et al. 1995. Una Evaluación del Estado de Conservación de las Ecorregiones Terrestres de América Latina y el Caribe. WMF-Banco Mundial) and extends the range ca. 236 km SW from the previously cited southernmost locality in the Canindeyú Department, Estancia Rama III near Mbaracayú Reserve (Brusquetti and Lavilla, *op. cit.*).

Submitted by **FRANCISCO BRUSQUETTI** (e-mail: franbrusquetti@gmail.com) and **FLAVIA NETTO** (e-mail: e-mail: flanettosisa@gmail.com), Instituto de Investigación Biológica del Paraguay (IIBP) – Del Escudo 1607. 1429 – Asunción, Paraguay.

DENDROPHRYNISCUS CARVALHOI (Sapinho-arborícola; Carvalho's Tree Toad). BRAZIL: ESPÍRITO SANTO: Ibitirama municipality: Santa Marta district: Fazenda Pico da Bandeira: Parque Nacional do Caparaó (20.467222°S, 41.733889°W; WGS84; elev. 1135 m). 07 November 2005. M. T. Rodrigues and J. Cassimiro. Museu de Zoologia da Universidade de São Paulo, São Paulo, Brazil (MZUSP 135662–64; M. T. Rodrigues field number MTR 11565, 11584–85, respectively); 01 November 2006. M. T. Rodrigues, J. Cassimiro, and V. K. Verdade. (MZUSP 139103; M. T. Rodrigues field number MTR 12622). Verified by D. Pavan. Previously known only from the type locality: Santa Tereza municipality, Espírito Santo state, southeastern Brazil (Izecksohn 1994 "1993." Rev. Brasil. Zool. 10:473–488) and included in the IUCN Red List of Threatened Species as "endangered" (Silvano and Peixoto 2004. *In* IUCN 2007. 2007 IUCN Red List of Threatened Species. Electronic database available at www.iucnredlist.org. Downloaded on 11 April 2008). These are the most inland records for the species and extend known distribution ca. 130 km airline SW from Santa Tereza municipality, Espírito Santo state (Izecksohn, *op. cit.*).

Submitted by **JOSÉ CASSIMIRO** (e-mail: geckoides@yahoo.com.br), **VANESSA KRUTH VERDADE** (e-mail: vverdade@usp.br), and **MIGUEL TREFAUT RODRIGUES** (e-mail: mturodri@usp.com), Departamento de Zoologia, Instituto de Biociências, Universidade de São Paulo, Caixa Postal 11.461, CEP 05422-970, São Paulo, SP, Brazil.

ELEUTHERODACTYLUS* (= *SYRRHOPHUS*) *CYSTIGNATHOIDES (Rio Grande Chirping Frog). USA: TEXAS: Montgomery Co.: town of Montgomery. Airfield off Highline Dr. (30.33243°N, 095.61238°W; WGS 84). 11 April 2008. Christopher E. Smith and Erica P. Hoaglund. Verified by Tony Gamble. Bell Museum of Natural History (JFBM P265), digital photographs. New county record (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. Texas A&M University Press, College Station, Texas. 421 pp.).

Submitted by **CHRISTOPHER E. SMITH** (e-mail: smit4155@umn.edu) and **ERICA P. HOAGLUND**, College of Food, Agriculture and Natural Resources, University of Minnesota, Saint Paul, Minnesota 55108, USA.

ELEUTHERODACTYLUS* (= *SYRRHOPHUS*) *MARNOCKII (Cliff Chirping Frog). USA: TEXAS Crockett Co.: 14.6 km E of Sheffield on State Highway 290. 05 June 2008. Brandon D. Pope and Robert Makowsky. The University at Arlington Amphibian and Reptile Diversity Research Center Collection (UTA A 58666). Verified by Carl J. Franklin. First record for this county (Dixon 2000. Amphibians and Reptiles of Texas. 2nd Edition. Texas A&M University Press. College Station, Texas. 432 pp.). The specimen was collected at 2130 h on the side of a vertical rock face. There were rainstorms immediately north of the area and conditions were windy.

Submitted by **BRANDON D. POPE,** 1706 Nueces Trail, Arlington, Texas 76012, USA (e-mail: wahoo100@hotmail.com); **COREY E. ROELKE** (e-mail: croelke@uta.edu), and **ROBERT MAKOWSKY** (e-mail: makowsky@uta.edu), Department of Biology, the University of Texas at Arlington, Box 19498, Arlington, Texas 76019, USA.

ELEUTHERODACTYLUS* (*EUHYAS*) *PLANIROSTRIS (Greenhouse Frog). HONDURAS: CORTES: San Pedro Sula, (15.32164°N, 88.00348°W), 100 m elev. 28 August 2007. Franklin E. Castañeda, Juan Ramon Collart, James R. McCranie, and José Mario Solis. Verified by Steve W. Gotte. USNM 565143–48. First record for Honduras (McCranie and Castañeda 2007. Guía de Campo de los Anfibios de Honduras. Bibliomania, Salt Lake City, Utah. x + 304 pp). The presence of adults, including calling males, and juveniles of this exotic species indicate an established population in San Pedro Sula. Frogs reported herein were collected in and around potted plants in the yard of a private residence. Ancestors most likely arrived in potted plants imported from Miami, Florida, because information from the nursery where the potted plants were purchased indicated most come from Miami.

Submitted by **JAMES R. McCRANIE**, 10770 SW 164th Street, Miami, Florida 33157–2933, USA (e-mail: jmccrani@bellsouth.net); **JUAN RAMON COLLART**, San Pedro Sula, Honduras (e-mail: jrcollart@gmail.com); and **FRANKLIN E. CASTAÑEDA**

(e-mail: franklin.castaneda@gmail.com) and **JOSÉ MARIO SOLIS** (e-mail: jm9biol@yahoo.es), Tegucigalpa, Honduras.

ELEUTHERODACTYLUS PLANIROSTRIS (Greenhouse Frog). USA: FLORIDA: Clay Co.: Keystone Heights, near Keystone Lake (29.78324°N, 82.032246°W). 4 July 2008. J. M. Butler and B. K. Atkinson. Verified by K. L. Krysko. UF 153148. New county record (Meshaka et al. 2004. The Exotic Amphibians and Reptiles of Florida. Kreiger Publ. Co., Malabar, Florida). Specimen collected under water spigot at private residence.

Submitted by **J. MICHAEL BUTLER** (e-mail: butlerj@ufl.edu) and **BENJAMIN K. ATKINSON** (e-mail: bka@ufl.edu), Florida Museum of Natural History, University of Florida, Gainesville, Florida 32611, USA.

GASTROPHRYNE OLIVACEA (Great Plains Narrow-mouthed Toad). USA: TEXAS: Van Zandt Co.: Pasture along Van Zandt County Road 2721, 2.90 km N of jct with US 198. 24 May 2007. R. Michael Burger. Verified by Carl J. Franklin. Color photo voucher. University of Texas at Arlington Amphibian and Reptile Diversity Research Center (UTA color images 1046–1047). Adult male 25 mm SVL located by vocalization after heavy rain. Several other calling males were in the immediate vicinity. New county record (Dixon 2000. Amphibians and Reptiles of Texas. 2nd ed. Texas A&M University Press, College Station, Texas. viii+421 pp.).

Submitted by **R. MICHAEL BURGER**, 510 VZCR 2721, Mabank, Texas 75147, USA; e-mail: mvburger@dctexas.net.

GASTROPHRYNOIDES BORNEENSIS (Long-snouted Frog). MALAYSIA: SABAH: TAWAU DIVISION: Tawau Hills Park: near km 10.3 Camp (04.45ºN, 17.9166667ºE). 16 February 2007. Boon-Hee Kueh and Ahmad Sudin. Institute for Tropical Biology and Conservation, Universiti Malaysia Sabah, Borneensis Collection (TBT025). Verified by Indraneil Das and Alexander Haas. SVL 28 mm. Found inside a rotting log in a drying stream bed, at 878 m elev., by daytime. New record for Sabah. The species is known from Sarawak, at under 500 m elev. (Inger and Stuebing 2005. A Field Guide to the Frogs of Borneo. Second ed. Natural History Publications [Borneo] Sdn. Bhd., Kota Kinabalu, Sabah, Malaysia. viii + 201 pp.).

We thank the Institute for Tropical Biology and Conservation, Universiti Malaysia Sabah, and Sabah Parks for support.

Submitted by **KUEHBOON-HEE** (e-mail: kbhkelvin@hotmail.com), and **AHMAD SUDIN (**e-mail: ahsdin@hotmail.com), Institute for Tropical Biology and Conservation, Universiti Malaysia Sabah, Locked Bag 2073, 88999 Kota Kinabalu, Sabah, Malaysia.

LITHOBATES AREOLATA (Crawfish Frog). USA. TENNESSEE: Henderson Co.: Westwood Acres subdivision, Scotts Hill Quad (35.51663°N, 88.26262°W, NAD 83). 17 March 2008. Chad Harden. Austin Peay State University Museum of Zoology (APSU 18893). Multiple individual Crawfish Frogs recorded as they called from streams and ponds along JoAnn Drive and Westwood Acres Road. New county record that extends the range in Tennessee into the southeastern portion of Henderson County (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Hard copy and Internet versions, the latter of which includes links to information on Tennessee herpetology having appeared since 1996 [http://www.apsu.edu/amatlas/, accessed 28 March 2008]). Gibson Co.: Holly Leaf community 3.8 miles ESE of Skullbone on Highway 105 in the Trezevant West Quad (35.029000°N, 89.265350°W; NAD 83). 20 March 2008. Andy Rutherford. APSU 18894. Crawfish Frog recordings collected at farm pond north of Highway 105 and south of South Fork Obion River. Specimens verified by A. Floyd Scott.

Voucher recording collection made under the authority of the Tennessee Wildlife Resources Agency; field work supported by State Wildlife Grant (SWG) funding under the authority of the U.S. Fish and Wildlife Service.

Submitted by **CHAD HARDEN**, Tennessee Wildlife Resources Agency Region I, 200 Lowell Thomas Drive, Jackson, Tennessee 38301, USA; e-mail: chad.harden@state.tn.us.

LITHOBATES SPHENOCEPHALUS (= RANA SPHENOCEPHALA) (Southern Leopard Frog). USA: TEXAS: Hays Co.: 1 km SW jct South Turnersville Road and Satterwhite Road, on Satterwhite Road (30.05649°N, 097.77151°W; WGS 84). 20 February 2008. Vincent R. Farallo, Romey Swanson, Jeff Troy, and Glen Hood. Verified by Toby Hibbitts, Texas Cooperative Wildlife Collection (TCWC 93002, 93003). Two individuals were captured by hand, representing the first recorded occurrence of this species in Hays County (Dixon 2000. Amphibians and Reptiles of Texas: With Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Publ. Texas A&M University Press. 421 pp.).

Submitted by **VINCENT R. FARALLO** (e-mail: VF1030@txstate.edu), **ROMEY SWANSON**, **JEFF R. TROY**, **GLEN R. HOOD**, and **MICHAEL R.J. FORSTNER**, Department of Biology, Texas State University, San Marcos, Texas 78666, USA.

PSEUDACRIS FERIARUM (Upland Chorus Frog). USA: TENNESSEE: Jefferson Co.: 12.7 km W of Jefferson City (36.107533°N, 83.625167°W). 22 March 2008. Ted M. Faust. Verified by Floyd A. Scott. Austin Peay State University Museum of Zoology (APSU 18898, 18899 [color photo]). An amplexed pair was found in a drainage ditch in an open field at 1245 h. Many others were heard calling in the immediate area. New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Hard copy and Internet versions, the latter [http://www.apsu.edu/amatlas/ accessed 23 March 2008] including links to data on amphibians in Tennessee that have appeared since 1996).

Submitted by **TED M. FAUST**, 11828 Couch Mill Road, Knoxville, Tennessee 37932, USA; e-mail: tmfaust21@gmail.com.

***PYXICEPHALUS* SP**. (NCN): REPUBLIC OF NIGER: AGADEZ REGION, Tasaouet Valley (17.40473ºN, 007.52751ºE), ca. 450 m elev. 15 March 2003. J. Sébastien Steyer. University of Washington, Burke Museum of Natural History (UWBM),

Seattle, Washington, USA. UWBM 2319. Verified by Marc Hayes. *Pyxicephalus* is known from southern and central Africa (*P. adspersus, P. edulis*) and Somalia (*P. obbianus*). In western Africa, documented in northernmost Cameroon (Perret 1966. Zool. Jahr. Syst. 8:289–464; Amiet 1973. Ann. Fac. Sci. Cam. 12:63–78), northern Nigeria (Schiøtz 1963. Vidensk. Medd. Fra Dansk Naturh. Foren. 125:1–92; Walker 1968. Copeia 1968:164–167), northern Benin (Nago et al. 2006. Salamandra 42:93–108), Senegal (Böhme et al. 2001. Zeit. Köl. Zoo 44:117–131), Gambia (Emms et al. 2006. Herpetol. Bull. 94:6–16), and southernmost Mauritania (Böhme et al. 2001. Zeit. Köl. Zoo 44: 117–131; Padial and De la Riva 2004. Rev. Esp. Herpetol. 18:89–99). These records are attributed to *P. edulis*, but taxonomic status of western populations are unclear. UWBM (head length ca. 31.9 mm) is a desiccated specimen and skeleton posterior to sacral vertebra missing, remaining skeleton mostly articulated with some associated skin and flesh. Collected from sand at base of rock face at western edge of Aïr Mountains. Among African frogs, specimen identifiable as *Pyxicephalus* by well developed exostosis of the dermal skull bones and by tight articulation between anterior ramus of squamosal and dorsal surface of maxilla (Scott 2005. Cladistics 21:507–574). Record extends range of genus in three important ways. First record from Saharan Desert and suggests its occurrence in other areas of Sahara with permanent or somewhat regular seasonal precipitation, including Adrar des Iforhas in northern Mali or Adrar in northern Mauritania. Northernmost record for genus, surpassing record from Ayoûn El Atroûs (Wilaya Hodh El Gharbi) in Mauritania (Padial and De la Riva 2004). Nearest known population of *Pyxicephalus* in Rimi in northern Nigeria, and thus this record extends range of genus > 500 km north at this longitude.

Submitted by **DAVID C. BLACKBURN**, Department of Organismic and Evolutionary Biology, Harvard University, 26 Oxford Street, Museum of Comparative Zoology, Cambridge, Massachusetts 02138, USA; e-mail: david.c.blackburn@gmail.com.

RHACOPHORUS MAXIMUS (Nepal Flying Frog): VIETNAM: BAC GIANG PROVINCE: Son Dong District: Thanh Luan Commune: Dong Ri (21.10665ºN, 106.47.950ºE, ca. 280 m elev., IEBR 3653), 10 May 2008; and Thanh Son Commune: Dong Thong (21.11131ºN, 106.43411ºE, 250 m elev., IEBR 3677–81), 12–13 May 2008. T. Q. Nguyen, T. T. Tran, C. T. Pham and N. H. Vi. Found both on tree (ca. 1–2 m above ground) and in small ponds in secondary forest. Verified by Thomas Ziegler. Outside of Vietnam, this species is known from northeastern India, Nepal, southern China, and western Thailand (Ahl 1931. Das Tierreich 55:169; Inger 1966. Fieldiana Zool. 52:321; Zhao and Adler 1993. Herptology of China. SSAR, Oxford, Ohio. 522 pp.; Chanard 2003. Photographic Guide to Amphibians of Thailand: 144). First country record for Vietnam. Orlov et al. (2008. Russian J. Herpetol. 15[1]:78) include this species in the amphibian fauna of Vietnam, but without reference to precise locality or voucher specimens.

Submitted by **NGUYEN THIEN TAO**, Vietnam National Museum of Nature, 18 Hoang Quoc Viet, Hanoi, Vietnam **TRAN THANH TUNG**, Education College of Vinh Phuc, Phuc Yen, Vinh Phuc, Vietnam; **NGUYEN QUANG TRUONG** and **PHAM THE CUONG**, Institute of Ecology and Biological Resources, 18 Hoang Quoc Viet, Hanoi, Vietnam (e-mail: nguyenthientao@gmail.com).

RHACOPHORUS RHODOPUS (Red-webbed Tree Frog): VIETNAM: BAC GIANG PROVINCE: Son Dong District: Thanh Son Commune: Dong Thong (21.11131°N, 106.43411ºE, 250 m elev., IEBR 3675–76), 12–13 May 2008. T. Q. Nguyen, T. T. Tran, C. T. Pham, and N. H. Vi. Found on tree (ca. 1–2 m above ground) near small pond in secondary forest. Verified by Thomas Ziegler. Known from Lao Cai, Ha Tinh, Quang Binh, Quang Tri, Thua Thien-Hue, Kon Tum, Gia Lai, Lam Dong, and Dong Nai provinces of Vietnam; and extralimitally, northeastern India, southern China, Myanmar, Laos, northern Thailand, and Cambodia (Zhao and Adler 1993. Herptol of China. SSAR, Oxford, Ohio. 522 pp.; Inger et al. 1999. Fieldiana Zool. 92:33; Nguyen et al. 2005. Checklist of Amphibians and Reptiles of Vietnam. Agri. Publ. House, p. 39; Orlov et al. 2002. Russian J. Herpetol. 9[2]:97; Ziegler et al. 2004. Hamadryad 28[1–2]:31; Stuart 2005. Herpetol. Rev. 36:478; Bain et al. 2007. Herpetol. Rev. 38:111; Bordoloi et al. 2007. Zootaxa 1653:5; Grismer et al. 2007. Hamadryad 31[2]:221). Bordoloi et al. (2007, *op. cit.*) proposed to used the name *Rhacophorus rhodopus* for the brown-backed form and *R. bipunctatus* for frogs of green-backed populations. Therefore, previous records of *R. bipunctatus* in Vietnam should be referred to *R. rhodopus*. First provincial record.

Submitted by **NGUYEN THIEN TAO**, Vietnam National Museum of Nature, 18 Hoang Quoc Viet, Hanoi, Vietnam; **TRAN THANH TUNG**, Education College of Vinh Phuc, Phuc Yen, Vinh Phuc, Vietnam; **NGUYEN QUANG TRUONG** and **PHAM THE CUONG**, Institute of Ecology and Biological Resources, 18 Hoang Quoc Viet, Hanoi, Vietnam (e-mail: nguyenthientao@gmail.com).

SCAPHIOPUS COUCHII (Couch's Spadefoot). USA: COLORADO: Pueblo Co.: 5 km N, 1 km W North Avondale. 26 July 2006. K. Max Canestorp. UCM Ancillary Collection 164. Photograph verified by Lauren J. Livo. Found AOR at ca. 0800 h. First record for county and northwesternmost record in Colorado, expanding the known range 38 km NW from the nearest records in Otero County (Hammerson 1999. Amphibians and Reptiles in Colorado, 2nd ed. University Press of Colorado, Niwot, Colorado. 484 pp.).

Submitted by **K. MAX CANESTORP**, 1350 Sun Valley Lane, Manitou Springs, Colorado, USA.

SCAPHIOPUS HOLBROOKII (Eastern Spadefoot). USA: INDIANA: Knox Co.: Vincennes (38.62542ºN, 87.55976ºW; WGS 84). 30 March 2008. Bethany Geboy and Angela Garcia. Verified by Chris Phillips, Illinois Natural History Survey (INHS 2008.a). New county record for Indiana. (Minton 2001. Amphibians and Reptiles of Indiana. 2nd ed., revised. Indiana Academy of Science. vii+404 pp.) A full chorus of individuals was observed in a flooded residential area across from an agricultural field. Several specimens were collected from the road. Numerous choruses of *S. holbrookii* were also heard ca. 5.25 km NW along the Wabash River. *S. holbrookii* is listed as a Species of Special Concern in Indiana.

Submitted by **BETHANY GEBOY**, **ANGELA GARCIA (**e-mail: agarcia@dnr.in.gov), **NATHAN ENGBRECHT**, and **ZACK WALKER**, Wildlife Diversity Section, Indiana Department of Natural Resources Division of Fish and Wildlife, 553 E. Miller Drive, Bloomington, Indiana 47401, USA.

TESTUDINES – TURTLES

APALONE SPINIFERA (Spiny Softshell). MEXICO: SONORA: Inflow of Wellton Canal to the Ciénega de Santa Clara, ca. 46 km SSW San Luis Río Colorado (32.05503°N, 114.89667°W, WGS 84), 5 m elev. 13 September 2007. Eduardo Soto Montoya, Martha Marina Gómez Sapiens, and James C. Rorabaugh. Verified by G. Bradley. UAZ 56727-PSV and UAZ 56731-PSV. First verified record for Sonora, although its range there is indicated on the map in Stebbins (2003. A Field Guide to Western Reptiles and Amphibians, 3rd Ed. Peterson Field Guide Series, Houghton Mifflin Co, Boston, Massachusetts. xiii+533 pp.), and it is well known in adjacent portions in the Río Colorado and delta region of Baja California Norte (Grismer 2002. Amphibian and Reptiles of Baja California: Including its Pacific Islands and the Islands in the Sea of Cortez. Univ. California Press, Berkeley. xii+399 pp.). These two specimens were captured in hoop nets at the terminus of the unlined Wellton Canal, which is surrounded by wetland and riparian vegetation.

Submitted by **JAMES C. RORABAUGH**, U.S. Fish and Wildlife Service, 201 N. Bonita Ave., Ste. 141, Tucson, Arizona 85745, USA (e-mail: Jim_Rorabaugh@fws.gov); **EDUARDO SOTO MONTOYA** (e-mail: esoto@conanp.gob.mx), and **MARTHA MARINA GÓMEZ SAPIENS**, Reserva de la Biósfera Alto Golfo de California y Delta del Río Colorado, Av. Jalisco No. 903 entre Calle 9 y 10 Col., San Luis Río Colorado, Sonora, México. C.P. 83440 (e-mail: mmgomez@conanp.gob.mx).

APALONE SPINIFERA PALLIDA (Pallid Spiny Softshell). USA: TEXAS: Marion Co.: Big Cypress Bayou, Jefferson, TX (32.7514056ºN, 94.3694389ºW). 02 August 2005. Thomas Rainwater. Verified by Duke DeWare. Campbell Museum (CUSC 2365), Clemson University, Clemson, South Carolina. County record (Dixon 2000. Amphibians and Reptiles of Texas. 2nd ed. Texas A&M University Press, College Station, Texas. 421 pp). Additional individuals are routinely captured in hoop nets at this locality.

Submitted by **THOMAS R. RAINWATER**, The Institute of Environmental and Human Health, Texas Tech University, P.O. Box 764, Jefferson, Texas 75657, USA (e-mail: trrainwater@gmail.com); **STEVEN G. PLATT**, Department of Biology, Box C-64, Sul Ross State University, Alpine, Texas 79832, USA; **STANLEE M. MILLER**, Department of Biological Sciences, 132 Long Hall, Clemson University, Clemson, South Carolina 29634, USA.

KINOSTERNON FLAVESCENS (Yellow Mud Turtle). USA: TEXAS: Cameron Co.: South Padre Island, 8.85 km N of the terminus of Park Road 100 (26.3248333ºN, 97.2060278ºW). 26 March 2008. Frank W. Judd and Robert I. Lonard. Verified by Frederick Zaidan III. University of Texas-Pan American Vertebrate Collection (UTPA 03081). Shell found adjacent to isolated, rainwater pool. Water depth 10 cm, salinity 10 ppt. Species is known from the adjacent Texas mainland (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. Texas A&M University Press, College Station, Texas. 421 pp.) and on North Padre Island at Padre Island National Seashore (http://www.nps.gov/pais/naturescienc/reptiles.htm) but has not been reported previously from South Padre Island.

Submitted by **FRANK W. JUDD** and **ROBERT I. LONARD**, Department of Biology, University of Texas-Pan American, Edinburg, Texas 78541, USA (e-mail: fjudd@utpa.edu).

MACROCLEMYS TEMMINCKII (Alligator Snapping Turtle). USA: TENNESSEE: Wayne Co.: Beech Creek and Tennessee River confluence located in the Clifton Quad (35.41980°N, 87.98018°W; NAD 83). August 2006. Mark Russell. Austin Peay State University Museum of Zoology (APSU 18868). Verified by A. Floyd Scott. One adult *M. temminckii* found dead on the river bank at the mouth of Beech Creek. Carapace length 62.2 cm. First record for Wayne County (Redmond and Scott 2008. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available from http://apsu.edu/reptiles/) accessed 28 January 2008.

Voucher collection made under the authority of the Tennessee Wildlife Resources Agency; field work supported by State Wildlife Grant (SWG) funding under the authority of the U.S. Fish and Wildlife Service.

Submitted by **CHAD HARDEN**, Tennessee Wildlife Resources Agency, 200 Lowell Thomas Drive, Jackson, Tennessee 38301, USA; e-mail: chad.harden@state.tn.us.

MALACLEMYS TERRAPIN CENTRATA (Carolina Diamondbacked Terrapin). USA: GEORGIA: Bryan Co.: Demeries Creek, 0.4 km W of Bryan Neck Rd. (31.7872056°N, 81.2560333°W, WGS 84). 09 April 2008. Andrew M. Grosse, Andrew Richard Ferreira, and Sean C. Sterrett. Verified by John Jensen. UGAMNH (GMNH 50090). New county record (Spivey 2008. *In* J. B. Jensen et al. [eds.], Amphibians and Reptiles of Georgia, pp. 485–487. University of Georgia Press, Athens, Georgia). Eight adults (7 males, 1 female) were captured by seining (11 m × 1.8 m, 2.54 cm mesh, with bag) a tidally influenced creek at low tide (methods in Gibbons et al. 2001. Chel. Cons. Biol. 4:66–74). This location was revisited on 27 April 2008, and 8 additional terrapins (7 males, 1 female) were captured. Although only 16 *M. terrapin* were captured, observations of other individuals were made within the same creek. On 22 April 2008, nine individuals (8 males, 1 female) were captured in another tidally influenced creek in Bryan County (north of Dutchman Bay, 2.5 km SW of Belfast, Georgia; 31.8018694°N, 81.2974361°W, WGS 84) using the same methods. These findings suggest that Carolina Diamondback Terrapins are permanent inhabitants of Bryan County and with this addition, their range extends along the entire coast of Georgia.

Submitted by **ANDREW M. GROSSE** (e-mail: grossea@warnell.uga.edu), **ANDREW R. FERREIRA** (e-mail: ferreiraa@warnell.uga.edu), **KERRY L. HOLCOMB** (e-mail: holcombk@warnell.uga.edu) , and **SEAN C. STERRETT** (e-mail: sterretts@warnell.uga.edu), D. B. Warnell School of Forestry and Natural Resources, University of Georgia, Athens, Georgia 30602, USA.

MESOCLEMMYS DAHLI (Dahl's Toad-headed Turtle). COLOMBIA: CESAR: Chimichagua, Quebrada San Fernandera-Caracolí (9.28852ºN, 73.79328ºW; datum Bogotá WGS84). 14 Febrary 2008. Guido F. Medina-Rangel and German Forero-Medina. Instituto de Ciencias Naturales-Universidad Nacional de Colombia sede Bogotá. (ICN 11368). Verified by: O. V. Castaño-Mora. This Colombian endemic species was only known from the departaments of Córdoba, Sucre, Bolívar, and Atlántico (Rueda-Almonacid et al. 2007. Las Tortugas y los Cocodrilianos de los Países Andinos del Trópico. Conservación Internacional. 538 pp.) First state record, extending the range ca. 180 km SE from the nearest known population.

Submitted by **GUIDO F. MEDINA-RANGEL** (e-mail: gfmedinar@unal.edu.co), and **GERMAN FORERO-MEDINA,** Instituto de Ciencias Naturales-Universidad Nacional de Colombia, Bogotá, Colombia.

TRACHEMYS SCRIPTA ELEGANS (Red-eared Slider). USA: TEXAS: Upshur Co.: Lilly Creek at FM 2454 bridge (32.8965583ºN, 95.0252056ºW). 13 August 2007. Thomas Rainwater. Verified by Ric Blevins and Beverly Allen. Campbell Museum (CUSC 2366), Clemson University, Clemson, South Carolina. County record. Fills distributional gap in northeast Texas (last county in this region from which the species was not recorded) (Dixon 2000. Amphibians and Reptiles of Texas. 2nd ed. Texas A&M University Press, College Station, Texas. 421 pp).

Submitted by **THOMAS R. RAINWATER**, The Institute of Environmental and Human Health, Texas Tech University, P.O. Box 764, Jefferson, Texas 75657, USA (e-mail: trrainwater@gmail.com); **STEVEN G. PLATT**, Department of Biology, Box C-64, Sul Ross State University, Alpine, Texas 79832, USA; **STANLEE M. MILLER**, Department of Biological Sciences, 132 Long Hall, Clemson University, Clemson, South Carolina 29634, USA.

SQUAMATA –LIZARDS

ANOLIS* (=*NOROPS*) *SAGREI (Brown Anole). USA: FLORIDA: Leon Co.: Tallahassee. 28 May 2008. D. B. Means, R. C. Means, R. P. M. Means. Verified by Kenneth L. Krysko, Florida Museum of Natural History. One male from 2121 NE Capital Circle (UF 152949); two males from 2748 NE Capital Circle (UF 152947–8); and one male from 3151 Capital Circle NE (UF 152950). New county record, extending the range about 120 km NE from the closest known population on St. George Island, Franklin Co., Florida (Means 1996. Herpetol. Rev. 27:151–152; Meshaka et al. 2004. The Exotic Amphibians and Reptiles of Florida. Krieger Publ. Co., Malabar, Florida). The voucher specimens were taken along a 1.5 km stretch of NE Capital Circle from the 2100 block (30.4813889ºN, 84.235ºW, 24 m elev.) to the 3300 block (30.4986111ºN and 84.2466667ºW, 59 m elevation) at the same time that 15 additional *A. sagrei* ranging from juveniles to adults of both sexes were seen basking in sunlight or facing downward on fence posts, trees, shrubs, and other structures. One of us observed *A. sagrei* at 2121 NE Capital Circle in 2004, but none was captured at that time. Local residents tell us that individuals are abundant more than two city blocks to the east and west of Capital Circle NE. Capital Circle NE is an urban commercial area with suburban residential streets paralleling it. Brown Anoles could have been imported in potted plants sold by three large nurseries along this street. One adult male Green Anole (*A. carolinensis*) was seen at the 2748 NE Capital Circle locality on 28 May 2008. On 13 June 2008, DBM visited a fourth commercial nursery at 2911 Thomasville Road, Tallahassee, Florida, ca. 1.5 km SE of our 3151 Capital Circle NE record, and saw three *A. sagrei* on small trees. Nursery workers said that they have seen the Brown Anole there since 1999. These records are important in determining the chronology of the geographic expansion of an invasive species.

Submitted by **D. BRUCE MEANS, RYAN C. MEANS**, and **REBECCA PHARR MEEGAN MEANS,** Coastal Plains Institute and Land Conservancy, 1313 Milton Street, Tallahassee, Florida 32303, USA; e-mail: means@bio.fsu.edu.

ANOLIS* (= *NOROPS*) *SAGREI (Brown Anole). USA: LOUISIANA: Calcasieu Parish: Lake Charles, Green Gate Garden Center, 4226 Lake St. 24 April 2008. Jay Comeaux. Verified by Jeff Boundy. Louisiana State University at Eunice Vertebrate Collection (LSUE 2841). New parish record. Single adult male was collected although juveniles were also observed on the grounds of the garden center in the vicinity of imported fruit trees. According to the management of the establishment, many of the fruit trees have been obtained from growers in southern Florida. It is likely that this population of Brown Anoles was introduced with the plant material from Florida; seemingly, this is a common mode of introduction into Louisiana for this species (see Thomas et al. 1990. Herpetol. Rev. 21:22; Platt and Fontenot 1994. Herpetol. Rev. 25:33; Boundy 2004. Herpetol. Rev. 35:194–196; and Wiley et al. 2007. Herpetol. Rev. 38:217). Boundy (*op. cit.*) reported the nearest recorded population in Louisiana from Lafayette Parish.

Submitted by **AVERY A. WILLIAMS**, Division of Sciences and Mathematics, Louisiana State University at Eunice, Eunice, Louisiana 70535, USA; and **JAY COMEAUX**, Department of Biological and Environmental Sciences, McNeese State University, Lake Charles, Louisiana 70609, USA.

BASILISCUS VITTATUS (Brown Basilisk). USA: FLORIDA: Indian River Co.: Sebastian Inlet State Park, Coconut Point (27.8510667ºN, 80.453566ºW, WGS84). 09 May 2008. Philip L. Rand. Adult male observed at 0845 h in mangroves at a boat ramp on a barrier island S of Sebastian Inlet. Florida Museum of Natural History photographic voucher (UF 152851). Verified by Kenneth L. Krysko. New county record and extends range ca. 42 km N of a population in St. Lucie Co. (Krysko et al. 2005. Herpetol. Rev. 36:85–87). Another *B. vittatus* was later observed 1 km NE.

Submitted by **PHILIP L. RAND**, Department of Environmental Protection, Sebastian Inlet State Park, 9700 South A1A, Melbourne Beach, Florida 32951, USA; **GRAHAM E. WILLIAMS**, Department of Environmental Protection, Florida Park Service, 1800 Wekiwa Circle, Apopka, Florida 32712, USA; and **KEVIN M. ENGE**, Florida Fish and Wildlife Conservation Commission, 1105 SW Williston Road, Gainesville, Florida 32601, USA (e-mail: philip.rand@dep.state.fl.us).

CHAMAELEO CALYPTRATUS (Veiled Chameleon). USA: FLORIDA: Hendry Co.: La Belle, 635 A Road (26.7061ºN, 81.4277ºW, WGS84). 05 May 2008. Richard D. Bartlett. Four males and one female observed in trees during the daytime. Florida Museum of Natural History photographic voucher (UF 152852). Verified by Kenneth L. Krysko. New county record and extends range ca. 39 km E of a population in Lee County (Krysko et al. 2004. Florida Sci. 67:249–253), which is still extant despite heavy collecting pressure. Hundreds of specimens, mostly neonates, have been collected for the pet trade from the Hendry County population (R. D. Bartlett, pers. comm.).

Submitted by **KEVIN M. ENGE**, Florida Fish and Wildlife Conservation Commission, 1105 SW Williston Road, Gainesville, Florida 32601, USA; e-mail: kevin.enge@myfwc.com

GERRHONOTUS LIOCEPHALUS (Texas Alligator Lizard). MÉXICO: MICHOACÁN: Municipality of Zitacuaro: Rancho la Carolina, 2 km W of Zitacuaro (19.2541°N, 100.2078°W; WGS 84), 1997 m elev. 22 March 2007. A. Torres. Verified by Oscar Medina. Colección Herpetologica, Instituto de Investigaciones sobre los Recursos Naturales, Universidad Michoacana (INIRENA 645). First record for Michoacán, extending its known range ca. 136 km (airline) NW of Jiutepec, Morelos (Castro and Bustos 2003. Acta Zool. Mex. 88:123–142). The specimen was found in pine-oak forest.

Submitted by **JAVIER ALVARADO-DÍAZ** and **M. ALEJANDRA SÁNCHEZ BELTRÁN** (CIC, Univ. Michoacana Proj. 5.5), Laboratorio de Herpetología, Instituto de Investigaciones sobre los Recursos Naturales, Universidad Michoacana, Av. San Juanito Itzicuaro s/n, Col. San Juanito Itzicuaro, Morelia, Michoacán 58330, México (e-mail: jadiaz@zeus.umich.mx).

GONATODES ALBOGULARIS (Yellow-headed Gecko). USA: FLORIDA: Monroe Co.: Bahia Honda Key, 323 Whitehead Street (24.6551497ºN, 81.2792019ºW; WGS84; elev. <1 m). 05 May 2008. Joseph Burgess, Kenneth L. Krysko, and Andrew P. Borgia. Verified by Kevin M. Enge. Florida Museum of Natural History photographic voucher (UF 152847). New island record and first verified record of this species in Florida since 1989 (Krysko 2005. Florida Sci. 68:272–280). Sub-adult male collected in leaf litter of Seagrape (*Coccoloba uvifera*).

Submitted by **JOSEPH P. BURGESS**, Florida Department of Environmental Protection, Guana Tolomato Matanzas National Estuarine Research Reserve, 505 Guana River Road, Ponte Vedra, Florida 32082, USA; **KENNETH L. KRYSKO**, Florida Museum of Natural History, Dickinson Hall, Division of Herpetology, University of Florida, Gainesville, Florida 32611, USA (e-mail: e-mail: kenneyk@flmnh.ufl.edu); and **ANDREW P. BORGIA**, P.O. Box 4346, Key West, Florida 33041, USA.

HEMIDACTYLUS TURCICUS (Mediterranean Gecko). MÉXICO: SONORA: Municipio de Hermosillo: Bahía de Kino Nuevo, Prescott College and Casa del Mar buildings, respectively (28.86018°N, 112.02207° W; WGS 84), 10 m elev. 4 September 2005 and 18 July 2006. A. Peralta-García and J. H. Valdez-Villavicencio. Verified by Bradford D. Hollingsworth. Herpetological collection of Facultad de Ciencias, Universidad Autónoma de Baja California (UABC 1439, 1590). First records for Sonora (Álvarez-Romero et al. 2005. Vertebrados Superiores Exóticos en México. Instit. Ecol., UNAM. Bases de datos SNIB-CONABIO. Proyecto U020. México, D.F.). A breeding population has apparently existed in Bajía de Kino for several years (Miguel Durazo, pers. comm.).

Submitted by **ANNY PERALTA-GARCÍA**, Department of Biology, San Diego State University, San Diego, California 92182, USA (e-mail: annyperaltagarcia@yahoo.com.mx); and **JORGE H. VALDEZ-VILLAVICENCIO,** Grupo de Ecología y Conservación de Islas, A.C. Ave. López Mateos 1590-3 Fracc., Playa Ensenada, Ensenada, Baja California, México. C.P. 22880.

HEMIDACTYLUS TURCICUS (Mediterranean Gecko). USA: LOUISIANA: Rapides Parish: Pineville, 217 Shady Crest Lane (31.346933ºN, 92.336072ºW). 29 April 2007. James Lind. LSU Alexandria R-85. St. James Parish: Gramercy, 100 White St., (30.1454°N, 90.5966°W). 27 Sept. 2003. Brittany George. LSU Alexandria R-29. Both verified by Avery A. Williams. New parish records (Meshaka et al. 2006. Herpetol. Conserv. Biol. 1[1]:46–51).

Submitted by **JERRY G. WALLS,** 486 Highway 3041, Bunkie, Louisiana 71322 USA; e-mail: gyretes@prodigy.net.

HEMIDACTYLUS TURCICUS (Mediterranean Gecko). USA: MISSOURI: Cape Girardeau Co.: Cape Girardeau. Two small juveniles (SVL = 23.9 and 24.2 mm) were collected in a basement of the Teamsters Local Union 600 building at 429 N. Broadview, 63701 (37.3127667ºN, 89.5539333ºW). 06 September 2008. Jamie Tucker. Verified by Chris Phillips of the Illinois Natural History Survey, INHS 20940 and INHS 20941. Both individuals were captured between 0930–1000 h on a wet, rainy day. A slightly smaller individual was observed in the basement on 13 December 2007, but was not captured. This location is less than 0.5 km from a commercial/industrial area, which may be the source of introduction to Cape Girardeau. This collection is the second reported occurrence of *H. turcicus* in Missouri; the first was reported from St. Louis County by Bufalino (2004. Herpetol. Rev. 35:188).

Submitted by **MICHAEL S. TAYLOR** and **JAMIE L. TUCKER**, Department of Biology, Southeast Missouri State University, Cape Girardeau, Missouri 63701, USA; e-mail: mtaylor@semo.edu.

HEMIDACTYLUS TURCICUS (Mediterranean Gecko). USA: TEXAS: Caldwell Co.: State Hwy 80, 3.07 km SE of County Line Road (29.862ºN, 97.8663611ºW). 25 February 2008. Romey Swanson, Vincent Farallo, Jeff Troy, and Glen Hood. Verified by Toby Hibbitts, Texas Cooperative Wildlife Collection (TCWC 93009–93012). Four individuals of various sizes were found under lights and caught by hand. These individuals represent the first recorded occurrence of this species in Caldwell County (Dixon 2000. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 421 pp.).

Submited by **ROMEY L. SWANSON (**e-mail: rs56761@txstate.edu), **VINCENT R. FARALLO**, **JEFF R. TROY**, **GLEN R. HOOD**, and **MICHAEL R. J. FORSTNER**, Department of Biology, Texas State University, San Marcos, Texas 78666, USA.

HEMIDACTYLUS TURCICUS (Mediterranean Gecko). USA: TEXAS: Guadalupe Co.: 950 m S jct FM 1978 and Hwy 123 (29.78302°N, 097.94715°W; WGS 84). 25 February 2008. Vincent R. Farallo, Romey L. Swanson, Jeff R. Troy, and Glen R. Hood. Verified by Toby Hibbitts, Texas Cooperative Wildlife Collection (TCWC 93004–93007). Four individuals of various sizes were observed under lights and captured by hand, representing the first recorded occurrence of this species in Guadalupe County (Dixon 2000. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 421 pp.).

Submitted by **VINCENT R. FARALLO (**e-mail: VF1030@txstate.edu), **ROMEY L. SWANSON**, **JEFF R. TROY**, **GLEN R. HOOD**, and **MICHAEL R. J. FORSTNER**, Department of Biology, Texas State University, San Marcos, Texas 78666, USA.

LEIOCEPHALUS SCHREIBERSII (Red-sided Curlytail Lizard). USA: FLORIDA: Miami-Dade Co.: Homestead, 24305 SW 142 Avenue (25.540744ºN, 80.420585ºW; WGS84; elev. 4 m). 3 May 2008. Kenneth L. Krysko and Joseph P. Burgess. Verified by Kevin M. Enge. Florida Museum of Natural History (UF 152827–28). New county record and extends range of this species 58 km S of closest verified record in Hollywood, Broward County (Townsend et al. 2002. Herpetol. Rev. 33:75). Reports of this species at several sites in northern Miami-Dade Co. (e.g., Meshaka et al. 2004. The Exotic Amphibians and Reptiles of Florida. Krieger Publ. Co., Melbourne, Florida. 166 pp.; Wilson and Porras 1983. Univ. Kansas Mus. Nat. Hist., Spec. Publ. No. 9, 89 pp.) have not been verified nor supported by vouchers. Two adult males collected. Nine other individuals of all size classes observed, suggesting a reproducing established population. We have observed this species at this site since 2002, and it has expanded its range at least one block to the north and west.

Submitted by **KENNETH L. KRYSKO**, Florida Museum of Natural History, Division of Herpetology, Dickinson Hall, University of Florida, Gainesville, Florida 32611, USA (e-mail: kenneyk@flmnh.ufl.edu); and **JOSEPH P. BURGESS**, Florida Department of Environmental Protection, Guana Tolomato Matanzas National Estuarine Research Reserve, 505 Guana River Road, Ponte Vedra, Florida 32082, USA.

LEPIDODACTYLUS LUGUBRIS (Mourning Gecko). MALAYSIA: SARAWAK: Kuching: from grounds of Telang Usan Hotel (01.35ºN, 110.20ºE; WGS84), Photographed by Ruchira Somaweera. 04 May 2008. Adult female (showing lack of hemipenial bulge). USDZ photographic archive, ZRC (IMG) 2.93. First record from Sarawak, and a range extension southwestward on Borneo, ca. 1290 km from Kota Kinabalu. Previous Bornean records, based on presumed naturalized populations, are from Sandakan, Sandakan District (Tan 1993. Checklist of Lizards of Sabah. Sabah Parks Trustees, Kota Kinabalu. [2] + 18 pp., based on FMNH 63632) and Tanjung Aru Beach Resort, Kota Kinabalu, Kota Kinabalu District (ZRC 2.6583, *ex*-ID 8145) both in Sabah and Sintang, Kalimantan Barat Propinsi, Kalimantan, Indonesia (de Rooij 1915. The Reptiles of the Indo-Australian Archipelago. Vol. I. Lacertilia, Chelonia, Emydosauria. E. J. Brill, Leiden. xiv + 384 pp.). Global distribution of species, as presently constituted (as a unisexual-bisexual complex), includes Maldives, the Andaman and Nicobar Islands, Sri Lanka, mainland Southeast Asia, Borneo, Riau Archipelago, Sulawesi, Halmahera, Lesser Sundas, Ternate, New Guinea, eastern Asia, Chagos Archipelago, Philippines, northern Australia, Micronesia, and Fiji. Several populations, believed introduced, are found in Brazil, Colombia, Costa Rica, Ecuador, Galapagos Islands, México, New Caledonia, Nicaragua, Panama, Peru, Suriname, and Hawai'i (Bauer and Henle 1994. Familia Gekkonidae [Reptilia, Sauria]. Part I Australia and Oceania. Das Tierreich 109. Walter de Gruyter, Berlin and New York. xiii + 306 pp.; Brown and Alcala 1978. Philippine Lizards of the Family Gekkonidae. Silliman University Natural Science Monograph Series No. 1, Dumaguete City. v + 146 pp + [1] errata sheet; Ineich 1999. *In* H. Ota [ed.], Tropical Island Herpetofauna. Origin, Current Diversity and Conservation, pp. 199–228. Elsevier Science B.V., Amsterdam; Zug 1991. Bishop Mus. Bull. Zool. 2: i–xii; 1–136). We thank Kelvin K. P. Lim for ZRC registration numbers.

Submitted by **RUCHIRA SOMAWEERA**, Department of Zoology, Faculty of Science, University of Peradeniya, Peradeniya, Sri Lanka (e-mail: ruchira.somaweera@gmail.com); and **INDRANEIL DAS**, Institute of Biodiversity and Environmental Conservation, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia (e-mail: idas@ibec.unimas.my).

SAUROMALUS HISPIDUS (Spiny Chuckwalla). MÉXICO: BAJA CALIFORNIA: Isla Rasa: ca. 49 km ESE of Bahía de los Ángeles (28.8246178°N, 112.9806675°W; WGS 84), 3 m elev. 17 May 2006. E. Velarde. Verified by J. Angel Soto-Centeno. San Diego Natural History Museum Herpetological Photo Collection (SDNHM-HerpPC 5208–5216). First record from Isla Rasa (Hollingsworth 1998. Herpetol. Monog.12:38–191). It is unknown if this individual is an isolated record or part of an established population. *Sauromalus hispidus* however does occur on Islas Ángel de La Guarda, 15 km NW and on Isla Las Ánimas (= San Lorenzo Norte), 22 km S of Isla Rasa, respectively. The lizard reported herein was observed near the south shore of the island, among rocky boulders close to stands of Cardon (*Pachycereus pringlei*) and cholla cactus (*Cylindropuntia* sp.).

Submitted by **ENRIQUETA VELARDE**, Unidad de Investigación de Ecología de Pesquerías, Universidad Veracruzana, Hidalgo 617, Boca del Río, Veracruz, 94290, Mexico (e-mail: enriqueta_velarde@yahoo.com.mx); **BRADFORD D. HOLLINGSWORTH** (e-mail: bhollingsworth@sdnhm.org), and **JON P. REBMAN** (e-mail: jrebman@sdnhm.org), San Diego Natural History Museum, P.O. Box 121390, San Diego, California 92112-1390, USA.

TROPIDURUS PINIMA. BRAZIL: BAHIA: Rio de Contas (13.566667ºS, 41.8°W; SAD69). D. Vrcibradic. 06 January 2005. Museu de Zoologia da Universidade de São Paulo (MZUSP 98047–8). Verified by Miguel T. Rodrigues. This species was described (as *Tapinurus pinima*) by Rodrigues (1984. Pap. Avul. Zool., São Paulo 35:367–373) from Santo Inácio (11.1°S, 42.716667°W), in the state of Bahia, and was believed to be endemic to the type locality (Rodrigues 2003. *In* I. R. Leal et al. [eds.], Ecologia e Conservação da Caatinga, pp. 181–236. Universidade Federal

de Pernambuco, Recife, Brazil). The present record extends the distribution of this species ca. 290 km to the south.

Submitted by **DAVOR VRCIBRADIC, ANGÉLICA FIGUEIRA FONTES, THAÍS KLAION, ALINE S. DIAS,** and **MONIQUE VAN SLUYS,** Departamento de Ecologia, Universidade do Estado do Rio de Janeiro, Rua São Francisco Xavier 524, Maracanã, 20550-011, Rio de Janeiro, RJ, Brazil.

TROPIDURUS TORQUATUS (Calango, Collared Lizard). BRAZIL: SÃO PAULO: Bertioga municipality: Praia de Itaguaré: Foz do Rio Itaguaré (23.779167°S, 5.968611°E; datum: WGS 84; sea level). 06 April 2008. M. A. Sena and J. G. Silva. Museu de Zoologia da Universidade de São Paulo, São Paulo, Brazil (MZUSP 98079, adult male; M. A. Sena field number MA 3615). Verified by Pedro M. S. Nunes. The range of this species includes Uruguay, Paraguay, Argentina, and Brazil. In Brazil, the species occurs in Cerrado core areas of Minas Gerais, Goiás, Mato Grosso do Sul, Mato Grosso, and Maranhão states; in Cerrado enclaves in the Atlantic Rainforest Domain of São Paulo, Rio de Janeiro, Espírito Santo, and Bahia states; an insular population in Abrolhos archipelago (Bahia state); in coastal sandy areas ("restinga" environments) from Rio de Janeiro to Bahia states; and in open areas of southern Brazil in Rio Grande do Sul and westernmost Santa Catarina and Paraná states (Rodrigues 1987. Arq. Zool., São Paulo 31:105–230; França-e-Souza et al. 2002. Herpetol. Rev. 33:149). *T. torquatus* is extremely abundant in open areas. Although there are numerous records south of Rio de Janeiro, these refer to interior populations which according to Rodrigues (1987, *op. cit.*) show significant morphological differentiation from those occurring along the coast. Despite exhaustive searches performed for several years in "restingas" along the coast (see Rodrigues, *op. cit.*), the species was never recorded in this habitat south of Rio de Janeiro state. This new record extends the known distribution at coastal areas ca. 215 km southwest from Restinga da Marambaia, Rio de Janeiro state (Carvalho and Araújo 2007. Rev. Bras. Biol. 24:786–792). This expansion of distribution, and recent occupation, appears to be the result of human expansion in areas along the coast where the species previously did not occur, or perhaps a consequence of the effects of global warming and climate changes. It is interesting to note that well established populations of this species now also occur near the city of São Paulo and surroundings where there were characteristically absent until a couple of years ago. These findings are very important because this lizard is an aggressive colonizer that can adversely affect native species.

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UROSAURUS GRACIOSUS (Long-tailed Brush Lizard). MÉXICO: SONORA: Municipio de Hermosillo: Km. 25.5, Calle 36 Norte, carretera a Puerto Libertad (29.05841° N, 111.74275° W; WGS 84), 45 m elev. 16 September 2007. J. H. Valdez-Villavicencio. Herpetological collection of Facultad de Ciencias, Universidad Autónoma de Baja California, Ensenada, Baja California, México (UABC 1748). 12.5 km E of Bahía de Kino Viejo (28.81949°N, 111.80603°W; WGS 84), 5 m elev. 8 October 2007. J. H. Valdez-Villavicencio. UABC 1757. Both verified by Bradford D. Hollingsworth. UABC 1757 represents the southernmost record for the species in Sonora, extending the range ca. 107 km SSE from the closest previous locality, ca. 40 km SE of Puerto Libertad (LACM 126607); UABC 1748 fills the gap between those two localities. Both lizards were found on a small mesquite tree (*Prosopis* sp.) in sparsely vegetated habitat with sandy soil.

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SQUAMATA – SNAKES

AGKISTRODON BILINEATUS (Cantil). MEXICO: OAXACA. Municipality of Santiago Tamazola: Cerro del Ídolo, road from Santiago Tamazola to San Miguel (17.4049°N, 98.1456°W, estimated from map), 1672 m elev. 25 July 2003. Verified by Edmundo Pérez Ramos. Museo de Zoología, Facultad de Ciencias, UNAM (MZFC 17893). New municipality record, extending range 126 km from the nearest locality in the Sierra de Huautla, Morelos (Aguilar et al. 2003. Anfibios y Reptiles de la Sierra de Huautla, Estado de Morelos. CONABIO, UAEM, FMCN. 32 pp.). The species is known elsewhere in Oaxaca from a few localities in the southeastern section of the state (Campbell and Lamar 2004. The Venomous Reptiles of the Western Hemisphere, Vol. 1. Comstock Publ. Assoc., Cornell Univ. Press, Ithaca, New York. 476 pp.). The snake was found in an oak forest located within the northwestern portion of the state.

Submitted by **LUIS CANSECO-MÁRQUEZ** (e-mail: lcanseco@gmail.com), and **ANA LAURA NOLASCO VÉLEZ,** Departamento de Biología Evolutiva, Museo de Zoología, Facultad de Ciencias, Universidad Nacional Autónoma de México, A.P. 70-399, C.P. 04510, México, D.F., México.

AGKISTRODON CONTORTRIX (Copperhead). USA: TENNESSEE: Fayette Co.: Wolf River Wildlife Management Area (35.02362°N, 89.24955°W). 17 July 2007. J. Ream and C. O'Bryan. Verified by A. Floyd Scott. Austin Peay State University's David H. Snyder Museum of Zoology (APSU 18919). Voucher specimen found dead, presumably crushed by automobile, at 1900 h near intersection of Beasley and Yager roads. New county

record (Scott and Redmond 2008 [latest update: 1 May 2008]. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available from http://apsu.edu/reptatlas/ [accessed 30 June 2008]).

Submitted by **JOSHUA TAYLOR REAM (**e-mail: jream14@apsu.edu), and **CHRISTOPHER JOEL O'BRYAN**, Center of Excellence for Field Biology, Austin Peay State University, Clarksville, Tennessee 37044, USA.

ATRACTUS SNETHLAGEAE. BOLIVIA: Departamento PANDO: MANURIPI: Chivé: 68.5333333ºW, 12.3833333ºS, elev. 200 m. 5 February 2002. L. Gonzales. Museo Historia Natural Noel Kempff Mercado, Santa Cruz de la Sierra (MNKR 3275). Verified by P. Passos. Species previously known from Brazil, Surinam (Uetz, P. (2005). http://www.reptile-database.org) and Argentina (Giraudo and Scrocchi 2000. Herpetol. J. 10[3]:81–90). First country record, extends known distribution 692 km SW from Santa Barbara, Brazil (Vanzolini 1986. Levantamento Herpetológico da Área do Estado de Rondônia sob Influência da Rodovia BR 364. Relatório de Pesquisa N°1).

Submitted by **LUCINDO GONZALES**, Museo Historia Natural Noel Kempff Mercado, Avenida Irala 565, Santa Cruz de la Sierra, Bolivia (e-mail: bichos10@hotmail.com); and **DIRK EMBERT**, Zoologisches Forschungsinstitut und Museum Alexander Koenig, Adenauerallee 150-164, 53113 Bonn, Germany (e-mail: dirkembert@hotmail.com).

BOTHRIECHIS LATERALIS (Lora). PANAMÁ: COCLÉ: Distrito de La Pintada: Río Tigrero (8.6020°N, 80.6816°W; WGS 84), 500 m elev. 01 June 2003. Edgardo J. Griffith. Museo de Vertebrados de la Universidad de Panamá (MVUP 1891). Distrito de San Carlos: Altos del María, Cerro La Gaita (8.6306°N, 80.0736°W; WGS 84), 1023 m elev. 15 July 2006. Edgardo J. Griffith. Círculo Herpetológico de Panamá (CH 6029). Both verified by Alejandro Solórzano. New records for Coclé and Panamá provinces, respectively, extending the geographic range ca. 105 km (airline) ENE of the nearest locality in Veraguas (Campbell and Lamar 2003. The Venomous Reptiles of the Western Hemisphere, Vol. I, Comstock Publishing Associates, Ithaca, New York. xviii + 476 pp.).

Submitted by **EDGARDO J. GRIFFITH**[1], **ROBERTO IBÁÑEZ D.**[1,2,3] and **CÉSAR A. JARAMILLO A.**[2,3,4]. [1]Departamento de Zoología, Universidad de Panamá, Panamá, Rep. de Panamá; [2]Smithsonian Tropical Research Institute, Unit 0948, APO AA 34002-0948, USA; [3]Círculo Herpetológico de Panamá, Apartado 0824-00122, Panamá, Rep. de Panamá; [4]Departamento de Histología, Facultad de Medicina, Universidad de Panamá, Panamá, Rep. de Panamá (e-mail: IBANEZR@si.edu).

CEMOPHORA COCCINEA COPEI (Northern Scarlet Snake). USA: MARYLAND: Worcester Co.: Millville Rd., 2.5 km SW junction with Rt. 12 (38.2174527ºN, 075.4811194ºW; NAD83), DOR 1300 h. 12 June 2004, William L. Grogan, Jr. and Matthew T. Close. Verified by Ned S. Gilmore, Academy of Natural Sciences, Philadelphia (ANSP 36238). A second specimen (TL 57.8 cm) from same locality, DOR 26 July 2005, L. T. Biechele, deposited in the vertebrate collection at Salisbury University. Specimens confirm two prior photographic records from Worcester County (Grogan 1985. Bull. Maryland Herpetol. Soc. 21:74–75; Grogan 1994. Bull. Maryland Herpetol. Soc. 30:27–32), and are only the third and fourth museum records of this species from Delmarva Peninsula (White and White 2002. Amphibians and Reptiles of Delmarva. Tidewater Publishers, Centreville, Maryland. 248 pp.). Both specimens are adult females, ANSP 36238 (TL 56.6 cm) contained 9 fully developed eggs with soft shells. The two earlier Delmarva records were a specimen found ca. 1940 near Salisbury, Wicomico County, adjacent to the NW of Worcester County, commented on by Conant (1958. Copeia 1958:50–52) as there were some inaccuracies about its provenance, etc., in the original report by Fowler (1945. Proc. Biol. Soc. Washington 58:89–90). The only other prior museum record was found in 1963 at Trap Pond, W of Laurel, Sussex County, Delaware. This specimen is still the only record from that state that was finally documented by Arndt (1985. Bull. Maryland Herpetol. Soc. 21:67–73) as it was the basis for the distribution maps of this species in Delaware in Conant's second edition (Conant 1975. A Field Guide to Reptiles and Amphibians of Eastern and Central North America. Houghton Mifflin Co., Boston, Massachusetts. 429 pp.) and later editons.

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COLUBER* (= *MASTICOPHIS*) *MENTOVARIUS (Neotropical Whipsnake). MEXICO: SONORA: Las Palomas, NW slope of Sierra Azul, Rancho El Aribabi, ca. 27 km ENE Imuris and 57 km S of Arizona/Sonora border (32.82000˚ N, 110.56667˚ W, WGS 84), 1311 m elev. 08 September 2007. Sergio Avila and Carlos Robles Elías. Verified by Jerry D. Johnson. UAZ 56736-PSV. Northernmost locality for this species and extends range 212 km NE of closest known locality, 37 km NE of Nacori Chico, Sonora (Lemos Espinal and Smith 2007. Anfibios y Reptiles del Estado de Chihuahua, México. Universidad Nacional Autónoma de México y CONABIO). Specimen was observed along an ephemeral stream in a mesquite/oak grassland association.

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CROTALUS ATROX (Western Diamond-backed Rattlesnake). USA: OKLAHOMA: McCurtain Co.: Cedar Creek, 9.7 km N North Pole Store (34.18°N, 94.89°W). 30 May 2008. D. Arbour. Verified by S. E. Trauth. Arkansas State University Herpetological Museum (ASUMZ photographic voucher 31207). First genuine record for the county; a much older record for McCurtain County [Kolb 1946. Oklahoma Game & Fish News 2(10):22], presumably from somewhere near Broken Bow, is

considered questionable (L. J. Vitt, pers. comm.). However, Webb (1970. Reptiles of Oklahoma. Univ. Oklahoma Press, Norman, Oklahoma. 370 pp.) included the older record without actually examining the specimen. In addition, Secor and Carpenter (1984. Oklahoma Herpetol. Soc. Spec. Publ. No. 3:1–57) listed the same as a Distribution of Oklahoma Amphibians and Reptiles by Recorded Sightings (DOKARRS) record with it appearing online (http://www.biosurvey.ou.edu/dbsrch/dokalist.php). Interestingly, this snake has not yet been collected immediately eastward from adjacent Little River and Sevier counties, Arkansas (Trauth et al. 2004. Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.) nor has it been taken in Bowie, Fannin, Lamar, and Red River counties immediately southward along the Red River in northeastern Texas (Dixon 2000. Amphibians and Reptiles of Texas. Univ. Texas A&M Univ. Press, College Station. 421 pp.; Werler and Dixon 2000. Texas Snakes: Identification, Distribution, and Natural History. Univ. Texas Press, Austin. 437 pp.).

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FARANCIA ABACURA REINWARDTII (Western Mudsnake). USA: ARKANSAS: Sevier Co.: off St. Hwy. 70, vic. Cossatot Community College, De Queen (34.025°N, 94.216°W). 30 April 2003. D. Arbour. Verified by S. E. Trauth. Arkansas State University Herpetological Museum (ASUMZ photographic voucher 31223). New county record filling a distributional gap in extreme southwestern Arkansas near previous records from Little River County (Trauth et al. 2004. Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.). This is one of the few records of *F. a. reinwardtii* from the Interior Highlands of the Ouachita foothills (Trauth, et al., *op cit.*).

Submitted by **CHRIS T. McALLISTER**, RapidWrite, 102 Brown Street, Hot Springs National Park, Arkansas 71913, USA (e-mail: drctmcallister@aol.com); **HENRY W. ROBISON**, Department of Biology, Southern Arkansas University, Magnolia, Arkansas 71754, USA (e-mail: hwrobison@saumag.edu); and **DAVID ARBOUR**, De Queen, Arkansas 69337, USA (e-mail: arbour@windstream.net).

FARANCIA ABACURA REINWARDTII (Western Mudsnake). USA: TEXAS: Van Zandt Co.: DOR 59.2 cm SVL snake was found on Van Zandt County Road 2721, 1.28 km N of jct. with US 198, 05 June 2007. The closest permanent body of water to this specimen was a cattle tank within a pasture approximately 30 m away. R. Michael Burger. Verified by Carl J. Franklin. Voucher specimen deposited in University of Texas at Arlington Amphibian and Reptile Diversity Research Center (UTA R 55370). New county record (Dixon 2000. Amphibians and Reptiles of Texas. 2nd ed. Univ. of Texas A&M Press, viii+421 pp.).

Submitted by **R. MICHAEL BURGER**, 510 VZCR 2721, Mabank, Texas 75147, USA; e-mail: mvburger@dctexas.net.

FORDONIA LEUCOBALIA (Crab-eating Snake). THAILAND: RANONG PROVINCE: Kraburi District: mangrove forest near Tham Phrakhayang, Phrakhayang Cave (10.33ºN, 98.77ºE). 20 October 2002. M. Sumontha. Chulalongkorn University Museum of Zoology, Bangkok (CUMZ R. 2003.16). Verified by A. Aowphol. Freshly ingested adult male (SVL 409 mm, TL 60 mm) regurgitated by an adult female *Bungarus fasciatus* (released; TL ca. 900 mm) caught at 1930 h. First provincial record. Closest Thai record from Phuket Island (Nabhitabhata et al. "2000" 2004. Checklist of Amphibians and Reptiles in Thailand. Office of Environmental Policy and Planning, Bangkok. 152 pp.; Murphy 2007. Homalopsid Snakes. Evolution in the Mud. Krieger Publ. Co., Malabar, Florida. 146 pp.), ca. 100 km southwards. We thank A. Aowphol and K. Thirakhupt for providing working facilities in their institution.

Submitted by **OLIVIER S. G. PAUWELS**, Département des Vertébrés Récents, Institut Royal des Sciences naturelles de Belgique, Rue Vautier 29, 1000 Brussels, Belgium (e-mail: osgpauwels@yahoo.fr); and **MONTRI SUMONTHA**, Ranong Marine Fisheries Station, 157 M. 1, Saphan-Pla Rd., Paknam, Muang, Ranong 85000, Thailand (e-mail: knotsnake2211@yahoo.com).

HETERODON NASICUS (Plains Hognose Snake). USA: COLORADO: Boulder Co.: Rabbit Mountain Open Space (40.248787°N, 105.224775°W; NAD83). 20 May 2008. Elijah Wostl and Tim Warfel. Photo verified by Lauren J. Livo. University of Colorado Museum Ancillary Collection 166. New County Record (Hammerson 1999. Amphibians and Reptiles of Colorado. 2nd ed. University Press of Colorado, Niwot. 424 pp.).

Submitted by **ELIJAH WOSTL;** e-mail ewostl@gmail.com.

HYDROMORPHUS CONCOLOR (Serpiente Acuática). PANAMÁ: PANAMÁ: Distrito de Chimán: Pacific slope of Serranía de Majé (8.8664°N, 78.5871°W; WGS84), 505 m elev. 17 March 2004. Marcos Ponce A. Verified by Mahmood Sasa. Museo de Vertebrados de la Universidad de Panamá (MVUP 1889). New district record, extending the geographic range ca. 98 km (airline) SE of the nearest locality in central Panamá (Ibáñez et al. "1994"[1995]. Scientia (Panamá) 9:17–31).

Submitted by **MARCOS PONCE A.**[1], **FRANK A. SOLÍS**[2,3], **ROBERTO IBÁÑEZ D.**[2,3,4] ,and **CÉSAR A. JARAMILLO A.**[2,4,5]. [1]Instituto de Ciencias Ambientales y Desarrollo Sostenible, Universidad Autónoma de Chiriquí, David, Rep. de Panamá; [2]Círculo Herpetológico de Panamá, Apartado 0824-00122, Panamá, Rep. de Panamá; [3]Departamento de Zoología, Universidad de Panamá, Panamá, Rep. de Panamá; [4]Smithsonian Tropical Research Institute, Unit 0948, APO AA 34002-0948, USA; [5]Departamento de Histología, Facultad de Medicina, Universidad de Panamá, Panamá, Rep. de Panamá (e-mail: IBANEZR@si.edu).

LAMPROPELTIS ALTERNA (Gray-banded Kingsnake). MEXICO: DURANGO: Municipio de Santiago Papasquiaro: East slope of the Sierra Madre Occidental (25.087°N, 105.542°W, WGS 84), 2218 m elev. 31 July 2007. J. Reyes Velasco and M. J. Ingrasci. Verified by J. A. Campbell. University of Texas Arlington Digital Collection (UTADC 1096). New municipality

record, third record for Durango, and first record for Sierra Madre Occidental, extending the known range ca. 100 km W of the closest other known Durango record, 5 mi. S of San Antonio near El Banco; 26 mi. N San Juan del Río, 4700 ft. elev. (Tanzer 1970. Herpetologica 26:419–428 [as *L. mexicana*]). Garstka (1982. Breviora 466:1–35 [as *L. alterna*]) reported the same specimen using the 26 mi. N San Juan Del Río locality (TCWC 36892) and Gadsden et al. (2006. Bull. Chicago Herpetol. Soc. 41:2–9) reported another taken in the Sierra el Sarnoso, Municipio Lerdo (between 1100 m and 1350 m elev.) in the northeastern portion of the state. The other two records are from Chihuahuan Desert scrub vegetation, whereas the snake reported herein was found in Madrean woodland vegetation at a higher elevation.

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LEPTOTYPHLOPS MAXIMUS **(**Giant Blind Snake). MÉXICO: OAXACA: Municipality of Huajuapan de León: 4 km SE Huajuapan de León (17.4717°N, 97.4530°W; WGS 84), 1671 m elev. 15 June 2007. Roberto Vargas. Verified by Luis Canseco Márquez. Colección de Anfibios y Reptiles de la Universidad Autónoma Metropolitana-Iztapalapa (CAR-I 266). First record for Oaxaca, extending the range 63 km S from the nearest locality in Tulcingo, Puebla (García-Vázquez et al. 2006. Publ. Soc. Herpetol. Mex. 3:152–169). The specimen was caught in xerophilic scrub vegetation close to an anthill (*Pogonomyrmex* sp.).

Submitted by **MATÍAS MARTÍNEZ-CORONEL** and **ISAÍAS DANIEL LÓPEZ-HERNÁNDEZ**, Departamento de Biología, Universidad Autónoma Metropolitana-Iztapalapa. Av. San Rafael Atlixco 186, Col. Vicentina, 09340. Iztapalapa, D.F., México (e-mail: marti17@hotmail.com).

MICRURUS SURINAMENSIS (Surinam Coralsnake). BRAZIL: GOIÁS: Municipality of Aragarças, confluence of Caiapó River with Araguaia River (15.9042ºS, 51.845ºW; datum SAD69 or 0409536, 8241455; 310 m elev.). 07 December 2007. I. Jr. Tonial. Museu de Zoologia da Universidade de São Paulo, São Paulo, Brazil (MZUSP 17211, juvenile male, 265 mm SVL). Verified by H. Zaher. The species is known from a wide range west of Araguaia River and north reaching Mato Grosso, Eastern Pará, Amapá, and Roraima states in Brazil; also known from Guyana, Suriname, French Guiana, and southern Venezuela (Campbell and Lamar 2004. The Venomous Reptiles of the Western Hemisphere. 2 vols. Cornell University Press. Ithaca, New York. 774 pp.; Strüssmann and Carvalho 1998. Herpetol. Rev. 29:183–185). This is the southeastern most and first state record (state of Goiás) for *M. surinamensis*, extending the known distribution ca. 594 km SSE of Nova Olímpia (14.7833ºS, 57.2833°W; datum SAD69; Mato Grosso), the only locality officially recorded for this species in southern Mato Grosso to date (Strüssmann and Carvalho, *op. cit*.).

Submitted by **NELSON JORGE DA SILVA JR**, **HÉLDER LÚCIO RODRIGUES SILVA**, Departamento de Biologia, Universidade Católica de Goiás, Ave. Universitária, 1440, Setor Universitário, 74.605-010, Goiânia, Goiás, Brazil; and **ANITA DE MOURA PESSOA**, Systema Naturae Consultoria Ambiental Ltda, Rua 58, nº 217 – Jardim Goiás, 74.810-230, Goiânia, Goiás, Brazil (e-mail: herp@terra.com.br).

NERODIA FASCIATA CONFLUENS (Broad Banded Watersnake). USA: TEXAS: Marion Co.: On the edge of a cattle pasture (Cypress River Ranch, FM 2208) and bottomland hardwood forest adjacent (ca. 100 m) to Big Cypress Bayou (32.7516306ºN, 94.3773056ºW) near Jefferson, Texas. 7 February 2006. Thomas Rainwater. Verified by C. Bob Sanders. Campbell Museum (CUSC 2363), Clemson University, Clemson, South Carolina. County record. Freshly dead from apparent head injury. Fills distributional gap of species in northeast Texas (Dixon 2000. Amphibians and Reptiles of Texas. 2nd ed. Texas A&M University Press, College Station, Texas. 421 pp).

Submitted by **THOMAS R.RAINWATER**, The Institute of Environmental and Human Health, Texas Tech University, P.O. Box 764, Jefferson, Texas 75657, USA (e-mail: trrainwater@gmail.com); **STEVEN G. PLATT**, Department of Biology, Box C-64, Sul Ross State University, Alpine, Texas 79832, USA; and **STANLEE M. MILLER**, Department of Biological Sciences, 132 Long Hall, Clemson University, Clemson, South Carolina 29634, USA.

NINIA SEBAE (Culebrilla del Café; Coffee Snake). PANAMÁ: BOCAS DEL TORO: Distrito de Changuinola: Changuinola, Finca 8 (9.4388°N, 82.5155°W; WGS84), 5 m elev. 14 November 2003. Marcos Ponce A. Verified by Alejandro Solórzano. Museo de Vertebrados de la Universidad de Panamá (MVUP 1890). New record for Panamá and extends the geographic range ca. 110 km (airline) SE of the nearest locality on the lowlands of the Atlantic versant of Costa Rica (Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna between Two Continents, between Two Seas. University of Chicago Press, Chicago, Illinois. xx + 934 pp.).

Submitted by **MARCOS PONCE A.**[1], **FRANK A. SOLÍS**[2,3], **ROBERTO IBÁÑEZ D.**[2,3,4] and **CÉSAR A. JARAMILLO A.**[2,4,5]. [1]Instituto de Ciencias Ambientales y Desarrollo Sostenible, Universidad Autónoma de Chiriquí, David, Rep. de Panamá; [2]Círculo Herpetológico de Panamá, Apartado 0824-00122, Panamá, Rep. de Panamá; [3]Departamento de Zoología, Universidad de Panamá, Panamá, Rep. de Panamá; [4]Smithsonian Tropical Research Institute, Unit 0948, APO AA 34002-0948, USA; [5]Departamento de Histología, Facultad de Medicina, Universidad de Panamá, Panamá, Rep. de Panamá (e-mail: IBANEZ@si.edu).

OXYRHOPUS RHOMBIFER RHOMBIFER (Coral-falsa). BRAZIL: BAHIA. Municipality of Paulo Afonso (9.4ºS, 38.2ºW). May 1988. Collectors unknown. Coleção Científica de Serpentes do Museu de Zoologia da Universidade Federal da Bahia, Salvador, Bahia, Brazil (UFBA 182, 187, 196, 199, 214). Verified by F. L. Franco. Species previously known from "província de Buenos Aires to east of Rio Paraná in Argentina," Uruguay, and in the Brazilian states of Rio Grande do Sul, Santa Catarina, Paraná, Minas Gerais, São Paulo, Rio de Janeiro, and

Bahia (Argôlo and Freitas 2000. Herpetol. Rev. 31:55; Peters and Orejas-Miranda 1970. Bull. U.S. Nat. Mus. 297:235). Second record of the species from northeastern Brazil, extends range ca. 350 km N from Lençóis, the previous northernmost locality (Argôlo and Freitas 2000, *op. cit.*).

Submitted by **BRENO HAMDAN (**e-mail: brenohamdan@gmail.com), and **REJÂNE MARIA LIRA-DA-SILVA**, Núcleo Regional de Ofiologia e Animais Peçonhentos da Universidade Federal da Bahia, Rua Barão de Geremoabo, 147 - Campus de Ondina, CEP 40170-290, Salvador, Bahia, Brazil.

PARIAS SUMATRANUS (Sumatran Pit Viper). BRUNEI DARUSSALAM: Ulu Temburong National Park: nr. Sungai Sibut. 01 October 2006. Alexander Keller, Matthias Siegle, and T. Ulmar Grafe. Photo voucher, Staatliches Museum für Naturkunde Stuttgart, SMNS V-1-001. Verified by Indraneil Das. Encountered coiled up within a rattan palm. On approach, showed aggressive behavior (hissing and directed extension). After several minutes of observation, disappeared into canopy of nearby tree. Length (ca. 1 m) and reddish tail suggest it was a juvenile.

Submitted by **ALEXANDER KELLER**, University of Würzburg, Department of Animal Ecology and Tropical Biology, Biocenter, Am Hubland, 97074 Würzburg, Germany; e-mail: info@biotopia.info.

PSEUDOLEPTODEIRA LATIFASCIATA (False Cat-eyed Snake). MEXICO: OAXACA: Municipality of Santiago Tamazola: road from Santiago Tamazola to Santa Rosa (17.4400°N, 97.5026°W, estimated from map), 1230 m elev. 15 July 2003. Verified by Edmundo Pérez Ramos. Museo de Zoología, Facultad de Ciencias, UNAM (MZFC 17890). First record from Oaxaca, extending its known range 58 km S of the nearest locality at Piaxtla, Puebla (Duellman 1958. Bull. Amer. Mus. Nat. Hist. 114:1–152). The specimen was found dead in oak forest.

Submitted by **LUIS CANSECO-MÁRQUEZ (**e-mail: lcanseco@gmail.com), and **ANA LAURA NOLASCO VÉLEZ,** Departamento de Biología Evolutiva, Museo de Zoología, Facultad de Ciencias, Universidad Nacional Autónoma de México, A.P. 70-399, C. P. 04510, México, D. F., México.

RAMPHOTYPHLOPS BRAMINUS (Brahminy Blindsnake). MÉXICO: TABASCO: Municipality of Centro, Municipality Palace of Villahermosa (17.5944°N, 92.5644°W, WGS 84), 10 m elev. 14 July 2007. José G. Paz Gutiérrez. Verified by Ireri Suazo Ortuño. Colección Herpetológica del Instituto de Investigaciones sobre los Recursos Naturales, Universidad Michoacana de San Nicolás de Hidalgo (INIRENA 678). First record for Tabasco and a 345 km SE (airline) range extension from Playa Mocambo, Veracruz (Mendoza-Quijano et al. 1993. Herpetol. Rev. 24:110) and 352 km NE (airline) from Cuicatlán, Oaxaca (Mendoza Quijano et al. 1994. Herpetol. Rev. 25:34). These records suggest that this exotic species is well established on the Gulf lowlands of México in a similar fashion as on the lowlands of the Pacific versant (Mata-Silva et al. 2007. Herpetol. Rev. 38:356)

Submitted by **JOSÉ GIL PAZ GUTIÉRREZ**, **CARLOS SOTO ROJAS,** and **JAVIER ALVARADO DÍAZ**, Laboratorio de Herpetología, Instituto de Investigaciones sobre los Recursos Naturales, Universidad Michoacana de San Nicolás de Hidalgo, Av. San Juanito Itzicuaro s/n, Morelia, Michoacán, México 58330 (e-mail: kumo345@hotmail.com).

REGINA GRAHAMII (Graham's Crayfish Snake). USA: ILLINOIS: Macon Co.: Decatur Lake at Reas Bridge Rd (39.88255ºN, 88.86804ºW). 19 May 2007. Collected by Leroy J. Walston Sr. Verified by C. A. Phillips. Illinois Natural History Survey, University of Illinois. Color photograph voucher (INHS 2008.12). One subadult (40 cm TL) captured along shoreline among rocks. First county record, filling the gap among central Illinois counties (Phillips et al. 1999. Field Guide to Amphibians and Reptiles of Illinois. Illinois Nat. Hist. Manual 8, Champaign, Illinois, 282 pp.).

Submitted by **LEROY J. WALSTON SR**., 1835 N. Bender Rd., Decatur, Illinois, 62521, USA; and **LEROY J. WALSTON JR**., Argonne National Laboratory, 9700 S. Cass Ave., Argonne, Illinois, 60439, USA (e-mail: lwalston@anl.gov).

SALVADORA GRAHAMIAE LINEATA (Texas Patch-nosed Snake). USA:TEXAS: Shackleford Co.: Hwy 351 ca. 4.8 km S of jct. with Hwy180 (32.6239167ºN; 99.4716333ºW). Collected by Edwin L. Gainey. Verified by Carl Franklin. University of Texas at Arlington Ampibian and Reptile Biodiversity Research Center (UTA R-55847). New county record. (Dixon 2000. Amphibians and Reptiles of Texas. Second ed. Texas A&M University Press, College Station, Texas. viii+421 pp; Dixon et al. 2007. Texas Herpetol. Soc. Publ. 2007:1–58).

Submitted by **CHRISTIAN L. COX (**e-mail: clcox@uta.edu), **COREY E ROELKE,** University of Texas at Arlington, Department of Biology, 501 S. Nedderman Dr., Arlington, Texas 76019, USA; and **BRANDON POPE,** 1706 Nueces Trl Arlington, Texas 76012, USA.

SIBON LAMARI (Caracolera). PANAMÁ: BOCAS DEL TORO: Distrito de Changuinola: Río Changuinola, El Guayabal (9.2104°N, 82.4699°W; WGS84), 150 m elev. 13 June 2007. Jhoana De Alba and César A. Jaramillo. Círculo Herpetológico de Panamá (CH 6214). COLÓN: Distrito de Donoso: La Sargenta, Río Toabré (8.9314°N, 80.5144°W; WGS84), 60 m elev. 22 March 2002. Roberto Ibáñez D. Círculo Herpetológico de Panamá (CH 5402). Punta Rincón (9.0210°N, 80.6862°W; WGS84), 5 m elev. 08 January 1983. Fidel E. Jaramillo A. Museo de Vertebrados de la Universidad de Panamá (MVUP 1892). All specimens verified by Alejandro Solórzano. New records for Panamá, extending the geographic range ca. 355 km (airline) SE of the nearest locality in Costa Rica and elevational range from 650 m to the lowlands (Solórzano 2004. Serpientes de Costa Rica: Distribución, Taxonomía e Historia Natural. Instituto Nacional de Biodiversidad, Santo Domingo de Heredia, Costa Rica. 791 pp.).

Submitted by **CÉSAR A. JARAMILLO A.**[1,2,3], **ROBERTO IBÁÑEZ D.**[1,2,4] **FIDEL JARAMILLO A.**[1,5], and **FRANK A. SOLÍS**[1,4]. [1]Círculo Herpetológico de Panamá, Apartado 0824-00122, Panamá, Rep. de Panamá; [2]Smithsonian Tropical Research Institute, Unit 0948, APO AA 34002-0948, USA; [3]Departamento de Histología, Facultad de Medicina, Universidad de Panamá, Panamá, Rep. de Panamá; [4]Departamento de

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STORERIA O. OCCIPITOMACULATA (Northern Red-bellied Snake). USA: MARYLAND: DORCHESTER CO.: 2.5 km NE of Blackwater near Barnes Landing on Blackwater Rd. (38.4166ºN, 76.125ºW). DOR adult, 05 November 1994. Arthur and Zack Meilhammer. Verified by Ned S. Gilmore, Academy of Natural Sciences, Philadelphia (ANSP 36239). New county record, verifies county record on distribution map in White and White (2002. Amphibians and Reptiles of Delmarva. Tidewater Publishers, Centreville, Maryland. 248 pp.).

Submitted by **WILLIAM L. GROGAN, JR**., Department of Biological Sciences, Salisbury, Maryland 21801, USA; e-mail: wlgrogan@salisbury.edu.

XENODERMUS JAVANICUS (Rough-backed Litter Snake). BRUNEI DARUSSALAM: Ulu Temburong National Park: nr. Sungai Esu. 22 September 2006. Alexander Keller, Matthias Siegle, and T. Ulmar Grafe. Photo voucher, Staatliches Museum für Naturkunde Stuttgart, SMNS V-2-001. Verified by Indraneil Das. Encountered three times (August–September 2006) within riparian areas with leaf litter. Nearby streams were small, < 5 m wide, and not deeper than 50 cm. In all cases, in hilly terrain with moderate vegetation. Encounters were > 1 km apart from each other, for which reason it is assumed the snakes were different individuals.

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New and Noteworthy Records of Snakes from Bolivia

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The last comprehensive list of Bolivian snakes with information about their distribution was published by Fugler et al. (1995). Since then, several new species, new country records and revisions have been published (e.g., Harvey 1994; 1999; Harvey et al. 2003; 2005; Reichle and Embert 2005; Embert et al. 2006; Jansen 2006). The present note provides three new country records, four new departmental records and other noteworthy records of snakes in Bolivia. The fieldwork was done during November 2004 and April 2005 and October 2005 and March 2006 predominantly in the eastern lowlands of Bolivia. The specimens were deposited in the Museo Noel Kempff Mercado (MNKR), Santa Cruz, and Museum Senckenberg (SMF), Frankfurt. The identities of the specimens were verified by G. Köhler (except *Thamnodynastes chaquensis* verified by F. L. Franco).

Clelia bicolor. BOLIVIA: SANTA CRUZ: Hacienda El Espinal, Pantanal, San Matias (17.0372167ºS, 58.5305667°W; 124 m). 15 April 2004 and 23 January 2005. Martin Jansen. SMF 86639, MNKR 4255. First record for Bolivia. *Clelia bicolor* occurs in southern Mato Grosso, Brazil, south to Paraguay and northern Argentina, and inhabits lowlands of the Platine Plains, Chaco, Pantanal, and their boundaries (Franco et al. 1997; Zaher 1996). The next known locality is ca. 210 km SE, in the Pantanal at Poconé, Mato Grosso, Brazil (Strüssmann and Sazima 1993).

Lystrophis pulcher (South American Hognose Snake). BOLIVIA: TARIJA: Villa Montes. 1 May 1927. F. Berg. SMF 32470. First departmental record. The species occurs in the Chacoan region of Argentina (Jujuy, Salta, Catamarca, Tucumán, Santiago del Estero, Formosa, Chaco, Córdoba, San Luis, Entre Dios, and Corrientes provinces), south of Paraguay and was known for Bolivia only from San Ignacio de Velazco, Department of Santa Cruz (Scrocchi and Cruz 1993). Nearest known locality is in Salta, Argentina, ca. 100 km S.

Lystrophis mattogrossenis (South American Hognose Snake). BOLIVIA: SANTA CRUZ: Provincia Ñuflo de Chavez, Hacienda and RPPN San Sebastián (16.3624833ºS, 62.02195ºW, 537 m). 08 November 2005. Martin Jansen and Arne Schulze. MNKR 4257. Second record for Bolivia. The species was only known from Mato Grosso and Mato Grosso do Sul states, Brazil to lowlands of eastern Bolivia (Giraudo 1997; Scrocchi and Cruz 1993). Extends the range about 350 km W from westernmost known locality in Sandoval, Department of Santa Cruz, Bolivia (Giraudo 1997).

Micrurus frontalis (Cerrado Coral Snake). BOLIVIA: SANTA CRUZ: Provincia Ñuflo de Chavez, Hacienda and RPPN San Sebastián. 29 November 2005 and 28 December 2005. Martin Jansen and Arne Schulze. MNKR 4253, SMF 86637. First country record. The species was only known from the Cerrado formations of Central Brazil (including Sao Paulo and Minas Gerais) west to the border of Bolivia and the Brazilian states of Mato Grosso and Mato Grosso do Sul. Extends the range at least 400 km W from westernmost known locality in Mato Grosso (Campbell and Lamar 2004; Silva and Sites 1999). Harvey et al. (2003) suspected *M. frontalis* to occur in Bolivia.

Phalotris nasutus. BOLIVIA: SANTA CRUZ: Provincia Ñuflo de Chavez, Hacienda and RPPN San Sebastián (16.3877167ºS, 61.9997167ºW; 566 m). 26 October 2005. Martin Jansen and Arne Schulze. MNKR 4256. First country record. *Phalotris nasutus* was only known from the Cerrados in central Brazil to north and southwest (Lema 2002). Enlarges the range of *P. nasutus* substantially to the west. The nearest known locality in Mato Grosso lies ca. 850 km E (Lema 1999).

Thamnodynastes chaquensis. BOLIVIA: SANTA CRUZ: Hacienda and RPPN El Espinal, Pantanal, San Matias. 17 April 2005 and 24 January 2006. Martin Jansen. MNKR 4284 (17.04ºS, 58.5189667ºW, 99 m), SMF 86332 (17.0372167ºS, 58.5305667ºW; 124 m). Verified by F. L. Franco from photographs and data of squamation. First departmental record. This species is

distributed from Paraguay, Uruguay, northeastern Argentina, and Brazil (Carreira 2003; Giraudo 1996; Giraudo and Scrocchi 2002; Franco and Ferreira 2002; Leynaud and Bucher 1999). In Bolivia it was only known from Tariquía, Department of Tarija (Lavilla and Scrocchi 1999). The nearest known locality is ca. 210 km SE, in the Pantanal at Poconé, Mato Grosso, Brazil [a photograph of *Thamnodynastes* sp. by Strüssmann and Sazima (1993) shows *T. chaquensis* according to Franco and Ferreira (2002)].

Xenodon rhabdocephalus. BOLIVIA: SANTA CRUZ: Hoyada (Prov. Florida, north of Aguaclara, at the southern limits of the Parque Nacional Amboro, 1650–1900 m) and RPPN Los Volcanes (18.1059ºS, 63.5977667ºW; 1051 m). 15 October 2004 and 09 March 2005. Eduardo Mamani, Fray Andres Langer and Martin Jansen. First departamental record. In its large distributional area from Central America and South America south to Brazil and Bolivia (Paolillo 1984) the species was only known from sea level to about 1300 m (Wilson and Meyer 1982). The record from the locality Hoyada extends the vertical distribution from *X. rhabdocephalus* at least 300 m. The record from Los Volcanes extends the distribution at least 350 km SSE; the nearest known locality is at the Rio Mamoré, Beni, Bolivia (Fugler et al. 1995).

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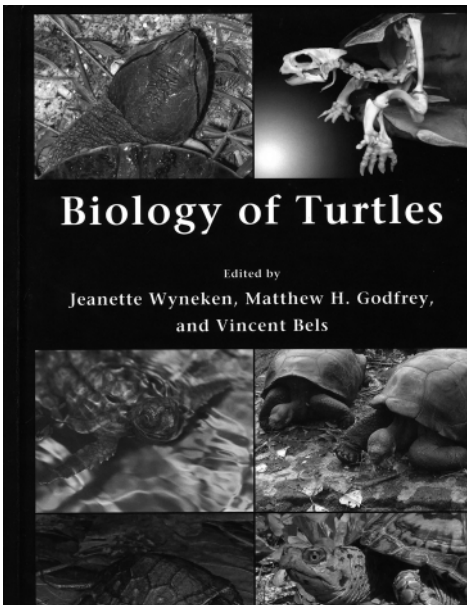
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BOOK REVIEWS

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Biology of Turtles, edited by Jeanette Wyneken, Matthew H. Godfrey, and Vincent Bels. 2008. CRC Press, Boca Raton, Florida (www.crcpress.com). Hardcover. xiii + 389 pp. US $149.95. ISBN 978-0-8493-3339-2.

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In the Preface to *Biology of Turtles* (BOT) the authors explain that their book is the result of a turtle anatomy symposium at the Sixth International Congress of Vertebrate Morphology held at Jena, Germany in 2001. Given the morphological focus of the conference, the book's purview encompasses several fields of biology within an anatomical context, including developmental biology, functional morphology, behavior, physiology, evolution and systematics. Thirty-five contributors from the United States and Europe provided 13 chapters that are discussed in detail below.

The first chapter (16 pages) by Scott Gilbert and colleagues explains the detailed process of ossification of the shell in turtles. The authors discuss how heterotopy and paracrine factors affect formation of the carapacial bones in the well-studied genera *Trachemys*, *Chelydra* and *Pelodiscus*. These same genera are the focus of the authors' discussion of neural crest cells and heterochrony during plastron formation. A final, brief section summarizes the evolutionary implications of shell formation, including a discussion of the anapsid-diapsid debate, and how different kinds of data have been used to reach different conclusions about the origin and classification of turtles.

Chapter 2 (27 pages) by Melissa Snover and Anders Rhodin focuses on the application of skeletochronology (specifically LAG's, or lines of arrested growth) to estimate age and growth rates in turtles. The two patterns of bone growth in turtles are discussed in detail in the next section, but the authors focus on chondro-osseous development in the leatherback sea turtle *Dermochelys coriacea*, which is unique among turtles—this fascinating section is richly illustrated with detailed photographs of fresh bone preparations, histological cross sections of bone, and electron micrographs of extant sea turtles, as well as joint surfaces of several extinct sea turtle genera. The evolution of vascularized cartilage in the superfamily Dermochelyidae is explored in the context of three competing hypotheses of phylogenetic relationships. Finally, the authors explain how their results demonstrate that *Dermochelys* is unique among turtles in relation to rates of growth to sexual maturity.

Peter Pritchard is the author of Chapter 3 (39 pages), which discusses the origin of turtles within the context of fossils and morphology, and then explores variation in turtle shells (including osteology, scutes and kinesis) in detail. Additional sections discuss sexual dimorphism, ankylosis, fontanels, plastral reduction, deformities (including "pyramiding," kyphosis, scute abnormalities, and premature ankylosis of individual shell sutures), and geodesics. Finally, specialized and unusual shell morphologies are discussed in the families Cheloniidae, Dermochelyidae, and Trionychidae. This chapter includes 38 black-and-white photographs of shell variation in turtles.

The brief Chapter 4 (12 pages) by Gustavo Llorente and colleagues is entitled "Long Bone Allometry in Tortoises and Turtles." The authors compare limb bone diameters and lengths across 11 families of turtles to test whether "limb scaling" differs among terrestrial and aquatic chelonians (possibly as a result of locomotor adaptations), and follows patterns described previously in other tetrapods. Their results are consistent with a "geometrical similarity" hypothesis, and it seems that turtle bones are more similar to the shape of bird bones than the long bones of quadrupedal mammals. Future directions to investigate the role of locomotor adaptation on the appendicular shape of turtles are discussed.

Sabine Renous and colleagues examine the relationship among morphological variation of extant and extinct turtle locomotor systems, their function, and diversity of aquatic and terrestrial habitats in Chapter 5 (42 pages). The chapter includes a discussion of environmental constraints and the origin of aquatic turtles, structural constraints on the chelonian body plan, and a detailed analysis of morphological variation in aquatic environments. The topic transitions to a section about locomotion in aquatic turtles, including different functions of the limb, propulsion, kinematics, and limb coordination.

Chapter 6 (24 pages) by Richard Blob and colleagues is entitled "Hindlimb Function in Turtle Locomotion: Limb Movements and Muscular Activation across Taxa, Environment, and Ontogeny." The authors compare aquatic and terrestrial patterns of hind limb kinematics and muscle activation (EMG) between aquatic, highly specialized spiny softshell turtles (*Apalone spinifera*) and generalized, semiaquatic sliders (*Trachemys scripta*). One section of the chapter compares adults of the two species, and although both species have largely similar modulation patterns, several interesting contrasts in hind limb function are discussed. A similar investigation of *Apalone* and *Trachemys* juveniles notes that several of the interspecific differences of adults are not evident in juveniles. The chapter ends by discussing future directions for studies of turtle locomotion.

The aim of Anthony Herrel and colleagues in Chapter 7 (23 pages) is to provide a detailed description of the cervical sys-

tem in pleurodiran (horizontal plane head retraction) and cryptodiran (vertical plane head retraction) turtles, and to emphasize the functional consequences of differences in morphology in the two groups. The authors studied the preserved anatomy of *Chelodina longicollis*, *C. reimani*, *Apalone ferox*, and *A. spinifera*, and used live animals from each species to study the kinematics of snorkelling behavior. The cervical vertebrae and musculature are illustrated in detail for *C. longicollis* and *A. spinifera*. Differences in these structures and movement patterns are discussed for both groups.

Chapter 8 (26 pages) by Vincent Bels and colleagues provides the first comparative analysis of feeding behavior in turtles, especially in marine and terrestrial species. An overview of turtle feeding and drinking behaviors is provided, and then the chapter focuses on the kinematics of terrestrial ingestion, the intra-oral transport cycle, swallowing, aquatic ingestion, and a specific case of feeding in *Dermochelys coriacea*. The chapter is illustrated with several schematic feeding diagrams, frames of video of feeding behavior, x-ray videofluoroscopy, and high-speed x-ray film sequences.

A brief Chapter 9 (12 pages) by BOT's lead editor Jeanette Wyneken explores the anatomy of the circulatory and pulmonary systems in turtles, including sections on the heart, great vessels and major tributaries, lungs and airways, cardiopulmonary circulation, ventilation, cardiovascular shunts, and respiratory physiology. Differences in these structures among turtles are generally correlated with ecology and behavior. The chapter ends with a comparison of turtle cardiopulmonary structures to other reptiles.

BOT's longest chapter (54 pages), by Jeffrey Miller and Stephen Dinkelacker, is a literature review entitled "Reproductive Structures and Strategies of Turtles." The authors state that their focus is on the morphological diversity of chelonian reproductive structures and the effects these have on the range of reproductive strategies exhibited by turtles; an extensive references section (18 pages) is provided to stimulate further research. The authors discuss variation in reproductive structures in several sections including general morphology, gonads, the oviduct, cloaca and associated structures, hormonal changes during reproduction, and eggs. A second, ambitious section on reproductive strategies explores sexual dimorphism, mating behavior, seasonal timing of reproduction, insemination and sperm storage, fecundity (including shape and number of eggs and clutches), nesting patterns and density, ovipositional site selection and oviposition, embryonic development and incubation, sex determination, developmental arrest, hatching and hatchling survivorship, overwintering, and growth. The authors have synthesized an ambitious amount of information in this chapter, and although the authors state that their literature review is not meant to be comprehensive, I would be remiss if I didn't point out that they omitted *Apalone spinifera* from the list of trionychid developmental stage studies (Greenbaum and Carr 2002). In the review of turtle development, it would have been nice to include several recent, detailed turtle development studies by Christopher Sheil that provide incubation data that are relevant to the discussion (e.g., Sheil 2003, 2005).

Chapter 11 (22 pages) by Vincent Hulin and colleagues is entitled, "Mixed and Uniform Brood Sex Ratio Strategy in Turtles: The Facts, the Theory, and Their Consequences." The authors have three goals in this chapter: (1) theoretically compare strategies producing unisex or mixed-sex ratios within a nest and their contribution to the population; (2) assess the risk of extinction of turtle populations according to the brood sex ratio strategy (mixed or unisex nests) used by individuals; and (3) compare their theoretical predictions with real-world scenarios from the literature. The authors discuss these aspects in detail and explain how they are related to the evolution of temperature-dependent sex determination (TSD) and its consequences to turtle evolution. One interesting section discusses global warming and the fate of TSD turtles, exploring different adaptive strategies that turtles might use to survive into the 22nd century. This chapter seems somewhat out of place with the rest of the contributions in BOT because it does not have an anatomical focus.

Sarah Milton is the author of Chapter 12 (44 pages) entitled, "The Physiology and Anatomy of Anoxia Tolerance in the Freshwater Turtle Brain." The chapter begins with an introduction to the central nervous system and brain, and continues with sections on "the brain in crisis," the anatomy and physiology of anoxic survival, energy supply and the enzymes of anaerobic glycolysis, ion channels, neurotransmitters and neuromodulators, excitatory neurotransmitters, nitric oxide, the visual system, antioxidants, and neurogenesis. The chapter concludes by saying that anoxia-tolerant turtles do not differ significantly from mammals and most other vertebrates in brain structure, neuronal pathways or presence/absence of specific neurotransmitters, but rather in the expression of protective pathways that are expressed more robustly and successfully in turtles.

BOT's shortest and last Chapter 13 by Olivier Rieppel (9 pages) begins with a discussion of the unique morphology of turtles, a lack of intermediate fossils, and the resulting difficulty with comparisons to other reptiles. Subsequent sections briefly discuss the history of changing ideas regarding turtle origins and relationships, the current status of the debate, and the ecological setting of turtle origins. Rieppel notes a general consensus has emerged that places turtles among the diapsid reptiles, but it is not yet clear whether they are more closely related to the lepidosauromorph or archosauromorph clades. A recent study of tetrapod RAG-1 sequences by Hugall et al. (2007) supports the latter choice, but the controversy is certain to continue for the foreseeable future.

In general, the quality of writing and illustrations in BOT are good, but I did note a few minor issues: pg. 1, "hardback turtles of the Emys [sic] and Chelydae families" instead of Emydidae and Chelydridae; pg. 2, "suprepygeal" instead of suprapygal; pg. 47, "…spines on the long tail, not the mention the ones on the back…"; pg. 165, "*A. spiniferus*" instead of *A. spinifera*; pg. 201, "*Trachymys*" instead of *Trachemys*; pg. 345, omitted parenthesis. The formatting of the References for each chapter was not consistent, and I noticed problems with switching the position of volume and publication years, and inconsistencies in how page ranges are provided. There also seem to be problems with consistent taxonomy among the chapters, especially with higher taxa—Chapter 1 (pg. 1) refers to turtles as Chelonia instead of Testudines as used in Chapter 13; Chapter 8 (pg. 201) lists *Cuora* in the Family Emydidae, but it should be in the Family Geoemydidae. It would have been helpful to include generalized diagrams of the carapace and plastron to guide the novice through scute terminology, especially because two chapters are devoted to shell morphology

and development. The price of US $150 seems expensive given the lack of color plates in most of the chapters, but the binding is sturdy and the book is printed on acid-free paper. These concerns aside, BOT is a useful reference for anyone interested in the morphology and evolution of turtles.

Acknowledgments.—John L. Carr provided comments on an earlier version of the manuscript.

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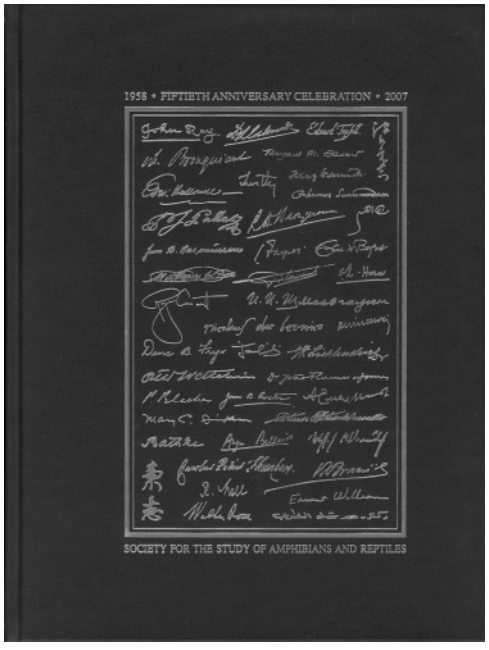
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On the occasion of the 50th anniversary meeting of the SSAR in Saint Louis, Kraig Adler brought out the second volume of his important work *Contributions to the History of Herpetology*. This second volume, being conspicuously more lengthy than the first (Adler 1989), again contains as its main part the biographies of "Herpetologists of the Past" sorted by time spans associated with the years of publication of their first herpetological work. These time intervals start with centuries (1400–1700), followed by one period of eight decades (1700–1780), then two periods of two-decades (1780–1820), followed by ten single decades (1820–1920), then shifting to six pentades from 1920–1950. After that, two decades follow (1950–1970) and finally a span of 20 years (1970–1990) concludes this section. The varying length of these periods reflects (1) that only few early herpetologists (or, more accurately, naturalists who have published on amphibians and reptiles) were not already treated by Adler (1989), and (2) that a large number of herpetologists who lived in the 19th and 20th centuries merited inclusion in this work. The shift to decade and two-decade periods at the end, in contrast, rather reflects the fact that many herpetologists who started publishing after 1950, and especially those beginning publishing from 1960 or 1970 onwards, are largely still alive and, therefore, have to "wait" to be included in Volume 3!



In the present volume the author was able to add no less than 285 new biographies to those contained in Volume 1. They range from Leoniceno in the 16th century, over nearly five centuries, to Joseph Slowinski who died only a few years ago (2001) in a tragic snake bite event. Not only was Adler successful in searching for biographic data and obituaries for all these predecessors and former colleagues of our discipline, but he also was able to collect portraits and signatures for nearly every one of them.

Considering the huge number of biographies, I approach this book as a curious, learning reader, and only in a few cases, can I provide a few additional details that might be useful, especially should the two volumes be fused into one new edition in the not-too-distant future (Volume 1 is now out of print). Of course, due to my personal experience, my few comments refer mainly to German herpetologists and institutions, but certainly this book will also be reviewed in many other journals from countries that also produced prominent herpetologists featured in this volume, so that other reviewers will direct their focus on persons relevant to their respective experiences.

The first point I should like to mention is the "Note" which follows the accounts on Johann Friedrich Blumenbach (p.31), Adolph Arnold Berthold (p. 69) and Wilhelm Keferstein (p. 87), three persons closely connected with the Zoological Museum of the University Göttingen which is, by the way, the oldest institutional natural history museum in Germany (at that time Kingdom of Hannover, now federal state of Lower Saxony). The note after their biographies identically states: "In 1977 the entire Göttingen collection was transferred to the Museum Alexander Koenig in Bonn." However, this is true only for the alcoholic collection of amphibians, reptiles and mammals (Böhme and Bischoff 1984; Hutterer 1984). For instance, the fish collection went to the Zoological Museum of the Hamburg University, the crustaceans were given to the Senckenberg Museum in Frankfurt am Main (Türkay, 1988), and the ornithological collection (the so-called Kirchhoff collection: ca. 4000 mounted birds, including extinct species) went to the Niedersächsisches Landesmuseum in Hannover. Dry, mounted mammal and reptile specimens stayed in Göttingen, where only a small teaching collection and a collection for public display was retained.

In the case of Heinrich Rudolf Schinz (p. 51) it would be worth mentioning his long term scientific correspondence with Prinz Maximilian zu Wied-Neuwied (Vol. 1, p. 22). Schinz loaned books to Wied who prepared handwritten copies, e.g., of the fish part of von Siebold's *Fauna Japonica*. In the latter case he even prepared more than 70 color plates, all personally redrawn from Schinz's copy of this book, in order to save some 120 Thaler. This

work is still in existence in the familial archives of Neuwied Castle (near Koblenz, Germany). This interesting correspondence took place – with longer intervals – between 1821 and 1854 and is housed in the University Library of Zürich, Switzerland.

The paragraph on Franz Leydig (p. 77) stresses the merits of this important anatomist in not only having created the term "Feinstruktur" but actually having discovered the fine structure of many glandular and sensory organs of amphibians and reptiles. I think it would be also worth while to mention here his discovery and first description (Leydig 1857, 1872) of the microscopic "stachliges" (= spiny) epithelium on the hemipenial surface in two lacertid lizard species, as this particular structure was subsequently found to be taxonomically relevant for lacertid systematics (Böhme 1971; Arnold 1973).

Gustav Tornier (p. 127) left us with a number of scientific herpetological names (e.g., *Lacerta vauereselli* – now *Adolfus vauereselli*, *Chamaeleon jacksoni* var. *vauerescecae* – now *C. j. jacksonii*), and *Geodipsas vauerocegae* – now *Buhoma vauerocegae*), the etymological derivation of which seems really improbable for those who have not heard the story. Fortunately, I learned it from one of Tornier's successors in Berlin, Günther Peters. Tornier felt that it might be advantageous if a species name included information on the position of the respective species in the zoological system. So he developed a naming system based on the initial letters of the higher categories the species belonged to. Thus, *L. vauereselli* was derived from the initial letters V for Vertebrata, R for Reptilia, S for Sauria, and L for Lacertidae, giving in (German) spoken form Vau, Er, Es, El, supplied with the masculine genitive singular ending *-li*. Accordingly, *C. vauerescecae* refers to a vertebrate reptilian saurian of the family Chamaeleonidae (VRSC), here supplied with the feminine genitive singular ending *-cae*. *Buhoma vauerocegae*, accordingly, is a vertebrate reptilian ophidian colubrid (VROC), here equipped with the feminine genitive singular ending *-gae*. I think it would be a pity if knowledge of Tornier's strange method of name construction were to be lost.

A small correction is necessary in respect to the account on Heinz Wermuth (p. 216). He did not, as stated in this account, "initiate," together with the paleoherpetologist and mammalogist Wolf Herre, the series *Handbuch der Reptilien and Amphibien Europas* which then was edited by myself from 1981 onwards. The first initiative was made by the publisher who approached me in order to complement multi-volume series on the birds of Central Europe and the mammals of Europe, which had begun in 1979. Rather, both Wermuth and my former doctoral supervisor Herre each agreed, at my request, to write a preface each for the first volume of this series.

Similar slight amendments, minor additions, and cross-references could certainly be made on some other herpetologists forming part of this volume but their accounts will have to be evaluated by readers of their respective nationalities. Any such comments aside, however, Kraig Adler, is to be admired for the massive task of again compiling such a huge amount of herpetobiographical information.

Apart from the main part of the book discussed above, Kraig Adler again engaged Richard Applegarth and Ronald Altig for the two following chapters of the book. Applegarth compiled a second edition of his Index of Authors in Taxonomic Herpetology which is an impressive list of nearly 60 pages with about 60 names per page on average. Here, in contrast to the first part, recent authors also figure alphabetically amongst their deceased predecessors and colleagues. Despite the large number of names with their dates of birth and death, there are some persons where the dates of birth are replaced by a question mark. Among them are even persons mentioned in the acknowledgements at the beginning of the book, so that the search for at least some of these dates should have been rather easy. But again, so few omissions within so many data really seem a "quantité négligeable" to me.

The same is true for the final part of the book, the second edition of the Academic Lineages of Doctoral Degrees in Herpetology compiled by Ronald Altig. The lineages are arranged by country in alphabetical order, starting with Armenia and ending with Zimbabwe. Although several of these countries do not have their own lineages, they are nonetheless listed and readers are referred to other countries in which relevant herpetologists were trained academically. The information given concerns the year of the doctoral award and the university where it was achieved. Again, some question marks could have been easily replaced by hard data — one e-mail would have been enough in some cases! But here it is also true that the vast majority is complete so that the few omissions are insubstantial. Turkey is listed but only with the hint "see Germany." Although it is correct that Muhtar Başoğlu was a doctoral student of Kurt Cosswig in Hamburg, the lineage founded by him at the Aegean University in Bornova-Izmir is so important and independent, not to mention the numerous academic "F2 generation" produced in Izmir, that it certainly merits listing under a Turkish, rather than German, signet.

In the German lineages, I found some errors and omissions including my own one which could easily be corrected or supplemented in a future edition: A nice, important starting point for a first series in Germany would have been the famous J.F. Blumenbach, with his likewise important academic offspring Adolph Arnold Berthold and Prince Maximilian zu Wied-Neuwied. Series 2: 001. The doctoral supervisor of Wolf Herre was Bruno Klatt. 003. My own former doctoral students S. Etti, J. Handwerk, K. Schmidt-Loske, and A. Schunke worked with topics other than herpetology, and Ronald Altig obviously got my list from someone else. Series 4: 004. Heinz Wermuth, student of Martin Eisentraut, did not establish his own university-related working group. Rather he co-supervised theses in cooperation with university professors; for example, that on New Guinean crocodiles by Dietrich Jelden. Günther Peters, however, who is listed here as his student, was in fact his successor at the Berlin Museum, but was himself a doctoral student of P. W. Terentyev in Leningrad (now St. Petersburg)! These few errors do not by any means lessen the great value of this important overview of academic genealogies.

In conclusion, Volume 2 of Kraig Adler's *Contributions to the History of Herpetology* is a monumental work and a landmark in this special discipline. Nevertheless, despite the admiration for this book and for all the great personalities included in it, the herpetological reader certainly still appreciates belonging to the "Herpetologists of the Present."

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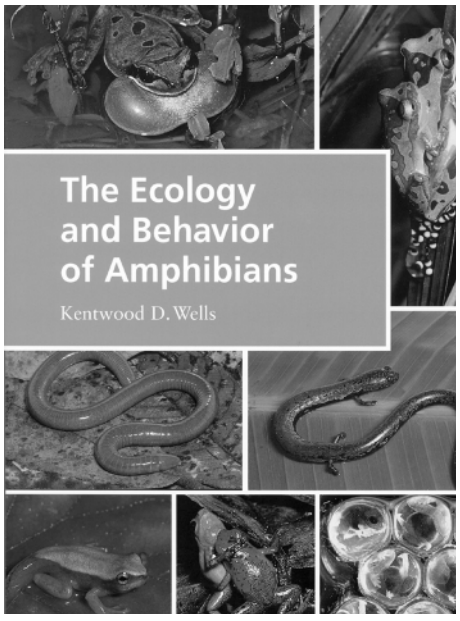
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The Ecology and Behavior of Amphibians, by.Kentwood D. Wells. 2007. University of Chicago Press (www.press.uchicago.edu). xi + 1148 pp. Hardcover. US$75.00. ISBN: 978-0-226-89334-1.

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In the preface to *The Ecology and Behavior of Amphibians*, Kentwood Wells muses that the book has resembled at times during its approximate 25-year development "one of those never-ending scholarly endeavors...[like] writing the definitive multivolume biography of Herman Melville." In fact, the book does resemble Melville's famous white cetacean in size, with a final page count of 1148. Despite the rather intimidating size of the book, however, the text is enjoyable. Wells' scholarly endeavor aims to be a single-volume synthesis of major themes in amphibian ecology and behavior and, given the ambitious nature of the task, he is remarkably successful.



The book is organized into 16 chapters, grouped roughly by topic. In each, Wells does a skillful job of discussing volumes of literature with clarity and a strong sense of historical perspective. The book's strength also comes from what Wells chooses *not* to write. Acknowledging that many topics are simply beyond the scope of a single volume, he frequently defers to more specific works. The result is a uncommon balance between depth and breadth of coverage.

For a volume of this scope and size, the book is surprisingly readable. Wells' conversational writing style contributes to this readability, as do the abundant photos, line drawings, and figures. It is rare to see more than four consecutive pages without a visual aid. Full- or half-page photo spreads are distributed throughout the text and, while black-and-white, are generally of high quality. Figures have been reproduced in a consistent format and the book's numerous line drawings (many by Mary Jane Spring) are excellent. Smaller aesthetic details should be appreciated, as well — for example, the matte-finish pages and clear printing. Editorially, the book contains very few typographical errors, which should reduce unwanted distractions from the text for those prone to be grammar and spelling sticklers.

Certainly this book could serve as a reference volume for anyone working on ecological questions involving amphibians. Portions of the book could be used in upper-level undergraduate courses, although its full potential would be better realized in a class of graduate students possessing the background to decipher sections that might prove incomprehensible to many undergraduates (such as the discussion of functional morphology of tadpole feeding). In fact, any graduate student in amphibian biology would do well to spend the first month of his or her graduate career immersed in this book. Students would emerge with a solid foundation in the discipline to which they plan to contribute and a fistful of project ideas, as Wells concludes nearly every chapter with a description of fruitful areas of future research.

In Chapter 1, Wells discusses the evolutionary origins of amphibians and introduces two evolutionary trends in the group — miniaturization and large genome size. Profiles of all recognized families of anurans, urodeles, and caecilians follow. The photos accompanying these descriptions of amphibian diversity also indicate where additional photos of members of each family can be found in the text. Some readers may criticize Wells' decision not to incorporate the taxonomic revisions of Frost et al. (2006), but others will appreciate the continuity of the more traditional nomenclature. The chapter ends — as does each subsequent chapter — with a "Summary and Conclusions" section.

Chapters 2 and 3 discuss two key influences on amphibian ecology and behavior: 1) water relations and 2) temperature relations. As Wells points out with historical quotes, amphibians' close association with moisture and ambient temperatures led some early naturalists to conclude that they were "little more than a peculiar type of fish which is capable of walking on land." In fact, even in *The Biology of the Amphibia* (1931), G. Kingsley Noble remarked that they "remain slaves to their surroundings." As these chapters illustrate, however, amphibians have developed unique ways to capitalize on temporally variable resources despite physiological constraints.

The respiratory and metabolic characteristics of amphibians dramatically reduce their maintenance energy demands, allowing this "defeated group" (as described by yet another early naturalist) to exploit niches unavailable to other vertebrates. These traits have even facilitated the evolution of the world's largest known lungless tetrapod—a typhlonectid caecilian. Chapters 4 and 5 focus on these unique modes of respiration and metabolism, respec-

tively. Wells celebrates the contributions of amphibians, and particularly anurans, to early experimental studies of gas exchange and energetics, although some readers may cringe at descriptions of frogs in vacuum chambers, frogs coated in paint, and frogs buried alive in stone chambers for years. On a less macabre note, the chapter also covers important aspects of amphibian ecophysiology and ecology, such as relationships between oxygen demand and egg size.

Chapter 6 discusses studies of amphibian movement and orientation. The initial section of the chapter focuses on the problems of marking and adequately tracking amphibians, as well as the danger of overestimating home range sizes. And despite an extensive history of work on orientation behavior, Wells is forced to conclude that we do not have an adequate understanding of how amphibians integrate sensory information from various channels to navigate through the landscape. He does, however, summarize movement distances and home ranges reported in the literature for salamanders and terrestrial anurans in several tables, and discusses the relevance of movement behavior for genetic structure and amphibian conservation efforts.

Chapters 7 and 8 cover vocal communication, mating systems, and sexual selection in anurans. Beginning with a description of sound production, Wells moves on to vocal interactions within a chorus and between individual males, as well as female responses to calling behavior. Some sections (e.g., on the processing of acoustic signals) may be compelling reading for a relatively narrow audience, but overall this chapter is a thorough treatment of some of the most intriguing behavioral interactions of anurans. In Chapter 8, Wells refers to his own (1977) review of anuran mating systems and explores three main mating strategies — scramble competition, chorusing and leks, and resource defense. A particularly interesting section of this chapter covers the empirical evidence (or lack thereof) for the ability of females to detect differences in male quality and the likelihood of genetic benefits to offspring as a result of female choice.

Compared to that of anurans, the body of work on urodele and especially caecilian communication and social behavior is modest, although some species have been studied in detail (e.g., *Plethodon cinereus*). Chapter 9 covers a stunning variety of urodele social behaviors and contains some of the book's most impressive line drawings. In addition to describing elaborate courtship displays, pheromone delivery, and territorial aggression, Wells places many of these behaviors in a phylogenetic context. Throughout the book, the importance of phylogenetically controlled studies to support basic biological predictions is a recurrent theme.

Chapter 10 begins with a 17th-century description of amphibian mating, "…with croaking voices the male provoketh the female to carnal copulation," which must be one of the most colorful quotes in the book. In this chapter Wells discusses the natural history of amphibian reproduction, including the segregation of fertilization and oviposition in space and time associated with internal fertilization. He also contributes his own meta-analysis of data on the relationship between egg size, clutch size, and reproductive mode. Based on the results, he argues that the generally reported direct tradeoff between egg size and clutch size in amphibians does not necessarily apply to species within all reproductive modes. Although he points out the limitations of sorting species into these defined reproductive modes, Wells does include descriptions of the 39 modes of Haddad and Prado (2005), grouped by ecological similarity.

Chapter 11 then covers parental care, specifically the evolution of parental care and sex roles and what Wells argues are the different selective pressures giving rise to parental care in anurans versus urodeles. This chapter also contains some of the more extraordinary photos in the book. One of my personal favorites is the series depicting a female African shovel-nosed frog digging out of a subterranean burrow and making her way down to the water, while a cluster of tadpoles clings to her back and the rest follow along behind in a mud channel of her own construction.

The following two chapters focus on the larval stage of amphibian lifecycles, beginning with the ecology and behavior of larvae in Chapter 12. Much of this section is devoted to the ecological morphology of tadpoles, with detailed drawings of lateral views and mouthparts (and several scanning electron micrographs of the latter) illustrating frequent convergent evolution among different anuran families. A discussion of kin recognition and its significance for social behaviors in both anuran and urodele larvae is also included. Chapter 13 then moves into the adaptive significance of complex life cycles and the ecology of amphibian development and metamorphosis. This is a particularly information-rich chapter, dealing with classic models of amphibian metamorphosis as well as paedomorphosis. Through Wells' skills in synthesis, large numbers of relevant papers are condensed into a series of figures and concise descriptions.

Chapter 14 addresses the role that amphibians play as prey for many organisms, as well as the ways predation can influence both individual amphibians and amphibian community structure. Although the descriptions of predators run a bit long, the cleverly named section "Man the Frog Hunter" gives an intriguing history of frog consumption by humans, including an account of 1,000 frogs served at a 16th-century banquet for Elizabeth of Austria. This section mentions the food-related exploitation of *Rana draytonii* and subsequent introduction of *Rana catesbeiana* in the western U.S., but could have also included issues associated with the importation and introduction of *Rana ridibunda* in western Europe.

The influence of predation on amphibian community structure is discussed further in Chapter 15, along with the influences of competition, hydroperiod, and canopy cover. This chapter is an invaluable reference for anyone interested in experimental ecology (as well as a nice primer on work from the labs of Henry Wilbur and Earl Werner). Wells discusses the influence of experimental venue on outcomes of competition experiments and points out that knowledge of terrestrial anuran communities is almost entirely lacking.

One benefit of a lengthy literary gestation period is the ability to incorporate emerging developments. Wells notes at the beginning of Chapter 16 that as evidence accumulated for worldwide amphibian population declines, his original concept of the book's final chapter evolved into a chapter on amphibian conservation. He stresses that basic amphibian biology should be the foundation of any research program on declines. In fact, he builds from this foundation in each of the main sections of the chapter — first discussing amphibian traits that influence vulnerability to environmental perturbations, then exploring causes of declines within a geographic context, and finally asking how ecosystems might

change if there were no amphibians. The concluding section addresses the future of amphibians. Wells' emphasis in this section on the intertwined needs of humans and wildlife in tropical hotspots is refreshing, given that the sociology of conservation could have easily been overlooked in a book of this sort. The chapter ends with a call for hope, outlining specific actions necessary to ensure the continued existence of frogs, salamanders, and caecilians.

In short, *The Ecology and Behavior of Amphibians* makes a weighty contribution to amphibian biology (in more than one sense of the word). Wells has distilled an amazing volume of literature into a single publication. I can recommend this book without reservation to anyone working with, or seriously interested in, the charismatic taxon that Linnaeus once famously dismissed as "loathsome animals."

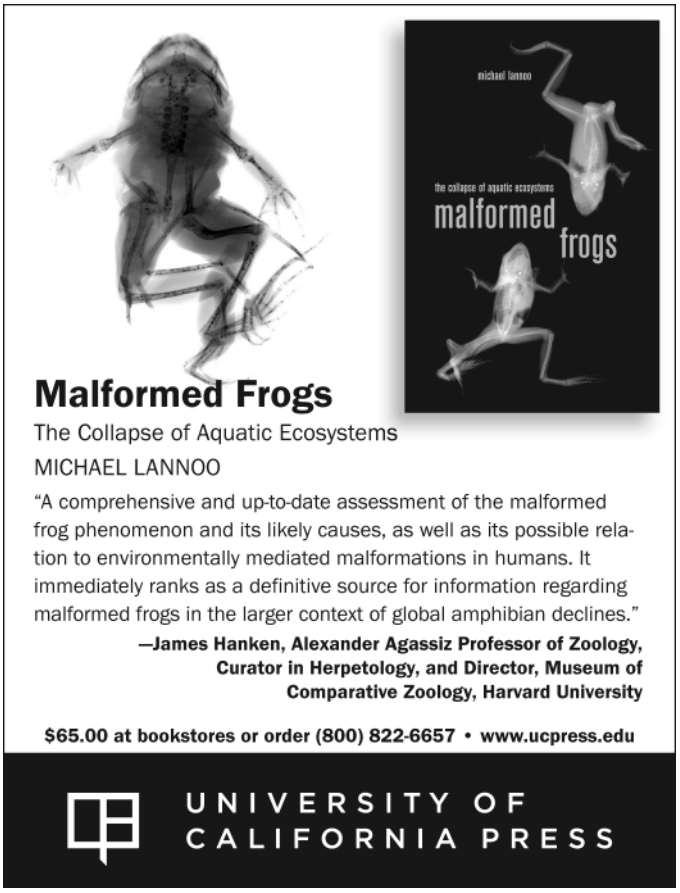
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Malformed Frogs

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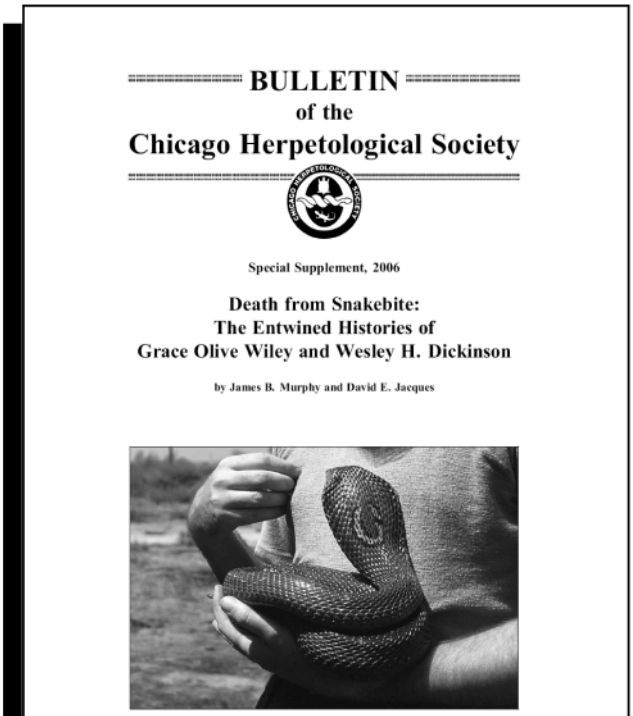
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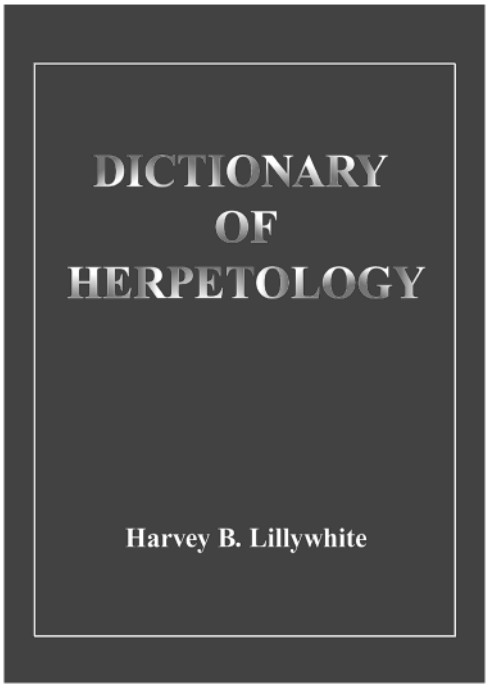
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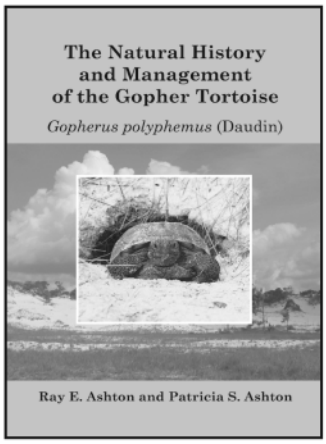


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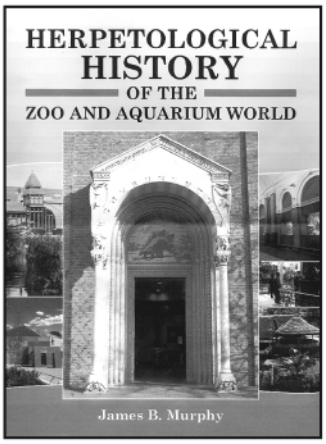


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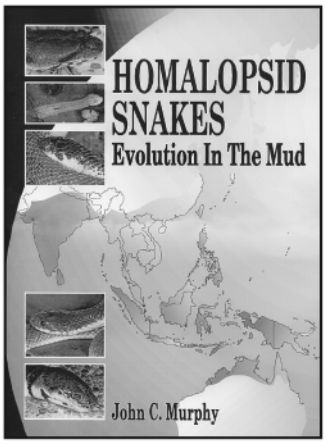


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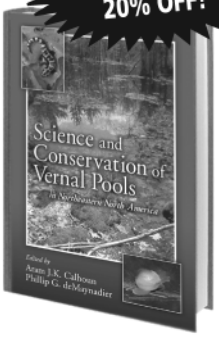
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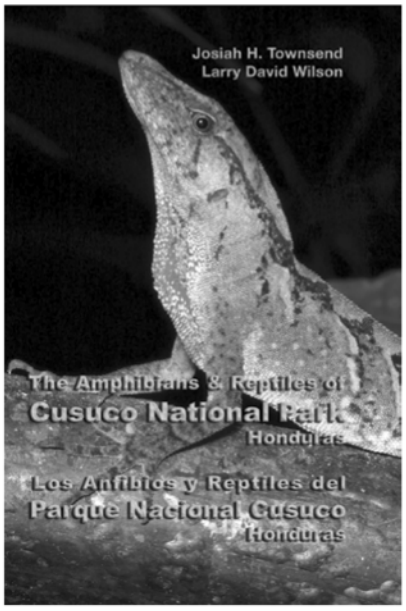
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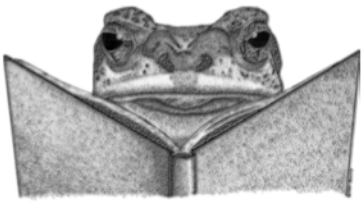
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About Our Cover: *Zonosaurus maramaintso*



The remarkable herpetofauna of Madagascar remains woefully underexplored. Many species have long been known from single type specimens collected over 100 years ago. However, a resurgence of exploratory interest over the last two decades has yielded new specimens of very poorly known species as well as numerous animals previously undescribed. Among the former is *Zonosaurus boettgeri*, described by Steindachner in 1891 from a single specimen obtained on the island of Nosy Be near the northwestern coast of Madagascar. Field work by Malagasy and American herpetologists beginning in 1993 yielded additional specimens of *Z. boettgeri*, along with new information about its diet and arboreal habits (Raselimanana, Nussbaum, and Raxworthy 2006. Occasional Papers of the Museum of Zoology, University of Michigan, No. 739, 16 pp.). Exploration of the Antsalova region in western Madagascar in late 1996 yielded a single specimen of a new species—*Z. maramaintso*, which seems to be closely related to *Z. boettgeri*. Both species are strongly arboreal canopy specialists, restricted to low elevation primary forests. Likely predators include Serpent Eagles, nocturnal lemurs, and arboreal snakes. Apparently rare—or at least rarely observed—*Z. maramaintso* is known only from an imprecise type locality and warrants conservation attention.

The cover image of *Z. maramaintso* was obtained by **Bill Love** at Olaf Pronk's export compound in Antananarivo. A collector had found the 46 cm long lizard in the Plateau de Bemaraha southwest of the capital, an isolated region of mixed forest and karst limestone ("tsingy") that was virtually unknown herpetologically at the time. Love recorded this image using a Nikon F90X camera with a Nikkor 55mm macro lens, Nikon SB29 ring flash unit, and Fujichrome RVP slide film. Bill is a photographer, writer, lecturer, and ecotour leader through his company Blue Chameleon Ventures (www.BlueChameleon.org). He is perhaps best known for his monthly column in *REPTILES* magazine. Bill resides in rural Lee County, Florida on wild acreage with wife Kathy and their captive colony of corn snakes and other herps.



NEWSNOTES

W. Frank Blair Eminent Naturalist Award

The W. Frank Blair Eminent Naturalist Award recognizes excellence in a lifetime of commitment to outstanding study or conservation of the flora or fauna of the southwestern United States, Mexico, and Central America. For 2007, this award, which is sponsored by the Southwestern Association of Naturalists (SWAN), was given to two herpetologists well known to SSAR members:



PHOTO BY CARL J. FRANKLIN.



PHOTO COURTESY OF KRAIG ADLER

Jonathan A. Campbell (University of Texas at Arlington; above left) and Ernest A. Liner (Houma, Louisiana; above right). The awards were presented at the SWAN annual meeting in Memphis, Tennessee in April 2008. SSAR congratulates Jon and Ernie for this well-deserved recognition.

USGS National Amphibian Atlas

The USGS Patuxent Wildlife Research Center has launched a new website, the National Amphibian Atlas (http://www.pwrc.usgs.gov/naa). This website replaces the former website, ARMI National Atlas for Amphibian Distributions (http://www.pwrc.usgs.gov/armiatlas). The National Amphibian Atlas displays amphibian distribution maps that are a compilation of current and historic records of amphibian occurrences. These maps are based on the original dataset assembled as background for the book edited by Dr. Michael Lannoo, *Amphibian Declines: The Conservation Status of United States Species.* The dataset has been revised to include new information, such as from recent editions of *Herpetological Review* and other sources.

New Features

- Users can select species by common or scientific name
- Maps allow users to zoom in
- Maps display data quality supporting the species occurrence, using 3 color codes to represent museum records, published records, or presumed presence. See website for more information.
- Maps are updated from the former version, which had last been updated in 2004. See Version Information in the Information section for more details.

- Maps will be periodically updated based on data from *Hepetological Review*, Herp Atlases, and other sources.
- Map images can be downloaded for PowerPoint presentations or other uses.

Coming Soon
- Download GIS layers
- View or Download data source information
- Print friendly version of maps

Please help to make better maps
Maps will be periodically updated based on museum and published data, including *Herpetological Review*, Herp Atlas Projects, and other sources. If you have data to contribute, please contact me. All data contributors are credited in the Acknowledgments section on the website.

National Amphibian Atlas website address is: http://www.pwrc.usgs.gov/naa

Contact information:
Linda Weir, USGS Patuxent Wildlife Research Center, 12100 Beech Forest Road, Laurel, Maryland 20708-4038, USA; e-mail: lweir@usgs.gov.

MEETINGS

2008 Gopher Tortoise Council Meeting Announcement and Call for Papers

Please join us for the Annual Meeting of the Gopher Tortoise Council at beautiful Jekyll Island, Georgia, 3–4 October 2008. The meeting will feature a special session on Friday of presentations on Wildlife and Ecosystem Health, with confirmed presentaitons by Elliot Jacobson, Sonya Hernandez Divers, Charles Innis, Steven H. Divers, Terry Norton, John Maerz, Scott Connelly, Nancy Stedman, Lori Wendland, Matt Aresco, Kimberely Andrews, and Greg Lewbart. Saturday the scientific program continues with contributed presentations and posters on any topic relating to the Gopher Tortoise and the Longleaf Pine ecosystem. There will be plenty of time for relaxing and socializing, and enjoying good food and drink at a Low Country Boil Friday night and a Barbecue Saturday night. Also, a tour of the Georgia Sea Turtle Center will be offered Friday evening. For more information and registration information, please visit the Gopher Tortoise Council's website: http://www.gophertortoisecouncil.org/events.php.

Meetings Calendar

Meeting announcement information should be sent directly to the Editor (rwh13@csufresno.edu) well in advance of the event.

23–28 July 2008—51st Annual Meeting, Society for the Study of Amphibians and Reptiles; 88th Annual Meeting, American Society of Ichthyologists and Herpetologists; 66th Annual Meeting, The Herpetologists' League. Montreal, Quebec, Canada. Information: http://www.dce.ksu.edu/jointmeeting/

17–20 August 2008—6th World Congress of Herpetology, Manaus, Brazil (meeting jointly with SSAR). Information: http://www.worldcongressofherpetology.org/index.php?section=51

3–4 October 2008—Annual Meeting of the Gopher Tortoise Council, Jekyll Island, Georgia, USA. Refer to meeting announcement above.

24–29 November 2008—VIII Latin-American Congress of Herpetology (VIII Congreso Latinoamericano de Herpetologia), Topes de Collantes, Sancti Spiritus, Cuba. Information: Roberto Alonso Bosch (e-mail: 8voclah@fbio.uh.cu or ralonso@ecologia.cu).

CURRENT RESEARCH

The purpose of **Current Research** is to present brief summaries and citations for selected papers from journals other than those published by the American Society of Ichthyologists and Herpetologists, The Herpetologists' League, and the Society for the Study of Amphibians and Reptiles. Limited space prohibits comprehensive coverage of the literature, but an effort will be made to cover a variety of taxa and topics. To ensure that the coverage is as broad and current as possible, authors are invited to send reprints to the Current Research section editors, **Joshua Hale** or **Ben Lowe**; postal and e-mail addresses may be found on the inside front cover.

The current contents of various herpetological journals and other publications can be found at: http://www.herplit.com/contents.

Assessment of Two Antivenoms for Coral Snakes

There are three species of coral snakes within the United States and all are considered extremely lethal. However, as one of them, *Micruroides euryxanthus*, is elusive, only two species, *Micrurus tener tener* and *Micrurus fulvius fulvius*, are considered medically relevant. Medical intervention involves treatment with antivenom, and while no deaths have been reported since antivenom became available, previously 10% of cases proved fatal. The North American Coral Snake Anitvenom (NACSA), produced by the pharmaceutical company Wyeth, was discontinued in 2006, necessitating development of an alternative antivenom. In this study, the authors compared the NACSA with Carolmyn, an antivenom produced by Mexican company Bioclon. The results of a number of trials using laboratory mice demonstrated that *M. f. fulvius* venom was 3.4 times more toxic than *M. t. tener* venom, consistent with past research. Importantly, results indicated that Carolmyn is more effective than NACSA at neutralizing venom from both clinically important coral snake species, with Carolmyn therefore representing a viable replacement for NASCA.

Sánchez, E. E., J. C. Lopez-Johnston, A. Rodriguez-Acosta, and J. C. Pérez. 2008. Neutralization of two North American coral snake venoms with United States and Mexican antivenoms. Toxicon 51:297–303.

Correspondence to: Elda E. Sánchez, Natural Toxins Research Center, 975 W. Avenue B, MSC 158, Texas A & M University-Kingsville, Kingsville, Texas 78363, USA; e-mail: elda.sanchez@tamuk.edu.

Prey-specific Predatory Behavior in a Snake

In predator-prey relationships, selection is generally much stronger on the prey, which may lose its life, than on the predator, which is only risking a meal. However, this situation is different when the prey is toxic. The Floodplain Death Adder, *Acanthophis praelongus*, from Northern Australia, feeds primarily on frogs. Of these frogs, some are non-toxic, like *Litoria nasuta*, others secrete sticky mucous, like *Limnodynastes convexiusculus*, and one species, *Litoria dahlia*, is highly toxic. Observation trials revealed that adders consume these prey items in different and specific ways. While non-toxic prey were consumed immediately, other taxa were envenomated, released, and consumed at a later time. As the toxins and glue-like mucous degrade within about 20 minutes, adders circumvent prey defenses by delaying consumption. The authors suggest that this highly specific predatory behavior is a consequence of the selective asymmetry operating on the predator and prey.

PHILLIPS, B., AND R. SHINE. 2007. When dinner is dangerous: toxic frogs elicit species-specific responses from a generalist predator. The American Naturalist 170:936–942.

Correspondence to: Ben Phillips, School of Biological Science A08, University of Sydney, Sydney, NSW 2006, Australia; mail: bphi4487@mail.usyd.edu.au.

Traffic Noise Masks Frog Calls

As reproduction in anurans is highly dependent on auditory communication, they are particularly vulnerable to anthropogenic noise which may interfere with calling behavior. Road traffic is a common source of anthropogenic noise. In this study, the authors tested the impact of traffic noise on acoustic signaling in the Grey Treefrog, *Hyla chrysoscelis*, in Minnesota. Females in amplexus were collected in the field and transported to the laboratory where they underwent a number of phonotaxis trials. Females were presented with recorded calls at one of nine signal levels (37–85 dB at 6 dB increments), without background noise, with a simulated chorus, or with recorded traffic noise. In trials where the signal was masked by traffic noise or the simulated chorus, females took longer to respond (by moving toward the signal source), and only responded to relatively loud signals. Although anthropogenic noise may significantly interfere with acoustic signaling in anurans, the authors suggest that more study is required to understand how plastic behavioral or physiological responses may potentially overcome this interference.

BEE, M. A., AND E. M. SWANSON. 2007. Auditory masking of anuran advertisement calls by road traffic noise. Animal Behaviour 74:1765–1776.

Correspondence to: Mark A. Bee, Department of Ecology, Evolution, and Behavior, University of Minnesota, 100 Ecology, 1987 Upper Buford Circle, St. Paul, Minnestoa 55108, USA; e-mail: mbee@unm.edu.

Survey of Chytrid Fungus in Hong Kong

Chytridiomycosis has been implicated in the decline and extinction of a number of amphibian species globally. *Batrachochytrium dendrobatidis*, the pathogen that causes Chytridiomycosis, is present in wild populations on every continent except Asia. However, little research has been completed in this region. For this study, the authors conducted a large scale survey for *B. dendrobatidis* in Hong Kong, the first systematic survey of this type undertaken in Asia. Four species of native amphibians, considered at high risk of infection, were examined, with none of the 274 individuals testing positive to *B. dendrobatidis* infection. A large number of amphibians are imported into Hong Kong each year as part of the pet and food trade representing a possible means of pathogen transmission. Despite this, the authors did not detect *B. dendrobatidis* on any of the 137 imported amphibians sampled. The authors concluded that, until it is confirmed that *B. dendrobatidis* is present in Hong Kong, management effort should be targeted at preventing it from entering the country and spreading into wild populations.

ROWLEY, J. J. L., S. K. F. CHAN, W. S. TANG, R. SPEARE, L. F. SKERRATT, R. A. ALFORD, K. S. CHEUNG, C. Y. HO, AND R. CAMPBELL. 2007. Survey for the amphibian chytrid *Batrachochytrium dendrobatidis* in Hong Kong in native amphibians and the international amphibian trade. Diseases of Aquatic Organisms 78:87–95.

Correspondence to: Jodi Rowley, School of Marine and Tropical Biology and Amphibian Disease Ecology Group, James Cook University Townsville, Queensland, Australia 4811; e-mail: jodi.rowley@gmail.com.

Convergence on Ultrasonic Communication in Southeast Asian Frogs

Odorrana tormota (previously *Amolops tormotus*), is the first non-mammalian vertebrate demonstrated to communicate with ultrasound. It is also one of two anuran species that possess tympanic membranes embedded in the skull, similar to mammals. Like *O. tormota*, the other anuran with sunken tympana, *Huia cavitympanum*, is both a southeast Asian member of the family Ranidae, and calls near rushing streams. However, they are not related at the generic level, and their distributions do not overlap. In this study, the authors investigated calls of *H. cavitympanum*, to determine if this species also communicates using ultrasound. Analysis of recordings of spontaneous male calls indicated that this species produces a number of high frequency calls, some of which are entirely ultrasonic. Along with the Blue-throated Hummingbird, *H. cavitympanum* is the only other non-mammalian vertebrate to produce purely ultrasonic vocalizations. The authors suggest that the convergence of call characteristics between *O. tormota* and *H. cavitympanum* may be a response to their calling environment, which is dominated by low frequency ambient stream noise. The authors also suggest that ultrasonic vocalization may confer an energetic advantage.

ARCH, V. S., T. U. GRAFE, AND P. M. NARINS. 2008. Ultrasonic signaling by a Bornean frog. Biology Letters 4:19–22.

Correspondence to: Peter M. Narins, Department of Ecology and Evolutionary Biology and Department of Physiological Science, University of California, Los Angeles, 621 Charles E. Young Drive S., Los Angeles, California 90095, USA; e-mail: pnarins@ucla.edu.

Species, Rather Than Body Size, Determines Social Dominance in Lizards

Large body size often confers a significant advantage in both intra- and interspecific resource competition, generally indicating superior fighting ability or strength. This has proven problematic to confirm experimentally, because if the dominant taxon consists solely of individuals larger than the subordinate taxon, then separating the influence of species from the influence of size becomes difficult. In this study, the authors separated the influence of species identity and body size in interspecific interactions by conducting laboratory shelter-choice trials using five sympatric montane skink species from southeastern Australia**:** *Egernia cunninghami, Egernia saxatilis, Egernia whitii, Eulamprus heatwolei,* and *Eulamprus tympanum*. Combinations of juveniles and adults from a number of the species were forced to compete for a desirable resource (in this case a 'hot' shelter maintained at 36.5°C, in contrast to a 'cold' shelter at 21°C). Interestingly, juveniles of larger species were as successful as conspecific adults at deterring adults of smaller species, even when much smaller than the adults they displaced. Analysis of bite force confirmed that juveniles posed limited threat to large heterospecifics. The authors conclude that in this system, species identity is more important than body size in determining interspecific dominance.

LANGKILDE, T., AND R. SHINE. 2007. Interspecific conflict in lizards: social dominance depends upon an individual's species not its body size. Austral Ecology 32:869–877.

Correspondence to: Tracy Langkilde, Department of Biology, 208 Mueller Laboratory, The Pennsylvania State University, University Park, Pennsylvania 16802, USA; e-mail: t1130@psu.edu.

Identifying Divergent mtDNA Lineages in a Lizard

Molecular research on hybrid zones has primarily focused on mtDNA, which displays substantial variation both between and within species. However, large scale sequencing is both costly and labor-intensive. In this study, the authors developed a quick, cost effective polymerase chain reaction (PCR)-based method to identify divergent lineages within a contact zone in a North American lizard, eliminating the need to sequence large numbers of individuals. Two highly divergent clades of the Side-blotched Lizard, *Uta stansburiana*, form a contact zone on the peninsula of Baja California in northwestern Mexico. The authors used lineage-selective primers generated from sequence data from 15 individuals to amplify a PCR product diagnostic of each of the two mitochondrial lineages. This assay was then applied to an additional 132 specimens from a transect spanning the contact zone to identify mitochondrial lineages. The authors suggest that this cost effective and reliable technique could be used in other species where diagnostic lineage variation occurs.

LINDELL, J., AND R. W. MURPHY. 2008. Simple identification of mitochondrial lineages in contact zones based on lineage-selective primers. Molecular Ecology Resources 8:66–73.

Correspondence to: Johan Lindell, Department of Ecology and Evolutionary Biology, University of Toronto, 25 Willcocks Street, Toronto, Ontario, Canada M5S 3B2; e-mail: johan.lindell@utoronto.ca.

Cost of Phenotypic Plasticity in the Wood Frog

Phenotypic plasticity can allow an organism to respond to temporal changes in its environment; however, plastic responses in one trait can have negative fitness consequences for another. In this study, the authors examined the impact of a plastic trait expressed at the larval stage on post-metamorphic fitness in the Wood Frog, *Rana sylvatica*. This species breeds in temporary ponds, and can accelerate larval development to avoid desiccation, but this has potential impacts on postmetamorphic immune functioning. To examine this, tadpoles housed in the laboratory were exposed to one of four desiccation treatments. Subsequently, individual immune function was assessed by administering a single phytohaemagglutinin (PHA) injection, which causes inflammation around the injection point, with greater inflammation representing a stronger immune response. Leucocyte counts were also conducted to assess immune functioning. Tadpoles exposed to desiccation developed faster than those from control conditions, but had reduced postmetamorphic immune functioning, as determined by both the PHA injection and leucocyte counts. The authors suggest that this reduction in immune functioning may result from a trade-off between rapid development of traits essential for terrestrial life and traits that may not be immediately important. While the duration of immune depression is currently unknown, the authors suggest that even a temporary period may be highly costly to individuals following metamorphosis.

GERVASI, S. G., AND J. FOUFOPOULOS. 2008. Costs of plasticity: responses to desiccation decrease post-metamorphic immune function in a pond-breeding amphibian. Functional Ecology 22:100–108.

Correspondence to: Stephanie Gervasi, Department of Zoology, Oregon State University, 3029 Cordley Hall, Corvallis, Oregon 97331, USA; e-mail: gervasis@science.oregonstate.edu.

Maternal Care in the Dwarf Newt

Most amphibian species do not demonstrate parental care, and there is an extremely high mortality at aquatic larval stages. However, females of the Dwarf Newt, *Triturus pygmaeus*, from the Iberian Peninsula, may indirectly affect embryonic survival by wrapping their eggs in leaves from aquatic plants. In this study, the authors investigated whether wrapping protects the eggs from contamination by ammonium nitrate, a compound commonly found in fertilizer, and water acidification. First, females were collected in the field (N = 54) and exposed in the laboratory to one of three treatments; water containing ammonium nitrate, acid water or a control treatment. Results indicated that low pH altered oviposition behavior, with the percentage of wrapped eggs lower in the

acid water treatment than in the controls. Second, to investigate the impact of egg wrapping on embryonic survival, pre-wrapped eggs were either unwrapped or left wrapped and then exposed to the three water treatments. In the ammonium nitrate treatment, unwrapped eggs suffered higher mortality than wrapped eggs, but there was no difference in the other treatments. The authors suggested that more research is needed to understand the complex interrelatedness between water pollution and egg wrapping behavior in this species.

Ortiz-Santaliestra, M. E., A. Marco, M. J. Fernández-Benéitez, and M. Lizana. 2007. Effects of ammonium nitrate exposure and water acidification on the dwarf newt: the protective effect of oviposition behavior on embryonic survival. Aquatic Toxicology 85:251–257.

Correspondence to: Manuel Ortiz-Santaliestra, Department of Animal Biology, University of Salamanca, Campus Miguel de Unamuno, Salamanca 37007, Spain; e-mail: meortiz@usal.es.

Costs of Tail Autotomy in the Cape Dwarf Gecko

The survival benefits of tail autotomy to avoid predation are well established; however, the loss of other tail functions may be costly. In this study, the authors compared the locomotor performance of autotomized and intact Cape Dwarf Geckos, *Lygodactylus capensis*, from Pretoria, South Africa. Intact geckos were tested for escape speed and distance, across both horizontal and vertical surfaces. Geckos were subsequently autotomized and retested. Results of repeated measures ANOVA demonstrated that autotomized geckos were slower than intact geckos on the vertical surface, but that there was no difference in performance on the horizontal surface. The authors propose that the observed differences in performance reflect the tail's importance in supporting the body against the vertical surface. The authors also suggested that the tail may not be of great use in horizontal movement, although more research is required. Finally, the authors discuss the impact of autotomization on behavior, suggesting that autotomized geckos may select denser, more horizontal habitats, to maximize escape speed and avoid predation.

Medger, K., L. Verburgt, and P. W. Bateman. 2008. The influence of tail autotomy on the escape response of the Cape Dwarf Gecko, *Lygodactylus capensis*. Ethology 114:42–52.

Correspondence to: Phillip Bateman, Department of Zoology and Entomology, University of Pretoria, Pretoria 0002, South Africa; e-mail: pwbateman@zoology.up.ac.za.

ZOO VIEW

"Crocodilians may perhaps live to a great age: probably longer in the sheltered conditions of captivity than when exposed to the active, combatant, competitive career that is theirs in nature."

—Major Stanley Smyth Flower (1925)

Crocodiles may have been the first zoo animals and they remain mysterious, frightening, yet popular with visitors, due to their large size, predatory habits, and occasional attacks upon humans. In my opinion, the most significant zoo program with crocodilians has been the one at the Bronx Zoo/Wildlife Conservation Society. There have been a number of crocodilian papers on a variety of topics, mostly by F. Wayne King, Herndon Dowling, John Behler, Peter Brazaitis, George Amato, and John Thorbjarnarson. One example is the publication by Dowling and Brazaitis (1966), who recorded size and growth of American and Chinese alligators, and Black Caiman, with extensive data on the Nile Crocodile. They provided a table of weight-length measurements for 14 species. In addition to the titles listed in the paper here by Peter Brazaitis and Joe Abene, staff members at the Zoo have published the following studies, focusing in large part on the protection and conservation of these endangered animals.

Behler, J. 1978. Feasibility of the establishment of a captive-breeding population of the American crocodile. National Park Service Report T-509, 94 pp.

———, and D. A. Behler. 1998. Alligators & Crocodiles. Voyageur Press, Inc., Stillwater, Minnesota.

———, and F. W. King. 1979. The Audubon Society Field Guide to North American Reptiles and Amphibians. Alfred A. Knopf, Inc., New York.

Brazaitis, P. 1969. Determination of sex in living crocodilians. Brit. J. Herpetol. 4:54–58.

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———. 1981. Maxillary regeneration in a marsh crocodile, *Crocodylus palustris*. J. Herpetol. 15:360–362.

———. 1982. International Union for Conservation of Nature and Natural Resources. Red Data Book, Brian Groombridge (ed.). Species accounts of eight species of endangered South American crocodilians.

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———. 1984. The U.S. trade in crocodilian hides and products, a current perspective, p. 103–107. Proc. 6th Working Meet., IUCN/SSC Crocodile Specialist Group, Victoria Falls, Zimbabwe and St. Lucia Estuary, Repub. South Africa, Sept. 19–30, 1982.

———. 1984. Problems in the identification of commercial crocodilian hides and products, and the effect upon law enforcement, p. 110–116. Proc. 6th Working Meet., IUCN/SSC Crocodile Specialist Group, Victoria Falls, Zimbabwe and St. Lucia Estuary, Repub. South Africa, Sept. 19–30, 1982.

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Imagining that larger crocodilians can attack, kill and eat them with gusto, these impressive reptiles have always fascinated zoo visitors. From *Histoire naturelle de Lacépède, comprenant les cétacés, les quadrupèdes ovipares, les serpents et les poissons* by Bernard Germain Etienne de La Ville sur Illon La Cépède (Count de Lacepède**)** in 1860. Imprint: Paris, Furne, 1860.

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———, and T. Joanen. 1984. Report on the status of the captive breeding program for the Chinese alligator *Alligator sinensis* in the United States. Proc. 6th Working Meet., IUCN/SSC Crocodile Specialist Group, Victoria Falls, Zimbabwe and St. Lucia Estuary, Repub. South Africa, Sept. 19–30, 1982, pp. 117–121.

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King, F. W. 1973. Summary of the status of crocodilian species in South America undertaken by Professor F. Medem. Crocodiles: Proc. 2nd Working Meeting of the IUCN/SSC Crocodile Specialist Group, New York, pp. 33–36. IUCN Publ. N.S., Morges, Switzerland.

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—James B. Murphy, Section Editor

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A History of Crocodilian Science at the Bronx Zoo, Wildlife Conservation Society

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Crocodilians have been an important element of the reptile collections at the Bronx Zoo since the original plans for the New York Zoological Park and a reptile house were finalized and set into motion on September 27, 1897. However, the history and evolution of crocodilian science at the Bronx Zoo does not stand alone. It is an inseparable part of the discoveries and achievements that were taking place in a wide range of scientific disciplines by new generations of scientists in many places at the same time. Table 1 provides a time line of crocodilian history and reproduction at the Bronx Zoo from 1900 to the present.

Throughout the 1800s, scientific collections of crocodilians, and the scholars who studied and wrote about them, resided largely in museums and universities located in the world's major cities. Collections included fossils, preserved carcasses, skulls, bones, and dried skins, often collected during expeditions to remote regions of the world. Crocodilians had not escaped the scrutiny of the scientific community and there was a wealth of biological information published in scientific journals and books (Brisbin 1986). Yet, what we knew about crocodilians predominantly involved paleontology, taxonomy, anatomy, and osteology. Despite the existence of fewer than two dozen known species, some of which might grow to lengths in excess of 6 m and regularly eat people, crocodilian species identification was based largely on skulls (Boulenger 1889; Mertens 1943; Mook 1921; Wermuth and Mertens 1961,

TABLE 1. Time-line history of crocodilian science at the Bronx Zoo.

Year	Event
1898	Raymond L. Ditmars, Curator (1898–1942)
1898	Bronx Zoo reptile house opens with American Alligators
1933	Hatched American Alligator eggs taken from the wild
1933	Mixed crocodilian collection exhibited (first time)
1944	John Tee-Van, interim Curator (1943–1945)
1945	Brayton Eddy, Curator (1945–1950)
1951	Dr. James A. Oliver, Curator (1951–1958)
1953	Reptile house renovated for the first time
1954	Peter Brazaitis, tenure as Keeper/Superintendent (1954–1988)
1954	Reptile house reopens with adult American Alligators as central exhibit
1957	Mixed collection emerges
1958	Herndon G. Dowling, Curator (1958–1967)
1960	Four large American Alligators leave reptile house
1960	Smooth-fronted Caiman, *Paleosuchus trigonatus*, unanticipated breeding
1962	Reptile house renovated second time
1963	Crocodilian sexing technique developed (Brazaitis 1966)
1964	First museum quality record keeping system (Dowling and Gilboa 1968)
1964	First attempt to breed Chinese Alligators, *Alligator sinensis*
1965	West African Dwarf Crocodile, *Osteolaemus tetraspis.* unanticipated breeding
1966	Endangered Species Act, amended 1969, 1981, 1988
1966	Crocodilian size and growth documented (Dowling and Brazaitis 1966)
1967	Dr. F. Wayne King, Curator (1967–1973)
1970	First crocodilian genetics study (Cohen and Gans 1970)
1971	Species identification of crocodilian hides and products (King and Brazaitis 1971)
1971	IUCN Crocodile Specialist Group founded
1973	Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
1973	Comprehensive identification account of living crocodilians (Brazaitis 1973a)
1973	Identity of *Crocodylus siamensis* confirmed (Brazaitis 1973b)
1973	John L. Behler, Curator (1973–2006)
1974	Second floor renovated to include crocodilian rearing facilities
1977	First successful breeding of Chinese Alligator, *Alligator sinensis* (Behler and Brazaitis 1982)
1977	Les Garrick, Crocodilian behavior studies (Garrick and Lang 1977)
1979	Crocodilian diets modified; improved 1981
1979	First Mugger Crocodile, *Crocodylus palustris* reproduction
1980	Yacare Caiman, *Caiman yacare*, bred (Brazaitis 1986)
1980	Captive breeding protocols implemented/breeding calendar
1980	Chinese Alligator SSP/studbook initiated to coordinate breeding efforts
1980	Siamese Crocodiles, *Crocodylus siamensis*, bred (Brazaitis and Watanabe 1983)
1981	West crocodilian pools retrofitted for multi-species breeding
1981	Black light/Vita light protocols initiated (Townsend and Cole 1985)
1983	Ultrasound scanning of *C. siamensis* eggs (Brazaitis and Watanabe 1983)
1983	Cuban Crocodile, *Crocodylus rhombifer*, bred
1985	Malayan False Gharial, *Tomistoma schlegelii*, bred (Brazaitis 1999)
1986	AZA Crocodilian Advisory Group founded
1988	William Holmstrom, Collection Manager (1988–present)
1988	Dwarf Caiman, *Paleosuchus palpebrosus*, bred
1989	Broad-snouted Caiman, *Caiman latirostris*, bred
2006	Dr. Jennifer Pramuk, Curator (2006–present)

1977; Werner 1933). Medem and Marx (1955) provided one of the first keys to the living New World species of crocodilians. Comprehensive papers on the species identification of living crocodilians, directed toward live animals and visible physical morphology, appeared in the 1970s (Brazaitis 1971, 1973a, 1973b).

What appeared to be lacking were behavioral, natural history, and reproductive data. One of the earliest comprehensive reports on observations and natural history of a crocodilian was made by E. A. McIlhenny of Louisiana in his classic work, *The Alligator's Life History*, first published in 1935, and reprinted in 1987. McIlhenny reported shooting and killing one of the largest wild alligators ever recorded, 584 cm in length, on January 2, 1890.

Probably the most knowledgeable group of crocodilian experts of the 1800s and early 1900s was composed of the hide hunters and crocodilian skin dealers who derived their livelihoods and profits from knowing where and when to find crocodiles. They had to know basic crocodilian behavior and habits if they were to avoid being killed or maimed during the course of their dangerous nightly work of hunting crocodiles. Some crocodile entrepreneurs put their knowledge to use to short-circuit the problem of having to spend numerous uncomfortable nights in mosquito-infested swamps to capture only a handful of crocodiles, or none, by starting crocodile farms in the hope of breeding the animals and increasing manyfold the number of skins they could have available to sell. Rather than sharing their knowledge, much of what they knew about crocodilian reproduction and behavior was kept secret, lest a competitor out-produce them.

Collections of living crocodilians were generally confined to considerably less than natural circumstances of captivity in private roadside attractions, circuses, and zoos, and they were managed by entertainment entrepreneurs. The Saint Augustine Alligator Farm, St. Augustine, Florida, opened to the public in May, 1893, is the oldest major exhibitor of crocodilians in the United States. The name is a misnomer as it was never a "farm" for breeding and producing alligators. The Alligator Farm, as it is still locally referred to, is now a registered national historical site and exhibits all of the 23 generally accepted species of crocodilians under natural conditions. The Alligator Farm is considered a world center for crocodilian study, reproductive biology, and conservation, and serves as an important repository and bank for crocodilians that are potentially part of captive endangered species breeding programs.

Zoos probably contributed least to the then-known lexicon of crocodilian knowledge. Space was limited and better devoted to large mammals and colorful birds that were more in the public or zoo director's interest. In the 1800s, exotic birds already enjoyed a great scientific following, augmented by a global cadre of serious collectors and breeders of live birds, who produced a wealth of scientific and popular writings. We knew a lot about birds and mammals, including that crocodiles were prone to eat some of our favorite species. Reptiles, including crocodilians, were usually reviled by the average zoo visitor, who wished only to see them

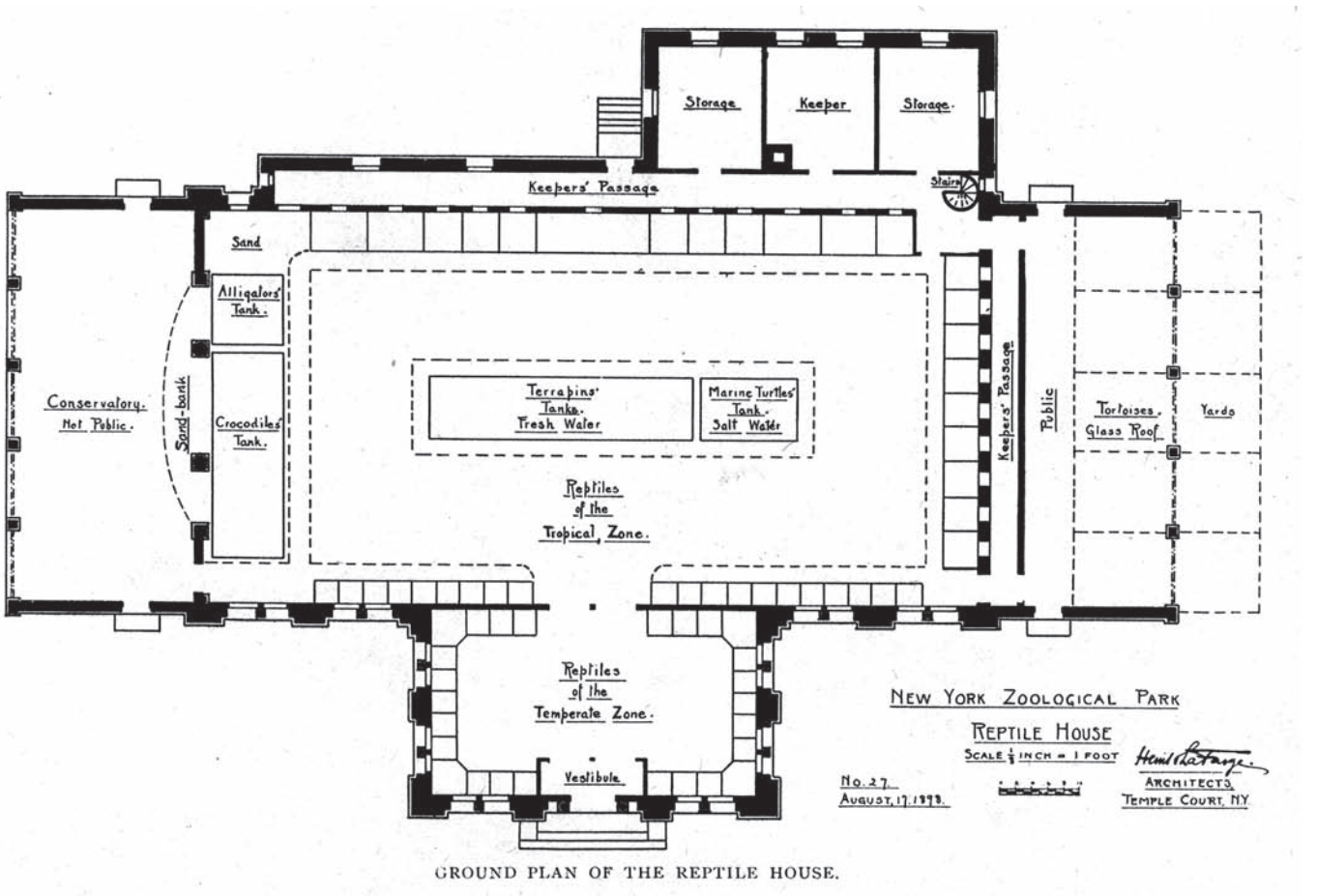


FIG. 1. Original floor plan of the reptile house. The alligator pools are major exhibits at the left, at the west end of the building. They are referred to as "The West Pools."



FIG. 2. The Reptile House at the Bronx Zoo as it appeared in 1898. West pools conservatory is to the left.

out of curiosity as ferocious potential man-eaters. It was generally held, even by the curatorial staff, that as crocodilians inhabited the warm tropical and sub-tropical wetlands of the world, they could be exhibited only at considerable cost in space and utilities if they were to be kept alive at all, especially in northern climates. Certainly, they would not reproduce.

A House for Reptiles in New York City

The Reptile House at the Bronx Zoo was one of the first buildings to be constructed in the newly chartered New York Zoological Park. Opened to the public in 1898, the Reptile House was immediately of immense popularity with the general public. Curator Raymond L. Ditmars (1899–1942) wrote in the zoological society's fifth annual report for 1900: "The Reptile House is permanently fixed in the minds of visitors as a center of attraction," and "All things considered, the alligator pool is perhaps the satisfactory single feature in the Reptile House" (anon., 1898, 1900). Fig. 1. shows the original floorplan of the Reptile House as it was constructed in 1898, in a spacious, state-of-the-art, modern building of the times (Fig. 2). To this day, the exterior of the reptile house remains much as it was originally constructed, a sturdy structure of steel and dense, fire-kilned brick. Its roofline and cornices are festooned with the sculptured cement heads of reptiles and amphibians to mark the presence of its scaly inhabitants. These were especially created by the well known animal sculptor of the time, Mr. A. P. Proctor. The alligator pools at the west end of the building were designed to be main attractions and meant to house only American Alligators (Fig. 3).

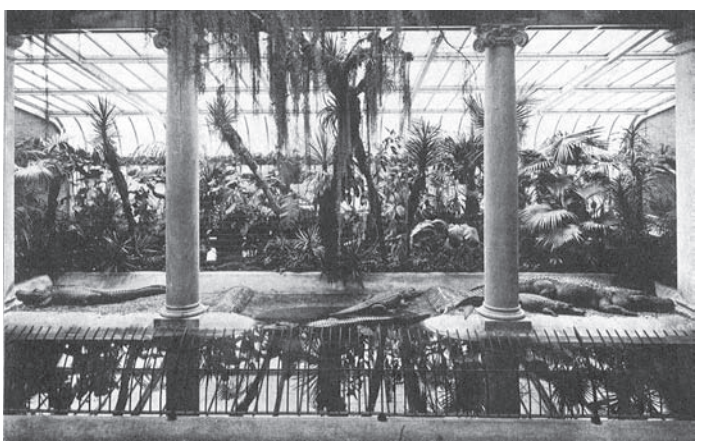


FIG. 3. Alligator pools in the conservatory at the west end of the reptile house in 1900.

Ditmars was well aware that a constant warm environment was essential to the health of crocodilians. He had insisted that heating pipes carrying warm water, immersed along the perimeter of the alligator pools to maintain pool water temperatures in the range of 27–30°C, be included in the construction of the 1898 building.

The Most Beautiful Reptile House in the World

The Reptile House remained largely unaltered until 1954, when, under the curatorship of Dr. James A. Oliver (1951–1958), it underwent its first renovation and modernization. Oliver's article in *Animal Kingdom* was aptly titled, "The most beautiful reptile house in the world" (Oliver 1954). The curved glass-walled conservatory can still be seen, designed to allow the overhead sunlight to brighten the alligator pools and their luxuriant plantings at the west end of the Reptile House (Fig. 4). Oliver's designs for the renovated reptile house advanced the heated pool concept and included a state-of-the art heating system for all of the reptile exhibits, with heated concrete slabs for basking crocodilians. An open nursery with an unobstructed view of juvenile crocodilians was added to the major exhibits, to exhibit the many public donations of alligators. Visitors were treated to a frenzy of crocodilian activity as the keeper staff provided regular feeding demonstrations several times a week (Fig. 5). True to the original concept, the renovated Reptile House exhibited only adult American Alligators, *Alligator mississippiensis*, in the center main pool. However, the east end of the Reptile House now included a spacious crocodile exhibit, patterned after an Egyptian tomb, and a doorway painted with pictograms taken from the *Book of the Dead*, attributed to Sobk, the Egyptian crocodile god, son of Neith (Faulkner 1985). The exhibit housed a single 3.7 m long Nile Crocodile, *Crocodylus niloticus*, named "Joe." The public would be greeted by a bevy of large alligators in a tropical setting as they entered the reptile house and leave with the image of a fearsome maneating crocodile. While the 1954 Reptile House included a nursery for rearing baby crocodilians, a main pool designed to exhibit a few spectacular animals, and two smaller flanking pools for exhibiting special species of interest, there was still no provision for breeding crocodilians, incubating a potentially large number of eggs, or housing a multi-species collection of crocodilians of various sizes and life stages.

The Early Bronx Zoo Collection

The 1900 annual report lists two species of crocodilians in the reptile collection. In September, 1899, Ditmars specifically called attention to the rapid growth of a 395 cm long alligator (Ditmars 1900) (Fig. 6). However, it is unclear how extensive a plan there was for increasing the diversity of crocodilian species in the Bronx Zoo collections between 1898 and the first major renovation in 1954. In the original zoo plan, there was some limited space for

small crocodilians but only two primary exhibit pools and no holding enclosures for larger animals. The exhibition of American Alligators in the main pool was an absolute given, while the acquisition of crocodilians of other species was most often one of chance rather than of design. Crocodilians, like all reptiles, were freely available in the exotic pet trade to anyone who might wish such a pet. Inevitably, if the pet survived poor care, it might be brought to the Reptile House as a donation. Such donations were commonplace, were routinely accepted, and were added to the collection without medical quarantine or concern for possible infectious diseases.

Ditmars proudly wrote in 1913 that the crocodile nursery displayed a mound of baby American Alligators, brought to the zoo by tourists who had vacationed in Florida, and a few crocodiles. By then, he reported that the collection included a number of rare species that included the Indian Gharial, *Gavialis gangeticus*; Senegal Crocodile (West African Slender-snouted Crocodile), *Crocodylus cataphractus*; Salt Marsh Crocodile (Saltwater Crocodile), *Crocodylus porosus*; Orinoco Crocodile, *Crocodylus intermedius*; American Crocodile, *Crocodylus acutus*; West African Broad-nosed Crocodile, *Osteolaemus tetraspis*; and Rough-eyed Caiman (spectacled caiman), *Caiman crocodilus*, as well as American Alligators (Ditmars 1913). Ditmars eloquently wrote of his visit to a ship, "a big freighter from the east," in New York harbor, whose holds were crammed with cages and boxes of large cats, hoofed stock, giant snakes, and crocodiles in long boxes, of which he purchased three. Ditmars did not have easy access to the scholarly literature, and had to depend on the dealers' anecdotal information for origin and species when he purchased animals for the zoo collections. We know that C. Ralph DeSola (1933) published a comprehensive article on crocodilians in the *Zoological Society Bulletin*, with a foreword by Ditmars, that suggested that a number of crocodilian species were on hand, and that the general philosophy among zoological institutions of the period was to outcompete each other by virtue of the number and rarity of species they exhibited. An outdoor pool located immediately to the east of the Reptile House, useable for crocodilians only during warm summer months, is shown to contain a number of basking animals, including several alligators and a crocodile (Fig. 7).



FIG. 4. The west alligator pools as they appeared in 1954, after the first reptile house renovation since 1898. The modernized configuration and supporting columns remain true to the original 1898 floor plan. The center pool houses four large alligators. Two smaller pools, designed to hold smaller crocodilians, lie just out of sight to the left and right. The large alligators were replaced with a multi-species group in the early 1960s.

Lack of Technology

No good record-keeping system for the reptile collection existed until 1964. Records included a small box of index cards on the head keeper's desk, with a card for each animal marked #1, 2, 3, etc. within each species. Should #2 die, the next animal of that species to arrive would assume the position of #2. Thus, it is retroactively impossible to track longevity of any individual animal within the collection other than, perhaps, an animal that might have some special notoriety attached to it. Herndon G. Dowling assumed the department curatorship in 1958 (1958–1966) and soon initiated a museum-based system of records keeping that included the permanent marking of individual animals for identification and a system of cataloging the collections (Dowling and Gilboa 1968). One of us (Brazaitis) had been unofficially recording crocodilian size data for many years, and the publication of these data gave the crocodilian collection new value, as a wide range of captive crocodilian growth data would be critical for planning future programs (Dowling and Brazaitis 1966). Dowling brought with him a new direction that positioned the collection and staff for a leap forward in science and the new era of conservation that was at hand.

A number of basic technological issues needed to be resolved before crocodilian collections could gain the scientific importance that avian collections had achieved after many bird species had been decimated by the milliners demand for fashionable feathers and commercial hunters had obliterated passenger pigeon populations. Globally, crocodilians had suffered a similar fate. The wild populations for most species were abusively over-utilized for the skin and pet trades, species were disappearing from many wild places, and even populations of common species were plummeting. The state of the art at the Bronx Zoo mirrored the state of the art throughout the zoological community: collection management and conservation were not yet in sight.

The sex of animals in the crocodilian collection generally re-



FIG. 5. A crocodilian nursery and public feeding enhanced the visitor experience in the modernized reptile house in 1954.

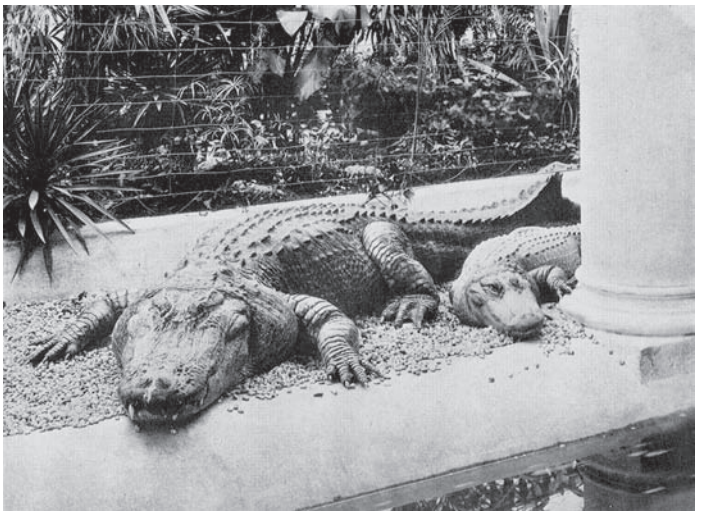
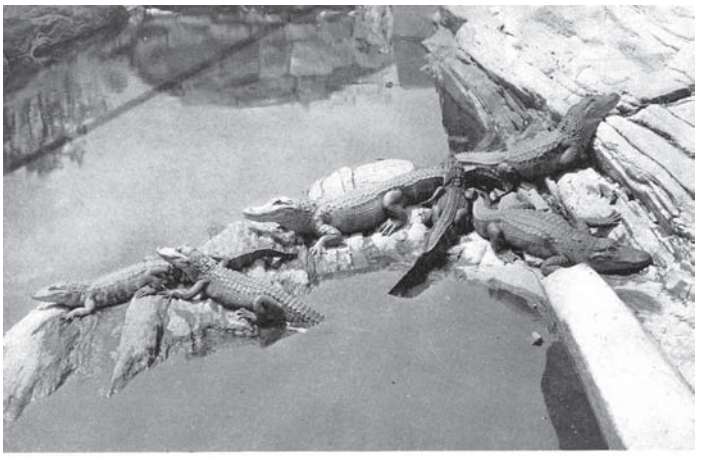


FIG. 6. A 3.9 m (12' 11$^1/_2$") American Alligator was a center of attraction in the 1898 reptile house.



YOUNG ALLIGATORS IN THEIR SUMMER HOME.

FIG. 7. Outdoor summer pool for crocodilians with a crocodile at the far right. About 1930. From the Bulletin of the Society.

mained unknown until they grew to adult sizes and displayed what might be construed as male behavior. Mature males might be identified, but the identification of females often remained dubious. Animals that might have been maintained for years in the hope of future reproduction might ultimately be found to be of the same sex. When Brazaitis arrived as a keeper in the reptile house (1954), the main west pools housed four large alligators, acquired in the hope that they constituted two breeding pairs. As they grew in size, their incessant combats led to their medication with hormones in an effort to reduce their belligerence. The animals were eventually disposed of to an animal dealer and the main pools were then dedicated to holding the array of crocodilian species that were accumulating.

Fig. 8 shows the northeast pool and two Indian Gharial, *Gavialis gangeticus*. The animal in the foreground lacks a lower jaw and was the oldest crocodilian in the collection, having been purchased for $100 from an animal dealer in 1946. Its importance as a rare species was immediately recognized. Measuring 116 cm on arrival, the animal was presumed to be a female. In 1954, at about 178 cm in length, the animal damaged its lower jaw in a gate accident and the lower jaw was amputated immediately anterior to the mandibular symphysis, at about the 20th mandibular tooth. Thereafter, all feeding had to be accomplished by a keeper using a long forceps, holding food in the animal's mouth until it could be swallowed. The animal thoroughly learned the technique and trained many new keepers, including Brazaitis, in its use. It died of unknown causes in 1974 at a length of 295 cm, having been in the collection for about 28 years. The second animal in Fig. 8 is one of four animals acquired around 1952, for the future opening of the newly renovated Reptile House. The sex of these animals was unknown, and all eventually perished from causes of undetermined etiology. Not until 1985, with the opening of Jungle World in the Wild Asia exhibit at the Bronx Zoo was the species exhibited again. five sub-adult gharial from Orissa, India, were added to the collection, to become the nucleus of a future captive breeding program for this critically endangered species.

Still, by 1954, there was no plan for breeding crocodilians**.** It was not until 1963 that a reliable method of sexing crocodilians was discovered at the Reptile House (Brazaitis 1969), when five American Alligators were placed on their backs and compared for any sexual dimorphism. The management of crocodilian collections, planned reproduction, and the interpretation of behaviors was now possible.

However, breeding potential was still haphazard. Most crocodilians died well before maturity due to dietary deficiencies or conflicts with larger animals as they approached adulthood. Rapidly growing juvenile crocodilians often suffered developmental anomalies. For food, zoos generally provided only those species of fish that were commercially available in human food markets, and it was yet unknown that certain fatty saltwater species, particularly after being frozen and thawed, were detrimental to crocodilians, prohibiting the absorption of critically needed vitamins and minerals, and adversely affecting fertility. Frozen saltwater fish, horsemeat, liver and heart meats, as well as all vitamin supplements, were removed from all crocodilian diets beginning in September 1979 and replaced with fresh-killed whole rodents, poultry, and live freshwater fish. In addition, color-corrected and ultraviolet lighting regimens, developed by Townsend and Cole (1985) at the American Museum of Natural History for enhancing reproduction of parthenogenic lizards, were applied to hatchling and rapidly growing crocodilians and proved equally successful. The management changes precipitated an unparalleled era of reproductive success.

Golden Age of Discovery in Crocodilian Science

Our ignorance of crocodilian behavior and reproductive biology was quickly being dissipated by a cadre of new scientists, inspired by awareness of the plight of threatened and critically endangered species. We had been working in the "dark ages" by the "seat of our pants," and there seemed to be no time left as species populations were designated by the international community as either threatened or endangered.

Ted Joanen, of the Louisiana Department of Fur, Fish and Game, was perhaps one of the most forward and practical thinkers of the times in conservation biology. Joanen understood the need for endangered species to have value if they were to be preserved for future generations, and he also set about developing management



FIG. 8. Indian Gharial, about 1957. The animal on the left has lower jaw amputated as a result of an earlier injury. It survived for more than 26 years by hand feeding. Photo by Peter Brazaitis.

protocols for captive breeding and husbandry that still stand as a model. Tracts of various types of alligator habitats were identified in Louisiana, along with their endemic alligator populations and ecology, to monitor the effects of human and natural predation, weather, and environmental changes on population dynamics, nesting, and reproductive success. Most important, a population of captive alligators was established under intensive control and study to compare the success of captive management techniques with the reproductive success of wild populations. His was the only study of its kind for any species anywhere in the world, where a known population of individually identified crocodilians was continuously monitored and documented through successive generations.

The facilities of the Rockefeller Refuge in Grand Chenier, Louisiana, which Joanen headed, and its invaluable wild and domestic alligator populations provided unparalleled opportunities that were utilized by scientists and students for many years. Data provided comparative standards for the management of wild populations and for developing the husbandry for any species of crocodilians in captivity. Much of what we know of crocodilian reproductive biology and behavior was generated from Joanen, his staff, and their work at Rockefeller Refuge (Joanen 1969; Joanen and McNease 1971, 1975, 1980). Much of this knowledge allowed the State of Louisiana to determine its alligator population and ways to manage it through controlled harvesting. Alligator populations and their habitats became a renewable, desirable, and highly profitable natural resource by allowing for sale of harvested animal hides and meat.

Unfortunately, upon his retirement around 2003, Joanen's domestic captive alligator research population was destroyed for lack of support funding and interest (Joanen, pers. comm.).

While Joanen provided ongoing data on reproduction and captive population management, a new field of animal behavior emerged. Myrna Watanabe, a graduate student from New York University, noted that little was known of maternal behavior in alligators or other crocodilians, and set about to observe alligators attending their nests and throughout the parenting process. In 1976, Watanabe was the first to record the litany of vocalizations and behaviors between mother alligators and their hatching young. Her reports of nest excavation by female alligators to liberate hatching young, of carrying hatchlings to the water in her jaws, and of providing ongoing protection and maternal care documented that true to their evolutionary ancestry, alligators continue to practice behaviors generally attributed to birds (Watanabe 1977, 1979, 1980, 1981, 1982a, 1982b, 1986a). Such observations were transmitted to Bronx zoo staff on a daily basis, as Bronx zoo crocodilians nested and produced offspring.

After first completing American Alligator studies at Rockefeller Wildlife Refuge, Watanabe, fluent in Chinese, continued her research in China, joining with Chinese scientists (Watanabe 1983, 1986a,b) to document the secretive behavior and biology of the Chinese Alligator, *Alligator sinensis*, the only relative of the American Alligator. They provided field data that promoted an understanding of the breeding behaviors of Chinese Alligators in captivity. By then, she estimated that the species had been reduced in the wild to fewer than 500 individuals, and it was designated the most endangered species of crocodilian. Her early reports indicated that nearly all wild individuals and their habitats were close to extinction, and the remaining wild population had been relegated to tree farms and cultivated areas, where they continued to be decimated. The first government-sponsored Chinese Alligator farm was established in 1981. Her collaborations with the Wildlife Conservation Society and National Geographic contributed greatly to the success of the Bronx Zoo's Chinese Alligator propagation program.

In St. Lucia, Natal, South Africa, Anthony (Tony) Pooley was also documenting Nile Crocodile nesting and maternal care behaviors and demonstrated that female crocodiles were so in-tune to the maternal care of their young that he recorded a 4-m-long female Nile Crocodile gently take her hatchling directly from Tony's hand (Pooley 1982; pers. comm.). Other researchers were working to understand crocodilian behaviors as well. Leslie D. Garrick, a crocodilian research intern at the Bronx Zoo, and Jeffrey Lang, then of the University of Minnesota, collaborated at the Zoo to document the social signals of crocodilians (Garrick 1974, 1975; Garrick and Lang 1977); and Kent Vliet, University of Florida, documented alligator social behavior (Vliet 2001) by observing their activities from the alligator's perspective: in the water at alligator eye level. His work continues today to enhance crocodilian reproduction programs at the St. Augustine Alligator Farm and provide guidance for crocodilian captive management programs throughout North America.

Mark W. J. Ferguson (1981), then a professor of anatomy at The Queen's University of Belfast, documented the embryonic development, egg degradation, and embryology of American Alligators, and astonished scientists by reporting that the sex of crocodilians was not determined by chromosomes, but by the temperature that the crocodilian's eggs were subject to during incubation (Ferguson and Joanen 1982). Also, Ferguson used the palatal development of American Alligator embryos to better understand the problem of cleft palate in humans (Ferguson et al. 1983). From these studies, we now know why crocodilian embryos perished so easily during some stages of development and not during others. Rotating crocodilian eggs during critical developmental periods during incubation may cause the embryo to break loose from its egg membranes and die. The incubating egg must also enjoy a fine balance of moisture and gas exchange if the eggshell is to degrade sufficiently during incubation to allow the fully developed embryo to break out of its shell and hatch.

One of the earliest studies of crocodilian genetics was conducted at the Bronx Zoo by human geneticist Maimon Cohen, director of the Cytogenetics Laboratory of the Greater Baltimore Medical Center, and herpetologist Carl Gans (Cohen and Gans 1970). With the advent of molecular genetics technology, a new generation of scientists emerged to give us a fresh look at the relationships among crocodilian species: George Amato, first at the Zoo and now at the American Museum of Natural History (Amato 1991, 1994; Amato et al. 1998); paleontologist Chris Brochu of the University of Iowa (Brochu 2001; Brochu and Densmore 2001), and Lew Densmore of Texas Tech University (Densmore 1983; Densmore and Dessauer 1984; Densmore and Owen 1989; Densmore and White 1991).

Roland A. Coulson and Thomas Hernandez (Coulson and Hernandez 1964, 1983), of Louisiana State University, pioneered work on crocodilian metabolism working with Ted Joanen and his colleagues at Rockefeller Refuge.

The Right Time and the Right Place for Crocodilians

The United Nations Convention on International Trade in Endangered Species of Wild Fauna Flora (CITES) came into being in 1973 and called attention to the alarming depletion of crocodilians worldwide. The Lacey Act of 1900 was broadened and the Black Bass Act of 1926 and the Endangered Species Act (ESA) (1966) were combined and amended, which gave sweeping protections to crocodilian species throughout the world. The exotic reptile leather trade was itself facing extinction as wild populations plummeted and anticipated profits evaporated, because the demands on the resource outstripped the legal and illegal supply of raw skins. In the United States, the American Alligator, the symbol of America's southland, was endangered. The Wildlife Conservation Society (then the New York Zoological Society) and the reptile department were at the heart of the crocodilian conservation movement. F. Wayne King (1967–1973) had succeeded Dowling as Curator of Reptiles and he soon developed a consuming interest in crocodilian conservation, expanding on the crocodilian work begun by Dowling and Brazaitis (1966). King organized a meeting in 1971 between law enforcement agencies, Louisiana and Florida wildlife authorities concerned with the plight of American alligators, and representatives of the exotic leather trade. The first comprehensive work on species identification of crocodilian hides and products was introduced to facilitate wildlife law enforcement (King and Brazaitis 1971) followed by the species identification of living crocodilians (Brazaitis 1973a). These factors provided a huge incentive to develop captive breeding programs.

In this new era at the Zoo, we still had no accommodations for breeding crocodilians, no conviction that crocodilians could be successfully bred in artificial pools, and no official plan to initiate a crocodilian breeding program at the Bronx Zoo. Then, one day in March 1964, a maintenance truck parked behind the Reptile House as the workers enjoyed a coffee break. In the back of the truck was a discarded wooden tub that had served for many years as a temporary pool for a Pigmy Hippopotamus in the Elephant House. It measured about 2.5 m in length, 2 m in width, and 70 cm deep at its deepest end. The reptile house keepers commandeered the half-rotted tub, installed it in the conservatory behind the west pools, and immediately populated it with a trio of Chinese Alligators (Figs. 9, 10). The first Bronx Zoo endangered crocodilian species breeding initiative was born (Brazaitis 1968). Something was missing, however, and no breeding occurred.

The west crocodilian pools and the conservatory areas (Fig. 11) were eventually retrofitted in 1981 to include two off-exhibit breeding pools, five nesting areas, and three main exhibit breeding pools. Conspicuous is the exceptionally small size of the complex and its nesting areas, and, in particular, the shallow nature of the pools. The main exhibit breeding pools (1, 2, 3) are less than 65 cm at their deepest point (Table 2).

A number of endangered species in the collection had now reached sexual maturity, and with improved diets and health, began to display reproductive behavior. Because more than one species, following their own intrinsic breeding cycles, would be breeding within a relatively short time period, it was necessary to establish a "breeding calendar," to anticipate having the appropriate accommodations ready at the right time for the right animals. The calendar indicated what species was anticipated to be breeding during what period, and when the females were scheduled to lay eggs. "Musical crocodiles" became the theme, as males and females of one species after another were scheduled in rotation, first to pair and breed in the main or rear breeding pools. Then, females were isolated in secluded rear pools during gestation and later given access to a nesting enclosure to deposit their eggs. Finally, the female crocodile was rotated out to make room for the next gravid female. Eggs would be removed immediately after laying for artificial incubation in the reptile nursery. Hatchlings and growing young, up to a meter in length, were then reared in galvanized cattle troughs on the second floor of the Reptile House, at about 30–35°C, under black light and color-corrected daylight fluorescent lights. In 1983, eggs of three species of crocodilians were under incubation simultaneously.

To date (2008), 10 species of crocodilians have been successfully bred at the Bronx Zoo. Prior to 1980, unanticipated and unrecorded reproduction had taken place with the hatching of single eggs of West African Dwarf Crocodile, *Osteolaemus tetraspis*, and a Smooth-fronted Caiman, *Paleosuchus trigonatus*, found in the pool water. Behler et al. (1987) provided an overview of crocodilian reproduction at the Bronx Zoo.

A Chronology of Crocodilian Reproduction

Initially, the species we bred were the species that were already on hand. As husbandry techniques were refined and new data on the status of wild populations emerged, captive breeding programs focused and gave priority to the most critically endangered species. Programs evolved to include collaborative efforts among consortiums of interested private individuals, zoological institutions, and governments; the Crocodilian Advisory Group of the American Zoo and Aquarium Association, and the IUCN Crocodile Specialist Group. Dedicated space and resources are limited, and priorities changed as some species and wild populations recovered.

Yacare Caiman, *Caiman yacare*

The Yacare Caiman of the grasslands of central South America deserved special interest. Decimated by excessive hide hunting, it

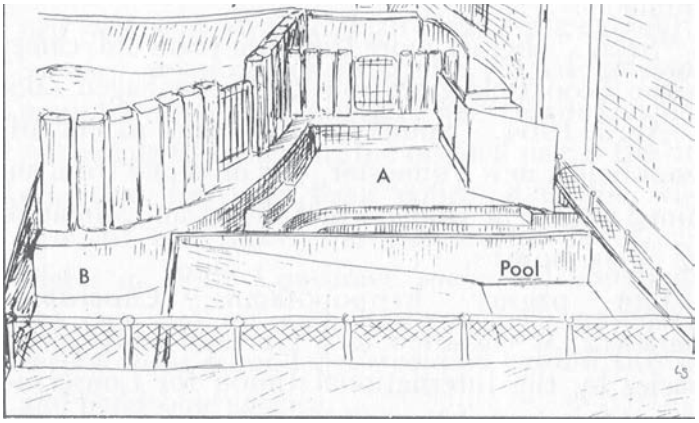


FIG. 9. Chinese Alligator enclosure with old hippo pool, reptile house conservatory, 1964. Illustration by Lloyd Sandford.

was the first crocodilian to be listed as an endangered species under the US ESA on June 2, 1970. Ten hatchling animals, ranging in length from 50–97 cm, were acquired from the U.S. Fish and Wildlife Service in September 1971. An 11-year-old yacare measuring 145 cm in length commenced to lay infertile eggs in 1977 and 1979. Diets prior to 1980 had yet to be improved and consisted largely of frozen saltwater fish and horse and beef meats and Vitamin E supplements. However, with the diet change to fresh-killed small mammals and birds in September 1979, the effect was dramatic. In April 1980, a 137-cm-long female laid four fertile eggs which were successfully incubated and hatched. This was the first of a planned and documented, successful, crocodilian reproduction at the Bronx Zoo (Brazaitis 1986).

Chinese Alligators, *Alligator sinensis*

The odyssey of the Chinese Alligator, a burrowing dwarf species found only in possibly three provinces in southern China (Chen 1990; Huang 1981), beginning with the Bronx Zoo collection, is a global story spanning decades. In 1963, the collection included three Chinese Alligators, which newly developed sexing techniques



FIG. 10. The original pair of Chinese Alligators in the first established breeding pool in 1964. The animal at the rear is the original male estimated to be more than 40 years old at the time. Photo by Peter Brazaitis.

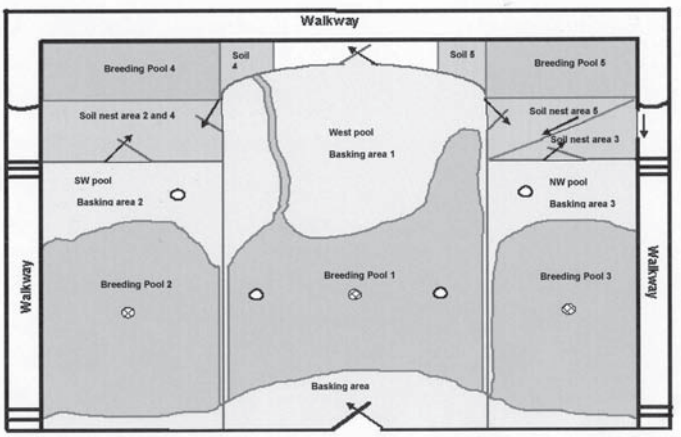


FIG. 11. The west crocodilian pools and the conservatory areas as they were retrofitted to provide a multi-species crocodilian reproduction complex. The complex includes: three primary exhibit and breeding pools (1, 2, 3), exhibit basking areas are bare cement and have imbedded heat coils to enhance basking; two off-exhibit breeding pools (4, 5). See Table 4 for dimensions for breeding pools and nesting areas. Connecting doorways and accesses allow for any crocodilian in any pool to be moved without capture to any pool or nesting area throughout the complex. Keeper staff may view all areas from the elevated walkway around the perimeter of the complex or from the public space. Soils nest areas are filled with a soil/sand/mulch substrate ca. 40–60 cm deep. All nest areas have buried temperature-controlled electric heated pads as attractive nest sites (grids). Nest Box 2 contains less than 30 cm deep substrate and measured ca. 80 × 100 cm in size. Illustration by Peter Brazaitis.

told us were comprised of an adult male and female and a second younger female. It now seemed logical to attempt to breed this small rare species, although the male had been acquired as an adult from Poland in 1956 and was presumed to be at least 40 years old. The trio was established in one of the smaller west pools with a small box of substrate to permit nesting. The older female immediately took over the nest box (Brazaitis 1968). No breeding occurred, although the animals engaged in regular courtship. A second attempt under slightly improved conditions in 1964 also met with failure. The Reptile House effort was abandoned.

In 1975, under the leadership of the late John Behler, who had assumed the curatorship of reptiles in 1973, the program was renewed and expanded to include two animals from the National Zoological Park, in collaboration with the Rockefeller Wildlife Refuge. Two pairs of Chinese Alligators were moved to Rockefeller Refuge in 1976, where a half acre of wetlands and ponds were included in each pair's enclosures. In 1977 the first breeding occurred, resulting in three offspring. The forty-year-old-plus males had sired their first offspring. As in American Alligators, a cold period of hibernation appeared to play a critical role in reproduction. Subsequent breeding occurred in 1978, 1979, and 1980 (Behler and Brazaitis 1982; Brazaitis and Joanen 1984). The program has since produced numerous offspring (Fig. 12), including in a number of satellite zoos, and has evolved into one of the most successful endangered species programs under the Association of Zoos and Aquariums (AZA).

Three Chinese Alligators were sent to China in 2003 to augment the national program to preserve the species. Twelve animals in total, including six males from the Bronx Zoo program

TABLE 2. Dimensions and water depths of the crocodilian breeding complex.

Breeding areas and pools	West pool Area 1	SW pool Area 2	NW pool Area 3	Rear Area 4	Rear Area 5
Pool depth (cm)	49	63.5	43.2	63.5	71.1
Total area (approx m^2)	45	11.8	14.6	8.9	4.9
Pool (approx sq m^2)	18.2	5.7	7.5	5.1	4.9
Basking area (approx sq m^2)	30	5.6	4	na	na
Soil nesting areas (approx. sq m^2)	shared (2, 4, 5)	shared (4)	2.67, shared (1, 5)	4.9	2.67, shared (3)

and three females each from St. Augustine and Disney Animal Kingdom, were sent to China in May 2006. The Chinese Alligator breeding centers in China are well funded and emphasize their roles as both tourist attractions and to ensure the survival of the species, at least in captivity (Thorbjarnarson, pers. comm.). Captive individuals now number in the thousands. Field surveys by Watanabe (1982) found, and Thorbjarnarson et al. (2002) confirmed, that the wild population of Chinese Alligators continues to face the prospect of imminent extinction.

Behler officially became the AZA Chinese Alligator studbook keeper in May 1982; this was the first studbook for a reptile breeding program. He was succeeded by Joe Abene, reptile keeper at the Bronx Zoo. The AZA Crocodilian Advisory Group was established in 1986, and the Chinese Alligator program, formally created by Behler in 1980, continues to stand as a model for AZA reptile and amphibian management programs.

Siamese Crocodiles, *Crocodylus siamensis*

Considered virtually extinct in the wild, this species had not been seen in the wild for decades, although older captive animals were the bases of extensive captive breeding for hides and meat in Thailand. The first crocodilians to be seized in 1971 under the new protections (listed as endangered under CITES, 1975; ESA, 1976) were a group of hatchling Siamese Crocodiles without documentation, hidden in an air cargo box at John F. Kennedy International Airport in New York. U.S. Fish and Wildlife Service Special Agents Warren Diffendal and Ed Baker were checking import cargo when they casually tapped on a box labeled machinery and the box began to croak. These 14 youngsters became the first group colony of managed endangered species at the Bronx Zoo, producing offspring almost annually from 1983, at age 12, (Brazaitis and Watanabe 1983) until 1987. They would eventually populate zoos throughout the United States.

Cuban Crocodiles, *Crocodylus rhombifer*

"Fidel" and "Maria" were perhaps two of the most famous crocodilians in US zoos. Fidel (Fig. 16) came to the Bronx Zoo in 1958 from the Tarpon Springs Zoo, Florida, as a juvenile and quickly made his mark by attempting to consume the hand of Brazaitis during a public feeding. The two crocodiles were tightly bonded and remained intolerant of all other crocodiles throughout their lives. Both animals were of immense genetic important to the AZA Cuban Crocodile endangered species propagation program in that they represented pure Cuban Crocodiles from times prior to the commercial hybridization of Cuban and American crocodiles in Cuban crocodile farms. "Fidel" and "Maria" produced numerous offspring: one in 1983, six in 1984, and 21 in 1985.

Indian Mugger Crocodile, *Crocodylus palustris*

Crocodylus palustris was well represented in the collection between 1969 and 1994, with the arrival of a male and a female in 1969. An additional male and two females were acquired from the U.S. Fish and Wildlife Service in 1971. All of the first eggs produced by these animals were infertile and laid in the water, probably as a result of poor diets of saltwater fish during their prereproductive ages, and not having available a nest site with a temperature elevated above the pool water temperature. Typically, pool water temperatures averaged 29°C, while ambient air temperatures might vary from 21 to 26°C during the months from February to April. Prior to the introduction of a heated nesting site in breeding enclosures in 1981, it was not unusual for animals to select for the warmer water as a "nest site" in which to lay their eggs. The pattern of egg production suggests that the reproductive cycle of these animals may well be genetically programmed. In India, *C. palustris* typically lays eggs from February to April in the wild, and averages 28 (10–48 range) eggs per clutch (Lang 1986; Whitaker and Whitaker 1977). Despite having been reared in captivity and subjected to an alien annual photoperiod, lack of natural sunlight, and varying temperatures from the first year throughout maturity, this group of *C. palustris* exhibited a repro-



Fig. 12. Hatching Chinese Alligator, Bronx Zoo, 1984. Photo by Peter Brazaitis.

TABLE 3. Reproductive history of *Crocodylus palustris* at the Bronx Zoo.

C. palustris	69086 female	No. eggs	71098 female	No. eggs	71099 female	No. eggs	71100 male	69503 male
Size on arrival cm	41.5		35.2		33.5		34.6	39.6
Year first breeding	1979		1986		1985		1982	None
First breeding size	219.0		218.44		221.0		193	na
Est. age first breeding	11 yrs		15 yrs		15 yrs		12yrs	na
Eggs laid	Month							
1979	March–May	27						
1980	April	31						
1981								
1982							mounting	
1983	March	27					mounting*	
1984	March	27						
1985	March	28			22	March		
1986			March	28				
1987	March	28			28	March		

* Successful breeding with *Crocodylus rhombifer*

ductive cycle that remained typical for the species in its native homeland (Table 3).

Indian Mugger Crocodile, *Crocodylus palustris* × Cuban Crocodile *Crocodylus rhombifer* hybrid.

In 1983, a male *Crocodylus palustris* successfully bred with an approximately 1.5 m long female *Crocodylus rhombifer.* A number of eggs were laid and artificially incubated on 30 April 1983. One egg successfully hatched on 5 July 1983, producing a healthy hybrid crocodile 249 mm in length and weighing 57.2 g. On 13 August 1984, it was transferred to Florida holding facilities. The animal measured 2.5 m in length and weighed 70 kg (Table 3).

Malayan False Gharial, *Tomistoma schlegelli*

Perhaps one of the most exciting breeding successes took place in July, 1985 (Brazaitis 1999) with the hatching of seven animals. The female, 245 cm long at the time of breeding, had been acquired from the San Jose Zoo, California, in 1974 with an injured upper jaw, which was splinted and wired to stabilize the jaw on arrival. The male, acquired in 1974 from an animal dealer, measured 131 cm on arrival, and was ca. 3.6 m long at the time of breeding in 1985. The female built a nest of hay, bark, and sand, in which she buried and guarded 26 eggs. Breeding took place in a pool shared with a third and smaller animal in breeding complex #4 (Fig. 14), in a pool only slightly longer than the larger male's length and half his width, with a water depth of less than 76 cm. However, breeding was never repeated by these young adult animals for unknown reasons. Their offspring have not, as yet, bred. *Tomistoma* in the care of Bruce Shwedick (pers. comm.), in Florida, where his animals are housed under more natural conditions, also have bred only one time to date.

Broad-snouted Caiman, *Caiman latirostris*

Although a lone male was acquired from the U.S. Fish and Wildlife Service in 1971 as an undocumented importation, it was not until October, 1985, that a group of five male and five female, four-year-old animals, ranging in size from 96 to 185 cm, were obtained from the Atagawa Crocodile Farm in Japan. The animals were captive bred and were to become the nucleus of a US captive breeding program. However, the animals appeared somewhat debilitated and undernourished on arrival, and it was not until April 1987 that the first ones began producing fertile eggs. Eighteen eggs hatched in July of 1987; eight in July, 1988; six in July 1990, seven in August 1994, and one each in July,1995 and August 1996. By that time, commercial farming operations were well underway in Argentina. The species was no longer considered endangered and it was downgraded to lower risk by the International Union for the Conservation of Nature and Natural Resources (IUCN).

Dwarf Caiman, *Paleosuchus palpebrosus*

Crocodilian reproduction continues today with the successful breeding of this prolific, secretive, but common northern and central South American species (Medem 1958). A male was collected in Surinam in 1977 and has since bred with two females acquired from the Paramaribo Zoo in Surinam in 1985 (103 cm and 89 cm, respectively). Since then, these animals have produced numerous eggs and hatchlings (Table 4).

Future History

The history of crocodilian breeding and reproduction has gone full circle over the past 107 years, since Ditmars first put a 12 foot long alligator on exhibit in the new Reptile House at the Bronx Zoo, and ecstatically announced the successful hatching of an American Alligator egg the zoo had acquired from a donor. We no longer put animals together whose species identity and sex are uncertain. Molecular science now allows us to selectively pair those individuals that best typify the species' genetic profile and preserve genetic diversity. Our basic concept of what is a species, and which "species" is more closely related to which and what do

we call it, is in flux.

Forty years ago, we learned that, all good intentions aside, the successful breeding of a single female could provide a stock of more animals than all of the facilities provided by most of the United States' zoos combined could maintain. Yet, other than the most critically endangered species, returning some of those animals to the wild to repopulate decimated populations is often neither possible nor practical. Original habitats, because of recent development and human encroachments, may no longer exist in a condition where they can still support crocodilian populations. In some cases, the countries involved may have implemented national breeding and reintroduction programs. The captive propagation of crocodilians has evolved from asking the question, "Can we breed any species at all?" to "What species do we really want to breed, and how often?" In fact, we have opted to not breed most of the 23-odd species of crocodilians because we have come to realize that, collectively, zoos do not have sufficient accommodations or resources to manage long-term captive breeding programs for any but the most critically endangered species, such as the Chinese Alligator and the Philippine Crocodile, *Crocodylus mindorensis*.

TABLE 4. Reproductive success of *Paleosuchus palpebrosus* at the Bronx Zoo.

Female	F Unknown	Hatched	F850075	Hatched	F850076	Hatched
1988	15 eggs	5				
1990			15 eggs	15	13 eggs	12
1991			14 eggs	11		
1992			14 eggs	0	10 eggs	1
1998		2				
1999		7				
2001		3				
2004*		15				

* Breeding curtailed and egg hatching interrupted. Resumed 2007.

However, the same crocodilian science and technology that allowed the Bronx Zoo to lead the way in captive crocodilian propagation also provided a more lucrative way to save endangered species through commercial propagation. We may yet lose species, not to over-utilization or lack of technology, but to the loss of species identity through the careless breeding of captive animals, disregard for the preservation of the species' genetic integrity, or worse, the large-scale deliberate hybridization of species to produce more prolific crocodilians that are faster growing and have a more valuable skin. The accidental hybridization of *C. palustris* with *C. rhombifer* at the Bronx Zoo in 1983 demonstrates the ease with which crocodilians may interbreed under captive conditions. *C. rhombifer* and American Crocodiles, *C. acutus*, were commercially hybridized for the commercial skin trade in Cuba, and may have compromised the genetic integrity of the Cuban Crocodile. The saltwater Crocodile, *C. porosus*, and the Siamese Crocodile, *C. siamensis*, continue to be hybridized in great numbers for the commercial skin trade in Thailand. In Colombia, commercial caiman skin and meat farms produce millions of skins per year as a product of indiscriminate captive breeding of closely related but distinct *Caiman* species with little regard for population integrity. Non-native crocodilian species continue to be introduced into non-endemic countries to commercially capitalize on a perhaps higher value of skins than those of native species. An example is the commercial introduction of Nile Crocodiles into Brazil for commercial farming. Future zoological historians may yet accuse, and simultaneously congratulate, our generation for developing the skills to produce thousands of individuals of any given species at will in captivity, yet failing to preserve the habitats and wild populations that are our natural wildlife heritage. There may well be tens of thousands of Chinese Alligators in captivity, while the species may yet become extinct in the wild.

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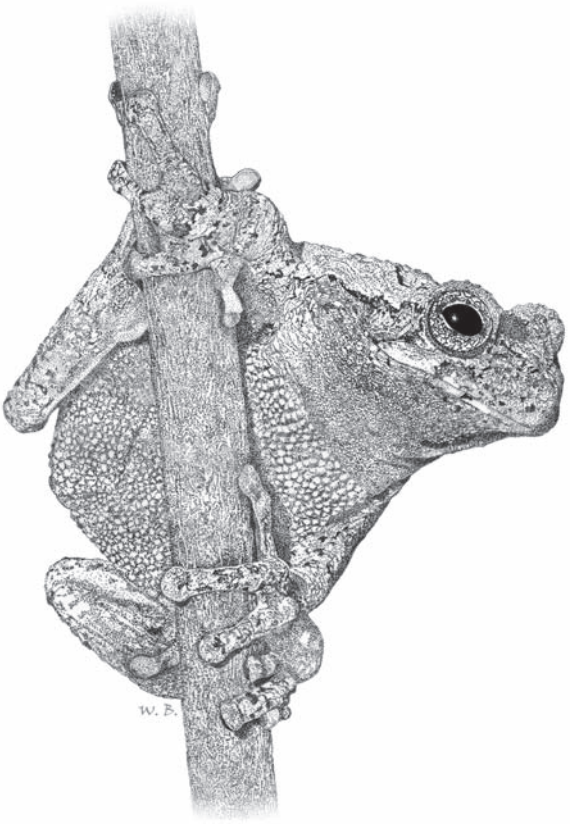
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Hyla versicolor (Gray Treefrog). USA: Virginia: Greene Co. Illustration by Will Brown (http://www.blueridgebiological.com/).

POINTS OF VIEW

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Toe Clipping of Anurans for Mark-Recapture Studies: Acceptable if Justified

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Individual marking of animals so that they are uniquely identifiable upon recapture is a common practice in ecological field studies (Nietfeld et al. 1994). The return rate observed during a mark-recapture study is a product of the probability of survival (survival rate) and the probability of recapturing an animal that is alive (recapture rate). An ideal marking method will not harm the study organism or change its behavior, and therefore will not affect survival or recapture rates. Toe clipping is a common method of marking anurans, but its use has become controversial (Funk et al. 2005; May 2004) following our study identifying a consistent, negative effect of toe clipping on the return rate of anurans in the wild (McCarthy and Parris 2004).

Phillott et al. (2007) argue that toe clipping is an acceptable method of marking anurans for mark-recapture studies, for three principal reasons. First, because it is unclear whether the observed reduction in the return rate of anurans with increasing numbers of toes clipped is due to changes in survival, changes in recapture rate, or both. Second, because the impacts of alternative marking methods have not been properly assessed; and third, because individual marking of anurans is essential for the conservation management of the group. We would like to respond to some of their points here.

As we state in our earlier papers (McCarthy and Parris 2004; Parris and McCarthy 2001), the negative effect of toe clipping on anuran return rates could be due to an increase in mortality, changes in the behavior of animals leading to a lower recapture rate, or a combination of the two. Phillott et al. (2007), like May (2004) and Funk et al. (2005), focus on the ethical problems associated with reduced survival of toe-clipped animals, implying that behavioral changes following marking are less important. While this distinction is understandable, any impact of toe clipping on anuran behavior also has ethical and scientific consequences. Changes in behavior following toe clipping such as a reduction in calling or foraging activity, or migration from the study area, could have consequences for the fitness of the study animals and the persistence of populations. Furthermore, whether the reduction in return rates is due to the death of the study animals or changes in their behavior, the data arising from a toe-clipping study will be biased. Interestingly, the scientific validity of studies using biased data from toe clipping has received little attention. Some researchers have taken issue with our papers because of subsequent restrictions that could be placed on their use of toe clipping. We are surprised by such reactions, because we had expected that users of a biased research method would want to know the size of the

bias so it could be corrected. Researchers using toe clipping in the future need to ensure that the inherent bias is 1) minimized by careful survey design, and 2) accounted for during data analysis (Parris and McCarthy 2001).

Phillott et al. (2007) propose a number of strategies for minimizing the negative impacts of toe clipping, including removing as few toes as possible and using aseptic handling techniques. We make these same recommendations (Parris and McCarthy 2001), although we propose that care be taken to remove the minimum number of toes from all anurans, not just species that are "heavily reliant on toes". Phillott et al. (2007) suggest that removal of the toe pad only ("toe tipping" rather than toe clipping) may reduce the effects of marking on anurans. While this may be the case, there are no supporting data – in fact, the effect of toe tipping on the return rate of *Hyla labialis* (Lüddecke and Amézquita 1999) is comparable to the effect of toe clipping on the return rate of *Bufo woodhousei* and *Crinia signifera* (Clarke 1972; Lemckert 1996; Williamson and Bull 1996; see McCarthy and Parris (2004), Figs 1 and 2).

It is true that the effects of alternative methods for marking anurans have not been properly assessed in the wild (although Davis and Ovaska (2001) found a 33% lower return rate of salamanders with three toes clipped compared to those implanted with fluorescent elastomer tags). It is likely that other marking methods will affect the recapture and/or survival rates of anurans to some degree, so they, too, must be used with caution. However, the prospect that other methods are just as bad, or worse, than toe clipping does not necessarily make it acceptable. The possible benefits of conducting a mark-recapture study using toe clipping must be weighed objectively against the likely impacts on the study animals, to determine whether toe clipping is justified in a particular circumstance. Phillott et al. (2007) argue that data gained from the individual marking of anurans is essential for their conservation management. For this to be the case, the data must be essential for identifying practical management actions that will improve the viability of a species, and must be of sufficient quality and quantity to achieve this objective. To our knowledge, few mark-recapture studies of anurans meet these criteria, especially studies of threatened species that have small populations. The burden of proof that the value of their research outweighs the harm it may cause lies with researchers who propose a mark-recapture study; the burden of oversight lies with ethics committees.

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Toe Clipping of Anurans for Mark-Recapture Studies: Acceptable if Justified. That's What We Said!

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Parris and McCarthy (2008) have over-simplified the arguments of Phillott et al. (2007) that toe-clipping is an acceptable method of marking anurans. We discussed six points in defending toe-clipping as a marking method:

1. The absence of unequivocal data to quantify the effect of toe-clipping on return rates. Parris and McCarthy (2001) and McCarthy and Parris (2004) used statistical projections, based on five studies with limited details of search effort to evaluate the likelihood of encountering a marked frog and hygiene procedures that may have influenced survival be-

yond current practices (Clarke 1972, Humphries 1979, Lemckert 1996, Williamson and Bull 1996, Lüddecke and Amézquita 1999).

2. The reasons for reduced return rates after toe-clipping. Mortality after an invasive marking procedure is a real and recognized concern. However, failure to encounter an individual after marking can also be due to behavioral changes that may or may not affect the fitness of the study animals.
3. Current hygiene practices minimise the risk of exposure to pathogens. These are less likely to have been or were not considered in the studies which Parris and McCarthy (2001) and McCarthy and Parris (2004) used as data sources.
4. Ethical concerns raised by May (2004) are unsubstantiated, yet have strongly influenced ethics committees, with some recommending the use of anesthetics that are at times inappropriate or have unknown dosage requirements that are likely to pose a greater threat to the well-being of the animals than toe-clipping.
5. Ethics committees have also favoured the use of other marking techniques, such as pit-tagging, over toe-clipping. The majority of these are still invasive, pit-tagging arguably more than toe-clipping, and their effects are at best no further understood than those of toe-clipping. They have certainly not been shown to pose less of a physiological or physical risk to animals.
6. Some field studies require the recognition of individuals, which for many species requires marking techniques such as toe-clipping. We believe such focused studies with measurable outcomes contributing to understanding and management of a species have value that outweighs the potential impacts on the species.

Parris and McCarthy (2008) responded to points 2, 3, 5, and 6. They are largely in agreement with these points although they do not distinguish between the importance of the effects of toe-clipping on mortality versus behavior. They argue that both are equally important because of the potential effect of changes in behavior on population fitness and study bias. Unfortunately there are no data to test whose opinion is correct. Parris and McCarthy (2008) point out that a minimum number of toes should be removed from all anurans; in general we agree but we stand by the intent of our comment that the function and importance of toes should equally be taken into account when toe-clipping. Parris and McCarthy (2008) also suggest that there is evidence that the effect of toe-clipping is no different from that of toe-tipping although the study they cite is confounded by species. In addition, they argue that toe-clipping may be unacceptable even if it is no worse than other invasive methods of marking animals. The point of our comment was that it is always best to use the most practical, least harmful method of marking, and that toe-clipping should be evaluated on that basis, along with other marking methods.

We believe that mark-recapture studies can contribute to the development of conservation management plans for many anurans in a variety of ways. McCarthy and Parris (2008) argue that the risk of toe-clipping is justifiable only if one is answering questions of direct relevance to management applications. Unfortunately, too little is known about many amphibian populations to know in advance what these questions might be. Correctly conducted population studies can be the only means of identifying risk factors. Potential increases in mortality or emigration rates are generally quite small, but can be accounted for in a study and the need for information must be balanced against those risks.

Parris and McCarthy (2008) are surprised that the scientific validity of potentially biased data from studies using toe-clipping has received little attention. We acknowledge that any field research involving the capture and marking of animals may potentially affect return rates through altered survival and/or behavior, so all techniques violate assumptions related to population estimation models, and bias needs to be considered (Phillott et al. 2007). However, in the absence of evidence-based results that prove a lesser effect on return rates of alternative marking techniques, field researchers will continue with toe-clipping as it is known to have small effects that have been quantified for some species. We hope this discussion has shown that toe-clipping and toe-tipping are acceptable techniques if carried out appropriately, that their use needs to be justified, that their effects on a study need to considered when analysing results, and that they will remain in use until alternative techniques are shown to be superior. We reiterate that controlled studies to evaluate the physical, physiological and behavioural effects of invasive marking techniques on a range of frog species are urgently needed.

Phillott et al. (2007) did not primarily aim to address Parris and McCarthy (2001) and McCarthy and Parris (2004) as we believe the weakness of their arguments was adequately discussed in Funk et al. (2003). Our concern is that animal ethics committees and government agencies have banned the use of toe-clipping as a result of these papers, but have done so without evidence that the procedure has a greater effect than the alternative marking methods. Our paper specifically demonstrated the problems with dismissing toe-clipping in favour of other, less understood invasive marking techniques.

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ARTICLES

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Oophagy and Larval Cannibalism without Polyphenism in Tadpoles of the Great Basin Spadefoot (*Spea intermontana*)

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Polyphenism associated with cannibalism has been reliably documented in two species of North American spadefoot toads (family Pelobatidae: *Spea bombifrons* and *S. multiplicata*) (Bragg 1956, 1964; Bragg and Bragg 1959; Pfennig 1989; Pomeroy 1981). *Spea* larvae occur as two morphologically distinct phenotypes: 1) carnivores are cannibalistic, have beak-shaped, keratinized mouthparts, and hypertrophied jaw musculature; and 2) omnivores have flat, keratinized mouthparts, and feed primarily on detritus (Bragg 1965; Pfennig 1992; Pomeroy 1981). Pomeroy (1981) noted polymorphism in pools containing *S. multiplicata* 2–4 days after feeding commenced. In *S. multiplicata*, consumption of anostracan shrimps or other tadpoles induces the carnivore morphology and morph determination is reversible based on diet (Pfennig 1990; Pomeroy 1981).

Reports of polyphenism in *Spea intermontana* have been limited to mouthpart characteristics (Acker and Larsen 1979; Black 1973; Orton 1954; Turner 1952). The description provided by Tanner (1939) of the mouthparts of *S. intermontana* collected in Utah has been interpreted as indicative of a carnivore morph (Hall et al. 2002; Pfennig 1992). Subsequent workers have assumed that larvae of *S. intermontana* are potentially morphologically variable (Hall 1993; Hall et al. 1997; Hall et al. 2002). Hall (1998) includes two photographs of the carnivorous and herbivorous morphological types. However, the two types have not been described in detail and there are no reports whether the carnivorous morph is cannibalistic. I report field observations of cannibalism and oophagy by larvae of *S. intermontana* and the lack of polyphenism associated with cannibalism.

Methods.—I conducted this study at permanent, semi-permanent and temporary ponds in Mono County, California, USA (118.965°N, 38.086°W), during the breeding seasons April through June of 1984–1989. Permanent and semi-permanent pools are created by artesian wells. Semi-permanent pools are present year-round, except in drought years. Temporary pools formed from ground water and surface run-off, and were present only during wet years. Study pools varied in size from less than one meter square to several hectares. Additional observations and collections were made from three small pools formed from springs near the south shore of Mono Lake, Mono County, California (119.053°W, 37.940°N).

Tadpoles were observed in the field for 1380 h on 260 days between April 1984 and May 1989. The duration of observations ranged from 3–7 h per day. I identified a tadpole as a cannibal if it was observed eating all or part of a conspecific, while a non-cannibal did not eat a conspecific. For cannibalistic encounters for which an entire sequence was observed I recorded: the length of time it took a cannibal to consume its prey; the number of cannibals feeding on a single tadpole; and the snout–vent length (SVL; tip of the snout to the junction of the posterior body wall and cloaca) and developmental stage (DS, Gosner 1960) of the cannibal(s) and prey.

Tadpoles were collected for morphometric analyses mid-April to mid-June in 1984 through 1987 and during May in 1988 and 1989. Tadpoles were randomly collected with a dip net once a week from the main study pool and less frequently from other pools that contained fewer tadpoles. While phenotypic differences between morphs of *S. bombifrons* and *S. multiplicata* are readily determined by visual inspection (Bragg 1965; Pfennig 1990; Pomeroy 1981; Storz 2004), there were no obvious morphological differences among tadpoles of *S. intermontana* in my study pools. For more detailed morphometric comparisons, cannibals and noncannibals were identified by offering field-collected tadpoles (stages 25–36) at least one pre-feeding stage conspecific for 24 h. Tadpoles were housed individually in 2.4-liter round plastic containers (16.8 cm x 12.5 cm) filled with approximately 1680 ml water to a depth of 8.75 cm. Cannibalism was inferred if a tadpole was missing or its partially consumed remains were present. Tadpoles that did not eat conspecifics were labeled non-cannibals. Cannibals (N = 34) and non-cannibals (N = 36) were preserved for morphometric analysis.

All tadpoles were cold-killed and preserved in 10% formalin. I examined the external morphology of 1089 tadpoles of different sizes and developmental stages. Using dial calipers and a dissecting microscope, three characteristics were measured: SVL, total length (TL; tip of the snout to the tip of the tail), DS, and number of posterior and anterior labial teeth rows (PLT and ALT) using Altig and McDiarmid's (1999) terminology. The criterion for labial tooth row presence was at least three teeth on a tooth ridge. A qualitative description of the keratinized jaw sheaths also was recorded (e.g., serrations on jaw sheaths, thick, thin; see Altig and McDiarmid 1999).

Gut length (GL) and *musculus orbitohyoideus* length (OH) were measured for the 70 experimental tadpoles identified as cannibals and non-cannibals and for 157 tadpoles collected from a single population over the course of their development. These two traits are diagnostic of the carnivore morphotype for *S. multiplicata* (Pfennig 1989; Pomeroy 1981). A dissecting microscope with ocular micrometer was used to measure OH to the nearest 0.1 mm. The relationships of GL and OH to body size were analyzed using analysis of covariance.

I tested whether metamorphs were cannibalized by conspecific larvae by placing metamorphs in the water of ponds 1–2 m from shore. This forced the individual to swim to shore above feeding aggregations of tadpoles. I conducted 35 trials with individual metamorphs in 1984 and 45 metamorphs in 1986.

Results.—Cannibalism was observed on 8 of 260 days of field observations: 6 days in 1984 (April 15–18, 21, 22) and 2 days in 1987 (May 8, 15). A total of 41 occurrences of cannibalism were observed in the 8 days over a period of 27.5 h, in three different ponds. Based on the number of egg clutches recorded in the three ponds and the average number of eggs per clutch (mean = 812, SD = 297), the number of tadpoles present on each day the cannibalism was recorded ranged from 4872 to more than 10,000 tad-

poles (Pond 1 ≥ 10,000, Pond 2 4,872, and Pond 3 5,684).

All cannibalistic encounters occurred in feeding aggregations in the vicinity of a clutch of conspecific eggs that had hatched within the previous two days or were in the process of hatching. Cannibals were in early feeding stages, 25–27, and preyed on tadpoles in stages 20–25. Prey tadpoles with yolk sacs did not struggle while older tadpoles in stages 24–25 lashed their tails, but did not escape. Cannibals seized conspecifics on all body sites, including the head, back, abdomen, and tail. Cannibalistic encounters were initiated by a tadpole butting into another individual with its snout. Butting was a characteristic behavior engaged in by feeding tadpoles. Cannibalistic tadpoles did not pursue their prey if it moved away when butted, nor did they remain in the vicinity of newly hatched tadpoles to selectively hunt and prey on them. Most tadpoles that butted into newly hatched conspecifics did not seize them. These non-cannibals were frequently observed resting alongside or on top of newly hatched tadpoles.

Other tadpoles butted the feeding cannibal and some individuals seized part of the prey. Some individual tadpoles fed on the prey for a few minutes before leaving and being replaced by another tadpole. In 32 instances where the entire cannibalistic encounter from initiation to complete consumption was observed, from 1–7 tadpoles consumed part of a single newly hatched tadpole (mean = 2, SD = 1.5).

Cannibals were behaviorally and morphologically indistinguishable from other tadpoles in the feeding aggregations. However, their cannibalistic feeding behavior was conspicuous because they jerked sharply from side to side as they engulfed their prey. Groups of cannibals feeding on one tadpole tugged in opposing directions and tumbled about in the water, often upside down. In three cases, one individual pulled the prey away from the other tadpoles and rapidly swam away. The other tadpoles pursued a few millimeters before stopping to feed elsewhere.

In 19 timed observations, a cannibal consumed a tadpole in less than 5–2400 sec (mean = 866 sec, SD = 697.7). Large cannibals consumed small prey faster than cannibals that consumed prey close to their size. Some cannibals were the same size (SVL) as their prey, while others were up to 50% larger. The length of time for ten groups of two or more cannibals to completely consume the same prey ranged from 79–1800 sec (mean = 610.6, SD = 554.4).

Cannibalism was not observed experimentally or incidentally on transforming tadpoles, but was recorded on dead and injured tadpoles. In 1985, cattle fed and watered directly in the main study pool. The cows killed some tadpoles and mortally wounded others when they waded in the pond. Dead and injured tadpoles burst open so that their intestines were exposed. Unaffected tadpoles ate the intestines of both dead and live tadpoles as well as other internal organs. The cannibals did not eat the remainder of the tadpoles' bodies (e.g., head, back, tail) until several days later when the carcasses were affected by fungus and algae. The cattle's hooves also created water-filled depressions along the pond's margin. Fluctuations in water levels caused some of the depressions to become separated from the main body of water, trapping tadpoles that died when the water evaporated. When the water level rose again, tadpoles formed feeding aggregations on the dead tadpoles.

Toads appeared to employ a flexible breeding strategy in response to annual hydrologic conditions that appeared to be related to the incidence of oophagy. During dry years (1985, 1986), they were explosive breeders and females deposited their eggs in a period of a few days. In wet years (1984, 1987), they were prolonged breeders and females deposited their eggs over a period of two months. During prolonged breeding seasons, oophagy was observed in all study pools, except in temporary pools in which only one clutch was deposited. In explosive breeding years, few to no feeding stage tadpoles were present that could eat conspecific eggs as there were only a few days of overlap in the time of occurrence of eggs and larvae.

Thirty-eight of 118 egg masses (32%) were completely eaten by conspecifics. Nine of 118 egg masses were destroyed by desiccation (7.6%). Dense aggregations of feeding tadpoles formed on both viable and nonviable clutches of eggs. Nonviable eggs were affected by fungus, and the outer jelly became coated with green algae. Females typically deposited multiple, discrete clumps of eggs. Asynchronous hatching of eggs was recorded in 75.6% of egg clutches (N = 91; range = 1–4 days). Asynchronous development of embryos within clutches provided opportunities for sibling cannibalism as some tadpoles hatched up to four days before their siblings. Sibling cannibalism was observed only once when two Stage 25 tadpoles ate a Stage 20 tadpole. All three tadpoles were from the same discrete clump of eggs.

Female toads appeared to select egg deposition sites away from egg clutches and aggregations of tadpoles (unpubl. data). Due to patterns of egg deposition and oophagy, few situations existed in the field where tadpoles greater than Stage 27 could prey on newly hatched tadpoles. The females' egg laying was not always effective at preventing complete depredation. In 1984, ten clutches of eggs were entirely consumed in less than five days.

Analysis of covariance, with SVL as a covariate, revealed no significant differences in GL or OH length between cannibals (N = 34) and noncannibals (N = 36) for these variables. The use of developmental stage as a covariate in addition to SVL also showed no significant difference between cannibals and noncannibals for either OH ($F = 0.32$; $df = 1, 70$; $p > 0.05$) or GL ($F = 0.79$; $df = 1, 70$; $p > 0.05$). The standardized residuals of OH (mean = 2.68, SD = 8) and GL (mean = 144.3, SD = 113.5) regressed against SVL (mean = 13.8, SD = 8.9) were used to check for bimodality for a subset of tadpoles randomly collected from a single pond (N = 157). The results showed normal curves, which suggest that only one morphotype was present (see Pfennig 1990).

There was a difference in the number of posterior labial teeth rows between cannibals and noncannibals ($\chi^2 = 13.2$, $df = 3$, $p < 0.01$) but not anterior teeth rows ($\chi^2 = 1.5$, $df = 2$, $p > 0.05$). Cannibals had more rows of posterior teeth (mean = 1.85, SD = 1, range = 0–3) than non-cannibals (mean = 0.9, SD = 1.2, range = 0–3).

The number of labial teeth rows varied among tadpoles sampled from the same pool from 1984–1987. Analysis of variance for homogeneity among samples of tadpoles from four different years revealed that the differences in mean number of posterior and anterior labial teeth rows among the years were significant (posterior: $F = 18.4$; $df = 3, 199$; $p < 0.001$; anterior: $F = 7.8$; $df = 3, 199$; $p < 0.001$). There was also a difference in the mean number of posterior labial teeth rows among samples of tadpoles collected from three different pools ($F = 6.5$; $df = 2, 77$; $p < 0.01$), but not for mean number of anterior labial teeth rows ($F = 1.2$; $df = 2, 77$;

$p > 0.05$).

The tadpoles' lower jaw sheaths formed a shallow to steep V-shape, while their upper jaw sheaths were medially rounded. No tadpole (N = 1089) had a jaw sheath with the incised morphology indicative of the carnivore morphs of other *Spea*. The jaw sheaths of tadpoles collected from small pools with little organic matter were characterized by reduced pigmentation that was brown in color rather than the typical black pigment. Sharply serrated jaws were present in 93 of 1089 (8.5%) tadpoles examined, but were not present in any of the known cannibals. The serration might wear away with use of the jaws because it was not observed in any tadpoles greater than Stage 30.

Discussion.—Tadpoles exhibited both opportunistic cannibalism in which the prey does not attempt to evade the predator (e.g., oophagy), and cannibalism, in which conspecifics were attacked, killed, and eaten (Crump 1986). Groups of tadpoles feeding on a single prey did not always involve predaceous cannibalism, because in many cases, the prey was already dead from the initial cannibal's feeding activity.

Cannibalism in this population of *S. intermontana* was not associated with poylphenism. Cannibalistic tadpoles did not appear to require specialized oral morphology because the age classes of their prey were vulnerable and easily eaten. The only morphological trait found to differ between cannibals and non-cannibals was the number of rows of posterior labial teeth, which were greater in cannibals. This trait cannot be considered diagnostic of cannibalism or a history of cannibalism because the number of tooth rows also varied by: pool site; year for the same pool; and developmental stage of the tadpole. Reduced number of labial tooth rows, particularly the anterior rows in *S. multiplicata*, is a characteristic trait of *S. hammondii*, *S. bombifrons*, and *S. multiplicata* carnivore morphs (Bragg and Bragg 1959; Bragg 1965; Pomeroy 1981). However, this is only one trait among a suite of morphological and behavioral characters indicative of polymorphism. Moreover, numerous investigators have reported microgeographic variability in labial tooth rows for other species of *Spea* (Bragg and Hayes 1964; Bragg et al. 1964; Hampton and Volpe 1963; Potthoff and Lynch 1986) as well as for *S. intermontana* (Brown 1989; Hall 1993).

Polyphenism in *S. mulitplicata* and *S. bombifrons* appears to occur because these species inhabit variable environments where discrete trophic morphs may provide a selective advantage. The carnivore develops faster than the omnivore and survives better in rapidly evaporating ephemeral pools, while the omnivore survives better in long-lasting pools (Pomeroy 1981; Pfennig 1990). The heterogeneous environmental conditions that make polymorphism evolutionarily advantageous for other *Spea* species may be missing in this population of *S. intermontana*. Tadpoles in my study area developed in permanent and long-lasting temporary pools and did not appear to experience any selection pressure to escape evaporation. Use of permanent bodies of water, including human-constructed impoundments, has been noted in other populations of *S. intermontana* (Blair 1956; Brown 1989; Morey and Reznik 2004). Desiccation before metamorphosis was not a source of mortality in this study population (unpubl. data). Morey and Reznik (2004) also reported no risk of evaporation for their study population of *S. intermontana*.

Differences in developmental markers between *S. intermontana* and other *Spea* suggest that *S. intermontana* might have evolved in long-lived pools. The eggs of *S. intermontana* took an average of 6.5 days to hatch, with a range of 4–9 days. The eggs of other *Spea* species hatch within an average of 48 h (Black 1973; Bragg 1965; Mayhew 1965; Pomeroy 1981). The minimum time to metamorphosis for *S. intermontana* tadpoles in my study area ranged from 36 days in 1985 to 75 days in 1984. Brown (1989) reported 36 days for *S. intermontana* tadpoles to complete development, Nussbaum et al. (1983) reported that *S. intermontana* larvae metamorphose after one or two months of larval development, and Morey and Reznick (2004) reported a range of 36–79 days. Other species of *Spea* have a minimum time to metamorphosis of 13 days (Black 1973; Pomeroy 1981).

It is likely that under natural field conditions, as well as in the laboratory experiment, cannibalism in this population was too limited in scope to produce any effect on morphology. Fairy shrimp (*Brachinecta mackkini*) were not sympatric with tadpoles of *S. intermontana* at my study sites; the fairy shrimp occupied saline water and could not survive in the fresh water inhabited by the tadpoles. Thus, a dietary mechanism that causes differential morph development in *S. mulitplicata* larvae appears to be lacking in this population of *S. intermontana*. The only other report of cannibalism in larvae of *S. intermontana* did not note any morphological differences among the larvae (Durham 1956).

The lack of evidence for a carnivore morph in *S. intermontana* from my study in Mono County, California, compared to specimens from Washington State and Idaho, might not be unexpected for a species that is widely distributed. It is possible that *S. intermontana* has a latent potential for polyphenism that is more readily expressed in other geographic locations and under different conditions. The mechanism by which this occurs warrants further investigation.

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Spring Peepers and Pitcher Plants: A Case of Commensalism?

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Sarracenia purpurea (Northern Pitcher Plant) is a carnivorous plant found throughout northeastern North America (Schnell 2002). This plant is frequently encountered in nutrient-poor bogs, often associated with *Sphagnum* spp. The water-filled, pitcher-shaped leaves of *S. purpurea* serve as a trap for small invertebrates attracted by extra-floral nectaries near the entrance to the pitcher. Once entry to the pitcher is accomplished, escape is difficult due to downward oriented hairs on the inner surface of the leaf, and captured organisms drown in accumulated rainwater. Nutrients from decomposing invertebrates are absorbed by the plant (Ellison and Gotelli 2001). Capture efficiency of insect prey in Northern Pitcher Plants is low (0.83–0.93%) (Newell and Nastase 1998). A mutualistic relationship is hypothesized to exist between pitcher plants and the inquiline community contained within the pitchers (Bradshaw and Creelman 1984; Ellison and Gotelli 2001). Tiny vertebrates are also known to become entrapped in *Sarracenia* pitchers (Schnell 2002).

There are a number of anecdotal references to amphibian consumption by *Sarracenia* pitchers as well as pitcher use by amphibians in the popular press (The Sentinel 2007). One of the earliest references to *Sarracenia* describes pitchers as insect refugia from amphibian predation (Catesby 1743). Amphibians are known to become entrapped and digested in pitchers (Butler et al. 2006; Schnell 2002), forage for insect prey on pitchers (Jones 1935), and inhabit pitchers (Lim and Ng 1991). In this study, I quantify pitcher use by *Pseudacris crucifer* (Northern Spring Peeper) and elucidate the nature of the frog-pitcher plant interaction.

Twelve adult Northern Spring Peepers (8 females, 4 males) were collected from the field in early May 2004 and placed in a 90-liter glass terrarium extensively planted with *Sphagnum* sp. and four Northern Pitcher Plants with 5–11 pitchers per plant. Pitcher plant density in the laboratory was similar to plant densities observed in the field and peepers had access to non-dessicating roosting sites within the *Sphagnum* mat. All spring peepers were reproductive and ranged in SVL from 18–26 mm. Spring peeper density in the laboratory was much greater than observed in the field. Amphibians were fed wingless fruit flies and juvenile crickets. The artificial habitat was observed at least 3 days per week from May–September for 15 minutes per day. Fruit flies were attracted to extra-floral nectaries on pitchers and spring peepers were frequently observed (at least once per observation period) climbing pitchers to consume these insects. Peepers were routinely observed inside *S. purpurea* pitchers during the day, but were never observed feeding while inside pitchers. Suitably sized pitchers of all plants were occupied and no territorial behavior was observed. Occupancy rates were typically less than 5% (0, 1, or 2 peepers observed in pitchers). Only pitchers large enough to admit peepers were used to

estimate occupancy. The entrance to the smallest pitchers was too small to admit adult frogs, but could potentially accommodate recently metamorphosed spring peepers. This microcosm was maintained for six months, with no amphibian losses resulting from entrapment in pitchers.

Sarracenia purpurea plants located on a coastal barren near Halifax, Nova Scotia, Canada (44°33.246'°N, 63°31.396'W) were surveyed for the presence of spring peepers. In 2004, 163 pitchers were observed and 306 in 2005. Density of Northern Pitcher Plants based on ten random 1 m quadrats was 8.5 ± 4.4 plants/m^2. Quadrats were selected by overlaying a sketch of the study area using approximate distances with a grid, randomly numbering the squares of this grid, then selecting ten squares by a random number generator for density estimates. Spring peeper surveys were conducted over three consecutive days during late May in both years in a large bog dominated by *Sphagnum* sp., *Eriophorum* sp., and *Sarracenia purpurea* where plants grew on a nearly continuous mat of *Sphagnum.* Observations were limited to a relatively short period at the peak of the spring peeper breeding season since these amphibians disperse back into the forest following reproduction. Additionally, in late May 2005, 50 pitchers were randomly collected from this site, dissected by longitudinal incision with a scalpel in the laboratory, and examined for the presence of amphibian remains. Five pitchers of sufficient size were collected from ten quadrats, randomly selected as described above.

There were no peepers observed in *Sarracenia* pitchers in 2004, however in 2005, four spring peepers were observed in pitchers during daylight. This corresponds to an incidence of 1.3% of pitchers occupied. When a pitcher was determined to be occupied by a spring peeper, it was marked with a ring of jute twine. Marked pitchers were inspected the following day and it was observed that none was occupied on consecutive days, indicating that amphibians had moved prior to the second survey. Frogs were not trapped within the previously occupied pitchers. Night surveys of 12 wetlands on this same coastal barrens from 2002 to 2006 (at least 8 surveys per year) revealed a large and active spring peeper population based on call surveys. Peepers were occasionally observed calling from pitchers at night and none of the 50 dissected pitchers contained identifiable amphibian remains. Complete digestion for trapped amphibians in *S. purpurea* pitchers requires at least 10 days (Butler et al. 2006). The sample of dissected pitchers was probably too small to detect amphibian remains with 1% or less.

The combination of laboratory behavior and field observations indicate that spring peepers occasionally use *Sarracenia* pitchers. Peepers forage for small insects attracted by extra-floral nectaries on the pitcher, intercepting invertebrates that might otherwise become plant food. There is no obvious advantage to the plant from this interaction, thus no mutualistic association, as observed with the pitcher-inquiline community, which assists in decomposition and release of nutrients to the plant. By intercepting nutrition that would normally be routed to the plant and inquiline community, spring peepers may function as parasites; however, only a small fraction of insects attracted to the extra-floral nectaries become entrapped in the pitcher (Newell and Nastase 1998). Parasitism is a minor interaction because of the low incidence of peepers in pitchers. Peepers may function as commensals by harvesting insects attracted to the pitcher.

Spring peepers forage for insect prey mostly during the day (Oplinger 1967), thus exposing these amphibians to potentially desiccating conditions. Peepers avoid desiccation during dry conditions by moving under debris (Wright and Wright 1949). The moist environment of the *Sarracenia* pitcher provides an ideal refuge from desiccation for amphibians. While refuge in the pitcher may appear to be neutral to the plant, the amphibian partially occludes the entrance to the digestion chamber by taking residence in the pitcher, which may affect pitcher trapping ability. Additionally, the frog is in an ideal position to consume trapped insects. This interaction clearly does not benefit the plant. Use of pitchers as a refuge was a rare event (1.3%) at the study site therefore this was not an important intertaxa interaction at this particular location. The importance of this interaction may increase where pitcher plants are less abundant. While use of Northern Pitcher Plants by spring peepers is not beneficial to the plant, it is a rare event. Consumption of amphibians by pitcher plants is an equally rare event (Butler et al. 2006) which could compensate plants for nutrition usurped by spring peepers.

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Body-flip and Immobility Behavior in Regal Horned Lizards: A Gape-limiting Defense Selectively Displayed Toward One of Two Snake Predators

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In 1937 Howard K. Gloyd led a herpetological expedition to southern Arizona (Gloyd 1937). Film records show a body-flipping reaction, termed "plays dead," of a Regal Horned Lizard (*Phrynosoma solare*) to prodding with a thin stick and subsequent human handling. An adult lizard repeatedly flipped itself onto its back, nine times within 25 s (immediately righted by Gloyd's hand after each flip). We found only one subsequent mention of the behavior in *P. solare*, without functional explanation (Parker 1971).

Death feigning, letisimulation, or tonic immobility, has been considered an antipredator response across invertebrate and vertebrate taxa without clear identification of its adaptive significance (Carpenter and Ferguson 1977; Greene 1994; Honma et al. 2006; Ruxton 2006; Ruxton et al. 2004), although in some predatory fish the use of death feigning appears to be clearly adaptive during aggressive mimicry (Tobler 2005). Many hypotheses offered to explain immobility responses of prey tacitly assume that prey manipulate predators by sending false information that they are dead and that this information interrupts prey-subjugation behaviors, thus providing opportunities for prey escape (Honma et al. 2006; Ruxton 2006). Honma et al. (2006) proposed that an inducible death-feigning response of a pygmy grasshopper (*Criotettix japonicus*) is a specific antipredator response against a gape-limited anuran predator to avoid being swallowed. The grasshopper's characteristic rigid posture, with body parts physically extended, interferes with prey manipulation and does not mimic death, but directly enhances prey survival.

In the case of *P. solare*, it is difficult to identify an evolutionarily adaptive advantage to body-flipping and re-flipping, to upside-down, by an immobile, death-feigning, animal. This leaves the behavior lacking a clear biological explanation. Our study attempts to place body-flipping and immobility behavior by *P. solare* in the context of adaptive antipredator behaviors that are effective resistance against specific predators that rely on jaw capture of prey which they ingest whole, such as a non-venomous snake.

We report several additional encounters (rare) of body-flipping behavior in *P. solare* in response to human handling. We then describe field trials aimed at elicitation of the body-flipping and immobility response or alternative responses (such as running flight) in specific predator-context encounters involving two snakes, one non-venomous (*Masticophis flagellum*) and one venomous (*Crotalus atrox*). The two snakes present the lizards with two different threats based on their prey-subjugation strategies (Endler 1991; Sherbrooke 2008), 1) *M. flagellum*: search/wait, identify, rapidly pursue, physically jaw-capture, subjugate, and ingest, and 2) *C. atrox*: wait, identify, envenomate (strike), track, and ingest carcass. We use our observations to propose that the lizards distinguish between two categories of predator threat, the two snakes, and respond to each with distinctive antipredator behaviors (flipping or running) that appear appropriate for selectively enhancing survival in response to each predator's subjugation skills. We also use the differences in responses of *P. solare* to the two snakes to propose a hypothesis for the previously unexplained body-flipping and immobility behavior, noting the predator contexts in which it is employed and not employed, and we discuss aspects of body-flipping and immobility that may function as antipredation defenses with *M. flagellum*.

Methods

Carpenter and Ferguson (1977) reviewed literature reports and numerically catalogued lizard behaviors (termed "act systems") involving body inversion (act system #26, turn over) and letisimulation (act system #150) in various lineages of lepidosaurians. Similarly, Greene (1994) enumerated several categories of antipredator behaviors (#3, catalepsy, letisimulation, death feigning, tonic immobility; #22, invert body). It is difficult to unequivocally assign our observations to a particular category due to the paucity of examples, diversity of descriptions, and frequent lack of meaningful context for the reported behaviors. We simply use descriptive terms, body-flip and immobility behavior. In a body-flip followed by immobility a lizard rapidly raises one side (by extending its legs on that side) to effect a role over along its nose-to-vent axis, landing upside down where it remains motionless (see Figs. 1 and 2).

Following an observation of repeated body-flipping and immobility of a captive *P. solare* in response to human handling (Fig. 1, A–C; 30 June 2006), we reviewed our field notes and summarized additional records of this behavior.

We then studied the behavioral responses of adult *P. solare* during field trials utilizing a known ophidian predator of *P. solare*, the Coachwhip (*M. flagellum*) (Kauffeld 1957), that also preys on other similarly-armored horned lizards (Sherbrooke 1981). The individual *M. flagellum* (SVL 128 cm, tail length [TL] 47 cm; mass 787 g) utilized had previously been observed to capture and eat a *P. solare* (SVL 88 mm, TL 48 mm; mass 36.4 g) on the study area (May, unpubl. data). Our trials involved four *P. solare* fitted with radio-transmitters (Holohil PD-2; approximately 3 g), which were relocated in the field, and six lizards encountered in situ while traversing the study area. Fourteen trials, involving 52 encounters (presentations), occurred between 26 August and 2 September 2006 (Table 1): 0930–1200 h MST (12), and 1730–1900 h MST (2). The study area is immediately adjacent, on the west and northwest sides, to a small volcanic hill in the Altar Valley, Pima Co., Arizona (32°02'11.5"N, 111°23'46.6"W, datum WGS 384).

During trial encounters, the *M. flagellum* was restrained in gloved hands at mid-body, allowing the anterior third or more to move freely as it was held to the ground approximately 1 m from the lizards. It was then allowed/encouraged to approach and contact each lizard (Fig. 2, A). During each trial, an attempt was made to expose the lizard four times to the snake. Contact by the snake

TABLE 1. Summary of behaviors exhibited by ten Regal Horned Lizards (*Phrynosoma solare*) in response to approach of a Coachwhip (*Masticophis flagellum*) in 14 trials involving 52 staged encounters (usually 4/trial). For runs, specific encounter numbers (1–4) are identified. Encounter data are summarized, including number of tilts/trial and the distance (estimated ranges in dm; distance data not complete for lizards #3 26 August, and # 7) of the snake when initiated, occurrence of horn raising by the lizard, and number of encounters in which the snake effected tactile contact, or not, with the lizard. In addition, for encounters of each trial, the mean time and range of the lizard remaining in a flipped position for encounters of each trial are presented.

Lizard # Trial — Date	Sex	SVL (mm)	Lizard body-flip encounters /trial	Lizard run encounters /trial, (#)	Tilt #/s distance (range, dm)	Horns raised (+ / –)	Snake contact (+ / –)	Flip mean/range (s)
1— 26 Aug	F	96	0	1 (1st)	0/—	0/1	0/1	
1— 2 Sept			4	0	4/1–2	0/4	3/1	52/11–106
2— 26 Aug	F	95	4	0	4/3–4	4/0	4/0	33/23–42
2— 2 Sept			4	0	4/0.5–2	0/4	3/1	92/43–123
3— 26 Aug	F	100	4	0	4/3	2/2	4/0	21/15–39
3— 2 Sept			4	0	4/0.5–1	1/3	3/1	36/19–49
4— 26 Aug	M	88	4	0	4/3–4	4/0	3/1	48/35–71
4— 2 Sept			2	1 (3rd)	3/3–4	0/3	2/1	6.5/5–8
5— 28 Aug	F	91	4	0	4/2–5	3/1	4/0	17/6–28
6— 27 Aug	F	109	3	1 (2nd)	4/2–5	3/1	3/1	28/6–51
7— 26 Aug	M	89	4	0	4/0.5–7	1/3	3/1	14/3–19
8— 26 Aug	M	82	4	0	4/2–3	4/0	4/0	21/3–41
9— 31 Aug	M	93	4	0	4/1–5	2/2	4/0	32/12–60
10— 1 Sept	F	97	3	1 (4th)	4/1–3	0/4	3/1	4/2–7
Totals	14		48	4	51/0.5–7	24/28	43/9	*n* = 46

(present +, or absent –) prior to a lizard response (body-flip or run) was noted. Following a lizard response, the snake was withdrawn and hidden from view behind the experimenter. A subsequent encounter was initiated within about 1 min of the lizard's righting itself. Reactions of the lizards were noted: distance at which body tilting (dorso-ventral flattening of the abdomen while raising one side and lowering the opposite side, as in "dorsal shield;" Sherbrooke 2008) toward the snake occurred, body-flipping, time lizards spent resting on dorsum following flipping before self-righting, eyelids (opened or closed), eyelid bulging (present or absent), horns raised (executed +, or not – ; Sherbrooke 1987), color change (effected or not, and resulting color), running escape (if employed, distance). For each trial, a range of the four encounters is given for the distance at which the lizard began exhibiting tilt behavior (except in trials with fewer encounters, Table 1).

On 14 September 2006 we studied, in a similar fashion (Table 2) and at the same field site noted above, the behavioral responses of adult *P. solare* to a known venomous ophidian predator, the Western Diamond-backed Rattlesnake (*C. atrox*) (Vorhies 1948), which also preys on other horned lizards (Sherbrooke 2003, unpubl. data). The snake was collected west of the Tucson Mountains, Avra Valley, Pima Co. Tucson, Arizona (32°11'09.5"N, 111°05'58.9"W). The snake (SVL 82 cm, TL 8 cm; mass 385 g) was placed in a 46 cm long clear plastic tube of 3.5 cm diameter. The snake's head and fore-body extended 15 cm from one end of the tube (Fig. 2C), and the tail extended from the opposite end. The apparatus, with snake, was hand held at the tube base where the posterior extending portion of the snake was duct-taped to the tube rim to ensure a grip of adherence to the snake's body scales without undue constriction, thus preventing forward movement in the tube. The tubed snake, safely and not aggressively restricted in its movements, was held with its head extended during encounters.

Trial encounters were conducted between 0900–1100 h MST, with five lizards (including the four radiotagged lizards) having had previous encounters with *M. flagellum*. The other three lizards (#s 1, 2, 7) had no previous experimental contact with snakes. The radiotagged lizards were located and tested where found in the field. The other four lizards had previously been captured and briefly maintained (3–8 days) in outdoor enclosures (fed and watered) before release back at their field capture sites, where they were subjected to our trial encounters.

The eight lizards were exposed to *C. atrox* in a total of 24 encounters (presentations), which varied between two and six depending on the outcome of encounters. Similar to the *Masticophis* encounters, the rattlesnake's fore-body was placed on the ground near the lizard and moved toward the lizard until it was within attack distance. The anterior portion of the snake extending from the tube moved freely as the snake explored its surroundings. Lizards that ran were followed and the snake was again presented to the lizard, usually within a minute of it having stopped.

RESULTS

Body-flip responses to human stimuli.—Incidental to other studies that involved capture of hundreds of *P. solare* over the years

TABLE 2. Summary of running (including distances run in m) and body-flipping behaviors exhibited by eight Regal Horned Lizards (*Phrynosoma solare*) in response to 24 encounters with a Western Diamond-backed Rattlesnake (*Crotalus atrox*). The number of encounters of a trial in which body tilting, horn raising, and snake contact with the lizard occurred are noted.

Lizard #	Sex	SVL (mm)	# encounters	Lizard run encounters #, distance (m)	Lizard body-flip encounters #	Tilt #	Horns raised (+)	Snake contact (+)
1	M	89	6	4 (1–2)	0	0	0	2
2	M	93	3	0	0	3	3	3
3	F	96	2	2 (0.5)	0	0	0	0
4	F	100	2	2 (1–2)	0	0	0	0
5	F	91	2	2 (1–4)	0	2	0	0
6	F	95	2	2 (1–4)	0	0	0	0
7	F	92	3	3 (1–2)	0	0	0	0
8	M	88	4	0	4	3	0	2
totals			24	15	4	8	3	7

1976–2006 in Pima Co., Arizona, we observed and recorded eight instances of body flipping and immobility (5 females, 3 males; SVLs 29, 48, 62, 69, 91 mm, and 61, 91, 96 mm, respectively) in response to human prodding or handling during the months of April (1), June (4), July (2), and September (1); we estimate this was < 1% of captures. All eight lizards repeated flipping of the body in response to being righted (6, 9, 11, and 10–15 times; and four lizards flipped numerous uncounted times), thus repeatedly exposing the lizard's solid-white or white with small black/gray-dots ventral surface, with all legs extended to the sides, tail down on substratum, and the lizard lying on its back (Fig. 1, A–C). Each body flip was accomplished quickly enough so that it was difficult for the human eye/brain to follow the motion (although captured on film, 1/250 s exposure). Lizards remained on their backs for several seconds to many minutes before righting themselves between flips. Four of these lizards had been previously or were subsequently captured without exhibiting body-flipping behavior.

Predator-prey trial encounters with *Phrynosoma solare* and *Masticophis flagellum*.—Of 52 total encounters with *M. flagellum*, 48 (92%) resulted in the lizard doing a body-flip (Fig. 2, A, B) and four (8%) resulted in a run, without a body-flip. All lizards that exhibited a body-flip initially showed some form of body tilting toward the approaching snake, as did three of the four lizards that ran. The snake's distance from the lizard at which this reaction by the lizard was initiated was usually 20–50 cm (Table 1). The raising of horns and lowering of rostral nose/chin areas was seen in approximately half of the encounters (24 of 52; Table 1), but not in the lizards that ran. In the raising of horns response, individual lizards showed variation within a trial from encounter to encounter (Table 1), and individual lizards changed the predominance of their reactions (+ or –) from one trial to another (lizard #s 2–4; Table 1). The snake made contact with the lizard in 43 of 52 encounters; of the nine encounters in which contact by the snake was absent, four resulted in lizard runs and five in body-flips. Most lizard body-flips (90%) were associated with a tactile stimulus by the snake. No runs were initiated by contact with the snake. Of 46 body-flips for which the duration of time spent on its back before the lizard righted itself was recorded, the mean time spent inverted was 34 s, range 2–123 s; encounter data were only recorded twice for lizard # 4 (2 September) and lizard # 6, and were only recorded three times for lizards # 7 and # 10. All body inversions (lateral rollovers) to return to standing posture were executed in a slower and more deliberate fashion than the original instantaneous body-flip, but still quickly. These were accomplished in the visual absence of the snake, in the presence of the experimenter, and with the lizard's eyelids open. In four cases of body-flipping behavior, the time the lizard remained inverted during a flip was not recorded (Table 1). Four encounters in two trials were omitted due to running escapes (lizard # 1 ran down a rodent hole on 26 August, and lizard # 4 ran 41 m, terminating the encounter trials, on 2 September); this reduced total encounters from 56 to 52 (Table 1). With the four radiotagged lizards (#s 1–4), trials of four encounters each were repeated twice, a week apart; all are reported together (Table 1).

During the trial encounters, no lizard exhibited eyelid swelling, engorging the circumorbital sinuses with blood (associated with canid defense; Middendorf and Sherbrooke 1992). In addition, lizards were noted to have their eyelids closed during body-flipping and initial resting upside down, but then to open their eyelids prior to rolling back onto their ventral side. And, frequently, but not always, lizards appeared to exhibit a change in color, usually becoming lighter and more yellow during the predator encounters. No tongue extrusions, that might have enhanced taste or vomeronasal exploration, were seen before or after body-flipping. The snake did not bite any lizard during the trials.

Predator-prey trial encounters with *Phrynosoma solare* and *Crotalus atrox*.—In responses during the 24 encounters with *C. atrox*, the eight lizards ran 15 times (62%), body-flipped four times (17%), and failed to respond five times (21%). Five lizards (#s 3–7; 63%) executed runs in all of their encounters (11), and one lizard (12.5%) ran in four of six encounters. Two lizards (25%) failed to run in any encounter; one was previously exposed to a snake (# 8) and one was not (# 2), and one was radiotagged and one was not. Only one lizard (12.5%) executed body-flips in all four of its encounters. In contrast to other lizards, this radiotagged lizard was found in heavy grass cover under a shrub. Time spent inverted was recorded for two encounters (103 s, 71 s). No changes in lizard color were noted.

Of the three lizards that executed body tilting, one ran, and one raised horns. Body contact by the snake was made with three lizards in non-running encounters. One lizard (#2) was struck and fatally envenomated by the rattlesnake during its third encounter (Sherbrooke and May 2008).

Comparison of *Phrynosoma solare* responses to two snake predators.—Some of the responses of *P. solare* to *M. flagellum* and to *C. atrox* appear to be distinct, in spite of the fact that slightly different designs of the two snake trials do not always provide directly comparative sets of data (Tables 1 and 2; see Discussion). These differences in responses of lizards are seen in the predominance of body-flipping/immobility (48 of 52; 92%) over running (4 of 52; 8%) responses to *M. flagellum* encounters and in the predominance of running (15 of 24; 62%) over body-flipping/immobility (4 of 24; 17%) responses to *C. atrox* encounters (no response, 5 of 24; 21%). Considering only the first encounter response of each lizard (omitting non-responses to *C. atrox*) to the two predator threats (to *M. flagellum* 9 body-flips, 1 run; to *C. atrox* 1 body flip, 6 runs), the lizards' reactions again suggest that *M. flagellum* is more likely to elicit body-flipping than *C. atrox*, which is more likely to elicit running that *M. flagellum*. Also, there appear to be differences in other responses of *P. solare* during each encounter with *M. flagellum* and *C. atrox* (Tables 1 and 2).

Discussion

The differences in defensive body-flipping and running escape reactions exhibited by *P. solare* to *M. flagellum* and *C. atrox* appear to be clear, with some possible errors in animal judgment (potentially influenced in one case with *C. atrox* by obscuring vegetation); *P. solare* tends to body-flip to *M. flagellum* and run from *C. atrox*. The other defense responses (Tables 1 and 2; tilt and horns raised) also suggest a greater tendency to run from *C. atrox*, and stand in place to *M. flagellum*. These data suggest that *P. solare* are able to differentiate between these two predatory snakes, as are *P. cornutum* (Sherbrooke 2008). Similarly, female skinks *Mabuya longicaudata* at their nests have been shown to respond with flight from a lizard-eating snake *Elaphe carinata*, and with nest defense against an intruding snake that is an egg-predator, *Oligodon formosanus* (Huang 2006).

Statistical tests were not run on comparisons of the body-flip versus run responses of *P. solare* to *M. flagellum* and *C. atrox* (first responses 9:1 and 1:6, respectively) due to a number of issues, including low number of experimental animals, involvement of some lizards in more than one encounter or trial, differences in pretrial treatment of lizards (radiotagged or not, field encountered or not), differences in methods of restraining snakes, and diversity of conditions at individual field sites. Nevertheless, we feel that the distinctly different responses of the lizards to the two forms of predatory snakes represent real differences in categorization of predators by the lizards during the execution of antipredator tactics exhibited in body-flipping and immobility, and in running flight. Supporting this view, we note that similar and statistically supported response differences were seen under controlled trials in non-field conditions with the same two predatory snakes and *P. cornutum* (Sherbrooke 2008).

The ten rare instances of body-flipping and immobility behavior in response to human handling (< 1%; versus 92 % to *M. flagellum*) that we recorded may be cases of prey error in categorization of predator threat. These responses to humans might be similar to blood squirting at humans in *P. solare*, which occurs in only 4.6% of encounters (Parker 1971), whereas with dogs it occurs in 60% of encounters (Sherbrooke and Middendorf 2001); in *P. cornutum* it occurs in 5.9% of human encounters, 70–100% of

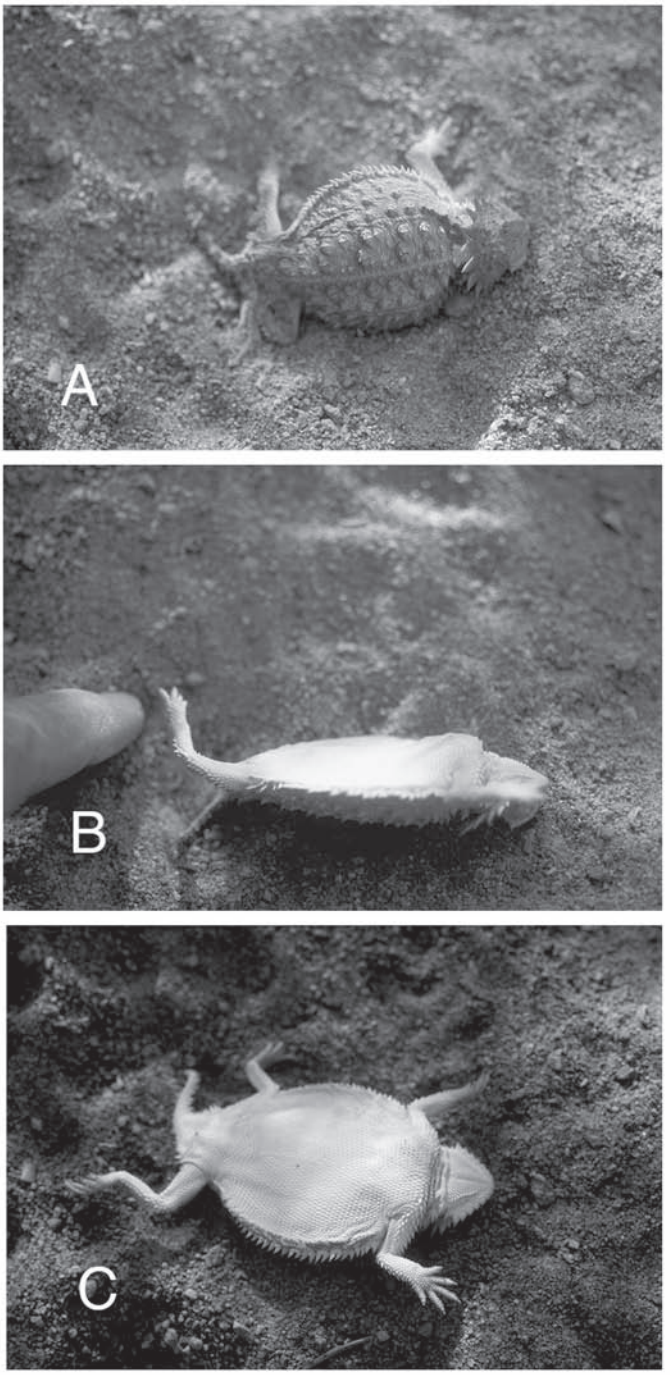


Fig. 1. Adult female (SVL 69 mm) Regal Horned Lizard (*Phrynosoma solare*) exhibiting body-flipping behaviors on 30 June 2006 in response to human handling and righting of body orientation. A) initial upward-thrust of one side in body-flipping. B) mid-flip position (immediately following tactile stimulation by a human finger, left); note closed eyelids. C) inverted posture held following flip, illustrating wide and white ventral surface (not inflated), spread legs, and tail depressed toward substratum. Eyelids were closed.

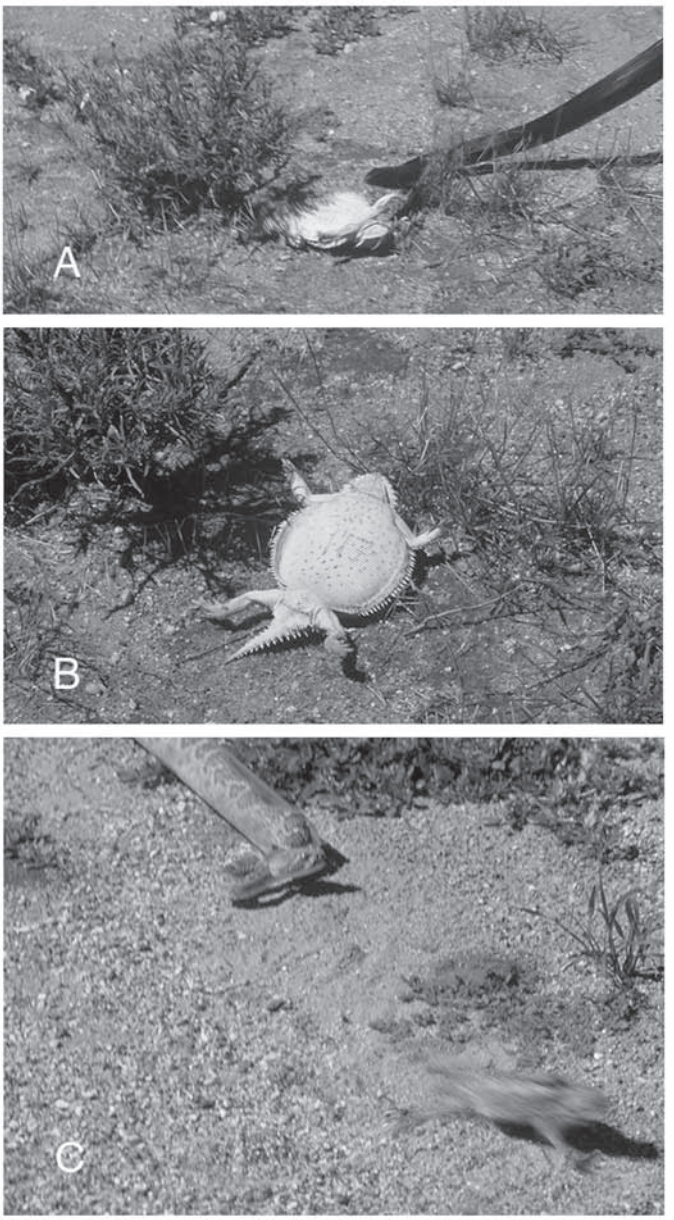


FIG. 2. Responses of adult Regal Horned Lizards (*Phrynosoma solare*) to presentation of encounters with ophidian predators. A) body-flip response to an approaching Coachwhip (*Masticophis flagellum*). B) continued holding of a body-flip response to a *M. flagellum* following retraction and hiding of the snake. C) running response (lower right) to a tubed Western Diamond-backed Rattlesnake (*Crotalus atrox*) (upper left/center).

dog encounters, and 75% of encounters with a native canid (Sherbrooke and Middendorf 2001, 2004). Assuming humans were not a selective force in the evolution of blood squirting (nor in the evolution of body-flipping/immobility behavior in *P. solare*), these significant differences in frequency of horned lizards employing antipredator defenses at humans versus at predators suggest that humans present confounding stimuli that may sometimes erroneously elicit defensive behaviors evolved as defenses against other categories of organisms.

Ingestion of horned lizards by gape-limited predators such as snakes involves significant risk of death to the predator (Holte and Houck 2000; Sherbrooke 1981, 2003; Vorhies 1948). Because of this, features of the *P. solare* body-flip and immobility display may inhibit the likelihood of further attack, depending on the relative size of the snake and the lizard, the experience of the snake, and the snake's level of hunger (Aubret et al. 2007). And, if a snake initiates an attack, the flipped and immobile lizard is in a position for maintaining a stance that maximizes the effectiveness of its physical defenses against such a predator. Rattlesnakes possess similar size-related ingestion limitations as do whipsnakes, but envenomation may reduce some features of resistance to capture and ingestion, such as leg rigidity, but not others, such as horn erection (Sherbrooke and May 2008). A body-flip and immobile response offers little defense against envenomation by a rattlesnake, but a running response distances the lizard from a strike by this predator that does not rapidly pursue fleeing prey.

Phrynosoma solare responses to *M. flagellum* were initiated at a distance of 5–70 cm, suggesting a visual identification of the predator as a precursor to subsequent reactions. Tilting was the most common response (98%). This was followed by body-flipping (92%) and horn raising (54%). We suggest that following visual identification of predator type (as non-venomous rather than venomous; breadth and characteristics of these predator categories have not yet been determined), the lizard adjusts its body defensively with a tilting of its dorsal surface toward the predator, with a raising of the horns in many cases, and then, or even before these reactions, it executes a body-flip.

Once body-flipping behavior has instantaneously inverted a *P. solare*, still located at the site of its encounter with a *M. flagellum*, its appearance has been visually altered. This may startle (Edmund 1974; Ruxton et al. 2004) a non-venomous snake enough to prevent an immediate jaw-grasping attack. During body-flipping the lizard's cryptically-colored and disruptively-patterned dorsal surface (visually fragmented) is replaced by a nearly pure white (sometimes with small gray spots; Fig. 2, B) ventral surface. This surface is broadly oval with a row of lateral fringe scales (jagged in appearance) along each side of the abdomen, four laterally-splayed limbs, and an extended tail. This suddenly appearing new vision may advertise to the snake that its potential prey possesses a broad dimension and extended sharp structures, which present potential difficulties for ingestion (Inbar and Lev-Yadun 2005; Speed and Ruxton 2005). The wide-taxonomic occurrence of uniformly-white ventral surfaces in iguanid lizards suggests that this character is plesiomorphic in the clade. Therefore the uniform-white color of ventral surfaces exposed during body-flip/immobility displays of *P. solare* may have evolved as an exaptation.

If body-flip and immobility displays do not successfully thwart subjugation and consumption by a relatively large *M. flagellum*, it may be unlikely that an attempted running escape would enhance survival. Limb length is short and sprint speed is low in *Phrynosoma* (Bonine and Garland 1999; Pianka and Parker 1975), virtually assuring capture by a pursuing *M. flagellum*. Fleeing prey often elicit chase and capture responses by predators (Cyr 1972), and running horned lizards 1) may not easily visually monitor the movements of a pursuing snake, 2) may provide a horizontally-flattened target for the vertically-grasping jaws of whipsnakes (Sherbrooke 2008), and 3) may be unable to display their morphological features that are threats to whole-prey ingestion.

The best defense of a *P. solare* against a *M. flagellum* appears to be remaining stationary (flipped and immobile), thus visually in-

timidating its adversary with potentially life-threatening defenses (horns), broad-body/appendage circumference and pseudo-defenses (pointed lateral-fringe scales). Unlike the "dorsal shield" response of *P. cornutum* to *Masticophis* spp. (Sherbrooke 2008), the body-flipping response of *P. solare*, once assumed, does not allow continuous adjustments of defensive positioning by the inverted lizard. Nevertheless, we noted increased rigidity of limbs and further raising of horns, possible antipredator adjustments, during our simulations of snake biting by pinching (dorso-ventrally) the edge of inverted lizards' bodies (unpubl. data, Sherbrooke and May). As a defense against ingestion by gape-limited snakes, body-flipping and immobility in *P. solare* resembles defenses in some anguid and cordylid lizards. When threatened by colubrid snakes, they effect body conformation changes by grasping their tail in their jaws to create a broad circular body form that is difficult or impossible for snakes to ingest (Arnold 1993; Fitch 1935; Mouton et al. 1999).

The apparent visual monitoring for the continued presence of *M. flagellum* by the lizards (by opening their eyelids), and the short duration of the time lizards spent resting in an inverted position once the snake was removed (usually < 1 min) suggests that the lizards, once flipped, remained open to subsequent running escapes from the snake encounter site. The duration of immobility may be influenced by access to escape routes and absence of predator threat (Burghardt and Greene 1988; Hennig et al 1976; O'Brien and Dunlap 1975). Repeated body-flips by *P. solare* during multiple-interrupted encounters of the trials (Table 1) illustrate the significance of the presence or absence of the predator threat to the lizard assuming the flipped and immobile posture.

In contrast to *M. flagellum*, *C. atrox* do not rapidly pursue prey, but strike nearby prey with a venomous injection from their fangs, from which a horned lizard has no chance of survival (Sherbrooke 2008; Sherbrooke and May 2008). Prevention of envenomation may be best accomplished by avoidance, which *P. solare* accomplishes by running to quickly remove itself from the vicinity of *C. atrox*. *Crotalus atrox* is unlikely to pursue an unenvenomated lizard. In contrast to this appropriate escape behavior, assumption of a body-flip and immobility stance by *P. solare* to a *C. atrox* threat would only facilitate prey capture and subjugation (envenomation). Thus, in response to two predator threats, *P. solare* appears to identify the category of snake predator involved and responds to each with a distinct defensive behavior that may enhance its potential for survival in each of two distinctly-different predation scenarios, non-venomous and venomous snakes.

We consider body-flipping behavior by *P. solare* to be an adaptive survival response involving honest presentation and amplification (Taylor et al. 2000) of prey resistance abilities to subjugation and consumption by a gape-limited predator. This is in contrast to the death-feigning hypothesis (untested) that prey death-feigning (tonic immobility, etc.) might have intrinsic survival value, without a clear explanation of how it functions in enhancing prey survival (Honma et al. 2006; Ruxton 2006; Ruxton et al. 2004). Although we see no support from our study for the death-feigning hypothesis, we note that the two hypotheses are not mutually exclusive: both display of features of morphological resistance and immobility per se may contribute to prey survival.

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Predation on Caecilians (*Caecilia orientalis*) by Barred Hawks (*Leucopternis princeps*) Depends on Rainfall

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Caecilians are limbless, subterranean or aquatic amphibians found throughout much of the tropics (Duellman and Trueb 1994; Himstedt 1996). Although amphibians are declining dramatically (Stuart et al. 2004), the conservation status of caecilians is largely unknown due to lack of information on their ecology and natural history (Gower and Wilkinson 2005). A handful of studies have documented caecilian life histories (e.g., Funk et al. 2004; Gans 1961; Kupfer et al. 2005; Malonza and Measey 2005; Parker 1936, 1958; Sanderson 1937; Sarasin and Sarasin 1887–1890; Taylor 1968; Wake 1980). Nevertheless, 114 out of 172 species (66%) of caecilians remain too poorly known for an accurate status assessment, and thus are listed as "Data Deficient" by the IUCN (2006). Perhaps because of their elusive nature, there is an increasing interest in the biology of caecilians (Kupfer et al. 2006; Measey and Herrel 2006).

Predator-prey interactions are widely recognized to have important effects on population dynamics (e.g., Krebs et al. 1995; Lotka 1925; Volterra 1926), but in the case of caecilians, little is even known about which taxa act as predators. Snakes are considered the main predators of caecilians (Duellman and Trueb 1994; Kupfer et al. 2003), although some other predators such as turtles (Zamprogno and Zamprogno 1998), spiders (Boistel and Pauwels 2002), and ants (Measey 2004) have been documented preying on caecilians. Identifying predators of amphibians is important in the context of amphibian declines, because predation may tip already declining populations over the edge toward extinction (Corn 1993; Parker et al. 2000). Here we show that a tropical hawk acts as an important predator of the caecilian *Caecilia orientalis* and that this unexpected ecological interaction depends strongly on weather.

Methods.—We filmed a Barred Hawk (*Leucopternis princeps*) nest using a hidden camera from 15 February–8 May 2004 and 7–28 January 2005 for a total of 599 h in the private reserve of Cabañas San Isidro, next to Yanayacu Biological Station (00°35'S, 77°53'W; 1950 m elev.). During most days of filming, the nest was filmed continuously during daylight hours (from morning to evening) when the hawks were active. The Barred Hawk is a rare, large hawk (total length = 52–61 cm) found from northern Peru to Costa Rica (700–2200 m; Ridgely and Greenfield 2001). The 1700 ha reserve comprises a mosaic of primary and secondary growth in humid, montane, evergreen forest about 3 km W of the town of Cosanga in the Napo Province of northeastern Ecuador (for a more complete site description, see Greeney et al. 2006).

Each year, the same Barred Hawk pair raised a single chick in the same nest. The nest was located on a rocky ledge 5 m from a rushing waterfall. The blind was installed 3.5 m above and 10 m from the nest, on the opposite side of a stream. All videos were transcribed at a later date. In addition to recording prey brought to the nest, we recorded whether it rained during each hour-long time interval. Since video quality was excellent, most taxa were clearly identifiable, but seven unknown taxa were excluded from the analysis. Because caecilians surface primarily during heavy rains and snakes are active at Yanayacu when it is clear and sunny, we hypothesized that Barred Hawks would bring more caecilians to the nest, but fewer snakes, when it was raining. We tested this in 2004 using a Fisher's exact test. This was the second Barred Hawk nest ever documented (Muela and Valdez 2003) and the first closely monitored to document feeding behavior. Details of the breeding ecology of these Barred Hawks are being prepared separately for an ornithological journal (R. A. Gelis and H. F. Greeney, unpubl. ms.).

Results.—To our surprise, a caecilian species (*Caecilia orientalis*) was the main prey item brought to the nest by two Barred Hawk parents to feed a single chick brooded each year (Fig. 1; videos available upon request). *Caecilia orientalis* is a large caecilian (total length = 31–62.5 cm) found in the Andes of Ecuador and Colombia and is the only caecilian known from this site (Funk et al. 2004; IUCN 2006). Prey items delivered to nestlings included 50 caecilians (48.1% of diet), 36 snakes (34.6%; *Atractus occipitoalbus* and two unidentified colubrid species), five giant

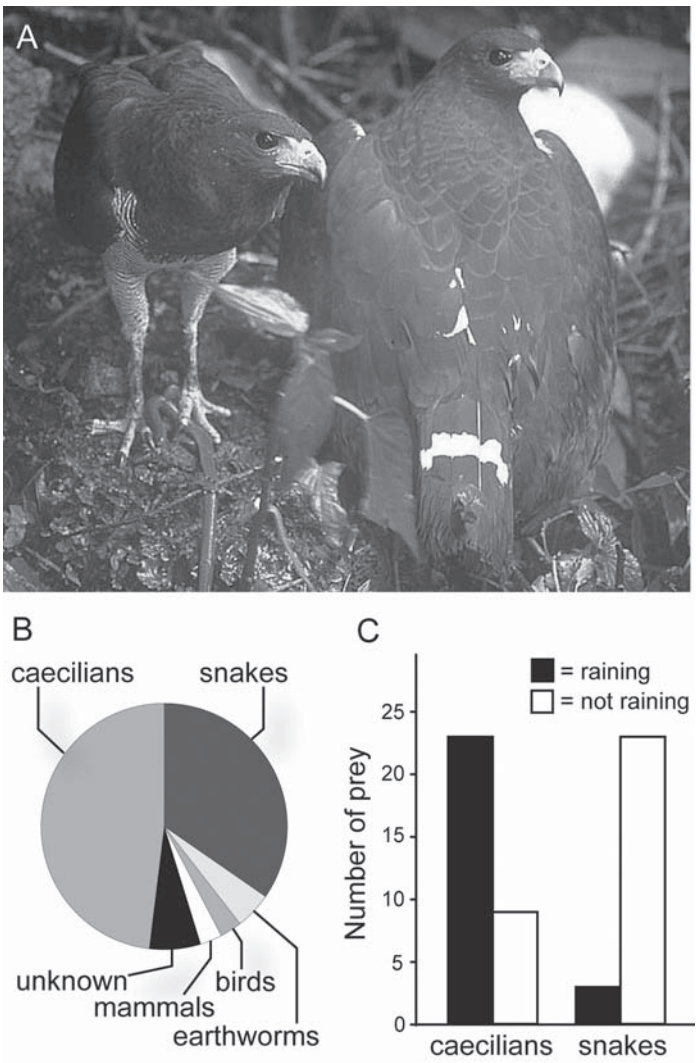


FIG. 1. (A) Barred Hawk (*Leucopternis princeps*) with caecilian (*Caecilia orientalis*) in talons (left). The white chick is seen in background (upper right). A color version of this photo is available upon request. (B) Proportion of Barred Hawk diet in 2004 and 2005 composed of different taxa. (C) Barred Hawks bring significantly more caecilians than snakes to the nest when it is raining ($P < 0.00001$, N = 58).

earthworms (4.8%), three young birds (2.9%), three small mammals (2.9%), and seven unknown animals (6.7%) (Fig. 1B). *Caecilia orientalis* vouchers from this site are available in the Museo de Zoología at the Pontificia Universidad Católica del Ecuador (QCAZ 21417–21419).

As predicted, we found that Barred Hawks brought significantly more caecilians than snakes to the nest during hour-long time intervals when it was raining (Fisher's exact test, $P < 0.00001$, N = 58; Fig. 1C).

Discussion.—It is surprising that an aerial predator, the Barred Hawk, was able to find subterranean prey such as caecilians. A previous report states that birds may occasionally prey on caecilians (Wake 1983), but this report did not provide specific bird species names or details of this predator-prey interaction. During several years of research at Yanayacu, caecilians were rarely encountered on the surface in the day even when it was raining (Funk et al. 2004). Thus it is unknown how Barred Hawks are able to consistently find these elusive amphibians. These results suggest that *Caecilia orientalis* may actually be fairly common, as has been found for some other caecilian species (Measey 2004), yet *C. orientalis* is reported as "uncommon in Ecuador" by the Global Amphibian Assessment (IUCN 2006). Because of the rarity and huge ranges of Barred Hawks, we were only able to find and intensively monitor one pair over two years. It will likely take several years of intensive searching to find additional Barred Hawk nests. Nonetheless, the dominance of caecilians in this pair's diet and consistent use of these amphibians over two years suggests that caecilian predation by Barred Hawks will likely be widespread at sites with abundant caecilian populations.

Rainfall has increased at some sites in Ecuador over the last 40 years (Haylock et al. 2006), although rainfall trends at Yanayacu are unknown. If predation on caecilians is typical for Barred Hawks, changes in rainfall could alter this predator-prey interaction and potentially impact populations of both species. Climate change has already been implicated in amphibian declines in Ecuador and elsewhere in the Neotropics (Blaustein and Dobson 2006; Pounds et al. 2006). Predicting the ecological impacts of climate change, however, will require a better understanding of trophic interactions and the influence of weather on these interactions as documented here.

Determining the effect of predators on caecilian populations will also require a much better understanding of caecilian population dynamics. Studying the population ecology of these fossorial amphibians has proven difficult in the past due to low detectability, a paucity of methods for individually marking caecilians, and the rareness of some caecilians species. However, at Yanayacu Biological Station and some other sites (Bustamante 2005; Measey 2004; Péfaur et al. 1987), caecilians can be abundant and thus potentially amenable to study. New methods have also recently been developed for marking caecilians for capture-recapture estimation of vital rates and demographic parameters (Gower et al. 2006; Measey et al. 2001, 2003). Use of these methods in combination with population modeling (Biek et al. 2002) and molecular genetic markers (Beebee 2005; Funk et al. 2005) should help illuminate the demography, ecology, and conservation status of these fascinating animals.

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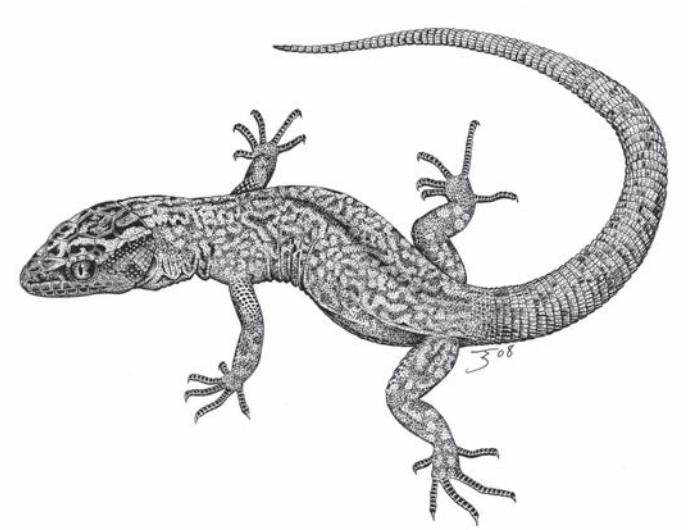
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Xantusia sierrae (Sierra Night Lizard): USA: California: Kern Co., foothills of Greenhorn Mountains. Illustration by Jackson Shedd.

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Ecology and Behavior of *Polypedates leucomystax* (Anura: Rhacophoridae) in Northeast Thailand

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Polypedates leucomystax (Rhacophoridae) is among the most common of the nearly 800 species of anurans in southeast Asia (Iskandar and Colijn 2000), and among the most widespread, ranging from southern China south to Indonesia, and from India to the Philippines. Compared to most anurans of tropical southeast Asia, there are several reports on its habitat (Garcia-Rutledge and Narins 2001; Inger and Steubing 1997; Malkmus et al. 2002; Narins et al. 1998), calls (e.g., Christensen-Dalsgaard et al. 2002; Sheridan 2008) and reproductive habits (Feng and Narins 1991; Malkmus et al. 2002; Yorke 1983). Despite this, relatively little is known of its population size, sex ratio, and variation in reproduction. In this paper, I present a detailed study of reproduction (clutch size and variation therein), time to metamorphosis, adult body size, and male site fidelity at a seasonal site (Sakaerat, Thailand) to allow for an evaluation of variation in these traits across the broad range of *P. leucomystax*. My observations permit the exploration of the adaptations seen in other tropical anurans that range from aseasonal to seasonal environments.

Polypedates leucomystax is a medium-sized tree frog (male SVL 37–64 mm, female SVL 57–89 mm) common in disturbed areas. It breeds in standing water such as natural ponds, cattle tanks, cisterns, and flower pots. Males form calling groups around standing water and females create foam nests above water in emergent vegetation or other suitable substrate (e.g., cistern wall). In some cases, multiple males will clasp a single female during a given breeding event (Feng and Narins 1991; pers. obs.). In Singapore, eggs have been found in January, February, April, August, and September, and females had enlarged oviducts in all months in which they were captured (all months except May, July, and November, Berry 1964). Zeller (1960) reported that they can breed throughout the year but are inhibited by dry conditions in western Java. Yorke (1983) noted that near Kuala Lumpur, Malaysia, the females deposit 100–400 eggs in foam masses measuring about 10 cm in length on vegetation above ephemeral ponds. In Sabah, Malaysia, Malkmus et al. (2002) found larger clutch sizes, 150–900 eggs. Time to metamorphosis was reported as 4 weeks at Sakaerat, northeast Thailand (Heyer 1973), and 7 weeks in Kuala Lumpur (Yorke 1983).

Polypedates leucomystax is not a well-defined species and is probably a complex of cryptic sympatric and allopatric taxa. Narins et al. (1998) reported significant differences in calling habits of two genetically distinct sympatric morphotypes of *P. leucomystax* near Kuala Lumpur, but did not propose new nomenclature. Within the Sakaerat, Thailand, population, Sheridan (2008) found no significant differences in calls, and analysis of 500 bp of the 16S gene indicated variation of less than 1%. Thus, all individuals encountered at Sakaerat are likely conspecific, but further studies of call, genetic, and morphological variation are necessary to determine how this population of *P. leucomystax* is related to others.

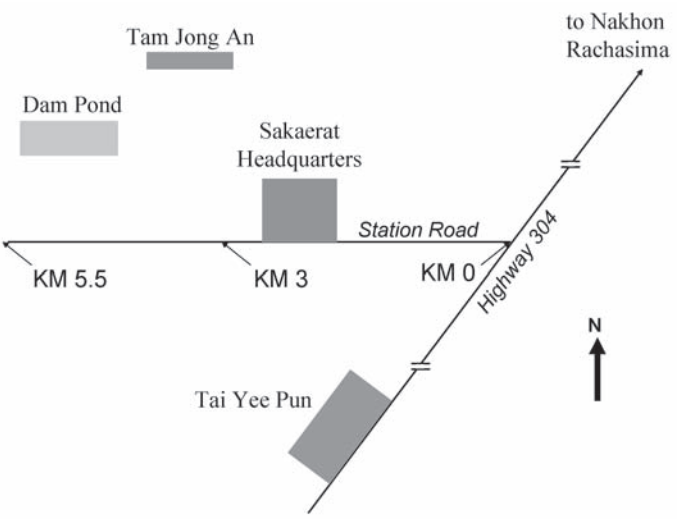


Fig. 1. Schematic diagram of study areas of *Polypedates leucomystax* breeding at Sakaerat, Thailand. Image not to scale. Tai Yee Pun is 7 km south of Sakaerat headquarters.

Methods.—I conducted this study from April to September 2005 (except for call recordings as noted below) at Sakaerat Environmental Research Station (14.5°N, 101.92°E), Thailand. This forested region is 60 km S of Nakhon Ratchasima and 250 km NE of Bangkok on the northeastern slope of the central highlands at the edge of the Korat Plateau. I monitored five areas during the rainy season between 25 April and 4 September 2005. Annual mean rainfall is 1240 mm and there is a marked dry season from November through March. The 78 km^2 area is 70% dry dipterocarp and dry evergreen forest, with the remaining area comprised of grasslands, bamboo, and plantation forests (Heyer 1973; Lynam et al. 2006). Elevation ranges between 280 and 762 m above sea level at the site, but all study areas were below 600 m. I selected areas in different habitat types, including dry dipterocarp forest, dry evergreen forest, two types of pond systems, and a cleared area (Fig. 1). For logisitical reasons, two areas (Tam Jong An and Tai Yee Pun) were added to the study at 3 and 5 weeks, respectively. For a full description of each study area, see Appendix 1.

Each area was surveyed 1–3 times per week between 1900 h and 000 h. Frogs were detected by eye-shine and vocalizations. All adult *P. leucomystax* encountered were measured for snout-vent length (SVL) using a ruler, individually marked according to Hero (1989), and released at point of capture. Sex was determined by size, calling behavior, or presence of male nuptial pads. In this species, females are larger than males, so any individual between 35 and 60 mm, heard calling, or with nuptial pads was assumed to be a male. All individuals above 70 mm were assumed to be female (no individuals measuring 65–70 mm SVL were found). Voucher specimens were deposited in the Natural History Museum of Chulalongkorn University, Bangkok.

Areas were searched in the morning at least every other day for foam-covered egg masses. Within 36 hours of discovery, eggs were staged (Gosner 1960) and counted. If eggs were at or below stage 13, diameter of ten eggs was measured under a dissecting scope to

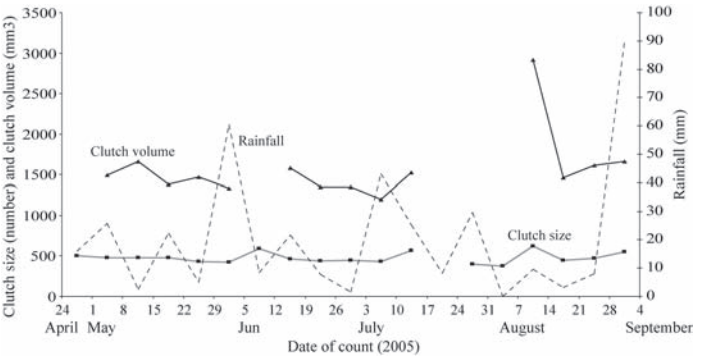


Fig. 3. Mean clutch size (number of eggs, solid line and squares) and mean clutch volume (mm^3, solid line and triangles) of *Polypedates leucomystax*, and rainfall (mm, dashed line and diamonds) at Sakaerat Environmental Research Station, Thailand.

the nearest 0.01 mm with digital calipers, averaged to give a mean egg size per clutch, and used to calculate clutch volume ((2/3*3.14*(radius of egg)^3)*clutch size). Eggs of this species lack jelly capsules, making it easy to obtain ovum size.

Time to metamorphosis for *P. leucomystax* was determined in 7 L round plastic basins, 35 cm in diameter. A single clutch was divided among eleven basins with thirteen tadpoles each when tadpoles were at developmental stage 25 (Gosner 1960). Tadpoles were given algae water once a week and fed commercial aquarium fish food (flakes and pellets). Basins were kept in a shade house with plastic roofing to prevent exposure to rainfall and direct sunlight. Nighttime water temperatures in cement basins in the forests of Sakaerat were 26.0 ± 0.2°C during the study period and that of the experimental basins was assumed to be similar. Mean daytime air temperature fell from 35.4°C in April to 30.0°C in September.

Calls were recorded between 5 July and 30 September 2006 using a Sony WM D6C Professional Walkman Cassette Recorder and an Audio-technica condenser. Calls were digitized using Windows Sound Recorder at 44.1 kHz. Audiospectrograms and oscillograms were produced and quantified by Raven Software 1.2.

Results.—I marked 225 *P. leucomystax* (174 males, 31 females, and 20 juveniles) over 150 search nights. Males were commonly

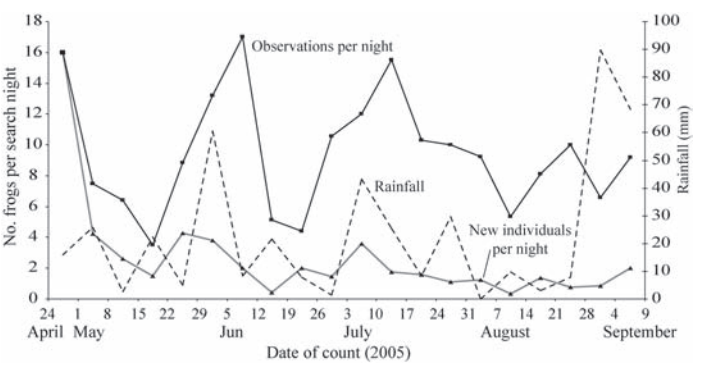


Fig. 2. Number of individual *Polypedates leucomystax* observed per search night (solid line and squares) and number of new individuals per search night (solid line and triangles) at Sakaerat, Thailand. Rainfall (mm, dashed line and diamonds) is also shown.

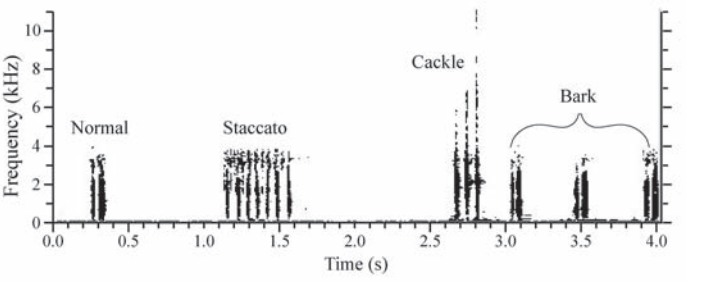


Fig. 4. Spectrogram of calls made by *Polypedates leucomystax* at Sakaerat, Thailand. Call elements are from a single individual but did not occur consecutively; call elements were cut and pasted from a 5 minute recording.

encountered and were heard calling even when no females were observed. Across weeks, the mean ± SE number of observations per night was 9.35 ± 0.87 (range = 3.5–17, N = 19). Mean ± SE male SVL was 55.05 ± 0.24 mm (range = 43–65 mm) and that for females was 79.0 ± 0.69 mm (range = 71–89 mm). Overall recapture rate during the study period was 75% for males and 29% for females (Table 1). Most of the locations where males were encountered were spaced such that determining site fidelity to an accuracy of 20 m was possible for 98 of the 130 recaptured males. Of these 98, 72 (73 %) were only ever encountered within 20 m of their original capture point, and 26 (27%) were encountered at least one time more than 20 m from their original capture point. Rainfall did not influence total observations or new individuals per search night (regression $R^2 < 0.01$ for both; see Fig. 2). After the first week of surveys, the number of new individuals per search night each week was 1.94 ± 0.28 (N = 19) which represented 23.3 ± 3.7% of the total observations per search night each week.

I counted eggs of 76 *P. leucomystax* clutches. Number of clutches found per week ranged between 1–15 (mean ± SE = 3.07 ± 0.76) and differed between weeks ($\chi^2 = 52.9$, $P < 0.01$). However, this variation between weeks is due to a single week in which 15 clutches were found, and was the week in which an additional area (Tai Yee Pun) was added to my searches. Number of clutches found in a given week did not change predictably over the study period and was not dependent on rainfall (regression $R^2 = 0.01$). An additional 10 clutches were not included in the analyses because ova could not be counted accurately due to their late stage of development or the presence of insect larvae which appeared to have eaten a large number of eggs. Mean ± SE clutch size for the entire study period was 454.45 ± 12.41 (range = 230–804; N = 76), mean ± SE egg diameter was 1.81 ± 0.02 mm (N = 37), and mean ± SE clutch volume was 1494.79 ± 75.11 mm^3 (N = 37). Not all clutches were used to calculate clutch volume because some clutches were found after eggs had passed developmental stage 13 (Gosner 1960). Dissections of preserved females and from females collected immediately after oviposition indicated that females contain eggs at different stages of development at any given time, but that all eggs of a given size class were oviposited at once (Sheridan 2008).

There was no difference in clutch size (ANOVA F-value = 0.76, $P > 0.70$) or clutch volume (ANOVA F-value = 0.60, $P > 0.85$) between weeks (Fig. 3). Clutch size and clutch volume were unrelated to rainfall in a given week (regression $R^2 = 0.01$ and 0.02,

TABLE 1. Overall recapture rate for adult *Polypedates leucomystax* at Sakaerat, Thailand, between 25 April and 4 September 2005.

	Number of recaptures				
	0	1–2	3–5	6–10	11+
Males	44	52	39	27	12
Females	22	8	0	1	0

respectively). Time to metamorphosis for tadpoles in basins with constant water levels was 41.66 ± 0.35 days and size (SVL) at metamorphosis was 19.40 ± 0.16 mm (mean ± SE).

I recorded several different call types. The most common was a single note ("normal") followed by 0–3 lower notes. Males also produced a "wreh-eh-eh" akin to a drawn out croak ("staccato"), a cackling sound ("cackle"), and a chuckle or laughing sound ("bark"; Fig. 4). These corresponded to call elements recorded in western Thailand (Christensen-Dalsgaard et al. 2002). All call elements were heard to be combined in various ways to create a complex call repertoire (Fig. 4). I analyzed call parameters of only the most common type of call, as this is believed to be the mating call (Christensen-Dalsgaard et al. 2002). Dominant frequency was 1197.1 ± 183.5 Hz, call duration was 58.5 ± 5.4 ms, pulse number (pulses/call) was 4.2 ± 0.3, and pulse rate (pulses/second) was 72.8 ± 4.2.

Discussion.—I report several new findings regarding the reproductive demography and behavior of *P. leucomystax* from Sakaerat, Thailand. First, both the mean and the maximum SVL of *P. leucomystax* at Sakaerat were larger than the maximum SVL of *P. leucomystax* in Borneo (Inger and Stuebing 1997: male maximum SVL, 50 mm; female maximum SVL, 75mm). The larger body size at higher latitudes is not surprising since many amphibians have been shown to follow Bergmann's Rule (Ashton 2002). Second, recapture rate for males was high, as was site fidelity (percentage of males only encountered within 20 m of their original capture point). This could indicate that males of this population are territorial. Christensen-Dalsgaard et al. (2002) frequently observed vocal interactions between males, in one case leading to wrestling between males. Although I never observed such interactions in the Sakaerat population, such interactions may also be indicative of territoriality. Although the number of new individuals found per search night was relatively low, it represented nearly a quarter of the total observations per search night. One possibility is that these individuals were present but not found during previous searches, but it is also possible that new individuals were constantly entering the local population.

Geographic variation in clutch size across the range of this species is uncertain. Although most reports on clutch size of *P. leucomystax* give only ranges and not mean values, Berry (1964) reported a mean clutch size of 315 (range 270–373) in Singapore, which is smaller than that found at Sakaerat (454). However, the range of clutch sizes at Sakaerat (230–804) overlapped with clutch size ranges from Borneo (150–900, Malkmus et al. 2002) and the Philippines (150–900, Alcala 1962; Taylor 1921; Villadolid and del Rosario 1930), indicating that within-site variation may swamp variation between sites.

Lack of variation in clutch size over time is surprising, as other frogs in seasonal tropical environments have shown decreasing clutch sizes over the course of the rainy season (Lampert and Linsenmair 2002; Lips 2001; Spieler and Linsenmair 1997; Williamson and Bull 1995). This could be due to the different variabilities, durations, or severities of the rainy seasons of each study location. For studies showing a decrease in clutch size as the rainy season progresses, rainfall generally decreases over the course of the season. At Sakaerat, the rainy season typically has five months of consistent rainfall (about 100 mm/month April–August) and then one to two months of extremely heavy rain (400 mm/month in September–October). Given the relatively short time to metamorphosis (about 42 d in basins kept in a shade house at ambient temperature), this 5–6 month rainy season might allow tadpoles to reach metamorphosis before larval habitat dries, even if eggs are laid in September or October. Temporal variation in breeding times of *P. leucomystax* at this site may reduce competition for resources among tadpoles and increase survivorship to metamorphosis.

Time to metamorphosis (42 d) was one and a half times longer than the 28 d previously recorded at Sakaerat (Heyer 1973) but nearly the same as the 49 d in Kuala Lumpur, Malaysia (Yorke 1983). It is important to note that Heyer's (1973) values are from non-experimental settings, and differences may be due to water temperature, food availability, and food type. Time to metamorphosis in my study was faster than the 70 to 119+ days reported for Philippine populations (Alcala and Brown 1956), and size at metamorphosis was slightly larger than the 14–17.5 mm reported for Philippine frogs (Alcala and Brown 1956). As with body size and reproductive measures, these differences in time to metamorphosis and size at metamorphosis could be due to temperature and rainfall differences between study sites, or could reflect the unrecognized taxonomic differences within this species.

Call types and diversity are similar to those reported from western Thailand (Christensen-Dalsgaard et al. 2002). Multiple call types also have been reported from northern Thailand (Garcia-Rutledge and Narins 2001) and Vietnam (Trepanier et al. 1999) but calls of *P. leucomystax* in Peninsular Malaysia, Borneo, and Bali appear to be less diverse (Marquez and Eekhout 2006; Matsui et al. 1986; Sanchez-Herriaz et al. 1995). A detailed summary of known call parameters from across the range of this species is given by Sheridan (2008).

Differences in life history variables between central Thailand and other populations of *P. leucomystax* are not surprising. Several studies on temperate amphibians show variation in clutch size, egg size, time to metamorphosis, and size at metamorphosis across a species' range (Berven 1982; Bury and Adams 1999; Kaplan 1980; Meeks and Nagel 1973; Riha and Berven 1991). However, no consistent trends of increases or decreases in these traits across latitude emerge from published data on temperate species and in general, we are still unable to predict variation in reproduction across latitudes for tropical species. Detailed studies on the reproductive ecology and behavior of tropical species such as *P. leucomystax* illustrate variation in reproduction across the range of a tropical species, and provide a baseline against which future changes can be measured.

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Appendix I

Detailed Description of Study Areas

Dry dipterocarp forest.—This area consisted of 20 cement cisterns located 1–5 m from the main road in the deciduous dipterocarp forest at Sakaerat. These cisterns are round, 0.75 m in diameter, 0.32 m deep, and held water at depths of 0.1–0.3 m during the study period. This area occurs between km 1 and km 2.7 of the station road, with km 0 located at the junction of Highway 304 and the station road (Fig. 1).

Dry evergreen forest.—This area consisted of 34 cement cisterns, 0.75 m in diameter, in the evergreen forest at Sakaerat. Water depths were not less than 0.25 m. Cisterns were 1–5 m from the main road, except for two cisterns located 10 and 20 m from the road. The evergreen forest extends west from km 3 along the station road (Fig. 1).

Tam Jong An (Cobra Cave Pond) .—This area comprised 70 m of an ephemeral stream that runs parallel to the main road through Sakaerat, about 700 m to the north of the main road in the evergreen forest. The western end of the area was a semi-permanent pool of water at the base of a 3 m waterfall. As the two years prior to the study year were drier than normal, rainfall was quickly absorbed by the ground, the stream was not flowing during the study period, and the pool shrank from 4 x 20 m, to 3.5 x 12 m. Water in the remaining 65 m of stream bed was restricted to small ephemeral pools in rock crevices. The stream was bounded on the north and south by steep banks about 6 m apart. Note that the first date this area was sampled was 9 May 2005.

Dam Pond.—This area was an ephemeral pond covering approximately 75 m^2 created by a 5 m dam located approximately 100 m north of the main road near the km 5 marker (distance measured from Highway 304 along the main road through Sakaerat) in evergreen forest. The bottom of the pond was covered with herbaceous vegetation during this study period and contained standing water on only 2 survey nights. No eggs were

ever found on this transect, but amplectant pairs were found twice. This is not the same area as the "dam stream pond" referred to in Heyer (1973).

Tai Yee Pun (Thai Japanese ReAfforestation Project) .—This area was separated from those detailed above by ca. 7 km, and was a cleared area used as a plant nursery, ca. 120 m on a side. There were 20 cement cisterns 0.8 m in diameter along the road, and four 15 x 25 m nurseries covered by shade cloth. Two nurseries contained 6 rectangular 0.8 x 2 m cisterns 1m deep, with variable volumes of water. Depth of water in these cisterns varied between 0.1–1 m. A third nursery had four of these cisterns and the fourth nursery had four standard 0.75 m round cisterns. Note that the first day this area was sampled was 25 May 2005.

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High Densities of a "Rare" Skink

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"Rarity" and "commonness" is more of a perception than a reality for some species. If one were to conduct a visual sampling of a cryptically colored species and compare it with that of a more conspicuous, non-camouflaged species of the same general size, the results might be very different, even if both species had the same absolute population density. In the same way, quiescent sit-and-wait predators may be more easily overlooked than similarly colored species of the same size that actively forage and attract attention because of their movement. This property of human visual perception can lead to erroneous assessments of densities, assemblage structure, and community dynamics by underestimating the relative importance of cryptic or secretive components of the fauna. General hand-collecting is especially prone to this source of error. Some other methods, such as pitfall traps that discount human visual acuity and discrimination, are more accurate by not being influenced by visual properties, but are biased in favor of selectively capturing the more active species and underestimating secretive ones. Even plot sampling can be highly inaccurate and numbers underestimated if the plots are small or unfenced and unless special measures are taken to prevent escapes or immigration (Heatwole 2008). Heatwole and Sexton (1966) devised a method of fenced plots, subsequently refined by Rodda et al. (2001a) and Heatwole (2008), that improves on other plot methods by completely censusing animals of all ages, including eggs, i.e., all individuals are found.

The present paper reports on a census of a small, Southeast Asian, forest-floor skink, *Sphenomorphus tridigitus* (Bourret 1939), using this method of fenced plots. This "rare" species was previously known from only four specimens. It was originally described on the basis of a single specimen in a poor state of preservation found dead on a road at Bach Ma, Thua Thien-Hue Province, Vietnam (Bourret 1939). Greer et al. (2006) redescribed the species from a second specimen found "at day, hidden inside a log lying on grass near a small creek in an open forest" at 1200–1250 m elevation on the Bolaven Plateau (="Boloven Highlands") in Champasak Province, Laos. Bain et al. (2007) reported on two additional specimens that were collected in pitfall traps, one at 940 m elevation and one at 1470 m elevation, on Mt. Ngoc Linh, Tra Don Commune, Tra My District, Quang Nam Province, Vietnam.

The present study took place at three sites (15°02'48"N 106°10'45"E, 400 m elev.; 15°04'37"N 106°08'15"E, 1000 m elev.; 15°03'55"N 106°13'03"E, 1200 m elev.) on the Bolaven Plateau in the Dong Hua Sao National Protected Area (formerly National Biodiversity Conservation Area), Pakxong District, Champasak Province, Laos during 10–25 September 1999. Eight plots, each 10 m x 10 m, were fenced by mosquito netting 1 m high with the bottom edge buried in a trench, and then the low vegetation, litter and wood removed down to mineral soil by Heatwole's (2008) method. Specimens of *S. tridigtus* collected in the study were deposited at The Field Museum (FMNH 258772–98, 258824–40, 258843–63, 258914–18, 258929–38). These specimens fully agree with the detailed redescription of the species by Greer et al. (2006), including discrepancies from the type. Like the specimens of Greer et al. (2006) and Bain et al. (2007), ours have a frontonasal scale with two separated prefrontals and the nasal and first supralabial are fused (erroneously called the "first infralabial" by Greer et al. [2006] and repeated by Bain et al. [2007]), and the loreal and the

TABLE 1. Abundance of *Sphenomorphus tridigitus* in the forest floor of Wet Evergreen Forest, Bolaven Plateau, Laos, September 1999.

Elevation/ Plot No.	Number of individuals	Number of eggs	Density (no./m^2) of individuals	Density (no./m^2) of eggs
400 m				
Plot 3	0	0	0	0
Plot 4	0	0	0	0
1000 m				
Plot 1	19	6	0.19	0.06
Plot 2	19	5	0.19	0.05
Mean: 1000 m	19	5.5	0.19	0.055
1200 m				
Plot 5	18	0	0.18	0
Plot 6	14	2	0.14	0.02
Plot 7	2	2	0.02	0.02
Plot 8	1	0	0.01	0
Mean: 1200 m	8.8	1	0.09	0.01

preocular are not fused. The specimens in our series have snout-vent length from 16.5 mm (hatchling) to 43.6 mm (largest adult). The eggs, collected from under leaf litter in the plots (see Table 1), are creamy-white to yellow, oval, and leathery and average 8.2 mm long by 4.8 mm wide (after preservation in 10% formalin). Most have a small, purplish-black spot visible through the eggshell. A fully developed skink is visible through the eggshell of two eggs (FMNH 258918). A baby skink hatched from one egg (FMNH 258917) immediately upon immersion of the egg in formalin in the field, making identification unambiguous. Animals with regenerating tails accounted 5.5% of the specimens captured.

The plot results for *S. tridigitus* are summarized in Table 1. All individuals and eggs from the census plots were found under leaf litter. Six of the eight plots (75%) contained this species and it was clear that abundance was related to elevation. Intensive searching over 16 days (10–25 September 1999) at these sites by the authors and two camp assistants (and others sporadically) in the conventional way yielded only two individuals of this species, one under leaf litter when clearing a campsite and the other inside a rotten log. Thus, by the standard methods of expeditionary field surveys, this species would have been considered rare at the study site. In fact, it was the most abundant reptile in the area. Without the plot method the small numbers of individuals otherwise obtained would not have revealed this. No animals were found at low elevations but they were relatively abundant at 1000 m. Population density was lower again at 1200 m. Hence, this species is most abundant at mid-elevations.

At 1000 m on average there was one egg for every 3.5 adults, whereas at 1200 this value dropped to one egg for every 8.75 adults suggesting either that reproductive rate was much lower at the higher elevation, or that the reproductive season differed between the two sites.

This species, rather than being an insignificant rarity, is abundant at higher elevations on the Bolaven Plateau, where it accounted for 86% of the total individuals of the forest-floor lizards and frogs (6 species; snakes inadequately sampled) at 1000 m and 57% of the individuals of forest-floor lizards and frogs (8 species) at 1200 m. At a lower elevation on the plateau where *S. tridigitatus* was not present, it was replaced by a similarly small skink in the *Scincella reevesi* complex (mean density: 0.05/m^2; 64% of total individuals of the forest-floor frogs and lizards; four species). These two skinks probably play an important role in the dynamics of the forest floor community as significant predators upon small invertebrates and as food for various snakes.

Rodda et al. (2001a,b), using a censusing technique similar to the present one, also found unexpectedly high densities of some small reptiles and it is likely that many small forest-floor lizards are far more abundant than they appear to be. Estimates of density are used in studies of population biology and structure of assemblages and often play an important role in decisions about conservation. Much of the previous literature, even that based on fenced plots, probably contains serious underestimates and needs to be reassessed by research using more refined, fenced-plot techniques.

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Bromeliad Patch Sampling Technique for Canopy Herpetofauna in Neotropical Forests

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The canopy strata of tropical forests are one of the remaining unexplored biotic frontiers. Canopy research is a relatively new discipline facilitated by recent methodological advances in canopy access techniques (Basset et al. 2003b). Forest canopies are among the most species-rich terrestrial habitats on earth, supporting approximately 40% of known extant species and estimated to hold up to 50% of the earth's biodiversity (Basset et al. 2003b; Mitchell et al. 2002). The ecological role of amphibians and reptiles in forest canopies is mostly unknown. Thus far the research focus has been on arthropods, birds, mammals, plants and ecological processes; investigations of canopy herpetofauna have only recently been documented (De Vries et al. 1997; Guayasamin et al. 2006;

Schiesari et al. 2003). Kays and Allison (2001) reviewed published ecology and study methods for arboreal tropical forest vertebrates and found amphibians and reptiles to be grossly understudied compared to mammals, primarily due to their cryptic habits and sampling difficulties. Of 752 articles on tropical forest arboreal vertebrates published between 1988 and 1998 only 4% focused on reptiles and amphibians, with the majority of those covering reptiles (Kays and Allison 2001). While many studies report arboreal occupancy by an extensive number of amphibian species, few have documented ecological characteristics besides presence/absence data based on calling males and new species descriptions (Duellman and Trueb 1986; Guayasamin et al. 2006; Schiesari et al. 2003). Most data for arboreal amphibians were obtained through collection and observation during reproduction of those species that descend from the canopy to breed in water bodies at the forest floor level (Duellman 1978; Duellman 2005; Ron and Pramuk 1999). Standard survey techniques for amphibians, such as those at breeding sites, only encompass a small stratum (~2 m vertical height) of forest diversity (McCracken et al. 2007). Amphibians that specialize within the upper canopy remain mostly unaccounted for as a result of this limited vertical sampling bias (Guayasamin et al. 2006). More practical methods for studying canopy amphibians and reptiles is a high priority to facilitate the need for more survey and natural history work (Kays and Allison 2001).

A component of neotropical rainforest canopies that provide rich fauna microhabitats are the phytotelmata, defined as plants or parts of plants which hold rainwater (e.g. bromeliads, fruits, inflorescences, palm fronds and tree holes). In some tropical locations the availability of this habitat for aquatic organisms is up to 50,000 liters per hectare, literally a "wetland in the sky" (Kitching 2000; McCracken and Forstner 2006). In particular, epiphytic tank bromeliads are capable of holding relatively large amounts of water and play a principal role as a "keystone resource" and microhabitat for invertebrates, vertebrates and other plants (Nadkarni 1994). Canopy bromeliad arthropod surveys have reported them as reservoirs of incredibly high biodiversity (Basset et al. 2003a; Kitching 2000). Typically, tank bromeliads occur in the upper canopy and overstory trees of lowland rainforest at vertical heights between 5–45 m. Bromeliads normally range in number of individuals from ~5 to >150 on a single tree. Herein, we describe a technique for canopy bromeliad patch sampling of herpetofauna in lowland neotropical forests which is similar to those used in other canopy research disciplines but has not been documented for herpetofaunal investigations.

Methods.—Bromeliad patch sampling was conducted during 2004 and 2006 at the Tiputini Biodiversity Station (TBS)–Universidad San Franciso de Quito (USFQ), Orellana Province, Ecuador (00.63847°S, 076.14908°W, 217 m elev.). The vegetation type of the site has been defined as Amazonian Evergreen Lowland Forest (Palacios et al. 1999). Sampling units consisted of five bromeliads from each of 16 trees for a total of 80 bromeliads sampled. A tree was not sampled if less than 15 bromeliads of any species to be sampled were present to ensure continued persistence of the bromeliad community. Host trees were measured for diameter at 1.5 m above ground, height using a clinometer, and canopy cover using hemispherical photography with the Gap Light Analyzer (GLA) software. A leader line was positioned in the tree using a large slingshot (Sherrill™ Big Shot) which enables setting lines at 30+ m. The canopy was accessed using single-rope technique, which should only be performed by trained and experienced individuals (Fig. 2d). The lowest and highest elevation bromeliads were sampled with the remaining three sampled at estimated even intervals in between (Fig. 1). Before removal of each bromeliad a wide-angle photograph was taken and the following variables collected: elevation, ambient air temperature, relative humidity, barometric pressure, water temperature and pH are measured inside one of the outer leaf bracts, and a 50 ml water sample is collected by siphon. Ambient air temperature, relative humidity and barometric pressure were also collected at 1.5 m elevation. The bromeliad was removed by holding several leaves at the tips in one hand and cutting its base support stem with a pruning saw. The response of most animals is to retreat into the bromeliad bracts and therefore alleviates loss of specimens due to escape. The bromeliad was placed in a 55 gal. plastic bag with minimal disturbance, sealed, and placed in a tarp connected to a rope that is threaded through a carabiner on the climbers harness and the other end held by a ground support person. It was then gently lowered to the forest floor by the ground support person. Another photograph was taken of the site where the bromeliad was removed. After removal of the five bromeliads, a herbarium sample was collected from the tree to confirm identification and deposit in a herbarium. Bromeliads were processed at camp in a screen tent to prevent escape of animals (Fig. 2c). Bromeliad water was strained through a 1 mm mesh screen to separate arthropods, leaf litter, and detritus. Water volume was measured with a graduated cylinder. Bromeliads were measured, number of leaves counted, and photographed including a meter stick for scale reference (Fig. 2a, b). Individual leaves were removed to facilitate collection of herpetofauna, which were temporarily stored in bags

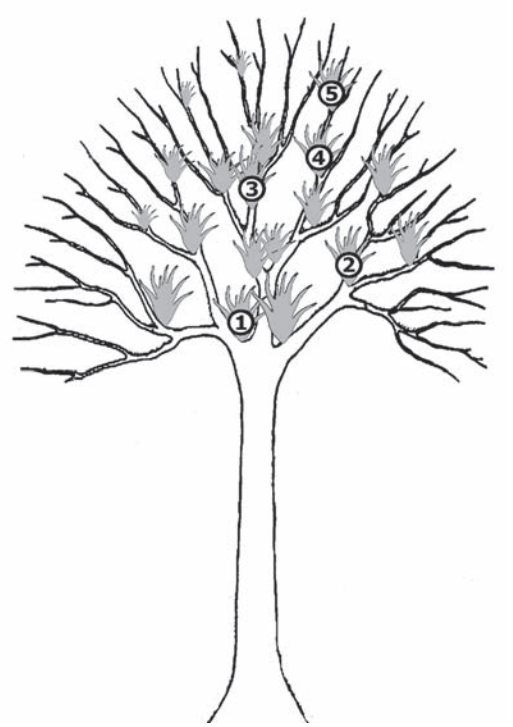


FIG. 1. Schematic of tree with bromeliads illustrating distribution strategy for sampling units (bromeliads), numbers denote bromeliads sampled.



FIG. 2A) Side view photo of *Aechmea zebrina* bromeliad with meter stick in background. Bar = 20 cm. 2B) Top view of *A. zebrina* bromeliad with meter stick below. Bar = 20 cm. 2C) Senior author in screened tent with sampled bromeliad to prevent escape of herpetofauna. 2D) Senior author ascending into canopy to access bromeliads for sampling using single-rope technique (SRT) to climb.

for further processing. Herpetofauna species were photographed, measured and weighed. Blood or tissue samples were collected and stored in blood storage buffer or 95% ethanol, respectively. Animals were euthanized in 10% ethyl alcohol or by ventral application of 20% benzocaine (Orajel®) and preserved using 10% formalin before being transferred to 70% ethyl alcohol for storage.

Results.—In 2004, eight trees were surveyed for a total of 40 bromeliads sampled. Three species of bromeliads were sampled: 20 individuals of *Aechmea zebrina*, 17 of *Aechmea* sp., and three of an unidentified tankless bromeliad. In 2006, eight trees were surveyed for a total of 40 *A. zebrina* bromeliads sampled as part of a current study. Bromeliads were collected at elevations of 5.7–38.0 m (mean 27.0 ± 6.2 m) above ground. *Aechmea zebrina* bromeliads were 58.5–125.0 cm (mean 79.9 ± 13.9 cm, N = 40) tall and 54.0–147.5 cm (mean 89.5 ± 22.2 cm, N = 40) in diameter, *A* sp. bromeliads were 32.0–58.0 cm (mean 47.2 ± 9.7 cm, N = 17) and 54.0–94.0 cm (mean 66.8 ± 12.6 cm, N = 17) in diameter, and the unknown tankless bromeliads were 41.0–47.0 cm (mean 43.8 ± 3.1 cm, N = 3) and 33.0–43.0 cm (mean 37.3 ± 5.1 cm, N = 3) in diameter.

Thirty-four adults, 10 juveniles, 15 tadpoles, and 17 eggs of anurans representing at least four species were collected during the two survey periods. The identified adult and juvenile species included *Dendrobates* (*Ranitomeya*) *ventrimaculatus*, *Eleutherodactylus* (*Pristimantis*) *aureolineatus*, *Eleutherodactylus* (*Pristimantis*) *waoranii*, and *Osteocephalus taurinus*. Eight of the tadpole specimens were easily identified as *D. ventrimaculatus* due to their advanced stages of development. The remaining tadpole specimens are to be identified using morphological and/or molecular techniques. One gecko, *Thecadactylus rapicauda*, was collected in an *A. zebrina* in 2006. Only one anuran was observed jumping from a bromeliad during removal and was visually identified when it landed on a nearby bromeliad before retreating into the leaf bracts.

Of the three bromeliad species, no anurans were found in the three tankless bromeliads, nine tadpoles of *D. ventrimaculatus* and three adult *E. waoranii* in five *Aechmea* sp., and the remainder in 26 *A. zebrina* (65% of *A. zebrina* sampled had anurans). All anurans were collected in bromeliads between 20.0–36.0 m (mean 28.3 ± 5.3 m) above ground.

Discussion.—Visual encounter surveys, focal point observations, and inspection of individual bromeliads along a 100 m-long canopy walkway and two ~40 m high observation towers built around emergent trees at TBS–USFQ revealed 13 species of anurans; these surveys were conducted 3–4 times a year from 1998 to 2001 dur-

ing the morning, afternoon, and night for 4–5 days duration (Cisneros-Heredia 2003; D. F. Cisneros-Heredia, pers. comm.). During one week in May 2002 canopy searches targeted at calling anurans were conducted using tree-climbing spurs at the Yasuni Scientific Research Station–Universidad Católica del Ecuador and resulted in the discovery of six anuran species occupying canopy habitat (S. Ron, pers. comm.). Canopy bromeliad patch sampling revealed a minimum of four species and the additional species *E. waoranii* (McCracken et al. 2007). Results from our surveys contributed significantly to the new species description for *E. aureolineatus* and a manuscript on the reproductive ecology and behavior; they are wholly responsible for the new species description of *E. waoranii* (Guayasamin et al. 2006; McCracken and Forstner 2006; McCracken et al. 2007). Three other species found during these canopy surveys are newly described since 1999, demonstrating the value of such research techniques (Guayasamin et al. 2006). The potential for the discovery of additional new species and collection of detailed ecological data at other sites is evident in the fact that our surveys and the previous canopy surveys represent a limited sampling effort at two sites within close geographic proximity (~28 km) and similar habitat structure.

The technique provides a labor intensive, but successful, method for surveying the otherwise inaccessible microhabitats of the upper forest canopy strata herpetofauna. While our bromeliad patch sampling technique recovered less than a third of the number of species collected during the canopy walkway/tower surveys it represents a much less intensive sampling effort. Our sampling focused on the specific microhabitat provided by bromeliads, of which we only investigated three species. Our results indicate that the largest tank bromeliad in our surveys, *A. zebrina*, had the greatest occurrence rate, with 65% of those sampled having anurans present. The use of canopy bromeliad patch sampling is also supported by the limited availability of canopy walkways and towers for research in Amazonia, and the financially prohibitive construction costs of such infrastructure for most research projects. Canopy bromeliad patch sampling can be employed anywhere the forest is accessible and facilitates the collection of independent replicate sampling units with associated biotic and abiotic factors for the analysis of ecological correlates of species diversity and abundance in a robust sampling design. Our current study targets a species specific (*A. zebrina*) tank bromeliad microhabitat, but the technique may be applied to other species and microhabitats (e.g. tree holes/cavities) within the canopy. The technique may also be used to survey other forest canopies and their specific microhabitats.

Fauna of forest canopy habitats are at risk due to high rates of deforestation and habitat fragmentation, which are primary reasons for the rapid decline in amphibian populations worldwide with nearly one-third of all amphibians being threatened and at least 43% declining in population size (IUCN et al. 2006). The rapid exploitation of natural resources is having a profound effect on the rainforests and its inhabitants of the Ecuadorian Amazon. Yet, little is known about the effects of canopy biota loss. Epiphytes are considered hypersensitive to climatic conditions, requiring the very conditions they promote for existence (Benzing 1998, 2000; Hietz 1998). This hypersensitivity makes them particularly susceptible to forest microclimate changes as a result of anthropogenic disturbance, making epiphytes suitable as a bioindicator of diversity and forest ecosystem functions (Benzing 1998; Brighigna et al. 2002; Hietz 1998). Loss of epiphyte diversity will degrade all biodiversity within inclusive ecosystems by causing shifts in faunal resource availability, nutrient budgets and cycling, system energetics, and hydrology (Benzing 1998). Amphibians may be considered a vertebrate counterpart to epiphytes as bioindicator species and their utilization of epiphytic tank bromeliad habitat provides the researcher with a unique system for monitoring anthropogenic disturbance in forest canopies. Bromeliad patch sampling surveys are essential to documentation of the faunal diversity in neotropical forest canopies and promoting the conservation of these important "wetlands in the sky" (McCracken and Forstner 2006).

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Efficacy of PIT Tags for Tracking the Terrestrial Anurans *Rana pipiens* and *Rana sylvatica*

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The terrestrial ecology of many amphibians is poorly known compared with the aquatic stages (e.g., Regosin et al. 2003). Although advances have employed radiotelemetry on terrestrial adults (e.g., Hodgkison and Hero 2001; Watson et al. 2003), the size and battery life of transmitters are limitations on the use of radiotelemetry for smaller amphibian species and life stages. Other approaches for following small amphibians have included powder tracking, radioactive tags, and harmonic radar diodes, but each of these techniques has significant limitations (Heyer et al. 1994; Langkilde and Alford 2002).

Passive integrated transponders (PIT tags) overcome many limitations of these other techniques. PIT tags are small, glass-encased electromagnetic coils with a microchip containing a 10-space unique alphanumeric code that is emitted at a radio frequency (typically 134.2 kHz) when the coil is activated. PIT tags are easily applied and relatively benign to the tagged animal, provide a unique and essentially permanent mark, and can be cost-effective (Arntzen et al. 2004; Gibbons and Andrews 2004; Ott and Scott 1999). As a result, PIT tags have been increasingly used for marking fish, amphibians, reptiles, and other animals for demographic and behavioral studies (e.g., Camper and Dixon 1988; Kurth et al. 2007; Reaser 2000; Rowe and Kelly 2005; Sinsch 1992). Usually, PIT tag detection relies on the physical recapture of the tagged organism because the tag needs to be within range (usually ~ 0.3 m) of an antenna to transmit the alphanumeric identification code to the transceiver (see review by Gibbons and Andrews 2004). Portable antenna and transceiver systems (PIT-packs) are a new approach to locating and identifying a tagged organism without physical recapture, thereby minimizing associated disturbances (Hill et al. 2006; Kurth et al. 2007; Zydlewski et al. 2001).

We evaluated a PIT-pack as a tool to locate and identify confined individuals of two pond-breeding amphibian species, recently metamorphosed *Rana pipiens* (Northern Leopard Frogs) and adult *R. sylvatica* (Wood Frogs). We evaluated the detection range of the PIT-pack using PIT tags alone and the detection probability of frogs implanted with PIT tags and held in terrestrial enclosures. We used the PIT-pack to identify breeding pairs in a small vernal pool and collect information on the breeding ecology of *R. sylvatica*. In addition, we evaluated three surgical implant locations and PIT-tag retention in recently metamorphosed *R. pipiens*.

Methods.—The PIT-pack consisted of a battery-powered Destron-Fearing transceiver (Model FS 2001A-ISO; Digital Angel Co., St. Paul, Minnesota, USA) and custom-built antenna. The antenna head was constructed in an airtight oval (0.20 × 0.25 m) with 1.27-cm schedule 40 PVC. The antenna consisted of 20-gauge multi-strand wire wrapped 26 times through the PVC frame until an inductance of approximately 425 μH was reached. Capacitors were attached to the antenna lead cable and enclosed in the PVC, fixing the capacitance at ~ 3300 pF. Fine-scale tuning was achieved with a 400–1600 pF variable capacitor. The head of the antenna was mounted on an adjustable 1.5-m long handle at an angle of ~ 120° (Fig. 1). The instrument was tuned in water or air immediately prior to use at each site to maximize current at 3.0 to 3.3 Amps. In theory, changes in soil or water density and chemistry can affect the electromagmetic field generated by the antenna, and consequently it is necessary to tune the antenna prior to use in the medium (i.e., air or water) in which it will be used to achieve the maximum detection range. The PIT-pack is light (3.1 kg) and portable in the terrestrial environment (Fig. 1), but the transceiver is small and low-powered. Heavier equipment with a larger antenna head size (e.g., 0.55 × 0.40 m and 19.3 kg in Hill et al. 2006) would probably have greater detection ranges but would sacrifice the convenience of the smaller unit (Kurth et al. 2007; Zydlewski et al. 2001). We used 12-mm PIT tags (134.2 kHz ISO tag; Model TX1411SST, Digital Angel Co., St. Paul, Minnesota, USA) in all experiments because the small size of our study frogs. Tag size may contribute to performance, and larger tags may increase the detection range for other applications (Hill et al. 2006; Roussel et al. 2000).



FIG. 1. Using a PIT-pack to search for PIT-tagged, recently metamorphosed *Rana pipiens* in a terrestrial enclosure in a three-year old clearcut in Maine, USA. We held the transceiver in a shoulder bag, and constructed the antenna using a modified forearm crutch for ergonomics. We varied the angle of the antenna to increase the detection probability as we searched for concealed frogs, and an audible beep from the transceiver alerted us to detection of a tag. Photograph by Valerie Moreau.

Prior research with larger 23-mm tags and more powerful readers reported detection ranges of 30–38 cm in air and 60–91 cm in water (Cucherousset et al. 2005; Hill et al. 2006). With a blind observer, we evaluated the PIT-pack detection range for 30 PIT tags in 30 mL polyethylene vials in each of two soil types commonly found in Maine, USA, forests (N = 60 total tags). We visually evaluated each area and assessed one to be predominantly glaciomarine hydric soils found in wetlands and the second to be predominantly well-drained till soils found in uplands (Natural Resources Conservation Service, 1963). One observer dispersed PIT tags in a 16 m^2 area (4 × 4 m) at depths ranging from the soil surface to 76 cm by driving a measured metal rod to the desired depths in the soil. A second observer, naive to the location and number of tags, searched the area with the PIT-pack by walking in a systematic zig-zag pattern through the area and making three passes through the area to find the tags. The first observer, who placed the tags, recorded the number and identity of the tags found on each pass. The first, informed observer then made one pass though the area and attempted to detect tags that were missed using the PIT-pack.

We collected recently metamorphosed *R. pipiens* and adult *R. sylvatica* from the University of Maine's Dwight B. Demeritt and Penobscot Experimental Forests (Penobscot County, Maine, USA, 44°50'N, 68°35'W) with hand capture and pitfall traps in August 2006. We housed all frogs in 125 L plastic tanks or 38 L glass aquaria in small groups (20 metamorphs and 5 adults) for 1–16 days prior to experiments (described below). Each container had leaf litter for cover, holes in the top, and a wet paper towel on the bottom to maintain moisture. We fed captive frogs crickets *ad libitum*. We measured (snout–vent length [SVL], mass) and marked each animal individually with a PIT tag.

We surgically implanted PIT tags sub-dermally as recommended for small amphibians (Ott and Scott 1999). We anesthetized all frogs using 0.5 g/L MS-222 (tricaine methanesulfonate; Sigma Aldrich, St. Louis, Missouri, USA) in well water prior to surgery. We lightly anesthetized the frogs to minimize mortality associated with small frogs (e.g., Cecala et al. 2007), and held frogs in anesthesia only until they lost their righting response but remained responsive to touch (< 15 min in most cases). We made a 2-mm long incision with a sterile, single-use blood lancet (Propper Mfg. Co., Long Island City, New York, USA). To cut only the skin, we placed the blood lancet at an acute angle to the body of the frog and lightly pressed it into the skin until the skin began to fold upwards. We continued to apply pressure until we pierced the skin. After making the incision, we slipped a sterile PIT tag through the

incision, and placed one drop of Bactine (Bayer Co., Pittsburgh, Pennsylvania, USA) on the wound to sterilize the incision and promote healing. Frogs recovered from surgery for 6 hours before release, and we assessed tag retention and the condition of the wound after the frog recovered.

We conducted a two-week laboratory trial to determine the best position for PIT tag placement in small ranids. Three positions (scapula insertion, pubis insertion, ilium insertion) were tested in recently metamorphosed *R. pipiens* (N = 20 for each position). For scapula insertion, a longitudinal incision on the dorsum was made above the scapula ~ 3 mm posterior to the eye and ~ 2 mm medial to the tympanum. For pubis insertion, a lateral incision was made ~ 2 mm anterior to the posterior end of the urostyle. For ilium insertion, a longitudinal incision was made ~ 1 mm anterior to the anterior end of the ilium and centered on the dorsum. The frogs used in the experiment were 34 ± 1 mm (mean ± SE; range 31–38) SVL and weighed 4.0 ± 0.3 g (range 2.8–6.1). Frogs were checked twice daily for tag retention and healing of the surgical wound.

Based on the results of the retention study, we PIT tagged (scapula insertion) 50 adult *R. sylvatica* (26 males, 24 females; 46 ± 1 mm SVL, range 41–55 mm; 14.5 ± 0.5 g, range 10.1–24.9 g) and 52 recently metamorphosed *R. pipiens* (37 ± 1 mm SVL, range 31–48; 4.5 ± 0.2 g, range 1.0–8.7 g) in August 2006. Tagged frogs were placed into uninhabited 3.8 × 3.8 m (14.4 m^2) terrestrial enclosures constructed 15 months prior to data collection in an unharvested forest (unharvested), a forest partially harvested to 50% crown closure (partial), and a 3-year old clearcut with coarse woody debris removed (removed) on the Dwight B. Demeritt and Penobscot Experimental Forests (see Patrick et al. 2006 for a description of the sites). Enclosure walls were 1.2 m tall galvanized steel hardware cloth (3.2 mm square mesh; TWP Inc., Berkeley, California, USA) supported with wooden garden stakes. Enclosure walls were buried 20–30 cm in the ground and bent 10 cm at the top toward the inside of the pen to prevent escape of animals.

We stocked terrestrial enclosures with *R. pipiens* metamorphs and *R. sylvatica* adults. *Rana pipiens* metamorphs were stocked to three enclosures: one enclosure in the removed treatment at a density of 12 per enclosure (0.83 m^{-2}), one in the removed treatment at a density of 20 per enclosure (1.39 m^{-2}), and one in the unharvested treatment at a density of 20 per enclosure (1.39 m^{-2}). We were unable to capture enough *R. pipiens* metamorphs at our study sites to replicate each density and treatment combination. For *R. sylvatica* adults, we stocked each of 10 enclosures at a density of five per enclosure (0.35 m^{-2}): five enclosures in the partial treatment and five in the unharvested treatment. We located *R. pipiens* metamorphs every three days during 23 August – 7 September 2006 and once weekly thereafter through 11 October (the end of the growing season in central Maine). We located *R. sylvatica* adults once weekly from 26 August to 27 September 2006. We removed dead frogs and did not include them in subsequent detection probability calculations.

Lastly, we captured (drift fences and by hand) 139 adult *R. sylvatica* (61 females, 78 males) returning to breed at a single, ~ 80-m^2 vernal pool on the University of Maine's Dwight B. Demeritt Experimental Forest in April 2007. Each frog was PIT tagged (scapula insertion), and held in captivity for < 9 h prior to release at ~ 1 h before sunset. Nightly during 22 April – 2 May we located pairs in amplexus with a spotlight and by scanning the surface of the water with the PIT-pack. We attempted to identify both members of each located pair with the PIT-pack without disturbing the frogs. We relocated the pair visually and with the PIT-pack until the female oviposited. Each morning we counted the number of fresh egg masses in the pond. We conducted all statistical analyses in SAS (SAS Institute, Cary, North Carolina, USA) with α = 0.05.

Results and Discussion.—Our mean detection probability was 0.65 ± 0.14 (± 95% confidence interval), and we detected 100 ± 0% of the tags at 13 cm and 33 ± 7% of PIT tags at 43 cm in the soil (Fig. 2). The informed observer (i.e., who knew the location of the tags) detected a higher proportion of tags in a single pass (0.76) than the blind observer (0.61 ± 0.03; range 0.57–0.67) did in three passes. This higher success in detecting tags is probably due to increased effort in an area known to have a tag versus the systematic pattern employed by the blind observer. Subtle changes in antenna orientation associated with concentrated effort in one area can change detection success without a change in detection range. The antenna is most effective at detecting a tag if the tag is perpendicular to the face of the antennae (Cucherousset et al. 2005).

No frogs died during the two-week tag retention experiment. Tag retention after two weeks was highest with the scapula insertion technique; all *R. pipiens* retained their tags. Retention also was high with ilium insertion (90%), but retention with pubis insertion was poor (55%). All tag loss occurred before the incision healed, generally in < 6 days during these laboratory trials. The scapula and ilium insertion techniques will probably result in high tag retention rates in other similar sized frogs, although retention rates are important to quantify for any field study.

The proportion of recently metamorphosed *R. pipiens* detected with a PIT-pack was not affected by harvesting treatment or density, and the proportion detected in the three terrestrial enclosures remained at 1.00 throughout the study (Fig. 3). The proportion of adult *R. sylvatica* detected remained high (> 0.90) until the first time the minimum daily temperature (MDT) was < 0°C, but declined over subsequent surveys. Because the proportion detected

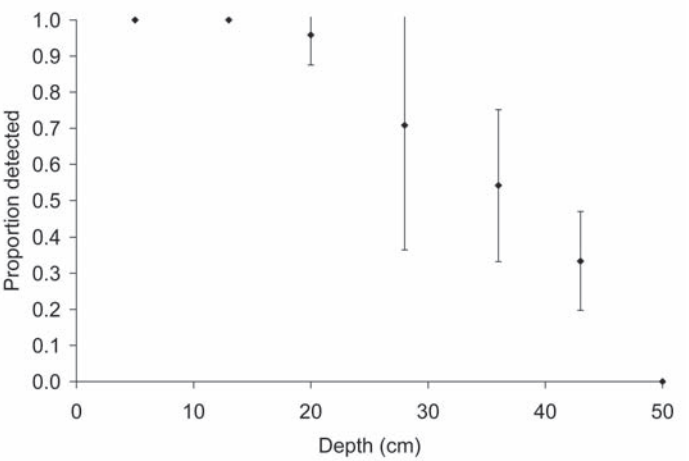


FIG. 2. Mean (± 95% confidence interval) proportion of PIT tags detected per depth in the soil using a PIT-pack in two 16 m^2 areas. Each depth had six tags available for detection and means were calculated from all four passes with the PIT-pack. All depths 50 cm were lumped.

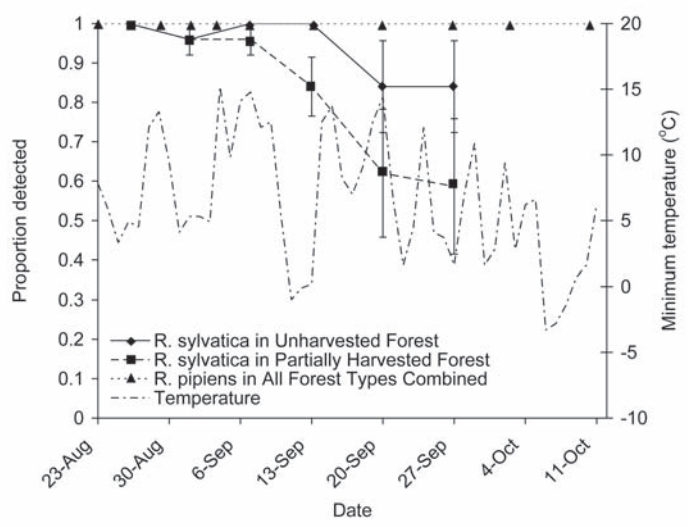


FIG. 3. Mean (± SE) proportion of PIT-tagged frogs detected with a PIT-pack in 14.4-m^2 terrestrial enclosures in unharvested forest (recently metamorphosed *Rana pipiens*: one enclosure with 20 frogs; adult *R. sylvatica*: five enclosures with five frogs each), a forest partially harvested to 50% crown closure (adult *R. sylvatica*: five enclosures with five frogs each), and a 3-year old clearcut (recently metamorphosed *Rana pipiens*: one enclosure with 20 frogs and one enclosure with 12 frogs) in Maine, USA, in 2006. Data for the three enclosures containing *R. pipiens* are presented together because the proportion of frogs detected was always 100%. Proportion of frogs detected dropped for *R. sylvatica* after the minimum daily temperature fell below 0°C for the first time.

remained high until 11 October 2006 for the aquatic hibernator *R. pipiens* (Rorabaugh 2005), we speculate that adult *R. sylvatica* began to enter subterranean hibernacula (Redmer and Trauth 2005) in refugia below our detection range with the PIT-pack, and thereby reduced the proportion of frogs detected. We are confident that the enclosures were escape proof (only one of 1600 *R. sylvatica* and *Ambystoma maculatum* stocked into 64 enclosures in 2005 escaped; SMB and MLH, unpubl. data). Although the steel walls reduce detection range when the antenna is nearby, we detected adult *R. sylvatica* within ~ 5 cm of the fences at depths of 16 cm deep on 27 September.

A PIT-pack is a non-invasive method for locating tagged individuals, and this technique can make multiple recapture studies in confined areas more feasible. Most studies using terrestrial enclosures use destructive sampling (e.g., Rodda et al. 2001) or pitfall trapping to sample or census animals in enclosures (e.g., Bailey et al. 2004). With a PIT-pack, a user can repeatedly search an enclosure with minimal disturbance. Advantages of this technique for sampling enclosures are that it is relatively noninvasive, the user can search until all animals are detected, and detection probability should remain at 1.00 unless the study animal is likely to move below a depth of 13 cm (detection range of the PIT-pack; Fig. 2). The effectiveness of the PIT-pack would be limited for species that burrow deeper than 13 cm. For example, *Ambystoma maculatum* burrows up to 1.3 m in winter (Semlitsch 1983). In addition, some species may not be detected during some seasons. For example, *Spea multiplicata* burrows 1.3–10 cm deep in summer and up to 90 cm in winter (Rubial et al. 1969).

Two potential future applications for this technology are tracking in subterranean environments and tracking juvenile anurans. Anurans, especially bufonids (e.g., Eggert 2002), are known to use the subterranean environment as a refuge from thermal extremes and to conserve water (Duellman and Trueb 1986). Ranid frogs can dig their own burrows (Parris 1998), and many species use burrows excavated by other animals (e.g., Blomquist and Tull 2002; Lips 1991). However, the duration of time spent in the subterranean environment is not well studied, and PIT-tag telemetry could be used to non-invasively monitor amphibians in shallow subterranean habitats (see the study design of Quintella et al. 2005 for a possible method). A PIT-pack would be an effective technique for tracking burrowing species that use shallow burrows <

TABLE 1. Number of pairs of adult *Rana sylvatica* identified and observed ovipositing at a breeding pond in Maine, USA, in 2007; number of pairs disturbed with a PIT-pack prior to laying or identification of both individuals; additional pairs observed and not disturbed but both individuals were not identified or the pair was not observed ovipositing; and new egg masses observed the next morning. Males began calling on 16 April 2007, but females were not present until 22 April at which time we began nightly observations at this vernal pool.

Date	Pairs identified and observed ovipositing	Pairs disturbed	Additional pairs observed	New egg masses observed
22 April	0	0	0	0
23 April	0	0	0	0
24 April	16	4	3	17
25 April	2	0	0	2
26 April	4	2	2	4
27 April	0	0	0	0
28 April	3	1	2	3
29 April	0	0	1	0
30 April	0	0	0	0
1 May	0	0	0	0
2 May	0	0	0	0
Total	25	7	8	26

13 cm deep (e.g., *Spea hammondii*; Morey 2005).

Juvenile survival and movement can be important factors in population persistence (e.g., Red-legged Frogs in Biek et al. 2002; Conroy and Brook 2003). For example, dispersal in most amphibian species probably occurs as juveniles (e.g., Berven and Grudzen 1990; Dole 1971). Survival and movement probably are quite different in many anuran species, and PIT-based telemetry could be used to improve knowledge about the ecology of juvenile and small adult amphibians. However, the applicability of PIT-tag telemetry to free-ranging individuals could be limited. The technique will probably work best with animals that have small home range sizes and are not likely to use the subterranean habitat deeper than 13 cm during the period of study. Searching the terrestrial habitat for moving individuals (e.g., dispersing juveniles) could be labor-intensive and thus costly and only generate low recaptures of marked animals (see Arntzen et al. 2004 for a detailed analysis of the use of PIT tags and associated costs of a capture-mark-recapture studies). For example, searching the 14.4-m^2 enclosures took 6 ± 4 (± SD) minutes with the 0.20 × 0.25 m head antenna across all forest types. In addition, dispersing or migrating animals can move relatively long distances in a short period when environmental conditions are conducive to movement (e.g., a warm, rainy night for pond-breeding amphibians in Maine, USA), which would necessitate more frequent relocation in these conditions.

We used a PIT-pack to non-invasively identify 40 pairs of PIT-tagged *R. sylvatica* in amplexus (Table 1), and relocate and monitor 25 of these pairs until the female oviposited. The number of pairs we identified and monitored until the female oviposited each night was highly correlated with the number of new egg masses in the pond the following morning (Pearson's correlation $r = 0.983$, $p < 0.0001$). This result indicates that we identified most of the frogs that successfully bred in the pond and the other 59 frogs we captured entering the pond did not successfully breed. In most instances where both male and female were identified, we were able to position the antenna underwater below the pair to read the female's tag. In seven instances, we were able to identify only the male because his PIT tag interfered with detection of the female's tag (Table 1, additional pairs observed column). We lost track of one pair prior to observing oviposition. The male stopped amplexus by releasing the female (Table 1, pairs disturbed column) when we placed the antennae near seven pairs. This disturbance typically occurred after we identified the male and moved the water and vegetation while moving toward the pair with the antenna to identify the female. We speculate that using a PIT-pack to identify breeding pairs of *R. sylvatica* was much less invasive than would be required using other techniques. Identifying animals marked with visual implant elastomer or toe clipping usually requires handling, and externally attached radio-transmitters can interfere with swimming and amplexus in some frogs (e.g., Muths 2003).

In summary, we successfully used PIT-tag telemetry to track recently metamorphosed and adult ranids in the terrestrial and aquatic environments, and this technique has potential for many more applications in anurans and other small animals, such as monitoring of animals in the shallow subterranean environment. Limitations for PIT tag and PIT-pack use are tag size and limited detection range. We successfully implanted 12-mm tags into ranids > 30 mm SVL. Currently available, 8-mm tags should be suitable for frogs > ~ 20 mm SVL and ~ 0.7 g, but use with smaller animals is not possible due to tag size. Also, additional work is needed to assess the long-term affects of tagging on animals of this size. A PIT-pack can detect 100% of tags in the terrestrial environment to a depth of 13 cm and > 90% of tags to a depth of 20 cm.

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A Minimally Invasive Method for Obtaining Venom from Helodermatid Lizards

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Biomedical researchers are examining the venoms of several reptiles in their search for bioactive peptides that may be beneficial to human medicine (Chen et al. 2002; Raufman 1996). Acquiring venom for research can be problematic. Some venoms are commercially available from biochemical supply companies, while others, such as Beaded Lizard *(Heloderma horridum)* and Gila Monster *(H. suspectum)* venoms, may only be periodically available (in our experience), may be of suspect origin, and are expensive. Therefore, researchers may have to collect venom from live or recently killed animals they have direct access to. In the past, proteomic and genomic research on helodermatid venom toxins often resulted in animal sacrifice or surgical removal of the lizard's venom glands (Chen and Drucker 1997; Pohl and Wank 1998).

Sacrificing animals for such research may be deemed objectionable on moral and ethical grounds or present conservation concerns. Thus, researchers may need to collect venom from live lizards, but this, too, can be problematic.

Helodermatid lizards are protected, either federally (in Mexico) or by state governments (in the U.S.), and all helodermatids are listed under CITES (Levell 1997). Thus, it can be difficult to acquire these animals. Venom collection from helodermatids may prove difficult due to the nature of the helodermatid venom apparatus (Strimple et al. 1997). Additionally, work with live venomous lizards presents safety risks, both to the researchers and the lizards, and necessitates special training and equipment to manipulate them safely (Poulin and Ivanyi 2003). Surprisingly, helodermatid bites are not uncommon and, at a minimum, these bites can be extremely painful. The only fatalities reported from Gila Monster bites are suspect (Beck 2005; Brown and Carmony 1999), but its venom and that of *H. horridum* can have systemic effects that can be life-threatening to humans, including a rapid drop in blood pressure (which can result in hypotensive shock) (Burnett et al. 1985; Preston 1989), severe angioedema (Piacentine et al. 1986), coagulopathy and renal failure (Preston 1989), acute myocardial infarction (Bou-Abboud and Kardassakis 1988), and anaphylaxis (Cantrell 2003).

We explored several published methods of helodermatid venom collection wherein the investigators forced the lizard to bite the edge of a saucer, which it was inclined to do (and, once the animal had seized the saucer, it was hard to remove); or offering a sponge material for the lizard to bite, with the venom collected from the sponge after the animal released it (Arrington 1930; Mitchell and



FIG. 1. Medicine dropper (60 ml) with rubber bulb, over plastic tube. Note: that only the squeeze bulb with plastic tube is used with this technique.

Reichert 1883; Russell and Bogert 1981). In addition, Stuart et al. (1998) demonstrated the toxic effects that anesthesia and parasympathetic stimulation can have on *Heloderma* while collecting venom. These techniques were found to be impractical, or injurious to the lizards, and/or ineffective. However, modifying the technique of offering a rubber-covered object to bite (Russell and Bogert 1981) worked extremely well.

Materials and Methods.—After the lizard was safely restrained (Poulin and Ivanyi 2003), had opened its mouth and the mouth cavity had been rinsed with water or saline, we presented it with a plastic-reinforced rubber squeeze bulb (14.5 mm diameter) from a Nalgene® 60 ml medicine dropper (Fig. 1). As soon as the bulb contacted the lizard's mouth, the lizard would voluntarily bite down on the bulb. Care was taken to ensure that the posterior teeth (toward the angle of the jaw) engaged the bulb. The lizard was then held with its head at a 30–45° angle (below horizontal) and its mouth was suspended above a glass or plastic vessel (Fig. 2).

Results and Discussion.—After a lizard bites the squeeze bulb, released and compressed its jaws several times, drops of venom would be produced and the venom would drop into the vessel from along the gums of the lower jaw (Fig. 2). Initially, 40 drops (~ 2 ml) of venom were obtained from a several adult specimens. Subsequent trials suggest that this volume of venom can frequently be obtained using this technique but the quantity of venom varies with animal size and vigor (range of 1–4 ml), and it is important to note that the venom may be mixed with saliva and blood. Though the amount of venom per bite diminished after several jaw compressions, generally enough venom was collected in two minutes, allowing us to stop the trial. After each trial, the animal was placed back in its enclosure. In every case, as soon as the lizard was released, it would release the medicine dropper, making it easy to retrieve.

This method was used on six each of *H. horridum* and *H. suspectum* during late morning to early afternoon hours in spring, summer, and autumn. The lizards ranged from subadults (2–3 yrs. old) to large adults (up to 21+ yrs. old), and in both species, males and females were used for venom collection. All of the animals had been in captivity for a minimum of 2 years and a maximum of 21 years. Each lizard would bite and release (but not let go of) the bulb in a rhythmic pattern (i.e., bite and hold down for 4 seconds, bite and hold for 6 seconds, etc.). Though the defensive attitude of animals varied, only the oldest animal (an adult male Gila Monster), displayed less vigor in biting frequency (quantity of bite compressions).

Collected venoms (pooled by species/collection event) were stored at 4°C and immediately transported to a facility for lyophilization and then kept at -80°C. After CITES permits were obtained, lyophilized venoms were shipped to the research laboratory for genomic and proteomic analysis. The lyophilized venoms from *H. suspectum* and *H. horridum* were separately analyzed by gel permeation chromatography, reverse-phase HPLC, and mass spectrometry for the isolation and structural characterization of bioactive peptides. The typical and novel helodermatid venom peptides, exendins and helokinestatin respectively, were both isolated and characterized from the lyophilized venoms collected by this method (Chen et al. 2006; Kwok et al. 2008). The precursor cDNAs of exendin-4 and exendin-3 were also cloned where the lyophilized venoms used as the material for reverse transcriptase PCR (Chen et al. 2006).

Data published by Chen et al. (2006) and Kwok et al. (2008) showed that this technique for helodermatid venom collection worked extremely well. The advantages of this method are that 1) generally it is non-injurious to the lizard; 2) reduces animal stress and the amount of blood from breaking teeth that might be inadvertently collected using other methods (Mitchell and Reichert 1883); and 3) maximizes the quantity of venom that can be safely collected.



FIG. 2. Restrained Gila monster biting down on rubber bulb. The animal's head is held at a 30-45° angle (below horizontal). Note drop of venom hanging from lower jaw of lizard.

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Analysis and Comparison of Three Capture Methods for the Eastern Hellbender (*Cryptobranchus alleganiensis alleganiensis)*

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The Hellbender (*Cryptobranchus alleganiensis* Daudin) is North America's only member of the Cryptobranchidae, and one of the world's largest salamanders. Hellbenders are elusive animals; they are nocturnal, cryptically-colored, and spend most of their time beneath large rocks on the bottoms of swift-flowing streams. These characteristics make them difficult to locate and capture. A variety of capture methods have been tested and evaluated, but even the most widely accepted of these are still questionable in terms of their impact on breeding habitat and reproductive behavior. In addition, no effective technique has been reported to consistently locate and capture larvae or juveniles.

A common method of searching for Hellbenders involves lifting the upstream ends of rocks greater than 30 cm diameter, and capturing any Hellbender below it by hand or net with or without the aid of a mask and snorkel. Whereas this method is inexpensive and relatively quick (Nickerson and Krysko 2003), turning rocks during the breeding season may disrupt nest sites and result in mortality of eggs or larvae (Williams et al. 1981). Although appropriate for locating large adults, it may be ineffective for locating smaller size classes, especially larvae and juveniles less than 20 cm total length (Peterson et al. 1983). Nickerson and Krysko (2003) speculated that turning small rocks and other objects in shallow water might yield more larval Hellbenders. Additional disadvantages to rock turning include injury to the researcher due to heavy lifting, difficulty seeing Hellbenders because of stream surface glare, possibility of Hellbenders escaping unnoticed by researchers, inability to locate Hellbenders in deep water, and time required for silt to clear after a rock is lifted (Nickerson and Krysko 2003; Pauley et al. 2003).

Electroshocking has been used extensively with high capture success reported (Williams et al. 1981). Bothner and Gottlieb (1991) reported that Hellbenders were completely unaffected by the electrode unless directly touched with it, and even then appeared only mildly disturbed. Regardless of capture success, electroshocking equipment is heavy and expensive, and risk to

researchers and Hellbenders, especially eggs and larvae, is potentially significant (Nickerson et al. 2002; Nickerson and Krysko 2003).

Searching the stream bottom at night using spotlights is another technique that has been used to locate Hellbenders (Humphries and Pauley 2000). Hellbenders observed in the open are captured by hand or net, and rocks are lifted when Hellbender heads are observed protruding out from underneath. Nighttime searches may be useful for determining the presence/absence of Hellbenders during periods of peak nocturnal activity (Humphries and Pauley 2000). Humphries (2007) reported on an apparently unique population in North Carolina that seasonally exhibits a high degree of diurnal activity which made daytime visual searches very productive.

Several attempts have been made to capture Hellbenders using baited traps. Hellbenders are believed to forage at least partially by chemoreception, and have been documented responding to dead bait from a considerable distance (Nickerson and Mays 1973). Wire mesh traps baited with chicken liver proved unsuccessful (Soule and Lindberg 1994), but hoop traps baited with sucker fish did successfully capture Hellbenders (Kern 1984). Despite the mixed success with which traps have been used, they allow researchers to investigate deeper areas, and are not affected by turbidity.

Nickerson et al. (2003) effectively used snorkeling and SCUBA to capture Hellbenders, including larvae, in deep water areas. In their study more than 20 Hellbenders under 20 cm total length were located and 16 of these were gilled larvae. Most were located under small rocks, or in the interstices of small accumulations of gravel or gravel mixed with twigs near the stream banks, but some were located under large rocks in deeper water, or in deep gravel beds. Petokas (pers. comm.) has captured Hellbenders in water as deep as 6 m in the Susquehanna River in Pennsylvania using SCUBA techniques.

The objective of this study was to examine three methods of searching for Hellbenders in terms of efficiency and effectiveness: turning rocks, trapping, and searching along stream banks. Advantages, disadvantages, and limitations also were assessed in order to recommend a capture protocol for Hellbender population studies that will minimize disturbance and increase the likelihood of locating individuals of a variety of size classes.

Materials and Methods

Study Sites

This study was conducted at eight sites in three streams of the Allegheny River drainage in Cattaraugus County, New York, USA. Extant populations of Hellbenders were documented in these sites by a previous study (Bothner and Gottleib 1991). Substrate composition and embeddedness were visually estimated along transects at each site. Percent composition was visually estimated across the entire transect. Embeddedness was estimated at each bank, and at $^1/_4$, $^1/_2$, and $^3/_4$ of the stream width. Three independent estimations were averaged for each transect.

Capture Methods

Rock Turning.—As part of a mark-recapture study, rock turning searches were conducted between late August and October of 2004 and 2005, and generally involved two to four active searchers. Hellbenders were located by slowly lifting the upstream ends of suitable rocks in each study site. A peavey or cant hook was used to provide leverage when needed. Suitable rocks were defined as those measuring at least 30 cm in diameter that did not require the use of multiple leverage devices for lifting. Before lifting a rock, a net was placed against the downstream edge to catch Hellbenders escaping with the silt plume. Hellbenders remaining in place or moving upstream were captured by grasping them behind the head and maneuvering them into a trout net. Rocks deemed likely to be nest sites were not turned in 2005. This is because during the 2004 survey, several nests were discovered and later found to be destroyed, possibly as a result of being disturbed.

Bank Searches.—Bank searches were conducted at all sites during the summer of 2005, between late May and late August, in an effort to locate smaller size classes. This technique was performed by two searchers. Habitable stretches of bank area, defined as having substrate larger than 7 cm in diameter, within the study site were divided into sections 1 m wide and extending 4 m into the stream. Five percent of these sections were randomly selected for search in each site (see Foster 2006 for site descriptions). Searching involved turning or agitating all substrate particles in the section. Aquarium nets with flat bottoms were held downstream to capture any juvenile hellbenders that were observed. Hellbenders were located by feel and captured by hand when visibility was poor.

Trapping.—The traps were a rectangular box design made of 1.3 cm plastic-coated hardware cloth. The traps measured 61 × 46 × 23 cm with a funnel on one end 7.5 cm high and 10 cm wide. A hinged door on the end opposite the funnel, held closed with a bungee cord, could be opened to add bait or remove any captured animals (Fig. 1). During the summer of 2004 we conducted a preliminary trapping test at Site No. 5 to aid in protocol development. We informally tested two baits: previously frozen venison (*Odocoileus virginianus*) and White Sucker (*Catostomus commersonii*). Both baits were selected for their availability, and

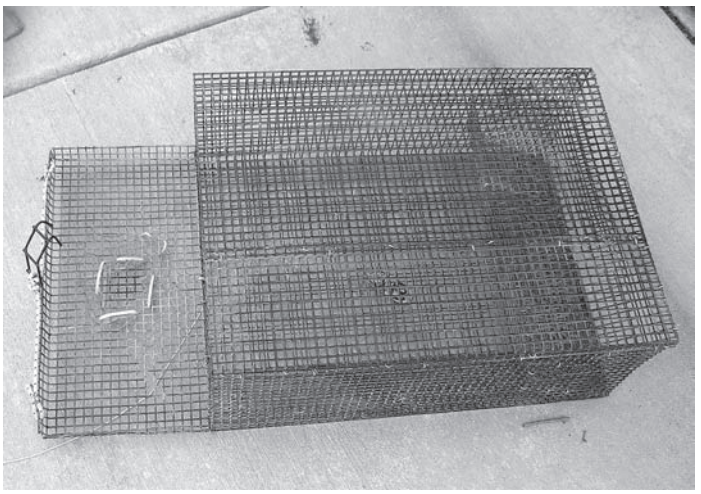


Fig. 1. Trap used to capture Hellbenders in Allegheny River drainage during the summers of 2004 and 2005. Bait (White Sucker) was attached to the inside of the hinged door in a wire mesh cage (later the cage was removed and replaced with plastic zip ties, see text).

sucker fish has been used successfully to capture Hellbenders in hoop traps (Kern 1984). Based on the preliminary data generated, we selected White Sucker as the bait for our future trapping efforts.

Trapping was conducted in all sites during the summer of 2005, between late May and late July. Trapping was performed at one site in May, two sites in June, and five sites in July. We performed four consecutive nights of trapping in each site. The number of traps used varied with site size. Traps were set approximately 20 m apart in potentially habitable areas with sufficient water depth to cover the entire trap (0.25 m minimum). These areas included sections of stream bed covered with large rocks, wood, or decaying vegetation, and areas with rock ledges at the banks. Traps also were set in areas that lacked large cover rocks, but were adjacent to habitable areas. In areas that contained habitat not accessible by turning rocks, such as rock ledges or large, unliftable rocks, and in areas too deep to be searched by hand, traps were set more densely (up to every 5 m). Traps were baited with pieces of White Sucker placed in a wire mesh cage on the trap door (Fig. 1) and set with the entrance facing downstream. In shallow water, traps were set flat against the stream bottom. In deep water, this often was not possible to ensure. Traps were tied to sturdy vegetation and weighted down with rocks. They were checked and bait was changed daily, except for site No. 8, at which bait was only changed every other day. Baiting and setting traps was completed by 1500 h each day, and traps were checked the following morning.

Evaluation of Capture Methods

Efficiency.—Capture efficiency was calculated for each method as the number of Hellbender captures per unit of effort. For the two manual search methods, effort was measured in person hours. Person hours included all time spent actively searching for and processing Hellbenders. Hellbenders were processed as they were found and processing time averaged 8 min/Hellbender. For the trapping method, effort was measured in trap nights. Trap nights were calculated by multiplying the number of traps set by the number of nights deployed. One trap night required 0.5 person hours (it took two people approximately 15 min to bait, set, and check a trap). All Hellbender captures, including recaptures, were included in this analysis.

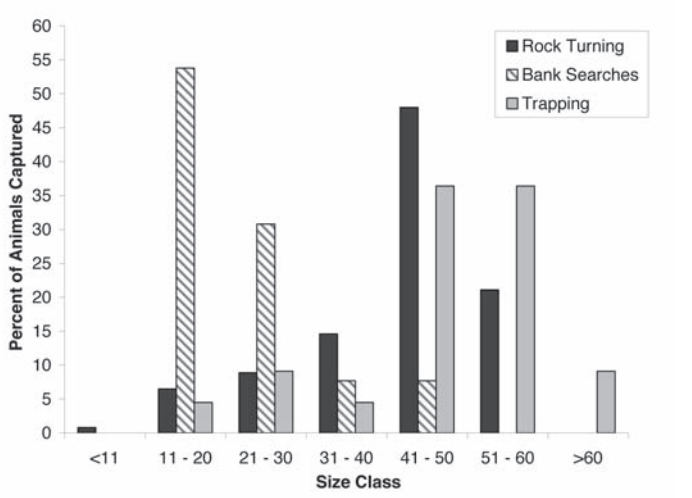


FIG. 2. Relative success of three capture methods in locating various size classes of Hellbenders (Rock Turning, N = 123; Bank Searches, N = 14; Trapping, N = 22; recaptures are not included in these numbers).

Effectiveness.—Each of the three methods was evaluated in terms of its effectiveness at locating Hellbenders of different sizes. Hellbenders were grouped into seven size classes, and the percentage of Hellbenders in each size class was determined for each method. Each animal was only counted once for this analysis, regardless of how many times it was captured. Each technique also was assessed in terms of its ability to capture Hellbenders at different water depths.

RESULTS

Study Sites.—Site areas ranged from 2355 to 15,741 m^2. Substrate in all sites included rocks > 30 cm diameter covering 4–8% of the stream bed, and fine particles (sand and silt) and gravel were prevalent. Site No. 8 also contained large areas of exposed

TABLE 1. Capture efficiency, measured as catch per unit effort, for three methods used to locate Hellbenders in the Allegheny River drainage in New York State. For rock turning and bank searches, effort was measured in person hours. For the trapping method, effort was measured in trap nights. One trap night is roughly equivalent to 0.5 person hours since it takes two people approximately 15 minutes to set a trap. Site No. 3 is excluded because no Hellbenders were observed.

Site	Rock Turning (No. of captures)[1]	Rock Turning (Captures / person hour)	Bank Searches (No. of captures)	Bank Searches (Captures / person hour)	Trapping (No. of captures)	Trapping (Captures / trap night)
1	5	0.21	2	0.50	1	0.03
2	19	0.35	7	0.47	2	0.03
4	33	0.49	0	0.00	4	0.05
5	32	0.55	0	0.00	4	0.03
6	12	0.32	0	0.00	2	0.02
7	33	0.83	5	1.00	1	0.01
8	23	0.64	0	0.00	8	0.10
total	157		14		22	

[1]These numbers include recaptures.

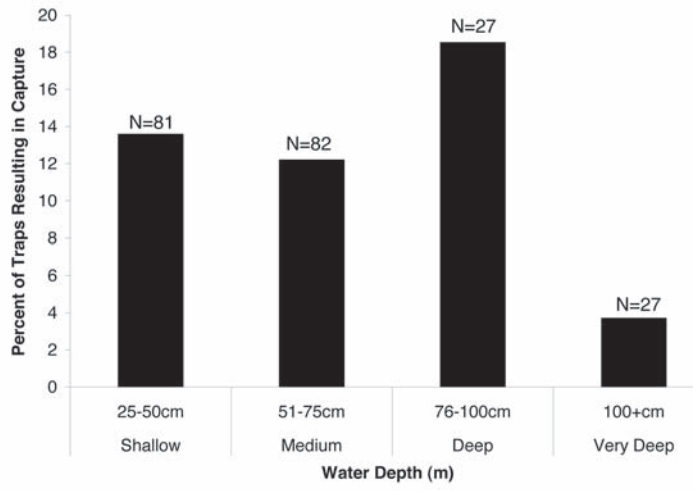


FIG. 3. Relative success of traps placed at different depth ranges. N = number of traps placed at each depth.

bedrock. Substrate embeddedness was greater than 50% at all sites. The study streams were all relatively shallow (< 1 m deep in most places) and very clear during the study period.

Efficiency.—Capture efficiency varied by site for both manual search methods (Table 1). A total of 317 person hours were spent on rock turning and 55 person hours were spent on bank searching. A total of 157 captures (including recaptures) resulted from rock turning searches. Rock turning yielded 0.2 to 0.8 captures/person hour. Bank searches resulted in a total of 14 captures. In four of the seven sites, no Hellbenders were captured using the bank searching method. In the remaining three sites, capture efficiency was higher for bank searching than for rock turning, ranging from 0.47 to 1.0 captures/person hour. Traps were set for a total of 627 trap nights among all seven sites, resulting in 22 captures. Capture efficiency was highly variable between sites, ranging from 0.01 to 0.10 captures/trap night (Table 1). Only rock turning resulted in recaptures.

Effectiveness.—Each of the three methods was successful at locating both adult and juvenile Hellbenders, but only the two manual search methods resulted in the capture of gilled larvae. The smallest animal, less than 11 cm total length, was captured using the rock turning method. Captures of very large Hellbenders, greater than 60 cm total length, resulted only from the use of traps. No method was capable of locating all size classes equally (Fig. 2). Rock turning searches were biased toward middle-sized adults, between 41 and 50 cm total length. Of 123 individual Hellbenders captured using this method, 48% were in this size class. Bank searches were biased toward immature animals. Of the 14 Hellbenders captured in bank searches, 53.8% were between 11 and 20 cm total length. An additional 30.8% were between 21 and 30 cm total length. Trapping was most successful in capturing large adults. More than 80% of the 22 Hellbenders captured in traps were greater than 40 cm total length.

Each method was capable of locating Hellbenders at a range of depths, although manual search methods were limited to water <1 m deep. Bank searches were successful within the narrowest depth range, from 0.145 to 0.540 m. Rock turning captures ranged in depth from 0.155 to 0.85 m. Trapping had the greatest successful depth range, with Hellbenders captured from 0.28 to 1.25 m depth.

TABLE 2. Summary of advantages, disadvantages, and limitations associated with three Hellbender capture methods used in the Allegheny drainage in 2004 and 2005.

Method	Advantages	Disadvantages	Limitations
Rock Turning	- High capture efficiency - Locates some juveniles - Risk of injury to Hellbender - May reduce reproductive success (if done during breeding season)	- Labor intensive - May damage habitat - High turbidity - Low light - Rock size and mobility - Depth - Minimum of five person hours per site recommended	- Wind - Rain
Bank Searches	- Effective for finding juveniles - High capture efficiency where successful - Potential impacts to reproduction of other stream organisms - May fail to detect presence	- Does not result in high capture rate for larvae - Habitat disturbance	- High turbidity - Rock density - High flow
Trapping	- Little habitat disturbance - Useful for water slightly exceeding maximum depth of other methods - Useful for areas with unliftable rocks or ledges - Captures largest size class - Only method that detected Hellbenders at all sites	- Labor intensive - Low capture success - Requires large supply of bait - Risk of injury to Hellbender - Incidental catch may result in mortality of turtles - Cannot use during breeding season - Did not detect larvae	- Shallow water (< 0.25 m deep) - Deep water (> 1 m deep) - Minimum of 100 trap nights / site recommended

Trapping appeared to be most successful in deep water, between 0.76 and 1.0 m (Fig. 3). Of 27 traps set at this depth range, 18.5% resulted in captures. Less than 15% of traps set in shallower areas resulted in captures, and fewer than 4% of traps set in water >1 meter were successful in capturing Hellbenders.

Discussion

Of the three methods examined, rock turning was the most efficient when viewed in terms of overall catch per unit effort. However, in some streams, bank searches were also highly efficient. Capture efficiency for trapping was lower than for rock turning in all sites, and was lowest in terms of overall catch per unit effort.

Bank searches were notable in the "all or nothing" type of capture success seen between sites. At all three sites where the method was successful, it exceeded the capture efficiency of rock turning. In the remaining four sites, it yielded no captures. This disparity is most likely due to differences in habitat between the sites. Bank searches were successful where stream margins included deep cobble piles interspersed with larger rocks. These areas presumably provide refuge from predation and an abundant food supply.

Sites at which bank searches were unsuccessful fell into two categories: those at which bank habitat was poor, and those at which bank habitat was exceptionally good. Poor bank habitat was characterized by silt and sparse rock cover. Exceptionally good bank habitat was characterized by dense piles of various-sized cobble and boulder along the stream edges. These areas were difficult to search thoroughly. It is possible that employing seines, buried into the substrate on either end of the search area, might increase the success of this method in areas with good habitat.

The capture rate for rock turning can be impacted by water and weather conditions. Hellbenders are difficult to see when the surface of the water is choppy. When turbidity is high, Hellbenders are often lost in the silt plume that is generated by lifting the rock. Under certain circumstances, a mask and snorkel might help alleviate these problems (Nickerson and Krysko 2003). Early in our study we tried using a mask and snorkel for both rock turning and bank searches, but because our streams were extremely shallow and clear this method did not prove useful. Even in our streams, SCUBA may have been useful for turning rocks in deep pools. However, we did not attempt this method and thus could not manually search for Hellbenders in areas deeper than ca. 1 m.

The usefulness of trapping may be limited by the nature of Hellbenders as predators. Hellbenders often lie in wait for prey, with only their noses protruding from rocks (Humphries and Pauley 2000), utilizing a powerful type of suction feeding enabled by unique jaw asymmetries and hyoid movements (Lorenz Elwood and Cundall 1994). This may limit their need to move about in search for food (Nickerson and Krysko 2003), reducing the likelihood of their capture using traps. On the other hand, Humphries and Pauley (2000) suggest that during times of high metabolic demand Hellbenders may forage more actively. This may increase trapping success at some times of the year, especially prior to the breeding season.

Prey availability may influence Hellbender foraging. Large numbers of crayfish were observed in our sites throughout the study period, which may have minimized trapping success. Bait choice also may affect trapping success. Although White Sucker was successful in capturing Hellbenders in our study, other baits may prove more enticing. For example, Hellbenders may be attracted to bait with fresh blood (Bishop 1941).

Traps appeared to be most successful when set at depths between 0.75 and 1.0 m. Few Hellbenders were trapped at depths >1 m, possibly due to difficulty in setting traps flat against the stream bottom at these depths. This problem could be corrected by diving to the bottom using a mask and snorkel or SCUBA equipment and properly setting the trap. Diving to set deep-water traps may be useful if rock ledges or unliftable rocks are present.

Each of these methods has associated advantages and disadvantages that affect their usefulness in various situations (Table 2). Rock turning may be the most efficient method for capturing Hellbenders, but may have serious repercussions during the breeding season. Hellbenders tend to select nest rocks that are mostly embedded in smaller substrate and have only a single opening, which the male defends (Bishop 1941). Once the nest is disturbed, several openings may exist, exposing the eggs or larvae to a variety of predators. In addition, overturning potential nest rocks may render them unsuitable as nest sites because they will no longer be sealed by small particles.

Bank searches are extremely useful for locating juvenile Hellbenders, but may be highly disturbing to the habitat. Many organisms may be affected, including crayfish, small fish, mudpuppies, tadpoles, and macroinvertebrates. While not impacting Hellbender reproduction, bank searches during the summer may affect the reproduction of some other organisms.

Trapping was the only method that did not cause substantial disturbance to the stream habitat. It also worked in situations where other methods failed, such as in habitat areas with very large rocks or rock ledges. Of the 22 Hellbenders trapped in 2005, 16 were not located using any other method. Of these, one was trapped near a rock ledge, seven were trapped near unliftable rocks, and five were trapped in deep water.

Trapping also has some disadvantages. Traps are heavy, bulky, and take a considerable amount of time to set. There is risk of injury to Hellbenders. Several Hellbenders sustained minor injuries on the original wire bait holder. As a result we removed the holders and used plastic zip ties to hold bait for the remainder of the study. There is also a risk to other animals that may become caught in the trap, particularly turtles. Trapping should not be conducted during the breeding season, since females captured in traps overnight could become stressed and drop their eggs, and captured males would be prevented from returning to their nests rocks, possibly exposing eggs to predation.

When determining which capture method to use for studying a particular group of Hellbenders, it is important to consider the attributes of the site and the advantages versus the disadvantages of each method. Our results suggest that no single method for Hellbender capture is capable of providing access to all portions of the population. Based on its high catch efficiency and ability to locate some juveniles, rock turning is most likely the best method for studies aimed at determining population size. The inclusion of rocks smaller than 30 cm diameter in bank areas may increase the ability of this method to provide information on age structure. However, the main advantage of rock turning in the breeding season, gathering sex ratio data, is outweighed by the potential negative impacts to reproductive success. To provide the most complete

data on Hellbender population structure, including age structure and habitat usage, we recommend a combined approach using extensive summer rock turning, bank searches focused on appropriate cobble piles adjacent to large rock areas, and limited trapping in areas of deeper water, or where unliftable substrate renders other search methods impossible.

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Relative Efficacy of Three Different Baits for Trapping Pond-dwelling Turtles in East-central Kansas

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The diverse array of collection methods used to sample freshwater turtles (e.g., Gibbons 1990; Glorioso and Niemiller 2006; Plummer 1979; Vogt 1980) do not necessarily provide equivocal results in ecological studies of freshwater turtles. Using different methods may significantly influence estimates of abundance, sex ratio, and population/community structure (Frazer et al. 1990; Gamble 2006; Ream and Ream 1966; Thomas et al. 1999). Frazer et al. (1990) argued that studies designed to compare different methods of capturing turtles were needed to ensure that the results of ecological studies accurately reflect reality.

Baited funnel traps of various designs are commonly used to sample freshwater turtle populations/communities, using a variety of baits (see Gibbons 1990; Kennett 1992; Plummer 1979). We are aware of three published studies that attempt to quantitatively compare the effectiveness of different baits on the capture rate of freshwater turtles (Ernst 1965; Jensen 1998; Voorhees et al. 1991). We experimentally examined the effectiveness of three types of bait in funnel traps to capture *Trachemys scripta elegans* and *Chrysemys picta bellii*. The baits selected were canned creamed corn (*Zea mays*), canned Jack Mackerel (*Trachurus symmetricus*), and frozen fish (*Pomoxis annularis* or *Lepomis cyanellus*); these baits were selected because they were commonly used in previous studies.

Methods.—Rectangular frame nets (65 × 90 cm frame covered with 3.8 cm treated nylon mesh; Nichols Net & Twine Inc.) were used to capture Red-eared Sliders (*T. s. elegans*) and Western Painted Turtles (*C. p. bellii*) in a complex of eight manmade ponds (pond sizes ranged from 0.2–9.6 ha) located on or within 2.5 km of Emporia State University's Ross Natural History Reservation (RNHR; Spencer 1988) near Americus, Kansas, USA (38.49491°N, 96.33540°W; NADS 1983). Three frame nets were set in each of the eight ponds (total = 24 frame nets). Baits were placed in perforated PVC tubes so that turtles could detect but not consume baits. The three frame nets within each of the eight study ponds were baited either with canned creamed corn, canned jack mackerel, or frozen fish (i.e., each of the three frame nets within a single pond were baited with a different bait). The initial assignment of bait

type to the three frame nets within a pond was random. Thereafter, frame nets were checked daily and the position of the PVC tubes containing the different baits systematically rotated daily among the three frame nets. The purpose of systematically rotating the baits among the three traps within each pond was to equally distribute the possible influence of differences in capture rates between specific trap locations within a given pond. Baits were removed from the perforated PVC tubes and replenished with fresh bait every other day.

Frame nets were set in 1–3 ponds/day over the 5 d period that began 14 May 2007. We reversed this staggered schedule for removal of frame nets at the end of the 13 d study period to maintain an approximately equal number of trap hours in all ponds. Thus, all ponds were sampled continuously for a total of 13 d with substantial temporal overlap of the trapping schedules (i.e., all trapping conducted from mid- to late May). There were 3 traps/pond for 13 d in eight ponds (overall, 7488 trap hours summed across all three baits, 2496 trap hours/ bait, 936 trap hours/pond, and 312 trap hours/pond/bait).

All *C. p. bellii* and *T. s. elegans* captured were uniquely marked using the system described by Cagle (1939). We considered all captures (original captures and recaptures) as independent in statistical analyses.

Trap success may have been influenced by inherent site-specific variation among the eight ponds and/or the temporal variation that may have resulted from slight differences in the precise trapping schedules among sites. Because of possible site-specific variation, we used Analysis of Variance (ANOVA) within a randomized block design to compare the mean number of turtles (of each species) captured with each of the baits during the 13 d study period. Blocking designs are desirable in such situations because they increase the precision of the model by removing one source of known (or suspected) variation (e.g., inherent site-specific variation in capture rates among ponds) from experimental error (Peterson 1985; Sokal and Rohlf 1995). The eight study ponds were considered as blocks, the different baits were the treatments, and mean number of turtles (i.e., either *C. p. bellii* or *T. s. elegans*) captured/pond with each of the three baits served as the response variable. Separation of means was accomplished using Fisher's Protected Least Significant Difference (LSD; Peterson 1985) and alpha was set at 0.05 in all statistical tests.

Results.—We captured 93 (69 original captures + 24 recaptures) *C. p. bellii* and 81 (50 original captures + 31 recaptures) *T. s. elegans* during the 13 d study period. We captured *C. p. bellii* in all ponds and caught *T. s. elegans* with one or more of the baits in all but one pond. Therefore, we excluded this pond from the analyses for *T. s. elegans*. We observed a significant bait effect for both species (*T. s. elegans*: F = 5.25; d.f. = 2, 12; P = 0.023; R^2 = 0.69; *C. p. bellii*: F = 4.73; d.f. = 2, 14; P = 0.027; R^2 = 0.75). We captured significantly more *T. s. elegans* in frame nets baited with frozen fish than with creamed corn, but observed no significant difference between frozen fish and canned mackerel or between canned mackerel and creamed corn (Fig. 1A). Mean separation procedures for *C. p. bellii* revealed that both canned mackerel and frozen fish were significantly more effective than creamed corn but canned mackerel and frozen fish were not significantly different from each other (Fig. 1B).

Discussion.—We concluded that both canned mackerel and frozen fish were significantly "better" than creamed corn for attracting these two species to frame nets. First, we discuss several potentially confounding factors that are known to influence capture rates. For example, captured females may serve as an additional enticement for males to enter nets (Frazer et al. 1990; Jensen 1998; Thomas et al. 1999). However, we did not observe unusually large numbers of males within traps containing females (see Jensen 1998), and we see no reason to expect that the particular food bait within a trap would alter the attractiveness of a female within that trap. Therefore, the influence of this factor should have been equal across all three baits. Likewise, individual turtles sometimes exhibit so-called "trap-happy" or "trap-shy" behaviors (Deforce et al. 2004; Koper and Brooks 1998). But, we do not think that the observed differences were an artifact of such behaviors. First, because of the short duration of our study period many individuals were never recaptured (i.e., captured only once) and most of those that were recaptured were recaptured only once. Second, turtles were not rewarded for entering a trap (i.e., not allowed to consume the baits) and the bait tubes were systematically rotated every day among the three traps within each pond. Therefore, we have no reason to expect the propensity for "trap-happiness" or "trap-shyness" to have differed among the three baits. Therefore, the influence of such behaviors (if any) should have been equal across all three baits.

Consistent with previous studies, we found that using different

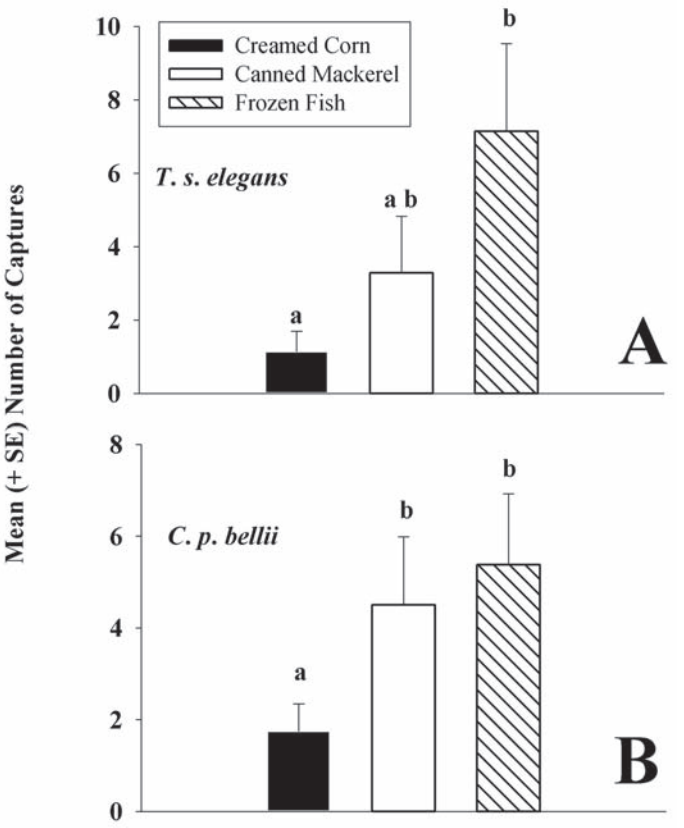


FIG. 1. Mean (+ SE) number of turtles captured/pond during 13 days of trapping (A = *Trachemys scripta elegans*; N = 7 ponds; B = *Chrysemys picta bellii*; N = 8 ponds) with canned creamed corn, canned mackerel, and frozen fish. Means sharing the same lower case letter were not significantly different (Fisher's Protected LSD; α = 0.05).

baits sometimes resulted in differences in capture rates. But various factors limit our ability to directly compare our results with those of previous studies. For example, the three published studies (Ernst 1965; Jensen 1998; Voorhees et al. 1991) were conducted in different geographic locations and/or habitats, sometimes used different baits, and/or involved different species. Our study was conducted in manmade ponds located within a small portion of east-central Kansas and we cannot necessarily assume that our results are applicable across the relatively large geographic distributions of these species. We examined three commonly used baits but there are a large number of baits that have been used as bait in funnel traps. Currently, nothing is known with respect to the relative effectiveness of most of these baits. Likewise, the potential for seasonal, sexual, and ontogenetic variation in the effectiveness of particular baits deserves further consideration.

Acknowledgments.—We thank landowners P. F. DeBauge, P. Matile, R. Moore, and A. S. Webb for generously granting permission to trap in their ponds. We acknowledge the support of the Emporia State University Department of Biological Sciences and thank the department for allowing access to ponds located on the RNHR. We thank T. Gamble for reviewing a previous version of the manuscript. This study was partially funded by an Emporia State University (ESU) Faculty Research and Creativity Grant to R. B. Thomas and an ESU Graduate Student Research Grant to I. M. Nall. All applicable Emporia State University animal care and use policies were followed during the study. Turtles were collected under permit number SC-127-2006 issued to R. B. Thomas by the Kansas Department of Wildlife and Parks.

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A Simple Pitfall Trap for Sampling Nesting Diamondback Terrapins

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The Diamondback Terrapin *(Malaclemys terrapin)* is an estuarine turtle inhabiting coastal salt marshes from Massachusetts to Texas (Ernst et. al. 1994). Previous data on nesting terrapins have primarily been collected via visual searches during peak nesting activity (Feinberg and Burke 2003; Roosenberg 1996; Roosenberg and Dunham 1997). Although effective, this method is time consuming, requires a reasonably large population, and sometimes requires numerous volunteers. Many of these studies occurred along the Atlantic Coast where nesting beaches are located on the mainland. This has allowed researches to easily access nesting beaches to conduct visual searches for terrapins. Nesting beaches in the Northern Gulf of Mexico, however, are located almost exclusively on islands (D. H. Nelson, pers. comm.), making nesting beaches accessible only by boat. Boat travel results in increased travel time and thus decreased searching time for nesting terrapins. To complicate matters, nesting beaches in the northern Gulf Coast are usually small and widely distributed, making typical nesting surveys almost impossible to conduct (Nelson et. al. 2005). Unlike Atlantic coast nesting beaches, beaches in Alabama are largely composed of oyster shells, which prevents locating turtles and their nests via female crawls (a method used in Feinberg and Burke 2003). Given these atypical nesting conditions, we decided that a passive trapping method would be more appropriate for capturing terrapins on local nesting beaches.

Initial efforts with pitfall traps constructed from Christiansen and Vandewalle (2000) fell short of our expectations. These traps did not hold up to the demands of the estuarine environment (e.g., saltwater, winds). Specifically, the wooden lid and metal rod degraded quickly, rendering the trap non-functional. Furthermore, 5-gallon buckets did not seem to provide suitable space for trapped terrapins to maneuver. We used the Christiansen and Vandewalle (2000) design as a starting point and began experimenting with various modifications of their design. Herein, we describe the

modified design that best addressed the specific problems described above.

We erected four, 90-m long drift fences on shell middens (composed of oyster shell) at Barton Island (30°23'N, 88°22'W), Mon Luis Island (30°20'N,88°11'W), and Cedar Point (30°19'N, 88°08'W) in southern Mobile County, Alabama, USA. Pre-staked construction silt fencing, 90 cm in height, was used for several reasons including, low cost, ease of handling, and durability. Fences were buried to a depth of 30 cm leaving 60 cm above ground. Two pitfall traps were installed along each fence 30 m from the ends and 30 m apart. Pitfalls had a self-righting lid that was placed over the pitfall (Fig. 1). This type of lid was chosen for two reasons: 1) to increase the numbers of turtles that were captured, since turtles seemed wary of uncovered pitfalls (Christiansen and Vandewalle, 2000), and 2) to provide shelter from thermal stress. Temperature was monitored in the month of June (tropical storms prevented sampling temperature in July) using HBE International Inc. Minimum-Maximum thermometers. One thermometer was secured with cable-ties midway inside a pitfall trap, while another thermometer was staked on exposed shell adjacent (outside) to the same pitfall trap. Thermometers were reset everyday to acquire daily temperature extremes. Minimum temperature inside the pitfall ranged from 18°C to 23°C and a maximum temperature ranged from 25°C to 29°C. Temperatures outside the pitfall had a minimum range of 24°C to 30°C and a maximum range from 40°C to 47°C (N = 20 days).

Each trap consisted of a single 68.1 L (19 gal) plastic storage container. The rigid construction of the Sterilite® brand worked better than other available styles, as shifting sand and shells of nesting beaches tended to warp and distort other plastic containers. To prevent water accumulation from rain and/or over wash caused by storm events, holes were drilled through the bottom of the containers. The lid was designed to rotate when a large or heavy animal walked across one side or the other. The lid returned to its original, horizontal position after a turtle fell into the trap via a pendulum. Construction of the rotating lid assembly began by drilling holes in the handles where 15.2 cm (6 inch) steel I-bolts were mounted on each handle with 3/8 inch washers and nuts to create a mount for the rotating lid. Next, the outer edges of the lids were cut to fit inside the container, which allowed the lids to rotate freely inside the pitfall trap. The lid was very flimsy, so 1/2 inch PVC tubing was used as a framework for the rotating lid and attached to the lid with 20.4 cm (8 inch) cable ties. The PVC was cut to fit through the I-bolts and capped to prevent sliding of the lid assembly. A hole was cut at the center of the lid for a pendulum to pass through into the pitfall. The pendulum consisted of a 15.2 cm (6 inch) section of 1/2 inch PVC, filled with lead fishing weights, attached to the central rib at the T-joint. The pendulum allowed the rotating lid to remain level even during high winds and right itself after a turtle was captured.

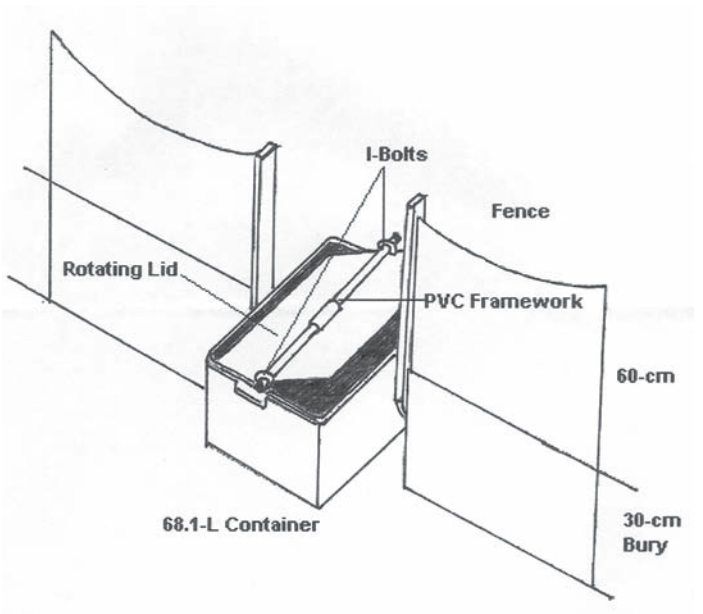


FIG. 1. Diagram for 68.1 L (19 gal) pitfall trap with self-righting lid, shown attached to a drift fence. (Illustration provided by B. Gill)

The labor and construction cost involved in erecting the fences and burying the pitfalls was minimal compared to hourly monitoring of nesting beaches. Total cost of one 90 m fence with two pitfall assemblies was US $90, and each array required 2 person-hours for construction and instillation. No part of the traps needed to be replaced throughout the nesting season, which included two tropical storm events.

From 13 May to 19 August 2005, we successfully captured 14 gravid female terrapins 16 times in 310 trap days (one trap day = one pitfall open for one night) for a catch per unit effort of 0.05 terrapins per trap day. Capture rates were greater than those of modified crab traps (similar traps used by Wood 1997) sampled near the nesting beaches, 21 captures over 2048 trap days (0.01; Borden, unpubl. data). Although catch per unit effort was low, terrapin populations in Alabama appear to be uncommon to rare and highly isolated (Nelson and Marion 2004). During the nesting season, the plastic pitfalls did not degrade. However, it was necessary from time to time to adjust the fit of the lid with a utility knife to ensure unobstructed rotation. We opened traps on Mondays and closed them on Fridays. Traps were checked daily. When not in use, we covered traps with a 60 × 80 cm piece of rubber-coated chicken wire and staked the wire at each corner, to prevent the inadvertent capture of terrapins. We observed no apparent predation on terrapins within the traps, although Raccoons *(Procyon lotor)* and River Otters *(Lontra canadensis)* were observed on the nesting beaches. Although nesting beaches are used by humans, there was no evidence of trap disturbance during this study.

We found this technique to work well for terrapins inhabiting estuaries with minimal nesting habitat. However, it may be less effective than visual searches in habitats with expansive or readily accessible nesting beaches. Longer drift fences with more pitfalls will need to be tested to determine their effectiveness at large nesting areas. Possible disadvantages of this technique are that nesting females may be forced to alter nesting behavior when they encounter the fence. In our experience, however, turtles nested along and even beneath drift fences with no adverse impacts.

In conclusion, although pitfall traps have been used to capture turtles for many years (Congdon et. al. 1987; Gibbons et. al. 1983; Tucker 2000), our trap is the first to incorporate a pendulum and the first designed for harsh, estuarine environments. This trapping system will be appreciated by terrapin researchers along the northern Gulf Coast where typical capture methods (e.g., visual transects, locating signs of nesting females) are not effective. Overall, this

trapping system seems to be a relatively inexpensive and time saving technique for sampling terrapins in an undersampled portion of their range.

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Use of Traditional Turtle Marking to Obtain DNA for Population Studies

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Genetic analysis has been applied extensively to studies of wildlife populations to examine population diversity, gene flow, inbreeding depression, source-sink dynamics, and extinction-recolonization frequencies (Hedrick and Kalinowski 2000; Jehle and Arntzen 2002). Blood or tissue samples and buccal swabs are the common source of DNA for most genetic studies. In chelonians, blood samples are acquired by drawing blood from the tail, leg, or neck (Avery and Vitt 1984; Jacobson et al. 1992; Rosskopf 1982). Although effective, obtaining blood samples is invasive, sometimes difficult to accomplish, and possibly stressful to the turtle. However, alternative methods have also had serious drawbacks, including a protocol using shell samples that required such large amounts of bone that either a deceased animal was needed or the animal had to be sacrificed (Hsieh et al. 2006).

In this paper, we describe a method of obtaining tissue for genetic studies that makes use of the traditional marking techniques for turtles, i.e., drilling or notching the marginal scutes (Cagle 1939; Ernst et al. 1974; Mockford et al. 1999). The drill shavings produced during marking are used as the source of DNA for genetic analysis instead of being thrown away thereby eliminating the invasive and stressful procedure of blood extraction and increasing the speed with which the samples can be taken.

Materials and Methods.—All samples collected came from gopher tortoises at the Kennedy Space Center (Brevard and Volusia Counties, Florida, USA) where mark-recapture studies have been conducted for over 30 years (Pike et al. 2005). Tortoises collected were examined for previous marks and mass and length measurements were recorded (Pike et al. 2005). While wearing sterile gloves, 100% ethanol was used to swab the scute area to be drilled in order minimize contamination of the sample. A 1/8th inch (3.17 mm) drill bit was used to drill holes in scutes of unmarked tortoises, while a larger bit was used to drill holes in scutes of previously marked individuals. Filter paper was placed under the scute area where the hole was drilled to catch the drill shavings during the marking process. Drill shavings from one or two holes were enough to facilitate genomic DNA extraction. After drilling, the shavings were placed in a sterile 15 ml polypropylene tube, and stored at ambient temperature. After a tortoise was marked, the drill bit was cleaned by brushing with a firm toothbrush dipped in 100% ethanol. The drill bit was then dipped in 100% ethanol and flamed to sterilize. (Note: Isopropyl alcohol could be substituted for ethanol.)

The extraction process used two 5/8th inch (15.88 mm) hex bolts

and a matching nut. Prior to use, the threaded end of the bolts were ground flat to provide an even grinding surface to maximize the pulverization of the drill shavings (Thomas and Moore 1997). The nuts and bolts were then wrapped in aluminum foil and sterilized in an autoclave. The nut was partially threaded on to one bolt creating a small cup that was then filled with approximately 0.1 g of drill shavings. The second bolt was added to make a sealed chamber encapsulating the drill shavings (Thomas and Moore 1997). The bolt assembly was placed in liquid nitrogen for 30 seconds to one minute (Thomas and Moore 1997). Upon removal from the liquid nitrogen, the sample was pulverized by simultaneously twisting both bolts together. The bolt assembly was tightened and loosened several times and tapped on the hard surface to assure the sample was uniformly pulverized (Thomas and Moore 1997). The bolt assembly was then carefully dismantled over a piece of filter paper to collect the powder and facilitate transfer to a 1.5 ml microcentrifuge tube.

The powdered drill shavings were decalcified in 500 µl of 0.5 M pH 8.0 EDTA at 37ºC while shaking at 225 rpm until the pellets had broken down, (approximately three to five days) following a modified protocol for the Qiagen DNeasy Blood and Tissue kit (Qiagen, Valencia, California) (Qiagen 2006). The decalcification step is critical since the cells containing DNA must be freed from the calcified matrix in order for the extraction to be successful. The samples were centrifuged at 13,000 rpm to pellet and washed three times with sterile deionized water to remove ions that had accumulated during the decalcification process. Decalcified samples were then processed using a Qiagen DNeasy Blood and Tissue kit following the modified protocol above.

Results.—A total of 0.1 g of drill shavings yielded enough DNA for multiple genetic analyses. Total DNA yields ranged from 110 to 4650 ng. The high molecular weight DNA produced with this method has been verified by ultraviolet spectrophotometry and PCR. Ratios of A260/A280 measurements ranged from 1.6 to 2.0. PCR amplifications with seven species-specific microsatellite primers produced strong, clear bands in >91% of the samples tested.

Discussion.—Our results show that DNA can be obtained from a standard method of marking turtles. By refining and combining existing techniques, we have developed a protocol that requires lesser amounts of shell material and minimizes the invasive procedures when compared to currently published techniques. The drilling or filing of the marginal scutes has been observed to show no signs of physical pain in the animals (Gibbons 1968). Pike et al. (2005) also noted that handling and drilling stress wore off quickly enough to have no discernable effect on recapture rates, demonstrating that drill marking has little detrimental effect on tortoises. Mockford et al. (1999) described a similar protocol for DNA extraction from freshwater turtle hatchlings; however it is important to note that the shell material was not ossified at the time of removal making the DNA extraction process less problematic.

Our technique provides the basis to easily gather and process genetic material from ossified shell to examine chelonian genetic diversity and long-term viability. A better understanding of the population structure and effective populations of these long-lived and slow reproducing animals is necessary to properly formulate management strategies for these animals (Gibbons et al. 2000; Scott and Seigel 1992). Our protocol uses a waste product of a common marking technique to obtain high-quality DNA allowing for the addition of genetic analysis to ongoing mark-recapture studies. Our technique enables non-invasive sampling of a population to get DNA samples of comparable quality to those obtained with more invasive methods.

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AMPHIBIAN CHYTRIDIOMYCOSIS GEOGRAPHIC DISTRIBUTION

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Amphibian Chytridiomycosis in Captive *Acris crepitans blanchardi* (Blanchard's Cricket Frog) Collected from Ohio, Missouri, and Michigan, USA

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Amphibian chytridiomycosis, a disease caused by the fungus *Batrachochytrium dendrobatidis* (*Bd*), has been documented in numerous wild populations in North America (Ouellet et al. 2005), including an Illinois population of Blanchard's Cricket Frog (*Acris crepitans blanchardi*) (Pessier et al. 1999). Herein we document the possible occurrence of *Bd* in this species in Ohio in 1999 and the likely occurrence of *Bd* in populations from Missouri in 2001 and Michigan in 2004.

On 16 September 1999, 10 Blanchard's Cricket Frogs were collected at St. Mary's Fish Hatchery in Auglaize County, Ohio, and transferred to the Toledo Zoo where they spent 10 days in isolation before being sent to the Detroit Zoo, Michigan. By 20 September 2000, eight frogs had been moved from their quarantine enclosure to a native-Michigan, mixed-species amphibian exhibit. The other two frogs were missing from their quarantine enclosure and presumed dead; it is not unusual for small amphibians to decompose completely before their death has been detected, particularly in naturalistic enclosures. The first two confirmed deaths were over a year after their arrival in Detroit and within months of their addition to the mixed exhibit (10 December 2000, 7 February 2001); these two frogs tested positive histologically for *Bd*. As the *Bd* treatment protocol had only recently been published (Nichols and Lamirande 2000) and was not yet known by zoo staff, nothing was done for the animals remaining in the exhibit. Three more frogs died between 27 February 2001 and 10 July 2003: histopathology results were inconclusive for two, and *Bd* was not detected histologically in the third. Two additional frogs were missing and presumed dead at that time also. On 30 March 2003, an American Toad (*Anaxyrus americanus*) in that exhibit died; this animal tested positive histologically for *Bd*. Medication with the established protocol (Nichols and Lamirande 2000) was begun for the other amphibians in that enclosure in late July 2003. The last cricket frog died on 22 July 2003 while under treatment for *Bd*; there was no histologic evidence of active *Bd* infection, but there was mild multifocal epidermal hyperplasia likely from previous *Bd* infection. There are two scenarios that could explain the presence of *Bd* in this group of cricket frogs from Ohio. The wild population could be infected and these frogs could have entered the collection asymptomatically carrying *Bd* and gradually succumbed over nearly four years. Although some species susceptible to *Bd* tend to die within a few weeks of infection, others can carry light infections of the disease with no clinical symptoms and only succumb under duress. In this case, the last cricket frog survived over two and half years after the first *Bd*-positive death in the enclosure. The other possibility is that, since the two positive cases were not detected until after the group was moved into the mixed-species exhibit, the cricket frogs could have been infected by the other amphibians in that exhibit, which could have been asymptomatic. Two of the three other taxa (*Anaxyrus americanus*, *Notophthalmus viridescens*, but not *Lithobates pipiens*) eventually tested positive.

On 22 October 2001, 10 Blanchard's Cricket Frogs were collected from Franklin County, Missouri, and transferred to the Detroit Zoo. All were dead within four months. Four frogs died in quarantine throughout December 2001; histopathology results were inconclusive. The remaining six frogs were moved on 2 January 2002 into a general holding room with other species but were maintained in isolation in their own enclosure. Two more frogs were dead by 10 January 2002; histopathology results on these frogs were also inconclusive. The seventh frog died on 29 January 2002; this frog tested positive histologically for *Bd*. The remaining three frogs were dead by 18 February 2002 before we learned the results from the seventh frog and had a chance to medicate them using the established protocol; histopathology results were inconclusive. The *Bd* in these animals could have come from poor husbandry (transmission from other isolated asymptomatic animals), but because these frogs were in an isolated enclosure with dedicated tools during their entire time in captivity, more likely they came infected from the wild.

From 4 August through 7 October 2004, 835 Blanchard's Cricket Frog adults and 176 tadpoles were collected from a wetland in Ypsilanti, Washtenaw County, Michigan, where their native habitat was slated for development. These frogs were held temporarily in isolated quarantine at the Detroit Zoo, then released into three newly constructed local wetland sites from 24 August to 7 October 2004 (Rickard et al. 2004). Histopathology results from three frogs and four tadpoles collected and sacrificed a month prior to translocation revealed no *Bd* or other diseases. While they were in captivity, 181 frogs died. Of those, eight were submitted for histopathology and the last two tested positive for *Bd*. Because these animals were kept in isolated quarantine in a new building with no other amphibians, it is likely that they came infected from the wild.

In all three cases, there is a possibility that the *Bd* in the captive cricket frogs originated from other animals in the captive collection. However, we feel that this is rather unlikely, at least in the two cases where the animals were kept isolated from others in the collection. In the future, we recommend testing for *Bd* in all amphibians arriving into captive collections. Not only will this benefit the health of the captive collection, it can also provide valuable data on the distribution of *Bd* in the wild. *Bd* is not something most zoos test for in quarantine, although a simple PCR test is now available (Annis et al. 2004) and might someday be afford-

able for such routine testing. Sampling a subset of the animals is cheaper, but as in the case of the cricket frogs from Michigan, it can lead to oversight.

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Occurrence of the Amphibian Pathogen *Batrachochytrium dendrobatidis* in Blanchard's Cricket Frog (*Acris crepitans blanchardi*) in the U.S. Midwest

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Batrachochytrium dendrobatidis is a chytrid fungal pathogen of amphibians that has been implicated in a number of amphibian declines (Berger et al. 1998; Lips et al. 2006). However, despite the importance of *B. dendrobatidis* as a potential causative agent of population declines and biodiversity loss in amphibians, many questions remain regarding this pathogen and its impact. Most importantly, we still have relatively few data on which species are infected by *B. dendrobatidis*, if infection is commonly associated with declines, and the geographic scope of its occurrence. Even in North America, where the amphibian fauna is relatively well-known, only a small number of studies have examined infection and distribution patterns of *B. dendrobatidis*.

Blanchard's Cricket Frog (*Acris crepitans blanchardi)* is a small North American hylid that was formerly one of the most common frogs in North America (Gray et al. 2005). Recently, serious declines have been reported in Blanchard's Cricket Frog populations throughout much of the midwestern United States, particularly the northern and western parts of its range (Brodman and Kilmurry 1998; Hay 1998; Lannoo et al. 1994; Lehtinen 2002; Lehtinen and Skinner 2006; Mierzwa 1998; Mossman et al. 1998). A number of hypotheses have been proposed to account for the asymmetric decline of Blanchard's Cricket Frog including: habitat loss and fragmentation, drought and climate change, contaminants, competition and/or predation by fish or other amphibians, and changes in local and regional successional patterns (Beasley et al. 2005; Gray and Brown 2005; Hammerson and Livo 1999; Hay 1998; Irwin 2005; Jung 1993; Lannoo 1998; Lehtinen 2002; Lehtinen and Skinner 2006; Reeder et al. 2005; Russell et al. 2002). The potential involvement of *B. dendrobatidis* in the decline of this species is clearly another hypothesis in need of investigation. Here we report on tests for the presence of *B. dendrobatidis* in Blanchard's Cricket Frog.

Methods.—Skin swabs or tissue samples from 205 Blanchard's Cricket Frogs were collected from 21 haphazardly chosen ponds in six states in the midwestern United States (Fig. 1). Most samples (N = 197) were collected between June and October of 2006 from live frogs in the field. A small number of samples (N = 8) came from venter skin sections of alcohol-preserved museum specimens collected in April 2002 and June 2003. Most samples were from juveniles or adults but a small number of larvae were also sampled. Skin swabs were obtained by running a sterile cotton swab along the skin of the captured frog for approximately 30 seconds, focusing on the hands, feet and pelvic region. For larvae, swabbing was concentrated around the oral apparatus. Tissue samples were either toe clips or skin sections. Toe clips were removed from live frogs using sharp, sterilized scissors. Both skin swabs and tissue samples were preserved in 70% ethanol in 2.0 ml screw-capped microcentrifuge tubes. In a few cases, voucher specimens were retained for reference purposes (deposited at the Illinois Natural History Survey and the James Ford Bell Museum of Natural History), otherwise frogs were released at the site of capture. All

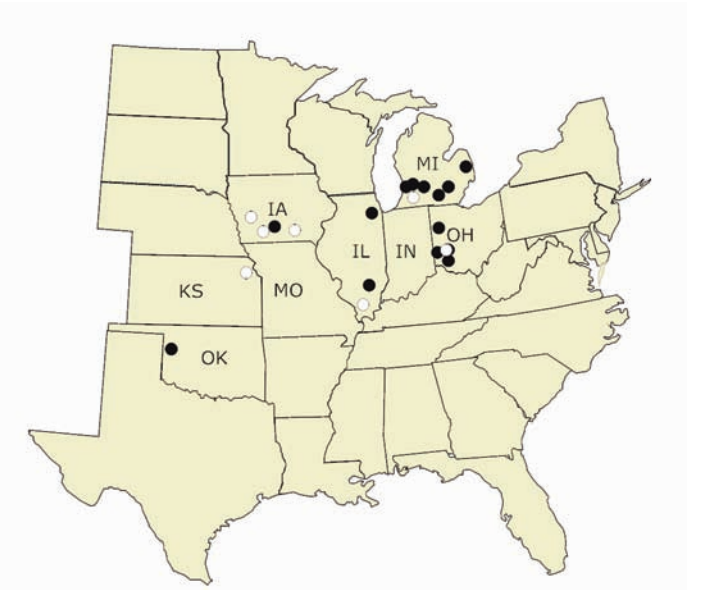


Fig. 1. Geographic distribution of sites where Blanchard's Cricket Frogs were sampled in the U.S. Midwest. Filled dots indicate sites where *B. dendrobatidis* was detected with the PCR assay. U.S. States: IL = Illiniois; IN = Indiana; IA = Iowa; KS = Kansas; MI = Michigan; MO = Missouri; OH = Ohio; OK = Oklahoma.

TABLE 1. Prevalence of *B. dendrobatidis* infection of Blanchard's Cricket Frog (*Acris crepitans blanchardi*) samples from the midwestern U.S., as determined by standard PCR assay.

State	County	Locality	Latitude	Longitude	No. infected / total sampled	Prevalence of infection
Ohio	Auglaize	St. Marys Fish Hatchery	40.526°N	84.418°W	6 / 42	0.14
Ohio	Preble	Woodland Trails W.A.	39.750°N	84.633°W	3 / 19	0.16
Ohio	Greene	Caesar Creek St. Park	39.748°N	83.816°W	0 / 1	0.00
Ohio	Greene	Fish & Game Club	39.856°N	83.943°W	2 / 9	0.11
Ohio	Clinton	Unspecified pond	39.667°N	83.964°W	3 / 10	0.30
Michigan	Kalamazoo	Harrison Lake	42.149°N	85.680°W	0 / 1	0.00
Michigan	Barry	Lux Arbor Reserve	42.613°N	85.228°W	2 / 8	0.25
Michigan	Lenawee	Ives Road gravel pit	42.180°N	84.156°W	2 / 10	0.20
Michigan	Washtenaw	Ypsilanti	42.207°N	83.578°W	1 / 10	0.10
Michigan	St. Clair	Port Huron	42.970°N	82.425°W	1 / 10	0.10
Michigan	Ottawa	Grand Rapids gravel pit	42.941°N	85.820°W	1 / 9	0.11
Michigan	Kent	Unspecified pond	42.989°N	85.509°W	2 / 6	0.33
Illinois	Jackson	Unspecified pond	37.727°N	89.209°W	0 / 9	0.00
Illinois	Effingham	Unspecified pond	38.995°N	88.621°W	5 / 16	0.31
Illinois	Will	Unspecified pond	41.570°N	88.072°W	1 / 14	0.07
Iowa	Madison	Unspecified pond	41.300°N	93.744°W	1 / 3	0.33
Iowa	Guthrie	Unspecified pond	41.686°N	94.359°W	0 / 1	0.00
Iowa	Lucas	Unspecified pond	41.016°N	93.115°W	0 / 8	0.00
Iowa	Ringgold	Unspecified pond	40.741°N	94.241°W	0 / 5	0.00
Kansas	Jefferson	Unspecified pond	39.082°N	95.546°W	0 / 5	0.00
Oklahoma	Ellis	Packsaddle Wildlife Area	35.846°N	99.616°W	1 / 9	0.11

samples were transported to the College of Wooster (Wooster, Ohio) for processing with a PCR-based assay.

All DNA from tissue samples were extracted according to the animal tissues protocol provided by the manufacturer (Qiagen, Valencia, CA; DNeasy Blood and Tissue Handbook, 07/2006). Skin swab samples were agitated for thirty seconds in a vortex and the swab was removed and squeezed along the side of the tube to remove the maximum amount of solution. An aliquot of 300 µl was removed from the tube and centrifuged in a 2.5 ml tube for five minutes. The supernatant was subsequently removed and the remaining pellet was used for the remainder of the extraction procedure. Following the extraction procedure, all samples were concentrated to approximately 20 µl by centrifugal evaporation.

Amplification of the extracted samples was completed with standard polymerase chain reactions (PCR) using the primers reported in Annis et al. (2004). Amplification reactions consisted of 13 µl of deionized water, 5.0 µl of template (containing approximately 10–30 µg of DNA), 2.5 µl 10x PCR buffer (Qiagen, Valencia, CA), 2.5 µl dNTPs (10 uM of each), 1.0 mM $MgCl_2$, 0.5 µl of each primer at a concentration of 50 pmol/µl, and 0.25 µl *Taq* polymerase (5 units/mL) in a volume of 24 µl. The amplification of the mixture took place according to the following steps: an initial denaturation at 94°C for 10 minutes, followed by 30 cycles of 45 seconds at 93°C and 45 seconds at 60°C, and then a final extension at 72°C for 10 minutes to complete the amplification. Products were then viewed on ethidium bromide stained 1.0% agarose gel dissolved in TAE (40 mM Tris [pH 8.0], 20 mM acetic acid, 1 mM EDTA) alongside a 1 kb ladder. A band approximately 300 base-pairs in length indicated the presence of *B. dendrobatidis* infection.

A positive control of *B. dendrobatidis* broth culture and zoospores was used to optimize and determine the sensitivity of the PCR assay. A dilution series of the positive control was run and successful amplification took place in 1/5, 1/10, 1/50, 1/100, and 1/500 dilutions. All PCRs were run twice for each sample. Amplification in both replicates was considered a true positive signal of infection, while no amplification in both replicates was considered a true negative signal. Templates that amplified once were subject to a third replicate, in which a successful amplification was taken as indicating infection. To avoid false-positive and false-negative results, negative and positive controls were used with all samples analyzed.

Available information suggests that declines in Blanchard's cricket frogs may be moving from north to south, and inward from both the western and eastern range boundaries (Lannoo and Grundel 2004; Lehtinen and Skinner 2006). Based on where declines have been reported, we used chi-squared analyses to test for differences in infection prevalence north and south of three latitudes (38°N, 40°N, and 42°N) and east and west of two longitudes (88°W and 90°W). Also, the difference in prevalence of infection between skin swab samples and tissue samples was tested using a chi-square test. All statistical analyses were performed using SPSS (version 13.0, SPSS Inc., Chicago).

Results.—*Batrachochytrium dendrobatidis* was detected in 15.1% (31 of 205) of samples from Blanchard's Cricket Frogs (Table 1). Within infected sites, prevalence of infection was generally low (18.8 ± 9.8%; Table 1). We did not detect *B. dendrobatidis* at seven sites but all of these localities had relatively small sample sizes. In all sites where more than ten frogs were sampled, *B. dendrobatidis* was detected (Table 1). No dead, dying or obviously diseased frogs were found at any of the investigated sites.

Infected frogs were found in Ohio, Michigan, Iowa, Illinois, and Oklahoma (but not in any of the five samples from Kansas; Table 1). There was no obvious geographic pattern in infection. Infection rates did not differ significantly at longitudes greater and less than 90°W or 88°W ($\chi^2 = 1.281$, df = 1, P = 0.258; $\chi^2 = 1.130$, df = 1, P = 0.288, respectively). Prevalence of infection also did not differ significantly at latitudes greater and less than 38° N ($\chi^2 = 1.407$, df = 1, P = 0.236), 40°N ($\chi^2 = 0.784$, df = 1, P = 0.376), or 42°N ($\chi^2 = 0.136$, df = 1, P = 0.712). The prevalence of infection did not differ significantly between samples obtained by skin swabbing and those from tissue samples ($\chi^2 = .273$, df = 1, P = .0602).

Discussion.—We document the widespread presence of *B. dendrobatidis* in populations of Blanchard's Cricket Frogs in the midwestern United States. Although *B. dendrobatidis* is now known from captive situations (Zippel and Tabaka 2008), to our knowledge, this is the first documented case of *B. dendrobatidis* infection in cricket frogs from wild populations. However, no mortality was found or reported in these infected, yet seemingly healthy cricket frogs. Additionally, we have mark-recapture data from one of these populations since 2004 (St. Marys Fish Hatchery, Ohio; R. Lehtinen, unpubl. data). This population has maintained a large and relatively stable population size over the last four years (2004–2007), despite *B. dendrobatidis* infection. In this respect, our results parallel Ouellet et al. (2005) who found *B. dendrobatidis* to be enzootic in Quebec with no symptoms associated with infection. It is possible that Blanchard's Cricket Frogs utilize antimicrobial skin peptides (Woodhams et al. 2006) or behavioral thermoregulation (Woodhams et al. 2003) as defenses against *B. dendrobatidis*, but these possibilities have yet to be investigated. While preliminary, our data suggest that Blanchard's Cricket Frog populations are able to persist in the face of ongoing *B. dendrobatidis* infection (e.g., Daszak et al. 2005; Retallick et al. 2004).

We found *B. dendrobatidis* to have no obvious geographic pattern of occurrence. In fact, *B. dendrobatidis* was present at every site where ten or more samples were available. These data reinforce the observations of others that *B. dendrobatidis* appears to be widespread in North America (Longcore et al. 2007; Ouellet et al. 2005; Pearl et al. 2007). Importantly, we detected *B. dendrobatidis* both in areas where Blanchard's Cricket Frog declines have occurred (Ohio, Michigan, northern Illinois) as well as where declines have not been reported (Oklahoma, southern Illinois). The apparent absence of declines in more southerly parts of the range suggests that *B. dendrobatidis* may not be solely responsible for recent population declines in Blanchard's Cricket Frogs further north. However, more northerly populations could be more vulnerable to infection since *B. dendrobatidis* grows best in cooler temperatures (Longcore et al. 1999) and the amphibian immune system functions most effectively at higher temperatures (Maniero and Carey 1997). The declines in the northern portions of the range could also have resulted from earlier declines caused by *B. dendrobatidis* that have now stabilized. Similar patterns of persistence with *B. dendrobatidis* after initial declines are known (Retallick et al. 2004; Woodhams and Alford 2005). More work is clearly needed to assess what threat (if any) *B. dendrobatidis* infection poses to Blanchard's Cricket Frogs.

Many records of *B. dendrobatidis* infection in North American anurans are from ranid and bufonid frogs (e.g., Ouellet et al. 2005; Pearl et al. 2007). Fewer hylid species have been reported to be infected. Using histological techniques, Ouellet et al. (2005) reported *B. dendrobatidis* infection in *Pseudacris triseriata* (54 out of 143 individuals) and *Hyla versicolor* (1 out of 16). However, Longcore et al. (2007) found no infection in *Hyla versicolor* (0 out of 50), or *Pseudacris crucifer* (0 out of 21). Pearl et al. (2007) also found no infections in *Pseudacris regilla* (0 out of 28) in the Pacific Northwest. Our results with *Acris crepitans* (31 out of 205) suggest that *B. dendrobatidis* may be more widely distributed in North American hylids than previously suspected.

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Low Prevalence of *Batrachochytrium dendrobatidis* Across *Rana sylvatica* Populations in Southeastern Michigan, USA

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The emerging infectious disease chytridiomycosis has been implicated in the decline and extinction of numerous amphibian species worldwide (Berger et al. 1998; Lips et al. 2006; Skerratt et al. 2007). The fungus causing this disease, *Batrachochytrium dendrobatidis* (*Bd*), has been present in North American amphibian populations since at least the 1960s (Ouellet et al. 2005); however, in many areas of North America, there is little evidence of negative effects of the disease on amphibian population persistence. Understanding how environmental factors affect infection prevalence is thus important for determining under what conditions chytridiomycosis is likely to have a devastating impact on populations.

We conducted a preliminary assessment of the role of season and habitat quality on chytridiomycosis infection prevalence in populations of the Wood Frog, *Rana sylvatica*, in southeastern Michigan, USA. In laboratory studies, *Bd* appears to be limited by temperatures outside the range of 4–25°C (Piotrowski et al. 2004). Several studies also have noted that the prevalence and severity of infections in wild populations tend to vary seasonally (Berger et al. 2004; Kriger and Hero 2006, 2007; Retallick et al. 2004; Woodhams and Alford 2005). Given this, we predicted that levels of infection would be higher in the spring as opposed to the summer because the warmer temperatures experienced during the summer months in southeastern Michigan should limit *Bd* infection rates (Berger et al. 2004; Kriger and Hero 2006, 2007; Ouellet et al. 2005; Retallick et al. 2004; Woodhams and Alford 2005; Woodhams et al. 2003). Additionally, habitat quality may affect

infection rates because the higher stress levels associated with low quality habitats may make individuals more susceptible to infection (Carey and Bryant 1995). Ponds that are exposed to high levels of agricultural and urban runoff may be particularly stressful for amphibians. For example, both pesticides (Relyea 2005) and road de-icing salt (Sanzo and Hecnar 2006) affect larval Wood Frog survivorship. Thus, we predicted that Wood Frog (*Rana sylvatica*) populations in ponds surrounded by agricultural or urban areas would show higher levels of infection than populations surrounded by intact, forested habitat.

Methods.—To assess whether season affects infection prevalence, breeding adults and metamorphs were tested for the presence of *Bd* DNA, since breeding adults often experience colder temperatures than metamorphs. Adults were sampled from eight populations in March 2007 and metamorphs were sampled from five populations in June 2007. All adults and metamorphs were sampled from populations on the University of Michigan's Edwin S. George Reserve (Fig. 1). Temperatures during the 30 days prior to sampling ranged from -16–23°C (mean temperature = 2°C) for the adults and 5–33°C (mean temperature = 20°C) for the metamorphs. The dorsum, venter, and feet of adults and metamorphs were swabbed with a sterile cotton swab. Swabs were stored in 95% ethanol until extraction.

In addition, to assess the relationship between habitat quality and *Bd* distribution, we collected larvae of *R. sylvatica* from 16 populations across southeastern Michigan (Fig. 1) during June 2005 and 2006. Aerial images (Michigan Department of Natural Resources 1998) were used to select ponds with varying degrees of surrounding forest and wetland fragmentation. Larvae were stored in 95% ethanol until extraction. The oral discs of six individuals from each population were excised in the lab using sterilized razor blades and forceps.

Extraction of *Bd* DNA was completed following the methodology of Hyatt et al. (2007). DNA from larval samples was extracted from the oral discs, whereas DNA from the metamorphs and adults was extracted from the swabs. DNA extracted from larvae was pooled in groups of three for each population. The pooled-larval samples and both the adult and metamorph samples were then diluted 1:10 with double deionized water. Taqman diagnostic quantitative PCR (Boyle et al. 2004) was used to detect the presence of *Bd* DNA. Quantitative Taqman PCR assays were performed in triplicate using an Applied Biosystems Prism 7700 Sequence Detection System following the protocol of Boyle et al. (2004). VIC$_{TM}$ Exogenous Internal Positive Control reagents were used for the detection of PCR inhibitors (Applied Biosystems following Hyatt et al. 2007). Inhibitors did not appear to be present in any of the samples. A sample was only considered positive for *Bd* if all three replicates indicated the presence of the fungus. Samples testing positive in one or two replicates were re-assayed once. If the second assay produced a consistent negative or positive result for all three replicates the sample was considered negative or positive, respectively. Samples testing positive in one or two replicates of the second assay were considered "suspicious." Prevalence rates were calculated by dividing the number of infected individuals by the total number of sampled individuals, and 95% confidence intervals were calculated based on a binomial distribution (Stata Intercooled v. 10.0).

The percentage of combined agricultural and urban land cover within 1 km (estimated genetic neighborhood size of *R. sylvatica*: Berven and Grudzien 1990) of each of the 16 ponds sampled for larvae was calculated in ArcGIS v. 9.2 using the 2001 National Land-Cover Database (Homer et al. 2004). This percentage ranged from 6.18 to 78.55 (Table 1).

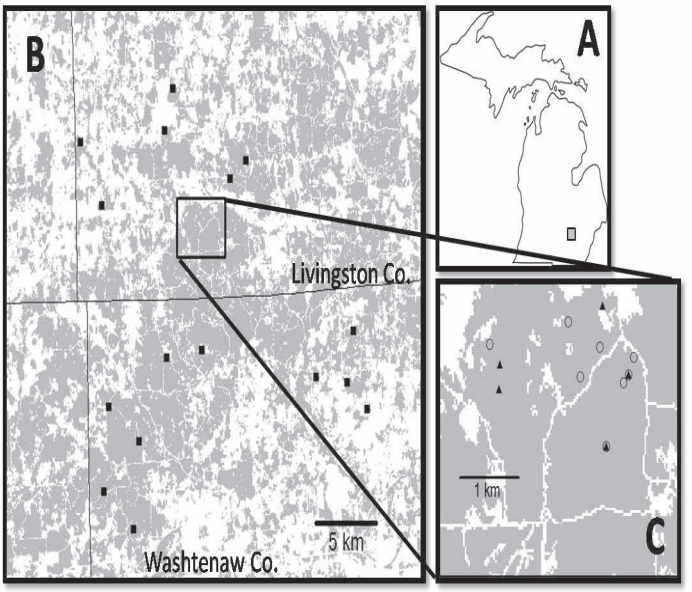


FIG. 1. Wood Frog (*Rana sylvatica*) sampling locations in southeastern Michigan, USA, showing areas sampled for *Batrachochytrium dendrobatidis* in adults (open circles), metamorphs (triangles), and larvae (squares). Agricultural and urban areas are white. Forests, wetlands, rivers, and lakes are gray.

Results.—Two of 239 (prevalence = 0.83%; 95% confidence interval = 0.1–3.0%) samples tested positive for the presence of *Bd*. One of 70 (1.4%) adults, zero of 73 metamorphs, and 1–3 of 96 (1.0–3.1%) larvae tested positive in each of three replicates. The range surrounding the number of infected larvae arises from pooling the larvae into groups of three for the analyses. As a result, a positive sample indicates that at least one of the three individuals was positive for *Bd*. In addition, one of 70 (1.4%) adults tested positive in two out of three replicates and thus was classified as suspicious.

Discussion.—We found a very low level of *Bd* infection in populations of *R. sylvatica* in southeastern Michigan (0.83%). Other studies of North American *R. sylvatica* populations have found much higher rates of infection (15.5%, Longcore et al. 2007; 6.6%, Ouellet et al. 2005). We calculated 95% confidence intervals for each of these studies to assess the extent to which our results differed from these previous studies and found that our confidence intervals did not overlap (Longcore et al. 2007: 6.4–29.4%; Ouellet et al. 2005: 3.4–11.1%). Our results are consistent with the idea that the quality of the habitat and the season may be important predictors of infection rates. For the effects of season, we found one adult that tested positive for *Bd*, while no metamorphs tested positive. Temperatures during the adult breeding period remained at or below the optimal temperature range for *Bd*, whereas during the metamorph sampling period, temperatures exceeded the maximum temperature at which *Bd* can survive in the laboratory (Piotrowski et al. 2004). Similarly, we detected *Bd* in larvae in a pond exposed to one of the largest areas of anthropogenic distur-

TABLE 1. Wood Frog (*Rana sylvatica*) larval infection rates in relation to amount of agricultural and urban habitat surrounding ponds in southeastern Michigan, USA.

Percent Agricultural/ Urban Land Cover	Number Infected/ Sample Size
6.18	0/6
8.73	0/6
14.61	0/6
15.35	0/6
17.06	0/6
17.09	0/6
18.09	0/6
25.42	0/6
35.28	0/6
54.07	0/6
55.49	0/6
57.57	0/6
59.24	0/6
62.82	0/6
65.39	(1–3)/6
78.55	0/6

bance in this study (Table 1). However, the low level of infection we found prevents us from testing our hypotheses statistically. Future research on the effects of habitat quality and seasonality on *Bd* infection prevalence remains a priority.

Two hypotheses may explain the low infection levels detected in this study, given the high prevalence of *Bd* both worldwide and in other areas of the Wood Frog's range. First, the more terrestrial life-history of *R. sylvatica* may help prevent infection in this species (Longcore et al. 2007). *Rana sylvatica* is an explosive breeder that breeds in early spring. Larvae develop and metamorphose in approximately 6 weeks, and juveniles then move into the terrestrial habitat for foraging (Regosin et al. 2003). In comparison to other co-occurring species, wood frogs are in the ponds for a shorter amount of time. These results are consistent with Lips et al. (2003) hypothesis that the probability of decline as a result of *Bd* infection is positively related to the amount of time the species spends in aquatic habitats. However, while rates of infection in *R. sylvatica* are typically lower than in other co-occurring species (Longcore et al. 2007; Ouellet et al. 2005), the levels of infection in *R. sylvatica* seen in this study are much lower than in other studies, suggesting that other factors may have contributed to the low prevalence of *Bd* across southeastern Michigan.

Second, it is possible that habitat differences between southeastern Michigan and other parts of *R. sylvatica*'s range could account for the low infection prevalence seen in our study, as compared with other studies. Differences in climate, for instance, in temperature or the amount of rainfall, are associated with differences in infection rates (Kriger and Hero 2007), and thus may dictate the range over which *Bd* is viable. However, this seems unlikely, because projections from an ecological niche model (Ron 2005) suggest that the habitat of southeastern Michigan is more climatically suitable for *Bd* than other areas where *Bd* prevalence in wood frogs has been found to be higher (Longcore et al. 2007). Similarly, differences in the structure of the landscape separating populations may contribute to the variation in infection prevalence across *R. sylvatica*'s range. A fragmented landscape, resulting in reduced connectivity among amphibian populations, may hinder the spread of *Bd* and thus keep regional infection rates low. Further research at a broader geographic scale will be necessary for evaluating whether such habitat differences contribute to the observed patterns of infection in *R. sylvatica*.

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Occurrence of *Batrachochytrium dendrobatidis* in Amphibian Populations in Denmark

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Amphibian decline is a global phenomenon with multiple causes (Stuart et al. 2004). Some declines have been attributed to the disease chytridiomycosis that affects the skin of amphibians (Skerratt et al. 2007). The agent responsible for chytridiomycosis is the fungus *Batrachochytrium dendrobatidis* (Berger et al. 1998). There is evidence that the spread of *B. dendrobatidis* around the world occurred in the last half century (Ouellet et al. 2005), and there is a need for detailed information on its current spatial extent. In Europe, *B. dendrobatidis* has been reported in several amphibian species in multiple countries, such as Spain, Portugal, Italy, Switzerland, France, Germany and the UK (Cunningham et al. 2005; Garner et al. 2005, 2006; Mutschmann et al. 2000; Simoncelli et al. 2005; Stagni et al. 2004). No comprehensive surveys have occurred in Denmark but a single record of *B. dendrobatidis* for *Rana* kl. *esculenta* on the island of Bornholm is reported (www.spatialepidemiology.net) and confirmed by Trent Garner (pers. comm. to R. Scalera, 2007). Here, we report the results of surveys carried out at four sites in Denmark (Fig. 1) on two native amphibians: *Rana temporaria* and *Rana* kl. *esculenta*.

In summer 2007, we hand captured individual amphibians and sampled them for *B. dendrobatidis* by rubbing a cotton-tipped swab over the body of each individual. Frogs were held separately prior to swabbing and technicians wore a new pair of gloves for each individual handled. The sampling is harmless and was carried out *in-situ* so as to release the sampled animals within just a few minutes at the location where they were captured. As the frog was restrained, the swab was firmly rubbed back and forth 25–30 times, targeting the drink patch, the mouth, and the webbing between each toe. The swab was immediately inserted, cotton side down, into a 2 ml screw-cap tube containing 1 ml of 70% ethanol and stored upright. Vials were shipped to the laboratory for analysis, and each swab was analyzed individually for the presence of *B. dendrobatidis*. Swabs were qualitatively analyzed using a PCR assay (45 amplification cycles). Presence of *B. dendrobatidis* was determined by presence of PCR product visualized on agarose gels (30–90 minute electrophoresis) containing positive controls. Fragments were sized using a molecular weight marker (Pisces Molecular LLC, Boulder, Colorado, USA (Annis et al. 2004; J. Wood, pers. comm.). All field gear was cleaned with a brush and water and then sterilized using a dilute bleach solution between each sampling location.

Two of the 13 amphibians we swabbed were positive for *B. dendrobatidis* (Table 1). We found *B. dendrobatidis* on individuals from both species and at 2 of the 4 study areas we examined. One of the positive results was for an adult of *Rana* kl. *esculenta* captured in Vestamager. The other positive result was for a juvenile of *Rana temporaria* captured in Egense. We did not find any frogs that were dead or that appeared to be sick.

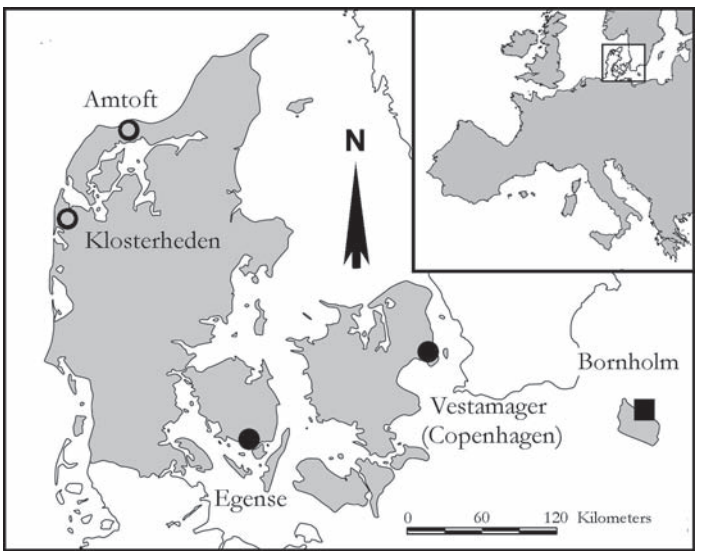


FIG. 1. Locations of study areas in Denmark where amphibians were sampled for the presence of *Batrachochytrium dendrobatidis* in 2007. Circles are filled at locations where we found *B. dendrobatidis*. The square symbol indicates the location of the positive record reported by Trent Garner (see text). Vestamager is located on the island of Zealand, close to Copenhagen, Egense is on Fyn Island, and both Amtoft and Klosterheden are on the Jutland Peninsula.

TABLE 1. Anurans that tested positive or negative for the presence of *Batrachochytrium dendrobatidis* in Denmark in 2007. See Fig. 1 for the locations of the study areas referenced in the table. The species examined were *Rana* kl. *esculenta* (RANESC), and *Rana temporaria* (RANTEM).

Study Area	Latitude	Longitude	Species	Stage	Sex	No. Positive	No. Negative
Egense	55.044167	10.519444	RANTEM	adult	unknown	1	3
Amtoft	57.007500	8.939722	RANTEM	adult	male	0	1
Klosterheden	56.485278	8.362500	RANTEM	juvenile	unknown	0	1
Vestamager	55.614722	12.577222	RANESC	adult	male	0	3
Vestamager	55.614722	12.577222	RANESC	adult	female	0	1
Vestamager	55.614722	12.577222	RANESC	juvenile	unknown	1	2

Further surveys should be undertaken to determine the extent of the pathogen in Denmark. In the meantime, proper sanitizing of equipment would be prudent for anyone entering amphibian habitats. Particular care should be used around sensitive species such as *Bombina bombina*, which is actively managed in Denmark (Pihl et al. 2001), however the threat posed by *B. dendrobatidis* to this and other Danish species is currently unknown.

Acknowledgments.—These surveys were authorized by The Danish Forest and Nature Agency of the Ministry of the Environment with letter of 15 January 2008 (SNS-441-00088). No chemicals or other substances were used on the body of the amphibians and all criteria for the human care of captured animals were followed. Use of trade names does not constitute endorsement.

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Batrachochytrium dendrobatidis Not Detected in *Oophaga pumilio* on Bastimentos Island, Panama

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Amphibian chytridiomycosis, caused by the chytrid fungus *Batrachochytrium dendrobatidis* (*Bd*), has been implicated in the decline and extinction of many populations worldwide (Berger et al. 1998; Lips et al. 2006; Skerratt et al. 2007), and has led to massive die-offs in Latin America over the past few decades (Lips et al. 2006). However, not all populations that carry *Bd* have experienced such declines (e.g., American Bullfrog: Garner et al. 2006; African Clawed Frog: Weldon et al. 2004). Some species have been shown to have physiological (Woodhams et al. 2007a), behavioral (C.L. Richards, pers. comm.), or bacterial (Woodhams et al. 2007b) defenses that may allow them to cope with *Bd*. For many species that have not experienced declines, it is unknown

whether they have lower susceptibility, due to such defenses, or if they have not been exposed to the disease. Evaluation of these alternatives is necessary for distinguishing between species that may be at risk of population declines and those that may be *Bd* carriers.

Despite the fact that an epidemic wave of *Bd* has apparently swept through Costa Rica and western Panama since the late 1980s (Lips et al. 2006), populations of the Strawberry Dart Frog, *Oophaga pumilio*, remain relatively stable. *Oophaga pumilio* is a dendrobatid frog found in rainforests of the Caribbean coast from Nicaragua to Panama. They are found across a range of elevations, from sea level to about 1000 m (Walls 1994). Populations of *O. pumilio* in the Bocas del Toro archipelago in Panama remain abundant and apparently healthy, and we are unaware of any chytrid-related die-offs in other areas of their range or any studies that have assessed *Bd* prevalence in this species. The stability of the Bocas del Toro populations suggests that either *O. pumilio* is able to physiologically or behaviorally cope with the disease or else *Bd* is not present in this region. To distinguish between these alternative hypotheses, we tested for the presence of *Bd* in *O. pumilio* across Bastimentos Island in the Bocas del Toro archipelago, Panama.

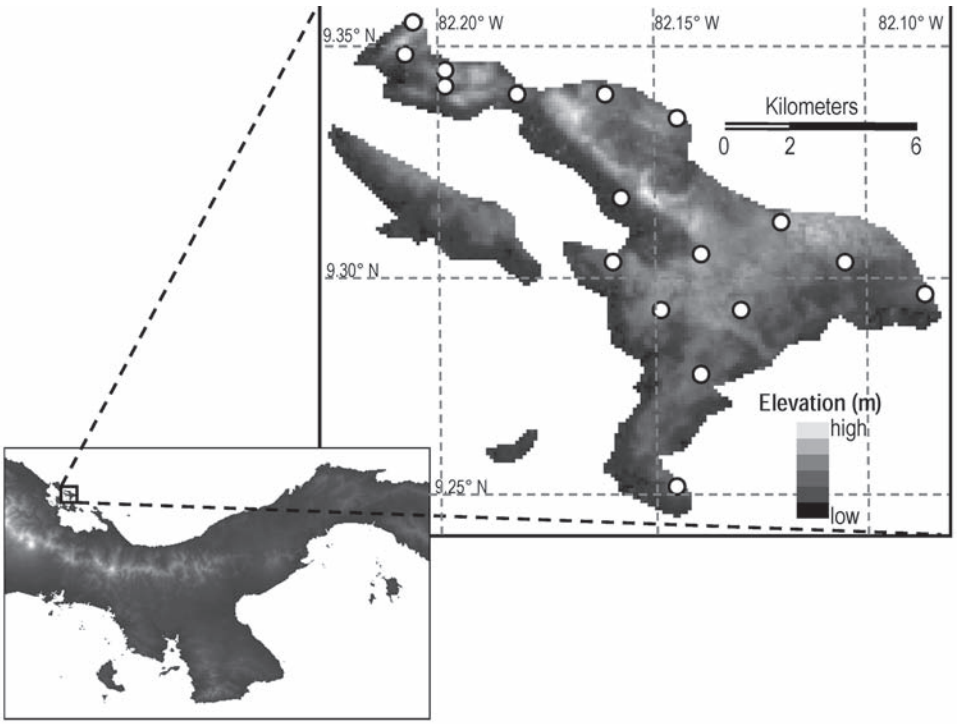


Fig. 1. Sampling locations for *Batrochochytrium dendrobatidis* in *Oophaga pumilio* frogs across Bastimentos Island, Panama.

Methods.—We captured adults from the leaf-litter at 17 transect points across Bastimentos Island (Fig. 1) during July 2007. Sampling locations were chosen to ensure all areas of the island (approximately every 2 km) were assessed for the presence of *Bd*. The dorsum, venter, and feet of five adults from each location were swabbed with a sterile cotton swab for a total of 85 individuals. Swabs were stored in dry microcentrifuge tubes and upon returning to the lab were refrigerated at 4°C until extraction. Individuals were released at the site of capture.

Extraction of *Bd* DNA was accomplished using the methodology of Hyatt et al. (2007). Taqman diagnostic quantitative PCR (Boyle et al. 2004) was used to detect presence of *Bd* DNA. Quantitative Taqman PCR assays were performed in triplicate using an Applied Biosystems Prism 7700 Sequence Detection System following the protocol of Boyle et al. (2004). VIC_{TM} Exogenous Internal Positive Control reagents were used for the detection of PCR inhibitors (Applied Biosystems following Hyatt et al. 2007). A sample was only considered positive for *Bd* if all three replicates indicated a presence of the fungus. Prevalence rates were calculated by dividing the number of infected individuals by the total number of sampled individuals, and 95% confidence intervals were calculated based on a binomial distribution (Stata Intercooled v. 10.0).

Results and Discussion.—None of the 85 individuals sampled tested positive for the presence of *Bd* in any of the three replicates (95% confidence interval = 0–4.2%). Inhibitors did not appear to be present in any of the samples. Our results suggest that there is either a very low level of *Bd* prevalence or that *Bd* is absent from the Island of Bastimentos. We have two hypotheses as to why *Bd* was not detected in our study. First, *Bd* may not yet have reached Bastimentos Island. The geographic isolation of Bastimentos *O. pumilio* populations from mainland populations may have impeded the spread of the disease. The island is, however, heavily traveled by tourists, implying that populations on these islands may be more connected to mainland populations than expected by geography alone.

Alternatively, the apparent absence of *Bd* on Bastimentos could be due to unsuitable environmental conditions. *Bd* is limited by temperatures outside the range of 4–25°C under laboratory conditions (Piotrowski et al. 2004), and the distribution and severity of infections appear to be correlated with rainfall and temperature patterns in wild populations (Kriger et al. 2007). However, *Bd* has been detected in at least one population of Panamanian frogs that

TABLE 1. Climate data for Bastimentos Island, Panama (Hijmans et al. 2005).

Climate Variable	Value
Annual Mean Temperature	25.8°C
Maximum Temperature of the Warmest Month (April)	30.0°C
Minimum Temperature of the Coldest Month (February)	21.0°C
Annual Temperature Range	9.0°C
Annual Precipitation	3109 mm
Precipitation of the Wettest Month (July)	398 mm
Precipitation of the Driest Month (March)	146 mm

is, on average, exposed to slightly hotter conditions than are *O. pumilio* populations on Bastimentos Island (C. L. Richards, pers. comm.). In addition, the average temperature and precipitation on Bastimentos Island (Hijmans et al. 2005; Table 1) is within the range of values for a number of infected sites in Central America (Ron 2005). It is therefore predicted that if *Bd* was introduced to these populations that it would be able to survive.

Identification of areas where *Bd* is absent is crucial for determining the physiological limits of the pathogen and for establishing areas of priority for conservation. Further research on the distribution of *Bd* will provide necessary information for predicting the patterns of spread, potentially assisting managers in preventing outbreaks of the disease.

Acknowledgments.—We thank the staff at the Smithsonian Tropical Research Institute (STRI) for their help with logistics and obtaining permits as well as Deanna Olson and Eli Greenbaum for providing useful comments that helped improve the manuscript. In conducting this research, we have complied with all applicable institutional Animal Care guidelines and obtained all required permits. This research was funded in part by a STRI Short Term Fellowship to CLR.

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Results of Amphibian Chytrid (*Batrachochytrium dendrobatidis*) Sampling in Denali National Park, Alaska, USA

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The amphibian chytrid fungus *Batrachochytrium dendrobatidis* (*Bd*) has been detected in amphibian populations along the northwest coast of North America from Vancouver Island, British Columbia (Adams et al. 2008) north to the Kenai Peninsula (Reeves and Green 2006). However, *Bd* has not been detected in interior Alaska in the Innoko or Tetlin National Wildlife Refuges (Reeves 2008). The Wood Frog (*Rana sylvatica*) is the only amphibian species that occurs in interior Alaska (Wright and Wright 1995) and is susceptible to *Bd* infection (Reeves and Green 2006; Ouellet et al. 2005). In 2006, we sought to determine if *Bd* occurred in Wood Frogs in Denali National Park.

Methods.—Denali National Park (DNP) is located in central Alaska, approximately 183 km S of Fairbanks and 317 km N of Anchorage in Denali Borough (63.97°N, 149.13°W), and covers 2.4 million ha (Fig. 1). Three areas were surveyed for Wood Frogs within the park boundary: Wonder Lake vicinity roadside and backcountry, Teklanika River vicinity roadside, and along the roadside between the park entrance and the Savage River.

Known Wood Frog pond sites were surveyed in the Wonder Lake area (Hokit and Brown 2006), and seven additional ponds with no Wood Frog survey history were selected along the roadside in the Teklanika River vicinity and between the park entrance and the Savage River for their high traffic location. Surveys took place during a two-week period in August 2006 using standard techniques (Olson et al. 1997). Non-invasive techniques were used to

recover skin cells (Boyle et al. 2004; Retallick et al. 2006); each frog was stroked 20 to 30 times on the abdomen, pelvic patch, inner thighs and in between toes or, in the case of larvae, the oral disk was rubbed 5 times in a circular motion with a sterile cotton swab. The swab was then placed individually in a 1.5 ml microfuge tube containing a DNA extraction buffer (Zolan and Pukkila 1986) and stored at ambient temperature. All samples were processed twice by JEJ using polymerase chain reaction (PCR) assay to detect *Bd* (Boyle et al. 2004; Annis et al. 2004). Individual animals were handled with clean latex gloves or a plastic bag inverted over the observers hand. Equipment was sprayed with a concentrated sodium hypochlorite solution between each site. Malformed metamorphs were collected, preserved in a 95% ethanol solution at ambient temperature and x-rayed by a veterinarian to determine if malformations were due to injury or amputation (Summit Industries, Innovet Classic, Model LX125V).

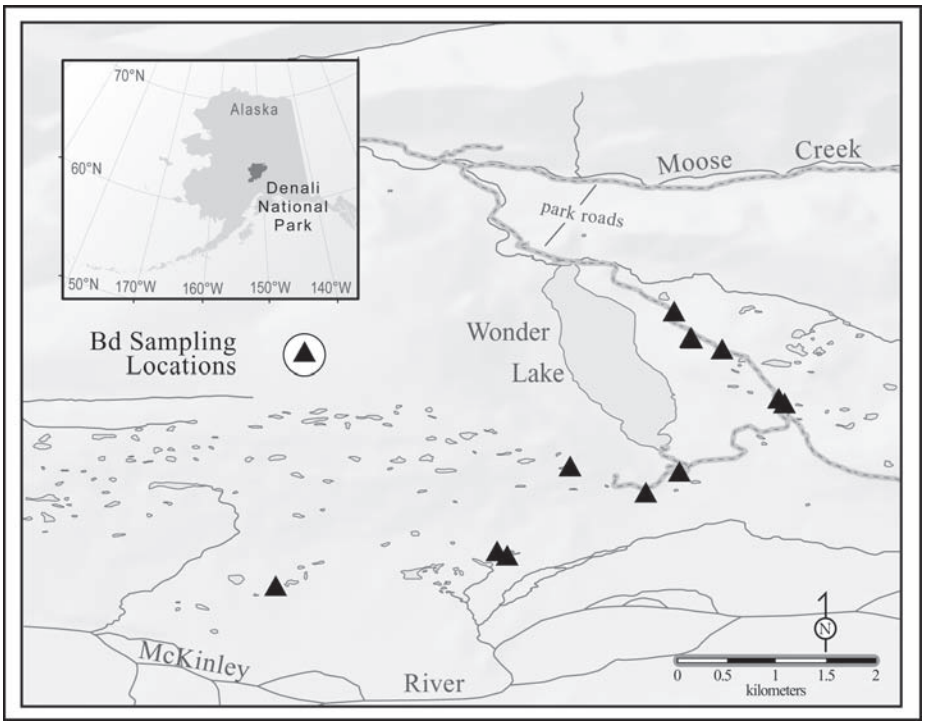


FIG. 1. Denali National Park (DNP), Alaska, USA, and Wood Frog (*Rana sylvatica*) *Bd* sampling locations in the Wonder Lake vicinity.

Results.—We found Wood Frogs at 20 of 26 known sites near Wonder Lake (Fig. 1). Frogs were not found at additional sites searched between the Park entrance and the Savage River or in the Teklanika vicinity, although they were not previously known to be present and may not occur at these sites. Thirty frogs were swabbed, 12 at roadside sites and 18 at backcountry sites up to 4.5 km from the road (Table 1). No *Bd* was detected. Nearly 87% of the animals sampled were newly metamorphosed. At one backcountry site, five (16%) metamorphs were malformed and had missing limbs, and three

TABLE 1. *Bd* was not detected in 30 wood frogs (*Rana sylvatica*) at Denali National Park, Alaska, USA, in 2006.

Date	Latitude	Longitude	Number Observed	Life Stage	Condition of Animal(s)	*Bd* Detected?
8 Aug 06	N63 26.960	W 150 52.169	1	Metamorph	Normal	No
8 Aug 06	N63 26.248	W 150 53.979	7	Metamorph	4 Missing Limb, 3 Dead	No
9 Aug 06	N63 25.826	W 150 56.670	1	Metamorph	Normal	No
10 Aug 06	N63 26.196	W 150 53.856	2	Adult	Normal	No
10 Aug 06	N63 26.197	W 150 53.857	1	Metamorph	Normal	No
11 Aug 06	N63 27.212	W 150 51.760	1	Metamorph	Normal	No
12 Aug 06	N63 28.041	W 150 50.481	2	Metamorph	Normal	No
14 Aug 06	N63 28.103	W 150 50.551	1	Metamorph	Normal	No
14 Aug 06	N63 28.694	W 150 51.241	3	2 Metamorph, 1 Larvae	Normal	No
14 Aug 06	N63 28.834	W 150 51.621	1	Metamorph	Normal	No
14 Aug 06	N63 28.824	W 150 51.612	2	Metamorph	Normal	No
14 Aug 06	N63 29.151	W 150 51.828	1	Metamorph	Normal	No
14 Aug 06	N63 27.280	W 150 53.086	1	Adult	Missing Limb	No
15 Aug 06	N63 27.279	W 150 51.806	1	Metamorph	Normal	No
15 Aug 06	N63 27.371	W 150 53.327	1	Metamorph	Normal	No
15 Aug 06	N63 27.485	W 150 53.706	1	Metamorph	Normal	No
15 Aug 06	N63 27.652	W 150 53.528	1	Metamorph	Normal	No
15 Aug 06	N63 27.646	W 150 53.402	2	Metamorph	Normal	No

(10%) were dead but not obviously malformed. The mechanism of malformation or death is unknown and could not be determined from the x-rays. In addition, one adult frog recovered from a site more than 4 km NNW of the metamorph malformation site was missing a hind limb.

Discussion.—The lack of *Bd* detection does not demonstrate absence from DNP. The low sample size at each site, between 1 and 7 animals, greatly reduces the probability and confidence level of *Bd* detection at each site. *Bd* prevalence varies with a number of abiotic (Berger et al. 2004; Drew et al. 2006) and biotic (Carey et al. 2003) factors. The effect of season (Berger et al. 2004), altitude (Young et al. 2001; Collins et al. 2003), rainfall (Collins et al. 2003), and temperature (Collins et al. 2003) are implicated in *Bd* outbreaks. Amphibians also exhibit differential sensitivity to *Bd* infection depending on life stage (Blaustein et al. 2005; Garcia et al. 2006). *Bd* may be less detectable in newly metamorphosed frogs (J. E. Johnson, unpublished), and may not be reliably detected in some species until two to three weeks after metamorphosis (C. Carey, pers. comm.). Pearl et al. (2007) reported a comparable sample size of juvenile frogs (N = 29) and detected *Bd* in 34.5% of their samples. However, they report fewer *Bd* detections in the summer months (6.15%) compared to the winter months (38.6%) which suggests sampling during the breeding season may improve the likelihood of *Bd* detection. An assay of a greater sample size of Wood Frogs across all life stages in DNP will better assess *Bd* prevalence.

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NATURAL HISTORY NOTES

Instructions for contributors to Natural History Notes appear in Volume 39, Number 1 (March 2008).

CAUDATA — SALAMANDERS

LISSOTRITON VULGARIS (Smooth Newt). **PREY.** *Lissotriton vulgaris* is a widespread species in Europe and western Asia. Because of their nectonic lifestyle (Dolmen 1983. J. Herpetol. 17:23–31), adult *L. vulgaris* feed primarily on planktonic Crustacea (Dolmen and Koksvik 1983. Amph.-Rept. 6:133–136). The following observations were made on 5 May 2007 between 1500 and 1545 h at an artificial pond in northern Hesse, Germany (51.2069444°N, 9.0722222°E; elev. 330 m). An adult female *L. vulgaris* (ca. 95 mm TL) was observed to capture a large dragonfly nymph (total length about 50 mm, family Aeshnidae). The nymph, which was sitting on a floating leaf, had recently moulted and the chitin armor appeared to be soft. The newt approached the leaf from beneath and captured the insect with a quick bite into its anterior portion. Another female *L. vulgaris* appeared and snapped several times at the legs of the nymph. The intruder took the prey from the other female and disappeared into deeper water, holding the nymph between its jaws. Whether the newt succeeded in swallowing its prey remains unknown. Because of their size and usually protective exoskeleton such large dragonfly nymphs may not form a regular part of the diet of *L. vulgaris* (Avery 1986. Oikos 19:408–412).

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NECTURUS MACULOSUS (Red River Mudpuppy). **HOST.** Several species of leeches have been known to prey upon amphibian species (Briggler et al. 2001. J. Freshwater Ecol. 16:105–111; Moser et al. 2005. J. North Carolina Acad. Sci. 121:36–40; Sawyer 1972. Illinois Biol. Monogr. 46:1–46). The leech, *Placobdella cryptobranchii* (Ozark Hellbender Leech) was described in 1977 (Johnson and Klemm 1977. Trans. Amer. Micros. Soc. 96:327–331). To date, the only known host for *P. cryptobranchii* is the Ozark Hellbender, *Cryptobranchus alleganiensis bishopi* (Moser et al. 2006. J. Arkansas Acad. Sci. 60:84–95). Herein, we provide information on the first report of *P. cryptobranchii* on *Necturus maculosus*.

On 1 Sept 2005, four juvenile *P. cryptobranchii* were found attached to a *N. maculosus* captured on the Eleven Point River, Oregon County, Missouri, USA. The *N. maculosus* appeared healthy (mass 105 g; SVL 16.5 cm; TL 25.5 cm). While attached to the *N. maculosus*, all four leeches exhibited a reddish colored crop area that indicated blood feeding upon the host. Two leeches were collected and deposited at the National Museum of Natural History, Smithsonian Institution, Washington DC (USNM 1100749) where blood-feeding was further confirmed by full crops in each leech (WEM, pers. obs.). This account is the first report of *P. cryptobranchii* feeding on *N. maculosus*, and the second known host for *P. cryptobranchii*. More information should be collected on *P. cryptobranchii* to determine if its presence on *N. maculosus* is a common occurrence or an isolated event. Since 2005, surveyors have captured 6 *N. maculosus* from the Eleven Point River in Missouri and this is the only instance when *P. cryptobranchii* was observed. With the continued decline of the main host, *C. a. bishopi*, this leech may need to rely increasingly upon *N. maculosus*.

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NOTOPHTHALMUS VIRIDESCENS LOUISIANENSIS (Central Newt). **LEECH INFESTATION**. Glossiphoniid leeches (*Placobdella picta*) have previously been reported to infest Red-spotted Newts, *Notophthalmus v. viridescens* in Maryland (Mock 1987. J. Parasitol. 73:730–737), New York (Barrow 1953. Trans. Amer. Microsc. Soc. 72:197–216; Pough 1971. Science 174:1144–1146), Pennsylvania (Raffel et al. 2006. J. Parasitol. 92:1256–1264), and Virginia (Gill 1978. Ecol. Monogr. 48:145–166). To our knowledge, *P. picta* has not been reported from *N. v. louisianensis*.

On 22 March 2007, D.J. visited a fishless pond with rooted aquatic vegetation situated in an oak-hickory forest of mountainous terrain, 1 km W St. Hwy. 23, Carroll County, Arkansas. Sixty-three *N. v. louisianensis* were collected and examined for leeches; 18 (29%) had *P. picta* firmly attached to their integument, the majority under their lip, while others had leeches attached to the tail and lower abdomen. On several occasions, newts were observed trying to physically remove leeches by biting at their tails and shaking their heads vigorously, unusual behavior previously reported in *N. v. viridescens* by Gill (*op. cit*.). The same site was revisited about 2 months later on 19 May 2007 and 49 *N. v. louisianensis* were examined; only three (6%) possessed leeches. This observation further supports the understanding that *P. picta* is a temporary ectoparasite on amphibians and may be an important regulator of certain populations (Brockleman 1969. Ecology 50:632–644; Berven and Boltz 2001. Copeia 2001:907–915).

We document herein the first report of *P. picta* infesting *N. v. louisianensis*. Interestingly, this leech has previously been reported on other amphibians in northern Arkansas (McAllister et al. 1995. J. Helminthol. Soc. Washington 62:143–149; Briggler et al. 2001. J. Freshwater Ecol. 16:105–111; Turbeville and Briggler. 2003. J. Freshwater Ecol. 18:155–159; Moser et al. 2006. J. Arkansas Acad. Sci. 60:84–95).

Voucher specimens of *P. picta* are deposited in the American Museum of Natural History (AMNH 5427); a voucher of *N. v. louisianensis* is deposited in the Arkansas State University Museum of Zoology, Herpetological Collection (ASUMZ 30705).

We thank the Arkansas Game and Fish Commission for Scientific Collecting Permits 032920062 and 042320071 issued to C.T. McAllister. We also thank S.E. Trauth (ASUMZ) and S.C. Watson (AMNH) for curatorial assistance.

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PSEUDOEURYCEA LEPROSA (Leprous False Brook Salamander). **REPRODUCTION**. There are ca. 26 species in the genus *Pseudoeurycea* that occur in Mexico, but data on reproduction exist only for eight of those species. *Pseudoeurycea leprosa* is one of the most abundant and broadly distributed species in Mexico, inhabiting the mountains of the central part and east of Eje Neovolcánico, from Pico de Orizaba to Serranía del Ajusco (Vega and Alvarez 1992. Act. Zool. Mex. 15:1–25). The habitat of *P. leprosa* is mainly pine forest, under decomposing logs, piles of dead vegetation, or under rocks. Reproduction in this species is mostly unknown. On 14 March 2005, at Parque Nacional Zoquiapan y Anexas, where the vegetation is dominated *Pinus hartwegii*, ALV observed a mature female *P. leprosa*, (19°27'4"N, 98°41'5"W; 3433 m elev.) under a log. The female (78 mm TL) was wrapped around a ball-shaped clutch of 10 eggs. The eggs were slightly oval, with a maximum diameter of 5 mm and the minimum of 4.9 mm. Nine eggs were attacked by fungus and only one egg hatched a month later (15 April), the hatchling measured 25 mm TL.

We thank the authorities of the Parque Nacional Zoquiapan who allowed us access to their facilities. Xóchitl Aguilar-Miguel verified identification of the salamander.

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ANURA — FROGS

CRAUGASTOR BERKENBUSCHII (Berkenbusch's Robber Frog). **MICROHABITAT USE**. *Craugastor berkenbuschii* has been reported as a common nocturnal species in the Los Tuxtlas rainforest (Vogt et al. 1997. *In* Gonzáles-Soriano et al. [eds.], Historia Natural de Los Tuxtlas, pp. 507–522. UNAM México). Some changes have recently been reported in Los Tuxtlas' concerning the herpetofaunal species abundance (Urbina-Cardona et al. 2005. *In* Halffter et al. [eds.], Sobre Diversidad Biológica: El significado de las Diversidades Alfa, Beta y Gamma, pp. 191–207. Vol. 4. Editorial Monografías Tercer Milenio, Zaragoza, España). To date there is little natural history information for *C. berkenbuschii*.

During six sampling seasons, between June 2003 and April 2005, I surveyed 108, 50 m permanent transects across the tropical rainforest at Los Tuxtlas, Veracruz, Mexico (18°32'N, 95°6'W). During 1007 person-hours of effort I recorded only a single adult *C. berkenbuschii* (80 mm SLV) in the tropical rainforest interior (100 m from the forest edge) on 31 July 2003 at 2350 h. This individual was located in the biggest forest fragment (472 ha), at 200 m elevation. Microhabitat characteristics were: in a hole in the soil 38 cm deep, 25°C soil temperature, 88% relative humidity, 62% leaf litter cover, 7 cm leaf litter depth, 40% herbaceous cover, 6.2% understory density, and 44.7% canopy cover. On 23 April 2005 at 2030 h in the second biggest forest fragment in the region (177 ha), and during the last survey night of the last field season I found a small congregation of *C. berkenbuschii* with 3 adults (72 mm average SVL) and 10 juveniles (22 mm average SVL). These individuals were in a 2 m^2 area surrounding an almost dried stream in the forest interior (200 m from the forest edge). Microhabitat characteristics at this site were: 25°C air temperature, 83% relative humidity, 90.5% leaf litter cover, 8.25 cm leaf litter depth, 30% herbaceous cover, 4.4% understory density, and 46.9% canopy cover.

This is the first report on habitat use by this species, which has been listed as Near Threatened (Santos-Barrera and Flores-Villela 2004. *In* 2006 IUCN Red List of Threatened Species. <www.iucnredlist.org>. 10 August 2007). *Craugastor berkenbuschii* should be placed on the "Los Tuxtlas forest interior species list" reported by Urbina-Cardona et al. (2006. Biol. Cons. 132:61–75). This population has been identified as fragile and may experience regional extinction. Thus, the extinction risk ranking of this species should be reconsidered because of its endemism, small range, and natural rarity. It is of special concern in the Los Tuxtlas region because of the increase in anthropogenic activities and habitat loss that continuously threaten the persistence of amphibians in the forest.

I thank Adriana González-Hernández for the species identification and help with my dissertation fieldwork. I thank Victor Hugo Reynoso for advice and support during the project, and Georgina Santos-Barrera for review of this note.

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HYPSIBOAS FABER (Smith Frog). **DIET.** *Hypsiboas faber* is a large hylid frog allocated to the *H. faber* group (Faivovich et al. 2005. Bull. Amer. Mus. Nat. Hist. 294:1–240) that occurs from northern Argentina to eastern Brazil, in permanent ponds in the Atlantic Forest Domain (Ab'Saber 1977. Geomorfologica 52:1–21; Martins 1993. Herpetol. J. 3:31–34). Published studies regarding the diet of *H. faber* are restricted to two papers that reported the major prey items are opilionids and arboreal hylid frogs (*Scinax granulatus* in Solé et al. 2005. Stud. Neotrop. Fauna Environ. 40[1]:23–28 and *S. granulatus* and *Aplastodiscus perviridis* in Solé et al. 2004. Herpetol. Rev. 35:159).

On 24 Jan 2007 at ca. 2100 h a gravid female *H. faber* (SVL 85 mm) was found preying on a juvenile *Eleutherodactylus binotatus* (SVL 29 mm) in a forest fragment at the municipality of Mariana,

state of Minas Gerais, Brazil (UTM:23K 0656671/7760247; ca. 1190 m elev.). The individual was encountered 2 m above ground and away from any pond or stream with the *E. binotatus* in its mouth. Both specimens were collected and the stomach contents of the female *H. faber* were examined and contained only plant material, likely ingested incidentally. Voucher specimens of the *H. faber* (LZV 855) and *E. binotatus* (LZV 856) were deposited in Laboratório de Zoologia dos Vertebrados of Universidade Federal de Ouro Preto (LZV/UFOP).

Eleutherodactylus binotatus is a medium-sized frog of the family Brachycephalidae occurring in Atlantic forests from Bahia to southeastern Brazil (Ribeiro et al. 2005. Biota Neotrop. 5[2]:1–15) and is found usually on the leaf litter and in low vegetation (Heyer 1990. Arq. Zool. 31[4]:237–410). This is the first record of a brachycephalid and of a terrestrial anuran being predated by *H. faber*.

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HYPSIBOAS FABER (Smith Frog). **PREDATION**. Predation is a major cause of mortality among tadpoles (Calef 1973. Ecology 54:741–758), and aquatic invertebrates often are cited as tadpole predators (Eterovick and Sazima 2000. Amphibia-Reptilia 21:439–461). Herein, we report predation by the belostomatid *Lethocerus melloleitaoi* on a *Hypsiboas faber* tadpole.

On 18 April 2006 at 2100 h (air temp. 12° C, water temp. 20°C) we found a *H. faber* tadpole (Gosner Stage 25; 34 mm TL) (Gosner 1960. Herpetologica 16:183–190) on the edge of permanent pond in Botucatu, State of São Paulo, Brazil (22°50'S, 48°25'W), being preyed upon by the water bug, *L. melloleitaoi* (68.1 mm body length; 25 mm width). The water bug was holding the tadpole on the anterodorsal region of the body (Fig. 1). The animals were captured and preserved. The tadpole had a cut on the side of its spiracle, caused by the belostomatid proboscis. The water bug is deposited in the entomological collection of the Museu de Zoologia of the Universidade de São Paulo, Brazil, and the tadpole is deposited at the Jorge Jim Collection, Departamento de Zoologia, Universidade Estadual Paulista, Botucatu, São Paulo State, Brazil (without numbers).



FIG. 1. *Hypsiboas faber* tadpole predated by *Lethocerus melloleitaoi.*

We thank C. Campaner for identification of the belostomatid and I. Martins for suggestions on the text. Sacae Watanabe permitted our fieldwork at the Recanto Ecologico, and S. Watanabe and CNPq provided financial support (S.C. Almeida, proc. 141733/2006-3).

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ISCHNOCNEMA HOEHNEI (Hoehnei's Robber Frog). **ADVERTISEMENT CALL**. *Ischnocnema hoehnei* was described from Paranapiacaba, in the coastal Atlantic Forest of the state of São Paulo, southeastern Brazil (Lutz 1958. Mem. Oswaldo Cruz, Rio de Janeiro, 56:378). It has also been observed at Boracéia, (Heyer et al. 1990. Arq. Zool., São Paulo, 31:231–410) and Teresópolis, ca. 400 km NE of the type locality in the state of Rio de Janeiro (http://www.globalamphibians.org/servlet/GAA).

On 29 Nov 1997 AAG observed the species at its type locality. Two males were heard calling, although only the call of a single individual was recorded. This call was recorded with a UHER 4200 (19 cm/s) tape recorder and a UHER M518A Microphone. The call was digitized and audio spectrogram prepared with the Spectrogram software (Horne 1994. Spectrogram. www.visualizationsoftware.com/gram.html). Sample rate was set at 22050 Hz, with 16-bit resolution. The call was analyzed and oscillogram and spectrogram derived with the SoundRuler software (Griddi-Papp 2007. Sound Ruler. V0.9.6.0. http://soundruler.sourceforge.net), using a Fast Fourier Transformation at 1024 data points, frequency resolution at 21.5 Hz, and low and high band limit at 50 and 7500 Hz. The individual recorded was calling on the ground in an open area, among tuffs of grass-like plants (40 cm tall) about 8 m from the forest border. The other calling individual was about 10 m away in similar habitat. Calls were released sporadically. The recorded call (Fig. 1) presented 50 pulses and lasted 1.3 s; pulses lasted 0.025–0.035 s; pulse rate was 2123/s. Call frequency and intensity modulated, beginning low and quiet, rising in frequency and intensity to about mid-call, then maintaining relatively constant frequency and intensity to the end; 4th to 13th note frequency ranging from 1591 to 1980 Hz; second half of call with frequencies between 720 to 2900 Hz; side bands evident. *Ischnocnema hoehnei* has traditionally been allocated to the *E. binotatus* species group (Lynch and Duellman 1997. Nat. Hist. Mus., Univ. Kansas Spec. Publ. 23:1–236), although Heinicke et al. (2007. PNAS. 104[24]:10092–10097) reported *E. binotatus* only distantly related to the other eleutherodactylines of southeastern Brazil. Acoustic data, such as presented here, might help resolve the species group relationships among the eleutherodactyline frogs of southeastern Brazil.

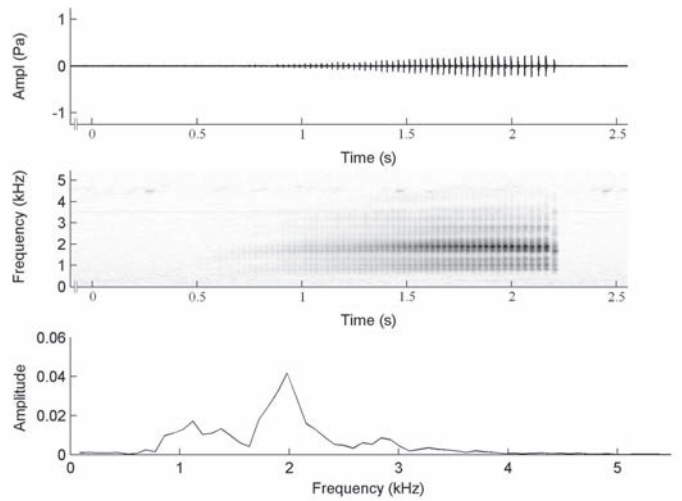


FIG. 1. Oscillogram, spectrogram, and power spectrum of the call of *Ischnocnema hoehnei*, Paranapiacaba, São Paulo, Brazil, air 16.5°C. Voucher: AmphibiaWeb photo (CalPhotos ID: 0000 0000 0504 0973); call also available in the AmphibiaWeb (unnumbered MP3 sound file).

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KALOULA PULCHRA (Painted Burrowing Frog). **ANTIPREDATOR BEHAVIOR**. *Kaloula pulchra* is known from northern India (Meghalaya) east into Vietnam (IUCN, Conservation International, and NatureServe 2006. Global Amphibian Assessment. <www.globalamphibians.org>. Accessed 15 June 2006). *Kaloula pulchra* occurs throughout Thailand (Nabhitabhata et al. "2000" 2004. Checklist of Amphibians and Reptiles in Thailand. Office of Environmental Policy and Planning. 152 pp.) and is often used for human consumption. To our knowledge, antipredator behavior in *K. pulchra* is poorly known and no antipredator behavior has been described from Thailand. On 29 March 2003 during our visit to Sam Pran Protected Unit, Khao Ang Rui Ni Wildlife Sanctuary, Tha Takhieb District, Chachoengsao Province (southeastern Thailand), we had an opportunity to photograph frogs that had been collected for food. While being handled during the daytime, an individual frog displayed an antipredator behavior when touched. The frog inflated its lungs and outstretched the limbs. It presented a large color pattern image on its dorsum. The inflation of the lungs did not lift the body. When we overturned the frog the lungs remained inflated and the individual remained rigid and immobile for several seconds (Fig. 1). Anurans frequently employ posture as a defensive mechanism, and in species of *Scaphiopus*, *Limnodynastes*, *Leptodactylus*, and *Bufo*, inflation of the lungs is usually accompanied by elevation of the body from the substrate (Duellman and Trueb 1986. Biology of Amphibians. McGraw-Hill Book Company, New York. 670 pp.).

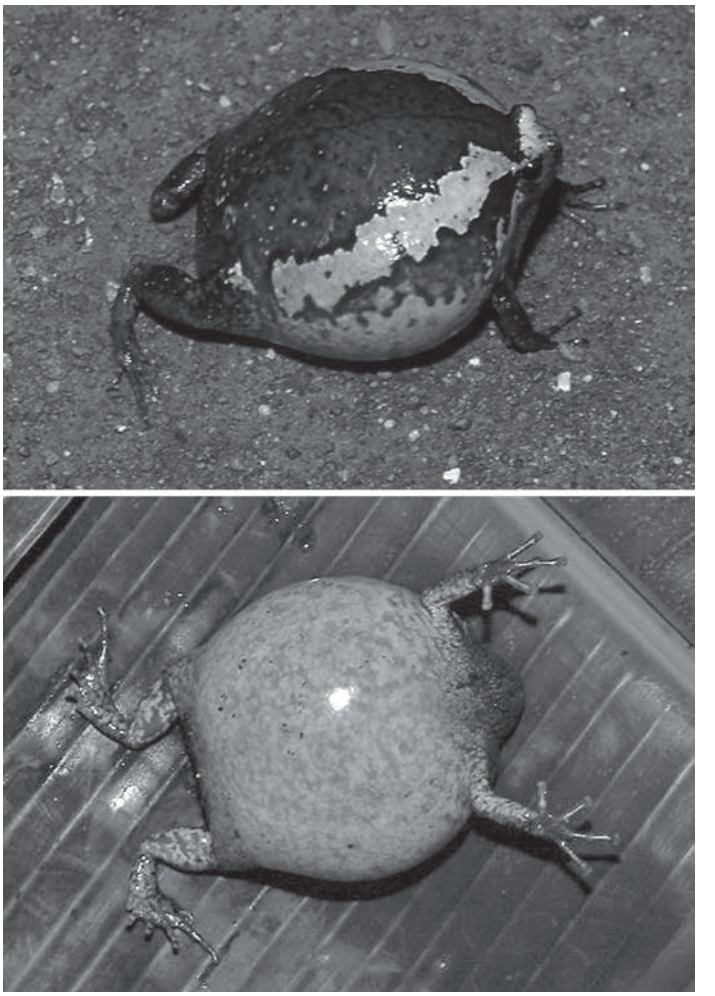


FIG. 1. Top: Dorsolateral view of *Kaloula pulchra*, showing antipredator behavior. Lower: Ventral view.

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NECTOPHRYNE BATESII (Bates' Tree Toad). **JUVENILE COLORATION.** Marked differences in the coloration and pattern between juvenile (i.e., recently metamorphosed) and adult anurans are seldom noted in the literature. In most cases, this is because there are few remarkable differences between different age classes. *Nectophryne* comprises two species found in Central African forests extending from the coast of Cameroon, Equatorial

Guinea, and Gabon across to northeastern Democratic Republic of Congo (IUCN et al. 2006. <www.globalamphibians.org>). Recently metamorphosed juveniles of *N. afra* are velvet black with thin bluish white lines that cover much of the dorsal surface and form loops or even rings (Scheel 1970. Rev. Zool. Bot. Afr. 81:225–236). In contrast, adult *N. afra* are black or brown with dorsolateral bands that extend posteriorly from the eyes to the inguinal region and are lighter shades of brown or yellow. There are no reports of similar ontogenetic changes in color or pattern in *N. batesii* or the closely related Cameroonian toad genus *Wolterstorffina*.

In June 2006, juvenile *Nectophryne* specimens, MCZ A-138204 (SUL 5.6 mm) and 138144 (SUL 6.9 mm), were collected by VD from leaves and branches surrounding orchids in moist, tropical, submontane forest near Bidjouka (3.1430556°N, 10.4775°E) and Akom 2 (2.7444444°N, 10.5305556°E), in Sud Province, Republic of Cameroon. These specimens exhibit a color pattern similar to each other but different from *N. afra* juveniles. The specimens are identifiable as *Nectophryne* because both exhibit lamellae on the hands and feet, which are a unique, derived characteristic of this genus. To determine the species identity of these specimens, a genomic region consisting of 2365 base pairs of the mitochondrial 12S and 16S ribosomal RNA, and intervening Valine tRNA, was amplified from MCZ A-138144 (Genbank [GB] No. EU394537) and compared to sequence data from the same genomic region of adults of both *N. afra* (MVZ 234685, GB EU394535; MVZ 234686, GB EU394533; CAS 207832, GB EU394534; GB DQ283360) and *N. batesii* (MVZ 234687, GB EU394536; GB DQ283169). Sequences were aligned in Clustal X v.1.83.1 using default parameters and uncorrected pairwise sequence divergences calculated using PAUP v.4.0b10. The mean pairwise divergence found within *N. afra* is 0.83% (range: 0.17–1.59%; N = 6 pairwise comparisons) and the pairwise divergence between the two *N. batesii* specimens is 6.67%. The mean divergence between *N. afra* and *N. batesii* is 10.80% (range: 10.08–11.23%; N = 8 pairwise comparisons). The mean pairwise divergence between the juvenile specimen (MCZ A-138144) and *N. afra* is 10.25% (range: 10.05–10.81%), whereas it is only 4.32% and 4.67% from the two *N. batesii* specimens. Because the latter are less than the divergence between the two *N. batesii* adults and fall within the range of intraspecific divergence in 16S rRNA documented in other anurans (i.e., Vences et al. 2005. Front. Zool. 2:1–12), it is reasonable to assign these juvenile specimens to *N. batesii*. Similar results were obtained by local BLAST searches in BioEdit v.7.0.5.

The juvenile specimens were compared to adults of both *N. afra* (MCZ A-2607, A-101156–59; MVZ 234685–86) and *N. batesii* (MCZ A-46621, A-101155; MVZ 234687). In dorsal view, juvenile *N. batesii* are black with four prominent and solid transverse stripes that are distributed at roughly equal intervals across the rostrocaudal axis. In life, these stripes are pale light green and change to either gray or white in preservative. In addition to the dorsal stripes, there is a white stripe extending proximodistally on the posterodorsal surface of the femur, a small transverse stripe at both the proximal and distal ends of the tibiofibula, and a spot at the most proximal part of the tarsus. The throat is somewhat darkened but the belly exhibits little, if any, pigmentation. Only one of the adult *N. batesii* examined (MCZ A-101155) exhibits any markings that can be interpreted as similar to the juveniles. However, these are only apparent as very poorly defined lighter regions on the dorsal surface in the approximate position of the four transverse stripes. Relatively little is known of the natural history of *Nectophryne* (Scheel 1970, *op. cit.*). The function, if any, of the strikingly different coloration and pattern of juveniles and adults remains enigmatic. Future study should focus on whether this distinctive juvenile coloration plays a role in crypsis, mimicry, or possibly aposematism.

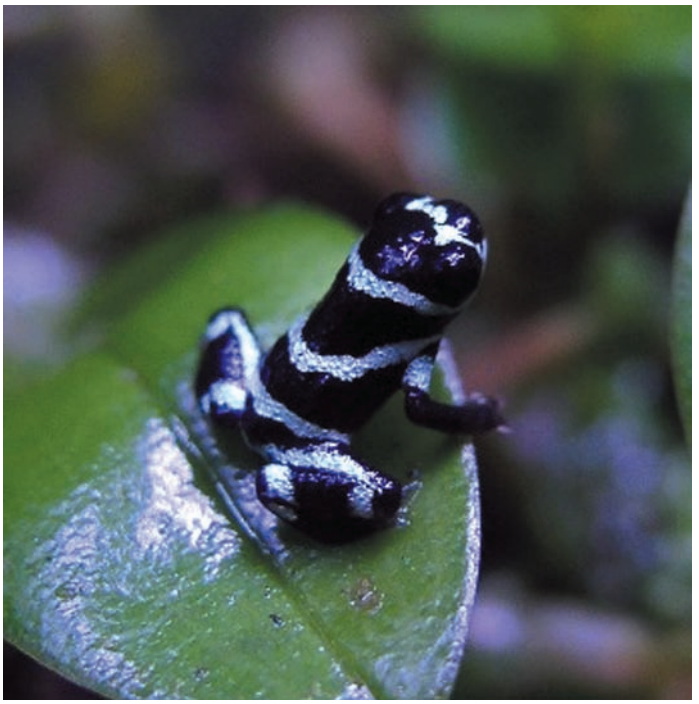


FIG. 1. Juvenile *Nectophryne batesii* (MCZ A-138144), photographed in life, exhibit coloration and pattern that differ remarkably from adults.

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PHYSALAEMUS CUVIERI (Barker Frog). **PREDATION.** Although anuran amphibians are often preyed upon by invertebrates, including spiders of the family Ctenidae (Toledo 2005. Herpetol. Rev. 36:395–400; Menin et al. 2005. Phyllomedusa 4:39–47), the taxonomic extent and size aspects of that relationship remain poorly documented. We observed a relatively small ctenid spider preying on a *Physalaemus cuvieri* at 2152 h, 1 Jan 2007, on the property of Escola Evangelica Buriti (5.4066667°S; 55.8030556°W), ca. 7 km W of Chapada dos Guimarães on Hwy MT251, Mato Grosso State, Brazil. The female spider (0.8 g) was obliquely head-up on a lichen- and moss-covered sapling (dbh 3 cm), ca. 1.2 m above the ground near a small stream, with the male *P. cuvieri* (SVL 29 mm; mass 1.8 g; CFBH 14277, Coleção de Anuros, UNESP Rio



FIG. 1. Adult *Physalaemus cuvieri* restrained in the chelicerae of an unknown species of ctenid spider. The *P. cuvieri* was more than two times the weight of the spider.

Claro, São Paulo, Brazil) restrained in its chelicerae. The frog was immobile but not limp, bleeding slightly from its wounds, and responded to human handling with faint leg movements. The impressively high prey/predator mass ratio (2.25) was likely facilitated by venom injection, a specialized predation tactic (Toledo et al. 2007. J. Zool. 271:170–177). *Physalaemus cuvieri* is typically terrestrial so perhaps the spider captured the frog on the ground and then carried it up the tree, after immobilizing it with venom. The ctenid is likely an undescribed species in an as yet undetermined genus of Cteninae (Daniele Polotow, pers comm.), and is deposited in the arachnology collection of Insituto Butantan, São Paulo, Brazil (IBSP 85314).

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PHYSALAEMUS CUVIERI (NCN). **PREDATION**. On 26 Dec 2006 at 2145 h in Eldorado City (26°24'32"S, 54°34'56"W), Misiones Province, Argentina, we found a dead adult male *Physalaemus cuvieri* (26.7 mm TL) caught by a giant water bug *Lethocerus annulipes* (Belostomatidae: Lethocerinae) (67.0 mm TL) (Fig. 1) in a shallow temporary pond surrounded by tall grasses. There were several calling males on the edge of the pond, and a foam nest was observed, indicating reproductive activity of *P. cuvieri*. Predation of adult anurans by Belostomatinae giant water bugs was previously reported by Oda (2006. Herpetol. Rev. 37:4) and Toledo (Phyllomedusa 2:105–108). To our knowledge, this is the first report of a Lethocerinae giant water bug predating an adult *P. cuvieri*.



Fig. 1. *Physalaemus cuvieri* predated by *Lethocerus annulipes* in Eldorado city, Misiones, Argentina.

We thank G. C. Küppers for her comments on the manuscript and for assistance in the field, and to J. Muzón for help identifying the giant water bug.

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***PROCERATOPHRYS* SP.** (NCN). **PREDATION.** An undescribed Cerrado species of the genus *Proceratophrys* belongs to the *cristiceps* group, and is found in open grasslands and in gallery forests (R. Brandão, pers. comm.). On 12 March 2002, at Fazenda Água Limpa, Distrito Federal, Brazil four adult White-eared Puffbirds (*Nystalus chacuru*) were captured on mist nets in a "campo cerrado" area. One of them was holding a *Proceratophrys* sp. in its beak (Fig. 1). This puffbird is known to dig in ground or banks to construct a gallery as an entrance for the nest chamber, and could have captured the frog in its diurnal retreat. The White-eared Puffbird is a common Cerrado species that is considered mostly insectivorous, although other food items, including lizards and vegetable matter, have been reported (Del Hoyo et al. 2002. Handbook of the Birds of the World. Cotingas to Pipits and Wagtails. Lynx Edicions, Barcelona). This is the first record of *Proceratophrys* being preyed upon by a White-eared Puffbird.

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FIG. 1. White-eared Puffbird captured in a mist net while carrying an individual *Proceratophrys* sp.

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SCINAX RUBER (Red-Snouted Treefrog). **PREDATION.** It has long been known that invertebrates are predators of adult frogs (Duellman and Trueb 1986. Biology of Amphibians. McGraw-Hill, New York. 670 pp.; Hayes 1983. Biotropica 15:74–76). Recently, Brasileiro and Oyamaguchi (2006. Herpetol. Rev. 37:451) reported a male *Scinax alcatraz* being preyed upon by an immature Wandering Spider, *Oligoctenus medius*. Here, we report the predation of adult *Scinax ruber* by a water bug, *Belostoma* sp. (Hemiptera: Belostomidae).

On 30 March 2007, between 1900 and 2200 h, in a small temporal pond close to the Coello River in Tolima, Colombia (4.25°N, 75.32°W), we observed three *Belostoma* sp. grasping frogs in the inguinal region to kill them (Fig. 1). This observation of high predation in a short time coincides with the beginning of the rainy season and the explosive reproductive behavior of *S. ruber*.



FIG. 1. Predation of *Scinax ruber* by *Belostoma* sp.

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SPHAENORHYNCHUS DORISAE (Spotted Hatchet-faced Treefrog). **OCULAR ANOMALY**. There are no reports in the literature regarding ocular anomaly in *Sphaenorhynchus dorisae*. On 18 May 2006 at 1050 h we observed an adult female *S. dorisae* (INPA-H 17704; SVL 28.3 mm, mass 2.8 g), without the visual organs, in the Reserva Extrativista do Baixo Juruá (03.60194°S, 066.06711°W), Amazonas, Brazil. We found the specimen in the margin of flooded forest near a branch 1.5 m above ground, at Igarapé Central. The ocular cavities were covered only with a fine membrane (Fig. 1).

We are grateful to IBAMA for financial, logistic support and research permits; we thank the inhabitants of the Reserva Extrativista do Baixo Juruá for fieldwork assistance; FAPEAM for scholarships to V. T. Carvalho; CAPES and IIEB (BECA Program, Gordon and Betty Moore Foundation) for scholarships to R. Arruda.

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FIG. 1. Adult female *Sphaenorhynchus dorisae* with ocular anomaly found at Reserva Extrativista do Baixo Jurua, Brazil. Photograph by Vinicius T. de Carvalho.

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TESTUDINES — TURTLES

APALONE SPINIFERA (Spiny Softshell Turtle). **DIET**. *Apalone spinifera* is a generalist carnivore known to consume a variety of invertebrates and vertebrates; vegetation is also occasionally eaten, but nuts (= a single seeded fruit with a woody pericarp, partially or wholly encased in a husk) have only rarely been reported in the diet (Ernst et al. 1994. Turtles of the United States and Canada. Smithsonian Institution Press, Washington, D.C. 578 pp.). On 22 July 2007 we captured two large (carapace length = 380 and 405 mm) female *A. spinifera* in a baited (canned sardines) hoopnet set in Bayou Duplantier, ca. 1 km downstream from the Louisiana State University Campus in Baton Rouge, East Baton Rouge Parish, Louisiana, USA. Bayou Duplantier is a turbid, low gradient stream draining an extensive urban watershed. We returned these turtles to the lab and each was placed in a water-filled plastic tub (capacity ca. 75 L) for 48 h, and then permanently marked and released at the capture site. Both turtles defecated within 24 h of capture and we passed the contents of each tub over a sieve (2-mm mesh) to recover food items. Numerous acorn (*Quercus* spp.) fragments were found in the feces of both turtles, and pieces of at least one pecan (*Carya illinoensis*) were recovered from the smaller female; other food items included cicadas (Cicadidae), crawfish (*Procambarus* sp.), grasshoppers (Caelifera), and an unidentified fish. The number of acorn fragments indicated that each turtle had consumed 5–6 of these fruits. We were unable to identify the acorns to species owing to the small size of the fragments; however, Water (*Quercus nigra*) and Live (*Q. virginiana*) Oaks are common along the bayou and produce small acorns that could be readily swallowed by turtles. Viable nuts rapidly sink (Schopmeyer 1974. Seeds of Woody Plants in the United States. USDA Forest Service, Agriculture Handbook No. 450, Washington, D.C. 883 pp.) and the fragments we recovered were darkly stained suggesting the nuts had been buried in sediments since the previous autumn and probably consumed as turtles foraged among the benthos. Our observation compliments an earlier report from Iowa (Williams and Christiansen 1981. J. Herpetol. 15:303–308) where 61% of *A. spinifera* stomachs contained plant material, including "acorns, leaves, and vegetable matter" (specific breakdown not provided). To our knowledge, these are the only two reports of *A. spinifera* consuming acorns. We are unaware of any previous report documenting pecan consumption by *A. spinifera*. *Apalone spinifera* are known to forage extensively among benthic debris (*op. cit.*) and consumption of nuts is therefore not unexpected. Acorns and pecans represent a concentrated source of carbohydrates and fat and also contain relatively high levels of protein, calcium, and phosphorus (Goodrum et al. 1971. J. Wildl. Manage. 35:520–532). Sloan et al. (1996. Chelon. Conserv. Biol. 2:96–99) found intact acorns and pecans in the stomachs of *Macrochelys temminckii* and raise the possibility that these turtles function as seed dispersal agents in riparian ecosystems. However, our observations, albeit limited, indicate that *A. spinifera* are seed predators rather than seed dispersers because nuts are digested instead of being passed intact through the digestive tract.

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APALONE SPINIFERA ASPERA (Gulf Coast Spiny Softshell). **PREDATION.** The Flathead Catfish, *Pylodictis olivaris*, is an obligate omnivore; adults are primarily piscivorous and young consume invertebrate prey. Native to the Rio Grande, Mississippi, and Mobile River drainages, *P. olivaris* has been introduced to other drainages beyond their native ranges in North America. Where introduced, they are considered an invasive species due to their heavy predation on native fish species and associated population declines (Pine 2005. Trans. Am. Fish. Soc.134: 901–909). During the summer of 2007, *P.olivaris* were captured on Ichawaynochaway Creek at the J.W. Jones Ecological Research Center (31.367°N, 84.800°W, Newton, Georgia) for a study examining the impacts of this species on native aquatic fauna. Stomach contents were examined and in one male *P. olivaris* (1016 mm TL; 13.3 kg) a partially digested *A. spinifera* was found. Much of the turtle was intact, enabling identification and measurements (carapace length 130 mm; width 128 mm; plastron length 109 mm; width 123 mm). Flathead Catfish at this size predominately feed on live fishes such as Centrarchidae (sunfish) and Percidae (perches and darters) in addition to decapods (crayfish). Known predators of *A. spinifera* include fishes, other turtles, snakes, alligators, wading birds, and small mammals (Webb 1962. Univ. Kansas Publ. Mus. Nat. Hist. 13:429–611). To our knowledge, this is the first record of turtles in the diet of *P. olivaris* in the southeastern U.S.

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CHELODINA LONGICOLLIS (Eastern Long-necked Turtle). **DRINKING BEHAVIOR**. Most species of freshwater turtles use terrestrial habitats at several points in their annual and life cycles, including nesting, movements between water bodies, and, in some species, for over-wintering and aestivation. Some of these behaviors require an extended time out of water (i.e., weeks, months, or even years) and thus present a challenge for the maintenance of water balance. During a radio-telemetric study of *C. longicollis* in

Booderee National Park, Jervis Bay Territory, Australia, I observed one obvious and two apparent instances of terrestrial drinking behavior during a rainfall event (44.2 mm) on 20 February 2005 in the austral summer. All three turtles (2 male, 1 female; carapace lengths 170.0–215.5) had been inactive and completely buried under leaf litter in the forest near a wetland that had been dry for 93 days, but between 1649–1655 h during heavy rainfall at 20°C, all three were observed on the surface within one meter of their refuge sites. Two turtles were in a sprawled posture with legs and neck fully extended, while the third was actively drinking water that had pooled in a shallow natural depression in the litter. The turtles were buried in their previous refuge sites the following day. During drought, terrestrial tortoises are well known for their ability to drink pooled water during rainstorms (Medica et al. 1980. Herpetologica 36:301–304), but this is apparently the first report for drinking in a freshwater turtle while in natural terrestrial aestivation. Such behavior may in part replace respiratory and evaporative water losses incurred throughout aestivation and allow for more extended periods of survival out of water.

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CHELONIA MYDAS (Green Sea Turtle). **HABITAT AND OCCURRENCE.** Of the seven recognized sea turtle species, five are known to visit the coastline of Brazil to feed and nest (Marcovaldi 1999. Marine Turtles of Brazil: The History and Structure of Projeto TAMAR-IBAMA. Biological Conservation. 35 pp.). The region of Cananéia, at the southernmost part of the state of São Paulo, southeastern Brazil, is a complex of conservational units visited by marine turtles year round, particularly the *Chelonia mydas*, which uses this region to feed and grow (Bondioli et al. 2005. *In* II Jornada de Conservação de Pesquisa de Tartarugas Marinhas do Atlântico Sul Ocidental, Praia do Cassino, Rio Grande do Sul. Livro de Resumos. 53 pp.). In this area, there are artisanal fishing traps called "cerco-fixo" or permanent fencing. These traps incidently capture the turtles, maintaining them alive. Since 2003, monitoring of the region's beaches, as well as the "cerco-fixo" distributed along the entire estuary, has allowed us to register the occurrence of 222 marine turtles. Of these, 216 were Green Sea Turtles (1% adults, with a curvilinear length of the top shell > 70 cm, and 99% juveniles), one subadult Leatherback Turtle (*Dermochelys coriacea*), two subadult Hawksbills (*Eretmochelys imbricata*), five Loggerhead Sea Turtles (*Caretta caretta*, two subadults and three adults), and the carcass of an adult Olive Ridley Sea Turtle (*Lepidochelys olivacea*). Of the 222 turtles, 177 (all juvenile Green Turtles) were collected in the "cerco-vivo," therefore, alive. Remaining turtles were found dead along the beaches in the region. Aside from these data, informal reports as well as shells displayed in homes, museums, and local restaurants (in approximately the same proportions registered in this study) confirm the presence of these species in this region. Based on these data, we can conclude that, besides being characterized as a feeding area for Green Sea Turtles, the Estuarine Complex Lagoon of Cananéia is visited by all the species of marine turtles which visit the Brazilian coastline. Because this region is characterized by different conservation units, its preservation also helps assure the preservation of the marine turtles that spend at least one phase of their lives in the region.

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DERMOCHELYS CORIACEA (Atlantic Leatherback Sea Turtle). **REPRODUCTION**. *Dermochelys coriacea* is reported to nest along the entire eastern coast of Florida, with highest concentrations in southern Florida (Meylan et al. 1995. Sea Turtle Nesting Activity in the State of Florida. Florida Marine Research, Pub. No. 52). Herein, we provide support for these findings along with a first county record voucher. At ca. 1645 h on 26 June 2007, a female (ca. 340 kg) *D. coriacea* (UF photographic voucher 151367) came ashore on Vilano Beach ca. 4 km N of the St Augustine Inlet, St. Johns County, Florida (29.950575°N, 81.3034694°W, datum WGS84, elev. <1 m). This turtle created a disturbed area (combined nest and adjacent sand displacement) of about 4.5 × 6.1 m. The entire act was captured on film, and nesting lasted from 1645–1811 h when the turtle returned to the Atlantic Ocean. There are currently three other known nestings of *D. coriacea* in St. Johns County, all to the north of this documented nest. Only five *D. coriacea* nests have been recorded in northeastern Florida since 2004.

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ERETMOCHELYS IMBRICATA (Hawksbill Sea Turtle). **PREDATION.** Predation on hatchling sea turtles by fire ants, crabs, fish, birds, and mammals is widely acknowledged, however, there are relatively few accounts of reptiles as hatchling sea turtle predators. To our knowledge, only varanid lizards and a few snakes have been reported as reptilian predators of hatchling sea turtles (Blamires 2004. Copeia 2004:370–377; Brattstrom 1955. Am. Midl. Nat. 54:219–229; Crother 1986. Herpetol. Rev. 17:47). Here we report neonate sea turtle predation by a teiid lizard, *Ameiva fuscata*, on the island of Dominica, West Indies.

At 1200 h on 6 September 2007, while walking the boardwalk at the Soufriere Scott's Head Marine Reserve at Champagne Bay we observed an adult *A. fuscata* scrambling up the coastal slope with a hatchling *Eretmochelys imbricata* in its mouth. The lizard had the dead hatchling sea turtle grasped by the head and dropped it as we followed to investigate further. We searched beneath the 1.5 m high boardwalk that runs parallel to the ocean and the coastal slope and found an *E. imbricata* nest. The nest was in a small sandy opening (ca. 20 cm diameter) among beach stones 5– 15 cm diameter. A minimum of six other *A. fuscata* were within 1 m of the nest but fled as we approached. Five live hatchlings were exposed in the ca. 12 cm wide exit burrow and after excavation we

discovered 145 live hatchlings and 36 eggs that were undeveloped or in different stages of decay. Whether the lizards were waiting for the hatchlings to emerge or digging them from the sand is unknown.

To our knowledge, this is the first reported observation of a neotropical lizard preying on hatchling sea turtles. Species of *Ameiva* are among the largest terrestrial carnivorous lizards in the Lesser Antilles and *A. fuscata* can reach mean densities of 379 individuals/ha on Dominica (Bullock and Evans 1990. J. Zool. Lond. 222:421–443). The consequences of high population densities and active foraging behavior of *A. fuscata* may have significant effects on hatchling sea turtle survival on Dominica and warrants further study wherever coastal populations of *Ameiva* are sympatric with nesting sea turtles.

We thank Alan Bolten and Karen Bjorndal for confirming the identification of the sea turtle hatchings and for providing comments on this note. This observation was made while conducting *Iguana delicatissima* research on Dominica, funded through the center for Conservation and Research for Endangered Species (CRES) at the Zoological Society of San Diego.

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GOPHERUS AGASSIZII (Desert Tortoise). **PREDATION**. Predation events on *Gopherus agassizii* are rarely observed and documented. Thus, most predators of the Desert Tortoise have been inferred by the presence of tortoise parts in scats, pellets, and/or carcasses deposited at nests or denning sites. Boarman (2002. *In* Boarman and Beaman [eds.], The Sensitive Plant and Animal Species of the Western Mojave Desert. U.S. Geological Survey, Western Ecological Research Center, Sacramento, California) records several native predators that are known to prey on Desert Tortoise eggs, hatchlings, juveniles, and adults, including Coyotes (*Canis latrans*), Kit Foxes (*Vulpes macrotis*), Badgers (*Taxidea taxus*), Skunks (*Spilogale putorius*), Common Ravens (*Corvus corax*), Golden Eagles (*Aquila chrysaetos*), and Gila Monsters (*Heloderma suspectum*).

During a four year study (2003–2006) of Desert Tortoises at a site ca. 40 km NE of Barstow, California, in San Bernardino Co. (Walde et al. 2007. Southwest. Nat. 52:147–149; Walde et al. 2007. West. N. Am. Nat. 67:147–149), we observed many Burrowing Owls (*Athene cunicularia*). Examination of owl pellets that are ejected close to burrows and perches revealed that they often contain insect remains (Lepidoptera and Coleoptera), and less frequently remains of small rodents. On 10 May 2006, a Burrowing Owl pellet was found close to a perch that had several parts of a beetle, *Cerenopus concolor* (Coleoptera: Tenebrionidae) in it, a species which frequently comprised 100% of pellets. This particular pellet, however, also contained vertebral and marginal scute material and bones of the Desert Tortoise. One vertebral scute was entirely intact and had growth annuli suggesting that the Desert Tortoise was at least one year old. The disarticulated pellet was deposited in the Natural History Museum of Los Angeles County, Los Angeles, California (LACM 168081). To our knowledge, this is the first documentation of predation by *A. cunicularia* on the Desert Tortoise.

We thank Rolf Aalbu for identification of the Tenebrionidae in the owl pellet and Rick Feeney of the Natural History Museum of Los Angeles County for his assistance with the specimen.

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GOPHERUS POLYPHEMUS (Gopher Tortoise). **RECORD SIZE**. To our knowledge, the largest *Gopherus polyphemus* reported to date had a straight-line carapace length of 38.7 cm (Timmerman and Roberts 1994. Herpetol. Rev. 25:64). Here we report a specimen that exceeds this size. In March 2007, one of us (AE) received for rehabilitation a large, injured Gopher Tortoise. The cause of injury was unknown, but its wounds, which proved fatal, were consistent with damage from a backhoe shovel. The tortoise originated from Lee County, Florida, west of Interstate Highway 75, within the city limits of Fort Myers. The exact point of collection was withheld, due to the potentially illegal action which led to the discovery and death of this tortoise. Ultrasound evaluation (by O. Diaz, DVM, of Orlando, Florida) revealed testes, showing the tortoise to be male. However, the posterior plastron has an unpronounced indentation, and the anal scute is single, flat, extends toward the tail, and is not divided or curved as is normal in male *G. polyphemus*. Post mortem weight was 12.2 kg. The straight-line carapace length was 41.6 cm, and the plastron length was 40.6 cm. The specimen is preserved in the Chelonian Research Institute collection (PCHP 12633).

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GRAPTEMYS FLAVIMACULATA (Yellow-blotched Map Turtle). **INTERSPECIFIC BASKING SITE COMPETITION.** *Graptemys flavimaculata* is a highly aquatic, riverine turtle endemic to the Pascagoula River and its tributaries of southern Mississippi, USA (Ernst et al. 1994. Turtles of the United States and Canada. Smithsonian Institute Press, Washington, D.C. 578 pp.). It is common to see multiple turtles of different species occupying the same snag within the Pascagoula River system, but there have been no reports concerning interspecific competition among turtles for basking locations in this area. Here we report observations of interspecific aggression and competitor avoidance behavior by *G. flavimaculata* when trying to secure a desired basking location.

On 17 April 2007 (1410 h), on the Leaf River (Forrest County, Mississippi), WS observed from a distance of 30 m a small *G. flavimaculata* female basking partly submerged on a low-angled tree crown snag, while a slightly smaller *Apalone mutica* was basking directly above her. The female *G. flavimaculata* extended her

forelimb and pushed the *A. mutica* off of the basking snag, then climbed to the location that the *A. mutica* had vacated. Shortly thereafter (ca. 30–45 sec), presumably the same *A. mutica* re-emerged on the same snag below the *G. flavimaculata*. Soon after the *A. mutica* emerged, a second small *G. flavimaculata* female, similar in size to the first, emerged from the bank side of the snag. While she was climbing onto the snag, she placed her right forelimb on the carapace of the *A. mutica*, apparently prompting it to move to another emergence point on the same snag (ca. 0.5 m away). After several minutes, the second *G. flavimaculata* vacated the log and then quickly reemerged and oriented itself behind the first *G. flavimaculata*.

Also on 17 April 2007 (1530 h), an alternative strategy, avoidance of a much larger interspecific, was observed by several *G. flavimaculata*. Upon approaching a 1.5 m long horizontal branch-sized snag, several emydid turtles were observed by WS vacating their basking locations before they could be identified. The snag was watched (via spotting scope) from a distance to see if the turtles would reemerge. Within minutes, a large female *G. flavimaculata* (>15 cm CL) emerged from the lowest angle of the snag/water interface and climbed approximately 15 cm up the snag. A large *Pseudemys concinna* (>20 cm CL) emerged behind the *G. flavimaculata* female and occupied the lowest emerged portion of the snag. After the emergence and 'roadblock' of the snag by the *P. concinna*, several more *G. flavimaculata* were observed swimming around the snag (heads emerged from the water). A second large *G. flavimaculata* female climbed vertically up the channel side of the snag to a basking location about 0.75 m away from the first *G. flavimaculata* female. A third *G. flavimaculata* female exhibited the same vertical climbing behavior, except approaching from the bank side of the snag and choosing a position between the first and second *G. flavimaculata*. It appeared that the second and third *G. flavimaculata* females used this technique, climbing a steeper, vertical angle, to get to a desired basking location while avoiding encounters with the previous two occupants of the snag.

In the first observation, aggression appeared to be advantageous for the larger *G. flavimaculata* females in order to obtain a favorable basking location. However, in the second observation, the two female *G. flavimaculata* 'climbers' were smaller than the *P. concinna*, and therefore, may not have had the option of using aggression to advance themselves to a favorable basking locality. These observations are supported by previous research that examined aggressive interactions among four emydids: *Trachemys scripta*, *Pseudemys concinna*, *Graptemys pseudogeographica*, and *Graptemys oauchitensis* (Lindeman 1999. J. Herpetol. 33:214–219). Lindeman noted that aggressive interactions were "won" 70% of the time by larger turtles, which is consistent with our observations and interpretations of *G. flavimaculata* behavior.

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GRAPTEMYS FLAVIMACULATA (Yellow-blotched Map Turtle). **FORAGING BEHAVIOR.** The *Graptemys flavimaculata* is a freshwater aquatic turtle that is endemic to the Pascagoula River system of southern Mississippi, USA (Ernst et al. 1994. Turtles of the United States and Canada. Smithsonian Institute Press, Washington, D.C. 578 pp.). R. J. Brauman and R. A. Seigel (unpubl. report) suggest that the primary food items of *G. flavimaculata* are insects, sponges, mollusks, and algae. They concluded that the presence of algae was due to secondary ingestion, rather than being a primary food item. However, very little is known about the foraging behavior of this species. Here we report two separate observations of female *G. flavimaculata* foraging on algae-covered submerged logs.

On 2 June 2006 (1650 h), a female *G. flavimaculata* was observed (by WS) ca. 0.3 m deep in a swift-flowing riffle section of the Leaf River (Forrest County, Mississippi) foraging on an algae-covered log. The female was grasping the downstream side of the log with her forelimbs as she appeared to "graze" on the periphyton. After brief observation, the female was captured with a dip net for marking and measurement (16.7 cm straight-line carapace length, 740 g); she had some filamentous algae in her mouth at the time of capture.

The second observation (also by WS) occurred on 30 August 2006 in the Lower Pascagoula River (Jackson County, Mississippi) at 1340 h. An adult female *G. flavimaculata* was observed from 2–2.5 m away (the presence of the boat did not appear to affect her behavior) "grazing" on the periphyton of a submerged log, in the same manner as noted before on the Leaf River. Her forelimbs were gripping the log as she foraged on the bank side. While feeding, she would quickly protrude her head, bite, and pull with her jaws, sometimes doing a "pushup" motion with her forelimbs to assist in tearing the algae off the submerged log. Feeding appeared at random without a side-to-side or a top-to-bottom order. This foraging behavior occurred in water ca. 20–80 cm deep and continued as the turtle moved ca. 1.5 m along the log, sometimes holding onto the log with all four legs. After continuously feeding for ca. 15 minutes, the turtle surfaced (apparently for air), noticed its observer and quickly swam away. Inspection of the log showed little evidence of aquatic insects, but it was covered by a very thick layer of short growth filamentous algae. Also, while watching the adult female, a juvenile female *G. flavimaculata* was also seen foraging in a similar manner for the first 3–5 minutes of the observation.

During both of these observations it could not be ascertained if the turtles were feeding directly on algae or on macroinvertebrates within the algae. Lahanas (1982. Unpubl. M.Sc. thesis, Auburn University) found that the diet of a closely related species, *G. nigrinoda*, had 28% and 41% average volume plant material for females and males, respectively. Similar behavior hás been noted in *G. oculifera*, another closely related species (R. L. Jones, pers. comm.). Thus, based on the above observations, it is plausible that *G. flavimaculata* is omnivorous and supplements its diet with plant material. More study is needed to determine if this species consumes algae as a primary component of the diet, or if algae is secondarily ingested during foraging for macroinvertebrates.

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GRAPTEMYS GIBBONSI (Pascagoula Map Turtle). **BASKING AND PARASITE REMOVAL**. The primary physiological role of basking by turtles is presumed to be for thermoregulation (Boyer 1965. Ecology 46:99–118), to increase metabolism and digestion rates (Moll and Legler 1971. Bull. Los Angeles Co. Mus. Nat. Hist. Sci. 11:1–102). However, additional basking hypotheses and secondary roles of basking have been proposed including to aid in vitamin D synthesis (Pritchard and Greenhood 1968. Int. Turtle Tortoise Soc. J. 2:20–25, 34) and to rid turtles of ectoparasites (Cagle 1950. Ecol. Monogr. 20:31–54; Neill and Allen 1954. Ecology 35:581–584; Vogt 1979. Auk 96:608–609). Here we provide evidence to support the hypothesis that basking aids turtles in parasite removal as a secondary role and (to our knowledge) the first documented observation of basking-induced release of a parasite from a turtle while basking.

On 17 May 2007 (1125 h), WS and DS observed a large female *Graptemys gibbonsi* (>20 cm, ca. 1500 g) emerge on a large log-sized snag to bask (Leaf River, Forrest Co., Mississippi). The female emerged facing the observers and a large leech (*Placobdella* sp.) was noted on the anterior left pleural scute of the carapace. At this time, the leech was in an elongated position. After 10 minutes (1135 h), the leech was observed shortening into a ball-shaped posture; it is presumed that this posture was used by the leech for water conservation. After 35 minutes of basking (1200 h), the turtle began to exhibit 'gaping' behavior while basking, evidently reaching a high internal body temperature. Soon after at 1212 h (47 minutes after turtle emergence), the leech terminated the ball-shape and moved slowly toward the left margin of the turtle near the bridge of the shell. At 1214 h (after 49 minutes), the leech removed one end of its body from the margin of the turtle and began to 'search' below toward the log, while the other end was still attached at the margin of the carapace. The leech attached the free end of its body to the log and the attached end on the carapace followed, thus removing itself from the turtle. At 1215 h (after 50 minutes), the leech reentered the water at the edge of the basking log.

During this time, a *G. flavimaculata* female was basking on the same log as the female *G. gibbonsi*. The surface temperature of the *G. flavimaculata* female was being monitored via a carapace mounted temperature sensitive transmitter (AVM Instruments). The carapace temperature of the *G. flavimaculata* female during this observation of the *G. gibbonsi* female was 40–42°C. Therefore, the carapace temperature of the *G. gibbonsi* female was probably comparable to the carapace temperature of the *G. flavimaculata*, and thus, likely hot enough to induce the leech to voluntarily release itself from its host organism. To our knowledge, this is the first documented observation of voluntary parasite release during basking, and supports the secondary hypothesis of basking as a means for parasite removal.

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GRAPTEMYS GIBBONSI (Pascagoula Map Turtle). **INTERSPECIFIC COMPETITION FOR BASKING SITES**. *Graptemys* gibbonsi is a highly aquatic freshwater turtle that inhabits the Pearl and Pascagoula rivers and tributaries of Mississippi and Louisiana, USA (Ernst et al. 1994. Turtles of the United States and Canada. Smithsonian Institute Press, Washington, D.C. 578 pp.). Very little is known concerning the life history and ecology of *G. gibbonsi*, and previous research within the Pearl and Pascagoula Rivers has focused predominantly on the two federally threatened species (*G. flavimaculata* within the Pascagoula River and *G. oculifera* within the Pearl River) that occur sympatrically with *G. gibbonsi*. These observations of *G. gibbonsi* basking behavior were made within the Pascagoula River system.

On 14 June 2006 (1200 h), on the Chickasawhay River (Greene County, Mississippi), WS observed a male *G. gibbonsi* emerge from the water and position himself above the water's surface on a low-angled, branch-sized snag. After several minutes, a slightly larger *Apalone* sp. approached and climbed onto the submerged portion of the same snag. The *Apalone* remained partially above the surface of the water, but was apparently not in an optimal basking location; it then extended its head forward and proceeded to nudge or bite (unknown due to the observation distance) the posterior of the male *G. gibbonsi*. The *G. gibbonsi* reacted by climbing up the snag. This sequence occurred again until the *G. gibbonsi* moved far enough up the snag to allow the *Apalone* to emerge fully from the water, presumably achieving a more optimal basking site.

On 11 April 2007 (1250 h), WS observed a male *G. gibbonsi*, ca. 9 cm in carapace length, climb vertically 19.5 cm to get to a desired basking location on a low-angled snag (Leaf River, Forrest County, Mississippi). No other turtles occupied the log at this time. This chosen basking location was 1.5–1.8 m from the lowest angle at the air/water interface where most turtles would emerge onto the snag. It could have chosen this "easier" location to emerge and only climb a 10–15° angle rather than the chosen vertical climb. It is unclear why the *G. gibbonsi* male chose this more difficult route to get to a desired basking location. However, it is possible that he took this route to avoid larger turtles that may emerge to bask from the lower angle at the air/water interface.

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GRAPTEMYS GIBBONSI (Pascagoula Map Turtle). **INTERACTIONS WITH DUCKS.** *Graptemys gibbonsi* is an aquatic turtle that inhabits the Pearl and Pascagoula rivers and tributaries of Mississippi and Louisiana, USA (Ernst et al. 1994. Turtles of the United States and Canada. Smithsonian Institute Press, Washington, D.C. 578 pp.). Very little is known about the life history of *G. gibbonsi* following its description as a species in 1992 (Lovich and McCoy 1992. Ann. Carnegie Mus. 61:293–315). Observations were made on two occasions of interactions between adult female *G. gibbonsi* and Wood Ducks (*Aix sponsa*).

On 11 May 2006 (1500 h), on Oakohay Creek (Covington County, Mississippi), WS observed a basking adult female *G. gibbonsi* on a horizontal log-sized snag, along with a pair of Wood Ducks. The two Wood Ducks were startled by the approaching boat, but the female *G. gibbonsi* was not startled off the log when they flew away. However, the turtle vacated the log ca. 30 seconds

after the ducks flew away, apparently in response to the boat's approach. On 16 April 2007 (1450 h), on the Leaf River (Forrest County, Mississippi) WS observed from shore via spotting scope a female *G. gibbonsi* basking on a large log-sized snag with three *Pseudemys concinna*. A female Wood Duck was also perched above the four turtles on the same log. Upon noticing their observer, the female Wood Duck, and a male Wood Duck (that was previously unnoticed nearby on the water), flew away but none of the turtles were startled by this event. The turtles remained on the log and were only startled once they were approached by boat ca. 5 minutes later. From these observations, it appears that Wood Ducks are not viewed as a potential predator by these turtles and further, do not serve in any 'sentinel' capacity to alert turtles of danger while these turtle species are basking.

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KINOSTERNON SCORPIOIDES ABAXILLARE (Central Chiapas Mud Turtle). **SIZE, GROWTH, AND REPRODUCTION**. Since its description (Baur, in Stejneger 1925. J. Washington Acad. Sci. 15[20]:462–463) the only published growth or reproductive data for *Kinosternon scorpioides abaxillare* were those of Alvarez del Toro (1983. Los Reptiles de Chiapas. Tercera Edición, Corregida, y Aumentada. Instituto Historia Natural, Los Tuxtlas, Chiapas. 248 pp.), who reported that 6–12 eggs are laid in March or April, and they hatch after three months. The present report is based on 23 specimens trapped between 1700 h 30 April and 0800 h 1 May 1981 (15 in the first two hours) near the Rio Cintalapa bridge on Hwy 190 in Chiapas, Mexico, as well as 52 examined museum specimens of this subspecies (see acknowledgments).

Males did not differ significantly from females in carapace length (CL: males, 122.4 ± 15.7 mm, 88–149, N = 21 versus females, 118.6 ± 14.6 mm, 84–153, N = 36; t = 0.93, P = 0.35) or plastron length (PL: males, 116.1 ± 15.6 mm, 83–143, N = 20 versus females,115.8 ± 14.8 mm, 81–149, N = 36; t = 0.8, P = 0.94), but differed significantly for the ratio PL/CL (males, 0.95 ± 0.02, 0.91–0.99, versus females, 0.98 ± 0.02, 0.93–1.01; t = 3.6, P = 0.0007). Females outnumbered males in the field collection (12:7) and the museum collections (24:14). Body mass (in grams) for the field-collected animals was related to CL (in mm) by the equation $BM = 0.000506CL^{2.727}$ (r = 0.994; P < 0.0001; N = 23), and the equations for males and females were nearly identical. A single neonate (CU 48847) was available, collected 25 June 1971, and measured 29.6 mm CL and 24.1 mm PL.

Although *K. s. abaxillare* was originally diagnosed as lacking an axillary scute, of 66 specimens examined for the trait, 8 had partial medial axillary seams, and 6 had complete axillary seams. In addition, I have observed the absence of axillary scutes in occasional specimens of *K. s. cruentatum* from Veracruz (BCB-SM 7852) and Cozumel (UF 24135, 24138).

The largest immature (no eggs, corpora lutea, or ovarian follicles > 3 mm), field-collected females were 99, 102, 110, 110, 121, and 126 mm CL. The smallest mature females were 124 mm CL (two 9 mm follicles), and 130 mm (one 8 mm follicle). Other mature females were 130 mm CL (follicles, 15, 15, 10, 10 mm), 130 mm CL (9, 9, 8, 8, 8, 8, 8 mm), 131 mm CL (9, 9, 8, 8 mm), and 133 mm CL (8, 8, 8, 7). These data suggest sexual maturity at 120–130 mm CL. Another 132 mm CL female (UIMNH 39373; 27 December 1955) bore 5 partially shelled oviducal eggs (3 crushed, the others 32.3 × 16.5 mm, and 28.75 × 17.5 mm), and follicles of 14, 13, 13, 9, and 8 mm, but counts of corpora lutea were not possible because of preservative effects. These preliminary dissection data suggest that clutch sizes might range from one to five eggs, and that the clutch sizes reported by Alvarez del Toro (*op. cit.*) may be exaggerated. The presence of preovulatory and enlarged follicles in females at the beginning of May suggest that the production of clutches might be possible in May and June, in addition to March and April as suggested by Alvarez del Toro (*op. cit.*). Furthermore, the ovaries of the UIMNH female suggest that eggs could also be laid in January. Whether *K. s. abaxillare* exhibits as long a reproductive season as captive *K. scorpioides* from Honduras (Goode 1994. *In* Murphy and Adler [eds.], Captive Management and Conservation of Amphibians and Reptiles, pp. 275–295. Soc. Study Amphib. Rept., Lawrence, Kansas) or *K. s. cruentatum* on the Yucatan Peninsula (Iverson, unpubl.) remains to be determined. In addition, whether *K. s. abaxillare* also exhibits delayed embryonic development, with hatching synchronized to the onset of the summer rainy season, like other populations of Mexican and Central American *K. scorpioides* (Ewert 1991. *In* Deeming and Ferguson [eds.], Egg Incubation: Its Effect on Embryonic Development in Birds and Reptiles, pp. 173–191. Cambridge Univ. Press, Cambridge, UK), also deserves attention.

Measurements of right abdominal scute annuli were used to estimate previous plastral lengths following the method of Ernst et al. (1973. Herpetologica 29:247–250). Three estimates of PL for age one year were 34.2, 40.9, and 39.3 mm; four estimates for two years were 45.2, 52.1, 62.0, and 66.4 mm; one for three years was 64.2 mm; and one for four years was 70.7 mm. A crude extrapolation of those data suggests that 8–10 years would be required to approach maturity at 120 mm PL (ca. 122 mm CL).

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KINOSTERNON SUBRUBRUM (Eastern Mud Turtle). **DIET**. *Kinosternon subrubrum* is an ubiquitous turtle found in wetlands throughout the eastern U.S. Food items taken by this turtle were listed in Ernst et al. (1994. Turtles of the United States and Canada. Smithsonian Inst. Press, Washington, D.C.), and include invertebrates, vertebrates, and plant material. On 27 July 2007, we discovered the carcass of an adult *K. subrubrum* on the substrate of a large drying beaver pond in Tuskegee National Forest, Macon County, Alabama (UTM 16S 0627179N 3588804E). The turtle measured 97 mm in carapace length and 82 mm in plastron length, and is believed to be a male due to its deep posterior plastral notch (AUMO 37608). Upon dissection, the specimen was found to contain 190 seeds of the aquatic plant *Nuphar luteum* (spatterdock or yellow pond-lily) and one chelicera of a crayfish (*Cambarus* sp.). This represents the first record of *K. subrubrum* feeding on the seeds of *N. luteum.* The seeds appeared to be ripe and at a later stage of development than seeds found on the *N. luteum* at the time of collection, suggesting that the turtle may have been foraging on the seeds in the mud on the bottom of the pond. Finally, it is possible that this species may play a role in the seed dispersal of this plant, although seed viability experiments would need to be performed to confirm this.

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TERRAPENE CAROLINA TRIUNGUIS (Three-toed Box Turtle). **CARRION FEEDING.** *Terrapene carolina triunguis* is common throughout Arkansas and is reported to have a broad-based omnivorous diet (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas, Univ. Arkansas Press, Fayetteville, 421 pp.). Carrion is commonly reported in the diet of box turtles (Dodd 2001. North American Box Turtles: A Natural History, Univ. of Oklahoma Press, Norman, 231 pp.). Dead birds, including ducks (*Anas* spp.) and Green Herons (*Butorides striatus*) have been recorded in the diet of *T. carolina* (Ernst et al. 1994. Turtles of the United States and Canada, Smithsonian Institution Press, Washington, 578 pp.). The literature appears to lack mention of smaller birds, such as songbirds (passerines) being consumed as carrion. Here we report the consumption of a Brown-headed Cowbird (*Molothrus ater*) as carrion by a *T. c. triunguis*.

As part of a study estimating scavenging rates of avian carcasses, we distributed eight female Brown-headed Cowbird carcasses throughout an open field in Greene Co., Arkansas on 10 September 2007. On 13 September 2007 at 0735 h, one of us (IG) observed a male *T. c. triunguis* (113.6 mm CL, 87.5 mm CW, 308 g) feeding on one of the cowbird carcasses (UTM 15N 0701128, 3975567). The turtle was measured, sexed, and then released. Because small birds inevitably share habitat with box turtles, their consumption as carrion by the turtles is not unexpected and may occur fairly frequently.

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TRACHEMYS GAIGEAE GAIGEAE (Big Bend Slider). **KYPHOSIS.** The term kyphosis has been used, often incorrectly, to describe a variety of spinal deformities seen in turtles, ranging from true kyphosis to lordosis (Rhodin et al. 1984. British J. Herpetol. 6:369–373). During studies of *Trachemys g. gaigeae* in the Rio Grande Valley of Socorro and Sierra counties, New Mexico in 1994–1998, we captured a small adult male that was distinctly kyphotic or possibly kyphoscoliotic (*sensu* Rhodin et al., *op. cit.*). The turtle (Fig. 1) was captured in May 1998 in Elephant Butte Reservoir near Nogal Canyon, Sierra Co. and had the following measurements: straight-line carapace length at midline (CL) = 135 mm; straight-line plastron length at midline (PL) = 123.5 mm; maximal shell width = 111 mm; maximal shell height (at hump) = 61.5 mm; mass = 346 g. The hump was centered slightly to the right of the carapace midline at the second vertebral scute, suggesting kyphoscoliosis. All five vertebral scutes (V1–V5) were irregular in shape and asymmetrical. No melanistic disruption of the shell and skin color pattern, a common feature of older and larger male *T. g. gaigeae*, was evident. The slider appeared healthy when captured, but later died in captivity.

Four other specimens (all adults that were marked and released) were examined from our study area that exhibited varying degrees of kyphosis or kyphoscoliosis, although none as pronounced as the illustrated example. These included: 1) a female (258.5 mm CL; 238 mm PL) with a slight, localized hump to the right of the midline of V2 and V3; 2) a female (245 mm CL; 233 mm PL) with a slight, localized hump to the left of the midline of V2 and V3; 3) a female (268 mm CL, 239 mm PL) with a highly domed carapace



FIG. 1. Kyphotic male *Trachemys g. gaigeae* from Sierra Co., New Mexico.

centered to the left of the midline; and 4) a male (114 mm CL; 105 mm PL) with a hump between V1 and V2; spine laterally curved at hump; scutes V1–V5 were deformed.

Only 5 of the 235 (2.1%) adult and subadult specimens examined in our study exhibited noticeable kyphosis or kyphoscoliosis, and only one (0.4%) was markedly abnormal. We observed no spinal deformities in any hatchlings (N = 123) obtained from gravid females captured in the study area (Stuart and Painter 2006. Herpetol. Rev. 37:79).

Within the genus, kyphosis or related spinal deformities have been reported in *T. scripta scripta* (Carr 1952. Handbook of Turtles: The Turtles of the United States, Canada, and Baja California. Cornell Univ. Press, Ithaca, New York), *T. s. elegans* (Tucker et al. 2007. Herpetol. Rev. 38:337–338), *T. s. troostii* (Cagle 1950. Ecol. Monog. 20:31–54), and *T. yaquia* (Plymale et al. 1978. Southwest. Nat. 23:457–462). Tucker et al. (*op. cit.*) found kyphosis in only 0.06% of all *T. s. elegans* (N = 21,786) they captured in Illinois but noted that higher rates of occurrence (< 2.6%) have been reported in other turtle species based on much smaller sample sizes. Our report is the first for spinal deformities in *T. gaigeae* and suggests that its occurrence is also uncommon in this species.

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SQUAMATA — LIZARDS

ABRONIA TAENIATA (Bromeliad Arboreal Alligator Lizard). **MICROHABITAT.** Lizards of the genus *Abronia* (Anguidae) display both morphology and behavior specialized for arboreality (Campbell and Frost 1993. Bull. Am. Mus. Nat. Hist. 216:1–121). The genus also appears to be among the most endangered of Neotropical squamate lineages, and several species are known from only one or a few specimens (Campbell and Frost, *op. cit.*). In addition, species of *Abronia* are secretive (Formanowicz et al. 1990. Biotropica 22:391–396), and probably exhibit naturally low densities, though detailed information on population size is difficult to obtain in their arboreal habitats. Consequently, observations of *Abronia* are rare, and few reports describe activity in terrestrial environments (Martin 1955. Copeia 1955:173–180; Campbell and Frost, *op. cit.*). *Abronia taeniata* is a relatively widespread Mexican species that occurs in the pine-oak forests of the Sierra Madre Oriental between 1000–3000 m (Martin 1958. Misc. Publ. Mus. Zool. Univ. Michigan 101:1–102). Terrestrial habitat use in this taxon has been infrequently reported, with little information available on associated behavior (Martin 1955, *op. cit.*). Here, we provide two additional observations of terrestrial activity in this species from the state of Hidalgo.

At 1545 h on 1 July 2006, BPS, ELMV, and NI found an adult female *A. taeniata* (83.9 mm SVL, 116.5 mm tail, 10.7 g) in the crevice of a large limestone boulder (20.8778°N, 99.2299°W, datum: WGS84; elev. 2464 m) under pine (*P. greggii/P. patula*)-oak (*Q. crassipes*) forest canopy near the community of La Manzana, in Parque Nacional Los Mármoles (PNLM). The observation was made following strong morning rains. On our approach, the *A. taeniata* retreated into the boulder, but we captured it at 1645 h after it reappeared at the edge of the same crevice. The nearest tree (a mature pine, probably *P. greggii)* was ca. 1.5 m away.

Elsewhere in the range of *A. taeniata*, the species has been collected in trees (Martin 1958, *op. cit.*). Other species of *Abronia* have been collected on tree trunks, and in epiphytic bromeliads and mosses (Campbell and Frost, *op. cit.*). In the Los Mármoles region, however, mature trees support few large epiphytes (BPS, pers. observ.), so *A. taeniata* may use terrestrial refugia in this area with greater frequency, at least during inclement weather. The specimen (BPS-CIB 24) was deposited in the vertebrate collections of the Centro de Investigaciones Biológicas (CIB) at the Universidad Autónoma del Estado de Hidalgo.

At 1030 h on 29 March 2007, IECS also found an adult female *A. taeniata* (106.8 mm SVL, 143.0 mm tail, 19.0 g) on leaf litter in a pine (*P. rudis)*-oak (*Q. rugosa*) forest at Campamento Conejo in Parque Nacional El Chico (20.1877°N, 98.7097°W, datum: WGS84; elev. 2915 m). The lizard was found in a patch of forest floor illuminated by morning sunlight; the nearest trees were 2–3 m away. IECS observed it for ca. 15 min, then captured it for deposition into the CIB vertebrate collection (specimen: ARP-00109).

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AMEIVA EXSUL (Puerto Rican Ground Lizard). **DIET**. *Ameiva exul* has a diverse diet that includes invertebrates (earthworms, snails, insects, crabs), vertebrates (frogs, lizards), vegetable matter (banana, apple, cactus fruits), dog food, and even certain types of garbage (Joglar [ed.] 2005. Biodiversidad de Puerto Rico–Vertebrados Terrestres y Ecosistemas. Editorial del Instituto de Cultura Puertorriqueña, San Juan. 563 pp.; Lewis 1989. J. Herpetol. 23:164–170; Rivero. 1998. Los Anfibios y Reptiles de Puerto Rico. Editorial de la Universidad de Puerto Rico, San Juan. 510 pp.). Here, we add observations of several unreported food items to its already broad diet.

At 1247 h on 3 November 2005, we observed an adult *A. exsul* (ca. 13 cm) capture and eat an adult male of the Puerto Rico ground tarantula spider (*Cyrthopholis portoricae*; ca. 30 mm cephalotho-



FIG. 1. Common Ground Lizard (*Ameiva exsul*) ingesting a Puerto Rico Ground Tarantula (*Cyrthopholis portoricae*).

rax–abdominal length)) at Gurabo Abajo, Juncos, Puerto Rico (18.2519°N, 65.8964°W; datum: WGS84; elev. 171 m). The lizard, which located the male tarantula from a distance of ca. 3 m, rushed the spider, grabbed it (Fig. 1), and broke it into pieces by striking it on the substrate before eating it. Additional photos of the episode were deposited in the collection at the University of Puerto Rico-Humacao (UPR-H -Ameiva 1,2,3 – 2007).

During February 2007 (dry season), RAPR twice observed a female *A. exsul* (ca. 15 cm) eating insect larvae on drying dog feces at Bairoa Park, Caguas (18.2594°N, 66.0439°W; elev. 82 m). This lizard also ingested 3–4 mm fragments of fecal material that broke off of the fecal bolus.

On 15 September 2007, also in Caguas (18.2353°N, 66.0278°W; elev. 79 m), RAPR observed a Greater Antillean Grackle (*Quiscalus niger*) eating the crust and the insides of a piece of a recently discarded cheese pie. This attracted an adult (ca. 13 cm) *A. exsul* that came to investigate, which induced the grackle to leave. The lizard began eating the coagulated melted cheese almost immediately. A little later, a larger (ca. 15 cm) *A. exsul* supplanted the first, and after examining the remains, also consumed cheese. Additionally, AMO has often observed *A. exsul* in Juncos consume discarded human food as cooked beans, boiled rice, and pieces of boiled squash.

Our observations represent the first report of predation on tarantula spiders and the ingestion of cheese and fecal material by *A. exsul*. Tarantulas such as *Cyrthopholis* may be atypical prey for diurnal lizards. Nevertheless, during the breeding season the males emerge from their holes and start wander in search of females even during light day hours (Torres and Pérez–Rivera 1976. Science-Ciencia 3/4:104–108). Ingestion of feces may also be atypical. Drought reducing the typical prey base for *Ameiva* may explain this rare behavior. Our observations may support the notion that *A. exsul* is and opportunistic generalist, but the possibility also remains that great variation in food selection by individuals in this lizard may exist.

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ANOLIS UNIFORMIS (Lesser Scaly Anole). **DIET.** *Anolis uniformis* is a small lizard widely distributed in wet tropical rain forests from southern Tamaulipas, México through northern Guatemala and Belize to northern Honduras. It occurs in forest understory from near sea level to about 900 m (Campbell 1998. Amphibians and Reptiles of Nothern Guatemala, the Yucatán, and Belize. University of Oklahoma Press, Norman. 380 pp.; Campbell et al. 1989. Biotropica 21:237–243; Lee 1996. The Amphibians and Reptiles of the Yucatan Peninsula. Cornell University Press. Ithaca, New York. 500 pp.). The most observable lizard at Los Tuxtlas tropical rain forest, Veracruz, México, *A. uniformis* is thought to be a diurnal insectivore across its geographic range (Duellman 1963. Univ. Kansas Publ. Mus. Nat. Hist. 15:205–249; Villarreal 1997. *In* González et al. [eds.], Historia Natural de los Tuxtlas. Universidad Nacional Autónoma de México. 647 pp.; Villarreal and Heras 1997. *In* González et al., *op. cit.*). Here we report predation by *A. uniformis* on an anuran.

At 2315 h on 3 September 2003 during a nocturnal herpetofaunal survey, we observed a young *A. uniformis* male (29 mm SVL) swallowing a very small (ca. 9 mm SVL) leaf litter frog (*Craugastor* sp.). The event occurred on a leaf of a medium-sized plant in a small bamboo and tropical rain forest remnant in the Los Tuxtlas region, Veracruz, México (18.6072°N, 95.1437°W, datum: WGS84; elev. 650 m). The anole was collected and deposited in Colección Nacional de Anfibios y Reptiles, Instituto de Biología, Universidad Nacional Autónoma de México (CNAR IBH 21138).

From September 2006 to July 2007, we also collected and dissected 30 *A. uniformis* adults at the Laguna Escondida rainforest remnant at Los Tuxtlas region (18.5909°N, 95.0883°W; elev. 150 m) as a part of a parasitological study. Examination of stomach and intestinal contents revealed only arthropod remains, mostly terrestrial and flying insects (flying Diptera, Hymenoptera, Hemiptera; terrestrial Orthoptera) and a few spiders. We found no amphibian remains in this sample.

Previous diet records for *Anolis uniformis* (Stuart 1948. Misc. Publ. Mus. Zool. Univ. Michigan 69:1–109; Villarreal, *op. cit.*; Villarreal and Heras, *op. cit.*) indicate that it preys on insects and litter-dwelling invertebrates, especially soft-bodied arthropods. Our 2003 observation indicates that *A. uniformis* can prey on small amphibians and that it may sometimes feed at night

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ASPIDOSCELIS VELOX (Plateau Striped Whiptail). **PREDATOR EVASION**. Successful attempts form the basis of most predation reports in the herpetological literature. In contrast, failed attempts are rarely reported even though they are essential to understanding of behavior, natural history, and selection pressures of predators and their prey. Here I report an observation of *Aspidoscelis velox* successfully avoiding a predation attempt by a

Long-tailed Weasel (*Mustela frenata*) in southeastern Utah.

At 1051 h on 19 August 2007, in the valley of Indian Creek, San Juan Co., Utah, USA (38.0523°N, 109.5587°W, datum: WGS84; elev. 1697 m), I observed a *M. frenata* moving from an open area of compacted sand to the cover of a Greasewood (*Sarcobatus vermiculatus*) shrub, ca. 40 m W of the intermittent stream channel of Indian Creek. Air temperature was ca. 27°C and cloud cover was 60%. Vegetation was dominated by Big Sagebrush (*Artemisia tridentata*), Greasewood, and Four–wing Saltbush (*Atriplex canescens*). I observed the weasel through 10× binoculars from a distance of ca. 3 m. The weasel seemed aware of my presence as its gaze was fixed in my direction. After ca. 1 min of observation, the weasel darted from the shrub in pursuit of an adult (ca. 7 cm SVL) *A. velox* that I had not previously noticed. The lizard maneuvered in a series of rapid zigzag movements up–slope and away from where the weasel had appeared, making at least four abrupt (ca. 90°) turns over a distance of ca. 4 m. The weasel seemed to follow closely, tracing each abrupt turn of the lizard, but the speed of the pursuit made it impossible to ascertain from my position whether the weasel was gaining on the lizard or the lizard was gaining distance from the weasel. The weasel gave up chase after ca. 4 m and returned rapidly to the shrub from which it had emerged, where it apparently entered a burrow and disappeared from sight. As the weasel gave up the chase, the lizard crested a small rise in the slope, leaving my field of view. Based on the recording times of photographs taken during the chase, the chase lasted ca. 26 sec.

Because the weasel was aware of my presence prior to chasing the lizard it may have been motivated to terminate the chase earlier than it would have otherwise. However, Long-tailed Weasels have been reported to continue apparently normal foraging behavior even in front of large groups of people (e.g., Hamilton 1933. Am. Midl. Nat. 14:289–344). Long-tailed Weasels are regarded as generalist predators even though they eat primarily small rodents, and only rarely take lizards (Sheffield and Thomas 1997. Mamm. Species 570:1–9). Predation attempts, successful or otherwise, by *M. frenata* on *A. velox* have not been previously reported. Whiptail lizards are known for their speed and evasive abilities, and being notoriously difficult for humans to capture is the origin for the species name "*velox*" (Springer 1928. Copeia 169:100–104; Stuart 1998. Cat. Am. Amphib. Rept. 656:1–6). This observation suggests that the rapid zigzag escape strategy of *A. velox* is effective in avoiding capture by other mammalian predators as well.

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COLEODACTYLUS NATALENSIS (NCN). **CLUTCH SIZE; HATCHLING SIZE.** *Coleodactylus natalensis* is a small lizard endemic to the Atlantic Forest of Rio Grande do Norte, Brazil (Freire 1999. Bol. Mus. Nac. 399:1–14). Clutch size is not known, but its geographically proximate congener, *C. meridionalis*, has a one-egg clutch (Vanzolini et al. 1980. Répteis das Caatingas. Acad. Bras. de Ciênc. Rio de Janeiro, Brazil. 161 pp.). Here, we provide an observation of clutch size and hatchling size in *C. natalensis*.

At 1630 on 24 January 2006, PAGS collected two eggs of *C. natalensis* ca. 1 m apart among leaf litter in a 30-cm deep cavity in a large rock (ca. 1 m^2) at the Estação Experimental Rommel Mesquita de Faria (Mata do Jiquí; 5.9305°S, 35.1814°W; datum: WGS84; elev. 40 m), an Atlantic Forest fragment on an EMPARN (Empresa de Pesquisas Agropecuárias do Rio Grande do Norte) farm of 79 ha in the of municipality Parnamirim. These data and field observations of females carrying one egg (CMCAL, pers. obs.) indicates that this species likely has a fixed clutch size of a single egg.

The eggs were placed in a terrarium (20 cm × 12 cm × 20 cm) with a substrate of sand and leaf-litter, and maintained at Laboratório de Herpetologia, in the Departamento de Botânica, Ecologia e Zoologia in Universidade Federal do Rio Grande do Norte) at an ambient temperature averaging about 25°C, but which varied between 24°C and 32°C over the incubation period. On 6 March 2006 (41 days after collection), one juvenile emerged. Measurements were SVL: 11 mm; tail length: 0.8 mm; foreleg length: 3.1 mm; fourth finger: 0.4 mm; hindleg length: 3.6 mm; fourth toe: 0.7 mm; head length: 2.9 mm; head width: 2.0 mm; jaw length: 1.6 mm; head height: 1.1 mm; body width: 2.2 mm; pelvis width; 1.3 mm; axilla–groin length: 4.4 mm; and mass: 0.024 g. This is the first record of hatchling size in *C. natalensis*.

The specimen (CHBEZ 1504) was deposited in the Herpetological Collection of Universidade Federal do Rio Grande do Norte (CHBEZ), municipality of Natal. We thank two anonymous reviewers for suggestions on the manuscript. Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) provided research grants to LBR (process 141993/2006-5) and to PAGS (process 107762/2006-4).

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CYCLURA CYCHLURA CYCHLURA (Andros Iguana). **ATTEMPED PREDATION.** Shifts in prey size may reflect several processes including limitations on gape (Shine and Sun 2003. Funct. Ecol. 17:340–348). Alternatively, rather than the ability to physically ingest prey, limitations may reflect a predator's ability to capture, kill, or digest prey of different sizes. Few field accounts exist demonstrating a snake's ability to dispatch but not ingest prey (but see Sabo and Ku 2004. Herpetol. Rev. 35:396–397). The few reports of failed predation attempts may reflect a combination of the inability to record them without direct observation and bias against reporting unsuccessful predation events even though such events can inform aspects of species-specific predation be-

havior unavailable elsewhere. Here we report three failed predation attempts by snakes on hatchling *Cyclura cychlura cychlura* from two island localities over an eight-day period in September 2003.

In coordination with a hatchling dispersal study of the Andros Iguana, we affixed 2.7 g radio-transmitters (model PD-2, Holohil Systems, Ltd., Ontario, Canada) to 41 hatchling iguanas (Knapp and Owens 2005. Herpetol. Rev. 36:264–266) on Sandy and Mangrove Cays of Andros Island, Bahamas (see Knapp and Owens 2004. Caribb. J. Sci 40:265–270 for site descriptions). We attempted to locate telemetered hatchlings daily after release at their respective nests. On 3 September 2003 (20 days after release), we found a dead hatchling *C. c. cychlura* (102 mm SVL, 45 g) on the limestone substrate of Mangrove Cay. The head of this hatchling was severely compressed with blood seeping from the mouth and tympanum, while the head and thorax were coated with shiny clear and brown residue. The residue extended down half the body and stopped ca. 10 mm anterior to the transmitter, which was attached on the dorsal side of the pelvic girdle. On 4 and 11 September 2003 (3 days after release for each hatchling), we found dead hatchling iguanas (98 mm SVL, 43 g; 93 mm SVL, 38 g) on the limestone substrate of Sandy Cay. The skull of each hatchling was similarly compressed with blood seeping from the mouth and tympanum. These hatchlings differed from the first observation in that only the head was coated with shiny clear and brown residue and stopped at the pectoral girdle. These observations are similar to a failed predation attempt on *Sceloporus occidentalis* (Sabo and Ku, *op. cit.*) and led us to conclude that the hatchlings had been captured, partially swallowed but regurgitated by a predator. Only two snakes (*Alsophis vudii* and *Epicrates striatus*) occurring at our study sites have been confirmed to be capable of ingesting hatchling *C. c. cychlura* iguanas. Indeed, we recorded 18 *A. vudii* individuals consuming 19 *C. c. cychlura* hatchlings and six *E. striatus* individuals consuming nine hatchlings. We infer that the failed predation attempts were attributable to *A. vudii* based on the fresh, wet residue on the carcasses, which were discovered during the day. Additionally, based on observations of predator-prey interactions for both species of snakes using radio telemetry, the open locations of the carcass discoveries are indicative of typical kill sites for the diurnal *Alsophis* rather than the nocturnal *Epicrates*. Snakes are known to feed selectively, and hence need to discriminate between objects that are or are not acceptable as food (Shine and Sun 2003, *op. cit.*). Our observations are significant because they indicate that potentially gape–limited snakes may be successful in capturing and subjugating prey but can fail in their ingestion attempts. Sabo and Ku (*op. cit.*) concluded that a failed predation attempt of a gravid *S. occidentalis* was the direct result of the girth of the body cavity caused by the internal egg mass. In our case, the first failed predation event where the clear and brown residue extended to within 10 mm of the pelvic transmitter could be attributable to the increased girth caused by the transmitter. However, it appeared as if the ingestion process was aborted anterior to the pectoral girdle in the latter two observations indicating that the snakes were able to dispatch but not ingest their prey items. We suspect that failed predation events may be more common than expected and that these events can provide interesting hypotheses for testing evolutionary predator-prey relationships.

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ECPLEOPUS GAUDICHAUDII (NCN). **REPRODUCTION.** *Ecpleopus gaudichaudii*, a poorly known gymnophtalmid lizard, is thought to be endemic to the Atlantic Rainforest of southeastern Brazil (Peters et al. 1986. U.S. Nat. Mus. Bull. 297:1–293). Data on clutch size and reproductive behavior is limited to one observation of two individuals (Uzzell 1969. Postilla 135:1–23). Herein, we report data on seven gravid females collected in Minas Gerais, southeastern Brazil.

All specimens are deposited in the herpetological collection of the Universidade Federal de Minas Gerais (UFMG), Belo Horizonte, Brazil. All seven females, collected in arthropod and/or herpetofauna pitfall traps, contained one developed egg averaging 7.0 ± 0.3 mm SD (range: 7.5–6.7 mm). UFMG 987 (36.6 mm SVL) was collected in an area of secondary forest of a small urban park, the Estação Ecológica da UFMG (19.92°S, 43.93°W; elev. 850 m) in the interval 24–30 October 2000. UFMG 1659, 1663, 1661, and 1660 (respectively 34.9, 34.7, 35.2, and 35.3 mm SVL) were collected in primary forest of a large Atlantic Rainforest reserve, the Parque Estadual do Rio Doce (19.80°S, 42.63°W; elev. 230–515 m) in the interval 1–10 September 2001. UFMG 1094 (38.4 mm SVL) was collected in primary forest of another Atlantic Rainforest reserve, the Reserva do Patrimônio Natural Feliciano Miguel Abdala (19.83°S, 41.83°W; elev. 340–680 m) in the interval 22 December 2000–16 January 2001, whereas UFMG 1095 (37.1 mm SVL) was collected in the same locality, but lacks a collection date. These observations agree with the previous observation (Uzzell 1969, *op. cit.*) that *E. gaudichaudii* clutch size is typically one egg.

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ELGARIA COERULEA (Northern Alligator Lizard). **JUVENILE GROWTH**. Rutherford (2004. Can. J. Zool. 82:817-822) provided the only juvenile growth data for *Elgaria coerulea*, but those data were based on individuals from the Creston Valley, British Columbia, located toward the northern end of the species range

(Stebbins 2003. A Field Guide to Western Reptiles and Amphibians, 3rd ed. Houghton Mifflin Co., Boston, Massachusetts. 560 pp.). Hence, we provide an observation of juvenile growth in *E. coerulea* from west-central Washington State.

We recorded these observations along the south edge of a second-growth Douglas-fir (*Pseudotsuga menziesii*) stand in a rural neighborhood < 0.15 km from Puget Sound near Olympia, Washington (47°06'59"N, 122°56'08"W, WGS 84; elev. 37 m). All measurements were made with a 15-cm ruler to the nearest 0.5 mm; and masses were obtained with a top-loading Ohaus 1320 field scale with 0.01 g accuracy.

While cleaning yard debris at 2010 h on 29 May 2007, CBH captured a juvenile female *E. coerulea* (49.0 mm SVL, 65.0 mm tail [unbroken], 1.70 g) beneath a discarded painting tarp exposed daily to midday and afternoon sun. Based on having recaptured *E. coerulea* under similar objects, we opted not to remove the tarp, marked the animal with a single toe clip, and released it at the capture point. MPH subsequently recaptured this animal at the same location three times over the next 65 days. On 15 June, it was 52.5 mm SVL (75 mm tail, 2.26 g); on 2 July, it measured 55 mm SVL (82.5 mm tail, 2.50 g); and on 8 August, it was 60 mm (92 mm tail [still unbroken], 3.55 g). These data reveal mean growth rates of 0.21 mm/dy and 0.59 mm/day for the body and tail in the 1st interval; 0.15 mm/dy and 0.44 mm/day in the 2nd interval; and 0.16 mm/dy and 0.24 mm/dy in the 3rd interval. Mass increased 0.04 g/dy in the 1st interval, declined to 0.01 g/dy in the 2nd interval, but increased again to 0.03 g/dy in the 3rd interval.

Based on the data of Rutherford (*op. cit.*) and the fact that the smallest *E. coerulea* observed locally (28–32 mm SVL) have always been found in later summer and fall (MPH, unpubl. data), the animal we captured belongs to the 2006 cohort. Based on the growth curve of Rutherford (*op. cit.*), the growth of this juvenile seems slightly faster than that of juveniles from the Canadian Okanogan; no animal that Rutherford captured had attained 60 mm by their second winter (see her Figure 2), and after our last recapture, we expect to have at least 40 days of higher-growth-rate temperature conditions in our summer season. One further point merits comment. Growth rate of the tail declining nearly three-fold relative to the roughly constant body growth rate as mass increased indicates that substantial allocation to tail growth occurs early, asymmetry that deserves exploration.

Work was done under a Washington Department of Fish and Wildlife programmatic handling permit under which MPH was a permitee. This is contribution No. 16 of the Forests and Fish Section of the Washington Department of Fish and Wildlife Habitat Program Science Division.

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EUMECES ELEGANS (Elegant Skink). **PREDATION**. *Eumeces elegans* occurs in eastern China, Taiwan, and the Diaoyutai (=Senkaku) Archipelago (Hikida 1993. Japan. J. Herpetol. 15:1–21). In Taiwan, it inhabits primarily open mountainous areas and

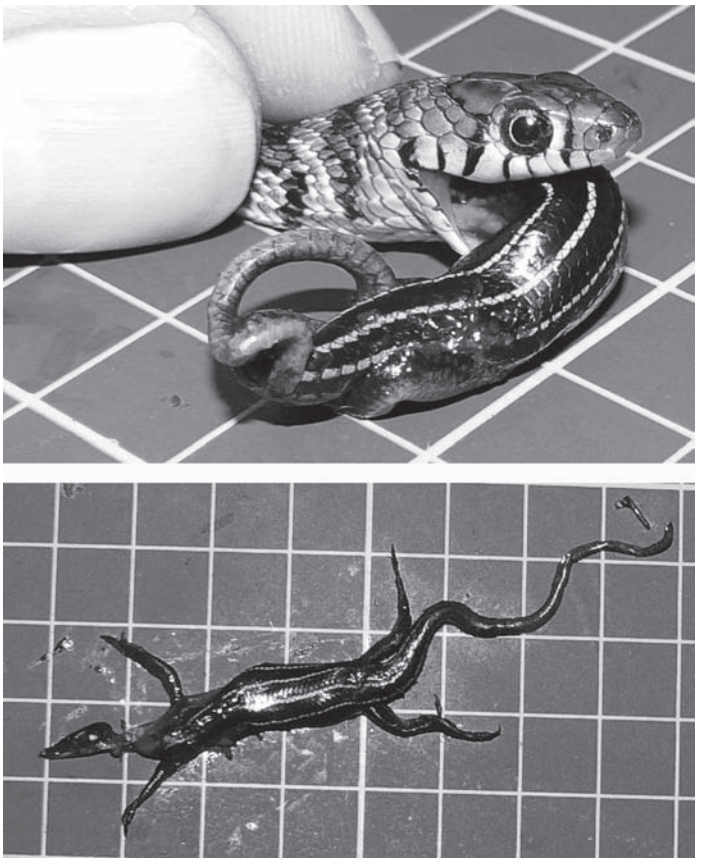


FIG. 1. The *Amphiesma stolatum* in the process of regurgitating the *Eumeces elegans* (top), and the prey item after it has been regurgitated (bottom). Note the partly digested head of the prey in the bottom image.

areas disturbed by human activities below 2500 m (Lue et al. 2002. The Transition World—Guidebook of Amphibians and Reptiles of Taiwan. SWAN, Taipei. 350 pp. [in Chinese]; Pope 1929. Bull. Amer. Mus. Nat. Hist. 58:335–487; Shang and Lin. 2001. Natural Portraits of Lizards of Taiwan. Big Trees Publishers, Taipei. 174 pp. [in Chinese]).

On 14 September 2007, a juvenile male Striped Keelback (*Amphiesma stolatum*) (293 mm SVL, 100 mm tail, 9.3 g post–regurgitation mass) was collected from a drift fence funnel trap set in a Betelnut Palm (*Areca catechu*) plantation in Santzepu, Sheishan District, Chiayi County (23.4267°N, 120.4856°E; datum: WGS84; elev. 85 m). Habitat consisted of *A. catechu*, *Alocasia odora*, *Bidens pilosa* var. *radiata*, *Ipomoea cairica*, *Mikania micrantha*, and *Panicum maximum*; canopy cover, created by the crowns of *A. catechu*, was 25%. The *A. stolatum* had an enlarged mid-body, and after gentle palpation, the snake regurgitated a juvenile *E. elegans* (Fig. 1) with a partly digested head (45 mm SVL, 59 mm tail, 1.4 g). After being scale-clipped for future identification, the snake was released in the area where it was collected.

Little is known about the feeding habits of *A. stolatum*, but the following prey types have been recorded: insects (Acrididae), tadpoles, toads, frogs, fish (Lee and Lue 1996. Biol. Bull. Nat. Taiwan Normal Univ. 31:119–121 [in Chinese]), earthworms, geckoes, lizards, and scorpions (Das 2002. A Photographic Guide to Snakes and Other Reptiles of India. New Holland Publishers [UK] Ltd., London. 144 pp.). Prey size of the skink reported here, at

15% of predator mass, is typical for a colubrid (Greene 1997. Snakes: The Evolution of Mystery in Nature. University of California Press, Berkeley. 351 pp.). This is the first description of *E. elegans* as prey of *A. stolatum*.

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FURCIFER LABORDI (Labord's Chameleon). **REPRODUCTION.** Though nesting behavior in *Chamaeleo chamaeleon* is relatively well-studied in Spain (Blázquez et al. 2000. Herpetol. J. 10:91–94), nest excavation behavior in chameleons of Madagascar remains undescribed. Additionally, such behavior in nature may differ from that described for captives or under semi-natural environments (e.g., Bourgat 1968. Bull. Soc. Zool. France 93:355–356.; Ferguson et al. 2004. The Panther Chameleon: Color Variation, Natural History, Conservation, and Captive Management. Krieger Publishing Co., Malabar, Florida. 118 pp.). Here, we describe clutch size and nest excavation behavior in a chameleon from Madagascar, *Furcifer labordi*. To our knowledge, no other published field observations of nesting in this species exist.

On 03 February 2004, we observed nest excavation and egg deposition by an adult female *F. labordi* (77.2 mm SVL) at Ranobe forest (23.0250°S, 43.6100°E, datum: WGS84; elev. 17 m), ca. 30 km N of the provincial capital of Toliara (Tuléar), southwestern Madagascar. We located this female ca. 2 h before dusk at 1654 h, after she had already excavated a burrow deep enough to have submerged ca. 10 cm of her total body length below the substrate. The female dug the entrance burrow in the sand substrate at a roughly 45° angle. For the next 4 h and 18 min, she remained underground. In *Chamaeleo chamaeleon*, and in captive chameleons from Madagascar, females use only one burrow during nest excavation (Blázquez et al., *op. cit.*; KBK, pers. obs.). However, the female of this species deposited eggs without exiting the same burrow, and instead, excavated upwards at an angle almost perpendicular to the entry burrow. She emerged from the opposite end at 2112 h, filling in the burrow as she exited. By 2137 h, she had completely exited and remained motionless for the next 18 min. By 2155 h, she began to crawl toward the burrow entrance, and began covering the partially collapsed entrance. She completed filling the entrance by 2230 h, after which she climbed nearby vegetation to roost. We estimate that nesting behavior in this individual lasted at least 6 h given that she had begun excavation before we arrived, much shorter than that described in *C. chamaeleon* (Blázquez et al., *op. cit.*).

The next day, we recorded egg and nest dimensions. The entrance burrow measured 175 mm in length and the exit angle was acute, resulting in the exit burrow being only about 150 mm. Nest depth, measured from the substrate to the top of the egg mass, was 138 mm. On 30 January 2004, the female weighed 12 g, but only 6.4 g after egg deposition on 04 February. The 11-egg clutch had a total mass of 4.4 g. Egg length averaged 11.7 ± 0.37 mm SD (N = 11). After data collection, we replaced all eggs to their original orientation and re-covered the nest. We recorded nest temperature at the same level as egg depth over the next several days between 0800–2200 h. Mean nest temperature was 27.2 ± 0.92°C (N = 9) during this early period of incubation. We were unable to record nest temperatures beyond 11 February. Hatching occurs in early November in this species (KBK, unpubl. data).

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HELODERMA SUSPECTUM (Gila Monster). **PREY**. Gila Monsters are specialized nest predators; their diet includes eggs of ground-nesting birds and reptiles, and juvenile mammals (e.g., *Ammospermophilus leucurus*, *Neotoma albigula*, and *Sylvilagus audubonii*; Beck 2005. Biology of Gila Monsters and Beaded Lizards. University of California Press, Berkeley. 247 pp.). Here, we report prey not previously known for *H. suspectum*, Desert Kangaroo Rats (*Dipodomys deserti*). We describe predation episodes on juvenile kangaroo rats in the field, and we document adult kangaroo rat rescue of nestlings from *H. suspectum* predation.

We radio-tracked *H. suspectum* from March 2000 to August 2004 at a Mojave Desert site near Lake Mead, Nevada (36.5°N, 114.5°W; elev. 600 m; Gienger 2003. Natural History of the Gila Monster in Nevada. Unpubl. MSc Thesis. Univ. of Nevada, Reno. 55 pp.). We located each lizard 2–4 times per day during the active season (March–October). When we found *H. suspectum* surface active, we followed each lizard from a distance of 5–10 m to record successful foraging bouts and specific prey.

At 0710 h on 30 May 2003, we observed an adult female *H. suspectum* excavating an entrance to a rodent burrow complex at the base of a sandy mound (Fig. 1a). After 2 min of excavation, the *H. suspectum* disappeared into the burrow and an adult kangaroo rat ran out of a hole on the other side of the sand mound. Immediately, two altricial (eyes still closed) kangaroo rat pups were observed trying to crawl out of the burrow. The *H. suspectum* then emerged from the burrow behind the pups (Fig. 1b) and seized one pup by the mid-body. After consuming the first pup, along with considerable sand, the Gila Monster then exited the burrow, seized the second pup by the head (Fig. 1c), and consumed it as well.

At 0758 h on 19 June 2003, we observed the same female *H. suspectum* excavating a rodent burrow. After digging for ca. 1 min, the burrow collapsed on itself and the lizard disappeared inside. An adult Desert Kangaroo Rat then sprinted out of a second burrow entrance 70 cm from the collapsed entrance. Three juvenile Desert Kangaroo Rats (pre-weening age; eyes still closed) became visible at the second entrance of the collapsed burrow, with one pup attempting to crawl out of the burrow. The adult Desert Kangaroo Rat (presumably the mother) returned to the opening of the second burrow (Fig. 2a), grabbed the pup that was outside of the burrow (Fig. 2b) and carried it to a third burrow opening located 3.5 m away from the second (Fig. 2c). The mother then stood out-



FIG. 1. Excavation and consumption of a nest of kangaroo rats (*Dipodomys* sp.) by a foraging Gila Monster.



FIG. 2 (opposite). Sequence showing adult female Desert Kangaroo Rat (*Dipodomys deserti*) attempting to rescue her pups from predation by a Gila Monster. The Gila Monster is inside the burrow and the mother removes one of the pups before it can be eaten.

side the third burrow and began a foot-drumming display (Kenagy 1976. J. Mammal. 57:781–785; Randall and Matocq 1997. Behav. Ecol. 8:404–413.) in which she rapidly and repeatedly beat her feet against the sand.

The remaining pups inside the second burrow were squeaking, and the mother returned and moved quickly into the burrow with both the remaining two visible pups and the *H. suspectum*. At 0807 h, the mother emerged from the second burrow (without any pups) and moved over to the third burrow where she had left the rescued pup. At 0820 h, the mother left the third burrow without her pup and moved out of sight. For 20 min, the *H. suspectum* remained inside the second burrow. At 0840 h, squeaking noises emanated from the third burrow where the Desert Kangaroo Rat mother had placed the rescued pup. The Gila Monster remained underground in the second burrow until 0923 h, and then emerged from the burrow (Fig. 2d) and walked to, and into, the third burrow, where it presumably consumed the rescued pup. The *H. suspectum* remained inside the third burrow for ca. 30 min and then emerged above ground. After walking a few steps, the *H. suspectum* licked its face and arched its back with snout pointed upward, a posture Gila Monsters often assume after eating large meals (pers. obs.; Beck 2005, *op. cit.*). This arching posture may help force food items down into the stomach, especially when the stomach is already full.

We were also able to verify nest predation by three other Gila Monsters on kangaroo rats at this Nevada site on four additional occasions. Each time, we were able to verify the genus of the prey (*Dipodomys*) by observing adults leaving the nest or pups attempting to crawl out of the burrow. Most of the time we were not able to identify *Dipodomys* to species, as the adults fled the nest once it was discovered, and Gila Monsters immediately consumed the pups. The possible kangaroo rat species in this area include *D. deserti and D. merriami* (Hall 1946. Mammals of Nevada. University of California Press, Berkeley. 710 pp.), but because these observations were made as part of a larger natural history study of Nevada *H. suspectum*, we did not interfere with lizard foraging activities to determine which of the two *Dipodomys* species were involved. However, the observation of 19 June 2003 is undoubtedly a nest of *D. deserti*, as the kangaroo rat we observed was large and had white hairs on the terminal end of its tail (*D. merriami* are smaller and have black terminal tail hairs).

These six observations suggest that kangaroo rats can constitute an important part of the diet for certain populations of Gila Monsters. Our study site had a considerable amount of sand dunes and Creosote Bush (*Larrea tridentata*), both of which are appropriate habitat elements for *Dipodomys* (Longland and Price 1991. Ecology 72:2261–2273; Schroder 1987. Ecology 68:1071–1083). Most previous ecological studies of Gila Monsters have been conducted at sites lacking sand dunes (Beck 2005, *op. cit.*), hence *Dipodomys* might not be available prey to those populations. Additionally, our Nevada study site lacks conspicuous populations of Desert Cottontail Rabbits (*S. audubonii)*, which constitute the most common food item at other study populations of Gila Monsters (populations in Arizona and Utah; Beck 2005, *op. cit.*).

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HEMIDACTYLUS MABOUIA (Tropical House Gecko). **HUMAN-INDUCED INTRODUCTION.** *Hemidactylus mabouia* occurs in urban and other anthropogenic environments as well as varied less disturbed habitats such as tropical rainforest, sand dunes and rock outcrops (Teixeira 2001. Atlântica 23:77–84). A small lizard native to sub-Saharan Africa, it was accidentally introduced to and has colonized most of the South and Central America and Florida (Butterfield et al. 1993. Herpetol. Rev. 24:111–112), Caribbean islands (Townsend and Krysko 2003. Florida Scient. 66:204–208), and Atlantic islands such as Cape Verde (Jesus et al. 2001. J. Herpetol. 35:672–675), Madeira (Jesus et al. 2002. Herpetozoa 15:179–180), São Thomé and Príncipe (Jesus et al. 2005. Mol. Phylogenet. Evol. 34:480–485), and the Abrolhos Archipelago, 70 km off the Brazilian coast (Rocha et al. 2002. Braz. J. Biol. 62:285–291). Populations in the Gulf of Guinea and Macronesian islands are genetically homogenous likely as a result of recent introductions (Jesus et al. 2005, *op. cit.*). Introduction to the Brazilian mainland likely occurred through slave ships from Africa (Vanzolini 1968. Arq. Zool. São Paulo 17:1–84). Here, we describe the recent colonization of the oceanic Trindade Island in the mid-Atlantic Ocean and discuss the likely introduction event. Trindade Island, located 1140 km off the Brazilian coast, is a small volcanic island (5 km × 2.5 km) with an area of 13.5 km^2 and elevations over 600 m (Almeida et al. 2001. *In* Schobbenhaus et al. [eds.], Sítios Geológicos e Paleontológicos do Brasil, pp. 369–377. DNPM, Brasília, Brazil). Originally covered by forests of *Colubrina glandulosa*, fire and domestic grazing (sheep and goats) drove this tree to extinction (Alves 1998. Ilha da Trindade & Arquipélago de Martin Vaz, um Ensaio Geobotânico. Serviço de Documentação da Marinha, Rio de Janeiro, Brazil). Reforestation was begun in 1994, and eradication of goats occurred over the interval 1999–2005 (Alves 2006. *In* Alves and Castro [eds.], Ilhas Oceânicas Brasileiras, da Pesquisa ao Manejo, pp. 83–104. MMA, Brasília, Brazil). Both these domestic grazers are now eradicated, but despite its success, reforestation has ceased. Apart from humans, the only terrestrial vertebrate on Trindade Island is the exotic House Mouse, *Mus musculus*, which is now abundant throughout the island. Since 1957, a small number of Navy personnel (currently ~25 people) who maintain a weather station live on Trindade Island. A boat transports food, equipment, and personnel to the island every two months.

We first observed *H. mabouia* at dusk on 31 December 2006 on a plateau above Príncipe Beach (20.5165°S, 29.3096°W; datum: Córrego Alegre; elev. 140 m) in rock outcrops bordered by the dense, tall (ca. 50 cm high) sedge, *Cyperus atlanticus*. The next day, we captured one *H. mabouia* and found one semi-buried clutch of two eggs and a second clutch of three eggs, both under rocks. Because this species typically deposits two eggs, this may have been a communal nest (Rocha et al., *op. cit.*). After this initial discovery, we made several subsequent observations of adults and juveniles. From January to April 2007, we found up to 10 individuals during search sessions lasting about 1 h, with higher num-

bers recorded near the reforestation area where we first recorded the species.

H. mabouia or their eggs were probably introduced with saplings during the reforestation interval in the late 1990s or early 2000s (Alves 2006, *op. cit.*). As no harbor exists on Trindade and because of its steep topography, saplings were usually transported from boats to the drop areas by helicopters, which would explain the absence of *H. mabouia* near human settlement. Despite the abundance of the terrestrial crab, *Gecarcinus lagostoma,* on the island that could prey on this lizard, a well-established population now exists that is apparently spreading to other areas. We also found 3 *H. mabouia* at sea level on Andradas Beach on different occasions at dusk and at night, roughly 400 m SE from the place where it was presumably first introduced. The nocturnal and crepuscular habit of *H. mabouia* is well known (Rocha et al. 2002, *op. cit.*).

Four specimens were collected and deposited in Setor de Herpetologia, Museu Nacional do Rio de Janeiro (MNRJ 17117, one juvenile collected 1 January 2007; MNRJ 17118 one adult collected 28 February 2007), and in the Museu de Biologia Prof. Mello Leitão, Santa Teresa, Espírito Santo (MBML 2107 and 2108, one juvenile recently hatched and one adult, both collected 19 January 2007). We also found exoskeleton fragments of insects and spiders underneath rocks inhabited by *H. mabouia*. Arthropods are the main prey of *H. mabouia* in Brazil in both urban (Bonfiglio et al. 2006. Biociências, Porto Alegre 14:107–111) and less disturbed coastal environment (Teixeira 2001, *op. cit.*). To our knowledge, no detailed study of the arthropods on Trindade has been undertaken, but the island is home to varied arthropod species including dragonflies, beetles, spiders, flies, moths, grasshoppers, and exotic cockroaches, and may include several introduced species as on Gough Island in the South Atlantic (Jones et al. 2003. Biol. Cons. 113:75–87). *H. mabouia* is expected to expand its distribution throughout the island and arrive at the human settlement soon. As it is the only terrestrial reptile on the island, no conservation concern for related species as a function of *H. mabouia* presence currently exists, as has occurred on other islands (Arnold 2000. Bonn. Zool. Monogr. 46:309–323), but it may represent a threat to endemic invertebrates.

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IGUANA DELICATISSIMA (Lesser Antillean Iguana). **MORTALITY.** Major natural disturbances such as hurricanes have been reported responsible for the extirpation of island biotas (Schoener et al. 2004. Proc. Natl. Acad. Sci. USA 101:177–181) and as a mechanism for overwater dispersal (Censky et al. 1998. Nature 395:556). Indeed, these catastrophic disturbances can have profound effects on insular ecosystems and influence current biogeographical patterns (Spiller et al. 1998. Science 281:695–697). Though extirpations and population reductions have been inferred to be caused by catastrophic hurricanes, to our knowledge, direct evidence of hurricane-induced mortality on larger squamates is lacking. Here, we report direct evidence of mortality on *Iguana delicatissima* caused by Hurricane Dean. The eye of Hurricane Dean passed south of Dominica between St. Lucia and Martinique during the morning of 17 August 2007. Hurricane Dean was a Category 2 storm with sustained winds of ca. 160 kph.

On 17 August 2007, hours after Hurricane Dean struck the Commonwealth of Dominica, SV was inspecting damage along the main western coastal road east of Layou Village. Approximately 100 m N of the Layou Quarry is a 10-m wide ravine (15.3989°N, 61.4236°W, datum: WGS84; elev. 20 m), which runs down the slope of the western coastal ridge to the main coastal road. The ravine is typically dry but a 1-m diameter culvert under the road accommodates runoff. On this day, the culvert was blocked with debris, causing runoff to overflow the main coastal road as it made its way toward the sea. Rapidly moving water, ca. 35 cm deep, was choked with debris including branches, leaves, and stones. Within this debris-choked flow, SV observed the head of an adult iguana (ca. 28 cm SVL) on the surface of the road being battered by the onrushing water. The force of the water appeared to have wedged the iguana between rocks. As the iguana lacked signs of rigor mortis or decomposition, we presumed it had recently died. However, whether the iguana was dead prior to becoming wedged in the rocks or it drowned as a result of being trapped in the rushing water was unclear.

On 19 August 2007, CRK was inspecting hurricane damage on a communal iguana nesting area (ca. 72 m^2) located on the coastal slope between the main western coastal road and Batali Beach (15.4497°N, 61.4478°W; elev. 16 m). The storm caused the upper portion of the ridge to fail, resulting in a landslide of large boulders (up to 2 m long; 1 m high) and trees. The heavy rains also caused severe erosional rutting up to 1.5 m deep. Twenty-five torn and crushed iguana eggs with near-term neonates were counted scattered about the lower and middle portions of the slope. One dead hatchling iguana was discovered partially unearthed while trapped in a 2-cm wide collapsed exit burrow located toward the lower portion of the slope. A group of dead hatchlings was found 5 m above the first hatchling. Three iguanas in the group were visible, protruding partially from the surface of the slope while 14 others were entombed just under the surface. All hatchlings were facing the same outward direction and appeared to be in the process of exiting the same ca. 10 cm wide collapsed tunnel of compressed soil. Three hatchlings had crushed skulls. These animals are presumed to have died in their exit burrow as a result of the landslide.

Hurricane season in the Caribbean is typically from 1 June to 30 November, which encompasses the incubation and emergent period for *I. delicatissima* hatchlings, and therefore can impact not only existing iguana populations but also the annual recruitment of hatchlings into these populations. In fact, hurricanes have been implicated in population declines of *I. delicatissima* on the Petite Terre Islands in the French West Indies (Lorvelec et al. 2004. Rev. Ecol. Terre Vie 59:331–344). By reporting mortality in multiple life stages (egg, hatchling, adult), our observations provide evidence for the ecological mechanisms of such population declines caused by catastrophic disturbance.

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LEIOCEPHALUS CARINATUS (Northern Curly-tail Lizard). **SAP FEEDING**. Despite their widespread distribution and locally high densities throughout the Caribbean, the natural history of lizards in the genus *Leiocephalus* is relatively poorly known. The few studies of *Leiocephalus* diet suggest that these lizards are omnivorous, eating vegetation, insects, and vertebrates, including lizards (Fong G. and Del Castillo 2002. Herpetol. Rev. 33:205–206; Jenssen et al. 1989. Anim. Behav. 38:1054–1061; Micco et al. 1997. Herpetol. Nat. Hist. 5:147–156; Schoener et al. 1982. Oecologia 53:160–169; Schwartz and Henderson 1991. Amphibians and Reptiles of the West Indies: Descriptions, Distributions, and Natural History. University of Florida Press, Gainesville. 720 pp.). They can also be scavengers (Iverson and Smith 2006. Herpetol. Rev. 37:345–346). Here, we describe a previously unreported potential food source for *Leiocephalus carinatus*.

On 25 June 2007, we observed an adult *L. carinatus* (sex unknown) feeding on the sap of a Bay Cedar (*Suriana maritima*) on Alligator Cay, Exumas, Bahamas (24.3931°N, 76.6428°W, datum: WGS84; elev. 2 m; see Knapp 2001. J. Herpetol. 35:239–248 for description of the island). The sap originated from a crack in a branch of the Bay Cedar. The lizard was observed to lick the surface of the Bay Cedar branch repeatedly at the location of sap "bubbles," which disappeared when the lizard licked them, suggesting that the tongue was used to consume the sap, rather than being used in exploratory tongue-flicking behaviors (digital video available from authors). To date, sap feeding has been documented in only one other lizard, the gecko *Gehyra australis* (Letnic and Madden 1997. West. Austr. Nat. 21:207–208; see review by Cooper and Vitt 2002. J. Zool. 257:487–517). Combined with the previous observations on the diets of *Leiocephalus*, our results suggest that these lizards are more broadly omnivorous than previously recognized.

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PLESTIODON REYNOLDSI (Florida Sand Skink). **ALBINISM**. *Plestiodon reynoldsi*, a federally threatened species, is restricted to upland scrub and sandhill habitats in central Florida (McCoy et al. 1999. Conserv. Biol. 13:190–194). On 1 September 2007, we collected an albino juvenile (30.5 mm SVL, 27.0 mm tail; 0.18 g) in an Inopina Oak (*Quercus inopina*) scrubby flatwood at Archbold Biological Station, Lake Placid, Highlands Co., Florida, USA (27.1346°N, 81.3597°W, datum: WGS84; elev. 40 m). This individual was recaptured at the same location on 16 and 19 September 2007. Albinism has never before been reported in *P. reynoldsi*. The background color was pink with a paler dorsal area and little contrast between dorsal and either the lateral or ventral coloration (Fig. 1). Juveniles are typically gray-brown with a distinctly dark brown lateral band from the snout to the tip of the tail on each side of the body. The heart, major circulatory system vessels, and parts of the digestive system were visible through its ventral side. Non-albino juveniles have a pattern of small, dark brown spots on a gray-brown light background on top of the head, whereas this albinistic juvenile had but one slightly darker spot on one of the parietal scales against a pale pink bakground. The irises of the albino juvenile were red (black in typical juveniles). We deposited digital color images of the specimen in the Calphotos database (http://calphotos.berkeley.edu/).



FIG. 1. Albinistic and typical juvenile of *Plestiodon reynoldsi*.

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SCELOPORUS POINSETTII (Crevice Spiny Lizard)**. DIET.** Lizards of the genus *Sceloporus* are mainly insectivorous (e.g., Ballinger 1978. Southwest. Nat. 23:641–649; Goldberg and Bursey 1990. J. Herpetol. 24:446–448; Pough 1973. Ecology 54:837–844), with notable herbivorous exceptions (*Sceloporus torquatus torquatus;* Búrquez et al. 1986. J. Herpetol. 20:262–264; *S. poinsettii*; Ballinger et al. 1977. Amer. Midl. Nat. 97:482–484). Ballinger et al. (*op. cit.*) described a shift in diet preference from insects to plants during ontogeny in *S. poinsettii*. We examined the diets of 21 *S. poinsettii* from northwestern Mexico, including 11 juveniles (44–93 mm SVL), 5 young adults (83–93 mm SVL), and 5 older adults (93–100.2 mm SVL), allowing examination of any potential ontogenetic dietary shift. As part of a taxonomic and

TABLE 1. Prey taken from 21 *Sceloporus poinsettii* stomachs from northwestern Chihuahua, México.

Prey Taxon	Individuals N	Individuals %	Items N	Items %	Volume cm^3	Volume %
Invertebrates						
Annelida	1	4.8	1	0.3	0.20	1.1
Insecta						
Coleoptera						
Adults	12	57.1	37	12.4	6.96	37.8
Larvae	1	4.8	1	0.3	0.02	0.1
Hemiptera	1	4.8	1	0.3	0.32	1.7
Homoptera	2	9.5	4	1.3	0.41	2.2
Hymenoptera						
Ants	4	19.1	156	52.2	5.06	27.5
Other	1	4.8	1	0.3	0.03	0.2
Isoptera	4	19.1	83	27.8	0.16	0.9
Orthoptera	4	19.1	83	27.8	0.16	0.9
Grasshoppers	1	4.8	1	0.3	0.09	0.5
Other	9	42.9	13	4.4	4.77	25.9
Unknown	4	19.1	83	27.8	0.16	0.9

distributional survey of the Chihuahuan Desert and surrounding areas (Lemos-Espinal et al. 2004. Introducción a los Anfibios y Reptiles del Estado de Chihuahua. UNAM/CONABIO, Ciudad de México. 128 pp.), specimens were captured in spring and summer 2001 and 2002 from various localities in northwestern Chihuahua, México. We removed their stomachs by dissection for dietary analysis. SVL, head-length (HL), and head-width (HW) were measured with digital calipers to the nearest 0.1 mm. We identified prey items to the lowest possible taxonomic category, usually order. We measured prey length and width with digital calipers to the nearest 0.1 mm and calculated prey volumes using the formula for a prolate spheroid (Vitt et al. 2005. Herpetol. Monogr. 19:137–152).

The *S. poinsettii* that we examined consumed nearly 100% insect material, with ants being most important numerically (156) and beetles being the most important volumetrically (37.83%) (see Table 1). We found no significant relationships among SVL, HL, or HW; and prey length, width, or volume (all $P > 0.30$).

Our findings are contrary to those of Ballinger (*op. cit.*) and Ballinger et al. (*op. cit.*) who report ontological diet shifts from insects to plants. Our samples showed no such shift. Thus, ontogenetic dietary shifts in *S. poinsettii* seem to vary among populations.

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TRACHYDOSAURUS RUGOSUS ASPER (Shingle Back, Boggi, or Pine-cone Lizard) **PREDATION**. *Trachydosaurus rugosus*, including four subspecies, is a lizard widespread across much of the southern half of continental Australia and selected western offshore islands (Shea 1992. Unpubl. Ph.D. thesis, University of Sydney; Shea 2000. *In* Hauschild et al. [eds.], Blauzungenskinke. Beitrage zu *Tiliqua* und *Cyclodomorphus*, pp. 108–112. Natur und Tier Verlag, Munster), but few records of its predators exist. This note documents an observation of predation on *T. r. asper* by Wedge-tailed Eagles, *Aquila audax*.

At ~0900 h on 8 December 2007, MD observed 3 *A. audax* ca. 40 km N of Conargo, New South Wales, on Conargo-Carrathool Road ca. 400 m S of its intersection with Steam Plains Road (35.0708°S, 145.3779°E, datum: WGS84; elev. 110 m). Two were sitting on a stock watering-trough drinking, and the third was circling in the air ~100 m distant from the other two. The latter was observed to swoop to the ground, where it stood erect with its head above the grass; when approached by the observer to within 25 m, it flew into the air ~4 m above the ground with an adult *T. r. asper* (ca. 25 cm SVL) in its talons, and briefly hovered for 2–3 seconds until the observer veered off. The *A. audax* then settled back on the ground, where it was joined by one of the other two eagles; both then commenced feeding on the lizard. Habitat was very open *Acacia pendula* woodland with sparse graminoid herbaceous layer; air temperature was ~22°C, with no cloud cover and no wind. *A. audax* is a well-known scavenger of road-kills and farm animal mortalities, and as a predator of small wallabies and introduced rabbits, however predation on reptiles is somewhat unusual. Interestingly, an *A. audax* was observed to seize a live adult Eastern Brown Snake, *Pseudonaja textilis*, in March 2007, ca. 16 km S of Riverina Highway on Aratula Road (Katrina Molesworth, pers. comm.), which is ca. 50 km SW of the above locality. There has been an extended drought in the region over the previous four years, which might partly explain the willingness of *A. audax* to take reptilian prey in this region, as rabbits and road-kills are currently few.

We thank M. Hayes for editorial suggestions.

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TROPIDURUS OREADICUS (Neotropical Ground Lizard). **DIET**. *Tropidurus oreadicus* occurs in savanna-like habitats. In Belém, it is usually seen on the trunks of isolated trees, and in some places, on walls and fences; in Amazonia, the species is also frequently terrestrial (Ávila-Pires 1995. Lizards of Brazilian Amazonian [Reptilia:Squamata]. Zool. Verhandelinger 299:1–706). Food consists of diverse insect arthropods, but can sometimes include centipedes, millipedes, and plant matter (Ávila-Pires, *op. cit.*). However, arthropod prey are typically not identified to species. Here I describe an observation of an adult *T. oreadicus* preying on an adult centipede, *Scolopendra viridicornis*.

At 1120 h on 13 July 2006, I found an adult male *T. oreadicus* (ca. 110 mm SVL) running in the leaf litter with an adult (ca. 85

mm) *S. viridicornis* in its mouth in a urban park of Museu Paraense Emílio Goledi (MPEG) (1.4523°S, 48.4762°W, datum: WGS84, elev. 25 m), where the trees are closely spaced but significant open areas still exist. The *T. oreadicus* exhibited some difficulty ingesting the centipede because its caudal appendices and the last two pair of legs were protruding from the lizard's mouth for 9 min before the lizard was able to completely swallow it.

My observation reveals that medium-sized (> 90 mm) centipedes can be vulnerable to medium-sized lizards, like *Tropidurus* species. In 71 *T. oreadicus* stomachs, centipedes were present in six (Ávila-Pires, *op. cit.*). Scolopendromorph centipedes can deliver a painful bite that has potential medical implications for humans and have been reported to sometimes prey upon small lizards (Lewis 1981. The Biology of Centipedes. Cambridge University Press, Cambridge, United Kingdom. 476 pp.), so they may present some risk that is in part related to size. *Scolopendra viridicornis* is a common large or medium-sized species in Brazil that can also be found in Guyana, Venezuela, Bolivia, Paraguay, and Argentina (Adis 2002. *In* Adis [org.], Amazonian Arachnida and Myriapoda—Identification Keys to All Classes, Orders, Families, Some Genera, and Lists of Known Terrestrial Species. Pensoft Publishers, Sofia, Bulgaria. 590 pp.).

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TROPIDURUS OREADICUS (Neotropical Ground Lizard). ***CNEMIDOPHORUS LEMNISCATUS*** (Rainbow Whiptail). **PREDATION.** *Tropidurus oreadicus* and *Cnemidophorus lemniscatus* are common lizards in open and sunny areas in eastern Amazonia (Ávila-Pires 1995. Lizards of Brazilian Amazonian (Reptilia: Squamata). Zool. Verhandelinger 299:1–706). Hawks of the genera *Leucopternis* and *Gampsonyx* and the Common Egret, *Egretta alba*, are documented avian predators of *C. lemniscatus* (Hoogmoed 1973. Biogeographica 4:1–419; Ávila-Pires, *op. cit.*), but few avian predators of *T. oreadicus* have been reported (Ávila-Pires, *op. cit.*). Here, I describe an observation of Guira Cuckoo (*Guira guira*) predation on *T. oreadicus* and *C. lemniscatus* from northern Brazil.

At 1520 h on May 2006, a clear sunny day, I observed a flock of 11 adult *G. guira* foraging on mowed grass on the campus of Universidade Federal do Pará, Belém, Pará State, Brazil (1.47°S, 48.45°E). During my observation, I noted a disturbance in bird group as one member of flock arose with a dead juvenile of *T. oreadicus* (ca. 5 cm SVL) in its bill. The *G. guira* began to run to avoid another member of its flock that tried to steal the lizard. When the *G. guira* with the lizard had distanced itself from its congener, it swallowed the lizard by head first. The entire predation episode took 9 min.

Forty minutes later, I noted another *G. guira* with a *C. lemniscatus* (ca. 10 cm SVL) in its beak. The lizard, held sideways by its neck, was entirely limp (including tail and limbs) and seemed dead. The lizard remained limp during the entire 2 min observation period, after which the *G. guira* flew out of view with its prey to a nearby tree, because three members of its flock simultaneously tried to steal the lizard.

Our observations suggest that *G. guira* may be important lizard predators in open habitats. The Guira Cuckoo, one of the best-known abundant birds in eastern Brazil, is common in parks, cities, pastures, and plantations, but is absent from most of Amazonia because it avoids continuous forests; it is also frequent in grasslands along the Amazonian estuary (Sigrist 2006. Aves do Brasil, uma Visão Artística. Brazil, São Paulo. 672 pp.). This bird is an active forager, preying on insects and small vertebrates such as frogs, mice, and small birds (Martins and Donatelli 2001. Ararajuba 9:89–94; Sigrist 2006, *op. cit.*), but few records exist of its preying on lizards.

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SQUAMATA — SNAKES

BOTHROPS ASPER (Terciopelo). **PREDATION.** Few predators of neotropical lanceheaded pitvipers (*Bothrops*) have been identified (Campbell and Lamar 2004. The Venomous Reptiles of the Western Hemisphere. Cornell University Press, Ithaca, New York. xviii+870+[28] pp.). I herein report predation on *B. asper* by a land crab (*Gecarcinus quadratus*, Gecarcinidae). On 26 August 2003 at 2000 h I found a juvenile *B. asper* (SVL ca. 60 cm) coiled up next to a trail in the coastal rain forest near La Leona station, Corcovado National Park, Peninsular de Osa, Costa Rica. When I passed the spot again at 2230 h, the snake was dead, with the anterior half of its body laying inside a hole in the ground. The hole turned out to be the burrow of a large land crab, which was found at the end of the burrow. It had already eaten the snake's head and anterior parts of the body. The short period between the two observations makes it unlikely that the snake was killed otherwise and only subsequently eaten by the crab. *Gecarcinus quadratus*, which is considered a seed and seedling predator, is abundant in the coastal forest of the Corcovado National Park, with up to six crabs / m^2 (Sherman 2002. J. Trop. Ecol. 18:67–89), and can be found several hundred meters from the coast inside the forest (pers. obs.). It is therefore possible that this crab is a regular, though opportunistic, predator of *B. asper* and other snakes in this area.

Submitted by **JONAS MAXIMILIAN DEHLING**, Department of Animal Ecology and Tropical Biology, Biozentrum, University of Würzburg, Am Hubland, D-97074 Würzburg, Germany; e-mail: Jonas.M.Dehling@stud-mail.uni-wuerzburg.de.

GEOGRAPHIC DISTRIBUTION

Instructions for contributors to Geographic Distribution appear in Volume 39, Number 1 (March 2008, p. 102). Please note that the responsibility for checking literature for previously documented range extensions lies with authors. Do not submit range extension reports unless a thorough literature review has been completed.

CAUDATA – SALAMANDERS

AMBYSTOMA JEFFERSONIANUM (Jefferson Salamander). USA: OHIO: SHELBY CO.: Washington Township: Lockington Dam Road. 1.5 km NW of Lockington. (40.21633°N, 84.25759°W). 13 April 2007. Jeffrey G. Davis. Verified by John W. Ferner. Voucher specimens deposited at Cincinnati Museum Center, Frederick and Amye Geier Research and Collections Center. (CMC 10672 and 10673). New county record (Pfingsten and Matson. 2003. Ohio Salamander Atlas. Ohio Biol. Surv. Misc. Contr. No. 9).

Submitted by **JEFFREY G. DAVIS**, Cincinnati Museum Center – Fredrick and Amye Geier Research and Collections Center, 1301 Western Avenue, Cincinnati, Ohio 45203-1130, USA; e-mail: anura@fuse.net.

AMBYSTOMA OPACUM (Marbled Salamander). USA: ILLINOIS: HAMILTON CO.: Hamilton County State Fish and Wildlife Area, vernal pond ca. 1.2 km SE of the Dolan Lake spillway parking lot (38.0508333°N, 88.3913889°W). 20 Jan 2008. Cy L. Mott. Verified by Ronald A. Brandon. SIUC H-8684. Larval specimens. New county record (Phillips et al. 1999. Field Guide to Amphibians and Reptiles of Illinois. Illinois Nat. Hist. Surv. Manual 8, Champaign, Illinois. xii + 282 pp.).

Submitted by **CY L. MOTT**, Cooperative Wildlife Research Laboratory, Department of Zoology, Southern Illinois University, Carbondale, Illinois 62901, USA; e-mail: cm8755@siu.edu.

AMBYSTOMA TIGRINUM (Tiger Salamander). USA: ILLINOIS: CLARK CO.: Sparkling Waters Tree Farm; 500 m W of Cooper Chapel Road on Fishback Road (39.3795°N, 87.5898°W; NAD83). 20 March 2008. Andrew R. Kuhns and John A. Crawford. Verified by Christopher A. Phillips. INHS 20813. One of five males captured in minnow traps from the westernmost pond on the property. County record (Phillips et al. 1999. Field Guide to Amphibians and Reptiles of Illinois. Illinois Nat. Hist. Surv. Manual 8, Champaign, Illinois xii + 282 pp.), further verified by checking recent issues of *Herpetological Review* and databases located at the Illinois Natural History Survey containing records of amphibians and reptiles from Illinois in 30 museum and private collections and unvouchered records from herpetologists and other state biologists. We thank the Pickering Family for granting us access to their ponds, and the Illinois Wildlife Preservation Fund for financial support.

Submitted by **ANDREW R. KUHNS**, Illinois Natural History Survey, Division of Biodiversity and Ecological Entomology, Section of Biotic Surveys and Monitoring, 1816 South Oak Street, Champaign, Illinois, USA (e-mail: arkuhns@uiuc.edu); and **JOHN A. CRAWFORD**, Indiana University, School of Medicine – TH and Lakehead University, Faculty of Forestry and Forest Environment, 135 Holmstedt Hall, Terre Haute, Indiana 47809, USA (e-mail: jcrawford10@isugw.indstate.edu).

AMPHIUMA PHOLETER (One-toed Amphiuma). USA: ALABAMA: COVINGTON CO.: Found under log in saturated muck of seepage in Conecuh National Forest, 50 m SW of Covington CR 24 bridge over Pond Creek (31.1015°N, 86.5390556°W). 28 March 2007. S. Graham. Verified by C. Guyer. AU 37412. New county record. This is only the third time this species has been reported in Alabama, and this specimen is the first voucher for this species collected in Alabama since 1985 (Carey 1985. Herpetol. Rev. 16:31). This record extends this species' range ca. 50 km N from the closest populations to the south (Eglin AFB). *Amphiuma pholeter* exists syntopically at this locality with *Pseudotriton ruber*, *Desmognathus cf. conanti*, *Eurycea cirrigera*, and *Amphiuma means*.

Submitted by **SEAN GRAHAM** , Auburn University Department of Biological Sciences, 331 Funchess Hall, Auburn University, Auburn, Alabama 36849, USA.

BOLITOGLOSSA PLATYDACTYLA (Broad-footed Mushroom-tongued Salamander). MÉXICO: HIDALGO: Municipality of Huejutla de Reyes (21.04543°N, 98.24259°W; WGS849), 148 m elev. 31 March 2006. A. Ramírez-Bautista and U. Hernández-Salinas. Verified by G. Parra. Herpetology collection, Laboratorio Ecología de Poblaciones, Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo, México (UHS-UAEH-00057). First record for Municipality and second for state, and a range extension of 20 km W from the closest record at Chapulhuacán, Hidalgo (Smith and Taylor 1966. Herpetology of Mexico. Annotated Checklist and Keys to the Amphibians and Reptiles. A reprint of Bulletins 187, 194, and 199 of the USNM. Eric Lundeberg, Ashton, Maryland. 610 pp.). The salamander was found under a log in rainforest. Field work was funded by SEP-PROMEP-1103.5/03/1130, Projects PIFI-PROMEP 3.3. 2007, CONACYT-S 52552-Q, and CONACYT-43761.

Submitted by **URIEL HERNÁNDEZ SALINAS** (e-mail: hu128613@uaeh.reduaeh.mx), **AURELIO RAMÍREZ BAUTISTA** (e-mail: aurelior@edu.uaeh.mx), and **ADRIAN LEYTE-MANRIQUE,** Centro de Investigaciones Biológicas (CIB), Universidad Autónoma del Estado de Hidalgo, A. P. 1-69 Plaza Juárez, C.P. 42001, Pachuca, Hidalgo, México (e-mail: leytebi2@yahoo.com.mx).

NECTURUS MACULOSUS (Mudpuppy) CANADA: MANITOBA: Berens River. Single larva collected while electrofishing over shallow bedrock outcrop along the south shore of the Berens River (ca. 52.3291417°N, 96.918713°W). 15 August 1991. University of Manitoba, Department of Zoology (MZH17; field sample KWS 91-22). Verified by K.W. Stewart, University of Manitoba. Previously known only to about 51°N around southern end of the Narrows of Lake Winnipeg, Manitoba (Preston 1982. The Amphibians and Reptiles of Manitoba. Manitoba Museum of Man and Nature, Winnipeg, Manitoba. 128 pp.); new record is ca. 110 km N of previously known range.

Submitted by **GAVIN F. HANKE**, Royal British Columbia Museum, 675 Belleville Street, Victoria, British Columbia, V8W 9W2 Canada; e-mail: ghanke@royalbcmuseum.bc.ca.

NECTURUS MACULOSUS (Common Mudpuppy). USA: NORTH CAROLINA: ALLEGHANY CO.: Adult caught in minnow trap in New River at New River State Park, 18.8 km airline NW Sparta. 09 March 2007. Lori Williams, Ed Corey, and New River State Park staff, Jeff Matheson, and Paul Bailey. First documented record in the New River for Alleghany County (Williams 2007. NC NHP Special Animal Survey Form). Specimen verified by Jeffrey C. Beane. North Carolina State Museum of Natural Sciences photo voucher (accession number 12194). Closest previous historical record is one occurrence from the New River at New River State Park in Ashe Co., North Carolina, 16 km airline SSW (Williams and Corey. 2007. Herpetol. Rev. 38:472.)

Submitted by **LORI A. WILLIAMS**, North Carolina Wildlife Resources Commission, 177 Mountain Laurel Lane, Fletcher, North Carolina 28732, USA; and **J. EDWARD COREY III**, North Carolina Division of Parks and Recreation, 12700 Bay Leaf Church Road, Raleigh, North Carolina, 27614-9633, USA.

NOTOPHTHALMUS VIRIDESCENS (Red-spotted Newt). CANADA: ONTARIO: Lake of the Woods. Single eft found under barrel when outhouse was renovated 02 September 1991, (49.4352111°N, 94.0198333°W). University of Manitoba, Department of Zoology (MZH27). Verified by K. W. Stewart, University of Manitoba. Collected by W. G. Franzin (Department of Fisheries and Oceans, Winnipeg) along with a *Plethodon cinereus*. This specimen is from the western-most limit of the species' range, with the nearest record in the Ontario Ministry of Natural Resources database at 49.4236111°N, 94.0877778°W (Oldham and Weller 2000. Ontario Herpetofaunal Atlas. Natural Heritage Information Centre, Ontario Ministry of Natural Resources. http://www.mnr.gov.on.ca/MNR/nhic/herps/ohs.html (updated 15-01-2001). http://nhic.mnr.gov.on.ca/herps/salamanders.html http://nhic.mnr.gov.on.ca/herps/Northern_Ont/Salamanders/cene.jpg). See also the generalized range map by MacCulloch (2002. Amphibians and Reptiles of Ontario. Royal Ontario Museum, Toronto, Ontario. 168 pp.).

Submitted by **GAVIN F. HANKE**, Royal British Columbia Museum, 675 Belleville Street, Victoria, British Columbia, V8W 9W2 Canada; e-mail: ghanke@royalbcmuseum.bc.ca.

NOTOPHTHALMUS VIRIDESCENS LOUISIANENSIS (Central Newt). USA: ARKANSAS: DALLAS CO.: 5.6 km S Sparkman off St. Hwy 7 at Brushy Creek (Sec. 15, T10S, R17W). 07 May 1986. Henry W. Robison. Verified by S. E. Trauth. Arkansas State University Herpetological Museum (ASUMZ 30829). New county record filling a distributional gap between Clark and Cleveland counties (Trauth et al. 2004. Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.), and leaving only Lafayette County without documentation of *N. v. louisianensis* for all of south Arkansas.

Submitted by **HENRY W. ROBISON**, Department of Biology, Southern Arkansas University, Magnolia, Arkansas 71754, USA (e-mail: hwrobison@saumag.edu); and **CHRIS T. MCALLISTER**, Department of Physical and Life Sciences, Chadron State College, Chadron, Nebraska 69337, USA (e-mail: drctmcallister@aol.com).

NOTOPHTHALMUS VIRIDESCENS LOUISIANENSIS (Central Newt). USA: MISSOURI: PERRY CO.: larva found in farm pond near PCR 606, Biehle (37.644444°N, 89.8575°W; WGS84). 02 September 2006. Collected by Richard L. Essner, Jr., Paul E. Brunkow, Roma Patel, Daniel L. Huff, and James H. Robins. Verified by Ralph W. Axtell, Southern Illinois University Edwardsville (SIUE 2949). New county record. This is the first report from Perry County (Daniel and Edmond 2008. Atlas of Missouri Reptiles and Amphibians for 2007).

Submitted by **RICHARD L. ESSNER, JR.** (e-mail: ressner@siue.edu)**, PAUL E. BRUNKOW** (e-mail: pbrunko@siue.edu), **ROMA PATEL, DANIEL L. HUFF,** Department of Biological Sciences, Southern Illinois University Edwardsville, Illinois, 62026, USA; and **JAMES H. ROBINS** Department of Biology, Southeast Missouri State University, Cape Girardeau, Missouri, 63701, USA (e-mail: jhrobins@semo.edu).

PLETHODON GLUTINOSUS (Slimy Salamander). USA: ILLINOIS: HAMILTON CO.: Hamilton County State Fish and Wildlife Area, forested hillside ca. 10 m S of Kiwanis Point Picnic Area (38.060277°N, 88.4°W). 06 Oct 2007. Cy L. Mott. Verified by Ronald A. Brandon. SIUC H-8683. Adult specimen. New county record (Phillips et al. 1999. Field Guide to Amphibians and Reptiles of Illinois. Illinois Nat. Hist. Surv. Manual 8, Champaign, Illinois. xii + 282 pp.).

Submitted by **CY L. MOTT**, Cooperative Wildlife Research Laboratory, Department of Zoology, Southern Illinois University, Carbondale, Illinois 62901, USA; e-mail: cm8755@siu.edu.

PLETHODON MISSISSIPPI (Mississippi Slimy Salamander). USA: TENNESSEE: GIBSON CO.: Bradford (36.03358°N, 88.47916°W; datum WGS 84). 04 February 2008. Joshua M. Hall. Verified by A. Floyd Scott. Austin Peay State University's David H. Snyder Museum of Zoology (APSU 18883 [color photo]). Two adult specimens found underneath damp log in heavily wooded area; one photographed and released. New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Austin Peay State Univ. Misc. Publ. 12:1–94; Redmond and Scott 1996. Atlas of Amphibians in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. http//www.apsu.edu/amatlas/).

Submitted by **JOSHUA M. HALL**, 4105 Caldwell Drive, Milan, Tennessee 38358, USA.

ANURA – FROGS

ATELOGNATHUS JEINIMENENSIS. ARGENTINA: SANTA CRUZ: DEPARTAMENTO LAGO BUENOS AIRES: 71 km by road (50 km air line) S of Los Antiguos (46.977444°S, 71.828222°W; datum: WGS84; 1256 m elev.). 23 March 2007. A. Scolaro. Herpetological collection, Museo de La Plata, Buenos Aires (MLP A 4994–4999, three adults and three juveniles, collected at a small stream in the arid Patagonian steppe). Verified by J. D. Williams. The species was only known from the type locality, a small pond in the Reserva Nacional Lago Jeinimeni, southern Chile, 46.8332222°S, 71.99925°W (Meriggio et al. 2004, Bol. Mus. Nac. Hist. Nat. Chile 53:99–123), and is listed as Near Threatened by the IUCN, Conservation International, and NatureServe (2006, Global Amphib-

ian Assessment. <www.globalamphibians.org>). The habitat differs from the type locality in lacking a *Nothofagus pumilio* forest. First country record, extends the known range of the species to the E of the Andes, 20.7 km air line SE from the type locality.

Submitted by **ALEJANDRO SCOLARO, LIZA B. MARTINAZZO,** and **NESTOR G. BASSO,** Centro Nacional Patagónico, Blvd. Brown 2825, 9120 Puerto Madryn, Chubut, Argentina.

BATRACHYLA ANTARTANDICA (Marbled Wood Frog). CHILE: DE LOS RIOS REGION (XIV): Valdivia Province, San Pablo de Tregua Farm (39.6127778°S, 72.0911111°W) 30 km by road from Panguipulli City. 09 December 2007. C. Cuevas and Y. Ugarte. Colección de Anfibios del Instituto de Zoología, Universidad Austral de Chile, Valdivia (IZUA 0001, female). The locality is in Pre-Andean Mountain (692 m elev.) with native forest dominated by *Nothofagus dombeyi*, *Laurelia philippiana*, and *Saxogotea conspicua*.Verified by R. Formas. *Batrachyla antartandica* has a wide distribution along the Andes (54.9333333°S to 40.5833333°S), and Coastal Range (42.6333333°S to 39.3833333°S) (Atalah and Sielfeld 1976. Anales del Instituto de la Patagonia [Chile] 7:169–170; Díaz and Ortiz 2003. Revista Chilena de Historia Natural 76:509–525). Northernmost record for the species along the Andes Range, extends distribution 102 km N from Puyehue (40.7497222°S, 72.2008333°W) the closest record previously known (Formas 1979. *In* W. E. Duellman [ed.], The South American Herpetofauna, pp. 341–379. Monograph 7, Museum of Natural History, University of Kansas).

Submitted by **CÉSAR C. CUEVAS**, Instituto de Zoología, Universidad Austral de Chile, Casilla 567, Valdivia-Chile (e-mail: ccuevas@uach.cl); and **YURI E. UGARTE**, Instituto de Botánica, Universidad Austral de Chile, Casilla 567, Valdivia-Chile (e-mail: yuriugarte@uach.cl).

BUFO OLIVACEOUS (Olivaceous Toad): INDIA: HARYANA: Gurgaon District: Sultanpur Bird Sanctuary (28.6166667°N, 77.0666667°E, 230 m elev.). 16 August 2006. Sukumar Ray and Sukesh Ray. ZSIC A 10667. Verified by Saibal Sengupta and compared with syntypes, ZSIC 3523–3525 from Balochistan, Pakistan. Adult male, SVL 54.6 mm. Found on moist ground, ca. 20 m from wetland. Previously known from Baluchistan Province, Pakistan (Blanford 1874. Ann & Mag. nat. Hist. Ser 414:35). Eastward range extension by ca. 750 km and a new record for India. We are grateful to the Director, ZSI, for support.

Submitted by **SUKUMAR RAY** and **KAUSHIK DEUTI**, Zoological Survey of India, 27 Jawaharlal Nehru Road, Kolkata 700 016, West Bengal, India; e-mail: kaushikdeuti@rediffmail.com.

CACOSTERNUM PLIMPTONI (Plimpton's Dainty Frog). ETHIOPIA: OROMIA REGION: Awash River, 40 km SW of Addis Ababa (08.84635°N, 38.4570333°E), 2048 m elev. 24 July 2006. B. M. Zimkus, R. Kerney, and D. Pawlos. AAU A2008–324–346 (23 specimens). Muti Deyo, 53 km S of Addis Ababa (08.6536333°N, 38.58155°E), 2108 m elev. 24 July 2006. B. M. Zimkus, R. Kerney, and D. Pawlos. AAU A2008-356–360 (5 specimens). Verified by D. C. Blackburn. Originally documented from northern Tanzania and highlands of Kenya (Channing et al. 2005. African J. Herpetol. 54[2]:139–148). New country records for Ethiopia, substantially extending range ca. 1300 km NNE from type locality at Musabi Plain in Serengeti National Park, Tanzania. Original species description postulated that populations isolated in Ethiopia as *C. boettgeri*, were in fact, *C. plimptoni*; additional study required to confirm this.

Submitted by **BREDA M. ZIMKUS,** Department of Organismic and Evolutionary Biology, Harvard University, 26 Oxford Street, Museum of Comparative Zoology, Cambridge, Massachusetts 02138, USA; e-mail: bzimkus@oeb.harvard.edu.

HEMIPHRACTUS SCUTATUS (Spix's Horned Treefrog). BOLIVIA: PANDO: Nueva Esperanza, Province Federico Román (10.0635278°S, 65.4026111°W; 114 m elev.). 02 November 2006. A. Muñoz. Museo de Historia Natural Alcide d'Orbigny Cochabamba, Bolivia (MHNC AF 1227, Digital photo, an adult specimen found dead in forest litter). Verified by I. De la Riva. Previously known from Brazil (Porto Walter and Juruá); Colombia; Ecuador (Parque Nacional Yasuní), and Perú, (Ucayali, Iquitos and Ampiyacu), (Lehr 2001. Herpetol. Rev. 32:130–132; InfoNatura: Birds, mammals, and amphibians of Latin America. 2004: NatureServe. Available: http://www.natureserve.org/infonatura; Vitt and Caldwell 1996. Inventário e Ecologia da Herpetofauna da Amazônia: Rio Juruá, Porto Walter, Acre, Brazil. Report Proj. NSF Project DEB-9505518, unpublished report). First country record extends known distribution 164 km E from range cited by Coloma et al. 2004. (IUCN Red List of Threatened Species. <www.iucnredlist.org>).

Submited by **ARTURO MUÑOZ-SARAVIA**, Museo de Historia Natural Alcide d'Orbigny, Casilla Postal 843, Cochabamba, Bolivia; e-mail: hyla_art@yahoo.com.

HYLA CINEREA (Green Treefrog). USA: ARKANSAS: Lincoln Co.: 1.6 km S Glendale off St. Hwy 54 at Sanders Creek (Sec. 8, T19S, R8W). 14 June 2003. Henry W. Robison. Verified by S. E. Trauth. Arkansas State University Herpetological Museum (ASUMZ 30830). New county record filling a distributional gap between Cleveland (Robison and McAllister 2007. Herpetol. Rev. 38:245–246) and Desha counties (Trauth et al. 2004. Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.).

Submitted by **HENRY W. ROBISON**, Department of Biology, Southern Arkansas University, Magnolia, Arkansas 71754, USA (e-mail: hwrobison@saumag.edu); and **CHRIS T. McALLISTER**, Department of Physical and Life Sciences, Chadron State College, Chadron, Nebraska 69337, USA (e-mail: drctmcallister@aol.com).

HYLA VERSICOLOR (Gray Treefrog). USA: ARKANSAS: Searcy Co.: Off AR 14, ca. 2 km down Ramblewood Trail by private residence. 12 June 2007. J. S. Hicks, M. B. Connior. Verified by S. E. Trauth. Arkansas State University Museum of Zoology Herpetology Collection (ASUMZ 30743). First county record (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. Univeristy of Arkansas Press, Fayetteville. 421 pp.).

Submitted by **MATTHEW B. CONNIOR** and **IDUN GUENTHER**, Department of Biological Sciences, Arkansas State University, P.O. Box 599, State University, Arkansas 72467, USA; e-mail: matthew.connior@smail.astate.edu.

LITHOBATES CATESBEIANUS (American Bullfrog). USA: ARKANSAS: SEARCY CO.: Off AR 14, ca. 2.2 km down Ramblewood Trail in small drainage creek (36.0566°N, 92.6002°W; NAD 83). 07 October 2007. M. B. Connior. Verified by S. E. Trauth. Arkansas State University Museum of Zoology Herpetology Collection (ASUMZ 30805). First county record (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville. 421 pp.).

Submitted by **MATTHEW B. CONNIOR,** Department of Biological Sciences, Arkansas State University, P.O. Box 599, State University, Arkansas 72467, USA; e-mail: matthew.connior@smail.astate.edu.

LITHOBATES CLAMITANS (Green Frog). USA: ARKANSAS: SEARCY CO.: Off AR 14, ca. 2.2 km down Ramblewood Trail in small drainage creek (36.0566°N, 92.6002°W; NAD 83). 06 October 2007. M. B. Connior. Verified by S. E. Trauth. Arkansas State University Museum of Zoology Herpetology Collection (ASUMZ 30806). First county record (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. Univeristy of Arkansas Press, Fayetteville. 421 pp.).

Submitted by **MATTHEW B. CONNIOR,** Department of Biological Sciences, Arkansas State University, P.O. Box 599, State University, Arkansas 72467, USA; e-mail: matthew.connior@smail.astate.edu.

LITHOBATES CLAMITANS (Green Frog). USA: TENNESSEE: GIBSON CO.: Bradford (36.03175°N, 88.47956°W: datum WGS 84). 08 February 2008. Joshua M. Hall. Verified by A. Floyd Scott. Austin Peay State University's David H. Snyder Museum of Zoology (APSU 18882 [color photo]). One adult specimen found underneath damp log in drainage ditch. New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Austin Peay State Univ. Misc. Publ. 12:1–94; Redmond and Scott 1996. Atlas of Amphibians in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. http://www.apsu.edu/amatlas/).

Submitted by **JOSHUA M. HALL**, 4105 Caldwell Drive, Milan, Tennessee 38358, USA.

LITHOBATES PALUSTRIS (Pickerel Frog). USA: ARKANSAS: VAN BUREN CO.: Choctaw at Choctaw Creek off St. Hwy 65 (Sec. 12, T10N, R14W). 10 July 1990. M. Evans. Verified by S. E. Trauth. Arkansas State University Herpetological Museum (ASUMZ 30828). New county record partially filling a distributional hiatus in north-central Arkansas among Cleburne and Pope counties (Trauth et al. 2004. Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.).

Submitted by **HENRY W. ROBISON**, Department of Biology, Southern Arkansas University, Magnolia, Arkansas 71754, USA (e-mail: hwrobison@saumag.edu); and **CHRIS T. MCALLISTER**, Department of Physical and Life Sciences, Chadron State College, Chadron, Nebraska 69337, USA (e-mail: drctmcallister@aol.com).

LITHOBATES SYLVATICUS (Wood Frog). USA: ILLINOIS: GALLATIN CO.: Shawnee National Forest, vernal pond ca. 1 km from Pounds Hollow Rd. on York Lane Rd. (37.6038889°N, 88.2627778°W). 26 March 2007. Cy L. Mott. Verified by Ronald A. Brandon. SIUC H-8685. New county record (Phillips et al. 1999. Field Guide to Amphibians and Reptiles of Illinois. Illinois Nat. Hist. Surv. Manual 8, Champaign, Illinois. xii + 282 pp.).

Submitted by **CY L. MOTT**, Cooperative Wildlife Research Laboratory, Department of Zoology, Southern Illinois University, Carbondale, Illinois 62901, USA; e-mail: cm8755@siu.edu.

LITHOBATES SYLVATICUS (Wood Frog). USA: OHIO: GREENE CO.: Spring Valley Township: Caesar Creek Wildlife Area. 3.5 km SE of Roxanna from floodplain of Caesar Creek. (39.57876°N, 83.93340°W). 03 June 2007. Jeffrey G. Davis. Verified by John W. Ferner. Cincinnati Museum Center, Frederick and Amye Geier Research and Collections Center (CMC 10799). New county record (Davis and Menze 2000. Ohio Frog and Toad Atlas. Ohio Biol. Surv. Misc. Contr. No. 6).

Submitted by **JEFFREY G. DAVIS**, Cincinnati Museum Center – Fredrick and Amye Geier Research and Collections Center, 1301 Western Avenue, Cincinnati, Ohio 45203-1130, USA; e-mail: anura@fuse.net.

NANORANA CHAYUENSIS (Chayun Bull Frog). INDIA: WEST BENGAL: DARJEELING DISTRICT: Neora Valley National Park: hill stream, 3 km from Kolakham village (27.1138889°N, 88.8905556°E, 1860 m elev.). 07 August 2007. A. K. Ayyaswamy and K. Deuti. ZSIC A10683. Verified by A. Ohler. Adult female (SVL 76.12 mm) on boulders under dense bushes, ca. 2 m from hill stream. Previously known from holotype (CIB 7319524), collected from Chayu (28°25'N, 97°06'E, 1540 m elev.), Xizang Zizhiqu Dixing, China (Ye 1977. Acta Zool. Sinica 23:58, 62). Westward range extension by ca. 920 km (map distance), and new record for India. We thank the Director, Zoological Survey of India, for support, West Bengal Forest Department for permission, and Raj Bose, Help Tourism, for logistic facilities.

Submitted by **KAUSHIK DEUTI** and **ANAND KUMAR AYYASWAMY**, Zoological Survey of India, Nizam Palace Office, 234/4 A. J. C. Bose Road, Kolkata 700 020, India; e-mail: kaushikdeuti@rediffmail.com.

NASIRANA ALTICOLA (Annandale's Frog). BANGLADESH: RANGAMATI DISTRICT: Kaptai National Park (22.5°N, 92.2°E; 201–210 m elev). 13 July 2007. A. H. M. Ali Reza. Wildlife Laboratory, Department of Zoology, Jahangirnagar University, Savar, Dhaka (JU 0082). Photograph deposited at USDZ, Raffles Museum of Biodiversity Research, National University of Singapore (ZRC [IMG] 1.24). Verified by Guin Wogan. First verified locality for Rangamati District. Reported from Dhaka (ca. 200 km NE) with no voucher specimens or photograph (Dutta 1997. Amphibians of India and Sri Lanka. Odyssey Publishing House, Bhubaneswar, India. xiii + 342 + xxii pp.). Mentioned in herpetofaunal list of Bangladesh, without voucher specimens, photographs, or locality information (Khan 2004. Cobra 57:1–31). Fieldwork supported by Cleveland Metroparks Zoo and Rufford Small Grants Foundation and conducted with permission of Bangladesh Forest Department (CCF [Wildlife]/2M–47/2006). I thank Md. Kamal Hossain from JU for assistance in the field.

Submitted by **A. H. M. ALI REZA**, Department of Natural Resources Management, Texas Tech University, Lubbock, Texas

79409, USA, and Department of Zoology, Jahangirnagar University, Dhaka 1342, Bangladesh; e-mail: wild_reza@yahoo.com.

OCCIDOZYGA BOREALIS (Northern Trickle Frog). BANGLADESH: BANDARBAN DISTRICT: Bandarban Hill District (22.1666667°N, 92.2166667°E; 195–210 m elev.). 16 July 2007. A. H. M. Ali Reza. Wildlife Laboratory, Department of Zoology, Jahangirnagar University, Savar, Dhaka (JU 0088). Photograph deposited at USDZ, Raffles Museum of Biodiversity Research, National University of Singapore (ZRC [IMG] 1.23). Verified by Guin Wogan. First country record for species. Nearest population reported from Nameri National Park, Assam, > 500 km N (Pawar and Birand 2001. A Survey of Amphibians, Reptiles, and Birds in Northeast India. CERC Tech. Rep. No. 6, Centre for Ecological Research and Conservation, Mysore, India. 118 pp.). Fieldwork financed by Cleveland Metroparks Zoo and Rufford Small Grants Foundation, and was conducted with permission of Bangladesh Forest Department (CCF [Wildlife]/2M–47/2006). Thanks are due to Md. Kamal Hossain for assistance in the field.

Submitted by **A. H. M. ALI REZA**, Department of Natural Resources Management, Texas Tech University, Lubbock, Texas 79409, USA, and Department of Zoology, Jahangirnagar University, Dhaka 1342, Bangladesh; e-mail: wild_reza@yahoo.com.

PHRYNOBATRACHUS BULLANS (Bubbling Puddle Frog). ETHIOPIA: SOUTHERN NATIONS, NATIONALITIES, AND PEOPLE'S REGION: East shore of Lake Awassa (07.04845°N, 38.4609833°E), 1692 m elev. 25 June 2006. B. M. Zimkus, R. Kerney, and D. Pawlos. AAU A2008–032. KENYA: NYANZA PROVINCE: Homa Bay (0.5166667°N, 34.45°E). 14 May 2003. D. R. Buchholz, T. B. Hayes, A. Espira, K. M. Haston, and M. Kahindi. MVZ 238716. TANZANIA: MWANZA REGION: Lamadi, near Lake Victoria (02.2434167°N, 33.8522167°E), 1145 m elev. 23 May 2000. D. R. Buchholz, T. B. Hayes, A. Vonk, E. Marquez, and A. Espira. MVZ 234151. All specimens verified by D. C. Blackburn. Originally documented from central Tanzania in the Arusha, Tabora, and Singida regions (Crutsinger et al. 2004. Afr. Zool. 39[1]:19–23). These specimens represent new country records for Ethiopia and Kenya and a new province record for Tanzania, and substantially extend range by over 1600 km N from holotype locality along Great Ruaha River, Tanzania, and suggests occurrence in additional areas in Kenya and Ethiopia. Presence in northwest Tanzania, as well as southwestern Kenya, suggests its distribution may be continuous along the shores of Lake Victoria.

Submitted by **BREDA M. ZIMKUS**, Department of Organismic and Evolutionary Biology, Harvard University, 26 Oxford Street, Museum of Comparative Zoology, Cambridge, Massachusetts 02138, USA; e-mail: bzimkus@oeb.harvard.edu.

PSEUDACRIS TRISERIATA (Upland Chorus Frog). USA: TENNESSEE: MADISON CO.: Field adjacent to a creek and woodland area along Old Pinson Road (35.513291°N, 88.760154°W;WGS 84). 23 February 2006. Mandy Messer. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 18281, audio recording). New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 25 pp.). GIBSON CO.: Woodland area adjacent to Rutherford Fork of the Obion River along Cades-Atwood Road (35.978074°N, 88.772482°W; WGS 84). 08 March 2006. Mandy Messer. (APSU 18257, audio recording). New county record (Redmond and Scott 1996, *op. cit*.). CARROLL CO.: Grassland area with temporary pools along Cutlip Road (35.931891°N, 92.146490°W; WGS 84). 08 March 2006. Mandy Messer (APSU 18248, audio recording). New county record (Redmond and Scott 1996, *op. cit*.).

Submitted by **MANDY MESSER, LAURIE BENNIE,** and **BRIAN P. BUTTERFIELD,** Department of Biology, Freed-Hardeman University, Henderson, Tennessee 38340, USA (e-mail: bbutterfield@fhu.edu).

TESTUDINES – TURTLES

CHELYDRA S. SERPENTINA (Eastern Snapping Turtle). USA: OHIO: CHAMPAIGN CO.: Urbana Township: Gravel quarry ponds in the Mad River Valley 1.5 km SW of Urbana (40.09651°N, 83.78784°W). 01 June 2007. Jeffrey G. Davis. Cincinnati Museum Center, Frederick and Amye Geier Research and Collections Center (CMC HP 469–471, photo vouchers). CLARK CO.: Moorefield Township, Prairie Road Fen (39.9971833°N, 83.7092667°W). 11 April 2006. Jeffrey G. Davis. (CMC HP 252, photo voucher). Both specimens verified by John W. Ferner. New county records (Wynn and Moody 2006. Ohio Turtle, Lizard, and Snake Atlas. Ohio Biol. Surv. Misc. Contr. No. 10).

Submitted by **JEFFREY G. DAVIS**, Cincinnati Museum Center – Fredrick and Amye Geier Research and Collections Center, 1301 Western Avenue, Cincinnati, Ohio 45203-1130, USA; e-mail: anura@fuse.net.

CLEMMYS GUTTATA (Spotted Turtle). USA: GEORGIA: JEFF DAVIS CO.: Found crossing Hwy. 107 between Snipesville and Coffee County line (31.76214°N, 82.82097°W). 26 February 2008. John B. Jensen and Dirk J. Stevenson. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50086, photographic voucher). First record for county (Jensen et al. [eds.] 2008. Amphibians and Reptiles of Georgia, Univ. Georgia Press, 575 pp.).

Submitted by **JOHN B. JENSEN**, Georgia Department of Natural Resources, Nongame Conservation Section, 116 Rum Creek Drive, Forsyth, Georgia 31029, USA (e-mail: john_jensen@dnr.state.ga.us); and **DIRK J. STEVENSON**, 414 Club Drive, Hinesville, Georgia 31313, USA.

GRAPTEMYS GEOGRAPHICA (Northern Map Turtle). USA: OHIO: CLARK CO.: Springfield Township. Buck Creek below the CJ Brown Reservoir spillway (39.9502817°N, 83.7515883°W). 30 May 2006. Brian Menker. Verified by John W. Ferner. Cincinnati Museum Center (CMC Herp Photodocumentation Collection HP 254). New county record (Wynn and Moody 2006. Ohio Turtle, Lizard, and Snake Atlas. Ohio Biol. Surv. Misc. Contr. No. 10, Columbus).

Submitted by **BRIAN T. MENKER**, C.J. Brown Dam and Reservoir, 2630 Croft Road, Springfield, Ohio 45503, USA (e-mail: Brian.T.Menker@lrl02.usace.army.mil); and **JEFFREY G. DAVIS**, Cincinnati Museum Center – Fredrick and Amye Geier

Research and Collections Center, 1301 Western Avenue, Cincinnati, Ohio 45203-1130, USA (e-mail: anura@fuse.net).

GRAPTEMYS GEOGRAPHICA (Northern Map Turtle). USA: ILLINOIS: Hancock Co.: Turtle was captured in a Mississippi River side channel between Eagle Island and the Illinois bank. Aproximate Mississippi River Mile 362 (40.37840°N, 091.39471°W). 03 June 2007. James T. Lamer, Sean E. Jenkins, Brian P. Jenkins, and Samuel W. Jenkins. INHS 20749. Verified by Chris Phillips. Specimen is a first county record and located at the Illinois Natural History Survey in Champaign/Urbana, Illinois (Phillips et al. 1999. Field Guide to Amphibians and Reptiles of Illinois. Illinois Nat. Hist. Surv. Manual 8, Champaign, Illinois. xii + 282 pp.). Male turtle was captured in a Legler-style hoop net baited with Common Carp (*Cyprinus carpio*) carcasses. Turtle drowned during 24 h set. The following measurements were recorded: carapace length = 131 mm, carapace width = 95 mm, carapace height = 44 mm, plastron length = 107 mm, and mass = 236 g.

Submitted by **JAMES T. LAMER, SEAN E. JENKINS, BRIAN P. JENKINS, SAMUEL W. JENKINS,** Western Illinois University, 1 University Circle, Macomb, Illinois 61455, USA; **CHAD R. DOLAN** and **JOHN K. TUCKER,** Illinois Natural History Survey, 8450 Montclair Ave, Brighton, Illinois 62012, USA.

GRAPTEMYS PSEUDOGEOGRAPHICA (False Map Turtle). USA: ILLINOIS: Pike Co.: Turtle was dip-netted during a 300 m stretch of shoreline electro-fishing off of Denmark Island in the Mississippi River at River Mile 292 (39.54534°N, 91.13331457°W. 25 September 2006. Eric Ratcliff, Eric J. Gittinger, and Adam Carey. INHS 20222. Verified by Chris Phillips. New county record (Phillips et al. 1999. Field Guide to Amphibians and Reptiles of Illinois. Illinois Nat. Hist. Surv. Manual 8, Champaign, Illinois. xii + 282 pp.). Male turtle was not immobilized during electrofishing, but was disoriented to allow capture.

Submitted by **JAMES T. LAMER,** Western Illinois University, 1 University Circle, Macomb, Illinois 61455, USA; **JOHN K. TUCKER, CHAD R. DOLAN, ERIC RATCLIFF, ERIC J. GITTINGER,** and **ADAM CAREY**, Illinois Natural History Survey, 8450 Montclair Ave, Brighton, Illinois 62012, USA.

GRAPTEMYS PSEUDOGEOGRAPHICA (False Map Turtle). USA: ILLINOIS: Tazewell Co.: Turtle was captured in a fyke net at Lower Powerton on Illinois River; mile 151 (40.55012°N, 89.68115°W). 03 October 2006. Kevin Irons, Melissa Smith, and Nerissa Michaels. INHS 20221. Verified by Chris Phillips, Illinois Natural History Survey. New county record (Phillips et al. 1999. Field Guide to Amphibians and Reptiles of Illinois. Illinois Nat. Hist. Surv. Manual 8, Champaign, Illinois. xii + 282 pp.). Male turtle was captured in a standard fyke net set perpendicular to the shoreline, set for a duration of 24 h. This individual had a *kohni* morph head pattern. Carapace length = 90 mm.

Submitted by **JAMES T. LAMER,** Western Illinois University, 1 University Circle, Macomb, Illinois 61455, USA; **JOHN K. TUCKER, CHAD R. DOLAN,** Illinois Natural History Survey, 8450 Montclair Ave, Brighton, Illinois 62012, USA; **KEVIN IRONS, MELISSA SMITH,** and **NERISSA MICHAELS,** Illinois Natural History Survey, 704 North Shrader, Havana, Illinois 62644, USA.

GRAPTEMYS PSEUDOGEOGRAPHICA PSEUDOGEOGRAPHICA (False Map Turtle). USA: FLORIDA: Columbia Co.: O'Leno State Park, Santa Fe River, 1.2 km upstream from River Sink (29.917°N, 82.574875°W; datum WGS84). 1 October 2007. Anthony Lau and Gerald R. Johnston. UF 150678. Verified by Kenneth L. Krysko. New county record. Adult male (carapace length 131 mm, plastron length 122 mm, mass 320 g) captured in turtle hoop trap baited with canned sardines and frozen fish chum. This is the only *Graptemys* that we observed in over 400 trap nights conducted during freshwater turtle surveys in O'Leno State Park from May 2006 to November 2007. This non-native species is commonly sold in the pet trade, and given its role as an omnivore in the Mississippi River drainage (Ernst et al. 1994. Turtles of the US and Canada. Smithsonian Inst. Press, Washington. 578 pp.), the potential exists for establishment if additional releases of unwanted pets occur. This is the second record of a *G. p. pseudogeographica* in Florida (K. Krysko, pers. comm, UF 121459, Miami-Dade Co.).

Submitted by **ANTHONY LAU,** Department of Wildlife Ecology and Conservation, University of Florida, Gainesville, Florida 32611, USA (e-mail: alau0924@ufl.edu); and **GERALD R. JOHNSTON**, Department of Natural Sciences, Santa Fe Community College, Gainesville, Florida 32606, USA (e-mail: jerry.johnston@sfcc.edu).

MESOCLEMMYS PERPLEXA. BRAZIL: CEARÁ: Viçosa do Ceará (03.3655278°S; 41.1555833°W; 707 m elev.). 29 May 2007. D. Loebmann. Verified by M. Trefaut Rodrigues. Coleção de referência do Instituto Butantan, São Paulo, Brazil (CRIB 289). Previously reported only from type locality, Serra das Confusões National Park, Piauí state (09°16'S, 43°51'W) in Bour and Zaher (2005. Papeis Avulsos Zool. 45[24]:295–311). First state record extends the species distribution nearly 780 km N from the type locality.

Submitted by **DANIEL LOEBMANN**, Departamento de Zoologia, Instituto de Biociências, Universidade Estadual Paulista, Caixa Postal 199, CEP 13506-970, Rio Claro, São Paulo, Brazil; e-mail: contato@danielloebmann.com.

TERRAPENE C. CAROLINA (Eastern Box Turtle). USA: OHIO: Clark Co.: Moorefield Township. Crabill Homestead (39.9602612°N, 83.7338066°W). 21 May 2006. Brian Menker. Verified by John W. Ferner. Cincinnati Museum Center (CMC Herp Photodocumentation Collection HP 253). New county record (Wynn and Moody 2006. Ohio Turtle, Lizard, and Snake Atlas. Ohio Biol. Surv. Misc. Contr. No. 10, Columbus).

Submitted by **BRIAN T. MENKER**, C. J. Brown Dam and Reservoir, 2630 Croft Road, Springfield, Ohio 45503, USA (e-mail: Brian.T.Menker@lrl02.usace.army.mil); and **JEFFREY G. DAVIS**, Cincinnati Museum Center – Fredrick and Amye Geier Research and Collections Center, 1301 Western Avenue, Cincinnati, Ohio 45203-1130, USA (e-mail: anura@fuse.net).

TRACHEMYS SCRIPTA ELEGANS (Red-eared Slider). USA: FLORIDA: Columbia Co.: River Rise Preserve State Park, Santa

Fe River, 0.3 km downstream from River Rise (29.8716389°N, 82.5897917°W; datum WGS84). 13 June 2007. Gerald R. Johnston. UF 152605. Verified by Kenneth L. Krysko. New county record. Adult male (carapace length 160 mm, plastron length 148 mm, mass 680 g) captured by hand while snorkeling. A second specimen, UF 152604, was collected in Santa Fe River on 12 October 2007. This non-native turtle was previously observed in the Santa Fe River in 1987 (K. Enge, pers. comm.), 1991 (R. Ashton, pers. comm.), and 2006 (GRJ), but no voucher specimen was collected. Alachua County is the southernmost distribution where *T. s. scripta* naturally occurs (Thomas 2006. *In* P. A. Meylan [ed.]. Biology and Conservation of Florida Turtles. Chelonian Research Monog. 3:296–312). Morphological intermediates between native *T. s. scripta* and non-native *T. s. elegans* have been recorded from the Florida panhandle in Leon County (Aresco and Jackson 2006. Herpetol. Rev. 37:239–240), as well as the Santa Fe River (AL, YVK, and GRJ, pers. obs.), suggesting that *T. s. elegans* might be negatively affecting the existence of the native population.

Submitted by **ANTHONY LAU** (e-mail: alau0924@ufl.edu) and **YURII V. KORNILEV** (e-mail: yukornilev@gmail.com), Department of Wildlife Ecology and Conservation, University of Florida, Gainesville, Florida 32611, USA; and **GERALD R. JOHNSTON**, Department of Natural Sciences, Santa Fe Community College, Gainesville, Florida 32606, USA (e-mail: jerry.johnston@sfcc.edu).

TRACHEMYS SCRIPTA ELEGANS (Red-eared Slider). USA: ILLINOIS: Hancock Co.: 600 North County Rd. (40.17833°N, 091.46452°W) 14 May 2007. Specimen collected by James T. Lamer. INHS 20750. Verified by Chris Phillips, Illinois Natural History Survey. Specimen is a first county record and located at the Illinois Natural History Survey in Champaign/Urbana, Illinois (Phillips et al. 1999. Field Guide to Amphibians and Reptiles of Illinois. Illinois Nat. Hist. Surv. Manual 8, Champaign, Illinois. xii + 282 pp.). Turtle was found dead on road between two small drainage ditches.

Submitted by **JAMES T. LAMER,** Western Illinois University, 1 University Circle, Macomb, Illinois 61455, USA; **CHAD R. DOLAN,** and **JOHN K. TUCKER,** Illinois Natural History Survey, 8450 Montclair Ave, Brighton, Illinois 62012, USA.

TRACHEMYS SCRIPTA ELEGANS (Red-eared Slider). USA: OHIO: Clark Co.: Springfield Township. Pond at Old Reid Park (39.949005°N, 83.7551133°W). 30 May 2006. Brian Menker. Verified by John W. Ferner. Cincinnati Museum Center (CMC Herp Photodocumentation Collection HP 256). New county record (Wynn and Moody 2006. Ohio Turtle, Lizard, and Snake Atlas. Ohio Biol. Surv. Misc. Contr. No. 10, Columbus).

Submitted by **BRIAN T. MENKER**, C. J. Brown Dam and Reservoir, 2630 Croft Road, Springfield, Ohio 45503, USA (e-mail: Brian.T.Menker@lrl02.usace.army.mil); and **JEFFREY G. DAVIS**, Cincinnati Museum Center – Fredrick and Amye Geier Research and Collections Center, 1301 Western Avenue, Cincinnati, Ohio 45203-1130, USA (e-mail: anura@fuse.net).

TRACHEMYS SCRIPTA SCRIPTA (Yellow-bellied Slider). CANADA: BRITISH COLUMBIA: Vancouver Island. Victoria, Beacon Hill Park, Fountain Pond (48.4130556°N, 23.3655556°W), (RBCM Herpetology 1955). 02 July 2005. Verified by C. Copley, Royal BC Museum. A second female with dark facial markings identified in Beacon Hill Park, Goodacre Lake (48.415°N, 123.3641667°W), 13August 2005. A smaller third specimen with bright facial markings found in Goodacre Lake (48.415°N, 123.3641667°W), 22 April 2006. This is a first record of *T. scripta scripta* in British Columbia (Matsuda et al. 2006. Amphibians and Reptiles of British Columbia. Royal BC Museum Handbook. Victoria, British Columbia. 266 pp.). Range extension of over 3245 km northwest of Alabama (western-most state with native *T. s. scripta*), and 2220 km northwest of the western-most native range of *T. s. elegans* (range extension estimated Ernst 1990. *In* Gibbons [ed.], Life History and Ecology of the Slider Turtle, pp. 57–67. Smithsonian Institution Press, Washington, DC).

Submitted by **GAVIN F. HANKE**, Royal British Columbia Museum, 675 Belleville Street, Victoria, British Columbia, V8W 9W2 Canada; e-mail: ghanke@royalbcmuseum.bc.ca.

SQUAMATA – LIZARDS

AMPHISBAENA MENSAE (Cobra-de-duas-cabeças; Worm Lizard). BRAZIL: MATO GROSSO: Municipality of Rondonópolis (16.4713056°S, 54.6371111°W, elev. ca. 304 m). 02 July 2007. E. Silva de Brito and R. A. Kawashita-Ribeiro. Verified by M. A. de Carvalho. Coleção Zoológica de Vertebrados da Universidade Federal do Mato Grosso, Cuiabá, Brazil (UFMT 6303–6309). Previously known from Brazil in Goiás State, municipality of Minaçú, Serra da Mesa, 14.0333333°S, 48.3166667°W (Castro-Mello 2000. Pap. Avul. Zool. 41[16]:243–246, type locality) and Distrito Federal, Brasilia (16.0°S, 47.9333333°W), nearly 250 km S of type locality (Campos-Nogueira 2001. Herpetol. Rev. 32:285–287). First state record, extends the known distribution about 730 km W from the type locality.

Submitted by **TAMI MOTT,** Departamento de Zoologia, Instituto de Biociências, Universidade Federal de Mato Grosso, Av. Fernando Corrêa da Costa, s/n, Bairro Coxipó, 78060-900, Cuiabá, MT, Brazil (e-mail: tamimott@yahoo.com); **ELIZANGELA SILVA DE BRITO,** Programa de Pós-Graduação em Ecologia e Conservação da Biodiversidade, Universidade Federal de Mato Grosso, Av. Fernando Corrêa da Costa, s/n, Bairro Coxipó, 78060-900, Cuiabá, MT, Brazil (e-mail: elizlinz@hotmail.com); and **RICARDO ALEXANDRE KAWASHITA-RIBEIRO,** Coleção Zoológica de Vertebrados, Universidade Federal de Mato Grosso, Av. Fernando Corrêa da Costa, s/n, Bairro Coxipó, 78060-900, Cuiabá, MT, Brazil (e-mail: serpentesbr@gmail.com).

ANOLIS (= NOROPS) SAGREI (Brown Anole). USA: GEORGIA: Charlton Co.: St Mary's River boat ramp along Georgia Highway 94. 09 March 2008. Giff Beaton. Georgia Museum of Natural History (GMNH 50087). Verified by John B. Jensen. First county record for this exotic anole (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press. 575 pp.). The individual was observed and photographed as it foraged along a rocky rip-rap.

Submitted by **GIFF BEATON**, 320 Willow Glen Drive, Marietta, Georgia 30068, USA; e-mail: giffbeaton@mindspring.com.

BRONCHOCELA VIETNAMENSIS (Vietnam Long-tailed Agama). VIETNAM: DONG NAI: Cat Tien (11.35°–11.8°N, 107.1666667°–107.5666667°E). 19 May 2001. Paul Moler. IEBR 657. Verified by Jakob Hallermann. Adult male, SVL 86.0 mm, TL 316 mm, Previously known from Gia Lai and Phu Yen provinces (Hallermann 2005. Russian J. Herpetol. 12[3]:176; Ananjeva et al. 2007. Mitt. Mus. Naturk. Berl., Zool. Reihe 83, Suppl.:17). Third and most southward record from Vietnam , and ca. 250 km from type locality in Gia Lai Province .

Submitted by **NGUYEN QUANG TRUONG**, Institute of Ecology and Biological Resources, 18 Hoang Quoc Viet, Hanoi, Vietnam; current address: Zoologisches Forschungsmuseum Alexander Koenig, Adenauerallee 160, D-53113 Bonn, Germany (e-mail: nqt2@yahoo.com); and **WOLFGANG BÖHME**, Zoologisches Forschungsmuseum Alexander Koenig, Adenauerallee 160, D-53113 Bonn, Germany (e-mail: w.boehme.zfmk@uni-bonn.de).

GEHYRA LACERATA (Kanchanaburi Four-clawed Gecko). THAILAND: KHON KHAEN PROVINCE: Ban Fang District, Hin Chang See. June 2004. K. Kunya. Institut Royal des Sciences Naturelles de Belgique, Brussels (IRSNB 17032). Verified by G. L. Lenglet (IRSNB). This adult male specimen (58.6 mm SVL, single series of 17 precloacal pores) and others found active at ca. 2200 h on rocks and on ground on limestone hill. Locally abundant and was found in syntopy with *Gehyra mutilata* (IRSNB 17031). First provincial record, and known from Chonburi, Kanchanaburi, Khon Kaen, Nakhon Ratchasima, Phetchaburi, and Sakaeo provinces, Thailand (Brown 1999. Copeia 1999[4]:990–1001; Chuaynkern 2004. Advanced Thailand Geographic 9[3]:42 [in Thai]; Nabhitabhata and Chan-ard 2005. Thailand Red Data: Mammals, Reptiles and Amphibians. Office of Natural Resources and Environmental Policy and Planning, Bangkok. 234 pp.; Nabhitabhata et al. "2000" 2004. Checklist of Amphibians and Reptiles in Thailand. Office of Environmental Policy and Planning, Bangkok. 152 pp.). *Gehyra lacerata* has previously been recorded from Thành Phô Hô Chí Minh, Vietnam (Szczerbak and Nekrasova 1994. Vestn. Zool. 1994:48–52; Bobrov 1995. Smithson. Herpetol. Inform. Serv. 105:1–28), but has not been included in the most recent checklist (Nguyen et al. 2005. Danh luc êch nhái và bò sát Viêt Nam. A Checklist of Amphibians and Reptiles of Vietnam. Nhà Xuât ban Nông Nghiêp, Hà Nôi. 180 pp. [in Vietnamese]) and its occurrence outside Thailand needs confirmation. We thank Yodchaiy Chuaynkern (National Science Museum, Pathumthani) for providing literature.

Submitted by **OLIVIER S. G. PAUWELS**, Département des Vertébrés Récents, Institut Royal des Sciences naturelles de Belgique, Rue Vautier 29, 1000 Brussels, Belgium (e-mail: osgpauwels@yahoo.fr); **KIRATI KUNYA**, Korat Zoo, Muang District, Nakhon Ratchasima, Thailand (e-mail: kkunya2006@yahoo.com); and **AARON M. BAUER**, Department of Biology, Villanova University, 800 Lancaster Avenue, Villanova, Pennsylvania 19085, USA (e-mail: aaron.bauer@villanova.edu).

HEMIDACTYLUS TURCICUS (Mediterranean House Gecko). USA: SOUTH DAKOTA: FALL RIVER CO.: Turkey Track Rd., 4.8 km W Hot Springs (43.426°N; 103.5370333°W). 01 September 2005. Steven G. Platt. Verified by Lars Bryan Williams. Campbell Museum, Clemson University (CUSC 2326). Found among debris in heated outbuilding. First record for South Dakota (Ballinger et al. 2000. Trans. Nebraska Acad. Sci. 26:29–46). Nearest documented populations in Utah and Nevada (Reed et al. 2006. Herpetol. Rev. 37:106).

Submitted by **STEVEN G. PLATT,** Department of Biology, P.O. Box C-64, Sul Ross State University, Alpine, Texas 79832, USA; **THOMAS R. RAINWATER**, The Institute of Environmental and Human Health, Department of Environmental Toxicology, P.O. Box 764, Jefferson, Texas 75657, USA; and **STANLEE MILLER**, Department of Biological Sciences, 132 Long Hall, Clemson University, Clemson, South Carolina, 29634-1903, USA (e-mail: amblyommavt@gmail.com).

KENTROPYX CALCARATA. BRAZIL, RIO GRANDE DO NORTE, Municipality of Parnamirim, Mata do Jiqui (05.9166667°S, 35.1833333°W). 03 February 2006. Pablo A. G. Sousa. Verified by Miguel T. U. Rodrigues. Coleção Herpetológica do Departamento de Botânica, Ecologia e Zoologia, Universidade Federal do Rio Grande do Norte, Natal. Rio Grande do Norte (CHBEZ 1316, 1487, 1488, 1566). The species was known from Venezuela to Maranhão State in Brazil. In the coastal areas of Brazil, it occurs from 19°S in Espírito Santo State to the Ambiental Preservation Area of Mamanguape in the Paraíba State and the Serra de Baturité, an isolated forested mountain range in the semiarid Caatingas in Ceará State. The Rio Grande do Norte State constitutes a gap between those two localities (Ávila-Pires 1995. Zool. Verh. Leid. 299:1–706; Gallagher and Dixon 1992. Boll. Mus. reg. Sci. nat. Hist. 10[1]:125–171; Vanzolini 1988. Proc. Work. Neotropical Distribution Patterns, pp. 317–342; Borges-Nojosa and Caramaschi 2003. Ecol. Cons. Caat. v. 01, pp. 489–540). First state record, extends the range 450 km E and 225 km N from the areas of Ceará and Paraíba states, respectively, and fills the gap in the distribution of the species.

Submitted by **PABLO A. G. SOUSA** and **ELIZA M. X. FREIRE**, Laboratório de Herpetologia. Departamento de Botânica, Ecologia e Zoologia, Centro de Biociências, Universidade Federal do Rio grande do Norte, Campus Universitário, Lagoa Nova, CEP 59072-970, Natal, Rio Grande do Norte, Brazil.

LEIOLEPIS TRIPLOIDA (Malaysian Butterfly Lizard). MALAYSIA: KEDAH: Kampung Wang Perah (6.3645333°N, 100.46005°E). 26 October 2008. M. S. Shahrul Anuar. La Sierra University Herpetological Collection (LSUHC 8734). Kuala Nerang (18.9 km SW of Kampung Wang Perah). 10 March 1930 and 15 March 1930. G. Hope Sworder. Raffles Museum of Biodiversity Research, National University of Singapore, Zoological Reference Collection (ZRC 2.961 and ZRC 2.962–63, respectively). Pokok Sena (22.2 km S of Kampung Wang Perah). 16 February 1930. G. Hope Sworder. ZRC 2.964. PENANG: Mengkuang Dam (5.3897833°N, 100.5025833°E). 25 October 2008. M. A. Muin. LSUHC 8715. All specimens verified by J. L. Grismer. Type locality given as "Malayisch-thailändisches Grenzgebiet auf der Malayischen Halbinsel" (= Malaysia-Thailand border of the Malay Peninsula; Peters 1970. Zool. Jb. Syst. Bd. 98:11–130), which could conceivably mean any place along the ca. 400 km border. A locality was subsequently illustrated on distribution maps (Darevsky and Kupriyanova 1993. Herpetozoa

6:3–20; Aranyavalai et al. 2004. Nat. Hist. J. Chulalongkorn Univ. 4:15–19), showing it to be near the Thai border in northern Kedah, Malaysia at the town of Baling (5.6752333°N, 100.9170167°N). We visited Baling on 26 October 2008 but residents indicated this species was not present and directed us to Kampung Bandar (5.7500333°N, 100.8808333°E), 9.2 km to the NW, where we found five specimens (LSUHC 8710–14). In reference to Kampung Bandar, the presence of this species at Kuala Nerang, 68 km to the NNW; at Kampung Wang Perah, 84 km to the NW; and at Pokok Sena, 68 km to the WNW, extends the distribution of this species along the Malaysia-Thailand border to the northwest. Its presence at the Mengkuak Dam in Seberang Perai, 57.8 km to the SW extends its distribution towards the west coast. These widely distributed localities suggest *L. triploida* ranges throughout most of Kedah, rather than being restricted to the border of Malaysia and Thailand.

Submitted by **L. LEE GRISMER,** Department of Biology, La Sierra University, 4700 Riverwalk Parkway, Riverside, California 92515, USA (e-mail: lgrismer@lasierra.edu); **M. S. SHAHRUL ANUAR,** School of Biological Sciences, Universiti Sains Malaysia, 11800 Penang, Malaysia; **PERRY L. WOOD, JR.,** Department of Biology, Villanova University, 800 Lancaster Ave, Villanova, Pennsylvania 19085, USA; **M. A. MUIN,** School of Biological Sciences, Universiti Sains Malaysia, 11800 Penang, Malaysia; and **N. NUROLHUDA**, World Wildlife Fund for Nature Malaysia, No. 49, Jalan SS23/15, Taman SEA, 47301, Petaling Jaya, Selangor, Malaysia.

LIOLAEMUS JOSEI (NCN). ARGENTINA: LA PAMPA PROVINCE: Chical Co Departament: Provincial road 14, 54 km W junction Nacional Road 151 (36.708833°S, 67.950111°W; datum: WGS84, elev. 802 m). 30 November 2001. N. Frutos, C. H. F.Perez and L. J. Avila (LJAMM 4229). Verified by N. Basso. Previously known from Agua del Toro, Salinillas, Puente El Zampal and 15 km N Matancilla; all localities from Malargüe departament, Mendoza province (Abdala 2005. Cuad. Herpetol. 19[1]:3–33). First province record and easternmost distributional record for the species extending 70 km E from the nearest vouchered locality in eastern Mendoza Province.

Submitted by **NICOLAS FRUTOS,** CENPAT-CONICET, Boulevard Almirante Brown 2825, U9120ACV, Puerto Madryn, Chubut, Argentina (e-mail: frutos@cenpat.edu.ar); **CRISTIAN HERNÁN FULVIO PEREZ** (e-mail: liolaemu@criba.edu.ar); and **LUCIANO JAVIER AVILA,** CENPAT-CONICET, Boulevard Almirante Brown 2825, U9120ACV, Puerto Madryn, Chubut, Argentina (e-mail: avila@cenpat.edu.ar).

LIPINIA VITTIGERA (Striped Tree Skink). CAMBODIA: SIEM REAP PROVINCE: Preah Khan Temple (13.4619444°N, 103.8722222°E), Angkor. 30 August 2004. S. Mahony. Actively foraging when found at 1300 h, ca. 1.5 m up on tree trunk within a moderately disturbed forest patch at rear of temple. Specimen not collected; digital voucher deposited at USDZ, Raffles Museum of Biodiversity Research, National University of Singapore (ZRC [IMG].2.71). Verified by Bryan L. Stuart. First record for northwestern Cambodia. Nearest recorded locality in Cambodia is >100 km S, from Phnom Aural (12°01'N, 104°08'E), Phnom Aural Wildlife Sanctuary in the eastern Cardamom Mountains (Grismer et al. 2007. Hamadryad 31:216–241).

Submitted by **STEPHEN MAHONY**, Madras Crocodile Bank Trust, Post Bag 4, Mamallapuram, Tamil Nadu 603 104, India; e-mail: stephenmahony2@gmail.com.

PLESTIODON FASCIATUS (Common Five-lined Skink). USA: ILLINOIS: Wayne Co.: Fairfield Reservoir (38.3738889°N, 8.2369444°W). 31 July 2007. Michael A. Steffen. Verified by Ronald A. Brandon. Color photo voucher SIUC R-03449. New county record (Phillips et al. 1999. Field Guide to Amphibians and Reptiles of Illinois. Illinois Nat. Hist. Surv. Manual 8, Champaign, Illinois. xii + 282 pp.).

Submitted by **MICHAEL A. STEFFEN**, Department of Zoology, Southern Illinois University, Carbondale, Illinois 62901, USA; e-mail: bass2187@siu.edu.

PLESTIODON LATICEPS (Broad-headed Skink). USA: OHIO: Ross Co.: Scioto Township. Earl G. Barnhart Nature Preserve (39.34805°N, 83.0571667°W). 15 Sept. 2007. Greg Gentry and William J. Letsche. Verified by Jeffrey G. Davis. Cincinnati Museum Center (CMC 11,000). New county record (Wynn and Moody 2006. Ohio Turtle, Lizard and Snake Atlas. Ohio Biol. Surv. Misc. Contr. No. 10, Columbus).

Submitted by **WILLIAM J. LETSCHE**, 168 Crouse-Chapel Rd., Chillicothe, Ohio 45601, USA; e-mail: salamanderhunter71@yahoo.com.

PTYCTOLAEMUS GULARIS (Green Fan-throated Lizard). BANGLADESH: Moulvibazar District: Lawachara National Park (24.3166667°N, 91.7833333°E; 144–150 m elev.). 27 June 2007. A. H. M. Ali Reza. Wildlife Laboratory, Department of Zoology, Jahangirnagar University, Savar, Dhaka (JU 0056). Photograph deposited at USDZ, Raffles Museum of Biodiversity Research, National University of Singapore (ZRC [IMG].2.69). Verifed by Aaron M. Bauer. First country record for genus and species. Nearest population reported from Barail Reserved Forest of Assam, northeast India, > 100 km E (Pawar and Birand 2001. A Survey of Amphibians, Reptiles, and Birds in Northeast India. CERC Tech. Rep. No. 6, Centre for Ecological Research and Conservation, Mysore, India. 118 pp.). Fieldwork financed by Cleveland Metroparks Zoo and Rufford Small Grants Foundation, with permission from Bangladesh Forest Department (CCF [Wildlife]/ 2M–47/2006). Thanks are due to Md. Kamal Hossain and DM Kamruzzaman for assistance in the field.

Submitted by **A. H. M. ALI REZA**, Department of Natural Resources Management, Texas Tech University, Lubbock, Texas 79409, USA, and Department of Zoology, Jahangirnagar University, Dhaka 1342, Bangladesh; e-mail: wild_reza@yahoo.com.

SAUROMALUS ATER (Common Chuckwalla). MÉXICO: SONORA: Isla Pájaros (27.88798°N, 110.84722°W; NAD 27), 10 m elev. 10 July 2007. J. Ventura-Trejo. Verified by J. Angel Soto-Centeno. SDNHM-HerpPC 5204. First record for Isla Pájaros, which lies 6 km SW of Guaymas, Sonora, where the southernmost mainland populations of the species occur (Hollingsworth 1998. Herpetol. Monog. 12:38–191).

Submitted by **JESUS VENTURA-TREJO**, Protección de Flora y Fauna de las Islas el Golfo de California SEMARNAT-CONANP

Oficina Regional Guaymas, Guaymas, Sonora, México (e-mail: jventurat@yahoo.com.mx); **JORGE H. VALDEZ-VILLAVICENCIO**, Grupo de Ecología y Conservación de Islas, A.C. Ave. López Mateos 1590-3 Fracc. Playa Ensenada, Ensenada, Baja California, México, C.P. 22880 (e-mail: jorge.valdez@conservaciondeislas.org); and **BRADFORD D. HOLLINGSWORTH**, Department of Herpetology, San Diego Natural History Museum, P.O. Box 121390, San Diego, California 92112-1390, USA (e-mail: bhollingsworth@sdnhm.org).

STENOCERCUS ROSEIVENTRIS (NCN). BRAZIL: RONDONIA: Municipality of Vilhena (12.7°S, 60.25°W). 24 October 2007. A. Pansonato and E. Silva de Brito. Verified by C. Strüssmann. Coleção Zoológica de Vertebrados of the Universidade Federal de Mato Grosso, Mato Grosso, Brazil (UFMT 6269). The species was known from western Amazon basin and eastern slopes of the central and southern Andes, in Peru, Brazil, Bolivia, and Argentina (Torres-Carvajal 2007. Herpetol. Monog. 21:76–178). Reported from Brazil from the state of Acre, by Etheridge (1970. *In* Peters and Orejas Miranda [eds.], Catalogue of the Neotropical Squamata. Bull. U.S. Nat. Mus. 297:254–258) (unvouchered), and Torres-Carvajal (2005. Phyllomedusa 4[2]:123–132). First state record and easternmost locality for the species, extends known distribution 1027 km southeast of Purus River (Torres-Carvajal, *op. cit.*).

Submitted by **ANDRÉ PANSONATO** (e-mail: andrepan@hotmail.com), **ELIZÂNGELA SILVA BRITO** (e-mail: esbbr@yahoo.com.br), and **DRÁUSIO HONÓRIO MORAIS**, Instituto de Biociências, Universidade Federal de Mato Grosso, Av. Fernando Corrêa da Costa, 780760-900 Cuiabá, Mato Grosso, Brazil (e-mail: amblyommavt@gmail.com).

SQUAMATA – SNAKES

COLUBER (=MASTICOPHIS) TAENIATUS (Striped Whipsnake). MÉXICO: AGUASCALIENTES: Municipality of Tepezalá: Western side of Cerro Altamira, 2 km airline E from the town Tepezalá (22.234032°N, 102.139619°W; NAD 27), 2299 m elev. 31 July 2004. Jorge Ivan Sigala-Rodríguez. Museo de Zoología, Departamento de Biología, Universidad Autónoma de Aguascalientes (UAA-VR-00317). Municipality of El Llano: 5 km airline E from El Llano (21.92441667°N, 101.93025°W; NAD 27), 2120 m. elev. 22 September 2005. Rarámuri Reyes Ardit. UAA-VR-00318. Municipality of Asientos: 2 km N vicinity of Las Adjuntas, Asientos (22.055990°N, 101.922762°W; NAD 27), 2044 m elev. 06 June 2006. Gustavo E. Quintero-Díaz and Joel Vázquez-Díaz. UAA-VR-00319. All verified by Jeffrey D. Camper. First records for Aguascalientes, and fills the approximate 300 km distributional gap between the closest previous records at 13.1 km ESE of Tepetatillo, Jalisco (CAS 165260) and two specimens (FMNH 106181; CAS 165223) from north of Ciudad Zacatecas, Zacatecas (Camper and Dixon 1994. Ann. Carnegie Mus. 63:1–48). All snakes were found on rocky hillsides covered with lower montane dry forest vegetation, as classified by Campbell (1999. *In* W. E. Duellman [ed.], Patterns of Distribution of Amphibians: A Global Perspective, pp. 111–210. John Hopkins Univ. Press, Baltimore, Maryland).

Submitted by **J. JESÚS SIGALA-RODRÍGUEZ**, Department of Ecology and Evolutionary Biology, Corson Hall, Cornell University, Ithaca, New York 14853-2701, USA (e-mail: js324@cornell.edu); **JOEL VÁZQUEZ-DÍAZ,** Departamento de Investigación y Desarrollo Tecnológico, Internacional de Relojes, Arte y Diseño S. A. de C. V., Ave. Aguascalientes Sur 203, Fracc. Prados del Sur, Aguascalientes 20280, México; and **GUSTAVO E. QUINTERO-DÍAZ, JORGE IVAN SIGALA-RODRÍGUEZ,** and **RARAMURI REYES ARDIT,** Universidad Autónoma de Aguascalientes, Centro de Ciencias Básicas, Departamento de Biología, Ave. Universidad 940, Aguascalientes, 20100, México.

CROTALUS ATROX (Western Diamondback Rattlesnake). USA: TEXAS: Caldwell Co.: Plumb Creek Farm off Farm Road 672, 3 miles NE of Lockhart (29.8983833°N, 97.6494667°W). 01 February 2006. Verified by J. R. Dixon, Texas A&M University, Texas Cooperative Wildlife Collection. TCWC 90669. New county record (Dixon 2000. Amphibians and Reptiles of Texas. Texas A&M University Press, College Station, Texas. 148 pp.). A total of 3 adult females, 1 adult male, and 1 juvenile female *Crotalus atrox* were collected from an old farm shed under a wood pile. These are the first reported specimens from within Caldwell County. Each individual was measured, weighed, and had a blood sample (MF-19885,19914–19917) and digital photo taken. The specimens ranged in size from SVL length of 38–96 cm and tail length of 22–71 mm. One individual was retained as a specimen voucher and preserved and accessioned into the Texas Cooperative Wildlife Collection (TCWC 90669).

Submitted by **MELISSA JONES, JEFF TROY,** and **M.R.J. FORSTNER**, Department of Biology, Texas State University at San Marcos, San Marcos, Texas 78666, USA; e-mail: mj46953@txstate.edu.

CROTALUS PUSILLUS (Tancitaran Dusky Rattlesnake). MÉXICO: JALISCO: Municipality Quitupan: 24.5 km (by road) S of Valle de Juarez (19.42630°N, 102.57527°W, WGS 84), 2288 m elev. 06 August 2007. Chris I. Grünwald and Jason M. Jones. Verified by Robert W. Bryson, Jr. UTA Digital Collection 1087. Fills a distributional gap of ca. 160 km between Nevado de Colima (14.4 km W of Atenquique, Jalisco) and Carapan, Michoacán (Campbell and Lamar 2004. The Venomous Reptiles of the Western Hemisphere, Vol. II. Comstock Pub. Assoc., Ithaca, New York, xiv + 477–870 pp.). The snake was found AOR at night in an area of humid pine-oak forest.

Submitted by **JACOBO REYES-VELASCO**, Centro Universitario de Ciencias Biológicas y Agropecuarias, Carretera a Nogales Km. 15.5. Las Agujas, Nextipac, Zapopan, Jalisco, México (e-mail: jackobz@gmail.com); **CHRISTOPH I. GRÜNWALD**, 450 Jolina Way, Encinitas, California 92024, USA (e-mail: cgruenwald@switaki.com); and **JASON M. JONES**, 16310 Avenida Florencia, Poway, California 92064, USA (e-mail: jjones@switaki.com).

DIADOPHIS PUNCTATUS (Ring-necked Snake). USA: MISSOURI: Perry Co.: limestone bluffs along Apple Creek near PCR 614, Biehle (37.631861°N, 89.866167°W; WGS84). 01 October 2006. Richard L. Essner, Jr. Verified by Paul E. Brunkow, Southern Illinois University Edwardsville (SIUE 2948). New county

record. First report from Perry County (Daniel and Edmond 2008. Atlas of Missouri Reptiles and Amphibians for 2007).

Submitted by **RICHARD L. ESSNER, JR.** (e-mail: ressner@siue.edu) and **RALPH W. AXTELL,** Department of Biological Sciences, Southern Illinois University Edwardsville, Illinois, 62026, USA (e-mail: raxtell@siue.edu)**.**

DIPSAS GAIGEAE (Gaige's Thirst Snake). MÉXICO: MICHOACÁN: Municipality of Aquila: 2.5 km N Maruata, on road to Pomaro (18.174679°N, 103.204734°W; WGS 84), 32 m elev. UTA Digital Collection 1084. 0.8 km E Maruata, on Hwy 200 (18.162361°N, 103.202725°W; WGS 84), 17 m. elev. UTA Digital Collection 1083. 15 August 2005. Daniel Grubb and Jason M. Jones. Verified by Jonathan A. Campbell. First records for the state and a range extension of ca. 60 km S from previously known records in southern Colima (Kofron 1982. J. Herpetol. 16:270–286). The snakes were AOR at night in tropical deciduous forest.

Submitted by **JACOBO REYES-VELASCO**, Centro Universitario de Ciencias Biológicas y Agropecuarias, Carretera a Nogales Km. 15.5. Las Agujas, Nextipac, Zapopan, Jalisco, México (e-mail: jackobz@gmail.com); **CHRISTOPH I. GRÜNWALD,** 450 Jolina Way, Encinitas, California 92024, USA (e-mail: cgruenwald@switaki.com); and **JASON M. JONES,** 16310 Avenida Florencia, Poway, California 92064, USA (e-mail: jjones@switaki.com).

ECHINANTHERA AFFINIS (Günther's Forest Snake). BRAZIL: CEARÁ: Ubajara (03.8404722°S, 40.9076389°W; 896 m elev.). 02 Jul 2007. D. Loebmann. Ubajara (03.8475278°S, 40.8890833°W; 884 m elev.). 05 Sep 2007. H. Klein. Coleção Instituto Butantan, São Paulo, Brazil (IBSP 76363–76364). Verified by M. Trefaut Rodrigues. The species was known from the states of Rio Grande do Sul, Santa Catarina, Paraná, São Paulo, Rio de Janeiro, Minas Gerais, Espírito Santo, and Bahia (Di-Bernardo and De Lema 1988. Acta Biol. Leopol. 10[2]:223–252; Argôlo 1998. Herpetol. Rev. 29:176). These new records represent an isolated population in the rain forests of Ibiapaba's plateau and also are the first records for Ceará state. Extends distribution ca. 1230 km N from Vitória da Conquista, Bahia state, Brazil (Argôlo, *op. cit*.).

Submitted by **DANIEL LOEBMANN**, Departamento de Zoologia, Instituto de Biociências, Universidade Estadual Paulista, Caixa Postal 199, CEP 13506-970, Rio Claro, São Paulo, Brazil; e-mail: contato@danielloebmann.com.

LAMPROPELTIS CALLIGASTER OCCIPITOLINEATA (South Florida Mole Kingsnake). USA: FLORIDA: Charlotte Co.: 4.4 km NE of intersection of Graham Road and County Road 74 (26.9711389°N, 81.6781667°W). 07 March 2008. Robert A. O'Horo. Adult male (825 mm SVL) collected alive on an unpaved road at 1215 h in an area of dry prairie habitat surrounded by agricultural fields. Verified by Kenneth L. Krysko. Florida Museum of Natural History photo voucher (UF 152523). New county record. Extends range ca. 22 km SE of the nearest record from DeSoto Co. (UF 152370). Vouchers of this subspecies also exist from Brevard and Okeechobee counties (Layne et al. 1986. Florida Sci. 49:171–175), and we have reports unsupported by vouchers from nearby Glades, Indian River, and Osceola counties. A purported specimen (UMMZ 77481) collected from Leesburg, Lake Co. (Layne et al., *op. cit*.), was a misidentified *Pantherophis guttatus* (G. Schneider, pers. comm.).

Submitted by **ROBERT A. O'HORO**, Florida Fish and Wildlife Conservation Commission, 2423 Edwards Drive, Ft. Myers, Florida 33901, USA (e-mail: robert.ohoro@myfwc.com); and **KEVIN M. ENGE**, Florida Fish and Wildlife Conservation Commission, 1105 S.W. Williston Road, Gainesville, Florida 32601, USA (e-mail: kevin.enge@myfwc.com).

LAMPROPELTIS TRIANGULUM ARCIFERA (Jalisco Milksnake). MÉXICO: MÉXICO: Municipality of Tejupilco, (18.51314°N, 100.25347°W; NAD27 México), 1800 m elev. 14 April 2001. Octavio Vilchis. Verified by Óscar Sánchez. IBH 15741. First record for Tejupilco and a 49.5 km range extension W from the closest known locality at Sultepequito, México (Casas and Aguilar 1998. Biol. Soc. Herpetol. Mex. 8:22–24). The record also fills the distributional gap on the southcentral portion of the Mexican Plateau that was depicted by Williams (1988. Systematics and Natural History of the American Milk Snake, *Lampropeltis triangulum.* 2nd revised ed. Milwaukee Pub. Mus., Milwaukee, 176 pp.). The snake was found in pine-oak forest (*Quercus elliptica* and *Pinus oocarpa*).

Submitted by **FELIPE RODRÍGUEZ-ROMERO, OCTAVIO MONROY-VILCHIS,** and **OSWALDO HERNÁNDEZ-GALLEGOS,** Facultad de Ciencias, Centro de Investigación en Recursos Bióticos–CIRB, Universidad Autónoma del Estado de México, Instituto Literario # 100, 50000, Toluca, Estado de México, México (e-mail: fjrr@uaemex.mx).

LAMPROPELTIS TRIANGULUM SYSPILA (Red Milksnake). USA: ARKANSAS: Pulaski Co.: 34.791535°N, 92.487877°W; WGS84, 195 m elev. 29 March 2007. UALR HPC 0001. 34.475527°N, 92.342141°W, WGS84, 165 m elev. 03 April 2007. UALR HPC 0002. Verified by M. V. Plummer. New county records (Trauth et al. 2004. Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville, Arkansas. 421 pp.).

Allocation to *L. t. syspila* based upon features of distinctive coloration and markings (Conant and Collins 1998. A Field Guide to Reptiles and Amphibians of Eastern and Central North America. 3rd ed. Houghton Mifflin Co., Boston, Massachusetts. 616 pp.). UALR HPC 0001 was captured under a piece of discarded carpet within a utility right-of-way adjacent to a mixed hardwood woodlot. It is currently housed as a live specimen within the University of Arkansas at Little Rock Biology Department and will be preserved as an alcohol specimen upon its death. The adjacent area from which UALR HPC 0001 was captured is currently undergoing development as a gated housing community. Urban sprawl in Little Rock might pose a threat to the habitat for *L.t. syspila* at this particular locality.

UALR HPC 0002 was captured at a private residence within a mixed hardwood forest and was photographed and released at the capture site. An additional individual was sighted 15 August 2007 at the same location as UALR HPC 0002.

Submitted by **DARRELL R. HEATH**, **DAVID W. CLARK,** and **KRYSTIAN A. SAMEK**, Department of Biology, University of Arkansas at Little Rock, Little Rock, Arkansas 72204, USA (e-mail: drheath@ualr.edu).

MICRURUS TENER (Texas Coralsnake). MÉXICO: HIDALGO: Municipality of Metztitlán, San Pablo Tetlapayac, Reserva de la Biosfera Barranca de Metztitlán (20.38311°N, 98.55400°W; WGS849), 993 m elev. 23 March 2007. V. D. Vite-Silva and U. Hernández-Salina. Verified by Adrian Leyte-Manrique. Herpetology collection, Laboratorio Ecología de Poblaciones, Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo (VDVS-UAEH-0042). First record for the municipality and a range extension of 51 km S of record in the Municipality of Tlanchinol (Mendoza-Quijano et al. 2006. Publicación Especial de la Sociedad Herpetológica Mexicana [3]:99–109). The snake was found in tropical dry forest. Fieldwork was funded by SEP-PROMEP-1103.5/03/1130, Projects PIFI-PROMEP 3.3. 2007, CONACYT-S 52552-Q, and CONACYT-43761.

Submitted by **URIEL HERNÁNDEZ SALINAS** (e-mail: hu128613@uaeh.reduaeh.mx), **VICTOR D. VITE-SILVA** (e-mail: dark_land121@hotmail.com), and **AURELIO RAMÍREZ BAUTISTA**, Centro de Investigaciones Biológicas (CIB), Universidad Autónoma del Estado de Hidalgo, A.P. 1-69 Plaza Juárez, C.P. 42001, Pachuca, Hidalgo, México (e-mail: aurelior@edu.uaeh.mx).

NERODIA ERYTHROGASTER (Plain-bellied Watersnake). USA: ILLINOIS: Henderson Co.: Snake was captured as it basked on riprap stone embankment alongside lake at Crystal Lake Gun Club, Gulfport, Illinois (40.83540°N, 091.06121°W). 08 June 2007. James T. Lamer and Sean E. Jenkins. Illinois Natural History Survey in Champaign/Urbana, Illinois (INHS 20745). Verified by Chris Phillips. First county record (Phillips et al. 1999. Field Guide to Amphibians and Reptiles of Illinois. Illinois Nat. Hist. Surv. Manual 8, Champaign, Illinois. xii + 282 pp.)

Submitted by **JAMES T. LAMER, SEAN E. JENKINS,** Western Illinois University, 1 University Circle, Macomb, Illinois 61455, USA; **JOHN K. TUCKER** and **CHAD R. DOLAN,** Illinois Natural History Survey, 8450 Montclair Ave, Brighton, Illinois 62012, USA.

NERODIA ERYTHROGASTER ERYTHROGASTER (Red-bellied Watersnake). USA: VIRGINIA: Henrico Co.: 11.4 km ESE Sandston, Whiteoak Swamp Creek (37.4683333°N, 77.2086111°W). 10 August 2004. H. Lacy. Verified by William M. Palmer. North Carolina State Museum of Natural Sciences (NCSM 73872). New county record. Extends range ca. 59 km NNE and ca. 68 km WNW of nearest records in Sussex and York counties, respectively (Mitchell 1994. The Reptiles of Virginia. Smithsonian Institution Press, Washington, DC. xv + 352 pp.).

Submitted by **JEFFREY C. BEANE**, North Carolina State Museum of Natural Sciences, Research Laboratory, 4301 Reedy Creek Road, Raleigh, North Carolina 27607, USA (e-mail: jeff.beane@ncmail.net); and **THOMAS J. THORP**, Three Lakes Nature Center and Aquarium, 400 Sausiluta Drive, Richmond, Virginia 23227, USA (e-mail: tho56@co.henrico.va.us).

OPHEODRYS VERNALIS (Smooth Greensnake). USA: ILLINOIS: DeKalb Co.: Kishwaukee River State Fish and Wildlife Area in Kirkland (42.09431°N, 88.86872°W). A live female individual (SVL 217 mm) was captured under cover boards on 20 April 2007. The individual was photographed and released as part of an ongoing herpetological survey within the park (verified and vouchered via photograph by Chris Phillips at the Illinois Natural History Survey, voucher number: INHS 2008-3). This is the second verified sighting of this species within this county, the first sighting was published as a county record (Walley 1977. Herpetol. Rev. 8:125). Walley's sighting occurred in the southern portion of the county, and this latest record documents that this species persists in the far northern portion of the county and potentially countywide. This capture extends the known range of this species 53.7 km NW, and is 123 km NW from the only viable population of this species in northern Illinois known to us.

Submitted by **JACE W. ROBINSON** and **JESSE W. RAY**, Department of Biological Sciences, Northern Illinois University, DeKalb, Illinois 60115, USA; e-mail: z052078@wpo.cso.niu.edu.

OXYRHOPUS GUIBEI. BRAZIL: RIO DE JANEIRO: Municipality of Resende: Serrinha do Alambari (22.3833333°S, 44.5333333°W, ca. 700 m elev.). 02 September 2005. U. Caramaschi and H. Niemeyer. Museu Nacional, Rio de Janeiro, RJ, Brazil (MNRJ 13737, 13738). Resende: District of Visconde de Mauá (22.3333333°S, 44.5333333°W, ca. 1000 m elev.). 02 January 2006. M. A. S. Alves. Museu Nacional (MNRJ 14627). Municipality of Barra Mansa (22.55°S, 44.1666667°W, ca. 450 elev.). 14 March 2006. A. Chiessi. Museu Nacional (MNRJ 15603). All localities in the Atlantic Forest biome. Verified by R. Fernandes. Species was previously known from Brazilian states of Minas Gerais, São Paulo, Goiás, Mato Grosso, Mato Grosso do Sul, Paraná, Bahia, and Alagoas, and the Distrito Federal; Bolivia, Paraguay, and northeastern Argentina (Argôlo 2004. As Serpentes dos Cacauais do Sudeste da Bahia. Editora da UESC, Ilhéus, 259 pp.; França and Araújo 2006. S. Amer. J. Herpetol. 1[1]:25–36; Freire 1999. Herpetol. Rev. 30:55; Zaher and Caramaschi 1992. Bull. Mus. Natl. Hist. Nat. 14[3–4]:805–827). First state records, the record from Barra Mansa extends known distribution ca. 230 km NE from the closest previous record (Municpality of Guarulhos, São Paulo; Zaher and Caramaschi, *op. cit*.) and ca. 320 km S from the closest record in Minas Gerais (Municipality of Lagoa Santa; Zaher and Caramaschi, *op. cit*.).

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OXYRHOPUS RHOMBIFER BACHMANNI (False Coralsnake). ARGENTINA: CHUBUT: Telsen Department: Estancia Maria de las Nieves, 15–20 km NW Sierra Chata (42.53124°S, 65.6369°W; WGS84) by Ruta Provincial 4. September 2007. V. Marquez and H. Vallejos. Verified by C. H. F. Perez. Museo Argentino de Ciencias Naturales Bernardino Rivadavia, Buenos Aires, Argentina (MACN 39042). First province record, southermost record for the species in Argentina, extends the known distribution 600 km (airline) S from previous and southernmost vouchered citation (Avila and Morando 1999. Herpetol. Rev. 30:114). Previous records in Argentina are for Catamarca, Córdoba, La Pampa, La Rioja, Mendoza, Río Negro, San Juan, San Luis, Santiago del Estero, and Tucumán (Giraudo and Scrocchi 2002. Smithson. Herpetol. Infor. Serv. 132:1–53).

Submitted by **MARCELO CARRERA** and **LUCIANO JAVIER AVILA**, CENPAT-CONICET, Boulevard Almirante Brown 2825, U9120ACF, Puerto Madryn (Chubut) Argentina; e-mail: avila@cenpat.edu.ar.

PHILODRYAS PATAGONIENSIS. BRAZIL: RIO GRANDE DO NORTE: Municipality of Parnamirim, Mata do Jiqui (05.9166667°S, 35.1833333°W). 31 January 2007. P. A. G. Sousa. Verified by M. T. U. Rodrigues. Coleção Herpetológica do Departamento de Botânica, Ecologia e Zoologia, Universidade Federal do Rio Grande do Norte, Natal. Rio Grande do Norte (CHBEZ 1609); Municipality of Natal, unknown collector (05.8°S, 35.15°W; CHBEZ 1400). This species presents a wide distribution from southern Argentina through Uruguay, Paraguay, and Bolivia to central Brazil in Brasília, Amazonian savannahs in the Pará State and all coastal regions of the state of Bahia (Laurent 1973. Acta Zool. Lilloana 26[20]:291–298; Thomas 1976. Ph.D. Thesis. Texas A&M University; Di-Bernardo et al. 2007. *In* Nascimento and Oliveira [organizers], Herpetologia no Brasil II, pp. 222–263. Sociedade Brasileira de Herpetologia; Marques and Sazima 2004. *In* Marques and Duleba [organizers], Estação Ecológica Juréia-Itatins: Ambiente Físico, Flora e Fauna, pp. 257–277. Ribeirão Preto: Holos Editora-FAPESP; Nogueira 2001. Herpetol. Rev. 32:285–287; Giraudo and Scrocchi 2002. Smithson. Herpetol. Infor. Serv. 132, 53 pp.; França et al. 2006. Occas. Pap. Oklahoma Mus. Nat. Hist.17:1–13; Freitas 1999. Serpentes da Bahia e do Brasil – Suas Características e Hábitos. Ed. Dall. 77 pp.). First state record extends range ca. 700 km N from the limit of coastal region of Bahia.

Submitted by **PABLO A. G. SOUSA** and **ELIZA M. X. FREIRE**, Laboratório de Herpetologia, Departamento de Botânica, Ecologia e Zoologia, Centro de Biociências, Universidade Federal do Rio Grande do Norte, Campus Universitário, Lagoa Nova, CEP 59072-970, Natal, Rio Grande do Norte, Brazil.

PHYLLORHYNCHUS BROWNI (Saddled Leaf-nosed Snake). USA: ARIZONA: PINAL CO.: East side of Goldmine Mountains (33.191596°N, 111.616985°W) 461 m elev. 17 May 2004. Justin P. Pullins and Tanzy D. Pullins. University of Arizona Museum (photo voucher; UAZ 56666-PSV). Verified by George Bradley. This record fills a gap in the known distribution of this species. Specimen found ca. 28 km NW of a series of specimens collected near Florence, Arizona and ca. 90 km ENE of the nearest specimen (ASU 33136) to the west (A. T. Holycross, pers. comm; Brennan and Holycross 2006. A Field Guide to Amphibians and Reptiles in Arizona. Arizona Game and Fish Department, Phoenix, Arizona. 150 pp.).

Submitted by **JUSTIN P. PULLINS**, Arizona State University Polytechnic Campus, 7001 E. Williams Field Road, Mesa, Arizona 85212, USA.

SISTRURUS MILIARIUS STRECKERI (Western Pigmy Rattlesnake). USA: ARKANSAS: SEARCY CO.: Off AR 14, ca. 2 km down Ramblewood Trail by private residence. 21 June 2007. J. S. Hicks, M. B. Connior. Verified by S. E. Trauth. Arkansas State University Museum of Zoology Herpetology Collection (ASUMZ 30742). First county record (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville. 421 pp.).

Submitted by **MATTHEW B. CONNIOR** and **IDUN GUENTHER**, Department of Biological Sciences, Arkansas State University, P.O. Box 599, State University, Arkansas 72467, USA (e-mail: matthew.connior@smail.astate.edu).

STORERIA DEKAYI (DeKay's Brown Snake). USA: OHIO: BROWN CO.: Pleasant Township: White Oak Creek at Old State Route 125 bridge, 1.0 km W of Georgetown (38.86546°N, 83.86546°W). 14 June 2007. Jeffrey G. Davis, John W. Ferner, and Paul J. Krusling. Verified by Jason Folt. Voucher specimen deposited at Cincinnati Museum Center, Ferderick and Amye Geier Research and Collections Center (CMC 10919). New county record (Wynn and Moody 2006. Ohio Turtle, Lizard, and Snake Atlas. Ohio Biol. Surv. Misc. Contr. No. 10).

Submitted by **JEFFREY G. DAVIS** (e-mail: anura@fuse.net), and **PAUL J. KRUSLING** (e-mail: pkrusling@fuse.net), Cincinnati Museum Center – Fredrick and Amye Geier Research and Collections Center, 1301 Western Avenue, Cincinnati, Ohio 45203-1130, USA; and **JOHN W. FERNER**, Department of Biology, Thomas More College, Crestview Hills, Kentucky 41017, USA (e-mail: JohnFerner@Thomasmore.edu).

THAMNOPHIS EQUES (Mexican Gartersnake). USA: ARIZONA: GILA CO.: Tonto Creek, between Gisela and Punkin Center. On 23 August 1995 at 2200 h, we found a *Thamnophis eques* (UAZ 50327) dead on State Route 188, ca. 3 km N of Punkin Center at 720 m elev. The specimen measured 310 mm SVL and 91 mm tail. This specimen is the first record of *T. eques* from the Tonto Creek watershed, and fills a substantial gap in the distribution of the species in the Gila River watershed between voucher specimens from Maricopa and Yavapai counties ca. 80 airline km to the west and records from the Black River and its tributaries ca. 110 airline km to the east.

On 14 July 2004, 18–19 August 2004, and 20–24 June 2005 we spent 165 person-hours searching along the banks of Tonto Creek between Gisela and "The Box" (ca. 3 km of stream at 870 m elev.); a location approximately 26 river km upstream of the collection locality of UAZ 50327 (Holycross et al. 2006. Surveys for *Thamnophis eques* and *Thamnophis rufipunctatus* in the Gila Watershed of Arizona and New Mexico. Report to Arizona Game and Fish Department. 105 pp.). We also deployed 32 Gee's "minnow traps" along the banks on 18–19 August 2004 (704 trap-hours) and 210 traps from 20–24 June 2005 (19,740 trap-hours). One adult female *T. eques* (ASU 34844) was trapped. From 20–23 June 2005 we captured 14 neonates (163–216 mm SVL, mean = 184; 2.5–6.0 g, mean = 3.8) and one adult female (820 mm SVL, 170 g) by hand. A second adult female (650 mm SVL, 135 g) was trapped twice.

Non-native predators (Bullfrogs, *Lithobates catesbeianus;* crayfish, *Orconectes virilis;* catfish, *Ameirus* spp.; bass, *Micropterus* spp.) were abundant, whereas a native prey species (Lowland Leopard Frog, *Lithobates yavapaiensis*) was not found. Only relatively large adult females and neonates were captured in 2004 and 2005. Low catch per unit effort (adults), absence of intermediate age classes, and presence of non-native predators suggest a low density population and raise the possibility that recruitment may be

declining in this recently discovered population.

Submitted by **J. ERIC WALLACE**, School of Natural Resources, University of Arizona, Tucson, Arizona 85721, USA (e-mail: batrachia@yahoo.com); **ROBERT J. BRAUMAN**, New York City Department of Environmental Protection, 182 Joline Avenue, Staten Island, New York 10307, USA; **JOHN WINDES**, 1128 West Emerine Drive, Tucson, Arizona 85704, USA; **WILLIAM P. BURGER**, Arizona Game and Fish Department, 7200 East University, Mesa, Arizona 85207, USA; **ERNEST J. NIGRO, THOMAS C. BRENNAN,** and **ANDREW T. HOLYCROSS**, School of Life Sciences, Arizona State University, Tempe, Arizona 85287-4501, USA.

TROPIDODIPSAS REPLETA (Black Snail-eating Snake). MEXICO: SONORA: MUNICIPIO DE YECORA: West slope of the Sierra Madre Occidental, west of Yecora Junction on Mex Hwy 16 (28.22336°N, 109.03293°W; WGS 84),1581 m elev. 17 August 2007. Young Cage and Kenneth Sharrocks. Verified by Jim Rorabaugh. LACM PC 1446. Second record for Sonora (Smith et al. 2005. Bull. Maryland Herpetol. Soc. 41:39–41), and only the third documented specimen of *T. repleta* (Lemos Espinal and Smith 2007. Amphibians and Reptiles of the State of Chihuahua México, Universidad Nacional Autónoma de México and CONABIO). The snake was found DOR in pine-oak forest.

Submitted by **ERIC A. DUGAN**, Department of Earth and Biological Sciences, Loma Linda University, Loma Linda, California 92350, USA (e-mail: edugan04g@llu.edu); **YOUNG CAGE**, 5839 West Sonoran Links Lane, Marana, Arizona 85653, USA (e-mail: ydcage@aol.com); and **KENNETH SHARROCKS**, 20437 North 17th Way, Phoenix, Arizona 85024, USA (e-mail: freeformdesigns@cox.net)

TYPHLOPS BRONGERSMIANUS (Brongersma's Worm Snake). BRAZIL: CEARÁ: Ubajara (03.8619444°S; 40.9172222°W; 834 m elev.). 06 April 2007. D. Loebmann. Coleção Instituto Butantan, São Paulo, Brazil (IBSP 76365). Verified by M. T. Rodrigues. Species widely distributed with recognized records from Trinidad, Peru, Ecuador, Colombia, Venezuela, Guiana, French Guiana, Suriname, Brazil, Bolivia, Paraguay, and Argentina (Dixon and Hendricks 1979. Zool. Verh. Leiden. 173:1–39; McDiarmid et al. 1999. Snake Species of the World: A Taxonomic and Geographic Reference, Vol. 1. Herpetologists' League, Washington, DC, xii + 511 pp.). First state record, extends the distribution previously known as follows: ca. 760 km NW from the João Pessoa city, Paraíba state, Brazil (Santana et al. 2008. Biotemas. 21[1]:75–84); ca. 700 km N from the ecological station of Uruçui-Una, Piauí state, Brazil and ca. 700 km NE from the Balsas city, Maranhão state, Brazil (Barreto 2007. Cerrado Norte do Brasil = North Cerrado of Brazil. União Sul Americana de Estudos da Biodiversidade, Pelotas, Brazil, 378 pp.); also ca. 620 km E from the Junco do Maranhão city, state of Maranhão, Brazil (Cunha and Nascimento 1993. Bol. Mus. Para. Emílio Goeldi, sér. Zool. 9[1]:1–191).

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Noteworthy Geographic Distribution Records for Colubrid Snakes from the Arkansas Valley Ecoregion of Westcentral Arkansas, USA

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Thirty-eight species and subspecies of colubrid snakes occur in Arkansas (Trauth et al. 2004). Since the compilation of Trauth et al. (*op. cit.*), numerous investigators have recently reported new county records for colubrids in various parts of the state (Engelbert and Patrick 2007; Engelbert et al. 2007; Howey and Dinkelacker 2007; Plummer and McKenzie 2007; Robison and McAllister 2007). Between December 2005 and September 2006, additional geographic (new county) records for eight species of colubrids were collected from Johnson, Pope, and Yell counties of the Arkansas Valley of west-central Arkansas. Township, section, and range are provided for each locality. Specimens were verified by S. E. Trauth and vouchers are deposited in the Arkansas State University Herpetological Museum (ASUMZ), State University, Arkansas. Current common and scientific names follow Crother et al. (2000) except where noted.

Colubrinae

Lampropeltis calligaster calligaster (Prairie Kingsnake). JOHNSON CO.: Clarksville, Clark Road (Sec. 1, T9N, R23W). 05 July 2005. Joe Kremers. ASUMZ 30796. New county record that partially fills a distributional gap among Franklin and Newton counties and near a previous record from Madison County (Roberts et al. 2005). Juvenile specimen.

Lampropeltis getula holbrooki (Speckled Kingsnake). JOHNSON CO.: Clarksville, Clark Road (Sec. 1, T9N, R23W). 05 July 2005. Joe Kremers. ASUMZ 30794. New county record that fills a hiatus in the northwestern Arkansas River Valley among Franklin, Logan, and Pope counties. Juvenile Specimen. This snake is one of the most common colubrids of the state, now being reported from 73 of 75 (97%) counties.

Opheodrys aestivus (Rough Greensnake). YELL CO.: Mt. George (Sec. 4, T5N, R21W). 08 June 2006. Joe Kremers. ASUMZ 30800. New county record partially filling a hiatus in the southern Arkansas River Valley among Perry and Scott counties.

Natricinae

Nerodia rhombifer rhombifer (Northern Diamond-backed Watersnake). JOHNSON CO.: Clarksville, Clark Road (Sec. 1, T9N, R23W). 27 December 2005. Joe Kremers. ASUMZ 30793. New county record and juvenile specimen.

Storeria dekayi wrightorum (Midland Brownsnake). JOHNSON CO.: Clarksville, Clark Road (Sec. 1, T9N, R23W). 11 September 2006. Joe Kremers. ASUMZ 30797. New county record.

Storeria occipitomaculata occipitomacula (Northern Red-bellied Snake). POPE CO.: 1.6 km N London (Sec. 17, T8N, R21W). 15 September 2006. Joe Kremers. ASUMZ 30799. New county record among Johnson, Logan, and Pope counties. This snake is uncommon in the state although it is widely distributed among all ecoregions (Trauth et al., *op. cit.*).

Thamnophis proximus proximus (Orange-striped Ribbonsnake). JOHNSON CO.: Clarksville, Clark Road (Sec. 1, T9N, R23W). 27 December 2005. Joe Kremers. ASUMZ 30795. New county record.

Thamnophis sirtalis sirtalis (Eastern Gartersnake). POPE CO.: 3.2 km S Dover (Sec. 3, T8N, R20W). 15 September 2006. Joe Kremers. ASUMZ 30798. New county record partially filling a hiatus among Conway and Johnson counties.

Acknowledgments.—We especially want to thank Joe Kremers (Clarksville, Arkansas) for providing these specimens. We also thank S. E. Trauth (ASUMZ) for curatorial assistance and specimen verification. Specimens were collected under the authority of Arkansas Scientific Collecting Permits issued to HWR by the Arkansas Game and Fish Commission.

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———, ———, AND M. SOLIS. 2007. Geographic distribution: *Opheodrys aestivus*. Herpetol. Rev. 38:105.

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TRAUTH, S. E., H. W. ROBISON, AND M. V. PLUMMER. 2004. Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.

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New Distribution Records for Reptiles and Amphibians from the Charlotte-Metropolitan Area of the Western Piedmont of North Carolina

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Knowledge of reptile and amphibian distribution patterns is essential for the development of effective conservation strategies (Tuberville et al. 2005), especially in regions that are becoming increasingly urbanized. Here we report new county records of reptiles and amphibians from the rapidly growing Charlotte-metropolitan area in the western Piedmont of North Carolina. The following records were collected from 2003 to 2007 by members of the Davidson College Herpetology Laboratory. All coordinates listed use NAD83/WGS84 datum and were recorded using a Garmin® hand-held geographic positioning system or online mapping software (www.carolinaherpatlas.org/utmfinder/). New distribution records were verified by Jeffrey C. Beane and/or Alvin L. Braswell at the North Carolina State Museum of Natural Sciences (NCSM) and were based on Palmer and Braswell (1995) or Braswell (1996). All specimens or photo vouchers are housed at NCSM.

Caudata– Salamanders

Eurycea guttolineata (Three-lined Salamander). LINCOLN CO.: 0.8 km ENE of intersection of Woodcock trail and Killian Farm Rd (35.4143°N, 80.9676°W). 03 May 2007. Steven J. Price and Kristen K. Cecala. NCSM 73513. New county record.

Gyrinophilus porphyriticus (Spring Salamander). MECKLENBURG CO.: Stephen's Road Nature Preserve, ca. 1.5 km SW of intersection of Stephen's Rd and Beaties Ford Rd (35.4013°N, 80.9448°W). 18 April 2007. Steven J. Price. NCSM 73512. New county record.

Pseudotriton ruber (Red Salamander). IREDELL CO.: Davidson College Ecological Preserve, ca. 1.0 km E of intersection of Dunmurry Rd and State Hwy 115 (35.5104°N, 80.8278°W). 1 May 2004. Yurii V. Kornilev and William J. Johnson. NCSM photo DC-308. New county record.

Anura – Frogs

Hyla cinerea (Green Treefrog). CABARRUS CO.: 0.9 km NW of intersection of Cox Mill Rd and Christenbury Rd (35.3853°N,

80.7372°W). 02 November 2005. Steven J. Price and Yurii V. Kornilev. NCSM 72672. New county record.

Testudines – Turtles

Chelydra serpentina (Snapping Turtle). IREDELL CO.: Five Mile Branch Stream Restoration Site, 0.3 km SSE of intersection of River Hill Rd and Swann Rd (35.4143°N, 80.9676°W). 23 February 2007. Leigh Anne Harden and Wesley M. Anderson. NCSM photo DC-305. Observation reported by Palmer and Braswell (1995). First photo voucher from county.

Chrysemys picta (Painted Turtle). IREDELL CO.: Five Mile Branch Stream Restoration Site, ca. 1.0 km ESE of intersection of River Hill Rd and Swann Rd (35.8462°N, 80.7680°W). 2 July 2007. Leigh Anne Harden and Steven J. Price. NCSM photo DC-306. New county record.

Kinosternon subrubrum (Eastern Mud Turtle). IREDELL CO.: ca. 0.7 km NE of intersection of Midway Lake Rd and Beracah Place (35.5294°N, 80.8210°W). 24 April 2006. Shannon E. Pittman. NCSM 72703. Observation reported by Palmer and Braswell (1995). First specimen from county.

Sternotherus odoratus (Eastern Musk Turtle). CABARRUS CO.: 0.3 km NE of intersection of Blackwelder Rd and Roberta Rd (35.3506°N, 80.6324°W). 8 July 2005. Elisabeth L. Failey. NCSM 72705. New county record.

Squamata – Snakes

Lampropeltis getula (Common Kingsnake). CABARRUS CO.: Morrison Rd, 0.3 km E of intersection with Pioneer Mill Rd (35.2612°N, 80.5870°W). 24 April 2006. Steven J. Price and Kristen K. Cecala. NCSM 72677. Observation reported by Palmer and Braswell (1995). First specimen from county.

Storeria dekayi (Dekay's Brownsnake). IREDELL CO.: Five Mile Branch Stream Restoration Site, ca. 2.0 km ESE of intersection of River Hill Rd and Swann Rd (35.8510°N, 80.7535°W). 29 October 2006. Leigh Anne Harden and Wesley M. Anderson. NCSM photo DC-307. Observation reported by Palmer and Braswell (1995). First photo voucher from county.

Storeria occipitomaculata (Red-bellied Snake). IREDELL CO.: Davidson College Ecological Preserve, ca. 1.0 km ENE of intersection of Dunmurry Rd and State Hwy 115 (35.5097°N, 80.8305°W). 30 April 2003. Kristine L. Grayson. NCSM 73525. Observation reported by Palmer and Braswell (1995). First specimen from county.

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New County Records of Reptiles and Amphibians from East Texas

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Here we report several new reptile and amphibian county records for the state of Texas. Despite the number of researchers working throughout the state, many common species have not been documented (Dixon 2000). During the summer and fall of 2007, we surveyed various east Texas counties to document unrecorded reptile and amphibian species. The nomenclature used is in accordance with Crother et al. (2000) and identifications were verified by C. J. Franklin. Voucher specimens are deposited at the Amphibian and Reptile Diversity Research Center (UTA), University of Texas at Arlington, Arlington, Texas and the University of Texas at Tyler, Tyler, Texas. All specimens were collected under the authorization of the Texas Parks and Wildlife Department (permit no. SPF-0806-713).

Anura – Frogs

Anaxyrus americanus charlesmithi (=Bufo americanus charlesmithi) (Dwarf American Toad). CAMP CO.: Approximately 0.48 km N from the intersection of County Rd 2319 and Farm Rd 1520 (33.06639°N, 095.02459°W; NAD27), 105 m elev. 14 September 2007. Jake A. Pruett and Jessica L. Coleman. UTA A-58017. Found in an oak-hickory woodland near Bob Sandlin Lake with at least 3 other *A. a. charlesmithi*, as well as several *Acris crepitans* and *Rana sphenocephala*.

Testudines – Turtles

Chelydra serpentina (Common Snapping Turtle). LAMAR CO.: Camp Maxey, Texas Army National Guard training site. Approximately 16.1 km N of Paris, Texas on Hwy 271 (33.79811°N, 095.567703°W; NAD27), 167 m elev. 24 July 2007. Jessica L. Coleman. UTA R-55473. Shell was found on shore of a small pond among sedges and grass species. Holes were present in the carapace resembling punctures of small mammal incisors; however, predation could not be determined.

Graptemys pseudogeographica kohnii (Mississippi Map Turtle). WOOD CO.: Texas Parks and Wildlife Department Old Sabine Bottom Wildlife Management Area. Approximately 12.8 km N of Lindale, Texas on County Rd. 4106 (32.60190°N, 095.32918°W; NAD27), 85 m elev. 15 May 2007. Jessica L. Coleman. UTADC 1094–95. Adult male photographed basking (1125 h) in a 1.5 km section of the Sabine River with approximately nine *G. p. kohnii* and five other species of turtles (Emydidae). In this section of river a total of 116 individual turtles of various species were observed basking that day.

Sternotherus carinatus (Razorback Musk Turtle). TITUS CO.: Bob Sandlin State Park. Approximately 19.3 km SW of Mt. Pleasant, Texas (33.06188°N, 095.06506°W; NAD27), 127 m elev. 14 September 2007. Jake A. Pruett and Jessica L. Coleman. UTA R-55474. Shell was found within 2 m of the north shoreline of Bob Sandlin Lake in oak woodland habitat.

Trachemys scripta elegans (Red-eared Slider). UPSHUR CO.: Approximately 0.2 km W from the intersection of West Lake Drive and Woodbine Drive (32.54222°N, 94.94694°W; NAD27). 15 September 2005. Jessica L. Coleman. University of Texas at Arlington (UTADC 1099). A female was found crossing West Lake Drive, ca. 50 m S of Gladewater Lake in a residential area.

Squamata – Snakes

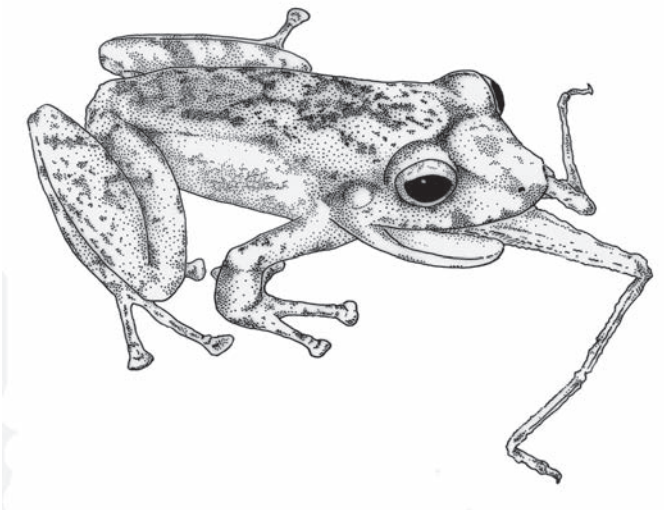
Regina grahamii (Grahams Crayfish Snake). SMITH CO.: Texas Parks and Wildlife Department Old Sabine Bottom Wildlife Management Area. Approximately 12.8 km N of Lindale, Texas on County Rd. 4106 (32.58589°N, 095.35719°W; NAD27), 129 m elev. 20 May 2007. Jake A. Pruett. University of Texas at Tyler (UT Tyler 516). Snake captured in minnow trap placed at the land/water interface of an oxbow lake. An unidentified species of crayfish (determined by palpation) had been consumed by the snake, but it could not be determined if predation occurred after entering the trap.

Acknowledgments.—We thank R. C. Jadin, C. J. Franklin, and J. A. Campbell for depositing specimens and images at the Amphibian and Reptile Diversity Research Center. We additionally thank R. C. Jadin and J. Placyk for their constructive criticism.

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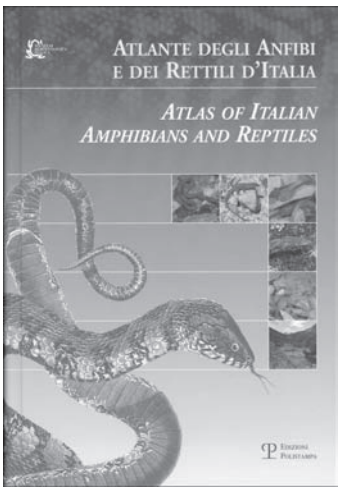
Pristimantis palmeri (Brachycephalidae) eating a small cricket. Illustration by Fernando Vargas-Salinas based on a photograph taken in western Andes, Department of Valle del Cauca, Colombia.

BOOK REVIEWS

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Atlante degli Anfibi e dei Rettili d'Italia/Atlas of Italian Amphibians and Reptiles, edited by Roberto Sindaco, Giuliano Doria, Edoardo Razzetti and Franco Bernini. 2006. Edizioni Polistampa, Firenze, Italy (www.polistampa.com). 789 pp. Hardcover. € 70.00 (approx. $US 109.00). ISBN 88-8304-941-1.

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Most Western and Central European countries have recently compiled national atlases of their herpetofaunas. The Italian effort to map the national herpetofauna has been noteworthy for its generation of many regional and provincial atlases, as well as a preliminary atlas (Societas Herpetologica Italica, 1996), prior to the publication of the definitive work. The result is a spectacular, highly readable and highly useful volume. The book provides a dual Italian/English text, making it accessible to a broad range of readers.

The book begins with an engaging history of Italian herpetology by Violani and Barbagli. This well illustrated chapter, with portraits of Italian herpetologists and illustrations and title pages from their works covers the gamut from the earliest forays into herpetology to the great collectors of the 19th and 20th centuries. Among the more illustrious names included are Aldrovandi, Redi, Malpighi, Vallisneri, Spallanzani, Rafinesque, Rusconi, Panizza, Gené, Peracca, Camerano, Lessona, Bonaparte, Jan, Scortecci, and Doria.

Chapter two, by Massimo Delphino, summarizes the fossil record of the living species. The Miocene to Holocene record is surprisingly representative of the living diversity, with 38 taxa represented plus another 11 genera that are extant, but no longer occur in Italy (e.g., *Tomistoma*, *Agama*, *Varanus*, *Eryx*). This chapter is illustrated by drawings of selected fossils and small photographs of the corresponding living taxa.

Chapter three overviews the genesis of the atlas project and relevant data gathering. The project was begun in 1994 and resulted, only two years later, in the publication of the provisional atlas (Societas Herpetologica Italica, 1996). Over the intervening years many regional and provincial atlases were published. In all over 70,000 data points were plotted on 3382 10 × 10 km UTM coordinates. These were gathered by more than 900 collaborators. Although most of Italy has been at least moderately well covered by

this effort, 7% of the 10 × 10 km units (chiefly in Basilicata and Sardegna [Sardinia]) have no records for any species.

A short chapter on altitudinal distribution presents data in the form of bar graphs by province and shows the results of a simple cluster analysis. Figure 4.1 (p. 142) would have been easier to use had the areas mentioned been clearly indicated on the map.

The final prelude to the accounts themselves is a checklist with taxonomic remarks. Ninety-one species (40 amphibians and 51 reptiles) inhabit Italian territory. The list is accompanied by extensive endnotes that provide useful information on dates of publication of names, ICZN rulings, recent generic allocations, and instances of taxonomic confusion, conflict, or uncertainty in the Italian herpetofauna.

The species accounts themselves begin with a convenient "how to read distributional maps" section. Each account except two of the sea turtles, *Chelonia mydas* and *Dermochelys coriacea*, and the naturalized Red-Eared slider, *Trachymys scripta*, is accompanied by full page, color, topographic map, marked with a half degree grid. Plotted points are divided into 1984 and earlier records, 1985 and later records from the SHI database, other records without specific locality (some provinces provided only imprecise localities to protect the animals), and doubtful records. Account sections are: taxonomy (including phylogenetics), general distribution, comments on the distribution map (often very detailed), habitat, altitudinal distribution, annual activity cycle, reproduction, and status of populations in Italy. All accounts are illustrated by multiple color photos. For some species these include eggs, larvae or juveniles, and views of courtship. In general the quality of the photos is good—only a photo of the venter of *Bombina pachypus* (p. 274) appears out of focus. The provenance of most photos is noted and the majority of photos actually depict Italian specimens.

Chapter 7 by Corti, Lo Cascio, and Razzetti is an overview of the Italian island herpetofaunas. The island groups include the relatively extensive island groups surrounding Sardinia and Sicily and off the coast of Tuscany, as well as the smaller archipelagoes and islands of Liguria, Latium (the Pontine Islands), Venetia, and southern Italy (Campania, Basilicata, Calabria, and Apulia). An extensive table provides species lists by island and a short text section outlines relevant literature and taxonomic issues. The islands have a disproportionately high number of outstanding taxonomic problems and conservation issues as many subspecies and even species have been described from them.

Razzetti and Sindaco briefly discuss 15 additional unconfirmed taxa that may or may not occur in Italy. Some are introductions (e.g., *Xenopus laevis* and *Agama agama*), whereas others approach the borders of Italy and might eventually be added to the fauna (e.g., *Rana arvalis* and *Pseudopus apodus*). Most interesting is the bizarre case of *Rana osca*, which the authors conclude is a synonym of *R. italica*—it was described multiple times, once in an unlocatable reference of uncertain date, and its type material appears to have disappeared within a decade of its description.

A biogeographic chapter by Bologna and Mazzotti reviews the geological history of Italy from the mid-Tertiary onwards and emphasizes the diversity of spatial patterns reflected by the herpetofauna and the resulting biogeographic mosaic. Among the faunal components recognized are widespread Euro-Asiatic elements, Western and Eastern Mediterranean forms, North African species, and peninsular, Sardinian, and Sicilian endemics. Of particular note are taxa with affinities outside of Europe, e.g., *Speleomantes* and *Proteus*, each with North American sister taxa. A variety of historical factors, including the Messinian salinity crisis and glacial advance and retreat, are proposed to explain some of the observed affinities of the fauna. Italian endemism at the species level is especially high for amphibians (50%), whereas reptile endemism is lower (17%) and largely restricted to Sardinia and Sicily, which are the most distinctive herpetofaunal regions of the country based on cluster analysis.

The last two chapters deal with herpetofaunal conservation and legislation. In Chapter 10, Roberto Sindaco evaluates the status of the Italian herpetofauna. Like most amphibians and reptiles worldwide, a lack of data regarding threats and population sizes necessitates categorization based chiefly on areas of occupancy and habitat fragmentation. All taxa are assigned to categories based on this information as well as the proportion of the global range in Italy and, for endemics, the specific nature of their distribution (e.g., insular or mainland). In the following chapter Vincenzo Ferri outlines the complex set of regulations than govern the protection of the herpetofauna. This includes European, Italian, and provincial statutes, some of which protect certain species and others of which focus on habitat protection. Tables summarize the categorization of each species under the Bern Convention, the European Union Habitats Directive, and CITES. All species are covered under the Bern Convention, and most by the Habitats Directive, but only sea turtles, tortoises, and *Vipera ursinii* are CITES listed. Twenty-one regional and provincial laws affecting amphibians and reptiles are also summarized.

As is fitting for such a comprehensive volume, the bibliography includes more than 1500 references, a resource in itself, as noted by Benedetto Lanza in his preface to the book. In a welcome change from many recent books, a good deal of care seems to have been paid to bibliographic accuracy. Finally the book concludes with short biographical sketches of the 54 authors who contributed to the volume, photo credits, and a taxonomic index listing entries by genus, species, and both English and Italian common name. Unfortunately, the references only relate to the species accounts proper; mentions in other chapters are not cited.

Aside from the inadequacy of the index, I find little to criticize in this aesthetically attractive volume. Although my knowledge of Italian is rudimentary, it appears that the English translation is faithful. The information provided is up-to-date and I especially appreciate the fact that potentially confusing taxonomic and distributional issues are explained and that the reader is lead to the original literature throughout the book. This volume is a testament to the vibrant herpetological community in Italy today. In addition to producing this atlas, the highly active Societas Herpetologica Italica has also recently launched the predominantly English language journal, *Acta Herpetologica*. I highly recommend the *Atlas of Italian Amphibians and Reptiles* to anyone with an interest in any aspect of the European herpetofauna.

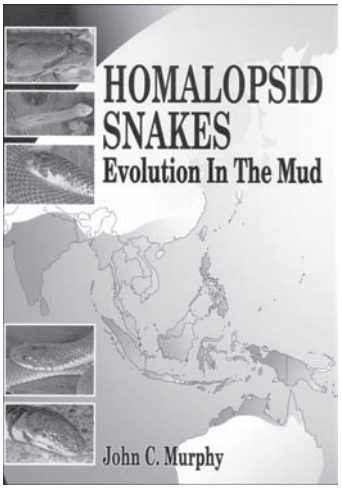
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Homalopsid Snakes. Evolution in the Mud, by John C. Murphy. 2007. Krieger Publishing Company, Malabar, Florida (www.krieger-publishing.com). viii + 249 pp. Hardcover. US $68.50. ISBN 1-57524-259-1.

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No synthetic work on Homalopsidae has been published since the group's revision by the late Myanmar herpetologist Ko Ko Gyi, which dates back to 1970. Much research has been done since then, including many ecological and taxonomic studies by Daryl Karns, John C. Murphy, Harold K. Voris and their collaborators. Several species have been described or revalidated, others synonymized, and after nearly four decades the time is right for a new major work on these snakes. Taxonomically, the main recent contributor to the knowledge of this group is John C. Murphy, who (co-)described *Enhydris chanardi*, *E. gyii*, and *E. vorisi*. He is, thus, the best placed herpetologist to provide us with an overview of the group, and his new opus is a very welcome contribution.

The book includes two main parts, i.e., the introduction and keys (pp. 1–48) preceded by the preface and acknowledgments, and the generic and specific accounts (pp. 49–212) followed by the literature cited, appendices and the index to scientific names. The author recognizes 10 genera and 37 species in the Homalopsidae, and adds a section on three homalopsid-like *incertae sedis* snakes (*Anoplohydrus aemulans*, *Brachyorrhos albus*, and *B. jobiensis*), which might eventually turn out to be homalopsids once detailed taxonomic studies have been conducted.

The introduction provides a well-written presentation of the group, its general ecology and classification. Figure 1 shows a snake phylogeny to help understand the homalopsids' position among other snakes; its caption mentions that groups containing at least one aquatic representative are marked with an "A." However, no A was associated to *Grayia ornata*, a strictly aquatic snake, nor to the Boidae, which however contain freshwater snakes such as *Eunectes murinus* (see Pauwels et al., 2008 for a review of freshwater snake diversity). The introduction also includes a chapter co-authored by Brooks et al. on the water snake harvest at Tonlé Sap Lake, giving really impressive figures on the homalopsid meat and skin business in Cambodia.

The identification keys include all homalopsid snakes, but unfortunately not the three *incertae sedis* ones. These keys are not fully reliable, since many ranges of characters provided are in contradiction with those given in the species accounts. As an example, couplet 9a mentions that female *Enhydris jagorii* have more than 50 subcaudals, while the species account (p. 134) says they have 48–54 subcaudals, and that males have about 68, while the species account gives a variation of 53–68. Another example is that couplet 2a, "Nasal scales in contact" leads a.o. to *Myron richardsonii* (couplet 4c), which actually has separated nasal scales, as rightly mentioned in its species account. I noted in total 34 such discrepancies between the keys and the main text, with more-or-less significant consequences on species identification. It is also to be noted that there is no entry to couplet 9 of the key, excluding identification of snake specimens identifiable as *Enhydris jagorii* and *E. longicauda*. Consequently, an identification using these keys must be carefully double-checked with a comparison of the specimen to the presumably associated species account.

The generic and species accounts are well constructed, with clear sections on etymology, species content, distribution, and diagnosis, and a partial chreso-synonymy. Each species account includes a partial chreso-synonymy and sections on etymology, common names, distribution, diagnosis (except *Enhydris punctata*), size, external morphology, habitat, diet and feeding behavior, reproduction, relationships, and on the museum material examined by the author. In cases in which certain aspects of natural history are particularly well known, additonal sections have been added (predators, etc.). The chreso-synonymies are most often incomplete; their literature references are mentioned using the authors, dates, and abbreviated titles. Since there is a literature section at the end of the book, citing the authors and dates only in the chreso-synonymy would have been sufficient and would have saved a lot of space. The external morphology section follows the same organization for all species and this is helpful for interspecific comparisons. A point locality map is provided for each species. Unfortunately, although there was an effort to track literature references even in local journals, as stressed by Luiselli (2008) in his review of this book, many such references were not listed by the author and numerous localities are thus missing from the maps of many species, sometimes giving a misleading impression of rarity or disparate populations.

Most species are illustrated in life and in color—the book includes 76 color photos. One species only, *Brachyorrhos jobiensis*, is not illustrated at all. There are also 38 black-and-white plates, each composed of six pictures, showing details of head or body. Additional illustrations, mainly drawings, are provided in 47 figures throughout the book, and there are often several drawings per figure. The book is thus lavishly illustrated, most illustrations being of very good quality. A number of specimen photographs present important information, such as the only known picture of a live *Enhydris dussumieri*, or a very unusually patterned *Homalopsis buccata* from Songkhla Lake, southern Thailand. Many photographs are accompanied by precise locality data, which increases their informational value. The natural history of Homalopsidae is extremely interesting, and is well detailed for each species: specialized diets and habitats, hunting strategies, etc. Typical biotope photographs are provided for a number of species.

The main text often refers to the work of Gyi (1970), re-evaluating the accuracy of his observations and updating the data and diagnostic characters for each species, indicating real progress in

the knowledge of the group. The author moreover stresses a number of gaps in the current knowledge of homalopsids and highlights interesting variation among populations (see for example p. 75 for *Cerberus rynchops*), and thus provides useful directions for future research. The inclusion of species accounts for the *incertae sedis* species is also an excellent feature and underscores the need of additional taxonomic studies on these taxa.

The literature cited section (pp. 213–229) is not exhaustive, but provides all of the most important references. The most recent reference dates from 2007 (only one for that year). A number of references cited in the main text are not in the literature section, some perhaps due to a *lapsus calami* with respect to publication date. Among those referred to in the text and which were certainly omitted from the literature section (since the authors do not even appear in the literature section) are the following: Biswas and Acharyo (1977) (p. 121), Duvernoy (1832) (p. 24), Frith and Boswell (1978) (p. 63), Hundley (1964) (p. 95), Iskandar and Nio (1996) (p. 116, etc.), Kaup (1858) (p. 56), Mattison (1995) (p. 63), Mocquard (1907) (p. 139, 166, etc.), Obst (1977) (p. 155), Phisalix (1922) (p. 139), Reitinger (1978) (p. 148, etc.), Seba (1735, etc.) (p. 233), Shaw (1802) (p. 72, etc.), Sing et al. (1970) (p. 76, etc.) and Thu (2001) (p. 94, etc.). I will not list here the presumed associated references, since this would be too speculative given the possibility of erroneous dates.

Appendix 1 gives a list of species names and their current status, information on the type material and type locality. Appendix 2 is a summary of species distribution by country. This latter information must be used with caution, since I detected not less than 19 discrepancies between this table and the maps and/or text provided in the species accounts. Appendix 3 gives the maximal known sizes for each species. One regrets that the errata on p. 244 could not have been included within the main text.

The most disturbing weakness of the book is the huge number of misspellings. Indeed, I counted more than 450 misspelled words, and this figure is certainly not exhaustive. Most such mistakes are found in the scientific names, authors' names, and in the French and English citations (chreso-synonymy and literature cited). As an example, the binomen *Homalopsis buccata* was spelled five different ways. So many easy-to-detect mistakes and the existence of an errata section seems to indicate that the book was published in a hurry. It would have greatly benefitted from a careful reading, particularly by French- and German-speaking herpetologists, since so many important literature references were written in these languages.

Discrepancies between character variations are not limited to the above mentioned contradictions between the keys and the species accounts. These discrepancies are also found within the text and between the text and tables. A striking example is found in the *Enhydris jagorii* species account (p. 133), where the type specimen is described twice, once in the left column, once in the right one. For the same specimen and on the same page, two different total lengths are given (463 vs. 471 mm), as well as two dorsal scale row numbers before vent (21 vs. 20) and two numbers of subcaudal scales (86 vs. 68). Another example is found in the *Enhydris punctata* species account, where one reads "The subcaudal scales are divided and number 27–46 (32–44 in females, 46–48 in males)." The diagnosis for *Myron richardsonii* (p. 205) mentions that the species has a white belly, while a picture on the same page shows a yellowish-pinkish belly with transverse lines on each ventral and a black mid-line; and so on. Often these discrepancies have an influence on the diagnosis and species identification. For instance, on p. 168 *Enhydris subtaeniata* is compared with *E. enhydris*. Their respective ventral scale numbers are given as 136–153 vs. 153–174, thus with nearly no overlap. However, on p. 170, the minimum ventral scale number for *E. subtaeniata* is given as 134, and on p. 118 (Table 9) the minimum number for *E. enhydris* is given as 148; their ventral numbers are thus to be corrected to 134–153 and 148–174, respectively, this time with a wide overlap. In addition to the discrepancies in morphological variation between the keys and the main text, I noted 106 problems within and between the main text and the tables, or sometimes between the text and the figures; this number does not include the discrepancies between the main text and Appendix 2. Tables 5, 6, and 11 exhibit an especially large number of discrepancies with the associated species accounts and information available on figures.

The preface explains that the main goal of the book is threefold: to "provide a means of identification for the species of homalopsid snakes, clear up some taxonomic confusion, and provide the reader with a summary of what is known about their natural history." With the caveat indicated above, i.e., always carefully compare a key-based identification with the associated species account, the book indeed does provide a means for identification. The second and third goals are achieved more successfully, and this makes of the present book an important reference to have not only for all herpetologists, but also for readers interested in general natural history and Southeast Asia. The price indicated on Krieger Publishing's website for the book is US $68.50. Given the very good binding and glossy paper quality, the well-illustrated hard cover, the high number of color pictures and the important content of the book, this is a very reasonable price. I thank Patrick David (Muséum National d'Histoire Naturelle, Paris) for useful comments on this review.

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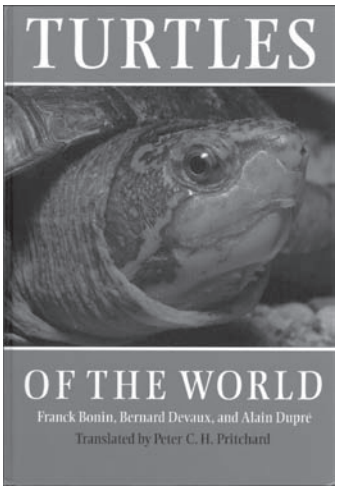
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Herpetological Review, 2008, 39(2), 251–252.
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Turtles of the World, by Franck Bonin, Bernard Devaux, and Alain Dupré (translated by Peter C.H. Pritchard). 2006. John Hopkins University Press, Baltimore Maryland (www.press.jhu.edu). 416 pp. Hardcover. US $50.00. ISBN 0-8018-8496-9.

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This book is the English translation of the third edition of the original French language work. It is difficult to know what the three authors set out to accomplish with this book, as there is neither a foreword nor a preface. Peter Pritchard, however, in his "translator's notes," suggests that their intent is to distinguish the book from other works with a chelonian world view by being taxonomically up-to-date and by including discussions of survival status.

This book is divided into two major sections, General Biology (9 pp.), and Identification (401 pp.), followed by a short list of references and index of scientific names. The volume is illustrated by 403 photos, two diagrams, and numerous maps. The binding and paper are of high quality, and there are handy colored page margins organized by family or section description throughout.

General Biology begins with a description of the placement of chelonians among living things. *Proganochelys*, considered by the authors the ancestor [sic] of all turtles, is the basis for further taxonomic discussion. The unique chelonian skeleton and other organ systems are treated in about one page, as are senses, sexual dimorphism, metabolism, ethology, and threats and protection. Caveats about taxonomy being a dynamic science always find their way into turtle books; there is a single highlighted paragraph at the end of the General Biology section which states that the nomenclatural concepts in the book incorporate many recent changes by Roger Bour, and that only minor disagreements are to be expected from turtle systematists around the world.

The Identification section is organized alphabetically by family, genus and species, first within Pleurodira, then within Cryptodira. There are 311 species accounts, 280 of which have at least one accompanying photo (of those lacking photos, over half have been described since 1950). Each species account begins with the scientific name, author, and year of description. Common names are also provided, but appear in the page margin adjacent to the reference maps (see below). Most accounts are divided into the subsections Distribution, Description, Natural History, and Protection, each of which may be followed by just one sentence or several detailed paragraphs for the chelonian of interest. A few accounts also include extra sections, such as 'Ethnozoology' for *Carettochelys insculpta* and *Centrochelys* (*Geochelone*) *sulcata*. Some short sections of text were inadvertently left untranslated and appear in the original French, as in the introduction to the Platysternidae (p. 116).

All accounts have a shaded range map indicating the approximate distribution of each species. In the page margin of each account is a continental scale reference map with a square box indicating the location of the more detailed distribution map featured in the main part of the account. Several of the range descriptions from the text are not in agreement with the distribution maps. Associated specimen photos are placed at various places within their respective accounts, but most figure legends do not mention the species name. As a consequence, the identity of photos immediately following the text for one species and preceding that for the next may be unclear to readers. Most of the photos are acceptable, but several have severe shadows, show animals posed in people's hands, or have poor depth-of-field. Interestingly, there is a short biographical appreciation of John Cann on page 30, lauding his skills as a photographer. Indeed, Cann's photos are as near perfect as they can be—no shadows, excellent focus, and alert subjects looking at the camera, always in a natural setting and pose. It is unfortunate that only six of his photos were included in the book!

The Distribution subsection uses both geographic features (rivers or mountains) and political boundaries for a general idea of the range. While usually straight forward, there are some confusing mix ups in this section, e.g., in the range description for *Manouria impressa*, it seems there was an intended comparison with *M. emys*, but the text reads as if to compare *M. impressa* with itself. 'Description' includes a general color and size scheme for the species as well as any other noteworthy shell, skin, or coloration feature. The Natural History subsection lists habitat type within the occupied range; some diet and reproductive information may be included too. The Protection text includes an incomplete listing of national and international laws or treaties that offer some level of legal protection. Appendix III listings under CITES are not included, and some species covered under Appendices I or II are not listed as such. Status, as listed by the IUCN and/ot the Turtle Conservation Fund, is sporadically noted and localized threats or conservation practices known to the authors are also mentioned. Protective status is always in flux, but the simple consistent reference to CITES, IUCN, and Turtle Conservation Fund status for each species would have increased the utility of the book.

Most references included in species accounts cannot be found in the book's reference section. For example, the account for the Pantanal swamp turtle, *Acanthochelys macrocephala*, cites "Buskirk (1988)" for documentation of Paraguay within the range of the species. Neither this paper, published in *Herpetological Review*, or any other senior authored works by Buskirk appear in the reference list. This systematic oversight severely hampers the use of the book by anyone wishing to obtain further information. Additionally there are errors for the works that are listed. *Turtle and Tortoise Newsletter* (TTN) is listed under "Kalb, J.H. 1992." Heather Kalb was one of two editors for the premier issue of this newsletter that was first published in January 2000, with a publication city and state of Lunenburg, Massachusetts, not Evansville, Indiana as the citation reads. The parent publication for TTN, is the peer reviewed journal *Chelonian Conservation and Biology*

which is listed under "Rhodin, A.," who is a founding editor, and sometime author in this journal, which was first published in November 1993, not 1997 as the citation reads.

The index of scientific names only lists taxa by genus, then species, following the authors' taxonomic interpretation. This does not provide user-friendly access, particularly in light of the taxonomic and nomenclatural changes that have occurred in recent years. For instance, the Western Pond turtle of North America cannot be found under the still widely used name *Clemmys marmorata*, but only under *Actinemys marmorata*. At a minimum, cross-listing by specific epithet followed by genus would have greatly facilitated reader use of the index.

After only two years, the English edition of *Turtles of the World* is already in its second printing. The online library catalogue WorldCat (www.worldcat.org) shows that at least 448 institutional libraries worldwide have a copy. It would be prudent for the thrifty turtle book enthusiast to seek one of these library holdings to inspect a copy before making a purchase.

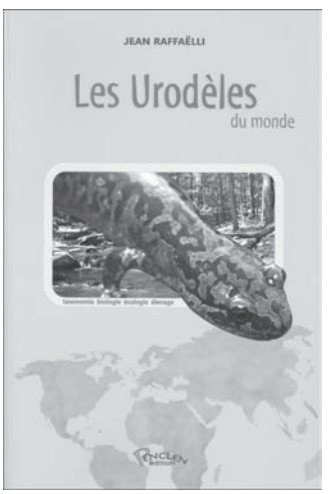
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Les Urodèles du Monde, by Jean Raffaëlli. 2007. Penclen Édition, Plumelec, France (contact: jean.raffaelli@laposte.net). 377 pp. Softcover. ISBN 978-2-9528246-0-6. € 65.00 (approx. US $97.00).

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Jean Raffaëlli has produced a strange, but useful and inspiring book on salamanders. *Les Urodèles du Monde* can best be understood in light of author's own background, interests, and motivations, which are summarized in the 26 pages of "L'aventure personnelle autour des salamanders." Raffaëlli began his personal odyssey with salamanders in his native France, studying them both in the field and in the terrarium. His love of all things urodelan led him to expand, not only his captive studies, but his field work to encompass much of the world, but particularly the Americas, where salamander diversity is greatest. Raffaëlli's narrative incorporates comments on and by a diversity of salamander experts from both Europe (e.g., Marc Alcher, Robert Thorn) and America (e.g., David Wake, James Hanken, Richard Highton, C. Kenneth Dodd, Jr.), all of whom have influenced his passion for salamanders or contributed to his own knowledge of and appreciation for these amphibians. This personal background, which also touches on chytrid fungus, habitat destruction in Mexico, and the secrets of maintaining salamanders in captivity, is illustrated by small photos of the people, places and salamanders that have made the deepest impressions on him.

The main body of the book consists of concise species accounts of all salamander taxa recognized as of June 2006. These have drawn heavily from the Global Amphibian Assessment (GAA; www.globalamphibians.org), using GAA threat categories, maps, and estimates of extent of occurrence. For each taxon (subspecies through all higher order ranks within Amphibia) the author and date of description are provided and for all groupings less inclusive than Urodela there is accompanying text. For supraspecific categories, diagnostic features, fossils, phylogeny and taxonomy are discussed. The currency of the taxonomy is impressive. I suspect that many of the genera, subgenera, and species detailed will be unfamiliar, even to most amphibian specialists, unless their own knowledge of the literature is both global and comprehensive.

Each species/subspecies account (all recognized forms, as well as several undescribed forms of *Chiropterotriton* and *Pachytriton*, are illustrated and discussed) occupies between a quarter of a half-page column and a full page. Although not divided into discrete subsections, each account provides information about taxonomy (particularly recent changes), characteristic features, color (including ontogenetic and sexual variation), habitat, reproduction (number of eggs, phenology), diet, threats, distribution (including extent of occurrence), and GAA threat/status category. For some accounts a separate "note d'élevage," in bold, provides husbandry observations. More extensive husbandry information is provided in boxed features scattered throughout the text and tailored for groups with similar housing and rearing requirements (e.g., ambystomatids, *Triturus* and related genera plus *Cynops*, *Plethodon*, small-bodied bolitoglossines).

The main complaint that I had and, I suspect, most readers will have is with the maps and illustrations. Each species account has a small (and I mean small!, mostly ~35 × 33 mm) map associated with it (subspecies are typically shown together on a single map, which for *Salamandra salamandra*, with 15 subspecies, is a problem). These are sometimes sufficient to allow the reader to get his/her bearings, but in other cases all but the most geographically savvy will be lost. In many instances the range markings on the maps are so small and inconspicuous that only careful inspection reveals them (a surprisingly large number of species have areas of occurrence of <20 km^2). This is particularly problematic for high elevation forms, as the red distribution shading is hard to distinguish from the reddish-orange used to denote areas of high elevation on the maps (see for example *Tylototriton verrucosus*, p. 145, as well as many of the bolitoglossine maps). In some cases the maps extend to the absolute inner margins of the page, nearly disappearing in the binding.

The illustrations are also almost uniformly too small. The vertebrate phylogeny on p. 35, for example, is nearly unreadable. Even the larger photos are only 60 × 40 mm, whereas some of the smallest are 30 × 20 mm. In part, this is the result of using (with permission) downloaded low resolution images from AmphibiaWeb. Adults of most taxa are illustrated by color photo-

graphs (although there are none for any of the five species of the subgenus *Oaxakia* within *Bolitoglossa* and few of *Oedipina*), and in some instances larvae and/or eggs are also depicted. For some Chinese taxa colored drawings are provided instead and in some cases, chiefly within the *Ambystoma tigrinum* group, museum specimens have been photographed. The photos come from many sources and, as such, are highly variable in quality. Some are adequate to illustrate diagnostic features, but many, especially given their small size, leave much to be desired. In one case the same photo, showing *Ambystoma macrodactylum* eggs, has been used twice (pp. 76 and 97). Some photos are on neutral backgrounds, others are clearly taken in aquaria or terraria, and still others on naturalistic backgrounds. On page 113 a photo of *Ommatotriton vittatus cilicensis* floating in a water column has an out of focus street scene behind it!

The text concludes with a table comparing the suprageneric taxonomy of Dubois (2005) with that of Frost et al. (2006) and a large table summarizing the familial and less inclusive taxonomy employed in the book, with allocation to subgenera, species groups and complexes as well as genera noted. There is a glossary of 58 terms and a bibliography of >450 references. The index entries are by genus only, except (rather confusingly) for species group names, such as "*dunni*" and "*elongatus*," which appear without reference to the genera to which they belong. At least one taxon, *Pseudoeurycea cephalica rubrimembris*, is not indexed, despite having a full text account.

What makes this book so unique is the juxtaposition of information of various types. On the one hand, the book should appeal to herpetoculturalists who specialize in urodeles. In comparison to other groups of amphibians and reptiles, the literature on salamander husbandry is limited, and Rafaëlli has provided concise, taxon-specific information about the care and breeding of most groups. On the other hand, the book's species accounts provide the only complete summarization of all living salamanders using current taxonomy in book form, and should be attractive to systematists and conservationists. Although much of the information is available from the Global Amphibian Assessment, Raffaëlli has added material and, of course, made everything available in book form. These two seemingly disparate elements of the book, however, make perfect sense in light of the third component — the author's autobiographical introduction. I especially enjoyed reading this "personal adventure" and suspect that it might inspire some readers with rather focused interests to expand their horizons and appreciate the "holistic salamander" as it is clear the author does. Jean Raffaëlli has written a book not for herpetoculturalists or for systematists, but for those, like himself, with an abiding fondness for urodeles in all contexts. On a more practical note, despite the too small images, *Les Urodèles du Monde* has become my "go to" source for basic information about salamanders on a global scale. For anyone with a serious interest in salamanders, amateur or professional, this book will serve as a global urodelan who's who.

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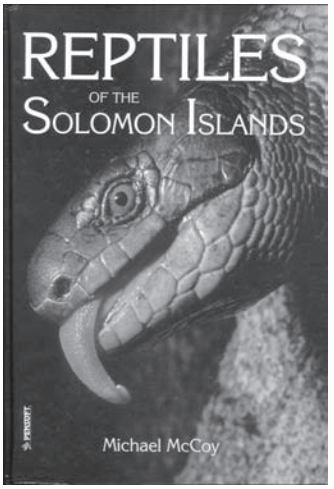
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Reptiles of the Solomon Islands, by Michael McCoy. 2006. Pensoft Publishers, Sofia, Bulgaria (www.pensoft.net). 147 pp. Hardcover. ISBN 978-954-642-275-0. € 45.00 (approx. US $67.00).

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This book is a new edition of a work initially published in 1980 and subsequently revised and released as a CD-ROM (McCoy 2000). The geographic scope of the volume includes the entirety of the nation of Solomon Islands, including the Santa Cruz Group to the southeast of the main Solomon chain, and Bougainville and nearby islands, which constitute a part of the North Solomons and are politically part of Papua New Guinea. The reptile fauna of the Solomons is both species-rich (86 species), and phylogenetically diverse. Lying close to New Guinea, these islands support reptiles, such as crocodiles, varanids, agamids, acrochordids, and terrestrial elapids, that are lacking from most of the more distant island groups of Oceania. Among the more widely-distributed scincid lizards, the Solomons boasts 11 genera, including the monotypic endemics *Corucia zebrata*, which was CITES listed in 2002, and *Geomyersia glabra*, and 16 species of *Emoia*. The need for a new edition of this work is clear given both the taxonomic advances and environmental losses (particularly the degradation of lowland forests and impact of the pet trade) of the last quarter century.

The introduction includes a brief overview of the topography, geological history, and climate of the region, and an explanation of the species accounts, each of which includes information on English and Latin names, author and date of description, distribution (extralimital and within the Solomons) and type locality, description (based on specimens and published data), color and pattern (based chiefly on observations of live specimens), and natural history. In general, the most recent taxonomic revisions have been followed, for example Zug (2004) for *Carlia*, and Manthey and Denzer (2006) for *Hypsilurus*. McCoy also provides insight (usually based on consultation with experts on particular groups) into remaining taxonomic problems, indicating that *Lepidodactylus guppyi*, *Emoia pseudocyanura*, and *Sphenomorphuis solomonis* are probably composite, signaling the presence of an undescribed species of *Sphenomorphus* (listed as *S. undulatus* by McCoy 1980),

noting that *Sphenomorphus bignelli* is currently incorrectly assigned to genus, and rejecting the validity of *Varanus juxtindicus* (Böhme et al. 2002) from Rennell Island. His observation that Solomons populations of *Cyrtodactylus louisiadensis* are probably not conspecific with those from the Louisiade Archipelago has subsequently been confirmed and *C. solomonensis* has been erected to accommodate these geckos (Rösler et al. 2007).

Keys are provided for marine turtles and for families and genera of lizards and snakes. Keys to species are also presented for all genera with two or more species. One significant problem is that the keys for geckos, as well as the corresponding text in species accounts, confuse digit I and digit V (e.g., on pp. 28 and 36 *Hemiphyllodactylus* is said to have a reduced and clawless digit V, whereas these features characterize digit I only). This error has some potential ramifications; most importantly, are the reported lamellar counts for digit IV (a standard character reported for geckos with scansors) actually referring to digit II because of the incorrect polarity? This aside, I noted only two substantive errors in the text: 1) Sprackland is credited as author of *Varanus spinulosus*, but the taxon was actually described by Mertens (1941) and subsequently elevated to full species by Sprackland (1994); and 2) *Ramphotyphlops angusticeps* is listed as occurring in New Caledonia as well as the Solomons; the New Caledonian type locality, and sole record, is considered incorrect (Bauer and Sadlier 2000).

Some of the most useful and interesting aspects of the text relate to the natural history notes, many of which are drawn from McCoy's own observations. While a few accounts, most notably that of *Corucia zebrata*, cite other sources, the majority of natural history data are unreferenced. At least for serious users of the book, it would have been beneficial to have citations in the relevant primary literature (e.g., pseudocopulation in *Lepidodactylus lugubris*, p. 41).

This new edition is far better illustrated than McCoy's first edition. Most taxa are illustrated by color photos (exceptions include *Caretta caretta*, *Dermochelys coriacea*, *Hypsilurus longii*, *Lepidodactylus mutahi*, *L. shebae*, *Acutotyphlops kunuaensis*, *A. solomonis*, *Ramphotyphlops mansuetus*, and the three regional *Hydrophis*) that appear two per page—large enough to be useful. Not only are the photos generally sharp and illustrative of important features, they are also accompanied by localities, with all but four species represented by animals from the Solomons. A few rare species are represented by photos of preserved specimens (*Sphenomorphus fragosus*, *S. tanneri*, *S. taylori*, *S. transversus*, *Parapistocalamus hedigeri*), but these are also of high quality. In comparison with the first edition (McCoy 1980), which had 20 plates (8, with 64 separate photos, in color), the current version has 128 color photos. The current volume is also nearly twice the length of the older book and offers a new set of checklists giving the occurrence of reptiles for each of 17 islands or island groups within the Solomons. The 82-entry glossary is essentially unchanged from the 1980 edition and the literature cited includes 71 references, only 15 more than the older book, but with many older entries replaced by more recent ones. A few seemingly relevant citations are missing but given that the corresponding text is not intended to be a technical monographic this is understandable. Only the index is a disappointment by comparison with the earlier book; the 1980 index conveniently included index entries by specific epithet as well as genus, whereas the 2006 index lists entries only by genus.

Although not every herpetologist needs a guide to the reptiles of the Solomon Islands, those who do will find this book to be concise, authoritative, and well illustrated. Although Euro prices make the book relatively expensive by American standards, it is the only up-to-date source for the region and should certainly find a place on the shelves of anyone working on insular herpetofaunas or interested in Pacific biodiversity.

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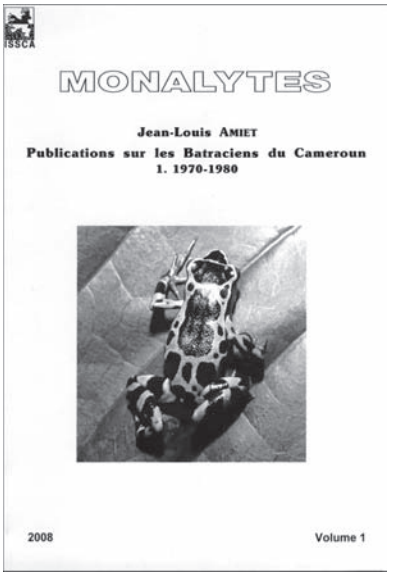
Erratum

In the article "Detection of Crotamine and Crotoxin Gene Sequences in Genomic DNA from Formaldehyde-fixed Rattlesnakes" by Corrêa et al., published in Volume 38, Number 2 (2007) of *Herpetological Review*, PCR conditions indicated on p. 159 should have read: 0.2 mM of dNTP, 2 mM of MgCl2 and 0.6 U of Taq polymerase.

A New Batrachological Reprint

Jean-Louis AMIET

Publications sur les Batraciens du Cameroun



From 1970 to 2007, Jean-Louis AMIET published 53 papers dealing with the amphibians of Cameroun. These papers covered many fields of the study of these animals: systematics (description of 42 new taxa), ethology, ecology, faunistics. Most of these papers were published in periodicals which no longer exist and may be difficult to find, especially for young biologists who do not have direct access to major libraries. The author decided to prepare a complete facsimile reprint of these works, including in many cases post-scriptum notes providing additional unpublished information on the topic of the paper.

The whole reprint covers 1587 pages, published by ISSCA as two separate volumes that will constitute the first two issues of *Monalytes*, a new series of batrachological monographs issued by ISSCA. Both volumes will be published in 2008. Volume 1 (748 pages) covers the period 1970–1980.

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Herpetological Circular 38

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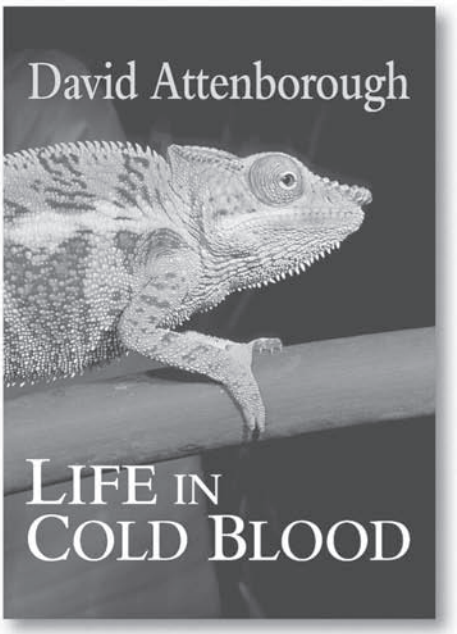
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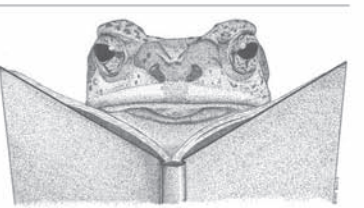
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www.ssarherps.org



The Society for the Study of Amphibians and Reptiles, the largest international herpetological society, is a not-for-profit organization established to advance research, conservation, and education concerning amphibians and reptiles. Founded in 1958, SSAR is widely recognized today as having the most diverse society-sponsored program of services and publications for herpetologists. Membership is open to anyone with an interest in herpetology—professionals and serious amateurs alike—who wish to join with us to advance the goals of the Society.

All members of the SSAR are entitled to vote by mail ballot for Society officers, which allows overseas members to participate in determining the Society's activities; also, many international members attend the annual meetings and serve on editorial boards and committees.

ANNUAL DUES AND SUBSCRIPTIONS: Annual membership dues for the year 2008 in the Society for the Study of Amphibians and Reptiles are as follows: **REGULAR** membership US$60 (Student $30)—includes *Journal of Herpetology* and *Herpetological Review*; **PLENARY** membership US$80 (Student $45)—includes *JH*, *HR*, and annual subscription to the *Catalogue of American Amphibians and Reptiles*; **INSTITUTIONAL SUBSCRIPTION** $115—includes JH and HR. Additional fee for airmail postage outside USA $35 for one year. Additional membership categories available on the SSAR webpage: http://www.ssarherps.org/pages/membership.html.

All members and institutions receive the Society's primary technical publication, the *Journal of Herpetology*, and its newsjournal, *Herpetological Review*; both are published four times per year. Members also receive pre-publication discounts on other Society publications, which are advertised in *Herpetological Review*.

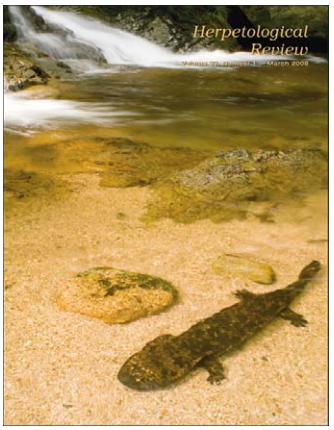
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Future Annual Meetings

2008 — Montreal, Canada, 23–28 July (with ASIH, HL)
2009 — Portland, Oregon, 22–27 July (with ASIH, HL)
2010 — Providence, Rhode Island, 7–12 July (with ASIH, HL)
2011 — Minneapolis, Minnesota, 6–11 July (with ASIH, HL)

About Our Cover: *Andrias japonicus*



Clear, cold mountain streams drain the rugged mountains of Japan's Honshu, Shikoku, and Kyushu islands. At one site on Honshu Island, at an elevation > 500 m, the riverbed is rocky and water-swept. Oak and maple trees grow in the surrounding closed canopy forest along with clusters of bamboo. Cold temperatures and constant agitation of the water produce a highly oxygenated environment. Lurking beneath the waters of these clear mountain streams is the Japanese Giant Salamander, *Andrias japonicus*. *Andrias* contains two living species: *japonicus* and *davidianus* (from China). Together with the North American Hellbender (*Cryptobranchus alleganiensis*), these are the only living members of the ancient family Cryptobranchidae. This group is remarkable both for containing the largest living amphibians (the two species of *Andrias*, to ~ 1.5 m TL) and displaying a remarkable geography—two species in eastern Asia and one in eastern North America.

The breeding season for *A. japonicus* spans August to September when males compete to control breeding sites. The breeding sites consist of grottos and cubbies in the waterway that are protected enough for the male to guard eggs deposited there. Male competition for these sites can be fierce, even resulting in death. Males that retain control of the sites are referred to as "den masters." Females deposit clutches of 400–500 eggs within the dens, which the males guard until the larvae hatch and disperse. The larvae take 4 or 5 years to metamorphose into an adult form. Captive animals have lived > 50 yrs. Wild longevities are still not clearly understood.

Danté Fenolio was in Japan (with funding from the Javitch Foundation) visiting research biologist Sumio Okada (Ph.D. student at Shimane University). Okada has been monitoring several populations of *Andrias* for over 7 years with pit tags in roughly 650 individuals. This work is critical in developing an understanding of the population ecology and habitat requirements of these ancient animals. Fenolio met an elderly gentleman in one such village who has interacted with *A. japonicus* since the pre-World War II era. His descriptions of the sizes of animals he has encountered and their abundance, past and present, speaks to a slow but steady decline of the species. The salamander on our cover resides in a stream that is slated for a controversial hydroelectric dam. Public awareness about the plight of these salamanders is increasing and a television special featuring Sumio and his work recently aired on the National Geographic Channel.

Fenolio's photograph of our cover subject came about with the assistance of Sumio Okada, who led Danté to the mountain stream locality on Honshu Island where they encountered the salamander. Wildlife photographer Michael Ready shared a tip involving a flash method to create the "foggy" look in the waterfall while keeping the salamander in the foreground crisp and well lit. The photo was taken with a Konica-Minolta 5D, Minolta 24mm lens on a tripod, with a Sony twin-flash unit.



Danté Fenolio is a Ph.D. Candidate at the University of Miami and a recent hire by the Atlanta Botanical Garden for their amphibian conservation program. His research focuses on subterranean biodiversity and amphibian ecology/systematics. Mike Ready took this image of him at the Tottori Prefectural Museum, Japan, and it is used here with their permission. The preserved *Andrias japonicus* shown here was 143 cm long (TL) with a mass of 44.3 kg at the time of death.

SSAR BUSINESS

New Opportunities for Students at Montréal Meeting

There was much discussion at the 2007 St. Louis Annual Meeting regarding student involvement in SSAR and how to make the Annual Meeting more accessible to students and encourage their attendance. With this in mind, a Student Participation Committee was formed (Dawn Wilson, Chair) and plans are underway to change a number of aspects of the meeting. The 2008 Joint Meeting of Ichthyologists and Herpetologists will be held in Montréal, Canada, July 23–28. SSAR is planning two new events specifically for our student members. We will hold a lunch meeting (pizza provided) with the members of the Student Participation Committee, several members of the Board, and those students who want to take a more active role in the Society. Every year we look for students to serve on committees and editorial boards, organize events at our Annual Meeting, etc. If you have an interest in serving the Society in any capacity, the Board needs to know who you are! Additionally we are planning an evening students-only social immediately prior to the opening general reception (finger food plus drink tickets provided). Board members and a number of senior herpetologists will be in attendance and there will be ample opportunities to meet and talk with younger members of the Society.

We wish to issue a reminder that the Board Meeting (which will be held on July 22) is open to all members of the Society and everyone is encouraged to attend. Because we know that most members are not usually able to arrive a day early, we will be changing the format of the Business Meeting (usually held on the 4th day of the meeting) so that it will now more closely resemble a Board Meeting. Officers and Editors will be in attendance and will each present a brief Annual Report and a summary of upcoming plans. Audience participation will be expected.

We hope that these changes will encourage all of our members, especially students, to continue to support our Society and attend our Annual Meeting. SSAR is proud of its student roots and rec-

ognizes that the future of our organization rests on continued student involvement.

The Student Participation Committee welcomes feedback or suggestions from any interested member (e-mail: dwilson@amnh.org). We hope to see many of you in Montréal.

—Marion Preest, SSAR Secretary

SSAR Henri Seibert Awards for 2008

The Henri Seibert Awards were initiated in 1992 to provide recognition for the best student papers presented at the annual meeting of the SSAR. To be eligible, the presented paper must be the result of research by the individual making the presentation. The research must have been conducted while the student was enrolled in either an undergraduate or graduate degree program. Please refer to *Herpetological Review* 28(4):175 and the SSAR website (http://www.ssarherps.org/pages/seibert.php) for recommendations to students entering the Henri Seibert Competition. Students entering the competition must be members of SSAR. The presentations will be judged by the SSAR student prize committee. One Henri Seibert Award of US $200 may be given in each of the following **four** categories: **Systematics/Evolution**, **Ecology**, **Physiology/Morphology**, and **Conservation**. Students may win the award only one time. Please indicate the appropriate category for which you are applying on the abstract submission form. Announcement of winners will be made at the **SSAR Business Meeting**. All participants should be present at the business meeting. Contact Patrick Owen for further information: owen.133@osu.edu.

6th World Congress of Herpetology Manaus, Amazonas, Brazil

We are preparing for a bumper crop of herpetologists from throughout the world to join us for the event of the millenia—the 6th World Congress of Herpetology, to be held jointly with SSAR, in Manaus, Amazonas, Brazil 17–22 August 2008. This will be first World Congress in the New World and it will be done with all of the flare and pomp of the First World Congress, with the added signature touch that people have appreciated in the SSAR-HL congresses I ran in Veracruz in 1987 and Manaus 2003. I will not try to outdo these, but come and see if I do! Remember my motto—no tickets, no lines, no limits!

Please see our website (www.worldcongressofherpetology.org). It is a dynamic site; as events and offers are solidifying they are being placed on the web, so visit us often.

It is our pleasure to host this meeting on the shores of the Rio Negro, in the heart of the Amazon Rainforest at the five-star Tropical Hotel. Since you are coming all this way, take some time before or after the meeting to go out and see the forest or take a river trip. Set up your own groups to go on river trips, many of the plenary speakers and symposium organizers will be accompanying post-meeting river trips, so you will have days to talk with some of the greats in herpetology on a one to one basis. Contact Vic Hutchison for his special Varig Airline Affiliated post meeting birding tours to the patanal.



Field trips along jungle rivers can be programmed aboard boats like our boat the *Enigma*, allowing total comfort and safety while fishing or observing wildlife.

On Sunday afternoon there will be a special session on "Amphibian Conservation: Moving from Global to Regional Planning" organized by Don Church of Conservation International, with an interval for the first plenary lecture, followed by a dinner and awards session for the invited members of the Amphibian Conservation session.

Each session of the meeting, from Monday–Friday, will begin with lectures by plenary speakers, followed by either symposia or contributed papers. Access to posters will be available all day, culminating with a happy hour session at the end of each afternoon when the poster authors will be available for discussions. There will be the traditional Monday night social icebreaker with regionally produced beverages, finger food, and regional dance show. Tuesday evening will be a special event—the Secretary General of the World Congress birthday party. Wednesday night will be a picnic (Churrasco) on the white sand beach of the Negro River complete with a Boi Boom Ba live dance show. Thursday night will be the traditional turtle group "lunch" as well as other optional choices such as trips to the Opera House, music and dance houses such as Remulos. Friday evening will be the final plenary presentation by Ian Swingland during the Banquet, followed by the AIHA sponsored live auction, and discotec until dawn.

Plenary Speakers

We have gathered a prestigious group of plenary speakers, known not only for the excellence of their science but also for their communication and entertainment skills. There will be no heads nodding in the aisles when these herpetologists are performing!

—William E. Magnusson, INPA. The evolution of herpetological studies in the Amazon. Sunday evening welcome address.
—Russell Mittermeier, President, Conservation International. Global priorities in reptile and amphibian Conservation. Keynote speaker.
—Darrel Frost, American Museum of Natural History, E.D. Cope Honorary Speaker. The past, present, and future of the science of amphibian systematics.
—Peter Narins, UCLA. Exploring frog communication behavior: continuing adventures of an expeditionary biologist.

—Michael Bull, Flinders University, Australia. Lizard social behavior and conservation: lessons from an Australian skink.
—Richard Shine, University of Sydney. Invasion biology and impact of cane toads in Australia—the way it really is!
—John M. Legler, Professor Emeritus, University of Utah. Turtles: a paradigm of versatility and venerability.
—Fred Allendorf, University of Montana. Genetic effects of habitat fragmentation.
—Jonathan Losos, Harvard University. Evolutionary diversification on islands and mainlands: historical contingency and adaptive radiation in *Anolis* lizards.
—Aaron Bauer, Villanova University. Spatial and temporal history of geckos of the world.
—Ian Swingland, Director of the First World Congress of Herpetology, from his world base in Kent. Peeling peaches in the pampas.
—James Parham, California Academy of Sciences. Human impact on the diversity, distribution, and systematics of turtles.
—Oscar Flores-Villela, UNAM. The making of a national herpetofauna, the herpetofauna of Mexico.
—Marvalee Wake, University of California, Berkeley. Evolution of amphibian viviparity and the origins of homoplasies.
—Celio Haddad, Universidade Estadual Paulista Júlio de Mesquita Filho (UNESP, Campus de Rio Claro). Reproductive behavior in anuran amphibians.

Featured Symposia

—Reproduction in Reptiles: From Genes to Ecology. Michael B. Thompson & Scott L. Parker, organizers.

—Invasive Reptiles and Amphibians: Global Perspectives and local solutions. Robert Reed, organizer.

—Sensory Ecology of Anuran Communication. T. Ulmar Grafe & Peter M. Narins, organizers.

—Evolutionary Transitions of Body Shape in Extant Amphibians and Reptiles: Call for Integrative Approaches. Tiana Kohlsdorf, organizer.

—Herpetofaunal Reintroductions, Translocations, and Supplementations. Jennifer M. Germano & Phillip J. Bishop, organizers.

—Disease and Amphibian Declines—Where Do We Go from Here? Jean-Marc Hero, Erin Muths, & Trenton W. J. Garner, organizers.

—The Biology and Management of Crocodilians. John Thorbjarnarson & Kent Vliet, organizers.

—Herpetological Conservation & Biology. Robert Brodman, Robert Murphy & Ben Bell, organizers.

—Biogeography of the South and South East Asian Herpetofauna. David J. Gower, organizer.

—Dendrobatoid Frog Biology. Taran Grant & Stefan Lötters, organizers.

—Ecophysiology of Reptiles. Denis Otávio Vieira de Andrade & Glenn Tattersall, organizers.

—Sequestered Defensive Compounds in Tetrapod Vertebrates and Defensive Mechanisms of Amphibians and Reptiles: Actual Knowledge and Future Perspectives. Alan H. Savitzky, Akira Mori, Deborah A. Hutchinson, & Luis Felipe Toledo, organizers.

—Status of South American Freshwater Turtles. Brian Bock, organizer.

—Development and Implementation of Recovery Programs for Endangered Chelonians. Rick Hudson, organizer.

—Conservation Genetics of Amphibians and Reptiles in the 21st Century. Robert Jehle & Trenton W. J. Garner, organizers.

All activities of the 6th World Congress of Herpetology 2008 will be held at the Hotel Tropical Conference Center, located 16 km from downtown Manaus, and 10 km from the airport, in a ritzy party area of Manaus known as Ponta Negra. The Ponta Negra Beach stretches along the high banks of the Negro River, which, at this point, enlarges to a width of 8 km. Outside the hotel complex an elevated riverside promenade with numerous bars and small restaurants provides an agreeable alternative for a late afternoon stroll in a safe atmosphere with local live music and live locals as well. You can share a privileged sight of the sunset over the Negro River.

There is a huge outdoor amphitheater where musical groups (boi, Manaus Philharmonic Orchestra, samba, pagode, etc.) perform free on Sunday afternoons and other special occasions. Because we are a special occasion, I am sure something will be happening there during your stay with us. It is too early to predict the program, but surely something lively will be happening.

The Hotel Tropical has 588 luxurious air-conditioned rooms with cable TV, minibar, telephone, and room service. The hotel has two swimming pools (one with a waterfall), a mini-shopping center, discotec (which will be open most nights), four restaurant-bars and two additional bars. The aviary, which used to occupy much of the lobby, has been transformed into a wonderful piano bar, a small zoo displaying some species of the local fauna, a botanical garden and orchid house, as well as access to the beach.

Several years ago, while on the beach at low water, a young girl walked by carrying a fresh meter-long anaconda. Frogs call from the trees, geckos scamper up walls. It is a huge, sprawling hotel with surrounding gardens and forest areas overlooking the Rio Negro! There is a security wall around the grounds, and security



Part of the local committee aboard the Enigma to welcome all herpetologists from around the world to the 6th WCH in Manaus.

guards at the access gates, so personal safety is guaranteed and the general public does not stroll onto the grounds by any means. So it is a safe place to turn your families loose. I personally recommend all people who do not speak Portuguese to stay at this hotel. A large percentage of the wonderfully friendly hotel staff speaks English.

The food is tremendous and you are not going to waste any time traveling back and forth to the paper sessions on buses or taxis. The hotel puts out a magnificent buffet breakfast with local fruits, juices, specialty Amazonian dishes, as well as standard eggs, cereals, meats, and dairy products. As the breakfast at all of the hotels comes with the room we will NOT have second breakfast being served at coffee breaks. Coffee breaks will be high on caffeine and low on carbohydrates and calories, but do not worry as there will be munchies!

Salads,vegetables, and pasta can be found in the menus offered at the hotel restaurants, as well as native fish, seafood, beef, and fowl, all in buffet style so it is not necessary to worry about something special for your palate or diet. Most of the fruit juices served are natural and the fruit collected locally. So if you want to eat only veggies or all red meat or only nibble a bit you are your own dietician and can fill and refill your plate to your taste, I would not try to lose weight while you are here. Remember, we are in the heart of the Amazon—not on the coast, so we will have a tremendous variety of local fishes prepared in traditional recipes to experiment with. Seafood is imported from the coast, expensive, frozen, and not to be expected as part of the local cuisine. We will have some surprisingly exotic food to sample both in the daily buffets as well as in the evening socials, anti-socials, picnics, and banquets.

There is a boat dock, helicopter pad, and pontoon plane hangar at the hotel with service to the surrounding jungle lodges. Most of these jungle lodges give daily boat taxi service to Hotel Tropical. The paper sessions are in the hotel complex. Most if not all of the picnics, banquets, social activities, dance presentations, etc., will be held at the hotel, or close by, so you will use your time much more efficiently and your stay will be much less hectic if you stay here.

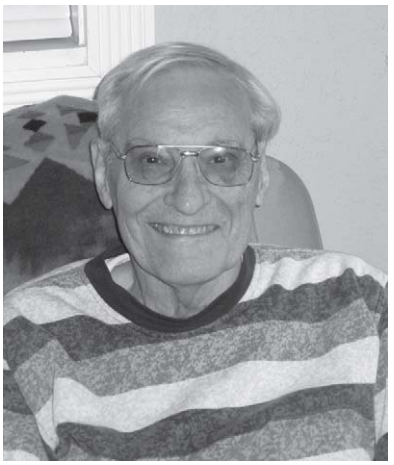
All other hotels are NOT within walking, running, or swimming distance from Hotel Tropical. If you prefer feeling the culture of Manaus, by all means stay at one of the smaller hotels downtown, but you will waste at least two hours a day doing so. Morning and evening shuttle buses will probably be provided, but you can also ride taxis back and forth, usually 4 people can ride for the price of the fare ($12US). There are inexpensive hotels downtown as well as youth hostels for people on a tight budget and we will run free shuttle buses to and from Hotel Tropical to downtown. Tap water is safe to drink, there is not a malaria problem at Hotel Tropical, the beer is cold, and the environment exciting to say the least. See our web site for registration material and hotel/airfare packages: www.Worldcongressofherpetology.org

See you in Manaus!

Richard C. Vogt, Director
Sixth World Congress of Herpetology-AIHA-SSAR Joint Meeting

NEWSNOTES

Herbert C. Dessauer Honored by LSU



On September 6, 2007 the Foundation for Louisiana State University Health Sciences Center added several positions to the Louisiana Board of Regents Endowed Professorship Program. Among these is the "Herbert C. Dessauer Professorship in Graduate Studies." Readers of HR will recognize Herb as a pioneer in the development of molecular systematics and the use of molecular techniques to analyze hybridization and its consequences. Herb was also the first graduate student to receive the Ph.D. from the LSU Health Sciences Center, in New Orleans, in 1952.

University of Illinois Museum of Natural History

The Illinois Natural History Survey (INHS) is pleased to announce that we are once again filling loan requests for the University of Illinois Museum of Natural History (UIMNH) Amphibian and Reptile Collection. This exceptional collection was moved to storage in 2002 because of space re-assignment by the University of Illinois. The INHS has just finished moving the entire collection to our facilities. Direct all inquiries to the curator, Chris Phillips, at chrisp@inhs.uiuc.edu. The collection is computerized and can be searched at the URL below. This search engine will return limited location data (county, state & country). Specific location information can be obtained by contacting the curator.

<www.inhs.uiuc.edu/cbd/collections/AmphReptColln/herp_links/uiherps.html>

Summer Field Course in Conservation Biology, with an Emphasis on Amphibians and Reptiles

A field course in Conservation Biology will be offered at the Lakeside Laboratory from 2–27 June 2008. Lakeside Lab is located in northwestern Iowa, along the intersection, from east to west, between the Eastern Deciduous Forest and Great Plains, and along the intersection, from north to south, between the recently glaciated Lakes Region and the older, better drained, and more variable stream systems associated with Missouri and Mississippi River uplands.

A combination laboratory and field course, Conservation Biology examines the history of the Upper Midwest from the retreat of the latest glaciers to the present day. Northwest Iowa is a land-

scape of lakes, wetlands, prairie, and oak savannah; it is also a place of intense agriculture, an area of concentrated summer tourism, and it hosts a wind farm. In this context, native ecosystems will be compared against altered ecosystems, and the processes of restoration will be measured against these extremes. Students will participate in a habitat restoration and should bring rugged clothing, sturdy boots, heavy canvas gloves, and a hard hat.

The herpetofauna of this area is well known. Highlights include the turn-of the-century (19th to 20th) commercial collections of 20 million leopard frogs/yr, the pioneering surveys of Frank Blanchard in the 1920s, and more recent findings that bear on the global problems of amphibian malformations and declines. We will visit the only known Prairie Rattlesnake populations in Iowa.

For information about Lakeside Lab see:

http://www.continuetolearn.uiowa.edu/lakesidelab/

For more information about the course, contact: Michael J. Lannoo, Indiana University School of Medicine - TH Holmstedt Hall, Rm 135, ISU Terre Haute, Indiana 47809, USA; e-mail: mlannoo@iupui.edu.

MEETINGS

Meetings Calendar

Meeting announcement information should be sent directly to the Editor (rwh13@csufresno.edu) well in advance of the event.

10–12 April 2008—55th Annual Meeting of the Southwestern Association of Naturalists, University of Memphis, Tennessee, USA. Information: http://www.biosurvey.ou.edu/swan/

11–13 April 2008—Fourth Annual Sonoran Desert Herpetological Symposium, Tucson, Arizona, USA. Information: http://www.arts.arizona.edu/herp/

5–8 June 2008—Joint Meeting of Texas Herpetological Society, SW PARC, Horned Lizard Conservation Society; University of Texas, Austin, Texas, USA. Information: gad.perry@ttu.edu

18–21 June 2008—32nd International Herpetological Symposium; Nashville, Tennessee, USA. Information: www.kingsnake.com/ihs/

23–27 June 2008—6th Symposium on Lacertids of the Mediterranean Basin, Lesvos Island, Greece. Information: http://www.elerpe.org/

23–28 July 2008—51st Annual Meeting, Society for the Study of Amphibians and Reptiles; 88th Annual Meeting, American Society of Ichthyologists and Herpetologists; 66th Annual Meeting, The Herpetologists' League. Montreal, Quebec, Canada. Information: http://www.dce.ksu.edu/jointmeeting/

17–20 August 2008—6th World Congress of Herpetology, Manaus, Brazil (meeting jointly with SSAR). Information: http://www.worldcongressofherpetology.org/index.php?section=51

24–29 November 2008—VIII Latin-American Congress of Herpetology (VIII Congreso Latinoamericano de Herpetologia), Topes de Collantes, Sancti Spiritus, Cuba. Information: Roberto Alonso Bosch (e-mail: 8voclah@fbio.uh.cu or ralonso@ecologia.cu).

CURRENT RESEARCH

The purpose of **Current Research** is to present brief summaries and citations for selected papers from journals other than those published by the American Society of Ichthyologists and Herpetologists, The Herpetologists' League, and the Society for the Study of Amphibians and Reptiles. Limited space prohibits comprehensive coverage of the literature, but an effort will be made to cover a variety of taxa and topics. To ensure that the coverage is as broad and current as possible, authors are invited to send reprints to the Current Research section editors, **Joshua Hale** or **Ben Lowe**; postal and e-mail addresses may be found on the inside front cover.

The current contents of various herpetological journals and other publications can be found at: http://www.herplit.com/contents.

Impacts of Invasion Stress on Invasive Cane Toads

The process of invading a novel environment may introduce new stresses to invasive species themselves, but these impacts have received little attention. While studying a Cane Toad (*Chaunus* [*Bufo*] *marinus*) invasion in the Northern Territory, Australia, the authors noticed frequent abnormalities in the spinal joints of toads at the invasion front. To determine whether the traits that facilitate successful invasion (e.g., larger body size and greater distance moved per day) are related to spinal arthritis, they examined toads from three invasive populations and established that arthritis only occurs in larger toads, and that the frequency of the condition in a population is correlated with the population's mean movement rate. Using pairs of size- and sex-matched toads that differed by spinal condition, both telemetry of free-ranging toads and locomotor performance tests showed that arthritic toads move as far and as fast as non-arthritic conspecifics. Bacterial cultures from arthritic and normal spinal joints showed that arthritic joints are infected by *Ochrobactrum anthropi*, a common soil bacterium. The authors conclude that the invasion process, which selects for larger body size and longer limb length (making animals more susceptible to degenerative disease), and a highly active lifestyle of almost constant movement (causing even greater stress on the spine), have rendered the cane toad susceptible to joint bacterial infection and spinal arthritis.

Brown, G. P., C. Shilton, B. L. Phillips, and R. Shine. 2007. Invasion, stress, and spinal arthritis in cane toads. Proceedings of the National Academy of Science 104:17698–17700.

Correspondence to: Richard Shine, School of Biological Science, University of Sydney, Sydney NSW 2006, Australia; and Department of Primary Industries, Fisheries, and Mines, Berrimah Veterinary Laboratories, Darwin NT 0801, Australia; e-mail: rics@bio.usyd.edu.au.

Scent Marks Indicate Competitive Ability in Lizards

Scent marks are typically thought to be signals of an individual's competitive ability, even in that individual's absence from its territory. However, in addition to conveying information about a potential competitor in an area, these marks may also signal the resource availability of the area. To determine the role of male scent

marks in intrasexual communication in the Iberian Wall Lizard (*Podarcis hispanica*), and whether these roles change across the reproductive season, the authors captured lizards from near Valencia, Spain in the early (March) and late (June) breeding season. Ten males from each season were exposed to four experimental tests: scent marks from a stimulus male similar in size, scent marks from a larger male, scent marks from a smaller male, and no scent (control). These trials showed that early (but not late) in the breeding season, males were attracted to areas scent marked by males of similar or larger size (as measured by time spent in marked area) but not to areas marked by smaller males. These results indicate that *P. hispanica* males can obtain information on rival male size, shown to be an honest indicator of dominance in this species, from scent marks. Because males spent more time in areas marked by presumably dominant rivals, the authors suggest that scent marks may function as indirect measures of territory resource quality, assuming that dominant males defend superior territories. They also discuss potential explanations of the seasonal change in male response to scent marks.

CARAZO, P., E. FONT, AND E. DESFILIS. 2007. Chemosensory assessment of rival competitive ability and scent-mark function in a lizard, *Podarcis hispanica*. Animal Behaviour 74: 895–902.

Correspondence to: P. Carazo, Instituto Cavanilles de Biodiversidad y Biología Evolutiva, Universidad de Valencia, Apdo. 22085, 46071 Valencia, Spain; e-mail: pau.carazo@uv.es.

Discrimination of Sea Turtle Artifacts Using DRIFT Spectroscopy

Sea turtle (Family Cheloniidae) scutes have been widely used in the manufacture of historic artifacts such as jewelry and furniture. Keratins from these scutes closely resemble those from bovid horn sheaths, and it is of great importance to museum curators and law enforcement officers to correctly identify the origin of artifacts, particularly given the endangered status of all sea turtle species. The authors investigated the utility of diffuse reflectance infrared Fourier transform (DRIFT) spectroscopy to distinguish between sea turtle and bovid keratin. Using 35 bovid samples from 24 species and 24 sea turtle samples from 4 species, they found that examinations using only raw DRIFT spectra may result in spurious taxonomic assignment, but analyzing these data using discriminant analysis provided reliable identification of all standards used in this study. This technique can also be used to differentiate protein-based plastics (i.e., casein) from sea turtle carapace. The authors conclude that DRIFT spectroscopy combined with discriminant analysis provides a rapid, non-destructive method of distinguishing sea turtle keratin in artifacts and may be a powerful tool in the modern wildlife trade.

ESPINOZA, E. O., B. W. BAKER, AND C. A. BERRY. 2007. The analysis of sea turtle and bovid keratin artifacts using drift spectroscopy and discriminant analysis. Archaeometry 49: 685–698.

Correspondence to: E. O. Espinoza, US National Fish & Wildlife Forensics Laboratory, 1490 E. Main St., Ashland, Oregon 97520, USA; e-mail: ed_espinoza@fws.gov.

Underestimation of Tropical Frog Diversity

Amphibians are rapidly declining, yet the number of amphibian species remains underestimated. Together, these observations reveal a pressing need for rapid evaluation of species richness. The authors used a combination of three methods—isolation by distance, phylogenetic analyses (to determine prevalence of paraphyletic species), and comparison of molecular distances (to determine patterns of intra- and interspecific distances)—to analyze previously published and new 16S mtDNA sequence data from 60 species of French Guianese frogs with the goal of estimating the number of undescribed species in this region. With these techniques, they calculated that the "true" number of species relative to the 60 study species is underestimated by 22–115%. They found that although geographically widespread species exist, most geographically distant populations could be considered new species, and that the many instances of paraphyletic species indicate the presence of undescribed cryptic species. From their results, the authors propose that a pairwise genetic distance of 0.03 is appropriate for distinguishing species in this group, and with this approach they identified 129 candidate species. This suggests that amphibian decline might be even more dramatic than previously thought, as both identified and unidentified species are being lost.

FOUQUET, A., A. GILLES, M. VENCES, C. MARTY, M. BLANC, AND N. J. GEMMELL. 2007. Underestimation of species richness in neotropical frogs revealed by mtDNA analyses. PLoS ONE 2: e1109.

Correspondence to: Antoine Fouquet, Molecular Ecology Laboratory, School of Biological Sciences, University of Canterbury, Christchurch, New Zealand; and EA 3781 EGEE Evolution Genome Environment, Université de Provence, Centre St Charles, Marseille, France; e-mail: afo23@student.canterbury.ac.nz.

Hormones and Performance Capacity in Male Lizards

Males of many species advertise their quality with elaborate sexual signals, but the mechanism that links male signals and their fighting ability remains unknown. To test the hypothesis that signal size and fighting ability are related through circulating hormone levels, the authors examined adult male Green Anole lizards (*Anolis carolinensis*), a species in which dewlap (throat fan) size has been shown to predict bite force performance. They captured males during (N = 82) and after (N = 26) the breeding season in Louisiana, USA and measured their morphology, bite force, and concentrations of testosterone and corticosterone in blood. Males were classified into two previously described (presumably age-related) size classes: heavyweights and lightweights. Comparisons of the size classes revealed that heavyweights had higher testosterone levels in the breeding season than lightweights, but corticosterone levels did not differ between the groups. Also, for lightweights, but not heavyweights, testosterone levels were correlated with dewlap size and bite force, but this relationship is due to the influence of body size on all three traits. The authors conclude that these results suggest complex relationships among testosterone, morphology, and performance. They propose that smaller

males suppress testosterone levels until they reach a competitive size, when higher testosterone then increases bite force and dewlap size.

HUSAK, J. F., D. J. IRSCHICK, J. J. MEYERS, S. P. LAILVAUX, AND I. T. MOORE. 2007. Hormones, sexual signals, and performance of green anole lizards (*Anolis cristatellus*). Hormones and Behavior 52:360–367.

Correspondence to: Jerry F. Husak, Department of Biology, University of Massachusetts, Amherst, Massachusetts 01003, USA; e-mail: husak@bio.umass.edu.

Diversification and Convergence in Desert Night Lizards

Species in the night lizard genus *Xantusia* are characterized as having high site philopatry and specific habitat requirements (e.g., individuals may spend their lives under a single log), and previous work has shown that the group has an evolutionary history of deep divergences. To test species delimitations and to compare morphological and mitochondrial assessments of phylogenetic relationships, the authors used sequence data from the mitochondrial cytochrome *b* gene (1143 bp) of 508 lizards in the *X. vigilis* species complex from 156 localities. For subsets of these lizards, they also sequenced a second mitochondrial region (ND2) and two nuclear introns (α-enolase and GAPD). Using standard Bayesian, maximum parsimony, and maximum likelihood techniques with mtDNA data, they propose a novel phylogenetic hypothesis for the *X. vigilis* group, which is largely supported by the nuclear data, and which suggests that the recognized taxonomy for this group underestimates species diversity. Their results support the conclusion that multiple species have converged on a rock-crevice-dwelling morphology, and they infer a deep history of cryptic speciation. The authors propose that vicariance in the late Miocene drove the diversification of *Xantusia*, while climate change in the Pleistocene determined their distribution.

LEAVITT, D. H., R. L. BEZY, K. A. CRANDALL, AND J. W. SITES, JR. 2007. Multi-locus DNA sequence data reveal a history of deep cryptic vicariance and habitat-driven convergence in the desert night lizard *Xantusia vigilis* species complex (Squamata: Xantusiidae). Molecular Ecology 16:4455–4481.

Correspondence to: Dean H. Leavitt, Department of Biology, San Diego State University, 5500 Campanile Drive, San Diego, California 92182-4614, USA; e-mail: dleavitt@rohan.sdsu.edu.

Environment Influences Developmental Trade-offs in Frogs

Fitness tradeoffs between size at and time to metamorphosis have been well-studied in amphibians and other taxa, and larval environmental conditions have been shown to influence these traits. However, multiple mechanisms may drive these tradeoffs. The authors tested the hypothesis that an individual's allocation of resources between growth and development in somatic versus reproductive structures may be driven by environmental conditions, a mechanistic explanation that has received little attention. To this end, they performed two experiments in which *Xenopus laevis* (African Clawed Frog) tadpoles were exposed to varying diets. In the first experiment, 5 groups of 5 tadpoles were reared communally in high or low food treatments, and one group per treatment were weighed and fixed for gonadal size measurement at approximately two week intervals. Results showed that food restriction reduced both somatic and gonadal growth rates, but not developmental rates. In the second experiment, 10 tadpoles were raised individually to metamorphosis on each of three food treatments (low, medium, and high), at which point they were weighed and fixed. These results showed that individuals that experienced food restriction had reduced somatic growth and development and smaller gonads, but the developmental stage of the male testes at metamorphosis was not affected. Together, these results suggest that the lower fecundity associated with small body size at metamorphosis may be at least partially due to gonadal size at metamorphosis, and not just reduced rates of somatic development. As habitats are continually degraded, the influence of environmental conditions on gonadal growth may be an important factor in population regulation.

MCCOY, K. A., M. W. MCCOY, A. AMICK, L. J. GUILLETTE JR., AND C. M. ST. MARY. 2007. Tradeoffs between somatic and gonadal investments during development in the African clawed frog (*Xenopus laevis*). Journal of Experimental Zoology 307A:637–646.

Correspondence to: Krista A. McCoy, Department of Zoology, University of Florida, P. O. Box 118525, Gainesville, Florida 32611-8525, USA; e-mail: kristam@zoo.ufl.edu.

A Developmental Staging Series for *Anolis* Lizards

As the field of evolutionary developmental biology ("evo-devo") has emerged, the need for new model organisms for the study of morphological evolution has grown. Although there is no typical model squamate for developmental studies, lizards in the speciose genus *Anolis* have become a model system in ecology and evolution and may be useful in developmental studies as well. The relationship between morphology and ecology is well-known in this group, as many Caribbean species have independently evolved distinct morphological adaptations that allow them to exploit particular microhabitats. The authors propose that *Anolis* offer the opportunity to integrate evolutionary and developmental studies, and they present a generalized developmental staging series for the genus. They examined approximately 1000 embryos of 8 *Anolis* species, and determined *A. sagrei* to be the most appropriate model for the genus. They describe 19 morphologically distinct stages of *Anolis* embryo development from preoviposition to hatching, with close attention paid to the development of traits known to be important in anole biology (e.g., limb and toe lamellae development). The authors suggest that this staging series can provide a baseline for future studies of evo-devo in this genus.

SANGER, T. J., J. B. LOSOS, AND J. J. GIBSON-BROWN. 2007. A developmental staging series for the lizard genus *Anolis*: a new system for the integration of evolution, development, and ecology. Journal of Morphology: Early View.

Correspondence to: Thomas J. Sanger, Department of Organismic and Evolutionary Biology, Biological Laboratories, 16 Divinity Avenue, Office 4110, Harvard University, Cambridge, Massachusetts 02138, USA; e-mail: TSanger@oeb.harvard.edu.

Fecundity and Female-Biased Size Dimorphism

Although there are many factors that may influence the evolution of sexual size dimorphism, fecundity is thought to be one of the most important selective forces on body size. The authors tested the hypothesis that female body size influences offspring number and size in the Mountain Dragon, *Rankinia* (*Tympanocryptis*) *diemensis*, an Australian agamid lizard with pronounced female-biased size dimorphism. Over four sampling years, they captured 93 gravid females in the field and housed them until oviposition, after which they measured clutch and individual offspring characteristics. Results showed a positive relationship between female size (and condition) and clutch size, but no correlation between female size or condition and average egg mass, or between number of eggs in a clutch and average egg mass. There were also no correlations between maternal size and hatching mass or hatching success. The authors infer that the only way for female *R. diemensis* to increase their reproductive output is to have a larger body size and therefore produce a larger number of offspring (as females did not vary individual egg size), a conclusion that contributes to explaining the female-biased size dimorphism in this species.

Stuart-Smith, J., R. Swain, R. D. Stuart-Smith, and E. Wapstra. 2007. Is fecundity the ultimate cause of female-biased size dimorphism in a dragon lizard? Journal of Zoology 273:266–272.

Correspondence to: E. Wapstra, School of Zoology, University of Tasmania, Locked bag 5, Hobart 7001 Tasmania, Australia; e-mail: Erik.Wapstra@utas.edu.au.

A New Phylogeny of African Cobras

Although many phylogeographic studies of widespread sub-Saharan African mammals exist, there are no such studies of reptiles. The authors examined African spitting cobras, a group of widespread elapid snakes that occur in savanna habitats and were once considered to be a single species (*Naja nigricollis*), to test phylogenetic and biogeographic hypotheses and to investigate the evolution of spitting. They obtained samples from 81 individuals of 48 taxa and sequenced fragments of two mitochondrial regions (ND4 and cytochrome *b*) totaling 1333 bp. Using standard phylogenetic analyses (maximum parsimony, maximum likelihood, and Bayesian inference), they propose a new phylogenetic hypothesis for the group that supports the monophyly of African spitting cobras, and of Asiatic cobras (both spitting and non-spitting). Biogeographic results indicate that the radiation of African spitting cobras likely predates the radiation of large African ungulates and the Pliocene expansion of the African savanna. The authors suggest that spitting evolved three times in cobras, but cannot exclude alternative hypotheses. They also discuss additional taxonomic implications of the new phylogeny.

Wüster, W., S. Crookes, I. Ineich, Y. Mané, C. E. Pook, J. Trape, and D. G. Broadley. 2007. The phylogeny of cobras inferred from mitochondrial DNA sequences: evolution of venom spitting and the phylogeography of the African spitting cobras (Serpentes: Elapidae: *Naja migricollis* complex). Molecular Phylogenetics and Evolution 45:437–453.

Correspondence to: Wolfgang Wüster, School of Biological Sciences, University of Wales, Bangor LL57 2UW, UK; e-mail: w.wuster@bangor.ac.uk.

Effectiveness of Coral Snake Antivenoms

Coralsnakes (Family Elapidae) occur from the southern U.S. to Argentina. Envenomations by coralsnakes are uncommon (< 2% of total snakebites), but their bites are considered serious medical emergencies, with antivenom as the main form of treatment. In the U.S., the two medically significant species of coralsnakes are *Micrurus fulvius* (Florida Coralsnake) and *M. tener* (Texas Coralsnake). In 2006, the lone producer of antivenom used for treatment of U.S. coralsnake envenomations announced that production would be discontinued, but that adequate supplies were available to meet expected needs into late 2008. In this study, Sánchez and colleagues evaluated the effectiveness of both the discontinued Wyeth antivenom (NACSA) and Coralmyn antivenom, produced by the Mexican company, Bioclon. Venom lethal doses (LD_{50}) and antivenom effective doses (ED_{50}) were determined in lab mice. Coralmyn antivenom was able to effectively neutralize LD_{50} doses from both *M. fulvius* and *M. tener*, while Wyeth antivenom only neutralized *M. fulvius* venom.

Sánchez, E. E., J. C. Lopez-Johnston, A. Rodríguez-Acosta, and J. C. Pérez. 2008. Neutralization of two North American coral snake venoms with United States and Mexican antivenoms. Toxicon 51(2):297–303.

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Fossil Anuran with South American Affinities Unearthed in Madagascar

Faunal connections between Madagascar and other Gondwanan land masses have long been a subject of interest for biogeographers. Comparisons of fossil dinosaur assemblages and molecular analyses on ratite birds, iguanian lizards, podocnemid turtles, and boid snakes all independently point to Madagascar having a late connection to the Indian subcontinent and South America (the later likely via Antarctica). The authors describe a large, highly ossified Late Cretaceous fossil anuran from Madagascar, rivaling in size the largest known extant (*Conraua goliath*) or extinct (*Calyptocephalella*) anurans. This anuran was placed in a newly erected genus: *Beelzebufo* (*Beel'zebul* [Greek], Devil, and *Bufo* [Latin], toad), and given the specific epithet *ampinga* ([Malagasy], shield). A suite of characters place *Beelzebufo* within the hyloid clade Ceratophryinae, a group whose extant and extinct members were previously known only from South America. This find represents the first Malagasy anuran (extant or extinct) belonging to a non-ranoid group with extant representatives. Because *Beelzebufo* appears to be nested within the clade, these results also point to an early diversification of extant Ceratophryinae (before 55 Mya) and cast doubt on the currently accepted estimates on the timing of the "main hyloid" (i.e., excluding Myobatrachidae and *Calyptocephalella*) radiation (65–55 Mya).

Evans, S. E., M. E. H. Jones, and D. W. Krause. 2008. A giant frog with South American affinities from the Late Cretaceous of Madagascar. Proceedings of the National Academy of Sciences 105: 2951–2956.

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OBITUARIES

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José Miguel Cei (1918–2007)

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PHOTO BY ALEJANDRO SCOLERO

José M. Cei, author of landmark works on the herpetofauna of Argentina and Chile and a specialist on systematics, ecology, and biogeography, and on the chemistry of anuran skin secretions, died on 8 January 2007 in Mendoza, Argentina, at the age of 88. He was born Giuseppe Michele Alfredo Maria Cei on 23 March 1918 to a father whose early Tuscan ancestors were Greek immigrants from Ceo (Latin for Kéa or Keos, one of the Cyclades Islands in the Aegean Sea), hence the family name. His mother was a descendent of the famed 16th-century Italian, Pietro Andrea Mattioli, one of the greatest Renaissance botanists and herbalists. Cei's parents owned a business founded by his grandfather in the 1860s that produced seeds for agricultural purposes. During 1935–1939 Cei studied at the Università degli Studi di Firenze (Florence) with Nello Beccari, a comparative and neuroanatomist who specialized on amphibians and reptiles, but it was Cei's first expedition—to Ethiopia in northeastern Africa in 1939—that whetted his interest for exploration and ecology. He received his doctorate at the Università degli Studi di Pisa in 1940 and then became the equivalent of an assistant professor of zoology at Florence. His early work was on the comparative anatomy of mammals, respiration in cyclostome fishes, and sexual cycles in amphibians. It was his interest in amphibians that led him into a collegial relationship with Robert Mertens of Frankfurt am Main, then the leading European herpetologist, who became his mentor.

By 1940 World War II was well underway and Cei was mobilized by the Italian Army, first as an artillery officer in North Africa and then as an officer in the topographical service. After the Italian armistice in September 1943, Cei was held briefly by British forces, but on his release he joined Italian partisans fighting German troops in northern Italy. Eventually he was captured by the Germans. During his interrogation by a German officer, Cei learned that the officer was from Frankfurt and that, in fact, he knew of Professor Mertens. By chance, Cei still had in his pocket his last letter from Mertens, which he showed to the officer. Cei was soon released. By July 1944, Cei was working with the United States occupation forces and in 1945 returned to Florence as a teacher in courses for American soldiers organized by the American Army in Europe. Later, he decided to emigrate and, after a short research visit to Senegal, in November 1947 he arrived in Argentina where he would spend most of the rest of his life.

Cei was hired as a professor of biology at the Universidad Nacional de Tucumán in northwest Argentina and became a citizen in 1952. During this period he held several important posts, including director of the Institute of Biology and, later, of the Institute of General Biology and Experimental Embryology. In 1950 he was one of the founders of the university's School of Medicine. In 1955, he moved south to the Universidad Nacional de Cuyo in the state of Mendoza, on the eastern slopes of the Andes, where he served as professor in the School of Medicine and director of the Institute of Animal Biology until he retired in 1980. Throughout this period and even after retirement, Cei held visiting professorships in several countries including Angola, Chile, Italy, Portugal, and the USA. He maintained a research relationship with the Museo Regionale di Scienze Naturali in Torino (Turin) during 1986–1998 and served in several important governmental advisory posts at the state and national levels in Argentina. He was a member of the executive committee that organized the First World Congress of Herpetology, held in the UK in 1989. He became an honorary professor in the national universities at Río Cuarto in 1981, at Tucumán in 1990, and at Cuyo in 1995. In 2005, he was awarded an honorary doctorate by Argentina's Universidad de San Luis and in 2006 was honored for his life's work by the Legislature of his home state of Mendoza with the "Libertador General San Martin" prize.

His first publication (1940) was on the ferns of the Kaffa primary forest in Ethiopia. What followed was a steady stream of nearly 370 titles on fishes, amphibians, reptiles, and mammals covering diverse topics including sexual cycles, ecology, physiology, biochemistry, systematics, evolution, and biogeography. His works appeared every year, except for the war year of 1945, and he became a regular contributor to European, South American, and North American serials including *Journal of Herpetology*. For three decades he collaborated with the Italian pharmacologist, Vittorio Erspamer, at the Università degli Studia di Roma "La Sapienza" in Rome, to investigate biogenic substances isolated from the skins of frogs. Cei's use of various biochemical techniques allowed him to distinguish sibling species which led him to work in systematics beginning in the 1950s. He described nearly 50 new taxa of frogs (in the genera *Atelognathus*, *Leptodactylus*, *Odontophrynus*, *Syrrhophus* [now in *Phrynopus*], *Telmatobius*), snakes (*Atractus*, *Elapomorphus*), and lizards (*Cnemidophorus*,

Ctenoblepharis, Diplolaemus, Homonota, Phymaturus, Pristidactylus, Tropidurus, Vilcunia, and especially *Liolaemus*). Cei was particularly interested in the natural history and systematics of the reptiles of arid and semi-arid environments in South America.

He authored several books, including college-level texts on animal biogeography (1946) and general biology (1951) and a Darwin anthology (1947). He is best remembered by herpetologists for his masterful monographs on the herpetofaunas of Argentina and of Chile. His "Batracios de Chile" (1962) is the companion to Roberto Donoso-Barros's volume on Chilean reptiles (1966). "Amphibians of Argentina" was issued in 1980, with supplements in 1987 and 2001, the latter co-authored with Esteban Lavilla. Cei's massive volumes on Argentina's reptiles covered the central and southern (1986) and northern and eastern regions (1993) of the country. In 1993, he co-authored a revision of the Neotropical colubrid genus *Chironius* with two herpetologists in the United States, James Dixon and John Wiest. Cei's systematic research involved some 25 years of work with his wife, Sylvana Silvi Cei, who died in 1998 (see *Herpetological Review*, 30:202, 1999). He had travelled some 350,000 km in the field with her and, as a skilled artist, she illustrated many of his books and papers.

José Cei was a dynamic teacher and research colleague who had a broad knowledge of modern biology, which he integrated in innovative ways in his research. He trained several doctoral students, co-workers, and disciples in Argentina (Beatriz Alvarez, Francisco D. Barbieri, Francisco Bertini, Victor Bottari, Rosa Graciela Cohen, Alejandra Hernando, Nora Ibarguengoytía, Arnaldo H. Legname, A. E. Paz, Dora Rengel, José Alejandro Scolaro, Maria E. Tedesco, Fernando Videla, Jorge D. Williams) and in Portugal (Eduardo G. Crespo). Cei's enthusiastic personality and contagious love of science and life will be greatly missed by his colleagues throughout the world.

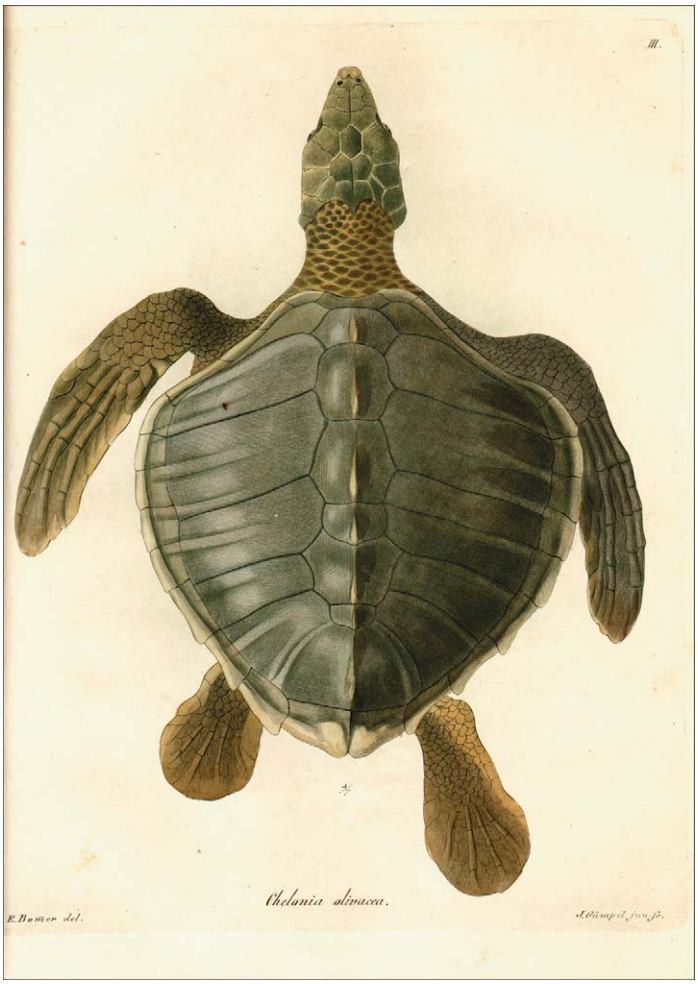
ZOO VIEW

Ridley Sea Turtle

MANY MEN DO LITTLE ELSE THAN SUPPLY THE MARKETS WITH THE MEAT AND EGGS. ACCORDING TO AN EXPERT IN THESE MATTERS, RICHARD M. KEMP, TURTLERS MOST OFTEN MAKE THEIR CAPTURES BY MEANS OF THE PEG. BITS OF THE GRASS FLOATING ABOVE THE GRAZING TURTLES BETRAY THEIR WHEREABOUT AND IF THEY ARE NOT STARTLED IT IS NOT DIFFICULT TO FASTEN THE PEG IN THE SHELL. A PEG IS AN IRON INSTRUMENT LIKE A BLUNT NAIL, TO WHICH A LINE IS ATTACHED; AND WHICH, WHEN DRIVEN INTO THE SHELL, EASILY SLIPS OUT OF THE END OF THE LONG POLE IN WHICH IT IS PLACED. BY MEANS OF THE LINE THE TURTLE IS DRAWN ON BOARD THE BOAT . . . IF A TURTLER GOING HIS ROUNDS IN THE MORNING FINDS THE TRACKS MADE ON THE WAY TO AND FROM THE NEST, HE TAKES A SHORT STICK AND CAREFULLY THRUSTS IT DOWN HERE AND THERE IN THE TRAMPLED SPACE UNTIL PUSHED THROUGH THE EGG, THE YOLK UPON THE PROBE DISCOVERS THE NEST. FOURTEEN NIGHTS LATER HE IS ON THE GROUND WAITING TIL THE CREATURE COMES ASHORE, WHEN HE TURNS HER ON HER BACK, AND IN THE MORNING CARRIES HER TO THE MARKETS. PERSONS IN THE BUSINESS CLAIM THAT THERE IS NO DIMINUTION IN NUMBERS, WHICH, IN VIEW OF THE WHOLESALE DESTRUCTION, SEEMS HARDLY POSSIBLE.

—SAMUEL GARMAN, *ON THE REPTILES AND BATRACHIANS*, 1883

Kemp's Ridley Turtle (*Thalassochelys Kempii*, now *Lepidochelys kempii*) was described by Samuel Garman in 1880 (Bull. Mus. Comp. Zool. 6[6]:123–126) using two specimens sent by Richard M. Kemp of Florida. At that time, this turtle, found in the Gulf of Mexico, was called "Bastard," because it was thought to be a cross between the Green and Loggerhead turtle. Director



The Olive Ridley Sea Turtle (*Chelonia olivacea*, now *Lepidochelys olivacea*) was described in Johann Friedrich Eschscholtz's *Atlas*, issued in five parts with lovely hand-colored plates. In this work, he described new species of amphibians and reptiles, including the sea turtle pictured here.

ESCHSCHOLTZ, J. F. 1829–1833. *Zoologischer Atlas: enthaltend Abbildungen und Beschreibungen neuer Thierarten, während des Flottcapitains v. Kotzebue zweiter Reise um die Welt, auf der russisch-kaiserlichen Kriegsschlupp Predpriaetië in den Jahren 1823-1826 / / beobachtet von Dr. Friedr. Eschscholtz . . .*
Imprint: Berlin, Gedruckt und verlegt bei G. Reimer.

Reprint of all the herpetological part from the *Atlas*; only parts I, II, and V contain material on amphibians and reptiles. Facsimile Reprints in Herpetology, No. 15. Ohio Herpetological Society, Athens, Ohio. 1966.

Credit: Courtesy of Emily Becker, Dana Fisher, and James Hanken, collections of Ernst Mayr Library, Museum of Comparative Zoology, Harvard University.

Patrick M. Burchfield from the Gladys Porter Zoo in Brownsville, Texas, has been involved in recovery efforts of this endangered sea turtle for the past 25 years. During that time, Burchfield has been a vital force in coordinating a joint program with the United States Fish and Wildlife Service (USFWS) and the Mexican government. He leads the U.S. portion of the Programa Binacional de la Tortuga Lora, the Binational Project by focusing on logistics, nest protection protocols, new technologies, and legal matters. He was a recipient of the USFWS Endangered Species Program's 2006 National Recovery Champion award, a prestigious honor indeed.

In a new book, *Biology and Conservation of Ridley Sea Turtles*, edited by Pamela T. Plotkin (2007, Johns Hopkins Press, Baltimore MD; ISBN-13: 978-0-8018-8611-9, ISBN-10: 0-8018-8611-2), Burchfield and two coauthors nicely summarize the recovery efforts in the chapter called "Kemp's ridley recovery: how far have we come, and where are we headed?"

Research Associate Jack Frazier from the Smithsonian's National Zoological Park Conservation and Research Center in Front Royal, Virginia, is senior author of another chapter entitled "Human-turtle interactions at sea."

Two Views of the Value of Zoos and Aquariums

For much of their history, zoos have affirmed only an imperial mastery over Nature. When operated with intelligence and compassion, however, zoos can be a most effective conservation tool. How can they best achieve this? By becoming conservation centers, by placing Nature preservation at the center of all their efforts, by reaching for the highest standards in all their projects and activities, by seeking to awake, enthrall, and educate, by articulating the wonderful benefits of conserving biological diversity, and by making strategic alliances with other cultural and natural history institutions. Zoos have the marvelous potential to develop a concerned, aware, energized, enthusiastic, caring, and sympathetic citizenry. Zoos can encourage gentleness toward all other animals and compassion for the well-being of wild places. Zoos can cultivate environmental sensitivity among their hundreds of millions of patrons. Such a populace might then want to live more lightly on the land, be more careful about using the world's natural resources, and actually to vote for politicians who care about the wild inhabitants of the earth and the health of the wild places that remain. To help save all wildlife, to work toward a healthier planet, to encourage a more sensitive populace: these are the goals for the new zoos."

—David Hancocks, *A Different Nature. The Paradoxical Work of Zoos and Their Uncertain Future*, 2001.

The zoo today is a cultural fossil, a barren evolutionary branch in the leafing of postmodernism. But it was not always so. Early on, a weak case could be made that here indeed was actual Nature, if not in the raw at least very close. Earlier zoo-goers saw the lions' fearsome teeth, felt the water buffalo's power. There was awe when the caged vulture spread its wings. Such attributes seemed real, the animals their embodiment. All it took was naïveté and a misdirected imagination after the manner of Flaubert's fictional characters Bouvard and Pécuchet. Today's zoo occupies a netherworld between real Nature, which can never be known, and a leaky bucket of cinematic "realism" that retains no secrets at all. Zoos claim to represent the first while competing actively with the second. Grasping at both, they fail to be either.

—Stephen Spotte, *Zoos and Postmodernism. Signs and Simulation*, 2006

Professionals in zoos and aquariums are faced with a multitude of critics who often ask challenging questions, the most serious of which is whether these institutions should exist at all. And if they deserve to continue, what form should they take? When these questions are generated by their colleagues with years of professional experience, it behooves the serious zoo worker to pay attention to their concerns, arguments, and conclusions.

An architect by training, David Hancocks was the director of several zoos: Woodland Park Zoo in Seattle, Washington; Arizona-Sonora Desert Museum in Tucson; and Werribee Open Range Zoo in Australia. In his writings, he has stressed the importance of naturalistic exhibits and the critical need for zoo workers to design aesthetic enclosures that appeal to both the visitor and the animals which live in these places. His book (2001; University of California Press; Berkeley; ISBN 0-520-21879-5) follows the historical evolution of zoos and aquariums throughout the world: the good, the bad, and the ugly. Overall, he stresses that much work needs to be done today to address the issues of animal welfare and conservation. Zoos and aquariums can become major forces only if enlightened and positive changes can be integrated into their missions.

Marine biologist Stephen Spotte has been director of the Aquarium of Niagara Falls, curator of the New York Aquarium, and director of Mystic Aquarium. His book (2006; Fairleigh Dickinson Press; Madison, Teaneck, New Jersey; ISBN 0-8386-4094-X) goes a step beyond Hancocks' book, for questioning whether zoos and aquariums should exist at all in their present form. His argument is unsettling: the dual purposes of education and conservation are not met in these institutions. He puts his conclusion this way, "Postmodernism is driven by images and other simulations of reality that make the exhibition of living animals passé. In shopping malls and theme parks, captive animals are transformed into their own images, becoming symbols of indirect commodification, objects of visual *flaneur*. Window shopping and a visit to the zoo have much in common."

It is easier to dismiss the views of critics outside the zoo profession but when the criticisms are generated from within our community, these harsh evaluations deserve careful scrutiny.

Bibliomania

Belin. Well; we live in a marvellous book-collecting and book-reading age—yet a word more :

Alman. I crave your pardon, Belinda ; but I have a thought which must be now imparted, or the consequences may be serious.

Lysand. I wait both your commands.

Alman. My thought—or rather the subject which now occupies my mind—is this :You have told us of the symptoms of the *Disease of Book Madness*, now pray inform us, as a tender-hearted physician, what are the *means of its cure*?

Belin. The very question I was about to put to our bibliomaniacal physician. Pray inform us what are the means of cure in this disorder?

Lysand. You should say **Probable Means of Cure**; as I verily believe that there are no certain and correct remedies.

Belin. Well, Sir ; *probable* means—if it must be so. Discourse largely and distinctly upon these.

Lysand. Briefly, and perspicuously, if you please : and thus we begin.

—Reverend Thomas Frognall Dibdin, 1811

Herpetologists throughout the ages have struggled with a seemingly incurable malady: bibliomania. Families have been torn apart, weeks spent in used bookstores, houses remodeled to accommodate more and more bookcases, and finances devastated. The condition is so severe and pervasive that a book was written about it by the Reverend Thomas Frognall Dibdin in 1811—*Bibliomania, or, Book Madness: A Bibliographical Romance, in Six Parts: Illustrated with Cuts* (Printed for the author, by J. M'Creery ..., and sold by Messrs. Longman, Hurst, Rees, Orme, and Brown).

The University of Michigan has digitized this book and it is available at http://mdp.lib.umich.edu/cgi/pt?id=39015005643682.

A lasting cure has still not been found to this day. Read *A Gentle Madness: Bibliophiles, Bibliomanes, and the Eternal Passion for Books,* by Nicholas A. Basbanes (New York, H. Holt and Co., 1995).

A Chelonian Armageddon

On 25–28 July 2007, I traveled to Atlanta, Georgia to attend the 5th Annual Symposium on Conservation and Biology of Freshwater Turtles and Tortoises, a joint annual meeting sponsored by the IUCN Turtle Survival Alliance (TSA) and IUCN Tortoise and Freshwater Turtle Specialist Group. Although I knew that the news about the continued survival of many of these creatures was problematical, I was not prepared for the constant stream of troubling papers by workers documenting pressures throughout the world, with many showing graphic images detailing the causes: habitat destruction and alteration, poaching and stockpiling of turtles and tortoises in range countries for eventual slaughter to satisfy the demand for pâté in Asia, mounds of hundreds of chelonians held in food markets, disease outbreaks, commercial turtle farming, trade in plastrons and shells for curios, and collection for the commercial pet trade. To get a sense of the scope of this catastrophe, consult IUCN Red List of Threatened Species 2006 <http://www.iucn.org/themes/ssc/redlist2006/redlist2006.htm>.

Each evening, many delegates gravitated to the nearest saloon to try and make sense about we had heard and what strategies could be employed to reverse the trend. By the end of the conference, I was nearly in shock even though organizer Rick Hudson tried to lift spirits by saying that the mission of TSA was to ensure that no chelonian became extinct during this century. It was gratifying to see that so many committed people, battling heroically against exploiters, developers, and bureaucrats, cared about the fate of terrapins, turtles, and tortoises; their efforts deserve support.

For more information on TSA activities, see 2004 *Herpetological Review* 35[2]:110 and contact Dwight Lawson (e-mail: dlawson@zooatlanta.org) or Rick Hudson (e-mail: rhudson@fortworthzoo.org), or visit the TSA website at www.turtlesurvival.org.

Biographies

Kraig Adler has written two important historical biographies of deceased biologists and their contributions to the science of herpetology: *Herpetologists of the Past, Part 1* (1989) and *Herpetologists of the Past, Part 2* (2007). In Adler's spectacular volumes, there are many references to zoos and aquariums—names of importance to the zoo community, details of the careers of people working in these places or authors writing about these institutions (Table 1). Each biography gives a sketch of the person's life with special emphasis on herpetology, references to other biographical information, the person's signature, and in almost every case their portrait. To obtain a copy of vol. 2, contact SSAR Publications Secretary Breck Bartholomew (details located inside front cover of this issue). Vol. 1 is now out of print but available on the web (www.ssarherps.org) [click on "Publications"]. Additional information may be found in Card and Murphy (2000. SSAR Herpetol. Circ. No. 27, 44 pp.) and Murphy (2007. Herpetological History of the Zoo and Aquarium World. Krieger Publ. Co., Malabar, Florida).

Table 1. Names of zoo-affiliated herpetologists profiled in *Contributions to the History of Herpetology*.

Volume 1 (1989)	Volume 2 (2007)
Raymond L. Ditmars *, **	Ensil Ross Allen **
Afrânio do Amaral	Miguel Alvarez del Toro **
Archie F. Carr Jr.	Walter Auffenberg Jr.
Doris M. Cochran	William Bartram
Georges Cuvier **	Johann Matthaeus Bechstein **
André-Marie-Constant Duméril **	John L. Behler **
Auguste-Henri André Duméril **	Edward G. Boulenger **
Leopold J. F. J. Fitzinger **	Alfred E. Brehm **
Carl F. Kauffeld *, **	Arthur E. Brown *, **
Vivian F. M. FitzSimons **	Mark Catesby
Emilio Augusto Goeldi **	Roger Conant *, **
Laurence M. Klauber *, **	Charles R. Darwin **
Wilhelm K. A. Klingelhöffer **	Edward R. Elkan **
B.-G.-É. Lacepède **	Johann von Fischer **
Arthur Loveridge	Frederick W. FitzSimons **
Robert F. Mertens **	Vivian F. M. FitzSimons **
Charles R. S. Pitman **	Stanley Smyth Flower **
Clifford H. Pope	Heini Hediger **
Raymond Rollinat	Catherine G. Hopley **
Hermann Schlegel **	James A. Oliver *, **
Karl P. Schmidt	Richard Owen
Léon-Louis Vaillant **	C. B. "Si" Perkins *, **
Zdenek Vogel **	Joan Beauchamp Procter **
Franz Werner **	Heinz H. Reichenbach-Klinke **
	Charles E. Shaw *, **
	Eric F. Worrell **

***** *Lineages of zoo herpetologists in the United States.*
****** *Herpetological History of the Zoo and Aquarium World.*

In the paper following, Hans-Werner Herrmann describes his exciting project in Cameroon which includes a study of the endangered Goliath Frog (*Conraua goliath*). This anuran is rarely kept in zoo collections because it is generally a delicate captive. An adult individual was successfully maintained at the Chicago Zoological Park (Brookfield Zoo) for 4 years, 4 months, and 7

days in a large semi-aquatic exhibit (Snider and Bowler 1992. SSAR Herpetol. Circ. No. 21, 40 pp.). In the mid-1960s at the Ft. Worth Zoo in Texas, late curator John Mehrtens hung wide, flexible strips from the top to the bottom of the enclosure to cover walls and exhibit glass; he said this arrangement prevented the jumping frogs from injury. From the Duisburg Zoological Garden in Germany, Gewalt (1977. Zool. Gart. [N.F.], Jena 47:161–192) covered catching, transport and keeping these frogs. Gillespie et al. (1988/1989. Proc. Amer. Assoc. Zoo Vet., p. 62) sexed Goliath Frogs by laparoscopy at the Cincinnati Zoo.

The American Association of Zoological Parks and Aquariums (AAZPA) was founded in 1924. Seventy years later, the name was changed to the Association of Zoos and Aquariums (AZA). Some of the organizational purposes of AZA are 1) to promote discussions and cooperation among zoo and aquarium professionals; 2) to set high standards for its accredited member institutions, now over 200; and 3) to support *in situ* and *ex situ* conservation initiatives. In the article below, Shelly Grow and Ruth Allard highlight the ambitious initiative by these institutions to address the issue of amphibian declines and the role that zoos and aquariums will play in 2008 to reverse this trend.

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Zoo-based In-situ Herpetology: Setting Baselines in Western Cameroon

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In 1998, when I was the curator of Herpetology, Ichthyology and Invertebrates at Cologne Zoo in Germany, I was contacted by representatives of the German branch of the American Linen Supply Company (ALSCO). The company wanted to contribute to the conservation of species and biodiversity. ALSCO Germany felt that their corporate identity would be enhanced by chameleons and that they would like to sponsor a chameleon enclosure at Cologne Zoo. After further correspondence, I realized that this could extend far beyond the common zoo practice of sponsored enclosures. Subsequently, we developed an outline for a conservation initiative sponsored by ALSCO Germany and implemented by Cologne Zoo. Chameleons were to be the flagship species for this project which in reality encompassed multiple species of amphibians and reptiles.

We eventually set our sights on Cameroon. Southwest Cameroon is one of the chameleon diversity hotspots in Africa, in particular the mountain chain known as "Dorsale Camerounaise" contains numerous montane species. We focused our attention on two areas: 1) Mt. Nlonako, a tropical rainforest mountain that reaches 1800 m in elevation situated approximately in the center of the north–south extending "Dorsale Camerounaise" and 2) Tchabal Mbabo, a mountain range at the northern limit of this mountain chain representing a humid island with cloud forests in a tropical savanna landscape.

Compared to other tropical African countries, Cameroon has received a considerable amount of herpetological attention, especially owing to the works by Swiss herpetologist J.-L. Perret and French herpetologist J.-L. Amiet, who both described a large number of new species from this area over the last 50 years. However, complete herpetofaunal inventories, quantitative surveys, and ecological studies on amphibians and reptiles are rare or lacking for large parts of Africa, including Cameroon. Baseline data from such studies constitutes the foundation on which conservation and management decisions should be based.

We started herpetofaunal inventories in 1998 at both locations, Mt. Nlonako and Tchabal Mbabo—the latter posing remarkable logistic challenges due to its remoteness and inaccessibility (Herrmann et al. 1999, 2000; Herrmann and Herrmann 1999, 2002; Kolter et al. 2001). The cooperate funding during the initial phase of the project permitted us to invite herpetologists from the Zoological Research Institute and Museum Alexander Koenig (ZFMK) in Bonn. Wolfgang Böhme and his students Oliver Euskirchen and Andreas Schmitz, who had just finished their graduate work at nearby Mt. Kupe, joined us for field work. At this time I was adjunct faculty at Philipps University in Marburg, where as a part of my teaching commitment, I gave herpetological lecture series and seminars. Some of the graduate students showed interest in fieldwork in Cameroon and joined us during several of our field trips. Later two of them, Mirco Plath and Markus Solbach, decided to conduct their graduate research on anuran communities at Mt. Nlonako (Plath 2003; Plath et al. 2004; Solbach 2003).

In 2002 I joined the Zoological Society of San Diego's Center for Reproduction of Endangered Species for a three-year field study on Goliath Frogs (*Conraua goliath)* in Cameroon. The species' distribution is limited to Cameroon and Equatorial Guinea. Goliath Frogs are under severe pressure from hunting and habitat degradation. During many long nights in rapids and around waterfalls of Cameroon's rivers, the preferred habitat of Goliath Frogs, we processed a large number of frogs, tadpoles, and eggs—which are deposited in nests on gravel banks. We used capture-recapture techniques and radiotelemetry (Figs. 1, 2) to gain insight into the species' ecology and behavior. As the number of Goliath Frogs in zoological collections is very limited, we performed morphological and anatomical studies on sexual diversity, reproductive status, stomach contents, and diet. Additionally, a large number of tissue samples were collected. These tissues are now being used in DNA-based studies on the phylogeography, population genetics, and mating systems of Goliath Frogs.

In 2003, Taylor Edwards from the University of Arizona joined us for seasonal field work. During his stay we discovered a novel type of locomotion in Goliath Frogs—"skittering"—which had previously been seen only in much smaller frogs (Herrmann and Edwards 2006). On 23 February 2003 at 0200 h, we found a pair of Goliath Frogs mating in a nest. The male measured 330 mm SVL, with a mass of 3220 g—which makes it the largest frog of this or any other living species ever documented (Fig. 3). This size is rivaled only by the recently described fossil frog *Beelzebufo ampinga* (Evans et al. 2008) which, extrapolated from skull bone fragments, may have reached SVL of > 400 mm. Does this indicate the functional size limit of the anuran body plan?

As for chameleons, which initially caught ALSCO's attention, we studied chameleon spatial distribution at Mt. Nlonako (Harbort



FIG. 1. Hans-Werner Herrmann and Taylor Edwards (right) implant a radio transmitter under field conditions into an adult Goliath Frog (*Conraua goliath*).

and Herrmann 2002) and aspects of the reproductive biology of Mountain Chameleons (*Chamaeleo montium*) (Herrmann and Herrmann 2005). Chameleons are a characteristic and relatively abundant herpetofaunal element of SW Cameroon. They are particularly attractive lizards and are in high demand in the international reptile pet trade. Large numbers are collected and exported from Cameroon. In this situation, baseline data and research on the biology of chameleons with the goal of establishing meaningful management plans is an immediate need.



FIG. 2. Field assistant Solomon Echalle crossing a river during a Goliath Frog radio tracking session.



FIG. 3. A male Goliath Frog captured on 23 February 2003 at 0200 h with a snout–vent length of 330 mm and a mass of 3220 g. Note the casting net that is used to capture the frogs.

A specimen of Sundevall's Worm Snake (*Leptotyphlops sundewalli gestri*) from the lower slopes of Mt. Kupe proved to be the second specimen recorded from Cameroon, and is a significant taxon range extension (Herrmann et al. 2004).

At the end of 2004 we concluded the detailed inventories of amphibians and reptiles at Mt. Nlonako (Herrmann, Böhme, Euskirchen et al. 2005; Herrmann, Böhme, Herrmann et al. 2005) and Tchabal Mbabo (Herrmann et al. 2007). Mt. Nlonako was established as the center for species richness for a single locality in Africa, with 93 amphibian and 63 snake species. Indeed, with regard to snake species diversity, Mt. Nlonako ranks as one of the most species-rich places in the world. Two new frog species, *Cardioglossa alsco* from Tchabal Mbabo (Herrmann et al. 2004) and *Phrynobatrachus nlonakoensis* from Mt. Nlonako (Plath et al. 2006), were discovered during our survey work.

An extensive collection of herpetological vouchers is now deposited at the Zoological Research Institute and Museum Alexander Koenig, Bonn (ZFMK), and the National Museum of Natural History, Smithsonian Institution, Washington, D.C. (USNM).

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The Zoological Community Celebrates 2008: The Year of the Frog

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YEAR OF THE FROG: ADDING THE *EX SITU* COMMUNITY'S STRENGTHS TO CURB AMPHIBIAN EXTINCTIONS

Since its formation in 1990 and until its merger with other World Conservation Union (IUCN) amphibian conservation groups into the IUCN/Species Survival Commission (SSC) Amphibian Specialist Group (ASG) in 2006, the Declining Amphibian Population Task Force (DAPTF) led the charge to verify anecdotal reports beginning in the 1970s of drastic and global amphibian population declines and disappearances, identify target populations and regions meriting immediate attention, gather evidence concerning the causal factors contributing to amphibian population declines, set up infrastructure to facilitate long-term data collection, and to disseminate information throughout the scientific community and to the public (Heyer and Murphy 2005). In September 2005, the IUCN and Conservation International convened an Amphibian Conservation Summit in Washington, DC to devise a global strategy of action to arrest amphibian declines and extinctions (Mendelson et al. 2006). A key outcome of this meeting was the *Amphibian Conservation Action Plan* (ACAP), which was published in July 2007 (Gascon et al. 2007). Even before its final publication, researchers, land managers, zoological community professionals, and others had already started tackling the pieces for which they were responsible. Momentum continues to build as awareness about the amphibian conservation crisis grows.

The ACAP charges the global zoological community with leading *ex situ* conservation efforts, creating assurance populations for those species that would go extinct before the threats facing them could be addressed in the wild (Lips et al. 2005; Mendelson et al. 2006; Pounds et al. 2007; Young et al. 2007). *Ex situ* conservation is only one component of the much larger holistic approach of the ACAP and species that are candidates for *ex situ* conservation primarily consist of those listed as Endangered and Critically Endangered by the Global Amphibian Assessment (GAA) (IUCN et al. 2006). The *ex situ* programs are implemented by regional zoological associations: the Association of Zoos and Aquariums (AZA) in the United States, the European Association of Zoos and Aquariums (EAZA), the Australasian Regional Association of Zoological Parks and Aquaria (ARAZPA), etc. To facilitate these efforts at the international level, the IUCN's Conservation Breeding and Amphibian Specialist Groups (CBSG and ASG), and the World Association of Zoos and Aquariums (WAZA) formed the Amphibian Ark (www.amphibianark.org) (Zippel 2007a).

An additional function of Amphibian Ark is to develop and deploy a public awareness and fundraising campaign to support the *ex situ* conservation community's efforts. Effectively addressing

the amphibian conservation crisis requires rapid expansion of zoos' and aquariums' capacity to meet immediate needs and funding to support these projects into the future. Amphibian Ark has designated 2008: Year of the Frog as the umbrella for this global effort. The goal of this campaign is to ensure that the general public will understand the critical issues facing amphibian populations and support the zoological community's efforts. The Amphibian Ark coordinates the international communication and networking associated with Year of the Frog, while regional zoological associations implement the campaign and related efforts in their respective regions.

Demonstrating a Growing Commitment to Amphibian Conservation and Public Outreach: A Regional Example

AZA's Year of the Frog is an integrated campaign approved by the AZA Board of Directors and developed by a task force representing AZA's Amphibian Taxon Advisory Group (ATAG; amphibian experts in the AZA community that guide collection planning, provide strategic conservation and research direction, and strive to improve amphibian husbandry throughout the AZA community); Conservation Education (CEC), Public Relations, and Marketing committees; and AZA executive office communications and conservation department staff.

While the emphasis of AZA's Year of the Frog is on challenging zoos and aquariums to expand or develop *ex situ* conservation initiatives, the campaign also encourages zoos and aquariums to support complementary *in situ* conservation efforts, develop capacity internationally, address local amphibian conservation through monitoring, surveying, research, partnering with local government agencies, advocacy, and to engage their 157 million visitors to build popular support for amphibian conservation.

The AZA Year of the Frog task force facilitates public engagement opportunities. The CEC has gathered, reviewed, culled and edited existing resources, and has created new amphibian education and outreach materials that focus on encouraging positive conservation impacts. They have also worked with the ATAG to develop fact sheets to inform visitors, docents, and staff about amphibians, population declines, the zoological community's response, and what visitors can do to help amphibians. The task force has developed campaign graphics and other items for widespread distribution, including a public service announcement that can be personalized for each participating zoo or aquarium's market. These materials, customized for a North American audience but also consistent with the global Amphibian Ark effort, are available free of charge to AZA members and the general public through the AZA Web site (www.aza.org/yearofthefrog).

The task force is also responsible for publicizing AZA members' amphibian conservation efforts within the zoological community and to a larger public audience. Articles for zoo and aquarium member magazines regarding amphibian declines and the zoological community's response have been generated, press releases have been circulated, and communication continues with well-known popular media outlets. For the campaign year, each monthly edition of the AZA member magazine *Connect* features an amphibian conservation-related story and the March 2008 edition will be devoted entirely to amphibian conservation. The general public can visit the AZA Web site and become "Friends of Frogs" by joining a grassroots advocacy network that will be contacted regarding regional and national opportunities for action. AZA zoos and aquariums will launch Year of the Frog on Leap Day, 29 February 2008, will use amphibian themes at their annual Party for the Planet on and/or around Earth Day (22 April 2008), and will also incorporate amphibian themes in their year-round education programming.

As amphibian experts for the AZA community, the ATAG provides strategic direction and shares expertise. In July 2007, the Fort Worth Zoo hosted a meeting where the ATAG identified amphibian species in Canada, the United States, Mexico, and the Caribbean whose populations would most benefit from *ex situ* conservation programs. Meeting participants included members of the ATAG steering committee and its advisory committee, staff from Amphibian Ark, and university scientists. The group utilized a prioritization tool developed by the Amphibian Ark that incorporates the species' conservation status, threats, the potential for mitigating these threats in the wild, phylogenetic uniqueness, social and scientific value, and other key variables. The group examined over 200 species listed by the GAA as Critically Endangered, Endangered, Data Deficient, or listed under the US Endangered Species Act. The resulting priority rankings are subject to change as new information and management processes are implemented, but in the meantime, provide much-needed direction for next steps. Programs to protect species outside of the US will be developed in collaboration with local experts, international zoological colleagues, and the Amphibian Ark, while programs within the US will complement state and federal priorities. The priorities, a description of the process used, and an analysis of current AZA amphibian collections and capacity (staffing, space, etc.) are included in the *Action Plan for* Ex Situ *Amphibian Conservation in the AZA Community* report (Crump and Grow 2007). The Action Plan was modeled deliberately after the *ARAZPA Amphibian Action Plan* published in June 2007 (Gillespie et al. 2007), so that zoological community capacity can be compared and evaluated internationally.

In addition to the Action Plan, the ATAG published the *Amphibian Conservation Resource Manual* in September 2007 with AZA staff support (Grow and Poole 2007). The Resource Manual is designed to help zoos and aquariums incorporate amphibian conservation into their institutional collection and master plans, create holistic *in situ* and *ex situ* conservation and research projects, build biosecure amphibian holding facilities, identify funding resources to support amphibian efforts, and develop programs for those species that would most benefit from *ex situ* conservation programs. The ATAG has also produced an *Amphibian Husbandry Resource Guide* so that AZA members can expand their staff skillsets and can respond appropriately to the conservation crisis (Poole and Grow 2008). When working with endangered species, there is little room for error, so all of these tools are designed to build capacity and expertise.

Perhaps the most important component of the Year of the Frog campaign is the infusion of AZA's significant and growing amphibian conservation efforts with a sense of urgency. AZA recognizes that the rapid and widespread declines in amphibian populations present a conservation challenge unlike any other faced by humans (Stuart et al. 2004). The Association is responding by dedicating more resources and attention to amphibians now than it has ever committed to any one taxonomic group in the organization's

history. For example, the Board of Directors created a conservation biologist position at the AZA office dedicated exclusively to amphibian conservation. Since 2004, the AZA Board of Regents has held an annual training course in *Amphibian Biology and Management*. In 2007, the Board of Regents offered this course twice to meet unprecedented student demand, thanks in large part to the generosity of volunteer instructors and the Toledo Zoo, which hosted both sessions. Because the April 2008 course filled by late 2007, it is likely that arrangements will be made to offer the course twice in 2008 as well. Tight budgets have been stretched to fund travel expenses for key meetings to expand amphibian conservation partnerships and every department at the AZA office has been engaged in Year of the Frog efforts.

The AZA community is expanding Year of the Frog beyond the zoological sector by engaging appropriate government entities in the campaign as well. At the national level, AZA's government affairs department is working with U.S. Congressional staff to support amphibian conservation, and at the local level, AZA members are engaging their public in local development projects affecting amphibian habitat and inviting civic officials to help launch and participate in Year of the Frog. Members are also reaching out to other local partners, such as parks, museums, and schools, to celebrate the Year of the Frog.

Year of the Frog Expectations

2008: Year of the Frog activities will raise the profile and the level of public support for amphibian conservation efforts. The Year of the Frog will also feature significant fundraising efforts. Already, the AZA has developed an amphibian-specific funding process that has received significant contributions from private individuals and companies. International and collaborative fundraising efforts, such as those led by the Emerging Wildlife Conservation Leaders program (EWCL; a collaborative effort sponsored by Defenders of Wildlife, U.S. Fish and Wildlife Service (FWS), and White Oak Conservation Center/Howard Gilman Foundation), the ATAG small grants program, Project Golden Frog/ Atelopus Conservation Trust (Zippel 2002), and Amphibian Ark are also underway.

Conservation success requires a long-term commitment and, as demonstrated by long-term participation in amphibian Species Survival Plans® (see next section for more detail), AZA facilities are dedicated to these efforts. 2008 will see the expansion of existing amphibian programs to both increase population sizes and include additional facilities. It will also welcome the laying of groundwork for additional programs that may not come online until after 2008. The Year of the Frog conservation goals are to lay the foundation for long-term amphibian conservation action and to garner institutional commitments so that these programs can grow over the next several years. Successful programs will not sprout immediately, but many new efforts will begin to take shape in 2008.

Partnerships are a key element to amphibian conservation success. The first 2008 edition of FWS' *Endangered Species Bulletin* periodical will be dedicated to amphibian issues, and approximately half of the articles will come from AZA-accredited zoos and aquariums. AZA members are increasingly engaging with Partners in Amphibian and Reptile Conservation (PARC), and each regional PARC network has been challenged to develop collaborative activities with local zoos and aquariums and to celebrate Year of the Frog at its 2008 meetings and events. Three AZA-accredited zoos and aquariums, the Columbus Zoo and Aquarium, Phoenix Zoo, and Houston Zoo, supported PARC's recent symposium, "Amphibian Decline and Chytridiomycosis: Translating Science into Urgent Action." Staff from fifteen zoos and aquariums and the AZA executive office participated in the meeting. The EWCL program has committed to raise funds so that AZA member Africam Safari in Mexico can expand its amphibian conservation work. AZA is helping EWCL with its fundraising and public outreach efforts. AZA is also growing its international partnerships, working with the Amphibian Ark and the Zoo Conservation Outreach Group (ZCOG) to train and support the work of international colleagues, utilizing internationally consistent prioritization processes, and sharing resources, information, and Year of the Frog campaign strategies.

Collaborative Conservation: A History of Commitment

AZA-accredited zoos and aquariums are already an active force in amphibian conservation (Wiese and Hutchins 1994; Zippel 2007b). Since 2000, AZA members have spent more than $1.1 million on amphibian conservation and research projects in more than 20 countries around the world. Two amphibian species, the Puerto Rican Crested Toad (*Peltophryne lemur*) and Wyoming Toad (*Anaxyrus baxteri*)[1] are already part of AZA's Species Survival Plan® (SSP) program (Fig. 1). The first amphibian SSP program was approved in 1984, focusing on the Puerto Rican Crested Toad (Johnson 1994). In 2007, more than 20 AZA-accredited zoos and aquariums continue to hold, breed, and provide animals for reintroduction at three sites in Puerto Rico. The program is far larger than its *ex situ* components: AZA members have developed extensive education and outreach programs that incorporate local folklore, passions, and interests, have helped create and maintain new toad habitat and have developed partnerships with government, academic, and other stakeholders throughout Puerto Rico. The second amphibian flagship program, the Wyoming Toad SSP, was approved in 1996. Listed by the GAA as Extinct in the Wild, nine AZA facilities continued to hold, breed, and reintroduce animals in 2007, in collaboration with other breeding facilities, the Wyoming Game and Fish Department, and the FWS. Causes of the population crash in the mid-1970s were unknown for decades, but the proximate cause of decline has now been attributed to the fungus *Batrachochytrium dendrobatidis* (*Bd*), complicating the rearing and reintroduction program (Johnson 1994; Odum and Corn 2005; Stebbins and Cohen 1995). Both of these SSP programs are fairly well known, in part due to their longevity and collaborative nature; however, other amphibian conservation efforts at AZA zoos and aquariums may be less familiar. The following program descriptions offer a sampling of what AZA institutions are currently doing and demonstrate the expertise and enthusiasm AZA institutions have for long-term amphibian conservation action.

Zoo staff were among the key players in discovering the novel pathogen, *Bd*, and the effect it was having on amphibians (Nichols 2003). In 1991, Dr. Donald K. Nichols took on a position as a pathologist at the National Zoological Park (NZP), following his experience as a resident there and as a pathologist at the National Institute of Health. He had consulted with zoos and universities throughout the country and in 1991 received the bodies of three



FIG. 1. The first amphibian AZA Species Survival Plan was approved for the Puerto Rican Crested Toad (*Peltophryne lemur*) in 1984. Photo courtesy of John Kast, Fort Worth Zoo.



FIG. 2. The Toledo Zoo and Bronx Zoo (Wildlife Conservation Society) house the only known surviving Kihansi Spray Toads (*Nectophrynoides asperginis)* and are developing plans in collaboration with international colleagues and the Tanzanian government to reintroduce this species to Tanzania in the future. Photo courtesy of R. Andrew Odum, Toledo Zoo.

preserved California Arroyo Toads (*Anaxyrus californicus*)[2]. The toads came from a captive colony whose population had declined 60% in just a few months; an unknown skin disease was responsible for their demise. Dr. Nichols reviewed amphibian pathology files from the NZP collection and saw evidence of the same disease. Over the next several years, clues surfaced indicating that a chytrid fungus might be involved; however, no chytrids had ever been recognized as pathogens in vertebrates at that time. In 1996, a new outbreak of the disease affected the National Zoo's collection. The zoo's resident pathologist at the time, Dr. Allan Pessier, and Dr. Nichols were able to locate and send fresh skin samples to one of the few chytrid experts in the world, Dr. Joyce Longcore. Dr. Longcore identified the fungus as not just a new chytrid species, but also as a previously unknown genus. The organism was eventually named *Batrachochytrium dendrobatidis*, meaning "frog chytrid of dendrobatids" (Longcore et al. 1999). While the organism was being identified, researchers in Central America and Australia began reporting identical situations in the field. While unable to culture the organisms, they had also identified the organisms as chytrids and Longcore later confirmed them as the same species (Berger et al. 1998; Nichols 2003). Zoological facilities continue to have an important role to play in efforts to prevent *Bd* from spreading between captive facilities and in trade, monitoring the disease, participating in captive-breeding and reintroduction programs, and limiting the impact of the disease on wild amphibian populations (Young et al. 2007).

Combining *in situ* and *ex situ* work, in 2000 the Bronx Zoo brought 500 Kihansi Spray Toads (*Nectophrynoides asperginis*) from Tanzania to US zoos when their habitat came under threat from the development of a dam (Krajick 2006) (Fig. 2). This transfer turned out to be extremely fortunate as the entire population collapsed in 2003. The timing of the crash coincided with the completion of the dam's construction and related changes to the ecosystem, the brief opening of floodgates to flush sediments, and the first observation of the fungus *Bd* in the habitat (Krajick 2006). Today, the sole surviving Kihansi Spray Toads live at the Toledo and Bronx Zoos. In May 2007, AZA members from the Bronx, Toledo, and San Diego zoos met with government and World Bank officials, facilitators from the IUCN's Conservation Breeding Specialist Group (CBSG), and other scientists to complete a Population and Habitat Viability Assessment and develop a long-range strategy to reintroduce the spray toad back to Tanzania.

Based on predictions made by Lips et al. (2006) on the rate that *Bd* was moving through Panama and its potential impacts, biologists from Zoo Atlanta and the Atlanta Botanical Garden knew that the devastating fungus *Bd* was rapidly approaching a hotspot of amphibian diversity in that country's central region (Norris 2007). Based on its location, elevation, and species assemblages (Lips et al. 2005), *Bd* was expected to take a high toll on its amphibian populations. Working with others in Panama and building on partnerships developed through Project Golden Frog (Zippel 2002), these researchers spearheaded an effort in 2005 to evacuate hundreds of frogs representing 35 species from central Panama in an effort to protect them from this devastating disease (Mendelson and Gagliardo 2005; Gagliardo et al., *in press*). The Houston Zoo and El Nispero Zoo (Panama) began constructing the first in-country, dedicated facility for maintaining critically threatened amphibians locally (Fig. 3). More than two dozen AZA facilities have supported the construction, training, and operations costs of this facility. The *Bd* fungus reached El Valle in early 2006 and wild amphibian populations began to plummet. While held temporarily at the Hotel Campestre as building construction was completed, today many of the species decimated by the arrival of *Bd* can still be found in assurance populations in the US and at El Valle Amphibian Conservation Center (Fig. 4). In 2007, the Houston Zoo was awarded a grant from the AZA Conservation Endowment Fund (CEF) to continue to support this Center and expand its outreach efforts in each of the partnering zoos and aquariums in North America.



FIG. 3. Jorge Garcia from Panama's Autoridad Nacional del Ambiente (ANAM) helps transfer Panamanian Golden Frogs (*Atelopus zeteki*) from temporary quarters to the El Valle Amphibian Conservation Center. Photo courtesy of Bill Konstant, Houston Zoo.

In the southwestern United States, AZA institutions participate in government-led ranid conservation projects. In the mountains of California, the Critically Endangered Mountain Yellow-legged Frog (*Rana muscosa*) has a limited and disjointed range (Fig. 5). Introduced trout have long been a threat to the eggs and tadpoles of this species in parts of its range and the removal of the trout has led to growth in populations of the frogs (Knapp and Matthews 2000; Vredenburg 2004). As a result, the U.S. Geological Survey (USGS) and the FWS developed a plan to remove these predators from the Angeles National Forest north of Los Angeles and zookeepers from the Los Angeles Zoo and Fresno Chaffee Zoo provided assistance in the field. The San Diego Zoo's center for Conservation and Research for Endangered Species (CRES) is currently safeguarding frogs rescued by government agencies from drying streambed pools in the San Jacinto Mountains. Once drought conditions have passed, zoo staff will work with state and federal agencies to return these individuals to their natural habitat (Bradley, *in press*).

The Santa Barbara Zoo works with the U.S. Forest Service (USFS) to survey streams in the Los Padres National Forest for California Red-legged Frogs (*Rana draytonii*) and the California Arroyo Toad (*Anaxyrus californicus*). In addition to surveying and recording ambient conditions and developmental stages when egg



FIG. 4. Spiny-headed Treefrog (*Anotheca spinosa*) is one of several imperiled species reproducing at the El Valle Amphibian Conservation Center (Gagliardo et al., *in press*). Photo courtesy of John Kast, Fort Worth Zoo.

masses are located, zoo staff place exclosures around the mass to prevent aquatic predators, especially the introduced Bullfrogs (*Lithobates catesbeianus*)[3] and Mosquitofish (*Gambusia affinis*), from consuming them (Foster et al. 2007). The Zoo is currently developing an exhibit that will feature reptiles and amphibians native to the Los Padres National Forest, and estimate that up to 450,000 visitors annually will learn about local herpetofaunal con-



FIG. 5. Several zoos and aquariums are supporting government-led recovery efforts on behalf of the Mountain Yellow-legged Frog (*Rana muscosa*) in the western United States. Photo courtesy of Jeff Lemm, San Diego Zoo's Center for Conservation and Research for Endangered Species (CRES).

servation through this exhibit, in addition to visitors that hear about these efforts through zookeeper talks and presentations, signage at the Zoo, and through the Zoo's newsletter (Foster et al. 2007).

In Arizona and New Mexico, ranid conservation at AZA facilities includes leopard and Tarahumara frogs. The Phoenix Zoo has been part of the Ramsey Canyon Leopard Frog Conservation Team (RCLFCT), a partnership of state and federal agencies and private groups for ten years. The Arizona-Sonora Desert Museum (ASDM) is also part of the Team. The Team's goal is to halt population declines of the Ramsey Canyon Leopard Frog (*Rana chiricahuensis*)[4]. Because of high mortality rates in the wild for eggs and small tadpoles, the team decided to rear egg masses collected in the wild at the zoo and museum, and delayed release until they had developed into large tadpoles or small frogs, life stages with higher survival rates. As a result of these reintroductions and translocations, the number of ponds where Ramsey Canyon Leopard Frogs have become or are becoming established has increased four-fold (Sprankle, *in press*). The Fort Worth Zoo headstarts Chiricahua Leopard Frogs (*R. chiricahuensis* from locales other than Ramsey Canyon) in close collaboration with the FWS, New Mexico Game and Fish Department, Arizona Game and Fish Department, and Turner Endangered Species Fund (Garrett 2006). Adult populations are brought to the Zoo for breeding purposes and the resulting tadpoles are returned to the field for repatriation.

ASDM also works with Tarahumara Frogs (*Lithobates tarahumarae*)[5]. The Tarahumara Frog's historical range included southern Arizona and northwest Mexico, but the last US Tarahumara Frog was found dead in Arizona in 1983; at least three of the last local extirpations were a result of *Bd* (Hale et al. 2005). Collaborative efforts involving two nations, two states, numerous state and federal agencies, universities, private landowners, and interested citizens have led to the collection of founder individuals in Mexico, captive rearing of these founders at ASDM, surveys of historical habitat, assessment of population responses to *Bd*, and in 2004–2006, reintroductions of the Tarahumara Frog in Arizona. While re-establishment of the species in the United States continues to face many challenges, so far, the animals are persisting and breeding in Arizona once again (Johnson 2007).

AZA efforts are not focused exclusively on frogs and toads. In the central and eastern United States, survey evidence suggests that Hellbender salamander populations of both subspecies (*Cryptobranchus alleganiensis alleganiensis* and *C. a. bishopi*) are declining throughout their ranges in the U.S. Southeast and Appalachian regions. Surveys from Missouri and Ohio suggest population declines of ca. 80% over the past few decades and a skewing of populations towards older and larger animals, indicating low recruitment into the populations (Briggler et al. 2007; Lipps 2007). Staff and volunteers from zoos and aquariums throughout the salamander's range have begun surveying and monitoring local populations in the wild. The North Carolina Zoo works with the state's Wildlife Resource Commission to monitor populations and collect water quality and population data, and in 2007 received CEF funds to expand this effort. In Ohio, AZA member The Wilds is creating a stream on-grounds to mimic Hellbender habitat with the hope of eventually housing Hellbenders and studying the reasons behind their decline. While captive animals have not yet reproduced in captivity, in October 2007, a female Hellbender laid eggs at an indoor facility at the Saint Louis Zoo. The males did not fertilize the clutch, but this landmark event was significant to those developing protocols for rearing this species in captivity. The Columbus Zoo and Aquarium, Fort Worth Zoo, Lincoln Park Zoo, Louisville Zoo, Nashville Zoo, National Aquarium in Baltimore, Oglebay's Good Zoo, Omaha's Henry Doorly Zoo, Pittsburgh Zoo and PPG Aquarium, Smithsonian National Zoological Park, and Wonders of Wildlife are all involved in Hellbender conservation as well.

Further north in Canada, the Toronto Zoo has taken an ecosystem approach to amphibian conservation. In partnership with Environment Canada, the Toronto Zoo developed an Adopt-A-Pond program in 1991 (Sealock 2005). The goal of this program is to address declining amphibian populations by providing teachers, students, and community groups with informational resources and educational opportunities to conserve, restore, and create wetland habitats. Through its FrogWatch program, people of all ages are taught to monitor local frog populations by listening for their calls and reporting their observational data to a central database. Their publication *The Urban Outback* (http://www.torontozoo.com/adoptapond/) provides technical information to homeowners for small-scale wetland restoration and includes sections dedicated to amphibians. Full curricula and complementary resource networks, such as the Zoo's Pond Guardian initiative, have been developed around these successful programs. The Toronto Zoo is a leader in promoting backyard conservation and putting international conservation issues into a familiar and local context.

Finally, throughout the AZA community, facilities are committing millions of dollars to expand their amphibian conservation capacity. The largest of these efforts will take place at the Fort Worth Zoo, where leaders have committed $18 million to build a new herpetarium. The new facility, dubbed Museum of Living Art (MOLA), will include spacious, humidity-controlled exhibits and state-of-the-art conservation tools, such as quarantine rooms and hibernacula that support the breeding of rare, endangered, and critically endangered amphibians. Both the Jacksonville Zoo and Toledo Zoo are utilizing existing space at their facilities to create additional amphibian conservation and exhibit space, while Omaha's Henry Doorly Zoo is increasing their amount of biosecure space to accommodate increasing numbers of endangered and critically endangered amphibian species.

Greater Than the Sum of its Parts: An Unprecedented Campaign

2008: Year of the Frog is a campaign unlike any other in the zoological community. Participation in the campaign is global. The campaign responds directly to an urgent conservation need. It focuses on a taxonomic group not generally given the spotlight at zoological facilities. It is fully integrated to include herpetologists, zoological veterinarians and epidemiologists, nutritionists and invertebrate specialists, small population biologists, educators, public relations departments, and marketers. It promises to raise public awareness so that 600 million annual zoo visitors worldwide understand and support amphibian conservation. The Year of the Frog campaign will raise money and attention so these programs can continue to grow in the future, even if the spotlight may shift to other taxonomic groups. And it promises to fulfill the *ex situ* recommendations outlined in the IUCN's *Amphibian Conservation Action Plan* (ACAP). The implementation of the campaign will

also provide support and participation to other components of the ACAP, making this campaign vital to the overall success of the ACAP.

This campaign is larger than the zoological community, and appropriately so. To halt amphibian declines, commitments and action must also be larger than the zoological community or any other single organization or interest group. Join us in this campaign and work together with your local zoos and aquariums to help this effort be unprecedented in its integration and ultimately, unprecedented in its success.

Guide to Acronyms

ACAP – Amphibian Conservation Action Plan
ARAZPA – Australasian Regional Association of Zoological Parks and Aquaria
ASG – Amphibian Specialist Group
ASDM – Arizona-Sonora Desert Museum
ATAG – Amphibian Taxon Advisory Group
AZA – Association of Zoos and Aquariums
Bd - Batrachochytrium dendrobatidis
CBSG – Conservation Breeding Specialist Group
CEC – Conservation Education Committee
CEF – Conservation Endowment Fund
CRES – Conservation and Research for Endangered Species
DAPTF – Declining Amphibian Populations Task Force
EAZA – European Association of Zoos and Aquariums
EWCL –Emerging Wildlife Conservation Leaders
FWS – U.S. Fish and Wildlife Service
GAA – Global Amphibian Assessment
IUCN – World Conservation Union
MOLA – Museum of Living Art
NZP – National Zoological Park
PARC – Partners in Amphibian and Reptile Conservation
RCLFCT – Ramsey Canyon Leopard Frog Conservation Team
SSC – Species Survival Commission
SSP – Species Survival Plan
USFS – U.S. Forest Service
USGS – U.S. Geological Survey
WAZA – World Association of Zoos and Aquariums
ZCOG – Zoo Conservation Outreach Group

Referenced and Related Web Sites

Amphibian Ark: www.amphibianark.org
AmphibiaWeb: http://amphibiaweb.org/index.html
AZA: www.aza.org; www.aza.org/yearofthefrog
Global Amphibian Assessment: www.globalamphibians.org
IUCN Red List of Threatened Species: http://www.iucnredlist.org/
Toronto Zoo: http://www.torontozoo.com/adoptapond/

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[1] The taxonomy of *Bufo baxteri* has been updated to *Anaxyrus baxteri*, as reflected in Frost (2007).

[2] The taxonomy of *Bufo californicus* has been updated to *Anaxyrus californicus*, as reflected in Frost (2007).

[3] The taxonomy of *Rana catesbeiana* has been updated to *Lithobates catesbeianus* as a result of the work of Dubois (2006), as reflected in Frost (2007).

[4] The Ramsey Canyon Leopard Frog was described as *Rana subaquavocalis* by Platz (1993), however, the U.S. Fish and Wildlife Service has adopted the taxonomy of *R. chiricahuensis* due to genetic work by Goldberg et al. (2004) and Hillis and Wilcox (2005) that supports subsuming *R. subaquavocalis* into *R. chiricahuensis* (U.S. Fish and Wildlife Service 2007).

[5] The taxonomy of *Rana tarahumarae* has been updated to *Lithobates tarahumarae* as a result of the work of Dubois (2006), as reflected in Frost (2007).

LETTERS TO THE EDITOR

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The Amphibian Extinction Crisis: A Call To Action

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The Global Crisis

Addressing the amphibian extinction crisis curently represents one of the greatest species conservation challenge in the history of humanity. The Global Amphibian Assessment (Stuart et al. 2004) revealed that one third to one half of the world's 6000 amphibian species are threatened with extinction. This is significantly more than any other group of organisms: by comparison, 12% of bird species and 23% of mammal species are threatened. As many as 165 amphibian species have already disappeared in recent years. This qualifies as a mass extinction event, and deserves special attention for reasons of ethics and also because amphibians deliver substantial goods and services to their ecosystems and to humans (e.g., biomedicines). The amphibian crisis has taught us a valuable lesson in that 20 years of monitoring, research, and conservation action have advanced our state of knowledge of the situation, but these efforts have failed to prevent numerous extinctions in places such as Australia, Puerto Rico, Costa Rica, and Ecuador. This sends the message that "business as usual" in terms of research and conservation, while remaining crucial, are insufficient by themselves to confront this crisis (Mendelson et al. 2006).

The Amphibian Conservation Action Plan

The myriad intertwined factors likely affecting amphibian declines and extinctions require novel, cross-disciplinary approaches to research and conservation. In September 2005, the IUCN and Conservation International convened an Amphibian Conservation Summit in Washington, DC. The world's amphibian authorities from academia, zoos, government, veterinary medicine, and other diverse disciplines gathered to conceptualize a global Amphibian Conservation Action Plan (ACAP, Gascon et al. 2007), outlining general responses required in the fields of research, assessment, conservation, and rapid responses to stem widespread global amphibian extinctions. The entire ACAP may be downloaded from the website of the IUCN-SSC Amphibian Specialist Group (www.amphibians.org).

The ACAP emphasizes basic research targeted at the underlying causes of amphibian declines, specifically highlighting diseases, climate change, and environmental contamination. The



The Lemur Leaf Frog *Hylomantis* (= *Phyllomedusa*) *lemur* is listed by IUCN as Endangered across its entire range in Costa Rica, Panama, and Colombia. Its current status in the wild appears to continue to decline as populations in Panama are being sequentially impacted by epidemics of amphibian chytridiomycosis. Following guidelines laid out by the Amphibian Conservation Action Plan and the Amphibian Ark, this species is currently well established in ex-situ populations in USA, UK, Costa Rica, and Panama and in-situ efforts are ongoing in Costa Rica. Progeny from the captive colonies are now forming the basis for basic academic studies on chytridiomycosis. Photo by Ron Holt/Courtesy Atlanta Botanical Garden.

ACAP calls for aggressive field efforts to refine our knowledge of amphibian diversity (phylogeny and taxonomy), distributions, and conservation status, in order to continuously update the Global Amphibian Assessment (www.globalamphibians.org). Conservation programs must address important long-term objectives in habitat protection, while also managing the difficult arenas of reintroductions and control of harvest. Finally, the ACAP delegation agreed that there are a number of examples in the wild where rapid-response interventions might be necessary. Such programs are to include capacity for responding to impending crises related to habitat loss, contamination, or disease outbreak, and also establishing a globally organized program to maintain captive survival assurance populations. Captive populations may represent short- or long-

term temporary solutions to prevent extinctions, while necessary research and conservation programs work to address the primary threats. They also should represent phylogenetically diverse groups for important research programs (e.g., evolution of resistance to emerging infectious diseases). These captive programs fall under the auspices of the newly launched Amphibian Ark (Pavajeau et al., *in press*; see below).

Despite substantial progress in recent years in understanding the underlying causes of the amphibian crisis, significant research gaps remain. Examples include:

- what are the effects of long-term sub-lethal exposure to environmental contaminants?
- are there direct cause-effect linkages between climate and disease?
- how exactly does chytridiomycosis kill amphibians?
- how and why are some species more affected by certain threats than are others?
- how is chytridiomycosis spread, and does the pathogen have a resting stage?
- can we design bioreserves to protect against invasive species, emerging infectious diseases, contaminants, and climate change?

These projects, among many others, will require significant time, effort, and resources before their results can be applied in any meaningful way to conserve amphibians. These questions will also require truly cross-disciplinary approaches, if we are to have any hope of identifying and responding to the potential synergistic effects between the various documented threats to amphibians. Using the ACAP as an outline, the specific role of the IUCN/SSC Amphibian Specialist Group is to support a holistic approach to the amphibian crisis that includes complementary efforts among *in situ* and *ex situ* conservation programs, basic research, and related issues of policy, law, ethics, and public education.

A Call to Action for Conservation Research

Academic institutions are the centers for much of the basic research necessary to inform conservation programs. Never has the connection between basic research and conservation been more imperative than in the present amphibian crisis. Mendelson et al. (2006) opined that the status quo approach of programs of research-as-usual and conservation-as-usual are insufficient to confront this crisis. The basic problem in this case is that conservationists, land-managers, and other stakeholders literally do not know how to implement conservation programs in the face of threats as global and pervasive as emerging infectious disease and climate change. Thus, synthetic programs must be coordinated among the research institutions globally, in order to discover the science underlying the current threats to amphibian biodiversity. This research must take place against a backdrop of continued vigilance of programs to protect habitat, prevent overexploitation, and other "familiar" threats to biodiversity. However, basic research takes time, and recent history has demonstrated that the passage of time correlates with additional amphibian extinctions. Thus, while researchers work to answer basic questions relevant to amphibian conservation (e.g., "Does amphibian chytrid fungus persist in the environment, in the absence of amphibians?") their results may come too late to save some species. Thus the clarion call was sounded to bolster such research programs contemporaneously with ambitious conservation programs (Gascon et al. 2007; Mendelson et al. 2006).

There have been a number of world-class amphibian research programs and facilities at universities and museums (e.g., Kluge 1996; Myers 2000; Trueb and Duellman 1996) that have framed our understanding of amphibian biology, and also our fundamental skills for maintaining and breeding certain species in captivity (e.g., Cullum and Justus 1973; Nace 1968; Nace et al. 1974). Nevertheless, these programs historically have tended to function in isolation from ongoing conservation programs—in fact, the focus was never on conservation. Fortunately, however, the recent call for integrated research and conservation programs comes as some such programs already exist (see below).

Model Programs

Environmental Contaminants

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Contaminants are both accidentally and purposefully released into the environment and can move through local, regional, and global cycles that result in widespread chemical exposure in both protected and human-dominated landscapes. Therefore, understanding how contaminants can influence population dynamics and community regulation is of great importance, particularly in light of worldwide amphibian population declines. Additionally, contaminants could also play a key role in amphibian declines by interacting with other stressors present in the environment, such as disease pathogens. While traditionally, toxicology has focused on lethal concentrations in simple systems in the laboratory, it is critical to integrate effects found in the laboratory with those in the field to gain better predictive power for population and community level consequences of contaminants in nature.

A group of scientists working in the field of ecotoxicology has been examining the effects of contaminants from the laboratory to field mesocosms to artificial wetlands to the natural environment, which has allowed us to explore the ecological ramifications of chemical exposure to the aquatic and terrestrial environment (reviewed in Boone and James 2005). For instance, our work with expected environmental concentrations of the insecticide carbaryl has allowed us to examine how carbaryl's toxicity was influenced by competition, predation, and pond hydroperiod across experimental venues (reviewed in Boone and Bridges 2003; Boone et al. 2004). These studies are among the first to examine how natural environmental factors can alter toxicity. From initial studies, it became clear that environmental factors influence and modify the effect of a contaminant on amphibians, that species are differentially susceptible to contaminants, and that the indirect effects of the contaminants (e.g., altering predator communities and food resources) are potentially more important than direct effects (Boone and Bridges 2003; Mills and Semlitsch 2004). We have also manipulated factors associated with chemical application, such as multiple contaminant exposures through larval development (reviewed in Boone and Bridges 2003) and exposure to chemical mixtures (reviewed in Boone and James 2005; Boone et al. 2007). These studies suggest that mimicking contaminant application through multiple exposures during larval development can stimulate larval development and lead to precocious metamorphosis.

Additionally, multiple contaminants can result in interactions that are not predictable from single factor studies. In this respect, these studies have directly addressed the question of "multiple stressors" and set the stage for evaluating ecological questions related to contaminants in natural environments that other researchers have and could follow.

The benefit of an approach evaluating effects of select contaminants in complex experimental environments (rather than broader testing of different contaminants in the simple laboratory or field conditions) is that it addresses relevant ecological questions and evaluates how contaminant effects may change or manifest themselves outside of traditional types of tests used for federal regulation. Currently, we do not understand the ecological effects of the major classes of chemical contaminants and we are only beginning to explore how other factors mediate the contaminants' effects. Although there is evidence suggesting that contaminants may play a role in amphibian population declines (e.g., Davidson et al. 2002), the mechanism is not clear. There is accumulating evidence indicating that contaminants play a role in the incidence of limb malformation through increased susceptibility to trematodes (Johnson and Chase 2004) and can decrease immune response (Christin et al. 2003; Gilbertson et al. 2003). Such studies suggest that presence of contaminants in combination with other factors could contribute to declines. Contaminants are present in the environment, and for this reason evaluating their effects, which can alter community structure and population dynamics, is of paramount importance.

Diseases

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Infectious disease is now acknowledged as a major threat to amphibian populations and species at a growing number of sites around the world (Daszak et al. 2003; Stuart et al. 2004; Lips et al. 2006; Ron 2005). While amphibian chytridiomycosis has been the focus of the majority of investigations in recent years, other pathogens (e.g., ranaviruses) must also be considered (see review by Daszak et al. 2003). Along with studies related to climate change (see below), it appears that the relative novelty of disease as a direct threat to biodiversity has effectively instigated a number of innovative collaborative projects that represent basic research related to disease or pathogens, but within an explicit framework of amphibian conservation (e.g., Carey et al. 2006; Harris et al. 2006; Kriger and Hero 2007; Lips et al. 2006; Rachowicz and Vredenburg 2004; Rollins-Smith et al. 2002; Wilcox 2006; Woodhams et al. 2007). Furthermore, cross-disciplinary research and conservation programs are coming to exist, such as the Endangered Frog Research Centre at Griffith University, the Amphibian Diseases Research Group at James Cook University (both in Queensland, Australia), the Integrated Research and Challenges in Environmental Biology amphibian disease group (based at Arizona State University, USA), the Latin American RANA organization, and the recently formed international Amphibian Ecotoxicology Consortium. While many more such projects and programs are needed, the evident synthesis of research and conservation priorities does bode well for amphibian biodiversity.

A key to the innovative nature and ultimate productivity of such cross-disciplinary programs is their culture of meeting and collaborating, rather than the more traditional approach of research labs around the world working independently and thus competing with one another, whether it be implicitly or explicitly so. Within such networks graduate students, for example, may have open access to expertise that that is beyond the scope of their base institution or advisory committee. This type of access to advice and training effectively ensures future generations of researchers with a broad array of skills, professional experience, and key contacts across disciplines. Similarly, international collaborations build a culture of trust that can simplify layers of bureaucracy, to allow better focus on the science at hand and improve diplomatic relations among academics across regions.

Climate Change

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An increasing number of studies show a correlation between amphibian population declines and climate change (e.g., Blaustein et al. 2003; Pounds et al. 2006). Climate change could produce population declines either directly (e.g., by reducing the area of distribution of the species' fundamental niche; Thomas et al. 2004) or indirectly by interacting with other risk factors. The most widely studied hypothesis for the role of climate change is known as the climate-linked epidemic hypothesis (Harvell et al. 2002; Pounds et al. 2006), which posits that declines are a consequence of synergisms between pathogens and novel climate conditions. A recently proposed variant is the chytrid thermal optimum hypothesis, which posits a link between climate change and population declines attributable to chytridiomycosis (Bosch et al. 2006; Pounds et al. 2006).

The available evidence suggests that research on the effects of climate change could be crucial to develop realistic conservation programs for amphibians. Future efforts should be directed to explore the link, if any, between climate change and population declines in a more diverse array of taxa and on a larger number of regions with emphasis in biodiversity hotspots. Because the association between climate change and disease does not necessarily imply causation, there is an urgent need to test the climate-linked epidemic hypothesis by acquiring a better understanding of how climate influences the immune response of amphibians and the survival rates, virulence, and transmission of pathogens. Climate change has been linked to disease outbreaks involving more than one pathogen at a single population (Di Rosa et al. 2007) suggesting that research should test interactions with a broad array of potential pathogenic agents.

Although there are numerous studies documenting distributional shifts as a the result of climate change (for a review see Parmesan 2006), there are surprisingly few published reports for amphibians (e.g., Seimon et al. 2007). It is expected that species with restricted ranges inhabiting polar regions and mountaintops will experience severe range contractions, population declines and extinctions (Parmesan 2006). Thus, future efforts should also focus on assessing how climate change is impacting distribution

ranges, especially in tropical mountains, the regions of greatest amphibian diversity.

Global warming is unlikely to weaken in the short term. A more complete baseline dataset on how climate influences disease spread and outbreaks will allow development of predictive models to forecast regions and taxa that are likely to become threatened by climate change.

The Amphibian Ark

Although the only place to truly conserve wildlife is in the wild, *in-situ* threats sometimes cannot be mitigated quickly enough to prevent extirpation or extinction. Even with timely protection from threats under our immediate control, such as habitat destruction and over-collection, we cannot protect wild populations from threats whose effects would continue long after the immediate cause has ceased, e.g., introduced diseases, climate change, and pollution. In cases where *in-situ* threats cannot be mitigated quickly, as appears to be the case for many of amphibian species, *ex-situ* intervention is the only option to prevent immediate extinction. The IUCN has urged that "All Critically Endangered and Extinct in the Wild taxa should be subject to *ex situ* management to ensure recovery of wild populations." (IUCN 2002). Comparable calls to action are included in the Global Amphibian Assessment, the ACAP, and other IUCN documents. In response to this challenge, the World Association of Zoos and Aquariums, the IUCN/SSC Conservation Breeding Specialist Group, and the IUCN/SSC Amphibian Specialist Group have jointly formed the Amphibian Ark (www.AmphibianArk.org, Pavajeau et al. in press)**,** to guide short-term *ex situ* management to help ensure long-term survival in nature of amphibian taxa for which adequate protection in the wild is not currently possible. The AArk will facilitate coordination of *ex situ* programs implemented by partners around the world, with the first emphasis on programs within the range countries of the species, and with a constant attention to our obligation to link *ex situ* conservation measures with complementary *in situ* programs. The AArk will lead a 2008 globally coordinated, zoo-based awareness and capital campaign, 'Year of the Frog' (www.2008YearoftheFrog.org) to help zoos raise the funds to support rapidly developing programs for *ex situ* rescue efforts, *in situ* conservation, research, and communication about the amphibian extinction crisis. The goal of AArk is to prevent the anticipated extinction of hundreds of species (*sensu* Stuart et al. 2004), and to buy time for these species while ongoing basic research and conservation programs develop effective long-term measures to restore and protect populations in the wild. The program will accomplish this goal primarily by developing capacity globally to provide amphibian species with care and protection when needed, and by forming effective partnerships between *ex situ* and *in situ* components of conservation. This framework will provide a model for responding to future species conservation crises.

A Call to Action for Conservation Breeding

Ex situ management for conservation is not just a job for zoos, aquariums, and botanic gardens. Currently there is not enough capacity among these institutions to meet the needs of most of the amphibian species that require help. We estimate that the global zoo community can currently manage viable populations of ~50 amphibian species, which amounts to perhaps 10% of those requiring *ex-situ* intervention. If we are to understand the needs and requirements of the diverse amphibian species that will need help, and which by the very nature of their vulnerability are likely to be specialized, it will be important to acknowledge the valuable contribution academic institutions and individuals can provide. In an effort to increase global capacity, and also harness the skills of such specialists, the AArk must include the expertise and facilities of universities, natural history museums, and the private sector. Several existing programs serve as models in this arena.

Model Programs

Pontificia Universidad Católica in Quito, Ecuador

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The Ecuadorian amphibian fauna comprise 464 described species, plus an estimated 270 awaiting discovery and/or description (Coloma et al. 2007). This fauna is not only one of the most diverse on the planet, but one the most threatened. Threats such as global warming, pathogens, and habitat destruction are magnified in this country. For example, mean temperatures in the Andes are increasing at least twice as fast as the mean global temperature (Merino-Viteri et al. 2005; Ron et al. 2003), pathogens are widespread in the Andean region (Merino-Viteri et al. 2005; Ron and Merino 2000), and the national deforestation rate (about half a million acres per year) is among the tenth highest in the world (CLIRSEN 2006). Most recent estimates indicate that at least 141 Ecuadorian amphibian species are threatened with extinction, with 5–25 presumably already extinct (updated from the Global Amphibian Assessment, IUCN et al. 2004); 84% of the threatened species live in the Andean Region. These numbers could be underestimated because at least 131 additional species are classified Data Deficient. It is expected that the number of threatened species will increase with further data.

The potential to have great losses or gains in the conservation of amphibians depends on immediate actions. Under these circumstances, Pontificia Universidad Católica del Ecuador (PUCE) is implementing the Project "Balsa de los Sapos" (Life raft for frogs), which includes a Strategic Plan for the Conservation of the Ecuadorian Amphibians in Risk of Extinction. Goals and activities within this initiative follow major guidelines of the global strategy for conservation of amphibians and the ACAP (Gascon et al. 2007). Thus, the Strategic Plan includes five major programs that are complementary to each other: 1) monitoring and research of native amphibians; 2) improvement of local capacities; 3) *ex-situ* management of all endangered species; 4) environmental education and public awareness; and 5) bioinformatics and diffusion of information. Diverse research laboratories of PUCE and its Museum of Zoology (QCAZ) have converged towards this ambitious project and several activities are already underway. Among them, PUCE raised awareness about the importance of amphibians and their crisis through a public amphibian exhibit "Sapari," carried out in Quito in 2005, which was attended by 105,000 visitors in 90 days. As well, PUCE is building capacity and initiating breeding programs for amphibians. A pilot center (with seed support of the Saint Louis Zoo) has been established for research,

management, and *ex-situ* conservation of some species, such as the surviving species of *Atelopus* (i.e., *A. exiguus, A. elegans, A. palmatus, A. spumarius, A.* sp.) and around a dozen species of Andean and Chocoan frogs under high risk of extinction. More information on this Ecuadorian "Life-Raft" initiative is available at AmphibiaWebEcuador (2006).

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At Manchester University's Museum, an important and specialized collection of Costa Rican anuran species is being professionally and demographically managed. Although unusual to find such a conservation-focused live collection in a museum, the level of animal care and commitment Manchester is providing also fulfils many aspects of the institution's key objectives. Increasingly, museums are considered to have to play an important role in delivering some of societies global responsibilities. Endeavoring to put something real back to the planet through their amphibian conservation work allows Manchester Museum to do this in a very powerful and meaningful way. The development of global academic links and the support and involvement with 'in country' initiatives further validates this. Large captive colonies for several selected species form a backbone to the successful captive breeding programs that have been initiated here and, apart from having the benefit of a multi-disciplined team of scientists on the doorstep, the collection forms part of a valuable educational and research resource. Many students conduct non-invasive behavioral and biological projects in the department and are also directly involved in supporting conservation efforts through fieldwork.

Amphibian Research Centre in Australia

GERRY MARANTELLI

Established by Gerry Marantelli in 1994, the ARC is a self-funded private facility dedicated to conservation management, research, and education for Australian anurans. The ARC currently holds one of the largest amphibian collections in the world and is involved with ten Nationally Endangered frog species (e.g., Hunter et al. 1999). Management activities also include pioneering work with hygiene and automation: in December 2004 the ARC hosted a workshop "Captivity, Reintroduction and Disease Control Technologies for Amphibians," from which the presentations are available online at the ARC website (www.frogs.org.au). Research efforts include work on assisted reproductive technologies, cryopreservation, and control of introduced Cane Toads. ARC was involved in the discovery of the amphibian chytrid (Berger et al. 1998) and subsequent research on its biology (Berger et al. 2004, 2005; Marantelli et al. 2004), diagnostics (Berger et al. 2002), and treatment (Woodhams et al. 2003). The ARC also focuses on public education through activities like school group tours, classroom tadpole projects, and housing the community outreach Victorian Frog Group. The ARC website is one of the largest and most popular frog websites in the world with over 1.5 million total hits and 80–100,000 visitors each month. ARC work is funded through corporate and private sponsorships, government threatened species recovery programs, and through sales of captive-bred pet frogs of common native species, live food items and other hobbyist supplies, and popular frog-related items.

Concluding Comments

The ACAP is an outline of proposed programs and priorities to work towards a synthetic research and conservation program to amphibian conservation. It is not a detailed plan of action, complete with tasks and funding assigned to specific labs and persons. Sadly, such critical details and organization must await remarkably ambitious and successful fundraising programs (e.g., 2008 Year of the Frog, and proposed activities by the Amphibian Specialist Group). In the meantime, however, inaction is not acceptable and we put forward that the questions and initiatives outlined in ACAP and in various Amphibian Ark documents offer a broad menu of academic honors thesis, dissertation, and post-graduate topics, as well as questions and challenges tractable to zoos, aquariums, botanical gardens, and natural history museums of all sizes.

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ARTICLES

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Biphasic Oviposition by Northwestern Salamanders (*Ambystoma gracile*) in the Cascade Mountains of Southern Washington, USA

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Little has been published about temporal patterns of oviposition by Northwestern Salamanders (*Ambystoma gracile*), either within or among years. Timing of oviposition can be critical to reproductive success and thus subject to strong selection pressures (*sensu* Resetarits 1996). In unpredictable, variable environments more than one tactic may be successful and evolutionarily stable. In this paper, I report the results of a four-year study that documented biphasic oviposition patterns of a population of Northwestern Salamanders, with a preliminary assessment of potential explanatory factors. Five hypotheses follow that may explain this pattern based on the effects of weather on breeding activity, or variation in breeding among different population cohorts. These hypotheses are neither exhaustive nor mutually exclusive. Testable predictions are provided for the first three, but I did not collect data relevant to the latter hypotheses.

H_1: interrupted rainfall.—Breeding in many pond-breeding amphibians appears linked to rainfall and temperature (Anderson 1967; Chadwick et al. 2006; Greenberg and Tanner 2004; Palis 1997; Semlitsch 1985; Sexton et al. 1990; Todd and Winne 2006). A period of either little or no rainfall (which is also often cooler) bracketed by wet and warm weather could interrupt breeding immigrations of Northwestern Salamanders resulting in two distinct oviposition bouts by metamorphic adults within a season. A prediction of this hypothesis is that the appearance of new egg masses is strongly positively correlated (r 0.7) with rainfall. In addition, cloudless dry periods also produce low night temperatures and the number of new egg masses should also be positively correlated with minimum air temperatures.

H_2: periodic drought.—Early breeders may have increased reproductive success during drought years because declining water levels over the summer favor earlier hatching, thus avoiding desiccation of embryos. In addition, larvae of early breeders go through metamorphosis earlier and avoid death due to complete pond drying. Furthermore, larvae of early breeders have more time to feed and develop prior to their first winter. During wetter years, late oviposition may serve to insure that embryos are not subject to late spring freezes, avoid periods of high water flow that could displace egg masses during spring run-off, and reduce exposure of embryos to predators (MacCracken 2007) through accelerated development associated with higher water temperatures later in the season (Brown 1976). Thus, periodic drought at a frequency less than the average individual life span would maintain cohorts of early and late breeders resulting in two peaks in oviposition within a breeding season.

For the advantages of early breeding to be realized: 1) oviposition should begin earlier as drought results in a shallow snowpack, early snowmelt, and relatively warm temperatures; 2) the active oviposition period should be shorter; and 3) the majority of egg masses should be deposited earlier compared to non-drought years because late breeders experience unfavorable weather during immigration.

H_3: paedomorph/metamorph.—Life history variation may result in two distinct oviposition bouts in some ambystomatid salamanders. Earlier breeding of 6–8 weeks by paedomorph versus metamorph Mole Salamanders (*A. talpoideum*) has been documented (Krenz and Sever 1995; Scott 1993; Whiteman and Semlitsch 2005). In addition, paedomorphs breed, and presumably, deposit eggs at greater water depths (Whiteman and Semlitsch 2005). Many Northwestern Salamander populations also contain both morphologies (Carl and Cowan 1945; Eagleson 1976; Efford and Mathias 1969; Snyder 1956; Sprules 1974), as did the population I studied. Contrary to the pattern reported for *A. talpoideum*, Richter and Kerr (2001) found no difference in oviposition chronology for paedomorphic and metamorphic Northwestern Salamanders, but did find that egg masses were deposited at greater depths by paedomorphs. A prediction of this hypothesis is that the peak in the number of new egg masses observed between early and late periods should be several weeks apart. In addition, the number of new egg masses should be nearly equal between early and late oviposition periods, because the proportion of paedomorphs in Northwestern Salamander populations increases with elevation (Carl and Cowan 1945; Eagelson 1976; Snyder 1956) and given the moderate elevation of my study area, I would expect the size of the two cohorts to be close to unity.

H_4: alternate year breeding.—Some ambystomatids have alternate (or more) year breeding (Church et al. 2007; Harris and Ludwig 2004; Kinkead and Otis 2007; Nussbaum et al. 1983), suggesting that resources may not be sufficient to support annual breeding by all individuals in a population. Alternate year breeders may reproduce later in the season because limited resources result in a longer period for ova to complete the yolking stage. For this scenario to produce two oviposition bouts, populations would have to contain both bi-annual and annual breeders.

H_5: double clutching.—Double-clutching also could produce two distinct periods of oviposition within a breeding season. Northwestern Salamanders are presumed to only lay one egg mass/season (Thoms et al. 1997), and this assertion likely rests with the physiological improbability of double-clutching. However, the lack of documentation prevents dismissing this hypothesis.

Methods.—This study was conducted in a 25.5-ha wetland in the Cascade Range of southwestern Washington, USA. The wetland had a southeast aspect, 3% slope, an elevation range of 915–940 m, and had over 40 ponds of various sizes (see MacCracken 2007) and in various stages of vegetation succession. MacCracken (2005, 2007) provided a more detailed description of the study area. Snow normally begins accumulating in late-November/early-December and persists until late March/early June. Rainfall is generally greatest in April–June, followed by a summer drought beginning in mid-July and persisting until September–October.

Thirty-three ponds consistently used for breeding by Northwestern Salamanders were surveyed annually from 1999–2002 (MacCracken 2007). I surveyed each pond every 5–7 days starting with the onset of Northwestern Salamander oviposition activity (early April–early May) until all egg masses had completely hatched, typically in mid-August. I searched each pond for egg masses by traversing the perimeter, and wading sections 1.3 m deep that were not visible from the shore. Water clarity allowed good visibility to a depth of about 2 m. When an egg mass was first discovered, I marked each with a numbered pin flag inserted into the substrate next to the egg mass, and measured the depth of the top of the egg mass below the water surface with a meter stick (MacCracken 2007).

Data on air temperature and precipitation were collected from 2–4 sites at each visit, except in 2000. Weather stations were established in the north and south portions of the wetland in 1999 with two more stations added in 2001 at intermediate locations. Each station had two rain gauges about 50 m apart and a maximum-minimum thermometer placed in a shaded location between the rain gauges. Instruments were set at ground level and read and reset at each visit. In addition, water temperature of each pond was measured with a liquid thermometer about 12 cm below the surface at each visit. These data allow for an assessment of hypotheses one, two, and three as outlined below.

For H_1, Spearman rank-order correlations were estimated comparing weekly rainfall and minimum air temperature with the number of new egg masses for 1999, 2001, and 2002.

For H_2, mean total rainfall and snow water equivalent for 1998–2006 water years (October–September) was calculated from data for the South Fork Bull Run Snotel station (15 km SE of my study area, 902 m elev., http://www.or.nrcs.usda.gov/snow/data/historic.html). The mean of these metrics were compared to the individual water year data for 1999–2002 to identify drought years during my study. The date of the onset of oviposition and the duration of the active oviposition period was compared between drought and non-drought years. The mean number of new egg masses laid between the early and late oviposition periods was compared with a Mann-Whitney *U*-test as the data were slightly skewed in some years (Fig. 1). Early and late periods were delineated based on the date of the fewest number of new egg masses observed following the initial peak.

For H_3, the mean number of new egg masses was compared between early and late periods with a Mann-Whitney *U*-test. Furthermore, paedomorphs of Northwestern Salamanders oviposit at greater water depths (Richter and Kerr 2001), thus early deposited egg masses should be at greater depths than late deposited egg masses. Mean egg mass depth was compared between early and late periods with a Mann-Whitney *U*-test as these data were also slightly skewed toward smaller values.

Results.—I observed a total of 762 egg masses during this study, with the greatest number in 2001. The temporal distribution of oviposition had two peaks each year (Fig. 1).

To examine H_1, rainfall data from the study area were available for each year except 2000. In 1999, 2001, and 2002, 1–5 weeks of either little or no rainfall, bracketed by wetter weather, occurred during the active oviposition period (Fig. 1). The strongest positive correlations between number of new egg masses and weekly rainfall occurred in 2001 ($r_s = 0.75$, $P = 0.05$) and 1999 ($r_s = 0.49$, $P = 0.13$; Fig. 1). However, the relationship was negative and weak in 2002 ($r_s = -0.19$, $P = 0.37$). There was a lag of about a week between the occurrence of new egg masses and rain in 2002. When that lag effect was removed, the correlation was moderate and positive ($r_s = 0.65$, $P = 0.09$). In addition, the strongest correlation between new egg masses and minimum air temperatures was for 2001 ($r_s = -0.67$, $P = 0.06$), but was in the opposite direction of that predicted. These comparisons provide mixed support for the interrupted rainfall hypothesis.

Relative to H_2, the winter of 2000–2001 experienced a strong El Niño event. Precipitation for the 2001 water year was 65% of normal; the snowpack was shallow, ephemeral, and had melted completely by mid-March on the study area (MacCracken, pers. obs.). The average January–April 2001 snowpack at the South Bull Run station had less water content (1.5[SE = 0.8] cm) than the average for 1998–2005 (5.8[1.0] cm).

Both average water and maximum air temperatures on the study area were 3° and 7°C warmer, respectively, in May 2001 than other years, despite May and June rainfall in 2001 being 145% and 35% greater than the same months in 1999 and 2002, respectively (Table 1). Oviposition by Northwestern Salamanders began 1–3 weeks earlier in 2001 compared to 1999, 2000, and 2002 (Fig. 1). Duration of the active oviposition period in 2001 was six weeks compared to 7–9 weeks for the other years. In addition, more egg masses were deposited during the early than late period in 2001, a pattern that was reversed in the other years (Fig. 1). These comparisons agree with the predictions of the periodic drought hypothesis.

For H_3, an average of 3.2(0.1) weeks separated the peaks between the early and late oviposition periods (Fig. 1). However, on average 22% fewer new egg masses were deposited during the early period (76[32]) when compared to the late period (93[18], $U = 8.0$, $P = 1.0$) over the four years of study. In addition, the average depth of egg masses below the water surface was 25(1) and 23(1) cm ($U = 63849$, $P = 0.01$) for early and late periods, respectively. This result was not a function of pond drying as water levels were stable during this time period (J. G. MacCracken, unpubl. data). These comparisons are consistent with the predictions of the paedomorph/metamorph hypothesis (H_3).

Discussion.—None of the hypotheses examined can be dismissed based on my analyses and are best viewed in the context of Chamberlin's (1965) method of multiple working hypotheses in that several mechanisms may act in concert (Elliott and Brook

FIG. 1. Counts of new *Ambystoma gracile* egg masses and average rainfall and minimum daily air temperature by 10-day increments for 1999–2002 in the Cascade Mountains of southwestern Washington, USA. Rainfall and air temperature data were not collected in 2000.

2007) to produce the pattern I observed. Furthermore, additional relevant hypotheses also may be developed in the future.

Given the caveat above, my analyses and those in the published literature lend the greatest support to the two weather-related hypotheses as explanations for biphasic oviposition by Northwestern Salamanders. At the seasonal level, numerous studies of a variety of amphibians have found two or more waves of immigrations to breeding ponds that corresponded to precipitation, air temperatures, or both (Anderson 1967; Beneski et al. 1986; Brodman 1995; Chadwick et al. 2006; Cook et al. 2006; Greenberg and Tanner 2004, 2005; Harris 1980; Healy 1975; Hurlbert 1969; Loredo and Van Vuren 1996; Palis 1997; Semlitsch 1981, 1985; Sexton et al. 1990; Timm et al. 2007; Todd and Winne 2006; Vasconcelos and Calhoun 2004). The weight of evidence from these studies lends strong support to the interrupted rainfall hypothesis, despite the relatively inconclusive results from this study, suggesting that: 1) Northwestern Salamanders might use other clues to initiate immigration, (e.g., declining barometric pressure); 2) that my sampling regime was temporally too coarse to capture the details of the relationship; 3) the occurrence of rain may be more important than the actual amount; or 4) paedomorphs make up a relatively large portion of the population.

My data lend some support to the periodic drought hypothesis as a mechanism sustaining two oviposition bouts. The response

TABLE 1. Mean (standard error) maximum and minimum air temperature (°C), pond water temperature (°C), and precipitation (mm) for May–September (5–9) from 1999–2002 in the Cascade Mountains in southwestern Washington, USA. nd = no data.

	1999					2000					2001					2002				
	5	6	7	8	9	5	6	7	8	9	5	6	7	8	9	5	6	7	8	9
$Air_{maximum}$	21(3)	15(1)	25(1)	27(1)	22(1)	nd	nd	28(2)	nd	23(2)	24(1)	20(1)	24(1)	23(1)	23(2)	15(1)	24(1)	26(1)	25(1)	27(1)
$Air_{minimum}$	-1(1)	1(1)	4(1)	5(1)	0(1)	nd	nd	0(1)	nd	3(2)	-1(1)	2(1)	5(1)	5(1)	5(2)	-2(1)	1(1)	3(1)	2(1)	1(1)
Water	9(5)	13(1)	15(1)	15(1)	11(1)	11(1)	14(1)	14(1)	17(2)	nd	13(1)	13(1)	15(1)	15(2)	nd	11(1)	14(1)	16(1)	13(1)	nd
Precipitation	6(0)	14(6)	15(7)	5(1)	9(2)	nd	nd	0	nd	1(1)	49(16)	20(5)	6(2)	21(9)	0(0)	38(33)	23(7)	22(12)	1(1)	11(6)

by Northwestern Salamanders to drought conditions during the winter of 2000–2001 may provide insight into the effects of climate change on this species. If increased frequency of drought is part of climate change (see Lueng et al. 2004 and Payne et al. 2004) then a pattern similar to that observed in 2001 also may occur more frequently. Precipitation amount and timing are likely the most important variables (Russell et al. 2005; Todd and Winne 2006). Warm winter/early-spring temperatures with adequate rainfall will favor early breeding. Chadwick et al. (2006) speculated that earlier breeding by *Triturus* spp. could increase reproductive success by: 1) increasing the length of time larvae have to feed before the next winter; 2) reducing the age at first breeding; 3) reducing competition with other larval amphibians; and 4) creating greater temporal separation between growing larvae and size-limited predators. However, these advantages will be realized only if ponds maintain adequate water levels, which is less likely during drought years.

The paedomorph/metamorph hypothesis also was weakly supported by the data. However, the prediction of equal numbers of egg masses being laid in early and late periods was based on my assumption that the paedomorph and metamorph cohorts were equal in size, and the prediction could also be consistent with the interrupted rainfall and periodic drought hypotheses. In addition, although the 2-cm difference in egg mass average depth between early and late periods was statistically significant, its biological significance is questionable. Furthermore, my findings both conflict and agree with Richter and Kerr (2001) who reported no temporal separation in oviposition, but a 5-cm difference in egg mass depth between the two morphologies in an experimentally manipulated Northwestern Salamander population in Washington. The temporal discrepancy could be due to differences in study areas, the experimental nature of Richter and Kerr (2001), or other unknown factors. Again, the biological significance of a 2–5-cm difference in egg mass depth is unknown. Surveys designed to quantify breeding activity of the two morphologies are needed to provide better information about the veracity of the paedomorph/metamorph hypothesis.

In summary, biphasic oviposition occurred in each of four years, with the temporal properties apparently influenced by seasonal and annual rainfall patterns and to a lesser degree by average minimum temperatures. A droughty winter followed by a wet spring resulted in an earlier and shorter oviposition period with more egg masses in the early peak; which was the opposite of wetter years. Although my data are consistent with predictions of the hypothesis that the biphasic pattern was a result of differential breeding by paedomorphs and metamorphs, the assumptions behind those predictions need validation.

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Eastern Kingsnake (*Lampropeltis g. getula*) Population Decline in Northern Florida and Southern Georgia

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The Common Kingsnake (*Lampropeltis getula*), distributed across much of the United States (Ernst and Ernst 2003) and inhabiting numerous habitats in the Southeast (Ernst and Ernst 2003; Gibbons and Semlitsch 1991; Means 2006), was historically a common member of Florida's snake communities (Krysko and Smith 2005). However, kingsnake populations have declined statewide, and many appear to have been locally extirpated (Krysko and Smith 2005). This decline has generated concern among conservationists, and speculation as to potential causes ranges from habitat loss, road mortality, and pollution, to collection for the pet trade (Ernst and Ernst 2003; Krysko 2002; Krysko and Smith 2005). Further ecological research including population monitoring is needed to enhance conservation efforts (Krysko 2002; Krysko and Smith 2005). Here, we examine long-term population trends of the eastern kingsnake (*L. g. getula*) in northern Florida and southern Georgia by comparing data from two studies conducted more than two decades apart.

Methods.—Tall Timbers Research Station (TTRS), Pebble Hill (PH), and the Wade Tract (WT), all located in the Red Hills of northern Georgia and southern Florida, served as the study sites. The Red Hills region lies between Tallahassee, Florida, and Thomasville, Georgia, and is bounded by the Ochlockonee River to the west and the Aucilla River to the east. TTRS is the southernmost site and is located ca. 30 km (20 miles) N of Tallahassee, Florida. The landscape, characterized by a rolling topography and rich clay soils, is dominated by open pine forests interspersed with hardwood bottomland drains and annually harrowed fields. The Red Hills region is intensively managed for Northern Bobwhite (*Colinus virginianus*) and other Longleaf Pine (*Pinus palustris*) associated species (Stoddard 1931). Management focuses on the maintenance of open upland habitats via prescribed burning and mechanical methods to inhibit hardwood encroachment and maintain herbaceous groundcover.

The initial study took place at TTRS from May 1976 to July 1983. Snakes were opportunistically collected during the daytime as we obtained radiotelemetry fixes for the Eastern Diamondback Rattlesnake (Means 1985), searching for Cottonmouths (Cook

1983), or conducting other field activities. Individuals were marked via scute clipping (Brown and Parker 1976) and basic biological data were obtained (Cook 1983; Means 2005).

During 2002–2005, an intensive study using a systematic trapping protocol on TTRS, PH, and WT reexamined the Red Hill's snake community. Snakes were captured with drift fences used in conjunction with box traps (D. Richardson, pers. comm.; Burgdorf et al. 2005), and single-ended funnel traps (Fitch 1987) were set at the end of each of the four fence arms. Fences were placed randomly across the landscape in bottomland hardwood drains, a forested "buffer" zone bordering hardwood drains, upland pine forests, and fields. Twenty-four fences were set at TTRS and PH for at least 11 days per month from March to October, 2002. In 2003, trapping effort was increased and standardized, with 42 fences set for 18 trap days per month from March to October at TTRS, PH, and WT. Thirty-six fences were set at TTRS and PH during 2004–2005 using a trapping protocol identical to 2003. Additional snakes were collected via opportunistic encounters by individuals conducting other research activities. Snakes were initially marked either via a passive integrated transponder (PIT) tag or via a unique scute clip.

Results and Discussion.—Methodological differences between the two studies prohibit rigorous statistical comparison of the data sets. However, the large change in detection of the Eastern Kingsnake is striking. During the initial 7-year study, 119 nonvenomous snakes representing 10 species were recorded. Twenty-four Eastern Kingsnakes were documented, constituting nearly 20% of captures during the period. The intensive drift fence trapping protocol of the second study period spanned 19,380 trapping array days and, with supplemental opportunistic captures, yielded 2310 individuals representing 16 nonvenomous species. However, only one Eastern Kingsnake was documented during this period. This individual was captured at PH and represents < 0.05% of total nonvenomous individuals.

Despite a more intensive and systematic sampling effort, the 2002–2005 study documented a tremendous reduction in absolute and relative detection of the Eastern Kingsnake. We acknowledge that biases exist with all survey methods of snakes (e.g., Dodd and Franz 1995; Enge 2001; Gibbons and Semlitsch 1987; Greenberg et al. 1994; Kjoss and Litvaitis 2001; Prior et al. 2001). Different sampling protocols thus may have contributed to the observed decline in detection. However, the intensity of the 2002–2005 study, the ability of the sampling protocol to capture other large, semi-fossorial species such as the Corn Snake (*Elaphe guttata*) and Florida Pine Snake (*Pituophis melanoleucus mugitus*) (Stapleton 2005; Sash, unpubl. data), and the presence of many field personnel to potentially encounter Eastern Kingsnakes strongly suggest a real and remarkable population decline.

Research conducted at the Joseph W. Jones Ecological Research Center at Ichauway (JWJERC), located in Newton, Georgia, ca. 105 km (70 miles) north, stands in contrast to the Red Hills' Eastern Kingsnake decline. Like our study sites, JWJERC primarily consists of open canopied pine forests managed extensively with prescribed fire. Sampling at JWJERC employed a similar drift fence design using box traps which, despite a less intensive trapping regime, resulted in the capture of 60 Eastern Kingsnakes from 2003 to 2006 (L. Smith, pers. comm.). These data thus illustrate the ability of our drift fence design to capture Eastern Kingsnakes and, interestingly, point to the localized nature of the kingsnake decline. This localization is further demonstrated by surveillance cameras identifying Northern Bobwhite nest predators in the region. During an 8-year period beginning in 1999, nest monitoring cameras did not document Eastern Kingsnakes on TTRS or PH. Conversely, Eastern Kingsnakes were the most commonly documented snake species in the Albany, Georgia region (Staller et al. 2005) and predated 40% of all video-monitored nests during 2005–2006 (J. Carroll, W. Palmer, and D. Sisson, unpubl. data).

Although the Eastern Kingsnake was not documented on TTRS with either the drift fence trapping regime or nest-monitoring cameras, non-detection of a species does not indicate its true absence from the site (Kery 2002; Mackenzie 2005; Mackenzie et al. 2002). Therefore, we do not suggest that the Eastern Kingsnake has been completely extirpated from TTRS. In fact, a DOR specimen was noted in 2004 on a secondary road < 1.5 km from TTRS. However, our data strongly suggest a severe decrease in the Red Hills' Eastern Kingsnake population.

Causes for the kingsnake decline in the Red Hills are currently unknown. In the southeastern U.S., *L. getula* is found in a variety of habitats, often associated with low-lying wetland areas and overlapping much of the historical range of longleaf pine forests (Ernst and Ernst 2003; Gibbons and Semlitsch 1991; Krysko 2002; Means 2006; Means and Krysko 2001; Palmer and Braswell 1995). Our study sites appear to provide a landscape suitable for Eastern Kingsnakes; fingerlike drains and permanent and ephemeral wetlands are scattered across the open pine forest landscape and a large lake forms the southern boundary of TTRS. Additionally, the current landscape at our sites is generally similar to habitat in the 1970s. A thinning to reduce hardwood encroachment in the upland pine forests did occur at TTRS and PH during the late 1990s, but similar hardwood thinnings occurred at the Albany sites which documented Eastern Kingsnakes with surveillance cameras (W. Palmer, pers. obs.). Moreover, any land management activities that restore or maintain the open-canopy, pineland habitat with a vigorous herbaceous groundcover—the native habitat of the Eastern Kingsnake—should be beneficial to kingsnakes.

Our data provide further documentation of the statewide decline documented by Krysko and Smith (2005). The location of some of our study sites in southern Georgia additionally suggests that kingsnake declines may extend beyond Florida and into other portions of the southeastern United States. Current population statuses and the uncertainties surrounding the causes of kingsnake declines suggest a directive for future research (Krysko 2002; Krysko and Smith 2005). Studies should assess the status of the Southeast's populations and identify the underlying causes from which conservation solutions may be developed (Krysko 2002; Krysko and Smith 2005).

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Midsummer Ground Surface Activity Patterns of Western Toads (*Bufo boreas*) in Southeast Idaho

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While some behavioral aspects of Western Toads (*Bufo boreas*) have been documented (Campbell 1970; Carey 1978; Hailman 1984; Lilliwhite et al. 1973; Mullally 1958; Muths 2003; Muths and Corn 1997; Pimentel 1955), a great deal remains unknown. Toads are ectotherms that rely on environmental conditions to maintain body temperature and conserve water. Activity patterns appear to be critical in determining body temperature (Stevenson 1985), but the specific daily behaviors used by Western Toads for thermoregulation are not fully known. The greatest gap in our understanding of amphibians derives from how little is known about daily activity (Shoemaker 1992).

Conservation measures must incorporate aspects of amphibian ecology and behavior, such as habitat relationships and factors that affect their daily movements and other activities. The response of amphibian populations to landscape changes may range from negative (e.g., habitat fragmentation; Funk et al. 2004) to positive (e.g., fire; Hossack and Corn 2007). Thus, more detailed information on their daily behaviors may help us better anticipate the effects of landscape changes on amphibians.

We conducted a focal animal study with radiotelemetry to investigate and quantitatively characterize activity patterns, behavior, and microsite selection by Western Toads in southeastern Idaho. Whereas habitat selection has been studied in this area (Bartelt et al. 2004), we advance our understanding of this species' behavior

by focusing on how time of day/night, environmental conditions, and habitat relate to activity. Our results may be particularly relevant to the species' conservation in this region because the Western Toad has experienced population declines within the Greater Yellowstone Ecosystem (Koch and Peterson 1995).

Methods.—Our study was conducted within the Greater Yellowstone Ecosystem at Stamp Meadows in the Targhee National Forest (UTM 471117 E, 4928908 N; elevation approx. 2000 m) in southeastern Idaho, USA. Stamp Meadows was a seasonally flooded meadow that contained a 13 ha pond, bordered by willows (*Salix*) and aspen (*Populus*), and surrounded by coniferous forest habitats (*Pinus*, *Picea*, and *Abies*) that had been modified by logging.

We studied the daily activity of 4 male (nuptial pads present) Western Toads (range 60–85 mm snout–urostyle length; 40–70 g). We used a plastic belt to secure a 1.85 g BD-2GT transmitter (Holohil Systems, Ltd., Carp, Ontario, Canada) to each toad, a method that appears not to affect toad behavior (Bartelt and Peterson 2000; Murray and Fuller 2000).

We used focal animal sampling and observed one toad at a time with continuous recording of all instances of behavior and time (Martin and Bateson 1993). We made observations from 17 July to 3 August 1995 and divided each 24 h day into 8 observation periods of 3 h (periods: 1 = 0000–0259 h, 2 = 0300–0559 h, 3 = 0600–0859 h, 4 = 0900–1159 h, 5 = 1200–1459 h, 6 = 1500–1759 h, 7 = 1800–2059 h, and 8 = 2100–2359 h). Periods 1, 2, and 8 included times of darkness and are described as night while other periods are described as day. Periods 4, 5, and 6 are specifically described as midday. We randomly selected 2 periods each day and randomly selected a toad to observe during each of these periods. We observed each toad for each 3 h observation period.

We located toads with a Telonics TR-2 receiver and H-type directional antenna (Telonics, Inc., Mesa, Arizona). The observer sat approximately 3 m away from the toad under a camouflage net to minimize toad disturbance. We made night observations with a red-filtered 3.8 V incandescent light and used diffuse light peripheral to the central beam to reduce light intensity (Buchanan 1993). To test the effects of our light on the toads, we changed position relative to toads on several occasions during nighttime observations and the light did not appear to change direction of travel or orientation of toads.

We measured ambient (the area encompassing the study site as a whole) and microsite (the area within 3 m of the toad) weather conditions. Terrestrial ambient air temperature 1 m above ground and relative humidity were recorded with a CR10 data logger (Campbell Scientific, Inc., Logan, Utah) and PCRC-11 humidity transducer (Phys-Chem Scientific Corp., New York, New York) (<3% error between 12 to 100% RH, <1% error between 25 to 94% RH) placed near the center of the study site. Ambient measurements were taken every second, then averaged for each observation period. Terrestrial microsite air temperature was recorded 1 m above ground in shade with a Schultheis rapid registering mercury thermometer (Miller and Weber, Inc., New York, New York) at the onset, termination, and periodically during each observation period, then averaged for each observation period. Aquatic microsite water temperature, 1 cm below the water surface, also was recorded when toads were located in an aquatic microsite.

We recorded the sequence and time of all activity (e.g., attempt to capture prey using a tongue strike (feeding strike), distance traveled, position change, direction change, vocalization, habitat change, interaction with other toads) during observation periods. A minute was considered active if any detectable activity, other than breathing, was observed. Distance traveled, a subcategory and more conservative measure of activity, was used for data analysis. Distance traveled was measured in body lengths and distance in cm was estimated based on the known snout–urostyle length of each study animal. Microsite habitats (e.g., terrestrial, aquatic, underground) used by toads also were recorded. When toads were underground, ground level active minutes and distance traveled were recorded as zero because toads could not be observed directly and were not exposed to ground level environmental conditions.

Independent variables were time (observation period), average temperature (terrestrial ambient, terrestrial microsite, and aquatic microsite) during the observation period, and average relative humidity during the observation period. Temperature was categorized for analysis (< 5°C, 5–9.9°C, 10–14.9°C, 15–19.9°C, and >19.9°C). Dependent variables were active minutes and distance traveled. We used one–way analysis of variance (ANOVA) to test for potential differences between independent and dependent variables. To examine for potential differences between microsite temperature and ambient temperature, we conducted a regression analysis with indicator variables for observation periods. To examine for a potential association between relative humidity and distance traveled, we conducted a linear regression analysis. Statistical analyses were performed using Stata 8.0 software (StataCorp 2004, College Station, Texas).

Results.—We made a total of 32 observations of the four toads over the 8 observation periods (Table 1). Individual toads were seldom observed for the same number of minutes for each observation period. This was usually due to the toad disappearing from view. Toads were active during all observation periods with peaks in activity during the midday and night (Fig. 1). Activity differed among observation periods ($F_{7, 24} = 2.4$, $P = 0.05$).

During the day, toads were located at terrestrial retreat microsites, where they moved short distances and frequently changed orientation or position while basking in the sunlight. At these microsites, toads were seen making feeding strikes (Table 1) at crawling insects such as ants, spiders, and beetles. Only once did we see a toad strike at a flying ant. Toads were observed to feed during all observation periods except at night during period 1.

At night, the four toads traveled up to 40 m during period 8 from terrestrial microsites to aquatic microsites where other toads were also observed (Fig. 2). We also observed toads returning to terrestrial microsites in the early morning during periods 2 and 3. Relatively shorter distances of movement (0–0.95 m) occurred during midday observation periods 4, 5, and 6. Distance traveled differed among observation periods ($F_{7, 24} = 3$, $P = 0.02$).

In addition to a relationship between distance traveled and observation period, distance traveled was significantly different among microsite temperature categories ($F_{4, 27} = 2.9$, $P = 0.04$). Toads traveled furthest when microsite air temperature was 5–9.9°C or 10–14.9°C, and traveled shorter distances when temperature exceeded 15.0°C (Fig. 3). Observation period and temperature are related and the relationship represents a sinusoidal pattern

TABLE 1. Observation periods and activities of four Western Toads radiotracked in southeastern Idaho, USA, in July and August 1995.

	Observation Period							
	1 (0000–0259)	2 (0300–0559)	3 (0600–0859)	4 (0900–1159)	5 (1200–1459)	6 (1500–1759)	7 (1800–2059)	8 (2100–2359)
Toad 1								
Observation minutes	173	133	156	170	28	143	16	112
Active minutes	41	16	13	47	11	3	4	70
Distance traveled (cm)	1050	340	2	0	0	0	1	3971
Feeding strikes	0	0	2	6	0	2	0	2
Toad 2								
Observation minutes	180	180	180	117	115	153	72	103
Active minutes	0	0	0	17	13	0	2	44
Distance traveled (cm)	0	0	0	82	0	0	0	995
Feeding strikes	0	0	0	0	0	0	0	7
Toad 3								
Observation minutes	166	157	146	123	167	164	157	156
Active minutes	3	72	3	18	9	42	4	52
Distance traveled (cm)	0	3720	0	3	0	7	5	765
Feeding strikes	0	2	1	6	1	0	1	2
Toad 4								
Observation minutes	180	180	187	136	180	166	96	148
Active minutes	0	0	71	23	52	37	12	97
Distance traveled (cm)	0	0	1846	10	65	0	45	4045
Feeding strikes	0	0	3	1	6	2	3	1
Total all toads								
Observation minutes	699	650	669	546	490	626	341	519
Active minutes	44	88	87	105	85	82	22	263
Distance traveled (cm)	1050	4060	1848	95	65	7	51	9776
Feeding strikes	0	2	6	13	7	4	4	12

(Fig. 4). Ideally, a multivariate analysis would be performed to evaluate the relative contributions of observation period and temperature to distance traveled, but the small sample size of this study prevents such analysis. However, distance traveled appears to be related more to observation period than temperature. For example, the average microsite temperatures during observation period 8 were category 2 (5–9.9°C) and 3 (10–14.9°C); and the average distance traveled during this period was 24.4 m. However, when the same average microsite temperature categories 2 and 3 occurred during other observation periods, the average distance traveled was only 7.9 m. This suggests that the longer distances traveled during observation period 8 were related in part to time of day rather than simply microsite temperature. Relative humidity also appears to contribute to distance traveled. For example, ambient relative humidity was significantly greater when toads traveled 9 m (88.3 ± 2.5% vs. 78.3 ± 2.4%; $t = 1.73$; P = 0.047).

Microsite temperature appears to be related to microsite habitat selection. Microsite air temperatures tended to be warmer than the surrounding terrestrial ambient air temperatures during periods 3, 4, 5, and 6 (Fig. 4) and were significantly warmer during midday periods 4 and 5 ($F_{1, 14} = 7.6$, P = 0.02 and $F_{1, 16} = 10.6$, P = 0.005, respectively). This suggests toads selected midday microsite habitat based at least in part on temperature. At night, ambient and microsite air temperatures were often near freezing. In these cold conditions, toads were found in warmer habitats, such as aquatic microsites. When toads were in aquatic microsites, water temperatures were up to 3°C warmer than terrestrial ambient air temperatures and 13°C warmer than terrestrial microsite air temperatures. In the later dates of the study, two toads traveled greater than 80 m from aquatic microsites and did not return to aquatic microsites at night. These two toads were located underground in a rodent hole and under a tree stump during cold nights. While driving to and from the study site at night on these cold nights, we also observed several toads in crouched positions on exposed dirt roads.

Vocalization was recorded on separate occasions for each toad, including occasions not provoked by contact with another animal. A toad was heard vocalizing while: 1) an ant was crawling on its head; 2) turning body orientation; 3) in an underground hole; and 4) in the process of digging in plant material. On two occasions at night, a toad vocalized when another toad attempted to amplex with it; upon vocalization, the other toad released its grasp and moved toward and clasped another nearby toad. On two other occasions at night, we heard three male toads, positioned at separate and distant (e.g., 50–70 m) points in the pond, repeatedly and sequentially vocalize.

Discussion.—We observed four male Western Toads during midsummer at high elevation in southeastern Idaho. We found them to be active during all observation periods with a peak in activity

in the midday and early night. Despite being active in the midday, distance traveled was limited during midday. Distance traveled was furthest in the early night when toads traveled to warmer aquatic microsites. Our results are similar to Mullally (1958) who described the activity patterns of Western Toads, especially in the higher elevations, as primarily nocturnal with some diurnal activity. However, like other amphibians, activity patterns of Western Toads are not adequately described simply as diurnal, nocturnal, or crepuscular (Hailman 1984). Data from our study show behavior patterns and how variation in environmental conditions may affect toad biology.

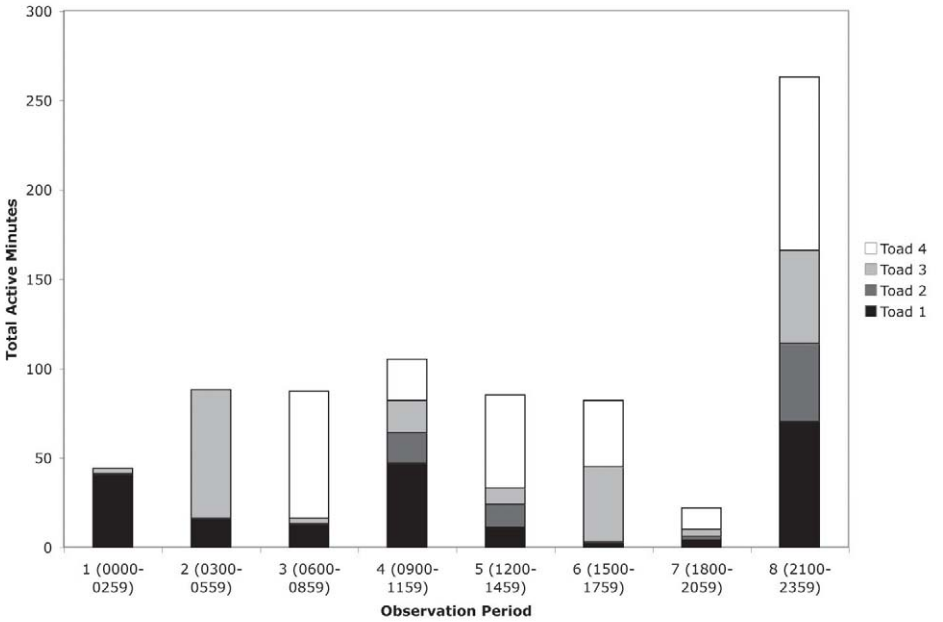


FIG. 1. Western Toad activity patterns were associated with observation period in southeastern Idaho, USA (ANOVA, P = 0.05).

We observed behavior patterns we believe were used to regulate body temperatures and water balance. The regulation of body temperature is primarily behavioral (Spotila et al. 1992) and the choices of times for daily activity appear to be the most critical behavior in determining body temperature (Stevenson 1985). During the day, each toad was located while basking in sunlight at a terrestrial retreat site. These microsites may have been selected, in part, due to their warmer temperatures relative to the surrounding habitat. Our observations that air temperatures of terrestrial retreat microsites were warmer than surrounding ambient air temperatures supports those of Campbell (1970), that toads basked in sunlight as a method to increase body temperature.

Distance traveled was furthest at night, consistent with the observations of other studies. Western Toads emerge and become active (including travel) at night (Mullally 1958; Pimentel 1955), during the hours of our observation period 8, 2100–2359 h (Hailman 1984). The toads may reduce water loss by traveling at these times when temperatures did not exceed 14.9°C and relative humidity generally did not drop below 78%. In addition, when < 80 m from an aquatic microsite, all four toads in our study were found to travel to an aquatic microsite at night. We suggest two reasons for the presence of toads in an aquatic microsite at night. First, during cold nights, the microsite water temperature was warmer than both ambient and terrestrial microsite air temperatures. Water is more thermally stable than many of the terrestrial microhabitats available to toads (Lillywhite 1970). The toads were, therefore, likely able to maintain a warmer body temperature by entering the aquatic microsite because an amphibian in water rarely experiences a body temperature more than 2°C different than the water (Spotila et al. 1992). Second, by entering the aquatic microsite, toads likely were able to regain, by absorption, any water lost during midday sun basking. Many amphibians move between aquatic and terrestrial microsites (Shoemaker 1992). *Bufo punctatus*, for example, has been described to have a pattern of behavior similar to the Western Toads we observed with up to 85 m of travel from its burrow to a small stream at night and returning to the same burrow early in the morning (McClanahan et al. 1994). Mullally (1956) also described Western Toads traveling to aquatic microsites

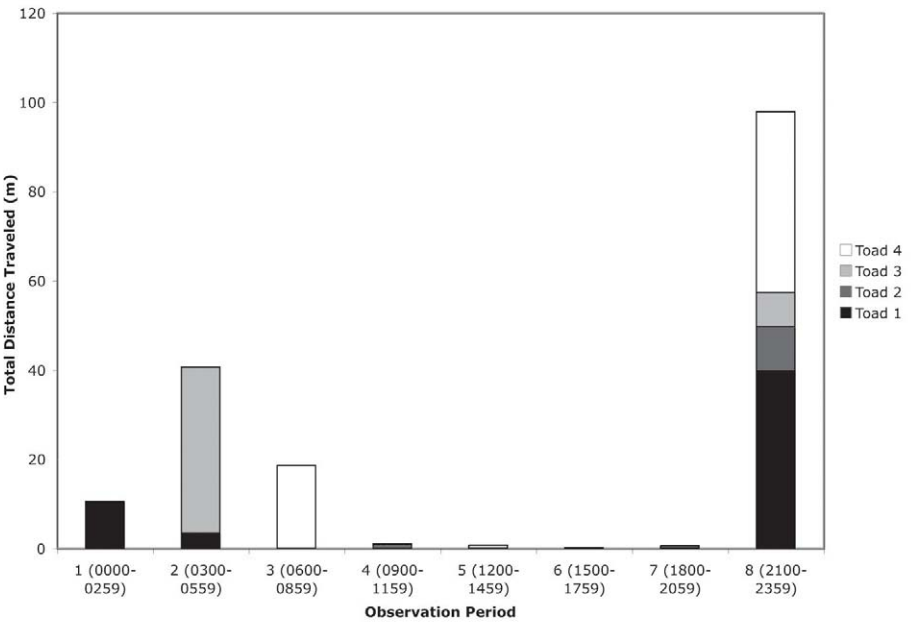


FIG. 2. Distance traveled by Western Toads was associated with observation period in southeastern Idaho, USA (ANOVA, P = 0.02).

in times of dry weather, probably to rehydrate.

Bartelt et al. (2004) observed Western Toads traveling 1.3 km from breeding sites in the late summer and these toads did not return to water. In the later dates of our study, two toads traveled from and were not found to return to aquatic microsites. These toads were located underground in a rodent hole and tree stump where they had no surface level activity. Limits on activity have been shown to be an important factor in water balance (Tracy 1976). Under moderate conditions of temperature and relative humidity, most amphibians cannot survive for more than a day in circulating air, because they quickly dehydrate (McClanahan et al. 1994). Retreating to cover likely reduces both evaporative water loss from midday basking and rehydration needs. Therefore, Western Toads without access to an aquatic microsite likely retreat from exposed sites during times of dryness, as we observed.

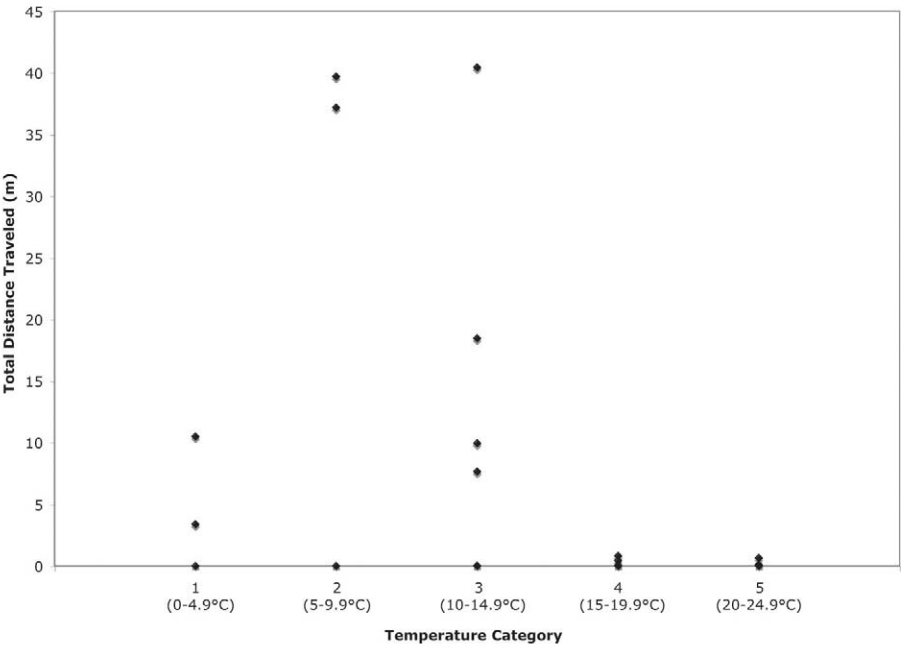


FIG. 3. Distance traveled by Western Toads was associated with microsite temperature category in southeastern Idaho, USA (ANOVA, P = 0.04).

In addition, we often found several non–telemetered toads on dry dirt roads at night. Mullally (1958) also found Western Toads on the road and Hailman (1984) discussed toads specifically seeking the road at night. The toads we found on roads were often in a crouched position, which maximized surface contact. Roads are not covered by vegetation and are exposed to radiant energy from the sun, which is stored and lost at the dirt surface. Typical of any system with storage and resistance, there is a time lag in heat flux out of dry soil (Campbell and Norman1998). The toads may crouch on the dry soil road to increase body temperature from this release of heat. Campbell (1970) and Carey (1978) proposed that toads increase temperature by conduction of heat from substrate. For toads on the road, mortality by vehicles may be a significant cause of death. We have previously reported the death by vehicle of a telemetered toad (Bartelt and Peterson 2000).

Mullally (1956) reports that male Western Toads vocalize only when provoked through contact with other animals such as when other males amplex them. In this situation, the clasped male vocalizes, whereupon the clasping male releases its hold. This interaction was observed and the presence of a radio-transmitter did not appear to inhibit or discourage other toads from clasping telemetered toads. We also found that toads vocalize at times when there is no contact by other animals, particularly at night when distant toads repeatedly called in sequence. The fact that vocalization was heard at times other than contact with other animals is interesting and may indicate that vocalization plays a larger role than that of communicating a release during amplexus or provocation.

The observations in our study represent a behavior sample of adult male free-living Western Toads. The activity and habitat use at different times and temperatures likely reflect thermal and water regulatory behavioral strategies. Though limited in sample size, our results demonstrate nocturnal peaks in travel with some level of activity present throughout the 24 h day, including a moderate diurnal component. Toads traveled over a narrow range of tem-

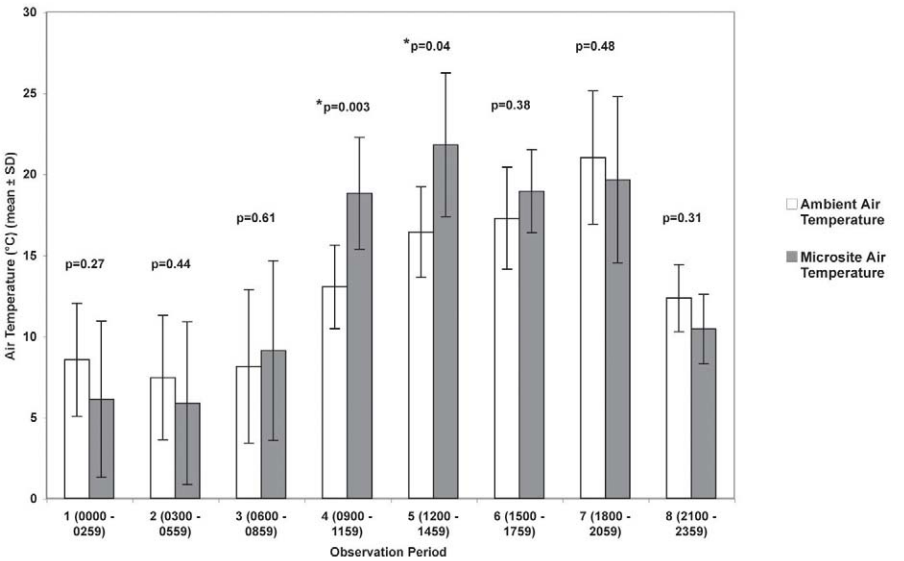


FIG. 4. Average microsite air temperature (°C at 1 m) where a Western Toad was located compared to ambient air temperature (°C at 1 m) during each observation period in southeastern Idaho, USA. Microsite air temperatures of the retreat sites selected by toads during periods 4 and 5 were warmer than ambient air temperatures.

peratures, and traveled longer distances during periods of high humidity. Toads were often found in aquatic microsites and on roads at night and at terrestrial retreat sites during the day.

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Checklist and Comments on the Terrestrial Amphibian and Reptile Fauna from Utai, Northwestern Papua New Guinea

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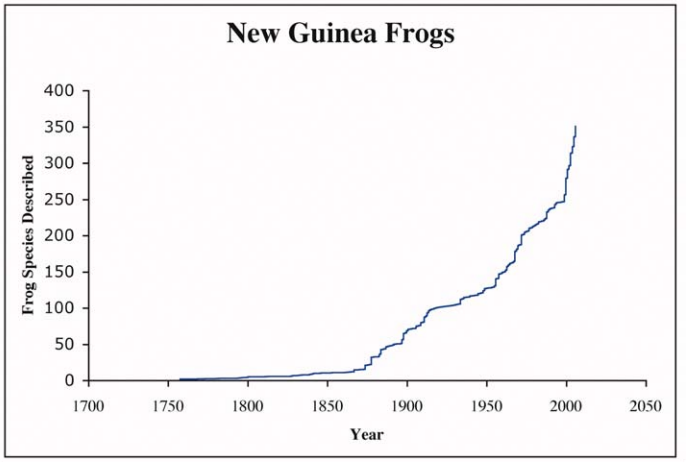
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New Guinea, the world's largest and highest tropical island, has been identified as one of the world's five High Biodiversity Wilderness Areas (Mittermeier et al. 2003). The island occupies less than 0.6% of global land area but harbors 5–7% of the world's biodiversity (Beehler 1993; Dinerstein and Wikramanayake 1993; Myers et al. 2000). The herpetofauna of New Guinea currently accounts for approximately 5% of the world's reptile and amphibian diversity (Allison et al. 1998). Remarkably, this is an underestimate of true diversity as species accumulation curves for both lizards and frogs continue to increase dramatically without hint of plateau (Fig. 1). The tallest peak on the island exceeds 5000 m and the rugged topography encompasses a wide range of habitat



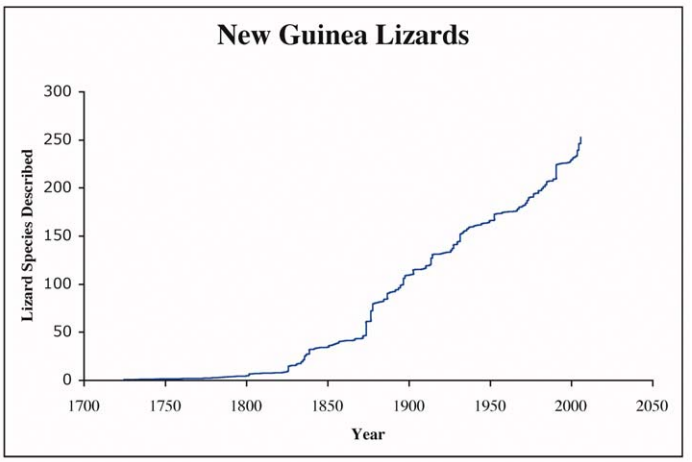


FIG. 1. Species accumulation curves for New Guinea frogs and lizards.

types packed into an area one-tenth the size of the United States. These habitats include mangrove forests, lowland eucalypt savannas, dense lowland rainforests, sago palm swamps, montane moss forests, cloud forests, alpine grasslands, and tropical glaciers on the tallest peaks. The New Guinea herpetofauna can be found in all but the last of these habitats.

Over the last several decades extensive logging has severely impacted the expansive lowland rainforest on the north coast of Papua New Guinea (Beehler 1993). Here we report on a 15-day survey of terrestrial amphibians and reptiles from the area surrounding Utai Village (3°23.765'S, 141°34.974'E, 208 m elev.) in north-central New Guinea in Sandaun Province, Papua New Guinea. Utai Village is situated on the Gedik River, a northern tributary of the Sepik River. The Sepik is the longest river on the island and possibly the largest uncontaminated drainage system in Australasia with a catchment of approximately 80,000 km^2 (Allen and Coates 1990). Utai Village is located at the intersection of upland and forest flood plains. North of Utai the rolling hills give rise to foothills of the Bewani Mountains and to the south is vast expanse of nipa flood plain forest that extends to the Sepik River. The forest includes primary, successional, and riparian lowland broadleaf evergreen forest as well as extensive Sago Palm (*Metroxylon sagu*) swamps. The immediate areas surrounding Utai village have been used for traditional shifting fruit and vegetable gardens and extensive harvesting of Sago Palms for food. The larger surrounding areas are largely unspoiled lowland rainforest in the extensive and broadly contiguous Northern New Guinea lowland ecoregion that contains diverse habitats including lowland and hill forest, grassy swamps, swamp forests, savannas, peat swamp forests, and woodlands (Conn 1995; Gressitt 1982; Henty 1981; Womersley 1978). Although the forests around Utai have



FIG. 2. Map of New Guinea showing Utai in northwestern Papua New Guinea and Kau Wildlife Area in northcentral Papua New Guinea.

TABLE 1. Checklist of the terrestrial amphibian and reptile fauna of Utai northwestern Papua New Guinea. We refer to a species as 'Common' if it is typically encountered in an approximate 8-person-hour search period. Species listed as 'Uncommon' are encountered infrequently in the area around Utai and typically require more than a single day/night search of 8-person-hours to locate. References refer to general literature associated with each species.

SPECIES		FAMILY	COMMENTS AND REFERENCES
SNAKES			
Candoia	*aspera*	Boidae	Uncommon; (Austin, 2000; O'Shea, 1996)
Candoia	*carinata*	Boidae	Uncommon; (Austin, 2000; O'Shea, 1996)
Boiga	*irregularis*	Colubridae	Uncommon; (O'Shea, 1996)
Dendrelaphis	*punctulatus*	Colubridae	Uncommon; (McDowell, 1974; O'Shea, 1996; McDowell, 1975; McDowell, 1979)
Dendrelaphis	sp.	Colubridae	Uncommon; (McDowell, 1974; O'Shea, 1996; McDowell, 1975; McDowell, 1979)
Stegonotus	*modestus*	Colubridae	Uncommon; (O'Shea 1996; McDowell, 1972)
Stegonotus	*parvus*	Colubridae	Uncommon; (O'Shea 1996; McDowell, 1972)
Stegonotus	sp.	Colubridae	Uncommon; (O'Shea 1996; McDowell, 1972)
Tropidonophis	*doriae*	Colubridae	Uncommon; (O'Shea, 1996; Malnate and Underwood, 1988)
Tropidonophis	*mcdowelli*	Colubridae	Uncommon; (O'Shea, 1996; Malnate and Underwood, 1988)
Tropidonophis	*multiscutellatus*	Colubridae	Uncommon; (O'Shea, 1996; Malnate and Underwood, 1988)
Tropidonophis	*picturatus*	Colubridae	Uncommon; (O'Shea, 1996; Malnate and Underwood, 1988)
Aspidomorphus	*muelleri*	Elapidae	Uncommon; (O'Shea, 1996; McDowell, 1967)
Aspidomorphus	sp.	Elapidae	Uncommon; (O'Shea, 1996; McDowell, 1967)
Micropechis	*ikaheka*	Elapidae	Uncommon; (O'Shea 1996)
Morelia	*viridis*	Pythonidae	Uncommon; (low density) (Rawlings and Donnellan, 2003)
LIZARDS			
Hypsilurus	*modestus*	Agamidae	Common; (Moody, 1980; Manthey and Denzer, 2006)
Hypsilurus	sp.	Agamidae	Uncommon; (Moody, 1980; Manthey and Denzer, 2006)
Cyrtodactylus	*sermowaiensis*	Gekkonidae	Common; (de Rooij, 1915; Brown and Parker, 1973)
Cyrtodactylus	sp.	Gekkonidae	Uncommon; (de Rooij, 1915; Brown and Parker, 1973)
Gehyra	cf. *lampei*	Gekkonidae	Uncommon; (King and Horner, 1989; King, 1984; Chrapliwy et al., 1961; Beckon, 1992)
Gekko	*vittatus*	Gekkonidae	Uncommon; (de Rooij, 1915; Brown and Parker, 1973)
Hemidactylus	*frenatus*	Gekkonidae	Common; (Mortiz et al., 1993)
Lepidodactylus	*lugubris*	Gekkonidae	Uncommon; (Mortiz et al., 1993)
Nactus	cf *multicarinatus*	Gekkonidae	Common; (Donnellan and Moritz 1995; Moritz 1987; Zug and Moon 1995; Kraus, 2005)
Nactus	*vankampeni*	Gekkonidae	Common; (Donnellan and Moritz 1995; Moritz 1987; Zug and Moon 1995; Kraus, 2005)
Cryptoblepharus	sp.	Scincidae	Uncommon; (Mertens, 1928)
Emoia	*caeruleocauda*	Scincidae	Common; (Brown, 1991)
Emoia	*jakati*	Scincidae	Common; (Brown, 1991)
Emoia	*kordoana*	Scincidae	Uncommon; (Brown, 1991)
Emoia	*longicauda*	Scincidae	Uncommon; (Brown, 1991)
Emoia	*obscura*	Scincidae	Common; (Brown, 1991)
Emoia	*pallidiceps*	Scincidae	Common; (Brown, 1991)
Lamprolepis	*smaragdina*	Scincidae	Common; (Greer, 1970)
Lipinia	*albodorsalis*	Scincidae	Uncommon; (Austin, 1998; Zweifel, 1979; Shea and Greer, 2002)
Lipinia	*pulchra*	Scincidae	Uncommon; (Austin, 1998; Zweifel, 1979)
Lobulia	*brongersmai*	Scincidae	Uncommon; (Greer et al., 2005; Zweifel, 1972; Allison and Greer, 1986)
Prasinohaema	*virens*	Scincidae	Uncommon; (Mys, 1988)
Sphenomorphus	*jobiensis*	Scincidae	Common; (Donnellan and Aplin, 1989)
Sphenomorphus	*minutus*	Scincidae	Uncommon; (Greer, 1974)
Sphenomorphus	*pratti*	Scincidae	Uncommon; (Greer, 1974)
Sphenomorphus	*simus*	Scincidae	Common; (Shea and Greer, 1999)
Sphenomorphus	*solomonis*	Scincidae	Common; (de Rooij, 1915)
Tiliqua	*gigas*	Scincidae	Uncommon; (Shea, 1990)
Tribolonotus	*gracilis*	Scincidae	Uncommon; (Zweifel, 1966; Cogger, 1972)
Varanus	*jobiensis*[2]	Varanidae	(Böhme, 2003)

TABLE 1.—Continued.

SPECIES		FAMILY	COMMENTS AND REFERENCES
FROGS			
Litoria	cf. *genimaculata*[1]	Hylidae	(Menzies, 2006)
Litoria	*huntorum*	Hylidae	Uncommon; (Richards et al., 2006)
Litoria	*infrafrenata*	Hylidae	Common; (Zweifel, 1980; Menzies, 2006)
Litoria	*nigropunctata*	Hylidae	Uncommon; (Menzies, 2006)
Litoria	*thesaurensis*	Hylidae	Uncommon; (Menzies, 2006; Kraus and Allison, 2004)
Litoria	sp.	Hylidae	Uncommon; (Menzies, 2006)
Austrochaperina	sp.	Microhylidae	Uncommon; (Menzies, 2006)
Choerophryne	*rostellifer*	Microhylidae	Uncommon; (Menzies, 2006)
Cophixalus	cf. *bewaniensis*	Microhylidae	Uncommon; (Menzies, 2006; Kraus and Allison, 2000)
Cophixalus	*balbus*	Microhylidae	Common; (Menzies, 2006)
Cophixalus	sp.	Microhylidae	Uncommon; (Menzies, 2006)
Copiula	sp.	Microhylidae	Common; (Burton, 1990; Menzies, 2006)
Hylophorbus	sp. 1	Microhylidae	Common; (Günther, 2001; Menzies, 2006)
Hylophorbus	sp. 2	Microhylidae	Uncommon; (Günther, 2001; Menzies, 2006)
Hylophorbus	sp. 3	Microhylidae	Uncommon; (Günther, 2001; Menzies, 2006)
Hylophorbus	sp. 4	Microhylidae	Uncommon; (Günther, 2001; Menzies, 2006)
Mantophryne	*lateralis*	Microhylidae	Uncommon; (Menzies, 2006)
Oreophryne	*biroi*	Microhylidae	Uncommon; (Menzies, 2006; Zweifel et al., 2003)
Oreophryne	*hypsiops*	Microhylidae	Uncommon; (Menzies, 2006; Zweifel et al., 2003)
Oreophryne	sp. 1	Microhylidae	Uncommon; (Menzies, 2006; Zweifel et al., 2003)
Oreophryne	sp. 2	Microhylidae	Uncommon; (Menzies, 2006; Zweifel et al., 2003)
Sphenophryne	*cornuta*	Microhylidae	Common; (Menzies, 2006; Bickford, 2002)
Xenobatrachus	*tumulus*[2]	Microhylidae	Uncommon; (Menzies, 2006; Kraus and Allison, 2002; Blum and Menzies, 1988)
Xenobatrachus	sp.	Microhylidae	Uncommon; (Menzies, 2006; Kraus and Allison, 2002; Blum and Menzies, 1988)
Xenorhina	*oxycephala*[1]	Microhylidae	(Menzies, 2006; Blum and Menzies, 1988)
Lechriodus	*melanopyga*	Myobatrachidae	Uncommon; (Menzies, 2006)
Limnonectes	*grunniens*	Ranidae	Uncommon; (Menzies, 2006)
Platymantis	*cheesmanae*	Ranidae	Uncommon; (Menzies, 2006)
Platymantis	*papuensis*	Ranidae	Common; (Zweifel, 1969; Menzies, 1982a; Menzies, 1982b; Menzies, 2006)
Rana	*arfaki*	Ranidae	Uncommon; (Menzies, 2006)
Rana	*daemeli*	Ranidae	Uncommon; (Menzies, 2006)
Rana	cf *grisea*	Ranidae	Common; (Menzies, 2006)
Rana	*volkerjane*[2]	Ranidae	(Menzies, 2006)

[1]Previously collected by CD in 2005.
[2]Reported by Kraus and Allison 2006.

yet to be commercially logged, logging roads are encroaching rapidly from the north and will reach the village within the next several years.

To date there have been no comprehensive herpetofaunal reports from northwestern Papua New Guinea. Here we compile a list of terrestrial reptile and amphibian species from the vicinity of Utai based on a field survey conducted from 27 June to 12 July 2006 (Table 1) as well as from previous fieldwork (CD) and published reports (Kraus and Allison 2006). Kraus and Allison (2006) reported range extensions for reptiles and amphibians along the northern versant of Papua New Guinea that included three species not collected by our team but reported within 5 km of Utai village. The fauna, exclusive of crocodilians and turtles, includes 79 species comprising 16 snakes, 30 lizards, and 33 frogs representing 40 genera in 11 families (Table 1). This list undoubtedly is an underestimate of the true diversity present in the region. Specific specimen (and associated tissues) and locality information can be accessed via a searchable database of the LSU Museum of Natural Science reptile and amphibian collection (http://www.lsu.edu/museum).

SPECIES RICHNESS, TAXONOMY AND SPECIES-COMPLEX GROUPS

There are a large number of species complexes in the diverse New Guinea herpetofauna, especially among the scincid lizards and microhylid frogs (e.g., Austin 2006). In addition to obvious species complexes, many currently recognized species likely harbor cryptic species (Bickford et al. 2006). Species richness, therefore, is likely much greater than is presently documented from our survey. We are taking a multidisciplinary approach using morphological and molecular data to tease apart many of the species complexes as well as to describe the species obviously new to science. Below we comment on and address some of the taxonomic impediments to understanding the terrestrial amphibian and reptile fauna in the Utai area.

Treesnakes of the genus *Dendrelaphis* are easy to identify to the generic level but extensive geographic variation in color pattern and scalation, inadequate keys, and cryptic diversity make *Dendrelaphis* a problematic group (McDowell 1974; O'Shea 1996). We collected one species that keys out to *Dendrelaphis punctulatus* but has a drastically different color pattern and thus

may represent an undescribed species. In addition, we collected several specimens of what is clearly an undescribed species of *Dendrelaphis*. Keelback snakes of the genus *Tropidonophis* have had a taxonomically complicated history, having been assigned to such diverse genera as *Amphiesma*, *Macropophis*, *Natrix*, and *Styporhynchus* (Malnate and Underwood 1988; O'Shea 1996). *Tropidonophis* are easily distinguished from other New Guinean snakes by having prominently keeled dorsal scales, but species identification remains difficult. We collected three specimens of the elapid genus *Aspidomorphus*. One adult and juvenile were easily assigned to *A. muelleri* and a third specimen was not readily assignable to any of the three currently recognized species of *Aspidomorphus* and likely represents a species new to science.

The angle head lizards of the agamid genus *Hypsilurus* have been recently revised (Manthey and Denzer, 2006). Manthey and Denzer (2006) recognize 14 species of *Hypsilurus*, while acknowledging that this diversity is undoubtedly an underestimate. There are two species of *Hypsilurus* in the Utai region. *Hypsilurus modestus* is a small-bodied (maximum SVL = 107 mm) *Hypsilurus* with a broad distribution throughout the Papuan region (New Guinea and nearby associated islands) and is common in the Utai area. A second *Hypsilurus* species does not key to any of the currently described species and likely represents a species new to science.

The gecko fauna of New Guinea consists of seven genera: *Cyrtodactylus*, *Gehyra*, *Gekko*, *Hemidactylus*, *Hemiphyllodactylus*, *Lepidodactylus*, and *Nactus*. Six of these seven gecko genera were found in the Utai region with the seventh, *Hemiphyllodactylus*, representing an uncommon, hard to find and/or patchily distributed gecko poorly represented in collections; one of us (CCA) has collected just three individuals of *Hemiphyllodactylus* in 18 years of fieldwork on the island. Although *Hemiphyllodactylus* was not recorded from the Utai area it may occur in the region. *Cyrtodactylus*, *Gehyra*, and *Nactus* represent taxonomically challenging groups in need of revision and study. The geographic distribution and specific-level delineation for virtually all species of New Guinea geckos is not well understood and many collections have misidentified taxa. Currently ten species of *Cyrtodactylus* are described from New Guinea, but several undescribed species exist in collections (Kraus and Allison 2006). *Cyrtodactylus sermowaiensis* was collected regularly at night and was the most abundant species of *Cyrtodactylus* present. Two specimens of a much larger species of *Cyrtodactylus* where collected. These are similar to *C. novaeguineae*, but differ in several aspects of morphology and likely represent an undescribed species.

The diverse skink fauna of New Guinea includes many species complexes (Austin 2006). Preliminary molecular investigations have revealed significant population structure within most widespread species, indicating a greater level of species-level diversity than currently recognized.

The frog fauna of New Guinea is incredibly diverse with more than 350 described species (Amphibian Species of the World Database http://research.amnh.org/herpetology/amphibia/index.php) with 90% endemism (Mittermeier et al. 2003). The rate at which new species are being described is extremely rapid and there is no sign of an asymptote (Fig. 1). Frog diversity in the region is expected to exceed 600 species (Günther 2006). Microhylid frogs are the most diverse group in New Guinea. Our survey included sound recordings of male frogs in order to identify and describe new taxa. Preliminary analyses suggest multiple species new to science in the microhylid genera *Hylophorbus*, *Oreophryne*, and *Xenobatrachus* (Table 1). In addition to the diverse microhylids, the hylid genus *Litoria* is also species rich with a new *Litoria* recently described from Utai (Richards et al. 2006) and another likely undescribed species recorded on our survey.

Notably absent from the Utai region were the common and widespread introduced toad *Bufo marinus* and the skink genus *Carlia*. The latter has a broad range across New Guinea and its members are typically some of the most abundant diurnal lizards in village, garden, and forest edge habitats. *Bufo* and *Carlia* were, however, common in the Provincial capital of Vanimo 75 km NW of Utai on the coast.

Although our survey targeted terrestrial herpetofauna we did collect one specimen of a juvenile *Elseya novaeguineae* (McDowell 1983). In addition, the New Guinea freshwater crocodile (*Crocodylus novaeguineae*) were reported by locals to be in the general vicinity but had been primarily extirpated from the nearby area. Freshwater crocodiles are distributed in lowland to upland areas throughout the island of New Guinea (Hall 1989).

Regional checklists for New Guinean herpetofauna are extremely limited. The only other checklists for the north coast are both from the Kau Wildlife Area (Austin 2006; Read 1998). These limited data allow partial comparative measurements of species richness across a spatial scale of approximately 500 km (Fig. 2). Alpha diversity refers to the total diversity for a given site or region; alpha diversity is 79 at Utai and 67 at Kau. Gamma diversity is the total summed diversity across all sites and the gamma diversity for Utai and Kau is 104. Beta diversity refers to the change in species richness between different sites and is a summed measure of those species unique to two or more compared areas, thus beta diversity reflects the non-overlap of species diversity. The beta diversity between Utai and Kau is 62, meaning that there are 62 species that are found either solely in Utai or Kau (conversely, there are 42 species in common between the two sites). These data suggest that alpha diversity is similar across these two sites and that beta diversity is quite high.

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Genetic Evidence for Single Season Polygyny in the Northern Leopard Frog (*Rana pipiens*)

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A species' mating system is an important life history characteristic that impacts many aspects of its ecology and evolution. Animal mating systems are differentiated by the number of mates each gender has in a breeding season. Many temperate pond-breeding anurans display what is likely a polygynandrous mating system, which may vary with the operational sex ratio of a population (Halliday and Tejedo 1995; Lode et al. 2004). There is genetic evidence for multiple paternity in some anuran amphibians, where eggs from a single mass are fertilized by more than one male (D'Orgeix and Turner 1995; Laurila and Seppa 1998; Lode and Lesbarreres 2004; Roberts et al. 1999; Sztatecsny et al. 2006). However, the ability of males to fertilize eggs from more than one female during a breeding season has not been demonstrated using genetic techniques. In the course of a larger study, we had the opportunity to look for this phenomenon in a population of Northern Leopard Frogs (*Rana pipiens*).

What is known about the mating system of *R. pipiens* suggests that males may be capable of breeding with multiple females in a single season. *Rana pipiens* is an explosive breeder, and the breeding season can last from a few days to a few weeks (Gilbert et al. 1994 and references therein). If female synchrony is high, there is a limited time when males can fertilize eggs, which could result in a functionally monogamous mating system where only full-sibs and unrelated individuals will be present among the progeny produced in a given year. However, as is true for other anuran species, males sometimes remain at breeding sites after being observed in amplexus (C. A. Paszkowski, unpubl. data), which suggests they may be attempting to find additional mating partners. Males can increase their fitness by producing offspring with more than one female in a breeding season (Arnold and Duvall 1994; Clutton-Brock and Vincent 1991). If males are successful in fertilizing eggs from more than one female, then half-sibs will also

be found within a cohort. In laboratory studies, male *R. pipiens* have been observed breeding with more than one female during a reproductive bout, although a decline in fertilization rates may have resulted (Paula Jackman, Environment Canada, pers. comm.).

Rana pipiens is considered a Species of Special Concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2000) as its numbers have been declining, especially in the western part of its range (Rorabaugh 2005). During a study on the conservation genetics of 14 populations of *R. pipiens* from across central and western Canada, we found that the distribution of genotypes from 31 tadpoles sampled from Belza Pond, Grasslands National Park, Saskatchewan, deviated significantly from linkage equilibrium at 10 of 28 pairwise locus comparisons (see *Results*). This was unusual, as no locus pairs deviated from linkage equilibrium when all populations were considered as a whole (data not shown). In this larger scale study, "populations" were defined as either individuals from a single pond or genetically similar nearby ponds. Deviation from linkage equilibrium can occur if related individuals are present in a sample. *Rana pipiens* lays up to 7000 eggs per breeding season (Corn and Livo 1989), so it is possible that multiple larvae sampled from a pond may be from the same egg mass. Because the Belza population was the only one from which tadpoles were sampled (as opposed to terrestrial juveniles and adults) we predicted that the distinct pattern observed at Belza was a result of sampling some combination of full-sibs (tadpoles likely originating from the same egg mass sharing both parents), maternal half-sibs (tadpoles likely originating from the same egg mass sharing a mother but not a father), and paternal half-sibs (tadpoles likely originating from different egg masses sharing a father but not a mother). To test this we estimated the genetic relationships among the tadpoles from Belza to determine if the sampled individuals shared a familial relationship. If paternal half-sibs are present in the population, this would be the first genetic confirmation that multiple fertilizations with different females in a single breeding season are possible by male *R. pipiens*, and increases our knowledge of the mating system in this species.

Materials and Methods.—Grasslands National Park, Saskatchewan, is located within the mixed-grass prairie ecosystem of North America. Belza Pond is ca. 20 × 20 m, located at 49°09'128"N, 107°31'546"W within Grasslands National Park. It is 500 m from the Frenchman River, but areas between ponds are quite dry and movement of frogs among ponds is likely infrequent and highly dependent upon rare weather patterns that cause high rainfalls. As Belza Pond is spring-fed and in a valley, it generally holds water throughout the year, despite having a maximum depth of 150 cm. The average precipitation at the Val Marie, Saskatchewan, weather station (approximately 10 km from Belza Pond) over a 12-month period from July to the following June from 1990 to 2004 was calculated as 410.19 mm (s.d. 104.47 mm, National Climate Data and Information Archive, Environment Canada 2007; years with missing data were not included in the analysis). Annual precipitation for 2003–2004 was 397.1 mm. Tailclips were collected from 31 tadpoles of *R. pipiens* at Belza Pond on a single date (19 July 2004). Tadpoles were collected opportunistically, but explicit effort was made to sample animals from throughout the pond. Little is known about the Belza population of *R. pipiens*, but at the time of sampling no adults and approximately 100 young of year were observed. Tadpoles were at a minimum of Gosner Stage 42 (where forelimbs erupt, Gosner 1960), and therefore capable of having moved throughout the pond since hatching.

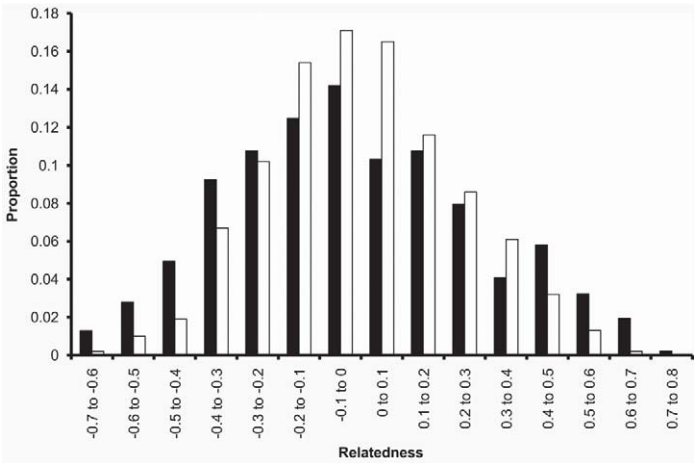


FIG. 1. Frequency histograms of Queller and Goodnight's (1989) relatedness values for the 31 Belza tadpoles (black) and 1000 simulated unrelated individuals (white). Some of the relatedness values are higher in the Belza population than in individuals that are simulated to be unrelated, suggesting the presence of related individuals in our sample.

DNA was extracted using a DNeasy Tissue Kit (Qiagen). For microsatellite analysis, we used loci Rpi100, Rpi101, Rpi103, Rpi104, Rpi107, Rpi108 (Hoffman et al. 2003), Rp193, and Rp415 (Hoffman and Blouin 2004a). Each PCR amplification contained 120 μM dNTPs, 0.27 μM each primer (one of which was dye-labeled), 1.5 U Taq polymerase, 1X PCR buffer (10 mM Tris buffer, pH 8.8, 0.1% Triton X-100, 0.16 mg/mL bovine serum albumin, 50 mM KCl), and ~40 ng genomic DNA in a final volume of 15μL. Rpi101 and Rpi193 were amplified with 2.0 mM $MgCl_2$, while all other PCR reactions contained 2.5 mM $MgCl_2$. PCR cycling conditions were as follows: 1 min at 94°C; 3 cycles of 30 s at 94°C, 20 s at 44°C, 5 s at 72°C; 30 cycles of 15 s at 94°C, 20 s at 45°C, 1 s at 72°C; 30 min extension at 72°C. PCRs were performed on an Eppendorf Mastercycler and electrophoresed on a 3100-Avant Genetic Analyzer (ABI).

All loci were examined for deviations from Hardy-Weinberg equilibrium and linkage disequilibrium using GENEPOP 3.4 (Raymond and Rousset 1995). Queller and Goodnight's (1989) relatedness was calculated with KINSHIP 1.3.1 (Goodnight and Queller 1999). Genotypes for 1000 pairs of unrelated individuals were also simulated with this program by choosing alleles at each locus based on the allele frequencies in the Belza population sample. The relatedness values from simulated unrelated individuals can be compared to those observed in the Belza population to determine if the Belza individuals had higher relatedness values (and were thus more closely related) than would be expected by chance. Individuals were assigned to full-sib families nested within half-sib groups using COLONY 12 (Wang 2004). This program is known to be effective at identifying full- and half-sib groups in a number of species (e.g., Carlsson et al. 2007; A. J. Wilson et al. 2005). The COLONY program utilizes maximum likelihood and allows for errors through allelic dropout and mistyping. Both types of error rates were set to 0, 0.01 and 0.02, and runs were per-

formed at each of these settings with 10 initial random seeds.

All individuals but one were sequenced for an 812 base pair (bp) fragment of mitochondrial DNA, corresponding to bases 27-838 of the NADH dehydrogenase subunit 1 (ND1) gene. The region was amplified using newly designed primers, RpND1F (5' GGT TCA AAT CCC CTT ACT A 3') and RpND1R (5' AGT TGG TCA TAG CGG AAT CGT G 3'), in a 25 μl reaction containing 1X PCR buffer, 2.5 mM $MgCl_2$, 160 μM dNTPs, 0.4 μM each primer, 1 U Taq polymerase, and ~50 ng genomic DNA. Cycling conditions were: 5 min at 95°C; 35 cycles of 1 min at 94°C, 1 min at 54°C, 90 s at 72°C; 5 min extension at 72°C. PCR products were purified using the QIAquick PCR purification kit (Qiagen) and directly sequenced using the forward primer and the BigDye v.3.1.1 (Applied Biosystems) chemistry following the manufacturer's protocol. Individuals with variable sites near the priming region were also sequenced using a reverse primer RpND1R.int (5' TTG AGG ATA CCG AGG CAG AGC 3') for sequence confirmation. Unincorporated dye terminators were removed using the DyeEx 96 kit (Qiagen) and the fragments were resolved using an Applied Biosystems 3730 capillary sequencer. Sequences were analyzed, basecalled, and aligned with ABI Prism SeqScape software v.2.1 (Applied Biosystems).

Results.—The number of alleles in the Belza Pond population per microsatellite locus ranged from 2 to 10, with a mean of 5.25. The Belza population was significantly out of Hardy-Weinberg equilibrium when the exact Hardy-Weinberg test was used (Haldane 1954) and all loci were considered (χ^2_{16} = 31.16, P < 0.05). We also observed significant (P < 0.05) linkage disequilibria for 10 of 28 locus comparisons. Two of these tests remained significant following Bonferroni correction for multiple tests (P < 0.0018). Neither linkage nor Hardy-Weinberg disequilibrium was observed in the 13 other populations of *R. pipiens* we examined from across western and central Canada (data not shown). The distribution of pairwise relatedness values for the Belza population and unrelated individuals simulated from this population's allele frequencies are shown in Fig. 1. On average, unrelated individuals have a relatedness value of 0. This increases to 0.25 for individuals related at the half-sib level, and 0.5 for full-sibs. Twenty-five of the 465 observed pairwise comparisons within the Belza population (5.4%) had relatedness values at the full-sib level or higher. Four of these comparisons (0.9%) were higher than any of the 1000 simulated r-values for unrelated individuals, and 28 (6.0%) were outside of the upper bound of the 95% confidence interval of the distribution of simulated unrelated individuals (-0.425, 0.473), suggesting a high degree of relatedness in these samples. The shapes of these distributions were significantly different from one another (G-test for heterogeneity based on counts grouped by 0.1; d.f. = 14; P < 0.0005).

Relatives were common in our sample, as only two individuals from the Belza population did not assign to a nested half-sib group generated by COLONY (full-sib groups 8 and 9 in Fig. 2). The most common arrangement of full-sib groups within half-sib groups (after examining all error rates and initial seeds) and the mitochondrial haplotypes possessed by these individuals is shown in Fig. 2. Other arrangements were similar, and saw either full-sib group 4 merged with full-sib group 3 or full-sib group 2 merged with full-sib group 1. Half-sib group B was the largest, containing 4 full-sib groups and 22 individuals (71% of the sampled population). Full-sib group membership ranged from 1 (groups 1, 2, 8, and 9) to 10 (32% of the sampled population, group 5). Two different mtDNA haplotypes were observed in the Belza population, differing by three synonymous mutations. These mutations all occurred in the first 580 bp of our sequenced region which overlapped the region sequenced by Hoffman and Blouin (2004b), and thus their haplotype numbering system was used. One of the nested half-sib groups (group B) possessed both of the haplotypes observed at Belza. Individuals in full-sib groups 3 and 4 shared haplotype 1 (GenBank accession AF548568) and all other individuals shared haplotype 7 (GenBank AF548575). The individual for which mtDNA sequence was unavailable was assigned to full-sib group 5.

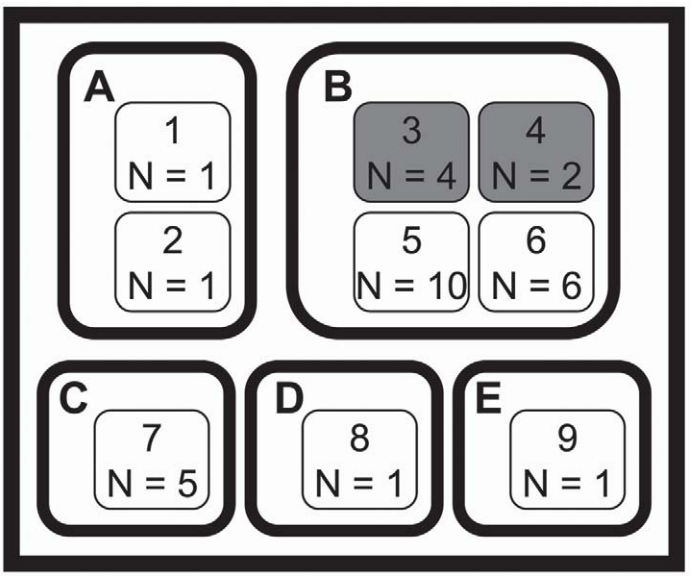


FIG. 2. Partitioned full-sib groups (1–9) nested within half-sib groups (A–E) and the sample size for each full-sib group based on microsatellite data. The largest square represents the sample from Belza Pond, Saskatchewan. Gray full-sib squares possess mitochondrial haplotype 1 and white squares possess haplotype 7.

Discussion.—Sampling tadpoles from the same age cohort allowed us to examine parentage in a population of *R. pipiens* using genetic techniques. Our results show that sib-groups may be commonly encountered among tadpoles. When a sample of individuals from a population consists of related individuals, the genetic material they share is overrepresented. For example, if a pair of full-sibs sharing 50% of their genetic material is sampled, then the shared material will occur in the sample not once, but twice. As populations in both Hardy-Weinberg and linkage equilibrium are assumed to consist of unrelated individuals, the presence of genetic material shared between relatives violates this assumption resulting in the rejection of these hypotheses. Under the assumption that the entire population is randomly mating, larvae analyzed from Belza did not represent a random sampling of the genetic diversity in this population, as suggested by the rejection of the null hypotheses of Hardy-Weinberg and linkage equilibria. This is likely due to the presence of related individuals within our sample, which is also supported by the fact that some pairwise relatedness values in the Belza population are elevated over what would be expected in an unrelated sample of individuals (Fig. 1).

The presence of related tadpoles in our Belza sample allowed us to test if male *R. pipiens* are capable of reproducing successfully with more than one female per breeding season. Sibship analysis identified high membership in full- and half-sib groups. These patterns could be explained by multiple paternity (a female breeding with multiple males) which is known to occur in anurans (D'Orgeix and Turner 1995; Laurila and Seppa 1998; Lode and Lesbarreres 2004; Roberts et al. 1999; Sztatecsny et al. 2006), or multiple fertilizations by males, which has not been documented. Within half-sib group B (Fig. 2), two full-sib groups possess haplotype 1 while the other two full-sib groups possess haplotype 7. The only way this pattern can occur is if a single male bred with at least two females that possessed different mitochondrial haplotypes. This does not mean, however, that all other half-sib groups we observed were paternal half-sibs. If multiple paternity occurs, all members of the half-sib group must share the same mitochondrial haplotype, as it is maternally inherited. However, paternal half-sibs will also possess identical mitochondrial haplotypes if their mothers share the same haplotype. Therefore, if nested full-sib groups within a half-sib group share the same mitochondrial haplotype, it is impossible to determine which parent they have in common. This lack of resolution typified half-sib group A (Fig. 2), where both nested full-sib groups possessed haplotype 7.

Males entering amplexus and successfully breeding with more than one female in succession is the best explanation for our observation of different haplotypes occurring within a half-sib group. However, this is not the only possible explanation for the phenomenon observed. Spermatozoa can survive for a short period of time in aquatic environments, and may be able to diffuse into nearby egg masses if amplexus is synchronous and pairs occur in close proximity (Laurila and Seppa 1998). However, spermatozoa diffusion has been deemed unlikely in other anurans (Lode et al. 2005; Sztatecsny et al. 2006). Consequently, we do not consider diffused spermatozoa a likely explanation.

This first genetic evidence that wild male anurans are able to reproduce successfully with more than one female offers new insight into anuran breeding systems. Some male *R. pipiens* are able to sire offspring from multiple egg masses in a single breeding season. This suggests that remaining at a breeding site after fertilizing one female's eggs is a good reproductive strategy for males and will increase their fitness, as they are sometimes able to mate with an additional female. This finding also has repercussions for the sampling of any anuran population for genetic study if sampling unrelated individuals is the goal. As the majority of tadpoles captured were related at least at the half-sib level, adults should be targeted to ensure a representative sample of the genetic diversity within a population. It should be noted, however, that the large number of half-sibs in our sample was likely exacerbated by the small size of this population and its isolation from other populations, which would both result in a higher proportion of related individuals than would be found in a large population with gene flow between regions.

Our results also apply to the selection of source individuals to be used in translocation efforts to restore or augment anuran populations if maximizing genetic diversity is a management goal (e.g., Goossens et al. 2002; Moritz 1999; G. A. Wilson et al. 2005). The use of subadults or adults as founding stock is more likely to result in a representative sampling of the genetic diversity present in the source population. However, since survivorship of translocated adults can be low (Dodd and Seigel 1991), obtaining subsamples from many egg masses may maximize genetic diversity in translocated animals while minimizing the effect on the source population.

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A Fluorescent Vertebrate: the Iberian Worm-lizard *Blanus cinereus* (Amphisbaenidae)

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Luminescence is the emission of radiation in excess of thermal radiation (Leverenz 1968). In biological systems there are two main types of luminescence: chemiluminescence (including bioluminescence) which results from biochemical reactions, and photoluminescence (including fluorescence) which results from low-energy photo-excitation (visible light, UV) (Leverenz 1968). Luminescence is found sporadically among different groups of organisms (Herring et al. 1990).

Most of the known bioluminescent organisms are marine, and few are bioluminescent over their entire body surface (Farrant 1997). Bioluminescent terrestrial vertebrates are unknown, but photoluminescencent fluorescence (where UV light is absorbed and re-emitted at longer wavelengths without a detectable afterglow i.e., phosphorescence; Leverenz 1968) is well documented for some vertebrate structures such as parts of bird feathers (Arnold et al. 2002). Among other terrestrial organisms whole-body fluorescence is documented in scorpions (Fasel et al. 1997; Frostet al. 2001), and has not been shown previously in vertebrates (although anecdotal reference is made to this phenomenon in young Western Banded Geckos [*Coleonyx variegatus*] Stahnke 1972; and the blind snake *Leptotyphlops humilis*, Hulse 1971).

We show here for the first time that the Iberian Worm-lizard *Blanus cinereus* (Vandelli) 1797 (Reptilia, Lacertilia, Amphisbaenidae) (Gans 2005) fluoresces blue/green light over its entire body when irradiated by UV radiation.

Materials and Methods.—During our undergraduate terrestrial biology field course a live specimen of the amphisbaenian *Blanus cinereus* was collected (and released after examination) in the Algarve, Portugal, along the sea cliffs of Albuifera at the west end of Praia de Oura Beach during April 2006. Digital photographs were taken using a Canon 1Ds mark II camera (at 16.7 megapixels) in Adobe RGB, 12 bit RAW capture mode at ISO 100 and 400. Macro lenses of 65mm and 100mm focal length and bulb exposure settings were used for fluorescent light capture. White light images were taken using electronic flash. Images were converted and analyzed using Adobe CS2 and RGB pixel values were converted to wavelengths using "*efg's Computer Lab*" "*WaveLengthToRGB*" program in the "*SpectraLibrary.PAS*" available at:

<http://www.efg2.com/Lab/ScienceAndEngineering/Spectra.htm>

Blanus cinereus was found to fluoresce using an excitation wavelength of 368 nm supplied by a portable Ushio ultraviolet lamp, Blacklight Blue (BLB), fitted with a low-pressure mercury-arc lamp code F4T5BLB that emits a narrow band of UV radiation with a sharp spectral peak at 368 nm. Specifications and emission spectra for the lamp are available at:

<http://www.ushio.com/Files/BLBLB.pdf>

Five representative fluorescent regions around the head and body of the worm lizard were sampled for RGB color pixel values (8 bit) using the eyedropper tool in "Info Palette" of Adobe Photoshop CS2. Ten readings were sampled at each of the five regions and the mean (± SD) was obtained from these. Similar measurements were obtained from the central non-fluorescing scale regions, and background (soil) for comparison.

Results.—Blanus cinereus fluoresces with a blue-green light between 437 and 550 nm (mean 465 ± 28 nm; ± SD; N = 5) when excited by UV at 368 nm (Fig. 1). Fluorescence between, and around, scale edges occurs over the entire body but is brightest around the head and tail tip (Fig. 1). A fluorescent scale (brille) covers the eyes (Fig. 1). The polished surfaces of some scales might reflect UV, but we were unable to quantify this (Fig. 1b). No phosphorescence was observed.

Discussion.—The fluorophor (Leverenz 1968) responsible for fluorescence in this amphisbaenian is unknown. However, intact scorpion cuticle fluoresces in the range 440–560 nm (Fasel et al. 1997) as a result of at least two fluorophors; beta-carboline and 7-

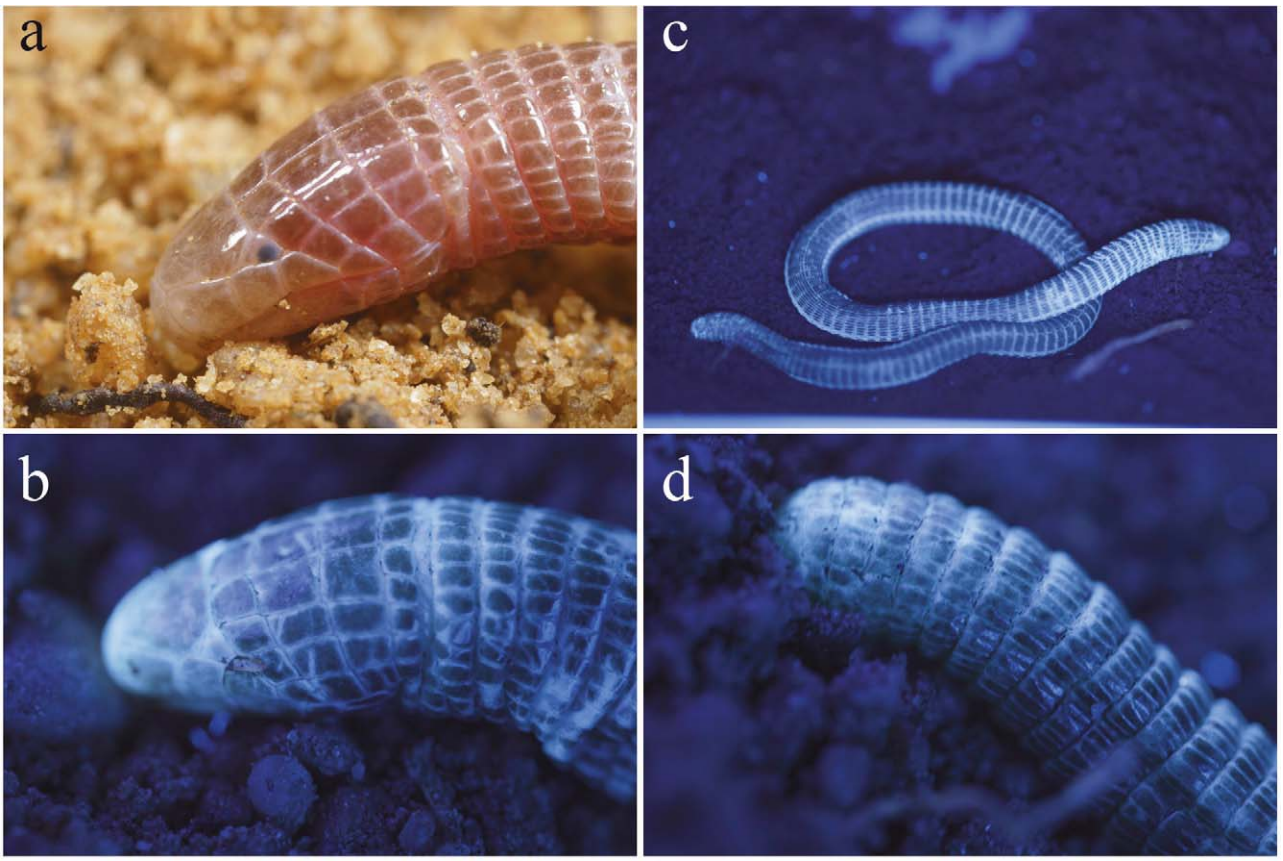


FIG. 1. Fluorescence in the Iberian Worm-lizard *Blanus cinereus* (specimen total body length ~155 mm, 5 mm diameter): a) the head photographed under white light; b) head, c) body, and e) tail, under UV light (368 nm). Photographs by DPM.

hydroxy-4-methylcoumarin, fluorescing at 450 nm and 441 nm respectively (Frost et al. 2001). It is possible, therefore, that scorpions and amphisbaenians possess similar fluorophors.

The function of whole-body fluorescence in *Blanus cinereus* and scorpions is unknown. In scorpions it has been suggested that the fluorophor 7-hydroxy-4-methylcoumarin might act as a block against the UV component of sunlight, because this is a function that coumarins perform in plants (Frost et al. 2001). Another suggestion for scorpions is that the fluorescence might simply be a byproduct of cuticle development in arid adapted organisms (Frost et al. 2001). Indeed, the majority of documented incidences of whole-body fluorescence occurs in invertebrates inhabiting arid environments (Stahnke 1972). Arthropod fluorophors are laid down in the epicuticle as part of the sclerotization process and freshly moulted scorpions and first instar juveniles do not fluoresce (Frost et al. 2001). Thus, whole-body fluorescence in desert-dwelling animals might indicate cuticular adaptations against desiccation and protection against UV radiation; it might not be coincidence therefore, that *Blanus cinereus*, also living in an arid environment and lacking a completely overlapping scale covering, displays whole-body cuticular fluorescence.

Although this report raises many more questions than it answers, further research is warranted. The elucidation of fluorescence in *Blanus cinereus* might lead to the development of new fluorescent tags for DNA and immunological investigations in biochemistry and medicine.

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TECHNIQUES

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A Protocol for Clearing and Double-Staining Squamate Specimens

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Clearing and double-staining of specimens for bone and cartilage is an invaluable tool for the study of skeletal development and morphology, and published protocols exist that are specific to fish (e.g., Song and Parenti 1995; Taylor and Van Dyke 1985) and amphibians (Hanken and Wassersug 1981). Because none is specific to squamates, the purpose of this paper is to describe a modification of the protocol of Potthoff (1984) that has been applied with excellent results to more than 600 squamate specimens with snout–vent lengths (SVL) ranging from 16 mm (neonates) to more than 120 mm (Fig. 1). For time-sensitive steps, data from previous preparations (Maisano 2000) are provided to allow the user to approximate durations for each step according to snout–vent length of the specimen (Figs. 2–7).

Step 1: Specimens must be formalin-fixed or they will disarticulate. Specimens should be measured (SVL), skinned, and gutted. If a dark peritoneum is present, it should be removed as it will not clear. Specimens are then dehydrated in 95–100% ethanol for a minimum of two days. Remaining steps will be accelerated slightly if conducted on a light table.

Step 2: Specimens are stained for cartilage in a solution of 30% glacial acetic acid/70% ethanol, with enough Alcian blue powder added to approximate the color value of window cleaner. Specimens remain in this solution until cartilaginous elements such as the suprascapular and epiphyseal cartilages are visible through the flesh (Fig. 2). Specimens that dessicated prior to fixation will absorb little or no Alcian blue. When preparing immature (small) specimens, it is important to avoid over-staining as this will make it difficult to detect initial centers of ossification and calcification. When preparing mature (large) specimens, cartilage should be stained an intense blue because the longer duration of subsequent steps will partially leach the stain, making it difficult to see elements that persist as un-mineralized cartilage in adult squamates (e.g., portions of the hyoid apparatus, sternum, etc.). Specimens cannot be re-stained for cartilage after they have been stained for bone (Step 5).

Step 3: Specimens are neutralized in a saturated sodium borate solution for at least 12 h. This step can be used to 'pause' the preparation for up to several days if necessary.

Step 4: Specimens undergo initial digestion in a saturated pancreatin (3X or 4X USP specifications) solution of 65% distilled water/35% saturated sodium borate. Specimens remain in this solution until the limb bones are visible (Fig. 3), and the solution should be changed every two days because it becomes increasingly acidic and the enzyme decreases in activity.

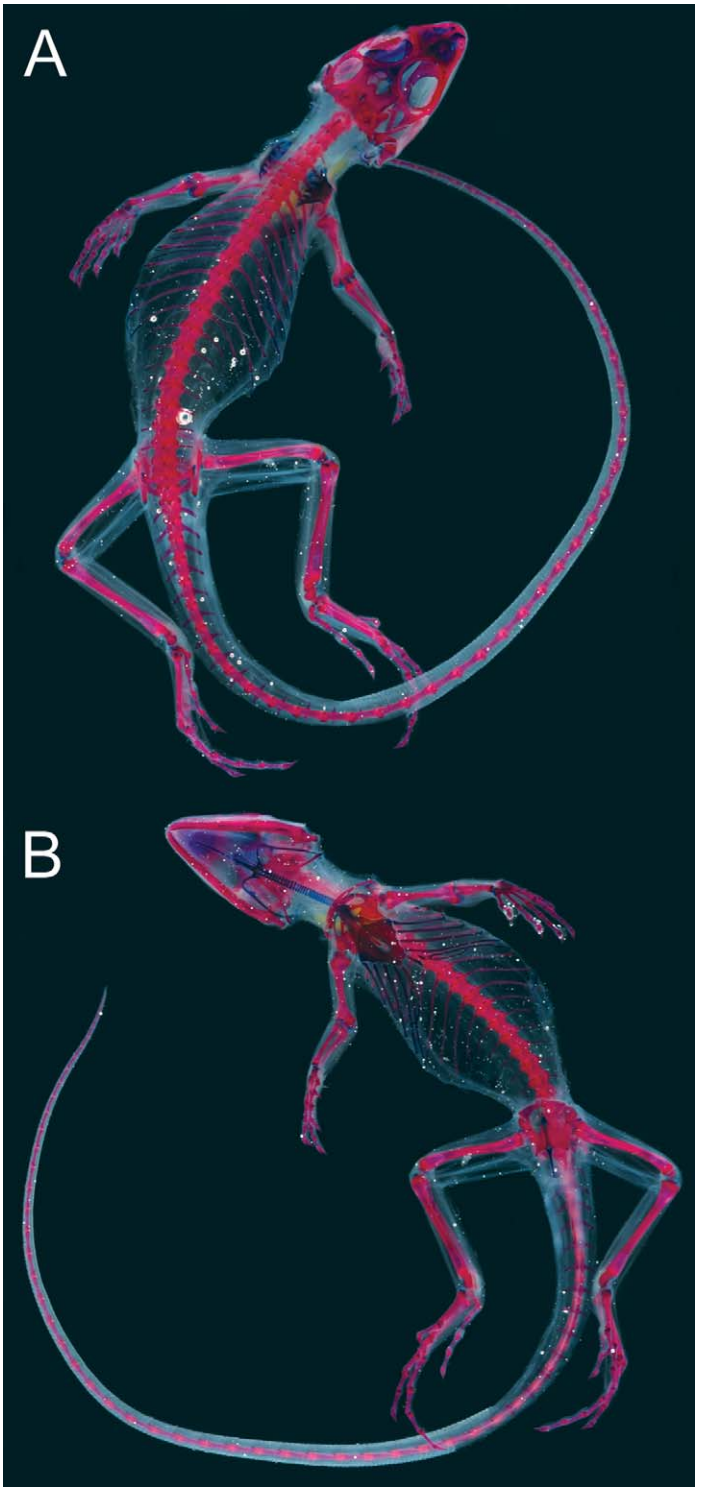


FIG. 1. A) Dorsal and B) ventral views of *Gambelia wislizenii* (Museum of Vertebrate Zoology, MVZ 50268, SVL = 72.8 mm) processed using the protocol described here.

Step 5: Specimens are stained for bone in a 0.75% potassium hydroxide (KOH) solution, with enough Alizarin red powder to make the solution a rich, dark purple. Specimens remain in this solution until their bones are stained a deep, vibrant purple-red (Fig. 4). It is better to over-stain bone rather than under-stain it, as subsequent steps may slightly leach the stain. Specimens may also

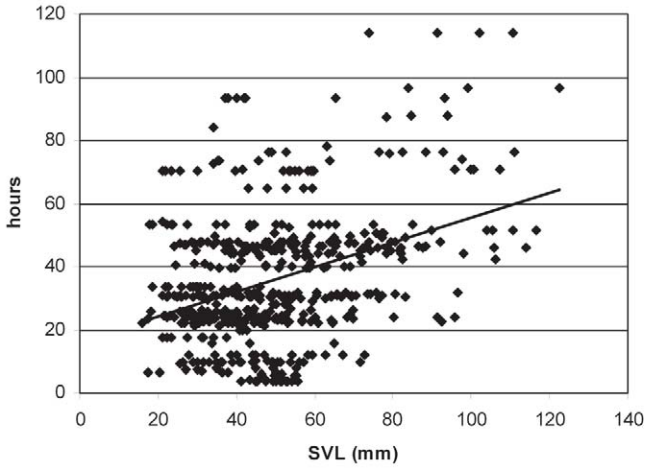


FIG. 2. Time required in Alcian blue stain for cartilaginous elements to become visible through the skin, as it relates to snout–vent length (SVL) (Step 2). Data here and in subsequent figures from Maisano (2000).

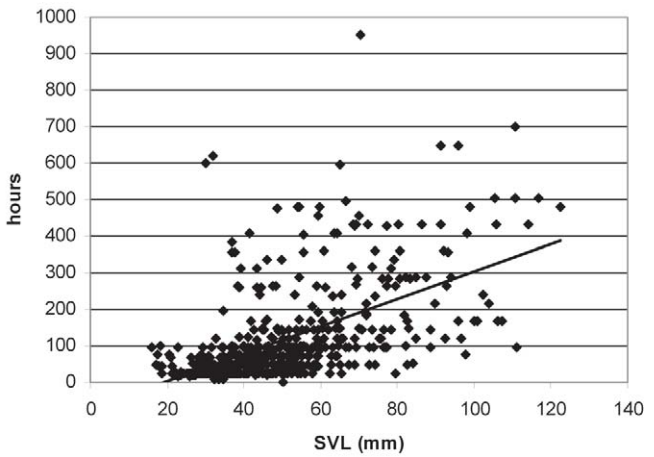


FIG. 3. Time required in first digestion for limb bones to become visible, as it relates to SVL (Step 4).

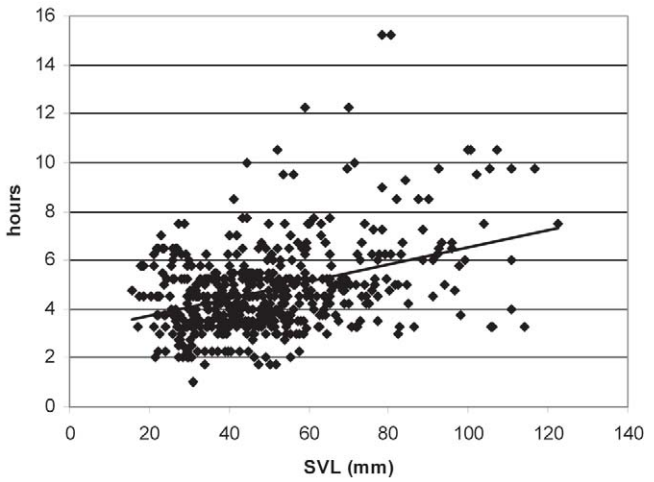


FIG. 4. Time required in Alizarin red stain for bones to stain a vibrant purple-red, as it relates to SVL (Step 5).

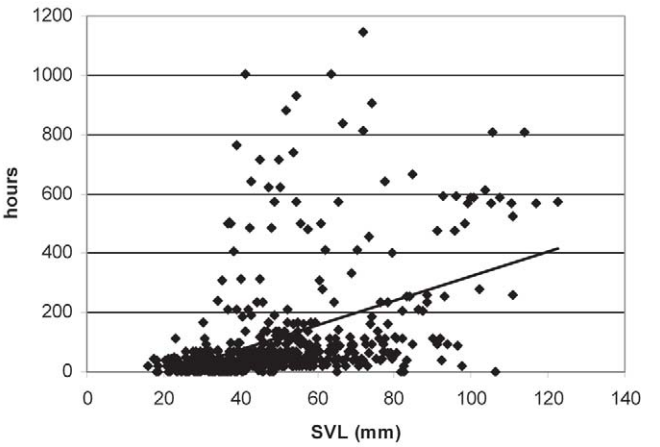


FIG. 5. Time required in second digestion for specimens to become limp, as it relates to SVL (Step 6).

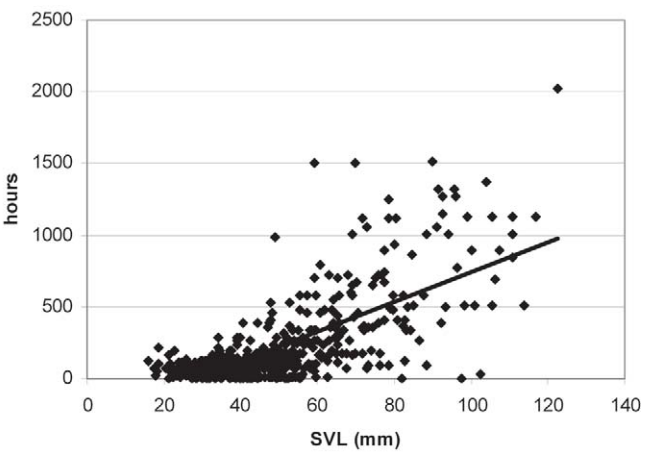


FIG. 6. Time required in first glycerol/KOH clearing solution for all but most resistant areas to clear, as it relates to SVL (Step 7).

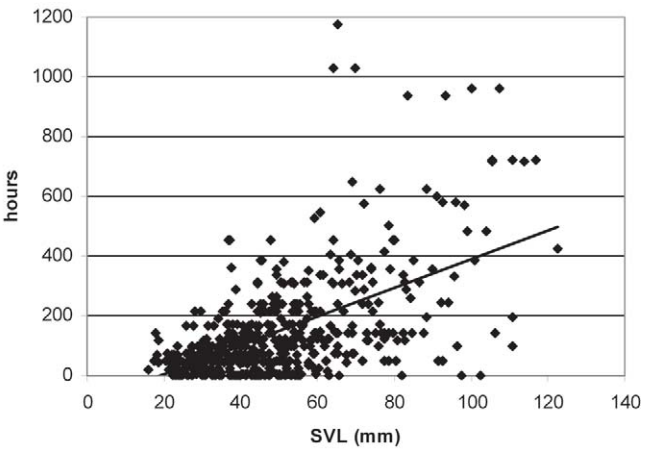


FIG. 7. Time required in second glycerol/KOH clearing solution for clearing to be complete, as it relates to SVL (Step 7).

be re-stained for bone at any time up to the completion of preparation.

Step 6: Specimens are placed in their second and final pancreatin digestion (same solution as in Step 4). Pothoff (1984) recommended that the bulk of the final clearing be accomplished in pancreatin. However, this enzyme substantially weakens the soft tissues, sometimes resulting in disarticulation. Instead, specimens are digested in pancreatin only up to the point where they become limp (i.e., droop when lifted at mid-body) (Fig. 5). Specimens that are already very limp after Alizarin red staining should skip the second digestion as they may begin to disarticulate.

Step 7: Final clearing is accomplished in this step, in two solutions, producing more durable specimens than does prolonged exposure to pancreatin. In fact, specimens will stiffen somewhat during these final steps. Be advised, however, that 0.75% KOH will eventually leach Alcian blue from cartilage, and in very long treatments (large specimens) will lighten Alizarin red staining as well. Specimens are placed in a solution of 30% glycerol/70% KOH until all but the most resistant areas (e.g., neck, base of tail) are clear (Fig. 6). Specimens are then moved to a 60% glycerol/40% KOH solution until clearing is complete (Fig. 7).

Step 8: Specimens are stored in 99% glycerol with a few crystals of thymol added to prevent fungal growth. Specimens should be stored in darkness to prevent fading.

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Rapid New Protocol for Clearing and Staining of Specimens for Osteological Examination

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Comparative osteology of small vertebrates has been greatly facilitated by the preparation of cleared and stained whole mounts. This procedure is relatively easy and rapid, especially with the most frequently used method: Alcian blue/ trypsin/ Alizarin red-S clearing and staining technique, as modified by Hanken and Wassersug (1981). This protocol requires the specimens to incubate in trypsin for 16 h or overnight. Trypsin, a proteolytic enzyme, breaks down soft tissues around the bone, after which these tissues are further macerated in KOH. This method produces exquisitely cleared and stained whole mounts. This protocol is used by both developmental biologists and herpetologists who study morphological characteristics.

Unfortunately, there are several disadvantages to the trypsin technique. One is the destruction of soft tissues so that the specimen cannot be used for other purposes, such as histology. Another disadvantage is the possibility of over-digestion, especially of delicate parts such as digits, in both large and small specimens. The length of time needed for the complete clearing and staining of a specimen is approximately 10–12 days, another disadvantage.

Materials and Methods.—We set out to develop a technique that would generate cleared and stained whole mounts of preserved amphibian specimens without excessive tissue destruction and in a faster time frame. This technique employs methyl salicylate and eliminates the trypsin and KOH:glycerol stages.

Formalin-fixed specimens were skinned and eviscerated using caution around the delicate digits. Next, specimens were placed into a solution of Alcian Blue Cartilage Stain 8Gx (20 mg/50 ml) in 3:1 ethanol:glacial acetic acid for 24 h, following the Hanken and Wassersug (1981) technique. This step was followed by two rinses in fresh 3:1 ethanol:glacial acetic acid, each lasting 1 h, and a final rinse in 100% ETOH for 2 h. Specimens were then soaked in several changes of distilled water with the last change sitting overnight to dilute out the ethanol. After being re-hydrated, specimens were transferred 0.5% KOH with 1.5 ml of Alizarin red-S stain from a saturated stock solution for 24 h followed by a rinse in distilled water for 2 h. Usually, several rinses were needed to remove excess stain. Next, specimens were placed into 70% ETOH for 12 h then transferred into two changes of 100% ethanol for 1 h each, followed by a third overnight incubation in 100% ethanol. Specimens were then placed into an appropriately sized vial of methyl salicylate which effectively cleared the specimens within minutes.

Results and Discussion.—Several advantages accompany this technique. This protocol takes 5–6 days to complete, with speci-

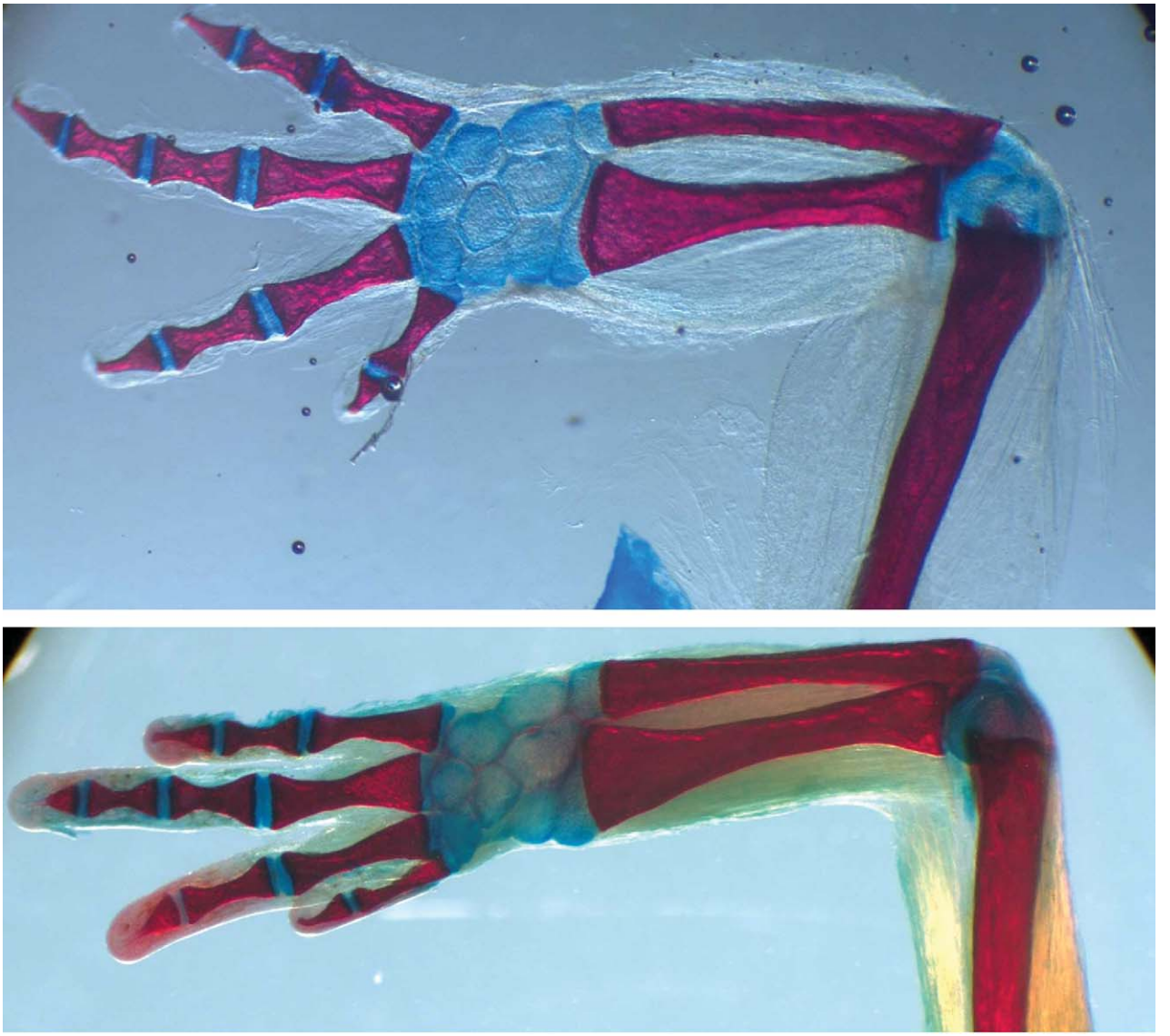


FIG. 1. Photographs showing comparison between a Hanken and Wassersug (1981) cleared and stained specimen (*Eurycea bislineata,* top) and our new approach (*E. bislineata*, bottom).

mens cleared well enough to examine skeletal morphologies (Fig. 1). All of the tissues remain intact and undamaged, and can be removed from methyl salicylate, dehydrated in 100% ethanol, and put back into 70% ethanol for storage. This also allows for histology to be performed on pre-stained specimens with the added benefit of visualizing bone and cartilage. The skinning step can be eliminated for small larvae.

Although this technique works well for specimens under 20 g, it does not clear larger specimens as well as the Hanken and Wassersug (1981) approach. One drop of 30% hydrogen peroxide can be added to approximately 50 ml during the 3:1 rinsings following the Alcian blue staining to aid in clearing any residual pigment left over from the initial skinning and evisceration.

Acknowledgments.—We would like to thank Stanley K. Sessions of Hartwick College for the use of his laboratory and for his advice while modifying this technique.

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A Fast, Non-invasive Method of Measuring Growth in Tadpoles Using Image Analysis

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Measuring the performance of anuran tadpoles under a variety of conditions is a common research theme in herpetology. There are a number of variations in how performance is measured including assessing tadpole survival (e.g., Brown et al. 2006; Loman 2004) or time to metamorphosis (e.g., Holbrook and Petranka 2004). The most often-used variable is the growth rate of tadpoles, measured either as the size of the animals at the end of the experiment (e.g., Pahkala et al. 2003) or by subtracting initial mass from final (e.g., Relyea 2004; Relyea and Hoverman 2003; Rosenberg and Pierce 1995). Rarely though, do researchers measure tadpole mass at multiple times throughout the duration of the experiment, likely due to the time required to perform the measurements or the stress induced upon the tadpoles. Indeed, to do this tadpoles must be weighed by removing them from water and blotting them dry, which if not done quickly, can result in mortality.

In this paper, we describe a novel measure for assessing anuran tadpole growth that is simple, inexpensive, requires minimal removal from water, and is nearly directly correlated with tadpole mass. This measure is therefore useful for obtaining repeated measures throughout experiments without harming individuals. Furthermore, this measure allows for bulk assessments of growth on multiple tadpoles at once if time is limited, or if large numbers of individuals are involved.

Our method involves the use of image analysis, whereby digital photographs of specimens are taken and computer software used to measure features of the specimens (Davis et al. 2004; Davis et al. 2007; Davis and Grayson 2007; Davis and Maerz 2007). Variations of this technique are already frequently employed by herpetological researchers interested in tadpole shape (Relyea 2004, 2005; Relyea and Hoverman 2003; Van Buskirk 2002; Wilson et al. 2005), though to our knowledge, this technique has not been used to assess growth rates or directly compared to other measured of size. We therefore set out here to determine if this technique could be used to assess tadpole size and if this measure of size was related to traditional mass measurements. There were two components to this research. First, we examined a set of lab-reared tadpoles that varied in size, using traditional (tadpole mass) and the image analysis size measures. Second, we employed this technique to measure tadpoles that were being raised in an ongoing, unrelated experiment to evaluate its utility in the field.

For our first component, we obtained egg masses of *Rana sylvatica* from Habersham Co., Georgia during February 2006 and divided them into four tubs in the lab where they hatched. Tadpoles were fed ad libitum thereafter with a powder, ground from a 60:40 ratio of rabbit food pellets to Reptomin floating aquatic turtle sticks. Two weeks later there was a natural range of tadpole sizes in each tub. At this point we haphazardly caught single individuals from each tub with dip nets and placed them each in a standard plastic weighing dish filled with water from its tub. The dish was then photographed from above with a Canon Powershot G6 digital camera that was mounted on a mini copy stand at a fixed distance from the specimens (Fig. 1A). Care was taken to ensure that the tadpole was not moving at the time of the photograph (to avoid blurring), and that its dorsal surface was fully in view. After photographing, the tadpole was removed from the dish, blotted dry and weighed on an electronic balance. This was repeated until 58 individuals were processed. Throughout the experiment, we made an effort to capture tadpoles that varied in size. We also photographed a standard metric ruler to provide a calibration image for the image analysis software (see below).

To measure the tadpoles we imported all digital photos into an image analysis program, Fovea Pro (Reindeer Graphics, Inc.), used previously to measure features of herpetofauna (Davis and Grayson 2007; Davis and Maerz 2007). We first calibrated the software using the ruler image so that the pixel-to-millimeter ratio could be retained for the tadpole images. For each tadpole image we digitally selected the entire tadpole (head and tail), which was made easier by the fact that the tadpole was darkly colored on a white background (Fig. 1B). A Fovea Pro measure routine was then initiated, which measured the total surface area of the selection, which in this case was the surface area of the tadpole (43 mm^2 in Fig. 1B). This surface area measure was the unit of 'tadpole size' for our analyses. Once all images were measured we compared the tadpole surface area data (log-transformed) to the mass data (log-transformed) using Pearson Correlation. There was a highly significant positive relationship between individual tadpole mass and our surface area measure ($r = 0.996$, $p < 0.001$; Fig. 2).

Because a tadpole's body is relatively spherical, one might expect a curvilinear (e.g., exponential) relationship between tadpole dorsal area and mass, and therefore be surprised by the strong linear correlation we observed. However, the minimum and maximum tadpole area measurements were 18 and 200 mm^2, and the relationship between dorsal area and volume [mass] is relatively linear between these values. The relationship would only be significantly curvilinear if extended to the origin and out well beyond 200 mm^2, but a tadpole never has zero area or mass, and is not infinitely large.

In the second part of this project, we tested the utility of this technique while conducting an unrelated experiment that involved monitoring the growth of tadpoles within 18 plastic 55-L tubs. Each tub contained 50 tadpoles of *Rana sylvatica*, and our goal was to measure the average size of tadpoles within each tub with minimal mortality. On the day of sampling, the camera and photographing stand were set on a portable table next to the tubs (as in Fig. 1A). Ten tadpoles were dipnetted from the first tub and placed into two large petri dishes (5 in each) along with water from their tub. When the tadpoles settled, a photograph of each dish was obtained as described above. The tadpoles were then released back to their respective tubs. This process was repeated until all tubs had been sampled. During this process we recorded the time to sample (i.e., dipnet and photograph 10 tadpoles) each tub, as well

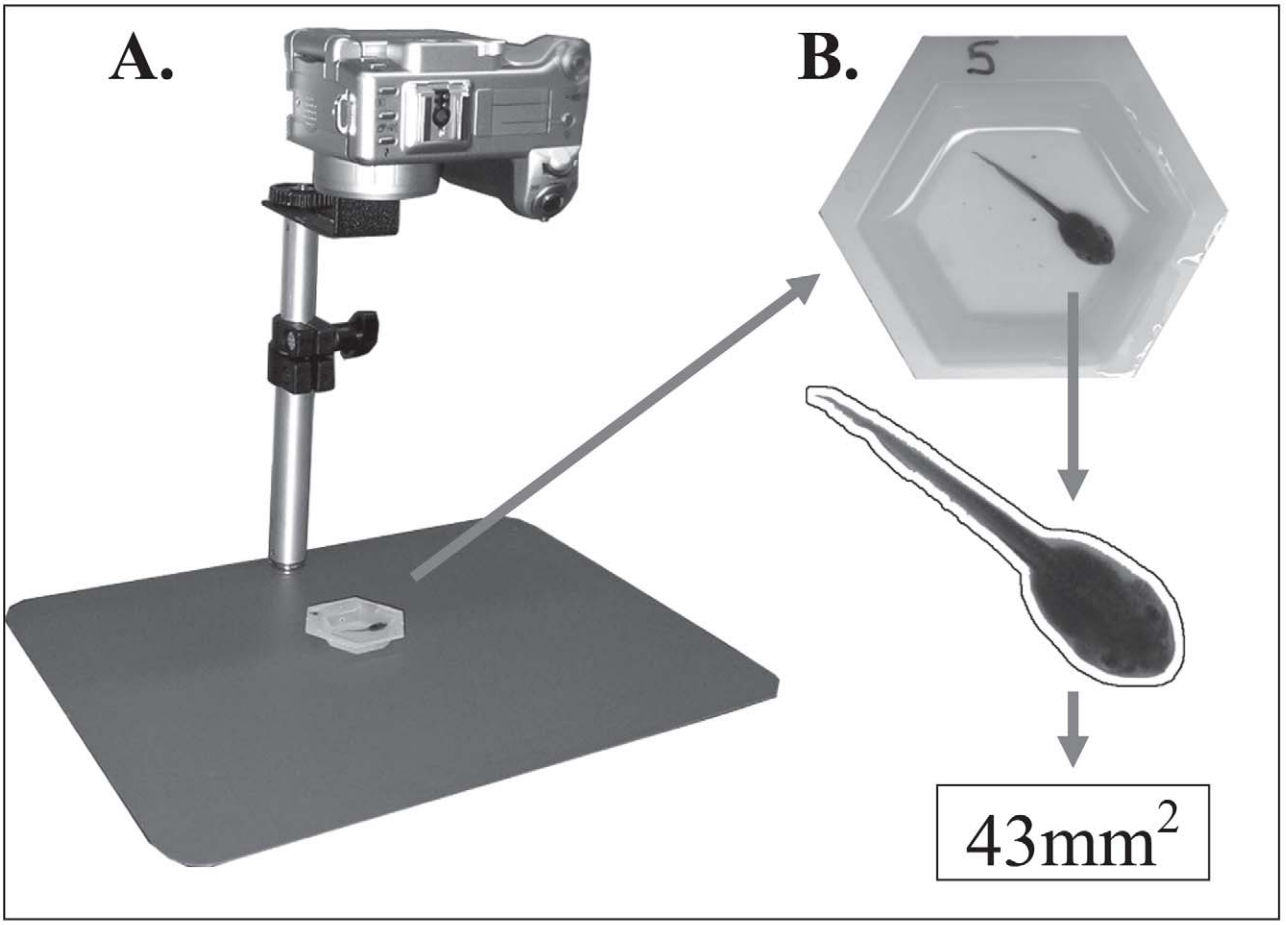


FIG. 1. Camera and photography stand used to photograph tadpoles in the lab and field (A). Tadpoles were held in white plastic weighing boats filled with water during photography. Later, digital images of tadpoles (B) were examined using Fovea Pro software. In the program, the entire tadpole was selected and its dorsal surface area measured in mm^2 based on a previously defined pixel-to-mm ratio obtained from a ruler image.

as the start and end times for the entire session. On average it took us approximately 2 min to sample the ten tadpoles per tub, with all 18 tubs finished in 48 min. In the lab, the same procedures were used to obtain size data from all individual tadpoles in the images as described earlier.

In the procedure described here, tadpoles are dipnetted and immediately placed in a dish of water for photography, they remain in this dish for no more than 2 min, and then are released back into their original water. Thus, tadpoles are subjected to minimal stress because they are never long out of water during the procedure. This technique can be used in the lab or field, and in both situations, large numbers of tadpoles can be quickly and non-invasively sampled, and sampling can be done multiple times over the course of experiments. Further, the measure of size we obtained for each tadpole (its surface area) was nearly perfectly correlated with tadpole mass (Fig. 2). Moreover, although not explored here, it is also possible to generate measures of body and tail length from the tadpole images (or the ratio of both). We also note that while the software used here costs ~ $ US800, there is a freely available image analysis program (ImageJ — http://rsb.info.nih.gov/ij/) that can perform the same tasks as outlined here. Thus, the method we describe is arguably faster and safer than mass measurements, and

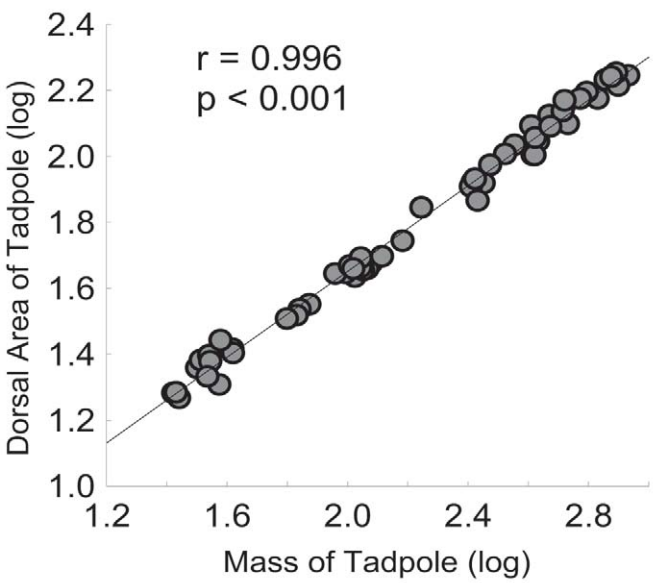


FIG. 2. Comparison of dorsal surface area measurement (log-transformed), obtained from image analysis procedure, and log-transformed mass of 58 lab-reared *Rana sylvatica* tadpoles.

allows for a wider range of data to be measured during experiments.

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Laboratory Protocols for Husbandry and Embryo Collection of *Anolis* Lizards

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Anolis lizards, or anoles, are a model system for evolutionary biology (e.g., Emerson 2002; Losos 1994), behavioral and physiological ecology (e.g ., Huey et al. 2003; Irschick and Garland 2001; Lovern et al. 2004; Stamps 1983), community ecology (e.g., Pacala and Roughgarden 1985; Schoener 1968), toxicology (e.g., Burger et al. 2004), and physiology and neuroendocrinology (e.g., Greenberg 2003; Wade 2005). Because the genome of *Anolis carolinensis* has recently been sequenced (http://www.genome.gov/Pages/Research/Sequencing/SeqProposals/GreenAnoleLizardAmericanAlligatorSeq.pdf), work on this genus is expected to expand as it becomes more accessible to new disciplines such as developmental and statistical genetics, comparative genomics, and the biomedical sciences. For this reason it is imperative that methods for working with *Anolis* be developed to facilitate comparisons between studies and assure the ethical treatment of these animals as they are used by researchers not accustomed to working with reptiles.

The goal of this manuscript is to describe methods for the maintenance of captive breeding colonies of *Anolis* species. The general characteristics of a species that must be considered to maintain healthy breeding populations include its availability (in the wild or the pet trade), physiological needs (e.g., temperature, humidity, nutrition), and sociality (density of housed individuals) (Greenberg 1992). These factors also must be independently considered for the care of juveniles to assure their proper growth and development. In addition to species-specific factors, practical limitations such as available space, number of species to be housed together, and available resources (incubators, cage washers, climate control systems, etc.) must be considered when developing protocols for the maintenance of animals in captivity. These likely vary greatly from institution to institution. A broad perspective on the general use of reptiles for research can be found in Greenberg (1992) and Pough (1991) and on reptilian egg incubation in Deming (2004).

Here we describe the detailed methods we have found to be successful for the care and maintenance of 13 *Anolis* species from southern Florida and four Caribbean islands that inhabit a wide

range of microhabitats. While we have worked primarily with *A. sagrei*, *A. carolinensis*, and *A. cristatellus*, we also have experienced success breeding *A. chlorocyanus*, *A. coelestinus*, *A. cybotes*, *A. distichus*, *A. evermanni*, *A. grahami*, *A. gundlachi*, *A. krugi*, *A. lineatopus*, and *A. valencienni*. Lovern et al. (2004) provided protocols for *A. carolinensis*, the northernmost species of the genus. We have modified these protocols to fit the needs of an additional 12 species. The methods we describe here are readily amenable to larger-scale laboratory settings where large numbers of animals from different species are maintained. We successfully raised all species through the F1 generation except for *A. cristatellus*, which we raised through the F2 generation. We developed these methods under the guidance of Washington University's animal facilities management (J. Diani), veterinary services, and the Institutional Animal Care and Use Committee. Based on explicit calculations of the effort and expense needed to care for these lizards (space, lighting, climate control, basic daily care, etc.), we were charged $0.16 per lizard per day to maintain these lizards in our animal care facility.

The key factor in developing protocols for the maintenance of captive breeding colonies is an understanding of a taxon's natural history. Anoles are remarkably variable in their natural history, ecology, behavior, and physiology. They inhabit a broad variety of habitats from hot xeric semi-deserts to cool montane rainforests, ranging from the equatorial forests of South America throughout the Caribbean Islands and into southeastern North America. Caribbean anoles, including populations found in the southern United States, breed from early spring through late-summer depending on the temperature and humidity of a given year (Licht and Gorman 1970). Mean field body temperatures range from 21.0–33.0°C (Clark and Kroll 1974). Some species narrowly regulate their body temperature by basking, whereas others are thermoconformers; furthermore, within a species, mean body temperature changes with altitude and season (Hertz 1981; Hertz and Huey 1981; Huey and Webster 1976; Ruibal 1961). Although fewer field data are available, similar observations are made regarding interspecific variation among anoles in their hydric environments (Hertz 1980, 1992), size at reproductive maturity, hatchling size, and growth rate (Kobayashi et al. 1983; Michaud and Echternacht 1995). In some cases, physiological differences observed among populations or even species may represent phenotypic plasticity, rather than genetic differences (e.g., Wilson and Echternacht 1987, 1990). Given these many and varied differences, there is no one-size-fits-all prescription for caring for and raising anoles; rather, to the extent possible, husbandry needs to be tailored to the biology of each species.

For the following discussion, it is important to note that many of the species we have maintained in captivity occur primarily in open, sunny habitats (but see Interspecific Variation below). Such species often thermoregulate actively and maintain relatively high body temperatures; moreover, they tend to be less sensitive to water loss than many other anoles (Hertz 1981, 1980, 1992). Because the species we have used in our research naturally occur in the Caribbean and southeastern United States, we chose mean conditions for humidity, moisture, and light based on climatic data in those regions for the months of peak breeding, April to June (for Florida and southeastern United States: Hamlett 1952, Lee et al. 1989, TJS pers. obs.; for the Caribbean: Jenssen and Nunez 1994).

Husbandry and Egg Collection

We have collected adults of each species from the wild or, for species found within the United States, purchased them from professional reptile vendors. Select species are also available from the pet trade; however the history and genetics of these individuals are not typically known. Occasionally, new animals in the lab do not breed or deposit eggs at first, but after two weeks, individuals generally show no visible signs of distress (as described in Greenberg 2002, 2003) and breed regularly. Wild-caught anoles commonly host parasitic mites, often found on the dewlap, groin, base of the tail, or axillae. Although specific host-parasite relationships likely exist between mite and lizard species from the same island, lizards may be more severely affected by novel parasites introduced from other locations. Because we do not have space to house each lizard species in its own room, lizards from different islands must be kept together. Consequently, upon arrival to the animal care facility, we remove all mites using forceps and treat the lizards with commercial de-miting solution as described by the manufacturer (Reptile Relief, Natural Chemistry). Endoparasites may be problematic as well. For example, we have discovered infestations of endoparasitic worms as tumor-like growths on the joints and jaws in wild-caught *A. cybotes* and *A. cristatellus*. We immediately cull individuals from our population as soon as a growth is detected to limit the spread of this parasite between individuals. Sarcophagic fly infestations are also common in some populations of wild-caught anoles (Irschick et al. 2006). We do not prophylactically treat for viral or bacterial infections.

To establish breeding groups, we kept three or four adult females (depending on size) and one adult male together in a standard rat cage (42 cm length × 27.5 cm width × 21 cm height, Ancare Corp.) with oak sticks collected from the outdoors to provide perches (Fig. 1). Before using the sticks as perches, we sterilize them with one cycle of a standard cage washing machine at 180°C. These sex ratios are within the range of those found in the wild for *A. carolinensis* (Jenssen and Nunez 1998) and in many species, several female territories occur within the territory of an adult male. This creates a breeding regime in which juveniles from each cage are half-sibs in genetic analyses, with known father and unknown mother. However, anoles are known to store sperm (Fox 1963; Licht 1973) for many months, so if females were reproductively mature when captured, one cannot assume that the male in the cage fathered the offspring; molecular testing is needed to verify that conclusion.

To prevent escape, we place screen mesh inserts in the cage tops rather than the cloth filter tops typically used when housing mice (New York Wire, mesh 16 × 84 inches). We cover cage bottoms with synthetic cage carpet (ReptiCage Carpet, ZooMed). Cage carpet is readily available, can be easily cleaned and sterilized, and is reusable. The carpet also holds moisture raising the humidity within each cage. We have avoided the use of gravel or sand as a cage substrate because we found that smaller individuals ingest these substrates and become impacted. We discovered that wood chips and sphagnum moss promoted fungal growth after a short time, needed to be changed often, and are not reusable. We clean and sterilize cage carpet and perches approximately once each

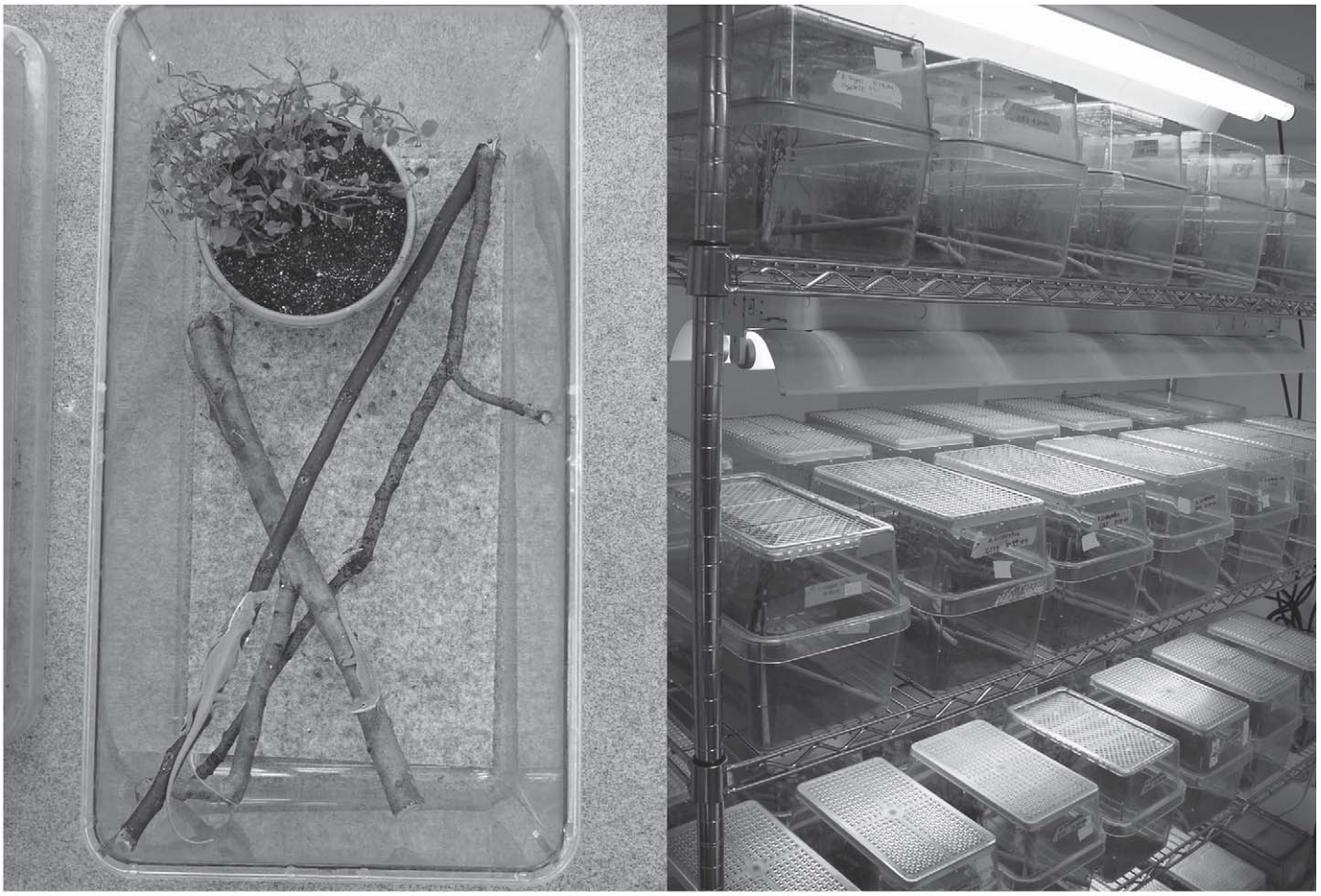


FIG. 1. A) A typical breeding cage for *Anolis*. Note the potted plant, cage carpet floor, sticks to act as perches, and several females held with one male. B) A typical rack of juvenile cages. Note the proximity of the UV lights over each row of cages.

month by soaking them in T.B.Q. disinfectant solution (Steris) while cages are washed using a cage washing machine. Anoles may exhibit "cage-novelty induced stress" when placed in unfamiliar conditions and thus perches and carpet should be exchanged separately so as not to return a lizard to a completely novel cage setting after cleaning (Greenberg 1992; Morgan and Tromborg 2007). Opaque cage dividers separate the cages to limit intraspecific male aggression. In cages not separated by cage dividers, males tend to develop open sores on their snout as they attempt to fight with males in adjacent cages. We recommend labeling each cage with the species name, locality of the collection, origin (wild caught or captive bred), date entered into the facility, number of individuals in the cage, and when applicable, age of the individuals and parentage information.

We maintain room temperature, humidity, and photoperiod using an automated climate control system (METASYS, Johnson Controls), cycled seasonally to mimic natural coastal Caribbean wet and dry season fluctuations. During the summer months room temperature cycles daily with a 28°C day, 25°C night and a constant 60–65% humidity. We mist each cage twice daily, raising the humidity within each cage to approximately 85% and supplying the animals with substantial drinking water. Relatively low humidity (less than 35%) is known to retard ovarian growth in *A. carolinensis* (Summers 1988). We also keep a small potted plant in each cage to help maintain relatively high levels of humidity between misting times. During the winter, we drop the room's humidity to approximately 50% and lower the temperatures by 1–2°C. The cages are still misted twice daily during this time. We keep light cycles at 13 h light/ 11 h dark cycles during the summer months and gradually shift to 11 h light/ 13 h dark cycles from early October though late March, approximately simulating the light cycles of the Caribbean. We light the room with both standard fluorescent ceiling lights and 15–20W fluorescent UV bulbs (ReptiSun 5.0) set directly over each cage. To simulate dawn and dusk we turn the ceiling lights on or off 30 minutes before or after the UV lights respectively. In the absence of an automated climate control system these conditions can be maintained with cost-effective, widely available alternatives such as electric timers, standalone humidifiers, and heat lamps (see Bartlett and Bartlett 2001; Hunziker 1994; Lovern 2004 for several more alternatives).

We feed adult anoles a diet of crickets twice weekly, sized appropriately for the species. Crickets are purchased from Timberline Fisheries Corp. (Marion, Illinois) sold in standard English units of 0.25," 0.5," or 0.75." To supplement the lizards' nutrition we dust crickets with a 1:1 mix of commercial vitamin supplement and a calcium additive (Rep-Cal brand Herpvitive and Cal-

cium Supplement) every other feeding. To maintain our cricket colony, we feed the crickets a diet of Laena Poultry (Purina) *ad libitum*. Be aware that some cricket suppliers regularly feed their animals diets that will be transferred to the lizards and may influence a specimen's growth or experimental results. For example, some cricket suppliers prophylactically administer antibiotics to their crickets. During our study of skeletal development (TJS), we found signs of the calcium chelator, tetracycline, in developing long bones. Tetracyclines are known to retard bone growth in many mammals, and thus we may have inadvertently compromised our experiment on bone growth by indirectly feeding it to lizards. We recommend inquiring into the treatment of lizard food when it is purchased from a commercial supplier.

To facilitate the collection of eggs, we supply each cage with a small leafy plant potted in a disposable plastic container (*Ziplock Snap and Seal*™, medium bowl or equivalent). Anoles lay one egg from alternating oviducts every one to four weeks (Andrews 1985; Andrews and Rand 1974; Hamlett 1952). We collected eggs every one to three days by removing the plant from the cage, removing the plant from the pot and thoroughly sifting through the root ball and potting substrate. Female anoles lay eggs at all depths in the pot. To ensure that eggs are not missed during collections, we completely remove the potting substrate from the container and search it by hand. Because female anoles can retain their eggs during times of drought (Socci et al. 2005; Stamps 1976), we remoisten the soil after each egg collection. When females are first brought into captivity, they may take some time to begin laying eggs in the potted plant. Initially, eggs may be laid on the cage bottom where they rapidly desiccate.

Viable eggs are generally white and range 0.5–1.5 cm in length. We clean eggs of excess soil using forceps or by hand and transfer them to a standard tissue-culture dish (100 mm × 20 mm) packed with moist, coarse-grained vermiculite, 1:1 vermiculite to de-ionized water by weight. We then cover the dish with its lid, secure it with *Fisherbrand* labeling tape and incubate at 27°C and ~75% humidity for 10–14 days. At this time, we remove the lid and cover the dishes with fiberglass screening to facilitate gas exchange (New York Wire, mesh 16" × 84"). We cut the screening into 15 cm squares and secure it around the circumference of the dish with rubber bands. We restack the dishes in the incubator in such a way that each dish acts as the cover for the dish below it. The top dish is loosely covered with its original lid and the weight of each dish is recorded. We then reweigh the dishes every one to two days and rehydrate them with drops of de-ionized water until the dish is returned to its initial weight. Additionally, to limit the evaporation from the culture dishes, we keep a pan of de-ionized water in the incubator.

Eggs of many squamates are highly permeable and actively exchange water and gas throughout embryonic development. Eggs not relatively free of debris will often desiccate or the embryo will die leading to fungal growth on the egg's surface (PMH, pers. obs). A fine balance also exists between the water within the egg and that in the surrounding substrate (Ackerman and Lott 2004). If the substrate is drier than the egg, the egg will lose water and desiccate. Inversely, if the egg is drier than the substrate, water will flood the egg, possibly damaging the embryo due to increased pressure. While these scenarios represent the extremes of a vast continuum, water balance in reptilian eggs is known to influence many developmental processes (e.g., Packard et al. 1999, 2000) and care should be taken to keep these conditions stable between species and throughout the period of development. Anole species living in different environments probably have adaptively differentiated in their ability to withstand humidity and desiccation, but this has been little studied (Andrews and Sexton 1981).

Care for Juveniles

For the 13 *Anolis* species we have bred in the laboratory, eggs hatch between 25 and 42 days from the date of laying. Upon hatching, we remove juvenile lizards from the culture dish and place them in a standard mouse cage (26 × 20.5 × 15.5 cm, Ancare Corp.) with conditions as described above. We immediately mist hatchlings with water (for drinking and to remove vermiculite stuck to their bodies) and feed them flightless *Drosophila* maintained in a stock culture. As individuals mature, we gradually transfer them to a standard cricket diet. Crickets are chosen by size: smaller lizards, ~2.5cm to 4.0cm SVL, are fed smaller crickets, "pinhead" to 0.25". We later transfer juvenile anoles larger than ~4.0 cm to a diet of larger crickets, 0.5", by adding crickets of both sizes to the cage for approximately one month. We only feed the largest crickets, 0.75", to cages with adult males greater than 5.0 cm SVL. Because we occasionally observed crickets feeding on juvenile lizards, we remove uneaten crickets from the cages within several hours of feeding.

Lizards raised without substantial social interaction throughout juvenile development rarely breed during adulthood (MAJ, pers. obs.); however, housing juveniles individually may be desirable for some studies (e.g., tracking individual growth). In this case, juvenile lizards can be allowed limited social interaction by removing cage dividers to provide visual access to the neighboring cages. Preferably, juvenile lizards would be housed in groups of three to five individuals per rat cage when individual records are not necessary or when marking individuals (e.g., Ferner 1979; Fisher and Muth 1989; Johnson 2005) will not interfere with an experiment. In this case however, the more dominant lizards tend to capture more food, leading to size disparity within each cage (PMH, pers. obs). As animals become dominant, especially males, they can be removed from the group cage and housed separately.

Captive-bred juvenile lizards often face problems during shedding. Lizards often encounter the most difficulty shedding the skin around the head, legs, and cloacal regions. On the head, unshed skin can block eyes, cover nostrils and impede feeding. Around the legs, excess skin can constrict and reduce circulation leading to the occasional loss of limb elements. Unshed skin around the cloaca can cause complications during excretion and promote infection. To prevent these complications we often removed unshed skin on juvenile and adult lizards by moistening the skin with warm water and then gently removing it with fine forceps. Care should be taken not to injure sensitive areas while removing unshed skin.

Embryo Collection

Anolis embryos of all stages can be dissected from eggs under a dissecting microscope. To do so, we remove eggs from their culture dish and submerge them in phosphate buffered saline solution (PBS; Sambrook and Russell 2001). While illuminating the

egg from the side, we then position the egg with the embryo upwards by locating its shadow beneath the shell. Using #5 watchmaker's forceps, we make a small incision outside of the darkened area and extend it, with shallow incisions, across the top of the embryo. Folding the shell away, the embryo is then visible lying on its left side within the yolk and can be easily removed from the yolk and surrounding amnionic membrane. For young embryos, adding a drop of 10% bovine serum albumin to the Petri dish may help in the removal of extra-embryonic membranes. We preserve young embryos by immediately submerging them in 4% paraformaldehyde PBS in a plastic centrifuge tube, incubating overnight at room temperature, and finally transferring them to 70% ethanol. This method of fixation is useful for many basic histological techniques such as gross examination of both soft and hard tissue. Additional measures may be needed for analysis of gene expression or other molecular or immunochemical assays. To assure the humane treatment of embryos approaching hatching, we euthanize these animals with an IP injection of xylazine (20 mg/ml) prior to fixing. Xylazine (Rompun**,** Bayer) is a non-narcotic anesthetic commonly used on mammals. We fix late-stage embryos in 10% buffered formalin for 24 h, and then move them to 70% ethanol. We have observed that *Anolis* embryos tend to adhere to "soft" polystyrene tubes during fixation and cannot be removed without damage. We prefer to use common polypropylene 15 ml conical tubes (i.e., Corning, FisherBrand) when preserving embryos for use in histological preparations or 2 ml centrifuge tubes when preserving embryos for long term storage.

Interspecific Variation

Although the methods described above have been successful for the majority of *Anolis* species we have examined, interspecific differences have required minor adjustments in our protocol. For example, most well-studied species of Caribbean *Anolis*, including the majority of species for which these methods have been utilized, occur in sunny, open areas. The temperature and humidity simulated in our animal care facilities reflect these microclimatic conditions. However, *A. gundlachi* and *A. krugi* are two species that occur in the montane rainforest of Puerto Rico. *Anolis gundlachi* occurs in the cool, deep shade of the forest, and *A. krugi* is typically found in shaded habitats, moving into the sun at higher elevations (Hertz 1992; Rand 1964; Schoener and Schoener 1971; Williams 1972). These habitats offer a very different climate than sunny, open habitats. In our work, after a number of *A. gundlachi* eggs died before hatching when incubated at the standard 27°C (i.e., no eggs from this species survived to hatching), we placed 4 *A. gundlachi* eggs in a 25°C room immediately after being laid. Three of these eggs then produced live hatchlings one month later. In addition, only 17 of 64 *A. krugi* eggs (25%) survived to hatching, but incubating these eggs at a lower temperature may have increased survivorship substantially. For this reason, we recommend matching the cage and egg incubation temperatures and humidity as closely as possible to the natural microclimates of the species for optimal breeding results. Moreover, we note that a comparative study on the thermal biology of anole eggs could prove very interesting.

Additionally, not all species of *Anolis* lizards exhibit the same egg-laying behavior. *Anolis valencienni* is a species that, at least occasionally, lays eggs communally in sites such as tree holes or bromeliads well above the ground (Rand 1967). We have observed that almost all female *A. valencienni* held in captivity do not bury their eggs in the potted plants initially, but instead deposit them on the cage carpet, adhere them to perches, or leave them on the soil surface. To collect viable eggs from this species, we found it necessary to check for eggs every day, particularly in the late evening. However, individuals that have been in captivity for longer times, typically greater than nine months, do begin to deposit their eggs in the pots; after two years in captivity, all eggs are found buried in pots. In the future, we plan to examine whether this species will preferentially lay eggs in an artificial cavity if one is provided in the cage. Whereas the other *Anolis* species we have studied have a mean incubation time of about 29 days, *A. valencienni* also appears to have a considerably longer mean incubation time of about 42 days when incubated under similar conditions.

In conclusion, basic knowledge of the reproductive biology and ecology of a species is necessary to establish successful breeding colonies of lizards. Further consideration of variation among species' ecology may allow for optimization of these methods for species from different habitats. Fortunately for anoles, a substantial body of literature exists on the natural history of many species in this genus, further supporting the utility of these lizards as a model system for a great diversity of research questions.

We have successfully maintained breeding colonies and collected embryos from a diverse collection of *Anolis* species. The above protocols should allow researchers with even a basic animal care facility to breed *Anolis* and collect their embryos for use in standard analyses.

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A Notching System for Marking Softshell Turtles

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Beginning with Cagle (1939), the marginal scutes of the turtle carapace have often been used for various marking systems on hard-shelled turtles (reviewed in Ernst et al. 1974; Ferner 2007; Plummer and Ferner, *in press*). Because the carapacial margin of trionychid turtles lacks discrete scutes, these turtles present difficulties for unambiguously marking a large number of individuals; thus a systematic marking system for softshells is needed. Herein, I describe a system used in two softshell population studies (Plummer 1977a, 1979). Plummer (1977a) made at least 2300 captures of 1500 marked *Apalone mutica* over a 3-yr period. A long-term population study of *A. spinifera* by Plummer and Mills (*in press*) was based on 570 captures of 270 marked turtles from 1994–2003 and this study continues today (716 captures of 322 turtles as of 2007). Although the marking method was briefly mentioned by Plummer (1977a, 1979), details were not provided.

Marks are made by cutting triangular-shaped pieces from the edge of the carapace using a pocketknife for adults and juveniles and small scissors for hatchlings. Alternatively, a paper hole punch may be used to apply marks (Doody and Tamplin 1992). A small amount of bleeding may follow marking because the shell is vascularized. The depth of the notched cut varies with turtle size, approximately 15–25 mm for adults and 8–12 mm for juveniles. The notches eventually heal and fill to the original carapacial edge; however, the triangular pale scar tissue remains evident. The numerical marking scheme is based on 12 h clock positions. From a dorsal view, the face of a clock is superimposed on the carapace (Fig. 1). Distinct positions are 12 and 6 (opposite each other on the midline of the carapace), 2 and 10 (just anterior to the bridge), and 3 and 9 (opposite each other but perpendicular to the midline. Positions 4–5 and 7–8 are less precise but positioned between unambiguous positions (3, 6, and 9).

To mark a turtle, one to five notches (notching groups 1–5) are cut in the edge of the carapace. Turtle nos. 1–12 are identified by one notch; nos. 13–78 by two notches; nos. 79–142 by three notches; nos. 143–195 by four notches, and nos. 196–238 by five notches (Fig. 1). Within a notching group (Fig. 1 B–L), numbers are consecutive by progressing from last notch clockwise. For example, turtles no. 13–23 are marked as follows: turtle no. 13 has notches at the nos. 12 and 1 positions, turtle no. 14 has notches at the 12 and 2 positions, etc., to turtle no. 23, which has notches at the 12 and 11 positions (Fig. 1B). For a four notch example, turtle no. 181 has notches at the 5, 6, 7, and 8 positions, turtle no. 182 has notches at the 5, 6, 7, and 9 positions, etc., to turtle no. 185, which has notches at the 5, 6, 7, and 11 positions (Fig. 1G). A final example is turtle no. 238, which has notches at the 8, 9, 10, 11, and 12 positions (Fig. 1J). For numbers greater than 238, the 1-238 series may be repeated by coding with additional marks on the plastron or by toe clipping. For example, a notch in the ante-

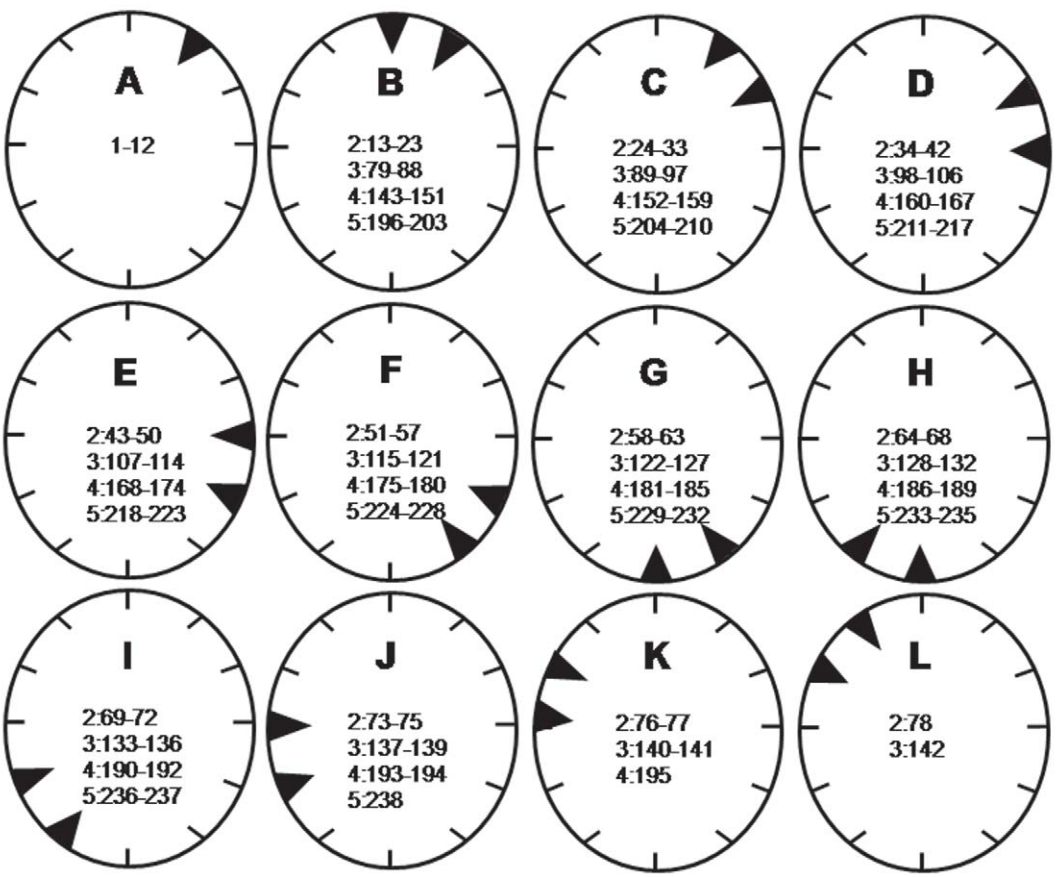


FIG. 1. Schematic of the proposed marking system for softshell turtles. Dark triangles represent notches in the carapacial margin corresponding to the hours of a 12 h clock. The first notch represents the starting position for numbering sequences in B (position 12) through L (position 10) for a two notch sequence. Numbers separated by a colon represent the number of notches to be cut and the range of turtle nos. that can be assigned from the starting position.

rior left quadrant of the plastron codes for turtle nos. 239–476, a notch in the anterior right quadrant codes for nos. 477–714, and notches in both the anterior left and right quadrants code for nos. 715–952. Using the 1–238 notching series and various combinations of just 1–2 notches in the four plastral quadrants would permit marking more than 2500 turtles.

Turtles unambiguously identified after extended periods of time between captures (Plummer and Mills, *in press*) demonstrate the long-term persistence of some marks. For example, 12 adult *A. spinifera* initially marked in 1994–95 were clearly identified 10–13 years later in 2005–07. In addition, five juvenile male *A. spinifera* initially marked at 30–60 mm plastron length (PL) were identified as adults 5–6 years later at 90–100 mm PL and 15 juvenile female *A. spinifera* initially marked at 30–60 mm PL were identified, some as adults, 7–13 years later at 140–215 mm PL. Whether marks on some individuals heal sufficiently to prevent identification is unknown; however, natural processes may occasionally alter marks. For example, the posterior most carapacial edge of adult males, which includes notching positions 5–7, is particularly susceptible to disfigurement resulting from aggressive intraspecific behavior (Doody and Tamplin 1992; Plummer 1977b). Growth from a small juvenile to a large adult may obscure marks such that periodic remarking is needed. Validation studies are needed to quantify the proportion of turtles that possibly "lose" their marks.

Several investigators have used shell marking in softshell mark-recapture studies (Breckenridge 1955; Doody and Tamplin 1992; Fitch and Plummer 1975; Graham and Graham 1997; Plummer 1977a; Plummer and Mills, *in press*); however, none described their marking methods in sufficient detail to be used by others. Thus, a systematic shell marking system designed specifically for the unique problems presented by marking large numbers of softshells for long-term studies is not available. The superiority of the system described herein may be open to question; however, its utility has been clearly demonstrated in population studies of two softshell species (Plummer 1979a; Plummer and Mills, *in press*). Whether the system would be suitable for other trionychid species is unknown. Various tagging techniques, such as PIT-tagging, offer advantages to shell marking and have been used on softshells (Galois et al. 2002), but they also have their own limitations (Gibbons and Andrews 2004).

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AMPHIBIAN CHYTRIDIOMYCOSIS GEOGRAPHIC DISTRIBUTION

This section offers a timely outlet for streamlined presentation of research exploring the distribution and prevalence of the amphibian chytrid fungus *Batrachochytrium dendrobatidis* (*Bd*). *Bd* is an emerging infectious disease linked to mass mortality of amphibians worldwide, yet *Bd* detections in amphibians with no symptoms also are known in many areas. To aid in our understanding of the scope of this issue, we encourage submission of studies on *Bd* geographic distribution, including research on individual species or groups of species, wild or captive animals, native or non-native species, live animals or museum specimens, environmental samples, and findings with no *Bd* detections. We ask authors to: 1) restrict the Introduction of their paper to a **maximum** of two paragraphs to highlight the context of their study; 2) briefly include both field and laboratory Methods; 3) present Results in a Table, although a map also might be very useful, and limited text; and 4) have a short discussion of a **maximum** of three paragraphs to touch upon key findings. Please consider including the following information in submissions: coordinates and description of sampling areas (or please note if locations are extremely sensitive to reveal, and provide general area instead); positive and negative results; disposition of voucher specimens; date of specimen collec-

tion; name of collaborative laboratory or researcher conducting histological sections or PCR analyses; and names of cooperative land owners or land management agencies. We aim to expedite the review and publication process! Please e-mail submissions directly to Associate Editor, Dr. Dede Olson: dedeolson@fs.fed.us.

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The Northern Leopard Frog *Rana pipiens* is a Widespread Reservoir Species Harboring *Batrachochytrium dendrobatidis* in North America

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The Northern Leopard Frog, *Rana pipiens*, is wide-ranging across North America and commonly harvested for research and teaching (Gibbs et al. 1971; Moriarty 1998). *Rana pipiens* were harvested on the order of 100,000 specimens per year in the early 1980s in Quebec (Gilbert et al. 1994) and 100,000 pounds per year in the early 1970s in Minnesota (Moriarty 1998). Carey et al. (1999) suggested that population declines observed in this species in the late 1960s or early 1970s in some areas (Gibbs et al. 1971; Rorabaugh 2005) may have been caused by the emergence of chytridiomycosis, a disease caused by infection with the fungus *Batrachochytrium dendrobatidis* (*Bd*). A histological survey of *Bd* infections in *R. pipiens* collected in Quebec province of Canada between 1960 and 2001 revealed a prevalence of 10–20% (Ouellet et al. 2004). Because of their widespread commercial use and transport, we sampled several populations of this species to test for the potential of adult *R. pipiens* to act as a reservoir for *Bd* that could potentially facilitate the spread of disease.

Rana pipiens from Minnesota and Vermont were obtained from commercial suppliers (Table 1) and sampled by swabbing 10 times on each of ventral surface, thighs, and feet upon receipt at Vanderbilt University or after several months in the laboratory. Frogs arrived in boxes with damp sphagnum moss and were in contact with one another. Frogs were then housed in groups of 4–5 in polypropylene (opaque) plastic tanks with Plexiglas® covers (45.7 × 25.4 × 20.3 cm), sterilized with bleach before use, and tilted to one side to allow access to both water and the dry bottom of the container. In addition, *R. pipiens* were sampled in the field at a site near Plainwell, Michigan (42°19'26.7"N, 85°47'01.2"W). At the field site, individuals of six other species were sampled concurrently. Diagnosis of infection status, including the number of zoospore equivalents per swab, was performed at the Australian Animal Health Laboratory, CSIRO, Geelong, Victoria, Australia. All samples were analyzed in triplicate by Taqman real-time PCR assay according to Boyle et al. (2004). Sampling was different to that described by Hyatt et al. (2007) for groups containing multiple tadpoles or juveniles. Animals were rinsed in 50 ml HPLC-grade water for 15 min and the solution absorbed onto swabs as described by Boyle et al. (2004), perhaps underestimating infection loads.

We found that *R. pipiens* obtained from Minnesota and Vermont by two commercial suppliers were positive for *Bd*, indicating infection, but clinical signs of disease were absent. It is unknown whether the frogs became infected in the wild or after collection by suppliers. In general, infection intensity was low, typically ranging from 0 to 651 zoospore equivalents. A swab from one frog contained 90,599 zoospore equivalents. Although some animals died in captivity, there were no significant die-offs observed after housing frogs in the laboratory for several years, indicating that some *R. pipiens* may have resistance to chytridiomycosis. All 55 individuals and seven species sampled in the field in Michigan in 2004 were negative for *Bd*, indicating infection prevalence at the site between 0 and 6.49% with 95% confidence. The data imply that the Michigan population was probably not infected in the field. After exposure to water housing *R. pipiens* from commercial suppliers, at least one and up to four of six frogs collected from Michigan developed low-level *Bd* infections (Table 1).

These results suggest that *R. pipiens* can function as a reservoir or carrier species for *Bd*. This places *R. pipiens* in a category with other wide-ranging and introduced species used for food, fish bait, research, teaching, and pets (Fisher and Garner 2007). Current regulations do not require amphibian suppliers or breeders to deliver uninfected frogs or to check infection status. However, unless frogs escape or are released into new habitats, or their waste water is not treated, they do not necessarily put susceptible amphibians at risk. Unfortunately, disease emergence caused by introduced species that are *Bd* reservoirs is increasingly detected (Fisher and Garner 2007), for example in Britain (Cunningham et al. 2005) and Uruguay (Mazzoni et al. 2003). We recommend increased monitoring and stricter biosecurity to prevent the spread of chytridiomycosis. The overall health of amphibians obtained from commercial suppliers has improved since the report by Gibbs et al. (1971), and more rigorous distribution procedures will surely benefit research and conservation.

It seems unlikely that all populations of *R. pipiens* carry *Bd*. Therefore, measures should be taken to limit human-mediated exposure to the pathogen. Populations that already carry *Bd* may still be at risk. Different strains of *Bd* may differ in pathogenicity (Berger et al. 2005; Retallick et al. 2007). Hence, exposure of susceptible amphibians to new strains of *Bd* carried by *R. pipiens* and other reservoir species may continue to threaten populations with disease.

Of interest for conservation management, population level variation in susceptibility may exist, and this awaits exposure experiments and immune defense characterization of different populations. Since carrier species are expected to survive *Bd* exposure, susceptible controls may be used in exposure experiments as in Daszak et al. (2004).

This study was not extensive and is comprised of information

TABLE 1. Amphibians sampled for diagnosis of infection with *Batrachochytrium dendrobatidis*. Frogs obtained by commercial suppliers were sampled in the laboratory at Vanderbilt University. Samples that returned a low number of zoospore equivalents in only one well* or two wells** (from a total of three) were defined as "indeterminate."

Date sampled (month/yr)	Location	Number swabbed	Species	Life-history stage	*Bd* diagnosis (no. zoospore equivalents)
3/04	BioCorporation, Alexandria, MN; frogs harvested in Minnesota, swabbed upon receipt	1	*Rana pipiens*	adult	0
		1	*Rana pipiens*	adult	0.2*
		1	*Rana pipiens*	adult	0.3*
		1	*Rana pipiens*	adult	1**
		1	*Rana pipiens*	adult	2**
		1	*Rana pipiens*	adult	6**
		2	*Rana pipiens*	adult	1
		1	*Rana pipiens*	adult	3
		3	*Rana pipiens*	adult	4
		1	*Rana pipiens*	adult	5
		1	*Rana pipiens*	adult	7
		1	*Rana pipiens*	adult	9
		2	*Rana pipiens*	adult	10
		1	*Rana pipiens*	adult	11
		1	*Rana pipiens*	adult	12
		2	*Rana pipiens*	adult	14
		1	*Rana pipiens*	adult	27
9/04	BioCorporation, Alexandria, MN; frogs harvested in Minnesota and kept in laboratory	3	*Rana pipiens*	adult	0
		1	*Rana pipiens*	adult	28
		1	*Rana pipiens*	adult	59
		1	*Rana pipiens*	adult	268
		1	*Rana pipiens*	adult	491
		1	*Rana pipiens*	adult	651
		1	*Rana pipiens*	adult	90599
12/04	BioCorporation, Alexandria, MN; frogs harvested in Minnesota and kept in laboratory	1	*Rana pipiens*	adult	0
		1	*Rana pipiens*	adult	0.46*
		1	*Rana pipiens*	adult	1*
		1	*Rana pipiens*	adult	13
		1	*Rana pipiens*	adult	18
		1	*Rana pipiens*	adult	288
12/04	Connecticut Valley Biological Supply Co., Southhampton, MA; frogs harvested in Vermont, swabbed upon receipt	2	*Rana pipiens*	adult	0
		2	*Rana pipiens*	adult	1
		1	*Rana pipiens*	adult	0.08*
		1	*Rana pipiens*	adult	3
		1	*Rana pipiens*	adult	248
7/04	Plainwell, Michigan	1	*Bufo americanus*	adult	0
		1 group of 5	*Bufo americanus*	juvenile	0
		2 groups of 5	*Hyla* sp.	tadpole	0
		1 group of 5	*Pseudacris crucifer*	juvenile	0
		1 group of 2	*Pseudacris triseriata*	juvenile	0
		1 group of 5	*Rana sylvatica*	juvenile	0
		1	*Rana* sp.	tadpole	0
		1 group of 2	*Rana clamitans*	juvenile	0
		2	*Rana clamitans*	juvenile	0
		3	*Rana clamitans*	adult male	0
		7	*Rana pipiens*	juvenile	0
9/04	Plainwell, Michigan	6	*Rana pipiens*	subadult	0
12/04	Laboratory (collected from Plainwell, Michigan, 9/04)	2	*Rana pipiens*	subadult	0
		1	*Rana pipiens*	subadult	0.13*
		1	*Rana pipiens*	subadult	0.73*
		1	*Rana pipiens*	subadult	1**
		1	*Rana pipiens*	subadult	17

accumulated while undertaking other studies. The data, however, are important because in addition to identifying *R. pipiens* as a carrier of *Bd*, they highlight the infectivity of *Bd* and the requirement for stringent biosecurity.

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Batrachochytrium dendrobatidis in Wood Frogs (*Rana sylvatica*) from Three National Wildlife Refuges in Alaska, USA

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Batrachochytrium dendrobatidis (*Bd*) is a fungal pathogen implicated in recent amphibian declines (Pounds et al. 2006). It was first documented in Alaska, USA, in 2002, in a single dead subadult Wood Frog (*Rana sylvatica*) in the Kenai National Wildlife Refuge (Reeves and Green 2006). Since then, there have only been two other studies of *Bd* in Alaska. In one, *Bd* was found in Boreal Toads (*Bufo boreas*) and Red-legged Frogs (*Rana aurora*) in western Canada and southeast Alaska (Adams et al. 2007). In the other, *Bd* was not found in wood frogs in Denali National Park (Chestnut et al. 2008). *Bd* distribution in other parts of Alaska is unknown. In summer of 2006, we sampled adult Wood Frogs from three Alaskan National Wildlife Refuges to screen them for *Bd*.

Methods.—Wood Frogs from the Innoko, Kenai, and Tetlin refuges were sampled (Fig. 1). From these refuges, we tested 48 opportunistically-encountered adult frogs from 29 breeding ponds between 11 May and 21 July 2006 (Table 1). At Kenai, four ponds were road-accessible and six were in remote areas, 1–10 km from any road (Fig. 1). All ponds at Innoko (N = 9) and Tetlin (N = 10) were in remote areas, 35–125 km from any road. All animals were alive when sampled and appeared healthy. Frogs were swabbed

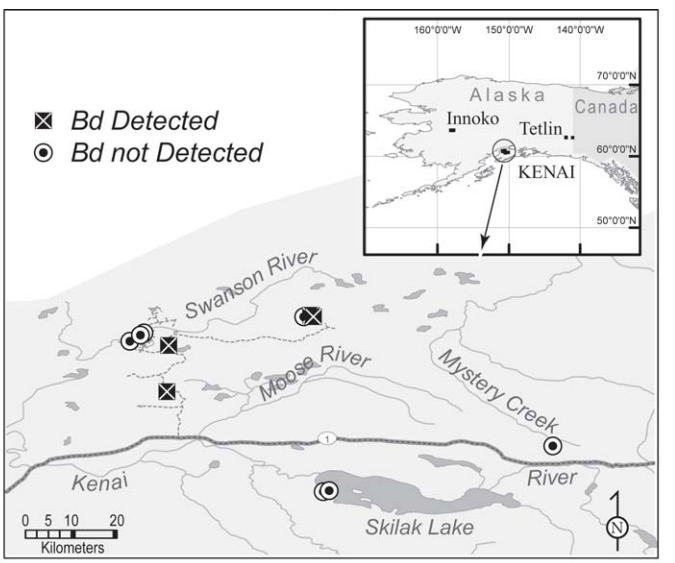


Fig. 1. Wood Frog (*Rana sylvatica*) *Bd* sampling locations in Alaska, USA, and Kenai Refuge sampling ponds and *Bd* detection locations. Dashed lines are gravel roads.

TABLE 1. Surveys for *Batrachochytrium dendrobatidis* (*Bd*) in Wood Frogs (*Rana sylvatica*) in three wildlife refuges in Alaska, USA. Prevalence indicates: number of frogs with *Bd* detected/total number of frogs sampled.

Date	Refuge	Latitude °N	Longitude °W	Prevalence
12 July 2006	Innoko	63.573080	-158.156880	0/1
6 July 2006	Innoko	63.599840	-158.136220	0/1
7 July 2006	Innoko	63.595970	-158.112640	0/1
14 July 2006	Innoko	63.615150	-158.081880	0/1
6 July 2006	Innoko	63.617460	-158.080380	0/1
13 July 2006	Innoko	63.618890	-158.020890	0/1
9 July 2006	Innoko	63.610790	-157.792040	0/1
15 July 2006	Innoko	63.648980	-157.750640	0/1
9 July 2006	Innoko	63.622410	-157.739620	0/1
23 June 2006	Kenai	60.725870	-150.889740	0/2
11 May 2006	Kenai	60.737920	-150.872070	0/8
11 May 2006	Kenai	60.743180	-150.863910	0/6
25 July 2002	Kenai	60.627410	-150.815570	1/1
20-29 June 2006	Kenai	60.714230	-150.815410	4/4
12 May 2006	Kenai	60.776810	-150.547290	0/1
28 June 2006	Kenai	60.780170	-150.543000	2/2
28 June 2006	Kenai	60.776550	-150.539150	1/1
24 May – 14 July 2006	Kenai	60.436260	-150.507710	0/3
14 July 2006	Kenai	60.439000	-150.500000	0/1
22 June 2006	Kenai	60.523690	-150.064090	0/1
18 July 2006	Tetlin	62.603330	-142.051030	0/1
13 July 2006	Tetlin	62.616140	-141.992900	0/1
15 July 2006	Tetlin	62.633420	-141.985200	0/1
12 July 2006	Tetlin	62.608420	-141.980030	0/1
12 July 2006	Tetlin	62.610000	-141.980000	0/1
21 July 2006	Tetlin	62.618210	-141.979860	0/1
17 July 2006	Tetlin	62.607280	-141.972820	0/1
13 July 2006	Tetlin	62.630000	-141.970000	0/1
17 July 2006	Tetlin	62.614990	-141.966540	0/1
17 July 2006	Tetlin	62.619140	-141.963100	0/1

30–35 times on the pelvic patch, inner thighs, and between toes with sterile, foam-tipped swabs (REF 25-1506 1PF: Puritan, Guilford ME). Swab tips were then placed in individual 1.5 ml microfuge tubes in reagent-grade ethanol and stored at room temperature until analysis. Samples were sent in late August 2006 to Pisces Molecular (J. Wood, Boulder, Colorado, USA) for analysis by polymerase chain reaction (Annis et al. 2004). Clean nitrile gloves were worn when handling each frog, and field equipment was decontaminated with 5% bleach solution between ponds. Pond coordinates were recorded with hand-held Garmin III GPS units and referenced to datum, WGS84.

Results.—Bd was detected in the Kenai refuge, but not in the Tetlin or Innoko refuges. In Kenai, *Bd* was found in one of four road-accessible ponds and in two of six remote ponds; in the three ponds where *Bd* was found, all sampled frogs tested positive (Table 1). All of the *Bd*-positive ponds were near the Swan Lake recreational canoe route or the gravel road used to access it (Fig. 1). One of the *Bd*-positive ponds was directly adjacent to the road, and the other two ponds were in a wilderness area within 3 km of the road and within 1 km of the canoe trails.

Discussion.—Wood Frogs are the only amphibian common in southcentral and interior Alaska (Wright and Wright 1995). In these regions, *Bd* has been found only on the Kenai refuge, in limited locations (1 pond in 2002 and 3 ponds in 2006). The dead Wood Frog found in 2002 (Reeves and Green 2006) was in a different pond along the same access road as our 2006 *Bd* detections; all positive detections in the Kenai refuge thus have been along this recreational access corridor. Of the four remote ponds that tested negative for *Bd* in 2006, two are in areas where human visitation is rare or nonexistent (access requires a motor boat and then a walk through trail-less forest), one is in a wilderness area near an established hiking trail, and one is near the recreational canoe route and the two ponds that tested positive. Amphibian researchers have visited all the remote ponds repeatedly since 2004, using hygiene protocols described above. The three road-accessible ponds that tested negative for *Bd* are on an operating oil field, where the public is not allowed. The oil field ponds have been visited by amphibian researchers since 2000, and access by other people is limited to oil field workers and other (non-amphibian) researchers. It is unlikely these other users enter the wetlands sampled in this study, although the roads pass within 100 m of each pond. The ponds in the Innoko and Tetlin refuges are all remote, requiring a combination of planes and watercraft to access, and it is unlikely that any people other than amphibian researchers enter the ponds sampled for this study. Although sample size is limited, the results from this study suggest *Bd* is not ubiquitous in southcentral and interior Alaska. More systematic research is needed on the distribution and abundance of *Bd* in Alaskan refuges, especially as it relates to recreational use.

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Amphibian Chytrid Fungus Infections in *Hyperolius* (Anura: Hyperoliidae) from Eastern Democratic Republic of Congo

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Amphibian chytrid fungus (*Batrachochytrium dendrobatidis*) infection has been well-studied in Australia and the New World, where species seem to be especially susceptible to infection in montane, stream habitats (e.g., Carnaval et al. 2006; Hero and Morrison 2004; Lips et al. 2004; McDonald et al. 2005). The destructive fungus also has been associated with frog die-offs and mortality in similar habitats in East and South Africa (e.g., Channing et al. 2006; Hopkins and Channing 2003; Smith et al. 2007), and it is likely that the fungus is killing frogs in other highland regions throughout Africa. If present, the fungus could be potentially catastrophic in Central Africa where the species richness, endemism, and numbers of threatened amphibians are among the highest in continental Africa (Burgess et al. 2004; IUCN et al. 2006). Moreover, the amphibians of Central Africa are poorly surveyed or unknown in many areas (Broadley and Cotterill 2004; Channing and Howell 2006; Laurent 1983; Plumptre et al. 2003; Schmidt and Noble 1919), and thus, infections could wipe out species before they are identified by science. Remarkably, no published study has examined amphibians in Central Africa for the presence of chytrid fungus.

We (EG, CK, and MA) conducted a preliminary survey of the herpetofauna at sites in and near Kahuzi Biega National Park (a UNESCO World Heritage Site in Danger), South Kivu Province, Democratic Republic of Congo between 14 August and 2 September 2007. Habitats ranged from high-elevation bamboo forest to lowland rainforest, and although the timing of our collecting corresponded to the dry season for the eastern Congo highlands (Chapin 1932) we observed some rainfall almost daily. Amphibians were collected by hand, euthanized via cutaneous contact with Orajel®, and preserved in 10% formalin solution; after a 24 h rinse in water, specimens were transferred to 75% ethanol and 1–4 mm toe clippings of 24 selected specimens (Table 1) were prepared for histological examination. Tissues were dehydrated in graded concentrations of ethanol and then xylene, paraffin-embedded, sectioned at 4 microns and stained with hematoxylin and eosin. To avoid delays from cataloging backlogs, field numbers are provided for voucher specimens, but these specimens will be deposited in an American natural history museum collection in the future. Abbreviations are as follows: EBG = Eli Greenbaum field series; SVL = snout–vent length.

Two of 24 specimens (EBG 1087 and EBG 1307) showed evidence of chytridiomycosis. The former specimen is a subadult *Hyperolius kivuensis* (19.7 mm SVL; adult size 22–39 mm according to Schiøtz 1999) with no evidence of lesions. A juvenile *H. kuligae* (EBG 1307; 10.1 mm SVL; adult size 20–31 mm according to Schiøtz 1999) has multiple small, white lesions on the venter of the hind limbs and abdomen. Infections were characterized by thickening of the superficial keratinized layers of the epidermis due to the presence of smooth-walled sporangia of *Batrachochytrium* that ranged in diameter from 10–25 microns. Most sporangia were empty, but several contained five to ten zoospores (Figs. 1A, B). No hyphae were present and there was no inflammatory cell response in the deeper layers of the epidermis and dermis. Twenty-two additional specimens representing 17 additional anuran species were negative for chytrid infection (Table 1).

To the best of our knowledge, the chytrid infections reported herein are the first positive results for any amphibian in Central Africa, where the fungus is present in both lowland (primary rainforest) and highland (secondary montane forest) habitats. Both infected individuals were collected in (EBG 1087) or near (EBG 1307) streams in close proximity to (< 1 km) human habitations and agricultural fields. The subadult and juvenile ages of the infected frogs are consistent with the high rate of infection and mortality reported for postmetamorphic frogs in Africa and Australia (Berger et al. 1999; Smith et al. 2007).

Weldon et al. (2004) hypothesized that *Batrachochytrium*

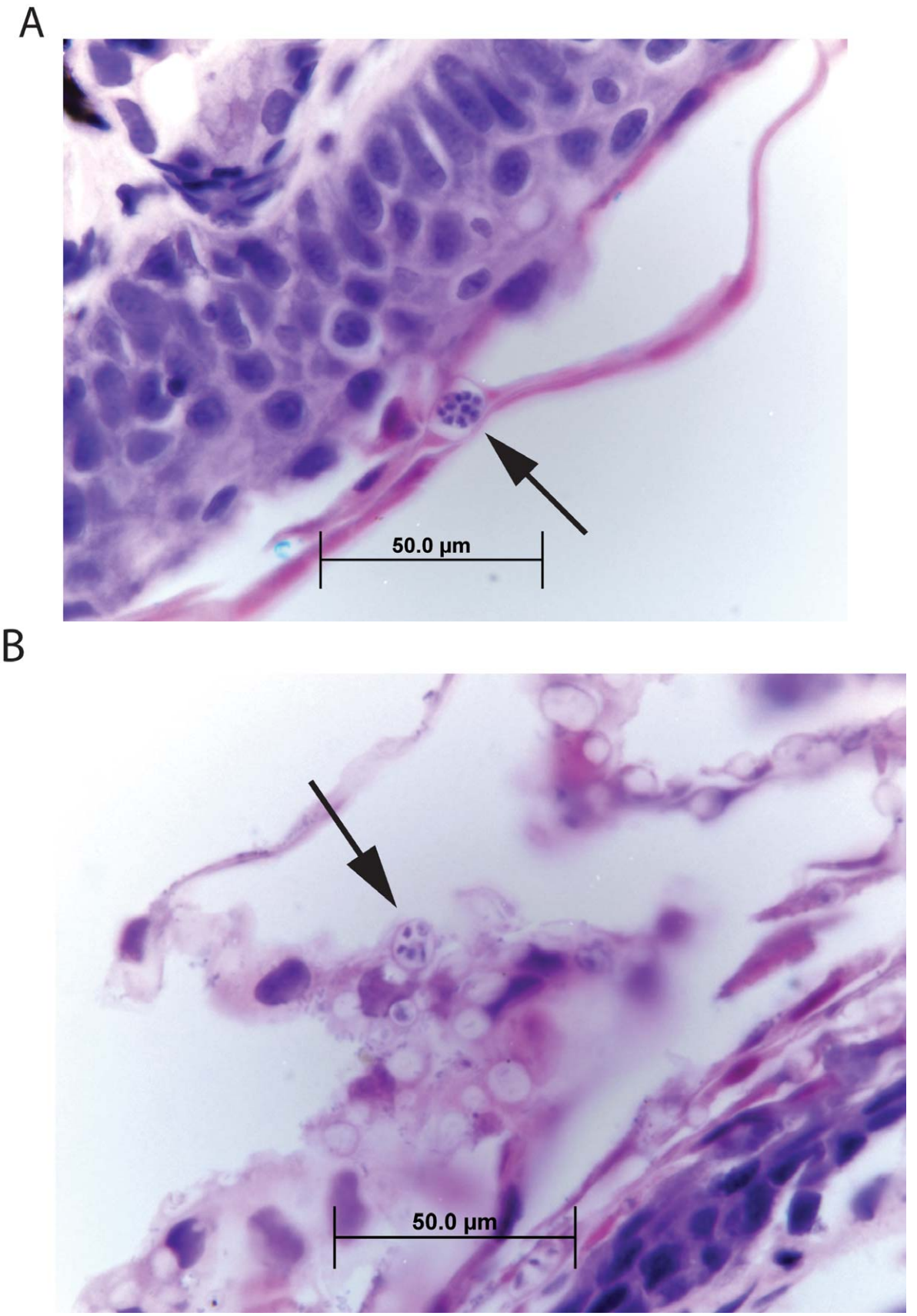


FIG. 1. Chytridiomycosis was detected in two frogs from the eastern Democratic Republic of Congo in Summer, 2007. (A) Sporangia (arrow) containing 10 zoospores from the toe of a subadult *Hyperolius kivuensis* (EBG 1087) from Tshivanga; (B) skin from the toe of a juvenile *Hyperolius kuligae* (EBG 1307) from Irangi. The superficial keratinzed layer of epidermis is markedly thickened from numerous round-to-oval sporangia of *Batrachochytrium dendrobatidis*. Most of the sporangia are empty, but one contains five zoospores (arrow).

TABLE 1. List of amphibian species tested for chytrid infection, including locality information. EBG = Eli Greenbaum field series. All localities are in South Kivu Province, Democratic Republic of Congo. Coordinates are from the WGS 84 datum.

Field Number	Species	Locality	Date of Collection	Habitat	Chytrid Infection
EBG 1316	*Afrixalus laevis*	Forest near Irangi, -1.8873055, 28.4495, 820 m	28 Aug 07	Primary rainforest	Negative
EBG 1336	*Afrixalus osorioi*	Irangi, -1.8743611, 28.4523611, 806 m	29 Aug 07	Secondary rainforest	Negative
EBG 1331	*Afrixalus quadrivittatus*	Irangi, -1.8743611, 28.4523611, 806 m	29 Aug 07	Secondary rainforest	Negative
EBG 1178	*Amietophrynus* sp.	Lwiro, -2.2383611, 28.8051944, 1750 m	18 Aug 07	Agricultural pond in cleared montane forest	Negative
EBG 1255	*Arthroleptis* cf. *adolfifriederici*	Mugaba, -2.2750278, 28.6631111, 2333 m	26 Aug 07	Bamboo forest	Negative
EBG 1111	*Hyperolius castaneus*	Mbayo, -2.2545833, 28.7680556, 2146 m	15 Aug 07	Stream near edge of montane forest	Negative
EBG 1253	*Hyperolius castaneus*	Mugaba, -2.2750278, 28.6631111, 2298 m	25 Aug 07	Montane forest	Negative
EBG 1372	*Hyperolius cinnamomeoventris*	Catena near Irangi, -1.8655, 28.4526944, 805 m	30 Aug 07	Primary rainforest	Negative
EBG 1087	*Hyperolius kivuensis*	Maziba village, near Tshivanga, -2.3128056, 28.7551944, 2200 m	14 Aug 07	Stream near edge of montane forest	Positive
EBG 1160	*Hyperolius kivuensis*	Lwiro, -2.2383611, 28.8051944, 1750 m	18 Aug 07	Agricultural pond in cleared montane forest	Negative
EBG 1307	*Hyperolius kuligae*	Forest near Irangi, -1.8873056, 28.4495, 820 m	28 Aug 07	Vegetation 2 m above a stream in primary rainforest	Positive
EBG 1110	*Hyperolius nasutus*	Mbayo, -2.2545833, 28.7680556, 2146 m	15 Aug 07	Stream near edge of montane forest	Negative
EBG 1226	*Hyperolius nasutus*	Nyakasaz Swamp near Lwiro, -2.2278889, 28.7793333, 1991 m	23 Aug 07	Swamp near secondary montane forest	Negative
EBG 1120	*Hyperolius* sp.	Mbayo, -2.2783611, 28.77175, 2146 m	15 Aug 07	Flooded reeds adjacent to montane forest	Negative
EBG 1344	*Leptopelis christyi*	Irangi, -1.8743611, 28.4523611, 806 m	29 Aug 07	Secondary rainforest	Negative
EBG 1116	*Leptopelis* cf. *kivuensis*	Mbayo, -2.2783611, 28.77175, 2146 m	15 Aug 07	Flooded reeds adjacent to montane forest	Negative
EBG 1282	*Leptopelis* cf. *kivuensis*	Mugaba, -2.2671389, 28.6455, 2267 m	26 Aug 07	Montane forest	Negative
EBG 1127	*Ptychadena* cf. *chrysogaster*	Kayumaga stream near Mbayo, -2.2663056, 28.7838056, 1943 m	17 Aug 07	Agricultural stream in cleared montane forest	Negative
EBG 1213	*Ptychadena* cf. *chrysogaster*	vicinity of Lwiro, -2.2333333, 28.8, 1750 m	23 Aug 07	Agricultural pond in cleared montane forest	Negative
EBG 1292	*Ptychadena mascareniensis*	Irangi, -1.8746667, 28.4523889, 793 m	27 Aug 07	Secondary rainforest edge puddles	Negative
EBG 1142	*Schoutedenella* cf. *schubotzi*	Mbayo, -2.2590278, 28.7683056, 2156 m	17 Aug 07	Road in cleared montane forest	Negative
EBG 1294	*Xenopus pygmaeus*	Irangi, -1.8743611, 28.4523611, 806 m	27 Aug 07	Roadside ditch near secondary rainforest	Negative
EBG 1169	*Xenopus victorianus*	Lwiro, -2.2383611, 28.8051944, 1750 m	18 Aug 07	Agricultural pond in cleared montane forest	Negative
EBG 1105	*Xenopus wittei*	Mbayo, -2.2783611, 28.77175, 2150 m	15 Aug 07	Agricultural pond near secondary montane forest	Negative

dendrobatidis originated in Southern Africa and spread to other regions of the world through commercial frog trade. Based on this premise, Smith et al. (2007:163) suggested that the relative rarity of amphibian die-offs associated with *B. dendrobatidis* in southern Africa reflects regional differences either in the pathogenicity or the host response to chytrid infection. Because we observed large, reproducing populations of *Hyperolius kivuensis* and *H. kuligae* in several localities in and near Kahuzi Biega, it is possible that chytrid infections in these species are not causing significant mortality rates.

Our results are likely an underestimate of the true incidence of chytrid infection in Kahuzi Biega for four reasons: 1) to minimize destructive sampling, we examined toe clippings from only one specimen per species in a given locality; 2) we sampled a small portion of the epidermis, and sampling from more areas of the body could have identified additional, positive infections; 3) we did not want to engage in destructive sampling of several unique specimens from species that are rare (e.g., *Arthroleptis* sp., *Hyperolius ocellatus*, *Leptopelis modestus*) or potentially new; and 4) because of recent warfare and ongoing rebel militia activity (Afoaku 2004; Barnes and Lahm 1997; Edgerton 2002; Hart and Liengola 2005), it was not possible to sample amphibians in many unique habitats in the park (Fischer 1996). Further testing is needed for additional species and localities throughout the Albertine Rift to assess potential threats to scores of amphibians (including several monotypic genera) with limited distributions in the highlands (IUCN et al. 2006; Laurent 1983; Plumptre et al. 2003). The presence of the fungus in lowland habitats of eastern Congo also underscores the need for testing in multiple elevations and habitats to improve understanding of the distribution and niche requirements of the fungus.

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NATURAL HISTORY NOTES

The Natural History Notes section is analogous to Geographic Distribution. Preferred notes should 1) focus on observations in the field, with little human intrusion; 2) represent more than the isolated documentation of developmental aberrations; and 3) possess a natural history perspective. Individual notes should, with few exceptions, concern only one species, and authors are requested to choose a keyword or short phrase which best describes the nature of their note (e.g., Reproduction, Morphology, Habitat, etc.). Use of figures to illustrate any data is encouraged, but should replace words rather than embellish them. The section's intent is to convey information rather than demonstrate prose. Articles submitted to this section will be reviewed and edited prior to acceptance.

Electronic submission of manuscripts is requested (as Microsoft Word or Rich Text format [rtf] files, as e-mail attachments). Figures can be submitted electronically as JPG files, although higher resolution TIFF or PDF files will be requested for publication. Please DO NOT send graphic files as imbedded figures within a text file. Additional information concerning preparation and submission of graphics files is available on the SSAR web site at: http://www.ssarherps.org/HRinfo.html. Manuscripts should be sent to the appropriate section editor: **Marc P. Hayes** (crocodilians, lizards, and *Sphenodon*; mhayesrana@aol.com); **Charles W. Painter** (amphibians; charles.painter@state.nm.us); **Andrew T. Holycross** (snakes; holycross@asu.edu); and **James Harding** (turtles; hardingj@pilot.msu.edu).

Standard format for this section is as follows: SCIENTIFIC NAME, COMMON NAME (for the United States and Canada as it appears in Crother [ed.] 2008. *Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico.* SSAR Herpetol. Circ. 37:1–84, available from SSAR Publications Secretary, ssar@herplit.com; for Mexico as it appears in Liner 1994, *Scientific and Common Names for the Amphibians and Reptiles of Mexico in English and Spanish.* Herpetol. Circ. 23:1–113), KEYWORD. DATA on the animal. Place of deposition or intended deposition of specimen(s), and catalog number(s). Then skip a line and close with SUBMITTED BY (give name and address in full—spell out state names—no abbreviations). (NCN) should be used for common name where none is recognized. References may be briefly cited in text (refer to this issue for citation format).

Recommended citation for notes appearing in this section is: Lemos-Espinal, J., and R. E. Ballinger. 1994. *Rhyacosiredon leorae*. Size. Herpetol. Rev. 25:22.

CAUDATA – SALAMANDERS

AMBYSTOMA CALIFORNIENSE (California Tiger Salamander). **PREDATION**. *Ambystoma californiense* is an endemic species listed as threatened by the Department of the Interior (U.S. Fish Wild. Serv. 2004. Fed. Reg. 69:47212–47248) and as a species of special concern by the State of California (Jennings 2004. California Fish Game 90:161–213). Although many factors are stated for the decline of this salamander, wild pigs (*Sus scrofa*)—a game species first introduced into California in the 1920s—are suspected to eat juvenile and adult salamanders and also negatively impact salamander habitats (U.S. Fish Wild. Serv. 2003. Fed. Reg. 68:28648–28670). Here we report on the first documented incident of wild pigs negatively effecting *A. californiense* eggs.

On Blue Oak Ranch in Santa Clara County, California (USA), an early storm brought ca. 7.6 cm of rain between 7 and 9 Nov 2003, saturating the soil. The next storm delivered just over 2.5 cm of rain overnight on 14–15 Nov, causing Junction Pond (37.375556°N, 121.724444°W; elev. 599 m) to fill to a maximum depth of 33 cm in a basin ca. 4 m in diameter. On 20 Nov, we discovered 60 *A. californiense* eggs attached to the substrate of the pond, primarily on Dove Weed (*Eremocarpus setigerus*). No precipitation events occurred over the next 5 days. Humidity was quite low because of offshore winds, with high temperatures reaching almost 29°C and nighttime lows dipping to 2°C. As a result, the water level in Junction Pond dropped to ca. 15 cm, with the diameter of the pond basin shrinking to ca. 2 m. While checking on the *A. californiense* eggs on the morning of 25 Nov, we discovered that wild pigs had used the pond basin as a wallow, crushing most of the eggs and detaching the remainder from their substrates. Those that were not crushed, eaten, or buried in the mud were frozen in the thin ice that covered the surface of the small area of remaining water. Pigs continued to wallow in Junction Pond until rains filled it completely in mid-December.

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ANURA – FROGS

ARGENTEOHYLA SIEMERSI PEDERSENI (Rana Tractor or Rana de Pedersen). **REPRODUCTION**. *Argenteohyla siemersi* is an uncommon Neotropical hylid frog listed as Endangered by IUCN (2006. Conservation International and NatureServe. Global Amphibians Assessment. http://www.globalamphibians.org. Accessed 01 Mar 2007). The main threat is habitat destruction caused by fires to expand/maintain pastures and pine forestry plantations. *Argenteohyla siemersi pederseni* occurs in northwest Corrientes Province (Argentina), inhabiting the leaf axils of terrestrial *Aechmae* bromeliads in gallery forests along main river systems. Its population appears to be stable (IUCN 2006, *op. cit*).

Reproduction in *A. siemersi pederseni* takes place in temporary pools close to bromeliads. The larva was described by Céspedez (2000. Bol. Asoc. Herpetol. Esp. 11:75–80), who counted 1020 ova (1–1.5 mm diam) in a gravid female. Barrio (1969. Physis 26[71]:225–228) reported diurnal choruses of *A s. siemersi*, from noon to late afternoon.

Here we provide data on clutch size and characteristics of the reproductive behavior in *Argenteohyla siemersi pederseni*. On 28 Sept 2006, at 2330 h after heavy rains (air temp 14.5°C; water temp 17.5°C; humidity 74%), we observed several calling males and two pairs in axillary amplexus in a semi-permanent pond in the Reserva Provincial Iberá (28.68°S, 57.43°W, WGS 84; elev. 65 m), near Colonia Carlos Pellegrini, Corrientes, Argentina. We did not observe bromeliads near the pond. The males had paired vocal sacs and called from the water, floating in open spaces, or near of the edge of the pond among aquatic vegetation (Fig. 1). The vocalization occurred from 1800 h to past midnight in choruses of 3–4 males.

The next day a clutch with ca. 2464 eggs was found in the same pond. The eggs were dark at the animal pole and creamy yellow at the vegetal pole. Mean diameter was 1.73 mm (SD = 0.86, range 1.5–1.9 mm, N = 109). They were laid in gelatinous ribbons floating at the surface of the water or among aquatic vegetation (Fig. 2). Other species reproducing in the same pond were *Scinax squalirostris*, *Chaunus fernandezae*, *Pseudopaludicola falcipes*, and *Elachistocleis bicolor*.



FIG. 1. Calling male *Argenteohyla siemersi pederseni*. Photograph by Víctor Zaracho.



FIG. 2. Egg clutch of *Argenteohyla siemersi pederseni*. Photograph by Víctor Zaracho.

This is the first description of an egg clutch of the genus *Argenteohyla*.

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BUFO AMERICANUS (American Toad). **REPRODUCTION**. Herein I report an instance of prolonged amplectant behavior with an inanimate object in the bufonid *Bufo americanus*. On 22 April 2007 at ca. 2200 h, I visited South Run District Park (Fairfax Co., Virginia, USA) and observed a male *B. americanus* in amplexus with a tennis ball (Fig. 1). The individual manipulated the tennis ball for ca. 2 min until he finally released his misguided embrace. Although a breeding chorus was well established, the sex ratios appeared to be skewed with males outnumbering females 30:1 in this particular vernal pool. Given the importance of release and advertisement calls for mate recognition in *B. americanus* (Leary 2001. Can. J. Zool. 79[9]:1577–1585), it is not surprising that this instance of amplectant behavior was prolonged. While some bufonid studies have incorporated mating interactions with inanimate objects (Hinsche 1926. Zeitschr. Vergl. Physiol. 4:564–606) few have given an example of this behavior in a natural setting. Despite this, it is well known among field workers that breeding male *B. americanus* will readily grasp objects placed between their front limbs (e.g., worker's fingers) (Tupper, pers. comm.). As suggested by Höbel (2005. Herpetol. Rev. 36:55–56; 2005. Herpetol. Rev. 36:439–440), it is likely that male anurans are more prone to mating mistakes when, as in this scenario, there is high competition for conspecific females.



FIG. 1. Male *Bufo americanus* in amplexus with a tennis ball, found in northern Virginia, USA.

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BUFO PUNCTATUS (Red-spotted Toad). **PREDATION**. Adult *Bufo punctatus* are predated by some vertebrates, mainly aquatic snakes but also, turtles (Stone et al. 2005. Herpetol. Rev. 36:312), and birds and mammals (Stebbins 2003. A Field Guide to Western Reptiles and Amphibians. Houghton Mifflin Co., Boston, Massachusetts, 533 pp.); tadpoles are predated by gartersnakes and aquatic beetle larvae (Coleoptera) (Livo and Kondratieff 2000. Herpetol. Rev. 31:168–169). In Baja California Sur (BCS), adult *B. punctatus* are part of the diet of gartersnakes (Blázquez 1996. Herpetol. Rev. 27:83–84; Rodríguez-Robles and Galina-Tessaro 2006. Herpetol. Rev. 37:335. Herein, we report predation of an adult *B. punctatus* by the giant aquatic bug, *Lethocerus angustipes* (Heteroptera: Belostomatidae).

At 2138 h on 30 Aug 2006, we found an adult male (60.6 mm SVL, 17 g) *B. punctatus* held by the left hind limb by an adult female *L. angustipes* (60 mm TL). The pair was floating in a small temporary pond near Rancho El Álamo, northern BCS, México (27.108083°N, 112.927306°W), ambient air temperature was 27.1°C and water temperature was 29.4°C. The toad made erratic movements with its forelimbs, but the posterior part of its body seemed paralyzed by the toxins of the *L. angustipes* (Smith 1997. Cambridge University Press). After an hour of observation the toad stopped moving and died.

This observation confirms that *L. angustipes* are voracious predators in freshwater systems and, in addition to aquatic invertebrates and tadpoles (Kehr and Schnack 1991. Alytes 9[3]:61–69), can predate adult toads.

Bufo punctatus and *L. angustipes* were deposited in herpetological and entomological collection respectively, of the Centro de Investigaciones Biológicas del Noroeste (CIBNOR), La Paz, Baja California Sur, México. We thank to A. Cota for assistance with fieldwork and C. Palacios for assistance identifying *L. angustipes*.

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CRAUGASTOR TALAMANCAE (NCN). **REPRODUCTION AND NEST ATTENDANCE.** The genus *Craugastor* contains 116 species of poorly known tropical direct-developing frogs. While most of the species are characterized by small clutch size, large egg size, and attendance of terrestrial nests by one of the parents, descriptions of reproductive behavior are lacking for the majority of species (Townsend 1996. *In* Powell and Henderson [eds.], Contributions to West Indian Herpetology, a Tribute to Albert Schwartz, pp. 229–239. SSAR Conrib. Herpetol. Vol. 12. Ithaca, New York). Herein, we provide what we believe to be the first report of reproduction in the Central American frog *Craugastor talamancae*, including descriptions of the clutch, the nesting site, and attendance of the nest by the female parent.

On 31 Jan 2007 at ca. 1300 h, we encountered an adult *C. talamancae* with a clutch of 36 eggs in an old-growth lowland tropical wet forest at La Selva Biological Station, Heredia Province, Costa Rica (10.41°N, 84.00°W, ca. 60 m elev.). The nest was located on the ground, under leaf litter, and consisted of a round depression in the soil ca. 50 mm diameter and ca. 25 mm deep. The egg mass was ca. 40 × 30 mm, and ca. 15 mm high. The eggs were ca. 6 mm in diameter. The attending frog was first noted leaping from the vicinity the clutch. We determined the attending frog to be a female by comparison of the relative size of the tympanum to the eye (Savage 2002. The Amphibians and Reptiles of Costa Rica. Univ. Chicago Press. Chicago, Illinois. 934 pp.). The female measured 43.5 mm SUL and 7.75 g. Embryos were stages 5–7 (Townsend and Stewart 1985. Copeia 1985:423–436) because the yolk was cream white, eyes were prominent and darkly pigmented, pupils were clear, and embryos were pink with nascent hind limbs and a short tail, but no evident forelimbs. We collected five eggs from the clutch and kept them in a small container containing moist paper towels at ambient temperature.



FIG. 1. A female *Craugastor talamancae* perched upon a clutch of eggs in leaf litter at La Selva Biological Station, Costa Rica.

We checked the status of the nest in the field on 08 Feb 2007 at ca. 1300 h. At this time, the nest was intact, and the female was perched directly on top of the clutch of eggs. When we checked the nest on 14 Feb 2007 at ca. 1300 h there were no eggs in the nest cavity and the female was not present nearby. However, one egg was still present in the vicinity of the nest, ca 15 cm from the nest cavity, and appeared intact. On 20 Feb 2007, all five of the artificially incubated eggs hatched; the froglets measured 8.8, 8.8, 9.0, 9.0, and 9.2 mm SUL.

To our knowledge this is the first report of reproduction and nest attendance in *Craugastor talamancae*. Nest attendance is common in *Craugastor*, although some species lack this or other parental behavior. While we observed no active parental behavior (such as hydrating eggs or defending the nest from predators), we believe that the occurrence of the female perched upon the clutch containing eggs at such a late developmental stage, on two occasions, to be strong evidence of active nest attendance. Further, while we are unable to determine the development time for these eggs, we presume that hatching must occur significantly longer than 21 days after oviposition because we found these eggs at an intermediate developmental stage. Finally, because the eggs in the field disappeared before the eggs in the lab hatched, we presume that these eggs failed to hatch, likely due to nest predation.

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FEJERVARYA LIMNOCHARIS (Indian Cricket Frog). **MORPHOLOGY.** In agriculture fields, amphibian populations are affected by chemical contaminants and managerial practices. Earlier reports have shown that exposure to these contaminants can result in expression of behavioral and morphological abnormalities and contribute to the decline of amphibian populations in agro ecosystems (Daniels 2003. Curr. Sci. 85:1415–1422). Similar incidences have been reported from various habitats of central Western Ghats (Gurushankara et al. 2007. Appl. Herpetol. 4:39–45). Ouellet (2000. *In* Sparling [ed.], Ecotoxicology of Amphibians and Reptiles, pp. 617–661) reported that abnormalities of amphibians in tropical habitats ranged between 0 and 2%. In the following report, we present information on abnormalities of adult *Fejervarya limnocharis* recorded in paddy fields of central Western Ghats. In these fields, regular application of pesticides (organochlorine and organophosphate, range 300–700 mL ha^{-1} per crop) and synthetic manures (nitrophosphate and potash, range 200–300 kg ha^{-1} per crop) is being practiced.

Fejervarya limnocharis is a common inhabitant of all agro ecosystems in central Western Ghats, where it breeds in the shallow water of paddy fields. A survey of *F. limnocharis* was made at ten different plots, each 2.5 ha, in paddy fields located (13.53°–1373°N and 75.63°–75.66°E), near the Bhadra River Dam in Karnataka State of India. Surveys were conducted during January–March 2007 after harvest. During these surveys 259 adult frogs (mean SVL 21.39 mm, SD 4.951 mm) were collected and visually examined for abnormalities following the field keys of Meteyer (2000. Biological Science Report USGS/BRD/BSR-2000-0005). Of the 259 individuals examined, 28 (10.8%) were abnormal. Abnormalities recorded were tumors with disfigured hind limb bones (39.29%), short-toe/ brachydactyly (35.71%), missing digit/Ectrodactyly (21%), and incomplete limb/Ectromelia (3.6%).

Becon et al. (2000. Appl. Herpetol. 3:39–65) observed 5% abnormality of frogs living in contaminated agro ecosystems of Asia, some parts of Europe, and America. Compared to these observations, the occurrence of 10.8% abnormality in our area is very high. Given that pesticides and chemical manures are added to every crop, the likelihood that contaminants cause abnormalities in *F. limnocharis* is high.

Submitted by **A. M. PATEL**, **PRAVEEN A. KULKARNI**, **K. G. GIRISH**, **H. P. GURUSHANKARA,** and **S.V. KRISHNAMURTHY**, Department of Environmental Science, Kuvempu University, Jnana Sahyadri, Shankaraghatta 577 451, Karnataka, India (e-mail: svkrishnamurthy@yahoo.co.in).

HYLARANA RANICEPS (White-lipped Frog). **PREDATION.** We relate herein an observation of the predation of a *Hylarana raniceps* metamorph by a spider. *H. raniceps* is a common species in the lowlands of Bornean dipterocarp forests. In March 2007, we observed a "fishing spider" of the species *Thalassius* cf. *albocinctus* (Doleschall, 1859) at a alluvial pond off Headhunters' Trail, near Camp 5 (04.139056°N, 114.899944°E), Gunung Mulu National Park, Sarawak, East Malaysia (Borneo), with a metamorph of *H. raniceps* as prey. The spider was sitting on a vertical trunk in the pond, about 20 cm above the pond surface and was grasping the right thigh of the metamorph (Fig. 1). The spider was disturbed by photography and ran down the trunk with the prey, entered into the water and actively dove to the bottom at about 1 m below surface. Shortly afterwards, it surfaced again and released the dead metamorph. *Thalassius albocinctus* is well known for fishing small sized fishes from the surface layer of standing or slow running waters.



FIG. 1. *Hylarana raniceps* metamorph captured by a "fishing spider" (Pisauridae: *Thalassius* cf. *albocinctus*), Gunung Mulu National Park, Malaysia.

At Gunung Mulu National Park, we frequently saw *T.* cf. *albocinctus* hunting on the surface of ponds with an abundance of breeding frogs and therefore we assume it to be a common amphibian predator. Toledo (2005 Herpetol. Rev. 36:395–400) reported that risk of invertebrate predation on amphibians is proportionately high during the breeding season and in recently metamorphosed frogs, compared to other life history stages, and we speculate that predation by fishing spiders might have an important impact on larval and metamorph survival.

We thank Hubert Höfer, State Museum of Natural History, Karlsruhe, for identification of the spider via photo and for advice on the manuscript; Volkswagen Stiftung for financial support; the Sarawak Forest Department for research permit (Number 38/2006, dated 3.8.2006.) and the staff of Gunung Mulu National Park, for support with logistics.

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Universiti Malaysia Sarawak, 94300, Kota Samarahan, Sarawak, Malaysia.

HYLA CHRYSOCELIS (Cope's Gray Treefrog). **OCULAR PATHOLOGY**. Ophthalmological disorders have been recorded in most vertebrates. Often, the animals in which these lesions have been described have been in captivity for varying lengths of time. However, it is unusual for such lesions to be discovered in wild populations. This disparity in discovery (not necessarily *incidence*) is probably because the condition may predispose the subject to predation or make it unable to compete successfully for resources. Captive animals are subject to observation and, thus, increased detection of ocular abnormalities. Intraocular inflammation, including panophthalmitis and uveitis have been reported in amphibians and reptiles (Zwart 1985. *In* R. Ippen et al. [eds.], Sinnesorgane: Erkrankungen der augen; Haut und anhangs-organe, pp. 250–269. Akadamie Verlag, Berlin (DDR); Millichamp and Jacobson 1986. *In* R. N. Kirk [ed.], Current Veterinary Therapy IX. Small Animal Practice, Ophthalmic Diseases of Reptiles, pp. 621–623, W. B. Saunders Company, Philadelphia, Pennsylvania; Frye 1991. *In* F. L. Frye [ed.], Husbandry, Medicine and Surgery in Captive Reptiles, Ophthalmic Conditions, 2nd Edition, Vol. 2, pp. 326–244. Krieger Publ. Co., Malabar, Florida; Lawton 1993. *In* S. M. Peterson-Jones and S. M. Crispin [eds.], Manual of Small Animal Ophthalmology, Ophthalmology of Exotic Species, British Small Animal Veterinary Association, Cheltenham, United Kingdom; Frye and Williams 1995. Self-Assessment Colour Review of Reptiles and Amphibians. Manson Publ., Ltd., London, United Kingdom, 192 pp.). The alteration of the crystalline lens, in the form of subcapsular lenticular disorganization, is well known in human ophthalmology (Hogan and Zimmerman 1962. Ophthalmic Pathology, 2nd Edition. W.B. Saunders Company, Philadelphia, Pennsylvania, pp. 344–468) but less often encountered (or recognized) in herpetological medicine.

An adult male *Hyla chrysoscelis* (50 mm SVL) was collected alive on 16 September 2000 by CTM in the South Texarkana/Liberty-Eylau area of Bowie County, Texas, USA (33.3716°N, 94.0733°W, elev. 92.1 m). The left eye was grossly enlarged and discolored. After obtaining essential measurements, the frog was photographed (Fig. 1), and euthanized by immersion in a satu-



FIG. 1. Pre-euthanasia photograph of *Hyla chrysoscelis* with panopthalmitis; note the massively swollen and enlarged left eye.

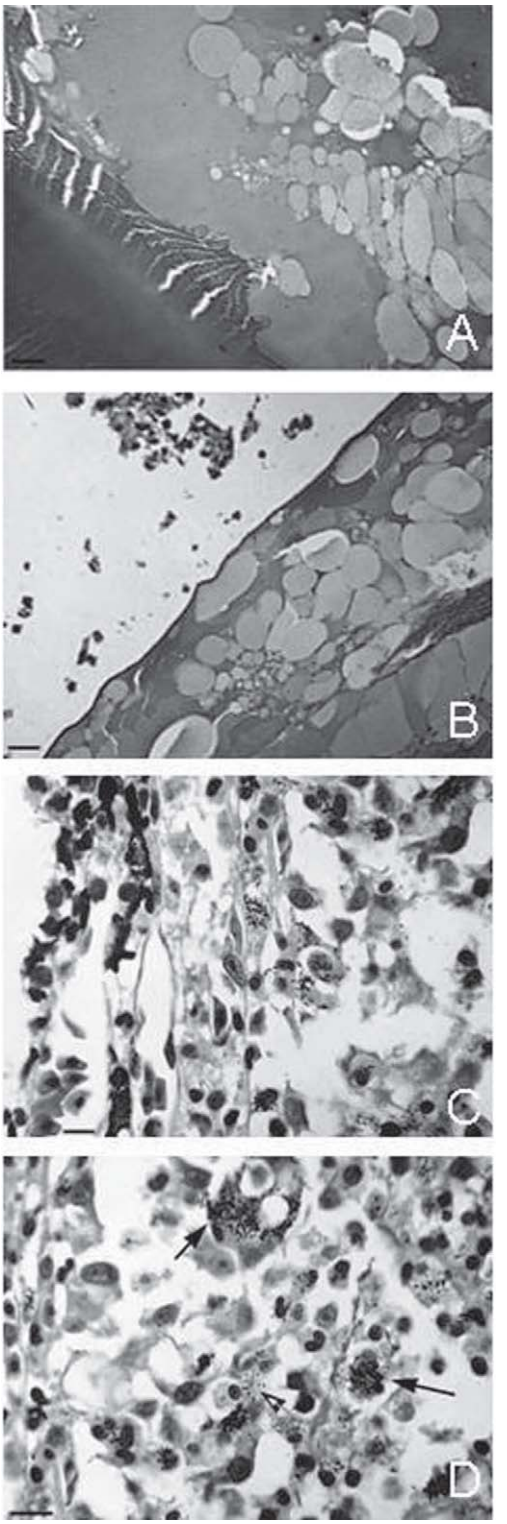


FIG. 2. A. Low power photomicrograph of the crystalline lens and intraocular fibrinous exudate adhering to a portion of the lens capsule. H & E. Bar = 20 µm. B. Photomicrograph of the affected lens. Note the degeneration and disruption of the normally lamellated concentric ring pattern and the pale-staining altered foamy areas. H & E. Bar = 20 µm. C. Photomicrograph of the intraocular exudate. Brown & Brenn. Bar = 30 µm. D. Another view of intraocular exudate; note large macrophages with engulfed bacteria and melanin pigment (solid black arrows) and individual bacteria (open black and white arrow). Brown & Brenn. Bar = 30 µm.

rated chlorobutanol (Chloretone®, Ward's Natural Science, Rochester, New York) solution (Etheridge 1958. Methods for Preserving Amphibians and Reptiles for Scientific Study. Mus. Zool., Univ. Michigan, Ann Arbor, Michigan, 18 pp.). The eye was enucleated, preserved in 10% neutral buffered formalin, and submitted for routine histopathological processing. A single hematoxylin and eosin stained section was examined by light microscopy and photographed by digital photomicroscopy. Supplemental sections were cut on a rotary microtome at 7 µm and stained with Brown and Brenn's modification of Gram's stain (Leaver et al. 1977. J. Clin. Pathol. 30:290–291). The frog voucher is deposited in the Arkansas State University, Herpetological Museum as ASUMZ 25326.

The anterior and posterior chambers of the eye were filled with a highly cellular exudate consisting of predominately mixed mononuclear inflammatory leukocytes comprised of lymphoplasmacytes, large histiocytic macrophages, a few heterophil granulocytes, and tenuous strands of fibrin that often adhered to the lens capsule (Figs. 2A–B). The crystalline lens had lost much of its normal concentric onion-like lammelated architectural pattern; the affected lens substance was lighter staining and possessed a patchy and foamy appearance (Figs. 2A–B). Small mononuclear cells were found adjacent to the lens capsule and numerous large macrophages with engulfed numerous Gram-negative and fewer numbers of Gram-positive bacteria were identified (Figs. 2C–D). In addition, engulfed melanin pigment granules were observed (Fig. 2D).

Ophthalmologic disorders have been recorded for many vertebrate species. Often, the animal involved is a captive and, thus, its ocular disease is more readily observed during daily animal care and maintenance. In this case, the affected frog was wild-caught, having already developed its severe ophthalmologic condition. In addition, 20 additional *H. chrysocelis* from the same site were not found to have this condition or any other noticeable gross pathology. Except for the finding of intra- and extracellular coccobacillary bacteria within the uvietic exudate, the etiology of the severe inflammation and subsequent lens disruption is unknown but, it is noteworthy because of its severity. Certainly, trauma associated with the introduction of pathogenic bacteria is a strong possibility. Had the frog escaped septicemic dissemination of the infection, it is conjectural as to whether the frog could have survived after having lost vision in one eye; however, there have been recorded instances of other wild-caught frogs after having lost the sight of an eye due to trauma, corneal, and lenticular opacities (Frye and Williams, *op. cit*.) Therefore, it can be surmised that in these cases binocular vision was not essential for prey capture and survival under wild conditions.

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LEPTODACTYLUS MELANONOTUS (Sabinal Frog). **DIET**. Some species of the Leptodactylidae are known for diverse diets (Savage 2002. Amphibians and Reptiles of Costa Rica. Univ. Chicago Press, Chicago, Illinois) and have tadpoles known for their intraspecific cannibalism (Silval et al. 2005. J. Nat. Hist. 39[7]:555–566). Herein we document a previously unknown scavenging habit of *Leptodactylus melanonotus*. In November 2005 in a Lowland Tropical Wet Forest in the northeastern coast of Costa Rica near Barra del Colorado, an adult male *L. melanonotus* was found advertising on the periphery of a desiccated ephemeral pool. The pool contained 48 dead, newly hatched *Rana vaillanti* tadpoles. Upon capture the *L. melanonotus* exhibited signs of a recent meal, and while being measured regurgitated 17 newly hatched *R. vaillanti* tadpoles. Among the stomach contents was an assortment of small springtail (Collembola) body parts and an intact aquatic Belostomatidae (Hemiptera). The adult frog weighed 3.5 g after regurgitating the tadpoles, and the regurgitated tadpoles totaled 2.3 g wet weight (the frog consumed 65% of its own body weight in tadpoles). The specimen and its stomach contents were deposited in the University of Costa Rica (UCR) collections within the Cãno Palma Biological Station specimens. To our knowledge this is the first record of consumption of tadpoles of another anuran species by adult *L. melanonotus*.

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RANA CASCADAE (Cascades Frog). **ALBINISM.** On 5 Aug 2002, we observed eight albino *Rana cascadae* larvae at a pond (65 m × 100 m; < 1 m deep) located 1.2 km NNW of Three Creek Lake, Deschutes County, Oregon, USA (44.1119444°N, 121.6313889°W; elev. 1960 m). Five albino larvae were captured and SVL measured (average SVL 25.4 mm, range 24–27 mm) and developmental stage estimated (stage 28–39; Gosner 1960. Herpetologica 16:183–190). During the survey, we observed 10 *R. cascadae* larvae with normal pigmentation that were of similar size and stage as the albino larvae. Albino larvae had a slight orangish hue in their eyes and throughout the body, typical of albinos of other species (Dyrkacz 1981. SSAR Herpetol. Circ. No. 11, 31 pp.). The brain, spinal column, internal organs, and almost completely developed forelegs were clearly visible through nearly transparent skin. We collected one albino larva (JC Braly Vertebrate Collection, Oregon State University 01550). We returned to the site on 16 Aug 2002 and collected a second albino larva and one non-albino larva. These two larvae transformed in the lab and died after 13 months.

In the only record of albinism in *R. cascadae* we were able to find, Altig and Brodie (1968. Wasmann J. Biol. 26:241–242) reported 13 albino larvae from 1965 and five from 1966 at a small pond "near Three Creek Lake, Deschutes County, Oregon." We were unable to confirm the exact pond through review of the museum records or communication with the authors. *Rana cascadae* breed in at least three lentic sites within 1.5 km of our site (C. Brown, unpubl. data: BM, pers. obs.). Nonetheless, our observations suggest the presence of albinos within a frog population > 35 years after original description. Our literature survey revealed only one report of albinism in the same anuran population in > 1 year (*Pseudacris triseriata* in two consecutive years; Corn 1986. J. Hered. 77:164–168).

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RANA CATESBEIANA (American Bullfrog). **LITHOPHAGY**. Gravel, sand, and plant matter have been documented in *R. catesbeiana* stomachs during numerous diet studies. Korschgen and Moyle (1955. Amer. Midl. Nat. 54[2]:332–341) documented a variety of plant material and a small amount of gravel in *R. catesbeiana*. In Arkansas, McKamie and Heidt (1974. Southwest. Nat. 19:107–111) found a 15.9 g rock and plant matter in 28% of the stomachs examined. Plant material, rocks, and gravel are likely ingested accidentally.

On 8 June 2006, an adult *R. catesbeiana* was collected ca. 15 mi. SE of Mena, Arkansas, USA in a mineshaft ca. 18 m from the entrance. Upon collection it was apparent that it had a full stomach. Dissection revealed a single salamander skeleton (presumably *Plethodon caddoensis*), a small piece of wood, and inorganic matter including rocks and grit. The wood's mass was 0.07 g. The inorganic material ranged from tiny grains to large pebbles. There were 34 rocks totaling 12.27 g. Average mass was 0.36 g/rock (range 0.05–1.63 g) not including the fine grit.

This frog likely ingested the gravel while attempting to feed on salamanders that frequent the mineshaft. The specimen is deposited in the herpetology collection at the Arkansas State University Museum of Zoology (ASUMZ 30143).

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RANA CLAMITANS (Bronze Frog). **RANID AGGRESSION AND INTERSPECIES AMPLEXUS**. On 3 July 2007, we observed and video-recorded inter- and intra-specific aggressive behavior of two male Bronze Frogs (*Rana clamitans clamitans*) and a male-female pair of Southern Leopard Frogs (*R. sphenocephalus*) in amplexus. The interactions occurred in the shallows of a slow moving creek in Santa Rosa County, Florida, USA, at ca. 1300 h and lasted for > 45 min. We first observed the behavior when the two Bronze Frogs began calling with increased frequency and then noticed one Bronze Frog aggressively moving (i.e., chasing) towards the pair of leopard frogs. The pair of leopard frogs submerged and crawled along the bottom of the creek, apparently to avoid the male Bronze Frog. However, each time they emerged, the Bronze Frog would reinitiate aggressive chasing and calling. After 12 min, the second male Bronze Frog moved toward the attacker and both frogs began grappling and ramming their heads together. Every 1–10 sec they would vocalize and jump between aggressive behaviors. After ca. 46 sec, the first Bronze Frog (and the larger of the two) retreated. The second, smaller Bronze Frog then chased the leopard frogs, which continued submerging and emerging to evade the aggressor. After another 50 sec of chase, the Bronze Frog amplexed the pair of leopard frogs (i.e., the male) using axillary amplexus. Next, the male leopard frog emitted a release call while the female leopard frog crawled along the bottom of the creek, carrying both males. The Bronze Frog remained amplexed for 96 sec before the first Bronze Frog returned and physically removed the amplexed Bronze Frog from the leopard frogs. Finally, the leopard frogs traveled a few more feet and the female slowly began depositing her eggs while the Bronze Frogs resumed their intra-specific aggression. After another 120 sec, the egg deposition ceased, and the larger Bronze Frog again chased the pair of leopard frogs. The leopard frogs quickly separated and retreated in different directions and the Bronze Frog eventually abandoned his pursuit and left the area.

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SPEA HAMMONDII (Western Spadefoot). **PREDATION AND USE AS BURROW DECORATIONS**. During 19–22 April 2004, I observed two breeding pairs of Western Burrowing Owls (*Athene cunicularia hypugaea*) located 20 m apart within a vernal pool system near Goshen, Tulare Co., California, USA (36.3451°N, 119.3991°W, NAD83/WGS84, 88 m elev.). Each pair used a network of burrows clustered 1–3 m apart. The primary burrow used by the pair at each cluster was decorated with domestic sheep dung, skunk (*Mephitis mephitis*) fur, and desiccated remains of *Spea hammondii*. The entrances of the burrows in each cluster exhibited 3–5 toads in various states of disarray. Hindquarters were present without the head or thoracic cavity, and nearby were the heads and upper bodies either still attached or in separate pieces. The soft organs of the thoracic cavity were missing. Both the Western Spadefoot and Western Burrowing Owl are species of special concern in California.

Burrowing Owls commonly decorate their burrows with a variety of items, such as dung, grass, paper, cotton, and dried moss (Levey et al. 2004. Nature 431:39; Smith and Conway 2007. Anim. Behav. 73:65–73). Flattened mummified remains of the Southern

Toad (*Bufo terrestris*), assumed to be roadkills, have been found at Burrowing Owl burrows as well (D. Levey, pers. comm.). The *S. hammondii* were readily available to the Burrowing Owls because their burrows were within a vernal pool system, a habitat where spadefoots commonly occur.

The Burrowing Owl has been infrequently reported to prey on toad species (Haug et al. 1993. Burrowing Owl. *Athene cunicularia*. *In* A. Poole and F. Gill [eds.], The Birds of North America, No. 61. Academy of Natural Sciences, Philadelphia, and American Ornithologists' Union, Washington, D.C.). Although toads commonly have toxins in their dorsal surfaces, owls and other predatory birds are able to avoid these toxins by consuming the vulnerable ventral portions (Olson 1989. Copeia 1989:391–397). Ervin et al. (2007. Herpetol. Rev. 38:197–198) were the first to report Burrowing Owl predation on Western Spadefoot adults, however, only the tongues were consumed in those cases. In this instance, the Burrowing Owl may have captured and consumed portions of *S. hammondii* and then used their remains as burrow decorations.

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TESTUDINES – TURTLES

DERMOCHELYS CORIACEA (Leatherback Sea Turtle). **NESTING**. *Dermochelys coriacea* is currently classified by the Brazilian Ministry of the Environment and the IUCN (World Conservation Union) as critically endangered. Although occasional nesting has been observed on the Brazilian coast (see Barata and Fabiano 2002. Marine Turtle News. 96:13–16), the only site reporting regular Leatherback nesting is located in a restricted area on the northern coast of the state of Espírito Santo, with an extent of ca. 200 km (18.35°S, 39.67°W and 20.07°S, 40.17°W) (Marcovaldi and Marcovaldi 1999. Biol. Conserv. 91:35–41). Here, we present the first record of *D. coriacea* nesting on the Brazilian northern coast. On 17 July 2004 at about 1800 h, within the limits of the Environmental Protection Area of the Delta do Parnaíba, Arrombado beach, Luís Correia city, state of Piauí (02.9097°S, 41.5325°W; 3 m elev.; Datum SAD69 IBGE/BR), we observed one *D. coriacea* deposit a clutch of 108 eggs. The nest was monitored after oviposition; 96 hatchlings emerged after an incubation period of 58 days (Fig. 1). Local fishermen also have reported the sporadic presence of *D. coriacea* nesting along Piaui's beaches. Although this species may be expected in Piauí state, considering its distribution in the neighboring states of Ceará and Maranhão (Barata et al. 2004. J. Mar. Biol. Assoc. U.K. 84:1233–1240), this is the first documented record of this species nesting in Piauí state.

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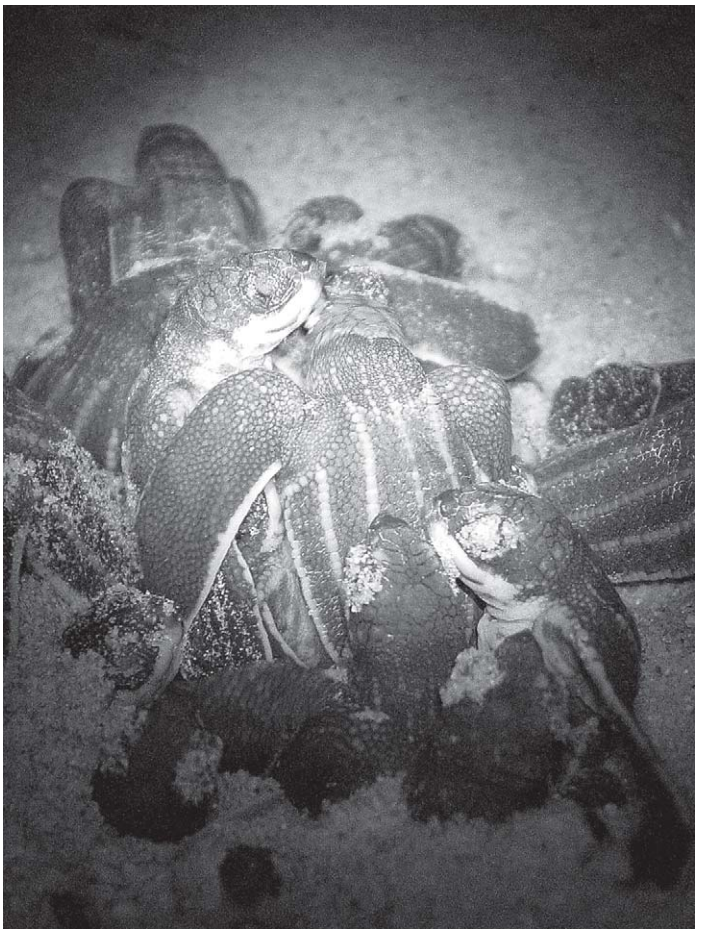


FIG. 1. Infrared photography of newborns of *Dermochelys coriacea* leaving the nest after sunset at about 1800 h. Photo by Daniel Loebmann.

GLYPTEMYS INSCULPTA (Wood Turtle). **HATCHLING BEHAVIOR**. Hatchlings of *Glyptemys insculpta* typically emerge from the nest in late summer and early fall (Buech et al. 2004. Herpetol. Rev. 35:54; Harding and Bloomer 1979. Bull. New York Herpetol. Soc. 15:9–26; Tuttle and Carroll 2005. Northeast. Nat. 12:331–348), even at the northern limits of their range (Brooks et al. 1992. Can. J. Zool. 70:462–469; Walde et al. 2007. Herpetol. Conserv. Biol. 2:49–60). In New Hampshire, newly-emerged hatchling *G. insculpta* were observed to migrate long distances (up to 445 m), spending several days and nights on land before reaching aquatic habitats where they are presumed to hibernate (Tuttle and Carroll, *op. cit.*). Parren and Rice (2004. Northeast. Nat. 11:229–233) reported a suspected terrestrial overwintering by a neonatal *G. insculpta* in Vermont.

As a follow up to a study of the nesting ecology of *G. insculpta* (Walde et al. 2007, *op. cit.*), hatchlings were tracked using fluorescent pigments (Butler and Graham 1993. Herpetol. Rev. 24:21–22) as they dispersed from nests in August through October 1997.

Hatchlings often used forms as resting places during periods of inactivity. Typically, forms consisted of a small excavation into which the turtle could fit; often under vegetation, rocks, or other objects. When in a form, hatchlings were observed to withdraw their head and limbs into their shells. Seven hatchlings emerged from one nest on 23 September 1997 and all hatchlings were treated with fluorescent pigments and subsequently released. Nocturnal tracking revealed five of the seven hatchlings were still on land, but not in forms or under any insulative material. At 0730 h on 24 September 1997, there was frost on the ground, ice on puddles, and the air temperature, measured with a handheld thermometer at the nesting site was -3°C. The five turtles were in the same position as the previous night, and all of them had their limbs and necks extended and were covered in ice crystals. Upon handling, two individuals were rigid, as if they were frozen solid, with their limbs rigid and extended. Both turtles were placed back where they were found. By 1100 h the temperature was well above freezing and four of the five hatchlings had moved; whereas, the fifth hatchling was alive but had not moved. Air temperature remained above 0°C the following two nights, when four of the five hatchlings were still on land and dug into forms; a fifth hatchling was not re-located.

Natural freeze tolerance, defined as the ability to survive freezing of body tissues under ecologically-relevant conditions, has been reported for several species of frogs, lizards, snakes, and turtles (Storey and Storey 1996. Ann. Rev. Ecol. Syst. 27:365–386). Hatchling turtles of several emydid species survive freezing to temperatures -3°C for at least 72 h (Costanzo et al. 2006. J. Comp. Physiol. B 176:697–707). Our observations suggest that hatchling *G. insculpta* can endure freezing at similar subzero temperatures, although we were not able to record actual body temperatures. In regions where overnight frosts occur during the fall emergence period, a tolerance for freezing of body tissues may increase survival of terrestrially migrating hatchling turtles.

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GLYPTEMYS INSCULPTA (Wood Turtle). **MAXIMUM CLUTCH SIZE.** Gammons (1871. Amer. Nat. 4:53) reported a clutch size of 18 eggs for *Glyptemys insculpta*. Carr (1952. Handbook of Turtles: The Turtles of the United States, Canada, and Baja California. Cornell Univ. Press. Ithaca, New York) rejected the account however, assuming it to be some sort of "hallucination" because of the odd nesting behaviors described by Gammons. Nevertheless, Harding (1977. Herpetol. Rev. 8:34) subsequently reported a clutch size of 18 eggs for *G. insculpta* in Michigan.

During studies of the nesting ecology of *G. insculpta* in Québec, Canada (Walde et al. 2007. Herpetol. Conserv. Biol. 2:49–60), we observed a record clutch for this species. On 17 June 1997 at 0930 h, a *G. insculpta* was observed constructing a nest. It was not possible to count the number of eggs, as approaching would have disturbed the other Wood Turtles present in the nesting area (Walde et al. 2007, *op. cit.*). Seventeen hatchlings emerged from this nest cavity; 16 on 27 August 1997, and an additional one on 30 August 1997. When the nest was excavated on 9 September 1997, there were 17 egg shells and an additional three eggs with dead embryos that were putrid and covered in fly larvae. Thus, the total clutch size was 20 eggs. The female that laid this clutch had a carapace length (CL) of 224 mm, plastron length (PL) of 214 mm, and mass of 1475 g. She was the largest of 39 females observed to nest during the two-year study, and was the second largest observed in the population of 83 females (Walde et al. 2003. Can Field-Nat. 117:377–388). Walde et al. (2007, *op. cit.*) reported that clutch size within this population was significantly positively correlated with CL, PL, and mass. There appears to be some level of geographic variation present, as maximal clutch sizes from northern populations tend to be larger than those from southern ones (Walde et al. 2007, *op. cit.*).

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GRAPTEMYS GEOGRAPHICA (Northern Map Turtle). **HABITAT.** *Graptemys geographica* is typically described as inhabiting larger, slow-moving rivers, and lakes with mud bottoms rather than small creeks and ponds (Conant and Collins 1998. A Field Guide to Amphibians and Reptiles of Eastern and Central North America. 3rd Edition. Houghton Mifflin Co., Boston, Massachusetts. 616 pp.; Ernst et al. 1994. Turtles of the United States and Canada. Smithsonian Inst. Press, Washington D.C. 578 pp.) Here I report two encounters of *G. geographica* in Marshall Co., Tennessee, in 2006 and 2007, in or near Bear Creek. These encounters happened at least 20 miles from the nearest large river (Duck River) and both encounters were with large females.

A mature female *G. geographica* was found during the morning of 23 April 2005 crossing Mooresville Highway (Highway 373) at a bridge (35.4545°N, 86.9304°W). This occurrence was after a heavy rain and water levels in Bear Creek were elevated. The reason for the turtle crossing the bridge was unclear; other than the creek, there are no other water sources in the direction from which she had presumably traveled, or in the direction she was moving. This large (though unmeasured) female was retrieved from the bridge, photographed, and released back into Bear Creek in the location that she was apparently headed.

The second *G. geographica* female was encountered in the afternoon of 1 June 2006 in the same general area, but was further away from the road and was further upstream (35.45005°N, 86.93107°W). This female, encountered while constructing a nest, was photographed but not otherwise disturbed. The water level in Bear Creek at the time was not abnormally elevated. The width of the creek nearest to where this female was found does not exceed 1.8 m and the depth does not exceed 0.3 m. The success of the nest was not determined because of time constraints.

Photo vouchers are deposited at Austin Peay State University Museum of Zoology: APSU 18305 (23 April 2005 record), APSU 18306 (1 June 2006 record).

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MANOURIA IMPRESSA (Impressed Tortoise). **ENDOPARASITES.** *Manouria impressa*, a medium-sized, forest dwelling tortoise, ranges from Myanmar and Malaysia to Vietnam and China (Iverson 1992. A Revised Checklist with Distribution Maps of the Turtles of the World. Privately printed, Richmond, Indiana. 278 pp). To our knowledge, no endoparasites have been reported from *M. impressa*. The purpose of this note is to report an occurrence of the nematode *Cissophyllus roseus* in *M. impressa*.

Wild-caught *Manouria impressa* confiscated by the US Fish and Wildlife Service were sent to Zoo Atlanta for triage and veterinary care. *Manouria impressa* is a particularly difficult species to keep in captivity. Wild-caught tortoises often succumb to a myriad of illnesses (Innis C et al. 2006. J. Herpetol. Med. Surg. 16:49–52). The confiscated tortoises appeared in good health and had adequate body weight. They were kept in quarantine for 45 days. On a routine fecal examination, during the first week in quarantine, we found two male and four gravid female nematodes. The nematodes were fixed in alcohol and later cleared in lactophenol for microscopic examination during which they were identified as *Cissophyllus roseus*.

Railliet and Henry (1912. Bull. Soc. Path. exot., Paris. 5:251–259) described the nematode *Cissophyllus laverani* from an Indomalaysian tortoise, *Testudo emys* (currently *Manouria emys*) and in a second paper (Railliet and Henry 1915. Bull. Soc. Path. exot., Paris. 8:446–452) mentioned that the nematode *Cucullanus roseus* described by Leidy (1851. Proc. Acad. Nat. Sci., Philadelphia 5:205–210) from the tortoise *Manouria fusca* (currently *Manouria emys*) had greater affinity for the genus *Cissophyllus* than for the genus *Cucullanus*; however, synonymy was not established. Walton (1927. Proc. Acad. Nat. Sci., Philadelphia 79:49–163) revised the Leidy collection and did synonymize *Cucullanus roseus* with *Cissophyllus laverani*, the name becoming *Cissophyllus roseus*.

Prior to our observation, *Manouria emys* was the only known host for *C. roseus*. *Manouria impressa* represents a new host record and only the second host known for *C. roseus*. To our knowledge there are no life history studies for this nematode, but zoological institutions and those in the private sector should be aware of the possibility of infection when introducing wild-caught specimens into established collections.

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STERNOTHERUS ODORATUS (Stinkpot) **MINIMUM SIZE / GROWTH**. On 26 April 2007 one of us (JKT) collected a juvenile *Sternotherus odoratus* using a dip net at Stump Lake, Jersey County, Illinois, USA (38.9912°N, 90.5554°W; NAD27 datum). This turtle had presumably hatched in 2006, and likely emerged from the nest in the fall of 2006, as this species typically does not overwinter in the nest (Ernst et al. 1994. Turtles of the United States and Canada. Smithsonian Institution Press, Washington, D.C. 578 pp.). Most reports on turtle size present record maximum lengths (e.g., Blasus et al. 2004. Herpetol. Rev. 34:54; Lubcke and Wilson 2006. Herpetol. Rev. 37:339; Tucker et al. 2006. Herpetol. Rev. 36:453–455). Here we report on the smallest non-hatchling turtle. Despite the possibility that the turtle was active for some weeks or months, it was remarkably tiny (Fig. 1). It weighed 1.54 g and had a carapace length of 18.8 mm, a carapace width of 17.7 mm, a carapace height of 11.5 mm, and a plastron length of 13.8 mm (all measurements made using methods of Tucker et al. 2006, *ibid*.). This individual was much smaller than eight recently emerged hatchlings (= those with no scute annuli on the carapace scutes) caught in Stump Lake during fall of 2005 (29 September and 5 October) using minnow traps. These eight averaged 4.58 g in wet mass (SD = 0.74 g, range = 3.70–5.90g), 27.4 mm carapace length (SD = 1.92 mm, range = 25–30 mm), 24.0 mm in carapace width (SD = 2.14 mm, range = 21–27 mm), 14.5 mm in carapace height (SD = 1.31 mm, range = 12–16 mm), and 19.4 mm in plastron length (SD = 1.51 mm, range = 17–22 mm). This species grows rapidly after hatching. For instance, nine individuals in their first full season of growth (= those with one

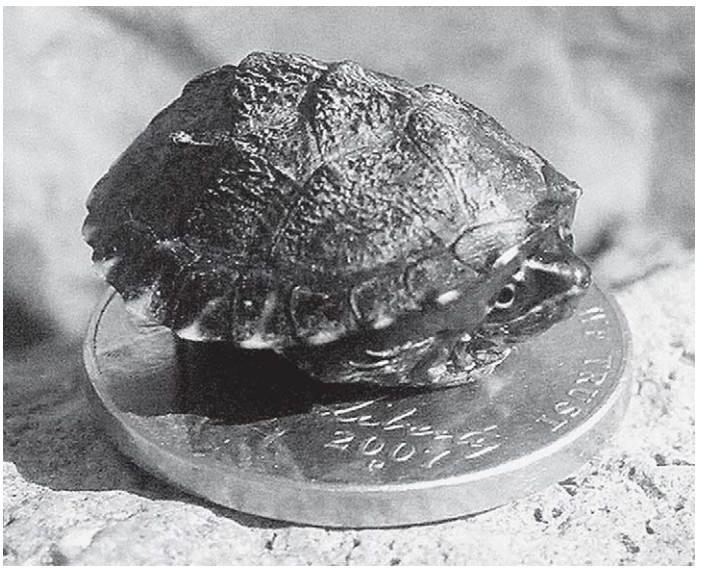


FIG. 1. Juvenile *Sternotherus odoratus* from Stump Lake, Jersey County, Illinois, placed on a U.S. nickel (21.15 mm in diameter) for scale.

scute annulus on the carapace scutes) from Stump Lake were caught between 30 June and 29 July 2005 with minnow traps. These juveniles had emerged from eggs laid in 2004. They averaged 10 g (SD = 0.80 g, range = 8.9–11.1 g) in wet mass, 34.3 mm in carapace length (SD = 1.22 mm, range = 32–36 mm), 30.2 mm in carapace width (SD = 1.20 mm, range = 29–32 mm), 19.2 mm in carapace height (SD = 0.67 mm, range = 18–20 m), and 24.8 mm in plastron length (SD = 1.09 mm, range = 24–27 mm). Thus juveniles from Illinois nearly double their size in the first full year after hatching. Reports on first year growth are few for this species (see Ernst et al. 1994, *op. cit.*, for a review). Nonetheless, Risley (1933. Pap. Michigan Acad. Sci. Arts Lett. 17:685–711) found that yearling Stinkpots averaged 32.5 mm in carapace length, similar to the 34.3 mm size we found.

The Stump Lake juvenile was smaller than 95 hatchlings from eggs induced from Jersey and Calhoun county females. These 95 eggs averaged 3.94 g in wet mass (SD = 0.47 g, range = 2.85–5.67 g) (see Tucker 1999. Bull. Maryland Herpetol. Soc. 35:61–75 for details on egg collection). The 95 hatchlings averaged 2.74 g in weight (SD = 0.32 g, range = 1.94–3.56 g), 22.8 mm in carapace length (SD = 1.15 mm, range = 19.6–25.2 mm), 16.7 mm in carapace width (SD = 1.44 mm, range = 12.8–20 mm), and 17.5 mm in plastron length (SD = 0.96 mm, range = 15.2–19.8 mm). These hatchlings were weighed and measured the day they left the egg (methods of Tucker et al. 2006, *op. cit.*). Carapace height was not measured for these hatchlings to avoid interference with residual yolk retraction.

Nonetheless, hatchlings of several species of Kinosternidae may leave the egg even smaller than the juvenile that we caught. Few published records of kinosternid hatchlings report mass, and the next smallest individual by weight was a hatchling Stinkpot that weighed 1.6 g (Mitchell 1994. The Reptiles of Virginia. Smithsonian Institution Press, Washington, D.C. 352 pp.). Many authorities report linear shell dimensions and several have reported hatchlings with carapace lengths smaller than 18.8 mm. These include *Sternotherus odoratus* with carapace length of 18.5 mm (Ernst et al. 1994, *op. cit.*; Mitchell 1985. Copeia 1985:941–949), *Kinosternon subrubrum* with carapace length of 16.7 mm, *K. baurii* with carapace length of 16.5 mm, and *K. flavescens* with carapace length of 17.7 mm (all from Ernst et al. 1994, *op. cit.*). These are, however, measurements of hatchlings fresh from the eggs and not of free ranging turtles such as the one we report. It is interesting that such genuinely minute juveniles only occur in North American Kinosternidae and apparently not in any non-North American turtles (see reviews by Pritchard 1979. Encyclopedia of Turtles. T.F.H. Publications, Inc. Ltd., Neptune, New Jersey, 895 pp.; Ernst and Barbour 1989. Turtles of the World. Smithsonian Institution Press, Washington, D.C., 313 pp.). Hatchlings tend to be much larger (25 mm + carapace length) in other turtle species (for a review of many worldwide species see Table 2 in Ewert 1979 (*In* Harless and Morlock [eds.], Turtles: Perspectives and Research. The embryo and its egg: development and natural history, pp. 333–413, John Wiley and Sons, New York). The adaptive significance for such small hatchlings has never been investigated and it may be simply a reflection of the small adult sizes of many kinosternids. Egg size can be strongly constrained in such small turtles (e.g. Tucker et al. 1978. Bull. Maryland Herpetol. Soc. 14:10–22; Congdon and Gibbons 1987. Proc. Natl. Acad. Sci. 84:4145–4147).

All hatchlings and juveniles that we examined were or will be released at the original collecting sites or at the collecting sites of the female parent. We thank Emily Dustman, Michael Avara, and Megan Dooling for help in collecting turtles. This research was partially funded by a grant to JKT from the National Great Rivers Research and Education Center, Richard E. Sparks, director of research and by support from the Illinois Natural History Survey, Great Rivers Field Station, John H. Chick, Director.

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SQUAMATA – LIZARDS

ANOLIS AENEUS (Grenadian Bush Anole), ***ANOLIS RICHARDII*** (Grenadian Tree Anole). **NECTARIVORY / POLLINATION**. Recent observations (e.g., Perry and Lazell 1997. Herpetol. Rev. 28:150–151) have contributed to the general notion that island-dwelling lizards may both feed on nectar and act as pollinators (Olesen and Valido 2003. Trends Ecol. Evol. 18:177–181). Here, we report accounts of nectarivory and presumptive pollinating behavior on two native plant species, *Charianthus grenadensis* and *Marcgravia umbellata*, by *Anolis aeneus* and *Anolis richardii*, in Grenada, Lesser Antilles. Our observations were made in the elfin forest along the Mt. Qua Qua trail within Grand Etang National Park in the montane interior (elev. 690–710 m) of Grenada.

Between 0828 and 0830 h on 22 June 2006, we observed *A. aeneus* visiting two flowers of *C. grenadensis*. This generalized anole (Germano et al. 2003. Caribb. J. Sci. 39:68–76) was slowly sliding its head into the broad opening of the flowers and licking nectar from the bottom of these. In the process, the anole touched both anthers and stigma with its head. *Charianthus grenadensis*, endemic to montane Grenada, is believed to be adapted for hummingbird pollination (Penneys and Judd 2005. Syst. Bot. 30:559–584) as it displays several classic ornithophilous features, e.g., bright red corolla, no obvious scent, and a large amount of diluted nectar (24-h sample of bagged flowers; volume: = 53.0 ± 24.8 µl; concentration: = 11.6 ± 0.9% weight/weight sucrose equivalents, N = 13; AT and LHA, unpubl. data).

On 22 June 2006, we observed two *A. richardii* visiting a single inflorescence of *M. umbellata*. The length of the visits was 15 and 6 min (1135–1150 and 1242–1248 h). Both anoles exhibited pollinating behavior, i.e., the head and dorsal part of the body brushed against the anthers and stigma of the flowers as they licked nectar from several of the pendulous tubular nectaries of the inflorescence (Fig. 1). *Marcgravia umbellata*, restricted to the Lesser Antilles, is adapted for bird and/or bat pollination (Dressler 1997. Curtis's Bot. Mag. 14:130–136; Zusi and Hamas 2001. Caribb. J. Sci 37:274–278). Its flowers have no scent, a large amount of dilute nectar (24-h sample of bagged flower; volume = 119.5 µl; concentration = 9% weight/weight sucrose equivalents; N = 1; AT and LHA, unpubl. data) and dull brown-green colors.

Our observations reveal that *Anolis* lizards have the potential to pollinate both *C. grenadensis* and *M. umbellata*. Nectar-feeding



FIG. 1. *Anolis richardii* visiting *Marcgravia umbellata*. The lizard was feeding on nectar and touching both anthers and stigma. Photo by Allan Timmermann.

lizards acting as pollinators on islands may result from reduced insect abundance, fewer predators and less interspecific competition than on comparable mainland environments, allowing density compensation and niche broadening by island lizards (Olesen and Valido 2003. Trends Ecol. Evol. 18:177–181). In the Caribbean, hurricanes may be an additional factor offering lizards the opportunity to expand their diet to include energy-rich nectar from typically bird-pollinated flowers. Hurricanes can cause nectarivorous bird populations to crash, subsequently limiting pollination and resulting in surplus nectar in bird-pollinated flowers (Rathcke 2000. Ecology 81:1951–1958). Whether lizards are important backup pollinators of otherwise bird-pollinated plants in the aftermath of hurricanes needs investigation.

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ASPIDOSCELIS COSTATA HUICO (Blue-chested Whiptail). **REPRODUCTION**. *Aspidoscelis costata huico* (*sensu* Reeder et al. 2002. Am. Mus. Novit. 3365:1–61) is among many named, but biologically poorly known reptiles from remote areas of México. Zweifel (1959. Bull. Am. Mus. Nat. Hist. 117:57–116) described the subspecies based on 193 specimens from the type locality (Peñitas, 19.2 km SE of Rosamorada, Nayarit) and other mainland sites in the states of Sinaloa, Nayarit, Jalisco, and Zacatecas; and Isla Isabel, Nayarit. Here, I provide reproductive data (clutch ranges and mean ± SE, SVL ranges and mean ± SE) for a subspecies which Zweifel (*op. cit.*) noted only maximum sizes of males and females (both 106 mm SVL) and described a mating incident observed at La Vuelta, Nayarit, on 25 August 1957 by T. H. Lewis.

I examined 255 *A. c. huico* from the California Academy of Sciences (CAS) collection obtained by A. E. Greer and F. W. Burley in two Mexican states: Sinaloa, 45.4 km E of jct Hwy 40 (Durango Road) and Hwy 15 on Hwy 40 [10 June 1963 (CAS 114865–114876, N = 12); Hwy 40, 17.0 km E of jct Hwy 15 [30 June 1963 (CAS 115230–115256, N = 27)]; 9.9 km E of jct Hwys 15 and 40 on Hwy 40 [30 June 1963 (CAS 115210–115221, N = 12)]; Hwy 40 at 39.7 km E of jct Hwy 15 [10 June 1963 (CAS 114877–114833, N = 7)]; 5.3 km W of Hwy 15 on dirt road 13.3 km N of Escuinapa [3 July 1963 (CAS 115295–115301, N = 7)]; 11.1 km E of jct 15 and Hwy 40 on Hwy 40 [14 June 1963 (CAS 114961–114991, N = 31)]; 25.9 km S of Escuinapa on Hwy 15 [2 July 1963 (CAS 115269–115287, N = 19)]; Nayarit, Arroyo de Rifilion, 9.0 km N of Compostela [13 May 1963 (CAS 114391–114416, N = 26)]; Laguna Santa Maria Road, 6.6 km NE of jct Hwy 15 and Laguna Santa Maria Road [28 May 1963 (CAS 114664–14669, N = 6)]; 1.3 km N of Navarette on Sauta Road [27 June 1963 (CAS 115154–115174, N = 21)]; 32.3 km S of Río Acoponeta on Hwy 15 [23 June 1963 (CAS 115036–115071, N = 36)]; 1.8 km S of Río Canas on Hwy 15 [2 July 1963 (CAS 115262–115267, N = 6); 23.0 km W of jct Mexcaltitan and Hwy 15 on Mexcaltitan Road [28 June 1963 (CAS 115194–115199, N = 6)]; end of Santiago Ixcuintla Road, 45.6 km W of jct of Santiago Road and Hwy 15 [7 July 1964 (CAS 95372–95389, N = 18)]; Laguna Santa Maria [26 June 1964 (CAS 95326–95346, N = 21). I obtained size (as SVL to the nearest 1 mm) for all except 41 males in the CAS sample. Females were dissected to identify the number and measure oviductals eggs and ovarian follicles.

The ca. 3:1 sex ratio (187 males:68 females) in *A. c. huico* was on the order of the ca. 2:1 (129 males:64 females) observed in *A. c. nigrigularis* (Walker 2008. Herpetol. Rev., *in press*). Only 10 (21.7%, 6 measurable clutches) of 46 gravid females contained oviductal eggs; all others had yolked ovarian follicles of 3.5–10.0 mm in diameter. Bias in the sex ratio of both subspecies may pertain to secretive female behavior during egg maturation and oviposition that make them less susceptible to collection than other adults. Alternatively, shorter life expectancy in females is a non-mutually exclusive explanation that may also contribute to the male-biased sex ratio. The latter may be reflected by the relative male-female numbers, respectively (in parens), by sizes (as 10-mm SVL increments where applicable) in the CAS sample: 50–59 mm (2:0); 60–69 mm (9:4); 70–79 mm (23:23); 80–89 mm (37:24); 90–99 mm (32:13); 100–109 mm (4:4); 110–118 mm (39:0). Assuming any secretive behavior by adult females is unrelated to their size, *A. c. huico* appears strongly sexually dimorphic in favor of males.

Females of *A. c. huico* appear to attain reproductive maturity at a small size (< 70 mm SVL) similar to *A. c. barrancarum* in south-

western Chihuahua (Walker et al. 2004. Herpetol. Rev. 34:366) and *A. c. nigrigularis* in Sinaloa (Walker 2008, Herpetol. Rev., *in press*). In *A. c. huico*, 2 females 67–69 mm SVL had clutches of 2–3 (mean = 2.5). Among females 70–79 mm SVL, 13 (56.5%) were gravid; clutch size was 2–5 (mean = 3.2, N = 13). Among females 80–89 mm SVL, 17 (70.8%) were gravid; clutch size was 2–6 (mean = 4.4, N = 17). Among females 90–99 mm SVL, 12 (92.3%) were gravid; clutch size was 3–8 (mean = 5.6, N = 12). Among females 100–105 mm SVL 2 (50%) were gravid; clutch size was 5–7 (mean = 6.0, N = 2). For the period 13 May–7 July 1964, 46 females with data had clutches (sample size in each category in parens) of 2 (4), 3 (11), 4 (13), 5 (6), 6 (7), 7 (4), and 8 (1) eggs; mean clutch size and SVL for these females were 4.4 ± 0.23 (2-8) eggs and 83.5 ± 1.27 (67–105) mm, respectively. A moderately strong relationship exists between clutch size and SVL (adjusted $r^2 = 0.50$). Data for the CAS sample established these additional reproductive characteristics for *A. c. huico*: SVL of all adult males, 92.7 ± 1.21 (67–118, N = 131) mm; SVL of all adult females, 83.6 ± 1.42 (62–105, N = 66); oviductal egg dimensions in 6 (60%) females with oviductal eggs, 8.2 ± 0.44 × 14.4 ± 0.45 (7.5–10.0 × 13–16) mm; reproductive season, minimally May–July (this study) into late August (Zweifel, *op. cit*.); and reproductive potential, multiple clutches based on maturation of both sexes at small body sizes within the long activity cycle near the northern fringe of the tropics in Sinaloa, Nayarit, and Jalisco. Collecting data for the CAS sample also revealed that *A. c. huico* achieves high population densities at numerous mainland sites and on Isla Isabel (based on CAS 59136–59295, N = 160) within an area occupied by a congener (*A. lineatissima duodecemlineata*; Zweifel, *op. cit*.) only at San Blas, Nayarit.

I thank Robert C. Drewes (CAS) for the opportunity to examine specimens in his care.

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ASPIDOSCELIS COSTATA NIGRIGULARIS (Sinaloa Black-throated Whiptail Lizard). **REPRODUCTION**. *Aspidoscelis costata nigrigularis* (*sensu* Reeder et al. 2002. Am. Mus. Novit. 3365:1–61) is among many named, but biologically poorly known reptiles from remote areas of México. Zweifel (1959. Bull. Am. Mus. Nat. Hist. 117:57–116) described the subspecies based on 47 specimens from the type locality (16.8 km NW of Culiacán) and other sites in western Sinaloa. Here, I provide reproductive data (clutch ranges and ± SE; SVL ranges and ± SE) for a subspecies which Zweifel (1959, *op. cit.*) noted only minimum size at maturity for females (62 mm SVL), maximum sizes for females (84 mm SVL) and males (114 mm SVL), and reproductive season between 18 July and August 20 (based on 3 gravid females).

I examined 196 *A. c. nigrigularis* from the California Academy of Sciences (CAS) collection obtained by A. E. Greer and F. W. Burley at 12 sites in Sinaloa over 13 days in 1963: 1.9 km E of La Cruz [6 July (CAS 115304–115313, N = 10)]; 8.5 km E of La Cruz [6 July (CAS 115314–115327, N = 14)]; 21.4 km S of San Lorenzo, Hwy 15 [10 July (CAS 115365–115384, N = 20)]; 14.4 km N of San Lorenzo, Hwy 15 [11 July (CAS 115385–115410, N = 26)]; 12.5 km S of Río San Lorenzo, Hwy 15 [11 July (CAS 115417–115435, N = 19)]; 12.8 km S of Culiacán, Hwy 15 [12 July (CAS 115440–115456, N = 17)]; 1.9 km N of El Dorado on El Dorado Road [13 July (CAS 115460–115482, N = 23)]; 3.5 km W of jct of road 4.5 km S of Navolato [14 July 1963 (CAS 115509–115523, N = 15)]; 22.9 km S of jct of El Dorado and Navolato Roads [14 July (CAS 115524, N = 1)]; 33.6 km N of Río Culiacán, Hwy 15 [17 July (CAS 115528–115546, N = 19)]; 11.4 km N of Río Evora Nocorito, Hwy 15 [18 July (CAS 115584–115596, N = 13)]; 85.8 km N of Río Culiacán, Hwy 15 [18 July (CAS 115611–115629, N = 19)]. I obtained size (as SVL to the nearest 1 mm) and gender on all except 3 animals. Females were dissected to identify the number and measure oviductal eggs and ovarian follicles; 5 females were too damaged internally to permit this assessment.

The ca. 2:1 sex ratio (129 males:64 females) in *A. c. nigrigularis* was on the order of the ca. 3:1 (187 males:68 females) observed in *A. c. huico* (Walker 2008. Herpetol. Rev., *in press*). Only 9 (20.5%) of 44 undamaged gravid females of *A. c. nigrigularis* contained oviductal eggs; all others had yolked ovarian follicles 3.5–9.5 mm in diameter. Bias in the sex ratio in both subspecies may pertain to secretive female behavior during egg maturation and oviposition that make them less susceptible to collection by humans than other adults in the population. Alternatively, shorter life expectancy in females is a non-mutually exclusive explanation that may also contribute to the male-biased sex ratio. The latter may be reflected by the relative male-female numbers, respectively (in parens), by sizes (as 10 mm SVL increments where applicable) in the CAS sample: 50–59 mm (3:2); 60–69 mm (15:12); 70–79 mm (25:13); 80–89 mm (18:20); 90–99 mm (20:14); 100–109 mm (26:3); 110–118 mm (22:0). Assuming any secretive behavior by adult females is unrelated to their size, *A. c. nigrigularis* appears strongly sexually dimorphic in favor of of males.

Females of *A. c. nigrigularis* appear to attain reproductive maturity at a small body size similar to *A. c. barrancarum* in southwestern Chihuahua (Walker et al. 2003. Herpetol. Rev. 34:366). In *A. c. nigrigularis*, 5 females 62–68 mm SVL had clutches of 1–2 (mean = 1.8) eggs. Among females 70–79 mm SVL, 11 (85%) were gravid; clutch size was 2–4 (mean = 2.9, N = 10). Among females of 80–89 mm SVL, 18 (95%) were gravid; clutch size was 3–7 (mean = 4.8, N = 14). Among females 90 mm SVL, all were gravid; clutch size of females 90–99 mm SVL was 4–7 (mean = 5.8, N = 12), but was 6–7 (mean = 6.7, N = 3) for females 100–105 mm SVL. For the period 6–18 July 1963, 44 females with data had clutches (sample size in each category in parens) of 1 (1), 2 (8), 3 (4), 4 (10), 5 (6), 6 (10), and 7 (5) eggs; mean clutch size and SVL for these females were 4.4 ± 0.26 (1–7) eggs and 83.6 ± 1.63 (62–105) mm, respectively. Clutch size was strongly correlated with SVL (adjusted $r^2 = 0.71$). Data for the CAS sample established these additional reproductive characteristics: SVL of all adult males, 90.8 ± 1.45 mm (range: 62–118, N = 123) mm; SVL of all adult females, 83.6 ± 1.42 mm (range: 62–105, N = 54) mm; oviductal egg dimensions in 9 females with oviductal eggs, 8.0 ± 0.17 × 14.5 ± 0.44 (7.5–9.0 × 13.0-17.0) mm; reproductive season, minimally July (this study)–August (Zweifel 1959, *op. cit.*) and probably much longer; and reproductive potential, multiple clutches based on maturation of both sexes at a small body size within the long activity cycle in subtropical regions of Sinaloa.

Collecting data for the CAS sample further indicated that *A. c. nigrigularis* achieves high population densities at numerous sites within a distribution area that is inhabited by no other species in the genus *Aspidoscelis*.

I thank Robert C. Drewes (CAS) for the opportunity to examine specimens in his care.

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ASPIDOSCELIS LAREDOENSIS (Laredo Striped Whiptail) × ***ASPIDOSCELIS GULARIS GULARIS*** (Texas Spotted Whiptail). **REPRODUCTIVE POTENTIAL**. Clonal complex A (Walker 1987a. Texas J. Sci. 39:313–334) of diploid (Bickham et al. 1976. Herpetologica 32:395–399) parthenogenetic *Aspidoscelis laredoensis* (nomenclature based on Reeder et al. 2002. Am. Mus. Novit. 3365:1–61), derived from a single hybrid (Abuhteba et al. 2000. Can. J. Zool. 78:895–904) of *A. gularis gularis* × *A. sexlineata* (McKinney et al. 1973. Herpetologica 29:361–366), is syntopic with *A. gularis gularis* at Los Ebanos (between the town and the Rio Grande), Hidalgo County, Texas (26.2341667°N, 98.5605556°W, datum WGS84; elev. 26 m; Walker 1987b. Am. Midl. Nat. 117:319–332). On 25 May 1986, JMW, JEC, and MAP collected 3 male lizards (University of Arkansas Department of Zoology, UADZ 1948–1950) at this site characterized by the basic striped and spotted adult dorsal pattern of all-female *A. laredoensis* and a ventral pattern intermediate between this species and *A. gularis gularis*. Each of these males is a triploid hybrid resulting from a haploid sperm of *A. gularis gularis* (1n = 23) fertilizing the unreduced egg of *A. laredoensis* (2n = 46). *Aspidoscelis laredoensis* A has been identified as a participant in numerous other hybridizations. Walker et al. (1989a. J. Herpetol. 23:119–130) listed 23 hybrids (including UADZ 1948–1950) from 8 sites in Texas and 3 in México and Walker et al. (1989b. Copeia 1989:1059–1064) described the triploid karyotype of a male *A. laredoensis* × *A. gularis gularis*. Here, we detail the morphological and histological examination of a male hybrid (UADZ 1948) from Los Ebanos.

Based on Walker et al. (1989b, *op. cit.*), Taylor et al. (2001. Am. Mus. Novit. 3345:1–65), and Walker et al. (2006. Herpetol. Rev. 37:344–345), JMW described the gross reproductive morphology of the preserved hybrid. Based on Goldberg and Beaman (2003. Herpetol. Rev. 34:143), SRG histologically examined the left testis and left epididymis of the hybrid and assessed its previous reproductive functionality.

The preserved hybrid was 62 mm SVL (mass unavailable). Compared to male *A. gularis gularis* of similar size from Los Ebanos, its testes (mean dimensions of both = ca. 4 × 6 mm), epididymides, and hemipenes were of expected size and structure. Histology of the left testis indicated that the hybrid was undergoing early spermiogenesis. As reported for other teiid lizards (Lowe and Goldberg 1966. J. Morphol. 119:277–281), a circumtesticular tunic 1–3 Leydig cells thick surrounded the left testis. Clusters of metamorphosing spermatids were present and tails of spermatozoa projected into the lumina of the seminiferous tubules. Sperm were also present in the sectioned epididymis.

This *A. laredoensis* × *A. gularis gularis* hybrid would have been deemed fertile based on cytological characteristic of testes in species such as *A. tigris* (Lowe and Goldberg 1966, *op. cit.*). However, though it seemed capable of producing sperm and inseminating females of *A. laredoen*sis and *A. gularis gularis* at Los Ebanos, its ability to produce a stable haploid chromosome complement from triploid number of 69 is dubious. Nevertheless, the hybrid likely would have interfered with normal reproduction in some females of these two species should any of them have been inseminated. Taylor et al. (2001, *op. cit.*) provided indirect histological evidence that the more numerous triploid hybrid males of *A. tesselata* × *A. marmorata* (N = 12) collected at Arroyo del Macho, Chaves County, New Mexico, may have inseminated congeneric females at this site.

Collection of UADZ 1948–1950 was made under authority of Permit No. 61 issued to JEC in 1986 by the Texas Parks and Wildlife Department. Field studies at the Los Ebanos site in the Lower Rio Grande Valley National Wildlife Refuge, under the protectorate of the U.S. Fish and Wildlife Service, were conducted under Permit 21552-07-09-ms granted to JEC.

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CHAMELEO RUDIS (Ruwenzori Side-striped Chameleon). **REPRODUCTION.** Few data exist on clutch size and sex ratio, and neonate size for most viviparous chameleons. Recently, many species have been described from the tropical and montane forests of East Africa (Neças et al. 2003. Trop. Zool. 16:1–12; Menegon et al. 2002. J. Herpetol. 36:51–57; Largen 1995. Trop. Zool. 8:333–339; Tilbury 1991. Trop. Zool. 4:159-165; Tilbury 1992. Trop. Zool. 5:1–9; Klaver and Bohme 1988. Bonn. Zool. Beitr. 39:381–393), and additional cryptic or semi-cryptic species have been distinguished from previously described species (Neças 1994. Herpetozoa 7[3/4]:95–108). Thus, even existing data addressing clutch characteristics may be questionable unless linked to voucher specimens that confirm species identity.

In mid-January 2007, a recently deceased gravid female chameleon, included in a shipment form Tanzania, was received from an animal dealer in Calgary. PADW identified it as *Chamaeleo rudis* (Spawls et al. 2002. A Field Guide to the Reptiles of East Africa. Academic Press, San Diego, California. 543 pp.) based on the enlarged granules on the median line of the throat extending onto the belly; no cranial horns or sail-like dorsal crest; heterogeneous body scalation with scattered large tubercles; head less than twice as long as broad; nostrils laterally directed; and body squat. Snout–vent length (SVL) and tail length were measured to the nearest 1 mm, head length (HL) and head width (HW) were measured using a Mitutoyo Digital Caliper Model 500-322 to the near-

TABLE 1. Data on 12 *Chameleo rudis* embryos; mass in grams, all other measurements in millimeters.

	Individuals	SVL	Tail	HL	HW	Mass
Females	1	30.7	24.8	9.9	6.2	0.61
	2	26.7	21.0	10.0	5.9	0.53
	3	24.7	23.0	9.6	5.8	0.47
	4	26.0	23.8	9.5	5.8	0.50
	5	26.3	24.3	9.8	5.8	0.48
	6	27.5	23.5	9.9	5.9	0.51
	mean	27.0	23.4	9.8	5.9	0.52
Males	1	26.7	21.0	10.2	5.9	0.57
	2	27.2	22.7	9.9	5.9	0.51
	3	27.0	22.3	10.1	6.2	0.46
	4	26.3	22.3	9.6	5.9	0.51
	5	27.7	22.0	10.0	6.0	0.49
	6	27.5	20.7	9.7	6.0	0.49
	mean	27.1	21.8	9.9	6.0	0.51

est 0.1 mm; each measurement was taken three times, then averaged. Measurements are: 81 mm SVL, 82 mm tail, 25.7 mm HL, 14.8 mm HW.

Twelve near full-term embryos were found *in utero*, six in each oviduct. The sex ratio was six males, six females (4.2 in one oviduct and 2.4 in the other). Gender was determined either by direct observation of at least one everted hemipenes in males (three specimens) or by observation of two circular openings into the retracted hemipenes at the lateral corners of the vent. Accuracy of the latter approach was verified by making a medial incision on the ventral side of the tail immediately posterior to the vent in two suspected males and two suspected females. Presence of a cone-shaped connective tissue sheath overlying the conical muscle, transversus penis, which surrounds the hemipene, confirmed male gender. These structures were absent in the suspected females. All embryos were measured and weighed (Table 1).

Female embryos had longer tails than male embryos (Mann Whitney U test: $P = 0.03$) but it is unknown whether this sexual dimorphism carries into adulthood with this species, however, in dwarf chameleons some ecomorphological sex-specific variation has been documented (Stuart-Fox and Moussalli 2007. J. Evol. Biol. 20:1073–1081). SVL, HL, HW, mass, ratio of tail length to SVL, and ratio of HW to HL did not differ between genders (Mann-Whitney U test: $P > 0.11$ for these 6 comparisons). However, variation in SVL for female embryos was significantly greater than variation in SVL for male embryos (Variance ratio test: F = 15.4, $P < 0.01$).

The adult female (L07.15.1) and male embryo 1 (L07.15.2; see Table 1) were deposited in the Royal Alberta Museum, Edmonton, Alberta, Canada.

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CROTAPHYTUS COLLARIS (Eastern Collared Lizard). **HOMING.** Previously, I reported an instance of homing by a male collared lizard that became separated from his territory by the outflow of the Arcadia Lake Reservoir (Baird 2004. Herpetol. Rev. 35:167). In that instance, possible routes for homing to its territory were either to travel an indirect and lengthy (> 800 m**)** overland route through the territories of several other *C. collaris* males, or to swim across the outflow channel (9.5 m). On 20 June 2006, I observed another territorial *C. collaris* male, a paint-marked subject in my space-use studies, attempting to swim across the channel. This male's territory was on the north side of the channel, but because no water was released during most of May and June 2006, he made occasionally forays into the dry channel and onto its south side. The outflow was opened at 0530 h on 19 June and remained open for three days. From 1000 to 1020 h on 20 June, I made a focal observation of this male, then on the south side of the now flowing channel that separated him from his north-side territory. Throughout the entire 20-min observation, this male moved back and forth along the bank while peering across to the north side. Thirty min after the end of the focal observation, I sighted this male swimming in the midst of the outflow, presumably in an attempt to return to his territory. I followed him for 120 m as the current carried him downstream. When it became apparent that he would not reach the rocks on the other side before being swept over the end of the spillway, I waded into the water, caught the lizard, and returned him to his territory. Upon capture, the male's lungs were completely inflated, allowing floatation. This observation implies that my 2002 report of homing also involved swimming across the flowing channel, and that the drive to home is strong enough in territorial *C. collaris* males that fast-flowing water does not appear to be a deterrent. The spillway at the Arcadia Lake Reservoir is human constructed, but *C. collaris* may face similar flowing aquatic barriers during flash flooding events.

This study was conducted under Oklahoma Department Wildlife Conservation permit 4097 to Troy A. Baird.

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HOPLOCERCUS SPINOSUS (NCN). **ENDOPARASITES.** *Hoplocercus spinosus* is a poorly known lizard distributed from Mato Grosso and Mato Grosso do Sul States, Brazil to adjacent Bolivia (Wiens and Etheridge 2003. Herpetologica 59:375–398). To our knowledge, no parasite records were published for *H. spinosus*. Hence, we report the nematode, *Cruzia rudolphii*, infecting *H. spinosus.*

Five adult *H. spinosus* (mean = 80.4 mm SVL, SD = 12.3 mm) deposited in the Coleção Zoológica de Referência, Laboratory of Zoology, *Campus* of Corumbá, Universidade Federal de Mato Grosso do Sul (UFMS; CEUCH 2888, 2892, 3374, 3375, and 3460) were examined for endoparasites. Lizards were captured in No-

vember 2003 and February 2004 in pitfall traps with drift fences in a remnant patch of Cerradão (savanna-like vegetation) of Dois Irmãos do Buriti and Terenos (55.30°W, 20.50°S, datum: WGS84) between the municipality of Aquidauna and Campo Grande, Mato Grosso do Sul State, Brazil. Endoparasites were cleared in phenol, identified and deposited in the Coleção Helmintológica do Instituto de Biociências da Unesp de Botucatu as *Cruzia rudolphii* (CHIBB 1052). Three adult females of *C. rudolphii* were recovered and the observed prevalence (infected lizards / examined lizards × 100) was 20%.

Species of *Cruzia* have been reported in mammals (Quintão e Silva and Costa 1999. J. Wildl. Dis. 35:371–374) and reptiles (Vicente et al. 1993. Rev. Bras. Zool. 10:1–183). *Cruzia rudolphii* was described from the colubrid snake *Erythrolamprus aesculapii* in southeastern Brazil (Ruiz [1947] in Vicente et al. 1993, *op. cit.*). *Hoplocercus spinosus* represents a new host record for *C. rudolphii* and Mato Grosso do Sul, Brazil is a new locality for *C. rudolphii*.

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PHRYNOSOMA CORNUTUM (Texas Horned Lizard). **MORTALITY.** Literature on horned lizards (*Phrynosoma*) reveals that horn length is an anti-predator device whereby individuals with larger horns are less susceptible to mortality from predation (Young et al. 2004. Science 304:65). Behaviors where horned lizards thrust their heads back to inflict puncture wounds into would-be predators support this idea (Brodie et al. 2004. Science 306:230b; Sherbrooke 2003. Introduction to Horned Lizards of North America. University of California Press, Berkeley. 177 pp.). However, elongated cranial horns have not been implicated as contributing to mortality. We report mortality of *Phrynosoma cornutum* resulting from entrapment of the horns in a hardware cloth fence.

On 15 April 2007, a young adult female *P. cornutum* (ca. 77 mm SVL) was found dead in a hardware cloth fence in the San Simon Valley, Cochise County, Arizona (31.93°N, 109.08°W; elev. 1330 m). The lizard was found entrapped in the area of overlap where two sections of 6.4-mm mesh wire hardware cloth had been joined to form a single fence (Fig. 1). The 60-cm tall fence was riveted at the top through a 15-cm tall strip of sheet metal, and at the ground the fence was buried in the soil. The lizard was aligned nearly vertically about midway up the 45 cm of exposed fence, ca. 10 cm from the edge of the overlap, where a small gap between



FIG. 1. Texas Horned Lizard, *Phrynosoma cornutum*, entrapped in overlapping sheets of hardware cloth used in a fence in Cochise County, Arizona.

the sheets of hardware cloth likely allowed entry. The lizard's occipital horns were protruding from and enmeshed in the hardware cloth. The body was completely desiccated but showed no other decay and was not noticeably faded. The only damage visible was two holes ca. 2 mm in diameter bored dorsally though the midway of tail and ventrally just caudal to the cloaca, likely the result of scavenging insects.

We suspect that the lizard was unable to escape entrapment of its horns in the mesh and later died. Entrapment or entanglement in anthropogenic materials has been recorded for many animal species, in some cases in surprising numbers (e.g., Barton and Kincead 2005. J. Soil Water Cons. 60:33A–35A; Loegering 1997. Wilson Bull. 109:353–355), though the cause of mortality we report is probably rare. Because of the potential for entrapment, however, we suggest caution in the use of hardware cloth in areas where horned lizards of conservation concern occur, such as in the range of the Flat-tailed Horned Lizard, *P. mcallii*. Thoroughly securing the overlapping ends of fencing would likely alleviate the potential for such mortality.

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PHRYNOSOMA CORNUTUM (Texas Horned Lizard). **PREDATION.** *Phrynosoma cornutum* has a broad distribution in North America (Price 1990. Cat. Amer. Amphib. Rept. 469.1–7; Sherbrooke 2003. Introduction to Horned Lizards. University of California Press, Berkeley 178 pp.). Knowlton (1942. Copeia 1942:186), Miller (1948. Copeia 1948:67), and Sherbrooke (2003, *op. cit*.) indicate that the vertebrate predators of *P. cornutum* include the Greater Roadrunner (*Geococcx californianus)*, Red-shouldered Hawk (*Buteo lineatus*), Chihuahuan Raven (*Corvus cryptoleucus)*, and the Western Diamond-backed Rattlesnake (*Crotalus atrox*). Prey decapitation, a important feeding tactic used by some raptorial birds to minimize risk from dangerous prey, has not been reported to be used on horned lizards. Hence, we report an observation of prey decapitation by Swainson's Hawk (*Buteo swainsoni*) on *P. cornutum*.

Our observations were made between 15 June and 15 August 2006 during research on the reproductive biology of *B. swainsoni* in the Reserva de la Biosfera de Janos (31.1854528°N, 108.9469917°W and 31.1909583°N, 108.9394694°W, datum: NAD27; elev. 1350–1400 m), in Janos, Chihuahua, México. Our study was conducted in open desert scrubs dominated by Honey Mesquite (*Prosopis glandulosa*), Viscid Acacia (*Acacia neovernicosa or A.constricta*), and Catclaw Mimosa (*Mimosa biunicifera*). We analyzed the regurgitated pellets and prey remains of 19 occupied *B. swainsoni* nests with young, all of which were in *P. glandulosa* trees. We found the remains of *P. cornutum* in 8 nests, all of which were heads. To estimate body size, we recorded the mean distance between the distal ends of temporal (squamosal bone) horns. For the 14 *P. cornutum* heads collected, temporal horn distance (D_{th}) ranged from 1.72 mm to 2.14 mm. Based on a preliminary linear SVL–temporal horn distance regression (SVL = 1.978 + 3.244[D_{th}]) constructed from 34 *P. cornutum* in the herpetological collection of the Universidad Autónoma de Nuevo León, the heads all belonged to adults estimated to range in size from 75 mm to 89 mm. No other remains from these lizards were found in the nests, suggesting that the lizards were either dismembered and fed to juveniles or consumed by adult hawks.

Buteo swainsoni, with a broad distribution throughout much of North and South America (Clements 2000. Birds of the World: A Checklist. Ibis Publishing Co., Vista, California. 867 pp.**)**, has a diet that includes horned lizards (Bednarz 1988. The Condor 90:311–323). Bednarz (*op. cit*.) notes that based on biomass, *B. swainsoni* diet included 6.2% *P. texanus (= cornutum*). Our observations imply that *B. swainsoni* may decapitate *P. cornutum* prior to eating them.

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PHRYNOSOMA MCALLII (Flat-tailed Horned Lizard). **RAIN HARVESTING**. Three species of *Phrynosoma* (*P. cornutum*, *P. modestum*, and *P. platyrhinos*) exhibit a behavior termed rain harvesting (Sherbrooke 2003. Introduction to Horned Lizards of North America. University of California Press, Berkeley, California. 178 pp.). In this stylized behavior, occurring during infrequent desert rains, a lizard elevates its venter from the substrate and positions its dorsal surface so that it intercepts rain which then moves by capillary action and bulk flow to the head and mouth where it is imbibed. We tested for this behavior in a fourth species of horned lizard, *P. mcallii*, because it lives in the most arid habitat of any horned lizard. Moreover, *P. mcallii* has never been observed to drink standing water in captivity and is assumed to procure moisture from its food (Mayhew 1968. *In* G. W. Brown, Jr. [ed.], Desert Biology: Special Topics on the Physical and Biological Aspects of Arid Regions, Volume 1, pp. 195–356. Academic Press, New York). Here, we provide evidence that *P. mcallii* engages in rain harvesting.

We equipped 64 lizards with radio-telemeters in the East Mesa area of the Imperial Valley (32.8222222°N, 115.2527778°W, datum: NAD83; elev. 10–15 m), California during the summer and fall of 2004. This area is in the Colorado Desert subsection of the Sonoran Desert. Large Creosote (*Larrea tridentata*) and sandy substrate characterizes the habitat. To test whether *P. mcallii* exhibits the stylized rain-harvesting posture, we opportunistically sprayed 5 relocated lizards with a heavy mist from a spray bottle. Two of these lizards exhibited behaviors consistent with rain harvesting. One lizard, from which we had just removed the transmitter harness, moved under a small, leafless bush where we sprayed it with water. This lizard promptly elevated its venter from the substrate, angled its dorsum to slope downward toward its head, and expanded its dorsum. Water sprayed on the lizard flowed toward the head and rhythmic swallowing motions followed. The second responsive lizard exhibited a less prompt and stylized response. This lizard walked under a small, leafless shrub that did little to obstruct our view or the sprayed water. When the lizard was sprayed, it remained off the substrate with its venter elevated and expanded the dorsum slightly. This lizard was standing on a slope which effectively angled its dorsum downward. Water collected on its dorsum and collected near the mouth, where it was swallowed. The transmitter was left on this individual. These observations parallel those described for the three species of *Phrynosoma* known to harvest rain; namely, venter elevated from the substrate, dorsum spread, and dorsum sloped toward head.

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PHRYNOSOMA SOLARE (Regal Horned Lizard). ***CROTALUS* ENVENOMATION**. On 14 September 2006, we studied the behavioral responses of an adult male *Phrynosoma solare* (93 mm SVL, 50.5 g) to a venomous ophidian predator, the Western Dia-

mondback Rattlesnake (*Crotalus atrox*; Vorhies 1948. Copeia 1948:302–303). The capture and experimental trial site of the *P. solare* was near a small volcanic hill in Altar Valley, Pima Co., Arizona, USA (32.0365278°N, 111.3962778°W, datum: WGS84; elev. 822 m). To conduct these trials, we released the lizard at its capture site after 5 days in captivity. We had collected the *C. atrox* (82 cm SVL, 8 cm tail, 385 g) in Avra Valley west of the Tucson Mountains, Pima Co. Tucson, Arizona (32.1859722°N, 111.0996944°W; elev. 792 m). For the trials, we placed the snake in a 46-cm long, 3.5-cm diameter clear plastic tube. The snake's head and forebody extended 15-cm from one end of the tube, while the tail extended from the opposite end. The experimenter held the posterior end of the tubed snake during presentations of its foreparts to the lizard. During trial encounters with this lizard, the lizard was unexpectedly struck by the snake on the third presentation of the snake. Before envenomation, the lizard had failed to exhibit antipredator escape-running or body-flip behaviors, but did tilt its body laterally toward the snake, raise its horns, and was contacted by the snake's head in all three encounters (Sherbrooke and May, unpubl. data). Though episodes of rattlesnake predation on horned lizards, including full and partial ingestions (successful or unsuccessful), have been reported (Beavers 1976. Southwest. Nat. 20:503–515; Funk 1965. Herpetologica 21:15–17; Sherbrooke 2003. Introduction to Horned Lizards of North America, University of California Press, Berkeley. 178 pp.), no accounts exist of the effects of *Crotalus* envenomation on horned lizards.

At 0928 h MST, a bite strike resulted in one fang penetrating the lizard's dorsal skin 11 mm anterior to the left hind leg and 8 mm above the lateral fringe scales. A small drop of blood immediately oozed from the wound, but did not spread. By 0934 h, a clear fluid (ca. 0.5 ml) seeped from the wound onto the experimenter's hand, and the lizard seemed to be experiencing difficulty moving its limbs. By 0950 h, the lizard was lethargic, with continuing fluid loss and a lightening of its body color; and by 1004 h, a pinkish fluid (presumably blood and lymph) was exuding from both nostrils. The lizard now appeared dead and was unresponsive to handling. Its head remained in a strong horns-raised posture (90° angle; Sherbrooke 1987. Southwest. Nat. 32:512–515).

The lizard was frozen and later formalin/ethanol preserved and is deposited in the Herpetology Collection of the University of Arizona, Tucson (UAZ 56621). Scientific collecting permit (SP651312) to WCS was provided by the Arizona Department of Game and Fish.

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PHYMATURUS ANTOFAGASTENSIS (NCN). **DIET**. *Phymaturus antofagastensis* is a viviparous lizard inhabiting the high plains (altiplano) of the Andean Mountains in central and northern Argentina (Cabrera and Willink 1980. Biogeografía de América Latina. Washington, DC. 109 pp.). This species is sexually dimorphic and females exhibit biennial reproduction (Boretto and Ibargüengoytía 2006. Amphibia-Reptilia 27:25–36). Its conservation status is ambiguous as it is defined as a species for which "insufficient knowledge" exists (Lavilla et al. 2000. Categorización de los Anfibios y Reptiles de la República Argentina. Asoc. Herpetol. Arg., San Miguel de Tucumán, Argentina, 97 pp.). The genus *Phymaturus* is considered herbivorous (Espinoza et al. 2004. Proc. Nat. Acad. Sci. 101:16819–16824), but we provide preliminary data indicating that *P. antofagastensis* can also be frugivorous.

Our observations were based on data from 10 *P. antofagastensis* collected during January 2005 in Valle de Chaschuil, Catamarca Province, Argentina (27.72°S, 68.15°W, datum: WGS84; elev. 4200 m). Soil is sandy and rocky; the vegetation is shrub-steppe. The climate is cold and semiarid with broad diel thermal range and intense solar radiation (Boretto and Ibargüengoytía 2006, *op. cit.*. The lizards were taken to the laboratory, where they defecated; we examined their feces with a magnifying lens. We analyze a total of 10 feces, counting the number of seeds of fruits present. We estimated the percent volume of non-seed vegetable matter as a function of total fecal volume.

We found no arthropod remains. Only plant material representing the seeds of *Lycium chanar* and *Ephedra multiflora*, and non-seed material representing leaves or fruit tissue of *L. chanar* and *E. multiflora* were observed. The fruits of *L. chanar* and *E. multiflora* in the feces were in various stages of digestion. We counted a total of 488 seeds. Mean number of *L. chanar* seeds in each fecal pellet was 45.7 (SD = 30.9, range: 0–103); mean number of *E. multiflora* seed was 3.1 (SD = 5.3, range: 0–16). Mean percent volume of non-seed vegetative material was 56.4 (SD = 7.1, range: 45–65).

Our results indicate that the fruits of *L. chanar* and *E. multiflora* represent an important source of nutrition for *P. antofagastensis*. Other Andean lizards (e.g., *Pristidactylus scapulatus* [Acosta et al. 2004. Herpetol. Rev. 35:171–172], *Liolaemus ruibali* [Villavicencio et al. 2005. Multequina: Latin American J. Nat. Res. 14:47–52], and *Homonota andicola* [Blanco and Acosta 2005. VI Congreso Argentino de Herpetología. 70 pp.]) also consume *Lycium* and *Ephedra* fruits. Fruits represent food with easily usable energy wealth for many squamates (Pough et al. 2001. Herpetology. Prentice Hall, New Jersey. 612 pp.). *Phymaturus antofagastensis* also has the potential to behave as a seed disperser. Given the observed frugivory, plant-lizard interactions involving *P. antofagastensis* and fruit-producing shrubs deserve investigation. We thank M. Hayes for comments and suggestions.

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PLESTIODON FASCIATUS **(**Common Five-lined Skink**). ESCAPE BEHAVIOR.** *Plestiodon fasciatus* is a small, diurnal skink that occurs throughout most of the eastern half of the United States (Mount 1996. The Reptiles and Amphibians of Alabama. University of Alabama Press. Tuscaloosa, Alabama). Between 1400 and 1500 h on 27 June 2006, during a visit to Glen Burnie, Maryland (39.16°N, 76.61°W), I witnessed what appeared to be a distinctive escape maneuver by *P. fasciatus*. Skinks (N = 7) basking on a

wooden railing along a path through a woodland fled for cover under a log when I approached. When I pursued the first skink by overturning the log under which it had taken cover, a large number of ants were found swarming beneath it. The same situation arose with another four *P. fasciatus*, each found along the same path. These lizards were also beneath cover objects (debris and leaf litter) housing ants. All five lizards observed appeared to be sub-adults,between ca. 50 and 65 mm SVL. When 25 nearby cover objects—similar to those used by skinks—were randomly sampled, only four housed ants beneath them, and (excepting the five mentioned above) only one had a high density of ants similar to that observed under cover objects utilized for escape by *P. fasciatus*.

Once established, *P. fasciatus* appear to have stable home ranges (Fitch 1954. Univ. Kansas Publ. Mus. Nat. Hist. 8:1–156). Consequently, individuals should be familiar with most possible escape routes within their home range. My observations imply that *P. fasciatus* preferentially flee to ant-associated cover objects during escape attempts. To my knowledge, this behavior is undocumented among lizards. Predators that pursue skinks under cover objects with ants may be deterred by the agitated ants. The smooth scales and associated osteoderms of *Plestiodon* would protect them from ants. Further observations are needed to determine how widespread this behavior is and to test the hypothesis of whether *P. fasciatus* actually exploit ant colonies within their home range for defense.

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PLESTIODON MULTIVIRGATUS EPIPLEUROTUS (Variable Skink). **MATING.** Little is known about reproduction in *Plestiodon multivirgatus epipleurotus* (Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. University of New Mexico Press, Albuquerque. 431 pp.). Everett (1971. J. Herpetol. 5:189–190) provided details of courtship and mating among captive specimens (two males and one female) from Lamb County, Texas, but mating has not been observed in the field. Hence, we report a field observation of mating in a high altitude population of *P. m. epipleurotus* near the southwestern limit of this taxon's range (Brennan and Holycross 2006. A Field Guide to Amphibians and Reptiles in Arizona. Arizona Game and Fish Department, Phoenix. 150 pp.).

At ca. 1300 h on 2 May 2007, CBG discovered a mating pair of *P. m. epipleurotus* in a small depression under a piece of particleboard in Fry Canyon, just west of US Hwy 89A, ca. 20 km SSW Flagstaff, Coconino Co., Arizona (35.0637833°N, 111.73315ºW, datum: WGS84; 2003 m elev.). Ambient temperature was 18.3°C and the sky was mostly overcast. A considerably smaller male (ca. 50 mm SVL) was in copula with a larger female (ca. 70 mm SVL), biting the left side of her neck and oriented on her left side. The lizards were apparently not disturbed, as they remained in copula after they were uncovered until the board was quickly (<10 sec) returned to its original position.

Timing of this mating event appears consistent with the seasonal appearance of eggs and hatchlings among other high-elevation populations of this taxon. Gehlbach (1956. Trans. Kansas Acad. Sci. 59:364–373) found hatchlings on 29 July at 2060 m elevation in McKinley Co., New Mexico. He also discovered a clutch of eggs on 28 June and hatchlings on 29 July and 17 August in the Zuni Mountains (2215 m), Cibola Co., New Mexico (Gehlbach 1965. Proc. U.S. Nat. Mus. 116:243–332). Similarly, Maslin (1957. Herpetologica 13:87–90) reported 4 egg clutches found 7 June on the Upper Colorado Plateau (2555 m) in San Juan Co., Utah. Our observation of an early May mating implies that egg development likely requires 5–7 weeks before the onset of oviposition.

We thank Andrew Holycross for suggestions and Kenneth Krysko for key literature.

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PLICA PLICA (NCN). **REPRODUCTION.** The scansorial arboreal tropidurid *Plica plica* is widespread in Amazonia (Vitt 1990. Can. J. Zool. 69:504–511). Reproduction in *P. plica* has been studied (Vitt, *op. cit.*), but data are lacking on the incubation interval. Here, we provide preliminary data on the incubation interval for *P. plica*.

On 4 March 2005, the day after the capture of a gravid female (145 mm SVL, 80 g) at Floresta Nacional de Carajás, Estado do Pará, Brazil (06.30°S, 50.20°W; elev. 500 m), she laid a clutch of five eggs in laboratory. The clutch was maintained in a plastic tub with moist sand and litter, at a constant 24°C. Placed near a glass window, the tub received indirect ambient light throughout incubation, but light regime was not rigorously controlled. One egg spoiled the week after oviposition and was discarded. The remaining four eggs hatched in 122 days (on 4 July 2005). Hatching from the first three eggs was almost simultaneous (at 1340, 1345 and 1346 h), but the fourth hatchling emerged almost two hours later (1538 h). Table 1 provides measurements of hatchlings. Simultaneous hatching of the first 3 eggs agrees with Vitt (*op. cit.*), who described synchronous hatching of *P. plica* eggs after disturbance.

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TABLE 1. Measurements of four *Plica plica* hatchlings from Estado do Pará, Brazil.

Individual	Snout–vent length (mm)	Tail length (mm)	Mass (g)
1	40.8	77.0	3.0
2	41.5	77.0	3.0
3	41.0	74.0	3.0
4	39.6	72.0	2.9

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POLYCHRUS MARMORATUS (NCN)**. MATING.** The neotropical genus *Polychrus* contains five medium-sized (120–150 mm) diurnal arboreal species (Peters and Orejas-Miranda 1986. Catalogue of Neotropical Squamata. Part II, Lizards and Amphisbaenians. Revised ed. Smithsonian Institution, Washington, DC. 293 pp.). Vitt and Lacher (1981. Herpetologica 37:53–63) described mating in *P. acutirostris*, and Beebe recorded but did not describe mating in *P. marmoratus* (Beebe 1944. Zoologica 29:195–216). Here we describe mating by *P. marmoratus* in eastern Brazilian Amazônia.

Our observations were made at Floresta Nacional de Carajás (06.0569444°S, 50.145°W, datum: SAD69, elev. 500 m). Lizards were captured on the morning of 23 December 2004 in low vegetation along a road in continuous forest. They were placed in a transparent plastic tub (25 × 35 × 15 cm) in a room under artificial (fluorescent) light where the temperature was a constant 24°C (slightly below field temperature at the time of capture). Observations began at 1800 h the same day, when we found the male riding the female's back while biting her neck and trying to penetrate her cloaca. Copulation began at 1820 h and lasted more than an hour. The male made rhythmic movements with his pelvis until 1930 h, and during all this time, a white secretion was visible on his vent. After copulation, the male disengaged from the female, gaped and made atypically fast respiratory movements. The male remained on female's back until 2315 h. The female remained passive througout all the process and no interactions were observed after separation.

Mating in *P. marmoratus* is similar to mating in *P. acutirostris*. However, prominent differences exist, including the longer copulatory period and the absence of aggressive behaviour on the part of the female post-copulation; however, these differences may be artifacts of the captivity that only field observations can elucidate. Vitt ánd Lacher (*op. cit.*) observed female aggressive behavior toward the male before copulation and concluded that females select their mates. Our observations began after mating had begun, preventing us assessing pre-copulatory behavior.

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RHACODACTYLUS AURICULATUS (Gargoyle Gecko). **SAP FEEDING.** *Rhacodactylus auriculatus* is a large (125 mm maximum SVL) diplodactylid gecko endemic to mainland New Caledonia (Bauer and Sadlier 2000. The Herpetofauna of New Caledonia. SSAR, Ithaca, New York. 322 pp.). Between 28 July and 4 August 2004, an adult female (122.8 mm SVL, 36.0 g) that was being tracked by radiotelemetry in Parc Provincial de la Rivière Bleue, Province Sud (22.1000°S, 166.6444444°E, datum: WGS84; elev. 225 m), was seen licking sap from a *Cunonia macrophylla* tree on three separate nights. During daylight hours, she perched on vegetation within a radius of < 3 m from the tree, returning within 2 h of sunset to feed on a wound on the tree trunk. During video-documentation lasting 69 min 56 sec, this female licked the sap 662 times (Fig. 1). Licking was intermittent; several consecutive licks were followed by pauses of up to 1 min 41 sec.

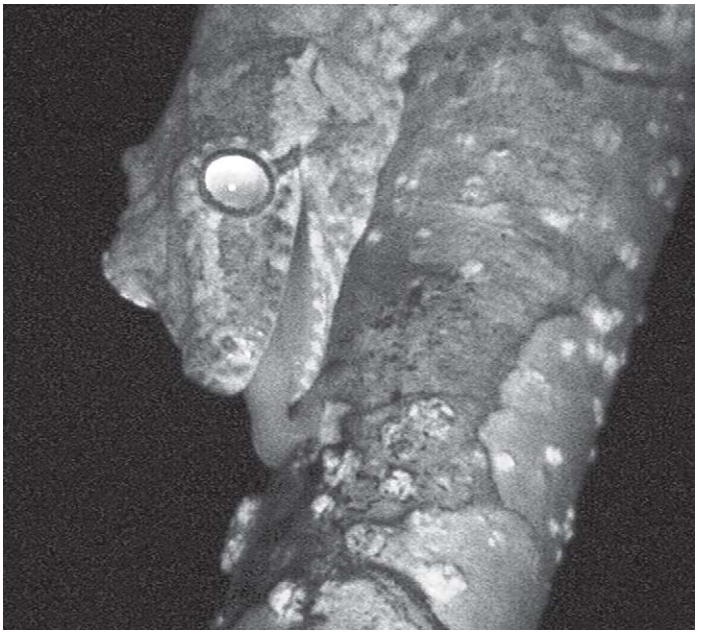


FIG. 1. Infrared video still of *Rhacodactylus auriculatus* feeding on the sap of *Cunonia macrophylla.*

Rhacodactylus auriculatus has been reported to feed on flowers and flower parts since the species was first described. Bavay (1869. Mém. Soc. Linn. Normandie 15:1–37) observed *R. auriculatus* feeding on flowers of *Geissois* spp., another member of the Cunoniaceae. Flower consumption by *R. auriculatus* has further been confirmed by the recovery of anthers and stamens referable to either the family Cunoniaceae or Myrtaceae from the stomach of a preserved specimen (Bauer and Sadlier 1994. Russ. J. Herpetol. 1:108–113) and Bauer and Sadlier (2001. Amphib. Rept. Conserv. 2:24–29) reported *R. auriculatus* activity on a flowering *Geissois* sp., though ingestion of plant material was not observed. Our observation constitutes the first field-based report of *R. auriculatus* feeding on sap and further supports the regular dietary use of plants of the Cunoniaceae by *R. auriculatus*.

Many gecko species (chiefly insular forms) have been implicated in frugivory or nectivory (Whitaker 1987. New Zeal. J. Bot. 25:315–328; Cooper and Vitt 2002. J. Zool. London 257:487–517), however field observations of feeding on sap has previously been recorded only for three species of the genus *Gehyra* (Couper et al. 1995. Mem. Qld. Mus. 38:396; Dell 1985. W. Aust. Nat. 16:69–70; Letnic and Madden 1998. W. Aust. Nat. 21:207–208). Because they are rapidly absorbed by the digestive tract, nectar and sap are difficult to identify in gut contents retrieved from preserved specimens. Flower parts consumed incidentally to high-energy nectar can indicate nectivory (Bauer and Sadlier 1994, *op. cit.*), but sap feeding is virtually undetectable unless a feeding event is actually observed.

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SCELOPORUS OLIVACEUS (Texas Spiny Lizard). **PREDATION.** *Sceloporus olivaceus* occurs from the Texas-Oklahoma border into México, extending to southern Tamaulipas, all through Nuevo León, southeastern Coahuila, northeast San Luis Potosí, and a tiny portion of northern Veracruz (Kennedy 1973. Cat. Amer. Amphib. Rept 143.1–143.4; Smith 1979. Handbook of Lizards of the United States and Canada. Comstock Publishing Associates, Ithaca, New York. 557 pp; Köhler and Heimes 2002. Stachelleguane. Herpeton, Offenbach, Bundesrepublik, Deutschland. 174 pp.). Several snake predators of *S. olivaceus* are reported, including *Masticophis flagellum*, *Hypsiglena ochrorhyncha texana*, *Crotalus lepidus lepidus*, and *Sistrurus catenatus* (Strecker 1927. Contr. Baylor Univ. Mus. [10]:1–14; Werler 1951. Zoologica 36:37–48; Wright and Wright 1957. Handbook of the Snakes of the United of the United States and Canada. Cornell University Press, Ithaca, New York. 564 pp.; Greene and Oliver 1965. Herpetologica 21:225–228), but *Imantodes cenchoa* is not among them. Hence, here we report an observation of *I. cenchoa* predation on *S. olivaceus*.

At 2343 h on 16 July 2006 during a collecting trip through the municipality of Aldama (state of Tamaulipas), we found a DOR adult female *I. cenchoa* (480 mm SVL, 223 mm TL, 19.81 g) as we were road-collecting at 8 km E of Aldama-Barra de Tordo (22.9414194°N, 99.9954°W, datum: NAD27; elev. 141 m). As we were preserving the specimen, we extracted a juvenile *Sceloporus olivaceus* (37 mm SVL, 65 mm TL, 1.94 g) from an expanded loop in the body mid-section. This snake species had been repeatedly found on this road in previous years. The area of Barra del Tordo is undergoing intensive human development, which has greatly increased the number of DOR animals encountered.

Imantodes cenchoa, which occurs at low to moderate elevations in Mexico from Chiapas on the Pacific slope to Tamaulipas on the Atlantic slope (Lee 1996. The Amphibians and Reptiles of the Yucatan Peninsula. Comstock Publishing Associates, Cornell University Press, Ithaca, New York. 500 pp.), is documented to consume lizards and frogs. Myers (1982. Amer. Mus. Novit. 2738:1–50) reported that anoles make up most of its diet, and Landy et al. (1966. J. Ohio Herpetol. Soc. 5:93–101) found an unidentifed *Anolis* sp. and reptile eggs in the stomach of one individual. Specific reports include *Anolis capito* and *A. uniformis* (Stuart 1948. Misc. Publ. Zool. Univ. Michigan [91]:1–31); *A. marianrum* (Gutierrez and Arredondo-S. 2005. Herpetol. Review.36:324); and juvenile *Basiliscus vittatus* (Lee, *op. cit.*). However, ours is the first report of *S. olivaceus* as prey.

The specimens of *S. olivaceus* (UANL 6831) and *I. cenchoa* (UANL 6830) were deposited in the herpetological collection of the Universidad Autónoma de Nuevo Leon. Research and collecting were conducted under the authority of SEMARNAT scientific research permits OFICIO NÚM/SGPA/DGVS/00800 issued to DL.

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STENOCERCUS CADUCUS (NCN). **REPRODUCTION.** Data on reproduction in *Stenocercus caducus* are scarce, and little is known about its biology in Paraguay. Cei (1993. Mus. Reg. Sci. Nat. Torino Monogr. 14:1–949) pointed out that few data exist on its reproductive activity. Clutch size has been reported in related species, such as *S. azureus* (Carreira and Baletta 2004. Herpetol. Rev. 35:270; Torres-Carvajal 2004. Herpetol. Rev. 35:172), but the nesting habits of *S. caducus* are unreported. Here, we provide preliminary observations on nesting in *S. caducus*.

At 1640–1700 h on 15 November 2006, we found a female *S. caducus* laying eggs along a forest path at Kangüery Biological Station (27.5126944°S, 55.7852222°W, datum: WGS84; elev. 158 m), inside San Rafael National Park. The female was laying the eggs in a small burrow (3–4 cm depth and 4–5 cm width) made in the earth underground, covered with leaf litter. The shape of the nesting burrow was a simple round hole, and the egg chamber was equal to or slightly small than the opening. Two eggs were deposited with an interval of ca. 10 min between them. The just-laid eggs were pale grey with white longitudinal stripes; after less than 10 sec, the eggs turned completely white, the stripes disappearing. Egg shape also changed, because just-laid eggs were bilaterally symmetrical, becoming ovoid as they dried in contact with air. We could not obtain precise egg measurements because eggs were not removed from the nest, but we estimated that they averaged 23 mm in major axis diameter. The female was 67.2 mm of SVL and 142.0 mm total length. Egg major axis diameter was 34% of the female's SVL. Measurements were taken once she finished laying eggs, and she was subsequently released at the same place.

While the female laid eggs, she was vulnerable to predator attack; however, she appeared highly cryptic on the leaf litter background. Only her hind limbs and posterior body were inside the small burrow; the rest of the body, including a large portion of the long tail, was exposed. The next day, we re-examined the nest location, and found it covered with soil and leaf litter; we could see no obvious evidence of the nest made the day before.

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TROPIDURUS HISPIDUS (NCN). **HATCHLING SIZE.** *Tropidurus hispidus* has a broad distribution from central-eastern and northeastern Brazil to Venezuela (Rodrigues 1987. Arq. Zool. 31:105–230; Rodrigues 1988. *In* Heyer and Vanzolini [eds.], Proceedings of a Workshop on Neotropical Distribution Patterns, pp.

305–315. Academia Brasileira de Ciências, Rio de Janeiro, Brazil). Data are available on clutch size (Vitt 1983. Copeia 1983:131–141), but information on hatchling size is lacking. Here, we provide preliminary data on hatchling size for *T. hispidus*.

At 0820 h on 8 June 2005, CMCAL and TBGC collected 8 eggs of *T. hispidus* at the Parque Estadual das Dunas do Natal (05.8135278°S, 35.1920278°W, datum: WGS84; elev. 72 m), Natal City, Estado do Rio Grande do Norte, Brazil. Located within Atlantic Forest Domain, the nest site, a small terrestrial cavity (5 cm diameter × 3 cm deep) covered with herbaceous and shrubby vegetation (notably *Anthurium affine*, *Aechmea aquilega*, and *Krameria tomentosa*), was encountered during a transect survey. On 4 April 2007 at 0910 h, EMXF collected one egg (1109 mm^3, 0.68 g) of this species, next to DBEZ - Departamento de Botânica, Ecologia e Zoologia (Department of Botany, Ecology and Zoology) at the Campus of Universidade Federal do Rio Grande do Norte – UFRN (05.8426667°S, 35.2018611°W; elev. 69 m), Natal City. The collection location of this egg was a garden area surrounded by a forest patch. The single egg was found in soil beneath sparse leaf litter (< 1 cm deep). Eggs from each collection date were placed in a terrarium (20 × 12 × 20 cm) in a sand substrate, and maintained at the Laboratório de Herpetologia (Departamento de Botânica, Ecologia e Zoologia/UFRN). We placed the terrarium next to a window protected from direct solar radiation, but we made no efforts to otherwise control light or temperature; incubation occurred under ambient conditions. In Natal City, ambient temperatures during the June–July incubation interval for the first clutch varied from 22.0°C to 30.0°C, whereas ambient temperatures during the brief April incubation of the second single egg varied from 24.0°C to 34.0°C.

On 12 July 2005, about five weeks after the first clutch was found, juveniles began to emerge; on 8 April 2007, four days later the single egg was found, the juvenile emerged. Body measurements were taken immediately upon hatching, and each individual was sexed following euthanization (Table 1). Coefficients of variation (CV) for data among all hatchlings were quite low (< 0.05) except for mass (CV = 0.25). Tail length/body length ratio differed significantly between males (mean = 1.70 ± 0.04 mm; N = 4) and females (mean = 1.59 ± 0.04 mm; N = 5; Mann-Whitney U test: $P = 0.0143$).

TABLE 1. Data on nine *Tropidurus hispidus* hatched in the Laboratory (Estado do Rio Grande do Norte, Natal City, Brazil). Individuals 1–8 were from one clutch; individual 9 was from a second clutch. Snout–vent length (SVL), tail length (Tail), head length (HL), head width (HW) measurements are in millimeters; mass is in grams.

	Morphological Variables				
Individual	SVL	Tail	HL	HW	Mass
1 (Female)	28.2	45.7	9.4	6.5	0.58
2 (Female)	27.7	43.5	8.8	6.1	0.52
3 (Male)	27.6	48.9	9.4	6.4	0.59
4 (Male)	28.7	48.6	9.6	6.6	0.74
5 (Male)	28.6	48.3	9.2	6.1	0.55
6 (Male)	28.4	47.5	9.2	6.3	0.63
7 (Female)	27.2	43.3	9.0	5.7	0.37
8 (Female)	27.6	45.7	8.8	6.0	0.35
9 (Female)	27.6	42.7	9.3	6.6	0.40
Mean	28.0	46.0	9.2	6.3	0.53
SD	0.53	2.4	0.28	0.30	0.13

Mean body size of nine *T. hispidus* hatchlings is similar to that observed by Vitt (*op. cit.*) for individuals hatched in the laboratory (mean = 27.8 ± 0.45 mm SVL; N = 5), but their average mass is somewhat less than that recorded by Vitt (*op. cit.*; mean = 0.74 ± 0.09 g).

The *T. hispidus* (CHBEZ 1167–1174; 1715) were deposited in the herpetological collection of Universidade Federal do Rio Grande do Norte, Natal City. We thank two anonymous reviewers for helpful comments. The Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) supported LBR with a research grant (Process 141993/2006-5).

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VARANUS KOMODOENSIS (Komodo Dragon). **OCCURRENCE.** *Varanus komodoensis* is a large monitor endemic to the Lesser Sunda region of southeastern Indonesia. Over the last 30 years, extant populations of *V. komodoensis* have been recorded from six islands (Auffenberg 1981. The Behavioral Ecology of the Komodo Monitor. Univ. Press of Florida, Gainesville, Florida. 406 pp.), five of which occur within Komodo National Park (KNP). However, a 1998 survey failed to detect any sign of *V. komodoensis* on Padar Island, a small mountainous island (20 km^2) within KNP, suggesting that this population was extirpated (Ciofi and deBoer 2004. Herpetol. J. 14:99–107). In 1969–1970, Auffenberg (*op. cit.*) had estimated that ca. 60 dragons inhabited this hilly and largely savannah-covered island. Anecdotal evidence suggests that this population of *V. komodoensis* had been extirpated by the early 1980s, possibly because of illegal harvesting of the Timor Deer (*Cervus timorensis)*, their preferred prey.

Recently, reports from fishermen plying local waters have suggested the renewed presence of *V. komodoensis* on Padar Island. To confirm these reports, we conducted trapping and visual surveys on Padar Island over five days in December 2004. To assess for *V. komodoensis* presence, direct and indirect methods were used. Direct methods involved the placement of two aluminium box traps (300 cm × 50 cm × 50 cm) baited with ca. 0.5 kg of goat meat. These traps were positioned in the largest forested valley on

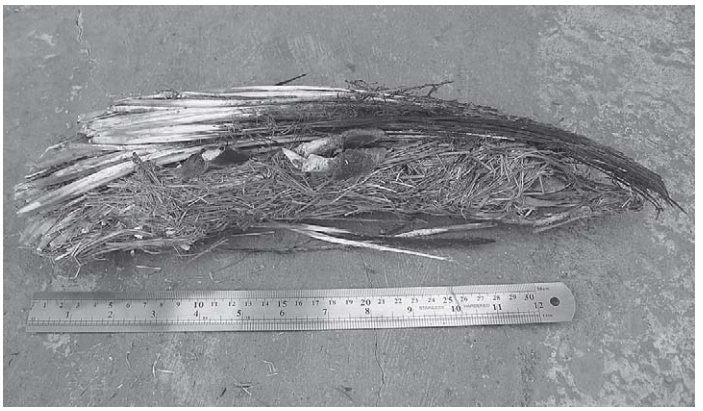


FIG. 1. Gastric pellet believed to be that of a Komodo Dragon collected from Padar Island that contains the flight feathers from a sea bird (top of pellet) and the hoof of a juvenile Timor Deer (mid center of pellet) surrounded by a matrix of grass. For scale, the ruler is 30 cm.

the south eastern corner of the island. Indirect methods involved focal searches along 30 × 150 m long transects randomly positioned across the island from which any signs of *V. komodoensis* were recorded. Transects were concurrently used for assessing the density of Timor Deer, based on fecal pellet counts. Visual sampling was also conducted between transects when walking to the start point of the next transect. The purpose of indirect sampling was to identify potential signs specific to Komodo Dragons, including: 1) gastric pellets or large boluses of indigestible food matter (keratin and often bone-based material) encased in grass, that *V. komodoensis* regurgitate after ingestion of prey; 2) foot or tail tracks or burrows; and 3) feces.

Despite laying out two baited traps, no *V. komodoensis* were captured or directly sighted on Padar over the trapping period. However, fresh tracks with the characteristic accompanying tail drag and a body pit that was likely to have been made on the day of sampling were recorded on a beach (8.656417°S, 119.600722°E, datum: WGS, elev. 4 m) ca. 1.3 km WSW from our trap locations. In addition, we found several feces (8.655175ºS, 119.5814722ºE; and 8.6554917ºS; 119.5814361ºE) that contained the remains of sea turtle eggs (either *Eretmochelys imbricata* or *Chelonia mydas*), and *C. timorensis*, prey items consistent with *V. komodoensis*. However, the sign most suggestive of *V. komodoensis* presence was a 40 cm × 10 cm gastric pellet (Fig. 1). This pellet contained the remains of deer bones and fur, and the remains of a large raptor (probably a White-bellied Sea Eagle, *Haliaeetus leucogaster*).

Our results suggest that either *V. komodoensis* engaged in inter-island movement or that the species was not completely extirpated on Padar Island. Based on the low density of tracks and scats, only one dragon may now occupy Padar Island. If inter-island movement was the source of this animal, the closest occupied islands would be Rinca (1.95 km) and Komodo Island (4.71 km). Anecdotal reports indicate that *V. komodoensis* has some capacity to swim and thus potentially move among islands. However, the frequency of such events in both ecological (TJ, unpubl. data) and evolutionary time (Ciofi and Bruford 1999. Mol. Ecol. 8:17–30) seems infrequent, suggesting that fidelity of individuals to their respective islands is high. Even within islands, dragons are very rarely recorded to move among valleys (TJ, unpubl. data).

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VARANUS KOMODOENSIS (Komodo Dragon). **PARASITES.** Ticks that parasitize varanid lizards are primarily from the genera *Amblyomma* and *Aponomma* (King and Green 1999. Goannas: The Biology of Varanid Lizards. Univ. New South Wales Press, Sydney. 116 pp.). Ticks as ectoparasites consume host blood, cause disease, and can function as important vectors for microparasites, which can negatively influence fitness (Main and Bull 2000. Oecologia 122:574–581). *Varanus komodoensis*, a large monitor lizard from southeastern Indonesia, has been documented to carry three species of tick, including *Amblyomma helvolum*, a generalist, and two host-specific species: *A. robinsoni* and *Aponomma komodoense* (Auffenberg 1981. The Behavioral Ecology of the Komodo Monitor. University Press of Florida, Gainesville, Florida. 406 pp.). However, little is known about either the general ecology or fitness implications of this host-parasite relationship. One aspect of this relationship that remains unknown is the possibility that ticks have evolved strategies to parasitize hatchling dragons upon emergence from their nests. From a parasite's perspective, the host environment of juvenile animals provide the least resistance with respect to immunological (i.e., lack of acquired immunity) or physical (e.g., skin thickness) barriers. Hence, here we report on the ability of ticks to parasitize hatchling Komodo Dragons recently emerged from three nests on Komodo Island.

In January of each observation year (2003–2006), a sample of known active nests of *V. komodoensis* were caged to enable capture of hatchlings as part of routine annual monitoring of the ecology and life-history of this species in Komodo National Park (Jessop et al. 2004. Biol. Conserv. 117:463–470). Prior to emergence in March/April (late wet season), nest cages were monitored twice daily (morning and afternoon coinciding with emergence of hatchlings from the ground) to enable measurement and marking of individual hatchlings prior to release. In 2004, we also examined for the presence of ectoparasites of hatchlings on Komodo Island, one of four extant populations within Komodo National Park.

From the three nests monitored on Komodo Island in 2004 (referred to as A, B, and C), 47 Komodo hatchlings were captured in March (estimated within 4 h post-emergence). These hatchlings averaged 95.5 ± 2.2 g in mass and 18.8 ± 0.1 cm SVL. Hatchlings from two of the three nests were found to be carrying nymphal ticks of one species, *Aponomma komodoense*. Two of 12 hatchlings (16.6%) from Nest A had ticks; one had 1 tick, the other had 3 (Table 1). Clutch B had 16 individuals, 9 (56.3%) of which carried ticks. The number of ticks ranged from 1 to 20, with an average number of ticks per hatchling of 7.4 ± 2.5. Hatchlings (N = 18) from Nest C lacked ticks.

Our results indicate that alongside larger Komodo Dragons, hatchlings can act as tick hosts. By parasitizing hatchlings on emergence, ticks could greatly increase their capacity to find new and,

potentially of greater importance, immunologically naïve hosts (i.e., no acquired resistance). Female dragons, which act as hosts for ticks, spend considerable periods of time around the nest both prior to and after oviposition and thus could enable ticks to deposit eggs (that remain quiescent) around the nest site until hatchlings emerge. Seasonal cues, including the conspicuous transition from an extended dry season through to the short summer wet season coinciding with the monsoon represent an important cue for many organisms breeding in the wet-dry tropics of Australasia (Madsen et al. 2006. Aust. J. Ecol. 31:30–37). This seasonal cue could provide necessary environmental information enabling nymphal ticks to synchronise their own hatching and questing activity with the emergence of hatchling dragons. At present, we do not know whether ticks impart specific fitness consequences to their hatchling hosts.

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SQUAMATA – SNAKES

AGKISTRODON CONTORTRIX (Copperhead). **DIET.** *Agkistrodon contortrix* is known to take a variety of prey items, including the snakes *Carphophis amoenus*, *C. vermis*, *Coluber constrictor*, *Crotalus lepidus*, *Diadophis punctatus*, *Rhinocheilus lecontei*, *Storeria dekayi*, and *Tantilla coronata* (McCrystal and Green 1986. Herpetol. Rev. 17:61; Gloyd and Conant 1990. Snakes of the *Agkistrodon* Complex: A Monographic Review. Society for the Study of Amphibians and Reptiles, Oxford, Ohio. 614 pp.; Palmer and Braswell 1995. Reptiles of North Carolina. University of North Carolina Press, Chapel Hill. 412 pp.; Fitch 1999. A Kansas Snake Community: Composition and Changes Over 50 Years. Krieger Publishing Co., Malabar, Florida. 165 pp.; and references therein). Here we report a novel prey item for *A. contortrix*.

On 23 May 2007 at 1415 h, one of us (JRL) captured a female *A. contortrix* (260 mm SVL, 44 mm tail length, 15 g) on the Camp Shelby Joint Forces Training Center, Perry County, Mississippi, USA. The snake appeared to have recently fed, as indicated by a large bolus in its stomach. Upon palpating, the *A. contortrix* regurgitated a female *Storeria occipitomaculata*, a gravid *Anolis carolinensis*, and a *Scincella lateralis* of undetermined sex. To the best of our knowledge this observation represents the first instance of a *S. occipitomaculata* having been consumed by an *A. contortrix*.

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CROTALUS MOLOSSUS (Blacktail Rattlesnake). **MORPHOLOGY**. Congenital absence of the rattle in rattlesnakes (Crotalidae) has been previously reported for *Crotalus cerastes*, *C. horridus*, and *C. pricei* by Klauber (1972. Rattlesnakes. Their Habits, Life Histories, and Influence on Mankind. Univ. California Press, Berkeley, California. 740 pp.), for *C. atrox* by Painter et al. (1999. Herpetol. Rev. 30:44) and Holycross (2000. Herpetol. Rev. 31:177–178), for *C. viridis* by Holycross (2000. Herpetol. Rev. 31:177), and for *C. lepidus* by Christman et al. (2004. Herpetol. Rev. 35:62). We report here this irregular condition of a missing rattle from another rattlesnake species discovered on a site in far west Texas.

On 6 July 2007, at 2326 h, an adult male *Crotalus molossus* (701 mm SVL, 64 mm tail length, 238.9 g) was found by two of us (LM and VMS) 0.6 km SE of the headquarters complex on Indio Mountains Research Station (IMRS) located ca. 40 km SW of Van Horn, Hudspeth County, Texas, USA (30.773056°N, 105.011944°W, WGS84; 1233 m elev.). IMRS is administered by The University of Texas at El Paso and includes 39,000 acres of rugged Chihuahuan Desert scrub landscape.

Close examination of the posterior end of the tail revealed a blunt tip with overlapping scales devoid of scar tissue, which indicates that the absence of the rattle was congenital and not the result of prior trauma. After processing for body measurements, the rattlesnake was pit-tagged (AVID #: 025-258-063) for permanent identification and then released at original capture site. Because of the snake's size and healthy condition and because the rattleless feature has been reported for adults of other rattlesnake species, we infer that lacking a rattle has negligible effects on survivability. On the other hand, the condition appears to be rare because of the 42 individuals of *C. molossus* captured and marked on IMRS since 1997, only the individual reported herein exhibited the rattleless condition. A digital image is deposited in the photographic collection, Laboratory for Environmental Biology, Centennial Museum, The University of Texas at El Paso (UTEP G2007.1.1).

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LATICAUDA SAINTGIRONSI (Sea Krait). **PREDATION.** Field observations and laboratory experiments indicate that sea snakes quickly and efficiently kill their prey (fishes) by injecting potent venom (Ineich and Laboute 2002. Sea Snakes of New Caledonia. IRD et Muséum national d'Histoire naturelle Editions, Collection Faune et flore tropicales, Paris. 302 pp.). Rapid death is probably essential to foraging success in sea snakes. If death were delayed (as is the case in most species of terrestrial venomous snakes) the fish might escape and be difficult to locate in the marine environment. Here, we present the first record of any species of sea snake regurgitating a living prey item (Moray Eel, *Gymnothorax undulatus*).

In the course of conducting mark-recapture studies of large populations of *Laticauda saintgironsi* and *Laticauda laticaudata* on Signal Islet, New Caledonia (22.29°S, 166.29°E), we captured an adult male (695 mm SVL) *L. saintgironsi* on 8 December 2005 at 1740 h while it was returning from the sea. Immediately after capture, it regurgitated a *G. undulatus*. Spontaneous regurgitation is uncommon in Sea Kraits. We have captured over 3300 Sea Kraits with prey items in their stomachs and have observed less than 10

spontaneous regurgitations. Upon regurgitation, the eel dropped into shallow (5 cm) water and was not easy to catch. We rapidly placed the eel in a container filled with seawater (which we replaced every 15 min.). Initially, the eel moved slowly but was still able to swim. Multiple bite marks visible on the body and the eel's behavior suggest it had been envenomated. The eel became increasingly lethargic over time. After 78 min. it lay on its back, but righted itself after tactile stimulation with a finger. After 95 min., gill (respiratory) movements became almost undetectable. It died 110 min after the regurgitation, very likely due to the effect of the venom. Overall, the eel survived ca. two hours after being bitten, swallowed, and then regurgitated. The eel was deposited in a collection of Sea Krait prey (# 630) at the Centre d'Etudes Biologiques de Chizé (CEBC-CNRS UPR 1934). Our observations indicate that although the venom of *L. saintgironsi* certainly causes a paralysis (perhaps transitory or partial) it does not necessarily kill prey instantaneously. Our observation also indicates that *L. saintgironsi* sometimes forages very near their home islands.

We thank the Direction des Ressources Naturelles de la Province Sud, New Caledonia for issuing the necessary permits.

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MICRURUS CORALLINUS (Painted Coral Snake). **DIET.** The diet of *Micrurus corallinus* includes amphisbaenians, snakes, lizards, and also caecilians (Marques and Sazima 1997. Herptol. Nat. Hist. 5:88–91; Roze 1996. Coral Snakes of the Americas: Biology, Identification and Venoms. Krieger Publ. Co., Malabar, Florida. 328 pp.). The natural predators of *Luetkenotyphlus brasiliensis* (São Paulo Caecilian) are largely unknown (Taylor 1968. The Caecilians of the World. Kansas Univ. Press, Lawrence. 848 pp.). Here, we report a previously unpublished predator-prey relationship.

The record is based on museum specimens from the herpetological collection of the Zoological Museum Hamburg (ZMH). A *L. brasiliensis* (249 mm total length) was removed from the stomach of a *M. corallinus* (ZMH R08751; 899 mm total length) collected by Wilhelm Ehrhardt in March 1910 at "Rio Humboldt-Gebiet (Flussgebiet des Itapocú), Brasilien" (in the vicinity of the Rio Humboldt River basin of the Itapocú, Corupá, Santa Catarina, Brazil). Orientation of the prey in the gut indicates that the snake ingested the caecilian tail-first. The caudal end of the caecilian is partially digested and the last 39 vertebrae are exposed. The anterior part of the caecilian up to the 89th primary annulus is completely undamaged, which is about two-thirds of the animal compared to the 125–131 primary annuli reported for *L. brasiliensis* (Nussbaum 1986. J. Herpetol. 30:441–444).

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PANTHEROPHIS VULPINA VULPINA (Western Fox Snake). **MORTALITY.** Sources of mortality in *Pantherophis vulpina vulpina* are rarely reported. Ernst and Ernst (2003. Snakes of the United States and Canada. Smithsonian Books, Washington D.C.) indicate that predatory birds take adult *P. v. vulpina*, and suggest that carnivorous mammals, automobiles, and habitat destruction might also be significant sources of mortality.

Snake mortality due to prescribed fire has been reported in other regions of North America (e.g., Durbian 2006. Am. Midl. Nat. 155:329–334; Erwin and Stasiak 1979. Am. Midl. Nat. 101:247–249; Smith et al. 2001. Southwest. Nat. 46:54–61), but has not been reported from the upper Midwest. On 16 April 2007 a prescribed fire was ignited on a 10-acre prairie preserve on the McKenzie Environmental Center near Poynette (Columbia County, Wisconsin, USA). Sunny skies, an air temperature of 17°C, and 20% humidity characterize weather conditions on the day of the burn. A post-burn survey of the property revealed a dead *P. v. vulpina* (ca. 90–105 cm TL), which had not escaped the fire. The *P. v. vulpina* was located in a corner of the burn unit where head fire, flanking fire, and backing fire converged. Flame lengths averaged ca. 3 m, giving off an estimated 980 BTUs/foot/second. Vogt (1981. Natural History of Amphibians and Reptiles of Wisconsin. Milwaukee Public Museum, Milwaukee. 205 pp.) suggests that *P. v. vulpina* typically emerge from winter dormancy during the last two weeks of April. If the individual caught in the fire had emerged from dormancy immediately prior to the prescribed fire, it may have been too sluggish to avoid the fire. Because prescribed fire is an effective management tool for short grass habitats, we recommend conducting burns prior to April 1 to avoid causing direct mortality to reptiles emerging from dormancy.

Snakes have been listed as a major predator of *Meleagris gallapavo* (Wild Turkey) eggs and poults (Reagan and Morgan 1980. Proc. Natl. Wild Turkey Symp. 4:136–144), and numerous bird species are reported to actively attack snakes in response to a perceived threat (e.g., Gottfried 1979. Condor 81:251–257). However, defensive attacks upon potential nest raiders are rarely reported (Hewitt [ed.]. 1967. The Wild Turkey and its Management. The Wildlife Society, Washington, D.C. 589 pp.), and those few reports involve attacks against predatory birds or mammals (Johnson 1961. Auk 78:646; Spear et al. 2003. Canad. Field Nat. 117:645–647). The potential effect of these mortality sources on snake populations, particularly in regards to *M. gallapavo* (i.e., predation of snakes and actively attacking snakes to deter a potential nest-predator) is unknown as accounts are mostly anecdotal and difficult to substantiate (but see Beasom and Pattee 1975. Wilson Bull. 87:281–282).

On 16 May 2007 at 1215 h in Polk County (Wisconsin, USA) we (MMC, KAM, and DW) observed an adult hen *M. gallapavo* repeatedly striking the head of an adult *P. v. vulpina* (ca. 1 m TL, 323 g). The bird struck the animal with both its beak and feet for approximately 20 min. MMC and KAM left for approximately 45 min to retrieve a camera and returned to find the hen still striking the snake. The hen was disturbed by their approach and flew off,

carrying the snake for a distance before dropping it. An examination revealed that, prior to the hen's attack, the snake was not underweight and bore no obvious deformities. The snake appeared to be alive throughout the majority of the attack, and attempted to defend itself against the hen before succumbing to its injuries. Although no poults or eggs were noticed, the fact that the turkey did not attempt to consume the snake, suggests that the hen's behavior was defensive rather than predatory.

Although *M. gallapavo* historically occurred in Wisconsin, they had been nearly or completely extirpated from the state by the late 1800s (Kubisiak et al. 2001. Wild Turkey Ecology and Management in Wisconsin. Wisconsin Dept. Nat. Res. PUB-SS-955 2001). Since the 1950s, significant effort has been made to re-establish populations of this species in several upper Midwestern states, including Wisconsin, with great success (Kubisiak et al. 2001, *op. cit.*). Whether turkey populations are a significant source of mortality for syntopic snake populations remains unclear.

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PORTHIDIUM HESPERE (Western Hognose Viper). **ENDOPARASITES.** *Porthidium hespere* is limited in distribution to western Mexico where it is known only from a few specimens (Campbell and Lamar 2004. The Venomous Reptiles of the Western Hemisphere, Vol. 1. Comstock Publ. Assoc., Ithaca, New York. 475 pp.). There are no reports of endoparasites from *P. hespere*. The purpose of this report is to establish the initial helminth list for *P. hespere*. One road-kill female *P. hespere* (total length = 30 cm) was found on Hwy 200, 2.7 km N of the turn off to El Faro de Bucerias, (18.379272°N, 103.515758°W) Michoacán, Mexico on 10 August 2005. It was deposited in the Museo de Zoologia, Facultad de Ciencias, Universidad Nacional Aútonoma de Mexico, Mexico as MZFC 19742. Three nematodes were recovered from the carcass. These were placed in a drop of glycerol on a glass slide. A cover glass was placed on top and the preparation was examined under a compound microscope. The nematodes were identified as one adult male, one adult female, and a juvenile of *Ophidascaris arndti.* These were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland as USNPC (100204).

Sphren (1929. Zool. Anz. 83:280–282) described *O. arndti* from specimens recovered from a *Lachesis lanceolatus* (currently *Bothrops lanceolatus*), a Brazilian snake in the Berlin Aquarium. Sprent (1988. Sys. Parasit. 11:165–213) divided the genus into five groups of species, Group 5 (arndti group) containing two species found in South American crotalines and colubrids, *O. arndti* and *O. sicki*, respectively. Hosts for *O. arndti* also include *Bothrops atrox* (Panama), and *B. cotiara* and *Crotalus durissus* (Brazil) (Sprent, *op. cit.*). Preliminary observations suggest that *O. arndti* is transmitted to crotalines by feeding on infected rodents (Sprent, *op. cit.*). *Porthidium hespere* represents a new host record for *O. arndti*. Mexico is a new locality record.

We thank Christopher I. Grünwald for collection of the *P. hespere*.

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PSAMMOPHIS BISERIATUS (Link-marked Sand Snake). **DIET**. As part of a larger study of psammophiine diets, we dissected and measured specimens of the East African species *Psammophis biseriatus* (N = 25). The sex ratio of the sample was 48% female and 52% male. None of the 20 adults examined contained prey. However, three juvenile females from Kenya had prey remains in their stomachs. CAS 131093 (516 mm SVL, 311 mm TL, 35.1 g) from Kakuma (3.70°S, 34.85°E; map datum WGS84), CAS 134502 (533 mm SVL, tail broken, 42.2 g) from near Mandera (3.93°S, 41.85°E), and CAS 165565 (474 mm SVL, 263 mm TL, 24.9 g) from near Kibwezi (2.70°S, 38.62°E) contained a *Trachylepis striata* (Striped Skink), *Trachylepis brevicollis* (Short-necked Skink), and *Hemidactylus mabouia* (Tropical House Gecko), respectively. None of the prey items extracted was intact enough for accurate measuring and weighing and all were ingested head first.

Psammophis biseriatus is a diurnal, predominately arboreal snake described as an ambush forager (Spawls et al. 2002. A Field Guide to the Reptiles of East Africa. Academic Press, San Diego. 543 pp.). Its known distribution is in eastern Africa, from western Somalia, Eritrea, and eastern Ethiopia south through Kenya to Tanzania, where its distribution becomes discontinuous (Brandstätter 1996. Die Sandrennattern. Westarp-Wissenschaften, Magdeburg, 142 pp.; Spawls et al. 2002, *op. cit.*). This species has been reported to take mostly lizard prey; however, few specific dietary records exist. Previous prey records for *P. biseriatus* are *Latastia longicaudata revoili*, *Heliobolus spekii*, *Trachylepis quinquetaentia*, *T. planifrons*, and *Chamaeleo dilepis roperi* (Loveridge 1940. Bull. Mus. Comp. Zool. 87:1–61; Spawls et al. 2002, *op. cit.*). These new prey records emphasize that scincids are important food sources for *P. biseriatus*, as they are for African *Psammophis* in general (Akani et al. 2003. J. Herpetol. 37:208–211; Shine et al. 2006. Copeia 2006:650–664), and also provide the first evidence of gekkonid prey for the species.

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PSAMMOPHIS CRUCIFER (Cross-marked Grass Snake). **OPHIOPHAGY**. As part of a larger study of psammophine diets, we dissected specimens of the temperate southern African species *Psammophis crucifer.* The stomach of an adult female (TM 69360, 425 mm SVL, 125 mm TL, 19.0 g) from Malolotja Nature Reserve, Swaziland (26.07°S, 31.12°E; map datum WGS84) contained a largely intact *Duberria lutrix* (Slug Eater) (186 mm SVL, 17 mm TL, 5.2 g [relative prey mass 27.2%]) that had been ingested head first. A portion of an unidentified lizard tail was found posterior to the *Duberria*. In addition, the hind gut of an adult male *P. crucifer* (PEM 974, 392 mm SVL, 168 mm TL, 20.2 g) from Port Elizabeth, Eastern Cape, South Africa (33.92°S, 25.57°E) contained the highly digested remains of a small snake that had been ingested head first. The color pattern of the remaining intact scales suggested that the prey was a *Psammophis* species, but the remains were too fragmentary to make a positive identification.

Psammophis crucifer is a habitat generalist that can be found in lowland and montane forest, moist savanna, grassland, and fynbos of southern Africa from the southwestern Cape, to the escarpment of Mpumalanga (Branch 1998. A Field Guide to Snakes and Other Reptiles of Southern Africa. Struik Publishing, Capetown, South Africa. 368 pp.). In Swaziland it co-occurs with *Duberria lutrix* in the highveld and western middleveld (Boycott 1992. A Herpetofaunal Survey of Swaziland. M.Sc. thesis, University of Natal, Durban, South Africa. v + [7] +175 pp., 43 figs.; Boycott and Culverwell 1992. J. Herpetol. Assoc. Afr. 40:38–41). It has been reported to feed chiefly on lizards, especially geckos, and frogs (Broadley 1983. FitzSimon's Snakes of Southern Africa, 3rd ed. Jonathan Ball and Ad. Donker Publishers, Parklands, South Africa. 387 pp.). The diet of most *Psammophis* species comprises predominantly lizards, frogs, or small mammals (Shine et al. 2006. Copeia 2006:650–664.) but ophiophagy has been reported in *P. phillipsi* (Haagner 1990. J. Herpetol. Assoc. Afr. 37:47; Luiselli et al. 2004. Amphibia-Reptilia 25:415–423), and the closely related *P. mossambicus* (Bruton and Haacke 1980. *In* Bruton and Cooper [eds.], Studies on the Ecology of Maputaland, pp. 251–287. Rhodes University, Grahamstown, South Africa; Broadley et al. 2003. Snakes of Zambia. An Atlas and Field Guide. Edition Chimaira, Frankfurt, Germany. 280 pp.; Shine et al., *op. cit.*), both mainly tropical in their distribution and considerably larger in size than *P. crucifer*. This record represents the first record of ophiophagy in *P. crucifer*, or any temperate southern African psammophiine.

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PTYAS MUCOSA (Oriental Rat Snake). **FORAGING BEHAVIOR.** *Bufo bankorensis* (Bankor Toad) is the most abundant anuran species in Da-Jiou-Shi Experimental Forest (Mao, unpubl.) and appears in the diet of *Ptyas mucosa* in Taiwan (Lin et al. 1996. NOW 3:19–21 [in Chinese]).

On 20 June 2006 at 1105 h a *P. mucosa* (ca. 1800 mm TL) was observed subduing a *B. bankorensis* on the northwestern side of a bridge over Orchid Stream (24.45722ºN, 121.67888ºE, 286 m elev.). When we approached the snake it released the toad and escaped. The toad had inflated its body and was covered in blood. Although still alive, the toad appeared to be paralyzed. Forty minutes later, when we returned to the site, we found the same snake with the same toad in its jaws. Our presence disturbed the snake and it again immediately released the toad and escaped into the nearby forest. At 1300 h we returned to the site again, and found the snake once again had the toad in its jaws. This time the snake carried the toad to the southeastern side of the stream, where it then released the toad and fled. At 1400 h when we checked for the last time, we found that the snake had returned and had almost completely ingested the toad.

Prey retrieval behavior is common in predatory birds, especially some raptors (Collopy 1977. Condor 79:63–68). In ophidians, some crotaline species will retrieve their prey after it has been envenomated (Diller 1990. J. Herpetol. 24:95–97). But in our review of the literature, we found no reports describing colubrid snakes retrieving prey they had previously abandoned. The persistence of the snake is especially interesting considering that the predation process was thrice interrupted by potential predators.

Submitted by **JEAN-JAY MAO**, Department of Natural Resources, National Ilan University. No. 1, Sec. 1, Shen-Lung Rd., Ilan, Taiwan 260 (e-mail: jjmao@niu.edu.tw); **GERRUT NORVAL**, Applied Behavioural Ecology & Ecosystem Research Unit, Department of Nature Conservation, UNISA, Private Bag X6, Florida, 1710, Republic of South Africa; and **LAN-WEI YEH**, Department of Natural Resources, National Ilan University.

RHABDOPHIS SWINHONIS (Taiwanese Keel-back)**. DIET**. *Rhabdophis swinhonis* is a diurnal, small to medium sized snake, endemic to Taiwan. Because of its cryptic behavior, little is known of its ecology, behavior, or diet (Lue et al. 1989. Taiwan Snakes. Taiwan Provincial Dept. of Education, Taiwan, Republic of China, 94 pp. [in Chinese]). On 22 April 2006 at 1422 h in Huban District (Yunlin County) we found a *R. swinhonis* (ca. 600 mm TL) ingesting a large earthworm by the side of a trail (23.72194ºN, 120.62444ºE; 191 m elev.). To the best of our knowledge, this is the first reported prey for *R. swinhonis*.

Submitted by **JEAN-JAY MAO**, Department of Natural Resources, National Ilan University. No. 1, Sec. 1, Shen-Lung Rd., Ilan, Taiwan 260 (e-mail: jjmao@niu.edu.tw); **GERRUT NORVAL**, Applied Behavioural Ecology and Ecosystem Research Unit, Department of Nature Conservation, UNISA, Private Bag X6, Florida, 1710, Republic of South Africa; and **HSU-LIANG TSENG** and **I-SHUO TSENG**, Minshiang Environmental & Ecological Research CO., Ltd.

RHINOBOTHRYUM BOVALLII (NCN). **REPRODUCTION.** *Rhinobothryum bovallii* is a large, slender colubrid restricted to Atlantic lowlands from southern Honduras to western Venezuela and to the Pacific lowlands from central western Panama to western Ecuador (4–550 m elev.) (Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna between Two Continents, between Two Seas. Univ. Chicago Press, Chicago, Illinois. 934 pp.). There are no published accounts of reproduction in either of the two species of *Rhinobothryum*.

Here we report on two clutches of eggs laid at the Fort Worth Zoo, Fort Worth, Texas. All of the parental snakes were captured prior to September 2000 from Guayacán de Siquirres, Limon Province, Costa Rica. Three eggs were laid by a female (1320 mm SVL, 282.0 g) on 10 February 2006. The eggs were set up in a 1.5:1 ratio of vermiculite to water at a constant 29.4ºC. Two infertile eggs were discarded on 15 and 23 February 2006. The single fertile egg (52 mm long, 18.1 mm wide, 11.7 g) was opened on 25 April 2006 revealing a seemingly fully developed dead snake (260 mm SVL, 80 mm tail, 11.4 g; University of Texas at Arlington Amphibian and Reptile Diversity Research Center, UTA R 54423) with kinked vertebrae.

A second clutch of 2 eggs (53.4 and 52.1 mm long, 17 and 17.4 mm wide, and 9.5 and 9.8 g respectively) was laid by another female (1142 mm SVL, 182.0 g) on 1 June 2006. Because high incubation temperatures often result in kinked vertebrae, this clutch was incubated on a shelf in a cooler section of the herpetarium in a substrate of 2:1 vermiculite to water by weight. Temperatures varied from a daytime high of ca. 26.6ºC to a nighttime low of ca. 21.1ºC. The morning of 26 September 2006 one egg was manually slit revealing a fully developed live neonate (307 mm SVL, 78 mm tail, 9.8 g). The second neonate (330 mm SVL, 89 mm tail, 10.0 g) hatched without assistance later the same day. All neonates had the same pattern and coloration as the adults, and both surviving neonates fed on juvenile *Anolis carolinensis* after their first ecdysis.

Submitted by **STEPHEN HAMMACK** and **ANDREW BRINKER**, Department of Herpetology, Fort Worth Zoo, 1989 Colonial Parkway, Fort Worth, Texas 76110, USA (e-mail: herp@fortworthzoo.org).

STORERIA OCCIPITOMACULATA OCCIPITOMACULATA (Northern Red-bellied Snake). **MAXIMUM SIZE**. On 2 June 2007, a gravid female *Storeria o. occipitomaculata* measuring 344 mm SVL and 422 mm TL, and weighing 18 g, was found beneath a flat rock on a wooded slope along the east side of US Hwy 62 (41.8148234°N, 79.2723545°W, WGS 84), Warren County, Pennsylvania, USA. This individual exceeds the maximum length record of 406 mm TL reported by Wright and Wright (1957. Handbook of Snakes of the United States and Canada. Comstock Publishing Associates, Ithaca, New York.). On 21 July 2007, this specimen produced a litter of 12 young, three of which were unable to escape from their egg membranes and perished. The litter size is well below the maximum of 21 reported for Pennsylvania *S. o. occipitomaculata* by Hulse et al. (2001. Amphibians and Reptiles of Pennsylvania and the Northeast. Cornell University Press, Ithaca, New York. 419 pp.). Size of the neonates (mean SVL = 71.0, SD = 7.8, range 52–76; mean TL = 91.0, SD = 9.0, range 69–97; N = 12) was slightly below the mean of 73.8 mm for SVL and 96.7 mm for TL reported by Hulse et al. (2001, *op. cit.*). The litter weighed 4 g; postpartum weight of the female was 14 g. The relative clutch mass (RCM) was 0.28, which is lower than the reported mean of 0.60 for this species (Ernst and Ernst. 2003. Snakes of the United States and Canada. Smithsonian Institution Press, Washington, D.C. 668 pp.).

Specimens deposited in Tom Ridge Environmental Center Natural History Collections at Presque Isle State Park (TREC R-031, TREC R-032). Material that was not mounted has been deposited in the Sternberg Museum of Natural History, Fort Hays University, Hays, Kansas. We thank J. T. Collins and J. Beane for encouragement and assistance.

Submitted by **BRIAN S. GRAY,** 1217 Clifton Drive, Erie, Pennsylvania 16505, USA (e-mail: brachystoma@hotmail.com); and **MARK LETHABY,** 535 East 29th Street, Erie, Pennsylvania 16504, USA (e-mail: mlethaby@verizon.net).

THAMNOPHIS BRACHYSTOMA (Short-headed Gartersnake). **PREDATION**. *Thamnophis brachystoma* has a very limited distribution that includes the Allegheny drainage of the Allegheny High Plateau from extreme southwestern New York to northwestern Pennsylvania (Asplund 1963. Herpetologica 19:128–132) and is listed as a species of conservation concern in Pennsylvania. Herein we describe predation on *T. brachystoma* by small mammals, including *Blarina brevicauda* (Northern Short-tailed Shrew) and/or *Microtus pennsylvanicus* (Meadow Vole).

During spring and summer 2005 we recorded vertebrates encountered under an array of 24 sheets of plywood and ca. 34 m^2 of corrugated asphalt (Ondura brand) boards. The coverboard array was located in DuBois, Clearfield County, Pennsylvania (USA) in a seasonally flooded wet meadow dominated by grass and forbs. The coverboard array was checked a total of 38 times during the period 13 April – 19 September at least once a week. On 4 July, 9 September, and 19 September boards were checked twice each day. The three most common vertebrates under the boards in order of occurrence were *T. brachystoma* (N = 183), *M. pennsylvanicus* (N = 81), and *Thamnophis sirtalis* (Eastern Garter Snake; N = 22). *B. brevicauda* (N = 9), *Condylura cristata* (Star-nosed Mole; N = 9), and *Diadophis punctatus* (Ring-necked Snake; N = 1) were also observed. Numerous grass nests were found under the plywood boards and five litters of young *M. pennsylvanicus* were recorded.

On five occasions we found dead *T. brachystoma* under coverboards. In two cases the snakes' head and neck were missing, with the most anterior part of the spine exposed and soft tissue removed, as if stripped off by a predator. These snakes had 38 cm and 33 cm of body and tail length remaining, indicating they were adults. A third dead snake was a 15 cm long juvenile with head and body intact but signs of mutilation on the head and body. The largest dead snake (38 cm remaining) was found with the anterior spine dangling down into a soil crack. Soil cracks were common under the plywood coverboards and snakes and small mammals escaped into them when the boards were lifted. On 23 Sept 2004 (prior to the start of our formal surveys) we observed a dead *T. brachystoma* under the same board as a large food cache of seven earthworms (dead, dying, partially paralyzed or eaten) and snail shells. Although the head was missing, 21 cm of the snake's body remained. A female *B. brevicauda* was captured under the same coverboard in close proximity to the cache two days prior. On 28 Sept 2004 the posterior portion (6 cm) of another freshly killed *T. brachystoma* was found under the same coverboard. A *B. brevicauda* was also under the coverboard in an extensive grass nest (ca. 30 cm in diameter). On four occasions *T. brachystoma* and *M. pennsylvanicus* were found under a plywood board at the same time. The snakes and voles were found from 25

cm to 46 cm apart, and lifting the board caused one or both of the animals to flee for cover.

Small mammals, birds of prey (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Books, London. 668 pp.), and other reptiles (Rossi and Rossi 2003. Snakes of the United States and Canada: Natural History and Care in Captivity. Krieger Publishing Co., Malabar, Florida. 520 pp.) are reported as potential predators of *T. brachystoma*. However, we were unable to find other reports of predation by specific small mammals on this species. The close association of the garter snakes and *M. pennsylvanicus* and *B. brevicauda* under the coverboards and repeated observations of mutilated *T. brachystoma* under the boards suggests that one or both of these mammals is killing these snakes.

Submitted by **JOSEPH W. HUMMER** and **KEELY TOLLEY ROEN**, Pennsylvania State University, DuBois Campus, 1 College Place, DuBois, Pennsylvania, USA (e-mail: kat175@psu.edu).

THAMNOPHIS EQUES (Mexican Gartersnake). **ENDOPARASITISM.** *Thamnophis eques* ranges from the vicinity of the Pico de Orizaba northwest through Sonora and Chihuahua, Mexico to Arizona and New Mexico in the United States (Conant 2003. Amer. Mus. Novit. 3406:1–64). On 15 October 2006 we found an adult male *T. eques* (620 mm SVL, 820 mm TL; Colección Nacional de Anfibios y Reptiles, Instituto de Biología, Universidad Nacional Autónoma de México, CNAR 12229) dead on the bank of Laguna de Yuriria, Guanajuato, Mexico (20.2777°N, 101.1111°W). The snake's mid-body was swollen and upon dissection we found two fourth-stage larvae of *Eustrongylides* sp. in the mesentery and some lesions in the surrounding tissues. Both nematodes were alive, red in color, and measured 97 mm and 124 mm in length (Colección Nacional de Helmintos, Instituto de Biología, Universidad Nacional Autónoma de México, CNHE 5599).

Larval forms of *Eustrongylides* sp. have been reported from *Nerodia sipedon* in Accomack County, Virginia, USA (Bursey 1986. J. Wildl. Dis. 22:527–532), from *T. eques* in Lago de Pátzcuaro, Mexico, and *T. melanogaster* in Pátzcuaro and Cuitzeo Michoacán lagoons, Mexico (Jiménez et al. 2002. J. Parasitol. 88:454–460). Death of captive *T. sirtalis*, with swellings in the body due to infection by *Eustrongylides* sp., has been reported (Lichtenfels and Lavies 1976. Lab. Anim. Sci. 26:465–467). *Eustrongylides* spp. adults have been reported from birds throughout much of the world and are associated with disease and even death in many avian species (Franson and Custer 1994. Colon. Waterbirds 17:168–172; Wiese et al. 1977. J. Wildl. Dis. 13:376–382). The life cycle of this genus of nematodes includes freshwater oligochaetes as first intermediate hosts, fish as second intermediate hosts, and piscivorous birds as definitive hosts. Amphibians and reptiles have been recorded as paratenic hosts (Cooper et al. 1978. J. Parasitol. 64:102–107; Yamaguti 1961. Systema Helminthum. Vol III. The Nematodes of Vertebrates. Interscience Publishers, Inc. New York. 669 pp.). In this context, our observation raises the possibility that infection of *T. eques* by *Eustrongylides* sp. larvae might be a cause of mortality in some wild populations.

Submitted by **ELISA CABRERA GUZMÁN,** Colección Nacional de Anfibios y Reptiles, Instituto de Biología, Departamento de Zoología, Universidad Nacional Autónoma de México, Circuito exterior, Ciudad Universitaria, México D. F. C.P. 04510; e-mail: anfisbenido@yahoo.com.

TRIMORPHODON VILKINSONII (Chihuahuan Lyre Snake). **ARBOREAL BEHAVIOR**. *Trimorphodon vilkinsonii* is a secretive snake that ranges throughout the central and western regions of the Chihuahuan Desert. This species has primarily been encountered in rock piles, rock outcroppings, and talus slopes (Werler and Dixon 2000. Texas Snakes: Identification, Distribution, and Natural History. University of Texas Press). *Trimorphodon biscutatus* is known to be arboreal (Scott and McDiarmid 1984. Cat. Amer. Amph. Rep. 353.1–353.4), as is *T. lambda* (Lowe 1964. The Vertebrates of Arizona. University of Arizona Press, Tucson); however, arboreality has yet to be noted in *T. vilkinsonii*. Here we report on two separate instances of aboreality in this species.

We found a female *T. vilkinsonii* (TNHC 66487; 591 mm SVL, 115 mm TL, 37.4 g) on 5 May 2007 at 2143 h in Cottonwood Canyon of the Sierra Vieja, Presidio County, Texas (30.54739°N, 104.67831°W, 1483 m elev.). This snake was climbing one of the main trunks of a large Gray Oak (*Quercus grisea*) and was 3.35 m above the ground. The cluster of oaks was located where the canyon bottom and rocky talus slope meet. A second female *T. vilkinsoni* (TNHC 66513; 715 mm SVL, 131 mm TL, 88 g) was found on 29 June 2007 at 2230 h in Box Canyon, a drainage on the eastern side of the Sierra Vieja, Presidio County, Texas (30.55059°N, 104.65919°W, 1378 m elev.). The female was found crawling among the outer branches of a Catclaw Acacia (*Acacia gregii*) approximately 1 m above the ground and 2 m from the dry wash.

Both specimens were collected under Texas Parks and Wildlife Scientific Collecting Permit SPR-1097-912 to Travis J. LaDuc. We thank the Miller family for support and assistance.

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GEOGRAPHIC DISTRIBUTION

Herpetological Review publishes brief notices of new geographic distribution records in order to make them available to the herpetological community in published form. Geographic distribution records are important to biologists in that they allow for a more precise determination of a species' range, and thereby permit a more significant interpretation of its biology.

These geographic distribution records will be accepted in a **standard format** only, and all authors *must* adhere to that format, as follows: SCIENTIFIC NAME, COMMON NAME (for the United States and Canada as it appears in Crother [ed.] 2008. *Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico*. SSAR Herpetol. Circ. 37:1–84, available from SSAR Publications Secretary, ssar@herplit.com; for Mexico as it appears in Liner 1994, *Scientific and Common Names for the Amphibians and Reptiles of Mexico in English and Spanish.* Herpetol. Circ. 23:1–113), LOCALITY (use metric for distances and give precise locality data, including lat/long coordinates in **decimal degrees** and cite the map datum used), DATE (day-month-year), COLLECTOR,

VERIFIED BY (*cannot* be verified by an author—curator at an institutional collection is preferred), PLACE OF DEPOSITION (where applicable, use standardized collection designations as they appear in Leviton et al. 1985, *Standard Symbolic Codes for Institutional Resource Collections in Herpetology and Ichthyology*, Copeia 1985[3]:802–832) and CATALOG NUMBER (required), COMMENTS (brief), CITATIONS (brief), SUBMITTED BY (give name and address in full—spell out state or province names—no abbreviations). If publishing specific locality information for a rare or endangered species has the potential to jeopardize that population, please consult with the Section Editor at time of record submission. If field work and/or specimen collection occurred where permits were required, please include permit number(s) and authorizing agency.

Some further comments. This geographic distribution section does not publish "observation" records. Records submitted should be based on preserved specimens which have been placed in a university or museum collection (private collection depository records are discouraged; institutional collection records will receive precedence in case of conflict). A good quality color slide or photograph may substitute for a preserved specimen *only* when the live specimen could not be collected for the following reasons: it was a protected species, it was found in a protected area, or the logistics of preservation were prohibitive (such as large turtles or crocodilians). Color slides and photographs *must* be deposited in a university or museum collection along with complete locality data, and the photographic catalog number(s) must be included in the same manner as a preserved record. Before you submit a manuscript to us, check Censky (1988, *Index to Geographic Distribution Records in Herpetological Review: 1967–1986*; available from the SSAR Publications Secretary) and other sources to make sure you are not duplicating a previously published record. The responsibility for checking literature for previously documented range extensions lies with authors. **Do not submit range extensions unless a thorough literature review has been completed.**

Please submit any geographic distribution records in the **standard format only** to one of the Section Co-editors: **Alan M. Richmond** (USA & Canadian records only); **Jerry D. Johnson** (Mexico and Central America, including the Caribbean Basin); **Indraneil Das** (all Old World records); or **Gustavo J. Scrocchi** (South American records). Short manuscripts are discouraged, and are only acceptable when data cannot be presented adequately in the standard format. **Electronic submission of manuscripts is required** (as Microsoft Word or Rich Text format [rtf] files, as e-mail attachments)**.** Refer to inside front cover for e-mail addresses of section editors.

Recommended citation for new distribution records appearing in this section is: Schmitz, A., and T. Ziegler. 2003. Geographic distribution. *Sphenomorphus rufocaudatus*. Herpetol. Rev. 34:385.

CAUDATA – SALAMANDERS

AMBYSTOMA MACULATUM (Spotted Salamander). USA: ARKANSAS: Desha Co.: 4.8 km SE Dumas off US 65 (Sec. 11, T10S, R4W). 12 April 2006. Nick Covington. Verified by S. E. Trauth. Arkansas State University Herpetological Museum (ASUMZ 30819). New county record filling a distributional gap between previous records in Lincoln (Robison 2006. Herpetol. Rev. 37:481) and Arkansas counties (Trauth et al. 2004. Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.).

Submitted by **HENRY W. ROBISON**, Department of Biology, Southern Arkansas University, Magnolia, Arkansas 71754, USA (e-mail: hwrobison@saumag.edu); and **CHRIS T. McALLISTER**, Department of Physical and Life Sciences, Chadron State College, Chadron, Nebraska 69337, USA (e-mail: cmcallister@csc.edu).

AMBYSTOMA MACULATUM **(**Spotted Salamander). USA: TENNESSEE: Weakley Co: Greenfield (36.2031667°N, 88.8884333°W). 14 November 2007. Joshua M. Hall. Verified by A. Floyd Scott. Austin Peay State University's David H. Snyder Museum of Zoology (APSU 18822 [color slide]). One adult specimen found beneath damp log. New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Austin Peay State Univ. Misc. Publ. 12:1–94; Redmond and Scott 1996. Atlas of Amphibians in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. http//www.apsu.edu/amatlas/).

Submitted by **JOSHUA M. HALL**, Union University, 4105 Caldwell Drive, Milan, Tennessee 38358, USA.

AMPHIUMA TRIDACTYLUM (Three-toed Amphiuma). USA: ARKANSAS: Praire Co.: Hazen (34.7776444°N, 91.5866444°W). 18 October 2007. Jeffery Hunter Sebern. Verified by Stanley E. Trauth. Arkansas State University Museum of Zoology Herpetological Collection (ASUMZ 30821). New county record (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. Univ. of Arkansas Press, Fayetteville. 421 pp.).

Submitted by **MICHAEL V. PLUMMER**, Department of Biology, Box 12251, Harding University, Searcy, Arkansas 72149, USA (e-mail: plummer@harding.edu), **SARAH G. JOHNSON**, and **JOHN R. JOHNSON,** 2401 Audley Bolton, Searcy, Arkansas 72143 USA (e-mail: scientificker@hotmail.com).

ANEIDES AENEUS **(**Green Salamander). USA: INDIANA: Perry Co.: Hoosier National Forest: 38.3 m W of Crawford County Line (38.12133°N, 86.46278°W). 14 November 2007. Angela Garcia. Verified by Chris Phillips, Illinois Natural History Survey (INHS 2007e). New county record (Minton 2001. Amphibians and Reptiles of Indiana. 2nd ed., revised. Indiana Academy of Science. vii–404 pp.) This observation is outside of Indiana's proposed range, suggesting an undiscovered westward projection of a population along the bluffs of the Ohio River. The salamander was captured by hand alongside a small crevice within a rock outcrop. *Aneides aeneus* is a state endangered species, previously known to occur in only two isolated populations in Crawford County.

Submitted by, **ANGELA GARCIA**, **NATHAN ENGBRECHT**, **JAMIE FALLER**, and**, ZACK WALKER**, Wildlife Diversity Section, Indiana Department of Natural Resources Division of Fish and Wildlife, 553 E. Miller Drive, Bloomington, Indiana 47401, USA (e-mail: zwalker@dnr.IN.gov).

HEMIDACTYLIUM SCUTATUM (Four-toed Salamander). USA: ARKANSAS: Perry Co.: 5.6 km NE Hollis, T3N, R19W, Sec18. 19 October 2007. Tobin Fulmer and Destiny Fulmer. Verified by Renn Tumlison. Henderson State University Museum of Zoology (HSUMZ 1412, 1413). Two adults were found under a log in a wooded area. New county record extends known range 24 km N of closest record (Saugey and Trauth 1991. Proc. Arkansas. Acad. of Sci. 45:88–91). A closer specimen, HSU 1086, 16.3 km S, is cataloged in the HSU collection.

Submitted by **TOBIN FULMER,** Arkansas Natural Heritage Commission, 1500 Tower Building, 323 Center Street, Little Rock, Arkansas 72201, USA; and **DESTINY FULMER**, 2305 Laverne Street, Bryant, Arkansas 72022 USA.

HEMIDACTYLIUM SCUTATUM (Four-toed Salamander). USA: INDIANA: Tippecanoe Co.: Brookston 7.5 minute USGS quad map; SW 1/4 of Sec. 21, T24N, R3W. 04 May 2005. Kyle W. Arvin. Verified by Christopher Phillips. Illinois Natural History Survey (INHS photo voucher 2007c). First record for county (Minton 2001. Amphibians and Reptiles of Indiana, rev. 2nd ed.,

Indiana Academy of Science, Indianapolis, Indiana).

First specimen found in upland woods under a log. On 06 May, 07 May and 08 May, 2005, additional specimens were found under logs in upland woods habitat by Kyle Arvin, Delano Arvin, and Rick Howard. On 14 May 2005, LAC found a female attending well-developed eggs in a clump of sedge and mosses. The nesting location was an open, spring-fed wetland dominated by clumps of sedges (*Carex* spp.), skunk cabbage (*Symplocarpus foetidus*), and marsh marigold (*Caltha palustris*). The wetland used for nesting was adjacent to the upland woods where the other salamanders were found.

Submitted by **LEE A. CASEBERE**, Indiana Department of Natural Resources, Division of Nature Preserves, 402 W. Washington Street, Rm. W-267, Indianapolis, Indiana 46204, USA (e-mail: Lcasebere@dnr.in.gov); and **KYLE W. ARVIN**, New York State Seed Testing Laboratory, New York State Agricultural Experiment Station, Cornell University, Sturtevant Hall, 630 West North Street, Geneva, New York 14456, USA (e-mail: kwa3@nysaes.cornell.edu).

NOTOPTHALMUS VIRIDESCENS (Eastern Newt). USA: ARKANSAS: Lonoke Co.: 2.2 km E Ward (T5N, R9W, S25). 3 April 2005. Donald F. McKenzie. Verified by Stanley E. Trauth. Arkansas State University Museum of Zoology Herpetological Collection (ASUMZ 30822). New county record (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. Univ. of Arkansas Press, Fayetteville. 421 pp.).

Submitted by **MICHAEL V. PLUMMER**, Department of Biology, Box 12251, Harding University, Searcy, Arkansas 72149, USA (e-mail: plummer@harding.edu); and **DONALD F. McKENZIE,** Wildlife Management Institute, 2396 Cocklebur Road, Ward, Arkansas 72176, USA (e-mail: wmidm@ipa.net).

NOTOPHTHALMUS VIRIDESCENS LOUISIANENSIS (Central Newt). USA: ARKANSAS: Lincoln Co.: county road 21 at Ten Mile Creek S of Cornerville (Sec. 27, T10S, R8W). 16 March 2006. Henry W. Robison. Verified by S. E. Trauth. Arkansas State University Herpetological Museum (ASUMZ 30820). New county record partially filling a distributional gap between Cleveland and Desha counties (Trauth et al. 2004. Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.).

Submitted by **HENRY W. ROBISON**, Department of Biology, Southern Arkansas University, Magnolia, Arkansas 71754, USA (e-mail: hwrobison@saumag.edu); and **CHRIS T. McALLISTER**, Department of Physical and Life Sciences, Chadron State College, Chadron, Nebraska 69337, USA (e-mail: cmcallister@csc.edu).

ANURA – FROGS

ACRIS CREPITANS (Northern Cricket Frog). USA: TENNESSEE: Haywood Co.: Hatchie National Wildlife Refuge, Hillville 35.48599°N, 89.19597°W. 20 May 2004. Jonathan W. Stanley. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 18222, audio voucher). First county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp.).

Submitted by **JONATHAN W. STANLEY,** Department of Biological Sciences, Arkansas State University, State University, Arkansas 72467, USA; and **BRIAN P. BUTTERFIELD**, Department of Biology, Freed-Hardeman University, Henderson, Tennessee 38340, USA (e-mail: bbutterfield@fhu.edu).

ACRIS CREPITANS (Northern Cricket Frog). USA: TENNESSEE: Tipton Co.: Bear Creek at the junction of Bluff, Coon Valley, Herring, and Pryor roads in the Drummonds 7.5 Minute Quad (35.44682°N, 89.96216°W; NAD83). 17 July 2007. Joshua R. Ennen and Brian R. Kreiser. Verified by A. Floyd Scott. David H. Snyder Museum of Zoology, Austin Peay State University (APSU 18806). One adult captured upstream from bridge in an isolated pool in the flood plain. First record for Tipton County (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 16 pp. Hard copy and Internet (http//www.apsu.edu/amatlas/) versions, the latter of which includes links to information on Tennessee amphibians that has appeared since 1996; accessed 1 November 2007).

The voucher specimen was collected by authors under authority of Tennessee Wildlife Resources Scientific Collecting Permit 1662 and deposited in Austin Peay State University's Museum of Zoology, APSU 18806.

Submitted by **JOSHUA R. ENNEN** (e-mail: Joshua.Ennen@usm.edu) and **BRIAN R. KREISER,** Department of Biological Science, University of Southern Mississippi, Hattiesburg, Mississippi 39406, USA (e-mail: brian.kreiser@usm.edu).

ANAXYRUS AMERICANUS (American Toad). USA: TENNESSEE: Knox Co.: Hardin Valley Area (35.94468°N, 084.20568°W). 06 August 2007. Ted M. Faust. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 18815, color photo). One individual was found on the front porch of a house shortly after sunset at 2105 h. Air temperature 25°C. Two more individuals were found in a nearby flower garden within an hour and a half of the first individual. New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Hard copy and Internet versions, the latter [http://www.apsu.edu/amatlas/ accessed 07 August 2007] including links to data on amphibians in Tennessee that have appeared since 1996).

Submitted by **TED M. FAUST**, 11828 Couch Mill Road, Knoxville, Tennessee 37932, USA; e-mail: tmfaust21@gmail.com.

ANAXYRUS FOWLERI (Fowler's Toad). USA: TENNESSEE: Morgan Co.: 5.4 km SW of Lancing (36.0941194°N, 84.703147°W). 11 May 2007. Ted M. Faust. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 18814, color photo). One individual was found at the base of a bluff at 0940 h. A second individual was found under an overhanging bluff at 1045 h. New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Hard copy and Internet versions, the latter [http://www.apsu.edu/amatlas/ accessed 07 August 2007] including links

to data on amphibians in Tennessee that have appeared since 1996).

Submitted by **TED M. FAUST**, 11828 Couch Mill Road, Knoxville, Tennessee 37932, USA; e-mail: tmfaust21@gmail.com.

ELEUTHERODACTYLUS CYSTIGNATHOIDES (Rio Grand Chirping Frog). USA: LOUISIANA: LAFAYETTE PARISH: Zoo of Acadiana grounds (30.1171333°N, 91.93995°W). 19 April 2007. James W. Beck and Robert C. Dobbs. Color photograph verified by David Cannatella. TNHC 66880. This individual was singing from exotic grass ca. 1 m above the ground within a natural area among zoo buildings, at ca. 2100 h under humid conditions. This represents the first documented record for Lafayette Parish (Dundee and Rossman 1989. Amphibians and Reptiles of Louisiana, Louisiana State Univ. Press, Baton Rouge. 300 pp.), and only the second documented state record (Hardy 2004. Southwest. Nat. 49:263–268). This species is expanding its range to the north and east, presumably as a result of human activity, and is now established throughout much of southeastern Texas, north to Smith and Nacogdoches counties (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. Texas A&M Univ. Press, College Station. 421 pp.; Hibbitts and Saenz 2007. Herpetol. Rev. 38:350), and in Caddo Parish in northwestern Louisiana (Hardy 2004, *op. cit.*).

Submitted by **JAMES W. BECK**, 100 Aurelien Loop #101, Broussard, Louisiana 70518, USA (e-mail: agkistrodon@worldnet.att.net); and **ROBERT C. DOBBS**, Department of Biology, Queen's University, Kingston, Ontario K7L 3N6, Canada (e-mail: 6rcd1@queensu.ca).

GASTROPHRYNE CAROLINENSIS (Eastern Narrow-mouthed Toad). USA: TENNESSEE: GIBSON CO.: Milan (35.970314647°N, 88.714316025°W). 29 April 2007. Joshua M. Hall. Verified by A. Floyd Scott. Austin Peay State University's David H. Snyder Museum of Zoology (APSU 18801 [color slide]). One adult specimen found underneath damp log. New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Austin Peay State Univ. Misc. Publ. 12:1–94; Redmond and Scott 1996. Atlas of Amphibians in Tennessee The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. http://www.apsu.edu/amatlas/).

Submitted by **JOSHUA M. HALL**, Union University, 4105 Caldwell Drive, Milan, Tennessee 38358, USA.

GASTROPHRYNE CAROLINENSIS (Eastern Narrow-mouthed Toad). USA: TENNESSEE: HAYWOOD CO.: Hatchie National Wildlife Refuge, Hillville (35.48599°N, 89.19597°W) 20 May 2004. Jonathan W. Stanley. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 18221, audio voucher). First county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp.).

Submitted by **JONATHAN W. STANLEY,** Department of Biological Sciences, Arkansas State University, State University, Arkansas 72467, USA; and **BRIAN P. BUTTERFIELD**, Department of Biology, Freed-Hardeman University, Henderson, Tennessee 38340, USA (e-mail: bbutterfield@fhu.edu).

HYLA AVIVOCA (Bird-voiced Treefrog). USA: TENNESSEE: FAYETTE CO.: Wolf River Wildlife Management Area, Mineral Slough (35.0292998°N, 89.2734998°W). 05 May 2007. J. Ream and E. Johansen. Verified by A. Floyd Scott. Austin Peay State University's David H. Snyder Museum of Zoology (APSU 18816). Voucher specimen collected by hand at 2200 h along the westernmost shore of a water tupelo/cypress slough adjacent to the Wolf River; many other individuals calling in vicinity. New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Hard copy and Internet versions, the latter [http://www.apsu.edu/amatlas/ accessed 20 November 2007] including links to data on amphibians in Tennessee that have appeared since 1996).

Submitted by **JOSHUA TAYLOR REAM**, Center of Excellence for Field Biology, Austin Peay State University, Clarksville, Tennessee 37044, USA; e-mail: jream14@apsu.edu.

HYLA CINEREA (Green Treefrog). USA: TENNESSEE: TIPTON CO.: Bear Creek at the junction of Bluff, Coon Valley, Herring, and Pryor roads in the Drummonds 7.5-minute quad (35.44682°N, 89.96216°W; NAD83). 17 July 2007. Joshua R. Ennen and Brian R. Kreiser. Verified by A. Floyd Scott. David H. Snyder Museum of Zoology, Austin Peay State University (APSU 18806). One adult captured upstream from bridge in an isolated pool in the flood plain. First record for Tipton County (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 19 pp. Hard copy and Internet (http//www.apsu.edu/amatlas/) versions, the latter of which includes links to information on Tennessee amphibians that has appeared since 1996; accessed 1 November 2007).

The voucher specimen was collected by authors under authority of Tennessee Wildlife Resources Scientific Collecting Permit 1662 and deposited in Austin Peay State University's Museum of Zoology, APSU 18805.

Submitted by **JOSHUA R. ENNEN** (e-mail: Joshua.Ennen@usm.edu) and **BRIAN R. KREISER,** Department of Biological Science, University of Southern Mississippi, Hattiesburg, Mississippi 39406, USA (e-mail: brian.kreiser@usm.edu).

HYLA GRATIOSA (Barking Treefrog). USA: GEORGIA: ATHENS-CLARKE CO.: Whitehall Forest, off of Phoenix Rd. (33.8906°N, 83.3578333°W; WGS 84). 21 August 2007. Collected by Andrew Richard Ferreira. Verified by John Jensen. UGAMNH (GMNH 50083). New county record (Williamson and Moulis 1994. Distribution of Amphibians and Reptiles in Georgia. Savannah Sci. Mus. Spec. Publ. No. 3, Savannah, Georgia. 712 pp.; Mitchell. 2005. *In* M. Lannoo [ed.], Amphibian Declines: The Conservation Status of United States Species, pp. 455–456. University of California Press, Berkeley, California). An adult *H. gratiosa* was found in a plastic cattle tank which held ca. 10 cm of water. On 18 and 29 September 2007, three metamorphic individuals (Gosner Stage 42; Gosner 1960. Herpetologica 16:183–190) were dip-netted from the edge of a pond within Whitehall Forest, located 0.5 km from above specimen location (33.8886139°N, 83.3628°W; WGS 84). The adult and metamorphic individuals suggest a breeding population in Whitehall Forest, Athens-Clarke County, Georgia.

Submitted by **ANDREW R. FERREIRA**, D. B. Warnell School

of Forestry and Natural Resources, University of Georgia, Athens, Georgia 30602, USA; e-mail: ferreiraa@warnell.uga.edu.

HYLA VERSICOLOR (Gray Treefrog). CANADA: ONTARIO: TIMISKAMING DISTRICT: South Lorrain Twp., southern terminus of Hwy 567 at Ontario Power Generation's Lower Notch Generating Station (47.1386°N, 79.4542°W; NAD27). 21 August 2007. Richard Burns. Royal Ontario Museum (ROM) 43033, digital photograph. Verified by Ross D. MacCulloch. One individual perched on a steel platform at the top of an 18 m metal tower at approximately 1300–1500 h (sunny, air temperature 20°C). First record for Timiskaming District, extending its documented range ca. 80 km ENE of the Sheppard Twp. location, ca. 98 km NNW of the location E of North Bay, and ca. 119 km NW of the location W of Deux-Rivières. Reduces the hiatus in NE Ontario 165 km to the NW between this record and an undocumented observation near Parting Lake (47.9703°N, 81.2825°W; NAD27), and another undocumented observation 225 km to the NNW at Nahma Bog, (48.9214°N, 80.8839°W; NAD27).

The documented northern range limit in northeastern Ontario is represented by specimens from the following three localities (west to east): Sudbury Dist., Sheppard Twp., near Sturgeon River (46.9315°N, 80.4555°W; NAD27), uncatalogued larvae identified by F. R. Cook, but material housed at Canadian Museum of Nature (formerly National Museum of Canada, NMC) – 1994; Nipissing Dist., 17 km E of North Bay on Hwy 17 (46.2671°N, 79.2481°W; NAD27), NMC 7067 – May 1963); and, Nipissing Dist., 21 km W of Deux-Rivières on Hwy 17 (46.2850°N, 78.5141°W; NAD27), NMC 28778 – September 1986).

Submitted by **WAYNE F. WELLER**, Ontario Power Generation – Hydro Business, 14000 Niagara Parkway, Niagara-on-the-Lake, Ontario L0S 1J0, Canada.

HYLOMANTIS GRANULOSA (Granular Leaf Frog). BRAZIL: BAHIA: Municipality of Amargosa, Timbó farm (13.1225°S, 40.7752778°W) 750 m elev. 15 April 2007. P. Fonseca. Museu de Zoologia da Universidade Federal da Bahia, Salvador, Brazil (MZUFBA 7.300, 7.301, 7.302). Collected at night on the ground of a cacao plantation. Verified by M. Napoli. Previously known from Recife, Pernambuco state, Brazil (Carnaval et al. 2003. Herpetol. Rev. 34:381; Cruz 1989 [1988] Arquivos da Universidade Federal Rural do Rio de Janeiro 11:41; Cruz 1991. Rev. Brasil. Biol. 50:720). First state record, extends distribution ca. 750 km S from Recife, Pernambuco state (Carnaval et al. 2003, *op. cit*).

Submitted by **MARCO ANTÔNIO DE FREITAS,** Programa de pós-graduação em zoologi.a, UESC (Universidade Estadual de Santa Cruz) CEP 46.500-000 Rodovia Ilhéus/Itabuna, Ilhéus, Bahia, Brazil **(**e-mail: philodryas@hotmail.com**)**; **THAÍS FIGUEIREDO SANTOS SILVA,** Biogeographia publicações e consultoria ambiental, Rua E quadra D lote 11, Jardim Aeroporto, CEP 42700-000, Lauro de Freitas, Bahia, Brazil; **PATRÍCIA MENDES FONSECA** (e-mail: patriciamfonseca@yahoo.com.br) and **RAFAEL OLIVEIRA DE ABREU,** Instituto de Biologia, Museu de Zoologia da Universidade Federal da Bahia (UFBA) CEP 40000-000, Salvador, Bahia, Brazil (e-mail: rafaoabreu@gmail.com).

HYPSIBOAS ALBOPUNCTATUS (Spotted Treefrog). BOLIVIA: BENI: Los Lagos (12.78275°S, 65.8233833°W; 168 m elev.). 08 January 2007. M. Jansen, O. Helmig, and J. Q. Vidoz. Museo Noel Kempff Mercado, Santa Cruz, Bolivia (MNKR 8357), and Museum Senckenberg Frankfurt, Germany (SMF 86655) Specimens found calling at 2140 h in the vegetation 120 cm above ground at the border of an inundated forest. Verified by G. Köhler. Previously known from central, southern, and southeastern Brazil, northeastern Argentina (Provincia Corrientes), northern Uruguay, eastern Paraguay, and eastern Bolivia, Department of Santa Cruz (Frost 2007. Amphibian Species of the World: an Online Reference. Version 5.1 (10 October, 2007) at http://research.amnh.org/herpetology/amphibia/index.php). First departamental record, extending the range ca. 450 km NW from a previous record in the Noel Kempff National Park, Department of Santa Cruz, and ca. 290 km S from a previous record in the Department of Pando, both at the border to Brazil (Reichle 2007. Distribution, Diversity and Conservation Status of Bolivian Amphibians. Diss. Univ. Bonn, Germany. 182 pp.).

Submitted by **MARTIN JANSEN**, Forschungsinstitut und Naturmuseum Senckenberg, Senckenberganlage 25, 60325 Frankfurt am Main, Germany (e-mail: martin.jansen@gmx.net); **JULIAN Q. VIDOZ**, Estancia y Centro de Investigación Ecológica Caparú, Bolivia; and **OSWALDO HELMIG**, Museo de Historia Natural Noel Kempff Mercado, Santa Cruz, Bolivia.

PHYLLODYTES MACULOSUS (NCN). BRAZIL: BAHIA: Municipality of Porto Seguro, Estação Veracel (16.3881667°S, 40.1134444°W), 77 m elev. 22 July 2007. M. A. de Freitas and T. Figueiredo Santos Silva. Museu de Zoologia da Universidade Federal da Bahia, Salvador, Brazil (MZUFBA 7479). Collected at night on bromeliads. Verified by C. A. Gonçalves Cruz. Previously known from Bandeira Municipality, Minas Gerais, and Mascote Municipality, Bahia, Brazil (Cruz et al. 2006. Arquivos do Museu Nacional, Rio de Janeiro 64[4]:321–324). First record from Porto Seguro Municipality southern Bahia, Brazil, and extends distribution ca. 110 km S from Mascote municipality, Bahia (Cruz et al. 2006, *op. cit.*).

Submitted by **MARCO ANTÔNIO DE FREITAS,** Programa de pós-graduação em zoologia, UESC (Universidade Estadual de Santa Cruz) CEP 46.500-000 Rodovia Ilhéus/Itabuna, Ilhéus, Bahia, Brazil (e-mail: philodryas@hotmail.com); and **THAÍS FIGUEIREDO SANTOS SILVA,** Biogeographia publicações e consultoria ambiental, Rua E quadra D lote 11, Jardim Aeroporto, CEP 42700-000, Lauro de Freitas, Bahia, Brazil.

PHYSALAEMUS CUVIERI (Barker Frog). BOLIVIA: BENI: Los Lagos (12.7691167°S, 65.8153333°W; 153 m elev.). 10 January 2007 at 2230 h. M. Jansen, O. Helmig, and J. Q. Vidoz. Museo Noel Kempff Mercado, Santa Cruz, Bolivia (MNKA 8358), and Museum Senckenberg Frankfurt, Germany (SMF 86656). Verified by G. Köhler. Previously known from northeastern, central, and southern Brazil, Misiones and Entre Ríos in Argentina, eastern Paraguay, Department of Santa Cruz in Bolivia, and possibly lowlands of southern Venezuela (Frost 2007. Amphibian Species of the World: an Online Reference. Version 5.1, 10 October 2007 at http://research.amnh.org/herpetology/amphibia/index.php). First departmental record, and the most northwestern locality known in

Bolivia. Nearest known locality is ca. 450 km SSE in the Department Santa Cruz (Reichle 2007. Distribution, Diversity and Conservation Status of Bolivian Amphibians. Diss. Univ. Bonn, Germany. 182 pp.). The specimens were found calling from small puddles in the Cerrado savanna after heavy rain during the day and calls were recorded.

Submitted by **MARTIN JANSEN**, Forschungsinstitut und Naturmuseum Senckenberg, Senckenberganlage 25, 60325 Frankfurt am Main, Germany (e-mail: martin.jansen@gmx.net); **JULIÁN Q. VIDOZ** (e-mail: qvidoz@yahoo.com.ar) and **OSWALDO HELMIG** (e-mail: oswaldito_ha@hotmail.com) Museo de Historia Natural Noel Kempff Mercado, Avenida Irala 565 Casilla postal 2489 Santa Cruz, Bolivia.

PSEUDACRIS FERIARUM (Upland Chorus Frog). USA: TENNESSEE: GIBSON CO.: Milan (35.9058°N, 88.7653°W). 24 February 2007. Joshua M. Hall. Verified by A. Floyd Scott. Austin Peay State University's David H. Snyder Museum of Zoology (APSU 18131 [color slide]). One adult male found calling and collected along with one clutch of eggs in roadside ditch. New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Austin Peay State Univ. Misc. Publ. 12:1–94; Redmond and Scott 1996. Atlas of Amphibians in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. http//www.apsu.edu/amatlas/).

Submitted by **JOSHUA M. HALL**, Union University, 4105 Caldwell Drive, Milan, Tennessee 38358, USA.

SCAPHIOPUS COUCHII (Couch's Spadefoot). USA: TEXAS: KAUFMAN CO.: Terrell (33.228°N, 96.4561667°W). August 1978. D. Schwab. Verified by A. Braswell. North Carolina Museum of Natural Sciences (NCSM 67561). New county record partially filling distribution gap just outside of eastern range limit among Ellis and Hunt Counties (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. Texas A&M University Press, College Station, Texas, 421 pp.).

Submitted by **CHRIS T. MCALLISTER**, Department of Physical and Life Sciences, Chadron State College, Chadron, Nebraska 69337, USA; e-mail: cmcallister@csc.edu.

TESTUDINES – TURTLES

CHELYDRA SERPENTINA (Snapping Turtle). USA: ALABAMA: BIBB CO.: Alabama Hwy 5, 5 km SW of Brent (32.8769444°N, 87.2238889°W). 23 April 2005. Peter V. Lindeman, Kathleen M. Ryan, and Denise I. Stetson. Juvenile specimen of ca. 100 mm midline carapace length observed and photographed crossing the road. Florida Museum of Natural History Herpetology Dept. photographic archive (UF 152443; two images). New county record (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn Univ. Agric. Exp. Sta., Auburn, Alabama. 347 pp.).

Submitted by **PETER V. LINDEMAN**, Department of Biology and Health Services, 150 Cooper Hall, Edinboro University of Pennsylvania, Edinboro, Pennsylvania 16444, USA; e-mail plindeman@edinboro.edu.

CHELYDRA SERPENTINA SERPENTINA (Eastern Snapping Turtle). USA: ARKANSAS: LINCOLN CO.: 3.2 km S Star City (Sec. 29, T9S, R7W). 10 November 1985. M. Evans. Verified by S. E. Trauth. Arkansas State University Herpetological Museum (ASUMZ 30825 [hatchling]). New county record completely filling all the eastern counties of the state (Trauth et al. 2004. Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.). This turtle has now been documented from 69 of 75 (92%) Arkansas counties.

Submitted by **HENRY W. ROBISON**, Department of Biology, Southern Arkansas University, Magnolia, Arkansas 71754, USA (e-mail: hwrobison@saumag.edu); and **CHRIS T. MCALLISTER**, Department of Physical and Life Sciences, Chadron State College, Chadron, Nebraska 69337, USA (e-mail: cmcallister@csc.edu).

GRAPTEMYS NIGRINODA (Black-knobbed Map Turtle). USA: ALABAMA: AUTAUGA CO.: Alabama River, Steele's Landing at southern end of Autauga County Rd. 1. (32.4304333°N, 86.8327389°W). 23 May 2007. Peter V. Lindeman. Verified by James Godwin. Three basking adult males photographed from close range at 30× with a Kowa spotting scope with built-in digital camera. Florida Museum of Natural History Herpetology Dept. photographic archive (UF 152444). New county record (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn Univ. Agric. Exp. Sta., Auburn, Alabama. 347 pp.).

Submitted by **PETER V. LINDEMAN**, Department of Biology and Health Services, 150 Cooper Hall, Edinboro University of Pennsylvania, Edinboro, Pennsylvania 16444, USA; e-mail plindeman@edinboro.edu.

GRAPTEMYS PULCHRA (Alabama Map Turtle). USA: ALABAMA: AUTAUGA CO.: Alabama River, 0.5 km downstream of Steele's Landing at southern end of Autauga County Rd. 1 (32.431811°N, 86.8381472°W). 23 May 2007. Peter V. Lindeman. Verified by James Godwin. Two basking adult females photographed from close range at 30× with a Kowa spotting scope with built-in digital camera. Florida Museum of Natural History Herpetology Dept. photographic archive (UF 152445). New county record (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn Univ. Agric. Exp. Sta., Auburn, Alabama. 347 pp.). PERRY CO.: Cahaba River 200 m S of crossing of County Road 49 near Heiberger (32.7741667°N, 87.2737389°W). 19 April 2007. Peter V. Lindeman. Verified by James Godwin. Basking juvenile female photographed from close range at 30× with a Kowa spotting scope with built-in digital camera. Florida Museum of Natural History Herpetology Dept. photographic archive (UF 152446). New county record (Mount 1975, *op. cit.)*

Submitted by **PETER V. LINDEMAN**, Department of Biology and Health Services, 150 Cooper Hall, Edinboro University of Pennsylvania, Edinboro, Pennsylvania 16444, USA; e-mail plindeman@edinboro.edu.

MESOCLEMMYS TUBERCULATA**.** BRAZIL: MARANHÃO: Municipalidade de Paulino Neves (2.6646389°S, 42.618388°W). 11 July 2005. A. Batistella and C. Pötter. Amphibian and Reptiles Collection, Instituto Nacional de Pesquisas da Amazônia - INPA, Manaus, Brazil (INPA-H 14842–4 collected in rainwater ponds

between sand dunes and the sea). Verified by R. Bernhard. Species previously known from Brazilian States of Ceará, Piauí, and Bahia (Luederwaldt 1926. Rev. Mus. Paulista 14:404–468.; Bour and Pauler 1987. Mesogee 47:3–23; Bour and Zaher 2005. Pap. Avuls Zool. 45:295–311; Loebmann et al. 2006. Check List 2:32–33). First state record, extends the distribution 113 km SW from Luís Correia, Piauí, the previous closest record (Loebmann et al., *op. cit.*).

Submitted by **ALEXANDRE BATISTELLA** (e-mail: alexbatistella@yahoo. com.br), **CAROLINA PÖTTER** (e-mail: pottercarolina@yahoo.com.br), **LARISSA BARRETO** (e-mail: lara@ele.com.br), and **RICHARD C. VOGT,** Instituto Nacional de Pesquisas da Amazônia - INPA, Coleção de Anfíbios e Répteis, Av. André Araújo, nº. 2936, C.P. 478, Manaus, Amazonas, Brazil, CEP 69011-970 (e-mail: vogt@inpa.gov.br).

PSEUDEMYS CONCINNA (River Cooter). USA: ALABAMA: Autauga Co.: Alabama River, 0.5 km downstream of Steele's Landing at southern end of Autauga Co. Rd. 1 (32.4318111°N, 86.8381472°W). 23 May 2007. Peter V. Lindeman. Verified by James Godwin. Three adults photographed from close range at 30× with a Kowa spotting scope with built-in digital camera. Florida Museum of Natural History Herpetology Dept. photographic archive (UF 152447). New county record (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn Univ. Agric. Exp. Sta., Auburn, Alabama. 347 pp.). Dallas Co.: Alabama River, 1 km upstream of Edmund Pettus Bridge in Selma (32.4062°N, 87.0149722°W). 23 May 2007. Peter V. Lindeman. Verified by James Godwin. Adult male photographed from close range at 30× with a Kowa spotting scope with built-in digital camera. Florida Museum of Natural History Herpetology Dept. photographic archive (UF 152448). New county record (Mount 1975, *op. cit.*)

Submitted by **PETER V. LINDEMAN**, Department of Biology and Health Services, 150 Cooper Hall, Edinboro University of Pennsylvania, Edinboro, Pennsylvania 16444, USA; e-mail plindeman@edinboro.edu.

STERNOTHERUS ODORATUS (Eastern Musk Turtle). USA: WISCONSIN: Manitowoc Co.: Pigeon Lake (43.9877778°N, 87.8763889°W). 25 July 2007. Stephen Surendonk. Photographs verified by Robert Hay (Wisconsin Department of Natural Resources-Bureau of Endangered Resources) and Gary Casper. Illinois Natural History Survey catalogue number: INHS 2007d. New county record. Extends range of species in Wisconsin (Casper 1996. Geographic Distributions of the Amphibians and Reptiles of Wisconsin. Milwaukee Public Museum, 87 pp.). One individual captured in a fyke net.

Submitted by **STEPHEN SURENDONK**, Wisconsin Department of Natural Resources, 2220 E. County Highway V, Mishicot, Wisconsin 54228, USA; and **JOSHUA M. KAPFER**, Natural Resources Consulting, Inc., 118 Main St, PO Box 128, Cottage Grove, Wisconsin 53527, USA.

TERRAPENE ORNATA LUTEOLA (Desert Box Turtle). USA: ARIZONA: Pinal Co.: Gila River floodplain, ca 4.2 km (airline) W and 0.2 km (airline) N Gila Co. line at Hwy 177 (W of Hayden), 33.0058°N, 110.8402°W; NAD27; 571 m elev. 23 July 2004. N. Olsker, H. Messing. UAZ 56315-PSV. Within 60 m of San Pedro River, Old PZ Ranch site, S of Dudleyville, (32.8743°N, 110.7224°W; NAD27), 625 m elev. 29 September 2004. R. Llewellyn. UAZ 56302-PSV. Alongside road, ca 0.6 km (airline) SSE Cook's Lake, 32.8546°N, 110.7160°W; NAD27; 657 m elev. 10 August 2003. D. Hall. UAZ 56325-PSV. E side San Pedro River, 9.7 km (by River Rd) SSE Copper Creek Rd (32.6642°N, 110.5930°W; NAD2), 738 m elev. 21 July 2005. R. Bezy, K. Bezy, K. Bolles. UAZ 56301-PSV. ARIZONA: Cochise Co.: San Pedro River Valley, ca 3.3 mi (by Cascabel Rd) SE Cascabel (32.2617°N, 110.3348°W; NAD27), 976 m elev. 22 July 2002. D. Hall. UAZ 56330-PSV. All verified by George Bradley.

These include the first records for Pinal County and extend the range 120 km N from the Whetstone Mts., Cochise County (Turner et al. 2003. Southwest. Nat. 48:347–355) and 40 km NW from Aravaipa Creek and the Bonita grasslands, Graham Co. (Nickerson and Mays 1970. Trans. Kansas Acad. Sci. 72:492–505). The scattering of these records along a 90 km stretch of the lower San Pedro River north to the Gila River floodplain suggests that the populations found in this riparian corridor within the Sonoran Desert are native rather than introduced (released captives).

Submitted by **HENRY MESSING** (e-mail: hmessing@lc.usbr.gov) and **NICHOLE OLSKER** (e-mail: nmolsker@lc.usbr.gov), U.S. Bureau of Reclamation, 6150 West Thunderbird Road, Glendale, Arizona 85306-4014, USA; **ROBIN LLEWELLYN**, 2219 E. Eastland Street, Tucson, Arizona 85719, USA (e-mail: robinia2@msn.com); **DAVID HALL**, 603 N. 3rd Avenue, Tucson, Arizona 85705, USA (e-mail: azkiso@msn.com); **KIT B. BEZY**, Northern Arizona University, Flagstaff, Arizona 86001, USA (e-mail: kbb25@nau.edu); **KATHRYN BOLLES** (e-mail: k_bolles@comcast.net) and **ROBERT L. BEZY** (e-mail: bezy@comcast.net)**,** Natural History Museum of Los Angeles County, Los Angeles, California 90007, USA; and **PHILIP C. ROSEN,** School of Natural Resources, University of Arizona, Tucson, Arizona 85721, USA (e-mail: pcrosen@u.arizona.edu).

TRACHEMYS ADIUTRIX. BRAZIL: PIAUÍ: Lake Sobradinho, Municipalidade de Luis Correia (2.9599444°S, 41.5704444°W). 15 November 2005. A. Rocha Araujo. Amphibian and Reptile Collection, Instituto Nacional de Pesquisas da Amazônia - INPA, Manaus, Brazil (INPA-H 16051– 6). Collected in rainwater-filled ponds between sand dunes and the sea. Verified by R. Bernhard. Previously known only from the type locality: Santo Amaro, Maranhão State, Brazil (Vanzolini 1995. Rev. Brasil. Biol. 55:111–125). First state record, extends the distribution 191 km E from Santo Amaro (Vanzolini, *op. cit.*).

Submitted by **ALEXANDRE BATISTELLA** (e-mail: alexbatistella@yahoo. com.br), **CAROLINA PÖTTER** (e-mail: pottercarolina@yahoo.com.br), and **RICHARD C. VOGT** Instituto Nacional de Pesquisas da Amazônia - INPA, Coleção de Anfíbios e Répteis, Av. André Araújo, no. 2936, C.P. 478, Manaus, Amazonas, Brazil, CEP 69011-970 (e-mail: vogt@inpa.gov.br).

SQUAMATA –LIZARDS

ACANTHOSAURA LEPIDOGASTER (Scale-bellied Spiny Lizard). THAILAND: NAKHON RATCHASIMA PROVINCE: Pak Chong District: Khao Yai National Park, nr. Lamtakong Stream (14.4322222°N, 101.4094444°E) 670 m elev. 09 October 2007.

M. Cota. Thailand Natural History Museum (THNHM-image/071002). Verified by T. Chan-ard. Previously known from northern Thailand and an isolated location in northern peninsular Thailand. Southeastern most record in Thailand, extending known range 230 km S from its nearest previous locality in Phu Khieo National Park, Khon San District, Chaiyaphum Province (Nabhitabhata et al. 2000. Checklist of Amphibians and Reptiles in Thailand. OEPP, Bangkok. 152 pp.; Nabhitabhata and Chan-ard 2005. Thailand Red Data: Mammals, Reptiles and Amphibians. OEPP, Bangkok. 234 pp.). This report represents the sole record in Thailand east of the Chao Phraya River basin and the flood plain region.

Submitted by **MICHAEL COTA**, Thailand Natural History Museum, National Science Museum, Technopolis, Khlong 5, Khlong Luang, Pathum Thani 12120 Thailand; e-mail: Herpetologe@gmail.com.

ELGARIA COERULEA PRINCIPIS (Northwestern Alligator Lizard). USA: IDAHO: VALLEY CO.: A single individual was observed ca. 4.6 km NE of Edwardsburg along the Big Creek Trail about 200–400 m downstream of the trailhead in the Frank Church River of No Return Wilderness, Payette National Forest (45.1538°N, 115.2935°W; NAD 83). 24 July 2006. Javan Bauder, Ashley Lange, and Brad Tucker. Color voucher photo deposited at the Idaho Museum of Natural History (IMNH 1923). Verified by Charles R. Peterson. Individual was crawling across dirt trail towards a talus slope at ca. 1700 h with sunny skies and 40–50% cloud cover. Had lost all but ca. 3 cm of its tail, the last ca. 1 cm of which appeared to be regrowth. New county record for this species, which extends the range ca. 105 km S of nearest unpublished observation (Idaho Co., Idaho; Bill Bosworth, Idaho Conservation Data Center, Idaho Department of Fish and Game, pers. comm.). Nearest published observations are ca. 195 and 225 km NW in Latah Co., Idaho (Nussbaum et al. 1983. Amphibians and Reptiles of the Pacific Northwest. University of Idaho Press, Moscow, Idaho; Cossel 1997. *Elgaria coerulea*. Digital Atlas of Idaho, http://imnh.isu.edu/digitalatlas/ bio/reptile /main/ repfram.htm, respectively).

Submitted by **JAVAN BAUDER**, Department of Fish and Wildlife Resources, University of Idaho, Moscow, Idaho 83844, USA. Current addres: Department of Biological Sciences, Idaho State University, Pocatello, Idaho 83209, USA; e-mail: baudjava@isu.edu.

HELIOBOLUS NITIDUS NITIDUS (Günther's Desert Lacertid). NIGER: Koure village (13.3433333°N, 02.57515°E; 408 m elev.). L. Chirio and I. Ineich. MNHN 2007.0038–51. Verified by Patrick David. First country record. Extends known range of subspecies 200 km N and into a former country gap, and previously known from Ivory Coast (Rödel et al. 1997. Salamandra 33[4]:225–240 [as *H. n. nitida*]), unreported from Ghana, Togo (Tornier 1901. Arch. Naturgesch., Beiheft Festschrift für Eduard von Martens, pp. 63–88), Benin (Loveridge 1952. Bull. IFAN, Dakar, sér. A, 14:229–242), and Nigeria (Dunger 1967. The Nigerian Field 32[3]:117–132 [as *Eremias nitida*]). A second subspecies, *H. n. garambensis* is known from Cameroon (Monard 1951. Mém. l'IFAN, sér. Sci. Nat. 1:123–170), Central African Republic (Joger 1990. *In* Peters and Hutterer [eds.], Vertebrates in the Tropics. Museum Alexander Koenig, Bonn; Chirio and Ineich 2006. African J. Herpetol. 55[1]:23–59), and Democratic Republic of Congo (formerly Zaire) (Schmidt 1919. Bull. Amer. Mus. Nat. Hist. 39:385–624 [as *Eremias nitida*]). Papenfuss (1969. Wasmann J. Biol. 27[2]:249–325) considered the species as inhabiting west African savannas from Guinea to Cameroon, but distribution clearly extends more to the east.

Submitted by **IVAN INEICH** and **LAURENT CHIRIO**, Muséum national d'Histoire naturelle, Département de Systématique et Evolution, USM 602 (Reptiles – Taxonomie et Collections) CP 30, 25 rue Cuvier, 75231 Paris Cedex 05, France; e-mail: ineich@mnhn.fr.

HEMIDACTYLUS TURCICUS TURCICUS (Mediterranean Gecko). USA: TEXAS: WILLIAMSON CO.: Georgetown, Sun City, N of Berry Creek bridge on Del Webb Blvd. 10 May 2007, DOR. TNHC 66523 (JLC 7136). Georgetown, 4304 Miramar. 01 August 2007. TNHC 66524 (JLC 7141*)*. BELL CO. Residence wall on farm road 2484, 3.5 mi. S. of Texas 195. 31 July 2007. TNHC 66525 (JLC 7145*)*. Verified by Travis LaDuc. First county records; fills in records for central Texas. (Dixon 2000. Amphibians and Reptiles of Texas. 2nd Edition. Texas A&M Univ. Press, College Station, 421 pp.).

Submitted by **JAMES L. CHRISTIANSEN**, Texas Natural History Collections, Texas Natural Science Center, The University of Texas at Austin, Austin, Texas 78705, USA; and **RICHARD WOOLHEATER,** 136 Fox Home Lane, Georgetown, Texas 78633, USA.

HEMITHECONYX CAUDICINCTUS (Fat-tailed Gecko). MAURITANIA: GUIDIMAKA REGION: 2 km NW Mbalou village (15.0333333°N, 12.083333°W). 15 November 2003. Jean-François Trape and Georges Diatta. Institut de Recherche pour le Développement at Dakar (IRD TR-166). Verified by Ivan Ineich. First record for Mauritania. A large adult male measuring 205 mm (122 + 83). Found inside a termitarium, ca. 2 m high during a study of borreliosis, when examining the content of a hole by introducing a flexible tube and sucking out contents with a portable petrol-powered aspirator (Vial et al. 2006. Lancet 368:37–43). Most records are from Sudan or Guinea savannah regions, and only two reach the 15th parallel: at Nioro du Sahel (15.233333°N, 09.5833333°W) in Mali, and Yonoféré (15.2666667°N, 14.466666°W) in Senegal (Grandison 1956. Bull. IFAN. 18[A]:224–245; Cisse and Karns 1978. Bull. IFAN. 40:144–211).

Submitted by **JEAN-FRANÇOIS TRAPE** and **GEORGES DIATTA**, Institut de Recherche pour le Développement (IRD, UR 77), B.P. 1386, Dakar, Sénégal; e-mail: trape@ird.sn.

PHYSIGNATHUS COCINCINUS (Chinese Water Dragon). THAILAND: NONG KHAI PROVINCE: SANGKHOM DISTRICT: Sangkhom Forest Reserve/Research Center for Medicinal Plants and Spices, along Nam Prai Stream (18.08°N, 102.2105556°E), 223 m elev.). 17 October 2007. M. Cota. Thailand Natural History Museum (THNHM 12868). Verified by T. Chan-ard. Previously known from eastern Thailand and an isolated locality in Sakon Nakhon Province. Northwestern most record, extending known range 220 km WNW from nearest record in Sakon Nakhon Province and N > 350 km from eastern Thailand at its closest point in Nakhon Ratchasima Province (Nabhitabhata et al. Checklist of

Amphibians and Reptiles in Thailand. OEPP, Bangkok. 152 pp.; Nabhitabhata and Chan-ard 2005. Thailand Red Data: Mammals, Reptiles and Amphibians. OEPP, Bangkok. 234 pp.). This report places the species in the region that transitions from the Khorat Plateau to the mountainous region that forms the topography of northern Thailand. The majority of the Khorat Plateau does not possess suitable habitat and is used primarily for agriculture, but it is possible that there are other isolated populations in areas retaining forest cover and permanent streams, canals, or rivers.

Submitted by **MICHAEL COTA**, Thailand Natural History Museum, National Science Museum, Technopolis, Khlong 5, Khlong Luang, Pathum Thani 12120 Thailand; e-mail: Herpetologe@gmail.com.

SCINCELLA LATERALIS (Little Brown Skink). USA: ARKANSAS: Chicot Co.: 3.2 km N jct. St. Hwy. 8 in Eudora (Sec. 14, T18S, R2W). 18 May 2004. D. J. Monks. Verified by S. E. Trauth. Arkansas State University Herpetological Museum (ASUMZ 30818). New county record. This skink has now been documented for all 75 counties of the state (Trauth et al. 2004. Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.).

Submitted by **HENRY W. ROBISON**, Department of Biology, Southern Arkansas University, Magnolia, Arkansas 71754, USA (e-mail: hwrobison@saumag.edu); and **CHRIS T. McALLISTER**, Department of Physical and Life Sciences, Chadron State College, Chadron, Nebraska 69337, USA (e-mail: cmcallister@csc.edu).

SPHAERODACTYLUS ELEGANS ELEGANS (Ashy Gecko). USA: FLORIDA: Broward Co.: Pembroke Pines: 1031 NW 93rd Ave (26.0168833°N, 80.2695694°W; WGS84; elev. <1 m). 27 October 2007. Collected by Lisa A. Charlton. Verified by F. Wayne King, Florida Museum of Natural History, University of Florida. One neonate captured in Jackson sticky trap set to sample insects in an alee tree (*Blighia sapida*). UF 152418. New county record. Originally turned in to Division of Plant Industry (DPI), Florida Department of Agriculture and Consumer Services, Gainesville, Florida, on 31 October 2007; Entomology Log No. 8204. This nonindigenous gecko was first reported from Key West, Monroe County, Florida, more than 85 years ago (Stejneger 1922. Copeia [108]:56). Since that time the species has slowly expanded its range through other islands in the Florida Keys, and onto mainland Florida in Miami, Miami-Dade County (Carr 1940. Univ. Florida Publ. Biol. Sci. Ser. 3[1]:1–118; Krysko and Daniels 2005. Caribb. J. Sci. 41:28–36.). On 11 September 1937, a single *Sphaerodactylus e. elegans* was collected in Port Everglades, Broward County, Florida (UF 183) and on 26 January 1963, another collected from inside a house in Miami, Miami-Dade County, Florida (UF 84234). This latest specimen is the third known mainland record in the continental U.S.

Submitted by **LOUIS A. SOMMA**, Department of Zoology, PO Box 118525, 223 Bartram Hall, University of Florida, Gainesville, Florida 32611-8525, USA (e-mail: las@zoo.ufl.edu); and **KENNETH L. KRYSKO**, Division of Herpetology, Florida Museum of Natural History, Dickinson Hall, University of Florida, Gainesville, Florida 32611, USA (e-mail: kenneyk@flmnh.ufl.edu).

TROPIDOPHORUS ASSAMENSIS (Assamese Water Skink). INDIA: ASSAM: Barail Hill Range, Adakuchi Basti Nullah (24.993°N, 92.7424°E), 163 m elev. 1215 and 1300 h on 29 March 2007. One example (SVL 41.23 mm; BNHM 1783) and another (SVL 68.65 mm; in private collection, AD/BR 05) collected from under bryophyte-covered rocks of evergreen forest streambed. Third specimen photographed from Lakhicherra Nullah, Barail Wildlife Sanctuary (24.9473667°N, 92.7781833°E), 40 m elev., 1022 h on 2 April 2007, under rocks of slow-flowing stream. Verified by Indraneil Das. Previously known from Nengpui Wildlife Sanctuary of Mizoram (Pawar and Birand 2001. A Survey of Amphibians, Reptiles and Birds in Northeast India, CERC Technical Report #6, Centre for Ecological Research and Conservation, Mysore. 118 pp.). First record from Assam state and ca. 300 km N of previous locality.

Submitted by **ABHIJIT DAS**, Division of Herpetology, Aaranyak, Samanwoy Path, Survey, Beltola, Guwahati 28, Assam, India; e-mail: abhijit@aaranyak.org.

SQUAMATA – SNAKES

AGKISTRODON BILINEATUS (Cantil). MÉXICO: SONORA: Municipality of Rosario Tesopaco, 13.2 m N of Tesopaco on Hwy 12. (ca. 27.81°N, 109.35°W). 13 August 1991. Randall D. Babb, Peter J. Mayne, Adam B. Schwalbe, and Amy Haddock. Verified by Charles H. Lowe and Cecil R. Schwalbe. UAZ 56577-PSV (specimen given to the Centro De Ecológico de Sonora). Northernmost record for this species in México and extends the known range ca. 120 km NW from the closest known locality near Alamos, Sonora (Schwalbe and Lowe 2002. *In* Robichaux and Yetman [eds.], The Tropical Deciduous Forest of Alamos, pp. 172–199. Univ. Arizona Press, Tucson, Arizona). The adult male was DOR in an area of tropical dry forest.

Submitted by **RANDALL D. BABB**, Arizona Game and Fish Department, Region VI Office, 7200 E. University, Mesa, Arizona, 85207, USA (e-mail: rbabb@azgfd.gov); and **ERIC A. DUGAN**, Department of Earth and Biological Sciences, Loma Linda University, Loma Linda, California 91330-9303, USA (e-mail: edugan1@hotmail.com).

CARPHOPHIS VERMIS (Western Wormsnake). USA: ARKANSAS: Lafayette Co.: Stamps (Sec. 21, T16S, R23W). 05 October 1989. J. Davis. Verified by S. E. Trauth. Arkansas State University Herpetological Museum (ASUMZ 30824). New county record partially filling distributional gap between Columbia and Hempstead counties (Trauth et al. 2004. Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.). Most records of this snake are in central and northern Arkansas (Trauth et al. 2004, *op. cit.*, fig. 493). Although extensive southern gaps remain, the species has now been reported from five counties in the extreme southern part of the state (see also Robison and McAllister 2007. Herpetol. Rev. 38:245–246).

Submitted by **HENRY W. ROBISON**, Department of Biology, Southern Arkansas University, Magnolia, Arkansas 71754, USA (e-mail: hwrobison@saumag.edu); and **CHRIS T. McALLISTER**, Department of Physical and Life Sciences, Chadron State College, Chadron, Nebraska 69337, USA (e-mail: cmcallister@csc.edu).

CEMOPHORA COCCINEA (Scarletsnake). USA: FLORIDA: LAFAYETTE CO.: 0.48 km N of County Road 360 on State Road 51 (30.01245°N, 83.1937833°W), 2219 h. 4 June 2004. Michael E. Welker and Michael Arnold. Verified by Kenneth L. Krysko. Florida Museum of Natural History, Gainesville, Florida (UF 142711, 142712). New county record and range extension (Ashton and Ashton 1988. Handbook of Reptiles and Amphibians of Florida. Part 1. The Snakes. Second Edition. Windward Publishing, Miami, Florida. 176 pp.). These two specimens were found DOR at the same location. Both were adult males and both have 8-8 upper labials. Further, the first black body blotch is separated from the parietal scales by one scale in both specimens. The Northern Scarletsnake (*C. c. copei*) usually has 6-6 upper labials and the first black body blotch touches the parietal scales. The Florida Scarletsnake (*C. c. coccinea*) usually has 7–7 upper labials and the first black body blotch is separated from the parietal scales by one to four scales. Thus these two specimens appear to more closely resemble the morphological characters for *C. c. coccinea*, the Florida Scarletsnake. However, *C. c. coccinea* is known to occur about 90 miles to the south at the northern extent of its range.

Submitted by **MICHAEL E. WELKER**, 3105 Eads Place, El Paso, Texas 79935, USA (e-mail: herpcon@cox.net); and **MICHAEL ARNOLD**, 1911 NW 55th Terrace, Gainesville, Florida 32605, USA (e-mail: marnold35@cox.net).

COLUBER CONSTRICTOR (North American Racer). USA: MINNESOTA: FILLMORE CO.: County Road 27, ca. 3.2 km W of River Road (east of Rushford). 5 October 2007. Stephen J. Schmitt and Philip A. Cochran. James Ford Bell Museum (JFBM 15217). Verified by Kenneth H. Kozak. DOR. First county record (Oldfield and Moriarty 1994. Amphibians & Reptiles Native to Minnesota. University of Minnesota Press, Minneapolis, Minnesota. 237 pp.).

Submitted by **STEPHEN J. SCHMITT** (e-mail: sjschm04@smumn.edu) and **PHILIP A. COCHRAN,** Biology Department, Saint Mary's University of Minnesota, 700 Terrace Heights, Winona, Minnesota 55987, USA (e-mail: pcochran@smumn.edu).

DIADOPHIS PUNCTATUS REGALIS (Regal Ring-necked Snake). USA: IDAHO: JEROME CO.: A single individual was observed ca. 10.4 km S of Jerome within the Snake River Canyon (42.6303°N, 114.5168°W; NAD83/WGS84). 31 May 2001. Javan Bauder and Jared Bauder. Color voucher photo deposited at the Idaho Museum of Natural History (IMNH 1922). Verified by Charles R. Peterson. Individual was lying in cheatgrass at the base of a large boulder ca. 1130 h with sunny skies and <10% cloud cover. Surrounding area consisted of scattered boulders intermixed with cheatgrass. First county record. Extends the published range of this species west ca. 170 km. An unpublished observation of *D. p. regalis* was made from Twin Falls County, Idaho, on the rim of the Snake River Canyon, ca. 6 km SE on 03 April 2006 (Bill Bosworth, Idaho Conservation Data Center, Idaho Department of Fish and Game, pers. comm.), suggesting that these observations may represent a previously undocumented population. Nearest published observations of *D. p. regalis* are from Bannock County, Idaho (Nussbaum et al. 1983. Amphibians and Reptiles of the Pacific Northwest. University of Idaho Press, Moscow, Idaho; Cossel 1997. Digital Atlas of Idaho, http://imnh.isu.edu/digitalatlas/bio/reptile /main/ repfram.htm). *Diadophis punctatus* is also documented from Boise County, Idaho, ca. 190 km NW (Nussbaum et al. 1983, *op. cit.*) and is reported as *D. p. occidentalis* (Wright and Wright 1957. Handbook of Snakes of the United States and Canada. Comstock Publishing Associates, Ithaca, New York).

Submitted by **JAVAN BAUDER**, Department of Biological Sciences, Idaho State University, Pocatello, Idaho 83209, USA; e-mail: baudjava@isu.edu.

ECHINANTHERA CEPHALOSTRIATA (NCN). BRAZIL: BAHIA: Municipality of Jussari, Boa Vista farm. 24 August 1992. M. O. Santos. Coleção Zoológica Gregório Bondar, of the Centro de Pesquisas do Cacau, Ilhéus, Bahia (CZGB 2045); Municipality of Arataca, Alto Rocha farm (15.1533333°S, 39.3025°W, 600–700 m elev.). 10 May–25 June 2001. Collector unknown. Museu de Zoologia da Universidade Estadual de Santa Cruz, Ilhéus, Bahia (MZUESC 1213); Municipality of Barra do Choça, Recanto da Adriana farm (14.9588889°S, 40.5491667°W, 800–900 m elev.) 02 May–29 November 2004. J. O. Ruas. (MZUESC 4337). Municipality of Pau Brasil, Mira Serra farm (15.3722222°S, 39.59°W, 600–700 m elev.) 05 October 2005–01 February 2006. Collector unknown. (MZUESC 4820). Precise data of the last three specimens are unknown, dates indicate periods between visits to the farms. All verified by V. Germano. The species was known from Espirito Santo to northeastern Santa Catarina, Brazil (Di-Bernardo 1996. The Snake 27:120–126). First state records extend known range 550 km N of Santa Teresa, the previous nearest locality known.

Submitted by **ANTÔNIO JORGE SUZART ARGÔLO,** Universidade Estadual de Santa Cruz – UESC, Km 16 Rodovia Ilhéus-Itabuna, CEP 45662-000, Ilhéus, Bahia, Brazil (e-mail: lachesis@uesc.br); and **JULIANA ALVES DE JESUS,** Rua Tertuliano Guedes de Pinho, n. 60, Apt 201, Bairro Jaçanã, CEP 45608-455, Brazil (e-mail: juli_dae@hotmail.com).

LAMPROPELTIS TRIANGULUM ELAPSOIDES (Scarlet Kingsnake). USA: FLORIDA: HAMILTON CO.: 21.1 km N of U.S. 41 on County Road 135 (30.4850167°N, 82.7112667°W), 1923 h. 10 May 2004. Michael E. Welker and Michael Arnold. Verified by Kenneth L. Krysko. Florida Museum of Natural History, Gainesville, Florida (UF 142709). New county record and range extension (Ashton and Ashton 1988. Handbook of Reptiles and Amphibians of Florida. Part 1. The Snakes. Second Edition. Windward Publishing, Miami, Florida. 176 pp.). This large adult male was captured alive as it began to enter the roadway. It died in captivity on 29 June 2004.

Submitted by **MICHAEL E. WELKER**, 3105 Eads Place, El Paso, Texas 79935, USA (e-mail: herpcon@cox.net); and **MICHAEL ARNOLD**, 1911 NW 55th Terrace, Gainesville, Florida 32605, USA (e-mail: marnold35@cox.net).

LYCODON JARA (Yellow-speckled Wolf Snake). INDIA: HARYANA: Kalesar National Park (30.8°N, 77.34°E), 314 m elev. 13 March 2007. A. N. Rizvi. Northern Regional Station, Zoological Survey of India, Dehra Dun, Uttarakhand. ZSI NRS R.61. Verified by Indraneil Das. First record from Haryana State. Known from Dehra Dun (Uttarkhand), Ganjam (Orissa), east to the eastern Indian states of West Bengal and Arunachal Pradesh (Whitaker

and Captain 2004. Snakes of India. The Field Guide. Draco Books, Chennai. xiv + 481 pp.), and extension of range to the west by ca. 75 km W of Dehra Dun.

Submitted by **ARCHANA BAHUGUNA** and **P. T. BHUTIA**, 218 Kaulagarh Road, Dehra Dun 248195, Uttarakhand, India; e-mail: bahugunaarch_nandini@yahoo.co.in.

MICRURUS FULVIUS (Harlequin Coralsnake). USA: FLORIDA: LAFAYETTE CO.: 5.15 km N of Dixie County line on County Road 357 (29.86575°N, 83.2381167°W), 1700 h. 2 May 2004. 0.97 km N of Dixie County line on County Road 357 (29.8337333°N, 83.237116°W), 1915 h. 29 September 2004. Michael E. Welker and Michael Arnold. Verified by Kenneth L. Krysko. Florida Museum of Natural History, Gainesville, Florida (UF 141545, 142710). New county record and range extension (Ashton and Ashton 1988. Handbook of Reptiles and Amphibians of Florida. Part 1. The Snakes. Second Edition. Windward Publishing, Miami, Florida. 176 pp.). The first specimen (UF 141545) was an adult and the second specimen (UF 142710) was a small juvenile. Both were found DOR.

Submitted by **MICHAEL E. WELKER**, 3105 Eads Place, El Paso, Texas 79935, USA (e-mail: herpcon@cox.net); and **MICHAEL ARNOLD**, 1911 NW 55th Terrace, Gainesville, Florida 32605, USA (e-mail: marnold35@cox.net).

PSAMMODYNASTES PICTUS (Painted Mock Viper). INDONESIA: SULAWESI: Propinsi Sulawesi Tenggara, Kabupaten Kolaka Utara, Kecamatan Lasusua, Desa Tobaku (3.4166667°S, 120.8666667°E), 19–27 m elev. 13 August 2007. J. A. McGuire, R. A. Chong, B. J. Evans, C. W. Linkem, R. Elianur, N. P. Sumanto, and A. Rasit. JAM (Jimmy A. McGuire field series, uncataloged voucher at MZB or MVZ, 7289–91). 4 September 2007. J. A. McGuire, R. A. Chong, C. J. Hayden, N. P. Sumanto, Umilaela, and A. Rachmansyah. (JAM 8352–69, 8422). Verified by D. T. Iskandar. Easternmost record (Stuebing and Inger 1999. A Field Guide to the Snakes of Borneo. Natural History Publications [Borneo] Sdn. Bhd., Kota Kinabalu. vii + 254 pp.). The range currently includes Malaysia, Singapore, and Indonesia (Borneo, Riau Archipelago, and Sumatra), but has not been previously reported from Sulawesi (de Lang and Vogel 2006. The Snakes of Sulawesi. A Field Guide to the Land Snakes of Sulawesi with Identification Keys. Edition Chaimaira, Frankfurt am Main. 312 pp.). A total of 22 individuals were collected: 12 males (SVL 350–435 mm), six females (SVL 360–389 mm), and four juveniles (SVL 230–295 mm). All collected in vegetation alongside or overhanging a small, highly disturbed stream within cacao plantations. Due to the disturbed nature of the habitat and the abundance of specimens collected at this one site, even after thorough sampling of surrounding areas, we suspect it was introduction through human agencies on the island.

Submitted by **REBECCA A. CHONG** (e-mail: rchong@berkeley.edu), and **JIMMY A. MCGUIRE** (e-mail: mcguirej@berkeley.edu), Museum of Vertebrate Zoology, University of California, Berkeley, California 94720, USA (e-mail: mcguirej@berkeley.edu).

REGINA RIGIDA RIGIDA (Glossy Crayfish Snake). USA: FLORIDA: LAFAYETTE CO.: 7.6 km E of State Road 51 on County Road 360 (29.9918833°N, 83.1198333°W), 2348 h. 13 May 2005. Michael E. Welker and Michael Arnold. Verified by Kenneth L. Krysko. Florida Museum of Natural History, Gainesville, Florida (UF 144324). New county record and range extension (Ashton and Ashton 1988. Handbook of Reptiles and Amphibians of Florida. Part 1. The Snakes. Second Edition. Windward Publishing, Miami, Florida. 176 pp.). This specimen was found writhing in the road, apparently after just being hit by a motor vehicle. It died a short time later.

Submitted by **MICHAEL E. WELKER**, 3105 Eads Place, El Paso, Texas 79935, USA (e-mail: herpcon@cox.net); and **MICHAEL ARNOLD**, 1911 NW 55th Terrace, Gainesville, Florida 32605, USA (e-mail: marnold35@cox.net).

RAMPHOTYPHLOPS BRAMINUS (Brahminy Blindsnake). USA: FLORIDA: LAKE CO.: Astatula, Lake Co. Landfill, 1.1 km SE of junction of State Road 19 and County Road 448 (28.7581667°N, 81.7453333°W; WGS84). 06 December 2007. Ridge Kaiser, Jennifer L. Matusick, and Julie Hanson. Florida Museum of Natural History photographic voucher (UF 152547). Verified by Kenneth L. Krysko. New county record. This exotic species has now been collected from at least 18 counties in Florida (Somma 2007. Herpetol. Rev. 38:355–356), and it has been documented from two adjacent counties, Seminole (Owen et al. 1998. Herpetol. Rev. 29:115) and Orange (Ernst and Brown 2000. Herpetol. Rev. 31:256). The specimen was found while excavating Gopher Tortoise (*Gopherus polyphemus*) burrows at a landfill.

Submitted by **LISA FAIRCHILD,** LPG Environmental and Permitting Services, Inc., 1174 Camp Avenue, Mount Dora, Florida 32757, USA (e-mail: lfairchild@lpgenvironmental.com); and **KEVIN M. ENGE**, Florida Fish and Wildlife Conservation Commission, 4005 South Main Street, Gainesville, Florida 32601, USA (e-mail: kevin.enge@myfwc.com).

SISTRURUS CATENATUS EDWARDSII (Desert Massasauga). USA: NEW MEXICO: SANTA FE CO.: 3.9 km S and 4.2 km E of Stanley (35.1128°N, 105.9337°W; NAD83/WGS84); 1925 m elev. 6 September 2007. J. N. Stuart and A. Q. Roberts. Verified by J. Tomasz Giermakowski. University of New Mexico Museum of Southwestern Biology (MSB 73380). New county record (Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. Univ. New Mexico Press, Albuquerque. xx + 431 pp.) and second record for the Estancia Basin of New Mexico (Stuart and Brown 1996. Herpetol. Rev. 27:214).

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STORIERIA OCCIPITOMACULATA (Red-bellied Snake). USA: ILLINOIS: MCDONOUGH CO.: Spring Lake (40.50309°N, 90.72056°W) On hiking trail. 28 August 2005. Collected by Benjamin R. Wodika. Verified by Michael A. Romano. Western Illinois University Herpetology collection 14161. Adult, 21.0 cm SVL. New county record. This species was believed to be present in the area, but there are few voucher specimens from surrounding counties. (INHS. Illinois Natural History Survey. http://

www.inhs.uiuc.edu/cbd/herpdist/species/st_occipit.html http. Accessed 10 Oct 2007; Phillips et al. 1999. Field Guide to Amphibians and Reptiles of Illinois. Illinois Nat. Hist. Surv. Manual 8. Champaign, Illinois. 282 pp.)

Submitted by **BENJAMIN R. WODIKA**, Department of Biological Sciences, Western Illinois University, 1 University Circle Macomb, Illinois, USA.

VIRGINIA VALERIAE VALERIAE (Eastern Smooth Earthsnake). USA: FLORIDA: WALTON CO.: 3.7 km S of State Road 20 on County Road 83A East (30.46945°N, 86.1536333°W), 0035 h. 08 April 2005. Michael E. Welker. Verified by Kenneth L. Krysko. Florida Museum of Natural History, Gainesville, Florida (UF 144325). New county record and range extension (Ashton and Ashton 1988. Handbook of Reptiles and Amphibians of Florida. Part 1. The Snakes. Second Edition. Windward Publishing, Miami, Florida. 176 pp.). This specimen, along with three Okaloosa County specimens (UF 99675, 115415, 117732), help fill a large gap in this species' range along the gulf coast in the panhandle of Florida. This specimen was found DOR after a heavy rain.

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Additions to the Herpetofauna of Endau-Rompin, Johor, West Malaysia

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The Endau-Rompin National Park is located at the southern end of Peninsular Malaysia. It encompasses 87,000 ha across the southernmost portion of the Banjaran Titi Wangsa mountain range in the states of Pahang and Johor (Fig. 1). The park is comprised of lowland mixed dipterocarp forests, flood plains, riparian environments, and hill top dipterocarp forests. The three highest peaks in the Johor section are Gunung Tiong (1014 m) near the center of the park, Gunung Bekok (953 m) in the west, and Gunung Besar (1036 m) in the northwest, all of which are flanked by many other smaller hills.

To date there have been three published herpetological surveys of the Johor section of Endau-Rompin (Daicus and Hashim 2004; Kiew 1987; Lim 1989), two amphibian surveys on the northern side in Pahang (Norhayati et al. 2004a,b), and an unpublished senior thesis on the amphibians from the Johor portion (Bhaarathyraja 2006). Collectively, these surveys listed one species of caecilian, 48 frogs, 4 turtles, 26 lizards, and 17 snakes. In addition to the herpetological surveys, there have been several other scientific surveys (zoological, botanical, and geological) conducted between 1985 and 2004 (Malayan Nature Society 1988; Shaharuddin et al. 2004).

Presented here are the results of a survey conducted in the Peta region (04°28.318'N, 101°22.635'E) on 24–31 August 2005 and in Selai (02°26.000'N, 103°15.283'E) from 30 August to 5 September 2006 (Fig. 1). Peta comprises 1600 ha of pristine lowland rainforest and Selai, which lies 26 km to the south, comprises 660 ha of similar habitat. These lowland regions are characterized by mixed dipterocarp forests and are crisscrossed by several small streams and one large river, Sungai Endau. New species records presented below are based on voucher specimens deposited in the Zoological Reference Collection (ZRC) at The Raffles Museum of Biodiversity Research, National University of Singapore, the La Sierra University Herpetological Collection (LSUHC), and a collection deposited in the Nature Education Research Center (NERC) in Peta. Voucher photographs of some species are deposited in the La Sierra University Digital Photograph Collection (LSUDPC). An up-to-date checklist of the herpetofauna of Endau-Rompin is presented in Table 1. The taxonomies of Frost et al. (2006) for the *Bufo quadriporcatus* group, Matsui et al. (2005) for *Microhyla*, Gower et al. (2002) for the Ichthyophiidae, Shaffer et al. (1997) for the higher classification of turtles, Carranza and Arnold (2006) for *Hemidactylus*, Mausfeld and Schmitz (2003) for *Eutropis*, Vogel and Van Rooijen (2007) for *Dendrelaphis*, Utiger et al. (2002) for Old World rat snakes, David and Das (2004) for *Ptyas*, David et al. (2006) for the *Trimeresurus puniceus* complex, and Malhotra and Thorpe (2004) for the Viperidae are followed. The following species are newly recorded for the park.

Anura

Ansonia endauensis Grismer, 2006. (Fig. 2). Peta; Sungai Kawal, 31 August 2005, ZRC 1.11555–58.

Ingerophrynus gollum Grismer, 2007. Peta; Sungai Kawal. 28 August 2005. ZRC 1.11569–71.

Microhyla butleri Boulenger, 1900. Peta; Visitor center, 25 August 2005, LSUHC 7619.

Micryletta inornata (Boulenger, 1890). (Fig. 3). Peta, Visitor center, 26 August 2005, LSUHC 7626.

Limnonectes plicatellus (Stoliczka, 1873). (Fig. 4). Selai; Sungai Ketiau Padi. 1 September 2006, LSUHC 8175.

Rana laterimaculata Barbour and Noble, 1916. Peta; Visitor center. 25 August, LSUHC 7634.

Rana miopus Boulenger, 1918. Johor, Endau-Rompin: NERC 50720. No data.

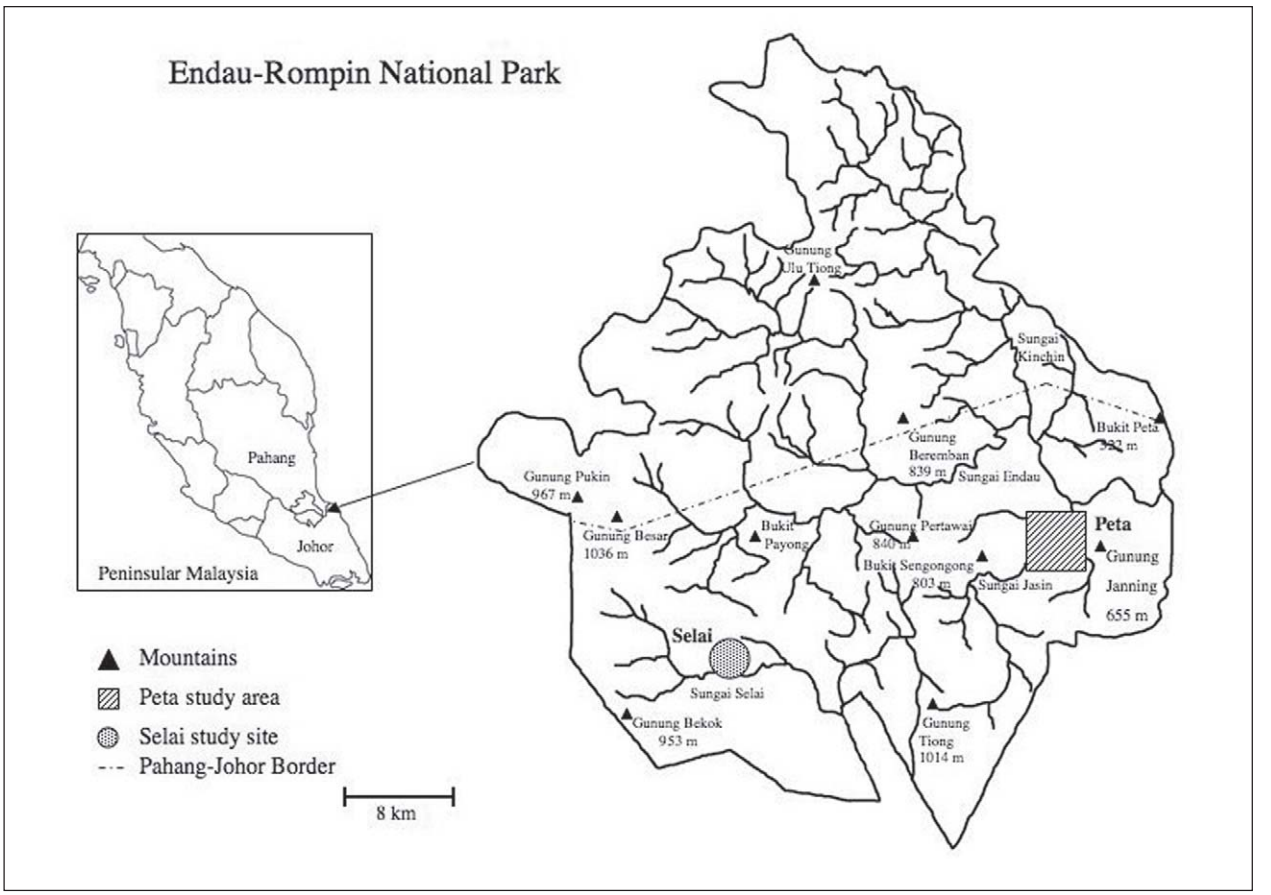


FIG. 1. Location of the Peta and Selai study sites, Johor, West Malaysia.

Rana nicobarensis (Stoliczka, 1870). (Fig. 5). Peta; Visitor center, 25 August, LSUHC 7624.

Testudines

Dogania subplana (Geoffroy Saint-Hillaire, 1809). Selai; Lubuk Merekek, Sungai Selai, 4 September 2006, LSUDPC 2619–29.

Manouria emys Schlegel & Müller, 1844. Selai, LSUDPC 2018. Photograph provided by park staff.

Squamata (Lizards)

Draco maximus Boulenger, 1893. (Fig. 6). Selai; Lubuk Tapah, 1 September 2006, LSUHC 8206.

Gonocephalus abbotti Cochran, 1922. (Fig. 7). Peta; NERC, 26 August 2005, LSUHC 7647. Sungai Semawak, 27 August 2005, LSUHC 7682. Selai; Lubuk Tapah, 31 August 2006, LSUHC 8172. These records represent a southern range extension of approximately 450 km.

Aeluroscalabotes felinus (Günther, 1864). (Fig. 8). Selai; Lubuk Tapah, 2 September 2006, LSUHC 8194.

Cnemaspis kendallii (Gray 1845). Peta; Sungai Semawak, 27 August 2005, LSUHC 7691. Selai; Lubuk Tapah, 30, 31 August and 2 and 4 September 2006, LSUHC 8122, 8210, 8126, 8191.

Gehyra mutilata (Wiegmann, 1834). Peta; Sungai Kawal. 28 August 2005, LSUDPC 1357. Selai; Lubuk Tapah, 2 September 2006, LSUHC 8187.

Hemidactylus craspedotus (Mocquard, 1890). Selai; Lubuk Merekek, 5 September 2006, LSUHC 8230.

Hemidactylus frenatus (Duméril & Bibron, 1836). Peta; Visitor Center. 25 August 2005, LSUHC 7645–46.

Hemidactylus platyurus (Schneider, 1792: 30). Peta; Visitor center, 25 August, LSUHC 7643–7644.

Hemiphyllodactylus typus (Bleeker, 1860). Peta. LSUDPC 1002–04. Photograph provided by park staff.

Ptychozoon kuhli Stejneger, 1902. Peta; Visitor Center, 27 and 30 August 2005, LSUHC 7640, 7716, respectively.

Dasia grisea (Gray, 1845). Selai; LSUPDC 1947–48. Photograph provided by park staff.

FIGS. 2–5, Opposite page, left column, from top to bottom. All photos by PLW. FIG. 2. *Ansonia endauensis* (ZRC 1.11555) from Peta, Sungai Kawal. FIG. 3. *Micryletta inornata* (LSUHC 7626) from the NERC. FIG. 4. *Limnonectes plicatellus* (LSUHC 8175) from Selai, Sungai Ketiau Padi. FIG. 5. *Rana nicobarensis* (LSUHC 7624) from Peta, Visitor Center.

FIGS. 6–8, Opposite page, right column, from top to bottom. All photos by PLW. FIG. 6. *Draco maximus* (LSUHC 8206) from Selai, Lubuk Tapah. FIG. 7. *Gonocephalus abbotti* (LSUHC 7647) near the NERC. FIG. 8. *Aeluroscalabotes felinus* (LSUHC 8194) from Selai, Lubuk Tapah.





Lipinia vittigera (Boulenger, 1894). Selai; Lubuk Merekek, 5 September 2006, LSUHC 8211.

Sphenomorphus scotophilus (Boulenger, 1900). Peta; Sungai Kawal, 28 August 2005, LSUHC 7688. Selai; Lubuk Merekek, 3 September 2006, LSUHC 8199.

Squamata (Snakes)

Ahaetulla facsiolata (Fischer, 1885). Peta: LSUHC 7697, found in collection at NERC with no data.

Ahaetulla mycterizans (Linneaus, 1758). Peta; Sungai Kawal, 26 August 2005, LSUHC 7680. Selai; Lubuk Merekek, 4 September 2006, LSUHC 8224.

Boiga drapiezii (Boie, 1872). (Fig. 9). Selai; Trail to Lubuk Tapah, 31 August and 2 September 2006, LSUHC 8143, 8192, respectively. Lubuk Tapah, 31 August 2006, LSUHC 8157.

Boiga nigriceps (Günther, 1863). (Fig. 10). Selai; Lubuk Merkek, 30 August 2006, LSUHC 8134, Trail to Lubuk Tapah, 31 August 2006, LSUHC 8142, Lubuk Tapah, 3 September 2006, LSUHC 8201.

Boiga jaspidea (Duméril, Duméril & Bibron, 1854). (Fig. 11). Peta; On road to Sungai Kawal, 25 August 2005, LSUHC 7679.

Calamaria lumbricoidea Boie, 1827. Peta; photographed provided by park staff. LSUDPC 1940.

Chrysopelea pelias (Boie, 1827). Peta; found in collection at NERC with no data, LSUHC 7696.

Coelognathus flavolineata (Schlegel, 1873). Selai; LSUDPC 2829. Photograph provided by park staff.

Dendrelaphis caudolineatus (Gray, 1830–1835). Selai; Lubuk Merekek, 5 September 2006, LSUHC 8225–26.

Dryocalamus subannulatus (Duméril, Bibron & (Duméril, 1854). Peta; Sungai Semawak, 27 August 2005, LSUHC 7661. Selai; Lubuk Merekek, 30 August 2006, LSUHC 8136.

Lycodon effraenis (Cantor, 1847). (Fig. 12). Peta; Sungai Semawak, 31 August 2005, LSUHC 7734.

Macrocalamus sp. Peta; LSUDPC 2830–31. No data. Photograph provided by park staff.

Oligodon purpurascens (Schlegel, 1837). (Fig. 13). Selai; on trail to Kuala Marong, August 30, 2005, LSUHC 7715.

Orthriophis taeniurus (Cope, 1861). Peta. LSUDPC 1005. No data. Photograph provided by park staff.

Pareas margaritophorus Jan, 1866. Peta; Bekok, photographed provided by park staff, LSUDPC 1078–79.

Pseudorabdion longiceps (Cantor, 1847). Peta; Visitor Center, 25 August 2005, LSUHC 7602.

Ptyas carinata (Günther, 1858). Peta; Sungai Semawak, 31 August 2005, LSUHC 7731. Selai; Lubuk Tapah, 31 August 200, LSUHC 8173.

Ptyas fusca (Günther, 1858). Peta; Sungai Semawak, 26 August 2005, LSUHC 7723.

Xenodermus javanicus Reinhardt 1836. Peta; LSUDPC 2032. No data. Photograph provided by park staff.

Calliophis bivirgatus (Boie, 1827). (Fig. 14). Peta; NERC 50716, no data. Photograph provided by park staff.

Parias hageni (Lidth De Jeude, 1886). (Fig. 15). Peta; NERC July 2006, LSUHC 8193.

Parias sumatranus (Raffles, 1882). Selai; LSUDPC 1971. Photograph provided by park staff.

Popeia fucata (Vogel, David & Pauwels, 2004). Peta. NERC 50704, 50748, no data. Photograph provided by park staff.

Trimeresurus wiroti (Trutnau, 1981). (Fig. 16). Peta; LSUDPC 952, no data. Photograph provided by park staff.

Discussion.—Daicus and Hashim (2004) reported both *Pelophryne signata* and *Pelophryne brevipes* as being present although only *P. brevipes* occurs in Peninsular Malaysia (Inger 1966). Also reported by Daicus and Hashim (2004) was *Ansonia leptopus*. Unfortunately, the specimen was released and no voucher photograph was taken. Given that *A. leptopus* is restricted to Borneo (Wood et al. 2008) it is likely the specimen was confused with *A. endauensis*. Daicus and Hashim (2004) reported *Rana signata* which we recognize here as *R. picturata* (*fide* Brown and Guttman 2002). *Typhlops diardii* was also reported (Daicus and Hashim 2004) although according to Wallach (2001) *T. diardii* is only found in NE Pakistan, N India, Nepal, Bangladesh, Myammar, Thailand, Laos, Vietnam, and China. This species is easily confused with *Typhlops muelleri* whose presence in the park had previously been reported (Daicus and Hashim 2004).

Kiew (1987) reported *Ansonia malayana* from Endau-Rompin, however there is no voucher specimen. We believe it is unlikely that this montane species, known no further south than Bukit Larut (Grismer 2006; Inger 1960), would not occur in a southern, lowland forest. It is our hypothesis that Kiew (1987) actually collected *A. endauensis*, a species that is superficially very similar to *A. malayana* (Grismer 2006a, b). Kiew (1987) also reported a specimen he referred to as *Microhyla* sp. Unfortunately the whereabouts of the specimen is unknown. It is likely, however, that it belonged to one of the six confirmed species of *Microhyla* known from Endau-Rompin (Table 1) that are often confused with one another.

Lim (1989) reported *Ichthyophis glutinosus* from Endau-Rompin. In light of the current taxonomic problems within the Ichthyophiidae in general and *Ichthyophis* (Gower et al. 2002; Grismer et al. 2006) in particular, it is difficult to accord any individual specimen to a particular species with any degree of confidence. Therefore, we follow Kiew (1987) in recognizing only

FIGS. 9–12, Opposite page, left column, from top to bottom. All photos by PLW. FIG. 9. *Boiga drapiezii* from Selai, Lubuk Tapah. FIG. 10. *Boiga nigriceps* from Selai, Lubuk Tapah. FIG. 11. *Boiga jaspidea* (LSUHC 7656) from Peta, at the NERC. FIG. 12. *Lycodon effraenis* (LSUHC 7734) from Peta, Sungai Semawak.

FIGS. 13–16, Opposite page, right column, from top to bottom. FIG. 13. *Oligodon purpurascens* (LSUHC 7715) from Peta, on the trail to Kulau Marong. Photo by PLW. FIG. 14. *Calliophis bivirgatus* from Peta. Photo by LLG. FIG. 15. *Parias hageni* from Peta. Photo by PLW. FIG. 16. *Trimeresurus wiroti* from Peta. Photo by LLG.

TABLE 1. List of amphibians and reptiles of Endau-Rompin National Park, Johor, West Malaysia, and the most recent reporting author. Species lacking an author designation were reported by earlier workers.

	Kiew 1987	Lim 1989	Norhayati et al. 2004	Daicus & Hashim 2004	Bhaarathyraja 2006	Present survey 2005–06
Species						
Amphibians (Frogs)						
Bufonidae						
Ansonia endauensis Grismer, 2006					X	X
Bufo asper Gravenhorst, 1829	X	X	X	X	X	X
Bufo melanostictus Schneider, 1799				X		
Ingerophrynus parvus (Boulenger, 1892)	X		X	X		X
Ingerophrynus gollum Grismer, 2007						X
Leptophryne borbonica Peters, 1867			X			
Pedostibes hosii (Boulenger, 1892)	X				X	X
Pelophryne brevipes (Peters, 1867)		X		X		
Megophryidae						
Leptobrachium hendricksoni Taylor, 1962	X	X	X			X
Megophrys nasuta (Schelegel, 1858)		X	X	X	X	X
Microhylidae						
Chaperina fusca Mocquard, 1892				X		
Kalophrynus palmatissimus Kiew, 1984				X	X	X
Kalophrynus pleurostigma (Gravenhorst, 1838)	X	X		X		X
Kaloula baleata (Müller, 1836)				X		X
Kaloula pulchra Gray, 1831			X	X		
Metaphrynella pollicaris (Boulenger, 1890)				X		
Microhyla annectens Boulenger, 1900				X		X
Microhyla berdmorei (Blyth, 1856)			X	X	X	
Microhyla butleri Boulenger, 1900						X
Microhyla heymonsi Vogt, 1911			X	X	X	X
Microhyla fissipes Boulenger, 1884				X		X
Microhyla mantheyi Das, Yakkob and Sukumaran, 2007					X	X
Micryletta inornata (Boulenger, 1890)						X
Ranidae						
Amolops larutensis (Boulenger, 1899)			X	X	X	X
Fejervarya cancrivora (Gravenhorst, 1829)				X		
Fejervarya limnocharis (Gravenhorst, 1829)			X	X	X	
Limnonectes blythii (Boulenger, 1920)	X	X	X	X	X	X
Limnonectes kuhlii (Tschudi, 1838)	X	X	X			
Limnonectes laticeps (Boulenger, 1882)	X	X		X		X
Limnonectes malesianus (Kiew, 1984)	X			X		X
Limnonectes plicatellus (Stoliczka, 1873)						X
Occidozyga laevis (Günther, 1858)	X		X	X		
Occidozyga martensii (Peters, 1827)	X					X
Rana erythraea (Schlegel, 1837–1844)		X				X
Rana glandulosa Boulenger, 1882	X		X	X		X
Rana hosii Boulenger, 1891	X	X	X	X	X	
Rana laterimaculata Barbour and Noble, 1916						X
Rana miopus Boulenger, 1918						X
Rana nicobarensis (Stoliczka, 1870)			X			X
Rana picturata Boulenger, 1920	X	X	X	X	X	X
Rana raniceps (Peters, 1871)	X	X	X	X	X	X
Taylorana hascheana (Stoliczka, 1870)	X	X				
Rhacophoridae						
Nyctixalus pictus (Peters, 1871)	X					X
Polypedates colletti Boulenger, 1890		X				
Polypedates leucomystax (Gravenhorst, 1829)	X	X	X	X	X	X
Polypedates macrotis (Boulenger, 1894)	X			X	X	X
Rhacophorus appendiculatus (Günther, 1859 "1858")					X	X
Rhacophorus cyanopunctatus Mathey and Steiof, 1998	X	X				
Rhacophorus nigropalmatus Boulenger, 1895				X	X	X
Rhacophorus pardalis Günther, 1858				X		
Rhacophorus tunkui Kiew, 1987	X					
Amphibians (Caecilians)						
Ichthyophiidae						
Ichthyophis sp.		X				

TABLE 1. Continued.

	Kiew 1987	Lim 1989	Norhayati et al. 2004	Daicus & Hashim 2004	Bhaarathyraja 2006	Present survey 2005–06
Species						
Reptiles (Turtles)						
Bataguridae						
Heosemys grandis (Gray, 1860)				X		
Heosemys spinosa (Gray, 1831)	X					
Notochyles platynota (Gray, 1834)	X					X
Testudinidae						
Manouria emys Schlegel and Müller, 1844						X
Trionychidae						
Amyda cartilaginea (Boddart, 1770)	X					
Dogania subplana Geffroy Saint-Hillaire, 1809						X
Reptiles (Lizards)						
Agamidae						
Aphaniotis fusca Peters, 1864	X			X		X
Bronchocela cristatella (Kuhl, 1820)				X		X
Calotes versicolor (Daudin, 1802)				X		
Draco blandfordii Boulenger, 1885				X		
Draco fimbriatus Kuhl, 1820				X		X
Draco formosus Boulenger, 1900				X		X
Draco maximus Boulenger, 1893						X
Draco melanopogon Boulenger, 1887				X		X
Draco quinquefasciatus Hardwicke and Gray, 1827	X					X
Draco sumatranus Schlegel, 1844	X			X		X
Gonocephalus abbotti Cochran, 1922						X
Gonocephalus grandis (Gray, 1845)				X		X
Gonocephalus liogaster Günther, 1872				X		X
Eublepharidae						
Aeluroscalabotes felinus (Günther, 1864)						X
Gekkonidae						
Cnemaspis kendallii (Gray, 1845)						X
Cyrtodactylus consobrinus (Peters, 1871)				X		X
Cyrtodactylus pulchellus Gray, 1828				X		
Cyrtodactylus quadrivirgatus Taylor, 1962				X		X
Cyrtodactylus sworderi (Smith, 1925)				X		X
Gehyra mutilata (Wiegmann, 1834)						X
Gekko gecko (Linnaeus, 1758)				X		
Gekko monarchus (Duméril and Bibron, 1836)				X		X
Gekko smithii Gray, 1842				X		X
Hemidactylus craspedotus (Mocquard, 1890)						X
Hemidactylus frenatus (Duméril and Bibron, 1836)						X
Hemidactylus platyurus (Schneider, 1792)						X
Hemiphyllodactylus typus (Bleeker, 1860)						X
Ptychozoon kuhli Stejneger, 1902						X
Scincidae						
Dasia grisea (Gray, 1845)						X
Dasia olivacea Gray, 1839	X					
Eutropis longicaudatus (Hallowell, 1857)				X		
Eutropis macularius (Blyth, 1853)				X		
Eutropis rugiferus (Stoliczka, 1870)				X		
Eutropis multifasciatus (Kuhl, 1820)	X			X		X
Lipinia vittigera (Boulenger, 1894)						X
Sphenomorphus scotophilus (Boulenger, 1900)						X
Varanidae						
Varanus nebulosus (Gray,1831)				X		
Varanus rudicollis (Gray, 1845)	X			X		
Varanus salvator (Laurenti, 1786)	X			X		X
Reptiles (Snakes)						
Typhlopidae						
Typhlops muelleri (Shlegel, 1839)				X		X
Pythonidae						
Python reticulatus (Schneider, 1839)	X					

TABLE 1. Continued.

Species	Kiew 1987	Lim 1989	Norhayati et al. 2004	Daicus & Hashim 2004	Bhaarathyraja 2006	Present survey 2005–06
Colubridae						
Ahaetulla facsiolata (Fischer, 1885)						X
Ahaetulla mycterizans (Linneaus, 1758)						X
Ahaetulla prasina (Boie, 1827)	X			X		
Asthenodipsas laevis Boulenger, 1900	X					
Boiga dendrophila (Boie, 1827)	X					
Boiga drapiezii (Boie, 1872)						X
Boiga jaspidea (Duméril,Duméril & Bibron, 1854)						X
Boiga nigriceps (Günther, 1863)						X
Calamaria lumbricoidea Boie, 1827						X
Chrysopelea paradisi Boie, 1827	X					
Chrysopelea pelias (Linnaeus, 1758)						X
Coelognathus flavolineatus (Schlegel, 1873)						
Dendrelaphis caudolineatus (Gray, 1830-1835)						X
Dendrelaphis formosus (Boie, 1827)				X		
Dendrelaphis pictus (Gmelin, 1789)	X					X
Dendrelaphis striatus (Cohn, 1906)						X
Dryocalamus subannulatus (Duméril, Bibron & Duméril, 1854)						X
Gongylosoma baliodeirus Boie, 1827	X					
Lycodon effraenis Cantor, 1847						X
Macrocalamus sp.						X
Macropisthodon rhodomelas (Boie, 1827)	X			X		
Oligodon purpurascens (Schlegel, 1837)						X
Oreophis porphyraceus (Cantor, 1839)	X					
Orthriophis taeniurus (Cope, 1861)						X
Pareas margaritophorus Jan, 1866						X
Pseudorabdion longiceps (Cantor, 1847)						X
Ptyas carinata (Günther, 1858)						
Ptyas fusca (Günther, 1858)						
Rhabdophis chrysargos (Schlegel, 1837)				X		X
Xenodermus javanicus Reinhardt, 1836						X
Elapidae						
Bungarus flaviceps Reinhardt, 1843	X			X		
Calliophis bivirgatus (Boie, 1827)						X
Calliophis intestinalis (Laurenti, 1768)	X					X
Ophiophagus hannah (Cantor, 1836)	X					
Viperidae						
Parias hageni (Lidth De Jeude, 1886)						X
Parias sumatranus (Raffles, 1882)						X
Popeia fucata (Vogel, David and Pauwels, 2004)						X
Trimeresurus wiroti Trutnau, 1981						X
Tropidolaemus wagleri Wagler, 1830	X			X		X

Ichthyophis sp.

Photographs were provided to us by park staff of what we believe is an undescribed species of *Macrocalamus* (LSUDPC 2830–31) based on the head not being distinct from the neck. This genus is currently represented by more northerly montane species and thus, this specimen is not only a southern range extension of approximately 180 km for *Macrocalamus* but the first specimen to be found in a lowland forest which represents a significant ecological departure as well (David and Pauwels 2004).

The new records reported here bring the total number of confirmed species of amphibians and reptiles in the park to 140 (1 caecilian, 51 frogs, 6 turtles, 39 lizards, and 43 snakes), representing an increase in diversity of 33% since Daicus and Hashim (2004) (Table 1). More importantly, these new records clearly underscore the understudied nature of the herpetofauna despite the many surveys that have been conducted (Bhaarathyraja 2006; Diacus and Hashim 2004; Kiew 1987; Lim 1989; Norhayati et al. 2004a,b). Additionally, the discovery of two new species of frogs, *Ansonia endauensis*, Grismer, 2006 and *Ingerophrynus gollum*, Grismer, 2007, the rediscovery of the gecko *Cyrtodactylus sworderi* (Smith, 1925; Grismer et al. 2007), and the discovery of *C. semenanjungensis* Grismer and Leong, 2005 just outside the eastern boundary of the park exemplify the need for continued systematic field work. The same argument could be made for the lowland rainforests of the entire state of Johor. Large portions of this unique section of the southern Malay Peninsula are being con-

verted into oil palm and rubber tree plantations with extensive tracts reaching deep into Endau-Rompin (authors, pers. obs., 2006).

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BOOK REVIEWS

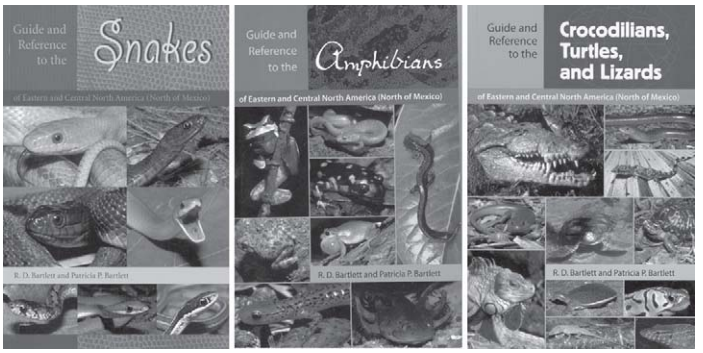
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Guide and Reference to the Snakes of Eastern and Central North America (North of Mexico), by Richard D. Bartlett and Patricia P. Bartlett. 2005. University Press of Florida (www.upf.com). Softcover. xvii + 342 pp. US $29.95. ISBN 978-0-8130-2935-1.

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Richard and Patricia Bartlett have been busy over the last decade or so. The sheer volume of work is impressive. In addition to the three volumes reviewed here, they coauthored a series of herpetoculture books, each about 50 pages long: three came out in 1999 (all on lizards), four in 2000 (two on frogs and two on snakes), six in 2001 (one on frogs, four on lizards, and one on snakes), one each in 2003 (Poison Dart Frogs) and 2004 (Box Turtles), and three in 2005 (all on snakes). The Bartletts are not newcomers to the field-guide scene either, having published texts about Florida (1998), Texas (1999), the western US (2000), and the Amazon (2003).

The current contributions share a consistent and attractive look, style, and geographic region, but focus on different taxonomic groups. Each offers a brief introduction (about 10 pages); species accounts (about 300 pages); a glossary and a list of additional readings (about four pages each); and an index (about six pages). The greatly similar introductions include information on the use of each book, comments on taxonomy, advice on captive care, some information on typical habitats, and illustrated keys to families. Contrary to what one might expect from authors who have heavily focused on the pet trade, the emphasis here is on conservation. There is discussion of declining species, loss of habitats, and the impacts of invasive species. The authors unambiguously advise against releasing animals in the wild and strongly advocate responsible herpetoculture.

Species accounts tend to be brief, ranging from less than a page to several pages. A nice feature is that the growing number of introduced species is also included, a valuable addition in many places, especially Florida. Each account includes the common and scientific name, both of which mostly follow Crother (2000). Purists may find this annoying, as there have been many proposed changes since then, but I suspect most readers, as the authors intended, will find it a relief to face familiar names. Occasionally, however, they are inconsistent. For example, soft-shelled turtles are all *Apalone* in the species accounts but *Trionyx* in the illustrations of snouts and shells. A range map and at least one photograph are also provided. As the authors point out, "[a]ll species and subspecies and several of the naturally occurring intergrades are pictured. There is no other field guide currently available that provides this important identification tool." Taxa with multiple color forms have multiple pictures, and occasionally this seems to get out of hand, as with the melanistic copperhead illustrated on p 288 (here and below, page numbers refer to the taxon-appropriate book). This appears intended to appeal to the hobbyist, particularly the one interested in the husbandry of unusual color morphs or trying to fill a life-list. Overall, however, this is a useful feature, and my copy of their Texas book is well-thumbed. Pictures are large, typically 1/3 of a page, and – like the distribution maps – are included within the text, rather than in a separate section as in some previous guides. Most pictures are quite good, but the quality varies. Frog pictures tend to be a bit smaller and are sometimes too dark, lacking in contrast, or out-of-focus to be really useful. This is the case with *Bufo americanus charlesithi* (p 17), *Acris c. crepitans* (p 37), *Hyla avivoca ogechiensis* (p 45), and *Rhinophrynus dorsalis* (p 116), for example. Such problems are less common in the other two books but they nonetheless occur, as with the fuzzy picture of *Acrochordus javanicus* (p 18 of the snake book) and *Anolis distichus* (p 243 of the final book), and the poorly contrasted pictures of *Anolis sagrei* and *A. cristatellus* (p 241). In addition to the all-color photographs, black-and-white drawings are occasionally provided (for example, a collared lizard on p 185 or the two salamander species on pages 118-119). These could have been left out, in my opinion, as they contribute little. Serviceable line drawings are used, often in the keys and occasionally elsewhere, to illustrate specific traits or distinguishing characters. Occasionally, as in the drawing of a pitviper head, the level of detail is insufficient: I'm not sure a naïve reader could tell the difference between the black dot representing the nostril and the equal-sized one representing the pit. The distribution maps are crisp and appropriately-sized for the area covered. Unlike some guides they include Canada, and sometimes pieces of Mexico. However, at least the map for the Mediterranean house gecko (p 170) does not include all the current Texas range. The authors may have been using dated sources: the 1987 edition of Dixon's book is referenced, rather than the second edition, published in 2000. In a similar vein, the work of Wilson and Porras (1983) appears in the citations, rather than the more recent Meshaka et al. (2004).

The text which follows offers brief coverage of range and abundance, size, and habitat. Snakes also get an entry on "disposition" and, if venomous, toxicity. Little information on natural history is provided, with most of the text focusing on identifying features. Many of those would require the animal to be in the hand to be discerned, however. Occasionally, a box contains the story of a memorable encounter with the species, printed in different font to indicate its less formal nature. At times, the authors use technical terms that are not given in the glossary (for example, "nuptial" and "distal" in the account of *Agama agama*). At times they use words that do not seem appropriate for the likely audience (e.g., "Lilliputian" [not capitalized for some reason] in the description of the genus *Sphaerodactylus*, "irascible" in describing the Prairie Rattlesnake). Unfortunately, the first paragraph of the preface to the first book I picked up (the amphibian volume) had a problem that is far too common in the age of electronic spellcheckers: the word "know" seems to have been lost, leaving the sentence "But we do that…" rather cryptic. However, I did not find other places with such problems. The index is comprehensive for common and scientific names.

In a review of an Arizona field-guide, Lamb (2007) recently shared a longing for the single-volume "indispensable little green book" such as Conant and Collins (1991) because of its "economy and ergonomic form." Alas, portability and natural history detail were sacrificed here for pictorial comprehensiveness, large font, and well-spaced text. These features, as well as the embedding of the pictures and range maps, and the affordable pricing, make the three books more attractive and easier to read. However, the combined size also makes them less useful as field guides. I can imagine these volumes sitting on the shelf of hobbyists, but I do not foresee well-used copies in the glove-compartments of many professionals.

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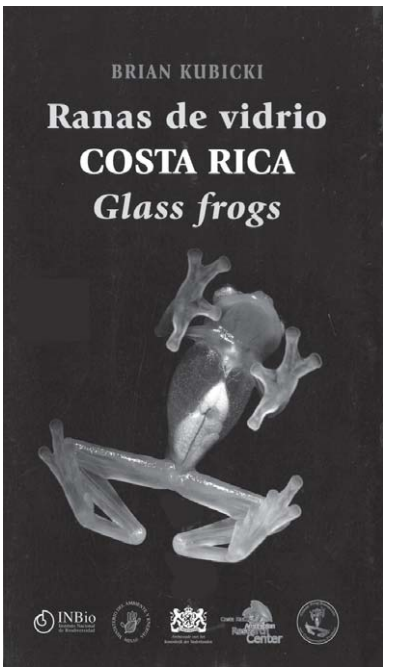
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Ranas de Vidrio COSTA RICA Glass Frogs, by Brian Kubicki. 2007. Instituto Nacional de Biodiversidad (INBio), San José, Costa Rica (http://www.inbio.ac.cr/en/default.html). 299 pp. Softcover. ISBN 978-9968-927-25-3. US $21.00.

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With facing pages in English and Spanish and more than 150 color photographs this outstanding book brings to life the Glassfrogs (Centrolenidae) of Costa Rica in a manner that sets an example for the treatment of any group of organisms. The author spent nearly a decade observing, rearing, and photographing Glassfrogs in Costa Rica. In so doing he gathered an enormous amount of data that is the basis for this book that greatly expands the accounts of centrolenid frogs given by Savage (2002).

This paper-bound book of 299 pages (15 × 22.8 cm) is printed on high-quality glossy paper. The first 79 pages contain a brief forward by Jay M. Savage, introductory material, an account of the taxonomic history of the family, and a summary of behavior and ecology of Costa Rican centrolenids. In the introduction, Kubicki thoroughly describes the external morphology of Glassfrogs and illustrates their principal characters. In the section on behavior and ecology, he summarizes information on habitat, diversity, activity, feeding, reproduction, male-male combat, and embryonic and larval development. Throughout these sections he has added his extensive observations to what was known previously (in most cases, very little), thereby providing a comprehensive review of the biology of Costa Rican centrolenids.

The major part of the book (201 pages) is devoted to accounts of each of the 13 species of Costa Rican centrolenid frogs. Each account contains sections on: Holotype, Type Locality, Synonymy and chronological history of the nomenclature, Common name, Etymology, Species group, Description, Similar species, Sex determination, Distribution, Natural history, Call, Calling position, Egg masses and larvae, and Abundance. Although data on morphology used in the descriptions, comparisons, and sex determination are common in recent literature on Glassfrogs, most of the information in the sections on natural history, behavior, and development is new. In the accounts there are 13 distribution maps

and 146 excellent color photographs, including 13 photographs of living tadpoles and 22 photographs of clutches of eggs. The account of each species contains no fewer than five photographs of living frogs, including ventral views, pairs in amplexus, and males in combat. Although the calls of each species are described in detail, sonograms and wave forms are not presented.

Kubicki listed 16 species of centrolenid frogs in Central America and noted that all but three occur in Costa Rica. The percentage of Costa Rican Glassfrogs increased with the placement of the Honduran *Hylalinobatrachium cardiacalyptum* and *H. crybetes* in the synonymies of *H. chirripo* and *H. colymbiphyllum*, respectively, by Cisneros-Heredia and McDiarmid (2007). Thus, the only species of Glassfrog extralimital to Costa Rica in Central America is *Hyalinobatrachium aureoguttatum*, a South American species that enters Darién in Panama. There are some minor discrepancies regarding the taxonomy: (1) *ilex* and *prosoblepon* are placed in the genus *Centrolenella*, which is listed as a junior synonym of *Centrolene* by Frost (2007); and (2) *pulveratum* is placed in *Hyalinobatrachium*, whereas the species was placed in *Cochranella* by Cisneros-Heredia and McDiarmid (2006).

Kubicki's "Glass frogs" contains much more information on natural history and has far superior color illustrations than two other recent publications dealing with centrolenid frogs of Ecuador (Cisneros-Heredia and McDiarmid 2007) and Venezuela (Señaris and Ayarzagüena 2005). "Glass frogs" is just one of many outstanding publications produced by the Costa Rican Instituto Nacional de Biodiversidad, an institution that has set high standards for gathering and disseminating data on national biodiversity. Both the author and the institute deserve international accolades.

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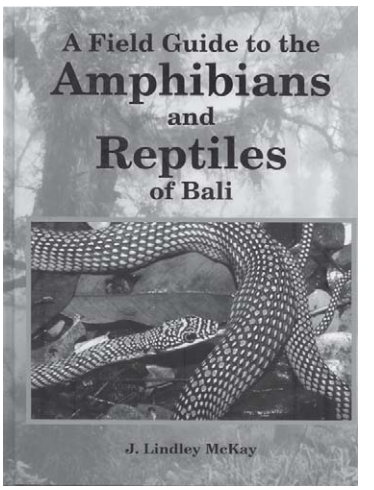
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A Field Guide to the Amphibians and Reptiles of Bali, by J. Lindley McKay. 2006. Hardcover. Krieger Publishing Co., Malabar, Florida (www.krieger-publishing.com). 146 pp. Hardcover. US $39.50. ISBN 1-57524-190-0.

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A Field Guide to the Amphibians and Reptiles of Bali is a detailed overview of the 114 species of amphibians and reptiles known from this tropical island. Bali is a relatively small Indonesian island (128 × 76 km) located 5 km east of Java and 45 km west of Lombok. It is of biogeographical interest in that it lies immediately west of Wallace's Line and represents the most southeasterly extent of the range of many taxa. This book presents the most up-to-date list of amphibians since Iskandar (1998) and the first list of reptiles for the island since Brongersma (1934). The author states that the purpose of the book is to provide an easy identification for any species of the island's amphibians or reptiles. Was this goal accomplished? In many aspects it was, and anyone could use this book to identify most of the herpetofauna of Bali, but it may have fallen short in some areas.

In the introduction the author provides a useful map, and gives an overview of some of the classic works and more recent book length treatments that have been published on southeast Asian herpetology. In Chapter 2, "Making an Identification," the author does a good job in discussing how to make an identification with a specimen in hand and provides diagnostic characters to look for if the specimen was not captured but only observed. This chapter is accompanied by clear and precisely labeled illustrations of frog and tadpole anatomy, turtle shell morphology, and lizard and snake head scalation (lateral, dorsal, and ventral views), and instructions on how to perform certain scale counts. Chapter 3, "Explanation of the species Accounts," provides instruction on how to use the species accounts along with descriptions of the subsections within the species accounts. Chapter 4, "Environment of Bali," gives background on the ecological and geological make up of the island and a detailed description of the different types of habitats, including a list of species that are generally associated with each habitat. This chapter also discusses human impact on the island's natural vegetation.

Chapter 5, "An Overview of Amphibian and Reptile Fauna," is a discussion concerning the evolutionary origins of the fauna of Bali as a mixture of southeast Asian and Papuan elements. Here

the author discusses the diversity of Bali compared to that of the surrounding islands and provides a general overview of the different types of lizard and snake ecologies observed on Bali. Chapter 6, "Traditional Uses and the Turtle Trade," is a discussion of the medicinal and commercial uses of the amphibian and reptile fauna. The majority of this chapter is concerned with the use of sea turtles as a food source and documents the growth and decline of this industry. It includes some disturbing anecdotes detailing the harsh treatment of these animals after they have been sold in the marketplace. In chapter 7 "First Aid for Snakebites," the author describes the types of bites one could receive from the different species of venomous snakes (cobras, kraits, pitvipers, and sea snakes) on Bali and the procedures to follow in case of a bite.

The following chapter, "Amphibians, Class Amphibia," begins with a key to all the frog species and their tadpoles; one in English and the other in Bahasa Indonesia. Each is accompanied by several diagrams of frog and tadpole characters useful for identifying certain species. This is followed by the species accounts for frogs. The species accounts consist of one or two small (8.5 × 5.8 cm) photographs of the species and a short (maximum one page) account with four sections. The first, "Description," is an adequate overview of the color pattern, snout–vent length, total length, tadpole morphology, and morphological variation within the species. The next section is "Habitat," describing the type of habitat and microhabitat in which each species occurs as well as its elevated range. Following this is "Biology," which discusses natural history, including activity times, call descriptions, and where tadpoles can be found. The last section, "Distribution," lists the major islands and mainland countries of each species' range throughout southeast Asia. One point of possible contention is that Iskandar (1998) records *Occidozyga lima* on Bali, where here and in Frost et al. (2006), *O. laevis* is the only species of *Occidozyga* recorded.

Chapter 9, "Reptiles, Class Reptilia," is organized similarly to the previous chapter. Each section (turtles, lizards, and snakes) has English and Bahasa Indonesia keys followed by illustrations of head scalation and other relevant morphological characters and species accounts mirror those for amphibians. The main difference between the treatments of the three reptile groups is in the emphasis on diet for snakes. In the appendix, there is a section called "Species Not Yet Recorded on Bali" in which species accounts are given for several species which the author believes have a high probability of being discovered on Bali due to their presence on nearby islands or their widespread distribution in the region. This is an interesting section but the inclusion of these species along with the confirmed species makes the keys unnecessarily long. Following the appendix is a glossary of terms used for describing amphibian and reptile morphology and certain terms in Bahasa Indonesia.

This book does have some shortcomings. The quality of photography makes it difficult to positively identify roughly 10% of the species (e.g., *Occidozyga laevis* [Plate 31], *Rana chalaconota* [Plate 35], *Rana nicobariensis* [Plate 39], *Eutropis rugifera* [Plate 77], *Sphenomorphus temminckii* [Plate 82], *Boiga cynodon* [Plate 94], *Enhydris plumbea* [Plate 106], *Gongylosoma balioderium* [Plate 108], and *Rhabdophis chrysargos* [Plate 123]). Many of the photographs are of individuals from outside of Bali. This is normally not a significant concern if the specimen was collected from an adjacent region, but in some cases the specimen photographed is from Australia, Sulawesi, or China where populations may look significantly different. An unfortunate oversight is the lack of a figure showing the details of foot morphology that are diagnostic for many species of reptiles and amphibians. The Literature Cited is divided into categories with citations listed under the category in which each was referenced in the text. This is a bit awkward as the reader must search in several places to locate any particular reference. Finally, without explanation the author chose to recognize recent taxonomic revisions for the Scincidae (*Mabuya*; Mausfeld and Schmitz 2005) and the ratsnakes (*Elaphe*; Utiger et al. 2002) but not for *Trimeresurus* (Malhorta and Thorpe 2004), or the paraphyletic genus *Rana* (Dubois 1987, 1992; Frost et al. 2006).

These drawbacks aside, this book is an informative field guide to most of the amphibians and reptiles of Bali and is a great stepping-stone for future work. It is also an indespensible piece of literature for anyone interested in southeast Asian herpetology in general.

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PUBLICATIONS RECEIVED

***Chamaeleo calyptratus*, the Yemen Chameleon,** Second Edition, by Wolfgang Schmidt. 2007. Natur und Tier-Verlag, Münster, Germany (www.ms-verlag.de). 96 pp. Hardcover. € 18.50 (approx. US $27.00). ISBN 978-3-86659-036-6.

This is an English translation of the original German language popular book on the biology and husbandry of *Chamaeleo calyptratus*, a large and charismatic chameleon in which males bear a huge casque. These impressive lizards have become relatively common in the private collections of terrarium keepers and this book was written to provide guidance to prospective owners, based on the author's years of experience with Yemen Chameleons. Basic information is provided about the evolution of chameleons, the habitat of the Yemen Chameleon, and distinctive features of this and other chameleons (color and color change, casque, tail prehension, independently mobile eyes, tongue protrusion). Advice is provided about selecting and sexing Yemen Chameleons and mating behaviors, copulation, and oviposition are discussed and illustrated by color photos of captive animals. Much of the text is devoted to information about housing individuals of this species (they should be kept alone and provided with good ventilation and adequate possibilities for climbing), feeding them (diet should be varied and vitamin-enriched), and regulating their environment (temperatures should reflect those seen in nature, with both diel and seasonal variation; Yemen Chameleons are particularly suitable for limited free-ranging activity in outdoor enclosures). The book concludes with brief comments on disease and other veterinary concerns and a 66-entry bibliography. This small book serves as a concise guide to *Chamaeleo calyptratus* and its captive care and breeding and is recommended reading for anyone considering maintaining this species in captivity. Unfortunately, most of the references to further sources of information are specific to Germany and this English edition suffers from some instances of awkward translation and some typographical errors. Nonetheless, the book contains a great deal of information gathered over the many years that this species has been successfully bred in Europe and the 75 color photographs and non-technical text make it accessible to a wide audience.

Amphibien an einem Stillgewässer in Peru mit einer illustrierten Checklist der Amphibien und reptilien des unteren Río Llullapichis, by Andreas Schlüter. 2005. Edition Chimaira, Frankfurt am Main, Germany (www.chimaira.de). 347 pp. Hardcover. € 49.80 (approx. US $74.00). ISBN 3-930612-51-8.

This book stems from the doctoral work conducted by Andreas Schlüter at a site on the lower Río Llullapichis in Amazonian Peru. Although the author has published many of his findings in the 30 years since the field work was initiated, this volume represents a comprehensive, if much belated, summary of his study as a whole, which examines the biotic and abiotic causes for the comparatively low frog diversity in the study site—a shaded pond in montane rainforest. The entire metazoan fauna of the pond is characterized and 71 anuran species were identified at the site, 30 utilizing the pond itself. Species accounts are presented for each of these 30 frogs. The information summarized includes synonymy, geographic distribution, size, recognition characteristics, breeding call, diet, reproductive mode and development, activity period, relationship to the pond, and autecological description. These accounts are variably accompanied by line drawings of a selected specimen, a sonogram, distribution map, and black and white photograph(s) of adults, larvae or eggs. These are supplemented by a section of 100 half page color photos illustrating the amphibians of the pond and remaining study site. Niche segregation of anuran mating calls is considered and a remarkable once-a-year mass concert is described and analyzed with respect to its chorus structure. The book also considers responses to predators, the adaptations of eggs, and the ethology and spatial niche partitioning of larvae. A checklist of the herpetofauna of the lower Río Llullapichis is provided and 65 color photos illustrate the reptiles of the area, which are otherwise peripheral to the work as a whole. The book concludes with a literature cited with about 350 entries. Despite the fact that the dissertation upon which this book is based was completed in 1984, the data presented remain valuable, particularly in a comparative light, as other anuran communities in Amazonia have subsequently been investigated. This book will certainly be of interest to amphibian ecologists and ethologists as well as herpetologists with general interests in Amazonia. Short English and Spanish abstracts provide an overview for non-German speakers.

Timber Rattlesnakes in Vermont and New York: Biology, History, and the Fate of an Endangered Species, by Jon Furman. 2008. University Press of New England, Lebanon, New Hampshire (www.upne.com). 224 pp., 12 color illustrations, softcover. US $24.95. ISBN 978-1-58465-656-2.

This highly readable book, targeting a non-professional audience, details the natural history and conservation status of *Crotalus horrridus* near the northeastern extreme of its historical range. In this region, Timber Rattlesnakes are highly endangered, in large part due to a long history of bounty hunting, which Furman covers in fascinating, albeit disturbing, detail. A number of bounty hunters are profiled, and some agreed to be interviewed for the book. Recent and ongoing conservation conflicts are presented, as well as future prospects. The author, an "accomplished naturalist" (from the press release), benefited from collaborations with field researchers William Brown, Marty Martin, and Randy Stechert; their cooperation ensured that the biological information presented was accurate and current. This book is likely to appeal to a broad audience of herpetologists, conservationists, and readers with an interest in wildlife of the northeastern U.S.

Inseparable Friends in Life and Death, the Life and Work of Heinrich Kuhl (1797–1821) and Johan Conrad van Hasselt (1797–1823), Students of Prof. Theodorus van Swinderen, by Charles Klaver. 2007. Barkhuis, Groningen, The Netherlands (www.barkhuis.nl). ix + 105 pp. Softcover. € 25,00 (approx. US

$37.00). ISBN 978-90-77922-316.

The history of herpetology is rife with personalities who made major contributions during very short lives. Among the most tragic of such deaths were those of two young friends who had met at the University of Groningen in the Netherlands, Heinrich Kuhl and Johan Conrad von Hasselt. Both were accomplished and respected zoologists by the age of 20 and were personally acquainted with the leadings scientists of the day, including Cuvier, Lichtenstein, and Temminck. In 1820 both men were appointed as delegates of the Natuurkundige Commissie voor Nederlandsch Indië (Commission for the Study of the Natural Sciences of the Netherlands East Indies) and departed for Java, where Kuhl died in September 1821 and Van Hasselt two years later. In their brief period of collecting, Kuhl and van Hasselt sent thousands of specimens back to Europe, among them 300 amphibians and reptiles of 90 species. Many were new and were described by them in published letters to colleagues in Europe. Another herpetological project of Kuhl's, completed before his departure for Asia, but never published, was the identification of the herpetological illustrations in Seba's *Thesaurus*.

Charles Klaver's biography of Kuhl and Van Hasselt provides a glimpse of the promising careers of the two men, who are unknown to most herpetologists. Although short, the biography and its detailed endnotes, both of which are fully indexed, are a wealth of information about Kuhl and Van Hasselt, their achievements, and the European zoological community in the early 19th century. A bibliography of the 66 publications of the two (1817–1845) is an invaluable tool, as the works of Kuhl and Van Hasselt are among the most miscited in systematic herpetology. A bibliography of more than 230 entries supports the biography. An appendix lists the valid names proposed by Kuhl and Van Hasselt (101 genera, species, and subspecies in all major tetrapod groups, as well as teleost fish and mollusks) and those zoological taxa named in their honor (31). A second appendix is a synopsis of the nomenclatural status of the herpetological names authored by Kuhl and Van Hasselt in their published letters from Java. This includes 32 names (including errors, nomina nuda, junior synonyms and valid names), among them such familiar taxa as *Megophrys*, *Rhacophorus*, *Homalopsis*, and *Ptychozoon*. The book is illustrated by 16 figures (four herpetological) representing portraits, animals, and images of manuscripts and published works.

Inseparable Friends is highly recommended to anyone with an interest in the history of zoology or in the fauna of the Indonesian region. However, it provides particular insight into the herpetological aspects of Kuhl and Van Hasselt's careers (in part because the author's first career was as a chameleon systematist).

Die Nilweichschildkröte *Trionyx triunguis*, by Dieter Gramentz. 2005. Edition Chimaira, Frankfurt am Main, Germany (www.chimaira.de). 166 pp. Hardcover. € 44,80 (approx. US $66.00). ISBN 3-930612-41-0.

This is a German language monographic work on the trionychid turtle *Trionyx triunguis*. It includes a synonymy, list of vernacular names, phylogenetic tree, and an extensive section on morphology, including carapace and plastron size and proportion, osteology, and soft anatomy (largely drawn from the earlier works of Girgis). Coloration, blood chemistry, karyology and both sexual and ontogenetic variation are also reviewed. This large softshell turtle (to 85 cm or more carapace length) has a huge distributional range — from the eastern Mediterranean south along the Nile into East Africa and from Senegal to northern Namibia in West Africa. Most of the author's observations were derived from his own extensive field work in Gabon and especially in Turkey. As might be expected for a species with such a broad range, ecological and reproductive parameters are highly variable. Water bodies of all sizes, flow rates, depths, acidities, and salinities, from small lakes to the ocean are utilized by *T. triunguis*. Data are presented on reproductive parameters (timing, egg and clutch size, hatching success) for populations from Turkey and Gabon. Factors threatening the Turkish populations are considered in some detail. These include habitat destruction, accidental deaths caused by fishing nets and boat propellers, as well as intentional killings by those who perceive the turtles as pests. As of 2005 there were no effective measures of protection, and relict inland populations at Dalyan and Dalaman, Turkey (totaling only a few hundred individuals) were particularly imperiled.

Table and figure legends are given in both German and English and an extensive six page English summary is provided, providing English speakers with access to all of the author's major findings. The book is illustrated with 129 figures, 69 of them in color. Most of these are adequate, but a few (e.g., Figs. 83, 111) are not in focus. In addition to adults, juveniles, eggs, and habitats, photos show dead and damaged turtles reflecting negative human impact on Turkish populations of *T. triunguis*. Numerous graphs and tables present original data relating to activity, nesting, incubation, and other aspects of life history. The bibliography cites 136 references. There are occasional typographical errors in both the English (e.g., scull instead of skull, p. 50) and Latin technical terms (e.g., Opithoticum instead of Opisthoticum, p. 18) but otherwise the text is largely free of errors. This monograph will, of course, be of interest to cheloniophiles, but also to herpetologists and conservation biologists with special interests in Turkey.

A New Herpetological Circular from the Society for the Study of Amphibians and Reptiles
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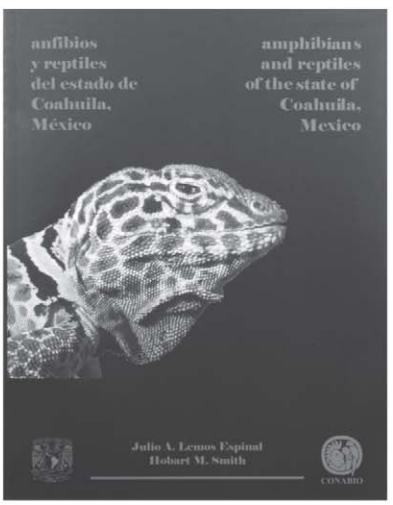
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This is the official name list of American Society of Ichthyologists and Herpetologists, The Herpetologists' League, and the Society for the Study of Amphibians and Reptiles. The list incorporates all taxonomic changes since the 2000 edition. This is a must for anyone working with North American herpetology. 84 pages. January 2008. ISBN 978-0-916984-74-8

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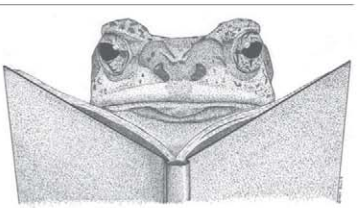


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The Quarterly News-Journal of the Society for the Study of Amphibians and Reptiles

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SOCIETY FOR THE STUDY OF AMPHIBIANS AND REPTILES

www.ssarherps.org



The Society for the Study of Amphibians and Reptiles, the largest international herpetological society, is a not-for-profit organization established to advance research, conservation, and education concerning amphibians and reptiles. Founded in 1958, SSAR is widely recognized today as having the most diverse society-sponsored program of services and publications for herpetologists. Membership is open to anyone with an interest in herpetology—professionals and serious amateurs alike—who wish to join with us to advance the goals of the Society.

All members of the SSAR are entitled to vote by mail ballot for Society officers, which allows overseas members to participate in determining the Society's activities; also, many international members attend the annual meetings and serve on editorial boards and committees.

ANNUAL DUES AND SUBSCRIPTIONS: Annual membership dues for the year 2008 in the Society for the Study of Amphibians and Reptiles are as follows: **REGULAR** membership US$60 (Student $30)—includes *Journal of Herpetology* and *Herpetological Review*; **PLENARY** membership US$80 (Student $45)—includes *JH*, *HR*, and annual subscription to the *Catalogue of American Amphibians and Reptiles*; **INSTITUTIONAL SUBSCRIPTION** $115—includes JH and HR. Additional fee for airmail postage outside USA $35 for one year. Additional membership categories available on the SSAR webpage: http://www.ssarherps.org/pages/membership.html.

All members and institutions receive the Society's primary technical publication, the *Journal of Herpetology*, and its newsjournal, *Herpetological Review*; both are published four times per year. Members also receive pre-publication discounts on other Society publications, which are advertised in *Herpetological Review*.

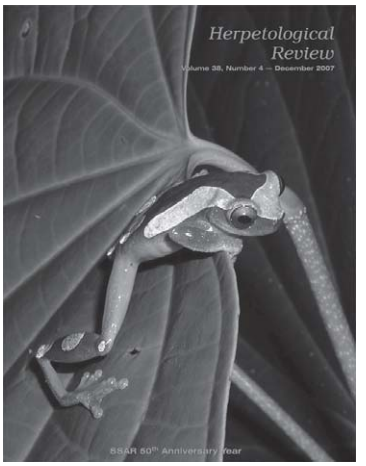
To join SSAR or to renew your membership, please visit the secure online Allen Press website:

http://timssnet.allenpress.com/ECOMSSAR/timssnet/common/tnt_frontpage.cfm

Future Annual Meetings

2008 — Montreal, Canada, 23–28 July (with ASIH, HL)
2009 — Portland, Oregon (with ASIH, HL)

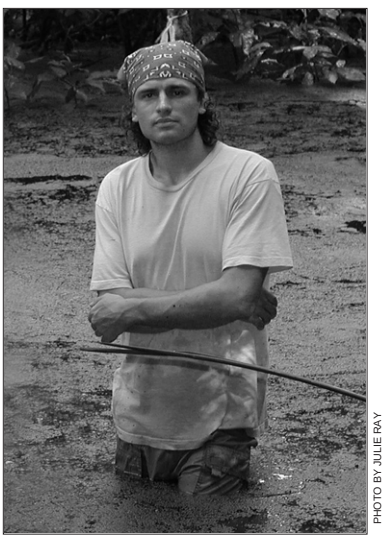
About Our Cover: *Dendropsophus leucophyllatus*



The family Hylidae includes about 850 species of treefrogs with 3 subfamilies and 42 genera (Frost et al. 2006. Bulletin of the American Museum of Natural History 297:1–371). Over 150 species of hylids are known to occur in the tropical lowlands of South America, with many new species yet to be described. The diversity of Amazonian hylids can only be trumped by the intensity of their breeding choruses and spectacular array of color patterns. Body patterns range from the cryptic, leaf-like pattern of *Cruziohyla craspedopus* and *Hemiphractus proboscideus*, to the vibrant coloration of *Dendropsophus rhodopeplus* and *D. leucophyllatus*, the subject of our cover.

Dendropsophus leucophyllatus—formerly *Hyla leucophyllata* (see Faivovich et al. 2005. Bulletin of the American Museum of Natural History 94:1–294)—the Clown Treefrog, is a moderate-sized anuran distributed throughout the Amazon Basin. This species exhibits an impressive array of polymorphism throughout much of its range. Within a population, individuals can vary from the more common "clown pattern" pictured on our cover, to a highly reticulated pattern similar to that of a giraffe, or some intermediate combination of these two patterns. The variation in color pattern is so disparate that historically, individuals with the giraffe pattern were considered to be a separate species, *Hyla favosa*, and individuals with an intermediate pattern were thought to be hybrids. It was not until Titus et al. (1989. Herpetologica 45:17–23) determined that individuals with these three phenotypes exhibited high degrees of genetic similarities and constituted the same species.

Although the clown phase is by far the most commonly encountered form, all three phenotypes can be found together at permanent wetlands. During the rainy season males will call alone or in small clusters of 3–5 individuals perched together on a bush or leafy vegetation above the water (Duellman 2005. Cusco Amazónico. Cornell University Press, Ithaca, New York. pp. 215–218). In breeding aggregations with multiple clusters, males of one cluster will call in synchrony while the other clusters remain silent. Before these males finish calling, males from the next cluster will begin calling, followed in a similar fashion by the remaining clusters before the males of the first cluster will call again.


PHOTO BY JULIE RAY

Clint R.V. Otto recorded the cover image with an Olympus C-3000 Zoom digital camera using a Justrite Electric Head Lantern as a secondary light source. At night, this specimen had light yellow/orange colored extremities, but they turned dark orange the following day. Otto has taken two trips to Reserva Amazonica, a wildlife sanctuary in the Peruvian lowlands, to participate in a long-term amphibian monitoring project headed by Erik Wild. He currently works for the U.S. Geological Survey in Laurel, Maryland, and intends to enter a Ph.D. program in the near future.

SSAR BUSINESS

2007 Annual Meeting, St Louis, Missouri

The Annual Meeting of SSAR took place from 11–16 July 2007 at the Hyatt Regency Hotel in St Louis, Missouri. This was a very special meeting for our Society as it occurred during our 50th Anniversary Year. As has been the case since 2001, SSAR met jointly with members of the American Elasmobranch Society (AES), the American Society of Ichthyologists and Herpetologists (ASIH), and the Herpetologists' League (HL). Also in attendance were members of the Neotropical Ichthyological Society and the North American Native Fishes Association. The meeting was hosted by the St Louis University College of Arts and Sciences and Department of Biology with local hosts Richard Mayden (chair), Robert Aldridge, Nevin Aspinwall, Jason Knouft, and Robert Wood.

A total of 1060 herpetologists and ichthyologists from 26 countries (including Argentina, Costa Rica, Ecuador, Italy, Jamaica, Japan, Mexico, and New Zealand) attended the meeting. The international flavor of the meeting was reflected in a poster produced by SSAR that issued welcomes to all attendees in some 15 languages (Fig. 1). Most meeting participants were from the United States. Canada, Brazil, and Australia were the 2nd, 3rd, and 4th best represented countries, respectively. Just over 50% of those present were students, and around 570 papers and 300 posters were presented. SSAR, ASIH, HL, and AES each sponsored one symposium.

A Brief History of OHS / SSAR

Fifty years ago, two young herpetologists, Kraig Adler and Dave Dennis (then aged 16 and 17, respectively), founded The Ohio Herpetological Society (OHS). Although ASIH and HL were in existence in 1958, the early members of the OHS felt the need to form a regional society that would allow them to connect through a journal, a newsletter, and an annual meeting and field trip (Fig. 2). By the end of its first year, OHS boasted around 100 members (many from outside Ohio and a number from overseas) including Ron Brandon, Joe Collins, Roger Conant, Carl Gans, Carl Kauffeld, Laurence Klauber, Jack McCoy, Graham Netting, Marlin Perkins, Jim Peters, Clifford Pope, Chuck Shaw, and Bob Stebbins and had subscriptions from such institutions as the American Museum, the Museum of Comparative Zoology at Harvard University, and the British Museum (Nat. Hist.). In 1967, the OHS changed its name to the Society for the Study of Amphibians and Reptiles (SSAR). By 1972, membership had risen to 1,000. Four of the original members of OHS are still active, 42 individuals have been members for more than 40 years, and 335 individuals have been members for more than 25 years.

From its humble beginnings, SSAR has become an extraordinarily successful international Society. We now have over 2,300 active members from 60 countries. Twenty five percent of our members are students. We have multiple categories of membership—student, regular annual, plenary, sustaining, contributing, and patron. Our annual budget is in the hundreds of thousands of dollars and most of that is used to support our publication efforts. We publish seven series on a regular basis (*Catalogue of American Amphibians and Reptiles*, *Contributions to Herpetology*, *Facsimile Reprints in Herpetology*, *Herpetological Circulars*, *Herpetological Conservation*, *Herpetological Review*, and *Journal of Herpetology*; Fig. 3), more series than are published by any other vertebrate society in the world. *Journal of Herpetology* and *Herpetological Review* are both published four times a year and we are currently issuing volumes 41 and 38, respectively. This year for the first time, *Journal of Herpetology* is likely to receive over 300 manuscript submissions. The *Facsimile* series in particular has been very important in the growth of the Society. In

regards to this publication effort, Jay Savage in 1988 remarked "First, the uniqueness of this activity (not duplicated by any other society) gave SSAR a special identifying quality that legitimized the group as a serious scientific association. Second, it provided an unusual and valuable prerogative that aided in the recruitment of new members. Finally, income from sales…provided additional revenue that subsidized…the publication of the *Journal of Herpetology* and *Herpetological Review*. Under these circumstances one must attribute much of the growth and success of SSAR to this innovative publishing venture that contributes so much to the reputation and vitality of the society" (*Herpetological Review* 19:42–43). The Society has come a long way from the ditto machine used in the early OHS days!

A sizeable fraction of our budget is also used to directly support student research and attendance at our Annual Meeting. We present four awards at the Meeting for the best student papers (the Henri Seibert Award), seven awards for student research (Grants in Herpetology and the Dean Metter Award), 10 student travel awards, and an award for the best student paper published in the *Journal of Herpetology* (the Kennedy Award)

The Society has its roots in member, particularly student member, participation and has become what it is because of the efforts of many individuals over the years. Hundreds of members have served as Officers, Editors, Associate Editors, Chairs and members of committees, manuscript reviewers, judges of student papers (oral and published), symposium organizers, etc. Some have served extraordinarily long terms. Henri Seibert for example, served for 28 years in various capacities and, in addition to filling several offices (including President), Kraig Adler has served as editor of various publications for 50 years. Doug Taylor was Publications Secretary and Treasurer for 16 years, and Robert Hansen, Bob Aldridge, and Joe Collins served for 16, 14, and 13 years respectively in several positions.

Female herpetologists have had a strong presence in the Society. As president of SSAR in 1979, Margaret Stewart was the first woman to serve as president of one of the major herpetological societies. Since Meg's term, SSAR has had four other female Presidents (Linda Maxson, 1992, Lynn Houck, 1994, Janalee Caldwell, 2003–2004 and Robin Andrews, 2005–2006) and women have held both elected and appointed positions at all levels of the Society.

SSAR and OHS have long enjoyed a sizeable international membership, particularly of students, and this is clearly reflected in the proportion of overseas herpetologists at our Annual Meetings. We reserve a position on our Board for a non-U.S. member and this has been filled by, among others, Gustavo Casas-Andreu (Mexico), David Green (Canada), Tim Halliday (United Kingdom), Gabriela Parra Olea (Mexico), Rick Shine (Australia), and Richard Wassersug (Canada). David Green also served a term as President (2001–2002). One of the awards in our Grants-in-Herpetology Program is preferentially reserved for students from countries where herpetological research has historically been under-funded. We maintain an updated list of international funding opportunities on our website and we offer a manuscript review service for herpetologists for whom English is not their native language who require editorial assistance.

Our website (http://www.ssarherps.org/), started in 1995 by George Pisani, received 973,213 hits in the past 12 months. The website includes a copy of our Constitution, lists of past and present Officers, Editors, and Committee Chairs, information about our publications, a discussion forum, and useful information about careers in herpetology, grant opportunities, job posting, and our manuscript review service. It is regularly updated by our dedicated webmaster Zack Walker and now Raul Diaz.

SSAR's Annual Meetings have been a high point for the field of herpetology for many years. This year's meeting was no exception. In celebration of our 50th Anniversary, many members, particularly older members, who had not attended meetings for a number of years, were present. It wasn't just the younger members of the Society who were impressed by the "Who's Who" in Herpetology at the meeting!

Many individuals worked extremely hard to make this 50th Anniversary Meeting one to remember. The Society wishes to thank in particular the members of the 50th Anniversary Committee (Al Savitzky, chair, Bob Aldridge, Robin Andrews, Janalee Caldwell, Jonathan Losos, Roy McDiarmid, Henry Mushinsky, and Kirsten Nicholson) as well as Ronn Altig, Kraig Adler, Breck Bartholomew, David Dennis, and Jim Murphy. As a society we have much to celebrate and much to take pride in. We also have some significant challenges to face. Here's to anticipating that we have even more to celebrate when our 100th Anniversary rolls around.

Annual Meeting, 2007

The Annual Meeting began officially on the morning of Thursday, July 12th with a welcome from Rick Mayden, chair of the Local Host Committee. Jeff Carrrier, President of AES, then introduced Jack Musick who spoke on "The Changing Face of Shark Research: 400 Million Years of Evolution and Four Decades of Shark Research." Jack was honored later during the meeting at a special retirement dinner. Plenary addresses were given by Darrell Frost, Immediate Past President of ASIH ("Progress and Controversy: Perspectives on the Last 40 years") and Marvalee Wake, The Herpetologists' League's Distinguished Herpetologist ("Eye of Newt and Toe of Frog: Herpetology in 21st Century Science"). Rick Mayden then presented Carl von Linné Awards for Outstanding Contributions in Herpetology and in Ichthyology to Darrell Frost and William Eschmeyer, respectively. As usual, group photographs followed the conclusion of the morning Plenary Session, and paper and poster presentations began after lunch.

The Joint Meeting Reception was held in the City Museum that evening. This Museum, which opened in 1997, was designed by the artist Bob Cassilly and is housed in the 600,000 ft^2 former International Shoe Company building. We were warned to dress appropriately as we would want to take advantage of the slides, tunnels, and various attractions. The warning was well heeded. The museum is hard to describe and photographs only begin to capture what an amazing and fun place it is. It has been called a "warehouse of adventure for people of all ages and a museum unlike any other." It contains an enchanted forest, secret caves and passageways, multiple slides, MonstroCity (two Saber 40 aircraft fuselages, a fire engine, a castle turret, a 25-foot tall cupola and several 4-foot wide wrought-iron slinkies), and a museum of oddities. Many of the exhibits and installations are made of recycled materials. I know of more than a few meeting attendees who snuck off during the meeting for a return visit!

On Friday, the SSAR 50th Year Symposium "Herpetology in the Age of Genomics" was held. Organized by Jonathan Losos, this symposium included 12 presentations and considered genomics very broadly, i.e., genome sequences of focal taxa as well as large-scale investigations (Fig. 4). This was a sequel to the symposium chaired by David Wake at SSAR's 25th Anniversary entitled "Molecular and Genomic Evolution of Amphibians and Reptiles" in 1982.

The highlight of the social events for many of our members was the 50th Anniversary Banquet, Program, and Live Auction held on Friday evening. Personal invitations were issued to past officers, editors, and committee chairs, however the banquet was open to all SSAR members and over 100 individuals attended. Many of the early officers of the OHS were there (Fig. 5), as well as sixteen Presidents, including the very first and our current President (Fig. 6). President Roy McDiarmid served as Master of Ceremonies for the evening and welcomed us to the Banquet. Kraig Adler spoke about the history of the Society. He particularly noted the involvement of students from the very founding of the Society and of the importance of volunteerism for SSAR and similar societies.

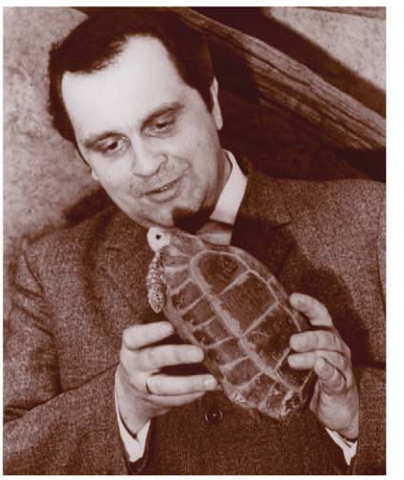
Individuals who have served the Society in particularly notable ways were presented with awards at the Banquet by President McDiarmid (Fig. 7). Roy made the point, that while these individuals certainly deserve special notice, they are representative of the many, many individuals who have made SSAR what it is today. Those honored were John Wright who published the first paper in the first volume of the first issue of *Journal of*

Another New Book to Celebrate SSAR's 50th Anniversary

THE LIVES OF CAPTIVE REPTILES

by Hans-Günter Petzold

Translated by Lucian Heichler and Edited by James B. Murphy













This book, originally published in German, is **a recognized classic on the biology of captive reptiles** (and selected amphibians). In it, the author carefully summarizes an enormous body of information—both his own extensive experience at Tierpark Berlin and a vast literature—much of which has been little known outside the German-speaking world. He synthesizes studies from captive and wild animals and discusses and interprets them in terms of contemporary physiology, ethology, and reproductive biology. Petzold reviews papers in biological, herpetological, zoo, and terrarium journals published throughout the world, including eastern Europe, Russia, and China, and he champions the role played by amateur terrarists in making studies of general importance. He shows how data derived from captive reptiles can lead to discoveries of importance to ethology, reproductive biology, systematics, and veterinary management. **This book will be of value to academics, zoo personnel, veterinarians, amateur terrarists, and conservationists interested in the maintenance, reproduction, and observation of reptiles in captivity.**

Hans-Günter Petzold, late Curator of Reptiles and Deputy Director of the Tierpark Berlin, one of the world's great zoos, was a leading expert on the biology of captive amphibians and reptiles and author of about 350 papers and five books on captive animals. He was trained at the University of Leipzig in systematics, ecology, and animal behavior, where he received his doctorate in 1960, and has conducted field research on reptiles overseas, including Algeria, Cuba, and Vietnam. In this book, Petzold has marshalled this breadth of experience to make insightful connections among diverse studies and to point out fruitful areas for future research. This English edition has been professionally translated by **Lucian Heichler**, who for more than 30 years served in the foreign service of the U.S. Department of State, and has been thoroughly edited by **James B. Murphy**, former Curator of Reptiles at the Dallas Zoo and now Research Associate at the Smithsonian Institution's National Zoological Park in Washington, D.C. The German edition was not illustrated, but this edition has been augmented by the staff of Tierpark Berlin with **60 photographs (57 in color)**.

Topics covered include aspects of **reproduction** (sexual dimorphism, age at maturity, sex recognition and attraction, courtship behavior, copulation, gestation and delayed fertilization, egg-laying, birth, reproductive cycles, parental care, data on eggs and clutches, incubation time, genetic questions), **development** (growth, coloration and markings, regeneration, skin shedding, longevity), and **nutrition** (search for and ingestion of food, digestion, excretion, defecation, pellet formation, gastroliths, keratophagy, cannibalism). There are also discussions of the origin and **history of zoos**, the relevance of **terrarium observations**, and species **conservation programs** in zoos and private terraria. The literature cited section includes 1200 titles and there is an index to genera and species.

Specifications: 300 pages (7 × 10 inches or 18 × 25.5 cm), hard cover, 60 photos (57 color), index. ISBN 978–0–916984–73–1. To be published March 2008. • **Regular Price:** $55. • **Special Price to SSAR Members** (if ordered *before July 2008*): $45. • **Shipping Costs:** USA address, add $4; non-USA add $11. • **Orders to:** SSAR Publications Secretary, P.O. Box 58517, Salt Lake City, Utah 84158–0517, USA (*telephone and fax*: 801–562–2660; *e-mail*: ssar@herplit.com). • **Payment:** Make checks payable to "SSAR." Non-USA orders must be paid in USA funds using a check drawn on a USA bank or by International Money Order. Books may be charged to American Express, Discover, MasterCard, or VISA (please give account number and expiration date). • **SSAR Membership and Other Publications:** Membership information and a complete list of society publications can be obtained from the Publications Secretary at the addresses given above or at www.ssarherps.org.

Herpetology ("Variation in Three Sympatric Sibling Species of Whiptail Lizards, Genus *Cnemidophorus*"), Bob Aldridge for his service as Publications Secretary and Treasurer, Joe Collins who has served the Society in many capacities (President, Secretary, Editor, etc.), Doug Taylor (Treasurer for 6 years and Publications Secretary for 10 years), Bob Powell (editor of *CAAR* for 13 years and who introduced color into the *Catalogue*), Corson Hirschfeld (long-time member, President, 1962–1965, and developer of *Herpetological Review*), Stephen Tilley (Publications Secretary and Editor of *CAAR*), and Robert Hansen (Editor of *Herpetological Review* since 1991). Special 50-year service awards were presented to the co-founders of the Society, Kraig Adler (President, Editor, member of various committees, etc.) and David Dennis (Secretary, Treasurer, and artist, etc.) (Fig. 8).

A slide show of the history of the Society and its members, organized by Al Savitzky and Roy McDiarmid, ran throughout the evening. Beautifully etched wine glasses with the SSAR logo designed and produced by Ronn Altig were given to attendees (all 125!) at the Banquet (Fig. 9). A few additional glasses were auctioned later in the evening and some lucky members walked away with a set of four. Joe Collins, who was the original SSAR auctioneer in 1981, agreed to return in the role of auctioneer for the 50th Anniversary Auction, assisted by Darrell Frost and Chuck Schaffer. As always, bidding was spirited and much needed funds were raised for Student Travel Awards.

On Saturday morning, in honor of the 300th Anniversary of the birth of Carolus Linnaeus, the International Society for the History and Bibliography of Herpetology and HL sponsored a symposium "The Historical Legacy of Linnaeus: A Celebration of the Linnaean Tercentenary."

The Joint Meeting Picnic was held in the St Louis Zoo in the hills of Forest Park on Saturday evening. Established in 1910, state legislation provided that admission to "the zoo shall be forever free." We enjoyed local barbeque and having free rein around the zoo. Many herpetologists spent time in the historic Charles H. Hoessle Herpetarium (renamed in 2002 in honor of the Zoo's Emeritus Director) that was built in 1927 as "The Reptile House" and currently houses over 700 animals, including live tuatara. This is the collection made famous by TV personality and zoo director, Marlin Perkins.

To celebrate this special year for SSAR, all meeting attendees received a copy of a poster produced by David Dennis of an Ohio *Hyla versicolor* (Fig. 10). Also on display were posters produced by Dave for the 1982 and 1989 meetings at North Carolina State Museum of Natural History, Raleigh, North Carolina and the University of Kent, Canterbury, United Kingdom, respectively (Fig. 11). The 1982 meeting occurred during our Silver Anniversary year and the 1989 meeting was held in conjunction with the First World Congress of Herpetology.

Throughout the meeting, Breck Bartholomew (Publications Secretary) displayed a remarkable collection of SSAR publications (Fig. 12). Breck began collecting all SSAR publications as well as originals for works reprinted and translated by SSAR after attending the 1996 meeting and seeing the display at the Spencer Library at the University of Kansas (this display was converted into "Slithy Toves"—an SSAR book). The display at the 50th meeting included originals of approximately 80% of the books reprinted by SSAR and all of the original versions of the books translated and published in English by SSAR. Many of the books are quite rare (some valued at more than $40,000), are highly sought after, and are seldom seen in herpetological collections. Breck expressed a hope that the display would act as a tribute to the Society and highlight the importance of the publications in the history of SSAR. In the same room was a display of all of OHS and SSAR's prior publications (selections of journals) and other historical documents, as well as a display of some of Linnaeus' publications in celebration of his tercentenary, arranged by Richard Wahlgren (Fig. 13).

The Herp Quiz was revived at this meeting thanks largely to the efforts of Marty Crump, Julian Lee, and John Simmons. As always, this quiz contained questions to stump even the most knowledgeable herpetologist! Winners were announced at the Joint Meeting Banquet at the end of the meeting. Winners of the student category were Eric Rittmeyer and Michael Grundler (both undergraduates from Cornell) and of the non-student category were Robert Reed and Bjorn Lardner.

The Joint Meeting Banquet was held on the last evening of the meeting. Larry Page (Past President ASIH) served as Master of Ceremonies and in his opening remarks acknowledged the 50th Anniversary of our Society (Fig. 14). ASIH made various awards including the Robert K. Johnson Award to our own Al Savitzky recognizing his long service to ASIH. Resolutions of the Societies were presented by Joe Nelson and Rafe Brown (for SSAR). David Green issued an invitation to attend the 2008 Joint Meeting of Ichthyologists and Herpetologists in Montreal.

Once again, SSAR extends thanks to the local co-hosts, other members of the Local Committee (especially the graduate students), and Sharon Brookshire and the staff of the Kansas State University Division of Continuing Education for all of their hard work, particularly as regards special events commemorating our Anniversary.

Board Meeting and Business Meeting Summaries

Society President Roy McDiarmid called the 2007 Board Meeting to order at 0802 h July 11th at the Hyatt Regency Hotel, St Louis, Missouri.

In attendance were 10 members of the Board of Directors and 17 Editors, Committee Chairs, or members of the Society. Minutes of the 2006 Board of Directors Meeting (New Orleans, Louisiana) were approved.

Annual reports for 2006/2007 were submitted by 31 of 32 Officers, Editors, and Committee Chairs. President Roy McDiarmid devoted much time in the first six months of his term to preparation for the celebration of SSAR's 50th Anniversary. For example, letters of invitation, particularly to attend the 50th Anniversary Banquet, were sent to all current and past officers of the Society and editors of SSAR publications. Awards and plaques recognizing certain individuals who have served the Society in special ways were arranged. Other routine duties that occupied Roy included those related to the Metter Award and the Symposium, Conservation, and Standard English and Scientific Names Committees. He was involved in the transition of the Treasurer's duties from Dora Pinou to Kirsten Nicholson and in moving the membership responsibilities to Allen Press. The Herpetologists' League is also working with Allen Press and this joint arrangement will result in financial savings for both societies. Roy invites feedback from members regarding interactions with Allen Press. He spoke with the Allen Press representatives at the meeting about some issues that had already been raised. John Moriarty pointed out that there are some issues relating to the Allen Press website that need to be resolved, e.g., there are no links to SSAR publications with which Allen Press is not involved, it is not currently possible to separately access lists of HL and SSAR members on the website, etc. President McDiarmid and George Pisani (Archivist) are working with the Smithsonian Archives which is willing to review a proposal to accept SSAR materials. A committee will be appointed to deal with this. Those interested in being appointed to this committee should contact Roy.

During the last six months of her term as President, Robin Andrews (Immediate Past-President) finalized the agreement between SSAR and HL and Allen Marketing and Management (AM&M, effective April 2007). AM&M will now handle subscription and membership services and the society will be able to broadcast email information to members. Robin appointed Betsy Rothermel as co-chair of the Conservation Committee and wrote letters of thanks to the members of the Local Committee who organized the very successful 2006 Annual Meeting in New Orleans. Additionally, she worked with Gad Perry and Geoff Smith to write an ethics statement for SSAR (this is posted on our webpage) and with Zack Walker to update the webpage. She was also involved in planning for the 50th Anniversary Celebration.

Kirsten Nicholson (Treasurer) reported that assuming the duties of the Treasurer's office continued to be challenging, but she is successfully handing the day-to-day responsibilities of the position. She plans to write a manual outlining the duties of the Treasurer. This will ease the transi-

tion to a new Treasurer when this occurs. Kirsten suggested that the Board should discuss endowments and investments. She has changed the way that page charges are invoiced. Authors will now be emailed a PDF copy of the first page of galley proofs. There was discussion of annual repayments of a loan to a Venezuelan foundation for the SSAR book, "Turtles of Venezuela."

Among her duties in the past year, Marion Preest (Secretary) prepared Board and Business meeting minutes for officers, editors, and committee chairs. Additionally, she prepared a summary of the 2006 meeting for publication in *Herpetological Review* and prepared the Annual Report for this year's Board meeting. On-going duties include updating SSAR letterhead, answering or forwarding numerous emails, and ensuring that reports from Committee chairs are submitted for publication.

Breck Bartholomew (Publications Secretary) reported that total income from sales of Society publications in 2006 was $184,031 (this includes $159,912 in membership dues). Book sales appear to have slowed a little in 2006. Breck suggested that this was due to people not purchasing as many books as they used to and the fact that the Society has not published many books recently. He expects sales to pick up next year particularly with the appearance of multiple volumes in the *Biology of the Reptilia* series. Breck was heavily involved in moving the membership duties to Allen Press.

Andy Price (Editor, *Catalogue of American Amphibians and Reptiles*) reported that 20 accounts were published in 2006. He wished to thank Larry David Wilson who stepped down as Snake Section Editor after serving for 34 yrs and Bob Powell for his service as Editor. Breck Bartholomew has started scanning old copies of *CAAR* (saving them as PDF's). Aaron Bauer suggested that access to this material (on a CD) could be used as an incentive to new members. Al Savitzky raised the issue of selling these files to provide income to the Society versus making them available free (via Open Access) and providing a service to professional herpetologists. Barbara Savitzky pointed out that electronic versions of literature have much greater appeal to younger members than to most of our older members.

No books in the *Contributions to Herpetology* series were published in 2006, however Kraig Adler (Editor) anticipates four in 2007–2008, including two volumes in the *Biology of the Reptilia* series. *Contributions to the History of Herpetology* (Vol. 2) by Adler, Applegarth, and Altig was distributed *gratis* to all delegates at the 2007 meeting, and includes biographies of almost 300 leading herpetologists, an index to taxonomic authors, and an update of doctoral lineages (Fig. 15). Three books are expected in 2008, including two in the *Biology of the Reptilia* series. Volume 22 will be the last in the series and will consist of a comprehensive index.

Editor of *Facsimile Reprints in Herpetology*, Aaron Bauer, reported that one facsimile was published in early 2007 (*The Herpetological Contributions of Mario Giancinto Peracca*) and two are planned for 2008 (*Gray's Catalogues of the Specimens of Amphibians and Reptiles in the Collection of the British Museum*, and a special World Congress of Herpetology facsimile for distribution in Brazil, Schweigger's papers on turtles). Several other works are in preparation or under consideration. For the foreseeable future, one *Facsimile* is likely to be published every two years.

John Moriarty (Editor) reported that *Herpetological Circulars* Numbers 35 and 36 have been published this year. Number 35 will be printed on demand and Number 36 *(Society for the Study of Amphibians and Reptiles: A Fifty Year History*) was distributed at the 2007 Annual Meeting (Fig. 16). Number 37 (*Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, Sixth Edition*, by Crother et al.) is scheduled for early 2008 and will likely have an accompanying website link.

Volume 2 of *Herpetological Conservation* (Conservation of Reptiles in Canada, edited by P. S. Corn) was published in May 2007. The Board wishes to acknowledge Breck Bartholomew for his assistance. Joe Mitchell (Co-Editor, *Herpetological Conservation*) reported that Volume 3 (Urban Herpetology) is nearing completion and publication is expected in 2008. This book will consist of over 40 chapters and a number of case studies and was partially funded by the U.S. Forest Service. Joe is interested in suggestions for a fourth volume in this series.

Robert Hansen (Editor) reported that *Herpetological Review* continues to increase in size but that submission rates seem to have leveled off. More space has been devoted recently to natural history notes to deal with a backlog of accepted manuscripts. There were minimal staff changes in 2006–2007. There was consideration of increasing the use of color in *Herpetological Review* and Bob plans to discuss this with Allen Press. Al Savitzky commented that *Herpetological Review* is the only major North American journal that is not yet available online. The Board realizes the importance of online availability and will continue discussion of this. Hard copies in black-and-white plus online publication in color may be possible. The Board once again thanked Bob for his impressive efforts with this news-journal.

Geoff Smith (Editor, *Journal of Herpetology*) reported a number of staff changes in the past year (four new Associate Editors and one addition to the Editorial Board). Allen Press now provides copy editing services. Geoff expects submissions this year for the first time to exceed 300 (perhaps partly because of ease of online submission). Acceptance rate remains approximately the same as it has been the past few years (i.e. ~ 40%). As a result of these factors, a backlog of accepted papers is being generated. An increase in number of pages is planned to relieve this pressure. Many manuscripts are received from overseas herpetologists, and many of this year's papers are from students eligible for the Kennedy Award. An ethics statement was developed by Geoff with assistance from Gad Perry and Robin Andrews. This statement is considered "a work in progress" and comments on it are welcome (contact Geoff Smith). The 50th Anniversary of SSAR is being commemorated with golden covers for *Journal of Herpetology* as well as cover art depicting the 1st meeting of SSAR and color photos of new species described in the *Journal*. Geoff expressed thanks to Kraig Adler and Al Savitzky particularly for help with this. There was some discussion of the editorial policy of *Journal of Herpetology* regarding the suitability of manuscripts based on descriptive research. Geoff indicated that these types of manuscripts will be considered for publication if the biological context within which they are presented is appropriate. The Board reiterated its support for all aspects of quality herpetology. Color plates are thought to be valuable in *Journal of Herpetology* especially in descriptions of new species. It may be possible to use endowments to support this or to publish color plates online and use black and white in the hard copies.

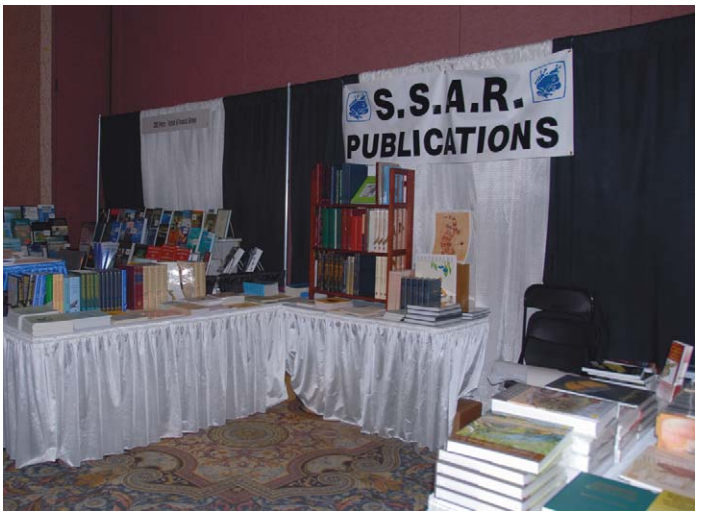
Reports submitted by the Chairs of Standing Committees were then discussed. The Committee on Celebration of the 50th Anniversary of SSAR (Al Savitzky, Chair) reported that it had been active planning a number of major events for the Annual Meeting including a commemorative banquet preceding the live auction, a symposium "Herpetology in the Age of Genomics," and reviving the Herp Quiz. The Board decided that entry to the Quiz would be by donation and that funds raised would be used to support the Student Travel Fund. All registrants at the Annual Meeting received a photographic poster produced by David Dennis, a copy of *Contributions to the History of Herpetology* (Volume 2) edited by Kraig Adler, and *Society for the Study of Amphibians and Reptiles A Fifty Year History, 1958 to 2007* by John Moriarty and Breck Bartholomew. A comment was made that the Board should pay attention to the timing of major events in the history of other Herpetological Societies so that letters of recognition may be sent to them. The Secretary will see to this.

Stephen Richter and Betsy Rothermel, co-chairs of Conservation Committee attended the annual Southeast Partners in Amphibian and Reptile Conservation (PARC) meeting and discussed with PARC members how activities of SSAR, HL, ASIH, and PARC might be better coordinated. The Committee sent a letter to the US House Committee on Science regarding the decision by the Department of Energy to suspend funding for the Savannah River Ecology Lab. Following this, there was some discussion of the autonomy of this and other SSAR committees, and whether a



Figures (this column)—1. Welcome sign used at SSAR's 50th Anniversary Meeting. 2. Early officers and editors of The Ohio Herpetological Society, SSAR's predecessor. From L to R: K. Adler, D. Dennis, C. Hirschfeld, J. Collins. Photo by M. Preest. 3. SSAR Publications sales booth at the meeting. Photo by K. Dodd.











Figures (this column) —4. Participants in the 50th Anniversary Symposium "Herpetology in the Age of Genomics." Top row (L to R): R. Voss, J. Wiens, S. Edwards, N. Valenzuela, J. Collins, J. Hanken, D. Wake, D. Hillis, H. Nagashima; Bottom row (L to R): J. Losos (organizer), E. Rosenblum, J. Wade, K. Zamudio. Photo by M. Preest. 5. Members active in The Ohio Herpetological Society. Top row (L to R): R. Brandon, R. Vogt, H. Heatwole, R. Ashton, R. Altig, S. Tilley; Bottom row (L to R): B. Valentine, C. Hirschfeld, D. Dennis, J. Collins, K. Adler, J. Wright. Photo by K. Dodd. 6. Presidents (past and present) of SSAR in attendance at the 50th Anniversary Banquet. Top row (L to R): R. Brandon, R. Webb, N. Scott, A. Savitzky, H. Mushinsky, L. Houck, V. Hutchison, D. Green, M. Nickerson; Bottom row (L to R): K. Adler, R. Andrews, J. Lee, C. Hirschfeld, J. Collins, R. McDiarmid, R. Axtell. Photo by K. Dodd.







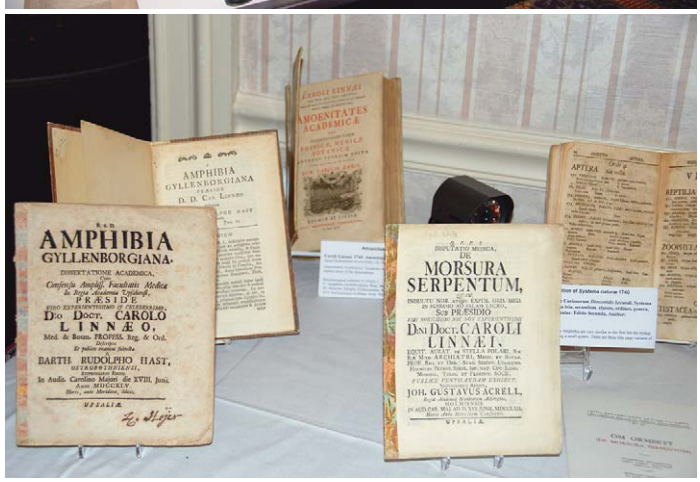


Figures (this column, top to bottom)—7. Awards presentation to the Society's co-founders at the 50th Anniversary Banquet. From L to R: K. Adler, D. Dennis, R. McDiarmid, R. Altig. Photo by M. Preest. 8.Winners of special awards at the 50th Anniversary Banquet. Top row (L to R): R. Hansen, S. Tilley, J. Wright, R. Aldridge, R. Powell; Bottom row (L to R): K. Adler, D. Dennis, C. Hirschfeld, J. Collins. Photo by K. Dodd. 9. Commemorative wine glasses designed and etched by Ronn Altig that were given to all persons who attended the 50th Anniversary Banquet. Photo by D. Dennis. 10. Poster produced by Dave Dennis for the 50th Anniversary Meeting. The frog, an Ohio *Hyla versicolor*, is in the pose of the SSAR logo with its vocal pouch extended in the act of communicating. Photo by D. Dennis.









Figures (this column, top to bottom)—11. Posters produced by Dave Dennis for the 1982 and 1989 Annual Meetings of SSAR. Photo by D. Dennis. 12. Originals of rare books and papers published in SSAR's *Facsimile* reprints series collected by Breck Bartholomew and displayed at the meeting. Photo by K. Dodd. 13. Display of Linnaean publications associated with the Linnaeus Tercentenary sponsored by the International Society for the History and Bibliography of Herpetology (ISHBH). Photo by K. Dodd.

letter written by members of a Committee representing SSAR should be signed by the President since Roy McDiarmid is a federal employee. Robin Andrews did not think that SSAR has a policy regarding this and suggests that whether or not the President signs such a letter should depend on the importance of the issue being discussed. Roy McDiarmid commented that government employees needed to be careful what they sign their names to and suggested that even if the President does not sign letters, he/she should be aware of their content. The Conservation Committee is planning to meet with the ASIH Conservation Committee and the SSAR/HL Herp Education Committee during the Annual Meeting.

Nine proposals of high quality were submitted for the Dean Metter Award (Joe Beatty, Chair) this year. The Award was presented to Barbara Banbury for her proposal "Tempo and Mode of Species Diversification in Megophryid Frogs." Ms. Banbury has worked with Drs. Linda Trueb, John Simmons, Robert Powell, and Anne Maglia and is currently a Ph.D. student in the lab of Dr. Michael Alfaro at Washington State University.

Erik Wild (Chair, Grants in Herpetology Committee) reported that 71 proposals from 26 states in the USA and eight countries were received in 2007. The "Travel" and "Laboratory" categories received the most applications (21 each). The following winners will each receive $500:

Conservation: Dana Wingfield, University of California, Santa Cruz
Field Research: Julie Ray, Old Dominion University
Laboratory Research: Michael Butler, University of Florida
Travel: Roberto Brenes, Southern Illinois University
International: Hanyeh Ghaffari, Azad University, Tehran (Iran)
Education: Justin Shaw, National Audubon Society

Erik is stepping down as chair of this committee and will be replaced by Josh Kapfer. In the future, applications for GIH will be submitted online. Josh will work with Zack Walker and Anne Maglia to implement this.

Lora Smith and Margaret Gunzberger (co-chairs) announced the winners of the 15th annual Henri Seibert Award at the meeting in New Orleans, 2007. Names of the winners were published in *Herpetological Review* 37(3):257–258. SSAR wishes to thank Chuck Crumly (University of California Press) for, once again, providing books for the winners. There was some discussion of the requirement that participants be members of SSAR at the time of abstract submission. Every year a handful of students apply to participate in this competition without being members and it takes many emails and many weeks to deal with this. It is hoped that online membership renewal will eliminate this problem.

The Herpetological Education Committee (Cathy Bevier, Chair) continues to respond to "Herp Hotline" questions and plans to develop a "Frequently Asked Questions" page and a webpage listing educational activities on herpetofauna for all ages. Members of the committee are involved with informal education activities, e.g. interviews, open house presentation, field trips. In the past year, they have updated the International Grants Programs list on the SSAR website. The Board gave approval to replace two members of the committee and to include a representative from ASIH. Lynnette Sievert (Chair, Kennedy Student Award Committee) reported that the winning paper for 2006 was by John Malone: "Ecology of the Basin Construction Reproductive Mode in *Smilisca sordida* (Anura: Hylidae), *Journal of Herpetology* 40:230–239." John will receive a check for $200 or the equivalent of $400 in SSAR publications.

Henry Mushinsky (SSAR Representative on the Meeting Management and Planning Committee) reported that this Committee met in St. Louis in March to develop a meeting schedule and review conference facilities. They extended the deadline for abstract submission for the 2007 meeting because of undersubscription at the original deadline. Approximately 900 presentations will be made at the 2007 meeting. The Committee requests that Society members read the submission instructions carefully to avoid making mistakes. They provided a reminder that each person can submit abstracts for only one oral paper and one poster.

Future meetings are to be held as follows:

– Montreal, Canada (2008, 23–28 July)
– Portland, Oregon (2009)
– Providence, Rhode Island (2010)
– Minneapolis, Minnesota (2011)

The Board continued to discuss participation of SSAR in meetings of the World Congress of Herpetology (WCH). In principle, we would like to meet with WCH when the meeting is held in North America. However, problems arise over the advanced planning that is necessary. Aaron Bauer (WCH Secretary-General-elect) indicated that a decision regarding the 2012/2013 meeting should be made by the end of this year. The venue is likely to be Tucson, AZ or Vancouver, BC. There was unanimous support expressed by the Board for SSAR to meet with WCH in 2012 in North America. Our level of involvement would need to be specified. There is nothing in the SSAR constitution that would prevent SSAR from having a presence at more than one meeting per year, thus it might be possible to participate in both the WCH and Joint ASIH/HL/SSAR meetings. The Board agreed to co-sponsor the 2008 WCH meeting in Manaus, Brazil. There was on-going discussion of the current hotel-based meetings with professional organizers versus the former university-based meetings and the issues of cost, ease of planning, and workload placed on the local hosts.

No election is scheduled for 2007. Greg Watkins-Colwell has been added to the Nominations Committee (Kirsten Nicholson, Chair) and an overseas member is being sought. Richard Wassersug (Resolutions Chair) presented resolutions at the Joint Meeting Banquet in 2006 and Rafe Brown presented them (for Richard) in 2007. Kraig Adler suggested that SSAR abandon the use of antiquated language in the resolutions. There was general support for this.

Brian Crother (Chair, Standard English and Scientific Names Committee) reported that Number 37 of *Herpetological Circulars* (*"Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico,"* by Crother et al.) is planned for 2008 and will likely have an accompanying website link. There was some discussion of the importance of this list and the fact that it has official approval of SSAR, HL, and ASIH. Brian currently receives many requests (e.g., by State agencies) for the list produced by this committee and the Board regards this as a worthwhile investment. There was also discussion of the need for both electronic and hard copies of publications. Some concern was expressed regarding citation of non-static, electronic-only documents. Roy McDiarmid suggested that Brian and John Moriarty talk with Anne Maglia or Zack Walker (Web Oversight Committee) about this. The committee has received a draft of "*Standard Spanish, English, and Scientific Names of the Amphibians and Reptiles of Mexico*" by Ernest Liner and Gustavo Casas-Andreu and recommends publication in limited paper run and as a downloadable pdf from the SSAR website. This manuscript will be sent out for review. The importance of including Spanish-speaking Mexican colleagues in the pool of reviewers was stressed. John Moriarty thinks that he will be able to find a donor to cover publication costs. The Board discussed the possibility of Brian Crother stepping aside from his position as chair of this committee now that he is President-Elect. However, the Board sees no conflict of interest and wishes for Brian to remain in this position.

Dawn Wilson reported that the number of applicants for Student Travel Awards continues to be low (12 applications for 10 awards). The Travel Award Winners in 2006 were:

Kimberly Andrews, University of Georgia (USA)
Kristin Bakkegard, Utah State University (USA)
Alessandro Catenazzi, Florida International University (USA)
Matt Chatfield, University of Michigan (USA)
Chris Feldman, Utah State University (USA)
Gillian Gouchie, Dalhousie University (Canada)
Joshua Kapfer, University of Wisconsin (USA)
Libby Liggins, Victoria University of Wellington (New Zealand)
Carolina Monteiro, University of Arkansas (USA)
Heather Waye, Oregon State University (USA)



FIG. 14. Treasurer Kirsten Nicholson and President Roy McDiarmid at the Joint Meeting Banquet. Photo by M. Preest.

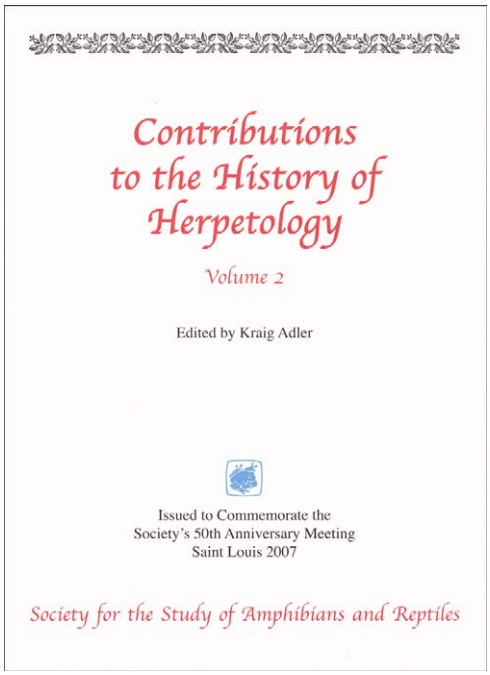


FIG. 15. Title page of "Contributions to the History of Herpetology," Vol. 2 issued to commemorate the 50th Anniversary of the Society. This volume contains "Herpetologists of the Past," Part 2 by K. Adler, "Index of Authors in Taxonomic Herpetology," 2nd ed. by J.S. Applegarth, and "Academic Lineages of Doctoral Degrees in Herpetology," 2nd ed. by R. Altig.

Anne Maglia (Chair, Web Oversight Committee) reported that the website underwent a major update this year. A number of individuals, including Committee members, assisted with this. A link to the website of Allen Marketing and Management (AM&M) will be provided from the Society website. Anne indicated that if the Society starts to publish more material on the website (e.g., PDF files) there will be an increase in costs. The website is very important in maintaining visibility for the So-

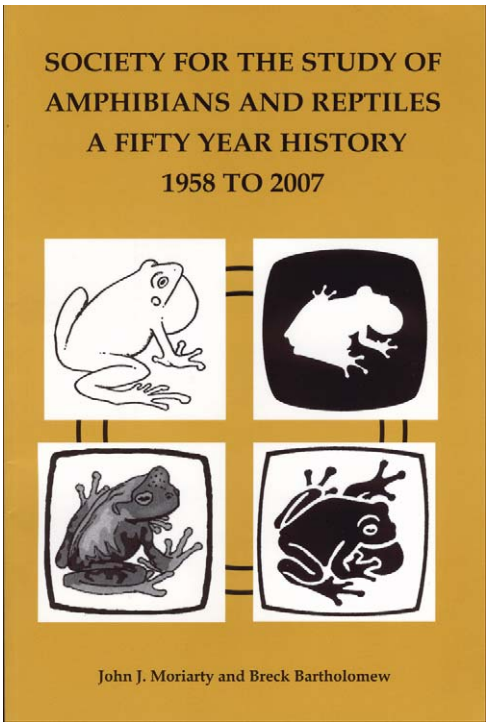


FIG. 16. Cover of "Society for the Study of Amphibians and Reptiles A Fifty Year History 1958 to 2007" by J. J. Moriarty and B. Bartholomew.

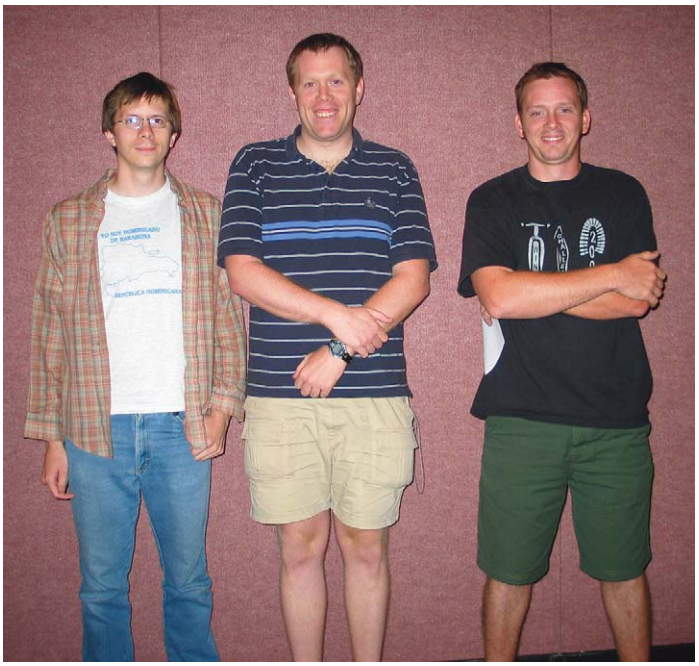


FIG. 17. Three winners of the 2007 Henri Seibert Awards for best student papers who were in attendance at the SSAR Business Meeting. From left to right: L. Mahler (Systematics Category), R. Sutherland (Conservation Category), and S. Graham (Physiology/Morphology Category). Photo by M. Preest.

ciety and the committee welcomes suggestions from members.

The SSAR election for 2007 was conducted during the Fall of 2006. Maureen Kearney (Elector) received 278 ballots. Brian Crother was elected President-Elect, Kirsten Nicholson was elected Treasurer, and Marion Preest continues as Secretary. Tiffany Doan, Travis LaDuc (Regional Society Representative), Stephen Richter (Conservation Representative), and Paul Chippendale were elected to the Board. No election is necessary in 2007, and from 2008 forward, elections will be run electronically. It is hoped that this will avoid the problem of overseas members not receiving ballots on time and may increase voting participation. Members who do not have access to email will continue to receive paper ballots. Maureen Kearney has resigned as Elector after several years of excellent service. There was discussion of the need to have an Elector, given the move to electronic voting and the fact that AM&M will be counting votes. It was felt necessary to have an election overseer and that perhaps this person could be an international member of the Society. Among other duties, the overseer could deal with the issue of family membership categories and ensure that couples/families with these memberships are able to cast the appropriate number of votes.

Al Savitzky (Representative to AIBS and BioOne) attended the annual meetings of both AIBS and BioOne in 2007 and reported on their activities as relevant to SSAR. AIBS continues to serve as an important voice for organismal biologists and ecologists. It deals, among other things, with public policy and biological education at all levels (focusing particularly on the controversies surrounding the teaching of evolution) and is currently involved in the cooperative development of a proposal to begin study of the current state of biological sciences in the U.S. Concern was expressed at the AIBS meeting at declining membership in many member societies due to a failure to recruit or retain young professionals. Information was presented on the recently launched Encyclopedia of Life. This will link many biological databases and provide information on biodiversity for use by professionals and the public.

A major new project is the *Coalition for the Public Understanding of Science* (COPUS). The first major activity of COPUS is to organize the "Year of Science 2009." This year is the bicentennial of the birth of Darwin, the sesquicentennial of the publication of *The Origin of Species*, and the bicentennial of the birth of Abraham Lincoln (who founded the U.S. National Academy of Sciences). The aim of the celebration is to focus on public understanding of the process of science. The Board voted unanimously to join COPUS and the Year of Science 2009. Information on COPUS can be found at http://www.copusproject.org and on the Year of Science 2009 at http://www.yearofscience2009.org.

BioOne launched a second collection of journals in 2007 under the name BioOne.2. Between BioOne.1 and BioOne.2, 125 journals are available (this is expected to grow to almost 170). BioOne has instituted a 52% increase in price over the past 6 yrs, but has offset this by an 88% increase in the number of titles and a 323% increase in the number of pages. Savitzky reported that BioOne continues to be supported by libraries. BioOne has returned 61% of its total 2006 revenue to publishers (SSAR received $15,235 in 2006 for 2005). SSAR is not currently enrolled in BioOne's Secondary Rights Management Program. This provides opportunities for journals to receive income from the sale of individual articles.

One proposal "Is Management of Sustainable Commercial Harvesting of Long-Lived Organisms Possible?" was received from Willem Roosenburg by Richard Durtsche (Symposium Coordinator) for the 2008 Montreal meeting. This Board voted in February to support this symposium. Individuals considering submitting proposals for 2009 need to ensure that they are aware of the new guidelines.

Following discussion of the Annual Reports, the Board moved on to new business. There was discussion of mounting another membership campaign. Membership numbers clearly increase following a campaign and such campaigns appear to be especially important in recruiting overseas members. Now that dues can be paid online, it may be easier to recruit overseas members. We particularly need to recruit (and retain) younger members. A suggestion was made to send membership brochures advertising the benefits of joining SSAR to other societies and to their meetings (e.g., WCH meeting in Manaus in 2008). Breck Bartholomew and John Moriarty (with advice from Kraig Adler) will spearhead this effort. There was discussion of various incentives that we could offer to new members (e.g., reduced page charges, reduction in prices of SSAR publications, etc.). Some concern was expressed that current/renewing members would not have these incentives available to them. Regional Herpetological Societies could also be targeted as sources of new members. Dave Hardy offered to work with Travis LaDuc on this. The Relations with Herpetologists at Zoological Parks Committee should also be involved.

The Student Travel Award is supported partly by proceeds from the Silent Auction. Dawn Wilson (Silent Auction organizer) reported that she has not been receiving the necessary support from local hosts and students (to obtain auction items and to run the auction) and the funds generated in recent years have been low. Dawn indicated her desire to step down as organizer. The Board then discussed the need for increased student involvement in the Society and various ideas to raise funds for student support. Student attendance at meetings is substantial and continues to increase. The cost to attend meetings is considered to be reasonable - housing costs can be on the low side with shared rooms and registration costs and cost of tickets to attend events are heavily subsidized by regular members. There was a suggestion to form a "Student Participation Committee" to determine why there is a general lack of participation by students in the Society and to generate ideas to increase involvement and student support. Dawn offered to chair this Committee and Rafe Brown, Tiffany Doan, Anne Maglia, and Stephen Richter indicated a willingness to become members. Others wishing to be involved (especially students) should contact Dawn or Roy.

A request for co-sponsorship of a symposium on "Amphibian Declines and Chytridiomycosis" was sent to the Conservation Committee by Joe Mendelson on behalf of PARC (Partners in Amphibian and Reptile Conservation). This symposium was held in Tempe, AZ in November 2007. The Board considered this a worthwhile symposium and voted unanimously to support it by providing $500. However, some concern was expressed that the money could be used to support other Society activities (e.g., student travel) and that, once it became known that the Society provides financial support, we would begin to receive multiple such requests.

The Board Meeting adjourned at 1345 h without having finished discussion of, or voted on, the 2008 Budget. As a result, a special Budget meeting was called.

Society President Roy McDiarmid called the Budget Meeting to order at 1530 h on July 12, 2007 in the Hyatt Regency, St Louis, MO. Treasurer Kirsten Nicholson presented a proposed 2008 budget. As first proposed, expenses exceeded income by approximately $60K. The Board then reviewed income and expenditure categories. Expenditures were cut in some cases where this was deemed possible. This had relatively little impact on the proposed budget. Income for 2008 from publications is expected to be higher than currently listed in the budget especially because of books from the *Contributions* series that will appear. This may add $20–40K to our income, however there is still likely to be a deficit.

There was discussion of raising the annual dues. The Board felt that a dues increase may be necessary especially given that dues have not increased since 2003, our current dues are lower than those of the other major USA-based societies, and we give "value for money" e.g., two journals with four issues each year, various forms of student support (travel awards, Kennedy Award, Seibert Awards, Grants-in-Herpetology, Dean Metter Award, etc.). However, it was decided to put this matter off temporarily, partly because of the recent change in Treasurer. It was agreed that an in-depth analysis of the financial state of the Society was necessary. After that, the implications of a dues increase could be looked at and

the size of that increase could be determined. The Board will revisit this issue at the 2008 Board Meeting. In the meantime, we realize that if there is a budget shortfall, we will need to dip into our investments.

The proposed 2008 budget was approved and received unanimous support.

Income estimated at $243,368
Expenses estimated at $296,560
(Deficit = $53,192)

The budget meeting adjourned at 1915 h.

The Annual SSAR Business Meeting was called to order by President McDiarmid at 1604 h on July 14th. Approximately 47 SSAR members were in attendance. David Green issued an invitation to attend the 2008 Annual Meeting in Montreal, Canada and Dick Vogt issued an invitation to attend the 6th World Congress of Herpetology in Manaus in 2008. President McDiarmid then summarized the meeting of the Board of Directors held a few days earlier. Larry David Wilson, long time Snake Section Editor (*CAAR*), received applause for his 34 years of service to SSAR in this capacity. Winners of the 2006 Dean Metter Award, Kennedy Award, Henri Seibert Student Awards (Fig. 17), Grants-in-Herpetology Awards, and Student Travel Awards were announced.

There was discussion of the costs of attending recent Annual Meetings. For some members (e.g., retirees) these costs are prohibitive. There was a suggestion that we add a small amount (e.g., $5) to the registration fee and the money raised could go into a pool to support members who otherwise would not be able to attend. Improving the ability to find compatible roommates and implementing an online "rideshare" program could make attendance at meetings possible for more of our members.

Discussion then turned to making the Annual Meeting more "student-friendly" and making it easier for students to learn who does what in SSAR. A suggestion was made that Officers and Editors present their own reports at the Business Meeting rather than the President as was done in years past. The scheduling of the Board Meeting (which begins in the morning of the day most attendees arrive) makes it difficult for students (and others) to attend (even though the Board Meeting is open to all SSAR members) because it would require them to arrive at the meeting venue a day earlier. It was suggested that the Board Meeting be rescheduled to occur later in the meeting; however, this would interfere with other scheduled activities and the ability of Board members to attend talks and poster sessions. There was discussion of a mentoring program and of arranging a reception specifically for student members of SSAR to welcome them to the meeting and enable them to get to know Board Members, Editors, and Committee Chairs. This reception could feature particularly prominent herpetologists who would introduce themselves to students. President McDiarmid promised a Welcome Reception for the 2008 meeting. Several students expressed interest in joining the Student Participation Committee.

The meeting was adjourned at 1745 h.

—Respectfully submitted by Marion Preest, SSAR Secretary

I would like to acknowledge the assistance in writing this report and photographs that I received from the following individuals: Kraig Adler, Breck Bartholomew, Dave Dennis, Ken Dodd, Bob Hansen, and Joe Mitchell.

Kennedy Student Award

The Kennedy Award Committee (Carl Anthony, Bill Lutterschmidt, Terry Schwaner, Wayne VanDevender, Lynnette Sievert, Chair) has completed its work for Volume 40 of the Journal of Herpetology. The Committee has selected "Ecology of the Basin Construction Reproductive Mode in *Smilisca sordida* (Anura: Hylidae)" by John H. Malone (Vol. 40:230–239). The Kennedy Award carries with it a cash prize of US $200 or the winner's selection of any SSAR publications valued at twice that amount.

The committee invites all student members of the Society to submit their work to the Journal, and encourages regular members who supervise the work of students to draw this award to the attention of those students.

Dean Metter Memorial Award

There were nine proposals submitted this year for the Dean E. Metter Memorial Award. Since the proposals were all of high quality, the committee required more time to deliberate than in previous years, and the decision was more difficult. The committee has unanimously selected Barbara Banbury to be the fifth recipient of the Metter Award. Ms. Banbury's proposal was entitled: Tempo and Mode of Species Diversification in Megophryid Frogs. Anne Maglia recused herself from the decision making process this year because Banbury did her master's degree under her supervision.

Barb Banbury graduated with a B.S. in Organismal Biology from The University of Kansas where she worked under the supervision of Dr. Linda Trueb and John Simmons, the Herpetology Collection Manager. She also was a participant in Dr. Robert Powell's NSF sponsored REU Program at Avila University. Her Master's degree was completed at the University of Missouri—Rolla where she explored the development of cranial and post-cranial elements in pelobatid tadpoles in Dr. Anne Maglia's laboratory. In 2006, she began her PhD work with Dr. Michael Alfaro at Washington State University.

Applications for the 2008 Metter award are due no later than 29 February 2008 and in order to be eligible, applicants must be members of SSAR with dues paid by 31 December 2007. The winner of the award for 2008 will be announced around 1 April 2008. Please see the SSAR web page for details on how to prepare an application. Applications should be submitted electronically to Joe Beatty (e-mail: beattyj@science.oregonstate.edu).

Annual Report (2007)
Grants-in-Herpetology Committee

An award in the amount of $500 was made to each of the following individuals:

Conservation.—**Dana K. Wingfield**, University of California Santa Cruz. Project title: "Elucidating the oceanographic processes that affect the endangered juvenile loggerhead sea turtle (*Caretta*

caretta) off Baja California Sur, Mexico."

Field Research.—**Julie M. Ray**, Old Dominion University. Project title: "Three dimensional study of a mid-elevation neotropical snake community."

Laboratory Research.—**J. Michael Butler**, University of Florida. Project title: "A genetic investigation into the population status and range intergradation of an endemic emydid subspecies, the Gulf Coast box turtle (*Terrapene carolina major*)."

Travel.—**Roberto Brenes**, Southern Illinois University. Project title: "Instantaneous growth rate and assimilation rates of Neotropical montane tadpoles."

International.—**Hanyeh Ghaffari**, Azad University, Tehran. Project title: "Ecology of the Mesopotamian soft shell turtle (*Rafetus euphraticus*) with implications for conservation and management in Iran."

Education.—**Justin J. Shew**, Starr Ranch Sanctuary, National Audubon Society, Trabuco Canyon, CA . Project title: "Snake Research: Educational Field Ecology Program at Starr Ranch Sanctuary (Trabuco Canyon, CA)."

2007 Grants-in-Herpetology Committee.—Chair: Erik R. Wild. Reviewers: Jeffrey Parmelee, Rafe Brown, Eli Greenbaum, Chris Parkinson, and Josh Kapfer. SSAR congratulates the 2007 GIH recipients and thanks the committee members for their efforts.

Grants-in-Herpetology 2008 Proposals

Proposals are now being accepted for the 2008 SSAR Grants-in-Herpetology Program. This program is intended to provide financial support for deserving individuals or organizations involved in herpetological research, education, or conservation. Application deadline is 28 February 2008. Grant application details are available at:

<http://www.ssarherps.org/pages/GIH.html>

Seibert Award Winners for 2007

The sixteenth annual Seibert Awards were presented at the 50th Annual Meeting of the SSAR in St. Louis, Missouri July 12–17, 2007. These awards are named in honor of Henri C. Seibert, an early and tireless supporter of SSAR, serving as an officer for over 20 years. In recognition of outstanding student presentations at the annual meeting, a single award is given in each of four categories: Morphology & Physiology (4 presentations), Evolution & Systematics (11 presentations), Ecology (16 presentations), and Conservation (12 presentations). All winners will receive a check for US $200 from SSAR and a book from University of California Press compliments of Chuck Crumly.

The Seibert Award Winners for 2007 were: **Morphology & Physiology**: Sean Graham (co-authors Ryan Early and Matthew Grober), Georgia State University, "Plasma corticosterone variation in free-ranging male cottonmouths (*Agkistrodon piscivorus*): diel, seasonal, and captive handling effects, and interactions with plasma testosterone." **Evolution & Systematics**: D. Luke Mahler, Harvard University, "Does ecology influence rates of phenotypic variation in island anoles?" Honorable Mention: Matthew Gifford (co-author Allan Larson), Washington University, "A multi-locus assessment of the phylogeography of *Ameiva chrysolaema* from Hispaniola. Honorable Mention: Michael Westphal, Oregon State University, "What can garter snakes tell us about coral snake mimicry?" **Ecology**: Amanda Subalusky (co-authors Lora L. Smith and Lee Fitzgerald), Texas A&M University, "Ontogenetic shifts in habitat use in the American alligator: another case for the importance of seasonal wetlands". Honorable Mention: Mizuki Takahashi (co-author Matthew Parris), University of Memphis, "A test of reproductive isolation between the subspecies of *Notophthalmus viridescens*." Honorable Mention: Shannon K. Hoss (co-authors Lora L. Smith, Gordon Schuett, Craig Guyer), Auburn University, "Home range and multi-scale habitat associations of the eastern diamondbacked rattlesnake (*Crotalus adamanteus*) in southwest Georgia. **Conservation:** Ronald Sutherland, Duke University, "Presence only models for rare North Carolina snake species confirmed with unbiased road-cruising data."

The judges for 2007 were Patrick Owen (Ohio State University, Lima, OH), Robert Reed (USGS, Ft. Collins, CO), Kevin G. Smith (Washington State University in St. Louis), Robert Espinoza (California State University, Northridge), Chris Austin (Louisiana State University), Frank Burbrink (College of Staten Island/CUNY), Mike Adams (USGS, Corvallis, OR), Michael Dreslik (University of Illinois Urbana-Champaign), James Vonesh (Virginia Commonwealth University), Brad Shaffer (University of California at Davis), and Lora Smith (Jones Ecological Research Center, Newton, GA).

NEWSNOTES

Slowinski Award Announced for 2007

The Center for North American Herpetology is pleased to announce that the recipient of The Joseph B. Slowinski Award for Excellence in Snake Systematics for 2007 is Brice P. Noonan, of the Department of Integrative Biology, Brigham Young University, Provo, Utah.

On 12 September 2001, the world lost one of its premier biologists, a loss that went virtually unnoticed in the wake of the tragedy that befell the United States the previous day. Joseph Bruno Slowinski, the 39-year old curator of amphibians, turtles, reptiles, and crocodilians at the California Academy of Sciences in San Francisco, died in the jungles of Burma from the bite of a venomous snake. Joe was bitten on 11 September and, despite heroic efforts to save his life by expedition companions and colleagues, succumbed to the effects of the bite the next day. Eventually, the world took notice, and numerous media outlets across the nation and throughout the world chronicled Joe Slowinski's exemplary career, cut so tragically short.

A distinguished committee, comprised of Simon Creer (University of Wales, Bangor), Hussam Zaher (Muesu de Zoologia da Universidade de São Paulo, Brazil), and Christopher L. Parkinson (committee chair, University of Central Florida), have deemed the paper "Dispersal and vicariance: the complex evolutionary his-

tory of boid snakes)" as the most distinguished paper on snake systematics to appear worldwide during 2006. The paper was co-authored with Paul T. Chippindale, and was published in Volume 40 of *Molecular Phylogenetics and Evolution*.

As senior author of the paper, Dr. Noonan becomes the fifth recipient of The Slowinski Award, and will receive a check from The Center for North American Herpetology for US $500 along with a commemorative memento in recognition of his achievement.

New Varanid Organization and Journal

The International Varanid Interest Group is a volunteer-based organization established to advance varanid research, conservation, and husbandry, and to promote scientific literacy among varanid enthusiasts worldwide. Membership to the IVIG is free, and open to anyone with an interest in monitor lizards. The Group publishes a quarterly journal, BIAWAK, which is available online at http://varanidae.org/biawak.

Ecuadorian Research Expeditions

Dates for 2008 Ecuadorian Research Expeditions have been announced. These trips will take participants to western Ecuador to study reptiles and amphibians in some of the most imperiled ecosystems on Earth. This work provides vital data on rare and endangered wildlife that will help make informed management decisions and ultimately save them from extinction.

People from all walks of life and backgrounds are welcome to join us in the field. We are offering four expeditions this year, in January, June, July and August. New this year we have three back-to-back, two-week trips, and participants can sign up for one or any combination of them.

If you might be interested, check out these links. Also, please spread the word to your friends, colleagues, and students.

Reptile Research Homepage: (http://www.reptileresearch.org/)
Western Ecuador Research Program: (http://www.reptileresearch.org/volunteer.htm)
Application Page: (http://www.reptileresearch.org/application.htm)

Kansas Herpetological Society Annual Meeting

The Kansas Herpetological Society held its 34th Annual Meeting at the Topeka Zoo in Topeka, Kansas, on November 2–4, 2007. Over 140 participants attended scientific paper sessions presented by scientists and students from across the nation. Featured speakers were Emily Moriarty Lemmon (University of Texas at Austin), and Jonathan Campbell (University of Texas-Arlington).

Melissa Boetig, student at Washburn University, received the 2007 Howard K. Gloyd/Edward H. Taylor Scholarship, honoring the memory of two great biologists with strong ties to Kansas. The 2007 Alan H. Kamb Grant for Research on Kansas Snakes was made to Page Klug, Kansas State University, Manhattan. J. Daren Riedle, West Texas A&M University, Canyon, was chosen as the tenth recipient of "The Suzanne L. & Joseph T. Collins Award for Excellence in Kansas Herpetology." George R. Pisani, Kansas Biological Survey at the University of Kansas, was installed as the ninth Distinguished Life Member of the Kansas Herpetological Society. In 2008, the Society will meet at Friends University, Wichita, Kansas.

Edward Elkan Memorial Lecture

This lecture commemorates the life and work of Dr. Edward Elkan who was medically qualified, had a life-long interest in comparative pathology and was a pioneer in the study of reptiles, amphibians and fish. Following Dr. Elkan's death in 1983, his microscope slides, gross specimens, books and reprints were put together as a teaching and research collection and a series of commemorative presentations was initiated—the Edward Elkan Memorial Lectures. The first four of these were given by Fredric L. Frye (USA), John E. Cooper (UK), Peer Zwart (The Netherlands), and Elliott R. Jacobson (USA). The fifth is due to be delivered by John Harshbarger (USA) in January 19, 2008 at the North American Veterinary Conference in Orlando, Florida, USA.

MEETINGS

Meetings Calendar

Meeting announcement information should be sent directly to the Editor (rwh13@csufresno.edu) well in advance of the event.

7–9 February 2008—International Conference on the Coqui Frog, Waikoloa Beach Marriot Resort and Spa, Waikoloa, Hawaii, USA. Information: http://www.ctahr.hawaii.edu/coqui/conf08.asp

21–24 February 2008—SEPARC (Southeast Partners in Amphibian and Reptile Conservation) Annual Meeting, University of Georgia, Athens, Georgia, USA. Information: www.separc.org

11–13 April 2008—Fourth Annual Sonoran Desert Herpetological Symposium, Tucson, Arizona, USA. Information: http://www.arts.arizona.edu/herp/

5–7 June 2008—Joint Meeting of Texas Herpetological Society, SW PARC, Horned Lizard Conservation Society; University of Texas, Austin, Texas, USA. Information: gad.perry@ttu.edu

23–27 June 2008—6th Symposium on Lacertids of the Mediterranean Basin, Lesvos Island, Greece. Information: http://www.elerpe.org/

23–28 July 2008—51st Annual Meeting, Society for the Study of Amphibians and Reptiles; 88th Annual Meeting, American Society of Ichthyologists and Herpetologists; 66th Annual Meeting, The Herpetologists' League. Montreal, Quebec, Canada. Information: http://www.dce.ksu.edu/jointmeeting/

17–20 August 2008—6th World Congress of Herpetology, Manaus, Brazil (meeting jointly with SSAR). Information: http://www.worldcongressofherpetology.org/index.php?section=51

CURRENT RESEARCH

The purpose of **Current Research** is to present brief summaries and citations for selected papers from journals other than those published by the American Society of Ichthyologists and Herpetologists, The Herpetologists' League, and the Society for the Study of Amphibians and Reptiles. Limited space prohibits comprehensive coverage of the literature, but an effort will be made to cover a variety of taxa and topics. To ensure that the coverage is as broad and current as possible, authors are invited to send reprints to the Current Research section editors, **Joshua Hale** or **Ben Lowe**; postal and e-mail addresses may be found on the inside front cover.

The current contents of various herpetological journals and other publications can be found at: http://www.herplit.com/contents.

Satellite Tracking of Migration in the Loggerhead Sea Turtle

Migration is important for species that rely on seasonally variable resources. The Atlantic Ocean off North America, has one of the world's largest populations of the loggerhead sea turtle, *Caretta carretta*; however, little is known about their migratory behavior. In this study, 12 adult female turtles were tracked for several years using satellite transmitters, and these data were combined with a number of oceanographic measures, including sea surface temperature, sea surface current and bathymetric data. Two different migration patterns were identified; the first involved northward migration in summer, extending 330–752 km from the nesting beach, and then southward migration in autumn. The second migration pattern was a southerly summer migration of 576–895 km from the nesting site, followed by winter residency in these sites. Of the 12 turtles monitored, nine migrated northward initially, exhibiting migration pattern one, and three migrated southward, exhibiting migration pattern two. Both these migration patterns allowed exploitation of warmer waters at the edge of the gulf stream. The satellite data also showed that turtles stayed largely in shallow waters (<100 m), which the authors suggest allows them to exploit benthic prey. Two turtles were also fitted with dive recording devices, and this showed that dive behavior at summer and winter breeding sites differed considerably, as dives in winter sites were of much greater duration. The authors suggest that the turtles may make long resting dives during winter, in a type of hibernation, and propose that this allows them to tolerate cold conditions while still taking advantage of productive waters. The authors highlight the need for further research that will be able to determine the frequency of the two migratory routes in the population and the selective pressures associated with them.

HAWKES, L. A., A. C. BRODERICK, M. S. COYNE, M. H. GODFREY AND B. J. GODLEY. 2007. Only some like it hot—quantifying the environmental niche of the loggerhead sea turtle. Diversity and Distributions 13:447–457.

Correspondence to: Brendan J. Godley, Marine Turtle Research Group, Centre for Ecology and Conservation, School of Biosciences, University of Exeter, Cornwall Campus, Penryn, TR10 9EZ, UK; e-mail: b.j.godley@exeter.ec.uk.

Responses of Tuatara to Removal of Introduced Rats

Invasive predator species are generally thought to have negative impacts on endemic plants and animals, but specific hypotheses about their effects have not been widely tested. Tuatara, *Sphenodon punctatus*, are extinct from the New Zealand mainland, and are only found on smaller offshore islands. Three species of rat are common on these islands: Pacific Rats (*Rattus exulans*), which were introduced to New Zealand at least 750 years ago by Polynesians, and Norway (*R. norvegicus*), and Ship Rats (*R. rattus*), which were introduced by Europeans within the last 250 years. Tuatara do not coexist with either Norway or Ship Rats, but are found occasionally with Pacific Rats. In this paper, the authors investigated whether tuatara densities and recruitment are impacted by the presence of Pacific Rats. To do this, rats were eradicated from three of the Marotere Islands, northeastern New Zealand, and body condition and recruitment in tuatara from these islands were compared to those from the nearby Taranga Island, where rats are still present. These islands provide a unique opportunity for this type of study as they have restricted human access, have similar forest cover, and rats are the only predatory mammals. Following rat eradication, tuatara recruitment increased, with the number of juveniles growing by up to 17-fold. Additionally, body condition of adult males and females improved considerably. The authors conclude that the reduction in predation of eggs and juveniles following rat removal is an important factor in tuatara recruitment and body condition. They also suggest that more subtle interactions, such as competition for food, might also play some part in population growth, especially for a long lived species such as tuatara.

TOWNS, D., R., G. R. PARRISH, C. L. TYRRELL, G. T. USSHER, A. CREE, D. G. NEWMAN, A. H. WHITAKER AND I. WESTBROOKE. 2007. Responses of Tuatara (*Sphenodon punctatus*) to removal of introduced Pacific rats from islands. Conservation Biology 21:1021–1031.

Correspondence to: David Towns, Terrestrial Conservation Unit, Department of Conservation, Private Bag 68-908, Newton, Auckland 1145, New Zealand and School of Biological Sciences, Victoria University of Wellington, P.O. Box 600, Wellington 6140, New Zealand; e-mail: dtowns@doc.govt.nz.

Evolution of Viviparity in Salamanders

The Fire Salamander, *Salamandra salamandra*, displays two reproductive strategies, viviparity and ovoviviparity, along its distribution on the Iberian Peninsula, which provides a unique opportunity to study the evolution of different reproductive modes. Ovoviviparity is the most common reproductive strategy in this species, but viviparity has been observed in a number of localities, including two small islands on the Atlantic coast that originated 8000–9000 years ago, after the last glacial period. In this study, the authors have sequenced approximately 1100bp of the Cyt *b* and *COI* regions on the mitochondrial genome from 1-15 individuals from each of 17 populations across the northern Iberian Peninsula, including both ovoviviparous and viviparous populations. Phylogenetic analyses revealed that the two viviparous

island populations do not form a monophyletic group with the mainland viviparous populations. Further, the authors suggest that it is unlikely that colonization of these islands occurred after they were cut off from the mainland, or that migration occurred between the islands. Therefore, the authors propose that viviparity has arisen independently multiple times, and conclude that this transition between reproductive modes can occur rapidly and often in island populations. The authors also discuss the ecological factors that may have led to the evolution of viviparity. As viviparity removes the need for water in the juvenile stage, a lack of water on these islands may be a factor for the evolution of this reproductive mode in island populations.

VELO-ANTÓN, G., M. GARCÍA-PARÍS, P. GALÁN, AND A. CORDERO-RIVERA. 2007. The evolution of viviparity in Holocene islands: ecological adaptation versus phylogenetic descent along the transition from aquatic to terrestrial environments. Journal of Zoological Systematics and Evolutionary Research **Online Early: doi: 10.1111/j.1439-0469.2007.00420.x**

Correspondence to: Guillermo Velo-Antón, Grupo de Ecoloxía Evolutiva, Departmento de Ecoloxía e Bioloxía Animal, Universidae de Vigo, E.U.E.T. Forestal, Campus Universitario, 36005 Pontevedra, Spain; e-mail: guillermov@uvigo.es.

Sperm Storage Effects on Sex Ratio in Lizards

Female storage of sperm post-mating is common in a variety of taxa, and may be a response to rare mating opportunities or male sperm limitation. Although sperm storage has been widely studied, its influence on sex ratio remains relatively uninvestigated. In this study, the authors investigated the consequences of sperm storage in the Australian painted dragon lizard, *Ctenophorus pictus*. They brought field-mated females into the lab and then staged repeated matings with additional males to determine the contribution of 'fresh' versus 'stored' sperm. Fifty-four clutches resulted from matings between 34 females and 26 males, producing 180 offspring. Microsatellites were used to determine paternity, and offspring were then categorized as resulting from 'stored' or 'fresh' sperm. The average sperm storage difference between stored and fresh sperm was approximately two months. Results showed that stored sperm was 23% more likely to produce sons than fresh sperm. Similar temporal changes in sex ratio have been observed in a variety of taxa, including birds, rats, and humans, and as these taxa have different sex determining mechanisms, the relationship between sex ratio and sperm storage is likely to involve multiple factors. While the authors were unable to identify the proximate mechanism underlying the overproduction of males from stored sperm, they suggest that this mechanism may explain annual variation in sex ratio.

OLSSON, M., T. SCHWARTZ, T. ULLER AND M. HEALEY. 2007. Sons are made from old stores: sperm storage effects on sex ratio in a lizard. Biology Letters **Online Early: doi:10.1098/rbsl.2007.0196**

Correspondence to: Mats Olsson, School of Biological Sciences, University of Wollongong, Wollongong, NSW 2522, Australia; e-mail molsson@uow.edu.au.

Communal Nesting in Montane Scincid Lizards

Females of the Australian montane scincid lizard, *Bassiana duperreyi*, oviposit communally, that is, they lay clutches within the same nests as other females. This communal nesting behavior is common in many reptile species, and may result from a lack of suitable oviposition sites (a constraint), or because females gain direct fitness benefits (an adaptation). In this study, the authors investigated whether communal nesting behavior represents an adaptation or constraint in *B. duperreyi*. In a field survey, the authors examined 367 nests over 11 years and demonstrated that communal and solitary nests were laid in similar sites, and were not related to the number of available sites. Further, investigation of 110 natural nests showed that incubation conditions did not differ between communal and solitary nests, or between eggs laid at the periphery and the centre of communal nests. This behavior was also investigated in a laboratory setting, with females laying 20 of 26 clutches in nests which contained dummy eggs rather than empty nests when four oviposition sites were available. Eggs laid in a communal setting absorbed less water and were larger than those laid in single nests, and furthermore, hatchlings from communal nests had shorter tails and ran quicker than those that were singly incubated. The authors suggest that communal nesting in this species is likely to be adaptive, and not due to a constraint in suitable breeding sites, however they suggest that this may be important in some species and in some conditions. While the authors propose that the fitness benefit of communal mating is likely to be due to the larger, faster hatchlings, the relationship of these traits with water uptake requires further study.

RADDER, R.S., AND R. SHINE. 2007. Why do female lizards lay their eggs in communal nests? Journal of Animal Ecology **Online early: doi: 10.1111/j.1365-2656.2007.01279.x**

Correspondence to: Richard Shine, School of Biological Sciences Ao8, University of Sydney, NSW 2006, Australia; e-mail: rics@bio.usyd.edu.au.

Impact of Fragmentation and Colonization on Genetic Diversity in Frogs

Genetic diversity is an important component of population health, in particular, as an individual from a population with high diversity is expected to have higher fitness when compared to an individual from a low diversity population. Postglacial colonization from refugia and contemporary habitat fragmentation can both reduce population genetic diversity, but as they act at different temporal and spatial scales, their impacts may differ. In this study, the impact of postglacial colonization and habitat fragmentation on genetic diversity and fitness was examined in the Italian agile frog, *Rana latastei*, in the Lombardy in northern Italy. This species likely had one glacial refugium in the eastern part of its range, and as a consequence, genetic diversity is greater in populations from the east than from the west. Microsatellite diversity at 6 polymorphic loci was examined in 295 frogs from ten populations, four in developed environments ("isolated" populations) and six in riparian woodlands ("nonisolated" populations). To assess fitness, 7335 eggs were collected from 218 clutches and were reared to tadpoles in the laboratory before release in their wetland of ori-

gin. Results showed that distance from refugium and degree of isolation explained greater than 90% of the observed variation in genetic diversity. The lowest genetic diversity populations were those furthest away from the glacial refugium and from areas with high road density. Hatch rate was positively correlated with the isolation of the population, but only when the distance from the refugium was held constant. However, there was no relationship between hatch rate and genetic diversity. The authors propose that the reduced fitness in low diversity, isolated populations suggests that this process is ongoing and not directly related to the historical impact of colonization from refugia. Potential conservation implications of these results are also discussed.

FICETOLA, G. F., T. W. J. GARNER, AND F. DE BERNARDI. 2007. Genetic diversity, but not hatching success, is jointly affected by postglacial colonization and isolation in the threatened frog, *Rana latastei*. Molecular Ecology 16:1787–1797.

Correspondence to: Gentile Francesco Ficetola, Université de Savoie, Laboratorie d'Ecologie Alpine, équipe Génomique des Populations et Biodiversité, 73 376 Le Bourget du Lac cedex France; e-mail: francesco.ficetola@unimi.it.

Distribution of Chytrid Fungus in Frog Populations

Amphibians are currently undergoing a well-documented decline, with a third of the more than 6000 species worldwide threatened. The chytrid fungus, *Batrachochytrium dendrobatidis*, infects the epidermis of amphibians and causes chytridiomycosis, a potentially lethal skin disease, and is often found at sites that are undergoing a population decline. Frogs display a variety of breeding strategies, from tadpole development in ponds or streams that may take years, to entirely terrestrial breeders. As the chytrid fungus cannot survive desiccation and has flagellated zoospores, it is unlikely that it would similarly impact frogs displaying different reproductive strategies. To test this hypothesis, the authors measured levels of chytrid infection in 19 frog species from southeast Queensland. Each species was identified as falling into one of five different breeding strategies; permanent stream, permanent pond, ephemeral stream, ephemeral pond and terrestrial. They found that 30.3% of the 519 individuals sampled were infected. Overwhelmingly, infected individuals were from species that bred in permanent streams and ponds, with ephemeral stream and pond breeders displaying no infection. There was only one terrestrial breeder sampled, and this species displayed very low levels of infection. The authors propose concentrating conservation efforts in relation to the chytrid fungus on frogs that breed in permanent waterbodies.

KRIGER, K. M., AND J. M. HERO. 2007. The chytrid fungus *Batrachochytrium dendrobatidis* is non-randomly distributed across amphibian breeding habitats. Diversity and Distributions **Online Early; doi: 10.1111/j.1472-4642.2007.00394.x**

Correspondence to: Kerry M. Kriger, Centre for Innovation Conservation Strategies, Griffith University, PMB 50 Gold Coast Mail Centre, Qld 9726, Australia; e-mail: kmk5g@yahoo.com.

Thermal Biology of Male and Female Lizards

Despite the considerable number of studies investigating the effects of body temperature on lizard physiology and ecology, these studies have generally not examined differences between sexes. As male and female lizards are often found utilizing different microhabitats and can be active at different times, thermally mediated differences in physiology and ecology may be important. In this study the authors reexamined a large data set which included 11,000 individuals from 56 desert species from Africa, Australia, and North America, to establish if sex differences in response to thermal conditions are present. Body temperature, air temperature, and daily activity times were compared between males and females from each species. Results showed that males and females had very similar body temperature (differing by less than 1°C on average), air temperature, and time of activity. The authors suggest that their large sample size ensured that small differences would have been detectable. Finally, the authors recognize that the very small differences between sexes in desert lizards may be an exception, and highlight the importance of investigating this in other lizard groups.

HUEY, R. B. AND E. R. PIANKA. 2007. Lizard thermal biology: do genders differ? The American Naturalist 170:473–478.

Correspondence to: Raymond B. Huey, Department of Biology, Box 351800, University of Washington, Seattle, Washington 98195, USA; e-mail: hueyrb@u.washington.edu.

Lineage Identification of Captive Galápagos Tortoises

Genetic data are invaluable in the conservation of natural populations, but utility of these data in the conservation of captive populations has been relatively unexamined. The Galápagos tortoise, *Geochelone nigra*, is an endangered species, limited to only six islands of its historical 11 island range. Captive populations of this species are important, not only to prevent extinction but also as a source for reintroductions. Genetic data can ensure that inbreeding is avoided in captive populations and that appropriate individuals can be selected for reintroduction. In this study, 98 individuals of unknown origin were sampled from zoos and private collections across three continents. To compare the unknown individuals to previously sampled natural populations, a ~695 bp fragment of the mtDNA control region was sequenced for all individuals, and each was genotyped using ten microsatellite loci. Twenty mtDNA haplotypes were identified from the 98 captive individuals, with 14 of the haplotypes currently represented in natural populations. Population assignment results from microsatellite data were highly consistent with assignments from mtDNA data, with 83.7% of individuals assigned to the same extant population using both datasets. The authors suggest that those individuals for which microsatellite and mtDNA data assigned different ancestral populations are the result of shallow phylogenetic divergence among some taxa, or mixed ancestry in captive breedings. The majority of captive individuals came from populations on the islands of Isabela and Santa Cruz, and in particular

from the large and diverse La Caseta population on Santa Cruz. The results of the genetic analyses were also used to assess suitable breeding partners for the one surviving member of the Pinta population, Lonesome George, and determined that the two females currently housed with George do represent the most appropriate genetic matches.

RUSSELLO, M. A., C. HYSENI, J. P. GIBBS, S. CRUZ, C. MARQUEZ, W. TAPIA, P. VELENSKY, J. R. POWELL, AND A. CACCONE. 2007. Lineage identification of Galápagos tortoises in captivity worldwide. Animal Conservation 10:304–311.

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Convergent Evolution in Drinking Adaptations in Two Desert Lizards

The Australian Thorny Devil, *Moloch horridus* (Agamidae), and the Texas Horned Lizard, *Phyrnosoma cornutum* (Iguanidae), are unrelated species yet are both able to drink by transporting water by capillary action through interscalar spaces on their skin to their mouth. In this study, the authors used scanning electron microscopy (SEM) and histological methods to examine the morphology of these interscalar spaces, or scale hinges, from both species, to investigate the potential for convergent evolution. Ventral scales were examined from 7 formalin-fixed *M. horridus* specimens and compared to 4 Australian agamid species. Likewise, 5 *P. cornatum* specimens were compared to 3 North American iguanids. The epidermis consists of two layers, the outer layer made up of ß-keratin, which is separated by a mesos layer from an inner layer made of α-keratin. In both species, each scale hinge has a semi-enclosed channel with convoluted walls, where the ß-keratin is very thin, which the authors call a hinge-joint channel. The authors propose that water is transported in these hinge-joint channels. Both species have a jaw-buccal cavity at the corner of the mouth, where jaw and tongue movements create negative pressure which promotes water flow to the mouth. Although there are slight differences in these structures between the two species, the authors suggest that the presence of these specialized structures, the jaw-buccal cavity and hinge-joint channels with convoluted walls, which are not present in closely related species, demonstrate that *P. cornatum* and *M. horridus* have undergone convergent evolution. They also conclude that this is most likely an adaptation to capturing water from temporally irregular rainfall events.

SHERBROOKE, W. C., A. J. SCARDINO, R. DE NYS, AND L. SCHWARZKOPF. 2007. Functional morphology of scale hinges used to transport water: convergent drinking adaptations in desert lizards (*Moloch horridus* and *Phrynosoma cornutum*). Zoomorphology 126:89–102.

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OBITUARIES

Herpetological Review, 2007, 38(4), 385–387.
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Maxime Lamotte (1920–2007)

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Maxime Lamotte (Fig. 1) died on 31 August 2007 in Collobrières in southern France. He was born in Paris on 26 June 1920. After brilliant studies in the famous lycées Henri IV and Saint-Louis in Paris, then in the Paris Ecole Normale Supérieure (ENS), he obtained both his degree of "Docteur ès Sciences" and "Agrégé de l'Université" (the latter as "major" at the national level in France). In 1944 he was nominated as "Agrégé préparateur" in zoology at the ENS, in 1949 Assistant in genetics at the Paris University, in 1953 Professor at the University of Lille in northern France, in 1956 Professor at the Paris University and the ENS, and in 1988 Emeritus Professor at the Pierre et Marie Curie University in Paris.

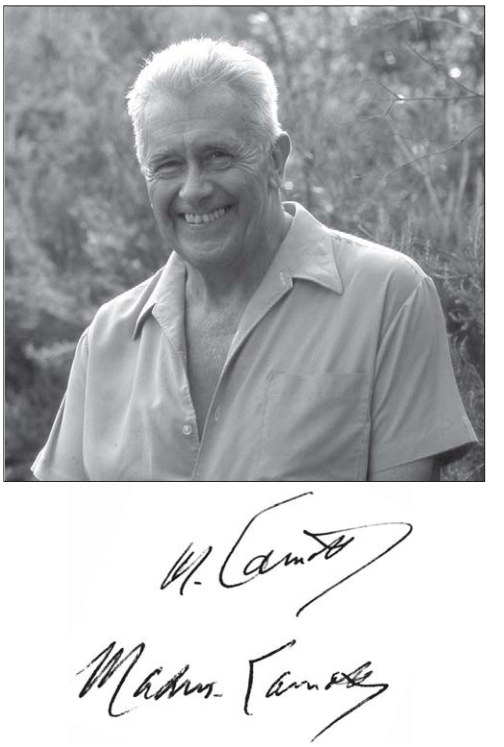


FIG. 1. Maxime Lamotte in Collobrières (Var), France, in August 1994 (photo Roger Bour). Lamotte's signatures, dated 3 November 1977 (upper, letter to Alain Dubois) and August 1994 (lower, book dedication to Roger Bour).

It is difficult to summarize his contribution to biology, as he was at the same time a theoretician, a field naturalist and an organizer of research. His thesis, defended in 1951 in the ENS, was dealing with the genetic structure of natural populations of the snail *Cepaea nemoralis*. In this work, he was the first to estimate allelic frequencies in many populations, in order to test the Sewall Wright models of Darwinian selection. In 1959, the results of this thesis launched the first large scientific polemics on the respective roles of random fluctuations (genetic drift) and natural selection in evolution, in a major symposium attended by Theodosius

Dobzhansky, Ernst Mayr, George Simpson, Bernhard Rensch, Leigh Van Valen, and Sewall Wright among others (*Cold Spring Harbor Symposia on Quantitative Biology*, 1959, 24:65–86).

His excellence in mathematics, as a pupil of Georges Teissier and a collaborator of Gustave Malécot, led him to write several textbooks of statistics. His *Introduction à la biologie quantitative* (1948) and his *Initiation aux méthodes statistiques en biologie* (1957) played a major role in the mathematical and methodological training and practice of generations of biologists in France and other French-speaking countries, especially in the fields of genetics, ecology and evolution.

His first travels in Africa on the Mount Nimba (Guinea), as soon as in 1942, developed his particular interest for the zoology and ecology of this continent. After administrative groundwork in 1961, he started with Jean-Luc Tournier the ecological field station of Lamto (named after the first letters of their names) in Ivory Coast in February 1962. In this station, he launched and supported many works on the quantitative and descriptive ecology of the forest savannas. These studies which dealt with many zoological groups, from earthworms to lizards, from spiders to crickets, fishes and birds, were also the basis for pioneer methodological works on sampling and data analysis in quantitative ecology, demography and productivity in terrestrial and aquatic habitats. He summarized some of these works, often in collaboration with François Bourlière, in a series of books (1967 to 1983) which were also a major source of training for many students and researchers in French-speaking countries.

From 1968 to 1994, he published several books about general problems of biology, dealing with the structure of the cell, sexual reproduction, laws and mechanisms of genetics, development and morphogenesis, and biological evolution. Several books published under his guidance by the Société Zoologique de France were particularly successful among the French-speaking zoological community: the volume *Le polymorphisme dans le règne animal* (1974) and the three volumes co-edited with Charles Bocquet and Jean Génermont and entitled *Les problèmes de l'espèce dans le règne animal* (1976, 1977 and 1980). As stressed by Ernst Mayr in his review of the first two of the latter books (*Systematic Zoology*, 1978, **27**: 250–252), it is a real pity that they were never translated and published in English, as they contain a unique synthesis of many works written in many different languages in various countries (including eastern Europe) and there exists no equivalent in English language. Other major publications by Maxime Lamotte include the three volumes of *Biologie générale*, co-authored with Philippe L'Héritier (1968), and *Théorie actuelle de l'évolution* (1994).

Beside being a theoretician, a mathematician, a methodologist, an organizer and a team leader, Maxime Lamotte was a very enthusiast field naturalist. All along his life, he collected specimens of many zoological groups in the numerous countries that he visited, and, after having kept them in the ENS for decades, he donated all these collections to the Paris Muséum National d'Histoire Naturelle (MNHN), where they will be available for study to researchers of the whole world. Although his first interests in this respect were insects, his discovery in January–July 1942 on the Mount Nimba of the extraordinary viviparous toad, described in 1943 by Fernand Angel as *Nectophrynoides occidentalis*, drew his attention, not only to this species and its very particular biology (on which he had many developmental, ecological and physiological works carried out by several students and researchers of his laboratory) but also on the other amphibians, especially of the Nimba and later of the Lamto region. With the collaboration of several colleagues, he was among the first batrachologists to pay attention to the tadpoles, as particular organisms worthy of interest for themselves, and to provide detailed descriptions of tadpoles referred to their proper species. He also worked on several groups of African ranids of difficult taxonomies, especially of the genera *Ptychadena* and *Phrynobatrachus*. Until his last years, he collected frog specimens, or had them collected, in various countries and habitats.

Maxime Lamotte was an exceptional teacher. He used a simple language to make even the most difficult questions accessible to many students. He was able to provide a clear presentation of any kind of biological subjects, even far from his own field of research. He had many students in genetics, population genetics, ecology, ecophysiology, physiology, and in taxonomy and evolutionary biology. Many of them are now prominent researchers or team leaders in various fields of biology in France and other countries. Maxime's hospitality and kindness were great, both with colleagues and students, either in the familial home in Paris, boulevard Raspail, or in the Collobrières house, and even in Lamto, where he invited a good number of researchers.

Maxime Lamotte was of the "old tradition" of research in French biology, in the sense that all his life he insisted to publish in French —although he could read easily other languages and understand the scientific literature in English, Spanish and German. Unfortunately, few of his works have been translated or summarized in English, and many are largely ignored by the English-speaking community—which nowadays almost covers the whole of the scientific community. This fate was in part avoided to his works in taxonomy and tadpole morphology, as reading these papers, even in French, is almost inescapable for anyone working on these questions, but the same is not true of many of his works in quantitative ecology, theoretical evolution and systematics, and even on the biology of *Nectophrynoides occidentalis*. Publication of summaries and syntheses of these works in English would be a useful endeavour.

Until his last days, Maxime Lamotte was an enthusiastic person. Although a bright mind, a famous biologist (who was among the youngest professors in biology ever in France and had received many distinctions, especially in France and Belgium), he always remained a very simple fellow. All along his life, he encouraged many young students, but also amateurs and persons interested in animals although they had not chosen to make zoology their profession, to develop their curiosity, their interest in life in the wild, or simple "natural history" studies based on hard field work, patient observations, careful specimen collection and preservation. He was more interested in the animals, their evolution, their adaptations, and in biologists contributing to understanding and knowing them better, than in honors, fame and power. As such, he was a bit unusual in his own community, especially in the last decades, as such matters seem to have become a priority for many. Long after his retirement, he continued to spend time at the MNHN, especially in the laboratories of entomology, herpetology and malacology.

Maxime Lamotte was very fond of the village of Collobrières,

in southern France (Var), that he had discovered, by chance, at the end of the fifties. He owned a house in the center of the village, in "Coppernic" street [sic], which was a preferred place for the holidays of his numerous family: Maxime and Françoise, his wife, had six children, followed by nineteen grandchildren and six great-grandchildren! Several members of this large family in their turn settled in Collobrières. An early riser, the naturalist would often take a walk in the hills of the Maures and the discovery of a treefrog in the vegetation along a small stream, or of a tortoise first heard in the bushes of the maquis, was always a new pleasure to him. The scientist could not help from examining the shell of a snail, or from reaping with large net casts a meadow full of orthopterans: all the equipment, net, boxes of all kinds, and even machete (!), was always ready in his great rucksack. The evils of age forced him to limit progressively the length of these walks, to his great sadness: Maxime would remain in the salon, sitting in his armchair, surrounded by books and his dear African masks, always glad to receive a visitor, parent or friend, under the attentive look of Françoise.

He will be regretted by all those who had the pleasure to share his experience, benefit from his courses, or from his friendship and his support to their own projects.

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Gary L. Paukstis (1953–2007)

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Gary Paukstis, a life-long naturalist, died suddenly and unexpectedly on 5 July 2007 in Bellevue, Washington. Although he worked in sales of high-speed data communications equipment over the past 25 years, Gary nonetheless drew much of his professional identity as a scientist. He emphasized herpetological studies, publishing extensively on his research activities (his very first paper appeared in these pages 30 years ago [Paukstis 1977]) and contributing considerably to our field (N = ~ 60 publications).

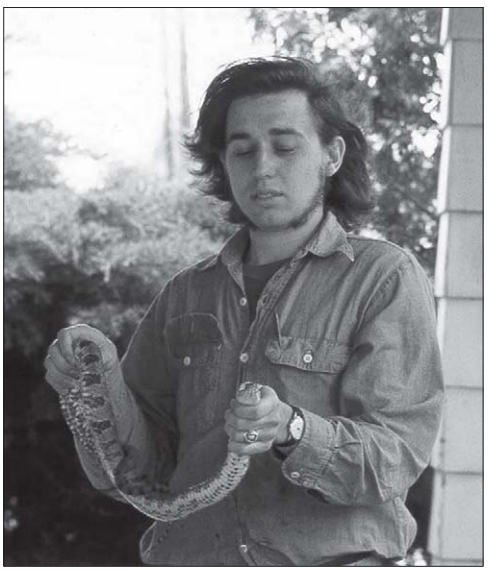


FIG. 1. Gary Paukstis holding a *Nerodia* in Illinois in 1974.

Gary Lynn Paukstis was born 1 February 1953, in Minneapolis, Minnesota. He lived in this area, as well as in Kansas and Wisconsin, for six years before his family settled for a long stretch in Hoffman Estates, Illinois. His father, Walter Paukstis, was a salesman and his mother, Edna Rosen Paukstis, was a piano teacher. Gary is survived by both of his parents, as well as his older brother Richard, his younger sister Donna, and their families. In addition to his wife Diane Bills Paukstis, Gary is survived by his children: Melissa, Hannah, and Christopher.

Beginning in 1971, Gary attended Illinois State University (ISU) intending to major in Music. But doubts about employability other than as a music teacher combined with a keen interest in biology led him to take courses in the sciences at ISU. It was a comparative vertebrate anatomy course taught by noted herpetologist Lauren Brown that inspired Gary to eventually change majors and join Lauren's fun group of students. Gary began as a volunteer who helped look after herps in the Brown lab (Fig. 1), but gladly accompanied the lab crew on herping adventures in Illinois and Florida and attended notable social events held at the Brown ranchero.

Upon graduation from ISU with a B.S. in Biological Sciences in 1975, Gary immediately joined the Brown lab formally to conduct graduate studies. During this time, Gary worked alongside, and occasionally roomed with, a strong cadre of herpetologically oriented students, including Richard Funk, Don Moll, and one of us (JKT), among others. Gary's M.S. work focused on variation in the intercalary cartilage as an important character for frog taxonomy, but he also joined in with members of the lab to explore all sorts of other interesting biological phenomena, primarily herpetological. Indeed, his years at ISU produced 10 publications on topics ranging from herpetological range extensions to invertebrate paleobiology, including a particularly influential paper concerning optimal egg size in turtles (Tucker et al. 1978).

After obtaining his M.S. in Biological Sciences from ISU in 1978, Gary joined Gary Packard's lab at Colorado State University (CSU) for Ph.D. studies. At CSU, Gary again struck up a number of productive collaborations in the Department of Zoology with other graduate students (most particularly William Gutzke in the Packard lab), leading to a series of significant publications, including some of the earliest experimental work on water relations of turtle eggs and temperature-dependent sex determination. Gary's dissertation research explored the roles of environmental variables in influencing the physiological ecology of turtle embryos and hatchlings in natural nests, yet he never completed his Ph.D. However, it was a semester-long return to CSU in fall 1985 that initiated another long-time productive collaboration, this time with a first-semester M.S. student in the Packard lab, the other one of us (FJJ). It was largely under Gary's influence that FJJ, an eager but very naïve student, learned many of the key unwritten rules of graduate school, scientific inquiry, and other important aspects of scholarly enterprise. At the same time, this budding friendship would prove crucial for maintaining Gary's research output.

Departing CSU in December 1985, Gary moved to northern Illinois to take a sales job with Okidata (and, subsequently, NEC

and, finally, Adtran) to be in the vicinity of his daughter Melissa. FJJ followed suit less than two years later, beginning Ph.D. studies at the University of Chicago in summer 1987. This immediate proximity initiated a rush of joint library, laboratory, and field research activities, initially focusing on aspects of sex-determining mechanisms in reptiles. Our collaboration produced a number of publications on this and other topics, including one of the top 20 most cited papers in the history of the *Quarterly Review of Biology* (Janzen and Paukstis 1991). We also undertook numerous herpetological adventures, primarily locally in northern Illinois, but also to the southern part of the state and to areas along the Mississippi River. These trips allowed us to indulge in some other shared passions, too: hunting, collecting baseball cards, listening to great music, drinking beer, immersing in natural history, and taking pictures (see http://www.garypaukstis.com for some of these), not necessarily in that order of preference. It was on a late 1980s trip that Gary helped FJJ found his long-term ongoing field site, known as Turtle Camp, in western Illinois. And it was on a trip to southern Illinois in the early 1990s that Gary introduced FJJ and JKT, generating 15+ years of a productive three-way research collaboration, including work on native gastropods and introduced zebra mussels (e.g., Paukstis et al. 1997) and a series of continuing publications on the evolutionary ecology of early life-history stages of turtles (e.g., Tucker and Paukstis 1999).

Then in 1998, Gary and family accepted a transfer from Adtran to take an equivalent sales position in the Seattle area. This move resulted in a dramatic decrease in Illinois fieldwork, but ultimately led to grander biological explorations and, in the end, to an important new chapter in his research activities and professional emphases. Gary and FJJ embarked on a series of major natural history adventures. Domestically, these trips emphasized the West Coast (his sales region with Adtran) and included an anxious physical encounter with a coral snake (*Micruroides euryxanthus*) in southern Arizona. Local medical personnel possessed neither antivenin nor correct knowledge of treatment, so the multihour drive to Phoenix was nerve-wracking to say the least. Internationally, these trips focused on Central and South America. Costa Rica was the most frequent destination, although a near-kidnapping by guerillas in remote Colombia was perhaps the most memorable experience, plus at least one anuran (*Osonophryne* sp.) encountered in Puracé National Park on that trip is almost certainly new to science (J. Savage, pers. comm., 7 December 2006).

Gary was just stepping into the next phase of his life, a return to science on a near full-time basis. He had retired from Adtran in 2006 with the expectation of decades of increased scientific productivity. He had turned his attention, in particular, toward serving the Organization for Tropical Studies (OTS) and writing field guides, activities that melded some of his favorite hobbies (exploring nature, taking pictures, working with people, etc.) with his strong business acumen. It is a testament to his skills in all these areas that he had already served on the Board of Visitors and then been elected to the Board of Directors (serving as Vice Chairman of Marketing and Development) of OTS, and had nearly completed the first (Paukstis et al., *in prep*.) of several planned field guides.

It was a great joy and honor to have known, and worked with, Gary. He was a man of many talents and interests. Beyond being intellectually creative and hard working, he possessed a keen, frequently employed wit, no doubt fed by his love of silly movies (the funniest of Woody Allen, Mel Brooks, and Monte Python, along with such fare as *Planes, Trains, and Automobiles*, *Wayne's World, Me, Myself, and Irene*, *The Three Amigos*, etc.). Gary also kept busy with numerous activities (some of which have already been mentioned), including tickling keyboards, constructing the Paukstis genealogy, playing tennis, spending time with his family, and hanging out at his cabin on the Olympic Peninsula (complete with a herp pond).

Gary would not have wanted a maudlin parting. Instead, we can envision him telling us all to get on with it in his own inimitable humorous style, likely quoting one of his very favorite movies, *Bill and Ted's Excellent Adventure*:

"Be excellent to each other……and party on, dudes!"

We will miss Gary greatly. Party on, dude, wherever you are!

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ZOO VIEW

Fourteen of my colleagues and friends have been instrumental in my professional development and, through example and wise counsel, have expanded my view of the unlimited possibilities available for research, conservation biology, historical perspectives, and education within a zoo and aquarium environment. I have been most fortunate and wish to take this opportunity to thank them.

For nearly fifty years, Kraig Adler, Joseph T. Collins, and George B. Rabb have supported my interest in zoos and stressed the potential of these institutions to be an important subset in herpetology. They encouraged me to become involved in many professional herpetological societies, especially SSAR. Adler's unique understanding of the history of herpetology served as a significant model for my investigation of the evolution of zoos and aquariums.

For nearly forty years, Jonathan A. Campbell, William W. Lamar and Barry L. Armstrong have supported my vocation, been generous in providing a wealth of specimens collected throughout Latin America for the Dallas Zoo collection, and broadened my understanding of the herpetofauna in that region.

For over thirty years, David Chiszar has taught me that important biological questions can be answered through the design of simple, yet elegant, experiments. As an academic supportive of zoos, he has a critical understanding of the necessary interface between both communities and is ingenious as to how bonds can be formed between them. During this period, Harry W. Greene, Carl Gans, Hobart M. Smith, and the late Roger Conant challenged me to find better ways to use a zoo collection to learn about interesting animals doing interesting things.

Thirty years ago, Charles C. Carpenter and James C. Gillingham stressed the importance of zoo research and stimulated my interest in documenting amphibian and reptile behaviors by working with me on a number of projects in the beginning stages of my career at the Dallas Zoo. During the same time, Gary W. Ferguson showed me the proper way to examine lizards in the field and in captivity. Later, we traveled together to study chameleons, working on several projects to more fully understand the biology of these fascinating saurians.

New Book

"So general is the repugnance of mankind to the animals composing these classes, that their study has been overlooked, and they have usually been considered as beings which it was not only necessary but meritorious to destroy. A part of this vulgar prejudice is derived from education, and perhaps some of it may originate from the fact that several of them are furnished with venomous fangs, capable of causing intolerable sufferings and death. To the naturalist and physiologist, however; to those who study nature through her various modifications of form and structure, they present some of most interesting objects of contemplation. Their utility, either in diminishing various noxious animals, or in furnishing food themselves to others, has been lost sight of; and because they were cold to the touch, with a naked slimy skin without hair or feathers, they have been considered as loathsome and hideous, although their structure displays as much of the omnipotence and care of the Creator as can be seen in those which are considered to be the most gorgeous and beautiful of his animated beings."

—James De Kay in Preface to *Zoology of New York* in 1842

In 1842, James Ellsworth De Kay published *Zoology of New York* in the series Natural History of New York and even then was concerned about the loss of amphibians and reptiles due to human activity. This contribution was the first comprehensive study of the herpetofauna of New York State and included many striking illustrations by artist J. W. Hill (Fig. 1). Over a century and one-half later, another beautiful book on the amphibians and reptiles of that region has been published: *The Amphibians and Reptiles of New York State: Identification, Natural History, and Conservation* by James P. Gibbs, Alvin Breisch, Peter K. Ducey, Glenn Johnson, John L. Behler, and Richard C. Bothner (2007, Oxford University Press, New York; 72 color plates, 422 pp., ISBN: 978-0-19-530444-2). One of the authors, the late John Behler, was curator of herpetology at the Wildlife Conservation Society, headquartered at the Bronx Zoo (see Herpetol. Rev. 37:137–138) and this book is dedicated to his memory. Given that John was a committed conservation biologist, it is not surprising that this field guide emphasizes this aspect by including chapters on threats, legal protections, habitat conservation guidelines, and conservation studies. This is a terrific book, based on distributional data gathered for the New York State Amphibian and Reptile Atlas project (more than 60,000 records compiled between 1990–1999).

Cautionary Note

In an article entitled "Aquarium Science: Diagnosis of chytridiomycosis in pet African dwarf frogs," Barbara Scott and Jay Vance describe the chytrid fungus (*Batrachochytrium dendrobatidis*) found for the first time in commercially available African dwarf frogs (*Hymenochirus*) in the United States (Tropical Fish Hobbyist, 2007, vol. 45(11) #616:138–140). These frogs are commonly offered for sale in pet outlets and may be found in zoo collections.

Seaturtles in Captivity

Although seaturtles often are kept in large public aquariums,

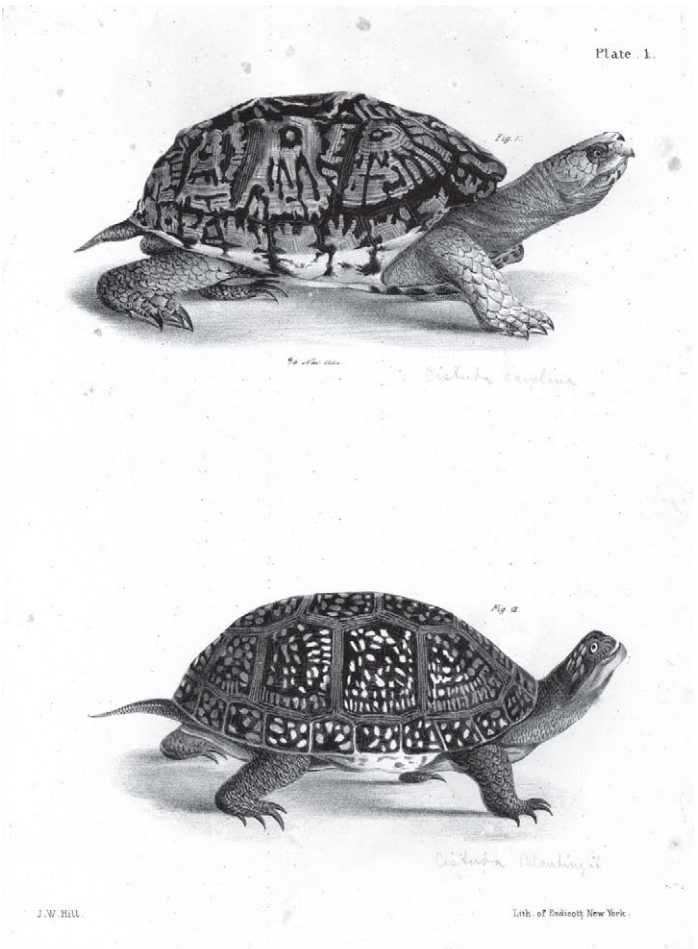
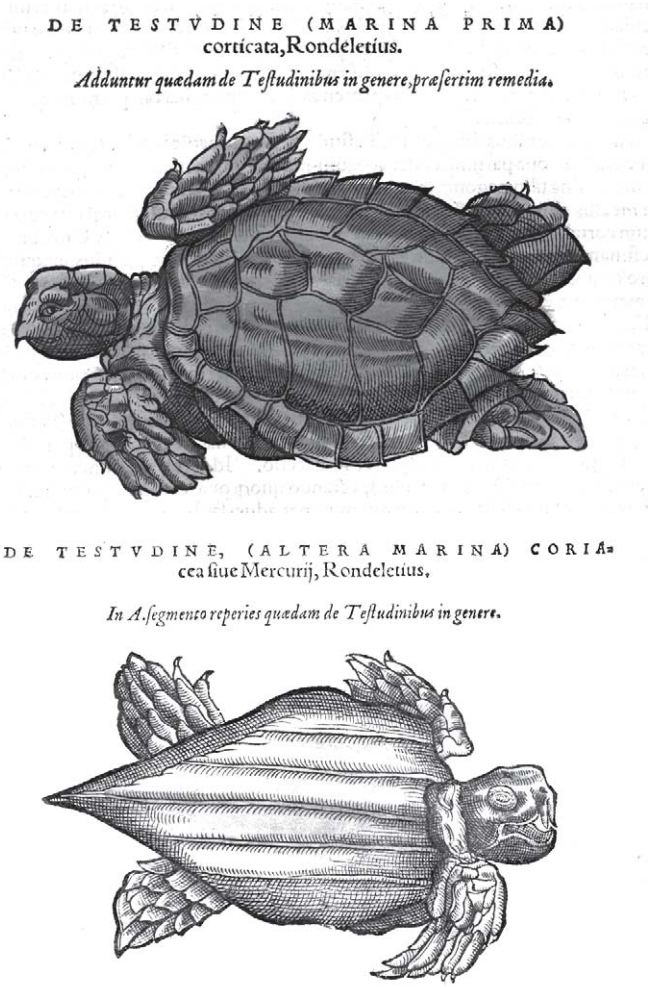


Fig. 1. Illustration of Eastern Box Turtle (Fig. 1, called *Cistudo carolina*, now *Terrapene c. carolina*) and Blanding's Turtle (Fig. 2, called *Cistudo blandingii*, now *Emydoidea blandingii*) by James Ellsworth De Kay. 1842–1844. Zoology of New York, or the New-York fauna: comprising detailed descriptions of all the animals hitherto observed within the state of New York, with brief notices of those occasionally found near its borders, and accompanied by appropriate illustrations. W. and A. White and J. Visscher, Albany, New York. Courtesy of Emily Becker, Dana Fisher, and James Hanken, collections of Ernst Mayr Library, Museum of Comparative Zoology, Harvard University.



Two views of seaturtles from the book by Konrad Gesner (= Conrad Gessner) in 1558. Woodcuts published during this period by Pierre Belon, Guillaume Rondelet, Joannes Jonstonus, and Nehemiah Grew often pictured chelonians with fangs, teeth, weird limbs, and bizarre shells with scutes (epidermal laminae) in the wrong places. In 1551, Gesner advertised in the preface of the first edition of *Historia Animalium I: de Quadrupedibus Viviparis* that hand colored copies were available "for customers who are not deterred by the higher price." *From:* Gesner, K. 1558. *Conradi Gesneri medici Tigurini Historiæ animalium liber IIII : qui est de Piscium & aquatilium animantium natura : cum iconibus singulorum ad uiuum expressis fere omnib. DCCVI. : continentur in hoc uolumine Gulielmi Rondeletij quoq[ue] medicinæ professoris regij in Schola Monspeliensi et Petri Bellonij Cenomanti, medici hoc tempore Lutetiæ eximij, de aquatilium singulis scripta. Tiguri : Apud Christoph. Froschouerum, 1558.* Courtesy of Emily Becker, Dana Fisher and James Hanken, collections of Ernst Mayr Library, Museum of Comparative Zoology, Harvard University.

they rarely breed in captivity. Most reports on management and reproductive behavior observed in captives have been written by Japanese researchers. Yoshioka and Samejima (1989) propagated the Loggerhead Seaturtle (*Caretta caretta*) at the Nagasakibana Parking Garden, Kagoshima, Japan. Uchida (1996) described indoor breeding of loggerheads at the Port of Nagoya Public Aquarium in Japan. Nuitja and Uchida (1982) followed growth and food consumption in juveniles. Oka et al. (1983), from the Shimonoseki Municipal Aquarium in Japan, kept the Leatherback Seaturtle (*Dermochelys coriacea*), a species difficult to maintain because of its specialized diet and pelagic habits. SeaWorld San Diego hatched 21 Green Seaturtles (*Chelonia mydas*) in 2003. In this issue, Ken Sakaoka, Makoto Yoshii, Hitoshi Nakamura, Kazuo Kureha, and Itaru Uchida from the Port of Nagoya Public Aquarium analyzed the reproductive behavior in captive *Caretta caretta*.

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—James B. Murphy, Section Editor

LETTERS TO THE EDITOR

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Amphibian Chytridiomycosis in Commercially Purchased Research Amphibians

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Amphibian chytridiomycosis has been recognized as an Emerging Infectious Disease by the World Wildlife Health Organization since 2001 (Speare et al. 2001). The causative agent, *Batrachochytrium dendrobatidis* ("Bd"), is a zoosporic fungal pathogen that has now been documented on all continents except Asia (Ouellet et al. 2005). Bd has been implicated as a causal agent in amphibian declines and extinctions in Spain (Bosch et al. 2001), South America (Ron et al. 2003), New Zealand (Waldman et al. 2001), Central America (Lips et al. 2005), Australia (Berger et al. 1998), California (Knapp and Morgan 2006; Rachowicz et al. 2006), Colorado (Muths et al. 2003; Carey et al. 2006) and Arizona (Bradley et al. 2002). Effects of Bd infection are species-specific (Davidson et al. 2003; Blaustein et al. 2005) and Bd pathogenicity may be affected by environmental factors (Drew et al. 2006), life history traits (Lips et al. 2003) or species biochemistry (Rollins-Smith et al. 2002; Woodhams et al. 2005, 2006). Bd has also been detected in two common laboratory species: *Xenopus*

tropicalis (Parker et al. 2002) and *Rana catesbeiana* (Mazzoni et al. 2003; Hanselmann et al. 2004; Garner et al. 2006). Some species are not clinically affected by Bd infection (Mazzoni et al. 2003; Davidson et al. 2003; Hanselmann et al. 2004; Garner et al. 2006) and thus can be carriers of the pathogen (Parker et al. 2002). While Bd in wild amphibian populations is of concern, attention also needs to be directed toward the potential for undetected Bd infection in commercially purchased amphibians used for laboratory research.

Herein we describe the chronology and events of a recent attempted pilot study, conducted at Southern Illinois University-Carbondale, Illinois, USA, in which we were using commercially harvested *Notophthalmus viridescens* (eastern newt) as the test species. Implementation of the pilot study was intended to finalize and troubleshoot the experimental design using a common species, prior to initiating the actual study on the target species, an endangered salamander from Texas, USA.

Three separate batches of *N. viridescens* were purchased from two well-known commercial vendors during Spring-Summer of 2006. The first batch of commercially purchased *N. viridescens* (N = 100, Batch No. 1) arrived on 20 June 2006. Animals in Batch No. 1 were immediately visually inspected for clinical signs of disease and were subsequently transferred to holding tanks (75.7 L tanks filled with 37.85 L of water) maintained in a room kept at 21.1°C ambient air temperature. Newts were randomly distributed initially between five tanks with 25 animals per tank undifferentiated by sex and were subsequently re-distributed into three tanks with 33 each in two tanks and 34 in the third. Behaviors were apparently normal and no specimens displayed any clinical signs of disease (e.g., excess skin sloughing, inappetance, lethargy or loss of righting reflex). Four days post-arrival numerous animals displayed excessive skin sloughing (Fig. 1), but were still active and eating well. Eleven days post-arrival two newts died. The dead animals had areas of focal hemorrhage on the latero-ventral surfaces and tail (Fig. 2). Fifty-two animals from Batch No. 1 died between 20 June 2006 and 21 July 2006.

Bd infection was initially diagnosed by David Green (U.S. Geological Survey) and the senior author (GEPF) via microscopic examination of wet mounts of sloughed skin samples. Total necropsy showed that no other pathogens were present. Bd diagnosis was confirmed by DNA analysis (Polymerase Chain Reaction, PCR, conducted at Pisces Molecular Laboratory, Boulder, Colorado; Boyle et al. 2002) following the methodology described in Annis et al. (2004) with some modifications. Changes in the method consisted of increasing the 35-cycle to a 45-cycle, increasing the annealing temperature from 15.6°C to 18.3°C, and also increasing [MG2+] from 1.5 mM to 3.5 mM (J. Wood, K. Rogers, L. Livo and J. Epp, ms. in prep.). Each PCR assay included controls of positive Bd DNA, negative Bd DNA and a contamination detection to ensure the Master Mix used was not contaminated.

The Bd PCR assay test is highly specific for the Bd ribosomal RNA Intervening Transcribed Sequence and the test is very sensitive as it will detect the presence of < 10 Bd zoospores in a 2µl sample (Annis et al. 2004). DNA analyses were conducted on pooled samples and therefore we have no indication of the prevalence of infection for any of the batches discussed herein.

A second batch of newts (N = 85, Batch No. 2) purchased from the same vendor arrived on 27 June 2006. Thirty-seven newts were placed in each of two 75.7 L tanks and 11 in a third 37.85 L tank. We experienced a similar sequence of events as described above and the first mortality occurred 10 days post-arrival. Ultimately 11 animals from Batch No. 2 died. Total mortality between Batches Nos. 1 and 2 reached 63 animals over a 30-day period.



FIG. 1. Commercially purchased *Notophthalmus viridescens* exhibited skin sloughing (arrows) four days after arrival at Southern Illinois University-Carbondale, Illinois, USA.

Notophthalmus viridescens purchased from a second vendor (N = 10, Batch No. 3) arrived on 6 July 2006. Batch No. 3 also tested positive for Bd via DNA analysis. This group was maintained separately [from Batches Nos. 1 and 2] and was held at 25.5°C. Animals in Batch No. 3 showed no clinical signs of disease (e.g., excessive skin slough) while being held at this temperature. On Day 22, five animals from Batch No. 3 were placed in a room kept at 21.1°C. Within eight days of relocation (Day 30 post-arrival at Southern Illinois University -Carbondale), this relocated subset displayed excessive skin sloughing. Mortality was observed 28 days later and eventually all five animals died. Animals in Batch No. 3 maintained at the higher temperature did not suffer mortality. To date, mortality in this third group was only observed in animals held at the lower temperature.

Wildlife and human-focused research commonly employ the use of commercially raised or harvested amphibians. Until our experience, scant attention was paid to the potential for Bd infection in commercially purchased research amphibians. The occurrence of



FIG. 2. Commercially purchased *Notophthalmus viridescens* exhibited numerous hemorrhagic areas, primarily located on the ventro-lateral surfaces and the tail (arrows), and began dying within 11 days of arrival at Southern Illinois University-Carbondale, Illinois, USA.

Bd in commercial research resources could have profound effects on research outcomes and may be particularly confounding when Bd is present but undetected. Results of studies on the effects of various treatments (e.g., contaminants, pesticides, UV exposure) may be confounded if the research subject is a species that can asymptomatically carry Bd; particularly if the experimental subjects have not been tested to verify they are Bd-free. In this scenario, conclusions about the treatment effects may be erroneous as the results could be related to the potential, yet largely unstudied, interaction(s) between the pathogen and treatment factor. Conversely, conclusions about treatment effects may be spurious as an observed effect may not be caused by the treatment or an interaction between treatment and pathogen, but may be a result of undetected, asymptomatic Bd infection.

Based on our experiences with these commercial research amphibians purchased from two different vendors, we recommend the following: 1) proposed budgets for research projects should include sufficient funding for maintenance costs during the quarantine period and for batched DNA testing for Bd; 2) all commercially purchased amphibians should be closely observed daily during a minimum quarantine period of 14 days; 3) quarantine areas should approximate the optimum temperature for Bd (17°C -23°C); and 4) pooled samples of these amphibians should be tested for Bd infection via DNA analysis prior to initiating the actual study.

Quarantine alone without DNA testing is likely insufficient to ensure that the group is Bd-free. Infection was present in all newt batches, yet Batch No. 3 was asymptomatic until a portion of the group was moved into a different temperature regime. In addition, the existence of carrier species which remain asymptomatic regardless of ambient air temperature, obviate the need for diagnostic testing. Given the financial, human and wildlife resources that are invested into research, the importance of reducing confounding variables in a study and the accurate interpretation of research results; it behooves us to take precautions to ensure that we are working with Bd-free animals.

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Size Record?

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DeVitt et al. (2007) recently published an interesting, yet most peculiar, maximum length record for *Pituophis catenifer*. As this record involves the maximum length for a native snake in the United States, it is of special interest to those for whom snake size maxima are an obsession, a condition which the disproportionate number of such records in snake literature reflects, and which has sometimes been humorously discussed (e.g., http://www.guardian.co.uk/g2/story/0,3604,1116074,00.html). Notably, DeVitt et al. (2007) report a "maximum" length following a captive interval of roughly two years, but curiously omit indicating the size of the animal at the time of collection. Even allowing that size at the time of collection was not obtained, and hence, unavailable, lack of understanding of the feeding regimen during captivity (not specified in DeVitt et al. [2007]) disallow this record as representing the maximum size that one might expect *P. catenifer* to attain in the field, and is inconsistent with Herpetological Review's primary guideline for Natural History Notes of "focusing on observations in field, with little human intrusion" (Hansen 2007). Furthermore, no presentation of growth data during the captive interval prevents potential contrasts with information on wild *P. catenifer* that might assist interpreting the size data presented, and is inconsistent with HR's secondary guideline for Natural History Notes of "possessing a natural history perspective" (Hansen 2007).

Briefly, it needs emphasis that this record only indicates the size that *P. catenifer* can attain in captivity, whether it does so in the wild remains to be seen.

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ARTICLES

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Examination of the Intestinal Contents of *Rana clamitans* and *Rana catesbeiana* Tadpoles for Symbiotic, Cellulose-Digesting Bacteria

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Bacterial symbiotic relationships exist in several groups of vertebrates (Prem Anand and Sripathi 2004; Pryor and Bjorndal 2005; Pryor et al. 2006), and arthropods (Cazemier et al. 1997). Symbiotic bacteria in the gut ferment cellulose in plants and allow animals to digest the fatty acid byproducts of fermentative digestion. Bullfrog tadpoles, *Rana catesbeiana*, recently have been documented to benefit from fermentative microorganisms (Pryor and Bjorndal 2005) and this may exist for green frog tadpoles, *Rana clamitans*, as well. Tadpoles of both species feed by scraping various surfaces in the water and by filtering suspended food particles from the water, and their diet typically consists of algae, plankton, and detritus (Alford 1999). These tadpoles need to acquire large amounts of energy in order to undergo metamorphosis into frogs. *Rana catesbeiana* has one year to complete this change while *R. clamitans* can metamorphose within the same year as the eggs are laid, depending on multiple factors.

Fermentative digestion has recently been found in *R. catesbeiana* using methods that measured microbial activity in the intestinal tract by detecting the presence of short-chain fatty acids (Pryor and Bjorndal 2005). Bacteria, protists, and nematodes were detected in the intestine and appear to be involved in symbiotic digestion. We build on these results in our study. We used a staining technique to detect the presence or absence of cellulose on agar plates that housed colonies of bacteria taken from the intestines of bullfrog and green frog tadpoles. Our goals were to detect the presence of cellulose digestion in tadpoles of a second species (*Rana clamitans*), and to explore the range of conditions under which tadpole gut bacteria can conduct cellulose digestion.

Methods.—Larval anurans were obtained from ponds in Allen County, Ohio, USA, via dip netting or seining. Tadpoles were euthanized via saturated sodium benzocaine solution. The intestinal tract was removed in its entirety, or as close as possible, and macerated in 10 milliliters physiologic saline solution. Maceration continued until the solution was clouded. This solution was used to inoculate plates as described below. Individuals were pre-

served in 70% ethanol for later species identification (*Rana clamitans* and *R. catesbeiana*) and determination of larval developmental stage (stages 24–26; Gosner 1960). A total of eight tadpoles were used for this study.

Experiment one included growing cultures of inoculated plates in aerobic conditions on tryptone-growth agar (TGA) with added carboxymethylcellulose (CMC) for 48 h. This was to confirm fermentative activity in the gut bacteria, and used two tadpoles (*R. clamitans* only). Experiment two consisted of inoculating TGA plates with added CMC and glucose, and growing them in either anaerobic or aerobic conditions. This was to see whether the bacteria would grow using glucose or cellulose under anaerobic and aerobic conditions, and used four tadpoles (two each of *R. clamitans* and *R. catesbeiana*). Experiment three was a comparison of glucose and cellulose usage by the intestinal flora. This was done by inoculating four plates with a sample from a single individual. This was done with two tadpoles (*R. clamitans* and *R. catesbeiana*). The plates were all TGA with added CMC, two with glucose and two without. One plate from each of these pairs was grown in aerobic conditions; the other from each pair was grown in anaerobic conditions. This was done to see under what conditions bacteria grew the best, and utilized cellulose the most.

Agar plates were made using TGA (recipe from Stukus 1997), with variations upon this original recipe. Agar included trypticase soy broth, yeast extract, agar, and CMC (cellulose source, added to original recipe). In half of the agar, glucose was added to allow growth of non-fermentative bacteria. Agar preparation consisted of boiling distilled water for 10 minutes prior to the addition of constituent chemicals to kill most contaminants present. The agar was poured to desired thickness onto sterile, single-use plastic Petri dishes, and covered. Plates were then allowed to cool at ambient temperature until set, after which plates were refrigerated until use. Also, control plates were made that were the same as the experimental plates, to verify sterility of the broth and technique.

Prior to use, plates were allowed to equilibrate to room temperature. Inoculation consisted of tapping a grid of three dots by three dots or four dots by four dots (yielding 9 or 16 total dots, each with a diameter of approximately 1.0 cm) of inoculate and marking their location with permanent marker on the Petri dish. This method allowed a more controlled comparison, by identifying specific areas of the plate that had been inoculated, and eased in identifying fermentative activity due to bacteria. The other plating method was flooding of the entire plate with one milliliter of inoculate, with later streak isolation of individual colonies. This method served to grow the largest amount of bacteria per plate. All fluid was absorbed within one half hour in the flooded plates. Inoculate for all samples were drawn from throughout the column of sample and saline solution. All growth occurred at room temperature, for 48–72 h, with plates upside down to avoid airborne contamination. The plates were grown in both aerobic and anaerobic conditions. The anaerobic conditions were obtained by using an anaerobic growth chamber from Ward's Science (AnearoPack©, no. 50-25 (container) and no. 10-01 (ascorbic acid sachets and indicators)), including a chemical oxygen fixing sachet, and an indicator sachet using methylene blue. All trials showed positive for lack of oxygen with the indicator changing from pink or white (oxygen negative) immediately upon removal from packaging, to blue after oxygen exposure, and back to pink or white after the oxygen-fixing sachet finished working.

All plates showing growth were then treated with Congo red dye and hydrochloric acid to test for the presence of polysaccharides (i.e., cellulose). The dye binds to polysaccharides such as cellulose, but not the products of their degradation (Ruijssnaars and Hartmans 2000), leaving a halo of non-colored agar around areas of degradation. Bacterial plates were first flooded with saturated Congo red solution, then washed with 1 M NaCl, and finally rinsed multiple times with distilled water (Ruijssnaars and Hartmans 2000). Hydrochloric acid (1 M) was then added to increase the contrast by converting the Congo red dye from red to blue, for better photographic resolution and ease of analysis. All plates were grown for 48–72 h. Experiment four was solely a control experiment checking for the presence of oxygen trapped in the agar and in solution in the anaerobic chamber. Plain agar (non-nutritive agar and water only) was inoculated with methylene blue. These plates as well as a vial of methylene blue solution were placed in the anaerobic chamber and the chamber was set up as per manufacturer's instructions.

Results.—Bacteria isolated from both species of tadpoles showed cellulolytic activity on the agar plates. All four experiments showed cellulolytic activity (indicated by haloes after Congo red staining) in all the samples under aerobic conditions. These cultures also grew and utilized cellulose under anaerobic conditions in experiments two and three. Moreover, cellulose usage was increased under anaerobic conditions (experiment two), as indicated by larger halo diameters compared to those in experiment one. The most growth occurred on the glucose positive, aerobic plates, and the least growth on the glucose negative, anaerobic plates. Cellulolytic activity was best on the glucose negative, aerobic plates, and worst on the glucose positive, anaerobic plates. In addition, under anaerobic conditions, bacterial growth proceeded as not just across the surface of the agar, but also into the agar. Whereas atmospheric oxygen was removed from the chamber, oxygen may have been trapped in the liquid agar solution, and then in the solidified agar, thus not being removed by the ascorbic acid sachet.

Discussion.—We found that general bacterial growth was positively affected by the presence of glucose and oxygen, while cellulolytic activity was negatively affected by these conditions. It is very possible that intestinal bacteria used in our study are facultative anaerobic fermenters, and only resort to fermentation when necessary. This would be expected considering the lower amount of energy made available by anaerobic fermentation compared to aerobic respiration. The identity of the intestinal flora and their status as resident or transient microbes are not known at this time.

Endosymbiotic bacteria are fairly common throughout vertebrates, and may provide a significant source of additional nutrition for organisms that survive on a low-energy, high-cellulose diet. Ranid tadpoles have a diet of algae, detritus, and plant-based material (Alford 1999), with occasional carnivorous morphs observed (L. Regula Meyer, pers. obs.). Due to the high energy demands of metamorphosis and early stages of larval growth, individuals with an ability to utilize larger amounts of energy may have an adaptive advantage over individuals that do not. With the increasing prevalence of antibiotics in water sources because of the overuse and nondegradation of antibiotics, both human and veterinary, (Shinwoo 2004), any changes in intestinal flora may have growth and survival implications for amphibians. At a time

when amphibians are in decline globally, it is essential to understand what conditions are detrimental to amphibian survival, especially if those conditions are anthropogenic.

Further research is continuing in this area, including identification of the intestinal flora, testing the microbial response to various antibiotics, and any life history changes in individuals lacking endosymbiotic bacteria.

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Quantitative Analysis of Reproductive Behavior in Captive Loggerhead Turtles (*Caretta caretta*)

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The large number of research projects on the reproductive ecology of sea turtles thus far has focused mainly on observations along the seacoast, concentrating on only several hours of the long life span of these turtles. Few studies have been made regarding courtship and mating in the wild due to the difficulty in observing these behaviors, particularly over a long period of time. Therefore, the temporal relationships between copulation, fertilization, and egg–laying in sea turtles remain unclear.

Although mating after the nesting period has been suggested in some early studies on Green Turtles, *Chelonia mydas* (Carr and Giovannoli 1957; Carr and Hirth 1962; Carr and Ogren 1960; Harrisson 1954; Hendrickson 1958), recent observational and satellite telemetry studies have shown that males of several species depart the breeding ground once the nesting period begins (Hays et al. 2001; James et al. 2005; Plotkin 1996). Furthermore, the peak of copulations of green turtles off the coast of Ascension Island coincides with that of female influx into the breeding ground (Godley et al. 2002). Such a temporal relationship between mating and nesting is in accordance with the hypothesis by Owens (1980) that female sea turtles copulate prior to the nesting period and store sperm during the reproductive season. Such a hypothesis is also supported by histological investigations of sperm storage organs of female reproductive tracts (Chaves et al. 2000; Gist and Jones 1988; Solomon and Baird1979). However, no study has investigated the relationship between mating history and reproductive success of individual female turtles in the wild.

We believe that research conducted in captivity, which enables observations on reproductive events of individually identifiable sea turtles, can elucidate behavioral aspects that are difficult to obtain in the wild. For example, in the Cayman turtle farm on Grand Cayman Island, British West Indies, male green turtles in a breeding pool were observed to mate most frequently approximately 30 days before laying the first clutch and no mating was observed after laying the first clutch (Simon et al. 1975; Ulrich and Parkes 1978). A similar pattern was observed in captive Kemp's Ridley Turtles, *Lepidochelys kempi* (Rostal et al. 1988). In addition, there existed a correlation between the duration of observed mating of female Green Turtles in a breeding pool and the hatchability of their clutch (Wood and Wood 1980). However, in studies conducted at night with poor water visibility and with a limited number of observers, it is conceivable that confusion in identifying individuals and behavioral patterns could occur, even dur-

ing long–term observations.

It is reasonable to assume that captive research would be even more beneficial under a system that enables quantitative and long–term observations of reproductive behavior. In the study reported here, we have utilized supersensitive cameras around the exhibit tank for a minute by minute, around the clock recording to conduct quantitative observations of mating behavior of captive Loggerhead Turtles, *Caretta caretta*. Our goals are to investigate the temporal relationship between mating and nesting, and relationships between mating histories of individual egg-laying females and fertility of their clutches.

At the Port of Nagoya Public Aquarium (PNPA), Nagoya, Japan, sea turtles are maintained in a doughnut-shaped exhibit tank (13 m in diameter, 2.5 m in depth, and 3.5×10^5 liters in tank volume) provided with a slow-moving current. Adjacent to the tank is an artificial dune (20 × 5 m) for the turtles to land and nest. During the study period, water temperature in the tank was regulated between 23° (winter) and 27°C (summer). A natural photoperiod was available through skylights above the tank. Between 1990 and 1993, a total of nine adult Loggerhead Turtles (four males and five females) were brought into captivity from the Sea of Kumano and Enshu off the coast of central Honshu Island and off the coast of Makurazaki in southern Kyushu Island. Also in the tank are three Loggerheads hatched from eggs collected on a beach in Hamamatsu, Shizuoka Prefecture in central Honshu in 1990. The Loggerheads are housed with Green (*Chelonia mydas*) and Hawksbill (*Eretmochelys imbricata*) turtles.

Two cameras were placed around the exhibit tank to monitor mating behavior of turtles in the breeding seasons of 2001 (1 November 2000 to 31 October 2001) and 2002 (1 January 2002 to 31 August 2002). These supersensitive cameras (Panasonic WV–BL734, Matsushita Communication Industrial Co., Ltd., Yokohama, Japan) were capable of providing images even in darkness at a minimum light intensity of 0.04 lx. Each camera was positioned to give the widest view with the lens directed toward the surface of the water. The range covered by each camera was about 3.0 × 4.0 m, aided at night by a spotlight with a 65 W mini halogen bulb with a red filter in order to minimize the effect of ambient light around the tank. Varying locations on the scutes of each turtle were painted white for accurate individual identification. Images during the 24 h period were recorded on S-VHS videotape using two time-lapse video recorders (Panasonic AG-6740, Matsushita Electronics Industrial Co., Ltd., Ibaraki, Japan). The elapsed period between images was 0.217 sec, rapid enough to record any behavioral sequence. Because the two cameras covered about one-third of the entire exhibit tank, we defined observed time per mounting as: 1) the interval from the start to the end of mounting if we observed these events using the cameras (including the time during which the mounting pair was out of sight); 2) the duration of observed time if we first observed an already mounted pair that subsequently moved out of sight (therefore, we observed the mounting pair only once); or 3) the interval from the start to the end of observation, or to the end of mounting if we first observed an already mounted pair and observed the pair intermittently. Furthermore, as each camera provided only an aerial view of the mounting pair,; we could not confirm whether penile insertion occurred during each observed mounting. Therefore, opportunistic observations were made by trained staff members in the aquarium (first, second, and third author) from the side of the exhibit tank to record copulatory frequency and duration.

Eggs laid by each female were excavated and transferred as a group to a hatchery near the aquarium. During the transfer the top of each egg was marked and firmly positioned to prevent turning. After eggs were weighed and measured, they were reburied in sand in artificial egg cavities, the bottom of which was at a depth of 50 cm. Each nest was surrounded by a fence so that we could identify where each group of hatchlings originated. During incubation the ambient temperature of the nests was maintained at approximately 29°C.

In order to calculate the fertility of each clutch, the number of emergent hatchlings from each artificial nest was counted. Three days after the last emergence of hatchlings, each artificial nest was excavated and dead hatchlings or unhatched eggs were collected. These unhatched eggs were opened and checked for embryonic development. In this study, fertility was defined as follows: fertility (%) = (number of emergent hatchlings + number of hatchlings that died before emerging from the nest + number of unhatched eggs with dead embryos if they could clearly be determined) / (clutch size) × 100. Since almost all the unhatched eggs had already decomposed in the nests, it was difficult to differentiate between infertile eggs and eggs containing dead embryos so decomposed eggs were arbitrarily categorized as infertile.

During the study period, four of the five females (F1, F4, F6, and F11) laid successive clutches (30 clutches in total; number of clutches per female per season, range = 3–5; clutch size, range = 37–118). The fifth female (F15) did not lay eggs at all during the study period. Among the four females, three females laid eggs in successive breeding seasons. At least two clutches from different females were deteriorated or lost during 2001 breeding season. One female suffered a prolapsed oviduct immediately after laying the third clutch and failed to nest for the rest of the season. However, using ultrasonography, it was confirmed that she retained mature follicles in the ovary. Another female laid a second clutch but in the exhibit tank rather than on land, so we were unable to retrieve her eggs. A total of 2217 hatchlings emerged from artificial nests in the hatchery, with incubation periods ranging from 50 to 67 days. The calculated fertility of each clutch ranged from 45.9% to 98.8%.

Quantitative observations using cameras confirmed that all egg-laying females were repeatedly mounted by multiple males, and that the peak of matings occurred prior to the nesting period (Fig. 1). Observed time per mounting through cameras showed an asymmetric distribution in which mountings lasting less than 10 min accounted for 69.9% of all observed mountings, and the frequency declined as the duration increased (median 3 min, interquartile range = 1–28 min, N = 623). On the other hand, the duration of mountings during which penile insertion was observed opportunistically was distributed normally (mean ± SD, 90 ± 43 min, N = 34). Cumulative time and the number of mountings observed through cameras are summarized in Table 1.

Among four instances of five successive clutches (F4 2001, F11 2001, F6 2002, F11 2002), fertility was not significantly different (Friedman test, $\chi^2 = 1.4$, d.f. = 4, $P = 0.84$; Fig. 2). For the three females that laid eggs in successive breeding seasons (F4, F6, and F11), fertility was compared between individual clutches of successive breeding seasons according to the cumulative time of

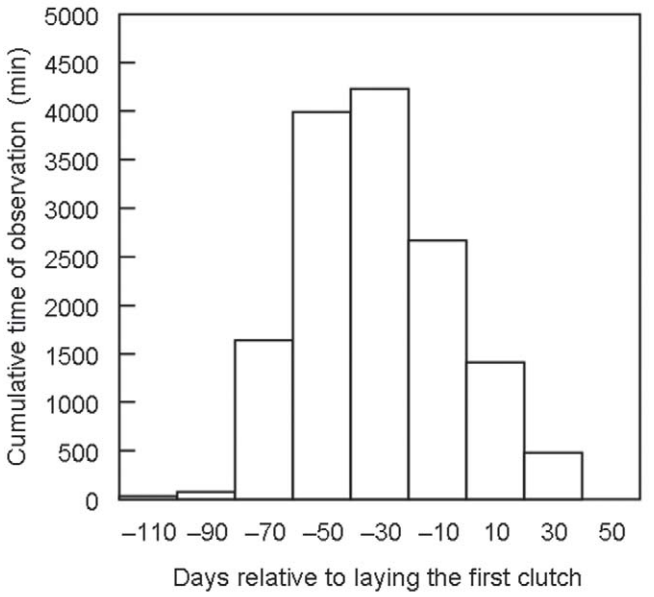


FIG. 1. Temporal distributions of observed time of mountings in loggerhead turtles under captive conditions.

mountings observed during the pre–nesting period (short vs. long, see Table 1). Fertility was not significantly different by the cumulative time of observed mountings (Wilcoxon matched-pairs signed-ranks test, $P = 023$; Fig. 3).

In this study, Loggerhead Turtles in the exhibit tank displayed a seasonal reproductive cycle in which the peak of matings occurred prior to the nesting period. Our work is based on a small sample size in captivity. Still, the findings concerning the relationship between mating and egg–laying are in general agreement with previous studies of several sea turtle species in the wild (Booth and Peters 1972; Godley et al. 2002; Hays et al. 2001; James et al. 2005; Plotkin 1996) and under captive conditions (Rostal et al. 1998; Simon et al. 1975; Ulrich and Parkes 1978; Wood and Wood 1980). Of special interest, in this study, there was no significant decline in fertility over successive clutches of individual turtles. These results indicate that females in the exhibit tank stored sperm during the breeding season and used it to fertilize successive clutches.

Because our observational method did not allow us to observe all the mountings occurred in the tank and evaluate reproductive success of each observed mounting, we could not compare the exact number of successful copulations among the egg-laying females. However, observed time per mounting through cameras and duration per copulation, during which penile insertion was observed by opportunistic observations indicate that there is a relationship between observed time per mounting and reproductive success. Wood (1953) observed a copulation bout by a pair of loggerhead turtle in captivity (during which insertion of the penis into the female's cloaca was seen) and reported that it lasted for at least 200 min. Dodd (1988) also suggested that copulation of loggerhead turtles lasts for several hours. On the other hand, shorter duration of mountings and attempted mountings observed frequently in this study have also been described in studies of green turtles with female rejection, such as circling or orientating toward an approaching male, and an attempt to dislodge a mounted male (Booth and Peters 1972; Hendrickson 1958; Wood and Wood 1980). Even if a male successfully mounted, the female sometimes covers her cloacae with the hind flipper to avoid penile insertion (Wood and Wood 1980). These findings indicate that majority of the shorter duration of mountings observed in this study were unsuccessful copulations during which female rejected penile insertion and that mounting needs to last for a given period of time to maximize reproductive success. Although, as mentioned above, our methods did not allow us to observe all the mountings that occurred in the tank, mountings which lasted for a long period of time were intermittently observed in the observational area, meaning that the probability of missing them was quite low. Taking these points into consideration, some females in this study may not have successfully copulated at all after laying the first clutch, and a female that was observed mounted with the shortest duration (F11, 2001 breeding season; cumulative time of observation, 128 min) may have successfully copulated only once during the breeding season.

Although there seemed to be a relationship between observed time per mounting and reproductive success, fertility was not significantly differentiated by the cumulative time of mountings observed during the pre–nesting period. Unfortunately, we could not explain this discrepancy using our experimental design. However,

TABLE 1. Cumulative time and the number of mountings observed through supersensitive cameras.

Female ID	Breeding season	Pre-nesting period					Inter-nesting interval				
		Cumulative time of observation (min)	Number of mountings (duration in min)				Cumulative time of observation (min)	Number of mountings (duration in min)			
			100	< 100	< 50	< 10		100	< 100	< 50	< 10
F1	2001	456	2	1	2	17	30	0	0	1	32
F4	2001	3251	10	14	17	67	1300	5	7	7	36
F6	2001	395	1	2	3	7	102	0	1	0	4
F11	2001	123	0	1	3	7	5	0	0	0	6
F4	2002	7180	22	39	35	153	309	0	2	3	23
F6	2002	1126	5	6	3	42	92	0	1	2	3
F11	2002	228	1	1	1	27	5	0	0	0	5

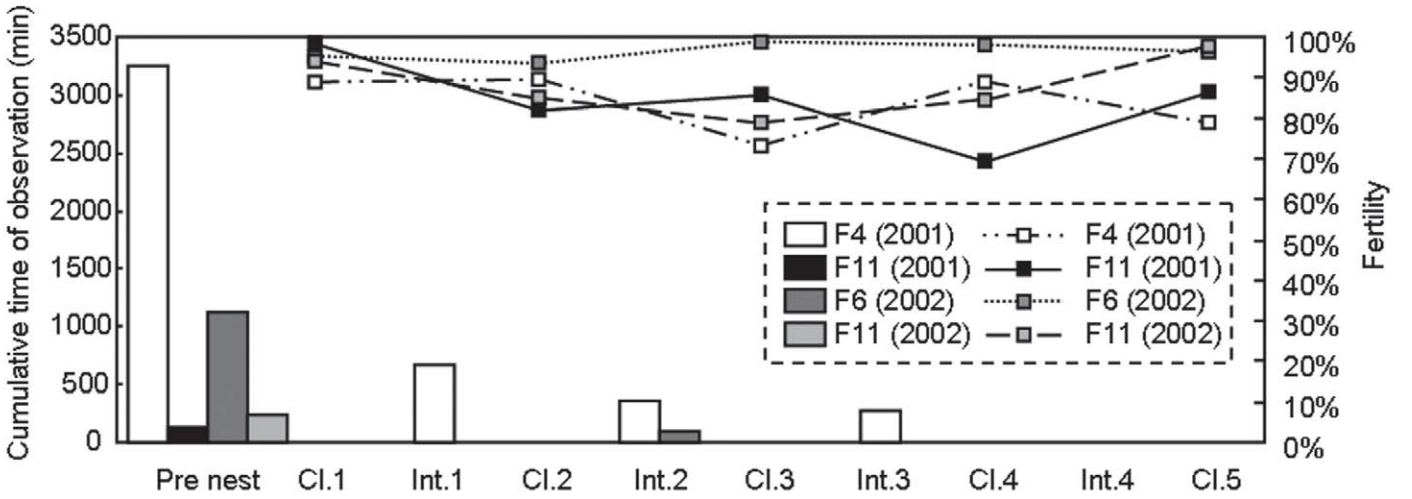


FIG. 2. Relationships between fertility of five successive clutches (line graphs) and temporal distributions of observed time of mountings (bar graphs).

we assume that this reflects the possibility that only a successful copulation could provide sufficient sperm to fertilize successive clutches, at least during a given reproductive season.

For the best understanding of the sperm utilization pattern to fertilize successive clutches, a method that directly evaluates reproductive success of copulations is indispensable. Recently, paternity analysis for hatchlings has been done in several turtle species (Bollmer et al. 1999; Crim et al. 2002; FitzSimmons 1998; Harry and Briscoe 1988; Hoekert et al. 2000; Kichler et al. 1999; Moore and Ball 2002; Parker et al. 1996). It is necessary to analyze paternity over successive clutches of individual female turtles and compare the mating history and paternity data to confirm how multiple copulations contribute to paternity and fertility over successive clutches, and whether copulations occurring during internesting intervals contribute to subsequent clutches.

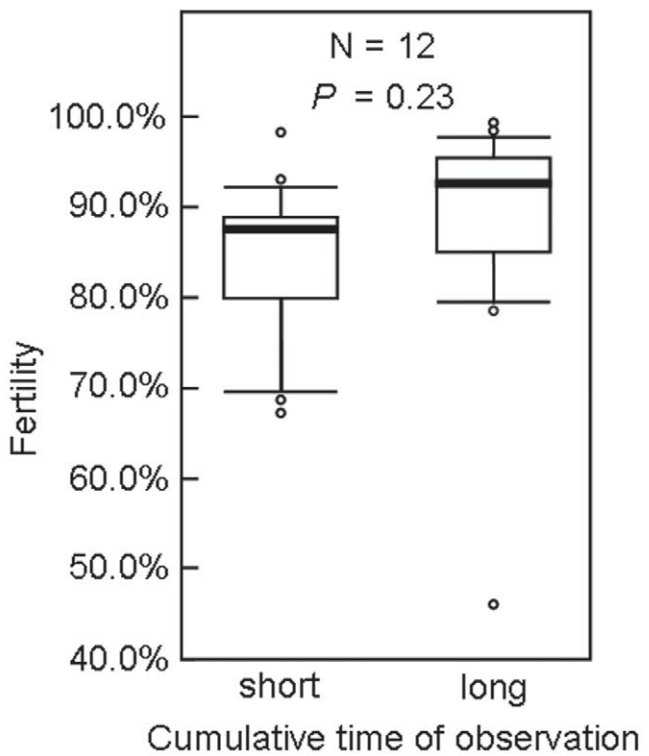


FIG. 3. Box plot comparison of fertility between individual clutches of successive breeding seasons according to the cumulative time of mountings observed during the pre–nesting period (short vs. long). The length of each box corresponds to the interquartile range, with the top boundary of the box representing the 75th and the bottom boundary the 25th percentile. The horizontal line in the box indicates the median value. The small bar at the end of the line extending upward from the box plot shows the 90th and downward 10th percentile. Outlier values are shown as open circles.

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Observations on Emigration and Habitat Use by Eastern Tiger Salamanders, *Ambystoma tigrinum*, in South Carolina

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For conservation and management of amphibians, it is now well recognized that aquatic and terrestrial habitats are essential to carry out life history functions of amphibians and that both habitats should be managed simultaneously (Semlitsch 2000). The amount of terrestrial habitat used during both breeding and post-breeding migrations, foraging, and overwintering defines the core terrestrial habitat of a population (sensu Semlitsch and Jensen 2001; Semlitsch 1998; Semlitsch and Bodie 2003), and is critical to the persistence of the local population. However, a better understanding of the habitats used for specific activities, and whether certain habitat types are being selectively used is also necessary. This is essential because it is often necessary to balance conservation needs for habitat protection with human landuse, and having more detailed information about the location of habitats essential for persistence is of great economic importance.

We present the results of a radio-telemetry study on four adults of the eastern tiger salamander, *Ambystoma tigrinum*, as they emigrate from a breeding site in South Carolina. We use the location of each individual to generate home ranges in the terrestrial habitat and maximum distance traveled away from the breeding site. We also provide limited data on the availability of habitat within the study area and within the home range of individuals.

Materials and Methods

Study site.—The study was conducted at a Carolina bay wetland called "Ellenton Bay" that serves as a major breeding site for many species of amphibians (Sharitz and Gibbons 1982; Gibbons et al. 2006). Ellenton Bay is approximately 10 ha in area, has a maximum water depth of 2.0 m, and was surrounded by agricultural fields until 1952. Since that time the terrestrial area has undergone succession and consists of primarily old fields (including powerline right-of-way), shrubs, and mixed pine-oak forest. These terrestrial habitats are xeric and consist of sandy, well-drained soils with patches of Sweetgum (*Liquidambar styraciflua*), oaks (*Quercus* spp.), Loblolly Pine (*Pinus taeda*), and Slash Pine (*Pinus elliottii*).



FIG. 1. Aerial photograph of the Ellenton Bay study area with minimum convex polygon home ranges (white cross-hatched areas, including emigration paths and connecting activity centers) of four salamanders.

Radio-telemetry.—The four salamanders were collected on 14 February 2000 at a drift fence with pitfall traps as they migrated to breed in Ellenton Bay. They were removed to the laboratory for implantation of radiotransmitters (model BD-2GH; 1.8 g; Holohil Systems Ltd., Ontario, Canada; 7.5–12% of the salamanders' body mass). Each salamander was placed in a 0.2% buffered solution of MS-222 (3-aminobenzoic acid ethyl ester) until unresponsive, rinsed with distilled water, and partially wrapped in a wet paper towel during surgery. Transmitters were inserted into the body cavity via a single longitudinal ventral incision to the right of the midline. Polygalactine 5-0 sutures were used to close both the abdominal muscle and skin. Individuals recovered from anesthesia 1–2 h after surgery. Salamanders were released within 48 h at their capture site on the inside of the drift fence. Upon emigration, individuals were captured leaving Ellenton Bay and were simply placed on the outside of the drift fence several meters in the presumed direction of travel.

We relocated individuals at least once a day for the first few days after release and then relocated them periodically until termination of the study on 24 May 2000. We used a four-band radio receiver (Model CE-12, Custom Electronics, Urbana, IL), with a three-element Yagi antenna (Model F151-3FB). Salamanders were located within 0.2 m, marked with a surveyor's flag, but left undisturbed either until no movement had occurred for several days or predation was suspected. Upon termination of the study, the three remaining live salamanders were retrieved and transmitters surgically removed.

Analyses.—The UTM coordinates of each relocation point were recorded using a backpack style Trimble GPS unit with submeter accuracy and imported into Arcview GIS (version 3.3; Environmental Systems Research Institute, Redlands, California). We estimated the home range of each salamander using minimum convex polygons (MCP, Animal Movements extension [Hooge et al. 1999] to Arcview). Net distance from the bay was also estimated. Habitat available to the salamanders was determined by encompassing the maximum distance traveled away from Ellenton Bay (~400 m) into an area approximately 800 × 800 m centered on the wetland. Habitat types within the available area (portion of Field 3-412 Set-Aside area extending ~400 m on all sides from the wetland edge) were classified by using a land-cover layer digitized from aerial photographs (old field-41%, scrub forest-7%, pine forest-31%, hardwoods-11%; Pinder et al. 1999). Salamander relocation points were overlaid onto the land-cover layer in ArcView to assign a habitat type to each salamander relocation. The devia-

TABLE 1. A summary of information for tiger salamanders implanted with radiotransmitters and followed during emigration from a breeding site.

ID	Sex	SVL (mm)	Mass (g)	Days tracked	*No. of movements	Net distance (m)
44	M	103	24.1	76	5	132.4
47	M	102	21.5	76	6	69.5
52	M	97	15.0	71	6	118.2
68	F	99	22.0	75	3	405.9

*Movements are defined as migratory movements away from the site > 2.0 m

tion in relocation points from random use of available habitat was tested with a Chi-square test.

RESULTS

Salamanders were tracked for an average of 74.5 days and made an average of five long-distance terrestrial movements (Table 1). Between long distance movements, salamanders remained underground in activity centers with an area of < 1.0 m^2. At the end of the study, we found one salamander dehydrated on the leaf litter and three salamanders alive in tunnel systems running parallel to the surface, 8–10 cm underground, and about 2.5–3.0 cm in diameter. Terrestrial movements were in a direction that was generally perpendicular to the wetland edge and final locations were an average of 181.5 m (range 69.5–406 m) away from Ellenton Bay (Table 1; Fig. 1). The proportion of time spent in different terrestrial habitats was non-random with respect to habitat available in the area surrounding Ellenton Bay ($\chi^2 = 14.98$, df = 3, $P < 0.005$). In general, salamanders used pine and hardwood forest more than old field and scrub habitats.

DISCUSSION

The terrestrial migrations of Eastern Tiger Salamanders in South Carolina fit the pattern found for tiger salamanders in other regions (Madison and Farrand 1998; Steen et al. 2006), and for other pond-breeding ambystomatid species (e.g., Madison 1997; Semlitsch 1998; Rittenhouse and Semlitsch 2007). Generally, salamanders emigrate from breeding sites in a direction perpendicular to the wetland edge, initially make several long distance movements associated with rainfall events, and then settle into a small activity center within a few hundred meters of the wetland edge. Although female amphibians of some species are known to emigrate farther away from breeding sites than males (Rittenhouse and Semlitsch 2007), we were unable to test this difference with our limited sample size but the single female tracked traveled 406 m from the site. Individuals occasionally move to new activity centers, short distances (2–20 m) away. Activity centers were focal points of lateral underground movements < 1.0 m, similar to that previously described in more detail (Semlitsch 1981, 1983), and presumably used for feeding and remaining hydrated. The area encompassing emigration paths from the breeding site and connecting all activity centers, here defined as a home range, was relatively linear compared to typical reptilian or mammalian home ranges (Fig. 1).

In our study, tiger salamanders used forested habitat more often than open, old field habitats but the preference was variable among individuals. Notably, one salamander spent the entire tracking period (76 days) in old field habitat. Despite 3–4 rainfall events when the other salamanders moved further away from Ellenton Bay, male #47 made only short movements, remained in the old field habitat (in a waterline right-of-way), and was not desiccated or undernourished when retrieved at the end of the study. Similarly, Steen et al. (2006) reported the use of a wildlife food plot by one individual and a strip of trees between two food plots for another tiger salamander suggesting agricultural habitat did not constrain their movements. Yet, Madison and Farrand (1998) reported avoidance of grassy fields, paved roads, and commercial areas by tiger salamanders in New York. Although better resolution of habitat use is needed, these mixed findings might indicate that forest canopy cover may not be as critical to the persistence of tiger salamander populations in terrestrial habitats as the quality of soil and litter for obtaining adequate underground refuges. For example, the ability of salamanders to move underground by digging in loose sandy soils or by using rodent burrows may be the critical habitat feature. Substantial evidence now indicates a positive association between mole salamanders and rodent burrows (e.g., Loredo et al. 1996; Madison 1997; Madison and Farrand 1998; Regosin et al. 2003; Trenham and Shaffer 2005; Steen et al. 2006). Discrimination as to which habitat features are essential to population persistence, especially among different species, is a critical question for further research.

In conclusion, we suggest that Eastern Tiger Salamanders use large amounts of terrestrial habitat surrounding wetland breeding sites, similar to other ambystomatid species, and they rely on loose sandy soils and rodents to gain access to underground refuges. Thus, land use that truncates the size of this area or reduces their ability to retreat underground may jeopardize their population persistence.

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TECHNIQUES

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Candlelight *vigilis*: A Noninvasive Method for Sexing Small, Sexually Monomorphic Lizards

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Determining the sex of an individual is essential to many studies, from investigations of ecological and evolutionary processes to molecular studies of gene expression and biochemistry. For some lizards, sexual identification is straightforward because of differences in external dimorphism between the sexes (e.g., sexual dichromatism, enlarged postcloacal scales, femoral or precloacal pore morphology). In other species, visible sexual dimorphism can be subtle or absent. Only about 18% of lizard species are sexually dichromatic, with fewer than 10% of geckos, skinks, and chameleons exhibiting sexual differences (Cooper and Greenberg 1992). Even diagnostic traits like body size or pore morphology can vary seasonally, behaviorally, or environmentally due to body condition, and thus may be ambiguous under certain conditions. Additionally, sexing juveniles of dimorphic species can be difficult if diagnostic sexual traits have not yet developed. In these situations, researchers traditionally rely on the identification of the gonads (usually postmortem) or invasively verify the presence of hemipenes to accurately determine sex.

Hemipenal verification is usually accomplished by probing the cloaca with a small, blunt-tipped rod to measure the depth of insertion or "popping" the hemipenes by manually everting them via manipulation of the tail base (Stebbins 2003). However, invasive procedures can cause permanent damage to the cloaca or hemipenes, especially when performed by novices. Even experienced herpetologists will occasionally cause tail loss or stress a lizard during invasive sexing methods. These techniques are even more difficult if the animals are small. Here we describe a noninvasive method using light to sex lizards based on our studies of a small, sexually monomorphic lizard (*Xantusia vigilis*), and we show the technique's applicability for four other species (two iguanians and two gekkonids).

Xantusia vigilis (Desert Night Lizard) is a viviparous lizard that inhabits the deserts of the southwest U.S. and Mexico and is often found under rock or fallen *Yucca*. Adult lizards average 43 mm snout-vent length (SVL) and 1.5 g, whereas neonates average 23 mm SVL and 0.25 g at birth (Zweifel and Lowe, 1966; Davis, unpublished data). Because of its small size and lack of sexual dichromatism, sexing this species using traditional methods has been challenging (Miller 1951; Zweifel and Lowe 1966).

Zweifel and Lowe (1966) sexed *X. vigilis* by evaluating the shape of the thigh in cross section and by comparing the SVLs of older adults. Females often have more rounded thighs (see also Stebbins 2003) and can achieve a maximum size 3–4 mm greater than males by about 7–8 years of age. Additionally, Zweifel and Lowe (1966) noted that many postnatal females have conspicuous skin folds along the abdomen that are usually absent in males, but females rarely give birth before 3 or even 4 years of age. Thus, Zweifel and Lowe's method has two major drawbacks: 1) it is difficult or even impossible to use with juvenile and young adult lizards, and 2) all three diagnostic criteria are influenced by fluctuating environmental conditions (e.g., food availability), decreasing the reliability of their method. The new sexing technique we describe below, especially in combination with Zweifel and Lowe's criteria, will allow researchers greater confidence in sexing *X. vigilis* across age classes and environmental conditions.

To sex *X. vigilis*, we first grasp the lizard underneath the forelimbs so the ventral body surface is visible. Next, we position a bright, focused light source (e.g., Maglight® Solitaire® penlight or any small LED light) behind the dorsal side of the tail to direct a focused beam of light through the tail base (Fig. 1). The light allows us to visualize internal anatomy and examine the tail base for evidence of hemipenes. Female lizards have no obvious subcutaneous structures (Fig. 1A), whereas males have paired red dots or ovals in the location of the hemipenes and dorsoventral thickening of the tail base (hemipenal bulge; Fig. 1B, C). The visibility of dots varies and probably depends on blood flow to the region, but one can always see the dorsoventral thickening of the tail base in males, which is more apparent when illuminated.

Both authors independently sexed the same 20 adult *X. vigilis* with this light technique, agreeing on the sex of 19 individuals. From this set, we randomly chose and dissected five presumed

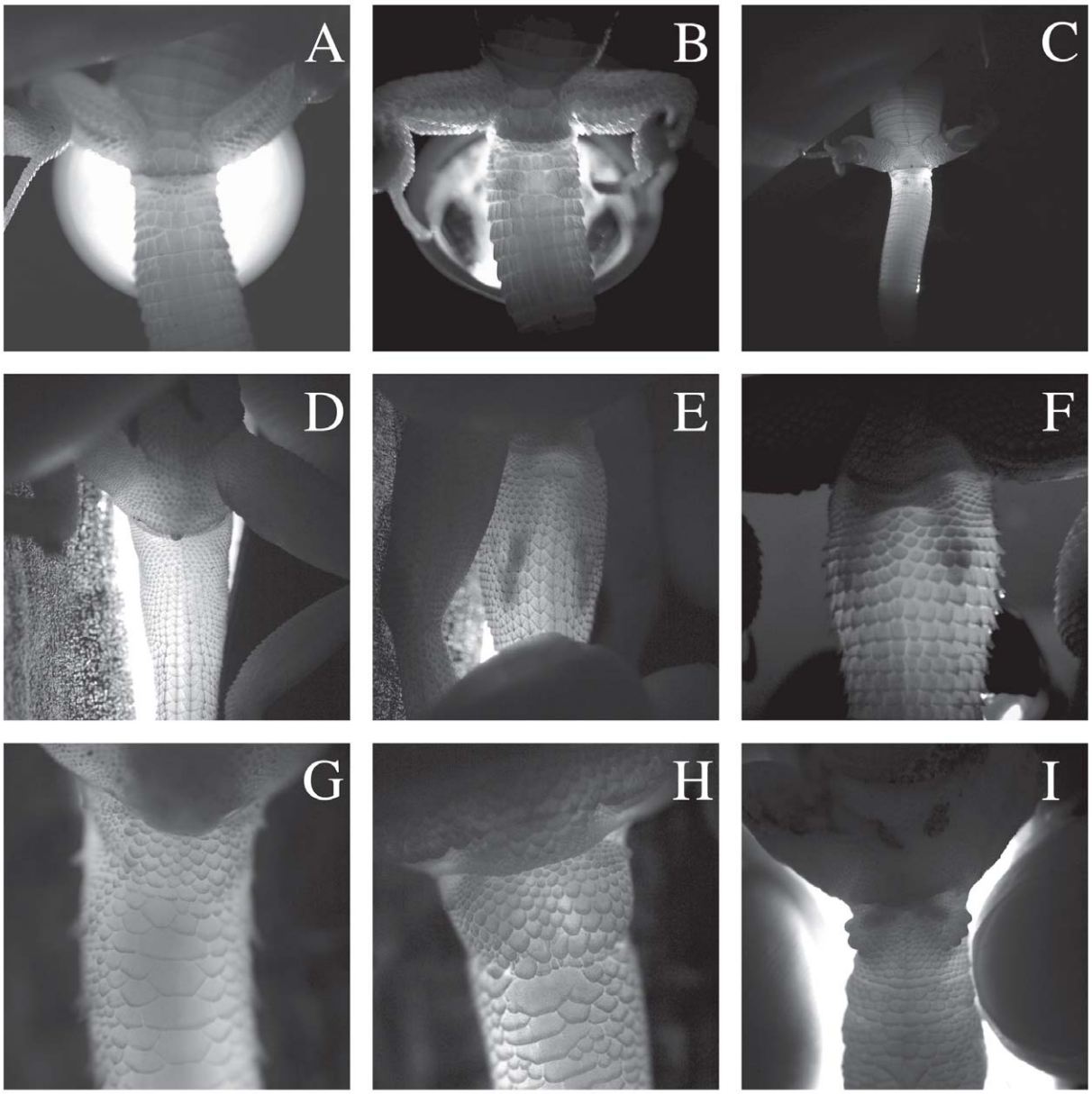


FIG. 1. Visualization of hemipenes by passing a bright condensed light through the tail base of males. Note that no such structures are visualized in females. (A) adult female *Xantusia vigilis*, (B) adult male *X. vigilis*, (C) neonate male *X. vigilis*, (D) adult female *Anolis wattsi*, (E) adult male *A. wattsi*, (F) adult male *Uta stansburiana*, (G) adult female *Hemidactylus mabouia*, (H) adult male *H. mabouia*, (I) adult male *Tarentola delalandii*.

males, five presumed females, and the contested individual to examine the gonads. These lizards were preselected for euthanasia for a separate project, and thus we viewed their dissection as an opportunity for a definitive test of our methods and not the motivation for it. The dissections revealed that all 10 of the randomly chosen individuals were sexed correctly using the light method and that the contested individual was a male. The single discrepancy likely resulted from a 10-fold difference in experience between the authors in sexing *X. vigilis* using this technique.

As further evidence for the repeatability of this method, we have captured, sexed, and uniquely marked over 1200 lizards in the field as part of a mark-recapture study. This sexing method has worked accurately through three years of study, across seasons, body conditions, and levels of melanism. Of the 156 lizards that have been captured more than once, only 11 have been assigned a different sex upon recapture (Table 1). There was no bias in the direction of the 11 sexing inconsistencies (N = 5 sexed initially as male, then female; N = 6 sexed initially as female, then male). Large lizards (38 mm SVL) were always assigned the same sex upon recapture , but even neonates (25 mm) were sexed fairly consistently (73%). Although neonates are the most challenging to sex because of their small size, hemipenes are still visible in many males (Fig. 1C).

As a preliminary test of the applicability of this sexing method for other lizard species, we illuminated tail bases in lizards from four additional species: two iguanians (*Uta stansburiana*, N = 15 females and 15 males; *Anolis wattsi*, N = 3 females and 4 males) and two gekkonids (*Hemidactylus mabouia*, N = 3 females and 2 males; *Tarentola delalandii*, N = 2 females and 2 males). Sexes were secondarily verified via external morphological characters (spurs, coloration, postcloacal scales) where applicable. Females in these species had a tail-base morphology similar to female *X.*

TABLE 1. Repeatability of sexing for *Xantusia vigilis* as a function of body size over a three-year study. SVL is size at first capture.

SVL (mm)	Approximate age (years)*	N recaptured	N (proportion) sexed identically
25	0	30	22 (0.73)
26–32	1	4	3 (0.75)
33–37	2	15	13 (0.86)
38–41	3–4	34	34 (1.00)
42–45	5–7	51	51 (1.00)
45	8+	22	22 (1.00)
TOTAL		156	145 (0.93)

* After Zweifel and Lowe (1966)

vigilis (Fig. 1A), within which no subcutaneous structures were visible (female *A. wattsi*, Fig. 1D; female *H. mabouia*, Fig. 1G; female *U. stansburiana* and *T. delalandii* not shown). Hemipenes in the males were clearly visible, although hemipenal morphology varied among species (Fig. 1E, F, H, I).

The strengths of this technique lie in the ability of researchers to sex individuals with high accuracy, at low cost, with little time investment, and with minimal contact with the lizard. The single discrepancy between the authors in sexing an adult *X. vigilis* and the increased difficulty in sexing neonates show that it takes practice to master the technique, but even investigators with little experience can sex lizards with high accuracy.

The successful use of this technique on species other than *X. vigilis* suggests that it may be widely applicable. Because dense melanin or extremely thick tissue may impede the passage of light through the tail, ideal candidates for use with this technique include other small, moderately pigmented lizards or small snakes (e.g., *Leptotyphlops* sp.), as well as juveniles of other squamate species. We encourage using this method in conjunction with other sexing techniques (e.g., scale or pore morphology, differences in dorsal pattern) on species with subtle dimorphism.

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An Efficient Method for Skeletochronology

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Within the last three decades, techniques for age determination in amphibians of the temperate zone have converged on a most accurate predictor of age, i.e., skeletochronology, in which lines of arrested growth (LAG) are counted in bone tissues (Halliday and Verrell 1988). In skeletochronological approaches, one LAG corresponds to one annual period of arrested growth, i.e., hibernation or winter-dormancy (Francillon-Vieillot et al. 1990). Most of these approaches have been conducted using femurs (hindlimbs), humeri (forelimbs), and/or phalanges (toes) of individuals which were captured, killed, dissected, and fixed during the aquatic phase of the breeding season (Alcobendas and Castanet 2000; Caetano and Leclair 1996; Diaz-Paniagua and Mateo 1999; Forester and Lykens 1991; Marunouchi et al. 2000; Misawa and Matsui 1999; Verrell and Francillon 1986) or during the larval stage (Bruce and Castanet 2006).

Although toes clipped for capture-mark-recapture (CMR) studies had previously been discarded (e.g., Huheey and Brandon 1973; Hurlbert 1969; Kusano 1982), for skeletochronological approaches, a few studies have exploited phalanges of the toes clipped from live individuals captured during the terrestrial phase of the breeding and nonbreeding seasons (Diaz-Paniagua et al. 1996; M. Hasumi, unpubl. data). Independent of CMR studies, several recent studies have used toes clipped from live individuals for skeletochronology (Bovero et al. 2003; Ento and Matsui 2002, third toes were clipped besides toes clipped for a CMR study; Kusano et al. 2006; Miaud et al. 2001). When dealing with a great number (occasionally > 500) of small-sized toes or other appendages in many studies of caudate amphibians, it can be difficult to section frozen samples quickly and skillfully with a cryostat (Bruce and Castanet 2006; Diaz-Paniagua and Mateo 1999; Ento and Matsui 2002; Kusano et al. 2006; Miaud et al. 2001; Misawa and Matsui 1999; Verrell and Francillon 1986).

As a more efficient method, we recommend a traditional paraffin-embedding method, but this involves some problematic issues. Muscular tissues, especially the muscle sheath, surrounding phalanges of the toes clipped became brittle during tissue dehydration, and thus while it was possible to section the toe itself, the brittle sections including muscle tissue often separate from glass microscope slides during staining procedures. Hence, the muscle tissue should be removed prior to sectioning phalangeal bone tis-

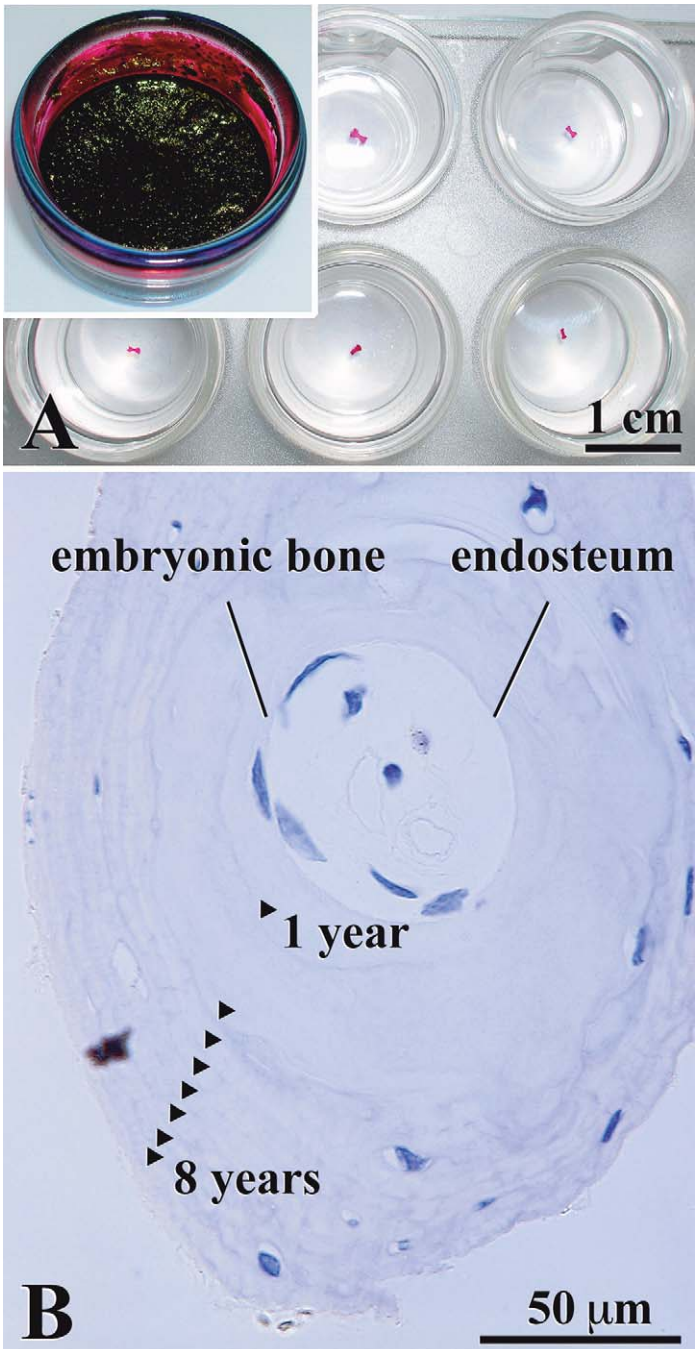


FIG. 1. A) Phalanges colored purple-red with acid fuchsine in the second 100% ethanol during tissue dehydration (note the indissolubility of acid fuchsine in alcohol), and viscous semi-dried acid fuchsine in water (upper left). B) A final product of a phalangeal bone processed using the method described here. Sample from an adult male *Salamandrella keyserlingii* (Kushiro Marsh, Japan) was sectioned transversely at 8 μm. Eight lines of arrested growth (LAG) and dense LAGs outside of a 2-year ring are visible. LAGs reflect yearly hibernation or winter-dormancy of animals in the temperate zone. Endosteal resorption of the innermost LAG (Eden et al. 2007) was not observed. Note the absence of both surrounding muscle tissue and acid fuchsine staining in the final product.

sue. However, if muscle tissue is completely removed, then it becomes difficult to identify and orient the remaining white-colored phalanx within the white-colored paraffin-embedding matrix. To solve these problems, we provide here the following unique method that one of us (MH) has utilized extensively for skeletochronology in hynobiid salamanders. This method involves removal of muscle to enhance adhesion of sections to microscope slides, and reversible staining of bone so that samples can be properly oriented in paraffin blocks.

PROCEDURE

Part I

(1) Fix clipped toes in 10% neutral buffered formalin; store samples from each individual in 1.5 ml microcentrifuge tubes. Neutral buffered formalin (10%) is recommended as the best fixative of bone tissue (Lillie 1976).

(2) Remove surrounding muscle tissues under a stereoscopic microscope after immersing samples in 2–4% potassium hydroxide (KOH) solution for 24 h or more.

(3) Decalcify phalangeal bones in 5% formic acid (HCOOH) solution or 5% nitric acid (HNO_3) solution for 1 h or more.

(4) Neutralize and stabilize phalanges in 5% sodium sulfate (Na_2SO_4) solution for 1 h or more to recover stainability.

(5) Preserve phalanges in 70% ethanol. Samples can be stored at this stage for long periods of time (more than 2–3 years).

Part II

(1) Dehydrate phalanges through a graded series of ethanols (70–100%) followed by xylenes for paraffin infiltration and embedding. Stain each phalanx purple-red with acid fuchsine (semi-dried, dissolved in water) between immersions in the 95% ethanol and the first 100% ethanol during tissue dehydration (Fig. 1A). A thick, viscous solution of semi-dried acid fuchsine will stain the entire phalanx.

(2) Embed dehydrated tissues in paraffin (Paraplast: Sherwood Medical Co., St. Louis, Missouri, USA).

(3) Section tissues transversely at 8–16 μm using a rotary microtome.

(4) Stain sections with Carazzi's hematoxylin, or use the Jordet J-322 Dip-Quick Stains (Rossell and Sheehan 1998) as an alternative to Carazzi's hematoxylin.

One of us (YGW) originally colored the very tiny neonatal pituitary of rats with acid fuchsine for determining orientation of sagittal-sections of the pituitary, but did not describe this method in any journal. MH applied this method to the identification of white-colored phalanges in white-colored paraffin, as a more efficient method for skeletochronology (e.g., in 558 individuals of *Salamandrella keyserlingii* inhabiting Kushiro Marsh, Japan: M. Hasumi, unpubl. data). Acid fuchsine was soluble in water but insoluble in alcohol, and therefore it was retained through final dehydration and paraffin embedding, but washed out during subsequent procedures in which water was used, and thus did not hinder final staining of bone (Fig. 1B).

This procedure is a rapid and efficient method for accurate processing of large numbers of phalangeal samples. It provides visible bone that is easy to orient in paraffin, sections that adhere well to glass microscope slides, and a staining method that clearly distinguishes lines of arrested growth in bone.

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Experimental Analysis of RFID Antennas for Use in Herpetological Studies Using PIT Tagged Salamanders (*Ambystoma tigrinum*)

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The study of life history, growth and population dynamics is critical in the development of comprehensive management strategies for amphibian populations. Typical methods include capturing and marking individuals and studies of an individual's growth and movement. Traditional amphibian marking has been some combination of toe clipping. Toe clipping is a good way to mark individual specimens but many species can regenerate toes within one season (Ott and Scott 1999). Additionally, toe clips can sometimes be confounded by individuals who have lost toes to accident or predation. Tracking movements has been accomplished by use of radio telemetry, but this technique is costly and time consuming (French et al. 1992; Oldham and Swan 1992; Madison and Ferrand 1998' Werner 1991). Currently, there are few studies focused on expanding the use of Radio Frequency Identification (RFID) antennas to track individuals buried in the soil. There is no single method that accomplishes individual marking and individual tracking with efficiency and economy (Ferner 1979).

One alternative is the use of Passive Integrated Transponder (PIT) tags and PIT tag antennas to mark and track individuals. Use of PIT tags and Radio Frequency Identification (RFID) antennas allow positive identification of individual animals over the life of the individual (Brown 1997). Many studies have used PIT tags for the assessment of movement, growth and population parameters (Eggert 2002; Matthews 2003; Richter and Seigel 2002). The use of PIT tags has several advantages in long term studies: PIT tags have high rates of retention if implanted properly; they have a low rate of mortality due to implantation; they can be functional for 10 to 20 years (greater than the lifespan for many salamanders); and they positively identify individuals (Kuhnz 2000; Matthews 2003; Pyke 2005).

Kuhnz (2000b) used PIT tags and RFID technology to track legless lizards in loose sandy soils at short distances. Several pertinent findings were presented including the following:

1) RFID antennas can detect PIT tags through sand, duff covered sand and wet sand to a distance of 12.0 cm.

2) RFID antennas can help to detect organisms in heavy vegetative cover.

3) Organisms can be located at short distances without disturbance using RFID antennas.

Kuhnz reported a minimum and a maximum detection distance for the unique circumstances involving legless lizards.

Ambystomatid salamanders spend much of their existence in the terrestrial environment in shallow tunnels either developed by

rodents or excavated on their own (Smith 2003). Because of this fossorial lifestyle, information on non-breeding habitat use and migration is incomplete. We evaluated the application of RFID antennas and PIT tags for tracking ambystomatid salamanders in their burrows. We tested the hypothesis that different antennas (described in methods) would have different detection distances (DD) and would perform differently when individuals were located at different depths within the soil. This experiment mimicked what we might expect to see in implementing RFID use in the field.

Our study uses the methodology of Kuhnz (2000b) but differs in the following ways:

1) We studied detection distances for two types of RFID antenna utilizing implanted salamanders in an open air treatment (control) and at different depths buried in soil in a 40 gallon Rubbermaid container.

2) We report maximal DD for both antenna types and describe their detection range and percent effectiveness in all experimental conditions.

3) We determined if the RFID tracking technique would be applicable in denser soils, which might block the antenna's ability to pick up the tag more than loose sandy soil.

TABLE 1. ANOVA table of mean detection distances and arcsine transformed % effectiveness of experimental RFID antennas.

Mean detection distances				
Source	df	Mean Square	F	Sig.
Depth	4	1.438E-02	1.322	.277
Antenna	1	6.928E-03	.637	.429
Depth X Antenna	4	1.962E-02	1.804	.145
Error	44	1.087E-02		

Arcsine transformed % effectiveness				
Source	df	Mean Square	F	Sig.
Depth	4	15858.490	29.354	<.001
Antenna	1	2732.295	5.057	.028
Depth X Antenna	4	932.436	1.726	.156
Error	60	540.251		

Methods and Materials.—PIT tags were implanted in seven, laboratory-housed *Ambystoma tigrinum* salamanders according to protocols outlined by Ott and Scott (1999). These individuals are also validation specimens for an ongoing drift-fence study where salamanders are tagged in the field in a similar fashion.

Methods were modified from Kuhnz (2000b). Antennas tested in our study were the Destron 2001 F-ISO Circular antenna and the Biomark Triangular Field antenna using attenuation box antn-04. Antennas were supplied on loan for the experiment from Biomark, Inc. Both antennas tested are slightly different in design and application from the Avid Power Tracker II used by Kuhnz (2000). The Power Tracker II was designed as a handheld device with limited DD. The Biomark circular antenna is designed as a handheld but was designed with a greater DD. Additionally, the triangular antenna is reported to have a greater DD range and is designed for use with a handle at different distances. Our study was designed to determine the maximum DD in typical soil found in North Dakota. Soil used in the study was obtained from a local source and was classified as clay loam (NRCS, 2002).

To develop a comparable measure of antenna performance we use the term detection distance (DD), which is defined as the distance between the antenna and the PIT tag at which a read response (detection) is initiated. In this study DD was determined by progressively lowering the antennas from a height of 30 cm in a leveled, straight line above the specimen until the tag was identified or until the surface of the soil was reached. Two parameters were recorded: tag detection (positive or negative) and DD (in the case of a positive detection). For many of the trails the tag was detected well in advance of the antenna reaching the soil level. Thus a soil depth of 13.2 cm might have a DD greater than 13.2.

PIT implanted salamanders were placed in a cloth bag to limit movement and then covered with differing levels of soil. The DD was recorded for each trial with every salamander tested five times for each of the different antennas within each experimental condition. This allowed for a total of 175 tests of detection and DD per antenna (350 detection attempts).

Antennas were analyzed for detection and DD using differing levels of soil coverage as experimental conditions. The following amounts of soil were used as mimics of soil depth in field conditions; 0 cm, 2.2 cm, 6.6 cm, 13.2 cm, and 15.4 cm of loose soil. Data were log-transformed for DD, arcsine transformed for % effectiveness, and analyzed with separate two-factor ANOVAs. Factors were antenna type and depth of soil covering salamander. Additionally, to avoid pseudoreplication only the mean values of each salamander were used for running the ANOVAs. In all hypothesis tests, α was set at 0.05. Where appropriate, significant hypothesis tests were followed by post hoc analysis with the least significant difference (LSD) test.

Results.—No significant differences in DD were observed between antenna types, or among soil depth profiles (Table 1). However, significant differences were observed when the % effectiveness was analyzed (Table 1). The circular antenna read at a greater distance in all treatments except the treatment without soil (Table 2).

There was a progressive loss of effectiveness in both antennas at increases in soil depth beyond 6.6 cm, at 13.2 cm and 15.4 cm the circular antenna showed less of a loss in effectiveness than the triangular antenna (Table 2).

Both antennas recorded at least one detection in each of the experimental conditions. There was a maximal DD for each of the antennas in all treatments (Table 2). The loss in effectiveness for the triangular antenna at 15.4 cm was 10 times greater than the loss for the circular antenna (Table 2).

Discussion.—Our study results support the use of PIT tags and RFID antenna to track and locate ambystomatid salamanders in fossorial burrows and in the terrestrial and aquatic environment. Both antennas tested could locate pit tagged salamanders in the loosely packed soil used during the tests. Additionally, both antennas could detect tags that were implanted in salamanders in soil of at least 15.4 cm; this condition approximates real field conditions. Of importance to researchers is the fact that this range of

detection is well within the burrow resting depth profile (Smith 2003). It is also important to note here that adult *A. tigrinum* have been found to excavate their own burrows or to utilize small mammal burrows within the effective range of both of these antennas but may also be found at greater depths which would be outside of the range of the antennas tested (Semlitsch 1983). This may be of importance for the researcher attempting to use antennas to locate individuals; the antennas tested may be more effective at distance detection when the individuals are occupying resting sites closer to the surface such as during breeding or active foraging.

TABLE 2. Percent effectiveness (# of tag detections/number of detection attempts × 100) of antennas in experimental conditions, including Detection Distance Maximums (DDM) for each antenna. For each animal at each depth 5 detection attempts were made, N = 350 (total number of detection attempts).

Treatment	% Effectiveness Circular Antenna	DDM	% Effectiveness Triangular Antenna	DDM
0 cm	100%	21.5 cm	100%	22.5 cm
2.2 cm	100%	26.2 cm	100%	22.2 cm
6.6 cm	100%	25.8 cm	97.1%	24.8 cm
13.2 cm	74.3%	21.8 cm	37.5%	20.8 cm
15.4 cm	28.6%	22.8 cm	2.8%	19.8 cm

The DD for an antenna is influenced by many factors including but not limited to: position of the tag in the individual, chemical component of the medium between the tag and the antenna (air, water, and soil), additional obstacles between tag and antenna (i.e. rocks, metal, landfill debris, other field equipment, or somebody's leg) and the angular relationship between the antenna field and the tag. It was not within the practical scope of this study to test these additional variables yet these are all factors that have a great deal of influence on antenna performance.

The tests that were performed supported the hypothesis that RFID antennas can locate herpetological study specimens at some distance beneath the soil. It follows that this method may also be utilized to track paedomorphic ambystomatids in aquatic habitat if they are within the DD for the antenna.

Both of the antennas tested showed a considerable loss in tag reading performance when the individual was buried in 15.4 cm of soil (Table 2). Each antenna showed an optimal range of performance (between 8 and 18 cm) and a discernable limit to the DD in open air and in soil covered treatments (Table 2). Beyond 6.6 cm the circular antenna was more effective at reading tags (Table 2).

Overall, both antennas showed the ability to read pit tags implanted in salamanders in typical loose packed North Dakota soil at least 15.4 cm deep. From our experiments we have determined the effective detection range for these antennas in our experimental conditions to be anywhere from 8 to 22 cm. Both antennas detected pit tags right at the limit of their reported detection range (Biomark reports a 25.4 cm limit for these antennas).

The valuable discovery for the field herpetologist is that the circular antenna was much more effective compared to the triangular antenna. The current cost of the triangular antenna is three times the cost of the circular antenna (please consult with Biomark for current prices and additional considerations). This type of cost differential is a real consideration for the researcher juggling limited budgets.

As a result of our research, we will be incorporating several aspects of tracking and locating salamanders in the field while utilizing RFID antennas. We will be working on a protocol for randomized and transect oriented surveys for our tagged salamanders in the terrestrial and aquatic environment and we will continue to test some of the other variables affecting antenna effectiveness and DD. Multipurpose use of PIT tags and antennas will allow the herpetologist to optimize the value of the cost of using pit tags in research. Continued research into alternative uses for pit tags will assure that manufacturers incorporate added value in the future development of PIT tag hardware.

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Use of Anesthesia Increases Precision of Snake Length Measurements

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Researchers typically use body length (snout–vent length; SVL) as the principal measure of snake size. Several techniques for determining SVL have been reported (e.g., Blouin-Demers 2003; Fitch 1987; Quinn and Jones 1974). However, numerous researchers have also commented on the imprecision of common methods of measuring snake length (e.g., Blouin-Demers et al. 2002; Fitch 1987; Madsen and Shine 2001; Measey et al. 2003; Taylor et al. 2005). In at least one publication, SVL measurements were considered so imprecise that head length was considered a more consistent measure of snake size than SVL (Houston and Shine 1994). Despite recognition of this problem, until recently, little effort has been made to report the precision of different measurement methods, or to assess sources of variation. Recently, several researchers have quantified measurement error in SVL measurements. However, these studies stopped short of testing factors which influence measurement error (e.g., Bertram and Larsen 2004; Blouin-Demers 2003).

Variation between SVL measurements may be partitioned into three source categories: variation between measurements made by a single measurer using a single technique (e.g., the "intrinsic limitations" of a measuring method; Blouin-Demers 2003),variation between measurements made by different measurers using the same technique, and variation between measurements made using different techniques.

It is likely that the greatest source of variation in SVL measurement results from differences between measurements of stretched and unstretched snakes (Fitch 1987). I consider measurement of unstretched snakes preferable for numerous reasons. 1) snakes spend the majority of their lives in relaxed postures, thus measurement of an unstretched snake is a truer measure of snake length; 2) stretched measurements are positively biased in comparison to measurements of preserved snakes (Fitch 1987; Reed 2001) and indirect measurements (e.g., squeeze box measurements; Bertram and Larsen 2004); 3) large snakes may be difficult to completely stretch, resulting in decreased precision (Fitch 1987; but see Blouin-Demers 2003); 4) snakes may vary in elasticity as well as in behavioral resistance to stretching, biasing interspecies comparisons; 5) stretching venomous snakes poses a danger to measurers; and 6) stretching can injure snakes (Fitch 1949, 1987). For these reasons, I chose to only evaluate methods for measuring unstretched snakes.

Here, I present the results of two separate evaluations of SVL measurement precision. In the first part of this study, I evaluated sources of variation in repeated SVL measurements of a diverse group of snakes. My objective was to quantify the effect of each source of error in SVL measurement, as well as to identify the most precise measurement technique. In the second portion of this study, I quantified the precision, under research conditions, of the most precise of the previously evaluated techniques.

Materials and Methods.—In the first portion of this study, I evaluated repeated SVL measurements of 24 snakes using three snake measurement techniques: squeeze box (Quinn and Jones 1974), conscious-straightened, and anesthetized. To increase the breadth of the statistical population, snakes from seven species (*Charina bottae, Crotalus horridus, C. lepidus, Elaphe emoryi, Lampropeltis pyromelana, L. triangulum,* and *Heterodon nasicus*), four clades (Colubrinae, Crotalinae, Erycinae, and Xenodontinae), and comprising a range of sizes (210–957 mm SVL) were selected. Measurements were recorded based on the following design; two measurers measured each snake three times per technique, resulting in 18 measurements of each snake. All measurements were recorded during a single session. Most measurements were performed independently, and each measurer was unaware of values recorded by the other measurer. However, measurers helped one another restrain venomous snakes during conscious-straightened measurements, and thus may have been aware of the values of these measurements.

In the second portion of this study, I quantified the precision of measurements of 24 anesthetized adult *Crotalus polystictus* recorded under more typical research conditions (i.e., taken by different measurers over a longer time frame while measurers were primarily focused on tasks other than snake measurement). Each snake was measured once by three measurers, totaling three measurements per snake. Snakes were measured as they were captured over a nine-day period. Measurers were instructed on measurement technique the first day, but were not provided subsequent instruction. All measurements were taken independently. However, some measurers were aware of some previously recorded values, possibly influencing subsequent measurements.

During both portions of the study, measurers attempted to measure from the snout to the posterior tip of the anal plate of each snake. For measurements made with a squeeze box, the position of each snake's anal plate was marked on the snake's dorsum using a temporary marker prior to measurement.

To measure snakes with a squeeze-box, snakes were placed within a wooden squeeze box (61 cm × 61 cm) outfitted with a plexiglass lid and lined with a 5 cm thick foamed rubber pad. Snakes were pressed against the pad with enough force to temporarily retard movement while measurers traced the dorsal mid line of the snake from snout to the anal plate mark using a temporary

TABLE 1. Variance components of SVL measurements divided by measurement technique and measurer. Number of measurements recorded from each snake (m), mean SVL, mean within-subject standard deviation (s_w), coefficient of variation (CV), and percent measurement error (ME) of repeated measurements of live snakes. Two measurers ($measurer_1$ and $measurer_2$) each measured 24 snakes three times using each technique, thus N = 24 in all cases.

technique	m	mean SVL (mm)	s_w (mm)	CV	ME
$conscious_1$	3	527	11.2	2.1	0.25
$conscious_2$	3	544	5.7	1.1	0.06
$squeeze_1$	3	494	14.5	2.9	0.45
$squeeze_2$	3	505	12.5	2.5	0.31
$anesthesia_1$	3	541	4.3	0.8	0.03
$anesthesia_2$	3	531	1.9	0.4	0.01
$conscious_{1+2}$	6	535	16.7	3.1	0.52
$squeeze_{1+2}$	6	500	16.4	3.3	0.55
$anesthesia_{1+2}$	6	536	8.0	1.5	0.11
total	18	524	24.7	4.7	1.16

marker. Measurers then draped a cotton cord along this line and measured the resulting length of cord along a flexible steel measuring tape. Snakes were allowed to move freely within the squeeze-box between measurements.

To measure snakes using the straightened-conscious technique, snakes were laid alongside a flexible steel measuring tape placed atop a table. Because substantial measurement variation can occur due the degree a snake is stretched, measurers attempted to straighten each snake without stretching it. Larger, more powerful, snakes that could not be straightened without stretching were measured piecemeal, with consecutive portions of the body straightened along the measuring tape. Venomous snakes were measured while an assistant restrained the head and 2-5 cm of the body inside a tightly fitting plastic tube while the measurer straightened the remainder of the body along the tape. Snakes were allowed to rest and re-coil briefly between measurements.

To measure snakes using the anesthesia method, snakes were anesthetized to the point that they lost all muscular rigidity using isoflurane gas (Blouin-Demers 2003; Blouin-Demers et al. 2000). Although the goal was to measure completely relaxed snakes, some snakes regained slight muscular control and rigidity before all measurements were recorded. Each snake was placed on its side and gently straightened along a flexible steel measuring tape resting atop a table. To avoid stretching, snakes were straightened by running a thumb or other finger along the ventral scales of the snake while simultaneously applying slight pressure to the corresponding portion of the snake's dorsum. Snakes were manually coiled then restraightened between measurements.

Snakes were anesthetized within plastic snakes tubes. I administered isoflurane using a variation on Blouin-Demers et al.'s open method (2000). Administered dosages ranged between 1.44 ml/l and 1.62 ml/l (1 and 2 ml of isoflurane in 0.70 and 1.24 l tubes). Isoflurane was injected into a cotton ball placed at the bottom of a glass vial, then topped with a second, dry, cotton ball and placed in the tube with each snake. Tubes were closed with rubber stoppers, but were not airtight. Because evaporation of isoflurane was slowed by the cotton and by the glass vial, and because tubes were not airtight, the dose of isoflurane delivered was undoubtedly lower than the administered dose. Time until complete muscle relaxation varied greatly among species. In general, crotaline snakes reached anesthesia rapidly, while colubrine snakes took longer.

I calculated variance components of the dataset from the first part of this study using a one-way ANOVA with SVL as the dependent variable and individual snakes as the independent variable (Bland and Altman 1996). Variance was partitioned into among-subject (s^2_A) and within-subject (s^2_W) components (Bailey and Byrnes 1990). I calculated measurement errors (ME), a relative metric describing the percentage of variation attributable to measurement error, and coefficients of variation (CV), a relative metric describing the within-subject standard deviation (s_W) as a percentage of the mean SVL.

To explicitly evaluate the contribution of measurement technique, measurer, and snake clade on measurement precision I evaluated variation between standard deviations of the measurements of each snake with a mixed-model ANOVA with individual snake as a random effect and measurement technique, measurer, and snake clade as fixed effects. Interactions between technique and measurer and technique and clade were included in the model. Snake length was not included as a factor because values of standard deviations can be expected to correlate with values of SVL; however snake size may influence the relative precision of SVL measurements (Blouin-Demers 2003).

To quantify the precision of measurements recorded in the second portion of this study, I partitioned variance components of these data with a one-way ANOVA and calculated ME and CV to describe measurement precision.

All statistical tests were performed with SAS 9.1 (SAS Institute Inc. 2004).

Results.—Measurements of snakes taken using the squeeze-box method were the least precise, while those taken under anesthesia were the most precise (Table 1). Precision decreased when measurements from two observers were combined, irrespective of measurement technique. Precision was poorest when measurements from different techniques and measurers were combined (Table 1). Measurements recorded using the squeeze-box technique were negatively biased in comparison with measurements recorded using anesthetized and conscious-straightened techniques, which shared similar mean values (Table 1).

Measurement precision was most strongly impacted by measurement technique (Table 2). One measurer was consistently more precise than the other measurer (Table 1), resulting in a measurer effect (Table 2). Neither clade, nor any interactions, contributed to measurement precision (Table 2).

Measurements of anesthetized snakes under research conditions were highly precise, despite measurements being taken by multiple measurers (mean SVL = 589 mm; s_w = 1.7 mm; CV = 0.3%; ME = 0.05%). The most disparate measurements of any individual snake were 586, 591, and 595 mm, a span of 9 mm. All three measurements of two snakes agreed exactly. The mean span between a snake's three measurements was 2.6 mm.

Discussion.—The most important source of variation in precision was measurement technique. A smaller effect on precision was due to differences between measurers. Although measurements recorded by each measurer using a single technique were rela-

TABLE 2. Results from a mixed model ANOVA of standard deviations (mm) from 3 SVL measurements per snake per technique per measurer of 24 live snakes. Individual snakes were treated as a random effect, and sources were treated as fixed effects.

source	numerator df	denominator df	F	P
technique (t)	2	109	16.32	< 0.0001
measurer (m)	1	109	5.14	0.025
clade	3	20	0.96	0.433
t x m	2	109	0.61	0.545
t x clade	6	109	1.19	0.315

tively precise, precision diminished when measurements taken by different measurers using different techniques were combined. Precision can be optimized by relying on a single measurer using a single technique. For this reason, caution should be exercised when combining data taken by different measurers using different techniques. This is particularly true when some techniques may exhibit not only substantial measurement error, but also bias (e.g., measurements of stretched snakes and measurements taken using squeeze boxes; Bertram and Larsen 2004; Blouin-Demers 2003; Fitch 1987; this study). Particular care should be exercised with measurements collected using a squeeze box. Bertram and Larsen (2004) reported a substantial negative bias of squeeze box measurements in comparison to measurements of stretched snakes. Results from this study indicate a similar bias exists even when snakes are not stretched.

Surprisingly, neither clade nor the clade by method interaction influenced measurement precision. Measurers subjectively considered muscular, constricting snakes such as *Elaphe* and *Lampropeltis* more difficult to control, and hence to measure. However, this difficulty did not produce less precise measurements. Similarly, Blouin-Demers (2003) had hypothesized that measurements of conscious large *Elaphe obsoleta* would be less precise than measurements of small conspecifics due to the difficulty of controlling larger snakes, but demonstrated an opposite effect.

Additional testing of measurements of anesthetized snakes taken under more typical research conditions indicated that multiple measurers can record highly precise measurements when provided with brief instructions on measurement technique. Imprecision (expressed as CV) was less than one percent of the mean body size of adult *C. polystictus*, a level of imprecision unlikely to impact conclusions of most studies.

Based on the results of this study, I advocate that snakes be measured while anesthetized when this option is feasible. In addition to high precision, measurements of unstretched, anesthetized snakes can be assumed to be less likely to display a bias in comparisons with measurements of preserved snakes than measurements taken using other techniques (based on Reed 2001; Fitch 1987). Use of anesthesia also eliminates the need to forcefully handle snakes, reducing the likelihood of injuries to snakes and the risk of bites from venomous snakes. Finally, increased standardization of measurement technique would facilitate comparisons among studies.

Use of anesthesia has four principal drawbacks. Foremost is the potential for snake death (Blouin-Demers et al. 2000). In studies involving sensitive taxa and/or small populations, the precision of measurements necessary to achieve research goals should be carefully balanced against potential mortality. Second, use of anesthesia is time consuming and may be impractical in studies where large numbers of snakes need be measured quickly. Third, although isoflurane has been widely used in mammals, the effects of isoflurane on snakes are less studied. Therefore, currently unreported deleterious side effects may exist. Side effects may be more likely with repeated exposure to anesthesia, such as may occur in growth studies. Finally, the use of anesthesia adds to research costs (ca. US $13 for 100 ml of isoflurane).

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Un-Weathered (New) Artificial Cover Objects Effectively Sample Plethodontid Salamanders in Michigan

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Many plethodontid species are small salamanders with restricted home ranges and are sensitive to natural and human disturbances, making them potential indicators of environmental health and biodiversity (Caro and O'Doherty 1999; Welsh and Droege 2001). Since the 1990s, many studies have documented population declines in amphibians, including salamanders, stressing the need for appropriate population monitoring techniques (Blaustein and Dobson 2006; Blaustein et al. 1994; Kohler et al. 2005; Pechmann et al. 1991; Pounds et al. 2006; Young et al. 2004). One such method for monitoring terrestrial salamander populations is the use of Artificial Cover Objects (ACOs).

ACOs cause little disturbance to the environment and require less time, effort and maintenance compared with other monitoring techniques. The repeatability of studies using ACOs and the ability to standardize this technique using number and area of cover objects also makes this method useful (Grant et al. 1992). The Terrestrial Salamander Monitoring Program (TSMP), established in the mid 1990s, recommends ACOs for monitoring terrestrial salamander populations (Droege 1997). Several studies have attempted to determine the most appropriate way to set up ACOs; however, very few ACO investigations have been done in the Midwestern United States and some specifics of the method are still debated in the literature (Bonin and Bachand 1997; Carfioli et al. 2000; Davis 1997; DeGraaf and Yamasaki 1992; Hyde and Simons 2001; Marsh and Goicochea 2003; Monti et al. 2000; Moore 2005). The TSMP protocol suggests that boards should be placed on bare, leveled soil and weathered for a year before any data are collected (Droege 1997). However, this protocol delays data collection, a potential problem in necessarily short-term surveys. To alleviate this problem, Bonin and Bachand (1997) suggested placing boards on existing wet leaf litter to accelerate the weathering process and reduce the time needed before data can be collected.

The goals of our study were 1) to investigate effectiveness of ACOs to sample terrestrial salamanders in Michigan, 2) to investigate use of aged boards versus new boards and 3) to provide baseline data for *Desmognathus fuscus*, a newly documented species in Michigan (Carlson and Szuch 2005).

In 2004, we set up ACOs at Kresge Environmental Education Center (KEEC) at Fish Lake in Lapeer County, Michigan. KEEC is owned by Eastern Michigan University and consists of 240 acres surrounded mostly by state land. The property consists of one large lake, several small lakes, a tamarack bog, mixed hardwood forests and many kettle ponds. We set up ACOs around a kettle pond surrounded by mostly deciduous forest to determine if there was a preference for aged boards placed on bare, leveled soil or new boards placed on existing wet leaf litter. ACOs consisted of CDX pine plywood (1.9 cm thick) cut to 121.9 × 61.0 cm. Size and design of boards were determined during a preliminary study in 2003 that tested four ACO designs of Carfioli et al. (2000). Aged boards were weathered for a year while new boards were weathered for only two weeks. All boards were placed in the field at the same time to eliminate bias. New boards were placed directly on existing leaf litter with no modification to the ground. Aged boards were placed on the ground after it had been cleared of leaf litter and leveled. Twenty-three pairs of boards were placed equidistantly around the pond approximately 10–12 m apart. Each pair consisted of one aged board and one new board. Within each pair, one board was placed near the pond's edge and the other board was placed 6–8 m upslope from the pond's edge. The location of board type relative to the pond, near or far, was alternated around the pond. ACOs were held in place with aluminum tent stakes and left in the field for two weeks before collecting data. Boards were checked biweekly from 28 April to 12 November 2004. Salamanders found beneath boards were identified to species, measured (SVL) and released at edge of boards.

During the 2004 field season, we observed 154 salamanders: 130 *Plethodon cinereus*, 17 *Ambystoma laterale*, 4 *Notophthalmus viridescens*, and 3 *Ambystoma maculatum*. Only data for *P. cinereus* were further analyzed. Without regard to season, *P. cinereus* were encountered under aged boards placed on bare, leveled soil significantly more than under new boards placed on existing topography and leaf litter (χ^2 = 20.320, df = 1, $p < 0.05$; Fig. 1). *P. cinereus* were encountered under boards that were upslope or farther from the pond's edge significantly more compared to boards that were down slope or closer to the pond's edge (χ^2 = 15.820, df = 1, $p < 0.05$); however, no association was found between number of encounters and age and location of board (χ^2 = 3.380, df = 1, $p > 0.05$).

Salamanders were most active in spring (28 April – 8 June 2004) and fall (3 September – 29 October 2004), with fall being the season of greatest activity (Fig. 1). In spring there was no significant difference in use of board type (χ^2 = 0.267, df = 1, $p > 0.05$) and in fall, aged boards placed on bare, leveled soil were used more than new boards placed on existing topography and leaf litter (χ^2 = 21.943, df = 1, $p < 0.05$). Boards that were placed upslope or farther from the pond's edge were used more in both spring and fall seasons (spring, χ^2 = 6.667, df = 1, $p < 0.05$; fall, χ^2 = 7.467, df = 1, $p < 0.05$). That *P. cinereus* were encountered more frequently under boards placed upslope or away from the pond's edge is not surprising since it has no aquatic larval stage and is not dependent on vernal or permanent ponds for breeding. *Plethodon cinereus* is often found farther from water than other terrestrial salamanders and avoids areas prone to flooding (Harding 1997; Petranka 1998).

That *P. cinereus* preferred aged boards placed on bare, leveled soil to new boards placed on existing topography and leaf litter corroborates TSMP recommendations; however, if age was the primary factor affecting board use, we would expect little or no use of new boards and significantly more use of aged boards in spring. We would also expect a more equitable use of aged and new boards in fall when both board types would be weathered. Our results suggest just the opposite. There is equal use of aged

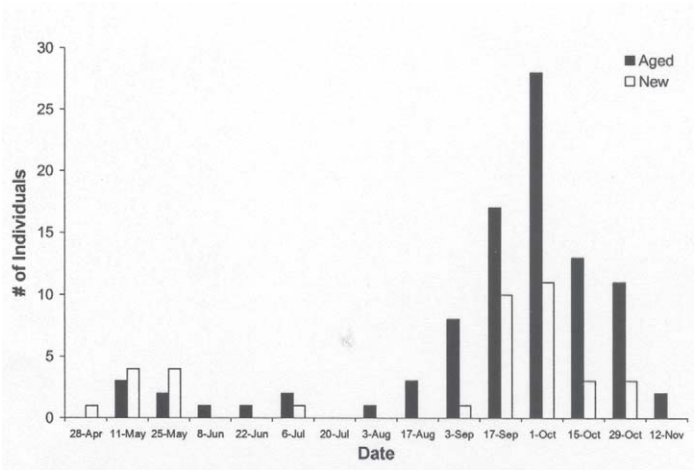


FIG. 1. Number of *Plethodon cinereus* observed beneath aged (weathered) boards placed on bare, leveled soil and new (un-weathered) boards placed on existing topography and leaf litter at Kresge Environmental Education Center, Lapeer County, Michigan in 2004.

and new boards in spring and a preference for aged boards in fall. This led us to speculate that something other than age was determining board use. In spring when conditions are typically cool and humid, both board types may offer suitable conditions for salamanders; however, in fall when conditions are typically warmer and drier, boards placed on bare, leveled soil may create a cooler, more humid micro-environment compared to new boards placed on unleveled ground with existing leaf litter.

In 2006, we tested our hypothesis that there was no significant difference in use of aged or new boards when both were placed on bare, leveled soil. Because of the recently discovered population of *Desmognathus fuscus* in Michigan (Carlson and Szuch 2005), we changed our research location to Murphy Lake State Game Area (MLSGA) in Tuscola County, Michigan. MLSGA is composed of 2645 acres surrounded mostly by agricultural land. Our study site was located in a Hemlock-Northern Hardwoods Forest

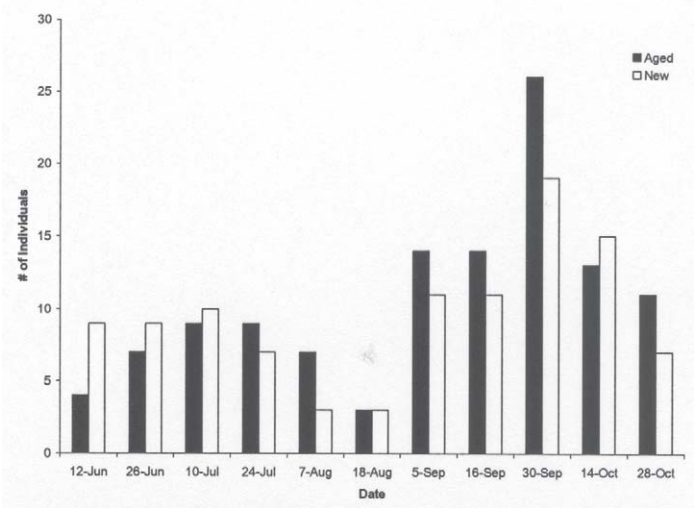


FIG. 2. Number of *Plethodon cinereus* observed beneath aged (weathered) and new (un-weathered) boards placed on bare, leveled soil at Murphy Lake State Game Area, Tuscola County, Michigan in 2006.

(Barnes and Wagner 2004) near the northern boundary of the game area. CDX pine plywood (1.9 cm thick) was cut to 30.5 × 61.0 cm. Smaller ACOs were used to better resemble downed woody debris. Boards were placed in pairs containing one aged board and one new board approximately 15 cm apart and each pair of boards was placed approximately 6 m apart. Aged boards were weathered for 2–3 years and new boards were weathered for only two weeks. All boards were placed in the field at the same time to eliminate bias. The site for each board was cleared of leaf litter and leveled before placing the board on the ground. Aluminum tent stakes were used to keep boards in place.

Within the forest community, three adjacent terrestrial sub-habitats were studied: 1) edge of a kettle pond, 2) within the forest proper and 3) along a stream. Thirty pairs of boards were used to sample the three sub-habitats with 10 sites in each sub-habitat. At the pond, half of the sites were placed 2 m from the pond's edge and the other half were placed directly along the pond's edge. In the forest proper, half of the sites were placed along a ridge, while the other half were placed either upslope or down slope relative to the ridge. Along the stream, each pair of boards was placed flush with the edge of the stream bank. Boards were checked biweekly from 12 June to 28 October 2006. Salamanders found beneath boards were identified to species, measured (SVL) and released at edge of boards.

During the 2006 field season, we observed 352 salamanders: 221 *Plethodon cinereus*, 116 *Desmognathus fuscus*, 6 *Hemidactylium scutatum*, 6 *Ambystomaa maculatum*, and 3 *A. laterale*. Only data for *P. cinereus* and *D. fuscus* were further analyzed. *P. cinereus* was found in all three sub-habitats: 81 individuals at the pond, 125 individuals in the forest proper and only 15 individuals along the stream. *D. fuscus* was only found along the stream.

Considering all three sub-habitats, we found no significant difference in number of encounters of *P. cinereus* between aged or new boards ($\chi^2 = 0.652$, df = 1, $p > 0.05$, Fig. 2). We also failed to detect a significant difference in encounters between aged or new boards in the pond, forest or stream sub-habitats (pond, $\chi^2 = 0.049$, df = 1, $p > 0.05$; forest, $\chi^2 = 1.512$, df = 1, $p > 0.05$; stream, $\chi^2 = 0.000$, df = 1, $p > 0.05$). There was also no difference in mean SVL of *P. cinereus* found under aged or new boards (Mean SVL $_{new} = 35.516 \pm 0.695$ mm, Mean SVL $_{aged} = 37.182 \pm 0.552$ mm, t = 1.973, df = 184, $p > 0.05$).

For *D. fuscus*, we detected no significant difference between encounters under aged boards versus new boards ($\chi^2 = 1.043$, df = 1, $p > 0.05$, Fig. 3); however, mean SVL of individuals found beneath aged boards was greater than mean SVL of individuals found beneath new boards (Mean SVL $_{new} = 31.196 \pm 1.453$ mm, Mean SVL $_{aged} = 35.403 \pm 1.305$ mm, t = 1.983, df = 103, $p < 0.05$). No gilled larvae were observed beneath boards, but juveniles as small as 14.7 mm SVL and adults as large as 55.9 mm SVL were observed (Fig. 4).

ACOs are an effective sampling technique for monitoring some species of terrestrial salamanders in Michigan. Six species were found beneath boards during both field seasons; however, only two species were found in quantities large enough for statistical analysis. Ambystomatid salamanders are terrestrial as juveniles and adults but often spend the majority of their lives underground. This behavior may explain why ambystomatids were found in low

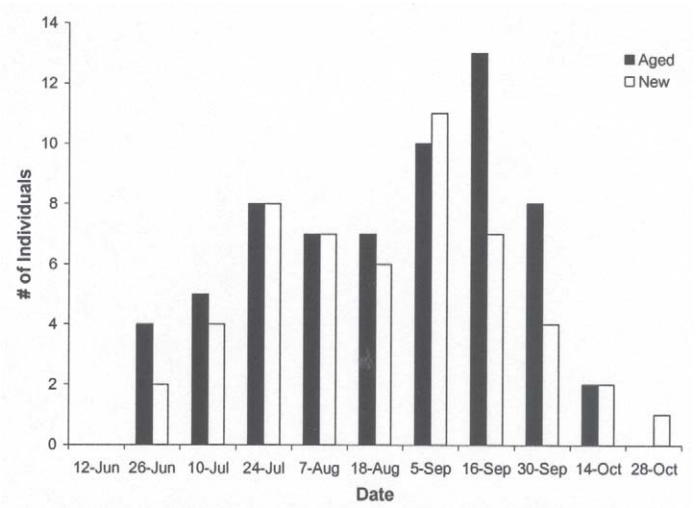


Fig. 3. Number of *Desmognathus fuscus* observed beneath aged (weathered) and new (un-weathered) boards placed on bare, leveled soil at Murphy Lake State Game Area, Tuscola County, Michigan in 2006.

numbers in our study as well as in studies by Bonin and Bachand (1997) and Grant et al. (1992). *Notophthalmus viridescens* is primarily terrestrial as a juvenile (eft) and often disperses away from its natal pond during this life-history stage.

The other three species found beneath boards are all terrestrial salamanders that we would expect to find in large numbers beneath ACOs. For two of these species, *P. cinereus* and *D. fuscus*, that was the case in our study. This corroborates findings of Stewart and Bellis (1970) and Carfioli et al. (2000). We are unsure why *H. scutatum* was found in low numbers but speculate that it is either because they have low population sizes at our study sites or that microhabitat conditions beneath boards were not ideal for this species.

Finding large numbers of *P. cinereus* during both the 2004 and 2006 field seasons was not surprising considering how common this species is throughout the Midwest. It can reach densities as high as 500-9000 per hectare in some parts of its range (Harding 1997; Heatwole 1962). *Desmognathus fuscus* was not documented

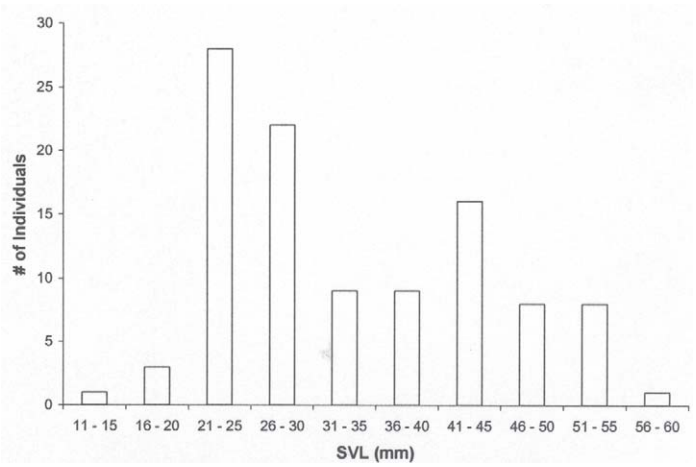


Fig. 4. Number of *Desmognathus fuscus* observed in SVL categories at Murphy Lake State Game Area, Tuscola County, Michigan in 2006.

in the state of Michigan until fall 2004 (Carlson and Szuch 2005). An unpublished study by Carlson and Szuch demonstrated that *D. fuscus* in Michigan could be sampled with ACOs placed either in the stream channel or on the stream bank, but not on boards placed 2 m from the stream. Finding such large numbers of *D. fuscus* at MLSGA suggests that the population is well-established and the range of SVLs observed suggests that reproduction is occurring.

In 2006, we tested the hypothesis that age of boards was not the factor affecting board use by terrestrial salamanders and found that when aged and new boards were both placed on bare, leveled soil, there was no difference in encounters between board types. This was observed in both *P. cinereus* and *D. fuscus*. Additionally, we found no difference in mean SVL for *P. cinereus* beneath aged or new boards; however, mean SVL of *D. fuscus* was larger under aged boards. These results suggest that the need to weather boards may be dependent on location, species and goals of the investigation. We found that in Michigan weathering boards is not always needed if the goals of the study are to determine species presence/absence and estimates of abundance; however, if the goal is to determine population age structure, boards may need to be weathered or a variety of board types may need to be used. For *P. cinereus*, weathering does not appear to be needed for studies in Michigan; however, in the case of *D. fuscus*, weathering boards may allow larger individuals to be sampled. Overall, we found that monitoring terrestrial salamander populations with ACOs in Michigan works well for *P. cinereus* and *D. fuscus*; however, further studies may find ACOs useful for other species.

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Comparison of Two Techniques for Capturing Geckos in Rocky Habitat

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Wildlife populations world-wide are threatened by habitat loss associated with human activities. One such activity is the extraction of rock for use in building and landscaping (Webb and Shine 2000). Quarrying practices may include the use of explosives and heavy machinery, both of which can cause mortality in wildlife. The problem is further exacerbated for nocturnal rock-dwelling reptiles because they may be difficult to detect, capture or translocate due to the inaccessibility of the habitat, complications of working at night, and/or a lack of effective capture methods. Although some authors have questioned the merits of translocation (e.g., Dodd and Siegel 1991; Reinert 1991), it may be the only means of preventing certain deaths in resident wildlife at sites where approval for rock extraction has been granted.

Here, I compared the sampling effectiveness of two methods for capturing terrestrial geckos (*Hoplodactylus maculatus*) from a basalt rock outcrop in New Zealand. *Hoplodactylus maculatus* is a primarily nocturnal species that uses postural adjustments to thermoregulate by day within retreat sites (Rock et al. 2002). Although *H. maculatus* is considered to be a cryptic species complex (Daugherty et al. 1994), I have used the term *H. maculatus* here pending formal description of the members of the species complex. The 'Canterbury' form encountered in this study is regarded as a distinct and threatened species by the New Zealand Department of Conservation (DOC; Hitchmough et al. 2007).

The basalt was nominated for extraction by NZ Quarry Managers Ltd., prompting capture and translocation of geckos in the year preceding rock extraction in accordance with conditions stipulated by DOC (Bruce Arnold, Department of Conservation, Christchurch, New Zealand, pers. comm.). The two capture methods used were searches of natural cover and artificial retreats (i.e., artificial cover objects or coverboards). Other methods could not be used because the steep, rocky terrain did not allow for the use of pitfall traps, and locating and capturing emerged animals at night by spotlight (Whitaker 1967) was considered too risky.

Artificial retreats have previously been used to sample a range of herpetofauna, including terrestrial salamanders (DeGraaf and Yamasaki 1992; Monti et al. 2000), frogs (Pearman et al. 1995; Wakelin et al. 2003), snakes (Hoyer and Stewart 2000; Kjoss and Litvaitis 2001; Reading 1997), and lizards (Lettink 2007; Lettink and Cree 2007; Sutton et al. 1999). More recently, artificial retreats were used in attempts to restore degraded habitats (Michael et al. 2004; Webb and Shine 2000) and to increase the abundance of endangered Pygmy Blue-tongue Lizards (*Tiliqua adelaidensis*; Souter et al. 2004). Although the technique itself is not new, the

retreat design used here is a recent and original development (Lettink 2007; Lettink and Cree 2007).

Measures of sampling 'effectiveness' considered in this study were catch-per-unit-effort (i.e., number of geckos captured per person h) and the proportion of animals that evaded capture (i.e., escapes). In addition, adult sex ratios and size (snout-vent length) distributions of geckos captured by each method were compared to assess whether artificial retreats and searches of natural cover produced similar samples.

Materials and Methods.—The study site was located on a basalt rock outcrop in the Kaituna Valley, South Island, New Zealand (173°41'E, 43°46'S; Fig. 1). A 2500 m^2 area on the lower slopes of this outcrop was nominated for quarrying due to the quality and accessibility of the rock contained within (Greg Wright, NZ Quarry Managers Ltd., Christchurch, New Zealand, pers. comm.). This 2500 m^2 area (hereafter referred to as the study site) was flanked by exotic forest (a *Pinus radiata* plantation), introduced woody weeds (primarily gorse *Ulex europaeus*) and grazed pasture. Also present were native lianas (*Muehlenbeckia complexa*), divaricating shrubs (a growth habit characterized by extreme branching; *Coprosma* spp., *Melicope simplex*, *Melicytus alpinus*) and several small tree species (*Griselinea littoralis*, *Kunzea ericoidis*, *Macropiper excelsum*). The study site had a slope that varied from ca. 30°–70° with an east/northeast aspect and an elevation of 60–100 m above sea level.

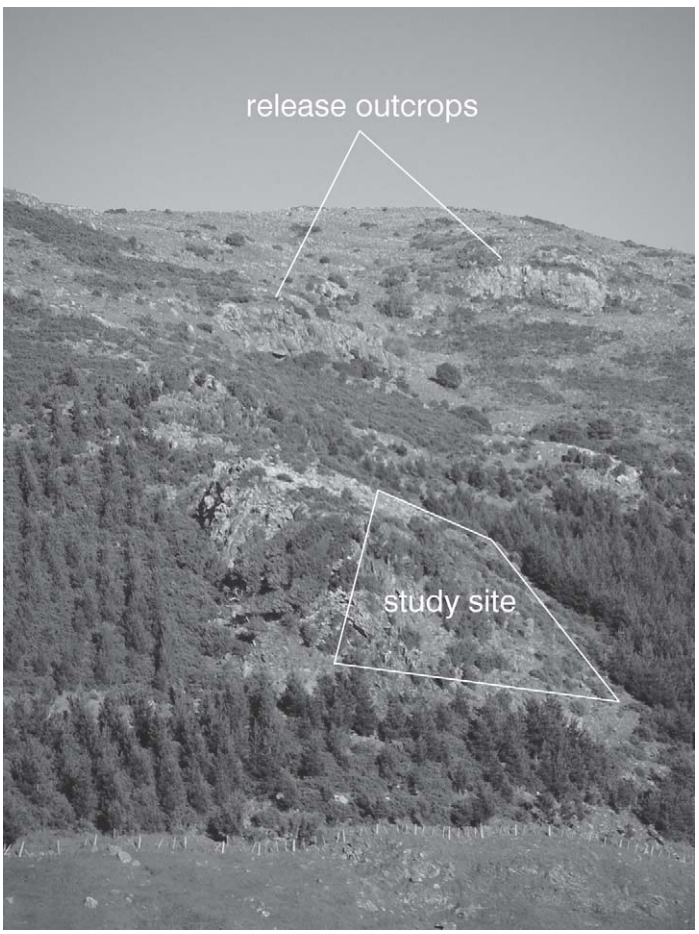


FIG. 1. Study area in the Kaituna Valley, South Island, New Zealand. Geckos (*Hoplodactylus maculatus*) were captured from the study site and released at two nearby rock outcrops.



FIG. 2. A double-layered artificial retreat made of Onduline positioned among basalt rocks and vines to attract the nocturnal gecko *Hoplodactylus maculatus*, Kaituna Valley, South Island, New Zealand. Animals are captured by hand when each layer is sequentially overturned.

In November 2005, 20 artificial retreats were installed within the study site. The artificial retreats were made of Onduline, a lightweight corrugated roofing and cladding product made from organic fibres saturated with bitumen (Composite Insulation Ltd., Christchurch, New Zealand; available world-wide http://www.onduline.com). Previous research revealed that *H. maculatus* preferred artificial retreats made of Onduline over those made of corrugated iron and concrete (Lettink and Cree 2007). In addition, Onduline retreats were shown to be highly effective at detecting *H. maculatus* following translocation when compared to pitfall traps (Lettink 2007).

Onduline retreats consisted of two 400 mm x 280 mm sheets stacked on top of each other (Lettink and Patrick 2006) and oriented horizontally or on a slight incline (up to ca. 30°). Sheets were separated by short (~2 cm) lengths of 10 mm-diameter pine dowel glued beneath the corners and centre of each sheet, and weighed down with one or two small rocks (Fig. 2). Approximate costs for materials were US $2 per artificial retreat. Placement of retreats was non-random to maximize the number of gecko captures. Most artificial retreats were placed near rock jumbles with deep crevices containing gecko faeces. Where possible, retreats were also positioned near patches of the liana *M. complexa*, favored by lizards for the shelter, invertebrate prey and fleshy fruits it provides (Whitaker 1987).

The study area was visited by up to three observers on seven occasions in 2006 (4 April, 6 April, 7 April, 20 May, 24 October, 29 October and 3 November) following a 'settling in' period of five months. All observers had previously worked with lizards. Some artificial retreats were re-positioned within the study area on 24 May to increase coverage. Capture sessions typically commenced at 0900 h (or earlier) on mornings when shade air temperatures were 15°C to facilitate easy capture and minimize the risk of escapes. Geckos were captured by hand by sequentially overturning each layer of a retreat and were placed in cotton holding bags. Geckos were sexed and measured after all artificial re-

TABLE 1. Number of geckos (*Hoplodactylus maculatus*) captured from Onduline artificial retreats and searches of natural cover, Kaituna Valley, New Zealand, April–November 2006. N = number, CPUE = catch-per-unit-effort (number of geckos captured per person h). Natural cover was not searched on the first and last occasions.

	Artificial Retreats				Natural Cover Searches			
Occasion	N seen	N caught	Person hours	CPUE	N seen	N caught	Person hours	CPU
1	18	15	2.5	6	—	—	—	—
2	17	13	2	6.5	12	6	4	1.5
3	4	4	1	4	6	2	7.5	0.27
4	26	25	2	12.5	6	3	2	1.5
5	16	16	2	8	1	1	0.5	2
6	9	9	1	9	3	2	1	2
7	5	5	1	5	—	—	—	—
Total	95	87	11.5		28	14	15	

treats had been checked. Mature males were identified by the presence of a hemipenial bulge and spurs. Animals of equivalent size lacking male reproductive structures were assumed to be females and subjected to gentle palpation of the abdominal region to determine whether follicles and/or embryos were present. Snout-vent length was measured to the nearest mm using a clear plastic ruler.

Natural cover was searched (by rock turning and crevice inspections) on all except the first and last sampling occasions. Most of the surface rock could not be turned because slabs were too heavy or deeply embedded in the ground. Geckos sighted within crevices were gently guided to a position where they could be captured by the observer(s), using flexible insulated electrical wire or pieces of vegetation. All geckos captured were sexed and measured as described above. The catch-per-unit-effort (i.e., number of geckos captured per person h) was noted for both methods and included the time taken to record measurements.

Captured geckos were released at two rock outcrops approximately 180 m (N = 69) and 470 m (N = 32) west of the quarry (Fig. 1). Additional Onduline retreats and rocks were used to create habitat at a number of release sites along the base of these outcrops. It was not known whether geckos would attempt to home back to the quarry site; however, I hoped that the poor quality of the intervening habitat (grazed pasture with patches of gorse) and additional habitat created at release sites would reduce the likelihood of such events occurring. Previous research revealed that *H. maculatus* was capable of homing over short distances (110 m; Marshall 1983) but failed to do so when moved over a distance of 1 km (Lettink 2007). Release sites were re-visited on an opportunistic basis and checked for the presence of *H. maculatus*.

Program R was used for all statistical analyses (R Development Core Team 2004). A Wilcoxon rank sum test (Crawley 2005) was used to compare the mean catch-per-unit-effort (CPUE) between methods. Pearson's chi-square tests were used to compare the number of escapes, adult sex ratios and size-class distributions between methods. For the latter, geckos were assigned to three groups (SVL 41 mm, 42–55 mm, and 56 mm) that corresponded approximately to neonates, juveniles and adults (Lettink Unpubl. data). Yates' continuity correction and simulated P values (N = 2000 replications) were used for 2 × 2 and 2 × 3 tables, respectively, because some of the categories contained fewer than 5 counts (Sokal and Rohlf 1995, Venables and Ripley 2002). A significance level of 0.05 was specified for all statistical tests.

Results.—After seven occasions, 101 geckos were captured, with artificial retreats producing the majority of captures (91.6%; Table 1). Mean CPUE for artificial retreats was 7.3 ± 1.08 SE (range 4.0–12.5), which was higher than CPUE for searches of natural cover (mean = 1.5 ± 0.32 SE, range = 0.3–2.0; W = 30.5, P = 0.042). Twenty-two animals escaped during capture sessions with significantly fewer escapes from artificial retreats than searches of natural cover (χ^2 = 22.7, df = 1, P = < 0.001; Table 1).

Snout-vent lengths of geckos captured (N = 101) ranged from 30–75 mm (mean = 54.5 ± 1.39 SE; Table 2). The smallest geckos for which sex identification was possible had SVLs of 56 mm. All animals with SVLs 56 mm were therefore considered adults. Adult male:female ratios for searches of natural cover (4:8) and artificial retreats (23:21) were not significantly different between

TABLE 2. Size-class distributions of geckos (*Hoplodactylus maculatus*) caught from Onduline artificial retreats and searches of natural cover, Kaituna Valley, New Zealand, 2006. N = number of geckos, SVL = snout–vent length, SE = standard error. Differences in size-class distributions between methods were significant (χ^2 = 6.96, P = 0.02).

Method	N	Neonates (SVL 41 mm)	Juveniles (SVL 42–55 mm)	Adults (SVL 56 mm)	SVL range (mm)	SVL Mean ± SE (mm)
Artificial retreats	87	25	18	44	30–75	53.1 ± 1.54
Natural cover searches	14	0	2	12	52–70	63.4 ± 1.62
Total	101	25	20	56	30–75	54.5 ± 1.39

methods (χ^2 = 0.70, df = 1, P = 0.40). Differences in the observed size-class distributions between methods were significant (χ^2 = 6.96, df = 2, P = 0.02), probably due to poor representation of neonates (N = 0) and juveniles (N = 2) from searches of natural cover (Table 2). The size-class distributions of samples from both capture methods were dominated by adults.

Opportunistic checks of artificial retreats installed at release sites resulted in sightings of 0 to 16 geckos per retreat. The group of 16 geckos was observed on 24 October , approximately five months after the last release at that site. This suggests that at least some geckos remained at the retreats where they were released; however, as individuals were not marked, translocated geckos could not be distinguished from any resident geckos that may have been present.

Discussion.—Onduline artificial retreats were superior to natural cover searches in the measures of sampling effectiveness considered in this study. More than 90% of the geckos captured were from artificial retreats. Moreover, CPUE was five times that observed for searches of natural cover, and fewer animals escaped from artificial retreats. In addition, the size range of animals captured from artificial retreats was much greater. The technique can be considered highly effective for capturing *H. maculatus* from rocky habitats that are difficult to sample by other means. It would be of great interest to know how many animals remained at the site, but unfortunately this could not be ascertained. The comparison of sampling methods therefore remains relative, and findings should not be generalized to other sites or habitats.

Onduline artificial retreats are likely to be useful in other reptile translocations, providing both an effective capture method and refuges where these are lacking. Future research should focus on defining the time period required for maximal occupancy of artificial retreats, as this will determine both the total number of animals that can be captured during a removal operation and the optimal time-frame required. Determining whether translocations of *H. maculatus*—an extremely long-lived species with a low recruitment rate—are ultimately successful may require a commitment spanning multiple decades (Lettink 2007). Additional research into the behavior of translocated reptiles is also needed. Whether translocation is an appropriate tool to allay conflicts between commercial activities and natural habitats for threatened species remains a key issue that merits further consideration.

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Attachment of Popup Archival Transmitting (PAT) Tags to Loggerhead Sea Turtles (*Caretta caretta*)

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Popup Archival Transmitting (PAT) tags are a relatively new tool used in marine animal studies (e.g., Block et al. 1998; Prince and Goodyear 2006; Sims et al. 2005). These tags differ from conventional satellite tags in that they collect and archive temperature, depth, and light level (for geolocation estimates) data over a period of time and then automatically are released from the animal on a designated date and transmit data to ARGOS satellites; the tag must detach before the data are transmitted. PAT tags are often used in survival studies (Domeier et al. 2003; Horodysky and Graves 2005).

One of the most important components of the system is the tether and how it is attached to the animal to ensure that the tag stays on and does not affect the behavior of the animals. Additionally, attachment is a compromise between the need for the tag to be released properly from the animal and the need for a long-term attachment which would still allow for a break-away link should the animal become entangled in fishing gear, marine debris, etc. Because the animals do not need to surface with the tag so that the satellite receives the data—instead the tag is released, floats to the surface, and transmits the archived data—the tether can be quite short, which reduces the risk of entanglement.

Marine turtles are protected species that interact with numerous types of fishing gear throughout the world (Gerosa and Casale 1999; Henwood and Stuntz 1987; Julian and Beeson 1998), often with lethal consequences. Pelagic longlines are identified as a source of mortality for marine turtles (Kotas et al. 2004; McCracken 2000; Yeung 2001), although the majority of the animals are released alive (Watson et al. 2005; see references above). However, the impacts of the fisheries have yet to be quantified because the post-hooking mortality rates are not known. NOAA Fisheries initiated a project in 2001 to evaluate the feasibility of using PAT tags to determine the post-hooking survival rates of marine turtles interacting with the pelagic longline fishery in the North Atlantic (Epperly et al. 2002; Sasso and Epperly 2007). Herein, we describe the tether system and attachment of PAT tags to Loggerhead Turtles, *Caretta caretta*, used in the pilot study. We monitored the attachment of PAT tags on three captive-reared loggerhead sea turtles in order to (i) evaluate the impact of the attachment on the turtles and (ii) determine if the attachment could remain intact for a one year deployment, the duration we needed to evaluate annual survival rates at sea.

Test Animals.—In May 2003 non-functional, but otherwise intact PAT tags (Wildlife Computers, Inc., Redmond, Washington, USA) were attached to three captive reared Loggerhead Sea Turtles in the NOAA Fisheries Service Laboratory in Galveston, Texas, USA (Fig. 1). The 31 month-old animals hatched from nests adjacent to Clearwater, Florida, USA in 2000. After emergence from the nest, the hatchlings were transferred to the Galveston rearing facility. Husbandry of turtles at this facility is described in Higgins (2003). The animals ranged in size from 48.1 to 49.8 cm minimum straight carapace length (SCL) at the time of tag attachment. In early June, soon after PAT tags were attached, one turtle (RRA816) was transferred to the NOAA Fisheries Service Laboratory in Panama City, Florida, USA where it was placed in a large outdoor pen (14.2 m long × 7 m wide × 0.9–1.5 m deep, depending on the tide) in St. Andrew Bay, with 12 or fewer other individuals of the same age. The other two turtles remained in Galveston. The one turtle was moved to better simulate conditions in the wild. The large outdoor pen allowed the turtle to swim more and faster and to dive deeper, exposed the animal to wave action and to UV radiation, and allowed for interaction with structures and with other animals. While in Panama City the turtle was fed a diet of squid (*Illex illecebrosus*). The Panama City turtle was returned to Galveston in early July. While in Galveston, the turtles were fed a minimal growth diet of whole Atlantic Mackerel (*Scomber scombrus*) in order to simulate the growth rates of wild turtles of that size (~5 cm yr^{-1}) (Mendonça 1981; NOAA Fisheries Service, unpubl. data; Schmid 1995). The turtles were held in-

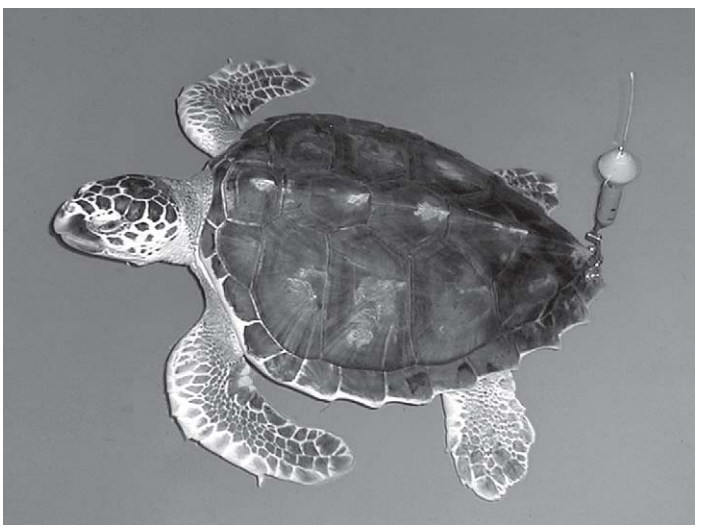


FIG. 1. Popup Archival Transmitting tag (PAT) attached to a captive-reared loggerhead sea turtle (*Caretta caretta*), approximately 49 cm minimum straight carapace length, in a raceway at NOAA Fisheries Service Laboratory in Galveston, Texas, USA.

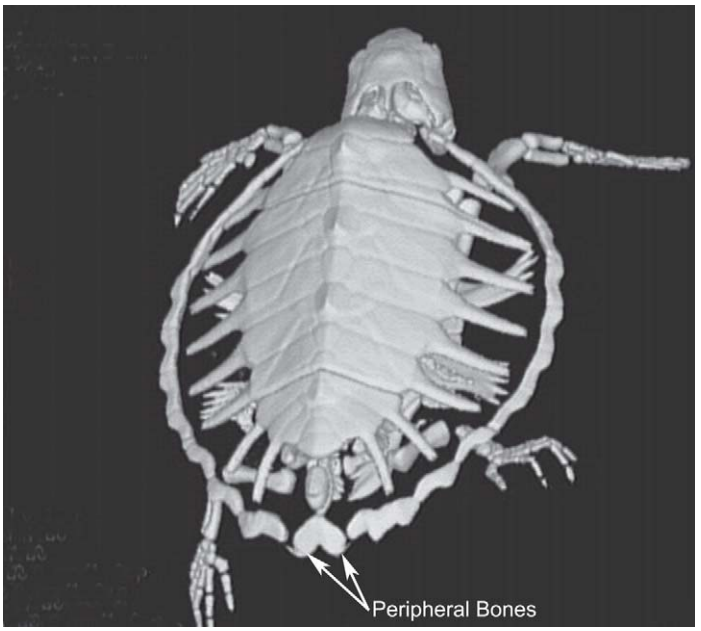


FIG. 2. Computed tomography (CT) scan of an immature loggerhead turtle showing peripheral bones which underlie postcentral scutes.

doors in a large divided raceway where each was allocated a space of 2 m × 1.8 m with a water depth of 0.9 m.

PAT Tag Attachment.—In order to attach PAT tags, the animals were removed from their raceway and immobilized on a platform of clean wet foam placed in a shallow plastic crate. Throughout the process, all attempts were made to maintain as aseptic a working environment as possible. Latex surgical gloves were worn throughout and changed frequently to avoid contamination. The caudal surfaces of the plastron and carapace were cleaned and any barnacles were removed. The area was scrubbed using sterile gauze sponges and 10% povidone iodine solution at least three times over a 15 min period, and the area was maintained damp with the solution. The posterior carapacial scutes were iced for 15 min to numb the area to be drilled. All attachment hardware and the drill bit were soaked in 10% povidone iodine solution for 15 min before they came in contact with the turtle. A 4.8 mm titanium nitride coated steel drill bit was used and drill speed was low to minimize frictional heat. Although there was no bleeding, a drop of Clotisol® (Benepet® Pet Care Products, St. Joseph, Missouri, USA; ferric sulfate, aluminum sulfate, collagen protein, and chloroxylenol in suspension) was placed in each hole prophylactically, and then the hole was flushed with 10% povidone iodine solution.

An eye strap connected to the carapace was used as an anchor for attaching the PAT tag (Fig. 1). The attachment involved drilling a pair of holes through the postcentral scutes and their peripheral bones, from dorsal to ventral (Fig. 2 and Fig. 3). The centers of the holes corresponded to centers of the attachment holes in the eyestrap. A 3.8 cm × 1.1 cm 18-8 stainless steel (SS) standard line eye strap was attached to the turtle with 2 SS slotted, round head bolts (#10/24 × 2.4–5.1 cm) and a #10/24 SS locking nut with nylon insert. The bolts were inserted ventral to dorsal when the length of the bolt was long enough to extend well past the locking nut and potentially chafe the rear flippers. In contrast, a dorsal to ventral insertion was used when the bolt was appropriately sized such that it did not extend well past the locking nut. Nylon washers (6.4 mm outside diameter) were placed between the SS hardware and the turtle (Fig. 3). Nylon washers were used rather than SS washers because nylon is both inert and flexible, allowing for fit to a scute's irregular surface, and it does not have any sharp edges. The locking nuts were threaded over exposed bolt ends and tightened until there was no space between the pieces of attachment hardware.

PAT Tag Tether.—A 10 cm long tether was used to connect the PAT tag to the eye strap. One end of the monofilament (182 kg test fluorocarbon, 1.8 mm diameter) was looped around the plastic thimble attached to a corrodible pin in the tag, and crimped using SS sleeves (oval, for 1.6 mm wire rope). The other end was looped around a 2 mm SS thimble for monofilament line and crimped. The thimble was attached to the eye strap before the bolts were

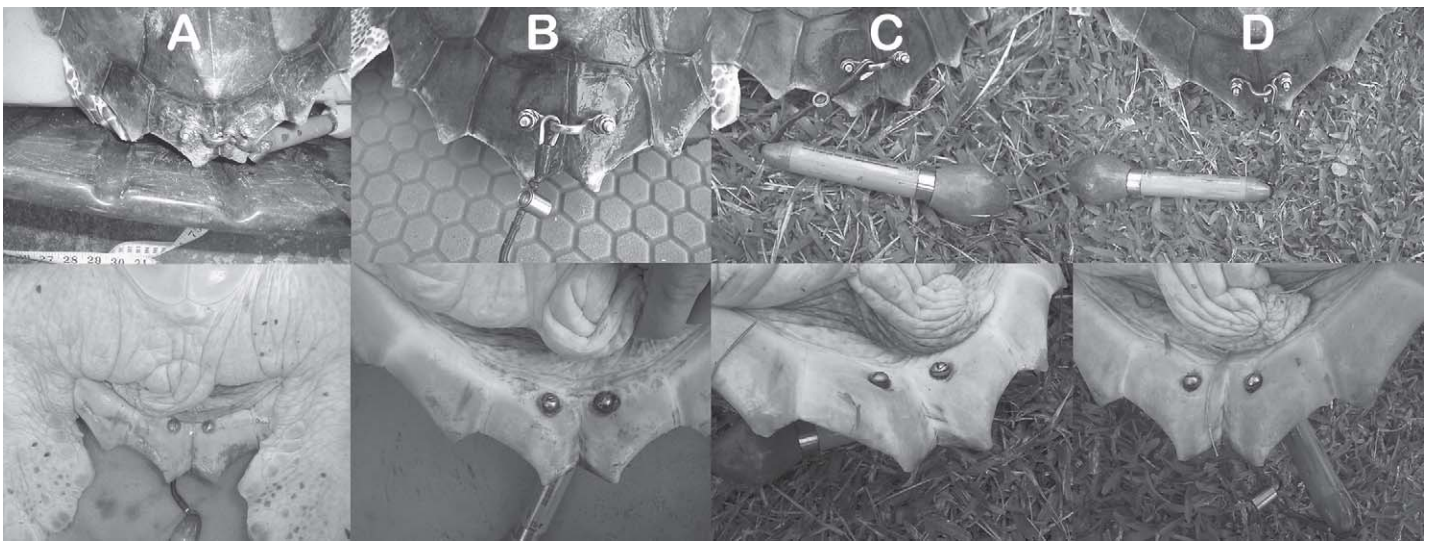


FIG. 3. Dorsal and ventral views of the PAT tag attachment on a 2000 year class loggerhead sea turtle (*Caretta caretta*; RRA806) photographed throughout the year: (A) May 22, 2003, (B) July 24, 2003, (C) November 17, 2003, and (D) May 20, 2004. The eye strap is bolted through the postcentral scutes and the underlying peripheral bones.

threaded through the shell. In order to prevent the tag from being crushed under extreme pressure (usually associated with great depths), the tether was equipped with a device (RD-1500) that severs the monofilament releasing the tag when a depth (approximately 1500 m) well outside the normal diving range of sea turtles is reached. The RD-1500 was centered on the tether. Marine grade adhesive-lined heat shrink tubing (3.2 mm and 4.8 mm inner diameter for line and crimp sleeves, respectively) was applied over the monofilament and both crimp sleeves on either side of the RD-1500 to reduce the monofilament's exposure to ultraviolet radiation and to prevent abrasion of the line. A corrodible pin base of the PAT tag provided a breakaway safety link for the turtle (22.7 kg static weight breaking strength) in case of unanticipated entanglement.

Monitoring.—During the following 12 months, the turtles were monitored for changes to the attachment (e.g., loosening bolts, corrosion), the tether (e.g., chafing, breakage), and impact to the turtle (e.g., necrosis, entanglement). The turtles were removed weekly from the raceways and both the dorsal and ventral surfaces of the attachment were photographed (Fig. 3). All authors monitored the fine resolution digital photographs (1024 × 768 pixels).

Computed Tomography Imagery.—The tags were removed in May 2004 and the animals, now 51.4–56.0 cm SCL (13.4–22.2 kg), were examined using Computed Tomography (CT) imaging (Wyneken 2005) to evaluate the impact of the attachment on the underlying bone (Fig. 4). Turtle health and body condition were normal. Prior to CT imaging, the animals were fasted for more than 48 hours. After removing the hardware, the animals were anesthetized using ketamine (5 - 6 mg/kg IV), medetomidine (0.15–0.18 mg/kg IV), and reversed with atipamezole (0.7–0.9 mg/kg IM) (after Chittick et al. 2002). The animals were sedated in 2–3 min and lightly anesthetized in 4–9 min. Animals were reversed 18–26 minutes after their initial injections, and recovered to a mildly sedated condition in 17–18 min. While sedated, the animals' heart rates were monitored using an ultrasonic doppler flow detector with an 8.9 MHz probe (Model 811-BTS, Parks Medical Electronics, Inc., Aloha, Oregon).

Results and Discussion.—Previous attachment methods for conventional satellite tags on cheloniid turtles relied on epoxy glued bases and/or fiberglass (Balazs et al. 1996; Godley et al. 2002; Swimmer et al. 2006). However, because of the turnover in scute material, these attachment systems may be sloughed before the tracking time is complete. Conventional tags required placement high on the carapace or at the end of a long tether to allow for transmission when a turtle surfaces. The PAT tag does not transmit while attached to the study animal. Thus, we were not restricted to placement high on the carapace, where drag is highest (Watson and Granger 1998), and could use a short tether. We elected to use a through-bolted attachment, relying on a pair of holes, rather than a single hole, to distribute torque from the tether over two attachment points and increase the chance of maintaining attachment integrity. The postcentral scutes were selected because: (i) the rear aspect of animals with tapered body profiles is a region of low drag (after Bannasch et al. 1994; Watson and Granger 1998); (ii) the postcentral scutes are supported by a pair of articulated peripheral bones that provide a strong, accessible and easily located attachment site (Fig. 2) (see Wyneken 2001), and (iii) given a sufficiently short tether length, both it and the tag would be out of the way of the rear flippers and the turtle's visual field. Holes were drilled proximally on the postcentral scutes, but clear of the ventral skin, to ensure that both bone and keratin supported the bolts. If holes are drilled distally in the scutes, they might only pass through the keratin, a weaker support than the composite we chose.

We used two criteria in the design of the tether. First, we wanted the tether to be long enough for tag to reside within the turbulent wake of the turtle, minimizing or effectively eliminating hydrodynamic costs to locomotion. Thus, the tether had enough length (10 cm) to allow the tag to follow behind the turtle and somewhat above the posterior-most part of the carapace. Secondly, the tether was also short enough so that the tag trailed linearly and avoided entangling or bumping the hind limbs when the turtles were swimming or in rough surface waters. The construction of our tether for sea turtles was modeled on the tether used in research of pelagic fishes (Graves et al. 2002; Prince and Goodyear 2006).

No general anesthesia or local anesthetic was administered during attachment. There are no conclusive studies of pain control in turtles or applicable studies in other reptiles to override the need to avoid risks from general anesthesia or injectable mammalian analgesics (Schumacher and Yelen 2005; Wyneken et al. 2005). In order to simulate anticipated field conditions in which the PAT tags would be attached and deployed on wild animals, we used ice as a potential local analgesic and avoided anesthetics. Trained fisheries observers would be attaching the tags to turtles caught at sea, often days to a week from the nearest port and away from veterinary support. Additionally, turtles would be released immediately following PAT tag attachment so post-anesthesia monitoring would not be possible. Furthermore, research permits would not allow for the administration of general anesthesia by the observers. Local anesthetic injection was not feasible as the attachment site was hard keratin overlying bony carapace. Innervation to the shell is via spinal nerves and their extent within bones is unknown. While we made attempts to minimize discomfort (15 min focal ice application, slow drill speed), some turtles initially reacted to the drilling by pushing with their limbs against the foam and crate, attempting to propel themselves forward, and were briefly (< 1 min) restrained. Based on videos of the animals taken immediately after they were placed in their holding tanks and taken the day after attachment, there was no overt evidence of continued discomfort subsequent to the attachment procedure, and weight gain over the next year was within the range for turtles without PAT tag attachment (NOAA Fisheries Service, unpubl. data).

The attachments remained intact for the full year (22 May 2003–25 May 2004) (Fig. 3), but the only grossly visible responses occurred within the first month. Within a week of attachment there was evidence of localized pressure necrosis deep to the washer on the ventral surface. The initial necrosis either progressed slightly or the holes wore over the next several weeks so that at the end of the first month the holes had enlarged a small amount allowing the eye straps to rock slightly (maximum ~1.5 mm) along the turtle's anterior-posterior axis and the bolts could move vertically (1–3 mm); these changes did not progress further. The nuts held fast and never loosened. The greatest eye strap movement was observed in the one turtle that was moved temporarily to a large outdoor pen in Panama City, Florida where it could swim greater distances and interact with other turtles as well as with the pen's

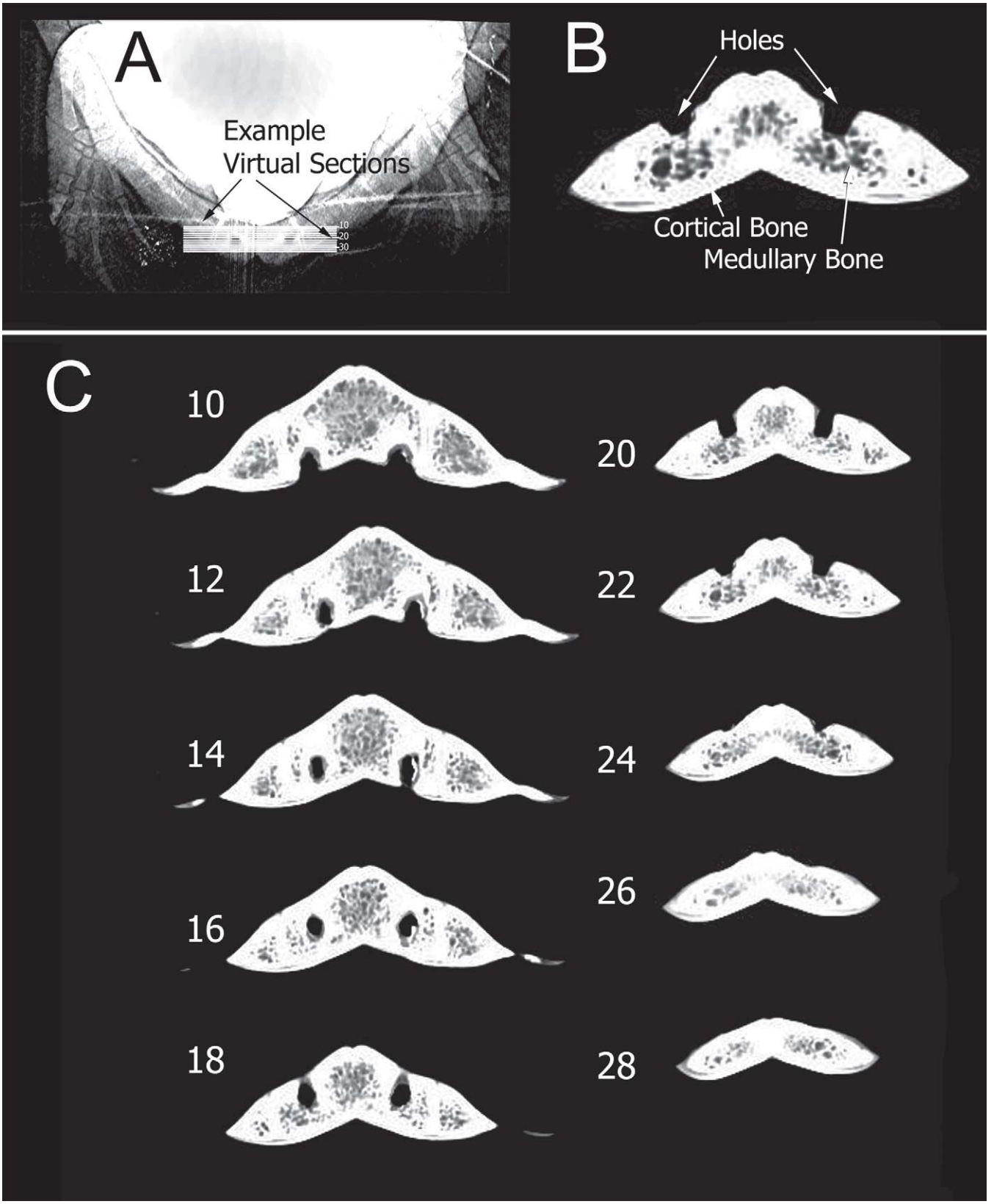


FIG. 4. (A) Computed tomography (CT) scans of the attachment site are collected as virtual serial sections (RRA806). (B) Cortical bone appears white; medullary (woven) bone appears gray. (C) Shown are the serial CT images of the posterior peripheral bones. Section 10 is the most anterior and section 28 the most posterior. The plane of sampling did not pass directly through the axis of PAT tag's mounting holes so they are shown starting with the inferior side of the holes and extending along the holes until just posterior to their superior openings. The bone along the holes is mostly compact, except along the tunnel walls where the stainless bolts passed (Images 12 right side, 14 right, 16-18). This gray material may represent adjacent debris or loosely woven bone. We could not distinguish the two without a biopsy; no biopsy was taken.

wall of webbing. During the first month all three turtles developed some microbial growth between the keratin and bone on the ventral surface around the holes. Over time, this resolved without treatment. Interestingly, it was least on the turtle that spent a month in Panama City where it was exposed to unfiltered sunlight.

After removing the tags, we found some cellular and keratinous debris in the bolt holes of two of the turtles, most of which fell out when the bolts were removed. Small depressions were present on the ventral surface around each hole, approximately the diameter of the washer. CT imaging showed the two bolt holes in the caudal-most shell region with little to no evidence of bone remodeling (Fig. 4C). None of the holes invaded into the coelomic cavity or caudal skin. There was no evidence of lysis surrounding the bolt holes and their borders had smooth margins; there was no evidence of clinically significant reaction.

The corrodible pins in the base of the tags were intact. The pin serves two purposes: (i) it is the weak link in the system and will break under enough stress, and (ii) it secures the tether to the tag and corrodes when the PAT-controlled application positively charges the pin to release the tag, which then will float to the surface. Temperature and salinity affect the rate of corrosion, but typically the pin breaks within 3 h, and is completely corroded within 9 h (Melinda Braun, Wildlife Computers, pers. comm.). Once the tag is free of the turtle, the turtle will still carry the tether and attachment hardware. Because the bolts were not marine grade stainless (e.g., they were 304 not 316 stainless), we fully expected the bolts to corrode and the hardware to be shed at some point well after PAT tag detachment on wild animals. There was some evidence of corrosion of the bolts, washers, and eyestrap when the hardware was removed after 1 yr.

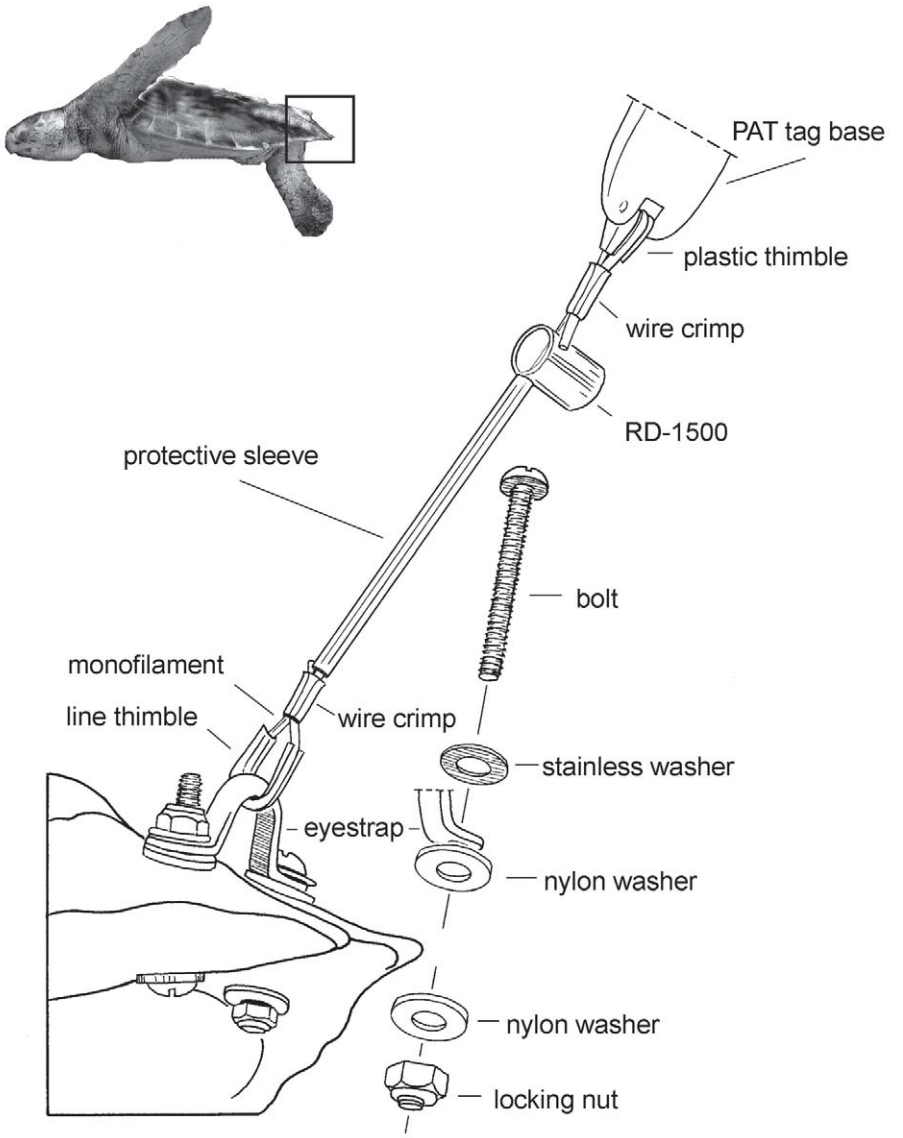


FIG. 5. Schematic of the current attachment hardware and tether for a PAT tag on a loggerhead sea turtle carapace (*Caretta caretta*). The corrodible breakaway pin in the base of the tag is not visible, but is surrounded by the plastic thimble. Note that the monofilament tail extending from the wire crimp sleeve is overlapping the RD-1500 to prevent it from spinning on the monofilament.

At the end of the study, the turtles were released in St. Joe Bay, Florida (29°49.5'N × 85°24.0'W) on 26 June 2004. They each bore 3 inconel flipper tags (one on the right front flipper and one on each rear flipper) and two 125 kHz passive integrated transponders (PIT tags; one in the right triceps superficialis muscle complex and one in the left front flipper, just above the second proximal scale on the trailing edge). Here we alert readers of the desire for follow-up information on the turtles, should anyone recapture the three test animals. We request readers to photograph the PAT tag attachment area (dorsal and ventral) and to contact us after the animal is released. Flipper tag numbers are RRA816/RRA801/RRA927 (PITs # 4367531D3B, 4349566D75), RRA806/RRA928/RRA929 (PITs # 43396C7F78, 4330691B6E), and RRA814/RRA930/RRA931 (PITs 4349504D1D, 43496A2344).

Since the conclusion of this laboratory study and after reviewing preliminary results from field testing, we made a few modifications to the tether and attachment to minimize the impact to the turtles and to ensure long deployments (Fig. 5). Wildlife Computers now recommends that the RD-1500 be placed adjacent to the corrodible pin in the tag and that a small length of the monofilament tether be left exposed through the crimp sleeve on the tether, overlapping the RD-1500 to prevent it from spinning around the monofilament which could score and weaken the line. Additionally, we learned that the application of heat weakens monofilament and no longer use heat shrink tubing. Instead, we now protect the monofilament with a flexible translucent sleeve (1.85 mm internal diameter). We found a variety of monofilament lines of the same diameter (1.8 mm), ranging in strength from 136 kg-test

to 182 kg-test, and we use them interchangeably. As a direct result of this laboratory research we now are using larger diameter (13 mm O.D.) nylon washers placed adjacent to the plastron and the carapace, and a 12 mm #10 stainless washer between the eye strap and the head of the bolt or the lock nut. Lastly, we are ensuring that the nuts are not over-tightened to minimize pressure necrosis.

We conclude that this procedure can be used in the field to attach PAT tags to wild cheloniid turtles of all species (with the possible exception of *Natator depressus*) without detrimental effect on the turtle, and that the attachment would be useful for long term tag deployments. Using the described methodology, NOAA Fisheries Service has released PAT tags on pelagic oceanic loggerheads captured in the north central North Atlantic Ocean. Of the 19 tags programmed for long deployments and that transmitted, only 4 released prior to 6 months (Sasso and Epperly 2007); we do not believe their premature release was due to attachment or tether failure.

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Retention and Readability of Visible Implant Elastomer Marks in Eastern Red-Backed Salamanders (*Plethodon cinereus*)

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The ability to recognize individual animals is valuable for estimating survival of individuals, population sizes, recapture rates, reproduction, and behavior of individuals through time (Gavin and Haas 1989; White et al. 1982). However, methods to uniquely mark salamanders are more problematic than for many other taxa because their small size, their permeable skin, and their ability to regenerate toes and skin complicates the use of traditional marking techniques.

Amphibians have been uniquely identified with coded wire tags, toe clipping (Clarke 1972), tattooing (Perret and Joly 2002), freeze-branding (Beebee 1996), beaded elastic waistbands (Beebee 1996; Gavin and Haas 1989), radioisotope tagging, photo-recognition of unique characteristics (Bailey 2004; Gill 1978), passive integrative transponders (PIT) (Perret and Joly 2002), alphanumeric tags (Buchan et al. 2005; Gower et al. 2006) and visible implant elastomer (VIE) (Bailey 2004; Marold 2001; Nauwelaerts et al. 2000) (marking reviews by Beebee 1996; Gavin and Haas 1989; Murray and Fuller 2000). These available marking techniques have limitations, many of which violate assumptions of mark-recapture studies. Most mark-recapture models assume that marks are not lost through time, read incorrectly, or likely to influence survival and behavior (Pollock 1991; Pollock et al. 1990), but these assumptions rarely are tested. For example, external tags may interfere with movement, behavior, or body condition of amphibians (Murray and Fuller 2000). Toe clipping is a commonly used and inexpensive method to mark amphibians; however, salamanders can regenerate toes (Heatwole 1961) and this method may decrease survival (Clarke 1972; Davis and Ovaska 2001; McCarthy and Parris 2004; Parris and McCarthy 2001). Individual recognition, sometimes in conjunction with photo-recognition of color patterns, is a useful, non-invasive method for identifying individuals of many salamander species (Bailey 2004), but not all species have clearly quantifiable or easily distinguishable markings. Amphibian color patterns may change with time (Arntzen and Teunis 1993), and identification may depend on photographic quality or software.

Visible implant elastomer (VIE, Northwest Marine Technology Inc., Shaw Island, Washington, USA) is an alternative to tagging or toe clipping and can be used in species too small for a PIT tag. This relatively new marking method involves subcutaneously injecting a liquid polymer into an animal to create individual patterns of colors by body location. Visible implant elastomer involves a longer period of handling than many traditional marking methods (Davis and Ovaska 2001), which may be more stressful to the animal and limit the number of individuals that can be marked in the field. Previous work has examined the influence of VIE on survival (Bailey 2004; Davis and Ovaska 2001; Harvey 2003; Marold 2001), body condition, (Bailey 2004; Davis and Ovaska), and the stress response of salamanders (Kinkead et al. 2006) in addition to evaluating tag loss (Davis and Ovaska 2001; Marold 2001) and observer bias (Bailey 2004). In these studies, survivorship following VIE marking was high, and tag loss and observer bias were low.

Despite the growing body of literature suggesting that VIE may be an appropriate marking technique, little information is available to guide researchers who plan to identify salamanders with VIE in choosing marking locations or colors of elastomer. Few researchers have quantified retention of marks for > 5 months (but see Davis and Ovaska 2001) and to our knowledge no experiments have compared effectiveness of different colors of VIE or marking locations on salamanders. Additionally, laboratory studies conducted on terrestrial life stages of salamanders have housed individuals in unnatural conditions, such as containers without soil or leaf litter (Bailey 2004; Davis and Ovaska 2001; Marold 2001), which may have affected mark retention.

Our objective was to evaluate VIE as an effective marking technique for Eastern Red-backed Salamanders (*Plethodon cinereus*), a widely studied salamander with relatively dark coloration. We investigated the effects of mark placement (dorsal or ventral marking) and color of VIE marks (red, blue, orange, yellow) on retention and visibility of marks for >1 year post-marking in a replicated laboratory experiment that mimicked natural habitat conditions.

Methods.—We collected Eastern Red-backed Salamanders on 31 March 2006 and housed them in a laboratory at Virginia Tech, Blacksburg, Virginia, USA, through 20 April 2007. We hand-captured 30 adult salamanders [snout–vent length (SVL) > 34 mm] (Petranka 1998) in the Jefferson National Forest, Montgomery County, Virginia. When capturing salamanders, we avoided gravid females. We transported salamanders to the laboratory, confirmed their reproductive condition and sex by candling with a fiber optic light (Gillette and Peterson 2001), weighed and measured (SVL) them. Salamanders were numbered one to thirty and randomly assigned to three treatments: dorsally marked (N = 12; 7 males, 5 females), ventrally marked (N = 12; 7 males, 5 females), or controls (N = 6; 3 males, 3 females).

We housed salamanders individually in plastic terrariums (approximately 50 × 30 × 20 cm) with a 15 × 15 × 5 cm wooden block for cover, approximately 6 cm of soil, and a 5-10 cm layer of deciduous leaf litter to simulate their natural habitat. Terrariums were kept on shelves in a temperature-controlled room with a 12:12 light-dark cycle. We changed leaf litter in the terrariums every 1–

3 weeks and misted leaves with water 1–2 times per week to allow the salamanders to behave naturally and forage for invertebrates in moist leaf litter. We prevented a shelf effect by randomly interspersing individuals in each treatment among the shelves.

At the beginning of the experiment, terrariums were enclosed with a plastic lid to prevent escape of study animals; however, several salamanders escaped so we secured the lids with rubber bands around terrariums, but losses continued. We minimized further escapes by sealing fiberglass screen to the terrarium rim with silicone caulking and then securing the lid on top to minimize moisture loss. Across the entire study period, 2 control, 5 ventrally marked, and 5 dorsally marked salamanders escaped. Escaped salamanders were replaced until 7 July 2006, after which 4 additional salamanders escaped. When salamanders escaped and were replaced with newly marked individuals, we evaluated their elastomer marks from their reset "time zero" (i.e., time of their replacement). Hence, sample sizes were smaller for later time periods.

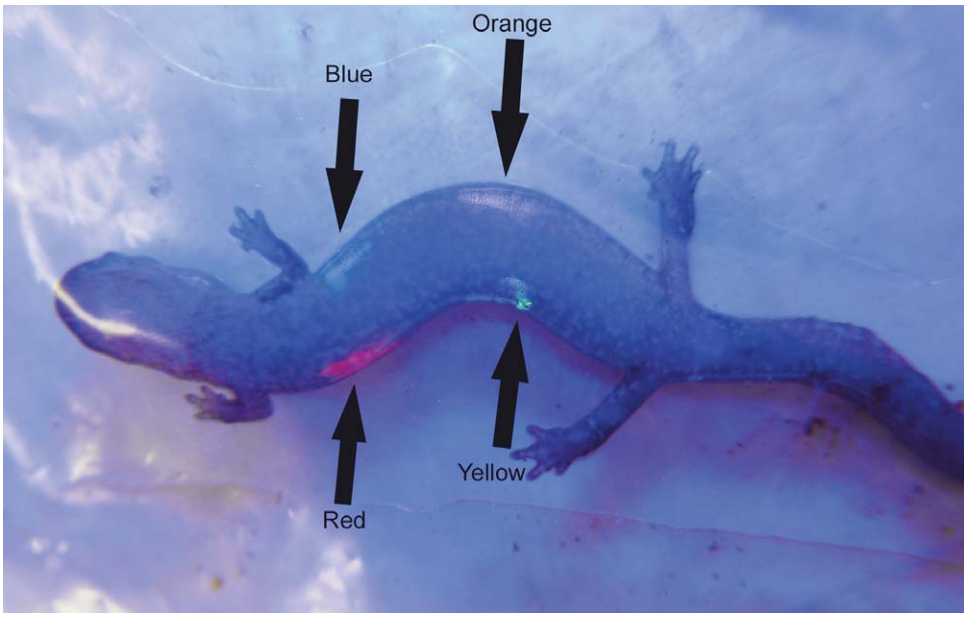


FIG. 1. Eastern Red-backed Salamanders (*Plethodon cinereus*) were marked with Visible Implant Elastomer in four locations, either ventrally or dorsally. Under fluorescent light, the appearance of some colors are altered.

One researcher (JAH) implanted all VIE marks subcutaneously with consistent placement of colors among salamanders for dorsal and ventral treatments. Red was placed posterior from the anterior left leg, blue was placed posterior from the anterior right leg, orange was placed anterior from the posterior right leg, and yellow was placed anterior from the posterior left leg (Fig. 1). Control salamanders (N = 6) were not marked nor treated with blank-injections and were used to qualitatively evaluate effects of VIE and associated handling on survival and mass. Marks were placed approximately 1–2 mm from the hip joint to prevent impairment of mobility, although exact placement varied because of the size of marks. Salamanders were placed in plastic bags to immobilize them and the elastomer was injected through the bag and into the salamander with a 1 cc insulin syringe.

Each week we weighed the salamanders and assessed elastomer marks with a visible implant (VI) fluorescent light (Northwest Marine Technology, Shaw Island, Washington, United States). VIE marks were evaluated on a 1–4 scale based on their difficulty to read, where 4 indicated "easily read," or could be seen under the VI light with no manipulation of the salamander body; 3 indicated "moderately easily read," or could be seen with the VI light with little manipulation; 2 indicated "difficult to read," or the mark could only be seen with a VI light after being manipulated for several seconds; and 1 indicated the mark was "absent," or not visible. We monitored migration of individual marks by making hand drawn records of the location of each mark throughout the duration of the study.

At 21 weeks post-marking (N = 7 dorsal, N = 9 ventral, N = 5 control salamanders were observed for this period of time), it was evident that VIE marks on the ventral surface were easier to read than marks on the dorsal surface. Salamanders added later to replace those that escaped had fewer observations, but the differences between treatments were still apparent. At that point, we opted to continue the experiment with only the ventrally marked group. We examined marks of the ventrally marked salamanders to 53 weeks post-marking (N = 6 completed the 53 weeks). From January–April 2007, we fed salamanders wingless *Drosophila melanogaster* weekly because salamanders were losing mass and few invertebrates were present in the leaf litter as potential prey items.

We averaged the readability of individual marks in salamanders by three week periods. We examined the effects of treatment (dorsal vs. ventral), time up to 21 weeks post-marking (7 periods), and a treatment × time interaction separately for each color of VIE with one-way repeated-measures analysis of variances (ANOVA; Zar 1996). In addition, we conducted one-way repeated-measures ANOVA that examined effects of VIE color, time post-marking and a color × time interactions up to 53 weeks (18 periods) for the ventrally marked group.

The evaluation of VIE marks for the dorsally and ventrally marked salamanders to 21 weeks post-marking could not meet the parametric assumption of normality for ANOVA, even after transformation of data. Similarly, the ANOVAs by color on the ventrally marked salamanders to 53 weeks were not normally distributed (Kolmogorov-Smirnov < 0.05) and were not improved by transformation. Therefore, we conducted one-way repeated-measures ANOVA on the ranked data (Conover 1999). No widely accepted non-parametric test exists that parallels a repeated-measures ANOVA with interaction terms, so we followed the suggestions of Conover (1999) to examine interaction terms and effects of time. Conover (1999) suggested that assessment of the parametric test be compared to the version conducted on the ranks, and if the results are very similar, to consider the parametric version to be a valid approximation of patterns in the data. We considered P-values of < 0.05 as significant. Program SAS 9.1 was used for all analyses.

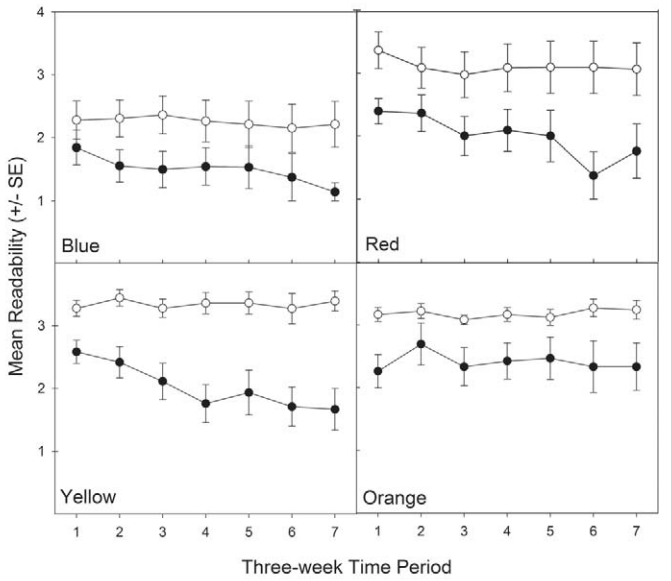


FIG. 2. Readability of Visible Implant Elastomer marks was greater in ventrally marked (open circles) *P. cinereus* than dorsally marked (filled circles) salamanders over seven three-week periods. Readability ranged from 1 (mark absent) to 4 (mark easily visible under fluorescent light).

Results.—Our results from the parametric versions of each repeated-measures ANOVA closely paralleled the results from each ANOVA on ranks. Thus, we considered the parametric versions to be reasonable and present their results. For each of the four colors, the mean visibility of marks was greater for the ventral treatment than dorsal (Blue: $F = 19.20$, $P < 0.001$; Red: $F = 33.95$, $P < 0.001$; Yellow: $F = 113.12$, $P < 0.001$; Orange: $F = 36.55$, $P < 0.001$) (Fig. 2). Additionally, for each color, there was not a significant effect of time ($P > 0.26$) or an interaction between treatment and time ($P > 0.24$).

For the analysis of only the ventrally marked salamanders, the F-statistics and associated P-values were very similar across parametric and non-parametric versions of the test, so that we present the parametric version. There was an effect of color ($F = 41.85$, $P < 0.001$), but no effect of time ($F = 0.18$, $P = 1.00$) and no interaction ($F = 0.13$, $P = 1.00$) for the ventrally marked salamanders (Fig. 3). Overall, blue was the most difficult to read and red, yellow, and orange were similar in their readability in our experiment (Fig. 3).

Migration of VIE marks occurred in 17% of salamanders (4% of marks), and 29% of salamanders had marks that broke into multiple pieces (7% of marks). Salamander mass decreased throughout the study period across all three treatments. By the end of the initial 21 week study period that encompassed dorsally, ventrally, and unmarked salamanders, mass of the control group (mean = -24.1, SE = 1.54%) decreased more than either the ventral (mean = -14.5, SE = 3.03%) or dorsal (mean = -16.1, SE = 2.79%) group.

Discussion.—Although several experiments have evaluated the effectiveness of VIE on salamanders, to our knowledge only one other study monitored VIE marks in salamanders for > 1 year (Davis and Ovaska 2001) and no research has compared colors and location of marks in salamanders. The results of our experiment suggest that VIE marks on the ventral surface are an appropriate and reliable tagging method for Eastern Red-backed Salamanders for at least one year. Dorsal markings were less visible, and should be considered less reliable identifiers than marking salamanders ventrally. The darker pigmentation on the dorsal side of our salamanders probably caused subcutaneous marks to be difficult to see even with the VI light. Of the elastomer colors examined in this experiment, orange, yellow, and red were easiest to read (Fig. 2, Fig. 3). Blue consistently was the most difficult color to read and the most likely to disappear in both dorsal and ventral treatments. Thus, we recommend that the color blue should be avoided as a choice of marks in future research of red-backed salamanders or other relatively darkly-pigmented amphibians. However, our results may be somewhat species-specific, so we suggest that researchers conduct a pilot test of readability for their study species prior to their investigation.

Not only were VIE marks relatively easy to identify in our study, but the readability of both dorsal and ventral marks did not change through time, as evidenced by the lack of an effect of time or treatment × time interaction for any of the four colors used. Therefore, the marks were as easy to read following the injections as at the end of the 21-week or 53-week period. Many field research projects use marks such as VIE to identify individuals for > 1 year. The researcher that marked salamanders was relatively inexperienced with VIE marking, so these results should be considered representative of a biologist newly trained to the technique. Our experiment provides evidence that VIE may be used to estimate parameters such as annual survival or recapture rates with little concern over mark loss.

In general, the results of our project are similar to research that compared VIE to other marking techniques or provided positive support for this method as a way to identify individual salamanders. For example, retention of VIE was greater than organic dyes in aquatic *Ambystoma tigrinum nebulosum* larvae (Harvey 2003) and was similar to photo-recognition in *Eurycea bislineata* (Bailey 2004). Further, VIE marks had a higher retention rate than toe clipping in *P. vehiculum* (Davis and Ovaska 2001). Visible im-

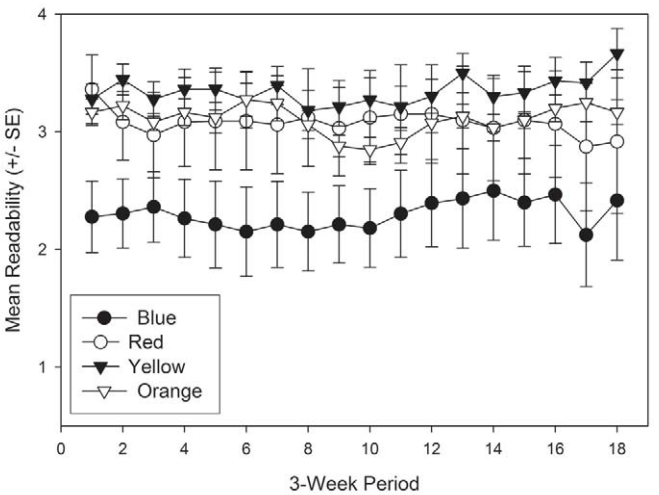


FIG. 3. Readability of Visible Implant Elastomer marks in *P. cinereus* that were ventrally marked and observed to 53 weeks post-marking was consistently less for the color blue than for red, orange, and yellow. Readability ranged from 1 (mark absent) to 4 (mark easily visible under fluorescent light).

plant elastomer marks were fully retained in *Eurycea bislineata* over a 15-week period (Marold 2001). However, in *Eurycea bislineata*, marks placed mid-body were confused with adjacent marks and the visibility of the marks varied due to pigmentation. Our study provides additional support that VIE marks are retained well without a decline in readability and offers specific recommendations to future researchers regarding locations and colors of elastomer.

Observed migration of marks implies that elastomers should be injected as far apart from one another as possible to prevent possible migration from confounding the individual identification. We observed migration and break-up of VIE marks during our study, but it is unlikely that wild Eastern Red-backed Salamanders would have higher incidents of mark movement or disintegration than we observed. *Plethodon cinereus* in our experiment were housed with soil, leaves, and a cover object so that daily activities of animals should have been similar to free-ranging salamanders. On several occasions study animals were observed burrowed in the soil or under the cover object, which may have facilitated movement of VIE marks from their initial location because of pressure applied from the substrate.

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Monitoring Nesting Female Turtles after Dark

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Detailed studies of the nesting ecology of turtles can be hampered when turtles complete their nests after dark (e.g., Bowen et al. 2005). This limits observation without night telescopy, and makes it difficult to locate completed nests precisely and capture females for measurements after nest completion. The situation is exacerbated when a small number of observers are monitoring a large number of nesting females (e.g., Rowe et al. 2003). To overcome this problem, I evaluated several restraining methods (wire baskets, metal fences, buckets, and tubs). This report describes the restraining method that I found most successful. I have used this method for a decade in the Nebraska Sandhills.

At my study site, Painted Turtles (*Chrysemys picta*) nest almost exclusively between 1600 to 2200 h (Iverson and Smith 1993), and many Snapping Turtles (*Chelydra serpentina*) nest from 1800

to 0100 h (Iverson et al. 1997). When a female is seen leaving the marsh, I track her at a distance to her nest site. Occasionally a female will enter areas of tall grass which might make her difficult to follow. In this case I quickly (and with minimal disturbance) duct-tape a radiotransmitter to her shell, and track her from a distance for the next hour (being certain that she does not return to the marsh). I then locate her more precisely about an hour later, at which time she is usually nesting. Although time/personnel intensive (see also Rowe et al. 2003), this technique minimizes disturbance to females, and hence very few females fail to nest the first night they leave the marsh. However, with few observers it is extremely difficult to monitor more than a few nesting females without disturbance, and to locate nests precisely after nightfall.

As last light approaches (about 15 min after sunset), I very quickly cover the nesting turtle (Fig. 1) with a fiberglass tote box (65 × 46 × 25 cm deep; Consolidated Plastics, Twinsburg, Ohio). The box is oriented lengthwise to the turtle's body and centered directly over the nest cavity. The tub is then pushed firmly into the surrounding substrate (by standing on it) to allow minimal light passage under the edge of the tub. In the case of snapping turtles and painted turtles over 1 kg, I usually place a 20-liter bucket of soil or water on top of the tub to prevent the female from escaping when she has finished nesting.

At the time of restraint I note the stage of nesting (e.g., preoviposition, partial clutch laid, etc) and then return after an appropriate time and begin monitoring the tubs for the sound of the female bumping the side of the tub. The tub is then removed, the female returned to the lab for processing, and the nest is covered with predator-proof wire and mapped for further study (Costanzo et al. 2004). Palpation in the lab confirmed that each female laid her entire clutch (e.g., Thornhill 1982).

On cloudy evenings or when storms are approaching, I often deploy these tubs well before sunset, but when light levels are low. Female painted turtles that have begun depositing eggs before being covered have never abandoned their nests, though a few snapping turtles have aborted oviposition if only a few eggs were laid before covering. I have not experimented with covering turtles under high light conditions (i.e., earlier in the evening). Overheating might be an issue under those conditions.



FIG. 1. Restraining a nesting Western Painted Turtle at last light in the Nebraska Sandhills. Author on left; T. Muir on right.

The specific tubs I use are wire-reinforced and expensive (ca. $60 each), but they have the added advantage of nesting within each other for transport. In addition, when their orientation is reversed, they are stackable and functional as holding bins for turtles awaiting processing (including induction of oviposition in other females; Iverson and Smith 1993). Although cheaper tubs are available, I have found them to be cost effective in the long-term, as I have never had one break or fail in over 20 years of heavy use. This technique has been used successfully with female snapping turtles up to 12 kg and painted turtles up to 1200 g. It should work with other turtles that nest on relatively flat terrain and into the late evening.

Acknowledgments.—I thank T. Muir and P. Baker for their help in experimenting with and perfecting this technique. J. Tucker provided comments on the manuscript. My research was conducted under the authority of permits issued by the Nebraska Game and Parks Commission and the Crescent Lake National Wildife Refuge. Treatment of all animals was in accordance with the ethical principles outlined in the SSAR Guidelines for Use of Live Amphibians and Reptiles in Field Research.

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AMPHIBIAN CHYTRIDIOMYCOSIS GEOGRAPHIC DISTRIBUTION

A special section on "Amphibian Chytridiomycosis Geographic Distribution" makes its debut in this issue of *HR*. This section will offer a timely outlet for streamlined presentation of research exploring the distribution and prevalence of the amphibian chytrid fungus *Batrachochytrium dendrobatidis* (*Bd*). *Bd* is an emerging infectious disease linked to mass mortality of amphibians worldwide, yet *Bd* detections in amphibians with no symptoms also are known in many areas. To aid in our understanding of the scope of this issue, we encourage submission of studies on *Bd* geographic distribution, including research on individual species or groups of species, wild or captive animals, native or non-native species, live animals or museum specimens, environmental samples, and findings with no *Bd* detections. We ask authors to: 1) restrict the Introduction of their paper to a **maximum** of two paragraphs to highlight the context of their study; 2) briefly include both field and laboratory Methods; 3) present Results in a Table, although a map also might be very useful, and limited text; and 4) have a short discussion of a **maximum** of three paragraphs to touch upon key findings. Please consider including the following information in submissions: coordinates and de-

scription of sampling areas (or please note if locations are extremely sensitive to reveal, and provide general area instead); positive and negative results; disposition of voucher specimens; date of specimen collection; name of collaborative laboratory or researcher conducting histological sections or PCR analyses; and names of cooperative land owners or land management agencies. We aim to expedite the review and publication process! Please e-mail submissions directly to Associate Editor, Dr. Dede Olson: dedeolson@fs.fed.us.

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Incidence of the Fungus *Batrachochytrium dendrobatidis* in Amphibian Populations along the Northwest Coast of North America

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The fungus *Batrachochytrium dendrobatidis* is the disease agent responsible for chytridiomycosis in amphibians and has been associated with amphibian declines and extinctions around the world (Berger et al. 1998; Lips et al. 2006). While there is evidence that *B. dendrobatidis* spread around the world in the latter part of the last century (Ouellet et al. 2005; Skerratt et al. 2007), the full extent of its current distribution remains unclear. Information on the spatial extent of *B. dendrobatidis* will help us understand the threat posed by chytridiomycosis to amphibians.

Batrachochytrium dendrobatidis has recently been detected in *Rana sylvatica* on the Kenai National Wildlife Refuge in Alaska (Reeves and Green 2006) and in introduced *Rana catesbeiana* on Vancouver Island, Canada (Garner et al. 2006). It is predicted to occur all along the northwest coast of North America (Ron 2005), but no other cases of amphibians with *B. dendrobatidis* have been reported in this region. Here, we report the results of surveys of 27 native amphibian populations at 22 sites spanning the northwest coast from Vancouver Island in British Columbia, Canada, north to the vicinity of Skagway, Alaska, USA (Fig. 1).

In the summers of 2005 and 2006, we captured adult, juvenile and larval amphibians by hand or dip net and sampled them for *B. dendrobatidis* by swabbing a rayon swab (Medical Wire, MW113) over the body of each individual. Frogs were held separately prior to swabbing and technicians wore a new pair of gloves for each individual handled. As the frog was restrained, the swab was firmly rubbed back and forth 30 times over the drink patch and mouth and was rubbed on the webbing between each toe. The swab was then air dried for 30 minutes and stored in a pre-labeled (cryo-

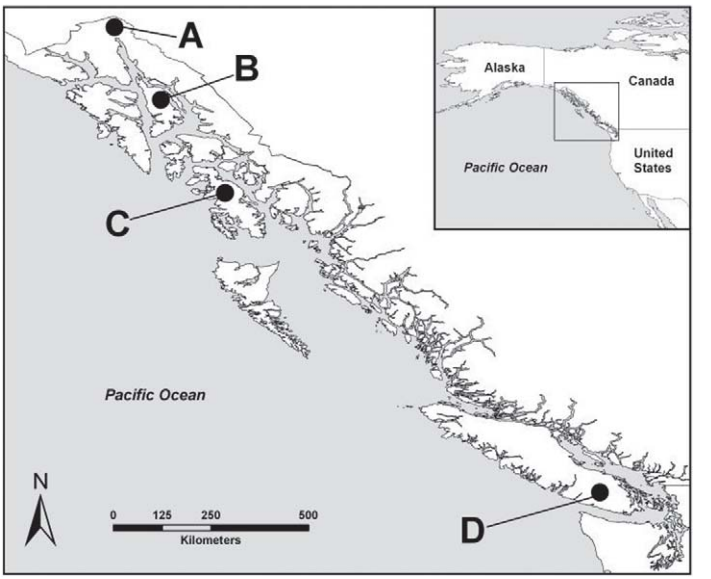


FIG. 1. Study areas where amphibians were sampled for the presence of *Batrachochytrium dendrobatidis* in 2005 and 2006 in Alaska, USA (Areas A, B, and C) and British Columbia, Canada (Areas A and D).

TABLE 1. The number of adult, juvenile, and larval anurans that tested positive (in bold) or negative for the presence of *Batrachochytrium dendrobatidis* in 2005–2006. See Fig. 1 for Study Area locations. The species examined were *Bufo boreas* (BUBO), *Rana luteiventris* (RALU), *R. sylvatica* (RASY), and *R. aurora* (RAAU).

Study Area	Latitude	Longitude	Species	Adults		Juveniles		Larvae	
				-	+	-	+	-	+
A	59.227350	-135.458100	BUBO	8	**7**	10	0	0	0
A	59.245880	-135.525250	BUBO	13	**4**	0	0	0	0
A	59.415410	-135.950260	BUBO	13	**4**	0	0	0	0
A	59.510111	-135.348638	BUBO	0	**3**	5	**2**	0	0
A	59.505750	-135.350694	BUBO	1	0	0	0	0	0
A	59.528611	-135.369111	BUBO	1	0	2	0	0	0
A	59.510944	-135.362083	BUBO	0	0	9	**1**	0	0
A	59.537083	-135.431694	BUBO	0	0	2	0	0	0
A	59.510555	-135.344194	BUBO	0	0	2	**8**	0	0
A	59.766416	-135.119722	RALU	2	0	3	0	0	0
A	59.777583	-135.087083	BUBO	2	0	0	0	0	0
A	59.777583	-135.087083	RALU	1	0	0	0	0	0
A	59.777583	-135.087083	RASY	1	0	0	0	0	0
A	59.795750	-135.036972	RALU	2	0	0	0	0	0
A	59.795750	-135.036972	RASY	0	0	1	0	0	0
B	58.299770	-134.672710	BUBO	17	0	0	0	0	0
B	57.575310	-134.396100	BUBO	10	0	0	0	0	0
C	55.575000	-132.642330	BUBO	2	**3**	3	**7**	0	0
C	55.926880	-132.767900	BUBO	14	**5**	1	0	0	0
C	55.688300	-132.634950	BUBO	16	**6**	0	0	0	0
D	48.802027	-123.952805	RAAU	4	**1**	0	0	5	0
D	49.766666	-125.100000	BUBO	1	0	0	0	5	0
D	49.766666	-125.100000	RAAU	0	0	0	0	5	0
D	49.260694	-124.260611	RAAU	0	0	0	0	10	0
D	48.516666	-123.716666	BUBO	0	0	5	0	0	0
D	48.516666	-123.716666	RAAU	2	**1**	2	0	0	0
D	49.341944	-124.620638	BUBO	0	0	5	0	5	0

babies labels, Diversified Biotech, 9188-2000) sterile, screw cap 1.5 ml microcentrifuge tube (Fisher # 05-669-12). In most cases vials were shipped to the laboratory for analysis within 2 weeks of sampling but in some cases were frozen and held for up to 6 months. Each swab was analyzed individually for the presence of *B. dendrobatidis* using a real-time Taqman PCR assay at the U. S. Geological Survey, National Wildlife Health Center (Boyle et al. 2004). All field gear was cleaned with a brush and water and then sprayed with a dilute bleach solution between each sampling location.

Of 242 amphibians swabbed, 52 were positive for *B. dendrobatidis* (Table 1). We found *B. dendrobatidis* on individuals from 11 of 22 populations and in 3 of the 4 study areas (A, C, and D). All but 2 of the positive results were for *Bufo boreas* adults or juveniles. The other two positives were for *Rana aurora* adults. No *R. luteiventris* or *R. sylvatica* were positive. We did not find any frogs that were dead or appeared to be sick. For populations with at least one positive animal and with N 5 adults and juveniles, the percent of adults and juveniles testing positive averaged 34% and ranged from 10 to 80%.

There is increasing documentation that *B. dendrobatidis* is geographically widespread (Berger et al. 1998; Carnaval et al. 2006; Garner et al. 2005; Lips et al. 2006; Ouellet et al. 2005; Pearl et al. 2007; Pounds et al. 2006). Our results add to this evidence and verify the prediction of Ron (2005) that this pathogen should occur along the northwest coast of North America.

Acknowledgments.—This work was funded by the U. S. Geological Survey's Amphibian Research and Monitoring Initiative. We complied with all applicable institutional animal care guidelines and obtained appropriate research permits to do this work. Use of trade names does not constitute endorsement.

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NATURAL HISTORY NOTES

Instructions for contributors to Natural History Notes appear in Volume 38, Number 1 (March 2007).

CAUDATA

AMBYSTOMA ANNULATUM (Ringed Salamander). **CAVE USE.** Numerous species of salamanders are known to utilize caves for their entire or partial life history requirements, such as foraging and feeding, refugia from summer drought or winter cold conditions, and/or reproduction, while others are considered accidentals (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Inst. Press, Washington, DC. 587 pp.). The karst area of the Ozark ecoregion in Arkansas, Missouri, and Oklahoma contains thousands of caves that are known to support a modest diversity of salamander species, especially plethodontids (Black 1973. Proc. Oklahoma Acad. Sci. 53:33–37; McDaniel and Gardner 1977. Proc. Arkansas Acad. Sci. 21:68–71; Graening and Brown 2000. Status Survey of Aquatic Cave Fauna in Arkansas. Arkansas Game and Fish Commission Rept., 43 pp.; Elliott and Ireland 2002. *In* Proceeding of the National Cave and Karst Management Symposium, pp. 123–130. Tuscon, Arizona; Briggler and Prather 2005. Am. Midl. Nat. 155:136–148). Occasionally, ambystomatid salamanders are observed within caves; two species (*Ambystoma tigrinum* and *A. maculatum*) have been reported in caves within the Ozark ecoregion (Black 1969. J. Herpetol. 3:183–184; McDaniel and Gardner, *op. cit.*; Bill Elliott, pers. comm.). Herein, we report the first known documented sighting of *A. annulatum* in a cave in southern Missouri.

On 2 Oct 2003, an adult *A. annulatum* was observed in Mud Spring Cave, a U.S. Forest Service-owned cave in the Willow Spring District, Mark Twain National Forest, ca. 4 m from the cave entrance (R. Rimer, pers. comm.). Return to the cave on 10 Jan 2004 by both authors yielded another finding regarding the presence of *A. annulatum* in Mud Spring Cave. A pool within the cave contained 18 larval *A. annulatum*. The pool starts ca. 30 m from the cave entrance and extends ca. 35 m further into the cave.

There were two size classes of *A. annulatum* larvae; sixteen of the larvae were ca. 20 mm TL while the remaining 2 larvae were ca. 30 mm TL. Two larvae were removed and allowed to transform for identification confirmation. One specimen was deposited in the Dean E. Metter Memorial Collection, University of Missouri, Columbia (UMC 7969). We would also like to document an unpublished observation of an adult *A. annulatum* discovered in a pit cave (Whiskey Pit Cave, Christian Co.) on 10 Oct 1984 (G. Gardner, pers. comm.). Gardner (pers. comm.) stated that this individual likely fell into the pit entrance of the cave and was trapped. To our knowledge, these accounts are not only the first documentations of *A. annulatum* use of caves, but the first account of the species using a cave pool for reproduction. The only other ambystomatid known to utilize caves for reproduction in the Ozark ecoregion is *A. tigrinum* (Black 1969, *op. cit.*).

We extend our thanks to Gene Gardner and Bill Elliott for providing unpublished information.

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AMBYSTOMA MACULATUM (Spotted Salamander). **MIGRATION/BREEDING OBSTRUCTION.** Ambystomid salamanders in the northeastern United States migrate to vernal pools to breed during the first warm rains of spring. These shallow, ephemeral pools form from snowmelt and precipitation in the spring, and typically dry up by late summer. This keeps vernal pools free of fish which could prey on amphibian eggs and larvae, but allows enough time for the eggs to hatch (ca. 6–8 weeks after deposition) and larvae to metamorphose (ca. 2–4 months). (Kenney and Burne 2000. A Field Guide to the Animals of Vernal Pools, Massachusetts. Div. Fisheries and Wildlife, 73 pp.).

Migrating salamanders can face a number of hazards en route to breed in vernal pools including barriers such as houses, shopping malls and roads (Kenney and Burne 2000, *op. cit.*). Roads in particular present a hazard to migrating salamanders, both as barriers that could prevent movement and through mortality from motor vehicles (Grant et al. 2004. Wood Frog and Spotted Salamander Double-Observer Egg Mass Count Protocol, U.S. Geol. Surv.).

On the evening of 2 April 2004 at ca 2200 h while walking on a dirt road in a wooded area in Groton, Massachusetts (42°37.112'N, 71°33.018'W), we observed several *Ambystoma maculatum* that seemed to be exhibiting breeding behavior in puddles on the road. There was construction going on nearby and straw bale barriers were lining one side of the dirt road. Straw bale barriers are often used at construction sites to prevent sediment runoff into adjacent wetlands and other natural habitats (V. Turano, pers. comm.). Upon closer inspection, we discovered several more *A. maculatum* wandering along the base of the straw bale barriers, presumably trying to find a way to the vernal pool sites on the opposite side of the road. This presumption was further strengthened by the discovery of an *A. maculatum* on top of a straw bale barrier.

On 3 April 2004, the Groton Conservation Committee was contacted to remedy the situation. After discussions with the Conservation Committee some of the straw bale barriers were removed to allow passage of the salamanders to the vernal pools.

Our observations suggest that if barriers prevent salamanders from reaching their vernal pool breeding sites, the animals may attempt to breed in temporary puddles they encounter on roads. This could present a hazard, as these shallow puddles might not last as long as the developing eggs or larvae would need to mature. This phenomenon has been referred to as a potential "ecological trap" (deMaynadier and Hunter 1995. Environ. Rev. 3:230–261).

This observation also presented a paradoxical situation where a conservation practice—placement of straw bale barriers to prevent runoff at construction sites—inadvertently caused a conservation problem—the creation of a barrier to salamander migration and breeding. Local conservation officers should be aware of this in areas where salamander migration might occur, and consider temporarily removing straw bale barriers to allow adult salamanders access to vernal pool breeding sites in the spring, and later in the season, to permit natal dispersal of metamorphs back to surrounding upland habitat.

We thank Vincent Turano, Merrimack College, for information on the use of straw bale barriers at construction sites.

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DESMOGNATHUS QUADRAMACULATUS (Black-bellied Salamander). **PREDATION**. Relatively little information exists on the natural predators of adult forms of *D. quadramaculatus*. The known predators include shrews (*Blarina brevicauda*), garter snakes (*Thamnophis* spp.), and larger conspecifics (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Instit. Press, Washington DC.; Lannoo 2005. Amphibian Declines: The Conservation Status of United States Species. University of California Press, Berkeley, California.). Here I report an adult *D. quadramaculatus* being preyed upon by an adult Northern Watersnake (*Nerodia sipedon*) on 8 May 2004 at 1130 h. The predation event occurred in a headwater stream in the Highlands Ranger District of the Nantahala National Forest, North Carolina (17S 0297732E, 3878045N).

Ducey and Brodie Jr. (1983. Copeia 1983:1036–1041) found that many salamanders will remain immobile when contacted by the head or body of a predatory snake. Once a *D. quadramaculatus* feels a tongue flick or bite, it will immediately bite the predator and begin to twist its body in an attempt to free itself from a predator (Brodie Jr. 1978. Copeia 1978:127–129). Brodie Jr. (1978, *op. cit.*) found that if a predator approached a *D. quadramaculatus* from the side or rear, the salamander would flip its body off the ground using its tail and land facing the predator. The adult *D. quadramaculatus* I observed was sitting on a semi-submerged log facing downstream on an overcast day. After ca. 3 min I noticed a *N. sipedon* slowly moving down the stream and as it approached the salamander it began to tongue flick rapidly. The *N. sipedon* slowly approached the *D. quadramaculatus* from the rear right-side, but never made contact with the salamander with its body or

tongue. Once the head of the *N. sipedon* was parallel with the head of the *D. quadramaculatus*, the snake stopped and began to tongue flick once again without contacting the salamander. The *D. quadramaculatus* remained completely motionless. After ca. 1 min, the *N. sipedon* rapidly struck to its left side and grasped the *D. quadramaculatus* by the head. The *D. quadramaculatus* began twisting its body but was unable to free itself and the *N. sipedon* swallowed the salamander in 2 min. After swallowing the salamander, the *N. sipedon* continued its path downstream. It has been speculated that *N. sipedon* are predators of *D. quadramaculatus*, but to my knowledge this is the first documentation of such an event.

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EURYCEA LUCIFUGA (Cave Salamander). **DIET**. Crowell (1981. Unpubl. Ph.D. diss., University of Arkansas, Fayetteville) provides a detailed account of the feeding habits of *Eurycea lucifuga*, *E. longicauda*, and *Plethodon glutinosus* in select caves from northwest Arkansas. In stomach content analyses of these species, he identified cave cricket remains in two of 128 *E. lucifuga*, three of 81 *E. longicauda*, and none of 65 *P. glutinosus* examined. Based on our review of the literature, Crowell (1981, *op. cit.*) is the only study that specifically identifies cave crickets in the diet of *E. lucifuga*.

White (1997. Unpubl. Masters thesis, Austin Peay State University, Clarksville, Tennessee. 81 pp.) conducted an extensive ecological study of *E. lucifuga* in select caves of central Kentucky and Tennessee. On 16 Feb 1995 at 2000 and 2200 h, during a 24-h census of the visible *E. lucifuga* population at the Great Onyx entrance of Mammoth Cave (Mammoth Cave National Park, Edmonson County, Kentucky) we observed one *E. lucifuga* with *Hadenoecus subterraneus* (cave cricket) hind legs protruding from its mouth. This individual represents 2.6% of the maximum number of *E. lucifuga* (N = 38) observed during this 24 h period.

Although Crowell (1981, *op. cit.*) found dipterans to be the dominant prey item, by total number, for all three species of salamanders he often found total prey volume to be dominated by a single large prey item. We found *H. subterraneus* and to a lesser degree *Ceuthophilus stygius* (camel cricket) to be quite common at the Great Onyx entrance of Mammoth Cave during our study period. These two species of crickets represent the maximum prey size class Crowell (1981, *op. cit.*) documented for *E. lucifuga* and they are likely an important prey item for *E. lucifuga* where they co-occur.

Fieldwork leading to this observation was supported by Austin Peay State University Center for Field Biology.

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GYRINOPHILUS PORPHYRITICUS DANIELSI **(**Blue-Ridge Spring Salamander) and ***DESMOGNATHUS MONTICOLA*** **(**Seal Salamander). P**REDATION/REGURGITATION.** *Gyrinophilus porphyriticus* ssp. are known to be successful predators of heterospecific salamanders (Petranka 1998. Salamanders of the United States and Canada, Smithsonian Inst. Press, Washington D.C. 587 pp.). In the southern Appalachian Mountains, 47% of all identifiable stomach contents of *G. p. danielsi* were salamanders (Bruce 1972. Herpetologica 28:230–245). Though a variety of salamander species have been described as prey of *Gyrinophilus* spp., *Desmognathus monticola* has not been included (Petranka 1998, *op. cit.*). Herein I describe the consumption and subsequent regurgitation of a *D. monticola* by *G. p. danielsi*.

On 3 June 2006 at 1000 h a *G. p. danielsi* (SVL 93 mm, total length 138 mm, 10.8 g) and a *D. monticola* (SVL 36 mm, TL 65 mm, 1.0 g) were captured in a trap along with three *Eurycea wilderae* larvae. The larger salamanders were placed in the same 1-quart Ziploc® bag with a small amount of water while the larval salamanders were weighed and measured. In the ca. 4 min it took to measure and release the larval salamanders, the *G. p. danielsi* had completely consumed the *D. monticola*, which was only evident because of the distended abdomen of the *G. p. danielsi*. I proceeded with my routine length measurements of the *G. p. danielsi*, but the jostling and momentary restraint of the salamander caused it to regurgitate its recent meal. The regurgitated *D. monticola* appeared to be unaffected by the process, aside from a few superficial skin abrasions. The *D. monticola* was then measured and both salamanders were released.

Gyrinophilus porphyriticus ssp. are gape-limited predators (Formanowicz and Brodie 1993. Herpetologica 49:265–270), restricting the size of ingestible prey. Though no gape or circumference measurements were made of the two salamanders, this appeared to be a rather impressive feat of ingestion as the total length of the *D. monticola* was ~70% of the snout–vent length (i.e., approximate abdominal cavity) of the *G. p. danielsi*. Further, this single meal comprised almost 10% of its entire body weight. The *G. p. danielsi* had no difficulty ingesting the smaller salamander, but my observation may have been an opportunistic feeding as both were placed in close proximity within a confined area. Similar observations of such feedings have been reported by Wright and Haber (1922. Copeia 31–32).

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NECTURUS MACULOSUS (Mudpuppy). **BODY SIZE AND DIET.** On 11 Feb 2004 a large 38 cm TL, *Necturus maculosus* was captured by hook and line angling through the ice at Put-in-Bay, Ohio at 41°39.285'N, 82°49.119'W. This is the largest specimen reported from Ohio (Pfingsten 1989. Salamanders of Ohio. Ohio Biol. Survey Bull. VII [2]). The mudpuppy was placed in an empty 22.7-liter bucket filled with lake water and kept for overnight observation. The specimen regurgitated 10 shiners (*Notropis* sp.) and one adult Round Goby (*Neogobius melanostomus*). Minimal digestion aided in the positive identification of the fishes. The goby was ca. 10 cm total length. Although *N. maculosus* has been

documented to feed on varying amounts and species of fish (Cagle 1954. Copeia 257–260; Hamilton 1932. Copeia 83–86; Harris 1959. Field and Lab. 27:105–111; Lagler and Goellner 1941. Copeia 96–98) we believe this is the first documentation of *N. maculosus* foraging on the invasive Round Goby.

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PSEUDOTRITON RUBER RUBER (Northern Red Salamander). **POLYMELIA**. Polymelia, the growth of an extra limb (Meteyer 2000. Field Guide to Malformations of Frogs and Toads with Radiographic Interpretations. Biol. Sci. Rept., USGS/BRD/BSR-2000-0005, Madison, Wisconsin), has been documented extensively in anurans. Observations of polymelia in salamanders have rarely been reported and primarily restricted to the genus *Ambystoma* (North American Reporting Center for Amphibian Malformations website; http://frogweb.nbii.gov/narcam/). Few malformations have been described in stream salamanders and generally reported a lack of proper limb growth (*Desmognathus fuscus:* anopthalmia, ectromelia, brachydactyly; and *Eurycea cirrigera:* hemimelia, ectrodactyly, and brachydactyly; NARCAM website). We describe polymelia in a larval *Psuedotriton ruber* collected from a stream at Cowan's Ford Wildlife Refuge in Mecklenburg County, North Carolina (3914850N, 0503155E Zone 17). The *P. ruber* larva (SVL 38 mm, TL 60 mm) was captured using a funnel trap in a first-order stream on 20 Nov 2006. The malformation occurred on the left foreleg, which appeared to be non-functional. At the elbow, two sets of radius and ulna emerge, one of which also appeared to have a rotational malformation (Appendage 1; Fig. 1). Appendage 1 appeared to have further malformations resulting in only 2 phalanges, but appendage 2 had four fully formed metatarsal bones and phalanges (Fig. 1). This larva is the only salamander of 540 captured individuals we found with any noticeable malformation. This represents the first report of multiple limbs in a stream salamander and the only known description of a malformation in *P. ruber.*

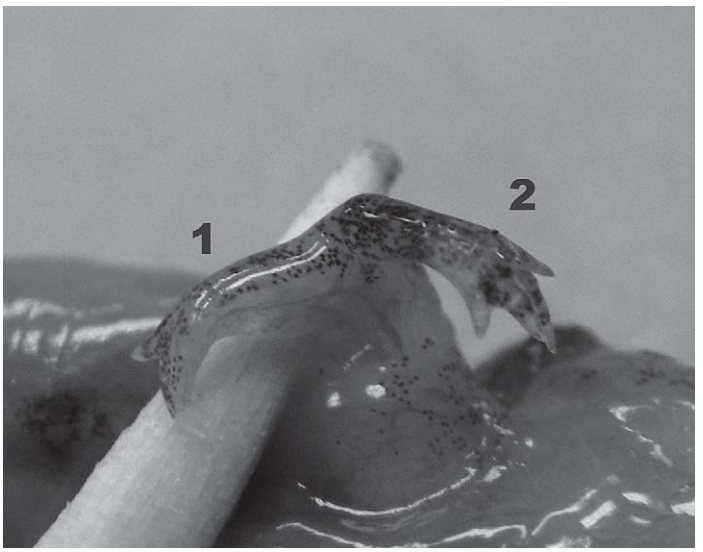


FIG. 1. Polymelia of the left foreleg of a *Pseudotriton ruber* larva.

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TRITURUS MARMORATUS (Marbled Newt). **NEWT PREDATION**. *Triturus marmoratus* feeds on earthworms, insects, and the eggs and larvae of amphibians (Salvador and Garcia-Paris 2001. Anfibios Españoles. Canseco Eds. 270 pp.). Herein I report predation of Bosca´s Newt (*T. boscai*) by *T. marmoratus* in NW Spain.

On 15 March 2006 some *T. marmoratus* were captured in our traps while monitoring the European Pond Turtle (*Emys orbicularis*) in Gandaras de Budiño wetland, NW Spain. During manipulation to release these newts, a large female regurgitated an almost intact *T. boscai*. As Salvador and Garcia-Paris (2001, *op. cit.*) stated, the diet of *T. marmoratus* in northern Spain includes eggs and larvae of other amphibians including *Bufo calamita*, *Rana perezi*, and *Pelobates cultripes*. Only an exceptional case of adult newt consumption is reported involving an adult Alpine Newt (*Triturus alpestris*). Adult *T. marmoratus* in NW Spain reach more than 150 mm TL, while *T. boscai* remains smaller, reaching 90 mm TL. Thus, *T. boscai* could be potential prey for *T. marmoratus*.

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ANURA

ATELOGNATHUS PATAGONICUS (NCN). **PREDATION**. Numerous species prey on larval and post-metamorphic anurans, including spiders, adults and larvae of aquatic insects, fishes, birds, and mammals (Duellman and Trueb 1994. Biology of Amphibians. Johns Hopkins University Press, Baltimore, Maryland. 670 pp.; Formanowicz 1986. Herpetologica 42:367–373; Heyer et al. 1975. Biotropica 7:100–111; Kokubum and Zacca 2003. Herpetol. Rev. 34:232–233; Prado 2003. Herpetol. Rev. 34:238–239). *Atelognathus patagonicus* occurs in Laguna Blanca National Park and the surrounding area of Neuquén Province, Argentina. The species was recently listed as Endangered (Lavilla et al. 2000. Categorización de los Anfibios y Reptiles de la República Argentina. Asociación Herpetológica Argentina. 97 pp.). Habitats are semi-permanent to permanent ponds and lakes. Species of aquatic and semi-aquatic birds, including grebes (*Podiceps*), Black-necked Swans (*Cygnus melancoryphus*), and Chilean Flamingos

(*Phoenicopterus chilensis*) also live at these sites.

Herein we report observations of predation on *A. patagonicus* by four species of birds. During a survey along the NW shore of Laguna Verde—a permanent pond 0.17 km^2 (39°0'S, 70°23'W; 1282 m elev.) in Laguna Blanca Park—we observed predation on tadpoles and post-metamorphic *A. patagonicus* by *Podiceps occipitalis* (Silvery Grebe) and *P. rolland* (White-tufted Grebe). Between 1120–1220 h on 28 Dec 2003, we observed 22 captures by these grebes. Seven *P. occipitalis* captured 6 tadpoles and 15 post-metamorphic frogs. One *P. rolland* captured one post-metamorphic *A. patagonicus*. A grebe would dive underwater for as long as two minutes, and then emerge with a prey item in its beak; tadpoles were held by their tails and frogs by one of their legs. The grebe would slap the prey against the water surface before swallowing it headfirst. We observed similar acts of predation by these two species on 29 and 30 Dec 2003, between 900 and 1700 h. At Laguna el Hoyo—another permanent pond in Laguna Blanca Park—two other birds, *Larus maculipennis* (Brown-hooded Gull) and *Oxyura ferruginea* (Andean Ruddy Duck), were observed preying on *A. patagonicus* on 15 Jan 2002. In these two lagoons the most commonly observed predators are birds. Hence, it is important to further investigate the interaction between bird predation and *A. patagonicus* populations.

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BUFO AMERICANUS (American Toad). **ALGAL SYMBIOSIS.** Recently, Tumlison and Trauth (2006. Herpetol. Cons. Biol. 1:51–55) reported a mutualistic relationship between algae and *Bufo* tadpoles in Arkansas. Prior to this report, algae/amphibian associations were only known to occur with amphibian egg masses. The initial observations were of relationships between an alga and *Ambystoma maculatum* (Spotted Salamander) egg masses (Gilbert 1942. Ecology 23:215–227; Orr 1888. Quart. J. Microsc. Sci. 29:257–259). Gilbert (1944. Ecology 25:367–369) described the association between the unicellular alga, *Oophila amblystomatis*, and developing *A. maculatum* embryos as symbiotic. The results of the symbiosis are greater survivorship and growth in the developing salamanders (Gilbert 1944, *op. cit.*), although Anderson (1971. Herpetol. Rev. 3:76) reported negative impacts on the developing embryos due to the presence of algae in a developing *A. tigrinum* (Tiger Salamander) egg mass.

Algae have been associated with egg masses of other species of *Ambystoma*, including *A. jeffersonianum* (Jefferson's Salamander; Gilbert 1942, *op. cit.*), *A. tigrinum* (Anderson 1971, *op. cit.*), and *A. gracile* (Northwestern Salamander; Marco and Blaustein 2000. J. Herpetol. 34:617–621.), as well as other amphibians, including *Rana sylvatica* (Wood Frog; Gilbert 1942, *op. cit.*). Algae are found not only associated with multiple amphibian species, but also distributed broadly across the United States (Cliburn and Ward 1963. Am. Midl. Nat. 69:508–509; Gilbert 1942, *op. cit.*; Marco and Blaustein 2000, *op. cit.*; Smith 1950. The Freshwater Algae of the United States. McGraw-Hill, New York.).

The phenomenon of algae aggregations on the skin of live tadpoles also appears to be distributed across several species, including toads and treefrogs (Tumlison and Trauth 2006, *op. cit.*) and geographically. While conducting a diurnal amphibian survey at Rose Pond Conservation Area, Clark County, Missouri, on 19 June 2006, we captured several *Bufo americanus* tadpoles. These tadpoles exhibited bright green patches on the ventral and lateral portions of the body, similar to those described by Tumlison and Trauth (2006. *op. cit.*). The tadpoles were in a shallow puddle (44 × 7 m,

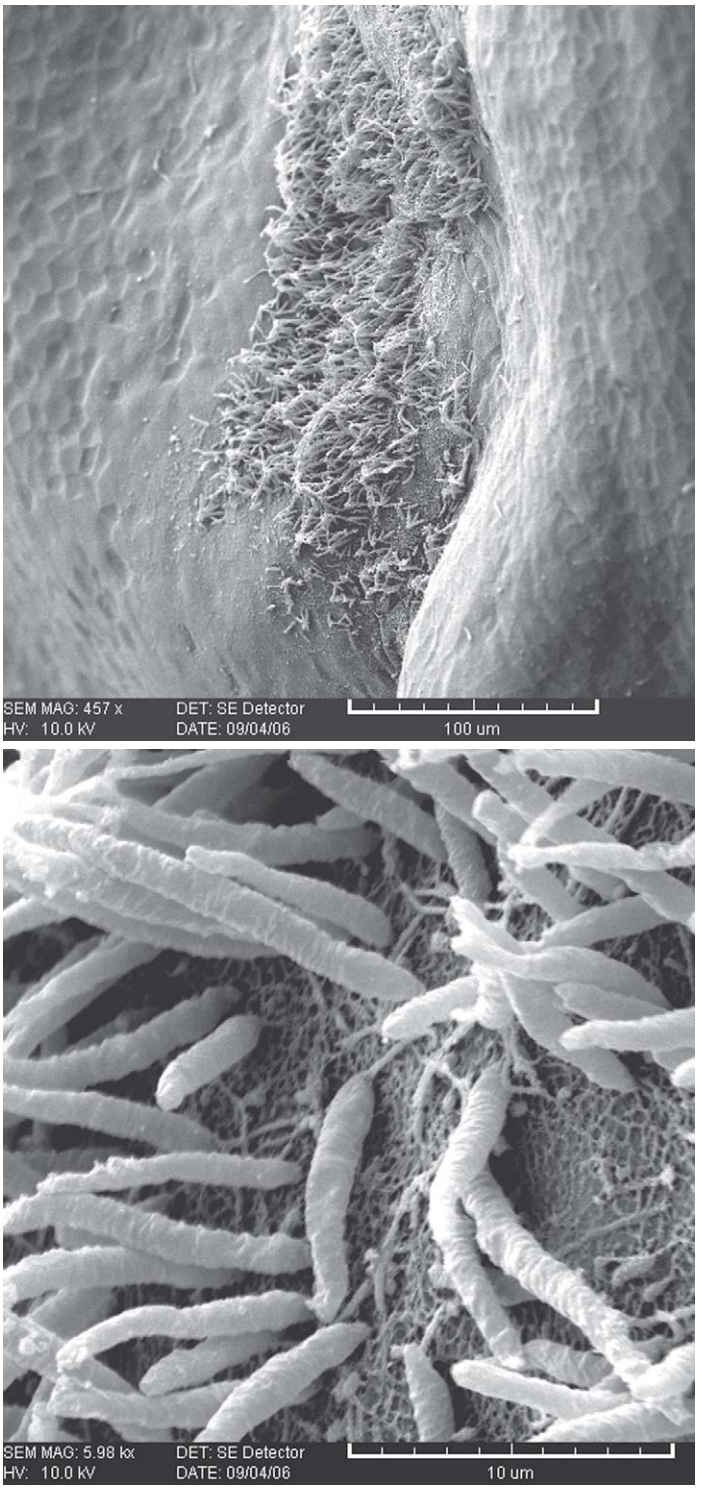


FIG. 1. Lateral aggregations of the biflagellated green alga (*Chlorogonium*) on a *Bufo americanus* tadpole.

max depth 0.27 m) that was devoid of vegetation in an open field. The water was slate gray, water temperature 32°C, dissolved oxygen content was 6.0 ppm. The pool was also inhabited by tadpoles of *Acris crepitans* (Northern Cricket Frog), *Rana pipiens* complex (Leopard Frog) and *Hyla versicolor/chrysoscelis* complex (Gray Treefrog/Cope's Treefrog), but none of these appeared to have the green algal patches. The *B. americanus* tadpoles were collected live, examined, and photographed with a stereomicroscope. The tadpoles were preserved in 10% formalin. The areas of the skin where green patches had been observed on the tadpoles were examined using a scanning electron microscope (Fig. 1). The images revealed patches of biflagellated algae that are similar to *Chlorogonium*, the same algae found on the tadpoles reported by Tumlison and Trauth (2006, *op. cit.*).

The phenomenon of algal symbiosis in amphibians is not limited to one life stage, and, as our observations indicate, the association between algae and tadpoles appears to occur in multiple species across a broad geographic range. If the species patterns were similar to those seen between algae and egg masses, we would expect algal-tadpole associations within other frog taxa beyond bufonids as well. The association of the algae and tadpole may have species- or site-dependent impacts or benefits, as is the case with algal associations with amphibian egg masses, and certainly warrants further examination.

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COCHRANELLA SAVAGEI (Savage's Glass Frog). **REPRODUCTION.** The family Centrolenidae is composed of ca. 120 species with a Neotropical distribution, mostly in mountainous areas (Zug et al. 2001. Herpetology: An Introductory Biology of Amphibians and Reptiles, 2nd ed. Academic Press, San Diego, California. 630 pp.). Reproduction is characterized by oviposition in arboreal or terrestrial substrates over small to large streams (Duellman and Trueb 1986. Biology of Amphibians. McGraw Hill, New York. 670 pp.). Although the reproductive mode is well established, basic aspects of the reproduction and natural history of many species have not been published. Here, we document clutch size, embryonic development, body size of hatchlings, parental care, and egg mortality in *Cochranella savagei*. This is a small frog (mean SVL 23.6 mm for females and 21.1 mm for males), which occurs in the Sub-Andean forest of the central and western Andes of Colombia (Ruíz-C. and Lynch 1991. Lozaina 59:1–18).

These observations were recorded at La Albania (five days during March 2006) and the Reserva Forestal Bosque de Yotoco (3 trips, each 10 days long during March, April, and June 2006). These localities are separated by ca. 5 km and are on the western slope of the western cordillera of Colombia in the Department of Valle del

TABLE 1. Data recorded for 9 egg clutches of *Cochranella savagei*. Clutches 1–3 were located at La Albania, 4–9 were located at Bosque de Yotoco. Hatching data were recorded in the six clutches marked with an asterisk (*). All measurements in mm.

Clutch	Male SVL	No. of eggs	Diameter of eggs (mean ± SD)		Days of monitoring
			First record	Last record	
1	22.4	17	4.96	5.10	3
2	20.0	19	3.93	4.21	3
3	—	18	5.00	5.20	2
4 *	23.1	18	3.90	6.40	10
5 *	22.5	19	4.48	6.36	8
6 *	23.0	15	4.90	6.29	9
7 *	23.3	19	4.10	6.11	10
8 *	22.4	16	4.56	6.23	9
9 *	2.50	18	5.00	6.00	9

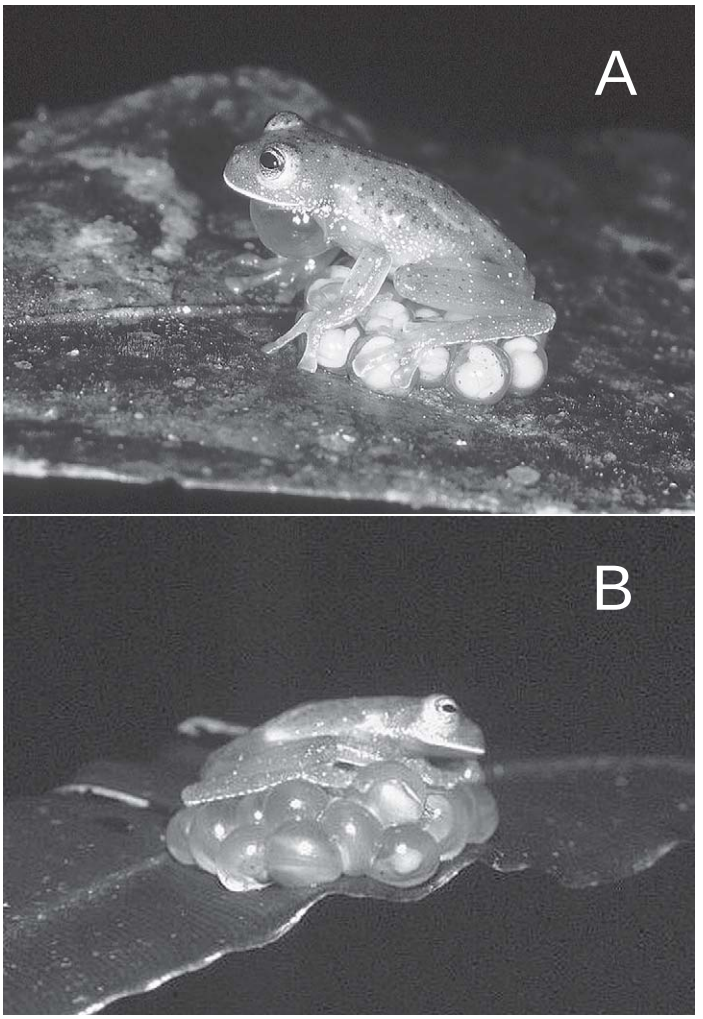


FIG. 1. Parental care and egg size changes in *Cochranella savagei*. A) Clutch with one day of development; males call above eggs or beside them to attract additional females; B) Embryos at 10 days of development, near hatching (note the eye development in embryos).

Cauca. During the first observation of each clutch, the number and diameter of eggs was counted, and the SVL of the male guarding the clutch was recorded. The number and diameter of eggs and the development of embryos was monitored during subsequent visits. When embryos of two clutches were near hatching they were captured and measurements taken (Hayes 1983. Herpetol. Rev. 14:115–116); developmental stage (Gosner 1960. Herpetologica 16:183–190) was also determined. The hatchlings were released at the capture site.

Nine clutches of *C. savagei* were recorded (Table 1). All clutches were observed on the top surface of leaves from 80–300 cm above ground. The mean number of eggs per clutch was 18 (sd = 1.41, N = 9). Mean diameter varied from 4.58 mm (sd = 0.46, N = 9) when they were 1–2 days old, to 6.4 mm (sd = 0.18, N = 6) when the embryos were close to hatching. Hatching occurred 10–12 after laying. The hatching of embryos in one clutch was not simultaneous (F. Vargas, pers. obs.). Embryos hatched at Stage 24 (Gosner 1960, *op. cit.*) with a mean size (body + tail) of 11.92 mm (sd = 0.63, N = 27). Egg predation was not recorded. Five eggs (belonging to two different clutches) did not develop. Parental care was continuous; the males were above or beside the eggs (Fig. 1) and after diurnal rains they called to attract females. However, we did not record a male at two or more clutches.

The Sub-Andean forest is one of the most threatened habitats in Colombia due to deforestation, fragmentation, and the development of urban complexes (Renjifo 1999. Conserv. Biol. 13:1124–1139; Viña and Cavalier 1999. Biotropica 31:31–36). Because of this and its narrow distributional range (< 20,000 km^2), *Cochranella savagei* is listed as "vulnerable" by the International Union for Conservation of Nature and Natural Resources (Bolivar et al. 2004. *In* IUCN 2006. IUCN Red List of Threatened Species. www.iucnredlist.org). A knowledge of the natural history of species such as *C. savagei* will be important in the implementation of management strategies for conservation.

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DENDROPSOPHUS ELEGANS (Elegant Forest Treefrog). **PREDATION.** Amphibians and reptiles are commonly preyed upon by spiders (Neill 1948. Herpetologica 4:158). In Brazil, the spider *Ancylometes* spp. (Araneae, Pisauridae) has been reported as an anuran predator (Bernarde et al. 1999. Biociências 7:199–203). Herein, we report predation of an adult *Dendropsophus elegans* in São José do Barreiro, São Paulo, southeastern Brazil (22°38'S, 44°34'W; 502 m elev.). A large number of *D. elegans* perched on branches and leaves of emergent vegetation were observed calling along the edge of a small perennial pool (ca. 6 × 12 m). On 13 Oct 2006 at 2100 h, one of us (HS) observed an adult male *D. elegans* (30 mm SVL) on grass leaves that was being eaten by the psaurid spider, *Ancylometes* spp. (21 mm cephalothorax and abdomen length). The spider was standing over the prey with its chelicerae fixed in the tree frog's head. After two hours a large area of necrotic tissue was visible around the bite. The frog was dead when the spider was collected.

Voucher specimens of the spider and frog are in the Instituto Butantan and Coleção Jorge Jim,UNESP, Botucatu, SP. We thank A. D. Brescovit for spider identification and FAPESP for financial support.

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DENDROPSOPHUS SARAYACUENSIS (Shreve's Sarayacu Treefrog). **PREDATION**. Predatory events in nature are rarely observed and published (Martins et al. 1993. Amphibia-Reptilia 4:273–296). However, these events are common and records in the literature are generally based on fortuitous observations of single events involving spiders and anurans (e.g., Formanowicz et al. 1981. Herpetologica 37:125–129; review in Menin et al. 2005. Phyllomedusa 4:39–47). Herein we report the predation of a juvenile *D. sarayacuensis* (15 mm SVL) by the spider, *Ancylometes rufus* (male; 9.32 mm cephalotorax + abdomen length). The observations were made in the "terra firme" forest, Municipality of Castanho, State of Amazonas, northern Brazil (03°60'66.5"S, 60°19'78.4"W).

On 15 May 2005 at ca. 1135h a juvenile *D. sarayacuensis* was observed in the grass moving in the direction of the spider and its web. When the frog was near to the spider, the frog was attacked. The spider caught and immobilized the frog, inserting its chelicerae in the abdominal region. The spider held the treefrog for 5 min until it was dead. Despite the fact that spiders commonly prey on amphibians, the impact of this predation on populations of amphibians is unknown (Menin et al. 2005, *op. cit*.).

We are grateful to A. P. Lima and C. S. Azevedo for identification of the treefrog and spider; M. Menin for suggestions on the manuscript; M. Davis for the English review; and CNPq for scholarships to DJR and CAPES to RA for financial support.

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HYALINOBATRACHIUM PULVERATUM (Chiriqui Glass Frog). **PREDATION.** *Hyalinobatrachium pulveratum* is found in

lotic habitats from Honduras to Colombia (Savage 2002. The Amphibians and Reptiles of Costa Rica. University of Chicago Press, Chicago, Illinois, 934 pp.). Little is known of its population biology, although Hawley (2006. J. Trop. Ecol. 22:731–734) reported embryonic development and mortality in a Costa Rican population. Here we report observations demonstrating that ants of the genus *Crematogaster* (Myrmicianae) are an additional predator capable of causing complete clutch mortality of *H. pulveratum* during early (immobile) and later (mobile) embryonic stages. All observations were made along the Quebrada Bilingual (8°26'N, 83°22'W) in the Osa Peninsula, Costa Rica.



FIG. 1. Top: Clutch of *Hyalinobatrachium pulveratum* embryos being attacked by *Crematogaster* ants on 5 August 2006. Bottom: Ants transporting embryos away from the clutch. Photos by TJH.

On 1 May 2005, TJH observed *Crematogaster* ants attacking a desiccated *H. pulveratum* clutch in an early developmental stage. Ants were extracting embryos from the thin layer of jelly. Two days later no eggs were found on the leaf.

On 5 Aug 2006, TJH and JC observed ants extracting, transporting, and consuming embryos from a desiccated clutch (ca. developmental stage 21; Gosner 1960. Herpetologica 16:203–210) (Fig. 1) on an *Inga* leaf. At 1445 h, four embryos were observed on the leaf separate from the clutch, two were intact (with body and tail), but only the body remained of the other two. During 55 minutes of observation (1530–1625 h) 15 ants were observed interacting with embryos. At 1530 h, we observed an ant transporting one embryo 3–5 cm from the clutch. Later, three ants moved this embryo about 9 cm from the clutch to the underside of the leaf. They pulled at the body and yolk region using their mandibles and legs, apparently consuming portions of the embryo. Another embryo was ca. 3–5 cm from the clutch, being consumed by three ants.

During the observation, ants attempted to extract one embryo from the clutch. One ant appeared to be chewing through the clutch jelly and trying to grasp a living embryo by its tail. Ants repeatedly arrived at the clutch, tried to extract the embryo, and then departed. Often their attempts were not successful, suggesting that it is difficult to extract embryos. Embryos occasionally moved, but were presumably unable to extract themselves from the jelly and hatch early. The tough, elastic nature of the dehydrated jelly may have made attempts to hatch early unsuccessful.

The following day (6 Aug) at 945 h more ants (30+ individuals) were observed and few embryos remained, but all were living. On 7 Aug, no embryos remained.

Crematogaster ants are known to receive sugar rewards from foliar nectaries on *Inga* in exchange for protecting the new leaves from herbivory (Koptur 1984. Ecology 65:1787–1793). *Hyalinobatrachium pulveratum* clutches are often found on *Inga* leaves but we suspect that the ants are capable of attacking the clutches only when the jelly layer is thin due to desiccation. The observations indicate that *Crematogaster* ants are capable of causing total clutch failure under these conditions.

We thank P. and G. Sanchez for permission to work on their property and support in the form of EPA-GRO and Evergreen Fellowships to TJH. We are grateful to J. Longino for confirming the identification of the ants, and to J. Lee and D. Matlaga for reviewing this manuscript.

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HYLA PICADOI (NCN)**. VOCALIZATIONS**. *Hyla picadoi* is a small to medium sized neotropical hylid frog that inhabits bromeliads attached to the trunks and branches of the humid montane forest canopy of Costa Rica and Panama (Savage 2002. The Amphibians of Costa Rica: a Herpetofauna Between Two Continents, Between Two Seas. University of Chicago Press, Chicago, Illinois. 934 pp.; Duellman 2001. The Hylid Frogs of Middle America.

TABLE 1. Call attributes (mean ± standard deviation) of the bromeliad dwelling *Hyla picadoi* from western Panama. Recorded *in situ* under weather conditions of intermittent rain, 86.1% relative humidity and 16.4°C air temperature.

call type	calls	dominant frequency (Hz)	total call lengths (s)	pulse length (s)	click series length (s)	total clicks	single clicks	double clicks	triple clicks
typical	N = 16	2035.19 ± 103.32	6.30 ± 0.88	1.53 ± 0.24	4.77 ± 0.86	12.75 ± 3.38	2.13 ± 1.41	4.38 ± 1.41	0.63 ± 0.81
short	N = 3	2067 ± 84.50	3.939 ± 0.75	0.24 ± 0.42	3.70 ± 0.96	12.67 ± 2.31	4.67 ± 2.31	2.00 ± 1.00	1.33 ± 1.15

2nd ed. Society for the Study of Amphibians and Reptiles. 1180 pp.). On 26 May 2006, 2100–2130 h, we made *in situ* recordings of this species in the cloud forests of the Los Quetzales Lodge Preserve (8°52'35"N, 82°32'50"W, 2200 m elev.), a private land holding adjacent to Parque Nacional Volcan Barú. Weather conditions consisted of bouts of intermittent rain, 86.1% relative humidity and 16.4°C air temperature. We recorded *H. picadoi* in the field at 44.1 kHz sampling rate using a Tascam DA-P1 digital audio tape recorder via an Audio-Technica 835b semi-directional microphone. Recordings have been deposited and catalogued (BLB-32346) in the archives of the Borror Laboratory of Bioacoustics at The Ohio State University.

Calls originated from at least five distinct locales within the forest canopy at varying distance and direction from the authors. Of these, 19 calls from three individuals (presumably male) were recorded under high quality conditions with low background noise. Recordings were made at distances ranging from 3 to 15 m from source animals. Vocalizations were analyzed and graphically constructed using Raven Pro v.1.2.1 interactive sound analysis software from Cornell University Bioacoustic Research Program. No morphometric measurements were possible on recorded subjects as they were out of reach of capture. Confirmation of this vocalization as being that of *H. picadoi* was established through visual identification by EDL at a date prior to obtaining digital recordings.

A typical vocalization for *H. picadoi* was initiated by a single, amplitude modulated pulsed segment, followed by a variable combination of single, double and/or triple clicks in series (Fig. 1 and Table 1). Typical calls sounded like "creeeeeek crik crik crikek crikek crikek crikek crikekek." Calls between neighboring males generally did not overlap. However, during bouts of intense calling activity, the pulsed initial segment was reduced or eliminated (N = 3), truncating the overall length of vocalization (Fig. 2 and Table 1). This observation is interesting and may indicate differ-

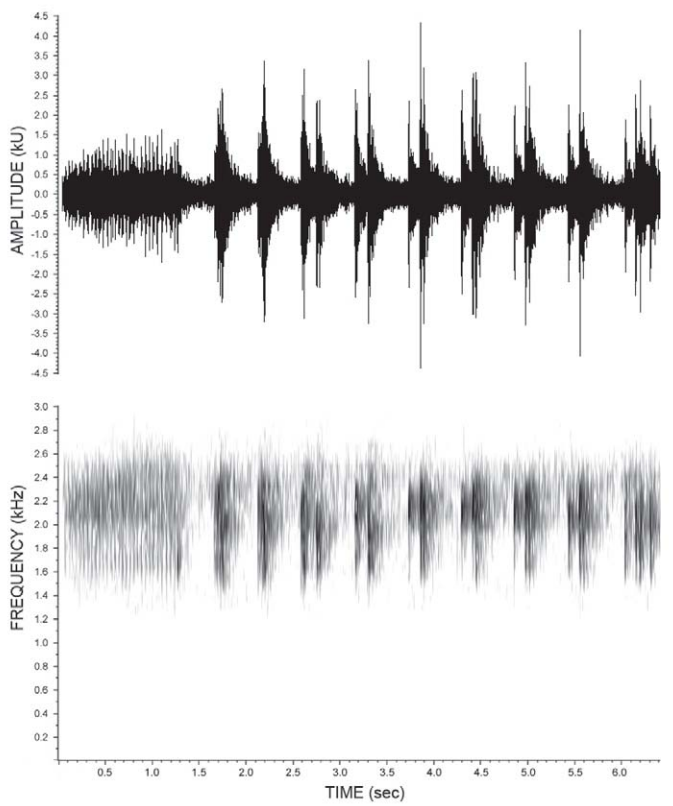


FIG. 1. Time waveform (top) and frequency spectrogram (bottom) of a typical call of *Hyla picadoi* from western Panama. Recorded *in situ* under conditions of intermittent rain, 86.1% relative humidity and 16.4°C air temperature.

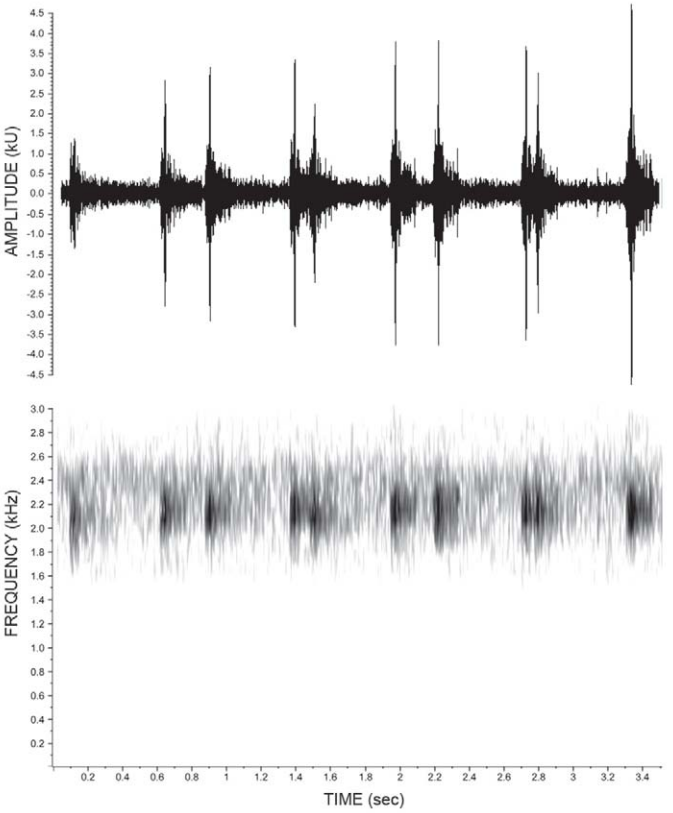


FIG. 2. Time waveform (top) and frequency spectrogram (bottom) of a short call of *Hyla picadoi* from western Panama. Recorded *in situ* under conditions of intermittent rain, 86.1% relative humidity and 16.4°C air temperature.

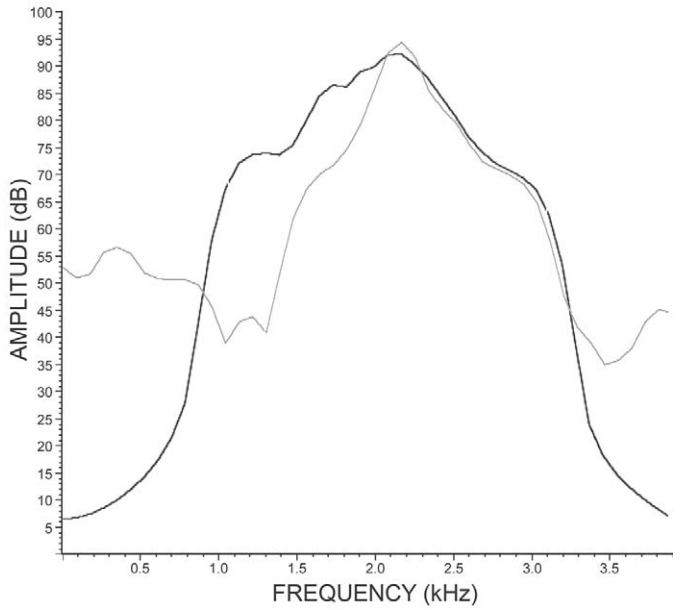


FIG. 3. Power spectrogram of typical (black) and short (gray) calls (512 pt, Hann Window) of *Hyla picadoi* from western Panama. Recorded *in situ* under conditions of intermittent rain, 86.1% relative humidity and 16.4°C air temperature.

ing functions of the pulsed segment and ensuing sequence of clicks (e.g., intersexual attraction, intrasexual territoriality, etc.). Spectral densities of both call types were dominant from 1866 to 2155 Hz (Fig. 3 and Table 1). Further research should elucidate the social contexts of each vocal component.

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OSTEOPILUS SEPTENTRIONALIS (Cuban Treefrog). **SAUROPHAGY**. On 11 Nov 2006, a subadult Cuban Treefrog (SVL 35 mm; 1.6 g; UF 150247) was observed consuming a subadult female Green Anole (*Anolis carolinensis*; SVL 33 mm; 0.8 g; UF 150248) among a coiled garden hose at 8711 W. Knights Griffin Road in Plant City, Florida (28°04'45.2"N, 82°14'75.1"W). The frog was photographed, allowed to finish consuming the lizard, collected, measured, weighed, frozen, then dissected to extract, identify, measure, and weigh the lizard; both were then preserved in formalin. One large male, a large female, and two other subadult Green Anoles were present among the coiled garden hose at the time of this observation. Green Anoles, Brown Anoles (*Anolis sagrei*), and Cuban Treefrogs are abundant at this location and regularly utilize this and other garden hose, water tank, and other ruderal sites, especially during winter months. The Cuban Treefrog is known to consume many native anurans (Meshaka 2001. The Cuban Treefrog in Florida, Univ. Press Florida; Meshaka et al. 2004. The Exotic Amphibians and Reptiles of Florida. Krieger Publishing, Malabar, Florida), at least one introduced lizard (*Anolis sagrei*; Meshaka 2001, *op. cit.*), and even native snakes (Maskell et al. 2003. Herpetol. Rev. 34:137), but this is the first record of the native *A. carolinensis* in its diet.



FIG. 1. Juvenile Cuban Treefrog in the process of consuming a similar-sized Green Anole.

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PHYSALAEMUS FISCHERI (Fischers Dwarf Frog). **MALE-MALE AGGRESSION**. Male-male combat has been described in two species of the genus *Physalaemus*, *P. cuvieri* (Barreto and Andrade 1995. Amphibia-Reptilia 16:67–76) and *P. centralis* (Aguirre 1998. Herpetol. Rev. 29:165), and in the closely related *Engystomops pustulosus* (Ryan 1985. The Túngara Frog: A Study in Sexual Selection and Communication. University of Chicago Press, Chicago, Illinois). Herein I report a field observation of male-male combat in *Physalaemus fischeri* (= *enesefae*), observed in 1997 at Fundo Pecuario Masaguaral (8°34'N, 67°35' W), Guárico State in the Venezuelan Central Llanos. *Physalaemus fischeri* males call from shallow water amidst vegetation. Males occupy the same site throughout the night and for several consecutive nights, although they do not defend territories (Tárano and Herrera 2002. Ethology 108:1–14). One night, while recording male calls in the field, I noticed an unusual call pattern and pitch shift from a nearby male. Initially, calls were typical (Tárano 2001. Copeia 2001:1064–1072) but suddenly the male's call pitch slightly increased, its call length shortened and the male stopped calling. Then I observed two males engaged in body combat. The two frogs, the caller and a presumed intruder, kicked, jabbed each other, and rolled on the ground. The combat lasted less than one minute. Afterwards, one male jumped away while the other remained in the vicinity of the original calling site. The former returned after a few seconds and both males resumed fighting for a few more seconds. The combat ended when one male left the site. I could not determine whether the 'winner' was the resident male or the intruder. The remaining male did not resume calling within the next 5 minutes. Displacement of amplectant males has not been observed in *P. fischeri* and potential satellite behavior has been observed rarely (Tárano and Herrera 2002, *op. cit.*). In addition, calling males can be close together in dense choruses (10 cm apart), or during high activity nights indicating that males are quite tolerant of other males. Proximate causes of the observed aggression could not be determined.

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PHYLLOMEDUSA AYEAYE (Reticulate Leaf Frog). **HABITAT AND CONSERVATION.** *Phyllomedusa ayeaye* is listed as critically endangered (Caramaschi and Gonçalves da Cruz 2004. 2006 IUCN Red List of Threatened Species. <www.iucnredlist.org>. 09 Feb 2007). This species is known from a few sites within the Poços de Caldas Plateau, state of Minas Gerais, Brazil (21°47'S, 46°33'W). The type specimens were collected around artificial, water-filled trenches (Lutz 1966. Copeia 1966[2]:236–240). Cardoso et al. (1989. Rev. Brasil. Biol. 49[1]:241–249) reported males calling around a permanent, water-filled artificial pit. In 1988 AAG found tadpoles in this same pit. On 18 Nov 2006, at the type locality, we found a male *P. ayeaye* calling perched on vegetation bordering a trench (ca. 1 m wide, 2 m deep) where rainwater had accumulated ca. 0.4 m deep. The trench is bordered by scattered small trees (< 4 m tall) and shrubs. It runs down a hill covered by natural altitudinal fields (ca. 1300 m asl) used for extensive cattle farming. *Leptodactylus cunicularius* (Sazima and Bokermann 1978. Rev. Brasil. Biol. 38:904) was also calling along the trench. This site is less than 10 km from the site described by Cardoso et al. (1989 *op. cit*.). As far as we know, this observation of *P. ayeaye* in nature is the first reported in the last 26 years. The Poços de Caldas Plateau is currently undergoing extensive human alteration by expansion of *Eucalyptus* plantations that eliminate natural grasslands. Considering the large number of endemic frogs in the region (Giaretta and Sazima 1993. Rev. Brasil Biol. 53[1]:13–19; Vasconcelos and Giaretta 2003 Rev. Esp. Herpetol. 17:21–27), immediate plans to reverse this trend are necessary. Our data is important because it indicates that *P. ayeaye* also uses deep ponds in open areas and that not only the forest habitat but also the natural altitude fields need to be protected.

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PLEURODEMA CINEREUM (Puna's Four-eyed Frog). **COMMUNAL OVIPOSITION.** Communal oviposition has been recorded in several species of Leptodactylid frogs in the genera *Pleurodema* and *Physalaemus* (Zina 2006. Amphibia-Reptilia 27:148–150). Here we describe communal oviposition from a population of *Pleurodema cinereum* in the urban area of Copacabana (16°09'58"S, 69°05'09"W), 700 m from the coast of Titicaca Lake, La Paz Dept., Bolivia. Titicaca Lake, 3850 m elev., is located in the Puna of the Bolivian Altiplano. The wet season extends from December through March, with an average of 1000 mm rainfall, but with 50% annual variation. The rains are mild and constant almost every day. These observations occurred on 31 Dec 2005 in two temporary pools located in an untilled field in the town of Copacabana. The two pools had a surface area of ca. 105 m^2 and ca. 35 m^2, with a mean depth of 15 cm. They were covered by some aquatic vegetation, principally Juncaceae. Explosive choruses of *P. cinereum* were found after several days of mild afternoon rainfalls. Observations began at 1500 h (Water = 10°C; Air = 7.5°C). Two different communal oviposition sites were located, with 9 amplecting pairs in the larger and 6 in the other. The release of eggs and the jelly beating were directed toward the center of the ellipse, and that produced a large foam mass. The foam of the 9 amplecting pairs measured 28 cm × 12 cm, and the other 20 cm × 11 cm. Only males were observed to participate in the jelly beating and building of the foam nest. This is similar to observations reported by Fernandez and Fernandez (1921. An. Soc. Cient. Arg. 91:97–140).

We found an additional 11 completed communal nests and 4 that, because of their small size (7 cm diameter), were probably built by single pairs in amplexus. All nests were within the more heavily vegetated areas that provided better attachment and protection. During the period of observation, we found ca. 40 calling males, 16 close to the communal oviposition sites. We also found 10 unmated females and 9 amplecting pairs close to each other that had not begun construction of their foam nest. The calling males and all of the amplecting pairs were in the shallowest parts of the ponds, 5–7 cm deep.

As suggested by Hödl (1990. Copeia 1990:547–554), communal oviposition could result from the scarcity of adequate sites for the construction of the foam nest, or else represent a strategy against



FIG. 1. Communal oviposition in *Pleurodema cinereum* found near the coast of Titicaca Lake, Dpto. of La Paz, Bolivia, on 31 December 2005. The arrow shows an unmated male.

desiccation. In this particular case both hypotheses appear feasible if we consider Puna's unfavorable weather, the conditions of the ponds, and the explosive reproductive behavior of *P. cinereum*.

We thank D. Ferraro, D. Baldo, C. Morgan, J. M. Barnett, and J. Zina for their contributions.

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PSEUDACRIS HYPOCHONDRIACA (San Lucan Chorus Frog). **REPRODUCTION**. Much of the information on reproduction in this species is available under an earlier name, *Hyla regilla* (Schaub and Larsen 1978. Herpetologica 34:409–416) and little is known of populations in Mexico. In Baja California Sur, *P. hypochondriaca* breeds during wetter months; in the Cape Region there are reports of calling males and amplexus from January through October (Grismer 2002. Amphibians and Reptiles of Baja California: Including Its Pacific Islands and the Islands in the Sea of Cortez. University of California Press, Berkeley. 399 pp.).

On 11 Dec 2006, 2120 h, we found an adult female (40.1 mm SVL, 8.9 g) *P. hypochondriaca* with evidence of eggs inside her body. At 0900 h the next day the frog was measured, weighed, and marked with VIE (Visible Implant Elastomer). At 1500 h she was released at the point of capture, a small, shallow (4 sq. m, 10 cm deep) temporary pond in Cañón de Santa Rita, Sierra de la Laguna, southern Baja California Sur, México (23°28.28'N, 109°48.5'W; elev. 267 m). At 1600 h we found the same female in amplexus with a male (33.4 mm SVL, 4.2 g) and two hours later the amplexus finished. The female deposited 6 egg massess (total of 82 eggs), which were attached to aquatic vegetation at 5 cm depth. After amplexus, the female lost 2.9 g (32.6%)of her mass. This information contributes to the knowledge of reproduction in *P. hypochondriaca* females in the southernmost part of their distribution.

We thank Abelino Cota for assistance with fieldwork.

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RANA BOYLII (Foothill Yellow-legged Frog). **PREDATION.** On 10 May 1996, an adult female Sacramento Pike Minnow (*Ptychocheilus grandis*; 451 mm TL, 950 g) was collected from the margin of the Eel River near Holmes, Humboldt Co. California, USA. Stomach analysis revealed an adult Foothill Yellow-legged Frog, *Rana boylii* (70 mm SUL), one complete *R. boylii* egg mass, and five Threespine Stickleback (*Gasterosteus aculeatus*). The frog and egg mass (31.49 g, combined weight) were undigested suggesting recent ingestion (< 1 h). With few exceptions, previous literature does not describe amphibians in the diet of *P. grandis* (Brown 1990. Southwest. Nat. 35:249–260; Taft and Murphy 1950. California Fish Game 36:147–164).

In California, *R. boylii*, a state species of special concern, is rare or absent in habitats where introduced aquatic predators are present (Jennings and Hayes 1994. Amphibian and Reptile Species of Special Concern in California. California Dept. Fish and Game, Rancho Cordova, California. 255 pp.). *Rana boylii* has been extirpated from much of its historical range in areas where it was sympatric with *P. grandis*, primarily the Central Valley and central Coast Ranges. The majority of extant *R. boylii* populations are outside the present range of *P. grandis*, although they are sympatric in the Eel River.

In 1979, *P. grandis*, a California endemic, was illegally introduced into the Eel River drainage. By 1986 it had successfully colonized ca. 200 km of river (Brown and Moyle 1997. Environ. Biol. Fishes 49[3]:271–291). During a diet analysis of this *P. grandis* population, amphibians were found in 42 of 345 individuals. Brown and Moyle (1997, *op. cit.*) concluded that in the Rice Fork of the Eel River, frogs and tadpoles are an important part of the diet. Although we do not believe *P. grandis* is a primary threat to *R. boylii*, it is of concern that an egg mass as well as an adult frog were taken. Monitoring of the interaction between these species would be valuable.

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RANA CAPITO (Gopher Frog). **REFUGE DURING FIRE.** Most animals have adaptive behaviors that help them escape fire, but little is known about how amphibians survive fires in fire-maintained ecosystems. During a radio-telemetry study of *Rana capito* in the Ocala National Forest, Marion County, Florida, USA, the U.S. Forest Service conducted a prescribed fire on 20 July 2006 as a normal management activity to maintain suitable habitat for *R. capito* and other species that occur in the longleaf pine, *Pinus palustris*, ecosystem. Two newly metamorphosed juveniles with attached transmitters were present in the burn area during this time. They were captured at drift fences surrounding ephemeral ponds and outfitted with external transmitters at ca. 1100 h on 19 July 2006. Immediately following transmitter attachment they were released near the capture site. We located the frogs immediately post-fire at ca. 2000 h on 20 July 2006. One frog moved 71 m from the drift fence into an abandoned burrow excavated by an adult Gopher Tortoise, *Gopherus polyphemus*. The second frog moved 43 m from the drift fence into an unburned patch of Wiregrass, *Aristida stricta*. Because we did not locate these frogs immediately before the fire, we do not know whether they moved to refuges in response to the fire or sometime during the previous day before the fire.

These observations indicate that *R. capito* is able to survive fires in underground refuges and in areas that do not burn when the fire passes. There was no evidence of mortality, as we might expect for a species that evolved in a fire-maintained ecosystem. Richter et al. (J. Herpetol. 35:316–321) reported no mortality of three adult Dusky Gopher Frog, *R. sevosa*, during a prescribed fire, also suggesting that *R. capito* are not highly vulnerable to fire. These observations highlight the importance of heterogeneous fire, which allows animals to take shelter in unburned areas when no other refugia are available.

The Florida Fish and Wildlife Conservation Commission provided funding for the radio-telemetry study on *R. capito*.

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RANA CATESBEIANA (American Bullfrog). **DIET.** On 2 January 2006 we observed *Rana catesbeiana* ingesting a native Haitian tree frog, *Osteopilus dominicensis*. The incident took place in an area of canal runoff near Hospital Albert Schweitzer in Deschapelle, Haiti at 2130 h. In Haiti, *R. catesbeiana* is an exotic, invasive species (Schwartz and Henderson 1988. Milwaukee Publ. Mus. Contr. Biol. Geol. No. 74, 264 pp.). *Rana catesbeiana* were first reported in Haiti in 2002 by the Invasive Species Specialist Group (ISSG). Surprisingly, *R. catesbeiana* is not listed as an invasive species threat in the Caribbean (Kairo and Ali 2003. Rept. to the Nature Conservancy. CAB International, Trinidad and Tobago). In other areas, introduced *R. catesbeiana* may be responsible for significant levels of predation on native anurans and other aquatic herpetofauna (Rosen and Schwalbe 1995. *In* Laroe et al. [eds.], U.S. Dept Interior, Natl. Biol. Serv., Washington, D.C. 530 pp.). Until recently, the range overlap of *R. catesbeiana* with any member of the genus *Osteopilus* has been limited to the Caribbean. However, the latest northward expansion of *O. septentrionalis* in Florida, USA has brought these two species together (P. Moler, pers. comm.). Thus, opportunities for such a predatory observation have been limited and this observation represents the first documented case of *R. catesbeiana* preying on a member of the genus *Osteopilus*. The *R. catesbeiana* appeared to foam at the mouth while ingesting the *O. dominicensis*, probably due to the toxic skin secretions, but this reaction did not appear to deter the act of ingestion. Several male and female *R. catesbeiana* were encountered at this site suggesting establishment in the immediate area.

We thank Becky and Ted Crosby of the Crosby Fund for Haitian Education for giving us the opportunity to visit Haiti.



FIG. 1. *Rana catesbeiana* ingesting *Osteopilus dominicensis.*

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RANA CATESBEIANA (American Bullfrog). **PREY.** *Rana catesbeiana* is known to be an efficient predator of small vertebrates. Although amphibians can make up a large part of the diet, predation on snakes has been noted by several authors. Here we report *Liophis p. poecilogyrus* as prey of a female *R. catesbeiana* (SVL 109.2 mm). The frog was collected by S. L. Lima on 17 Aug 1983, in the municipality of Coimbra, Minas Gerais State, southeastern Brazil. The frog was fixed opened to show the whole prey (Fig. 1). The snake (TL 336.1 mm) was well preserved and its tail was hanging out of the frog's mouth, suggesting that it was swallowed just before collection. *Liophis poecilogyrus* is a terrestrial snake that feeds on anurans. It is well distributed over South America, with diurnal and nocturnal habits.

Rana catesbeiana is a nonnative species in Brazil, where it was introduced in the 1930s for commercial harvest. Because of poor management practices and high survival of individuals in wild habitats, this species established feral populations in many regions of the country. The voucher specimens currently are deposited at Museu de Zoologia João Moojen, Universidade Federal de Viçosa, Viçosa, Minas Gerais State, Brazil (*R. catesbeiana* MZUFV 202, *Liophis p. poecilogyrus* MZUFV 1380).

We thank Jorge A. Dergam for his comments on this note.



FIG. 1. A female *Rana catesbeiana* (MZUFV 202) showing a whole specimen of *Liophis p. poecilogyrus* in its stomach.

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RANA SPHENOCEPHALA (Southern Leopard Frog) and ***SCAPHIOPHUS HOLBROOKII*** (Eastern Spadefoot). **REPRODUCTIVE BEHAVIOR.** Southern Leopard Frogs are most active in the winter and spring, and Eastern Spadefoots are explosive breeders stimulated by heavy rainfall events (Ashton and Ashton 1988. Handbook of Reptiles and Amphibians in Florida. Part III: The Amphibians. Windward Publ. Co., Miami. 191 pp.). In Florida, both species can be found breeding in the same wetland, especially in the fall or winter months. Here I report a case of inter-species amplexus following a heavy rain in early February.

From 1–2 February 2007, ca. 7 cm of rain fell in Micanopy, Alachua County, Florida, USA. On the night of 2 February a chorus composed of *Pseudacris crucifer* (Spring Peeper), *P. ocularis* (Little Grass Frog), *Rana grylio* (Pig Frog), and *R. sphenocephala* was heard in an ephemeral wetland ca. 6 km E of Micanopy. *Scaphiopus holbrookii* were not heard at this location, although large numbers were heard and seen in nearby wetlands. Several *R. sphenocephala* were observed in amplexus within the wetland, including one male (48.5 ± 0.1 mm SVL, 9.5 ± 0.5 g) that had amplexed a male *S. holbrookii* (46.1 ± 0.1 mm SVL, 7.7 ± 0.5 g). The pair was found floating near emergent vegetation in 0.5–0.75 m of water at ca. 2130 h. When approached, the *R. sphenocephala* attempted to escape, but I easily captured the pair and relocated them to shallow water for a photograph.

Aside from missed feeding and reproductive opportunities, the cost of inter-species amplexus may include increased predation risks. Encountered pairs of amplexed *R. sphenocephala* attempted escape by swimming together. The *S. holbrookii* amplexed by the *R. sphenocephala* remained motionless throughout the encounter. Several active *Agkistrodon piscivorus* (Cottonmouth) were observed in the wetland.



FIG. 1. Male *Rana sphenocephala* in amplexus with a male *Scaphiopus holbrooki*, from north-central Florida on 2 February 2007.

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SMILISCA SORDIDA (Drab Tree Frog). **PREDATION**. Spiders are well known predators of frogs (Brasileiro and Oyamaguchi 2006. Herpetol. Rev. 37:451; da Costa et al. 2006. Herpetol. Rev. 37:337–338; Formanowicz et al. 1981. Herpetologica 37:125–129; Prado and Borgo 2003. Herpetol. Rev. 34:238–239). Herein I report a case of spider predation on *Smilisca sordida*. On 22 Jan 2005 at 1955 h, in the Refugio de Vida Silvestre, Golfito (Costa Rica, Puntarenas Province, 08°39'N, 83°11'W, ca. 5 m elev.) I observed an adult male *S. sordida* being caught and bitten in the chest by the spider *Ancylometes bogotensis* (Fig. 1). The frog was 41 mm SVL, whereas the combined length of prosoma and opisthosoma of the spider was 21 mm. The frog struggled and tried in vain to get free by grabbing the spider with its forelegs but stopped moving and was apparently dead after about 90 sec. After an additional 4 min the spider carried the dead frog into its hide and immediately started to feed.

I thank the University of Costa Rica for support, and G. Dehling, M. Dehling, W. Lapinski, and T. Sandner for suggestions.



FIG. 1. Predation on adult male *Smilisca sordida* (SVL = 41 mm) by *Ancylometes bogotensis* (combined length of prosoma + opisthosoma = 21 mm).

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GYMNOPHIONA

CAECILIA THOMPSONI (Thompson's Caecilian). **MAXIMUM BODY SIZE**. *Caecilia thompsoni* occurs in northern South America, specifically in the Magdalena River Valley, Colombia. Previously, a specimen 1550 mm total length was reported as the largest caecilian known. The specimen was collected on the Riomanso Private Natural Reserve, La Dorada municipality, Caldas Department (Acosta et al. 2006. Rev. Acad. Colomb. Cienc. 30[115]:291–303). Here, I report a new maximum body size for *Caecilia thompsoni* from a specimen collected in Victoria municipality (southwestern of the Riomanso Reserve).

On 19 Jan 2006, at 1550 h I collected an adult male *C. thompsoni* on the east margin of Casanguillas stream in the vereda El Llano, Victoria municipality, Caldas Department (5°19'38.8"W,

74°50'45.8"N, 328 m elev.). The Casanguillas stream is located in a pasture with a narrow strip of riparian vegetation (3–5 m wide). This specimen was 1767 mm total length, exceeding the previous record of maximum body size for this species by 217 mm. This specimen increases the range of primary annuli for the species from 240 to 253 (Lynch 1999. Rev. Acad. Colomb. Cienc. 23 [spec. suplem.]:317–337). This specimen is the longest caecilian reported.

The specimen is deposited in the Museo de Herpetología Universidad de Antioquia (MHUA 4432) and was collected under environmental authority permits obtained by Instituto De Estudios Ambientales (IDEA) of Universidad Nacional de Colombia Sede Medellín.

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CROCODYLIA

CROCODYLUS INTERMEDIUS (Orinoco Crocodile). **JUVENILE FEEDING.** *Crocodylus intermedius,* one of the most critically endangered species of crocodilians (Rodríguez and Rojas 2003. Libro Rojo de la Fauna Venezolana, IUCN. 2nd ed., Fundación Polar/PROVITA, Caracas. 472 pp.), inhabiting the Orinoco River Basin in Venezuela, is the focus of captive breeding and habitat protection policies (Thorbjarnarson 1988. Proc. World Conf. Breeding Endangered Species Captivity 5:307–314). Few data exist on the feeding behavior of juvenile crocodiles (*C. acutus* [Thorbjarnarson 1989. *In* Hall [ed.], Crocodiles: Their Ecology, Management and Conservation, pp. 228–258. Special Publication of the Crocodile Specialist Group IUCN/SSC. Gland, Switzerland]; *C. johnstoni* [Webb et al. 1982. Aust. J. Zool. 30:877–899]; *C. niloticus* [Games 1990. *In* Proc. Ninth Working Meeting Crocodile Specialist Group. Vol. 1, pp. 251–267. IUCN. Gland, Switzerland]; *C. porosus* [Taylor 1979. Aust. Wildl. Res. 6:347–359; Davenport et al. 1990. J. Zool. London 220:569–592]), but no published data exist on the feeding behavior of juvenile *C. intermedius*. Hence, here I report an observation of juvenile *C. intermedius* feeding.

I made the observation at Fundo Pecuario Masaguaral, a cattle ranch with a crocodile farm (Blohm 1982. *In* Proc. Fifth Working Meeting IUCN/SSC Crocodile Specialist Group, pp. 267–285. Gland, Switzerland) in the State of Guárico in the Central Llanos of Venezuela (8°34'N, 67°35'W; elev. 60–75 m). The Central Llanos are lowlands (below 75 m elevation) with a well-defined wet season (May–Nov) dominated by open grasslands interspersed with deciduous forests (Troth 1979. *In* J. Eisenberg [ed.], Vertebrate Ecology in the Northern Neotropics, pp.17–30. Smithsonian Inst. Press, Washington, DC). At 2000 h (at night), I encountered a juvenile *C. intermedius* (ca. 2.5 months old, 38 cm total length) holding an adult dead male *Bufo granulosus* (ca. 4.5 cm SVL) with its jaws in a water-filled truck track ca. 9 cm deep on an unpaved road. The juvenile *C. intermedius* was in the water, with only its head above the surface, holding the dead toad with its jaws, which first I noticed when I captured the juvenile. The toad was flaccid, belly down, head inward, body axis almost parallel to the *C. intermedius*' jaws axis, with only the toad's hind legs being visible outside the *C. intermedius*' jaws. The juvenile *C. intermedius* discarded the toad following capture, presumably because it has been disturbed.

Bufo granulosus males usually call from the ground around puddles (Hoogmoed and Gorzula 1979. Zoologische Mededelingen 54:183–216), so the male *Bufo* may have been vocalizing. The juvenile *C. intermedius* escaped from an enclosure two months before this observation was made but displayed no signs of injury or starvation, suggesting that it was feeding regularly on its own. The juvenile was subsequently returned to its enclosure.

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PALEOSUCHUS TRIGONATUS **(**Schneider's Smooth-fronted Caiman**). PREDATION**. Crocodilians, opportunistic predators that eat almost any animal they capture, have diets that vary with age, size, habitat, season, year, and prey availability (Da Silveira and Magnusson 1999. J. Herpetol. 33:181–192; Campos 2004. Herpetol. Review 32:140–141). *Paleosuchus trigonatus*, a small caiman that lives along rainforest streams in Amazonia (Magnusson 1991. J. Herpetol. 25:41–48), is fairly abundant and has a relatively broad distribution. Still, it is rarely observed and data on its foraging behavior are few. Although *P. trigonatus* juveniles and adults are known to consume vertebrates such as small fish, birds, reptiles and mammals (Magnusson et al. 1987. J. Herpetol. 21:85–95), no reports exist of it preying on *Bufo marinus*. Hence, we describe a predation event by *P. trigonatus* on *B. marinus* from northern Brazil.

We made these observations on the night of 28 July 2005 at a small forest lake near the municipality of Curionópolis, State of Pará, Brazil (06°26'2"S, 49°42'59"W, datum: South America 69; elev. 625 m). At 1905 h, we observed an adult (ca 100 cm SVL) *P. trigonatus* that was moving slowly through the water approach the shore and capture an adult *B. marinus* (19 cm SVL) 40 cm above the shoreline. After capturing the toad, the caiman took it to water, but remained at the surface. It then proceeded to elevate its head above the water up to the front arms (ca. 25 cm), and bringing its head down rapidly, slamming its prey on the shoreline margin. This process lasted 20 min. This behavior continued until the caiman had broken off the toad's right leg, and a small piece of the body and the right arm; these were subsequently swallowed. During dismemberment the rest of the *B. marinus*'s body had been thrown onto shore ca. 30 cm from the water margin, where they remained for ca. 10 min. After the caiman had swallowed the first portion of the toad, it retrieved the remains, dragged them back into the water and immediately swallowed them. The entire predation episode took ca. 35 min. After finishing, the *P. trigonatus* sought refuge near some downed branches from a dead tree in the middle of the lake.

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TESTUDINES

APALONE SPINIFERA (Spiny Softshell). **PREDATION.** On 2 March 2007, we observed an Eastern Screech Owl (*Otus asio*) in a Wood Duck nest box on the bank of Tippo Bayou on Tallahatchie National Wildlife Refuge, ca. 5 km E Philipp, Tallahatchie County, Mississippi, USA (90°8'35.23"W, 33°45'44.94"N) that had partially eaten a juvenile *Apalone spinifera spinfera* × *A. s. hartwegi* ca. 49 mm in shell diameter. Most hunting by Screech Owls is nocturnal but can be crepuscular, as well as occasionally diurnal (Spendlow 1979. N. Am. Bird Bander 1979:111). They are sit-and-wait hunters that usually make straight-line perch-to-prey strikes (Gehlbach 1994. The Eastern Screech-Owl: Life History, Ecology, and Behavior in Suburbia and the Countryside. Texas A&M Univ. Press, College Station, Texas. 302 pp.). The owl had apparently caught the turtle and brought it back to the Wood Duck box to consume it. When first observed, the owl had eaten the head, three of the legs, and the tail. The remaining leg had been consumed and the shell was desiccated when the box was inspected again on 17 March.

Turtles have not heretofore been reported in the diet of Screech Owls (Gehlbach 1995. *In* A. Poole and F. Gill [eds.], The Birds of North America, No. 165, Academy of Natural Sciences, Philadelphia, and The American Ornithologists' Union, Washington, D.C.; http://bna.birds.cornell.edu/BNA/account/Eastern_Screech-Owl/FOOD_HABITS.html, accessed 23 March 2007). Likewise, Screech Owls have not been reported previously as predators of *A. spinifera* (Carr 1952. Handbook of Turtles. Cornell Univ. Press, Ithaca, New York. 542 pp.; Ernst et al. 1994. Turtles of the United States and Canada. Smithsonian Inst. Press, Washington, DC. 548 pp.; Moler 2007. *In* P. A. Meylan [ed.], Biology and Conservation of Florida Turtles, pp. 173–177. Chelonian Res. Monogr. 3, Chelonian Res. Found., Lunenburg, Massachusetts). This is the first report of *A. spinifera* predation by an Eastern Screech Owl, and this owl as a predator of a freshwater turtle.

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EMYS ORBICULARIS (European Pond Turtle). **NEST PREDATION.** On 18 September 2006 a predated nest of *Emys orbicularis* was found on a track near the Arnoia River, Ourense province, northwestrern Spain. Fragments of eggshells were visible within one meter of the hole. A hatchling turtle remained inside the hole, and a small stick was used to get the hatchling out of the nest. Because the nest was positioned between stones, the predator had apparently not been able to reach the bottom of the nest.

Several feces, found near the nest hole and on the track, contained grapes and insects, and presumably were those of a Red Fox (*Vulpes vulpes*). *V. vulpes* is a suspected predator on nests and hatchlings of *E. orbicularis* in Spain (Andreu and Lopez-Jurado 1998. *In* Fauna Iberica. Museo Nacional de Ciencias Naturales, Madrid.; Salvador and Pleguezuelos 2002. Reptiles Españoles. Canseco Eds.). Wild Boars (*Sus scrofa*) and Badgers (*Meles meles*) are also potential predators of nesting female turtles, eggs, and hatchlings, but in this case it seems likely that *V. vulpes* was the nest predator.

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GLYPTEMYS INSCULPTA (Wood Turtle). **CARRION-FEEDING**. *Glyptemys insculpta* has been referred to as an opportunistic omnivore (Harding and Bloomer 1979. Bull. New York Herpetol. Soc. 15:9–26). Although carrion is sometimes listed among dietary items for the this species (DeGraaf and Rudis 1983. Amphibians and Reptiles of New England. University of Massachusetts Press, Amherst), observations of carrion-feeding seem to be limited. Surface (1908. Zool. Bull. Div. Zool. Pennsylvania Dept. Agri. 6:105–196) found bird remains in two *G. insculpta* stomachs in Pennsylvania and attributed these to scavenging on dead material. Harding and Bloomer (1979, *ibid*.) and Farrell and Graham (1991. J. Herpetol. 25:1–9) both report the species consuming dead fish. Walde et al. (Can. Field-Nat. 117:377–388) observed Wood Turtles fighting over and eating carrion, including mice, toads (*Bufo americanus*) and fish. On several occasions turtles were observed with feathers in their mouths. Here we report an observation of a *G. insculpta* feeding on the remains of a fresh, road-killed, White-tailed Deer (*Odocoileus virginiana*).

On 30 May 2007, a White-tailed Deer, road-killed the previous day, was field-dressed and disposed of by wildlife technicians off a woods road at North Branch, New Brunswick, Canada (46°10'22"N, 65°15'51"W). The disposal site was about 10 m from the Canaan River, with two small brooks nearby. Approximately 2 h following disposal, two of us (DB and KE) returned to the site and observed an adult female *G. insculpta* (estimated carapace length ca. 180 cm) feeding on the carcass. When first encountered, the turtle had a piece of muscle tissue in its mouth. It continued feeding for about 1 minute while under observation, during which time it was photographed. The turtle was then picked up and briefly examined; when returned to the ground the turtle moved quickly towards the nearest water.

This observation provides additional evidence of the carrion-feeding proclivity of *G. insculpta*. It also suggests that road-killed vertebrates should not be overlooked as a potential source of mortality, where the presence of such might encourage turtles to linger on highways.

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GOPHERUS AGASSIZII (Desert Tortoise). **FOOD/MECHANICAL INJURY.** During a long-term growth study on *Gopherus agassizii* growth rates, tortoises have been captured annually since 1964 in Rock Valley, Nevada Test Site, Nye County, Nevada, USA (Medica et al. 1975. Copeia 1975:630–643; Turner et al. 1987.

Copeia 1987:974–979). On two occasions we noted mechanical injury caused by grass seeds, a phenomenon apparently not previously documented. Two tortoises captured 24–25 June 1998 (one subadult and one adult male) exhibited swelling below the eye and posterior to the junction of the upper and lower jaw on both sides of the head. Two additional tortoises (a subadult and an adult female) were observed with the identical condition on 16–17 September 1999. We determined that this was caused by a bolus of plant material (seeds of Red Brome Grass, *Bromus madritensis* ssp. *rubens*) lodged in the junction of the upper and lower jaw on both sides of the head, resulting in an oval distention of the facial integument (Fig. 1). The high precipitation that occurred in Rock Valley during the fall and winter of 1997–1998 (September–March total 304 mm) resulted in the germination and luxuriant growth of this exotic annual grass. Desert Tortoises find Red Brome Grass a palatable food item especially when green (Turner et al. 1984. Copeia1984:811–820; Nagy and Medica 1986. Herpetologica 42:73–92; Esque 1994. MS thesis, Colorado State University, Ft. Collins, Colorado), and will also consume it when it when dry if the tortoise is well hydrated (Nagy and Medica 1986, *op. cit.*)

Between 1998 and 1999, 4 of the 18 (22%) tortoises recaptured in Rock Valley exhibited this condition. The damage inflicted to the jaw by the seeds has persisted for a number of years. In the two adult animals, any sign of mechanical damage (distended flesh in the region impacted by the seeds) disappeared after 3 yr in the female and after 4 yr in the male. After the red brome seeds were removed in two subadult animals, the distended cheek condition continued for 4 yr, and additional seed material was removed each year. Whether the condition is permanent in subadults or might reappear in adult Desert Tortoises is unknown. Three of the tortoises were consumed by predators in 2003, but one subadult tortoise survived through 2004. Its distended mandibular region was still impacted and additional red brome seed material was removed 5 yr after it was first observed with the condition. This bolus of wedged seed material was moist and appeared to be starting to decompose when removed (Fig. 1).

When Red Brome Grass and the related Cheatgrass (*Bromus tectorum*) senesce, the mature seeds have sharp pointed florets that can injure livestock and wildlife species (Crampton 1974. Grasses in California. University of California Press, Berkeley.178 pp.; Currie et al. 1987. J. Range Manag. 40:547–550; McCrary and Bloom 1984. J. Wildl. Manag. 48:1005–1008; Upadhyaya et al. 1986. Can. J. Plant Sci. 66:689–709; Bossard et al. 2000. Invasive Plants of California's Wildlands. University of California Press, Berkeley. 360 pp.). We have also observed a Red Brome seed imbedded its full length within the nostril and in another instance impaled in the corner of the eye of Desert Tortoises. These latter two injuries were observed in Piute Valley, Clark County, Nevada, also during 1998 (the year that Red Brome production was extremely good in Nevada).

We do not know how common injury to Desert Tortoises from Red Brome seeds might be. However, both species of *Bromus* have become widespread throughout the Mojave Desert since the 1960s (Shields et al. 1963. Ecology 44:697–707; Beatley 1966. Ecology 47:548–554; Hunter 1991. Great Basin Nat. 51:176–182) and have increased dramatically in vast areas that have burned in recent years (Brooks and Esque 2002. Chelon. Cons. Biol. 4:330–340). Once invasive annual plants dominate Mojave and Sonoran Desert habitat, an invasive plant-fire regime cycle can be established (Esque et al. 2002. *In* T. R. Van Devender [ed.], The Sonoran Desert Tortoise: Natural History, Biology and Conservation, pp. 312–333. University of Arizona Press and Arizona-Sonora Desert Museum, Tucson, Arizona; Brooks et al. 2004. BioScience 54:677–688). In 2005, over one million acres of Mojave Desert habitat burned in southern Nevada (Young and Clements 2006. Rangelands 28:10–15). Of that burned area ca. 400,000 acres were considered potential *G. agassizii* habitat of which 32,000 acres were within Desert Tortoise critical habitat (Prentice 2006. Desert Tortoise Council Symposium, Tucson, Arizona). The consequent increase in Red Brome Grass might pose both a habitat degradation issue as well as a health risk if tortoises are affected at rates similar to what we observed in Rock Valley.

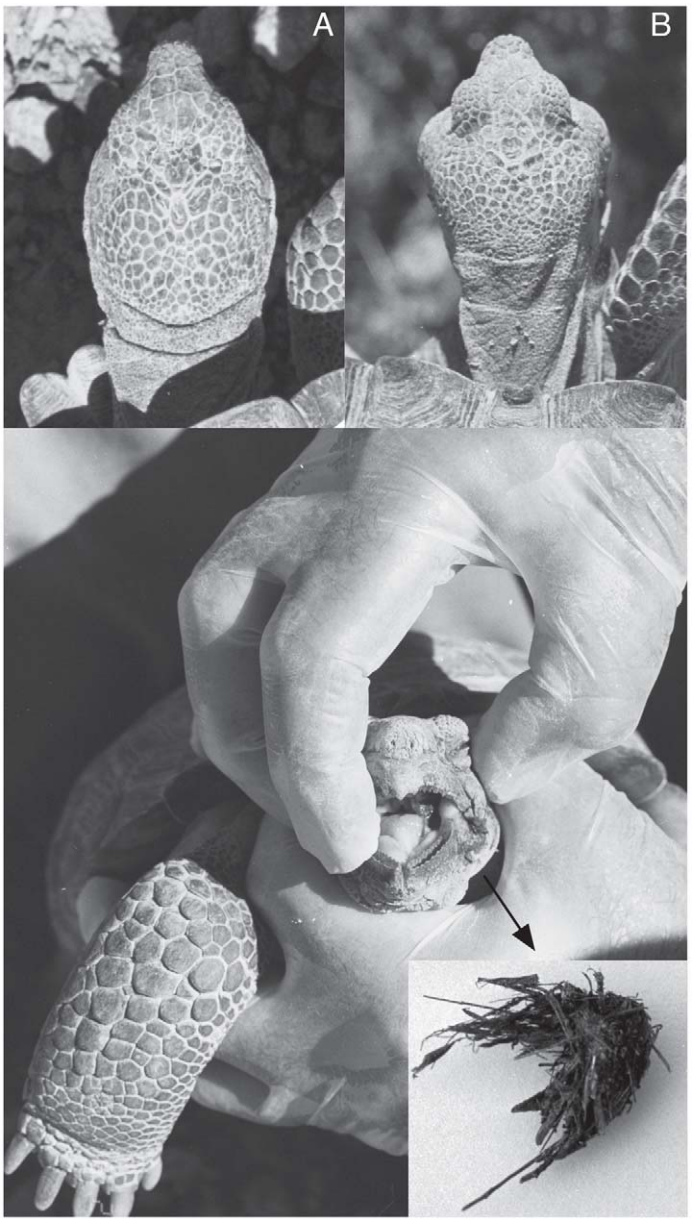


FIG. 1. Upper: Normal head (A) and abnormal head with impacted maxillary region (B). Lower: Impacted maxillary region with inset of the bolus of Red Brome seeds *Bromus madritensis* ssp. *rubens*.

We thank P. S. Corn, K. Nussear, and K. J. Phillips for review-

ing this note. Additionally, we thank the numerous dedicated individuals that have volunteered to assist in the recapture of the Rock Valley Desert Tortoises particularly, J. Burroughs, M. Burroughs, P. Greger. We thank K. Murphy, K. Drake, K. Nolte, and M. Walden for preparing the figures. This study was conducted under Fish and Wildlife Service, U.S. Threatened Species Permit TE 759747, and Nevada Division of Wildlife Permits S-21692, S-24391, and S-28154 issued to (PAM). We gratefully acknowledge the U.S. Department of Energy, National Nuclear Security Administration for continued access to the study area.

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NATATOR DEPRESSUS (Flatback Sea Turtle). **HABITAT**. *Natator depressus* are presently believed to occupy habitats with soft substrata during all phases of their lives, almost exclusively in turbid shallow inshore waters (Limpus et al. 1983. Aust. Wildl. Res. 10:557–561; Walker 1990. J. Herpetol. 25:246–248), and to our knowledge have not previously been documented inhabiting hard substrata such as coral reefs, rocky reefs, or mangroves. Here we report a potentially extended range of habitat use that may include rocky reefs and/or mangroves, as surmised by the presence on the carapace of turtles of two species of hard substratum epibionts characteristic of rocky reefs and mangrove forests.

We identified the epibionts attached to the carapace of *N. depressus* while they were ashore nesting on a 2 km long sandy beach near Cape Domett, northern Western Australia (14°48.1'S, 128°24.5'E). Epibionts were present on 28.9% of turtles (N = 142). They consisted of three species of barnacle (Crustracea: Cirrepedia), *Chelonibia testudinaria* (Linnaeus, 1758) (19.0%), *Tubicinella* cf. *cheloniae* Monroe & Limpus, 1979 (4.2%) and *Amphibalanus amphitrite* (Darwin, 1854) (1.4%), and one species of rock oyster (Bivalvia: Ostreidae), *Booneostrea cucullina* (Deshayes, 1836) (7.0%). Thick mud was present on the carapace of 11.3% of turtles, with light mud present on a further 3.5% of turtles.

The barnacle *A. amphitrite* and the oyster are generalists, the former inhabiting the intertidal and shallow subtidal zones, where it lives on many types of natural hard substrata (Stafford and Willan 2007. Is it a Pest? Introduced and Naturalised Marine Animal Species of Torres Strait Northern Australia. Queensland Government Department of Primary Industries and Fisheries, Cairns. 33 pp.) and mangrove pneumatophores (Bayliss 1993. Mar. Biol. 116:251–256), as well as piers and vessel hulls (Stafford and Willan 2007, *op. cit*.). The oyster *B. cucullina* has a similar range of depths and habitat types, including intertidal and shallow subtidal rocky reefs, estuaries and mangrove forests (including mangrove trunks and pneumatophores) (pers. obs). The mud present on the carapaces of the turtles is consistent with such low energy environments.

Both *A. amphitrite* and *B. cucullina* are opportunistic and fast-growing. Therefore, they are easily capable of achieving their observed shell sizes of 16.0 and 17.8 mm maximum diameter, respectively, within the expected 45 days that *N. depressus* are within the nesting area (based on 2.84 nests/season at 16.0 day intervals, Limpus et al. 1984. Aust. Wildl. Res. 11:579–587). The barnacles were sexually mature, but the oysters were not. The presence of these two epibionts on *N. depressus* indicates that the turtles were resident within these habitats for sufficient time for the planktonic larvae of the barnacles and oysters to settle on them, and probably much longer during which time the barnacles had grown to maturity.

These epibionts provide no information as to whether rocky reefs or mangrove forests are utilized only during the inter-nesting period or whether these habitats are used throughout the juvenile and adult phases of the turtles' life cycle. This suggestion of hard substratum residence by *N. depressus* highlights the paucity of information on natural habitats for these turtles in tropical northern Australia and underlines the need for further research.

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LACERTILIA

AMEIVA AMEIVA (Giant Ameiva). **PREDATION.** *Ameiva ameiva* is broadly distributed throughout South America, ranging from Venezuela and Colombia to Argentina (Vitt and Colli 1994. Can. J. Zool. 72:1986–2008). In the Cerrado Region, it occupies a broad range of habitats but is more abundant in areas with some forest cover (Nogueira 2006. Diversidade e Padrões de Distribuição da Fauna de Lagartos do Cerrado. PhD dissertation, Universidade de São Paulo. São Paulo, Brazil. 295 pp.).

During a diurnal raptor road census at 0950 h on 16 October 2006, we observed predation on *A. ameiva* by the White-tailed Hawk, *Buteo albicaudatus*. It took place at the edge of a small forest fragment, 4 m from an unpaved road on a private farm (22°12'38"S, 47°55'39"W, datum: Corrego Alegre; elev. 760 m) located in the municipality of Brotas, Estado do São Paulo, southeastern Brazil. When first seen, the *B. albicaudatus* was perched on the branch at a height of 2.5 m in a small tree pecking at a lizard held in its claws. Our approaching car caused the hawk to fly away without its prey and perch about 10 m away. The lizard, an adult *A. ameiva* (170 mm SVL, 362 mm tail, 144 g), was dead and had extensive damage right below the head, which was nearly separated from the body.

Buteo albicaudatus is a large (865–1100 g) raptor found in open areas, hill slopes and other open or sparsely wooded country from Texas to Argentinean Patagonia (Ferguson-Lees and Christie 2001. Raptors of the World. Houghton Mifflin Company, New York. 992 pp.). According to Granzinolli and Motta-Junior (Emu, *in press*) lizards represented 0.94% (N = 3296) of all prey consumed and 7.19% (N = 7.2 kg) of biomass ingested by *B. albicaudatus* in Juiz de Fora, southeastern Brazil. However, all *B. albicaudatus* prey lizards found in Juiz de Fora were anguids. Apart from Granzinolli and Motta-Junior (Emu, *in press*), no studies addressing White-

tailed Hawk diet have identified lizards in family level, they just mention "lizards."

Removal of the head from the body may be a common strategy among raptors. Del Royo et al. (1994. Handbook of the Birds of the World. Vol 2: New World Vultures to Guineafowl. Lynx Ediciones. Barcelona. 639 pp.) noted that raptors attack the anterior end of snakes to immobilize the head, presumably reducing risk of being bitten. *Buteo albicaudatus* seems to also use this tactic on lizards. Records of predation on *A. ameiva* exist for snakes (*Crotalus durissus*: Santos and Germano 1996. Herpetol. Rev. 27:143; *Oxybelis fulgidus*: Fischer and Gascon 1996. Herpetol. Rev. 204) and for the Burrowing Owl (*Athene cunicularia*: Tozetti et al. 2005. Herpetol. Rev. 36:443–444). Our observation adds *B. albicaudatus* to its predator set.

The *Ameiva ameiva* voucher was deposited in the Coleção Herpetológica Alphonse Richard Hoge, Instituto Butantãn (IBSP – CRIB 0219). H. Fachin and the staff of Instituto Florestal supported our fieldwork. M. Hayes provided helpful suggestion on a previous version of this note. FAPESP (Fundação de Amparo a Pesquisa do Estado de São Paulo) and FBPN (Fundação o Boticário de Proteção a Natureza) provided financial support. MAMG acknowledges FAPESP for PhD fellowships. This is publication number 30 of the "Ecology of the Cerrados of Itirapina" project.

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AMPHIBOLURUS MURICATUS (Jacky Dragon). **PREDATION**. *Amphibolurus muricatus* is a common agamid found primarily in the coastal heathlands of southeastern Australia (Cogger 2000. Reptiles and Amphibians of Australia. Ralph Curtis Publishing, Sanibel Island, Florida. 808 pp.). Despite frequently attaining high local densities, surprisingly little is known about *A. muricatus* ecology. Here, I report several instances of predation on adult *A. muricatus* by the monitor lizard, *Varanus rosenbergi*.

From October 2005 to January 2006, I conducted an extensive field study on *A. muricatus* nesting behavior at The Royal National Park, New South Wales, Australia (34°04'S, 151°05'E, datum: WGS84, elev. 95–105 m). During this study, radio-transmitters were attached to gravid *A. muricatus* throughout the nesting season, and each lizard was relocated hourly until they nested. On two occasions (25 October and 18 November 2005), gravid females were preyed upon by large *V. rosenbergi* within 2 h of release at the study site. These females may have been released in proximity of an unnoticed monitor lizard. On two additional occasions (16 and 31 December 2005), gravid females were preyed upon 2 and 11 days after their respective release dates at the study site. After each predation event, I was able to locate and observe each monitor lizard because the transmitters they swallowed continued to provide a signal. The monitors were not captured, but based on observations of their body sizes, all four predation events may have been the result of at least two different *V. rosenbergi* (~30 cm and ~50 cm SVL).

Additionally, of 15 *A. muricatus* study nests unprotected by chicken wire, two were predated on 25 and 26 October 2005. In both instances, the nests were dug out and all eggs were completely gone only one day after nest construction. Potential predators include small nocturnal marsupials, foxes, cats, or varanid lizards. However, the varanid-like claw marks in the sand around the nest sites, and the fact that both nests were preyed upon during the day strongly suggests varanids were responsible. As I did not observe predation on these nests, the species responsible could have been either *V. rosenbergi* or *V. varius*. Varanids have previously been reported to prey on reptile nests (Blamires 2004. Copeia 2004:370–377) as well as other lizard species (King and Green 1979. Copeia 1979:64–70).

Having to carry a transmitter or female reproductive status, as both factors that can impair mobility or sprint performance (Olsson and Shine 1999. J. Evol. Biol. 13:263–268), could explain these predation events. However, considering that only 4 of out 54 gravid *A. muricatus* with radio-transmitters were preyed upon, predation rates on gravid females may be similar even when they lack transmitters. In general, these observations suggest that *A. muricatus* (and probably their eggs) contribute to the diet of *V. rosenbergi* in this part of their range.

I thank M. Greenlees and R. Shine for comments on this note.

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ANISOLEPIS GRILLI (NCN). **REPRODUCTION**. No data exist on reproduction for the enyaliinid anoline, *Anisolepis grilli*. Hence, we provide preliminary data on its reproduction from southern Brazil. We made these observations in the municipality of Vacaria, Rio Grande do Sul state (28°33'S, 50°42'W; elev. ca. 900 m). Vacaria is located in a physiographic region known as the Mountain Top Grasslands in the northeast region of the state. This is the coldest area in the state with mean temperatures ca. 17°C; during winter, temperatures may drop as low as -8°C with frost and occasional snow flurries. Precipitation, 1500–2000 mm annually, is well-distributed seasonally (Boldrini 1997. Bol. Inst. Biocienc. [56]:1–39). Two major vegetation associations exist locally: Brazilian pine (*Araucaria angustifolia*)-dominated forest and savanna (Boldrini, *op. cit*.). Once a month, we visited nine fields in the savanna association with rocky outcroppings and searched for reptiles beneath rocks. We recorded data and collected the eggs from nests of *A. grilli* on 20 May 2005. All specimens collected were deposited in the Scientific Collection of the Herpetology Laboratory of the Universidade Federal do Rio Grande do Sul, Brazil.

During winter 2005, we found two clutches of *A. grilli* under a rock on a transect where all rocks where overturned; this rarely visited place borders a trail with shrubby vegetation (28°16'45.94"S, 50°45'50.03"W, datum: SAD69; elev. 948 m). The depth of the cavity beneath the rock was ca. 25 cm. One clutch (A) had 6 eggs, 3 were no longer viable; the second clutch (B) had seven eggs. Soil temperature was 15.6°C (clutch A) and 16.2°C (clutch B). All eggs had a flexible calcareous shell that was somewhat wrinkled, spherical and averaged ca. 1.5 cm in long axis diameter. One egg was removed from each nest, opened and the embryonic stage recorded. Embryos were deposited in the collection under the numbers DZ 3989 (clutch A) and DZ 3990 (clutch

B). These embryos were, respectively, 23.8 mm and 22.3 mm SVL. We also removed one egg from each nest for incubation in the laboratory; each of the latter eggs was placed in a plastic bag with substrate from the site for transport to the laboratory. We incubated these eggs by locating them 10 cm away from a 40-watt light bulb continuously from 23 May 2005 until they hatched. The individual from clutch A hatched on 30 June 2005 at 27.8 mm SVL, 54.6 mm tail length, and 0.43 g. The individual from clutch B hatched on 7 July 2005 at 28.8 mm SVL, 60.4 mm tail length, and 0.54 g. These individuals were euthanized on 15 July 2005 and were deposited in the aforementioned collection, respectively, under the numbers DZ 3920 and DZ 3921.

These records are of interest because the few data available on *A. grilli* refers to it as arboreal (Lema 1994. Comun. Mus. Ciênc. Tecnol. PUCRS. 7:41–150). In the present study, we found the clutches in open savanna, at ca. 1000 m from the nearest *Araucaria* forest. Forested areas within the area we sampled have been reduced by *Pinus* plantations, but small areas of *Araucaria* forest still exist. Morphology of the species, characteristic of the family Leiosauridae (long fingers and very long tail), revealed that it has an unquestionable arboreal habit, but the data presented in this study suggest that further investigation of the non-arboreal aspects of *A. grilli* behavior, of which one appears to be oviposition, is warranted.

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ASPIDOSCELIS TIGRIS TIGRIS (Great Basin Whiptail). **DIET**. *Aspidoscelis tigris*, one of the largest whiptail species in North America (Stebbins 2003. Western Reptiles and Amphibians, 3rd ed. Houghton Mifflin, Boston, Massachusetts. 558 pp.), is a wide-ranging forager known to prey on diverse invertebrates (Pianka 1970. Ecology 51:703–720). Although records exist of *A. tigris* preying on small lizards, *Sceloporus graciosus* is not among the reported prey. We report the first observation of predation on *S. graciosus* by *A. tigris*.

At 1155 h on 8 July 2006 (sunny, hot [air temperature just over 41°C]), while looking for lizards just east of Ubehebe Crater (37°01'04"N, 117°26'38"W, datum: NAD83; elev. 2260 m), Death Valley National Park, we observed an adult *A. tigris* (ca. 320 mm total length) foraging on an open slope with a sand/gravel substrate. We followed the *A. tigris* until it took refuge in the shade of a shrub, approached it to ca. 1 m and then remained motionless; based on its behavior, the lizard did not seem disturbed by our presence. At 1159 h, the *A. tigris* began searching for prey and dug into the sand around the base of the shrub. Almost instantly, a ca. 70 mm total length *S. graciosus* appeared, fled toward us, and the *A. tigris* almost as rapidly caught it at mid-body, but closer to the hind limbs. For a few seconds, the *S. graciosus* vigorously tried to escape but the *A. tigris* kept a firm hold, and shook and chewed it repeatedly. Once the *S. graciosus* ceased struggling, the *A. tigris* began to swallow it hind end first. During the process, the tail of the *S. graciosus* broke, dropping on the sand. After swallowing the *S. graciosus*, the *A. tigris* began to investigate the nearby substrate with its tongue. When the *A. tigris* found the dropped tail, this was also swallowed. After ingestion at 1201 h, the *A. tigris* remained under the shrub but in a sunny patch. The entire predation event took just under 2 min; during this time, the *A. tigris* remained < 50 cm from the base of the shrub.

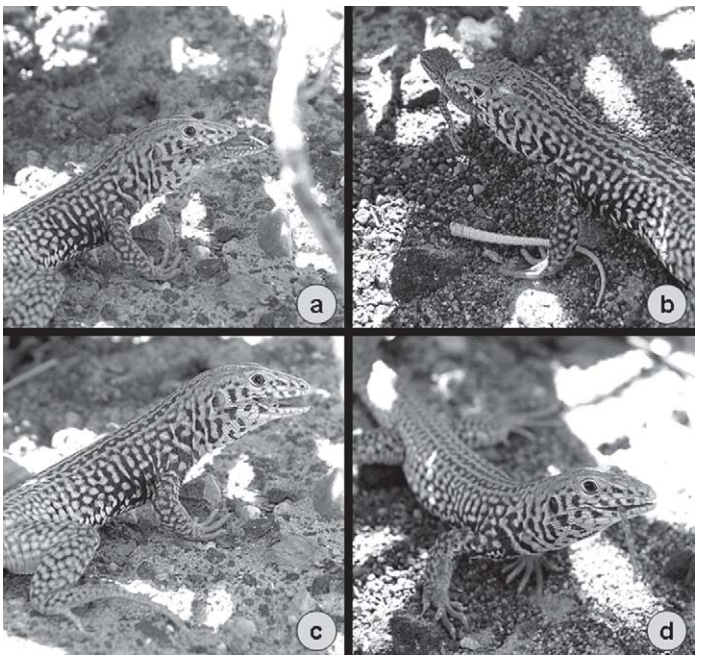


FIG. 1. A large *Aspidoscelis tigris* preying on a *Sceloporus graciosus*: a) Swallowing process, hind parts first; b) Note the tail of the *S. graciosus* just under the whiptail's head; c) Termination of swallowing the *S. graciosus*; and d) *A. tigris* swallowing the tail of the *S. graciosus* found on the sand.

We took 20 photos to document the process; some of them are presented in Fig. 1. We thank J.-F. Desroches and M. P. Hayes for useful comments.

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CARLIA GRACILIS (Slender Rainbow Skink) and ***GLAPHYROMORPHUS DARWINIENSIS*** (Darwin Skink). **FEEDING AGGREGATION.** Lizards of the Indo-Australian skink genera *Carlia* and *Glaphyromorphus* are small terrestrial insectivores (Greer 1989. The Biology and Evolution of Australian Lizards. Surrey Beatty & Sons, Chipping North, New South Wales, Australia. 264 pp.). Feeding aggregations in these genera are unreported. Here, I provide an observation of a multi-species feeding aggregration of members of these two genera from northern Australia.

At 0830 h on 30 October 2004, over 30 lizards were observed feeding on alate termites in an open patch of leaf litter in a suburban garden in Darwin, Northern Territory, Australia (UTM: 701480E, 8629686N, datum: WGS84; elev. 10 m). The site was observed from a distance of 4 m using a pair of 10 × 42 binoculars. Six lizard species were recorded feeding in an area 4 m ×

3 m: *Carlia gracilis* (ca. 20 sightings, precise number of individuals unknown), *Glaphyromorphus darwiniensis* (ca. 10 sightings), *Glaphyromorphus douglasi* (1 individual), *Lophognathus temporalis* (a female or juvenile male), and *Hemidactylus frenatus* (2 individuals). The *Glaphyromorphus darwiniensis* and *C. gracilis* were observed feeding together separated by less then a body length; occasionally upon contacting or nearly contacting another individual, a skink would flee a short distance (< 20 cm). Otherwise, I observed no aggressive behaviour even though I had observed intraspecific chasing and fighting in these two species at the same location earlier in the year. Winged termites were abundant in the air and lizards took these when they landed on leaves, the adjacent shed wall and the leaves of palm saplings < 10 cm above the ground. Observations were made until 0850 h, at which time termite numbers in the air had declined to nearly zero and the number of lizards visible was likewise reduced. A pitfall trapline 5 m long with 3 pitfall traps ca. 13 m from the location of the feeding aggregation yielded no captures that day; for 36 operational days between 29 September and 20 December 2004, I captured an average of 0.81 lizards per day, indicating that the aforementioned feeding aggregation represented a local high-density circumstance.

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CERCOSAURA ARGULUS (White-lipped Cercosaura). **ENDOPARASITES.** *Cercosaura argulus* occurs in French Guiana, Colombia, Ecuador, Peru, Bolivia, and Brazil (Avila-Pires 1995. Lizards of Brazilian Amazonia [Reptilia: Squamata], Zoologische Verhandelingen National Natuurhistorisch Museum, Leiden, Netherlands. 706 pp.). In Peru, it has been recorded in the Departments of Amazonas, Huánuco, Loreto, Madre de Diós and Pasco (Lehr 2002. Amphibian und Reptilien in Peru, Die Herpetofauna entlang des 10. Breitengrades von Peru: Arterfassung, Taxonomie, ökologische Bemerkungen und biogeographische Beziehungen, Natur und Tier – Verlag GmbH. Münster, Germany. 208 pp.). To our knowledge, no reports exist of helminths in *C. argulus.* The purpose of this note is to establish an initial helminth list for *C. argulus* by reporting it as a host for nematodes in Peru.

Five *C. argulus* (4 females, 1 male: mean SVL = 38 mm ± 4.3 SD, range: 33–43 mm) collected in 1963 or 1972 from Loreto Department, Peru, were borrowed from the Texas Cooperative Wildlife Collections (TCWC), Texas A&M University, College Station, Texas. Four (TCWC 36724, 36725, 38144, 41833) were from the vicinity of Moropon, on Río Nanay (3°43'S, 73°14'W, datum: WGS84; elev. 100 m), one (TCWC 39038) was from Mishana, on Río Nanay (3°52'S, 73°29'W; elev. 100 m). The esophagus, stomach, small and large intestines were opened and separately examined for helminths under a dissecting microscope. The body cavity was also examined for helminths. Four species of nematodes, *Oswaldocruzia peruensis* (two adult males in the small intestine of TCWC 41833), *Physaloptera* sp. (three larvae in the stomach of TCWC 36724, one larva in the large intestine of TCWC 36725, one larva in the small intestine of TCWC 38144), unidentified cosmocercid (one mature female each in the small intestine of TCWC 36725 and 41833), unidentified acuariid (one larva in the small intestine of TCWC 39038). Nematodes were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland as: *Oswaldocruzia peruensis* (99356); *Physaloptera* sp. (99359); acuariid (99357); cosmocercid (99358).

Oswaldocruzia peruensis was described from *Sternocercus roseiventris* from Peru (Ben Slimane et al. 1995. Bull. Mus. Nat. Hist. Nat. 17:77–82). Bursey et al. (2005. Comp. Parasitol. 72:50–68) also found it in *Anolis punctatus* from Peru. Larvae of *Physaloptera* sp. and the Acuariidae are common in amphibians and reptiles (Goldberg et al. 1993. Bull. S. California Acad. Sci. 92:43–51). Insects act as intermediate hosts (Anderson 2000. Nematode Parasites of Vertebrates: Their Development and Transmission. CABI Publishing, Wallingford, Oxon, U.K. 650 pp.); thus physalopteran and acuariid larvae might be expected in any insectivore. Examination of a male is needed to identify cosmocercid nematodes to species. Infection is direct with no intermediate host utilized (Anderson, *op. cit.*). *Oswaldocruzia peruensis*, *Physaloptera* sp., acuariid and cosmocercid nematodes in *C. argulus* are new host records.

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CNEMIDOPHORUS NATIVO (NCN). **PREDATION**. *Cnemidophorus nativo* is a parthenogenetic whiptail lizard endemic to restingas (coastal sand dune habitats covered with herbaceous and shrubby vegetation) in the states of Bahia and Espírito Santo, Brazil (Rocha et al. 1997. Herpetologica 53:374–352). Some information has been published on its ecology (e.g., Bergallo and Rocha 1994. Australian J. Ecol. 19:72–75; Menezes et al. 2004. J. Herpetol. 40:280–282), but data on its predators are lacking. During a herpetological survey of Parque Estadual Paulo Cesar Vinha (PEPCV), a largely undisturbed restinga in the municipality of Guarapari, Espírito Santo, Brazil (20°35'S, 40°24'W; near sea level), we obtained data on two native predators of *C. nativo*. Here, we report on two observations of predation by the colubrid snake *Philodryas patagoniensis* and one observation of predation by the tropidurid lizard *Tropidurus torquatus*.

We observed predation attempts by *P. patagoniensis* on each of 27 December 2005 and 13 January 2006. Both observations were made between 1100 and 1200 h, which correspond, in part, to the interval of highest activity by *C. nativo* in this area (PLP, unpubl. data). The first observation was made on a sunny day in a forest trail developed for human access to the beach. The trail, ca. 2–3 m wide, cuts through a ca. 1.5 km of forested area. When found, the snake was coiled around the lizard, which was immobilized in a head down position, and the snake was grasping its tail (Fig. 1). During photography of the event, we disturbed the snake, which took flight immediately, leaving the lizard on the ground. The

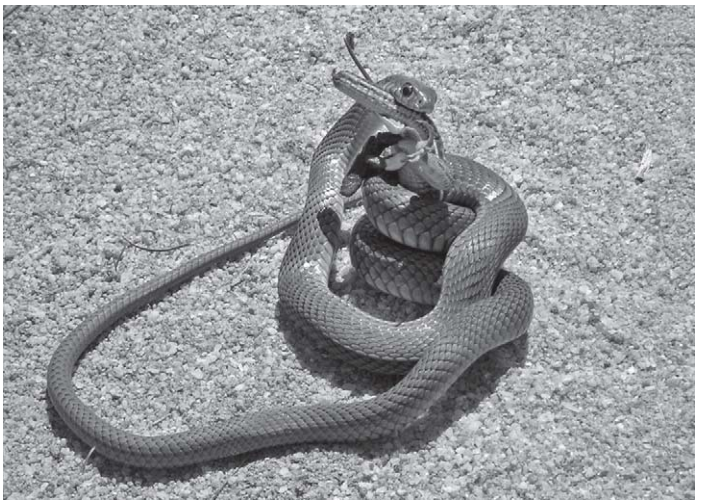


FIG. 1. *Philodryas patagoniensis* preying on an adult *Cnemidophorus nativo*. Photo by Ana C. Pavan.

whiptail remained motionless for a few seconds then also fled. The second observation was made in a shrubby vegetation-dominated portion of the PEPCV. In this case, we only had the time to see the *C. nativo* (certainly an adult based on its size) hanging from the mouth of the snake before it retreated into an area with taller vegetation still holding the lizard.

Philodryas patagoniensis is mainly a terrestrial species known to prey on a variety of vertebrates (Marques et al. 2001. Serpentes da Mata Atlântica: Guia Ilustrado para Serra do Mar. Holos, Ribeirão Preto, São Paulo, Brazil. 184 pp.). Gonzaga et al. (1997. Herpetol. Rev. 28:154) and Rocha and Vrcibradic (1998. Ciência e Cultura 50:364–368) published a few data on the food habits of this species in a restinga habitat, mentioning scincid lizards (*Mabuya* spp.), a Four-eyed Opossum (*Metachirus nudicaudatus*), and nestlings of an emberezid bird (*Coereba flaveola*) as prey. This represents the first report of *P. patagoniensis* predation on *C. nativo*.

At 1100 h on 25 January 2006, we observed a large (ca. 10 cm SVL) adult *Tropidurus torquatus* preying on an adult *C. nativo*. When first found, the *C. nativo* was in the tropidurid's mouth, but was clearly still alive and seemed to be attempting to release itself from its predator. The *T. torquatus* fled with the whiptail in its mouth immediately after noticing our presence, and we did not see the outcome of the event. *Tropidurus torquatus* is an ambush-foraging lizard known to feed on diverse prey, but mainly arthropods (e.g., Bergallo and Rocha, *op. cit.*), but may also consume plant material (e.g., Teixeira 2001. Atlantica, Rio Grande 23:77–84; Rocha et al. 2002. Brazilian J. Biol. 62: 285–291), other lizards (e.g., Araújo 1991. Rev. Brasileira Biol. 51:857–865; Teixeira, *op. cit.*) and even small mammals (J. L. Gasparini and PLP, unpubl. data) in its diet. However, this is the first report of *C. nativo* as prey.

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CNEMIDOPHORUS OCELLIFER (Brazilian Whiptail Lizard). **FORAGING BEHAVIOR**. Climbing behavior has been described for a number of lizards, but these represent primarily arboreal or semi-arboreal species (Pianka 1973. Ann. Rev. Ecol. Syst. 4:53–74; Vitt and Zani 1998. J. Trop. Ecol. 14:63–86). However, except for the genus *Kentropyx* (Martins 1991. Stud. Neotrop. Fauna Environ. 26:179–190), climbing behavior is undescribed among Brazilian teiid lizards. All other species are typically ground-dwelling (Vitt 1995. Occ. Pap. Oklahoma Mus. Nat. Hist. 1:1–29; Mesquita and Colli 2003. J. Herpetol. 37:498–509). Here, we describe arboreal behavior in the Brazilian teiid, *Cnemidophorus ocellifer*.

Our observations were made in the Reserva Particular do Patrimônio Natural Fazenda Almas, located between São José dos Cordeiros and Sumé, State of Paraíba, Brazil (07°28'S, 36°52'W; elev. 760 m). Between 1100 h and 1200 h on 9 November 2005, we observed 6 *C. ocellifer* foraging in roadside vegetation, which included herbaceous vegetation within a stand of a dozen small woody shrubs up to 0.7 m high. Three of these individuals displayed non-terrestrial foraging behavior. The behavior began with an investigation of the soil, where leaf litter was overturned in search of prey. Each lizard would then climb into a shrub to a height of ca. 40 cm, capturing small insects (orthopterans and membracids with body lengths < 5 mm) along its stem and branches until it reached the top of the shrub. After reaching the top of the shrub, the animal would first look down, scan the ground, and then jump down in an attempt to capture insects that had been dislodged during its ascent. One of the *C. ocellifer* exhibited this behavioral sequence only once, but the other two animals each repeated it four or five times, in each case always climbing the same shrub. Repeated use of a single plant may have been partly related to the fact that only four of the shrubs provided a substrate appropriate for climbing, although it is also possible that the presence of invertebrate prey was also a factor. Both these individuals also repelled other *C. ocellifer* repeatedly and aggressively whenever they approached the plants on which the former were foraging, as though they were defending a resource.

The climbing behavior we observed has not been reported previously for teiids native to the Caatinga, a xeric shrubland biome of northeastern Brazil (see Ab'Saber 1974. Geomorfologia 43:1–39). Such exploitation of a novel habitat may represent a behavioral strategy aimed at reducing potential competition with the much larger, syntopic teiid *Ameiva ameiva* (mean body weight ca. 60 g vs. 12 g in *C. ocellifer* [Vitt 1995. Occ. Pap. Oklahoma Mus. Nat. Hist. 1:1–29]), which we also observed in the vicinity of the shrubs. However, more systematic observations of the behavior will be necessary to understand its ecological implications.

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CNEMIDOPHORUS OCCELIFER (Whiptail Lizard)**. PREDATION.** *Cnemidophorus ocellifer* is a conspicuous element of open habitats in Brazilian Cerrado (Mesquita and Colli 2003. J. Herpetol. 37:498–509). Despite this, field observations of predation on this species are scarce. Hence, we report an observation of predation on *C. ocellifer* in the Brazilian Pantanal.

On 10 September 2001 at ca. 0900 h, we captured a juvenile (245 g) Road Hawk, *Ruphornis magnirostris*, using a 12 m × 2.6 m mist-net in a semi-deciduous forest association popularly known as "cordilheira" at Retiro Novo Ranch, Estado do Mato Grosso (16°14'13"–16°23'47"S, 56°17'45"–56°22'31"W; datum: South America 69; elev. 240 m). This association, located on fluvial sediments on the margins of abandoned riverbeds, occurs in narrow bands ranging from but a few meters up to 100 m wide. After administering an emetic solution of potassium antimony tartarate ($C_4H_4KO_7Sb$) at a concentration of 1 mg/kg of body mass, the hawk regurgitated an entire juvenile *C. occelifer* (54.0 mm SVL). The bird was then measured and released.

Accipitrid hawks are known lizard predators (Rivas et al. 1998. Herpetol. Rev. 29:238–239; Rivero and Manzanilla 2006. Herpetol. Rev. 37:85), but to our knowledge, this is the first predation record on an actively foraging teiid lizard.

Mist netting was done under license number 021/06-GEREX-I.IBAMA/MT awarded to Jõao Batista de Pinho from CEMAVE/IBAMA. The lizard (UFMT 4389) was deposited in the herpetological collection in the Vertebrate Collection of Universidade Federal do Mato Grosso.

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CROTAPHYTUS BICINCTORES (Great Basin Collared Lizard). **DIET.** Lizards of the genus *Crotaphytus* feed predominantly on arthropods, such as orthopteran, coleopteran, hymenopteran, and lepidopteran insects (Fitch 1956. Univ. Kansas Mus. Nat. Hist. Publ. 8:213–274). Nevertheless, *Crotaphytus* lizards have been reported to feed on small vertebrates, mainly other lizards but occasionally snakes (Husak and Ackland 2000. Herpetol. Rev. 31:47), birds (Best and Pfaffenberger 1987. Southwest. Nat. 32:415–426), and rodents (McAllister and Trauth 1982. Southwest. Nat. 27:358–359; Montanucci 1971. Herpetologica 27:183–197). Lizards that *Crotaphytus* have been reported to consume include *Uta stansburiana* (Springer 1928. Copeia 169:100–104); *Aspidoscelis* sp., *Phrynosoma modestum* (Best and Pfaffenberger 1987. Southwest. Nat. 32:415–426); *Xantusia vigilis* (Banta 1960. Wasmann J. of Biol. 18:309–311); *Sceloporus undulatus*, *Scincella lateralis* (McAllister 1985. Southwest. Nat. 30:597–619); and *Eumeces sp.* (Fitch 1956. Univ. Kansas Mus. Nat. Hist. Publ. 8:213–274; Lappin 2002. Herpetol. Rev. 33:305–306). Here, we provide the first report of *Crotaphytus bicinctores* eating *Sauromalus ater* (Common Chuckwalla).

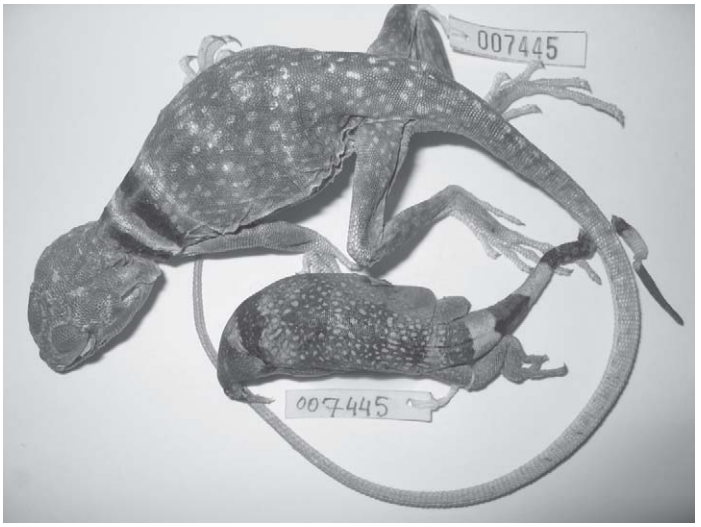


FIG. 1. A *Crotaphytus bicinctores* (weighing 17.6 g) with its prey, a young-of-year *Sauromalus ater* (weighing 6.6 g).

On 1 April 1996, ALH collected an adult female *C. bicinctores* (89 mm SVL, 17.6 g) in the Newberry Mountains, Clark Co., Nevada, USA. Upon capture, ALH noticed that a tail was hanging from its mouth. The lizard was later dissected and the stomach contained an almost intact young-of-the-year *S. ater* (48 mm SVL, 6.6 g; Fig. 1). The relative prey mass of the *S. ater* was 37.5%. The female *C. bicinctores*, which had likely recently emerged from hibernation, appeared very emaciated (note its tail in Fig.1).

A study on the closely related *Crotaphytus collaris* revealed that the total mass of prey items contained in the stomachs of 48 lizards averaged 1.11 g (Husak and McCoy 2000. Texas J. Sci. 52:93–100). The size of the prey item we report here is much larger, and feeding on such large prey is probably infrequent for *C. bicinctores*. As noted above, the female *C. bicinctores* seemed in poor condition. To assess whether this was the case, we weighed 8 non-gravid female *C. bicinctores* of similar size (mean = 88.6 mm SVL, SD = 2.2 mm; range: 85–91 mm) collected around the same locality. The mean mass of the 8 females was heavier (mean = 23.2 g, SD = 5.5 g; range: 13.4–32.3 g) than this female, suggesting that she was on the poor condition end of variation in mass. We believe that the condition of the female *C. bicinctores* at emergence from hibernation may be one factor that led her to feed on such large unusual prey.

The *C. bicinctores* and its *S. ater* prey were deposited in the Marjorie Barrick Museum of Natural History, the University of Nevada, Las Vegas (MBM 7445). Specimens were collected under permit S27454 to ALH from the Nevada Department of Wildlife. Specimens of *Crotaphytus bicinctores* examined: MBM 443, 550, 1031, 1035, 2284, 3856, 3871, 7228.

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CTENOSAURA SIMILIS (Black Spiny-tailed Iguana). **PREDATION.** *Ctenosaura similis* is exotic to Florida (Meshaka et al. 2004. The Exotic Amphibians and Reptiles of Florida. Krieger Publishing Co., Malabar, Florida. 155 pp.). In particular, they were released on Gasparilla Island (Charlotte and Lee Counties) 30–35 years ago, where they are now abundant (Krysko et al. 2003. Florida Sci. 66:141–146). This species may pose a threat to a number of endemic threatened and endangered species on Gasparilla Island such as eggs of nesting shore birds, beach mice, hatchling sea turtles and gopher tortoises (*Gopherus polyphemus*) (Krysko et al., *op. cit*.), but to date, local predators on *C. similis* are unreported (Meshaka et al., *op. cit.*). Indigenous predators might exert one controlling influence on exotic Florida herpetofauna (Butterfield et al. 1997. *In* Simberloff et al. [eds.], Strangers in Paradise, pp. 123–138. Island Press, Washington, DC). Hence, we report evidence of Bobcat (*Felis rufus*) predation on *C. similis* on Gasparilla Island.

On 17 April 2007, RME located 3 *F. rufus* scats on the sandy aprons of *C. similis* burrows in coastal strand habitat (FDEP 2002. Gasparilla Island Unit Management Plan. Florida Dept. Environ. Protection, Tallahassee. 68 pp.) within Gasparilla Island State Park (larger *C. similis* often use Gopher Tortoise burrows, but cohabitation has not been observed [McKercher 2001. *Ctenosaura pectinata* (Iguanidae) on Gasparilla Island, Florida: Colonization, habitat use and interactions with *Gopherus polyphemus*. MS Thesis, Univ. Florida, Gainesville. 117 pp.]). Examination of the *F. rufus* scats revealed fragments of *C. similis*. Notable among the fragments was a desiccated right front forefoot ca. 3.5 cm long, suggesting a mature lizard of reproductive size had been taken. Given the large *C. similis* population on Gasparilla Island as indicated by the high density of active burrows (ca. 42/ha) and large number of juveniles we located with minimal searching of the area in which we found the scats, bobcat predation alone is unlikely to suppress *C. similis* populations. Population reduction of this invasive species on Gasparilla Island will likely require a comprehensive integrated pest management plan that incorporates multiple control tools and strategies and involves the responsible government entities on Gasparilla Island (Charlotte County and Lee County governments and Florida Florida Fish and Wildlife Conservation Commission). In fact, the management plan for Gasparilla Island State Park recognizes the need for ctenosaur management to protect gopher tortoises, but also recognizes such management would only be effective if government entities coordinate efforts (FDEP, *op. cit.*).

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CYCLURA CYCHLURA CYCHLURA (Andros Iguana). **SCOLIOSIS; KYPHOSIS.** Spinal curvatures are reported infrequently in wild lizard populations (Frutos et al. 2006. Herpetol. Rev. 37:468–469; Mitchell and Georgel 2005. Herpetol. Rev. 36:183). These infrequent accounts have reported no obvious limitations to mobility or prey capture. However, spinal malformation



FIG. 1. Scoliosis of the lower back (A) and kyphosis of the tail (B) in an adult female *Cyclura c. cychlura* from South Andros, Bahamas.

impact on fitness (e.g., affecting production of viable offspring) is unknown among wild lizard populations. To our knowledge, no documented reports exist of lizards with malformed spinal columns reproducing successfully. Here, we report on an iguanid lizard with a case of scoliosis and kyphosis that produced viable eggs and offspring in the wild.

On 9 June 2004, we captured an adult female *Cyclura cychlura cychlura* (34.4 cm SVL, 1.81 kg) while she was guarding her eggs oviposited within an active termite (*Nasutitermes rippertii*) mound on an unnamed cay in Lisbon Creek, South Andros Island, Bahamas (24°05'24"N, 77°42'42"W, datum: WGS84; elev. 1.5 m). Nesting within *N. rippertii* mounds and aggressive nest-guarding behavior is typical for females of this subspecies (Knapp et al. 2006. Can. J. Zool. 84:1566–1575). The iguana exhibited a convex curvature of the spine (scoliosis) anterior to the pelvic girdle, and a concave spinal curvature over the pelvic girdle. Multiple lateral curvatures (kyphosis) spanned the entirety of the tail (Fig. 1). Despite these malformations, the lizard seemed healthy, had normal use of all limbs, and aggressively defended her nest from us as we approached. As part of our study, we excavated the nest and discovered seven eggs. The clutch size fell within one standard deviation of clutch size for our 2004 sample (N = 34 clutches; mean = 9.8, SD = 3.3). Mean egg length (67.3 mm) also was within one standard deviation of the 2004 sample (N = 34 clutches; mean = 70.7, SD = 3.6). However, mean egg width (37.2 mm) and mass (53 g) were slightly lower than one standard deviation of the 2004 sample (N = 34 clutches; mean = 40.3, SD = 2.8; mean = 59.8, SD = 4.9, respectively). We replaced the eggs and returned 76 days later to excavate the nest to determine hatching success. All eggs hatched within the nest and none of the hatchlings were malformed. Though unconfirmed, the spinal curvatures may have resulted in a restricted cloacal opening and constrained egg width, while a reduced abdominal cavity may have caused the below average egg mass.

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HEMIDACTYLUS TURCICUS (Mediterranean Gecko). **NESTING**. Over the past century, *Hemidactylus turcicus* has dramatically expanded its introduced range in North America (Fowler 1915. Proc. Acad. Nat. Sci. Phila. 67:244–269; Robinson and Romack 1973. J. Herpetol. 7:311–312). Small body size, calcareous eggs, a nocturnal lifestyle, a preference for human habitats (Meshaka 1995. Florida Sci. 58:10–15; Nelson and Carey 1993. Northeast Gulf Sci. 13:53–58), and an affinity of humans for the species (Locey and Stone 2006. J. Herpetol. 40:528–532) seem to have contributed importantly to the frequency and success of its human-aided saltatory dispersal. Less attention has been paid to factors that may promote successful diffusion dispersal and local expansion of established populations. Here, we report *H. turcicus* nesting behaviors that may facilitate diffusion dispersal of hatchlings to unoccupied habitats.

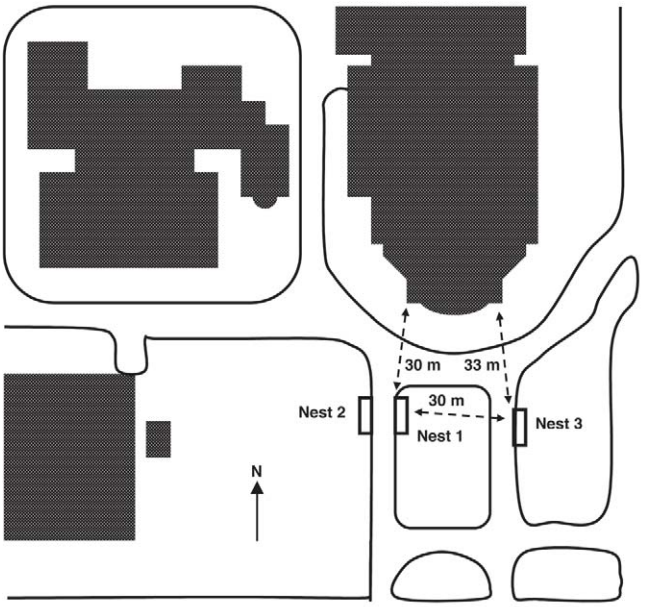


FIG. 1. Map of *Hemidactylus turcicus* nest locations relative to the population boundary. Campus buildings (stippled) shown represent the southeast corner of the population boundary (Locey and Stone 2006. J. Herpetol. 40:528–532).

On 25 August 2006, we found a communal nest (Nest 1, Fig. 1) of 10 unhatched *H. turcicus* eggs inside a storm sewer 35 m beyond a population boundary that was documented via intense censusing (Locey and Stone 2006. J. Herpetol. 40:528–532) of the campus of the University of Central Oklahoma, Edmond, Oklahoma (35.65503°N, 97.47302°W, datum: WGS84; elev. 360 m). These eggs were located on a soil substrate level to the street. The eggs were in a corner of the storm sewer, covered by ca. 20 cm of leaf litter, sticks, and debris. We revisited Nest 1 the next night and found 12 eggs, three of them hatched. On that same night we found another nest (Nest 2, Fig. 1) of five unhatched eggs in a different storm sewer on the opposite side of the street. Nest 2 was covered by ca. 20 cm of leaf litter and debris, and was elevated ca. 15 cm above the sewer bottom on a mound of soil. We revisited the nests on 9 September 2006: Nest 1 contained six unhatched and three hatched eggs; Nest 2 contained two unhatched and two hatched eggs. That same night, we found yet another nest (Nest 3, Fig. 1) located inside a different storm sewer on an adjacent street. Nest 3 contained one hatched egg and remnants of egg shells. The nest site was located in the only dry area in the storm sewer. On 15 October 2006, we visited the nests: Nest 1 had five unhatched eggs and one hatched egg; Nest 2 had one unhatched egg; and Nest 3 had no eggs. All three nests were similar in structure and were located on the most elevated portion of the storm sewer. We searched all storm sewers and areas near campus buildings, streets, and parking lots. We found several adult and hatchling geckos in storm sewers at each corner of the population, but no other nests.

We found no geckos east of Nest 3 and only two adults south of Nests 1 and 2, both occupying the same storm sewer ca. 30 m south of Nest 1.

Communal nests have been reported for *H. turcicus* elsewhere (Punzo 2001. Florida Sci. 64:56–66; Selcer 1986. Copeia 1986:956–962). However, this is the first record of *H. turcicus* nests located on the periphery of an introduced population, outside the immediate vicinity of buildings. These sewers are unheated and therefore probably unoccupied by geckos during winter months. If true, females would need to disperse from buildings to lay eggs in storm sewers in the same season. These observations suggest that hatchlings may be placed in habitats where competition for resources is minimized, and diffusion dispersal promoted.

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HOLBROOKIA APPROXIMANS (Speckled Earless Lizard). **PREDATION.** The phrynosomatid lizard, *Holbrookia approximans*, has a broad distribution throughout the southwestern United States and much of northwest-central México (Conant and Collins 1998. A Field Guide to the Reptiles and Amphibian of Eastern and Central North American, 3rd ed. Houghton Mifflin, Boston, Massachusetts. 429 pp.; Stebbins 2003. A Field Guide to Western Reptiles and Amphibians, 3rd ed. Houghton Mifflin, New York, New York. 533 pp.). These guides mention nothing about its predators, but Smith (1979. Handbook of Lizards. Comstock Publ. Assoc., Cornell University Press, Ithaca, New York. 557 pp.) noted that a large (size unspecified) *Bufo* (= *Cranopsis*) *alvarius* ate an earless lizard, and also mentioned hawks (species not specified) as predators. Here, we add the Burrowing Owl, *Athene cunicularia,* to the set of predators of *H. approximans*.

Our data were obtained during a survey of the winter ecology of *A. cunicularia* at Llano de la Soledad (25°05'44.92"N, 100°48'37.46W, datum: WGS84; elev. 1850 m), La Trinidad (24°56'29.80"N, 100°28'41.91W; elev. 1850 m), and La Hediondilla (25°05'44.92"N, 100°48'37.46W; elev. 1890 m) in the municipality of Galeana, Nuevo León, México. Survey areas were open grassland; on their periphery, an association dominated by *Larrea tridentata, Flourensia cernua, Rhus microphylla, Prosopis* sp., and *Acacia* sp. was present. Agriculture, largely consisting of potatoes (*Solanum tuberosum*) is also extensive in the area. On 12 December 2002, during analysis of 125 regurgitated pellets and prey remains representing an unspecified number of occupied *A. cunicularia* nests and roosting mounds at these localities, we found one pellet containing the upper portion of the body (395 mm; size of body fragment only) of an adult *H. approximans*.

With a broad distribution across the Americas, *A. cunicularia* has the opportunity to take diverse prey (American Ornithologists Union 1983. Check-list of North American Birds, 6th ed. Allen Press, Lawrence, Kansas. 829 pp.; Wellicome and Holroyd 2001. J. Raptor Res. 35:269–273). Mammals, birds, and invertebrates dominate the prey of *A. cunicularia*, which has been the focus of a number of dietary studies over the past 40 years (Grant 1965. Loon 37:2–17; Coulombe 1971. Condor 73:162–176; Marti 1974. Condor 76:45–61; Valdez-Gómez 2003. Dieta del tecolote llanero occidental, *Athene cunicularia hypugae* [Bonaparte, 1825], durante su estancia invernal en el Bajío Mexicano. Tesis Profesional, Universidad de Guadalajara, Centro Universitario de Ciencias Biológicas y Agropecuarias, División de Ciencias Biológicas y Ambientales, Guadalajara, México. 41 pp.), a diet in which relatively few amphibians and reptiles appear (Moulton et al. 2005. J. Raptor Res. 39:429–438). Our observation is the first record of *H. approximans* as prey of *A. cunicularia*.

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HOPLODACTYLUS CHRYSOSIRETICUS (Goldstripe Gecko). **BODY TEMPERATURE**. *Hoplodactylus chrysosireticus* is a small (maximum 75 mm SVL) endangered New Zealand gecko found only on Mana Island (Cook Strait) and on the mainland at Taranaki (Gill and Whitaker 2001. New Zealand Frogs and Reptiles. David Bateman, Auckland. 112 pp.). It is viviparous, nocturnal, and arboreal and, like many other nocturnal *Hoplodactylus*, can be found basking during the day (e.g., Common Gecko, *H. maculatus* [Werner and Whitaker 1978. New Zealand J. Zool. 5:375–393]). Here, I report on the first account of body temperatures for *H. chrysosireticus* during both diurnal emergence and nocturnal foraging.

During a larger study addressing lizard physiology on Mana Island (41°40'S, 174°00'E; elev. 121 m), I obtained body temperature data on *H. chrysosireticus*. On 4 days between 14 and 25 November 2003 (austral spring), I captured by hand *H. chrysosireticus* that had emerged on vegetation (flax, *Phormium tenax* and *P. cookianum*, N = 25; and mahoe, *Melicytus ramiflorus*, N = 2). All searches and captures were made between 1400–1700 h and 2100–2400 h along the lower 100 m of the Weta Valley trail.

Body temperature (T_b) was measured cloacally to the nearest 0.1°C using a quick reading mercury thermometer (Avinet Inc, Dryden, New York, USA). All T_bs were recorded within 5 sec of initial capture to avoid handling effects. Environmental temperatures were also measured, including air temperature (T_a) in the shade at the height of the gecko at the time of capture and air temperature within the base of flax bushes (T_f; most individuals were located on flax). Sex was determined by presence of enlarged hemipenal sacs and femoral pores in males, and females were recorded as pregnant or non-pregnant based on abdominal palpation (see [Wilson and Cree 2003. Austral Ecol. 28:339–348] for accuracy of this procedure in other viviparous New Zealand geckos). All individuals had SVL (± 1 mm) and mass (± 0.1 g Pesola™) recorded and were semi-permanently marked with an individual number on the dorsal surface using a non-toxic pen (Sharpie, Bic Pens). Following processing, geckos were all released at the point of capture.

Twenty-seven adult *H. chrysosireticus* had their T_b measured

including 17 females (14 pregnant and 3 non-pregnant) and 10 males, with 21 captured during the day (6 males and 15 females) and 6 at night (4 males and 2 females). No pregnant females were captured at night.

Body temperatures were significantly higher during the day (t-test: t = -5.178, $P < 0.001$), and ranged from 10.5°C to 14.0°C at night (mean = 12.5 ± 0.7°C), and 17.0–27.9°C during the day (mean = 20.8 ± 0.8°C). Sample sizes were too small to determine statistical differences between T_b of males and females at night, and between pregnant and non-pregnant females during the day. Day T_b for pregnant females (mean = 20.3 ± 0.8°C; range = 17.0–27.9°C) and males (mean = 22.2 ± 1.6°C; range = 18.2–27.1°C) were not significantly different (t-test: t = 0.765, $P = 0.451$). Body temperature during the day also did not vary with SVL, mass, or an interaction of these terms ($P > 0.05$).

In all but two individuals, T_b was greater than T_a (day = 6.2 ± 0.8°C; night = 1.2 ± 0.4°C). The two individuals with T_b less than T_a were captured during the day in the shade (T_b 0.2°C and 0.3°C cooler than T_a). During the day, T_b was typically 7.4 ± 1.0°C greater than T_f. At night, T_b was similar to T_f, on average 0.1 ± 0.2°C less than T_f. In all but one case, T_a was greater than T_f during the day and less than T_f at night (mean difference = 1.2 ± 0.3°C).

The data presented here confirm diurnal emergence and basking in *H. chrysosireticus* to T_b above ambient environmental temperatures. The daily T_b of *H. chrysosireticus* is similar to other species of New Zealand geckos. For example, *H. maculatus* on Stephens Island (Takapourewa) forage at night with T_b ranging from 10–13°C and by diurnal basking during the day their T_b averages 20.6°C in males and 22.6°C in females; T_b of the sympatric diurnal gecko *Naultinus manukanus* averages 23.8°C during the day (Werner and Whitaker, *op. cit.*). Pregnant females of other *Hoplodactylus* species have higher T_bs compared with males and their non-pregnant conspecifics (Rock et al. 2000. Physiol. Biochem. Zool. 73:344–355). Thus, it was unexpected that pregnant *H. chrysosireticus* have a T_b similar to that of males. Diurnal basking behavior in nocturnal species is attributed to, among other factors, embryo development (Rock et al., *op. cit.*). An in-depth study of the thermoregulatory behavior of *H. chrysosireticus* may help to reveal what drives these species differences.

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LEIOCEPHALUS CARINATUS ARMOURI (Northern Curlytail Lizard). **MOCKINGBIRD ATTACK; ASSERTION DISPLAYS.** *Leiocephalus carinatus armouri* is a well-established exotic species in Florida (Meshaka et al. 2004. The Exotic Amphibians and Reptiles of Florida. Krieger Publishing Co., Malabar, Florida. 155 pp.; Smith and Engeman 2004. Florida Field Nat. 32:107–113; Meshaka et al. 2005. Southeast. Nat. 4:521–526). Various avian species are predators of *L. c. armouri* in Florida including the Northern Mockingbird (*Mimus polyglottos*) (Smith et al. 2006. Herpetol. Rev. 37:224). Here we report an attack by a *L. c. armouri* on a pre-fledgling Northern Mockingbird (*Mimus polyglottos)* in Florida.

At 1853 h on 31 July 2006, a sunny early evening (temperature ca. 27°C), HTS observed a pre-fledging stage *M. polyglottos* on the blacktop parking lot surface at the Woolbright Road colony of *L. c. armouri* located in Boynton Beach, Florida (see descriptions in Smith and Engeman 2003. Herpetol. Rev. 34:245°246; Smith and Engeman 2004, *op. cit.*). The fence line shrubbery at the site had been trimmed noisily earlier in the day and it is common to find pre-fledgling *M. polyglottos* and other birds displaced from nests in the shrubbery in the parking lot after these disturbances (HTS, pers. obs.). Judging from its size, plumage, clumsy behavior, inability to fly, and plaintive high-frequency begging calls, HTS estimated the bird to be 10–12 days old, and 20–25 g (see review in Derrickson and Breitwisch 1992. *In* Poole et al. [eds.], The Birds of North America, Species Account No. 7, Northern Mockingbird. American Ornithologists' Union, Washington, D.C. and the Academy of Natural Sciences, Philadelphia, Pennsylvania. 26 pp.).

This initial observation lasted about 2 min when the Mockingbird hobbled east about 2 m into the territory of a large (ca. 12–13 cm SVL) adult male *L. c. armouri* and was attacked at 1855 h with a "rush" (Smith and Engeman 2004, *op. cit.*). It appeared the lizard was attempting to grab the bird with open jaws. The bird escaped, running awkwardly about 2 m, at which point the lizard broke off its pursuit. Within a minute, the lizard assumed a vigilant posture on a cement parking curb stop, a favorite basking spot for this individual, and performed assertion displays (tail curled, and "wagging" [rotating/twitching] to the right and left) (Cooper 2001. Ethology 107:1137–1149; Smith and Engeman 2004, *op. cit.*). At 1859 h, the bird walked slowly west past the parking stop and was attacked a second time from a distance of about 1 m. This time the bird escaped by hopping into the air and then running about 2–3 m, at which time the lizard again broke off its attack. The lizard then held this position on the parking lot surface performing assertion displays until 1901 h, at which time it returned to the parking curb stop. At 1906 h, an exotic adult Ringed Turtle Dove (*Streptopelia risoria*) ca. 20–25 cm and 125–150 g (mass estimate from Hedrick et al. 2002. J. Exp. Biol. 205:1389–1409) pecking at seeds on the parking lot surface passed within 0.75 m of the *L. c. armouri* and the lizard retreated to its burrow, stopping briefly at the entrance while curling and wagging its tail before disappearing. This final behavioral display is typical for this species in Florida (Cooper 2001, *op. cit.*; HTS, unpubl. data; Smith and Engeman 2004, *op. cit.*). The *M. polyglottos* continued walking west and the dove continued northwest. The *L. c. armouri* was still out of sight in its burrow when observations were ended at 1915 h. Most likely, the larger Ringed Turtle Dove was responded to as a potential threat with a retreat, especially in light of the observation of the similar-sized adult Northern Mockingbird as a predator of *L. c. armouri* (Smith and Engeman 2006, *op. cit.*).

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LEPIDOPHYMA TUXTLAE (Tuxtla Tropical Night Lizard). **PREDATION.** *Lepidophyma tuxtlae* is a viviparous lizard endemic to tropical rain forest in the states of Veracruz, Oaxaca, and Chiapas, México (Bezy and Camarillo 2002. Contrib. Sci. Los Angeles County Mus. 493:1–41). Data on predators of this species are scarce because *L. tuxtlae* is secretive, inhabiting narrow concealed refuges mostly beneath fallen logs, under tree bark and within decaying logs (Castillo-Cerón and López-González 1990. Bull. Maryland Herpetol. Soc. 26:153–158; unpubl. data). Here we describe an observation of predation on *L. tuxtlae*.

At ca. 1400 h on 14 July 2006 during a diurnal herpetofaunal survey, we found an immature wolf spider (prosoma = 8 mm, opisthosoma = 9 mm) of the genus *Hogna* feeding on a neonate *L. tuxtlae* (ca. 28 mm SVL, 35.5 mm tail) beneath the bark of a decaying log. We made this observation in a small fragment of tropical rain forest in the Los Tuxtlas region, Veracruz, Mexico (18°36'6.72"N, 95°08'18.76"W, datum: WGS84, elev. 570 m). The spider held the neonate with its chelicera and the neonate's head and anterior body were partly digested.

Many spiders display opportunistic feeding behavior, and several records exist of spiders feeding on lizards (Corey 1988. J. Arachnol. 16:392–393; Hampton et al. 2004. Herpetol. Rev. 35:269–270); however, our observation represents the first record of predation on night lizards by wolf spiders.

We thank Alejandro Valdez for identifying the spider, and J. Cime for assistance in the field. The *L. tuxtlae* neonate (CNAR 12228) was deposited in Colección Nacional de Anfibios y Reptiles, Instituto de Biología, Universidad Nacional Autónoma de México.

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LEPOSTERNON WUCHERERI (NCN). **VERTEBRATE PREY**. The diet of the Brazilian amphisbaenian *Leposternon wuchereri* is mainly composed of soft items such as oligochaete worms and coleopteran larvae (Barros Filho and Valverde 1996. Sitientibus 14:57–68); ants, termites, beetles, lepidopteran and other insect larvae are the most frequent prey of other amphisbaenians (Kearney 2003. J. Herpetol. 37:379–464). Although amphisbaenians are sometimes fed small vertebrates in captivity (e.g., Gans 1971. Bull. Am. Mus. Nat. His. 144:379–464), consumption of vertebrates in the wild has been rarely demonstrated (e.g., Barbadillo et al. 1998. Herpetol. Rev. 29:236; Colli and Zamboni 1999. Copeia 1999:733–742). Here, we report the first case of *L. wuchereri* feeding on vertebrates.

During faunal rescue at the site of the Santa Clara Hydroelectric power plant, municipalities of Nanuque and Serra dos Aimorés (mean air temperature: 23.1°C), Minas Gerais state, southeastern Brazil (17°53'S, 40°11'W; elev. 105 m), 146 *L. wuchereri* captured were transported to the hydroelectric plant laboratory and kept in a ventilated wooden collection box (40 × 20 × 20 cm) without temperature control for 2–3 days. Wet cotton wads were put in the box to maintain humidity, but the animals were not fed. Animals were subsequently sacrificed, fixed in 10% formalin, placed in a storage solution of 70% alcohol, and deposited at Museu de Ciências Naturais da Pontifícia Universidade Católica de Minas Gerais (MCNR 279–425). During examination of the stomach of an adult (393 mm SVL) female *L. wuchereri* (MCNR 294), we found some small bones (three pterygoids, one ileum, a frontoparietal, two maxillae and a phalange) belonging to anurans and five keratinized claws (probably of some lizard species).

Environmental conditions during flooding of a previously terrestrial area by a new hydroelectric dam represent novel local environmental conditions. As the water floods the area, some animals escape, typically to higher ground, which may cause local and presumably temporary increases in species densities. This has the potential to either decrease food availability or increase competition, and may force individuals to feed on atypical prey. Many unpublished observations indicate that, when crowded in a captive environment, amphisbaenians bite one another and larger individuals eat smaller ones (Gans 1966. Bull. Am. Mus. Nat. Hist. 134:185–260). Our data might indicate that *L. wuchereri* is capable of varying its food habits under such unusual circumstances. If so, the species may be a generalist-opportunist as has already been suggested for other amphisbaenians (Cabrera and Merlini 1990. Herpetol. Rev. 21:53–54).

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LIOLAEMUS CHACOENSIS (NCN). **BODY TEMPERATURE.** *Liolaemus chacoensis* is an oviparous lizard that inhabits entangled thorny vegetation in the forested landscapes of Chaco Phytogeographic Province, northeastern Argentina (Cabrera and Willink 1980. Biogeografía de América Latina. O.E.A.Washington D.C. 109 pp.). It can maneuver nimbly among well-armed cacti, such as *Opuntia sulphurea*, that hinder its capture. Limited study has addressed its reproduction (Cruz and Ramírez Pinilla 1996. Rev. Española Herpetol. 10:33–39), but data are lacking on its thermal ecology. Here, we present preliminary data on *L. chacoensis* thermal ecology.

On 25 February 2006, we conducted field work in Las Tumanas, Departmento Valle Fértil, San Juan Province (30°52'S, 67°19'W, datum: WGS84; elev. 750 m). Data are based on 11 captures (7 females and 4 males) obtained from randomized visits to shrubs and cacti across the study site. Each individual was captured by noosing. For each capture, cloacal (T_c), substrate (T_s) and air (T_a) were measured (to nearest 0.1°C) with a digital Barnant thermometer. We took T_s at the precise point where an animal was first sighted and T_a 1 cm above the substrate, both immediately following captures. We also recorded microhabitat type (as barren substrate or vegetation litter) for each capture. Individuals were

sacrificed and fixed in the field with 10% formalin. Afterward, SVL was measured (to nearest 0.02 mm).

Mean body temperature of the 11 adult *L. chacoensis* was 33.3°C (SD = 4.0°C). No significant differences were found between the sexes ($F_{1,9} = 0.2$, $P = 0.9$). Body size was unrelated to T_c (Spearman Rank correlation: $r_s = 0.21$, $P = 0.66$). An ANOVA revealed significant differences between T_c and T_a ($F_{1,20} = 6.72$, $P = 0.01$). In contrast, neither T_c nor T_s ($F_{1,20} = 0.04$, $P = 0.84$) or T_a and T_s ($F_{1,20} = 2.83$, $P = 0.10$) differed significantly from one another. Cloacal temperature and each of T_s and T_a were correlated (Spearman Rank correlation: T_s: $r_s = 0.75$, $P = 0.006$; T_a: $r_s = 0.87$, $P = 0.0004$). We found no significant differences in temperature between the two habitat type (Chi-square: $\chi^2 = 0.81$; df = 1; $P = 0.36$).

Based on correlations among T_c, T_s and T_a, thermoregulation in *L. chacoensis* is similar to that in *L. olongasta* (Cánovas et al. 2001. Herpetol. Rev. 37:88), *L. wiegmanni* (Martori et al. 1998. Rev. Española Herpetol. 12:19–26), *L. koslowsky* (Martori et al. 2002. Cuad. Herpetol. 1:78–99), *L. sanjuanensis* (Acosta et al. 2004. Herpetol. Rev. 35:171), and *L.* cf. *elongatus* (Acosta et al. 2006. Herpetol. Rev. 37:466–467), which show a stronger relationship between T_c and T_a. In contrast, *L. pseudoanomalus* (Villavicencio et al. 2007. Amphibia-Reptilia 28:163–165) and *L. elongatus* (Ibargüengoytía and Cussac. 2002. Herpetol. J. 12:131–134) show a more significant correlation between T_c and T_s. Our analysis suggests that *L. chacoensis* is heliothermic and moves among microhabitats to thermoregulate.

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LIOLAEMUS DARWINII (NCN). **CANNIBALISM.** *Liolaemus darwinii* is a medium-sized liolaemid lizard of arid western Argentina. Males of this species are territorial (Cei 1986. Reptiles del Centro, Centro-oeste y Sur de la Argentina. Herpetofauna de Zonas Áridas y Semiáridas. Monografie IV, Museo Regionale di Scienze Naturali, Torino, Italy. 527 pp.). Some aspects of their diet, known to include insects, have been described (Avila and Acosta 1993. Facena 10:57–61; De Viana et al. 1994. Rev. Biol. Tropical 42:379–381; Videla 1983. Deserta 7:192–202). Here, we report an observation of cannibalism by an adult male *L. darwinii* on a hatchling.

In February 2001, we collected lizards at Médanos Grandes, Caucete in San Juan Province, Argentina (31°11'S, 68°10'W; elev. 600 m) during an ecological study of this species. Examination of the stomach contents of an adult (54 mm SVL) male *L. darwinii* revealed a hatchling (25 mm SVL) conspecific, and some ants and other Hymenoptera.

Cannibalism has been documented in two other species of *Liolaemus* (*L. koslowskyi*: Avila and Belver 2000. Herpetol. Rev. 31:174; *L. petrophilus*: Avila and Morando 2002. Herpetol. Rev. 33:52). The relative importance of cannibalism in *Liolaemus* population dynamics remains to be investigated.

Specimens (MCN-UNSJ 1845a and 1845b) were deposited in the Herpetological Collection of the Instituto y Museo de Ciencias Naturales de la Universidad Nacional de San Juan (MCN-UNSJ).

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NOROPS HUMILIS (Ground Anole). **INTERSPECIFIC INTERACTION.** Aggressive interactions among organisms exhibit a gradient of intensity and frequency depending on how related participating individuals may be. Interactions between conspecifics are usually more intense and more frequent than those between congeners. Aggressive contacts among species of different taxonomic classes, not taking into account predator/prey interactions, are infrequent. These interactions can arise because of interference or exploitative competition (Shields and Bildstein 1979. Ecology 60:468–474), mistaken identification (Hess and Losos 1991. J. Herpetol. 25:256–259), or interspecific territoriality (Robinson and Terborgh 1995. J. Anim. Ecol. 64:1–11).

At 1215 h on 10 August 2006 in Pacuare-Matina Forestry Reserve, Limón Province, eastern Costa Rica (10°12'31.5"N, 83°15'57.2"W, datum: WGS84; elev. 3 m), we observed an adult male *N. humilis* (ca. 37 mm SVL) on a branch 54 cm above the ground. The male perched on the branch for ~90 min, and then jumped to a horizontal stem and did several dewlap extensions, some accompanied with headbobs. We attemped to locate another *N. humilis* nearby, but found none. After a few minutes of remaining immobile, the male ran down the stem and approached a Strawberry Poison-dart Frog, *Dendrobates pumilio*, that was hopping upon a log about 1.5 m away. The lizard initiated a new series of dewlap extensions and headbobs every time the frog hopped, and after these displays the frog stopped and raised its body on its four legs, remained in this position without movement for a few seconds and moved again. Both individuals repeated these interactions for around 10 min until the frog finally jumped away from the log and disappeared behind some bushes.

Whether the interactions we describe resulted from competition, mistaken identification, or interspecific territoriality is unclear. The substantial difference in body shape between *N. humilis* and *D. pumilio* may make mistaken identification less likely than the other possibilities. Likewise, competition and interspecific territoriality could reflect the same intensity of behavior if a limiting resource, such as space, exists, and both species occur at high densities. Both species inhabit primarily the forest floor, are highly territorial, and exhibit high densities where we made our observations. Males *N. humilis* have been reported to spend ca. 20% of their time defending their territories (Talbot 1979. Copeia 1979:472–481), and aggressive contacts among *D. pumilio* conspecifics are frequent in habitats where they reach high densities (Pröhl 1997. Amphibia-Reptilia 18:437–442).

Observations were made during MDB's master's thesis fieldwork. We acknowledge Pacuare-Matina staff for support, and thank Pablo Allen for suggestions.

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NOROPS POLYLEPIS (NCN). **PREDATION.** *Norops polylepis*, a denizen of lowland and premontane tropical forests in southwestern Costa Rica and Panama (Savage 2002. The Amphibians and Reptiles of Costa Rica, University of Chicago, Chicago, Illinois. 934 pp.), is known to be preyed upon by several birds, larger lizards, and snakes (Andrews 1983. *In* D. H. Janzen [ed.], Costa Rican Natural History, pp. 409–410. University of Chicago Press, Chicago, Illinois). Here, I report observations of an insect predator of *N. polylepis*.

At 2050 h on 27 May 2005, I observed a female Spear Bearer Katydid (*Copiphora cultricornis*) eating a *N. polylepis* as it perched on vegetation over the Quebrada Agua Buena in Rincon, Costa Rica (8°42'12"N, 83°31'13"W; datum: WGS84; elev. 238 m). The narrow, rocky stream (ca. 3 m in width) was located in lowland tropical wet forest (Holdridge 1967. Life Zone Ecology [revised ed.]. Tropical Science Center, San Jose, Costa Rica. 206 pp.). The katydid was perched upside-down on a small branch (ca. 2 m above the stream), with the body of the anole oriented upright and its anterior end grasped by the katydid's front legs (Fig. 1). When first encountered, the head of the anole was missing, apparently it had been eaten. Over the 10 min of observation, the katydid continued to consume the anole from head to tail. *Copiphora* katydids are known to feed on diverse items including seeds, fruits, and insects (Naskrecki 2000. Katydids of Costa Rica, Vol. 1. Orthopterist's Society, Philadelphia, Pennsylvania. 164 pp.). A congener, *C. rhinoceros*, has been observed feeding on snails and *Norops* sp., but this is apparently the first record of *C. cultricornis* preying on a vertebrate.

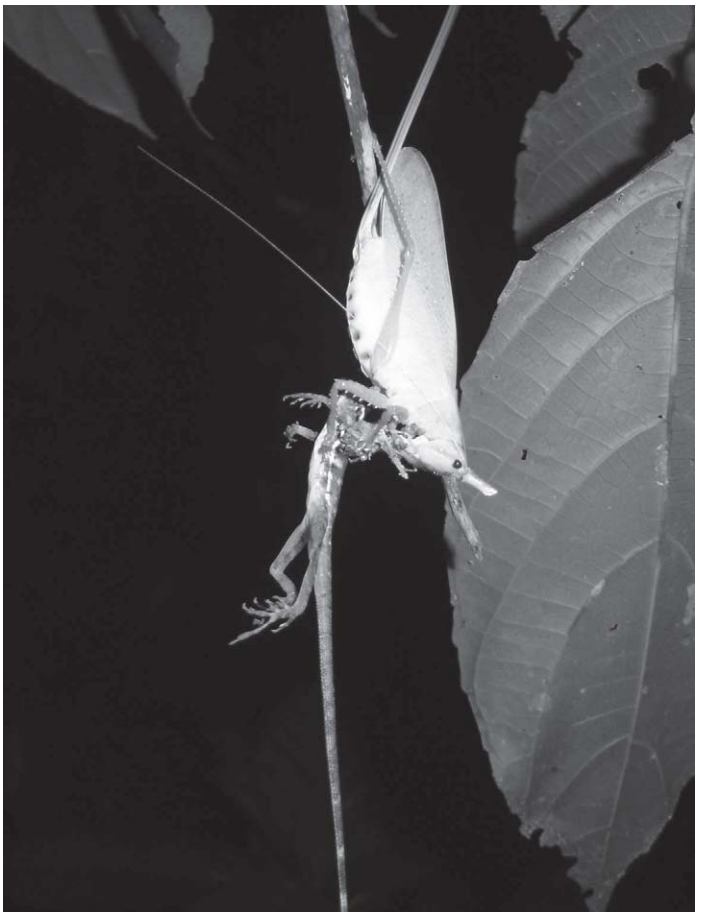


FIG. 1. A katydid (*Copiphora cultricornis*) eating a *Norops polylepis* along the Quebrada Agua Buena in Rincon, Costa Rica.

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OEDURA RETICULATA (Reticulated Velvet Gecko). **PREDATION**. During an ecological and genetic study of the arboreal gecko *Oedura reticulata* in the Western Australian wheatbelt (between Kellerberrin and Trayning), I recorded two occasions of predation on the species by the Australian huntsman spider, *Isopeda* cf. *magna*. Observations were made in a 1-ha habitat remnant (31°18'S, 117°42'E; elev. 323 m) on *Eucalyptus salubris*, the tree species *O. reticulata* is thought to most prefer. At the first observation at 2320 h on 1 February 2006, the prey, a subadult *O. reticulata* (ca. 50 mm SVL; Sarre 1995. Austral. J. Ecol. 20:288°298), was found already dead. I made the second observation at 0114 h on 10 February 2006, after I released a gecko on its tree of capture. The attacked individual was an adult male (63 mm SVL). After releasing the gecko on one side of the tree, the spider, which had been sitting on the opposite side of the tree trunk, ran along the tree's surface and attacked the gecko. The gecko shed its tail and managed to escape. The *I.* cf. *magna* did not pursue the escaping gecko, but held onto the tail. Both spiders were adults, ca. 50 mm in body length (without legs).

Excluding potentially artificial encounters in pitfall traps (Bauer 1990. Herpetol. Rev. 21:83–87), predation by arachnids is thought to be common among geckos, but few observations exist from the wild. In particular, few reports exist of arboreal geckos as huntsman spider prey. For the arboreal species *Gehyra variegata*, an unsuccesful predation attempt by another species of Australian huntsman spider, *Holconia immanis*, has been recorded in Kinchega National Park, Western New South Wales (Henle 1993. J. Arachnol. 21:153–155).

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OPHISAURUS VENTRALIS (Eastern Glass Lizard). **FIRE-INDUCED MORTALITY.** Direct mortality to wildlife due to prescribed fire is of concern to land managers using fire as a manage-

ment tool. The ability of individual animals to escape fire is critical to the long-term survival of species inhabiting fire-maintained systems. Many wildlife species in Florida are both adapted to and dependent upon periodic fire to maintain suitable habitat (Myers and Ewel 1990. Ecosystems of Florida. University of Central Florida Press, Orlando, Florida. 765 pp.). However, species not adapted to survive in pyrogenic landscapes might suffer directly from fire-induced mortality; consequently fire might be a limiting factor. Long-term fire exclusion in many of Florida's forests, habitats that historically burned regularly under natural conditions (lightning ignition), have undergone shifts in vegetation composition, fuel loads (higher), and leaf litter accumulation (higher), essentially altering the vegetative associations (Myers and Ewel, *op. cit.*). Likewise, the suite of wildlife species that inhabit these systems might also shift over time (Myers and Ewel, *op. cit.*). We hypothesize that one such change could favor fossorial species that utilize the litter for cover and foraging. Without normal woodland fire return intervals, non-fire adapted species may be able to augment their populations to a "pseudo-elevated" status resulting in denser populations than were historically present. However, data concerning historical population levels of many species are often lacking and the documentation of wildlife mortality as a result of fire can be difficult.

The benefits of prescribed fire to endangered species and other wildlife in Southeast Florida natural communities are well documented (Myers and Ewel, *op. cit.*), in particular for the many threatened and endangered species found in Savannas Preserve State Park (Marti et al. 2005. Endangered Species Update 22:18–28; Cowan 2005. Endangered Species Update 22:29–39). However, during post-burn evaluations following five prescribed burns and two wildfires, dead Eastern Glass Lizards (*Ophisaurus ventralis*) were observed within three distinct conservation areas in Southeast Florida (including Savannas Preserve) between January 2003 and March 2004. Burned areas were surveyed to characterize the fires and at the same time were canvassed for wildlife mortality. *Ophisaurus ventralis* was the only lizard species for which mortalities were observed. One dead *O. ventralis* was found on each of two prescribed fires conducted at J. W. Corbett Wildlife Management Area, Palm Beach County Florida, on 15–16 January 2003. Burn unit sizes were 14.2 ha and 4.0 ha, respectively. One dead specimen was also observed following a 32.4-ha prescribed burn conducted on the North Fork St. Lucie River Preserve State Park, St. Lucie County Florida on 28 January 2003. On 15 January 2004, search of a 12.1-ha prescribed burn on a separate parcel of land within the boundaries of the same park revealed 8 dead specimens. Three post-burn observations were made at Savannas Preserve State Park, Martin and St. Lucie Counties, Florida. On 26 November 2003 following a 6.1 ha prescribed burn, one dead lizard observed; 30 July 2003 following a 0.8 ha wildfire, one dead lizard observed; and, a single dead lizard was also found following a 87.4-ha wildfire on 22 March 2004. Unlike many other amphibians, reptiles, birds, and mammals in Southeast Florida adapted to and dependent upon fire (Cowan, *op cit.*; Marti et al., *op cit.*), these observations suggest that this species, often associated with dense herbaceous growth, appears susceptible to some level of fire-induced mortality. Therefore, it may be to this species' benefit to apply patchy prescribed burns resulting in a mosaic of burned and unburned areas.

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PHRYNOSOMA CORNUTUM (Texas Horned Lizard). **POTENTIAL DIETARY THREAT.** Seed-harvesting ants of the genus *Pogonomyrmex* are important prey for horned lizards, including *Phrynosoma cornutum* (Pianka and Parker 1975. Copeia 1975:141–162; Sherbrooke 1995. Herpetol. Rev. 26:25–26). These venomous ants pose both biting and stinging threats to feeding lizards (Rissing 1981. Ecology 62:1031–1040; Schmidt et al. 1989. Copeia 1989:603–607). Though the coating of ants with pharyngeal and esophageal mucus secretions (Schmidt et al., *op. cit.*; Schwenk and Sherbrooke 2003. Integr. Comp. Biol. 43:1061; Sherbrooke 2003. Introduction to Horned Lizards of North America, University of California Press, Berkeley. 178 pp.) and blood plasma resistance to ant venom (Schmidt et al., *op. cit.*) provide protection during feeding on *Pogonomyrmex*, ingestion of other noxious invertebrates might not always be successful (Cohen and Cohen 1990. Southwest. Nat. 35:369; Manley and Sherbrooke 2001. Southwest. Nat. 46:221–222; Sherbrooke 2002. Herpetol. Rev. 33:312). Stomach analyses have often reported extraneous (non-food) materials assumed to be inadvertently ingested during feeding (Milne and Milne 1950. Am. Midl. Nat. 44:720-741; Pianka and Parker, *op. cit.*). Nonetheless, *P. cornutum* capture ant prey (Ott et al. 2004. J. Exp. Biol. 207:3067–3072; Ott et al., unpubl. data) using acute vision and split-second control of tongue-tip direction. During capture, ant prey are moved past a horned lizard's teeth without mastication into the esophagus via "pharyngeal packing" (Schwenk 2000. *In* Schwenk [ed.], Feeding : Form, Function and Evolution in Tetrapod Vertebrates, pp. 175–291. Academic Press, San Diego, California; Meyers and Herrel 2005. J. Exp. Biol. 208:113–127). The purpose of this note is to report an observation suggesting that during use of this prey-capture system, *P. cornutum* occasionally ingests items that present a dietary threat, and to note that this threat may be minimized by the lizards during prey selection.

On 2 June 2005, I examined the peritoneal cavity of a juvenile *P. cornutum* (56 mm SVL, 8.8 g) collected 27 May 2005 in Antelope Pass, Peloncillo Mountains, Hidalgo Co., New Mexico (Sherbrooke 2002. Herpetol. Rev. 33:21–24) and discovered an intact 12 mm long, sharply-pointed grass seed with three awns (*Aristida*, perhaps *purpurea*; identification by D. K. Aasen-Rylander and J. Bowers). No wounds were evident and the lizard appeared otherwise healthy, although externally the desiccated head of a *Pogonomyrmex* ant clung by its mandibles to a toe of the lizard.

Captive *P. cornutum* fed *Pogonomyrmex* ants obtained through colony excavation (Sherbrooke 1995, *op. cit.*) often avoid eating workers carrying larvae and pupae inadvertently mixed with unburdened ants (pers. obs.). Similarly, Bott et al. (2001. Herpetol. Rev. 32:41) reported that a *P. cornutum* feeding on alate termites (*Gnathamitermes perplexus*; sex not identified) made no attempt to capture *Pogonomyrmex* ants carrying these same termites. Field observations of a selection of *Pogonomyrmex* ants during feeding by *P. cornutum* (H. Topoff, pers. comm.) and *Phrynosoma solare* (C. May, pers. comm.) also suggest that horned lizards selectively avoid capturing ants carrying seeds. If the seed I found in the peritoneal cavity of the juvenile *P. cornutum* originated with seed-carrying ant prey, my observation suggests that ants carrying seeds are occasionally taken, and the seeds have the potential to penetrate the walls of the digestive tract, thus becoming potentially deleterious to internal organs or tissues.

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PHRYNOSOMA DOUGLASII (Pygmy Short-horned Lizard) **MAXIMUM ELEVATION.** St. John (2002. Reptiles of the Northwest: California to Alaska, Rockies to the Coast. Lone Pine Publishing, Auburn, Washington. 272 pp.) and Stebbins (2003. Western Reptiles and Amphibians, 3rd ed. Houghton Mifflin Co., Boston, Massachusetts. 533 pp.) reported a maximum elevation of 1830 m for *Phyrnosoma douglasii*. Here, we report observations that significantly increase known maximum elevation.

During a visit to Hart Mountain National Antelope Refuge, Lake County, Oregon (42°30'06"N, 119°43'11"W, datum: WGS84; 2200 m elev.) between 0945 and 1445 h on 1 July 2006 (air temperatures 25.5–29.5°C), we observed 13 *P. douglasii* (5 adult males [38, 38, 45, 46, and 53 mm SVL], 3 subadult males [33 and 36 mm SVL; one lizard not measured], 2 adult females [51 and 71 mm SVL], and 3 subadult females [35, 38, and 39 mm SVL]) on an unnamed mountain ca. 12 km NNE of Hart Mountain. Lizards were observed over an elevation range between 1910 and 2200 m in shrub-steppe habitat with lithosol terrain dominated by Stiff Sage (*Artemisia rigida*) and on bare dirt trails in grassland habitat with loamy soil terrain dominated by bunchgrasses (*Pseudoroegneria spicata*). Our observations extend the maximum elevation range ca. 370 m above maximum reported by St. John (*op. cit.*) and (Stebbins, *op. cit.*).

We deposited 4 color voucher photographs (BYU 4086–4089) and their associated locality data in the herpetological collection at the Brigham Young University Museum. Jack Sites verified the species identity of the animals.

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PODARCIS SICULA (Italian Wall Lizard). **OPPORTUNISTIC FORAGING BEHAVIOR**. Native to southern Europe, *Podarcis sicula* was accidentally introduced to Long Island, New York in 1967 (Gossweiler 1975. Copeia 1975:584–585). Burke and Mercurio (2002. Amer. Midl. Nat. 147:368–375) studied the diet of *P. sicula* on Long Island but only utilized stomach contents; no reports exist of *P. sicula* foraging behavior in the urban-industrialized environment. Here, I describe preliminary observations on *P. sicula* foraging behavior in this environment.

During my investigation of their occurrence along the Long Island Railroad, I made observations of *P. sicula* at the Carle Place train station in Carle Place, New York (40°44'56"N, 73°36'19"W, datum: WGS84; elev. 30 m) between May and July 2006. Vegetation where I made these observations consisted primarily of exotic shrubs (e.g., *Artemisia vulgaris*) and herbaceous annuals and perennials (e.g., *Centaurea* sp.). Ground cover consisted of dead *A. vulgaris* and *Centaurea* stems, and human-generated debris such as bottles, cans, and paper litters much of the ground near the east- and west-bound train platforms.

At 1224 h on 1 June 2006, an adult (ca. 7.0 cm SVL) male *P. sicula*, seen foraging along the edge of an *A. vulgaris* patch, approached an empty aluminum beverage can behind the westbound platform. The lizard stopped beside the can remaining motionless for ca. 45 sec until a small unidentified fly (Diptera) landed on the can. The fly was rapidly seized and consumed, and the lizard proceeded to feed on 4 additional flies attracted to the can over the next 3 min. Shortly afterwards, the lizard returned to the same patch of vegetation along which it was originally seen foraging. About 30 sec after the male retreated, an adult (ca. 6.0 cm SVL) female approached the same can from another nearby patch of vegetation. It then proceeded to feed in the same manner as the male, consuming a house fly (probably *Musca domestica*) and two ants (likely *Tapinoma sessile*) over the course of ca. 2 min before also retreating into the vegetation. On 6 June 2006 at 1147 h, a second adult (ca. 6.4 cm SVL) male was observed feeding on small flies (seemingly the same fly species observed on 1 June 2006) attracted to an empty glass beer bottle located behind the eastbound platform. This lizard consumed three flies as each landed on the bottle, and then moved to a nearby rock where it basked for ca. 2 min before retreating beneath a rock.

Comparative studies have aided in understanding the differences in ecologies between the introduced Long Island and indigenous European *P. sicula* populations (Burke et al. 2002. Copeia 2002:836–842; Burke and Mercurio, *op. cit.*; Burke and Ner, *op. cit.*). In Europe, *P. sicula* occur in both natural and disturbed environments (Foa et al. 1992. Herpetol. J. 2:86–89; Avery 1993. Ethol. Ecol. Evol. 5:511–518), but Italian Wall Lizards in New York are restricted to anthropogenic environments (Burke and Mercurio, *op. cit.*; Burke and Deichsel, *in press* Herpetol. Conserv.). Review of the literature reveals that no reports of opportunistic foraging associated with human-generated debris exist for *P. sicula* or any other *Podarcis*. Further research is needed to determine both how common and how important such behavior is in maintaining *P. sicula* in heavily-disturbed environments.

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TEIUS OCULATUS (NCN)**. COURTSHIP; MATING.** *Teius oculatus* is a diurnal, oviparous, insectivorous species (Avila 2002.

Biogeographica 78:15–33) with a broad distribution in eastern and central Argentina, Uruguay, and southeastern Brazil (Cei 1993. Reptiles del Noroeste, Nordeste y Este de la Argentina. Herpetofauna de las Selvas Subtropicales, Puna y Pampas. Museo Regionale di Scienze Naturali, Torino, Italia, Monogr. 14. 949 pp.). Save a brief account by Gudynas et al. (1981. C. E. Don Orione Contr. Biol. Montevideo 8:1–9), courtship and mating are undescribed. Here, we relate behaviors during courtship and mating in both free-ranging and captive *T. oculatus*.

On 10 December 2006, HJPT filmed a free-ranging pair of *T. oculatus* in the National Park Lihue Calel, La Pampa, Argentina (37°55'S, 65°32'W, datum: WGS84; 275 m elev.), and on 5 February 2006, JS filmed a captive pair that came from El Bagual Reserve, Formosa, Argentina (26°10'S, 58°56'W, datum: WGS84; 75 m elev.). The captive pair had been living in a terrarium (70 cm × 30 cm × 30 cm) for about a year when the behaviors we report were first observed. Both were of approximately the same snout–vent lengths, the male being 11.5 cm and the female 10.4 cm long. The male approached the female, climbed on her back and began performing lateral head movements over her neck and head region as if gently rubbing it. The female walked a few steps and occasionally moved her head laterally in unison with the male's back and forth movements. The male also tongue-flicked and did a few "leg strokes" (Carpenter and Ferguson 1977. *In* Gans and Tinkle [eds.], Biology of the Reptilia, Volume 6, pp. 335–403. Academic Press, New York, New York), moving one hind leg up and down the side of the female as if stroking her. After about 3 min, the female lifted her cloacal region. The male immediately grasped the female from the left side of her pelvis, formed an arc around her and introduced the right hemipenis in her cloaca. During mating, the female remained motionless. After about 19 min, the pair abruptly disengaged, apparently initiated by the female who took refuge in their common shelter. Meanwhile, the male dragged his cloacal region with hind legs extended in an apparent attempt to reintroduce the everted hemipenis. In October 2006, the same pair was observed mating a second time. On this occasion, we did not observe courtship prior to mating.

We observed a similar sequence of behaviors in the free-living pair. The main difference seemed to be the apparent inexperience of the male. In this case, the male was about 8 cm in snout-vent length and the female 10 cm. The male was possibly a subadult (the pair was not captured to confirm). Although this male performed the same behaviors observed in the captive male, he appeared more animated, moving about the female erratically. While performing the lateral head movements as well as trying to gain a position over the female's back, he seemed to be slipping off so that the behavior was done over different parts of her back as well as over her head as he turned around several times, front and back, looking for the right position. This lasted about 3.5 min. The male then did a few leg strokes over her tail, turned around, and resumed the lateral head movements for about 30 sec, after which he seized her by the pelvic region, in this case from the right. A little less than 2 min later, the female disengaged and ran off as the male followed her for 4–5 m. At that moment, another, larger (11 cm SVL), brightly colored male, appeared. The two males started fighting. During the struggle, which did not last more than 2 sec, the two males stood up on their hind legs, facing each other, apparently wrestling with their anterior limbs (the latter was not filmed). Following this short quarrel, the smaller male quickly retreated, disappearing into the bush. The larger male then started looking for the female but they were soon lost from our sight.

Mating behavior we observed in *T. oculatus* was similar to that reported by Gudynas et al. (1981, *op. cit.*), i.e., the male grasping the female by the trunk and forming an arc around her. However, these authors did not observe courtship. Instead, males ran persistently after a female until seizing her. When mating was over, the authors also observed the male drag the cloacal region, hind legs extended, thus reintroducing the everted hemipenis. Other examples of lateral rubbing of the neck or head of female as part of courtship in lizards were not found in the literature, though Carpenter and Ferguson (*op. cit.*) described a behavior called "head press" or "jaw rub" as "rubbing or pressing of the chin or head region against another individual, usually associated with courtship or copulation," but specific examples were not provided. On the other hand, leg strokes have been reported in *Tupinambis teguixin* and in *T. rufescens* (Chani 1988. Proyecto *Tupinambis*: Estado de las investigaciones hasta la primavera de 1988. Comportamiento. III Congreso de Producción, Industrialización y Comercialización de la Fauna; Federación Argentina de la Comercialización e Industrialización de la Fauna, Bs.As.) and in some skinks and anguids (Carpenter 1978. *In* Greenberg and MacLean [eds.], Behavior and Neurology of Lizards, pp. 253–267. NIMH, Rockville, Maryland).

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TRETIOSCINCUS BIFASCIATUS (Limpia Casas). **DIET.** *Tretioscincus bifasciatus*, a diurnal gymnopthalmid lizard known from northern and central Colombia and northern Venezuela, inhabits a variety of life zones from dry to moist Tropical and Premontane forests over a broad altitudinal range (sea level to 1500 m; S. Ayala and F. Castro, unpubl. data). Most often observed in sunny patches near the base of large trees or in nearby litter, it can also be found under brush in open areas or on rocks in deforested sites, but always near a large tree or dense vegetation. It seems most active during sunny intervals, but almost nothing is known of its ecology. Here, we provide preliminary data on its diet from central Colombia.

We studied 32 *T. bifasciatus* from the Inspección de Policía Guadualito, Municipality of Yacopí, Departamento Cundinamarca (74°18'W, 5°37'N, elev. 800–1100 m) over the interval February 1998–January 1999). The area, on the Cordillera Oriental of the Colombian Andes, is located on steep slopes draining to the

Magdalena Valley. Highly human-altered, forest fragments occur only at the top of the mountains; sugar, corn, and casaba plantations, and cattle pastures occur on the slopes. The lizards were most often found in sunny spots on the palm thatch roofs of the sugar mills (''trapiches'') (37.5%), or in the nearby litter close to the "trapiches" (25%), or near the base of large trees (15.6%), other individuals were seen on fallen trunks (12.5%), and inside or around abandoned rural houses (9.4%).

We examined the stomachs of 24 lizards by dissection. Eleven *T. bifasciatus* had food remnants in their stomachs; the remaining 13 lizards had empty stomachs. The high number of lizards with empty stomachs seems unrelated to foraging interval because the lizards were randomly collected at different times. Food found in the stomachs was exclusively cockroaches, spiders and grasshoppers; no plant material was found. Cockroaches were the most important prey, based on numbers (N = 7, 41.8%), volume (1763 mm^3, 50.2%), and frequency with which prey was recorded among lizards with food (N = 6, 54.5%). Grasshoppers (N = 4, 23.5%) followed cockroaches in volume (1336 mm^3, 38%) and frequency (N = 4, 36.4%). Prey volume of spiders (N = 6, 35.3%) was the least among three prey groups (414 mm, 11.8%) but was in similar frequency to grasshoppers (N = 4, 36.4%).

Tretioscincus bifasciatus are sympatric and synoptic with *Mabuya* sp. We recorded 15 prey species from 89 *Mabuya* sp. (unpubl. data), but the same three prey groups were dominant (70% of individual prey) implying that these prey taxa are generally availability to both lizards.

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TROPIDURUS TORQUATUS (Brazilian Collared Lizard). **DIET**. *Tropidurus torquatus* is an ambush forager that feeds mainly on arthropods, but may also eat some plant material, e.g., seeds, flowers and leaves (Bergallo and Rocha 1994. Austral. J. Ecol. 19:72–75; Teixeira and Giovanelli 1999. Rev. Brasileira Biol. 59:11–18). Vertebrate prey is poorly documented though *T. torquatus* is known to consume smaller lizards (Araújo 1991. Rev. Brasileira Biol. 51:857–865; Teixeira and Giovanelli, *op. cit.*).

On 10 April 2006, we observed a *T. torquatus* eating a juvenile rodent, probably *Rattus rattus*. The rodent, which was being eaten head first, had only its tail and a hind limb outside the tropidurid´s mouth. The *T. torquatus* specimen, clearly a large (ca. 10 cm SVL) adult male, could not be captured for more accurate measurement, though photographs were taken before the lizard fled. The observation was made at Praia do Canto, Vitória, Espírito Santo, Brazil (20°18'13"S, 40°17'46"W, datum: Córrego Alegre SAT 69; elev. near sea level).

Inclusion of small mammals in the diet of *T. torquatus* reinforces the idea that this species is an opportunistic and dietary generalist. Males grow larger than females and it has been suggested that larger individuals ingest larger prey (Van Sluys et al. 2004. J. Herpetol. 38:606–611). For that reason, though both males and females are reported to feed upon vertebrates, males may consume larger vertebrates (e.g., rodents) more frequently, though this assumption remains to be adequately tested.

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TROPIDURUS TORQUATUS (Lagartixa, Collared Lizard). **TAIL AS FOOD**. *Tropidurus torquatus* is a common iguanid lizard ranging from Brazil to Argentina that inhabits the Cerrado and Atlantic Forest domains in Brazil (Rodrigues 1987. Arq. Zool. 31:105–230). Though widely distributed and abundant, few records of predators on *T. torquatus* exist; we known of only one record of predation, involving a Burrowing Owl, *Speotyto cunicularia* (Kokubum and Zacca 2004. Herpetol. Rev. 35:270). This note describes the first observation of a harvestman (an opilionid arachnid) feeding on the tail of the lizard, *T. torquatus*.

At night on 8 November 2005, JC observed a female harvestman, *Gonyleptes* sp. nov. (Opiliones, Gonyleptidae, dorsal scute length 7.4 mm), eating a tail (66 mm long) of a *Tropidurus torquatus* at the Parque Nacional do Caparaó, Santa Marta district, Ibitirama municipality, State of Espírito Santo, Brazil (20°29'40"S, 41°44'00"W; elev. ca. 960 m). The harvestman was located head down, ca. 50 cm above ground level on a wall inside an abandoned house surrounded by relatively undisturbed forest, with its chelicerae and pedipalps holding the basal portion of the lizard's tail. One vertebral bone in the tail was visible, the tissues around it presumably having been swallowed by the harvestman, and about 0.6 mm of the tail was partially digested.

Harvestmen are omnivorous arachnids that prey chiefly on small invertebrates (Acosta and Machado, *in press*. *In* Pinto-da-Rocha et al. [eds.], The Harvestmen: The Biology of Opiliones. Harvard University Press, Cambridge, Massachusetts). With the exception of two records of feeding on frog metamorphs (Castanho and Pinto-da-Rocha 2005. Rev. Ibérica Aracnol. 11:43–45), only dead vertebrates have been recorded as food items (Acosta and Machado, *op. cit.*). Nevertheless, we stress that diet items are known for only about 40 of the ca. 6000 known species of harvestmen. The harvestman encountering the tail of this lizard was not recorded. However, the harvestman probably did not remove the tail from a live lizard as it would not strong enough to do so; more likely, it was found opportunistically. This observation represents a new item in the diet of harvestmen in general.

We know of one other instance of a harvestman feeding on a lizard tail. A picture (online at: http://commons.wikimedia.org/wiki/Image:Harvestman_eating_skink_tail.jpg) shot by Tim McCormack in Virginia (USA) shows a skink tail (identified as that of a *Eumeces fasciatus*) being eaten by a *Leiobunum* sp., a sclerosomatid opilione.

Vouchers of the harvestman and lizard tail (MZUSP-26.836) were deposited at the Museu de Zoologia da Universidade de São Paulo, State of São Paulo, Brazil. We are grateful to Glauco Machado (UNICAMP) for making us aware of the internet photo. We thank the Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (IBAMA, license number 030/2005 – CGFAU/LIC) and Estêvão José Marchesini Fonseca, director of the Parque Nacional do Caparaó, for lodging facilities during our stays in the park and for permission to work there. We thank Felipe Franco Curcio for photographic assistance, and M. P. Hayes and an anonymous reviewer for editorial assistance.

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UTA STANSBURIANA (Side-Blotched Lizard). **MORTALITY**. Many reports of human-induced mortality exist among vertebrates (mammals: Karraker 2001. Wildl. Soc. Bull. 29:1158–1162; amphibians: DiMauro and Hunter. 2002. Forest Sci. 48:397–406; turtles: Barko et al. 2004. J. Wildl. Manage. 68:1145–1150). Here, I add to the data describing instances of mortality with observations made at a water pipe cover in eastern New Mexico.

My observations were made during fieldwork on 20 June 2003, within the city limits of Fort Sumner, De Baca County (34°28'26"N, 104°14'22"W; elev. 1250 m). A slightly ajar water pipe lid used to cover a valve for a water line was removed to reveal a trapped (but living) adult *Uta stansburiana*. This partially buried pipe has an inner diameter of 45 cm and is 38 cm deep. The lizard was captured, photographed, then released. This individual seemed healthy, suggesting it was recently trapped. Further investigation revealed 9 skulls and other bones at the bottom of this pipe. After closing the pipe lid, I rechecked it on 23 June 2003, 15 and 17 August 2003, 17 and 21 June 2004, and 10 August 2004; no additional animals or bones were found.

Four of the five lizard skulls were adult *U. stansburian*a, an abundant species throughout New Mexico (Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. University of New Mexico Press, Albuquerque. 431 pp.). The fifth skull was that of an adult Great Plains Skink, *Eumeces obsoletus*. Except for the *E. obsoletus* skull, little to no flesh remained on the skulls. The four remaining skulls were identified as *Reithrodontomys* sp. (two species, *R. megalotis* [Western Harvest Mouse] or *R. montanus* [Plains Harvest Mouse], are possible at this locality [Burt and Grossenheider 1980. A Field Guide to the Mammals: Field Marks of All North American Species Found North of the Mexican Boundary. Houghton Mifflin Co., Boston, Massachusetts. 289 pp.]).

Water pipes of the kind I describe can unquestionably trap small vertebrates, including *U. stansburiana* and *Reithrodontomys* spp. Trapped individuals might have attempted to escape the heat of the day or night cold; if true, this example represents an "ecological trap" (Schlaepfer et al. 2002. Trends Ecol. Evol. 17:474–480). Skulls and bones mostly lacking flesh implies that the water pipe cover had been ajar for some time. No mortality was observed after the pipe lid was properly closed. Hence, similar to standard pitfall traps, water pipe lids should always be snugly closed when not in use if no mechanism exists to allow escape of trapped animals.

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SERPENTES

AGKISTRODON PISCIVORUS LEUCOSTOMA (Western Cottonmouth). **ACTIVITY**. The ecology of *Agkistrodon piscivorus leucostoma* is poorly understood, relative to western subspecies. For example, most studies of home range and activity patterns have been conducted on subspecies other than *A. p. leucostoma* (Dundee and Burger 1948. Chicago Acad. Sci. 21:1–2; Wharton 1969. Bull. Florida State Mus. 14:227–272; Kofron 1978. J. Herpetol. 12:543–554; Martin 1982. Home range, movements, and activity patterns of the cottonmouth, *Agkistrodon piscivorus*, in southern Louisiana. M.S. Thesis, Univ. of Southwestern Louisiana, Lafayette. 53 pp.; Cook 1983. Activity patterns of the cottonmouth water moccasin, *Agkistrodon piscivorus* Lacepede, on a northwest Florida headwater stream. M.S. Thesis, Univ. Florida, Gainesville, Florida. 88 pp.; Sexton et al. 1992. *In* Campbell and Brodie [eds.], Biology of Pitvipers, pp. 337–345. Selva, Tyler, Texas). Kofron (*op. cit.*) noted that *A. p. subspecies* moved up to 80 m way from water. Martin (*op. cit.*) found that between May and October, *A. piscivorus* in southern Louisiana moved an average of several meters a day, usually immediately after dusk, and concluded they were both crepuscular and nocturnal.

Here, we characterize movements and activity ranges of six radio-tagged *A. p. leucostoma* (two males and four females; 55–85 cm SVL, 150–480 g) between July 1993 and January 1994 in the Ouachita National Forest (Montgomery County, Brier Creek, Arkansas). We recorded 272 observations for all snakes (30–51 observations/snake). Total distance traveled by each individual ranged from 468–827 m (mean = 604 m). Three females exhibited noncontiguous summer and fall activity ranges. The number of meters moved per day (mean = 8.0 m, range = 0.5–14.0) significantly differed between months (Kruskal-Wallis, $H = 21.07$, $p<0.01$), with the greatest movement occurring in October. Activity ranges (convex polygon) ranged from 0.13–1.14 ha (mean = 0.45 ha).

Our radio-tagged snakes were found 7% of the time in the creek, 17% within 1 m of the creek, 52% within 5 m, and 75% within 10 m. The mean distance from water (excluding snakes found in the water) for all six snakes was 10.7 m. Proximity to the creek (or associated bodies of water) did not significantly differ between males and females (Kruskal-Wallis, $H = 0.02$, $p = 0.88$), but did significantly differ by month (Kruskal-Wallis, $H = 33.6$, $p<0.01$). The farthest-ranging *A. piscivorus* was a female found 85 m from water. Most Brier Creek cottonmouths showed increased frequency of movement during the fall return to their hibernacula. *Agkistrodon piscivorus* were relatively sedentary overall; the greatest distances

moved occurred during October and averaged only 8 m/day. Movement ranges reported from Louisiana cottonmouths indicated distances of 10 m or more every night during summer periods and the beginning of a return to hibernacula in late November (Martin, *op. cit.*).

Three of the six snakes (two males and a female) migrated to a den site outside of their summer/fall activity range. The greatest distance moved from a location in a summer activity area to a den site was 436 m. All den sites were located within 10 m of Brier Creek or a tributary. Hibernacula were located in rocky outcroppings high on streamside banks, occasionally under embedded boulders. These habitats are superficially similar to rocky hillside hibernacula described for northern populations (Neill 1947. Herpetologica 3:203–205; Barbour 1956. Trans. Kentucky Acad. Sci. 17:31–41; Burkett 1966. Publ. Univ. Kansas Mus. Nat. Hist. 17:435–491). Four of the cottonmouths were periodically observed (1–3 times each) on the surface at the den site during the winter.

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ARRHYTON EXIGUUM (Puerto Rican Garden Snake). **REPRODUCTION**. I witnessed two adult *Arrhyton exiguum* engaged in what appeared to be courtship behaviors at 1240 h on 6 March 2007 in pastureland in the Río Grande region of northeastern Puerto Rico. The two snakes were entwined, but were not moving when first sighted. One individual appeared to be larger than the other. However, no chin rubbing, tongue-flicking, or aggressive behaviors were observed. I could not ascertain whether the male's hemipenes was intromitted without disturbing the snakes. The habitat consists of moist, clay-like soils with little vegetation cover, though the snakes were between small shrubs when observed. Ambient temperature at the time of observation was approximately 27.2°C, with both individuals exposed to sunlight. When encountered, the two individuals fled (still entwined) under a nearby piece of aluminum. To my knowledge, this is the first observation of reproductive behavior in Puerto Rico or any other West Indian location.

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CORALLUS COOKII (St. Vincent Treeboa). **FORAGING**. *Corallus cookii* is endemic to the Lesser Antillean (West Indies) island of St. Vincent, where it is widespread in a variety of habitats (including some that are dramatically altered) from sea level to at least 425 m (Henderson 2002. Neotropical Treeboas: Natural History of the *Corallus hortulanus* Complex. Krieger Publ. Co., Malabar, Florida. 197 pp.). Its diet is comprised of *Anolis* lizards and introduced rodents (*Mus* and *Rattus*), but specific details of foraging behavior are unknown, although young boas are known to be active foragers and large adults are ambush strategists (Henderson, *op. cit.*).

On 6 June 2006, we observed a *C. cookii* (~ 755 mm SVL) stalk and capture an adult *Anolis trinitatis* at Ferret (St. Patrick Parish: 13.212°N, 61.251°W, datum WGS84; ~160 m elev.), an area of mixed agriculture and secondary forest. When first noticed (at 2220 h), the boa was at 2.0 m in a tree of undetermined species, about 15 cm from the sleeping lizard, approaching slowly from behind and slightly above it. As we did not want to disturb the boa, we only intermittently used diffuse light from a headlamp to monitor the snake's progress, and therefore were unable to determine whether or not the boa exhibited tongue-flicks. By 2230 h, the snake was within 2.0 cm of the anole and, for the next 15 min, movement by the boa was almost imperceptible. The *C. cookii* was virtually touching the anole before it grabbed it in the nuchal region, commenced to throw a coil around it, and subdue it. The stealthy manner in which the boa approached the anole, especially the almost imperceptible movement over the last 2.0 cm, closely parallels the foraging behavior of *C. grenadensis* on Grenada, a closely related species in which foraging behavior has been studied in some detail (Yorks et al. 2003. Stud. Neotrop. Fauna Environ. 38:167–172). At 2256 h, upon completion of swallowing the lizard, the boa ascended into the crown of the tree.

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ENULIUS SCLATERI (White-headed Snake). **REPRODUCTION.** *Enulius sclateri* is an uncommon, neotropical, and fossorial amastidine colubrid (Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna Between Two Continents, Between Two Seas. University of Chicago Press, Chicago. 954 pp.). Here we provide the first report of basic reproductive ecology in the wild.

On 09 May 2004 a torrential tropical storm caused a 25-m tall *Cordia alliodora* (Boraginaceae) tree to fall in the laboratory clearing of the La Selva Biological Station (Heredia, Costa Rica: 10.4327°N, 84.0080°W, 35 m elev.). Within 12 h of treefall, CLC excavated a tree hollow (ca. 10 cm deep and 16.4 m from the base of the tree) uncovering 5 nearly equivalent-sized snake eggs, later determined to be *E. sclateri*. The temperature of the canopy soil under the eggs was 24.8°C. Two eggs were punctured and no embryo present, possibly from predation. The three remaining eggs, adhered together along the longitudinal axis, were brought into the laboratory for size and weight measurements using calipers and a 5 g Pesola scale. On 09 May the three eggs measured 22.8 mm × 9.2 mm, 21.8 mm × 9.7 mm, and 21.1 mm × 8.6 mm, and all weighed exactly 3.6 g. The eggs were incubated in ambient outdoor conditions until they hatched. On 18 June 2004, a fungus infected one egg, but the hatchling actively emerged as we attempted to extract it from the egg. The other two hatchlings

emerged on 23 and 25 June. Upon hatching, the snakes were identified to species, measured, and weighed using a digital electronic balance. The hatchlings exhibited the same pattern and coloration as adults of this species. The unfed 11-day old hatchlings measured 89, 92, and 90 mm SVL, 58, 57, and 56 mm tail length, and weighed 0.79, 0.74, and 0.65 g. All three snakes were released on 27 June at the site of the treefall.

This observation is the first known record of arboreal oviposition by a species commonly believed to be solely fossorial, providing evidence that some fossorial species use tree hollows and canopy soil on branches of trees in the third dimension of the forest. Facultative use of arboreal habitats has been described for other presumably "terrestrial" or "fossorial" snake species for foraging (Keller and Heske 2000. J. Herpetol. 34:558–564) and/or unknown reasons (Stidham 2001. Herpetol. Rev. 32:262) but thus far none has confirmed reproductive behavior in the canopy habitat.

There are two possible explanations for our observation. First, *E. sclateri* oviposition site depends on the drier more exposed microenvironment found in the canopy compared to the forest floor, or second, despite differences between canopy and forest floor habitats, the structural similarities are sufficient to make canopy oviposition desirable for *E. sclateri.* Predator or prey interactions likely underlie arboreal oviposition: deep tree holes or cover by canopy soil shield the eggs from potential predators, or place adults and/or hatchlings near a potential food source. Our observation confirms that some species are using a much larger range of forest microhabitats than previously considered. This observation of a putatively 'fossorial' snake ovipositing in the canopy is evidence that facultative use of arboreal habitats may be more widespread than commonly thought.

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HETERODON SIMUS (Southern Hognose Snake). **HIBERNACULA.** The natural history of *Heterodon simus* is poorly known (Tuberville et al. 2000. J. Elisha Mitchell Sci. Soc. 116:19–40) and hibernacula have not been described. Between 11 October 1998 and 18 February 2006, we radio tracked three adult male and three adult female *H. simus* through a single winter each, and one adult female through two consecutive winters, in upland sandhill habitats (Scotland County, North Carolina, USA). In all cases (N = 8), the snakes essentially excavated their own hibernacula, burrowing more or less vertically into sandy soil in inconspicuous spots. No obvious stump holes or other existing underground chambers were used, and entrance and exit holes were usually not visible after a few days. One male over-wintered in the road bank of a state maintained sand road (ca. 2 m from the edge of the road bed); all others hibernated in relatively open woods dominated by Longleaf Pine (*Pinus palustris*), Wiregrass (*Aristida stricta*), and scrub oaks (*Quercus* spp.). Dates of hibernaculum entry ranged between 26 October and 24 November, and dates of first emergence ranged between 24 March and 10 April.

Two females were excavated from their hibernacula for recapture to remove or replace failed transmitters. Both were found in damp, firmly packed sand in narrow tunnels, apparently of their own making. One entered her hibernaculum between 26 and 31 October and was excavated on 29 November at a depth of ca. 26 cm (ca. 23 cm of sand and ca. 3 cm of surface litter). The other entered her hibernaculum between 28 October and 4 November and was excavated on 16 February at a depth of ca. 38 cm (ca. 36 cm of sand and ca. 2 cm of surface litter). Both were active when uncovered. The female that was tracked through two winters did not exhibit hibernaculum fidelity, but spent the second winter ca. 306 m from the hibernaculum she occupied the previous winter.

These observations suggest that *H. simus* do not depend on stump holes or other existing subterranean chambers for hibernacula (though they were sometimes observed using such sites when not hibernating). Other relatively large-bodied snake species that we have observed overwintering in the same area (several instances each for *Coluber constrictor*, *Elaphe guttata*, *Heterodon platirhinos*, *Masticophis flagellum*, *Pituophis melanoleucus*, *Agkistrodon piscivorus*, and *Sistrurus miliarius*) in all cases used existing stump holes, old root channels, or mammal burrows as hibernacula. Hibernaculum fidelity was observed on several occasions in *M. flagellum* and *P. melanoleucus*.

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HYPSIGLENA OCHRORHYNCHA CHLOROPHAEA (Dusky-green Nightsnake). **DIET.** Previous records of the diet of nightsnakes have identified snakes and lizards, including eggs, as their primary prey items (Diller and Wallace 1986. Southwest. Nat. 31:55–64; Rodríguez-Robles et al. 1999. Copeia 1999:93–100; Setser and Goode 2004: Herpetol. Rev. 35:177). Here we provide observations on the diet of *H. ochrorhyncha chlorophaea* from Sonora and Coahuila collected as part of a survey of the herpetofauna of the Chihuahuan Desert and surrounding regions (Lemos-Espinal et al. 2004. Bull. Chicago Herpetol. Soc. 39:206–213; Smith et al. 2005. Bull Chicago Herpetol. Soc. 40:66–70). We examined the gut contents of 18 specimens collected in the

summers of 2003 and 2004 in Chihuahua, Sonora, and Coahuila. Of the 18 specimens, 12 had empty stomachs, 4 had unidentifiable contents, and 2 had identifiable prey items. One snake (SVL = 26.0 cm) from Cumpas, Sonora (30°2'5.8"N, 109°47'0.4"W, datum: WGS84; elev. 814 m) contained > 20 ants. A second snake (SVL = 16.0 cm) collected 53 km S Químicas del Rey (26°38'44.5"N, 103°9'13.4"W; datum: WGS84; elev. 1084 m) contained an orthopteran (length = 1.27 cm, width = 0.32 cm). Rodríguez-Robles et al. (1999. Copeia 1999:93–100) suggested that insects are rarely taken by small nightsnakes, but not by larger nightsnakes. Our observations confirm the presence of insects in the diets of *Hypsiglena*, particularly in smaller individuals.

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HYPSIGLENA TORQUATA CHLOROPHAEA (Sonoran Nightsnake). **PREDATION.** Web-building spiders generally take prey their own size and larger (McCormick and Polis 1982. Biol. Rev. 57:29–58), including small snakes that become entangled in spider webs and are subsequently killed and consumed by the spider (Burt 1949. Herpetologica 5:127; Bayliss 2001. Herpetol. Rev. 32:48–49; Lazcano et al. 2005. Herpetol. Rev. 36:186; McKeown 1963. Australian Spiders. Angus and Robertson, Sydney. 287 pp.; Pinkus 1932. Sci. Mon. 34:80–83). Also, Zippel and Kirkland (1998. Herpetol. Rev. 29:46) reported finding a dead adult *Opheodrys aestivus* wrapped in silk in the web of a *Nephila clavipes*. Finally, an anecdotal report by Anderson (1930. Nat. Mag. Smithson. 16:234) describes the sequence of events of a "small green snake" falling into the web of an orb-web spider and becoming entangled; the spider periodically resecured and bit the struggling snake, and fed on it some three hours later after it ceased moving.

We report an additional observation of snake entrapment in a spider web from Chino Valley, Yavapai County, Arizona, USA (34.850833°N, 112.439739°W; 1345 m elev., WGS 84). On 15 August 2005, we found a dead adult *Hypsiglena torquata chlorophaea* (295 mm TL) suspended in the web of a black widow spider (*Latrodectus mactans*; Theridiidae), 0.5 m from the floor in a screened back porch. The spider was still attached to the snake. Both snake and spider are deposited in the herpetological collection of the California Academy of Science (CAS 233784). It is uncertain if this encounter represents an act of predation (the killing and consumption of prey). However, based on other reported predatory encounters between *L. mactans* and snakes, it is possible that the *H. torquata* did fall prey to *L. mactans.* Neill (1948. Herpetologica 4:158) reported independent predatory encounters between *L. mactans* and the snakes *Storeria dekayi* and *Opheodrys vernalis*.

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MASTICOPHIS ANTHONYI (Clarion Racer). **DIET.** Snakes of the genus *Masticophis* have a varied diet (Camper and Dixon 2000. Texas J. Sci. 52:83–92), including taking chicks (e.g., Powell and Steidl 2000. Condor 102:823–831). *Masticophis anthonyi* is endemic to Clarion Island, Pacific Ocean, and is the only snake recorded from the Revillagigedo Archipelago (Slevin 1926. Proc. California Acad. Sci. 4th ser. 15:195–207). Virtually nothing is known about its diet (Brattstrom 1955. Amer. Midl. Nat. 54:219–229). During a study on breeding success of Laysan Albatrosses (*Phoebastria immutabilis*) on Clarion during 2002–2003, we discovered a *M. anthonyi* preying on a hatching albatross chick. Our presence disturbed the snake, which left the moribund chick uneaten. The albatrosses on Clarion experienced zero breeding success (0 fledglings of 46 eggs laid) in that season, and we speculate that predation by the snake was responsible for more failures than the single event we observed. Although this is the first record of seabird chick predation from this species, Slevin (1926, *op. cit.*) noted that it seemed most abundant around seabird colonies, suggesting an evolutionary history of seabird nest depredation by this species.

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NERODIA RHOMBIFER (Diamond-backed Watersnake). **COURTSHIP AND DIET**. Gibbons and Dorcas (2004. North American Watersnakes: A Natural History. University of Oklahoma Press, Norman, Oklahoma. 438 pp.) report that there have been few observations of courtship behavior among watersnakes. Aggregate mating behavior has been reported for a few species of *Nerodia*, *Regina*, and *Seminatrix*, but it is not clear whether this behavior is prevalent in these species. For example, there is only a single observation of a probable mating aggregate involving three or four males and one female *Nerodia rhombifer* from Franklin County, Kansas (Gloyd 1928. Trans. Kansas Acad. Sci. 31:115–141), but at least three reported copulating pairs, one each from Kansas, Oklahoma, and Kentucky (Keck 2004. *In* Gibbons and Dorcas [eds.], North American Watersnakes: A Natural History, pp. 138–177. University of Oklahoma Press, Norman).

Herein, we describe mating behavior involving one female and three male *N. rhombifer*. At approximately 1330 h CST on 6 April 2006 at Estero Llano Grande State Park, Weslaco, Hidalgo County, Texas (26.126°N, 97.952°W, 18 m elev., WGS84), a large, female *N. rhombifer* corralled a relatively large Blue Tilapia (Perciformes: Cichlidae: *Oreochromis aureus*) and forced it up onto the shoreline of Alligator Lake, a small sheltered pond surrounded by a fragment of mesquite/spiny hackberry woodland. As the snake began to ingest the fish, at least three smaller conspecifics (presumed to be males) emerged from the water and approached the female. The larger female prevented at least one of the individual's

advances by incidentally hitting it with the fish. The three smaller individuals appeared to be attempting to effect cloacal apposition with the female. Eventually, the female moved off into the water with the fish still in her mouth and the smaller individuals struggling for position.

Our observations are similar to behaviors described by Mushinsky (1979. J. Herpetol. 13:127–129) for a mating aggregate of *Nerodia sipedon* in both orientation of the snakes relative to each other and the posture of the males on the female. The males were parallel to the female with their chins pressing on the female's dorsum, and the posterior portions of their bodies were coiled around the female. We could not determine whether the group moved to water because they were disturbed by the observer or because the female was attempting to escape persistent attempts at mating. It is also unclear whether copulation occurred.

This account documents a second occurrence of mating aggregations in *N. rhombifer* and is the only known case where the behavior occurred while a female was feeding. One factor that may affect the prevalence of multi-male courtship behavior in populations of *Nerodia* is the distribution of receptive females, which may be related to available substrate for mating (Brown and Weatherhead 1999. Behav. Ecol. Sociobiol. 47:9–16). Blue tilapia is a novel food item for *N. rhombifer*. The relative size of the tilapia is consistent with descriptions of ontogenetic shifts to larger prey sizes for diamond-backed watersnakes (Keck *op. cit.*).

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PITUOPHIS MELANOLEUCUS MELANOLEUCUS (Northern Pine Snake). **REPRODUCTION.** Female *Pituophis melanoleucus* are known to excavate their own nest chambers, at least in portions of their range (Moore 1893. Amer. Nat. 27:878–885; Zappalorti et al. 1983. Bull. Chicago Herpetol. Soc. 18:57–72.). Burger and Zappalorti (1986. Copeia 1986:116–121; 1991. J. Herpetol. 25:152–160) reported extensively on nesting behavior of *P. m. melanoleucus* in the New Jersey Pine Barrens. However, information on nesting in other portions of the range of *P. melanoleucus* is scant. We here describe a natural nest from the Sandhills region of North Carolina.

On 22 September 2006, a nest was located after LTP discovered a live hatchling and a road-killed hatchling female (433 mm SVL, 60 mm tail length) *P. m. melanoleucus* within a few m of each other on a paved road (4.5 km S.SE Eagle Springs, Moore County, North Carolina, USA). After a search of <1 h, the nest was found in an open area along a fence line at the edge of a horse pasture, 14.8 m from the edge of the paved road. The nest was not readily obvious, as the small "apron" or "dump pile" of sand around the nest entrance had been obscured by weather and dead leaves. Shed skins, or fragments thereof, from at least eight hatchlings were found either inside the nest tunnel or outside it <1 m from the entrance. A large female Southern Black Widow spider (*Latrodectus mactans*) had constructed a web in the nest entrance. We excavated the nest and found it contained nine adherent, recently hatched eggshells. The nest tunnel was 69 cm in total length—shorter than any among 22 New Jersey nests reported by Burger and Zappalorti (1986, *op. cit.*), and well below the mean (140 ± 7 cm), but within the range (39–228 cm), reported by Burger and Zappalorti (1991, *op. cit.*) in a study of 93 nests in New Jersey. The bottom of the nest chamber was 41 cm below the surface. Interestingly, of 93 nest chambers described by Burger and Zappalorti (1991, *op. cit.*), none was deeper than 25 cm. The road-killed hatchling (presumably, but not conclusively, from this nest) and eggshells are deposited in the collection of the North Carolina State Museum of Natural Sciences (NCSM 71769 and 71770, respectively). The live hatchling was released.

To our knowledge, this is the first published description of a natural nest of *P. m. melanoleucus* outside of the New Jersey Pine Barrens. We thank Wayne, Angela, and Chance Greene for permitting access to their private land.

Submitted by **JEFFREY C. BEANE**, North Carolina State Museum of Natural Sciences, Research Laboratory, 4301 Reedy Creek Road, Raleigh, North Carolina 27607, USA (e-mail: jeff.beane@ncmail.net); and **L. TODD PUSSER**, P.O. Box 122, West End, North Carolina 27376, USA (e-mail: tpusser@nc.rr.com).

REGINA RIGIDA (Glossy Crayfish Snake). **MELANISM**. On 11 April 2004, while conducting a herpetological survey of Cat Island (Tom Yawkey Wildlife Center, Georgetown County, South Carolina), we captured a completely melanistic specimen of *Regina rigida* (198 mm SVL, 56 mm tail length) as it crossed a sand road at dusk. The specimen was uniformly black on both dorsum and venter. Melanism has been reported previously in this species (Etheridge 1950. Copeia 1950:321; Shoop 1959. Herpetologica 15:160), but only for the southeastern portion of Louisiana and from the area near the mouth of the St. Johns River in Florida and not in more than 45 years. The specimen was released at the point of capture. During the course of the survey two additional *Regina rigida* were collected that both exhibited typical coloration. Photographic vouchers of the specimen are deposited in the South Carolina State Museum (2005.82.1–8).

Submitted by **WILL DILLMAN** and **TIMOTHY MOUSSEAU**, Department of Biological Science, University of South Carolina, Columbia, South Carolina 29208, USA.

THAMNOPHIS CYRTOPSIS COLLARIS (Black-necked Gartersnake). **DIET AND BROOD SIZE.** The natural history of *Thamnophis cyrtopsis* in Mexico is relatively unknown. Here we provide observations on the diet and brood size of *T. cyrtopsis* collected as part of a survey of the herpetofauna of the Chihuahuan Desert (Lemos-Espinal et al. 2004. Introducción a los Anfibios y Reptiles del Estado de Chihuahua, CONABIO. 128 pp.). We examined the gut contents and reproductive tracts of 9 specimens of *T. cyrtopsis* collected in the summer 2003 near Chínipas, Chihuahua (27°23'29.9"N, 108°32'9.7"W, datum: WGS84; elev. 469 m) (see Lemos-Espinal et al. 2004. Bull. Chicago Herpetol. Soc. 39:206–213). Of the 9 specimens, 8 had empty stomachs. The

single specimen that contained a prey item was a juvenile of unknown sex (SVL: 16.5 cm). The single prey item was a toad (*Bufo* sp.) metamorph. This observation of a toad metamorph in the diet of *T. cyrtopsis* is consistent with the few other observations of the diet in other parts of their range. Previous studies on the diet of *T. cyrtopsis* suggest the diet of this species consists primarily of frogs and other aquatic organisms (e.g., fish, tadpoles, etc.) (Fleharty 1967. Southwest. Nat. 12:207–229; Smith et al. 2005: Herpetol. Rev. 36:300). Indeed, Jones (1990. Southwest. Nat. 35:115–122) found *T. cyrtopsis* spends much of its time foraging in the water, but also noted it appears to be a generalist forager. One of the females (34.0 cm SVL) we examined contained 9 ovarian follicles. The only other previous report of brood size in *T. cyrtopsis* from Mexico (San Luis Potosí) also reported a brood size of 9 for a female with an SVL of 54.2 cm) (Ramírez-Bautista et al. 2000. Herpetol. Rev. 31:180).

Submitted by **JOSHUA J. SCHULTE**, **GEOFFREY R. SMITH**, Department of Biology, Denison University, Granville, Ohio 43023, USA (e-mail: smithg@denison.edu); **JULIO A. LEMOS-ESPINAL**, Laboratorio de Ecología, Tecnología y Prototipos, Facultad de Estudios Superiores Iztacala, UNAM, Apartado Postal 314, Avenida de Los Barrios No. 1, Los Reyes Iztacala, Tlalnepantla, Estado de México, 54090 México (e-mail: lemos@servidor.unam.mx); and **HOBART M. SMITH**, Department of Ecology and Environmental Biology, University of Colorado, Boulder, Colorado 80309, USA (e-mail: hsmith@colorado.edu).

THAMNOPHIS ORDINOIDES (Northwestern Garter Snake)**. EXOTIC PREY.** *Thamnophis ordinoides*, a garter snake endemic to the moist coastal regions of Pacific North America (Stebbins 2003. Field Guide to Western Reptiles and Amphibians. Houghton Mifflin, New York. 519 pp.), consumes a large proportion of molluscs and annelid worms (Fitch 1941. California Fish Game 27:2–32; Fox 1952. Herpetologica 8:4–8; Gregory 1978. Can. J. Zool. 56:1967–1974). However, the exact species of such prey have not been reported. Here, I provide four observations of predation by *T. ordinoides* on an introduced annelid, the African nightcrawler (*Eudrilus eugeniae*).

Three observations were made ca. 1.6 km W of Aurora, Marion County, Oregon, USA (UTM 5008761N, 516528E, WGS84). On 24 July 2004, at 1850 h, CJR captured a juvenile male *Thamnophis ordinoides* (201 mm SVL, 55 mm tail, 3 g) with a markedly distended abdomen. The snake was resting beneath a piece of corrugated aluminum on dry grass and soil (air temperature = 21.8°C). Palpation of the snake revealed its prey to be a mature African nightcrawler, *Eudrilus eugeniae*. The anterior end of the worm had been swallowed first, and was partly digested. The remains of the worm were 182 mm long, 6.2 mm wide, and 1.72 g (the worm was dried with a paper towel to remove excess water and saliva prior to weighing). After measuring, the snake was photographed and released.

On 5 April 2004, at 1800 h, CJR observed another male *T. ordinoides* (ca. 260 mm SVL) capturing an adult *E. eugeniae* (beneath a piece of aluminum, on soil and dry grass, ca. 20 m east of the previous snake). When discovered, this snake had the anterior end of the worm in its jaws and was attempting to pull the worm from its burrow; loops of the snake's body were braced against the grass for leverage. At this point, the snake had extracted and swallowed the anterior 40 mm of the worm; upon capture, it released the worm, which bore lacerations on the anterior 5mm of its body from the snake's teeth. The snake was replaced under the aluminum; 5 min later, the snake had recaptured the worm and reswallowed the anterior 40 mm. A final observation, made 10 min after the initial encounter, revealed the snake to have completely extracted and consumed the worm; the snake was resting in a coiled position on the dry grass (under the aluminum).

On 06 August 2006, JAR collected a juvenile *T. ordinoides* (135 mm SVL, 10 mm tail [broken], 1.21 g) ca. 50 m west of the previous two snakes. The snake, dead when found, appeared to have been run over. It had recently swallowed an adult *E. eugeniae*, 7 mm of which was protruding from its mouth. The worm (131 mm, 1.19 g) was missing its posterior end, and had been swallowed anterior end first.

Evidence that *E. eugeniae* may be more than an occasional prey for *T. ordinoides* is provided by a final observation. At 1820 h on 02 June 2006 CJR captured an adult female *T. ordinoides* (520 mm SVL, 130 mm tail, 100 g) crawling across a piece of corrugated aluminum at the edge of a gravel road at the Little White Salmon National Fish Hatchery, Skamania County, Washington, USA (45.773056°N, 121.781667°E**,** WGS 84). Upon capture, this snake regurgitated the remains of at least five adult *E. eugeniae*, including two whole worms measuring 166 mm and 180 mm, respectively. The total mass of regurgitated worms was 8.6 g. Worm remains ranged from very fresh to heavily digested.

E. eugeniae is not native to the United States and has been introduced primarily for fish bait but is now established in portions of western Oregon and Washington (C. Rombough, pers. obs.). It is a large (to > 200 mm) anecic worm with a setae-lined, spoon-shaped tail, which it uses to resist being pulled from its burrow, making it a seemingly difficult prey to obtain. Of special note is the fact that in two of the cases reported here (24 July 2004 and 06 August 2006), the worms were almost as long as the snakes which ate them, and potentially greater in mass. Though these observations demonstrate the ability of *T. ordinoides* to prey on *E. eugeniae*, further data are needed to determine the effect of such predation on *T. ordinoides* populations.

Submitted by **CHRISTOPHER J. ROMBOUGH** (e-mail: rambo2718@yahoo.com) and **JEFFREY A. ROMBOUGH**, P.O. Box 365, Aurora, Oregon 97002-0365, USA (e-mail: bigjfire@yahoo.com).

UROTHECA* (*PLIOCERCUS*) *EURYZONUS (Halloween Snake). **DIET**. *Urotheca euryzonus* occurs from northern Nicaragua to western Ecuador and feeds on salamanders and adult frogs (Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna Between Two Continents, Between Two Seas. The University of Chicago Press, Chicago, Illinois. 934 pp.).

On 24 June 2004, we observed an *U. euryzonus* feeding on *Agalychnis callidryas* (Red-eyed Treefrog) eggs inside a small pool formed within the rusting back end of a tractor abandoned along the road from El Copé to La Rica, 100 m N of the visitor's center of Parque Nacional General de División Omar Torrijos Herrera, El Copé, Panamá (8°40'5.15"N, 80°35'33.41"E; 708 m elev.).

Agalychnis callidryas eggs typically are laid on leaves overhanging water, but on 22 June 2004 we found 20–30 *A. callidryas* tadpoles and more than 50 *Smilisca phaeota* tadpoles inside the tractor pool. On the evening of 23 June 2004, we captured (and subsequently released) two *A. callidryas* males near the tractor and heard a third calling. Also, we observed a *S. phaeota* male calling from within the tractor pool. Mid-morning on 24 June 2004 we checked the tractor and observed a new *A. callidryas* egg clutch, resting on the flat metal ledge above the water inside the tractor pool, and a new *S. phaeota* clutch, in the water. We did not count the number of eggs in the clutch, but *A. callidryas* clutches average 40–68 eggs (Pyburn 1963. Texas J. Sci. 14:155–170). When we arrived at the tractor at 2000 h on 24 June, an *U. euryzonus* was already consuming *A. callidryas* eggs, and there were fewer than ten eggs left. The *S. phaeota* eggs were untouched. From 2001 h until 2004 h the snake consumed the remaining eggs. The snake opened its mouth wide and descended on the eggs from above, scooping eggs and jelly into its mouth (Fig. 1). During feeding, the snake paused after consuming each egg, looked around, and sometimes retreated from the egg mass for several seconds. Our headlamps and the flash from the camera might have interrupted feeding. After eating the last egg, the snake traversed the edge of the water, darting its head erratically, flicking its tongue, moving in quick stops and starts, and often shooting forward and then retreating. By 2006 h the snake left the tractor, and moved into the surrounding vegetation.

In the most recent published phylogeny, *Urotheca* is placed within one of five clades of the Dipsadinae along with *Coniophanes*, *Rhadinaea*, and *Trimetopon*. Both *Coniophanes* and *Rhadinaea* feed on the terrestrial eggs of *Eleutherodactylus* frogs (Savage 2002, *op. cit.*, pp. 594–627), but species of *Urotheca* or *Trimetopon* have not been reported to eat frog eggs. Snake predators of frog eggs occur in two other clades of dipsadines, including *Imantodes inornatus* and *Leptodeira septentrionalis* in the Dipsadini (Donnelly and Guyer 1994. Oecologia 98:291–302), and *Sibon argus* in the 'goo-eater' clade (Ryan and Lips 2004. Herpetol. Rev. 35:278). Our report of *U. euryzonus* eating frog eggs thus suggests promising avenues for future work on the evolution of diet and feeding ecology in dipsadine snakes.



FIG. 1. *Urotheca* (*Pliocercus*) *euryzonus* consuming *Agalychnis callidryas* eggs in a tractor abandoned on the edge of a Panamanian montane forest.

We thank H. W. Greene for encouraging us to submit this note, and for comments on an earlier draft. Financial support provided by the Mellon Foundation and am Organization for Tropical Studies grant to JMR.

Submitted by **CORINE F. VRIESENDORP**, Environmental and Conservation Programs, Field Museum of Natural History, 1400 South Lake Shore Drive, Chicago, Illinois 60605, USA (e-mail: cvriesendorp@fieldmuseum.org); and **JEANNE M. ROBERTSON**, Ecology and Evolutionary Biology, Cornell University, E406 Corson Hall, Ithaca, New York 14850, USA (e-mail: jmr79@cornell.edu).

WAGLEROPHIS MERREMII (Boipeva). **REPRODUCTION.** *Waglerophis merremii* is a ground-dwelling, diurnal snake found throughout much of South America. Reported clutch sizes are 6–8 eggs (Amaral 1977. Serpentes do Brasil. Melhoramentos, SP, 248 pp.), 5–29 eggs (Vanzolini et al. 1980. Répteis das Caatingas. Acad. Bras. Ciências, RJ, 161 pp.), and 7–35 eggs (Pontes and Di-Bernardo 1988. Comum. Mus. Ciênc. PUCRGS, Ser.Zool. 1:123–149).

On 11 May 2000, I found 71 *W. merremii* eggs inside a termite nest on Santa Elisa Farm (22°36'S, 46°14'W, 1650 m elev.), in the municipality of Munhoz (Minas Gerais, Brazil). I also found a carangejeira spider (*Vitalius* sp.) and pieces of a lizard's (*Tupinanbis* sp.) shed skin. The eggs were at a depth of 60 cm and organized in the following manner: 33 eggs were isolated and the remainder occurred in groups of 18, 10, 6, and 4 eggs. Fifty-five eggs had already hatched, 14 eggs were close to hatching, and two were unfertilized. The fourteen healthy eggs (ranging from 8.3–8.5 g, 30–36 mm long, 20–24 mm wide) were incubated in the laboratory and all hatched between 8–18 days after collection, resulting in nine male (range = 160–185 mm SVL, 25–35 mm TL, 5.3–7.2 g) and five female (range = 170–190 mm SVL, 25–30 mm TL, 6.2–7.3 g) neonates.

Although it was not possible to determine whether or not this is a communal nest, the large number of eggs, together with the configuration of the nest site are suggestive of communal use. There are few reports of communal nesting by South American snakes, although these are usually associated with species that inhabit cold areas. Albuquerque and Ferrarezi (2004. Phyllomedusa 3:73–77) report a *Sybinomorphus mikanii* nest with 66 eggs that were not stuck together and contained embryos in different stages of development (more suggestive of communal nesting). The present observation is either a novel report of communal nesting or a new upper limit on litter size in this species.

Submitted by **SILVIA REGINA TRAVAGLIA CARDOSO**, Laboratorio de Herpetologia, Instituto Butantan, Avenida Vital Brazil, 1500, CEP 05503-900, São Paulo, SP, Brazil; e-mail: silviacardoso@butantan.gov.br.

GEOGRAPHIC DISTRIBUTION

Instructions for contributors to Geographic Distribution appear in Volume 37, Number 1 (March 2006). Please note that the responsibility for checking literature for previously documented range extensions lies with authors. Do not submit range extension reports unless a thorough literature review has been completed.

CAUDATA

EURYCEA LONGICAUDA MELANOPLEUARA (Dark-Sided Salamander). USA: ARKANSAS: JOHNSON CO.: (35°41'21"N, 93°36'27"W elev. 308 m). 19 September 2006. Glenn J. Manning. University of Kansas Natural History Museum (KU CT 12010–12012). Verified by John E. Simmons. This individual was found under a rock near a small wet drainage within the Ozark National Forest. First county record (Trauth et al. 2004 The Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville. 421 pp.).

Submitted by, **GLENN J. MANNING**, Department of Biology, University of Arkansas, 601 SCEN, Fayetteville, Arkansas 72701, USA; e-mail: gmannin@uark.edu.

EURYCEA LUCIFUGA (Cave Salamander). USA: ARKANSAS: JOHNSON CO.: 35°41.478'N, 93°36.565' W; elev. 344 m. 14 October 2006. Glenn J. Manning and Kory Roberts. University of Kansas Natural History Museum (KU 307072). Verified by John E. Simmons. Ths specimen was collected during the fall 2006 field trip of the Arkansas Herpetological Society. This specimen was found in a small muddy cavity in a rocky drainage within the Ozark National Forest. First county record (Trauth et al. 2004 The Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville. 421 pp.).

Submitted by, **GLENN J. MANNING**, Department of Biology, University of Arkansas, 601 SCEN, Fayetteville, Arkansas 72701, USA (e-mail: gmannin@uark.edu); and **KORY ROBERTS**, 8 Castle Acre Lane, Bella Vista, Arkansas 72714, USA (e-mail: webmaster@snakesofarkansas.com).

HEMIDACTYLIUM SCUTATUM (Four-toed Salamander). USA: WISCONSIN: IRON CO.: Duck Lake Road, 3.1 km W junction of Duck Lake Road and Chippewa Fire Lane (46°10.933'N; 90°24.101'W; 512 m elev.: T43N R1E NW1/4 Sec 29). 05 May 2006. E. R. Wild. University of Wisconsin-Stevens Point, Natural History Museum, Herpetology Collection (UWSP 3745–46, UWSP 3747–48). Verified by Rori A. Paloski. New county record completing documentation of distribution along Wisconsin-Lake Superior shoreline and western Wisconsin-upper peninsula of Michigan border. (Casper 1996. Geographic Distributions of the Amphibians and Reptiles of Wisconsin. An Interim Report of the Wisconsin Herpetological Atlas Project, Milwaukee Public Museum. 87 pp.).

Submitted by **ERIK R. WILD**, Museum of Natural History and Department of Biology, University of Wisconsin-Stevens Point, Stevens Point, Wisconsin 54481, USA; e-mail: ewild@uwsp.edu.

NECTURUS MACULOSUS (Common Mudpuppy). USA: NORTH CAROLINA: ASHE CO.: Adult caught on fishing line in New River at New River State Park, 8 km airline ESE Jefferson. 15 March 2006. Curtis Gentry and Fred Fogel with assistance from New River State Park staff. First documented record in the New River in North Carolina and first county record for Ashe (Williams 2006. NC NHP Special Animal Survey Form). Specimen verified by Jeffrey C. Beane. North Carolina of Natural Science voucher (NCSM 71331). Previously, only four historical records known in North Carolina, all from the French Broad River drainage in SW North Carolina (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, D.C.). Closest previous historical record is one occurrence from the New River in eastern Pulaski County, Virginia, 109 km airline NE (Tobey 1985. Virginia's Amphibians and Reptiles: A Distributional Survey. Virginia Herpetological Society).

Submitted by **LORI A. WILLIAMS**, North Carolina Wildlife Resources Commission, 177 Mountain Laurel Lane, Fletcher, North Carolina 28732, USA; and **ED COREY**, North Carolina Division of Parks and Recreation, 12700 Bay Leaf Church Road, Raleigh, North Carolina 27614-9633, USA.

NOTOPHTHALMUS VIRIDESCENS (Eastern Newt). USA: TENNESSEE: MARSHALL CO.: Approximately 200 m from Mooresville Highway (Highway 373) (35°26.805N, 86°55.959W). Numerous individuals were found in a small pond; those captured had nuptial pads. 13 March 2007. Nathan Haislip. Austin Peay State University Museum of Zoology, APSU 18312 (color photo). Verified by A. Floyd Scott. New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, Center for Field Biology, Austin Peay State University, Clarksville, Tennessee, hard copy and Internet [http://www.apsu.edu/amatlas/] versions, the latter of which includes links to information on amphibians in Tennessee published since 1996, accessed 15 March 2007).

Submitted by **NATHAN HAISLIP**, 3817 Mooresville Highway, Culleoka, Tennessee 38451, USA; e-mail: nhaislip@utk.edu.

NOTOPHTHALMUS VIRIDESCENS LOUISIANENSIS (Central Newt). USA: ARKANSAS: CARROLL CO.: 1.0 km W St. Hwy 23, vic. Arkansas/Missouri border in oak/hickory forest. 19 May 2007. David Jamieson. Verified by S. E. Trauth. Arkansas State University Herpetological Museum (ASUMZ 30705). New county record partially filling a distributional hiatus in northwestern Arkansas between Benton, Madison and Marion counties (Robison 2006. Herpetol. Rev. 37:484; Trauth et al. 2004. Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville. 421 pp.). Although only one voucher was retained and referenced herein, over 60 newts were examined and released at this fishless pond.

Submitted by **CHRIS T. McALLISTER**, Department of Physical and Life Sciences, Chadron State College, Chadron, Nebraska 69337, USA (e-mail: cmcallister@csc.edu); and **DAVID JAMIESON**, Biological Sciences, Northwest Arkansas Community College, One College Drive, Bentonville, Arkansas 72712, USA (e-mail: djamieson@nwacc.edu).

SIREN I. INTERMEDIA (Eastern Lesser Siren). USA: ALABAMA: SHELBY CO.: Ebenezer Swamp (33°10'05"N, 86°48'41"W). 21 April 1969. J. Patton. Verified by Joseph R. Mendelson III.

University of Montevallo (UMCV-AC0001). County record. Extends range of this Coastal Plain subspecies northward, above the Fall Line, and into the Valley and Ridge Physiographic Province (Lannoo 2005. Amphibian Declines: The Conservation Status of United States Species, University of California Press, Berkeley, 1094 pp.; Mount 1975. The Reptiles and Amphibians of Alabama. University of Alabama Press, Tuscaloosa, 347 pp.).

Submitted by **JILL A. WICKNICK (**e-mail: wicknickja@montevallo.edu) and **BENJAMIN C. BUCKLEY**, Department of Biology, University of Montevallo, Montevallo, Alabama 35115, USA.

ANURA

ACRIS CREPITANS (Northern Cricket Frog). USA: TENNESSEE: MARSHALL CO.: Approximately 350 m from Mooresville Highway (Highway 373), numerous individuals were found throughout a spring leading into a pond (35°26.799'N, 86°56.023'W). 12 March 2007. Nathan Haislip. Austin Peay State University Museum of Zoology, APSU 183 (color photo). Verified by A. Floyd Scott. New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee, hard copy and Internet [http://www.apsu.edu/amatlas/] versions, the latter of which includes links to information on amphibians in Tennessee published since 1996, accessed 15 March, 2007*)*.

Submitted by **NATHAN HAISLIP**, 3817 Mooresville Highway, Culleoka, Tennessee 38451, USA; e-mail: nhaislip@utk.edu.

BUFO AMERICANUS (American Toad). USA: TENNESSEE: MARSHALL Co.: Approximately 200 m from Mooresville Highway (Highway 373), an individual and a male and female in amplexus were found in a small farm pond (35°26.805'N, 86°55.959'W). 13 March 2007. Nathan Haislip. Austin Peay State University Museum of Zoology, APSU 18311 (color photo). Verified by A. Floyd Scott. New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee, hard copy and Internet [http://www.apsu.edu/amatlas/] versions, the latter of which includes links to information on amphibians in Tennessee published since 1996, accessed 15 March 2007).

Submitted by **NATHAN HAISLIP**, 3817 Mooresville Highway, Culleoka, Tennessee 38451, USA; e-mail: nhaislip@utk.edu.

BUFO FOWLERI (Fowler's Toad). USA: TENNESSEE: MARSHALL CO.: Approximately 400 m from Mooresville Highway (Highway 373) (35°27.048'N, 86°55.956'W) found leaping through a field of clover. 09 June 2006. Nathan Haislip. Austin Peay State University Museum of Zoology, APSU 18300 (color photo). Verified by A. Floyd Scott. New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee, hard copy and Internet [http://www.apsu.edu/amatlas/] versions, the latter of which includes links to information on amphibians in Tennessee published since 1996, accessed 18 January, 2007).

Submitted by **NATHAN HAISLIP**, 3817 Mooresville Highway, Culleoka, Tennessee 38451, USA; e-mail: nhaislip@utk.edu.

BUFO MARINUS (Marine Toad). USA: FLORIDA: BAY CO.: Florida Hwy 77, ca. 10 km N of junction County Road 2302 (30°21'56.7"N, 85°40'08.7"W). 17 June 2007. Jason Dombrowsky. Four subadults collected on grounds of abandoned Panama City Zoo. FLMNH 151348–151351. Verified by Kevin Enge. First record from the Florida panhandle, extending range ca. 500 km by land from nearest records in Citrus (Stevenson and Crowe 1992. Herpetol. Rev. 23:85) and Pasco counties (Meshaka et al. 2004. Exotic Amphibians and Reptiles of Florida. Krieger Publishing Company, Malabar, Florida. 155 pp.).

Toads found among two former pond exhibits that had become partially overgrown with wetland vegetation. The former zoo owner released six adult *Bufo marinus* at the site five years ago, and Marine Toads have been regularly observed at the site for two years. Several hundred larvae observed on 20 June 2007 and a single calling male heard on 02 August 2007 by JGH indicate that this is a reproducing population. It is not currently known whether the toads are still restricted to the immediate vicinity of the abandoned zoo.

Submitted by **JOHN G. HIMES**, Florida Fish and Wildlife Conservation Commission, 3911 Hwy 2321, Panama City, Florida 32409, USA; e-mail: john.himes@myfwc.com.

COLOSTETHUS CAERULEODACTYLUS (Blue-Toed Rocket Frog). BRAZIL: AMAZONAS: Municipality of Borba, Estrada do Lixão (04°26'03"S, 59°37'25"W), 41 m elev. 15 February 2007. P. I. Simões. Herpetological collection, Instituto Nacional de Pesquisas da Amazônia, Manaus, Amazonas, Brazil (INPA-H 18846–18850, four males, one female). Verified by A. P. Lima. Males were found calling intensively during the day or carrying tadpoles to rainwater ponds. First record outside the type locality, defined as coordinates 03°37'10"S, 59°86'78"W, in the municipality of Castanho, Amazonas, Brazil, on the left bank of the Madeira River (Lima and Caldwell 2001. Herpetologica 57:180–189). Extends known distribution 102 km to southeast.

Submitted by **PEDRO IVO SIMÕES,** Coordenação de Pesquisas em Ecologia, INPA, CP 478, Manaus, Amazonas, 69011-970, Brazil; e-mail:pedroivo@inpa.gov.br.

COLOSTETHUS NIDICOLA. BRAZIL: AMAZONAS: Municipality of Borba, Estrada do Lixão (04°26'03"S, 59°37'25"W), 41 m elev.15 February 2007. P. I. Simões. Herpetological collections of the Instituto Nacional de Pesquisas da Amazônia (INPA-H 18832–18839, four females, four males). Municipality of Novo Aripuanã (05°09'01"S, 60°20'48"W), 38 m elev. 22 February 2007. P. I. Simões (INPA-H 18840–18845, three females, three males). Verified by A. P. Lima. First records outside type locality, defined as coordinates 03°37'10"S, 59°86'78"W, in the municipality of Castanho, south of Manaus, on the left bank of the Madeira River (Caldwell and Lima 2003. Herpetologica 59:219–234). Extends known distribution 175 km to south.

Submitted by **PEDRO IVO SIMÕES**, Coordenação de Pesquisas em Ecologia, INPA, CP 478, Manaus, Amazonas, 69011-970, Brazil; e-mail:pedroivo@inpa.gov.br.

CYCLORAMPHUS CARVALHOI. BRAZIL: SÃO PAULO. Municipality of Campos do Jordão (22°42'23.2"S, 45°28'18.7"W), 1750 m elev. 20 October 2005. I. A. Martins; P. H. Bernardo; A. P.

Suarez and F. B. R. Gomes. Célio F. B. Haddad collection, deposited in Departamento de Zoologia, Universidade Estadual Paulista, Rio Claro, SP, Brazil (CFBH 9894, adult male SVL: 52.63 mm). Verified by C. F. B. Haddad. Species previously known only from the type locality (Brejo da Lapa, alto do Itatiaia, Rio de Janeiro, RJ: Heyer 1983. Arq. Zool. 30[4]:235–339; Frost 2004. Amphibian Species of the World: An Online Reference V3.0, http://research.amnh.org/herpetology/amphibia/index.html,). First state record, extends known distribution ca. 200 km SW from the type locality.

Submitted by **ITAMAR ALVES MARTINS** (e-mail: istama@uol.com.br) and **FELIPE BITTIOLI R. GOMES,** Universidade de Taubaté - UNITAU, Laboratório de Zoologia/IBB. 12030-1800, Taubaté, SP, Brazil; **PEDRO H. BERNARDO**, Universidade Federal de Ouro Preto (UFOP), Lab. de Zoologia dos Vertebrados, 35400-000, Ouro Preto, MG, Brazil; and **ANA PAULA SUAREZ**, Estação Ecológica de Bananal – IF, 12850-000, Bananal, SP, Brazil.

CYCLORAMPHUS MIGUELI (Miguel's Button Frog). BRAZIL: BAHIA: Municipality of Amargosa, Timbó farm (13°27'39"S, 39°28'35"W). 20 January and 15 April 2007. 850 m elev. P. Fonseca and R. Abreu. Museu de Zoologia da Universidade Federal da Bahia, Brazil (MZUFBA 6436, 6456). Verified by M. Napoli. Previously known only from the type locality in the southern Bahia state: Municipality of São José da Vitória and Uruçuca (Frost 2007. Amphibian Species of the World 5.0, an Online Reference; Dixo and Verdade 2004. Herpetol. Rev. 35:280). Extends known distribution ca. 150 km N from Municipality of Uruçuca, Bahia, Brazil (Dixo and Verdade, *op. cit.*).

Submitted by **MARCO ANTÔNIO DE FREITAS,** Programa de pós-graduação em zoologia, UESC (Universidade Estadual de Santa Cruz) CEP 46.500-000 Rodovia Ilhéus/Itabuna, Ilhéus, Bahia, Brazil (e-mail: philodryas@hotmail.com); **THAÍS FIGUEIREDO SANTOS SILVA,** Biogeographia publicações e consultoria ambiental, Rua E quadra D lote 11, Jardim Aeroporto, CEP 42700-000, Lauro de Freitas, Bahia, Brazil (e-mail: thaisfsilva@hotmail.com); **PATRÍCIA MENDES FONSECA** (e-mail: patriciamfonseca@yahoo.com.br) and **RAFAEL OLIVEIRA DE ABREU,** Instituto de Biologia, Museu de Zoologia da Universidade Federal da Bahia (UFBA) CEP 40000-000, Salvador, Bahia, Brazil (e-mail: rafaoabreu@gmail.com).

ELEUTHERODACTYLUS HENSELII. BRAZIL: RIO GRANDE DO SUL: Sertão (28°02'31"S, 52°13'28"W), in a mixed ombrophilous forest, 650 m elev. 04 September 2006. N. Zanella, C. S. Busin, and L. Crestani. Coleção de Anfíbios da Universidade de Passo Fundo, Passo Fundo, Rio Grande do Sul, Brazil (CAUPF 2025). Verified by G. Vinciprova. Previously known from subtropical Atlantic rainforest and parts of the Araucaria forest in southern Brazil (states of Rio Grande do Sul and Santa Catarina) and Misiones, Argentina (Kwet and Solé 2005. J. Herpetol. 39:521–532; Frost 2007. Amphibian Species of the World: An Online Reference: V5.0 http://reserarch.amnh.org/herpetology/amphibia/index./html). This new record extends known distribution ca. 161 km NW from Caxias do Sul, State of Rio Grande do Sul, Brazil (Kwet and Solé, *op. cit.*).

Submitted by **NOELI ZANELLA** (e-mail: zanella@upf.br), **CARMEN SILVIA BUSIN,** and **LEONARDO CRESTANI**, Universidade de Passo Fundo, Campus I, Bairro São José, Br 285, Km 171, Caixa Postal 611, CEP 99001-970, Passo Fundo, Rio Grande do Sul, Brazil.

ELEUTHERODACTYLUS PLANIROSTRIS (Greenhouse Frog). USA: LOUISIANA: St. Tammany Parish: Mandeville (30°22'5"N, 90°3'37"W). 04 August 2006. Jean Elbers. Verified by Brian Crother. Deposited in Museum of Natural History, Tulane University (TU 24205, one adult). New parish record that extends the distribution north across Lake Pontchartrain. This species originates from Cuba and other Caribbean Islands (Goin 1947. Studies on the Life History of *E. r. planirostris* (Cope) in Florida. Univ. Florida Studies, 66 pp.). It has been known in Florida as of 1875 and may have been introduced by shipments of foreign Caribbean plants (Dundee and Rossman 1989. The Amphibians and Reptiles of Louisiana. Louisiana State University Press, Baton Rouge. 300 pp.). In Louisiana, this species has been documented in Orleans Parish as early as 1975 (Plotkin and Atkinson 1979. Herpetol. Rev. 10:59) and has spread to Easton Baton Rouge, Calcasieu, St. Bernard and St. John the Baptist, and Plaquemines Parishes (Boundy 1998. Herpetol. Rev. 29:251–252; Boundy 2004. Herpetol. Rev. 35:194–196; Platt and Fontenot 1995. Herpetol. Rev. 26:207; Williams and Wygoda 1997. Herptol. Rev. 28:207). This species may compete with native *Gastrophryne carolinensis* (Eastern Narrow-mouthed Toad) (Dundee and Rossman 1989, *op. cit.*; Goin 1947, *op. cit*.). In Louisiana, the two species have been found sympatrically (pers. obser.).

I thank B. Crother, C. Fontenot, and T. Schriever for specimen identification and manuscript comments.

Submitted by **JEAN P. ELBERS,** Department of Biological Sciences, Southeastern Louisiana University, Hammond, Louisiana 70402, USA; e-mail: jean.elbers@selu.edu.

GASTROPHRYNE OLIVACEA (Great Plains Narrow-mouthed Toad). USA: TEXAS: Van Zandt Co.: Pasture along Van Zandt County Road 2721, 2.90 km N of jct. with US 198. 24 May 2007. R. Michael Burger. Verified by Carl J. Franklin. Color photo voucher. University of Texas at Arlington - Amphibian and Reptile Diversity Research Center (UTA color images 1046–1047). Adult male 25 mm SVL located by vocalization after heavy rain. Several other calling males were in the immediate vicinity. New county record (Dixon 2000. Amphibians and Reptiles of Texas. 2nd ed. Univ. of Texas A&M Press, viii+421 pp.).

Submitted by **R. MICHAEL BURGER**, P.O. Box 4099, Dallas, Texas 75208, USA; e-mail: mvburger@dctexas.net.

GASTROTHECA DENDRONASTES (Río Calima Marsupial Frog). COLOMBIA: DEPARTAMENTO DE ANTIOQUIA: Municipio Anorí, Finca El Chaquiral, Vereda El Retiro (06°59'0.4"N, 75°07'59"W, ca. 1704 m elev.), northern part of Cordillera Central. 18 November 2004. J. C. Arredondo-S. and C. Molina-Z. Museo de Herpetología Universidad de Antioquia, Medellín, Colombia (MHUA 3868, female). Verified by J. D. Lynch. Previously known only from the Río Calima, 1.5 km (by road) W of Lago Calima (1230 m elev.), Departamento del Valle del Cauca, Cordillera Occidental, Colombia and Río Faisanes, 14

km ENE of Las Palmas (1380 m elev.) Provincia de Pichincha, Ecuador (Duellman 1983. Copeia 1983:868–874). This record extends the known distribution ca. 374 km from its nearest known locality, toward the northeastern part of Colombia through the eastern versant of the Cordillera Central. First documented record from Departamento de Antioquia and from the Cordillera Central. Ruiz et al. 1996 (Rev. Acad. Colomb. Cienc. 20:365–415) and Acosta-Galvis 2000 (Biota Colombiana 1:289–319) mentioned that this species is present at Departamento de Antioquia, but no voucher exists to support their assertions.

Submitted by **PAUL D. A. GUTIERREZ-C.** and **LUCAS S. BARRIENTOS**, Grupo Herpetológico de Antioquia (GHA), Instituto de Biología, Universidad de Antioquia, oficina 7-121, teléfono 574-2105628, A.A. 1226, Medellín, Colombia (e-mail: pdgutierrez2@yahoo.com).

HYALINOBATRACHIUM EURYGNATHUM (Rio Glass Frog). BRAZIL: BAHIA: Municipality of Amargosa, Timbó farm (13°07'21"S, 39°39'4051"W) 750 m elev. 15 January 2007. P. Fonseca. Museu de Zoologia da Universidade Federal da Bahia, Salvador, Brazil (MZUFBA 6491; 6505). Collected at night on the ground of the forest. Verified by M. Napoli. Previously known from highlands of southeastern Brazil in Rio de Janeiro, Espírito Santo, and south Bahia state (Frost 2007. Amphibian Species of the World, An Online Reference, ver. 5.0; Freitas et al. 2004. Herpetol. Rev. 35:281). First record from northern Bahia, Brazil; extends distribution ca. 310 km N from Itapebi municipality, Bahia (Freitas et al., *op. cit.*).

Submitted by **MARCO ANTÔNIO DE FREITAS,** Programa de pós-graduação em zoologia, UESC (Universidade Estadual de Santa Cruz) CEP 46.500-000 Rodovia Ilhéus/Itabuna, Ilhéus, Bahia, Brazil (e-mail: philodryas@hotmail.com); and **THAÍS FIGUEIREDO SANTOS SILVA,** Biogeographia publicações e consultoria ambiental, Rua E quadra D lote 11, Jardim Aeroporto, CEP 42700-000, Lauro de Freitas, Bahia, Brazil; and **PATRÍCIA FONSECA** (e-mail: patriciamfonseca@yahoo.com.br), Instituto de Biologia, Museu de Zoologia da Universidade Federal da Bahia (UFBA) CEP 40000-000, Salvador, Bahia, Brazil.

HYLA CHRYSOSCELIS/VERSICOLOR (Gray Treefrog). USA: ILLINOIS: Putnam Co.: Highway 26, 5.5 km N of Highway 18 (41°08.966'N, 89°18.249'W). 26 May 2007. John G. Palis. Verified by Jeffrey G. Stewart. Southern Illinois University at Carbondale (SIUC H-8678). DOR adult at 2145 h. *Hyla versicolor* heard vocalizing from several locations along Highway 26. First record for county, filling gap among Bureau, LaSalle, and Marshall counties (Petzing et al. 2000. Herpetol. Rev. 31:189–194; Phillips et al. 1999. Field Guide to Amphibians and Reptiles of Illinois. Illinois Nat. Hist. Surv. Manual 8, Champaign, Illinois xii + 282 pp.).

Submitted by **JOHN G. PALIS**, P.O. Box 387, Jonesboro, Illinois 62952, USA; e-mail: jpalis@yahoo.com.

HYLA CINEREA (Green Treefrog). USA: ARKANSAS: Crawford Co.: Dyer Lake, Arkansas (35°28'29"N, 94°05'59"W; elev. 121 m). 26 July 2006. James U. Van Dyke, Glenn J. Manning, and Brad Birchfield. University of Kansas Natural History Museum (KU CT 12013–12015). Verified by John E. Simmons. At 2300 h CST, numerous individuals were heard calling in the immediate vicinity of the animal captured. The animal captured was a large calling male. Franklin Co.: Back water of the Arkansas River, 3 mi. SSE of Mulberry, Arkansas (35°27'53"N, 94°00'47"W; elev. 121 m). 05 August 2006. Glenn J. Manning, James U. Van Dyke, and Brad Birchfield. University of Kansas Natural History Museum (KU CT 12016–12017). Verified by John E. Simmons. At 2145 h CST, three males were heard calling in the immediate vicinity of the animal captured. The individual captured was either a small satellite male or a female. First county records (Trauth et al. 2004 The Amphibians and Reptiles of Arkansas, University of Arkansas Press, Fayetteville. 421 pp.).

Submitted by **JAMES U. VAN DYKE** (e-mail: juvandy@uark.edu) and **GLENN J. MANNING** (e-mail: gmannin@uark.edu), Department of Biology, University of Arkansas, 601 SCEN, Fayetteville, Arkansas 72701, USA; and **BRAD BIRCHFIELD,** 11050 Cain Road, Mountainburg, Arkansas 72946, USA (e-mail: mulebrother@msn.com).

HYLA CINEREA (Green Treefrog). USA: TEXAS: Calhoun Co.: 9.82 road km E of TX 238 on TX 185 (28°24'59.8"N, 96°38'51.3"W). 15 May 2007. D. Laurencio, R. E. Nelson. Verified by Toby J. Hibbitts. Texas Cooperative Wildlife Collection, TCWC 91810–91811. New county record (Dixon 2000. Amphibians and Reptiles of Texas. 2nd Ed. Texas A&M University Press, College Station, Texas. 421 pp.).

Submitted by **DAVID LAURENCIO,** Texas Cooperative Wildlife Collection, Department of Wildlife and Fisheries Sciences, 2258 TAMU, Texas A&M University, College Station, Texas 77843-2258, USA (e-mail: norops@tamu.edu); and **RYAN E. NELSON**, Crouch Environmental Services, Inc., 402 Teetshorn, Houston, Texas 77009, USA.

HYLA SQUIRELLA (Squirrel Treefrog). USA: TEXAS: Calhoun Co.: 2.41 road km S of Victoria County line on TX 185 (28°36'20.6"N, 96°51'22.0"W). 29 May 2007. D. Laurencio, R. E. Nelson. Verified by James R. Dixon. Texas Cooperative Wildlife Collection, TCWC 92079–92081. New county record (Dixon 2000. Amphibians and Reptiles of Texas. 2nd Ed. Texas A&M University Press, College Station, Texas. 421 pp.). Jackson Co.: 8.0 road km ENE of FM 1593 on TX 35 (28°42'37.7"N, 96°28'58.2"W). 25 June 2007. D. Laurencio and J. T. Williams. TCWC 92435. Verified by Toby J. Hibbitts. New county record (Dixon 2000, *op. cit.*). Wharton Co.: 1.6 road km E of FM 3086 on FM 441 (29°2'30.2"N, 96°16'26.7"W). 26 June 2007. D. Laurencio, J. T. Williams. Verified by Toby J. Hibbitts. TCWC 92436. New county record (Dixon 2000, *op. cit.*).

Submitted by **DAVID LAURENCIO** (e-mail: norops@tamu.edu) and **JOHN T. WILLIAMS**, Texas Cooperative Wildlife Collection, Department of Wildlife and Fisheries Sciences, 2258 TAMU, Texas A&M University, College Station, Texas 77843-2258, USA; and **RYAN E. NELSON**, Crouch Environmental Services, Inc., 402 Teetshorn, Houston, Texas 77009, USA.

HYLA SQUIRELLA (Squirrel Treefrog). USA: VIRGINIA: Northampton Co.: 1.4 km SE Kiptopeke, Eastern Shore of Virginia National Wildlife Refuge (37°08'7.48"N, 75°58'5.06"W,

NAD 83). 28 June 2006. J. C. Mitchell. USNM 565041–565044. Verified by Susan C. Walls. The very large population represents an extension of the known range in Virginia across the Chesapeake Bay 25.7 km N of nearest location in First Landing State Park, City of Virginia Beach, Virginia (Mitchell and Reay 1999. Atlas of Amphibians & Reptiles in Virginia. Virginia Dept. Game & Inland Fisheries, Richmond, Virginia). County record and first record for the Delmarva Peninsula.

Submitted by **JOSEPH C. MITCHELL**, Mitchell Ecological Research Services, LLC, P.O Box 5638, Gainesville, Florida 32627-5638, USA (e-mail: dr.joe.mitchell@gmail.com); and **PAMELA DENMON**, U.S. Fish and Wildlife Service, Eastern Shore National Wildlife Refuge/Fisherman Island NWR, 5003 Hallett Circle, Cape Charles, Virginia 23310, USA (e- mail: Pamela_Denmon@fws.gov).

HYPSIBOAS ALBOPUNCTATUS. BRAZIL: BAHIA: Municipality of Mucugê, Três Irmãos farm (12°51'41"S, 41°30'51"W), 1100 m elev. 07 September 2005. M. A. de Freitas, T. Figueiredo Santos Silva, and P. Fonseca. Museu de Zoologia da Universidade Federal da Bahia, Salvador, Bahia, Brazil (MZUFBA 6053–6055). Verified by M. Filgueiras Napoli. Previously known from: central, southern, and southeastern Brazil; northeastern Argentina; northern Uruguay; eastern Bolivia; and eastern Paraguay (Frost 2007. Amphibian Species of the World 5.0 An Online Reference; Garcia and Vinciprova 1998. Herpetol. Rev. 29:117; Kopp et al. 2002. Herpetol. Rev. 33:220. First state record, extends distribution ca. 700 km N from Belo Horizonte, Minas Gerais, Brazil (Frost 2007, *op. cit.*).

Submitted by **MARCO ANTÔNIO DE FREITAS**, Programa de pós-graduação em zoologia, UESC (Universidade Estadual de Santa Cruz) CEP 46.500-000 Rodovia Ilhéus/Itabuna, Ilhéus, Bahia, Brazil **(**e-mail: philodryas@hotmail.com**)**; **THAÍS FIGUEIREDO SANTOS SILVA** (e-mail: thaisfsilva@hotmail.com) and **PATRICIA FONSECA**, Biogeographia publicações e consultoria ambiental, Rua E quadra D lote 11, Jardim Aeroporto, CEP 42700-000, Lauro de Freitas, Bahia, Brazil.

HYPSIBOAS MULTIFASCIATUS (Many-Banded Treefrog). BRAZIL: CEARÁ: Ubajara (03°49'36"S, 40°55'02"W; 857 m elev.). 04 April 2007. D. Loebmann. Coleção de Anuros Célio F. B. Haddad, Departamento de Zoologia, Instituto de Biociências, Universidade Estadual Paulista, Rio Claro, São Paulo, Brazil (CFBH 16142; 16147–16149; 16151–16156). Verified by J. Faivovich. GOIÁS: Aruanã (14°55'13"S, 51°04'59"W; 254 m elev.). Coleção Zoológica da Universidade Federal de Goiás, Goiânia, Brazil (ZUFG 1835); Caiapônia (16°57'24" S, 51°48'37" W; 593 m elev.) (ZUFG 1347–1948); Cidade de Goiás (15°56'04" S, 50°08'25"W; 329 m elev.) (ZUFG 2772); Guapó (16°49'50"S, 49°31'55"W; 771 m elev.) (ZUFG 1029–1930); Iporá (16°26'31" S, 51°07'04"W; 561 m elev.) (ZUFG 2439); Jussara (15°51'54"S, 50°52'05"W; 329 m elev.) (ZUFG 1184–1185); Mossâmedes (16°07'36"S, 50°12'54"W; 518 m elev.) (ZUFG 273–277, 430–431, 641, 834, 844, 851–852); Palmeiras de Goiás (16°48'18"S, 49°55'33"W; 615 m elev.) (ZUFG 968, 970); Santa Rita do Novo Destino (15°08'07"S, 49°07'13"W; 737 m elev.) (ZUFG 2638); São Miguel do Araguaia (13°16'30"S, 50°09'46"W; 352 m elev.) (ZUFG 1814, 2038); and Serranópolis (18°18'22"S, 51°57'44"W; 679 m elev.) (ZUFG 2494–95). All specimens from Goiás collected by R. P. Bastos and L. D. Guimarães and verified by J. Perez Pombal Júnior. Species previously reported from eastern Venezuela, through the Guianas to northern Brazil in Amapá, Pará, Maranhão, and Piauí (de Sá 1996. Cat. Amer. Amphib. Rept. 624:1–4; Barreto 2007. Cerrado Norte do Brasil. União Sul Americana de Estudos da Biodiversidade, Pelotas, Brazil, 378 pp.). First state records, extending distribution ca. 560 km E from the city of Uruçui, Piauí state, Brazil, and ca. 786 km S from the city of Balsas, Maranhão state, Brazil (Barreto, *op. cit.*).

Submitted by **DANIEL LOEBMANN** (e-mail: contato@danielloebmann.com), **CYNTHIA PERALTA DE ALMEIDA PRADO**, **CÉLIO FERNANDO BAPTISTA HADDAD**, Universidade Estadual Paulista, Instituto de Biociências, Departamento de Zoologia, Rio Claro, Caixa Postal 199, CEP 13506-970, São Paulo, Brasil; **ROGÉRIO PEREIRA BASTOS** and **LORENA DALL'ARA GUIMARÃES**, Universidade Federal de Goiás, Instituto de Ciências Biológicas, Departamento de Biologia Geral, Laboratório de Comportamento Animal, Goiânia, Caixa postal 131, CEP 74001-970, Goiás, Brazil.

KASSINA SENEGALENSIS (Senegal Running Frog). MAURITANIA: BRAKNA REGION: 10 km N Bogué (16°58'N, 16°07'W). 11 November 2003. Sid'Ahmed ould Mohamed. Institut de Recherche pour le Développement at Dakar (IRD TR-139). Verified by Youssouph Mané. Second record for Mauritania and first record for Brakna region. One specimen found near a seasonal pond. Extends range 360 km W from Bou Bleït'îne (17°07'N, 10°59'W) where this species was collected for the first time in Mauritania (Padial 2004. Herpetol. Rev. 35:405). Eleven species of amphibians are currently known in Mauritania (Padial and De la Riva 2004. Rev. Esp. Herpetol. 18:89–99).

Submitted by **SEBASTIEN TRAPE**, Laboratoire ECOLAG, Institut de Recherche pour le Développement (IRD, UR 70) and Université Montpellier II, 34095 Montpellier Cedex 5, France; e-mail: sebastien_trape@yahoo.fr.

PHRYNOMEDUSA MARGINATA (Bi-colored Leaf Frog). BRAZIL: RIO DE JANEIRO: Paraty municipality, 23°12'50"S, 44°47'36"W, 250 m elev. 18 March 1979. Amphibian collection, Departamento de Zoologia, Universidade Federal de Rio de Janeiro, Rio de Janeiro, Rio de Janeiro State (ZUFRJ 312 –315). 12 October 1979. (ZUFRJ 600–603). All collected by S. Potsch de Carvalho e Silva. SÃO PAULO: Paraibuna municipality; 23°37'13"S, 45°34'30.4"W, 740 m elev. 12–14 April 2007. T. Silva Soares, A. M. P. Telles de Carvalho e Silva, P. Nogueira da Costa, F. Rosa, and M. dos Reis Gomes (ZUFRJ 10019–10021, 10046, 10066, 10073–10074). Males collected while calling perched on small trees at the margin of permanent lotic ponds, inside the Atlantic Forest in the Serra do Mar. All specimens verified by E. Izecksohn. Previously known only from the type locality, Espírito Santo State, Santa Teresa municipality (19°56'08"S, 40°36'01"W; 655 m elev.) (Izecksohn and Cruz 1976. Rev. Brasileira Biol. 36 [1]:257–261). First records for the states of Rio de Janeiro and São Paulo, Brazil; the Paraibuna record extends range ca. 680 km SW from the type locality.

Submitted by **ANA M. P. TELLES CARVALHO-E-SILVA** (e-mail: atelles@unirio.br), **SERGIO P. CARVALHO-E-SILVA** (e-mail: sergio@biologia.ufrj.br), and **THIAGO SILVA-SOARES**, Departamento de Zoologia, Universidade Federal do Rio de Janeiro, caixa postal 68.044, CEP 21944-970, Cidade Universitária, Rio de Janeiro, Brazil.

PSEUDACRIS CLARKII (Spotted Chorus Frog). USA: TEXAS: BORDEN CO.: US Hwy 180, 100 m E of Mesquite Creek, N side of road (32.77264°N, 96.75287°W; WGS 84). 11 May 2007. Michele A. Gaston, Elizabeth Riedlinger, and Akiko Fujii. Verified by James Dixon. Texas Cooperative Wildlife Collection (TCWC 91874). Specimen was found calling from a flooded, grassy road embankment, and represents the first recorded occurrence of this species from this county (Dixon 2000. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Publ. Texas A&M University Press. 421 pp.).

Submitted by **MICHELE A. GASTON** (e-mail: mg45447@txstate.edu), **ELIZABETH RIEDLINGER** (e-mail: riedline@gmail.com), **AKIKO FUJII** (e-mail: akiko1983@hotmail.com), and **MICHAEL R. J. FORSTNER**, Department of Biology, Texas State University, San Marcos Texas 78666, USA (e-mail: mf@txstate.edu).

RANA CATESBEIANA (American Bullfrog). USA: TENNESSEE: MARSHALL CO.: Approximately 800 m from Mooresville Highway (Highway 373) on bank of farm pond (35°27.131'N, 86°56.090'W). 18 May 2005. Nathan Haislip. Austin Peay State University Museum of Zoology, APSU 18301 (color photo). Verified by A. Floyd Scott. New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, Center for Field Biology, Austin Peay State University, Clarksville, Tennessee, hard copy and Internet [http://www.apsu.edu/amatlas/] versions, the latter of which includes links to information on amphibians in Tennessee published since 1996, accessed 18 January 2007).

Submitted by **NATHAN HAISLIP**, 3817 Mooresville Highway, Culleoka, Tennessee 38451, USA; e-mail: nhaislip@utk.edu.

RANA CATESBEIANA (American Bullfrog). USA: TEXAS: CALHOUN CO.: 0.08 road km SE of TX 238 on FM 1289 (28°33'10.8"N, 96°38'7.6"W). 16 May 2007. D. Laurencio, R. E. Nelson. Texas Cooperative Wildlife Collection (TCWC 91812). A second specimen, TCWC 91813 (28°32'32.7"N, 96°37'35.8"W) was also found. YOAKUM CO.: Yoakum County Park, 0.16 road km S of FM 213 on FM 214 (33°2'59.8"N, 102°48'58.7"W). TCWC 92125. 06 June 2007. D. Laurencio, L. A. Fitzgerald, T. J. Hibbitts. New county records. All verified by James R. Dixon (Dixon 2000. Amphibians and Reptiles of Texas. 2nd Ed. Texas A&M University Press, College Station, Texas. 421 pp.).

Submitted by **DAVID LAURENCIO** (e-mail: norops@tamu.edu**)**, **LEE A. FITZGERALD**, and **TOBY J. HIBBITTS**, Texas Cooperative Wildlife Collection, Department of Wildlife and Fisheries Sciences, 2258 TAMU, Texas A&M University, College Station, Texas 77843-2258, USA; and **RYAN E. NELSON**, Crouch Environmental Services, Inc., 402 Teetshorn, Houston, Texas 77009, USA**.**

RANA C. CLAMITANS (Bronze Frog). USA: TEXAS: MILAM CO.: 400 m W jct Milam County Road 374 and CR 342 (north end), on CR 374 (30.72354°N, 101.39190°W; WGS 84). 29 April 2007. Michele A. Gaston, Laura M. Villalobos, and Daniella Buzo. Verified by James R. Dixon. Texas Cooperative Wildlife Collection (TCWC 91875). Specimen was found calling from a reed bed near a creek crossing, and represents the first recorded occurrence of this species in Milam County (Dixon 2000. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Publ. Texas A&M University Press. 421 pp.).

Submitted by **MICHELE A. GASTON** (e-mail: mg45447@txstate.edu), **LAURA M. VILLALOBOS** (e-mail: lmvill@txstate.edu), **DANIELLA BUZO** (e-mail: db1243@txstate.edu), and **MICHAEL R. J. FORSTNER,** Department of Biology, Texas State University, San Marcos Texas 78666, USA (e-mail: mf@txstate.edu).

RANA PALUSTRIS (Pickerel Frog). USA: ARKANSAS: CARROLL CO.: 0.5 km S Arkansas/Missouri State Line, off St. Hwy 23. 23 March 2007. David Jamieson. Verified by S. E. Trauth. Arkansas State University Herpetological Museum (ASUMZ 30713, photographic voucher). New county record partially filling a distributional hiatus in northwestern Arkansas among Benton and Marion counties (Trauth et al. 2004. Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.) and Barry County, Missouri (Johnson 2000. The Amphibians and Reptiles of Missouri. Second Ed. Missouri Dept. Conserv., Jefferson City. 400 pp). Specimen was collected AOR while crossing state highway, photographed, and released.

Submitted by **CHRIS T. MCALLISTER**, Department of Physical and Life Sciences, Chadron State College, Chadron, Nebraska 69337, USA (e-mail: cmcallister@csc.edu); and **DAVID JAMIESON**, Biological Sciences, Northwest Arkansas Community College, One College Drive, Bentonville, Arkansas 72712, USA (e-mail: djamieson@nwacc.edu).

RANA PALUSTRIS (Pickerel Frog). USA: TENNESSEE: MARSHALL CO.: Approximately 200 m from Mooresville Highway (Highway 373) (35°26.805'N, 86°55.959'W), an individual was found with minor injury to left side. 13 March 2007. Nathan Haislip. Austin Peay State University Museum of Zoology, APSU 18313 (color photo). Verified by A. Floyd Scott. New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, Center for Field Biology, Austin Peay State University, Clarksville, Tennessee, hard copy and Internet [http://www.apsu.edu/amatlas/] versions, the latter of which includes links to information on amphibians in Tennessee published since 1996, accessed 15 March 2007).

Submitted by **NATHAN HAISLIP**, 3817 Mooresville Highway, Culleoka, Tennessee 38451, USA; e-mail: nhaislip@utk.edu.

RANA PIPIENS (Northern Leopard Frog). USA: ILLINOIS: PUTNAM CO.: Highway 26, 4.5 km N of Highway 18 (41°08.456'N, 89°18.431'W). 26 May 2007. John G. Palis. Verified by Jeffrey G. Stewart. Southern Illinois University at Carbondale (SIUC H-8677). DOR adult at bridge over stream at 2141 h. First county record, filling gap among Bureau, LaSalle, and Marshall counties

(Petzing et al. 2007. Herpetol. Rev. 38:240–243; Phillips et al. 1999. Field Guide to Amphibians and Reptiles of Illinois. Illinois Nat. Hist. Surv. Manual 8, Champaign, Illinois xii + 282 pp.).

Submitted by **JOHN G. PALIS**, P.O. Box 387, Jonesboro, Illinois 62952, USA; e-mail: jpalis@yahoo.com.

RHACOPHORUS HTUNWINI (Htunwin's Treefrog). BANGLADESH: CHITTAGONG DIVISION: Kaptai National Park, ca. 2.83 km ENE Kaptai (22°28.890'N, 92°13.472'E). 25 June 2005. Suprio Chakma. Verified by Jeffery A. Wilkinson. Museum of Zoology, Chittagong University, CUZ 40 – 402. New record for Bangladesh. Habitat consists of forested hills of mixed evergreen forests and plantations of Segun Trees (*Tectona grandis*), 350 m elev. Specimens were found adjacent to the Kaptaimuk Forest Beat Rest House on trees, 3–8 m above ground. There was a rain water pool ca. 2.5 m on roof near sampling site, and were collected from Jackfruit (*Artocarpus heterophyllus*) and Mango (*Mangifera indica*) trees. Species described from adjacent regions of Myanmar (Wilkinson et al. 2005. Proc. California Acad. Sci. 56:42–52), including neighboring Rakhine State (CAS 222065, 222136).

Submitted by **SUPRIO CHAKMA**, Wildlife Trust of Bangladesh, 69/1 New Circular Road, Malibag, Dhaka-1217, Bangladesh; e-mail: supriochakma@yahoo.com.

SCAPHIOPUS HURTERII (Hurter's Spadefoot).USA: ARKANSAS: Izard Co.: Found on private property by Twin Creek off Co. Rd. 1, 2 km E of St. Hwy 9. UTM 15N, 0587123E, 3980749N. 15 March 2007. Collected by M. B. Connior and I. Guenther. Arkansas State University Herpetological Museum (ASUMZ 30423). Verified by S. E. Trauth. Caught in a drift fence pitfall trap. First county record (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville, Arkansas. 421 pp.).

We thank K. Irwin and B. Sasse from the Arkansas Game and Fish Commission for support of our study, Y. and N. Whitehurst, M. and K. Smith, and R. and S. Smith for permission to conduct the study on their land, and S. Trauth for specimen verification and curatorial preparation. Thanks also to the ASU Wildlife Management Investigational Techniques class for installing the drift fences.

Submitted by **MATTHEW B. CONNIOR**, **IDUN GUENTHER**, and **THOMAS S. RISCH**, Department of Biological Sciences, Arkansas State University State University, Arkansas 72467, USA (e-mail: matthew.connior@smail.astate.edu).

SCAPHIOPUS HURTERI (Hurter's Spadefoot). USA: TEXAS: Hill Co.: 6.1 rd km E Jct FM 934 and 933, off 934, 763 ft elev., J. R. Dixon II property. 06 June 2007. Collected by James R. Dixon. Verified by Toby Hibbits. Texas Cooperative Wildlife Collection (TCWC 91966). This juvenile specimen represents the first recorded occurrence of this species in Hill County and measured 25 mm SUL (Dixon 2000. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Publ. Texas A&M University Press. 421 pp.).

Submitted by [1]**JAMES H. BELL** (e-mail: jhbell@txstate.edu), [2]**JAMES R. DIXON**, and [1]**MICHAEL R. J. FORSTNER** [1]Department of Biology, Texas State University, San Marcos Texas 78666, USA; [2]Texas Cooperative Wildlife Collection, Texas A&M University, College Station, Texas 77843 USA; (e-mail [MF]: mf@txstate.edu).

SCINAX RANKI (NCN). BRAZIL: MINAS GERAIS: Serra da Pedra Branca, Pedralva Municipality (22°12'30"S, 45°20'36"W), 1150 m elev. 30 April 2007. C. Luna-Dias and J. P. Braga. Amphibian Collection of Departamento de Zoologia of Universidade Federal do Rio de Janeiro, Rio de Janeiro state (ZUFRJ 10189–10191, three adult males). Verified by M. R. Gomes. Previously known only from type locality, Poços de Caldas, Minas Gerais (21°52'S, 46°50'W, 1400 m elev.) (Andrade and Cardoso 1987. Rev. Brasileira Zool. 3[7]:433–440). The new occurrence extends distribution 123 km ESE (straight line).

Submitted by **CYRO DE LUNA-DIAS** (e-mail: cyroluna@gmail.com), **JOÃO PAULO BRAGA** (e-mail: pedrabranquense@gmail.com), and **SERGIO POTSCH DE CARVALHO-E-SILVA**, Departamento de Zoologia, Universidade Federal do Rio de Janeiro, caixa postal 68.044, CEP 21944-970, Cidade Universitária, Rio de Janeiro, Brazil (e-mail: sergio@biologia.ufrj.br).

SPEA INTERMONTANA (Great Basin Spadefoot). USA: COLORADO: Mesa Co.: On Hwy 141, 19.6 km S by road from junction with John Brown Canyon; approximately 38°31'52"N, 108° 53'51"W; NAD83). 05 July 2007. Elijah Wostl and Tim Warfel. Photo verified by Lauren J. Livo. UCM Ancillary Collection 165. Found AOR after heavy afternoon rain. Southernmost record in Colorado and first Colorado record in the Dolores River drainage. Expands the known range ca. 53 km SSE of Glade Park, the nearest record in Mesa County (Weins and Titus 1991. Herpetologica 47:21–28).

Submitted by **ELIJAH WOSTL**, 9390 Perry Street, Westminster, Colorado 80031, USA; e-mail ewostl@gmail.com.

SYNCOPE ANTENORI (Ecuador Silent Frog/Dusky Pygmy Sheep Frog). PERÚ: MADRE DE DIOS: Manu: Los Amigos Conservation Concession, Los Amigos Research Center (12°34'S, 70°06'W, 270 m elev.). 25 February, 13 March, and 25 March 2007. R. Santa Cruz, R. Jennings, and R. von May. Museo de Historia Natural Universidad San Marcos, Lima, Perú (MHNSM 25854–56: juvenile 9.3 mm SVL; male 11.2 mm SVL; female 13.2 mm SVL). Verified by E. Lehr. Species previously known from the eastern parts of Amazonian Ecuador and Peru (Walker 1973. Occas. Pap. Mus. Nat. Hist. Univ. Kansas 20:1–7; Rodriguez and Duellman 1994. Univ. Kansas Mus. Nat. Hist. Spec. Publ. 22:1–80). The southernmost known locality for *Syncope antenori* was Cashiriari 3, Lower Urubamba, Cusco department (Icochea et al. 2001. *In* Alonso et al. [eds.], Urubamba: The Biodiversity of a Peruvian Rainforest, SI/MAB Biodiversity Program, pp. 129–142. Smithsonian Institution, Washington D.C.); the southernmost known locality for the genus *Syncope* (unidentified species) was Katarompanaki, in Zona Reservada Megantoni, Cusco department (Rodríguez and Catenazzi 2004. *In* Vriesendorp et al. [eds.], Perú: Megantoni, Rapid Biological Inventories Report 15, pp. 199–204. The Field Museum, Chicago, Illinois). First record for Madre de Dios department extends more than 200 km the southeastern distribution border. Although this species was predicted to occur in

Madre de Dios department (www.globalamphibians.org, species information and map of *Syncope antenori* distribution, accessed on 24 August 2007), no earlier voucher specimens were found (Rodríguez et al. 1993. Publ. Mus. Hist. Nat. UNMSM [A] 45:1–22; Duellman 2005. Cusco Amazonico: The Lives of Amphibians and Reptiles in an Amazonian Rainforest. Comstock Publishing Associates, Ithaca, New York. 433 pp.).

Submitted by **RUDOLF VON MAY**, Department of Biological Sciences, Florida International University, Miami, Florida, USA; **ROY SANTA CRUZ**, Facultad de Ciencias Biológicas, Universidad Nacional de San Agustín, Arequipa, Perú; and **RANDY D. JENNINGS**, Department of Natural Sciences, Western New Mexico University, Silver City, New Mexico, USA.

SYRRHOPHUS CYSTIGNATHOIDES (Rio Grande Chirping Frog). USA: TEXAS: San Jacinto Co.: US Hwy 190, S side of Hwy; 1 road mile W San Jacinto/Polk County line; 30°46'48.6"N, 95°10'24.4"W (WGS 84). TCWC 91795. 4 March 2007 by T. B. Cotten and L. A. Fitzgerald. Verified by T. J. Hibbitts. New county record (Dixon 2000. Amphibians and Reptiles of Texas. Texas A&M University Press, College Station. 421 pp.).

Submitted by **TAYLOR B. COTTEN** and **LEE A. FITZGERALD**, Department of Wildlife and Fisheries Sciences, Texas A&M University, 2258 TAMU, College Station, Texas 77843, USA.

TESTUDINES

APALONE SPINIFERA (Spiny Soft-shelled Turtle). USA: TEXAS: Caldwell Co.: Collected 6 miles S of Farm Road 713 on State Highway 304 (29°44'6.5"N, 97°24'34.9"W). 27 June 2006. TCWC 91318. Verified by Toby Hibbitts. New county record (Dixon 2000. Amphibians and Reptiles of Texas, Second ed., Texas A&M Univ. Press, College Station. 421 pp.). Partially fills the hiatus between Bastrop and Bexar counties. Specimen collected dead on paved road.

Submitted by **KJ LODRIGUE, JR.**, Texas A&M University, Department of Wildlife & Fisheries Sciences, College Station, Texas 77843-2258, USA; and **GRAHAM S. CRIGLOW**, Brazos Valley Museum of Natural History, 3232 Briarcrest Drive, Bryan, Texas 77802, USA.

CHELYDRA SERPENTINA (Snapping Turtle). USA: TEXAS: Eastland Co.: TX Hwy 36, 0.8 rd mi E Rising Star (jct US Hwy 183 and TX Hwy 36); 32°05'49.4"N, 98°56'58.8"W, 486 m elev. (NAD 83). TCWC 91967. 29 May 2007 by M. T. Hill and T. J. Hibbitts. Verified by H. L. Prestridge. New county record (Dixon 2000. Amphibians and Reptiles of Texas. Texas A&M University Press, College Station. 421 pp.).

Submitted by **MICHAEL T. HILL** and **TOBY J. HIBBITTS**, Texas Cooperative Wildlife Collection, Department of Wildlife and Fisheries Sciences, Texas A&M University, 2258 TAMU, College Station, Texas 77843, USA.

CHELYDRA SERPENTINA (Snapping Turtle). USA: TEXAS: Hill Co.: 6.1 rd km E Jct FM 934 and 933, off 934, 763 ft elev., J. R. Dixon II property. 06 June 2007. Collected by James R. Dixon II. Verified by Toby Hibbits. Texas Cooperative Wildlife Collection (TCWC 91964). Female with one egg in oviduct. New county record (Dixon 2000. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Publ. Texas A&M University Press. 421 pp.).

Submitted by **JAMES H. BELL**, Department of Biology, Texas State University, San Marcos Texas 78666, USA (e-mail: jhbell@txstate.edu); **JAMES R. DIXON**, Texas Cooperative Wildlife Collection, Texas A&M University, College Station, Texas 77843, USA; and **MICHAEL R. J. FORSTNER**, Department of Biology, Texas State University, San Marcos Texas 78666, USA (e-mail: mf@txstate.edu).

CHELYDRA SERPENTINA (Snapping Turtle). USA: TEXAS: Milam Co.: US Hwy 79, 3.2 km E Jct TX 36 (30.71888°N, 096.83958°W; WGS 84). 15 April 2007. Michele A. Gaston and Laura M. Villalobos. Verified by James R. Dixon. Texas Cooperative Wildlife Collection (TCWC 91873). Specimen found injured in the roadway. This is the first recorded occurrence of this species in Milam County (Dixon 2000. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press. 421 pp.).

Submitted by **MICHELE A. GASTON** (e-mail: mg45447@txstate.edu), **LAURA M. VILLALOBOS** (e-mail: lmvill@txstate.edu), and **MICHAEL R. J. FORSTNER** (e-mail: mf@txstate.edu), Department of Biology, Texas State University, San Marcos, Texas 78666, USA.

CHRYSEMYS PICTA BELLII (Western Painted Turtle). USA: NEBRASKA: Rock Co.: 9.7 km E Bassett off US 20 (DOR). 11 May 2007. C. T. McAllister. Verified by S. E. Trauth. Arkansas State University Herpetological Museum (ASUMZ 30709). New county record filling a distributional gap among Brown, Holt, and Keya Paha counties in the northern sandhills (Lynch 1985. Trans. Nebraska Acad. Sci. 13:33–57). It is only one of nine turtle species in Nebraska considered statewide in distribution (Lynch, *op. cit.*, p. 39, fig. 15; http://snrs.unl.edu/herpneb/turtle/basicturtlekey.html), although a few counties remain to be documented by voucher specimens.

Submitted by **CHRIS T. McALLISTER**, Department of Physical and Life Sciences, Chadron State College, Chadron, Nebraska 69337, USA; e-mail: cmcallister@csc.edu.

GRAPTEMYS ERNSTI (Escambia Map Turtle).USA: FLORIDA: Holmes Co.: Pea River, 0.15 mi S SR 2 (30°56'51.2"N, 85°50'35.4"W, WGS84, elev. 20.4 m). 01 September 2007. Christopher J. Lechowicz and John Archer. Verified by Kenneth L. Krysko. Florida Museum of Natural History (photographic voucher UF 151595). New county record and first record in the Choctawhatchee River drainage (Aresco and Shealy 2006. *In* P. A. Meylan [ed.], Biology and Conservation of Florida Turtles, pp. 273–278. Chelonian Research Monographs No. 3).

Submitted by **CHRISTOPHER J. LECHOWICZ,** Sanibel-Captiva Conservation Foundation, Sanibel, Florida 33957, USA (e-mail: clechowicz@sccf.org); and **JOHN ARCHER,** Medinah, Illinois 60157, USA (e-mail: j-archer@sbcglobal.net).

KINOSTERNON ARIZONENSE (Arizona Mud Turtle). USA: ARIZONA: Maricopa Co.: Sonoran Desert National Monument, Vekol Valley (32°39'45"N, 112°12'42"W) 619 m elev. 16 August

2006. Thomas R. Jones, Bruce D. Taubert, Mark L. Zornes, and Randall D. Babb. Verified by George Bradley. University of Arizona Museum (photo voucher by R. D. Babb; UAZ 56581-PSV). An adult male was found on the berm of a spreader dike that seasonally impounds flood waters (Branson 1956. J. Range Mgmt. 9:187–191). Limited attempts to trap additional individuals were unsuccessful. This is the northernmost record (new county record) and the only verified record for the Gila River drainage.

Iverson (1989. Southwest. Nat. 34:356–368) concluded that in the Arizona portion of its range *K.* [*flavescens*] *arizonense* was confined to two river basins, the Río Sonoyta and Río de la Concepción, which empty into the Gulf of California in NW Sonora, México. Although Iverson (*op. cit.*) mentioned an unconfirmed sighting in the Gila River drainage, none has been verified. One credible sight record from 1996 (Arizona Game and Fish Department Heritage Database Management System) is from the upper reaches of the Kaka Valley, Tohono O'odham Indian Reservation, 21 km SSW of the Vekol Valley site (Troy Corman, pers. comm.). The Kaka Valley drains into Kohatk Wash, and ultimately N into the Santa Cruz River, a Gila River tributary.

The southern end of Vekol Valley is separated from headwaters of the Kaka Valley and Kohatk Wash by a low elevation divide of less than a few meters, thus turtle movement into Vekol Valley from the south would not be unexpected.

We thank Cristina Jones, Lisa Bucci, Paul Moler, and Barry Mansell for assistance with trapping efforts.

Submitted by **THOMAS R. JONES**, **BRUCE D. TAUBERT**, **MARK L. ZORNES,** and **RANDALL D. BABB**, Arizona Game and Fish Department, 2221 West Greenway Road, Phoenix, Arizona 85023, USA. Current address for MLZ: Wyoming Game and Fish Department, Green River Region, 351 Astle Ave, Green River, Wyoming 82935, USA.

MESOCLEMMYS VANDERHAEGEI (NCN). ARGENTINA: CORRIENTES: Departamento Santo Tomé: Garruchos (28°92'59"S, 55°43'15"W). 21 January 2007. E. Etchepare. Colección Herpetológica de la Universidad Nacional del Nordeste, Corrientes, Argentina (UNNEC 9077; juvenile carapace, length 63.9 mm; plastron length 55.4 mm; shell depth 24.5 mm). Verified by M. Cabrera. *M. vanderhaegei* is distributed in the basin of Paraguay River from Cuibá, Mato Grosso, Brazil, through eastern Paraguay to northeastern Argentina (Bour and Zaher 2005. Pap. Avul. Zool. 45:298–311; Cei 1993. Reptiles del Noroeste, Nordeste y Este de la Argentina. Museo Regionale di Scienze Naturali, Monografía XIV, 949 pp.; Cei 1998. Las Tortugas Continentales de Sudamérica Austral, 114 pp.). Previously known in Argentina from Misiones and Santa Fe provinces (Cabrera, *op. cit.*). First province record, fills the gap between Arroyo Zaimán, Misiones (90 km NW from Garruchos) and Malabrigo, Santa Fe (300 km SW from Garruchos).

Submitted by **EDUARDO GABRIEL ETCHEPARE,** Anatomía Comparada de los Cordados, Laboratorio de Herpetología, Departamento de Biología, Facultad de Ciencias Exactas y Naturales y Agrimensura, Universidad Nacional del Nordeste. Av. Libertad 5470. CP 3400. Corrientes. Argentina; e-mail: eduardoetchepare@hotmail.com.

PSEUDEMYS TEXANA (Texas River Cooter). USA: TEXAS: Burnet Co.: Specimen was found about 3.2 km SW of the intersection of Ranch Road 2341 and County Road 114, at Val Montgomery's Revelle Park Ranch (30.78464°N, 98.35508°W, WGS84, 300 m elev.). 29 April 2007. Toby Hibbitts. Verified by Heather Prestridge. Texas Cooperative Wildlife Collection, TCWC 91808. First county record (Dixon 2000. Amphibians and Reptiles of Texas. 2nd Edition. Texas A&M Univ. Press, College Station, Texas, 421 pp.). Two other specimens were found on 15 March 2007: one intact shell (John H. Duvall-Jisha and James R. Dixon, TCWC 91852) and one decomposing entire specimen (Josie L. Duvall, TCWC 91853) were found about 1 km SSW of the intersection of US Highway 281 and Park Road 4, within an impounded tributary of Honey Creek, at the creek edge (30.68105°N, 98.26469°W, WGS84, 352 m elev.).

Submitted by **DIANA J. McHENRY**, Division of Biological Sciences, University of Missouri, Columbia, Missouri 65211, USA; **TOBY J. HIBBITTS**, **JAMES R. DIXON**, Department of Wildlife and Fisheries Sciences, Texas A&M University, College Station, Texas 77843, USA; and **MICHAEL R. J. FORSTNER**, Department of Biology, Texas State University, San Marcos, Texas 78666, USA; (e-mail: mf@txstate.edu).

TERRAPENE CAROLINA TRIUNGUIS (Three-toed Box Turtle). USA: ARKANSAS: Izard Co.: Found in a hayfield on private property off Co. Rd. 3, 4 km E of St. Hwy 9. UTM 15N 0597591E, 3987699N. 28 March 2007. Collected by M. B. Connior and I. Guenther. Arkansas State University Herpetological Museum (ASUMZ 30427). Caught by hand. Verified by Stanley E. Trauth. First county record (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. The University of Arkansas Press, Fayetteville, Arkansas. 421 pp.).

We thank K. Irwin and B. Sasse from the Arkansas Game and Fish Commission for support of our study, Y. and N. Whitehurst, M. and K. Smith, and R. and S. Smith for permission to conduct the study on their land, and S. Trauth for specimen verification and curatorial preparation. Thanks also to the ASU Wildlife Management Investigational Techniques class for installing the drift fences.

Submitted by **MATTHEW B. CONNIOR**, **IDUN GUENTHER**, and **THOMAS S. RISCH,** Department of Biological Sciences, Arkansas State University State University, Arkansas 72467, USA (e-mail: matthew.connior@smail.astate.edu).

TRACHEMYS SCRIPTA ELEGANS (Red-eared Slider). USA: FLORIDA: Palm Beach Co.: West Palm Beach, South Florida Water Management District Office, 3301 Gun Club Road (26°40'32"N, 80°05'40"W). 12 December 2006. Ellen M. Donlan. Hatchling collected by hand in a manmade pond while trying to enter a baited hoop trap. UF 150156. New county record (Meshaka et al. 2004. The Exotic Amphibians and Reptiles of Florida. Krieger Publishing Co., Malabar, Florida, 155 pp.). Eleven adults were also trapped here in six hoop traps on 12–13 December 2006. At the same pond, an adult male Ouachita Map Turtle (*Graptemys ouachitensis ouachitensis*) was trapped on 13 December 2006. Kevin M. Enge. UF 150157. Verified by Christopher J. Lechowicz. New state record but no evidence of reproduction. *Trachemys scripta elegans* is an introduced species in southeastern Florida,

where it is common in many canals, rock pits, lakes, and ponds in urban and suburban areas. However, it has only been reported from two of the Florida Keys, Monroe Co. (Butterfield et al. 1994. Herpetol. Rev. 25:81; Krysko and Sheehy 2005. Carib. J. Sci. 41:169–172; Meshaka et al., *op. cit.*), several sites in Miami-Dade Co. (Meshaka et al., *op. cit.*), and in Davie, Broward Co. (Johnston and Johnston 2003. Herpetol. Rev. 34:164).

We documented additional sites in Miami-Dade and Broward counties. In Miami-Dade County we trapped 28 adults (UF 146977, 147508–9); three adults (UF 146973–5); four adults (photographic voucher UF 150241; five adults and one juvenile (photographic voucher UF 150242); and six adults (UF 137005–8). In Broward County we trapped six adults (UF 150243).

Submitted by **KEVIN M. ENGE**, Florida Fish and Wildlife Conservation Commission (FWC), 4005 South Main Street, Gainesville, Florida 32601, USA (e-mail: kevin.enge@myfwc.com); **ELLEN M. DONLAN**, South Florida Water Management District, 3301 Gun Club Road, West Palm Beach, Florida 33406, USA ; **CLINTON P. SMITH**, FWC, 8535 Northlake Boulevard, West Palm Beach, Florida 33412, USA; **DAVID G. COOK**, FWC, 620 South Meridian Street, Tallahassee, Florida, 32399, USA; **PAUL E. MOLER**, FWC, 4005 South Main Street, Gainesville, Florida 32601, USA; and **KENNETH L. KRYSKO**, Florida Museum of Natural History, Division of Herpetology, University of Florida, Gainesville, Florida 32611, USA.

AMPHISBAENIA

AMPHISBAENA FULIGINOSA WIEDI. BRAZIL: MINAS GERAIS: Municipality of João Pinheiro (area of "Cerrado" biome): Salobo farm (17°45'39.8"S, 46°11'39.5"W; 727 m elev.). December 2006. A. L. Silveira. Museu Nacional, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil (MNRJ 14633–14634). João Pinheiro: Gameleira farm (17°40'37.5"S, 46°11'04.0"W; 718 m elev.). 1996. A. L. Silveira. Museu Nacional (MNRJ 11331). Verified by R. Fernandes. This subspecies occurs in Brazil south of the Amazonas River, to the latitude of the upper Tocantins River, and was previously recorded from a single locality in the Atlantic Forest (Bahia state: Santa Maria Eterna; type locality of *A. f. wiedi*), two localities in the "Cerrado" central (Goiás state: Mesa mountain range and Piracanjuba municipality), and two localities in transition area between Amazonia and Cerrado (Maranhão state: Açailândia municipality; Mato Grosso state: Aripuanã municipality) (Vanzolini 2002. An. Acad. Bras. Cienc. 74[4]:609–648). First state record and the meridional limit of its known distribution, ca. 300 km ESE from the closest previous record (Brazil: Goiás state: Piracanjuba; MZUSP 80223) (Vanzolini, *op. cit.*).

Submitted by **ADRIANO LIMA SILVEIRA,** Setor de Herpetologia, Departamento de Vertebrados, Museu Nacional, Universidade Federal do Rio de Janeiro, Quinta da Boa Vista, São Cristóvão, CEP 20940-040, Rio de Janeiro, RJ, Brazil; e-mail: biosilveira@yahoo.com.br.

LACERTILIA

ALEXANDRESAURUS CAMACAN. BRAZIL: BAHIA: Municipality of São Sebastião do Passé, Timbó farm (12°28'07"S, 38°22'35"W; 50 m elev.). 15 December 2001. M. A. de Freitas and L. Moysés. Museu de Zoologia da Universidade Estadual de Feira de Santana, Bahia, Brazil (LAPH/UEFS 358). Verified by M. Rodrigues. Previously known from Una municipality, Bahia, Brazil (Rodrigues et al. 2007. Amer. Mus. Novitates 3565:1–27). New record from northeastern Bahia, Brazil, extends known distribution ca. 330 km N of Una municipality, Bahia (Rodrigues et al. 2007, *op. cit.*).

Submitted by **MARCO ANTÔNIO DE FREITAS,** Programa de Pós-graduação em Zoologia, UESC (Universidade Estadual de Santa Cruz) CEP 46.500-000 Rodovia Ilhéus/Itabuna, Ilhéus, Bahia, Brazil (e-mail: philodryas@hotmail.com**)**; **THAÍS FIGUEIREDO SANTOS SILVA,** Biogeographia publicações e consultoria ambiental, Rua E quadra D lote 11, Jardim Aeroporto, CEP 42700-000, Lauro de Freitas, Bahia, Brazil (e-mail: åthaisfsilva@hotmail.com); and **ELBANO PASCHOAL DE FIGUEIREDO MORAES,** Grupo Ambientalista da Bahia (GAMBÁ), Av Juracy Magalhães Jr n 768, sala 102, Rio Vermelho, CEP 419400-000, Salvador, Bahia, Brazil **(**e-mail: pasch@svn.com.br).

ANOLIS CAROLINENSIS (Green Anole). USA: TEXAS: Burnet Co.: 500 m E of Hwy 281 and 9.4 km N of Marble Falls (30°40.730'N, 98°15.834'W). 25 May 2007. Daniela Buzo, Michele A. Gaston, Julie A. Parlos, James R. Dixon, and Michael R. J. Forstner. Verified by Toby Hibbits. Texas Cooperative Wildlife Collection (TCWC 91817). SVL 54 mm, tail 100 mm. This female specimen represents the first recorded occurrence for the county.

Submitted by **[1]DANIELA BUZO** (e-mail: db1243@txstate.edu), **[1]MICHELE A. GASTON**, **[1]JULIE A. PARLOS**, **[2]JAMES R. DIXON**, and **[1]MICHAEL R. J. FORSTNER**, [1]Department of Biology, Texas State University, San Marcos Texas 78666, USA; [2]Texas Cooperative Wildlife Collection, Texas A&M University, College Station, Texas 77843,USA.

ANOLIS EQUESTRIS (Knight Anole). USA: FLORIDA: Brevard Co.: 4310 MacTavish Street, Cocoa (28°27'56.24"N, 81°47'27.00"W). 03 June 2007. Diane M. Coben. Two adults were observed mating in a tree in the backyard of a residence in the Port St. John area. Verified by Kenneth L. Krysko. Florida Museum of Natural History photo voucher (UF 150871). New county record. Extends range ca. 134 km N of the closest known locality in St. Lucie Co. (Krysko et al. 2005. Herpetol. Rev. 36:85–87). An individual was also observed here in 2006.

Submitted by **KEVIN M. ENGE**, Florida Fish and Wildlife Conservation Commission, 4005 South Main Street, Gainesville, Florida 32601, USA (e-mail: kevin.enge@myfwc.com); and **DIANE M. COBEN**, 4310 MacTavish Street, Cocoa, Florida 32927, USA; (e-mail: diane.coben@pwr.utc.com).

ANOLIS SAGREI (Brown Anole). USA: FLORIDA: Leon Co.:, Tallahassee, Tallahassee Nurseries, 2911 Thomasville Road (30.48316°N, 84.25693°W). 23 May 2007. Dale R. Jackson. Verified by Kenneth L. Krysko. Florida Museum of Natural History: adult male (UF 151203, 59 mm SVL) and three adult females (UF 151200–151202, 46–47 mm SVL); these were among nine individuals, including three adult males, observed during a 1-h search from 1200–1300 h EST. First vouchered records for county although past sightings of the species elsewhere in the vicinity have

been made (K. Enge, K. Krysko, pers. comm). I have not observed the species at this site in past years. All individuals observed were within a 45-m radius centered around a single shed and adjacent greenhouse on the 6-ha property, this suggests that the introduction was recent. I examined reproductive tracts of two of the females; one contained a single shelled egg, and the second a shelled and an unshelled egg. All three females bore small dewlaps colored as in males.

This is only the fourth documented record for the "Panhandle" (Means 1990. Herpetol. Rev. 21:96; Means 1996. Herpetol. Rev. 27:151–152; Townsend et al. 2002. Herpetol. Rev. 33:75; Meshaka 2004. The Exotic Amphibians and Reptiles of Florida. Krieger Publ. Co., Malabar, Florida. 155 pp.) and the most inland of these (43 km from coast), although several localities further north in Georgia have been recorded (J. Jensen, pers. comm.). The species' widespread distribution has been attributed in large part to incidental dispersal among ornamental plants via the nursery industry as well as to vehicular transport (Meshaka, *op. cit.*). Both of the occurrences reported by Means (*op. cit.*) from west of Leon Co. exhibited high winter mortality. However, the presence of buildings and greenhouses at the present site, coupled with gravid females, suggests the potential for long-term viability. If so, possible effects on *A. carolinensis*, which was observed microsympatrically and upon which *A. sagrei* is known to feed (Meshaka, *op. cit.*), will be of interest.

Submitted by **DALE R. JACKSON**, Florida Natural Areas Inventory, Florida State University, 1018 Thomasville Road, Suite 200-C, Tallahassee, Florida 32303, USA; e-mail: djackson@fnai.org.

ASPIDOSCELIS LINEATTISSIMA (Many-lined Whiptail). MÉXICO: COLIMA: Isla Peña Blanca. 9 February 2007. Jaime Lúevano, Eric Mellink, and Mónica Riojas-López. Verified by Luis Canseco-Márquez. Colección Herpetológica, Museo de Zoología, Facultad de Ciencias, UNAM (MZFC 20090). First record for the island. The species is known elsewhere from lowlands of the adjacent mainland from Nayarit to Colima (García and Ceballos. 1994. Field Guide to the Reptiles and Amphibians of the Jalisco Coast, Mexico. Fundación Ecológica de Cuixmala, A.C. and Instituto de Biología, U.N.A.M, Mexico D.F. 184 pp.). The species is especially common amid rocky outcrops located on highest portion of the island.

Submitted by **ERIC MELLINK** (e-mail: emellink@gmail.com) and **JAIME LUÉVANO**, Centro de Investigación Científica y de Educación Superior de Ensenada, B.C., Carretera Tijuana-Ensenada Km. 107, 22800 Ensenada, B.C., México; and **MÓNICA E. RIOJAS-LÓPEZ**, Centro Universitario de Ciencias Biológicas y Agropecuarias, Universidad de Guadalajara, Km. 15.5 carretera a Nogales, 45100 Zapopan, Jalisco, México.

ASPIDOSCELIS TIGRIS MUNDA (California Whiptail). USA: CALIFORNIA: Plumas Co.: North Fork Feather River Canyon at Rock Creek, along north edge of unnamed dirt road 0.9 mi. NE of intersection with Highway 70 (39.90480°N, 121.35609°W; datum: WGS84; 695 m [2280 ft.] elev.). An adult female (California Academy of Sciences 237055; 69.7 mm SVL; 136.2 mm TL; 8.3 g [preserved weight]) . 22 June 2007 at 1434 h. New county record (Koo and Vindum 1999. Amphibians and Reptiles of the Plumas National Forest: Historical Collections and California Academy of Sciences 1998 and 1999 Surveys. Unpubl. report on file, Department of Herpetology, California Academy of Sciences. San Francisco, California). In neighboring Butte County, *A. tigris munda* is found between 200–650 m (656–2133 ft.) elevation in chaparral and mixed chaparral-foothill woodlands (Hayes and Cliff 1982. Herpetol. Rev. 13:85–87), and has been documented in the North Fork Feather River Canyon along the right bank just upstream of the confluence with Bear Ranch Creek (39.8439°N, 121.3968°W; pers. obs.), near the intersection of Cedar Creek and the railroad tracks (39.8434°N, 121.4063°W; pers. obs.), and adjacent to an unnamed tributary along the railroad tracks (39.8431°N, 121.4096°W; CAS 235786).

Submitted by **KEVIN D. WISEMAN,** Garcia and Associates (GANDA), 2601 Mission Street, Suite 600, San Francisco, California 94110, USA (e-mail: kwiseman@garciaandassociates.com); and **JENS V. VINDUM,** Department of Herpetology, California Academy of Sciences, 875 Howard Street, San Francisco, California 94103, USA.

ASPIDOSCELIS SEXLINEATUS (Six-lined Racerunner). USA: MISSOURI: St. Francois Co.: Pond adjacent to Indian Creek Road, northeast of Iron Mountain Lake (37°42'50.5"N, 90°35'48.3"W). A clear photo was taken prior to a failed attempt to capture the lizard. 11 July 2007. Tony Gamble and Eli Greenbaum. Verified by Greg Watkins-Colwell. YPM Herp Media collection No. 1188. Fills a distributional gap in southeastern Missouri (Johnson 2000. The Amphibians and Reptiles of Missouri, Second ed. Missouri Dept. of Conservation. Jefferson City. 200 pp.). First county record with specific locality data (Daniel and Edmond. 6 February 2006. Atlas of Missouri Amphibians and Reptiles for 2005. http://atlas.moherp.org/, Accessed 25 July 2007).

Submitted by **TONY GAMBLE**, Bell Museum of Natural History, University of Minnesota, 100 Ecology, 1987 Upper Buford Circle, St. Paul, Minnesota 55108, USA (e-mail: gambl007@umn.edu); and **ELI GREENBAUM,** Department of Biology, Villanova University, Villanova, Pennsylvania 19085, USA (e-mail: eli.greenbaum@villanova.edu).

CHAMAELEO AFRICANUS (African Chamaeleon). MAURITANIA: TRARZA REGION: Boû Tâfrâouat (17°05'N, 16°04'W). 30 August 2006. Mohamed Ould Salem. Institut de Recherche pour le Développement at Dakar (IRD TR 2166–2167). Verified by Youssouph Mané. Second record for Mauritania. Two specimens found in acacia trees. Extends range ca. 100 km N from Diawling National Park where it was cited without reference to specific locality or voucher information (Nickel 2003. Ökologische Untersuchungen zur Wirbeltierfauna im südöstlichen Mauretanien. GTZ, Echborn, 89 pp.; Padial 2006. Graellsia 62:159–178). Before these records, the westernmost locality in Africa for this species was 18 km NNE Didieni in Mali (14°05'N, 08°02'W), i.e., ca. 920 km E of Mauritania (Joger and Lambert 1996. *In* Ulrich [ed.], Tropical Biodiversity and Systematics. Proceeding of the International Symposium on Biodiversity and Systematics in Tropical Ecosystems, Bonn, 1994. Zoologisches Forschunginstitut und Museum Alexander Koening, Bonn, pp. 189–202). These records provide evidence for the continuous distribution of *C. africanus* south of the Sahara in the Sahel savannah from Sudan to the At-

lantic Ocean.

Submitted by **SEBASTIEN TRAPE**, Laboratoire ECOLAG, Institut de Recherche pour le Développement (IRD, UR 70) and Université Montpellier II, 34095 Montpellier Cedex 5, France; e-mail: sebastien_trape@yahoo.fr.

COLEODACTYLUS AMAZONICUS. BOLIVIA: DEPARTMENT PANDO: Federico Román Province: Río Negro (09°50'S, 65°39,W; 115 m elev.). 8 November 2002. L. Gonzales. Museo de Historia Natural Noel Kempff Mercado, Santa Cruz, Bolivia (MNKR 4316). Puerto Abuná (09°47'15.8"S, 65°32'00.5"W; 98 m elev.). 2 November 2006. A. Muñoz. Museo de Historia Natural Pedro Villalobos, Pando, Bolivia (MHNPV-R 405). Verified by J. Aparicio. Specimens found in the leaf litter in forest, active during the day. Previously known from eastern and central Amazonia in Brazil, French Guiana, Suriname, southern Guyana, and southern Venezuela (Avila-Pires 1995. Zoologische Verhandelingen 299:1–706). First country records extend known distribution 215 km E from Seringal Catuaba, 23 km E of Rio Branco in Brazil, the nearest record known (Avila-Pires, *op. cit.*).

Submitted by **LUCINDO GONZALES ALVAREZ**, Museo de Historia Natural Noel Kempff Mercado, Casilla postal 2489, Santa Cruz-Bolivia (e-mail: bichos10@hotmail.com); and **ARTURO MUÑOZ SARAVIA**, Museo de Historia Natural Alcide d'Orbigny, Casilla Postal 843, Cochabamba-Bolivia (e-mail: hyla_art@yahoo.com).

GEHYRA MUTILATA (Stump-toed Gecko). MÉXICO: NAYARIT: Isla Isabel (21°51'7"N, 105°53'12"W), 25 m elev. 16 July 1993. Adrián Quijada-Mascareñas. Verified by Oscar Flores-Villela. Museo de Zoología, Facultad de Ciencias, UNAM (MZFC-5838). First record for island. Closest known locality is from mainland Nayarit (Flores-Villela 1993. Carnegie Mus. Nat. Hist. Spec. Publ. [17]:1–73). The lizard was found on the trunk of a ruache tree, *Crataeva tapia*.

Submitted by **ADRIÁN QUIJADA-MASCAREÑAS**, Facultad de Biología, Universidad Michoacana de San Nicolás de Hidalgo (UMSNH), Ciudad Universitaria, Morelia 58030, Michoacán, México (e-mail: adrianquijada@hotmail.com); and **LUIS CANSECO-MARQUEZ**, Museo de Zoología, Facultad de Ciencias, Universidad Nacional Autónoma de México, A.P. 70-399, México, D.F. 04510.

HEMIDACTYLUS BOUVIERI (Bouvier's House Gecko). CAPE VERDE: ILHEO SÃO NICOLAU: Ribeira Funda Valley, 250 m elev. (16°40'2.5"N, 24°20'35.1"W). 01 April 2007. G. Köhler. Verified by K. Klemmer. Forschungsinstitut und Naturmuseum Senckenberg (SMF 86991). First record for Ilheo São Nicolau (Schleich 1987. Spixiana Suppl. 12:1–75; Jesus et al. 2001. J. Herpetol. 35:672–675).

Submitted by **GUNTHER KÖHLER** (e-mail: gkoehler@senckenberg.de), **ANDREAS HERTZ, JAVIER SUNYER**, Forschungsinstitut und Naturmuseum Senckenberg, Sektion Herpetologie, Senckenberganlage 25, D-60325 Frankfurt a.M., Germany; and **ALINE MONTEIRO**, National Institut for Research and Agriculture Development (INIDA), BP 84 – Praia, Santiago, Cabo Verde.

HEMIDACTYLUS GARNOTII (Indo-Pacific Gecko). USA: FLORIDA: Bay Co.: Ca. 3 km ESE Southport on E side Hwy 2321 (30°16'37"N, 85°36'28"W). 07 June 2005. John G. Himes. Juvenile collected on outside wall of building at 2230 h. FLMNH 144335. Verified by Kenneth L. Krysko. First record from the Florida panhandle and extends range ca. 320 km W of nearest record (Baker Co., Florida; Townsend and Krysko 2003. Florida Sci. 66:204–208). Three adults were also observed on outside walls and one adult inside building.

Submitted by **JOHN G. HIMES**, Florida Fish and Wildlife Conservation Commission, 3911 Hwy 2321, Panama City, Florida 32409, USA (e-mail: john.himes@myfwc.com); and **KEVIN M. ENGE**, Florida Fish and Wildlife Conservation Commission, 5300 High Bridge Road, Quincy, Florida 32351, USA.

HEMIDACTYLUS MABOUIA (Amerafrican House Gecko). USA: FLORIDA: Hillsborough Co.: Ruskin, I-75, Rest Area (27°40'56.64"N, 82°25'15.096"W, Datum WGS84, elev. 6.7 m). 08 August 2007. Kenneth L. Krysko and Brian J. Camposano. UF 151458–59. Verified by Kevin M. Enge. New county record (Townsend and Krysko 2003. Florida Sci. 66:204–208). Six other juveniles and adults observed near lights on walls.

Submitted by **KENNETH L. KRYSKO** and **BRIAN J. CAMPOSANO**, Florida Museum of Natural History, Division of Herpetology, University of Florida, Gainesville, Florida 32611, USA.

HEMIDACTYLUS TURCICUS (Mediterranean House Gecko). USA: GEORGIA: Baker Co.: On Coon Pond Road, 0.4 miles S of intersection with State Route 37 (NAD 83, UTM Zone 16N, E 748656.451 N 3468173.734). 03 March 2007. Matthew P. Greene. Verified by John Jensen. Four geckos observed among mobile home debris following a tornado touchdown on 02 March 2007.One individual deposited at Auburn University Natural History Museum (AUM 37433). New county record for this non-native species. Closest records are from Thomasville in Thomas County, Georgia ca. 70 km to the SE (Jensen et al. 2008. Amphibians and Reptiles of Georgia, *in press*).

Submitted by **MATTHEW P. GREENE, ERIN WILICHOWSKI**, **ANDY W. WHELAN**, and **J. LEIGHTON REID,** Joseph W. Jones Ecological Research Center, Rural Route 2, Box 2324, Newton, Georgia 39870, USA (e-mail: mgreene@jonesctr.org).

HEMIDACTYLUS TURCICUS (Mediterranean House Gecko). USA: TEXAS: Calhoun Co.: LaSalle Ranch, 2.09 road km W of FM 1289 on TX 185 (28°25'14.0"N, 96°32'58.7"W). 16 May 2007. D. Laurencio, J. A. Holm. Verified by James R. Dixon. Texas Cooperative Wildlife Collection, TCWC 91814. New county record (Dixon 2000. Amphibians and Reptiles of Texas. 2nd ed. Texas A&M University Press, College Station, Texas. 421 pp.). A second county record (TCWC 91815) was collected on 16 May 2007.

Submitted by **DAVID LAURENCIO,** Texas Cooperative Wildlife Collection, Department of Wildlife and Fisheries Sciences, 2258 TAMU, Texas A&M University, College Station, Texas 77843-2258, USA (e-mail: norops@tamu.edu); and **JAMES A. HOLM,** Crouch Environmental Services, Inc., 402 Teetshorn, Houston, Texas 77009, USA.

HEMIDACTYLUS TURCICUS (Mediterranean Gecko). USA: TEXAS: BURLESON CO.: Specimen collected south of Lake Somerville, Texas, under a rock on the shore of Lake Somerville and adjacent to Welch Park. Collected by KJ Lodrigue, Jr., and Graham S. Criglow (30°20'26"N, 96°32'55"W) on 18 April 2007. TCWC 91807. Verified by Toby Hibbitts. New county record (Dixon 2000. Amphibians and Reptiles of Texas, Second ed., Texas A&M University Press, College Station, Texas. 421 pp.). Fills in the hiatus between Brazos and Lee counties.

Submitted by **KJ LODRIGUE, JR.**, Texas A&M University, Department of Wildlife & Fisheries Sciences, College Station, Texas 77843-2258, USA.

HEMIDACTYLUS TURCICUS (Mediterranean House Gecko). USA: TEXAS: MATAGORDA CO.: Palacios, 1.1 road km N of Business 35 on TX 35 (28°43'27.0"N, 96°12'36.7"W). 26 June 2007. D. Laurencio, J. T. Williams. Verified by Toby J. Hibbitts. Texas Cooperative Wildlife Collection, TCWC 92437. New county record (Dixon 2000. Amphibians and Reptiles of Texas. 2nd ed. Texas A&M University Press, College Station, Texas. 421 pp.).

Submitted by **DAVID LAURENCIO** (e-mail: norops@tamu.edu) and **JOHN T. WILLIAMS**, Texas Cooperative Wildlife Collection, Department of Wildlife and Fisheries Sciences, 2258 TAMU, Texas A&M University, College Station, Texas 77843-2258, USA.

HOLBROOKIA PROPINQUA PROPINQUA (Northern Keeled Earless Lizard). USA: TEXAS: CALHOUN CO.: Matagorda Island, Aransas/Matagorda National Wildlife Refuge Complex (28°04'44.98"N, 096°50'02.94"W), 1 m elev. 26 June 2007. Peter Keller. Verified by Toby Hibbitts, Texas A&M University Texas Cooperative Wildlife Collection (TCWC 92458). New county/refuge record (Dixon 2000. Amphibians and Reptiles of Texas. 2nd ed. Texas A&M University Press, College Station, Texas. 421 pp.) Adult female specimen found active by day among the gulf beach primary dunes at the southern tip of Matagorda Island, and measured 55.5 mm SVL, tail 64.0 mm, weight 5.0 g. Several adults were observed at this location. Vegetation at the collection site consisted of Marshhay Cordgrass, Gulfdune Paspalum, Evening Primrose, and Fiddleleaf Morning Glory. We speculate that the appearance of *H. p. propinqua* on Matagorda Island is the result of the temporary closing of Cedar Bayou. This closing allowed the formation of a land bridge between Matagorda and San Jose islands where *H. p. propinqua* is a common species.

Submitted by **SHAWN F. McCRACKEN**, Texas State University, Department of Biological Sciences, 601 University Drive, San Marcos, Texas 78666-4615, USA (e-mail: smccracken@txstate.edu); **CHAD STINSON**, Aransas National Wildlife Refuge, 213 Royal Oak Drive, Rockport, Texas 78382, USA; **PETER KELLER**, Aransas National Wildlife Refuge, P.O. Box 294, Austwell, Texas 77950, USA; and **MICHAEL R.J. FORSTNER**, Texas State University, Department of Biological Sciences, 601 University Drive, San Marcos, Texas 78666-4615, USA.

LEIOCEPAHLUS CARINATUS (Northern Curly-tailed Lizard). USA: FLORIDA: MONROE CO.: Ramrod Key, 27338 St. Vincent Lane (24°39'31.248"N, 81°24'22.3956"W, Datum WGS84). 08 August 2007. Kenneth L. Krysko and Andrew P. Borgia. UF 151455. New island record (Meshaka et al. 2006. J. Kansas Herpetol. 17:6). Adult collected on limestone boulder. Four juveniles and three other adults were observed on boulders and Buttonwood Trees (*Conocarpus erectus*) on three adjacent properties, suggesting that this species is reproducing. Little Torch Key, 565 Barry Avenue (24°40'25.65119"N, 81°23'16.3608"W, Datum WGS84). 08 August 2007. Kenneth L. Krysko and Andrew P. Borgia. UF 151455. New island record. Juvenile collected on umbrella tree (*Schefflera actinophylla*). This species has been observed at this site since at least 2004. Specimens verified by Brian J. Camposano.

Submitted by **KENNETH L. KRYSKO**, Florida Museum of Natural History, Division of Herpetology, University of Florida, Gainesville, Florida 32611, USA; and **ANDREW P. BORGIA**, P.O. Box 4346, Key West, Florida 33041, USA.

SCELOPORUS LINEOLATERALIS (NCN). MÉXICO: COAHUILA: Municipalty of Torreón: Sierra de Jimulco, ca. 5 km NE of La Flor de Jimulco (25°06'52"N, 103°16'43" W), 1647 m elev. 19 August 2006. Gamaliel Castañeda-Gaytán. Verified by Edmundo Perez-Ramos. Colección Herpetológica del Museo de Zoología Alfonso L. Herrera, Facultad de Ciencias, UNAM (MZFC 19972). The specimen was found in a canyon covered by Chihuahuan Desert scrub vegetation. New state record, extending the known range of this species ca. 40 km (airline) SE of the type locality, 6 mi. NE Pedriceña, Durango (Smith 1936. Proc. Biol. Soc. Washington 49:87–96; Wiens et al. 1999. Evolution 53:1884–1897). This species was recently elevated from a subspecies of *S. jarrovii* (Bell et al. 2003. Acta Zool. Mexicana [n.s.] 90:103–174).

Submitted by **GAMALIEL CASTAÑEDA-GAYTÁN,** Reserva Ecológica Municipal Sierra y Cañón de Jimulco; BIODESERT, A.C. calle Blanco 35 Int. 1. Col. Centro. Torreón, Coahuila, México (e-mail: gamaliel.cg@gmail.com); **CRISTINA GARCÍA-DE LA PEÑA,** Universidad Autónoma de Nuevo León, San Nicolás de los Garza, Nuevo León, México; **URI OMAR GARCÍA-VAZQUEZ,** Museo de Zoología, Facultad de Ciencias, UNAM, A.P. 70-399, México D.F.; and **JOSUE ESTRADA ARELLANO,** Universidad Juárez del Estado de Durango, Av. Universidad s/n., Gómez Palacio, Durango, México.

SERPENTES

ATRACTUS ZIDOKI. GUYANA: Potaro-Siparuni District, talus slope of Mt. Roraima beneath its northernmost promontory called "The Prow." (05°15'30"N, 60°43'30"W), ca. 2090 m elev. 08 April 2003. D. B. Means, J. Rivas, and M. Mayor. Verified by R. W. McDiarmid. Centre for the Study of Biological Diversity, University of Guyana Museum, Georgetown, Guyana (HR 701), plus 5 photographs deposited in the Florida Museum of Natural History, Gainesville, Florida (UF 150240). Found crawling on peaty soil of the El Dorado Swamp (MacInnes 1974. Climb to the Lost World. Hodder and Stoughton, London) across a recently cut footpath in tepui cloud forest dominated by small trees of *Bonnetia roraimae* with a dense groundcover of *Brocchinia tatei* tank bromeliads. Previously known from Amazonian Colombia, eastern Amazonia of Brazil, Suriname, and French Guiana. First country record, extends range about 450 km E of the closest known locality in Suriname and fills the distributional gap between Surinam on the

east and Colombia on the west (Hollowell and Reynolds [eds.] 2005. Bull. Biol. Soc. Washington 13:1–109; Hoogmoed 1980. Zoologische Verhandelingen, [175]:1– 47; Silva 2004. Rev. Acad. Colomb. Cienc. 28[108]:409–446).

Submitted by **D. BRUCE MEANS**, Coastal Plains Institute and Land Conservancy, 1313 Milton Street, Tallahassee, Florida, 32303, USA.

BOTHRIECHIS SUPRACILIARIS (Blotched Palm Viper). PANAMÁ: CHIRIQUI: Finca Santa Clara (Finca Hartmann) (08°51'N, 82°45'W), ca. 1300 m elev. 17 July 1980. Mrs. Hartmann. Verified by C. W. Meyers. AMNH 147743. First record from Panamá and a range extension of ca. 21 km SE of its closest known locality in adjacent Puntarenas, Costa Rica (Solórzano et al. 1998. Rev. Biol. Trop. 46:453–462). The snake was found in a coffee plantation.

Submitted by **JUAN E. DEJESUS**, Department of Herpetology, American Museum of Natural History, Central Park West at 79th St., New York, New York 10024-5192, USA; e-mail: Dejesus@amnh.org.

BOTHROPS JARARACA (Jararaca). BRAZIL: BAHIA. Municipalities of Ibicoara (12°24'S, 41°17'W), October 2001; Palmeiras (12°31'S, 41°33'W) August 2003; and Miguel Calmon (11°25'S, 40°35'W), November 2006. Collectors unknown. Verified by F. L. Franco. Coleção Científica de Serpentes do Museu de Zoologia da Universidade Federal da Bahia, Salvador, Bahia, Brazil (UFBA 1295, 1658, 1774–76, 1822). Species previously known from northeastern Paraguay, northeastern Argentina, and eastern Brazil from states of Rio Grande do Sul, Santa Catarina, Paraná, Mato Grosso do Sul, São Paulo, Rio de Janeiro, Espírito Santo, Minas Gerais, and Bahia (Sazima 1992. *In* Campbell and Brodie [eds.], Biology of the Pitvipers, pp. 199–216. Selva, Tyler, Texas; Campbell and Lamar 2004. The Venomous Reptiles of the Western Hemisphere. Cornell University Press, Ithaca, New York; Puorto et al. 1992. Resumos do XVII Congresso Brasileiro de Zoologia: 442; Oliveira and Argôlo 2004. As Serpentes dos Cacauais do Sudeste da Bahia. Ilhéus, Editus). Northernmost record for the species, extends range ca. 205 km N from Amélia Rodrigues, the northernmost locality (Lira-Da-Silva et al. 2000. Livro de Resumos do 1º Simpósio da Sociedade Brasileira de Herpetologia, 2000. p. 65).

Submitted by **BRENO HAMDAN** (e-mail: brenohamdan@gmail.com), **REJÂNE MARIA LIRA-DA-SILVA**, Núcleo Regional de Ofiologia e Animais Peçonhentos da Universidade Federal da Bahia; and **MARCELO FELGUEIRAS NAPOLI**, Laboratório de Taxonomia e História Natural de Anfíbios da Universidade Federal da Bahia, Rua Barão de Geremoabo, 147 - Campus de Ondina, CEP 40170-290, Salvador, Bahia, Brazil.

COLUBER CONSTRICTOR FLAVIVENTRIS (Eastern Yellow-bellied Racer). USA: ARKANSAS: Izard Co.: Found in a hayfield on private property off Co. Rd. 3, 4 km E of St. Hwy 9. UTM 15N 0597627E, 3987505N. 2 June 2007. Collected by M. B. Connior and I. Guenther. Arkansas State University Herpetological Museum (ASUMZ 30724). Caught in a drift fence funnel trap. Verified by Stanley E. Trauth. First county record (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville, Arkansas. 421 pp.).

We thank the following individuals: K. Irwin and B. Sasse, Arkansas Game and Fish Commission for support of our study; Y. and N. Whitehurst, M. and K. Smith, and R. and S. Smith for permission to conduct the study on their land; and S. Trauth for specimen verification and curatorial preparation. Thanks also to the ASU Wildlife Management Investigational Techniques class for installing the drift fences.

Submitted by **MATTHEW B. CONNIOR** (e-mail: matthew.connior@smail.astate.edu), **IDUN GUENTHER**, and **THOMAS S. RISCH,** Department of Biological Sciences, Arkansas State University State University, Arkansas 72467, USA.

CROTALUS HORRIDUS (Timber Rattlesnake). USA: ARKANSAS: Johnson Co.: 35°38.815'N, 93°31.307'W elev. 520 m. 03 October 2006. Glenn J. Manning. University of Kansas Natural History Museum (KU CT 12018–12020). Verified by John E. Simmons. This male was seen crossing the road at 2015 h. First county record (Trauth et al. 2004 The Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville. 421 pp.).

Submitted by, **GLENN J. MANNING,** Department of Biology, University of Arkansas, 601 SCEN, Fayetteville, Arkansas 72701, USA; e-mail: gmannin@uark.edu.

CROTALUS HORRIDUS (Timber Rattlesnake). USA: ARKANSAS: Van Buren Co.: Rumley Rd. near U.S. Hwy 65 along Middle Fork of Little Red River 35.7875°N, 92.5319°W. 19 July 2006. David M. Hayes. Verified by Brian P. Butterfield. Arkansas State University Museum of Zoology Herpetology Collection (ASUMZ 30222). One adult DOR collected. First county record (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville. 421 pp.).

Submitted by **JONATHAN W. STANLEY** (e-mail: jonathanw.stanley@smail.astate.edu) and **STANLEY E. TRAUTH**, Department of Biological Sciences, P.O. Box 599, State University, Arkansas 72467, USA (e-mail: strauth@astate.edu).

CROTALUS SCUTULATUS SALVINI (Humantlan Rattlesnake). MÉXICO: QUERÉTARO: Municipio el Marquez, Zona Industrial Bernardo Quintana (20°33'58"N, 16°18'48"W), 1900 m elev. 03 January 2001. M. Domínguez-Laso and U. Padilla-García. Verified by Javier Alvarado-Diaz. Colección de Anfibios y Reptiles de la Universidad Autónoma de Querétaro (HUAQ 044–045). First record for Municipio el Marquez, and extends range ca. 45 km SE from Cadereyta, Querétaro (Dixon et al. 1972. Southwest. Nat. 16:225–237).

Submitted by **MATIAS DOMÍNGUEZ-LASO,** Herpetario de la Universidad Autónoma de Querétaro, Centro Universitario s/n, Cerro de las Campanas, Querétaro, Qro. CP 76010, México; **ULISES PADILLA-GARCÍA,** Facultad de Ciencias Naturales, Universidad Autónoma de Querétaro, Avenida de las Ciencias s/n, Juriquilla, Querétaro 76230, México; **EDMUNDO PÉREZ-RAMOS,** Museo de Zoología "Alfonso L. Herrera" Facultad de Ciencias UNAM 70399 México D. F.; and **ADRIAN QUIJADA-MASCAREÑAS,** Facultad de Biología, Universidad Michoacana de San Nicolás de Hidalgo, Morelia 58030, Michoacán, México; (e-mail: adrianquijada@hotmail.com).

DRYMOLUBER DICHROUS. BRAZIL: ESPÍRITO SANTO: VITÓRIA (20°18'S, 40°19'W). 07 January 1996. J. L. Gasparini. Museu Nacional, Rio de Janeiro (MNRJ 4858). Verified by A. Velosa. LINHARES: Reserva Florestal da CVRD (19°10'S, 40°00'W). July 1993. A. A. Giaretta (MNRJ 10661, 10663). Verified by P. Passos. First vouchered records for the state. Until recently, this species was reported to occur only in the Amazonian region, where it is widespread (Peters and Orejas-Miranda 1986. Catalogue of Neotropical Squamata. Part. I – Snakes. Bull. U.S. Natl. Mus. 297:1–347). Subsequent records have extended its distribution eastwards and southwards into the Atlantic Forest domain in the states of Bahia (Franco et al. 1998. Répteis na Estação Veracruz. Veracel Celulose S.A., Eunápolis, Bahia. 39 pp.; Argôlo 2004. As Serpentes dos Cacauais do Sudeste da Bahia. Editus, Ilhéus, Bahia. 259 pp.), Ceará (Borges-Nojosa and Lima 2001. Bol. Mus. Nac. Rio de Janeiro, Zool. 468:1–5), and Minas Gerais (Passos and Brandão 2002. Herpetol. Rev. 33:324). The presence of *D. dichrous* at the Reserva Florestal da CVRD had been previously reported by Rocha (1998. *In* J. E. Santos [ed.], Anais do VIII Seminário Regional de Ecologia [vol. II], pp. 869–881. UFSCar, São Carlos), though no voucher material was mentioned. The record from Vitória extends the species' distribution ca. 270 km SE of the previous southernmost record, in the state of Minas Gerais (Passos and Brandão, *op. cit.*).

Submitted by **DAVOR VRCIBRADIC,** Departamento de Ecologia, Universidade do Estado do Rio de Janeiro, 20550-011, Rio de Janeiro, RJ, Brazil (e-mail: davor@centroin.com.br).

ELAPHE GUTTATA (Cornsnake). USA: TEXAS: CALHOUN CO.: 4.28 air km S and 2.95 air km W of junction of TX 185 and FM 1289 (28°23'18.72"N, 96°33'56.45"W). 18 May 2007. J. A. Holm, H. L. Prestridge. Verified by Toby J. Hibbitts. Texas Cooperative Wildlife Collection, TCWC 92299. New county record (Dixon 2000. Amphibians and Reptiles of Texas. 2nd Ed. Texas A&M University Press, College Station, Texas. 421 pp.). A second specimen, TCWC 92438, was also found.

Submitted by **JAMES A. HOLM**, Crouch Environmental Services, Inc., 402 Teetshorn, Houston, Texas 77009, USA; **HEATHER L. PRESTRIDGE** and **JOHN T. WILLIAMS**, Texas Cooperative Wildlife Collection, Department of Wildlife and Fisheries Sciences, 2258 TAMU, Texas A&M University, College Station, Texas 77843-2258, USA.

ELAPHE GUTTATA EMORYI (Great Plains Ratsnake). USA: ARKANSAS: IZARD CO.: Found crossing Co. Rd. 3 from hayfield, 4 km E of St. Hwy 9. UTM 15N 0597721E, 3987544N. 01 May 2007. Collected by M. B. Connior and I. Guenther. Arkansas State University Herpetological Museum (ASUMZ 30653). Verified by S. E. Trauth. First county record (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. The University of Arkansas Press, Fayetteville, Arkansas. 421 pp.).

We thank the following individuals: K. Irwin and B. Sasse, Arkansas Game and Fish Commission, for support of our study; Y. and N. Whitehurst, M. and K. Smith, and R. and S. Smith for permission to conduct the study on their land; and S. Trauth for specimen verification and curatorial preparation. Thanks also to the ASU Wildlife Management Investigational Techniques class for installing the drift fences.

Submitted by **MATTHEW B. CONNIOR** (e-mail: matthew.connior@smail.astate.edu), **IDUN GUENTHER**, and **THOMAS S. RISCH,** Department of Biological Sciences, Arkansas State University State University, Arkansas 72467, USA.

ELAPHE OBSOLETA (Texas Ratsnake). USA: ARKANSAS: JOHNSON CO.: Ozark National Forest Rd 1003 at Pinecrest Camp ca. 0.25 mi W of jct with Arkansas Scenic Hwy 21. 15 May 2006. Jonathan W. Stanley. Verified by Brian P. Butterfield. Arkansas State University Museum of Zoology Herpetology Collection (ASUMZ 30049). One adult DOR collected. First county record (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville. 421 pp.).

Submitted by **JONATHAN W. STANLEY** (e-mail: jonathanw.stanley@smail.astate.edu) and **STANLEY E. TRAUTH**, Department of Biological Sciences, P.O. Box 599, State University, Arkansas 72467, USA (e-mail: strauth@astate.edu).

ELAPHE VULPINA (Western Foxsnake). USA: MICHIGAN: LEELANAU CO.: North Manitou Island in an ephemeral wetland directly adjacent to the Crescent Dock ruins, Sleeping Bear Dunes National Lakeshore (16T 0574170E, UTM 4995996N, NAD83). 22 May 2007. Kenneth D. Bowen. Verified by James H. Harding. Iowa State University Research Collection (ISUA 200720; digital image). New record for North Manitou Island and for the Eastern Lake Michigan Archipelago. This species is the only representative of the herpetofauna of the Eastern Lake Michigan Archipelago that cannot be found on the adjacent Lower Peninsula of Michigan (Bowen and Gillingham 2004. Michigan Acad. 35:213– 223).

Submitted by **KENNETH D. BOWEN, SUSAN D. McMAHON,** and **ERIK A. BEEVER**, National Park Service, Great Lakes Inventory and Monitoring Network, 2800 Lakeshore Drive East, Suite D, Ashland, Wisconsin 54806, USA (e-mail: Ken_Bowen@nps.gov).

FARANCIA ABACURA (Red-bellied Mudsnake). USA: TEXAS: CALHOUN CO.: 5.5 road km N of TX 185 on FM 1289 (28°28'10.5"N, 96°33'8.3"W). 15 May 2007. D. Laurencio, R. E. Nelson, J. A. Holm, H. L. Prestridge. Verified by Toby J. Hibbitts. Texas Cooperative Wildlife Collection, TCWC 91809. New county record (Dixon 2000. Amphibians and Reptiles of Texas. 2nd Ed. Texas A&M University Press, College Station, Texas. 421 pp.).

Submitted by **DAVID LAURENCIO** (e-mail: norops@tamu.edu), **HEATHER L**, **PRESTRIDGE**, **JOHN T. WILLIAMS**, Texas Cooperative Wildlife Collection, Department of Wildlife and Fisheries Sciences, 2258 TAMU, Texas A&M University, College Station, Texas 77843-2258, USA; **JAMES A. HOLM** and **RYAN E. NELSON**, Crouch Environmental Services, Inc., 402 Teetshorn, Houston, Texas 77009, USA.

FARANCIA ABACURA REINWARDTII (Western Mudsnake). USA: TEXAS: VAN ZANDT CO.: DOR (59.2 cm SVL) found on Van Zandt County Road 2721, 1.28 km N of jct. with US 198, 05 June 2007. The closest permanent body of water to this specimen was a cattle tank within a pasture ca. 30 m away. R. Michael Burger. Verified by Carl J. Franklin. Voucher specimen deposited in University of Texas at Arlington (UTA R 55370). New county record (Dixon 2000. Amphibians and Reptiles of Texas. 2nd ed. Univer-

sity of Texas A&M Press, College Station, Texas. viii+421 pp.).

Submitted by **R. MICHAEL BURGER**, P.O. Box 4099, Dallas, Texas 75208, USA; e-mail: mvburger@dctexas.net.

LAMPROPELTIS GETULA GETULA (Eastern Kingsnake). USA: FLORIDA: LEVY CO.: Seahorse Key, beaches. 01 May 2004, 21 April 2007. David Wooten, David J. Hall, Cedric Worman. Florida Museum of Natural History, University of Florida, Gainesville (UF 141415, 151204). Verified by Kenneth L. Krysko. These are first records for Seahorse Key, one of numerous small Gulf Coast islands comprising the Cedar Keys, part of the Cedar Keys National Wildlife Refuge. One of us (DW) found a kingsnake on the south beach of Seahorse Key on 1 May 2004 (photo voucher UF 141415). The snake was wet and found crawling away from the water and shoreline, suggesting it had just swam or rafted to the island. A second snake was found by two of us (DH, CW) on the south beach in April 2007 (voucher photo UF 151204). The snake was found further west than the first specimen, near the transition from beach to hammock. Both of the snakes were healthy adults. There does not appear to be a resident population on Seahorse Key nor has the species been documented from other outer Cedar Keys. Both snakes were likely found soon after dispersing onto the island from the surrounding Gulf waters.

There is a large population of Florida Cottonmouth (*Agkistrodon piscivorus conanti*) on Seahorse Key. Many large specimens are present, especially near the bird rookeries (Wharton 1969. Bull. Florida State Mus., Biol. Sci. 14:227–272), probably attracted by fish carrion dropped or regurgitated from colonial nesting birds. Cottonmouths are ophiophagous, terrestrial, and achieve large body size. The presence of a robust population likely hinders other snake species from establishing populations on the island. Our observations suggest that *Lampropeltis getula*, like some other species of snakes (e.g., *Crotalus adamanteus*), are capable of dispersing considerable distances across Gulf waters. Eastern Kingsnakes are known from Cedar Key and the adjacent mainland, and specimens have been found in salt marsh near the coastline (e.g., UF 95544: 1 May 1976). We estimated minimum dispersal distances from satellite photos, considering both direct routes from the mainland and routes that involved "island hopping." In all cases, the maximum over-water distance is about 3 km.

Submitted by **DAVID WOOTEN**, **DAVID HALL**, **CEDRIC WORMAN**, and **HARVEY B. LILLYWHITE**, Seahorse Key Marine Laboratory, Department of Zoology, University of Florida, Gainesville, Florida 32611-8525, USA (e-mail: hbl@zoo.ufl.edu).

LAMPROPELTIS TRIANGULUM ELAPSOIDES (Scarlet Kingsnake). USA: SOUTH CAROLINA: GEORGETOWN CO.: Hobcaw Barony, 7.5 km SSE Georgetown. 31 March 2007. Travis W. Knowles. Verified by Alvin L. Braswell. Digital image deposited in the North Carolina State Museum of Natural Sciences (NCSM AN 12174). New county record.

Submitted by **JEFFREY D. CAMPER** (e-mail: jcamper@fmarion.edu) and **TRAVIS W. KNOWLES,** Department of Biology, Francis Marion University, Florence, South Carolina 29506, USA (e-mail: tknowles@fmarion.edu).

LAMPROPELTIS TRIANGULUM SINALOAE (Sinaloan Milksnake). MÉXICO: SONORA: Municipio de Yécora, 47.6 km (by Mex. Hwy. 16) W Yécora (28.40430°N, 108.67572°W), 720 m elev. 06 July 2006. E. Enderson and R. Bezy. Verified by George Bradley. UAZ 56576-PSV. First record from Yécora municipality and northernmost record in northwestern Mexico, extending the range ca. 183 km (airline) N from Guirocoba, Sonora (Williams 1988. Systematics and Natural History of the American Milk Snake, *Lampropeltis triangulum*, 2nd revised ed. Milwaukee Public Museum, Wisconsin. x +176 pp.). The snake was DOR in tropical deciduous forest.

Submitted by **ERIK F. ENDERSON,** Drylands Institute, PMB 405, 2509 North Campbell Avenue, Tucson, Arizona 85719, USA (e-mail: erikenderson@msn.com); and **ROBERT L. BEZY**, Herpetology, Natural History Museum of Los Angeles County, Los Angeles, California 90007, USA.

LEPTODEIRA SEPTENTRIONALIS SEPTENTRIONALIS (Northern Cat-eyed Snake). USA: TEXAS: STARR CO.: 26°39.226'N, 98°34.307'W. 28 April 2007. Estela Escalera. Verified by Frank W. Judd. University of Texas – Pan American Vertebrate Museum (UTPA) Photographic specimen 04071. Male (35.2 cm SVL and 43.2 cm total length, measured from photographic scale) found under a dry *Opuntia* cactus that was shaded by small huisache and mesquite trees in an otherwise open area in northern Starr County. First county record and westernmost record (likely northernmost record as well) in the United States. Previously reported in adjacent Hidalgo County (Dixon 2000. Amphibians and Reptiles of Texas. 2nd ed. University of Texas A&M Press, College Station, Texas. viii + 421 pp.; Werler and Dixon 2000. Texas Snakes: Identification, Distribution, and Natural History. University of Texas Press, Austin, Texas. xv + 437 pp.).

Submitted by **ESTELA ESCALERA, DANIEL S. SAENZ,** and **FREDERIC ZAIDAN III,** Department of Biology, University of Texas – Pan American, Edinburg, Texas 78539, USA (e-mail: fzaidan@utpa.edu).

LIOPHIS FLAVIFRENATUS (Cope's Legion Snake). URUGUAY: DEPARTAMENTO TACUAREMBÓ: near "Los Argentinos," Rincón de Zamora (32°22'45"S, 55°32'38"W). 17 December 2006. S. Carreira and R. Maneyro. Colección Zoología Vertebrados, Reptiles, Facultad de Ciencias, Montevideo (ZVC-R 6417, adult male). Departamento Durazno: Ruta 6, ca. 10 km from La Paloma de Durazno (32°38'11"S; 55°27'53"W). 05 April 2007. I. Lombardo and S. Carreira. (ZVC-R 6495, adult, probable male – specimen damaged).

The species was known from São Paulo to Rio Grande do Sul (Brazil); from Paraguay to Argentina in the provinces of Corrientes, Chaco, Entre Ríos, Formosa, Misiones and Uruguay in Artigas, Salto, and Paysandú departments (Giraudo and Scrocchi 2002. Smithson. Herpetol. Infor. Serv. 132, 53 pp.; Carreira et al. 2005. Reptiles de Uruguay. DI.R.A.C. Facultad de Ciencias, Universidad de la República, Montevideo, 639 pp.). Carreira et al. (*op.cit.*) erroneously includes Tacuarembó and Cerro Largo in the distribution, but no specimens were reported in these areas, despite the fact that Meneghel and Achaval (1983. Bol. Soc. Zool. Uruguay, 2a. ép., 1:15–24) mentioned Tacuarí, Treinta, and Tres departments without vouchers. These new records extend the southern limit of the species ca. 100 km from the southern report in El Palmar National Park, Argentina (Giraudo 2001. Serpientes de la Selva

Paranaense y del Chaco Húmedo. L.O.L.A. Buenos Aires, Argentina, 328 pp.).

The defensive display observed in captivity and cited by Carreira and Meneghel (1999. Bol. Soc. Zool. Uruguay, 2a época 10:101–102) was observed in the field at the first contact with the specimen ZVC-R 6417.

Submitted by **SANTIAGO CARREIRA** (e-mail: carreira@fcien.edu.uy) and **IGNACIO LOMBARDO,** Secc. Zoología Vertebrados, Facultad de Ciencias, Iguá 4225, CP 11400, Montevideo, Uruguay (e-mail: ilombardo@fcien.edu.uy).

MANOLEPIS PUTNAMI (Ridgehead Snake). MEXICO: JALISCO: Municipality of Zapopan, Bosque La Primavera (20°39'28.88"N, 103°29'15.55"W), 1812 m elev. 20 September 2006. Ivan T. Ahumada-Carrillo. Verified by Fernando Mendoza. UTA Image 1045. An elevation record and state range extension ca. 200 km E from closest known localities in coastal Jalisco (Garcia and Ceballos 1994. Field Guide to the Reptiles and Amphibians of the Jalisco Coast, Mexico. Fundacion Ecologica de Cuixmala, A.C., Inst. Biologia, UNAM, Mexico, D.F. 184 pp.). The snake was found in leaf litter at the edge of an oak forest. This species is typically recorded from tropical sub-humid forests in the Pacific lowlands of México, although Johnson (1978. Southwest. Nat. 23:538) reported it from pine-oak forest on the Gulf versant of the Sierra Madre de Chiapas at ca. 717 m elev.

Submitted by **IVAN T. AHUMADA-CARRILLO**, **OCTAVIO VAZQUEZ-HUIZAR**, and **JACOBO REYES-VELASCO** (e-mail: jackobz@gmail.com)**,** Centro Universitario de Ciencias Biológicas y Agropecuarias, Carretera a Nogales Km. 15.5. Las Agujas, Nextipac, Zapopan, Jalisco, México.

MASTICOPHIS FLAGELLUM (Coachwhip)**.** MÉXICO: AGUASCALIENTES: Municipality of Tepezalá: 3 km W Valle de las Delicias, Tepezalá (22.31324°N, 102.171120°W), 2010 m elev. 22 September 1998. Gustavo Quintero-Díaz. Museo de Zoología, Departamento de Biología, Universidad Autónoma de Aguascalientes (UAA-VR 00314). Municipality of El Llano: vicinity of El Milagro, 15 km W of Aguascalientes on State Road 68 (21.9230556°N, 102.098889°W), 2044 m elev. 6 June 2003. José Luis Carrasco Rosales. UAA-VR 00315. Municipality of El Llano: km 18 on State Road 5 (21.9422233°N, 102.0681429°W), 2070 m elev. 18 May 2005. Luis Felipe Lozano Román and Ricardo Galván de la Rosa. UAA-VR 00316. All verified by L. D. Wilson. First records for Aguascalientes (McCranie and Wilson 2001. Cour. Forsch.-Inst. Senckenberg 230:1–57) and a range extension for UAA-VR 00315 ca. 144 km S of the vicinity of Illescas, San Luis Potosí (Wilson 1970. Tulane Stud. Zool. Bot. 16:31–99). All snakes were found in semi-desert scrub vegetation dominated by prickly pear (*Opuntia* sp.).

Submitted by **GUSTAVO E. QUINTERO-DÍAZ,** Universidad Autónoma de Aguascalientes, Centro de Ciencias Básicas, Departamento de Biología, Ave. Universidad 940, Aguascalientes, 20100, México; **J. JESÚS SIGALA-RODRÍGUEZ**, Department of Ecology and Evolutionary Biology, Cornell University, Ithaca, New York 14853-2701, USA (e-mail: js324@cornell.edu); **JOEL VÁZQUEZ-DÍAZ,** Departamento de Investigación y Desarrollo Tecnológico, Internacional de Relojes, Arte y Diseño S. A. de C. V., Ave. Aguascalientes Sur 203, Fracc. Prados del Sur, Aguascalientes 20280, México; **JOSÉ LUIS CARRASCO**, **JORGE IVAN SIGALA-RODRÍGUEZ,** Universidad Autónoma de Aguascalientes, Centro de Ciencias Básicas, Avenida Universidad # 940, Aguascalientes 20100, México; and **LUIS FELIPE LOZANO ROMÁN** and **RICARDO GALVÁN DE LA ROSA**, Dirección de Recursos Bióticos, Instituto del Medio Ambiente del Estado de Aguascalientes, Aguascalientes 20040, México.

MICRURUS DISTANS DISTANS (West Mexican Coral Snake). MÉXICO: SONORA: Municipio de Yécora, 3.7 km (by Mex. Hwy. 16) E of Río Maycoba between Yécora and Maycoba (28°23'21"N, 108°44'47"W), 1415 m elev. 15 August 2003. M. C. Peñalba, C. Ortega, F. Paz, A. L. Reina-G., and T. R. Van Devender. Verified by George Bradley. UAZ 56584-PSV. First record for the Municipio de Yécora and northernmost record for the species, extending the range ca. 119 km (airline) NW from the vicinity of Batosegachic, Chihuahua (Campbell and Lamar. 2004. The Venomous Reptiles of the Western Hemisphere, Vol. I. Comstock, Ithaca, New York. 475 pp.) and 155 km (airline) NNE of Alamos, Sonora (Schwalbe and Lowe 2000. *In* Robichaux and Yetman [eds.], The Tropical Deciduous Forest of Alamos. Biodiversity of a Threatened Ecosystem in Mexico, pp. 172–199. University of Arizona Press, Tucson, Arizona). The snake was DOR in grassland with scattered oaks.

Submitted by **THOMAS R. VAN DEVENDER**, Arizona-Sonora Desert Museum, 2021 North Kinney Road, Tucson, Arizona 85743, USA; and **ERIK F. ENDERSON,** Drylands Institute, PMB 405 2509 North Campbell Avenue, Tucson, Arizona 85719, USA (e-mail: erikenderson@msn.com).

NERODIA CYCLOPION CYCLOPION (Green Watersnake). USA: TEXAS: Calhoun Co.: Specimen collected from the stomach of a female American Alligator with a SVL of 116 cm. The alligator was captured on the Myrtle Foerster Whitmire Division of the Aransas National Wildlife Refuge by Marc Ealy, Kevin Kriegel, Todd Merendino, and Matt Nelson (28°30'49.1"N, 96°30'33.9"W) on 17 August 2005. The alligator was lavaged and released. Diet analysis was conducted at Texas A&M University. TCWC 91806. Verified by Toby Hibbitts. New county record (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. Texas A&M University Press, College Station, Texas. 421 pp.) Fills in the hiatus between Matagorda and Refugio Counties.

Submitted by **KJ LODRIGUE, JR.**, Texas A&M University, Department of Wildlife & Fisheries Sciences, College Station, Texas 77843-2258, USA.

NERODIA ERYTHROGASTER FLAVIGASTER (Yellow-bellied Watersnake). USA: ARKANSAS: Faulkner Co.: T4N R15W SE 1/4 Sec 10. 09 April 2005. Stephen Brandebura and Nathan Stephens. Arkansas State University Museum of Zoology Herpetology Collection (ASUMZ 29063). Two additional specimens ASUMZ 29471 and ASUMZ 29476 were collected in Faulkner County. All verified by Brian P. Butterfield. First county records (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville. 421 pp.).

Submitted by **JONATHAN W. STANLEY (**e-mail: jonathanw.stanley@smail.astate.edu) and **STANLEY E.**

TRAUTH, Department of Biological Sciences, P.O. Box 599, State University, Arkansas 72467, USA (e-mail: strauth@astate.edu).

NERODIA FASCIATA PICTIVENTRIS (Florida Watersnake). USA: CALIFORNIA: SACRAMENTO CO.: City of Folsom, Humbug Creek from Oak Avenue Parkway to confluence with Willow Creek, downstream to Willow Creek confluence with Lake Natoma. This occurrence was originally documented as *Nerodia fasciata fasciata* (Banded Watersnake) by Balfour and Stitt (2002. Herpetol. Rev. 33:150, based on CAS 215207–215214). Subsequent genetic analysis and collections of numerous additional specimens indicate that the subspecies is *N. f. pictiventris* (Stitt et al. 2005 The Southern Watersnake [*Nerodia fasciata*] in Folsom, California: History, Population Attributes, and Relation to Other Introduced Watersnakes in North America. Final report to U.S. Fish and Wildlife Service, Sacramento, California). This subspecies is native to peninsular Florida (Gibbons and Dorcas 2004. North American Watersnakes: A Natural History. University of Oklahoma Press, Norman), and specimens from the introduced population matched the mitochondrial haplotype of those collected from Volusia, Pinellas, and Hillsboro counties in that state (S. A. Karl, pers. comm.). Recently, Fuller and Trevett (2006. Herpetol. Rev. 37:363) reported a reproducing population of *N. f. pictiventris* from Harbor City, Los Angeles County as a new state record for the subspecies (based on LACM 161154). This was reported prior to their knowledge of the updated information regarding the subspecific identity of the Sacramento County population.

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NERODIA SIPEDON (Northern Watersnake). USA: CALIFORNIA: PLACER CO.: Roseville, Kaseberg Creek, along margin of a large freshwater marsh adjacent to Woodcreek High School, NW of the intersection of Junction Blvd. and Woodcreek Oaks Blvd. Two female specimens (678 mm SVL and 906 mm SVL) were collected on 27 April 2007 by P. S. Balfour. CAS 235995–235996. Verified by Michael Dorcas, John Willson, and Whit Gibbons. One female was captured on land ca. 5 m from the water's edge and the other was captured in the water copulating with a male that subsequently escaped. Additional individuals of undetermined sex were also observed but were not captured. Analysis of mtDNA sequence data for these specimens was consistent with the field identification. When compared to published *N. sipedon* sequences (GenBank accession numbers AY523573 and AF384832) one of the specimens exactly matched 223 base pairs of the control region and had three single nucleotide polymorphisms (SNP) different in 546 base pairs of the ND2 region. The other specimen had one SNP in the control region comparison and five in the ND2 region (A. K. Buchanan and T. E. Edwards, unpubl. data).

The presence of several (at least five) individuals and observed copulation suggest that reproduction is occurring at the site. If so, this is the first recorded population of *Nerodia sipedon* in northern California. However, at least one additional *N. sipedon* may have been captured in California. Bury and Luckenbach (1976. Biol. Conserv. 10:1–14) and Jennings (2004. California Fish Game 90:161–213) both report a specimen of *N. sipedon* collected from an El Dorado Park, Los Angeles Co. (reported by Jennings [*op. cit.*] as LACM 109564). However, some confusion exists regarding this record, as two parks with lakes, located ca. 11.8 miles from each other, are known colloquially as El Dorado Park. Fuller and Trevett (2006. Herpetol. Rev. 37:363) suggest the specimen may actually be *N. fasciata*, potentially collected from Harbor Park (also known informally as El Dorado Park), the locality for Fuller and Trevett's (2006) *N. fasciata* population. We have not inspected LACM 109564 to verify its identity. However, no watersnakes have been observed by staff at El Dorado Park (as opposed to Harbor Park) since the collection of the one individual in 1976 (Richard James, pers. comm.). Thus, the current status of *Nerodia* at that locality is unknown.

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NERODIA SIPEDON PLEURALIS (Midland Watersnake). USA: ARKANSAS: FAULKNER CO.: Cadron Creek at Hwy 65. 22 October 2005. Jonathan W. Stanley, Cyndi Porter, Erica Shelby. Arkansas State University Museum of Zoology Herpetology Collection (ASUMZ 29472–473). Two juveniles collected. Two additional specimens (ASUMZ 29474–475) were also collected in Faulkner County. All verified by Brian P. Butterfield. First county records (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville. 421 pp.).

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OPHEODRYS AESTIVUS AESTIVUS (Northern Rough Greensnake). USA: ALABAMA: BIBB CO.: Bibbville Church. 20 May 1969. J. Bearden. Verified by Joseph R. Mendelson III. University of Montevallo (UMCV-RS0001). County record. Fills the gap between Chilton, Perry, Shelby, and Tuscaloosa counties (Mount 1975. The Reptiles and Amphibians of Alabama, The University of Alabama Press, Tuscaloosa, 347 pp.). Bibbville Church is located at 33°11'55"N, 87°10'71"W. Specimen from museum collection.

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PORTHIDIUM HESPERE (Colima Hognosed Pitviper). MÉXICO: MICHOACÁN: Municipio de Arteaga: Los Pozos, Rancho La Cuesta del Novillo (18°15'57"N, 102°30'32"W), 609 m elev. 21 March 2007. Naftali Mendoza and Ramon Cancino. Verified by Javier Alvarado-Diaz. Instituto de Investigaciones Sobre los Recursos Naturales, Universidad Michoacana de San Nicolás de Hidalgo (INIRENA 648). This is only the third documented record for this species and second from Michoacán (Campbell and Lamar 2004. The Venomous Reptiles of the Western Hemisphere. Cornell University Press, Ithaca, New York. 870 pp.), and extends the known range ca. 100 km SE from Playa Colola, Michoacán (Alvarado-Diaz et al. 1997. Herpetol. Rev. 28:98). The snake was found in a transitional area of oak and tropical deciduous forest.

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RAMPHOTYPHLOPS BRAMINUS (Brahminy Blind Snake). MÉXICO: NAYARIT: Isla Isabel (21°51'7.61"N, 105°53'12.84"W), 25 m elev. 12 July 1993. Adrián Quijada-Mascareñas. Verified by Oscar Flores-Villela. Museo de Zoología, Fac. de Ciencias, UNAM (MZFC 6148–49). First record for state and island. Closest previously known localities are in adjacent states of Sinaloa and Jalisco (Guzmán and Muñiz-Martínez 1999. Vertebrata Mexicana 5:1–3). The snakes were common in pineapple and banana fields in the center of the island.

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RAMPHOTYPHLOPS BRAMINUS (Brahminy Blind Snake). MÉXICO: SONORA: Hermosillo, Parque Madero (29°05'56"N, 110°57'15"W), 282 m elev. 14 September 1991. Adrian Quijada-Mascareñas. Verified by Oscar Flores-Villela. Museo de Zoología, Fac. de Ciencias, UNAM (MZFC 6147). New state record, extending its range northwest along the Pacific coast of mainland Mexico ca. 793 km (airline) from the vicinity of Mazatlan, Sinaloa (Hardy and McDairmid 1969. Univ. Kansas Publ. Mus. Nat. Hist. 18:153–154). It has also been reported from across the Sea of Cortez in Baja California Sur (Guzmán and Muñiz-Martínez 1999. Vertebrata Mexicana 5:1– 3).

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RAMPHOTYPHLOPS BRAMINUS (Brahminy Blindsnake). USA: FLORIDA: Volusia Co.: New Smyrna Beach. 23 September 2006. Collected by Stacy Simmons. Verified by Kenneth L. Krysko, Florida Museum of Natural History, University of Florida. One individual found on floor of residence. UF 151313. First county record. Originally turned in to Division of Plant Industry (DPI), Florida Department of Agriculture and Consumer Services, Gainesville, Florida, as a "worm for ID" on 27 September 2006; Entomology Log No. 6879. It is not clear if this single specimen indicates an established breeding colony in this county. However, this invasive, parthenogenic exotic is established in other Florida counties and other regions of the world through its ability to disperse in the soil of transported potted plants (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Books, Washington and London; Meshaka et al. 2004. The Exotic Amphibians and Reptiles of Florida. Krieger Publishing Company, Malabar, Florida).

Submitted by **LOUIS A. SOMMA**, Department of Zoology, PO Box 118525, 223 Bartram Hall, University of Florida, Gainesville, Florida 32611-8525, USA (e-mail: las@zoo.ufl.edu); and **PAUL E. SKELLEY**, Florida State Collection of Arthropods, Division of Plant Industry – Entomology Section, PO Box 147100, Florida Department of Agriculture and Consumer Services, 1911 SW 34th St., Gainesville, Florida, 32614-7100, USA (e-mail: skellep@doacs.state.fl.us).

RAMPHOTYPHLOPS BRAMINUS (Brahminy Blind Snake). USA: GEORGIA: Dougherty Co.: Private residence on Strout Avenue in Albany. 24 March 2007. Eric McGuire. GMNH 50035–50041. Verified by Elizabeth McGhee. First record of an established population in the state. Extends range ca. 100 km N of nearest record (Leon County, Florida; Krysko et al. 2005. Herpetol. Rev. 36:85–87). Seven individuals were collected while digging in sandy soil. In 2005, a single specimen (which was later lost) was collected from this same site and the author confirmed its identification. Other individuals were observed by the homeowner in 2006, but not collected. Together, these observations and collections suggest that an established population of this exotic species exists, having survived at least two winters.

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RHADINAEA FLAVILATA (Pine Woods Littersnake). USA: FLORIDA: Broward Co.: 17887 SW 8th Street, Pembroke Pines (25°59'58.8"N, 80°23'05.2"W). 08 April 2007. Christopher R. Gillette. Adult collected under artificial cover in the backyard of a developed lot in Misty Harbor at Silver Lakes subdivision. Verified by Kenneth L. Krysko. Florida Museum of Natural History photo voucher (UF 151119). New county record. Extends range ca. 76 km SSW from Lake Worth, Palm Beach Co. (UF 80245). Three other specimens have been found here.

Submitted by **CHRISTOPHER R. GILLETTE**, 143 Brescia Street NE, Palm Bay, Florida 32907, USA (e-mail: cgill002@fiu.edu); and **KEVIN M. ENGE**, Florida Fish and Wildlife Conservation Commission, 4005 South Main Street,

Gainesville, Florida 32601, USA; (e-mail: kevin.enge@myfwc.com).

SONORA SEMIANNULATA (Western Groundsnake). USA: CALIFORNIA: LASSEN CO.: Honey Lake Basin, N of eastern end of Honey Lake; 40.365341°N, 120.236081°W (WGS84 datum), elev. 1244 m. 15 July 2007. L. Prins. CAS HPV-43 (photo voucher). New county record and the first for northeastern California. This population is likely contiguous with those of the Pyramid Lake region of adjacent Washoe Co., Nevada (MVZ 200580, CAS-SUR 5597, SDNHM 38359, 38671), Snake was found crawling in bright daylight at 1900 h at an air temp of ca. 32°C.

We thank David Wake (MVZ), Jens Vindum (CAS), and Brad Hollingsworth (SDNHM) for specimen information from their institutions.

Submitted by **ROBERT W. HANSEN**, 16333 Deer Path Lane, Clovis, California 93619-9735, USA (e-mail: rwh13@csufresno.edu); and **LOREN PRINS**, 1805 Elder Lane, Modesto, California 95355, USA.

THAMNODYNASTES STRIGATUS. ARGENTINA: BUENOS AIRES: Partido de Berisso: 35°00'13"S, 57°34'58"W. 26 December 2003. D. O. Di Pietro and S. J. Nenda. Herpetological Collection of Museo de La Plata, Buenos Aires, Argentina (MLP-R 5318 adult female; SVL 374 mm, TL 117 mm). Verified by J. Williams. Species previously known from Paraguay, south and southeastern Brazil, Uruguay, and Argentina in the provinces of Misiones, northeastern Corrientes, Entre Ríos (associated with Río Uruguay), and northeastern Buenos Aires in delta region by occasional overflowing of Río Paraná (Giraudo 2001. Serpientes de la Selva Paranaense y del Chaco Húmedo, L.O.L.A., Buenos Aires, Argentina, 328 pp.; Giraudo and Scrocchi 2002. Smithson. Herpetol. Infor. Serv. 132:1–53). Southernmost locality, extends the known distribution along the coastline of Río de la Plata throughout the "Marginal Forest" ca. 110 km SE from San Fernando, Buenos Aires, which was the previous nearest known locality (Miranda et al. 1982. Asociación Cooperadora Jardín Zoológico de La Plata, Buenos Aires, 71 pp.; Williams 1991. Anfibios y Reptiles. *In* López and Tonni [eds.], Situación Ambiental de la Provincia de Buenos Aires. A. Recursos y Rasgos Naturales en la Evaluación Ambiental. C.I.C. La Plata, Buenos Aires, Argentina 1[4]:1–21).

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Lizards of Niau Atoll, Tuamotu Archipelago, French Polynesia

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French Polynesia encompasses five archipelagos: Marquesas, Society, Tuamotu, Gambier and Austral (sometimes called Tubuaï Islands). The terrestrial herpetofauna of French Polynesia has been reviewed by Ineich (1987a) and Ineich and Blanc (1989). Since these reviews, only one new report on the lizards of the Tuamotu Archipelago has been published (Nukutipipi Atoll, see Ineich 1990a-d). During a recent (October–November 2006) field trip by the SOP (Polynesian Ornithological Society; Expedition MANU SOP) to Niau Atoll (Tuamotu; for location, see Fig. 1), 10 lizards, including several species new for the atoll, were collected. Previously, five to six species have been reported from Niau Atoll (Ineich and Blanc 1989): *Emoia cyanura* sensu lato (then including the taxon now regarded as *E. impar*, as well as *E. cyanura* sensu stricto; see Ineich 1987b; Ineich and Zug 1992; Guillaume et al. 1994), *Cryptoblepharus poecilopleurus* and *Lipinia noctua* among skinks, and *Gehyra mutilata* and *Lepidodactylus lugubris* among geckos.

List of the MANU SOP expedition collected specimens are provided below:

Scincidae – 7 SPECIMENS

***Cryptoblepharus poecilopleurus* (Wiegmann, 1835) – 3 specimens**

MNHN 2007.0001, Coconut plantation, north of the village, coll. 25 October 2006 by Ludwig Blanc.

MNHN 2007.0006–07, Coconut plantation, south of the village, lagoon side, coll. 22 October 2006 by Ludwig Blanc.

***Emoia cyanura* sensu stricto (Lesson, 1826) – 3 specimens**

MNHN 2007.0004–05, Coconut plantation, south of the village, lagoon side, coll. 22 October 2006 by Ludwig Blanc.

MNHN 2007.0009, Coconut plantation, south of the village, coll. 17 October 2006 by Anne Gouni.

***Emoia impar* (Werner, 1898) – 1 specimen**

MNHN 2007.0010, West of the abandoned village of Tupana, marsh, coll. 27 October 2006 by Jean-François Butaud.

Gekkonidae – 3 SPECIMENS

***Gehyra oceanica* (Lesson, 1830) – 1 specimen**

MNHN 2007.0008, 5 km from the village, south of the ocean, coll. 20 October 2006 by Ludwig Blanc and Jean Durieux.

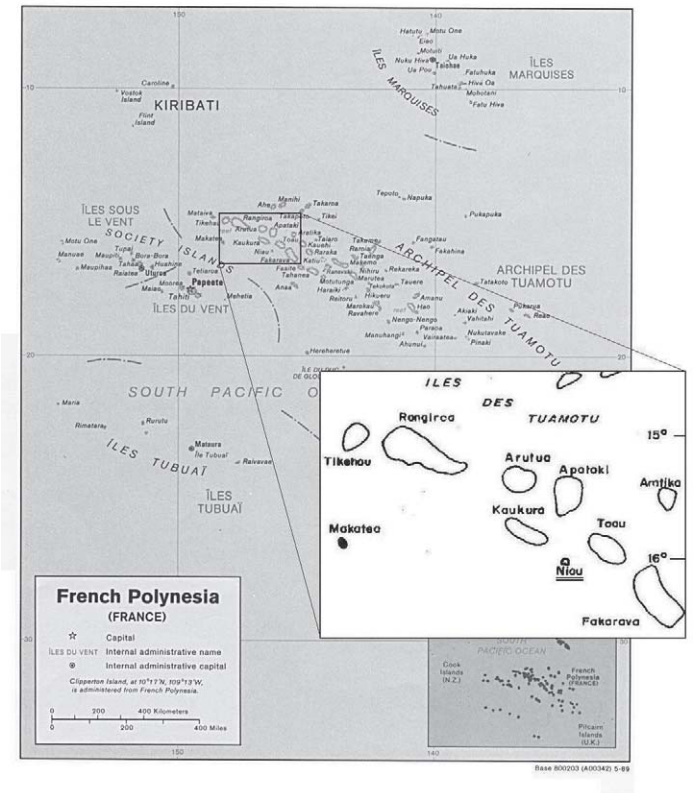


FIG. 1. Map showing the location of French Polynesia and Niau Atoll inside French Polynesia.

***Hemidactylus frenatus* Duméril & Bibron, 1836 – 1 specimen**

MNHN 2007.0003, in a house in the village, coll. 29 October 2006 by Ludwig Blanc.

***Lepidodactylus lugubris* (Duméril & Bibron, 1836) – 1 specimen**

MNHN 2007.0002, Coconut plantation, north of the village, bisexual female, coll. 25 October 2006 by Ludwig Blanc.

The MANU SOP Expedition material does not confirm the occurrence of one previously reported skink, *Lipinia noctua* (Lesson 1830) and one previously reported gecko, *Gehyra mutilata* (Wiegmann 1834) on Niau Atoll. Both are widespread and common on Pacific islands, and their absence probably reflects a collecting artifact. This recently collected material confirms for the first time, the occurrence of both *Emoia cyanura* and *E. impar,* as well as *Gehyra oceanica,* on Niau Atoll. It also confirms that bisexual *Lepidodactylus lugubris* populations still occur on the Atoll, and that they are not excluded by the recent invasion of the unisexual diploid clone A (see Ineich 1999). The most surprising result of the examination of that small lizard collection is the presence of *Hemidactylus frenatus* on Niau Atoll. This gecko was recently introduced into French Polynesia. It was not present on the five archipelagos around 1985–1986 (see Ineich 1987a; Ineich and Blanc 1989), and was first reported from Tahiti (Society Archipelago) in 1988 (Petren et al. 1993; Case et al. 1994). It has since spread rapidly and is now present on remote atolls of the Tuamotu Archipelago, such as Niau, although the precise extent of its current distribution in French Polynesia remain unknown. It is generally considered an aggressive species, with potential to have strong negative interactions with the local gecko populations. Such competition has been demonstrated in anthropophilous areas but not in natural habitats (Case and Bolger 1991; Case et al. 1994).

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A Bioblitz Competition to Assess a Distribution Gap in Georgia Herpetofaunal Records

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Range maps from Conant and Collins (1991) give the impression of a continuous range for certain species from the Blue Ridge Mountains of Georgia into the uplands of Alabama. Though corridors of rugged terrain (the Talladega Uplands and Gainesville Ridges *sensu* Wharton 1979) potentially serve as conduits for these species into the region of Alabama's highest elevations, the actual connectivity between the known segments of these species' ranges remains assumed. Several species illustrate this trend, and the ranges of species associated with montane habitats in Alabama and Georgia (e.g., *Rana sylvatica*, *Pseudacris brachyphona*, *Desmognathus aeneus*, *D. monticola*, and *Gyrinophilus porphyriticus*) are assumed to be either continuous or disjunct, when in fact the intervening region of Georgia (Polk, Haralson, and Paulding counties) is one of the least known herpetologically in the state (Williamson and Moulis 1994), and records for these species in these counties are lacking.

To address this lack of baseline information about an important region, we organized a "bioblitz" survey. To ensure robust volunteer turnout and enthusiasm, the bioblitz was conducted as a competition between four herpetological organizations (three university herpetological societies and the herpetology lab of an ecological research center). Each group organized a team and surveyed the region from 16–18 March 2007. The competition documented 30 total species and yielded 21 new county records for Georgia, including several for target species (e.g., those mentioned above).

There are several advantages to utilizing bioblitz competitions as survey techniques in record depauperate areas. First, herpetologists are typically competitive and often fancy themselves as good (if not the best) at finding and catching herpetofauna, a characteristic easily exploited in competition. Second, when a competition arises, it generates a larger turn out of skilled herpetologists than does a general collection trip. This provides a friendly yet competitive atmosphere, generating numerous records over a very short time period. We encourage others to utilize bioblitz competitions to survey other areas in need of assessment. All identifications were verified by Craig Guyer.

Caudata

Ambystoma maculatum (Spotted Salamander). PAULDING CO.: Paulding Forest Wildlife Management Area (PWMA, 33°56'48"N, 84°57'39"W). 17 March 2007. C. Camp, W. Smith, E. Timpe, and V. Johnson. AHAP-D 8.

Eurycea cirrigera (Southern Two-lined Salamander). POLK CO.: First order stream off Braswell Road 500 m W of Braswell (33°59'20.4"N, 84°58'09.5"W). 18 March 2007. S. Graham and E. Timpe. AHAP-D 11.

Desmognathus conanti (Spotted Dusky Salamander). HARALSON CO.: Small first order stream off of Coppermine Road (33°51'23.9"N, 85°04'20.7"W). 17 March 2007. S. Graham and A. Nelson. AU 37410.

Desmognathus monticola (Seal Salamander). HARALSON CO.: Small first order seep off Dugdown Road (33°53'53.1"N, 85°18'15.2"W). 17 March 2007. S. Graham and A. Nelson. AU 37408. POLK CO.: (34°00'54"N, 84°58'11"W). 18 March 2007. S. Graham and E. Timpe. AU 37407. DOUGLAS CO.: (33°44'52"N, 84°37'30"W). 16 March 2007. S. Graham, E. Timpe, and V. Johnson. AU 37406.

Notophthalmus viridescens (Eastern Newt). PAULDING CO.: Pond just north of Braswell Mountain Road ca. 800 m W of Lee Road (34°00'25.1"N, 84°54'30.0"W). 18 March 2007. J. Jensen, V. Johnson, and A. Nelson. AHAP-D 27.

Pseudotriton ruber (Red Salamander). POLK CO.: In a pool below a rock outcrop on Vinson Mountain Road 0.8 km N from the Paulding/ Polk County line (33°57'22"N, 84°59'56"W). 18 March 2007. K. Holcom and D. Van Dijk. AHAP-D 23.

Gyrinophilus porphyriticus (Spring Salamander). DOUGLAS CO.: (33°44'52"N, 84°37'30"W). 16 March 2007. S. Graham, E. Timpe, and V. Johnson. AHAP-D 17. PAULDING CO.: PWMA (33°56'48"N, 84°57'39"W). 17 March 2007. C. Camp, W. Smith, E. Timpe, and V. Johnson. AHAP-D 16.

Anura

Pseudacris brachyphona (Mountain Chorus Frog). DOUGLAS CO.: (33°45'06"N, 84°37'43"W). 16 March 2007. S. Graham, E. Timpe, and V. Johnson. AU 37401.

Testudines

Chrysemys picta (Painted Turtle). PAULDING CO.: Braswell Mountain Road approximately 480 m east of Lee Road (34°00'26.3"N, 84°53'32.0"W). 18 March 2007. J. Jensen, V. Johnson, and A. Nelson. AHAP-D 29.

Lacertilia

Eumeces fasciatus (Five-lined Skink). HARALSON CO.: In ruins of a house along Mountain View Road (33°54'15.0"N, 85°09'49.1"W). S. Graham and A. Nelson. 17 March 2007. AHAP-D 15a,b.

Sceloporus undulatus (Eastern Fence Lizard). PAULDING CO.: PWMA (33°59'05.7"N, 84°56'53.1"W). 17 March 2007. C. Camp, W. Smith, E. Timpe, and V. Johnson. AHAP-D 30.

Anolis carolinensis (Green Anole). PAULDING CO.: PWMA (33°59'05.7"N, 84°56'53.1"W). 18 March 2007. J. Jensen, V. Johnson, and A. Nelson. AHAP-D 28. HARALSON CO.: Small first order stream off Coppermine Rd. (33°51'23.9"N, 85°04'20.7"W). 17 March 2007. S. Graham and A. Nelson. AU AHAP-D 9.

Serpentes

Diadophis punctatus (Ringneck Snake). HARALSON CO.: Small first order stream off Coppermine Rd. (33°51'23.9"N, 85°04'20.7"W).

17 March 2007. S. Graham and A. Nelson. AHAP-D 13.

Carphophis amoenus (Eastern Worm Snake). HARALSON CO.: (33°52'27.9"N, 85°09'54.7"W). 17 March 2007. S. Graham and A. Nelson. AHAP-D 10.

Thamnophis sirtalis (Common Garter Snake). POLK CO.: (33°52'12"N, 85°11'11"W). 18 March 2007. S. Graham and E. Timpe. AHAP-D 26.

Storeria dekayi (Brown Snake). HARALSON CO.: (33°52'23.8"N, 85°09'49.1"W). 17 March 2007. S. Graham and A. Nelson. AHAP-D 12.

Nerodia sipedon (Northern Water Snake). POLK CO.: (33°55'09"N, 85°04'35"W). 18 March 2007. S. Graham and E. Timpe. AHAP-D 25.

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Significant New Records for Georgia Herpetofauna

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Despite having one of the richest herpetofaunas (with at least 166 species) in the United States and several large academic institutions, Georgia remains one of the most poorly known states in terms of geographic distribution of amphibians and reptiles. To date, the most comprehensive assessment of amphibian and reptile distributions in Georgia is the under-circulated work of Williamson and Moulis (1994), in which large portions of certain species' ranges are assumed and lack verification. This report underscores the rewards possible to those interested in Georgia herpetofauna, and represents significant range extensions for three species, new county records for uncommon or secretive species, and the first published records in the state for two species.

Anura

Eleutherodactylus planirostris (Greenhouse Frog). THOMAS CO.: Found on the campus of Thomas College. 20 October 2002. S. Graham and L. Giovanetto. Verified by John Jensen. GMNH 49896. New county record.

Rana sylvatica (Wood Frog). MERIWETHER CO.: Found crossing Mt. Sinai road 5.6 km E of Gay at bridge over White Oak Creek in Joe Kurz Wildlife Management Area (33°07'25.8"N, 84°30'58.3"W). 17 January 2006. S. Graham. Verified by John Jensen. GMNH 49980. PIKE CO.: Found DOR on Dripping Rock Rd. 5 m N of bridge over Elkins Creek (33°58'14.6"N, 84°30'58.3"W). S. Graham. Verified by John Jensen. GMNH 49981. New county records. TALBOT CO.: Found on River Rd. 100m W of Flint R. and 1 km S. of Big Lazar Cr. in Big Lazar Creek Wildlife Management Area (32°48'00.2"N, 84º24'01.7"W). 2 February 2006. S. Graham. Verified by John Jensen. GMNH 49982. This new county record is currently the most southerly record known for this species (ca. 10 km S from the last published range extension by Camp and Pyron [2003]).

Caudata

Desmognathus apalachicolae (Apalachicola Dusky Salamander). MARION CO.: Found under logs in lowland swampy area 100 m N of St. Route 26 and Kinchafoonee Creek (32°18'24.9"N, 84°35'01.7"W). 29 March 2006, 27 August 2006. S. Graham and E. Timpe. Verified by John Jensen. GMNH 49993–49994. TAYLOR CO.: Found in lowland swampy area under log in small tributary of Whitewater Creek 1 km S of St. Route 137/Hobbs Road intersection. 11 March 2006. S. Graham and E. Timpe. Verified by John Jensen. GMNH 49988. The above county records extend this species' range into the upper Flint River basin (ca. 10–20 km E from the nearest populations in the upper Chattahoochee River basin, and ca. 115 km N of the nearest population in the lower Flint River basin), a significant extension for this narrowly endemic salamander. In addition, the habitat occupied by these populations (lowland gum swamp) is very different from the ravine habitat often cited as this species' preferred habitat (Petranka 1998). UPSON CO.: Found in mesic ravine along Double Branch 50 m E of Flint River at Camp Thunder Scout Reservation (32°56'59.3"N,84°30'56.7"W). 23 March 2006, 27 August 2006. S. Graham. Verified by John Jensen. GMNH 49995–49996. This county record is the first documentation of this species' occurrence in the Piedmont region and outside the Coastal Plain physiographic province.

Desmognathus conanti (Spotted Dusky Salamander). EFFINGHAM CO.: Found along seepages and mucky swamp 4.6 km SE of Springfield, 0.25 miles N of St. Route 225, and 50 m E of railroad crossing of Ebenezer Creek. S. Graham. Verified by John Jensen. GMNH 50001–50007. WAYNE CO.: Collected under litter 25 m N of Jaycee's boat landing at Altamaha River Bluff 8.05 km NE of Jesup (32°31'10.7"N, 81°16'50.6"W). S. Graham.

Verified by John Jensen. GMNH 50031–50033. These county records are significant southerly range extensions for this species in Georgia (over 100 km if considered disjunct), and suggest many populations might exist in seepages in the Coastal Plain with major rivers serving as corridors for dispersal from the Piedmont.

Eurycea chamberlaini (Chamberlain's Dwarf Salamander). CRAWFORD CO.: Crossing St. Route 341 50 m S of Roberta city limits (32°42'33.9"N, 84°00'35.8"W). 10 March 2006. S. Graham and E. Timpe. Verified by John Jensen. GMNH 49991. MERIWETHER CO.: 4.8 km NE of Gay crossing Mt. Sinai Rd. in Joe Kurz Wildlife Management Area (33°06'42.3"N, 84°32'43.1"W). 21 January 2006. S. Graham. Verified by John Jensen. GMNH 49989. TAYLOR CO.: Found crossing St. Route 208 6.2 km E of Talbotton (32°39'37"N, 84°20'45.8"W). 10 March 2006. S. Graham and E. Timpe. Verified by John Jensen. GMNH 49990. These represent the first state records for *Eurycea chamberlaini* in Georgia.

Hemidactylium scutatum (Four-toed Salamander). MERIWETHER CO.: Found crossing Mt. Sinai Rd. 4.8 km E of Gay in Joe Kurz Wildlife Management Area (33°06'41.8"N, 84°32'45"W). 17 January 2006. S. Graham. Verified by John Jensen. GMNH 49979. New county record.

Plethodon shermani (Red-legged Salamander). TOWNS CO.: Found under logs near the private residence of the late C. H. Wharton. Tate City, 200 m SW of the end of the Tallulah River Rd. in Georgia (34°59'25.2"N, 83°33'32.7"W). 30 April 2003. S. Graham, M. Meadows, C. H. Wharton. Verified by John Jensen. GMNH 49897–49898. First record of this taxon in Georgia. A previous county record of *Plethodon jordani* from near this locality (Jensen 2001) may have been this recently elevated species.

Plethodon websteri (Webster's Salamander). MERIWETHER CO.: Found under log on Buzzard's Roost, 50 m W of Flint River, 4.8 km S of St. Route 74 (32°58'08.9"N, 84°31'55.7"W). 5 March 2003. S. Graham and B. King. Verified by Craig Guyer. AU 35931. PIKE CO.: Found under rock on Buzzard Mountain, 14.5 km E of Molena, 50 m N of St. Route 109. 6 March 2003. S. Graham and B. King. Verified by Craig Guyer. AU 36378–36380. New county records.

Pseudotriton montanus flavissimus (Gulf Coast Mud Salamander). CLAYTON CO.: Found under log in Flint River floodplain 75 m NW of private residence on S. Hampton Ct. (33°28'5.0"N, 84°30'56.7"W). 24 October 2006. E. Timpe. Verified by Craig Guyer. AHAP-D 19. New county record.

Pseudotriton montanus floridanus (Rusty Mud Salamander). COFFEE CO.: Found in first order creek confluence with the Seventeen Mile Creek floodplain in General Coffee State Park, 50 m S of campground. 5 April 2006. S. Graham. Verified by Craig Guyer. AHAP-D 20. ECHOLS CO.: Found under log 50 m N of Hwy. 129, 150 m SE of its intersection with Howell Rd (30°49'41.2"N, 83°11'2.3"W). 29 October 2006. S. Graham, E. Timpe, L. Giovanetto. Verified by Craig Guyer. AHAP-D 24. New county records.

Pseudotriton ruber vioscai (Southern Red Salamander). STEWART CO.: Found in seepage under log 100 m N of St. Route 26 bridge over Bluff Springs Branch (32°18'19.1"N, 84°35'00.5"W). 27 August 2006. S. Graham. Verified by Craig Guyer. AHAP-D 21. SUMTER CO.: Found in seepage under log 10 m N of Hwy. 280, 5.15 miles E of Plains (32°02'58.0"N, 84°20'13.8"W). 29 March 2006. S. Graham and E. Timpe. Verified by Craig Guyer. AHAP-D 22. New county records.

Serpentes

Farancia abacura abacura (Eastern Mudsnake). MCINTOSH CO. (SAPELO ISLAND): Found crossing Nannygoat Rd. 300 m E of University of Georgia Marine Institute. 25 April 2003. S. Graham. Verified by John Jensen. GMNH 49899. This is the first record for Sapelo Island (Laerm et al. 2000).

Lampropeltis triangulum elapsoides (Scarlet Kingsnake). MCINTOSH CO. (SAPELO ISLAND): Found on road ca. 1.6 km NW of University of Georgia Marine Institute (31°24'30.1"N, 81°17'07.1"W). 29 June 2003. S. Graham. Verified by John Jensen. GMNH 49894. First record of this species on Sapelo Island (Laerm et al. 2000). TALBOT CO.: Found crossing Po Biddy Rd. 5 km W of Flint River (32°45'26.3"N, 84°24'07.4"W). 21 July 2006. S. Graham and E. Timpe. Verified by Craig Guyer. AHAP-D 31. New county record.

Lampropeltis triangulum triangulum (Eastern Milksnake). MURRAY CO.: Found under rock along rock "fort" archaeological structure at Fort Mountain State Park. 3 May 2006. S. Graham. Verified by Craig Guyer. AHAP-D 14. New county record.

Lampropeltis calligaster rhombomaculata (Mole Kingsnake). GORDON CO.: Found crossing St. Route 156, 1.6 km W of its intersection with Cash Rd. and Owens Rd.; 5.59 km E of Calhoun. 2 May 2006. S. Graham and D. West. Verified by Craig Guyer. AHAP-D 20. New county record.

Regina septemvittata (Queen Snake). CLAYTON CO.: Found DOR on Fitzgerald Rd. 2 km S from intersection with Mundy's Mill Rd. 24 September 2003. S. Graham. Verified by John Jensen. GMNH 49895. New county record.

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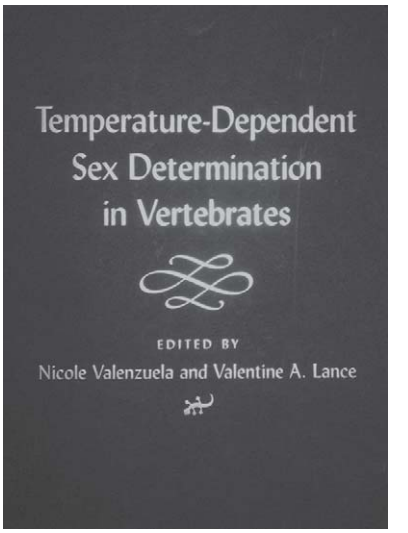
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BOOK REVIEWS

Herpetological Review, 2007, 38(4), 496–498.
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Temperature-Dependent Sex Determination in Vertebrates, edited by Nicole Valenzuela and Valentine A. Vance. 2004. Smithsonian Books, Washington D.C., distributed by NBN/ Rowman & Littlefield (www.rowmanlittlefield.com). vi + 194 pp. Cloth hardcover. US $69.95. ISBN 1-58834-203-4.

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In vertebrates, an individual's sex is influenced by a range of mechanisms, most of which can be grouped into one of two possible categories: genetic sex determination (GSD) and environmental sex determination (ESD); temperature-dependent sex determination (TSD) is categorized as a particular case of GSD. Nearly four decades have passed since the discovery that sex can be determined by temperature. *TSD in Vertebrates* is testament to fact that TSD research has blossomed since this time. In short, this title provides a synthesis of what is currently known about the ecological, physiological, molecular and evolutionary aspects of TSD. This book is arranged along four themes: prevalence of TSD in vertebrates; thermal effects, ecology, and interactions; evolutionary considerations; and conclusions: missing links and future directions. These sections are based on questions relevant to TSD: who possess TSD, how did it arise, how is it maintained, will it prevail, and what remains to be learned? In a brief introduction Valenzuela provides a short outline of the content of each Chapter and pertinent background on TSD in vertebrates, including a schematic figure illustrating the different patterns of TSD (i.e., TSD Ia, TSD Ib, TSD II).

In the first chapter, James Bull provides a past versus present perspective of sex determination with a view towards the future. He profiles how much of the early work that established the existence of TSD in reptiles, with particular emphasis on testudines, emerged and evolved from a sceptical academic environment. In fact, after learning of the existence of TSD as an undergraduate much of Bull's own research focus centered on disproving the existence of TSD in reptiles; presuming instead, that the apparent existence of TSD in this order was the result of differential mortality or from laboratory artefact. However, by 1978 Bull and colleagues

had adequate data to show that TSD occurred in at least four species of emydid turtles. In fact, it turned out there were two forms of sex determining mechanism within reptiles (i.e., sex-specific chromosomes and TSD). Bull acknowledges that one of the biggest challenges for workers of TSD in reptiles is how sex determined during a small phase of incubation influences fitness, particularly in long lived species. While the past two decades have provided a more thorough understanding of the taxonomic distribution of TSD, much of the original work has stood-up to past scrutiny. However, many problems still remain. He also highlights the importance of egg oestrogen content for sex determination; with particular emphasis on variation both within and among eggs and clutches and its influence on the sex of many species.

Chapter 2 by David Conover presents TSD in fishes. Due to the broad array of sex-determining systems identified both within and among fish species, definitions are provided for terms that are often used ambiguously. This chapter provides a summary of the TSD mechanisms in fishes and their evolutionary and ecological importance to natural systems, with the primary goals of highlighting gaps in our understanding of the adaptive significance of TSD to fish life history in nature and to providing motivation and advice for further investigation. Conover suggests that until studies of TSD move from the fishery to the wild we will remain ignorant of the ecology and evolution of what is perhaps the most diverse form of phenotypic plasticity in fish.

Chapter 3 (Michael Ewert et al.), focuses on modes, patterns and correlates of TSD in turtles. Using a combination of both previously published and original data the authors provide ample insight into the diversity of TSD in this group. They use rigorous statistical approaches to characterize TSD variation in patterns, pivotal temperatures, and transitional ranges both between and among species. Indeed, by examining and analyzing data for a few well studied species they were able to tease apart a number of other interesting patterns including, the correlation between pivotal temperature and transitional ranges, and the ecological significance and functionality of different transitions of geographic trends.

"Prevalence of TSD in crocodilians" is the title of Chapter 4 by Denis Deeming. Of the 25 species of living crocodilians, 12 posses TSD, and all are predicted to display the FMF pattern of TSD, due to their lack of heteromorphic chromosomes. However, the usefulness of TSD patterns observed in crocodilians are likely to be of limited value for understanding the TSD mechanisms of other reptiles, due to their closer phylogenetic affinities with archosaurs. Perhaps the most interesting aspect of this chapter is the list of potential explanations for the adaptive benefit of TSD in crocodilians. For instance, developmental asynchrony is presumed to be the result of male-determining factor (MDF) in the production of male offspring: eggs incubated above a threshold temperature for adequate duration of a specific thermally-sensitive period develop as male. Eggs that do not exceed this threshold during the thermally-sensitive period remain as female even at potential male developmental temperatures. In closing, Deeming suggests that much of the evolutionary success of crocodilians may be attributed to their ability to link gender, growth rate and other physiological conditions to environmental conditions.

In Chapter 5, Peter Harlow introduces considerable new data in a thorough review of the occurrence of TSD among lizard families (the group within which TSD was first described). In so doing, he expands on some earlier studies that lacked sufficient data to firmly conclude the presence of TSD. Finally, Harlow presents a probable adaptive scenario for TSD in a short lived, early maturing lizard—for which the effects of incubation temperature and seasonal timing of hatching are likely have the greatest effect on life-time reproductive success.

In the shortest chapter (Chapter 6; 6 pages), Nicola Nelson et al. provide an extensive overview of TSD in the two species of tuatara, using data from laboratory incubation and natural nests under field conditions. In short, this Chapter presents a nice mix of science and natural history information and observation. In closing, the authors acknowledge that while much of the well-known aspects of TSD in other reptiles remain unknown for tuatara, the information which has been gained up until now has greatly assisted management and conservation efforts of this order.

Thermal sex reversals in amphibians (Chapter 7; Dominique Chardard et al.), provides an in-depth perspective of sex determination in amphibians. For amphibians to date, the consensus suggests that sex determination is GSD, with the sex of some species being reversed at abnormally high or low temperatures. A description of the thermal effects of sex differentiation at the inter- and intra-specific level are presented; as few species have been examined in sufficient detail it is unknown how widespread this thermal lability is among amphibians. Indeed, to date, all work has focussed on the thermal effects of sex differentiation in the Anura and Urodela, with considerable research required on the Gymnophiona if the generality of thermal effects within the Amphibia is to be resolved.

Following this, Marshall McCue introduces readers to the 'General effects of temperature on animal biology' (Chapter 8), which provides a review of the general thermal biology of vertebrates. Included in a table, are definitions of some of the more commonly used terms, thermal limits, thermal sensitivity, and acute and chronic thermal effects on vertebrates. Understandably, there is much emphasis placed on ectotherms, with the discussion focused at varying levels of biological organization. This Chapter serves well to refresh the reader of biological phenomena important to those processes integral to temperature effects.

Relating the thermal effects influencing sex ratios measured under laboratory conditions to what happens in the field is the main focus of Chapter 9, 'Thermal models of TSD under laboratory and field conditions' (Arthur Georges et al.). Because the ways temperature affects incubation duration and sex determination is of central importance, the authors highlight three main steps to quantify the interaction between mean nest temperature and daily variation in temperature in the field, including: accommodating the interaction between mean nest temperature and daily variation in temperature, non-invasively identifying the thermosensitive period (TSP), and predicting the outcome of sex differentiation during complex thermal conditions. To resolve these issues, they present mathematical and descriptive models for TSD under different scenarios. They present information on the way temperature affects development and sex ratios under laboratory and field conditions, and provide information on how nest temperature data can be used to predict embryonic developmental trajectories, TSPs and the sex of hatchlings. The greater rate of embryonic developmental at higher temperatures implies that more development occurs above the mean incubation temperature than below it (Bull

and Vogt 1981; Pieu 1982). To ameliorate the difficulties associated with comparing results from controlled laboratory experiments and variable temperature regimes, Georges et al. present both a 'degree-hour approach' and 'constant temperature equivalent' (CTE) approach, that focus on development rather than absolute time.

Chapter 10, Phenotypic effects of incubation temperature in reptiles (Turk Rhen and Jeffrey Lang), reviews the effects of incubation temperature on the morphological traits of GSD and TSD species unrelated to sex, and how it relates to fitness. While there is considerable information on the biology of reptiles, much of the discussion of this chapter is somewhat removed from the rest of the book. However, much of the information presented is relevant for adaptive evolutionary explanations of TSD.

Chapter 11, 'The temperature-dependent sex determination drama: same cast different stars' (Allen Place and Valentine Lance) reviews current knowledge of the molecular networks associated with sex determination and differentiation in amniote vertebrates, beginning with mammalian and bird GSD systems and comparing these with TSD in reptiles. This chapter is well presented with detail and descriptions of genes, and their location on chromosomes for each family, and their putative functions.

Yolk steroid hormones and their possible roles in TSD is the title of Chapter 12 (Pamela Elf). Here, the focus is specifically on reptiles, a group that has received little work in terms of maternally derived hormones on sex differentiation, compared to mammals and birds. Hypotheses on mode of action, including published and unpublished observations on the dynamics of yolk hormones during development in TSD species are described. Indeed, it appears this area of research is beginning to gain momentum (Elf 2003; Radder et al. 2007).

Chapter 13 (Fredric Janzen and James Krenz) presents and discusses results of phylogenetically-based character analyses to determine whether TSD or GSD was the basal sex-determining mechanisms in vertebrates. The results suggest that while GSD appears ancestral, with TSD basal for sauropsids, the timing of its earliest appearance differs depending on the particular phylogenetic hypothesis chosen. Presumably, such ambiguities may be clarified as phylogenies gain increased resolution.

Chapter 14 (Nicole Venezuela) reviews hypotheses that attempt to explain the origins, diversification, maintenance and loss of TSD among vertebrate groups. Adaptive and neutral scenarios are discussed on the basis of whether they relate to genetic or environmental, maternal or paternal effects on gonadal sex and morphological traits, and whether they affect survival, fecundity or sex ratios. The distinction is made between short- and long-lived species with regards to the collection of relevant data and different hypotheses. Much emphasis is placed on examining the evolution of TSD using a comparative approach at varying levels of biological organization.

The final Chapter (Chapter 15; Girondot et al.) presents an improved age-structured model of population dynamics that incorporates various parameters that account for some of the unique traits of TSD taxa. A review of primary and secondary sex ratios is reviewed, and the suitability of alternative methods for measuring such ratios is provided. How primary and operational sex ratios influence population dynamics and differences in population sex ratios between TSD and GSD taxa is examined. Based on an unpublished phylogenetic analysis the most probable sex-determining pattern is inferred for various species for which this information is unknown. The authors also examine the reliability, using theoretical and empirical cases, of considering TSD as a factor in species decline. In closing, Valenzuela places the preceding fifteen chapters in perspective by highlighting gaps in the knowledge and potential areas of fruitful future research. She also provides an overall summary view and conclusions.

To close, this work brings together a wealth of information on TSD from a broad range of sources. The text is complemented by numerous tables (20), and figures (35), and there are relatively few typographical errors. Further, while recent work has identified TSD in a megapode bird (Goth and Booth 2004), it is absent altogether from the mammalian vertebrate class, suggesting the book's title is too general and may be misleading to some. I believe the price (US $70.00), while reasonable for an academic publication that includes contributions from many world-leading authorities, may be out of reach for many students. Given the rate at which TSD continues to attract research attention much of the content of this book is already dated. Nonetheless, this volume should prove useful to a wide range of biologists, interested in TSD and sex-determination mechanisms in general, and should become a core reference for those working on issues pertaining to TSD for years to come.

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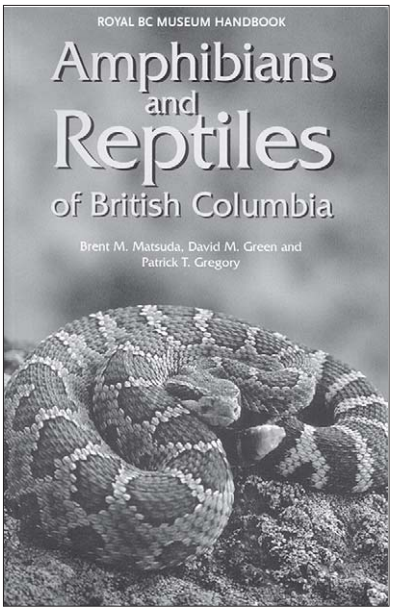
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Royal BC Museum Handbook. Amphibians and Reptiles of British Columbia, by Brent M. Matsuda, David M. Green and Patrick T. Gregory. 2006. Royal British Columbia Museum, 675 Belleville Street, Victoria, BC, Canada V8W 9W2. [6] +266 pp., 16 pp. pls. Softcover. CN$25.95 (approx. US$25.00). ISBN 0-7726-5448-4.

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The present volume is the third generation of a series of amphibian and reptile guides for British Columbia published by the Royal British Columbia Provincial Museum, beginning with the handbooks of Carl (1943, 1944), and continuing through those of Gregory and Campbell (1984) and Green and Campbell (1984). It gives both the amateur and the professional a good handle on the British Columbian amphibian and reptile fauna (20 native and two introduced amphibians, 16 native and one introduced reptile).

The book is divided into an introductory portion and a field guide. The Introduction, 61 pages in length, consists of a series of short general discussions of various aspects of amphibian and reptile biology. In each, various features of the British Columbia amphibian and reptile fauna are noted, where appropriate. The Introduction comprises a good, if short, summary of amphibian and reptile morphology, physiology and ecology, and as such will be principally of use to readers with less knowledge of the more academic aspects of herpetology. This is not to say that it is unduly simple or watered-down; ectothermy, for instance, is discussed as a physiological strategy permitting the allocation of resources overwhelmingly into growth and reproduction while allowing a miniscule adult mass; thus we can have very abundant little salamanders in cool climates. Apparent gaps, such as the failure, in the section on Venoms, to mention tetrodotoxin in *Taricha*, are generally made up in the species accounts. A section on folklore quite properly deals mainly with examples of the rich First Nations oral traditions. The topics of where to find amphibians and reptiles, and how to deal with them in captivity, are, quite rightly, hedged with cautions on the legal issues surrounding all aspects of dealing with wildlife these days, and discussions of the ethics of the wild animal trade. Issues of conservation status and protection for British Columbia's amphibians and reptiles are dealt with briefly in the text, but a checklist of all of the British Columbian species features their present provincial (British Columbia Ministry of Environment) and federal (Committee on the Status of Endangered Wildlife in Canada) statuses. The Introduction ends with a call for more formal and informal studies of British Columbia's amphibian and reptile fauna, pointing out how much remains to be done, even at the level of basic ecology and ascertaining range limits. The interested amateur is referred to an appendix listing government and academic contacts for formal reporting of observations. Rapid and wide dissemination of locality records is encouraged.

The Introduction is peppered with small pen-and-ink or pencil drawings of various British Columbian amphibians and reptiles, generally germane to the adjacent text. These are delicate and detailed, the result of close attention to anatomical detail and characteristic attitudes.

The field guide portion consists of keys and individual species accounts. These are laid out systematically, and are restricted to native species and established exotics. Species with occasional, accidental or possible occurrences in the province are dealt with elsewhere. A dichotomous key to the adults of each order to be found in British Columbia precedes the species accounts of that order, with some simple clear illustrations of the morphological features mentioned (illustrations of a salamander and an anuran with limbs adpressed would have been useful here; also, the figure of a frog's face labeled "eyes vertical" (p. 109) might better have been labeled "upturned eyes", as this is the expression used in the text); technical terms used in the keys are also defined in the Glossary at the end of the book. A field key for snakes is followed by a laboratory key. There are no keys for amphibian larvae, and the reader is, quite properly, referred to Corkran and Thoms (1996) for these. Each species account is headed by the currently accepted colloquial and Latin binomial (Green, 1999; Gregory and Gregory, 1999; Crother et al., 2000; Crother et al., 2003; the revisions of Frost et al., 2006 are not accommodated) for the species, with alternate colloquial names listed immediately below. These are generally followed by a short paragraph summarizing recent relevant taxonomic changes, general remarks on cardinal features of the genus or family if this species is the first or only such to be dealt with in the book, its status in British Columbia, and the like. A description of the species' appearance follows; for amphibians, larval morphology and development are also briefly described. A color plate (all of these are bound in a single signature) is associated with each description. These are generally sufficient to identify a specimen in the hand to species, and for the most part the animals are suitably framed and represent British Columbia populations. Plates illustrate cases of possibly confusing polymorphism (*Ensatina eschscholtzii*, the three *Thamnophis* species, juvenile and adult *Coluber constrictor*, neotenic and terrestrial *Dicamptodon tenebrosus* and *Ambystoma tigrinum*). A short list of the distinguishing features comes immediately after, longer in cases (such as the three species of *Thamnophis*, or the four species of "brown spotted frogs") where there is scope for misidentification; the authors are quite frank about the possibilities for confusion here. The section on habits briefly delineates what is known of habitat preferences, diet, behavior, predators, etc., with reference particularly (and explicitly) to what is known from the literature on British Columbia populations; the authors note more than once that

this is not extensive for some species. A section on breeding describes courtship behavior, calls (for anurans), oviposition, clutch size and characteristics, and again for amphibians, a few remarks on larval morphology, behavior and development. This is followed by a short note on subspecies, if any, and which are represented in British Columbia, and a description of the geographic distribution, both extralimital and within the province; this last is also illuminated by a dot map of documented provincial localities for the species in question (introduced and native populations are distinguished by symbol). Each account is rounded off with a short list of relevant citations, generally but not always from the primary literature and again with an emphasis on British Columbia. A detailed pen-and-ink drawing of an adult representative of the species is either within the species account or on the preceding facing page. These are done with a good eye and a careful hand, and for most of the species would be sufficient to identify specimens in the hand, without further reference to the text or keys; the exceptions are the species which would take some close examination and pondering anyway.

The species accounts are generally clearly-written and unambiguous, and there is little to find fault with. I was somewhat puzzled to note that the picture of the Boreal Chorus Frog (*Pseudacris maculatus* – p. 131) had its lateral stripe terminate in the axillary region, rather than (as described in the text) at the groin. This is more than compensated for by the description of the leopard frog's breeding call as resembling "a fart in a tight pair of chest waders" (p. 151). One can only defer to the authors' experience here. A few omissions rather surprised me. For instance, there is no reference to the caudal glandular ridge and the dermal toxin produced by the Long-toed Salamander (*Ambystoma macrodactylum*), although these features are strikingly evident to anyone who handles one for any length of time. However, these and the few other such lacunae that I noted are of no great consequence. Even a neophyte would be able to identify a capture to species using this book, would be reliably informed about its biology, and would be clearly directed to further sources of information on it.

The species accounts are followed by a short section on amphibians and reptiles that might be encountered in British Columbia—possible undiscovered natives (such as the Cascades Frog, *Rana cascadae*), exotics which survive in the province but do not successfully breed, such as Red-eared Slider Turtles (*Trachemys scripta*), and possible accidentals such as Loggerhead Sea Turtles (*Caretta caretta*). Common unestablished exotics and accidentals may be described in sufficient detail for diagnosis, but possible undiscovered natives are simply listed. The guide ends in a Glossary, its definitions clearly-written and adequately supplementing the text, and a Bibliography, divided into Additional Reading (field guides and general works) and References (sources, mainly primary literature, cited in the text).

A good regional field guide should be the reference of first resort within its geographical limits. The present volume mostly succeeds in this—it must be supplemented with the easily-available Corkran and Thoms (1996) for larval identification, but the latter's keys are difficult to improve upon. I can recommend Amphibians and Reptiles of British Columbia without hesitation to anyone interested in the amphibian and reptile fauna of western Canada. It serves as a useful benchmark to what's currently known about British Columbia's amphibians and reptiles, actively and constructively solicits new observations from all and sundry, and will encourage further research.

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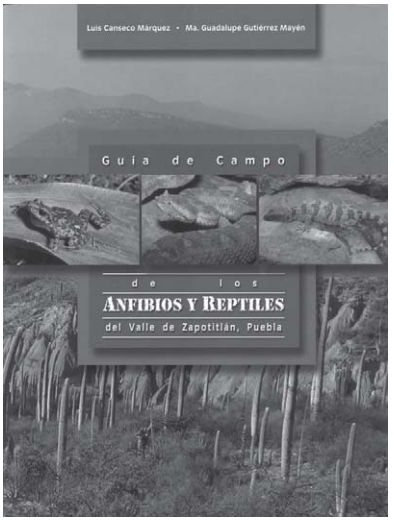
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Guía de Campo de los Anfibios y Reptiles del Valle de Zapotitlán, Puebla, by Luís Canseco Márquez and Guadalupe Gutiérrez Mayén. 2006. Sociedad Herpetológica Mexicana, A. C., Escuela de Biología, Benemérita Universidad Autónoma de Puebla. México, D. F., México. 78 pp. Softcover. MXN $160 (available for US $24.00 from Bibliomania!; www.herplit.com).

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The Valle de Tehuacán-Cuicatlán, actually a complex of five smaller valleys, comprises one of Mexico's four desert systems (Briones 1994). One of these, the Valle de Zapotitlán de las Salinas, may well be considered the pearl of the Pueblan high desert. I first saw this magical place nearly thirty years ago when Jonathan Campbell and I camped near the home of the Pacheco Gil family along the Río Salado. It was then that I got my first look at snakes like *Lampropeltis triangulum campbelli* (as yet undescribed), *Leptotyphlops maximus*, and *Trimorphodon tau*. Some of my fondest memories include wandering among the *Agave-Beaucarnia-Yucca* associations (*izotales*) along the high ridges in search of *Ophryacus melanurus*, *Phrynosoma braconnieri*, and *P. taurus*. As a plant enthusiast, the presence of three endemic *Dioon* species made things all the more special.

Zapotitlán is rough country, and its wildlife can swelter as much as two years between rains. The Pacheco Gil family claimed there were turtles in the basin. Standing there listening to them while the dust blew, looking at their meager supply of drinking water, it was simply impossible to believe that a turtle could exist anywhere near the spot. So, after a bit of banter, we told the family we would come by in a month, on our way back north from Guatemala, to see what they had produced. And wouldn't you know it, four weeks later we stood speechless before them as they chuckled and handed up a dozen *Kinosternon integrum*. One can scarcely imagine the type of existence led by these turtles, inert and buried for most of their lives.

Recently the basin has been the object of excellent investigations dealing with vegetation, physiography, and habitat destruction (among others: Arias et al. 2001; Montoya-Ayala 2000; Osorio et al. 1996; Valiente-Banuet et al. 2000; Villaseñor et al. 1990). It is recognized as a world center for megadiversity and endemism by the IUCN (Dávila et al. 1991, 2002). Ironically the fauna has been little studied, so when Canseco Márquez and Gutiérrez Mayén (1996) published a list of 32 species of reptiles and amphibians and announced their plans to produce a comprehensive field guide to the region (ARVZ), it was good news, indeed.

While the authors were engaged in fieldwork for their book, Mata-Silva (2003) published a comparative study examining populations of amphibians and reptiles in the basin versus the impact of habitat destruction. Subsequently, Woolrich Piña et al. (2005) increased the species total to 35 and presented a nicely illustrated guide that unfortunately is already out-of-print and difficult to obtain. Publication of ARVZ expanded the list for Zapotitlán de las Salinas to 40 species comprising 7 amphibians and 33 reptiles in 32 genera representing 17 families.

Both guides contain illustrated keys and ARVZ is noteworthy for its excellent line drawings of snakes. Despite including comprehensive color photographs, neither guide provides captions or locality data for the specimens illustrated, or a "Remarks" section. Woolrich Piña et al. (2005) includes a useful summary of comparative literature and ARVZ contains interesting notes about distribution and natural history for most species. Still, the reader is left clueless as to why the species recognized as *Ctenosaura pectinata* by Woolrich Piña et al. is referred to as *C. acanthura* in ARVZ.

The two guides provide extensive illustrations and descriptions of habitats and vegetation and ARVZ includes maps of the area. Scientific nomenclature used in ARVZ is more current than that used by Woolrich Piña et al. Inclusion of subspecies would have rendered both guides more useful. Area of coverage is specifically the Zapotitlán Basin in Woolrich Piña et al., while ARVZ includes surrounding ridges. Inasmuch as the latter only represents five additional species, the broader coverage provided by ARVZ makes more sense.

Why review a guide with such limited coverage? Because the region is unique and important, the habitat is fragile, and the 40 species are so difficult to obtain that their mere acquisition represents as much work as a broader assemblage would entail. The authors of ARVZ have done a nice job in treating this important herpetofauna and presenting their data in a readable, informative manner.

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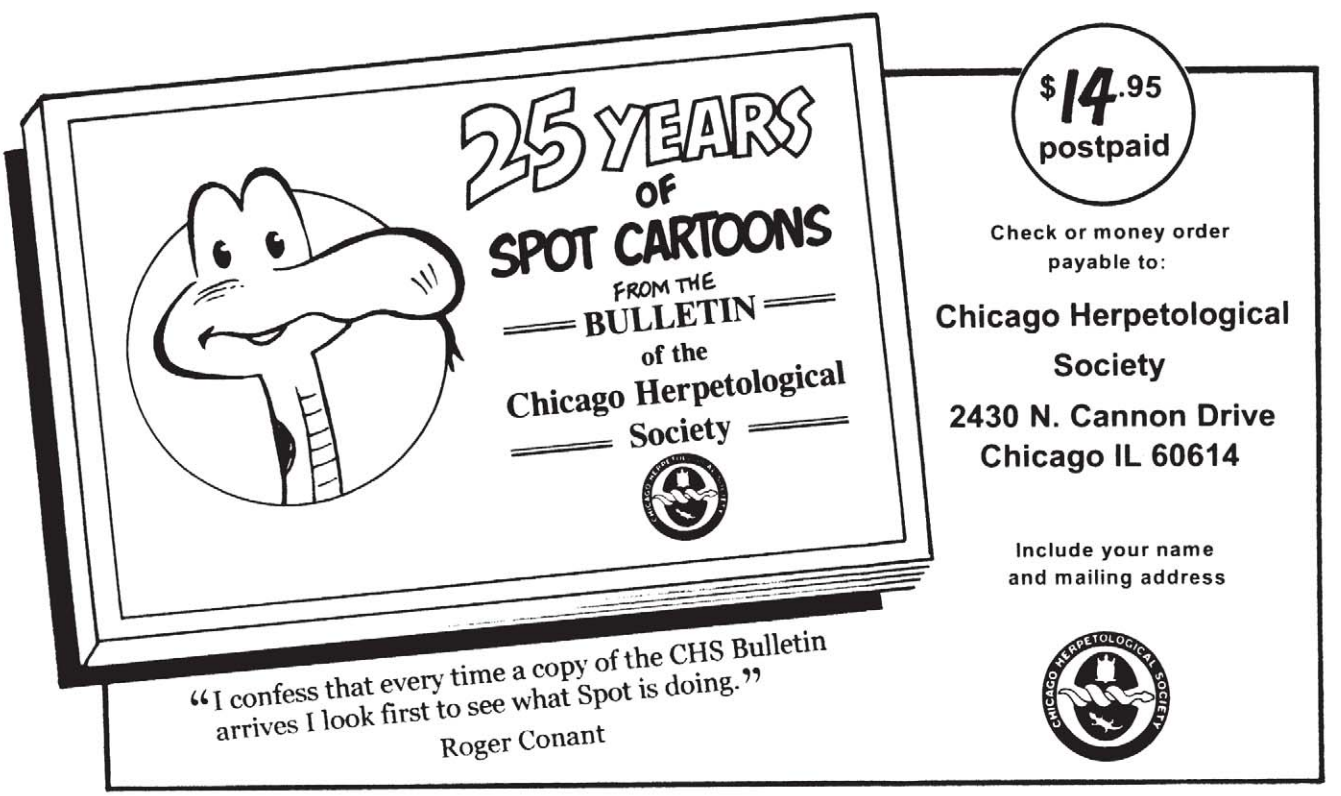
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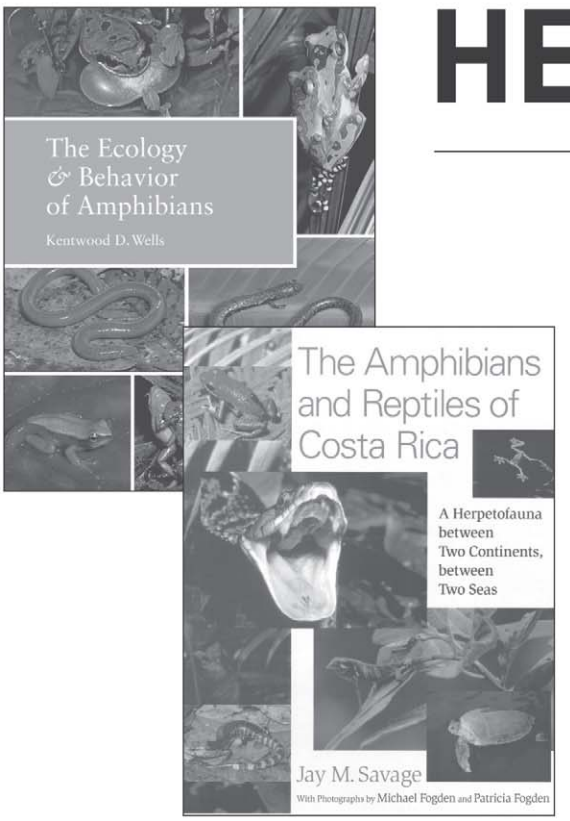
Volumes 1 (1989) and 2 (2007)



Volume 2 in this series was published by SSAR in July (see *Herpetological Review*, June 2007, p. 130, and *Journal of Herpetology*, September 2007, p. 544, for ordering details).

Note: Volume 1, out of print by 2000, has now been put on the web for public access at www.ssarherps.org (click on "Publications").





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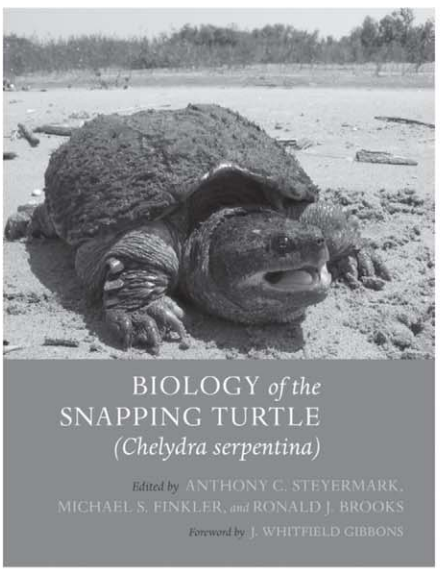
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BIOLOGY OF THE SNAPPING TURTLE *(Chelydra serpentina)*

edited by Anthony C. Steyermark, Michael S. Finkler, and Ronald J. Brooks
foreword by J. Whitfield Gibbons

The name "snapping turtle" conjures up images of powerful, prehistoric-looking beasts that lurk in the dark waters of local swimming holes. Beyond its status as childhood legend, *Chelydra serpentina* is one of the most interesting reptiles of the New World. One of our largest turtles, this animal has a nasty bite, weighs up to thirty-five pounds, and can lay as many as one hundred eggs. Due to its wide distribution, abundance, and large reproductive output, the snapping turtle has become one of the most extensively studied species of reptiles.

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First Announcement

Current Research on Herpetofauna of the Sonoran Desert IV

April 11–13, 2008

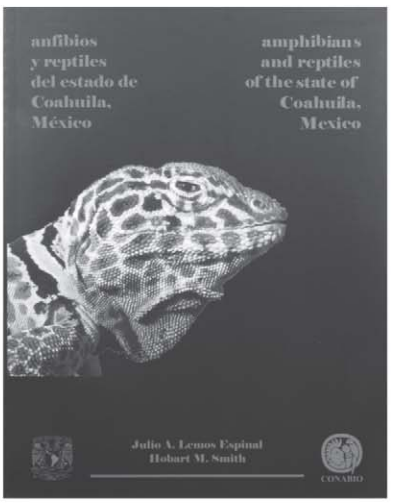
Tucson, Arizona

The Tucson Herpetological Society (THS) and co-sponsors are pleased to announce the fourth meeting of *Current Research on Herpetofauna of the Sonoran Desert* (CRHSD). The first CRHSD meeting was held at The Phoenix Zoo April 9–10, 1999. This conference, co-sponsored by the Arizona Game and Fish Department, Arizona State University West, and The Phoenix Zoo, was hugely successful with a number of would-be registrants turned away due to seating limitations. Since then, this event has been held every 3 years and has grown in interest and enthusiasm. The second CRHSD meeting, sponsored by the THS and others, was held in April 2002 in Tucson, and the third meeting was hosted by ASU in Phoenix in April 2005.

The goals of this fourth meeting are two-fold: 1) dissemination of information concerning research on the herpetofauna of the Sonoran Desert (in the states of Arizona, Sonora, and on the Baja California peninsula and gulf islands); and 2) provide opportunities for social interaction and dialogue among meeting participants.

The meeting will begin on Friday evening with an Icebreaker Social Event. Scientific Sessions on Saturday and Sunday will include approximately 30–40 oral presentations as well as poster presentations. Saturday evening will include a Social Hour followed by a Banquet. There will be three invited speakers at the meeting. Harry W. Greene, Professor at Cornell University, will open the Scientific Session on Saturday morning. Cecil Schwalbe, of the U.S. Geological Survey, will be the Banquet speaker on Saturday evening, and Edward O. Moll, Professor Emeritus at Eastern Illinois University and Adjunct Professor at the University of Arizona, will be the featured speaker on Sunday morning.

The CRHSD IV second announcement will be made in the fall and will include registration information, call for papers, and information on accommodations at the Inn Suites Hotel. All information is available on the THS web site (www.tucsonherpsociety.org). We hope you will mark your calendar and plan to attend what will be the continuation of an exciting and informative scientific meeting.



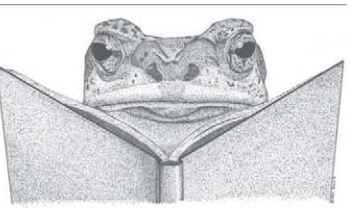
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Volume 38, Number 4
December 2007

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The Society for the Study of Amphibians and Reptiles, the largest international herpetological society, is a not-for-profit organization established to advance research, conservation, and education concerning amphibians and reptiles. Founded in 1958, SSAR is widely recognized today as having the most diverse society-sponsored program of services and publications for herpetologists. Membership is open to anyone with an interest in herpetology—professionals and serious amateurs alike—who wish to join with us to advance the goals of the Society.

All members of the SSAR are entitled to vote by mail ballot for Society officers, which allows overseas members to participate in determining the Society's activities; also, many international members attend the annual meetings and serve on editorial boards and committees.

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Future Annual Meetings

2008 — Montreal, Canada, 23–28 July (with ASIH, HL)
2009 — Portland, Oregon (with ASIH, HL)

About Our Cover: *Adenorhinos barbouri*

The Udzungwa Short-Headed Viper, *Adenorhinos barbouri*, is among the rarest and least known vipers in Africa. Known from only a few localities in the Udzungwa and Ukinga Mountains of southwestern Tanzania, *A. barbouri* was described in 1930 by Arthur Loveridge (Proc. New England Zoöl. Club 11:107–108), who placed it within the genus *Atheris*. It has been seen few times since, and until the discovery of this specimen, had yet to be photographed alive. The snake remains enigmatic—museum specimens number fewer than 25 and several of these were obtained as dead specimens from local farmers or tea estate workers.

After Loveridge formally described the species from localities in the Udzungwas, he reported on a collection of additional material in 1933 (Bull. Mus. Comp. Zoöl., Harvard College 74[7]:195–416), extending the range south to the Ukinga Mountains, which have volcanic origins in the East African Rift rather than the more ancient Eastern Arc orogeny. Remarkably, no specimens of *Adenorhinos* were reported for nearly 50 years following this publication. A few individuals were sporadically collected during the 1980s and 1990s, in large part because of focused efforts to locate the species. Instrumental in these efforts was Jens Rasmussen, the late curator of herpetology at the University of Copenhagen who, along with Kim Howell (University of Dar es Salaam, Tanzania), summarized all known information on *Adenorhinos* in a 1998 paper (Rasmussen and Howell 1998. Afr. J. Herpetol. 47[2]:69–75).

The taxonomy of *Adenorhinos* has fluctuated somewhat over the last 77 years. In his original description, Loveridge placed this snake within *Atheris*, the genus containing the African bush vipers. However, in light of several morphological apomorphies, in particular a unique subcutaneous compound mucus secreting gland, Marx and Rabb (1965. Field. Zool. 44[21]:161–206) elevated the species to its own genus, *Adenorhinos* (adeno = gland, rhinos = nose). *Adenorhinos* is unique in many additional respects as well, and several features led Marx and Rabb to place *Adenorhinos* near the base of the viperine radiation, a hypothesis that was supported by later morphological phylogenies (Groombridge 1986. *In* Z. Rocek [ed.], Studies in Herpetology, pp. 219–222. Proceedings of the Third Ordinary General Meeting of the Societas Europaea Herpetologica, Prague; Ashe and Marx 1988. Field. Zool. [N.S.] 52:1–23). It exhibits a foreshortened snout, a squat, seemingly terrestrial habitus, brown checkered coloration, and an extremely short tail. Hardly resembling the bush vipers at first glance, *Adenorhinos* has several hallmarks of a terrestrial lifestyle.

Nonetheless, affinities with the atherine bush vipers have been strongly supported by a recent molecular study (Lenk et al. 2001. Mol. Phylogen. Evol. 19[1]:94–104). Surprisingly, despite its disparate morphology, analysis of mitochondrial DNA places *Adenorhinos* well within the *Atheris* clade where it is sister to *Atheris ceratophora*, a horned bush viper and another endemic of Tanzania's ancient highland rainforests. If this result is supported by further molecular studies, *Adenorhinos* will represent the evolution of a truly different morphology from within a somewhat more conservative clade of relatives.



PHOTO BY MIKE HETTWER

Luke Mahler is a PhD candidate in the Department of Organismic and Evolutionary Biology at Harvard University. His thesis research investigates the role of ecological factors on rates and patterns of evolution in several families of lizards. Luke encountered this female *Adenorhinos* fortuitously in the Udzungwa Mountains of Tanzania in March 2007. The snake was photographed using a Canon 20D digital camera with a 100mm macro lens (f2.8) and an MT-24EX Twin Lite flash.

NEWSNOTES

USNM Collections Moving

The collections of the Division of Amphibians and Reptiles, National Museum of Natural History (Smithsonian Institution) are scheduled to be moved from the Natural History Building on the National Mall to a new storage wing at the Museum Support Center in Suitland, Maryland beginning about 1 October 2007 and continuing through the first week of April 2008.

It is anticipated that the collection management staff will be devoting significant amounts of time to preparing the collection for the move as well as moving the collection. It is realistic to assume that there will be significant periods of time between now and when the collection move is complete when there will be delays in processing loan requests and times when parts of the collection will not be available for examination by visitors. Visitors in particular should contact us well ahead of their projected visits to assure that collections will be available for their use. The collection will be moved by major taxonomic units. Each unit will be unavailable for study during the time that unit is being moved to the new facility.

Once the move has been completed, we will send out an announcement, including new contact information for the collection management staff as well as appropriate addresses to use for loan returns.

The Use of Amphibians in the Research, Laboratory, or Classroom Setting

The Institute for Laboratory Animal Research announced the publication of *ILAR Journal*'s most recent issue, "Use of Amphibians in the Research, Laboratory, or Classroom Setting" (vol. 48, no. 3). This important issue covers a broad range of topics relevant to research and related work with amphibians, as indicated in the table of contents: Introduction: The Art of Amphibian Science (Stephen A. Smith and Michael K. Stoskopf); Amphibians Used in Research and Teaching (Dorcas P. O'Rourke); Facility Design and Associated Services for the Study of Amphibians (Robert K. Browne, R. Andrew Odum, Timothy Herman, and Kevin Zippel); Amphibian Biology and Husbandry (F. Harvey Pough); Reproduction and Larval Rearing of Amphibians (Robert K. Browne and Kevin Zippel); Diseases of Amphibians (Christine L. Densmore and D. Earl Green); Medicine and Surgery of Amphibians (Edward J. Gentz); Amphibians as Animal Models for Laboratory Research in Physiology (Warren W. Burggren and Stephen Warburton); Amphibians as Models for Studying Environmental Change (William A. Hopkins); IACUC Issues Associated with Amphibian Research (Leanne C. Alworth and Stephen B. Harvey); Amphibian Resources on the Internet (Michael W. Nolan and Stephen A. Smith); Compendium of Drugs and Compounds Used in Amphibians (Stephen A. Smith). To purchase copies of this issue or for more information about the *ILAR Journal*, please visit our website: http://dels.nas.edu/ilar_n/ilarjournal/journal.shtml. In

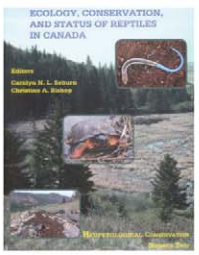
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Herpetological Conservation

ECOLOGY, CONSERVATION, AND STATUS OF REPTILES IN CANADA by Seburn and Bishop (eds.)

This volume covers the current view of the status of all 46 species Canadian reptiles and the difficult issues faced in their conservation. Overviews of the ecology and conservation of the major groups (turtles, sea turtles, snakes, and lizards). Published in association with the Canadian Amphibian and Reptile Conservation Network. x + 246 pp., clothbound with a dust-jacket. June 2007. ISBN 978-0-916984-70-0. $40.00 (member price until Nov. 2007 $32.00) plus shipping.



Facsimile Reprints in Herpetology

THE LIFE AND HERPETOLOGICAL CONTRIBUTIONS OF MARIO GIACINTO PERACCA (1861-1923)

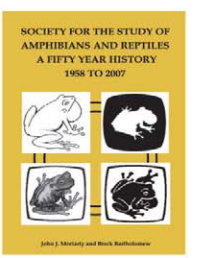
Mario Peracca was one of the foremost Italian herpetologists of the late 19th and early 20th centuries. He published numerous faunal works and described 72 species in 64 papers–all of which are reproduced in this facsimile. He was a pioneer of reptile husbandry, keeping a great diversity of species. The book includes an extensive biography, bibliography and synopsis of taxa by Franco Andreone and Elena Gavetti. Published in cooperation with Societas Herpetologica Italica. 570 pp., clothbound. February 2007. ISBN 978-0-916984-69-4. $55.00 plus shipping.



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A REVIEW OF MARKING AND INDIVIDUAL RECOGNITION TECHNIQUES FOR AMPHIBIANS AND REPTILES by Ferner

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MEETINGS

Meetings Calendar

Meeting announcement information should be sent directly to the Editor (rwh13@csufresno.edu) well in advance of the event.

11–14 October 2007—29th Annual Meeting of the Gopher Tortoise Council, Milton, Florida, USA. Information: http://www.gophertortoisecouncil.org/.

2–4 November 2007—34th Annual Meeting, Kansas Herpetological Society, Topeka Zoo, Topeka, Kansas, USA. Information: http://www.cnah.org/khsAnnualMeetingInfo.html.

23–27 June 2008—6th Symposium on Lacertids of the Mediterranean Basin, Lesvos Island, Greece. Information: http://www.gli.cas.cz/seh/news/6th%20Lacertids%20Symposium%20-%20First%20Circular.pdf.

17–22 August 2008—6th World Congress of Herpetology, Manaus, Brazil. Information: www.worldcongressofherpetology.org.

CURRENT RESEARCH

The purpose of **Current Research** is to present brief summaries and citations for selected papers from journals other than those published by the American Society of Ichthyologists and Herpetologists, The Herpetologists' League, and the Society for the Study of Amphibians and Reptiles. Limited space prohibits comprehensive coverage of the literature, but an effort will be made to cover a variety of taxa and topics. To ensure that the coverage is as broad and current as possible, authors are invited to send reprints to the Current Research section editors, **Michele Johnson** or **Josh Hale**; postal and e-mail addresses may be found on the inside front cover.

The current contents of various herpetological journals and other publications can be found at: http://www.herplit.com/contents.

Influence of Altitude and Topography on Population Structure in Salamanders

Understanding the influence of abiotic factors on the spatial distribution of genetic variation is one of the primary goals of molecular ecology. The authors investigated the effects of altitude and topography on genetic variation in *Ambystoma macrodactylum*, the long-toed salamander, in northwestern Montana. They sampled individuals (N = 549) from 10 low altitude (< 1200 m) and 11 high altitude (> 1200 m) populations and used seven microsatellite loci to genotype each individual. Genetic structure was analyzed using pairwise F_{ST} estimates, population graphing methods and Bayesian analyses of population structure. The authors found that gene flow was limited between high and low altitude populations and among high altitude sites. Results also showed that gene flow was relatively higher among low altitude populations. The authors propose that wide-scale spring flooding may account for the high genetic diversity of low altitude populations by facilitating gene flow among these populations, while harsh habitat and climatic conditions may explain the limited gene flow between high altitude populations. The authors also suggest that different life history characteristics of high and low altitude populations (e.g., clutch size, egg size, time to metamorphosis) may result from divergent selection pressures and could further contribute to the limited gene flow observed between high and low altitude populations.

GIORDANO, A. R., B. J. RIDDENHOUR, AND A. STORFER. 2007. The influence of altitude and topography on genetic structure in the long-toed salamander (*Ambystoma macrodactulym*). Molecular Ecology 16:1625–1637.

Correspondence to: Andrew Storfer, School of Biological Sciences, Washington State University, Pullman, Washington 99164-4236, USA; e-mail astorfer@wsu.edu.

Effect of Leaf-Litter Depth on Rainforest Frog Distribution

Anurans are recognized as an important component of leaf-litter communities in tropical forests; however, studies of microhabitat characteristics and their effect on these anurans are limited. To address this, the authors investigated the abundance, distribution and microhabitat of leaf-litter anurans in the Atlantic Rainforest at Ilha Grande, south-eastern Brazil. They conducted nocturnal and diurnal surveys, counting all frogs within 234 2m × 1m plots on the forest floor, and determined the depth, weight and composition of the leaf-litter from each plot. The authors found 185 frogs of eight species, each of which was endemic to the Brazilian Atlantic Rainforest: *Brachycephalus didactylus*, *Dendrophryniscus brevipollicatus*, *Adenomera marmorata*, *Eleutherodactylus binotatus*, *Eleutherodactylus guentheri*, *Eleutherodactylus parvus*, *Zachaenus parvulus*, and *Chiasmocleis* sp. Results indicated that the depth and proportion of leaves in the leaf-litter was positively related to frog abundance and species richness. The authors propose that species richness and abundance are higher in environments with deep leaf-litter because these environments provide a wider range of microhabitats—especially for egg laying, a greater number of refuges against predators, and a higher density of arthropod prey. They also found that while leaf litter depth and leaf composition correspond to higher anuran community diversity, individual species had different responses to local leaf litter conditions.

VAN SLUYS, M., D. VRCIBRADIC, M. A. S. ALVES, H. G. BERGALLO, AND C. F. D. ROCHA. 2007. Ecological parameters of the leaf-litter frog community of an Atlantic Rainforest area at Ilha Grande, Rio de Janeiro state, Brazil. Austral Ecology 32:254–260.

Correspondence to: M. Van Sluys, Departmento de Ecologia, Instituto de Biologia Roberto Alcantara Gomes, Universidade de Estado do Rio de Janeiro, Rua São Francisco Xavier 524, CEP 20550-013, Rio de Janeiro, RJ, Brazil; e-mail vansluys@uerj.br.

Delaying Parturition in a Viviparous Lizard

The delaying of parturition (i.e., birth) following the completion of embryonic development can be important for maximizing offspring fitness in challenging environmental conditions. This is especially true in ectothermic viviparous species, where the environment experienced by the female during pregnancy can profoundly influence both gestation length and offspring phenotype and fitness. The authors studied populations of the viviparous Snow Skink, *Niveoscincus ocellatus*, at the extremes of their altitudinal range in Tasmania, Australia, by investigating their ability to delay parturition in cold conditions and the fitness consequences for the offspring. Late-term pregnant females from both high (1200 m) and low (50–75 m) elevation sites were maintained in one of four treatments: control conditions in which they could effectively thermoregulate in a thermal gradient ranging 12–35°C (N = 60), or treatments at 10°C with no chance of thermoregulation for one (N = 60), two (N = 40), or three weeks (N = 40). The authors found that females from both the high and low altitude sites were able to delay parturition in cold conditions with no effect on offspring weight at birth, dispersal distance or survivorship after birth, with one exception: females from the high altitude site maintained at 10°C for three weeks were less able to delay parturition and suffered a decrease in offspring viability. The authors propose that while delaying parturition can act to maximize fitness in some conditions, in severe environments, such as those experienced by the high altitude population, the benefits of delayed parturition in response to environmental cues are reduced by the constraints of their short breeding season.

Atkins, N., R. Swain, E. Wapstra, and S. M. Jones. 2007. Late stage deferral of parturition in the viviparous lizard *Niveoscincus ocellatus* (Gray 1845): implications for offspring quality and survival. Biological Journal of the Linnean Society 90:735–746.

Correspondence to: Susan M. Jones, School of Zoology, University of Tasmania, Private Bag 5, Hobart, Tasmania 7001, Australia; e-mail: s.m.jones@utas.edu.au.

Marine Resources Subsidize Diet Of Desert Geckos

The movement of nutrients from aquatic ecosystems to coastal habitats via biotic and abiotic vectors can have a profound influence on terrestrial ecosystems. This is especially true in the Atacama desert in Peru, an arid area of extremely low productivity that faces the Peru-Chile cold current, one of the world's most productive marine ecosystems. To investigate the relationship between marine and terrestrial food webs in the Atacama desert, the authors surveyed populations of terrestrial consumers (i.e., desert invertebrates and geckos) and analyzed stomach contents and stable isotope ratios of carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) from several desert predators, one of which was the Paracas Gecko, *Phyllodactylus angustidigitus* (N = 105). The average number of geckos in near-shore plots was significantly higher than in desert plots situated inland, and the majority of gecko prey items were intertidal invertebrates, although the proportion of intertidal prey items covaried with the geckos' distance to the shore. The $\delta^{13}C$ isotope signatures of geckos was more similar to *Ulva*, a marine algae, than to terrestrial plants, and the $\delta^{15}N$ values suggested that geckos occupy a high trophic level in both the intertidal and desert nocturnal food webs. The authors compare these results to those from other desert predator species, and suggest that a lack of rainfall in the Atacama desert promotes a reliance on marine resources in these geckos and other desert species, which as a consequence, are more affected by variability in marine productivity than patterns of terrestrial plant growth.

Catenazzi, A., and M. A. Donnelly. 2007. The *Ulva* connection: marine algae subsidize terrestrial predators in coastal Peru. Oikos 116:75–86.

Correspondence to: Alessandro Catenazzi, Department of Biological Sciences, Florida International University, Miami, Florida 33199, USA; e-mail: acaten01@fiu.edu.

Potential Impacts of Climate Change on Marine Turtles

Climate change has the potential to affect the ecology, phenology and survival of many species, particularly thermally sensitive species. In the Loggerhead Seaturtle, *Caretta caretta*, sex is determined by temperature in the middle third of incubation. Female offspring result from high, and male offspring from relatively low, temperatures. To investigate potential affects of climate change on this species, the authors compiled 26 years of nesting site data from North Carolina, the northernmost nesting site for this species in the United States, with local climate data. They used these data to predict current sex ratios and to model possible changes under different climate change scenarios. Currently, North Carolina nesting sites produce proportionally more males than nests further south in Florida, which has the majority of nesting sites in the United States but produces less than 10% males. The results of their model show that a 2°C increase in air temperature would likely lead to the complete feminization of the primary sex ratios in Florida, and with a 3°C increase, incubation temperature would be above lethal. In contrast, the model shows that on North Carolina beaches, turtles need only shift temporal distribution of nesting by one week to adapt to a 3°C increase in air temperature. The authors highlight the importance of preserving the disproportionately significant male-producing beaches, especially those beaches that may be shielded from future climate change.

Hawkes, L. A., A. C. Broderick, M. H. Godfrey, and B. J. Godley. 2007. Investigating the potential impacts of climate change on a marine turtle population. Global Change Biology 13:923–932.

Correspondence to: Brendan J. Godley, Centre for Ecology and Conservation, School of Biosciences, University of Exeter, Cornwall Campus, Penryn TR10 9EZ, UK; e-mail: bgodley@seaturtle.org.

Geckos in Termitaria

Gymnodactylus carvalhoi, a gecko species found in the Brazilian Cerrado, appears to be entirely restricted to termitaria (i.e., termite nests), but reasons for this habitat specialization remain unknown. The authors tested three, non-exclusive hypotheses to explain this specialization, including: to avoid thermal extremes, to avoid predators, or to take advantage of abundant food. First, the authors used drift nets and pit traps to confirm that these geckos are restricted to termitaria, most likely only leaving to find new nests. The authors used data loggers to monitor temperature within and on the surface of four termitaria every 10 mins for 13 days. To assess the effect of predators on this population, and to determine diet, geckos were collected and examined for tail loss (N = 69), and stomach contents were analyzed (N = 60). Results showed that temperature remained relatively constant within the temitaria, buffering these geckos against external temperature extremes. Stomach content analysis revealed that termites are abundant and comprise the vast majority of the geckos' diet (92% of prey by number, 77% by volume). The authors suggest that the high frequency of tail loss indicates that predator avoidance is not an important factor. The authors concluded that a combination of thermal constraints, a paucity of other suitable refuges, and diet preferences explain the restriction of these geckos to termitaria in the Brazilian Cerrado.

VITT, L. J., D. B. SHEPHARD, J. P. CALDWELL, G. H. C. VIERA, F. G. R. FRANÇA, AND G. R. COLLI. 2007. Living with your food: geckos in termitaria of Cantão. Journal of Zoology, Online Early; doi: 10.1111/j.1469-7998.2006.00273.x.

Correspondence to: Laurie J. Vitt, Sam Noble Oklahoma Museum of Natural History, 2401 Chautauqua Avenue, Norman, Oklahoma 73072, USA; e-mail: vitt@ou.edu.

Chemicals Signal Status in Male Iberian Rock Lizards

Conspicuous badges of status play an important role in male competition in many species, preventing potentially costly fights by signaling fighting ability or dominance. Most previous studies have concentrated on visual or acoustic signals; however, it is increasingly being recognized that chemical signals can also indicate male status. To examine this, the authors determined whether chemicals in femoral gland excretions signaled dominance status in male Iberian rock lizards, *Lacerta monticola monticola*. The authors staged encounters between pairs of males (N = 30 males) to establish which individuals were dominant, while controlling for body size. Femoral secretions were collected from each male and analyzed with a gas chromatograph-mass spectrometer. A phytohaemagglutinin injection test was used to assess immune response from each lizard. Finally, behavioral responses to different components of the femoral gland secretions were also measured. Results were analyzed using both Principal Component Analysis and ANOVA. Dominant males had high levels of hexadecanol in their femoral gland secretions, a substance which was also shown to elicit aggressive behavior in males. Further, male immune response was correlated with the abundance of hexadecanol in the femoral gland secretions. The authors suggested that, because of its correlation with immune responses and the aggressive behavior it elicits in conspecifics, the hexadeconol content of femoral gland secretions may provide a reliable signal of male dominance and status in the Iberian Rock Lizard.

MARTÍN, J., P. L. MOREIRA, AND P. LÓPEZ. 2007. Status-signalling chemical badges in male Iberian rock lizards. Functional Ecology 21:568–576.

Correspondence to: J. Martin, Departamento de Ecología Evolutiva, Museo Nacional de Ciencas Naturales (MNCN), CSIC, José Gutiérrez Abascal 2, 28006, Madrid, Spain; e-mail: Jose.Martin@mncn.csic.es.

Timberland Rattlesnakes Use Public Information to Assess Foraging Locations

Animals generally make foraging decisions based on an integration of information from their own experience and from monitoring other foraging animals. The use of public information to make decisions about resource quality has been well studied in animals that live in groups, however, its importance for solitary animals is unknown. To address this, the author conducted choice experiments to determine whether public information, in this case chemical cues, inform foraging decisions in the timber rattlesnake, *Crotalus horridus*. All experiments were performed using 16 captive-born snakes. In the first experiment, snakes were given the choice between an arm of a T-maze containing chemical cues from a conspecific, and another arm with no cues. In the second, one arm of the T-maze contained the chemical cue of a fed, and the other of an unfed, conspecific. Finally, a third experiment, an arena trial, was designed to measure the amount of time spent in an ambush coil in areas previously occupied by fed or unfed conspecifics. Results revealed that snakes were more likely to choose the arm of the T-maze that contained the chemical cue of a conspecific over an untouched arm, but they did not distinguish between fed and unfed conspecifics. However, the results of the third choice trial showed that snakes spent more time in an ambush coil in areas previously occupied by fed than unfed individuals. The author concludes that public information may be a more important factor informing foraging decisions in solitary animals than previously thought.

CLARK, R. W. 2007. Public Information for solitary foragers: timber rattlesnakes use conspecific chemical cues to select ambush sites. Behavioral Ecology 18:487–490.

Correspondence to: Rulon W. Clarke, Department of Neurobiology and Behavior, Seeley G. Mudd Hall, Cornell University, Ithaca, NY 14853, USA; email: rwc13@cornell.edu.

Multiple Stressors and Frog Declines

Worldwide, more than 40% of the 6000+ described amphibian species have undergone alarming declines, with a number of studies having examined potential causing factors. However, the majority of these studies have concentrated on single stressors, which may mistakenly inflate the importance of a particular stressor in the decline. To address these concerns, the authors investigated the effect of two stressors, pesticides and introduced fish, on the

Mountain Yellow-legged Frog, *Rana muscosa*. Each lake, pond, and marsh encountered in the central southern Sierra Nevada of California (N = 6831 waterbodies) was categorized for frog and fish presence, and the surrounding habitat was surveyed and upwind pesticide use estimated. Results from multivariate generalized additive models suggested that while frog presence was influenced by multiple stressors, pesticide use contributed substantially more to frog presence or absence than introduced fish. Further, the topography of the waterbodies themselves was important, with sheltered waterbodies far more likely to have frogs, despite the presence of pesticide use. The authors suggest that windborne pesticides may be a crucial factor in amphibian declines, even in pristine locations, especially as pesticide exposure weakens immune responses in amphibians and increases susceptibility to disease. Finally, the authors emphasize the importance of investigating multi-factor causes in amphibian decline research.

DAVIDSON, C. AND R. A. KNAPP. 2007. Multiple stressors and amphibian declines: dual impacts of pesticides and fish on yellow-legged frogs. Ecological Applications 17:587–597.

Correspondence to: Carlos Davison, Environmental Studies Program, San Francisco State University, 1600 Holloway Avenue, San Francisco, California, 94132, USA; e-mail: carlosd@sfsu.edu.

Lizard Pollinator Mediates Positive Interactions Between Plant Species

Previous studies of indirect relationships between species have focused primarily on predator-prey and competitive interactions. However, indirect interactions can also be an important factor in mutualistic relationships. In this study, the authors tested whether the declining, endemic *Trochetia blackburniana* plant benefits from proximity to the endemic *Pandanus* plant in Le Pétrin, Mauritius. This positive interaction is thought to be mediated by the blue-tailed day gecko, *Phelsuma cepediana*, which moves between *Pandanus* thickets, the gecko's preferred microhabitat, and *T. blackburniana*, where it feeds on nectar and pollinates the plants. By comparing *T. blackburniana* plants growing close to (< 10 m) with those growing away from *Pandanus* (> 20 m), the authors confirmed that gecko visitation to *T. blackburniana* was related to its proximity to *Pandamus* plants. Also, by fitting a generalized linear mixed-model, the authors demonstrated that the number of fertilized fruits on the *T. blackburniana* plants was also positively related to proximity to *Pandamus* thickets, but results from a previous study show that these differences are unrelated to variation in soil quality. Finally, an experiment was conducted in which geckos were excluded from some *T. blackburniana* branches. This resulted in fewer fertilized fruits relative to branches on the same plant from which geckos were not excluded. The authors highlight the importance of considering these types of indirect, positive interactions in both plant and lizard conservation.

HANSEN, D. M., H. C. KIESBÜY, C.G. JONES, AND C. B. MÜLLER. 2007. Positive indirect interactions between neighboring plant species via a lizard pollinator. American Naturalist 169:534–542.

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ZOO VIEW

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Seventy-Five Years of Herpetology at the Smithsonian's National Zoological Park: The Facilities, Collection, People, and Programs

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A major challenge presented itself to zoo herpetologists since World War II: how could they become important players in a world of shrinking biodiversity and maximize the use of their collections? It is beyond the scope of this paper to provide specific details but what happened at the Smithsonian's National Zoological Park (NZP) over 75 years may mirror, in part, what happened at other zoo herp departments and at other zoos throughout the world and provide clues as to the substantial change during this period.

FACILITIES

"This building promises to be one of the finest of its kind in the world."

—William M. Mann in *1930 Smithsonian Annual Report, 100*

"The content of the art fulfills two roles; identifying the building as a reptile house, and artistically displaying the evolutionary history of reptiles. The large mosaic stegosaurus over the entrance connects present day reptiles to their larger ancestors. Pterodactyls clutching the corners of the portico ready to spring off into flight hint at the ancestral connection between birds and reptiles. The ten panels on the doors alternately display a lumbering stegosaurus and battling yin-yang lizards. Much like religious stained glass, the art is used in the traditional role as a means to communicate. A simple message is conveyed: 'these animals are all related, and here are some of their ancestors.'. . . The art enriches the experience of the building: yielding pleasure and education, two of the founding directives of the zoo."

—Gavin Farrell in *Smithsonian Institution National Zoological Park: A Historic Research Analysis* in 2004.

William M. Mann, Director of the National Zoological Park (NZP), and municipal architect Albert L. Harris traveled to Europe in the spring of 1929 to evaluate zoo reptile buildings to use as models for the new one being planned at NZP. Mann's vision was to construct a facility second to none by using artwork and architectural ornamentation prominently to place the visitor in a beautiful setting immersed in animal imagery. Only two years later, the National Zoo's Reptile House was opened to the public and

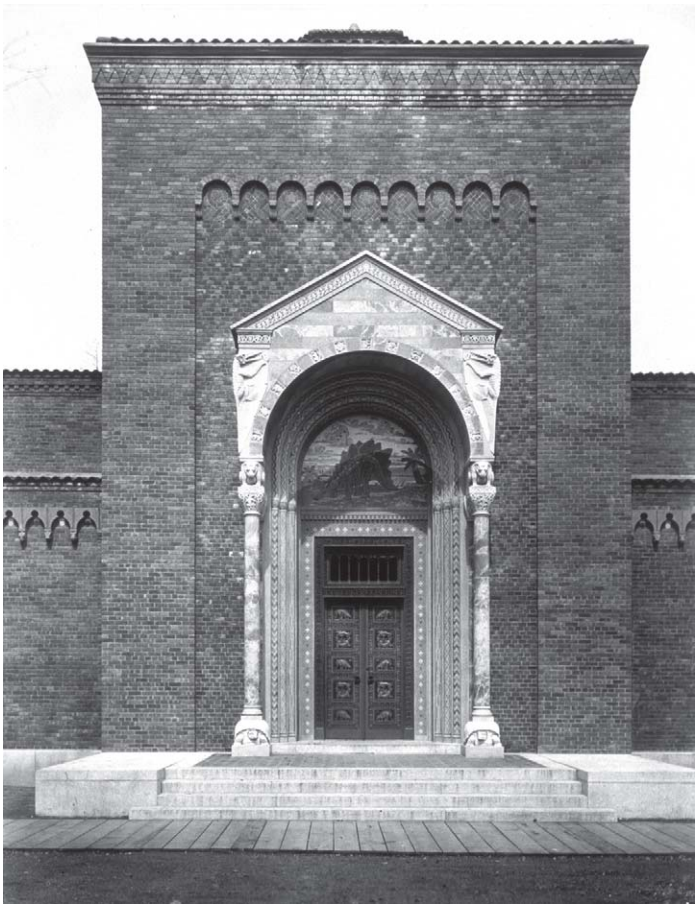


FIG. 1. Photograph of Reptile Building at National Zoological Park shortly after completion in 1931. Credit: National Zoological Park Photo Archives.

this impressive building remains one of the most beautiful reptile facilities in the world (Figs. 1–4). Ewing (1990) published a report called "An Architectural History of the National Zoological Park." According to Ewing, the architecture exemplifies the Italian Byzanto-Romanesque ecclesiastical style and the main cathedrals in Ancona and Verona, built in Romanesque style in Northern Italy, provided the idea for Harris' design. ". . . The brick structure was assembled in a building-block fashion, accumulating to form several ranges. Rising from a low asymmetrical level, the tower culminated in an octagonal drum and lantern . . . articulated with round windows encircled by alternating red and white marble blocks . . . the arch of the pedimented porch displayed small alternating curved blocks of little creatures: toads, turtles, lizards, etc. Under the cornice along the entire facade the arched corbels culminated in roughly-hewn abstracted reptiles. These terracotta figures served as subtle gargoyles, continuing the correlations with the cathedral model." Unfortunately, the original elevated porch leading to the entrance has been removed but the porch columns supported by turtles remain. The massive wooden entrance doors with essonite/gold leaf panels depicting many extinct and extant

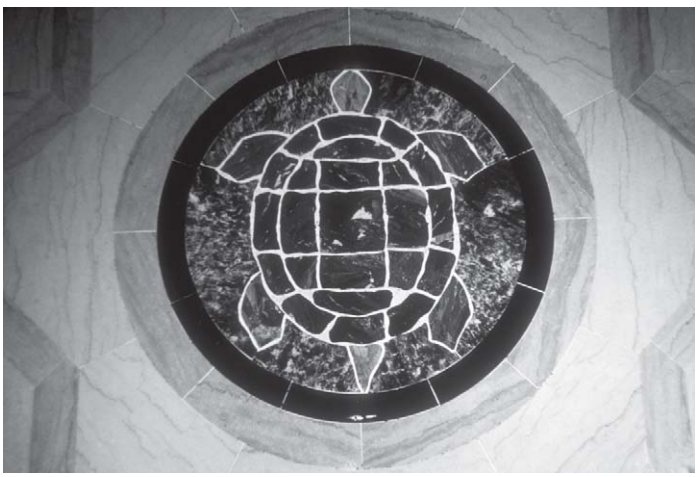


FIG. 2. Inlaid marble turtle mosaic medallion on floor by John Joseph Earley. Credit: National Zoological Park Photo Archives.

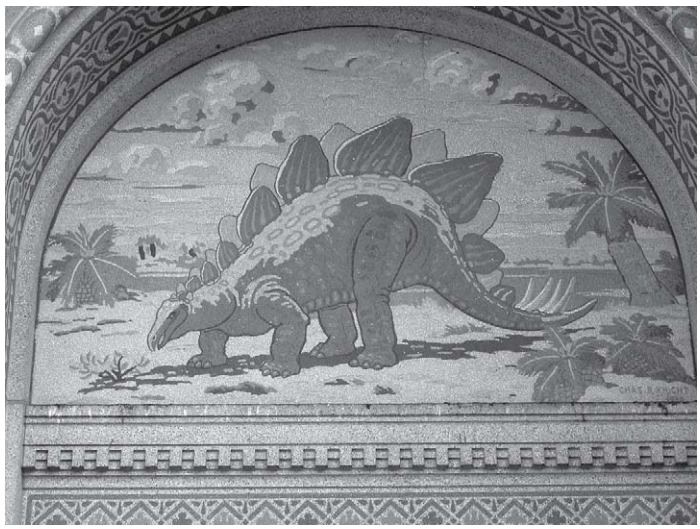


FIG. 3. Mosaic of *Stegosaurus* above doorway of visitor entrance to reptile building at Smithsonian Institution's National Zoological Park. Credit: photograph by Dennis Desmond in 2004.



FIG. 4. Carved rock tortoise supporting column at entrance to reptile building at Smithsonian Institution's National Zoological Park. Credit: photograph by Dennis Desmond in 2004.

reptiles have been moved to an interior space; the original bronze door pulls with two entwined serpents have been replaced. A secondary entrance shows two dragon-like reptiles facing each other under a rounded arch of molded bricks.

The renowned artist and sculptor John Joseph Earley[1], known for his remarkable creations of concrete mosaics and figures, in part fashioned the façade which abounds with stylized reptiles and amphibians—*Stegosaurus* over the entrance and crocodiles as decorative figures (Fig. 3), turtles supporting columns (Fig. 4), toady creatures peering down from the top of the archway, and an array of turtles, toads, and lizards scattered near the roof and around the building. The colored concrete door molding was fashioned by Earley, and the dinosaur mosaic in the transom was by artist Charles R. Knight. All of the larger exhibits within the building had background murals painted by Knight. These were detailed paintings of ancient ruins, such as Egyptian temples, as well as natural habitat scenes. Unfortunately, all of these murals were either painted over or the exhibits were totally destroyed and rebuilt during the middle 1950s and into the early 1960s. Even with these changes, this wonderful building is a spectacular edifice which probably could not be duplicated today because of cost and lack of skilled artisans. It must be said, however, that many modern reptile buildings are impressive structures with splendid exhibits[2].

The basement served as a commissary and butcher shop for animal feed (pictured in Conant 1980). In the early 1980s, the interior of the building was remodeled, exhibits were improved, and an acoustical ceiling was added to reduce noise in the visitor area. Added outside the building in 1980–1981 was a series of three small exhibits constructed of concrete masonry (and a wooden walkway) and four outdoor displays containing pools which now hold crocodilians and Komodo Dragons. The central basement interior area was re-worked into an invertebrate exhibit in 1986, and a walk-through greenhouse with butterflies and hummingbirds was added five years later. During the past few years, the exterior of the building has been cleaned, the roof has been repaired, the original skylights replaced, and the interior walls re-plastered and re-painted.

In 1984, a family learning center called HERPlab was installed in the building. There, docents and zoo staff interact with zoo visitors by describing amphibian and reptile biology, answering questions and leading tours. Curator Dale Marcellini and herpetologist Thomas Jenssen observed visitor behavior in the National Zoo's Reptile House and discovered that zoo visitors spend an astonishingly brief time viewing exhibits, averaging only ca. 8 sec per stop (Marcellini and Jenssen 1988). Based on this disturbing finding, a stronger emphasis on interactive education was developed by opening the Reptile Discovery Center, supported by a grant from the National Science Foundation. This unique exhibit approach incorporated some of the aspects of HERPlab but added a series of interesting modules and displays throughout the building addressing other features of amphibians and reptiles. One important element of the approach was the use of polling/survey data derived from visitors to quantitatively assess the effectiveness of this exhibit. Doering (1994:viii) stated that the modules had significant effects on visitors: "*Behaviorally*, the interactive stations slowed persons down, made them more attentive, and lengthened their time in the exhibit. *Emotionally*, the modules improved visitors' feelings about reptiles. *Intellectually*, they communicated new ideas, especially about internal anatomy, communication, and feeding."

During the past seventy-five years, reptile buildings and accompanying exhibits throughout the world were often designed by architects and zoo administrators who had little experience with living herps, public education, or who paid scant attention to the concept of exciting and aesthetically-pleasing presentations. Educational and interactive exhibits were an afterthought; visitors were subjected to row after row of uninspiring and unimaginative displays, hardly an enriching experience. One problem was the lack of input from the biological staff. Until the 1960s, amphibians and reptiles were rarely kept in appropriate social situations and little attention was paid to behavioral or environmental cues; social stressors among conspecifics such as competition or aggression were barely considered. Fortunately, zoo biologists have now become aware of these deficiencies and have worked to remedy them.

History of the Collection

In the late 1920s and early 1930s, a number of interesting herps were represented in the NZP collection: Komodo Dragons[3], Sumatran Cobras, King Cobras, Boa Constrictors, Gila Monsters and Beaded Lizards, Zaire Toads, many rattlesnakes, Radiated Tortoises, Gould's Monitor, and other lizards. In the Annual Reports of NZP beginning in 1931, one can see the enormous variety of specimens in the collection, such as tuataras.

The Zoo collection was utilized in 1932 for a classic scientific study on brooding behavior in pythons by Frances G. Benedict, Director of the Nutrition Laboratory at the Carnegie Institution of Washington. He observed an incubating female African Rock Python (*Python sebae*) on exhibit and made detailed environmental and body temperature readings during one entire day.

Captive crocodilians can be exceedingly dangerous, especially if their exhibits are poorly designed without shift cages[4]. In the late 1950s, the solarium housed a Nile Crocodile (*Crocodylus niloticus*) and an American Crocodile (*Crocodylus acutus*) in the same enclosure. The middle enclosure housed an aggressive and agile[5] Saltwater Crocodile (*Crocodylus porosus*) called "Biggie" by the staff, and the end enclosure featured a group of 5–7 foot long American Alligators (*Alligator mississippiensis*). Because there were no shift cages, keepers had to work around the crocodilians. The Nile and American crocodiles were extremely aggressive, attacking the keepers constantly. Two keepers were always in attendance, one to clean and the other to fend off the reptiles. Holding them off with a broom and shovel worked for the most part but cleaning these enclosures was a constant strain on the staff.

"Biggie" was acquired in the 1930s and lived over 40 years at the zoo where it attained a length of over 14 feet. When the crocodilian was weighed and measured in 1932, its size was modest: 150 lbs and six feet total length. One of us (WAX) was responsible for cleaning its enclosure during the late 1950s and early 1960s, a very dangerous task indeed, for the procedure was to actually enter its domain. On one occasion, "Biggie" was lying in the emptied pool and WAX was on the surrounding land, picking up some leaves. "Biggie" spun around and charged with mouth agape and WAX had to leap over the recurved bars. Unfortunately,



FIG. 5. Adult male Cayman Island blue iguana (*Cyclura nubila lewisi*) on exhibit at Smithsonian National Zoological Park in 2003. Described in 1940, the lizard was widely distributed in dry habitats over most of the island but is now restricted to a few remnant populations, due to human influences. In 2005, the population crashed precipitously; now only 15–25 lizards are left. Credit: photograph by Jessie Cohen, Smithsonian National Zoological Park.

the cuff on his pants was caught on one of the pointed tips. As WAX tried to free his cuff while balanced on the top of the bars, his hand fell off to one side. The reptile redirected the attack toward the dangling hand rather than the foot and just missed a tasty snack when WAX was able to pull his hand away, extricate his leg from the bars, and fall into the next enclosure.

At NZP, live food was used until the 1960s[6]. When one of the keepers was seen by a mother and child carrying a rabbit in a wicker basket, the child recognized his pet "Fluffy," donated just minutes before to the zoo. When the child asked where the keeper was taking his rabbit, the latter said, "I am going to feed him to the python" and continued on to finish his task. His horrified parents wrote a seething letter to Director Theodore H. Reed, who immediately banned the use of live food during public hours. Although offering dead prey is now common in zoos, some reptile buildings remain closed during feeding, due to concern about public sensitivities. NZP feeds only dead vertebrate prey and stays open.

Many years ago, NZP herp keepers also fed dead animals from the collection to reptiles. Head keeper Lee Schmeltz acquired a carcass of a muntjac that recently died in the collection and fed it to the Komodo Dragon. The dragon seized the muntjac by the belly and tossed its head in a violent slashing motion which eviscerated the deer, and splashed the glass front of the enclosure. Someone reported the incident to higher authorities and Schmeltz was warned never to let it happen again (C. Wemmer, pers. comm.).

NZP is the national zoo of the United States, so governmental employees, Smithsonian scientists, and military personnel, particularly the Naval Medical Research Unit-S.E. Asia (NAMRU) and the Army Medical Research Unit-North Africa (AMRU), often sent amphibians and reptiles to the Zoo. During the 1960s, unannounced large shipments regularly arrived at the local airport, such as one sent by Wesley Dickinson from India (see Murphy and Jacques 2006). The animals in these shipments were mostly unidentified, some venomous, often loose in the box or with their cloth bags unmarked; unpacking these shipments, although exciting, could also be hazardous. Many of the venomous species, such as sea snakes (*Laticauda*), King Cobras (*Ophiophagus*), Indian Cobras (*Naja naja*), kraits (*Bungarus*), Asian coralsnakes (*Calliophis*, *Maticora*), bamboo vipers (*Trimeresurus*), Hundred-Pace Vipers (*Deinagkistrodon acutus*), and saw-scaled vipers (*Echis*) were new to the collection.

On Easter Sunday in 1983, a teenaged boy who liked snakes waited until the building closed, broke the glass of the Gaboon Viper (*Bitis gabonica*) exhibit, put two adult snakes into a plastic garbage bag, flung the bag over his shoulder and caught a bus to take them home. He was bitten through the bag on the shoulder while departing the bus and rushed to the hospital. He survived the ordeal after antivenin therapy was undertaken but recovery was protracted. Later, some well-meaning citizens, including Smithsonian Secretary S. Dillon Ripley's wife, suggested that he be hired at the Zoo since he liked snakes but this recommendation was not adopted. Several others sent get-well cards to Mr. and Mrs. Gaboon Viper.

Play behavior in reptiles is rarely reported. At NZP, an adult Nile Softshell Turtle (*Trionyx triunguis*) collected by William Mann in Liberia, played with a variety of objects: pushing a basketball with its snout, swimming through a hoop, and biting and pulling a hose (Burghardt et al. 1996). One of the captive-hatched Komodo Dragons (*Varanus komodoensis*) named Kraken interacted in the most unexpected way with humans and objects (see Burghardt et al. 2002; Murphy and Walsh 2006 for details).

When we entered the zoo profession (WAX in the late-1950s, JBM in the mid-1960s), there was little discussion in zoos about wildlife conservation. Most efforts centered on keeping amphibians and reptiles alive and plans to accumulate breeding groups were rarely considered. We could not sex our animals accurately and if successful reproduction occurred, it was a major event. Virtually all zoo collections at that time were composed of herps from the wild; captive-bred amphibians and reptiles were mostly unavailable. Now that captive breeding has been relatively successful (although long-term breeding programs producing multiple generations are still somewhat rare), zoos tend to get their new ani-

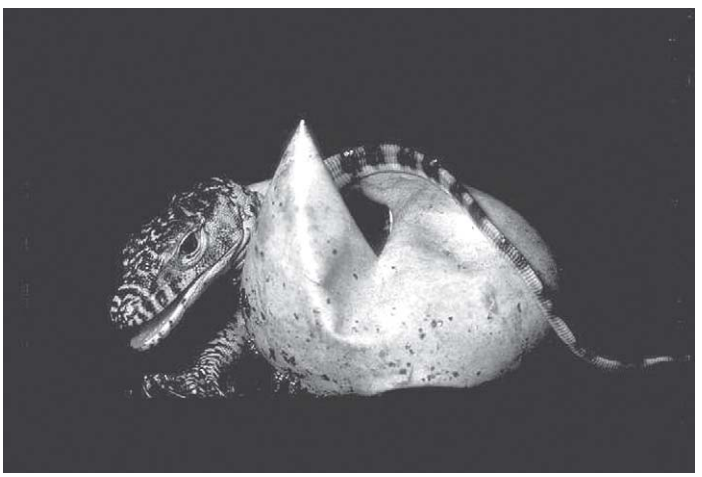


FIG. 6. Komodo dragon (*Varanus komodoensis*) female named "Kraken," hatched in 1992 at Smithsonian National Zoological Park. Credit:
photograph by Jessie Cohen, Smithsonian National Zoological Park.

mals from other zoos rather than the wild. Today there are many cooperative breeding programs in zoos. The downside of these collaborative programs is that we now rarely see something new in zoos; there is not room or resources for a diverse collection with many new species.

Today, the NZP collection is stable, many of the specimens bred in captivity, with ca. 63 species of reptiles totaling nearly 350 specimens and 15 species of amphibians numbering nearly 140 animals. The collection includes Cuban Crocodiles, Gharials, highly-endangered Cayman Island Iguanas (Fig. 5), Aldabran and Radiated Tortoises, an adult Japanese Giant Salamander, large constrictors and a variety of amphibians such as breeding colonies of a number of poison dart frogs (*Dendrobates*) and Panamanian Golden Frogs (*Atelopus zeteki*). Komodo Dragons reproduced at NZP in 1992 for the first time in any zoo in the Western Hemisphere (Fig. 6). Reproduction over multiple generations has been accomplished in several taxa: Emerald Tree Boas (*Corallus canina*), Green Tree Pythons (*Morelia viridis*), Brazilian Rainbow Boas (*Epicrates cenchria*), African Rufous-beaked Snake (*Rhamphiophis oxyrhynchus rostratus*), Chinese Water Dragons (*Physignathus cocincinus*), and Madagascan Giant Day Geckos (*Phelsuma madagascariensis*).

People

Like a notorious keeper at London a century earlier[7], WAX and a fellow keeper at NZP held contests to see who could handle pitvipers (rattlesnakes, copperheads, moccasins, bamboo vipers) without getting bitten. Their reasoning, hardly justifiable and certainly illogical, was this practice was acceptable as a displacement activity to relieve the stress of battling crocodilians. The snakes chosen to be handled all resided on the same row of exhibit cages. Each day before the building opened, these foolhardy caretakers would take turns, starting at the first exhibit cage and working their way down the line. The process was simple: when the serpent was in a resting coil, the contestants would slide hands beneath the coils, lift gently from the substrate for a few seconds, then replace the reptile in its original resting place. The contest ended after the entire group of exhibits holding venomous snakes was sampled or one of the participants lost courage. Miraculously, no one was bitten so none of the snakebite recommendations in Footnote #7 could be tried but had this practice been discovered by their bosses, repercussions would have probably been more unpleasant than a bite.

Over the years, Roy Jennier, Charlie Braxton, Jack Armstrong, Lester Ratliff, Lee Schmeltz, Cecelia Chang, Russell Morrison, Mike Johnson, William Xanten, Sam Davis, Bob Davis, Tom Keefer, Roger Rosscoe, Charles Coutris, Rob Lewis, and David Kessler worked as keepers in the department. The first woman keeper ever hired at NZP was Brenda Hall in the early 1970s, who wrote a paper on tegu lizards (*Tupinambis teguixin*). Today, women outnumber men in the Animal Department. Before curatorial positions were established at NZP, Mario (Jack) DePrato was the Head Keeper. Now retired, the first herpetological curator was Jaren Horsley, who was elevated to General Curator (Fig. 7). His replacement was Dale Marcellini, whose research interests were primarily directed toward public education and visitor behavior, as well as gekkonid and iguanid ethology (Fig. 8). Louis (Trooper) Walsh retired from the zoo as Biologist/Museum Specialist and is best known for his work with Komodo Dragons and boid snakes. Biologist Béla Demeter published a number of papers on Malagasy geckos. Michael Davenport is the current curator who focuses on the captive breeding of crocodilians. In addition to Davenport and Demeter, the current staff is Janis Gerrits, Sean Henderson, and Robin Saunders. After retiring from the Dallas Zoo, one of us (JBM) is now a research associate at the Zoo.

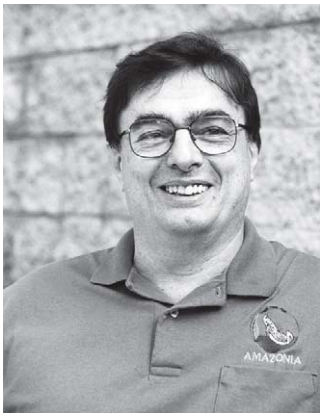


Fig. 7. Retirement photograph of Jaren Horsley in 1996. Credit: photograph by Jessie Cohen, Smithsonian National Zoological Park.

Jonathan Ballou is the Population Manager at NZP's Department of Conservation Biology; he has published many papers and several books on the proper management of captive populations.

Long-term investigation of essential dietary ingredients for captive and wild reptiles by Mary Allen and Olav Oftedal includes evaluating the diets of desert tortoises. The evolution, expansion and sophistication of herpetological medicine and the understanding of emergent diseases has contributed to significant advances. Recently, the pathogenic chytrid fungus attacking captive and wild amphibians was isolated and described by former NZP pathologist Donald Nichols.

John (Jack) Frazier has studied chelonians since 1979 as a Smithsonian research associate. His major focus centers on the conservation of marine turtles and he has published widely in this area. In addition, his earlier studies have included behavioral and ecological aspects of the Aldabran Tortoise and the Star Tortoise, and recently a sortie into nomenclatural never-never land (see Frazier 2006).

The Smithsonian Institution offers stipends for limited periods to outside investigators, mostly from the academic community, to do research at the Zoo. Using this program, Marcellini brought in an impressive series of herpetologists. Eliezer Frankenberg (The Hebrew University of Jerusalem) focused on animal communication, lizard ecology, and reproductive biology. Thomas Jenssen (Virginia Polytechnic Institute and State University) studied lizard ethology and visitor behavior, beginning in the 1980s. Paul Weldon (Texas A & M University) was a research associate at the Zoo from January 1991 to January 1993, working closely with zoo personnel on a variety of studies, such as collecting and analyzing glandular materials from reptiles in zoos. Now living in Baltimore, he currently

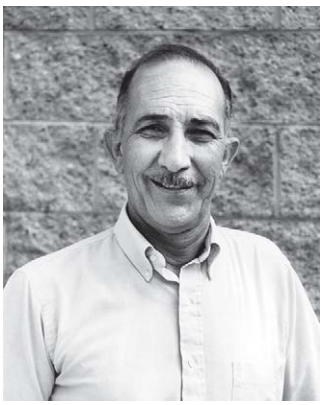


Fig. 8. Retirement photograph of Dale Marcellini in 1996. Credit: photograph by Jessie Cohen, Smithsonian National Zoological Park.

holds the same appointment at the Zoo's Conservation and Research Center in Front Royal, Virginia. Eric Wikramanayake from Sri Lanka was a research associate at the Zoo, specializing in field studies on varanid lizards. He is now a senior conservation biologist for World Wildlife Fund-US in Southeast Asia.

Programs

Christen Wemmer, retired Director of the NZP Conservation and Research Center (CRC) in Front Royal, Virginia, and his associates were instrumental in creating Zoo Biology Training Courses held in many developing countries throughout the world (see Wemmer et al. 1990 for description). The program and all written materials were developed by the staff at the Zoo, beginning in 1987. These courses included a herpetological component and focused on captive management. Zoo herpetologists, including JBM, were participants in these various training courses. In 1997, Wemmer, George Zug from the US National Museum of Natural History, and JBM traveled to Myanmar (Burma) to teach a workshop on herpetology to local wildlife biologists. The course provided an introductory treatment of amphibian and reptile biology, including a field component for sampling populations. This herpetofaunal survey continues to this day.

The American Association of Zoos and Aquariums hosted a Wildlife Conservation and Management Committee (WCMC) workshop on the conservation and captive management of Komodo Dragons, held at Tamin Safari in Bogor, Indonesia in 1995, which included a presentation by Trooper Walsh on the husbandry of these lizards. Three years later, the Thoiry Komodo Dragon Symposium was held at the Thoiry Zoological Park in France. The program was created by Walsh and Colomba de La Panouse, who invited the world's leading experts involved with field research and conservation, laboratory studies, and zoo conservation/education initiatives, to present their findings and write chapters for a comprehensive book on dragons. The research presented by several of the attendees was supported financially by grants from NZP's "Komodo Dragon Conservation Fund." Four years later, the book entitled *Komodo Dragons: Biology and Conservation* appeared.

There have been several herp initiatives at CRC: metapopulation analysis of the Eastern Newt (*Notophthalmus viridescens*) in northern Virginia, including sampling the CRC population; drift fence survey of indigenous species; Box Turtle (*Terrapene carolina*) study; and northern Virginia frog study guide written by Joseph Mitchell for the education program at CRC.

In the reptile building, several dozen volunteers serve as instructors, teaching zoo visitors about amphibians and reptiles. As an example, these interpreters explained the research that was being done on play behavior in Komodo Dragons.

Summary

Retired curator Dale Marcellini (1994) summarized the challenges that zoo herpetologists face when managing zoo collections, "Conservation is one of the main goals of zoo reptile houses, and yet curators act in ways which may be harmful to the conservation of species in the wild. Collections are composed largely of exotic, rare, and wild-caught species. Only rarely are breeding programs done on a long-term basis. When breeding is successful, reintroduction into the wild is almost never done. Zoo herpetologists must begin to act more responsibly in the way collections are managed, and more emphasis needs to be placed on conservation education."

In the same volume, Robert J. Wiese and Michael Hutchins (1994) enumerate additional responsibilities, "There is much work to be done if we are to assist even a fraction of the species currently at risk. Through the successful use of captive-breeding and reintroduction programs in conjunction with strategic collection planning, scientific research, in situ conservation efforts, and public education, professionally managed zoos and aquariums can play a significant role in amphibian and reptilian conservation."

In our view, the results have been mixed! On the plus side, the dramatic improvements of husbandry protocols have led to better lives for captive herps—no longer are "snake dens" ordered every year from suppliers to replace losses as was the case occasionally in the past. Zoos and aquariums are involved in many *in situ* and *ex situ* conservation projects. We are concerned, however, that herpetological collections and buildings are viewed as a relict from the past[8]; as a result, there has been a significant decline in new facilities, emphasis, and financial support. Instead, many zoo administrators build elaborate and costly zoogeographic mixed exhibits housing mostly mammals and birds.

One can track the paradigm shift over seventy-five years at NZP in the literature citations below as the staff gradually became more aware of the enormity of the threat to a diverse and interesting natural world, and began taking steps to intervene by adjusting their programs and research focus.

Acknowledgments.—We dedicate this contribution to veterinarian and retired NZP director Theodore H. Reed, who was at the helm from 1956 until 1983. Reed inherited a facility where major building construction and preventive maintenance had been halted for over twenty years due to inadequate funding. Under his leadership, NZP was reborn with increased appropriations, construction of a number of new buildings and revitalized exhibits. He established the first education department in a zoo in the United States and created the first research positions (Department of Zoological Research) with the hiring of the late John Eisenberg. The acquisition of the Conservation and Research Center (CRC) in Front Royal, Virginia, comprising more than 1200 hectares, was the culmination of a dream and years of intense work by Dr. Reed and Assistant Director John Perry.

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Footnotes

[1] "John Earley was the last of the concrete pioneers. Others before him had discovered how to produce the 'magic powder' — portland cement — how to mix it with stone and sand to make concrete, and how to use concrete as a structural material. But Earley was the first to control the exterior appearance of concrete in an important way and to impart brilliant permanent color to the surface. His contribution was unique: he was the man who made concrete beautiful."
Frederick W. Cron in *The man who made concrete beautiful: A biography of John Joseph Earley* in 1977

[2] "One of the most interesting and one of the most fascinating additions of recent years to zoological exhibits is the modern reptile house. Both the animal and the vegetable world are represented in it. It is a whole world of forests, dusky swamps, barren deserts, and tangled jungles brought from North and South and East and West and crowded under one roof. And under the roof, caged among giant palms, hanging bushrope, and drooping resurrection ferns, there squirm and coil the most mysterious and uncanny and merciless of all of God's creatures, housed according to the most advanced ideas of animal science, with all the surroundings peculiar to the wild and natural state of each. This novelty of showing the animals, and the modern facilities for feeding them as once they fed themselves, for studying reptile diseases, and even for operating with the surgeon's knife, have practically revolutionized the snake house of old into the marvelous reptile house of to-day."
—A. W. Rolker in *Treasury of Snake Lore* (1956)

[3] In the paper files on Komodo Dragons in the Reptile House there is an interesting entry attributed to Raymond L. Ditmars. Back in ~1934 when the first dragon arrived at NZP Ditmars was contacted and asked what he thought the lizards would eat and how often they should be fed. He replied, "Offer lobster, fish, octopus, horse meat, cattle organs, fresh killed rats and mice, deer meat, and pig . . . offered three times a day." It is fascinating that the then "world authority" on reptiles would provide such guess work about how much food was appropriate, showing how little was really known about the biology of these animals at the time.

[4] Raymond L. Ditmars (1933) described crocodilians in this way: "Such is the average crocodile—an active, vicious and, above all, treacherous brute. When the keepers of the reptile house in the New York Zoological Park clean out the big pool for crocodilians, they actually walk over the backs of some of the big 'gators, so tame are these. They never become unduly familiar with the crocodiles, finding it necessary to pen the latter behind heavy barred gates—and in the process the men are often chased from the enclosure."

[5] Saltwater Crocodiles have acute vision. At Zoo Atlanta, a large individual located and consumed mealworms tossed into its pool. At NZP, a mixed exhibit of birds and crocodilians was attempted. A large Asian jay was released into the solarium where it flew several times from one end to the other. When it passed overhead on its final journey, "Biggie" exploded from the water and caught the bird in mid-air—over a meter above the surface.

[6] The feeding of live food to snakes has always been controversial among some sectors of the public. It was an issue so inflammatory in London over a century ago that it was discussed in Parliament. For many years, live mice, rabbits, birds, frogs and other prey had been fed to snakes at the London Zoo but little public outcry ensued; in fact, the feeding demonstrations were enthusiastically viewed by the visitors. In 1869, however, the climate began to change, fueled in part by newspaper campaigns in London to elicit reader responses as to whether the practice should continue. A few selected sentences quoted in Blunt (1976) should put the controversy in proper perspective:". . . that a rabbit should be shut up in a cage with a snake without any chance of his life, deprived of the means of escape allotted to him by nature, and subject to the exquisite torture of terror prolonged by factitious circumstances and enhanced by despair" or ". . . trembling rabbits devoured by a serpent?-a monster reptile maintained and thus feasted for the pleasure of the English—for their children . . ." To deal with continuing public pressure, P. Chalmers Mitchell, Secretary of the Society from 1902 to 1935, and curator of mammals Reginald I. Pocock presented dead prey to snakes at the Zoo to determine whether this practice was a viable alternative. They documented (Proc. Zool. Soc. London 1907:785–794) that dead prey would be taken by many different species and would often be ingested at night. A subsequent study on the acceptance of dead prey by

snakes was undertaken by curator Edward George Boulenger in 1915 (Proc. Zool. Soc. London 1915:583–587). The situation at the London Zoo becomes clear when one refers to a quote by Mitchell in 1929: "My rule about no living prey being given except with special and direct authority is faithfully kept, and permission has to be given in only the rarest cases, these generally of very delicate or newborn snakes which are given new-born mice, creatures still blind and entirely unconscious of their surroundings."

[7] Edward Horatio Girling, head keeper of the snake room in 1852 at the London Zoo, may have been the first zoo snakebite victim**.** After consuming alcohol in prodigious quantities in the early morning with fellow workers at the Albert Public House on 29 October, he staggered back to the Zoo and announced that he was inspired to grab an Indian cobra a foot behind its head. It bit him on the nose. Girling was taken to a nearby hospital where current remedies available at the time were tried: artificial respiration and galvanism; he died an hour later. Many respondents to *The Times* newspaper articles suggested liberal quantities of gin and rum for treatment of snakebite but this had already been accomplished in Girling's case. Other recommendations were a bit unnerving: 1) being buried in manure to the neck; 2) application of a white-hot iron or other fiery instrument for at least an hour; 3) solicit a bite from a second snake to neutralize the effects of the first one; and 4) since sleep was always fatal, taking desperate measures to keep the injured party awake. For example, two Indians in the British army had dragged a screaming victim around a verandah for $3^{1}/_{2}$ hrs; death was prevented.

[8] Two of the three most popular exhibits were the aquarium and reptile house at the London Zoo (Balmford 2000).

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POINTS OF VIEW

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The Destabilization of North American Colubroid Snake Taxonomy

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The classification of taxa has always been an area of debate among systematists—empirically, methodologically, and philosophically. Arguably, the single most important change over the past forty years is the widespread recognition that a classification system is only useful when it functions as a storage and retrieval system of phylogenetic information. Although the type of information to be stored has largely been agreed upon (i.e., propinquity of descent and monophyly), debate continues on the method of this system (e.g., PhyloCode: Cantino and de Queiroz 2003; contra Keller et al. 2003; Nixon et al. 2003). Regardless, the role of classification as a subdiscipline of the science of systematics is clear, and it is separate from that of nomenclature, although both are subdisciplines of taxonomy (de Queiroz 2006). Taxonomy is informed by phylogenetics, and this information is used in the naming of biodiversity (nomenclature) and in the organization of the named groups (classification). All systems of classification and nomenclature that are based on evolutionary hypotheses (phylogeny) provide ranks and names for only monophyletic groups. It is from this framework that we address recently proposed changes to the taxonomy of the Colubroidea in North America (NA; Table 1).

One of the largest groups of squamates, the Colubroidea, was recently found to contain a number of families and subfamilies that were determined to be para- or polyphyletic (Kelly et al. 2003; Lawson et al. 2005). The 'traditional' classification, with four families and 15 subfamilies, has remained in this state at least since Dowling and Duellman (1978; although five subfamilies were used as tribes in that work). All of the subfamily names (except Pseudoxyrhophiinae), even those used as tribes in Dowling and Duellman (1978), long predate that publication (Table 2). To rectify this disconnection between phylogeny and taxonomy, establish consistency with phylogenetic hypotheses generated from a large number of morphological and molecular studies (see references in Lawson et al. 2005), and make only modest corrections

TABLE 1. A comparison of recent classifications of North American colubroid snake genera.

Zaher (1999) and Zug et al. (2001)			Lawson et al. (2005)			Collins (2006)		
Family	Subfamily	Genus	Family	Subfamily	Genus	Family	Subfamily	Genus
Colubridae			Colubridae			Colubridae		
	Colubrinae			Colubrinae			N/A	
		Arizona			*Arizona*			*Arizona*
		Bogertophis			*Bogertophis*			*Bogertophis*
		Cemophora			*Cemophora*			*Cemophora*
		Chilomeniscus			*Chilomeniscus*			*Chilomeniscus*
		Chionactis			*Chionactis*			*Chionactis*
		Coluber			*Coluber*			*Coluber*
		Drymarchon			*Drymarchon*			*Drymarchon*
		Drymobius			*Drymobius*			*Drymobius*
		Ficimia			*Ficimia*			*Ficimia*
		Gyalopion			*Gyalopion*			*Gyalopion*
		Lampropeltis			*Lampropeltis*			*Lampropeltis*
		Masticophis			*Masticophis*			*Masticophis*
		Opheodrys			*Opheodrys*			*Opheodrys*
		Oxybelis			*Oxybelis*			*Oxybelis*
		Pantherophis [*Elaphe*]			*Pantherophis*			*Pantherophis*
		Phyllorhynchus			*Phyllorhynchus*			*Phyllorhynchus*
		Pituophis			*Pituophis*			*Pituophis*
		Rhinocheilus			*Rhinocheilus*			*Rhinocheilus*
		Salvadora			*Salvadora*			*Salvadora*
		Senticolis			*Senticolis*			*Senticolis*
		Sonora			*Sonora*			*Sonora*
		Stilosoma			*Stilosoma*			*Stilosoma*
		Tantilla			*Tantilla*			*Tantilla*
		Trimorphodon			*Trimorphodon*			*Trimorphodon*
	Natricinae			Natricinae		Natricidae		
		Clonophis			*Clonophis*			*Clonophis*
		Nerodia			*Nerodia*			*Nerodia*
		Regina			*Regina*			*Regina*
		Seminatrix			*Seminatrix*			*Seminatrix*
		Storeria			*Storeria*			*Storeria*
		Thamnophis			*Thamnophis*			*Thamnophis*
		Tropidoclonion			*Tropidoclonion*			*Tropidoclonion*
		Virginia			*Virginia*			*Virginia*

TABLE 1. Continued.

Zaher (1999) and Zug et al. (2001)			Lawson et al. (2005)			Collins (2006)		
Family	Subfamily	Genus	Family	Subfamily	Genus	Family	Subfamily	Genus
Colubridae			Colubridae					
	Dipsadinae (Xenodontinae)			Xenodontinae		Dipsadidae		
		Carphophis (*incertae sedis*)			*Carphophis*			*Carphophis* (*incertae sedis*)
		Contia (*incertae sedis*)			*Contia*			*Contia (incertae sedis)*
		Coniophanes			*Coniophanes*			*Coniophanes*
		Diadophis (*incertae sedis*)			*Diadophis*			*Diadophis* (*incertae sedis*)
		Hypsiglena			*Farancia*			*Hypsiglena*
		Leptodeira			*Heterodon*			*Leptodeira*
		Rhadinea			*Hypsiglena*			*Rhadinea*
	Xenodontinae (Xenodontinae)				*Leptodeira*			
		Farancia			*Rhadinea*			
		Heterodon	Elapidae			Xenodontidae		
Elapidae				Elapinae				*Farancia*
	Elapinae				*Micrurus*			*Heterodon*
		Micrurus			*Micruroides*	Elapidae		
		Micruroides		Hydrophiinae				*Micruroides*
	Hydrophiinae				*Pelamis*			*Micrurus*
		Pelamis	Viperidae			Hydrophiidae		
Viperidae				Crotalinae				*Pelamis*
	Crotalinae				*Agkistrodon*	Crotalidae		
		Agkistrodon			*Crotalus*			*Agkistrodon*
		Crotalus			*Sistrurus*			*Crotalus*
		Sistrurus						*Sistrurus*

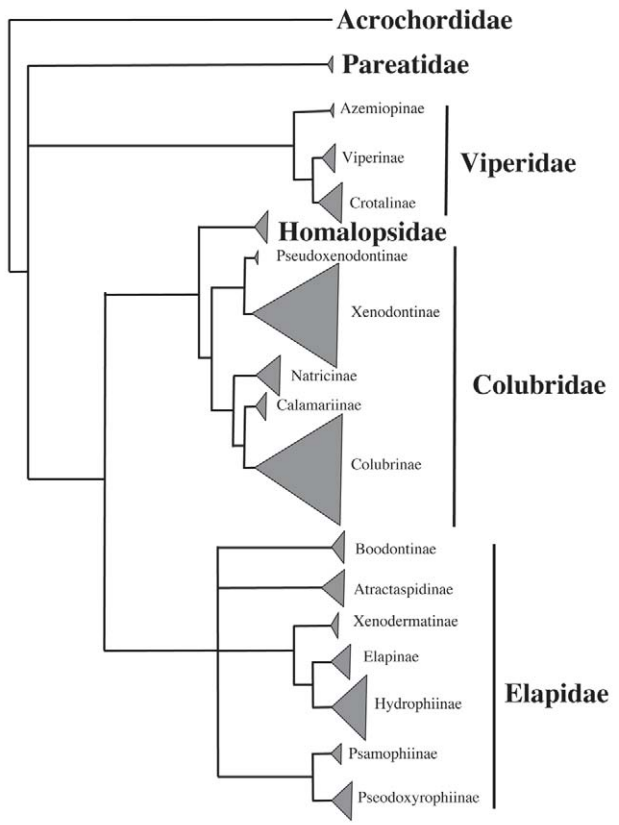


FIG. 1. Phylogenetic relationships of the Colubroidea (including the outgroup Acrochordidae) based on Lawson et al. (2005). The widths of the triangles for families and subfamilies indicate relative numbers of genera.

to the currently used taxonomy, while providing enough information to reflect taxonomic changes, Lawson et al. (2005) proposed a new classification (Table 1; Fig. 1). This classification included the following five families and 15 subfamilies (in parentheses): Colubridae (Calamariinae, Colubrinae, Natricinae, Pseudoxenodontinae, and Xenodontinae), Elapidae (Atractaspidinae, Boodontinae, Elapinae, Hydrophiinae, Psammophiinae, Pseudoxyrophiinae, and Xenodermatinae), Homalopsidae, Pareatidae, and Viperidae (Azemiopinae, Crotalinae, and Viperinae). The only radical change here concerned the inclusion of "nonvenomous" snakes (in the traditional sense) in the Elapidae. However, both venomous subfamilies of the former Elapidae, Elapinae and Hydrophiinae, were retained. This taxonomic decision was based on strong evidence and an application of the oldest family name, Elapidae, to the most recent common ancestor of the node including all aforementioned taxa (Fig. 1).

Collins (2006) suggested that placing the NA colubroid snake genera into the seven basic Linnean categories (Kingdom, Phylum, Class, Order, Family, Genus, and Species) would be more useful because the "layperson" would have difficulty memorizing one extra category, the subfamily. Aside from an unqualified assessment concerning the intelligence of the public on taxonomic matters, the system unilaterally proposed by Collins (2006) destabilizes colubroid classification to an extent possibly worse than the para- or polyphyletic classification in existence prior to Lawson et al. (2005). Here we address several major concerns that the proposal of Collins (2006) would have on colubroid classification. We also present a classification of the NA colubroid snakes that reflects Lawson et al. (2005), which provides the maximum phylogenetic information in this nomenclatural system (Table 1). Finally, we discuss three main areas where the classification of Collins (2006) is detrimental to information storage, communication, and phylogenetic representation.

THE LOSS OF PHYLOGENETIC INFORMATION

By eliminating subfamily from the classification hierarchy, Collins (2006) has effectively reduced the phylogenetic information inherent in the taxonomy proposed by Lawson et al. (2005). The arrangement of the NA Colubroidea in Collins (2006) simply elevates seven subfamilies to familial level while discarding interfamilial relationship. Retaining these as subfamilies nested within families, as suggested by Lawson et al. (2005), reveals information concerning relationships among these subfamilies (Table 1; Fig. 1). For example, it is not clear in Collins (2006) that the Elapidae and Hydrophiidae share a more recent common ancestor with each other than any of the other NA families of the Colubroidea (i.e., Colubridae, Natricidae, etc.).

In classification B of Collins (2006), he misrepresents Lawson et al. (2005) by suggesting this system contains less taxonomic information than his preferred system (classification A; Table 1) because it only reveals three taxonomic groupings for the Colubroidea of NA: Colubridae, Elapidae, and Viperidae. If he were to use the classification system in Table 5 of Lawson et al. (2005) for NA snakes, then it should have been clear that various monophyletic groups within NA are represented by subfamilies nested within families. This not only yields more taxonomic information than Collins (2006), but is more consistent with the historical use of these names and modern phylogenetic hypotheses.

The claim that Collins (2006) represents a standard classification because it refers only to the seven primary Linnaean groupings is also misleading. For example, Collins (2006) only includes two of the Linnaean ranks (family and genus)—a practice that is not commonplace in herpetology. In fact, the oldest use of subfamilies for the Colubroidea dates back to 1768 (Viperinae; Laurenti) and the majority of the others date to the 1800s (Table 2). All the names applied in Lawson et al. (2005) were used in Dowling and Duellman (1978) and are still used by two of the standard college texts on Herpetology (Pough et al. 2004; Zug et al. 2001).

DISRUPTION OF INTERNATIONAL SCIENTIFIC COMMUNICATION

The primary goal of the Linnaean hierarchy is to facilitate accurate scientific communication among researchers living throughout the world and speaking different languages. Elevating the subfamily names for colubroid snakes only occurring north of the Mexican border ignores the higher-level taxonomy of snakes occurring outside of the U.S. and Canada. It does not facilitate scientific communication between researchers speaking different languages when the same taxa found in two different countries are represented by two different classification systems. For instance, 92% of the snake genera in the U.S. and Canada are also found in Mexico (Conant and Collins 1991; Stebbins 2003), but the pro-

TABLE 2. Earliest usage of colubroid subfamily and tribe names adopted by Lawson et al. (2005).

Taxon Name	Author(s)	Dowling & Duellman (1978)
Atractaspidinae	Guenther (1858)	Subfamily
Azemiopinae	Liem et al. (1971)	Subfamily
Boodontinae	Cope (1893)	Tribe
Calamariinae	Bonaparte (1838)	Tribe
Colubrinae	Oppel (1811)	Subfamily
Crotalinae	Oppel (1811)	Subfamily
Elapinae	Boie (1827)	Subfamily
Homalopsinae	Jan (1863)	Tribe
Hydrophiinae	Boie (1827)	Subfamily
Natricinae	Bonaparte (1838)	Subfamily
Pareatinae	Romer (1956)	Tribe
Psammophiinae	Bonaparte (1845)	Tribe
Pseudoxenodontinae	McDowell (1987)	Not used
Pseudoxyrhophiinae	Dowling (1978)	Tribe
Xenodermatinae	Smith (1939)	Tribe
Xenodontinae	Bonaparte (1845)	Subfamily
Viperinae	Laurenti (1768)	Subfamily

posal of Collins (2006) only grants the same hierarchical classification for species in the two countries north of Mexico. Moreover, this taxonomic change does not consider how to place the nearly 90% of other snake genera not found within the U.S. and Canada. For instance, the family Colubridae of Lawson et al. (2005) contains 244 genera in five subfamilies and occurs on all continents except Antarctica. In comparison, the family Colubridae of Collins (2006) addresses only 25 genera, no subfamilies, and only applies to the U.S. and Canada. It is not a grand revelation to understand that species distributions do not coincide with political boundaries. Likewise, classification systems should not be bounded by political borders.

Phylogenetic Inaccuracies

In two cases, the elevation of subfamily to family by Collins (2006) requires a taxonomic decision not in keeping with the phylogenetic hypothesis presented by Lawson et al (2005). The Xenodontinae have typically been divided into two groups: the Xenodontinae representing South American genera and the Dipsadinae representing Central American genera (Cadle 1984; 1985; Crother 1999). For the nine genera of NA xenodontines, Zaher (1999) tentatively placed *Farancia* and *Heterodon* in the Xenodontinae and the remaining genera in the Dipsadinae. Lawson et al. (2005) found a sister relationship between *Farancia* (Xenodontinae) and *Carphophis* (Dipsadinae), which suggests that either the taxonomic contents of the subfamilies are incorrect, or that these groups are artificial. Lawson et al. (2005) contended that their sampling was not adequate to address this issue, so they placed both the Xenodontinae and Dipsadinae under the heading of Xenodontinae in their taxonomic list in Table 5. This classification placed all of the monophyletic Xenodontinae and Dipsadinae under one subfamily, but still made note of the traditional groupings of Xenodontinae and Dipsadinae of Zaher (1999). Collins (2006), without conducting any original phylogenetic research or reanalysis of available data, indicated that the uncertainty in the classification of the Xenodontinae had been solved when he placed *Farancia* and *Heterodon* in the family Xenodontidae and the other NA xenodontines in Dipsadidae. To aid with the description of this putatively paraphyletic classification, he also invented new common names for these subfamilies that do not accurately define either group: slender rear-fanged snakes (Dipsadidae) and robust rear-fanged snakes (Xenodontidae). Again, this classification does not reflect the phylogeny presented in Lawson et al. (2005), creates two paraphyletic groups, and should not be supported.

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ARTICLES

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Notes on the Ecology of the Colubrid Snake *Leptodeira annulata* in the Pantanal, Brazil

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The ecology of many Neotropical snakes, especially Brazilian species, is poorly known (Cadle and Greene 1993; Vitt 1996). Moreover, published studies are often based on examination of preserved specimens (Marques 1996) and therefore deal mainly with diet and reproduction of particular species (e.g., Bizerra et al. 2005), whereas activity patterns, habitat use and thermal ecology are infrequently reported (e.g., Oliveira and Martins 2001).

The Brazilian Pantanal is a low-lying floodplain covering an area of some 140,000 km^2, consisting of a mosaic of lakes, permanent swamps and seasonally inundated grassy fields with elevated patches bearing forest or cerrado vegetation (Ratter et al. 1988). The Pantanal is located in the Western region of Brazil and eastern Bolivia and is characterized by mean annual temperature of 25°C, and annual precipitation of 1100–1200 mm (Brasil 1997). The Pantanal has low species richness relative to the Cerrado and Amazon, but has some locally abundant snake species, thus facilitating studies of snake ecology (Strüssmann and Sazima 1993).

In spite of being one of the most abundant species in the Pantanal, little is known about the biology of the cat-eyed snake *Leptodeira annulata* in Brazil (Brasil 1997). Moreover, available data on *L. annulata* are largely from the Amazon (Vitt 1996) and Chaco (Lavilla and Scrocchi 1996) biomes. Here we present data on the activity, thermal ecology and habitat use of *Leptodeira annulata* in the Nhecolândia region, Pantanal, collected over five months.

Materials and Methods

Study Site.—The study was conducted from February–May and July 2005 in the vicinity of human habitation at the Nhumirim Ranch (18°98'814"S; 56°61'900"W), Corumbá municipality, Mato Grosso do Sul state, western Brazil. The region has an elevation of around 100 m and consists of a mosaic of lakes, grassland, savanna ("cerrado" vegetation) and semideciduous forest (Ratter et al. 1988).

One-hour searches were conducted on seven days each month, between 1800 h and 2400 h, with two observers searching for snakes in all accessible microhabitats. Each observed snake was considered an activity record; thus, each individual could have been observed more than once during the study. However, no snake was counted more than one time in a day.

We marked all trees (N = 32) at the 4 ha study site and recorded tree height (m) and diameter at breast height (mm). For each snake observed we recorded the microhabitat (tree, ground, building). When possible we caught the snake by hand and took the body, substrate, and air temperature with a cloacal thermometer (Miller and Weber Inc.). We considered snakes as active if they were moving or otherwise observed outside of tree holes.

In the laboratory, we measured snout–vent length (SVL) to the nearest cm using a measuring tape, tail length (TL) and head length (HL) to the nearest mm with a digital caliper (Mitutoyo Corp.), and mass to the nearest g using a Pesola scale. The snakes were sexed by probing. We then marked the individuals with ventral scale clips and released them at the site of capture.

To evaluate sexual size dimorphism we used analysis of covariance (ANCOVA) on tail length, head length, head width, and body mass with SVL as covariate and sex as a factor. Differences in SVL between sexes were tested by *t*-test. We also performed a Pearson's correlation between body vs. air and substrate temperature.

Results

We marked 19 (10F: 9M) *Leptodeira annulata*. Female SVL (481.60 ± 54.41 mm) was not significantly different from male SVL (528.44 ± 99 mm; t = 1.277, P = 0.218). Females also had significantly wider heads and were heavier than males (ANCOVA F = 7.097, P = 0.017, r^2 = 0.358; F = 12.434, P = 0.003, r^2 = 0.470; Table 1).

Observed activity of *L. annulata* (N = 81) occurred mainly between 1830 h and 2330 h, with a peak from 1930 h to 2230 h (Fig. 1). Around 1830 h snakes were observed emerging from tree holes. We found snakes in Acuri palms (*Attalea phalerata*) most often

TABLE 1. Summary of statistics on sexual size dimorphism of *Leptodeira annulata* in the Pantanal, Brazil. Test statistics for head length (HL), head width (HW), tail length (TL) and body mass (MASS) are from ANCOVAs adjusting for SVL, and thus refer to intersexual differences in size.

	Males (N = 9)	Females (N = 10)	Statistical Results
SVL	528.44 ± 99.00	481.60 ± 54.41	t = 1.277, df = 1, P = 0.218
HL	14.12 ± 1.27	14.64 ± 1.69	F = 4.434, P = 0.054
HW	10.15 ± 1.77	11.15 ± 1.93	F = 7.097, P = 0.017
TL	140.11 ± 17.14	139.20 ± 18.56	F = 0.869, P = 0.365
MASS	29.91 ± 7.13	33.70 ± 8.11	F = 12.434, P = 0.003

(63%), followed by fig trees (*Ficus calyptroceras*; 23%) and an unidentified tree species of Leguminosae (6%; Fig. 2). Only 3% of detections were of snakes on the ground. Trees where snakes were located averaged 0.80 ± 0.83 m diameter and snake height on the tree averaged 1.65 ± 0.65 m.

Body temperature averaged 26.8 ± 2.9°C (range 22.5–31.4°C, N = 20 including one recapture) and was positively correlated with substrate (r = 0.92, P < 0.001) and air temperature (r = 0.88, P < 0.001). There was no difference in body temperature between sexes (t = 0.46, P = 0.81).

DISCUSSION

Although we conducted our investigation in close proximity to human habitations, we did observe several *L. annulata* in more pristine environments, indicating that this species occurs in a variety of habitats.

The observed activity of *L. annulata*, a primarily anuran-eating snake (Lavilla and Scrocchi 1986) seems to coincide with amphibian activity, as suggested by Vitt (1996). At our study sites, we observed *Scinax acuminatus* and *Scinax nasicus* during observations, including in the same tree with *L. annulata*. The activity of these amphibians is, in general, restricted to 4–6 h after dark (Cardoso and Martins 1987), which may explain the reduced activity of *L. annulata* after 2230 h. Our sampling efforts however ceased at 2400 h so we cannot say anything about snake activity after midnight.

Although snakes may regulate their body temperature both behaviorally and physiologically (Peterson et al. 1993), the thermal environment (e.g., air and substrate temperature) can influence activity patterns, even in tropical nocturnal snakes (Shine and Madsen 1996). Thus, the observed low snake activity in late evening could conceivably be due to the drop in ambient temperature (Shine and Madsen 1996), rather than due to reduced prey availability as discussed above.

In the Pantanal, *L. annulata* largely used arboreal habitats, in contrast to previous findings (Vitt 1996; Martins and Oliveira 1998). It is notable that the Pantanal has more open habitats (even in forests) than the Amazon, but even so, fewer snakes were found on the ground in the Pantanal. Habitat openness or vegetation cover may affect vulnerability of reptiles to visual predators (Stuart-Fox and Ord 2004). Thus, predation pressure may cause greater use of vegetation and reduced use of open habitats (Watts 1991). Alternatively, taxonomic differences may account for the observed differences, since Vitt (1996) studied the biology of *L. a. annulata*, while we studied the subspecies *L. a. pulchriceps.* It is also possible that our detection probability for terrestrial snakes was lower than for arboreal snakes.

The use of Acuri palms by *L. annulata* may be due to either the ready availability of crevices and holes in the trunk (provided also by *F. calyptroceras* in the study area) or the abundance of this tree, which represents 44% of individual trees on the study site. In pristine areas of the Pantanal at Nhumirim Ranch, Acuri palms are the most common tree species in forests (Ratter et al. 1988).

Due to the short duration of our study, further work is needed to understand seasonal variation in body temperatures, activity and habitat use. The Pantanal has a highly seasonal climate with rainfall restricted to November–March and a flood season from April-August (Junk and Cunha 2005) and these cycles may affect snake biology.

Although apparently abundant, *Leptodeira annulata* is vulnerable to reductions in population size, due to indiscriminate killing of individuals. During our study, two individuals were known to have been killed by local inhabitants. Humans may have a natural

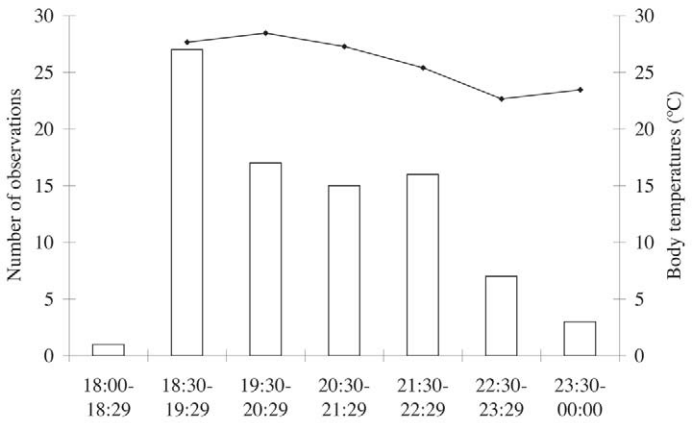


FIG. 1. Observed activity patterns (bars) and body temperatures (line) of *Leptodeira annulata* in the Pantanal, Brazil.

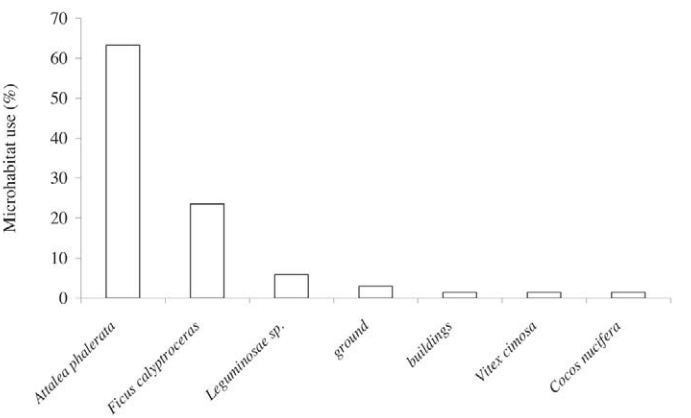


FIG. 2. Observed habitat use of *Leptodeira annulata* in the Pantanal, Brazil, based on 81 observations of active snakes.

fear of snakes (Greene 1997) and this species in particular is often confused with a venomous snake (the pitviper *Bothrops mattogrossensis*; Lavilla and Sccrochi 1986; pers. obs). Educational programs, especially for children, are necessary in the region to prevent indiscriminate killing of snakes.

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A Previously Undescribed Bone in the Snout of the Brown Watersnake, *Nerodia taxispilota*

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While examining more than 400 skulls of thamnophiine snakes currently assigned to the genera *Nerodia* and *Thamnophis*, we encountered a bone in the snout region of most of the specimens of the Brown Watersnake, *Nerodia taxispilota*, that was not present in any other species we examined—nor are we aware of a comparable osseous element being described in any other snake species. Here we describe and illustrate this neomorph and speculate about its possible function.

The neomorph, which we propose to call the **postnasal strut,** is present in ten of the 16 skulls (62.5%) of *Nerodia taxispilota* we examined (LSUMZ 10569, 16849, 20555, 21062, 24363, 28213–214, 34183, 43155, 43455). The skulls range in length from 22.5–33.1 mm, and represent both sexes (5 females, 4 males, 1 undetermined). Six specimens are from Florida, two from North Carolina, and two from undetermined localities. The six skulls that lack the postnasal strut (LSUMZ 12876, 16851, 16935, 39194, 43159, 43454) range in length from 19.3–35.5 mm, and also represent both sexes (4 females, 2 males). Four are from Florida, two from North Carolina.

The following description is based on the skull of LSUMZ 34183, a large (1029 mm snout–vent length, 33.1 mm skull length) female from Lake Newnan, Alachua Co., Florida. The faintly grooved dorsal surface of the narrow postnasal strut lies essentially in the same horizontal plane as the dorsal laminae of the nasal bones and the dorsal surface of the frontals, hence the strut is readily apparent when the dorsal aspect of the snout region is viewed (Fig. 1, upper). The strut is relatively long, its dorsal surface being nearly 70% as long as the dorsal laminae of the nasals (nearly 60% in LSUMZ 20555; 29.5 mm skull length). The anterodorsal tip of the strut is inserted between the posteromedial ends of the nasals. The posterodorsal tip of the strut is inserted between the anteromedial ends of the frontals, which are deflected laterally to accommodate it, but they are not deflected in snakes lacking the strut (Fig. 1, lower).

In order to better determine the relationship of the strut to the bones around it, we soaked the skull in water for several hours to loosen the dried soft tissue that remained after the initial cleaning by dermestid beetles. Further cleaning was then accomplished by hand-picking tissue with a small needle-nosed forceps. Finally, the entire nasal component was removed when it was discovered

that this could be accomplished without damaging or altering the position of the strut, which apparently has only loose connections to the nasal and septomaxillary bones.

The postnasal strut was thus revealed to be shaped somewhat like an I-beam in cross-section, with the dorsal "crosspiece" being narrower than the ventral one (which expands toward its posterior articulation; Fig. 2). Anteriorly, where the dorsal "crosspiece" extends forward between the posterior ends of the nasal laminae, the ventral "crosspiece" appears to rest on the posterior processes of the septomaxillae—which themselves articulate with the articular facets on the anterior frontals to form the nasofrontal joint.

Posteriorly, the dorsal "crosspiece" sits between the anteromedial ends of the frontals, which it appears to contact only by way of connective tissue (Fig. 1, upper). The ventral "crosspiece," on the other hand, appears to form a three-way articulation with the dorsal tip of the parasphenoid process of the sphenoid medially, and with the descending anteromedial laminae of the frontals laterally. Although the postnasal strut is immobile when the skull is dry, when moistened it is capable of a limited amount of dorsoventral flexure against the fulcrum provided by the dorsal tip of the parasphenoid process.

Discussion.—The presence or absence of the postnasal strut in *Nerodia taxispilota* clearly does not reflect sex, size, or geography, so the genetic potential for its development appears to exist throughout the genome. Failure to find any trace of the strut in 55 skulls of *N. rhombifer*, the sister taxon of *N. taxispilota*—or in any of the smaller series of other *Nerodia* species available to us—strongly suggests that the presence of the strut in *N. taxispilota* is an autapomorphic feature of the species.

In the absence of studies of its functional morphology, we can

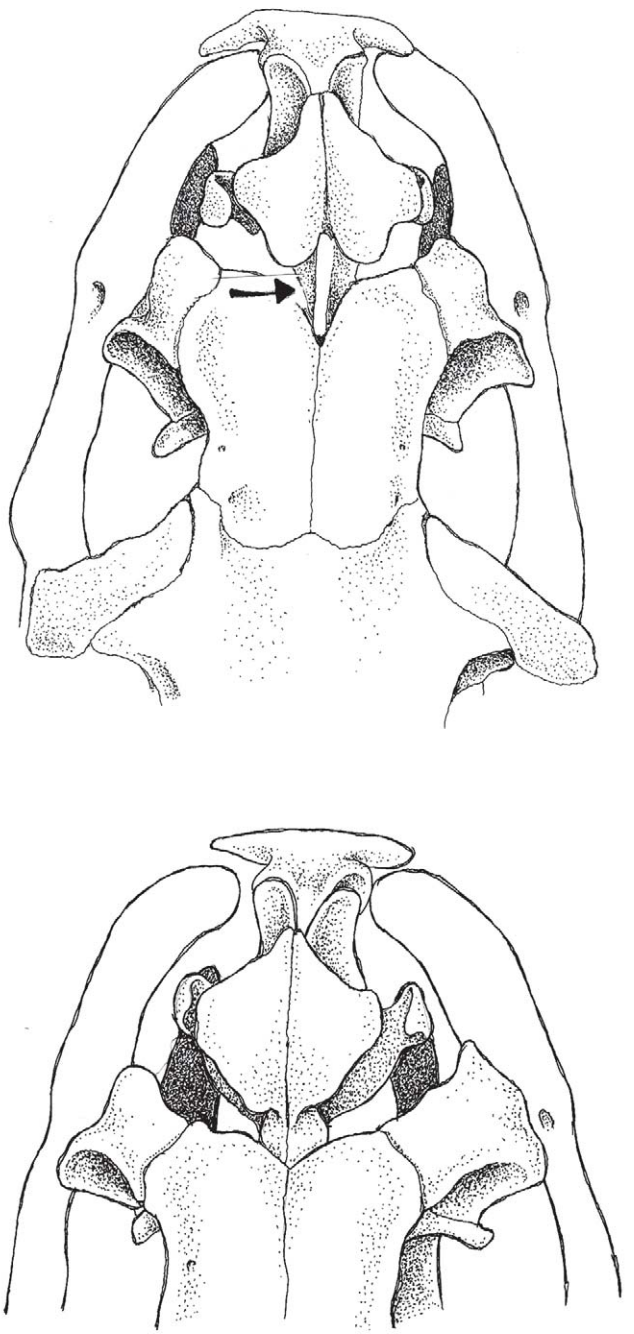


FIG. 1. Dorsal views of skulls in *Nerodia taxispilota* with (upper, LSUMZ 20555), and without (lower, LSUMZ 16851), the postnasal strut (arrow).

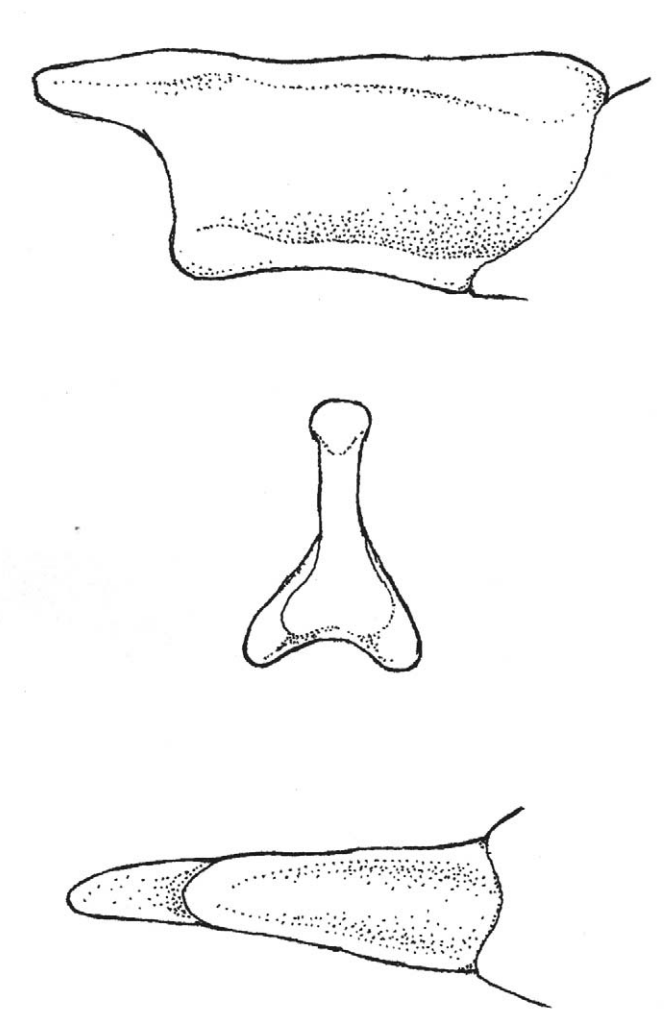


FIG. 2. Lateral, frontal, and ventral views of the postnasal strut in *N. taxispilota* (LSUMZ 34183).

only speculate about the role of the postnasal strut. The most obvious possibility is that by bracing against the frontals posteriorly, the strut serves to limit the dorsal flexion of the nasal component at the prokinetic nasofrontal joint during prey manipulation (Albright and Nelson 1959). Whether or not the strut could also restrict axial rotation at that point is less clear, but it remains a possibility (Cundall and Shardo 1995).

Assuming there is some adaptive advantage to limiting dorsal flexion of the snout in *Nerodia taxispilota*, what might it be? The Brown Watersnake is a catfish specialist (Gibbons and Dorcas 2004) that, in the course of ingesting its prey, must overcome the obstacles posed by the catfish's erected-and-set pectoral and dorsal spines. Richmond (1944) gave a detailed description of how this was accomplished by one large individual he observed closely. When the snake's jaws reached the base of the spines, they slid up them for a short distance, then the snake paused and maintained pressure on them until the struggling fish relaxed the spines. This permitted the snake to close its jaws down on the spines and prevent them from being re-erected.

We suggest that a more rigid snout would more effectively maintain pressure on the catfish spines than could a more flexible snout. Perhaps in the postnasal strut we may be seeing a novel morphological adaptation that is in a stage of evolution where it has become widespread but not yet fixed. Yet, the strut's absence in *Nerodia rhombifer*, equally a catfish specialist (Gibbons and Dorcas 2004), is puzzling. Clearly, a sophisticated study of the strut's function in living *N. taxispilota* will be required to test our speculations.

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Courtship Behavior of Two Treefrog Species, *Aplastodiscus arildae* and *A. leucopygius* (Anura: Hylidae), from the Atlantic Rainforest, Southeastern Brazil

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Complex courtship behaviors in anurans have been described mostly in dendrobatids (e.g., Juncá 1998; Limerick 1980; Roithmair 1992; Wells 1977). Nevertheless, recent studies on reproductive behavior of hylids revealed complex courtship behaviors, mostly in the genus *Aplastodiscus* (e.g., *A. leucopygius*: Haddad and Sawaya 2000; *A. perviridis*: Haddad et al. 2005; *A. eugenioi*: Hartmann et al. 2004). The courtship of these hylids involves mutual tactile stimuli and egg deposition in a subterranean nest previously constructed by the male, who guides the female to the nest.

Visual communication plays an important role in courtship contexts of diurnal frog species (e.g., Haddad and Giaretta 1999; Pombal et al. 1994). Recently, visual signaling has been considered an important type of communication also for nocturnal frogs where this communication seems to be more common than previously thought (Hartmann et al. 2005). Giasson and Haddad (2006), Hartmann et al. (2004), and Heying (2001) described visual signaling during the courtship of *Hypsiboas albomarginatus*, *Aplastodiscus eugenioi*, and *Mantella laevigata* respectively, providing evidence that the courtship behavior of nocturnal frogs is more complex than previously known and visual signals are employed by nocturnal species of frog of different genera or families.

Aplastodiscus arildae belongs to the *Aplastodiscus albofrenatus* species group and *A. leucopygius* to the *A. albosignatus* species group (Faivovich et al. 2005), both restricted to the Brazilian Atlantic rain forest. Information on the courtship behavior of the *A. leucopygius* is available in Haddad and Sawaya (2000). These authors described the courtship as a complex behavioral sequence that involved mutual tactile stimuli and egg deposition in a subterranean nest previously constructed by the male, who guided the female to the nest (reproductive mode 5 according to Haddad and Prado 2005). There is no documentation of the courtship behavior of *A. arildae* since this species occurs at low population densities (Zina and Haddad 2007) making the probability of observation very low. The aims of our study were to describe the courtship behavior of *A. arildae* and compare it with the courtship behavior of *A. leucopygius*. In addition, we provide new information on the visual communication in the courtship behavior of *A. leucopygius*.

Methods.—Our study was conducted in the Serra do Japi (23°14'S, 46°56'W, 1030 m elev.), Municipality of Jundiaí, State of São Paulo, southeastern Brazil, between March 2004 and Janu-

ary 2006. Field observations began after sunset and finished when reproductive activity ended each night. During this period we monitored all the calling males of both species in the studied sites (stream, lake, and swamp). The period of observations had a mean duration of 06 h 47 min ± 2 h 25 min (N = 21; range = 2–9 h) per night. Focal animal observations were used to record behavior (Lehner 1996). We followed the nomenclature proposed by Wells (1977) to classify the different types of calls (advertisement and courtship calls) emitted by both species, according to the social context. To observe courtship behavior, we used headlights with weak batteries to reduce disturbance to the frogs.

Results.—We observed 20 courtship sequences of *Aplastodiscus leucopygius* and only one of *A. arildae*. The courtship behavior of *A. arildae* consisted of a complex sequence of tactile stimuli. The pair behaved as follows (Fig. 1): A—the male was calling parallel to the ground on a leaf 1.5 m above the ground; B—the female jumped onto a leaf next to where the male was calling, and when the male noticed the presence of the female, he stopped emitting the advertisement call; C—the female touched the male's snout with her hand; D—the female repeatedly tapped the male with her snout; E—the female touched the male's snout with her hand; F—the male moved himself slightly and started to move one foot up and down repeatedly, beating it against the leaf; G—the male moved again and positioned himself face to face with the female; H—the female moved one foot up and down repeatedly, beating it against the leaf; I—the male repeated this behavior; J—the female positioned her head above the male's head; L—the male moved slightly preparing himself to get down from the leaf were the couple stayed for two hours; M—the male started a descending journey from his perch, emitting courtship calls; N—the male stopped emitting courtship calls and the female followed the male, touching him with her hand; O—after three hours from the beginning of courtship, the pair reached the ground, and the female continued to follow the male, touching his dorsum with her hand. This courtship occurred during a rainy night over more than nine hours. The pair separated after a branch fell down next to them.

We observed 10 complete courtship sequences (prior to the female approaching the male) of *A. leucopygius*, which had a mean duration of 4 h 30 min ±1 h 20 min (N = 10; range = 2–7 h). These started with the female approaching the male, and ended with the entrance of the pair into the subterranean nest. Another 10 sequences were observed from the moment when the females were already close to the males. During the observation of the journey of the couples to the subterranean nest we observed two behaviors that were not reported by Haddad and Sawaya (2000): 1) both females (N = 5) and males (N = 8) of *A. leucopygius* passed their hands over their eyes and/or blinked when facing each other; and 2) during this interaction, we also observed males performing toe trembling (N = 6). After the oviposition occurred, males abandoned the subterranean nests and females did the same soon after the males. The time that a pair spent in the subterranean nest until the exit of the male averaged 4 h ± 1 h (N = 15; range = 3–5 h). Males of *A. leucopygius* (N = 14) returned to their calling sites three days or more after having been observed in courtship.

Fifteen of 20 courtship sequences observed for *A. leucopygius* ended in oviposition. In three courtship sequences observed during nights of intense rain in December 2004, females came out of the subterranean nest soon after they had entered, and oviposition did not occur. Nests on those occasions were almost entirely full of water. In January 2005, we observed three courtship sequences; two of them were interrupted when the pairs were inside the subterranean nest, due to the incidental interference of the observer trying to visualize the oviposition behavior inside the subterranean nests. In these two situations, we observed the males at the entrance of the nest, while the females were inside with their snouts smeared with mud.

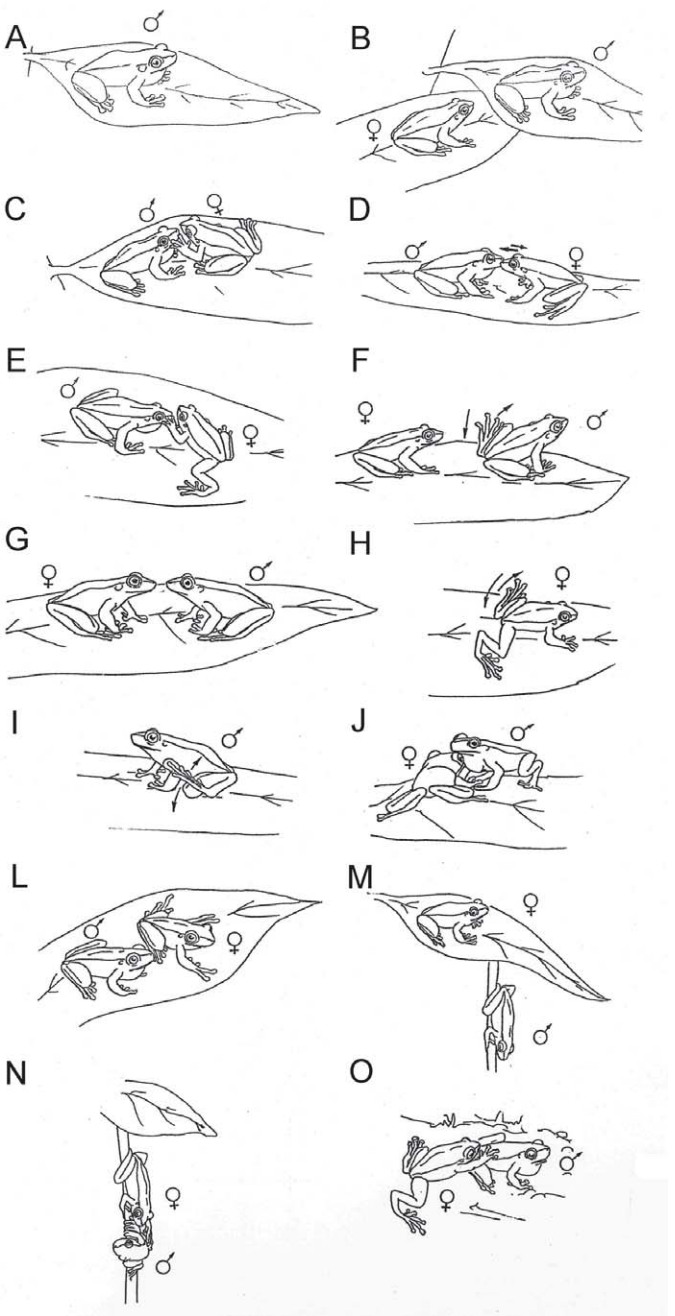


Fig. 1. Behavioral sequence of the courtship behavior of *Aplastodiscus arildae* from the Serra do Japi, Municipality of Jundiaí, São Paulo, Brazil. Letters A– O refer to the behavioral sequence (see text).

On two occasions, an individual of *Hypsiboas bischoffi* (Hylidae) jumped close to the leaf where a male of *A. leucopygius* was emitting advertisement calls. In both occurrences the males of *A. leucopygius* started to emit courtship calls.

TABLE 1. Courtship behaviors (X) observed for different species of *Aplastodiscus*.

Species	Visual signaling				Tactile signaling			Reference
	Toe or fingers trembling	Limbs/foot moved up and down	Eye blinked	Female raised herself on all four limbs	Passed the leg or foot across own body	Female positioned the head above male's head	Male and/or female touched each other with snout or hand	
A. arildae	—	X	—	—	—	X	X	Present study
A. eugenioi	X	X	—	—	X	X	X	Hartmann et al. 2004
A. leucopygius	X	—	X	—	—	X	X	Haddad & Sawaya 2000; Present study
A. perviridis	—	—	—	X	—	—	X	Haddad et al. 2004

Discussion.—Tactile stimuli between male and female and the behavior of guiding the female to the oviposition site are typical of anuran species in which males construct nests before the arrival of females (e.g., *A. perviridis*: Haddad et al. 2005; *Hylodes asper*: Haddad and Giaretta 1999; *A. leucopygius*: Haddad and Sawaya 2000; *A. eugenioi*: Hartmann et al. 2004; *Leptodactylus fuscus*: Martins 1988).

Our observations of the courtship behaviors of *Aplastodiscus leucopygius* were similar to those described by Haddad and Sawaya (2000); however, we registered two more behaviors that were not observed by those authors. Until now, specialized courtship behaviors similar to that observed for *A. leucopygius* and *A. arildae* were described only for *A. perviridis* (Haddad et al. 2005) and *A. eugenioi* (Hartmann et al. 2004). According to Hartmann et al. (2004), *A. eugenioi* produced visual signals during courtship, which are considered an unusual communication mode for nocturnal anurans. Contrasting colors and postural displays in anurans may be related to conspecific visual communication (e.g., Wells 1980a, b). During the courtship of *A. leucopygius* we observed that males and females blinked at each other and/or passed their green hands over their red eyes, a behavior that may involve visual communication. A similar behavior was performed by *Brachycephalus ephippium* (Anura, Brachycephalidae), where the males passed their yellow hands over their black eyes during agonistic interactions (see Pombal Jr. et al. 1994). This behavior, as well as the visual behaviors of *A. leucopygius*, may produce a color contrast for the receiver. According to Pombal et al. (1994), this visual behavior in *B. ephippium* may be derived from a cleaning behavior observed for this species. Descriptions of visual signals are uncommon in frogs and are predicted to be predominantly employed by diurnal species at sites with an unobstructed view (Endler 1992). Leg shaking is involved in visual communication (see Hödl and Amézquita 2001). It was observed during the courtship of *A. eugenioi* (Hartmann et al. 2004) and during aggressive interactions between males of *Aplastodiscus perviridis* (Toledo et al. 2007). In our study, we observed foot shaking behavior in *A. arildae* during the courtship sequence. While this is a visual signal as described by Hödl and Amézquita (2001), we cannot discard the possibility of seismic communication, in which the female or male perceive the presence of other individuals by the propagation of low frequency signals in the substrate or vegetation.

Although visual communication may appear to be less effective than acoustic communication for nocturnal species of frogs, as a consequence of light limitations, the combination of these two communication types might be very important for females to localize the males during the courtship behavior. This may be especially important for species of *Aplastodiscus* because males move constantly from one place to another on their way to the subterranean nest. Acoustic communication is mainly used in long-distance communication (Rand 1985). Visual signaling might be very efficient for short-distance communication in nocturnal frogs (e.g., distance between male and female during the courtship) and might be involved with the coordination of female and male during the journey to the subterranean nest. We did not observe the end of the courtship behavior in *A. arildae*. Because the courtship behavior observed for *A. arildae* is similar to that performed by the other species of this genus (*A. perviridis*: Haddad et al. 2005; *A. leucopygius*: Haddad and Sawaya 2000; *A. eugenoi*: Hartmann et al. 2004) we presume that it ends in a subterranean nest where oviposition occurs. The similarities of the courtship of *A. leucopygius* and *A. arildae* with the other species of the genus (Table 1) support this behavior as being synapomorphic at the genetic level. The perception of an individual by its movements on the vegetation was observed for *A. leucopygius* male, which started to emit courtship calls as soon as another conspecific or heterspecific individual jumped next to them. However, experiments using appropriate equipment to measure seismic signals are necessary to confirm if this additional communication mode is used by this species. In summary, for *A. leucopygius* and *A. arildae* we observed at least three types of male-female communication during courtship behavior (acoustic, visual, and tactile).

During intense rainy nights in December 2004, the courtship sequences of *A. leucopygius* did not end in oviposition. Nests, in these occasions, were almost entirely filled with water. Lack of oviposition following courtship suggests that the females inspect the nests and may reject males if the nests are not adequate. Another fact which suggests that the nests are inspected by females was their snouts smeared with mud, observed when they were already inside the nests. This behavior was not known for the species and could mean that females may not only inspect the nest,

but also modify it before oviposition, a behavior previously observed in other species that construct mud nests such as *Hypsiboas faber* (Martins and Haddad 1988).

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Recent Nesting of the American Crocodile (*Crocodylus acutus*) in Everglades National Park, Florida, USA

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The American Crocodile (*Crocodylus acutus*) is one of two native species of crocodilians found in southern Florida, USA. It occurs primarily in estuarine environments in extreme southern mainland Florida and northern Florida Keys (Kushlan and Mazzotti 1989; Mazzotti 1999). In Florida, habitat loss due to development along coastal areas of Palm Beach, Broward, Miami-Dade, and Monroe counties has been the primary factor endangering the American crocodile. This loss of habitat principally affected nesting range of crocodiles, restricting nesting to a small area of northeastern Florida Bay and northern Key Largo by the early 1970s (Kushlan and Mazzotti 1989; Ogden 1978). At this time most remaining crocodiles (about 75% of known nests) were in Florida Bay in Everglades National Park (ENP) or on North Key Largo (25% of known nests), with few sightings (no nests) in Southwest

Florida. The American Crocodile was declared endangered in 1975 by the U.S. Fish and Wildlife Service (Federal Register 40:44149).

In 1978 a third nesting area was discovered at the Florida Power and Light Company, Turkey Point Power Plant site (TP) (Mazzotti 1983). During the 1980s monitoring programs were established for all three nesting locations. These monitoring programs focused on nesting, growth, and survival of crocodiles and led to the discovery of an additional nesting area in the Cape Sable/Flamingo area of ENP. The outlook for crocodiles in Florida is more optimistic today, and currently the Florida population of *C. acutus* is under review for reclassification from endangered to threatened by the U.S. Fish and Wildlife Service (Federal Register 70:15052–15062). In addition to endangered species recovery, the federal government, in partnership with state, local, and tribal governments, has initiated the South Florida Ecosystem Restoration Initiative (SFERI). This is an unprecedented effort to restore and manage ecosystems of southern Florida that have been degraded by human activities. Alternatives for improving water delivery into South Florida estuaries may change salinities, water levels, and availability and suitability of nesting habitat in receiving bodies of water. Continued monitoring will be essential to ensure survival of this endangered species within its changing environment.

Surveys for nesting of *C. acutus* have been conducted in ENP since 1970 (Ogden 1978). Mazzotti (1989, 1999) summarized factors affecting nesting success from 1970 to 1995. The purpose of this paper is to review nesting of *C. acutus* in Everglades National Park to 2004.

Methods.—This study was conducted at the southern tip of mainland Florida from US Highway 1 to and including Cape Sable, ENP (Mazzotti 1999). The mainland has very low relief with many creeks, ponds, small bays, and a few man-made canals and ditches draining into Florida Bay (Mazzotti 1983, 1999). Marl banks that line creeks, canals, and sand beaches on mainland and island shorelines are important as nesting sites for crocodiles (Mazzotti 1999). Vegetation in the study area is primarily mangrove swamp (Olmstead et al. 1981). Higher ground supports tropical hardwoods and buttonwood (*Conocarpus erectus*) (Olmstead et al. 1981). The presence of plants intolerant of flooding is a good indicator of potential nesting habitat for crocodiles (Mazzotti 1989).

Since 1978 consistent survey methods have been used under supervision of one investigator (FJM) to collect the data analyzed here. Crocodile nesting effort (number of nests with eggs) and success (number of nests that produce at least one hatchling) were determined by searching known and potential nesting habitat in ENP. Searches were conducted by skiff, foot, and canoe during April and May for nesting effort and July and August for nesting success. Evidence of nesting activity included tail drags, digging, or scraping. Shells of hatched eggs or hatchlings were considered evidence of successful nests. When nests were located, vegetation, habitat (creek, island, shoreline, or man-made), substrate, distance from shore, nest dimensions, and salinity of adjacent water were recorded. Successful nests produced at least one hatchling. The number of failed eggs and causes of egg failure were noted when evident. Nests that failed to hatch were located by excavating areas of nesting activity at least 30 days after the last known nest hatched for that year.

Trends in numbers of nests in northeastern Florida Bay (1978–2004) and Cape Sable/Flamingo (1986–2004) nesting areas were analyzed using log linear regression models. Trends in numbers of nests in different habitats (island, creek, shoreline, artificial) also were analyzed using log linear regression models. We compared proportion of nests lost to depredation and embryonic mortality during 1985 to 1995 to the proportion of nests lost to those factors during 1997 to 2004 using a Fischer's Exact Right-Sided test. The proportion of nests lost to depredation and embryonic mortality in natural versus artificial surfaces was analyzed using a

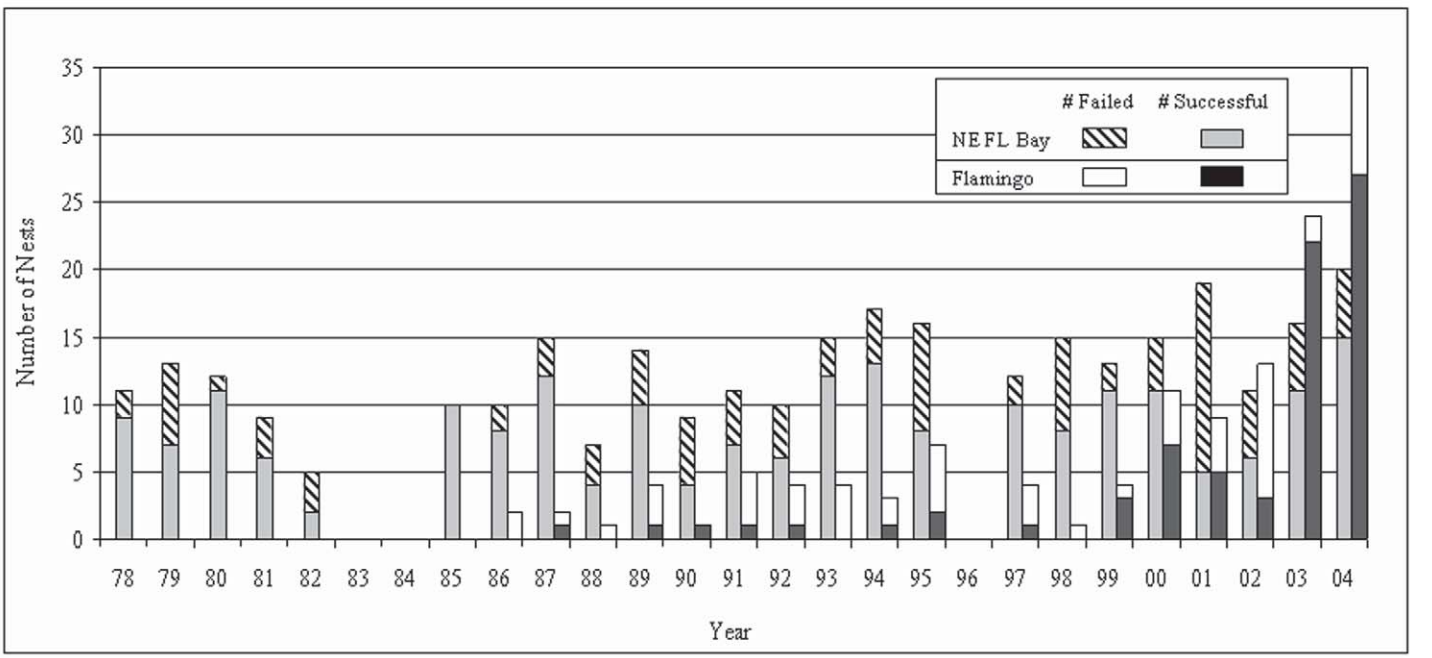


FIG. 1. Summary of American Crocodile nesting within Everglades National Park. Each bar represents the total number of nests at a site for a given year. Nesting surveys were not performed in 1983, 1984, or 1996.

TABLE 1. Summary of locations and habitats of American Crocodile nests in Everglades National Park (modified from Mazzotti 1999).

	Number (%) of Known Clutches								
Habitat/Location	< 1930	1930–1950	1950–1959	1960–1969	1970–1979	1980–1989	1990–1995	1997–2004	Total
Creek	2 (67%)	3 (18%)	1 (8%)	2 (9%)	28 (35%)	12 (13%)	7 (7%)	1 (0.5%)	56 (10%)
Mainland shoreline	1 (33%)	4 (23%)	5 (38%)	16 (69%)	38 (48%)	53 (58%)	55 (54%)	126 (56.7%)	298 (54%)
Island shoreline	0	10 (59%)	7 (54%)	5 (22%)	14 (17%)	17 (19%)	18 (18%)	31 (14%)	102 (19%)
Man-made	0	0	0	0	0	9 (10%)	21 (21%)	64 (28.8%)	94 (17%)
NE Florida Bay	3 (100%)	17 (100%)	13 (100%)	23 (100%)	80 (100%)	82 (90%)	78 (77%)	121 (55%)	417 (76%)
Cape Sable/Flamingo	0	0	0	0	0	9 (10%)	23 (23%)	101 (45%)	133 (24%)
Number of clutches	3	17	13	23	80	91	101	222	550

Pearson Chi-square test.

Results.—The number of crocodile nests observed in ENP increased from 16 in 1997 to 55 in 2004 (Fig. 1). With the exception of a single nest on Shark Point near the mouth of Shark River, the footprint of crocodile nesting remained the same as that reported by Mazzotti (1999). Nesting increased in the historical core area of northeastern Florida Bay at an annual rate of 2.5% from 1978 to 2004 ($P = 0.0006$, $R^2 = 0.4219$). However, most of the increase in crocodile nesting occurred in the relatively new Cape Sable/Flamingo nesting area, where nests increased from 2 in 1986 to a high of 35 nests in 2004, an annual rate of 14.1% ($P = 0.0003$, $R^2 = 0.5648$). Prior to 1995, 90% of crocodile nests (N = 328) were located in northeastern Florida Bay. Since 1997, 45% of crocodile nests (N = 222) were located in the Cape Sable/Flamingo nesting area (Table 1).

The number of crocodiles nesting in different habitats has also changed (Table 1). The number of creek nests decreased at an annual rate of -4.3% ($P < .0003$, $R^2 = 0.4585$), whereas the numbers of nests on man-made substrates increased at an annual rate of 10.5% ($P = 0.0008$, $R^2 = 0.4956$) (Table 1). All nests on artificial substrates were in the Cape Sable/Flamingo area. Most (70 of 94) nests on artificial substrates were on canal banks. Other artificial nest sites included spoil piles (4), parking lots (9), roadside (10), or canal plugs (1). The number of nests on mainland and island shorelines increased at annual rates of 5.7% ($P < 0.0001$, $R^2 = 0.7026$) and 4.3% ($P = 0.0036$, $R^2 = 0.3250$), respectively, between 1978 and 2004.

Overall nesting success has remained high in ENP (Table 2). The proportion of nests lost to depredation increased slightly and the proportion of nests lost to embryonic mortality decreased slightly in the period 1997–2004 as compared to 1985–1995 (Right-sided Fisher Exact Test, $P = 0.0556$ for depredation and $P = 0.0313$ for embryonic mortality). Depredated nests were distributed randomly between artificial and natural substrates (Pearson Chi-square Test, $P = 0.3546$, N = 456), as was embryonic mortality (Pearson Chi-square Test, $P = 0.8153$, N = 449).

Discussion.—The number of nests of the American Crocodile in ENP has increased fivefold from 1978 to 2004 and more than doubled since 1997 (Fig. 1). Although a slight increase has occurred in the core nesting area of northeastern Florida Bay, most of this increase can be attributed to the new Cape Sable/Flamingo nesting area of ENP. Most of those nests were on artificial substrates (Table 1). Hence, in ENP as elsewhere in Florida, most of the increase in crocodile nests was on man-made substrates in areas where crocodiles did not nest historically.

Nesting occurred within a few years of creation of peat canal banks created at TP and the Crocodile Lake National Wildlife Refuge (CLNWR; Mazzotti 1983; Ogden 1978). In ENP, crocodiles nested on a canal plug within hours of construction completion (Mazzotti 1999). However, most of the increase in nesting in the Cape Sable/Flamingo area was on canal banks that were created more than 40 years ago (Beard 1938; Lodge 1994). Mazzotti et al. (2007) hypothesized that plugging canals in the Cape Sable/Flamingo area in the 1980s and 1990s to reduce saltwater intrusion and retain fresh water provided more suitable habitat for nesting for the few crocodiles present in the area and for growth and survival of hatchling crocodiles. The rapid increase in numbers of crocodiles nesting in the Cape Sable/Flamingo area since 2000

TABLE 2. Patterns of nesting success and failure of American Crocodiles observed in Everglades National Park between 1970 and 2004. Successful nests are those that produced at least one hatchling. Data from Ogden (1978), Mazzotti (1989, 1999), and present study.

	1970–1982	1985–1995	1997–2004
Number of nests	104	166	222
% successful (#)	74	62	66 (146)
% depredated (#)	13	23	29 (64)
% infertile or embryonic mortality* (#)	13	10	4.5 (10)
% relocated (#)		5	0.5 (1)
% successful in NE Florida Bay (#)		72	64 (77)
% successful in Cape Sable/Flamingo (#)		29	68 (69)

*most embryonic mortality is caused by flooding and desiccation (Mazzotti 1989, 1999)

may be the result of offspring of the original nesting crocodiles entering the breeding population.

The decrease in creek nests coincides with sea level rise (Mazzotti et al. 2007; Simmons and Ogden 1998). Not only did crocodiles formerly nest more frequently along creek banks, but some of the creek banks were farmed in the early 1900s (Moore 1953a). That suggests that water salinity and water levels were lower than at present. Current estimates of sea level rise suggest that water levels around Florida Bay have been rising at a rate of 38 cm/100 yr since 1932 (Wanless et al. 1994). Canal banks are at higher relative elevations than creek banks, are less susceptible to flooding, and may possibly provide additional nesting habitat as sea level continues to rise.

Although the number of island nests has increased, crocodiles have not returned to nest on many of the islands where they were known to nest in the 1950s (Moore 1953b; Ogden 1978). Instead, crocodiles are now nesting on islands close to the mainland in northeastern Florida Bay. We hypothesize that the overall increase in nests on islands and on the mainland shoreline is related to an increase in relative density of crocodiles in the area. Nesting islands in the southern portion of northeastern Florida Bay were probably used by crocodiles from Key Largo and were abandoned when crocodile habitat on Key Largo was developed (Ogden 1978). Islands in central Florida Bay, like islands in northern Florida Bay, are in an area where we suspect relative density of crocodiles has increased (Mazzotti 1999). Yet, there has not been a corresponding increase in nesting on those islands. One possible explanation is that nesting surveys have shown that elevated nesting beaches are no longer present on any of the islands in central Florida Bay mentioned by Moore (1953b). The cause of the loss of nesting beaches on those islands is unknown but could be the result of storm erosion (Mazzotti 1989), sea level rise, or both.

Nesting success of the American Crocodile in Everglades National Park compares favorably to nesting success of American Crocodiles elsewhere (Arteaga and Gomez 2000; Schubert 2002; Thorbjarnarson 1989) and other species of crocodilians (Allsteadt 1994; Hall and Johnson 1987; Metzen 1978; Webb et al. 1983). In Florida, nesting success in ENP is intermediate between that found at the TP nesting area (highest) and at CLNWR (lowest; Mazzotti et al. 2007). In ENP, nest failure is the result of embryonic mortality caused by flooding or desiccation, and depredation by raccoons (Mazzotti 1989, 1999). For example, nesting in ENP is timed to avoid the wettest and driest times of the year, and embryonic mortality is limited to years with extreme rainfall events (Mazzotti 1999). Sand nests were more susceptible to desiccation and creek nests were most susceptible to flooding. With fewer creek nests embryonic mortality has been reduced (Mazzotti 1999).

Depredation of crocodile nests by raccoons in Florida has only occurred in ENP, despite the presence of raccoons at both of the other nesting areas (TP and CLNWR) (Mazzotti et al. 2007; Moler 1992). One difference among the nesting areas is that, until recently, all nesting at TP and CLNWR was on man-made substrates whereas most nesting in ENP was on natural substrates. However, when nesting on man-made substrates began in ENP, it appeared as if those nests were particularly vulnerable to depredation (Mazzotti 1999). That trend has not continued (this study).

If the pattern of increasing numbers of nests and good nest success continues, the data would support reclassification of the American Crocodile from endangered to threatened. This underscores the importance of long-term monitoring programs for endangered species recovery. The response of nesting crocodiles to the plugging of canals to restore more natural salinity patterns in interior wetlands confirms the value of crocodiles as indicators of ecosystem response to restoration projects. Also, this highlights the value that relatively simple projects can have for endangered species recovery and ecosystem restoration.

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Summer Breeding and Accelerated Larval Development in the Myobatrachid Frog, *Neobatrachus pictus* Peters, 1863

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Anurans living in arid and semi arid environments have to overcome high temperatures and a seasonal lack of water (Bentley 1966). Many arid zone frogs avoid desiccation from high temperatures and water loss by burrowing (Bentley 1966; Main et al. 1959). Some species also form a cocoon for further protection from desiccation and water loss until the next heavy rains that may be three or more months away (Lee and Mercer 1967). Anurans living in arid environments must adapt their breeding strategies to take advantage of water when it is available. Consequently, desert species may not breed for several years (Bragg 1967; Main et al. 1959; Morton et al. 1993). Many species living in arid areas will breed whenever water becomes available regardless of the time of year, usually following heavy rain (Bragg 1967). Hence, they may have non-seasonal but extremely restricted breeding periods usually only lasting two or three days (Bragg 1967; Main et al. 1959). As water is only available for a limited amount of time, metamorphosis is often accelerated, ensuring offspring have enough time to complete development before the water source has dried up (Bragg 1967; Main et al. 1959; Read 1999).

The reproductive biology of some Australian myobatrachid frogs, including those in the genus *Neobatrachus*, is poorly understood. This is especially true when compared to the well-studied North American pelobatids, including *Spea* and *Scaphiopus*, that appear similar in their basic biology and ecology to Australia's myobatrachids, particularly those in the genus *Neobatrachus* (Read 1999). Opportunistic breeding occurs in pelobatids, usually following rain (Bragg 1967; Woodward 1982). Fast development from egg to metamorph (e.g., from 7 to 40 days) occurs in most *Spea* and *Scaphiopus* species (Bragg 1967; King 1960; Voss 1961). The speed of development has been shown to be affected by water levels, water temperature, food availability, and competition and cannibalism from conspecifics (Bragg 1967; Morey and Reznick 2000; Pfennig 1990; Semlitsch and Caldwell 1982). Skeletochronology studies suggest that these frogs are relatively long lived (> 13 years) and may take two or more years to reach maturity (Tinsley and Tocque 1995; Woodward 1982). However, comparable data are lacking for many of the species in the genus *Neobatrachus*.

Herein, I provide some new data on the general reproductive biology, occurrence of summer breeding and accelerated larval development in *N. pictus*. I also highlight similarities between the Australian *Neobatrachus* and the North American pelobatids.

Neobatrachus pictus is a locally common burrowing frog found in southern South Australia and in western Victoria (Cogger 2000). It occurs in a wide range of habitats from open grasslands and mallee woodlands, and in farmed and cleared land (Barker et al.

1995; Robinson 1995), usually near dams, claypans or ditches where water pools after rain (Robinson 1995). Currently, *N. pictus* is thought to breed at any time of the year, usually following heavy rain (> 25 mm) (Roberts 1978). Breeding and calling have been observed in the late austral summer and early autumn (February and March) as well as throughout winter and into the early spring (Roberts 1978). Males call from the water while floating (Roberts 1978). Larval life has been reported to be 4–9 months (Anstis 2002; Barker and Grigg 1977).

Methods and Results.—Frogs were observed at two study sites near Burra (33°42'S, 138°56'E), in the mid-north of South Australia. Site 1, Rosalea, is located approximately 10 km S of Burra and is surrounded by ploughed fields. Site 2 is located on the outskirts of Burra in natural grassland that is grazed by sheep. After a prolonged dry period (< 100 mm in previous 6 months), heavy rain fell consistently between the 18 and 21 January 2007. Total rainfall over the four days was 82 mm at Site 1 and 88 mm at Site 2. One dam was monitored at Site 1 (Dam 1, length × width = 38.8 m × 27.2 m) and two dams located approximately 1 km apart at Site 2, one small (Dam 2, 15.7 × 14.9 m) and the other large (Dam 3, 108 × 33.5 m). All three dams are man made and dug out of clay, and all were dry and empty prior to the rain event. On 23 January the water levels within the dams were measured and depths recorded were 1.7 m, 1.6 m, and > 2 m for Dams 1, 2, and 3 respectively. When possible, all three dams were inspected daily from the onset of rain to monitor larval development.

Breeding observations.—On 21 January *Neobatrachus pictus* called at all 3 dams from ~ 2100 h to at least 0100 h; there were no calls heard prior to 21 January. Ten captured specimens were confirmed to be *N. pictus*, based on their size, call and lack of skin connection from the knee to the side of the body that distinguishes them from other *Neobatrachus* spp. in the region (Roberts 1978), and were released back to their capture locations.

The choruses lasted 5 days, to 25 January, with no frogs heard or observed on or after 26 January. Male *N. pictus* called from the water and the water's edge and their numbers and location within the dam across the 5 nights at Site 1 were visually estimated (Table 1). From 22 to 24 January, egg masses were seen at night but were not visible the following mornings at ~ 0900 h. Amplexus, however, was not observed at any of the dams. Adult *N. pictus* were found over 300 m away from the dam at Site 1. A second frog species, *Limnodynastes tasmaniensis*, was present at Dam 1 from 23 to 25 January in much lower numbers (visual estimate: 15 animals per night). Ambient temperatures were recorded between the 21 to 25 January 2007 using a data logger located at Site 1. Temperatures ranged from 11.3–24.1°C between 2130 h and 0430 h, during the five days of the chorus.

Tadpoles.—Tadpoles were first observed in all three dams on 2 February 2007. Tadpoles aggregated in large groups, 50–100 individuals, in the shallow water and many appeared to come to the water's surface frequently to gulp air. The water at Site 2 was very clear and more than 1000 tadpoles could be seen at each of the dams. However, at Site 1 it was difficult to estimate tadpole numbers due to the muddy water.

Tadpoles were first observed with hind legs on 14 February. Front legs were observed in some individuals on 20 February. Tadpoles with no legs were present until 26 March 2007 at all three dams. However, by 6 April 2007, water levels were very low (< 30 cm) at Dam 1 (Site 1) and Dam 2 (Site 2) and all remaining tadpoles had died, with many seen dead in the shallows and on the banks of the dams.

TABLE 1. Estimated numbers of *Neobatrachus pictus* and their locations around the dam during five breeding nights at Rosalea, Site 1, in South Australia.

Date	No.	Location
21 Jan 2007	60+	Highly visible near waters edge
22 Jan 2007	60+	Highly visible near waters edge
23 Jan 2007	40+	Edge and in middle of dam
24 Jan 2007	20+	Few near edge most in water
25 Jan 2007	20+	Few near edge most in water

Metamorphs.—Metamorphs were first observed at all dams on 26 February 2007, and then were observed nightly until the 5 April 2007. There were no observable differences in metamorphosis rates between the frogs in ploughed land or natural grassland, or between large or small dams. This suggests that *N. pictus* can develop from egg to metamorph in ~ 37 days. On 27 February 2007, 16 metamorphs were collected from Site 1 between 2030 h and 2120 h, from up to 10 m away from the water's edge. The captured metamorphs were measured for snout–vent length, head length (snout tip to posterior tip of jaw articulation), head width (behind eyes and between the tips of the jaw), tibia length (leg flexed), remaining tail (vent to tip of tail) and weight (to the nearest gram) (Table 2). The metamorphs were then returned to their place of capture. Metamorphs were observed over 200 m from the nearest dam. Three specimens were collected and deposited into the South Australian Museum (SAM) (SAM reference numbers: R62503-5).

Discussion.—My study is the first to document summer breeding and accelerated development of *N. pictus* in the semi-arid landscape of South Australia. It is also the first reported case of *N. pictus* breeding in January, and confirms the temporal flexibility in breeding time in this species (Roberts 1978). This observation also highlights the similarities between the *Neobatrachus* of Australia and the North American pelobatids.

Neobatrachus pictus from near Burra, South Australia, had an accelerated rate of metamorphosis compared to other published accounts (Anstis 2002; Barker et al. 1995), reaching froglet stage after only a few weeks (37 days), rather than 4–9 months, if conditions are suitable (Anstis 2002; Barker et al. 1995). Fast meta-

TABLE 2. Metamorph *Neobatrachus pictus* body measurements (N = 16) of specimens collected from Rosalea, Site 1, South Australia.

Body Measurement	Range	Mean (SD)
SVL (mm)	21–27	23.5 (1.46)
Head length (mm)	8–10	8.75 (0.68)
Head width (mm)	8–10	8.75 (0.68)
Tibia (mm)	7–9	8.19 (0.75)
Tail remaining (mm)	3–21	7.56 (4.21)
Weight (grams)	2–3	2.19 (0.40)

morphosis has been recorded for *N. centralis* with metamorphosis taking as little as 17–40 days (Read 1999). This rapid development is comparable with the North American pelobatids living in similar environments (Bragg 1967). The benefits of fast metamorphosis include maximizing recruitment (Newman 1989; Wilbur 1987), and enhanced survival when early developers can attain larger sizes and mature earlier than slow developers (Berven 1990; Smith 1987). It is also an advantage to species living in environments with unpredictable rainfall and areas where water is only available for short periods of time (Bentley 1966). Many species of *Neobatrachus*, including *N. pictus*, may overwinter as tadpoles and develop in the spring (Anstis 2002). However, flexibility in the breeding strategy, as shown by *N. pictus*, may also be present in congeners, possibly allowing breeding or larval development to take place at any time of year if conditions are suitable. Further studies would need to be conducted to fully understand the factors that trigger the accelerated larval development in *N. pictus*.

In my study, there was no apparent difference in the rate of larval development in the dams in natural grasslands and ploughed fields, or between large and small dams. However, I only measured dam depth and size. Other studies have found differences between development rates due to water levels, water temperature, food availability and competition (Bragg 1967; Morey and Reznick 2000; Pfennig 1990; Semlitsch and Caldwell 1982). These factors should be considered in future studies.

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Some Forgotten Descriptions of *Nasikabatrachus* (Anura: Sooglossidae)

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Much excitement was justifiably generated in the recent past in association with the description of a purported new family of amphibians (the Nasikabatrachidae) by Biju and Bossuyt (2003). Dubbed 'the coelacanth of frogs' (Hedges 2003), its sole described member, *Nasikabatrachus sahyadrensis*, is restricted to the Western Ghats complex of Southwestern India, a known biological diversity hotspot (see also Aggarwal 2004; Gadagkar 2004). Another research group described its tadpole and added details of adult morphology and confirmed a relationship with the African Heleophrynidae and the Seychellian Sooglossidae (Dutta et al. 2004). Most recently, Frost et al. (2006) synonymized Nasikabatrachidae under Sooglossidae. Two recent papers have discussed the distribution of this enigmatic frog (Andrews et al. 2005; Das 2006).

These recent papers, however, make no mention of several early papers that described in detail (for the first time), the tadpoles and post-larval stages of *Nasikabatrachus*, including osteological details of adults, and inference to an African relationship.

The first report of tadpoles that are clearly *Nasikabatrachus* is in Annandale and Rao ("1916" 1917), who provided a brief de-

scription, based on specimens from Kerala State, Southwestern India. In another paper, Annandale (1918) provided an extended description and measurements, and presented illustrations of the body and mouthparts, tentatively assigning the species to the family Cystignathidae (at present synonymous with Leptodactylidae). Subsequently, Annandale and Hora (1922) remarked on the similarities between their unidentified tadpole, which they considered closely related to *Heleophryne*, and wrote: "No frog of the family Cystignathidae is known from the Oriental Region, but the Batrachia of the hills of the Malabar Zone are still imperfectly studied and the adult of this tadpole is a burrowing form and, therefore, liable to escape notice. The Ethiopian affinities of the fauna of the Malabar Zone are well recognized by Zoogeographers." The larva was also discussed in a paper on convergent evolution of torrent fish and tadpoles by Annandale and Hora (1922). Later, Rao (1938) reexamined some of the early specimens, as well as a metamorph, and inferred a relationship of the Indian frog with the African Heleophrynidae (using *Heleophryne natalensis* as a representative) and Hemisotidae (comparisons made with *Hemisus*), rather than to any Asian taxa, but clearly diagnosed the Indian taxon as different, writing of the justification of "creation of a new genus or even a sub-family for their reception." The Sooglossidae, to which family *Nasikabatrachus* was allocated by Frost et al. (2006) was described by Noble only in 1931. Two other papers which describe the cranial osteology of *Nasikabatrachus* (tentatively allocated to the family Cystignathidae) include Ramaswami (1943) and Ramaswami (1944), while noting its non-confamilial status.

The description (p. 22) and images (Pl. I; figs. 6, 6a) of the tadpoles provided in Annandale (1918) of a species *incertae sedis* match the description of *Nasikabatrachus* provided by Dutta et al. (2004), including: 1) dorsoventrally flat; 2) reduced tail fin; 3) beak with keratinized labial teeth rows; 4) sinistral spiracle; 5) cloacal tube with flap-like extensions ventral to tail fin; 6) ventrally-located suctorial mouth; 7) head large; and 8) the dorsal orientation of the eyes and nostrils. Dutta et al. (2004) mentioned an additional character that is at variance with the description in Annandale (1918)—a white head. Specimens reported in that paper were examined several years after preservation, which might explain the discoloration of head and body, described as "dark grey with small black spots." A uniquely derived character of the Nasikabatrachidae—funnel-shaped cloacal tube—is not mentioned in the early description, perhaps because of the technical limitations of the optics of the time. Both Annandale (1918) and Dutta et al. (2004) describe the tadpoles as being torrenticole in habits. Adult and metamorph descriptions in Annandale (1918) and Rao (1938) match *Nasikabatrachus* in the following: 1) inner metatarsal tubercle spade-like; 2) sternum absent; 3) firmisternal pectoral girdle; 4) lateral end of coracoid wider than median; and 4) hind limbs dark with a white inner metatarsal tubercle.

Aggarwal (2004) pointed out that *Nasikabatrachus* was familiar to the local people, revealing once again the failure of science to pay enough attention to local knowledge. In this short communication, I show that early workers in India, in a series of forgotten papers published nearly a century ago, have remarkably predated the discovery of a new species and genus of an ancient group of frogs. They also arrived at a conclusion on relationships rather similar to that confirmed using contemporary knowledge on morphology and molecular techniques.

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Rediscovery of the Rare Coralsnake *Micruroides euryxanthus neglectus* (Serpentes: Elapidae)

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The New World coralsnakes are currently allocated to three genera: *Micruroides*, *Micrurus*, and *Leptomicrurus* (Campbell and Lamar 2004). The monotypic Sonoran coralsnake (*Micruroides euryxanthus*) is likely the sister taxon to all other New World coralsnakes, and is morphologically distinguished from the other genera by having a single pair of gular shields and by the presence of solid maxillary teeth situated posterior to the fangs. Zweifel and Norris (1955) recognized two subspecies of *M. euryxanthus* (*M. e. euryxanthus* and *M. e. australis*), distributed from southern Arizona and New Mexico south through Sonora and western Chihuahua, Mexico. *Micruroides e. australis* has subsequently been collected from extreme northern Sinaloa, Mexico. In 1967, Roze described the taxon *M. euryxanthus neglectus* on the basis of two male specimens collected between 25–32 km north of Mazatlán, in southern Sinaloa. Since its description, no additional specimens of *M. e. neglectus* have been reported. Furthermore, no specimens of *Micruroides* have been collected from the region intervening the type locality of *M. e. neglectus* in the south and extreme northern Sinaloa, a hiatus of over 400 km.

On 17 July 2006, we obtained a specimen of *Micruroides* from near Cosalá, Sinaloa (24.293°N 106.759°W; 289 m elevation) that we identified as *Micruroides e. neglectus* based on color pattern and scalation (Figs. 1A, B). The specimen is notable in that it is the first known female of the taxon to be deposited in a herpetological collection (Museo de Zoología, Facultad de Ciencias [MZFC], Universidad Autónoma de México: MZFC 19683), and is the first specimen reported since the original description. In most aspects of morphology MZFC 19683 is consistent with the description of the holotype provided by Roze (1967): the specimen has 13 black body rings and 2 black tail rings; black body rings 5–7 dorsal scales long; a pale nuchal ring 3.5 scales long not extending onto parietals; pale body rings 1.5–2 scales long; and 13 unmelanized red body rings. There are a total of 112 red scales along the middorsal line of the body (excluding the tail), which is the highest number reported for *Micruroides*. MZFC 19683 has 226 ventrals (males of *M. e. neglectus* have 206–207), and 24 subcaudals (males have 25–26). The specimen has a snout–vent length of 390 mm and a tail length of 28.9 mm.

Although broadly associated with the arid Sonoran Desert region of southern Arizona and northwestern Mexico, the distribution of *M. euryxanthus* is locally restricted to regions that receive

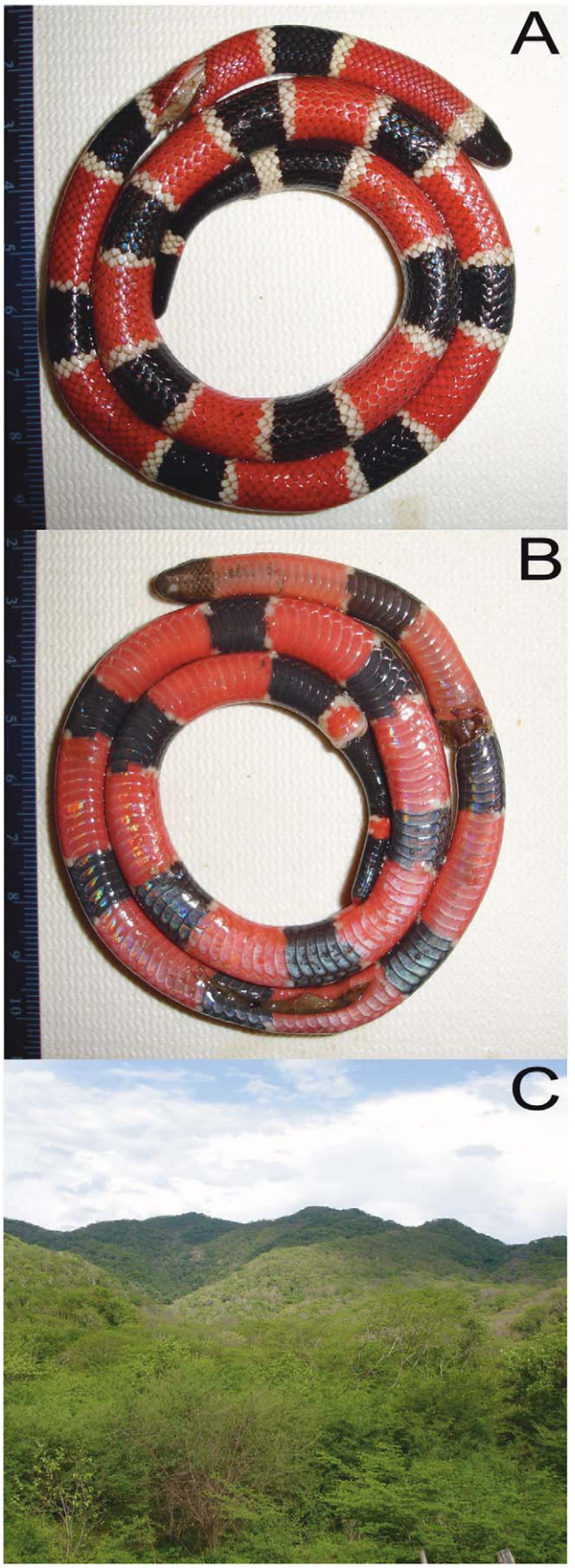


FIG. 1. Dorsal (A) and ventral (B) aspects of *Micruroides euryxanthus neglectus*, adult female (MZFC-19683); (C) tropical deciduous forest near the collecting locality.

relatively high amounts of summer rainfall; thus throughout most of its range its primary habitats are subtropical thornscrub and palo verde cacti desert (*sensu* MacMahon 1985). Over the north to south axis of Sinaloa, the transition from thornscrub to tropical deciduous forest is gradual; the new specimen was obtained from tropical deciduous forest (Fig. 1C), similar to that of the type locality of *M. e. neglectus*. It was found crossing a paved road (Sinaloa Hwy 8) during warm, humid conditions at approximately 2219 h. During the same night, several other snake species were encountered near the collecting locality, including a similarly patterned *Lampropeltis triangulum*.

Most coralsnakes are ophiophagus, consuming primarily small colubrids and typhlopids (Campbell and Lamar 2004). Considerable information exists on the diet of *Micruroides euryxanthus* but not from the extreme southern portion of its distribution. The specimen collected near Cosalá contained the partially digested remains of a small colubrid snake, *Hypsiglena torquata* (MZFC 19684). The snake had been swallowed head-first and only about the posterior third of the body was undigested. As far as we have been able to ascertain, this is the first reported incidence of a non-captive coralsnake consuming *H. torquata* (reviewed in Campbell and Lamar 2004).

The new locality for *M. e. neglectus* is situated approximately 100 km northwest of the type locality in the vast region indicated by Campbell and Lamar (2004) to be of probable, but unknown, occurrence for the species. The new specimen partially fills in this gap in the distribution of *Micruroides*; however, considerable distance still exists between the specimens assigned to *M. e. neglectus* and known *Micruroides* populations to the north. Future collecting efforts will likely substantiate the presence of *Micruroides euryxanthus* throughout Sinaloa. Furthermore, efforts are currently underway to evaluate and revise the taxonomy of all New World coralsnakes, including *Micruroides* (ENS et al., in prep).

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An Anole Lizard Preserved in Colombian Copal

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The term 'copal' is generally used for any hard, semi-fossilized resin produced by diverse broadleaf and coniferous trees found in both the Old and New World. In Colombia, large amounts of resin are often seen hanging from the branches of the leguminous tree *Hymenaea courbaril*, commonly known as the *algarrobo*. Through a process of oxidation and polymerization, this resin gradually hardens—particularly after exposure to sunlight (Lagenheim 1995). The result is a highly durable material named after the Aztec *copalli*, meaning 'resin.' Copal is easily mistaken for amber but is softer and, when heated, burns with a smoky flame (Rice 1980). A drop of a suitable non-polar solvent (e.g., acetone) on copal causes it to become sticky, whereas on true amber there is no reaction. It can take upwards of three to four million years for copal to acquire the properties of amber (Poinar 1992).

Large amounts of fossiliferous material from Colombia are readily available on the market as either semi-fossilized copal or fossilized amber, most of it from the Departamentos de Bolívar, Antioquia, Santander, Boyacá, and Tolima (Poinar 1996). Studies of the nuclear magnetic resonance (NMR) spectra of samples from the Departamento de Santander map almost perfectly to those of modern *H. coubaril*, indicating that they are geologically immature and should be classified as copal (Lambert et al. 1995). In addition, copal from Colombia has always contained recent, extant species of insects (DuBois and LaPolla 1999; Rice 1980).

In the late 1990s a polished piece of Colombian copal, 68.9 mm in length with a diameter of 20.6 mm and weighing 16.3 g, was purchased by Michael Oschin of Temecula, California, from a private collector in Florida (Fig. 1). The copal is from the Departamento de Santander, where most of it comes from near the towns of Bucaramanga, Vélez, and Girón (Poinar 1992, 1996). The piece is unusual for its anole lizard inclusion. The anole is approximately 31 mm in snout–vent length and consists primarily of skin fragments from the left side of the head, the left forelimb, the right forefoot, and the lower two thirds of the body; the latter is represented by a shell of skin and includes approximately the first third of the tail. Skeletal elements include the left maxilla, portions of the left forelimb and right forefoot, the pelvis, parts of the hindlimbs, and a number of tail vertebrae.

In a letter appraising the copal, dated November 16, 1999, James C. Wyatt of Garland, Texas, mentions site visits to the "Amazon Jungle, Santandre [sic] Province, Colombia" by "geologist Allen Gratham of Ardmore, Oklahoma." According to Wyatt, Gratham dated the piece from the Miocene series (23.8–5.2 mya) based on stratigraphy. Wyatt also mentions an unnamed "recent researcher, a geophysical chemist," who estimated the age of the copal at "less than two million years." After Wyatt assigned it a commercial retail value of US $25,000, Oschin donated the copal to the Natural

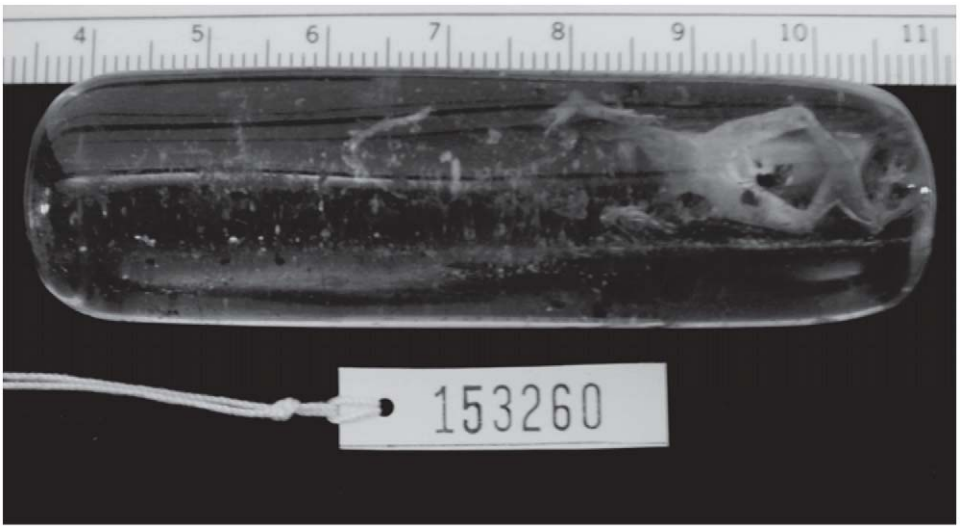


FIG. 1. Copal from Departamento de Santander, Colombia, with anole lizard inclusion (ventral view). Scale bar is in millimeters.

History Museum of Los Angeles County (LACM 153260), where it was included in an exhibit on organisms preserved in amber.

Five resin-preserved anoles have previously been documented (Böehme 1986; de Queiroz et al. 1998; Lazell 1965; Polcyn et al. 2002; Rieppel 1980), although others are known to exist. All five specimens are preserved in amber from the Dominican Republic, two of which were described as new species: *Anolis electrum* Lazell 1965, and *A. dominicanus* Rieppel 1980. The present study is unique in that it examines the first known resin-preserved anole from South America.

Materials and Methods.—The anole inclusion was X-rayed in the Ichthyology Section of the Natural History Museum of Los Angeles County with Faxitron Model 43855C, set at 2.5 mA and 30 kV. Exposure settings were at 60, 120, 180, and 240 sec. The radiograph images were then scanned and enhanced with the Microsoft computer program PhotoDraw. In the Museum's Section of Mineralogy, a 1.0 mm section was sliced from one end of the copal with a Buehler Isomet Precision Saw and sent to Beta Analytic Inc. in Miami, Florida, for radiometric analysis. The rest of the copal was transferred to the Section of Ichthyology for digital photomicrography. Using a Polaroid DMC 1 digital camera in tandem with a dissecting microscope, photographs were taken at 120× magnification of the left loreal region of the head, and at 250× magnification of the left forelimb, left forefoot, and base of the tail. The photographs were later enhanced using PhotoDraw and the following details noted: condition of scales on the anterior portion of the forelimb; condition of middorsal scales at the base of the tail; number of loreal rows under the second canthal; proximity of subocular scale rows relative to supralabials; number of supralabials to below center of eye; and number of subdigital lamellae under fourth toe of left forefoot.

Results.—The X-rays revealed the presence of transverse processes on the autotomic caudal vertebrae (Fig. 2), identifying the specimen as a β-anole (Etheridge 1959). These anoles have been found to be the most derived among the polychrotids (Poe 2004).

The following diagnosis was made from the digital micrographs: scales on anterior portion of forelimb unicarinate (Fig. 3A); middorsal scales at base of tail keeled and slightly enlarged (Fig. 3B); six loreal rows under second canthal, suboculars separated from supralabials by one row of scales, and eight supralabials to below center of eye (Fig. 3C); and 16 subdigital lamellae under fourth toe of left forefoot (Fig. 3D).

The results of the radiocarbon dating were reported in pMC (percent modern carbon) units rather than years BP (before present). With a measured radiocarbon age of 115.4 ± 0.4 pMC, the sample had more ^{14}C in it than the modern reference standard. This excess is attributed to thermonuclear bomb testing during the 1950s (D. Hood, in litt.).

Discussion.—The copal was still respiring carbon post-1950s, implying that the specimen was alive within the last 50 yrs. Of the three possible species of β-anoles currently known from the Departamento de Santander—*A. auratus*, *A. sulcifrons*, and *A. tropidogaster* (Ayala 1986), *A. auratus* was eliminated because of its large, keeled ventrals. *Anolis sulcifrons* was also ruled out because of its smooth supradigital scales (Myers 1971). After comparison with preserved specimens from Colombia, the copal anole agrees most closely with *A. tropidogaster*.

The results of this study emphasize the need for qualified scientists in preventing the misinterpretation of copal specimens. In

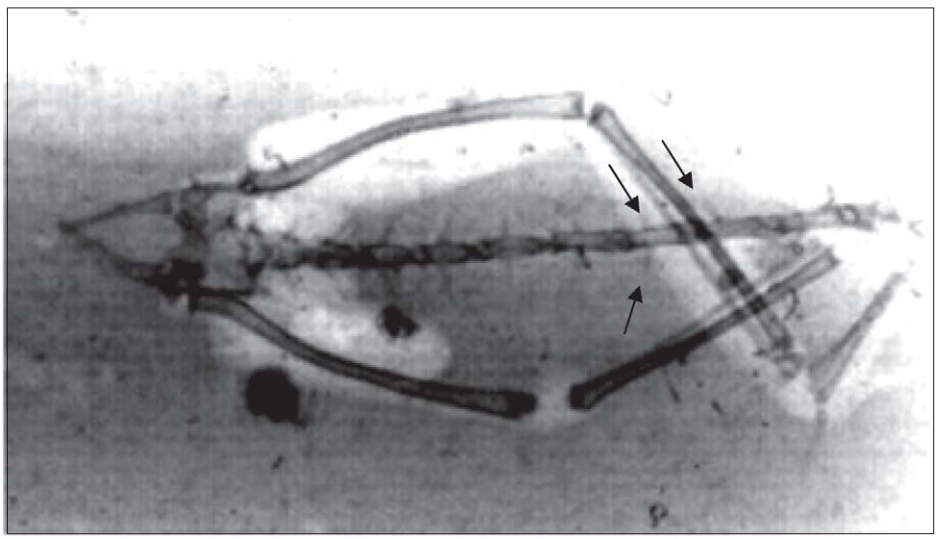


FIG. 2. X-ray radiograph of specimen, showing pelvic region with elements of the hindlimbs and tail. Arrows indicate the presence of transverse processes on the autotomic caudal vertebrae.

this instance, commercial fossil collectors and dealers were initially responsible for the authentication of the copal. The appraisal letter alone contained a number of egregious mistakes. To begin with, the Departamento (not Provincia) de Santander lies within the Valle del Magdalena and is entirely isolated from the Amazonian region by the Cordillera Oriental de Colombia. Second, the name of the geologist from Ardmore, Oklahoma, is Allen Graffham (not Gratham), of Geological Enterprises, Inc. (DuBois and LaPolla 1999). Finally, determining the age of copal based solely on stratigraphy can be highly misleading, as copal is easily re-deposited by water (it floats) or during landslides (DuBois and LaPolla 1999).

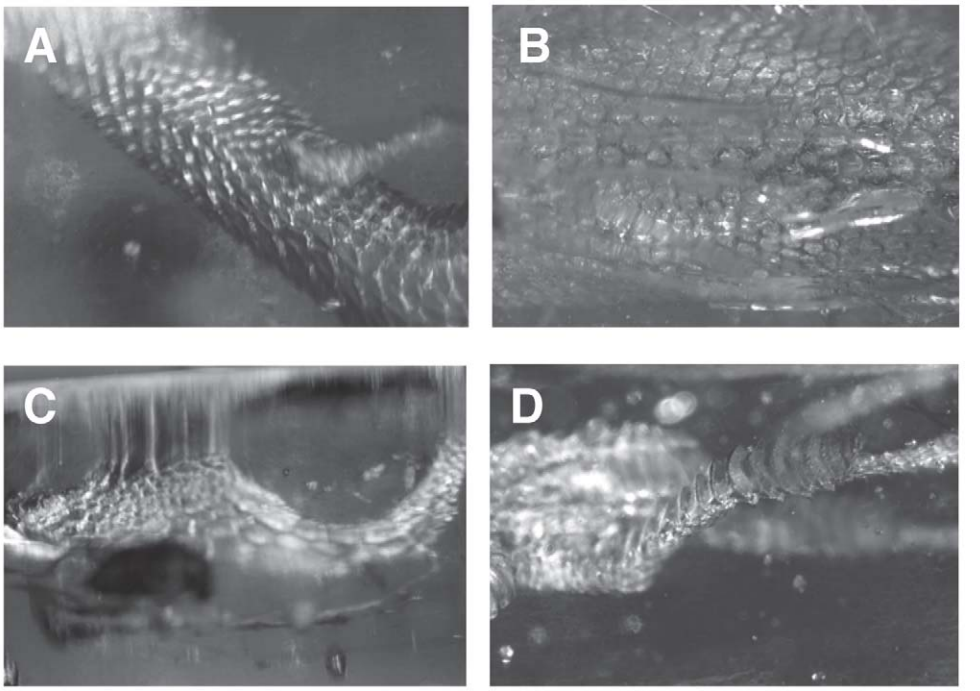


FIG. 3. (A) Scales on left forelimb (250× magnification); (B) dorsal scales at base of tail (250×); (C) scales of loreal region (120×); (D) subdigital lamellae under fourth toe of left forefoot (250×).

Acknowledgments.—This study would not have been possible without the kindness and generosity of M. Oschin. Thanks also to D. Kizirian and the following individuals, who contributed their valuable time and services: J. Seigel, R. Feeney, and D. Ettensohn; K. Oliva; A. Summers and R. Jacinto; D. Hood; and G. Poinar. Inspiration was provided by D. Buth.

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APPENDIX 1

Specimens Examined

Anolis auratus.—COLOMBIA: Dept. Antioquia: Santa Fe de Antioquia: LACM 131456–59. Dept. Cesar: 15 km S Bosconia, Finca el Diamante: LACM 114534. Dept. Córdoba: 15 km S Lorica (El Campano) on Río Sinú: LACM 131460–64. Dept. La Guajira: Colombia Nuevo, 28 km E Palomino: LACM 131465–66; 2 km E Río Palomino, near mouth: LACM 114533. Dept. Magdalena: Parque Nacional Tayrona, western end: LACM 114535–36. Dept. Sucre: 4 km E Tolú, Hacienda la Estanzuela: LACM 114537–38. Dept. Vichada: Tuparro: LACM 131467–70.

Anolis tropidogaster.—COLOMBIA: Dept. Cesar: 15 km S Bosconia, Finca el Diamante: LACM 114542. Dept. Chocó: W bank Río Atrato, below Bellavista: LACM 51543–44. Dept. Córdoba: Río Esmeralda, approx. 25 km from mouth: LACM 114539, 114546–47; Río Esmeralda, 4 km above mouth: LACM 114541; upper Río Napipí, 45 min by canoe (going upstream) below mouth of Río Merendo (tributary of Napipí): LACM 42170; Río Sinú, 2 km below jct with Río Esmeralda: LACM 114540. Dept. Magdalena: Río Magdalena: LACM 131477–80. Dept. Sucre: 4 km E Tolú, Hacienda la Estanzuela: LACM 114532. Dept. Tolima: Mariquita, forest next to town: LACM 42220.

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Genetic Verification of Possible Gigantism in a Southern Toad, *Bufo terrestris*

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Ectothermic vertebrates are well known for indeterminate growth, a process by which animals continue to grow throughout life, although the rate of growth slows with age. Maximum size is a morphological characteristic of amphibians and reptiles that is useful in species identification (Conant and Collins 1998), but because of indeterminate growth, older, larger individuals are occasionally found, necessitating periodic revisions of the size information available for species. Examples of true gigantism (abnormally large size) have not been reported in amphibians, probably because it is difficult to know whether an exceptionally large-sized individual represents the far end of the normal size distribution of a species or whether some other phenomenon is operating such as acromegaly, a genetic anomaly that influences the overproduction of growth hormones (Ferone et al. 2004).

The maximum reported size of *Bufo terrestris* is 113 mm SVL (Conant and Collins 1998). On 18 December 2003, Brenda Boland found a large toad (Fig. 1) in her yard near the town of Wacissa, Jefferson Co., Florida (30°21'31"N, 83°59'14"W). The female toad (sex later determined by dissection) measured 150 mm SVL and weighed 193.6 g. This specimen is 33% longer than the previous maximum SVL reported for *B. terrestris* and about 1335% larger by weight than the average Southern Toad (14.5 g) determined by weighing a sample of 10 live adults (8 males, 2 females) from a site (30°21'08"N, 84°18'30"W) 33 km to the west in adjacent Leon County, Florida. The normally pronounced knobs and high cranial crests, diagnostic for *B. terrestris*, were present but extremely exaggerated in this individual; dark, dorsal spots contained one to three warts, themselves larger than normal (Fig. 1). Although the external morphology of the giant toad was consistent with that of *B. terrestris*, we wanted to verify this with genetic data. Therefore, we compared its mtDNA with samples of known *B. terrestris* and previously published sequences of *B. americanus*, *B. fowleri*, and *B. terrestris* by Masta et al. (2002).

Toes were preserved in 95% ethanol from 5 *Bufo terrestris* collected on 4 March 2002 in Leon County, Florida just south of Tallahassee (30°21'08"N, 84°18'30"W). One toe from the large toad was collected on 5 June 2004. All samples were stored in 95% ethanol until DNA was extracted. DNA was extracted from each individual using a Qiagen® DNEasy Tissue Kit. For each individual, DNA was PCR amplified for a mitochondrial genome region that began at the 3' end of 16S gene and spanned $tRNA^{Leu(UUR)}$, ND1 gene, $tRNA^{Ile}$, $tRNA^{Gln}$, $tRNA^{Met}$, and to the 5' end of ND2 gene using primers Bw16S-L and BwND2-H developed by Masta et al. (2002). This region was chosen because primers had been developed and because sequence data were available on GenBank for *B. americanus*, *B. fowleri*, and *B. terrestris*.

PCR products were prepared for sequencing using a Qiagen® QIAquick PCR Purification Kit to remove carried over primers, dNTPs, buffers, enzymes, and non-target DNA. Purified products were then used in sequencing reactions. Sequencing reactions for each primer and individual were performed using ABI Prism® BigDye Terminator Cycle Sequencing Ready Reaction Kit (Applied Biosystems). These products were ethanol precipitated, dried, and resuspended in Template Suppression Reagent (Applied Biosystems) in preparation for loading into an automated DNA sequencer. Nucleotide sequence data were then collected using an ABI Prism® 310 Genetic Analyzer and DNA Sequencing Analysis Software™ Version 3.4.5 (Applied Biosystems). Sequences were aligned and edited using Sequencher™ version 4.1.4 (Gene Codes Corporation).

Two individuals each of the three morphologically similar toad species were haphazardly chosen from Table 1 of Masta et al. (2002) with the following GenBank accession numbers: *B. americanus* (AF462491; AF462500), *B. fowleri* (AF462507; AF462522), and *B. terrestris* (AF462529; AF462530).

A total of 1062 bases were sequenced and aligned for 5 *B.*



FIG. 1. Giant *Bufo terrestris* female with normal-sized adult female on her back.

terrestris and the large toad. Of these, 757 overlapped with sequences from the *Bufo* study of Masta et al. (2002). The sequence data for the 5 *B. terrestris* and gigantic toad had identical nucleotides at all 1062 positions. Based on the alignment of the four toads in this study and six GenBank sequences, six species-specific positions occurred within the 757-base segment of overlap. All identified the four toads in this study as *B. terrestris* (i.e., the nucleotide at each of the six positions were the same as the two *B. terrestris* from GenBank and differed from *B. americanus* and *B. fowleri* from GenBank.

Because this toad is so much larger than one would expect from a normal distribution of *Bufo terrestris* SVLs, we believe it is not simply the largest toad of its kind but represents a case of abnormal growth. Several causes are possible. Interspecific hybridization is unlikely because only *B. quercicus*, a tiny species, is sympatric with *B. terrestris* in the area where our giant toad was found. If our giant toad's father (mtDNA tells us the mother was a *B. terrestris*) was an escaped or naturalized alien species such as *B. marinus*, we should have seen some morphological expression of his genes, but in all external characteristics, the giant toad has only *B. terrestris* morphology. Moreover, the large natural size difference between a female *B. terrestris* and a male *B. marinus* would seem to preclude amplexus in this pair.

Acromegaly results from excessive growth hormone in adults and usually results in an overgrowth of bone and connective tissue that produces coarse facial features, hands, and feet (Van Der Lely et al. 2005). We have found no published studies of acromegaly in cold-blooded vertebrates, so we do not know how acromegaly presents in amphibians except to say that our giant toad does not have any grossly coarse features of the head, hands, and feet. We cannot rule out another possible cause, genome multiplication, because we didn't assay nuclear DNA. The simplest and most likely cause, in our opinion, is gigantism, the result of excessive growth hormone secretion that begins in juvenile humans and other animals (Tortora and Derricksen 2005).

Environmental pollutants such as fertilizers, herbicides, and pesticides have all been shown to influence amphibian growth and development (Boone and Bridges 2003; Halliday 2000; Relyea 2005). We cannot say whether the size of our giant toad is the result of the effects of one or more of these chemical agents, but body deformities, inhibition of larval growth, and survival of populations and species of amphibians are of increasing concerns to herpetologists (Lannoo 2005; Semlitsch 2003).

Abnormal size due to genome multiplication remains to be tested in our giant toad. We have been unable to locate any literature on gigantism or acromegaly in amphibians, so it is important that this example may be the first of its kind to be reported.

We were unsuccessful in getting the toad to breed. She was found dead in her cage on 02 February 2005, preserved in 95% ethanol, and was deposited in the Florida Museum of Natural History (UF 144211) and is available for further study.

Acknowledgments.—Kenneth L. Krysko, Wayne King, Kevin Enge, Paul Moler, and Max Nickerson of the Florida Museum of Natural History verified the size and identity of the giant toad. Michael P. Krick of Pet Paradise, Tallahassee, Florida, kindly loaned us the specimen for study.

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TECHNIQUES

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A Simplified and Inexpensive Method for Extraction and Quantification of Tetrodotoxin from Tissue Samples

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Tetrodotoxin (TTX) is a potent neurotoxin that blocks sodium channels, preventing the propagation of action potentials, causing paralysis and eventually death (Miyazawa and Noguchi 2001). It is perhaps most well known from pufferfish (e.g., Brillantes et al. 2003; Lin et al. 1998), but it is also known to occur in the tissues of newts and other amphibians (reviewed in Daly 2004). Among amphibians, the antipredator defensive role of TTX in the rough-skinned newt (*Taricha granulosa*) has been the subject of extensive study (e.g., Brodie et al. 2002; Hanifin et al. 2003; Hanifin et al. 1999; Lehman et al. 2004). Further, TTX was recently found to be retained in the liver of *Thamnophis sirtalis*, which is a natural predator of T. *granulosa* (Williams et al. 2004). The ecology and function of TTX in other amphibian, and potentially reptilian, species is not well known. Further study of *T. granulosa* and other species with TTX would be enhanced with easier extraction and quantification of TTX, particularly if the method is easily implemented. Here I describe a new technique (tissue sonication) for TTX extraction from tissue samples and the use of a quick and efficient indirect competitive-inhibition enzyme immunoassay (CIEIA) to quantify TTX.

TTX extraction protocols have previously used manual grinding of tissue samples in extraction buffer. This extraction method is labor-intensive and slow, not desirable traits for processing a large number of samples. Further, previous methods of identifying and quantifying TTX include gas chromatography-mass spectrometry and high performance liquid chromatography (HPLC; Noguchi and Mahmud 2001). These techniques require highly specialized equipment and training, and can be both expensive and time-consuming. The improvements I report here should make TTX quantification easier and more accessible to researchers with access to standard molecular biology equipment.

TTX Extraction

Some types of tissues are difficult to manually grind, leading to a physically demanding and time consuming extraction process. Manual grinding also requires a relatively large volume of extraction buffer to accommodate the tissue and pestle in the grinding vessel. By employing a tissue sonifier, the time, physical demand and expense associated with extracting TTX can be reduced. To prepare samples for sonication, a small amount of tissue (e.g., a single egg or a skin sample) is placed in a 2 ml microcentrifuge tube with a screw cap. 400 μL of extraction buffer (0.1 M acetic acid) is added to the microcentrifuge tube. In the case of larger amounts of tissue, more extraction buffer (e.g., 800 μL) may be necessary. Each sample is then sonicated for 15–20 seconds, or until the tissue is completely homogenized, using a sonifier (Branson Sonifier 450) fitted with a microtip probe at a power setting of 3 (medium-low). Care must be taken to not touch the probe to the side of the microcentrifuge tube, as this can melt the plastic. To prevent cross-contamination of samples, the sonicator probe should be cleaned with ethanol and water, and then manually wiped, after each sample is sonicated. Based on working with *T. granulosa* skin samples, 16 samples can be sonicated in less than 10 min; manually grinding the same number of samples may take upwards of 2 h. Following sonication, the homogenized samples are heated for 5 min in a boiling water bath or in a 100°C dry heat block, and then cooled to room temperature. The homogenate is then centrifuged at 13000 rpm for 20 min. After centrifugation, the supernatant is removed in 400 μL aliquots and transferred to Millipore centrifugal filter devices (Ultrafree®-MC, 10000 NMWL filter units). The final step in the extraction process is centrifugation at 13000 rpm for 20 min in the filter units. The extract can then be stored at -80°C until needed.

This protocol differs from previously used protocols primarily in the use of a sonifier to extract TTX from tissue instead of manual grinding, saving a large amount of time. Additionally, tissue sonication lowers expenses by reducing the volume of extraction buffer used, which subsequently lowers the number of costly Millipore centrifugal filter devices. Samples extracted using this protocol can be assayed both by indirect CIEIA (below) and HPLC. I have successfully used this method to extract TTX from *T. granulosa* eggs, and skin samples taken from both *T. granulosa* (5 mm diameter piece of skin) and *Notophthalmus viridescens* (3 mm diameter) using a skin punches (Hanifin et al. 2002).

Indirect CIEIA

Direct and indirect CIEIA methodologies have been developed for quantifying TTX (Kawatsu et al. 1997; Raybould et al. 1992). These methodologies differ in their use of a labeled (direct) or unlabeled (indirect) anti-TTX antibody. A labeled antibody is bound to a chromagenic enzyme (e.g., alkaline phosphatase), and the addition of a particular substrate (e.g., p-nitrophenyl phosphate (pNPP)) results in a color change indicating the amount of antibody present. However, only an unlabeled anti-TTX antibody is available commercially (Hawaii Biotech, Inc.), making the indirect (rather than direct) CIEIA is necessary. The method described here (indirect CIEIA) uses an unlabeled anti-TTX antibody and a secondary antibody that is bound to alkaline phosphatase to elicit a color change.

The TTX assay procedure begins by attaching TTX to the wells of a 96-well immunoassay plate. However, TTX does not bind to the surface of a plate because it is such a small molecule; therefore it must first be chemically conjugated to bovine serum albumin (BSA, Sigma, Inc.) with the aid of formaldehyde (F), forming the BSA-TTXF complex. To create the BSA-TTXF, the following ingredients are mixed in an amber glass vial: 700 μL of 1 mg/mL TTX in 1% (v/v) acetic acid, 300 μL 1M sodium acetate buffer (pH 7.4), 179 μL of 33.6 mg/mL bovine serum albumin (BSA) in 1M sodium acetate buffer, and 41 μL 37% formaldehyde. The vial is then sealed and incubated on a shaker at 37°C for 3 days. The solution is then dialyzed against four 1 L changes of phosphate buffered saline (PBS) spaced approximately evenly over 3 days at 4°C. The concentration of BSA in the solution is then determined spectrophotometrically using an extinction coefficient of 0.667 mg·cm/mL at 280 nm, with the spectrophotometer blanked with PBS. The solution can then be stored at 4°C and diluted to 10 μg/mL in PBS as needed for the assay.

The TTX assay procedure is outlined in Table 1. On each plate, a positive and a negative control are run, in addition to TTX stan-

Table 1. Instructions for the indirect CIEIA to measure TTX concentration.

1. Add 100 μL of 10 μg/mL BSA-TTXF, diluted in PBS, to each well of a 96-well microtiter plate (Nunc MaxiSorp).
2. Coat wells by incubating overnight at 4°C or at room temperature for 1 hour.
3. Wash all wells 3 times with 300 μL per well of PBS-T (PBS with 0.5 mL/L Tween-20®).
4. Block each well with 200 μL of 1% BSA in PBS (PBS+BSA) for one hour at room temperature.
5. Wash all wells 3 times with 300 μL per well of PBS-T.
6. Add 50 μL of sample or standard, diluted in PBS+BSA, to their assigned wells.
7. Add 50 μL of anti-TTX antibody, diluted to 2 μg/ml in PBS+BSA, to all wells except positive and negative controls.
8. Incubate plate for 1 hour at room temperature.
9. Wash all wells 3 times with 300 μL per well of PBS-T.
10. Add 100 μL per well of alkaline phosphatase-labeled goat anti-mouse IgG + IgM (H+L) conjugate, diluted in PBS+BSA, to all wells except the positive and negative controls.
11. Incubate for 1 hour at room temperature.
12. Wash all wells 3 times with 300 μL per well of PBS-T.
13. Add 200 μl per well of 1mg/ml pNPP solution.
14. Add 50 μl of goat anti-mouse IgG+IgM to the positive control wells.
15. Incubate at room temperature, protected from light, for 20 min.
16. Determine absorbance of each well at 405 nm.

dards and the samples of unknown TTX concentration. The positive control verifies that the chromagen pNPP (Sigma, Inc.) and secondary antibodies are functional. The negative control verifies that no color change occurs when no secondary antibodies are present. The protocol outlined in Raybould et al. (1992) was followed with the following exceptions: plates were coated with BSA-TTXF overnight at 4°C; plates were blocked with 1% BSA in PBS for 1 hr at room temperature; plates were washed 3 times with PBS-T (PBS with 0.5 mL/L Tween-20®) prior to application of pNPP. The following concentrations or dilutions were used: 10 µg/mL BSA-TTXF diluted in PBS; 2 µg/mL anti-TTX murine monocolonal antibody (Hawaii BioTech, Inc.) diluted in PBS+BSA; 1:4000 dilution of alkaline phosphatase-labeled goat antimouse IgG + IgM (H+L) (Jackson ImmunoResearch, Inc) diluted in PBS+BSA. TTX standards, diluted in 1% BSA in PBS, are used at the following concentrations (ng/mL): 100, 75, 50, 25, 10. After addition of pNPP to the wells, the plate is incubated at room temperature, away from light, for 20 min. The absorbance at 405 nm of each well is then read on a microplate reader. A strong linear relationship between absorbance and the log of the concentration for each standard is found between 10 and 100 ng/mL (Fig. 1). The linear equation from this standard curve is used to calculate the concentration of TTX in all the samples from the absorbance values of the corresponding wells. For accurate results, samples must be diluted into this linear range. The dilution factor used must then be accounted for when calculating the unknown concentrations. There is a negative relationship between absorbance and TTX concentration because this is a competitive inhibition assay—the strongest color change is seen in those wells that contained samples without TTX.

Following the protocol of Raybould et al. (1992) for preparation of a BSA-TTXF conjugate and the indirect CIEIA as described here, one is able to assay 40 samples (in duplicate) per microtiter plate. All samples, standards and controls are run in duplicate (or triplicate, etc.) to allow determination of variation in the readings.

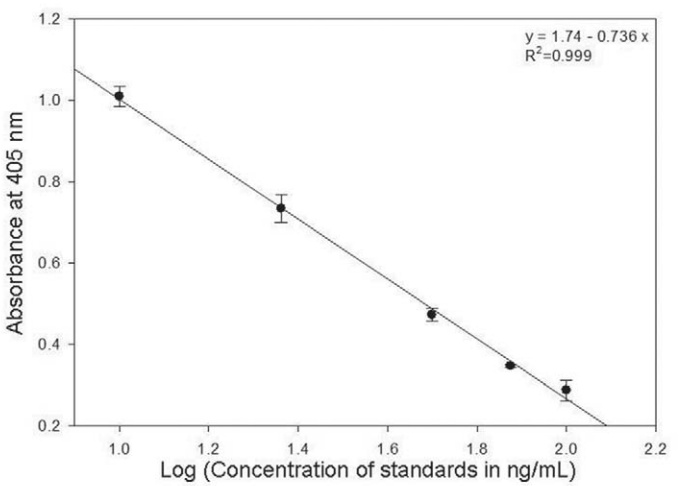


FIG. 1. An example standard curve for the linear portion of the curve (10 to 100 ng/mL). The mean absorbance values (± 2 S.E.) of two wells per concentration are shown. The equation shown in the upper right hand corner is used to calculate the log TTX concentration (x) of samples based on the absorbance value (y) for each well. The log concentration is then converted back into regular units (ng/mL).

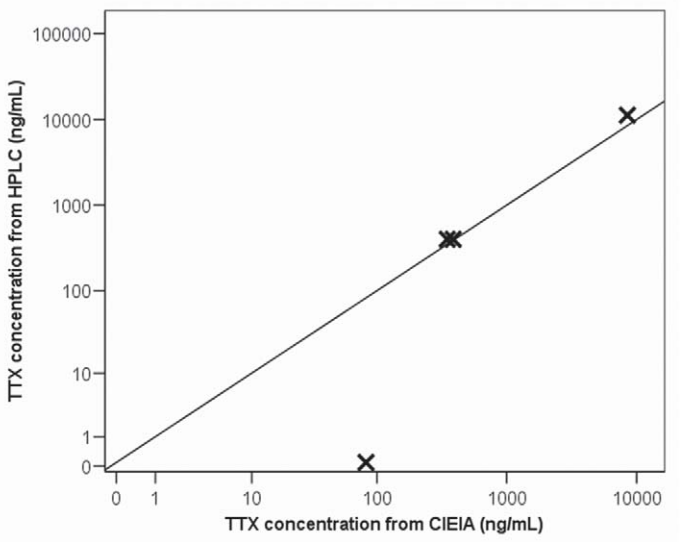


FIG. 2. Concentrations of TTX (ng/mL) in samples assayed by both CIEIA (x-axis) and HPLC (y-axis). These samples (provided by C. T. Hanifin) were from *T. granulosa* skin, extracted using manual tissue grinding and assayed by conventional HPLC techniques (Hanifin et al. 1999). The line is a 1-to-1 line illustrating identical results from CIEIA and HPLC; points fall along the line if both assay methods yield the same concentration.

One plate takes approximately 22 h to complete as described, but this could be reduced to approximately 6 h if the plate is coated with BSA-TTXF for 1 h at room temperature; careful record-keeping allows multiple plates to be run at the same time. Further, plates can be coated with BSA-TTXF and blocked with 1% BSA in PBS in advance, and stored at 4°C for a few days.

Results from this indirect CIEIA method are remarkably similar to those obtained using HPLC (Fig. 2). Samples tested were provided by C. T. Hanifin, from *T. granulosa* skin samples that were manually ground for TTX extraction and assayed using conventional HPLC methods (Hanifin et al. 1999). The primary discrepancy between the two methods is found at a low concentration of TTX, where the indirect CIEIA is more sensitive than HPLC. Samples with high TTX concentrations can be carefully diluted into the appropriate concentration range.

One potential limitation of CIEIA is that it does not allow identification of TTX analogs or structurally similar compounds that can be identified by HPLC (e.g., Yotsu-Yamashita and Mebs 2001). The quantification of TTX by CIEIA should not be affected by TTX analogs because the anti-TTX antibody does not bind to TTX analogs (Raybould et al. 1992), so there is no risk of false positives. Even when TTX analogs are identified by HPLC they are not quantified because the necessary standards are unavailable (C. T. Hanifin, pers. comm.), making this a limitation common to both TTX quantification methods. Thus, CIEIA is appropriate for TTX quantification but inappropriate for identification of TTX analogs that may be present.

Indirect CIEIA, as described here, provides a quantification method for TTX that is not only efficient but also easily employed by any researcher in a university or laboratory setting. No special equipment is needed other than a plate reader capable of reading at 405 nm, and plate washer for more efficient washing between

steps. The collective cost of this equipment is well below the cost of that needed to quantify TTX via HPLC. Further, individuals do not need much training to perform the indirect CIEIA because only general laboratory protocols (e.g., use of a pipette) and common reagents are used. It should be noted that particular care must be taken in the handling of samples and disposal of TTX waste, as is required for any TTX use. Implementation of the TTX extraction and assay procedures may require institutional approval.

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A Technique to Collect and Assay Adhesive-free Skin Secretions from Ambystomatid Salamanders

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Salamander skin secretions are effective defenses against both vertebrate and invertebrate predators (Arnold 1982; Barach 1951; Brodie 1983; Brodie et al. 1979; Digiovanni and Brodie 1981; Ducey and Brodie 1983; Pough 1971; Rand 1954). These secretions arise from granular glands located on the skin's surface (Brodie and Gibson 1969) and are generally a combination of adhesive compounds and noxious chemicals that act in a synergistic manner with stereotypical behaviors to effectively protect the salamander from predation (Brodie 1977). This combination of adhesiveness and noxiousness is often seen in the ambystomatid salamanders, which are known for their distinctive antipredator postures (Brodie 1977, 1983). Although the granular gland secretions of ambystomatids are distasteful to humans (Brodie 1983), shrews (Brodie et al.,1979), moles (Anderson 1963), and Sprague-Dawley rats (Mason et al. 1982), we know little about the chemical composition of their defensive secretions (Williams and Anthony 1994).

Research on the nature of granular gland chemistry has been extensively investigated in anurans (Clarke 1997; Daly 1998; Daly et al. 1987), but is notably sparse among urodeles (Brodie 1983; Williams and Anthony 1994) with a few exceptions (Brandon and Huheey 1981; Buchwald et al. 1964; Habermehl 1971). The adhesive nature of ambystomatid secretions often thwarts chemical investigations of granular gland secretions, and this has stymied secretion chemistry from progressing beyond the identification of proteinaceous material (Brodie and Gibson 1969; Hamning et al. 2000; Williams and Anthony 1994). Flocculence from adhesive components presents a challenge to further isolation of active compounds, and has hampered the testing of solutions at known concentrations (Hamning et al. 2000; Williams and Anthony 1994). Characterization and identification of the chemicals in granular gland secretions of salamanders may enable a deeper understanding of their evolutionary relationships as well as the evolution of salamander antipredator mechanisms. Therefore, we developed methods to (i) isolate adhesive-free secretion from ambystomatid

salamanders, and (ii) assay distastefulness of known concentrations of this secretion. This technique allows us to differentiate between the adhesive and noxious effects of salamander skin secretions against a reliable and consistent control.

We used three adult Jefferson's Salamanders (*Ambystoma jeffersonianum*), collected in Tompkins County, New York in 2000, five Spotted Salamanders (*A. maculatum*), collected in Tompkins County, New York and four near St. Louis, Missouri in 2000, and three Tiger Salamanders (*A. tigrinum*) collected near Portal, Arizona in 2000.

Salamanders were housed in clear plastic boxes (10 cm tall × 40 cm long × 20 cm wide) and provided with inverted black plastic food trays for shelter, and a substrate of moist paper towels. *A. tigrinum* specimens were part of a captive population that was fed crickets *ad libitum* once every two weeks during the duration of their captivity. Their secretions were collected at approximately six months into captivity. Although other amphibians obtain their defensive compounds from the diet (Daly et al. 1997a; Daly et al. 1997b), we did not expect this to have a significant effect on ambystomatid secretion composition because their secretions are proteinaceous (Williams and Anthony 1994). Peptides and proteins are generally produced endogenously and not derived from the diet (Apponyi et al. 2004). *A. jeffersonianum* and *A. maculatum* were locally collected during the breeding season, held overnight, sampled the next morning, and released within 24 h. Mean weight (± standard deviation) of salamanders was 6.3 ± 4.3 g (SVL: 5.5 ± 1.1 cm) for the *A. jeffersonianum*, 13.0 ± 4.3 g (SVL: 7.8 ± 1.3 cm) for the *A. maculatum*, and 49.0 ± 1.0 g (SVL: 12.5 ± 0.5 cm) for the *A. tigrinum*. All animals maintained or gained weight during captivity; no unhealthy salamanders were used in the study. Salamanders were not sexed because sexual dimorphism has yet to be described in the defensive chemistry of any amphibian.

As our predator we used Red Swamp Crayfish (*Procambarus clarkia*) obtained from Carolina Biological Supply Company (Burlington, North Carolina) and kept in plastic ice-chests. They were fed carrots and dry dog or cat food pellets *ad libitum* approximately twice per week. Mean weight (± standard deviation) of the twenty crayfish was 28.5 ± 6.3 g. Although they do not likely prey upon adult ambystomatids, crayfish are predators of many larval amphibians (Axelsson et al. 1997; Formanowicz and Brodie 1982; Gamradt and Kats 1996; Gamradt et al. 1997; Holomuzki 1989) and potentially might attack recent metamorphs that possess defensive glands. Furthermore, crayfish possess traits that make them good generalized predators for laboratory studies: they are omnivorous and use chemical cues to locate food (Dunham et al. 1997).

We collected crude secretions from individual salamanders by applying a benign electrical stimulus to the skin (Grant and Land 2002; Hamning et al. 2000; Tyler et al. 1992; Williams and Anthony 1994). We used a Transcutaneous Amphibian Stimulator (TAS) developed by Grant and Land (2002) to deliver the electrical stimulus, which ranged from 10 to 15 V pulsed for 2 msec at a frequency of approximately 50 Hz. We focused our collection efforts on the tail ridge of all species (Fig. 1) because it and the parotoid glands on the head contain the richest secretions (Williams and Larsen 1986). Before stimulation each salamander was lightly moistened with distilled water to facilitate transmission of the stimulus. Secretions were washed off the skin with approximately 50 ml distilled water and funneled into a flask.

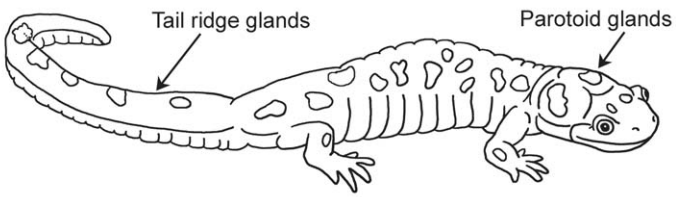


FIG. 1. Granular gland rich areas of a typical ambystomatid salamander (parotoid glands on head and areas of the tail ridge) are indicated with arrows. Illustrated by JBG.

Amphibian skin secretions consist of four major groups: biogenic amines, bufogenines and bufotoxins, alkaloids, and peptides and proteins (reviewed in Barthalmus 1994; Clarke 1997; Daly and Witkop 1971; Erspamer 1984, 1994). Preliminary high performance liquid chromatography (HPLC) data suggested that peptides and a *N*,*N*-dimethyl homolog of serotonin, bufotenine, were the major compounds in the secretion (Grant, unpubl. data). Because bufotenine and many amphibian skin secretion peptides are soluble in both water and methanol (Brodie and Gibson 1969; Daly et al. 1987; Erspamer 1984, 1994; Hamning et al. 2000; Mason et al. 1982; Williams and Anthony 1994), these were chosen as extraction solvents.

Crude aqueous extracts were filtered through glass wool to remove adhesive components of the secretion because they prevent proper measurement of the concentration of active components (Brodie and Gibson 1969). This aqueous solution was lyophilized (freeze-dried) to remove water and any remaining traces of adhesive compounds. The dried residue was washed twice with methanol then filtered through glass wool to remove suspended particulates, which were assumed to primarily consist of inactive adhesive flocculent. The methanolic extract was dried under nitrogen to obtain the residual weight of adhesive-free secretion obtained from each salamander. All solvent-free samples were stored in Teflon-lined vials at 0°C until use, at which time adhesive-free secretion from all fourteen salamanders was pooled to provide an adequate amount of material for testing during these pilot studies. The combination of secretion at this stage did not effect the extraction methods because we performed it post-extraction.

We used a modified method of Lindquist (1992) to make agar pellets suitable for testing feeding responses of the crayfish. Pellets consisted of water, agar, a crayfish feeding stimulant (0.25 g Fancy Feast™ salmon cat food mixed with 5 mL water then filtered through cheesecloth), and food coloring (green or blue). Control pellets were made by boiling 5 mL of water with 0.10 g of agar until the agar dissolved completely. Five ml of feeding stimulant solution plus one drop of blue food coloring were added to the hot agar solution to make a total of 10 ml. This solution was cooled to between 40°C and 45°C and immediately pipetted into prepared PVC molds (described below). The solution was cooled prior to pipetting into PVC molds to prevent leakage from under the PVC mold. Treated pellets were made by boiling 5 mL of water with 0.10 g of agar until the agar dissolved completely. Five ml of 9.6 mg/ml aqueous adhesive-free extract (AFS) were mixed with 0.25 g feeding stimulant then added to 5 mL of 45°C agar solution and one drop of green food coloring to make a total of 10

ml. This solution was mixed well and pipetted into prepared PVC molds where it solidified (described below). This preparation resulted in 10 ml of agar solution at a concentration of 4.8 mg/ml adhesive-free extract. Crayfish are essentially green blind (Crandall and Cronin 1997; Wald 1968) and did not demonstrate a color preference for either blue or green dyed pellets in our preliminary trials (unpubl. data, 1 h trials, blue pellet remaining wt. = 0.12 g ± 0.02 g; green pellet remaining wt. = 0.11 g ± 0.02 g; Wilcoxon rank sum test: N = 12, *Z* = -0.5449, P = 0.59). Therefore, we dyed all control pellets blue, and all treated pellets green in the secretion assays.

Pellet molds were made by cutting polyvinyl chloride (PVC) pipe (6.35 mm inner diameter) into 8-mm long sections with a band saw. The ends of the sections were filed to clean, flat edges. Dark gray, 7.62 cm × 7.62 cm PVC squares were used to anchor two circles (6.35 mm diameter) of adhesive backed, hook end Velcro® 7.5 cm apart along the diagonal of the square (Fig. 2). These Velcro® circles fit snugly into the piece of PVC molding and prevented semi-cooled agar solution from leaking out during the solidification process.

Pellet molds were filled with either treated (green) or untreated (blue) agar solution until a dome formed on top of the mold. Pellets were cooled for 20 minutes at room temperature until the agar solution solidified. Excess agar was cut off with a razor blade flush against the PVC mold surface. The PVC molds were carefully lifted off the agar pellets, which were retained in place by the Velcro® circles. Each 8 mm high agar pellet had an approximate volume of 0.25 mL and treated pellets contained 1.2 mg of adhesive-free extract.

Because pellets were molded onto Velcro®, we could not obtain their weight prior to a trial. Therefore, we made 40 untreated pellets (20 green, 20 blue), and sliced them off their Velcro® bases to determine the approximate weight of an intact, uneaten pellet. There was no bias in pellet weight between pellets dyed blue (0.21 g ± 0.003 g, N = 20) and those dyed green (0.21 g ± 0.003 g, N = 20; Wilcoxon rank sum test: N = 20, *Z* = -0.5873, P = 0.56). Therefore, these two dyes were used in all further assays and pellets that weighed less than 0.20 g after crayfish trials were considered to have been sampled by crayfish.

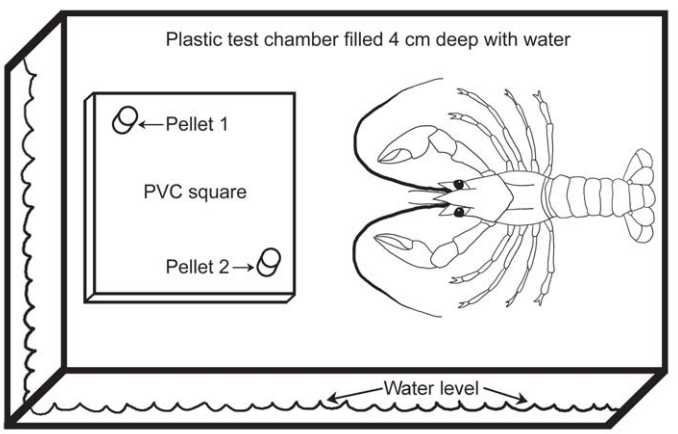


FIG. 2. Schematic representation of the experimental setup. (A) Pellet delivery system consisting of a PVC square with two Velcro® circles. (B) Bioassay chamber used to test crayfish response to treated and untreated pellets. Illustrated by JAE.

We developed a bioassay to determine if crayfish were repelled by AFS. Twenty crayfish were placed in 20 separate plastic containers (9.5 cm tall × 18.5 cm long × 13.0 cm wide) filled with water to a depth of 3 cm. Each crayfish was offered a plastic square to which control and treated pellets were affixed. Squares were placed in the test chamber such that pellet location was randomized with respect to the crayfish, which were allowed to feed for 4 h. Crayfish were prevented from seeing neighboring crayfish during assays. After 4 h we removed the crayfish, sliced pellets off their Velcro® bases with a razor blade, and blotted them dry. Pellets left longer than 5 h began to lose their color, which prevented their identification in cases where crayfish dislodged the pellet from its Velcro® base. All pellets were weighed to the nearest 0.01 g. Trials in which a crayfish did not consume any of either type of pellet were not considered for analysis. Crayfish activity during assays occasionally knocked pellets from the Velcro® base; this necessitated the marking of pellets with treatment-specific dye.

Six of 20 crayfish in the secretion deterrence assay did not eat either type of pellet and were removed from analysis. At 1.2 mg/pellet, adhesive-free salamander skin secretion deterred crayfish feeding as evidenced by a lower remaining pellet weight in control pellets (0.01 g ± 0.01 g, N = 14) than in treated pellets (0.05 g ± 0.02 g, N = 14; two-tailed permutation test for paired replicates: N = 14, P = 0.01). Crayfish avidly ate control pellets and generally avoided treated pellets until nearly all of the control pellet was eaten.

Our methods represent the first and most crucial step in development of a bioassay-guided fractionation scheme necessary to isolate and identify the active chemical compounds of amphibian defensive skin secretions. Bioassay-guided fractionation is an important tool in the identification and chemical characterization of natural chemical products (Debont et al. 1996; Ohta et al. 2000) and will be important in the chemical identification of active components in adhesive-free salamander secretions. Despite over 50 years of research on amphibian skin compounds, very few salamander skin compounds have been identified (Erspamer 1984).

Our approach confirms the antifeedant (*sensu* Eisner et al. 1981) properties of ambystomatid adhesive-free secretion and provides an improved method for quantitatively assaying the effects of salamander skin secretions in general. Brodie et al. (1979) measured predator response after they were offered palatable or unpalatable species. Our approach overcomes difficulties associated with the use of a separate species as the control, and removes the effect of salamander behavior from the effect of secretion. Other research tested aqueous volume/volume secretion solutions of unknown concentrations (Hamning et al. 2000; Mason et al. 1982). Our method eliminates the adhesive components that hamper reproducibility across test subjects due to individual variation among salamanders (Hamning et al. 2000) and loss of secretion as salamander glands are "milked" (Digiovanni and Brodie 1981). Because we pooled secretions from three species, we can not definitively say to which species crayfish were responding. Pooling of secretions from multiple species may cause confounding effects related to synergy among interspecific compounds. This is not expected to diminish the general utility of the method because crayfish response was robust. Our method is generally applicable

to most salamanders and will be useful for future studies on the distastefulness of secretion or assay-guided isolation of secretion components.

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Toe-Clipping as an Acceptable Method of Identifying Individual Anurans in Mark Recapture Studies

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Mark-recapture studies are an important and sometimes essential means for developing a detailed understanding of all aspects of amphibian natural history. Toe-clipping has historically been regarded as the most appropriate marking technique for use in many anuran population surveys and ecological research. Unique combinations of multiple digits are removed from the hands and/or feet when the animal is first captured, to allow recognition of each individual (see Donnelly et al. 1994 for a summary). Bogert (1947) first described the procedure, and it has subsequently allowed some individuals to be followed for more than 34 years (Bell and Pledger 2005).

Often toe-clipping has involved amputation above the toe base or webbing (Clarke 1972; Davis and Ovaska 2001; Funk et al. 2003; Lemckert 1996; Reaser and Dexter 1996; Waichman 1992). Current practice by authors Phillott, Skerratt, McDonald and Alford is to remove the toe pad/disc only from a hylid digit or the most distal phalanx from a non-hylid digit. This procedure is more accurately defined as "toe-tipping" rather than "toe-clipping", as there is a substantial distinction between the length of the digit removed. Frequent surveys can rely on toe-tipping rather than toe-clipping as a reliable means of identifying individuals with minimal tissue regrowth (Lüddecke and Amézquita 1999).

Recently, the appropriateness of toe-clipping frogs has been called into question (Funk et al. 2005; May 2004) when studies by Parris and McCarthy (2001) and McCarthy and Parris (2004) predicted decreased recapture rates following toe-clipping. This was considered due either to mortality arising from digit/limb inflammation and infection (see Golay and Durrer 1994; Lemckert 1996; Reaser and Dexter 1996; Williamson and Bull 1996), disturbance resulting in movement of animals away from the study site, or inability to recapture marked animals. Although Parris and McCarthy (2001) and McCarthy and Parris (2004) only used statistical models to project the effect of toe-clipping on amphibian recapture rates and did not conduct studies to quantify this potential effect, these predictions brought into question the scientific validity and ethical status of toe-clipping (e.g., May 2004) and have led some research and government organizations to refuse permission to use this method. However, there has been little consideration given to the impacts of alternative methods of marking anurans (Funk et al. 2005), no real discussion of how these impacts occur and if they may be overcome, and no assessment of the necessity of toe-clipping for carrying out ecological research that may be critical for species conservation.

The actual reasons for the reduced return rates after toe-clipping described by Parris and McCarthy (2001) and McCarthy and Parris (2004) need to be further explored. Reductions in survival rates (due to infection or limited mobility leading to starvation or increased predation risk) and recapture rates may both contribute to reduced return rates. Actual increases in mortality as a result of toe-tipping or -clipping have not been directly measured, and the validity of the assumption that this is the only factor affecting recapture rates following toe-clipping is questionable. Behavioral changes of several types could lead to decreased recapture rates following toe-clipping. Animals could alter activity patterns or locations within their home ranges, decreasing the probability of recapture. The degree of site fidelity of many amphibians is unknown, and at least some are known to be nomadic (Schwarzkopf and Alford 2002). If toe-clipping increases the probability of animals moving away from the location at which it occurred, it will appear to reduce survival, since survival and emigration rates are very difficult to separate using mark-recapture techniques. Distinguishing the mechanisms responsible for changes in recapture probability following the application of toe-clipping and other marking techniques should be a priority subject for future research.

Even if increased mortality is the cause of decreased returns, it is possible that these increases can be minimized through a more considered approach to toe-clipping. Frequent surveys can rely on toe-tipping rather than toe-clipping as a reliable means of identifying individuals with slow or no tissue regrowth. It has long been

TABLE 1. Alternative marking techniques to toe-clipping/tipping.

Marking Procedure	Advantages	Disadvantages
PIT (Passive Integrated Transponder) Tags	Should not effect mobility[1]	Invasive Requires extensive handling, anaesthesia and recovery[1] Potentially suitable for inducing foreign body tumorigenesis[2] Tags can migrate or be lost[1] Cannot be applied to small frogs[1]
VIE (Visible Implant Elastomer) Tags	Relatively inexpensize[3] Should not effect mobility[4]	Invasive Can be difficult to visualise[3] Requires extensive handling and anaesthesia[3,4] Easiest when amphibians tagged in groups[4]
VIA (Visible Implant Alphanumeric) Tags	Relatively inexpensive Should not effect mobility[4]	Invasive Requires extensive handling, anaesthesia and recovery time[3] Tags can migrate[3] Can be lost[3] Can be difficult to visualise[3]
External Radio Transmitter	Non-invasive Allows researcher to find location of individual[5,6,7]	Normal movements and behaviour may be hindered[5] Skin lesions can occur[6] Restricted to medium to large amphibians[5] Time consuming[5] Limited battery life[5] Expensive[5] Tags can be lost[6]
Internal Radio Transmitter	Allows researcher to find location of individual[5]	Invasive Time consuming[5] Requires extensive handling, anaesthesia and recovery time[6,7] Tags can migrate[8] Tags can be lost[6]
Pattern Mapping	Non-invasive Can be applied to small animals[9]	Limited application due to lack of or limited patterns in many species[10] Temporal inconsistency of patterns in suitable species[9,11] Time consuming[9]
Pressurized Fluorescent Marking	Tagged amphibians do not require capture to identify[12]	Invasive Only reliable for few weeks[12] Can result in immediate mortality [12] Equipment heavy[12]

[1]Lane 2005a, [2]Vogelnest et al. 1997, [3]Nauwelaerts et al. 2000, [4]Lane 2005b, [5]Richards et al. 1994, [6]Werner 1991, [7]Weick et al. 2005, [8]Gray et al. 2005, [9]Donnelly et al. 1994, [10]Lemckert and Shine 1993, [11]Reaser 1995, [12]Schlaepfer 1998

recognized that toe-clipping could negatively affect anurans, and there are current guidelines for amphibian toe-clipping that provide guidance regarding how best to undertake these procedures (e.g., Herpetological Animal Care and Use Committee HACC [2004] and National Wildlife Health Centre NWHC [2001]). Some of the studies reviewed by Parris and McCarthy (2001) and McCarthy and Parris (2004) did not use, or at least did not report, the use of aseptic techniques such as those recommended by the National Wildlife Health Centre (2001) and NSW National Parks and Wildlife Service (2001). These recommend the use of single-use gloves, sterilized stainless steel scissors, and application of the antiseptic Bactine® to minimize infection (though the latter may not be effective for some species such as stream dwelling frogs that immediately wash off the antiseptic when they return to the water after capture). Higher infection rates are likely to occur if unsterilized instruments are used, and diseases may be transferred between multiple individuals if equipment and handling surfaces are not disinfected. The prevention of contamination and infection should be a primary concern in studies using any tagging technique, and toe-tipping/clipping is less likely to result in infection if the above standards are followed.

Alternatively, some increased mortality may result from a loss of mobility due to the loss of toes. This aspect does not appear to have been explored, and we recommend that controlled studies should be undertaken to compare the mobility and survival of clipped versus unclipped frogs. However, even given this lack of

knowledge, steps can be taken to minimize any possible effects on mobility. The effect of toe-tipping/clipping on populations can be minimized by careful consideration of frog activities. Species heavily reliant on toes (e.g., arboreal or burrowing species) should be given a minimal number of clips. Removal of the toe pad only, instead of the entire toe, still allows a reliable means of recognition. It is already recommended that toes essential for burrowing, climbing, amplexus or nest excavation should not be not removed (HACC 2004).

May (2004) describes the practice of toe-clipping as "casually barbaric." The relative pain of toe-tipping/clipping has not been assessed or compared with alternative marking procedures. We have rarely observed a clinical pain response after toe-pad removal. While invasive procedures should not be applied without due consideration of the pain and stress caused to the animal, it must be remembered that mammals have a greater capacity to perceive pain than do other vertebrates (Stevens 1992). Toe-tipping/clipping amphibians cannot be considered as causing the equivalent distress and pain as digit amputation in a human or other mammal. We acknowledge that amphibians are able to perceive pain, however we regard the use of anaesthetics, analgesics and sedatives as far more likely to negatively affect an amphibian's homeostasis because it may be difficult to localize effects of applications of chemicals associated with toe-clipping. No single anaesthetic is effective for all amphibians due to their species-specific responses (Fellers et al. 1994) so their use can be both difficult and harmful. Chemical intervention during minor procedures increases handling and recovery time, and is thus likely to impose further stress on animals. In addition, the HACC (2004) regards pain as an adaptive response that reduces the use of an injured limb during recovery, and describes the use of anaesthetics in procedures such as toe-clipping as undesirable. This reduces handling time and allows post-operative, field-released animals to adapt their activity to compensate for the affected limb/s.

While toe-tipping/clipping is the least expensive of the marking procedures suitable for amphibians, the decision to use this method should not be based on cost alone. We believe that toe-tipping/clipping is fast, reliable, and toe-tipping possibly the least stressful marking method for anurans. Furthermore, we note that in many countries, toe-tipping/clipping cannot occur without the approval of animal ethics committees at research institutions.

In recent times a range of alternative techniques have been proposed as suitable means to mark individuals over extended periods. Proponents of alternatives (e.g., May 2004) have provided no evaluation of impacts of the procedures on marked individuals. The only entirely non-invasive technique successfully used to identify individual anurans is pattern mapping by photograph or sketch. Alternative invasive techniques to toe clipping or toe tipping have included dye markers (e.g., Visible Implant Elastomer [VIE] tags and pressurised fluorescent marking techniques), individual recognition tags (e.g., Visible Implant Alphanumeric [VIA] Tags and Passive Integrated Transponder [PIT] tags), radio telemetry transmitters, and branding (using tattoos, silver nitrate, heat, or freezing). The advantages and disadvantages of all procedures are summarised in Table 1. It is clear that all marking techniques carry risks and may have adverse effects on marked animals, so all techniques violate assumptions related to population estimation models. However, more study is required to determine which techniques have the least adverse effects.

All invasive marking techniques have ethical considerations. The value of the work to the species as a whole should be weighed against the potential impacts on individuals. The stress imposed on a limited number of individuals needs to be balanced against the increased knowledge that can be gained for the species. Management plans must be based on an understanding of the natural history of the animal, including site fidelity, home range and longevity, and factors such as disease, which affect survival. Assured recognition of individuals is essential to determine such parameters.

As extinctions of frog species occur with the global emergence of chytridiomycosis, threatened and potentially-threatened populations must be studied to understand the epidemiology of this disease. Prevalence, incidence, survival and transmission rates cannot be calculated without absolute certainty of individual recognition. In the absence of another widely applicable tagging technique, known to have at most small effects on return rates, we suggest that toe-clipping is the only feasible option that can be applied to many species and to all post-metamorph members of a community. Additional research is urgently needed to evaluate the impacts of all marking techniques, and to develop new ones with lower impacts. Until this has been done, we believe that it is more ethical to use toe-clipping in studies aimed at understanding and preventing further loss of anuran diversity than it would be to stand by, leaving many species unstudied, or to use alternative techniques that have not been studied and which may have greater impacts on amphibians.

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Non-Contact Infrared Thermometers Can Accurately Measure Amphibian Body Temperatures

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Body temperature affects almost all biochemical and physiological processes in ectothermic organisms (Hutchinson and Dupré 1992), and thus affects movement, habitat selection and thermoregulatory behavior (Bartelt and Peterson 2005). A variety of devices have been used to determine the body temperatures of amphibians in the field. The most typical is a thermocouple probe connected to a quick-reading thermometer, which has been used to measure skin (Brattstrom 1963; Heath 1975; Lillywhite 1970; Navas 1996; Tracy 1976), oral (Brattstrom 1963; Lillywhite et al. 1973; Lillywhite et al. 1998), or cloacal (Brattstrom 1963; Cabanac and Cabanac 2004; John-Alder et al. 1988; Passmore and Malherbe 1985; Thorson 1955; Vences et al. 2002) temperature. These methods require manual handling of each individual, which may artificially elevate its body temperature (due to conduction; Navas and Araujo 2000), or may alter the behaviour of individuals in studies of a longer duration (i.e., by capture stress).

To date, non-invasive methods of measuring amphibian body temperature that do not require the manual handling of individuals have included the attachment of thermally sensitive radio-transmitters (Bradford 1984; Heath 1975; Seebacher and Alford 2002) and the use of physical models (Bartelt and Peterson 2005; Hasegawa et al. 2005; Navas and Araujo 2000; O'Connor and Tracy 1987; Seebacher and Alford 2002). More recently, an additional method of measuring amphibian body temperature has become available, via the use of hand-held, non-contact, infrared thermometers (e.g., Young et al. 2005). These thermometers have been widely adopted in the medical sciences, and have been shown to accurately measure body temperature in humans (Koçak et al. 1999; Rotello et al. 1996; Terndrup et al. 1997). Despite their promise as a rapid, non-invasive method of measuring amphibian body temperature, their accuracy for measuring amphibian body temperature has not been quantified. We designed this study to determine whether a non-contact infrared thermometer can be used to accurately measure the body temperatures of amphibians.

Materials and Methods.—Our experiment was designed to allow us to measure body temperatures of frogs allowed to experience a wide range of thermal environments in a laboratory setting. We set up three opaque plastic containers (60 cm × 40 cm × 40 cm), each with a small water bowl in the center and a metal fly-screen lid. The containers were housed in a constant temperature room, which maintained ambient temperature between 19.5 and 21.5°C. Relative humidity fluctuated between 64 and 96% (mean 74%). A 150-watt heat lamp was provided at one end of the container during the day (0930–2130 h) in order to provide a heat gradient within

the normal temperature range of the species.

Twelve adult Common Green or White's Tree Frogs (*Litoria caerulea*) were captured near Townsville, Queensland, Australia. They ranged from 74.1–91.8 mm SVL and 26–65 g body mass. Prior to experiments, they were maintained in the constant temperature room in which the experiments were carried out, but in smaller containers with no access to heat lamps. Frogs were fed crickets *ad libitum*. Each frog was used in a single run of the experiment. We ran four temporal replicates of the experiment, creating a total of twelve sets of measurements of frog and model temperatures for comparison. Each replicate ran for three days.

Body temperatures of frogs were recorded five times per day (0900, 1100, 1300, 1500, and 1700 h), producing 15 measurements for each of the 12 frogs. The first time (0900 h) was chosen because at that time the frogs had received no source of heat for almost 12 h, and their body temperature should have been similar to a nocturnal reading in the field. Each run of the experiment was set up at least 60 minutes before the first temperature reading was taken, allowing frogs to reach a thermal steady state.

At each reading, frog body temperature was recorded using three techniques. Firstly, temperature was recorded by holding a Raytek ST80 Pro-Plus Non-contact thermometer (RAYST80; "IR thermometer") approximately 5 cm away from the frog and aiming at the lower dorsal area near the thigh. The model of IR thermometer used in this study had a distance to spot ratio of 50:1, and the area measured is delineated by a circle of laser diodes. Emissivity was set on the IR thermometer at 0.95, as it is generally accepted that amphibians have a long-wave emissivity of approximately 0.95–0.97 (Carroll et al. 2005; Tracy 1976), regardless of their color (Nussear et al. 2000; Tracy 1979). In initial trials, we determined that measured frog body temperatures did not vary by more than 0.1°C when the emissivity setting of the IR thermometer was varied between 0.95–1.0.

After taking a reading using the IR thermometer, we then measured skin and cloacal temperatures (in that order) using a small, chromel-alumel "K" type thermocouple (diameter approx. 1 mm) with the tip coated in plastic, attached to a digital thermometer type 90000. To measure skin temperature, the thermocouple was held firmly against the skin on the lower dorsal area near the thigh while the frog remained in its original position in the container. During cloacal temperature measurement, each frog was held by a single leg, while still in the container, and the thermocouple was inserted 10–20 mm inside the cloaca and the reading was taken when the indicated temperature stablized.

Frogs were usually in the water conserving posture immediately prior to temperature measurement, except for several instances at 0900 h. It is probable that there are small differences among individual frogs, related to body size or individual behaviour, that affect how temperatures measured using the three techniques are correlated, so that the measurements for each individual frog are not entirely statistically independent. We therefore did not carry out any hypothesis tests, but concentrated on modelling the relationships between measurements taken using the three techniques, and determining how well our models fit the data. Because all three variables are measured with error, we constructed models of their relationships using major axis regression (Sokal and Rohlf 1995). We determined how well our regression models fit the data by calculating coefficients of determination, using standard correlation analysis.

Room temperatures were recorded every 30 minutes using thermal data loggers (Thermochron iButtons by Dallas Semicondictor, Dallas, Texas USA). Data loggers and thermocouples were calibrated against a high precision mercury thermometer in a magnetically stirred water bath.

Results.—Body temperatures measured using the IR thermometer and both skin and cloacal temperatures measured using the thermocouple probe were highly correlated. The major-axis regression lines relating each type of temperature measurement to the others were all very similar to the line of equality (Fig. 1). The major-axis regression lines never predict a mean difference greater than approximately 0.5°C between any two temperatures in the range of 18–34°C for any pair of measurements.

Discussion.—The surface of basking animals may reach slightly higher temperatures faster and decrease more rapidly after basking ceases than the body core (Remmert 1985). However, we found that skin temperatures measured either by contact thermocouple or IR thermometer were almost always within 0.5°C of cloacal temperatures (Fig. 1); this appears to be relatively common in small ectotherms such as frogs (Wygoda 1984), and other small ectotherms such as lizards (<10–20 g; Jones and Avery 1989). It is likely that the small number of points which depart to a larger-than-usual extent from the lines of equality and regression lines in Fig. 1 were measured on animals that had recently changed from basking to non-basking or the reverse.

We found that cloacal temperature was slightly better predicted by surface temperature as measured by the IR thermometer than it was by skin temperature measured using a thermocouple. This indicates that surface temperatures measured using the IR thermometer should provide accurate indicators of internal body temperatures in most amphibians.

Good quality IR thermometers have long-range optical resolution, allowing measurement of small targets at long distances. As the distance from the object increases, the spot size of the area measured by the unit becomes larger. Therefore, the smaller the target, the closer you must be to it in order to avoid measuring a combination of amphibian and background temperatures. Especially in the field, it is necessary to take the distance to spot ratio into account. When studying small frogs, it may only be possible to measure temperatures at short ranges (< 0.5 m). As the laser is located above the sensor in many models, it is also important to take parallax effects into account when aiming the sensor, as at near distances the point of aim of the sensor will be displaced from the point of aim of the laser diode.

It is likely that IR thermometers will be useful in measuring other small animals, such as reptiles, in the field. As all plants and animals act almost as black-bodies in the middle infrared (Sustare 1979), having an emissivity nearing 1.0, no major changes in the technique will be necessary when used on different species. Indeed, we are presently using IR thermometers successfully for measuring the body temperatures of a number of amphibian species in the field (Rowley and Alford, unpubl. data).

We have shown that non-contact infrared thermometers can be used to accurately determine the body temperatures of amphibians. Benefits of this technique include relatively low cost (approximately US $340), small size and therefore high portability, and the ability to rapidly record the temperature of a large number

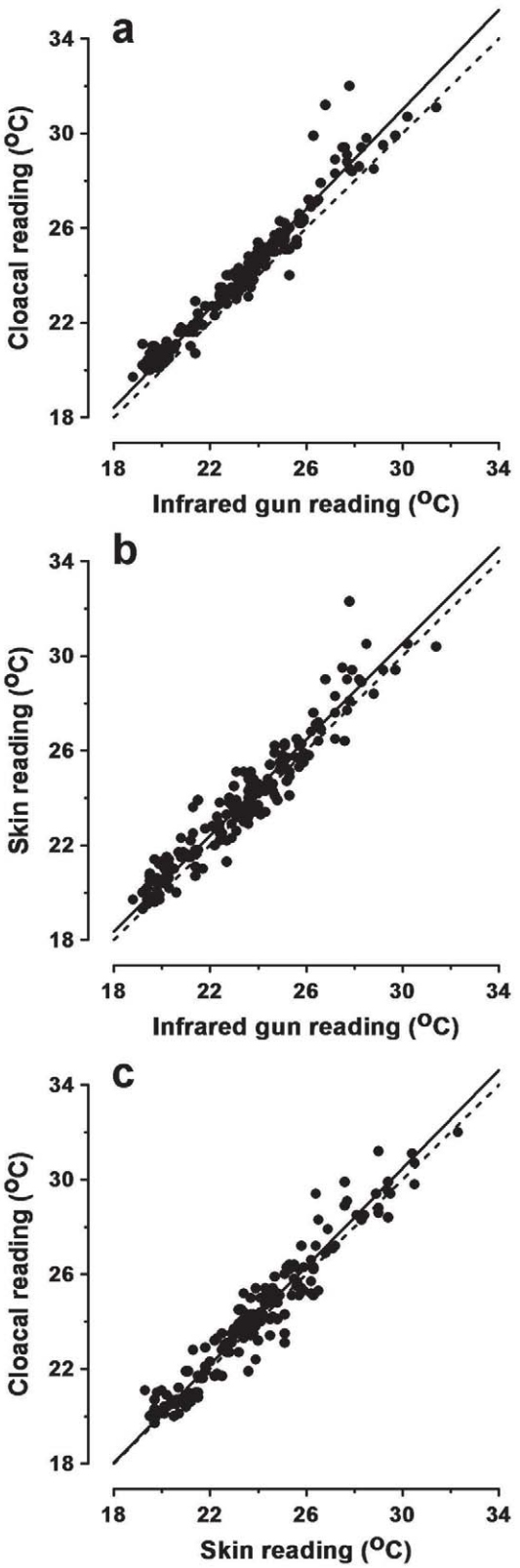


FIG. 1. (a) Measured cloacal temperature as a function of infrared gun reading. Dashed line is at y = x, solid line is the major axis regression $y = 1.052x - 0.535$ with $r^2 = 0.949$. (b) Measured skin temperature as a function of infrared gun reading. Dashed line is at y = x, solid line is the major axis regression $y = 1.014x + 0.1049$, with $r^2 = 0.922$. (c) Measured cloacal temperature as a function of skin temperature. Dashed line is at y = x, solid line is the major axis regression $y = 1.038x - 0.657$, with $r^2 = 0.932$.

of individuals. Perhaps the most important feature of the technique, however, is its ability to record the temperature of amphibians without handling them. This reduces disturbance, which can be important when the same individual is to be measured repeatedly, or when disturbance may cause an animal to abandon a retreat or basking site, exposing it to increased risks of predation or desiccation. In addition, such non-invasive methods of determining amphibian body temperature are likely to be increasingly important due to the need to minimise handling stress and the possibility of disease transmission, particularly when studying species of conservation concern.

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Correct Orientation of a Hand-held Infrared Thermometer is Important for Accurate Measurement of Body Temperatures in Small Lizards and Tuatara

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Measurement of cloacal temperature using a thermocouple (TC) is a standard and long-established method for determining body temperature (T_b) in reptiles. There are some disadvantages, however, to this method. The animal must first be captured and handled, and the thermocouple must be inserted into the cloaca; such manipulations potentially raise the animal's breathing rate (Langkilde and Shine 2006) and, if prolonged, could initiate a stress response involving elevated plasma corticosterone (e.g., Moore et al. 1991). Furthermore, the animal's retreat to a different microenvironment when chased, and/or its subsequent handling, potentially result in an unrepresentative measurement of T_b. An experienced researcher is able to minimize these outcomes in most cases; however, alternative non-invasive methods are desirable.

Useful alternatives for long-term studies of T_b include radiotelemetry and intra-coelomically implanted temperature loggers. While these methods do not require frequent recapture of the animal, they still require the initial attachment of the device, which itself sometimes requires surgery (Charland 1995; Forsythe et al. 2004; Taylor et al. 2004). Consequently, these methods are not suitable for very small animals.

The advent of infrared technology potentially offers a non-invasive alternative for on-the-spot measurement of T_b in small reptiles. Both infrared imaging systems and hand-held thermometers are now available. Imaging systems have proved useful in controlled laboratory environments where relatively large systems can be set up for a long period of time, and if properly calibrated produce highly accurate results (Jones and Avery 1989). Unfortunately these systems are too bulky for use in the field. However, hand-held infrared thermometers (IRT) are available, at much lower cost. These devices consist of a handle, a sensor, and a laser sight. The sensor beneath the laser sight measures infrared radiation of the surface at which the IRT is aimed, and produces a temperature reading precise to about 0.1°C (see Methods), comparable to many thermocouples. Studies using IRT are currently being evaluated for medical purposes, and show promising results for use in some non-critical applications, although some reservations have been expressed (Banitalebi and Bangstad 2002; Hoffman et al. 1999; Leon et al. 2005).

An IRT potentially offers several advantages for measuring T_b in small reptiles. The method has already been used to study temperatures selected by small geckos on a thermal gradient (Christian et al. 1998; Werner et al. 2005) but no rigorous comparison of

results with those from a cloacal TC is available. The main aim of the present study was to determine if skin temperature (T_{sk}) measured with an IRT was sufficiently accurate to substitute for the standard method (cloacal TC) for inferring T_b in small lepidosaurian reptiles. Measurements of T_{sk} and T_b were collected both in the field and laboratory from adults of McCann's Skink (*Oligosoma maccanni*), and in the laboratory from juvenile Tuatara (*Sphenodon punctatus*). The usefulness of substrate temperature (T_{sub}, measured with an IRT) as a substitute for T_b on a thermal gradient was also examined for Tuatara.

Methods.—Adult McCann's Skinks of both sexes, including pregnant females (mean mass 3.53 ± 0.11 g), were captured from rock outcrops at Cloverdowns Farm, near Macraes Flat, New Zealand (45°28'S, 170°28'E, 600–700 m elev.). Captures of this diurnal, heliothermic species were made by day during the austral spring (8–14 October 2004). Although a few skinks were captured from basking positions on rocks, cool and windy weather meant that most skinks were under rocks.

Preliminary tests showed that hand capture was necessary to determine T_{sk} because skinks would otherwise escape before the IRT could be brought close enough (ca. 100 mm) for a reading. Upon capture, the field T_{sk} of 36 individuals was immediately taken by an IRT (Raytek, Raynger® model ST80 ProPlus™, Santa Cruz, California), which provides a reading precise to 0.1°C. Accuracy as reported by the manufacturer is ± 2°C between -18 and 23°C and ± 1°C above 23°C for surfaces with an emissivity of 0.95; we verified this by comparison with a thermocouple (see below for model) for surfaces including terracotta tile and paper. We assumed that the skin of the reptiles we studied had a similar emissivity, which appears reasonable as most biological materials have an emissivity in the medium to long infrared of between 0.90 and 0.99 (Willmer et al. 2000). Taking care to ensure that the laser beam avoided the eyes of animals and researchers, the IRT was pointed at the dorsal surface of the skink such that the target laser sights all fell on the posterior abdomen or pelvic region. Adult skinks typical of those studied had a mean width (± SE) at the posterior abdomen of 6.68 ± 0.12 mm (measured later in laboratory, N = 40). During measurement, skinks were held by their pectoral girdle over the surrounding substrate to avoid the handler's body heat from influencing the readings.

Immediately following measurement of T_{sk}, which usually took only a few seconds, a cloacal thermocouple (Digi-Sense® model 8528-40, Cole-Parmer, Niles, Illinois, USA; hereafter, "TC"), which had been calibrated to within 1.0°C against a reference thermometer (SAMA-CT40, Eveready Thermometer Co., West Patterson, New Jersey, USA), was used to measure cloacal T_b. Ambient temperature (T_a) was then measured with the TC at 1 m height in the shade.

Field T_{sk} measured with the IRT was compared with T_b measured with the TC using linear regression analyses and paired *t*-tests. The absolute magnitude of the difference between T_b and T_{sk} was plotted against T_a, and a regression was used to determine whether T_a affected the difference. At the time of measurement, we noticed five readings of T_{sk} to be very different from T_b. We re-measured T_{sk} of these skinks over a different substrate (rock versus grass). The second IRT measurement for these five skinks was always more similar to the TC reading than the first one, and this value was used for analyses (as we show later, the discrepancy was likely due to the way the IRT was oriented relative to the lizard's body rather than to the nature of the substrate per se).

Nine adult *O. maccanni* (pregnant females, mean mass 3.91 ± 0.17 g) were brought to the laboratory and placed on a thermal gradient lined with clean brown paper over a metal base-plate. Individual runways (8.5 × 100 cm) offered a temperature range from 16°C at one end to 34°C at the other end (see Rock et al. 2000 for further details of gradient). After a familiarization period of 14 hours, T_{sk} and T_b were measured up to three times over the following 12 h (1000, 1500 and 2200 h). Measurements of T_{sk} were in most cases obtained without handling, although in a few cases the skinks ran along the gradient and had to be restrained before measurements of either T_{sk} or T_b were taken. Measurements at night (2200 h) were made with the aid of a dim red light. The inclusion of night measurements increased the range of skin/body temperatures selected by the skinks. In total, 19 paired measurements were obtained from 9 skinks, and for the purposes of the comparison between methods these were treated as independent measures (analysis of time-of-day effects on mean T_b will be reported elsewhere). Differences between T_{sk} and T_b were examined using regression analysis and paired *t*-tests.

Ten juvenile *S. punctatus* of approximately 7 months age (mean mass 4.18 ± 0.37 g) were also placed on the thermal gradient. These tuatara had been obtained from eggs laid and incubated in captivity and were maintained indoors under semi-natural conditions of temperature and photoperiod. Data for T_{sk} and T_b were collected and analyzed as for skinks, except that the familiarisation period lasted 8 h and measurements were subsequently collected at five time points (0600, 1000, 1400, 1800 and 2200 h, with 0600 and 2200 h being in darkness). Substrate temperatures available within the gradient ranged from a mean of 13.6°C at the cool end to 33.1°C at the warm end. In addition to measurements of T_{sk} and T_b, at each time point the substrate temperature (T_{sub}) selected by each tuatara was measured by IRT directly alongside a hind limb of the tuatara. In total, 50 paired measurements of T_{sk} and T_b were obtained from ten tuatara, and analyzed as for skinks. The relationship between T_{sub} and T_b was also examined.

Results from the above experiments led us to suspect that background (substrate) temperature had an influence on T_{sk} when the IRT was held at close distance and with a certain orientation (at 90° to the animal's body axis). With such an orientation, the laser sight does not provide an accurate indication of the spot at which infrared radiation is being measured (owing to the offset between laser source and sensor). The manufacturer's instruction booklet alludes to this possibility under a section entitled "Reminders," in which it is recommended that, at distances less than 0.5 m, a manual sight on top of the IRT should be used instead of the laser.

We therefore tested the effect of using either the laser or manual sight for determining T_{sk} (and hence inferring T_b) in skinks. We also tested, using the laser sight, the influence of orientation of the IRT (relative to the skink's body axis) on T_{sk}. For this trial, 20 skinks with a body temperature of about 18°C were placed on a warm ceramic tile with a surface temperature of about 30°C. The first measurement of T_{sk} was made using the laser sight and with the IRT oriented at 90° to the body axis. The second measurement of T_{sk} was made with the IRT in the same position but using the manual sight. The third measurement of T_{sk} was made using the laser sight but with the IRT oriented in-line with the skink's body

axis. Finally, T_b was measured with the cloacal TC. All measurements for each skink were completed within about 30 seconds. Paired *t*-tests were used to compare each T_{sk} measurement with T_b.

Results.—By day, wild skinks had cloacal temperatures (T_b, measured with the TC) of between 10.4 and 28.6°C. Skin temperature (T_{sk}, measured with the IRT) showed a significant relationship with T_b ($r^2 = 0.586$, $df = 1, 34$, $P < 0.001$, Fig. 1A). Mean values differed by 1.21 ± 0.62°C (T_{sk} = 20.53 ± 0.95°C, T_b = 21.75 ± 0.81°C) but this difference was not significant (paired $t = 1.996$, $df = 35$, $P = 0.057$). Individual differences ranged up to 12.9°C, even after re-testing over a different substrate. Ambient temperature played a significant, albeit small, role in explaining the absolute magnitude of the difference between T_{sk} and T_b (data not presented; $r^2 = 0.189$, $df = 1, 34$, $P = 0.008$); in other words, the discrepancy between T_{sk} and T_b was reduced at warmer temperatures.

Depending on time of day, skinks on the thermal gradient selected a T_b of between 17.6 and 31.9°C. The relationship between T_{sk} and T_b was highly significant ($r^2 = 0.899$, $df = 1, 17$, $P < 0.001$; Fig. 1B), and mean values for T_{sk} (29.03 ± 1.16°C) and T_b (28.37 ± 0.81°C) did not differ (paired $t = 0.17$, $df = 18$, $P = 0.173$). The maximum discrepancy between T_{sk} and T_b was 4.1°C.

Tuatara on the thermal gradient selected a T_b of between 12.8 and 28.1°C. The relationship between T_{sk} and T_b was highly significant ($r^2 = 0.936$, $df = 1, 48$, $P < 0.001$; Fig. 1C), and mean T_{sk} (21.22 ± 0.63°C) did not differ significantly from mean T_b (20.92 ± 0.57°C; $t = 1.787$, $df = 49$, $P = 0.08$). The maximum discrepancy between T_{sk} and T_b was 3.2°C. The relationship between substrate temperature (T_{sub}) and T_b of tuatara (Fig. 1D) was more variable than that between T_{sk} and T_b, though still highly significant ($r^2 = 0.847$, $df = 1, 48$, $P < 0.001$). Mean T_{sub} and mean T_b came close to differing significantly ($t = 1.979$, $df = 49$, $P = 0.053$), and individual differences ranged up to 5.4°C.

Measurements of T_{sk} made with the IRT oriented at 90° to the skink's body axis were highly influenced by background temperature, regardless of whether the laser sight or manual sight was used (Fig. 2). Mean values for T_{sk} measured in this way differed greatly from T_b measured by TC ($t \geq 17.592$, $df = 19$, $P < 0.001$). However, when T_{sk} was measured with the IRT oriented in line

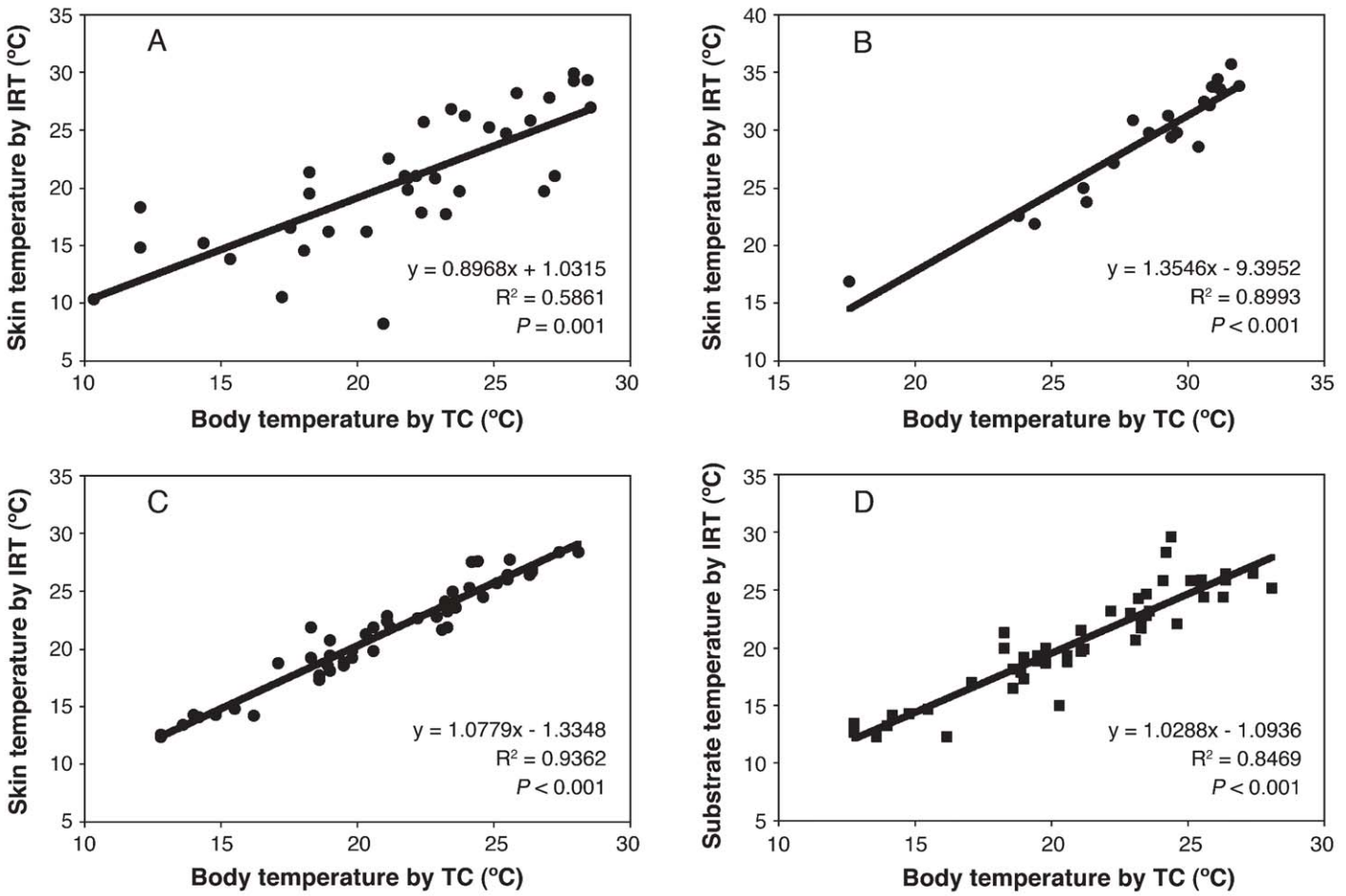


FIG. 1. Comparison of skin temperature (T_{sk}) or substrate temperature (T_{sub}), measured by infrared thermometer (IRT), with cloacal temperature measured by thermocouple (TC), in two small lepidosaurian reptiles. A) Skin temperature of adult McCann's Skinks (*Oligosoma maccanni*) in the field. B) Skin temperature of McCann's Skinks in the laboratory (free choice on thermal gradient). C) Skin temperature of juvenile Tuatara (*Sphenodon punctatus*) (free choice on a thermal gradient). D) Substrate temperature of juvenile Tuatara (free choice on a thermal gradient). Line equations and coefficients are for linear regression. In these data sets, the IRT was used without precise orientation relative to each animal's body axis.

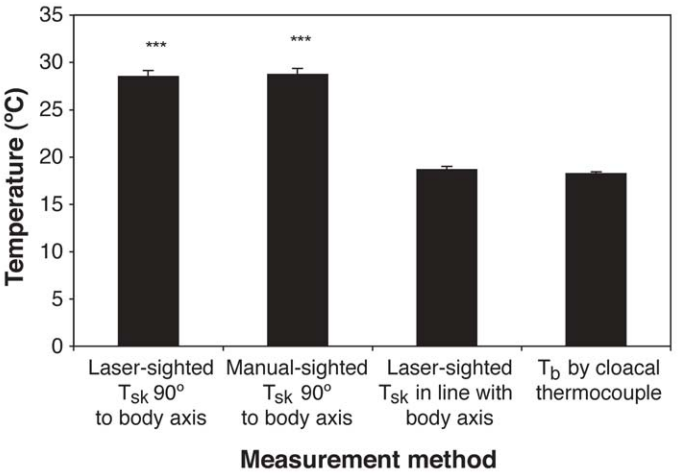


FIG. 2. Mean skin temperature (T_{sk}, measured by IRT) and body temperature (T_b, measured by TC) of the skink *Oligosoma maccanni* on a substrate of about 30°C. The first measurement of T_{sk} was made using the laser sight, with the IRT oriented at 90° to each skink's body axis. The second measurement of T_{sk} with the IRT was made with the same orientation but using the manual sight. The third measurement of T_{sk} was made with the laser sight and with the IRT oriented in line with each skink's body axis. Finally, T_b was measured (N = 20 for all measurements). Bars show standard error. *** indicates significantly different ($P < 0.001$) from T_b by TC.

with the skink's body axis, a much more accurate indication of T_b was obtained ($t = 2.012$, $df = 19$, $P = 0.059$). For the latter comparison, 95% of paired values differed by no more than 1.0°C (maximum difference 3.4°C).

Discussion.—In principle, the infrared thermometer (IRT) offers an attractive and non-invasive method for measuring T_b in small reptiles. In practice, we found its usefulness in the field with *O. maccanni* limited in that it needed to be brought to such a close distance that most animals had to be captured first, removing one advantage over the use of a thermocouple (TC). (In the thermal gradient, however, it was usually possible to measure T_{sk} without animal capture.) We also noted that in the field, although mean T_{sk} measured by IRT and mean T_b measured by TC did not differ significantly, the regression explained only 59% of the variation and there were several large discrepancies (up to 12.9°C) between T_{sk} and T_b. Many skinks had field body temperatures below 23°C, in a range where the accuracy of the IRT is reduced. Nevertheless, the discrepancies we observed were too great to be explained by this factor alone. Discrepancies could have also arisen from a real difference between skin and core body temperature, but we do not believe that thermal gradients of up to 12.9°C could exist over a few millimeters of body tissue in small skinks. This assumption is supported by research on the similar-sized *Lacerta vivipara* (3.5 g), in which core and skin temperatures differed by not more than 0.2°C (Jones and Avery 1989).

The most likely reason for occasional large discrepancies between T_{sk} and T_b in the field is that the IRT was not always precisely oriented in line with the skink's body axis. Thus, the background temperature is likely to have influenced some measurements. Further tests with *O. maccanni* in the laboratory showed that the influence of background temperature was substantial if the IRT was oriented at 90° to the skink's body axis, regardless of whether the laser or manual sight was used. However, with the IRT oriented in line with the skink's body axis, the effect of background temperature was eliminated, as the laser source and infrared sensor were now both in line with the skink's body.

Results for skinks and tuatara on the thermal gradient are consistent with the above interpretation. In these trials, the IRT may not have always been oriented in line with each animal's body axis, thus explaining occasional discrepancies between T_{sk} and mean T_b. However, the discrepancies were smaller than in the field for *O. maccanni*, probably because background temperature on the gradient was in most instances very similar to T_b. Overall, there was no significant difference between mean T_{sk} and mean T_b for either *O. maccanni* or *S. punctatus* on the thermal gradient, and the match between individual values is likely to be further improved with more care in orientation of the IRT.

Two previous studies have used T_{sk} measured with an IRT for inferring T_b selected by small lizards on a thermal gradient. In one study, T_{sk} was assumed to represent T_b of the gecko *Oedura marmorata* (mean species mass ~9–20 g) but no calibration was reported (Christian et al. 1998). In another, T_{sk} was calibrated against T_b for a combined sample of one or more individuals of the geckos *Goniurosaurus kuroiwae kuroiwae* (mean species mass 7.7 g) and *Eublepharis macularius* (mean species mass 47.1 g; Werner et al. 2005). A significant relationship was reported (regression $r = 0.83$; N = 21 measurements; $P < 0.0001$), although occasional discrepancies (magnitude not reported) were noted, especially in small individuals. Neither of these studies reported the orientation of the IRT relative to the lizards' bodies, so the possible influence of background temperature on the measurements is unknown.

Substrate temperature (T_{sub}) on a thermal gradient has sometimes been used as a surrogate for T_b in small reptiles, for example, for the semi-fossorial lizard *Chalcides ocellatus* on a substrate of sand (Daut and Andrews 1993). In our study with tuatara, although substrate temperature was easy to measure with little disturbance to the animal, it was not as precise an indicator of T_b as was T_{sk} measured with the IRT. Discrepancies presumably arise when animals occasionally move on the gradient to a region of cooler or warmer substrate than T_b. Given that further improvements in the accuracy of estimating T_b are probable with precise orientation of the IRT, we recommend measuring T_{sk} directly rather than T_{sub} when accurate estimates of T_b on a thermal gradient are required for small reptiles.

An IRT for measuring T_{sk} has considerable advantages over a cloacal TC for estimating T_b in small reptiles. Handling of animals is essentially eliminated when animals are confined (as on the thermal gradient), and thus the risk of a handling-induced increase in respiration rate (Langkilde and Shine 2006), as well as escape and other negative outcomes, is reduced. This could have benefits for both animals and researchers, making subsequent measures of animal temperature in a repeated-measures design (e.g., where time-of-day effects are of interest; Rock et al. 2000) less affected by previous disturbance. Werner et al. (2005) also pointed out a reduced risk of tail autotomy when using an IRT rather than a TC for measuring selected temperature in small geckos. Although we have not observed tail loss in either of our study species here (or the gecko *Hoplodactylus maculatus*: Rock et al.

2000) when measuring T_b by TC for animals on a thermal gradient, it is certainly true that handling and the risk of escape are reduced using the IRT.

Further studies are needed to assess the potential use of an IRT for inferring T_b in larger reptiles. Although some modeling suggests that reptiles under 30 g should act as though they have zero heat capacity (Bakken 1992), other work suggests that even in reptiles of this small size, lags between skin and core temperature could occur in animals that move into new thermal environments (Seebacher and Shine 2004). Differences between skin and core temperature will depend not only on animal size but also on the extent of temperature equilibration with the environment, and thus on the amount of movement by the animal and the extent to which the environment is thermally heterogeneous (Seebacher and Shine 2004). In a laboratory environment such as a thermal gradient where thermal equilibration is possible, or with sedentary wild animals in relatively homogeneous thermal environments such as adult tuatara emerged in forest, T_{sk} may yet provide a useful substitute for T_b. However, empirical studies are clearly needed before assuming the accuracy of an IRT for inferring T_b in reptiles larger than those studied here.

One area of biomedical interest where use of the IRT has been explored has been the measurement of body temperature in humans. Studies assessing the accuracy of IRT measurements of the inner ear in humans have found discrepancies of 2°C or more compared with the standard rectal temperature measured by a thermometer (Hoffman et al. 1999; Modell et al. 1998; Stavem et al. 1997). Similarly, in a comparison between IRT and TC methods for determining human skin temperature, differences between the two methods were often 1–2°C, precluding the use of IRT for studies where accurate measurements of T_b are necessary (Matsukawa et al. 2000). As in our initial trial with the IRT in the field for *O. maccanni*, a significant regression or correlation between the two measurements was not in itself a guarantee of accuracy (discussed further by Yaron et al. 1995).

In conclusion, the hand-held IRT is very easy, quick and convenient to use. If appropriately oriented when aiming at small reptiles, it records values for T_{sk} that can substitute for measurements of T_b taken with a cloacal TC, with the advantage for animal welfare that handling is reduced. If care is not taken with orientation and aiming, however, then discrepancies (potentially large) may arise due to the influence of background temperature. Our findings illustrate the importance of testing new equipment and methods against previously established methods, to ensure that the quality of data is acceptable for research purposes.

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Comment on Papers by Hare et al. and Rowley and Alford

There is an uncertainty principle involved in measuring the body temperatures of small ectothermic animals: the mechanics of measuring are likely to affect the quantity measured. To take cloacal or core body temperatures, animals must be captured and handled, or logging or telemetry devices must be implanted or attached. Particularly for small animals with low thermal inertia, capture and handling may mean that body temperature changes before it is measured. Repeated capture and handling may disrupt normal behavior, so that accurate temperatures are measured, but are not relevant to normal behavioral patterns. Implantation or attachment of devices may lead to similar disruptions. Both papers demonstrate that, at least for frogs and small reptiles, the uncertainty can be reduced by measuring temperature using infrared thermometers (IRTs), which allow skin temperatures to be measured without handling. These temperatures are more likely to reflect the outcome of natural behavior, even when measured repeatedly, and to be unaffected by handling, so they should be more accurate estimates of the temperature of an undisturbed animal with normal behavior. This higher accuracy might be preferable to that of temperatures taken using other techniques, even if IRT temperatures were somewhat less precise. However, both papers demonstrate clearly that, if properly used, with an understanding of the parallax problems that arise when using IRTs to measure small areas at close distances, IRTs can provide both precise and highly accurate estimates of skin temperatures of frogs and reptiles. These mirror cloacal temperatures, at least in frogs and relatively small reptiles, and can thus be used as proxies for core body temperature. When it is important to avoid the effects of disturbance and handling, as when body temperatures are to be repeatedly taken during behavioral observations, this technique should prove to be an invaluable addition to the herpetologist's repertoire.

—Ross A. Alford and Jodi J. L. Rowley

Response to "Non-contact Infrared Thermometers Can Accurately Measure Amphibian Body Temperatures" by Jodi Rowley and Ross Alford

We agree with Rowley and Alford about the potential advantages of using an infrared thermometer (IRT) for measuring body temperatures in small amphibians and reptiles: reduced handling means potentially more reliable measurements, less stress to animals, and a reduced risk of disease transmission (especially relevant at present to amphibians)—and that IRTs can also allow more rapid data collection.

We also agree that the offset between the laser sight and infrared sensor raises the issue of parallax when IRTs are used with very small, narrow-bodied species that must be closely approached. This means, as we show, that care is needed when orienting the IRT to ensure that skin temperature, rather than temperature of the background, is what is being measured. This was presumably less of an issue with the larger and more compact frogs with which Rowley and Alford worked than with our small and elongate lepidosaurs.

Collectively, our studies seem broadly complementary, but largely or exclusively laboratory-based. We encourage more work by others to assess the significance of body size, body shape, and movements between different thermal environments on the potential lag between skin temperature (measured by an IRT) and core temperature, and on the practicality of using IRTs in the field with small species, which need to be closely approached.

—Jon Hare, Elaine Whitworth, and Alison Cree

NATURAL HISTORY NOTES

Instructions for contributors to Natural History Notes appear in Volume 38, Number 1 (March 2007).

CAUDATA

AMBYSTOMA OPACUM (Marbled Salamander). **HABITAT**. Typically, adult *Ambystoma* utilize lentic habitats for breeding and egg deposition; such habitats include temporary and permanent ponds, flooded fields, and roadside ditches. However, previous reports indicate that up to six species of *Ambystoma* may utilize lotic habitats (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington. 587 pp.). Here we provide the first report of lotic habitat use by *Ambystoma opacum*.

On 25 Mar 2006 we encountered a stream pool containing *A. opacum* larvae in the Saline County State Fish and Wildlife Area (37°41'43"N, 88°23'19"W), Equality, Illinois, USA. The pool was ca. 180 cm in length, with a maximum depth of 45 cm and an average flow rate of 3 cm/sec. Initially, no larvae were visible in the pool, but disturbance of a submerged root system resulted in visible larval movement and subsequent identification. Five larvae were visible in the pool and three were collected for species verification. All larvae were between 15–17 mm total length, and none had developed rear legs. We also surveyed all stream pools within ca. 100 m upstream and downstream from the pool where the *A. opacum* larvae were collected, but no additional larvae were found.

To our knowledge, this is the first record of stream use by *A. opacum*. As all previous reports of lotic habitat use by *Ambystoma* concern species that deposit eggs directly into water, our observation is also the first record of lotic habitat use by a species of *Ambystoma* that typically deposits eggs in terrestrial nests (Petranka 1998, *op. cit.*). We thought it plausible that *A. opacum* larvae might have washed into the stream channel from upland ponds during a rain event; therefore, we searched the surrounding upland for > 300 m upstream and downstream from the pool for the presence of temporary ponds. No ponds or dry pond basins were found, and analyses of topographical maps support our observations. Whether adult female *A. opacum* deposited eggs directly into this pool, into terrestrial nests along the pool margin, or in the surrounding upland is unknown. The small sizes of pools in this stream suggest that during dry periods, these stream pools may be reduced to isolated pools similar in appearance to the temporary ponds typically utilized by *A. opacum*. In addition, we failed to encounter fish in this stream, suggesting that larval *A. opacum* could survive in these

pools until metamorphosis. Continued monitoring of this stream and surrounding streams in future years will help us determine if our observation represents a single occurrence or a common behavior.

Larvae were verified by Ronald A. Brandon. Specimens were deposited in the SIUC Fluid Vertebrate Collection (SIUC H-08675).

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SIREN LACERTINA (Greater Siren). **DIET.** On 10 Sept 2006, a dead *S. lacertina* was retrieved from a minnow trap in Dry Bay, a 5-ha fishless Carolina bay located on the Dept. of Energy Savannah River Site, Aiken Co., South Carolina, USA. The siren was returned to the laboratory and frozen. On 28 Nov 2006, the siren was dissected and an *Ambystoma talpoideum* (Mole Salamander) was found in its stomach. The siren was 310 mm SVL, 485 mm TL, and mass was 236 g. Its mouth had a maximum vertical gape of ca. 10 mm with a horizontal opening of ca. 15 mm. The remains of the *A. talpoideum* weighed 3.27 g and appeared to be in the early stages of digestion (e.g., the skin was mostly digested, but the organs were relatively identifiable). The head was separated from the rest of the body and was possibly decapitated during mastication. Although *S. lacertina* are known to consume small fish (Hanlin 1978. Copeia 1978:358–360), this is the first report of a non-fish vertebrate consumed by *S. lacertina*.

Salamanders were captured under scientific research permit 56-2003 from the South Carolina Dept. Natural Resources. Funding was provided by the National Science Foundation (Awards DEB-0242874 and DBI-0139572) and the Savannah River Ecology Laboratory under Financial Assistance Award DE-FC09-96SR18-546 between the University of Georgia and the U.S. Dept. of Energy.

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TARICHA GRANULOSA (Rough-skinned Newt). **PREDATION**. On 6 Aug 2006, JRT and SF observed an immature Great Blue Heron (*Ardea herodias*) catch and swallow an adult *Taricha granulosa* at a small pond at Point Reyes National Seashore, Marin County, California, USA (UTM 505530E, 4219240N). The heron was observed at Abbott's Lagoon pond at 1225 h on a clear, sunny day. The heron was seen catching the newt, holding the newt in its bill (Fig. 1), moving to a shallower part of the pond, and then repeatedly dunking the newt in the pond. The heron also dropped the newt a few times, only to pick it back up and proceed to dunk it in the water. After 5–8 minutes the heron tilted its head back and swallowed the newt whole. The heron was photographed >10 min after it ate the newt. This same behavior had been observed by SF on several occasions at the same pond during August. On 12 Aug, a Great Blue Heron was observed by SF eating three newts over a 45 min period. This suggests that the heron survived eating newts, and continued to include newts as part of its diet. We subsequently searched the perimeter of the pond and did not find any dead herons.



FIG. 1. Great Blue Heron (*Ardea herodias*) holding a *Taricha granulosa* in its bill. A single heron was observed eating as many as three newts in 45 min.

The newt can be identified to species from the photo, but we have also conducted 72 amphibian surveys at the pond since 1993. We found *T. granulosa* on 12 occasions and have never found *T. torosa*, the only other *Taricha* present in the area. Based on 1426 amphibian surveys conducted throughout the park since 1993 (309 sites), the nearest known *T. torosa* localities are 8.5 km and 12 km away.

Brodie et al. (1974. Copeia 1974:506–511) described the skin toxins of *T. granulosa* as more toxic than any known substances from the skin of other salamanders. The Common Gartersnake (*Thamnophis sirtalis*) is the only species reported to regularly feed on *T. granulosa*. Of the six species of North American newts, birds have been reported to eat only *T. granulosa* (Lannoo 2005. Amphibian Declines: The Conservation Status of United States Populations. Vol. 2. Univ. California Press, Berkeley, California, xxi + 1094 pp.), and in all cases, the birds had been found dead (Marks and Doyle 2005. *In* Lanoo [ed.], Amphibian Declines: The Conservation Status of United States Populations. Vol. 2, pp. 894–900. Univ. California Press, Berkeley, California). The birds included a Pied-Billed Grebe (*Podilymbus podiceps*), Mallard (*Anas platyrhynchos*), and domestic chicken (*Gallus domesticus*). Brodie (1968. Copeia 1968:307–313) placed the tail of a *T. granulosa* in the rear of the mouth of a Great Blue Heron and reported that the heron was unable to stand upright after 90 sec, and was dead after 120 sec. This suggests that Great Blue Herons have little tolerance for tetrodotoxin and that the apparent washing behavior reported above might be effective at reducing the level of toxin on the skin of the newts. However, Hanifin et al. (1999. J. Chem. Ecol. 25[9]:2161–2175) reported variation in *T. granulosa* toxicity, both within populations and between populations. *Taricha granulosa* at the Point Reyes pond almost certainly have low toxicity.

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ANURA

ASCAPHUS TRUEI (Tailed Frog). **SPIDER PREY**. Few data describe the diet of the postmetamorphic *Ascaphus truei*. Springtails (Collembola), amphipods (Amphipoda), stonefly nymphs (Plecoptera), fly larvae (Diptera), and beetle larvae (Coleoptera) dominated the prey of 11 adult and 39 juvenile *A. truei* from Trinity County, California (Bury 1970. Copeia 1970:170–171). Bury (1970, *op. cit.*) also reported that six juvenile *A. truei* had each taken a spider (Araneae), but these were not identified to species, a condition necessary to properly interpret predator-prey natural history. Here, we report the first observation of spider prey identified to species for adult *A. truei*.

On 14 Aug 2006 at 1530 h, FTW found an adult male (36 mm SVL) *A. truei* along an unnamed headwater tributary of the South Fork Willapa River, Pacific County, Washington (46.5790N, 123.7239W, NAD 27, 224 m elev.). The stream is 2nd-order (*sensu* Strahler 1952. Geol. Soc. Am. Bull. 63:1117–1142), ca. 0.8 m wide, and located within a 55-year old second-growth mixed Western Hemlock (*Tsuga heterophylla*) and Douglas-fir (*Pseudotsuga menziesii*) managed forest on an intrusive basalt geology. The riparian canopy was undifferentiated from Western Hemlock/Douglas-fir vegetation upslope, but the riparian understory was differentiated by scattered Stink Currant (*Ribes bracteosum*), Salmonberry (*Rubus spectabilis*), Lady Fern (*Athyrium filix-femina*), and Fringecup (*Tellima grandiflora*). Skies were clear; air temperature was 18°C. The frog, captured <1 m from the stream, had an adult (ca. 13 mm cephalothorax–abdominal length) male Folding-door Spider, *Antrodiaetus pacificus*, in its mouth. FTW removed the spider from the frog, preserved it, and measured and released the frog at the capture site.

Antrodiaetus pacificus is a soil-dwelling spider in the Suborder Mygalomorphae, which also includes tarantulas (Coyle 1971. Bull. Mus. Comp. Zool. 141:269–402). Though relatively small for a mygalomorph, it is one of the larger spider species in Willapa Hills conifer forests. Females live in burrows, whereas mature males wander seasonally in search of mates. As the species is often recorded from riparian forest habitats in the Pacific Northwest (Parsons et al. 1991. Invertebrates of the H. J. Andrews Experimental Forest, Western Cascade Range, Oregon. V: An Annotated List of Insects and Other Arthropods. USDA Forest Service, GTR, PNW-GTR-290, Portland, Oregon; Johnston 1994. California Forests and Woodlands: A Natural History. Univ. California Press, Berkeley. 222 pp.; Hocking and Reimchen 2002. BMC Ecology 2:4), terrestrial stream-margin wandering of males may make them vulnerable to adult *A. truei*, which can be common in this habitat (Jones et al. 2006. Amphibians of the Pacific Northwest. Seattle Audubon Society, Seattle, Washington. 227 pp.). However, at any given site, availability of male *Antrodiaetus* as prey is likely limited to a few days each year, varying from early August to October for different coastal Washington populations of the spider (Coyle, *op. cit.*; RLC, unpubl. data). Many more common spiders are available as frog prey in this habitat, including some ground dwellers in the same size range as *Antrodiaetus* (e.g., *Cybaeus* spp. [family Cybaeidae], which are abundant much of the year in coastal conifer forests).

The *A. pacificus* was deposited in the Arachnology collection at the University of Washington Burke Museum. This is contribution No. 13 of the Forests and Fish Section of the Washington Department of Fish and Wildlife's Habitat Program Science Division.

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BUFO AMERICANUS (American Toad). **HINDLIMB DEFORMITIES.** Amphibian ecologists and the public have recently given a great deal of attention to the issue of amphibian limb deformities. It has become evident there are many causes of amphibian deformities (e.g., Blaustein and Johnson 2003. Front. Ecol. Environ. 1:87–94; Sessions 2003. *In* Semlitsch [ed.], Amphibian Conservation, pp. 168–186. Smithsonian Press, Washington, D.C.). To better understand the extent and effects of amphibian limb deformities, additional information is needed on the rates of amphibian limb deformities from a variety of locations and species, particularly from ponds that appear relatively undisturbed or contaminated, to provide a better baseline for comparison to mass deformity events.

While collecting information on the performance of metamorphs from three local ponds, we examined several hundred American Toad tadpoles for limb deformities. The three ponds (Spring Peeper, Olde Minnow, and Taylor-Ochs) examined were on the Denison University Biological Reserve (Granville, Licking County, Ohio, USA) and are apparently free from any major pollutants or disturbance (see Schultz and Mick 1998. Ohio Biol. Surv. Notes 1:31–38 for a description of the ponds). We collected American Toad metamorphs from the water's edge of each pond from 2–9 June 2006. Each metamorph was examined for deformities and the type of deformity, if present, was recorded. We found hind limb deformities of varying degrees in two of the three ponds (Table 1). The observed frequencies of hind limb deformities in the three ponds ranged from 0–3.6%. These values fall within the range of frequencies observed in other species for historical records (i.e., prior

TABLE 1. Incidence of hindlimb deformities in American Toad, *Bufo americanus*, metamorphs from three ponds in central Ohio. All deformities were ectromelia of the femur or the tibiafibula (*sensu* Meteyer 2000. Field Guide to Malformations of Frogs and Toads with Radiographic Interpretations. USGS Biol. Sci. Rep. USGS/BRD/BSR-2000-0005).

	N Examined	N Deformed	% Deformed
Spring Peeper Pond	172	1	0.6%
Olde Minnow Pond	215	8	3.6%
Taylor-Ochs Pond	155	0	0%

to 1980) or for relatively undisturbed sites (e.g., Ouellet et al. 1997. J. Wildl. Dis. 33:95–104; McCallum and Trauth 2003. J. Wildl. Dis. 39: 522–528; Eaton et al. 2004. J. Herpetol. 38:283–287). The two ponds (Spring Peeper and Olde Minnow) where we found deformities were also the ponds with the slowest tadpole growth rates, smallest metamorphs, and highest numbers of predators (mosquitofish and dragonfly nymphs) (G. R. Smith et al., unpubl. data).

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BUFO TERRESTRIS (Southern Toad). **ARBOREAL BEHAVIOR**. North American *Bufo* are highly terrestrial ground-dwellers. Only a few accounts describe climbing behavior: a *Bufo americanus* climbing a steep rocky incline in Tennessee, USA (G. Lepera, pers. comm.), *B. marinus* found in natural tree holes in Venezuela (Mijares-Urrutia et al. 1996. Herpetol. Rev. 27:138), and *B. valliceps* in arboreal refugia in Texas, USA (Neill and Grubb 1971. Copeia 1971:347–348). Here, I report an observation of a *B. terrestris* using an arboreal tree cavity as a refuge on Cumberland Island, Camden County, Georgia, USA.

At 2230 h on 23 Sept 2006, I found a funnel-shaped cavity (ca.10 cm wide by 15 cm deep) at a height of ca. 1.6 m on a mature oak (*Quercus* sp.). The cavity likely originated from a branch that broke at its base, with subsequent decomposition of the heartwood. Inside the hollow, I found an adult *Bufo terrestris* resting about 10 cm from the entrance. The toad retreated inside the hollow, which slightly curved towards the trunk of the tree and stopped at what coincided with the middle of the branch. I probed the hollow with a piece of grass in an attempt to determine whether it continued past the curve, but I was unsuccessful in finding an opening. The toad inflated its body, raised its back, and pointed its paratoid glands at me, but did not retreat further.

I was unable to discern how the toad reached the cavity. Because of the relative remoteness of the locality, it is unlikely that humans put it there. Either the toad climbed up the outside of the vertical trunk until it reached the hollow's opening, or it used a vertical open space within the tree's trunk and followed it until it reached the cavity. However, no external opening to such an internal cavity was found at the base of the tree.

I thank C. Kenneth Dodd, Jr. for helpful comments on the manuscript.

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BUFO WOODHOUSII (Woodhouse's Toad). **CANNIBALISM.** Little information exists on the feeding habits of *Bufo woodhousii* although they are presumed to feed on a variety of invertebrates (Lannoo 2005. Amphibian Declines. The Conservation Status of United States Species. Univ. California Press, Berkeley. 1094 pp.). In Kansas, *B. woodhousii* has been reported to feed on bees, beetles, insect larvae, spiders, and ants (Smith 1934. Amer. Midl. Nat. 15:377–528). Smith and Bragg (1949. Ecology 30:333–349) examined the stomach contents of 517 adult and 43 juvenile *B. woodhousii* from Oklahoma and reported no vertebrate remains. However, Smith and Bragg (*op. cit*.) reported the consumption of a small lizard by a juvenile *B. woodhousii* maintained in captivity. In Nebraska, *B. woodhousii* is reported to feed on beetles, ants, spiders, and other invertebrates (Hudson 1942. Nebraska Cons. Bull. 24:1–146).

During summer 2006, 56 *B. woodhousii* were collected at Beckius Pond (41.12529°N, 101.37276°W) Keith Co., Nebraska. Twenty-eight toads were collected during the night (2230–2330 h) on 23 July 2006 and 28 toads were taken during the day (1430–1530 h) on 27 July 2006. Toads were placed in refrigeration until dissection. Toads were euthanized and SVL and gape size were recorded to the nearest mm for each individual. The stomach, small intestine, and large intestine were removed, and the stomach was separated from the rest of the gastrointestinal tract. Each stomach was opened and preserved in 70% ethanol. The stomach contents were examined under a dissecting microscope, and identified into several broad categories and recorded as frequencies of organism ingested. Arthropods were identified to order according to Triplehorn and Johnson (2005. Borror and Delong's Introduction to the Study of Insects. 7th ed. Thomson, Grooks/Cole. 864 pp.).

Toads ranged from 2.9–7.3 cm SVL (mean 4.5 ± 1.2 cm) and gape size 8–28 mm (mean 1.67 ± 0.47 cm). Toads fed on 11 different groups of arthropods; 1944 items were recovered from stomach contents, including Diptera (1440), ants and other Hymenoptera (378), Coleoptera (93), Orthoptera (10), Hemiptera (8), Odonata (6), Pseudoscorpiones (3), Araneae (2), Lepidoptera (2), Homoptera (1), and Isopoda (1). Additionally, three toads contained remains of four smaller *B. woodhousii*. A single male collected at night (SVL 6.7 cm) contained one partially digested *B. woodhousii* (ca. 2.5 cm), and two toads (one female SVL 6.1 cm; one male SVL 6.6 cm) collected during the day contained one and two partially digested *B. woodhousii* (ca. 2.0–2.5 cm), respectively.

Although there are reports of ranids feeding on bufonids (Pearl and Hayes 2002. Am. Midl. Nat. 147:145–152) and ranid cannibalism (Stuart and Painter 1993. Herpetol. Rev. 24:103) we are not aware of any reports of bufonid cannibalism. These are important observations as many bufonids are considered ant and beetle specialists (Clarke 1974. Am. Midl. Nat. 91:140–147; Smith and Bragg, *op. cit.*).

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CHAUNUS ARENARUM (Argentine Toad). **ENDOPARASITES.** *Chaunus arenarum* ranges from northern Jujuy Province to the southern borders of Neuquén Province reaching 2400 m in La Rioja Province, Argentina. The species also occurs in southern Brazil, Uruguay, and Bolivia (Cochabamba) (Cei 1980. Amphib-

ians of Argentina. Monit. Zool., Italia, Firenze, Monogr. 2:1–609). Previous reports of nematodes in *C. arenarum* are in Baker (1987. Mem. Univ. Newfoundland, Occas. Pap. Biol. 11:1–325). The purpose of this note is to report the nematodes *Oswaldocruzia proencai* and *Ophidascaris* sp. in *Chanus arenarum* from Argentina.

Three *C. arenarum* (one male SVL 80 mm and one female 110 mm SVL) from Itaú River (22°20'51"S, 64°05'47.7"W; 483 m elev.), and one male (SVL = 83 mm) from Astilleros (22°23'01"S; 64°06'14.4"W; 493 m), General San Martín Department, Province of Salta, Argentina were collected in Sept 2005. They were deposited in the Herpetology Collection, Fundación Miguel Lillo as 17186–17187, and 17196. The body cavity was opened by a mid-ventral incision and the digestive tract was removed. The esophagus, stomach, and small and large intestines were longitudinally slit and the contents were examined for helminths using a dissecting microscope. Two species of Nematoda were found: *Oswaldocruzia proencai* (1 male, 3 females) in the large intestines and *Ophidascaris* sp. (2 juveniles) in the stomach. They were deposited in the Helminthological Collection, Fundación Miguel Lillo as *O. proencai* (CH 07443; CH 07448) and *Ophidascaris* sp. (CH 07445).

Slimane and Durette-Desset (1995. Revue Suisse Zool. 102:635–653) redescribed *Oswaldocruzia mazzai* as a parasite of *C. marinus* from Argentina, and in so doing reassigned specimens from *C. schneideri* (as *Bufo paracnemis), Leptodactylus ocellatus*, and *L. bufonius* collected in Paraguay by Lent et al. (1946. Mem. Inst. Oswaldo Cruz 44:195–214) to a new species, *Oswaldocruzia proencai. Oswaldocruzia proencai* differs from *O. mazzai* in morphology of the cephalic vesicle, that of *O. mazzai* is simple, that of *O. proencai* is in two parts. Hendrikx (1983. Zeits. fur Parasiten. 69:119–126) reported oral infection of toads by *Oswaldocruzia* sp.

Ophidascaris sp. is a member of the Ascaridae, which typically utilizes vertebrates as intermediate hosts in which development to the stage infective to the definitive (final) host occurs (Anderson 2000. Nematode Parasites of Vertebrates. Their Development and Transmission. CABI publishing, Wallingford, Oxon, U.K. 650 pp.). *Oswaldocruzia proencai* and *Ophidascaris* in *C. arenarum* are new host records.

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CHAUNUS MARINUS (Cane Toad). **PREDATION**. *Chaunus marinus* is native to South and Central America and produces cardiac poisons known as bufotoxins in their paratoid glands and skin. In northeastern Australia, Hawaii, the Philippines, South Florida, and the Caribbean, where the species has been introduced, the Cane Toad is noxious or lethal to many vertebrate predators, including quolls (*Dasyurus* spp.), monitor lizards (*Varanus* spp.), snakes, and domestic dogs (Lever 2001. The Cane Toad: The History and Ecology of a Successful Colonist. Westbury, Otley, UK, 230 pp.; Phillips et al. 2003. Conserv. Biol. 17:1738–1747). After a predator bites or mouths a toad, death or temporary paralysis occurs within minutes, with foaming at the mouth, vomiting, and convulsions often being observed (Covacevich and Archer 1975. Mem. Queensland Mus. 17:305–310; Lever 2001, *op. cit*.; Phillips et al. 2003, *op. cit*.).

On a late afternoon in mid-November 2001, we observed an adult Common Opossum (*Didelphis marsupialis*) climb a 5-m tall avocado tree outside our kitchen window in Gamboa (9°07'N, 79°38'W), a small township that borders the Panama Canal and Soberania National Park in central Panama. It was holding in its mouth a large and apparently recently killed Cane Toad, with an estimated SVL 12–13 cm. To our surprise the opossum completely consumed the toad, initially gnawing and swallowing its rostrum and head, and then proceeding to its hindquarters and rear legs, over a period of several minutes. The opossum was 6 m away from us and we watched it closely with 10-power binoculars. The large paratoid glands of the Cane Toad were readily visible, and we anticipated that the opossum would attempt to avoid these, but it consumed the entire toad with apparent impunity.

After the toad was entirely eaten, the opossum remained in the tree and under our observation for about 20 min until darkness approached. As it rested in the tree it thoroughly licked clean its bloody paws and face and showed no signs of poisoning or distress. We do not know the ultimate fate of the opossum, but there was no dead body anywhere in the vicinity the following morning. The Cane Toad is common in the mosaic of lawns and secondary forest in Gamboa, and the combination of its large body size, distinctive head shape, massive paratoid glands, mottled yellow-brown dorsal coloration, and warty skin surface easily discriminate it from other toad species in the area (e.g., *Rhaebo haematiticus, Rhinella alatus* (*typhonius*); Ibañez et al.1999. The Amphibians of Barro Colorado Nature Monument, Soberania National Park, and Adjacent Areas. D'Vinni Editorial Ltd., Bogota, Colombia. 187 pp.). Aside from the resilience of the opossum to Cane Toad poisoning, we were surprised to see the event occurring before nightfall, as both the opossum and Cane Toad are typically nocturnal (Emmons and Feer 1997. Neotropical Rainforest Mammals: A Field Guide. Univ. Chicago Press, Chicago. 307 pp.; Ibañez et al. 1999, *op. cit*.).

We described our observation to various herpetologists including the late Stanley Rand (a Smithsonian Institution herpetologist and long-term resident of Gamboa). None had observed or heard of similar accounts. There are several possible explanations for our observation. It is possible that bufotoxins are toxic to opossums but are manifested only slowly, or that the toad we observed was somehow deficient in toxin production. Alternately, the Common Opossum, whose geographic range in Central and northern South America overlaps broadly with the natural range of the Cane Toad, might have evolved specific resistance to bufotoxins. Perhaps the most plausible explanation, however, is that Common Opossums might be broadly immune or resistant to a wide range of organic toxins. This latter interpretation is supported by the observation that *Didelphis* opossums are immune to the venom of crotalid vipers, on which they are known to prey (R. S. Voss, American Museum Natural History, pers. comm.), and that this immunity is conferred by a so-called Lethal Toxin Neutralizing Factor, originally isolated from *D. virgianus*, which neutralizes a

wide range of snake, scorpion, and bee venoms as well as many animal, plant, and bacterial toxins (Lipps 1999. J. Venom. Anim. Toxins 5:56–66). The remarkable physiological tolerance of opossums is in striking contrast to most predatory vertebrates in areas where Cane Toads have been introduced, especially in Australia where no native toads occur, for which the Cane Toad is highly toxic.

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CHAUNUS POMBALI (Pombali's Toad) **PREDATION.** *Chaunus pombali* is found extensively in Minas Gerais State, southeastern Brazil, where this species occurs in the Atlantic rainforest and transition areas with the Cerrado formation (Baldissera et al. 2004. Arq. Mus. Nac., Rio de Janeiro 62:255–282).

During an anuran survey on 30 Aug 2006 in Viçosa, Minas Gerais State (20°45'S, 42°51'W), we observed predation of *C. pombali* by the exotic American Bullfrog (*Rana catesbeiana*). The observation occurred at a permanent dam on the Universidade Federal de Viçosa campus. At 1840 h, we observed an adult male *R. catesbeiana* holding an individual *C. pombali*, with the head and forelimbs protruding out of the mouth. For ca. 5 min. the *R. catesbeiana* remained motionless, then jumped into the water still holding the *C. pombali*. Stomach content analysis of a *R. catesbeiana* collected on 28 Sept 2005 (SUL 147.95 mm, Museu de Zoologia João Moojen de Oliveira, Universidade Federal de Viçosa, MZUFV 6374) from the same locality revealed a whole *C. pombali* (SVL 56.1 mm), indicating that predation on this species is not uncommon.

Rana catesbeiana was introduced into Brazil in the 1930s for commercial breeding. Poor management practices and high survival of individuals in wild habitats have allowed this species to establish viable populations in many regions of the country. Amphibians represent a substantial part of the diet of *R. catesbeiana* (Pearl et al. 2004. Copeia 2004:11–20). Our observations suggest that the poison glands of *C. pombali* do not deter predation by *R. catesbeiana*.

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COPHIXALUS ORNATUS (Ornate Nursery Frog). **CHYTRIDIOMYCOSIS.** Chytridiomycosis is an emerging infectious disease linked to amphibian population declines worldwide (Berger et al. 1998. Proc. Natl. Acad. Sci. 95:9031–9036). The chytrid fungus *Batrachochytrium dendrobatidis*, causative agent of chytridiomycosis, has an incredibly broad host range: it is currently known to infect over 160 amphibian species in two orders and 14 families (Speare and Berger 2004. www.jcu.edu.au/school/phtm/PHTM/frogs/chyglob.htm, updated with recently published accounts). Only seven of these species, however, are direct developers that bypass the free-swimming tadpole stage (*Eleutherodactylus cruentus, E. emcelae, E. melanostictus, E. karlschmidti, E. saltator, E. coqui*, and *Leiopelma archeyi*). Tadpoles are thought to be an important life stage with respect to disease transmission; they stand a high chance of being exposed to the fungus' aquatic zoospores and they do not succumb to chytrid infections, making them likely disease reservoirs (Daszak et al. 1999. Emerg. Inf. Dis. 5:735–748). Currently, there are no records of chytridiomycosis in Australian direct-developing frog species.

On 23 Sept 2005, KMK captured a male *Cophixalus ornatus* that was calling while perched on a leaf 2 m from the edge of Babinda Creek (70 m elev.), in Queensland, Australia. KMK firmly ran a cotton swab over the frog's dorsum, ventrum, sides, thighs, and the webbing of its feet, and used quantitative PCR (Boyle et al. 1994. Dis. Aquat. Org. 60:141–148) to test for the presence of *Batrachochytrium dendrobatidis*. Thirty-one chytrid zoospores were detected on the swab. This represents the first record of chytridiomycosis in an Australian direct-developing frog species, and only the eighth record worldwide.

There are no published reports of population declines in *C. ornatus*, a species whose large geographic range encompasses the localities of many of north Queensland's recent amphibian declines and disappearances, including that of *Taudactylus acutirostris* (the last known individual of which died of chytridiomycosis in 1995; Wright et al. 2001. J. Herpetol. Med. Surg. 11:14–27). Our finding of chytridiomycosis in *C. ornatus* supports the hypothesis that while all frog species may be exposed to the disease, there are ecological differences among sympatric species that might lead to differing disease outcomes, ranging from no effect on the population to mass mortality events and local extinctions (Daszak et al. 1999, *op. cit.*; Hero et al. 2005. J. Zool. Lond. 267:221–232).

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DENDROBATES AURATUS (Green and Black Poison Dart Frog). **LARVAL PREDATION.** *Dendrobates auratus* was intentionally introduced onto the island of O'ahu, Hawai'i in 1932 from Taboga Island, Panama for mosquito control. *Phelsuma laticauda* was accidentally introduced from Madagascar in 1996 to the University of Hawaii at Manoa. Both species are well established in the Manoa Valley.

While observing *D. auratus* tadpole depositions in the axils of a large *Vriesea imperialis* (Bromeliaceae), we often noticed adult *P. laticauda* on the leaves. At 0835 h on 1 Aug 2005, we witnessed an adult *P. laticauda* staring at the water in an upper axil of a large (ca. 1 m diameter at the base) *V. imperialis*. The skies were clear and the temperature was 26.2°C. The *P. laticauda* did not appear to notice our observations and continued to stare at the surface of the water. It moved lower into the axil until its snout was ca. 0.5 cm from the surface and continued to stare at the surface. It did

this for ca. 3 minutes. At this point, a *D. auratus* tadpole ca. 2 weeks old (2.5 cm total length) swam to the surface. Almost instantly, the *P. laticauda* struck at the tadpole and pulled it out of the water headfirst. It shook the tadpole back and forth three of four times and cocked its head back and swallowed all but the tip of the tail. It then quickly walked up the leaf and finished swallowing the tadpole. We observed the gecko for ca. 30 min after the predation event before it disappeared into the leaf litter at the base of the bromeliad.

A second predation event occurred at 1200 h on 28 Aug 2005 that was practically identical to the previous event. A different adult *P. laticauda* consumed a *D. auratus* tadpole of comparable size in a different *V. imperialis* ca. 0.4 km away. To our knowledge, this behavior has not been observed in the field. This is probably due to the fact that the natural distribution of these two species does not overlap.

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DISCOGLOSSUS GALGANOI (West Iberian Painted Frog). **PREDATION.** *Discoglossus galganoi* is endemic to the western half of the Iberian Peninsula (Spain and Portugal). Much information exists about predators of adults and juveniles (review in Martínez-Solano 2003. Sapillo pintojo ibérico - *Discoglossus galganoi*. Enciclopedia virtual de los vertebrados españoles. Museo Nacional de Ciencias Naturales, Madrid. www.vertebradosibericos.org; García-París et al. 2004. Fauna Ibérica. 24. Amphibia, Lissamphibia. Museo Nacional de Ciencias Naturales, CSIC, Madrid. 640 pp.), although relatively little is known about predators of the larvae. Aquatic insects, fish, water snakes (*Natrix maura*, *N. natrix*), and amphibians (*Triturus marmoratus*) have been cited as predators of the larvae (García-París 1985. Los Anfibios de España. Publicaciones de Extensión Agraria, Madrid. 287 pp.; Barbadillo 1987. La Guía de Incafo de los Anfibios y Reptiles de la Península Ibérica, Islas Baleares y Canarias. Ed. Incafo, Madrid. 694 pp.; Salvador and García-París 2001. Anfibios Españoles. Canseco Ed., Talavera de la Reina. 269 pp.).

Discoglossus galganoi reproduces in shallow seasonal ponds, thus larvae may suffer high mortality when these ponds dry. It tolerates moderate concentrations of salt in breeding pools, therefore it can breed in marine cliff rainwater pools very close to the sea (Curt and Galán 1982. Esos Anfibios y Reptiles Gallegos. Ed. J. Curt, Pontevedra. 166 pp.; Galán 2003. Anfibios y Reptiles del Parque Nacional de las Islas Atlánticas de Galicia. Faunística, Biología y Conservación. Organismo Autónomo Parques Nacionales, Ministerio de Medio Ambiente, Madrid. 276 pp.). Reproduction in Galicia (northwest Spain) lasts from December until July (Galán and Fernández 1993. Anfibios e Réptiles de Galicia. Ed. Xerais, Vigo. 501 pp.; Vences 1994. Salamandra 30:81–83).

In some marine cliffs near the Hércules Lighthouse in the city of A Coruña (Galicia, northwest Spain; UTM 29T NJ 48 03; 43°23'N, 8°24'W), a population of *D. galganoi* reproduces in a series of small (average 250 × 100 cm; 7 cm average depth, range 1–35 cm) seasonal rainwater pools and run-offs, situated in the cracks and hollows of the cliff rock. These pools are located in the upper region of the marine cliffs, 9–15 m from the sea (depending on the tides). During the frequent storms, they receive spray from the surf, thus during these periods the water salinity is relatively high. The only amphibian that reproduces in these pools is *D. galganoi*. These seasonal pools have practically no larval predators. In this area, *D. galganoi* reproduces from November to June, with larvae present from the end of December until the ponds dry, typically in July (Galán, unpubl. data).

On 12 Jan 2006, at a rain pool (340 × 210 cm; max depth 12 cm; 11 m from the sea) with a rock bottom and 30% of its surface covered with vegetation formed by submerged *Paspalum vaginatum* and small *Armeria maritima* and *Ulex europaeus* shrubs at the edge, where *D. galganoi* larvae were found, one could observe a turnstone (*Arenaria interpres*) pecking at the edge (1230 h). This bird was observed with binoculars, verifying that it was capturing *D. galganoi* larvae with its beak. The turnstone scoured the periphery of the pool, submerging its head to a depth of 4–6 cm to capture larvae. On other occasions, it lifted up the submerged vegetation with its beak, capturing larvae that it found among the submerged stalks. At 1330 h, two turnstones were observed feeding in the same way at this pool and two other nearby ones of similar size, where there were also *D. galganoi* larvae. The density of *D. galganoi* larvae decreased in the pools where the turnstones fed, from an average of 350 larvae per m^2, estimated the previous day, to 62 larvae per m^2 after the predation.

This species of turnstone occupies the coastal cliffs in northern Spain from August until March, where it is a common wintering bird (Cramp and Simmons 1983. The Birds of the Western Paleartic. Vol. 3. Waders to Gulls. Oxford University Press, Oxford. 913 pp.; Díaz et al. 1996. Aves Ibéricas. Vol. 1. No Paseriformes. J. M. Reyero Ed., Madrid. 303 pp.; Penas-Patiño et al. 2004. Guía das Aves de Galicia. 2nd ed. Bahia Ed., A Coruña. 463 pp.). Its diet includes insects, mollusks, crustaceans, plant matter, fish, and carrion; amphibians are unrecorded (Cramp and Simmons 1983, *op. cit.*; del Hoyo et al. 1996. Handbook of the Birds of the World. Vol. 3. Hoatzin to Auks. Lynx Ed., Barcelona. 821 pp.). It frequently gets its food in tidewater pools formed in the rocks of the cliffs and some individuals specialize in certain prey types (Cramp and Simmons 1983, *op. cit.*).

Northwest Spain is one of the few areas where *D. galganoi* and *A. interpres* can be found together. This is true both in terms of location (coastal cliff pools) and time (the reproduction period of the *D. galganoi* and the wintering period of *A. interpres* overlap). Therefore, it seems logical that a bird with an opportunistic winter diet would consume amphibian larvae found near the seacoast.

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ELEUTHERODACTYLUS RIDENS (Pygmy Rainfrog). **PREDATION**. Workers of the large ponerine ant *Paraponera clavata* typically forage on small to medium-sized arthropods or collect pieces of plants or nectar (Janzen and Carroll 1983. Univ. Chicago Press, pp. 752–753.) but have been suspected of predating small vertebrates (Fritz et al. 1981. Biotropica 13[2]:158–159). Under experimental conditions (Fritz et al. 1981, *op. cit.*) individual *Paraponera* have been shown to sting and kill unidentified *Eleutherodactylus* that were restrained and presented to these ants. Here we present the first record of *P. clavata* potentially predating on *Eleutherodactylus ridens* under natural conditions.

At 0845 h on 6 Dec 2005, TE observed a single *P. clavata* transporting a dead adult male *E. ridens*. This observation was made in primary forest near Selva Verde Lodge in the vicinity of Guaria, Heredia Province, Costa Rica (10°26'59.6"N, 84°04'02.3"W). The insect was found on a leaf of a ca. 50 cm high plant (Maranthaceae), holding the already dead *E. ridens* in its mandibles and maneuvering its prey through the vegetation. It is possible that a recently dead individual was scavenged, although it is more likely that the ant stung and killed the frog, as Fritz et al. (*op. cit.*) demonstrated that the sting and powerful poneratoxins of *P. clavata* are sufficient to kill *Eleutherodactylus* spp. *Eleutherodactylus ridens* is abundant in the area (TL, pers. obs.) and is commonly found sleeping on low vegetation during the day, primarily relying on crypsis to avoid detection by predators and only fleeing when the leaf it is resting on is moved by a potential predator (TAL, pers. obs.). Foraging *P. clavata* would be able to readily approach and attack sleeping *E. ridens* as their small size and low body weight would not trigger an escape response by the frog.

Photographs of this event have been deposited in the media collection of the Division of Vertebrate Zoology at the Yale Peabody Museum of Natural History (YPM HER M 1142–43).



FIG. 1. Adult male *Eleutherodactylus ridens* being transported by a ponerine ant (*Paraponera clavata*), vic. of Guaria, Heredia Province, Costa Rica.

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HYLA ARENICOLOR (Canyon Treefrog). **DIET**. Although there have been several recent studies on various aspects of the ecology of *Hyla arenicolor* (e.g., disease, Bradley et al. 2002. J. Wildl. Dis. 38:206–212; parasites, Goldberg et al. 1996. J. Parasitol. 82:833–835, Sladky et al. 2000. J. Zoo. Wildl. Med. 31:570–575, Jung et al. 2000. Herpetol. Rev. 32:33–34; thermoregulation and water economy, Preest et al. 1992. Herpetologica 48:210–219, Snyder and Hammerson 1993. J. Arid. Environ. 25:321–329), there are few, if any, reports on its diet. Here we report observations on the stomach contents of six *H. arenicolor* collected during 2003 and 2004 from Milpillas, Municipio Chínipas, Chihuahua (N = 1; 27°12'9.7"N, 108°38'47.3"W; WGS 84; 1259 m elev.), Huisivo, Chihuahua (N = 1; 27°23'39.9"N, 108°32'36.0"W; WGS 84; 469 m elev.); km 17 Creel-San Rafael, Municipio Urique, Chihuahua (N = 1; 27°40'1.1"N, 107°44'42.7"W; WGS 84; 2233 m elev.), and Yécora, Sonora (N = 3; 28°22'4.0"N, 108°55'32.6"W; WGS 84; 1545 m elev.) (see Lemos-Espinal et al. 2004. Bull Chicago Herpetol. Soc. 39:107–109; Smith et al. 2005. Bull Chicago Herpetol. Soc. 40:45–51). All six individuals contained identifiable stomach contents. The diet of *H. arenicolor* contained a fairly large diversity of organisms (Table 1). Numerically, termites and beetles were the most important prey, but volumetrically, beetles and orthopterans were most important.

TABLE 1. Stomach contents of 6 *Hyla arenicolor* from Chihuahua and Sonora, México.

Prey type	Prey Items N	Prey Items (%)	Volume cm^3	Volume (%)	Number of Stomachs
Coleoptera	6	(30)	0.72	(45.3)	3
Dermaptera	1	(5)	0.14	(8.8)	1
Homoptera	1	(5)	0.12	(7.6)	1
Hymenoptera (ants)	1	(5)	0.01	(0.6)	1
Isoptera	10	(50)	0.03	(1.9)	1
Orthoptera	1	(5)	0.57	(35.9)	1

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LEPTOBRACHIUM SMITHI (Smith's Litter Frog). **ANTIPREDATOR BEHAVIOR**. *Leptobrachium smithi* is a megophryid frog described from "Ton Nam Plu Waterfall" Khao Chong, Trang Province, southern Thailand (7°34'N, 99°49'E, 260 m elev.) (Matsui et al. 1999. Japan J. Herpetol. 18:19–29). Distribution includes Thailand, Myanmar, India, Bangladesh, and Laos (Nabhitabhata et al. "2000" [2004]. Checklist of Amphibians and Reptiles in Thailand. Office Environmental Policy and Planning. 152 pp.; Das et al. 2004. Asiatic Herpetol. Res. 10:245–246;



FIG. 1. An adult male *Leptobrachium smithi* exhibiting antipredator behavior.

Sengupta et al. 2001. J. Bombay Nat. Hist. Soc. 98[2]:289–291; Asmat et al. 2003. Univ. J. Zool. 22:141–143; Stuart 2005. Herpetol. Rev. 36:473–479). Defensive behavior in *L. smithi* has not been reported previously.

On 30 June 2006, an adult male *L. smithi* was collected as it called in hilly evergreen forest (47 Q 0700022, UTM 1834963, 714 m elev.) at Nong Mae Na Protected Unit of Thung Salaeng Luang National Park, Khao Khor District; Phetchabun Province by Y. Chuaynkern and C. Inthara. While being manipulated for photographs, the frog assumed an antipredator behavior when touched near the vent. The individual arched its back with its head elevated ca. 90°, the eyes were bulged which prominently displayed the contrasting orange and black eye color (Fig 1). The limbs were outstretched and the frog remained motionless. A somewhat similar behavior is well known in *Bombina variegata*, with the frog resting on its belly, the chin elevated, and the bright orange palms and soles of the feet upturned (Duellman and Trueb 1986. Biology of Amphibians. McGraw-Hill Book Co., New York. 670 pp.).

Fieldwork was financed by a grant to PD from the Office of Environmental Policy and Planning (OEPP), and permitted by the National Park, Wildlife, and Plant Dept., Ministry of Natural Resource and Environment (Thailand). We thank Thaweesak Kaentong and Panya Chanma (Nong Mae Na Protected Unit, Thung Salang Luang National Park) for the assistant in the field.

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LEPTODACTYLUS MELANOTUS (Sabinal Frog). **DIET**. Little is known about the ecology of *Leptodactylus melanotus*. Here we report observations on the stomach contents of seven *L. melanotus* collected during 2004 from Río Mayo at the gates of Presa Mocuzari, Sonora, México (27°13'25.6"N, 109°6'30.6"W; WGS 84; 90 m elev.) (see Smith et al. 2005. Bull Chicago Herpetol. Soc. 40:45–51). Of the seven individuals, five contained identifiable stomach contents, one contained unidentifiable stomach contents, and one had an empty stomach. Table 1 lists the prey items. Numerically, beetles and collembolans were the most important prey items, but volumetrically beetles were the most important.

TABLE 1. Stomach contents of *Leptodactylus melanotus* from Sonora, México.

Prey Type	Prey Items N	(%)	Volume cm^3	(%)	Number of Stomachs
Coleoptera	9	(45)	0.13	(10.5)	3
Collembola	8	(40)	0.03	(68.4)	1
Hymenoptera (ants)	1	(5)	0.01	(15.8)	1
Araneae	2	(10)	0.02	(5.3)	2

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OSTEOPILUS SEPTENTRIONALIS (Cuban Treefrog). **DIET**. Anurans are generally cited as the prey and not the predators of aeshnid dragonflies (Buskirk 2000. Ecol. 81:2813–2821; Caldwell et al. 1980. Oecologia 46:285–289). Dragonflies have been occasionally recorded in *Osteopilus septentrionalis* diet (0.6 % of stomachs examined), but the species taken were not identified (Meshaka 2001. The Cuban Treefrog in Florida. Univ. Press Florida, Gainesville. 192 pp.). Here we document the first observation of *O. septentrionalis* preying on the dragonfly *Anax junius* (Green Darner).

Osteopilus septentrionalis and *A. junius* have been observed on many occasions to perch on the window shutters of the Environmental Learning Center at Rookery Bay National Estuarine Research Reserve, Collier County, Florida, USA. At ca. 1130 h on 14 July 2006, TMB observed an adult female *O. septentrionalis* (6.4 cm SVL) capture and eat an adult (7.8 cm TL) female *A. junius*. Conditions at the time were hot (33°C) and humid (65% RH), with light wind (5 mph), high pressure (1018.6 mb) and overcast. The treefrog lunged at the dragonfly with its mouth open and its tongue pad protracted. The dragonfly was captured sideways, and its wings and abdomen protruded from the treefrog's mouth. Subsequently, the treefrog used its forelimbs to push the prey headfirst into its mouth. Handling time was ca. 15 min. The treefrog was immediately captured, and subsequent dissection revealed a rapid digestion of the *A. junius* abdomen and no other prey within the stomach, few fat bodies, and a nearly gravid reproductive status.

Osteopilus septentrionalis is a sit-and-wait predator capable of eating very large prey (Meshaka 2001, *op. cit.*). The wide variety of prey items in the diet of *O. septentrionalis* indicates that it is not a specialized feeder, but Coleoptera and Blattaria are the prevailing categories of items in stomach contents (Meshaka 2001, *op. cit.*). *Anax junius* is one of the largest (60–80 mm) dragonflies in South Florida (Dunkle 1989. Dragonflies of the Florida Peninsula, Bermuda, and the Bahamas. Gainesville, Florida, Scientific Publishers. 154 pp.). The geographic range of *A. junius* overlaps with that of *O. septentrionalis*. Although it is unlikely to be preyed upon by the smaller native treefrogs, the depredated individual was ca. 122% of the predator's body length, and average body sizes of female *O. septentrionalis* exceeding 6 cm are typical of Florida populations (Meshaka 2001, *op cit.*). Furthermore, the *O. septentrionalis* was yolking and had little fat development. Thus, it would seem that in chance encounters between these species on sultry days or near dusk, even large *A. junius* are susceptible to the depredations of *O. septentrionalis*, and in turn mature females are provided with a nutritious meal.

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PLEURODEMA NEBULOSA (NCN)**. REPRODUCTION.** *Pleurodema nebulosa* occurs in the arid areas of western Argentina, from Catamarca to Rio Negro (Cei 1980. Amphibians of Argentina. Monit. Zool. Ital. [NS]. Monogr. 2, 609 pp.). Herein we present the first data on the reproductive ecology of *Pleurodema nebulosa* in Argentina. Our study area was located 40 km N of San Juan City on National Route N40. This area is in the Monte Phytogeographic Province (Cabrera and Willink 1980. Biogeografía de América Latina. O.E.A. Washington, DC. 109 pp.). Dominant vegetation includes *Prosopis* sp., *Bulnesia retama*, *Solanum eleagnifolium*, *Caparis atamisquea*, *Grabousquia obtusa*, and *Tamarix gallica*.

Individual male and female *P. nebulosa* were captured by hand after heavy rains occurred in the area on 17–18 and 20 Jan 2004. Ovarian mass was determined by weighing to 0.001 g. The number of mature ova was calculated by counting a subset of the entire mass, and ova diameter was measured to 0.02 mm under a binocular magnifying glass. Testicular volume was calculated using the formula for an ellipsoid sphere (Dunham 1983. *In* Huey et al. [eds.], Lizard Ecology, pp. 261–280. Harvard Univ. Press, Cambridge, Massachusetts).

The mean number of mature ova was 547 (SD = 318.3, range = 175–962, N = 11); mean ova diameter was 0.91 mm (SD = 0.13, range = 0.74–1.2 mm, N = 11). As female size increases so does fecundity, i.e., the number of ovules produced increases ($R^2 = 0.55$, $p < 0.0059$). Mean testicular volume was 2.39 mm^3 (SD =1.36, range = 0.55–5.8 mm^3, N = 22). A positive and significant relationship exists between testicular volume and SVL ($R^2 = 0.54$, $p < 0.00005$) and between testicular volume and mass of the individuals ($R^2 = 0.57$, $p < 0.00002$).

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PLEURODEMA TUCUMANA (NCN). **REPRODUCTION.** *Pleurodema tucumana* is a small leptodactylid frog that occurs in northern and west-central Argentina (Lavilla et al. 2000. Categorización de los Anfibios y Reptiles de la República Argentina. Asoc. Herpetol. Arg. 97 pp.). Information on the species is restricted to preliminary data on reproduction (Perotti 1997. Rev. Chilena Hist. Nat. 70:277–288). Herein, we report the first reproductive data of the species from Chaco Phytogeographic Province, Distrito Chaco Serrano in western Argentina (Cabrera and Willink 1980. Biogeografía de América Latina. O.E.A. Washington D.C. 109 pp.).

We collected 30 *P. tucumana* (20 males and 10 females) from the Las Tumanas River (30°52'S, 67°19'W. 750 m elev.), Valle Fértil Department at 137.5 km from San Juan city during January 2000. Flora at the study site was dominated by *Schinopsis haekeana* and *Aspidosperma quebracho-blanco*. Frogs were captured by hand, preserved, and deposited in the Facultad de Ciencias Exactas, Físicas y Naturales of the Universidad Nacional de San Juan Collection (MCN-UNSJ4100-4129).

Mean SVL of males (N = 20) was 32.7 mm (range 27–35 mm; SD 1.68 mm), mean body mass was 3.34 g (1.18–4.96 g; SD 0.82 g), and mean testicular volume was 0.83 mm^3 (0.31–1.27 mm^3; SD 1.44 mm^3). SVL was not associated with testicular volume ($r_s = -0.025$; $p = 0.91$) nor body mass ($r_s = 0.16$; $p = 0.49$).

Mean SVL of gravid females (N = 10) was 37.3 mm (range 36–39 mm; SD 1.05 mm), mean body mass was 5.16 g (3.37–6.77 g; SD 1.07 g), mean mature ovum count was 993 (255–2933; SD 838), mean mature ovum diameter was 0.68 mm (0.04–0.98 mm; SD 0.37 mm), mean ovary mass was 0.33 mg (0.04–1.1 mg; SD 0.33 mg), and mean factor of ovarian size was 22.2 (0.29–34.1; SD 22.8). The mature ovum count was not correlated with SVL ($r_s = 0.33$, $p = 0.35$) nor body mass ($r_s = 0.56$, $p = 0.08$). There was a significant relationship between mature ovum diameter and mature ovum count ($r_s = 0.74$, $p = 0.01$). The ovary mass averaged 6.8% of the body mass in females.

The reproductive data presented herein for *P. tucumana* from Chaco serrano is similar to that from Chaco semiarid (Perotti 1997, *op. cit.*).

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RANA CATESBEIANA (American Bullfrog). **DIET**. On 27 Aug 2006, three adult *R. catesbeiana* were collected from Big Muskego Lake (42°51.241'N, 88°07.456'W), Muskego, Waukesha County,

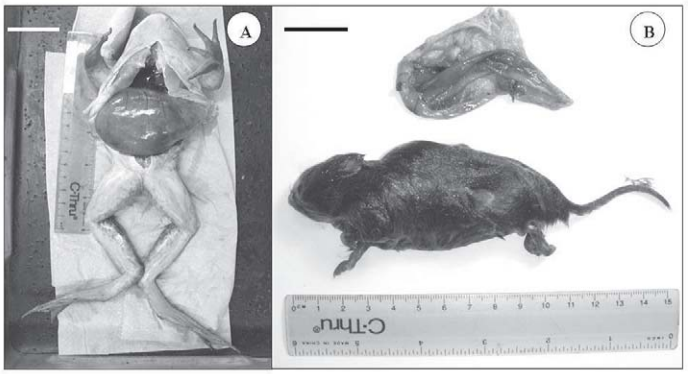


FIG. 1A. Adult male *Rana catesbeiana*; note the distended stomach. Bar = 40 mm. 1B. Adult male meadow vole, *Microtus pennsylvanicus*. Bar = 25 mm.

Wisconsin, USA. Frogs were captured by hand with the help of a headlamp (ca. 030 h). All frogs were euthanized and SVL and gape size were recorded to the nearest mm for each individual. The stomach, small intestine, and large intestine were removed, and the stomach was separated from the rest of the gastrointestinal tract. Each stomach was opened and contents examined under a dissecting microscope. A male *R. catesbeiana* (SVL 13.5 cm; gape size 5.2 cm) had a greatly distended stomach (Fig. 1a), which contained a small mammal (Fig. 1b). The two other specimens had empty stomachs.

The mammal was identified as an adult male meadow vole, *Microtus pennsylvanicus* (Jackson 1961. Mammals of Wisconsin. Univ. Wisconsin Press. 504 pp.). The vole was 11.5 cm in total length; 4.8 cm tail length; hind foot 20 mm with six plantar tubercles; was dark brown above, and somewhat paler below with short ears (length 11 mm from notch). Few reports exist on species identification of small mammals in bullfrog stomachs (Lannoo 2005. Amphibian Declines. The Conservation Status of United States Species. University of California Press, Berkeley. 1094 pp.), and no reports exists of *R. catesbeiana* feeding on small mammals in Wisconsin (Vogt 1981. Natural History of Amphibians and Reptiles of Wisconsin. Milwaukee Public Museum, and Friends of the Museum, Inc., Milwaukee, Wisconsin, 205 pp.).

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RANA YAVAPAIENSIS (Lowland Leopard Frog). **REPRODUCTION**. *Rana yavapaiensis* typically exhibit a bimodal breeding season in Arizona. Most reproductive activity occurs in early spring (February–April), with a second season of lesser activity in late September and October (Sartorius and Rosen 2000. Southwest. Nat. 45:267–273). In Arizona, winter months are generally periods of relatively low activity with no reports of reproductive behavior (Sredl 2005. *In* Lannoo [ed.], Amphibian Declines: The Conservation Status of United States Species, pp. 596–599. Univ. California Press, Berkeley, California). The only documented January reproduction in *R. yavapaiensis* was at –38 m elev. in the Coachella Valley, California (Ruibal 1959. Copeia 1959:315–322; reported as *Rana pipiens*).

On 29 Dec 2005, 2115 h, at Walnut Springs, a tributary to the Verde River, Mazatzal Mountains, Maricopa County, Arizona (UTM 3750734N, 451734E, NAD 27, 1119 m elev.), JBV observed an amplexing pair of *R. yavapaiensis* and heard several adult males calling. On 6 Jan 2006, there were two freshly laid *R. yavapaiensis* egg masses in the spring pool. We believe this is the first report of reproductive activity in mid-winter (December or January) in Arizona. Walnut Springs is a thermally stable system (T_w = 17°C on 29 Dec 2006) and perhaps provides a suitable microhabitat for successful winter breeding. Therefore, reproductive patterns in *R. yavapaiensis* might be more labile than previously thought, depending on local conditions.

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SMILISCA FODIENS (Lowland Burrowing Treefrog). **DIET**. Little is known about the ecology of *Smilisca fodiens* beyond reports of its distribution (Sullivan et al. 1996. Great Basin Nat. 56:38–47), endoparasites (Goldberg et al. 1999. Great Basin Nat. 59:195–197), cocoon formation (Ruibal and Hillman 1981. J. Herpetol. 15:403–408), and metabolism (Taigen et al. 1982. Oecologia 52:49–56). To our knowledge there have been no reports on its diet. Here we report observations on the stomach contents of 15 *S. fodiens* collected during 2004 from Valle de Tacupeto, Sonora, México (28°15'20.5"N, 109°18'1.9"W; WGS 84; 435 m elev.) (see Smith et al. 2005. Bull Chicago Herpetol. Soc. 40:45–51). Of the 15 individuals, nine contained identifiable stomach contents, five contained unidentifiable stomach contents, and one had an empty stomach. Table 1 lists the prey items. Numerically and volumetrically, beetles were the most important prey, followed by orthopterans. Beetles were found in seven of the nine stomachs containing identifiable stomach contents. It seems that the diet of *S. fodiens* at this site is made up primarily of beetles.

TABLE 1. Stomach contents of *Smilisca fodiens* from Sonora, México.

Prey Type	Prey Items N	Prey Items (%)	Volume mm^3	Volume (%)	Number of Stomachs
Coleoptera	17	(70.8)	3.26	(56.4)	7
Hymenoptera (ants)	4	(16.7)	1.20	(20.8)	2
Lepidoptera	1	(4.2)	0.08	(1.4)	1
Orthoptera	1	(4.2)	0.21	(3.6)	1
Odonata	1	(4.2)	1.03	(17.8)	1

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TESTUDINES

ACTINEMYS MARMORATA (Pacific Pond Turtle). **EGGS**. As with nearly all turtles, *Actinemys marmorata* typically deposits its eggs in a terrestrial, excavated nest (Ernst et al. 1994. Turtles of the United States and Canada. Smithsonian Inst. Press, Washington DC, 578 pp.). On 11 August 2006, six eggs of *A. marmorata* were found submerged in a natural pool (4 m long, 2.5 m wide, and 0.8 m deep) along a tributary of Adobe Creek, Sonoma County, California, USA. The six eggs were not damaged or predated and were located under water 12 cm deep within 30 cm of the shoreline. The eggs were slightly dispersed from each other. Most eggs had a slight silt deposit on the shell, suggesting that the eggs were not recently deposited. At this pool two *A. marmorata* adults had been observed basking on a log three weeks earlier. There were no signs of depredated turtle nests around the bank of the pool.

Weight and size of eggs: 11.3 g, 35.4 mm (total length), 22.9 mm (largest width); 12.3g, 36.4 mm, 23.9 mm; 10.8 g, 35.4 mm, 22.9 mm; 12.9 g, 36.4mm, 24.9 mm; 10.1g, 34.3 mm, 23.9 mm; 11.7g, 36.4 mm, 22.9 mm. Mean weight was 11.5 g, and mean length 35.7 mm, and width 23.6 mm.

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ACTINEMYS MARMORATA (Pacific Pond Turtle) and ***TRACHEMYS SCRIPTA ELEGANS*** (Red-eared Slider). **REPRODUCTIVE BEHAVIOR**. Attempted mating between native and introduced turtle species in the wild rarely has been documented (e.g., Ernst et al. 1994. Turtles of the United States and Canada, Smithsonian Inst. Press, Washington, D.C.), let alone between different genera. Although there have been several observations of aggressive behavior between Pacific Pond Turtles (*Actinemys marmorata*) and various species of sliders (*Trachemys* spp.), mostly in association with competition for prime basking sites (Spinks et al. 2003. Biol. Cons. 113:257–267), this is apparently the first documentation of attempted mating between the two.

On 9 May 2005, one of us (BML) observed an attempted mating between a male Pacific Pond Turtle and a female Red-eared Slider (*Trachemys scripta elegans*). The observation occurred along Oso Creek in the City of Mission Viejo, south Orange County, California (USA). Habitat consisted of a large pool formed at the base of a rip rap outflow structure where 1.2-m corrugated metal pipes conduct stream flow under the Interstate 5 freeway. Large willow (*Salix* sp.) and Western Sycamore (*Platanus racemosa*) trees overhang a portion of the pool partially shading the area. Several partially submerged rocks (riprap) and emergent logs provide suitable basking sites. The source of water is primarily urban runoff, with residential developments and a golf course along Oso Creek immediately upstream (on the other side of the freeway).

At approximately 0900 h, the two turtles were observed swimming together parallel to the edge of the pool, with the male Pond Turtle swimming on top of the female Slider, his head and legs fully extended. The female appeared to be intentionally moving away from the male, and moved out of the water onto the shore, with the male partially on her back. The male continued his pursuit of the female, mounting and balancing on the carapace of the female while they were out of the water. At this time the male was continuously probing the tip of his tail back and forth along the posterior edge of the female's plastron attempting copulation (at which he appeared to be successful). The female finally returned to the water and the male slid off her back as she swam away. The entire encounter lasted approximately two to three minutes and was photographed with a hand-held, digital camera.

Only two adult male *A. marmorata* were observed in the habitat during a total of eleven visits to the site through the spring and summer of 2005; the second male was observed basking in a pool approximately 300 m downstream. Because Pacific Pond Turtles are relatively long-lived (Jennings and Hayes 1994. Amphibian and Reptile Species of Special Concern in California. California Dept. of Fish and Game, Inland Fisheries Division, Contract No. 8023. 255 pp.), adults may persist for many years in degraded, human-modified habitats where upland habitat suitable for egg deposition is absent, resulting in an adult-biased age structure (Jennings and Hayes, *op. cit.*). It is possible that the Oso Creek population at this location has been reduced to two adult males, and the attempted mating by the male only occurred because conspecific female turtles were unavailable.

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ACTINEMYS* (=*CLEMMYS*) *MARMORATA MARMORATA (Northwestern Pond Turtle). **COURTSHIP BEHAVIOR.** Courtship behavior of the southern subspecies *A. m. pallida* has been observed in the field in May, June, and late August and in captivity in late August and early September (Buskirk 1991. *In* Beaman et al. [eds.], Proceedings of the First International Symposium on Turtles and Tortoises: Conservation and Captive Husbandry, pp. 16–23. Chapman University, Orange, California; Goodman 1997. The Biology of the Southwestern Pond Turtle [*Clemmys marmorata pallida*] in the Chino Hills State Park and the West Fork of the San Gabriel River. Master's thesis, California State Polytechnic University, Pomona, California; Holland 1988. Herpetol. Rev. 19:87–88). Here I provide a detailed description of the courtship behavior of *A. m. marmorata* observed in the wild, and note the timing of two other observations of probable courtship behavior.

At 1215 h on 19 September 2003, while snorkeling in the south

fork of the Trinity River near Hyampom, California (UTM 465160E, 4474972N), I observed two *A. m. marmorata* engaged in presumed courtship activity. I was floating near the left bank, hidden by overhanging vegetation, where I had a clear view of two turtles below without them noticing me. The water was clear and sunlit from directly overhead, and visibility was excellent. Water temperature was 15.3°C and air temperature was 23.4°C.

Both turtles were adults, of similar size, and the genders were easily discerned from standard dimorphic characters. The female was resting on the bottom of the pool on sandy substrate. She was orientated away from the left bank with her head and forelimbs retracted beneath the carapace. Her hind limbs were partially extended and in firm contact with the substrate. The male was facing the female, scratching the anterior of her carapace with the claws of his forelimbs. He would first scratch three times with the left forelimb, three times with the right, then three times with both forelimbs simultaneously, and then repeat this cycle. The scratching was usually in sets of three. He did this for about a minute then he reared up on his hind limbs with his anterior raised off the substrate at about a 45° angle and waved both forelimbs side to side in a symmetrical manor for 10–15 seconds. This action seemed to push him up and backward until he was nearly vertical on his hind limbs. Then he would stop waving, settle back down to the bottom of the pool in front of the female, and within a few seconds, resume scratching on her carapace following the same pattern as previously described. He went through this cycle of scratching and front limb waving three times. After a few minutes of this behavior the female extended her head and forelimbs, turned approximately 120° to the left, and began walking downstream. The male quickly followed. The female only moved about 2 m downstream before he swam over the top of her carapace and settled down in front of her, again face to face, blocking her forward movement. She tucked back into her shell, in the same position previously described, with hind limbs extended like braces. The male immediately began the scratching behavior, again following the same pattern of threes. This lasted for several minutes, until the female's head protruded from under her carapace and she suddenly turned 180° and began to walk quickly upstream as if attempting to flee the male. The male followed and swam up over her and settled down on the substrate facing her, again blocking her forward progress. At this point the two turtles were directly below me at about 1.5 m in depth. The male once again resumed the scratching and waving behavior, but during the first bout of waving the female looked up, appeared to see me and immediately fled, swimming along the bottom towards the middle of the river and deeper water. The male watched her flee, but did not follow. She took refuge beneath large submerged boulders near the deepest part of the river (ca. 5 m away and 5 m deep). Once the female was out of sight, the male slowly turned and began to swim toward the surface as if surfacing to breathe. He came straight up towards me in a relaxed manor. At about 30 cm from my face mask, he looked straight at me, paused a second, then fled rapidly to the deep water mid-channel. He went under a boulder about 3 m from the female's retreat. Although I had remained motionless during the encounter to avoid detection and thus did not consult my wristwatch for exact timings, the entire observation lasted approximately 8 minutes.

In late May, 1994, I briefly observed a similar interaction on the mainstem of the Trinity River near Junction City, California, but in this instance the male turtle noticed my presence in less than a minute and both turtles attempted to flee. Similar courtship behavior was observed by James Bettaso (USFWS) in the South Fork Trinity River, near the confluence of Surprise Creek near dusk on 28 September 2005. Observations of courtship behavior in both spring and fall are consistent with previous reports.

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CHELODINA* sp.** (Kimberley Long-necked Turtle) and ***EMYDURA AUSTRALIS (Northwest Red-faced Turtle). **PREDATION**. Freshwater turtles have been noted as prey taken by pelicans, jabirus, hawks, sea eagles, and wedge-tail eagles (Worrell 1966. Australian Snakes, Crocodiles, Tortoises, Turtles, and Lizards. Angus and Robertson, Sydney). However, published life history data that quantify turtle species, number, and size classes taken by avian predators are lacking. Here we report on predation by White-bellied Sea Eagles (*Haliaeetus leucogaster*) on two turtle species of inland rivers in northwestern Australia.

During turtle surveys of the Kimberley Plateau (by ADT and NNF) in June 2006, residents from Tirralintji Station (SW, BW) reported carcasses of freshwater turtles predated by White-bellied Sea Eagles at the Traine River (-17.198°S, 126.436°E). A partial carcass of *Chelodina* sp. (reconstructed straight-line carapace length [SCL] estimated at 18 cm) was beneath an eagle nest on the southern bank. Beneath a feeding station tree on the northern bank were shells of four *Chelodina* (16.4, 18.8, 19.1, 19.8 cm SCL) and one *Emydura australis* (16.2 cm SCL). Voucher specimens were deposited with the Western Australia Museum (specimen numbers pending). Several carcasses had injuries to the anterior carapace as described for bird-predated adult *Chelodina rugosa* reported by Cann (1989. Australian Freshwater Turtles. Beaumont Publ. Pty. Ltd, Singapore).

The lengths of these predated turtles was compared to the size range of turtles trapped from the same pool and a nearby section of the Traine River (-17.195°S, 126.456°E). The trapped sample of *Chelodina* sp. ranged from 18.0 to 21.3 cm SCL (N = 3) and *E. australis* ranged from 12.9 to 22.3 cm SCL (N = 23). The carcass sizes reported here are similar to lengths of carcasses recovered at sea eagle nests at other inland and coastal locations (Clark 1982. J. Field Ornithol. 53:49–51; Mitchell et al. 2006. Herpetol. Rev. 37:216–217; Woodall 1982. Sunbird 12:11–14). Taken together, these observations suggest that small freshwater turtles generally comprise a minor dietary resource of large coastal raptors.

Tirralintji residents observed that the sea eagles reside locally only for nesting, and migrate elsewhere after the young fledge. The billabong is from 190 to 275 km distant from coastal areas near Flatback Turtle (*Natator depressus*) nesting and/or developmental habitats. Given that sea eagles are identified predators of juvenile Flatbacks (Walker 1991. Mar. Turt. Newsl. 55:6), two speculative scenarios may apply—foraging tactics developed for juvenile Flatback Turtles at sea would facilitate switching to similar-sized freshwater turtles, or the opposite scenario. Tirralintji residents noted that eagle predation occurred during the late dry season (September–November) when turtles often migrate over-

land from drying billabongs to permanent pools. Further observations will be necessary to determine whether turtle predation by eagles is a localized phenomenon due to unique site characteristics at the pool, or possibly represents opportunistic scavenging.

We thank Earthwatch Institute, Australia for funding and field volunteers. Specimens were collected with permission of the Australian Wildlife Conservancy (property owners and managers) and also the Tirralintji community (traditional owners). Fieldwork was facilitated by T. Vigilante of Kimberley Land Council and S. Legge of Australian Wildlife Conservancy. J. Mitchell and R. Welsh gave helpful critique on an early draft. Surveys were covered by animal ethics board approval of the University of Canberra and collecting permit SF5344 from the Department of Conservation and Land Management, Western Australia.

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CHELUS FIMBRIATUS (Matamata). **REPRODUCTION.** On 21 September 2006 we found a clutch of *Chelus fimbriatus* eggs in the Caño Guaritico, at the Estación Biológica El Frío (Apure, Venezuela; UTM: 0508375 N; 0872150 W). The ten egg clutch was found at the edge of the stream (7 cm above the water level), inside a hole excavated by fishes locally called "bagres" (Loricariidae: *Hypostomus plecostomus*, *Liposarcus multirradiatus*, and *Glyptoperichthys gibbiceps*). The hole was partially collapsed by stream flow, which allowed us to find the clutch. There were no signs of depredation. The eggs were transferred to a polyurethane box filled with sand and taken to the biological station. The eggs were spherical, with a smooth, white shell. Egg diameter in this clutch ranged from 37.8 to 39.4 mm (mean 38.4 mm); egg mass ranged from 33.5 to 36.5 g (mean 34.9 g). Although the deposition date of this clutch is unknown, it is earlier than most previous reports, such as October in Colombia (Medem 1969. Caldasia 8:341–351) and October–November in Venezuela (González Ortiz, in Mondolfi 1955. Memorias Sociedad Ciencias Naturales La Salle 15:177–183; Lasso, pers. obs.). This report is apparently the earliest date for a clutch of *Chelus fimbriatus* in the wild, although in all cases the reported dates for egg laying coincide with decreasing water levels at the start of the dry season.

Clutch size reported here is smaller than clutches reported by Medem (*op. cit.*), Mondolfi (*op. cit.*) and Hausmann (1968. Int. Turt. Tort. Soc. J. 2[4]:18–19, 36), who note a range of 12–28 eggs. Our egg size data agree with those compiled by Pritchard and Trebbau (1984. Turtles of Venezuela, SSAR, Ohio), who reported that egg diameter ranged from 3.4 to 4.0 cm.

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CHRYSEMYS PICTA BELLII (Western Painted Turtle)**. COLORATION**. Variations in pigmentation, independent of subspecies characteristics, have been observed in many indigenous populations of *Chrysemys picta* throughout North America. These variations have been attributed to a number of biotic and abiotic factors such as sexual cycles, age, differences in habitat quality such as minerals or tannins in the water, or variable substrate colors (Rowe et al. 2006. Herpetol. Rev. 37:293–298). Here we report the first published account of reticulate blue coloration in *C. picta*. On 9 September 2005, we captured a large male *C. picta bellii* (171 mm PL) in an irrigation ditch adjacent to the South Platte River in Brush, Colorado (Morgan County). In addition to the usual red and black markings, this individual displayed distinct blue reticulate coloration along the marginal scutes. This coloration was especially striking on the inframarginal scutes and bridge. These reticulate blue marking appeared to have completely replaced the yellow markings typically found on these scutes. On 28 May 2006, two other *C. picta* males (141 mm and 142 mm PL) displaying similar blue coloration, were captured in a small pond near Limon, Colorado (Elbert County) ca. 160 km S of the Morgan County location. Although reticulate melanism is well documented for older males of this subspecies (Ernst et al. 1994. Turtles of the United States and Canada. Smithsonian Inst. Press, Washington DC. 578 pp.), it is not known if the blue reticulation pattern follows a similar pattern of expression. To date, no females have been discovered with similar coloration. Differences in habitat quality and distance between these two locations make it unlikely that environmental conditions alone would account for this unusual color pattern.

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CYCLEMYS DENTATA (Asian Leaf Turtle). **FIRE SCARS**. On 25 November 2004, during a larger study on freshwater turtles in Loagan Bunut National Park (LBNP) (03°44'–03°N, 114°09'–114°17'E), Sarawak, Malaysia, a small adult *Cyclemys dentata* (straight carapace length 130 mm) was collected, measured, and released. On the left side, marginals III–VII were damaged; scutes were partially missing, and portions of marginals V–VII missing (Fig. 1). All edges of the remaining portions of the marginals appeared to have undergone trauma presumably from exposure to fire. The injury was not new and had apparently healed.

Cyclemys dentata is known to occur in both highlands and, more commonly, in lowlands near small streams and ponds throughout Southeast Asia. Out of five individuals located at LBNP, all but one were found in secondary forest and the burnt individual was found on the eastern edge of the park, near an oil palm plantation. Fire is a common, yet controversial, tool used in the region to quickly clear brush and weeds for planting, particularly on oil palm and pulp wood plantations (Kinnaird and O'Brien 1998. Conserv. Biol. 12:954–956). Fires are routinely set at or near the end of the southwest monsoon, which corresponds to the dry season, and has

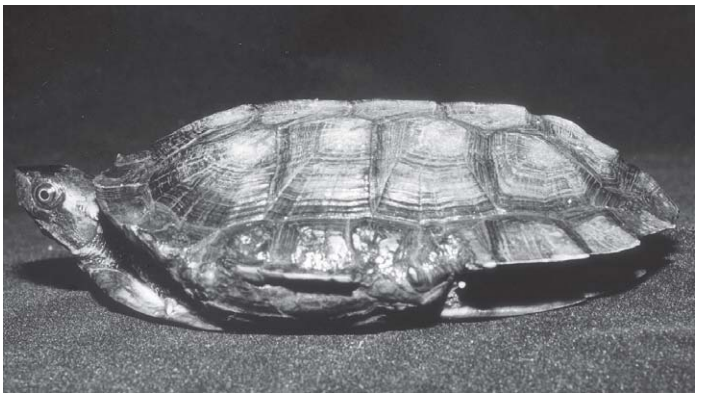


FIG. 1. View of the left aspect of an individual of *Cyclemys dentata* showing scarred and missing marginals.

been known to affect other turtle species in the region (Mitchell et al. 2005. Herpetol. Rev. 36:169).

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DERMOCHELYS CORIACEA (Leatherback Seaturtle). **DIET**. Leatherback Seaturtles are dietary specialists, consuming planktonic gelatinous prey such as medusae (Scyphozoa, Siphonophora), salps and pelagic tunicates (Bjorndal 1997. *In* Lutz and Musick [eds.], The Biology of Sea Turtles, pp. 199–232. CRC Press, Boca Raton, Florida). Small quantities of other organisms are sometimes identified in gut contents, such as amphipods, other crustaceans, and fish, thought to have been consumed coincidentally together with commensal jellyfish (Frazier et al. 1985. J. Herpetol. 19:159–160). Here, we report the consumption of two new dietary items for this species

On 5 April 2005, an adult female Leatherback Seaturtle (CCL= 143.0 cm), was found stranded and dead on San Luis Beach, Canelones, Uruguay (34°46'34"S, 55°35'18"W). The turtle was probably captured by a trawling vessel of the Uruguayan fleet, evidenced by a rope tied around its front flippers, used to discard the animal off the ship (Martin Laporta, pers. comm.). We examined the contents of the digestive tract and identified remains of the jellyfish *Lychnorhiza lucerna* (Scyphozoa, Rhizostomeae) and seven spider crabs *Libinia spinosa* (Decapoda, Majidae). The crabs were determined to be juveniles because of the relatively small size of their carapaces (10.8–18.2 mm. length, 8.7–14.5 mm. width, N = 7). Additionally, an adult Weakfish (*Cynoscion guatucupa*) (size = 250 mm) was also found in the esophagus of the turtle.

Lychnorhiza lucerna is a scyphozoan jellyfish that belongs to the Order Rhizostomeae, Superfamily Inescapulatae (Mianzan and Cornelius 1999. *In* D. Boltovskoy [ed.], South Atlantic Zooplankton, pp. 513–559. BACKHUYS Publishers, Leiden). It is common in the region, with a known geographic range that extends from San Clemente del Tuyú, Argentina, north to the Guyanas (Mianzan 1989. Inv. Mar. CICIMAR Vol. 4 nº 1). However, to our knowledge this is the first report of *L. lucerna* consumption by *D. coriacea*. A mutualistic-commensalistic relationship between the spider crab and *L. lucerna* has been documented in Uruguay by Vaz-Ferreira (1969. Bol. Soc. Zool. Uruguay 2:64–66), indicating that the crabs were ingested incidentally with the jellyfish. We believe that the presence of a Weakfish in the turtle's digestive tract is likely to be accidental, and suspect that was ingested while the turtle was captured within the trawl net.

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ERYMNOCHELYS MADAGASCARIENSIS (Madagascan Sidenecked Turtle). **DIET**. A number of authors (Siebenrock 1903. Abhandlungen der Senckenberg Naturforschenden Gesellschaft 27: 241–259; Vaillant and Grandidier 1910. *In* Histoire Physique, Naturelle et Politique de Madagascar, Paris, Librarie Hachette 17:1–86; Decary 1950. Les reptiles Chapitre III. La faune malgache. Paris: 77–89; Tronc and Vuillemin 1973. Bulletin de l'Academie Malgache, T. 51/1:190–224) described *Erymnochelys madagascariensis* as carnivorous, feeding primarily on molluscs, arthropods, fish, and amphibians. More recent studies (Kuchling and Mittermeier 1987. IUCN SSC 2:121–124; Jenkins et al. 1990. Expedition Final Report, Oxford Univ.: 13 pp.; Kuchling 1993. Salamandra 28:231–250) suggested the species was omnivorous because significant amounts of plant material were found in sampled guts. These authors identified three main components in the turtle's diet; animal matter (mostly made up of the small gastropod, *Melanoides tuberculata*), fish, and green shoots and root-tips of the reed *Phragmites mauritaunicus*. However, these data were collected over short time periods and are not representative of all ages, sizes, or habitats. In 1998–2000 the first author completed a study of the dietary preferences of the species by analyzing stomach contents (stomach flushing: Legler 1997. Herpetologica 33:281–284) and fecal samples of turtles trapped or accidentally collected at Ankarafantsika National Park, Madagascar, as part of his PhD thesis research (García 2005. DICE Institute, University of Kent, Canterbury. 299 pp.). A total of 298 stomach samples from 243 turtles and a total of 499 fecal samples from 72 turtles were collected from seven localities during the study period.

Juvenile and mature turtles differed in percentage animal and plant material identified in gut samples (juveniles: 59% animal and 41% plant; matures: 28% animal, 72% plant), but no significant differences were found between sexes. Aquatic arthropods and then seeds, fruits, and freshwater snails were the main items in the diet in juvenile turtles. In mature turtles, the most common items were fig fruits, seeds, nuts, and freshwater snails. This study suggests that *E. madagascariensis* at this site were more carnivorous in the smaller class sizes (<125 mm PL), shifted to opportunistic, omnivorous feeding habits as they got larger (125–200 mm

PL), and finally become opportunistic herbivores as adults (>200 mm PL), although they did continue to opportunistically take animal prey.

During the study period three fecal samples from juvenile *E. madagascariensis* revealed remains of the scorpion *Grosphus hirtus* Kraepelin (Lourenço and Goodman 2006. Zool. Anz. 244:181–185). The first sample was from a juvenile #215 (105 mm PL) caught at Antsilomba Lake (16°16'25.2"S, 46°43'04.3"E) on 22 February 1999. The second sample came from juvenile #585 (160 mm PL) on 3 March 2000 from the locality of Ambarindahy (16°15'11.7"S, 046°43'21. 8"E), and the third sample was collected from juvenile #711 (75 mm PL) at Lake Antsilomba on 13 March 2000.

This is the first record of turtles preying on scorpions in Madagascar, and possibly the first record of turtles eating scorpions anywhere (McCormick and Polis 1990. *In* The Biology of Scorpions, pp. 294–320. Stanford, Stanford Univ. Press).

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GOPHERUS POLYPHEMUS (Gopher Tortoise). **MORTALITY**. *Gopherus polyphemus* has declined precipitously in range and numbers in Florida and recently was state-listed as a "threatened" species under the Florida Wildlife Code (Chap. 39, Florida Administrative Code). At ca. 1000 h on 27 July 2006, GK observed a 23 cm carapace length male *G. polyphemus* between the North-South railroad tracks on the eastern boundary of Savannas Preserve State Park (SPSP) in St. Lucie County, Florida (Fig. 1). The tortoise seemed uninjured, but was deceased. Eastern Box Turtles (*Terrapene carolina*) were recently shown to have great difficulty escaping railroad tracks, with overheating to critical levels likely to occur in 4.5–5 h (Kornilev et al. 2006. Herpetol. Rev. 37:145–148). Similarly, the most logical explanation for the Gopher Tortoise death would be entrapment between the tracks, followed by critical overheating and/or dehydration (high and average temperatures for the previous day had been ca 31°C and 28°C, respectively). Recent re-contouring of the railroad track right-of-way corridor with crushed rock had coincidentally created "ramps" (Fig. 2) increasing the feasibility for tortoises to scale the track rail to reach the interior portion of the tracks. Alternatively, access to the interior of the tracks could have been accomplished at the crossing intersection at nearby Walton Road, 186 m south of where the carcass was found, with the tortoise continuing to move along the tracks, instead of escaping by retracing its route. Turtle species with superior climbing abilities to *G. polyphemus* might be more able to escape entrapment between the 19 cm high rails (if they are of sufficient size). For example, Engeman (*in press*, J. Kansas Herpetol.) observed a 33 cm carapace-length *Apalone spinifera* climb a series of 14 stairs, each 18–19 cm high, indicating that such an individual might be able to escape the railroad tracks.



FIG. 1. Deceased *Gopherus polyphemus* found between railroad tracks at Savannas Preserve State Park, Florida. Photo by G. Kaufmann.



FIG. 2. View of tracks showing re-contouring of right-of-way with crushed rock, possibly allowing easier access to the interior of the tracks by *G. polyphemus.* Photo by G. Kaufmann.

Tortoises are subject to a variety of anthropogenic sources of mortality, with collisions with vehicles the most apparent for *G. polyphemus* in southeastern Florida State Parks (HTS, pers. obs.). Vehicles have likewise been well-documented as hazards for the related *G. berlandieri* (Engeman et al. 2004. Herpetol. Rev. 35:54–55), and *G. agassizii* (e.g., Boarman and Sazaki 1996. *In* Evink et al. [eds.], Trends in Addressing Transportation Related Wildlife Mortality, pp. 179–184. State of Florida Dept. Transportation, Tallahassee, Florida; Luckenbach 1982. *In* Bury [ed.], North American Tortoises: Conservation and Ecology, pp. 1–38. USFWS Wildl. Res. Rpt. 12). Additional causes of anthropogenic mortality for *Gopherus* spp. have included entanglement in wire fences (Engeman et al. 2004, *op. cit*.), although we have not detected this for *G. polyphemus* during fenceline searches in nearby Jonathan Dickinson State Park. Similarly, numerous patrols down the SPSP track corridor since Jan 2004 have not identified railroad related tortoise mortality prior to this observation. Therefore, we speculate that the re-contouring of the railroad track right-of-way may

have had made track entrance more likely for *G. polyphemus*.

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HYDROMEDUSA TECTIFERA (South American Snake-necked Turtle). **COPULATION**. The freshwater chelid turtle *Hydromedusa tectifera* is distributed in rivers and streams of northeastern Argentina, Paraguay, eastern and southeastern Brazil, and part of Uruguay (Cei 1993. Mus. Reg. Sci. Nat. Torino Monogr. 14). The province of Córdoba (central Argentina) is home to a population that is isolated from the species' core distribution area and inhabits streams in the central region of the Sierras (Cabrera 1998. Las Tortugas Continentales de Sudamérica Austral. Privately printed, Córdoba, Argentina. 108 pp.). We report three observations of copulation of this species in two streams in Córdoba. In all observations, males were on top of females, grabbing them with the front and rear claws by the carapace edge, and continuously biting the central region of the neck. Males folded the tail to have it closer to the tail of the female. Copulation lasted less than 60 minutes on all three occasions. After copulation, the male released the female, which then swam rapidly away. The first copulation was observed at 2100 h on 11 October 2005 (spring) in Toro Muerto stream (31°23.5'S, 64°35.8'W). The specimens (carapace length 243 mm, male; 257 mm, female) were submerged at a depth of 40 cm, in a river section with sandy substrate, at a water temperature of 16.5°C and air temperature of 10°C. On 4 August 2006 (winter), we made a second observation, at 2015 h in Toro Muerto stream (31°22.7'S, 64°36.3'W). The specimens (carapace length 264.6 mm, male; 256.9 mm, female) were submerged at a depth of 30 cm, on a rocky, well vegetated substrate. Water temperature was 9°C and air temperature 3.5°C. The third observation was made in Tanti stream (31°21.2'S; 64°33.9'W) at 1920 h on 5 September 2006 (winter). The specimens (carapace length 240 mm, male; 251.2 mm, female) were submerged at a depth of 90 cm, on a rocky bed with sand and submerged aquatic vegetation. Water and air temperatures were 17°C and 20°C, respectively. *Hydromedusa tectifera* is one of the least documented reptile species in Argentina, especially concerning aspects of its ecology. This is apparently the first description of copulation of this species in the wild.

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KINOSTERNON SCORPIOIDES (Scorpion Mud Turtle). **BEHAVIOR.** Semiaquatic mud turtles (genus *Kinosternon*) are broadly distributed in a variety of habitats from eastern North America to northern Argentina. The southern two-thirds of this range is occupied by its largest member, *Kinosternon scorpioides*, of which various regional subspecies have been described based upon head and plastron coloration, extent of carination of the carapace, plastral seam ratios, and adult size (Ernst and Barbour 1989. Turtles of the World. Smithsonian Inst. Press, Washington DC. 313 pp.). The natural history of this species is not well known; its penchant for turbid shallow water, including anthropogenic habitats, outside of rain forests in northern South America is noted in the most exhaustive account of the species to date (Pritchard and Trebbau 1984. The Turtles of Venezuela. SSAR Contrib. Herpetol. No. 2, 403 pp. + 47 color plates + 16 maps).

On 11 November 1999 six specimens of *K. scorpioides* were found in a roadside pool and in a roadside ditch between Mariscal Estigarribia, Depto. Boquerón, and Parque Nacional Defensores del Chaco, Dept. Alto Paraguay, Paraguay. The GPS coordinates are 21°29'885"S, 59°52'736"W and 21°11'184"S, 59°45'188"W. The first individual was seen from a moving vehicle as it sat motionless, possibly basking, on the far embankment of the pool at 1115 h. Seconds later, upon my approach, the turtle moved quickly upwards, away from the water, towards the dense, spiny vegetation locally known as "chañar" consisting of various species of *Bromelia*, *Dyckia*, and *Aechmea*. More than 2 h later, in a roadside ditch stretching to the horizon, movement seen from the vehicle prompted investigation. Within 2 minutes, three searchers found 5 *K. scorpioides* (2 males, 2 females, 1 juvenile) in water no deeper than 30 cm. As they were pursued, two of the turtles emerged from the water body, climbed the embankment, and moved towards the adjacent chañar. The larger male and one female bore several ticks in the soft parts of their anterior portions, whereas the juvenile's carapace had a dense growth of algae.

There appear to be few literature records of aquatic turtles (i.e., those known to largely live and feed in aquatic habitats) purposely seeking immediate refuge away from the water. In this case, the spiny vegetation may have offered better protection from predators than did the open, shallow water.

Terrestrial refugia are apparently used by non-estivating aquatic chelonians elswhere in the Gran Chaco, in most of which there is no permanent surface water. In January 1987 and 1988, 7 of 26 specimens of *Acanthochelys pallidipectoris* were found beneath broad leaves of living bromeliads on dry land during the rainy season in nearby northern Argentina, in the vicinity of abundant, seasonal shallow bodies of water (Monguillot and Fabius 1993. Bol. Soc. Zool. Uruguay 2nda época 8:196–203). The seeking of terrestrial refugia (rather than nearer aquatic habitat) upon release by the third species of non-terrestrial chelonian in the region, *A. macrocephala,* following capture in shallow water has been recently documented by Métrailler (2006. Manouria 9[33]:26–32). This observation took place in February 2002.

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LEPIDOCHELYS KEMPII (Kemp's Ridley Seaturtle). **DEVELOPMENTAL HABITAT**. Kemp's Ridley Seaturtle is unique because it nests primarily on a single beach in Tamaulipas, Mexico (Rancho Nuevo), and it nests during the day in large groups called

arribadas. Unfortunately, the population was severely reduced by the 1960s from intense egg harvesting and further reduced by the 1980s because of incidental capture in commercial fishing gear (Márquez-M. et al. 2005. Chelon. Conserv. Biol. 4[4]:761–766).

Studies describing the coastal developmental habitats of hatchling and juvenile Kemp's Ridley Seaturtles are important to scientists, conservationists, and resource managers for drafting sound recovery plans. A newly discovered developmental habitat has recently been described in Gullivan Bay, Ten Thousand Islands, southwestern Florida, USA (Witzell and Schmid 2004. Gulf Mexico Sci. 22:54–61; see also Schmid and Barichivich 2005. Chelon. Conserv. Biol. 4[4]:828–834). This area is centered just north of the Everglades National Park boundary. After the original turtle research was completed in Gullivan Bay, a visual survey was conducted southwards through the Everglades Park because tagging data suggested that the Gullivan Bay turtles were possibly transient.

The survey was conducted from December 2003 to August 2004. Each survey consisted of five individual days and was conducted bimonthly from a 7.6-m flat-bottom commercial fishing vessel. Each day typically lasted from 0700 h to 1600 h with two persons in the vessel at all times looking for turtles. We moved southwards from the village of Goodland through Gullivan Bay into the Everglades National Park, stopping in likely places and waiting for Ridleys to surface to breathe. We stayed within 1 km of the shore and frequently stopped at passes between islands where ridleys often congregate and waited at least 4–6 h before moving southwards to a new location. It was impossible to synoptically survey the entire area because stormy weather conditions frequently dictated where we could safely go. All sightings were recorded using a portable global positioning system (GPS).

There were 92 immature Ridley, 24 Loggerhead (*Caretta caretta*), 2 Green (*Chelonia mydas*), and 2 unknown turtle sightings recorded. Because of the possibility of duplicate sightings, these figures do not represent an actual turtle census, but they do indicate that Ridleys are utilizing this entire coast as developmental habitat. Turtles were seen on each survey in sea surface temperatures ranging from 17.3°C in December to 31.1°C in August. The sightings extended from Gullivan Bay to Lostmans River, a distance of approximately 68.6 km (Fig. 1). We were not able to safely travel beyond this point in this particular vessel so we do not know if Ridleys inhabit the waters further south in the Park. Immature Kemp's Ridleys were sometimes seen in small groups of 2–3 individuals but never consistently in the same locations, and no particular area seemed to consistently be more productive than other areas. This indicates possible movement throughout the entire area as they feed. There were proportionately more sightings in the north because we traveled through this area more often as we moved southward from Gullivan Bay (Fig. 1).

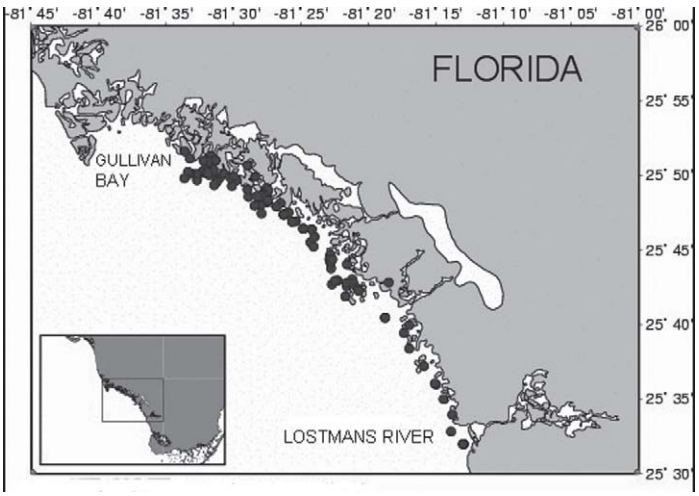


FIG. 1. Sightings of immature Kemp's Ridley Seaturtles from Gullivan Bay to Lostmans River, Ten Thousand Islands, Southwest Florida.

This stretch of Florida coast is the largest developmental habitat for immature Kemp's Ridley turtles discovered to date (76 km including Gullivan Bay). This habitat remained hidden until now because the area is remote and because there is little opportunity for turtles to be impacted by human activities (e.g., commercial fishing or channel dredging). Additionally, the coastline is not conducive for turtle strandings to be found due to the dense mangrove habitat, so the presence of these turtles remained unknown to sea turtle researchers until now. The other developmental habitats reviewed by Witzell and Schmid (*op. cit.*) are all important for the continued expansion of the population but they are relatively insignificant in size and possibly importance compared to the potentially huge habitat of the Ten Thousand Islands along the southwestern tip of Florida. This area will become more important as the population continues to rebuild and it is critical that it remain as pristine and undisturbed as possible. Fortunately, this area is protected from commercial fishing and coastal development by the Everglades National Park and it is suggested that National Park personnel be involved in the Kemp's Ridley Recovery Team as they draft a new Recovery Plan.

I thank the many volunteers from the National Marine Fisheries Service Laboratory in Miami who participated in the survey, M. Finn for logistical support, and to SEATURTLE.ORG for providing the Maptool graphics program.

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MACROCHELYS TEMMINCKII (Alligator Snapping Turtle). **TERRESTRIAL REFUGIUM.** With the exception of nesting, *Macrochelys temminckii* has rarely been reported leaving the water (Ernst et al. 1994. Turtles of the United States and Canada. Smithsonian Inst. Press, Washington, D.C., 578 pp.; Ewert 1976. Herpetologica 32:150–156). The few reported occurrences have been described as basking attempts (Ewert 1976, *op. cit.*; Farr et al. 2005. Herpetol. Rev. 36:168; Shelby and Jensen 2002. Herpetol. Rev. 33:304). On 7 July 2006 at 1251 h in the East Fork of Cadron Creek, Arkansas (USA), a male *M. temminckii* (354 mm carapace length, 309 mm carapace width) was located out of the water. This turtle was part of an ongoing telemetry project and was located every 3–5 days prior to and after the aforementioned observation. Between 2 July (previous location) and 7 July 2006, the turtle left the water and entered an exposed beaver den within the bank of the stream. The opening to the burrow was located under a large maple tree (*Acer* sp.) and was ca. 200 mm from the water. The

TABLE 1. Air, stream, and burrow temperatures for a *Macrochelys temminckii* refugium. All values are mean ± SD. Statistical differences, determined by a Tukey test, are indicated by letters.

	Air Temperature (°C)	Stream Temperature (°C)	Burrow Temperature (°C)
Mean	26.3 ± 3.6 [A]	25.7 ± 0.7 [B]	21.8 ± 0.5 [C]
Maximum	40.7	26.7	22.8
Minimum	17.3	24.1	20.3

entrance to the burrow was 450 mm in width and 250 mm in height. The burrow depth and width was unknown, but the turtle was located ca. 3 m from the burrow entrance using a long pole. Within 300 mm of the entrance, the burrow angled upward at ca. 30°. Humidity was high enough within the burrow to cause droplets of water to form on overhanging roots and the substrate was slightly muddy. On first location of the turtle (7 July 2006), the burrow temperature was 4.5°C cooler than the stream temperature.

On 17 July 2006, the turtle was still within the burrow. At this time a temperature sensitive data logger was launched and placed within the burrow ca. 3 m from the burrow entrance, directly next to the turtle. In addition, a temperature sensitive data logger was launched and placed directly outside of the burrow to record air temperature and another was placed in the stream (1 m in depth and ca. 2 m from the burrow entrance).

Between 9 August and 15 August 2006, the turtle left the burrow. On 15 August 2006 the turtle was located in the water ca. 20 m from the burrow entrance. The turtle had remained in the burrow for 33–44 days. A summary of the data collected during this time are shown in Table 1.

It is believed that the turtle was using the burrow as a form of refuge from the unfavorable conditions within the stream (e.g., high temperatures, shallow waters, and open canopy). Riedle et al. (2006. Southwest. Nat. 51:35–40) also reported *M. temminckii* using beaver dens and lodges within the stream, but did not determine if these turtles were completely submerged within the water or were perhaps above water level. A female *M. temminckii* was also found to use a beaver den within the bank of the stream during this study, but it was believed that this turtle was below the water level at the reported time. This female remained in the burrow from 27 May 2006 to 17 July 2006. During this time, the same burrow was occupied twice by one other female.

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STERNOTHERUS ODORATUS (Stinkpot). **MORPHOLOGY**. During amphibian surveys on 14 April 2005 at 2000 h, a kyphotic adult female Stinkpot (Fig. 1) was observed resting on the bottom of the north end of Manlove Lake in northern Fayette County, Indiana, USA, at a depth of ca. 50 cm. This was the only Stinkpot observed during three nights (ca. 6 h) of shallow-water surveys in April 2005. She was captured by hand, measured (maximum carapace length 93 mm, maximum carapace width 73 mm, maximum carapace height 60 mm, maximum plastron length 78 mm),



FIG. 1. Kyphotic adult female *Sternotherus odoratus* from Indiana.

euthanized by freezing, dissected for reproductive data (seven 14 mm preovulatory follicles plus eight 8–10 mm secondary follicles present, suggesting two potential clutches), preserved in fixative, and deposited in the Florida Museum of Natural History (UF 150163). This is the only kyphotic Stinkpot observed among approximately 1000 captures in Indiana (e.g., see Smith and Iverson 2002. Amer. Midl. Nat. 148:185–189). Kyphosis in *S. odoratus* has previously been reported by Hartweg (in Nixon and Smith 1949. Turtox News 27:28–29) but without any details. In addition, Saumure (2001. Chelon. Conserv. Biol. 4:159) reported a kyphotic adult male from Ontario, Canada in 1984. Osteopathologic study of this most recent specimen might shed light on the cause of this rare phenomenon in turtles (reviewed by Saumure 2001, *op. cit.*). This turtle was collected under a Scientific Research Permit issued by the Indiana Department of Natural Resources.

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TERRAPENE CAROLINA (Eastern Box Turtle). **THREATS.** On 9 June 2005 at 1435 h an adult male *Terrapene carolina* was observed (TPC) consuming a red paintball. The turtle appeared to have broken the paintball open and was consuming the liquid paint inside. The specimen was held for two hours, during which time it appeared normally active. It was then released. The site of this observation was at a recreational paintball facility in a forested area of the coastal plain of southeastern Virginia. Further observations in the area revealed numerous unspent and spent paintballs of many colors including; orange, red, pale green, bright green, blue and purple. No other box turtles were observed in the area at this time.

Terrapene carolina is omnivorous, selecting a wide array of food items (Ernst et al. 1994. Turtles of the United States and Canada. Smithsonian Inst. Press, Washington, DC). Braun and Brooks (1987. Amer. Midl. Nat. 117:312–318) observed that color of fruits eaten by box turtles varied widely and included red, yellow, blue,

purple, and black, essentially the same colors as paintballs. Items documented in the diet of *T. carolina* that might resemble a paintball include blackberries (*Rubus* sp.), mayapples (*Podophyllum peltatum*), blueberries (*Vaccinium* sp.), grapes (*Vitis* sp.), wild strawberries (*Fragaria virginiana*), and black cherries (*Prunus serotina*) (Mitchell 1994. The Reptiles of Virginia. Smithsonian Inst. Press., Washington, DC). In addition, Ernst et al. (1994 , *op. cit.*) note that they also consume plums, tomatoes, and ground cherries. These fruits are similar in size, texture, color, and/or shape, to a paintball.

The ingredients of paintballs vary according to manufacturer and may include polyethylene glycol, glycerol (glycerin), gelatin, sorbitol, dipropyleneglycol, mineral oil, dye, ground pig skin, and water (Donaldson 2003. Veterinary Medicine 98:995–997). There is little information on the potential effects of some of these ingredients on reptiles, but Donaldson (2003, *op. cit.*) reviewed cases of ingestion by dogs and noted vomiting, ataxia, diarrhea, tachycardia, blindness, seizures, and tremors, among other symptoms. In two cases the dogs were euthanized because their central nervous system signs did not respond to treatment. Therefore, it is possible that consumption of paintballs could be harmful to turtles and/or other reptiles and wildlife. This observation adds to the growing body of literature on reptiles negatively interacting with litter, recently reviewed by Walde et al. (2007. West. N. Am. Nat. 67:147–149). Although box turtles remain locally common in Virginia, many are lost each year to road mortality and collection as pets, and populations generally are in decline because of habitat destruction and fragmentation (Mitchell 1994, *op. cit.*).

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TRACHEMYS DORBIGNI (Brazilian Slider). **DIET.** Juveniles of *Trachemys dorbigni* feed on insects and aquatic vegetation, while adults are predominately carnivores (Gallardo 1977. Reptiles de los Alrededores de Buenos Aires. EUDEBA/Lectores, Bs. As. 213 pp.; Gallardo 1982. Anales de Parques Nacionales 15:65–75) or opportunists (Cabrera 1998. Las Tortugas Continentales de Sudamerica. Edic. Indep., Córdoba. 108 pp.). An opportunist grazer generally feeds on the most available and abundant food resource (Holland 1985. Herpetol. Rev. 16:112–113). Here we report *Trachemys dorbigni* feeding on *Limnoperna fortunei* (Golden Mussel), a bivalve native to Southeast Asia and introduced in the Delta do Jacuí region (Rio Grande do Sul, Brazil), in the 1970s (Mansur et al. 2002 Rev. Bras. Zool. 20[1]:75–84). *Limnoperna fortunei* exhibits a fast life cycle, with rapid sexual maturation and the capability for rapid dispersal. Additionally, it displays gregarious behavior, apparently lacks natural predators in the region, and, as an invasive species, is considered a major cause of the loss of biological diversity where it has been introduced (Ziller 2006. *In* http://www.sobrade.com.br/textos/trabalhos.htm. acc. 200610-13). Golden Mussels can cause the extinction of native bivalve species, death of macrophytes by root suffocation, modification of the planktonic community, increase in fish fragility, and economic damage (e.g., clogging of pipes in urban water systems in the vicinity of the delta) (Neves et al. 1997. *In* Benz and Collins [eds.], Aquatic Fauna in Peril: The Southeastern Perspective, pp. 43–85. Southeast Aquatic Research Institut. Spec. Publ. 1, 554 pp.).

We observed the feeding habits of *T. dorbigni* from September 2004 to March 2005, while working on the Chelonia-RS Project (long-term research about biology and conservation of freshwater turtles in southern Brazil), in the State Park of Delta do Jacuí (29°53'–30°03'S, and 51°28'–51°13'W – Rio Grande do Sul State, Brazil). Observations occurred at fixed sites on the margin of a silt canal (Pintada Island) heavily impacted by human activities. To facilitate fecal analysis, eight turtles (4 males and 4 females) were captured in baited traps and placed individually in plastic buckets with clean water. These animals were kept in the buckets for a maximum of 24 h to allow collection of fresh feces and then returned to the capture site. Fecal matter was isolated by filtration, fixed in 70% alcohol, and separated and analyzed using a dissecting microscope.

Brazilian Sliders will feed on sessile mollusks attached to dock pilings, as well as on those attached to ship's hulls. To remove the prey from the substrate, a turtle places the anterior limbs on the mollusk mass, and stabilizes its position with the posterior limbs. At the same time, it engulfs a mollusk shell in its mouth and retracts its head inside the carapace, breaking the mollusk from its attachment point. This predation appeared to target the Golden Mussel, as the species was present in all samples. Fecal analyses supported the visual observation of predation on the Golden Mussel, and showed that the animals also feed on native gastropods (Family Hydrobiidae), *Trichodactylus* sp. (Crustacea), plant material (Poacea, Angiospermae), and also ingest sand and synthetic material (fish line).

These results demonstrate the importance of *Trachemys dorbigni* as a potential biological regulator of *Limnoperma fortunei*.

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TRACHEMYS DORBIGNYI (Brazilian Slider). **HATCHLING OVERWINTERING**. Turtles have evolved diverse strategies to maximize the success of incubation and the survival of hatchlings. In some species, hatchlings may postpone emergence from the nest after hatching, at times overwintering below ground and emerging in spring. This habit is known for several species of emydid turtles, including species of *Trachemys* from the northern hemisphere (Aresco 2004. J. Herpetol. 38:249–256; Tucker and Paukstis 1999. J. Herpetol. 33:608–615). Here we report the first known occurrence of this behavior for *Trachemys dorbignyi*, the most southerly distributed species of the genus.

Sampling over 13 years in southern Brazil had demonstrated that *T. dorbignyi* nest between the months of October and January

(Spring and Summer) (Bager 2007. Herpetologica. In press), and have an incubation period of approximately 95 days. All nest monitoring to date suggested that hatchlings leave the nests soon after hatching.

A *T. dorbignyi* nest was found opportunistically on 19 September 2006 (spring) when we were monitoring a nesting area in southern Rio Grande do Sul State - Brazil (UTM 22J x = 0370303mE; y = 6484280mN). The nest, constructed in argillo-arenaceous soil, had a narrow opening to the surface, presumably made by hatchlings which had left the nest previously. Four living hatchlings and egg shells, but no dead hatchlings or infertile eggs, were found. The hatchlings had lost the caruncle ("egg tooth"), and the abdominal yolk scar was totally closed, indicating a long post-hatching period. This observation was deemed an unusual instance of overwintering, as the majority of slider hatchlings in this area leave the nests immediately after total absorption of the residual yolk, still possessing a caruncle and with clear separation between the abdominal scutes at the yolk scar.

The hatchlings had an average maximum carapace length of 32.0 ± 2.2 mm (N = 4) and average 13.5 ± 0.6mm (N = 4) carapace height. These hatchlings were smaller than those measured in other localities in southern Brazil (average carapace length = 35.1 ± 1.3m; average carapace height = 16.8 ± 0.7mm [N = 77], unpubl. data).

Considering the latest nesting date known for the species in this region (10 January), hatching would usually occur by late April or early May (Autumn). In this area the lowest winter temperature does not reach the freezing point; average low temperature during July (coldest month) is 12.3°C (range 11–13.6°C). Considering that this species occurs in northern Argentina, where winter temperatures can fall below 0°C, future studies could determine if the hatchlings in the nest are tolerant of freezing temperatures.

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FIG. 1. Top: Dorsal view of carapace depicting large yellow blotches on the first two pleural scutes and thick yellow ring around the marginal scutes. Bottom: Anterior view showing absence of dark green skin with black and yellow stripes replaced by yellow broken up by thin black stripes and narrow red bridge across the snout between the eyes.

TRACHEMYS SCRIPTA ELEGANS (Red-eared Slider). **COLORATION**. A turtle captured alive in Lake Springfield in Springfield, Illinois, USA, on 21 August 2005, displayed an unusual color pattern morph. UTM coordinates are as follows using NAD27CONUS map datum in zone 16: N 0257716m, E 4429578m. The turtle is a female with the following physical measurements: carapace length = 166 mm, carapace width = 127 mm, carapace height = 63 mm, plastron length = 155 mm; total mass = 700 g. The turtle has an unusually high density of yellow pigment on the carapace, head, legs and tail. This is the only turtle discovered out of several thousand turtles captured to display these particular characteristics in our trapping in Illinois. Yellow pigment formed a thick ring around the outer carapace margin and formed dense blotches on the first two pleural scutes on both the right and left side with yellow comprising greater than half the area of the scute. In addition, the head, tail and legs lack the typical dark green with black and yellow stripes, which instead are all yellow separated by thin black stripes. The characteristic red patch is present behind the eye, along with a thin red stripe running horizontally across the snout. Similar color variations in wild *T. scripta* have been reported (Cagle 1947. Nat. Hist. Misc. 6:1–3; Tucker et al. 1995. Bull. Chicago Herpetol. Soc. 30[7]:148–149), as well as for *Chrysemys picta* (Harding 1982. Herpetol. Rev. 13:19).

The color pattern on this turtle is consistent with some of the so-called "pastel" color morph Red-eared Sliders which are commonly offered in the pet trade industry. Because Lake Springfield is highly accessible to the public and located within an urban area, it is plausible that a "pastel" Red-eared Slider was introduced here. However, because these pigmentation anomalies can occur under natural conditions, there is no way to be certain of this turtle's origin. The turtle was photographed, marked, and released.

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TRACHEMYS SCRIPTA (Red-eared Slider Turtle). **PREDATION**. Predation on waterfowl and other birds by Common Snapping Turtles (*Chelydra serpentina*) is well known, but avian predation by other aquatic turtles is rarely reported (Pryor 1996. Wilson Bull. 108:190–192; Ernst et al. 1994. Turtles of the United States and Canada, Smithsonian Inst. Press, Washington, DC). Here I report an observation of predation of an adult passerine by aquatic emydid turtles.

At approximately 1400 h on 31 May 2002, an agonistic encounter was observed between two adult male Red-winged Blackbirds (*Agelaius phoeniceus*) on the surface of a small pond in Greer County, Oklahoma (USA). While viewing the dispute through field glasses, three adult Red-eared Sliders (*Trachemys scripta elegans*) were observed swimming toward the two birds. When the turtles got within approximately 3 m, one of the birds flew away. The second bird stayed on the surface of the water with wings spread and beak agape, apparently exhausted. A third male Red-winged Blackbird attacked the water-bound male, but retreated almost immediately, perhaps noticing the turtles nearby. After the second aggressor retreated, all three turtles disappeared beneath the water, and seconds later the remaining blackbird disappeared as well. An incomplete bird carcass floated back to the surface less than a minute after being pulled under water, and the turtles were not observed again.

With the exception of waterfowl, predation of adult birds by turtles is apparently an unusual and opportunistic event. The fact that three turtles were involved likely does not necessarily suggest cooperation, but is perhaps an indication of the high densities of Red-eared Sliders in this and other nearby ponds

I thank Joy Yoshioka and Wesley Webb for assistance in the field, and Oklahoma Department of Corrections for access to the ponds where the above observations were made.

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TRACHEMYS SCRIPTA ELEGANS (Red-eared Slider). **KYPHOSIS**. Turtle research at the Great Rivers Field Station of the Illinois Natural History Survey has resulted in the capture of more than 25,000 individual Red-eared Sliders (*Trachemys scripta elegans*) in west-central Illinois and neighboring Missouri. These turtles have included a number of specimens with unusual carapace morphologies that likely represent extremes in range of morphologies for turtle shells, including kyphotic individuals (Tucker 1997. Bull. Md. Herpetol. Soc. 33:171–177). Most kyphotic turtles have the highest point on the carapace located at vertebral scute two or three on the front half or middle of the carapace (e.g., Plymale et al. 1978. Southwest. Natur. 23:457–462; Rhodin et al. 1984. Brit. J. Herpetol. 6:369–373; Stuart 1996. Bull. Chicago Herpetol. Soc. 31:60–61), but see Fig. 1, an unusual four-year old male. Our large sample sizes allow a robust estimate of the frequency with which kyphosis occurs in this slider population.

Kyphosis in naturally occurring sliders is apparently rare. We found 14 turtles (0.06%) that we identified as kyphotic among 21,786 turtles captured in Calhoun and Jersey Counties in Illinois between 1994 and 2006. Males (N = 8) and females (N= 6) were equally likely to be kyphotic ($\chi^2 = 0.29$, 1df, $P = 0.5830$). Kyphosis seems to be uncommon in other turtles as well but the rate of occurrence varies considerably. Five of 929 (0.5%) Lancaster County, Pennsylvania Painted Turtles (*Chrysemys picta*, Ernst 1971. J. Herpetol. 5:216–220) were kyphotic. Stuart (*op. cit.*) found a single kyphotic Western Painted Turtle (*Chrysemys picta belli*) among 429 total captures (0.23% of sample). A single Spotted Turtle (*Clemmys guttata*, Ernst 1976. J. Herpetol. 10:25–33) among 207 (0.5%) examined was kyphotic. Spinal deformities occur in sea turtles at a low rate. Only 0.03% of more than 11,000 turtles of five species were kyphotic (Rhodin et al., *op. cit.*).

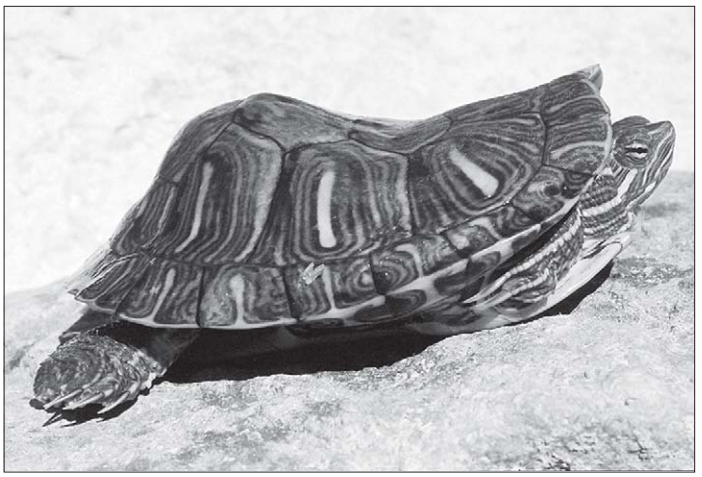


FIG. 1. An unusually shaped Red-eared Slider (*Trachemys scripta elegans*) juvenile male collected at Long Lake, Jersey County, west-central Illinois.

Despite the frequency with which kyphotic turtles have been reported in the literature, virtually nothing is known of the etiology of the condition. Various hypotheses have been advanced from problems with yolk retraction (Williams 1957. Herpetologica 13:236) to premature fusion of the shell (see Stuart, *op. cit.* and Saumure 2001. Chelonian Conserv. Biol. 4:159 for recent reviews). Only experimental manipulation will lead to an understanding of the basis for kyphosis. Such experiments will be difficult given the apparent rarity of the condition. It is, however, important to record the frequency of occurrence of kyphosis in various species of turtles because variation in rates of occurrence may shed light on the cause of the condition and the effect on individual turtles. Thus, the relatively high rate (2.6%) of kyphosis in a small sample of Common Musk Turtles (*Sternotherus odoratus*, Saumure, *op. cit.*) may be noteworthy or simply reflect the small sample studied (N = 39). The variation in rate of occurrence (0.03–2.6%) reported here further underscores the need for data on large samples from more species. It may be that smaller turtles (*C. picta, C. guttata*, and *S. odoratus*) are more likely to exhibit kyphosis than are larger turtles (*T. scripta* and sea turtles). Rate of occurrence among the small-bodied turtles is roughly 10 times that for larger-bodied species (0.23% to 2.6% versus 0.03% to 0.06%, respectively). Perhaps yolk retraction is more difficult among smaller turtle hatchlings or errors in shell development have more profound effects in small turtles. Any hypothesis, however, is premature until more species are studied.

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CROCODYLIA

CROCODYLUS INTERMEDIUS (Orinoco Crocodile). **JUVENILE FEEDING.** *Crocodylus intermedius* is one of the most critically endangered crocodilians (Rodríguez and Rojas 2003. Libro Rojo de la Fauna Venezolana, IUCN. 2nd. ed, Fundación Polar/PROVITA, Caracas. 472 pp.). It occurs in the Orinoco River Basin in Venezuela, and has been the focus of captive breeding and habitat protection policies (Thorbjarnarson 1988. Proc. World Conf. Breeding Endangered Species Captivity 5:307–314). Few data exist on the feeding behavior of juvenile crocodiles (*Crocodylus acutus* [Thorbjarnarson 1989. *In* Hall (ed.), Crocodiles: Their Ecology, Management and Conservation, pp. 228–258. A Special Publication of the Crocodile Specialist Group IUCN/SSC. Gland, Switzerland]; *C. johnstoni* [Webb et al. 1982. Aust. J. Zool. 30:877–899]; *C. niloticus* [Games 1990. *In:*Proc. Ninth Working Meeting Crocodile Specialist Group. Vol. 1, pp. 251–267. IUCN. Gland, Switzerland]; *C. porosus* [Taylor 1979. Aust. Wildl. Res. 6:347–359; Davenport et al. 1990. J. Zool. Lond. 220:569–592]), but no published data exist on the feeding behavior of juvenile *C. intermedius*. Hence, here I report an observation of juvenile *C. intermedius* feeding.

I made the observation at Fundo Pecuario Masaguaral, a cattle ranch with a crocodile farm (Blohm 1982. *In* Proc. Fifth Working Meeting IUCN/SSC Crocodile Specialist Group, pp. 267–285. Gland, Switzerland) in State of Guárico in the Central Llanos of Venezuela (8°34'N, 67°35'W; elev. 60–75 m). The Central Llanos are lowlands (below 75 m elevation) with a well-defined wet season (May–Nov) dominated by open grasslands interspersed with deciduous forests (Troth 1979. *In* J. Eisenberg [ed.], Vertebrate Ecology in the Northern Neotropics, pp.17–30. Smithsonian Inst. Press, Washington, DC). At 2000 h (at night), I encountered a juvenile *C. intermedius* (ca. 2.5 months old, 38 cm total length) holding an adult dead male *Bufo granulosus* (ca. 4.5 cm SVL) with its jaws in a water-filled truck track ca. 9 cm deep on an unpaved road. The juvenile *C. intermedius* was in the water, with only its head above the surface, holding the dead toad with its jaws, which first I noticed when I captured the juvenile. The toad was flaccid, belly down, head inward, body axis almost parallel to the *C. intermedius*' jaws axis, with only the toad's hind legs being visible outside the crocodile's jaws. The juvenile *C. intermedius* discarded the toad following capture, presumably because it has been disturbed.

Bufo granulosus males usually call from the ground around puddles (Hoogmoed and Gorzula 1979. Zool. Mededelingen 54:183–216), so the male *Bufo* may have been vocalizing. The juvenile *C. intermedius* escaped from an enclosure two months before this observation was made but displayed no signs of injury or starvation, suggesting that it was feeding regularly on its own. The juvenile was subsequently returned to its enclosure.

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SERPENTES

ALSOPHIS ANOMALUS (Hispaniolan Brown Racer). **MAXIMUM SIZE.** On 24 June 2006, at Fondo Paradí, Parque Nacional Jaragua, Pedernales Province, Dominican Republic, about 1.5 km from the main road to Pedernales (town) at 17°48'11.93"N, 71°26'49.47"W, the body of an *Alsophis anomalus* that had been killed by locals was found by Miguel Landestoy, Pedro Genaro Rodríguez, and Enrique Ureña. It had a total length of 2743 mm and a SVL of ca. 2000 mm, which exceeds by a substantial margin the maximum SVL (1770 mm) reported in Schwartz and Henderson (1991. Amphibians and Reptiles of the West Indies: Descriptions, Distributions, and Natural History. Univ. Florida Press, Gainesville. 720 pp.). This species is infrequently encountered despite a relatively extensive distribution on the western half of Hispaniola (Powell and Henderson 1998. Cat. Amer. Amphib. Rept. 659:1–2). Given that *A. anomalus* is the largest species in the genus, this specimen also constitutes a size record for the genus, for West Indian colubrids, and probably for any xenodontine colubrid (rivaled only by *Clelia clelia*). Total length of the specimen was

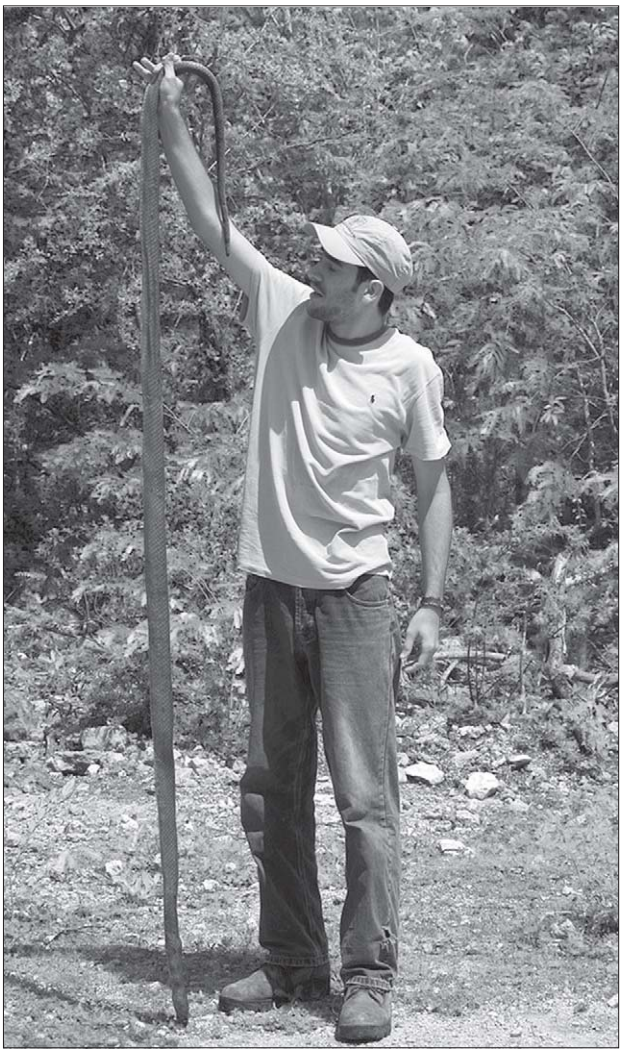


FIG. 1. *Alsophis anomalus* of record length. Miguel Landestoy, holding the snake, is 1855 mm (73 inches) tall. Photograph by Pedro Genaro Rodríguez.

measured in the field (Fig. 1). Although the specimen was easily identifiable, by the time it was recovered for preservation it could only be saved as a skeleton. It has been deposited in the University of Puerto Rico-Rio Piedras (UPRRP 6492).

We thank S. Blair Hedges, Jorge Brocca, Nicolas Corona, and Eladio Fernandez for facilitating recovery of the specimen.

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BOTHROPS MATTOGROSSENSIS (Mato Grosso Lancehead). **PREDATION**. *Bothrops mattogrossensis* is a terrestrial, medium-sized pitviper that inhabits open areas adjacent to semidecidual forests in seasonally flooded open plains (Martins et al. 2002. *In* Schuett et al. [eds.], Biology of the Vipers, pp. 307–328. Eagle Mountain Publishing, Eagle Mountain, Utah). On 21 Oct 2005 at ca. 0805 h, we found an adult *B. mattogrossensis* (ca. 70 cm SVL) being attacked by a *Buteogallus urubitinga* (Great Black Hawk) in a grassy field in the Brazilian Pantanal (19°27'10.5"S, 56°35'27.3"W, elev. 107 m), Mato Grosso do Sul State. The hawk gripped the pitviper by the head and, upon our approach, flew away to semideciduous forest carrying the snake in its talons. Raptors are important predators on reptiles; however, Burrowing Owls are the only published predators of *Bothrops* species (Martins et al. 2003. Herpetol. Rev. 34:147–148; Valdujo and Nogueira 2000. Herpetol. Rev. 31:45). Moreover, snakes are uncommon prey for *B. urubitinga*, which prey primarily on frogs and lizards, but also consume birds (Lewis and Timm 1991. Ornitologia Tropical 2:37).

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CONIOPHANES FISSIDENS (Brown Spotbelly). **REPRODUCTION.** *Coniophanes fissidens* is known from San Luis Potosí and Michoacán, Mexico through Central America to central Ecuador (Savage 2002. The Amphibian and Reptiles of Costa Rica: A Herpetofauna Between Two Continents, Between Two Seas. The University of Chicago Press. 934 pp.). Zug et al. (1979. Smithsonian Cont. Zool. 300:1–20) and Solorzáno (2004. Snakes of Costa Rica. Distribution, Taxonomy and Natural History, Instituto Nacional de Biodiversidad [INBio], Costa Rica, 791 pp.) reported on reproduction of female *C. fissidens*. The purpose of this note is to present the first information on the testicular cycle of *C. fissidens* from a histological examination of museum specimens.

Twelve *C. fissidens* (mean SVL = 299 mm ± 35 SD, range = 225–339 mm) from Costa Rica and Mexico were examined from the herpetology collection of the Natural History Museum of Los Angeles County, (LACM), Los Angeles, California. Snakes were collected during 1959–1985. Specimens examined by province (Costa Rica) and state (Mexico) were: Costa Rica: Cartago (LACM 150451, 150456, 150459, 150460); Heredia (150455, 150458); Puntarenas (150452–150454, 150466); Mexico: Chiapas (38179, 114063). The left testis and a portion of the vas deferens were removed for histological examination. Tissues were embedded in paraffin and histological sections were cut at 5 µm. Sections were mounted on glass slides and stained with Harris' hematoxylin followed by eosin counterstain. Slides were examined to determine the stage of the testicular cycle.

The testes of all males were undergoing spermiogenesis (= sperm formation). The lumina of the seminiferous tubules were lined by spermatozoa or several rows of metamorphosing spermatids. Monthly samples of spermiogenic males were: January (1), February (1), March (1), April (2), June (1), July (1), September (1), October (2), December (2). The vasa deferentia contained sperm. The smallest reproductively active male measured 251 mm (LACM 150454) and was collected in March. While samples were not available from all months, the presence of males undergoing spermiogenesis from most of the year indicates an extended period of spermiogenesis.

Other snakes from Costa Rica also exhibited extended periods of sperm formation: *Dendrophidion vinitor* (Goldberg 2003. Trans. Illinois State Acad. Sci. 96:295–300); *Drymobius margaritiferus* (Goldberg 2003. Texas J. Sci. 55:195–200); *Ninia maculata* (Goldberg 2004. Texas J. Sci. 56:81–84); *Erythrolamprus bizona*, *E. mimus* (Goldberg 2004. Texas J. Sci. 56:171–174); *Micrurus nigrocinctus* (Goldberg 2004. Carib. J. Sci. 40:420–422); *Hydromorphus concolor* (Goldberg 2006. Bull Maryland Herpetol. Soc. 42:169–170); *Geophis godmani* (Goldberg 2007. Bull Chicago Herpetol. Soc. 42:7–8). *Coniophanes fissidens* should be added to this group. Subsequent examinations of the testicular cycles of additional snake species are needed to determine the prevalence of prolonged periods of spermiogenesis in Central American snakes.

I thank Christine Thacker (LACM) for permission to examine snakes. Specimens from Costa Rica are part of the CRE collection donated to LACM by Jay M. Savage in 1998.

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CROTALUS CERASTES (Sidewinder). **ATTEMPTED FEEDING** and **MORTALITY**. The diet of *Crotalus cerastes* consists largely of lizards and rodents (Brown and Lillywhite 1992. *In* Campbell and Brodie, Jr. [eds.], Biology of the Pitvipers, pp. 279–308. Selva, Tyler, Texas; Funk 1965. Herpetologica 21:15–17). Antelope squirrels (*Ammospermophilus* sp.) are among the rodents that have been recorded as prey of *C. cerastes* (Funk, *op. cit.*). Moore (1978. Copeia 1978:439–442) suggested that only very large

C. cerastes were capable of feeding on White-tailed Antelope Squirrels (*A. leucurus*). Here, we document an instance of a *C. cerastes* attempting to ingest an *A. leucurus*, which resulted in the death of both animals.

On 2 April 2001, one of us (BC) found a pair of courting *C. cerastes* on the eastern edge of the Kelso Dunes in Mojave National Preserve, San Bernadino County, California, USA. The pair was captured and the female (567 mm SVL; 133 g) was implanted with a radio-transmitter, released, and tracked until 31 May 2001 (the end of the spring field season). During this period she moved an average of 4.8 m/day. On 28 August 2001 (the beginning of the autumn field season), the signal was again located. The snake was 157.4 m from her 31 May location and was below ground in a dune stabilized by Big Galleta Grass (*Pleuraphis rigida*). The signal remained stationary throughout the entire autumn and following spring field seasons. We excavated the dune on 21 May 2002 and discovered the mummified body of the snake with the remains of an *A. leucurus* in her mouth. The pair was lying on their backs in a burrow system about 20 cm from the nearest entrance. The head of the snake was twisted slightly to her left and her mouth held the antelope squirrel around the shoulder.

It is unclear exactly how the snake died, but it is possible that after engaging her teeth to begin feeding, she was constrained by the position of the squirrel in the burrow and was unable to either continue swallowing or release the prey item. In this scenario, the cause of death would either be starvation or suffocation. Alternatively, the burrow might have collapsed as a result of movements associated with feeding, resulting in suffocation. Both specimens are deposited in the Soda Springs Desert Studies Center, Zzyzx, California (*Crotalus cerastes*, SSDSC 59; *Ammospermophilus leucurus*, SSDSC 60).

We thank J. Patton, A. Brumbaugh, the Columbus Zoo, and Ohio State University for assistance.

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ELAPHE GUTTATA EMORYI (Great Plains Ratsnake). **DIET.** *Elaphe guttata emoryi* eats a wide variety of prey including rodents, ground nesting birds, and occasionally lizards (Werler and Dixon 2000. Texas Snakes: Identification, Distribution, and Natural History, University of Texas Press, Austin, Texas. 437 pp.). On 7 October 2006 (1100–1130 h) we collected an adult male *E. g. emoryi* (154 mm SVL, 72 mm TL, 124 g) under green briar vines in a live oak motte at Camp Bowie National Guard Training Facility (31°35'44.6"N, 098°53'58.7"W, 429 m elev.), Brown County, Texas, USA. The snake had an adult female *Sceloporus olivaceus* (103 mm SVL, 153 mm TL, 44 g) in its stomach that was consumed headfirst. The lizard and snake are deposited in the Angelo State Natural History Collection (ASNHC 14192-93), Angelo State University, San Angelo, Texas.

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MASTICOPHIS FLAGELLUM (Eastern Coachwhip). **REPRODUCTION**. The reproductive ecology of *Masticophis flagellum* in the northwestern Gulf Coastal Plain near the convergence of the borders of northeast Texas, southeast Oklahoma, southwest Arkansas, and northwest Louisiana is poorly understood. Two *M. flagellum* clutches from northern and central Arkansas contained 14 and 18 eggs (Trauth et al. 1994. Proc. Arkansas Acad. Sci. 48:196–209). Clutches from Oklahoma contained 7, 12, and 13 eggs, and were oviposited from early to mid-July (Carpenter 1958. Herpetologica 14:113–115). A single female (1160 mm SVL, 322 g) from Smith County, Texas laid a clutch of 11 eggs on 29 June 1988 (Ford et al. 1990. Texas J. Sci. 42:355–368). Eggs from that clutch were 4.47 (SD = 0.29) cm long, 2.33 (SD = 0.05) cm wide, and weighed 15.3 (SD = 9.61) g.

On 14 June 2006, a female *M. flagellum* (1154 mm SVL, 1484 mm TL, 465.2 g [mass taken prior to egg removal]) was recovered from a rubbish pile ca. 4 km from the Arkansas-Texas border along George Thomas Road (33.33098-N, 94.0852-W, elev. 129 m, Datum: NAD27) and ca. 0.75 km S of the junction of this road with Fricks Road in the Liberty Eylau region of Texarkana, Bowie County, Texas. The animal was placed in cool storage (2.5°C) until 15 June 2006 when it was removed for photography. After approximately 30 min at 30°C the animal was listless and its vent appeared dilated for oviposition. I placed the animal in a 40 L aquarium with a lid, water, and a terra cotta flower pot as a shelter. On 16 June 2006 at about 0830 h the specimen was found dead. Fourteen eggs were dissected from the abdominal cavity, weighed with an electronic balance, and measured using Vernier calipers. Mass of individual eggs (mean = 11.16 g, SE = 0.097) was not normally distributed (Anderson-Darling: $A^2 = 0.739$, $P = 0.041$), whereas length (mean = 37.88 mm, SE = 0.377; $A^2 = 0.213$, $P = 0.815$) and diameter (mean = 22.82 mm, SE = 0.213; $A^2 = 0.383$, $P = 0.347$) were normally distributed. Eggs had the following measurements based on their location in the oviduct: Cranial (N = 5): mean mass = 11.1 g (SE = 0.1), mean length = 36.5 mm (SE = 0.5), mean diameter = 22.9 mm (SE = 0.2); Middle (N = 5): mean mass = 11.3 g (SE = 0.22), mean length = 38.3 mm (SE = 0.5), mean diameter = 22.5 (SE = 0.2); Caudal (N = 4): mean mass = 11.1 g (SE = 0.2), mean length = 37.2 (SE = 1.0), mean diameter = 23.2 (SE = 0.7). Although the absolute mean dimensions of eggs located centrally in the reproductive tract seemed larger, the position of the eggs in the reproductive tract was not a significant indicator of an egg's mass (Kruskal-Wallace: $H = 1.09$, $df = 2$, $P = 0.580$), length (ANOVA: $F = 0.71$, $df = 13$, $P = 0.501$), or diameter (ANOVA: $F = 0.730$, $df = 13$, $P = 0.504$).

The timing of reproduction by this female mirrors observations in northeast Arkansas and southeast Oklahoma (Carpenter, *op. cit.*; Trauth et al., *op. cit.*) and is only two weeks earlier than observed in Smith County, Texas (Ford et al., *op. cit.*). The clutch size in this observation is identical to the observation from Smith County,

Texas, comparable to the observations from southeast Oklahoma, and smaller than that observed in northeast Arkansas. Mean egg mass in this clutch is nearly 4 g lighter than observed in Smith County, Texas, despite the fact that our female is only 6 mm smaller. After data collection, the eggs were held at ambient temperature and misted daily until signs of mold appeared accompanied by a foul odor (18 June 2006). At this time the eggs were fixed in 10% formalin and deposited in a private (MLM) teaching-research collection. This observation fills a geographical void in our knowledge of the reproductive biology of *M. flagellum* in this region.

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MASTICOPHIS SCHOTTI SCHOTTI (Schott's Whipsnake). **DIET.** Although documentation of the feeding habits of *Masticophis schotti schotti* is lacking (Werler and Dixon 2000. Texas Snakes: Identification, Distribution, and Natural History. University of Texas Press, Austin, Texas. 437 pp.), its diet is assumed to be similar to that of other *Masticophis*, which prey chiefly on lizards and birds. At 1730 h on 28 October 2006, I collected a DOR adult female *M. s. schotti* (945 mm SVL, 425 mm TL, 162 g) 1.1 mi N of the intersection of Texas Hwy 16 and Farm Road 2295 on Hwy 16 (27.59304°N, 098.65605°W, 193 m elev.) in Duval County, Texas, USA. The snake had an adult male (TD = 15 × 6 mm) *Peromyscus leucopus* in its stomach that was consumed headfirst. The mouse's measurements were: total length 178 mm, tail length 80 mm, hind foot 18 mm, ear 15 mm, and it weighed 23 g. The snake (ASNHC 14197) and mouse (ASNHC 13039) are deposited in the Angelo State Natural History Collection, Angelo State University, San Angelo, Texas.

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MEHELYA NYASSAE (Black File Snake). **FEEDING.** On the evening of 23 February 2006 a female *Mehelya nyassae* (450 mm SVL, 44 mm tail length, 30 g) was discovered swallowing an *Acontias plumbeus* (Giant Legless Skink; 252 mm SVL, 44 mm tail length, 34 g) on the road in Mtunzini, South Africa. The two animals had been recently hit by a vehicle and both were dead. The anterior 150 mm of the skink had been swallowed by the snake before the snake had been hit by the vehicle and thus it is unclear whether the snake would have completely ingested the prey. Shine et al. (1996. J. Zool. London 240:327–340) indicate that the diet of *M. nyassae* consists largely of scincid lizards, but did not record any members of the subfamily Acontinae in the diet of this species. Shine et al. (*op. cit.*) also report the mean prey mass to predator mass ratio as being 0.15 with a maximum ratio of 0.45. Assuming that this snake would have completely ingested the prey item, this feeding record would represent a prey mass to predator mass ratio of 1.14, well exceeding the reported range.

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NOTECHIS SCUTATUS (Australian Tiger Snake). **CANNIBALISM.** Incidental cannibalism in young snakes is frequently observed in captivity in a wide range of species, and usually occurs while the animals are being fed in a communal space. High frequency of cannibalism has been previously reported in *Notechis scutatus* from island populations during feeding events (Worrel 1963. Reptiles of Australia. Angus and Robertson, Sydney. pp. 132). Cannibalism between young *N. scutatus* was also recorded in the absence of food (Firmage and Shine 1996. Amphibia-Reptilia 17:55–65).

In March 2006, four pregnant female *N. scutatus* were captured on Williams Island, South Australia (35°01'54"S, 135°58'28"E) and two pregnant females were captured at Herdsman Lake, Western Australia (31°55'16"S, 115°48'17"E). In April 2006, 79 *N. scutatus* were born in captivity to these six females. Island neonates (22.8 ± 1.9 cm SVL, 8.9 ± 1.5 g; N = 50) and mainland neonates (17.8 ± 0.7 cm SVL, 4.4 ± 0.3 g; N = 29) significantly differed in snout–vent length ($F_{1,77}$ = 183.4; P < 0.01) and in body mass ($F_{1,77}$ = 256.4, P < 0.01) at birth. All snakes were housed individually under standardized conditions and fed dead mice every two weeks.

In the course of conducting other experiments, the now two-month-old snakes (body mass ranging from 4–11 g) were kept in groups of 3–16 individuals in small plastic boxes for three days. Cannibalism was observed on seven occasions, always in the absence of food stimuli and several days from the last feeding event. Victims ranged from 41% lighter up to 25% heavier, and from 17% shorter up to 11% longer than their attackers. Island snakes (Williams Island, South Australia) as well as mainland snakes (Herdsman Lake, Western Australia) displayed cannibalism. Island snakes preyed upon island snakes (2 occurrences) as well as mainland snakes (3 occurrences), while mainland snakes only consumed mainland snakes (2 occurrences), possibly reflecting the much larger size (and presumably strength) of island juveniles compare to their mainland counterparts (see above). Biting and other fighting behaviors were often observed, once involving two snakes biting a third individual. In most instances, snakes were separated by hand before cannibalism could occur. No bitten snakes seemed to suffer in an observable way from the effect of their attacker's venom. This report indicates that island and as well as mainland young *N. scutatus* are capable of cannibalism in captivity. There is no evidence that cannibalism occurs in the wild in this species. However it seems likely that some Island Tiger Snakes would display such behavior, especially in the absence of small prey items such as frogs (*Crinia*) and skinks (*Ctenotus*) that are the staple diet of mainland neonates (Aubret et al. 2004. Amphibia-Reptilia 25:9–17).

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PSAMMOPHIS LEIGHTONI TRINASALIS (Fork-marked Sand Snake) and ***PSAMMOPHIS NOTOSTICTUS*** (Karoo Sand Racer). **ENDOPARASITES.** *Psammophis leightoni trinasalis*

occurs in eastern Namibia, Botswana, and northern South Africa; *P. notostictus* occurs in the Cape provinces and Southern Free State, South Africa through Namibia to southern Angola (Branch 1988. Field Guide to Snakes and other Reptiles of Southern Africa. Ralph Curtis Books, Sanibel Island, Florida. 399 pp.). To our knowledge, there are no reports of helminths from these snakes. The purpose of this note is to establish the initial helminth lists for *P. leightoni* and *P. notostictus*.

Twenty *P. leightoni trinasalis* from southern Africa (SVL = 431 mm ± 151 SD, range: 165–637 mm) and 4 *P. notostictus* (SVL = 453 mm ± 39 SD) deposited in the herpetology collection of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California were examined: (*P. leightoni trinasalis* LACM 77106, 77107, 77463, 77660, 77661, 84178–84188, 84190–84193; *P. notostictus* LACM 77657–77659, 127500). A mid-ventral incision was made in the posterior third of the body and the coelomic cavity was searched for helminths. Nematodes were cleared in lactophenol and identifed from wet-mounts. Cestodes were stained in Delafield's hematoxylin, mounted in Canada balsam, coverslipped and identified from whole-mounts. Two species of Cestoda were found in *P. leightoni trinasalis*: *Oochoristica truncata* in LACM 77106 (prevalence, % infected/sample = 5%; mean intensity, mean number helminths per infected individual = 1.0) and *Mesocestodes* sp. in LACM 77660, 84181 (prevalence = 10%, mean intensity = 11.5 ± 0.72, range = 11–12), and one species of Nematoda, *Polydelphis anoura* in LACM 84180, 84181, 84185, 84187 (prevalence = 20%, mean intensity = 2.5 ± 2.4 SD, range = 1–6). One species of Cestoda was found in *P. notostictus*, *Mesocestoides* sp. in LACM 77657, 77659 (prevalence = 50%, mean intensity = 67.0 ± 11.3, range = 59–75). Helminths were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland as *P. leightoni trinasalis*: *Oochoristica truncata* (USNPC 99514), *Mesocestoides* sp. (USNPC 99515), *Polydelphis anoura* (USNPC 99516); *P. notostictus*; *Mesocestoides* sp. (USNPC 99513).

Oochoristica truncata is widespread in reptiles from southern Africa and has been reported from agamid, chameleonid, gekkonid, and scincid lizards, as well as boid and colubrid snakes (Goldberg and Bursey 2004. Afr. Zool. 39:111–114). *Psammophis* presumably becomes infected by ingesting prey harboring larvae of *O. truncata*. *Mesocestoides* is a cosmopolitan genus with a unique larval form, the tetrathyridium, commonly found in reptiles, birds, and mammals, which is infective to the predatory definitive hosts (Schmidt 1985. Biology of the Acanthocephala. Cambridge University Press, Cambridge, U.K. 519 pp.). Reports of tetrathyridia of *Mesocestoides* sp. in amphibians and reptiles are summarized in Goldberg et al. 2004 (Comp. Parasitol. 71:49–60). *Polydelphis anoura* is a widespread nematode reported from snakes from both the New and Old World (Baker 1987. Occas. Pap. Biol. Univ. Newfoundland 11:1–327; Ernst and Ernst 2006. SSAR Herpetol. Circ. 34. 86 pp.). Snakes are presumably infected by ingesting rodents harboring larvae (Anderson 2000. Nematode Parasites of Vertebrates. Their Development and Transmission. CABI Publishing, Wallingford, Oxon, U.K. 650 pp.). *Psammophis leightoni trinasalis* represents a new host record for *Oochoristica truncata*, *Mesocestoides* sp., and *Polydelphis anoura*. *Mesocestoides* sp.; *Psammophis notostictus* represents a new host record for *Mesocestoides* sp.

We thank Christine Thacker (LACM) for permission to examine snakes.

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PYTHON MOLURUS BIVITTATUS (Burmese Python). **CLUTCH SIZE**. *Python molurus bivittatus* is the largest of three subspecies of *P. molurus*, all of which are native to Southeast Asia. Through popularity in the exotic pet trade and subsequent release or escape of captive specimens, *P. m. bivittatus* has established a viable breeding population within Everglades National Park (ENP), Florida, USA. This is of particular concern from a management stand point, given that clutch sizes for *P. molurus* have been reported as high as 107 eggs (Wall 1921. Ophidia Taprobanica or Snakes of Ceylon. Government printer, Colombo. 66 pp.). In contrast, the two largest native snake species present in ENP, the Eastern Indigo Snake (*Drymarchon corais couperi*) and the Eastern Diamondback Rattlesnake (*Crotalus adamanteus*) have much smaller reproductive capability, producing an average of ca. 8–9 eggs (range = 5–12; Ernst and Barbour 1989. Snakes of Eastern North America. George Mason University Press, Fairfax, Virginia. 282 pp.) and 15.7 live young (range = 4–28; Timmerman 1989. Unpubl. master's thesis, Univ. of Florida, Gainesville. 81 pp.), respectively. However, most accounts for *P. molurus*, in particular *P. m. bivittatus*, have been from captive animals with information on reproduction in the wild scant. Here, we report the first account of clutch sizes of wild-caught female *P. m. bivittatus* from ENP.

Using egg, oviductal, and ovarian follicle counts from females (Everglades National Park, EVER-8888: overall accession no. for python project) recovered and examined between 5 March 2004 and 17 March 2006, we found mean clutch size of *P. m. bivittatus* within ENP to be 35.8 ± 3.4 (N = 8; range 19–46). Females ranged in size from 266–462 cm total length, with the two largest females 462 cm and 385 cm total length producing the largest clutch sizes of 46 eggs each (one of shelled eggs and the other oviductal). Four females for which data were available had a mean total egg mass to female body mass ratio before oviposition of 17.6 ± 4.1%. For most species of snakes, clutches can account for between 10–45% of a female's mass before oviposition or birth, with an average of 30% (Greene 1997. Snakes: The Evolution of Mystery in Nature. University of California Press, Berkeley. 351 pp.). Clutch sizes reported here agree with previous observations that suggest average clutch sizes for *P. molurus* generally range from 29–50 eggs (Cox et al. 1998. A Photographic Guide to Snakes and other Reptiles of Peninsular Malaysia, Singapore and Thailand. Ralph Curtis Books, Sanibel Isle, Florida. 144 pp.) with larger clutch sizes associated with larger females (Greene, *op. cit.*).

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33314, USA; and **RAY W. SNOW**, South Florida Natural Resources Center, Everglades National Park, 40001 State Road 9336, Homestead, Florida 33034, USA.

SIBON LONGIFRENIS (Drab Snaileater). **DIET**. *Sibon longifrenis* is a small, nocturnal, arboreal snake that is reported to be a terrestrial gastropod specialist (Solorzano 2004. Snakes of Costa Rica. Instituto Nacional de Biodiversidad, Santo Domingo de Heredia, Costa Rica. 791 pp.). Congeners, *S. argus* and *S. nebulatus*, have been reported to eat centrolenid and hylid frog eggs, respectively (Ryan and Lips 2004. Herpetol. Rev. 35:278). At 2100 h on 8 October 2005 we encountered an adult male *S. longifrenis* (383 mm SVL, 162 mm TL, 9.3 g) in the process of consuming an egg mass of *Cochranella albomaculata* at Gosner Stage 20 (Gosner 1960. Herpetologica 1960:183–190). The snake was located ca. 2.75 m up on a mossy vine overhanging Rio Maria (Panama Province, Panama). Within 10 minutes we located an additional adult male *S. longifrenis* (396 mm SVL, 173 mm TL, 9.0 g) moving among branches ca. 3.5 m above the stream. The second snake contained an obvious food bolus. We manually palpated the food item from the gut and identified it as an egg mass of *C. albomaculata* at Gosner Stage 10. Both snakes and their gut contents were collected and assigned field numbers (AHS F-1913 and F-1911).

At the time of the observation, *C. albomaculata* was going through a seasonal breeding event where we observed multiple amplectic pairs, as well as recently deposited egg masses. In addition to the *S. longifrenis* consuming eggs, we also located a juvenile female *Leptodeira septentrionalis* (282 mm SVL, 75 mm TL, 4.9 g) moving through vegetation above the stream that had eaten a *C. albomaculata* egg mass at Gosner Stage 10. The *Leptodeira* specimen was collected and deposited in the Museo de Vertebrados de la Universidad de Panama (MVUP-1874), and the *C. albomaculata* egg mass was deposited in the Southern Illinois University at Carbondale Museum (H-2636).

This is the first report of *S. longifrenis* feeding on egg masses. Our report provides further evidence that members of the genus *Sibon* are not strictly terrestrial mollusk and earthworm eaters (Kofron 1985. Copeia 1985:164–174), but rather "goo-eaters" as reported by Greene (1997. Snakes: The Evolution of Mystery in Nature. University of California Press. Berkeley. 351 pp.). Based on our observation and the two published observations (Ryan and Lips, *op. cit.*) of *Sibon* spp. eating egg masses, these snakes may opportunistically consume whatever egg masses are available at the time, since all observations were during breeding events of the species consumed. Egg masses might constitute a seasonally abundant, clumped food source for a genus that typically feeds on other prey types, e.g., mollusks and earthworms.

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SISTRURUS CATENATUS (Eastern Massasauga). **REPRODUCTION**. Organisms must allocate available resources among the competing demands of maintenance, growth, and reproduction. Allocation among these demands often can be shifted in response to changing environmental conditions (Lourdais et al. 2003. J. Zool., Lond. 259:123–129). This observation coupled with observations of ova atresia and the apparent disappearance of embryos in captive, gravid females has lead researchers to postulate that resorption can offset the extreme costs of reproduction in female squamates (see Blackburn et al. 1998. J. Morphol. 235:97–108). However, no direct evidence substantiating this inference exists (Blackburn et al. 2003. J. Morphol. 256:219–234). The female squamate uterus is not morphologically capable of enzymatic degeneration, although degeneration of embryos situated outside of the uterus (ectopic embryos) may occur (Blackburn et al. 1998, *op. cit.*). Ectopic embryos are rare (constituting 2% of embryos in some snake populations), and typically are the result of either an injury sustained during a previous breeding season or a dysfunction at ovulation (Shine 1977. Aust. J. Zool. 25:655–666). Oocytes may occasionally migrate through the infundibulum into the peritoneal cavity where embryogenesis can still occur before degeneration (Shine 1977, *op. cit.*).

On 25 July 2002, we encountered a gravid female *Sistrurus catenatus* at Eldon Hazlet State Park, Clinton County, Illinois, USA. An ultrasound on 29 July 2002 at the Saint Louis Zoological Park by staff veterinarians revealed four seemingly viable embryos and one unfertilized oocyte. On 22 August 2002, the female birthed three offspring (two viable, one stillborn) and one unfertilized oocyte. The discrepancy in number prompted a postpartum ultrasound on 30 August 2002, which revealed one embryo was not passed. This embryo was not located in the reproductive tract, but rather, in the peritoneal cavity. Following veterinary recommendation, we monitored the female in captivity where she was provided food and water *ad libitum*. A follow-up ultrasound on 14 October 2002 revealed complete embryonic degeneration and a large amount of fluid in the peritoneal cavity. The female died in captivity from unknown causes approximately one month later. Complications resulting from embryonic degeneration can neither be substantiated nor ruled out.

Although the exact cause of this ectopic pregnancy and factors pertaining to the death of the female remain unknown, it is evident that ectopic embryos can reach full embryogenesis before degeneration. Though the morphology of the oviduct is incapable of resorption (Blackburn et al. 1998, *op. cit.*), it is unknown whether females are capable of resorption of ectopic embryos.

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THAMNOPHIS COUCHII (Sierra Gartersnake). **PREDATOR-PREY INTERACTION**. Recent studies have demonstrated that populations of the Common Gartersnake (*Thamnophis sirtalis*) have evolved variable amounts of resistance to tetrodotoxin (TTX), a powerful neurotoxin found within newts of the genus *Taricha* (Brodie and Brodie 1999. Bioscience 49:557–568). Production of TTX in the Rough-skinned Newt (*Taricha granulosa*) and associated resistance in *T. sirtalis* form the basis of a complex coevolutionary relationship between these two species (Brodie et al. 2002. Evolution 56:2067–2082). Within the range of *T. granulosa*, sympatric populations of *T. sirtalis* exhibit a wide spectrum of TTX-resistance that is present in some populations, and absent in others (Brodie et al. 2002, *op. cit*.). It remains unclear if, and to what extent, other species pairs of *Thamnophis*/*Taricha* exhibit TTX-mediated parallel co-evolutionary relationships. While conducting surveys along Cold Springs Creek in the Greenhorn Mountains (Tulare County, California) on 7 June 2000, C. R. Feldman and J. V. Vindum observed an adult *Thamnophis couchii* (CAS 212868) in the process of consuming a juvenile *Taricha torosa* (CAS 212869). This observation and subsequent lab studies demonstrate that TTX-resistance evolved independently in *T. couchii* (Brodie et al. 2005. J. Chem. Ecol. 31:343–356). Herein, we report an additional field observation of predation between these two species from another locality, over 300 km northwest of the Cold Springs Creek site.

On 8 October 2003 at 1257 h, while conducting amphibian surveys along the North Fork Mokelumne River, Calaveras County, California (38°27'39"N, 120°26'39"W; ca. 793 m elev.), ACP observed a subadult *T. couchii* (ca. 23 cm SVL) at the base of a sedge (*Carex* sp.) clump, in a shallow area. The snake had recently captured a juvenile *T. torosa* (ca. 3 cm SVL; Fig. 1). After ca. 5–6 minutes, the *T. couchii* had completely consumed the newt, tail-first. Following ingestion, the snake swam downstream and showed no outward behavior (e.g., paralysis or poor locomotor function) to indicate TTX poisoning from the ingested newt.

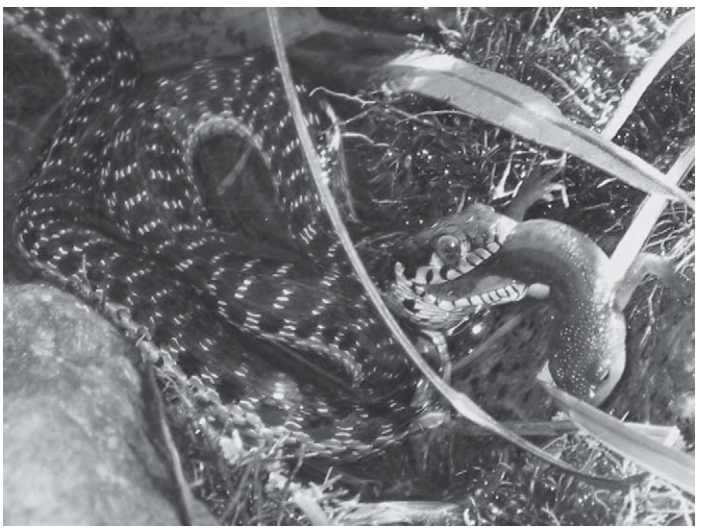


FIG. 1. A subadult Sierra Gartersnake (*Thamnophis couchii*) consuming a juvenile California Newt (*Taricha torosa*) from the North Fork Mokelumne River, California.

Newt prey from both field observations were juveniles, which typically have less TTX by surface area, than the average adult newt (Brodie et al. 2005, *op. cit.*). However, snakes from these observations differed in size: the *T. couchii* reported by Brodie et al. (2005, *op. cit.*) was an adult snake (48 cm SVL), while the snake reported here was a subadult (ca. 23 cm SVL). *Thamnophis sirtalis* are able to assess the toxicity of newts relative to their own resistance prior to ingestion, and symptoms of TTX-poisoning can occur as soon as one minute after prey capture (Williams et al. 2003. Herpetologica 59:155–163). We suspect that snakes from this locality may have elevated resistance to TTX, because the snake completely ingested the newt within an exposure time of at least 5–6 minutes (the newt was already captured upon initial observation), and because the snake swam away following ingestion. Alternatively, this population of *T. torosa* may exhibit uncharacteristically low levels of TTX, thus enabling *T. couchii* to consume them. The geographic structure of resistant/non-resistant populations within areas of sympatry of two coevolved species is believed to be an important component within such systems (Brodie et al. 2002, *op. cit.*). The geographic structure of the *Thamnophis sirtalis*/*Taricha granulosa* system resembles a mosaic of hotspots and coldspots within areas of sympatry and it seems possible that similar structure is present in the *Thamnophis couchii*/*Taricha torosa* system. The North Fork Mokelumne site is ca. 324 km northwest of the Cold Springs site within the Sierra Nevada of California and appears to be a resistant population. In a feeding ecology study of *T. couchii* from the North Fork Feather River (ca. 494 km northwest of the Cold Springs site), *T. torosa* was not identified in 102 prey items recovered from over 170 captured snakes (K. Wiseman, unpubl. data), even though both species are common locally and often encountered in the same microhabitats.

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THAMNOPHIS COUCHII (Sierra Gartersnake). **PREDATION**. *Thamnophis couchii* is a highly aquatic species that inhabits streams, rivers, meadow ponds, and reservoirs of the Sierra Nevada of California from the Pit River drainage south to the western edge of the Tehachapi Mountains, with several populations east of the Sierran crest at Owens Valley, and along the Walker, Truckee, and Carson rivers in Nevada (Rossman et al. 1996. The Garter Snakes: Evolution and Ecology. Univ. of Oklahoma Press, Norman. 332 pp.; Stebbins 2003. A Field Guide to Western Reptiles and Amphibians, 3rd ed. Houghton Mifflin Co., New York. 533 pp.). Despite the fact that this species is frequently encountered within

its range, there are few reports detailing its ecological relationships with other species. To our knowledge the only documented predator of *T. couchii* is the Red-tailed Hawk (*Buteo jamaicensis*; Fitch 1949. Amer. Midl. Nat. 41:513–579). Herein, we report on two ophidian predators of *T. couchii* and discuss other likely predators.

On 10 June 2004 at 1615 h an adult *Coluber constrictor* (500 mm SVL; 630 mm TL) was captured ca. 5 m from the right bank of the North Fork Feather River near Shady Rest Area, Butte County, California (39°50'56.7"N, 121°23'38.6"W; 457 m elev.). The sluggish snake regurgitated a subadult *T. couchii* (330 mm TL; 10 g) which had been consumed head-first and was still alive following palpation. The snakes were released at the site (photos on file with KDW). The air temperature was 25.5°C (clear, sunny) and the water temperature was 16.5°C.

On 23 July 2004 at 1257 h a dead, adult *Diadophis punctatus* (422 mm SVL; 484 mm TL; CAS 231463) was found with a partially ingested subadult *T. couchii* (455 mm SVL; 549 mm TL; deposited with CAS 231463) at the same general locality as the *Coluber* observation (39°50'55.3"N, 121°23'38.2"W). The *D. punctatus* had ingested 65 mm of forebody of the *T. couchii* (11.8% of the gartersnake's TL) before it died (Fig. 1). The combined mass of both snakes was 22.8 g (preserved weight). The air temperature was 32.5°C (clear, sunny) and the water temperature was 22.0°C. The decomposed and dessicated snakes were found partially submerged in an edgewater along a lateral cobble bar. A small water release occurred on the morning of 23 July 2004 from above Cresta Dam, which likely inundated the snakes following death. Based on the level of decomposition, we estimate that the snakes died 2–3 days earlier.

Other likely, but as of yet undocumented predators of *T. couchii* include Great Blue Herons (*Ardea herodias*; Fitch, *op. cit*.; R. W. Hansen, pers. comm.; A. Lind, pers. comm.), Raccoons (*Procyon lotor*; Fitch *op. cit*.), and skunks (*Mephitis mephitis* and *Spilogale putorius*; Fitch, *op. cit*.). Introduced Signal Crayfish (*Pacifasticus leniusculus*) are also likely predators of *T. couchii* where the two species come into contact. On 24 June 2003 at 1910 h, during underwater video monitoring of *Rana boylii* egg masses on the North Fork Feather River, a signal crayfish was observed attacking (the crayfish crawled out beneath an egg mass and "pinched" the snake's tail with its cheliped) a subadult *T. couchii* that had briefly come to rest adjacent to an egg mass (our unpubl. data). Similar aggressive behavior was observed between a crayfish (species unknown) and *Thamnophis atratus hydrophilus* on 4 September 1986 at 1610 h at Hurdygurdy Creek in Del Norte County, California. A neonate *T. a. hydrophilus* (215 mm SVL; 284 mm TL; 5.0 g) was observed struggling in a shallow (9 cm deep) portion of the creek. When several rocks were moved around the struggling snake, a crayfish retreated from the snake's injured tail (A. Lind, pers. comm.). Although these aggressive behaviors do not demonstrate a predator/prey relationship, crayfish have been observed capturing and consuming other species of gartersnakes both in the field (*Orconectes virilis*/*Thamnophis elegans*; Weaver 2004. Herpetol. Rev. 35:278) and in controlled laboratory settings (*O. virilis*/*Thamnophis cyrtopsis*; Fernandez and Rosen 1996. Arizona Game and Fish Department, Heritage Fund IIPAM Project No. I94054, Phoenix, Arizona. 56 pp.).

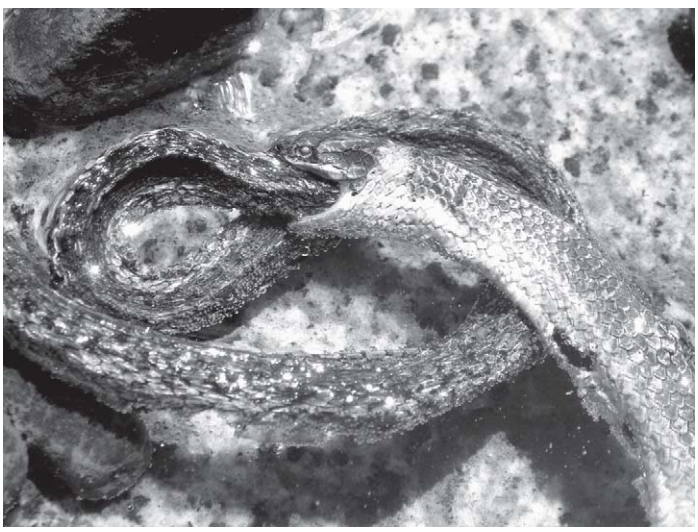


FIG. 1. An adult *Diadophis punctatus* (CAS 231463) which died while consuming a subadult *Thamnophis couchii*. The pair were found dead on 23 July 2004 on the North Fork Feather River, Butte County, California.

We thank R. W. Hansen, A. J. Lind, J. V. Vindum, and C. R. Feldman for their input. Field work was conducted in support of the Federal Energy Regulatory Commission's #1962 hydroelectric relicesening project.

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THAMNOPHIS HAMMONDII (Two-striped Gartersnake). **FORAGING BEHAVIOR.** *Thamnophis hammondii* is considered one of the most aquatic of the gartersnakes and is closely associated with creeks and impoundments (Fitch 1940. Univ. California Publ. Zool. 44:1–150) with a diet consisting largely of both the larvae and transformed stages of amphibians (*Spea*, *Bufo*, *Rana*, *Pseudacris*) and small fish (*Oncorhynchus*, *Gasterosteus*, *Eucyclogobius*, and *Cottus*) (Jennings and Hayes 1994. Amphibian and Reptile Species of Special Concern in California. Final report contract no. 8023, California Department of Fish Game. 255 pp.; Rossman et al. 1996. The Garter Snakes: Evolution and Ecology. Univ. of Oklahoma Press, Norman. 332 pp.). Little is known regarding the foraging behavior of *T. hammondii* (Rossman et al., *op. cit*.). Herein, we describe the details of a predation sequence (approach, strike, and capture) observed in a natural setting.

On 13 March 1996 we observed an adult *T. hammondii* (ca. 45 cm SVL) preying on *Xenopus laevis* larvae (ca. 25 TL) in a seasonal cattle pond (ca. 50 m × 18 m, 0.75 m deep) in Dulzura, San Diego County, California, USA (32.62491°N, 116.77640°W, 475 m elev.). Except for several open areas maintained by a pair of swimming Mallards (*Anas platyrhnchos*), the majority of the pond's surface was covered by dense mats of well-established submergent vegetation (*Potamogeton illinoensis*, *Ranunculus aquatilis*). Centered in one of the open areas (ca. 0.5 m diameter) a school of *X.*

laevis larvae (N = 15–20) were observed about 10 cm below the surface. As nektonic filter-feeders, *X. laevis* larvae form essentially stationary schools near the surface of deeper water rather than hiding in the shallows (Wassersug and Hessler 1971. Anim. Behav. 19:386–389). An adult *T. hammondii* revealed its presence in the column of open water when it slowly protruded its rostrum above the water surface (duration not noted). Upon drawing its head down and slightly backwards in a slow and deliberate fashion, it formed (presumably resumed) an ambush position about 15 cm below the surface. With its tail anchored in stable aquatic vegetation, the greater part of its length was compressed into side by side loops from which the snake would periodically, quickly lunge (strike) forward. After each lunge the body was compressed again in preparation for the next lunge, sometimes remaining virtually motionless for ~2 minutes. Upon apprehending a *X. laevis* larva, the snake would retreat out of sight into the dense aquatic vegetation for ~1.5 minutes, and then reappear in the same place facing the same direction to resume its ambush position. This sequence of events continued for 25 minutes (N = 6 forward lunges: 2 successful captures, 4 misses) until observations ended.

The predation sequence of the snake does not fit into any of the foraging behavioral categories developed for *Thamnophis* snakes by Drummond (1983. Behaviour 86:1–30). The detailed Drummond study was the first to develop standard foraging behavioral categories for aquatic foraging snakes. In a subsequent study, Lind and Welsh (1994. Anim. Behav. 48:1261–1273), studying *T. atratus*, added two additional foraging categories to the Drummond scheme. We term the above reported underwater sit-and-wait predation sequence 'underwater ambush' and define it as: body completely submerged, tail anchored to a rigid object, strikes directly at prey. We propose that underwater ambush be considered an additional foraging mode for species of *Thamnophis*.

Additional reports of *Thamnophis* species foraging underwater while anchoring their tail have been made (*T. atratus*; Boundy cited in Rossman et al., *op. cit.*), although further details were not provided. In regard to *Thamnophis* species orienting their head towards prey and slowly compressing their body into a series of opposite loops in preparation of a forward strike, it has been reported in *T. couchii* during controlled underwater *ex situ* attack trials (Alfaro 2002. Funct. Ecol. 16:204–215).

Although other North American aquatic snake species (e.g., *Nerodia sipedon*) are known to anchor their tail to assist in underwater prey capture, they weave open jawed with a back and forth sweeping motion actively searching for prey, as opposed to the sit-and-wait strategy, as described above. Random searching with open mouth (open-mouthed searching, *sensu* Drummond 1983, *op. cit.*) is believed to be a strategy based on a combination of chemo and tactile senses (Drummond 1985. Anim. Behav. 33:206–215; Schaeffel and de Queiroz 1990. Copeia 1990:50–58), while forward-strike strategies (e.g., underwater ambush) are dependent on visual acuity (Alfaro, *op. cit.*; Drummond, *op. cit.*).

Additionally, single elements of the underwater ambush mode described above (e.g., anchoring of the tail, organizing the trunk into high amplitude loops, or lunging directly at prey with entire body underwater) have all been observed individually for *Thamnophis* by other investigators under controlled conditions (Alfaro 2002, *op. cit.*; Drummond 1983, *op. cit.*). Based on previous observations of single elements, and our observation of the combination of elements in a natural setting, it is likely that the underwater ambush strategy, reported here as a novel foraging behavior, is not an uncommon mode of foraging behavior for other aquatic specialist *Thamnophis* species while preying on nektonic prey (e.g., fish, *X. laevis* larvae) in the wild.

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THAMNOPHIS PROXIMUS (Western Ribbon Snake). **FORAGING BIOLOGY**. Although nocturnal foraging in or near ponds has been reported for *Thamnophis proximus*, Rossman et al. (1996.The Garter Snakes: Evolution and Ecology. University of Oklahoma Press, Norman, Oklahoma. 332 pp.) note the absence of scavenging behavior during road surveys in Texas and indicate that, although chemosensory cues are important for finding locations with prey, sight and motion play integral roles in the isolation of individual prey items by *Thamnophis*. On 21 May 2005, I drove a ca. 2.5 km section of Mecom-McCreit Road (near Hull, Liberty County, Texas, USA) between 2130 h and 2345 h. A thunderstorm had recently passed and during my survey light rains continued and air temperature measured 20.5°C. *Bufo valliceps* and *Hyla cinerea* were present on the road in an estimated density of several hundred per kilometer, many of which were DOR. During this time I observed seven adult *Thamnophis proximus* active on the road. Two were found attempting to ingest anurans. A female (621 mm SVL, 808 mm total length, 62.3 g) was collected at 2158 h near a portion of the road that was partially covered with water (30°10'03.5"N, 94°40'08.8"W). The snake was attempting to swallow a DOR *Bufo valliceps* (52 mm SVL, 18.1 g) breech. The toad's viscera were exposed and its skull crushed. The snake fled and continued to hold onto the toad even after capture. It was later released to the roadside near the point of collection. To the best of our knowledge, this represents the first observation of scavenging of road-killed anurans in this species.

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TRIMORPHODON BISCUTATUS (Western Lyresnake). **DIET**. *Trimorphodon biscutatus* is a common species in the regenerating tropical dry forests of Guanacaste Province, Costa Rica. It is one of the most frequently encountered snakes in the secondary forests in and around the administration area of Sector Santa Rosa, Área de Conservación Guanacaste (10.84°N, 85.62°W, 295 m elev.), and often is observed crawling along the ground at night or foraging in scrubby vegetation 1–2 m above the ground. Although *T. biscutatus* has been described as primarily terrestrial (Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna

Between Two Continents Between Two Seas. Univ. of Chicago Press., Chicago, Illinois. 934 pp.), it has been observed to climb trees when disturbed.

On the night of 7 October 2001, I watched a *T. biscutatus* consume a *Nyctidromus albicollis* (Common Pauraque; University of Kansas Digital Archive, KUDA 1863). Total length of the *T. biscutatus* was estimated at 130–140 cm from scaled photographs (not shown), while *N. albicollis* average ca. 22–28 cm total length and 55 g (Latta and Howell 1999. *In* Poole and Gill [eds.], The Birds of North America, No. 429, The Birds of North America, Inc., Philadelphia; Stiles and Skutch 1989. A Guide to the Birds of Costa Rica. Comstock Publishing Associates, Ithaca, New York. 656 pp.). The snake had swallowed ca. 25% of the *N. albicollis* at the time I encountered it, and the bird was no longer moving. From the body position of the snake, the bird appeared to have been constricted before swallowing. The snake took 45 more minutes to finish swallowing the bird.

Nyctidromus albicollis is a sit-and-wait predator that commonly sits on open ground (particularly road edges) waiting for insect prey to pass above it. I encountered the pair on a very low traffic road in a site known to be frequented by an individual *N. albicollis*. As the beginning of the encounter was not observed it is possible that the *N. albicollis* was killed by something else and scavenged by the snake, however it seems most likely that the bird was captured while foraging for insects.

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TROPIDOPHIS MORENOI (NCN). **SIZE RECORD**. The previously reported measurements for *T. morenoi* (Hedges et al. 2001. J. Herpetol. 35:615–617) are 295 mm SVL and 45 mm tail length (holotype CZACC 4.5492; Colecciones Zoológicas del Instituto de Ecología y Sistemática, La Habana, Ciudad de La Habana province, Cuba; ex-collection IB 2493 from ex-Instituto de Biología, Cuba) and 285 mm SVL and 44 mm tail length (paratype CZACC 4.5493; ex-collection IB 2942). The type locality is Dolinas de Cueva de Humboldt, Caguanes, Villa Clara Province, Cuba (22°50'04"N, 80°12'02"W). This site now lies within Sancti Spíritus Province. An adult female of the genus *Tropidophis* (CZACC 4.12052) was collected by J. Salas (unknown date) from the same locality. It was identified by the senior author as *T. morenoi* on 20 January 2004 and is the first specimen of *T. morenoi* reported since the species description (Hedges et al., *op. cit.*). This specimen measures 359 mm SVL and 57 mm TL, exceeding the previous records by 64 mm SVL and 12 mm TL. Measurements of the head are not possible to determine because the head and neck are damaged. Coloration, scale counts, and measurements are the similar to those reported for the holotype and paratype.

We thank Elier Fonseca for suggestions on the manuscript.

Submitted by **MICHEL DOMÍNGUEZ** (e-mail: michel.dominguez@ecologia.cu), **LUIS V. MORENO**, and **LOURDES RODRÍGUEZ SCHETTINO** (e-mail: zoologia.ies@ama.cu), Instituto de Ecología y Sistemática, Carretera de Varona km 3½, Capdevila, Boyeros, A.P. 8029, C.P. 10800, Ciudad de La Habana, Cuba.

GEOGRAPHIC DISTRIBUTION

Instructions for contributors to Geographic Distribution appear in Volume 38, Number 1 (March 2007, p. 95). Please note that the responsibility for checking literature for previously documented range extensions lies with authors. Do not submit range extension reports unless a thorough literature review has been completed.

CAUDATA

AMBYSTOMA MACULATUM (Spotted Salamander). USA: ARKANSAS: Faulkner Co.: 6.9 km S Damascus (Sec. 29, T8N, R13W). 28 October 2006. Henry W. Robison. Verified by S. E. Trauth. Arkansas State University Herpetological Museum (ASUMZ 30640). New county record filling a distributional hiatus in the Arkansas River valley between Conway and White counties (Trauth et al. 2004. Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.). This salamander has now been reported from 68 of 75 (91%) counties of the state (Robison 2006. Herpetol. Rev. 37:481; Trauth et al., *op. cit.*).

Submitted by **HENRY W. ROBISON**, Department of Biology, Southern Arkansas University, Magnolia, Arkansas 71754, USA (e-mail: hwrobison@saumag.edu) and **CHRIS T. McALLISTER**, Department of Physical and Life Sciences, Chadron State College, Chadron, Nebraska 69337, USA (e-mail: cmcallister@csc.edu).

AMBYSTOMA OPACUM (Marbled Salamander). USA: TENNESSEE: Hamilton Co.: Moccasin Bend National Park/ Archaeological District, Chattanooga (35.04003°N, 085.34193°W). 10 April 2007. Matthew B. Smith, Timothy J. Gaudin, and Thomas P. Wilson. Verified by Enrico Walder, Senior Herpetologist and Assistant Curator of Forests, Tennessee Aquarium. The University of Tennessee at Chattanooga Natural History Museum (UTCA 191). Adult female collected posthumously from leaf litter while surveying mammals. A second live female *A. opacum* collected two days later from a pitfall trap and released in same area. Represents first verified record for Hamilton County (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. http//www.apsu.edu/amatlas/; Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington and London, 587 pp.). Collection made under Tennessee Wildlife Resources Agency Permits 1534 and 1944 and National Park Service Scientific Research and Collecting Permit CHCH-2007-SCI-0002.

Submitted by **MATTHEW B. SMITH**, **TIMOTHY J. GAUDIN**, and **THOMAS P. WILSON**, Department of Biological and Environmental Sciences, The University of Tennessee at Chattanooga, 615 McCallie Avenue, Chattanooga, Tennessee 37403, USA.

NECTURUS MACULOSUS (Mudpuppy). USA: ILLINOIS: Greene Co.: Mudpuppy live-captured by Shawn Shewmake on hook and line. Macoupin Creek, 25 m downstream of Reddish Ford Bridge (N 715732 and W 4337970, zone 15 using NAD27CONUS map datum in UTMs). 27 March 2007., TL 419 mm (INHS Herpetological Photograph 2007.27). Verified by Chris

Phillips, Illinois Natural History Survey. First county record (Phillips 1999. Field Guide to Amphibians and Reptiles of Illinois. Illinois Nat. Hist. Surv., Manual 8. Champaign, Illinois. 300 pp.). Macoupin Creek is channelized and 15 m wide at the site, and its steeply eroded banks are bordered by an agricultural field with a 3-m buffer strip vegetated by Silver Maple *Acer saccharinum*, American Sycamore *Platanus occidentalis*, and various understory species (typical of a soft-maple floodplain forest community).

Submitted by **CHAD R. DOLAN** and **JOHN K. TUCKER**, Illinois Natural History Survey, Great Rivers Field Station, 8450 Montclair Ave., Brighton, Illinois 62012, USA; and **JAMES T. LAMER**, Department of Biological Sciences, Western Illinois University, 1 University Circle, Macomb, Illinois 61455, USA.

SIREN INTERMEDIA NETTINGI (Western Lesser Siren). USA: ARKANSAS: Jefferson Co.: 7.2 km S Pine Bluff (Sec. 15, T7S, R9W). 27 November 2006. Henry W. Robison. Verified by S. E. Trauth. Arkansas State University Herpetological Museum (ASUMZ 30641). New county record partially filling a tri-county distributional gap between Cleveland, Grant and Monroe counties (Robison 2006. Herpetol. Rev. 37:484; Trauth et al. 2004. Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.).

Submitted by **HENRY W. ROBISON**, Department of Biology, Southern Arkansas University, Magnolia, Arkansas 71754, USA (e-mail: hwrobison@saumag.edu); and **CHRIS T. McALLISTER**, Department of Physical and Life Sciences, Chadron State College, Chadron, Nebraska 69337, USA (e-mail: cmcallister@csc.edu).

ANURA

BARBOURULA BUSUANGENSIS (Philippine Discoglossid Frog). PHILIPPINES: BALABAC ISLAND: Barangay: Indalawan; Tugas Creek, 30 m elev. 01 March 2007. Pierre Fidenci. California Academy of Sciences photo voucher (CAS-HPV 42). Verified by Hallie Brignall. First record for Balabac Island. Known records are from Busuanga and Palawan (Alcala and Brown 1998. Philippine Amphibians. An Illustrated Fieldguide. Bookmark, Inc., Makati City. xii + 116 pp.; Fidenci 2006. Herpetol. Rev. 37:98). The closest known occurrence is in Palawan, > 70 km N of Balabac (Fidenci 2004. Herpetol. Rev. 37:98). Adult observed at 2030 h on bank, 10 cm from water, in large creek (8 m wide, 0.1–1 m deep) with a mixture of sand, silt, gravel, and boulder as substrate. The creek is surrounded by secondary forest and banana plantation.

Submitted by **PIERRE FIDENCI**, ESI, 755 Bush Street #302, San Francisco, California 94108, USA; e-mail: pfidenci@endangeredspeciesinternational.org.

HYLA GRATIOSA (Barking Treefrog). USA: MISSISSIPPI: Smith Co.: Found on road at night. County Road 504 W of Pineville (32°08'07"N, 89°24'19"W). 11 July 2006. Tony Gamble and Mike Bush. Verified by Andrew M. Simons. JFBM 15169. New county record (Mitchell 2005. *In* M. Lannoo [ed.], Amphibian Declines: The Conservation Status of United States Species, pp. 455–456. University of California Press, Berkeley, California; Minnis 1998. Mississippi Herpetological Atlas and Mississippi Gap Analysis Program, http://www.cfr.msstate.edu/gap/atlas.htm, accessed 19 April 2007).

Submitted by **TONY GAMBLE** and **MICHAEL BUSH**, Bell Museum of Natural History, University of Minnesota, 100 Ecology, 1987 Upper Buford Circle, St. Paul, Minnesota 55108, USA (e-mail: gambl007@umn.edu).

KALOPHRYNUS INTERLINEATUS (Striped Sticky Frog). BANGLADESH: MYMENSINGH DIVISION: Madhupur National Park (24°41'N, 90°07–08'E, 134–136 m elev.). 29–30 June 2006. A. H. M. Ali Reza and S. Mahony. Wildlife Laboratory, Department of Zoology, Jahangirnagar University, Savar, Dhaka (JU 0026, 0028). Photograph deposited at USDZ, Raffles Museum of Biodiversity Research, National University of Singapore (ZRC [IMG].1.3). Verified by Indraneil Das. Western range extension, and first country record for genus and species. Nearest known population ca. 380 km NE in Orang National Park, Assam (Dutta et al. 2000. Hamadryad 25:67–74). Supported by Cleveland Metroparks Zoo and Rufford Foundation to the second author, which partially supported the first author. Bangladesh Forest Department issued permission (CCF [Wildlife]/2M–47/2006) for this work to the second author.

Submitted by **STEPHEN MAHONY**, 3 Park View Lawns, Greenpark, Clondalkin, Dublin 22, Ireland. (e-mail: stephenmahony2@gmail.com); and **A. H. M. ALI REZA**, Department of Natural Resources Management, Texas Tech University, Lubbock, Texas 79409, USA (e-mail: ali.reza@ttu.edu).

KALOULA TAPROBANICA (Sri Lankan Bull Frog). BANGLADESH: MYMENSINGH DIVISION: Madhupur National Park (24°41'N, 90°08'E; 136 m elev.). 30 June 2006. A. H. M. Ali Reza and S. Mahony. Wildlife Laboratory, Department of Zoology, Jahangirnagar University, Savar, Dhaka (JU 0029). Photograph deposited at USDZ, Raffles Museum of Biodiversity Research, National University of Singapore (ZRC IMG].1.2). Verified by Indraneil Das. First verified locality for Bangladesh. Nearest population reported from Kolkata, West Bengal, India, > 200 km to SW of this locality (Dutta 1997. Amphibians of India and Sri Lanka. Odyssey Publishing House, Bhubaneswar. xiii + 343 + xxii pp.). Supported by Cleveland Metroparks Zoo and Rufford Foundation to the first author, which partially supported the second author. Bangladesh Forest Department issued permission (CCF (Wildlife)/2M–47/2006) for this work to the first author.

Submitted by **A. H. M. ALI REZA**, Department of Natural Resources Management, Texas Tech University, Lubbock, Texas 79409, USA (e-mail: ali.reza@ttu.edu); and **STEPHEN MAHONY**, 3 Park View Lawns, Greenpark, Clondalkin, Dublin 22, Ireland (e-mail: stephenmahony2@gmail.com).

MICROHYLA BUTLERI (Tubercled Pygmy Frog). INDIA: MIZORAM: Sairang (23°48'38.5"N, 92°39'09.8"E), 57 m elev., SVL 31–34 mm; 04 December 2004. Department of Zoology Museum, North Eastern Hill University. SP 37–38. Saipari Sailo, H. T. Lalremsanga and R. N. K. Hooroo. Verified by Saibal Sengupta. Previously reported from China, Myanmar, Thailand, Laos, Cambodia, Vietnam, and Peninsular Malaysia and Singapore (Berry 1975. The Amphibian Fauna of Peninsular Malaysia. Tropical Press, Kuala Lumpur. 130 pp.; Boulenger 1900. Ann. Mag.

Nat. Hist., ser. 6, 7:186–193; Lim and Lim 1992. A Guide to the Amphibians and Reptiles of Singapore. Singapore Science Centre, Singapore; Stuart 1999. *In* Duckworth et al. [eds.], Wildlife in Lao PDR: 1999 Status Report, pp. 43–67. IUCN/WCS/CPAWM, Vientiane; Taylor 1962. Univ. Kansas Sci. Bull. 43:267–599). New record for India.

Submitted by **H. T. LALREMSANGA** (e-mail: htlrsa@yahoo.co.in), **SAIPARI SAILO** (e-mail: spsailo@yahoo.co.in), and **R. N. K. HOOROO**, Department of Zoology, Developmental Biology Laboratory, North Eastern Hill University, Shillong 793 022, Meghalaya, India (e-mail: rnkhnehu@hotmail.com).

OSTEOPILUS SEPTENTRIONALIS (Cuban Treefrog). USA: GEORGIA: Chatham Co.: Savannah, house on Windward Island at 79 Rio Road (31.976°N, 81.186°W). 23 September 2004. Diane M. Butler. Verified by Kenneth Krysko. Florida Museum of Natural History, University of Florida (UF 142332). One adult female (111 mm SVL) was collected at the base of a sliding glass door in the backyard of the house. Cuban Treefrogs occur throughout much of Florida's peninsula (Meshaka et al. 2004. The Exotic Amphibians and Reptiles of Florida. Krieger Publ. Co., Malabar, Florida. 155 pp.; Meshaka 1996. Herpetol. Rev. 27:37–40) and appear to be established as far north as Jacksonville on the Atlantic Coast (Krysko et al. 2005. Herpetol. Rev. 36:85–87), Cedar Key on the Gulf Coast (Johnson et al. 2003. Herpetol. Rev. 34:381), and Gainesville in the center of the peninsula (Krysko et al. 2005. Herpetol. Rev. 36:85–87). This is the first documented occurrence of a Cuban Treefrog in Georgia (J. Jensen, pers. comm.). The closest known record for the species is from Duval Co., Florida (Krysko et al. 2005. Herpetol. Rev. 36:85–87), approximately 180 km S of Savannah, Georgia.

Submitted by **STEVE A. JOHNSON**, Department of Wildlife Ecology and Conservation, University of Florida—IFAS Plant City Education Center, 1200 North Park Rd., Plant City, Florida 33563, USA; e-mail: tadpole@ufl.edu.

OTOPHRYNE PYBURNI. BRAZIL: AMAZONAS: Municipality of São Gabriel da Cachoeira, Parque Nacional do Pico da Neblina: Bebedouro velho (0°41'54"N; 65°55'41"W, 418 m elev.), 15 August 2005. Coleção de Anfíbios e Répteis, Instituto Nacional de Pesquisas da Amazônia, Manaus, Amazonas, Brazil (INPA-H 16473, SVL 46.8 mm; body mass in life 11 g). Bebedouro novo (0°45'21"N; 65°57'55"W, 847 m elev.), 17 August 2005 (INPA-H 16472, SVL 48.2 mm; body mass in life 11 g) and (INPA-H 16474 SVL 52.1 mm; body mass in life 13.5 g); 22 August 2005 (INPA-H 16475 SVL 20.1 mm; body mass in life 0.7 g). Three specimens were collected in dense closed canopy montane forest and one in dense closed canopy submontane forest near right bank of forest stream by V. T. Carvalho and L. Bonora and verified by R. de Fraga. This species occurs from Vaupés and Amazonas, Colombia, across the lowlands of southern Venezuela and through the Guianan region to Amapa, Brazil (Campbell and Clarke 1998. Herpetologica 54:301–317). In Venezuela this species was reported in Sierra Parima, 1100 m elevation (Barrio 1999. Herpetol. Rev. 30:173). Our record is 362 km and 358 km from these records reported in Sierra Parima. First state records, extends the known distribution 446 km and 440 km (airlane) east, respectively, from the type locality in the Vaupés, Wacará, SW Colombia (01°09'N, 69°55'W) (Campbell and Clarke, *op. cit.*).

Submitted by **VINICIUS T. DE CARVALHO** (e-mail: viniciustc@ig.com.br)**, LUCÉIA BONORA** and **RICHARD C. VOGT,** Instituto Nacional de Pesquisas da Amazônia – INPA, Coleção de Anfíbios e Répteis – Campus II. Av. André Araújo, 2936. C.P. 428. CEP 69.083-000 Manaus, Amazonas, Brazil.

PLEURODEMA MARMORATA (Andean Four-eyed Frog, Sapito de cuatro ojos andino). CHILE: TARAPACA: I Región, Quebe, ca. 180 Km NE of city of Iquique (19°27'18.0"S; 68°48'34.1"W), 3958 m elev.; 12 April 2007. M. A. Méndez, M. Sallaberry, and L. Pastenes. Herpetological Collection of Departamento de Biología Celular y Genética de la Universidad de Chile, Santiago, Chile (DBGUCH 0704038 juvenile). Lauca Sur (18°22'37.6"S; 69°20'49.0"W), 4232 m elev.; 14 April 2007. Same collectors. DBGUCH 0704058, adult. All verified by A. Veloso. Previously known from Caquena, Parinacota, Chungara, and Putre, XV Región (Cei 1962. Batracios de Chile. Ediciones de la Universidad de Chile, Santiago, Chile. cviii + 128 pp.; Veloso et al. 1981. *In* Veloso and Bustos [eds.], El Hombre y los Ecosistemas de Montaña I. La Vegetación y los Vertebrados Inferiores de los Pisos Altitudinales entre Arica y Lago Chungará, pp. 135–169). New record from Quebe extends southern range ca. 145 km S of Putre, the closest locality previously known (Cei 1962, *op. cit.*; Veloso and Navarro 1988. Boll. Mus. Reg. Sci. Nat. Torino 6:481–539).

The study was supported by the Grants PG-025-06 and MULT 05-04/2, University of Chile, and Fondecyt 1061256-2006.

Submitted by **MICHEL SALLABERRY A.**, Departamento de Ciencias Ecológicas, Facultad de Ciencias, Universidad de Chile, Las Palmeras 3425, Ñuñoa, PO Box 653, Santiago, Chile (e-mail: msallabe@uchile.cl); **LUIS PASTENES O.**, **CLAUDIO CORREA Q.**, and **MARCO A. MÉNDEZ T.**, Laboratorio de Genómica Evolutiva, INTA, Universidad de Chile, Macul 5540, PO Box 138-11, Santiago, Chile (e-mail: mmendez@uec.inta.uchile.cl).

PSEUDACRIS CLARKII (Spotted Chorus Frog). USA: TEXAS: Sterling Co.: 16.9 road km S of junction of US 87 and TX 163 on TX 163 (31°41'8.30"N, 101°3'29.10"W). 14 April 2007. D. Laurencio, M. T. Hill, and T. J. Hibbitts. Verified by James R. Dixon. TCWC 91803, 91804. New county record (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. Texas A&M University Press, College Station, Texas. 421 pp.).

Submitted by **DAVID LAURENCIO**, **MICHAEL T. HILL**, and **TOBY J. HIBBITTS**, Texas Cooperative Wildlife Collection, Department of Wildlife and Fisheries Sciences, 2258 TAMU, Texas A&M University, College Station, Texas 77843-2258, USA (e-mail: norops@tamu.edu).

PSEUDACRIS PACIFICA (Pacific Treefrog). USA: WASHINGON: Franklin Co.: Route 261, 50 m W of Lyons Ferry Park entrance (46°35.574'N, 118°13.198'W) 171 m elev. 15 October 2006. Robert E. Weaver. Verified by Kenneth V. Kardong. Voucher specimen deposited in the Central Washington University Department of Biological Sciences Herpetology Collection (CWU 1694). Adult (35 mm SVL, 4.8 g) collected while crossing Route 261 at 2039 h during a period of light precipitation. Ambi-

ent temperature at time of collection was 15.5°C. First county record. This record fills a gap in distribution data, as localities for this species have been reported for all other counties in Washington State (Hallock and McAllister 2005. Washington Herp Atlas. http://www.dnr.wa.gov/nhp/refdesk/herp/).

Submitted by **ALEX DORNBURG** (e-mail: dornburgalex@yahoo.com) and **ROBERT E. WEAVER**, School of Biological Sciences, Washington State University, Pullman, Washington 99164, USA (e-mail: weaverr@wsu.edu).

SPEA BOMBIFRONS (Plains Spadefoot). USA: TEXAS: Crane Co.: 4.54 air km N, 2.88 air km W of junction of FM1601 and FM 1233 (31°34'00.3"N, 102°30'58.3"W). 13 April 2007. D. Laurencio, M. T. Hill, and T. J. Hibbitts. Verified by James R. Dixon. Texas Cooperative Wildlife Collection, TCWC 91801, 91802. New county record (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. Texas A&M University Press, College Station, Texas. 421 pp.).

Submitted by **DAVID LAURENCIO**, **MICHAEL T. HILL**, and **TOBY J. HIBBITTS**, Texas Cooperative Wildlife Collection, Department of Wildlife and Fisheries Sciences, 2258 TAMU, Texas A&M University, College Station, Texas 77843-2258, USA (e-mail: norops@tamu.edu).

SYLVIRANA LEPTOGLOSSA (Long-tongued Frog). BANGLADESH: MYMENSINGH DIVISION: Madhupur National Park (24°41'N, 90°08'E, 134–136 m elev.). 03 July 2006. S. Mahony and A. H. M. Ali Reza. Wildlife Laboratory, Department of Zoology, Jahangirnagar University, Savar, Dhaka (JU 0031). Photograph deposited at USDZ, Raffles Museum of Biodiversity Research, National University of Singapore (ZRC [IMG].1.4). Verified by Indraneil Das. First locality record for Mymensingh Division and western range extension for species. Only other Bangladesh population recorded in Chittagong Division (ca. 230 km to SE) with no locality details, specimen numbers or voucher photographs (Asmat et al. 2003. Univ. J. Zool., Univ. Rajshahi, Bangladesh 22:141–143). Supported by Cleveland Metroparks Zoo and Rufford Foundation to the second author, which partially supported the first author. Bangladesh Forest Department issued permission (CCF [Wildlife]/2M-47/2006) for this work to the second author.

Submitted by **STEPHEN MAHONY**, 3 Park View Lawns, Greenpark, Clondalkin, Dublin 22, Ireland (e-mail: stephenmahony2@gmail.com); and **A. H. M. ALI REZA**, Department of Natural Resources Management, Texas Tech University, Lubbock, Texas 79409, USA (e-mail: ali.reza@ttu.edu).

SYRRHOPHUS CYSTIGNATHOIDES (Rio Grande Chirping Frog). USA: TEXAS: Nacogdoches Co.: Nacogdoches; 1203 Ferguson (31°36'48.36"N; 94°39'05.22"W). 1 August 2006. Toby J. Hibbitts and Daniel Saenz. Verified by James R. Dixon. Texas Cooperative Wildlife Collections, TCWC 91544. This invasive species is now widespread in residential areas in much of southeast Texas. New county record (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. Texas A&M University Press, College Station, Texas. viii + 421 pp.).

Submitted by **TOBY J. HIBBITTS**, Texas Cooperative Wildlife Collections, Department of Wildlife and Fisheries Sciences, Texas A&M University, 2258 Tamu, College Station, Texas 77843-2258, USA (e-mail: thibbitts@tamu.edu); and **DANIEL SAENZ**, Wildlife Habitat and Silviculture Laboratory, Southern Research Station, USDA Forest Service, Nacogdoches, Texas 75962, USA.

TESTUDINES

CHELYDRA SERPENTINA (Snapping Turtle). USA: TEXAS: Nolan Co.: 1.0 road km N of Interstate 20 on US 80 at exit of Business 84 (to Roscoe) (32°26'53.5"N,100°30'56.8"W), 730 m elev. 10 May 2006. David Laurencio, Laura R. Laurencio, and Nicole Smolensky. Verified by Toby J. Hibbitts. Texas Cooperative Wildlife Collection, TCWC 91336. New county record (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. Texas A&M University Press, College Station, Texas. 421 pp.).

Submitted by **DAVID LAURENCIO** (e-mail: norops@tamu.edu), **LAURA R. LAURENCIO**, and **NICOLE SMOLENSKY**, Texas Cooperative Wildlife Collection, Department of Wildlife and Fisheries Sciences, MS 2258, Texas A&M University, College Station, Texas 77843-2258, USA.

STERNOTHERUS ODORATUS (Stinkpot). USA: WISCONSIN: Oconto Co.: town of Underhill. Northeast corner of Berry Lake, off of Highway HH (44°53'40.6"N, 88°28'31.6"W). April 16 (N = 5) and 17 (N = 6) 2007. Lee Meyers and Rod Lange. Verified by Christopher A. Phillips. INHS 2007b. New county record. Extends range of species in Wisconsin (Casper 1996. Geographic Distributions of the Amphibians and Reptiles of Wisconsin. Milwaukee Public Museum. 87 pp.). Eleven individuals captured in a fyke net over two days, along with several *Chrysemys picta* and *Chelydra serpentina.* All individuals surveyed were associated with a portion of the lake possessing a soft mud bottom with adjacent marsh along the lake periphery. These observations complement the finding of a shell from a deceased individual in the same area on 06 November 2004 (Brian Ewart and Randy Korb).

Submitted by **BRIAN EWART,** 14415 Berry Lake N. Shore Rd, Gillett, Wisconsin 54124, USA; **RANDY KORB,** PO Box 1963, Green Bay, Wisconsin 54305, USA; **LEE S. MEYERS** and **RODNEY M. LANGE**, Wisconsin Department of Natural Resources, 2984 Shawano Avenue, Green Bay, Wisconsin 54307-0448, USA; and **JOSHUA M. KAPFER**, Department of Biological Sciences, University of Wisconsin-Milwaukee, Milwaukee, Wisconsin 53211, USA.

TERRAPENE ORNATA ORNATA (Ornate Box Turtle). USA: NEBRASKA: Rock Co.: 1.6 km W Bassett off US 20 (DOR). 09 May 2007. C. T. McAllister. Verified by S. E. Trauth. Arkansas State University Herpetological Museum (ASUMZ photographic voucher 30668). 8.0 km E Bassett off US 20 (DOR). 11 May 2007. C. T. McAllister. Verified by S. E. Trauth. ASUMZ photographic voucher 30669. New county record partially filling a distributional hiatus in the northcentral sandhills of Nebraska between Antelope and Brown counties (Lynch 1985. Trans. Nebraska Acad. Sci. 13:33–57).

Submitted by **CHRIS T. McALLISTER**, Department of Physical and Life Sciences, Chadron State College, Chadron, Nebraska 69337, USA; e-mail: cmcallister@csc.edu.

LACERTILIA

ANOLIS EQUESTRIS (Knight Anole). USA: FLORIDA: MONROE CO.: Key West, 323 Whitehead Street (24°33'23.699"N, 81°48'18"W, WGS84; elev. < 1 m). 14 May 2007. Andrew P. Borgia and Kenneth L. Krysko. Verified by Kevin M. Enge. Florida Museum of Natural History (UF 151192). New island record and extends the range ca. 140 km SW of the closest known locality on Plantation Key (Achor and Moler 1982. Herpetol. Rev. 13:131). Juvenile found wounded on wall below banyan tree.

Submitted by **KENNETH L. KRYSKO**, Division of Herpetology, Florida Museum of Natural History, Dickinson Hall, University of Florida, Gainesville, Florida 32611, USA (e-mail: kenneyk@flmnh.ufl.edu); and **ANDREW P. BORGIA**, P.O. Box 4346, Key West, Florida 33041, USA.

CNEMIDOPHORUS TIGRIS (Western Whiptail). USA: TEXAS: GAINES CO.: 21.9 air km S jct US Hwy 62/180 and NM/TX state line (32°31'29.6"N; 103°03'43.9"W). 12 June 2006. David Laurencio and Toby J. Hibbitts. Verified by James R. Dixon. Texas Cooperative Wildlife Collections, TCWC 91476–91478. New county record (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. Texas A&M University Press, College Station, Texas. 421 pp.). The specimens were collected during research on *Sceloporus arenicolus* with funding from Texas Parks and Wildlife Department.

Submitted by **TOBY J. HIBBITTS**, **DAVID LAURENCIO**, and **LEE A. FITZGERALD**, Texas Cooperative Wildlife Collections, Department of Wildlife and Fisheries Sciences, Texas A&M University, 2258 Tamu, College Station, Texas 77843-2258, USA (e-mail: thibbitts@tamu.edu).

COLOBOSAUROIDES CEARENSIS. BRAZIL: PIAUÍ: Parque Ambiental Paquetá (03°58.828'S; 042°05.659'W): Municipalidade de Batalha, 10 September 2004. M. Basto da Silva, V. Rodrigues, L. Barreto, and W. A. Rocha. Museu Paraense Emilio Goeldi, Belém, Pará, Brazil (MPEG 23022–23025). Verified by T. C. S. Ávila-Pires. Previously known only from Maciço do Baturité, Fortaleza, Ubajara and Serra da Aratanha localities in Ceará state, Brazil (Soares and Caramaschi 1998. Bol. Mus. Nac. Zool. 388:1–8.) First state record, extends distribution 200 km from Ubajara (Ceará), the nearest, previously known locality.

Submitted by **MARCÉLIA BASTO DA SILVA** (e-mail: marceliabasto@uol.com.br); **VALDEMAR RODRIGUES** (e-mail: desertpi@uol.com.br), Departamento de Biologia - CCN, Universidade Federal do Piauí, Campus da Ininga, Av. Ininga s/n, 64049-550, Teresina PI, Brazil; **LARISSA BARRETO** (e-mail: lara@elo.com.br), Departamento de Oceanografia e Limnologia, Universidade Federal do Maranhão, Campus do Bacanga, Av. dos Portugueses s/n, 65080-040, São Luís MA, Brazil; and **WÁLDIMA ALVES DA ROCHA**, Museu Paraense Emilio Goeldi, Pós-graduação em Zoologia. Av. Perimetral, 1901, C.P. 399, 66040-170 – Belém PA, Brazil (e-mail: waldima@yahoo.com.br).

CYRTOPODION HETEROCERCUM HETEROCERCUM (Asia Minor Thin-toed Gecko). IRAN: MARKAZI PROVINCE: NW Arak City (34°07'45"N, 49°41'37"E, 1800 m elev.). 10 June 2006. Aria Herpetological Institute, Tehran, Iran (ARIA1001). 23 June 2006 (ARIA1002). Omid Mozaffari. Verified by S. C. Anderson. One juvenile and one adult male collected at night from a courtyard under a lamp. First record for Markazi Province. Nearest locality is Hamedan, Hamedan Province, ca. 200 km NW of the present locality (Anderson 2000. The Lizards of Iran. SSAR Contributions to Herpetology, Vol. 15. Ithaca, New York. vii + 442 pp.; 25 pl.). Second record from Iran.

Submitted by **OMID MOZAFFARI**, No.21 Taleghani 3 Street, Ashrafi Esfehani Highway, Tehran, Iran 14699-76599; e-mail: omozaffari@yahoo.com.

GONATODES HUMERALIS. BRAZIL: PIAUÍ: Municipalidade de Batalha, Parque Ambiental Paquetá (03°58.828'S; 042°05.659'W). 13 August 2004. M. Basto da Silva, V. Rodrigues, and W. Alves da Rocha. Universidade Federal do Piauí, Teresina, Piauí, Brazil (LZUFPI 0472–0474; in semi-deciduous forest). Verified by T. C. S. Ávila Pires. The distribution was restricted to the Amazonian Region and the states of the Maranhão and Mato Grosso (Ávila-Pires 1995. Zoologische Verhandelingen 299:1–706). First state record, extends known distribution 200 km E from Timon, state of Maranhão, the nearest locality previously mentioned (Silva et al. 2006. *In* XXVI Congresso Brasileiro de Zoologia).

Submitted by **MARCÉLIA BASTO DA SILVA** (e-mail: marceliabasto@uol.com.br); **VALDEMAR RODRIGUES** (e-mail: desertpi@uol.com.br) Departamento de Biologia - CCN, Universidade Federal do Piauí, Campus da Ininga, Av. Ininga s/n, 64049-550, Teresina PI, Brazil; and **WÁLDIMA ALVES DA ROCHA**, Museu Paraense Emilio Goeldi, Pós-graduação em Zoologia, Av. Perimetral, 1901, C.P. 399, 66040-170 – Belém PA, Brazil (e-mail: waldima@yahoo.com.br).

HEMIDACTYLUS MABOUIA (Amerafrican House Gecko). BAHAMAS: ELEUTHERA: Governor's Harbour, North Shore Drive, 2.0 km E Queens Hwy (25°11.9739'N, 76°13.56402'W; datum WGS84). 11 March 2007. Kenneth L. Krysko, Travis M. Thomas, and Eric F. Schrieber. UF 150826. Verified by Josiah H. Townsend. First record for Eleuthera (Krysko and Borgia 2005. Herpetol. Rev. 36:468). We also collected this species in Governor's Harbour at North Shore Drive, 7.0 km SE Queens Hwy (25°10.44'N, 76°11.2824'W) on 11, 12, 15 March 2007 (UF 150829, 150865–66); North Shore Drive, 1.3 km E Queens Hwy (25°12.0432'N, 76°13.98558'W) on 14 March 2007 (UF 150844–49); and Banana Beach (25°14.03358'N, 76°16.3368'W) on 15 March 2007 (UF 150850). All specimens were collected under bark of Australian Pine trees (*Casuarina equisetifolia*) during the daytime and on building walls at night. This species has also been found recently on Long Island, Great Exuma Island, New Providence Island, and San Salvador Island (Krysko and Borgia, *op. cit.*; R. Franz, pers. comm.).

Submitted by **KENNETH L. KRYSKO** (e-mail: kenneyk@flmnh.ufl.edu) and **TRAVIS M. THOMAS,** Division of Herpetology, Florida Museum of Natural History, Dickinson Hall, University of Florida, Gainesville, Florida 32611, USA.

HEMIDACTYLUS MABOUIA (Amerafrican House Gecko). COSTA RICA: SAN JOSÉ: La Uruca. 21 August 2006. Ana M. Monge. Verified by Jay M. Savage. Collection of Laboratorio de

Recursos Naturales y Vida Silvestre (LRNV 000152). First record for Costa Rica, and according to Köhler (2003. Reptiles of Central America. Herpeton, Offenbach, Germany. 367 pp.), this exotic species is presently known elsewhere in Central America from Panamá and Honduras.

Submitted by **JUAN ABARCA** (e-mail: antinosedal@yahoo.es) and **ANA M. MONGE,** Laboratorio de Recursos Naturales y Vida Silvestre, Universidad Nacional, Heredia, Costa Rica (e-mail: ammocr@gmail.com).

HEMIDACTYLUS MABOUIA (Amerafrican House Gecko). USA: FLORIDA: ALACHUA CO: Gainesville, University of Florida campus, Museum Road & Newell Drive (29°38'42.114"N, 82°20'35.592"W, Datum WGS84). 20 November 2006. Kenneth L. Krysko. UF 150119. Gainesville, 704 SW 16th Avenue (29°38'8.18"N, 82°19'55.3"W, Datum WGS84). 06 and 08 May 2007. Louis A. Somma. UF 151218–19, respectively. Gainesville, 990 SW 16th Avenue (29°38'8.71"N, 82°20'16.47"W, Datum WGS84). 9 May 2007. Louis A. Somma. UF 151220. Gainesville, 1111 SW 16th Avenue (29°38'11.25"N, 82°20'14.67"W, Datum WGS84). 12, May 2007. Louis A. Somma. UF 151221–22. Gainesville, 1100 SW 16th Avenue (29°38'11.27"N, 82°20'14.32"W, Datum WGS84). 15 and 16 May 2007. Louis A. Somma. UF 151224–25, respectively. Gainesville, 1001 SW 16th Avenue (29°38'11.51"N, 82°20'10.8"W, Datum WGS84). 12 May 2007. Louis A. Somma. UF 151223. All specimens verified by Kevin M. Enge. New county record and northernmost known localities in Florida (Meshaka et al. 2004. The Exotic Amphibians and Reptiles of Florida. Krieger Publ. Co., Malabar, Florida).

Submitted by **KENNETH L. KRYSKO**, Florida Museum of Natural History, Division of Herpetology, University of Florida, Gainesville, Florida 32611, USA; and **LOUIS A. SOMMA**, Department of Zoology, PO Box 118525, 223 Bartram Hall, University of Florida, Gainesville, Florida 32611-8525, USA (e-mail: las@zoo.ufl.edu).

HEMIDACTYLUS TURCICUS (Mediterranean House Gecko). USA: TEXAS: TRINITY CO.: 4218 FM 357, Kennard (31°15.570'N, 95°02.853'W). Collected on 18 July 2006. TCWC 91800. Verified by Toby Hibbitts. New county record (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. Texas A&M Univ. Press, College Station, Texas. 421 pp.). Specimen collected at a residence.

Submitted by **CORY K. ADAMS**, Southern Research Station, USDA Forest Service, Nacogdoches, Texas 75965, USA.

HETERODACTYLUS LUNDII. BRAZIL: BAHIA: Municipality of Mucugê, Caraíbas Farm (13°08'09"S, 41°24'15"W). 8 December 2005. 1100 m elev. M. A. de Freitas and T. F. Santos Silva. Museu de Zoologia da Universidade de São Paulo, São Paulo, Brazil (MZUSP 95588). Verified by A. J. Suzart Argôlo. Previously known only from the type locality in the southern portion of the Serra do Espinhaço, Minas Gerais state, Brazil (Bertoluci 1998. *In* Machado et al. [eds.], Livro Vermelho das Espécies Ameaçadas de Extinção de Minas Gerais, pp. 442–443. Fundação Editora Biodiversitas, Belo Horizonte, Brazil). First state record, extends known distribution ca. 700 km N from Serra da Piedade, Caeté, Minas Gerais, Brazil (Bertoluci 1998, *op. cit.*)

Submitted by **MARCO ANTÔNIO DE FREITAS,** Programa de Pós-graduação em Zoologia, UESC (Universidade Estadual de Santa Cruz) CEP 46.500-000 Rodovia Ilhéus/Itabuna, Ilhéus, Bahia, Brazil **(**e-mail: philodryas@hotmail.com**)**; **THAÍS FIGUEIREDO SANTOS SILVA**, Biogeographia publicações e consultoria ambiental, Rua E quadra D lote 11, Jardim Aeroporto, CEP 42700-000, Lauro de Freitas, Bahia, Brazil (e-mail: thaisfsilva@hotmail.com); and **MIGUEL TREFAUT RODRIGUES**, Instituto de Biociências, Museu de Zoologia da Universidade de São Paulo (USP) CEP 05586-060, São Paulo, SP, Brazil (e-mail: mturodri@usp.br).

LEIOCEPAHLUS CARINATUS (Northern Curly-tailed Lizard). USA: FLORIDA: MONROE CO.: Key West, 3700 Northside Drive (24°34'11.69"N, 81°45'25.398"W, Datum WGS84). 09 February 2006. Kim Gabel. UF 150934. Verified by Kevin M. Enge. New island record. Southernmost verified locality in the United States and extends known range of this species ca. 82 km S of previous southernmost record in Islamorada, Lower Matecumbe Key (Meshaka et al. 2006. J. Kansas Herpetol. 17:6). Big Pine Key, 263 Ship's Way (24°40'26.641"N, 81°22'5.941"W, Datum WGS84). 29 March and 04 May 2007. Jeanette Hobbs. UF 150933 and 151170, respectively. Verified by Kenneth L. Krysko. New island record and ca. 45 km NE of our Key West locality.

Submitted by **KENNETH L. KRYSKO**, Florida Museum of Natural History, Division of Herpetology, University of Florida, Gainesville, Florida 32611, USA; and **KIM GABEL**, UF/IFAS/ Monroe County Extension, 1100 Simonton Street, Suite 2-260, Key West, Florida, USA; and **JEANETTE HOBBS**, 263 Ship's Way, Big Pine Key, Florida 33043, USA.

LIOLAEMUS FITZINGERI. ARGENTINA: SANTA CRUZ: DEPARTAMENTO RIO CHICO: Ruta Nacional 40, 99.6 km N Tres Lagos, 3 km N Estancia La Siberia, dunes on east shore of Lago Cardiel (48°57'S; 71°01"W 399 m elev.) 16 January 2007. L. J. Avila, C. H. F. Perez, C. Zanotti, J. W. Sites, Jr. Museo de La Plata herpetological collection (MLP.S 2598); Luciano Javier Avila/ Mariana Morando-CENPAT Herpetological collection (LJAMM 7340, 7343). Verified by D. R. Perez. Previously known from southern Chubut and northern and eastern Santa Cruz provinces (Cei 1986. Reptiles del Centro, Centro-oeste y Sur de la Argentina. Herpetofauna de las Zonas Aridas y Semiaridas. Monograph 4. Museo Regionale di Scienze Naturalli Torino. 427 pp.). Southwesternmost record for the species and new department record, extends the known distribution 250 km S from nearest locality on southern coast of Lago Buenos Aires (Avila et al. 2006. Biol. J. Linn. Soc. 89[2]:241–275). This record is a notable geographic extension for the species in the area. Lago Cardiel sand dunes are apparently isolated from any other suitable habitat for *Liolaemus fitzingerii* and sampling efforts in other surrounding areas were unsuccessful, suggesting that this population is a remnant of a larger distribution in the past.

Submitted by **LUCIANO J. AVILA, CRISTIAN H. F. PEREZ, MARIANA MORANDO**, CENPAT-CONICET, Boulevard Almirante Brown 2825, U9120ACF, Puerto Madryn (Chubut), Argentina (e-mail: avila@cenpat.edu.ar); and **JACK W. SITES**, Jr., Integrative Biology, 401 WIDB, Brigham Young University, Provo, Utah 84602, USA.

LIOLAEMUS LAURENTI. ARGENTINA: MENDOZA PROVINCE: Lavalle Departament: 11 km. SW from Encón, San Juan Province, 32°17'22.7"S, 67°52'34.3"W. 01 February 2006. C. S. Abdala, J. S. Abdala, and J. O. Abdala. Herpetological Collection Fundación Miguel Lillo, Tucumán, Argentina (FML 18106–107). Verified by F. Lobo. Known from southern central Catamarca, central and southwestern La Rioja, and eastern San Juan (Etheridge 1992. Boll. Museo Reg. Sci. Nat., Torino 10[1]:1–19). First province record, extends the range 90 km SW from 4 km W of Bermejo, San Juan Province (Etheridge and Espinoza 1997. Herpetol. Rev. 28:160–161).

Submitted by **CRISTIAN ABDALA**, CONICET - Instituto de Herpetología de la Fundación Miguel Lillo, Miguel Lillo 251, 4000, Tucumán, Argentina (e-mail: popper@tucbbs.com.ar); **FLAVIO MARTINEZ** (e-mail: martinezflavio@yahoo.com.ar) and **LEONARDO MUÑOZ**, Dirección de Recursos Naturales Renovables, Almirante Brown s/n, Parque Gral. San Martín Mendoza, CP 5500, Argentina.

LYGOSOMA BOWRINGII (Bowring's Supple Skink). BANGLADESH: COMILLA DISTRICT: Lalmai-Tipperah Hills (23°22'N, 91°07'E), 12 July 2006. S. Mahony and A.H.M. Ali Reza. Wildlife Laboratory, Department of Zoology, Jahangirnagar University, Savar, Dhaka (JU 0050). Photograph deposited at USDZ, Raffles Museum of Biodiversity Research, National University of Singapore (ZRC[IMG].2.1). Verified by Indraneil Das. First record for Bangladesh and western range extension from nearest populations in Myanmar (of which the border is > 240 km w of Comilla) (Das 2002. A Photographic Guide to Snakes and Other Reptiles of India. New Holland Publishers [UK] Ltd., London. 144 pp.). Supported by Cleveland Metroparks Zoo and Rufford Foundation to the second author, which partially supported the first author. Bangladesh Forest Department issued permission (CCF [Wildlife]/ 2M–47/2006) for this work to the second author. Thanks are due to Md. Kamal Hossain from JU for his enthusiastic assistance in the field.

Submitted by **STEPHEN MAHONY**, 3 Park View Lawns, Greenpark, Clondalkin, Dublin 22, Ireland (e-mail: stephenmahony2@gmail.com); and **A. H. M. ALI REZA**, Department of Natural Resources Management, Texas Tech University, Lubbock, Texas 79409, USA (e-mail: ali.reza@ttu.edu).

NOROPS SAGREI (Brown Anole). USA: ALABAMA: Lee Co.: Opelika, Plant World Nursery. 7509 Lee Road 146. Approximately 100 m NW of Parkers Crossroad (intersection of Lee Rd 146 & Lee Rd 166). Collected first by Roger Birkhead, then by John Steffen, verified by Craig C. Guyer. Voucher specimens deposited in Natural History Museum at Auburn University (AU 37296, 37297). First published record for Alabama. Nearest localities are 286 km SE in Valdosta, Georgia (Echternacht et al. 1995. Herpetol. Rev. 26:107) and 270 km SE in Panama City, Florida (Means 1990. Herpetol. Rev. 21:96). On 23 January 2006, RB collected a solitary male (AU 37293). On 25 March 2006, JS sighted a minimum of 30 adult males and 20 adult females in approximately one hour search time. Animals were seen perching on plant scaffolding, nursery walls and tables, and at least one pair was seen copulating on greenhouse scaffolding.. Brown Anoles are common invaders throughout Florida (Lee 1985. Copeia 1985:182–194), and have recently been found in Georgia (Echternacht et al., *op. cit*; Campbell and Hammontree 1995. Herpetol. Rev. 26:107), Louisiana (Platt and Fontenot 1994. Herpetol. Rev. 25:33), and Texas (Krusling et al. 1995. Herpetol. Rev. 26:108). It is speculated that lizards in Georgia and Louisiana have colonized these localities when transported as propagules from Florida plant nurseries. This current sighting definitively implicates plant nurseries as propagules for colonization.

Submitted by **JOHN STEFFEN** and **ROGER BIRKHEAD**, 331 Funchess Hall, Department of Biological Sciences, Auburn University, Auburn, Alabama 36849, USA.

PLESTIODON OBSOLETUS (Great Plains Skink). MÉXICO: SONORA: Municipality of Hermosillo, 34 km (by Son. Hwy 104) E Hermosillo (29.049928°N, 110.604418°W). 4 July 1991. Adrian Quijada and Ivan Parra. Verified by C. H. Lowe. UAZ 49170. First record for the Municipality of Hermosillo, extending the range ca. 146 km (airline) SW from the vicinity of Gúasabas, Sonora (Cliff 1953. Copeia 1953:186–187). The lizard was found in a transition zone between Sonoran Desert scrub and Sinaloan thorn scrub.

Submitted by **ADRIÁN QUIJADA MASCAREÑAS**, Facultad de Biología, Universidad Michoacana de San Nicolás de Hidalgo (UMSNH), Ciudad Universitaria, Morelia 58030, Michoacán, México; **ERIK F. ENDERSON**, Drylands Institute, PMB 405 2509 North Campbell Avenue, Tucson, Arizona 85719, USA (e-mail: erikenderson@msn.com); **IVAN PARRA-SALAZAR**, School of Natural Resources, 325 Biological Sciences East, University of Arizona, Tucson, Arizona 85721, USA; and **ROBERT L. BEZY**, Herpetology, Natural History Museum of Los Angeles County, Los Angeles, California 90007, USA.

SCINCELLA GEMMINGERI **(**Forest Ground Skink) MÉXICO: CHIAPAS: Municipality of Tuxtla Gutiérrez: Km 12.7 on Tuxtla Gutiérrez–Cañón del Sumidero road (16°48'31.4"N, 93°05'21.6"W), 1186 m elev. 12 November 2004. Alberto Mendoza Hernández and Roberto Luna Reyes. Instituto de Historia Natural y Ecología, Chiapas (IHNHERP 3377, 3383, 3384). Verified by Luis Canseco Márquez. First state record, extending its known range ca. 121 km NE of Rodulfo Figueroa, Oaxaca (MZFC 15558; García-Vázquez 2004. Revisión Taxonómica del Genero *Scincella* [Lacertilia: Scincidae] de México. Unpubl. thesis, Univ. Autón. de Puebla, Puebla). The specimen was collected in tropical deciduous forest.

Submitted by **ROBERTO LUNA-REYES,** Dirección de Investigación, Instituto de Historia Natural y Ecología, Tuxtla Gutiérrez, Chiapas; **URI OMAR GARCÍA-VÁZQUEZ** and **ANDRÉS ALBERTO MENDOZA-HERNÁNDEZ,** Museo de Zoología, Facultad de Ciencias, UNAM, A.P. 70-399, México D.F. 04510, México (e-mail: urigarcia@gmail.com).

TUPINAMBIS QUADRILINEATUS (Teiu). BRAZIL: DISTRITO FEDERAL: Ponte Alta de Cima: Gama (16°01'S, 48°12'W). 09 November 2006. G. B. Figueiredo, W. E. Salmito, and T. C. S. Guimarães. Verified by G. R. Colli. Coleção Herpetológica da Universidade de Brasília, Brazil (CHUNB 49442, adult male collected in a gallery forest from Cerrado). Previously known in Brazil only from the states of Tocantins (Mesquita et al.

2006. Copeia 2006:460–471), Mato Grosso, and Goiás (Colli et al. 1998. Herpetologica 54:477–492). First record for the State of Distrito Federal, extends known distribution ca. 82 km NW from Pirenópolis, Goiás State, the nearest previous record (Colli et. al., *op. cit.*).

Submitted by **TAINAH C. S. GUIMARÃES** (e-mail: tainah.correa@gmail.com), **GIOVANNI B. FIGUEIREDO** (e-mail: calangoboca@yahoo.com.br), and **WALFRIDO E. SALMITO** (e-mail: walbsb@hotmail.com), Departamento de Zoologia, Universidade Católica de Brasília, Prédio São Gaspari Bertoni, QS 07, Lote 01, EPTC, 72030-170, Águas Claras, Distrito Federal, Brazil.

UTA STANSBURIANA (Side-blotched Lizard). USA: TEXAS: COCHRAN CO.: 4 road km N FM 769 on State Line Road (33°36'22.6"N; 103°02'42.3"W). 10 June 2006. David Laurencio and Toby J. Hibbitts. Verified by James R. Dixon. Texas Cooperative Wildlife Collections, TCWC 91462–91464. New county record, closest known populations are in Roosevelt County, New Mexico. (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. Texas A&M University Press, College Station, Texas. 421 pp.). The specimens were collected during research on *Sceloporus arenicolus* with funding from Texas Parks and Wildlife Department.

Submitted by **TOBY J. HIBBITTS, DAVID LAURENCIO**, and **LEE A. FITZGERALD,** Texas Cooperative Wildlife Collections, Department of Wildlife and Fisheries Sciences, Texas A&M University, 2258 Tamu, College Station, Texas 77843-2258, USA (e-mail: thibbitts@tamu.edu).

SERPENTES

BOTHROPS ALTERNATUS. BRAZIL: RIO DE JANEIRO: Três Rios municipality (22°07'S, 43°12'W). 05 July 1960. Museu Nacional, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil (MNRJ 8337). Verified by R. Fernandes. Species previously known from northern and central Argentina (provinces of Buenos Aires, Catamarca, Córdoba, Corrientes, Chaco, Entre Rios, Formosa, La Pampa, Misiones, San Luis, Santa Fe, Santiago del Estero, and Tucumán), throughout Uruguay, southern Paraguay, and southern, southeastern, and central Brazil (States of Rio Grande do Sul, Santa Catarina, Paraná, São Paulo, Minas Gerais, Mato Grosso, and Goiás) (Campbell and Lamar 2004. The Venomous Reptiles of the Western Hemisphere, Vol. 1. Cornell Univ. Press, Ithaca, New York. p. 366; Hoge and Belluomini 1960/62. Mem. Inst. Butantan 30:97–102; Nogueira and Valdujo 2001. Herpetol. Rev. 32:58). First state record, ca. 120 km SE from the closet previous record (Minas Gerais: Barbacena municipality; Hoge and Belluomini, *op. cit.*).

Submitted by **ADRIANO LIMA SILVEIRA** (e-mail: biosilveira@yahoo.com.br) and **PAULO R. EVERS JR.,** Setor de Herpetologia, Departamento de Vertebrados, Museu Nacional, Universidade Federal do Rio de Janeiro, Quinta da Boa Vista, São Cristóvão, CEP 20940-040, Rio de Janeiro, RJ, Brazil (e-mail: pauloevers@hotmail.com).

CHARINA BOTTAE (Rubber Boa). USA: IDAHO: LEWIS CO.: Mission Creek Rd, 1.8 km N of Slickpoo (46°19.014'N, 116° 42.665'W). 24 September 2006. Robert E. Weaver. Verified by Kenneth V. Kardong. Voucher specimen deposited in the Central Washington University Department of Biological Sciences Herepetology Collection (CWU 1693). Juvenile female collected DOR (265 mm SVL, 13.6 g). First county record. Although regional field guides depict the distribution of *Charina bottae* as continuous throughout the Pacific Northwest (Storm et al. 1995. Reptiles of Washington and Oregon. Seattle Audobon Society, Seattle, Washington. 176 pp.), several counties in north-central Idaho form a significant gap in distribution data for this species (Nussbaum et al. 1983. Amphibians and Reptiles of the Pacific Northwest. University of Idaho Press, Moscow, Idaho. 332 pp.). This locality fills a gap between the nearest record in Nez Perce Co., 12.1 km NW near Lewiston, and historical records in Adams Co.

Submitted by **ROBERT E. WEAVER** (e-mail: weaver@wsu.edu) and **ALEX DORNBURG** (e-mail: dornburgalex@yahoo.com), School of Biological Sciences, Washington State University, Pullman, Washington 99164, USA.

CHIRONIUS QUADRICARINATUS. BRAZIL: BAHIA: Municipality of Mucugê, Caraíbas Farm (13°08'09"S, 41°24'15"W). 15 December 2005. 1100 m elev. M. A. de Freitas and T. Figueiredo Santos. Museu de Zoologia da Universidade de São Paulo, São Paulo, Brazil (MZUSP 15049). Verified by A. J. Suzart Argôlo. Previously known from south-central Brazil, including São Paulo, Mato Grosso, Minas Gerais, Rio de Janeiro, and southeastern Bahia state (Dixon et al. 1993. Revision of the Neotropical Snake Genus *Chironius* Fitzinger [Serpentes, Colubridae]. Museo Regionale di Scienze Naturali – Torino; Argôlo 1998. Herpetol. Rev. 29:175). Second record of the species from northeastern Brazil, extends its distribution ca. 400 km N of Canavieiras, Bahia state (Argôlo 1998, *op. cit.)*.

Submitted by **MARCO ANTÔNIO DE FREITAS,** Programa de Pós-graduação em Zoologia, UESC (Universidade Estadual de Santa Cruz) CEP 46.500-000 Rodovia Ilhéus/Itabuna, Ilhéus, Bahia, Brazil (e-mail: **(**philodryas@hotmail.com**)**; **THAÍS FIGUEIREDO SANTOS SILVA,** Biogeographia Publicações e Consultoria Ambiental, Rua E quadra D lote 11, Jardim Aeroporto, CEP 42700-000, Lauro de Freitas, Bahia, Brazil (e-mail: (thaisfsilva@hotmail.com); and **MIGUEL TREFAUT RODRIGUES,** Instituto de Biociências, Museu de Zoologia da Universidade de São Paulo (USP) CEP 05586-060, São Paulo, SP, Brazil **(**e-mail: mturodri@usp.br**).**

CROTALUS INTERMEDIUS GLOYDI (Oaxacan Small-headed Rattlesnake). MÉXICO: VERACRUZ: MUNICIPALITY OF ATZOMPA: 3 km S of Atzompa (18°43'7.9"N, 97°12'20.9"W), 2571 m elev. 02 May 2004. Uri Omar García Vázquez. Verified by Luis Canseco Márquez. Colección Herpetológica del Museo de Zoología Alfonso L. Herrera, Facultad de Ciencias, UNAM (MZFC 19841). New state record, extending the known range of this subspecies slightly east of localities in southeastern Puebla (Campbell and Lamar 2004. Venomous Reptiles of the Western Hemisphere. Cornell Univ. Press., Ithaca, New York. 870 pp.). The snake was found in pine-oak forest.

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brysonjr@unlv.nevada.edu); and **URI OMAR GARCÍA-VÁZQUEZ**, Museo de Zoología, Facultad de Ciencias, UNAM, A.P. 70-399, México D.F. 04510, México (e-mail: urigarcia@gmail.com).

DENDRELAPHIS NGANSONENSIS (Nganson Bronzeback). CHINA: YUNNAN: Lung Ling Ting. 21 March 1917. Roy C. Andrews and Edmund Heller. AMNH R–21045. HAINAN ISLAND: NODOA. January 1922–July 1923. Clifford H. Pope. Verified by Gernot Vogel. AMNH R–27754. First country record. Currently known from Ngan Son (Bac Kan Province, type locality), Tam Dao (Vinh Phuc Province), Cuc Phuong N.P., Ky An-Ke Go and Chin Xai (Ha Tinh Province), Phong-Nha - Khe Bang N.P. (Quang Binh Province), Bach Ma (Thua Thien-Hue Province), and "Col des Nuages, near Tourane" (= Danang), Vietnam (Bourret 1936. Les serpents de l'Indochine. Henri Basuyau, Toulouse. Vol. 2., pp. 505; Ziegler and Vogel 1999. Russ. J. Herpetol. 6:199–208; Ziegler et al. 2004. Hamadryad 28:19–42). Also recorded from Laos from the "mountainous provinces of Xieng-Khouang" (= Xien Khoang Province) (Deuve 1970. Serpents du Laos. Office de la Recherche Scientifique et Téchnique Outre–Mer. Memoires ORSTOM No. 39, Paris. 251 pp.). Pope (1935. The Reptiles of China. Natural History of Central Asia. Vol. 10. American Museum of Natural History, New York. li + 604 pp.; 27 pl.) referred to these specimens as *Dendrophis boiga boiga*. New record for China (Daming 2002. Atlas of Reptiles of China. Henan Publishing House of Science and Technology, C.W.P. Zhengzhou. 346 pp.; Zhou and Yu 2002. Sich. J. Zool. 21:236–238).

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HYPSIGLENA TORQUATA (Night Snake). USA: WASHINGTON: Columbia Co.: Tucannon River Rd (46°26.792'N, 117°46.165'W). Alex Dornburg. Verified by Kenneth V. Kardong. Voucher specimen deposited in the Central Washington University Department of Biological Sciences Herpetology Collection (CWU 1695). Adult female (285 mm SVL, 11.4 g) collected DOR 15 October 2006. First county record. Until very recently, few specimens of *H. torquata* have been recorded from SE Washington, and confusion surrounds the official regional documentation of this species. Some regional field guides show a single record for Asotin Co., and none for Columbia Co. (Nussbaum et al. 1983. Amphibians and Reptiles of the Pacific Northwest. University of Idaho Press, Moscow, Idaho. 332 pp.), while some report no specimens from Asotin Co., but one for Columbia Co. (Hallock and McAllister 2005. Washington Herp Atlas http://www.dnr.wa.gov/nhp/refdesk/herp/). Regardless, no voucher specimens (photo or otherwise) exist for either county. Given this confusion and the absence of any voucher, we consider this to be the first specimen recorded from Columbia County, Washington.

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LAMPROPELTIS CALLIGASTER (Prairie Kingsnake). USA: TEXAS: Montgomery Co.: 1.6 road km N of junction of FM 149 on FM 1774 (30°10'45.12"N, 95°41'50.28"W). 5 April 2007. D. G. Henderson. Verified by Toby J. Hibbitts. Texas Cooperative Wildlife Collection, TCWC 91799. New county record (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. Texas A&M University Press, College Station, Texas. 421 pp.).

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PLATYCEPS TAYLORI (Taylor's Racer). ERITREA: Gahtelay (15°31'N, 39°10'E), caught in a dry wadi. 08 November 2006. Beat Schätti. MHNG 2680.55. Verified by Andreas Schmitz. Northernmost known locality of the species and first record from N of Danakhil depression; extends range by at least 400 km northwest of closest record from Assab (Largen and Rasmussen 1993. Trop. Zool. 6[2]:313–434).

Submitted by **BEAT SCHÄTTI**, Apartado postal 383, San Miguel de Allende, 37700 Guanajuato, Mexico; e-mail: beatschaetti@hotmail.com.

PYTHON MOLURUS BIVITTATUS (Burmese Python). USA: FLORIDA: Monroe Co.: Key Largo, 0.27 mi E CR 905 and Loquat Drive, Dagny Johnson Key Largo Hammock Botanical State Park (25°10'28.158"N, 80°21'58.92"W, WGS84; elev. < 1 m). 13 April 2007. Daniel U. Greene, James G. Duquesnel, Joanne Potts, and Clay Degayner. Verified by Kenneth L. Krysko. Florida Museum of Natural History (UF 151037). First record from the Florida Keys (Snow et al. 2007. *In* R. W. Henderson and R. Powell [eds.], The Biology of Boas and Pythons, pp. 416–438. Eagle Mountain Publ., Eagle Mountain, Utah). A single male python (200 cm SVL, 5.7 kg) found while radio-tracking a Key Largo woodrat (*Neotoma floridana smalli*). Necropsy revealed the radio collar and animal, along with a second (non-collared) *N. f. smalli*, which is both Federally and State listed as Endangered. Because of the potential threat that *Python molurus* poses to native species in Florida, especially on small islands, this record heightens concern for the endemic and endangered fauna in the Florida Keys (Reed 2005. Risk Analysis 253:753–766).

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RAMPHOTYPHLOPS BRAMINUS (Brahminy Blindsnake). USA: FLORIDA: Alachua Co.: Gainesville: SR 121 N of intersection with SR 24 (1911 SW 34th St.) (29°38'04.07"N, 82°22' 15.55"W). 16 May 2007. Collected by Louis A. Somma. Verified

by Kenneth L. Krysko, Florida Museum of Natural History, University of Florida. One adult within a termite colony, beneath rock. UF 151211; additional specimens (UF 151212–14) were also found. All specimens were collected between 1200–1240 h at the Division of Plant Industry (DPI), Florida Department of Agriculture and Consumer Services. In 2006, another adult *R. braminus* was collected by an employee at this site, near a greenhouse, and was kept in captivity until it escaped. *Rhamphotyphlops* is occasionally encountered by employees of DPI and it may be expanding its range, as there is one specimen (UF 147001) collected from the University of Florida campus (Powell Hall) adjacent to the DPI site (29°38'7.9080"N, 82°22'12.4320"W) on 10 May 2006, by J. Weber.

The first evidence of this species from Gainesville is an unpublished single specimen record (29°39'23.0761"N, 82°22'33.0240"W), from November 1999, I. A. Minno (UF 120116). The first published account referenced a specimen found at the USDA lab on the University of Florida campus (Townsend et al. 2002. Herpetol. Rev. 33:75). Although these specimens reported here do not expand the range of this species, they establish the presence of a population of *R. braminus* in Gainesville, Alachua Co. This Southeast Asian, parthenogenic typhlopid has been collected from at least 17 counties in Florida (Ernst and Brown 2000. Herpetol. Rev. 31:256; Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Inst. Books, Washington, DC; Meshaka et al. 2004. The Exotic Amphibians and Reptiles of Florida. Krieger Publ. Co., Malabar, Florida; Krysko et al. 2005. Herpetol. Rev. 36:85–87).

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RAMPHOTYPHLOPS BRAMINUS (Brahminy Blindsnake). MÉXICO: OAXACA: Municipality of Villa de Tututepéc de Melchor Ocampo, Río Grande (16°00'45"N, 97°25'59"W), 29 m elev. 03 January 2007. Martín Cruz Santiago. Verified by Adrian Leyte-Manrique. Colección Herpetológica del Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo (CIB-CH1376). First record for the municipality and a 205 km range extension S of the only other verified Oaxacan record from Cuicatlán (Mendoza Quijano et al. 1994. Herpetol. Rev. 25:34), which is located on the Gulf versant of the state. The closest known localities to this record are from adjacent Guerrero (Dixon and Hendricks 1979. Zool. Verh. 173:1–39). Literature records indicate that this exotic species has become well established along the Pacific lowlands from Sinaloa (Dixon and Hendricks, *op. cit.*), Jalisco (Dundee and Flores-Villela 1991. Herpetol. Rev. 22:26), Michoacán (Duellman 1965. Univ. Kansas Publ. Mus. Nat. Hist. 15:629–709), Guerrero (Dixon and Hendricks, *op. cit.*), into Oaxaca. Casas-Andreu (2004. *In* Garcia-Mendoza et al. [eds.], Biodiversidad de Oaxaca, pp. 375–390. Inst. Biol. UNAM, México, D.F.) indicated that this species occurs on the Pacific coastal plain of Oaxaca, but cites no localities. The snake was found crawling on a street in the town of Río Grande.

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RAMPHOTYPHLOPS BRAMINUS (Brahminy Blindsnake). USA: TEXAS: NACOGDOCHES CO.: Nacogdoches, 134 North Church St. (31°36'13.38"N, 94°39'09.84"W). 29 July 2006. William B. Godwin. Verified by James R. Dixon. Texas Cooperative Wildlife Collections, TCWC 91545. This is the second known locality for this species in the state. New county record and second state record (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. Texas A&M University Press, College Station, Texas. 421 pp.; J. R. Dixon, pers. comm.).

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Discovery of an Introduced Population of *Discoglossus pictus* Beyond its Known Distributional Range

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The introduction of invasive species is, after habitat destruction, the second most important cause of biodiversity loss on the planet (Devine 1998; IUCN 2000; Mack et al. 2000). The main problems related to the introduction of invasive species are competition with local fauna, introduction of pathogens and genetic pollution of autochthonous populations (Arano et al. 1995; Butterfield et al. 1997; Dodd and Seigel 1991; Elton 1958; Manchester and Bullock 2000). According to one estimate, 39% of all known extinctions that have taken place in the last 300 years have been as a result of the introduction of exotic species (Guijarro 2001). Especially injurious are the introductions of invasive species that disperse well and adapt quickly to new environments (Kolar and Lodge 2001; Sax and Brown 2000).

Discoglossus pictus is a North African species that was intro-

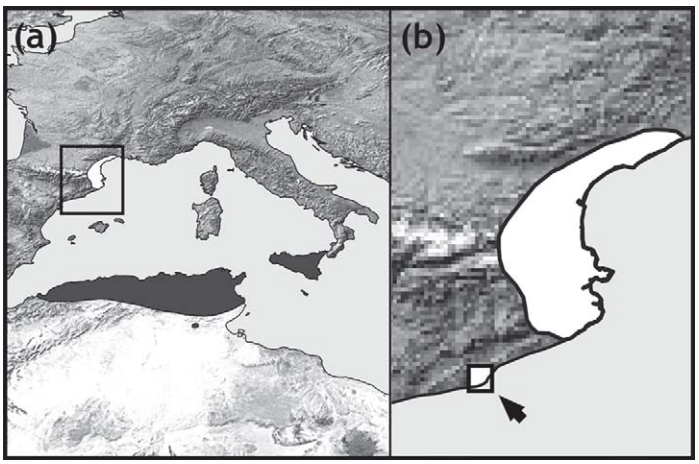


FIG. 1. Distribution of *Discoglossus pictus* in the western Mediterranean basin (left) and in the northeastern Iberian Peninsula (right). The black arrow shows the new 10 × 10 UTM (31T DF21) occupied by *D. pictus.*

duced from Algeria to a small village in Continental Europe (Banyuls Sur Mer), approximately 100 years before present (Wintrebert 1908), and now has a continuous range extending > 7000 km^2, from SW France to NE Iberia (Fig. 1) (Barbadillo et al. 1999; Fradet and Geniez 2004; Geniez and Cheylan 1987; Knoepffler 1962; Lanza 1989; Llorente et al. 1995, 1997; Montori et al. 2007; Salvador and García-París 2001; Wintrebert 1908). New data on the distribution of the introduced population of *D. pictus* suggest that it is extending its range at a similar rate to other amphibians (Leblois et al. 2000; Llorente et al. 1995, 2002; Montori et al. 2007). These studies indicate that populations have progressed within the province of Girona 60 km to the west and 140 km to the south in the last century, being its southern expansion the most accentuated (Montori et al. 2007). This progress has moved the southern limit of the distribution range of *D. pictus* in Iberia on the north of Barcelona province (Fig. 1).

In this study we report a recent introduction event of *Discoglossus pictus* in the Llobregat River Delta, 60 km south of its present distribution range, and discuss the effects that this introduction might have on the local amphibian fauna, as well as the possibility that this new population might act as a new focus of dispersal towards the south.

This study was part of a larger project on the short and long-term ecological and biological impact that the creation of new infrastructures has on the local amphibian fauna of the Llobregat River Delta (Llorente 2005). Between 2004 and 2005, extensive field surveys were carried out by means of habitat transects with constant capture effort. All amphibian species could be easily identified with the only exception of several specimens of the genus *Discoglossus* found during the surveys. The genus *Discoglossus* includes seven relatively similar species all found in the Mediterranean Basin: *Discoglossus galganoi* and *D. jeannae*, endemic to the Iberian Peninsula, *D. montalentii* and *D. sardus*, endemic to the Tyrrhenian islands, *D. scovazzi* endemic to North Africa, *D. nigriventer* endemic to Israel (probably extinct) and *D. pictus*, found in North Africa, with introduced populations in continental Europe and some Mediterranean islands (Fromhage et al. 2004; Zangreti et al. 2006). Fortunately, all seven species are easily diagnosable through the comparison of the mitochondrial 16S rRNA gene region (Zangreti et al. 2006; Fromhage et al. 2004).

Genomic DNA was extracted from small non-invasive pieces of tissue from three specimens of *Discoglossus* sp. from the Llobregat Delta and from two specimens of *Discoglossus pictus auritus* from a population in Riudarenes, Girona province. All samples were processed following standard protocols described in Carranza et al. (1999). Gene fragments were amplified by the polymerase chain reaction (PCR) and were sequenced using the same standard protocols and conditions as in Carranza et al. (1999, 2000). Primers 16Sa 5'- CGC CTG TTT ATC AAA AAC AT-3' and 16Sb 5'-ACG TGA TCT GAG TTC AGA CCG G-3' were used in amplification and sequencing of approximately 558 base pairs (bp) of the 16S rRNA gene (Palumbi 1996). The 16S rRNA mtDNA sequences from the Llobregat Delta and the population from Girona were aligned together with 16S rRNA sequences from all seven extant species of *Discoglossus* downloaded from Genbank (AY333712 – AY333724; Fromhage et al. 2004) using ClustalX (Thompson et al. 1997) with default parameters (gap opening = 10; gap extension = 0.2), and their sequences compared with the computer program PAUP* 4.0b10 (Swofford 1998).

The first observations of *Discoglossus* sp. in the Llobregat Delta occurred on 21 April 2004 at 41°17'15.71"N, 02°06'7.78"E (see Fig. 2). Other surveys carried out in 2004 near this location detected three new individuals and, in 2005, 11 individuals (two males, eight females and one juvenile) and one breeding site where tadpoles and metamorphs were detected. The collected specimens were housed in museological institution of the University of Barcelona (Animal Biodiversity Resource Center - www.ub.es/crba/). All observations of *D. pictus* in the Llobregat River Delta were close to water—in floodplains, drainage channels, and pools.

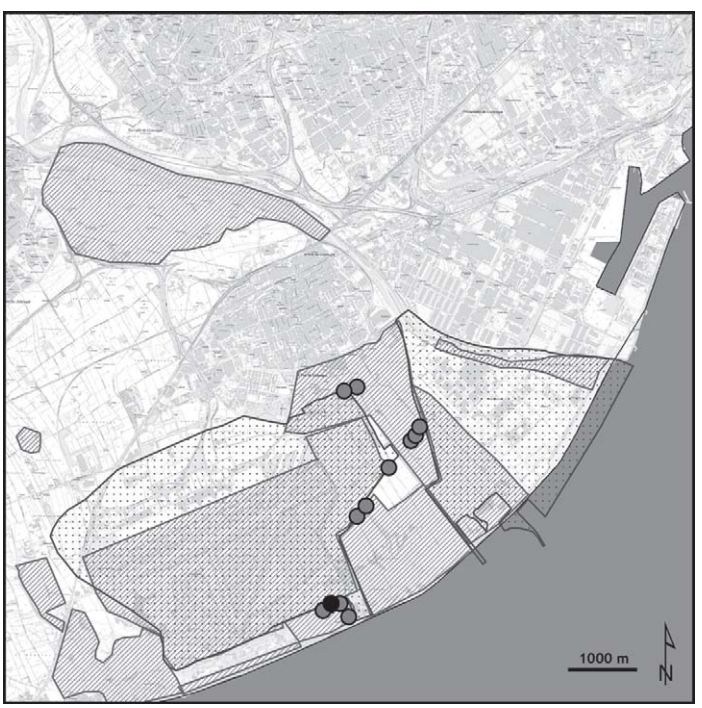


FIG. 2. Specific localities (gray circles) known for *Discoglossus pictus* in the Llobregat River Delta. Breeding locality marked with a black circle. Reticulated areas represent prospected zones cover by the study.

The mitochondrial DNA sequence analysis of three specimens (see above) from the Llobregat Delta showed that all of them were identical in the 558 bp of 16S rRNA sequenced to the specimen of *Discoglossus pictus auritus* from Girona (the control population) and showed two differences with the sample of *Discoglossus pictus auritus* from France (Genbank accession number AY333723), which is also part of the population that was introduced into continental Europe in the Nineteenth Century (Wintrebert 1908). These results expand 60 km further south the known distribution range of *D. pictus* (Fig. 1), and suggest that this is probably another case of human-mediated introduction. Two possible origins of introduced individuals are suggested. One is the indirect introduction by heavy machinery coming from northeast of Catalonia during the construction of new infrastructures in Delta. Second possible origin is voluntary introduction of individuals. In the surrounds of Barcelona it is usual to detect punctual introductions of herpetological species. For example *Triturus marmoratus* and *Lissotriton helveticus* were cited in Barcelona Metropolitan Park out of their distribution ranges.

The Llobregat Delta is located within the potential distribution area estimated by Montori et al. (2007) for this species. This will probably facilitate the establishment of a large viable population that might serve as a springboard for future expansions to other suitable habitats further south. We have verified that the species has been successfully reproducing in the Llobregat Delta, since several juveniles, metamorphs and tadpoles were found in this area.

This new introduced population implies the existence of a second centre of expansion that makes management of the species difficult. Moreover, this area has experienced a substantial decrease in its amphibian diversity as a result of the recent disappearance of three species (*Epidalea calamita*, *Bufo bufo*, and *Pelobates cultripes*) through habitat disturbance and deterioration of water quality. Future surveys in this area will indicate if the range of the species is expanding and if it has been able to establish new populations or, on the contrary, its dispersal has not progressed further. New metamorphs were detected during 2007 proving the persistence of the new population

When the introduction of an allochtonous species takes place, it is important to monitor it from the beginning. This fact facilitates the planning of immediate management measures. The reason for concluding the presence of *Discoglossus pictus* in the Llobregat Delta is the result of a human-mediated introduction and not natural range expansion is because the present expansion front of *D. pictus* in Catalonia is relatively distant (60 km to the north), without intermediate populations. Although the Llobregat River Delta is within the calculated potential distribution range for this species in Catalonia (Llorente et al. 1995; Montori et al. 2007), at the present expansion rate estimated for *D. pictus* (1.53 km/year ± 0.8 km; Montori et al., *op. cit.*), it would take approximately 30 years to disperse naturally to the Llobregat Delta from its closest populations located in the northern limit of the Barcelona province (see Fig. 1).

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Range Extensions for Eight Species of Turtles in Gasconade, Osage, and New Madrid Counties, Missouri

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During a 2006 Wisconsin-type fyke net turtle exclusion device study conducted in Gasconade, Osage, and New Madrid counties, Missouri, ten new county records for turtles were established. The specimens listed below represent the first reported occurrence of the species within the county listed. Turtles were photographed and records were submitted to University of Missouri-Columbia (UMOC) collection. All voucher photographs were verified by Jeffrey T. Briggler and catalogued into the collection. Except where specified all animals were captured by the authors. All records were found within the ranges predicted by Ernst et al. 1994.

Apalone mutica mutica (Midland Smooth Softshell). GASCONADE CO: Gasconade River, Sec. 20 T44N R6W. 01 June 2006. UMOC 1083P.

Apalone spinifera hartwegi (Western Spiny Softshell). OSAGE CO: Gasconade River, Sec. 34 T43N R7W. 19 May 2006. Collected by Zach Fratto and Phil Pitts. UMOC 1073P.

Chelydra serpentina serpentina (Eastern Snapping Turtle). GASCONADE CO: Gasconade River, Sec. 20 T44N R6W. 01 June 2006. UMOC 1062P.

Graptemys ouachitensis ouachitensis. (Ouachita Map Turtle). GASCONADE CO: Gasconade River, Sec. 20 T44N R6W. 01 June 2006. UMOC 1062P.

Graptemys pseudogeographica pseudogeographica (False Map Turtle). NEW MADRID CO: Donaldson Point Conservation Area, Sec. 6 T22N R15E; Bottomland Hardwood Mississippi River floodplain water body. 16 May 2006. University of Missouri-Columbia collection 1057P. GASCONADE CO: Gasconade River, Sec. 20 T44N R6W. 01 June 2006. UMOC 1064P.

Pseudemys concinna concinna (Eastern River Cooter). GASCONADE CO: Gasconade River, Sec. 20 T44N R6W. 01 June 2006. UMOC 1068P.

Sternotherus odoratus (Stinkpot). OSAGE CO: Gasconade River, Sec. 31 T43N R7W. 14 June 2006. University of Missouri-Columbia collection 1072P. GASCONADE CO: Gasconade River, Sec. 22 T44N R6W. 28 June 2006. UMOC 1061P.

Trachemys scripta elegans (Red-eared Slider). GASCONADE CO: Gasconade River, Sec. 20 T44N R6W. 01 June 2006. UMOC 1070P.

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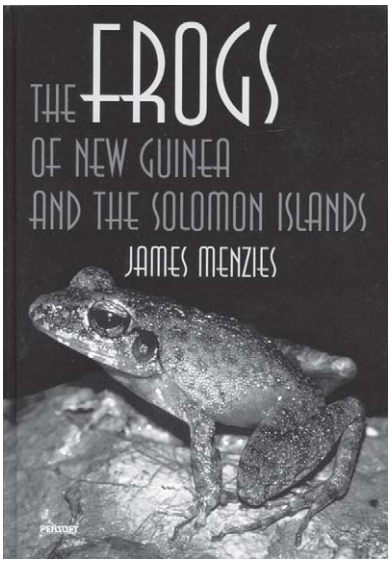
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BOOK REVIEWS

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The Frogs of New Guinea and the Solomon Islands, by James Menzies. 2006. Pensoft Publishers, Sofia, Bulgaria (www.pensoft.net). x + 346 pp., 48 pp. pls. Hardcover. 45.00 € (approx. US $62). ISBN 954-642-273-8.

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The Papuan region comprises New Guinea and immediately adjacent islands, and the Bismarck, Admiralty, Solomon, and Aru islands. It contains a unique biota recognized since the time of Alfred Wallace. Its frog fauna is among the world's largest, with ~350 species described to date and an approximately equivalent number no doubt waiting to be discovered or described. Yet it is also among the poorest known anuran faunas in the world because of its large size, difficulty of geographic access, and paucity of researchers. Among those researchers is Dr. James Menzies, who taught for most of his career at the University of Papua New Guinea and who has probably the greatest amount of wide-ranging field experience with that region's frog fauna. He has now produced a book treating the frog fauna of this region that is a tremendous expansion of his 1975 *Handbook of the Common Frogs of New Guinea*, which has long been out of print and was, as the title suggests, of more limited scope. Included in the new treatment are mention of all 331 frog species known by the end of 2005 to occur in the Papuan region or in the Moluccas for those genera (e.g., *Callulops*, *Litoria*, *Oreophryne*, *Platymantis*) having a few relatives that have filtered westward.

The book is divided into seven sections of widely varying length. An introduction gives the goal of the book to "discuss the frog fauna of New Guinea in its regional context by assembling all that is recorded in the literature." This is followed by sections treating 2) the diversity and biology of Papuan frogs; 3) background information on the topography, geology, climate, and vegetation of the region; 4) origin and biogeography of Papuan frogs; 5) a brief discussion of the layout for the systematic accounts; 6) the systematic accounts themselves, which comprise the large majority of the book; and 7) a one-page description of how to preserve frogs. The sections are followed by an appendix providing spectrograms of many Papuan frog calls, distribution maps for selected genera and species, a glossary of some terms used in the book, a gazetteer of many place names referred to in the book, references cited in the text, and an index. Tacked on too are two pages of newly described species either overlooked in the original compilation (6 spp., p. 346) or described after the book was sent to press (5 spp., p. 273). The meat of the book, of course, are the systematic accounts. Each includes scientific name, author, and year of description; complete citation for the original description; a brief diagnosis of the species (or genus, in some cases); ecological notes; and verbal description of the geographic range. Frequently, descriptions of the acoustic impression of a species' call is provided, which makes interpretation of the spectrograms easier. Species accounts are typically brief; poorly known species frequently verge on telegraphic owing to paucity of available information.

I am sorry to report the book to be disappointing and frustrating at many levels. It is replete with errors of fact, logical inconsistencies, poor writing and editing, and omission of useful information. It is difficult to choose where to begin but I will start with the less important points and proceed to the more important.

Spelling, grammatical, and writing errors are common throughout the book. The first are most often a minor annoyance but the few cases involving species or place names could confuse the novice. Into this category fall "valkuriorum" for "valkuriarum" throughout p. 10, "Carstenz" for "Carstensz" on p. 15, "macosceles" for "macrosceles" on p. 90, "Bainings" for "Baining" on p. 91, "nexippus" for "nexipus" on p. 90, and "elkae" for "elkeae" on pp. 107 and 342.

Spelling inconsistencies are of modest frequency. In this category fall "San Cristobal" vs. "San Christobal" on pp. 80 and 81 as well as "Jayawija", "Jajawijaya", and "Jayawidjaya" on pp. 262 and 264. Most annoying is the consistent use throughout the book of "Guenther" as author following a species name, with "Günther" invariably used in the subsequent line providing complete reference for the original description. Too, it would have been helpful to distinguish A. Günther from R. Günther. Punctuational mistakes are common; in particular, commas are seemingly randomly interspersed throughout the text.

Menzies makes the useful distinction throughout the taxonomic accounts of providing both maximum male and female body sizes. This is important because females are larger than males for most Papuan frogs. However, this standard is inconsistently applied and accounts for several species in which both sexes are known provide only one body size measurement (e.g., *Nyctimystes pulcher*, p. 165); in other cases accounts don't specify sex, leaving the reader to guess to which the information is intended to apply (e.g., *Litoria quadrilineata*, p. 122). Too, the information is usually provided as, e.g., "HBf" but sometimes as "HB female". When he notes that female hylids are up to 30% larger than males (p. 100), he presumably is referring to HB length and not mass.

The writing style in many sections of the book is poor or awkward and leads to confusing, nonsensical, or misleading statements. As one example among many: "Call consisted of a series of double notes contrasting with other species in the *gracilenta* group, with simple notes" (p. 107). Another from p. 37: "The Pliocene was a time of mountain building when the Miocene 'Mobile Belt' Islands became consolidated and developed into the central mountain ranges of present day New Guinea, although the south-east-

ern 'tail', which remained separated by a gap, where the Watut-Bulolo River Valleys now lie." This is especially common in the introductory chapters but improves considerably by the time the microhylid species accounts occur. In other parts, the language is unnecessarily vague: we learn, for example, on p. 15 that New Guinea is one of the largest islands in the world, but not the second-largest island in the world nor the largest tropical island; we discover on p. 17 that the major rivers of northern New Guinea were marine incursions until recently, but we do not learn how recently; we are told on p. 25 that the vegetation seen "on the ground" is likely to be quite different from vegetation-classification systems of Thornthwaite (1948) and Holdridge et al. (1971) but we are not told why. The descriptions of call variables (p. 11) are also unnecessarily brief and not particularly helpful to the uninitiated. Such lack of specificity detracts from the book.

Numerous internal inconstencies occur in the book. A sampling of these include implied polyphyly of Papuan microhylids (p. 37) vs. stated monophyly (p. 39); discussion of alpine vegetation and alpine-dwelling frogs under the section labelled "Species of the subalpine regions (>3000 m)" (p. 45); inclusion of the Owen Stanley Mts. in the range of *Lechriodus aganaposis* on p. 61 but its omission from Map 2; the claim for eight and for seven genera of Papuan ranids in the same paragraph on p. 64; including *Platymantis acrochordus* for comparison with *Discodeles malekuna* in one sentence and then inadvertently comparing it with *P. myersi* in the next (p. 82); noting that *Platymantis nexipus* has longitudinal skin folds (p. 94) while later claiming the dorsum to be smooth (p. 95); calling *Litoria exophthalmia* "mostly green" (p. 102) while the Plate 61 shows a mostly brown frog; stating that the *Litoria nigropunctata* complex is characterized by extensively webbed fingers (p. 114) while ignoring that *L. rubrops* (p. 117) and *L. vocivincens* (p. 119), both members of that group, have fingers with only basal webbing; inclusion of Milne Bay and Popondetta in the range of *Litoria congenita* (p. 122) while omitting them from Map 9; remarking that color in life of *Litoria exophthalmia* is unrecorded (p. 127) while providing a color photo of the species in life (Plate 61); claiming *Litoria modica* to have longer legs on average than *L. pratti* (p. 139) while providing a range of TL/SV for the former (0.52–0.60) that comfortably brackets the single value given for the latter (0.56); stating that *Nyctimystes papua* is smaller than *N. oktediensis* (p. 157) while providing identical HBm values for each; writing "although not known to be sympatric, their distributions overlap" (p. 227); claiming that each of *Hylophorbus picoides* and *H. wondiwoi* is the largest of Günther's new species (p. 250 and p. 252, respectively); and noting that *Xenobatrachus tumulus* occurs only in the Adelbert Mts. (p. 266) but is sympatric with *X. zweifeli* (p. 266), which is only known from the Bewani and Hunstein Mts. The plate numbers cited for the photos of *Litoria leucova* and *L. majikthise* (p. 144) do not accord with the names attached to those plates.

Menzies usefully provides a glossary of some scientific terms at the end of the book. However, some of these—holotype, terrane—are mistakenly defined. Other terms used in the book—acromiohumeralis muscle, adherent tongue, alary processes, centric fission, clavicle, diplasiocoelous, firmisternal, lumbar, mandibular bones, mandibular depressor muscle, maxillary bones, megathermal, mesohumid, mesothermal, nasal bones, omosternum, perhumid, premaxillae, presacral, procoelous, procoracoid, sacral diapophyses, sacrum, subhumid, symphyses, urostyle—are omitted from the glossary and remain undefined in the text. Two terms of non-obvious meaning, "bidomicilic" and "ecological vicars" are frequently used in the book but do not appear in the glossary, although the former is defined on p. 33, at its second usage. Similarly, the term "mid-green" is used (p. 105) but its meaning is unclear – "mid" in terms of hue? saturation? intensity? Geographic terminology is largely relegated to a series of footnotes scattered from pp. 6–33. More profitably, this fragmented approach should have been eschewed in favor of an introductory paragraph explaining the terms involved. This is frequently required in treatments of the Papuan region because of the many possible ways of parsing the assorted geographical and political entities involved.

A useful attribute of the book is the inclusion of a gazetteer for most mentioned place names. However, several localities mentioned in the book (e.g., Ok Tedi, Astrolabe Bay, Mt. Kerewa) are not included, nor are historically important localities (e.g., Bernhard Camp, Moroka, Lorentz River) whose inclusion would have provided a useful service to beginning researchers. Nonetheless, this is a resource not frequently available elsewhere and is a valuable addition making it easier for the novice to locate numerous place names used in the text and throughout the primary literature.

In a few cases, important literature is left uncited. James (1997) is mentioned on p. 36 but not included in the Literature Cited. On p. 181, it is noted that *Choerophryne* is similar to *Albericus* but the paper first arguing and presenting evidence for this relationship (Burton 1986) is not cited. Tyler and Davies' (1978) partitioning of *Litoria* into 37 heuristic species groups is largely followed by Menzies but without attribution. In a few instances, literature is mis-cited (e.g., Kraus and Allison 2001, p. 183, first paragraph). More problematic is that a few sources are incorrectly referenced. Most common of these is that the Global Amphibian Assessment for Papuan frogs, which involved nine specialists meeting at Bishop Museum in February 2003 (this reviewer did not attend) and which has a widely available summary of findings properly cited as a web source (Global Amphibian Assessment. http://www.globalamphibians.org/) is routinely cited by Menzies as "Richards (2003)." This improper citation slights the contributions made by the numerous other participants in the meeting, implies the existence of a finished product from 2003, and ignores the updated information made available on the website since that time. Similarly, the report properly cited as Allison et al. (1998) is variously cited by Menzies as either "Mack (1998)," e.g., on p. 107, or as "Richards (in Mack 1998)," e.g., on p. 121.

Of greater consequence for the uninformed reader are numerous errors of fact, most of which are concentrated in three different sections of the book: the discussion of geology, section on frog biogeography, and the species accounts themselves. I will discuss each in turn, leaving more relatively minor errors of fact to Table 1.

Menzies bases his discussion of the geological history of the Papuan region primarily on seven prior papers and books. He does consult the immensely useful and detailed summary of Pigram and Davies (1987) but fails to note the refinements provided by Pigram and Symonds (1991) and Davies et al. (1996, 1997). Menzies' summary of this history has several errors of fact or implication, the latter deriving from omission of detail. On p. 17, he notes that the central ranges of New Guinea "consist largely of

uplifted marine sediments." This is formally true but neglects to emphasize their geological diversity: they are in fact a mix of lithified limestone, ophiolitic, and volcanically derived terranes as well as remnant continental microplates. On p. 21 and again on p. 37, he implies that the central dividing ranges are due to tectonic activity during the last 10 million years (MY), but in fact uplift of these regions extends back to the Oligocene at ca. 30 MY. He claims (p. 29) that New Guinea "has consisted of isolated island chains that have had a checkered history, and only became joined at the last fall in sea level, some 15–10,000 years ago." This is a thoroughly false way of perhaps trying to convey that New Guinea consists of the northern margin of the Australian Craton, onto which have been sequentially sutured two separate island arcs. However, as noted above, those arcs accreted during the past 30 MY, not the past 15,000. The most recent docking event, involving the Huon Peninsula, occurred approximately 5 MY. Further, since sea levels have risen in the past 15–10,000 years, it is difficult to understand how New Guinea has not been recently fragmented into separate islands if their former uniting into a single island was due to lowered sea levels. The answer, of course, is that fluctuating sea levels had nothing to do with the amalgamation of New Guinea; plate tectonics did. Menzies' terminology for these two island-arc systems can also be somewhat confusing. The more recent arc system, now forming the north coast ranges of New Guinea and including New Britain and the Solomon Islands, is the "Solomons Arc." Menzies refers to different components of this system as either the "Melanesian Arc" (p. 19), a somewhat misleading and outdated term (cf. Polhemus and Polhemus, 1998), or the "East Philippine Arc" (p. 20). Lastly, the Southeast Peninsula was formed as an offshore composite of diverse accreted terranes during the Late Oligocene and later sutured to the margin of New Guinea. This biogeographically important detail goes unmentioned in the book.

The section discussing biogeographic patterns of Papuan frogs is largely speculative, and much of it is inconsistent and incredible at face value. Conjectures in this vein include that the myobatrachids *Lechriodus* and *Mixophyes* are old invasions from Australia displaced more recently by the Asian-derived microhylids (p. 32). Such ancient invasion and displacement are hard to reconcile with the close, congeneric relationships among these Papuan and Australian myobatrachids vs. the diversity of a microhylid clade containing 170 described species and 15 endemic genera. Rapid evolution indeed! There is a 2+ page discussion of whether frogs can cross marine barriers that doesn't lead anywhere much. Despite the indubitably rare nature of such events, biogeographic evidence (not discussed by Menzies) makes it clear that such events must sometimes occur (e.g., Vences et al. 2003) and no other explanation seems credible for the arrival of Oriental families of frogs (e.g., Microhylidae, Ranidae) into the Papuan region. The presence of two microhylids on New Britain is argued to be due to a "limited migration" during the Pliocene (p. 38) but the larger ensemble of 18 Australian microhylids and the large radiation of New Guinean *Litoria* and *Nyctimystes* are relegated to presumed Pleistocene invasions (p. 38). Discussion of "routes for exchange" (p. 35–36) appears a type of informal Croizatean track analysis and it is unclear whether these tracks are intended to signify overseas dispersal routes, land bridges, patterns of island-arc accretion, or a mix of all.

Biogeographic discussions should necessarily be based on understanding of phylogenetic relationships. Little such work has been done on Papuan frogs, but Menzies either misinterprets the work so done or repeats the errors of prior workers. Hence, he argues repeatedly (pp. 39, 75) that *Platymantis* is not proven monophyletic, citing an unpublished thesis by Norris (2002). But Norris did not test *Platymantis* monophyly, nor even that of the Solomon Islands species; hence, Menzies' inference is invalid. On p. 41, he discusses the "entry" of *Oreophryne* into New Guinea, implying a polyphyletic origin of the Papuan microhylids that is belied by the literature (Savage 1973; Tyler 1979; Burton 1986; Frost et al. 2006 [the last, of course, unavailable to Menzies when composing this book]), and his claim that the ancestor of the direct-developing Papuan clade probably had tadpoles (p. 33) is an unparsimonious interpretation for a presumed monophyletic clade. Most confusing of all, perhaps, is his choice to repeat a conjecture attributed to Norris (2002) that the ranid genus *Batrachylodes*, endemic to the Solomon Islands, had an origin on Borneo (p. 75)! The rationale for this conclusion is not provided.

Menzies discusses (pp. 42–48) several of the more interesting distributional patterns found within Papuan frogs. This section is useful for giving the novice a feel for some of the ecological and regional subsets of Papuan frogs, although I think it would have been improved if ecological patterns had been distinguished from geographical patterns instead of intermingled. These patterns are illustrated by reference to a few exemplar species instead of a comprehensive treatment or listing of all constituent species. This is fine, but it is hard for me to see why so much discussion was given to the depauperate and poorly known fauna of the Aru Islands (p. 48) while providing only cursory discussion of the far more speciose, endemic, and better-known faunas of the Bismarck and Solomon islands (p. 47) and no discussion of those of Yapen, Biak, D'Entrecasteaux, and Louisiade islands.

To my mind, however, the greatest fault of the book is that it cannot be used in most instances to reliably identify Papuan frogs. Only three complete keys (for 3 spp. of *Lechriodus*, 8 spp. of *Batrachylodes*, 4 spp. of *Choerophryne*) appear in the book, and these (with one minor addition) are cribbed from existing literature. Other published keys requiring no (e.g., *Barygenys*) or little (e.g., *Callulops*) modification are not repeated here. This reflects the author's stated belief (e.g., p. 102) that diagnostic keys are not possible for most of these genera. Instead, Menzies provides a table of assorted attributes on p. 53 that is intended to guide the student toward or away from particular taxa in comparison to a specimen in hand. But this table has errors (Table 1) and the genus *Oxydactyla* is omitted. A few examples of partial keys (typically modified prior keys from the literature) appear in the book but these are of limited use or are utterly misleading. For example, the key to *Platymantis* of New Britain (p. 90) distinguishes among some incredibly different species (e.g., *P. browni* and *P. mamusiorum*) using only trivial morphometric ratios not easily determined in the field and doesn't distinguish among others (e.g., *P. boulengeri*, *P. magnus*) that are separable at a glance. In that same key, diagnostic couplets are incorrect (e.g., *P. rhipiphalcus* lacks longitudinal skin folds but has a diverging fan of such folds, hence its name; *P. akarithymus* and *P. schmidti* have more than two longitudinal skin folds; *P. gilliardi* is equivalent in size to *P. mimicus*, not smaller) or internally inconsistent (e.g., one must

TABLE 1. Corrections to some errors of fact in *The Frogs of New Guinea and the Solomon Islands.*

Page	Correction
24	Most recent El Niño event was in 2002–03, not 1997–98
38	Is only 1 species of Australian *Nyctimystes*, not 3
44	*Litoria pratti* and *Nyctimystes montanus* are also endemic to Bird's Head region
46, 190	*Cophixalus cryptotympanum* restricted to Mt. Dayman area, not widespread, according to Global Amphibian Assessment
46, 155	Range of *Nyctimystes kubori* includes the Owen Stanley Mts.
53	Character 2 should read "S" for *Austrochaperina*, "R" for *Oreophryne*, and "R" for *Xenorhina*
53	Character 12 should read "R" for *Choerophryne* and "+" for *Pherohapsis*
66	Sonnini should be included as author in original citation for *Limnonectes grunniens*
79–80	*Ceratobatrachus* eating *Platymantis* is not an instance of cannibalism
83	There were 55 species of *Platymantis* described by the end of 2005, not 40
85	*Platymantis macrosceles* is not smooth but has scattered pointed warts
86	*Platymantis pelewensis* is not a Philippine species
86	Range of *Platymantis* extends well north of Mindanao
87	Original name for *Platymantis papuensis* was *P. corrugatus papuensis*, not vice versa
88, 91	*Platymantis papuensis* is not known from New Britain
91	Place name is Weitin Valley, not Weitin
92	*Platymantis browni* is known from New Britain, as noted in original description
94	*Platymantis nexipus* lacks longitudinal skin folds
95	Original name is *Platymantis rhipiphalcus*
97	Fingers of *Platymantis acrochordus* are pointed, not just without discs
134	Kraus & Allison (2004b) did not report *Litoria arfakiana* from the D'Entrecasteaux Islands
154, 167	*Nyctimystes semipalmata* is not large and it lacks a heel lappet; the description given under this species is fictional
155	*Nyctimystes kubori* also ranges throughout the Owen Stanley Mts.
174	Not all *Albericus* are brown; some are gray or green
182	*Choerophryne rostellifer* has discs on first fingers
183	Kraus & Allison (2001) did not include the upper Fly R. specimen of *Choerophryne rostellifer* in *C. proboscidea*
185	All species of Menzies' Group 2 have the first finger present, though all have it reduced to some greater or lesser extent
190	Range of *Cophixalus verrucosus* includes Woodlark and Sudest islands
230	Elevational range of *Oxydactyla crassa* extends to 2880 m
236	Type locality for *Barygenys exsul* is Rossel Island, not Sudest Island
246	*Callulops slateri* is known from many more than 6 specimens
253	*Mantophryne infulata* is known from the Finisterre Mts., not the Adelberts
254	*Xenorhina doriae* was changed to *Callulops doriae* in 1988
254	*Pherohapsis menziesi* is known from several more than 7 specimens
265	The call for *Xenobatrachus subcroceus* is C144, not C148

traverse through 6a to get to 9b but the two are contradictory).

The claim that keys cannot be written is, of course, specious but application of this claim seriously undermines the utility of the book. This is worsened by the fact that the sections on "Field recognition" for most species are usually a general color-pattern description that doesn't always focus on diagnostic features, combined with the author's astounding claim (p. 52) that color and pattern are not much help for species identification beyond a few examples. Omission of explicit diagnostic features is widespread in the book and disqualifies it from being viewed as a field guide or from providing much assistance to anyone for identification purposes. I could give many examples where diagnostic, easily discernible features of species and genera go unmentioned, but I will provide only a few to give a flavor of the problem: *Rana jimiensis* is distinguished from *R. arfaki* by relative size of the tympana alone (p. 69), a character not liable to assessment in the field, even though the two may be distinguished at a glance by the broad finger fringes and tuberculate tympana of the former; *Rana kreffti* is easily distinguished by its lateral white stripe from all Papuan congeners but this feature goes unremarked (p. 72); *Litoria impura* is distinguished from *L. thesaurensis* solely on the basis of amount of foot webbing and *L. flavescens* is distinguished from neither, even though all are closely related and unambiguous color-pattern features distinguish each (Menzies and Zug 1979; Kraus and Allison 2004a); *Litoria dorsalis* is not diagnosed from its close relative *L. timida* by its diagnostically different canthus and its size (Tyler and Parker 1972) but is contrasted instead with the "*Litoria dorsalis* complex" which contains only those two species in the Papuan region. Many additional examples exist, and I simply note that it might be possible to get a tentative identification using this book but that the serious student will necessarily require reference to the original literature for verification. So why use the book and add a step?

Identification difficulties are exacerbated by substandard supple-

mentary materials (color plates, range maps) that would normally assist in identification. Several of the color plates are informative and will help in the identification of some species. But many (most?) of these images clearly date back to the 1970s, are of poor or mediocre quality, and do not reflect the standards usual in today's books. Many photos are out of focus, too dark, have the animal partially hidden, appear to be of animals anaesthetized and draped over vegetation, or are not shot in profile. It is hard to imagine what identifying information is intended to be conveyed by Plates 36, 67, 72, 84, 89, 94, 113, 117, 127, 129, 137, 138, 139, or 166, for example. Many other plates are substandard but serviceable; few shine. Plate 154 is almost certainly *Callulops personatus*, not *C. robustus*. Given the wealth of good photographs available from other researchers of this fauna, I find it incredible that Menzies did not attempt to borrow from them so as to improve his photographic coverage.

Almost as important, the range maps in the book are not comprehensive, either in terms of species coverage or in areal coverage for a species. All are unfriendly to use, with several taxa invariably combined into each map and separated only by difficult-to-read symbols in small font. Fortunately, far better and more comprehensive range maps are available on the web at either the Global Amphibian Assessment website (http://www.globalamphibians.org/) or the Papuan Herpetofauna website (http://www.bishopmuseum.org/research/pbs/papuanherps/), so the reader with Internet access will not have to rely on those provided in this book. But that won't help those in the field with a frog in hand. (I must note, though, that in one case [*Litoria timida*] the range given on the GAA website is wrong and Menzies is correct.)

Despite the long list of problems above, I stress that I have by no means attempted an exhaustive search for errors. Most of my attention was focused on the 83 species (out of 331 treated) for which I have direct experience in the field, and I have omitted mention of several other statements, practices, emphases, and omissions in the book liable to disputation from knowledgeable researchers in this field. Hence, this review should not be mistaken as a definitive treatment of this book's errors and questionable claims.

Given this litany of faults, it might be wondered if there are any positive aspects to the book. Indeed there are. First, Menzies' description of the climatic regimes in New Guinea and effects of El Niño events is quite good. His plates illustrating different habitats around the island are uniformly excellent and they nicely capture the impression one has on the ground. This is welcome given the extent to which so many published photos of tropical forests merely illustrate an uninformative swath of dark green; Menzies has admirably avoided that problem. For those having some familiarity with frog-call analysis, the many graphs of spectrograms and waveforms provided in Appendix A will be a welcome addition, especially when taken in concert with verbal descriptions of a call's acoustic impression, available in many of the systematic accounts. Still, it must be noted that some of these spectrograms illustrate nothing more than the sound of rushing water and culling those would have improved this section. Extremely useful for the beginning student will be Menzies' practice of including complete citations for each original description. This will prove an invaluable service considering the inability of the book to serve as a reliable identification guide. Also, some of the color plates are helpful for discriminating among certain difficult-to-identify species (e.g., *Xenobatrachus*), and others (e.g., *Palmatorappia*, *Nyctimystes granti*) usefully illustrate color-pattern polymorphisms not detailed in prior literature.

In my opinion, the most valuable aspect of this book is the ecological information given for many species. Menzies has considerable breadth of experience with these animals in the field and little ecological information has been previously published for this fauna, so provision of so much of it is truly a boon for researchers active in the region. It is this aspect of the book that I think will prove of longest value for future students of this fauna.

Given the nature of the numerous criticisms raised above, it is only fair to point out the utter negligence of the publishers in providing any sort of meaningful editing or external review for this volume. Many of the book's failings could easily have been avoided by doing so. To their credit, the binding of the book does seems sturdy, although I confess that despite many temptations I did not utilize the rigorous testing procedures pioneered by Crombie (1992).

So how to rate this book overall? Its approach to the subject seems decidedly lackadaisical; fact-checking appears scarce; concern for rigor and scholarship is not evident; resort to museum specimens other than those collected by the author appears lacking. I suppose this book could provide some form of service to the novice by comprehensively summarizing the species names and literature sources and by providing some degree of faunal overview, however compromised. But much of the constituent information cannot be accepted at face value, especially for distinguishing among species and understanding the evolutionary processes creating its subject fauna. For these reasons, the book is likely to be of questionable utility to the professional scientist (ecological information excepted) and, worse, is liable to mislead those not well-versed in the subject. The book could have avoided its numerous problems while retaining its useful features if Menzies had chosen to co-author (or at least vet) it with a more meticulous person such as Richard Zweifel (who, in more than 700 pages of contributions to the Papuan frog fauna has made only two important errors, one later corrected by himself). It is a pity that option was eschewed.

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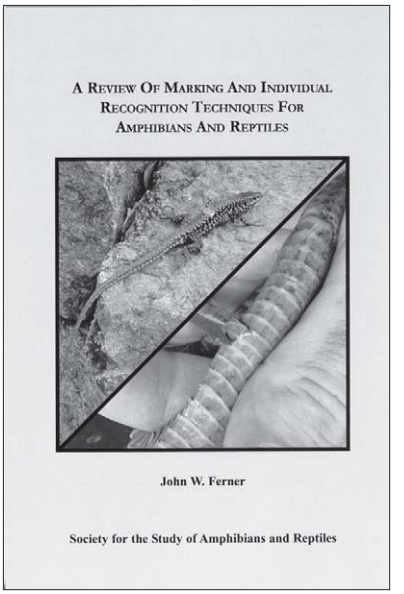
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A Review of Marking and Individual Recognition Techniques for Amphibians and Reptiles, by John W. Ferner. 2007. Society for the Study of Amphibians and Reptiles (ssar@herplit.com), Herpetological Circular no. 35. iii + 72 pp. Softcover. US $11.00. ISBN 0-916984-68-0.

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Much of organismal biology relies on the ability to identify individual animals. Without it, one cannot calculate home ranges, estimate population size, measure growth rate in the field, or document dispersal patterns. Consequently, many methods books include sections on marking of amphibians or reptiles, including an old mainstay, that of Ferner (1979). This slim circular (42 pages), now out of print, summarized the state of the knowledge at the time, covering major taxonomic groups and methods in a readable and easy-to-follow way. However, as Ferner points out in the preface to the current update, many things have changed in the three decades that have intervened. For one thing, technology has greatly improved, giving us tools such as the Passive Integrated Transponder (PIT) tag. Another major change has been the ascendancy of the animal rights movement and the increased control of animal care and use committees (ACUCs) and veterinarians over herpetological research. In 1979, one decided what was most appropriate and went about doing it. Today, most universities require ACUC approval of herpetological research, even though it is in most cases not actually required by law in the US. One must justify the use of techniques to non-experts and list ACUC permit numbers on papers, if possible (for the SSAR policy see http://www.ssarherps.org/pages/ethics.php). The current circular rather successfully brings this compendium up to date.

The current text is 72 pages long, of which 59 pages are devoted to the methods and the rest to references spanning 1933–2006. Many of them are taken from the pages of *Herpetological Review* but the coverage is quite wide. Besides the various herpetological journals it also includes *Nature*, *Ecology*, a variety of books, and less readily available sources such as *Froglog*, *Missouri Speleology*, and a research publication of the Texas Parks and Wildlife Department. Most of the book is organized by group, with coverage of larval amphibians (pp. 1–3, which include the egg-mass marking method of Regester and Woosley [2005]), frogs

and toads (pp. 3–13), salamanders (pp. 14–20), caecilians (seven lines on p. 20), turtles (pp. 20–28), lizards (pp. 29–37), snakes (pp. 37–45), and crocodilians (p. 46). The tuatara, a rather specialized case, does not receive a separate section. Toe clipping, a common method which has become somewhat controversial, receives expanded coverage in relevant sections. Two additional sections follow, one on the use of PIT tags (pp. 47–51) and the other on radio-transmitters (pp. 51–59, also briefly covering the use of GPS-based technology), each internally organized by taxonomic group. Twenty-two helpful illustrations, many of them taken from the previous version, are provided, as is a table listing possible combinations available for toe-clip marking using one of the techniques.

No technique is free of limitations and unintended consequences so, as Ferner emphasizes, it is important to use the correct methods for the species, environment, and study type. Ferner wisely does not attempt to list every study that uses a particular technique, instead focusing on original descriptions of methods and subsequent evaluations of their efficacy, with common techniques receiving broader attention. I paid special attention to the section on lizards, the organisms with which I have the most experience. This section begins with discussion of toe and scale clipping and is updated enough to include recent work by Langkilde and Shine (2006) which suggests that not only does clipping have little impact on stress hormone levels but that methods many favor as more apparently humane, such as PIT tag use, appear more stressful. Methods based on integument pattern, branding and painting, and tagging follow, and recent methods such as implanted elastomers, only recently applied to lizard studies, are included.

Overall, the coverage is good. Common methods are all listed, and methods that are rarely used nowadays, such as the use of radioactive tags, still receive coverage. Ferner spends enough time to familiarize the readers with the basic plusses and minuses, but often avoids detailed descriptions of issues such as surgery for radio-transmitter implantation. Ferner also carefully avoids making strong statements for or against a particular technique, letting readers draw their own conclusions. Although this can be a drawback, the author is clear from the start that "use of very complex techniques … require careful review of the original sources." This seems essential if one is to maintain the compactness of the original work, and references to more detailed work abound.

There are some drawbacks to the work, but they tend to be minor. I found the occasional misspelling ("were" instead of "where" near the bottom of page three, unfortunately a common type of problem in the age of computerized spell-checkers) and awkwardness (an outline of a gecko inserted into a figure illustrating frog markings on page four), but these are few and far between. Some references cited as "in press" in the now defunct Smithsonian Press will likely never see the light of day, an extremely unfortunate situation that is not of Ferner's doing. A reference or technique is sometimes absent or difficult to find. For example, the general reviews of Murray and Fuller (2000) and Beausoleil et al. (2004) are absent, as are some other general references on marking that include herpetological sections. The heat-branding method for iguanas cited by Hayes et al. (2000) is absent in the lizard section, but heat-based branding can be found in the snake section, complete with methodological citation. However, this rarely happens and, when it does, tends to involve a minor variant on a common technique that is listed (freeze-branding does appear in the lizard section). One recent method completely absent is the use of DNA for individual identification. Albeit still infrequent in herpetological studies, DNA is already being used for individual identification in the case of highly endangered and intensely-studied species such as some iguanas (e.g., Hayes et al. 2000). DNA-based individual identification is unlikely to soon become the standard for field studies, but will doubtlessly become more common as the technology improves and costs continue falling. Another absence that, although not crucial, could have helped readers is a summary table quickly listing each method, basic pros and cons, and pages where relevant text is displayed. Finally, my personal preference would have been to arrange things by method first and taxonomy second, as a method applied for one group may well apply to another where it has not yet been tried, and is therefore not currently listed. Doubtlessly, this would have created its own difficulties.

Despite these minor weaknesses, this is a valuable contribution. Ferner's circular is best when used as an initial screening tool for eliminating inappropriate techniques and zeroing in on more likely tools. In the case of low-tech methods such as toe-clipping, one can find everything they need here. For more complex methods, additional reading will definitely be required. Because of this, the booklet is most likely to be of primary use to those starting out in herpetological field research or seeking alternative methods to the ones they are familiar with. However, it also holds an important benefit for the seasoned professional. Having an updated, taxon-specific volume listing methods can be a huge boon in the process of obtaining ACUC approval, since most such committees are geared towards biomedical work and are unfamiliar with appropriate methods for herpetological field studies (Lindzey et al. 2002). One can refer to it as the state-of-the-art in the field, an authoritative source of acceptable methods which goes considerably beyond the less detailed considerations jointly published and occasionally updated by the herpetological associations in the US (http://www.asih.org/files/hacc-final.pdf) and elsewhere (e.g. the Australian position on toe clipping is at http://www.griffith.edu.au/school/asc/ppages/academic/jmhero/ash/pdf/Lizard_Toe_Clip_Position_Statement_1.pdf). Overall, especially given the very reasonable cost of this booklet, this is a contribution every field herpetologist should have access to.

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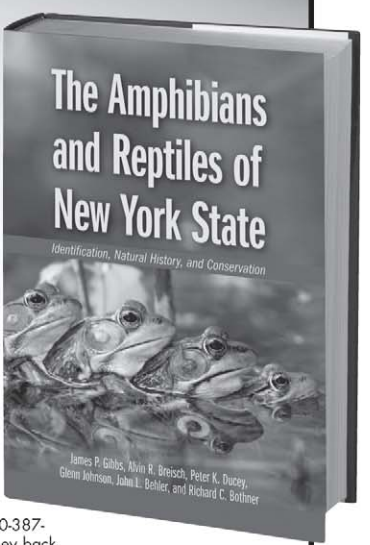
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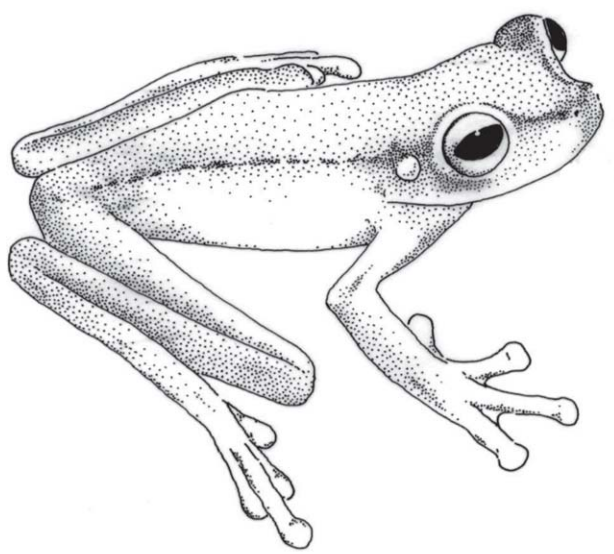


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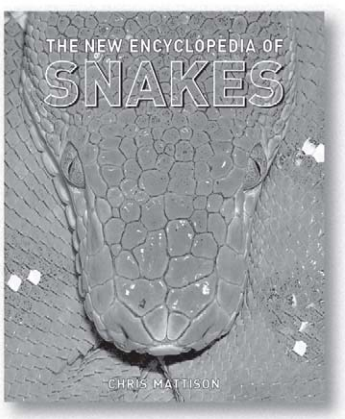
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Hyla rubracyla. El Tigre, Río San Juan, Valle del Cauca, Pacific Coast of Colombia. Illustration by Fernando Vargas Salinas.



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Current Research on Herpetofauna of the Sonoran Desert IV

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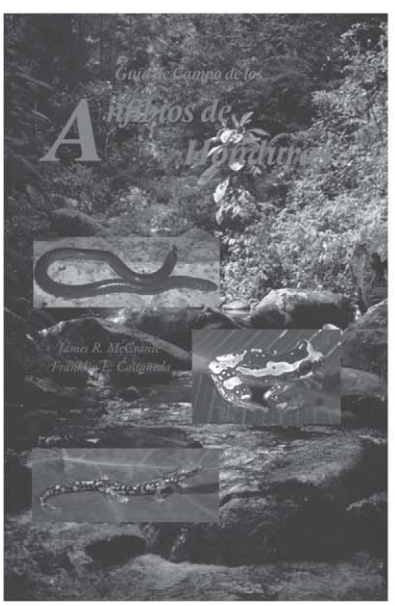
Tucson, Arizona

The Tucson Herpetological Society (THS) and co-sponsors are pleased to announce the fourth meeting of *Current Research on Herpetofauna of the Sonoran Desert* (CRHSD). The first CRHSD meeting was held at The Phoenix Zoo April 9–10, 1999. This conference, co-sponsored by the Arizona Game and Fish Department, Arizona State University West, and The Phoenix Zoo, was hugely successful with a number of would-be registrants turned away due to seating limitations. Since then, this event has been held every 3 years and has grown in interest and enthusiasm. The second CRHSD meeting, sponsored by the THS and others, was held in April 2002 in Tucson, and the third meeting was hosted by ASU in Phoenix in April 2005.

The goals of this fourth meeting are two-fold: 1) dissemination of information concerning research on the herpetofauna of the Sonoran Desert (in the states of Arizona, Sonora, and on the Baja California peninsula and gulf islands); and 2) provide opportunities for social interaction and dialogue among meeting participants.

The meeting will begin on Friday evening with an Icebreaker Social Event. Scientific Sessions on Saturday and Sunday will include approximately 30–40 oral presentations as well as poster presentations. Saturday evening will include a Social Hour followed by a Banquet. There will be three invited speakers at the meeting. Harry W. Greene, Professor at Cornell University, will open the Scientific Session on Saturday morning. Cecil Schwalbe, of the U.S. Geological Survey, will be the Banquet speaker on Saturday evening, and Edward O. Moll, Professor Emeritus at Eastern Illinois University and Adjunct Professor at the University of Arizona, will be the featured speaker on Sunday morning.

The CRHSD IV second announcement will be made in the fall and will include registration information, call for papers, and information on accommodations at the Inn Suites Hotel. All information will soon be available on the THS web site (www.tucsonherpsociety.org). We hope you will mark your calendar and plan to attend what will be the continuation of an exciting and informative scientific meeting.



Guia de Campo de los

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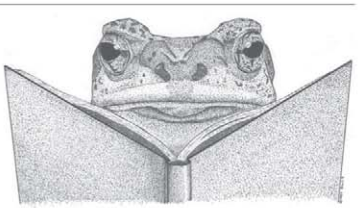
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Herpetological Review is a peer-reviewed quarterly that publishes, in English, articles and notes of a semi-technical or non-technical nature, as well as book reviews, institutional features, commentaries, regional and international herpetological society news, and letters from readers directed to the field of herpetology. Articles reporting the results of experimental research, descriptions of new taxa, or taxonomic revisions are not published in ***HR***, but should be submitted to the ***Journal of Herpetology*** (see inside front cover for Editor's address). To submit a manuscript to ***HR***, please consult the SSAR webpage at:

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Herpetological Review

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SOCIETY FOR THE STUDY OF AMPHIBIANS AND REPTILES

www.ssarherps.org



The Society for the Study of Amphibians and Reptiles, the largest international herpetological society, is a not-for-profit organization established to advance research, conservation, and education concerning amphibians and reptiles. Founded in 1958, SSAR is widely recognized today as having the most diverse society-sponsored program of services and publications for herpetologists. Membership is open to anyone with an interest in herpetology—professionals and serious amateurs alike—who wish to join with us to advance the goals of the Society.

All members of the SSAR are entitled to vote by mail ballot for Society officers, which allows overseas members to participate in determining the Society's activities; also, many international members attend the annual meetings and serve on editorial boards and committees.

ANNUAL DUES AND SUBSCRIPTIONS: Annual membership dues for the year 2007 in the Society for the Study of Amphibians and Reptiles are as follows: **REGULAR** membership US$60 (Student $30)—includes *Journal of Herpetology* and *Herpetological Review*; **PLENARY** membership US$80 (Student $45)—includes *JH*, *HR*, and annual subscription to the *Catalogue of American Amphibians and Reptiles*; **INSTITUTIONAL SUBSCRIPTION** $125—includes JH and HR. Additional fee for airmail postage outside USA $35 for one year. Additional membership categories available on the SSAR webpage: http://www.ssarherps.org/pages/membership.html.

All members and institutions receive the Society's primary technical publication, the *Journal of Herpetology*, and its newsjournal, *Herpetological Review*; both are published four times per year. Members also receive pre-publication discounts on other Society publications, which are advertised in *Herpetological Review*.

Payment must be made in USA funds, payable to "SSAR," or by International Money Order, or with VISA or MasterCard (account number and expiration date must be provided). Payment should be sent to: Breck Bartholomew, SSAR Membership Office, P.O. Box 58517, Salt Lake City, Utah 84158, USA. Fax: (801) 453-0489; e-mail: ssar@herplit.com.

Future Annual Meetings

2007 — Saint Louis, Missouri, 11–16 July (with ASIH, HL)
2008 — Montreal, Canada (with ASIH, HL)
2009 — Portland, Oregon (with ASIH, HL)

About Our Cover: *Diporiphora winneckei*



Agamid lizards, popularly known as dragons, are strongly visually-cued. They have alert, upright postures, and most species seek elevated perches from which they adopt a sit-and-wait ambush style of prey capture.

The family is widespread throughout the Old World, from Australia and New Guinea to Asia, Africa, the Middle East, and southern Europe. Australia is home to 71 described species. The 14 species of *Diporiphora* make up Australia's second largest agamid genus. While dragons are distributed across the continent, with highest diversity in central and western deserts, *Diporiphora* is most numerous across northern Australia, particularly in semi-arid north-western tropical savannahs where the ground cover is dominated by spinifex (*Triodia* spp.).

Diporiphora are relatively poorly known. Little ecological work has been undertaken and the group is sorely in need of taxonomic review. The most recent systematic studies were in the 1970s and the most comprehensive of these dealt only with Western Australia and the Northern Territory (Storr 1974. Records of the Western Australian Museum 3[2]:121–146). Identification of species can be problematic and a number of unresolved taxa are known to occur in eastern Australia.

For the most part, *Diporiphora* species are outwardly similar in appearance, being relatively slender and small (maximum SVL for most species is 60–80 mm), lacking the elaborate spines, crests, and dewlaps that typify many agamids. Most are patterned with a pair of pale dorsal stripes overlaying a series of short dark cross-bands. This is ideal cryptic coloration for terrestrial to semi-arboreal dragons that dwell among grasses and low shrubs. Many dragons can accelerate to rapid, often bipedal sprints when pursued, but *Diporiphora* tend to be less swift, generally scuttling on all four limbs to the nearest cover.

The Canegrass Dragon (*Diporiphora winneckei*), depicted on our cover, is notable for its extremely slender, almost emaciated-looking build and the smooth, silky white ventral surface boldly striped with grey (males) or yellow (females). Breeding males develop a red flush on the flanks. *D. winneckei* has the broadest distribution of the genus, spanning the vast central and western sand-ridge deserts. Its habitat comprises interdunes and lower slopes vegetated with spinifex or canegrass (*Zygochloa*) and generally bare dune crests.

This *D. winneckei* is basking atop a hummock of spinifex, one of Australia's most herpetologically significant grasses. Wherever spinifex grows it supports a high diversity of lizard species including many endemics. When inactive or pursued, the lizard takes refuge within the matrix of slender, tough, needle-sharp spines.

D. winneckei is one of the most heat-tolerant Australian lizards, with specimens caught on the tops vegetation at midday having body temperatures of 42–46°C (Greer 1989. Biology and Evolution of Australian Lizards. Surrey Beatty & Sons, Sydney). This is above the lethal thermal limit for most species.

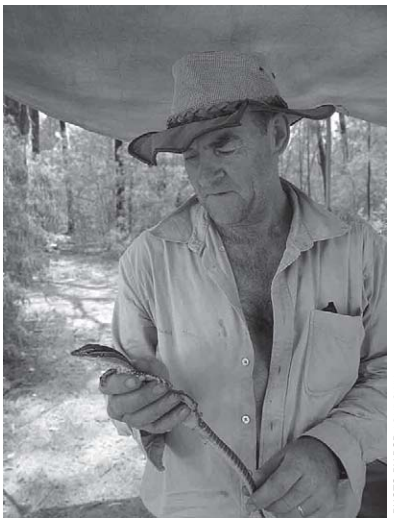


PHOTO BY BOB ASHDOWN

Our cover lizard was photographed by Australian herpetologist **Steve Wilson**, at Windorah in southwestern Queensland. Steve used Provia 100 ISO slide film and an Olympus OM2n camera with a 50mm macro lens, using natural daylight. Steve has written a number of field guides to reptiles of Australia and his home state of Queensland. His most recent book, a reptile book for children, is designed to instill a sense of wonder into the next generation. It was published in late 2006. His next project is a popular guide to the natural history of Australian lizards.

SSAR BUSINESS

Open Letter to Membership

SSAR will celebrate its 50th Anniversary in 2007. Special activities will take place during the Joint Meeting of Ichthyologists and Herpetologists (JMIH) in St. Louis, 11–16 July. The major events associated with SSAR's Anniversary are scheduled for 13 July. These events feature a symposium organized by Jonathan Losos entitled "Herpetology in the Age of Genomics." Jim Murphy and Kraig Adler will be the Masters of Ceremonies for a special SSAR Banquet that evening. The SSAR/HL auction will follow the banquet. And, of course, everyone is invited to attend the Business meeting on July 15. A link to registration on our website (http:www.ssarherps.org) will be available in January. Registration can be for the entire meeting or only for the day of the SSAR celebration.

—Roy McDiarmid, SSAR President
—Robin Andrews, SSAR Immediate Past President

NEWSNOTES

6th World Congress of Herpetology Call for Symposium Proposals

On behalf of the 6th World Congress of Herpetology Organizing Committee, we would like to invite colleagues to organize and propose symposia. Proposals should state clearly that the symposium organizer is ready to assume the organization of the symposium. Proposal submissions will be open until 30 September 2007 and should include the following items:

1) A symposium title; 2) The full name of the organizer or chair of the proposed symposium; 3) Institutional affiliation of the organizer and contacts (full address, e-mail, phone, and FAX numbers; 4) A brief text (200 words) explaining the goal of the symposium; 5) A list of potential speakers and their topics.

Presentations should be of 20 minutes duration for each participant (this time should include time for questions and discussions). If the Symposium organizer has compelling reasons for other time allotments, the symposium organizer must make his/her case with the Organizing Committee for an alternate scheme of time allotments that would allow for time coordination with the other symposia being held simultaneously.

Organizers should inform symposium participants to prepare their presentations in Power Point for PC.

Below are the names and contact of the members the Symposium Committee of the 6th World Congress of Herpetology; please send your proposal to one of the following:

Dr. Carlos Frederico D. Rocha (Head of Symposium Committee) (Rio de Janeiro, Brazil); e-mail: cfdrocha@uerj.br

Dr. Claudia Keller (Manaus, Brazil); e-mail: keller@inpa.gov.br

Dr Jean-Marc Hero (Queensland, Australia); e-mail: m.hero@griffith.edu.au

A New Book to Celebrate SSAR's 50th Anniversary

Contributions to the History of Herpetology

Volume 2 by Kraig Adler, John S. Applegarth, and Ronald Altig

From the reviews of volume 1, published in September 1989:

"Of absorbing interest." —Alwyne Wheeler (Archives of Natural History).

"Here is a portrait gallery that to browse will delay your next paper in progress!" —Joseph Ewan (Taxon).

"An important original contribution to the history of herpetology . . . exacting and exhaustive scholarship, and an unmistakable touch of class." —Hobart M. Smith (Herpetological Review).

This book consists of three sections, each worldwide in coverage. **The first and longest section, by Kraig Adler**, is a series of completely new biographies of the leading contributors to herpetology beginning with the author of the first book on the subject, Nicolò Leoniceno (1428–1524). The accounts have a portrait, signature, and references for further interest. These feature 285 herpetologists and also include information about their colleagues and students and many other persons. The comprehensive index encompasses volumes 1 and 2 and covers nearly 1,400 individuals.

Among the biographies included in volume 2 are these:

• Authorities on venomous snakes and antivenoms—Brazil, Calmette, Charas, Fayrer, Fontana, Mitchell, and Noguchi.

• Bartram, Bocourt, Cantor, Catesby, David, the Grandidiers, Pallas, Rüppell, the Sarasins, Swinhoe, and others who explored then-unknown continents.

• The classifiers, Blainville, Brongniart, Oppel, and Ray.

• Aldrovandi, Bogert, Brongersma, Dickerson, Lichtenstein, McCoy, Wettstein and others who built great museum collections.

• The anatomists, Gadow, Gegenbaur, Hyrtl, Lebedkina, Leydig, Rathke, Severino, Tyson, and Wiedersheim.

• The artistic team of Sowerby and Lear.

• Experts on diseases and cures, Elkan and Reichenbach-Klinke.

• Schmalhausen, Szarski, Williams, and other evolutionists.

• Popular writers, among them Behler, Bellairs, the Conants, Hopley, the Mintons, Oliver, Rose, Topsell, and Worrell.

Coverage is global: Africa (El-Toubi, FitzSimons, Power), Asia (Chang, Đào, Gasperetti, Gharpurey, Hoofien, Hora, Hu, Kirtisinghe, Makino, Namiye, Tweedie), Australia (Fry, Lucas, Macleay, Storr), Europe (Ahl, Boscá, Cherchi, Cott, Dely, Eiselt, Flower, Gmelin, Guibé, Guichenot, Hediger, Hellmich, Hillenius, Lataste, Mocquard, Morescalchi, Rasmussen, Špinar), North America (Auffenberg, Barton, the Brimleys, Burt, Cagle, De Kay, Estes, Gorham, Hallowell, Lowe, Mosauer, Neill, Perkins, Schwartz, Slevin, Strecker, Yarrow), and Central and South America (Álvarez del Toro, Carvalho, Freiberg, Gomes, the Iherings, Laurent, Orcés, Orejas Miranda, Picado, Rand, Vellard).

Also included are experts on taxonomic groups such as salamanders (Brame, Green, Rusconi, Twitty, the Wilders, Wolterstorff, Wurffbain), turtles (Caldesi, Hay, Schweigger, Wermuth), and snakes (Fukada, Mell, Saint Girons, Slowinski, Stull, Underwood). The book contains an additional 150 biographies.

The second section, by John S. Applegarth, is an index of 3,603 authors in taxonomic herpetology. This alphabetical list includes the full names, dates, countries of residence, and orders of taxa for everyone who has proposed a new taxon (genus or below, within the living families) or has had a taxon named in their honor. This is a unique resource for zoologists, historians, and librarians. In less than two decades (since the 1989 edition), the number of persons covered has increased by nearly 50 percent.

The third section, by Ronald Altig, is a listing of herpetologists giving the names of their doctoral university, their major professor, and the date of their degree. This extensive revision is three times longer than the 1989 edition. The information is arranged in such a manner that the academic lineages can be followed from generation to generation, both forward and backward in time. 3,810 names are included and fully indexed.








Specifications: 400 pages (8.5 × 11 inches or 21.5 × 28 cm), bound in library-grade cloth. Color frontispiece, 269 portraits. ISBN 978–0–916984–71–7. To be published July 2007. • **Regular Price:** $65. • **Special Price to SSAR Members** (if ordered *before November 2007*): $50. • **Shipping Costs:** USA address, add $4; non-USA add $9. • **Orders to:** SSAR Publications Secretary, P.O. Box 58517, Salt Lake City, Utah 84158–0517, USA (*telephone and fax*: 801–562–2660; *e-mail*: ssar@herplit.com). • **Payment:** Make checks payable to "SSAR." Non-USA orders must be paid in USA funds using a check drawn on an American bank or by International Money Order. Books may be charged to American Express, Discover, MasterCard or VISA (please give account number and expiration date). • **SSAR Membership and Other Publications:** Membership information and a complete list of society publications can be obtained from the Publications Secretary at the address given above or at www.ssarherps.org.

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More information and details about the meeting may be found on the WCH web page:

http://www.worldcongressofherpetology.org/index.php?section=11

Herpetologists Honored for Contribution to Conservation

The Florida Chapter of The Wildlife Society (FLTWS) has announced the winners of the first annual Paul Moler Herpetological Conservation Award. The recipients, Mark Bailey, Kurt Buhlmann, Jeff Holmes, and Joe Mitchell, were selected for producing the new Partners for Amphibian and Reptile Conservation publication, "Habitat Management Guidelines for Amphibians and Reptiles of the Southeastern United States." Featuring detailed, yet easy-to-understand ideas and methods to help landowners improve the conservation value of their land, the book has received excellent reviews from land managers and conservation professionals across the region. The Guidelines effectively cover the wide variety of habitats and herpetofauna (amphibians, turtles, reptiles, and crocodilians) present in the southeastern United States, both with text and exquisite photography. The book is available to the public and can be ordered at http://www.parcplace.org/

The conservation award was presented during this year's annual meeting of the FLTWS, 11–13 April 2007, in St. Petersburg, Florida. The award was established in honor of one of Florida's preeminent herpetologists, Paul Moler, who retired in 2006 after 29 years of service with the Florida Fish and Wildlife Conservation Commission. "I am especially gratified to see this first Herpetological Conservation Award go to the authors of PARC's outstanding southeastern Habitat Management Guidelines," Moler said upon hearing the announcement. The FLTWS is made up of over 300 wildlife professionals dedicated to sustainable management of wildlife resources and their habitats in Florida. For more information on the society or this year's meeting, visit: http://www.fltws.org/.

MEETINGS

Meetings Calendar

Meeting announcement information should be sent directly to the Editor (rwh13@csufresno.edu) well in advance of the event.

20–23 June 2007—31st International Herpetological Symposium, Toronto, Canada. Information: http://www.kingsnake.com/ihs/.

11–16 July 2007—50th Annual Meeting, Society for the Study of Amphibians and Reptiles; 87th Annual Meeting, American Society of Ichthyologists and Herpetologists; 65th Annual Meeting, The Herpetologists' League. St. Louis, Missouri, USA. Information: http://www.dce.ksu.edu/jointmeeting/.

25–29 July 2007—5th Annual Symposium on Conservation Biology of Tortoises and Freshwater Turtles, Joint Annual Meeting of the IUCN Turtle Survival Alliance and the Tortoise and Freshwater Turtle Specialist Group. Atlanta, Georgia, USA. Information: http://www.turtlesurvival.org/.

3–6 August 2007—5th Conference on the Biology of Plethodontid Salamanders: Symposium in Honor of David B. Wake. Instituto de Biologia, UNAM and ECOSUR, San Cristobal de la Casas, Chiapas, México. Information: http://www.ibiologia.unam.mx/barra/congresos/salamandra/salamandra.html.

20–22 August 2007—Northeast Partners in Amphibian and Reptile Conservation (NEPARC) meeting, University of Virginia's Mountain Lake Biological Station. Meeting information, including registration and agenda are now available on the NEPARC website: www.pwrc.usgs.gov/neparc/Meetings/index.htm.

3–7 September 2007—Venom Week 2007. Tucson, Arizona, USA. Information: http://www.ocme.arizona.edu.

11–14 October 2007—29th Annual Meeting of the Gopher Tortoise Council, Milton, Florida, USA. Information: http://www.gophertortoisecouncil.org/.

2–4 November 2007—34th Annual Meeting, Kansas Herpetological Society, Topeka Zoo, Topeka, Kansas, USA. Information: http://www.cnah.org/khsAnnualMeetingInfo.html.

CURRENT RESEARCH

The purpose of **Current Research** is to present brief summaries and citations for selected papers from journals other than those published by the American Society of Ichthyologists and Herpetologists, The Herpetologists' League, and the Society for the Study of Amphibians and Reptiles. Limited space prohibits comprehensive coverage of the literature, but an effort will be made to cover a variety of taxa and topics. To ensure that the coverage is as broad and current as possible, authors are invited to send reprints to the Current Research section editors, **Michele Johnson** or **Josh Hale**; postal and e-mail addresses may be found on the inside front cover.

The current contents of various herpetological journals and other publications can be found at: http://www.herplit.com/contents.

Phylogenomics Of Reptiles

Our understanding of amniote genome evolution is based solely on chicken-mammal comparisons, but without large scale genomic data from phylogenetically intermediate taxa (i.e., nonavian reptiles) we cannot interpret the evolution of genome diversity in this group. Therefore, the authors used a BAC- (Bacterial Artificial Chromosome) and plasmid-end sequencing approach to characterize the genomes of three reptilian lineages: American Alligator (*Alligator mississippiensis*), Painted Turtle (*Chrysemys picta*), and Bahamian Green Anole (*Anolis smaragdinus*). The resulting data

show that, unlike the chicken, reptilian genomes are dominated by diverse, mammal-like transposable elements and simple sequence repeats (SSRs). Substantial differences exist among the reptilian genomes, as the *Anolis* genome displays higher SSR frequencies and lower GC content than the turtle and alligator genomes, which are characterized by distinctive CR1 (Chicken Repeat 1)-like long interspersed elements (LINEs) and fewer A-T rich SSRs. Additionally, all three reptiles have frequent tandem duplications that do not occur in chickens or mammals. The authors also found that DNA "words" evolve several orders of magnitude slower in reptiles than in mammals. They conclude that the ancestral amniote genome likely had a diversity of repetitive elements that were lost sequentially in reptilian and bird lineages.

SHEDLOCK, A. M., C. W. BOTKA, S. ZHAO, J. SHETTY, T. ZHANG, J. S. LIU, P. J. DESCHAVANNE, AND S. V. EDWARDS. 2007. Phylogenomics of nonavian reptiles and the structure of the ancestral anmiote genome. PNAS 104:2767–2772.

Correspondence to: Andrew M. Shedlock, Department of Organismic and Evolutionary Biology, Museum of Comparative Zoology, Harvard University, 26 Oxford Street, Cambridge, Massachusetts, 02138, USA; e-mail: shedlock@oeb.harvard.edu.

New Courtship Pheromone in Salamanders

Courtship pheromones are male chemical signals that affect female mating receptivity. Among vertebrates, these pheromones are known only in salamanders, and are most extensively studied in plethodontid salamanders. Courtship pheromones in plethodontids are delivered when a male brings his submandibular (mental) gland in contact with a female, transferring a multiprotein secretion from the gland. A single protein (PRF, plethodontid receptivity factor) from this secretion has been previously shown to increase female receptivity in *Plethodon shermani*, the Red-legged Salamander. In this study, the authors examined a second protein that, together with PRF, comprise 85% of the mental gland extract. They collected *P. shermani* adults from North Carolina, USA, removed the mental gland from males, and extracted the protein of interest from the gland secretions. In subsequent staged encounters between females and deglanded males (N = 32), females in 16 pairs were treated with the protein extract, and females in the other 16 pairs were treated with a saline control. While insemination success did not differ between the groups, treatment with the protein unexpectedly decreased female receptivity, as treatment prolonged the "persuasion" stage of courtship. The authors named this new pheromone, which acts in opposition to PRF, PMF (plethodontid modulating factor). They suggest that PMF may calm females, thereby facilitating the receptive effects of PRF, as the combined effect of both proteins increases female receptivity.

HOUCK, L. D., C. A. PALMER, R. A. WATTS, S. J. ARNOLD, P. W. FELDHOFF, AND R. C. FELDHOFF. 2007. A new vertebrate courtship pheromone, PMF, affects female receptivity in a terrestrial salamander. Animal Behaviour 73:315–320.

Correspondence to: L. D. Houck, Department of Zoology, Oregon State University, 3029 Cordley Hall, Corvallis, Oregon 97331-2914, USA; e-mail: houckl@onid.orst.edu.

Snakes Sequester Toxic Compounds from Prey, Provision Offspring with Toxins

The Asian snake *Rhabdophis tigrinus* exhibits geographic variation in its use of nuchal glands in antipredatory behavior; in toad-free regions the snakes display the nuchal glands much less often than in regions where toads are potential prey items. The nuchal glands contain cardiotonic steroids called bufadienolides, which are major components of toad skin secretions. To determine whether variation in toad availability correlates with variation in bufadienolides in *R. tigrinus*, the authors compared the glandular fluid from snakes in toad-free (n=3), toad-rich (n=4), and toad-present (n=15) localities using proton NMR spectroscopy; as expected, snakes in regions where toads were available prey had higher toxin concentrations in their nuchal glands. The authors also conducted feeding experiments that confirmed that bufadienolides are sequestered from ingested toads.

Further, they found that offspring of dams from three mothers with no bufadienolides contained none of these toxins in their nuchal glands, while offspring of one dam with a high toxin concentration possessed bufadienolides immediately upon hatching, demonstrating that *R. tigrinus* can maternally provision their offspring with these defensive compounds.

HUTCHINSON, D. A., A. MORI, A. H. SAVITZKY, G. M. BURGHARDT, X. WU, J. MEINWALD, AND F. C. SCHROEDER. 2007. Dietary sequestration of defensive steroids in nuchal glands of the Asian snake *Rhabdophis tigrinus*. PNAS 104:2265–2270.

Correspondence to: Deborah A. Hutchinson, Department of Biological Sciences, Old Dominion University, Norfolk, Virginia 23529, USA; e-mail: dhutchin@odu.edu.

Sexual Size and Shape Dimorphism in *Podarcis* Lizards

Differing selective pressures acting on males and females can result in sexual dimorphisms (SD), but SD may decrease when similar species co-occur to decrease intersexual competition in the presence of interspecific competition. The authors investigated SD in two closely-related, ecologically similar lizard species, *Podarcis bocagei* and *P. carbonelli*, in northwestern Portugal in both allopatry (*P. bocagei*: 55 males, 48 females; *P. carbonelli*: 53 males, 46 females) and in sympatry (*P. bocagei*: 42 males, 24 females; *P. carbonelli*: 52 males, 44 females). For each adult specimen, they measured 10 biometric characters for use in multivariate (size) analyses and digitized 46 landmarks for geometric morphometric (shape) analyses. They found that males of both species are larger than females, and that females have longer trunks. Their results also showed that patterns of size SD were not modified in sympatry; the differences between males and females are consistent when the species co-occur, although there is some evidence for an increase in male head size for both species when in sympatry. Shape analyses further explored changes in head shape SD. These observations suggest that morphological differences between the two species are not due to interspecific competition in sympatry, but are likely the result of sexual and natural selection.

KALIONTZOPOULOU, A., M. A. CARRETERO, AND G. A. LLORENTE. 2007. Multivariate and geometric morphometrics in the analysis of sexual dimorphism variation in *Podarcis* lizards. Journal of Morphology 268:152–165.

Correspondence to: Antigoni Kaliontzopoulou, CIBIO, Centro de Investigação em Biodiversidade e Recursos Genéticos, Campus Agrário de Vairão, 4485-661 Vairão, Portugal; e-mail: antigoni@mail.icav.up.pt.

Phylogeography of the California Newt

Divergence among lineages can be strongly influenced by geological change. In this study, the authors used mtDNA sequences and allozyme variation to examine genetic differentiation of the two subspecies of the California newt, *Taricha torosa*, in light of the geological history of the California coast and the Sierra Nevada mountains. They sampled 23 populations (198 individuals), from which they determined allozymic variation at 45 loci, and from 37 populations (62 individuals) they sequenced fragments of up to 778 bp of the cytochrome *b* gene. Standard phylogenetic analyses using either mtDNA or allozyme data supported the monophyly of *T. torosa* and of both subspecies [*T. t. torosa* (which occurs throughout coastal California and the southern Sierra Nevada) and *T. t. sierra* (which occurs in the central and northern Sierra Nevada)], and demonstrated geographic structure within these groups. Using a molecular clock, the authors estimated that the subspecies diverged from one another 7-13 Mya. To examine genetic differentiation at more shallow time depths, they used population genetic methods and inferred that the phylogeographic history of the species is complex, including allopatric divergence, isolation by distance, and range expansions. Although mtDNA and allozyme data for *T. t. torosa* were discordant at the boundary of the coastal-southern clades, they developed a biogeographic scenario that explains the different patterns of the two datasets. By using multiple genetic marker types, the authors were able to refine their phylogeographic interpretation for this species, and they encourage the use of multiple marker types in future work.

KUCHTA, S. R. AND A. TAN. 2006. Lineage diversification on an evolving landscape: phylogeography of the California newt, *Taricha torosa* (Caudata: Salamandridae). Biological Journal of the Linnean Society 89:213–239.

Correspondence to: Shawn R. Kuchta, University of California, Santa Cruz, Department of Ecology and Evolution, Earth & Marine Sciences, Room A316, Santa Cruz, California 95064, USA; e-mail: skuchta@biology.ucsc.edu.

Rattlesnake Responses to Prolonged Starvation

Snakes can tolerate periods of starvation of two years or more, yet few studies of starvation physiology have examined reptiles or amphibians. To address this taxonomic gap, the author investigated the physiological and biochemical responses to prolonged starvation in *Crotalus atrox*, the Western Diamondback Rattlesnake, a species that occurs in environments that experience periods of severe food limitation. Sixteen wild-caught, subadult rattlesnakes were fed and acclimated in the laboratory and then assigned to one of four treatments (0, 56, 112, or 168 days of starvation). At the end of each treatment period, snakes were euthanized and analyzed for blood and tissue content. During fasting, snakes experienced decreased plasma glucose but increased ketone bodies, although with continued fasting ketone levels recovered to non-fasting levels. Relative body composition changed dramatically during starvation, with snakes relying mostly on lipid stores for fasting energetic demands. Further, fasting snakes appeared able to prevent essential fatty acids from oxidation, but essential and non-essential amino acids were used indiscriminately during starvation. Finally, the author suggests that changing excreted nitrogen profiles could be used to noninvasively monitor the nutritional status of natural populations.

MCCUE, M. D. 2007. Western diamondback rattlesnakes demonstrate physiological and biochemical strategies for tolerating prolonged starvation. Physiological and Biochemical Zoology 80:25–34.

Correspondence to: Marshall D. McCue, Department of Biological Sciences, University of Arkansas, 601 Science Engineering, Fayetteville, Arkansas 72701, USA; e-mail: mmccue@uark.edu.

Frog Phylogeny Informs Study of Island Colonization

Amphibians are thought to be poor dispersers, and as a salt-intolerant group, they are typically absent from oceanic islands that have never been connected to a mainland. Three volcanic islands in the Gulf of Guinea off the coast of West Africa, however, have seven endemic amphibian species (six frogs, one caecilian). To explore island endemism and colonization, the authors combined molecular genetic techniques with data on ocean currents and salinity and atmospheric circulation to explore the origins of the endemic frog *Ptychadena newtoni*. They sequenced the mitochondrial 16S rDNA gene from 30 specimens in the genus *Ptychadena*, and to increase resolution within the *P. mascareniensis* complex (of which *P. newtoni* is a member), fragments of cytochrome *b* and cytochrome oxidase subunit I genes were also sequenced from species in this complex. Using maximum likelihood techniques, *P. newtoni* was found to be a distinct species endemic to the island São Tomé, showing strong divergence from its closest relatives. This species is deeply nested within the *P. mascareniensis* clade. The authors propose that the most likely colonization mechanism for these frogs (and other endemics of the Gulf of Guinea islands) involved a synergy of rafting, favorable surface currents, and reduced surface salinity. They suggest that amphibian distributions may not be determined predominantly by vicariance, and that this common assumption should be reconsidered.

MEASEY, G. J., M. VENCES, R. C. DREWES, Y. CHIARI, M. MELO, AND B. BOURLES. 2007. Freshwater paths across the ocean: molecular phylogeny of the frog *Ptychadena newtoni* gives insights into amphibian colonization of oceanic islands. Journal of Biogeography 34:7–20.

Correspondence to: G. John Measey, Laboratory of Animal Ecology, Department of Biology, University of Antwerp, B-2610 Antwerp, Belgium; e-mail: john@measey.com.

Tuatara Body Condition Declines Over 50+ Years of Monitoring

Long-term monitoring is vitally important for conservation efforts, particularly for long-lived species such as the Tuatara (*Sphenodon punctatus*). Using a dataset that spans 54 years, the authors examined how long a Tuatara population must be monitored before significant long-term trends become evident. They calculated a body condition index [log(mass) versus log(snout-vent length)] for all adults marked on Stephens Island between 1949 and 2003 (1888 individuals). Results showed that body condition has substantially declined since 1949 for both sexes (although rainfall remained constant during the sampling period), but that a consistent pattern of decline is evident only after >22 years of data. To investigate seasonal trends in body condition, a separate morphological dataset was collected from 201 Stephens Island Tuatara in 2004–2005 during November, January, March, and May. They found that male body condition was significantly higher than that of females and that seasonal variation in body condition existed, but found no correlation of condition with monthly temperature or rainfall. The authors suggest that the long-term decline in body condition may be the result of a density dependent response to resource competition from increasing population size.

MOORE, J. A., J. M. HOARE, C. H. DAUGHERTY, AND N. J. NELSON. 2007. Waiting reveals waning weight: monitoring over 54 years shows a decline in body condition of a long-lived reptile (tuatara, *Sphenodon punctatus*). Biological Conservation 135:181–188.

Correspondence to: Jennifer A. Moore, Allan Wilson Centre, School of Biological Sciences, Victoria University of Wellington, P.O. Box 600, Wellington, New Zealand; e-mail: Jennifer.Moore@vuw.ac.nz.

Heterospecific Eavesdropping in Frogs

Many animal behaviors can provide "public" information to unintended recipients, information which may be useful for different kinds of audiences. Multi-species frog choruses provide an example of such a case: calls are typically interpreted as competition for mates within a species, but if calling behavior indicates the presence of predators, heterospecifics could also use information from the chorus regarding predation risk. The authors tested whether Panamanian túngara frogs (*Physalaemus pustulosus*) use heterospecific calls to assess predation risk by observing male frog responses to one of four treatments after exposure to conspecific calls and the appearance of a potential predator (N = 10 per treatment): silence, a conspecifc call, a heterospecific call of an allopatric congener (*P. enesefae*), or a heterospecific call of a sympatric frog species (*Leptodactylus labialis*). They predicted that if sympatric calls are an indication of predation risk, túngara frogs should respond to the stimuli in the following order of decreasing intensity: conspecific, *L. labialis*, *P. enesefae*, silence. Results showed that call rate and chuck frequency decreased in this order, while call latency (time after stimulus before calling resumed) increased in this order, supporting their prediction and demonstrating that túngara frogs can distinguish between informative and uninformative heterospecific calls. The authors suggest that participating in mixed-species choruses may allow males to reduce their predation risk without increasing mate competition. These choruses also provide an opportunity to further study emergent group behavior.

PHELPS, S. M., A. S. RAND, AND M. J. RYAN. 2007. The mixed-species chorus as public information: túngara frogs eavesdrop on a heterospecific. Behavioral Ecology 18:108–114.

Correspondence to: Steven M. Phelps, Department of Zoology, University of Florida, Gainesville, Florida, USA; e-mail: phelps@zoo.ufl.edu.

Thermoregulatory Mechanism in Reptiles

To effectively thermoregulate, ectothermic animals must be able to sense both environmental and internal temperatures. Although thermoregulatory behavior is vitally important for maintaining cellular functions, the mechanisms that allow heat sensing are unknown. Recently, heat-sensitive transient receptor potential ion channels (TRPs) were discovered in *Drosophila* and mammals, and they may be suitable temperature sensors in reptiles as well. The authors demonstrated the presence of TRPs in reptiles and tested the hypothesis that TRP genes control reptilian thermoregulation. They sequenced a region of the heat sensing TRPV1 gene from three reptilian species [a crocodile (*Crocodylus porosus*), a skink (*Pseudemoia entrecasteauxii*), and an agamid (*Amphibolurus muricatus*)] and combined this data with existing sequence data to find that the reptilian TRPV1 sequences have a unique insertion of two amino acids, forming a well-supported clade sister to mammalian TRPV1. Using real-time PCR, they determined that TRPV1 and TRPM8 are expressed in heart, liver, and surface muscle tissues in the crocodile, and therefore have the potential to sense both internal and external temperatures. Inhibiting these genes in crocodiles (N = 7) led to dramatically altered thermoregulatory behavior, as the animals stopped their typical shuttling between basking and diving in cooler water. These results describe the proximate mechanism for temperature sensing in reptiles.

SEEBACHER, F. AND S. A. MURRAY. 2007. Transient receptor potential ion channels control thermoregulatory behaviour in reptiles. PLoS ONE 2:e281.

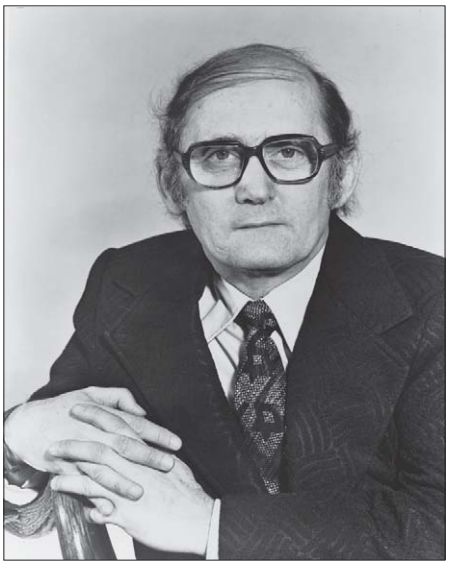
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OBITUARIES

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Hymen Marx (1925–2007)

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Hymen Marx. Formal portrait taken in 1978. Courtesy of the Field Museum of Natural History (Neg. No. GN82890).

Hymen Marx, Curator Emeritus at the Field Museum of Natural History in Chicago, Illinois, died on 25 January 2007 in Sun City, Arizona. During his 42 years at the Field Museum, Hy contributed much to the field of herpetology through his own research and through his unique, lively, and supportive personality.

Hymen "Hy" Marx, was born 27 June 1925, in Chicago, Illinois. He lived in the Chicago area until his move to Arizona in the early 1990's. His father, Phillip Marx, was a butcher and his mother, Minnie Serota Marx, was a homemaker. Hy had one sister, Molly, born 17 October 1921. Hy was drafted into the U.S. Air Force in 1943. He served as a radar mechanic and was stationed in the UK where he worked on a ground crew of the 8th Air Force maintaining the radar systems of the famous "Flying Fortresses." Like so many others, Hy went back to school in 1945 under the G.I. Bill and graduated in 1949 from Roosevelt University with a B.S. degree and a major in biology. That marked the end of Hy's formal education, and from then on he depended on his colleagues and his own intellectual curiosity to fuel his career development. In Hy's case and to his great credit, that was enough. While in school, Hy met Audrey Elaine Greene and they married in 1950. Hy and Audrey had two children, Michael Phillip Marx and Nancy Lynn Marx Ruesch. Nancy and her husband, David, now have three lovely teenage daughters, Melissa, Stephanie and Devyn who fondly remember their grandpa.

In 1948, while he was a student at Roosevelt University, Hy began volunteering in the Division of Amphibians and Reptiles, working as an assistant to Karl P. Schmidt. Hy referred to Clifford H. Pope and "K. P." Schmidt as his "academic papas." Hy joined the Division in 1950 as its first full-time assistant. For the next ten years, he served as "Collection Manager" and managed the collection through significant growth and reorganization including a major move from the third floor to the ground floor in 1952–53. This period of intensive collection growth was marked by the arrival, in 1954, of 35 five-gallon milk cans containing 77,000 frogs and toads that were sent by the Institut des Parcs Nationaux de Congo Belge to Karl Schmidt for identification. This huge shipment almost matched the number of specimens (85,000) in the entire collection at the time and a significant number of these specimens were deposited at the Field (Bauer 1954). This period was also marked by the Division's single most significant purchase, that of the Edward Harrison Taylor collection of 35,000 specimens, which was accessioned beginning in 1959. That collection, which is extensively cited in the herpetological literature, includes many type specimens, caecilians and skeletons. Its geographic strengths include Mexico, Costa Rica, Liberia, Sri Lanka, and Thailand. During these ten years, Hy also published 16 papers which led to his promotion to the curatorial ranks. He was promoted to full curator in 1973.

For roughly 40 years, Hy's career at Field Museum overlapped with that of Robert (Bob) F. Inger. Hy and Bob collaborated on several publications but the most notable was their monograph on the snakes of the colubrid genus *Calamaria* (Inger and Marx 1965). This monograph embraced many of the newest methods and approaches of that time and it remains a landmark work on this group of snakes today.

In addition, Marx's research interests also included the herpetofauna of Egypt, the systematics and zoogeography of the vipers, the phyletics of morphological characters, the application of phyletic character analysis to convergent snake species, and the application of Sharrock and Felsenstein's combinatorial method to phylogenetic studies. To facilitate his NSF supported collaborative research with George Rabb, over 500 snake skulls were removed from preserved specimens and prepared for character analysis studies. These skulls, comprising over 235 genera, form a subset of the osteology collection that is well used by researchers. This work resulted in their "50 characters volume" (Marx and Rabb 1972) that is still of great practical use to students of the biology and systematics of squamates.

Following this time, one of us (HKV), had the privilege of collaborating with George Rabb and Hy on a project involving character analysis (Marx et al. 1977). During the two years that we worked on this project the three of us had many stimulating and heated discussions. Those readers who knew Hy will understand us when we say that Hy provided us with plenty of aggravation and entertainment. He often referred to his two co-workers, not as his esteemed collaborators, but rather as his "close enemies."

Hy's research interests were varied but the subject that interested him most was the evolution of the venomous snakes of the family Viperidae. But Hy did not fit any stereotype of a dusty, dry museum curator—if you met Hy, even briefly, you immediately learned that he was exceptionally gregarious! This was true in both his personal and professional life. In his professional life, this took the form that most of us call collaborations, but Hy referred to it as "sharing our sandbox." He was fun to collaborate with but this activity was not for the weak of heart! He was sharp, witty, insightful, and prone to wander far off the subject. It was entirely



Federico Medem and Hymen Marx (right) examining South American crocodile skulls at the Field Museum in 1954. Courtesy of the Field Museum of Natural History (Neg. No. Z86441).

possible to begin with a lively discussion of the shape of the dentary bone in the Gaboon Viper, *Bitis gabonica*, and then find yourself listening to Hy giving you a review of "Sleeper," Woody Allen's latest movie at the time. This was vintage Hy Marx. No collaborator could expect to not be a victim at some point of one of Hy's practical jokes. That was the cost of doing business. Karel Liem, Henry Bryant Bigelow Professor of Ichthyology at Harvard University and George Rabb, now President Emeritus of the Chicago Zoological Society, and several others know this only too well!

Hy contributed greatly to the academic and administrative life at Field Museum. He served as the Head of the Division of Amphibians and Reptiles from 1970–79 and from 1985–1990, and over the years he served on more than 20 Museum committees. Hy fully understood the importance of encouraging young people in their interests and for that reason, he was an active contributor to Members' Nights at the Museum when it opens its doors for members to view the work that goes on "behind the scenes." Hy also had many unofficial roles at the Museum and he served as a sort of social guru to staff throughout the Museum. In this regard, Hy referred to himself as a "social butterfly" and enjoyed organizing both intellectual discussions on character analysis as well as recruiting teams and scheduling times for doubles tennis matches.

During Hy's four decades of service at Field Museum he also served on the Committee on Evolutionary Biology at the University of Chicago. In this capacity, he did not teach formal classes but rather he informally guided both master's and doctoral degree students in their research programs. On this, one of us (HKV) can speak from first hand experience. Hy helped me choose a Ph.D. research topic on sea snakes that has shaped my entire professional career. He freely gave his time and expertise to help many young visiting scientists prosper in their special fields of study. One of the "official" activities of visiting researchers and students was to visit Hy's office and kibitz about their research. For this we are all very grateful to him!

Hy was not a man to try to impress others by putting on airs of self-importance. No, he was equally friendly to the Museum's housekeeping staff and the top administrators of the Field Museum and other lofty institutions. He was not impressed with administrative rank and academic credentials and he applied uniquely Marxian methods to make this evident, as, for example, in his assignment of nicknames. No one received much respect and no one could hide!! For example, Robert K. Johnson, Chairman of the Zoology Department, was "Bunky" or "El Bunko Grande," James P. Bacon, Curator of Reptiles, San Diego Zoo, was "Bakey," and George Rabb, Director of the Brookfield Zoo, was "Georgy Porgy." Of course, behind each of these nicknames was an endearing story that showed how Hy paid attention to the human beings that he lived and worked with. We were individual people, not Directors, Curators, and Chairmen. In the end, that is why so many at the Field Museum and in the field of herpetology counted Hy Marx as a close friend, a great colleague, and a real human being. Hy Marx was truly one of a kind, absolutely unique, an amazing rare bird, and irreplaceable. All of our lives have been immensely enriched by knowing Hy Marx and we will miss him greatly.

Hy Marx, Impish Innovator

I first met Hy in 1972, during a visit the Field Museum to examine preserved coral snakes for my thesis research. Over the ensuing decades I came to know him as a friend and important, if under appreciated, player in the late twentieth century rise of snake biology. Hy was a committed curator, obsessed with facilitating the use and long-term welfare of museum specimens, as well as a shrewd, smart, and decent man. He was also insatiably curious about everything and everyone, and often extraordinarily funny.

We became friends at a time when research on snakes, which had figured in some of Hy's first publications, was reaching critical mass. By the early 1970's Henry Fitch's Kansas natural history monographs were stacking up and Rick Shine had begun doctoral studies of Australian snake natural history; Carl Gans was churning out papers on reptilian functional morphology and Gor-

don Burghardt's first publications were revealing the rich texture of snake behavior. By the early 1980s the Hennigian revolution in systematics had inspired a paradigm shift in evolutionary studies, from largely hand-waving about such topics as adaptive novelties and historical effects on community structure to the now-routine use of explicit analytic frameworks. Fulfilling the promise of historical evolutionary approaches to snake ecology requires phylogenetics, and beginning in 1965, thanks to a pioneering collaboration, we got it in spades.

With George B. Rabb and Karl F. Liem, Hy wrote a series of papers that set the stage for the integrative studies of snake biology that have flourished over the past three decades. It began when George called him out to Brookfield Zoo to see a live *Eristicophis*, and their attempts to better understand that strange creature led to an exceptionally interesting paper on the evolution and biogeography of viperines. Next they teamed up with Karl F. Liem for an anatomical study of the enigmatic "pitless pitviper," *Azemiops feae*, known then from 11 specimens, one of which Hy found in a large jar of uncatalogued frogs in his own collection! A truly ambitious survey by Marx and Rabb of 50 characters in 500 snakes appeared in 1972, followed by several more synthetic papers in *Evolution* and other prestigious journals.

Hy was short in stature and big in personality. My visits to the Field Museum typically encompassed several predictable stages. Upon arrival I'd be summoned to his office, whereupon he'd demand to know why I was there (regardless of the appropriate letter I'd always sent in advance, inevitably in plain sight on his desk), then launch into a merciless combo of inquiry and gossip. I'd catch my breath, tease Hy about his "ridiculous comb-over," and ask about the latest phylogeny for colubroids; he'd harangue me about the palatine teeth of *Pythonodipsas* and brag about some rare taxon he'd secured from a foreign colleague, all of it punctuated with "Hey putz, now watch this!" and "You're outta your mind!" After a half hour or so he'd unroll the latest computer output, swear me to secrecy, and after a spirited discussion admonish me to quit loafing and get to work. Once on a particularly hot summer's day I encountered Hy in his office, shirtless and watering several large potted plants. After growling a rude nickname and giving me a hug, he propped back in a chair, clasped his hands behind his head with a big grin, and said "Come on in, the water's fine!" The guy made his mark and we miss him.

—Harry W. Greene, Department of Ecology and Evolutionary Biology, Cornell University

Hymen Marx: in Tribute to a Loveable Rascal

Hy Marx was a truly unique person—in more ways than one. Always the practical joker and goof-off, he did have a serious streak**,** but it was well hidden. Hy enjoyed life and his carefree attitude was refreshing. He had a genuinely charming smile with a glint in his eyes, rather like a leprechaun. He also was one screw loose from being a nutcake, but that didn't bother him in the least; he reveled in being wacky and crazy. Hy had a different perspective on life than most people and he just had a good time in whatever he did. He poked fun at everyone, regardless of rank or importance, including himself as often as not. Hy had three passions that I know of: viperid snakes, Gilbert & Sullivan, and tennis.

Upon his retirement, I referred to him as the "fourth, funniest, and ever-youngest of the Marx brothers." And I pointed out that he paradoxically combined "the traits of a ruthless, savage killer (as on the tennis court where he showed no mercy) with those of a wonderfully likable and charming fellow with a heart of gold." I also pointed out that when he retired the museum could put him on exhibit and charge special admission if they wanted to increase their revenue.

The summer I spent at the Field Museum on a Dee Fellowship I was privileged to be able to sleep in the Division's lab. Hy was the first person I saw each morning. I had convinced him that his back needed adjustment. One morning after I adjusted him, he fell on the floor, screaming and clutching his lower back as if in great pain, "You broke my back!" Then he jumped up and started laughing like crazy—he really had me fooled. Another time he came into the museum limping, holding one leg an inch shorter than the other—again blaming it on me.

Hy was a man of few words when it came to answering correspondence. My first letter from him consisted of two lines with the salutation and signature twice as long as the letter; the next letter was three lines long. I discovered early on that the easiest way to get information out of Hy regarding FMNH holdings was to mail a pre-addressed and stamped postcard with the questions written out, leaving blank spaces for him to fill in. And presto! Back came the awaited answers in the filled in spaces.

Hy made it clear from the beginning that he refused to take the time to look at, read, or critique any of my manuscripts. He only liked to see the final publication! But I got even with him once. Because of my fondness for Hy, I dedicated my first snake species after him, a Philippine blind snake (*Typhlops marxi*). I hoped to keep this hidden from him and have it be a surprise upon publication. However, due to several problems, I was forced to send Hy a draft of the paper for his review. The cat was out of the bag and he was forced to help me with the manuscript, which he actually did. He began his letter with "I am pleased to hear from you and your written lunacy" and ended it with "Flattery will get you everywhere."

When I presented Hy with a list of rare snakes that I wanted to dissect for my project he went hysterical with lamentations and anguish at the thought of me opening up his precious (and often unique) specimens. Every rare snake I wanted to look at was like an act of pulling teeth. He even swore to track me down and kill me if I didn't publish the acquired data within five years.

There is no doubt that Hy Marx is dearly missed by everyone who knew him. His playful good humor dispensed so freely during his life continues in the smiles that cheer us in remembering him. He was certainly one in a million!

—Van Wallach, Museum of Comparative Zoology, Harvard University

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ZOO VIEW

Three New Books

AMERICAN ZOOS AND AQUARIUMS HAVE BEEN, AND REMAIN, ENMESHED IN THE POLITICAL SYSTEM IN WHICH THEY RESIDE. JUST LIKE THE MENAGERIES OF THE PAST, ZOOS TODAY ARE SHAPED BY POLITICS. INSTEAD OF MONARCHS CEMENTING POLITICAL ALLIANCES OR DEMONSTRATING THEIR MILITARY POWER BY CONTROLLING ANIMAL COLLECTIONS, WE NOW HAVE INTEREST GROUPS, ATTORNEYS, CITY COUNCILS, CONGRESSMEN, BUREAUCRATS, AND CITIZENS DEBATING THE EXHIBITION OF ANIMALS. AT THE MOST FUNDAMENTAL LEVEL, THE STRUGGLES AT ZOOS AND AQUARIUMS ARE OVER WHO GETS TO CONTROL THE FATES OF THE ANIMALS. IN THE MICROCOSM OF THE ZOO WE SEE INTEREST GROUP POLITICS PLAYED OUT AS VARIOUS ORGANIZATIONS STRUGGLE TO TRANSLATE THE WISHES OF THEIR CONSTITUENTS INTO A COHERENT POSITION ON THE PUBLIC DISPLAY OF ANIMALS. THE CHANGING ANIMAL ENCLOSURES FREQUENTLY NOTICED BY THE VISITORS, SUCH AS ELABORATE NEW IMMERSION EXHIBITS, MASK MUCH DEEPER POLITICAL CHANGES THAT HAVE HAPPENED WITHIN ZOOLOGICAL PARKS AND AQUARIUMS IN THE UNITED STATES. IT IS QUESTIONABLE, FOR EXAMPLE, WHETHER THE VERY ANIMALS EXHIBITED IN ZOOS TODAY WOULD HAVE BEEN THERE WITHOUT THE POLITICAL PROTECTION AFFORDED BY THE AZA.

— JESSE DONAHUE AND ERIK TRUMP

The American Association of Zoological Parks and Aquariums (AAZPA) was founded in 1924. Seventy years later, the name was changed to the American Zoo and Aquarium Association (AZA). Some of the organizational purposes of AZA are (1) to promote discussions and cooperation among zoo and aquarium professionals; (2) to set high standards for its accredited member institutions, now over 200; (3) and to support *in situ* and *ex situ* conservation initiatives.

In their book, *The Politics of Zoos. Exotic Animals and Their Protectors* (Northern Illinois University Press, DeKalb, Illinois, 2006; ISBN-0-87580-364-4 [cloth]; ISBN-0-87580-613-9 [paperback]), Jesse Donahue and Erik Trump describe the political environment surrounding zoos and aquariums from the 1960s to the present and the role of AZA and its leaders in interacting with federal regulatory agencies, animal rights activists, and other interested parties. This is a particularly relevant book for me as a zoo professional. My career started in the mid-1960s and I watched firsthand as zoo workers tried to address new challenges in the face of criticism on many fronts as described in this useful history. The book elaborates on the sad reality that many of us are concerned but traumatized by the enormity of the problem of disappearing biodiversity. We continue to struggle to find suitable niches, both within our institutions and in the broader conservation and academic community. If we are able to do so more effectively, the final beneficiaries will be the plants and animals entrusted to our care. I recommend this book without reservation.

David Barker and I worked together at the Dallas Zoo for many years. During our time together, he began to take courses in photography at one of the local colleges. It was clear from the beginning that Dave had a superb artist's eye and special skill for photographing herps. In my view, his images are some of the finest ever put on film. If you doubt my statement, pick up a copy of *Pythons of the World, Volume II. Ball Pythons. The History, Natural History, Care and Breeding* (VPI Library, Boerne TX, 2006; ISBN: 0-9785411-0-3), produced by Dave and his wife Tracy Barker. This book is the most impressive treatment of a single python species ever produced. Although ball pythons have become a mainstay in the herpetocultural trade, I had no idea that they came in so many color morphs, often affixed with a colorful name such as "Jester," "Jaguar," "Killer-bee," "Dreamsicle," "Phantom-lesser-lucy," "Wanna-bee," "Fireball," "Ghost/Pastel," "Sandblast," "Scratchoff," "Zipper," and "Dirty-Joe," to name but a few of the 200 or so identified color phases. Many of these variations are beautifully pictured. The Barker book is much more than a handsome coffee-table tome, for it is filled with information on snake biology, natural history, and suggestions for captive maintenance. The book is a useful primer chock-full of recommendations for keeping captive snakes of other species as well. The book is of the highest quality—beautifully bound, first-class paper quality, and even the shipping box is impressive. No pythonophile should even consider living without this book in hand. A review of this book was published recently by Michael Burger (2007. Herpetol. Rev. 38:118–119). Notably, the book has just been named "Best Animal Book of 2006" by the Independent Publishers Awards.

The San Diego Zoo has a long history of publishing herpetological observations. Laurence M. Klauber was the first curator of reptiles in the 1920s, consulting curator beginning in 1931, and served on the Board of Trustees from 1943 to 1968 (Fig. 1). Between 1931 and 1955, C. B. "Si" Perkins was the head of the reptile collection and was in charge of the project to build a new reptile house, which stands to this day (Figs. 2, 3). When Klauber wrote *Rattlesnakes: Their Habits, Life Histories, and Influence on Mankind*, he referred to "Si" and Charles E. Shaw, his curatorial successor, repeatedly in his opus as many behavioral observations in that book were made at the Zoo with these two men. Klauber named the leaf-nosed snake, *Phyllorhynchus decurtatus perkinsi*, after Perkins. In turn, Perkins published several compilations in *Copeia* on longevity of amphibians and reptiles in cap-

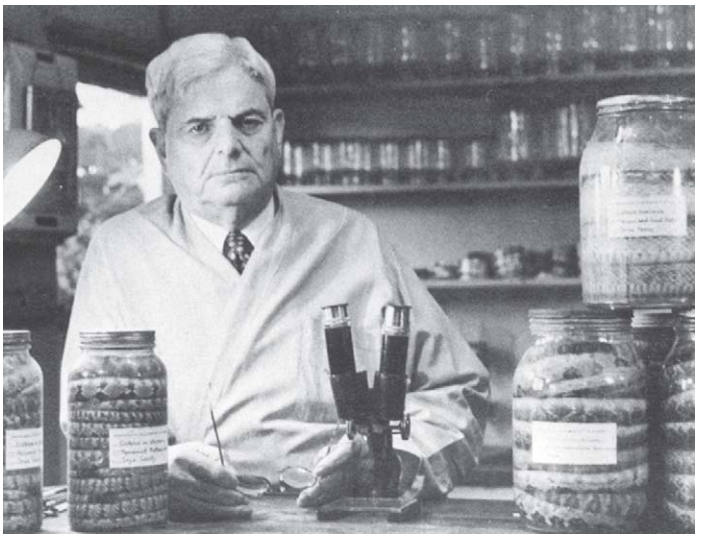


FIG.1. Laurence M. Klauber. Photograph provided by Kraig Adler.



FIG. 2. C. B. "Si" Perkins (right). Credit: San Diego Zoological Society Archives.

tivity, notes on captive-bred snakes, incubation and hatching of snake eggs, frequency of shedding in injured snakes, and hybrid rattlesnakes.

Shaw published papers on chuckwallas, eggs and young of some African, United States, and Mexican lizards and other reptiles, longevity of snakes in North American collections, and husbandry of sea snakes (Fig. 4). Based on observations at the Zoo, he documented reproduction in the Cuban and Rhinoceros Iguanas, and Galápagos Tortoise. His studies on the male combat "dance" of some crotaline snakes, American colubrid snakes, and additional remarks on combat in other colubrid and elapid snakes serve as classic behavioral reports. He wrote many articles in the zoo publication *ZOONOOZ*. In 1974, Shaw and Sheldon Campbell, a Zoo board member and later president, published the book *Snakes of the American West*.

Some 80 years after Klauber began his stint at the Zoo, Jeffrey M. Lemm from San Diego Zoo's Conservation and Research for Endangered Species (CRES) carries on the strong tradition in herpetology with his new book, *Field Guide to Amphibians and Reptiles of the San Diego Region* (University of California Press, Berkeley and Los Angeles, 2006; ISBN-13: 978-0-24573 [cloth]; ISBN-13-0-520-24574 [paperback]; 326 pp., 197 color photographs; 72 range maps; taxonomic key by Jay Savage). In the Preface, Lemm acknowledges the contributions of Klauber, Perkins,



FIG. 3. Photograph taken in 1935 of C. B. Perkins (left) with Sheldon Campbell (middle) and Charles Shaw (right) holding several snakes. Credit: San Diego Zoological Society Archives.

and Shaw. His book is filled with useful information about geology and climate, geologic history, major habitats, animal diversity, problems and conservation, species accounts, amphibian chytridiomycosis, snakebite and venom, and glossary. This field guide deserves a place on the bookshelf.

Lemm identifies two anuran taxa of special concern: Califor-

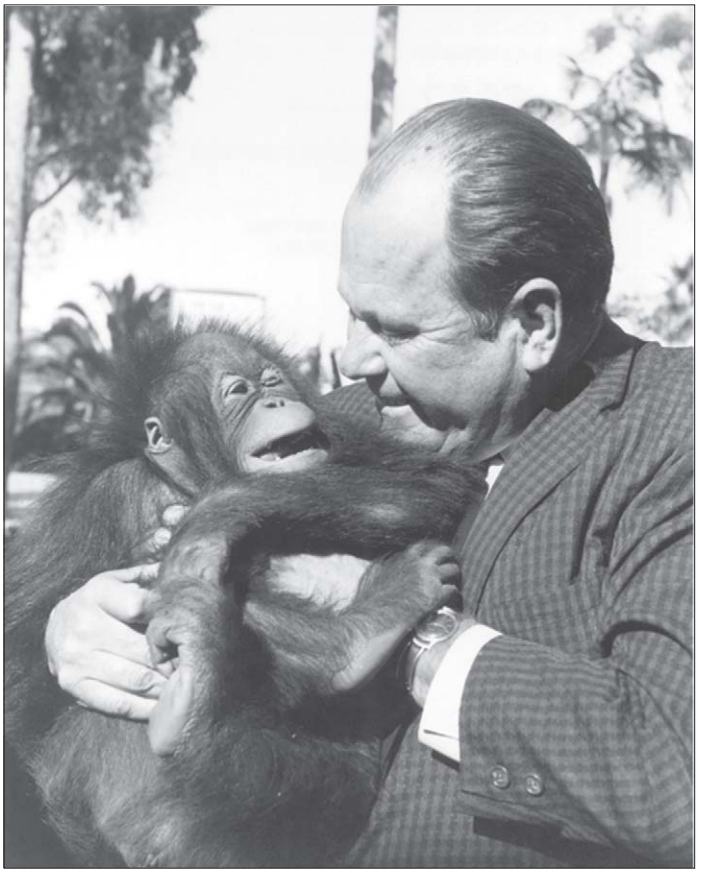


FIG. 4. Charles E. Shaw and "Maggie" in 1964. Credit: San Diego Zoological Society Archives.

nia Red-Legged Frogs (*Rana draytonii*) which have probably been extirpated in San Diego County, and the seriously endangered California Arroyo Toad (*Bufo californicus*). In the following article, zoo personnel at the Santa Barbara Zoo have developed a multi-faceted initiative of field surveys and educational programs to address the plight of these amphibians.

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— James B. Murphy, Section Editor

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Anuran Conservation through Collaborations: Santa Barbara Zoo Teams up with the U.S. Forest Service

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There are more than 200 accredited members of the Association of Zoos and Aquariums (AZA) dedicated to wildlife conservation through education and research. In fact, participating in field research has become an important activity of accredited zoos and aquariums (e.g., see Herrmann and Herrmann 2002; Zippel 2002). The Santa Barbara Zoo (the Zoo) is a comparatively young zoo that opened in 1963 and was first accredited by the AZA in 1981. The Zoo is dedicated to the preservation, conservation, and enhancement of the natural world and its living treasures through education, research, and recreation.

Beautifully situated on 30 acres of land in Santa Barbara, California, the Zoo overlooks the Pacific Ocean out to the Channel Islands to the south and the chaparral-covered slopes of the Santa Ynez Mountains to the north. Although the Zoo has a modest animal collection of about 600 specimens, we play an active and important role in field research, collaborating with various agencies on several conservation projects with one devoted to native amphibian conservation. Through a partnership between the Zoo and the United States Forest Service (USFS), Zoo staff currently survey streams in the Los Padres National Forest (LPNF) for California Red-legged Frog (*Rana draytonii*) and Arroyo Toad (*Bufo californicus*) egg masses and larvae. Both *R. draytonii* and *B. californicus* inhabit portions of LPNF in Santa Barbara County, California and are of critical conservation concern.

Prior to Bullfrog (*Rana catesbeiana*) introduction (Storer 1922), *R. draytonii* was the most abundant (Jennings and Hayes 1994) and largest (Storer 1925) of the ranid frogs occurring on the west coast. *Rana draytonii* has disappeared from approximately 75% of its known historical range and is listed as a federally threatened species (USFWS 1996). Habitat loss, exotic predators, off-road vehicle use, and dam and reservoir construction currently threaten *R. draytonii* populations. Although higher numbers of *R. draytonii* occur between Marin County and Santa Barbara (Jennings and Hayes 1994), an area that includes our study sites (Upper and Middle Santa Ynez in LPNF), these populations are still threatened by introduced predators, particularly Bullfrogs (Moyle 1973) and Mosquitofish (Hayes and Jennings 1986).

Bufo californicus has disappeared from 76% of its known historical range (Jennings and Hayes 1994) and in 1994 was listed as a federally endangered species (USFWS 1994). Being that the primary cause for declining *B. californicus* numbers is habitat loss, management recommendations for this species include greater habitat protection, and some recreational areas of LPNF are closed to visitors during the *B. californicus* breeding season (V. Hubbartt, pers. comm.). Exotic predators, however, still negatively affect the aquatic life stages of both *R. draytonii* (Jennings and Hayes

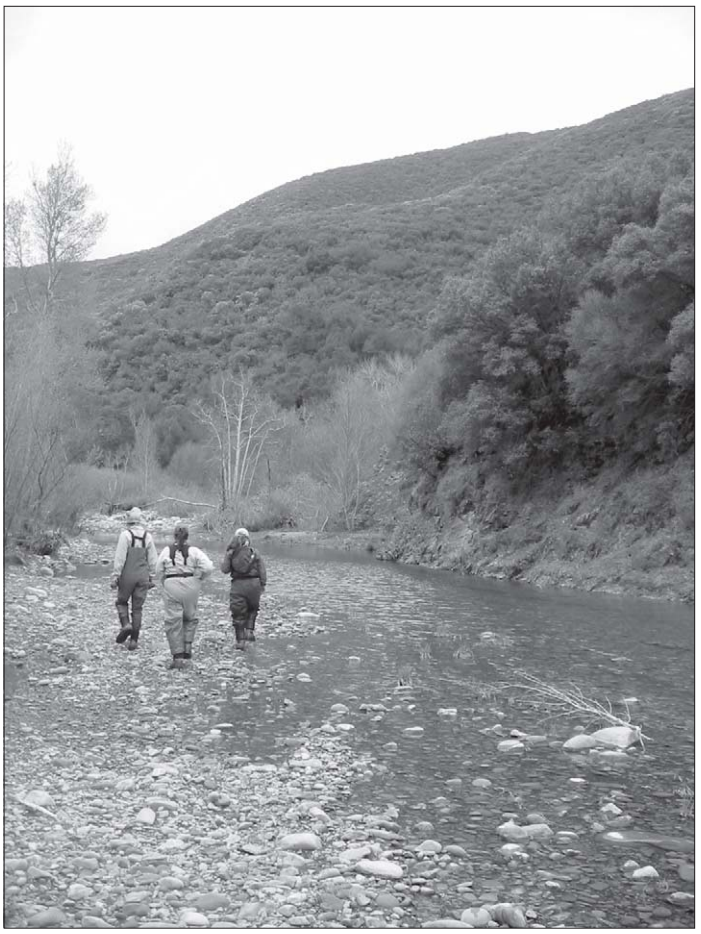


FIG. 1. A stream in the Santa Ynez River Valley, Santa Barbara County, California used as breeding grounds by California Red-legged Frogs (*Rana draytonii*) and Arroyo Toads (*Bufo californicus*).



FIG. 2. A California Red-legged Frog egg mass.



FIG. 3. C. Drew Foster and Estelle Sandhaus place an exclosure around a California Red-legged Frog egg mass in the Upper Santa Ynez Valley, Santa Barbara County, California.

1994; Kiesecker and Blaustein 1997; Lawler et al. 1999) and *B. californicus* (Jennings and Hayes 1994; Sweet 1993).

Because both anuran species are more vulnerable during their aquatic stages (e.g., to aquatic predators, chemicals from runoff, rising waters, etc.), the Zoo, in cooperation with the USFS, is examining population numbers in this phase and attempting to reduce larval predation by exotic aquatic predators. In suitable breeding areas, transects are established and regularly monitored during the breeding season. When egg masses are located, we quantify the developmental stage of the eggs and record the date, time, water depth, geographic coordinates (to allow for future monitoring of individual egg masses), and water and air temperature. Additionally, exclosures constructed of metal mesh formed into a cone shape are placed around egg masses to prevent aquatic predators from consuming them. This practice appears to be effective (we have observed egg masses placed in exclosures undergoing complete development), but will be evaluated further beginning in Spring 2007. We will also further examine the role of exotic aquatic predators.

In addition to playing an active role in *B. californicus* and *R. draytonii* conservation through research, the Zoo is promoting native herpetofaunal conservation through public education. Because of the Zoo's close proximity to LPNF, frequent day trips to the sites can be accommodated, and fieldwork participants can disseminate the conservation message to Zoo visitors through keeper talks and presentations. Additionally, the Education and Guest Services Departments are able to convey these messages on signage throughout the Zoo and newsletters that reach over 15,000 households per mailing. The Zoo also has an agreement with the USFS to create an exhibit featuring native reptiles and amphibians of LPNF. This exhibit will be part of a themed area of the Zoo dedicated to celebrating and promoting stewardship of our local wildlife. We estimate that as many as 450,000 visitors annually will learn about local herpetofaunal conservation by attending this exhibit. Communication is an essential component in raising community awareness of local conservation needs, and the Zoo's role as a center of conservation, education, research, and recreation affords us a unique opportunity to reach a large number of individuals.

Acknowledgments.—We are extremely grateful for the opportunity to participate in *Bufo californicus* and *Rana draytonii* conservation efforts, and wish to thank Richard Block (CEO/Zoo Director), Nancy McToldridge (Chief Operating Officer), and Sheri Horiszny (Assistant Director of Animal Programs), all of the Santa Barbara Zoo, Valerie Hubbartt (Resource Assistant/Wildlife Biologist) of the LPNF Santa Barbara Ranger District, and Jamie Uyehara (Specialist for SoCal Listed Species) of the LPNF Supervisor's Office for these opportunities.

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LETTERS TO THE EDITOR

Herpetological Review, 2007, 38(2), 143.
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Standard Language (Insert Language of Choice) Names Versus Common Names

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Caramaschi et al. (2005) recently published an excellent paper on providing "common" names to species of frogs in the genus *Leptodactylus*. They are to be commended for this and for their logic on why it is important to devise these names. Their criteria for determining these names are models to be followed.

However, I have a single comment that I hope will be informative and useful. In the North American amphibian and reptile names publications (Crother et al. 2000, 2003), notice that we never use "common name" and it is for specific reasons. First, what is common about them? These are unique appellations that are simply non-binomial and non-Linnaean. In the North American list they are called Standard English names. We did not presume to tell Spanish or German or Chinese, etc. what they should call the taxa in their language. Caramaschi et al. gave a beautiful example when they translated from the Portuguese or Spanish to an English name. They made a Standard English name, not a common name. They also make Standard Spanish and Standard Portuguese names and this should be wholeheartedly applauded and supported. These are not Spanish or Portuguese common names in any sense. I hope workers providing non-binomial non-Linnaean species names will consider that these are not common names, but Standard Language names.

It is important to provide these names, I just hope we can agree that they are not common.

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ARTICLES

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Effects of Toe-Clipping on the Survival and Growth of *Hyla squirella*

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Toe-clipping is a widely used and cost-effective method for marking amphibians for ecological studies, but recent research has suggested that toe-clipping may cause adverse impacts on amphibian health and behavior. Several studies have documented decreased growth or recapture rates in toe-clipped animals (Davis and Ovaska 2001; McCarthy and Parris 2004). Other studies have noted inflammation and necrosis of clipped toes, suggesting this method may adversely affect mobility and survivorship (Davis and Ovaska 2001; Golay and Durrer 1994; Lemckert 1996). Recently, McCarthy and Parris (2004) questioned the ethics of toe-clipping based on findings that recapture rates in four studies decreased linearly with the number of toes removed.

One important assumption of mark-recapture studies is the mark has no influence on the survival or recapture probability of an animal (Donnelly and Guyer 1994). Thus, any direct or indirect impact of toe-clipping, such as negative effects on growth, health, or behavior may bias results unless those effects are known and can be accounted for during data analysis (Donnelly and Guyer 1994). Unfortunately, study results conflict over the existence and degree of such effects. Instances where toe-clipping did not affect survivorship or growth were documented by Ott and Scott (1999) for *Ambystoma opacum* and by Van Gelder and Strijbosch (1996) for *Bufo bufo*. However, the magnitude and cause of adverse impacts are difficult to quantify in the field and have not conclusively been addressed under controlled settings.

In a laboratory study, we evaluated the impact of toe-clipping on growth and survivorship of Squirrel Treefrogs (*Hyla squirella*). Conducting the study in a controlled setting allowed us to separate direct effects of toe removal on survivorship and growth due to physiological stress and wound infection, from possible indirect effects such as behavioral avoidance of capture locations and decreased foraging success or increased predation due to impaired mobility.

Methods.—Sixty-two adult *H. squirella* were collected in Baker County, Georgia, USA (31°13'16.88"N, 84°28'37.81"W) during November 2004 and maintained in the lab until sufficient numbers were gathered for the study. On 2 December 2004, frogs were weighed (± 0.01 g) and the snout-vent length (SVL; ± 0.1 cm) was

measured. To ensure that size at capture did not bias the results, frogs were sorted by body mass into small (N = 22, mean = 1.44 g, range = 1.10–1.86 g), medium (N = 20, mean = 2.22 g, range = 2.01–2.53 g) and large (N = 20, mean = 2.82 g, range = 2.59–3.21 g) size groups, and individuals within each size group were randomly assigned to one of two treatments (control or toe-clipped) using PROC SURVEYSELECT in SAS version 8.2 (SAS Institute Inc. 2001, Cary, North Carolina, USA). Each size group was equally represented in each treatment.

Animals in the toe-clipped treatment were marked by complete excision of the third toe on the left front foot and the fourth toe on the right rear foot with scissors sterilized in 95% ethanol. This mark corresponded to a mark of 72 under the Hero (1989) marking scheme. All wounds from toe removals were sprayed immediately with Bactine®, as recommended by Martin and Hong (1991). Animals in the control group were not toe-clipped or marked in any way. All animals were housed individually in 15 × 15 × 6 cm plastic Tupperware® containers on a substrate of moist paper towels. Frogs within the same size group were offered the same number and size of crickets 2–3 times a week. Crickets were dusted biweekly with Herpcare Cricket Dust®, which served as a vitamin supplement. All containers were maintained at a temperature of ca. 20ºC, and a 12:12 L: D photoperiod was maintained with full spectrum 60-watt incandescent bulbs hung 1 m above the containers. Individuals from each treatment were measured and weighed and their toes were examined monthly for signs of inflammation for five months. Survivorship of frogs from each group was also recorded. The sex of each frog was determined at the end of the study when secondary sexual characteristics (distended vocal sacs in males) were expressed with the onset of the breeding season.

Repeated measures analysis of variance was used to compare changes in SVL and mass among treatment groups using size group as a blocking variable. To test for any influence of sex on growth response variables, a separate repeated measures analysis of variance was used to compare SVL and mass among the sexes with size group as a blocking variable. Frogs with missing data (two escapes, and one death) were not included in the analysis. Analyses were conducted using the GLM procedure with a repeated statement in SAS version 8.2 (SAS Institute Inc. 2001, Cary, North Carolina, USA). This procedure produces both univariate and multivariate (Manova) tests for the effects of the treatments and time on the response variable.

Results.—One toe-clipped animal died of unknown causes during the fourth month, and two control animals escaped. Inflammation of clipped toes was recorded in nine animals (29%) during the first month and in two animals (6.5%) during the second month of the experiment. However, the wounds of all animals healed after 2 months, and no instances of tissue necrosis were observed.

Mean mass (t_{57} = -0.12, p = 0.91) and SVL (t_{57} = 0.28, p = 0.78) did not differ between treatment groups at the start of the experiment. Treatment had no effect on SVL ($F_{1, 55}$ = 0.00, p = 0.95) or mass ($F_{1, 55}$ = 0.10, p = 0.75), and there was no treatment by time interaction for either response variable (in both univariate and multivariate tests) (Figs. 1 and 2). However, both mass and SVL varied over time (mass: Wilk's lambda = 0.16, $F_{5, 51}$ = 52.63, p < 0.0001, univariate $F_{5, 275}$ = 40.91, G-G adjusted p < 0.0001; SVL: Wilk's lambda = 0.33, $F_{5, 51}$ = 20.60, p < 0.0001, univariate $F_{5, 275}$ = 29.07, G-G adjusted p < 0.0001). Neither SVL nor mass was significantly different between the sexes (SVL: $F_{1, 55}$ = 0.16, p = 0.69; Mass: $F_{1, 55}$ = 0.00, p = 0.98), and the sex by time interaction was not significant in any test.

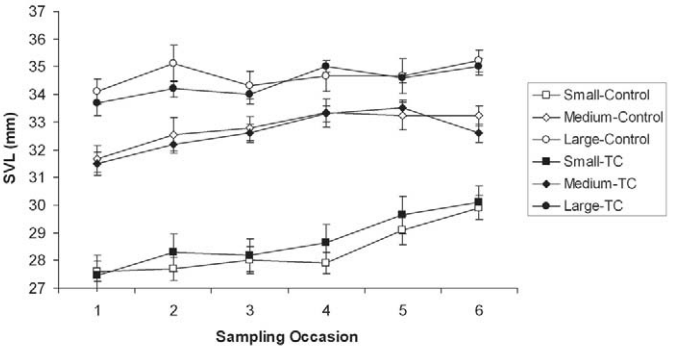


FIG. 1. Mean (± SE) SVL of toe-clipped (TC) and control frogs within different size groups sampled at 1 month intervals from December 2004 – May 2005. The 1 mm decrease between sampling events 5 and 6 for the medium sized toe-clipped group was due to measurement error.

Discussion.—Toe-clipping did not significantly affect the short-term growth or survivorship of *H. squirella* in this experiment. Our results are similar to those of Davis and Ovaska (2001) who examined the survivorship and growth of toe-clipped *Plethodon vehiculum* under laboratory conditions and to those of Ott and Scott (1999) who found no effects of toe-clipping on *Ambystoma opacum* maintained in small outdoor enclosures. Van Gelder and Strijbosch (1996) similarly found no differences in food consumption or mass between toe-clipped and unmarked *Bufo bufo* kept in small outdoor vivaria. Taken together these studies provide no evidence for a direct negative effect of toe-clipping on the health and growth of amphibians when they are provided ample food and maintained in a controlled, predator-free environment.

However, several studies conducted in field situations have demonstrated that amphibians marked by toe-clipping are recaptured less often than individuals marked by other methods, and that return rates are negatively related to the number of toes removed (Davis and Ovaska 2001; McCarthy and Parris 2004). In light of the laboratory studies, these observations suggest two possible

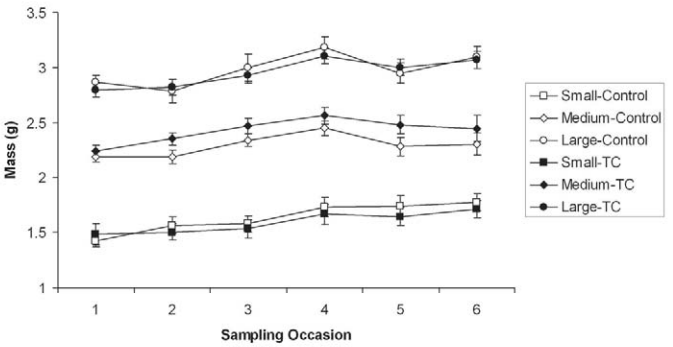


FIG. 2. Mean (± SE) mass of toe-clipped (TC) and control frogs within different size groups sampled at 1 month intervals from December 2004 – May 2005.

hypotheses: 1) toe-clipping may have an indirect negative effect on survival through increased predation and/or decreased foraging ability due to decreased mobility, 2) toe-clipping may affect amphibian behavior causing individuals to avoid capture locations. Evidence exists for both hypotheses. In a field experiment, Davis and Ovaska (2001) found that daily weight gain of *P. vehiculum* was significantly lower in toe-clipped animals than in unmarked individuals. However, they noted that both marked and unmarked *P. vehiculum* were consistently found under the same cover objects where they were initially captured. In contrast, Castellano and Giacoma (1993) found a negative correlation between the number of toes clipped and the number of days male *Bufo bufo* spent at a breeding pond. Similarly, Lemckert (1996) noted that 25% of newly toe-clipped *Crinia signifera* caught immigrating into a breeding pond left the pond within 1–3 days of marking, a behavior never observed in returning, previously marked individuals.

One consideration when gauging the impacts of toe-clipping is that individual species may be affected to different degrees and through varying combinations of mechanisms. Species with different feeding strategies, habits (e.g., arboreal vs. fossorial), antipredator behaviors, or habitat relationships may be differentially affected by the removal of one or more toes. Species also may vary in degree of susceptibility to stress or infection. For example, Lemckert (1996) found only rare incidences of infection in toe-clipped *C. signifera* but an almost 100 % infection rate in *Uperoleia laevigata*. Thus, marking by toe-clipping may be an effective, non-disruptive technique for some species but not for others.

The ethics of toe-clipping were recently questioned when McCarthy and Parris (2004) found that return rates of several frog species decreased linearly with the number of toes removed. Their study provides clear evidence that toe-clipping induces a negative effect on either the survivorship or the behavior of frogs. However, all available marking methods for amphibians involve the handling of animals and/or invasive procedures (see Donnelly et al. 1994), and it is likely that all marking methods induce some negative effect on the marked animals. In order to assess the ethics of toe-clipping and to determine the least disruptive marking method, the nature of the negative effects of toe removal should be fully understood. For instance, a marking method that results in a decrease in return rates due to behavioral avoidance of the capture site would be preferable to a method that results in a decrease due to mortality, particularly in the case of a rare or protected species. Unfortunately, few studies have compared the effects of toe-clipping to other marking methods (see Davis and Ovaska 2001) and the effects of other marking procedures on amphibian health and behavior are poorly known.

It should be emphasized that this study had several limitations, which should be carefully considered when interpreting the relevance of our results to the practice of toe-clipping in field studies. First and foremost, this was a laboratory study in which frogs were maintained in small enclosures in a predator-free, constant environment with an abundant and easily accessible food supply. This study could therefore not measure negative effects on the climbing ability and general mobility of the treefrog *Hyla squirella* or assess any influence of toe removal on behavior. However, given the importance of the adhesive toe discs of treefrogs in climbing and movement, it is likely that toe-clipping does have a negative effect on the mobility of this species. In addition, it is possible that our study animals healed at a different rate than they would have in the wild where a wider range of thermal environments, food items, and opportunities for infection exist. Secondly, all excision wounds in this experiment were treated with antiseptic, which may not be a common practice in most field studies. Our results may therefore represent an underestimate of the negative impacts of toe-clipping on growth and survivorship compared to field studies where antiseptic is not used. However, despite the limitations of this study, we believe our results add to a growing body of evidence that suggests that the negative impacts of toe-clipping observed in field studies are related to factors other than direct health effects.

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Observations of Boreal Toads (*Bufo boreas boreas*) and *Batrachochytrium dendrobatidis* in South-Central Wyoming and North-Central Colorado

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Boreal Toads (*Bufo boreas boreas*) are found throughout much of the western United States, and were historically viewed as common. Presently, this taxon is considered a species of concern in some western states (Maxell et al. 2003; McGee et al. 2002) and populations in the southern Rocky Mountains have decreased to the extent that they have been considered for listing under the Endangered Species Act (U.S. Fish and Wildlife Service 2005). Although a causal link has not been established, rapid declines in Boreal Toad populations have been associated with the presence of the chytrid fungus *Batrachochytrium dendrobatidis* (hereafter *Bd*) in northern Colorado (Muths et al. 2003; Scherer et al. 2005) and *Bd* has been implicated in the mass mortality of several other species of amphibians (Quellett et al. 2005; Rachowicz et al. 2006).

Accurately monitoring trends in Boreal Toad abundance and distribution is difficult partly because population surveys often rely on qualitative observations at or near breeding areas (Loeffler 2001). Temporal variation in habitat availability (Bartelt et al. 2004), explosive breeding behavior (Olson et al. 1986), periodic recruitment failures (Olson 1992), high turnover in the use of breeding areas (Trenham et al. 2003), and difficulty in detecting breeding assemblages (Hammerson 1999) may lead to substantial fluctuations in actual and perceived toad abundance (Corn et al. 2005; Heyer et al. 1994; Wente et al. 2005). Consequently, alternative methods for detecting the presence and relative abundance of Boreal Toads would be useful. Recently, researchers in Montana studying the summer movements of stream fishes coincidentally captured large numbers of downstream-drifting Boreal Toads in hoop nets (Adams et al. 2005). Subsequent netting directed at assessing in-stream movements by Boreal Toads detected them in many previously unsampled basins (M. Young and D. Schmetterling, unpubl. data). If use of streams by Boreal Toads is geographically widespread and temporally consistent, the installation of upstream-facing hoop nets may increase the options for sampling toad populations (cf. Heyer et al. 1994; Willson and Dorcas 2004).

Substantial testing for *Bd* in amphibians has been done at historical and current Boreal Toad breeding locations in Colorado, Utah, and Montana (Muths et al. 2003; Boreal Toad Conservation Team, unpubl. data), but only limited sampling has been done in Wyoming. Testing for *Bd* in amphibians in Wyoming began in earnest around 2000 in the Laramie River basin, with additional testing in portions of the Green River drainage in 2002 and more recent sampling in other portions of the state (W. Turner, Wyoming Game and Fish Department, pers. comm.). Determining the distribution of *Bd* is critical to identifying Boreal Toad populations at risk of declines from infection and to locating populations free from disease that might be used for reintroductions elsewhere, as well as describing its prevalence in amphibians in areas where boreal toads are no longer extant but other amphibians may be at risk.

Our study had three objectives: 1) determine whether hoop-net sampling could detect the presence of Boreal Toads in streams on the Medicine Bow-Routt National Forests of south-central Wyoming and north-central Colorado; 2) compare the relative efficiencies of visual encounter surveys and in-stream, hoop-net sampling for detecting Boreal Toads; and 3) assess the prevalence of *Bd* among amphibians detected by this sampling, by targeted breeding site surveys not evaluated as part of this study, or found incidentally in this region in 2004 and 2005.

Methods.—Hoop nets were placed in first- to third-order streams across the Medicine Bow-Routt National Forests during July and August 2004 and 2005 (Fig. 1). In 2004 and 2005, we hoop-net sampled streams adjacent to, or connected by the stream network to locations known to recently have Boreal Toads (based on breeding season or summer visual encounter surveys not associated with this study, N = 19). Of the 13 locations in which Boreal Toads had been observed or known to breed since 1996, the 11 with the most readily accessible streams were subsequently sampled with hoop nets at sites 0.1–8.0 km from the breeding or observation locations. Also in both years, we sampled randomly selected streams (N = 46) if their basins supported potential amphibian breeding habitats (lakes, ponds, or wetlands, usually in the vicinity of the stream and upstream from net locations). Individual streams were hoop-net sampled in only one year. The average elevation at net sites was 2657 m (range 2260–3014 m) and channel low-flow wetted widths averaged 3.3 m (range 0.3–11.6 m). Dominant stream substrate varied from small gravel to rubble and boulder. Willows (*Salix* spp.), Aspen (*Populus tremuloides*), and occasionally conifers dominated most riparian areas.

We installed hoop nets in 1–6 sites at least 1 km apart within each stream, depending on stream length and access. Each hoop net was 1.4 m long, had four 38-cm hoops, two leads 1–4 m long, and a single throat with a 5.0–7.5 cm opening, and was constructed of Delta heavy 44, 6.3-mm nylon mesh (Miller Net Company, Memphis, Tennessee). Costs per net averaged US $165. Nets were set in the channel thalweg and affixed to rebar driven into the stream bottom or banks. The opening of each net faced upstream and the leads were angled slightly upstream to direct downstream-drifting toads into the net. On average nets intercepted 1.2 m (range 0.4–1.8 m) of the wetted width of the channel. Nets were partially submerged such that the throat was underwater and the upper portion of the leads, first hoop, and cod end were above the stream surface to intercept toads drifting near the surface and to provide a resting area for captured toads.

Nets were installed as flows declined in summer and were monitored daily over the 9-d interval they occupied each site. This interval was chosen because probability of capture of at least one

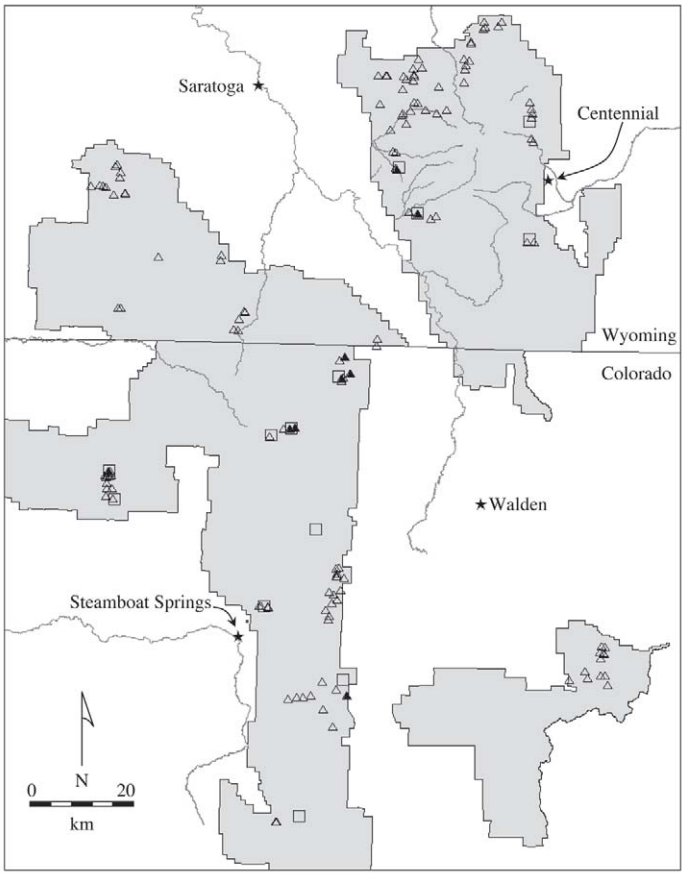


FIG. 1. Locations of sites monitored with hoop nets in 2004 and 2005 and locations of recent breeding areas on the Medicine Bow-Routt National Forests (shaded area). Filled triangles = sites where Boreal Toads were captured in hoop nets in 2004 and 2005 (N = 9); open triangles = sites without captures in hoop nets in 2004 and 2005 (N = 136); and open squares = breeding locations or sites with observations since 1996 (N = 13).

boreal toad exceeded 76% with this sampling intensity during midsummer in Montana streams (M. Young and D. Schmetterling, unpubl. data). Occasionally this period was shortened if nets incurred damage or Beaver (*Castor canadensis*) activity inundated or clogged them.

Upon capture, all toads were weighed (±1 g) and measured (snout–vent length, ±1 mm). Toads were sexed by inspecting the inner toes on the front legs for roughened nuptial patches and by attempting to induce them to vocalize by applying gentle pressure behind the front legs. Boreal Toads < 55 mm were considered to be juveniles (Hammerson 1999; Nussbaum et al. 1983) unless they vocalized or possessed nuptial pads. All toads > 55 mm were marked with a passive integrated transponder (PIT) tag inserted underneath the skin along the dorsal midline and posterior to the parotoid gland (Camper and Dixon 1988). An outside rear toe was clipped at the first joint and sealed with surgical cement to provide a secondary mark. All toads of this size were also checked for marks to identify previously captured individuals. After handling, toads were released downstream from the capture site.

We also conducted visual encounter surveys (Heyer et al. 1994) by making a sinuous traverse of the riparian areas along each side of the channel (including inspection of the stream) near net sites. These traverses extended 1 km upstream or until valley walls constrained the channel and effectively eliminated low-gradient, near-channel habitats. Most riparian surveys were completed up to a month prior to net installation when the probability of detecting breeding adults or egg masses was higher. Each Boreal Toad observed during these surveys was measured and marked, as previously described, and its location noted. Finally, the time necessary to complete hoop-net sampling and visual encounter surveys was recorded for work conducted in Wyoming.

Most live and dead amphibians captured in hoop nets and visual encounter surveys, as well as those found during monitoring of known amphibian breeding areas or located opportunistically, were tested for *Bd*. In general, handling procedures followed Livo (2004). For live animals, we sampled for *Bd* by obtaining skin swabs and conducting genetic analyses because this method is less injurious and yields rates of detection comparable to those of more intrusive sampling when tested on known *Bd*-positive individuals (Livo 2004). We used scissors to remove toes or ventral skin patches from dead animals (N = 3). Samples were submitted to a laboratory (Pisces Molecular, Boulder, Colorado) for detection of fungal DNA using a PCR assay.

Results.—In 2004 and 2005, we sampled for 1267 trap-days at

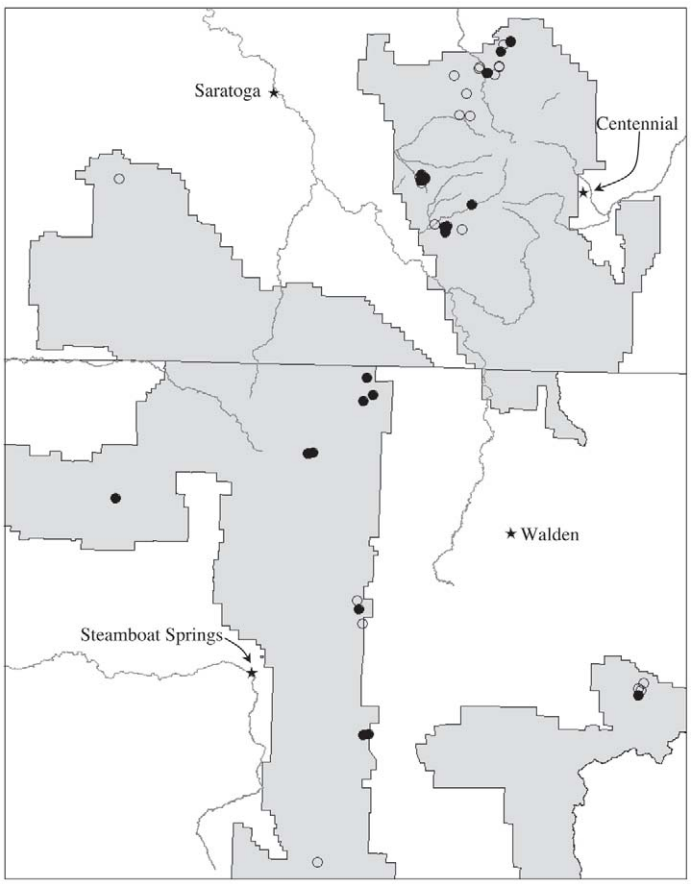


FIG. 2. Locations of amphibian samples from five species that were tested for *Batrachochytrium dendrobatidis* (*Bd*) in 2004 and 2005 on the Medicine Bow-Routt National Forests (shaded area). Filled circles = *Bd* detected (N = 20 sites, 81 individuals) and open circles = *Bd* not detected (N = 19 sites, 105 individuals). Note that not all amphibians captured were tested.

145 net sites on 65 streams on the Medicine Bow-Routt National Forests (Fig. 1). At or near nine net sites on eight streams—Beaver Creek, S. Fk. Big Creek, N. Fk. Elk River, Grizzly Creek, Torso Creek, and Twisty Creek in Colorado and Barrett Creek and Sourdough Creek in Wyoming—we captured 40 toads (6 males, 8 females, and 26 juveniles), of which 37 were first caught in hoop nets and 3 during visual encounter surveys. We caught 1–6 toads over the 9-d netting interval in seven of these streams, and 20 juvenile toads in Torso Creek. Marked toads were recaptured on five occasions; all recaptures were within 3 d of the initial marking. Four of these were made adjacent to the stream in the vicinity of the hoop nets where the toads were initially captured, and one marked toad was recaptured in the same net where it was first caught. All toads found in hoop nets were alive with one exception (this toad tested positive for *Bd*), and it is unknown whether this animal was already dead at the time of capture. All toads observed during visual surveys were alive.

Although hoop nets produced more captures than did visual encounter surveys (and visual encounter surveys only detected toads in those locations adjacent to net sites producing captures), other measures of sampling efficiency suggested some shortcomings of using hoop nets. Hoop-net sampling resulted in captures of boreal toads near only 6 of 11 locations with relatively recent (since 1996) observations of Boreal Toads or toad breeding areas, although Boreal Toads may have been absent from some of these locations by the time hoop-net sampling was conducted; toads were captured near all locations with observations since 2000. Mean distance from known breeding areas to net sites with captures was 1.1 km (range 0.1–4.2 km). Also, Western Chorus Frogs (*Pseudacris triseriata*) were the only other amphibians captured in hoop nets (N = 5), whereas Northern Leopard Frogs (*Rana pipiens*) and Wood Frogs (*Rana sylvatica*) also were observed (but not counted) during visual encounter surveys. On average, it required 4.5 h for a crew of two people to monitor 10–15 nets, depending on road conditions and the distance between sites. Days on which traps were installed required an additional 6 h. Visual encounter surveys required approximately 1 h for two people to examine 1.6 ha.

Amphibians infected with *Bd* were present in many portions of the study area. Of the 186 amphibians sampled at 39 locations in 2004 and 2005, 81 individuals from 20 locations were positive for *Bd* (Fig. 2). Overall, 54 of 102 Boreal Toads tested positive for the presence of *Bd* and 14 of 16 locations with Boreal Toads that were tested (including eight sites where toads were detected with hoop nets or visual encounter surveys) were positive. Also, 21 of 54 Western Chorus Frogs, 3 of 5 Northern Leopard Frogs, and 3 of 24 Wood Frogs were positive for *Bd*; the lone Tiger Salamander (*Ambystoma tigrinum*) tested negative.

Discussion.—Although earlier studies gave anecdotal (Carpenter 1954) or indirect (Campbell 1970) evidence of stream use by Boreal Toads in Colorado and Wyoming, our study confirms their presence in streams in this region (cf. Muths et al. 2001), and suggests that stream-related movements by Boreal Toads might not be restricted to populations in the northern Rocky Mountains. However, not all locations that support populations of Boreal Toads have perennial streams (e.g., northeastern Utah; Thompson et al. 2004), thus their use of such habitats might be regarded as somewhat opportunistic.

The 37 Boreal Toads captured in nine hoop nets were far fewer than those detected in western Montana watersheds using a similar sampling regimen. For example, in brief late summer sampling in 2001 and 2002 in three western Montana streams, Adams et al. (2005) made over 250 captures of Boreal Toads in hoop nets, and additional in-stream trapping in this area during portions of two subsequent summers produced 497 captures of Boreal Toads from 16 of 21 streams sampled (M. Young and D. Schmetterling, unpubl. data). These regional differences in captures are consistent with the perception of widespread and rapid declines of this species in the southern portion of its range (Carey et al. 2005; Corn et al. 2005). Nevertheless, the actual distribution of Boreal Toads is probably greater than that determined from in-stream trapping, but how much greater is uncertain because the probability of detection using this method is unknown and the design we employed did not permit an evaluation of detection probabilities (sensu MacKenzie et al. 2002).

All captures of Boreal Toads in nets were associated with areas with recent (since 2000) observations (cf. Wente et al. 2005), but only 9 of 20 nets in these streams captured toads. As part of our field protocol, we concentrated sampling downstream from known or potential breeding areas based on the assumption that Boreal Toads would disperse in this direction following breeding. However, in the two instances in which we set a net upstream from an existing breeding area, both captured Boreal Toads. It might be more likely that individuals disperse after breeding via terrestrial movements (Bartelt et al. 2004), perhaps farther up in a basin, or that non-breeding individuals might have used the stream channel above breeding areas. Comprehensive investigations of the pre- and post-breeding movements of sexually mature Boreal Toads and of non-breeding individuals are necessary to resolve this uncertainty.

In-stream sampling in summer was more effective for detecting the presence of Boreal Toads than roughly concurrent visual encounter surveys in the same basin. This might be because Boreal Toads are cryptic and are difficult to locate outside the breeding season (Hammerson 1999; Keinath and McGee 2005) when they are largely nocturnal (Gregory 2000; Hailman 1984; M. Young and D. Schmetterling, unpubl. data). However, visual encounter surveys appeared to require less time to complete, and were more effective for detecting the entire suite of amphibians present in this region. Although hoop nets can be checked in 5 min and installed in 15 min by experienced individuals (M. Young, pers. obs.), much of the effort associated with hoop-net surveys is related to the spatial distribution of hoop nets, which in this study required traveling on average 75 km on unimproved forest roads each day. Moreover, we caution that because hoop-net sampling did not consistently detect Boreal Toads near all locations where they were known to be breeding in recent years, it cannot be considered a replacement for targeted surveys of breeding areas.

In-stream trapping revealed some aspects of these populations that might have been overlooked by other techniques. For example, we inferred that Boreal Toad recruitment was successful in 2004 in the Torso Creek watershed, based on captures of juveniles that metamorphosed the previous summer. Their presence may be a more reliable indicator of reproductive success than observations of egg masses, tadpoles, or recently metamorphosed toads, given the potentially high rates of mortality of each of these life stages

(Biek et al. 2002; Carey et al. 2005). Furthermore, sex ratios were much closer to unity than typically observed at breeding areas (Olson et al. 1986; Thompson 2004).

Based on our sampling, *Bd* appears to be widely distributed throughout south-central Wyoming and north-central Colorado (51% of sites tested), and was present in the majority (53%) of Boreal Toads that were tested. Positive samples were collected from the Elkhead Mountains, Park Range, Never Summer Mountains, and Sierra Madre in Colorado and from the Medicine Bow Mountains in Wyoming. We did not detect *Bd* in samples from the Wyoming portion of the Sierra Madre, but owing to the rarity of samples of amphibians from there, this is not conclusive evidence that *Bd* is absent. Because these locations were not previously sampled for *Bd*, it is not possible to determine if its prevalence is a recent phenomenon. Nevertheless, the putative arrival of *Bd* in central Colorado coincided with a rapid decline in Boreal Toads (Corn et al. 2005), and similar circumstances might explain the apparent current rarity of Boreal Toads in the study area. Also, the presence of *Bd* at many locations and among most Boreal Toad populations suggests that, should reintroductions of Boreal Toads be attempted, ensuring that breeding areas remain disease-free might prove problematic.

In summary, we established that Boreal Toads of the southern Rocky Mountain populations may use streams in mid-summer and can be captured by using upstream-facing hoop nets. This approach was more successful at detecting Boreal Toads than were visual encounter surveys in the same area. However, the failure to capture Boreal Toads in all nets near locations suspected to support breeding populations indicates that stream-based netting alone is inadequate for assessing their status, and might better serve as a complement to targeted breeding area surveys or for the detection of toads in previously unrecognized locations. Finally, the limited number of captures of Boreal Toads, and of captures only in association with locations where this species had recently been observed, is consistent with the perceived large-scale reductions in distribution and abundance of Boreal Toads in this region and that this apparent decline might be associated with the high prevalence of *Bd* among Boreal Toads and other amphibians in this area.

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Breeding Ponds Colonized by Striped Newts after 10 or More Years

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Many amphibian populations are thought to be structured as metapopulations across a landscape (but see Smith and Green 2005), particularly those species breeding in isolated temporary ponds (e.g., Gill 1978, Hecnar and M'Closkey 1996, Skelly 2001). In terms of Levins' (1969) classic metapopulation concept, isolated wetlands could serve as demes or subpopulations in a larger metapopulation context. This also includes the uplands surrounding isolated wetlands for those species that migrate between upland refuges and isolated breeding sites. Because of variable hydroperiods or presence of predators (e.g., some fishes), certain ponds may be subject to prolonged periods without sufficient hydroperiod to allow metamorphosis (e.g., Semlitsch et al. 1996), whereas others may persist through time and allow the production of metamorphs to maintain populations (sources). A prolonged period of metamorphic failure could lead to a local extinction event. Should conditions change, sites from which populations had been extirpated might be recolonized via dispersal of individuals from source populations. This dynamic interplay of occupancy, colonization and local extirpation thus produces a mosaic of occupation scenarios at any point in time. As Marsh and Trenham (2001) point out, however, this model is somewhat simplistic since there are many variables which affect landscape occupancy by pond-breeding amphibians, including various deterministic factors, the distribution of terrestrial habitats, and the isolation of the pond "patches."

Despite the general acceptance of the metapopulation model, few studies have demonstrated amphibian colonization of a former breeding site after a long absence (see Taylor et al. 2006 for a possible example involving *Eurycea quadridigitata* after 8 years) or colonization of previously unsuitable sites. Here, we report on the colonization of aquatic breeding sites by the Striped Newt (*Notophthalmus perstriatus*) in north-central Florida after a period of 10 years or more with no water, or under previously unsuitable conditions, and suggest that Striped Newts may form metapopulations. Metapopulation dynamics have important implications for the conservation and management of this imperiled species (Dodd et al. 2005). For example, for Striped Newts to persist as metapopulations it is crucial to protect a suite of wetlands with a diversity of hydroperiods and to properly manage uplands to facilitate dispersal among ponds.

For five years, Breezeway Pond on the Ordway-Swisher Biological Station, Putnam County, Florida was monitored five days per week using an encircling drift fence-pitfall trap sampling procedure (see Dodd 1992 for details of this study). Hydroperiod was monitored daily. From 1985 to 1990, > 2500 Striped Newts were marked as they entered and exited the 0.16 ha pond. During the latter half of the study (1988 - 1990), a prolonged drought affected north-central Florida (Franz 1991) and Breezeway Pond went dry on 23 December 1988. Captures of Striped Newts declined accordingly, from 744 in 1987 to 16 in 1990 (Dodd 1993). After October 1990, Breezeway Pond was periodically checked for the next 10 years, especially after substantial rain events, to monitor its hydroperiod. It did not refill until January 1998. During this period the pitfall traps were closed and the drift fence was opened in numerous places to allow animals to move freely in the dry pond basin. On 8 May 1998, a larval Striped Newt was collected from the pond (UF 133756). Despite rigorous dip-net sampling of the pond, which was less than 0.1 hectares in extent at the time, only four larval newts were captured. Although we cannot be sure, this could indicate that very few adults, which migrate to Breezeway Pond in the winter (Dodd 1993), recolonized the pond.

Smith Lake is a 7.55 ha clear-water lake located 350 m N of

Breezeway Pond. It had been stocked with fish when the station was a private hunt club (prior to 1980). In 1983, fish surveys documented the presence of *Etheostoma fusiforme, Gambusia holbrooki, Lepomis macrochirus,* and *Micropterus salmoides* (R. Franz, pers. comm.). During aquatic surveys prior to 1990, no Striped Newts were collected in the lake, which was not surprising since Striped Newts do not inhabit ponds with predatory fishes (Dodd et al. 2005). However, a small isolated wetland (Smith Lake Pond #1, ca. 425 m east of Smith Lake) had Striped Newts on 9 April 1993 (UF 91485). Smith Lake dried on 29 May 1990 because of a severe drought that affected many lakes and wetlands on and near the Ordway-Swisher Biological Station (Franz 1991) and remained dry for several years before refilling. No fishes have been found in the lake since it dried completely in the early 1990s. Striped Newts were collected from Smith Lake for the first time on 1 February 1997 (UF 133789), again on 2 November 1997 (UF 125759), and most recently on 20 April 2005 (no voucher collected).

A similar situation occurred at a neighboring wetland, Blue Pond (0.71 ha basin), on the Ordway-Swisher Biological Station. Prior to the mid-1980s, when the Station was in private ownership, Blue Pond was a popular fishing site. In the spring of 1985, approximately 100 largemouth bass were caught in Blue Pond (S. Scaife pers. commun.). Blue Pond dried completely in 1989 during the same severe drought that caused Smith Lake and Breezeway Pond to dry. No fish have been found in Blue Pond since the drought. Striped newts were first documented in Blue Pond on 9 February 1997 (UF 128031), and most recently on 11 November 2006 (no voucher taken). They have been documented in Blue Pond numerous times during the interim between these dates. Because Striped Newts only breed in fishless ponds, and thus to our knowledge did not occur in Blue Pond prior to the drought, this is another example of colonization of previously unsuitable habitat by the species.

Salamanders are known to colonize breeding sites after the extinction of predatory fish. Funk and Dunlap (1999) conducted surveys for introduced trout and native Long-toed Salamander larvae in high elevation lakes in 1978 and again in 1997/1998. They found evidence to suggest that Long-toed Salamanders were able to colonize lakes in which trout went extinct. This is similar to our findings with Striped Newts at the Ordway-Swisher Biological Station. Population estimates at known Striped Newt breeding ponds on the biological station vary. Dodd (1993) documented 2521 individuals over a 62.5 month period (1985–1990) at Breezeway Pond. During a two-year period (1996–1998), Johnson (2002) counted 8127 Striped Newts entering and exiting One Shot Pond. However, Johnson (unpubl. data) only found 32 individuals at neighboring Fox Pond during a 270-day period from Nov 1997 to Aug 1998. Drift fences encircled both of these ponds. Despite herpetologists working on the biological station for the past 25 years and sampling many of the station's wetlands, this was the first time Striped Newts were documented in Fox Pond and thus may represent a colonization or recolonization event. Fox Pond is very isolated from other wetlands and likely never supported predatory fishes naturally.

Striped Newts have been found in 12 ponds on the Ordway-Swisher Biological Station, all of which have dried for varying lengths of time during the last three decades. The larger wetlands (Smith Lake, Blue Pond, Clear Pond) and two deep but small ponds (Berry, One-Shot) have the longest hydroperiods, but even at these locations drought may completely eliminate or severely limit the duration and timing of suitable conditions for Striped Newt breeding. At such times, Striped Newts may attempt to disperse to other wetlands if available. Striped Newts have been found terrestrially 700 m from the nearest possible breeding site (Dodd 1996), and an inter-pond movement of ca. 685 m (movement of a marked newt from One Shot Pond to Fox Pond) was recorded on the Ordway-Swisher Biological Station (Johnson 2003). Johnson (2003) suggested that 16% of a Striped Newt breeding population may migrate > 500 m from non-breeding terrestrial habitats to reach an isolated breeding pond. Although they have the ability to migrate hundreds of meters into upland habitats, there appears to be strong philopatry to natal breeding ponds, and inter-pond dispersal is a relatively rare event. This supports our supposition that Striped Newts form metapopulations because it means that recruitment is more likely to come from within a patch (e.g., breeding pond and surrounding uplands) rather than via immigration from nearby patches (Harrison and Taylor 1997).

Understanding the synchrony of local population dynamics is important for differentiating between patchy populations and true metapopulations (Harrison and Taylor 1997; Hecnar and M'Closkey 1996). Unfortunately, details of the synchrony of pond occupancy (e.g., extinction and recolonization rates) by Striped Newts across all potential breeding ponds on the Ordway-Swisher Biological Station are unknown. Long-term studies among multiple patches (ponds) are required to collect such data. Nonetheless, we believe our data support the hypothesis that Striped Newts on the station persist as a metapopulation. Because of environmental stochasticity (e.g., drought, predator colonization), local extinctions are likely over time for Striped Newt breeding ponds on the station. Variation in pond hydroperiods leads to variation in the synchrony of extinction events.

The source of the individuals that recolonized Breezeway Pond after 10 years, as well as the source of animals that colonized Smith Lake and Blue Pond following the drought, remains unknown. They likely originated from another breeding pond as part of a metapopulation at the Ordway-Swisher Biological Station, as suggested above. Alternatively, it is possible that in some situations individual Striped Newts may wait out short-term droughts in terrestrial refugia. Eastern Red-spotted Newts (*N. viridescens*) may live > 8 years (Forester and Lykens 1991; Gill 1985), although attempts to age Striped Newts have been unsuccessful (G. Zug, pers. comm.). A single individual *N. perstriatus* from the Ordway-Swisher Biological Station has been kept in captivity since 1991, a period of 15 years (L. LaClaire, pers. comm.). Thus, it is possible that wild Striped Newts are long lived.

Like *N. viridescens* (Gill 1978), *N. perstriatus* seems to fulfill the criteria (patchy occupancy through time of a series of breeding ponds in close proximity; periodic extinction and recolonization due to stochastic environmental fluctuation; potential for long distance dispersal; inter-pond movement) for having a metapopulation structure. Surveys for this declining species need to take into consideration the extent to which individuals and populations are dispersed across a landscape over time. What appears to be an unoccupied or unsuitable site during a short-term survey may be an important location for metapopulation dynamics during optimal

environmental conditions.

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The Diets of Three Sympatric Barred River Frogs (Anura: Myobatrachidae) from Southeastern Australia

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There are five species of large (7–10 cm) ground-dwelling myobatrachid frogs of the genus *Mixophyes* found along the coast and adjacent ranges of eastern Australia (Cogger 2000). This genus is of some conservation interest because three species (*M. balbus, M. iteratus,* and *M. fleayi*) have had major declines in numbers and ranges in recent years, presumably due to the chytrid fungus, *Batrachochytrium dendrobatoides*, and habitat loss (Ehmann 1997; Hines et al 1999). Advancing knowledge of their basic biology is imperative for their long-term conservation.

The diet of the *Mixophyes* has been poorly documented. Cogger (2000) notes that they generally feed on "insects and smaller frogs." However, the only specific published report of any kind is Wotherspoon's (1980) note of Leaf Green Tree Frogs (*Litoria phyllochroa*) in the stomach of a *M. fasciolatus*. We document the gut contents of three of the species of barred river frogs (*M. balbus, M. fasciolatus,* and *M. iteratus*) to determine if there is any obvious dietary specialization that might be of importance in the declines of *M. balbus* and *M. iteratus*.

Preserved specimens from each of the three species were obtained from the collections of the Australian Museum, Melbourne Museum, and the Australian Wildlife Collection. These specimens come from a wide range of sites and span more than 100 years in time. Each specimen was sexed and the contents of the gut cavity removed and placed into a separate specimen tube along with the corresponding museum identification number. Each was examined later in order to identify the number of food items present and, as far as possible, the identity of the prey items. Where an item could be clearly distinguished, it was identified to the family level for insects and order for the other items. Initially, we attempted to estimate the volumes of each food item, but the inconsistent nature of digestion made useful comparisons impossible and this approach was abandoned. Individuals were assigned a sex based on obvious secondary or internal sexual characteristics and were considered sub-adults if less than 5 cm snout–urostyle length (SUL) and showed no distinct sex.

We described diet composition, but did not attempt statistical data analysis because of the small number of individuals containing food items. Furthermore, exploratory analysis (using Principle Component Analysis and Analysis of Variance) revealed that the gut contents of a few individuals with much larger numbers of prey strongly influenced any statistical testing, confounding the

TABLE 1. Prey items from the stomachs of 52 *Mixophyes iteratus*, from southeastern Australia.

Prey Group	Females	Males	Sub-adult	Total
Insects				
Blattodea	0	0	0	0
Coleoptera	5	1	0	6
Coleoptera larva	1	0	0	1
Dermaptera	0	0	0	0
Hemiptera	0	0	1	1
Lepidoptera	0	0	0	0
Orthoptera	1	1	0	2
Trichoptera	0	0	0	0
Unidentified Insect	5	4	0	9
Total Insects	12	6	1	19
Non-Insects				
Arachnid	2	0	0	2
Amphipod	3	0	0	3
Anuran	2	0	0	2
Centipede	4	0	0	4
Gastropod	2	0	0	2
Millipede	0	1	0	1
Nematode	1	0	0	1
Skink	2	0	0	2
Total Non-Insects	16	1	0	17
Total Items	28	7	1	36
No. frogs with item	6	5	1	12
No. empty stomachs	12	18	10	40

analysis interpretation.

Each species ate a broad range of food items that included various invertebrate groups such as spiders, centipedes, and snails (Tables 1–3). Insects dominated the diets: *Mixophyes balbus*, 25/30 = 83%; *M. fasciolatus*, 34/44 = 77%; and *M. iteratus*, 19/36 = 53%. *Mixophyes iteratus* ate a greater range of non-insect items with eight non-insect groups being recorded, whereas both *M. balbus* and *M. fasciolatus* each included only three non-insect groups. Spiders were the most prevalent non-insect eaten (12/32 non-insect items = 37%). Overall, 105 of the 110 (98%) dietary items were invertebrates. Of the remaining dietary items, the *M. iteratus* sample included two frogs. One could not be identified, but the other was a stream-breeding species, the Tusked Frog, *Adelotus brevis*. Additionally, small skinks were found in the diet of both *M. iteratus* and *M. balbus*.

The dietary samples for the three *Mixophyes* species suggest that there was no particular dietary specialization. This is in keeping with the limited available information on Australian frogs which indicates that most species are dietary generalists and that larger species have varied and broad diets (Barker et al. 1995; Tyler 1994). All three species of *Mixophyes* are reasonably large frogs (*M. iteratus* females reach up to 12 cm SUL; *M. balbus* and *M. fasciolatus* reach 7–10 cm SUL; Cogger 2000) that likely attempt to eat any potential prey items they encounter when foraging. If anything, smaller prey items such as collembolans, amphipods, ants, or termites appeared to be relatively rare within the guts of the sampled specimens. These have been found to be important prey items for smaller (and often sympatric) species of Australian myobatrachid frogs (Cappo 1986; MacNally 1983), but relatively small invertebrates may not be worth the effort of capture by the large adult barred river frogs. Sub-adults of all three *Mixophyes* species may eat these smaller prey items, however we sampled few frogs of less than 5 cm SUL.

Mixophyes iteratus appeared to have a wider prey base and ate relatively fewer insects than the other two species in our sample. Insects form the major part of the diets of nearly all Australian frog species on which we have information (Tyler 1994). The fact that this is such a large-bodied species may allow it to take larger non-insect prey such as centipedes and frogs as well as large "king" crickets (up to 7 cm long; F. Lemckert, pers. obs.), and typically it is the larger frogs in Australia that are recorded eating large prey items (e.g., *Litoria raniformis*: Fleay 1935; *Litoria caerulea*: Tyler 1994).

Dietary difference may originate from frog habitat preferences. While *M. iteratus* breeds in streams (Barker et al. 1995; Cogger 2000), it appears to be relatively restricted to riparian areas in wetter forest types (Lemckert and Brassil 2000). The stream-breeding *M. balbus* and, particularly, the pond-breeding *M. fasciolatus* for-

TABLE 2. Prey items from the stomachs of 62 *Mixophyes balbus*, from south-eastern Australia.

Prey Group	Female	Male	Others	Total
Blattodea	2	3	0	5
Coleoptera	0	2	0	2
Coleoptera larva	0	0	1	1
Dermaptera	0	0	0	0
Hemiptera	0	0	1	1
Lepidoptera	0	2	0	2
Orthoptera	2	3	1	6
Trichoptera	0	1	0	1
Unidentified Insect	1	4	2	7
Total Insects	5	15	5	25
Amphipod	0	0	0	0
Anuran	0	0	0	0
Arachnid	0	2	0	2
Centipede	0	0	0	0
Gastropod	2	0	0	2
Nematode	0	0	0	0
Millipede	0	0	0	0
Skink	1	0	0	1
Total Non-Insects	3	2	0	5
Total Items	8	17	5	30
No. frogs with item	5	7	4	16
No. empty stomachs	12	22	12	46

TABLE 3. Prey items from the stomachs of 73 *Mixophyes fasciolatus*, from southeastern Australia.

Prey Group	Female	Male	Others	Total
Blattodea	1	0	1	2
Coleoptera	3	2	1	6
Coleoptera larva	0	0	0	0
Dermaptera	0	0	3	3
Hemiptera	0	0	0	0
Lepidoptera	0	0	0	0
Orthoptera	7	6	4	17
Trichoptera	0	0	0	0
Unidentified Insect	1	3	2	6
Total Insects	12	11	11	34
Amphipod	0	0	0	0
Anuran	0	0	0	0
Arachnid	4	4	0	8
Centipede	1	0	0	1
Gastropod	0	0	1	1
Nematode	0	0	0	0
Millipede	0	0	0	0
Skink	0	0	0	0
Total Non-Insects	5	4	1	10
Total Items	17	15	12	44
No. with item	9	6	9	24
Empty	14	22	13	49

age in drier forest away from the riparian zone (Lemckert and Morse 1999). Nematodes, amphipods, and gastropods would generally prefer moister environments and are likely to be more prevalent in riparian areas so *M. balbus* and *M. fasciolatus* may not encounter the riparian-associated wider prey base of *M. iteratus*. The partial dominance of crickets in the diet of *M. fasciolatus* might be explained by its greater occurrence in drier forest areas. However, there is not enough evidence on the distribution of crickets in these forest environments to know if this is the case or whether they preferentially target crickets in the diet.

The dietary intake from this study suggests it is unlikely that a decline in specific prey items has played a significant role in the declines of *M. iteratus* and *M. balbus*. They do not have obvious specializations on particular prey groups that could lead to impacts on populations if specific prey bases declined. The diets of the sub-adults may be more specialized and so affected by disturbances and should be explored further, although the limited data we obtained suggested that the diets of these smaller individuals were as broad as the adults.

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Natural History Notes on *Crotalus tancitarensis* (Serpentes: Viperidae)

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The Tancítaro Cross-banded Mountain Rattlesnake, *Crotalus tancitarensis*, is only known to inhabit the upper elevations of the volcano known as Cerro Tancítaro in Michoacán, México. The species was recently described from three specimens by Alvarado-Díaz and Campbell (2004), who placed it in the *Crotalus intermedius* species group of Mexican montane rattlesnakes, which also includes *C. intermedius*, *C. pricei*, and *C. transversus* (Murphy et al. 2002). This report provides information on nine additional individuals of *C. tancitarensis* with respect to variation in scalation and color pattern, and also on parturition dates, litter size, neonate characters, and food acceptance in captivity.

Methods

All snakes were collected approximately 800 m N of the type locality at Los Portales, Michoacán, México, at 3220 m elevation (coordinates 19°24'13"N, 102°19'45"W) on Cerro Tancítaro. The site is a steep, south-facing slope about 70 × 250 m, covered by grass, herbs, and rocks. The site is bordered to the north by a 3 m high rock wall, to the south by a deep cliff and to the east and west by pine-fir forest, which is the dominant plant formation in the area. Cerro Tancítaro (max. elev. 3900 m) is located in the western portion of the Transverse Volcanic Cordillera. Above 3000 m, the mean annual temperature ranges from 5–12°C, with an average annual rainfall of 1500 mm. Most rain falls from June to October after a 5–6 month dry season (García et al. 2002).

One adult female and two juvenile females were collected on 19 July 2003 between 1400 and 1530 h when the air temperature was 23°C. Another adult female was caught on 29 October 2005 at 1345 h when the air temperature was 19°C. Palpation indicated that the second female was gravid, so it was held in the laboratory until after giving birth to four live and one stillborn neonates on 21 March 2006. All individuals eventually either died or were euthanized and were later deposited in the herpetological collection, Instituto de Investigaciones sobre los Recursos Naturales, Universidad Michoacana de San Nicolás de Hidalgo (INIRENA).

The non-gravid adult female collected in July 2003 (INIRENA 421) was active and the juveniles (INIRENA 414, 423) were coiled under stones. The juveniles were euthanized and preserved immediately after capture. The female was maintained live in a glass vivarium (L50 × W26 × H30 cm) in a laboratory building located at an elevation of 2000 m until she died on 23 November 2006. Ambient temperatures were maintained between 16 and 24°C (mean = 21°C) and laboratory windows provided a natural photoperiod. Room temperature readings were taken every day with a mercury thermometer to the nearest 1°C at 1000 and 1600 h. Basking spots were provided from 1100 to 1500 h, at temperatures between 27 and 30°C, using 50 W incandescent spot-light bulbs. Food acceptance was evaluated by presenting various kinds and life stages of live invertebrates and vertebrates to the adult female INIRENA 421. If food items were not consumed, after 2 h in the case of vertebrates and 24 h for invertebrates, the items were removed from the cage.

The gravid female (INIRENA 560) was found inactive under a stone. The snake was maintained live for five months under the same conditions as described above, until parturition. Of the five neonates (INIRENA 570–575, 3 females and 2 males), the four live ones were maintained in captivity within the same glass terrarium for 60 days. They were maintained at a natural photoperiod with a mean room temperature of 23°C and a range of 18–26°C. Basking spots, as described above, were available every day from 0930 to 1630 h.

Scale counts, body measurements (to the nearest 1 mm using a meter stick), and notes on color patterns follow those described in Klauber (1972) and Campbell and Lamar (2004). Color pattern was recorded from live individuals only, and after the first molt in the case of neonates. Character values from the holotype and two paratypes of *C. tancitarensis* were taken from Alvarado-Díaz and Campbell (2004).

Results and Discussion

Scalation and color pattern.—Table 1 lists character values of the nine specimens reported herein and of the holotype and paratypes of *C. tancitarensis*. The new material conforms well with scutellation and color pattern of type specimens, all the new material expands the range of ventral scale number (from158–160 to 151–160), subcaudal scale number (from 21–22 to 15–22) and dorsal body crossband number (from 49–51 to 48–52). The two males have fewer ventral scales than do females (151 vs. 156–160). Subcaudal scales numbers were 17 and 22 in males (vs. 15–22 in females). Tail length constitutes about 9 and 9.3% of total body length in the two males and 7.5–8.9 % in females. All specimens (including types) exhibit 21 dorsal scale rows at mid-body, a loreal scale that does not contact the lower preocular scale but contacts the supralabial scale series, and a loreal scale that is longer than high (except in INIRENA 414, in which the right loreal is as long as high). Color pattern of the new specimens is similar to type specimens; dorsal ground color pale blue-gray, dark crossbands on body and tail, and a black omega-shaped nape mark. However, neonates and juveniles lacked the pinkish copper-colored stripe along the vertebral line that is exhibited by the types and the other two adults (Fig. 1). Although the range of variation for some characters increased, lepidosis aspects and color pattern of the new material are consistent with the characters that separate *C. tancitarensis* from other members of the *C. intermedius* group (Alvarado-Díaz and Campbell 2004).

Diet in captivity.—During the first two months of captivity, the non-gravid female (INIRENA 421) was offered various types of potential prey, including invertebrates (crickets, mealworms, centipedes), amphibians (*Hyla eximia*, *H. arenicolor*), rodents (newborn mice), and lizards (*Sceloporus grammicus*, *S. aeneus*, *Anolis*



FIG. 1. Adult female (INIRENA 421) and neonates of *Crotalus tancitarensis.*

nebulosus, *Plestiodon copei*). The snake only accepted lizards, consuming all species presented except *A. nebulosus*. Lizard species known to share the local habitat with *C. tancitarensis* include *S. grammicus*, *P. copei*, and *Barisia imbricata*. *Sceloporus grammicus* is the most abundant lizard in the area, so that species is most likely the primary food source of *C. tancitarensis*. Under captive conditions described above, the snake was sustained (until death occurred 41 months after capture) on a diet of adult *S. grammicus* and juvenile *S. aeneus*, at an average feeding rate of one lizard per week.

The gravid female (INIRENA 560) was fed an adult *S. grammicus* about every 10 days after being placed in captivity on 29 October 2005. She stopped feeding in mid February 2006, about one month before parturition. After giving birth on 21 March 2006, she refused all food and died 21 days later.

Neonates refused to eat various types of prey that were similar to those offered to adults, although all vertebrate pretty offered were neonates or juveniles. After 60 days without feeding, one neonate was force-fed a liquefied *S. grammicus*, but died within an hour. The rest of the neonates were subsequently euthanized.

Camarillo and Campbell (2002) reported that captive adult *C. transversus* fed on lizards (*P. copei, S. grammicus, S. mucronatus, S. aeneus*) and mice. They also reported that captive born *C. transversus* neonates refused to eat and eventually died. However, Camarillo and Campbell (1993) earlier reported a neonate *C. transversus* that fed readily in captivity on a diet of *S. grammicus*.

Reproduction.—As mentioned above, the gravid female (INIRENA 560) captured 29 October 2005 gave birth to five young on 21 March 2006. Neonate total lengths ranged from 131 to 150 mm (mean = 143 mm) and they weighed from 2.2 to 3.2 g (mean = 2.7 g). The entire litter weighed a total of 13.7 g, and after giving birth, the mother weighed 20.5 g. When originally captured, the female weighed 40 g, indicating that at time of parturition energy reserves were low. The first molt was on the 10th day postbirth for two neonates and on the 11th day for the other two.

Numerous authors have reported litter sizes of various species of rattlesnakes (see Campbell and Lamar 2004 for a review). Smaller species generally produce fewer offspring (often 5–8) that are relatively large as compared to adults. Conversely, large species produce more young (15–40) that are relatively small as compared to adults. Litter size and relative litter mass recorded herein for *C. tancitarensis* follow this pattern, as do reported litter sizes of other members of the *C. intermedius* group. As examples, a litter of *C. intermedius* from Guerrero consisted of five young

(Armstrong and Murphy 1979), a litter of *C. transversus* from the state of México consisted of four young (Camarillo and Campbell 2002), and litter size for *C. pricei* ranges from 3 to 9 (Campbell and Lamar 2004).

To our knowledge, only five adult *C. tancitarensis* have ever been reported by scientific investigators. Of those, all were females, two are reported for the first time herein, and the three others belong to the type series. Four of the five were collected in summer (June and July) and the other in fall (October). The females collected in summer showed no signs of pregnancy or recent parturition, as would be indicated by flaccid abdomens and longitudinal skin folds on the posterior part of the body (Macartney and Gregory 1988). The sizes of the two juveniles collected in the summer suggest that they were not more than two months old. Therefore, the parturition date of the captive female and the collection date of the two juveniles suggest that the parturition season for *C. tancitarensis* extends from March to July.

Table 1. Measurements (mm) and meristic counts of *Crotalus tancitarensis*. Data for holotype and paratypes from Alvarado-Díaz and Campbell (2004). All adult specimens are female. A = adult, J = juvenile, N = neonate, SVL = snout-vent length, TL = tail length, V = ventrals, S = subcaudals, SL = supralabials, IL = infralabials, PS = scales in the prefrontal region, HL = head length, BC = body dorsal crossbands (exclusive of tail). INIRENA 571 and 575 are males.

	SVL	TL	V	S	SL	IL	PS	HL	BC
INIRENA 560 (A)	397	37	156	22	9/9	9/9	3	16.6	51
INIRENA 421 (A)	363	28	160	20	9/9	9/9	3	17	52
INIRENA 423 (J)	172	14	156	19	9/9	9/9	3	11	50
INIRENA 414 (J)	156	15	156	21	9/9	9/9	4	11	52
INIRENA 570 (N)	119	12	156	18	9/9	9/9	4	10	51
INIRENA 571 (N)	130	13	156	18	9/9	9/9	3	10	48
INIRENA 572 (N)	133	13	156	15	9/9	9/9	4	10	50
INIRENA 574 (N)	134	12	160	18	9/9	9/9	4	10.5	50
INIRENA 575 (N)	136	14	151	22	9/9	9/9	3	10.5	51
INIRENA 309 (A)*	356	29	158	21	9/9	9/9	3	17.5	51
UTA R-52401 (A)**	397	30	159	21	9/9	9/9	3	18.2	49
FMNH 39115 (A)**	410	26	160	22	9/10	9/10	4	19.2	—

* Holotype, ** Paratypes

A number of literature sources have specified parturition dates in rattlesnakes from central and southern México that coincide with the rainy season (see Campbell and Lamar 2004 for a review). The presence of adult females with no signs of reproductive activity during the summer rainy season on Cerro Tancítaro suggests that *C. tancitarensis* has a more-than-annual reproductive cycle (Wharton 1966). The high elevation inhabited by *C. tancitarensis* might also influence reproductive cycles. Other species of Neotropical viperids from highland environments exhibit biennial reproductive cycles (Camarillo and Campbell 2002; Campbell and Solórzano 1992). Additional specimens collected from throughout the year and throughout its geographic distribution are needed to substantiate or refute hypotheses delineating reproductive season in *C. tancitarensis*.

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TECHNIQUES

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Detection of Crotamine and Crotoxin Gene Sequences in Genomic DNA from Formaldehyde-fixed Rattlesnakes

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Museum collections are an important source of material for studies of phylogeny, systematics, and phylogeography. These collections can represent rare or extinct species and provide historical samples and may be very useful for genetic studies of reptile populations. The material is usually formalin–fixed and stored in ethanol. Formalin (an aqueous solution of formaldehyde) is the fixative agent most widely used to preserve tissues and organisms, but it causes cross-links in DNA-DNA, DNA-protein and protein-protein (Schander and Halanych 2003; Srinivasan et al. 2002). Several chemical reactions between formaldehyde and nucleic acids have been demonstrated, such as the addition of a hydroxymethyl group (-CH_2OH) in any nucleotide, formation of a methylene bridge between two amino groups, generation of apurinic and apyrimidic sites, and hydrolysis of phosphodiester bonds (Masuda et al. 1999; Srinivasan et al. 2002), causing the break of DNA, mutations and the inhibition of *in vitro* polymerization reactions of nucleic acids. The polymerase chain reaction (PCR) enzymatically amplifies specific sequences of nucleic acids, using very small amounts of DNA as template. In addition to innumerable current applications, PCR also allows nucleic acids from fixed tissues to be used in molecular analyses (Chatigny 2000; France and Kocher 1996; Gioia et al. 1998; Karlsen et al. 1994).

Given that the Herpetological Collection Alphonse Richard Hoge at Instituto Butantan in São Paulo, Brazil has the largest Neotropical collection of snakes with a majority of Brazilian species, we decided to investigate if these formalin-fixed samples are useful for molecular analysis of venom variation. Thus, we studied the crotamine polymorphism of some Brazilian rattlesnakes.

The rattlesnake *Crotalus durissus* occurs throughout most of South America except in Ecuador and Chile. Seven subspecies occur in Brazil: *C. d. cascavella*, *C. d. collilineatus*, *C. d. dryinas*, *C. d. marajoensis*, *C. d. ruruima*, *C. d. terrificus*, and *C. d. trigonicus* (Campbell and Lamar 1989). The venom of *C. d. terrificus* contains four main toxins: crotoxin, convulxin, gyroxin and crotamine (Bercovici et al. 1987). Crotoxin, the most toxic component in *C. durissus* venom, is a neurotoxin with a basic and weakly toxic phospholipase A_2 subunit (Crotoxin B or CB), and an acidic, non-toxic subunit (Crotoxin A, crotapotin or CA) (Hendon and Fraenkel-Conrat 1971). The cDNA precursors of both subunits have been cloned and sequenced. The 5'-untranslated tracts of cDNAs encoding CA and CB are nearly identical and the 3'-untranslated tracts are very similar (Bouchier et al. 1991).

The other major toxic component in *C. durissus* venom is crotamine. Crotamine—a cationic peptide (4.9 kDa, pI 10.8)—translocates into cells *in vitro*, and causes hind limb paralysis and myonecrosis *in vivo* (reviewed in Oguiura et al. 2005). Gonçalves (1956) described a crotamine polymorphism in the South American rattlesnake venoms: the crotamine-positive venoms have the toxin while the crotamine-negative venoms do not. Later, Schenberg (1959) defined two regions in São Paulo state: in the northeastern region he found only crotamine-positive venoms, but in the southwestern region he found predominantly crotamine-negative venoms. Collares et al. (2006) observed that snakes in the northwestern part of Paraná had the highest proportion of crotamine-positive venoms, with the majority of the venoms (71%) having crotamine content more than 10%. Although the individual venom sample sizes varied among the regions, Collares et al. (2006) observed crotamine-positive venoms less frequently in the northern regions including the states of Maranhão and Bahia.

Crotamine-positive rattlesnakes possess the crotamine gene, which is organized in three exons and is located in the extremity of the long arm of chromosome 2 (Rádis-Baptista et al. 2003). The crotamine cDNA of 340-360 base pairs encompasses an open reading frame of 198 nucleotides with 5' and 3' untranslated regions of variable size, signal peptide sequences, and can produce two crotamine isoforms (crotamine and crotamine-Ile19) (Rádis-Baptista et al. 1999). Furthermore, it was demonstrated immunologically that crotamine-negative rattlesnakes do not have crotamine in their venom using (Oguiura et al. 2000) or crotamine mRNA in their venom glands (Rádis-Baptista et al. 1999). Although the crotamine gene is absent in crotamine-negative snake genome, a paralogous crotamine-like gene is present (Rádis-Baptista et al. 2004).

In this work, we present data concerning to the crotamine gene polymorphism in the genome of fixed *C. durissus* subspecies, which are maintained for up to 22 years in the Alphonse Hoge Collection at Instituto Butantan (São Paulo, Brazil), by using PCR and genomic DNA from preserved samples.

Material and Methods

Tissues.—Table 1 indicates the sites where the snakes were collected, their voucher numbers, and their storage time.

DNA.—The DNA was purified using the method described by Ausubel et al. (2000). One hundred milligrams of scraped tissues were washed in TE solution (pH 8.0) for 24 hours at 4°C and then treated at 37°C for 18 h with 0.5% SDS, 10 mM Tris.HCl, 0.1 mM EDTA, 0.1 M NaCl, 0.16 mg/ml Proteinase K and 40 ng/ml RNAse A. The DNAs were purified by phenol/chloroform extraction and

TABLE 1. *Crotalus durissus* tissue samples and sources used in this study.

Sample	Tissue	Taxon	Locality	State	Voucher number	Storage time
1	Blood	*C. d. terrificus*	—	—	—	non-fixed
2	Heart	*C. d. terrificus*	Cianorte	Paraná	61.808	two years
3	Liver	*C. d. terrificus*	Cianorte	Paraná	61.808	two years
4	Gut	*C. d. terrificus*	Tapejara	Paraná	61.805	two years
5	Lung	*C. d. terrificus*	Tapejara	Paraná	61.805	two years
6	Kidney	*C. d. terrificus*	Cianorte	Paraná	61.807	two years
7	Kidney	*C. d. terrificus*	Ponta Grossa	Paraná	61.811	two years
8	Heart	*C. durissus* ssp.	Itapagipe	Minas Gerais	60.130	five years
9	Liver	*C. durissus* ssp.	Pouso Alegre	Minas Gerais	60.288	five years
10	Skin	*C. durissus* ssp.	Ponta Grossa	Paraná	61.812	two years
11	Trachea	*C. durissus* ssp.	Ponta Grossa	Paraná	61.813	two years
12	Skin	*C. durissus* ssp.	Ponta Grossa	Paraná	61.813	two years
13	Liver	*C. durissus* ssp.	Pouso Alegre	Minas Gerais	60.287	five years
14	Liver	*C. durissus* ssp.	Itapagipe	Minas Gerais	60.118	five years
15	Liver	*C. d. marajoensis*	São Luís	Maranhão	44.779	22 years
16	Liver	*C. d. cascavella*	São Luís	Maranhão	45.305	21 years
17	Liver	*C . d. cascavella*	São Luís	Maranhão	45.310	21 years
18	Liver	*C. d. cascavella*	São Luís	Maranhão	46.968	20 years
19	Liver	*C. d. cascavella*	Brumado	Bahia	51.791	19 years
20	Liver	*C. d. cascavella*	Juazeiro	Bahia	51.794	19 years
21	Liver	*C. d. cascavella*	Ibiquera	Bahia	54.952	12 years
22	Liver	*C. d. cascavella*	Grajaú	Bahia	57.306	seven years
C+	Liver	*C. d. terrificus*	—	—	—	non-fixed

acetate (pH 7)/ethanol precipitation. The DNAs were analyzed by 1% agarose gel electrophoresis in TBE buffer (89 mM Tris; 89 mM boric acid; 25 mM EDTA) and stained with 1 μg/ml ethidium bromide.

Primers.—The crotoxin primers, F crotox (forward): 5'- CCC CTG CCT GGC TTC TCC TTC- 3' and R crotox (reverse): 5'- CCT CAA TCC AGA CCT GGG AA- 3', were synthesized based on cDNA sequences described by Bouchier et al. (1991). The crotamine primers, 5 crot (forward): 5'- CAG TGT CAT AAG AAA GGA GG- 3' and 3 crot (reverse): 5'- CAT CTC CAT CGA CAG TCC AT- 3', were designed based on cDNA sequences described by Rádis-Baptista et al. (1999).

PCR conditions.—The PCR of crotoxin gene was done in 30 μl, using 600 ng of genomic DNA, 6 mM dNTPs, 60 mM $MgCl_2$, 4 pmol of each primer and 1 U of Biotools DNA polymerase and temperature profiles of: 94ºC for 4 min; 40 cycles of 94ºC for 45 sec, 49ºC for 45 sec, and 72ºC for 30 sec. The PCR of crotamine gene was performed in two rounds using 30 μl reaction, and a temperature profile of: 94ºC for 4 min; 25 cycles of 94ºC for 20 sec, 45ºC for 20 sec, 72ºC for 20 sec; and 72ºC for 2 min. In the first round, we used 100 ng of genomic DNA as template and two micro-liters from this first step were added to the second reaction round.

PCR reaction analysis.—Five micro-liters of each amplification product was analyzed in 7.5% polyacrylamide gel electrophoresis (PAGE) in TBE buffer and was stained with 1 μg/ml ethidium bromide.

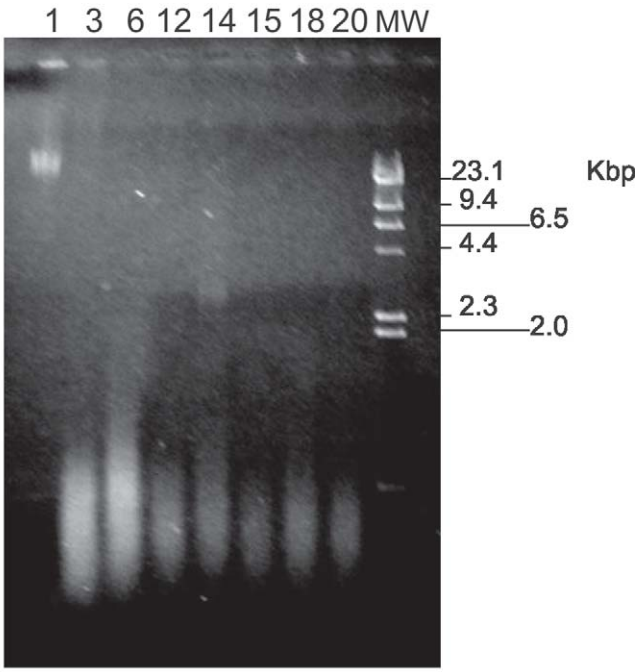


FIG. 1. 1% agarose gel of DNA purified from fresh and fixed tissues. The molecular weight standard (MW) was lambda DNA digested with *Hind* III purchased from Life Technologies.

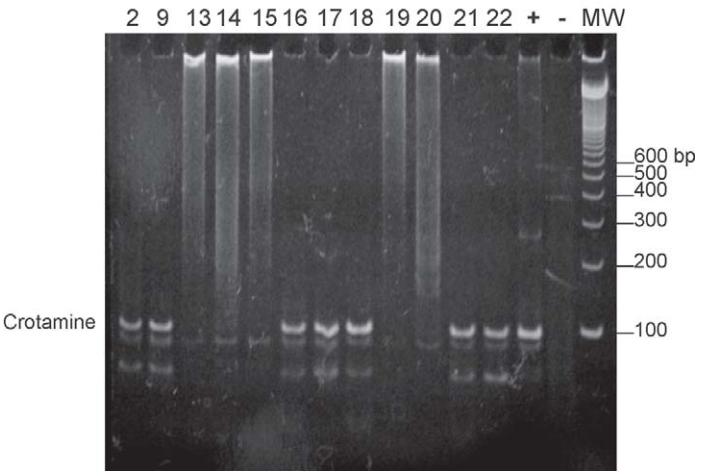


FIG. 2. 7.5% PAGE of PCR of fixed samples, a fresh sample (+), and no DNA (-). The arrow indicates the 100 bp fragment amplified using 5 crot and 3 crot primers. MW is the 100bp DNA ladder purchased by New England Biolabs.

RESULTS

The purification of DNA from fixed tissues took longer to be prepared by proteinase K/SDS method. More amount of proteinase K and longer time of digestion were necessary to disrupt the snake fixed tissue, in comparison to fresh tissues. Even so, a smaller quantity of DNA was obtained from fixed tissues than from non-fixed ones, starting from the same initial amount of material. In addition, the DNA purified from fresh tissue was longer than 23.1 kbp, as indicated in lane 1, Fig. 1, for DNA isolated from blood. Samples 3, 6, 12, 14, 15, 18, and 20 that represent genomic DNA from fixed tissues were markedly degraded, showing DNA lengths of less than 500 bp.

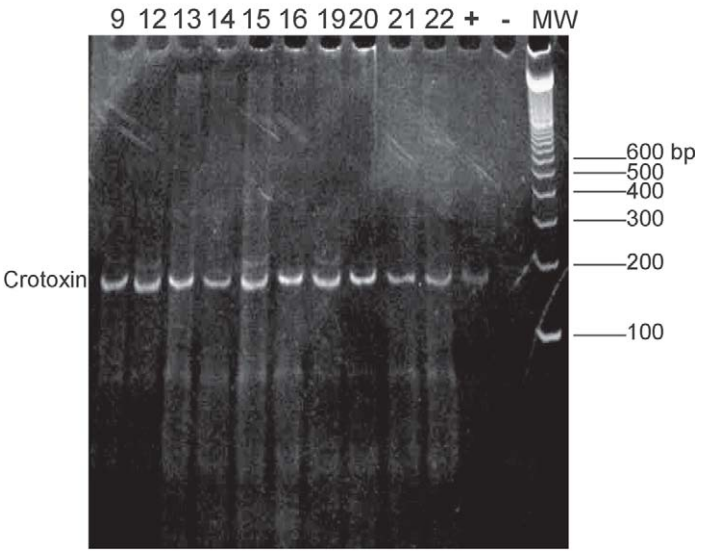


FIG. 3. 7.5% PAGE of PCR of fixed samples, one fresh sample (+) and no DNA (-). The arrow indicates the 200 bp fragment amplified using F-crotox and R-crotox primers. MW is the 100bp DNA Ladder purchased from New England Biolabs.

The PCR product (amplicon) of the crotamine gene was 100 bp long (Fig. 2) while that of the crotoxin gene was 200 bp (Fig. 3). Table 2 shows the PCR results for all the samples. Samples 2, 4, 6, 7, and 10 from the state of Paraná; 8 and 9 from Minas Gerais; 16, 17, and 18 from Maranhão; and 21 and 22 from Bahia were crotamine-positive. On the other hand, samples 5, 11, and 12 from the state of Paraná; 13 and 14 from Minas Gerais; 15 from Maranhão; and 19 and 20 from Bahia were crotamine-negative. As expected, all the samples have the crotoxin gene amplified, since all *C. durissus* in Brazil contain this neurotoxin in their venom. We observed some smear and faint bands in crotamine gel that are non-specific amplifications probably appeared in function of the high number of cycles used, more than 50 in polymerase chain reaction (double PCR reaction).

DISCUSSION

As it may be widely known, formalin fixation imposes a harsh condition of tissue preservation that damages nucleic acids inside the cells, despite its powerful ability to keep the intact structure of any preserved tissue. Huge collections of animals and plants that are potentially useful for studies of the molecular history of such organisms along space and time are kept in museums. For example, the Alphonse Richard Hoge Collection at Instituto Butantan (São Paulo, Brazil), contains over 70,000 catalogued Neotropical snake specimens, some of which are up to 100 years old.

Here, using PCR and specific primers, two genes encoding toxic components of rattlesnake venom (crotoxin and crotamine) were successfully amplified from genomic DNA extracted from formalin-fixed snake specimens. We were able to amplify the majority of DNA tested (approx. 90% of all samples), even in conditions of snake fixation that are not ideal for use in molecular biology protocols.

The low yield of DNA purified from formalized tissues may have resulted from the loss of low molecular weight (LMW) nucleic acid sequences that bind to proteins. During phenol treatments, it is possible to diminish the loss of DNA linked to protein by using DTE (dithioerythritol) or DTT (dithiothreitol) in extraction buffer, because these reducing agents break the cross-links between DNA and protein (Chatigny 2000; Schander and Halanych 2003). It is also possible to improve the recovery of LMW DNA during nucleic acid precipitation using carriers such as tRNA or glycogen (De Giorgi et al. 1994). The links between DNA-protein and DNA-DNA can also be broken by heating the DNA from fixed tissue in TE at 70°C, which improves the DNA yield (Masuda et al. 1999).

Even though the sizes of recovered genomic DNA samples were around 500 bp, they were useful for the molecular analysis of crotamine gene polymorphism and for accessing the presence of crotoxin gene. This is because the amplicons' size we were investigating lie between 100 and 200 bp. In fact, the lengths of amplicons in the PCR of genomic DNAs from fixed and fresh tissues were identical (that is, 100 bp) when using primers for crotamine gene (5 crot and 3 crot) and 200 bp when using crotoxin-specific primers (F crotox and R crotox). Both gene fragments were amplified from a single exon: exon II, in the case of crotamine, and the 5'-untranslated region of CA which is identical in CB, in the case of crotoxin. The crotamine gene polymorphism is well

TABLE 2. PCR of **CRO** – crotamine sequence and **CTX** – crotoxin sequence that resulted in amplification (+), no amplification (-) and not tested (**NT**).

Sample	CRO	CTX	Sample	CRO	CTX
1	NT	NT	13	-	+
2	+	+	14	-	+
3	NT	+	15	-	+
4	+	+	16	+	+
5	-	+	17	+	+
6	+	+	18	+	+
7	+	+	19	-	+
8	+	+	20	-	+
9	+	+	21	+	+
10	+	+	22	+	+
11	-	+	C+	+	+
12	-	+			

known among herpetologists: crotamine-negative rattlesnake have neither crotamine transcripts in their venom gland nor crotamine in their venom.

Our molecular results on fixed samples are consistent with the expected pattern of crotamine distribution. For example, Itapagipe and Pouso Alegre cities are in a region described as a mixed one, where both varieties are found, in the south-central region of Minas Gerais state (Bicalho et al. 1990). In the northwestern region of Paraná, including Cianorte and Tapejara, the rate of crotamine-positive venoms is high (Schenberg 1959), Crotamine was also detected in some venoms from Bahia it was using immunological method in a venom from Ibiquera (Collares et al. 2006). On the other hand, crotoxin is an ubiquitous toxin that is expressed in all *C. durissus* venom, independent of the local where snake are found. So, as expected all genomic DNA samples have the crotoxin gene fragment amplified, what worked as a positive control of PCR reaction. Lung tissue proved not to be useful because of the false negative result of sample 5.

In a parallel experiment, the PCR results of samples 2 to 14 were confirmed using DNA taken from the frozen livers from the same animals (data not shown). The amplification of gene sequences from genomic DNA isolated from fixed tissues posed greater difficulties than from fresh ones, since a larger amount of template was required to amplify the crotoxin sequence. Moreover, this was particularly true in the amplification of crotamine gene, for which an extra PCR round was carried out when compared with the PCR conditions routinely used in our laboratory, i.e., 100 ng of genomic DNA and 30 cycles. However, even in these circumstances, the formalin-fixed snakes constitute a valuable source to investigate the natural history of these animals and the correlation with their respective toxic traits.

Crotalus durissus terrificus is the predominant rattlesnake subspecies found in Brazil. In addition to it, we tested two subspecies, *C. d. marajoensis*, and *C. d. cascavella*, whose crotamine polymorphism has been little studied. *C. d. marajoensis* occurs in northern Brazil (Ilha de Marajó, Pará) and *C. d. cascavella* in northeastern Brazil (states of Maranhão, Piauí, Ceará, Rio Grande do Norte, Paraíba, Pernambuco, Alagoas, Sergipe, and Bahia). Although the venoms of rattlesnakes from the states of Bahia, Pernambuco, Piauí, and Maranhão are believed to be crotamine-negative (Santoro et al. 1999, Toyama et al. 2005), we detected the crotamine gene in *C. d. cascavella* from São Luiz (Maranhão) and from Ibiquera and Grajaú (Bahia). Dr I. Biondi also observed the effect of some crotamine-positive venoms from Bahia in mice which showed myonecrosis in hystological preparations from muscles (personal communication). Our findings therefore indicate not only that these specimens tested positive for crotamine gene but also that these populations of *C. d. cascavella* contain crotamine-positive individuals. The only *C. d. marajoensis* snake we tested was crotamine-negative. Interestingly, this is the first time that crotamine has been detected in the rattlesnake *C. d. cascavella* inhabiting the northeastern regions of Brazil, encompassing the states of Bahia and Maranhão. Thus, in addition to molecular analysis by northern and southern blot and immunological approaches like ELISA, PCR of fixed tissue appears to be a useful method to study venom variation in preserved rattlesnakes obtained from museum collections.

In conclusion, this study demonstrated that PCR is a reliable technique for detecting crotamine and other toxin genes, and to analyze their distribution among population of snakes without using the snake venom itself. This is valid for the investigation of genomic DNA isolated from fresh tissues, as well as from fixed specimens.

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The Effectiveness of Fluorescent Powdered Pigments as a Tracking Technique for Amphibians

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Researchers often use thread-trailing devices or radio-telemetry to study amphibian movement and terrestrial habitat use (Madison and Farrand 1998; Schwarzkopf and Alford 2002; Sinsch 1988; Tozetti and Toledo 2005; Watson et al. 2003). However, small size and sensitive skin can make these methods problematic, if not impossible, for some amphibian species or life stages. Fluorescent powdered pigments are useful for obtaining detailed information about short-term movement, behavior, and microhabitat use of other animals, including mammals (e.g., Lemen and Freeman 1985; Mullican 1988), reptiles (e.g., Blankenship et al. 1990; Dodd 1992; Stark and Fox 2000), and insects (e.g., Johansson 1959; Sujii et al. 2000). More recently, they have been used to track the terrestrial movements of amphibians (Birchfield and Deters 2005; Eggert 2002). Using fluorescent powder to track amphibians has several advantages, including being relatively inexpensive, harmless to amphibians (Rittenhouse et al. 2006), and suitable for use on juveniles and small species.

Powder tracking is becoming recognized as an underutilized amphibian tracking method that has great potential and may be the preferred method under certain circumstances (Birchfield and Deters 2005; Rittenhouse et al. 2006). However, the effectiveness of this method across amphibian taxa and under varying field conditions has not been evaluated. We present data from three species, the Marbled Salamander (*Ambystoma opacum*), Southern Toad (*Bufo terrestris*), and Southern Leopard Frog (*Rana sphenocephala*), to evaluate the potential strengths and limitations of powder tracking as a technique for amphibians. Our results shed light on the relative distances different species can be tracked with powder, the influence of precipitation on detectability of path length, and the effectiveness of different powder colors. This evaluation of fluorescent powder tracking as a technique has been extracted from a habitat and movement study by Graeter (2005) that is part of a larger experimental study called LEAP (Land-use Effects on Amphibian Populations).

Materials and Methods.—We released 44 adult *A. opacum* (February–March 2005; 22M, 22F), 36 adult *B. terrestris* (March–May 2005; 28M, 8F), and 48 adult *R. sphenocephala* (May–August 2004; 25M, 19F) on forest-clearcut edges at three LEAP sites (named 37, 119, and 1000) on the Savannah River Site (SRS) in the Upper Coastal Plain of South Carolina, USA (see Graeter 2005 for details). The forests were predominantly *Pinus* species (e.g., Longleaf, Loblolly, Slash Pine), but had hardwoods interspersed throughout (e.g., oak, maple, hickory, dogwood, sweetgum). Ten-acre clearcuts were created in the spring of 2004. At the time of this study, clearcuts had patches of resprouting hardwoods, bare soil, and scattered piles of woody debris.

We collected *A. opacum* and *B. terrestris* at drift fences encircling wetlands at LEAP sites 37 and 119, and released each animal within approximately 100 m of its capture location. Because our study sites did not have breeding populations of *R. sphenocephala*, we collected frogs from a wetland >15 km from the two LEAP sites (37 and 1000) where they were released, a distance at which there is no evidence for homing of ranids (Dole 1968). Body size (mean snout–vent length ± SD) was 57 ± 3 mm for *A. opacum*, 56 ± 6 mm for *B. terrestris*, and 65 ± 6 mm for *R. sphenocephala*.

Prior to release, we applied fluorescent powder (US $12/lb, Radiant Color Series T1, Richmond, California; now DayGlo Color Corporation, Cleveland, Ohio) to each individual by dipping the rear 2/3 of its body into powder until the skin was thoroughly covered. We were careful to prevent powder from coming in contact with the animal's eyes or mouth. The handling time was kept to less than 30 seconds per individual, and all releases took place just after dark. To give them sufficient time to move, we returned approximately 24 h after release and tracked the path of each individual using a Portable Rechargeable UV Lamp (UVL-26P, Fisher Scientific, Hampton, New Hampshire) until we either located the animal or could not find any more powder. We used a Global Positioning System (GPS) Trimble Pro-XR backpack unit with submeter accuracy to record each path from start to end. We then downloaded the GPS data and used the Animal Movement extension (Hooge and Eichenlaub 1997) in ArcView 3.3 (Environmental Systems Research Institute, Redlands, California) to calculate the detected path length for each individual. We recorded daily rainfall (All-Weather Rain Gauge, Forestry Suppliers Inc.), percent relative air humidity (Bacharach Pocket-Size Sling Psychrometer, Forestry Suppliers Inc.), and percent soil moisture (TH_20 Soil Moisture Meter, Dynamax Inc., Houston, Texas); humidity was recorded approximately 0.5 m off the ground and soil moisture was taken in the top 8 cm of soil.

We tested the effects of powder color, species (*A. opacum, B. terrestris, R. sphenocephala*), and the interaction of species and powder color on path length using a two-way ANOVA (Proc GLM, SAS Institute 2000). We used Type III sums of squares because we had unequal sample sizes and Tukey-Kramer's test to determine which colors differed from each other. We also assessed the effects of post-release precipitation on mean and maximum detected path length for each species. For this analysis, we categorized rainfall into precipitation classes: 0 mm, light (< 10 mm), and heavy (> 10 mm). Because there was no precipitation after releases of *B. terrestris*, we could not examine the effects of rainfall on path length for this species.

Results.—Path length differed among the three species ($F_{species\ 2,114} = 16.81$, $P < 0.0001$). The mean detected path length after 24 h was shortest for *A. opacum* and longest for *R. sphenocephala* (Fig. 1). The minimum distance an individual traveled was similar among the three species (1.9–3.5 m). Detected path length also varied among powder colors ($F_{color\ 3,114} = 2.36$, $P = 0.0757$; Fig. 2a). Chartreuse paths were longer than pink paths ($P = 0.0937$, Tukey-Kramer test). Path length did not differ among powder colors for *A. opacum*; however, chartreuse paths tended to be longer than other colors for both *B. terrestris* and *R. sphenocephala* (Fig. 2b). The interaction between species and powder color was not significant ($F_{species*color\ 6,114} = 1.02$, $P = 0.4157$).

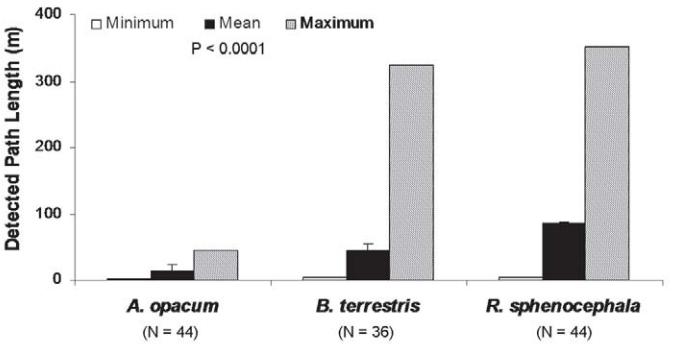


FIG. 1. Minimum, mean (± 1 SE), and maximum detected path lengths of *Ambystoma opacum*, *Bufo terrestris*, and *Rana sphenocephala* in South Carolina (24 h post-release).

The amount of post-release rainfall affected the detectability of path length. Light amounts of precipitation (< 10 mm/day) did not make detection of powder more difficult (Fig. 3). However, heavy rainfall (> 10 mm/day) tended to decrease the mean detected path length for *R. sphenocephala* (mean path length = 54.5 m for > 10 mm vs. 79.7 m for 0 mm). Most importantly, the maximum detected path length for *R. sphenocephala* was greatly reduced by heavy rains (77.0 m for > 10 mm vs. 178.7 m for 0 mm; Fig. 3a). Shorter paths, such as those created by *A. opacum*, were not affected by light rainfall (Fig. 3b). We observed that paths remained mostly intact for 1–2 days after the release when there was no precipitation. We could discern whether an individual had rested

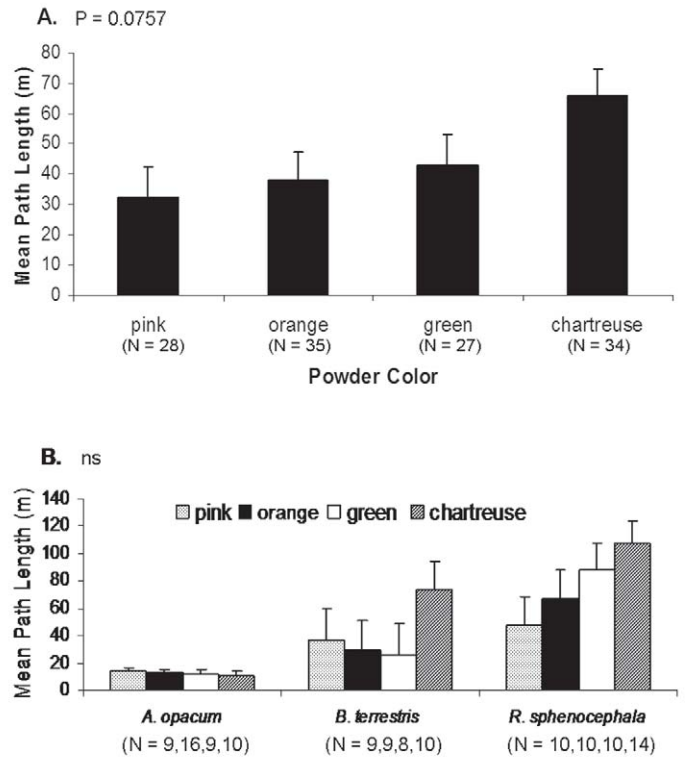


FIG. 2. Detected path length (mean ± 1 SE) for (A) the powder color and (B) powder color specific to species. Chartreuse paths were longer than pink paths ($P = 0.0937$).

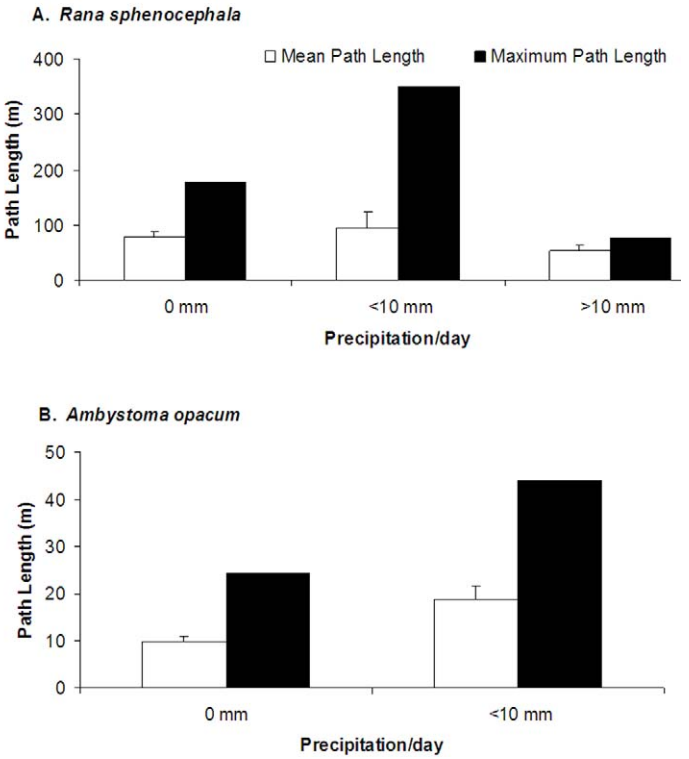


FIG. 3. Relationship between post-release precipitation per day and mean and maximum detected path length in (A) *Rana sphenocephala* at three different precipitation levels and (B) *Ambystoma opacum* at two different precipitation levels. No rainfall > 10 mm was recorded during the *A. opacum* releases, thus, that category is not included.

on woody debris or moved under it, the type of vegetation it had traveled through or avoided, and what type of cover it selected. The percent relative humidity and percent soil moisture (mean ± 1 SE), respectively, were 82.05 ± 1.31 and 19.90 ± 0.93 during the *A. opacum* trial, 67.03 ± 1.43 and 16.14 ± 1.22 during the *B. terrestris* trial, and 84.06 ± 1.12 and 10.36 ± 0.73 during the *R. sphenocephala* trial.

Discusssion.—Fluorescent powder tracking can be used successfully with a broad range of amphibian taxa, but the effectiveness of the technique depends greatly on a species' movement patterns and the environmental conditions. We found that amphibians can be tracked long distances (> 350 m) within a 24 h time period under ideal conditions (i.e., dry ground, little or no precipitation, and when movement is on the surface). However, some colors are more difficult to detect than others (Birchfield and Deters 2005; Stark and Fox 2000). The effect of powder color on path length was only evident for the relatively long paths we obtained with *B. terrestris* and *R. sphenocephala*. As path length increased and the flecks of powder became infrequent along the path, certain colors became more difficult to detect than others. Chartreuse and green paths were easiest to detect, followed by orange and then pink. With relatively short path lengths or slow-moving animals (e.g., *A. opacum*), the powder trails were heavy and color had little effect on detectability, as found in previous studies (Birchfield and Deters 2005). Although detectability varies by color, this is not an issue unless animals travel long distances. Some powder colors (e.g., pink and orange, chartreuse and green) are difficult to differentiate under UV light (Birchfield and Deters 2005; Stark and Fox 2000). However, this problem could often be remedied through close examination of the specks of powder under a white light.

Fluorescent powder, while non-toxic, is fairly persistent in the landscape (Halfpenny 1992), particularly if there is little moisture or precipitation. Thus, if movements are concentrated within a small area, it can be difficult to follow the path when powder trails cross and a heavy rainfall will be necessary before powder of the same color can be used again (Stark and Fox 2000). Although specks of powder sometimes remained visible for weeks, even after a heavy rain, the paths themselves were not discernable for more than a few meters. In situations where paths are unlikely to overlap (e.g., individuals are being tracked in separate locations) and only one powder color is needed, chartreuse may be the optimum color to use.

This technique is most effective in answering questions about fine-scale movement and microhabitat use because paths usually persist only 1–2 days after application. To answer long-term questions, powder could be reapplied, but rehandling and reapplication have the obvious disadvantage of influencing the animal's behavior. Recapturing individuals for reapplication is likely to be most effective when the study species is not moving long distances (e.g., *R. sphenocephala*, this study) or burrowing deep underground (e.g., some *A. opacum* in this study).

In other studies that have used fluorescent powder to track amphibians, path lengths were similar to the values and ranges presented here. For example, adult ringed salamanders (*A. annulatum*; tracked 3 h post-release; N = 60) and wood frogs (*R. sylvatica*; tracked 4 h post-release; N = 10) were tracked using fluorescent powder at LEAP study sites in Missouri and Maine, respectively, (C. Conner and S. Blomquist, unpubl. data). The mean detected path length for *A. annulatum*, at 36.9 m (range: 2.4–133.8 m), was slightly longer than the mean path length of *A. opacum*, indicating that this technique has the potential to be equally successful with two closely related species in different geographic regions. *Rana sylvatica* had a much shorter mean (10.4 m) and maximum (27.3 m) detected path length relative to *R. sphenocephala* and *B. terrestris* (this study), and this may have been due to wet ground conditions at the Maine site (S. Blomquist, unpubl. data). In another study, the mean path length of green frogs (*R. clamitans)* on golf courses in Missouri was 19.1 m (range: 4.7–33.9 m) when the frogs were given 1–3 h in which to move (Birchfield and Deters 2005). Likewise, in France, spadefoot toads (*Pelobates fuscus*) were tracked 17.0 m on average (range: 3.1–73.0 m) approximately 24 h after release (Eggert et al. 1999); these distances are well within the range of the species we studied. Eggert (2002) attributed the short movement distances of *P. fuscus* to their relatively small size and locomotory behavior (e.g., frequent burrowing, short daily movements, walking rather than jumping).

Just as powder works better for tracking some lizard species than others because of their scale type (Dodd 1992; Stark and Fox 2000), differing skin types and body sizes in amphibians may affect how well and how much of the powder clings to the skin, and thus, the efficacy of this technique. For example, powder may stay on *B. terrestris* better than *A. opacum* because *B. terrestris* has more surface area and uneven skin to which powder clings. However, by observing some individuals over multiple days we know that within 1–2 days, the majority of the powder had usually

brushed off the amphibians, such that only small remnants of powder were still visible on their skin. In a laboratory setting, where there was less opportunity to brush the powder off on natural objects (Rittenhouse et al. 2006), amphibians lost powder at a rate comparable to what we observed.

We found that certain techniques improved application and retention of the powder. Like many salamanders, *A. opacum* squirmed while being handled, causing the powder to wipe off; thus, we suggest minimizing handling time and keeping the powder in a small plastic container to ease application. *Rana sphenocephala* also can be difficult to handle so we advise holding the frog by its front legs with its snout in the palm of your hand while applying powder. Lastly, the powder clung best to *B. terrestris* if loose soil was brushed off and the animal's skin was slightly moist.

The success of this technique also can be influenced by the behavior of the study species. For example, if the study species spends time in an aquatic or moist environment (e.g., *R. sylvatica* in Maine, also Eggert 2002) or burrows underground (e.g., *A. opacum*, also see Eggert 2002), it will be more difficult to track them with powder. Likewise, species that move closer to the ground (e.g., *A. opacum*) may rub off more powder per distance traveled than those that hop (e.g., *R. sphenocephala*). Additionally, powder tracking will likely be most effective for pond-breeding amphibians if used during the non-breeding season at times when some surface activity is exhibited.

Others have suggested that precipitation reduces the visibility of powder trails or even obliterates them entirely (Blankenship et al. 1990; Lemen and Freeman 1985), but the relationship between rainfall and the detectability of path length of amphibian powder trails has not previously been evaluated quantitatively. We found that fluorescent powder trails made by amphibians persisted under light rainfall, but the detected path length was shortened considerably by rainfall > 10 mm. Likewise, light rainfall did not seem to affect the maximum detected path length of *R. sphenocephala*, but heavy rainfall tended to truncate the maximum path length, thus demonstrating that fluorescent powder tracking can be successful even with some precipitation. However, South Carolina is relatively dry (mean annual rainfall on SRS 1973-2003: 124.5 cm; Hunter 2004) and what we have termed heavy rainfall is likely considered light in other regions. Therefore, local and regional weather conditions should be carefully considered in deciding whether to use this technique. In areas where field conditions are typically moist, powder tracking may not be as informative or useful as it is in drier regions.

This technique has several advantages relative to other tracking techniques, such as radio-telemetry and thread-trailing, including that it is harmless to the animal (Rittenhouse et al. 2006) and can be used on juveniles and small species because a tracking device is not attached or inserted. Additionally, powder tracking is inexpensive relative to radio-telemetry and can yield high sample sizes due to the low intensity of the work. Nonetheless, when a study involves tracking for long periods of time and following movement in aquatic or subterranean habitats, other techniques may be more effectively employed.

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Evaluation of Two Types of Commercially-Made Aquatic Funnel Traps for Capturing Ranid Frogs

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Recently, several studies have attempted to develop methods for sampling aquatic or semi-aquatic amphibians and reptiles with minimal observer bias. Field experimentation has included devising and testing novel aquatic traps (Mushet et al. 1997; Richter 1995), and assessing efficacy of commercially-available aquatic traps (Buech and Egeland 2002; Casazza et al. 2000; Johnson and Barichivich 2004; Willson and Dorcas 2004; Willson et al. 2005). Trapping for amphibians has generally been directed towards larvae, a combination of larvae and breeding adults, or aquatic species. However, none of these studies sufficiently addressed our objective to determine which commercially-available funnel trap best samples relatively large (9–15 cm SUL [snout–urostyle length]) ranid frogs in aquatic habitats.

To evaluate the effectiveness of traps to capture ranids, we compared two commercially-available funnel traps having large-diameter interior funnel openings. These included 79 cm × 23 cm cylindrical, 6 mm galvanized steel mesh traps (steel trap) with interior funnel openings 5.5 cm in diameter (model G40CF, Cuba Specialty Manufacturing Company, Fillmore, New York) and 43 cm × 23 cm rectangular, 3 mm nylon mesh traps (nylon trap) having interior funnel openings 5 cm in diameter (model RN10, Memphis Net and Twine Co., Inc, Memphis, Tennessee). To allow traps to rise and fall with water levels, two polystyrene floats were attached to the interior, middle, and opposing sides of each trap with plastic cable ties (steel trap floats were 22.5 cm × 5 cm × 5 cm, nylon trap floats were 22.5 cm × 5 cm × 2.5 cm). Floats were attached to the interior of traps to reduce the likelihood of damage to or loss of floats, and to permit placement of traps directly against drift fences to maximize the probability of frogs encountering traps. Traps floated low enough in the water to completely submerge their interior funnel openings, yet high enough to provide trapped animals access to air.

Trap efficiency was tested in two aquatic habitats in Jackson and Union counties, Illinois between 30 August and 7 October 2005. Trap Site One (TS1) was a 0.1 ha human-made pond in Giant City State Park. Water depth (> 1 m) limited aquatic vegetation (common cattail [*Typha latifolia*] and cutgrass [*Leersia* sp.]) to within 3 m of the bank. Trap Site Two (TS2) was a shallow-water (< 0.45 m), 1.74 ha constructed wetland on private property. Wetland vegetation, which covered > 95% of the inundated portion of the basin, included Water Primrose (*Jussiaea repens*) and Waterthread Pondweed (*Potamogeton diversifolius*). During sampling, water covered half the basin.

At TS1, 20 pairs of traps were set 3 m apart within the nearshore vegetation along half the shoreline. Each trap pair included one steel trap and one nylon trap, 0.5 m apart, set parallel to the bank in water deep enough to inundate the interior openings of each trap. The type of trap was alternated at successive stations to eliminate possible bias associated with trap location relative to shore and water depth. For example, at trap station 1 the nylon trap was closer to shore than the steel trap, at trap station 2 the steel trap was closer to shore than the nylon trap, etc. Each trap was checked daily from 31 August–9 September 2005 (400 trap-nights). Captured frogs were marked for individual recognition by toe-clipping before releasing them into the water within 0.5 m of their point of capture. To prevent cross-contamination and infection, scissors were dipped in isopropyl alcohol between each use.

At TS2, traps were set along aquatic drift fences. Nine, 10-m long × 0.6-m high drift fences were constructed from 0.6-cm black polyethylene mesh by attaching the mesh to 1.5-m tall steel fence posts with plastic cable ties. The mesh extended from the substrate to an average of 0.4 m above the water surface. The fences were installed approximately 30 m apart, 2.5–19.5 m (mean = 6.25 m) from shore, and bordered approximately 25% of the shoreline. A steel trap and a nylon trap were paired on opposite sides of each end of every fence. Each fence had a shore-side steel trap and nylon trap, as well as a pond-side steel trap and nylon trap (four traps per fence). Traps were set between the fence and a pair of 1.5-m long, 1.2-cm diameter galvanized-steel pipes sunk vertically into the substrate. Each trap was loosely attached to the pipes with plastic cable ties to keep traps adjacent and parallel to the fence while allowing them to float up and down with fluctuations in water level. Traps were opened prior to predicted rain events and closed within 1–2 days. Trapping during rain events increased the likelihood of capturing Southern Leopard Frogs (*Rana sphenocephala*) which sometimes breed during fall rains in southern Illinois (Petzing and Phillips 1999). Traps were closed by fitting 0.26-L plastic cups into each funnel opening. Frogs were trapped for 11 nights during five trapping periods (15–17 September, 18–21 September, 25–27 September, 28–30 September, 5–7 October 2005) for a total of 396 trap-nights. Each captured frog was batched-marked by cutting the longest toe on the left hind limb.

Excluding recaptures, we captured 38 American Bullfrogs (*Rana catesbeiana*) and 60 Green Frogs (*Rana clamitans*) at TS1, and 211 *R. catesbeiana*, 12 *R. clamitans*, and three *Rana sphenocephala* at TS2 (Fig. 1). Our assumption of equal trap efficacy was tested by using chi square goodness-of-fit analyses (Sokal and Rohlf 1995). Both trap types were equally effective at capturing *R. catesbeiana* ($\chi^2 = 1.68$, df = 1, P = 0.194), *R. clamitans* ($\chi^2 = 0.6$, df = 1, P = 0.439), and both species combined ($\chi^2 = 0.408$, df = 1,

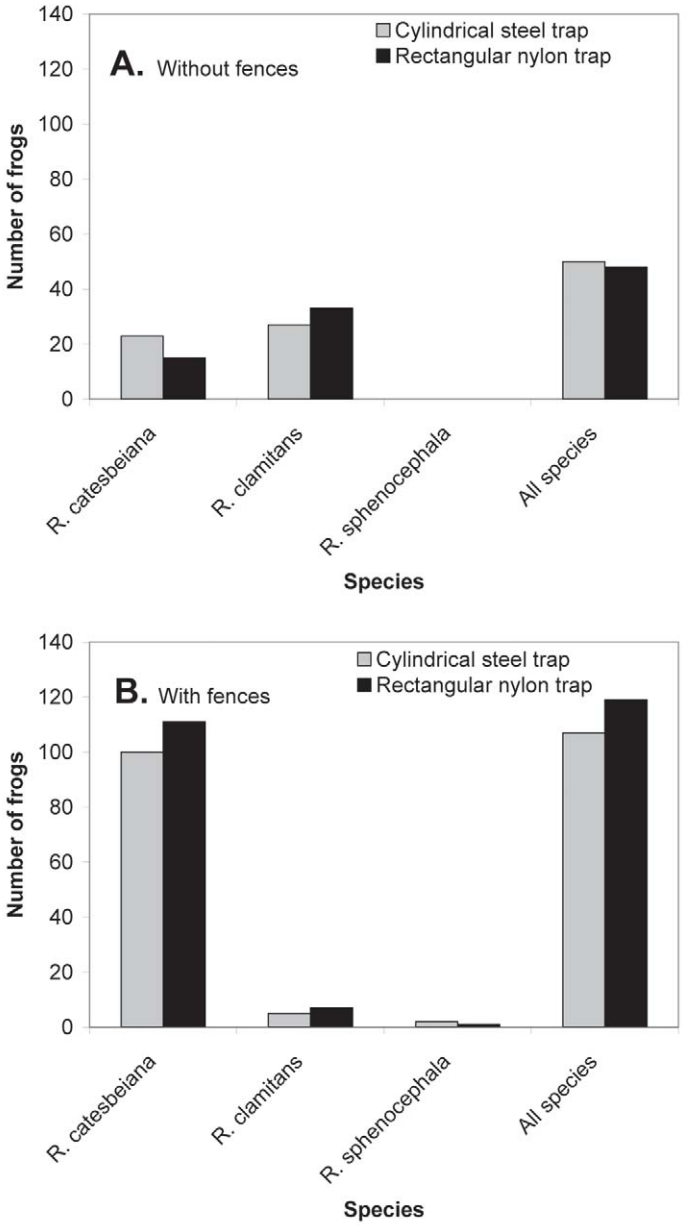


FIG. 1. Total capture of ranid frogs in cylindrical steel traps and rectangular nylon traps placed at study site TS1 without drift fences (A), and study site TS2 with drift fences (B).

P = 0.84) at TS1 and *R. catesbeiana* ($\chi^2 = 0.573$, df = 1, P = 0.449) and all frogs combined ($\chi^2 = 0.637$, df = 1, P = 0.425) at TS2. Although most frogs captured were young-of-the-year (93.9% at TS1 and 95.1% at TS2), traps did yield 12 subadult-adult *R. catesbeiana* (6 per trap type) ranging from 9–14 cm SUL.

Eight *R. catesbeiana* and four *R. clamitans* were recaptured once each at TS1, with most (83.3%) frogs being captured in one trap type then recaptured in the other. At TS2, we recorded eight recaptures (all *R. catesbeiana*). Trap mortality was low (1.0% at TS1, 0.4% at TS2) and appeared to be the result of invertebrate predation. One *R. clamitans* was killed by a fishing spider (*Dolomedes* sp.) and one *R. catesbeiana* was a casualty of crayfish (*Orconectes* sp.) predation.

Despite homogeneous shoreline habitat at both sites, the number of frogs captured at individual trap stations ranged from 1–10 at TS1 and from 15–41 at individual drift fences at TS2. Unequal catch along the shoreline suggests frogs were distributed non-randomly. Non-random distribution of frogs along the shoreline could influence results when using funnel traps, either alone or in conjunction with drift fences, to estimate frog abundance. The use of numerous traps or drift fences along as much shoreline as possible may compensate for location bias in studies designed to estimate population size. However, unequal capture probabilities along the shoreline can hamper interpretation of trapping results even when using large numbers of traps (K. Dodd, pers. comm.).

In summary, both trap types are equally effective for capturing ranid frogs. Nylon traps, however, are less durable than steel traps (Willson et al. 2005). Three nylon traps required repair (e.g., zippers broke) and two were rendered unusable following attempted predation of trap contents by a Snapping Turtle (*Chelydra serpentina*). In addition, nylon traps were more harmful to trapped animals; more frogs in nylon traps than steel traps rubbed surficial layers of skin from their snouts while attempting to escape.

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Glow Sticks as Effective Bait for Capturing Aquatic Amphibians in Funnel Traps

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Funnel traps of various designs have been used to capture adults and larvae of aquatic amphibians (e.g., Buech and Egeland 2002; Richter 1995). Most studies use unbaited funnel traps to capture amphibians while others have used shrimp or salmon eggs (Adams et al. 1997). Light traps and light sticks are commonly used in studies of fish, particularly larvae (Doherty 1987; Marchetti et al. 2004), but have not been widely used to capture amphibians. Glow sticks have been mentioned briefly in the literature as a means to increase capture rates of aquatic amphibians (Smith and Rettig 1996), but no studies have estimated their effectiveness. In this study we compared the capture success of unbaited funnel traps and funnel traps baited with glow sticks.

We used commercially available plastic minnow traps (similar to Challenge Plastic Products #50176) to capture eastern red-spotted newts (*Notophthalmus viridescens*) in Station Pond at Mountain Lake Biological Station (MLBS) in Giles County, Virginia. Station Pond is a 0.65 ha stream-fed permanent pond constructed in 1965. One hundred and four minnow traps were used to capture aquatic adult *N. viridescens* as part of a larger project to estimate the population size of newts in the pond. We used Pollock's robust design for our sampling regime (Pollock 1982), with eight sampling occasions divided into four primary periods with two secondary sampling occasions per primary period (Table 1), so the data could be used in a capture-recapture study reported elsewhere. Trap locations were randomly assigned to receive a glow stick or remain empty on the first sampling occasion and were switched to the other treatment for the subsequent primary period. Therefore, fifty-two randomly selected traps contained glow sticks for sampling occasions 1, 2, 5, and 6 (primary periods 1 and 3) and the other fifty-two contained glow sticks for sampling occasions 3, 4, 7, and 8 (primary periods 2 and 4). This design was chosen to maintain consistent conditions within a primary period, a requirement for Pollock's robust design, and to account for spatial and temporal effects in capture efficiency.

Sixty-four minnow traps were placed around the perimeter of Station Pond with 4–4.5 m between each trap. Traps were attached to a length of rope, tied to a PVC stake on the bank, and alternated between being placed 1 meter and 2 m from the bank. Forty traps were placed in a grid in the middle section of the pond using a row boat. A foam float tied to a rock using string noted the location for each trap. A second string for the trap was attached to each foam float with a fishing stringer tied to the end of the string for ease of placement and removal of traps. Therefore, every trap was in approximately the same location for each sampling occasion.

For each sampling occasion traps were placed in the pond from 1900–2000 h. A small rock was placed in each trap so it rested on the substrate of the pond. Traps were removed from 0800–1000 h the following morning and *N. viridescens* were counted and sexed. The number of tadpoles captured was also recorded.

The glow stick treatment traps were baited with non-toxic yellow bracelet-sized glow sticks (Glow Universe, US $9.49 per 100; 20.32 cm length, 0.5 cm diameter, 6–8 h glow time). We chose thinner bracelet-sized glow sticks to avoid catching more individuals than could be handled in one day due to the large number of traps. Glow products, which are widely available and normally used as novelty jewelry, come in several sizes and our preliminary trapping indicated thicker glow sticks (10.16 cm length, 10 mm diameter), which emit more light, catch more individuals (38.2 *N. viridescens* captured per trap using thick glow sticks vs. 10.8 captured per trap using bracelet-size glow sticks). We suggest that glow sticks are activated in a darkened setting before placing them in traps as we found that 5–10 glow sticks per 100 were defective and did not produce light.

We first tested if glow sticks increased the number of captures per trap. Based on the distribution of the number of individuals captured per trap, we used a generalized linear model (PROC GENMOD in SAS; SAS Institute, Inc., Cary, North Carolina) to analyze the effect of glow sticks on the total number of newts and tadpoles captured per trap assuming the Poisson distribution. Of the 832 trappings (104 trap locations for eight sampling occasions), nineteen trappings were excluded from this analysis because of trap failure due to the trap not being closed correctly or variable water levels, which left a few traps without the funnel in the water. Next, we determined if male and female newts responded differently to the glow stick bait by testing for differences in trap sex ratio due to glow stick treatment using a one-way ANOVA. We calculated the proportion of males captured in each trap and performed an arcsine square-root transformation to achieve normality. A further 121 trappings were excluded from this analysis where no newts were captured (87 of the trapping occasions with zero captures were unbaited traps while 34 were baited with glow sticks). We weighted the ANOVA by number of individuals captured because traps which contained more individuals most accurately reflected the trapped sex ratio. Lastly, to account for spatial differences in capture success, we conducted paired t-tests to compare the mean number of newts and tadpoles captured at each trapping location with and without glow sticks (N = 4 trapping occasions per location with glow sticks and 4 trapping occasions per location without glow sticks). We square-root transformed the data to achieve normality. Of the 104 trap locations, only locations with all eight sampling occasions being successful were used in the analysis (N = 89 with 15 trap locations excluded due to one or more sampling occasions being failures).

Results.—Notophthalmus viridescens is the main salamander species present in Station Pond. Very small numbers of *Eurycea cirrigera* and *Desmognathus* spp. are washed in from a stream and a single adult *E. cirrigera* was captured, the only non-newt salamander captured during all sampling occasions. *Ambystoma jeffersonianum* is the only species of mole salamander known to be present at MLBS and is rarely seen in Station Pond (elevation 1160 m). A variety of frogs have bred in Station Pond (*Pseudacris*

TABLE 1. Total captures of *Notophthalmus viridescens* for each sampling occasion. Secondary sampling occasions within a primary period were separated by one day. The vast majority of captured tadpoles were native *R. catesbeiana*.

Date	Sampling Occasion	Primary Period	Male Captures	Female Captures	Total Newt Capture	Tadpole Captures
5 June 2006	1	1	466	83	549	75
7 June 2006	2	1	351	67	418	73
3 July 2006	3	2	367	125	492	149
5 July 2006	4	2	313	114	427	113
11 July 2006	5	3	137	60	197	97
13 July 2006	6	3	299	118	417	95
24 July 2006	7	4	352	124	476	104
26 July 2006	8	4	460	175	635	90

crucifer, Hyla versicolor, Rana clamitans, R. sylvatica, R. palustris), but Bullfrogs (*R. catesbeiana*) dominate the tadpole community and comprised the majority of tadpoles captured.

Over the eight sampling occasions, 3611 adult *N. viridescens* and 796 tadpoles were captured (Table 1). We found that glow sticks significantly increased the number of *N. viridescens* captured (Fig. 1; $\chi^2_1 = 163.75$, $P < 0.0001$). Glow sticks increased the number of individuals captured for both males (mean ± SE per trap = 4.77 ± 0.22 for glow stick trappings vs. 1.99 ± 0.11 for unbaited trappings) and females (mean ± SE per trap = 1.45 ± 0.09 for glow stick trappings vs. 0.63 ± 0.04 for unbaited trappings). Overall, more male newts were captured than female newts (Table 1; mean ± SE per trap = 3.36 ± 0.13 males and 1.03 ± 0.05 females). The male-biased sex ratio per trap was not significantly affected by glow stick use ($F_{1, 691} = 1.64$, $P = 0.20$).

Similar results were found for tadpole captures (Fig. 2). More tadpoles were captured in traps with glow sticks than in unbaited traps (mean ± SE per trap = 1.21 ± 0.09 for glow stick trappings vs. 0.78 ± 0.07 for unbaited trappings; $\chi^2_1 = 17.91$, $P < 0.0001$).

We also found that spatial variation in trap success was high. Trapping locations varied from capturing a mean of 0.25–16.5 *N. viridescens* individuals per trap when glow sticks were used and 0–7 mean individuals per trap when unbaited. When examining captures at each trap location we found that traps captured significantly more newts when baited with glow sticks compared to when unbaited (mean increase ± SE = 3.80 ± 0.35 individuals; Student's $t = 12.44$, d.f. = 88, $P < 0.0001$). Trap locations also captured significantly more tadpoles when baited with glow sticks (mean increase = 0.30 ± 0.12 individuals; Student's $t = 3.59$, d.f. = 88, $P = 0.0005$). Overall, glow sticks increased newt captures at trapping locations by an average of 273% and increased tadpole captures at trapping locations by an average of 93%

We observed no negative effects of funnel trapping or glow stick use on captured amphibians. Of the 3611 *N. viridescens* captured, only two individuals were found dead. Both were gaunt and found in traps with other healthy individuals. No tadpole mortality was observed.

Discussion.—We found glow sticks to be extremely effective at increasing capture efficiency of aquatic amphibians in funnel traps. Overall, when using glow sticks as bait, we captured greater numbers of adult *N. viridescens* and *R. catesbeiana* tadpoles than when no bait was used. When the spatial variation in capture success was removed we found that a given trapping location was more successful when glow sticks were used compared to when the trap was set unbaited.

We captured significantly more male newts than female newts. A male-biased sex ratio in pond populations has been reported in numerous studies of *N. viridescens* (e.g., Attum et al. 2002; Chadwick 1944; Massey 1990), but has not been found in juveniles entering ponds and lakes to breed (Gill 1978; Healy 1974; Hurlbert 1969). A biased sex ratio in individuals captured in ponds could be due to an actual biased sex ratio (possibly caused by differential survival between the sexes) or differences in

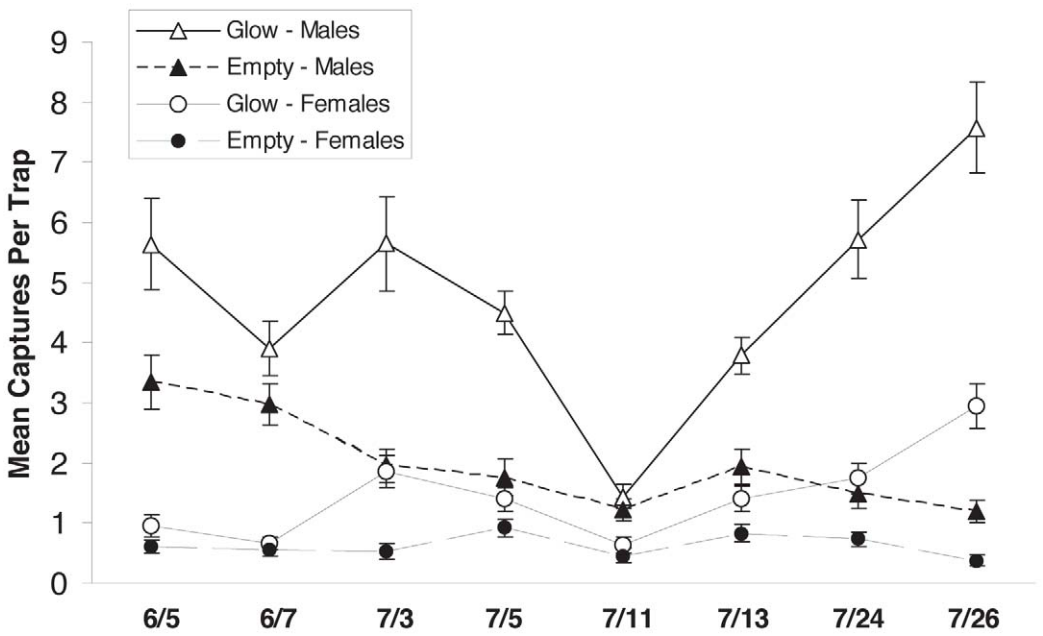


FIG. 1. Mean number of captures per funnel trap of *Notophthalmus viridescens* males and females over eight sampling occasions.

catchability between the sexes. For example, *N. viridescens* could have differences in movement patterns or microhabitat use between the sexes, which may result in female newts being more difficult to detect. Our data do indicate that male and female newts do not respond differently to glow sticks. Thus, while glow sticks increase captures for both sexes, one sex is not preferentially attracted to the glow stick bait compared to the other sex.

Capture efficiency varied over time likely due to differences in environmental conditions between sampling occasions. In particular, during the fifth trapping occasion (11 July 2006) less than half the typical numbers of individuals were captured. We noticed that a full moon and cloudless conditions resulted in particularly bright light conditions that evening. Moonlight can significantly impact the activity of aquatic salamanders (Anderson and Graham 1967; Green 2006) and we believe lunar illumination can lessen the effectiveness of the glow sticks compared to darker nights.

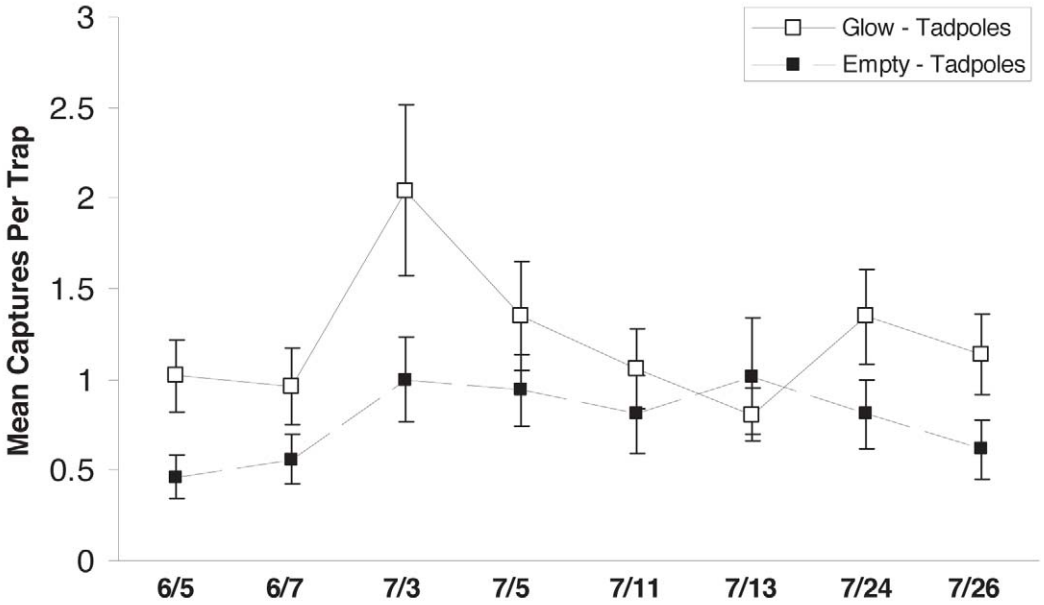


FIG. 2. Mean number of tadpole captures per funnel trap over eight sampling occasions. The vast majority of individuals captured were *Rana catesbeiana* due to their large size and numerical dominance in Station Pond.

The greatest number of individuals captured in a single trap was 37 *N. viridescens* and 14 *R. catesbeiana* for a glow stick trap and 14 *N. viridescens* and 12 *R. catesbeiana* for an unbaited trap. The pond trapped in this study is dominated by these two species but we suspect glow sticks would be effective for other species as well. Unless capturing too many individuals in a given night is a concern, we suggest the thickest glow sticks that produce the most light will result in the greatest number of captures per trap. However, further examination is necessary for studies of multiple species communities. As different species may vary in their catchability, response to glow sticks may also vary by species. We believe that glow sticks are a useful and inexpensive method for increasing capture efficiency in studies using funnel traps.

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Husbandry and Captive Reproduction in *Vipera nikolskii* (Viperidae)

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Nikolsky's Adder (*Vipera nikolskii*) is a moderately short, thick-bodied viperid occuring in woodland meadows, forest-steppe, forest edges, and broadleaved forests in the Ukraine, Moldova, and southern to central Russia (Ananjeva et al. 1998; Bozhansky and Orlova 1997; Milto and Zinenko 2005; Sytnik and Loparev 2003; Vedmederja et al. 1986). An inhabitant of predominately wet areas with dense vegetative cover (Mallow et al. 2003), observations suggest that it readily takes to water (Stettler 1991, 1993; Gumprecht 1994; Trutnau 1998), as well as occasionally burrows within loose soil (Stettler 1993). Despite recent studies (Milto and Zinenko, 2003; Sytnik and Loparev, 2003; Tabachishin et al. 2003), the taxonomy of *V. nikolskii* remains unclear. It appears to be genetically similar to *V. berus berus* (Joger et al. 1997), however, morphologically distinct from other forms (Franzen and Heckes 2000; Milto and Zinenko 2005). Hence, it has been recognized as a full species (Vedmederja et al. 1986), a subspecies of *V. berus* (Joger et al. 1997; Milto and Zinenko 2005; Sokolov 2003), and tentatively, even a subspecies of *V. barani* (Stettler 1993; Nilson and Andrén 1997). Joger et al. (2003) additionally suggest that two clades exist within this taxon, one being closely allied to *V. b. berus* and *V. b. sachalinensis*, the other being a geographically restricted population of *V. nikolskii*.

Although Nikolsky's Adder often is maintained in captivity, reproduction is not commonly reported (Gumprecht 1994; Trutnau 1998). Three pairs (3.3), ranging in size from 460 to 605 mm TL, were collected from the Ukraine and acquired in 1999 and 2000. Upon arrival, the snakes were treated with a 0.0025% solution of Neostomosan spray (theta-cypermethrin; produced by Agrochemie®) to eliminate possible external arthropod parasites. Entizol (metronidazol; S-D Chemical®) against protozoans and Drontal Plus (praziquantel; Bayer®) against helminths were applied per os. All specimens were quarantined in pairs on a substrate of newspaper with the addition of a water bowl and plastic hide box. Both light and heat were provided by a 25-watt incandescent bulb positioned inside each enclosure for 13 h a day. Temperatures fluctuated between 22–28°C during the day, with the provision of a basking area that reached 35°C, dropping to 18–22°C at night. One pair of snakes succumbed from sepsis soon after being received. The remaining specimens were initially force fed pink mice, eventually accepting subadult laboratory mice every 7–10 days. After a three-year period, the snakes reached 640–715 mm in TL, with females being larger than males.

In November 2000, after an initial year-long acclimation period, both lighting and heating were discontinued. Temperatures were maintained between 18 and 22°C for two weeks before transferring specimens to individual plastic enclosures that were placed within a darkened room at temperatures of 7–9°C. Water was provided *ad libitum*. In February 2001, after a 90-day hibernation period, temperatures and lighting were gradually returned to a warmer regimen and all snakes commenced feeding within 20 days. Introductions were made after a 30-day period, though no reproductive activity was observed.

The specimens were cooled down again in mid-October 2001. Both females were allowed to hibernate three weeks longer than the males, however, all other conditions remained the same as the previous year. Upon introduction in March 2002, copulatory activity was observed twice between one pair lasting approximately 60 minutes during each episode. On 25 July 2002, 143 days after the second copulation, the female produced 5 infertile ova.

The hibernation conditions were changed the following year. The males were cooled down from the beginning of November to the end of February; the females were allowed to hibernate two weeks longer. Temperatures during this period were reduced to -1 to +2°C. After the hibernation period, individual snakes were exposed to sunlight for 2–4 h a day several times a week. Introductions were made in the beginning of April 2003 by placing one female at a time with both males. Ritualized combat behavior was subsequently noted between the males. Upon removal of one male, copulation was observed between the remaining pair. This regimen was repeated several times resulting in copulations lasting 60–90 minutes. The last copulation was observed on 12 April 2003, after which both females were housed together. The females were fed *ad libitum* and accepted prey until 13 June 2003. On 21 June 2003, 70 days after the last observed copulation (78 days after the first), the first female gave birth to seven neonates. Two of the neonates had kyphoscoliotic deformations in the anterior third of the body, one of which died shortly after rupturing the fetal membrane. The remaining young averaged 188 mm SVL (157–202 mm, SD = 17.1) and 5.8 g (5.1–6.2 g, SD = 0.4). On 2 July 2003, 82 days after the last observed copulation (89 days after the first), the second female gave birth to three neonates as well as 4 infertile ova. The young averaged 205 mm SVL (198–211 mm, SD = 6.6) and 8.3 g (7.2–9.1 g, SD = 0.9). All neonates shed immediately after escaping from the fetal membrane.

All juveniles were set up in small containers in groups of 2 to 3 on paper substrates with a water bowl. Temperatures were maintained between 22–25°C during the day and 20–22°C at night. Some juveniles accepted prey after being tease fed while others actually trailed and consumed envenomated prey. The remaining neonates were force fed sections of pink mice.

Previous authors reported that *V. nikolskii* is problematic when housed indoors under dry conditions (Gumprecht 1994; Trutnau 1998), yet my experiences suggest that this viperid may be successfully maintained and reproduced in a captive indoor environment after adequate quarantine measures. The gestation periods of 70 and 82 days are considerably shorter than the 130 to 133 days previously reported by Stettler (1993) and Grumprecht (1994). Although further studies are needed, the regimen of providing lower hibernation temperatures and exposing specimens to natural sunlight might have been important for successfully reproducing this species.

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Prolonged Sperm Storage in the Asian Water Dragon (*Physignathus cocincinus*)

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Sperm storage has been documented in a number of species of squamates (Adams and Cooper 1988; Birkhead and Moller 1993; Conner and Crews 1980; Cuellar 1966). This note reports prolonged sperm storage in a captive female Asian Water Dragon (*Physignathus cocincinus*) at the Buffalo Zoo.

Three female and one male *P. cocincinus* were housed together in a large mixed species exhibit for a period extending from October to November 2004. Repeated copulations were observed during this period between the male and all three females. On different occasions all three females were observed depositing eggs on exhibit from December 2004 to March 2005. Due to medical reasons the male expired on 2 December 2004. On 3 July 2006, one female was observed digging test holes in the exhibit enclosure. Twelve eggs were discovered and collected the following day. The eggs, averaging 3 g, were placed in an incubator at 29°C. Over the next 30 days, eight eggs had collapsed and were found to be infertile after opening. After a period of 70 days, two of the four remaining eggs began sweating. The eggs stopped sweating after two days and began to cave in. Because there was no sign of pipping the decision was made to manually open the eggs. All eggs contained near full-term embryos, two of which were dead and beginning to decay. The remaining two were still living, but noticeably deformed. Major organs such as the heart and liver were outside the body cavity and attached to the yolk. Based on the date of the male's death and the date of egg laying, there was a minimum of 581 days between last possible copulation and deposition of the eggs.

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NATURAL HISTORY NOTES

Instructions for contributors to Natural History Notes appear in Volume 38, Number 1 (March 2007).

CAUDATA

AMBYSTOMA MABEEI (Mabee's Salamander). **DIET**. *Ambystoma mabeei* is a small mole salamander known from the Coastal Plain of southeastern Virginia to South Carolina. Relatively little natural history information is available for *A. mabeei* compared to its conspecifics. Recent studies have revealed the feeding ecology of *A. mabeei* larvae, however no published data exists for the diet of terrestrial forms (McCoy and Savitsky 2004. Southeast Nat. 3:409–416; Petranka 1998. Salamanders of the United States and Canada. Smithsonian Instit. Press, Washington, D.C. 587 pp.). On 7 Feb 2006 stomach contents of 35 freshly preserved juvenile to adult specimens (33.2–55.8 mm SVL) were examined. Twenty specimens contained prey, while 15 had empty stomachs (Table 1). Most prey items are invertebrates and are found terrestrially/fossorially, where *A. mabeei* spends a majority of its time. Plant parts were likely consumed incidental to prey capture. Supporting specimens (NCSM 18854) and stomach contents are in the NC State Museum of Natural Sciences collection.

TABLE 1. Stomach contents of freshly preserved *Ambystoma mabeei* adults (N = 20) collected near Laurinburg, Scotland Co., North Carolina. Data are presented as number of salamanders containing prey species (P).

Diet Categories	P
skin	3
Diptera (Mycetophilidae)	1
Lepidoptera (Noctuidae: *Leucania sp*. **)	1
Cantharidae (*Chauliognathus* sp. soldier beetle**)	9
Gryllotalpidae (mole cricket)	1
Lithobiomorpha (centipede)	1
unidentified centipede	1
unidentified arthropod	1
spider	3*
snail	2
vegetation (plant matter)	5
debris (unidentifiable matter)	5

* multiple prey digested by one specimen. ** includes larvae of prey items.

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AMPHIUMA TRIDACTYLUM (Three-toed Amphiuma). **COTTONMOUTH ENVENOMATION**. *Amphiuma tridactylum* is sympatric with the Cottonmouth (*Agkistrodon piscivorus*) throughout the amphiuma's entire range. Both species reside in swampy lowlands and likely encounter one another frequently while searching for prey. Few reports are available on their interactions, but *A. piscivorus* is known to prey upon amphiumas (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Inst. Press. Washington, D.C. 587 pp). On 8 July 2004 we captured a large (100 cm TL) *A. tridactylum* in a 1-m terrestrial funnel trap with a Cottonmouth (73 cm TL) in a small backwater slough (30.98ºN, 87.92ºW), in the Mobile-Tensaw Delta Wildlife Management Area Baldwin County, Alabama. When we approached the trap the amphiuma became agitated and began moving inside the trap. The Cottonmouth struck and envenomated the amphiuma several times on the head and mid-body. In our opinion, the snake expended the vast majority of its venom supplies into the amphiuma. The amphiuma then bit the snake with surprising force and shook the snake side-to-side. The amphiuma scraped dorsal scales off the snake and broke several of the snake's ribs. We separated the two individuals and within seconds the amphiuma's head swelled to twice its normal size and the bites on the body of the amphiuma each swelled to the size of a golf ball. We released the Cottonmouth and it slowly swam away, we do not know if the snake survived the altercation. We transported the amphiuma to a 151 l tank at the Univ. South Alabama Vertebrate Natural History Museum for observation.

The bites secreted copious amounts of mucus for several hours after the envenomation. The amphiuma's bites remained swollen for two days while it remained motionless on the bottom of the tank, except when it surfaced to breathe every 10–15 minutes. On the third day the swelling subsided and the amphiuma began swimming around the tank. We offered the amphiuma chicken liver, which it quickly consumed. We released the amphiuma on day five, after it made a full recovery. To our knowledge, this is the first record of an envenomation of an amphiuma by a snake. Besides the amphiuma, we are unaware of any amphibians that are able to recover from envenomation by a Cottonmouth. The exact mechanism that allowed the amphiuma to survive the envenomation is unknown and needs further study.

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CHIOGLOSSA LUSITANICA (Golden Striped Salamander). **PREDATION.** *Chioglossa lusitanica* is endemic to the Iberian Peninsula. It is one of the most endangered European amphibians and is listed as "Vulnerable" by the IUCN. This salamander has the ability to autotomize its tail when being preyed upon.

Few data exists on the predators of this species. On 2 July 2004 (1800 h; air temp 20.4ºC), a sub-adult *C. lusitanica* (SVL 42 mm) was observed in Zarzo (San Julian de Vigo, Paderne, A Coruña province, NW Spain; UTM 29T NH79) moving among moss cov-

ered rocks along a shady stream bank in a forest with *Alnus glutinosa, Corylus avellana, Salix atrocinerea* and *Fraxinus excelsior*. The salamander went under a rock and quickly came out pursued by a 17 mm land beetle, *Carabus* (*Eucarabus*) *deyrollei* (Carabidae). The beetle bit the salamander's tail, which immediately autotomized at the point where it was bitten, approximately a third of the way along its length. The salamander took refuge under another nearby rock. A few seconds later the beetle with the tail moving between its jaws, went back under the rock from where it originally emerged. Twenty minutes later, the rock was lifted and the beetle was observed eating the piece of detached tail, which was no longer moving. It is interesting to note the rapid recognition of the beetle as a predator on the part of the salamander, its quick escape, and the automatization of its tail upon the first encounter with the beetle's jaws.

On 8 July 2005, at the same site, about 250 m from the previous observation and 4 m from the river (1930 h; 23.0ºC air temp), I observed, upon lifting a rock, a dead juvenile *C. lusitanica* (SVL 26 mm), which was being devoured by another species of land beetle, a 30 mm *Carabus* (*Chrysocarabus*) *lateralis.*

These observations confirm the role of the large carnivorous carabid beetles as predators of juvenile *C. lusitanica*. These beetles are numerous and at least six species ranging in length from 15–35 mm are found in the area. These beetles share the same habitat (Atlantic riverbank forests) and microhabitats (under rocks and between layers of moss and dead leaves) as the salamander, likely resulting in them being important predators of *C. lusitanica*.

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CRYPTOBRANCHUS ALLEGANIENSIS (Hellbender). **CHYTRID FUNGUS.** The chytrid fungus, *Batrachochytrium dendrobatidis*, has been implicated as a cause of the amphibian decline worldwide (Berger et al. 1998. *In* Campbell [ed.], Declines and Disappearances of Australian Frogs, pp. 23–33; Green et al. 2002. Ann. New York Acad. Sci. 969:323–339; McDonald et al. 2005. Cons. Biol. 11:114–120). Ouellet et al. (2004. Cons. Biol. 19:1431–1440) provided a review of the historical distribution of chytrid in North America with a list of species that have been examined for the presence of *B. dendrobatidis*. To our knowledge, this is the first report of *B. dendrobatidis* in captive-reared and wild *Cryptobranchus alleganensis*. During the past four years the St. Louis Zoo has been caring for 126 juvenile Ozark Hellbenders (*C. a. bishopi*) and Eastern Hellbenders (*C. a. alleganensis*), collected as eggs by Unger (2003. MS Thesis, Southwest Missouri State Univ.) from the wild in Missouri, Georgia, and North Carolina. Unger (2003, *op. cit.*) collected eggs from Eastern Hellbenders in the Gasconade River, and from Ozark Hellbenders in the North Fork of the White River in Missouri. In March 2006, the captive-reared hellbenders were diagnosed with *B. dendrobatidis*. Further investigations led to the testing for chytrid on hellbenders from the wild in locations where eggs were collected in 2002 in Missouri. Eight skin scrape samples of *C. a. bishopi* from the North Fork of the White River were obtained on 22 May 2006 and one skin scrape sample from *C. a. alleganensis* was obtained from the Gasconade River on 1 June 2006. Polymerase chain reaction assay showed that two *C. a. bishopi* from the North Fork of the White River had *B. dendrobatidis*, while the one sample from the Gasconade River was negative for *B. dendrobatidis*. These data confirm the presence of *B. dendrobatidis* from hellbenders in captive-reared conditions and wild populations in the North Fork of the White River. *Batrachochytrium dendrobatidis* may be one reason for the decline of hellbenders in Missouri. Further testing for *B dendrobatidis* in Missouri and throughout the range of *C. alleganensis* is warranted to determine the extent and prevalence of this lethal fungus in wild hellbender populations.

We thank J. Wood from Pisces Molecular, Boulder, Colorado for analyzing the skin scrape samples, J. Longcore for graciously providing the laboratory standard culture for *B. dendrobatidis* to Pisces Molecular, and numerous individuals who assisted with field collections and logistic support. We also thank the Saint Louis Zoo veterinarian staff for providing collection materials and other technical support.

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EURYCEA BISLINEATA (Northern Two-lined Salamander). **COLORATION.** The Northern Two-lined Salamander is described as having a pale yellowish to brown dorsum bordered by dark lines (Bishop 1941. The Salamanders of New York. New York State Mus. Bull. No. 324, Albany. 365 pp.; Conant and Collins 1998. A Field Guide to the Reptiles and Amphibians, Eastern and Central North America, Houghton Mifflin Company, Boston and New York, 616 pp.; Petranka 1998. Salamanders of the United States and Canada, Smithsonian Institution Press, Washington and London. 587 pp.). The 1373 records of this species from Québec in the provincial Atlas database (from D. Rodrigue, 22 Aug 2005) and the 293 records from Ontatio in the Ontario Herpetofaunal Summary (from M. Oldham, 21 Aug 2005); do not include any mention of unpatterned, dark, or pale individuals (Jock River specimens cited below are represented in the OHS by records that do not mention coloration). We report here two widely separated sites where we found unpatterned individuals of this species; we describe their pigmentation, and speculate on their significance. Specimens are deposited in the Canadian Museum of Nature (CMNAR).

On 1 Aug 1975, FWS, Aleta Karstad, and Paul W. Schueler visited the Jock River at the old Hwy. 16 bridge (Ontario: Ottawa-Carleton Region: Nepean, 45°15'35"N, 75°42'37"W, WGS 84), and collected a 69 mm pinkish, yellowish, cream-colored larval *E. bislineata*. Return visits to the seepage bank of this small clear rocky river, between *Tsuga canadensis* (Hemlock)/deciduous woods and grassy oldfields (now a municipal park) on 4, 9, and 10 Aug and 11 and 21 Sept 1975 resulted in the collection of more *Eurycea.* The largest individual (109 mm TL), had no dark pigmentation, but rather a pale mottled pattern all over the body. Since then, additional *Eurycea* have been found at this site, with one

unpatterned individual taken in 1980, and one possibly seen in 1995 (Schueler 2002. Trail and Landscape 36:68–71.

The overall frequency of unpatterned adults in the early sample was about 3%, and while none have been found recently, a sample of about 225 without an unpatterned individual would be needed to demonstrate a significant decline (p = 0.05) in the abundance of the unpatterned morph.

On 6 June 1999 J-FD and IP found two dark *Eurycea* at Rivière aux Rosiers, Ragueneau County, northeastern Québec (49°10'42"N; 68°36'35"W). This is a clear rock and gravel river, with fast current, 8 m wide, in Black Spruce (*Picea mariana*) forest, in an area of sport fishing and timbering, with a gravel access road. In 15 minutes, a search for salamanders under rocks on the river bank allowed them to observe 20 adults, all but two mentioned above being normally colored. One dark specimen (CMNAR 35817; 92 mm TL) was collected. The coloration of this live specimen was blackish with pale dots on the dorsum. The belly, usually yellow or yellowish at least in its posterior part (Bishop 1941, *op. cit.*; Petranka 1998, *op. cit.*), was gray.

On 21 July 2004 they returned to the site. An 8 min search yielded six typically-colored individuals (2 mature adults, 1 small adult, and 3 larvae). A second 25 min search yielded 21 individuals (15 adults and 6 larvae) with one adult and one larva dark in coloration. They then searched 200 m lower in the river (49°10'36"N; 68°36'34"W) for 10 min and found about 10 adults (1 dark morph). The river was 5–7 m wide at this site. Eleven specimens were collected, including those dark specimens (64 and 67 mm TL; CMNAR 35818). Overall, about 10% of those observed (5/57) were dark.

While specimens from these sites were described as 'black' and 'pale' upon capture (in life the Jock River specimen, CMNAR 21008, was "almost without non-melanic pigmentation except a faint pinkish blush all over the body"), the pattern of pigment in the specimens is similar. There is a background coverage of unclumped melanocytes which is interrupted by irregular pale areas, typically 1 mm in diameter, though 0.7 mm in CMNAR 19628 (which retained a trace of yellow in the pale patches in 1992, though no yellow was evident in 2006 or in the Rivière aux Rosiers specimens). The background melanocytes are sparsest in CMNAR 21008, denser in CMNAR 19628, and densest in the Rivière aux Rosiers specimens. The initially collected pale larva (CMNAR 16896) was "pinkish yellowish cream in color" at collection, while in 2006 it was creamy white with no trace of dark pigmentation or melanocytes.

The unpatterned adults differ from normal striped individuals both in completely lacking the densely melanic markings that constitute the lateral lines, and in the absence of irregular dark clumps of melanin which are scattered throughout, and sometimes concentrated along the dorsal midline of normal individuals (though the Rivière aux Rosiers specimens did have flecks of individual dark cells). Large normal larvae (60 mm) have the background coverage of unclumped melanocytes interrupted both by the pale patches seen in the unpatterned adults and the dark flecks seen in the striped adults. Smaller larva have the background coverage interrupted only by pale areas similar to those seen in the unpatterned adults (based mostly on CMNAR 21007 from the Jock River, FWS Jan 2006). The pale patches of the smaller larvae comprise the 6–9 pairs of dorsolateral pale spots described by Petranka (1998, *op. cit.*) and Bishop (1941, *op. cit.*).

The significance of this coloration is an open question. Unpatterned morphs have not been previously mentioned in this species, and there is no association with size, as large larvae from both sites were unpatterned. The simplest explication of this morph is retention of early larval coloration, with pale spots on the unpatterned adults that are about the same size (1 mm) as those on much smaller larvae. This is presumably the result of failure to develop the dark flecks that compose the lateral bands and other adult markings, and the persistence of the pale spots in the background coloration, but we cannot speculate further. The retention of larval pattern elements in these two populations, separated by about 700 km along the St Lawrence, Ottawa, and Rideau rivers, may be induced by some environmental characteristics, or genetic drift in isolated populations, without having a particular advantage for individuals.

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EURYCEA LONGICAUDA LONGICAUDA (Long-tailed Salamander). **PREDATION.** Natural predators of *Eurycea longicauda* are largely unknown. On 13 April 2006, 1500 h, we observed two adult *Thamnophis sirtalis sirtalis* that had recently fed on *E. longicauda*. The snakes were among six conspecifics observed within 10 m of a spring fed-pond lying adjacent to a small (< 10 hectare) fragment of upland deciduous forest. Upon capture one snake (ca. 55 cm TL) regurgitated an adult (45 mm SVL) male *E. longicauda*. The still living salamander was coated in shed skin and a mucus-like slime, possibly a combination of digestive enzymes and salamander skin secretion. The salamander was folded against itself, suggesting that it had been grasped and swallowed at mid-body by the snake. The tail was intact. Another *T. s. sirtalis* (size not recorded) was observed with the tail of an *E. longicauda* protruding from its mouth. The snake's mouth was held partially agape and was covered with a frothy secretion, presumably from the salamander. Eastern Garter Snakes are opportunistic foragers that are known to prey on other species of plethodontid salamanders including *E. bislineata, Desmognathus fuscus,* and *Pseudotriton montanus.* (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Inst. Press. 587 pp.). This is the first report of predation on *E. longicauda* by *T. sirtalis* of which we are aware.

The spring-fed pond where this predation was observed is located in Wayne Co., Franklin Township, Ohio and is a productive site for *E. longicauda* (Wicknick et al 2005. Ohio J. Sci. 105:2–7). The hillside from which the spring emerges may serve as an underground winter retreat where these salamanders emerge in April

and return to in September and October (Bishop 1941. Salamanders of New York. New York State Mus. Bull. 324:1–365; Petranka 1998, *op. cit.*) A previous observation of predation on *E. longicauda* by *P. ruber* at this same locality (Reblin and Anthony 2001. Herpetol. Rev. 32:245–246) suggests that predators of *E. longicauda* might locate and exploit emergence sites when foraging.

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HEMIDACTYLIUM SCUTATUM (Four-toed Salamander). **REPRODUCTION.** Little is known about the disjunct Gulf Coast populations of *Hemidactylium scutatum*, with few records of adults reported from four counties (Gadsden, Leon, Walton, and Washington) in the Florida panhandle. Here we report the first published nesting and larval records of the species in Florida. Surveys for *H. scutatum* were conducted from 7–8 March 2005 in Joe Budd and Talquin wildlife management areas in Gadsden and Leon counties, Florida.

In Joe Budd WMA, Gadsden County, Florida, on 7 March 2005, three unattended, full-term *Hemidactylium* eggs were discovered in a tussock of mixed grass and *Sphagnum* sp. overhanging a small (ca. 1 m × 4 m) oxbow pool. The eggs hatched upon disturbance of the nest, and the larvae escaped to water before photographs could be taken. Alongside a slow-moving stream ca. 1.5 m wide, 5.5 m from the first nest, a female *H. scutatum* was observed tending 22 eggs under bark fragments in mixed pine needle/hardwood leaf litter adjacent to a sparse growth of *Sphagnum* sp. The eggs were located 17 cm above the waterline and contained fully developed embryos. Although *Sphagnum* sp. was present near both nests, the eggs were not located within dense hummocks of the moss, as is typified by the nesting microhabitat reported for more northern *Hemidactylium* populations (Breitenbach 1982. J. Herpetol. 16:341–346). When the second nest location was revisited on 8 March 2005, following heavy overnight rains, neither eggs nor the attending female could be found. The moisture from the rain may have triggered hatching and washed the larvae into the stream below. A single larval *H. scutatum* was dipped from the oxbow pool at the site of the first nest on 8 March 2005. Habitat at the Gadsden County site consisted of a meandering stream, 1–2 m wide with barely perceptible flow, surrounded by numerous oxbows in upland hardwood forest.

On 8 March 2005, a bottomland forest site in Talquin WMA, Leon County, Florida, was surveyed where adult *Hemidactylium* had previously been reported (Enge 1988. Proc. Annu. Conf. Southeast Assoc. Fish and Wildl. Agencies 52:336–348). Multiple *H. scutatum* larvae were seen in a shallow, seepage film wetland in the floodplain of a second-order stream in a steephead ravine. Two of these larvae were dipped by hand, photographed, and collected. Mosses noted around wetlands included *Thuidium*, *Climacium*, and some *Sphagnum*.

Previous reports indicate a geographical progression of nesting dates for *H. scutatum*, with females in warmer southern and coastal populations nesting earlier in the season, followed by populations in cooler, inland locales (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Inst. Press, Washington, D.C. 587 pp.). Our findings corroborate this trend, and by extrapolating with a relatively low estimated incubation time of 38 days (Blanchard 1923. Am. Nat. 57:262–268), and a very conservative within-population egg-laying period of two weeks (Wood 1955. Am. Midl. Nat. 53:381–389), an early nesting date of 15 Jan 2005 is calculated. This would be the earliest reported nesting date to our knowledge, as would be expected from one of the southernmost coastal populations of *Hemidactylium*.

Photographs of the female, eggs, habitat, and larvae were taken and submitted with collection data to the Florida Natural Areas Inventory. Tissue collected from the female (autotomized tail) and larvae were preserved in 95% ethanol for genetic analysis at Bowling Green State University (sample ID#s: FL-GA-01, FL-GA-02, FL-LE-01, FL-LE-02).

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PLETHODON DORSALIS (Northern Zigzag Salamander). **MAXIMUM SIZE**. Although Smith (1961. The Amphibians and Reptiles of Illinois. Bull. Illinois Nat. Hist. Survey 28:1–298) reported 114 mm TL for the largest *Plethodon dorsalis* collected in Illinois, Conant and Collins (1998. A Field Guide to Reptiles and Amphibians of Eastern and Central North America, 3rd ed., Expanded. Houghton Mifflin Co. Boston, Massachusetts, 616 pp.) reported maximum body size for this species as 111 mm TL. On 10 March 2006 we captured an adult female *P. dorsalis* beneath a decaying board at a field/forest edge in Cooper Hollow, Cannon County, Tennessee, USA that surpassed the previous record length. The specimen, deposited in the Middle Tennessee State University collection (MTSU 342C) had a TL of 120.1 mm and a SVL of 56.0 mm when relaxed prior to fixation. After preservation in 10% buffered formalin for 11 days TL was 118.6 mm and SVL was 55.2 mm.

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TARICHA TOROSA (California Newt). **FUNGAL INFECTION**. *Batrachochytrium dendrobatidis* (Bd) a fungal pathogen of amphibians, was first described as a new species in 1999 (Longcore et al. 1999. Mycologia 91:219–227). Bd is a recently emerged chytridiomycete fungus that has been identified as a causative agent in selected amphibian declines around the world (Berger et al. 1998. Proc. Nat. Acad. Sci. USA 95:9031–9036; Daszak et al. 1999. Emerg. Infect. Diseases 5:735–748; Bosch et al. 2001. Biol. Conserv. 97:331–337). In California this pathogen has been reported in wild populations of eight anuran species, Santa Cruz Long-toed Salamander (*Ambystoma macrodactylum croceum*), and

California Tiger Salamander (*Ambystoma californiense*) (Speare and Berger 2000. http://www.jcu.edu.au/school/phtm/PHTM/frogs/chyglob.htm; Vredenburg and Summers 2001. Herpetol. Rev. 32:151–152; Padgett-Flohr and Longcore 2005. Herpetol. Rev. 36:50–51). It has also been reported in Sonoran Tiger Salamander (*A. tigrinum stebbinsi*) in Arizona (Davidson et al. 2003. Copeia 2003:601–607). Herein, we report the first documented case of *B. dendrobatidis* in California Newt (*Taricha torosa*).

Ten California Newt larvae from nine different ponds (N = 90) in Joseph D. Grant County Park, Santa Clara County, California (37º20'29"N, 121º42'17"W; 650 m elev.) were collected in 2003 following a newt die-off observed by park personnel. The samples were preserved in 70% alcohol. We removed small pieces of toe skin from each specimen and microscopically examined unstained tissue for *B. dendrobatidis* zoosporangia. Six specimens from two different ponds were positive for the pathogen, as indicated by the presence of non-hyphal spherical zoosporangia with one or more inoperculate discharge papillae (Longcore et al. 1999, *op. cit.*). These data demonstrate that the potentially harmful pathogen is present in wild populations of California Newt.

Permission to collect California Newt specimens was authorized by permits issued by the California Department of Fish and Game (801160-02) and the County of Santa Clara Parks and Recreation Department to GEP. We thank D. Clark, K. Coffer, M. Goble, M. Jennings, M. Khosla, D. Rocha, and J. Wilcox for assistance in the field.

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ANURA

AGALYCHNIS CALLIDRYAS (Red-eyed Treefrog). **REPRODUCTION**. *Agalychnis callidryas* occurs from southern Mexico to western Colombia adjacent to Panama, in tropical forests (Frost 2004. Amphibian Species of the World: an Online Reference. Version 3.0, 22 Aug 2004). This species lays its eggs in "nests" with an average of 33 eggs on the underside of leaves above (average height 106 cm) relatively shallow water (Leary and Packer 1998. Herpetol. Nat. Hist. 6:55–59). Breeding behavior of *A. callidryas* was observed in a small, semi-permanent pond at the border of the forest, on Bocas del Toro Island (9°25'01"N, 82°19'30"W, WGS 84, ca. 9 m elev.), in western Panama. A pair was observed on 17 July 2002 from 2200 h until 0530 h of the following day (7.5 h observation). Observation began at 2200 h when the pair was seen to enter amplexus. The pair was ca. 1.5 m above the water in a large shrub. Carrying the male, the female moved among the vegetation, apparently searching for an oviposition site. Egg-laying began at 0125 h (after 3.25 h of movement). This first oviposition site was at 1.7 m height, and the egg mass was 5.2 cm length, 2.3 cm width, 1.5 cm deep with 62 eggs, on a leaf that was 12 × 7 cm. Following oviposition, the female descended the vegetation, while carrying the male, to the ground, where she laid against the humid soil to absorb water. This lasted for 32 minutes. Then, the female, still carrying the male, climbed the vegetation searching for the next oviposition site. The second oviposition began at 0330 h at a height of 2.6 m, with egg-mass dimensions of 6.7 × 2.8 × 1.3 cm, with 52 eggs, on a 10 × 6 cm leaf. The pair then moved to another leaf and began the third oviposition. At 2.4 m height, this nest was 2.9 × 2.4 × 1.7 cm, with 25 eggs on a 14 × 8 cm leaf, ending at 0505 h. At that time, the pair moved to a larger branch and began climbing. At 0515 h the pair separated and the female continued climbing into the higher vegetation until lost from sight while the male settled on a leaf ca. 2.5 m height. Thus, in ca. 4 h, this pair oviposited three times, laying a total of 139 eggs, with only one pause for rehydration. We suggest that this species lays eggs in several nests to reduce predation risk on any one nest, since nest survival until larvae fall into the water is low. Eggs predators observed at this same pond included a cat-eyed snake (*Leptodeira septentrionalis*) and unidentified wasps.

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AGALYCHNIS SPURRELLI (Gliding Leaf Frog). **CLUTCH SIZE.** The genus *Agalychnis* is composed of six species with Neotropical distribution, arboreal behavior, and oviposition on substrate out of water (Faivovich et al. 2005. Bull. Amer. Mus. Nat. Hist. 294:1–240). There are several studies of the natural history and breeding behavior of *Agalychnis*, but many aspects are unknown or incomplete. The largest clutch size reported for *A. spurrelli* had 67 eggs (Duellman 2001. Hylid Frogs of Middle America. SSAR Contrib. Herpetol. 18:1–1180 pp.; Savage 2002. The Amphibians and Reptiles of Costa Rica. Univ. Chicago Press 934 pp.). There is a record of a clutch with 533 eggs (Scott and Starret 1974. Bull. South. California Acad. Sci. 73:86–94) although Duellman (2001, *op. cit.*) suggested that report could be a multiple clutch. Here, I report two ovipositions, both larger than the clutch size previously reported for *A. spurrelli*.

During Oct 2005, I observed two ovipositions of *A. spurrelli* around an artificial body of water located in El Danubio, Region de Anchicayá, Department of Valle del Cauca, western Colombia. The frogs were in the water 15–20 min before they moved up into the vegetation and started to oviposit on the surface of a leaf. One clutch was 322 eggs (female SVL 11.3 cm), the other was 159 eggs (female SVL 8.8 cm). The first oviposition lasted ca. 30 min, while the second lasted ca. 19 min.

The larger oviposition described here is the biggest clutch size reported for *A. spurrelli*. Vargas et al. (2000. Rev. Acad. Colomb. Ciencias 24[90]:85–99) mentioned large clutch sizes (> 200 eggs) for *A. spurrelli*. The clutch size of 533 eggs reported by Scott and Starret (1974, *op. cit.*) was not verified as a single clutch because oviposition was not observed by the authors. Small clutch sizes (67 eggs) reported by Duellman (2001, *op. cit.*) and Savage (2002, *op. cit.*) for *A. spurrelli* could be due to: 1) no direct observation of oviposition; females may move to a different site and split the clutches into three or more parts (Fig. 1); and/or 2) differences in female body size (often related to the number of eggs laid); female *A. spurrelli* are larger in South American populations than in

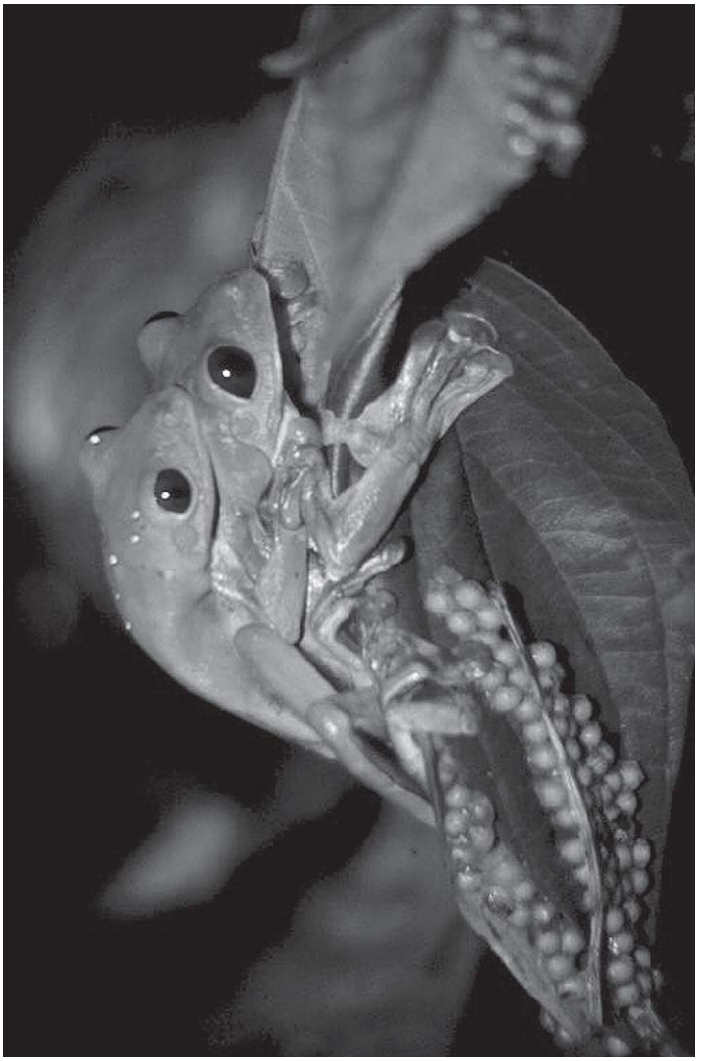


FIG. 1. Oviposition of the treefrog *Agalychnis spurrelli*. During oviposition the female may move to a nearby leaf, which divides the clutch into two or more parts (note several eggs in the upper right corner of photo).

Central American populations (Duellman 2001, *op. cit.*).

I thank J. D. Lynch for identification of these frogs.

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BUFO AMERICANUS (American Toad). **PREDATION.** Although bufonid toads produce toxic compounds that render them unpalatable to many vertebrates, they have been reported as prey of several species of mammals, snakes, and other predators (Groves 1980. Amer. Midl. Nat. 103:202–203; Heinen 1993. Amer. Midl. Nat. 130:184–192, and references therein). On the evening of 22 June 2001, JAC collected a Brown Trout (*Salmo trutta*), 22.8 cm total length (TL), by angling in Beaver Creek along County Road 30, ca. 2 km upstream from its confluence with the Whitewater River, Winona Co, Minnesota, USA (T108N R10W S16). The belly of the trout was obviously distended, and it contained, in addition to a few insect larvae, 13 newly metamorphosed *Bufo americanus*. We returned to the same location on the evening of 24 June 2001 and collected 10 Brown Trout (22.5–25.4 cm TL) by angling. Two had empty stomachs, five contained invertebrate prey, and three (22.9–25.4 cm TL) contained, in addition to invertebrates, newly metamorphosed toads (minimum individual counts of 3, 15, and 48). The creek where the trout were captured is bordered by springfed marshes; newly metamorphosed toads were abundant along the roadside and at some sites along the stream margin. In some pools we observed toads floating downstream along the surface (as many as several dozen during a ten-minute period). Trout were feeding at the surface in the same pools, although they were also feeding on caterpillars, grasshoppers, and other insects of terrestrial origin. Newly metamorphosed toads measured 9–12 mm, and, as noted by Vogt (1981. Natural History of Amphibians and Reptiles of Wisconsin, Milwaukee Public Museum, Milwaukee, Wisconsin), have bright red warts. It is conceivable that the latter serve an aposematic function against some predators, but they would not have been visible to trout attacking from below.

Our observations suggest that predation by trout on toads is substantial at this locality, where Cochran and Cochran (2003. Herpetol. Review 34:360) reported predation by a trout on a Spring Peeper (*Pseudacris crucifer*). Brown Trout are not native to North America, but they are present in most of the 1145 km in 139 streams that currently are managed for trout in southeastern Minnesota (Thorn et al. 1997. N. Amer. J. Fish. Manag. 17:860–872). Thus, they may be an important source of mortality to anurans associated with streams in this part of the state.

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BUFO BOREAS HALOPHILUS (California Toad). **LARVAL CANNIBALISM**. Cannibalism has been observed in anuran larvae within the genera *Rana* (Petranka and Thomas 1995. Anim. Behav. 50:731–739) and *Scaphiopus* (Low 1976. *In* Goodall [ed.], Evolution of Desert Biota, pp. 149–195. Univ. Texas Press, Austin.). Of the bufonids, cannibalism has been studied in the laboratory in *Bufo bufo* (Nagai et al. 1971. Agricult. Biol. Chem. 35:697–703) and *B. a. americanus* (Heinen and Abdella 2005. Am. Midl. Nat. 153:338–347) larvae, although field observations of larval cannibalism are lacking for these species. Recently, however, Jordan et al. (2004. West. N. Am. Nat. 64:403–405) documented *Bufo boreas boreas* larvae feeding on conspecifics and the larvae of two other species (*Rana cascadae* and *Pseudacris regilla*) in Oregon. Here we supplement the field observations of Jordan et al. (2004, *op. cit.*) with a report of apparent cannibalism by tadpoles of the California Toad (*B. boreas halphilus*) in California.

At 1330 h on 8 May 2006 while surveying the Santa Ynez Valley, Santa Barbara County, California for *B. californicus* larvae and egg masses, we observed eight *B. boreas halophilus* larvae in a circle feeding on a conspecific in Indian Creek (UTM Zone 11 0258628E, 3824554N; 1488 m elev.). The eight predators and the prey item were all similar in size (2–2.5 cm TL). These individuals were removed from the larger aggregation; the nearest individual was ca. 125 cm away. The event occurred ca. 20 cm from

the shore in shallow water (ca. 5 cm deep), which was 27.8°C. Although many *B. boreas halophilus* larvae were observed that day (estimated at > 100,000 individuals) and other trips to the area have been conducted, this was the only event of cannibalism observed.

Because the prey was dead at the time of the observation, it is impossible to state that the observed feeding was cannibalism rather than scavenging. Other factors suggest active cannibalism, however. Besides being partially eaten, the observed prey item appeared normal (with no anatomical abnormalities or signs of disease, and it was similar in size to the predators). Additionally, desiccation seems unlikely at the observation location and water depth, and no other dead conspecifics were observed in the area. Taken together, this observation most likely indicates a cannibalistic event, rather than one of scavenging. The small aggregation of eight individuals cannibalizing a conspecific is quite similar to events described by Jordan et al. (2004, *op. cit.*) in *B. boreas boreas* tadpoles, but this is the first account of apparent cannibalism in larvae of *B. boreas halophilus*.

We thank Richard Block, Nancy McToldridge, Alan Varsik, Sheri Horiszny, James Traverse, and Patrick Martin of the Santa Barbara Zoological Gardens (SBZG) for helping develop a partnership between SBZG and the USDA Forest Service on *Bufo californicus* and *Rana draytonii* conservation efforts.

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BUFO BUFO (Common Toad). **FORAGING BEHAVIOR**. Two individual *Bufo bufo* recorded were observed climbing on Lamiaceae shrubs (genus *Rosmarinus*) in Falmouth (50°08'52''N, 05°04'45''W) Cornwall, United Kingdom. These individuals were observed actively foraging during the night (2217–2346 h) of 12 July 2006. Air temperature was 14°C. One individual was observed for more than 10 minutes moving on the top of the shrub; the other was observed while climbing. The common toad has largely been recognized as a terrestrial species, assembling in ponds and streams almost exclusively during the breeding season (Arnold 2002. Reptiles and Amphibians of Europe. Princeton Univ. Press, Princeton and Oxford. 288 pp.). This note provides the first record of *Bufo bufo* selecting shrubs as microhabitat to forage.

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BUFO BUFO (Common Toad). **DEPTH RECORD**. In temperate climates, several anuran species are known to spend the winter months hibernating underwater, often below a layer of ice (Emery et al. 1972. Copeia 1972:123–126; Matthews and Pope 1999. J. Herpetol. 33:615–624). Even during the activity season, some adult (Hutchison et al. 1976. Respirat. Physiol. 27:115–129) and larval



FIG. 1.*Bufo bufo* elevating its body off of the substrate in response to approach of submersible vehicle at 99 m depth in Loch Ness, Scotland, on 9 Sept 2005.

(Richmond et al. 1999. Herpetol. Rev. 30:90–91) frogs have been observed at depths of 3–8 m. Herein, we describe an observation of *Bufo bufo* at nearly 100 m depth in the Loch Ness of Scotland.

On 9 Sept 2005, at 1037 h local time, we were surveying the bottom of Urquhart Bay of Loch Ness, ca. 57°11'36"N, 4°35'36"W, ca. 250 m from the nearest shoreline. We were using a remote operating vehicle (ROV) with a mounted video camera. The surface air temperature was ca. 15°C, and the water temperature at the ROV depth (between 95–100 m) was 5.6°C. A toad was observed on the substrate, with its limbs splayed out slightly away from its body. The specimen was recorded on video for 78 sec, during which time it elevated its torso from the substrate (Fig. 1) and attempted to move away from the ROV. The toad's movements resembled lunges, but were very sluggish. The upper layers of sediment were disturbed with each of the toad's movements, indicating the loose substrate texture. Although the specimen was not collected, the species was inferred because it is the only bufonid known to occur in that part of Scotland (Gasc et al. 1997. Atlas of Amphibians and Reptiles in Europe. SEH and MNHN, Paris. 494 pp.).

The oligotrophic nature of the Loch Ness keeps oxygen saturation levels at around 80% and surface ice rarely forms during the winter months (Shine and Martin 1988. Scottish Nat. 100:111–199). In addition to a low metabolic rate inherent to the constant 5.6°C, the toad experienced pressures approaching 10 atm at 99 m. As such, its lungs would be completely deflated and the animal is negatively buoyant. We did not observe any swaying behaviors that would facilitate cutaneous respiration as have been documented in other species of anurans underwater (Hutchison et al., *op. cit.*).

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BUFO FERNANDEZAE (Lesser Common Toad). **BODY TEMPERATURE**. *Bufo fernandezae* is a typical inhabitant of northeastern Argentina, and is also found in Paraguay and Uruguay. (Cei 1980. Amphibians of Argentina. Monitore Zool. Ital., N. S. Monografia 2, 609 pp.). The thermal ecology of this toad is unknown. To study the thermoregulatory strategy of this species we measured the relationships between cloacal temperature (CT), snout-vent length (SVL), air temperature (AT), and substrate temperature (ST) of individuals of this species in natural microhabitats.

The study area was a permanent pond in the floodplain of the Middle Paraná River in Santo Tomé city, Santa Fe Province, Argentina (31º39'15.7"S, 60º45'35.3"W). The shore was largely covered with grass and *Solanum glaucophyllum* while the shallow areas were covered with *Ludwigia peploides*. Eleven individuals (SVL 5.5 ± 2.08 cm; mean ± SD) were captured between 1900 and 2200 h on 23 Nov 2005 in different microhabitats, including grass, mud, and shallow water. For each specimen, CT, ST, and AT were measured where the individual was collected with a digital thermocouple thermometer (Barnant model 600-1040).

Mean CT was 22.2 ± 1.3°C (N = 11, range 18.8–23.7°C). There were significant differences between ST and AT measured in each site (Mann Whitney, U = 14, N = 11, $p < 0.002$). CT differed significantly from AT (Mann Whitney, U = 21, N = 11, $p < 0.009$) but did not differ from ST (Mann Whitney; U = 0.43, N = 11, $p > 0.25$). CT showed a positive lineal association with ST (Spearman, R = 0.69; $p < 0.01$), but not with AT (Spearman, R = 0.27; $p > 0.47$). No association between the TC and SVL was observed ($p > 0.07$).

These results show that *B. fernandezae* analyzed in this study were predominantly thermopassive, following a mechanism in which the individuals do not actively invest time and energy selecting microhábitats for thermoregulation (Labra y Vidal M. 2003. *In* Francisco Bozinovic [ed.], Fisiología Ecológica y Evolutiva, pp. 207–224. Ediciones Universidad Católica de Chile. Santiago, Chile). The body temperature of this species depends primarily on the substrate temperature.

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BUFO GRANULOSUS (Granular Toad). **PREDATION**. On 9 May 2005 at 1905 h we found a juvenile *Bufo granulosus* (SVL 36.1 mm) in the stomach of the colubrid snake *Leptodeira annulata* (SVL 417 mm; adult male) at buildings surrounded by grassy fields and a mosaic of Cerrado vegetation in the Brazilian Pantanal, Nhumirim Ranch (18º59'S, 56º40'W), Mato Grosso do Sul State, Brazil. After it regurgitated the frog (deposited in Coleção Zoológica de Referência do Campus de Corumbá - CEUCH 3671), the snake was measured and released. Bufonids are known for their skin toxins, although they do not seem to be an effective strategy against anuran specialists, like *L. annulata* (Duellman 1958. Bull. Amer. Mus. Nat. Hist. 114:7–152).

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BUFO PUNCTATUS (Red-spotted Toad). **PREDATION**. Predation on chorusing *Gastrophryne olivacea* by *Thamnophis cyrtopsis* has recently been reported from Sonora, Mexico (Smith et al. 2005. Herpetol. Rev. 36:300). On 1 Aug 2005, we observed a similar event in the Pajarito Mountains of Santa Cruz Co., Arizona, USA. At ca. 0045 h, we encountered a mixed chorus of *G. olivacea* and *Bufo punctatus* calling from intermittent pools in a streambed adjacent to an unpaved road (31.460°N 111.249°W; 1243 m elev.). The sky was completely overcast with cloud cover and there was sporadic light rainfall. We observed four *T. cyrtopsis* foraging in and around the pools; two of the snakes had visible food boluses. We gently palpated these two snakes until they regurgitated; both contained recently swallowed *B. punctatus*. Smith et al. (2005, *op. cit.*) commented that in mixed breeding choruses of *Hyla wrightorum* and *G. olivacea*, *T. cyrtopsis* appeared to selectively consume the latter species. Our observation is noteworthy in that we observed *T. cyrtopsis* seemingly selecting *B. punctatus* in preference to more numerous *G. olivacea*. This provides an additional observation suggesting that foraging *T. cyrtopsis* may selectively consume specific anuran species in a chorus. This observation also further documents the potential importance of anurans as a seasonally concentrated and locally abundant food source for *T. cyrtopsis* in the Sonoran Desert region. A color transparency of a *T. cyrtopsis* with its associated food item is deposited at the University of Texas at Arlington slide collection (UTA 33309).

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CHAUNUS ARENARUM (Dunes Toad). **DIET**. *Chaunus arenarum* is a common toad in coastal dunes of Brazil, Uruguay, and Argentina. During the night, individuals of this species may go to the beach to forage. On 11 Jan 2002 at 2200 h, we observed an individual feeding on a juvenile Plata Pompano (*Trachinotus marginatus*, Pisces; Carangidae) within the wave wash zone. To our knowledge, this is the first record of anurans feeding on a marine fish.

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CHAUNUS BERGI (NCN). **ENDOPARASITES.** *Chaunus bergi* is associated with the floodplains of the Parana and Paraguay rivers in the northern Corrientes, eastern Chaco, Formosa, and northern and eastern Santa Fe, Argentina, and southern Paraguay (Céspedez 1999. Facena 15:69–82). The endoparasites of this toad have not been reported. The purpose of this note is to report the presence of three nematode species from Corrientes, Argentina.

Twenty adult (7 females, 13 males) *C. bergi* (mean SVL 30.78 mm ± 12.38 SD, range 2.81–43.0 mm; mass 4.67 g ± 2.32 SD, range 0.06–8.23 g) were collected in Corrientes, Argentina (27°28'S, 58°50'W) during Sept 2002–Nov 2003 and deposited in the herpetology collection of the Centro de Ecologia Aplicada del Litoral (CECOAL 2893, 2896–98, 3061–64, 3103, 3170, 3191, 3360–62, 3365–66, 3370–72, 3458). Toads were transported to the laboratory and placed in ether sulfuric solution. At necropsy, the alimentary canal, lungs, liver, and urinary bladder were examined for parasites by dissection. Nematodes were observed in vivo, counted and killed in distilled hot water, and fixed in 70% ethyl alcohol. They were cleared in glycerin or lactofenol and examined as temporary mounts.

Fifteen toads were parasitized (prevalence 75%) by three species of nematodes [in parentheses, prevalence (number infected frog/number examined × 100), mean intensity (mean number nematodes/infected frogs ± 1 standard deviation) and range]: one specimen of *Rhabdias* sp. localized in the lung (5%, 1), one hundred twenty-three *Cosmocerca podicipinus* localized in the large and small intestine and in the lung (65%, 9.46 ± 7.38, 1–24), and one hundred twenty-two *Cosmocerca parva* localized in the large and small intestine (40%, 15.25 ± 10.15, 2–30).

The nematodes are stored in the helminthological collection of Centro de Ecología Aplicada del Litoral: *Rhabdias* sp. (female 02103064), *C. parva* (male 02092898), and *C. podicipinus* (female 02092897).

In South America, nematodes belonging to the genera *Cosmocerca* and *Rhabdias* are widely distributed in amphibians and reptiles (Baker 1987. Mem. Univ. Newfoundland, Occas. Pap. Biol. 11, 325 pp.; Bursey et al. 2001. Comp. Parasitol. 68:21–35; Vicente et al. 1990. Rev. Brasil. Zool. 7:549–626) although they have not been found in *C. bergi*. This note represents the first record of *Rhabdias* sp., *C. podicipinus*, and *C. parva* in *C. bergi*.

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CHIASMOCLEIS PANAMENSIS (Panama Humming Frog). **PREDATION.** *Chiasmocleis panamensis* is a small, explosively breeding microhylid whose distribution is restricted to central Panama and northwestern Colombia (Nelson 1972. Copeia 1972:895; IUCN, Conservation International, and NatureServe 2004. http://www.globalamphibians.org/). Breeding choruses of *C. panamensis* are rarely observed and its ecology remains little known (Ibáñez et al. 1999. The Amphibians of Barro Colorado Nature Monument, Soberania National Park and Adjacent Areas Zone, Editorial Mizrachi and Pujol, S.A., Panama, 187 pp.). Here I report a predation event on *C. panamensis* by the colubrid snake, *Leptodeira annulata* observed on 18 May 2005 at 0320 h, under a partly cloudy sky and a moon roughly 4/7 full, following perhaps the heaviest rain of the newly begun wet season. The locality was Bridge Pond, Gamboa, Colón Province, Republic of Panama, 30 m elev. (9.116ºN, 79.700ºW).

While observing a chorus of *C. panamensis*, I noticed a *L. annulata* moving through the leaf-litter along the pond's edge. The snake had a bulge in the anterior portion of its body. I caught the snake and forced regurgitation of its prey. A still-living *C. panamensis* emerged from the snake, but the frog died within a few minutes. The frog was male, judging from the darkly colored throat region (Nelson 1972, *op. cit.*; Ibáñez et al. 1999, *op. cit.*), (SVL 25.45 mm). This is exceptionally large for a male *C. panamensis* (Nelson 1972, *op. cit.*). The snake measured 32.0 cm SVL, and 44.5 cm total length. *Leptodeira annulata* from Costa Rica, Brazil, and Ecuador are known to commonly prey on frogs (Vitt 1996. Herpetol. Nat. Hist. 4:69; Savage 2002. Amphibians and Reptiles of Costa Rica. Univ. Chicago Press, Chicago, 934 pp.).

Identification of the frog and snake were confirmed by César Jaramillo. The snake was released two days after capture. The frog (field number AJC 1164) was deposited in the Museo de Vertebrados de la Universidad de Panamá (MVUP number not yet available).

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CROSSODACTYLUS GAUDICHAUDII (Gaudichaud's Frog). **BEHAVIOR.** *Crossodactylus gaudichaudii* is endemic to southeast Brazil (states of Rio de Janeiro and São Paulo), inhabiting rocky streams inside forests (Heyer et al. 1990. Arq. Zool., São Paulo 31:291; Izecksohn and Carvalho-e-Silva 2001. Ed. UFRJ, Rio de Janeiro: 70). The only report on agonistic behavior comes from captive observations (Weygoldt and Carvalho-e-Silva 1992. Amphibia-Reptilia 13:35–45) and includes calling, visual displays, and agonistic interactions. Here we present the first record of agonistic behavior in this species in nature. On 10 Aug 2003, between 1210–1230 h, an agonistic encounter between two male *C. gaudichaudii* was observed in an area of Atlantic Forest at Ilha Grande, Rio de Janeiro state, Brazil. The observation was made along a trail in the forest, close to Vila Dois Rios Village (23º11'S, 44º12'W). One of the males was calling while perched on a rock ca. 15 cm above the water, at the margin of a puddle ca 1 m diameter and 3 cm deep. Four minutes after this male was located, a second male (distinguishable from the first one by its paler dor-

sum) entered the puddle and started to call from a distance of ca. 50 cm from the rock where the first male was perched, while facing the latter. After ca. 30 seconds, the two males apparently noticed each other's presence and began signaling with their four limbs. During the signaling, they raised the anterior part of the body and lifted the front limbs first and then the hind limbs, one at a time, apparently without a defined pattern. During those displays, the front limbs were completely raised from the substrate, but the hind limbs were not, with only the feet being lifted. Simultaneously, the male on the rock started to emit a differentiated call (presumably an aggressive encounter call). After ca. 2 min., the resident male jumped off the rock into the puddle below and approached the intruder male up to a distance of ca. 10 cm. The two males stayed face to face for about 1 minute, partially immersed and motionless. Then, the resident male jumped on the intruder and started a "wrestling" combat in which they wrapped their front limbs around each other and started rolling, venter to venter, until the resident male overturned the intruder and pushed him underwater with his forefeet, keeping him completely submerged. This combat sequence lasted for about five seconds, with the resident male seemingly subduing the invader. After the end of the combat, the resident male chased the invader off the puddle. Then, the resident male returned to the top of the rock it was initially sighted on, restarting calling activity. After about one minute, the invader male reappeared and returned to the center of the puddle. After about 30 seconds, the two males repeated the sequence of visual signaling and (in the case of the resident male) aggressive encounter calls. Then, the resident male jumped once again to the water and stayed at a distance of ca. 30 cm from the intruder, with the two males facing each other until another combat ensued. This time, however, it was the invading male who took the initiative to attack the resident. Again, the combat ended with the resident male chasing the invader off the puddle, before returning to his original perch on the rock to resume his calling activity. The invader male stayed outside the puddle for about 2 minutes and then returned, but, unlike the first time, he did not move to the center of the puddle and instead remained near its margin at a distance of about 1 m from the resident male's rock, almost totally submerged and silent. Apparently, neither of the two males suffered any kind of physical damage during the combats.

The observations made in the present study are similar to those described by Weygoldt and Carvalho-e-Silva (*op. cit.*) in captivity. The present observation indicates that males *C. gaudichaudii* may compete actively and directly for calling perches. The rock on which the resident male was perched apparently allowed a panoramic view of the puddle area, making it an important observation point at that particular site.

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CTENOPHRYNE GEAYI (Brow Egg Frog). **BEHAVIOR.** Defensive behavior is common in many species of amphibians and can evolve stereotyped postures (Duellman and Trueb 1994. Biology of Amphibians. Johns Hopkins Univ. Press. 670 pp.). On 29 and 30 April 2004, two adult *Ctenophryne geayi* were captured in pitfall traps in the Reserva Florestal Adolpho Ducke (02°55'S, 59°59'W), Manaus County, central Amazonia, Brazil. While being manipulated for photographs, we observed three different defensive postures in *C. geayi*. During the daylight one individual (female, SVL 52 mm) assumed the following posture: crouched with the chin near the ground, eyes closed, limbs held tightly against the slightly arched body, and immobile. The other female (SVL 47.5 mm), manipulated during the night, exhibited a defensive posture of a fully inflated body with head down, forelimbs extended parallel to the body, and an elevation of the posterior part of the body, displaying a bright black color on the posterior and ventral surface of the thighs. The ventral surface of *C. geayi* is black with irregular white or cream spots. A third defensive posture (legs stretched backwards in a stiff-legged posture), described by Schlüter and Salas (1991. Stuttgarter Beitr. Naturk., Ser. A, 458:1–17), also was observed in the second individual. The first and third postures assumed by *C. geayi* could be associated with the cryptic coloration of the dorsum, thus protecting against visually oriented predators. The second posture, elevating the rear of the body by extending the hindlegs, causes these frogs to appear even larger which may help deter predators.

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DENDROPSOPHUS COLUMBIANUS (NCN). **DISPERSAL**. In Europe there are sometimes rumors of live animals such as spiders or frogs that arrive as stowaways in shipments of fruit or flowers from South America. A package of flowers imported from Colombia to Vienna, Austria, included such a stowaway. On 15 May 2006, I was notified by the owner of a flower shop in Vienna that a recently received shipment of flowers of the genus *Heliconia* contained a live frog. The flowers were wrapped in newspapers from Colombia, and the shop owner reported that the shipment came from Cali, Colombia. The shop owner gave me the frog, which was in good condition. I maintained the frog for a week in captivity and shared photographs via the internet. The frog was identified as *Dendropsophus columbianus* (formerly *Hyla columbiana*) and donated a week later to a local frog breeder who had others of the same species. The geographic distribution of *D. columbianus* is limited to the upper Río Cauca valley and roughly centered on the city of Cali, Colombia (IUCN, Conservation International, and NatureServe. 2006. Global Amphibian Assessment. Downloaded 4 May 2006), although the frog has also been reported from northern Ecuador (Frost 2004. Amphibian Species of the World: an Online Reference. Ver. 3.0 [22 Aug 2004] http://research.amnh.org/herpetology/amphibia/index.html). According to my contacts, this case is not singular: a local frog breeder has

collected three *D. columbianus* in Vienna in the last few years. Species identification verified by Christian Proy.

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ELEUTHERODACTYLUS BUCCINATOR (NCN). **CLUTCH SIZE AND PARENTAL CARE**. *Eleutherodactylus buccinator* is a moderate-sized leptodactylid known from the departments of Madre de Dios and Puno in southeastern Peru, in lowland tropical forest (Rodriguez 1994. Alytes 12:49–63). The species may also occur in Bolivia (Köhler 1999. Bonn. Zool. Monog. 48:69).

On 14 Sept 2004 we found a brooding adult female (SVL 41.0 mm; Fig. 1) *E. buccinator*. The female and eggs were found under leaf litter in the floodplain forest of the Rio Los Amigos Research Center (12°35'10"S, 70°05'26"W WGS 84; 270 m), Departamento Madre de Dios, Peru. The nest contained 43 eggs, each ca. 4 mm in diameter. The egg nest was in a ground depression approximately as large as the frog. We observed the female protecting the eggs and noted the development of eggs (with embryos moving inside the eggs) every day for a week after our initial finding. On 22 Sept we noted that both the female and the eggs had disappeared with no visible trace of predation around the nest. However, it is unlikely that all embryos had hatched at the same time, based on our observations of egg development in other species of *Eleutherodactylus*.

This is the first report of egg nest size and parental attendance in *E. buccinator*. Egg attendance in Eleutherodactlyinae frogs is performed by the male only (*E. coqui*, Townsend 1986. Behav. Ecol. Sociobiol. 19:187–195), the female only (*E. cundalli*, Diesel et al. 1995. Copeia 1995:354-360), or by both genders (*E. johnstonei*, Bourne 1998. Behav. Ecol. 9:1–7) depending on the species. Our finding excludes male-only egg attendance as the form of parental care in *E. buccinator*.

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FIG. 1. Female *Eleutherodactylus buccinator* attending terrestrial eggs.

ELEUTHERODACTYLUS COQUI (Puerto Rican Coqui). **ENDOPARASITES.***Eleutherodactylus coqui* is native to Puerto Rico and has colonized Culebra (Joglar and Rios-Lopez 1998. Herpetol. Rev. 10:101), Dominican Republic (Joglar and Rios-Lopez 1998. Herpetol. Rev. 29:107), Florida (Meshaka et al. 2004. The Exotic Amphibians and Reptiles of Florida. Krieger Publ. Co., Malabar, Florida, 155 pp.), U.S. Virgin Islands (Thomas 1966. Quart. J. Fla. Acad. Sci. 28:375-391), Vieques (Joglar 1998. Los Coquîes de Puerto Rico: su Historia Natural y Conservación. Editorial de la Universidad de Puerto Rico, San Juan, 232 pp.), and the Hawaiian Islands (Kraus et al. 1999. Herpetol. Rev. 30:21-25). *Eleutherodactylus coqui* arrived in Hawaii in potted plants from the Caribbean or Florida in the late-1980s or early 1990s (Kraus et al. 1999. Herp. Rev. 30:21-25; Kraus and Campbell 2002. Biol. Inv. 4:327-332). There are currently no reports of helminths from Hawaiian *E. coqui*, but there are four reports from Puerto Rico: *Aplectana* sp., *Poekilostrongylus puertoricensis* (Schmidt and Whittaker 1975. Parasitology 70:287-294), *Oswaldocruzia lenteixeirai* (Moravec and Kaiser 1995. Carib. J. Sci. 31:252-268), and *Parapharyngodon garciae* (Dyer et al. 1995. Trans. Illinois State Academy Sci., 88:39-41). The purpose of this note is to report helminths from *E. coqui* from Hawaii.

Five hundred twenty *E. coqui* (mean SVL 26.1 mm ± 4.4 SD, range: 8-39) were collected between Dec 2000 and Sept 2005. Thirty-four were collected off Huina Road, 2 km W of Hwy 11, Puna District, (19°35'N, 155°05'W) Hawaii, Hawaii. The remainder were collected at Lava Tree State Monument, Puna District, (19°29'N, 154°54'W) Hawaii, Hawaii. Frogs were fixed in 10% formalin and preserved in 70% ethanol and are deposited at the Museum of Zoology, University of Michigan (UMZ), Ann Arbor, Michigan and the Bernice P. Bishop Museum, Herpetology Collection, (BPBM), Honolulu, Hawaii.

A mid-ventral incision was made in the abdominal wall and the digestive tract removed and examined for helminths. The body cavity was also examined for helminths. Nematodes were cleared in a drop of concentrated glycerol and identified. Trematodes were regressively stained in hematoxylin, mounted in Canada balsam and identified. One species of cosmoceroid nematode (n = 296, prevalence: number infected/number examined x 100 = 57 %; mean intensity; mean number helminths per infected frog = 5.0 ± 7.2; range: 1-66) was found in the intestine. Cysts containing larvae of the nematode *Physocephalus* sp. were found embedded in the stomach wall: prevalence: 1.0%, mean intensity: 15.0 ± 21.4: range 2-47. The trematode, *Mesocoelium monas*, was found in the intestine: prevalence: 0.4%; mean intensity: 1.0. Helminths were deposited in the United States National Parasite Collection, USNPC, Beltsville, Maryland and the Bishop Museum, BPBM, Honolulu, Hawaii as: *Cosmocerca* sp. (USNPC 97601, BPBM H142); *Physocephalus* sp. (USNPC 97602); *Mesocoelium monas* (USNPC 97600).

Cosmocercoid nematodes are identified to genus by the morphology of males, i.e., presence of plectanes, rosette papillae, or simple papillae. Our sample of cosmocercoids consisted on 294

females and 2 males; based on the presence of plectanes we have assigned them to *Cosmocerca*. Unfortunately, the post cloacal portion of the body was missing in both of the males, thus it was not possible to assign a species to our *Cosmocerca*. *Eleutherodactylus coqui* represents a new host record for each of the helminth species found in this study, *Cosmocerca* sp. *Physocephalus* sp. (larvae), and *M. monas*.

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ELEUTHERODACTYLUS DANAE (NCN). **REPRODUCTION**. In tropical frogs, reproductive variations in altitudinal gradients have not been documented. Studies of ectotherms found that females are larger and have bigger eggs in colder zones than in warmer zones. These variations are influenced by environmental characteristics, which are correlated with latitudinal variations. For this reason, it is not surprising to find the same responses to an increase in altitude, given its correspondence with environmental characteristics (Stevens 1992. Am. Nat. 140:893–911).

Here we report variations in body size, and number and size of eggs in *Eleutherodactylus danae*. This study took place in a mountain cloud forest (1240–2040 m) in Cosñipata Valley, Department of Cuzco, Peru. Between January and March 1999, we collected 5 reproductive females at each of the 3 study locations at different altitudes: Radiochayoc (13°02'S, 71°31'W, 1240 m elev.), San Pedro (13°03'S, 71°32'W, 1480 m elev.) and Suecia (13°02'S, 71°34'W, 2040 m elev.). Female SVL was measured to the nearest 0.01mm. In the laboratory we measured egg size and counted the number of eggs with a millimetric microscope. To measure the reproductive effort, body and egg mass and volume were measured using the Archimedes principle of water displacement. The difference between egg mass and female body volume represents female energy investment in the production of eggs.

We found that female body size and the size of eggs they lay are larger at higher altitudes (Table 1), showing an association between both variables (0.6634, $P < 0.01$). Furthermore, we found that the number of eggs produced decreases at higher altitudes (Table 1), observing that there is a negative correlation between the number of eggs and their diameter (-0.8916, $P < 0.001$). On the other hand, neither female body volume nor egg mass volume were different among the 3 locations. Although our observations suggest that the reproductive effort would decrease at higher altitudes. The increase in body size of females *E. danae* along its altitudinal range would be related to the decrease of temperature at higher altitudes (=5.5°C), while precipitation does not present any influence due to the amount of rain in the altitudinal range of the species, which is more than 400 cm (450 cm at 201 m elev. and 540 cm at 982 m elev., data taken at Cosñipata Valley, PROMANU project).

Studies have shown that frog species, living in high latitudes and cold zones when females are bigger, lay fewer and bigger eggs (Berven 1982. Evolution 36:962–983; Pettus and Angleton 1967. Evolution 21:500–507; this study). Studies among turtles, snakes, lizards, and frogs—including this study—found a correlation between female body size and egg size. If this is a phenotypic or genotypic trait it will have implications in the conservation of *Eleutherodactylus*, the genus that accounts for the majority of frog diversity.

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ELEUTHERODACTYLUS RANOIDES (NCN). **DISTRIBUTION.** Many amphibian populations have been severely threatened by habitat destruction (Ron et al. 2003. J. Herpetol. 37:116–126). In addition, several populations are threatened by unknown agents even in unaltered habitats (Young et al. Cons. Biol. 15:1213–1223). Species that inhabit riparian habitats seem to be the most affected (Lips et al. 2003. Cons. Biol. 17:1078–1088). The *Eleutherodactylus "rugulosus"* species group is one of the best examples. There are eight species in this group in Costa Rica (Savage 2002. The Amphibians and Reptiles of Costa Rica. Univ. Chicago Press, Chicago. 934 pp.). In recent years, the only record of any of these was one population of *E. ranoides* inhabiting the Río Murciélago in Península de Santa Elena (Puschendorf et al. 2005. Herpetol. Rev. 36:53). This finding was based on previous observations of Sasa and Solórzano (1995. Herpetol. Nat. Hist. 3:113–126).

On 25 Jan 2005, we confirmed the continued presence of *E. ranoides* in the Río Murciélago. This was early in the dry season and the habitat was somewhat dry and the water level in the river

TABLE 1. Comparison of body size, egg size, and number of *Eleutherodactylus danae*, mean (± SE, range) at three study locations at different elevations using Kruskal–Wallis Test.

Variables	N	Radiochayoc (1240 m)	San Pedro (1480 m)	Suecia (2040 m)	H	P< 0.1
SVL (mm)	5	45.02 ± 2.32, 41.3–47.3	46.56 ± 1.41, 44.5–48.2	48.34 ± 1.39, 46.4–49.7	6.6506	0.036
Egg size (mm)	5	2.3 ± 0.41, 2.0–3.0	2.75 ± 0.31, 2.5–3.0	2.89 ± 0.23, 2.5–3.2	5.5317	0.0629
Egg number	5	35.4 ± 3.88, 32–40	32.6 ± 2.57, 30–35	31 ± 3.57, 28–34	4.8051	0.0905

was low. A total of 41 individuals were counted on rocks and under boulders in the stream (10º54'10"N, 85º44'48"W) between 1900–2100 h along a transect of 300 m. Water temperature was 28ºC. One specimen was collected.

On 26 Jan 2005, we visited two additional sites. The first one was the Río Potrero Grande. This is a river with many tributaries and a large volume of water during the rainy season. One frog was observed and collected (10º52'51"N, 85º43'07"W) between 1930–2030 h. In addition, we found 2 individuals between 1800–1915 h in the Quebrada La Danta (10º52'52"N, 85º43'04"W), a tributary of the Río Potrero Grande. It had a slow and continuous flow of water with a high water temperature (28ºC). One specimen was collected.

The same day we visited the Río La Calera, a slow flowing river. We found 11 individuals (10º52'54"N, 85º40'53"W) between 2245–2315 h. Water temperature was 28ºC. One specimen was collected. All specimens are deposited at the Museum of Zoology, Universidad de Costa Rica.

The sites where *E. ranoides* was found were always slow flowing, rocky, watercourses with high water temperatures during the dry season in dry forest. The existence of some unexplored watercourses in the Península de Santa Elena, which share the same characteristics, may represent new records for *E. ranoides* in Costa Rica.

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ELEUTHERODACTYLUS STEJNEGERIANUS (Stejneger's Robber Frog). **PREDATION.** *Eleutherodactylus stejnegerianus* is a small, generally diurnal, leptodactylid frog common in the leaf litter of the humid lowlands and premontane Pacific slopes of western Panama and Costa Rica. In Costa Rica it occurs on the Meseta Central Occidental, in gallery forests in the subhumid northwest, and peripherally on the Atlantic lowlands near Laguna Arenal, 3–1330 m elev. (Frost 2005. Amphibian species of the world 3.0, http://research.amnh.org/herpetology/amphibia/index.php; Savage 2002. The Amphibians and Reptiles of Costa Rica: a Herpetofauna between Two Continents, Between Two Seas, Univ. Chicago Press, 954 pp; Scott 1976. Biotropica 8:41–58). Scott (1976, *op. cit.*) reported *E. stejnegerianus* (as *E. bransfordii*) as the most common amphibian species in the forest litter at study sites in the Osa Peninsula and San Vito, Puntarenas Province, Costa Rica.

Predation of *E. stejnegerianus* by the wandering spider, *Cupiennius coccineus* (Ctenidae), was observed on two separate occasions. On the evening of 8 Nov 2004 (~1830 h), within the La Merced National Wildlife Refuge, Puntarenas Province, Costa Rica (9°11'14"N, 83°45'43"W; ca. 60 m elev.) a *C. coccineus* (8 mm carapace length [CL]) was observed grasping a partially consumed *E. stejnegerianus* adult (~15 mm SUL). On the evening of 10 Nov 2004 (~1915 h), in the Oro Verde Biological Reserve, Puntarenas Province, Costa Rica (9°12'40"N, 83°1545'48"W; ca. 300 m elev.) another *C. coccineus* (8 mm CL) was observed grasping a partially consumed *E. stejnegerianus* adult (~15 mm SUL).

During both observations, the spider was grasping the frog with its chelicerae, positioning the frog under its body as it actively chewed on exposed frog viscera. Both frog/spider pairs were photographed, and submitted to the herpetological collection of the Los Angeles County Museum of Natural History (LACM-PC 1428-29).

To our knowledge these are the first reports of a ctenid spider preying on *E. stejnegerianus* in a natural setting. A variety of spider species are known to prey on anurans in tropical areas (Hayes 1983. Biotropica 15:74–76; McCormick and Polis 1982. Biol. Rev. 57:29–58). Based on the abundance of *E. stejnegerianus* (*sensu lato*, Scott 1976, *op. cit.*) and the variety and commonness of spider taxa in leaf litter, we agree with Hayes (1983, *op. cit.*) that spiders likely are important predators of tropical leaf litter anurans.

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HELEIOPORUS AUSTRALIACUS (Giant Burrowing Frog). **PREDATION**. A series of predation events of adult *Heleioporus australiacus* were observed during a radio-telemetry study of a population in southeastern Australia. The study was undertaken between 1 Feb 2002 and 30 June 2004 (Penman et al. 2006. Wildlife Res. 33:35–40). During this time 33 individuals (19 male; 13 female; 1 sub-adult male) were radio-tracked for periods of 5–599 days, of which five males and one female were lost to predation. In four cases the predator was located and identified through the use of the telemetry signal. One male frog was eaten by a Laughing Kookaburra (*Dacelo novaeguinaea*). Three others (two males; one female) were eaten by a Red-bellied Black Snake (*Pseudichis porphyriacus*). The other two male frogs were also eaten by snakes that were observed briefly but were not positively identified. They were either *P. porphyriacus* or the Tiger Snake (*Notechis scutatus*). Four of the six frogs were taken by predators at their breeding sites after having migrated from their non-breeding activity areas. Furthermore, while another frog was last observed burrowed ca. 30 m from a breeding site, its recent movement and the presence of rain suggested that it was migrating to the breeding site and we

believe it was also predated at the breeding site. The final frog (taken by an unidentified snake) was predated 100 m from the breeding site and was consumed the night it was released. Hence this may not represent a "natural" predation event.

One of the *P. porphyriacus* was killed shortly after eating a telemetered frog and an examination found it had eaten two additional *H. australiacus* (one male: one female) that had been marked with PIT tags at a breeding site. We cannot be sure that the snake found these frogs at the breeding site, but it seems likely.

Rates of predation in the study were higher than expected. When distressed *H. australiacus* produces a sticky white substance from its back that was thought to be toxic to predators (Lemckert 2001. Nat. Aust. 26–33). However this substance is not a deterrent to all predators with one snake consuming three *H. australiacus* within a week.

We believe that all natural predation occurred immediately around the breeding sites, suggesting that these sites represent the highest mortality risk for this species. In this study, individuals spent less than 3% of the time in the breeding habitat with many individuals not accessing the breeding site every year (Penman 2005. PhD Thesis, Univ. Newcastle). It is possible that this represents a behavioral adaptation to the high predation risk. However, there is limited information on the breeding behavior or predation of *H. australiacus* in other areas to determine whether this is the typical situation.

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HYLA LOQUAX (Swamp Tree Frog). **PREDATION**. Wandering spiders (*Cupiennius;* Araneae, Ctenidae) are known to prey upon a variety of insects and small vertebrates (Toledo 2005. Herpetol. Rev. 36:395–400). Herein we report on invertebrate predation of an adult male *H. loquax* at the Cantarana Swamp, Organization of Tropical Field Studies La Selva Field Station. On the evening of 26 June 2002, between 2100–2200 h we observed a small chorus of male *H. loquax* calling from emergent vegetation and several amplectic pairs ca. 0.3–0.61 m above the water. We observed a wandering spider (*Cupiennius* sp.) perched on vegetation, digesting an adult male ca. 1 m above the water (Fig. 1). *Hyla loquax* has not been reported previously as a source of prey for spiders or any other invertebrate.

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HYPSIBOAS FABER (Blacksmith Treefrog). **PREDATION.** Predators are a major source of mortality of tadpoles (Alford 1999. *In* McDiarmid and Altig [eds.], Tadpoles: The Biology of Anuran Larvae, pp. 240–278. Univ. Chicago Press, Chicago). The hylid frog *Hypsiboas faber* occurs from eastern to southern Brazil, southeastern Paraguay, and northern Argentina (Frost 2004. Amphibian Species of the World: an Online Reference. Ver. 3.0, 22 Aug 2004). The natural history of *H. faber* is fairly well known (Martins and Haddad 1988. Amphibia-Reptilia. 9:49–60; Martins 1993. Amphibia-Reptilia 14:441–421; Martins et al. 1993. Amphibia-Reptilia 14:307–309; Martins et al. 1998. Amphibia-Reptilia 19:65–73). Important predators include frogs, snakes, and water-bugs (Kluge 1981. Misc. Publ. Mus. Zool. Univ. Michigan 160:1–170; Martins et al. 1993, *op. cit*.).

During fieldwork in RPPN Estação Vera Cruz, Municipality of Porto Seguro, State of Bahia, Brazil (16º20'S, 39º10'W; 30–60 m elev.) I observed an adult turtle (*Acanthochelis radiolata*), capture and consume *H. faber* tadpoles. To my knowledge, this is the first report of predation on *H. faber* tadpoles by a turtle.

Thanks to C.C. Canedo (Museu Nacional/UFRJ, Brazil) for comments.

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ITAPOTIHYLA LANGSDORFFII (NCN)**. DIURNAL BASKING.** Thermoregulatory behavior can be highly significant in the overall energetics of ectothermic animals (Lillywhite et al. 1973. Ecology 54:375–383) and yet constitute a challenge for amphibians in terms of cutaneous water loss (Tracy and Christian 2005. Physiol. Biochem. Zool. 78:839–846). On 27 February 2006 at ca. 1000 h, we observed a large tree frog, *Itapotihyla langsdorffii* (Anura: Hylidae), attached to a dry cliff face 30 m from the Cachoeira do Salto, Estação Ecológica Juréia-Itatins, municipality of Iguape, São Paulo State, Brazil (24°33'13"S, 47°13'48"W). The rock was facing the sun and warm to the touch; the frog's body (SVL 107 mm after preservation) was completely exposed to solar radiation, flattened with fore and hind limbs tucked along the lateral body surface, head lowered on its forefeet, and thus seemingly forming a seal between the underside of the frog and the rock surface (Fig. 1). Its eyes were shut. The basking site was ca. 10 m from the nearest vegetation (15 m from the nearest forest, *I. langsdorffii*'s natural habitat) and at least 20 m distant from wet rock surfaces. The individual was collected as part of a biological survey and when first seized it voided a substantial volume of clear liquid. Upon dissection, we found that the animal's stomach and upper intestine were empty; the lower intestine contained unidentified debris and a few fragments of arthropods.

Itapotihyla langsdorffii is endemic to the Brazilian Atlantic coastal rain forest (Izecksohn and Carvalho-e-Silva 2001. Anfíbios do Município do Rio de Janeiro. Editora UFRJ, Rio de Janeiro), and we were surprised to encounter this nocturnal mesophyllic species basking on a warm summer morning. Thermoregulatory behavior has been documented in hylids of arid habitats; *Hyla arenicolor*, a North American species, exhibits the same stereotyped posture to conserve water while basking (Snyder et al. 1993 J. Arid Environ. 25:321–329). The Brazilian hylid *Bokermannohyla*



FIG. 1. Basking site (indicated by arrow) for *Itapotihyla langsdorfii* near the Cachoeira do Salto, Estação Ecológica Juréia-Itatins, São Paulo State, Brazil.

alvarengai is commonly found in arid open rocky habitats ("campos rupestres;" Sazima and Bokermann 1977. Rev. Bras. Biol. 37:413–417), and its resting posture appears similar to that we observed in *Itapotihyla*. Also, *B. alvarengai* seems to modify the coloration of its skin in response to temperature and illumination (Tattersall et al. 2006 J. Exp. Biol. 209:1185–1196), an ability that remains to be investigated in *I. langsdorffii*. Tracy and Christian (2005, *op. cit.*) suggested that daytime retreat site selection by frogs might be important for temperature regulation and therefore influences daily energy budgets, allowing them to digest and/or grow more quickly. Basking by *I. langsdorffii* might be related to temperature regulation due to its large size; in addition, its dorsal color pattern closely resembles rock lichens despite its arboreal habit, suggesting that basking on rocks might be a common behavior for this species and the coloration may have adaptive value in predator avoidance under exposed conditions.

The voucher specimen (CFBH 11474) is housed in the Coleção de Anuros Célio F. B. Haddad, Depto. de Zoologia da Universidade Estadual Paulista, campus de Rio Claro.

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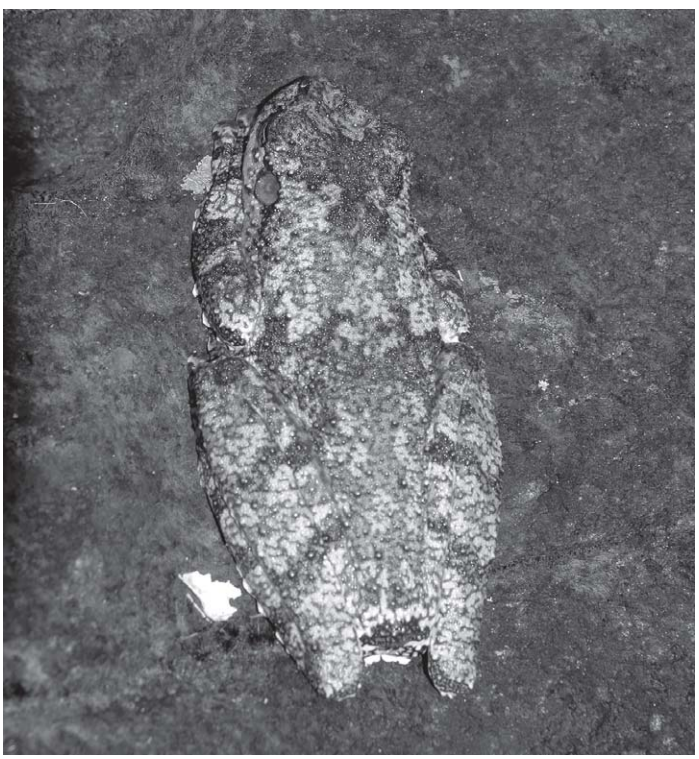


FIG. 2. *Itapotihyla langsdorfii* basking near the Cachoeira do Salto, Estação Ecológica Juréia-Itatins, São Paulo State, Brazil.

LEIOPELMA PAKEKA (Maud Island Frog). **REPRODUCTION.** The leiopelmatid frogs of New Zealand are among the most archaic anuran species in the world. The genus is comprised of three extinct and four extant species, all currently threatened. Despite the attempts at conservation of these species, little is known about their reproductive biology. For two of the four extant species, *L. pakeka* and *L. hamiltoni*, which were recently recognized as separate cryptic species (Bell et al. 1998. J. Royal Soc. New Zealand 28:39–54), there are no published reports of mating in the wild nor have eggs been observed in the wild. All of the current information about reproduction in these species comes from captive individuals (Bell 1978. Herpetologica 34:340–354; Bell 2002. Unpubl. report to NZ Native Frog Recovery Group).

During recent field studies on Maud Island in the Pelorus Sound, New Zealand (41°01'S, 173°53'E WGS 84), three pairs of amplecting frogs were found up trees. The first pair was found in Dec 2005, and two additional pairs were found in Jan 2006. This behavior is surprising for these species, which are thought to be extremely saxicolous and spend the majority of their lives under rock piles. Though all frogs from amplecting pairs were examined, none appeared to be carrying eggs and no eggs were found

in the vicinity of the event. To our knowledge this type of arboreal mating behavior in *Leiopelma* has only been anecdotally reported twice before. In 1972, a NZ Wildlife Service worker took photographs of pairs of frogs in the trees on a rainy night (R. Morris, pers. comm.). In 2004, a pair of frogs in amplexus was captured up a tree in December (Waldman 2004. ARC Conference, Captivity, Reintroduction and Disease Control Technologies for Amphibians, Victoria, Australia, URL: http://frogs.org.au/arc/conference.html). This pair was taken to Canterbury University where the male later died. No eggs were laid.

These sightings provide information on the timing of reproductive events for *L. pakeka* and likely for the closely related *L. hamiltoni*. All events appear to occur later than those recorded in captivity in Wellington, New Zealand (Bell 2002, *op. cit*.). Despite these recent sightings, eggs of *L. pakeka* or *L. hamiltoni* have not been found laid in the wild and much remains unknown about their reproductive biology. Current work is investigating the timing, effects of habitat, behavior, and other aspects of *Leiopelma* reproduction.

We thank S. Madill and A. Frost for assistance in the field. We are grateful for funding from the SSAR Grants-in-Herpetology and the SRARNZ Herpetological Research Award. Department of Conservation permit granted under authority number NM-16664-RES.

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LEPTODACTYLUS OCELLATUS (Rã Manteiga). **DIET**. *Leptodactylus ocellatus* has a broad distribution that includes Brazil, Argentina, Paraguay, and Uruguay (Maneyro et al. 2004. Iheringia 94[1]:57–61). Several reports describe the diet of this species (Gallardo 1964. Anfibios de los Alrededores de Buenos Aires. Buenos Aires, Editorial Universitaria de Buenos Aires; Basso 1990. Monografias Asociación Herpetológica Argentina 1:1–70; França et al. 2004. Stud. Neotrop. Fauna Environ. 39[3]:243–248), which consists of arthropods, mollusks, and amphibians. An adult male *L. ocellatus* (Museu de Ciências e Tecnologia of the Pontifícia Universidade Católica do Rio Grande do Sul [MCP 8865]; SVL 91.8 mm) was collected at 0730 h on 28 Jan 2006, under a rock on the seashore in the State of Santa Catarina (Municipality of Palhoça). The specimen was dissected and two partially digested *Ligia* sp. (beach woodlouse) were found in the stomach. Maneyro et al. (2004, *op. cit*.) cite isopods and amphipods in the diet of *L. ocellatus* from Uruguay. However Maneyro (pers. comm.) informed us that the isopods found in the diet of *L. ocellatus* in Uruguay are a terrestrial species popularly known as woodlouse. This is the first record of *Ligia* sp. in the diet of *L. ocellatus*.

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MEGAELOSIA APUANA (NCN). **PREY**. *Megaelosia apuana* is a recently described giant torrent frog from Pedra Azul, municipality of Domingos Martins, State of Espírito Santo, Brazil (Pombal et al. 2003. J. Herpetol. 37:453–460). Congeners are known to prey on other anurans (Giaretta et al. 1993. J. Herpetol. 27:276–285), but this habit has not been reported for *M. apuana*.

Herein we report a predation attempt by *M. apuana* on *Proceratophrys boiei*. The observation was made on 25 Sept 2005 at 2000 h near the type locality for *M. apuana* in Pedra Azul (20°24'47"S, 41°01'30"W, 1100 m elev.). We observed an adult *M. apuana* (SVL 83 mm) attempting to swallow an adult *P. boiei* (SVL 52 mm). At the moment of the observation, both individuals were in a shallow pond near a stream at the forest edge. The *P. boiei* was being bitten on its cloacal region and had both hind limbs outside of the *M. apuana* mouth. We did not see if the prey was captured on land and brought to the water or if it was captured in the pond. As a defensive behavior the *P. boiei* inflated its body, not allowing the *M. apuana* to finish swallowing it (Napoli 2001. Herpetol. Rev. 32:36–37; Toledo and Zina 2004. Herpetol. Rev. 35:375). After nearly two minutes of observation the *P. boiei* escaped its predator, which stayed motionless for a few moments before it tried to escape.

Both specimens were captured and deposited in the Amphibian Collection Célio F. B. Haddad (CFBH), at Universidade Estadual Paulista, Rio Claro, São Paulo (CFBH 10811, *M. apuana*; CFBH 10812, *P. boiei*).

We thank João L. Gasparini and Charles R. Nunes for help with fieldwork. Célio F.B. Haddad read the manuscript and provided valuable suggestions. The Brazilian National Institute of Natural Environments (IBAMA) issued the collecting permit to J.L. Gasparini (license number 054/05 – IBAMA/RAN, Process number 02001.002792/98-03).

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ODONTOPHRYNUS OCCIDENTALIS (NCN). **BODY TEMPERATURE**. *Odontophrynus occidentalis* inhabits western Argentina from Catamarca to Neuquén and Río Negro, eastward into the Pampa and Sierras de Cordoba (Cei 1980. Amphibians of Argentina. Italian J. Zool., N.S. Monografia 2, 609 pp.). The thermal ecology of this species has not been previously studied. Herein we briefly describe select aspects of the thermal ecology of *O. occidentalis.*

Our study area was located 70 km SE of San Juan City, Argentia on National Route N 141. This area is in the Monte phytogeographic Province (Cabrera 1994. Enciclopedia Argentina de Agricultura y Jardinería, Tomo II, Regiones fitogeograficas Argentinas, Editorial ACME S.A.C.I.). Elevation reaches 749 m. The region is arid with an annual mean temperature of 20°C (mean max 40°C, mean min 16°C). The rains occur mostly in the summer with an annual average of 84 mm.

Thirteen *O. occidentalis* (mean SVL 5.03 cm; SD 1.7 cm) were collected on 16 Dec 2005. The cloacal temperature (TC), soil temperature (TS), and air temperature (TA) were measured with a digital thermometer (Barnant Model 600-1040). TS and TA were

significantly different (t-student, t = -2.5, df = 24, p < 0.01). Mean TC was 20.5°C (SD = 1.6, range = 19.4–24°C, N = 13). TC was positively associated with TS (Spearman, R = 0.6; p < 0.02), and TA (Spearman, R = 0.67; p < 0.02). TC was not significantly different from TS (t-student; t = -0.3, df = 24, p > 0.7) and was significantly different than TA (t-student, t = 2.33, df = 24, p < 0.02). There was no association between TC and SVL (p > 0.91).

These results indicate *O. occidentalis* in this situation is thermopassive, a mechanism where individuals do not need to invest time and energy actively selecting microhabitat for thermoregulation (Labra and Videl. 2003. *In* F. Bozinovic [ed.], Fisiología Ecológica y Evolutiva, pp. 207–224. Ediciones Universidad Católica de Chile. Santiago, Chile). These individuals were in a breeding chorus, when the biggest demand for energy is in calling to attract females, thus this thermopasive mode seems to be the most effective strategy for thermoregulation.

We thank Alejandro Laspiur for help with fieldwork.

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OSTEOCEPHALUS YASUNI (NCN) and ***OSTEOCEPHALUS PLANICEPS*** (NCN). **TERRESTRIAL BEHAVIOR**. Frogs of the genus *Osteocephalus* are largely arboreal and nocturnal and occur throughout the Amazon Basin and along the eastern Andean slope. There are 18 species recognized, at least 8 of which are known from Yasuní Research Station (YRS) (0°40'S, 76°24'W) and Tiputini Biodiversity Station (TBS) (0°37'S, 76°8'W) in the Province of Orellana, Ecuador. Information on the natural history of most *Osteocephalus* species is scarce, although species exhibit a variety of reproductive strategies including the use of streams, seasonally flooded pools, and phytotelms for amplexus and egg deposition.

Osteocephalus yasuni and *O. planiceps* are common species at YRS and TBS. Eggs and tadpoles are undescribed, but it is suspected that *O. planiceps* is a phytotelm breeder, because males often call from bromeliads in the canopy (Ron 2006. http://www.bio.utexas.edu/grad/ecuador/web/yasuni/esp/anfyas.htm), and that *O. yasuni* uses seasonally flooded ponds for breeding, because males form large choruses around pools after heavy rains (Ron and Pramuk 1999. Herpetologica 55:433–446). Like other *Osteocephalus* species, *O. yasuni*, and *O. planiceps* are nocturnal and arboreal (Ron 2006, *op. cit*.) although, *O. yasuni* choruses may occasionally continue calling into the day following their nocturnal assembly and pairs in amplexus have been witnessed during the morning hours (pers. obs.).

Here we report an unusual behavior: during 2 field seasons in the Ecuadorian Amazon, we observed *O. planiceps* and *O. yasuni* females sleeping in the litter during the day. The first individual, a small adult female *O. yasuni* (SVL 48.9 mm, mass 6.97 g), was found at YRS on 24 May 2005 (ca. 1030 h) in a 5 × 5 m forest floor quadrat that was sampled for leaf litter herpetofauna. The frog was buried under the leaf litter and completely concealed from view. Despite disturbance, it remained motionless until it was picked up by hand, at which point it attempted to escape. During our second field season, we encountered three additional *O. yasuni* and two *O. planiceps* sleeping in the litter at TBS. On 27 March 2006, we found an adult female *O. planiceps* (SVL 56.5 mm, 9.74 g) at ca. 1030 h. On 28 March at ca. 830 h, we encountered a second *O. planiceps* (SVL 59.5 mm, 12.05 g). We found two *O. yasuni* on 29 March: the first (SVL 57.0 mm, 12.14 g) at ca. 1030 h and the second (SVL 59.0 mm, 14.6 g) at ca. 1500 h. All were found during searches of 5 × 5 m forest floor plots, and they were buried under the litter, just as the first individual found at YRS in 2005. On 31 March at ca. 1000 h, while searching an 8 × 8 m quadrat we encountered a third female *O. yasuni* (SVL 59.2 mm, 11.28 g) sleeping on the ground. Five of the individuals were photographed and released.

All six females were found in primary, terra firme forest within a week following a heavy rain. At TBS, the rain stimulated a very large chorus of *O. yasuni* males. However, the females were found a kilometer or more away from where the males were calling and they were completely inactive when found. Because the females were so well buried under the litter, the possibility that they fell from the trees seems unlikely. The leaf litter habitat may represent an important and previously unrecognized part of the life cycle of adult female *O. planiceps* and *O. yasuni*. We suggest that this behavior may be typical and that *O. planiceps* and *O. yasuni* may only exhibit this behavior in the breeding season, though this warrants further investigation.

We thank our field assistants at YRS and TBS, especially A. Enomenga and I. Nenqemo, as well as K-H. Jungfer and D. Cisneros-Heredia for verifying species identification. These observations were made during dissertation fieldwork of JLD, which was supported by grants from the Conservation, Food and Health Foundation, and the Louisiana Governor's Office of Environmental Education. Research was conducted under permit issued by the Ecuadorian Ministerio del Ambiente (004-IC-FA-PNY-RSO).

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PELOBATES CULTRIPES (Iberian Spadefoot Toad). **MAXIMUM SIZE**. *Pelobates cultripes* occurs in southern France and throughout most of the Iberian Peninsula (Spain and Portugal) (Lizana et al. 1994. J. Herpetol. 28:19–27). De La Vega (1988. Anfibios y Reptiles de la Provincia de Huelva, Ertisa [Ed.]. Huelva, Spain. 238 pp.) reported maximum size as 89 mm SVL. Talavera (1990. Evolución de Pelobatidos y Peloditidos [Amphibia: Anura]: Morfología y Desarrollo del Sistema Esquelético. Unpubl. Ph. D. Thesis, Universidad Complutense de Madrid, Spain.) reported maximum size for females from Madrid, Spain as 101 mm SVL. The record size reported for females is 113 mm SVL (Salvador and García-París 2001. Anfibios Españoles. Identificación, Historia Natural y Distribución. Canseco [Ed.], Talavera de la Reina. 269 pp.). Herein, we report a new maximum size for this species.

On 21 Oct 2002, between 1900–2200 h, we captured three gravid adult female *P. cultripes* that surpassed the previous record length (119 mm SVL, 124 g; 120 mm SVL, 145 g; 125 mm SVL, 168 g) in a temporary pond near Aznalcóllar (Seville Province, Spain, 37º31'N, 6º16'W; 130 m elev.). Each individual was measured in

the field and then carefully released into the pond where they were captured. The terminal phalange of the third digit of the right forefoot was removed for a skeletochronological study to estimate the age of each individual based on successive resting lines in the bone (Hemelaar 1998. J. Herpetol. 22:369–388). The biggest female was five years old, but in the remaining individuals age determination was not possible.

Recently reported geographic variation in body size of *P. cultripes* (Marangoni 2006. Variación clinal en el tamaño del cuerpo a escala microgeográfica en dos especies de anuros [*Pelobates cultripes* y *Bufo calamita*]. Ph.D. Thesis. Univerdidad de Sevilla, Spain), suggests that the differences in body size among different studies could be due to latitudinal variation in body size.

We thank the Consejería de Medio Ambiente de la Junta de Andalucía and the Reserva Biológica de Doñana, for providing the corresponding permits and facilities.

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PELOBATES CULTRIPES (Iberian Spadefoot Toad). **PREDATION.** *Pelobates cultripes* occurs in southern France and throughout most of the Iberian Peninsula (Spain and Portugal) (Lizana et al. 1994. J. Herpetol. 28:19–27). In southern Spain, *P. cultripes* breed in a mosaic of small temporary ponds and streams that generally fill with the first autumnal rains in October–November, and dry at the end of May (Tejedo and Reques 2002. *In* Pleguezuelos et al. [eds.], Atlas y Libro Rojo de los Anfibios y Reptiles de España, pp. 94–96. Dirección General de Conservación de la Naturaleza, Madrid). Birds, mammals, and reptiles have been reported as important predators of juvenile and adult *P. cultripes* (Salvador and García-París 2001. Anfibios Españoles. Identificación, Historia Natural y Distribución. Canseco [Ed.], Talavera de la Reina. 269 pp.; Díaz-Paniagua et al. 2005. Los Anfibios de Doñana. Organismo Autónomo Parques Nacionales, Ministerio de Medio Ambiente [Ed.], 181 pp. and references therein). In addition, the snake *Natrix maura* may also be an important predator of this species (Santos 2004. *In* Carrascal and Salvador [eds.], Enciclopedia Virtual de los Vertebrados Españoles. Museo Nacional de Ciencias Naturales, Madrid. http://www.vertebradosibericos.org).



FIG. 1. Ventral side photo of *Pelobates cultripes*, showing three injuries caused by *Natrix maura*. The photo was taken 12 h after the capture.

On 5 Nov 2001 at 1920 h, we observed a gravid female *P. cultripes* being preyed upon by *N. maura* in a temporary pond near Aznalcóllar (Seville Province, Spain, 37º31'N, 6º16'W; 130 m elev.). The middle anterior part of the toad's body was inside the snake's mouth, and only its stomach and legs were visible. The snake was captured and the toad (SVL 79.5 mm, head width 29.5 mm, right hind leg length 92 mm, mass 41.5 g) was photographed and released alive. Injuries were observed on the body of the toad; three on the ventral side (with two apparent bite marks: Fig. 1), and two on the head immediately behind the eyes. The toad died ca. 30 min after capture. We estimated the age of the female (five years old) by skeletochronology (Hemelaar 1998. J. Herpetol. 22:369–388).

The *P. cultripes* (ID AZN2) was deposited in the Estación Biológica de Doñana (CSIC), Seville Province, Spain. We thank the Consejería de Medio Ambiente de la Junta de Andalucía and the Reserva Biológica de Doñana, for providing the corresponding permits and facilities.

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PHYSALAEMUS PUSTULOSUS (Tungara Frog). **DISPERSAL**. *Physalaemus pustulosus* is widely distributed along the isthmus of Central America and northern South America through northwestern Venezuela (Ryan 1985. The Tungara Frog: A Study in Sexual Selection and Communication. Univ. Chicago Press, Chicago), and occurs as two disjunct populations on the northern and southern Pacific Coast of Costa Rica, with an approximately 165 km gap between them (N. J. Scott, pers. comm.; Savage 2002. The Amphibians and Reptiles and Costa Rica: a Herpetofauna Between Two Continents, Between Two Seas. Univ. Chicago Press, Chicago). The northern population occurs in the Tropical Dry Forest of Guanacaste Province and the southern population occurs in the Tropical Moist Forest of the Golfo Dulce region (Holdridge 1967. Life Zone Ecology. Tropical Science Center, San Jose, Costa Rica). The northern population is contiguous with the species' range in Nicaragua, and in the south the population is continuous into Panama and east into South America (Ryan 1985, *op. cit*.). *Physalaemus pustulosus* is a small, conspicuous species as males vocalize loudly in choruses and breed in altered and disturbed habitats including roadside ditches, puddles, ponds, and flooded agricultural fields (Rand 1983. *In* Janzen [ed.], Costa Rica Natural History, pp. 333–335. Univ. Chicago Press; Savage 2002, *op. cit*.).

The apparent Costa Rican gap in distribution has been surveyed periodically since 1964 (Savage and Scott, unpubl.; Bolaños and Chavez, unpubl.) and this species had not been recorded from 1964–2002. I surveyed the south-central Pacific Coast of Costa Rica from Dec 2000–April 2002 from Quepos to Palmar Norte,

and east to San Isidro de El General as part of a herpetological inventory. Herein I report on the expansion of the range of *P. pustulosus* into this gap along the Pacific Coast and the Valle General.

On 12 Jan 2002 I found a small chorus of ca. 5 *P. pustulosus* males calling from a flooded rice field adjacent to the Coastal Highway near Coronado (08º57'99"N, 83º26'60"W; 35 m elev.) after heavy rains. The rice field was ca. 2 ha in size, and water depth ranged from 2 cm at the shore to 0.5 m towards the center of the field, and less than 20 m from the Coastal Highway. This population is ~ 45 km N of the Golfo Dulce populations and is across the large Río Terraba. Six days later on 18 Jan 2002 I found 3 puddles along the Pan American Highway in San Isidro de El General (09º31'97"N, 84º46'51"W; 900 m elev.) with 1–3 male *P. pustulosus* calling. The first puddle was 500 m, the second 1.5 km, and the third 4 km south of San Isidro on the southbound side of the Pan American Highway. There is little forest left in the valley but it is in the Premontane Moist forest. I had surveyed these areas bimonthly from Dec 2000–April 2002 and it was not until Jan 2002 that I encountered this species.

Two major highways, the Pan American Highway and the Coastal Highway, connect this region to the Golfo Dulce and Panama. I suggest that *P. pustulosus* is expanding its range northward in southwestern Costa Rica along trucking routes, possibly as stowaways on commercial trucks shipping agricultural or forest products from the Golfo Dulce region or Panama where this species is known to occur. Savage (2002, *op. cit*.) also reports a "new" population in Siquirres in the Limón Province providing evidence that this species is also invading on the Caribbean versant. Future monitoring along the Coastal Highway north to Quepos may validate my hypothesis that *P. pustulosus* is moving north along trucking routes. It is possible that genetic markers could be used to identify where these "new" populations of *P. pustulosus* originated and the speed at which the species is expanding its range.

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PROCERATOPHRYS AVELINOI (Cow Frog). **ADVERTISEMENT CALL**. *Proceratophrys avelinoi* was recently described (Barrio and Barrio 1993. Amphibia-Reptilia 14:13–18) and its advertisement call was described by Kwet and Baldo (2003. Amphibia-Reptilia 24:104–107), who classified *P. avelinoi* as rare. Ecological information on advertisement call and reproductive site and seasonality of this species remain little known. Herein I present information on advertisement call and reproduction.

Surveys of calling male *P. avelinoi* were conducted from Sept 2003 to Dec 2004 in Brazil, Paraná state, municipality of São João do Triunfo (25º34'18"S; 50º05'56"W), 780 m elev.. Sites were surveyed two days each month in two fountainheads in Araucaria Forest and two in plantation fields; all sites were ca. 10 m^2. During each visit information was collected on seasonal, daily, and spatial patterns of vocalization and reproduction.

In the Araucaria Forest, *P. avelinoi* could be heard calling all day between September and February. In plantation fields there was only one record of a single male in October 2003. No more than six individuals were heard in the same fountainhead (1–6, N = 36). Individuals were recorded and collected on 25 Oct 2003 by A M X Lima and placed at the Instituto de Pesquisas em Cananéia, Campinas, state of São Paulo (MIPEC 0001; MIPEC 0002). For individuals recorded (N = 7) on 25–26 Oct 2003 (air temp 11–24ºC; water temp 16.5–22ºC), I observed differences in call duration (868–1184 ms at this locality vs. 220–754 ms reported by Kwet and Baldo 2003, *op. cit*.), although there were no differences between SVL, pulse rate, number of pulses/call, or dominant frequency. Distance between calling males was 52–128 cm (N = 26) and no contact interactions were observed. Call site selection was consistent (N = 63), always in the water, and often under or above dead leaves. A mark-recapture effort (toe clipping) was conducted in Sept (N = 11) and Oct (N = 8) 2004, although no individuals were recaptured. Tadpoles were found from October–February in the forest.

The patterns of vocalization, distribution, and tadpole occurrence suggest the species has low density, open populations, with a variable length of advertisement call, and an extended reproductive season (six months) coinciding with the wet season. Although *P. avelinoi* can be found in fountainheads in open areas, reproduction is sensitive to deforestation.

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PROCERATOPHRYS MELANOPOGON (NCN). **REPRODUCTION.** *Proceratophrys melanopogon* is a little known species of ceratophryine leptodactylid that inhabits the forest floor leaf litter in Atlantic Rainforest areas of southeastern Brazil (Izecksohn et al. 1998. Rev. Univ. Rural, Sér. Ciênc. Vida 20:37–54). Males of this species vocalize near small bodies of water, and tadpoles develop in lentic water at the edges of permanent streams (Izecksohn and Peixoto 1996. Rev. Univ. Rural, Sér. Ciênc. Vida 18:105–107). Little else is known of the biology of this species, which was removed from the synonymy of the morphologically similar *P. appendiculata* (Heyer et al. 1990. Arq. Zool., São Paulo 31:318). On 16 Nov 2005, at 1845 h, a pair of *P. melanopogon* in were collected in axillary amplexus in an area of montane rainforest (22º21'38.5"S, 44º34'14.6"W; 1360 m elev.) located within the Área de Preservação Ambiental (APA) da Serra da Mantiqueira, in Resende municipality, state of Rio de Janeiro, Brazil. The pair (female: SVL 47.6 mm, preserved mass 11.7 g; male: SVL 34.7 mm, preserved mass 4.4 g) was kept in a plastic bag containing a small amount of water and some leaves. The following morning, the female had laid 664 eggs. Upon dissecting the female, we found an additional 78 eggs, indicating that all eggs were not laid at spawning. The frogs were deposited in the Museu Nacional, Rio de Janeiro (MNRJ 40711, male; MNRJ 40712, female).

The total number of eggs (742) reported for the female *P. melanopogon* is within the range (729–946; N = 3) reported by

Boquimpani-Freitas et al. (2002. J. Herpetol. 36:318–322) for the closely-related species *P. appendiculata*. We know of no other published information on fecundity for members of the genus *Proceratophrys*.

We thank Eugênio Izecksohn and Gustavo M. Prado for the identification of the frogs. The Center for Biodiversity Conservation (CCB) of the Conservation International do Brasil and the Conselho Nacional de Desenvolvimento Científico e Tecnológico – CNPq provided financial support for fieldwork at the APA da Serra da Mantiqueira.

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PSEUDACRIS REGILLA (Pacific Treefrog). **DEATH FEIGNING**. Anurans commonly employ death feigning (Edmunds 1974. Defense in Animals. Longman, New York, 357 pp.; Pough et al. 1998. Herpetology. Prentice-Hall, Inc. Upper Saddle River, New Jersey. 579 pp.) as an anti-predatory strategy (Zamprogno et al. 1998. Herpetol. Rev. 29:96–97; McCallum et al. 2003. Herpetol. Rev. 34:54–55; Carneiro and Rocha 2005. Herpetol. Rev. 36:301), although this behavior has not been documented in *Pseudacris regilla*. Herein, I report two instances of death feigning in *P. regilla*, a hylid common along the Pacific Coast of USA.

At 1515 h on 7 Aug 2006, an adult *P. regilla* (SVL 38.5 mm, 5 g) was captured underneath a metal grate (34°25'11"N, 119°39'57"W, WGS 84; 233 m elev.) at the Santa Barbara Zoological Gardens, Santa Barbara Co., California. While being handled, the frog abruptly tucked all four limbs in close to the abdomen while lying on its dorsum. I placed the frog onto a table, and the frog remained motionless in this position for ca. 20 seconds. I then turned the frog right side up so that it was sitting on its ventral side. It quickly became alert and active, and attempted to flee. The frog was taken back to the site of capture and released.

At 0900 h on 13 Aug 2006, I captured a smaller adult *P. regilla* (SVL 34.5 mm, 4 g) in the same location. Upon handling, this individual exhibited death-feigning behavior similar to the individual captured six days prior. With all limbs pulled tightly into and underneath the abdomen and its snout tucked tightly into its body, the frog became very rigid. I placed the frog on a table and it remained on its dorsum for ca. 5 min while I photographed it. Afterwards, I turned the frog over onto its abdomen. The frog continued to feign death, remaining motionless with the snout terminus tilted downwards into the body and all four limbs tucked tightly underneath for ca. 20 sec. The frog then raised its head, became alert, and attempted to escape. This individual was also released at the site of capture. To my knowledge, this note represents the first reported case of death feigning in *P. regilla*.

I thank P. Martin and D. Mantooth of the Santa Barbara Zoological Gardens for assistance.

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RANA AURORA (Northern Red-legged Frog). **MOVEMENT**. The spatially finite nature of movement studies often imposes the cost-linked restriction that population-level and maximum movement distances will be underestimated (Barrowclough 1978. Bird Banding 49:333–341). Such underestimation, confirmed using molecular methods (e.g., Sumner et al. 2001. Mol. Ecol. 10:1917–1927), may be highest among species with the potential to move the longest distances (i.e., >1 km), since the search area for even a simple radial model increases as no less than the square of the distance, with variation depending on local topography. Based on our previous report of seasonal movement distances up to 2.4 km (Hayes et al. 2001. Herpetol. Rev. 32:35–36), *R. aurora* (*fide* Shaffer et al. 2004. Mol. Ecol. 13:2667–2677) represents an extreme example of this problem. Here, we provide seasonal movement distances for *R. aurora* which much exceed those of our previous report.

Our observations were made during a habitat study of *R. aurora* within the Squaw Flat Research Natural Area (Umpqua National Forest) in the South Umpqua basin, Oregon, USA; a site description is provided elsewhere (Hayes et al., *op. cit.*). Over the interval of May–July 2002, during ca. monthly surveys of the riparian margin of Squaw Creek, we recaptured four adult *R. aurora* at straight-line distances of 4.8, 4.2, 3.5, and 3.7 km from the known breeding pond. These frogs were, respectively, three adult females (102 mm SVL, 84 g; 97 mm SVL, 61 g; 89 mm SVL, 53 g), and an adult male (79 mm SVL, 35 g). All four had been previously marked using PIT tags and had been recaptured or first marked during January–February 2002 surveys of the breeding pond. A fifth frog (also an adult female; 104 mm SVL, 82 g), captured 4.5 km from the breeding pond, may also represent a recapture. However, some uncertainty exists regarding the capture status of this frog, as it was marked with a single toe clip rather than a PIT tag.

The maximum distance reported here doubles that of our earlier report. Longer movements have been reported for other North American ranid frogs, but those consist of recaptures of dispersing juveniles (e.g., Seburn et al. 1997. *In* D. M. Green [ed.], Amphibians in Decline: Canadian Studies of a Global Problem, pp. 64–72. Herpetol. Cons. 1; Funk et al. 2005. Biol. Lett. 1:13–16), between-year recaptures of adults or subadults (e.g., Dole 1971. Copeia 1971:221-228; Reaser and Dexter 1996. Herpetol. Rev. 27:195–196), or annual movement distances estimated from the colonization of habitat in areas where species had been recently introduced (Platz et al. 1990. Copeia 1990:324–333; see Smith and Green 2005. Ecography 28:110–128 for details). The key difference between these reports and ours is that we report adult frog movements within a season. Coupled with our previous report (Hayes et al., *op. cit*), this pattern of movement appears annual, but whether the same individuals move in the same general pattern each year remains unclear. Movement distances for three (and perhaps four) of the frogs we report here match or exceed the seasonal maxima reported for adults of other North American ranid taxa (see especially Bugler et al. 2003. Biol. Cons. 110:85–95; Rathbun and Schneider 2001. Wildl. Soc. Bull. 29:1300–1303; and Smith and Green, *op. cit.*). Although the frogs described here may be approaching the maximum seasonal movement distance for *R. aurora*, Barrowclough's missive (*op. cit.*) about movement distance underestimation remains. Lastly, we recaptured few individuals more than once, so our low within-season recapture reso-

lution may also contribute to underestimating the movement distances of the individuals upon which we report.

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RANA BOYLII (Foothill Yellow-legged Frog). **CANNIBALISM AND PREDATION**. Cannibalism has been reported in 12 of 21 families of anurans, including ranids (Crump 1992. *In* Elgar and Crespi [eds], Cannibalism: Evolution Among Diverse Taxa, pp. 256–276. Oxford University Press, Oxford). *Rana boylii* consume a wide variety of invertebrate prey including insects, spiders, centipedes, and water snails, however cannibalism has not been reported (Ashton et al. 1998. Foothill yellow-legged frog (*Rana boylii*) natural history. USDA Forest Service, Pacific Southwest Research Field Station, Arcata, California). Herein, we report two observations of cannibalism in *R. boylii*.

On 8 Sept 2004 at 1300 h an adult *R. boylii* (ca. 50 mm SUL) was observed in a seep 3.0 m from the bank of the South Fork Trinity River near Surprise Creek, Humboldt Co., California (UTM 0452944E; 4515190N; NAD 27 Zone 10). The frog had captured a recently metamorphosed juvenile (ca. 23 mm SUL) conspecific. After the photograph was taken (Fig. 1), the frogs were not captured and were left undisturbed. On 27 Sept 2005 at 1143 h, an adult *Thamnophis couchii* (field no. KDW 243; 46.5 cm SVL; 63.5 cm TL; 39.0 g) was observed along the left bank of Silver Creek, ca. 315 m upstream of the confluence with the South Fork American River (UTM 0709458E; 4296166N; NAD 27 Zone 10; ca. 634 m elev.) within a large aggregation of hibernating ladybird beetles (*Hippodamia convergens*). The snake was noticeably distended and upon palpation, regurgitated an adult female *R. boylii* (California Academy of Sciences [CAS] 233406; 60.0 mm SUL; 26.0 g), which was swallowed legs-first. On 29 Sept 2005, stomach contents of CAS 233406 were examined and included: 6 ladybird beetles (*H. convergens*), one vespid wasp, one tetrigid grasshopper, one spider, one moth, one geometrid caterpillar, one mycetophilid gnat, four *Campanotus* ants, and a juvenile *R. boylii* (17 mm SUL; ca. 1.0 g; Fig. 2).



FIG. 1. Adult *Rana boylii* consuming a juvenile conspecific (Humboldt County, California).

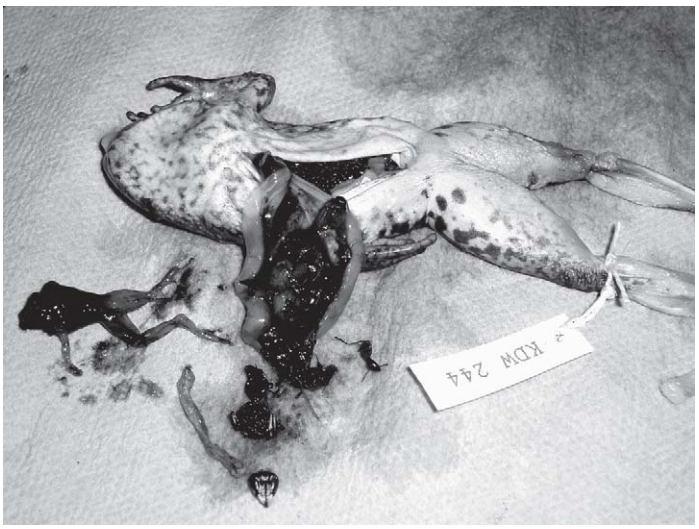


FIG. 2. Stomach contents of CAS 233406 included a juvenile conspecific (El Dorado County, California).

Both observations of cannibalism in *R. boylii* occurred in September, a time when recently-metamorphosed frogs are relatively abundant, and could constitute a significant proportion of the available prey base. On the North Fork Feather River (Butte Co., California) adult female *R. boylii* lose an average 31% of their body mass following oviposition (range 8–46%; N = 52; GANDA, unpubl. data) and the consumption of juvenile conspecifics may help recoup some of this mass in the fall. Given the taxonomic variation of prey found in the Silver Creek frog and that numerous metamorphs were in the immediate vicinity of both observations, cannibalism in *R. boylii* is likely indiscriminate, where juvenile frogs are of appropriate size and elicit a feeding response from adults.

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RANA CASCADAE (Cascades Frog). **PREDATION**. Because predator/prey relationships are a key factor in food web interac-



FIG. 1. Dragonfly naiad (*Aeshna* sp.) eating a metamorphosing Cascades Frog in the Trinity Alps Wilderness, California. The frog was alive at the time this photograph was taken.

tions, it is important to identify all the species and their role in the ecosystem. Documented invertebrate predators for larval *Rana cascadae* include dragonfly naiads (Jones et al. [eds.] 2005. Amphibians of the Pacific Northwest. Seattle Audubon Society, Seattle, Washington. 227 pp.), beetles (Dytiscidae), and giant water bugs (Belostomatidae) (Peterson and Blaustein 1992. Copeia 1992:577–584). The only documented invertebrate predators of post-metamorphic *R. cascadae* are giant water bugs (Nauman and Dettlaff 1999. Herpetol. Rev. 30:93).

On 10 Oct 2004 at ca. 1500 h, we observed a dragonfly (*Aeshna* sp.) naiad (32 mm TL) consuming a metamorphosing *R. cascadae* (17.5 mm SUL, Gosner Stage 45) in a small spring-fed meadow pond (6.8 m^2, 0.31 m deep) located in the Trinity Alps Wilderness, Trinity Co., California USA (UTM Zone 10, 509661E 4530014N; 2118 m). The naiad's lower mandibles were fastened onto the frog's right hindlimb and its appendages were grasping the frog's body (Fig. 1). The frog was alive and attempting to escape; however its foot, tibia/fibula, and most of the femur of the right hindlimb had been chewed off and presumably eaten. We returned to the pond at ca. 1600 and found the frog dead, half-consumed and floating in the pond. The frog's left forelimb and right hindlimb were completely amputated, a significant portion of its left lateral tissue was removed and the internals were exposed.

This observation extends the reported predation capabilities of naiad dragonflies from tadpoles to metamorphosing *R. cascada*e. There are at least 18 species of Odonata that occur within the Trinity Alps Wilderness area (Pope, unpubl. data). This local diversity suggests that Odonata may be an important natural predator of *R. cascadae* larvae and newly metamorphosed individuals in this area.

Ongoing research on *R. cascadae* ecology has been supported in part by the US Forest Service, California Department of Fish and Game, National Fish and Wildlife Foundation, and Declining Amphibian Populations Task Force.

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RANA SPHENOCEPHALA UTRICULARIA (Southern Leopard Frog). **ECTOPARASITES.** Chiggers (Acari: Leeuwenhoekiidae and Trombiculidae) are known to infest a variety of reptile and amphibian species worldwide (Wharton and Fuller 1952. A Manual of the Chiggers. Mere. Entomol. Soc. Washington 4:1–185), yet their occurrence is often overlooked and underreported in the literature. Larvae of the genus *Hannemania* (Leeuwenhoekiidae) parasitize a variety of amphibian species including salamanders, toads, spadefoot toads, tree frogs, and rain frogs (Duszynski and Jones 1973. Int. J. Parasit. 3[4]:531–532; Loomis 1956. Univ. Kansas Sci. Bull. 37, II[19]:1195–1443).

The chigger *Hannemania dunni* was first described as a parasite on the Dusky Salamander (*Desmognathus fuscus*, Sambon 1928. Ann. Trop. Med. Parasitol. 22:67–132). Within Alabama, infestations have only been reported on Southern Two-lined Salamanders (*Eurycea bislineata* = *E. cirrigera*) (Hribar and Tyler 1989. Melsheimer Entomol. Ser. No. 37:28). We present here the first report of *H. dunni* in the Southern Leopard Frog (*Rana sphenocephala utricularia*) and provide the second documented occurrence of this parasite in Alabama.

Three adult Southern Leopard Frogs were encountered under a section of log on a sandbar thickly vegetated with Water Willow (*Justicia americana*) in Big Canoe Creek near Ashville, St. Clair County, Alabama, USA (33°50'25"N, 86°16'11"W WGS84/NAD83) on 14 Oct 2005. Two of the frogs were captured and upon close examination numerous orange subcutaneous lesions were apparent on the ventral surface, especially the ventral and posterior aspects of the thighs and the interdigital webbing. These frogs were collected and transported back to Auburn University.

The frogs were euthanized on 17 Oct 2005 with benzocaine. The frogs had 16 and 29 lesions on their ventral surfaces. Eleven mites (two from the first host and nine from the second) were removed from these lesions using fine-tipped forceps. The frogs were formalin fixed and deposited in the Auburn University Museum of Natural History Collection (AUM 37280–37281). Mites were cleared in Andre's Fluid (1/3 glacial acetic acid, 1/3 chloral hydrate, and 1/3 water), and preserved by slide mounting in Hoyer's Medium (50 ml distilled water, 30 g gum Arabic, 200 g chloral hydrate, 20 ml glycerin; Krantz 1978. A Manual of Aracology. OSU Bookstores Inc., Corvallis, Oregon 335 pp.). They were identified to genus using Brennan and Goff (1977. J. Parasitol. 63:554–566) and to species using Loomis (1956, *op. cit.*) by examination under a light microscope. Voucher specimens of the *Hannemania dunni* are deposited in the Florida State Collection of Arthropods Gainesville (E2006-881-1).

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RANA SYLVATICA (Wood Frog). **PREDATION**. Much information exists on the role of predation in the larval ecology of *Rana sylvatica* (Wellborn et al. 1996. Ann. Rev. Ecol. Syst. 27:337–363; Wilbur 1972. Ecology 53:3–21), but little data exist on specific predators of adult Wood Frogs (Muths et al. 2005. http://

www.fs.fed.us/r2/projects/scp/assessments/woodfrog.pdf). During Spring and Summer 2003 we radiotracked 43 Wood Frogs in southern Maine for an average of 25.6 days each. Wood Frogs were tracked using 0.9 g external transmitters attached with a soft rubber belt (Baldwin et al. 2006. J. Herpetol. 40:443–454). During this time, 15 frog remains were found, and 12 deaths (27.9% of tracked frogs) were attributed to vertebrate predation. Of these, three were confirmed Common Gartersnake (*Thamnophis sirtalis*) predation, and three were suspected to be raptor predation. An additional six events showed signs of predation or consumption but could not be traced to a specific predator. All snake predation events occurred during the post-breeding, springtime emigration period (3 May; 18 June; 23 June), while raptor predation overlapped temporally and continued into midsummer (7 June; 19 June; 14 July).

Garter snake predation occurred in or on the margins of breeding pools and neighboring forested wetlands. One snake carrying a frog and transmitter was captured while it was swimming in a vernal pool within 2 m of the last location of the frog (previous day). Another was tracked to a sphagnum hummock in a large forested wetland where the Wood Frog had migrated following breeding. The third garter snake was tracked to an upland refuge under a log and dry leaves, 13 m from the pool margin where the Wood Frog was located 4 days earlier. Two of the snakes were held in captivity and excreted the Wood Frog transmitters within 1 week of capture.

Raptor predation was inferred from semiarboreal locations and conditions of the carcasses. In one instance the transmitter was recovered from an oak tree (*Quercus* sp.), 2 m from the ground, adjacent to a mossy stream bank in which the frog had been located the previous day. The carcass had been largely stripped of flesh, leaving the belt, transmitter, and bones. A second carcass was found on top of a *Tsuga canadensis* snag, 2.3 m from the ground, inside a forested wetland and 21 m from the previous location. The carcass was relatively fresh with only the head consumed. The third attributed to a raptor was found 4 m from its previous location on top of a sphagnum hummock in a forested wetland, with sharp incisions near the base of the hind legs and a portion of its skull removed. The 6 events that were not attributed to a specific predator occurred terrestrially, and involved crushing-type wounds suggestive of those caused by a mammal (e.g., fox, skunk, raccoon).

Vernal pools are threatened ecosystems, widely recognized for their value as important amphibian breeding habitat (Comer et al. 2005. http://cheetah.natureserve.org/library/isolated_wetlands_05/isolated_wetlands.pdf). Our observations suggest that vernal pools also play a significant role in the local ecology of terrestrial forest food webs.

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RANA SYLVATICA (Wood Frog). **PREDATION**. I observed the predation of an adult *Rana sylvatica* by a giant water bug (*Lethocerus* sp.) in a vernal pool in Shapleigh, Maine, USA (43°30'32.3"N, 70°46'33.4"W). On 15 April 2006, in a small (<0.1 ha) vernal pool containing Red Maple (*Acer rubrum*) hummocks, calls emitted on various pitches attracted my attention to a Wood Frog attempting to haul itself out of the water onto a small floating log, while being clasped at the waist level by a giant water bug. The giant water bug's rostrum appeared to be inserted near the base of the spine. During a period of ca. 3 min., the frog was partly pulled back in the water, its upper body gradually tilted forward until the snout was just under the surface. Over this period the calls became progressively shorter in duration and volume, until the frog was flat on the water surface, motionless and silent.

Giant water bugs have been observed preying on adults of two species of anurans, *Rana cascadae* (Nauman and Dettlaff 1999. Herpetol. Rev. 30:93) and *Bufo terrestris* (McCoy 2003. Herpetol. Rev. 34:135–136). This observation provides evidence for another interaction, part of the complex ecology of vernal pools.

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RANA YAVAPAIENSIS (Lowland Leopard Frog). **LARVAL CANNIBALISM.** *Rana yavapaiensis* is known to oviposit primarily in late winter-spring, with a smaller pulse of oviposition in early fall (Sartorius and Rosen 2000. Southwest. Nat. 45:267–273). Large tadpoles sometimes overwinter (Collins and Lewis 1979. Southwest. Nat. 24:371–373). These observations occurred during winter 2005–06 in a semi-natural, urban backyard pond (3 × 4 m, 0.4 m deep), which had a self-sustaining frog population derived from three southeastern Arizona populations. In monitoring the fourth of eight egg masses deposited in February–early March 2006, I noted 5–6 large tadpoles (5.5–7.5 cm LOA) from a single September 2005 clutch active around and under the egg mass, which had just begun to hatch on 5 March. On 7 March, closer inspection of the fifth egg mass, which was estimated to be at Gosner stages 16–19 and predicted to be 50% hatched on 9 March, revealed 12–18 large tadpoles (of an estimated 48+ present in the pond) active under, around, and on the egg mass. Tadpoles were swimming lazily, pushing into the mass with actively moving mouthparts and, in at least one case observed to swallow a dislodged embryo. Water was 11 cm deep at the mass, which was about 8 cm diameter, temperature was 17ºC (range 13–20ºC over 24 h). The mass contained an estimated 1100 eggs based on previous counts of hatchlings in clutches of similar size; 30 h later there were only 18 developing ova remaining, the egg mass was reduced in size but not dissociating as expected post-hatching, and no hatchlings were observed near the egg mass site, as would normally be seen. Other egg masses appeared to be less affected in proportion to the depth of water column below them, with hatchlings seen around all of them, and there was less activity of large tadpoles near them. However, the eighth and deepest-water egg mass, which hatched last (15 March), attracted about 15 large tadpoles on the bottom where a cone of detaching hatchlings from

it would likely fall. Five of these tadpoles transferred to a screened-in observation tray with 10 hatchlings apparently consumed four hatchlings in a 24 h period.

The frog and tadpole densities involved here are similar to the highest Lowland Leopard Frog abundances I have observed in Arizona and Sonora during 1983–2005, and the only other vertebrate in the pond is the Gila Topminnow (*Poeciliopsis occidentalis*). An accumulating literature on oophagy, larvivory, and cannibalism in tadpoles (Gunzberger and Travis 2005. J. Herpetol. 39:457–571), and their occurrence in species with generalized tadpoles such as *R. yavapaiensis* and the American Bullfrog (*R. catesbeiana*; Kiesecker and Blaustein 1997. Ecology 78:1752–1760) may support suggestions in McDiarmid and Altig (1999. Tadpoles: The Biology of Amphibian Larvae, pp. 218, 246) that these might be widespread and ecologically important phenomena.

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SCINAX FUSCOVARIUS (Snouted Treefrog). **DEATH FEIGNING**. Posturing is often important in defense (Ducey and Brodie 1991. Herpetologica 47:89–95). Death feigning or thanatosis is widespread in amphibians (Duellman and Trueb 1994. Biology of Amphibians. John Hopkins Univ. Press, Baltimore and London), mainly among frogs (Azevedo-Ramos 1995.Rev. Bras. Biol. 55:45–47). *Scinax fuscovarius* occurs in south, southern, and central Brazil as well as in the eastern regions of Argentina, Paraguay, and Bolivia (Kwet and Di-bernardo 1999. Amphibians. Edipucrs, Porto Alegre). On 4 Jan 2006 at 1839 h in Poxoréu municipality (54º24'W; 15º51'S), Mato Grosso state, Brazil, we found an adult male *S. fuscovarius* (46 mm SVL) resting ca. 0.5 m above the ground on a shrub. When we approached, the frog jumped to the ground and remained motionless with the head tipped downward and eyes closed for two minutes. When DJR captured the treefrog, it jumped from his hand and fell to the ground in a death feigning position with the dorsum on the ground and the limbs close to the body. This behavior protects vulnerable parts of the body, and sometimes creates an impression of bigger size. This is the first report of death feigning in *S. fuscovarius.*

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SCINAX TRAPICHEIROI (NCN). **PREDATION**. Although most adult viperid snakes consume predominantly warm-blooded prey, juvenile viperids commonly prey on frogs (Duellman and Trueb 1986. Biology of Amphibians. McGraw-Hill. New York. 670 pp.; Martins et al. 2002. *In* Campbell and Brodie [eds.], Biology of the Vipers, pp. 307–328. Eagle Mountain Publishing, Utah). Some invertebrates are also important predators of frogs, although crustaceans have rarely been reported to prey on such animals (Duellman and Trueb 1986, *op. cit.*; Toledo 2005. Herpetol. Rev. 36:395–400). Here we describe two cases of predation on the treefrog *Scinax trapicheiroi* in an Atlantic rainforest area—one by the viperid snake *Bothrops jararaca* and the other by the freshwater shrimp *Macrobrachium carcinus.* Both predators, and their prey, were deposited at the Museu Nacional, Rio de Janeiro (MNRJ).

On 29 Oct 2004, at night, during fieldwork at a creek near Vila Dois Rios (23°12'S, 44°13'W), on Ilha Grande island, State of Rio de Janeiro, Brazil, we collected a juvenile Jararaca Lancehead (*Bothrops jararaca;* MNRJ 12663) (SVL 232.3 mm; tail 50.6 mm), that was resting on a branch 1.88 m above the ground. It was transferred to a cloth bag where it regurgitated a partly digested adult male *S. trapicheiroi*. *Bothrops jararaca* has been reported to prey on other hylids (*Scinax fuscovarius*, *Hyla leucopygia*, and *H. prasina*; Sazima 1992. *In* Campbell and Brodie [eds.], Biology of the Pitvipers, pp. 199–216. Selva Press, Tyler, Texas), but this is the first report of *S. trapicheiroi* as prey.

During Feb 2005, at night, during an anuran mark-recapture study at the same creek, after we released an adult male *S. trapicheiroi* on a rock, it jumped into the water, being promptly captured by the freshwater shrimp (*Macrobrachium carcinus*; body size 83.3 mm, MNRJ 19524) which started to consume it. Before the shrimp had finished eating, we collected and placed it (and its prey) in a plastic bag with water. Inside the bag, the shrimp finished consuming the frog. *Scinax trapicheiroi* are known to release their eggs in lentic water (Rico et al. 2004. Amphibia-Reptilia 25:277–286) and thus predation by aquatic invertebrates might be relatively common.

This note suggests that *Bothrops jararaca* and freshwater shrimp might be important sources of mortality for *S. trapicheiroi* at Ilha Grande, because of their abundance in the area.

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SPEA HAMMONDII (Western Spadefoot). **REPRODUCTIVE PATTERN.** It is known that breeding congregations of *Spea hammondii* quickly assemble in response to heavy rainfall that triggers emergence, saturates the soil, and fills ephemeral breeding pools (Storer 1925. Univ. California Publ. Zool. 27:153–163; Morey 2005. *In* Lannoo [ed.], Amphibian Declines: The Conservation Status of United States Species, pp. 514–517. Univ. California Press, Berkeley, California). Breeding records are strongly correlated with regional rainfall patterns; consequently, breeding generally occurs from January through May (Stebbins 2003. Western Reptiles and Amphibians, 3rd ed. Houghton Mifflin Co., Boston, Massachusetts; Storer 1925, *op. cit.*) with a peak in activity, most years, during the months of February and March (Brown 1976. Contrib. Sci., Los Angeles Co. Mus. Nat. Hist. 286:11; Morey 2005, *op. cit.*).

On 12 Aug 2005, *S. hammondii* larvae (N = 30) (4–10 mm TL)

were collected from an excavated unshaded temporary pond (ca. 7 m × 11 m, 0.5 m deep) located within a Redshank Chaparral plant community (*Adenostoma fasciculatum, A. sparsifolium, Arctostaphylos* spp., *Ceanothus* spp., *Quercus dumosa, Rhus ovata*) in Tierra Del Sol, San Diego Co., California, USA (T17S, R6E, Sec. 35; ca. 1160 m elev.). Because of the size range of the larvae, we inferred that breeding likely took place during or shortly after a storm on 1 Aug 2005 that resulted in 1.4 cm of rainfall. A series of preserved larvae (N = 14) was deposited in the herpetological collection of the California Academy of Science (CAS 233766).

Opportunistic breeding as a reproductive pattern is defined by the ability to breed throughout the year and often is a strategy used by species from arid regions characterized by uncertain rainfall, with heavy rainfall being the most common cue to initiate reproductive behavior (Duellman and Trueb 1986. The Biology of Amphibians. John Hopkins Univ. Press, Baltimore, Maryland; Long 1989. J. Herpetol. 23:176–179). Because *S. hammondii* has the ability to breed shortly after emerging from aestivation, and has been documented to breed in at least 11 months of the year (Brown 1976, *op. cit.*; Ervin et al. 2005. Herpetol. Rev. 36:309–310; this report), the species clearly demonstrates the characteristics of an opportunistic breeder. Based on this new information, *S. hammondii* should be recognized as a species that generally breeds from January through May, as well as being an opportunistic breeder (*sensu stricto*) that is physiologically capable of breeding any time of the year given favorable environmental conditions.

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SPEA HAMMONDII (Western Spadefoot). **PREDATION.** *Spea hammondii* is an aquatic breeding terrestrial anuran. Although highly nocturnal, occasionally it remains active into daylight hours while in amplexus (Storer 1925. Univ. California Publ. Zool. 27:153–163; E. Ervin, pers. obs.).

An increase in predation risk has been demonstrated for aquatic breeding terrestrial species during breeding periods because of a combination of factors, including increased density, increased activity levels, and spawning pairs occupying aquatic sites into daylight hours (Beebee 1996. Conservation and Ecology of Amphibians, Chapman and Hall, UK; Stebbins and Cohen 1995. The Natural History of Amphibians. Princeton Univ. Press, Princeton, New Jersey).

Amphibians, reptiles, wading and passerine birds, and mammals are known to prey on transformed individual *Spea* (see individual species accounts in Lannoo [ed.] 2005. Amphibian Declines, The Conservation Status of United States Species. Univ. California Press, Berkeley, California). The only cases of predation on transformed *S. hammondii* individuals we are aware of are the Two-striped Gartersnake, *Thamnophis hammondii* (Ervin and Fisher 2001. Herpetol. Rev. 32:265–266) and the introduced American Bullfrog, *Rana catesbeiana* (Hayes and Warner 1985. Herpetol. Rev. 16:109; Morey and Guinn 1992. *In* Williams et al. [eds.], Endangered and Sensitive Species of the San Joaquin Valley, California, pp. 149–158. Wildlife Soc., Western Section, Sacramento, California; Balfour and Ranlett 2006. Herpetol. Rev. 37:212).

Because there are no previous reports of predation on transformed *S. hammondii* by any bird or mammal species the following accounts are notable. On 27 Sept 1997 (1250 h), JPP discovered the remains of two adult *S. hammondii*; two heads with intact skin (1F:1M), on the bank of an ephemeral pool (10.5 m × 15.25 m, 70 cm deep) in the headwaters of Temecula Creek, Dodge Valley, San Diego Co., California (33.362°N, 117.756°W, 955 m elev.). The only fresh animal sign left by the predator were raccoon tracks at the place the remains were observed.

On 27 April 1998 (ca. 1600 h), DSJ observed three desiccated adult (1F:2M) *S. hammondii* at the entrance of a burrow occupied by a pair of Burrowing Owls (*Athene cunicularia*) at Naval Air Station Lemoore, near Lemoore, Kings Co., California (36.3565°N, 119.9335°W, 66.4 m elev.). The carcasses were wholly intact; mouths stretched open, less their fleshy tongues. In addition to a single Burrowing Owl observed active at the burrow, owl pellets were present at the top of the mound located adjacent to the burrow.

On 24 Feb 2004 (1505 h), AKG and ELE collected the remains of two adult *S. hammondii* from the bank of an ephemeral pool (18 m × 5 m, 25 cm deep) in Escondido, San Diego Co., California (33.12005°N, 117.11745°W, 237 m elev.). The remains were found within an area of ca. $1m^2$. The disarticulated remains consisted of two skulls with intact skin (1F:1M), two complete stomachs, two fat body clusters, as well as sections and pieces of large and small intestines, fat body clusters, livers, and oviducts containing ova. Because of the lack of direct observation and no fresh animal sign found, it is unclear what preyed on the adult *S. hammondii*. In this observation, we rule out raptors as the predator for the following reasons: Typical raptor predatory behavior, based on raptor predation sequence observations, including those based on adult spadefoots, report that the raptors often fly to a more secure place after the capture of their prey (Mills 1977. Wilson Bull. 89[4]:623; Sexton and Marion 1974. Wilson Bull. 86[2]:167–168). In addition, we are unaware of discussions that have identified diagnostic physical characteristics that would enable us to reliably determine whether the predator was either avian or mammalian by reexamining the physical remains (e.g., intact heads, limbs, viscera).

To our knowledge, this is the first report of avian and mammalian predation on adult *S. hammondii*. Specific details suggest that the *S. hammondii* remains collected in 1997 and 2004 were preyed on as amplexing pairs. At each of the sites, individuals collected consisted of one male and one female (determined by degree and pattern of vocal sac pigmentation), the male and female remains were generally found in the same area, and the pool contained *S. hammondii* egg clusters < 24 h old (pre neural folds; pre Gosner Stage 14). Consequently, our observations support the idea that aquatic breeding terrestrial anurans might be at greater risk of predation while at their breeding habitat and while engaged in amplexus.

We thank M. R. Jennings and S. R. Morey for suggestions that improved the manuscript. *Spea hammondii* specimens were sal-

vaged under California Department of Fish and Game collecting permit issued to ELE and AKG. Remains were preserved in 70% ethanol and are retained by ELE for further study.

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STEFANIA WOODLEYI (Woodley's Treefrog). **DEFENSIVE BEHAVIOR.** Antipredator strategy and defensive behavior is widespread among anurans, the most common being crypsis, mimicry, thanatosis (death feigning), toxicity, Unken reflex, and other defensive postures (Duellman and Trueb 1994. Biology of Amphibians, The Johns Hopkins University Press, Baltimore and London, 670 pp.; Zug et al. 2001. Herpetology – An Introductory Biology of Amphibians and Reptiles, 2nd Ed., Academic Press, San Diego, California, 630 pp.). Aggressive response to a potential predator, unrelated to parental care, is less typical. This behavior includes gaping, jumping towards the potential predator with mouth wide open, sometimes with the emission of a distress call, and occasionally biting (Duellman and Trueb 1994, *op. cit.*; Fabrezi and Emerson 2003. J. Zool., Lond. 260:41–51; Myers 1966. Herpetologica 22:68–71; Veloso 1977. Herpetologica 33:434–442; Zweifel 1972. Bull. Am. Mus. Nat. Hist. 148:1–140). Most frogs exhibiting this behavior are stout-bodied and some have fang-like teeth (Fabrezi and Emerson 2003, *op. cit.*).

We collected 14 specimens of the poorly known cryptobatrachid *Stefania woodleyi* in Kaieteur National Park, west-central Guyana. *Stefania woodleyi* is endemic to the southern Pakaraima region, Guyana (Señaris and MacCulloch 2005. Bull. Biol. Soc. Washington 13:9–23), and little is known about its ecology (MacCulloch and Lathrop 2002. Herpetologica 58:327–346). One of these specimens, IRSNB 13799, a male SVL 45.8 mm, collected 25 March 2006 at 2130 h, in the vicinity of Elinkwa River in the southeastern part of the park (5°09'46"N, 59°24'01"W; 550 m elev.) displayed an aggressive defensive behavior on two occasions. When first captured, and later while being photographed, the frog suddenly inflated its lungs, opened its mouth wide and jumped toward the handler's hand while emitting a single high-pitched catlike "meow" distress call. The defensive mechanism was similar to an attempt to bite the handler's hand. The first "attack" was so surprising that the handler almost released the frog. Three other specimens from the same locality also displayed the same behavior with some variation. IRSNB 13801, a male SVL 47.3 mm collected 23 June 2006 at 2230 h only inflated its lungs and opened its mouth without jumping, emitting any distress call and/or attempting to "bite". IRSNB 13802, a female SVL 58.2 mm collected 26 June 2006 at 2130 h several times displayed the same aggressive defensive behavior as IRSNB 13799 and IRSNB 13803, a juvenile SVL 26.8 mm also displayed, but a single time only, the complete aggressive defensive behavior. This indicates that both sexes and juveniles display this defensive mechanism.

There is much intraspecific variation in defensive behaviors (Myers 1966, *op. cit.*), which may be influenced by ecological factors (Gomes et al. 2002. Copeia 2002:994–1005). Interestingly, only some of the *S. woodleyi* collected in Kaieteur National Park displayed this aggressive antipredator mechanism and all of them were collected at the same locality, in the vicinity of Elinkwa River. As far as we know, this is the first report of aggressive defensive behavior within the genus *Stefania* and within the family Cryptobatrachidae. Unlike most anuran taxa that exhibit this type of behavior, *Stefania* are gracile, and lack fang-like teeth. Specimens are deposited in the herpetological collections of the Institut Royal des Sciences Naturelles de Belgique (IRSNB), Brussels, Belgium.

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XENOPUS LAEVIS (African Clawed Frog). **PREDATION.** Observations of predation on *Xenopus laevis* by fish, birds, and otter have been documented in native and feral populations (Lobos et al. 2005. Biodivers. Conserv. 14:429–439; McCoid 1980. Bull. South. California Acad. Sci. 79[2]:82–86; Tinsley et al. 1996. *In* Tinsley and Kobel [eds.], The Biology of *Xenopus*, pp. 35–59). Virtually no information exists on predation of clawed frogs by invertebrates. Here we provide field observations of predation by crabs on adult *X. laevis* in South Africa.

We observed *X. laevis* in South Africa, Mpumalanga province (previous NE-Transvaal), Hoedspruit district, at the "Torchwood Pond" (24°25'S; 30°50'E). The pond was 65 m^2 in size, fed with crystal clear water by a perennial mountain torrent, and located on the wooded slopes of the Drakensberg Mountains at 750 m elev. The pond harbored a native population of about 80–100 *X. laevis* and ca. 20–30 river crabs, *Potamonautus* sp. (Decapoda: Potamonautidae).

On 2 Feb 1996 at 0045 h, while we were observing *Xenopus* with the aid of a flashlight, a hand-sized crab was spotted at a depth of about 60 cm, holding a female *Xenopus* (ca. 80 mm SVL) in its claws. The frog was fixed by the claws at the head and at the left hind leg and was almost unable to move. The crab was feeding using its mandibles at the frog's left lateral side, and had produced an injury about 15 mm. Small motions of the forelegs and the right hind leg of *Xenopus* indicated that it was still alive. Probably disturbed by the flashlight, the crab moved backward under the rotten leaf litter.

A similar case of predation was observed on 7 Feb 1996 at 2200 h at a depth of 40 cm. Two hand-sized crabs were observed feeding on a female *Xenopus* (ca. 70 mm SVL). One of the crabs had

grasped the head of the female, the second crab grasped one hind leg. The frog had large wounds at the eye region and at its shank, but still showed some motion. Checking the site about 10 min later, both crabs and the body of the frog had disappeared.

We never directly observed a crab catching a clawed frog successfully. But we often observed grasping movements of the crabs when frogs came close. A male (SVL 67 mm) and a female (SVL 88 mm) frog have been observed being grasped by crabs at the hind legs, but escaped. We also found two other *Xenopus*, a male (SVL 62 mm) and a female (SVL 96 mm), with wounds at the hind legs consistent with attack by crabs.

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GYMNOPHIONA

GYMNOPIS MULTIPLICATA (Purple Caecilian). **PREDATION.** The natural predators of *Gymnopis multiplicata* are relatively unknown and the diet of *Micrurus mipartitus* is assumed to be other snakes (Guyer and Donnelly 2005. Pp. 228-229 *in* Amphibians and Reptiles of La Selva, Costa Rica, and the Caribbean Slope). Here I report on predation by *M. mipartitus* on *G. multiplicata* from the La Selva Biological Station, Heredia Province, Costa Rica. On 15 Oct 2005 at 2105 h, I observed an adult *M. mipartitus* (ca. SVL 80 cm) consuming an adult *G. multiplicata* (ca. SVL 35 cm; Fig. 1). This interaction was observed on the ground adjacent to the Sendero Sura trail between 200 and 250 m elevation. To the best of my knowledge, this represents the first report of a predator for *G. multiplicata* and the second report of a prey item for *M. mipartitus*.



FIG. 1. Predation by an adult *Micrurus mipartitus* on an adult *Gymnopis multiplicata* at La Selva Biological Station, Costa Rica.

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TESTUDINES

ERETMOCHELYS IMBRICATA (Hawksbill), ***CHELONIA MYDAS*** (Green), and ***CARETTA CARETTA*** (Loggerhead) Seaturtles. **EPIZOANS**. The Columbus Crab, *Planes* sp., is a common epizoan of oceanic stage (juvenile) Loggerhead Seaturtles (*Caretta caretta*) in the southwestern Atlantic. Columbus or Swimming Crabs, including *Planes minutus*, *P. cyaneus*, and *P. marinus*, are essentially oceanic species rarely found near the coast (Davenport. 1992. J. Mar. Biol. Ass. U.K. 77:611–620), and occur on both natural and artificial floating material (Chace 1951. Proc. U.S. Nat. Mus. 101:65–103; Dellinger et al. 1997. J. Mar. Biol. Ass. U.K. 77:185-194). Columbus Crabs occurred with 83% of southwestern Atlantic juvenile Loggerheads (Carranza et al. 2004. Mar. Turtle Newsl. 102:5–7), 82% of those found off Madeira Island (Dellinger et al. 1997, *op. cit.*), and 27% from the Mediterranean (Casale et al. 2004. J. Mar. Biol. Ass. U.K. 84:1005–1006).

On the other hand, Columbus Crabs rarely are reported to associate with other sea turtle species. Columbus Crabs were scantly reported for the Olive Ridley Seaturtle, *Lepidochelys olivacea*, in Playon de Mexiquillo, Pacific coast of Mexico (Díaz et al. 1992. Publ. Soc. Herpetol. Mex. 1:19–25) and Chile (Miranda and Moreno. 2002. Rev. Biol. Mar. Oceanogr. 37:145–146), both pertaining to *P. minutus*, while off La Jolla, California, (Hubbs 1977. California Fish Game 63:263–267) and Jalisco, Mexico (Hernandez-Vazquez and Valadez-Gonzales 1998. Cienc. Mar. 24:119–125) they pertain to *P. cyaneus*. For the Hawksbill Seaturtle, *Eretmochelys imbricata*, Chace (1951, *op. cit.*) reported *P. minutus* from Rhode Island turtles and *P. cyaneus* from Baja California, while Schärer (2003. Rev. Biol. Trop. 51:87–89) reported only 3 out of 105 Hawksbills to be associated with *P. minutus* in Puerto Rico. Schärer (2003, *op. cit.*) found them associated with small turtles, and argue they were probably arriving from a pelagic habitat. For Green Seaturtles, *Chelonia mydas*, *P. cyaneus* was recorded by Crane (1937. *apud* Chace 1951, *op. cit.*) in Baja California, by Chace (1951, *op. cit.*) in Acapulco, Santa Inez Bay, Mexico, in the Galápagos Islands, by Brown and Brown (1995. *In* K.A. Bjorndal [ed.], Biology and Conservation of Sea Turtles, pp. 235–240. Smithsonian Institution Press, Washington, D.C.) in Peru, by Wickstein and Behrens (2000. SCAMIT Newsl. 19:7) in California, and by Green (1998. NOAA Tech. Memo. 412:63) who reported 'small crabs hiding among algae' on Galápagos Green Seaturtles, which could be Columbus Crabs.

Planes cyaneus and *P. marinus* are the species that occur in the southwestern Atlantic (Juanicó 1976. Dusenia 9:145–150; Spivak and Bas 1999. J Crustacean Biol. 19:72–76; Prado and Melo 2002. Crustaceana 75:579–595), but only the former was reported as a commensal of Loggerhead Seaturtles by Carranza et al. (2003, *op. cit.*). During 2005 we found Columbus Crabs associated with Hawksbill, Green, and Loggerhead turtles and report these findings here. Crabs were identified according to Chace (1951, *op. cit.*) and Spivak and Bas (1999, *op. cit.*) and all belong to *P. cyaneus*. Records for each turtle species are given in detail below.

A juvenile Hawksbill Seaturtle (Curved Carapace Length, CCL

= 39 cm, Curved Carapace Width-CCW = 33.5 cm) was captured by handnet on 19 January 2005 off southern Brazil (27.76°S, 46.80°W) over waters ca. 1500 m in depth. Five *P. cyaneus* were found, one male with Curved Carapace Length-CL = 11.3 mm, and four females CL = 10.8, 11.4, 12.6, and 12.9 mm. The largest female was gravid and the smallest one had an autotomy at the base of the left chelae. In addition, 1 remora, *Remora* sp., and 1 Goose Barnacle, *Lepas anserifera*, were found on the turtle.

A juvenile Green Seaturtle (CCL = 40.7 cm, CCW = 37.1 cm) was captured by gillnet on 18 February 2005 off southern Brazil (29.06°S, 49.24°W) over waters 35 m deep. One gravid female crab was found (CL = 16.3 mm).

During three cruises on a pelagic longline vessel carried out in January, July, and August 2005, Columbus Crabs were found on 18 Loggerhead Turtles incidentally captured. Capture locations were between 27.51 and 33.77°S, and 44.88 and 50.28°W, over waters 266–4600 m deep. Turtle CCL ranged from 49 to 97 cm (mean = 61.3 cm). Only one female with CCL of 97 cm was adult based on minimum CCL of nesting females of 83 cm in Espírito Santo, southeastern Brazil (Baptistote et al. 2003. Chel. Conserv. Biol. 4:523–529). All others were immature in their pelagic stage. A total of 32 *P. cyaneus* were collected (mean 1.8 crabs per turtle, min = 1, max = 3), of which 16 were male and 16 female, which does not differ from the expected 1:1 ratio reported for the genus (Dellinger et al. 1997, *op. cit.;* Spivak and Bas 1999, *op. cit.*; Carranza et al. 2003, *op. cit.*). Crab measurements - CL and Carapace Width CW (mean ± 1 SD, minimum-maximum), in mm, were: males CL - 15.6 ± 3.7, 9.3–21.3, CW - 15.6 ± 3.6, 9.3–21.3, N = 16; ovigerous females CL - 17.4 ± 3.1, 12.7–20.7, CW - 17.5 ± 3.0, 12.9–21.1, N = 7; nongravid females CL - 13.9 ± 3.7, 10.1–22.0, CW - 14.0 ± 3.7, 9.8–22.2, N = 9. CL and CW of gravid females were significantly larger than that of nongravid (Mann-Whitey U = 13, p = 0.05, both CL and CW); males and females (gravid and nongravid pooled) did not differ in CL and CW (Mann-Whitney test U = 119, p = 0.73 and U = 123.5, p = 0.87, respectively). The 22% of crabs with pereiopod autotomy was similar to 25% reported for *P. minutus* in Madeira Is. (Dellinger et. al. 1997, *op. cit.*) and lower than 45% reported for *P. marinus* in Argentina (Spivak and Bas 1999, *op. cit.*).

The scarcity of records of *Planes* spp. on adult Loggerheads or on other sea turtle species could be related to the preference of Columbus Crabs for deep waters as opposed to the shallow habitats used by all nesting turtles, and large immature Green and Hawksbill Seaturtles. However, because of opportunistic commensalisms with crabs, all hard-shelled turtles are equally prone to being colonized by crabs when in deep waters, as shown by this study.

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GRAPTEMYS GIBBONSI (Pascagoula Map Turtle). **DIET.** *Graptemys pulchra* (*sensu lato*) was originally described as inhabiting coastal rivers of the Gulf of Mexico from the Pearl River drainage in Louisiana to the Yellow River in Florida and south Alabama (Lovich 1985. Cat. Amer. Amphib. Rept. 360.1). However, based on morphological data, Lovich and McCoy (1992. Ann. Carnegie Mus. 61:293–315) split *G. pulchra* into three distinct species by describing two new species, *G. gibbonsi* and *G. ernsti*. The *pulchra* clade, at the time comprised of only *G. pulchra* and *G. barbouri*, was considered by McKown (1972. Phylogenetic Relationships within the Turtle Genera *Graptemys* and *Malaclemys*. Unpubl. Ph.D. dissertation, University of Texas, Austin) to be part of the "broad-headed" group. The larger head width in this clade compared to other *Graptemys* species was thought to be an adaptation for consuming mollusks (Ernst et al. 1994. Turtles of the United States and Canada. Smithsonian Institution Press, Washington, D.C. 578 pp.; Lindeman 2000. Biol. J. Linn. Soc. 69:549–576).

G*raptemys gibbonsi* inhabits the Pearl and Pascagoula River drainages in Mississippi and Louisiana. Since its split from *G. pulchra*, there has been little ecological research conducted on the species, especially on feeding ecology. Prior to the recognition of *G. gibbonsi*, Cagle (1952. Copeia 1952:223–234) reported fragments of clams and snails in the stomach of one juvenile female *G. pulchra* (now *G. gibbonsi*) from the Pearl River. On 18 April 2006, we witnessed the capture of a large female *G. gibbonsi* by a local fisherman using hook and line baited with chicken liver at the MS Hwy 42 boat ramp on the Leaf River near the confluence of the Bouie River (31°20'562"N, 89°16'855"W [WGS84]). We acquired and transported the individual to the laboratory for blood collection and held the individual in a cooler over night prior to its release. During that time, the individual defecated 56 fragments of *Corbicula fluminea* ranging from 2 to 17.7 mm (mean = 9.24 mm, SD = 4.23 mm) in length. This is the first observation of *Corbicula* in the diet of *G. gibbonsi* from either the Pearl or Pascagoula River basins. This is not an aberrant report for the *pulchra* clade, as *Corbicula* has been documented in the diets of other species: *G. barbouri* (Sanderson 1974. Unpublished master's thesis, University of South Florida, Tampa); and *G. ernsti* and *G. pulchra* (Shealy 1976. Bull. Florida St. Mus. 21:47–111).

The research that led to this observation was being conducted under Mississippi Administrative Scientific Research Collection Permit for collection of *G. flavimaculata* and *G. gibbonsi* for hormone and genetic analysis. We thank Jon Davenport for reviewing this document.

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MACROCHELYS TEMMINCKII (Alligator Snapping Turtle). **REPRODUCTION.** *Macrochelys temminckii* is considered a valuable commodity in portions of the United States, leading to potential overexploitation of the species (Sloan and Lovich 1995. Chelon. Cons. Biol. 1:221–222; Pritchard 1989. The Alligator Snapping Turtle: Biology and Conservation. Milwaukee Publ. Mus. 104 pp.).

TABLE 1. Temperatures (°C) of an Alligator Snapping Turtle (*Macrochelys temminckii*) nest during Summer 2005, in Faulkner County, Arkansas.

Time Period	Mean	Maximum	Minimum
11–25 Jun	24.2	28.1	21.0
26 Jun–10 Jul	25.4	28.7	23.2
11–25 Jul	26.1	29.8	23.2
26 Jul–9 Aug	26.1	30.5	23.5
10–20 Aug	26.5	28.7	24.8

Conservation planning will require life history information from throughout the species' range. Apparently, there are no published reports on the nesting habits of *M. temminckii* in Arkansas.

On 9 June 2005, a nest of *Macrochelys temminckii* was discovered on a southeast-facing bank (35°10.229'N, 92°19.020'W) of Cadron Creek in Faulkner Co., Arkansas, USA. The nest, located 2.8 m from the water, was situated on a small ledge devoid of vegetation. The flask-shaped nest had a maximum diameter of 20 cm and a depth of 17 cm. Thirty-six spherical eggs were excavated from the nest and measured. Egg mass ranged from 21.0 to 24.7 g (mean = 22.7 g). Egg diameter ranged from 33.2–35.5 mm (mean = 34.4 mm). The eggs were subsequently reburied to incubate under natural conditions, with a temperature-sensitive data logger placed in the center of the nest to record hourly nest temperatures. Nest temperatures are reported in Table 1. The nest was checked on 20 August and 25 eggs and the data logger were retrieved; of the remaining 11 eggs left in the nest, external appearance suggested that 9 were unfertile and 2 were fertile. Incubation of the 25 collected eggs continued in the laboratory at 29°C for the duration of development. Thirteen eggs hatched from 23 to 28 September. The remaining 12 unhatched eggs were dissected and found to be infertile.

Hatchling morphometrics were recorded within 12 h of hatching. Hatchling mass ranged from 12.0–15.4 g (mean = 13.8 g). Carapace length varied from 33.2–37.7 mm (mean = 35.7 mm) while carapace width ranged from 30.6–34.3 mm (mean = 33.0 mm). Plastron length ranged from 22.1–25.7 mm (mean = 23.8 mm) and plastron width ranged from 12.0–17.2 mm (mean = 15.2 mm).

Scientific collecting permits were obtained from the Arkansas Game and Fish Commission prior to commencement of the study. An Institutional Animal Care and Use Protocol was issued by the University of Central Arkansas.

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RHINOCLEMMYS PUNCTULARIA (Spot-legged Wood Turtle). **REPRODUCTION.** *Rhinoclemmys p. punctularia* is a semi-aquatic geoemydid turtle found in Trinidad, eastern Venezuela, French Guiana, and northern Brazil (Pritchard and Trebbau 1984. Turtles of Venezuela. SSAR Contr. Herpetol. 2:1–403; Ernst and Barbour 1989. Turtles of the World. Smithsonian Inst. Press, 313 pp.). The exact distribution and habitat requirements of this turtle need further study but it apparently inhabit igarapés (small rivers) and tributaries (Vogt et al. 2001. Biodiversidade e Funções Ecológicas dos Ecossitemas, ISA). The reproductive behaviors of this species are not well known, but clutches generally consist of one or two large eggs that are deposited on the ground in depressions or under leaf litter. (Pritchard and Trebbau, *op. cit.*; Ernst and Barbour, *op. cit.*).

Copulation of two specimens at Maranhão, Brazil, was observed in July 1997, at about 1030 h, on a cloudy day with an ambient temperature of 23°C. The duration of copulation was undetermined. The female weighed 1400 g, the male 700 g. In January 1998 (182 days after the observed copulation), a nest of three eggs (possibly a product of the observed copulation) was found in tall grass near the water reserve of the habitat. Two of the eggs were standing up and the third on its side. They were slightly elongated and had a white-yellowish coloration. The eggs ranged from 59.6 to 63.6 mm (mean 61 ± 2.2 mm) long and 29.9–30.5 mm (mean 30.3 ± 0.3 mm) wide. Egg mass was 32.2–36.5 g (mean 34.4 ± 2.2 g). The eggs were incubated in the laboratory and in April 1998, 90 days after the nest was found, a single egg hatched. The hatchling had a mass of 16 g, the carapace was 46 mm long and 37 mm wide, and the plastron was 46 mm long and 30 mm wide. On the next day another egg hatched, but the hatchling had a malformed carapace and plastron. The third egg was lost to an apparent fungus infestation. Clutch size reported here is the same as that from a captive specimen in a zoo in Guiana (Pritchard 1979. Encyclopedia of Turtles, TFH, Inc., Neptune, New Jersey. 895 pp.) and confirms that *R. punctularia* clutch size is small, but the eggs are relatively large.

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TRACHEMYS SCRIPTA ELEGANS (Red-eared Slider). **PREDATION**. Predation on waterfowl and other birds by Common Snapping Turtles (*Chelydra serpentina*) is well known, but avian predation by other aquatic turtles is rarely reported (Pryor 1996. Wilson Bull. 108:190–192; Ernst et al. 1994. Turtles of the United States and Canada. Smithsonian Inst. Press, Washington, D.C.). Here I report an observation of predation of an adult passerine by aquatic emydid turtles.

At approximately 1400 h on 31 May 2002, an agonistic encounter was observed between two adult male Red-winged Blackbirds (*Agelaius phoeniceus*) on the surface of a small pond in Greer Co., Oklahoma, USA. Three adult *Trachemys scripta elegans* were observed swimming toward the two birds. When the turtles got within ca. 3 m, one of the birds flew away. The second bird stayed on the surface of the water with wings spread and beak agape, apparently exhausted. A third male blackbird attacked the water-bound male, but retreated almost immediately, perhaps after noticing the turtles nearby. After the second aggressor retreated all three turtles disappeared beneath the water, and seconds later the remaining blackbird disappeared as well. An incomplete bird carcass floated back to the surface less than a minute after being pulled under water, and the turtles were not observed again.

With the exception of waterfowl, predation of adult birds by turtles is apparently an unusual and opportunistic event. The fact that three turtles were involved likely does not necessarily suggest cooperation, but is perhaps an indication of the high densities of *T. scripta* in this and other nearby ponds

I thank Joy Yoshioka and Wesley Webb for assistance in the field, and Oklahoma Department of Corrections for access to the ponds where the above observations were made.

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SERPENTES

AGKISTRODON PISCIVORUS LEUCOSTOMA (Western Cottonmouth). **BEHAVIOR**. *Agkistrodon piscivorus leucostoma* is highly nocturnal during summer months in the Missouri Ozarks (Johnson 2000. The Amphibians and Reptiles of Missouri. Missouri Department of Conservation, Jefferson City. 339 pp.). Aggregations of *A. p. leucostoma* have been documented denning (Dundee and Burger 1948. Nat. Hist. Misc. 21:1–2) and feeding (Keiser 1993. Herpetol. Rev. 24:34), but not basking.

On 12 August 2004 we observed an aggregation of three similar-sized *A. p. leucostoma* basking on the root system of an overturned tree located on a gravel-bar, near the shoreline of the North Fork of the White River, Ozark Co., Missouri. The root system extended about 0.5 m in height above the gravel-bar and had been invaded by vegetation along one side, creating sun mosaics within the lower portions. The three snakes were coiled and basking on the top of the root system. Two recently shed individuals flashed their mouths and retreated into a more secure area within the root system upon disturbance. On 14 August 2004, five individuals were observed on the same root system. Two snakes on top had just shed and were coiled over the body of a third. The two remaining snakes had opaque eyes and were lower, coiled within the root system in dappled sunlight. Both observations occurred at ca. 1500 h on overcast days with high temperatures of 20°C (below the average daytime high temperature for August of 27°C). Based on size, all of these snakes appeared to be about two years old (MAN, unpubl. data). We did not observe any abundant food source, thus there was no indication that these were feeding aggregations. We made more diurnal observations of cottonmouths on these two days (eight observations) than were made over 179 days during a survey in the same area (MAN, unpubl. data).

Funding was provided by the Saint Louis Zoological Park and the Reptile and Amphibian Conservation Corps.

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AGKISTRODON PISCIVORUS PISCIVORUS (Eastern Cottonmouth). **PREDATION**. Numerous avian predators, primarily wading birds and raptors, are known to feed on juvenile *Agkistrodon piscivorus* (Gloyd and Conant 1990. Snakes of the *Agkistrodon* Complex: A Monographic Review. SSAR, Oxford, Ohio. 614 pp., and references therein; Ernst 1992. Venomous Reptiles of North America. Smithsonian Institution Press, Washington, D.C., 236 pp.; Mitchell 1994. Reptiles of Virginia. Smithsonian Institution Press, Washington, D.C., 352 pp.). Here, we provide the first report of juvenile *A. p. piscivorus* predation by a passerine.

On 14 March 2006 at 1640 h, while driving on a dirt road within the Donnelly Wildlife Management Area (WMA), Colleton Co., South Carolina, USA, we encountered an adult crow (*Corvus* sp.) subduing a juvenile *A. p. piscivorus* (273 mm SVL, 326 mm TL) on the road edge adjacent to a large pond (32°41'48"N, 80°36'12"W). The crow was manipulating the snake by the head with its bill, but upon our approach released the snake and flew to a nearby tree. The snake suffered trauma to its head, particularly the left eye and jaw, and within ca. 10 min of our arrival the snake died. The fresh condition of the snake, the limited road traffic in the WMA, and the absence of any trauma normally associated with road injuries (e.g., crushed body, torn skin, viscera protruding from mouth or vent) suggested that the snake had been killed by the crow. A bulge in the snake's abdomen indicated the animal had recently eaten, and palpation of the stomach contents revealed a partially digested frog (likely *Rana clamitans*), which had been swallowed head-first. Voucher photographs of the snake and frog were deposited in the Campbell Museum, Clemson University, Clemson, South Carolina (CUSC 2314).

Birds of the family Corvidae (jays and crows) are generalist predators that feed on a variety of vertebrates, including snakes (Bent 1947. Life Histories of North American Birds. Jays, Crows, and Titmice. Bull. 191, U.S. Nat. Mus, Washington, D.C., pp. 226–257). Thus, predation of juvenile cottonmouths by large corvids such as crows is not unexpected.

We thank Stanlee Miller of the Campbell Museum, Clemson University for archiving voucher materials.

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AGKISTRODON PISCIVOROUS PISCIVOROUS (Eastern Cottonmouth). **BRUMATION.** *Agkistrodon piscivorous* is one of the last snakes to begin brumation in our area, sometimes waiting until the first heavy frost of winter to move to higher ground to hibernate in stumps (Gloyd and Conant 1990. Snakes of the *Agkistrodon* Complex. A Monographic Review. SSAR, Oxford, Ohio. 614 pp.). Between ca. 1245 h and 1345 h on 27 November 2005, three *A. piscivorous* were seen on the grounds of the Sumter High School Environmental Education Center (33°53.748'N 80°23.604'W), Sumter, South Carolina, USA. The first was a juvenile perched ca. 1.5 m above the water line on the steep bank of a free flowing ditch. The snake fled into the bank when approached. The second snake was a larger female (1030 mm SVL, 590 g)

found coiled on the northwest side of a small island under an observation tower. The third snake was a smaller female (760 mm SVL, 426 g) found on a moderately traveled path on an east-facing bank.

The latter two snakes did not flee when approached. The location of these two snakes was checked daily at ca. 1430 h and their location and position noted. During the observation period (27 November 2005 to 21 December 2005) both snakes remained exposed in the same general location (within 2 m^2 of the original location). Sometimes the snakes were found coiled and sometimes stretched out. The average temperature during this time was 9.6°C with frost events occurring on 2, 6, 10, 11, 13, and 20 December (total time below freezing was ca. 52 h over the observation period). During the measuring process neither snake displayed defensive behaviors. Head tracking was observed, but the snakes did not vibrate their tails, gape their mouths, musk, or assume defensive coils. The second snake was last observed at 1045 h on 21 December 2005. She swam away at a moderate speed upon approach (water temperature 6.2°C). The third snake was last observed at 1730 h partially submerged in the water (5.9°C).

Previous records of *A. piscivorous* activity in December (Gloyd and Conant, *op. cit.*) have attributed their presence to unusually warm periods in winter. This is obviously not the case here. The presence of *A. piscivorous* in December following six frost events suggests that these snakes may be more cold tolerant than previously thought. There may also be a bioenergetic advantage to female snakes that can tolerate colder temperatures. Zaidan et. al. (2003. Copeia 2003:231–240) noted that parturition in *A. piscivorous* occurs in August or September, potentially leaving a short time for the snake to prepare energetically for brumation. Females that are capable of foraging at colder temperatures would then have a selective advantage over the snakes that entered brumation earlier. There could be, however, an energetic disadvantage to snakes that are active too late into the colder months (M. Dorcas, pers. comm.) because of their inability to properly digest food items at cold temperatures.

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ALSOPHIS PORTORICENSIS ANEGADAE (Puerto Rican Racer). **SCAVENGING**. Evidence for scavenging by pit vipers and aquatic species continues to accumulate (DeVault and Krochmal 2002. Herpetologica 58:429–436), but cases of terrestrial colubrids feeding on carrion are much less common. On 23 September 2005 at 1150 h we captured a male *Alsophis portoricensis angadae* (560 mm SVL, 82.5 g) within a hotel complex (18.4793ºN, 64.5781ºW) on Guana Island, British Virgin Islands. It had recently ingested a relatively large food item of unusually angular shape, which we obtained by forced regurgitation (Fig. 1). The ejected food items consisted of two chicken bones (a humerus weighing about 5 g and about half of an ulna, weighing about 1 g) which we deposited in the Yale Peabody Museum (YPM F-4171-2). The snake was released at the site of capture. Chicken wings are provided to workers at a construction site located about 70 m from the capture site and leftovers are often discarded in the nearby brush. Based on the state of digestion, which had left few traces of meat on the bones, the snake had likely encountered the bones very recently. *Anolis cristatellus*, a major component of the diet of the racer, is abundant at the site, thus lack of food is unlikely to have been a factor. Although scavenging is not a large part of the diet of *A. portoricensis*, this observation suggests that some snake species have greater dietary flexibility than often believed.

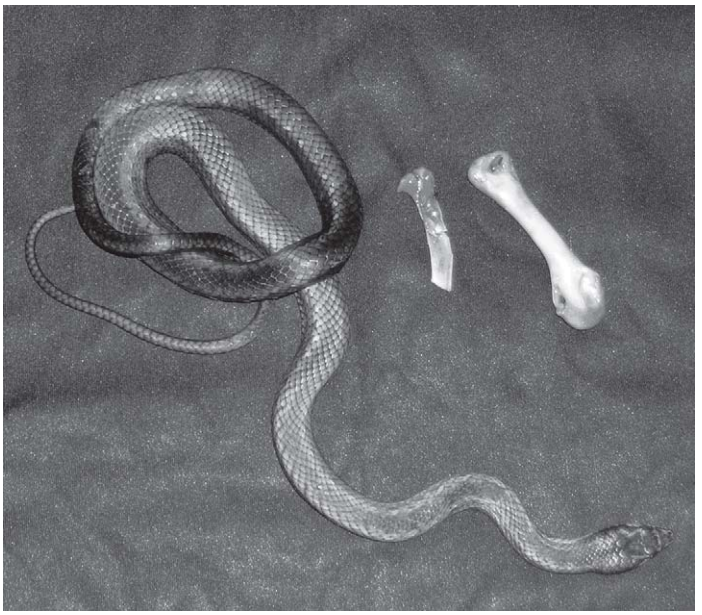


FIG. 1. *Alsophis portoricensis* and chicken bones it regurgitated.

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CLELIA RUSTICA (NCN). **REPRODUCTION**. Maximum clutch size for *Clelia rustica* is reported as eight eggs (Achaval 1973. Trab. V. Congr. Latinoam. Zool. 1:17–29; Vaz-Ferreira et al. 1973. Trab. V Congr. Latinoam. Zool. 1:232–244; Cei 1993. Mus. Reg. Sci. Nat. Torino 14:1–949). An adult specimen collected 19 December 2004 at Parque Rivera (Departamento Montevideo, Uruguay) laid thirteen eggs (mean dimensions = 41 × 22 mm, mean mass = 11.72 g) on 27 December 2004. Twelve neonates (mean SVL = 257.9 mm; mean mass = 7.49 g) hatched after 68–71 days of incubation. Two specimens were sacrificed and along with the unhatched egg were deposited in Colección Zoología Vertebrados, Reptiles (ZVC-R), Facultad de Ciencias, Montevideo (ZVC-R 6300-6302).

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COLUBER CONSTRICTOR MORMON (Western Yellow-bellied Racer). **CANNIBALISM**. Cannibalism has been reported for multiple subspecies of racers including *C. c. constrictor* (Conant 1938. Amer. Midl. Nat. 20:53), *C. c. priapus* (Hamilton and Pollack 1956. Ecology 37:519–526; Jackson 1971. J. Herpetol. 5:196), and *C. c. flaviventris* (Fitch 1963. Univ. Kansas Publ. Mus. Nat. Hist. 15:351–468). Here, we report cannibalism by *C. c. mormon*. On 21 August 2006 at 1810 h, we encountered an adult (678 mm SVL) *C. c. mormon* in the act of ingesting another snake (headfirst) on a hillside adjacent to Greenwood State Beach, Mendocino Co., California, USA (39º07'40"N, 123º42'56"W). Approximately 10 cm of the ingested snake's tail protruded from the mouth of the predator and was securely wrapped around a poison oak (*Toxicodendron diversilobum*) stem, deterring further ingestion. The predator vigorously struggled to pull the snake's tail free, but was unsuccessful. After 15 min, we carefully extracted the racer from among the dense vegetation to obtain a body measurement and voucher photograph. In doing so, the ingested snake, still secured to the plant stem by its tail, was released from the racer's grasp and pulled completely free from the racer's gut. The partially ingested snake was an apparently unharmed (no visible bite marks) *C. c. mormon* (436 mm SVL) and was immediately active and seemingly alert upon removal from the larger racer. Voucher photographs of the two snakes were taken (CUSC 2348; Campbell Museum, Clemson University) and both snakes were released at the capture site. Cunningham (1959 Herpetologica. 15:17–19) reported consumption of conspecifics by captive *C. c. mormon*, but to our knowledge this is the first reported observation of cannibalism by this species in the wild.

We thank Stanlee Miller of the Campbell Museum, Clemson University for archiving the voucher photographs.

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CROTALUS AQUILUS (Queretaran Dusky Rattlesnake). **MAXIMUM SIZE**. The maximum total length recorded for *Crotalus aquilus* is 678 mm, but most adults are less than 500 mm (Campbell and Lamar 2004. The Venomous Reptiles of the Western Hemisphere. Cornell University Press, Ithaca, New York. 870 pp.). During July and August of 2006 we measured three adult male *C. aquilus* that exceed the previously reported maximum size. All three were found near Acambay, Estado de México, México at an elevation of ca. 2510 m. We preserved a male captured on 12 July 2006 with a total length of 681 mm (618 mm SVL, 63 mm tail length, 237.3 g). This specimen was deposited in the herpetological collection of the Museo de Zoología de la Facultad de Ciencias at the Universidad Nacional Autónoma de México (MZFC 19258). Additional males captured on 5 August 2006 (619 mm SVL, 66 mm tail length, 203.4 g) and 6 August 2006 (633 mm SVL, 61 mm tail length, 230.7 g) also exceeded the previously reported maximum length. Because three of 17 male *C. aquilus* exceeded the recorded maximum length, we suggest that animals of this size are not unusual at this location.

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CROTALUS AQUILUS (Queretaran Dusky Rattlesnake). **MORTALITY**. In México, forest fires follow one of two seasonal patterns. In most of the country, the fire season runs from January to June, but in northeastern México the fire season begins in May and ends in September. Both fire seasons coincide with the dry season (SEMARNAP 2000. Texto Guía Forestal. Subsecretaría de Recursos Naturales, Dirección General Forestal-SEMARNAP. México, D.F., 150 pp.). Forest fires have the potential to negatively affect forest faunas, and in particular, amphibians and reptiles (Bury 2004. Conserv. Biol. 18:968–975). Fire-induced formation of light gaps in forest canopies can favor certain reptiles, but reptiles may also have greater difficulty finding refuge in fire-affected sites (Bury, *op. cit*.; Ernst et al. 1995. Herpetol. Rev. 26:185–187). However, few data exist indicating the vulnerability of reptiles in Mexico. Hence, here we provide an observation from the Mexican state of Hidalgo suggesting that *Crotalus aquilus* may sometimes be at risk from fires.

During a visit to the state of Hidalgo at 0030 h on 16 July 2005, we found a *C. aquilus* in an area known as El Calicanto at kilometer 13.5 on Highway 105 between Pachuca and Tampico, municipality of Mineral del Chico (20º09'01"N, 98º40'51"W, elev. 2590 m, NAD27). The area lies in the Sierra de Pachuca and has a mixed oak (*Quercus*) forest vegetation with *Q. laurina*, *Q. affinis*, *Q. mexicana*, and *Pinus teocote* present. The snake, a juvenile female (270 mm SVL; 18 mm tail length), died a few days later. The tail, which was missing the rattle, appeared burned to a distance 22 mm anterior to the vent, and displayed wrinkled and infected tissue dorsally. Although we did not weigh the snake, she appeared emaciated.

During 12–23 June 2005, a forest fire had swept through this entire area (Jimenez-Rosenberg et al. 2004. Biodiversitas 52:1–10). The appearance of the snake suggested that it was either exposed to fire directly or to a hot substrate. Our visit to the site occurred about a month after the fire, and we suggest that this animal survived the fire but succumbed from fire-related injuries.

The *C. aquilus* (ITAH1278) was deposited in the herpetological collection of the Instituto Tecnologico Agropecuario de Hidalgo, Mexico.

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CROTALUS AQUILUS (Queretaran Dusky Rattlesnake). **REPRODUCTION**. Published reports of litter size in *Crotalus aquilus* are few, although Armstrong and Murphy (1979. The Natural History of Mexican Rattlesnakes. Univ. Kansas Mus. Nat. Hist. Spec. Publ. 5:1–88) reported that litter size ranged from 6–7 young that ranged in size from 153–177 mm SVL. On 03 March 2004 a gravid female *C. aquilus* (459 mm SLV, 139.55 g) was collected by Jessica Cortes, in Cerro del Tenayo, Estado de México, México. She was maintained in captivity (Laboratorio de Herpetología de la Facultad de Estudios Superiores Iztacala, UNAM) on a diet of mice. On 26 March she gave birth to six live offspring. The neonates averaged 161.3 ± 6.0 (range 134–177) mm SVL and 4.8 ± 0.3 g (range 4.4–5.1) g in mass. Relative clutch mass (Vitt and Price 1982. Herpetologica 38:237–255) was 0.271.

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CROTALUS MOLOSSUS MOLOSSUS (Northern Black-tailed Rattlesnake). **DIET.** Many snake species are known to prey upon bats, primarily by capturing them while they are roosting, although some snakes capture flying bats that are either emerging or returning from roosts or while the bats are foraging (Hutson et al. 2000. Microchiropteran bats. IUCN Global Status and Conservation Action Plan. IUCN/SSC Chiroptera Specialist Group. IUCN, Gland, Switzerland). The only rattlesnakes known to prey on bats are *Crotalus helleri* and *C. horridus* (Klauber 1972. Rattlesnakes: Their Habits, Life Histories, and Influence on Mankind, Second Edition. University of California Press, Berkeley, California; Uhler et al. 1939. *In* Transactions of the Fourth North American Wildlife Conference, pp. 605–622. Washington, D.C.). Here we report an instance of predation by *Crotalus m. molossus* on Pallid Bats (*Antrozous pallidus*). At ca. 0200 h on 17 September 2006, in Brewster Co., Texas, USA (NAD 1927, 029°39'N, 103°06'W, ca. 742 m elev.), we watched an adult *C. m. molossus* striking at Pallid Bats flying in and out of a roadway bridge. A small colony of bats were roosting in the internal structure of the bridge. The snake was positioned on the bridge at the edge of the pavement with its anterior extended into the air near where the bats were flying in and out of the culvert. We captured the snake and palpated a single recently ingested bat from its stomach. Lumps present in the snake (but not palpated) suggest additional recently ingested food items.

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CROTALUS WILLARDI AMABILIS (Del Nido Ridge-nosed Rattlesnake). **DIET**. The diet of *Crotalus willardi* is known to include mice, lizards, centipedes, and birds (Holycross et al. 2002. *In* Schuett et al. [eds.], Biology of the Vipers, pp. 243–252. Eagle Mountain Publishing, Eagle Mountain, Utah). However, there are only a few diet records for *Crotalus willardi amabilis*. These include a Southern Pocket Gopher, *Thomomys umbrinus* (Bryson and Holycross 2001. Herpetol. Rev. 32:262), the mention of a rodent in one stomach (Smith et al. 2005. Bull. Chicago Herpetol. Soc. 40:210), and mention of unidentified rodent hairs in the scat of wild specimens (Armstrong and Murphy 1979. The Natural History of Mexican Rattlesnakes. Univ. Kansas Mus. Nat. Hist. Special Publ. 5:1–88).

Here we report the presence of an adult squirrel (*Tamias dorsalis*) in the stomach of an adult female *C. w. amabilis* (Colección de Anfibios y Reptiles del Laboratorio de Ecología de la Unidad de Biología, Tecnología y Prototipos, LE-UBIPRO 14490). The snake was collected 21 September 2005 at the bottom of a deep canyon near the crest of the Sierra del Nido, Chihuahua (29º29'37.7"N, 106º43'21.8"W, 2550 m elev.). The squirrel was at least twice the normal diameter of the snake's body.

We thank David Armstrong for identifying the squirrel.

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CROTALUS WILLARDI (Ridge-nosed Rattlesnake). **REPRODUCTION**. On 8 August 2004, one of us (KS) encountered a gravid female *Crotalus willardi* (453 mm SVL, 43 mm tail length, 99.1 g) in the northern Sierra San Luis, Sonora, México (31º17.2'N, 108º46.2'W, 2104 m elev.). Surrounding habitat consists of young oak woodland-scrub regenerating from a 1989 wildfire. The female was maintained in captivity until parturition on 30 August 2004. On the morning of 30 August, the female gave birth to four live healthy neonates, and a single live deformed neonate. The four healthy neonates were measured, weighed and sexed (172, 181, 172, 176 mm SVL; 5.5, 6.8, 6.1, 6.2 g; sex male, male, female, female). The deformed neonate was eyeless, smaller than siblings, had failed to completely absorb available yolk prior to birth, weighed 4.1 g, and died soon after birth. The female weighed 63.5 g immediately following parturition. Relative clutch mass (including 1.9 g of undigested yolk) was 0.31. This litter was born later in the year than all but one previously reported parturition event (Holycross and Goldberg 2001. Copeia 2001:473–481). Clutch size and neonate sizes fall within previously reported ranges (Holycross and Goldberg, *op. cit.*)

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CROTALUS WILLARDI (Ridge-nosed rattlesnake) **DIET.** *Crotalus willardi* are known to consume small mammals, lizards, centipedes, and birds (Holycross et al. 2002. *In* Schuett et al. [eds.], Biology of the Vipers, pp. 243–252. Eagle Mountain Publishing, Eagle Mountain, Utah). To date, only six accounts of avian prey items have been recorded from the diet of *C. willardi*, five from *C. w. obscurus* in the Animas Mountains and the Sierra San Luis (Holycross et al., *op. cit.*), and an additional record from *C. w. willardi* in the Huachuca Mountains (Parker and Stotz 1997. Bull. Maryland Herpetol. Soc. 13:123). Three of these prey items were identified to species, all small passerines; *Aimophila ruficeps*, *Myadestes townsendi*, and *Wilsonia pusilla* (Parker and Stotz, *op. cit.*; Holycross et al., *op. cit.*).

Here we report another observation of avian predation by *C. willardi*. At 1640 h on 4 October 2003, one of us (EMD) observed an adult female *C. willardi* (465 mm SVL, 78.8 g) attempting to ingest an adult male Hermit Thrush (*Catharus guttatus*) (30.1 mm tarsus length, 101.6 mm wing chord length, 153 mm total length). The snake was found beneath a manzanita shrub within a meter of a small pool of a mostly dry intermittent stream in the northern Sierra San Luis (Chihuahua, México; 31°17.3'N 108° 45.5'W, 2068 m elev.). The snake regurgitated the thrush when we disturbed it. However, because the widest part of the bird's body had already been ingested, we believe the snake would have been able to completely swallow the bird had it not been disturbed. Feces obtained while processing this snake contained feathers, suggesting that the snake had consumed a bird prior to the witnessed attempt. The thrush was deposited in the Colección de Aves of the Museo de Zoología de la Facultad de Ciencias, Universidad Nacional Autónoma de México (MZFC 19304).

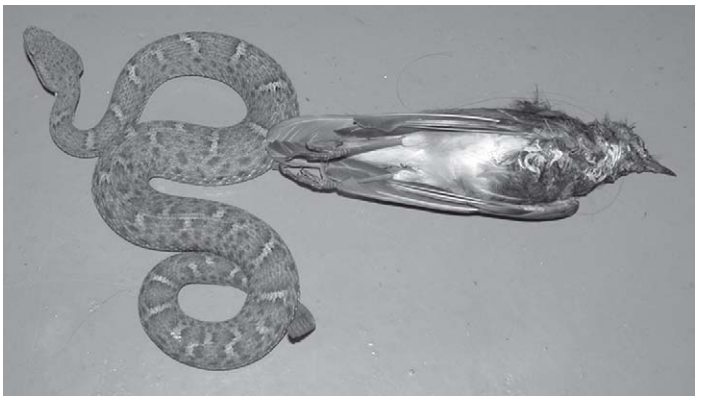


FIG. 1. Female *Crotalus willardi* with a male *Catharus guttatus* she attempted to swallow.

We thank José León Pérez, Alejandro Gordillo, Eric Garcia Trejo, Luis Antonio Sánchez, and the Rocky Mountain Research Station, U. S. Forest Service for assistance.

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ELAPHE CARINATA CARINATA (Keeled Rat snake). **DIET.** Keeled rat snakes appear to be dietary generalists and have been known to prey on mice, rats, birds, bird eggs, frogs, lizards, snakes and reptile eggs (Schulz 1996. A monograph of the Colubrid snakes of the genus *Elaphe* Fitzinger. Koeltz Scientific Books, Würselen, Czechoslovakia. 439 pp.).

In September 2004 a monitoring program was initiated in a wetland habitat near an industrial park of Taoyuan County, northern Taiwan. We collected YOY *Elaphe carinata carinata* with prey items in their stomachs in permanent drift fence/funnel traps on 18 February, 26 March and 31 March, 2 males (391 and 393 mm SVL, 28 and 33 g) and 1 female (410 mm SVL, 37.7 g), respectively. The fence was set along the bank of a pond, where the dominant vegetation consists of *Bambusa oldhamii*, *Broussonetia papyrifera*, *Lantana camara*, and *Pennisetum purpureum*. Forced regurgitation revealed that the snakes had consumed one *Crocidura attenuata* (Tanaka's Gray Shrew), two newborn *Apodemus agrarius* (Formosan Striped Field Mouse), one *Laevicaulis alte* (garden slug), and one *Takydromus stejnegeri* (Stejneger's Grass Lizard). In Taiwan, a chick, a beetle (Scarabaeidae), a grasshopper (Acridiidae), a damselfly (Euphaeidae) (Lin et al. 1995. Foods of snakes from Taiwan. NOW 3:19-21), *Dinodon rufozonatum* (Lee and Lue 1996. A preliminary study on the food habits of snakes in Taiwan. Biol. Bull. National Taiwan Normal University. 31:119-124), *Ptyas mucosus* (Hsien-Pin Chu, pers. comm.), and *Rattus rattus* (Norval *pers. obs.*) have been recorded as prey of *Elaphe carinata carinata*. To our knowledge this appears to be the first record of this snake species preying on shrews and land slugs.

We thank Ying-Ping Fang and Wei-Shin Jenq for assistance with identifications.

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ELAPHE VULPINA (Western Foxsnake). **HABITAT USE**. *Elaphe vulpina* is a state endangered species (Missouri Dept. Conservation 2006. Missouri Species and Communities of Conservation Concern, Jefferson City, Missouri. 58 pp.) that occurs in northern Missouri, including Squaw Creek National Wildlife Refuge (SCNWR). Past research conducted on SCNWR suggests this spe-

cies avoids wetland centers and is associated with wetland prairies, wetland edges and developed lands (Shew 2004. Spatial Ecology and Habitat Use of the Western fox Snake (*Elaphe vulpina vulpina*) on Squaw Creek National Wildlife Refuge. Masters thesis. Southwest Missouri State University, Springfield, Missouri. 51 pp.). Although observations have been made of this species preying upon duck nests on wetland edges (Wheeler 1984. Wildl. Soc. Bull. 12:77–78), they have not been reported to utilize wetland centers containing relatively deep water habitat (> 90cm).

During the period of May through mid-June 2005 and 2006, ca. 50 *E. vulpina* were observed utilizing deep water wetland habitats in a 239-ha marsh located on the southwest portion of SCNWR, Holt County, Missouri, USA. Individuals were typically observed in cattail (*Typha* sp.) patches coiled on Red-wing Blackbird (*Agelaius phoeniceus*) and Yellow-headed Blackbird (*Xanthocephalus xanthocephalus*) nests, ca. 60–90 cm above the surface of the water. Using a geographic information system we calculated that the snakes had to swim a minimum of 130 m to reach the cattail patches where they were located. Utilization of this habitat type has been observed on SCNWR annually since 2001 by refuge staff members.

Although *E. vulpina* were never observed feeding on eggs or nestlings, depredation was suspected as this appears to be one of the major food resources in this habitat type during this time period which coincides with nesting period of several bird species. The three dominant species of arboreal nesting birds located in this habitat include the aforementioned blackbirds and Least Bittern (*Ixobrychus exilis*). Additionally, five other species of platform nesting birds may also be found in this habitat including Piedbilled Grebe (*Podilymbus podiceps*), American Bittern (*Bontaurus lentiginosus*), Ruddy Duck (*Oxyura jamaicensis*), American Coot (*Fulica americana*), and Common Moorhen (*Gallinula chloropus*). The eggs and nestlings of all of these species represent potential prey items. Cattail patches as well as other deep water wetland vegetation may play a more significant role in the spatial ecology of the species than previously suspected. This relationship is likely on a temporal basis that coincides with wetland breeding bird activity. Further research on the habitat use of *E. vulpina* within managed wetlands may prove useful in fully understanding the ecology of this species.

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FARANCIA ABACURA REINWARDTII (Western Mud Snake). **REPRODUCTION**. Information regarding reproduction of *Farancia abacura reinwardtii* is limited due, in part, to its secretive habits. Specifically, copulation has only been reported once, by Anderson (1965. The Reptiles of Missouri. Univ. Missouri Press, Columbia. 330 pp.). Herein, we report on copulation of *F. a. reinwardtii* from Reelfoot Lake, Lake County, Tennessee, USA.

On 05 June 2005 at 1100 h, we observed (from a boat) a large (142 cm SVL, 162 cm TL) *F. a. reinwardtii* on the northwest bank of Horse Island Ditch at Reelfoot Lake, Tennessee (36º24'57"N, 89º22'30"W, NAD27). Upon approach, we noticed that the snake was copulating with a smaller individual. We captured the pair after 2–3 minutes of observation, and discovered that the larger individual was a dead, bloated female. The pair was transported, *in coitus*, to the University of Tennessee-Martin Reelfoot Lake Research and Teaching Center at Samburg, Tennessee. Copulation continued until 1430 h, when the smaller male separated from the dead female. The male (ca. 95 cm TL) was returned to the point of capture the following day. The female was deposited into the Herpetology Collection at Middle Tennessee State University (MTSU 178S).

We could determine neither the cause nor timing of death of the female, or if copulation was initiated before or after the female died. Although from the bloated appearance of the female, we speculate post-mortem initiation of copulation. In field experiments, several snake species have followed chemical trails left by (and courted with) recently deceased females (Shine et al. 2000. Behaviour 137:727–739). Besides providing an additional observation of post-mortem copulation, our observation on 05 June appears to be the earliest report of copulation for *F. a. reinwardtii*. Copulation in Western Mud Snakes has been observed as early as 13 June in southeastern Missouri (reported by Max Nickerson in Anderson 1965, *op. cit.*). Additionally, this observation supports the conclusions of Robinette and Trauth (1992. Proc. Arkansas Acad. Sci. 46:61–64) that the reproductive cycles of both male and female *F. a. reinwardtii* peak in May and June. Research was supported by a grant to VAC from the Tennessee Wildlife Resources Agency (Contract Num. ED-05-01679-00). Specimen was collected under authorization of the Tennessee Wildlife Resources Agency (permit no. 1798).

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LAMPROPELTIS PYROMELANA (Sonoran Mountain Kingsnake). **PIGMENT LOSS.** On 22 September 2003 we captured a normally pigmented adult female *Lampropeltis pyromelana* (622 mm SVL, 74.0 g) in the northern Sierra San Luis (Chihuahua, México; 31°18.1'N, 108°45.9'W, 1878 m elev.). We surgically implanted a radio transmitter, and released her on 27 September 2003. Between 28 September and 2 November 2003 we relocated this individual five times, however we observed her only once, on 2 November, at which time she weighed 71.3 g, and remained normally pigmented. We next relocated this snake on 17 May 2004. Although she had lost considerable weight (mass 59.6 g), and had an open, dry wound along her side exposing a small section of the transmitter antenna, the snake seemed to be in good health otherwise, and exhibited no signs of infection or systemic disease. However, she had lost some pigment. Most orange bands exhibited areas where the orange had been replaced by an uneven alabaster to faded salmon coloration. Pigment loss was most severe dorsally, with pigment loss extending down towards the venter in some bands. Most white bands were unchanged, however small areas along the dorsum of some bands had changed from cream to alabaster. Black bands were unaffected by any pigment loss. Coloration on both the head and tail remained unchanged.

Mid-body bands were more severely impacted than were bands closer to the snake's head and tail. The snake's venter remained normally pigmented along the length of the snake. Pigment loss was not centered at the site of the surgical scar, nor did the snake display any natural wounds or evidence of skin disease. We removed the transmitter from this individual on 18 May 2004 and did not again observe her after her release. Hence, we cannot speculate on the permanence of this color change. We observed 28 other *L. pyromelana* in the Sierra San Luis and contiguous areas of the Sierra Pan Duro during 2002–2004, all of which were typically colored.

We thank Rocky Mountain Research Station, U. S. Forest Service for funding.

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LEPTOTYPHLOPS BORRICHIANUS (NCN). **PREDATION**. *Leptotyphlops borrichianus* is known from La Rioja, San Juan, Mendoza, and Rio Negro provinces in Argentina (Cei 1993. Reptiles del centro, centro-oeste y sur de la Argentina. Herpetofauna de zonas áridas y semiáridas. Mon. IV Mus. Reg. Sci. Nat. Torino. 524 pp). Here we report an incidence of predation on *L. borrichianus* in San Juan, Argentina (31°31'44"S, 68°41'44"W). A male (140 mm SVL) *L. borrichianus* was discovered in the stomach of a male *Bufo arenarum* (89 mm SVL) during the course of a dietary study. The *B. arenarum* had been collected from a desert shrubland dominated by *Prosopis* sp., *Bulnesia retama, Solanum eleagnifolium*, *Caparis atamisquea*, *Grabousquia obtusa*, and *Tamarix gallica.*

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LIOPHIS MILIARIS (Common Water Snake). **PREY**. In the wild *Liophis miliaris* feeds on a wide array of ectothermic prey, including a variety of amphibians (adults, larvae, and eggs), lizards, amphisbaenids, and fish (Michaud and Dixon 1989. Herpetol. Rev. 20:39–41; Chicarino et al. 1998. XXII Congresso Brasileiro de Zoologia, Recife 271–272). In August 2005 we collected a juvenile female of *L. miliaris* (310 mm SVL, 70 mm tail length, 16.3 mm head length; 10 g) moving along an unpaved road at Caucaia do Alto, São Paulo, Brazil (23°41'S, 47°01'W, 895 m elev.). The snake contained a recently ingested juvenile *Bufo ornatus* (29 mm SVL, 1.3 g). To the best of my knowledge, this species has not been previously documented in the diet of *L. miliaris*. Both specimens are deposited in the Coleção Herpetológica "Alphonse Richard Hoge," São Paulo, Brazil (IBSP 73.469).

I thank Valdir José Germano (IBSP) and Jorge Jim (UNESP, Botucatu) for assistance.

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LYSTROPHIS HISTRICUS (Rayed or Jan's Hog-nosed Snake). **DIET.** No specific prey records have been published for *Lystrophis histricus*, probably because the species is scarce throughout its distribution and poorly represented in zoological collections. Several authors suggest that amphibians appear in the diet (Amaral 1977. Serpentes do Brasil: Iconografia Colorida. Univ. São Paulo, Ed. Melhoramentos, Inst. Nac. Do Livro y Universidade de Sao Paulo. 248 pp.; Schouten 1931. Rev. Soc. Ci. Paraguay 1:5–32) but do not cite specific records.

We discovered prey remains in the guts of two of three specimens held in the Uruguay Museum of Natural History collection (MNHN). A male (MNHN 58; 270 mm SVL) collected in 1914 in Departmento Maldonado contained two reptilian eggs (11 × 5 mm and 10 × 6 mm). A female (MNHN 87; 249 mm SVL) collected on 23 March 1935 in the Departmento Cerro Largo contained one eggshell that measured ca. 25 mm length. Based on the comparison with reptile eggs deposited in the Faculty of Sciences Collection, we believe that the eggs eaten by MNHN 58 are *Cercosaura schreibersii* (supported by number of eggs, size, color, and shape). The shell found in MNHN 87 appears to be than of an amphisbaenid (based on shape and size). These observations indicate that the diet of *L. histricus* includes the eggs of other reptiles.

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MASTICOPHIS SCHOTTI SCHOTTI (Schott's Whipsnake). **MAXIMUM SIZE RECORD**. *Masticophis schotti schotti* is a large, long-tailed (to 38% TL), boldly striped whipsnake inhabiting arid scrub and grassland throughout south central Texas in the United States westward through eastern Coahuila, northern Nuevo Leon, and extreme northern Tamaulipas, Mexico (Camper 1996. Cat. Amer. Amphib. Rept. 638.1–638.4). The maximum size listed for *M. s. schotti* is 1676 mm total length (Boundy 1995. Bull. Chicago Herpetol. Soc. 30:109–122.; Conant and Collins 1998. A Field Guide to Reptiles and Amphibians: Eastern and Central North America. 3rd ed. Houghton Mifflin Company, Boston, Massachusetts. 616 pp.). However, no supporting information exists for this record (locality and date of collection or disposition of the specimen). Herein, we report a new maximum size record for this species.

On 30 September 2005 at 1750 h an exceptionally large female DOR *Masticophis schotti schotti* was collected on Sage Road ca. 120 m east of the junction with farm road 1898 (27°32.292N, 097°52.589W) Kleberg County, Texas, USA. The specimen measured SVL 1169 mm, TL 1681 mm. This exceeds the maximum length previously recorded for this species. The specimen is deposited in the Laboratory for Environmental Biology, Centennial Museum, University of Texas at El Paso (UTEP 19302).

Submitted by **RANDY L. POWELL** (e-mail: randy.powell@tamuk.edu), **M. ANDRES SOTO**, **MICHAEL L. LEIDNER**, and **WENDY R. AUSTIN**, Department of Biology, Texas A&M University-Kingsville, Texas 78363-8202, USA.

MICRURUS ALTIROSTRIS (Southern Coral Snake). **DIET**. The diet of South American coral snakes includes amphisbaenians, lizards, snakes, caecilians, fishes and invertebrates (Souza et al. 2003. Herpetol. Rev. 34:151). *Micrurus altirostris* is a semifossorial species that feeds primarily on amphisbaenids of the genus *Amphisbaena*, and terrestrial, fossorial and semifossorial snakes and lizards (Carreira et al. 2005. Reptiles de Uruguay. Ed. Dirac – Facultad de Ciencias, Montevideo. 639 pp.).

We examined an adult male *M. altirostris* deposited in the Museu de Ciências Naturais da Fundação Zoobotânica do Rio Grande do Sul (MCN 3866, 755 mm total length) and discovered a specimen of *Sordellina punctata* (357+ mm total length) in its stomach. MCN 3866 was probably collected in the state of Rio Grande do Sul, Brazil, though specific collection data are not associated with the specimen. The prey was swallowed headfirst and its head was completely digested. *Sordellina punctata* is a diurnal, semiaquatic snake that feeds on earthworms (Marques et al. 2001. Serpentes da Mata Atlantica - Guia Ilustrado para a Serra do Mar. Ed. Holos, São Paulo, 184 pp.). This is the first record of *Sordellina punctata* in the diet of *Micrurus altirostris.*

We thank Moema Leitão de Araujo, Nelson R. de Albuquerque, and the Conselho Nacional de Desenvolvimento Científico e Tecnológico for assistance.

Submitted by **LUÍS FELIPE S. AGUIAR** (e-mail: lufecotiara@yahoo.com.br) and **MARCOS DI-BERNARDO***, Laboratório de Herpetologia, Museu de Ciências e Tecnologia y Faculdade de Biociências, Pontifícia Universidade Católica do Rio Grande do Sul, Avenida Ipiranga 6681, 90619-900 Porto Alegre, Rio Grande do Sul, Brazil. * Deceased.

OXYBELIS FULGIDUS (Green Vine Snake). **PREY**. The diet of *Oxybelis fulgidus*, a neotropical, arboreal colubrid, consists of lizards and small birds (Martins and Oliveira 1998. Herpetol. Nat. Hist. 6:78–150). Prior to this report, the largest bird consumed by *O. fulgidus* was a *Thraupis episcopus* (Martins and Oliveira, *op. cit.*) which average 165 mm in length (Hilty and Brown 1984. A Guide to the Birds of Colombia. Princeton University Press, Princeton, New Jersey. 996 pp.).

Here we report predation upon an adult *Monasa nigrifrons* (Black-fronted Nunbird; ca. 280 mm) in March 2002 on the border of a seasonally flooded Amazonian forest at the Mamirauá Sustainable Development Reserve, Amazonas State, in northwest Brazil (03°03'S; 64°50'W). The forest floor was partially flooded by rising waters and the snake was first observed in a tree ca. 3 m above the water at around mid-day. The snake did not constrict the bird, but grasped it near the head and let it hang until it seemed to be dead (Fig. 1), whereupon the bird was ingested head-first. Despite its size the bird was completely ingested in less than 30 min.

We thank the Conselho Nacional de Desenvolvimento Científico e Tecnológico, Setor Mamirauá, M. Menin, and F. Waldez for assistance.



FIG. 1. *Oxybelis fulgidus* killing its prey, *Monasa nigrifrons*. Photo by M. Amend.

Submitted by **WHALDENER ENDO**, **MARCOS AMEND,** and **LEONARDO C. FLECK,** Instituto de Desenvolvimento Sustentável Mamirauá, 69470-000 Tefé, Amazonas, Brazil (e-mail: neotropical@gmail.com).

PITUOPHIS CATENIFER (Bullsnake). **MAXIMUM LENGTH**. The Eastern Indigo Snake (*Drymarchon corais couperi*) has been heralded as the longest native snake in the United States, having been documented to reach 2629 mm TL (Boundy 1995. Bull. Chicago Herpetol. Soc. 30:109–122). Although Dixon (1952. Copeia 1952:193) reported a bullsnake measuring "9ft" (2745 mm), he took this measurement from a skin and not a whole animal (J. Dixon, pers. comm.). In June 1999 one of us (AM) collected a *Pituophis catenifer* near Loma Alta (Val Verde County, Texas, USA) that measured 2667 mm TL on 12 October 2001 after being kept and fed in captivity for ca. 2 years (Fig. 1). This specimen represents a new record for the longest native snake in the United States and extends the record length for the genus *Pituophis* by 127 mm (Boundy, *op. cit.*). A voucher image of this snake has been deposited in the Texas Natural History Collection (TNHC 65425).



FIG. 1. Armin Meier (185 cm) with a *Pituophis catenifer* (2667 mm TL) captured in Val Verde County, Texas.

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PITUOPHIS MELANOLECUCUS LODINGI (Black Pinesnake). **TREE CLIMBING**. On 11 April 2005 a non-gravid female *Pituophis melanoleucus lodingi* was captured on the Camp Shelby Training Site, Forrest Co., Mississippi, USA and implanted with a temperature sensitive radio-transmitter (Hohohil SI-2T). Upon release, the snake immediately climbed an *Ilex vomitoria*, and attained a height of ca. 4 m; it remained in the shrub until we left (~20 min later). When the snake was relocated on 12 May 2005, it was found 2 m off the ground in a *Magnolia virginiana*, it remained motionless until we left. The next day it was located 4–5 m off the ground in an *Ilex vomitoria* and upon our approach it moved into the branches of a *Quercus incana*. On 16 May 2005 this snake was located 4 m off the ground in an *Ilex vomitoria*, and remained motionless while it was photographed. On 8 June 2005 this snake was found dead on the road. Of the 23 observations made of this animal it was found in trees or shrubs on only the four occasions (17%) described above. To the best of our knowledge this is the first report of arboreality for this subspecies.

Submitted by **MELISSA A. OLSEN** and **JAMES R. LEE**, The Nature Conservancy, Camp Shelby Field Office, CSTS-ENV Building 6678, Camp Shelby, Mississippi 39407, USA (e-mail: molsen@tnc.org).

PITUOPHIS MELANOLEUCUS LODINGI (Black Pine Snake). **BEHAVIOR.** When threatened, *Pituophis melanoleucas lodingi* retreat into a defensive coil and hiss loudly (Cook 1943. Snakes of Mississippi. Survey Bull., Mississippi Game and Fish Comm., Jackson, Mississippi. 73 pp.) or attempt to escape into nearby subterranean refugia, most often stump holes (D. Baxley, pers. obs.). The following account is the first record, to our knowledge, of *P.m. lodingi*, seeking an arboreal retreat when threatened. On 30 July 2005 at 1350 h we radio-tracked an adult female *P.m. lodingi* within a recently burned stand of *Pinus palustris* (longleaf pine) adjacent to a mesic bottom-land area in Wayne County, Mississippi, USA. Presumably in response to our presence, the snake moved towards the bottom-land area while the observer recorded locality and temperature data. At 1401 h the snake was observed, hissing loudly, 1.83 m above the ground, coiled in the crook of a *Quercus nigra* (Water Oak). Of 112 previous radio-telemetry location records for six individuals between 24 April and 30 July 2005, no other occurrences of tree use by *P. m. lodingi* have been recorded.

Submitted by **DANNA BAXLEY** (e-mail: Dannaster@yahoo.com) and **CARL QUALLS**, Department of Biological Sciences, University of Southern Mississippi, Hattiesburg, Mississippi 39406-0001, USA.

REGINA RIGIDA SINICOLA (Gulf Crayfish Snake). **DIET**. *Regina rigida* is a secretive snake that inhabits the lowlands of the southeastern United States (Conant and Collins 1991. Reptiles and Ampbihians Eastern/Central North America. Houghton Mifflin, Boston, Massachusetts. 450 pp.). They feed predominately on both soft and hard-shelled crayfish; however, they are also known to prey on fish and amphibians (Ernst and Ernst 2004. Snakes of the United States and Canada. Smithsonian Institution Press, Washington, DC. 680 pp.). On 12 November 2004 we collected three males and one large female (69 cm SVL) in a single aquatic funnel trap placed in a small backwater slough (30.98ºN, 87.92ºW), in the Mobile-Tensaw Delta Wildlife Management Area (MTD) Baldwin Co., Alabama, USA. All four snakes were transported to the University of South Alabama Vertebrate Natural History Museum (USAVNHM) to acquire tail clippings for DNA. Snakes were then placed into separate cages overnight. Early the next morning we noticed the female snake had defecated in her cage, we found her feces to be primarily composed of crayfish pieces. However, upon closer inspection we discovered mammalian hairs and uni-

dentifiable bone fragments in the feces. Given the amount of fur and the presence of bones in the feces we feel it unlikely the hair was secondarily ingested. The hairs were identified as that of a Golden Mouse (*Ochrotomys nuttalli*), a common resident of the MTD. Slides were deposited at the USAVNHM. This is the first record of *Regina* spp. consuming mammalian prey. It is possible the snake mistook the mouse for its normal prey (crayfish). Alternately, large *Reginia rigida* might occasionally take mammalian prey as part of their diet.

We thank Suzanne Peurach of the USGS Patuxent Wildlife Research Center at the Smithsonian Institution for identifying the hairs of the Golden Mouse.

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SIPHLOPHIS PULCHER (NCN). **PREY**. The colubrid *Siphlophis pulcher* feeds primarily on lizards (*Placosoma glabella*, *Hemidactylus mabouia*: Sazima and Argôlo 1994. Herpetol. Rev. 25:126; Prudente et al. 1998. Rev. Bras. Zool. 15:375–383; *Gymnodactylus darwini*, *Tropidurus torquatus*, *Mabuya* sp., *Ophiodes striatus*: Prudente et al., *op. cit.*) and snakes (*Imantodes cenchoa*; Sazima and Argôlo, *op. cit.*). Here we report a new prey record as well as the largest prey/predator mass ratio for this semi-arboreal species. An adult female *S. pulcher* (SVL = 530 mm, tail length = 150 mm, mass = 31 g, IBSP 73308) from Cananéia Island (25º00'S, 47º55'W, 8 m elev.) was collected in remnants of Atlantic Forest in May of 2005 with a freshly eaten *Ophiodes fragilis* (Sauria, Anguidae; SVL = 70 mm, tail = 170 mm, mass = 14 g). The lizard was ingested head first and found in the gut along with its broken tail. Prey/predator mass ratio was ca. 0.451, although the head was partially digested. *Ophiodes fragilis* readily exhibit tail autotomy, we suspect that the tail and lizard were ingested separately. Vouchers of snake and lizard are in the Instituto Butantan, São Paulo, Brazil.

Submitted by **MARCELO RIBEIRO DUARTE**, Laboratório de Herpetologia, Instituto Butantan, CEP 05503-900 São Paulo, SP, Brazil (e-mail: mrduarte@butantan.gov.br); and **MARCO AURÉLIO DE SENA**, Departamento de Genética e Biologia Evolutiva, Instituto de Biociências, Universidade de São Paulo, São Paulo, Brazil (e-mail: mausena@yahoo.com).

STENORRHINA FREMINVILLII (Freminville's Scorpion-Eating Snake). **DIET**. *Stenorrhina freminvillii* is a medium-sized fossorial inhabitant of thorn forest, savannas, and agricultural areas (Lee 1996. The Amphibians and Reptiles from the Yucatan Peninsula. Cornell Univ. Press, Ithaca, New York. 500 pp.). The diet of *S. freminvillii* includes insects, scorpions, and tarantulas (Greene 1997. Snakes. The Evolution of Mystery in Nature. University of California Press, Berkeley and Los Angeles. 351 pp).

On 19 March 2005 at 1120 h, I found a *S. freminvillii* (810 mm SVL, 115 g) feeding on an undescribed scorpion (Diplocentridae, male, 81 mm, 15.3 g) alongside a road in tropical deciduous forest ca. 23 km south of Ejido Caobas (18º14'57"N, 89º03'06"W), Quintana Roo, México. When I first observed the pair, the scorpion was alive and its stinger embedded in the snake's neck. After ca. four minutes the snake began to ingest the scorpion (Fig. 1). I captured the snake and recovered the live scorpion. The scorpion was preserved and the snake was held for behavioral observations. Three days later the snake defecated and its feces contained exoskeletal remains of a tarantula (*Brachypelma vagans*). The scorpion was sent to O. Francke at Universidad Nacional Autónoma de México. The snake will be deposited in the Herpetological Collection of El Colegio de la Frontera Sur, Chetumal, Quintana Roo, México (ECO-CH-H).



FIG. 1. *Stenorrhina freminvillii* consuming an undescribed diplocentrid scorpion.

Submitted by **VÍCTOR H. LUJA,** El Colegio de la Frontera Sur (ECOSUR), Unidad Chetumal. Av. Centenario km 5.5, A. P. 424, C.P. 77000, Chetumal Quintana Roo, México (e-mail: lujastro@yahoo.com). Current address: Centro de Investigaciones Biológicas del Noroeste. Mar Bermejo #195 Colonia Playa Palo de Santa Rita, La Paz, Baja California Sur, 23090, México.

THAMNOPHIS ATRATUS HYDROPHILUS (Oregon Gartersnake). **DIET**. *Thamnophis atratus hydrophilus* use a variety of foraging methods including crawling underwater on the bottom of streams and probing in crevices in search of prey (Lind and Welsh 1994. Anim. Behav. 48:1261–1273). *Thamnophis a. hydrophilus* feed on a variety of prey items including adult ranid frogs and tadpoles (Garwood and Welsh 2005. Herpetol. Rev. 36:165), aquatic salamanders such as the Pacific Giant Salamander (*Dicamptodon tenebrosus*) and fishes such as juvenile salmonids (Welsh and Lind 2000. J. Herpetol. 34:67–74) and sculpins (Brown et al. 1995. Reptiles of Washington and Oregon. Seattle Audubon Society. Seattle, Washington. 176 pp.).

On 28 May 2005 at ca. 1600 h, an adult female *T. a. hydrophilus* (501 mm TL) was captured during routine snake surveys on Spanish Creek (40°11'00"N, 124°15'24"W), located in the King Range National Conservation Area in northern California, USA. We forced the snake to regurgitate a single hard mass of small eggs, each ca. 1.2 mm in diameter. These eggs were later identified as fish eggs

from the genus *Cottus*. Two species of sculpin are known to co-occur in this stream: C*ottus asper* and *C. aleuticus* (W. Duffy, pers. comm.). *Cottus asper* eggs generally are found in burrows or tunnels whereas the eggs of *C. aleuticus* are found under rocks (Kresja 1965. Ph.D. dissertation. University of British Columbia, Vancouver. 109 pp.; Moyle 2002. Inland Fishes of California. University of California Press. Berkeley, California. 502 pp.). Although we did not observe the snake find and consume the eggs, *T. a. hydrophilus* actively forage along stream substrates by probing cracks and crevices, and it seems likely that this individual found the eggs in this manner.

Predation on fish eggs by *T. a. hydrophilus* has not been documented and could represent an important seasonal component of their diet. Our observation suggests that *T. a. hydrophilus* can feed on all life stages of some sculpins.

Submitted by **JAMES B. BETTASO**, US Fish and Wildlife Service, Arcata, California 95521, USA (e-mail jamie_bettaso@fws.gov); **REBECCA S. STUDEBAKER**, Fisheries Biology, Humboldt State University, Arcata, California 95521, USA; and **JUSTIN M. GARWOOD**, USFS Redwood Sciences Laboratory, 1700 Bayview Drive, Arcata, California 95521, USA.

GEOGRAPHIC DISTRIBUTION

Instructions for contributors to Geographic Distribution appear in Volume 38, Number 1 (March 2007, p. 95). Please note that the responsibility for checking literature for previously documented range extensions lies with authors. Do not submit range extension reports unless a thorough literature review has been completed.

CAUDATA

AMBYSTOMA OPACUM (Marbled Salamander). USA: ARKANSAS: Hot Spring Co.: 4.8 km S Lono on St. Hwy. 9 (Sec. 25, T6S, R16W). 4 December 2006. Henry W. Robison. Verified by S. E. Trauth. Arkansas State University Herpetological Museum (ASUMZ 30351). New county record, filling a distributional hiatus in the west Gulf Coast Plain of south-central Arkansas among Clark, Grant, and Saline counties (Trauth et al. 2004. Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.).

Submitted by **HENRY W. ROBISON**, Department of Biology, Southern Arkansas University, Magnolia, Arkansas 71754, USA (e-mail: hwrobison@saumag.edu); and **CHRIS T. McALLISTER**, Department of Physical and Life Sciences, Chadron State College, Chadron, Nebraska 69337, USA (e-mail: cmcallister@csc.edu).

AMBYSTOMA OPACUM (Marbled Salamander). USA: TENNESSEE: Sullivan Co.: Off of TVA Road South ca. 100 m NE of intersection with Holston View Dam Road across from Osceola Island parking area (36.5213°N, 82.1081°W). 13 October 1970. Wallace Coffey. Austin Peay State University Museum of Zoology, APSU 18171 (photo of live individual). On this date Coffey and Brent Rowell also had an unvouchered nesting record of one female with 40–50 eggs that was found under a log. An additional specimen was collected 1.5 km SW of the original location along Piney Hill Road (36.5166°N, 82.1222°W). 03 May 1978. Tim Malone. APSU 18170. On the night of 18 March 1998, an individual was observed crossing Holston View Dam Road across from Osceola Island parking area (36.5211°N, 82.1071°W). It was raining and the animal was moving toward a wetland area. Phil Gentry. APSU 03459 (photo of live individual). 21 October 2005. South Holston Weir Dam Wetland 100 m from the 1998 location (36.5237°N, 82.1108°W). Kevin Hamed, Tom Laughlin, and Phil Gentry. Two individuals were observed guarding eggs under leaf litter at the edge of a dry wetland. Verified by A. Floyd Scott, Austin Peay State University Museum of Zoology, APSU 18165 (photo of live individual). An additional 55 nests (41 with females guarding eggs) were found in the same wetland during October and November 2005.

These observations represent the first records from Sullivan County and the only records from upper East Tennessee (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee 94 pp. [Hard copy and Internet versions, the latter of which includes a link to information on amphibians in Tennessee having appeared since 1996], http://www.apsu.edu/amatlas, accessed 26 April 2006).

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AMBYSTOMA TEXANUM (Smallmouth Salamander). USA: ARKANSAS: Howard Co.: 4.0 km NW Athens on St. Hwy. 246 (Sec. 8, T5S, R28W). 17 September 2006. Henry W. Robison. Verified by S. E. Trauth. Arkansas State University Herpetological Museum (ASUMZ 30349). New county record filling a distributional hiatus in the Ouachita Mountains of southwestern Arkansas among Hempstead, Pike, and Polk counties (Trauth et al. 2004. Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.).

Submitted by **HENRY W. ROBISON**, Department of Biology, Southern Arkansas University, Magnolia, Arkansas 71754, USA (e-mail: hwrobison@saumag.edu); and **CHRIS T. McALLISTER**, Department of Physical and Life Sciences, Chadron State College, Chadron, Nebraska 69337, USA (e-mail: cmcallister@csc.edu).

DESMOGNATHUS BRIMLEYORUM (Ouachita Dusky Salamander). USA: ARKANSAS: Faulkner Co.: 5.6 km S Conway. 18 April 1965. J. H. Bartee. Angelo State Natural History Collection (ASNHC 5750, 5752). 4.8 km W Conway. 18 April 1965. J. Wilkinson. (ASNHC 5753). Verified by J. Kelly McCoy. New county record and only the second and third verifiable localities north of the Arkansas River (the other being the city of Russellville) (Means 1974. Bull. Florida State Mus., Biol. Ser. 18:1–100; Trauth

et al. 2004. Amphibians and Reptiles of Arkansas. Univ. of Arkansas Press, Fayetteville. 421 pp.).

Submitted by **CHRIS T. McALLISTER**, Department of Physical and Life Sciences, Chadron State College, Chadron, Nebraska 69337, USA (e-mail: cmcallister@csc.edu); and **STANLEY E. TRAUTH**, Department of Biological Sciences, Arkansas State University, State University, Arkansas 72467, USA (e-mail: strauth@astate.edu).

DESMOGNATHUS FOLKERTSI (Dwarf Black-bellied Salamander). USA: NORTH CAROLINA: Clay Co.: An unnamed tributary of Beech Creek, ca. 0.8 km N of the Georgia state line (34°59'58.5"N, 83°32'51.6"W, 836 m elev.). 15 October 2006. Betsie Rothermel and Scott Rothermel. GMNH 49978. Identification was confirmed through gel electrophoresis of allozymes at the MDH-2 locus, one of four loci for which *D. folkertsi* and *D. quadramaculatus* show fixed differences (Camp et al. 2002. Herpetologica 58:471–484); morphological verification by Carlos D. Camp. First state record (Lannoo 2005. Declining Amphibians: the Conservation Status of United States Species. Univ. of California Press. 1094 p.) and first record within the Savannah River drainage (Camp 2004. Cat. Amer. Amph. and Rept. 782:1–3).

Submitted by **BETSIE B. ROTHERMEL**, The Center of Excellence for Field Biology, Austin Peay State University, P.O. Box 4718, Clarksville, Tennessee 37044, USA (e-mail: rothermelb@apsu.edu); **JOHN B. JENSEN**, Georgia Department of Natural Resources, Nongame Conservation Section, 116 Rum Creek Drive, Forsyth, Georgia 31029, USA; **CARLOS D. CAMP**, Department of Biology, Piedmont College, P.O. Box 10, Demorest, Georgia 30535, USA; and **TERRY D. SCHWANER**, Department of Biology, North Georgia College & State University, Dahlonega, Georgia 30597, USA.

HYDROMANTES PLATYCEPHALUS (Mount Lyell Salamander). USA: CALIFORNIA: Placer Co.: Blackwood Canyon, Fourth of July Chutes (Peak 8514): 39°3'56.8"N, 120°13'35.8"W, 2560 m elev. 20 July and 12 August 2006. T. Will Richardson. Two adults collected 12 August: MVZ 250724–725. Verified by Sean M. Rovito. One probable adult and four juveniles found and photographed on 20 July. Two adults and two juveniles found on 12 August. Found under granite stones on moist decomposed granite gravel near base of cliffs, adjacent to melting snowfields. One adult on 12 August was found under a stone, in matted *Primula suffrutescens* with snowmelt running through it. This population represents the first record for Placer County, the Lake Tahoe basin, and the Truckee River drainage, the northernmost record for the eastern slope of the Sierra Nevada, and the second-northernmost record for the species (Schlesinger and Romsos 2000. Appendix G. Vertebrate Species of the Lake Tahoe Basin, pp. G1–G15 *In* D. D Murphy and C. M. Kopp [eds.], Lake Tahoe Watershed Assessment: Volume II. Appendices. U.S. Forest Service SW-GTR-176; Stebbins 2003. A Field Guide to Western Reptiles and Amphibians, 3rd. Ed. Houghton Mifflin, New York). This also bridges a significant gap between the nearest known populations at Smith Lake, El Dorado Co. (23 km S) and Sierra Buttes, Sierra Co. (69 km NW). This report establishes a second salamander species from the Lake Tahoe basin.

Submitted by **T. WILL RICHARDSON** and **C. M. GIENGER,** Department of Biology, MS 314, University of Nevada, Reno 89557, USA.

PSEUDOEURYCEA QUETZALANENSIS (Cuetzalan Salamander). MÉXICO: PUEBLA: Municipality of Zacapoaxtla: Ejido Apulco (19º91'91.7"N, 97º60"67'W), 1450 m elev. 08 May 2004. Carlos Hernández Jiménez. Museo de Zoología, Facultad de Ciencias, Universidad Nacional Autónoma de México (MZFC 19350). First record for municipality and extends the known range ca. 18 km (airline) SE of Xocoyolo, Cuetzalan, Puebla (Parra-Olea et al. 2003. Herpetologica 60:478–484). Municipality of Tlatlauquitepec: Ejido La Unión (19°53'51.3"N, 97°28'38"W), 1585 m elev. 30 August 2005. Israel Solano Zavaleta. MZFC 19301. First record for municipality and extends the known range ca. 11.64 km (airline) from 2 km NE Xocoyolo, Cuetzalan, Puebla (Para-Olea et al., *op. cit.*). Both specimens verified by Edmundo Pérez Ramos. Another individual collected in Tlatlauquitepec, within Ejido Atlalpa (MZFC 19304; 19°51'1.3"N, 97º30'12"W), was found at 1900 m elev., which is the highest recorded elevation for this species (Parra-Olea et al., *op. cit.*). MZFC 19301 and 19350 were found under decaying logs in montane cloud forest; MZFC 19304 was found beneath a rock in pine-oak forest.

Submitted by **ESTRELLA MOCIÑO-DELOYA, URI OMAR GARCÍA-VÁZQUEZ, ISRAEL SOLANO-ZAVALETA,** and **MANUEL ROSADO-LUNA,** Museo de Zoología, Facultad de Ciencias, Universidad Nacional Autónoma de México, Ciudad Universitaria, A.P. 70-399, México, D.F. 04510, México (e-mail: allertsemoci@yahoo.com).

SIREN INTERMEDIA NETTINGI (Western Lesser Siren). USA: ARKANSAS: Howard Co.: 3.2 km S Tollette on St. Hwy. 355 (Sec. 20, T11S, R29W). 17 September 2006. Henry W. Robison. Verified by S. E. Trauth. Arkansas State University Herpetological Museum (ASUMZ 30348). New county record filling a distributional hiatus in the Millwood Lake watershed area of southwestern Arkansas among Hempstead, Polk, and Sevier counties (Trauth et al. 2004. Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.).

Submitted by **HENRY W. ROBISON**, Department of Biology, Southern Arkansas University, Magnolia, Arkansas 71754, USA (e-mail: hwrobison@saumag.edu); and **CHRIS T. McALLISTER**, Department of Physical and Life Sciences, Chadron State College, Chadron, Nebraska 69337, USA (e-mail: cmcallister@csc.edu).

SIREN INTERMEDIA NETTINGI (Western Lesser Siren). USA: TENNESSEE: Chester Co.: Henderson, Freed-Hardeman University Campus in the vicinity of Hwy 100 bypass and Sugar Creek (16S, 0351701E, 3922459N). 10 November 2006. David Crowell. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 18303, photo voucher). New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp.). Collected in a cypress slough adjacent to Sugar Creek using an unbaited minnow trap.

Submitted by **DAVID A. CROWELL** and **BRIAN P.**

BUTTERFIELD, Department of Biology, Freed-Hardeman University, Henderson, Tennessee 38340, USA (e-mail: bbutterfield@fhu.edu).

BUFO ATACAMENSIS (Atacama Toad; Sapo de Rulo). CHILE: III REGION (Atacama): QUEBRADA DE LOS SAPOS: 70 km N of the city of Vallenar and 16 km E of the main Panamericana Highway (28º04'48.4''S, 70º24'35.2''W, 1002 m elev.), 25 October 2006. Herpetological collection of Departamento de Biología Celular y Genética de la Universidad de Chile (16 specimens, DBGUCH 061001–16); QUEBRADA LA HIGUERA: 70 km N of the city of Vallenar and 32 km E of the main Panamericana Highway (28º01'21.3''S, 70º16'29.5''W, 1100 m elev.), 25 October 2006 (5 specimens, DBGUCH 061017–21). IV REGION, COQUIMBO: Chungungo, 56 km N of La Serena, at ca. 1 km W of the main road (29º35'12.5''S, 71º15'10.4''W, 161 m elev.), 28 October 2006 (3 specimens, DBGUCH 061022–24); Canela Alto, 140 km S of Ovalle and 38 km W of the main road in the Colihue stream (31º23'08.2''S, 71º25'11.7''W, 307 m elev.), 18 January 2007 (1 adult and 24 immature specimens, DBGUCH 070101–25); Mauro, at the origin of Pupío stream, 70 km E of Los Vilos (31º56'59.5''S, 71º03'50.7''W, 764 m elev.), November 2006 (1 immature specimen and larva, DBGUCH 061101–02). All collected by the authors, and verified by A. Veloso. This new information includes precise localities for the species in the central part of the range, extending the southern limit of the distribution previously described by Sallaberry and Mendez 2002 (Herpetol. Rev. 33:218–219) by more than 152 km. These new localities have been recorded with the support of grants PG-025-06 University of Chile and Fondecyt 1061256-2006.

Submitted by **MICHEL SALLABERRY A.** (e-mail: msallabe@uchile.cl) and **EDUARDO SOTO M.** (e-mail: edosoto@gmail.com), Departamento de Ciencias Ecológicas, Facultad de Ciencias, Universidad de Chile, Las Palmeras 3425, Ñuñóa, PO Box 653, Santiago, Chile; and **CLAUDIO CORREA Q.** (e-mail: ccorrea@uec.inta.uchile.cl) and **MARCO MENDEZ T.** (e-mail: mmendez@uec.inta.uchile.cl), Laboratorio de Genómica Evolutiva, INTA, Universidad de Chile, Macul 5540, PO Box 138-11 Santiago, Chile.

EPIPEDOBATES MACERO (Manu Poison Frog): PERU: JUNÍN: Satipo: Río Tambo: Coriteni Tarso Native Community (11º12´27"S 74º02´56.6"W, 583 m elev.). 26 July 2004. M. Medina-Müller and J. Rodrigo. Verified by L. O. Rodríguez. Museo de Historia Natural Universidad San Marcos, Lima, Peru (MHNSM 22102, MHNSM 22109, adult collected on leaf, near forest stream). Endemic from Peru, previously known from Peruvian departments of Cuzco, Ucayali, and Madre de Dios (Dallmeier et al. 1997. SI/MAB Series No. 2. Smithsonian Inst. MAB Biodiv. Progr., Washington, D.C.; Myers et al. 1998. Amer. Mus. Nat. Hist. Novitates 3238:1–20; Rodríguez et al. 1993. Amer. Mus. Nat. Hist. Novitates 3068:1–15). First departmental record, extends the known distribution 190 km NW from Campamento Kapiromashi at Bajo Urubamba, Cusco, Peru (Dallmeier et al. 1997, *op. cit.*).

Submitted by **MARGARITA MEDINA-MÜLLER**, Museo de Historia Natural San Marcos, Av. Arenales 1256, Jesús María, Lima, Perú; e-mail: emmmuller@yahoo.com.

EUHYAS PLANIROSTRIS (Greenhouse Frog). USA: LOUISIANA: TERREBONNE PARISH: Houma. June 2005. Ernest A. Liner. Louisiana State University Museum of Zoology (LSUMZ 89720–89729 adults; 89739 eggs). Verified by Jeff Boundy. Extends the range ca. 60 miles SW of the range as given by Dundee and Rossman (1989. The Amphibians and Reptiles of Louisiana. LSU Press, Baton Rouge, Louisana, XXX pp.) and establishes the species in the ninth of 64 parishes of the state (J. Boundy, pers. comm.).

Submitted by **ERNEST A. LINER**, 310 Malibou Boulevard, Houma, Louisiana 70364-2598, USA; e-mail: eliner@mobiletel.com.

HYLA CHRYSOSCELIS/HYLA VERSICOLOR **SIBLING SPECIES COMPLEX** (Cope's Gray Treefrog/Gray Treefrog). USA: ARKANSAS: VAN BUREN CO.: 5.6 km S Bee Branch on US 65 (Sec. 20, T9N, R13W). 21 May 2006. Henry W. Robison. Verified by S. E. Trauth. Arkansas State University Herpetological Museum (ASUMZ 30350). New county record filling a distributional hiatus in the southern Ozark foothills/Arkansas Valley among Conway, Pope, and Stone counties (Trauth et al. 2004. Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.).

Submitted by **HENRY W. ROBISON**, Department of Biology, Southern Arkansas University, Magnolia, Arkansas 71754, USA (e-mail: hwrobison@saumag.edu); and **CHRIS T. MCALLISTER**, Department of Physical and Life Sciences, Chadron State College, Chadron, Nebraska 69337, USA; e-mail: cmcallister@csc.edu.

ISCHNOCNEMA SAXATILIS (Tarapoto Big-headed Frog): PERU: JUNÍN: Satipo: Río Tambo: Coriteni Tarso Native Community (11º12´27"S 74º02´56.6"W, 583 m elev.). 21–29 July 2004. M. Medina-Müller, J. Rodrigo, and M. FitzPatrick. Verified by C. Aguilar. Museo de Historia Natural Universidad San Marcos, Lima, Peru (MHNSM 22078, MHNSM 22082, MHNSM 22087, MHNSM 22096, MHNSM 22141. Collected on rocks of a forest stream). The Coriteni Tarso native community record represents the southernmost locality for this endemic species of Peru. The new record extends the distribution 605 km SE from the only known locality (Ponga de Shilcayo, 6°31´S, 76°53´W; Duellman 1990. Occas. Pap. Mus. Nat. Hist. Univ. Kansas 138:1–7).

Submitted by **MARGARITA MEDINA-MÜLLER**, Museo de Historia Natural San Marcos, Av. Arenales 1256, Jesús María, Lima, Perú; e-mail: emmmuller@yahoo.com.

KALOULA BALEATA (Brown Bull Frog). BRUNEI DARUSSALAM: Belait District, Melilas (04º13'N, 114º40'E), Labi. 11–12 November 1992. Collected by F. Kraus. Brunei Museum, BM 79.1992; BM 141.1992; UMMZ 201718–20. Vicinity (between 1.6–24.6 km N) Sungei Liang (04º30'N, 114º40'E), Labi Road. 6 December 1992. Collected by F. Kraus. BM 254–256.1992; UMMZ 201721–24. First records for Brunei Darussalam (see Das 2007. A Pocket Guide. Amphibians and Reptiles of Brunei. Natural History Publications [Borneo] Sdn Bhd. Kota Kinabalu. viii + 200 pp.). Previous Bornean records were from Sabah, Sarawak, and Kalimantan (Inger and Tan 1996. Raffles Bull. Zool. 44:551–574), and the species is generally widespread in Southeast Asia (Inger 1999. *In* W. E. Duellman [ed.], Patterns of Distribution of

Amphibians. A Global Perspective, pp. 445–482. The John Hopkins University Press, Baltimore and London).

Submitted by **INDRANEIL DAS**, Institute of Biodiversity and Environmental Conservation, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia (e-mail: idas@ibec.unimas.my); and **FRED KRAUS**, Bishop Museum, 1525 Bernice Street, Honolulu, Hawaii 96817, USA (e-mail: fkraus@hawaii.edu).

LEPTODACTYLUS PLAUMANNI (Nova Teutonia White-lipped Frog). BRAZIL: Paraná: Municipality of São João do Triunfo (25º34'18"S, 50º05'56"W) 780 m elev. 22 December 2003. A. M. X. Lima. Scientific collection of Instituto de Pesquisas em Cananéia, Cananéia, São Paulo State (MIPEC 024). Verified by R. A. Machado. Individual was collected from a short grass pasture close to Iguaçu River margin while it was calling. Previously known from Argentina in Misiones, and Brazil, in Rio Grande do Sul and Santa Catarina State (Silva et al. 2004. Amphibia-Reptilia 25:186–195). First state record, extends the known range of the species 400 km NE from the municipality of Seara, Santa Catarina State.

Submitted by **ANDRÉ MAGNANI XAVIER DE LIMA**, Programa de Pós-Graduação em Ecologia e Conservação, UFPR, rua Bento Viana, 932, ap 41, CEP 80210-170, Curitiba, Paraná, Brazil; e-mail: "mailto:andremxlima@uol.com.br" andremxlima@uol.com.br.

LEPTODACTYLUS SYPHAX. BRAZIL: GOIÁS: CALDAS NOVAS MUNICIPALITY: 17º43'56"S, 48º40'0"W. 12 August 2002. K. G. Facure. Verified by A. A. Giaretta. Coleção Zoológica da Universidade Federal de Uberlândia (Anura), AAG-UFU 002307. *Leptodactylus syphax* was known from the Brazilian states of Mato Grosso, Minas Gerais, and Paraíba, as well as southern Paraguay and eastern Bolivia (Heyer 1979. Smithson. Contrib. Zool. 301:1–43; Frost 2004. Amphibian Species of the World: An Online Reference. Amer. Mus. Nat. Hist., New York, http://research.amnh.org/herpetology/amphibia/index.php). Adult male, calling in sandy rocks beside water (ca. 35°C). First state record, Caldas Novas is intermediate between previously known localities in Alpinópolis (Minas Gerais State, ca. 500 km SE) and Cuiabá (Mato Grosso State, ca. 800 km NW) (Cardoso and Heyer 1995. Alytes 13[2]: 67–76).

Submitted by **WAGNER R. SILVA** (e-mail: wagnerdrigues@yahoo.com.br) and **KÁTIA G. FACURE**, Laboratório de Taxonomia, Sistemática e Ecologia Comportamental de Anuros Neotropicais, Instituto de Biologia, Universidade Federal de Uberlândia, CEP 38 400-902, Uberlândia, Minas Gerais, Brazil; e-mail: thoropa@inbio.ufu.br,

OSTEOPILUS SEPTENTRIONALIS (Cuban Treefrog). NETHERLANDS ANTILLES: SABA: Windward side. 27 July 2006. John Magor. MPM P736. Verified by Robert W. Henderson. First record for Saba (Powell et al. 2005. The Reptiles and Amphibians of the Dutch Caribbean: St. Eustatius, Saba, and St. Maarten. St. Eustatius National Parks Foundation, Gallows Bay, St. Eustatius, Netherlands Antilles. 192 pp.). The species is well established on St. Maarten, the presumed origin of this individual.

Submitted by **ROBERT POWELL**, Department of Biology, Avila University, Kansas City, Missouri 64145, USA; e-mail: robert.powell@avila.edu.

PHYLLOMEDUSA OREADES (NCN). BRAZIL: MINAS GERAIS: Municipality of Cabeceira Grande, District of Palmital (16º14'S, 47º18'W, 877 m elev.). 18 October 2006. R. R. Carvalho-Jr. and E. G. Pereira. Laboratório de Herpetologia, Museu de Ciências Naturais, Pontifícia Universidade Católica de Minas Gerais, Belo Horizonte, Minas Gerais, Brazil (MCNAM 8294–95). Verified by L. B. Nascimento. *Phyllomedusa oreades* was found only in states of Goiás (Serra da Mesa, Chapada dos Veadeiros, and Serra dos Pirineus) and Distrito Federal (ARIE Capetinga-Taquara and Reserva Ecológica do IBGE, Brasília), Brazil, above 900 m elev. (Brandão 2002. Herpetologica. 36:571–578; Caramaschi 2006. Arq. Mus. Nac. 6[2]:159–179). First state record extends known distribution ca. 295 km airline SE from the type locality, Minaçu/Serra da Mesa, state of Goiás, and ca. 110 km airline from Brasília (Brandão, *op. cit.*).

Submitted by **RONALD REZENDE DE CARVALHO JÚNIOR**, Pontifícia Universidade Católica de Minas Gerais, Museu de Ciências Naturais, Av. Dom José Gaspar 290, Coração Eucarístico, 30536-610, Belo Horizonte, MG, Brazil (e-mail: rcjunior.bh@terra.com.br); and **MARCO ANTÔNIO SCHETTINO CANELAS** (e-mail: cotonhocanelas@yahoo.com).

PLETHODONTOHYLA MIHANIKA (Malagasy Climbing Rain Frog). MADAGASCAR: (1) Masoala Peninsula, Andranobe Field Station, Maroantsetra Fivondronana, Toamasina Faritany (15°39.50'S, 49°57.50'E; 15 m elev.), Museo Regionale di Scienze Naturali di Torino, MRSN A2645. 29 October 1998. J. E. Randrianirina; (2) Masoala Peninsula, Antsarahan'Ambararato, Antalaha Fivondronana, Antsiranana Faritany (15°23.52'S, 50°02.82'E; 500–530 m elev.), MRSN A4594. 9 December 1999. F. Andreone and J. E. Randrianirina; (3) Masoala Peninsula, Mahalevona Maroantsetra Fivondronana, Toamasina Faritany (15°25.12'S, 49°56.77'E, 778 m elev.), MRSN A2705. 09 February 2002. J. E. Randrianirina. Verified by M. Vences. Recently described from eastern Madagascar by Vences et al. (2003. J. Herpetol. 37:629–636). Data on distribution is scanty and known from localities on the east coast of Madagascar, including Ambatovaky, Zahamena, Andasibe, Ankeniheny, Fierenana, Ranomafana, and Sandranantitra. The three new records from Masoala mark the northernmost sites, at ca. 150 km N of Ambatovaky. The specimen from Andranobe was listed as a voucher in a recent mt-DNA analysis on Malagasy cophyline frogs (Andreone et al. 2005. Mol. Phylogen. Evol. 34:315–322). Antsarahan'Ambararato and Mahalevona lie outside boundary of Parc National de Masoala, and fall within relatively undisturbed rainforests. The three specimens measure, respectively, 37.1 mm (MRSN A2645), 34.5 mm (MRSN A2705), and 36.6 mm (MRSN A4594), and are larger than those previously reported (26.4–31.1 mm). They were further assigned to *P. mihanika* because of the longer hind limbs relative to those of *P. notosticta*, the dorsal pattern, and semiarboreal habits. Specimens were captured using a pitfall device associated with a plastic drift-fence, as described by Andreone et al. (2000. Biodiv. Conserv. 9:1587–1622), thus showing the value of this method to detect secretive amphibian species.

Submitted by **FRANCO ANDREONE**, Museo Regionale di Scienze Naturali di Torino, Via G. Giolitti, 36, I-10123 Torino, Italy; e-mail: f.andreone@libero.it.

RANA BLAIRI (Plains Leopard Frog). USA: NEW MEXICO: DONA ANA CO.: Hatch, 0.62 mi S, 0.54 mi E jct. I-25 and NM Hwy 26; T19S, R3W, S9 (NE 1/4); 13S, 3617236N, 0298848E (WGS 84). MSB 71927. 15 September 2004. Shawn Collier. Verified by Charles W. Painter. New county record (Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. University of New Mexico Press, Albuquerque. 431 pp.).

Submitted by **MICHAEL T. HILL**, Department of Wildlife and Fisheries Sciences, Texas A&M University, 2258 TAMU, College Station, Texas 77843, USA; and **DEBRA M. HILL**, U.S. Fish and Wildlife Service, 500 Gold Avenue, Suite 9019, Albuquerque, New Mexico 87103, USA.

RHINELLA SCITULA. BRAZIL: MATO GROSSO DO SUL: Aquidauana (Piraputanga, Vale das Bruchas, 20°27'23,01"S; 55°29'55,70"W). 08 February 2007. F. P. Maragno. Verified by M. Uetanabaro. Coleção Zoológica do Departamento de Biologia, Universidade Federal de Mato Grosso do Sul, Campo Grande, Brazil (ZUFMS 01254 adult male, SVL 44 mm). Known only from the type locality (Bonito, Mato Grosso do Sul State; Caramaschi and Niemeyer 2003. Boletim do Museu Nacional. Rio de Janeiro. 501:1–16). This new record extends distribution 121 km W from type locality (Caramaschi and Niemeyer, *op. cit*.).

Submitted by **FRANCIÉLE PEREIRA MARAGNO**, Programa de Pós Graduação em Ecologia e Conservação, Universidade Federal de Mato Grosso do Sul, 79070-900, Campo Grande, Mato Grosso do Sul, Brazil (e-mail: fmaragno@gmail.com); and **FRANCO LEANDRO DE SOUZA**, Centro de Ciências Biológicas e da Saúde, Departamento de Biologia, Universidade Federal de Mato Grosso do Sul, 79070-900, Campo Grande, Mato Grosso do Sul, Brazil (e-mail: flsouza@nin.ufms.br).

SYRRHOPHUS CYSTIGNATHOIDES (Rio Grande Chirping Frog). USA: TEXAS: AUSTIN CO.: San Felipe: Stephen F. Austin State Park (29°48'25''N, 096°05'49''W, 155 ft elev.) 3 January 2007, 1430 h, 52°F. Collected by Thomas A. Sinclair, John T. Williams, and Scott A. Wahlberg. Verified by Travis J. LaDuc. Texas Natural History Collections-Texas Memorial Museum-University of Texas (TNHC 65939). New county record (Dixon 2000. Amphibians and Reptiles of Texas. Second Edition. Texas A & M University Press, College Station, Texas, 421 pp.). An adult found under a rotten log next to a *Eumeces fasciatus*, in a torpid state. The animal was released at the site.

Submitted by **THOMAS A. SINCLAIR**, 12903 Cloverwood Drive, Cypress, Texas 77429, USA (e-mail: tsinclair2@houston.rr.com); **JOHN T. WILLIAMS**, 1001 Harvey 14, College Station, Texas 77840, USA (e-mail: john-thomas-williams@neo.tamu.edu); and **SCOTT A. WAHLBERG**, 3008 Chimney Rock, Apartment 2, Nacogdoches, Texas 75965, USA (e-mail: wahlbergsa@titan.sfasu.edu).

SYRROPHUS INTERORBITATLIS (Spectacled Chirping Frog). MÉXICO: SONORA: MUNICIPIO DE YÉCORA: 26.1 km (by Mex. Hwy. 16) E Yécora (28.38234°N, 108.76937°W), 1332 m elev. 7 July 2005. E. Enderson and R. Bezy. Verified by John Lynch. UAZ 56549-PSV. First record for Sonora, extending the range ca. 350 km (airline) N from the vicinity of Guamuchil, Sinaloa (Hardy and McDairmid 1969. Univ. Kansas Publ. Mus. Nat. Hist. 28:39–252). The voucher was one of about 30 others calling in oak woodland.

Submitted by **ERIK F. ENDERSON**, Dryland Institute, PMB 405 2509 North Campbell Avenue, Tucson, Arizona 85719, USA (e-mail: erikenderson@msn.com); and **ROBERT L. BEZY,** Herpetology, Natural History Museum of Los Angeles County, Los Angeles, California 90007, USA.

XENOPUS MUELLERI (Müller's Platanna). SOUTH AFRICA: LIMPOPO PROVINCE: 1 km N of Albasini Dam (23°05'47"S, 30°05'22"E, 780 m elev.). 01 December 2004. B. Maritz. Verified by Lemmy Mashinini. Transvaal Museum, Tswane, South Africa (TM 85487–88). Extends the known distribution by at least 50 km from the closest record—the opposite slope of the Soutpansberg Mountains (Minter et al. 2004. Atlas and Red Data Book of the Frogs of South Africa, Lesotho and Swaziland. SI/MAB Series No. 9. Smithsonian Institution, Washington, D.C.). This record also increases the altitudinal distribution by >150 m (previously thought to occur <600 m elev.). Additionally, this is the first record from the Luvuvhu River catchment. *Xenopus laevis* was recorded within 500 m, but not in the same water body. Possible case of micro-allopatry between these two species.

Submitted by **BRYAN MARITZ**, **GAVIN P. R. MASTERSON**, **DARIAN MACKAY**, and **GRAHAM J. ALEXANDER**, School of Animal, Plant and Environmental Sciences, University of the Witwatersrand, Johannesburg, South Africa, Private Bag 3, Wits, 2050, South Africa (e-mail: maritz@gecko.biol.wits.ac.za).

TESTUDINES

ACTINEMYS MARMORATA (Pacific Pond Turtle). MEXICO: BAJA CALIFORNIA NORTE**:** Río San Rafael, 17.12 air km ENE of Punta Colonet near Potrero (31.09353ºN, 116.02786ºW), 157 m elev. 18 May 2005. Thomas Akre, John Blackburn, Antonio Robison, and Robert Lovich. Verified by Jeffrey Lovich. Universidad Autónoma de Baja California UABC 1524. First documented record from the Río San Raphael, although sightings in the upper reaches of the river were reported by Welsh (1988. Proc. California Acad. Sci.46:1–72) and other sightings without precise locality data were mentioned by Roberts (1981. Paper presented during California Riparian Systems Conference, Univ. California Davis, 17–19 September; 1982. Abstr., Proc. Desert Tortoise Council Symposium, pp. 154–161). The record also bridges the distribution gap between known localities in the Río San Telmo (19 km NW) and Río San Juan (35 km SW) reported in Lovich et al. (2005. Herpetol. Rev. 36:200–201). The adult male turtle was observed swimming downstream in a shallow (< 0.5 m), bolder-strewn riffle with gravel substrate.

Submitted by **ROBERT E. LOVICH**, Department of Earth and Biological Sciences, Loma Linda University, Loma Linda, California 92350, USA (e-mail: rlovich@gmail.com.); **THOMAS S. AKRE**, Department of Natural Sciences, Longwood University,

201 High Street, Farmville, Virginia 22309, USA; **JOHN BLACKBURN,** Department of Biology, George Mason University, 4400 University Drive, Fairfax, Virginia 22020, USA; **TONY ROBISON,** 5505 Woodlawn Manor Court, Alexandria, Virginia 22309, USA**;** and **CLARK MAHRDT,** San Diego Natural History Museum, San Diego, California 92112, USA.

KINOSTERNON INTEGRUM (Mexican Mud Turtle). MÉXICO: SONORA: MUNICIPIO DE BAVIÁCORA: W slope of the Sierra El Chinito, ca. 27 km (airline) E of Baviácora (29.768530°N, 109.988982°W), 1400 m elev. 04 September 2004. E. Enderson, R. Bezy, and S. Hale. Verified by Philip C. Rosen. UAZ 56547-PSV. Northernmost record for Sonora, extending the range ca. 116 m (airline) NE of Río Matape, Sonora (Iverson 1998. Cat. Amer. Amphib. Rept. 652.1–6). Habitat at this locality is a mosaic of oak woodland and foothills thornscrub.

Submitted by **ERIK F. ENDERSON**, Drylands Institute, PMB 405 2509 North Campbell Avenue, Tucson, Arizona 85719, USA (e-mail: erikenderson@msn.com); **ROBERT L. BEZY**, Herpetology, Natural History Museum of Los Angeles County, Los Angeles, California 90007, USA; and **STEPHEN F. HALE,** EcoPlan Associates, Inc., 701 West Southern Avenue, Ste. 203, Mesa, Arizona 85210, USA (e-mail: sfhale@comcast.net).

PSEUDEMYS TEXANA (Texas River Cooter). USA: TEXAS: COLORADO CO.: Shell fragments were found at a picnic area next to Cummins Creek on FM-1291, 220 m W of intersection of FM-1291 and Kickler Road (29.89916°N, 96.6065°W, WGS84, 75 m elev. 18 June 2006. Diana J. McHenry and Shawn F. McCracken. Verified by Toby Hibbitts. Texas Cooperative Wildlife Collection, TCWC 91783. First county record (Dixon 2000. Amphibians and Reptiles of Texas. 2nd Edition. Texas A&M Univ. Press, College Station, Texas, 421 pp.).

Submitted by **DIANA J. MCHENRY**, Division of Biological Sciences, University of Missouri, Columbia, Missouri 65211, USA; **SHAWN F. MCCRACKEN** and **MICHAEL R. J. FORSTNER**, Department of Biology, Texas State University, San Marcos, Texas 78666, USA (e–mail: mf@txstate.edu).

LACERTILIA

***AMPHISBAENA PLUMBEA*.** ARGENTINA: CHUBUT: TELSEN: Road to Laguna de la Vaca, 5 km SW Provincial Road 4 (42°26'52.6"S 67°18'51.6"W) 667 m elev. 08 February 2007. L. J. Avila, M. Kozykariski, and N. Feltrin. Fundación Miguel Lillo herpetological collection (FML 18118). Verified by R. Montero. This species is endemic to western Argentina and shows a large distribution along Monte phytogeographic formation, from northern Tucumán province to the Atlantic shore of Chubut province. Its geographic distribution is poorly known for Rio Negro and Chubut provinces where only three localities are cited. This is the westernmost record for Chubut and extends the known distribution ca. 200 km W from the nearest records in the coastal areas (Montero 1996. Cuad. Herpetol. 10:25–45).

Submitted by **LUCIANO JAVIER AVILA**, **MONICA KOZYKARISKI**, **NATALIA FELTRIN**, and **MARIANA MORANDO**, CENPAT-CONICET, Boulevard Almirante Brown s/n, U9120ACV, Puerto Madryn (Chubut), Argentina (e-mail: avila@cenpat.edu.ar).

ANOLIS SAGREI (Brown Anole). USA: LOUISIANA: LAFOURCHE PARISH: Thibodaux, Hebert's Nursery, 1500 St. Mary St. 5 October 2006. Michael P. Wiley. Verified by Ernest A. Liner. American Museum of Natural History (AMNH R156219). TERREBONNE PARISH: Houma, Starke's Garden Center, 4836 Hwy. 311. 27 October 2006. Michael P. Wiley. Verified by Ernest A. Liner. American Museum of Natural History (AMNH R156218). New parish records. The owner of Starke's Garden Center has observed *A. sagrei* arriving on shipments of Sable Palm (*Sable major*) from southern Florida. Hebert's Nursery also receives plants from southern Florida. Starke's is located ca. 25 km SSE of Hebert's Nursery. Nearest recorded locations are Orleans Parish (ca. 80 km ENE of Thibodaux; Thomas et al. 1990. Herpetol. Rev. 21:22) and East Baton Rouge Parish (ca. 85 km NNW of Thibodaux; Platt and Fontenot 1994. Herpetol. Rev. 25:33).

Submitted by **MICHAEL P. WILEY**, **ALLYSE M. FERRARA**, and **QUENTON C. FONTENOT,** Bayousphere Research Lab, Department of Biological Sciences, Nicholls State University, Thibodaux, Louisiana 70310, USA.

CROTAPHYTUS VESTIGIUM (Baja California Collared Lizard). MEXICO: BAJA CALIFORNIA SUR: 9.5 km N of Loreto on peninsular coast facing Isla Coronados (26°05'52.6"N, 111°19'26.9"W), near sea level. 25 September 2004. Armando Tejas. Verified by Jesse L. Grismer. La Sierra University Digital Photo Catalogue (LSUDPC 690–91). Southeastern most record for the Central Gulf Coast phytogeographic region, extending the range 66 km SE from Bahía Concepción (Grismer 2002. Amphibians and Reptiles of Baja California Including Its Pacific Islands and the Islands in the Sea Of Cortez. Univ. California Press, Berkeley. 399 pp.) and a 41 km range extension SE from the closest known locality, 28 km S of San José Comondú on the Sierra de La Giganta (McGuire 1996. Bull. Carnegie Mus. Nat. Hist. 32:1–193), which is located in the arid tropical phytogeographic region.

Submitted by **CRYSTIAN S. VENEGAS-BARRERA**, **GUSTAVO ARNAUD**, Centro de Investigaciones Biológicas del Noroeste, La Paz, B.C.S. 23090, México (e-mail: sadiel@cibnor.mx); and **L. LEE GRISMER**, Department of Biology, La Sierra University, Riverside, California 92515, USA.

CTENOSAURUS SIMILIS (Spiny-Tailed Iguana). USA: FLORIDA: SARASOTA CO.: Englewood, 446 Court Street (26.959367^{0}N, -82.343267^{0}W). 15 January 2007. Missy L. Christie and Cathy A. Olson. Verified by Kenneth Krysko. University of Florida Museum of Natural History (UF 150493, photo voucher). New county record. Although common on Boca Grande, an island ca. 11 miles SE in Charlotte and Lee counties, there are few reports on the mainland. This represents the first report in Sarasota County and is ca. 8 miles N of other reports from Cape Haze (Krysko et al. 2003. Florida Sci. 66[2]:141–146).

Submitted by **CATHY A. OLSON**, Lee County Department of Parks and Recreation, 3410 Palm Beach Blvd., Fort Myers, Florida 33916, USA (e-mail: colson@leegov.com); **GREGG S. KLOWDEN**, Department of Wildlife Ecology and Conservation, University of Florida, P.O Box 110430, Gainesville, Florida 32611, USA (e-mail: geckoguy@ufl.edu); and **MISSY L. CHRISTIE**, Charlotte County Natural Resources Division, 25550 Harborview Rd., Punta Gorda, Florida 33980, USA (e-mail: missy.christie@charlottefl.com).

CYRTODACTYLUS IRIANJAYAENSIS (NCN). INDONESIA: PAPUA PROVINCE: 'Waibya Camp,' northern Salawati Island (130°47'060"E, 00°57'383"S; < 100 m elev.). 28 June 2005. Arthur Tipawael. Museum Zoologicum Bogoriense (MZB 5576). Verified by Mark Hutchinson. Adult female, with a moderately enlarged follicle. Collected at night from ca. 6 m on trunk of large tree along road in disturbed lowland rainforest. Previously known from pet trade specimens exported from Papua Province, without specific locality data (Rösler 2001. Zool. Abhand. Staatliches Mus. Tierkunde Dresden 51:61–71). First specimen in an institutional collection with locality data. Further collecting required to ascertain whether the species is endemic to Salawati Island, or is more widespread.

Submitted by **PAUL OLIVER**, Herpetology Section, South Australian Museum, 0 North Terrace, Adelaide, South Australia 5000, Australia (e-mail: paul.oliver@adelaide.edu.au); **BURHAN TJATURADI,** Conservation International Papua Program, Jl. Bhayangkara, 1#5, Jayapura 99610, Papua Province, Indonesia; and **STEPHEN RICHARDS**, Herpetology Section, South Australian Museum, Adelaide, South Australia 5000, Australia.

DRYADOSAURA NORDESTINA (Briba Cabeçuda). BRAZIL: BAHIA: MUNICÍPIO DE MATA DE SÃO JOÃO: Fazenda de Camurujipe (12º30'5''S, 38º2'19''W).12 and 23 February 2005. A. Camacho Guerrero. Museu de Zoologia da Universidade Federal de Bahia, Salvador, Bahia, Brazil (UFBA – 672). Caught with pitfall traps near the border of a 1390-ha patch of well preserved Atlantic Rainforest. Verified by E. M. Xavier Freire. Species previously known from Paraiba, Pernambuco, Alagoas, and Rio Grande do Norte states, Brazil (Rodrigues et al. 2005. Zool. J. Linn. Soc. 44[4]:546–547). First state record, extends the range more than 400 km S from Maceió, Alagoas (Rodrigues et al. *op. cit.*).

Submitted by **AGUSTÍN CAMACHO GUERRERO**, Laboratório de Vertebrados Terrestres, Departamento de Zoologia, Instituto de Biologia.Universidade Federal da Bahia, Rua Barão de Geremoabo, 147 - Campus de Ondina, CEP 40170-290, Salvador-BA, Brazil; and **MIGUEL TREFAUT RODRIGUES**, Instituto de Biociências, Departamento de Zoologia, Universidade de São Paulo, Caixa Postal 11.461. CEP 05422-970 São Paulo, SP, Brazil.

GEKKO MONARCHUS (Malaysian House Gecko). THAILAND: SURAT THANI PROVINCE: Muang District, Surat Thani (9°10'N, 99°15'E). 12 October 2004. N. Paisanwattanakul. Institut Royal des Sciences Naturelles de Belgique, Brussels (IRSNB 17008). Verified by Georges Lenglet (IRSNB). Subadult specimen (SVL 63 mm) caught on a building in the city. Only specimen observed. First provincial record and extension of ca. 140 km northwest from the previous northernmost locality which was situated in Takua Pa District, Phang-Nga Province (Grossmann and Tillack 2001. Sauria 23[3]:21–34; Pauwels et al. 2000. Dumerilia 4[2]:123–154). The species is now recorded in Thailand from Narathiwat, Pattani, Phang-Nga, Phuket, and Surat Thani provinces (Nabhitabhata et al. "2000" 2004. Checklist of Amphibians and Reptiles in Thailand, Office of Environmental Policy and Planning, Bangkok). We thank Nopnarong Paisanwattanakul (Surat Thani) for the donation of the specimen.

Submitted by **OLIVIER S. G. PAUWELS**, Department of Recent Vertebrates, Institut Royal des Sciences Naturelles de Belgique, Rue Vautier 29, 1000 Brussels, Belgium (e-mail: osgpauwels@yahoo.fr); and **MONTRI SUMONTHA**, Ranong Marine Fisheries Station, 157 M. 1, Saphan-Pla Rd., Paknam, Muang, Ranong 85000, Thailand (e-mail: knotsnake2211@yahoo.com).

HELODERMA HORRIDUM HORRIDUM (Mexican Beaded Lizard). MÉXICO: ZACATECAS: MUNICIPIO DE VALPARAÍSO: on dirt road between San Juan Capistrano and San Rafael de las Tablas, ca. 1300 m elev. 12 July 2006. Nicolás Escalante Grijalva. Verified by Oscar Flores-Villela. Photographic collection of Museo de Zoología de la Facultad de Ciencias, Universidad Nacional Autónoma de México (MZFC 1599–1601). First record for Zacatecas (Beck 2005. Biology of Gila Monsters and Beaded Lizards, University of California Press, Berkeley). The dirt road passes through tropical scrub vegetation within the Sierra Madre Occidental near the border with Nayarit, Jalisco, and Durango.

Submitted by **HECTOR AVILA-VILLEGAS,** Dirección de Recursos Bióticos, Instituto del Medio Ambiente del Estado de Aguascalientes, Aguascalientes, México; e-mail: avila_hec@yahoo.com.mx.

HEMIDACTYLUS TURCICUS (Mediterranean House Gecko). USA: ARKANSAS: COLUMBIA CO.: Magnolia city limits (Sec. 31, T16S, R20W). 02 October 2006. Lindsey Fowler. Arkansas State University Museum of Zoology, Herpetological Collection (ASUMZ 30415). Verified by Stanley E. Trauth. New county record in southern Arkansas (Trauth et al. 2004. Amphibians and Reptiles of Arkansas, Univ. of Arkansas Press, Fayetteville). The specimen was taken from an office wall of a local trucking company.

Submitted by **LINDSEY FOWLER** and **HENRY W. ROBISON**, Department of Biological Sciences, Southern Arkansas University, Magnolia, Arkansas 71754-9354, USA (e-mail: hwrobison@saumag.edu).

HEMIDACTYLUS TURCICUS. (Mediterranean House Gecko). USA. LOUISIANA: BEAUREGARD PARISH: Outside walls of South Beauregard High School, 19.31 km N of the Beauregard Parish/Calcasieu Parish line on US Hwy 171. 14 January 2007. Terry Sylvester and Constance Kersten. Verified by Avery Williams. Louisiana State University at Eunice Museum (LSUE 2575–76). First parish record (Meshaka et al. 2006. Herpetol. Conserv. Biol. 19[1]:45–50). The two specimens are sub-adults collected at night. A large population of geckos lives on the brick buildings of the South Beauregard Elementary School/High School complex and has been the subject of population studies since 2005.

Submitted by **TERRY SYLVESTER** and **CONSTANCE KERSTEN**, Department of Biological and Environmental Sciences, McNeese State University, Lake Charles, Louisiana 70609, USA (e-mail: msu-tsylvester@student.mcneese.edu); and **MARK A. PAULISSEN**, Department of Natural Sciences, Northeastern State University, Tahlequah, Oklahoma 74464, USA (e-mail: paulisse@nsuok.edu).

HEMIPHYLLODACTYLUS TYPUS TYPUS (Common Indo-Pacific Tree Gecko). THAILAND: KANCHANABURI PROVINCE: Sai Yok District, Sai Yok Noi. September 2002. M.

Sumontha. Institut Royal des Sciences Naturelles de Belgique, Brussels (IRSNB 17014). Verified by Georges Lenglet (IRSNB). First provincial record. The species is thus presently recorded in Thailand from Kanchanaburi, Nakhon Ratchasima, Narathiwat, Phang-Nga, Phuket, Ranong, Trang, and Trat provinces (Chanard et al. 1999. Amphibians and Reptiles of Peninsular Malaysia and Thailand. An Illustrated Checklist. Bushmaster Publications, Würselen, 240 pp.; Nabhitabhata et al., "2000" 2004. Checklist of Amphibians and Reptiles in Thailand, Office of Environmental Policy and Planning, Bangkok; Pauwels and Bauer 2001. Herpetol. Rev. 32:119).

Submitted by **OLIVIER S. G. PAUWELS**, Department of Recent Vertebrates, Institut Royal des Sciences naturelles de Belgique, Rue Vautier 29, 1000 Brussels, Belgium (e-mail: osgpauwels@yahoo.fr); and **MONTRI SUMONTHA**, Ranong Marine Fisheries Station, 157 M. 1, Saphan-Pla Rd., Paknam, Muang, Ranong 85000, Thailand (e-mail: knotsnake2211@yahoo.com).

HOLASPIS GUENTHERI (Günther's Gliding Lizard). EQUATORIAL GUINEA: Monte Alen National Park. July 2001. T. Stévart. Institut Royal des Sciences Naturelles de Belgique, Brussels (IRSNB 16638). Verified by Georges L. Lenglet (IRSNB). Adult specimen found active by day in secondary forest nr. ECOFAC station and hotel (01°39'N, 10°18'E, ca. 800 m elev.). New record for Park and for Centro Sur Province (Lasso et al. 2002. Graellsia 58[2]:21–34; De la Riva 2004. Quercus 215:56–61). We thank Ignacio J. De la Riva (Museo Nacional de Ciencias Naturales, Madrid) for comments. This is Contribution 89 of the Smithsonian Institution's Gabon Biodiversity Program.

Submitted by **OLIVIER S. G. PAUWELS**, Smithsonian Institution, National Zoological Park, Monitoring and Assessment of Biodiversity Program, Gamba, Gabon; mailing address: Département des Vertébrés Récents, Institut Royal des Sciences naturelles de Belgique, Rue Vautier 29, 1000 Brussels, Belgium (e-mail: osgpauwels@yahoo.fr); and **TARIQ STÉVART**, Missouri Botanical Garden, mailing address: Laboratoire de Botanique systématique et de Phytosociologie, Université Libre de Bruxelles, CP 169, Av. F. D. Roosevelt 50, 1050 Brussels, Belgium (e-mail: tstevart@yahoo.com).

LIOLAEMUS TELSEN (NCN). ARGENTINA: RIO NEGRO: 9 DE JULIO DEPARTMENT: Ruta Provincial 60, 65.6 km S Police Post El Rincón, near Cerro Corona (41°23'40.8"S 66°57'33.3"W) 1425 m elev. 2 November 2006. L. J. Avila. Museo de La Plata herpetological collection (MLP.S 2596). Verified by J. A. Scolaro. Previously known only from type locality—"Chubut, Argentina (some 80 km to west from Telsen)." First province record and northernmost record for the species, extending the known distribution ca. 100 km NE from the type locality in Chubut Province (Cei and Scolaro 1999. Revue Francaise de Aquariologie 1–2:79–82).

Submitted by **NICOLAS FRUTOS, CRISTIAN H. F. PEREZ, MONICA KOZYKARISKI, MARIANA MORANDO,** and **LUCIANO JAVIER AVILA,** CENPAT-CONICET, Boulevard Almirante Brown s/n, U9120ACV, Puerto Madryn (Chubut), Argentina (e-mail: avila@cenpat.edu.ar).

PHELSUMA MADAGASCARIENSIS GRANDIS (Madagascar Giant Day Gecko). USA: FLORIDA: MONROE CO.: Vaca Key, Marathon, 1117 28th Street (24°42'26.924"N, 81°5'52.051"W, NAD83; elev. <1 m). 15 October 2006. Richard S. Lake. Verified by Josiah H. Townsend. Florida Museum of Natural History (photographic vouchers UF 150102–04). New island record and extends the range 16.5 km SW of the closest known locality on Grassy Key (Krysko et al. 2003. Florida Sci. 66:222–225; Krysko and Sheehy 2005. Carib. J. Sci. 41:169–172). Neonate and adults observed on side of house. On 27 October 2006, three neonates (photographic voucher UF 150105) and three adults were observed at this site. On 7 January 2007, several individuals were again observed at this site, as well as an adult (photographic voucher UF 150187) at 1313 28th Street (24°42'25.056"N, 81°5'51.54"W, NAD83; elev. <1 m).

Submitted by **KENNETH L. KRYSKO**, Division of Herpetology, Florida Museum of Natural History, Dickinson Hall, University of Florida, Gainesville, Florida 32611, USA (e-mail: kenneyk@flmnh.ufl.edu); **RICHARD S. LAKE**, 302 Daniel Paul Drive, Archdale, North Carolina 27263, USA; and **CARL D. MAY**, 1311 N Lakeside Drive, Lake Worth, Florida 33460, USA (e-mail: cdmfla@aol.com).

PHRYNOSOMA DOUGLASII (Pygmy Short-horned Lizard). USA: WYOMING: LINCOLN CO.: T21N, R113W, SW 1/4 Section 16. 08 August 1994. Kris H. Johnson. YPM 10176. Juvenile, with distinct umbilical scar. Verified by Greg Watkins-Colwell. New species record for Wyoming, and new county record for the genus (Baxter and Stone 1985. Amphibians and Reptiles of Wyoming, Wyoming Game and Fish Dept. Bull. 16; Cerovski et al. 2004. Atlas of Birds, Mammals, Amphibians, and Reptiles in Wyoming. Wyoming Game and Fish Dept.). Extends known range ca. 70 km E of the Idaho/Wyoming border (e.g., Hodges 2003. Digital Morphology, accessed 18 December 2006 at http://digimorph.org/specimens/Phrynosoma_douglassii/**;** Stebbins 2003. A Field Guide to Western Reptiles and Amphibians, 3rd Ed.. Houghton Mifflin Co.).

Submitted by **KRIS H. JOHNSON**, U.S. Fish and Wildlife Service Ecological Services Division, 620 East Greene Street, Carlsbad, New Mexico 88220, USA.

SCELOPORUS CYANOGENYS (Blue Spiny Lizard). USA: TEXAS: NUECES CO.: South of Bishop, ca. 20 m S of County Road 4, 1 road km E of business Highway 77 (27°34.130N, 097°48.358'W). 08 October 2006. Randy L. Powell. Verified by Travis J. LaDuc. Texas Natural History Collections (TNHC 65743). New county record, extends range east one county (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. Texas A&M Univ. Press, College Station. 421 pp.).

Submitted by **RANDY L. POWELL** Department of Biological and Health Sciences, MSC 158, Texas A&M University, Kingsville, Texas 78363, USA; e-mail: randy.powell@tamuk.edu.

SCINCELLA GEMMINGERI (Forest Ground Skink) MÉXICO: QUERÉTARO: MUNICIPALITY OF CADEREYTA DE MONTES: 0.5 km E de Maconi. (20º49'48"N, 99º32'99"W), 1920 m elev. 23 May 1996. Laura Contreras Narváez. Verified by Luis Canseco Márquez. Colección Herpetológica, Facultad de Ciencias, UNAM (MZFC 9781). First record for the municipality and second record for the state, extending the known distribution 44.6 km SW from 1.6 km

W Landa de Matamoros in the Sierra Gorda region, Querétaro (Ketchersid 1974. Herpetofauna of Two Biogeographic Transects in Eastern Mexico. Unpublished dissertation. Texas A&M Univ., College Station), and ca. 40.9 km range extension W from the closest known locality at La Placita, Hidalgo (García-Vázquez 2004. Revisión Taxonómica del Genero *Scincella* [Lacertilia: Scincidae] de México. Unpublished thesis, Univ. Autón. de Puebla, Puebla). The specimen was caught in riparian vegetation.

Submitted by **URI OMAR GARCÍA-VÁZQUEZ** and **ANDRÉS ALBERTO MENDOZA-HERNÁNDEZ,** Museo de Zoología, Facultad de Ciencias, UNAM, A.P. 70-399, México D. F. 04510 (e-mail: urigarcia@gmail.com).

SERPENTES

AHAETULLA FASCIOLATA (Speckled-head Whip Snake). THAILAND: RANONG PROVINCE: Muang District: forest stream near Klong Hat Som Paen (ca. 9°57'N, 98°41'E). 21 February 2004. M. Sumontha. Queen Saovabha Memorial Institute, Bangkok (QSMI 600). Verified by L. Chanhome (QSMI). Found on a tree along a forest stream in syntopy with *Ahaetulla prasina* (voucher at the Institut Royal des Sciences Naturelles de Belgique, Brussels: IRSNB 16997). First provincial record and extension of ca. 175 km N from the previous northernmost locality which is situated at Raman Forest Park, Takua Thung District, Phang-Nga Province (Pauwels et al. 2002. Nat. Hist. J. Chulalongkorn Univ. 2[1]:25–30). We thank Lawan Chanhome (QSMI) and Wudtichai Wungkahart (Ranong Marine Fisheries Station) for working facilities.

Submitted by **OLIVIER S. G. PAUWELS**, Department of Recent Vertebrates, Institut Royal des Sciences Naturelles de Belgique, Rue Vautier 29, 1000 Brussels, Belgium (e-mail: osgpauwels@yahoo.fr); and **MONTRI SUMONTHA**, Ranong Marine Fisheries Station, 157 M. 1, Saphan-Pla Rd., Paknam, Muang, Ranong 85000, Thailand (e-mail: knotsnake2211@yahoo.com).

CLONOPHIS KIRTLANDII *(*Kirtland's Snake). USA: MISSOURI: Clark Co.: Near Wayland (T65N, R6W). 28 April 2006. Christopher Shulse. Verified by J. M. Jones and R. Daniel. Dean E. Metter Memorial Collection, University of Missouri, Columbia (UMC 7936). Rediscovery in state, new county record, only second report west of Mississippi River, and extends the range in Missouri by ca. 51 km. One dead specimen was found on the shore of a constructed pond. Four live specimens were observed near the pond from 28 April – 31 May 2006. This species was first recorded in Missouri in 1964. A single live female was collected on 10 May 1964 in Marion County near Taylor, Missouri (Jones 1967. Herpetologica 23:66–67). No additional specimens were observed until those described herein. Therefore, this species was not included as part of Missouri's herpetofauna by Johnson (2000, The Amphibians and Reptiles of Missouri. Second Ed. Missouri Dept. Conserv., Jefferson City. 400 pp.). Based on these discoveries, *C. kirtlandii* is now considered extant in Missouri and is state ranked as critically imperiled (Missouri Department of Conservation 2007. Missouri Species and Communities of Conservation Concern. Missouri Dept. Conserv., Jefferson City. 50 pp.) This species is known to occur in six other states where it is listed as either state endangered or threatened (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Inst. Press, Washington, DC. 668 pp.), and has an imperiled global rank (Missouri Department of Conservation 2007, *op. cit.*). Additional studies are planned to investigate its distribution and abundance in northeast Missouri (J. Briggler, pers. comm.).

Submitted by **CHRISTOPHER SHULSE**, 212 Tucker Hall, Division of Biological Sciences, University of Missouri, Columbia, Missouri 65211, USA; e-mail: cdsxzc@mizzou.edu.

CROTALUS WILLARDI WILLARDI (Arizona Ridge-nosed Rattlesnake). MÉXICO: SONORA: Municipio de Nogales: Sierra de Pinitos, unnamed canyon on private land S of Los Picos Peaks, ca. 20 km SE (straight line) from the city of Nogales (ca. 31°13'10.15"N, 110°49'30.04"W; UTM: 518000E, 3450000N; horizontal datum ITRF92; ellipsoid GRS80; UTM zone 12), ca. 1524 m elev. 05 May 2006. Robert Villa, Paul Condon, and Trevor Hare. Verified by George L. Bradley. UAZ Sonoran Herpetological Photographic Voucher Initiative, UAZ 56499-PSV (skin with rattle). Westernmost locality for the species in México, extending known range ca. 50 km NW (straight line) from Cananea, Sonora (UAZ 27945). This is also the only record west of the Santa Cruz River. The snake was found in Madrean evergreen woodland.

Submitted by **ROBERT A. VILLA**, 1125 East Missouri Street, Tucson, Arizona 85714, USA (e-mail: herpsandviolin@aol.com); **PAUL T. CONDON**, 8832 East Buckboard Road, Tucson, Arizona 85749, USA; **TREVOR A. HARE** and **SERGIO AVILA-VILLEGAS**, Sky Island Alliance, 738 North 5th Avenue, Suite 201, Tucson, Arizona 85705, USA; and **DAVID G. BARKER**, Vida Preciosa International, Inc., P.O. Box 300, Boerne, Texas 78006, USA.

DENDRELAPHIS KOPSTEINI (Kopstein's Bronzeback Tree Snake). BRUNEI DARUSSALAM: BELAIT DISTRICT: Sungei Rampayoh (04°26'N, 114°24'E). Earlier reported as *Dendrelaphis formosus* (Das 1999. Malayan Nat. J. 53[4]:349–350; Das 2007. A Pocket Guide. Amphibians and Reptiles of Brunei. Natural History Publications [Borneo] Sdn Bhd. Kota Kinabalu. viii + 200 pp.), this species was recently described as new on the basis of specimens formerly identified as *D. formosus* from Thailand, Peninsular Malaysia, Singapore, and Sumatra (Vogel and van Rooijen 2007. Zootaxa 1394:25–45) and diagnosable from congeners in showing the following combination of characters: dark stripe covers only the lower part of temporal region, terminating at rear of neck; nuchal region red in life when inflated; eyes large; two supralabials in contact with orbit of eye. First record for Borneo.

Submitted by **INDRANEIL DAS**, Institute of Biodiversity and Environmental Conservation, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia; e-mail: idas@ibec.unimas.my.

LEPTODEIRA SPLENDIDA EPHIPPIATA (Saddled Cat-eyed Snake). MÉXICO: SONORA: Municipio de Yécora, 45.7 km (by Mex. Hwy. 16) E Yécora (28.40430°N, 108.67572°W), 1280 m elev. 06 July 2006. E. Enderson and R. Bezy. UAZ 56548-PSV. Verified by George Bradley. Northernmost record for Sonora, extending the range ca. 232 km (airline) N from the vicinity of Agua Marín, Sonora (Duellman 1958. Bull Amer. Mus. Nat. Hist. 114:1–

152) and 150 km NW of Río Urique, Chihuahua (Tanner 1986. Great Basin Nat. 45:615–676). The snake was DOR in pine-oak woodland.

Submitted by **ERIK F. ENDERSON,** Drylands Institute, PMB 405 2509 North Campbell Avenue, Tucson, Arizona 85719, USA (e-mail: erikenderson@msn.com); and **ROBERT L. BEZY**, Herpetology, Natural History Museum of Los Angeles County, Los Angeles, California 90007, USA.

LEPTOPHIS MEXICANUS (Mexican Parrot Snake). HONDURAS: CAYOS COCHINOS ARCHIPELAGO: BAY ISLAND PROVINCE: Cayo Cochino Grande, on east side of island near village of Eastend (15º58'36"N, 86º28'19"W, datum: WGS84), 1 m elev. 22 June 2006. J. A. Frazier. Verified by Robert Henderson. Photographic collection, ASU HP.00057–58). First record for Cayo Cochino Grande (McCranie et al. 2005. Amphibians and Reptiles of the Bay Islands and Cayos Cochinos, Honduras. Bibliomania, Salt Lake City, Utah).

We thank the Honduran Coral Reef Foundation and Operation Wallacea for supporting our research in the Cayos Cochinos.

Submitted by **JULIUS A. FRAZIER**, Department of Zoology, Southern Illinois University, Carbondale, Illinois 62901, USA (e-mail: tonyf@siu.edu); **CHAD E. MONTGOMERY**, University of Wisconsin La Crosse, La Crosse, Wisconsin 54601, USA (e-mail: chad_mont@yahoo.com); **SCOTT M. BOBACK**, Department of Biological Sciences, University of Alabama, Tuscaloosa, Alabama 35487, USA (e-mail: sboback@ua.edu); and **ROBERT N. REED**, Invasive Species Science, USGS Fort Collins Science Center, 2150 Centre Ave, Bldg C, Fort Collins, Colorado 80526, USA (e-mail: robert_reed@usgs.gov).

MASTICOPHIS TAENIATUS (Striped Whipsnake). USA: CALIFORNIA: MODOC CO.: Jess Valley Road (41.23089°N, –120.43909°W, WGS 84). 02 September 2006. Thomas J. Devitt and Susan E. Cameron. Verified by Jimmy A. McGuire. Museum of Vertebrate Zoology (MVZ 253453). New county record. Data were obtained from records held in the following institutions accessed via the HerpNET data portal (http://www.herpnet.org) on 05 March 2006: California Academy of Sciences, San Francisco; Museum of Vertebrate Zoology, University of California, Berkeley. The same results were obtained when all participating providers were included.

Submitted by **THOMAS J. DEVITT**, Museum of Vertebrate Zoology, University of California, Berkeley, California 94720-3160, USA (e-mail: tdevitt@berkeley.edu); and **SUSAN E. CAMERON**, Department of Environmental Science and Policy, One Shields Avenue, University of California, Davis, California 95616, USA.

OPHEODRYS AESTIVUS (Rough Greensnake). USA: ARKANSAS: VAN BUREN CO.: Near Brock Creek Lake: 35.49037°N, 92.80132°W. 15 Oct. 2005. Josh Engelbert, Melissa Patrick, Ashley Patrick, and Mauricio Solis. Verified by Stanley E. Trauth. Voucher specimen in Arkansas State University Museum of Zoology (ASUMZ 29441). Record represents first for county (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. Univ. of Arkansas Press, Fayetteville, 421 pp.)

Submitted by **JOSH ENGELBERT, MELISSA PATRICK,** and **MAURICIO SOLIS**, Department of Biological Sciences, Arkansas State University, P.O. Box 599, State University, Arkansas 72467-0599, USA (e-mail: josh.engelbert@smail.astate.edu).

RAMPHOTYPHLOPS BRAMINUS (Brahminy Blindsnake). USA: FLORIDA: CHARLOTTE CO.: Port Charlotte, 2376 Elkcam Blvd (26.99295ºN, -82.103593ºW). August 2003. Joyce Burke. Verified by Kenneth Krysko. University of Florida Museum of Natural History (UF 150413, photo voucher). New county record. This fills in a distributional gap for this non-native species on the west coast of Florida from Pasco County south to Monroe County (Meshaka et al. 2004. The Exotic Amphibians and Reptiles of Florida, Krieger Publ. Co., Malabar, Florida).

Submitted by **GREGG S. KLOWDEN**, University of Florida, Department of Wildlife Ecology and Conservation, P.O. Box 110430, Gainesville, Florida 32611, USA (e-mail: geckoguy@ufl.edu); and **CATHY A. OLSON**, Lee County Department of Parks and Recreation, 3410 Palm Beach Blvd, Fort Myers, Florida 33916, USA (e-mail: colson@leegov.com).

REGINA RIGIDA (Glossy Crayfish Snake). USA: TEXAS: FORT BEND CO.: Cow Creek Rd, 10.7 mi S County Rd 42. 22 May 2006. 423+125 mm; adult female collected DOR. TNHC 66071 (TNHC-FS 4258). Cow Creek Rd, 9.5 mi S TX Rte 762. 21 May 2006. 463+130 mm; adult female collected DOR. TNHC 66072 (TNHC-FS 4263). Verified by Travis J. LaDuc. First two county records, fills in gap within distribution (Dixon 2000. Amphibians and Reptiles of Texas, 2nd edition, Texas A&M University Press, 421 pp.).

Submitted by **DAVID W. HALL**, Department of Genetics, The University of Georgia at Athens, Athens, Georgia 30602, USA.

SEMINATRIX PYGAEA (Black Swampsnake). USA: FLORIDA: NASSAU CO.: US Hwy 301, 2.24 km S of Georgia state line (S of Boulogne near Hwy 301 crossing of Pigeon Creek). 4 September 2005. M. P. Wallace and D. Wallace. Verified by Kenneth L. Krysko. Florida Museum of Natural History photo voucher (UF 144585). New county record (Meshaka and Ashton 2005. *In* Meshaka and Babbitt [eds.], Amphibians and Reptiles Status and Conservation in Florida, pp. 242–282. Krieger Publ. Co., Malabar, Florida).

Submitted by **MARK P. WALLACE**, 784 Kelsall Drive, Richmond Hill, Georgia 31324, USA; and **DIRK J. STEVENSON**, 414 Club Drive, Hinesville, Georgia 31313, USA.

SEMINATRIX PYGAEA (Black Swampsnake). USA: FLORIDA: OKEECHOBEE CO.: CR 724, 0.1 mi E 700A (27.4652°N, -81.0096°W, datum WGS84). 15 March 2006. Verified by Kenneth L. Krysko. Florida Museum of Natural History (UF 150211). New county record (Ashton and Ashton 1988. Handbook of Reptiles and Amphibians of Florida. Part One: The Snakes. Windward Publ., Inc. 176 pp.). Adult found DOR at 2100 h in area of a mixture of dry prairie, marsh, and cattle pasture, and bordered by periodically flooded drainage ditches, which contained Pickerel Weed (*Pontederia cordata*), Wax Myrtle (*Myrica cerifera*), and Cabbage Palm (*Sabal palmetto*). Several live individuals, which were not collected, have been observed on the road or netted out of drainage ditches (Chris Lechowicz, pers. comm.) in the same area.

Submitted by **DANIEL J. PARKER**, 741 Star Fruit Ave, Lake Placid, Florida 33852, USA; e-mail: Mudsnake6@earthlink.net.

SONORA SEMIANNULATA (Groundsnake). USA: NEVADA: PERSHING CO.: Sonoma Range, above Sonoma Creek (40°48'49.0"N, 117°42'29.8"W, 1505 m elev.) under a small rock in sagebrush habitat. 07 May 2006. Bryan Hamilton. Verified by Jack Sites (BYU 8591). Three individuals of this species were observed at this locality in 1993 but no vouchers were collected (Scott, pers. comm.). This record fills a gap in the northeastern distribution of this species with the nearest documented records 64 km E (Battle Mountain, Humboldt Co., Nevada; CAS-SUR 10032), 160 km NW (Denio, Pershing Co., Nevada; Stebbins 2003. Western Reptiles and Amphibians. 3rd Ed.. Houghton Mifflin Co., Boston, Massachusetts, xxx pp.), and 60 km SW (Humboldt House, Pershing Co., Nevada; UNR 493).

Submitted by **BRYAN HAMILTON,** 100 Great Basin National Park, Baker Nevada 89311, USA; and **PAULETTE CONRAD,** Nevada Department of Wildlife, 4747 Vegas Drive, Las Vegas, Nevada 89108, USA (e-mail: pconrad@ndow.org).

TELESCOPUS FALLAX SYRIACUS (Common Cat Snake). LEBANON: HERMEL: Hermel Pyramid (34º22'N, 36º25'E). 28 May 2006. Collected by David Jandzík. Verified by Ján Kautman. Specimen (dead on road) deposited in Slovak National Museum (SNMB St. 634). This is the northernmost country record for the species, extending the range in Lebanon ca. 40 km NE from the closest previous locality in Bcharré (Müller and Wettstein 1933. Sitz. Akad. Wiss., math-naturwiss. Abt. 1 142:135–144; Hraoui-Bloquet et al. 2002. Zool. Middle East 27:35–46).

Submitted by **DAVID JANDZÍK**, Department of Zoology, Faculty of Sciences, Comenius University, Mlynská dolina B-1, SK-84215 Bratislava, Slovakia; e-mail: jandzik@fns.uniba.sk.

THAMNOPHIS ELEGANS ELEGANS (Mountain Gartersnake). USA: CALIFORNIA: AMADOR CO.: El Dorado National Forest, Oyster Lake (38°40'20.0"N, W120°6'59.4"W) 2205 m elev. 5 August 2006. Chris R. Feldman. CAS 233734–35. AMADOR CO.: El Dorado National Forest, unnamed pond 0.5 km NE of Mud Lake via FSR 17E24 (38°36'47.0"N, 120°8'39.0"W) 2402 m elev. 6 August 2006. Chris R. Feldman. CAS 233736–55. Verified by E. D. Brodie Jr. New county record. There is a literature account of *T. e. elegans* from a small, unnamed lake near the southern end of Silver Lake, Amador Co. (Livezey 1953. Herpetologica 9:73) but apparently no vouchers exist to support this record. Otherwise, the nearest known localities are: 3.9 km to the north, Carson Spur, El Dorado Co. (MVZ 67502), 15.7 km to the east, near Blue Lake, Alpine Co. (CAS-SUR 9127), and 21.6 km to the south, Big Meadows, Calaveras Co. (MVZ 65741). Along the western slope of the Sierra Nevada, *T. e. elegans* generally occurs in wet meadows and along pond and lake margins at mid to high elevations (usually above 1200 m). Such habitat is common and *T. e. elegans* is likely contiguous throughout this mountain range.

We thank the California Department of fish and Game for Scientific Collecting permits to CRF (803059-5).

Submitted by **CHRIS R. FELDMAN**, Department of Biology, Utah State University, Logan, Utah 84322-5305, USA (e-mail: elgaria@biology.usu.edu); **JENS V. VINDUM**, Department of Herpetology, California Academy of Sciences, San Francisco, California 94103-3009, USA (e-mail: jvindum@calacademy.org); and **ROBERT W. HANSEN**, 16333 Deer Path Lane, Clovis, California 93619-9735, USA (e-mail: rwh13@csufresno.edu).

THAMNOPHIS PROXIMUS PROXIMUS (Orange-striped Ribbonsnake). USA: ARKANSAS: LEE CO.: At intersection of US Hwy 79 and US Hwy 78: 34.46.545N, 90.57.874W (WGS 84): 22 April 2005. Josh Engelbert and Melissa Patrick. Verified by Stanley E. Trauth. Voucher specimen in Arkansas State University Museum of Zoology (ASUMZ 29276). Record is first for county (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. Univ. of Arkansas Press, Fayetteville, 421 pp.)

Submitted by **JOSH ENGELBERT** and **MELISSA PATRICK**, Department of Biological Sciences, Arkansas State University, P.O. Box 599, State University, Arkansas 72467-0599, USA (e-mail: josh.engelbert@smail.astate.edu).

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New Country and Department Records for Amphibians and Reptiles from El Salvador

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El Salvador is the smallest Central American country, encompassing an area of approximately 21,000 km^2. Despite massive deforestation over the last century due primarily to agriculture practices associated with coffee, corn, cotton, and sugar cane and a national parks system that protects less than 1% of El Salvador's land area (Komar 2002), a panoply of aquatic and terrestrial habitats continue to support a surprising diversity of vertebrates (Serrano 1995). Until recently, but with a few exceptions (e.g., Hidalgo 1983; Mertens 1952), herpetologists had largely ignored El Salvador, which was considered to have the most poorly known herpetofauna in Central America as recently as 2001 (Dueñas et al. 2001). Renewed interest in the last decade has resulted in several new species descriptions, country records, natural history reports, and a book about the Salvadoran herpetofauna

(e.g., Köhler and Kreutz 1999; Greenbaum et al. 2002; Greenbaum 2004; Leenders and Watkins-Colwell 2004; Herrera et al. 2005; and Köhler et al. 2006). Greenbaum and Komar (2005) assessed the threat for each of El Salvador's 130 species of amphibians and reptiles and noted that distribution and taxonomic status of many species remained poorly known.

Herein, we present one new country record and 64 new department records for El Salvador amphibians and reptiles compiled during field work undertaken from 1997 through 2006 that were not reported in Köhler et al. (2006). Abbreviations for museum collections housing voucher specimens include the American Museum of Natural History (AMNH); The University of Kansas Natural History Museum Color Transparency collection (KUCT); The University of Kansas Natural History Museum Digital Archive (KUDA), and Museo de Historia Natural de El Salvador, San Salvador (MUHNES). Most of the following records are based on photographs or digital images of specimens; only photos showing unambiguously diagnostic features are listed as vouchers. All vouchers were verified by Larry David Wilson, except for ones identified separately in the text. Generic name changes identified by Frost et al. (2006a) for several anuran species are recognized. Additional taxonomic changes that differ from Köhler et al. (2006) are discussed in the species records below.

New Country Record

Anura

Ollotis ibarrai. SANTA ANA: Municipio de Metapán, Hacienda Los Planes de Montecristo. 9 October 1976. Victor Hellebuyck. Verified by Joseph R. Mendelson III. AMNH 125854. New El Salvador record based on maps shown by Mendelson et al. (2005), although Köhler et al. (2006) discussed the likely presence of this species within moderate to high elevations (likely between 1800–2400 m) of northwestern El Salvador. Identification of this specimen was determined after reexamination of a toad tentatively identified as *Bufo coccifer* by Köhler et al. (2006). Frost et al. (2006b) recently changed the name of this genus from *Cranopsis* to *Ollotis*.

New Department Records

Gymnophiona

Dermophis mexicanus. USULUTÁN: Municipio de Jiquilisco, Chaguantique protected natural area (13º17'N, 88º33'W), 30 m elev. 18 June 2001. Néstor Herrera. Verified by William E. Duellman. KUCT 11946.

Caudata

Oedipina taylori. SONSONATE: Municipio de Caluco, Plan de Amayo protected natural area (13º41'N, 89º40'W), 260 m elev. 27 December 2002. Néstor Herrera. Verified by William E. Duellman. KUCT 11947.

Anura

Craugastor rhodopis. SANTA ANA: Municipio de Chalchuapa, La Magdalena protected natural area (14º05'24"N, 89º41'3"W), 700 m elev. 12 December 2005. Ricardo Pérez León. Verified by James R. McCranie. KUDA 000104. Crawford and Smith (2005) first recognized *Craugastor* as a distinct genus from *Eleutherodactylus*, and their phylogenetic results do not support the recognition of *Craugastor loki* (Frost et al. 2006a; Lynch 2000).

Leptodactylus fragilis. CABAÑAS: Municipio de Cinquera, Montaña de Cinquera protected natural area (13º52'21.4"N, 89º57'49.0"W), 550 m elev. 16 September 2005. Néstor Herrera. KUDA 000105.

Leptodactylus melanonotus. LA PAZ: Municipio de Zacatecoluca, Escuintla protected natural area (13º23'33.4"N, 88º54'8.1"W), 50 m elev. 9 September 2001. Néstor Herrera. KUDA 000106.

Lithobates forreri. LA PAZ: Municipio de Zacatecoluca, Escuintla protected natural area (13º23'33.4"N, 88º54'8.1"W), 50 m elev. 9 September 2001. Néstor Herrera. KUDA 000107. LA UNIÓN: Municipio de Conchagua, Laguna Los Negritos (13º16'36"N, 87º55'50"W), 100 m elev. 28 March 2003. Vladlen Henríquez. KUDA 000149.

Ollotis luetkenii. CABAÑAS: Municipio de Cinquera, Montaña de Cinquera protected natural area (13º52'21.4"N, 89º57'49.9"W), 550 m elev. 21 September 2003. Vladlen Henríquez. KUDA 000100. LA PAZ: Municipio de Zacatecoluca, Escuintla protected natural area (13º23'33.4"N, 88º54'8.1"W), 50 m elev. 9 September 2001. Néstor Herrera. KUDA 000101.

Scinax staufferi. CABAÑAS: Municipio de Cinquera, Montaña de Cinquera protected natural area (13º52'21.4"N, 89º57'49.0"W), 550 m elev. 16 September 2005. Néstor Herrera. Verified by James R. McCranie. KUDA 000103.

Trachycephalus venulosa. CABAÑAS: Municipio de Cinquera, Montaña de Cinquera protected natural area (13º52'21.4"N, 89º57'49.0"W), 550 m elev. 16 September 2005. Néstor Herrera. KUDA 000102.

Crocodylia

Caiman crocodilus. SAN MIGUEL: Municipio de El Transito, Laguna El Jocotal, El Desagüe (13º20'N, 88º15'W), 30 m elev. 9 October 1997. Néstor Herrera. Verified by William E. Duellman. KUCT 11953.

Testudines

Kinosternon scorpioides. CHALATENANGO: Municipio de El Paraíso, Santa Bárbara protected natural area (14º04'17"N, 89º05'37"W), 550 m elev. 1 April 2005. Néstor Herrera. KUDA 000108.

Rhinoclemmys pulcherrima. CABAÑAS: Municipio de Cinquera, Montaña de Cinquera protected natural area (13º52'21"N, 89º57'49.0"W), 550 m elev. 5 May 2006. Pedro Ramón Fuentes. Verified by William E. Duellman. KUDA 000153. CUSCATLÁN: Municipio de Suchitoto, Colima protected natural area (14º02'13"N, 89º07'10.4"W), 300 m elev. 22 September 2004. Vladlen Henríquez. KUDA 000148.

Lacertilia

Aspidoscelis deppii. AHUACHAPÁN: Municipio de San Francisco Menéndez, Laguna El Bijagual (13º41'32"N, 89º34'38.5"W), 30 m elev. 15 May 2004. Vladlen Henríquez. KUDA 000116. SAN VICENTE: Municipio de San Estebán Catarina, Laguna de Chalchuapán (13º42'30.0"N, 88º45'22.4"W), 600 m elev. 25 May 2004. Néstor Herrera. KUDA 000115.

Ctenosaura similis. CABAÑAS: Municipio de Cinquera, Montaña de Cinquera protected natural area (13º52'21.4"N, 89º57'49.0"W), 550 m elev. 16 September 2005. Néstor Herrera. Verified by Gunther Köhler and James R. McCranie. KUDA 000117.

Gonatodes albogularis. CABAÑAS: Municipio de Cinquera, Montaña de Cinquera protected natural area (13º52'21.4"N, 89º57'49.0"W), 400 m elev. 4 October 2003. Vladlen Henríquez. KUDA 000109.

Gymnophthalmus speciosus. USULUTÁN: Municipio de Jiquilisco, Chaguantique protected natural area (13º17'N, 88º33'W), 30 m elev. 28 July 2004. Vladlen Henríquez. KUDA 000114.

Hemidactylus frenatus. AHUACHAPÁN: Municipio de Jujutla, Barra de Santiago protected natural area (13º41'48"N, 89º59'11"W), 5 m elev. 30 December 2005. Néstor Herrera. Verified by Aaron M. Bauer. KUDA 000110. SAN SALVADOR: Municipio de Mejicanos, Residencial Metrópolis Norte, Cantón Zacamil, (13º43'56.52"N, 89º12'44.0"W), ca. 760 m elev. 18 November 2003. Oliver Komar. Verified by William E. Duellman. KUCT 11948. This introduced species was first collected in El Salvador in the department of La Libertad (Greenbaum 2002), and later observed in La Paz by Herrera et al. (2005).

Lepidophyma smithii. CABAÑAS: Municipio de Cinquera, Montaña de Cinquera protected natural area (13º52'21.4"N, 89º57'49"W), 550 m elev. 10 January 2004. Vladlen Henríquez. Verified by Gunther Köhler and James R. McCranie. KUDA 000122.

Mabuya unimarginata. CABAÑAS: Municipio de Cinquera, Montaña de Cinquera protected natural area (13º52'21.4"N, 89º57'49.0"W), 550 m elev. 16 September 2005. Néstor Herrera. KUDA 000120. SAN VICENTE: Municipio de San Esteban Catarina, Laguna de Chalchuapán (13º42'30.0"N, 88º45'22.4"W), 600 m elev. 11 September 2002. Néstor Herrera. KUDA 000121.

Norops sericeus. CABAÑAS: Municipio de Cinquera, Montaña de Cinquera protected natural area (13º52'21.4"N, 89º57'49.0"W), 550 m elev. 10 January 2004. Vladlen Henríquez. KUDA 000118.

Phyllodactylus tuberculosus. CABAÑAS: Municipio de Cinquera, Montaña de Cinquera protected natural area (13º52'21"N, 89º57'49.0"W), 550 m elev. 16 September 2005. Vladlen Henríquez. KUDA 000112. CHALATENANGO: Municipio de El Paraíso, Santa Bárbara protected natural area (14º04'17"N, 89º05'37"W), 550 m elev. 1 April 2005. Néstor Herrera. KUDA 000111. LA PAZ: Municipio de Zacatecoluca, Escuintla protected natural area (13º23'33.4"N, 88º54'8.1"W), 50 m elev. 9 September 2001. Néstor Herrera. KUDA 000113.

Sceloporus olloporus. LA PAZ: Municipio de Zacatecoluca, Escuintla protected natural area (13º23'33.4"N, 88°54'8.1"W), 50 m elev. 9 September 2001. Néstor Herrera. KUDA 000119. Although the phylogenetic study of Mendoza-Quijano et al. (1998) did not include samples from Central America, *S. variabilis olloporus* was elevated to species status, which presumably includes *S. variabilis* populations in El Salvador (Köhler et al. 2006).

Serpentes

Agkistrodon bilineatus. LA LIBERTAD: Municipio de La Libertad, Parque Walter Thilo Deininger (13º31'N, 89º16'W), 8 m elev. 24 August 2002. Vladlen Henríquez. KUDA 000144.

Boa constrictor. CHALATENANGO: Municipio de El Paraíso, Santa Bárbara protected natural area (14º04'17"N, 89º05'37"W), 550 m elev. 4 December 2000. Néstor Herrera. KUDA 000147. SANTA ANA: Municipio de Metapán, San Diego-La Barra protected natural area (14º16'2.7"N, 89º28'0.6"W), 472 m elev. 8 May 2005. Vladlen Henríquez. KUDA 000146.

Coniophanes piceivittis. LA LIBERTAD: Municipio de La Libertad, Parque Walter Thilo Deininger (13º31'N, 89º16'W), 200 m elev. 10 September 2002. Néstor Herrera. Verified by William E. Duellman. KUCT 11950.

Conophis concolor. SAN VICENTE: Municipio de San Esteban Catarina, Laguna de Chalchuapán (13º42'30.0"N, 88º45'22.4"W), 600 m. 25 May 2004. Néstor Herrera. KUDA 000123. Pérez-Higareda et al. (2002) elevated *C. lineatus concolor* to species status based on a disjunct distribution of *C. l. lineatus* in central Veracruz, Mexico, and variation in stripe pattern.

Crotalus simus. CUSCATLÁN: Municipio de Suchitoto, Colima protected natural area (14º03'N, 89º08'W), 230 m elev. 12 September 2000. Néstor Herrera. Verified by William E. Duellman. KUCT 11944. First department record with specific locality. CABAÑAS: Municipio de Cinquera, Montaña de Cinquera protected natural area (13º53'N, 88º57'W), 400 m elev. 9 August 2003. Néstor Herrera. MUHNES 30-1463. CHALATENANGO: Municipio de La Montañona (14º07'N, 88º55'W), 1430 m elev. 1 April 2006. Néstor Herrera. KUDA 000152. SAN MIGUEL: Municipio de San Miguel, Volcán de San Miguel (13º26'N, 88º16'W), 2000 m elev. 3 December 2002. Néstor Herrera. MUHNES 30-1462. Shed skin (with distinctive Mesoamerican rattlesnake diamond pattern) found in a depression under an agave plant in tropical altimontane meadow containing plants in the families Ericaceae, Agavaceae, Onagraceae, and Plantaginaceae. New elevational record in El Salvador (Köhler et al. 2006).

The taxonomic status of *C. simus* in El Salvador is presently controversial. A molecular phylogenetic study by Wüster et al. (2005) indicated that *C. s. simus* (*sensu* Campbell and Lamar 2004) was polyphyletic with respect to a population in Veracruz, Mexico (sister to *C. culminatus*), and a clade from Chiapas, Mexico, El Salvador, and Costa Rica (sister to South American *C. durissus*). The Veracruz population (that renders *C. simus* polyphyletic) is likely to be described as a full species when additional data become available (W. Wüster, pers. comm.). Seemingly unaware of Wüster et al. (2005), Savage et al. (2005) designated a neotype for *Crotalus simus* from Guatemala, presumably based on Campbell and Lamar's (2004) idea of *C. simus*. Until future studies clarify its taxonomy, we recognize El Salvador Neotropical rattlesnakes as *C. simus*, as defined by Campbell and Lamar (2004) and Savage et al. (2005).

Drymarchon melanurus. CABAÑAS: Municipio de Cinquera, Montaña de Cinquera protected natural area (13º52'21.4"N, 89º57'49.0"W), 550 m elev. 15 September 2005. Néstor Herrera. KUDA 000125. SANTA ANA: Municipio de Santa Ana, Finca Kilimanjaro (13º52'17.1"N, 89º37'17.9"W), 1720 m elev. 31 August 2004. Walter Chacón. KUDA 000124. New elevation record for El Salvador (Köhler et al. 2006). Although Köhler et al. (2006) continued to recognize *D. corais* for Salvadoran populations of *Drymarchon* because molecular data remain lacking, *D. melanurus* has gained common acceptance as a valid species (e.g., Cisneros-Heredia 2006; McCranie et al. 2005).

Imantodes gemmistratus. CABAÑAS: Municipio de Cinquera, Montaña de Cinquera protected natural area (13º52'21.4"N,

89º57'49.0"W), 550 m elev. 22 April 2003. Néstor Herrera. Verified by James R. McCranie. KUDA 000131.

Lampropeltis triangulum. MORAZÁN: Municipio de Osicala, Cantón Llano Alegre (13º48'47.62"N, 88º8'46.17"W), 478 m elev. 21 December 2005. Néstor Herrera. KUDA 000127. SANTA ANA: Municipio de Metapán, San Diego-La Barra protected natural area (14º17'N, 89º29'W), 500 m elev. 18 June 2000. Ricardo Ibarra Portillo. KUDA 000126.

Leptodeira annulata. CABAÑAS: Municipio de Cinquera, Montaña de Cinquera protected natural area (13º52'21.4"N, 89º57'49.0"W), 550 m elev. 16 October 2005. Vladlen Henríquez. KUDA 000129. LA PAZ: Municipio de Zacatecoluca, Escuintla protected natural area (13º23'33.4"N, 88º54'8.1"W), 50 m elev. 9 September 2001. Néstor Herrera. KUDA 000128. SAN VICENTE: Municipio de San Esteban Catarina, Laguna de Chalchuapán (13º42'30.0"N, 88º45'22.4"W), 600 m elev. 25 May 2004. Néstor Herrera. KUDA 000130.

Leptophis mexicanus. LA PAZ: Municipio de Zacatecoluca, Escuintla protected natural area (13º23'33.4"N, 88º54'8.1"W), 50 m elev. 27 August 2003. Néstor Herrera. KUDA 000132. SANTA ANA: Municipio de Metapán, San Diego-La Barra, (14º17'N, 89º29'W), 500 m elev. 18 June 2000. Roberto Rivera. KUDA 000133.

Loxocemus bicolor. SANTA ANA: Municipio de Metapán, San Diego-La Barra protected natural area (14º17'N, 89º29'W), 500 m elev. 18 July 2002. César Mendoza. KUDA 000143. USULUTÁN: Municipio de Jiquilisco, Laguna San Juan del Gozo (13º14'3.9"N, 88º44'5.0"W), 10 m elev. 2002. Enriqueta Ramírez. Verified by William E. Duellman. KUCT 11949.

Masticophis mentovarius. SONSONATE: Municipio de Caluco, Plan de Amayo, Plan de las Mesas protected natural area (13º40'N, 89º39'W), 260 m elev. 6 August 2002. Néstor Herrera. Verified by William E. Duellman. KUCT 11951.

Micrurus nigrocinctus. CABAÑAS: Municipio de Cinquera, Montaña de Cinquera protected natural area (13º52'21.4"N, 89º57'49.0"W), 550 m elev. 12 September 2005. Karla Lara. KUDA 000150. MORAZÁN: Municipio de Osicala, Cantón Llano Alegre (13º49'45.91"N, 88º08'50.02"W), 343 m elev. 21 December 2005. Vladlen Henríquez. KUDA 000151.

Ninia sebae. CABAÑAS: Municipio de Cinquera, Montaña de Cinquera protected natural area (13º52'21.4"N, 89º57'49.0"W), 550 m elev. 7 September 2003. Néstor Herrera. KUDA 000134.

Porthidium ophryomegas. SANTA ANA: Municipio de Metapán, San Diego-La Barra protected natural area (14º16'2.7"N, 89º28'0.6"W), 472 m elev. 8 May 2005. Néstor Herrera. KUDA 000145.

Rhadinaea pilonaorum. SONSONATE: Municipio de Izalco (13º47'18"N, 89º35'37"W), 1000 m elev. 12 August 2005. Vladlen Henríquez. Verified by James R. McCranie. KUDA 000135–36.

Sibon anthracops. SANTA ANA: Municipio de Chalchuapa, La Magdalena protected natural area (14º05'24"N, 89º41'39"W), 700 m elev. 12 December 2005. Ricardo Pérez León. Verified by James R. McCranie. KUDA 000137.

Sibon carri. CABAÑAS: Municipio de Cinquera, Montaña de Cinquera protected natural area (13º52'21.4"N, 89º57'49.0"W), 550 m elev. 7 September 2003. Vladlen Henríquez. Verified by James R. McCranie. KUDA 000138.

Spilotes pullatus. LA UNIÓN: Municipio de Nueva Esparta, Upire (13º52'36"N, 87º50'28"W), 910 m elev. 4 October 2005. Ricardo Ibarra Portillo. KUDA 000139. USULUTÁN: Municipio de Jiquilisco, Nancuchiname protected natural area (13º22'N, 88º30'W), 30 m elev. 15 March 1997. Néstor Herrera. Verified by William E. Duellman. KUCT 11952.

Stenorrhina freminvillii. CABAÑAS: Municipio de Cinquera, Montaña de Cinquera protected natural area (13º52'21.4"N, 89º57'49.0"W), 550 m elev. 16 January 2004. Vladlen Henríquez. KUDA 000140.

Thamnophis proximus. CABAÑAS: Municipio de Cinquera, Montaña de Cinquera protected natural area (13º52'21.4"N, 89º57'49.0"W), 550 m elev. 12 September 2004. Néstor Herrera. KUDA 000141.

Trimorphodon biscutatus. CUSCATLÁN: Municipio de Suchitoto, Colima protected natural area (14º02'13.8"N, 89º07'10.4"W), 300 m elev. 22 September 2004. Néstor Herrera. KUDA 000142.

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New Distributional Records for Amphibians and Reptiles from the State of Tamaulipas, México

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Tamaulipas lies in the northeastern corner of México; it is bordered to the north by the state of Texas (USA) and by the Gulf of México to the east. Transected by the Tropic of Cancer, the state's relatively small area (ca. 79,389 km^2) has encompassed within its boundaries arid tropical thorn forest, tropical deciduous forest, cloud forest, the eastern limits of the Chihuahuan Desert, beaches and barrier islands at sea level, and pine-oak forest at elevations over 3200 m in the Sierra Madre Oriental. A complete overview of the Tamaulipas herpetofauna has never been published. The pioneering work of Martin (1958), is the most comprehensive, although it was restricted to a limited area of the state and in some aspects was taxonomically flawed (King and Thompson 1968) and is now outdated. Canseco-Márquez et al. (2004) described the herpetofauna known to them from the Sierra Madre Oriental, including southwestern Tamaulipas, in relationship to vegetation types, elevational ranges, and general distributions of included species. However, numerous species that have been documented in the Sierra Madre Oriental of Tamaulipas in various publications, including several recorded in Martin (1958), were overlooked by Canseco-Márquez et al. (2004). Other publications on the amphibians and reptiles of Tamaulipas are few in number, limited in scope, and many included inconsistent and contradictory distributional information.

We have all conducted numerous field surveys within Tamaulipas over the last 15 years, both independently and in collaboration. During that time, we also searched the literature and museum collections for additional distributional data on the herpetofauna occurring within the state. This report addresses information on 20 species, including 19 range extensions involving eight new state records and a statement on one species that we believe should not be counted among the fauna of Tamaulipas, contrary to over 110 years of literature placing it in the state.

Over one hundred natural history museums and universities in Canada, the United States, and México were polled for their amphibian and reptile holdings from Tamaulipas. Sixty-one institutions responded, providing a combined total of approximately 11,500 localities and other data on reptiles and amphibians col-

lected in the state. Museum abbreviations used follow the standard symbolic codes found in Leviton et al. (1985) and Leviton and Gibbs (1988), except the following institutions that were not included in those publications: Instituto Tecnológico Agropecuario de Hidalgo (ITAH), Hidalgo, México; Instituto Tecnológico de Cd. Victoria, (ITCV), Tamaulipas, México; Universidad Autónoma de Ciudad Juárez (UACJ), Chihuahua, México; West Texas A&M University Natural History Museum (WTAMU) Canyon, Texas; and the private collection of Ernest A. Liner (EAL), Houma, Louisiana (The EAL collection was recently donated to the AMNH).

All longitude and latitude coordinates are expressed using the WGS84 (World Geodetic System 1984) datum. Longitude and latitude coordinates and elevations recorded in the original locality data are presented in parentheses ( ). Data in brackets [ ] were obtained either by plotting original localities without corresponding data on topographic maps produced by INEGI (Instituto Nacional de Estadística Geografía Informática), or in some cases, by taking readings with a handheld GPS unit after returning to the original localities. Due to the imprecise nature of some of the original locality data, the supplemented coordinates and elevations presented in brackets should be interpreted as approximate points of collection. Original locality data listed as miles and feet have been converted to metric measurements and presented along side coordinates in brackets. Distances were calculated on INEGI topographical maps and are expressed in air km (not road km) unless otherwise stated. Sierra de Miquihuana, as used herein, includes all areas in the municipality of Miquihuana, Tamaulipas, México, at elevations above 2250 m and lying north of 23°33'N and west of 99°40'W, including El Aserradero, El Capulín, Las Joyas de Miquihuana, Marcela, Valle Hermoso, Sierra El Borrado, Sierra Los Borregos, Sierra La Gloria, Sierra El Pedregoso, and the eastern slopes of Sierra San Antonio Peña Nevada.

Caudata

*Bolitoglossa platydactyla (*Broadfoot Mushroomtongue Salamander). Municipio Gómez Farías: Gómez Farías, Estación Los Cedros [23°02'62"N, 99°09'54"W, 320 m elev.]. 11 January 1994. James R. Dixon. Verified by Kathryn Vaughan. TCWC 71137. Municipio Ocampo: Santa Maria de Guadalupe, 22 km NW of Ocampo (22°54'89"N, 99°29'37"W, 346 m elev.). 11 July 2005. William Farr and José Cortes-Larriva. Verified by Fernando Mendoza-Quijano. UANL 6406. First record for Tamaulipas for both genus and species (Wake and Lynch 1976; Canseco-Márquez et al. 2004) and range extensions of ca. 105 km N for UANL 6406 and *ca*. 120 km N for TCWC 71137, from the nearest locality in southeastern San Luis Potosí (Wake and Lynch 1976). Both localities are situated in tropical deciduous forest.

Chiropterotriton priscus (Primeval Splayfoot Salamander) Municipio Miquihuana: Las Joyas de Miquihuana, 11 km N La Peña (23°39'44"N, 99°42'53"W, 2940 m elev.). 4. July 2004. William Farr, Pablo Lavín Murcio, Gilberto Herrera-Patiño, Oscar M. Hinojosa-Falcón, Ricardo Enrique-Nuñez, Armando Martínez, and Michael R. J. Forstner. Tentatively verified by James R. Dixon (see below). TCWC 90156-161. First record for Tamaulipas, although Rabb (1956) predicted its occurrence there, and a 30 km range extension S from the closest known locality in Nuevo León (Liner 1998a). The identity of this series as *Chiropterotriton priscus* is tentative and may represent examples of an undescribed species discussed by Rabb (1958) from a locality approximately 35 km to the NE in Tamaulipas and addressed in more detail below. All specimens were found on the ground, in and under logs, in dead agaves, and rarely under rocks, in pine-oak-madrone forest with an understory of agaves and scrub heavily littered with fallen logs. Reasons for the tentative identification of these salamanders are discussed below.

The salamanders agree, in most aspects, with the original description of *C. priscus* given in Rabb (1956), including, short legs with three to four costal spaces between adpressed limbs, twelve costal spaces between axilla and groin, eleven distinct costal grooves, and a weak mid-dorsal furrow. However, two key characters given for *C. priscus*, ventral coloration and size seem to be irreconcilable with the series from the Sierra de Miquihuana, and in both features are more consistent with the *Chiropterotriton* sp. discussed in Rabb (1958). Rabb (1956) describes ventral color in *C. priscus* as having "sides progressively lighter than the dorsum as the tan ventral surfaces are approached." Likewise, Liner's (1998a) definition describes a lighter, mostly cream-colored venter. This condition is exactly reversed in the salamanders from Sierra de Miquihuana, with sides progressively darker than the dorsum as the black ventral surfaces are approached, so in this respect they more closely resemble the purported undescribed *Chiropterotriton* represented in Rabb (1958) that had a dark venter. Rabb (1956) does note that ontogenetic variation shows young being considerably darker than the adults, particularly on the venter in *C. priscus*. However, these salamanders were extremely abundant in July and August of 2003 through 2005, so it seems unlikely that of the hundreds of these salamanders observed over three years, all were juveniles.

The average size of the six Sierra de Miquihuana specimens is 31.66 mm snout–vent length (64.33 mm total), with the largest specimen being 37 mm SVL (74 mm total). This is slightly smaller than the 32–42 mm SVL of the *Chiropterotriton* sp. in Rabb (1958), but notably smaller than the 37–50 mm SVL given by Rabb (1956) for *C. priscus*. Rabb (1956) also comments on the robust body of *C. priscus* and notes the resemblance to small individuals of *Pseudoeurycea galeanae*. Subsequent authors (Darda 1994; Liner 1998a; Parra-Olea 2003; Wake and Lynch 1976) all commented on the robust body and *Pseudoeurycea*-like appearance of *C. priscus*. These descriptions would not seem applicable to the small and slender *Chiropterotriton* from the Sierra de Miquihuana. In numerous surveys conducted from 1997 to 2005, many *P. galeanae* were found in and under dead logs and in dead agaves alongside the *Chiropterotriton* in question, but the morphological differences between samples of the two genera from the Sierra de Miquihuana are clear and obvious. Likewise, the general and overall appearance of these salamanders is quite consistent with other species of *Chiropterotriton* (e. g., *C. cracens* and *C. multidentatus*) observed by us in other areas of Tamaulipas.

The coloration of these salamanders can be highly variable. Most, but not all, have a faint and poorly delineated rusty-colored ring or collar around the dorsal part of the neck on a drab and nondescript mottled or peppered ground color of tans, browns and black on the dorsal surface and a darker, mostly black ventral surface. Many individuals have a weak and poorly defined dark line, or sometimes a dark line of weakly defined chevrons, pointing to-

wards the anterior, running down the spine. Another less common "red-backed" variant bears a faint rusty-red dorsal surface on the body and tail outlined by darker pigment that extends down the lateral surface.

Individuals of the undescribed *Chiropterotriton* discussed in Rabb (1958) are currently in the University of Michigan Museum of Zoology (UMMZ 111323–327) cataloged as *Chiropterotriton multidentatus* and have not been examined by us. Rabb (1958) believed these salamanders were clearly related to the two Tamaulipan populations of *C. multidentatus*, but most likely represented another species. Rabb (1958) furthermore included the original description of *Chiropterotriton chondrostega cracens* (= *Chiropterotriton cracens*), and by having previously described *C. priscus*, he obviously believed the undescribed *Chiropterotriton* was distinct from both of those taxa. The UMMZ series were collected by Paul Martin in 1953, from two localities, El Chihue, 17 km by road southeast of Revillagigedo [23°52'N, 99°25'W] Tamaulipas, México, ca. 6200 ft. [1860 m elev.] and from Ojitos Mine, ca. 2 miles [3.21 km] west of El Chihue, 8600 ft. [2580 m], which is ca. 65 miles [104 km] north of the Gómez Farías region (Rabb 1958). One character described by Rabb (1958) in the UMMZ series, the longer length of the legs, is irreconcilable with the salamanders from the Sierra de Miquihuana. Rabb (1958) reported a gap of 1/2 to an overlap of 1/2 of a coastal groove between adpressed limbs in the UMMZ series. Dental characters have not been examined in the present series, although Rabb (1958) questioned their importance for discriminating among taxa in the genus.

More recently, Darda (1994) and Parra-Olea (2003) examined *Chiropterotriton* allozyme variation and DNA from multiple localities throughout México, including samples from all of the currently recognized species in the genus except *C. mosaueri*. Those publications identified at least seven new cryptic species, but left them undescribed, and regrettably did not include samples collected from the Sierra de Miquihuana or from El Chihue, the locality of the UMMZ specimens.

We conclude that these salamanders represent either: a) a southern range extension of *Chiropterotriton priscus* with characters that exceed the current definition of the species, or b) an undescribed species of *Chiropterotriton* geographically located 30 km S of the known distribution of *C. priscus* in adjacent areas of Nuevo León, and 60 km NW of *C. multidentatus* in the Sierra de Guatemala (= El Cielo).

Pseudoeurycea sulcata (Sulcate False Brook Salamander). Municipio Casas: 10 km N of Rancho La Sauceda [23°11'50"N, 99°20'50"W, 1140 m elev.] in the Sierra de Tamaulipas, ca. 39 km N of González. 11 October 2002. Pablo Lavín Murcio and Oscar M. Hinojosa-Falcón. Verified by James R. Dixon (as *P. cephalica*, see below). ITCV 970-971. First record from the Sierra de Tamaulipas and a range extension of 90 km E from the Sierra de Guatemala range of the Sierra Madre Oriental where *Pseudoeurycea sulcata*, *P. bellii*, and *P. scandens* are all documented (Martin 1958; Walker 1955). The Sierra de Tamaulipas is an isolated mountain range located over 50 km E of the Sierra de Guatemala, and separated by 30 km of lowland tropical thorn scrub that is unsuitable habitat for *Pseudoeurycea*. The habitat in the Sierra de Tamaulipas, where these salamanders were collected, is pine-oak forest.

As a side note, a single specimen (KU 129226) cataloged as *Pseudoeurycea scandens*, reportedly collected 9 October 1955, at Agua Linda in the Sierra de Tamaulipas, is in fact a *Pseudoeurycea sulcata*. We consider this specimen as having erroneous locality data and believe it was actually caught 9 October 1965, at Agua Linda, Sierra de Guatemala along with other specimens in the University of Kansas collection obtained by the same collectors on the latter date and location. We are unaware of any locality by the name of Agua Linda in the Sierra de Tamaulipas, whereas Agua Linda in Sierra de Guatemala is a familiar locality and has long been an established destination for biologists (Martin 1955, 1958; Sutton and Pettingill 1942; Walker 1955). Therefore, we consider the record of *P. sulcata* to be the first record for a plethodontid salamander from the Sierra de Tamaulipas. The name *Pseudoeurycea sulcata* has previously been referred most often to *P. cephalica*, which, as pointed out by Frost (2007), is a *nomen nudum*; the next available name is *P. sulcata* (Brocchi 1883), as used herein.

Pseudoeurycea galeanae (Galeana False Brook Salamander). Municipio Miquihuana: Las Joyas de Miquihuana, 11 km N of La Peña. (23°39'30"N, 99°42'65"W), 2936 m elev. 4 July 2004. William Farr, Pablo Lavín Murcio, Gilberto Herrera-Patiño, Oscar M. Hinojosa-Falcón, Ricardo Enrique-Nuñez, Armando Martínez, and Michael R. J. Forstner. Verified by James R. Dixon. UACJ 474. First record for Tamaulipas and a 20–30 km range extension S from the closest known locality in Nuevo León (Liner 1998b). The salamander was caught in pine-oak forest.

Notophthalmus meridionalis (Black-spotted Newt). Municipio Ocampo: Laguna La Loca, 5 km E of El Pensil, 20 km S of Ocampo [22°40'00"N, 99°19'75"W, ca. 300 m elev.]. 27 October 2001. Oscar M. Hinojosa-Falcón and Gilberto Herrera-Patiño. Verified by Jerry D. Johnson. ITCV 683, 741. Westernmost record for this species from throughout its geographical range and a range extension of ca. 37 km W of the vicinity of Ciudad Mante [22°45'00"N, 98°59'00"W, 80 m elev.] (Mecham 1968). Laguna La Loca lies just east of the main body of the Sierra Madre Oriental, and west of the smaller Sierra Tamalave and Sierra Cucharas. Vegetation in the area is tropical deciduous forest.

Anura

Anaxyrus punctatus (Red-spotted Toad). Municipio Jaumave: 5.2–6.2 [road] mi. [8.36–9.97 km] NW Jaumave, Hwy 101 [23°29'N, 99°25'W], 2425–2450 ft. [727.5–735 m] elev. 26 June 1976. James R. Dixon and Carl S. Lieb. Verified by Kathryn Vaughan. TCWC 52642–644. Jaumave [23°24'50"N, 99°23'00"W, 740 m elev.]. 16 May 1946. Hellmuth Wagner. Verified by Gregory Schneider. UMMZ 95237. Hwy 101 at Río Chihue [23°35'30"N, 99°20'10"W, 660 m elev.]. 9 June 1978. Peter Meylan, John Iverson, and Ron Magill. Verified by James R. Dixon from a digital photograph supplied by Kenneth L. Krysko. FLMNH 44080. Municipio San Carlos: 2.6 mi. [4.18 km] WNW San Carlos [24°36'N, 98°58'W, 500 m elev.]. 3 January 1975. Fred. S. Hendricks and party. Verified by James R. Dixon. TCWC 49393. 0.4 mi. [0.64 km] SW Rancho Carricitos [24°36'N, 98°55'W, 600 m elev.]. 8 January 1976. Fred S. Hendricks and party. Verified by James R. Dixon. TCWC 49394. Vicinity Rancho Carricitos [24°37'N, 98°55'W, 700 m elev.]. 17 May 1977. Fred S. Hendricks and H. E. Bonham.

Verified by James R. Dixon. TCWC 58053, 58059. 0.3 mi. SSW Rancho Carricitos [24°37'N, 98°55'W, 750 m elev.]. 18 May 1977. M. Sims. Verified by James R. Dixon. TCWC 58066. 6.4–7.0 mi. [10.29–11.26 km] S San Carlos [24°30'N, 98°57'W, 700–800 m elev.]. 5 May 1977. Fred S. Hendricks. Verified by James R. Dixon. TCWC 58131. Marmolejo [24°37'50"N, 99°00'30"W, 540 m elev.]. 28 July, 5 August 1930. L. R. Dice. Verified by Gregory Schneider. UMMZ 69206 (two specimens), 69208. Municipio Casas: 42.2 [road?] mi. [67.89 km] E of Ciudad Victoria [23°34'N, 98°30'W, 400 m elev.], near Soto La Marina. 27 August 1972. Jeremy F. Jacobs. Verified by James R. Dixon. USNM 244735-736. Municipio Bustamante: 9 km S of Bustamante on the paved road going to highway 101. (23°21'25"N, 99°43'91"W), 1435 m elev. 12 July 2004. William Farr and Michael R. J. Forstner. Verified by James R. Dixon. UACJ 480. Municipio Burgos: Mulato [24°53'50"N, 98°57'00"W, 250 m. elev.]. 20 August 1930. L. R. Dice. Verified by Gregory Schneider. UMMZ 69209–210. Municipio Tula: 9 [road?] mi. [14.48 km] SSW of Tula [22°51'50"N, 99°50'30"W, 1100 m elev.]. 14 July 1951. Paul and Marian Martin. Verified by Gregory Schneider. UMMZ 110731 (12 specimens). Municipio Palmillas: 2 [road?] mi. [3.21 km] N of Palmillas [23°19'50"N, 99°33'00"W, 1000 m elev.]. 16 July 1951. Paul and Marian Martin. Verified by Gregory Schneider. UMMZ 110732 (2 specimens). 15 km S of the town of Palmillas, near Ejido El Llano de Azuas, on the dirt road going to San Vicente. (23°10'04"N, 99°33'24"W). 1506.6 m elev. 11 July 2004. William Farr, Pablo Lavín Murcio, Gilberto Herrera-Patiño, Oscar M. Hinojosa-Falcón, Ricardo Enrique-Nuñez, Armando Martínez, and Michael R. J. Forstner. Verified by James R. Dixon. UTA slide collection 31343. Municipio Soto La Marina: Soto La Marina [23°46'00"N, 98°11'50"W], 500 ft. [150 m] elev. [The elevation of the town of Soto La Marina is 30 m., so 500 ft. was either recorded in error or the specimen was collected in hills 10–20 km S or W of the town]. 18 May 1953. Gerd H. Heinrich. Verified by James R. Dixon. KU 33986. Municipio Victoria: 1 [road] mi. [1.60 km] E Ciudad Victoria [23°43'N, 99°06'W, 300 m elev.]. 6 June 1959. James R. Dixon. Verified by Omar Torres-Carvajal. KU 60515–516. 3–5 [road] mi. [4.82–8.04 km] E Ciudad Victoria [23°43'N, 99°04'.0W– 99°02'60"W, 200–300 m elev.]. 6 June 1959. James R. Dixon. Verified by Omar Torres-Carvajal. KU 60517–525. 6–8 [road] mi. [9.65–12.87 km] E Ciudad Victoria [23°43'N, 99°01'20"W–98°03'80"W, 200–300 m elev.]. 6 June 1959. James R. Dixon. Verified by Omar Torres-Carvajal. KU 60526–532. 10–13 [road] mi. [16.09–20.91 km] E Ciudad Victoria [23°43'N, 98°57'50"W–98°54'70"W], 1100 ft. [330 m] elev. 6 June 1959. James R. Dixon. Verified by Omar Torres-Carvajal. KU 60533–536. Municipio Antiguo Morelos: 47 mi. [75.63 km] N Valles on hwy 85 [22°36'N, 99°02'W]. 24 August 1952. Collector not recorded. Verified by James R. Dixon. FLMNH 7674-1, 2. Municipio Miquihuana: In the town of Miquihuana (23°34'N, 99°46'W), 1840 m elev. 10 August 2003. William L. Farr, Gilberto Herrera-Patiño, Omar Martínez Alvirde, and Ricardo Enrique-Nuñez. Verified by James R. Dixon. UTA slide collection 31336–338. 0.5 km SE of the town of La Peña (23°33'16"N, 99°41'33"W), 1781.1 m elev. 4 July 2004. William L. Farr and Michael R. J. Forstner. Verified by James R. Dixon. UTA slide collection 31339–340. 17 km SE of Miquihuana, near Ejido Altamira, on the paved road going to highway 101 (23°27'51"N, 99°37'68"W), 1719.6 m elev. 8 July 2004. William L. Farr, Oscar M. Hinojosa-Falcón, and Ricardo Enrique-Nuñez. Verified by James R. Dixon. UTA slide collection 31341–342.

The distribution of *Anaxyrus punctatus* in Tamaulipas has not been well documented. Frost (2007) and Smith and Taylor (1966) include Tamaulipas in the range of the species, but partial distribution maps in Conant and Collins (1998) and Stebbins (2003) fail to show the species as occurring within the state. The distribution map in Korky (1999) shades a small portion of southwest Tamaulipas, but precise distribution was not supported by any locality dots. Our data reveal *A. punctatus* occurring in 11 of the 43 municipalities in the state, including all five positioned west of the Sierra Madre Oriental. Localities ranging from the Municipio of Burgos in northcentral Tamaulipas, to Soto La Marina (KU 33986) near the Gulf Coast, and Municipio of Antiguo Morelos on the state's southern border (and numerous localities in between), establish the distribution of this species through most of the central and southern two-thirds of the state. Vegetation types occupied by this species in Tamaulipas are predominantly tropical thorn scrub east of the Sierra Madre Oriental, Chihuahua Desert scrub west of the Sierra Madre, and the Jaumave Valley, where elements of both environments overlap. The Antiguo Morelos locality has elements of both thorn scrub and tropical deciduous forest.

Syrrhophus verrucipes (Bigear Chirping Frog). Municipio Palmillas: Near El Llano de Azúas, 15 km S of Palmillas on the road to San Vicente (23°10'04"N, 99°33'24"W), 1506.6 m elev. 11 July 2004. William Farr, Pablo Lavín Murcio, Gilberto Herrera-Patiño, Oscar M. Hinojosa-Falcón, Ricardo Enrique-Nuñez, Armando Martínez, and Michael R. J. Forstner. Verified by James R. Dixon. UACJ 481. New state record and a range extension ca. 200 km NNW of the nearest known locality, 9.6 km W Ahuacatlán, San Luis Potosí (Lynch 1970). This specimen was found under a rock within a canyon in the Sierra Madre Oriental during morning hours in a cleared field that previously contained thorn scrub.

Lacertilia

Basiliscus vittatus (Brown Basilisk). Comments on distribution in northeastern México. Numerous publications including, but not limited to Köhler (2003), Lee (1996), Peters and Donoso-Barros (1970), Savage (2002), and Smith and Taylor (1966), all affirmed that southern Tamaulipas comprises the northernmost geographic range of *Basiliscus vittatus* on the Atlantic slopes of México. Lang (1989) and Maturana (1962) also include Tamaulipas in the range of the species, although maps provided in those publications clearly identify central Veracruz or eastern Hidalgo as the northernmost occurrences based on actual localities. No specimens of *Basiliscus vittatus* from Tamaulipas are cataloged among 11,500 vouchers from the 61 institutions that we queried. Only a very small percentage of the holdings from these collections have been personally examined by us, but misidentification is highly unlikely because *B. vittatus* is easily recognized and not to be confused with other lizards native to Tamaulipas. Additionally, over 20 natural history museums and universities in Europe were surveyed specifically for records of *B. vittatus* from Tamaulipas. Of those, 14 responded and no specimens from Tamaulipas were located. Literature searches have not yielded any locality records specific to Tamaulipas, nor did numerous field surveys conducted over many years.

The origin of the prevailing idea that *B. vittatus* occurs in Tamaulipas might date to Velasco (1892), although Smith and Smith (1976) commented on the probable inaccuracy of his list. An examination of literature published before Velasco revealed no prior references to *B. vittatus* in Tamaulipas (e.g., Boulenger 1885, 1887; Cope 1863, 1887; Duges 1896; Dumeril and Dumeril 1851; Dumeril et al. 1870–1909; Fitzinger 1826, 1843; Griffth and Pidgeon 1831; Günther 1885–1902; Hallowell 1861). Therefore, we judge that *B. vittatus* should not be considered among the herpetofauna of Tamaulipas. Available locality records indicate that central Veracruz is the northern limit of the species in eastern México, as illustrated in the maps of Lang (1989) and Maturana (1962).

Iguana iguana (Green Iguana). Municipio Altamira: 17 km N of Playa Miramar on the road to Puerto Altamira (22°27'00"N, 97°53'00"W), 10 m elev. 16 July 2004. Pablo A. Lavín-Murcio. Verified by James R. Dixon. ITCV 980. First record for Tamaulipas and a range extension of ca. 50 km N of the nearest previously known locality in Veracruz, on the shore of Laguna de Tamiahua, 17 miles [27.5 km] S of Tampico (Smith and Burger 1950; de Queiroz 1995). The specimen was found DOR in a transition zone between a beach and remnants of mangrove forest.

Crotaphytus collaris (Collared Lizard). Municipio Jaumave: near San Vicente, 5 km E of Jaumave (23°25'08"N, 99°19'67"W), 658.5 m elev. 9 September 2005. William L. Farr. Verified by James R. Dixon. UANL 6431. New municipality record and a range extension of ca. 90 km NE from the closest known locality in extreme southwestern Tamaulipas (Axtell and Webb 1995). The habitat in the Jaumave Valley is a combination of elements of Chihuahuan Desert scrub and the tropical thorn scrub of the Tamaulipan plain.

Phrynosoma modestum (Roundtail Horned Lizard). Municipio Villagran: Carretera de Lucio Blanco-San Carlos en San Salvador a 2 km (Terraceria) [Highway from Lucio Blanco to San Carlos, in San Salvador (ca. 24°40'N, 99°20'W), ca. 350 m elev.]. 6 December 1996. David Lazcano. Verified by James R. Dixon. UANL 4311. First municipality record and a range extension of ca. 150 km NE from the only other record of this species in the extreme southwestern corner of the state, as depicted by Whiting and Dixon (1996). This is also the first record for this species east of the Sierra Madre Oriental, although isolated accounts from Jim Hogg, Webb, and Zapata counties, Texas (Dixon 2000; Whiting and Dixon 1996) suggests that this species might be more widely distributed on the Gulf lowlands of northeastern México than currently confirmed. The habitat in this area is arid tropical thorn scrub.

Anelytropsis papillosus (Mexican Blind Lizard). Municipio Tula: San Pablo, 17 km SW of Tula (22°54'35"N, 99°50'51"W), 1103 m elev. 15 August 2004. William L. Farr and Tim Burkhardt. UANL 6740. El Malpais, km 16 carretera Tula SW Ejido Magdaleno Cedillo [22°49'N, 99°53'W, 1050 m elev]. 18 August 2002. Humberto Velez. ITCV 803. Municipio Gomez Farías: 20.5 km by road WNW of Los Estación Cedros in Gómez Farias [22°03'N, 99°14'W, 1360 m elev]. 23 May 1995. J. T. Anderson. TCWC 72818. All verified by James R. Dixon. These localities fill a gap between numerous records in southeastern San Luis Potosí (Campbell 1974) and from 2 miles [3.21 km] SW of Cd. Victoria, Tamaulipas (Axtell 1958). Greer (1985) commented on the wide variety of habitats occupied by this species, but did not list the two plant formations acknowledged herein. The Tula localities are in Chihuahuan Desert scrub within a valley on the western slope of the Sierra Madre Oriental, whereas the record northwest of Gómez Farías is from humid cloud forest on the eastern slopes of that mountain range.

Plestiodon lynxe (Oak Forest Skink). Municipio Antiguo Morelos: 4.0 mi. [6.43 km] N (via Mex. Hwy 85), 0.2 mi. [0.32 km] W of Tamaulipas-San Luis Potosí border [22°27'83"N, 99°05'05"W, 266 m elev.]. 29 May 1980. Laurence M. Hardy. Verified by Amanda Crnkovic and James R. Dixon. LSUS 4513. First record for the state and a range extension of ca. 100 km N of the nearest localities in southern San Luis Potosí (Parker 1960; Webb 1968). The habitat was originally tropical deciduous forest and tropical thorn forest with patches of palm forest, but has since been altered for grazing and agriculture.

Plestiodon obsoletus (Great Plains Skink). Municipio Victoria: Rt. 101, 5 mi. [8.04 km] N Ciudad Victoria [23°50'N, 99°04'W, 200 m elev]. 28 April 1974. John Iverson and party. Verified by James R. Dixon from digital photographs provided by Kenneth L. Krysko. FLMNH 41951. Municipio Tula: El Malpais, km 16 carretera Tula SW Ejido Magdaleno Cedillo [22°49'N, 99°53'W]. 18 August 2002. Humberto Velez. Verified by James R. Dixon. ITCV 794. According to Hall (1976), the nearest recorded localities are from northern Tamaulipas in the vicinity of Matamoros, which is a range extension of ca. 280 km SW for FLMNH 41951 and a range extension of ca. 410 km SW for ITCV 794. FLMNH 41951 is from tropical thornscrub east of the Sierra Madre Oriental and ITCV 794 was from Chihuahuan Desert scrub, west of the Sierra Madre Oriental.

Anguis incomptus (Plainneck Glass Lizard). Municipio Aldama: 11.7 km. NE Aldama. 1983 [day and month not recorded]. Michael Bishop. Verified by Oscar Flores-Villela, Luis Canseco-Márquez, and Carl Franklin. UTA 14069. 19.2 mi. [30.7 km] E Aldama (Carretera 100, Aldama-Barra del Tordo) [ca. 22°57'35"N, 97°49'15"W, 50 m elev.]. 18 July 2006. Chris Rodriquez, Ian Recchio, David Lazcano, and Alan Kardon. Verified by Fernando Mendoza-Quijano. UANL 6824. New state records and range extensions of ca. 150 km NE of the type locality, 7 mi S of Valles, San Luis Potosí (Holman 1971) in tropical deciduous forest. These appear to be only the second and third published records for this species. UANL 6824 was found DOR in tropical thorn scrub, although riparian areas in the region support some tropical deciduous forest. We suspect that UTA 14069 was caught on the same road, so we have reservations about the preciseness of its locality data; specifically the probable direction east as opposed to northeast as originally recorded. Unfortunately the collector is now deceased, thus clarification was not possible. This potential discrepancy will be discussed in more detail below with the intent of identifying specific habitat associations for this extremely rare lizard.

The locality 11.7 km NE of Aldama [ca. 22°59'N, 97°59'W, 430 m elev.] as recorded, is near the center of a small isolated volcanic mountain range covered by oak forest with a maximum elevation of 660 m. This range has no towns or villages, is only accessible by one unpaved road that is not shown on road maps, is unmarked on the highway, and dead ends on private ranch land. To access

this road one must drive north on highway 180 from Aldama approximately 11 km and then return southeast to reach a point 11.7 km NE of Aldama. Although not impossible, it seems extremely unlikely that the specimen came from this out-of-the-way locality.

A more feasible point of origin is 11.7 km E of Aldama [22°57'N, 97°58'W, 140 m elev.] on a paved road leading to the coastal fishing village of Barra del Tordo. The habitat there is arid tropical thornscrub. An examination of this specimen indicated it was DOR. Based on surveys of the area and examining INEGI topographical maps, there is only one road going east from Aldama (no roads going northeast), which is the highway to Barra del Tordo. This highway is on all road maps of Tamaulipas and is one of only four paved roads in the state between Matamoros and Tampico that access the Gulf of México. Barra del Tordo is located northeast of Aldama and without careful analysis it would be reasonable for someone to assume that if they were driving from Aldama to Barra del Tordo that they were going northeast. However, because there are mountains between the two towns, the highway goes east from Aldama and then just a few kilometers before reaching the coast it turns north and parallels the coast to Barra del Tordo.

Serpentes

Boa constrictor (Boa Constrictor). Municipio Jaumave: La Florida, 12 km W of Jaumave (23°23'25"N, 99°30'25"W), 1040 m elev. 11 July 2004. Pablo A. Lavín Murcio. Verified by James R. Dixon. ITCV 974 (head only). Municipio Soto La Marina: Carretera Soto La Marina-La Pesca, en km 16 Rumbo a La Pesca (23°47'48"N, 98°03'01W). 19 July 1997. David Lazcano. Verified by James R. Dixon. UANL 4889. First municipality records and a range extension of ca. 130 km NE for UANL 4889, the northernmost record known to us from the state and northeastern México, and a range extension of ca. 45 km NW for ITCV 974, the westernmost record within the state (Martin 1958). While commenting on specimens from the municipality of Gómez Farías, Martin (1958) stated that the species is restricted to tropical deciduous forest in the south. The Soto La Marina locality is tropical thornscrub of the Tamaulipan plain. La Florida is in the Jaumave Valley where the Tamaulipan plain thornscrub blends with elements of the Chihuahuan Desert.

Hypsiglena torquata (Night Snake). Municipio Bustamante: 7 km S of the town of Bustamante, on the paved road going to highway 101 (23°22'57"N, 99°44'63"W), 1476 m elev. 8 July 2004. William Farr, Oscar M. Hinojosa-Falcón, and Ricardo-Nuñez. Verified from photographs by James R. Dixon. UTA slide collection 31347–349 (three slides of one specimen). Municipio Tula: San Pablo, 17 km SW of Tula (22°54'35"N, 99°50'51"W), 1103 m elev. 15 August 2004. William L. Farr and Tim Burkhardt. Verified from photograph by James R. Dixon. UTA slide collection 31350. New municipality records that fill a large gap in known distribution of this species within the Sierra Madre Oriental of southwestern Tamaulipas (Dixon and Dean 1986; maps in Conant and Collins 1998 and Stebbins 2003). A range extension of ca. 60 km W for UTA 31347–349 from the nearest locality, 3 mi [4.8 km] S of Cd Victoria, Tamaulipas (Dixon and Dean 1986), and a range extension of ca. 50 km E for UTA 31350 from nearest locality in San Luis Potosí (Dixon and Dean 1986). The specimens recorded herein represent only two of many individuals observed within the Sierra Madre Oriental of southwestern Tamaulipas, and all were associated with arid canyons and valleys at elevations below 1476 m.

Masticophis mentovarius (Neotropical Whipsnake). Municipio Aldama: Los Colorados Rancho, 26 km NE, 7 km S Aldama [22°54'50"N, 97°51'00"W, 30 m elev.]. 12 January 1992. James R. Dixon. Verified by Kathryn Vaughan. TCWC 70389. First verified record for the state and a range extension of ca.140 km NE of the nearest known locality, 3 mi [4.8 km] E Taruin [= Tamuin?] (Johnson 1977, 1982; EAL 3429) in southeastern San Luis Potosí. An unconfirmed record mentioned in Blair et al. (1997; WTAMU 312, now apparently lost), from 4 mi. [6.4 km] E Mante, Hwy. 80 [22°43'00"N, 98°53'75"W, 40 m elev.], is located ca. 110 km W of the Aldama record, and is not unexpected. The habitat around the Aldama locality is tropical thornscrub.

Senticolis triaspis (Green Rat Snake). Municipio Soto La Marina: 24 km SW of Soto La Marina on Mexican Highway 70 (23°37'04"N, 98°22'46"W), 397 m elev. 23 October 2004. William L. Farr. Verified by Fernando Mendoza-Quijano. UANL 6741. First municipality record and a range extension of ca. 85 km E of the nearest localities in the vicinity of Cd. Victoria (Schulz 1996). The habitat is a transition zone between arid tropical thorn forest and the more humid montane oak forest located at higher elevations in the Sierra de Tamaulipas to the south. It is curious why Price's (1991) distribution map has the southeastern quarter of Tamaulipas shaded even though there are no locality dots to support his contention. We are unaware of any previous records of this species, published or unpublished, from that region of the state.

Thamnophis exsul (Montane Garter Snake). Municipio Miquihuana: Las Joyas de Miquihuana, 11 km N of La Peña (23°39'44"N, 99°42'53W), 2916 m elev. 8 July 2004. James R. Dixon, Michael R. J. Forstner, and William L. Farr. Verified by Jerry D. Johnson. UACJ 585–86. Las Joyas de Miquihuana,11 km N of La Peña (23°39'50"N, 99°42'37"W), 2884 m elev. 16 August 2004. William L. Farr and Tim Burkhardt. Verified by Fernando Mendoza-Quijano. UANL 6742. First state records and a range extension of ca. 20 km S from 19.6 km NE San Antonio de Peña Nevada, Nuevo León (Liner 1992; Rossman et al. 1989).

Thamnophis exsul was described by Rossman (1969) from a single specimen found 6 July 1961, 17.5 km E, 5.6 km S San Antonio de las Alazanas, Coahuila. Rossman et al. (1989) considered *T. exsul* the rarest of all garter snakes because only 10 individuals were known to them when they redescribed the species. High rates of encounter in our surveys have lead us to the conclusion that this species can be locally abundant, so its reported rarity is probably an artifact of under representation in museum collections, restricted distribution, and remote habitat. As an example, on 8 July and 16 August 2004, eight individuals were observed during about six hours of searching.

A vertical distribution of 2650–2860 m elevation was reported for the species in Rossman et al. (1996). The specimens reported herein were found at slightly higher elevations, between 2884 and 2916 m. Additionally, numerous observations of this species were taken at even higher elevations. A GPS reading of 3007.8 m was recorded for three specimens observed 3 km N of Las Joyas de Miquihuana on 16 August 2004, and others were observed at 3237 m in another study site on Sierra San Antonio Peña Nevada, Zaragoza, Nuevo León, on 29 June 2001 (Lazcano 2005).

Rossman et al. (1996), and our experiences, indicate that this species is not restricted to semiaquatic habitats near water sources, as is typical of most species of *Thamnophis.* All individuals observed in our surveys were fast moving and associated with dead agaves and talus slopes in semiarid terrestrial habitats, even though some small streams, seeps, seasonal pools, and cattle tanks were found in the study areas. Another interesting note is that the distribution of *T. exsul* is largely sympatric with *Crotalus pricei miquihuanus*. There is an ontogenetic change in *T. exsul*, resulting in an adult body form that bears striking resemblance to that small rattlesnake, suggesting a possible Batesian mimetic system involving the two species.

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New County Records for Amphibians in Middle Tennessee

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Here we report new county records of amphibians from middle Tennessee. Several counties within middle Tennessee have few if any amphibian distribution records in contrast to the more thoroughly documented regions around Reelfoot Lake in northwest Tennessee, the Land Between the Lakes area in north-central Tennessee, and the Great Smoky Mountains in east Tennessee (Redmond and Scott 1996). Localities were determined by either use of a Garmin® global positioning system (GPS) or use of U.S. Geological Survey topographic maps. Voucher specimens were verified by Brian T. Miller and were deposited into the Middle Tennessee State University Herpetology Collection (MTSU) in Murfreesboro, Tennessee. Specimens were collected under authorization of the Tennessee Wildlife Resources Agency (permit no. 1450) and the Tennessee Department of Environment and Conservation (permit no. 2004-018).

Caudata

Ambystoma opacum (Marbled Salamander). RUTHERFORD CO: Larva in spring-fed pond ca. 2.4 km SE of Shiloh (35º51'12.6"N, 86º18'26.8"W). 20 February 2004. M. Niemiller and G. Wyckoff. MTSU 340C.

Desmognathus fuscus (Northern Dusky Salamander). WARREN CO: Adult in Hurricane Hollow Creek on Harrison Ferry Mountain (35º35'38.7"N, 85º38'19.4"W). 11 October 2003. M. Niemiller, B. Glorioso, and G. Wyckoff. MTSU 319C.

Eurycea cirrigera (Southern Two-lined Salamander). WARREN CO: Adult in Hurricane Hollow Creek on Harrison Ferry Mountain (35º35'24.6"N, 85º38'16.8"W). 11 October 2003. M. Niemiller, B. Glorioso, and G. Wyckoff. MTSU 316C.

Notophthalmus viridescens viridescens (Red-spotted Newt). WARREN CO: Eft adjacent to Hurricane Hollow Creek on Harrison Ferry Mountain (35º35'26.9"N, 85º38'14.7"W). 11 October 2003. M. Niemiller, B. Glorioso, and G. Wyckoff. MTSU 315C.

Pseudotriton ruber ruber (Northern Red Salamander). MOORE CO: Adult in creek in Bobo Hollow ca. 1.4 km NW of Raysville (35º20'08.9"N, 86º19'47.0"W). 2 March 2004. M. Niemiller and B. Glorioso. MTSU 336C.

Anura

Acris crepitans crepitans (Northern Cricket Frog). DEKALB CO: Adult ca. 140 m NNE of privately-owned cave on Caney Fork River (35º50'11.9"N, 85º39'00.9"W). 19 September 2004. M. Niemiller. MTSU 141A.

Bufo americanus americanus (Eastern American Toad). MOORE CO: Adult on road ca. 0.2 km SE of junction of Motlow Road and Spring Creek Road (35º20'50.2"N, 86º1'50.9"W). 1 July 2003. M. Niemiller. MTSU 123A. WARREN CO: Adult on old logging road adjacent to Hurricane Hollow Creek on Harrison Ferry Mountain (35º35'22.5"N, 85º38'21.4"W). 11 October 2003. M. Niemiller, B. Glorioso, and G. Wyckoff. MTSU 128A.

Rana catesbeiana (American Bullfrog). MOORE CO: Juvenile on road ca. 1.7 km W of junction of Rt 130 and Ledford Mill Road (35º22'13.5"N, 86º17'27.2"W). 1 July 2003. M. Niemiller. MTSU 121A.

Rana clamitans melanota (Northern Green Frog). MOORE CO: Adult on road ca 0.7 km NE of Rural Road 6 and Raysville Road (35º20'31.3"N, 86º18'24.7"W). 1 July 2003. M. Niemiller. MTSU 127A.

Rana palustris (Pickerel Frog). DEKALB CO: Adult in stream exiting privately-owned cave on Caney Fork River (35º50'07.6"N, 85º39'02.2"W). 19 September 2004. M. Niemiller. MTSU 140A. MARSHALL CO.: Adult in creek adjacent to Bradford Road ca. 2.2 km NE of Archer (35º20'27.1"N, 86º44'23.4"W). 7 December 2003. M. Niemiller and J. Spiess. MTSU 142A. MOORE CO: Adult on road ca. 0.3 km NW of junction of Spring Creek Road and Motlow Road (35º21'00.9"N, 86º18'06.6"W). 1 July 2003. M. Niemiller. MTSU 126A. WARREN CO: Adult in Hurricane Hollow Creek on Harrison Ferry Mountain (35º35'37.3"N, 85º38'21.0"W). 11 October 2003. M. Niemiller, B. Glorioso, and G. Wyckoff. MTSU 129A.

Rana sphenocephala utricularia (Southern Leopard Frog). MOORE CO: Adult on road near junction of Motlow Road and Spring Creek Road (35º20'55.3"N, 86º17'56.0"W). 1 July 2003. M. Niemiller. MTSU 122A.

Scaphiopus holbrookii (Eastern Spadefoot). MOORE CO: Adult on road ca. 0.4 km W of Rural Road 6 and Spring Creek Road (35º20'44.5"N, 86º18'02.4"W). 1 July 2003. M. Niemiller. MTSU 124A. Adult on road ca. 2.0 km SE of junction of junction of SR 55 and Raysville Road (35º20'22.6"N, 86º18'52.1"W). 1 July 2003. M. Niemiller. MTSU 125A.

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New Distributional Records of Amphibians and Reptiles from Estado Zulia in the Maracaibo Basin, Venezuela

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The Estado Zulia, with a surface of 63,100 km^2, is located in northwestern Venezuela and comprises a large portion of the biogeographic region denominated Maracaibo Basin (Barrio-Amorós 1998; Liddle 1946). This region is covered by dry tropical forest and xerophytic coastal zones in the north, and by tropical lowland rain forest and extensive wetlands zones in the south. The state also includes the Lake Maracaibo, at 12,780 km^2, is the largest in South America; this is filled by numerous rivers originating from the eastern versant of Sierra de Perijá and the western versant of the Cordillera de Mérida. The eastern slopes of the Sierra de Perijá, a mountain range of the northernmost Andes, are also included in the state and that watershed represents the natural limit between Colombia and Venezuela.

Scarce studies on the amphibians and reptiles from this state and particularly on the Venezuelan slope of Perijá and south of Lake Maracaibo, make the composition and geographic distribution of the local herpetofauna poorly understood. Recent herpetological records lend evidence to the great potential of the region for new contributions to the herpetofauna of Venezuela, both by the discovery of new species and new records (Barrio-Amorós 1998, 2001; Barros and Barrio 2001; Barros and Pirela 2000; Harvey et al. 2004; Manzanilla et al. 1998; Manzanilla et al. 1999; Rivas et al. 2002). Some authors foresee the occurrence of several species, not yet recorded for the country (Barrio 1998; Harvey et al. 2004), in the state.

Ongoing efforts by the staff of the herpetology section at the Museo de Biología de La Universidad del Zulia, Maracaibo, Venezuela (MBLUZ) focused on data collected during field expeditions and collections examinations, form the basis for these contributions to the herpetology of the region. In this document, we report new herpetological records and range extensions for the state. All specimens reported herein were verified by Gilson Rivas and are deposited in the amphibian and reptile collections of the MBLUZ and/or the Museo de la Estación Biológica Rancho Grande, Maracay, Venezuela (MEBRG).

Anura

Eleutherodactylus johnstonei (Coquí antillano). Municipio Maracaibo: Ciudad de Maracaibo (10°41'00"N, -71°38'22"W). July 2004. C. Solórzano. MBLUZ-A-0236. This species native to the Lesser Antilles was introduced in Venezuela about five decades ago (Barrio-Amorós 1998). Currently recorded from several cities of the country (mainly in northern Venezuela), and neighboring Colombia (see Kaiser et al. 2002 for a detailed list of inhabited towns in both countries). First state record of this exotic anuran, extending the distribution ca. 200 km northwest of the city of Trujillo in Estado Trujillo, the nearest locality recorded (La Marca 1992), and confirming the expansion of the species throughout northern South America.

Rhaebo haematiticus (Sapo hojarasquero). Municipio Machiques de Perijá: Hacienda Nevada, comunidad El Guamo, Río Yasa. 02 February 2002. T. Barros. MBLUZ-A-0173–74. The species occurs from Honduras to Chocoan Colombia, western Ecuador, and northwestern Venezuela (Frost 2004). These vouchers confirm the presence in Venezuela. Previously known from a single specimen from northwest Estado Zulia (Barrio-Amorós 2001), the eastern limit of the species. This specimen represents the southernmost record for the country, extending the range ca. 110 km south from the previous record (Barrio-Amorós 2001).

Scarthyla vigilans (Ranita vigilante). Municipio Mara: Fundo La Orchila, Sierra de Perijá (10°48'44"N, -72°21'13"W), 210 m elev. 18 October 2003. F. Rojas and E. Infante. MBLUZ-A-0186. *H. vigilans* is only know from northeastern Colombia and northwestern Venezuela. In Venezuela the range had been restricted to south of the Maracaibo Basin among the states of Zulia, Mérida, and Trujillo (Barrio-Amorós 1998; La Marca 1992; Péfaur and Rivero 2000), with one isolated record from northeast Estado Falcón (Mijares-Urrutia et al. 1998). This specimen represents the northernmost record for the species and extends the range to the foothills north of the Sierra de Perijá in the western Maracaibo Basin, about 215 km from the nearest previously known locality (Barrio-Amorós, *op. cit*.).

Testudines

Podocnemis vogli (Galápago llanero). Municipio Lagunillas: Burro Negro, embalse de Pueblo Viejo (10°10'00"N, -71°03'40"W). 07 October 1999. T. Barros. MBLUZ-R-0444. The species is found only in the Llanos of the Orinoco basin, in Venezuela and Colombia (Pritchard and Trebbau 1984). First state record, extending the distribution ca. 260 km northwest of Guanarito, the nearest locality mentioned by Pritchard and Trebbau (*op. cit.*). One of us (TBB) has information that the population established at the Pueblo Nuevo dam is the result of one or more human introductions.

Lacertilia

Anolis nigropunctatus (Aguacerito). Municipio Machiques de Perijá: Sierra de Perijá. 13 August 1975. M. Castro. MEBRG-863. The species is known in the Departamento Norte de Santander in Colombia, and two localities of estados Táchira and Trujillo in the Venezuelan Andes (Williams 1974). First state record and northernmost locality for the species. This record extends the distribution ca. 240 km from Villa Páez, estado Táchira, the nearest locality recorded (Williams, *op. cit*.).

Gymnophthalmus speciosus (Lucia). Municipio Maracaibo: Ciudad Universitaria, La Universidad del Zulia (10°40'15"N, -71°38'27"W). 06 October 2003. J. Larreal. MBLUZ-R-0777. The distribution of this species comprises Central America and northern South America (Peters and Donoso-Barros 1970). It has a wide distribution through savannas and dry forests of Venezuelan lowlands, but it was unknown from the Maracaibo Basin (Donoso-Barros 1968; Esqueda et. al. 2001; Markezich 2002; Pefaur and Rivero 2000; Rivas and Oliveros 1997). This taxon is probably part of a species complex. This is the first state record, and also the first for the Maracaibo Basin. This account extends the range ca. 257 km to the northwest of Guanare (estado Portuguesa), the nearest locality previously mentioned (Markezich, *op. cit.*).

Norops tropidogaster (Machorro). Municipio Mara: Fundo La Orchila, Sierra de Perijá (10°48'44"N, -72°21'13"W), 230 m elev. 05 June 2004. F. Rojas and E. Infante. MBLUZ-R-0794; MBLUZ-R-0797; Municipio Jesús María Semprún: Hacienda El Mirador, km 497 carretera Machiques-Colón (08°36'34"N, -72°31'42"W). 11 May 2004. C. Hernández and C. Valeris. MBLUZ-R-0803. The distribution of the species extends from southern Panama through northern Colombia, reaching northwestern Venezuela, were it is known from one locality (El Tokuko) in the foothills of the Sierra de Perijá, Estado Zulia (Donoso-Barros 1968). Second country record. The two first specimens extend the distribution ca. 117 km northward, and the third extends the range ca. 130 km towards the southeast of the single locality previously recorded for the country. The species is now known from the entire western side of the Maracaibo Basin, the eastern limit of its distribution.

Serpentes

Atractus ventrimaculatus (Culebra tierrera). Municipio Machiques de Perijá: Ayajpaina, cuenca del río Negro (10°03'00"N, -72°45'58"W), 1200 m elev. 19 April 1994. J. Urdaneta and J. C. López. MBLUZ-R-0390. *A. ventrimaculatus* has been considered an endemic species of the Cordillera de Mérida in the Venezuelan Andes (Esqueda and La Marca 2005; Roze 1966). First state record, extending the distribution ca. 260 km to the northwest of the others localities recorded.

Micrurus mipartitus anomalus (Coral). Municipio Jesús María Semprún: Hacienda El Mirador, km 497 carretera Machiques-Colón (08°36'34"N, -72°31'42"W). 11 May 2004. C. Hernández and C. Valeris. MBLUZ-R-0804. This subspecies ranges from Cordillera Oriental and the Sierra Nevada de Santa Marta in Colombia, to the Cordillera de Mérida in Venezuela (Roze 1996). This record bridges the previous distribution gap of ca. 260 km between Sierra de Perijá and the Cordillera de Mérida (Roze, *op. cit*.).

Liophis epinephelus kogiorum. Municipio Rosario de Perijá: Mesa Turik, Sierra de Perijá (10°24'44"N, -72°42'06"W), 1700 m elev. 20 March 1991. F. Herrera. MBLUZ-R-0318; MBLUZ-R-0319; Municipio Machiques de Perijá: Sierra de Perijá, Valle del Ocari, cañón del río Negro. 1300 m elev. 28 March 1990. T. Barros. MBLUZ-R-0235. The distribution previously known for this subspecies was restricted to the Sierra Nevada de Santa Marta and the western slopes of the Sierra de Perijá in Colombia (Bernal-Carlo 1994; Dixon 1983). This record of the subspecies is the first for Venezuela and the easternmost locality. This record extends the distribution of this subspecies about 40 km eastward of the locality reported by Dixon (*op. cit.*) in Colombia.

Tantilla melanocephala (Culebrita cabeza negra). Municipio Mara: Granja Santa Genoveva, road Campo Mara – Carrasquero (10°56'N, -71°56'W). 8 October 1990. J. Moscó. MBLUZ-R-0229. This species ranges from Guatemala in Central America, through South America, to northern Argentina (Peters and Orejas-Miranda 1970; Wilson 1992). Widely distributed in Venezuela (Gorzula and Señaris 1998; Lancini 1986; Lancini and Kornacker 1989; Markezich 2002; Rivas and Oliveros 1997; Roze 1966). First state record and westernmost locality for the country, with a range extension of ca. 244 km northwest of nearest record from Estado Mérida (Wilson and Mena 1980). This record fills the gap between Venezuelan Andes (Wilson and Mena, *op. cit*.) and Colombian Guajira (Pérez-Santos and Moreno 1988).

Typhlops reticulatus (Culebra ciega). Municipio Colón: río Abajo, cerca de San Carlos del Zulia (08°59'59"N, -71°55'10"W). 05 July 2003. E. Arrieta. MBLUZ-R-0761. This species is widespread over tropical South America east of the Andes (Peters and Orejas-Miranda 1970). In Venezuela, the species has been documented from the states of Amazonas, Bolívar, Yaracuy, Falcón, Portuguesa, and Barinas (Dixon and Hendricks 1979; Gorzula and Señaris 1998; Markezich. *op. cit*.; Rivas 2001; Rivas et al. 2001). New record for the Maracaibo Basin, first record from Estado Zulia, and westernmost locality known for the species, with a range extension of ca. 290 km to the west of the nearest localities previously recorded (Markezich 2002; Rivas et al. 2001).

Xenodon rabdocephalus (Culebra sapa). Municipio Jesús Enrique Lossada: Ocagui, San José de los Altos, Sierra de Perijá, 1000 m elev. 05 May 1963. G. Vargas. MBLUZ-R-0043; Cueva La Carlotica, cuenca del río Socuy, Sierra de Perijá, 1200 m elev. 22 December 1990. T. Barros and A. Viloria. MBLUZ-R-0297; cuenca del río Socuy, 1300 m elev. 17 December 2000. T. Barros and O. Guerrero. MBLUZ-R-0534; Municipio Machiques de Perijá: Cuenca del río Negro, carretera vía Toromo, Sierra de Perijá (10°03'07"N, -72°40'40"W), 100 m elev. January 2000. T. Barros. MBLUZ-R-0484; Municipio Mara: Fundo La Orchila, riecito Maché, Sierra de Perijá (10°48'44"N, -72°21'13"W), 230 m elev. 31 April 2000. E. Arrieta. MBLUZ-R-0523; 04 August 2004. E. Infante. MBLUZ-R-0834. Species is widely distributed from Mexico through Mesoamerica to Bolivia (Peters and Orejas-Miranda 1970). In Venezuela, it was only known from south of the Orinoco River, in the states of Bolívar and Amazonas (Lancini and Kornacker 1989; Paolillo 1984). The species is apparently very common in the foothills of the Sierra de Perijá. First state record and first record from the Maracaibo Basin. This is the northwesternmost locality recorded for the country, and northernmost for South America. This record extends the distribution of this species more than 700 km to the northwest of the state of Amazonas, the nearest locality recorded for the country (Paolillo, *op. cit*.), and fills a wide gap of ca. 1200 km between southern Venezuela (Paolillo 1984) and northern Colombia (Pérez-Santos and Moreno 1988).

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New Distributional Records for Reptiles in Central Arkansas

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The distribution of reptiles within Arkansas was first described in 1957 in "A Review of the Amphibians and Reptiles of Arkansas" (Dowling1957). In 2004, distributions were updated with "The Amphibians and Reptiles of Arkansas" (Trauth et al. 2004). Since that date, there have been numerous county records and range extensions for reptiles reported throughout the state, but little was ever reported for Faulkner and adjacent counties. Within the following article, we report new county records for Faulkner County and neighboring Conway County. All records were verified by Kelly Irwin (Arkansas State Herpetologist) and are currently housed at the University of Central Arkansas Museum (UCAM).

Testudines

Apalone spinifera hartwegi (Western Spiny Softshell). Faulkner Co. Caught on the East Fork of Cadron Creek ca. 7 km E of Springhill. 24 April 2006. C.A. Howey. Voucher specimen in

UCAM (UCAA119). Caught using turtle hoop trap. First county record (Trauth et al. 2004).

Chrysemys picta dorsalis (Southern Painted Turtle). FAULKNER CO. Caught on the East Fork of Cadron Creek ca. 7 km E of Springhill. June 2005. C.B. Caldwell. Voucher specimen in UCAM (UCAA120). Caught using a turtle hoop trap. First county record (Trauth et al. 2004).

Deirochelys reticularia miaria (Western Chicken Turtle). CONWAY CO. Caught in borrow pits adjacent to Cox Lake, Plumerville. May 2005. S.A. Dinkelacker and R. Bland. Photo voucher in UCAM (UCAA136). Caught using a fyke net. First county record (Trauth et al. 2004).

Graptemys ouachitensis ouachitensis (Ouachita Map Turtle). CONWAY CO. Caught near Morrilton cut-off on the Arkansas River. 14 June 2005. S.R. Adams. Voucher specimen in UCAM (UCAA122). Caught using a gill net. First county record (Trauth et al. 2004).

Graptemys ouachitensis ouachitensis (Ouchita Map Turtle). FAULKNER CO. Caught on the Arkansas River at Toad Suck Park, Conway. 2004. S.R. Adams. Voucher specimen in UCAM (UCAA123). Caught using a seine. First county record (Trauth et al. 2004).

Lacertilia

Eumeces septentrionalis obtusirostris (Southern Prairie Skink). FAULKNER CO. Caught in University of Central Arkansas Jewel Moore Nature Reserve, Conway. 16 March 2006. S. Ruane. Voucher specimen in UCAM (UCAD114). Found under pile of debris in sandy substrate with numerous ground skinks. This is a first county record and also extends the range of *E. septentrionalis obtusirostris* by four counties. This species was originally reported to only inhabit extreme western portions of the state (Trauth et al. 2004). This record extends the range ca. 170 km into the central regions of the state.

Serpentes

Agkistrodon piscivorus leucostoma (Western Cottonmouth). FAULKNER CO. Two females were collected on the East Fork of Cadron Creek ca. 7 km E of Springhill. 14 April 2006. C.A. Howey and S.A. Dinkelacker. Voucher specimens are in UCAM (UCAG123, UCAG124). An additional *A. piscivorus leucostoma* juvenile was found dead after a flood on the East Fork of Cadron Creek ca. 7 km E of Springhill. 1 May 2006. C.A. Howey. Voucher specimen in UCAM (UCAG145). First county record (Trauth et al. 2004).

Opheodrys aestivus (Rough Greensnake). FAULKNER CO. Caught in University of Central Arkansas Jewel Moore Nature Reserve, Conway. 11 April 2006. G. Adams. Voucher specimen in UCAM (UCAG113). First county record (Trauth et al. 2004).

Regina grahamii (Graham's Crayfish Snake). FAULKNER CO. Caught in a ditch on the S side of Highway 64 ca. 1 km E of Menifee. 12 June 2004. S.R. Adams. Female was pulled out of the mouth of *A. piscivorus leucostoma*. Voucher specimen in UCAM (UCAG116). First county record (Trauth et al. 2004).

Thamnophis proximus proximus (Orange-striped Ribbonsnake). FAULKNER CO. Found near large debris piles in University of Central Arkansas Jewel Moore Nature Reserve, Conway. 16 March 2006. S. Ruane. Voucher specimen in UCAM (UCAG117). First county record (Trauth et al. 2004).

Thamnophis sirtalis sirtalis (Eastern Gartersnake). FAULKNER CO. Found dead on Route 65 ca. 4 km N of Conway. 20 June 2006. R. Bland. Voucher specimen in UCAM (UCAG128). First county record (Trauth et al. 2004).

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Updated and New Amphibian and Reptile Records from Clark County, Illinois

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Habitat loss and fragmentation are major contributors to declines of amphibian and reptile species (Kingsbury and Gibson 2002). Changes in the land use of Illinois (especially the Grand Prairie region) have led to a decrease in the percentage of land covered by forest. Agricultural fields fragment much of this forested area; croplands cover approximately70% of available habitat within Illinois (Bretthauer and Edgington 2003). Early knowledge of herpetofaunal distributions in Illinois was chiefly due to the work of Smith (1961). A preliminary search of one of the two state parks in Clark County (Foster and Hampton 2003) indicated that the herpetological species list for this area is incomplete. Prior to these surveys 17 species of amphibians and 17 species of reptiles were documented in Clark County (Phillips et al. 1999), nineteen of these records are pre-1980 reports. Twenty-four additional species occur in surrounding counties. We hypothesized that some of these species might occur within Clark County. We surveyed approximately 280 ha of privately owned land, locally referred to as Rocky Hollow, in Clark County, Illinois and report herein, data for 14 different species.

Specimens reported were found by active searching (e.g., turning rocks and logs), by use of cover boards at our field site, or as

road kills. All specimens were verified by Christopher A. Phillips of the Illinois Natural History Survey (INHS).

Anura

Bufo woodhousii (Woodhouse's Toad). 100 m W of CR1400E at top of ravine, S of Joe's Fork Mill Creek, Melrose (39°15.51'N, 87°44.56'W). 08 May 2003. C. Drew Foster and Stephen J. Mullin. INHS 18902. Updates pre-1980 records for this species in Clark County (Phillips et al. 1999).

Testudines

Chrysemys picta marginata (× *bellii*) (Midland Painted Turtle × Western Painted Turtle). 60 m E of CR1400E along east side of dam across Joe's Fork Mill Creek, Melrose (39°15.51'N, 87°44.56'W). 12 April 2003. Stephen J. Mullin and Anthony Fennel. IHNS 18800. Updates pre-1980 records for this species in Clark County (Phillips et al. 1999).

Lacertilia

Eumeces fasciatus (Common Five-lined Skink). 150 m E of CR 1400E along ravine, S of Joe's Fork Mill Creek, Melrose (39°15.51'N, 87°44.56'W). 12 April 2003. Stephen J. Mullin and Justin Florey. INHS 18801–18802. Updates pre-1980 records for this species in Clark County (Phillips et al. 1999).

Scincella lateralis (Little Brown Skink). W of CR1400E, S of Joe's Fork Mill Creek, Melrose. 2 May 2002. Stephen J. Mullin and C. Drew Foster. INHS 18494. New county record (Phillips et al. 1999). Many individuals of both sexes and all age/size classes were seen crawling on substrate.

Serpentes

Carphophis amoenus helenae (Midwestern Wormsnake). 200 m W of CR1400E, S of Joe's Fork Mill Creek, Melrose (39°15.65'N, 87°45.37'W). 02 May 2002. Stephen J. Mullin and C. Drew Foster. INHS 2002.10 (Photo). New county record (Phillips et al. 1999).

Coluber constrictor foxii (Blue Racer). 100 m W of CR1400E at top of ravine, S of Joe's Fork Mill Creek, Melrose (39°15.51'N, 87°44.56'W). 08 May 2003. C. Drew Foster and Stephen J. Mullin. INHS 18901. Updates pre-1980 records for this species in Clark County (Phillips et al. 1999).

Diadophis punctatus edwardsii (Northern Ring-necked Snake). 100 m W of CR1400E at top of ravine, S of Joe's Fork Mill Creek, Melrose (39°15.51'N, 87°44.56'W). 8 May 2003. C. Drew Foster and Stephen J. Mullin. INHS 18900. Updates pre-1980 records for this species in Clark County (Phillips et al. 1999).

Elaphe spiloides (Central Ratsnake). 1.6 km N of Interstate 70 overpass on Cleone Road, Martinsville. 2 July 2003. C. Drew Foster and Stephen J. Mullin. INHS 19338. Updates pre-1980 records for this species in Clark County (Phillips et al. 1999). Specimen was dead on road (DOR).

Lampropeltis c. calligaster (Prairie Kingsnake). 1.6 km E of SR-49 on CR1700, Oilfield. 27 August 2003. C. Drew Foster and Stephen J. Mullin. INHS 19339. Updates pre-1980 records for this species in Clark County (Phillips et al. 1999). Specimen was DOR.

Nerodia sipedon pleuralis (× *sipedon*) (Midland Watersnake × CommonWatersnake). 40 m E of CR1400E along east side of dam across Joe's Fork Mill Creek, Melrose (39°15.63'N, 87°45.50'W). 12 April 2003. Stephen J. Mullin and Justin Florey. INHS 18799. Updates pre-1980 records for this species in Clark County (Phillips et al. 1999).

Opheodrys aestivus (Rough Greensnake). 4.8 km W of Cleone Road on CR1700, Oilfield. 5 June 2003. C. Drew Foster and Stephen J. Mullin. INHS 19337. Updates pre-1980 records for this species in Clark County (Phillips et al. 1999). Specimen was DOR.

Storeria dekayi wrightorium (Midland Brownsnake). Along ravine, S of Joe's Fork Mill Creek, Melrose (39°15.80'N, 87°45.35'W). 15 April 2004. C. Drew Foster and Stephen J. Mullin. INHS 19434. Updates pre-1980 records for this species in Clark County (Phillips et al. 1999).

Storeria o. occipitomaculata (Northern Red-bellied Snake). 120 m E of CR1400E, S of Joe's Fork Mill Creek, Melrose (39°15.51'N, 87°44.56'W). 10 May 2002. Stephen J. Mullin and C. Drew Foster. INHS 18495. New county record (Phillips et al. 1999).

Thamnophis s. sirtalis (Eastern Gartersnake). CR1400E near Joe's Fork Mill Creek, Melrose (39°15.63'N, 87°45.50'W). 30 April 2003. Stephen J. Mullin, C. Drew Foster, and Leroy Walston. INHS 18803. Supplemental record for Clark County (supports two skins submitted in May 2002 as county records).

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Filling in the Gaps II: New Illinois Amphibian and Reptile County Records from 2000–2005

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Since the early 1990s, numerous geographic distribution notes and articles have appeared in *Herpetological Review* regarding new amphibian and reptile county records in Illinois. Larger contributions include Crawford and Meyer (2002), Giazzon (2002), Kuhns and Crawford (2004), Markezich and Beckett (2001), Petzing et al (1998, 2000, 2002), Redmer and Ballard (1995), Tucker (1994), and Wilson (1999). This article is the second in the "Filling in the Gaps" series detailing new amphibian and reptile county records in Illinois. Specimens reported herein are housed in the Illinois Natural History Survey (INHS) amphibian and reptile collection. County records were verified by checking databases located at the Illinois Natural History Survey and recent issues of *Herpetological Review*. Databases at the Illinois Natural History Survey contain records of amphibians and reptiles from Illinois in 30 museum and private collections and unvouchered records from herpetologists and other state biologists. Using information from these databases, county-level distribution maps for all 102 species of amphibians and reptiles in Illinois have been developed and are accessible at http://www.inhs.uiuc.edu/cbd/collections/amprep/distribmaps.html. Common names follow Crother et al (2000). All Universal Transverse Mercator (UTM) coordinates are in 1983 North American datum.

Caudata

Ambystoma texanum (Small-mouthed Salamander). BUREAU CO: SW of Bureau, pond bordered by IL Rt. 26 to the ENE, floodplain forest of Big Bureau Creek to the N, and the Chicago, Rock Island and Pacific RR to the S (Zone 16: E300519m, N4572434m). 07 May 2002. J. E. Petzing and J. M. Mui. Verified by C. A. Phillips. INHS 18086. Adult found under RR tie on RR embankment at the edge of an ephemeral pond; PERRY CO.: E of Pinckneyville, flooded forest S of IL Rt. 154 and W of Beaucoup Creek (Zone 16: E292190m, N4217311m). 14 March 2002. J. M. Mui, M. J. Dreslik, J. E. Petzing, and D. B. Shepard. Verified by C. A. Phillips. INHS 18017. Adult male collected under log in floodplain forest.

Ambystoma tigrinum (Tiger Salamander). PERRY CO.: 5.7 km SW of Pinckneyville (Zone 16: E285781m, N4212648m). 01 March 2001. B. C. Jellen, J. E. Petzing, M. J. Dreslik, and D. B. Shepard. Verified by C. A. Phillips. INHS 17698. Larva; SCOTT CO.: 0.6 km S of IL Rt. 106 on the Hillview-Eldred Blacktop (Zone 15: E712126m, N4389008m. 15 March 2001. J. K. Tucker. Verified by C. A. Phillips. INHS 17895. DOR adult.

Notophthalmus viridescens (Eastern Newt). SALINE CO.: 6.75 km NW of Carrier Mills; 0.8 km E of Saline/Williamson Co. line and N of IL Rt. 13 (Zone 16: E350568E, N4177844m). 15 March 2002. D. B. Shepard, M. J. Dreslik, J. M. Mui, and J. E. Petzing. Verified by C. A. Phillips. INHS 18018. Adult female collected in wetland. Two males (INHS 18019 and 18020) were also collected on this date just east of where the female was collected.

Anura

Acris crepitans (Northern Cricket Frog). LEE CO.: Richardson Wildlife Foundation (Zone 16: E317278m, N4619314m). 12 June 2002. V. Olinik. Verified by C. A. Phillips. INHS 18210. Individual collected in pothole pond. *Acris crepitans* has now been vouchered from every county in Illinois.

Bufo americanus (American Toad). WHITESIDE CO.: Fulton Quarry, Ackers Rd. 1.6 km S of Co. Rd. 2100N; 10 km S of Thomson (Zone 15: E741078, N4640595m). 21 June 2001. J. K. Warner, M. J. Dreslik, C. A. Phillips, and J. M. Mui. Verified by J.E. Petzing. INHS 17273. Individual 38 mm SVL.

Bufo fowleri (Fowler's Toad). FRANKLIN CO.: 2.8 km NNE of Mulkeytown, 0.2 km N of Co. Rd. 900N on County Rd. 300E (Zone 16: E316001m, N4207545m). 15 June 2001. J. M. Mui, J. E. Petzing, and M. J. Dreslik. Verified by C. A. Phillips. INHS 17343. AOR adult.

Pseudacris crucifer (Spring Peeper). CARROLL CO.: 1.6 km NE jct. Mill Hollow Rd. and Scenic Ridge Rd. (Zone 15: E734139m, N4672804m). 20 June 2001. C. A. Phillips, J. K. Warner, M. J. Dreslik, J. M. Mui, and W. C. Handel. Verified by J. E. Petzing. INHS 17811. Twelve metamorphic individuals were collected from a sand pond surrounded by forest; IROQUOIS CO.: N side of County Rd. 3300N ca 1.8 km W of Co. Rd. 3000E (Zone 16: E451055m, N4538346m). 04 May 2002. D. Mauger. Verified by C. A. Phillips. INHS 18145. Adult collected in ditch; KANKAKEE CO.: E of Doney (Zone 16: E450196m, N4547171m). 14 April 2002. D. Mauger and T. G. Anton. Verified by C. A. Phillips. INHS 18140. Adult collected in shallow ditch along edge of fallow farm field.

Pseudacris triseriata (Western Chorus Frog). BUREAU CO.: SW of Bureau, pond bordered by IL Rt. 26 to the ENE, floodplain forest of Big Bureau Creek to the N, and the Chicago, Rock Island and Pacific RR to the S (Zone 16: E300519m, N4572434m). 09 April 2002. A. R. Kuhns and J. E. Petzing. Verified by C. A. Phillips. INHS 18008. One of four individuals (INHS 18008–18011) that were found under cover objects along the edge of an ephemeral pond; FULTON CO.: ENE of Marietta, jct. East Pony Rd. and North Pheasant Lane (Zone 15: E722507m, N4487176m). 13 May 2004. J. E. Petzing and W. C. Handel. Verified by C. A. Phillips. INHS 19444. Male collected from puddle along side of the road; LIVINGSTON CO.: S of Fairbury, N of E 670 North Rd. and E of N 2150 East Rd. near unnamed tributary of Indian Creek (Zone 16: E372254m, N4509530m). 18 April 2005. H. Wessels. Verified by C. A. Phillips. INHS 19658. Adult found dead in plowed field; MENARD CO.: WNW of Petersburg at Hilltop at SE corner jct. Kelly Lane and Chicago and Illinois Midland RR (Zone 16: E254708m, N4434493m). 15 May 2002. J. E. Petzing, J. M. Mui, and J. R. Jakubanis. Verified by C. A. Phillips. INHS 18179. One of two adults (INHS 18179–18180) that were collected from a flooded railroad right-of-way; OGLE CO.: NE of Daysville, north-central part of the Kyte River bottoms along S side of the Burlington Northern RR tracks (Zone 16: E308820m, N4651597m). 03 April 2004. D. Mauger. Verified by C. A. Phillips. INHS 19500. Adult captured on northwest side of shallow, open water depression rimmed by buttonbush; WHITESIDE CO.: NE of White Pigeon; E of Rock Creek, S of Pilgrim Rd. (Co. Rd. 2200N), and W of Yorktown Rd. (Zone 16: E262178m, N4642455m). 13 April 2002. A. M. Readel. Verified by C. A. Phillips. INHS 18053. One of two adults (INHS 18053–18054) that were collected from this site.

Rana blairi (Plains Leopard Frog). MOULTRIE CO.: Shelbyville Fish and Wildlife Area, West Okaw River Unit (Zone 16: E352552m, N4386682m). 26 June 2001. J. M. Mui, J. R. Jakubanis, and M. J. Dreslik. Verified by C. A. Phillips. INHS 17372. Confirms literature record of Brown and Morris (1990). Adult; PUTNAM CO.: 0.4 km S Bureau Co. line on IL Rt. 29 adjacent to Miller Anderson Woods Nature Preserve (Zone 16: E298897m, N4567294m). 19 June 2001. D. B. Shepard and A. R. Kuhns. Verified by C. A. Phillips. INHS 17319. Confirms literature record of Brown and Morris (1990). Adult collected from right-of-way adjacent to wetland along the west side of IL Rt. 29.

Rana catesbeiana (American Bullfrog). FRANKLIN CO.: 0.3 km S of Co. Rd. 1010N on County Rd. 300E by Christopher Lake (Zone 16: E316022m, N4208300m). 15 June 2001. J. M. Mui, J. E. Petzing, and M. J. Dreslik. Verified by C. A. Phillips. INHS 17342. AOR individual collected just south of where Christopher Lake meets the county road; PUTNAM CO.: 1.8 km N of IL Rt. 18 on IL Rt. 26, pond on W side (Zone 16: E305174m, N4554482m). 19 June 2001. A. R. Kuhns and D. B. Shepard. Verified by C. A. Phillips. INHS 17338. Adult; WHITESIDE CO.: W of Rock Falls, Rock River at terminus of Regan Rd. (Zone 16: E271525m, N4627523m). 03 September 2001. A. R. Kuhns, M. J. Dreslik, and J. M. Mui. Verified by C. A. Phillips. INHS 17596. Adult.

Rana clamitans (Green Frog). CALHOUN CO.: Salt Spring Rd. (Illinois side), 0.8 km W of Illinois River Rd. (Zone 15: E705716m, N4332188m). 20 August 2003. C. A. Phillips, T. R. Hunkapiller, F. T. Burbrink, and A. R. Kuhns. Verified by J. E. Petzing. INHS 19086. Female; PUTNAM CO.: 1.8 km N of IL Rt. 18 on IL Rt. 26, pond on W side (Zone 16: E305174m, N4554482m). 19 June 2001. A. R. Kuhns and D. B. Shepard. Verified by C. A. Phillips. INHS 17339. Adult; ST. CLAIR CO.: Wagon Lake (Zone 16: E260523m, N4253003m). 12 June 2002. D. B. Shepard, A. R. Kuhns, and N. J. Kuhns. Verified by C. A. Phillips. INHS 18363. Adult male.

Rana pipiens (Northern Leopard Frog). MARSHALL CO.: Ditch W side of IL Rt. 29, N of County Rd. 1005N (Camp Grove Rd.) and S of Crow Creek (Zone 16: E296653m, N4549273m). 07 May 2002. J. E. Petzing and J. M. Mui. Verified by C. A. Phillips. INHS 18089. Adult collected from roadside ditch.

Testudines

Chelydra serpentina (Snapping Turtle). FORD CO.: N of Paxton, mile marker 263 on northbound I-57 (Zone 16: E406797m, N4481782m). 25 May 2001. J. M. Mui and J. E. Rice. Verified by C. A. Phillips. INHS 17742. DOR adult; MARION CO.: U.S. Rt. 50, 0.4 km W of I-57 Salem overpass (Zone 16: E327756m, N4276872m). 01 July 2001. M. J. Dreslik and D. B. Shepard. Verified by C. A. Phillips. INHS 17741. DOR adult; SALINE CO.: 7 km NW of Carrier Mills; 0.5 km E of Saline/Williamson county line on IL Rt. 13 (Zone 16: E350046m, N4177826m). 23 April 2002. J. E. Petzing. Verified by C. A. Phillips. INHS 19657. DOR.

Chrysemys picta (Painted Turtle). GALLATIN CO.: 7 km N Old Shawneetown, Round Pond (Zone 16: E403170m, N4179400m). 08 August 2002. M. J. Dreslik and J. K. Warner. Verified by C. A. Phillips. INHS Herpetological Slide 2002.08. Adult male captured in fyke net. This specimen was not vouchered because it is a marked individual that is part of a long-term study of a floodplain lake turtle community.

Graptemys geographica (Northern Map Turtle). CASS CO.: W of Beardstown (Zone 15: E717980m, N4432104m). 22 April 2001. B. Wilson. Verified by C. A. Phillips. INHS 17906. Hatchling.

Graptemys ouachitensis (Ouachita Map Turtle). MADISON CO.: S end of Piasa Island, just S of the Jersey Co. line (Zone 15: E736433m, N4312286m). 13 July 2001. E. Ratcliff and E. Gittinger. Verified by C. A. Phillips. INHS 17904. Male.

Graptemys pseudogeographica (False Map Turtle). MADISON CO.: Piasa Island, Mississippi River (downstream, channel side; Zone 15: E737126m, N4312250m). 13 July 2001. E. Gittinger, R. Cosgriff, and B. Lubinski. Verified by C. A. Phillips. INHS 17907. Adult male.

Terrapene carolina (Eastern Box Turtle). CHRISTIAN CO.: 0.2 km N of County Rd. 990E on IL Rt. 48 (Zone 16: E298587E, N4376004m). 18 June 2001. J. K. Tucker and J. B. Towey. Verified by C. A. Phillips. INHS 18001. DOR adult.

Terrapene ornata (Ornate Box Turtle) CASS CO.: 1.6 km SSW of Beardstown Airport (Zone 15: E721015m, N4426387m). 20 June 2001. C. A. Phillips, J. M. Mui, M. J. Dreslik, and J. K. Warner. Verified by J. E. Petzing. INHS 17813. Carapace and plastron (some scutes still attached) of an adult collected in a sand prairie.

Trachemys scripta (Pond Slider). CLAY CO.: 0.6 km S of Co. Rd. 800N on County Rd. 1875E; 1.1 km S of Little Muddy Creek and N of the Little Wabash River (Zone 16: E382328m, N4285766m). 08 June 2001. J. E. Petzing, M. J. Dreslik, and J. M. Mui. Verified

by C. A. Phillips. INHS 17710. DOR adult male; MONTGOMERY CO.: 1.6 km S of Taylor Springs, 2.9 km S of IL Rt. 185 on IL Rt. 127 (Zone 16: E284945m, N4332250m). 05 May 2002. A. R. Kuhns. Verified by C. A. Phillips. INHS Herpetological Photograph 2002.06. AOR individual in the southbound lane of Illinois Route 127; it was not collected because it was an adult female.

Apalone spinifera (Spiny Softshell). JEFFERSON CO.: S of Bonnie, Atchison Creek at Chicago and Eastern Illinois RR trestle (Zone 16: E333328m, N4228164m). 17 September 2003. J. R. Jakubanis and J. E. Petzing. Verified by C. A. Phillips. INHS 19262. Juvenile.

Lacertilia

Cnemidophorus sexlineatus (Six-lined Racerunner). IROQUOIS CO.: Iroquois County Conservation Area (Zone 16:E452758m, N4538322m). 26 May 2003. T. R. Hunkapiller. Verified by C. A. Phillips. INHS 18990. Adult male.

Eumeces laticeps (Broad-headed Skink). VERMILION CO.: NNW of Humrick, Cherokee Hills Camp (Zone 16:E451880m, N4421836m). 23 May 2002. C. Montgomery. Verified by C. A. Phillips. INHS 18489. Adult male.

Serpentes

Coluber constrictor (Eastern Racer). MORGAN CO.: S of Jacksonville, jct. U.S. 67 and IL Rt. 267 (Zone 15:E737898m, N4387662m). 05 July 2000. J. K. Tucker and J. B. Towey. Verified by C. A. Phillips. INHS 17849. DOR adult.

Elaphe vulpina (Western Foxsnake). MOULTRIE CO.: W of Lanton, just S Co. Rd. 2500N on Co. Rd. 950E (Zone 16:E359969m, N4403328m). 06 July 2003. J. E. Petzing, K. S. Petzing, and E. E. Petzing. Verified by C. A. Phillips. INHS 19034. DOR adult.

Heterodon platirhinos (Eastern Hog-nosed Snake). CASS CO.: W of Beardstown (Zone 15: E717980m, N4432104m). 30 April 2001. J. K. Tucker and B. Wilson. Verified by C. A. Phillips. INHS 17900. Adult; CLINTON CO.: Eldon Hazlet State Park (Zone 16: E298347m, N4282302m). 10 May 2001. D. B. Shepard, B. C. Jellen, and M. J. Dreslik. Verified by C. A. Phillips. INHS 17731. Adult collected in woodland.

Lampropeltis calligaster (Yellow-bellied Kingsnake). FULTON CO.: WSW of Seville on Seville Rd. (Zone 15:E724212m, N4484644m). 16 April 2004. J. E. Petzing and A. M. Readel. Verified by C. A. Phillips. INHS 19427. DOR juvenile on gravel road; KNOX CO.: 0.8 km E of Warren County line on Co. Rd. 300N (Zone 15: E716325m, N4514886m). 12 August 2003. C. A. Phillips, A. R. Kuhns, and J. K. Warner. Verified by J. E. Petzing. INHS 19164. AOR sub-adult.

Lampropeltis triangulum (Milksnake). IROQUOIS CO.: 0.5 km N of N boundary of Hooper Branch Nature Preserve just W of W boundary of N unit Iroquois County Conservation Area (Zone 16: E453580m, N4540279m). 16 May 2005. C. A. Phillips. Verified by J. E. Petzing. INHS 19582. Juvenile collected under piece of corrugated tin; WASHINGTON CO.: S side of Clear Lake (Zone 16: E268993m, N4256625m). 03 June 2002. A. R. Kuhns and D. B. Shepard. Verified by C. A. Phillips. INHS 18261. Adult.

Nerodia erythrogaster (Plain-bellied Watersnake). GREENE CO: 0.5 km N Apple Creek on Hillview-Eldred Blacktop (Zone 15: E711072m, N4361073m). 29 April 2003. J. K. Tucker. Verified by C. A. Phillips. INHS 18914. DOR adult.

Opheodrys vernalis (Smooth Greensnake): PIATT CO.: County Rd. 1500E immediately N of jct. with Co. Rd. 3100N (Zone 16: E375800m, N4455100m). 15 August 2003. P. Nielsen. Verified by C. A. Phillips. INHS 19165. DOR adult salvaged from a road bordered by a cemetery and soybean and corn fields.

Pituophis catenifer (Gophersnake). PUTNAM CO.: ENE of Hennepin on IL Rt. 71 (Zone 16: E305480m, N4569859m). 10 October 2002. J. E. Petzing, C. A. Phillips, and J. F. Doolen. Verified by M. J. Dreslik. INHS 18690. DOR adult.

Storeria dekayi (DeKay's Brownsnake). BOND CO.: Crane Woods, NE of Old Ripley (Zone 16: E275890m, N4313000m). 26 September 2001. D. B. Shepard, M. J. Dreslik, J. M. Mui, A. R. Kuhns, D. Baum, and T. A. Cochran. Verified by C. A. Phillips. INHS 17721. Male collected on small rock outcrop on slope of ravine; FULTON CO.: 1.4 km N of Ogden Lane (Co. Rd. 555N) in Summum on Hammack Rd. (Co. Rd. 900E) (Zone 15: E731409m, N4462892). 20 October 2003. A. R. Kuhns and J. E. Petzing. Verified by C. A. Phillips. INHS 19279. DOR adult; GRUNDY CO.: 1.1 km SSE of Morris, W of Mud Slough (Zone 16: E382990m, N4579096m). 06 July 2001. A. R. Kuhns, J. E. Petzing, and J. M. Mui. Verified by C. A. Phillips. INHS 17454. Adult male found in flood debris in old field habitat; OGLE CO.: S side Burlington Northern RR tracks along the N boundary of the Kyte River bottoms, approx. 100 ft. W of where the bend in the Kyte River comes closest to the RR (Zone 16: E309321m, N4651555m). 20 June 2003. T. G. Anton and D. Mauger. Verified by C. A. Phillips. INHS 19106. Gravid female captured under piece of RR tie; WAYNE CO.: Forest along E side of Moutray Slough (Zone 16: E394688m, N4268057m). 11 October 2002. J. E. Petzing, J. M. Mui, M. J. Dreslik, J. F. Doolen, and C. A. Phillips. Verified by A. R. Kuhns. INHS 18745. Adult found in wood debris on forest floor.

Storeria occipitomaculata (Red-bellied Snake). FAYETTE CO.: 0.3 km S of Lorton Bridge (Kaskaskia River) on Co. Rd. 1925E (Zone 16: E336380m, N4337975m). 14 April 2002. J. E. Petzing. Verified by C. A. Phillips. INHS 18050. DOR individual collected on a gravel road; FULTON CO.: S of Marietta on the Toledo, Peoria and Western RR tracks (Zone 15: E721647m, N4485198m). 17 September 2004. J. K. Warner and J. E. Petzing. Verified by C. A. Phillips. INHS 19508. Male collected under piece of wood on the railroad.

Thamnophis proximus (Western Ribbonsnake). Cass Co.: W of Beardstown (Zone 15: E717980m, N4432104m). 08 April 2001. J. K. Tucker, P. Owen, and B. Wilson. Verified by C. A. Phillips. INHS 17902. New county record. Adult.

Virginia valeriae (Smooth Earthsnake). FULTON CO.: S of Marietta, forest along Toledo, Peoria and Western RR tracks (Zone 15: E721898m, N4484722m). 17 September 2004. J. K. Warner and J. E. Petzing. Verified by C. A. Phillips. INHS 19507. Adult male collected under rock and debris on a forested hillside.

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publish the Lee County Northern Cricket Frog record.

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New Distributional Records for Amphibians and Reptiles in Northeastern Louisiana

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We found several new locality records in the course of reviewing museum holdings of amphibians and reptiles from northeastern Louisiana. All the specimens reported here represent either new parish records (Dundee and Rossman 1989), or clarification of parish records. The majority of these help fill in distributional gaps for parishes in northeastern Louisiana, particularly in the Mississippi Alluvial Valley. Museum acronymns follow Leviton et al. (1985). Taxonomy and vernacular names used follow Crother (2000) and Crother et al. (2003). Unless indicated otherwise, specimens were verified by J. L. Carr.

Anura

Hyla chrysoscelis/versicolor (Gray Treefrog). Franklin Par: 7 mi S of Hwy 33 & Hwy 84 intersection at Roxie. 06 June 1989. M. Farr. NLU 70172–70182. New parish record.

Pseudacris crucifer (Spring Peeper). Caldwell Par: Columbia, 1.1 mi N, 0.5 mi E of Copenhagen. 08 April 1997. LSUMZ 58347. New parish record. Tensas Par: 8 mi W of Newelton. 27 February 1965. M. Carnaham. AMNH A-123120. New parish record.

Rana catesbeiana (American Bullfrog). Franklin Par: Big Creek at Baskin. 12 September 1992. Seltzer and Boudreaux. NLU 70047. New parish record.

Rana sphenocephala (Southern Leopard Frog). LaSalle Par: Hwy 460 between Nebo and Whitetail. R.Wallus, J. Hatten. 03 August 1968. NLU 19360; 5 mi W of Nickel. 12 June 1950. TU 12603. Hemphill Creek at Hwy 460, R3E, T7N, Sec. 14. 27 September 1985. TU 22018. Both verified by Harold Dundee. New parish records.

Caudata

Ambystoma maculatum (Spotted Salamander). CALDWELL PAR: 12 mi SE Chatham. 30 January 1950. F. Cagle. One clutch of eggs, TU 19523. Verified by H. A. Dundee. New parish record.

Testudines

Kinosternon subrubrum (Eastern Mud Turtle). EAST CARROLL PAR: 6 mi S Lake Providence, Hwy 134. 09 April 1966. C. B. Coburn, Jr. LSUMZ 30011. New parish record.

Graptemys pseudogeographica kohnii (Mississippi Map Turtle). CALDWELL PAR: no specific location. 13 March 1953. LSUMZ 34032. New parish record.

Terrapene carolina triunguis (Three-toed Box Turtle). RICHLAND PAR: 3 mi S of Dunn. 13 June 1966. H. Stegall. NLU 10338. New parish record.

Trachemys scripta elegans (Red-eared Slider). FRANKLIN PAR: 8 km SW of Winnsboro. 1 April 1966. D. D. Smith. KU 177218. Verified by E. Greenbaum. New parish record.

Lacertilia

Eumeces laticeps (Broad-headed Skink). CONCORDIA PAR: Slocum, ~10 mi N abandoned farm off Hwy 15 along Mississippi River levee. 03 March 1987. J. W. Tamplin. TNHC 55988, 55998, 56004. New parish record.

Sceloporus consobrinus (Prairie Lizard). RICHLAND PAR: 7 mi S Mangham in woods. CM 44166–44174. New parish record.

Scincella lateralis (Little Brown Skink). FRANKLIN PAR: 7 mi S of Hwy 33 & Hwy 84 intersection at Roxie. 29 May 1989. M. Farr. NLU 70185–70187. New parish record.

Serpentes

Agkistrodon piscivorus (Cottonmouth). FRANKLIN PAR: SE of Winnsboro. April 1969. D. D. Smith. KU 177035-177039. 17 April 1965. D. D. Smith. KU 177040–177049. Verified by E. Greenbaum. New parish record.

Crotalus horridus (Timber Rattlesnake). EAST CARROLL PAR: no specific location. 1 September 1956. J. L. Herring. FMNH 245315–245316. New parish record.

Lampropeltis getula holbrooki (Speckled Kingsnake). CALDWELL PAR: Columbia Lock and Dam sight [sic] on the Ouachita River. 3 April 1966. LSUMZ 41364. New parish record. LASALLE PAR: 2 mi E of Nickel. 12 June 1950. TU 12611. Verified by Harold Dundee. New parish record.

Lampropeltis triangulum amaura (Louisiana Milksnake). MADISON PAR: Hunter's Bend Club. 28 May 1985. K. Lofton. NLU 53792. New parish record.

Nerodia cyclopion (Mississippi Green Watersnake). CALDWELL PAR: S of Columbia. 06 April 1973. C. Corkern. NLU 36400. New parish record. RICHLAND PAR: Clear Lake. 15 April 1963. R. F. Cox. NLU 874 and 01 May 1963. R. F. Cox. NLU 875. New parish record.

Nerodia sipedon pleuralis (Midland Watersnake). OUACHITA PAR: Russell Sage about 1/4 mi off Hwy. 80 at exit 2. 3 November 1972. S. G. Walmsley. NLU 35886. Verified by Jeff Boundy. New parish record. This is the first vouchered specimen reported from northern Louisiana (Dundee and Rossman 1989; Gibbons and Dorcas 2004).

Regina grahamii (Graham's Crayfish Snake). LASALLE PAR/ CATAHOULA PAR: Gibbons and Dorcas (2004) attribute this species to LaSalle Parish. The basis for their literature record was Dundee and Rossman (1989), in which a dot straddles the border between Catahoula and LaSalle parishes. The basis for the dot was "Walters" (fide J. Boundy; LSUMZ 4824). Specimen identification has been verified by Jeff Boundy. Walters is a place name found approximately 1.1 km E of the parish line in Catahoula Parish (Anon. 1997). The same specimen was correctly used to document the Catahoula Parish museum record (Gibbons and Dorcas 2004).

Storeria dekayi (Dekay's Brownsnake). TENSAS PAR: Chicago Mills Game Management Area. 27 March 1965. E. D. Keiser. Verified by Jeff Boundy. LSUMZ 23774. New parish record.

Virginia valeriae elegans (Western Smooth Earthsnake). FRANKLIN PAR: Extension 0.5 mi SE off LA Hwy 356. 24 March 1971. D. Dosher. NLU 35430. New parish record.

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New Records for Anurans from Lawrence County, Tennessee

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The geographic distribution of the amphibians of Tennessee is well documented (Redmond and Scott 1996). However, many counties in west and south-central Tennessee have not been adequately sampled. Here we provide records of four common anurans not previously recorded from Lawrence County, Tennessee (Redmond and Scott 1996). All specimens were collected while compiling a herpetofaunal list for use by park personnel at David Crockett State Park. All voucher specimens are deposited in the Austin Peay State University Museum of Zoology (APSU) and were verified by A. Floyd Scott. Collections were made under the authority of TWRA Permit No. 1494 to BPB.

Bufo fowleri (Fowler's Toad). Found on main park road adjacent to an open field and Lake Lindsay. UTM 16S, 0467005E, 3903059N. 22 July 2006. Collected by H. A. Messer. APSU 18217 (color photo). First county record.

Rana catesbeiana (American Bullfrog). Found in a small spring that feeds a millpond located behind David Crockett State Park Visitor Center. UTM 16S, 0467540E, 3902521N. 26 July 2006. Collected by H. A. Messer. APSU 18218 (color photo). First county record.

Rana clamitans (Green Frog). Found in a small spring that feeds a millpond located behind David Crockett State Park Visitor Center. UTM 16S, 0467724E, 3902577N. 14 July 2006. Collected by H. A. Messer. APSU 18219 (color photo). First county record.

Rana sphenocephala (Southern Leopard Frog). Found on the main park road adjacent to a wooded area near Crockett Falls. UTM 16S, 0467563E, 3902436N. 10 August 2006. Collected by H. A. Messer. APSU 18220 (color photo). First county record.

Acknowledgments.—We thank the David Crockett State Park personnel for their cooperation in the survey. R. Bridges and J. Walsh assisted on numerous occasions during the survey. We especially thank H. Phillips for allowing HAM to conduct this survey during work hours.

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New Geographic Distribution Records of Amphibians and Reptiles in South Arkansas

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In the three short years since the seminal publication of Trauth et. al. (2004) on amphibians and reptiles of Arkansas, numerous new county records have been published for species in the state (Milanovich et al. 2005; Plummer and McKenzie 2005; Solis et al. 2006; Stanley and Trauth 2005; and many others). Between February 2005 and May 2006, we discovered 12 additional, new county records for four amphibians (one salamander, three frogs) and eight reptiles (one turtle, seven snakes) from south Arkansas. Specimens were verified by Stanley E. Trauth. Township, section, and range are provided for each locality. Voucher specimens were deposited in the Arkansas State University Herpetological Museum (ASUMZ), State University, Arkansas.

Caudata

Siren intermedia nettingi (Western Lesser Siren). Ashley Co.: 3.2 km S Crossett on St. Hwy. 133 (Sec. 5, T19N, R8W). 30 May 2006. H. W. Robison. ASUMZ 30256. New county record that completely fills in hiatus in extreme southern part of state between Chicot and Union counties.

Anura

Hyla chrysoscelis/versicolor complex (Gray Treefrog). Chicot Co.: 4.8 km SE Lake Village on US 82 (Sec. 23, T16S, R2W). 07 April 2006. Dan Thomas. ASUMZ 30257. New county record that fills a gap in extreme southeast part of state; this sibling species complex has now been reported from all but three counties of Arkansas (Trauth et al., *op. cit.*, pp. 149–151, fig. 187).

Hyla cinerea (Green Treefrog). Cleveland Co: Saline River at US 79 (Sec. 27, T9S, R11W), 5.6 km NE Kingsland. 28 April 2006. H. W. Robison. ASUMZ 30254. New county record. Partially fills hiatus but species has yet to be recorded from adjacent Dallas and Lincoln counties.

Pseudacris triseriata (Western Chorus Frog). Calhoun Co.: 1.6 km E Locust Bayou at US 278 (Sec. 31, T13S, R15W). 23 Feb. 2005. H. W. Robison. ASUMZ 30253. New county record filling gap in distribution between Bradley and Ouachita counties. Robison and Rader (2005a) recently reported this frog from nearby Cleveland County.

Testudines

Sternotherus odoratus (Stinkpot). CLARK CO.: 1.6 km N Whelen Springs on St. Hwy. 53 (Sec. 22, T10S, R20W). 15 October 2005. Patrick Daniel. ASUMZ 30261. New county record that partially fills a hiatus between Dallas and Pike counties.

Serpentes

Agkistrodon contortix contortrix (Southern Copperhead). HEMPSTEAD CO.: 3.2 km SE Washington (Sec. 35, T11S, R25W). 15 October 2005. Patrick Daniel. ASUMZ 30264. New county record that fills a gap in distribution in southwestern Arkansas between Little River and Nevada counties.

Carphophis vermis (Western Wormsnake). UNION CO.: 1.6 km N Cairo on St. Hwy. 172 (Sec. 21, T17S, R17W). 27 October 2005. H. W. Robison. ASUMZ 30255. New county record. This secretive species is relatively uncommon in the southern part of the state and has been reported from only four counties: Clark, Columbia, Drew, and Hempstead (Trauth et al., *op. cit*.).

Crotalus horridus (Timber Rattlesnake). UNION CO.: 6.4 km W El Dorado (Sec. 30, T17S, R10W). 13 November 2005. Patrick Daniel. ASUMZ 30263. New county record filling a hiatus between Bradley and Columbia counties.

Lampropeltis triangulum amaura (Louisiana Milk Snake). HEMPSTEAD CO.: 3.2 km SE Washington (Sec. 35, T11S, R25W). 15 October 2005. Patrick Daniel. ASUMZ 30262. New county record that represents the southwestern most locality for the subspecies in the state.

Sistrurus miliarius streckeri (Western Pigmy Rattlesnake). UNION CO.: 13.7 km S El Dorado (Sec. 18, T19S, R15W). 08 Oct. 2005. H. W. Robison. ASUMZ 30260. New county record that fills a distribution gap between Ashley and Columbia counties (see Robison and Rader 2005b).

Storeria dekayi wrightorum (Midland Brownsnake). CLARK CO.: 1.6 km S Gurdon (Sec. 4, T10S, R20W). 13 November 2005. Patrick Daniel. ASUMZ 30259. New county record that fills a hiatus between Hot Spring and Pike counties. Specimen appears to be an intergrade *S. d. wrightorum* × *texana*; another intergrade was reported previously from nearby Hempstead County of southwestern Arkansas (Trauth et al., *op. cit*., pp. 333–336, fig. 474).

Thamnophis sirtalis sirtalis (Eastern Gartersnake). NEVADA CO.: 11.3 km W Rosston (Sec. 35, T13S, R20W). 13 November 2005. Patrick Daniel. ASUMZ 30258. New county record that partially fills a distribution gap between Hempstead and Ouachita counties.

Acknowledgments.—We thank S. E. Trauth for curatorial assistance and specimen verification, and the various collectors noted herein for providing vouchers. Specimens were collected under the authority of Arkansas Scientific Collecting Permits issued to CTM and HWR by the Arkansas Game and Fish Commission.

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New County Records of Amphibians and Reptiles from Rains County, Texas

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Rains County, a small county in northeastern Texas, has been overlooked for its amphibian and reptile diversity. Although sufficient habitat exists, many common species remain undocumented. In the spring of 2006, we sampled this county periodically and collected previously unrecorded species for the county (Dixon 2000). These records help fill gaps in the distribution of the regional herpetofauna. Our nomenclature is in accordance with Crother et al. (2000) and identifications were verified by Ronald L. Gutberlet, Jr. Voucher specimens are deposited at the Amphibian and Reptile Diversity Research Center (UTA), University of Texas at Arlington, Arlington, Texas.

Anura

Gastrophryne carolinensis (Eastern Narrow-mouthed Toad). Approximately 50 m E of County Road 1490 (1 km S of Farm Road 2324). UTM (NAD 83) 15S, 0230367 N, 3636061 W, 119 m elev. 05 May 2006. Jessica L. Coleman and Robert C. Jadin. UTA A-57308. Adult male calling among large chorus of *Gastrophryne* and *Hyla versicolor*. Collected in cattle pasture (2040 h) composed of sedges, grasses, and some shrubs. Pasture partially flooded with standing water from previous night/morning rain.

Hyla versicolor (Gray Treefrog). 62.3 m N of Farm Road 779 (0.5 km W of Highway 69). UTM (NAD 83) 15 S, 0244540 N, 3637960 W, 143 m elev. 14 April 2006. Robert C. Jadin and Jessica L. Coleman. UTA A-57311. Captured in tree (2035 h) approximately 2.4 m above the ground. Tree was approximately 10 m N of small pond. Adult male found calling among large chorus of *H. versicolor* and *Acris c. crepitans*. Species identified from *H. chrysoscelis* by call. Vocal recordings and sonograms were made for verification.

Pseudacris feriarum (Southeastern Chorusfrog). Just off County Road 1490 (1.5 km W of County Road 1495). 17 May 2002. Ronald L. Gutberlet, Jr. and Carol Gutberlet. UTA A-57607–57608. An amplectant pair collected in a partially flooded field. On 05 May 2006 the authors heard several small choruses in the southwestern section of the county and a male was captured but not collected.

Scaphiopus hurterii (Hurter's Spadefoot). Farm Road 779 (10.0 km SE of Jct 3274). UTM (NAD 83) 15 S, 0249235 N, 3628237 W, 124 m elev. 20 April 2006. Robert C. Jadin, Jessica L. Coleman, and Allyson M. Modra. UTA A-57310. Found alive on road (2035 h) during moderate rainfall. Solitary adult with no chorus heard in background.

Testudines

Terrepene ornata ornata (Ornate Box Turtle). Highway 69 (2.0 km S of Jct 47). UTM (NAD 83) 15S, 0232823 N, 3646028 W, 157 m elev. 05 May 2006. Jessica L. Coleman and Robert C. Jadin. UTA R-54163. Adult female found recently run over with front half of body and carapace missing.

Lacertilia

Anolis carolinensis carolinensis (Northern Green Anole). 163 m W of Farm Road 514 (0.4 km N of Jct 2946). UTM (NAD 83) 15 S, 0250837 N, 3647152 W, 123 m elev. 25 March 2006. Robert C. Jadin and Jessica L. Coleman. UTA R-54164. (55 mm SVL, 160 mm TL). Captured on large branch (approx. 1200 h) in incomplete clear cut oak forest. Two additional green anoles observed within 60 m of vicinity.

Serpentes

Agkistrodon piscivorus leucostoma (Western Cottonmouth). 34 m NE of Farm Road 779 (8.0 km S of Jct 3274). UTM (NAD 83) 15 S, 0249289 N, 3629877 W, 138 m elev. 25 March 2006. Robert C. Jadin and Jessica L. Coleman. UTA R-54070. Adult male (545 mm SVL; 660 mm TL; 28 mm HW; 39 mm HL). Captured at an abandoned tin field (1640 h) in small open pasture. Found under 8 ft × 8 ft piece of tin 13.7 m W of small drainage canal. Approximately 20ºC on sunny afternoon. Hemipenis everted and stained. Recorded from all neighboring counties.

Acknowledgments.—We thank Ron and Carol Gutberlet for graciously donating two specimens of *Pseudacris feriarum* to this publication. Alan Byboth was generous in lending equipment for the *Hyla versicolor* recording and putting it into digital format.

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New Records for Amphibians and Reptiles from Trousdale County, Tennessee

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Here we report new county records of amphibians and reptiles from Trousdale County, Tennessee. Unlike such regions as the Land Between the Lakes area in north-central Tennessee, and the Great Smoky Mountains in east Tennessee, Trousdale County has few records of amphibians and reptiles (Redmond and Scott 1996). The lack of records in Trousdale County can be attributed to the county's small size and scarcity of state and federal lands. With permission from landowners we were able to survey some expanses of private lands. Localities were determined by use of a Magellan handheld global positioning system (GPS) unit. Voucher specimens were verified by Brian T. Miller and were deposited into the Middle Tennessee State University Herpetology Collection (MTSU) in Murfreesboro, Tennessee. Photo vouchers were verified by A. Floyd Scott and deposited into the Austin Peay State University (APSU) database in Clarksville, Tennessee. Scientific and common names follow Crother et al. (2000). All specimens were collected under authorization of the Tennessee Wildlife Resources Agency (permit no. 1450) and the Tennessee Department of Environment and Conservation (permit no. 2004-018). Collectors were B. M. Glorioso and J. Pruett for all specimens except as noted.

Caudata

Eurycea cirrigera (Southern Two-lined Salamander). Adult in Rocky Creek under the overpass at Canoe Branch Road (36º20'54"N, 86º15'33"W). 27 February 2005. MTSU 352C.

Notophthalmus viridescens viridescens (Red-spotted Newt). Adult found in shallow pond on private property 550 m NW of Cumberland River mile marker 265 (36º19'32"N, 86º15'09"W). 27 February 2005. MTSU 351C.

Plethodon dorsalis (Northern Zigzag Salamander). Adult found under water meter cover 10 m E of Highway 231 in the 3200 block at private residence (36º20'44"N, 86º15'22"W). 27 February 2005. MTSU 350C.

Plethodon glutinosus (Northern Slimy Salamander). Adult found on private property under fallen timber 700 m WNW of Cumberland River mile marker 265 (36º19'27"N, 86º15'19"W). 04 May 2005. MTSU 349C.

Anura

Acris crepitans crepitans (Eastern Cricket Frog). Adult found at edge of shallow pond on private property 550 m NW of Cumberland River mile marker 265 (36'32"N, 86º15'09"W). 27 February 2005. MTSU 160A.

Rana catesbeiana (American Bullfrog). Juvenile found in spring on private property 350 m SW of Cumberland River mile marker 265 (36º19'12"N, 86º15'01"W). 27 February 2005. MTSU 159A.

Rana clamitans melanota (Northern Green Frog). Juvenile found in Rocky Creek under the overpass at Canoe Branch Road (36º20'54"N, 86º15'33"W). 27 February 2005. MTSU 158A.

Rana palustris (Pickerel Frog). Juvenile found in spring on private property 350 m SW of Cumberland River mile marker 265 (36º19'12"N, 86º15'01"W). 27 February 2005. MTSU 157A.

Rana sphenocephala (Southern Leopard Frog). Adult found on road during rainy night in the 2500 block of Oldham Road (36º22'49"N, 86º13'27"W). 28 April 2005. J. Pruett. MTSU 156A.

Testudines

Trachemys scripta elegans (Red-eared Slider). Adult found DOR in the 2100 block of State Highway 25 (36º24'16"N, 86º11'18"W). 04 May 2005. APSU Photo Voucher 18181.

Lacertilia

Eumeces fasciatus (Common Five-lined Skink). Adult found under tin 45 m E of Highway 231 in the 3200 block at private residence (36º20'43"N, 86º15'20"W). 04 May 2005. MTSU 50L.

Serpentes

Coluber constrictor constrictor (Northern Black Racer). Adult encountered on private property at edge of limestone bluff 175 m NW of Cumberland River mile marker 265 (36º19'25"N, 86º14'56"W). 4 May 2005. APSU Photo Voucher 18179.

Lampropeltis triangulum triangulum (Eastern Milksnake). Subadult found under tin 50 m E of Highway 231 in the 3200 block at private residence (36º20'46"N, 86º15'19"W). 4 May 2005. APSU Photo Voucher 18180.

Regina septemvittata (Queen Snake). Juvenile found under rock at edge of Rocky Creek under the overpass at Canoe Branch Road (36º19'32"N, 86º15'09"W). 4 May 2005. MTSU 179S.

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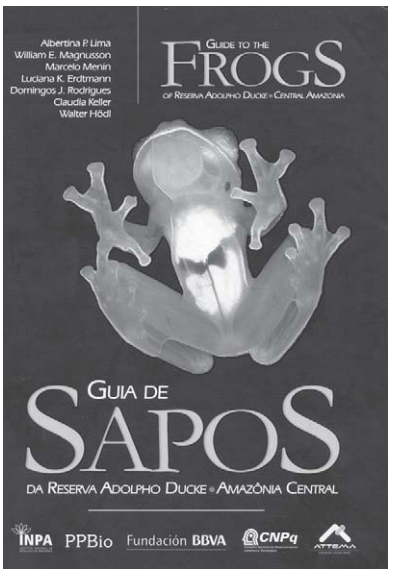
BOOK REVIEWS

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Guia de Sapos da Reserva Adolpho Ducke, Amazônia Central (Guide to the Frogs of Reserva Adolpho Ducke, Central Amazonia), by Albertina P. Lima, William E. Magnusson, Marcelo Menin, Luciana K. Erdtmann, Domingos J. Rodrigues, Claudia Keller, and Walter Hödl. 2006. INPA, PPBio, Fundación BBVA, CNPq, Attema, Manaus, Brazil. Hardcover. 168 pp. Sent free to recognized investigators. ISBN 85-99387-01-4.

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Amazonia is among the most well investigated areas of high biodiversity in the world. Regarding herpetology, some places have a long tradition of surveys, and thus, are reasonably well known. Unfortunately, these areas are few in comparison to the total extent of Amazonia, which is also one of the most threatened zones in the world. Some of these well-studied locations are Santa Cecilia (Duellman 1978) and Cuyabeno (Vitt and de la Torre 1996), both in Ecuador, Manu (Morales and McDiarmid 1996), Llullapichis (Schulter et al. 2004), Iquitos (Rodriguez and Duellman 1994), and Cusco Amazonico (Duellman 2005) all in Peru, and the Reserva Florestal Adolpho Ducke (RFAD) close to Manaus, in Brazil (e.g., Martins and Oliveira 1998 for snakes). The book reviewed here provides a comprehensive review of the amphibians of the last of these localities.

Guia de Sapos da Reserva Adolpho Ducke, Amazonia Central is well designed and illustrated and is printed on plasticized paper, making it very bright, attractive, and durable. The book starts with a preface by William E. Duellman, a table of contents, and an introduction placing the area into context and giving a general idea about the importance of the Reserva Adolpho Ducke and the scientists who have studied there. The occurrence of taxonomically difficult groups, such as *Colostethus* and the *Leptodactylus pentadactylus* group, in the area is also noted.

This is followed by a chapter on the general biology of anurans, including information about the confusion associated with common names, color and defence, predation, reproductive mode, and developmental strategies (aquatic – 21 species; semiterrestrial – 19 species; terrestrial – 8 or 9 species, and egg deposition and

direct development on the dorsum of the female – 2 species). Frog call types (including mating, aggressive, release and distress calls) are also explained at an introductory level. All these components of the introduction are very well illustrated by good examples taken from many of the species occurring in the area.

A short chapter on how to use the guide is also provided. This points out that the book is aimed at ecologists, tourist guides and the general public. Given the audience, the characters used for identification purposes are geared toward live identification in the field and, as the authors explain, the many photos provided, supplemented by a figure (page 47) showing the principal names of body parts that appear in the text, are intended to be adequate for that purpose.

The species accounts making up the bulk of the guide include representatives of the Bufonidae (5 species), Centrolenidae (1 species), Dendrobatidae (3 species, one unnamed), Hylidae (17 species), Leptodactylidae (16 species), Microhylidae (6 species), and Pipidae (2 species), totaling 50 species at the RFAD. Each account appears on one page of two columns (one in Portuguese, the other in English) and includes data on distribution in RFAD, general distribution, a superficial description, similar species, and natural history. The facing page usually displays four or five photos of each species, all of very high quality, including ventral views, multiple dorsal patterns (if intraspecifically variable), animals in amplexus, calling males, nests and tadpoles. The result is an excellent overview of the batrachofauna of the area.

A short bibliographic section containing all references appearing in the text follows, as well as a page introducing each of the authors of the book. The book closes with acknowledgments, and introductions to the BBVA (Banco Bilbao Vizcaya) Foundation (which financed the printing) and the PPBio (Program for Biodiversity Research).

I found no errors in the book and I only can congratulate the authors for providing such jewel for my library. The book is not currently for sale but, in a real act of philanthropy by the authors and financers, it will be sent to researchers and especially to local schools and students who could not normally afford it.

One caveat is that in books dealing with Neotropical amphibians, the names of the species can change (often as result of new phylogenetic data). In this respect, the book was probably in press when the two most recent important revisions of Neotropical amphibians, Faivovich et al. (2005) and Frost et al. (2006), appeared. Accordingly, the names listed in the book corresponding to the revised taxonomy of these authors are: *Bufo granulosus* = *Chaunus granulosus*, *Bufo marinus* = *Chaunus marinus*, *Bufo proboscideus* = *Rhinella proboscidea*, *Epipedobates femoralis* = *Allobates femoralis*, *Hyla boans* = *Hypsiboas boans*, *Hyla* cf. *brevifrons* = *Densropsophus* cf. *brevifrons*, *Hyla geographica* = *Hypsiboas geographicus*, *Hyla granosa* = *Hypsiboas cinerascens* (see also Barrio-Amorós 2004), *Hyla lanciformis* = *Hypsiboas lanciformis*, *Hyla minuta* = *Dendropsophus minutus*, *Phrynohyas resinifictrix* = *Trachycephalus resinifictrix*, *Adenomera andreae* = *Leptodactylus andreae*, *Adenomera hylaedactyla* = *Leptodactylus hylaedactylus*, *Lithodytes lineatus* = *Leptodactylus lineatus*.

Further, taxonomic issues in Neotropical amphibians are not well resolved for many species. Thus, in the book, the species *Atelopus spumarius*, *Bufo granulosus*, *Scinax ruber* (or, more likely, a *S. x-signatus* complex), both *Adenomera* species (now *Leptodactylus*), and *Elachistocleis bicolor*, are members of complexes that could soon be subject to name changes as species boundaries become established through systematic research.

Taxonomic issues aside, I have only two minor criticisms of the work. First, the general distribution section of the species accounts is too general and sometimes does not include all confirmed species in adjacent regions. For example, there is no mention of the presence of *Hyla boans*, *Hyla granosa*, *Osteocephalus buckleyi*, *Phyllomedusa bicolor*, *P. tarsius*, *P. vaillanti*, *Scinax garbei*, *S. ruber*, *Leptodactylus petersi*, *Chiasmocleis hudsoni*, *Ctenophryne geayi*, and *Synapturanus salseri* in Venezuela, where these species are reported or well known (Barrio-Amorós 2004). On the contrary, two species (*Ceratophrys cornuta* and *Leptodactylus rhodomystax*) are listed as present in Venezuela, although neither is supported by vouchers or included in the most recent Venezuelan checklist (Barrio-Amorós 2004). Second, a local guide such a this would be an ideal place to include more detailed descriptions of species calls, even if only in an onomatopoeic way. Indeed, a future edition of this book would benefit by the inclusion of a CD with all possible calls from the area, as was provided by Ibañez et al. (1999) for the Barro Colorado area in Panama.

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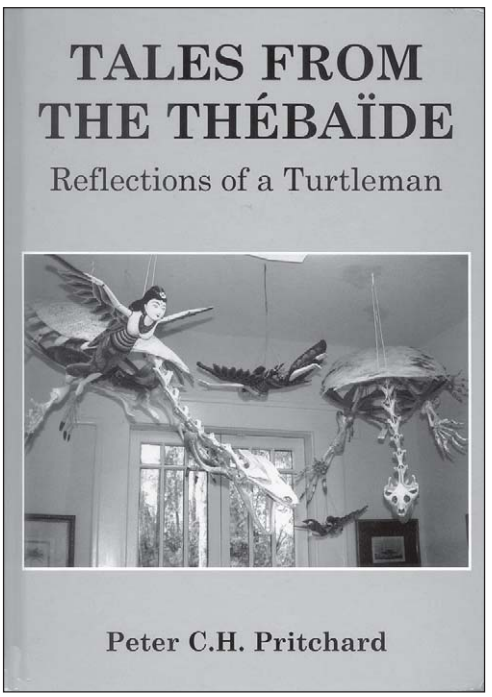
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Tales from the Thébaïde: Reflections of a Turtleman, by Peter C.H. Pritchard. 2007. Krieger Publishing Company, Malabar, Florida (www.krieger-publishing.com). 340 pp. Hardcover. US $44.50. ISBN 1-57524-277-X.

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Tales from the Thébaïde is a collection of articles, essays, and speeches by Peter C.H. Pritchard. In the publisher's news release it is stated that "a cheloniological thread thus runs through his Tales from the Thébaïde, as he (Pritchard) expands the study of his favorite animals into commentaries upon the universe itself, and includes brilliant, erudite, and always humorous accounts of his adventures in many lands seeking further insight into the shelled reptiles." There are some golden threads within this book, but they do not run through it. In several places the thread gets snarled and in other areas an out-of-place stitch is added to try to tie a chapter to chelonians.

The book starts with a collection of stories about Archie Carr in the chapter "The Master Turtler." These stories bring new views of the greatest turtle researcher and advocate of the twentieth century, from Carr's changing views on the use of sea turtles to his opinions on personal recognition. Pritchard gathered these stories though his long friendship with Carr, first as a Ph.D. student and then as a colleague. This is followed by a chapter on "Tortoise Life" which meanders from feeding strategies, including an interesting piece on early morning forays by Aldabra Tortoises, to the learning ability of tortoises—Pritchard relates how his captive tortoises are known to ram their heater when it is not on during cold weather. This chapter has other interesting stories and bits of natural history, but does not flow well from point to point.

After the introductory chapters, the remaining 26 chapters are organized into six sections: Galápagos, Sea Turtles, Schooldays, Personalities and History, Speeches, and Essays. Pritchard, one of the leading turtle experts in the world, provides personal insights that include important information not normally provided in the turtle literature. This is especially true in the chapters dealing with the Galápagos and sea turtles.

In a Galápagos tortoise chapter, "Whatever Happened to the Pinta Tortoise?," Pritchard details a survey of Pinta Island to try to find a live female tortoise for Lonesome George. During their expedition they located a number of sites with tortoise shells and bones, but not live tortoises. Pritchard's conclusions on the "extinction" of this race of turtles include a discussion on how the whalers collected the smaller females because they were more easily carried and came to the lower elevations of the island for nesting. This skewed the harvest, which led to a male-dominated population that could not sustain itself.

A sea turtle chapter, "Life and Death in Oaxaca," provides a very graphic, but important view of the commercial sea turtle business in Mexico during the 1970s. The efficient harvest and processing of turtles highlights how they can be easily exploited. The owner of the processing plant, Antonio Suarez, is shown to be an intelligent man with a different view on the role of sea turtles. Many turtle conservationists would not be able to see past the negative side of Suarez's business of killing sea turtles. The information contained in this chapter makes the entire book worthwhile.

The chapters "Old Masters Remembered" and "Origins" give an interesting look into 1950s Northern Ireland boarding school life and the semi-aristocratic background of the Pritchard clan, but has little connection to turtles. These chapters might have worked better earlier in the book, although the book would not have been diminished if they were omitted all together.

The chapter on "Greenie Remembered" was fun to read. We have all had a college friend similar to Greenie. They are always willing to help, provide conversation, and freeload, but normally they were not willing to tough it out in primitive field camps as Greenie did in Suriname and other locales. The description of the early Suriname field station shows the difficulty accessing remote areas. The lack of roads and expansive mud flats in front of the beach made it a challenge to get to and set up camp at the premier turtle beach in the country. Those same barriers probably also allowed the beach to persist.

The collections of speeches and essays give several different viewpoints into Pritchard's thoughts on turtle conservation, turtle conservationists, and the future of conservation in general. Several previously published papers and speeches appear in other sections of this book. In all over one third of the chapters consist of previously published material.

In the essay section, there is a long chapter on why Pritchard set up his personal Thébaïde, the Chelonian Research Institute. The publisher includes the French dictionary definition of thébaïde — "an intellectual retreat, a remote place, away from the bustle of life, where conversation, scholarship, and scientific and literary discourses are sacred." This chapter gives a history on the formation of the Institute and the diverse collection of turtle specimens, representing a greater species diversity than most major research museums. In parts of the chapter, Pritchard seems to vent on es-

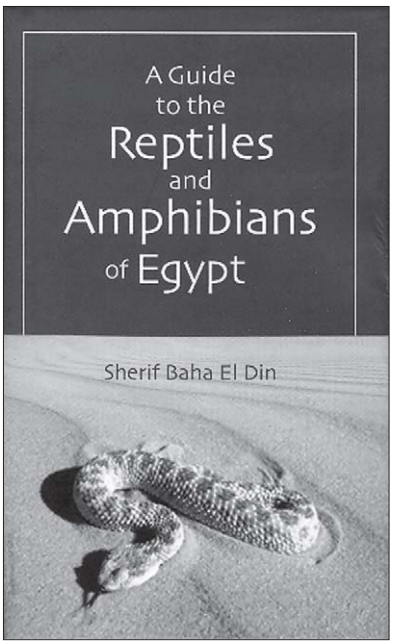
tablished research institutions and their funding sources for not treating the Chelonian Research Institute as an equal. This gives the chapter a negative tone, when it should have been one of the most positive chapters highlighting Pritchard's legacy.

Peter Pritchard has provided an interesting view into his life and research. It is too bad that there is not more structure to the work as a whole. The sections about Schooldays and Personalities would have been workable had they been located at the beginning of the book and included a better thread connecting them to the overarching chelonian theme. This problem, and the general organization of the book, should have been corrected by the publisher when the early drafts of manuscript were received. However, despite some negative issues raised in this review, *Tales from the Thébaïde* is an interesting foray into the thoughts and experiences of an interesting gentleman who is one of the modern day turtle gurus.

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A Guide to the Reptiles and Amphibians of Egypt, by Sherif M. Baha El Din. 2006. American University in Cairo Press, 113 Sharia Kasr el Aini, Cairo, Egypt (www.aucpress.com). xvi + 360 pp., 48 pls. Hardcover. US $34.95. ISBN 997-424-979-8.

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The herpetology of North Africa has received increasing attention during the past twenty years, mostly from European researchers. Several introductory guides to the herpetofauna have been produced for the region, which is treated variously as North Africa (Schleich et al. 1996), Northern Africa (Salvador 1996), or the Sahara (Le Berre 1989), as well as for specific countries or territories, including Morocco (Bons and Geniez 1996) and Western Sahara (Geniez et al. 2004). While not the earliest study of amphibians and reptiles in North Africa, John Anderson's (1898) zoological study of Egypt was the first major contribution to studies of the reptiles and amphibians of this region. This detailed and scholarly work firmly established Egypt as an important crossroads of the herpetofauna of Africa, the Mediterranean, and the Middle East. Nearly a century after the publication of Anderson's work, Mostafa Saleh's (1997) *Amphibians and Reptiles of Egypt* provided a synthesis of more recent knowledge of Egypt's herpetofauna, including major works such as the checklist by Hyman Marx (1968) and descriptions of new species such as *Bufo kassasii* (Baha El Din 1993). However, most species accounts in Saleh's book are very short and most details on the biology and ecology were taken from the literature rather than personal experience. Until now, Saleh's (1997) work has been the only recent summary of the study of Egypt's amphibians and reptiles.

Sherif Baha El Din's new book, *A Guide to the Reptiles and Amphibians of Egypt*, surpasses previous work on the Egyptian herpetofauna and stands as perhaps the most thorough book focused on the reptiles and amphibians of any single African country. Unlike many other treatments of the North African herpetofauna, this book is written by an Egyptian and sets an excellent precedent for future work by African herpetologists. The book builds on Baha El Din's extensive and expert knowledge of the biology and distribution of Egypt's reptiles and amphibians, which were the focus, at least in part, of his recent doctoral thesis work at the University of Nottingham. This work is of a high caliber and is an extremely important contribution to both African and Mediterranean herpetology.

As Saleh's (1997) book is the only other recent extensive treatment of Egypt's herpetofauna, it is appropriate to make comparisons between it and the recent work by Baha El Din (2006). In many ways, the layout of the two books is very similar. Baha El Din's book begins with several brief chapters introducing the reader to Egyptian herpetology, climate, geological history, patterns of herpetofaunal diversity, relevant habitats, and conservation. Each chapter is short and concise but contains sufficient details and references to enable further pursuit of the topics. These chapters build on similar sections found in Saleh's book that detail the history of Egyptian herpetological research, the relevant habitats of Egypt, and general remarks about Egypt's herpetofaunal diversity. In general, the sections of Saleh (1997) are more extensive, but the briefer descriptions by Baha El Din (2006) are very appropriate for a field guide. The photographs of representative habitat types included by Baha El Din are less numerous than those found in Saleh (1997) but still provide a general idea of diversity. Both books consist mostly of species accounts and keys for determining genera and species. For example, Baha El Din's section on lizards begins with a key to the families that occur in Egypt, which is then followed by sections on each family that contain keys to both genera and species as well as accounts for each. The keys of the two books are quite similar and those of Baha El Din's book are essentially refined versions of the other that include additional species, additional characters, and/or more precise descriptions. Several of the keys, including those for anurans, lizards in general, gekkonids in particular, and snakes, are accompanied by useful illustrations showing characters of interest; drawings of head scales are also presented for all of the Egyptian leptotyphlopid and typhlopid snake species. Brief accounts are provided for each genus and include comments on diagnostic features and geographic range.

The species accounts in Baha El Din's book are extensive and much more detailed than those of Saleh (1997). These accounts are full of useful information regarding biology and ecology, most of which Baha El Din gained from personal experience with the species. Each species account contains a map showing the geographic distribution on a half-degree grid, a list of synonymies, including at least those relevant to Egypt, the English and Arabic

common names, and thorough sections on taxonomy, variation, habitat and ecology, range, distribution within Egypt, and conservation status. In general, each section is well referenced. Information on the conservation status comes from the recent Global Amphibian Assessment (IUCN et al. 2004) and the ongoing, but still unpublished, Global Reptile Assessment. Except for the photographs placed in the center of the book, all information for a given species is found in the species account. The detailed species accounts and consolidation of information for each species makes this book a truly handy field resource.

Baha El Din specifically details information regarding particular museum collections on which the distribution and taxonomic data is based. In some species accounts, especially for species that are poorly known in Egypt (e.g., *Ptychadena schillukorum*, *Leptotyphlops nursii*) or those with interesting or isolated populations (e.g., *Eumeces schneideri*), museum specimens are referenced by catalogue number. In other species accounts, Baha El Din discusses and redetermines particular museum specimens that were previously assigned to a given species; some of these redeterminations result in significant changes in the distribution maps (e.g., *Acanthodactylus pardalis*). The citation of museum specimens is a welcome departure from most other books focused on the reptiles and amphibians of African countries. Impressively, all but one of the 118 species included in the book were documented based on voucher specimens (single exception: *Psammophis punctulatus*), although these are not referenced in the text.

Much of the data regarding geographic distributions comes from Baha El Din's work over more than 20 years. His extensive fieldwork and examination of museum specimens has resulted in the refinement of the species distribution maps presented by Saleh (1997) and includes many new localities. Baha El Din takes a very systematized approach to presenting geographic distribution data; each species has a map on which its presence is indicated on a half-degree base map. This is an improvement over many other works that include maps with overlapping point localities, which can be difficult to interpret. Baha El Din inferred the presence of species in areas intervening between known localities by using ecological data to refine a minimal complex polygon around the known localities. This is entirely appropriate and quite useful. However, this does not entirely explain a few distribution maps of species with discontinuous ranges in which there are seemingly isolated cells where a species is predicted to occur (e.g., *Hemidactylus turcicus*, *Stenodactylus petrii*, *Lytorhynchus diadema*). A gazetteer of localities including coordinates is an excellent accompaniment to the geographic distribution data presented in the species accounts. By explicitly presenting both known localities and predicted areas of occurrence, the distribution maps should be very useful for guiding future field research in Egypt. Scientific names are accompanied by information on synonymy that, appropriate for a guide, is restricted to that which is most relevant to Egypt. In addition, common names in both English and Arabic are provided; names in Arabic script can be found in Saleh (1997). If readers are interested in other common names for North African animals in Arabic or other languages, including Tamasheq, Tebu, or Fulfulde, they should refer to Monteil (1951) and Le Berre (1989).

Color photographs of living specimens accompany most species descriptions. These images are generally sufficient and significantly add to the species descriptions by illustrating coloration and even details of morphology such as snout shape (e.g., *Scincus scincus*, Fig. 74). In comparison to the photographs of Saleh (1997), those presented by Baha El Din are of higher quality and exhibit both greater detail and better color.

I found very few errors in the text. A very minor exception is the statement on page 145 that there are 16 lacertids in Egypt; there are actually 17 species, as correctly indicated by the number of species accounts.

Both museum and field researchers will enjoy Baha El Din's *A Guide to the Reptiles and Amphibians of Egypt*. The extensive species accounts, which include references to museum specimens, are an excellent resource for collections-based research, whereas the range maps, ecological data, photographs, and compact size ensure that this will be the single resource used by interested professional or amateur herpetologists traveling in Egypt. I highly recommend this book to anyone interested in the zoology of Africa, the Mediterranean, or the Middle East. It will be difficult to surpass such an excellent work.

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PUBLICATIONS RECEIVED

Turtles in My Sandbox, by J. K. Curtis. 2006. Sylvan Dell Publishing, 976 Houston Northcutt Blvd., Suite 3, Mt. Pleasant, South Carolina 29464, USA (www.sylvandellpublishing.com). 31 pp. Hardcover. $15.95. ISBN 78-0976882374.

I shared this book with a member of its target audience, an el-

ementary school level child, as well as two younger children, and it was well received in every case. The brief text and excellent illustrations tell the story of a little girl who finds a diamondback terrapin nest in her sand box and then with the advice of experts she and her mother headstart the hatchlings for nine months. The youngsters are then released into the ocean under the watchful eye of terrapin conservationists. The controversies regarding headstarting are, of course, not mentioned, but the text is biologically accurate. I liked that the eggs were incubated *in situ*, and that the hatchlings were fed somewhat natural foods. It would have been advisable to recommend hand washing to a child maintaining turtles. The text implies that it is difficult to find good advice on terrapin husbandry and conservation, so the book could have listed some of the good sources that are available on the web and in print. The last three pages of the book contain outlines for making fun turtle cut-out toys. A great gift for the 4–8 year old you know.

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Bibliotheca Cordyliformium, by Klaus Adolphs. 2006. Squamata Verlag, Sankt Augustin, Germany (www.squamata.de). 304 pp. Hardcover. € 42,00 (approx. US $55.00). ISBN 978-3-9805086-1-2.

This book is intended as a reference work on the lizard families Cordylidae and Gerrhosauridae. It begins with an up-to-date listing of the 120+ species and subspecies in these groups, complete with synonyms and a short statement (in German) of their distribution. The bulk of the work is occupied by a comprehensive bibliography, with over 1370 numbered entries listed alphabetically. The entries span the period from Seba's *Thesaurus* in 1734–35 to mid-2006 and include even the most obscure references in all languages. An extremely valuable feature is the inclusion of the complete (unabbreviated) titles of journals—a feature lacking in most bibliographies of any kind and one that is especially critical for those working with early systematic literature. For all references for which the content of the paper is not self-evident from the title, a short summary of the taxa dealt with and the nature of the data presented is provided. This is usually in German, but some references are accompanied by their original English abstracts. Separate indices are provided to authors, co-authors and editors, species and subspecies, and subjects (more than 100 keywords). This handsomely produced volume will be invaluable for those interested in cordylids and gerrhosaurs and is recommended for herpetobibliophiles and those studying African herpetology.

Avian and Exotic Animal Hematology and Cytology, 3rd Edition, by Terry W. Campbell and Christine K. Ellis. 2007. Blackwell Publishing (www.BlackwellVet.com). ix + 287 pp. Hardcover. US $149.99. ISBN 978-0-8138-1811-5.

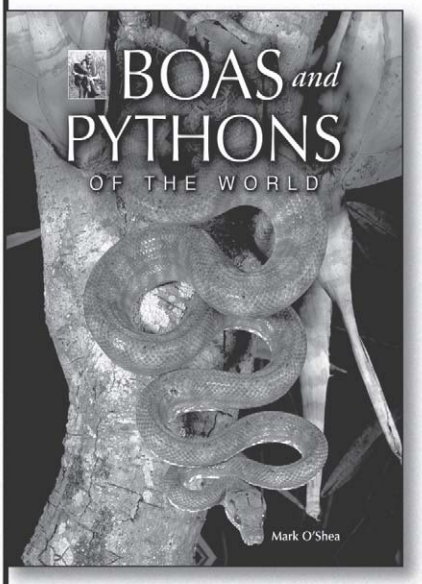
This is the third edition of a standard veterinary work on the hematology and cytology of a diversity of vertebrates, including amphibians and reptiles. Herpetological information is included chiefly in chapters 2 (Hematology of Reptiles, 31 pp.), 3 (Hematology of Amphibians, 9 pp.), and 6 (Comparative Cytology, 83 pp). Topics covered include blood sample collecting and handling, cytological sampling techniques, morphology, laboratory evaluation and disease responses of erythrocytes, leucocytes, and thrombocytes, blood parasites, hematopoiesis, and normal and abnormal cytology. Most examples are drawn from species commonly kept as pets, but others derive from sea turtles, crocodilians and other, more exotic taxa. Also, there is an extensive section dealing with the hematology of birds and shorter chapters treating fish and small mammals (exclusive of dogs and cats). A separate chapter on diagnostic microscopy using wet-mount preparations focuses on fish, but is relevant for amphibian disease detection and treatment. Two appendices provide a useful guide to stains and solutions and give hematologic values for selected taxa, including 33 reptile and eight amphibian species. A 27-page bibliography of over 1000 references completes the book, which is illustrated throughout by color cytological, parasitological, and blood film micrographs. Of obvious direct relevance to veterinarians dealing with herpetological patients, this book will also be valuable to those academics, zoo professionals, and very serious herpetoculturists with an interest in amphibian and reptile diseases and parasites. However, the treatment of some relevant topics with an extensive literature, such as lizard malaria, is relatively superficial; other topics, such as chytridiomycosis in amphibians, which one might expect to be treated in the cytological and/or wet-mount preparation sections of the book, are not mentioned.

Ecology and Ecosystem Conservation, by Oswald J. Schmitz. 2007. Island Press, 1718 Connecticut Avenue, NW, Suite 300, Washington, D.C. x + 166 pp. Hardcover. US $40.00, ISBN 978-1-59726-048-0; Softcover. US $19.95. ISBN 978-1-59726-049-7.

This small book is aimed at a broad audience and is part of the series Foundations of Contemporary Environmental Studies. It uses specific examples from conservation biology to present underlying principles of modern ecology and to explain why ecosystem and biodiversity conservation are crucial to dealing with current environmental problems. Among the topics included are climate change, carrying capacity, habitat fragmentation, and population dynamics. Amphibians and reptiles are mentioned in several places, with sea turtles serving as a focal taxon in the chapter "Viability of Threatened Species." This book is perhaps most appropriate for an undergraduate audience in introductory courses in environmental science or conservation biology, but its clear, simple style and real-life examples make it accessible to laypeople in general. Biologists whose research interests are far removed from ecology might also find this a convenient introduction to some of the main issues in conservation biology.

Back Issue Clearance for Publications of The Herpetologists' League

In an effort to reduce the need for storage space, The Herpetologists' League will be holding a clearance sale of back issues of its publications at the Joint Meetings in St. Louis in July 2007. Single issues of *Herpetologica* or *Herpetological Monographs* ($5°°) or complete volumes of *Herpetologica* ($20°°) will be available for purchase as long as supplies last. Only cash or checks (USD$, drawn from a US bank) will be accepted, and these sale prices are valid only when purchasing back issues in person at JMIH'07. Sale hours will be from 1330–1700 h on 12–15 July. Please contact Steve Mullin (<sjmullin@eiu.edu>) with any questions.

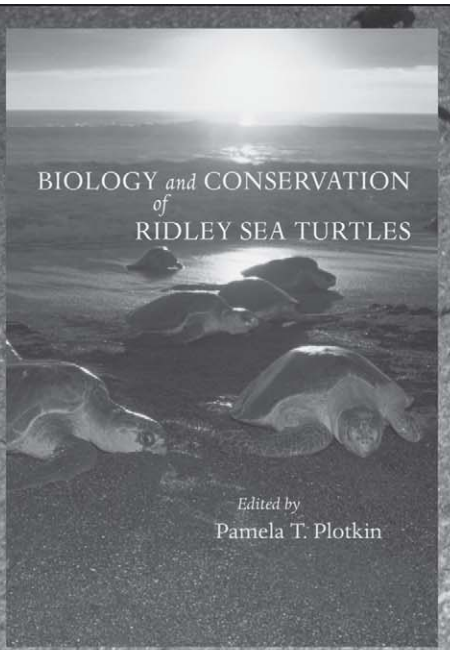


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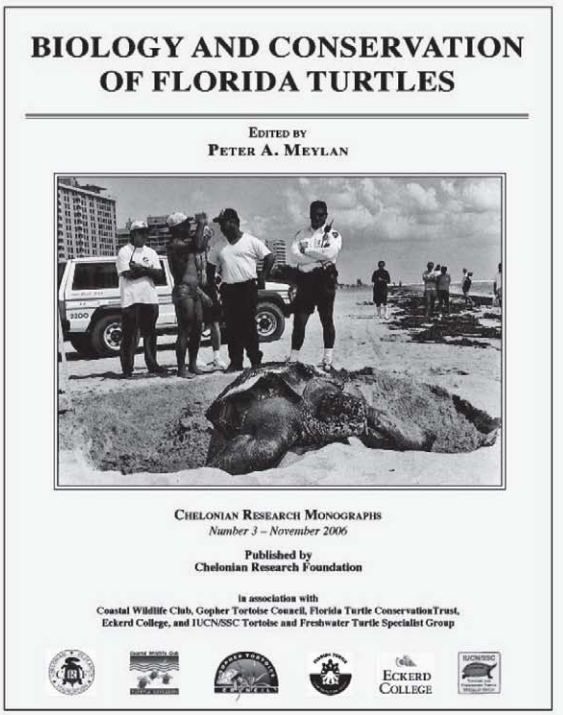
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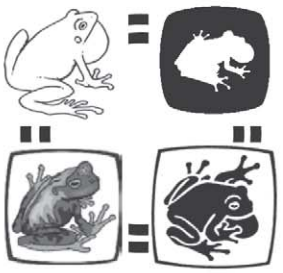
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Herpetological Circular 36

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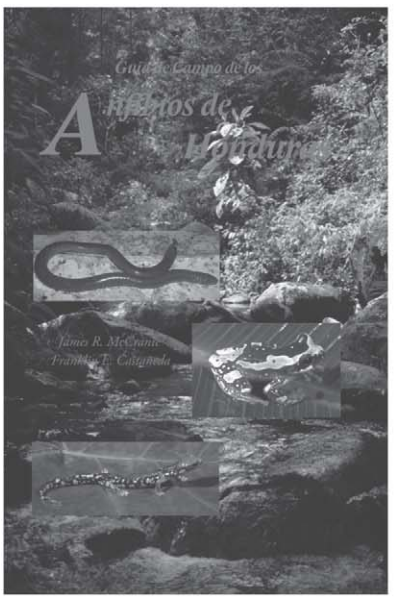
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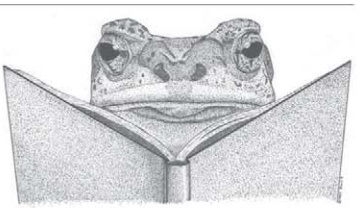
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Herpetological Review

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The Society for the Study of Amphibians and Reptiles, the largest international herpetological society, is a not-for-profit organization established to advance research, conservation, and education concerning amphibians and reptiles. Founded in 1958, SSAR is widely recognized today as having the most diverse society-sponsored program of services and publications for herpetologists. Membership is open to anyone with an interest in herpetology—professionals and serious amateurs alike—who wish to join with us to advance the goals of the Society.

All members of the SSAR are entitled to vote by mail ballot for Society officers, which allows overseas members to participate in determining the Society's activities; also, many international members attend the annual meetings and serve on editorial boards and committees.

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2007 — Saint Louis, Missouri, 11–16 July (with ASIH, HL)
2008 — Montreal, Canada (with ASIH, HL)
2009 — Portland, Oregon (with ASIH, HL)

About Our Cover: *Cruziohyla craspedopus*



Amazon and Western Leaf Frogs were recently placed in the phyllomedusine genus *Cruziohyla* (Faivovich et al. 2005. Bull. Amer. Mus. Nat. Hist. 294:1–240). The Amazon Leaf Frog, *Cruziohyla craspedopus* (Funkhouser, 1957), occurs in the upper and central Amazon Basin where it is locally common but seldom observed by humans owing to its habitat, the understory and canopy of primary and transitional rainforest. Syntopic anurans include *Phyllomedusa bicolor*, *Ecnomiohyla tuberculata*, *Trachycephalus resinifictrix*, and *Nyctimantis rugiceps*. Amazon Leaf Frogs possess the remarkable ability to alter the color on the periphery of the iris from tan to yellow. Dermal fringes adorn the lips and shanks, and the dorsal pattern is reminiscent of a leaf laced with fungi or lichens. They rest by day on leaf surfaces with their appendages tightly adpressed and the eyes concealed by reticulate palpebra. This crypsis is advantageous in evading two of their principal predators: monkeys of the genus *Pithecia* and *Cebus*.

In the upper Amazon Basin, *A. craspedopus* is most easily observed in *várzea*, seasonally flooded forest (including *bajial* and *tahuampa* in Peru), comprised of *Ficus* sp. (*Renaco*) – *Attalea butyracea* (*Shapaja)* associations, and marginal habitat (*restinga)* where alluvial soils support an understory of *Guadua, Heliconia, Phytelephas*, and *Bellucia*, and a mixed canopy including *Pourouma, Clusia, Pausandra*, *Couma*, and *Couratari*. The advertisement call, a soft "wort," is produced infrequently as males converge upon communal nesting sites during the dry season. Suitable sites include stagnant water in buttress pans and branch axils of *Renacos*; hollow stumps; logs with catch basins; rot holes; isolated pools; and artificial habitats caused by cutting. Up to two dozen large eggs are deposited in adhesive masses on twigs, bark, and over-hanging vegetation. The larvae grow in water stained with tannin from rotting leaves. Adults and eggs are consumed by Cat-eyed Snakes, *Leptodeira annulata*. Tadpole predators include larval odonates, lycosid and ctenid spiders, and aquatic hemipterans and coleopterans. Metamorphs are tan, pale lavender, or bluish dorsally. Upon emerging, they ascend to the canopy, where they feed on diminutive arthropods.

The cover image was made in 1993 in the río Chambira drainage system, Loreto, Peru, by **William W. Lamar** with a Pentax LX 35mm SLR camera, a Vivitar Series 1 105mm macro lens stopped down to f/22, and a Vivitar Series 1 flash with Fujichrome Velvia film pushed to ISO 100. Lamar's fieldwork in the Neotropics spans 35 years, and his efforts in northeastern Peru have produced nearly 400 species of amphibians and reptiles. Lamar is an Adjunct Professor of Biology at the University of Texas at Tyler. He coauthored *The Venomous Reptiles of Latin America* and *The Venomous Reptiles of the Western Hemisphere* with Jonathan A. Campbell. He leads natural history tours for GreenTracks, Inc., http://www.greentracks.com. Recent travel has taken him to Amazonian Brazil and several islands in the tropical Pacific.



PHOTO BY AUSTIN STEVENS

SSAR BUSINESS

Open Letter to Membership

SSAR will celebrate its 50th Anniversary in 2007. Special activities will take place during the Joint Meeting of Ichthyologists and Herpetologists (JMIH) in St. Louis, 11–16 July. The major events associated with SSAR's Anniversary are scheduled for 13 July. These events feature a symposium organized by Jonathan Losos entitled "Herpetology in the Age of Genomics." Jim Murphy and Kraig Adler will be the Masters of Ceremonies for a special SSAR Banquet that evening. The SSAR/HL auction will follow the banquet. And, of course, everyone is invited to attend the Business meeting on July 15. A link to registration on our website (http:www.ssarherps.org) will be available in January. Registration can be for the entire meeting or only for the day of the SSAR celebration.

—Roy McDiarmid, SSAR President
—Robin Andrews, SSAR Immediate Past President

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The SSAR STAC announces the Twelfth Annual Frameable Art Silent Auction to be held at the 2007 SSAR meeting in St. Louis, Missouri from 11–16 July. Preferred donations include herp-related photos, line drawings, prints, paintings, plates, engravings, or anything frameable, if not already framed. If you are interested in donating an item (tax deductible for U.S. residents), please email ALDRIDGE@SLU.EDU. If you will be bringing silent auction items with you to the meeting, you may drop them off at the service desk with Sharon Brookshire. Make sure you specify SSAR silent auction.

SSAR Student Travel Awards: Call for Applications

Ten awards of US $200 each are available. An applicant for a travel award must be a student and a member of SSAR, must not have previously received a travel award from SSAR, and must be the first author of a paper or poster to be presented. Application package must include: 1) letter signed by his/her major advisor or

department chair that states: he/she is not completely funded for travel from another source; 2) an official copy of the poster or paper abstract to be presented; 3) a self-addressed, stamped envelope. If the research is co-authored, the applicant must also include a letter from his/her advisor stating that the work was primarily the product of the applicant. Qualified applicants are pooled and winners are drawn at random. Students from local meeting site and current members of the SSAR Travel Awards Committee are excluded from applying for a travel award. Applications must be postmarked by 15 April 2007. Award checks will be disbursed at the meeting. Send application package to: Dawn S. Wilson, Southwestern Research Station, P.O. Box, 16550, Portal, Arizona 85632, USA, or for further information email: dwilson@amnh.org.

NEWSNOTES

NAI Honors Conant and Stebbins in Albuquerque

The National Association for Interpretation (NAI) is an organization made up of 5000 members dedicated to advancing the profession of heritage interpretation. Individual members include those who work at parks, museums, nature centers, zoos, botanical gardens, aquariums etc.

Interpreters of natural history have relied on the two herpetological Peterson Field Guides for decades. For this and many other reasons, at its 2006 meeting, held 7–11 November, NAI bestowed awards to both Roger Conant (posthumously) and Robert C. Stebbins.

NAI's president Evelyn Kirkwood decided to create the first-ever Lifetime Achievement Award for Conant. The NAI professional awards committee chose Stebbins for the Senior/Retired Interpreter Award.

At the award banquet, the 400 members in the audience enjoyed historical photos of both awardees projected on screen, and a video segment of Roger Conant accepting his David S. Ingalls, Jr. Award of Excellence at the Cleveland Museum of Natural History in 1996. Dr. Stebbins chose not to make the long trip, so his friend and colleague, Alan Kaplan of East Bay Regional Park District in California, accepted on his behalf.

For more information about NAI, visit the website at: www.interpnet.com.

Robert Inger Honored in Malaysia

Robert Inger, Curator Emeritus at Chicago's Field Museum of Natural History, was honored recently with the Panglima Setia Bintang Sarawak (PSBS) award. A special investiture was held in January 2007 at Kuching, during which Inger was presented the award from the Yang di-Pertua Negeri Tun Datuk Patinggi Abang Muhammad Salahuddin. Inger received the award in recognition for 50 years of research on Sarawak, much of which has focused on cataloguing the enormous diversity of the Bornean herpetofauna. Beginning in 1956, Inger's field work at Sarawak, often in collaboration with graduate students and fellow scientists, has resulted in the description of more than 50 new species, nearly all of which are Bornean endemics. As noted in the press release accompanying the award ceremony: "His work has been a vibrant source of inspiration to a great throng of herpetologists, students and field biologists from all over the world. His most outstanding characteristic, however, is his unflagging kindness and generosity in helping generations of young herpetologists, including many from Malaysia."



Salahuddin confers the PSBS award to Dr. Inger. Penerangan photo, courtesy of the Field Museum of Natural History.

MEETINGS

Meetings Calendar

Meeting announcement information should be sent directly to the Editor (rwh13@csufresno.edu) well in advance of the event.

16–20 April 2007—First Mediterranean Herpetological Congress, Marrakech, Morocco. Information available from the Congress website: www.ucam.ac.ma/cmh1.

14–18 April 2007—14th ARAV Conference, Association of Reptile and Amphibian Veterinarians, New Orleans, Louisiana, USA. Information: http://www.arav.org/.

31 May–2 June 2007—Southwest Partners in Amphibian and Reptile Conservation, First Annual Regional Meeting, Albuquerque, New Mexico, USA. Information: http://chelydra.unm.edu/swparc/.

20–23 June 2007—31st International Herpetological Symposium, Toronto, Canada. Information: http://www.kingsnake.com/ihs/.

11–16 July 2007—50th Annual Meeting, Society for the Study of Amphibians and Reptiles; 87th Annual Meeting, American Society of Ichthyologists and Herpetologists; 65th Annual Meeting, The Herpetologists' League. St. Louis, Missouri, USA. Information: http://www.dce.ksu.edu/jointmeeting/.

3–6 August 2007—5th Conference on the Biology of Plethodontid Salamanders: Symposium in Honor of David B. Wake. Instituto de Biologia, UNAM and ECOSUR, San Cristobal de la Casas, Chiapas, México. Information: http://www.ibiologia.unam.mx/barra/congresos/salamandra/salamandra.html.

3–7 September 2007—Venom Week 2007. Tucson, Arizona, USA. Information: http://www.ocme.arizona.edu.

CURRENT RESEARCH

The purpose of **Current Research** is to present brief summaries and citations for selected papers from journals other than those published by the American Society of Ichthyologists and Herpetologists, The Herpetologists' League, and the Society for the Study of Amphibians and Reptiles. Limited space prohibits comprehensive coverage of the literature, but an effort will be made to cover a variety of taxa and topics. To ensure that the coverage is as broad and current as possible, authors are invited to send reprints to the Current Research section editors, **Michele Johnson** or **Josh Hale**; postal and e-mail addresses may be found on the inside front cover.

The current contents of various herpetological journals and other publications can be found at: http://www.herplit.com/contents.

Ontogenetic Color Changes in Lizards Driven by Behavioral Changes

Tails with conspicuous coloration are a common feature in juveniles of reptiles, amphibians and fish, a characteristic that is usually lost in adults. Most studies have associated the presence of conspicuous tails with deflection of predators to a less vulnerable body part or with visual signaling for social behavior. The authors questioned why juveniles lose that coloration if it provides a specific advantage. Previous studies suggested that differences in threats encountered by juveniles and adults could explain the change in coloration; the authors propose a new alternative: changes in behavior may change the costs and benefits of bright coloration. They studied whether changes in body pattern and tail color in *Acanthodactylus beershebensis* are associated with behavioral differences before and soon after the ontogenetic color changes. Foraging mode and microhabitat use of one-week-old hatchlings (with bright blue tail and yellowish stripes on dorsum) and 3 week-old juveniles (that have already loss the bright coloration) were recorded in the Northern Negev desert (Israel). During 20-minute observation intervals, movements per minute (MPM) and proportion of time spent moving (PTM) were calculated to estimate foraging mode, and the proportion of time spent in open gaps between shrubs (PTO) was used to quantify microhabitat use. Two additional sympatric lacertid species (*Mesalina guttulata* and *Acanthodactylus boskianus*) that do not exhibit an ontogenetic coloration change were also studied. A MANOVA found significant differences in MPM, PTM, and PTO between hatchlings and juveniles of *A. beershebensis*; newly hatched lizards with conspicuous blue tails move more and spend more time in the open microhabitat than brown-tailed juveniles. No significant differences were found between MPM and PTM in hatchlings and juveniles of *M. guttulata*. However, a significant difference was found in PTM in *A. boskianus*: juveniles move less than adults (i.e., exhibit a safer foraging mode). The authors suggest that predation risk is a possible explanation for the behavioral change associated with the ontogenetic changes in color and body pattern in *A. beershebensis*; in addition they discuss alternative hypotheses and the possibility that multiple factors could be operating together.

HAWLENA, D., R. BOOCHNIK, Z. ABRAMSKY, AND A. BOUSKILA. 2006. Blue tail and striped body: why do lizards change their infant costume when growing up? Behavioral Ecology 17:889–896.

Correspondence to: Dror Hawlena, Department of Life Sciences and Mitrani Department of Desert Ecology, Blaustein Institute for Desert Research, Ben-Gurion University of the Negev, PO Box 653, 84105 Beer-Sheva, Israel; e-mail: hawlena@bgu.ac.il.

Dietary Changes in the Cannibalistic Morphs of *Ambystoma* Salamanders

In salamanders, cannibalistic morphology is an example of phenotypic plasticity, expressed as the development of prominent teeth and a larger head. The benefits of cannibalism are associated with faster growth rate and larger size, while the costs are associated with the fitness loss from eating relatives and being more vulnerable to predators. In most cases studied, cannibalistic morphs ate mostly conspecifics; however, is has been found that some cannibal morphs do not eat conspecifics at all. It appears that the degree of cannibalism depends on the density of heterospecific vs. conspecific prey. Still, it is unknown if cannibal morphs are obligatory cannibals or if they can change their diet through time. The authors studied a population of *Ambystoma tigrinum nebulosum* located at Kettle Pond, Colorado, which includes cannibalistic morphs. The dietary components of cannibalistic and typical morphs were sampled four times, at one-week intervals. Each individual sampled was measured and weighed, and their stomachs were flushed. Stomach contents were identified by prey type and prey length, and later quantified by dry weight. MANOVA found differences between typical and cannibalistic forms in the consumption of chironomid larvae, mollusks, and terrestrial invertebrates; also, only cannibalistic forms ate conspecifics. However, after the second week of the study period, the diet of cannibal forms changed, decreasing the amount of conspecifics and showing a composition more similar to the typical forms. A significant difference in prey size was also found between the two groups,

but only in the first week of sampling; during weeks 2-4, there was no size difference found given the decrease of prey size in cannibal forms. In conclusion, the authors found that cannibalistic forms are not obligatory cannibals and that diet components changed through time. The authors discussed the increase of dietary niche overlap between the two morphs, the impacts on resource partitioning and the evolutionary advantages of alternative trophic morphologies.

DENOËL, M., H. H. WHITEMAN, AND S. A. WISSINGER. 2006. Temporal shift of diet in alternative cannibalistic morphs of the tiger salamander. Biological Journal of the Linnean Society 89:373–382.

Correspondence to: Mathieu Denoël, Laboratory of Fish and Amphibian Ethology, Behavioural Biology Unit, Department of Environmental Sciences, University of Liège, 4020 Liège, Belgium; e-mail: mathieu.denoel@ulg.ac.be.

Functional Trade-Off Between Swimming and Running in *Triturus* Salamanders

Structural requirements for multiple competing functions often result in a compromised morphology that does not optimize the performance of either function. Aquatic vs. terrestrial trade-offs in locomotor performance are common, as the same functional system must perform dissimilar tasks under different environmental conditions, and a single phenotype cannot maximize different traits at the same time. Theory predicts that morphological adaptations for efficient locomotion in aquatic environments will reduce terrestrial locomotor ability and vice versa. *Triturus* salamanders are an especially interesting case, given that different species spend different amounts of time in water or on land, predicting different degrees of trade-off between optimal terrestrial or aquatic phenotypes. The authors compared body elongation, head width, fore- and hindlimb length, tail length and height in females of 10 species of *Triturus*, in addition to swimming and running speed from trials performed in a linear track. Data were analyzed using non-phylogenetic correlation tests, and by incorporating phylogenetic information using independent contrasts and phylogenetic generalized least squares; morphological variables were corrected for body size using Mossimann's (1970) multivariate method. Axillary-groin distance was negatively correlated with forelimb length and head width, but no association was found between relative axilla-groin distance and tail length or height. Species with longer tails and shorter axilla-groin distances swam faster, and surprisingly, species with shorter axilla–groin distances also ran faster. No negative correlation between running and swimming speed was found; that is, there was no evidence of a trade-off between swimming and running speed at the interspecific level. The authors discuss the lack of association between body elongation and swimming speed, considering the current understanding of mechanics of movement in water. In addition, alternative scenarios are considered: the association of body elongation with a swimming characteristic other than speed, and the association of body elongation with a function outside locomotion.

GVOZDÍK, L., AND R. VAN DAMME. 2006. *Triturus* newts defy the running-swimming dilemma. Evolution 60:2110–2121.

Correspondence to: Lumír Gvozdík, Department of Population Biology, Institute of Vertebrate Biology AS CR, Studenec 122, 67502 Konesín, Czech Republic, e-mail: gvozdik@brno.cas.cz.

Parthenogenesis in Captive Komodo Dragon Females

Parthenogenesis, the production of offspring without fusion of male and female gametes, is rarely seen in vertebrates. In this study, the authors report findings of parthenogenetic offspring in Komodo Dragons (*Varanus komodoensis*) from captive females kept in isolation from males. Genetic fingerprinting was used to identify the parentage of the offspring of two females kept in separate UK zoos, one of which had never been in contact with a male. In both, all produced offspring were homozygous for all loci, although not each other's identical clones. One of the females later resumed sexual reproduction after mating with a male, suggesting that parthenogenesis in Komodo Dragons is facultative and not a fixated state, and that asexual reproduction occurred when mating was not possible. Results provide evidence for previously overlooked threats for the Komodo Dragon populations that are already under strong extinction pressures: 1) the reduction of genetic variability, as parthenogenesis entails complete homozygosity of the entire genome, and 2) sex ratio bias in the population, in this case favoring males, as females are the heterogametic sex (WZ). The authors explore the consequences for maintaining genetic variability in the reproduction program based on captive individuals, and describe the need for further studies on the genetic load of the parthenogenetic offspring, the frequency of parthenogenesis in captivity and in wild populations, and its consequences on fitness.

WATTS, P. C., K. R. BULEY, S. SANDERSON, W. BOARDMAN, C. CIOFI, AND R. GIBSON. 2006. Parthenogenesis in Komodo dragons. Should males and females be kept together to avoid triggering virgin birth in these endangered reptiles? Nature 444:1021–1022.

Correspondence to: Phillip C. Watts, School of Biological Sciences, University of Liverpool, Liverpool L69 7ZB, United Kingdom; e-mail: p.c.watts@liv.ac.uk.

Population Status of the Black Caiman: Towards a Conservation Strategy

The Black Caiman (*Melanosuchus niger*) was once an abundant, wide spread predator present in the entire Amazon basin and neighboring river drainages. In the last century there has been an estimated 90% reduction of its population due to the strong hunting pressure and habitat loss in the area. To increase the amount of information available to establish a conservation program, the authors studied microsatellite polymorphisms in 169 individuals from seven populations in Brazil, Ecuador, and French Guiana. Allelic diversity and heterozygosity levels were used to estimate current population status. Isolation by distance was measured using a Mantel test and a Reduced Major Axis (RMA) regression between genetic and geographic distances, and population structure was assessed using FIS and FST coefficients. Genetic diversity and heterozygosity was high in all populations (highest in two

populations in central Amazon of Brazil and lowest at the Ecuadorian population), despite the absence of hatchlings and large breeders in some populations, evidence of population decline. The authors discuss the difficulty of assessing loss of genetic diversity after significant but recent threats and the effect of migration on the observed results. An overall differentiation in the allelic variation was found among populations, with tests indicating a significant population structure at all loci. Even those populations in close proximity were significantly different at the genetic level, a result probably associated with differential occupation of habitats (e.g., black water swamps vs. estuarine waters) and/or sex-biased dispersal. The authors highlight the necessity of collecting more data on the biology and ecology of the black caiman and recommend concentrating the management efforts on the protection of key sites and the implementation of sustainable habitat use programs to ensure ecological functions and gene flow.

DE THOISY, B., T. HRBEK, I. P. FARIAS, W. R. VASCONCELOS, AND A. LAVERGNE. 2006. Genetic structure, population dynamics, and conservation of black caiman (*Melanosuchus niger*). Biological Conservation 133:474–482.

Correspondence to: Benoit de Thoisy, Association Kwata, BP 672, F-97335 Cayenne cedex, French Guiana, e-mail: thoisy@nplus.gf.

Differences in Tropical vs. Temperate Diversity: An Integrated Evolutionary and Ecological Approach

The higher species diversity observed in tropical versus temperate regions has been a pattern subject of multiple studies, but is still not completely understood. Most research addressing this pattern has focused on the differences between the two regions in ecological processes, diversification rates, and/or environmental variables. Recently, the tropical conservatism hypothesis was proposed as an explanation that combines ecological factors that are correlated with species richness patterns with the evolutionary and biogeographic processes that ultimately shape these patterns. In this paper, the authors present an empirical test for the three major predictions of the tropical conservatism hypothesis: 1) groups with high tropical diversity originated in the tropics and have dispersed to the temperate zones only recently, 2) dispersal of tropical groups in temperate areas is limited by their inability to tolerate freezing temperatures in the winter, and 3) a large number of extant groups originated in the tropics, because the tropics were more geographically extensive until ~30–40 millions years, when the temperate zones expanded. Phylogenetic analysis (based on combined mitochondrial and molecular data), ancestral area reconstruction (using parsimony and likelihood reconstructions), molecular dating methods (combining molecular branch length information and fossil calibration points, using penalized likelihood analysis) and ecological niche modeling (based on museum locality records and 19 climatic variables) were used to test these predictions in hylid frogs. Among other results, the authors found that hylids have low species richness in areas that have been colonized more recently, independently of whether those regions are tropical or temperate, supporting the time-for-speciation effect: more species accumulate in regions where a group has been present longer. No significant relationship was found between diversification rates in clades and the latitudinal midpoint of those clades. Also, they found that the northern limit ranges of many tropical clades converge in Middle America; however, the ecological niche modeling suggests that the climatic variable shaping geographical limits is not the extreme freezing temperatures, but the temperature seasonality over the year. The authors further discuss the extent and limitations of the tropical conservatism hypothesis and the caveats found based on their results.

WIENS, J. J., C. H. GRAHAM, D. S. MOEN, S. A. SMITH, AND T. W. REEDER. 2006. Evolutionary and ecological causes of the latitudinal diversity gradient in hylid frogs: treefrog trees unearth the roots of high tropical diversity. American Naturalist 168:579–596.

Correspondence to: John J. Wiens, Department of Ecology and Evolution, Stony Brook University, Stony Brook, New York 11794, USA; e-mail: wiensj@life.bio.sunysb.edu.

Evolution of Acoustic Communication in Amazonian Dendrobatid Frogs

Studies on the evolution of anuran communication have examined the relationship between calling features, geographic variation, receivers' (usually females) preference, and breeding success of the senders and receivers. However, before the receivers can react to a signal, it first must be detected over the background noise, and in species that breed together, heterospecific signals can be considered as masking noise. A possible outcome of the selective effects of masking interference is the spectral partitioning between calls of co-occurring species. Yet, masking interference depends not only on the call's frequency, but the range of sensitivity of the receiver. In addition, as body size constrains calling frequency, selection of call frequency can be confounded with selection on body size. To test the masking interference effects on communication traits, the authors studied the variation in the Amazonian frog *Allobates femoralis* in relation to the presence of *Epidedobates trivittatus* (which has a similar calling activity and an overlapping call frequency). Eight sites, four with both species present and four with only *A. femoralis* were studied in Brazil, Colombia, French Guiana, and Perú. To characterize calls, the authors recorded males of *A. femoralis* and all active species at each site and calculated temporal and spectral parameters for each population. To establish response-frequency curves, the authors recorded male *A. femoralis* phonotactic reactions towards conspecific synthetic calls representing variations in frequency of the average call of the population, but keeping the temporal properties constant. In addition, they examined the correlation between variation in communication traits of *A. femoralis* and the presence of acoustically coactive species, and studied the geographic covariation between call frequency traits, response-frequency traits and body size. The authors found that the occurrence of *E. trivitattus* was a significant predictor of the variance in the traits associated with the frequency-response curve: when *E. trivitattus* was present the curve was narrower due to an increase in the response low frequency and asymmetric due to a decrease in the response of the high frequency. In addition, the variation of the communication traits was not associated with the number of coactive species and the geographic covariation was correlated with call frequency or response-frequency range.

AMÉZQUITA, A., W. HÖDL, A. PIMENTEL LIMA, L. CASTELLANOS, L. ERDTMANN, AND M. C. DE ARAÚJO. 2006. Masking interference and the evolution of the acoustic communication system in the amazonian dendrobatid frog *Allobates femoralis.* Evolution 60:1874–1887.

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Color Variation and Alternative Reproductive Strategies in *Lacerta vivipara* Females

In reptiles, color variation within sexes is usually associated with the existence of alternative behavioral strategies in males, and with thermoregulation or predator avoidance in females. However, as females have been observed to play an active role in mate choice, it has been suggested that their differences in coloration might also reflect different reproductive strategies. The authors studied *Lacerta vivipara* females, which exhibit a ventral color variation ranging from pale yellow to bright orange. The population studied is located on Mont Lozère, Southern France, and is divided into two adjacent zones: one with high structural microhabitat diversity and high lizard density and the other with low structural diversity and low density. Females were captured annually from 1989 to 2002 and kept in the laboratory until parturition; weight and snout-vent length of females and hatchlings were recorded. Color phenotype was determined by comparison with a color reference and then confirmed using discriminant analysis based on several parameters measured with a spectrophotometer. Color variation throughout life and heritability of this variation were estimated, and reproduction success and survival were compared between phenotypes in relation to year of capture and density of each phenotype. Results show differences in clutch size, clutch hatchling success and clutch sex-ratio among females of different phenotypes. The authors discuss the diverse responses to density and environmental conditions and suggest alternative strategies that could maintain the color variation in females in this population.

VERCKEN, E., M. MASSOT, B. SINERVO, AND J. CLOBERT. 2007. Colour variation and alternative reproductive strategies in females of the common lizard *Lacerta vivipara*. Journal of Evolutionary Biology 20: 221–232.

Correspondence to: Elodie Vercken, Laboratoire d'Ecologie, Université Pierre et Marie Curie, Bâtiment A, 7 quai Saint Bernard, 75252 Paris Cedex 05, France; e-mail: evercken@snv.jussieu.fr.

Effects of Machinery and Modern Agricultural Practices on *Glyptemys insculpta*

The expansion of the agricultural frontier has reduced natural habitats and displaced many species, while many others have become an active part of the transformed landscape. Although disturbance-resistant species have persisted in agricultural landscapes for a long time, the introduction of modern machinery has created new threats for them. The authors studied the impact of current agricultural practices on *Glyptemys insculpta* turtles in 330ha that include deciduous forest, cattle pastures and crop fields in southern Québec, Canada. Turtles were captured during 1995, 1998–1999, and marked, aged, sexed, measured and photographed. Injuries on the limbs and carapace were recorded, and a carapace mutilation index is proposed to standardize and quantify severity of injuries. In addition, a total of 30 individuals were equipped with transmitters for radio-telemetry tracking; each turtle was located once or twice a week during the 1998–1999 period. Results indicate that turtles are being strongly affected by the new machinery as determined by the type and severity of the injuries found. Six of the 30 individuals tracked died as a result of agricultural activities. Estimated annual mortality rates for adults were 0.10 and 0.13, and for juveniles 0.18 and 0.17, for 1998 and 1999 respectively. Mutilation rates in the carapace reached 90±3%, while mutilation in the limbs reached 21.2%. Differences in carapace injuries were found between juveniles and adults, probably associated with differences in body size and habitat use. In addition, most of the injuries were found on the right side, probably related with habitat preferences and movement patterns. The authors argue that estimated mortality rates are evidence that the population is unsustainable in the long term and suggest that slight changes in the height of the machinery (disc mowers) used will not only make a significant difference in the effect of harvesting in turtles, but will also provide some benefits to agricultural production.

SAUMURE, R. A., T. B. HERMAN, R. D. TITMAN. 2007. Effects of haying and agricultural practices on a declining species: The North American wood turtle, *Glyptemys insculpta*. Biological Conservation 135:581–591.

Correspondence to: Raymond A. Saumure, Research Division, The Springs Preserve, 1001 South Valley View Boulevard, Las Vegas, Nevada 89107, USA; e-mail: insculpta@hotmail.com.

Back Issue Clearance for Publications of The Herpetologists' League

In an effort to reduce the need for storage space, The Herpetologists' League will be holding a clearance sale of back issues of its publications at the Joint Meetings in St. Louis in July 2007. Single issues of *Herpetologica* or *Herpetological Monographs* ($5°°) or complete volumes of *Herpetologica* ($20°°) will be available for purchase as long as supplies last. Only cash or checks (USD$, drawn from a US bank) will be accepted, and these sale prices are valid only when purchasing back issues in person at JMIH'07. Sale hours will be from 1330–1700 h on 12–15 July. Please contact Steve Mullin (<sjmullin@eiu.edu>) with any questions.

ZOO VIEW

Not every zoo keeper begins the day collecting rattlesnakes on the grounds of their place of employment. In this article by Jan Johnson on the Arizona-Sonora Desert Museum, one of her most interesting descriptions (in my view) is the remarkable number of rattlesnakes found over a fourteen year span (once, 177 snake encounters in a single year). What a wonderful setting for the zoo herpetologist.

Jan and I worked together at the Dallas Zoo years ago before she went to Arizona, but we never found a single rattlesnake on zoo grounds, even though Western Diamondback rattlers were relatively common in outlying areas at that time . . . no wonder she left for greener snake pastures!

Another interesting feature in Jan's article is the new daily venomous reptile presentation, which reminds me of the earlier exhibit at Tierpark Berlin-Friedrichsfelde in Germany. In 1956, the snake farm or vivarium opened, housing a large number of venomous snakes. Werner Krause started working at the Tierpark shortly after the building opened and was known as "Snake Farmer Krause." Krause accumulated many varieties of venomous snakes, some from his private collection, which were "milked" in front of zoo visitors (Fig. 1). This exhibit was unique in a zoological garden for it was a combination research center, educational display and venom extraction laboratory. The venoms extracted were made available for medical research at Leipzig University.



FIG. 1. "Snake Farmer" Werner Krause and wife Pia extracting venom from water moccasin or cottonmouth (*Agkistrodon piscivorus*) at Tierpark Berlin Snake Farm on 25 November 1959. Photograph by Gerhard Budich, courtesy of Falk Dathe and Gisela Petzold.

ADDITIONAL READING

DATHE, F. 1995. Die Amphibien- und Reptilienhaltung in 40 Jahren Tierpark (Care of amphibians and reptiles during 40 years in the Tierpark). Milu 8:307–325. [historical photographs of Pia and Werner Krause.].

ENGELMANN, W.-E., AND F. J. OBST. 1982. Snakes: Biology, Behavior and Relationship to Man. Exeter Books, New York. [story of Werner Krause (1905–1970), "snake farmer" at the Tierpark (p. 184).].

PEDERZANI, H.-A. 2000. Erinnerung an Werner Krause (1905–1970) (Commemoration for Werner Krause (1905–1970)). Milu 10:230–235.

PETZOLD, H.-G. 1971. WERNER KRAUSE. Aquar. Terrar. 18:57. [Werner Krause was born on 14 December 1905. He died on 28 October 1970.].

SCHEFFEL, S. 2001. Werner Krause (1905–1970). *In* W. Rieck, G. T. Hallmann, and W. Bischoff (eds.), Die Geschichte der Herpetologie und Terrarienkunde im deutschsprachigen Raum. Mertensiella 12:500–501. Deutschen Gesellschaft für Herpetologie und Terrarienkunde e.V. (DGHT).

—James B. Murphy, Section Editor

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Herpetology at the Arizona-Sonora Desert Museum

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The humble beginnings of the Arizona-Sonora Desert Museum (ASDM) originated with the visions of William Carr and Arthur Pack. Modeled after Bear Mountain State Park in New York, the Arizona Desert Trailside Museum, as it was originally named, was formally approved by the Pima County Board of Supervisors in March of 1952. Carr's appeal to the board stated his desires for this new museum: "…To establish Tucson Mountain Park and the buildings known collectively as 'The Mountain House' as a leading educational center for the purpose of acquainting the public with their rich but vanishing heritage in wildlife, plant life and scenic values, to the end that, through knowledge, will come appreciation and a better attitude toward all resource conservation …" (Carr 1982). The museum opened Labor Day weekend 1952. A binational institution focusing on the plants, animals, geology, and people of the Sonoran Desert, ASDM flies the national flags of Mexico and the United States at the entrance to illustrate the concept that the Sonoran Desert knows no political boundaries.

Facilities.—The original 'Mountain House' buildings, built and funded by the federal government's Civilian Conservation Corps and Works Progress Administration during the 1930's, consisted of a main building, a small house and a stable. By 1952, these buildings, formerly used for overnight camping by church groups and scout troops, had become termite ridden and dilapidated. Prior to opening day, the lounge of the 'Mountain House' was repaired and became the small animal exhibit room. It is still home to the main reptile exhibit area, although reptile and amphibian exhibits are found throughout the grounds. The original wooden, top-opening exhibit enclosures that were hurriedly built during the five months prior to the grand opening continue to house exhibit specimens to this day. For many years, adjoining areas to the main exhibit hall served as reserve holding for reptiles and invertebrates.

Since 1952 numerous new reptile and amphibian exhibits have been added. In 1953 fiberglass dioramas were incorporated into the small animal exhibit room. These dioramas depict Sonoran Desert scenes and include innovative burrows for bi-level viewing of the enclosure residents. These large dioramas sit on wheeled dollies and can be pulled away from the wall for servicing. Additionally, the hinged lobby wall can be opened to allow the diorama to be wheeled outside for extensive cleaning.

Opening in 1957, a 46-m long exhibit area, called "The Tunnel," allowed visitors to walk along an underground path to view "where the animals go when it gets too hot to be outside." Visitors

could peer at rattlesnakes face-to-face as the ophidians sought shelter in packrat middens. The tunnel closed in 1978, reopening after renovations were completed in 1989.

Unheard of in 1958, because amphibians were rarely exhibited in zoos, an amphibian room opened in another of the 1930s-era Mountain House buildings. Utilizing the best in museum and zoo exposition techniques, a variety of toads, frogs, and salamanders resided in beautiful dioramas, with painted backdrops, constantly circulating water and simulated rocks and plants. The four large amphibian dioramas represent different Sonoran Desert aquatic environments: temporary rain pool, permanent pond, Mexican river and canyon stream. Always pushing the innovation envelope, these unique, glass-fronted dioramas sit on fixed bases and have hydraulically controlled walls. To service an enclosure, a flip of a switch raises the entire semi-circular back of the diorama!

In addition to the above exhibit halls, there are several large outdoor reptile enclosures. One such enclosure houses the Desert Tortoise (*Gopherus agassizi*). Another enclosure, the showpiece exhibit at the museum's front entrance, contains several native lizard species. The lizards are quite active and provide ample opportunity for interpreting lizard behavior to the visiting public. They readily breed in this enclosure.

In the early 1990s a new master plan was created. This plan focused on representing the different habitats within the Sonoran Desert. The first of these habitats opened in 1992 and illustrates a desert grassland. While there are cages for prairie dogs and burrowing owls, the bulk of the enclosures house reptiles and amphibians, including: Mojave Rattlesnake (*Crotalus scutulatus*), Prairie Rattlesnake (*C. viridis viridis*), Desert Massasauga (*Sistrurus catenatus edwardsi*), Common Kingsnake (*Lampropeltis getula*), Desert Box Turtle (*Terrapene ornata luteola*), Tiger Salamander (*Ambystoma tigrinum*), and Green Toad (*Bufo debilis*).

Through a generous donation from the Olsen family, in memory of their son Glenn Charles Olsen, an off-exhibit facility was built in 1998 to house reptiles, amphibians, fish, and invertebrates. This modern facility has rooms along the eastern wall equipped with ultraviolet penetrating glass to provide ultraviolight light for the animals (Fig. 1). It also has a quarantine wing with separate air ventilation for each room. The Olsen building has ample room for holding reserve exhibit specimens and is spacious enough for breeding groups of animals as well as the accommodation of small research projects. Behind the Olsen building are numerous, large breeding enclosures for species such as Tarahumara Frog (*Rana tarahumarae*), San Esteban Chuckwalla (*Sauromalus varius*), and horned lizards (*Phrynosoma* spp.).

With a planned opening in Fall 2006, "Life-on-the-Rocks" will focus on the plants and animals of the Arizona Upland subdivision of the Sonoran Desert. Several large enclosures in this exhibit are outdoor, open-air enclosures with glass fronts. A few species to look for include, but are not limited to: Western Diamondbacked Rattlesnake (*Crotalus atrox*), Tiger Rattlesnake (*C. tigris*), Black-tailed Rattlesnake (*C. molossus),* and Western Lyresnake (*Trimorphodon biscutatus*). One large enclosure will have Gila Monster (*Heloderma suspectum*), Coachwhip (*Masticophis flagellum*), and Gophersnake (*Pituophis catenifer*).

Animal collection.—Animal records dating back to ASDM's first few years are scant. Carr (1982) stated that of the 35 animals exhibited on opening day, it was heavy on the side of reptiles. By



FIG. 1. Reptile holding room in Olsen Building, 2005.

ASDM's second anniversary, 80 reptiles were on exhibit. In the early years Chuck Lowe, Merv Larson, and Bill Woodin were responsible for collecting many of the reptiles, and donations from the public were widely accepted as well. For an institution focusing on the Sonoran Desert, it is odd that historical records show the following animals entered the collection at one time or another: Lance-headed Rattlesnake (*Crotalus polystictus*), Copperhead (*Agkistrodon contortrix*), Texas Tortoise (*Gopherus berlandieri*), and American Alligator (*Alligator mississippiensis*). It is unknown what became of these specimens. Several ASDM specimens may represent longevity records. One wild-caught Filetailed Snake (*Sonora aemula*) lived nearly 17 years, a wild-caught Mexican Rosy Boa (*Lichanura trivirgata trivirgata*) lived slightly over 33 years, and a wild-caught Western Green Toad (*Bufo debilis insidior*) lived 17 years. One captive born Sinaloan Milksnake (*Lampropeltis triangulum sinaloae*) lived for 30 years. Over the years the collection has grown from 97 reptiles and 13 amphibians in 1959 to its current size of 81 reptile species (464 specimens) and 21 amphibian species (112 specimens).

Because of constraints placed on the disposition of surplus animals by both the American Zoo and Aquarium Association (AZA) and the Arizona Game and Fish Department (AGFD), the ASDM staff only attempts to reproduce species where there is a demand for the offspring. In 1958 ASDM had the first known captive reproduction of a "coral kingsnake" (presumably a Sonoran Mountain Kingsnake, *Lampropeltis pyromelana*). In 1981, a reproduction program was initiated for the insular chuckwallas found in the Sea of Cortez, with a primary focus on the San Esteban Chuckwalla (*Sauromalus varius)* resulting in over 200 hatchlings. Although some hatchlings did not survive for long, many were sent out on loan to other institutions. Since 1990, ASDM has had reproductive success with several rattlesnakes including: Western Twin-spotted Rattlesnake (*Crotalus p. pricei*), Banded Rock Rattlesnake (*Crotalus lepidus klauberi*), Northern Black-tailed Rattlesnake (*Crotalus m. molossus*), and Arizona Black Rattlesnake (*Crotalus viridis cerberus*).

Staff.—Stewart Thomas served as Curator of the Small Animal Department (SAD) in 1959, leaving two years later for college. Hired, at the age of 17, to care for the fish, arachnids, and reptiles, Merritt Keasey was ASDM's youngest employee during its first year of operation (Fig. 2). Keasey left ASDM in 1954 to work at Cobra Gardens in New Mexico, returning after Thomas' departure to become ASDM's SAD Curator until retiring in 1979. Serving as Keasey's assistant, Steve Prchal worked from 1970 until 1985, when he resigned to run Sonoran Arthropod Studies Institute (SASI). Arriving in 1980, Howard Lawler, previously of Knoxville Zoo and Zoo Atlanta, took over as Curator of SAD. Lawler was instrumental in establishing accurate record keeping policies, as well as initiating captive breeding programs with insular chuckwalla species. Lawler departed the museum in 1996. Hugh McCrystal, a former keeper at the Bronx Zoo, arrived in 1985 for the position of Keeper Supervisor. When Prchal left the museum, McCrystal accepted the position of Assistant Curator. Upon McCrystal's departure from the museum in 1991, Craig Ivanyi took over as Assistant Curator. At Lawler's parting, Ivanyi became departmental curator. In 1997, the ichthyology and invertebrate zoology portion of the department became a separate department, rejoining herpetology in 2002, when the department was renamed Herpetology, Ichthyology and Invertebrate Zoology (HIIZ). As HIIZ Curator, Ivanyi has been instrumental in establishing numerous departmental research projects and collaborative projects with outside institutions. Currently, Ivanyi serves as both HIIZ Curator and General Curator for the entire museum.

The current HIIZ staff is composed of five highly trained keepers coming to ASDM from many other zoological institutions. They are: Warren (Ken) Wintin (Jacksonville and Knoxville Zoos), Renée Lizotte (Columbus Zoo), Janice Johnson (Dallas and Audubon Zoos), Bill Altimari (Philadelphia Zoo), and Stéphane Poulin (Ecomuseum, Montreal, Canada). ASDM does not have a staff veterinarian. However, the contract veterinarian for the herpetological collection, since 1979, is Dr. James Jarchow. Prior to veterinary school, Jarchow worked as a herpetology keeper under Louis Pistoia at the Columbus Zoo.

Although venomous reptile bites are rare in zoological institutions, ASDM has had two venomous reptile bites in its history. The first bite, in September 1953, was from a Gila Monster (*Heloderma suspectum*). The victim reported that he sat down, applied suction and liberal amounts of ice to the bite site, and took copious notes on the bite's symptoms. The second bite, in June 1994, was from an Arizona Black Rattlesnake (*Crotalus viridis cerberus*). Suction was applied to the bite site and the victim was transported to the nearest hospital. Neither bite had any long-term effects other than acute embarrassment on the victim's part.

Programs.—As a service to the Arizona Game and Fish Department, ASDM coordinates a "Tortoise Adoption Program" for southern Arizona. This program focuses only on the Desert Box Turtle (*Terrapene ornata luteola*) and the Desert Tortoise (*Gopherus agassizi*). Protected in 1989, it is illegal to collect Desert Tortoises. However, there are many "grandfathered" (pre-legislation exemption) tortoises in captivity born to "grandfathered" tortoises which need homes. To this end ASDM assists with the transfer of these unwanted or surplus captive tortoises to qualified private custodians. The tortoises remain the property of the State of Arizona.

In 1998, as an across-the-border educational outreach, Poulin and Ivanyi worked with the Seri Indians of Sonora, Mexico, to build an enclosure for San Esteban Chuckwallas in their native village of Punta Chueca in Sonora, Mexico. The enclosure assists the Seri in teaching their children about their cultural history as well as to encourage ecotourism in their impoverished village. The enclosure has been quite successful for breeding chuckwallas, however it is not known whether it has attracted visitors to their village.



FIG. 2. Merritt Keasey with Gila Monster, circa 1975.

As stated earlier, education has always been a primary focus of ASDM. While many of the early education programs focused on the desert and its inhabitants at large, reptiles were frequently represented. The first of these early educational outreach programs was a television show, *Desert Trails*, which first aired in 1953. This show, hosted by ASDM employee Hal Gras, featured residents of the Sonoran Desert, many of them reptiles, and continued until 1985. For several decades Gras, and his Desert Ark, made frequent visits to local classrooms. He was instrumental in introducing generations of Tucson school children to reptiles. To this day, the name Hal Gras is synonymous with the desert museum among native Tucsonans. For many years a weekly column in the Tucson newspaper featured ASDM mascot George L. MountainLion, Research Associate in Human Behavior. Readers could write to George asking questions concerning the desert and its inhabitants. His column, simple and straightforward, was initially ghost written by Carr, with the task taken on by other staff as time went by.



FIG. 3. Janice Johnson giving "Live and *sort of* on the Loose" presentation, 2005.

In keeping with its education focus, the HIIZ department takes rattlesnakes and gila monsters, as well as arthropods, on the road to many different venues. Most notable of these is the yearly safety day at Fort Huachuca Military Base. Tens of thousands of army personnel get a close up view of the rattlesnakes occurring on the base.

On Labor Day weekend in 2003, the exciting new daily venomous reptile presentation "Live and *sort of* on the Loose" (LOTL) made its debut (Fig. 3). This hour long presentation gives ASDM visitors a close-up view of venomous reptiles supplemented with a lecture about their biology, natural history, venom, and snakebite. This sometimes humorous, sometimes serious, show features a helodermatid (either Gila Monster or Beaded Lizard) and two rattlesnake species. LOTL is extremely popular, with over 200 attendees daily during peak season.

Publications.—ASDM administers three AZA North American Regional Studbooks. Janice Johnson and Craig Ivanyi are co-studbook keepers for the Mexican Beaded Lizard (*Heloderma horridum*). Janice Johnson is also the studbook keeper for the Arizona Ridge-nosed Rattlesnake (*Crotalus willardi willardi*). Stéphane Poulin is the studbook keeper for the San Esteban Chuckwalla (*Sauromalus varius*). The Bibliography details much of the staff-authored publications in recent years.

Research.—The natural desert setting at ASDM is home to several rattlesnake species. The public and staff encounter rattlesnakes every year on grounds, with 25 rattlesnakes encountered on grounds during the first year of operation. Luckily no guest has been bitten while visiting, including those visitors who actually stepped on rattlesnakes! When the public encounters rattlesnakes on the paths HIIZ staff frequently hear comments about our 'loose snakes' or, as a visitor once stated, " . . . that rattlesnake on the walk. It looked just as if it were real!" (Carr 1982). Whenever a rattlesnake is spotted on the grounds, staff members remove the snake. Records dating back to 1967 show rattlesnakes were identified by species and capture date prior to being moved out of harm's way. In 1991, a more thorough study was initiated where all rattlesnakes are identified, sexed, measured, and marked with a unique identification number. Techniques for marking the snakes varied over the years from scale clipping in the early years, to inserting PIT-tags in later years. All Western Diamond-backed Rattlesnakes and Mojave Rattlesnakes have their tail band patterns photocopied. For quick visual recognition, all rattlesnakes initially have the three anterior rattle segments painted with their unique ID number according to a color-coded system, whereby each color represents a number (0–9). This also provides information about shedding frequency as the painted segments move down the rattle with each successive shed, necessitating repainting the ID number on occasion. Capture location and date are recorded prior to release at a designated release area. Release sites varied over the years. Early in the study, release sites ranged from on property in non-public areas to 3.5 km away from grounds. Current protocol divides the grounds into four quadrants. When a rattlesnake is found in one quadrant, it is released in non-public areas within the same quadrant. Since 1991, the four species encountered are: Western Diamond-backed Rattlesnake (*Crotalus atrox*), Tiger Rattlesnake (*C. tigris*), Black-tailed Rattlesnake (*C. molossus*), and Mojave Rattlesnake (*C. scutulatus*). Snake-human contacts on grounds have numbered as high as 177 encounters a year by visitors and staff, with some individual snakes captured 35 times over the years (Fig. 4). Snakes originally captured in 1994 are still encountered. In 2005, several male *C. atrox* were fitted with radio transmitters and are tracked several times a week. Radio implanted snakes move on and off grounds at their own discretion with the most movement seen during the warmer months of the year. They have been observed out in the open, basking on winter days.

Another research project involves an introduced population of Spiny-tailed Iguanas (*Ctenosaura hemilopha*) on ASDM grounds. During the mid 1970s, staff released approximately seven lizards at the bighorn sheep exhibit. Since 1998, a volunteer staff of trained 'lizard-watchers' walk the grounds and areas adjoining the grounds, several times a week to identify all native lizards and Spiny-tailed Iguanas they encounter. These volunteers document all lizards observed on-and-off grounds. Blood for genetic analysis was also taken from several iguanas. This study is intended to demonstrate whether or not the lizards have become established into the surrounding desert, as well as determine the relatedness of the population. The lizard watchers have noted approximately 30 *C. hemilopha* currently living on grounds, however, none has been observed roaming significant distances off grounds.

The ASDM is involved with a conservation project on



FIG. 4. Stéphane Poulin and crowd around wild Western Diamondback Rattlesnake, 2005.

Tarahumara Frogs (*Rana tarahumarae*), a species extirpated from Arizona in the early 1980s. As part of a multi-agency reintroduction program begun in 1992, ASDM was critical in hatching egg masses brought from Mexico, raising them to adulthood, and subsequently breeding the adult frogs. In spring 2005 tadpoles, froglets and adult frogs raised at ASDM were released into the Santa Rita Mountains of southern Arizona. Observations the following year at the same time indicate the introduced population survived the horrific Florida fire that burned 23,183 acres in the Santa Rita Mountains during July 2005 and the anurans appear to be reproducing.

In conjunction with the beaded lizard studbook, Johnson and Ivanyi have been assisting Dr. Michael Forstner, of Southwest Texas University, in a genetic analysis to determine the subspecific status of the captive beaded lizard population. Initial results have been surprising, with *Heloderma horridum* subspecies showing a greater genetic diversity than *Cyclura* species.

The HIIZ staff assists with outside research requests when feasible. We have supplied *Crotalus* and *Heloderma* venom, as well as blood and shed skins for genetic research.

Acknowledgments.—I thank Peggy Larson for her stories about the early days of the desert museum and her assistance in locating historical photographs. Thanks also go to Craig Ivanyi for compiling a list of staff members and employment dates. Finally, I am grateful to the herpetology staff for providing the recent photos accompanying the article.

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LETTERS TO THE EDITOR

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Editorial Linguistic Deficiency Causes a Superfluous Nomen Nudum in the Gekkonid Genus *Ptyodactylus* (Squamata: Gekkonidae)

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In his "Gekkotan lizard taxonomy" Kluge (2001) listed not only all species names of gekkotan lizards but also included an alphabetical listing of all the authors of these names. Recently, I happened across the citation of Leptien (1996:20) as the author of *Ptyodactylus keinerlei*, which was considered a nomem nudum referring to *Ptyodactylus hasselquistii* Donndorff, 1798 (Kluge 2001:124). The cross-reference (Kluge 2001:54) reads: "*keinerlei* [n.n.] Leptien 1996 (see *Ptyodactylus hasselquistii* Donndorff, 1798)."

I was surprised by this obviously invalid species description because I have long known Rolf Leptien as an expert of lizards of Africa and the Middle East. Moreover, the name "*keinerlei*" is a German word meaning "not of any sort, not any." Because I could not imagine Rolf Leptien applying such a strange and senseless name, I referred to his 1996 article (which deals with the natural history and husbandry of Arabian leaf-toed geckos, genus *Asaccus*) and found the sentence: "... no difficulties arose when the *A. elisae* were housed in terraria with the larger *Ptyodactylus keinerlei*" (p. 20). Still, no sense emerged from this sentence upon which I asked the author directly. He was absolutely surprised because he was never told by the respective journal (*Dactylus*, now defunct, but then published by the International Gecko Society) that this article had been published. It was in 1994 that he had submitted a short report on *Asaccus* in the United Arab Emirates. He was told by the editor that he could submit a manuscript written in German because it would be translated into English by the journal's staff. The original German version of the respective sentence reads: "Terrarienversuche ergaben, dass sie sich auch mit dem im gleichen Biotop lebenden, größeren *Ptyodactylus hasselquistii* ausgezeichnet vertragen, auch hier kam es zu **keinerlei** Aggressionen." The correct translation is: "Terrarium experiments revealed that they were excellently sociable with the syntopic, larger *Ptyodactylus hasselquistii*; also here, **not any** aggression occurred."

This brief note aims (1) to clarify the origin of the presumed species name "*keinerlei*," (2) to note that it was not Rolf Leptien's fault to have become the involuntary author of a new albeit invalid gekkonid name, and (3) to emphasize that pet journals like *Dactylus* should maintain minimum editorial standards when handling scientific names.

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ARTICLES

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Breeding Behavior of the Cane Toad *Bufo marinus* (Bufonidae): A Successfully Invasive Species

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Habitat destruction and invasive species are the most important threats to native biodiversity. However, invasive species also provide one of the few opportunities to see population establishment in nature. Thus, the study of ecological and behavioral characteristics of invasive species can provide useful information for increasing the effectiveness of control strategies while also providing an opportunity to study basic aspects of population and evolutionary biology (Sakai et al. 2001).

The Cane Toad, *Bufo marinus* (Amphibia: Anura: Bufonidae), has been introduced in several countries around the tropics for the control of insect plagues in agriculture yet has resulted in negative impacts to native fauna (Lever 2001). For example, native populations of snakes and birds in Australia have declined or disappeared following the expansion of *B. marinus*. These predators are possibly being poisoned when they prey upon this introduced toad (Lever 2001, 2003). However, *B. marinus* also offers an excellent opportunity for understanding the population and evolutionary dynamics of invasive species. This is due to: 1) the history of *B. marinus* invasions is known (date, number, and origin of

individuals introduced; Easteal 1981; Lever 2001); 2) aspects of its natural history and demography have been studied both in native and introduced populations (e.g. Lever 2001; Zug and Zug 1979); and 3) *B. marinus* is relatively abundant and easy to see, catch, and mark for monitoring.

Knowledge of the breeding behavior of *B. marinus* is largely anecdotal (except see Lee 2001; Lee and Corrales 2002). These accounts lack information on sex ratio in breeding aggregations, mating patterns, and female mate selection. Understanding these aspects is important because they affect the direction and strength of sexual selection, including the quality/quantity of offspring produced, genetic variation, population growth rate, and evolutionary dynamics of populations (Blumstein 1998; Caro 1998; Parker and Waite 1997). I studied an invasive population of *B. marinus* in a permanent pond located in northwestern Puerto Rico, West Indies. My aims were: 1) describe the breeding behaviors of males and females; 2) investigate potential mating patterns; and 3) assess relationships between toad body size and clutch size and fertilization success.

Materials and Methods.—I conducted the study in a permanent pond located in the municipality of Quebradillas, northwestern Puerto Rico (18º25.113'N; 66º54.266'W). The pond was in a grassy area, but bordered by a 4–6 m margin of high-density shrubs. Only in the southern part of the pond was the shrub margin wider (up to 20 m), where it connected to a farm with diverse second growth trees. The size of the pond varied with rainfall from <100 m^2 to >500 m^2. When the pond was small, there was a mud bank between the water's edge and the shrubs. When the pond size increased, the mud bank was submerged and the water extended several meters into the shrubs. The mean precipitation in the study area is >1500 mm/year, with the highest rainfall occurring in April–May and August–November.

From March 2003 to April 2004, except in January and February 2004, I made one or two visits per month to the study area to assess breeding activity. I also assessed breeding in May and August 2004. During wet seasons, I monitored rainfall in the study area through the web page <www.wunderground.com>. When there was heavy rain (radar reflectivity > 40 dBZ; estimates of rainfall > 75 mm/h; see web page for details), I went to the study area. During site visits I looked for breeding events (males in the pond, arriving females) and made behavioral observations.

During nights with breeding events, I first divided the pond into eight sections of similar shore length. These sections were useful to record abundance of males around the pond, and location of mating pairs and oviposition. Because the pond size was variable, those sections were redetermined on each breeding event by using several points of reference with known distances. Second, I walked along the shoreline of the pond recording a visual count of the number of individuals per pond section. Third, I caught cane toads, marked them by toe clipping, measured snout-vent length (SVL), recorded sex, and released them in pond section of capture. Lastly, I made behavioral observation for the remainder of the night.

I made behavioral observations from static points and from walks around the pond (2–4 per hour). It was possible to see most breeding individuals from any place in the shoreline of the pond. Because *B. marinus* is a large toad and its eyes turn red and conspicuous with the headlamp light, it was easy to observe individuals swimming, calling, and clasping. I captured pairs to establish their identity and sizes for mating pattern assessments.

I investigated two potential mating patterns, size-dependent mating and size assortative mating (Arak 1983), and spatial patterns of breeding toads among pond sections. First, I examined size-dependent mating by comparing the number of mating and non-mating males between small and large SVL categories per breeding event using a Fisher exact test. Small and large male size categories were determined using the median SVL of all males per breeding event as a cutoff point between small and large. While a greater number of male SVL categories can give more accurate results (Sullivan 1983), few females arriving to mate in each breeding event supported the use of two categories in my study. Second, I examined size-assortative mating by SVL with a Spearman correlation. To see if males aggregated in certain pond sections during breeding, the spatial distribution of males (number of calling and non-calling males) around the pond was analyzed per breeding event using chi-square test. Similarly, to examine whether pairs in amplexus or clutches were aggregated, the numbers of pairs and oviposition episodes in each pond section were analyzed with chi-square tests, pooling the records of all breeding events.

Toad SVL also was examined relative to clutch size and fertilization rate. To examine for a relationship between female SVL and number of eggs oviposited, clutch sizes were counted from six mating pairs collected in a breeding event and put inside containers (45 × 44 × 42 cm of high) with 18 L of water, and regression analysis was conducted. I assessed fertilization rate of mating pairs observed in oviposition in the pond by recording the identity and SVL of mating pairs and flagging their oviposition location. Eggs of each pair were allowed to develop for 24–36 h. Then, I recorded the number of embryos and the number of non-fertilized eggs in a random sample of ± 1000 eggs per clutch. Regression was used to assess relationships between the ratio of male to female SVL and fertilization success, and male SVL and fertilization success. All analyses followed Sokal and Rohlf (1981) and Zar (1999), using STATISTICA (StatSoft Inc., 2000; available at <http://www.statsoft.com> and Statistix (Analytical Software, 1996; available at <http://www.statistix.com>).

Results.—I recorded six breeding events (Table 1); each lasted only one night and occurred after heavy rains, especially at the beginning of wet seasons (March–May and August). Males were abundant during breeding events (23–52 individuals), but on other nights none or very few (1–7 males) were observed around the pond. Females were only present during breeding (Table 1), however on 16 September 2003, I recorded one pair (SVL male: 100 mm, SVL female: 134 mm). There was no evidence (heavy rains, clutches, tadpole congregations) suggesting I missed a breeding event during the period of study. During breeding events, males were observed for the first time from 1900 h, while females were observed from 2000–2330 h, with most of them in amplexus. The breeding event sex ratio was male biased (3.25 to 11.5, Table 1). One male (SVL = 120 mm) mated twice but not in a same breeding event (events 24 and 31 August 2003), and one female (SVL = 129 mm) mated twice (events 24 August 2003 and 20 April 2004).

Males exhibited behavioral plasticity between breeding events (Table 1). When the pond was small (~100 m^2), with a mud bank between the water's edge and the shrub vegetation, the males exhibited scramble competition. Males actively searched for mates, either swimming or jumping on the mud bank. Males seemed to

TABLE 1. *Bufo marinus* breeding events observed in Puerto Rico, West Indies. Each breeding event lasted one night.

Date	Pond size (m^2)	Male behavior	No. males	Mean male SVL ± SD (mm)	No. females	Mean female SVL ± SD (mm)	Male distribution around pond
9 March 2003	~170	Chorus	39	113.4 ± 7.52	8	127.6 ± 8.90	$\chi^2 = 25.6$; P < 0.01
24 August 2003	~100	Scramble	43	113.5 ± 7.86	7	122.0 ± 14.78	$\chi^2 = 6.30$; P < 0.50
31 August 2003	~190	Chorus	40	114.7 ± 7.92	8	135.5 ± 14.10	$\chi^2 = 11.8$; P < 0.10
20 April 2004	~220	Chorus	35	115.4 ± 8.84	5	132.8 ± 5.97	$\chi^2 = 12.30$; P < 0.09
7 May 2004	~160	Chorus	23	114.9 ± 7.91	2	132.5 ± 0.71	$\chi^2 = 12.11$; P < 0.10
13 August 2004	~130	Chorus-active searching	52	116.60 ± 8.74	16	129.88 ± 15.40	$\chi^2 = 4.62$; P > 0.71

be alert to any movement or vibration source close to them. When unpaired males detected a movement, they usually jumped or swam vigorously and attempted to clasp its source. Males clasped tree trunks, mud monticules, turtles, a dead female bullfrog (*Rana catesbeiana*) and swam to clasp birds on the water surface. The interaction between males was frequent, but clasping quickly ended when the male being clasped gave a release call. I conducted several tests which consisted of hitting the ground, moving the water and/or touching the males with my hand and several inanimate objects; males reacted quickly to approach and clasp. Occasionally, a few males (up to 6) gave advertisement calls from the edge of the pond, but only for a few minutes before stopping. During these scramble competition breeding events, the number of males per pond section followed a random pattern (Table 1).

Females arriving at the pond during scramble competition were detected and clasped as soon as they entered the water. I observed several males (up to 5) struggling for the possession of a female and those females trying to move away from the pond (Fig. 1). Unpaired males often tried to dislodge an amplectant male, but most were left behind when the females reached the shrub around the pond. Later, these pairs were immobile among stems and roots of the bank vegetation for the rest of night. The pairs remained among vegetation without going back to water for oviposition until I collected pairs at 0430–0530 h for placement into containers and determination of clutch size counts.

When the pond increased in surface area (>100 m^2), the mud bank was flooded and the water penetrated into the abundant vegetation surrounding the pond. Male searching behavior appeared disrupted by shrub vegetation along this wetted shoreline. Some males (up to 9) formed choruses that persisted for several hours during the night. These calling males were located on mounds of leaves and branches, separated from one another by > 2 m. I did not observe agonistic interactions between males for a calling place. Most males were non-calling; they were floating in the water, but with a tendency to be in the same portion of the pond as calling males (Table 1, nonrandom spatial distribution of males was observed).

The interaction between males was reduced in breeding events with choruses. Males appeared to be much more discriminating about what they clasped; in no case was a male clasping an inanimate object. I conducted the same series of tests with males in these breeding events, but males never responded by clasping objects. The SVL of calling males tended to be larger than that of non-calling males (Table 2). Pairs were observed immobile on the ground or in the water within emergent vegetation; this behavior was contrary to that recorded in scramble breeding events in which the females left the pond rapidly after being clasped. Displacements attempts were rarely seen and were always unsuccessful. Pairs were recorded in oviposition by 0430 h, and most were in the same pond section as the initial pairing record. Overall, there was no particular section of the pond with a disproportionate number of pairs ($\chi^2 = 2.248$; P = 0.938) or clutches ($\chi^2 = 1.579$; P = 0.979).

The scramble behavior and chorus formation were two extremes of a behavioral continuum in male *B. marinus*. An intermediate behavior was recorded on 13 August 2004. During this breeding event, some males formed a chorus (9 males) and others (43 males) were in the water actively searching but without a scramble behavior characterized by frequent male-male interactions and misdirected male clasping of various objects (Table 1). Also, in contrast to the other breeding events with chorus formation, the number of males among pond sections followed a random pattern (Table 1).

Size-dependent mating and size-assortative mating were not observed during any breeding event (Table 3). Large female *B. marinus* produced more eggs than small females (Y = -15390 + 206X; N = 6; r = 8.4; P = 0.023). The ratio of male to females sizes within pairs did not affect fertilization (Y = -0.9011 x + 100.15; R^2 = 0.029; F = 0.42; P = 0.528; Fig. 2a), and male SVL did not affect fertilization rate (Y = -0.0142x + 101; R^2= 0.015; F = 0.22; P = 0.649; Fig. 2b).

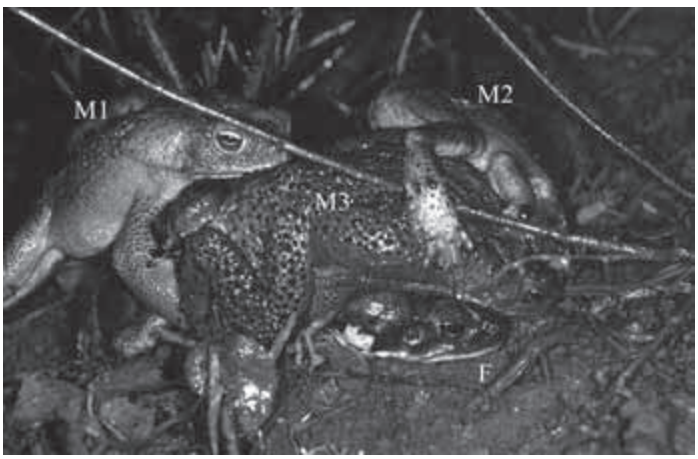


FIG. 1. Mating struggles in *Bufo marinus*. Three males (M1, M2, and M3) compete for a gravid female (F).

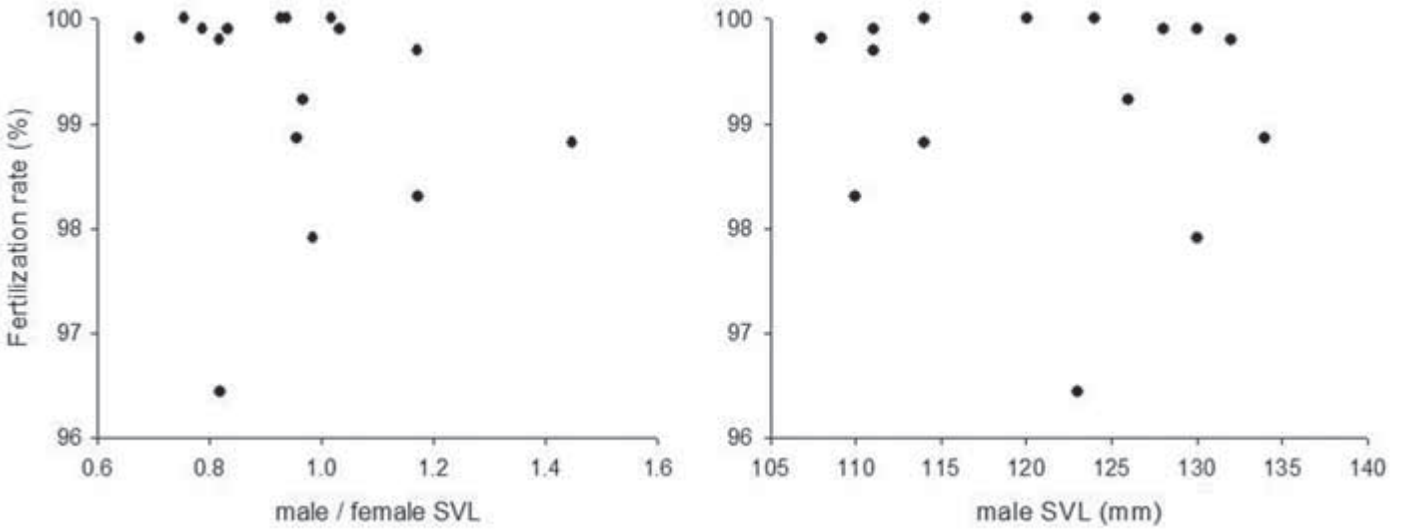


FIG. 2. The ratio of male to female body size (A) and male body size (B) did not appear to affect egg fertilization success in *B. marinus (*N = 16).

Discussion.—In anurans, when the density of males is high and arrival of females is synchronous, the active searching for mates by males appears to be favored (Arak 1983). Under these conditions, the strategy of calling from stationary places may produce very little or no reproductive success because active males intercept females and the advantage of first encountering a female likely outweighs the disadvantage of clasping mistakes (Arak 1983; Wells 1977). Males, however, may change their mating strategies from scramble to chorus formation if they experience a reduction in density (e.g., *Bufo calamita*, Arak 1988a,b; *B. bufo*, Hoglund and Robertson 1987; *B. americanus*, Sullivan 1992; *Rana sylvatica*, Woodbright et al. 1990). In my study, males were not dispersed when the pond increased in size (Table 1). Thus, a reduction in density is not likely the main factor promoting the change in behavior of males in this population; the vegetation around the pond appears to play a more important role. Calling may be favored rather than searching actively among barriers imposed by the vegetation. Other studies also point out the role of vegetation in different aspects of the mating behavior of anurans (Arak 1988a; Gerhardt 1994; Wells and Schwartz 1982).

Explosive breeding in anurans such as *B. marinus* imposes limits to male and female behavior that affect their reproductive success (Emlen and Oring 1977; Sullivan et al. 1995). In explosive breeders, males mate simultaneously. Hence, the rapid acquisition of females is crucial for male reproductive success and it is not expected that male *B. marinus* discriminate among females to further increase their fitness, such as searching for larger females with more eggs (Arak 1983; Wells 1977). Similarly, an abundance of single males actively clasping moving objects likely results in few opportunities for females to select particular males as mates (Sullivan et al. 1995). In summary, time restrictions and male-biased sex ratios during breeding events of *B. marinus* may explain the non-random mating and the non-assortative mating by size I found, and limits the opportunity for a male to mate many times. Also, male-biased breeding congregations promote a strong intra-sexual competition among males, which may promote diverse male mating strategies (Halliday and Tejedo 1995). In *B. marinus*, those strategies were associated with male spatial distribution patterns around the pond: scramble behavior (random distribution), chorus and non-calling males (aggregated distribution).

Displacement of paired males by single males is common in species of the genus *Bufo* and could produce a change from random mating to non-random mating (Lamb 1984, Halliday and Tejedo 1995). According to Lee (2001) and Lee and Corrales (2002), amplexus displacements in *B. marinus* are commonly successful and can produce non-random mating; however, commentaries by Savage (2002) suggest the contrary. Differences in breeding environment may reduce the success of amplexus displacements in *B. marinus* and thus, reduce consequent effects on mating patterns. While my results do not show a large male mating advantage in *B. marinus*, there was a tendency (P = 0.1) for non-random mating in the breeding event with scramble behavior, which is attributed to successful displacement performed by two large males (Vargas 2005a). In contrast, when pond size was large (>100 m^2) females in amplexus appeared to easily avoid intruder males by diving bellow the surface of the water, and moving in the emer-

TABLE 2. Body size, mean SVL ± SD (N), of calling and non-calling male *Bufo marinus* at a pond in Puerto Rico, West Indies. There are no data for the 24 August 2003 breeding event because the males were in scramble competition and calling males were intermittent.

Date	Male SVL (mm)		Student's t-test
	Calling	Non-calling	
9 March 2003	116.4 ± 10.26 (7)	112.8 ± 6.82 (32)	t = 1.149, P = 0.257
24 August 2003	—	—	—
31 August 2003	118.8 ± 6.85 (9)	113.6 ± 7.91 (31)	t = 1.787, P = 0.082
20 April 2004	118.9 ± 8.26 (8)	114.39 ± 8.89 (27)	t = 1.272, P = 0.212
7 May 2004	121.4 ± 9.32 (7)	112.6 ± 6.32 (16)	t = 3.043, P = 0.116
13 August 2004	122.1 ± 8.06 (9)	115.6 ± 8.56 (43)	t = 2.002, P = 0.050

TABLE 3. No size-dependent mating patterns were observed for *Bufo marinus*. There is no analysis for the 7 May 2004 breeding event because only two pairs were recorded.

Date	Median male SVL (mm)	No. small males		No. large males		Size-dependent mating (Fisher Exact test)	Size-assortative mating (Spearman correlation)
		Paired	Unpaired	Paired	Unpaired		
9 March 2003	114	5	10	3	21	P = 0.442	r_s = 0.55; P = 0.159
24 August 2003	112	2	22	5	14	P = 0.121	r_s = 0.04; P = 0.939
31 August 2003	116	4	17	4	15	P = 0.592	r_s = -0.23; P = 0.575
20 April 2004	114	2	16	3	14	P = 0.472	r_s = 0.30; P = 0.624
7 May 2004	113	1	8	1	13	—	—
13 August 2004	115.5	7	19	9	17	P = 0.382	r_s = 0.122; P = 0.651

gent vegetation. Moreover, intruder males appeared to need to lean on a hard substrate to gain sufficient leverage to dislodge the paired male (Vargas 2005a), and that load point was absent in the water.

At oviposition, larger single males may challenge smaller paired males and displace them from females (Davis and Halliday 1977, 1979). It is curious that at 0430 h females started oviposition during breeding events with choruses but not in the breeding event with scramble competition. It is possible that during chorus breeding events females started oviposition earlier because they were hidden among emergent vegetation and were not disturbed by single males. In contrast, in scramble breeding events there was not emergent vegetation for females to use as refuge if they returned to water for oviposition. It is possible that females might delay oviposition until sunrise when single males stopped activity and left the pond (F. Vargas, pers. obs.) and thus avoid risk of suffocation if multiple males were to clasp them. This hypothesis needs further study in *B. marinus* but behavioral plasticity in breeding behavior of females has been recorded in many species (Jennions and Petrie 1997).

When explosive breeders form choruses, females could have more opportunity to express their mating preferences because they are less likely to be intercepted by searching males (Sullivan et al. 1995). In my study, female *B. marinus* could be attracted to or have mating preferences for calling males with particular phenotypes, but as a female approached a calling male, non-calling males in the water had an opportunity to intercept her. However, if a female approached by ground or within emergent vegetation to a calling male, she appeared to reduce the possibility of being intercepted by non-calling males (FV, pers. obs.). From the male's perspective, calling can increase the chance of attracting females, but calling males could be susceptible to predators such as rats (Fitzgerald 1990; FV, pers. obs.). Non-calling males in the water may have a lower risk of predation, but they do not readily attract females. Non-calling males can clasp females they detect but due to the high number of non-calling males the probabilities of mating may be low for each male in the water. A possible difference in the reproductive success between calling and non-calling males is still an unresolved aspect in *B. marinus* (Lever 2001).

Mate choice is expensive, and it is expected that the level of female's selectivity will correspond to the benefits obtained if mated with particular males (Andersson 1994; Grafe 1997). The absence of direct benefits in *B. marinus* such as territories with abundant resources, parental care (Vargas 2005b) and/or differential egg fertilization rate (Fig. 2) does not suggest high selectivity by females. Female *B. marinus* might move to the male that is easiest to find (Arak 1988a; Parker 1983). This behavior may be beneficial if it reduces the risk of predation, disease and/or parasitism, which may be associated with time spent in the water. In many anurans, more time in the pond also increases the risk of dangerous interactions with unpaired males (Arak, op cit.). These take-over attempts imply a cost to females in terms of energy, and also expose them to death by suffocation by the conspecific males (e.g., *B. bufo*, Davis and Halliday 1979). I did not observe this extreme case in *B. marinus* but it cannot be discarded due to the physical constraints multiple male clasping could have on a female (Fig. 1). Also, the hypothesis of beneficial rapid pairing is supported by the random spatial pattern of pairs and clutches around the pond.

Studies of breeding behavior in different populations of a same species under different environmental characteristics are useful for understanding ecological determinants of the breeding behavior, the strength and direction of sexual selection (Sullivan et al. 1995), and the role of reproduction in the population ecology, which is particularly relevant for invasive species. This study shows how characteristics of breeding locations can change in just days or weeks, and affect breeding behavior. Behavioral plasticity may increase adaptability to novel breeding conditions (Sakai et al. 2001), such as those conditions experienced by invading species as they enter new areas. Also, low female selectivity could reduce the strength of the Allee effect (reduction in fitness of individuals in small populations) when few individuals invade new habitats (Blumstein 1988; Møller and Legendre 2001). Lastly, high female fecundity and the high fertilization rate can optimize the recruitment of abundant juveniles with the subsequent positive effect on population growth rate and recovery of genetic variation (Nei et al. 1975). The Cane Toad, *B. marinus*, appears to have all these attributes, contributing to its successful invasion of many tropical areas worldwide.

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Reference Hematology and Serum Chemistry Values for the Diamondback Terrapin (*Malaclemys terrapin)*

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Health assessment of turtles is important in order to successfully manage wild animal populations and knowledge of hematologic and serum chemistry values for apparently normal wild individuals are an essential part of this evaluation (Jacobson et al. 1999; Werner et al. 2002). Evaluation of blood samples can provide information on red and white blood cell distribution, electrolyte levels, waste products, and selected enzyme activity. An apparently healthy looking turtle could have serious internal disease that would likely be missed without examining a blood profile. In order to accurately evaluate turtle blood samples, a reference range of values must be established for each species. Blood reference values have been established for less than 5% of all known turtle

species (McArthur et al. 2004). The present study was undertaken to establish reference ranges for various blood parameters in the Diamondback Terrapin, *Malaclemys terrapin*. It should be emphasized that the term "reference" is preferred over the mostly obsolete term "normal" since it is virtually impossible to determine whether or not each sampled individual in a wild population is "normal" (Solberg 1994). The goals of the present study were: to establish reference ranges for diamondback terrapin hematology and serum chemistry values, to determine if differences in blood values exist between males and females, to determine if variations exist due to the time of year, and to find out if the blood parameters reported by veterinary clinical pathology laboratories are of any diagnostic value in *M. terrapin*.

Malaclemys terrapin is found in brackish marshes of the eastern and Gulf Coasts of the United States. Although seven subspecies have been identified, this study only looked at the Northern Diamondback Terrapin. Various factors have led to a decline in the numbers of Diamondback Terrapins over the years and conservation efforts are now needed to protect this species. It has been well known as one of the best tasting turtles in the world, which almost led to its extinction at the beginning of the 20th century (Garber 1990a). This turtle is once again resurging as a desirable food delicacy in Asian communities (Garber 1990b). Exhibitors and hobbyists are also attracted to this colorful, intriguing reptile and it often appears in both public and private collections. Oil spills (Burger 1994), heavy metals (Burger 2002), traffic (Wood and Herlands 1993), commercial crabbing (Garber 1990b), predation (Feinberg and Burke 2003) and coastal development have taken their tolls on local diamondback populations. Regulations to protect diamondbacks vary widely among the coastal states and range from limited hunting seasons to designations such as special concern, threatened, or endangered.

An extensive search of the literature uncovered two references for blood values in *Malaclemys terrapin*. One paper examined hemoglobin values in two specimens (Goin and Jackson 1965). The other reference evaluated red blood cell (RBC) counts that were obtained from three animals (Hutchison and Szarski 1965).

Other studies have examined a few parameters of Diamondback Terrapin blood. One paper reported on the percentage of RBCs in blood smears from one individual (Englebert and Young 1970) and another article evaluated changes in hemoglobin and RBC counts for one to six captive terrapins over a one year period (Gilles-Baillien 1973). Changes in sodium, potassium, and urea were noted in three different experiments involving salinity manipulations (Bentley et al. 1967; Dunson 1970; Gilles-Ballien 1970). Serum chemistry reference values for *Malaclemys* are not available.

Materials and Methods.—From June through August of 2003 and May through August of 2004, 103 apparently normal *M. terrapin* were captured, bled, and released in Stone Harbor, New Jersey (ca. 39.05°N, 74.80°W) and Wellfleet (Cape Cod), Massachusetts (ca. 41.90°N, 70.03°W). Salinity at both collection sites was a constant 28–30 parts per thousand (ppt). The sample population consisted of 76 females and 27 males of various sizes (Table 1). In Stone Harbor, all terrapins were captured in baited crab traps that were checked within six hours of being set. The terrapins in the Wellfleet group were caught with hand nets from a kayak. In both locations, the turtles were transported in dry, plastic pails to a laboratory for blood collection and then released the same day or the following morning at the area of capture. Blood samples were obtained from one to fourteen hours following capture. In May 2004, only three terrapins were sampled. For June 2003–2004, 23 blood specimens were obtained while July 2003–2004 produced 33 specimens and August 2003–2004 yielded an additional 44 blood samples. All turtles were examined, weighed, and the carapace length was recorded.

Blood was obtained from the femoral vein using a disposable one milliliter syringe with a 26 gauge 3/8 inch needle. The collection site for blood testing must be carefully selected because of the extensive lymphatic network in turtles (Ottavaini and Tazzi 1977). In a study by Werner and Lindley (2005) on the effects of lymph dilution on blood samples in *Malaclemys*, the femoral vein was found to be the most accessible and reliable collection site for obtaining undiluted blood samples.

Part of the sample was immediately placed into one or two heparinized microhematocrit tube(s). Two drops of blood were used two make two blood smears, and a drop of blood was hemolyzed by vigorous stirring for hemoglobin analysis. The remainder of the sample (ca. 0.3–0.6 ml) was placed in a Microtainer® lithium separator tube and immediately spun down in a Statspin RP® centrifuge. Only one sample was hemolyzed and it was discarded. All samples were immediately refrigerated and remained that way until processed.

A commercial laboratory (Antech Diagnostics, 1111 Marcus Avenue, Lake Success, New York 11042, USA) did white blood cell counts (WBC) from blood smears, hematocrits, and serum chemistries, which included glucose, serum urea nitrogen (SUN), total protein (TP), albumin, aspartate aminotransferase (AST), calcium, phosphorous, sodium, potassium, chloride, globulin, creatine phosphokinase (CPK), and uric acid (UA). This panel of tests is offered by Antech as a Comprehensive Reptilian Profile. Hemoglobin was measured by the author utilizing a BMS® hemoglobinometer.

Means, medians, standard deviations, ranges, and histograms were calculated for each blood value. The only subset analyses performed were male versus female and time of the collecting season. The males and females were compared by two-tailed t-tests ($\alpha = 0.05$). The blood values were tested for correlations with collection date (Spearman Rank Correlation test).

Results.—Of the total 103 terrapins sampled there was not always enough blood to perform all tests on each individual. There were 56 serum chemistries, 61 hematocrits, 87 white blood cell (WBC) counts, and 85 hemoglobins that made up the final results. The values are given as means, standard deviations, and ranges.

The mean hematocrit value for 61 samples was 31.8% ± 7.5.

TABLE 1. Size data for male (M) and female (F) *Malaclemys terrapin* from New Jersey (NJ) and Cape Cod (CC).

Sex	Site	Carapace L (cm)			Weight (gm)		
		mean	median	range	mean	median	range
M (N = 26)	NJ	10.8	10.7	8–13	216	216	114–351
M (N = 1)	CC	10.9			218		
F (N = 60)	NJ	15.6	13.1	9.8–19.8	537	369	166–1600
F (N = 16)	CC	17.3	17.4	13.2–21	851	885	349–1705

The range was from 15–55%. Hemoglobin concentration averaged 9.6 g/dL ± 1.1 with a range of 7–11.7 g/dL. The WBC counts for 87 terrapins had a mean of 11.3 × 10^3/μL ± 4.5 and a range of 3.5–28 ×10^3/μL (Table 2). Males (N = 21) had significantly higher WBC values (P < 0.05) with an average of 13.9 × 10^3 /μL ± 4.8. Female (N = 66) WBC values had a mean of 11.3 × 10^3/μ/L ± 4.5 (Table 3). The predominant WBC was the heterophil (74.6%). The next most common cell type was the lymphocyte (17.7%). Azurophils averaged 3.8% and the mean for monocytes was 2.3% (Table 2).

Serum chemistry values for 56 terrapins are tabulated in Table 4. Analysis of male (N = 8) and female (N = 48) values using a two tailed t-test revealed that males had significantly lower (P < 0.05) calcium, phosphorous, chloride, total protein, and albumin levels than females (Table 3). A significant positive correlation (values increased as the season progressed) was demonstrated for SUN and CPK, while a negative correlation was seen for both calcium and phosphorous.

Discussion.—Establishing reference blood and serum chemistry values for a species presents several problems. Reptiles do not precisely regulate serum constituents as do mammals so results from free living reptiles must be evaluated in light of age, reproductive status, environment, and overall condition (Mautino and Page 1993). The data presented here were obtained from 76 female and 27 male wild Diamondback Terrapins. One reason for this sex disparity is that obtaining femoral vein blood from smaller specimens, which were mostly males, was often unsuccessful. In *M. terrapin* the femoral vein is not visible so venipuncture was "blind" and, at times, unproductive. The second reason that there were fewer males in the sample group is that in both collecting areas captured females outnumbered males by approximately two to one.

Hematocrit, hemoglobin, and WBC ranges were very similar to published values for other turtle species (Anderson et al. 1997; Dessauer 1970; Dickinson et al. 2002; Frye 1991; Fudge 2000; Gaumer and Goodnight 1957; Marks and Citino 1990; Mader 1996; McArthur et al. 2004; Rosskopf 1982). One exception was a hematologic study of Aldabra Giant Tortoises (*Aldabrachelys gigantea)* where hemoglobin, hematocrit, and WBC means were lower than for most other species (Hart et al. 1991). This disparity was most likely the result of lymph dilution, as previously noted, because blood was taken from the dorsal coccygeal vein and a clear fluid was often noted in the syringe prior to obtaining blood (Hart et al. 1991). No differences were seen in the hematocrits and hemoglobins of males and females nor were there any significant differences as the collecting season progressed as have been reported in some other turtle species (Anderson et al. 1997; Dickinson et al. 2002; Gilles-Baillien 1973; Lawrence and Hawkey 1986; McArthur et al. 2004; Pages et al. 1992). Male *M. terrapin* in this study had higher average WBC numbers than their female counterparts. A similar disparity was noted in Desert Tortoises (*Gopherus agassizii)* (Dickinson et al. 2002). A possible explanation is a more pronounced stress response in captured males but it might also just be due to variation in a small sample size. While azurophils were the third most commonly observed WBC type, their function in turtles in unknown (Christopher et al. 1999) and even their existence in chelonians is clouded (McArthur et al. 2004). Eosinophils and basophils were not found very often and, combined, only made up about 2.7% of the total WBC popula-

TABLE 2. Values for red blood cells (RBC) and white blood cells (WBC) for *Malaclemys terrapin* from New Jersey and Cape Cod. RBC values based on 16 males and 45 females; WBC values based on 21 males and 66 females.

Test	Mean	SD	Range	Units
Hematocrit	31.8	7.6	15–55	%
Hemoglobin	9.6	1.1	7–11.7	g/dL
WBC	11.3	4.5	3.5–28	10^3/μL
Heterophils	74.6	13.4	29–91	%
Lymphocytes	17.7	12.6	4–63	%
Monocytes	2.3	3.0	0–16	%
Eosinophils	1.1	1.9	0–7	%
Basophils	1.6	2.1	0–14	%
Azurophils	3.8	3.5	0–14	%

TABLE 3. Blood and chemistry values significantly different between male and female *Malaclemys terrapin* (P < 0.05).

	Male		Female		
Test	Mean	SD	Mean	SD	Units
WBC	13.9	4.8	10.6	3.9	10^3/μL
Calcium	9.2	1.3	13.6	5.1	mg/dL
Phosphorous	4.1	0.7	5.5	1.7	mg/dL
Chloride	99.7	11.2	108.0	9.1	mEq/L
Total protein	3.6	1.1	4.2	0.7	g/dL
Albumin	1.0	0.3	1.3	0.3	g/dL

TABLE 4. Serum chemistry values for male (N = 8) and female (N = 48) *Malaclemys terrapin* from New Jersey and Cape Cod. Refer to Table 3 for gender differences.

Test	Mean	SD	Range	Units
Glucose	100.9	69.0	10–267	mg/dL
SUN[1]	104.7	54.0	27–258	mg/dL
Uric acid	1.3	0.9	0.3–5.3	mg/dL
TP[2]	4.1	0.8	1.8–5.7	g/dL
Albumin	1.3	0.3	0.4–2	g/dL
Globulin	2.8	0.6	1.4–3.9	g/dL
Calcium	13.0	5.0	6.6–30	mg/dL
Phosphorous	5.3	1.7	2.8–11.1	mg/dL
Sodium	148.7	11.0	120–174	mEq/L
Potassium	4.9	1.0	3.4–7.5	mEq/L
Chloride	106.9	9.7	86–123	mEq/L
AST[3]	218.1	130.1	75–681	U/L
CPK[4]	4194.1	3849.4	261–21570	U/L

[1]Serum urea nitrogen
[2]Total protein
[3]Aspartate aminotransferase
[4]Creatine phosphokinase

tion. This agrees with other published values for turtles (Anderson et al. 1997; Dickinson et al. 2002; Fudge 2000; Marks and Citino 1990; Mader 1996; Mader 2000; McArthur et al. 2004; Rosskopf 1982).

Serum chemistries in many instances had extremely large ranges. A lack of references on normal *M. terrapin* physiology makes interpretation of these data difficult.

In this study glucose levels fluctuated widely. Frye (1991) summarized glucose concentrations for 12 species of turtles. The average was 65 mg/dL with a range of 33–99 mg/dL. Glucose levels in chelonians do not seem to be related to diet (Anderson 1997) but they might be related to reproductive activity. In *Lissemys punctata,* the Indian Soft-shelled Turtle, fasting glucose values in reproductively active males were 91.4 ± 2.8 mg/dL while in females the glucose values were 119.3 ± 1.7 mg/dL (Chandavar and Naik 2004). The reverse was seen in the Pancake Tortoise (*Malacochersus tornieri*), where glucose levels were reported higher in males than in females (Raphael et al. 1994). In addition, seasonal glucose variations have been shown to occur in turtles from temperate zones (Christopher et al. 1999; McArthur et al. 2004). An experiment with Argentine Sideneck Turtles (*Phrynops hilarii*) found that plasma glucose was not affected by starvation or re-feeding (DaSilva and Migliorini 1990). It seems that glucose levels in chelonians are not well understood (Chandavar and Naik 2004) and therefore are difficult to interpret.

Urea nitrogen levels in this study varied widely. Similar results were found in 30 *Aldabrachelys gigantea* (Ghebremeskel et al. 1991). Raphael et al. (1994) found that urea nitrogen in *M. tornieri* was below the limit of sensitivity of their test method. Other studies have reported SUN values that ranged from <1–80 mg/dL (Anderson et al. 1997; Dickinson et al. 2002; Pages et al. 1992; Rosskopf 1982). A five year study of *G. agassizii* noted that urea nitrogen concentrations were highest when the turtles emerged from hibernation and then decreased significantly (Christopher et al. 1999). The present study showed the opposite—a significant ($P = 0.002$) increase in SUN from June through August. The reason for this increase is unknown. In a study of osmoregulation in *M. terrapin*, urea was found to be one of the major regulators of osmolarity and was likely reabsorbed from the bladder or excreted as the surrounding water salinity changed (Gilles-Ballien 1970). Serum urea nitrogen does not seem to be very useful for assessing renal disease in reptiles and this would seem especially true in *M. terrapin* (Fudge 2000; Mader 1996; McArthur et al. 2004).

The uric acid levels of *M. terrapin* were similar those of eight other species of chelonians (Mader 1996). Uric acid is primarily the end product of protein and purine metabolism, and thus increases following a meal. Uric acid is influenced by other variables precluding its use as an indicator of renal failure in turtles (Fudge 2000; Mader 1996; McArthur et al. 2004).

The mean total protein results in this study are similar to values reported for 13 different turtle species (Frye 1991). I found that albumin was lower in males but globulin levels were the same in both sexes. The reference laboratory (Antech) uses a colorimetric assay for total protein and the bromcresol green dye (BCG) method for albumin determination. Globulin is then calculated as the difference. The BSG method of albumin determination can overestimate this protein due to lack of specificity (Clase et al. 2001; Stokol et al. 2001) so it is possible that albumin values for both sexes are artificially elevated. Dessauer (1974) noted that the highest reptilian protein values are most likely to be found in females during estrous. Estrogen has been shown to increase serum protein levels (Clark 1967) and one study has reported higher TP values in female Gopher Tortoises (*Gopherus polyphemus*) (Taylor and Jacobson 1982). The plasma protein, vitellin, can also alter plasma protein values in egg-producing females (Dessauer 1974). Since most of the blood in the present study was collected during the egg-laying season, it seems probable that the higher TP concentration in females was probably due to albumin and vitellin.

Although sodium concentration was similar for both sexes, chloride values were higher in female *M. terrapin*. Another study noted the same male/female chloride disparity in *Elseya novaeguineae,* the New Guinea Snapping Turtle (Anderson et al. 1997). The sodium, potassium, and chloride values for 14 other turtle species were comparable to this study (Frye 1991). Because these three electrolytes and urea are involved in the regulation of osmolarity in *Malaclemys* their concentrations should increase or decrease as local water salinity increases or decreases (Bentley et al. 1967; Dunson 1970; Gilles-Baillien 1970). Diamondback Terrapins also possess a "salt gland" that helps to rid the body of excess sodium in a saline environment since their kidneys lack the ability to excrete hyperosmotic urine relative to blood plasma (Dunson 1970). In a study by Dunson (1970), sodium averages went from 100.7 mEq/L for terrapins spending a year in fresh water to 154.0 mEq/L for those in sea water. Gilles-Baillien (1970) found similar results. The conclusion is that sodium values (along with potassium, chloride, and urea) must be interpreted in light of environmental salinity. Although the salinity of both collecting sites was similar (28–30 ppt) little is known about the water routes of this species. Preliminary radio telemetry studies at the Stone Harbor collecting site indicate that individual *M. terrapin* travels between areas of varying salinity during the day (pers. obs.).

The sex disparity in chloride may be due to the low number ($N = 8$) of males in this part of the study. Another possibility is that nesting females leaving the water to lay eggs become somewhat dehydrated.

Calcium and phosphorous were both significantly elevated in female *M. terrapin*. The samples collected during this two-year study were during the breeding/nesting season and often were from females that were producing (or had just deposited) eggs. Several other sources have documented increased calcium levels in ovulatory chelonians (Anderson et al. 1997; Christopher et al. 1999; Clark 1967; Dessauer 1970; Dickinson et al. 2002; Fudge 2000; McArthur et al. 2004; Raphael et al. 1994). It was found however that as the season progressed the calcium and phosphorous values declined, which may be the result of continual egg production from June to August.

The two serum enzymes, AST and CPK reported by the diagnostic laboratory are included in their Comprehensive Reptilian Profile. Antech does not provide reference values for either of the two enzymes and they do not seem to be of much diagnostic value. Aspartate aminotransferase (AST) is present in all body tissues so it is not specific for any particular organ (Duncan et al. 1994; Mader 1996). Creatine phosphokinase (CPK) is primarily found in skeletal and cardiac muscle. The average AST values were similar to those observed in pancake tortoises (*M. tornieri*) (Raphael et al. 1994). Aspartate aminotransferase values for Desert Tortoises (*G.*

agassizii) were much lower (Dickinson et al. 2002). The Radiated Tortoise (*T. radiata*) also had relatively low AST values (Marks and Scott 1990). Such a large range and standard deviation of AST and CPK in the present study of apparently healthy Diamondback Terrapins makes interpretation difficult. The highest ten values for AST and CPK were scattered throughout both populations and collection days so specific capture and/or handling techniques did not seem to be a factor. The most likely explanation for the high enzyme values in the Diamondback Terrapin and Pancake Tortoise studies is that probing for a vein with a needle caused tissue trauma and resulted in the release of these two enzymes which in turn contaminated the blood sample (Duncan et al. 1994; McArthur et al. 2004). It is unlikely that the relatively high diamondback values were due to massive muscle (or other tissue) damage since all terrapins appeared healthy at the time of capture and were not obviously injured during handling. The significant (P = 0.03) increase in CPK with the time of year is hard to explain. It would seem that blood collection techniques would improve as the season continued which should lower CPK values.

Stress is reported to cause an increase in heterophils (Fudge 2000) but changes in other blood parameters due to stress are mostly unknown (McArthur et al. 2004). An inspection of the highest ten values for heterophils, glucose, and SUN showed no pattern with regards to collection date or site. This would tend to preclude specific capture, holding, or collection techniques as being responsible for the elevations. It is reasonable to assume that all wild chelonians are under stress when captured, restrained, and sampled for blood and thus all results are going to be "stress" values to some degree.

The reference ranges reported here are for terrapin populations in two areas of the northeastern United States. Blood testing of terrapins throughout their natural range will provide information on any differences that may exist in various geographic locations or subspecies. Finally, examination of blood from diseased diamondbacks may uncover valuable diagnostic markers to aid in assessing health status.

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Egg Clutch Characteristics of the Barking Treefrog, *Hyla gratiosa*, from North Carolina and Florida

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Information on the basic life histories of many species of amphibians is lacking in the literature. This deficiency can hinder comparative studies and contribute to a poor understanding of broad patterns of life-history variation. A striking example of this deficiency is the minimal amount of published information on egg clutch characteristics of *Hyla gratiosa*. Published data for this species consists of an estimate of 2084 eggs from a single clutch collected in 1921 in the Okefenokee Swamp in southern Georgia (Livezey and Wright 1947; Wright 1932). In addition, a study evaluating the influence of time spent in amplexus on oviposition behavior of *H. gratiosa* in northern Florida found an average clutch size of 867.2 (SD = 330.5, N = 11) for females in the longest amplecting group, which were allowed to remain in amplexus for 1.5 h prior to separation (Scarlata and Murphy 2003). Here we report characteristics of egg clutches for *Hyla gratiosa* in two areas in the southeastern United States: Scotland Co., North Carolina and Leon Co., Florida, and evaluate relationships between female body size and clutch size and geographic variation in clutch size. These data contribute to baseline reproductive information for this species and suggest some interesting questions for future studies.

Materials and Methods.—Seventeen clutches were collected from two localities in Leon Co., Florida (FL; 30.375°N, 84.37°W, elevation 7 m and 30.389°N, 84.329°W, elevation 9 m) from April through June 2003, and 13 clutches were collected from Grassy Pond in Scotland Co., North Carolina (NC; 35.009°N, 79.422°W, elevation 80 m, Travis 1983) in 1979. Amplexed pairs were collected, transported to the laboratory, and placed in separate covered buckets filled with well water (FL) or pond water (NC) for oviposition (as described in Gunzburger 2006). The following morning, adult size was measured using wet mass (g) in NC or tibio-fibula length (TFL, in mm) in FL. Number of eggs in each clutch was counted (NC) or photographed in a small container and eggs counted later from the photograph (FL). Diameter of the vitellus of 9–18 eggs from each clutch collected in NC was also measured using a dissecting microscope. Vitellus diameter data are presented, but no analysis was performed, because a small proportion of the eggs in each clutch were measured and variation in vitellus diameter may have arisen due to variation in development time. All analyses were performed for each population separately because the data for the two populations were collected at different time intervals separated by almost 30 years.

TABLE 1. Summary data (± SD, minimum – maximum in parentheses) of clutch characteristics and adult size [tibio-fibula length (TFL, mm) or mass (g)] from two populations of *Hyla gratiosa*. ND indicates no data was collected on that characteristic for that location.

Location	Sampling Interval	N	Clutch Size	Egg Diameter	Female TFL	Female Mass	Male TFL	Male Mass
Scotland Co., North Carolina	1979	13	2826 ± 842 (1825–4381)	1.39 ± 0.10 (1.19–1.55)	ND	14.72 ± 2.40 (11.01–17.28)	ND	15.71 ± 2.60 (13.50–20.28)
Leon Co., Florida	2003	17	1008 ± 249 (459–1492)	ND	22.63 ± 1.01 (21.5–25)	ND	24.00 ± 1.47 (22–26.4)	ND

Results.—Clutch size of *H. gratiosa* ranged from 459–4381, covering a two- to three-fold range even when considered among females from a single location (Table 1). Clutch size was significantly larger in NC than FL (t-test, t = -8.48, P < 0.001, Table 1). For the FL population, TFL of female *H. gratiosa* was significantly smaller than males (t-test, t = -3.13, P = 0.004, Table 1). Female TFL was not strongly correlated with the TFL of the male with which they were in amplexus (Pearson r = -0.08) or clutch size (r = 0.06, Fig. 1). For the NC population, mass was similar in males and females (t-test, t = -1.01, P = 0.32). Female mass was not strongly correlated with mass of the male with which they were in amplexus (Pearson r = -0.06). Larger females produced larger clutches (r = 0.59, Fig. 1). The diameters of individual eggs varied widely among the NC females, with the largest size being 30% larger than the smallest (Table 1).

Discussion.—Clutch size was larger for *H. gratiosa* in NC than in FL; this could be due to larger body sizes in NC (Travis, unpubl. data), temporal changes, or independent geographic variation, all of which are confounded in these collections. The published data on intraspecific geographic variation in body size in anurans suggests a trend toward larger sizes at higher latitude and elevation, but further study is needed to determine if this is the case for *H. gratiosa* (Ashton 2002; Berven 1982; Morrison and Hero 2003). *Hyla gratiosa* is the largest native hylid in the southeastern United States (Mount 1975), and in comparison to other closely-related hylids, has both a higher maximum and a greater range of variation in clutch size. In this study, *H. gratiosa* clutch size was found to range from 459 to 4381 eggs. In comparison, *H. cinerea* average clutch size ranges from 700 to 1472 (Garton and Brandon 1975; McAlpine 1993) and *H. squirella* average clutch size ranges from 957 to 1059 (Brugger 1984; Wright 1932). Limited evidence indicates that *Hyla gratiosa* females may oviposit more than one egg clutch each season (Perrill and Daniel 1983), so it is possible that some of the variation in clutch size for *H. gratiosa* is due to females ovipositing smaller second clutches.

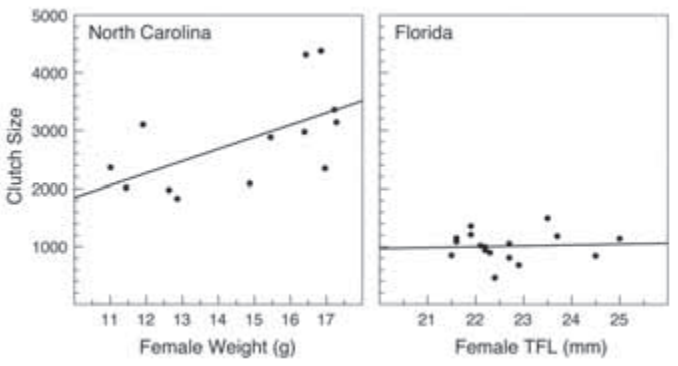


FIG. 1. Female body size and clutch size for *Hyla gratiosa* from the Florida population (N = 17) and North Carolina (N = 13).

Female size was more strongly correlated with clutch size for *H. gratiosa* from NC relative to FL. This could be due to differences in the measurement of adult size between the two data sets (mass and TFL, respectively) or differences between locations in the range of female body size. Future studies of reproductive ecology of this species should include both measurements of body size. Mean egg diameter was similar in this study in NC (Table 1) to that measured from a single clutch in the Okefenokee Swamp (mean = 1.37, SD = 0.19, N = 29, Wright 1932). The relationship between clutch size and egg size warrants further investigation as this study suggests that, at least in the NC population, larger females lay larger clutches of larger eggs. Although limited in scope, this study suggests there may be significant variation in reproductive characteristics of *H. gratiosa*.

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Herpetofauna of Mount Roraima, Guiana Shield Region, Northeastern South America

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The Guiana region of northeastern South America is an area of high biodiversity, and the varied habitats on the tepuis of the region support a significant portion of this diversity. The zoogeography of the pantepui region has been a recent topic of interest, with several sources of published data (Duellman 1999; Gorzula and Señaris 1999; Hollowell and Reynolds 2005a; Hoogmoed 1979a; McDiarmid and Donnelly 2005).

The herpetofaunal communities of several tepuis have been described (Donnelly and Myers 1991; Gorzula 1992; McDiarmid and Paolillo 1988; Myers 1997; Myers and Donnelly 1996, 1997, 2001). Mount Roraima, the most famous of these table mountains, has been explored extensively (McDiarmid and Donnelly 2005). Although numerous specimens have been collected on Roraima, these collections have never been summarized or analyzed.

Roraima (05º12'N, 060º44'W) is one of the highest points in northeastern South America, and it marks the boundary between Guyana, Venezuela, and Brazil. The summit plateau, from 2600 to 2810 m elevation, is some 34 km^2 in area. The plateau is known for its varied rock formations, and for its very sparse vegetation. The summit is at the top of steep walls which extend from below 2000 m up to 2600–2700 m; these walls are occasionally broken by more gradual slopes. At the bottom of the vertical walls, below about 2000 m, the tepui is surrounded by forested slopes. The forest is most extensive below 1500 m, with only a narrow band encircling the mountain above this elevation. Descriptions of the physical features and vegetation of Roraima are in Huber (1995a, b).

Herpetofaunas on tepui summits often differ in species composition from faunas on tepui slopes. Summit faunas are often more depauperate than slope faunas (Myers and Donnelly 2001). Both elevation and microhabitat can affect species distributions, and many species occur over a range of elevations (McDiarmid and Donnelly 2005). It is therefore worthwhile to have a compilation of slope and summit species, for comparison with faunas on other mountains.

The first aim of this paper is to compile a list of the known herpetofauna of Roraima, from both summit and slopes. The second aim is to compare the Roraima herpetofauna with those of other tepuis in the Guiana Shield (following Hollowell and Reynolds 2005b, p.1); this consists of 1) comparison using criteria developed by McDiarmid and Donnelly (2005), and 2) the hypotheses of tepui zoogeography of Myers and Donnelly (2001), who enumerated five general points about the composition of tepui herpetofaunas. Such comparisons can provide valuable insight about the zoogeography of the region.

Methods.—Information was taken from museum records or published literature. Amphibian taxonomy follows Faivovich et al. (2005), Frost et al. (2006) and Grant et al. (2006); reptile taxonomy follows Avila-Pires (2005). Institutional abbreviations follow Leviton et al. (1985), with the following additions: CSBD – Centre for the Study of Biological Diversity, University of Guyana, Georgetown, Guyana; MHNLS – Museo de Historia Natural La Salle, Caracas, Venezuela (formerly SCNLS); ULABG – Laboratorio de Biogeografia, Universidad de Los Andes, Mérida, Venezuela.

The aims of this study require that two points be defined. First, what are the boundaries of Roraima? Second, what are highland species? These questions were resolved as follows:

Roraima: We defined the boundaries of Roraima as that part of the mountain which is above 1500 m. Although some studies of the Guiana Shield region have used 1000 m as a minimum elevation (e.g., Hoogmoed 1979a), the use of this criterion at Roraima would necessitate the inclusion of the extensive surrounding uplands, and would increase the boundaries of Roraima to an unrealistic extent. We therefore adopted the 1500 m criterion, as have other studies of the Guiana fauna (Gorzula and Señaris 1999; McDiarmid and Donnelly 2005).

Because of the potentially great difference between faunas on tepui summits and faunas on forested tepui slopes, we have indicated the location from which each species was recorded, in order to determine whether each is part of the summit or slope faunal assemblages. The habitat on the slopes of Roraima is varied, ranging from steep rocky walls to more gently sloping forested areas (Huber 1995a, b).

Highland Species: Highland species are those which typically occur above 1500 m; any such species is here considered a highland species, although it may have been occasionally collected below 1500 m. McDiarmid and Donnelly (2005) followed a similar procedure. Although a highland species may occasionally occur at elevations below 1500 m, it will not be widespread below that elevation. Table 1 contains all species reported from above 1500 m, plus several highland species collected slightly below

TABLE 1. Amphibians and reptiles collected from Mount Roraima. G = Guyana, V = Venezuela. Species marked with (h) are considered to be highland species, seldom occurring below 1500 m.

Family	Species	Country	Location	Latitude	Longitude	Elevation (m)	Institution	Citation
AMPHIBIA								
Aromobatidae	*Anomaloglossus praderoi* h	V	Third valley from base	05º10'	060º47'	1800, 1950	MHNLS, ULABG	La Marca 1997
	Anomaloglossus roraimae h	V	Paso de la Muerte just below summit			2700	ULABG	La Marca 1997
	Anomaloglossus roraimae h	G	North slope			1860–2350	USNM	Grant et al. 2006
Brachycephalidae	*Eleutherodactylus marmoratus* h	V	Summit Plateau			2600	UMMZ	
	Eleutherodactylus sp.	G	Summit	05º 12'	060º 44'	2600	USNM	
Bufonidae	*Oreophrynella macconnelli* h	G	North slope			1477–1800	BMNH	Warren 1973
	Oreophrynella quelchii h	V	Summit	05º 12'	060º 44'	2650	BMNH	Boulenger 1900b
	Oreophrynella quelchii h	V	Summit, west	05º 11'	060º 48'	2750	EBRG, MHNLS	
	Oreophrynella quelchii h	V	Summit	05º 12'	060º 44'		MCZ, UMMZ	Rivero 1961
	Oreophrynella quelchii h	V	Slope	05º 09'	060º 46'	1700	MHNLS	
	Oreophrynella quelchii h	G, V	Summit				USNM	
Cryptobatrachidae	*Stefania roraimae* h	G	North slope			1402	CSBD	Duellman and Hoogmoed 1984
Hylidae	*Hyla warreni* h	G	North slope	05º 17'	060º 44'	1480	BMNH, CSBD, KU	Duellman and Hoogmoed 1992
	Hypsiboas roraima h	G	North slope	05º 17'	060º 44'	1430–1480	BMNH, CSBD, KU	Duellman and Hoogmoed 1992
	Hypsiboas sibleszi h	G	North slope			1476	BMNH, CSBD	Hoogmoed 1979b
	Myersiohyla kanaima h	G	North slope	05º 17'	060º 45'	1430	BMNH, CSBD, KU, USNM	Duellman and Hoogmoed 1992
Leiuperidae	*Pseudopaludicola* sp. h	V	Slope	05º 10'	060º 47'	1550	MHNLS	
Leptodactylidae	*Leptodactylus fuscus*	V	Philipp Swamp			1570	AMNH	
Microhylidae	*Otophryne steyermarki* h	V	Slope	05º 10'	060º 44'	1550	MHNLS	
REPTILIA								
Gymnophthalmidae	*Arthrosaura versteegei*	V	Southeast slope	05º 11'	060º 43'	1920	MHNLS	
	Riolama leucosticta h	V	Summit			2700	BMNH	Boulenger 1900a
Polychrotidae	*Norops chrysolepis*	V	Slope	05º 10'	060º 45'	1920	MHNLS	
Scincidae	*Mabuya nigropunctata*	V	Slope	05º 09'	060º 47'	1550	MHNLS	
Tropiduridae	*Tropidurus hispidus*	V	Slope	05º 09'	060º 47'	1550	MHNLS	
Colubridae	*Liophis breviceps*	V	Slope	05º 10'	060º 45'	1950	MHNLS	
Viperidae	*Bothriopsis taeniata*	V	Slope	05º 09'	060º 47'	1550	MHNLS	
	Crotalus durissus	V	Slope	05º 09'	060º 47'	1550	MHNLS	

1500 m (between 1400 and 1500 m) on Roraima.

Comparisons: Not all species in Table 1 are included in that part of the Discussion concerning comparisons among tepui faunas. In order to make the comparisons as valid and accurate as possible, we used the same criteria as those used by other studies to which we compare the Roraima fauna. Two types of comparisons are made. The first is based on elevational and distributional ranges of species occurring on each mountain as defined by McDiarmid and Donnelly (2005). These authors (2005, p. 483) examined the elevational ranges (ER) and distribution patterns (DP) of tepui species. Elevation ranges and distribution patterns are weighted according to their extent, and the weighted results are added to produce two values: Sum of elevational ranges (SUMER) and Sum of distribution patterns (SUMDP), which reflect the composition of each tepui community. Only those species which occur above 1500 m are used in this comparison. The second type of comparison is based on the hypotheses of tepui herpetofaunas proposed by Myers and Donnelly (2001); only those species which fit the above definition of highland species are used in this comparison.

Results.—The search of institutional records and published literature turned up 14 amphibian and 8 reptile species in 18 genera and 13 families occurring on Roraima. These taxa are shown in Table 1. Where data such as coordinates, elevation and precise location are known, they are provided in the table.

Several changes have been made to information from the literature. These are as follows:

1) Phelps (1938) determined that the specimens collected by McConnell and Quelch, reported in Boulenger (1900a, b) as being from Guyana, were actually collected in Venezuela. Table 1 follows this determination.

2) Rivero (1961) reported two species of *Leptodactylus* from the summit of Roraima in the AMNH collection: *L. sibilatrix* AMNH 39752 and *L. podicipinus petersi* AMNH 39753. However, according to AMNH records, 39752 is *L. fuscus* from Philipp Swamp and 39753 is *L. sabanensis* from a location below 1500 m. Table 1 follows this determination.

3) Gorzula and Señaris (1999, p. 255) reported *Tepuihyla edelcae* from Roraima. However, although *T. edelcae* is reported from Roraima on p. 255, the more detailed species account (p. 49) contains no mention of its presence on Roraima. This species has been collected only from several tepuis to the west of Roraima (Auyán, Chimantá, Los Testigos). Table 1 follows this determination, as do McDiarmid and Donnelly (2005).

4) The latitude given for the north slope of Roraima in Duellman and Hoogmoed (1992) corresponds to a location some 35 km N of Roraima. Following Warren (1973) we have amended this latitude to 05º17'N.

In addition to *Norops chrysolepis*, which has also been recorded above 1500 m (Table 1), 39 additional species, *Chaunus granulosus, C. marinus, Rhinella margaritifer, Anomologlossus* sp., *Stefania scalae, Dendropsophus minutus, Hypsiboas boans, H. crepitans, H. multifasciatus, Scinax ruber, Adelophryne gutturosa, Eleutherodactylus* sp., *Leptodactylus bolivianus, L. pallidirostris, L. petersi, L. sabanensis, Otophryne robusta, Synapturanus* sp., *Lithobates palmipes, Norops auratus, N. fuscoauratus, Polychrus marmoratus, Mabuya nigropunctata, Ameiva ameiva, Arthrosaura guianensis, Cnemidophorus lemniscatus, Kentropyx calcarata, K. striata, Neusticurus rudis, Boa constrictor, Leptodeira annulata, Liophis lineatus, Liophis typhlus, Mastigodryas bifossatus, M. boddaerti, Oxybelis aeneus, Tantilla melanocephala, Micrurus lemniscatus,* and *Bothrops atrox*, were collected on the slopes of Roraima below 1500 m (Barrio 1998; Boulenger 1900a, b; Campbell and Clarke 1998; Heyer 1994; Hoogmoed 1979b; Rivero 1961).

Discussion.—Seventeen species have been collected from above 1500 m on Roraima. Numbers of species collected on Roraima are compared to collections from some other tepuis in Table 2. In order to ensure that such comparisons are as meaningful as possible, only large, frequently-visited tepuis in the eastern Guiana region are included in the table. There are few such tepuis; for this reason we include Guaiquinima, even though it does not reach 1500 m.

Roraima's diversity is lower than that on other comparable tepuis (Table 2), despite having been visited by collectors at least as often as have other tepuis. While other large tepuis have forested slopes which support considerable faunal diversity, Roraima's slopes are mostly steep rocky walls, with only a narrow forested band above 1500 m. The summit of Roraima also supports little vegetation, and its area is smaller than the summits of other tepuis (Huber 1995a). Thus, the limited amount of suitable habitat on Roraima may account for its low faunal diversity.

Faunal composition on the slopes of Roraima changes with elevation, and there is no overlap between the slope and summit faunas. The faunal changes are summarized in Table 3. Specimens have never been collected systematically along an elevational transect on the slopes of Roraima; most are from the vicinity of locations which are suitable for camping. It is possible that elevational changes in faunal composition are partly an artefact of

TABLE 2. Species diversity on frequently visited large tepuis of the eastern Guiana Shield.

Location	Elevation (m)	Number of Species Collected	Season of Visit(s)	Reference
Auyán	1600–2100	24	various	Myers 1997 McDiarmid and Donnelly 2005
Chimantá	1800–2600	18	various	Gorzula 1992 McDiarmid and Donnelly 2005
Guaiquinima	1030–1380	21	February–April	Donnelly and Myers 1991 Gorzula and Señaris 1999
Roraima	1500–2810	17	various	Table 1, this paper

TABLE 3. Elevational distribution of families on Mount Roraima.

Family	> 1500 m	Summit
Aromobatidae	2	0
Brachycephalidae	2	2
Bufonidae	2	1
Leptodactylidae	2	0
Microhylidae	1	0
Gymnophthalmidae	2	1
Polychrotidae	1	0
Scincidae	1	0
Tropiduridae	1	0
Colubridae	1	0
Viperidae	2	0
Total	17	4

collecting efforts. For example, the Hylidae, which are very diverse at lower elevations, are not represented above 1500 m. However, several highland species (*Hyla warreni*, *Hypsiboas roraima*, *H. sibleszi*, *Myersiohyla kanaima*, *Stefania roraimae*) were collected between 1400 and 1500 m on Roraima. All of these have been collected above 1500 m on other tepuis, and it is possible that they occur above 1500 m on Roraima as well.

Only four species (*Oreophrynella quelchii*, *Eleutherodactylus marmoratus*, *Eleutherodactylus* sp. [USNM], *Riolama leucosticta*) are known from the summit of Roraima, with *Anomaloglossus roraimae* collected from a location just below the summit. Tepui summit faunas are typically depauperate, but nonetheless this number is somewhat lower than the numbers of species collected on the summits of other frequently-visited tepuis (McDiarmid and Donnelly 2005; Myers and Donnelly 2001).

The remaining species (Table 1) were recorded from a variety of habitats on the slopes of Roraima. Some slope species have been reported only from higher elevations elsewhere, such as *Hyla warreni* (MacCulloch and Lathrop 2005), *Stefania roraimae* (MacCulloch and Lathrop 2002) and *Otophryne steyermarki* (Barrio 1999; Campbell and Clarke 1998; Myers 1997), but many reptile species have been reported from a broad range of elevations.

Some genera which have been collected in several other highland locations in the Guiana Shield (e.g., *Hyalinobatrachium*, *Tepuihyla*, *Thamnodynastes*) have not been collected on Roraima.

McDiarmid and Donnelly (2005, p. 512) listed elevation ranges for many Guiana Shield species. Table 1 increases the elevation ranges for *Oreophrynella quelchii*, *Otophryne steyermarki*, and *Tropidurus hispidus*.

Comparisons: Elevational ranges (ER) and distribution patterns (DP) of tepui species were examined by McDiarmid and Donnelly (2005). Elevational ranges and distribution patterns for the Roraima community are in Table 4; SUMER = 648 and SUMDP = 739. These values are similar to those presented by McDiarmid and Donnelly (2005) for other large tepuis. SUMER and SUMDP for Roraima, and for other tepuis, will undoubtedly change as knowledge of the fauna increases.

Myers and Donnelly (2001, p. 79) established five general statements concerning tepui herpetofaunas. The assembled data from

TABLE 4. Elevational ranges and distribution patterns for the 17 species which occur above 1500 m on Mount Roraima. Distribution patterns (from McDiarmid and Donnelly 2005): HR = highly restricted (occurs on only one tepui); MR = moderately restricted (two or more tepuis); GE = Guiana endemic; WS = widespread.

Species	Elevational Range (ER) (m)	ER Weighting Factor	Distribution Pattern (DP)	DP Weighting Factor
Anomaloglossus praderoi	1800–1950	1	HR	1
Anomaloglossus roraimae	1860–2700	2	HR	1
Eleutherodactylus marmoratus	100–2600	100	GE	10
Eleutherodactylus sp. (summit)	2600	0	HR	1
Oreophrynella macconnelli	1067–1800	2	HR	1
Oreophrynella quelchii	1700–2800	10	MR	2
Leptodactylus fuscus	100–1570	10	WS	100
Pseudopaludicola sp.	1550	0	HR	1
Otophryne steyermarki	1550–2150	2	GE	10
Arthrosaura versteegei	100–1920	100	GE	10
Riolama leucosticta	2500–2700	1	MR	2
Norops chrysolepis	100–1920	100	WS	100
Mabuya nigropunctata	100–1550	10	WS	100
Tropidurus hispidus	20–1550	10	WS	100
Liophis breviceps	100–1950	100	WS	100
Bothriopsis taeniata	0–2000	100	WS	100
Crotalus durissus	30–1920	100	WS	100
		SUMER = 648		SUMDP = 739

TABLE 5. Herpetofaunal community composition on summits of Roraima and neighboring tepuis.

Species	Roraima	Kukenán	Ilú	Yuruaní	Wei-Assipu	Citation or Institution
Anomaloglossus sp.					X	Villarreal et al. 2002
Eleutherodactylus marmoratus	X					UMMZ
Eleutherodactylus sp.	X					USNM
Eleutherodactylus sp.				X		Mägdefrau and Mägdefrau 1994
Oreophrynella nigra		X		X		Señaris et al. 1995
						Gorzula and Señaris 1999
Oreophrynella quelchii	X				X	Señaris et al. 2005
Oreophrynella vasquezi			X			Señaris et al. 1995
						Gorzula and Señaris 1999
Oreophrynella weiassipuensis					X	Señaris et al. 2005
Stefania riveroi				X		Señaris et al. 1997
						Gorzula and Señaris 1999
Stefania sp.					X	Villarreal et al. 2002
Hyla warreni					X	Villarreal et al. 2002
Tepuihyla sp.					X	Villarreal et al. 2002
Riolama leucosticta	X	X		X		Gorzula and Señaris 1999

Roraima are examined below to determine the extent to which they support these five points.

Point 1: tepuis have relatively depauperate herpetofaunas. This is true for summit faunas. The Roraima summit fauna consists of four species; the fauna on other tepui summits ranges from zero to 15 species (McDiarmid and Donnelly 2005; Myers and Donnelly 2001, see also Table 5). Herpetofaunas on the slopes of tepuis are usually more diverse.

Point 2: neighboring tepuis are likely to have significantly different faunas. Although Myers and Donnelly (2001) did not quantify the definition of neighboring tepuis, they used Auyán and Chimantá, which are 50 km apart, as examples. Therefore we use this distance as a criterion, and consider tepuis within 50 km of Roraima to be neighboring tepuis.

Four tepuis within a 50-km radius have been visited: Kukenán (05º13'N, 060º51'W, 2650 m elev.), Yuruaní (05º19'N, 060º51'W, 2300 m elev.), Ilú (05º25', 060º59'W, 2700 m elev.), and Wei-Assipu (05º13'N, 060º42'W, 2400 m elev.). Although some specimens have been collected on the slopes of Kukenán (Gorzula and Señaris 1999; Rivero 1961), collections from Ilú, Yuruaní, and Wei-Assipu were made only on the summits, accessed by helicopter (Gorzula and Señaris 1999; Villarreal et al. 2002). Therefore only the summit faunas will be used for comparison among these five tepuis (Table 5). Collections from Kukenán contained one amphibian species (*Oreophrynella nigra*) which has not been collected on Roraima. Specimens from Wei-Assipu include four species which have apparently not been collected on Roraima, although three of these are identified only to genus. The Wei-Assipu community also includes one genus (*Tepuihyla*) which has not been reported from Roraima.

The herpetofauna of Wei-Assipu is more diverse than those of the neighboring tepuis Roraima, Kukenán, Ilú, and Yuruaní. This may be because of summit habitat; on the latter four tepuis the summit is rocky and vegetation is sparse (Señaris et al. 1995, 1997), while the summit of Wei-Assipu supports more vegetation (Villarreal et al. 2002).

Only three species, *Oreophrynella nigra*, *O. quelchii*, and *Riolama leucosticta*, occur on more than one tepui. The ten remaining species are found on only one of the five, although two also occur at more distant locations (*Eleutherodactylus marmoratus* and *Hyla warreni*).

Although *Oreophrynella* are found on all five tepuis, and *Riolama* on three, other genera and even families exhibit little overlap. The summit faunas of these neighboring mountains are quite different. This situation is similar to that observed on Auyán and Chimantá (Myers 1997).

Point 3: tepui endemics outnumber widespread highland species. Expanding on the criterion established in Point 2, we consider any species from Roraima which also occurs in one or more locations more than 50 km distant from Roraima to have a widespread distribution. Using this criterion, seven of the highland species occurring on Roraima have been reported from locations at distances of 50–200 km from Roraima, and are therefore considered widespread species. These are *Stefania roraimae* (MacCulloch and Lathrop 2002), *Hyla warreni* (MacCulloch and Lathrop 2005), *Hypsiboas roraima* (MacCulloch and Lathrop 2005), *H. sibleszi* (Duellman 1997; Hoogmoed 1979b; MacCulloch and Lathrop 2005), *Myersiohyla kanaima* (Duellman and Hoogmoed 1992; Goin and Woodley 1969; MacCulloch and Lathrop 2005), *Eleutherodactylus marmoratus* (Frost 2004), and *Otophryne steyermarki* (Barrio 1999; Gorzula and Señaris 1999).

Of the four Roraima summit species, only *Eleutherodactylus* sp. (USNM) is endemic. Of the highland slope species only four (*Oreophrynella macconnelli*, *Anomaloglossus praderoi*, *Anomaloglossus roraimae*, *Pseudopaludicola* sp. [MHNLS]) have never been reported from elsewhere and can be considered endemic. On Roraima, widespread highland species outnumber endemics.

Point 4: some endemic species have counterparts on other tepuis. This point is supported by the Roraima data. The genera *Oreophrynella*, *Eleutherodactylus* and *Anomaloglossus* are good examples of this phenomenon.

Point 5: lowland species find their way onto tepuis in an irregular, unpredictable manner. This point is well supported by the Roraima data. Several lowland species, *Leptodactylus fuscus*, *Mabuya nigropunctata*, *Tropidurus hispidus*, *Liophis breviceps*, *Bothriopsis taeniata* and *Crotalus durissus*, occur above 1500 m on Roraima. Some of these species (*Leptodactylus fuscus*, *Tropidurus hispidus*, *Bothriopsis taeniata*, *Crotalus durissus*) have also been reported from high elevations elsewhere (Donnelly and Myers 1991; Gorzula and Señaris 1999; McDiarmid and Donnelly 2005; Means 2004).

The Roraima data support Points 2, 4, and 5 well, but provide little support for Points 1 and 3. Some points appear to apply more to summit faunas than to slope faunas.

The Roraima herpetofauna is a mixture of high- and low-elevation taxa, similar to the faunas on numerous other tepuis in the Guiana Shield region. Although knowledge of the region's amphibians and reptiles is far from complete, the situation will improve as more of the region is explored, and as previously collected locations are revisited.

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First Detailed Report of Predation on Anuran Metamorphs by Terrestrial Beetle Larvae

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Invertebrates are known predators of both aquatic and terrestrial stages of amphibians (reviewed in McCormick and Polis 1982; Toledo 2005). Seventy-three percent of reported predation events in and out of the water on anurans involved spiders (ca. 48%) and water bugs. The remainder included crabs, leeches, and various insect groups (Toledo 2005). A review of the published information on predation of juvenile and adult amphibians by beetles revealed reports on predation by adult carabids (Huheey and Stupka 1967; Littlejohn and Wainer 1978; Ovaska and Smith 1988; Robertson 1989; Smith 1946), dytiscids (Hinshaw and Sullivan 1990), cicindelids (McCormick and Polis 1982) and staphylinids (Jung et al. 2000).

There are three reported cases of terrestrial beetle larvae preying on amphibians, all belonging to the carabid tribe Chlaeniini (= Callistini). Shiina and Tachikawa (1988) reported how *Epomis nigricans* larvae ambush *Hyla* sp. and *Rhacophorus schlegelii* on vegetation and prey upon them (shown in photographs by Tachikawa 1994). There is a preliminary report from South Africa on carabid beetle larvae associated with *Bufo* sp. (Moore 1971). That author received two preserved first instar larvae identified as Chlaeniini, which had been found attached by means of the mandibles to the hind leg of a toad. No further information was given as to whether the described larvae were able to kill or physically harm the toad.

While studying the population dynamics of the Green Toad (*Bufo viridis*), a species that was recently declared endangered in Israel (Gafny 2004), we encountered on several occasions a carabid larva attached to Green Toad and Yellow Lemon Tree Frog (*Hyla savignyi*) metamorphs. We describe here the predation behavior and its frequency of occurrence in the central coastal plain of Israel, together with a description of the beetle's larval development and pupation.

Methods.—We monitored *Bufo viridis* breeding populations in the central coastal plain of Israel (0–50 m elevation) at seven rain pools over a period of four years (2002–2005), at two pools for two years (2002–2003), and at one pool for one year (2006). We searched seasonally for metamorphs under cover items including logs, stones and debris, along the edge and in the vicinity of the rain pools. Each site was sampled regularly every two weeks, starting in the third week of March, until no additional metamorphs were located at the site for at least two consecutive visits. All metamorphs were transferred to the laboratory for inspection of malformations or other signs of abnormality and were then returned to the collection site. Among them we found beetle larvae

attached to metamorphs. In spring 2005 and 2006, we conducted laboratory observations to study larva-metamorph interaction.

In spring 2005, we conducted laboratory observations of three pairs of beetle larvae and toad metamorphs. Two beetle larvae (one first-instar and one second-instar) were detached from *B. viridis* metamorphs and one single larva (second-instar) was found in the collection container. Beetle larvae were placed individually in 500 ml circular semitransparent plastic containers, and kept indoors at 20–24°C, under a natural photoperiod (L/D, 14:10). Each container held about a 3-cm-deep mixture of peat and coconut fiber bedding that was kept moist. A piece of crumpled tissue paper was added to provide the larvae with substrate for successful molting and for cover. A single toad metamorph was placed into each of the three containers. When a metamorph was consumed, the larva was presented with an additional *B. viridis* metamorph. If the beetle larva did not respond within several hours, the metamorph was removed and offered again on the next day. The metamorphs in the experimental containers were left unfed. In a second set of feeding trials, to examine the diet specificity of the carabid larvae, we offered larvae a selection of macroinvertebrates that they might encounter in their natural habitat. These included house crickets (*Acheta domestica*), snails (*Xeropicta vestalis*) and earthworms (*Lumbricus* sp.). We also tested larval response to mealworms (*Tenebrio molitor*). Larval development was monitored continuously through all molting stages, pupation and adult emergence, to identify the beetle species.

In the following winter (February 2006) we collected four adult beetles (2 females, 2 males) at a rain pool site (Dora; 32°18'N, 34°11'E). We placed the beetles in a 5 L rectangular semitransparent plastic container, indoors at 24–26°C, under a natural photoperiod (L/D, 14:10). The container had bedding similar to that described for the observations in 2005. At least 45 eggs were laid, three were preserved and the rest were left to hatch (all hatched). We repeated the predation experiment following the procedure performed in 2005 with 12 beetle larvae and *B. viridis* metamorphs (reared in the laboratory from tadpoles collected from a drying pool). In addition, three first-instar beetle larvae hatched in captivity were retained in containers but not fed. The remaining hatched larvae were retained and fed metamorphs to document their development.

Results.—Predatory interactions of carabid beetle larvae on anuran metamorphs were found for both *B. viridis* and *H. savignyi* collected in the vicinity of rain pools. We examined a total of 4907 metamorphs, and 909 juveniles and adults of *B. viridis*, as well as occasionally encountered adults (N = 64) and metamorphs (N = 1894) of *Hyla savignyi*. Predation interactions were recorded for less than 0.5% of each of the above anuran species, between April 25 to May 22, at 3 of 10 sites studied. At one site (Hadera-West; 32°96'N, 34°17'E), we encountered 8 carabid larvae attached to metamorphs of *B. viridis* and one to a metamorph of *H. savignyi*. At another site (Dora), we recorded one carabid beetle larva attached to a metamorph of each of the above anurans. Upon checking cover objects in a dried pool (Qadima, 32°27'N, 34°89'E), we observed a first instar carabid larva moving around among a group of *B. viridis* and *H. savignyi* metamorphs. When introduced into a container that held a *B. viridis* metamorph, the beetle larva immediately attached to the metamorph's forelimb. Under a different cover object at the same site we observed a second instar larva attached to a *B. viridis* metamorph.

The attacked *B. viridis* metamorphs were 12–33 mm SVL, and weighed 0.24–3.8 g; *H. savignyi* were 15.5–23.5 mm SVL and weighed 0.3–1.06 g. A single beetle larva was found per anuran individual. In the case of *B. viridis*, 7 were attached to the abdominal area, one to the hind limb, one to the lower jaw and one to the back of the head. For *H. savignyi*, one larva was found attached to the back, and the other to the forelimb. The larvae were strongly attached to the metamorphs' skin by the mandibles and force was needed to dislodge them from the prey, which was left with deep skin lesions (photographs available at: http://www.tau.ac.il/lifesci/departments/zoology/Amphibia/index.html).

Analysis of predation behavior of the beetle larvae on metamorphs is based on laboratory observations of 3 larvae in 2005 and 12 in 2006. Free beetle larvae were relatively inactive during the day, but moved around on the soil surface at night. Upon presentation of a toad metamorph, each larva responded vigorously, grasping the prey's skin with its mandibles. Some toads tried unsuccessfully to rid their body of the larva, but eventually continued apparently normal behavior. Feeding of the beetle larvae on small metamorphs (< 16 mm) appeared to first entail sucking of their body fluids, which lasted less than an hour, and was then followed by chewing of soft tissue. Sucking of larger metamorphs lasted up to 32 h, during which the larvae also changed their attachment position on the prey's body. The larva's body progressively inflated and increased in size while that of the prey shrunk. The larva, which sucked the prey's fluids completely, concomitantly released liquid droplets from its anus. Only 2 of 45 metamorphs survived being preyed upon by the beetle larvae in the laboratory studies (2005–2006), and both were > 29 mm SVL. The larva either moved away from the dead metamorph, or started chewing it, leaving behind only skin and bones (photographs available at: http://www.tau.ac.il/lifesci/departments/zoology/Amphibia/index.html). In 2006, three first-instar larvae were kept without metamorphs and survived for six days.

To examine diet specificity we also presented the carabid larvae with invertebrates that they might encounter in their habitat. In only one of six trials did a larva respond to an earthworm and grab it; and this occurred only after repeated presentations directly in front of its mandibles. It sucked the worm and killed it, as observed for the toads. House crickets, snails and mealworms were ignored.

Beetles emerged in captivity in 2005 were identified as *Epomis dejeani*, Chlaeniini (Dejean 1831, cited in Makarova 2005), a species widely distributed throughout the eastern Mediterranean, the Crimea, southern Russia and central Asia (Winkler 1932). In 2006, we observed adult *E. dejeani* in moist soil in the vicinity of rain pools (Hadera West, Dora) under the same type of cover used by anuran metamorphs. The 4 adult beetles collected in February 2006 laid eggs 32 days later. Six days after spotting of the eggs the first larvae hatched. Hatching continued for another 10 days. The duration of the instar stage progressively decreased from a maximum of 7 days of the first instar to 4 of the third instar (Table 1). In 2005, larval period above-ground lasted 18–24 days (N = 3), while in 2006 it was 8–9 days shorter (Table 1). Construction of the pupation chamber was completed within a period of five days (N = 2, 2005). The pupation period lasted 8 days. The adults remained in the pupating chamber for another 3 days and then

TABLE 1. Developmental stage, duration, and size of *Epomis dejeani* larvae observed under laboratory conditions in 2006, and number of toad metamorphs consumed per larval instar stage. Number in parentheses indicates sample size. NA: not applicable.

Developmental stage	Duration (days)	Length (mm)	Consumed prey
1st instar	4–7 (12)	5–11 (7)	1 (9)
2nd instar	3–5 (10)	7–18 (10)	1 (9)
3rd instar	2–4 (7)	11–27 (8)	4 (5)
Underground period	19; 21 (2)	NA	NA
Total	31; 37 (2)	NA	6

emerged (males, 16 and 18 mm). In 2006, the underground period until emergence lasted 19 and 21 days (N = 2, females, each 19 mm).

First and second instars each consumed one *B. viridis* metamorph. Third-instar larvae presented with metamorphs larger than 16 mm SVL consumed two toadlets per larva (2005 experiment), whereas those presented with smaller prey consumed four (2006 experiment, Table 1). In one case we observed a first-instar larva attached to a second-year juvenile *B. viridis* (50 mm SVL). It completed first, second and third instar stages on the same individual, ultimately killing it.

Discussion.—This is the first detailed description of predation on juvenile anurans (*Bufo viridis* and *Hyla savignyi*) by a terrestrial beetle larva (*Epomis dejeani*). *Epomis dejeani* belongs to the carabid tribe Chlaeniini in which most species are well-known hemi-cryptobionts (i.e., organisms colonizing hidden surfaces; Makarova 2005) of humid, clay-type soils (Thiele 1977). The genus *Epomis* comprises of about 20 species, found mainly in tropical Africa and south and southeastern Asia; five species are known from the Palaearctic region, among them *E. dejeani* (Kryzhanovskij 1983). The larva of this species was first described in 2005 (Makarova 2005). Representatives of the tribe in Israel are often found around the edges of water bodies (Schweiger 1989; A. Gasith, unpubl. data). In our study, *E. dejeani* was found in clay-type and sandy soils around rain pools. These habitats are major breeding sites of *B. viridis* and *H. savignyi* in Israel. Along the coastal plain, metamorphs of both anuran species emerge from the pools in late March and early April. They seek cover in moist soil in the vicinity of the pools until leaving the breeding sites in late May through June (E. Elron, unpubl. data). Larvae of *E. dejeani* are also active during this period. Most carabid larvae and adults are polyphagous, feeding on a wide range of soil invertebrates (Ekschmitt et al. 1997; Lövei and Sunderland 1996). Larval feeding behavior resembles parasitism in the initial phase (sucking body fluids) and can develop into typical predation (tissue ingestion) at the end. They encounter and attack anuran metamorphs on the ground near breeding sites during a relatively short window of opportunity, from late April to late May. Encounters between the beetle larvae and anurans are inevitable because both use the same moist habitats at the same time. Whereas *E. dejeani* larvae attack the prey on the ground, larvae of *E. nigricans* were reported to ambush amphibians on vegetation (Shiina and Tachikawa 1988). Our findings on *E. dejeani* together with the reports on predation of anurans by *E. nigricans* in Japan (Shiina and Tachikawa 1988; Tachikawa 1994) and South Africa (Moore 1971), indicate that this phenomenon is not a peculiar predation behavior of a single Chlaeniini species. Such predators can be categorized as "temporary specialized predators," a term used by Toledo et al. (2007) for vertebrate predators "who look specifically for anurans in a determined phase of their life cycle or for a determined purpose."

Epomis dejeani appear to complete larval development in 40 days or less, consuming four or more anuran metamorphs. This is similar to the life history reported for *E. nigricans*, which completes its life cycle in a month, consuming three anurans (Shiina and Tachikawa 1988). In only one-third of the cases studied (N = 333) were arthropod predators smaller than their vertebrate prey (Toledo et al. 2007). This is also the case of *E. dejeani* larvae, which consumes prey many times larger than their size (5–20 fold in weight). This allows the predator to efficiently supply its energetic needs while impacting a relatively small number of prey. In the present study all affected metamorphs were found with a single larva attached to their body. We have evidence for one case in which a *B. viridis* metamorph was attacked by two carabid larvae simultaneously (M. Vonshak, pers. comm.; Sde Boqer, 30°52'N, 34°46'E, Israel, July 1997).

The carabid larva is a newly reported predator of amphibians. The apparently low frequency of occurrence (< 0.5%) of this interaction and the relatively small number of prey affected per beetle suggest a limited effect on amphibian populations.

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Bacterial Microflora of the Anterior Digestive Tract of Two *Agkistrodon* Species: Additional Evidence for Food Partitioning?

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Copperheads (*Agkistrodon contortrix*) and Cottonmouths (*A. piscivorus*) are closely related species that are sympatric throughout much of their range (Conant and Collins 1998). Although these species overlap in geographic range, reported habitat use by these species differ (Gloyd and Conant 1990; Roth 2005). The differences in habitat use most likely reflect differences in prey preference between the two species (Fitch 1999). Copperheads are primarily upland species and feed on small mammals, cicadas, and upland frogs while cottonmouths are lowland species and feed primarily on fish, thus its given specific eptithet *piscivorus* meaning piscivor or fish eater (Conant and Collins 1998). Although both *Agkistrodon* species are opportunistic feeders (e.g., Lutterschmidt et al. 1996; Roth et al. 2003) and may demonstrate considerable overlap in diet, each species demonstrates unique food habits characteristic to the prey availability within their preferred microhabitat.

Because differences in diet may introduce different bacterial microflora to the oral cavity and esophageal track, we conducted an investigation to inventory the common bacterial microflora of the anterior digestive tract and to address the following questions: 1) Does the bacterial microflora in the oral cavity and esophageal tract differ between *A. contortrix* and *A. piscivorus*?; 2) Do differences in bacterial microflora support the differences in diet and food partitioning between the two *Agkistrodon* species?; and 3) Do wild caught snakes have a greater richness of bacterial microflora in the esophageal tract than captive snakes fed only a diet of laboratory mice (*Mus musculus*)?

Both freshly captured and captive snakes were obtained from populations located in Walker Co., Texas, USA. The four freshly captured snakes (two *A. contortrix* and two *A. piscivorus*) were collected from sampling sites that included FM 2821, the Center for Biological Field Studies (CBFS) and Harmon Creek. These snakes were brought back to the laboratory and immediately sampled for bacteria in their anterior digestive tracts. The four captive snakes used in this study were from the captive snake colony housed in the Lutterschmidt Physiological Ecology Research Laboratory at Sam Houston State University. Theses snakes were housed and fed only laboratory mice (*M. musculus*) for at least one year.

Bacterial microflora were sampled only once from each snake by allowing each snake to crawl into a plastic tube for safe handing and straight positioning of the snake's body for oral and esophageal swabbing. A sterile cotton swab (ca. 30 cm in length) was inserted into the mouth and slowly pushed into the esophageal tract. The swab was inserted to approximately a fourth of the snake's body length and slowly retracted. Once removed, the cotton end of the pharyngeal swab (i.e., sample of both the oral cavity and esophageal tract) was broken off into 15 ml Falcon polystyrene conical tubes (Becton Dickinson and Co., Franklin Lakes, New Jersey) containing 5 ml of Butterfield's buffer. Serial dilutions were prepared for each sample and cultured aerobically at 35°C for 24 h on MacConkey agar for the isolation of Enterobacteriaceae. Isolated colonies were subcultured onto tryptic soy agar and cultured aerobically at 35°C for 24 h. Colonies that were oxidase negative were emulsified into 5 ml of sterile 0.85% NaCl (Leboffe and Pierce 2002). API 20E strips (bioMerieux, Inc., Hazelwood, Missouri) of 20 microcupules containing dehydrated substrates were inoculated according to directions supplied by the manufacturer. All reactions were read after 24 h. Each isolate was identified by using the API 20E profile index.

Only enteric species richness was tabulated for comparison of bacterial microflora among wild and captive *A. contortrix* and *A. piscivorus*. Blaylock (2001) found that most oral bacteria (81.5%)

TABLE 1. Alphabetical listing of the bacterial microflora sampled form eight snakes showing similarities and differences in bacterial species composition between copperheads (*A. contortrix*) and cottonmouths (*A. piscivorus*).

Bacterial Species	**Wild**		**Captive**	
	A. contortrix	*A. piscivorus*	*A. contortrix*	*A. piscivorus*
Acinetobacter baumannii	X	X		
Aeromonas caviae			X	
Aeromonas schubertii			X	
Aeromonas spp.			X	
Citrobacter freundii	X	X	X	
Citrobacter spp.	X		X	X
Enterobacter agglomeras	X			
Enterobacter cloacae		X		X
Enterobacter spp.		X		
Escherichia coli	X		X	
Klebsiella oxytoca			X	
Klebsiella pneumonia		X	X	X
Kluyvera spp.		X		
Leclercia adecarboxylata	X			
Proteus spp.			X	
Providencia alcalifaciens		X		
Providencia rettgeri			X	X
Pseudomonas aeruginosa			X	
Pseudomonas putida		X		
Salmonella spp.		X	X	
Xanthomonas maltophilia	X			
Species Richness (A.c. vs. A.p.)	7	9	12	4
Species Richness (Wild vs. Captive)	14		13	

were Enterobacteriaceae. Jaccard binary similarity coefficients for presence/absence data were used to investigate community similarity of bacterial microflora (Krebs 1999).

We identified 21 (15 to species level and 6 to genus level) bacterial species from the esophageal tracts of the eight *Agkistrodon* snakes. The comparison of bacterial microflora from the esophageal tract of wild-caught *A. contortrix* and *A. piscivorus* indicated that only two bacterial species (*Acinetobacter baumannii* and *Citrobacter freundii*) were shared between the snake species. Five bacterial species found in *A. contortrix* were not observed in *A. piscivorus* and seven bacterial species found in *A. piscivorus* were not observed in *A. contortrix* (Table 1). Of the 14 bacterial species found in the esophageal tract of wild-caught snakes, there was little similarity ($S_J = 0.143$) between wild *A. contortrix* and *A. piscivorus*. If differences in esophageal bacteria are influenced by difference in prey ingestion between *A. contortrix* and *A. piscivorus*, this finding may provide additional evidence for food partitioning between these sympatric snake species.

Although captive and wild snakes had similar species richness in bacterial microflora (13 and 14, respectively), there were considerable differences between the bacterial communities. Wild-caught snakes had eight bacterial species that were not observed in captive snakes (Table 1). These bacterial species may be common in the environment allowing these wild *Agkistrodon* snakes to inoculate their esophageal tracks. The presence of only four bacterial species in captive *A. piscivorus* supported our hypoth-

TABLE 2. Jaccard binary community similarity indices for comparisons of bacterial microflora among snake species for both captive and wild individuals.

		Wild		**Captive**	
		A. contortrix	*A. piscivorus*	*A. contortrix*	*A. piscivorus*
Wild	*A. contortrix*	_	0.143	0.200	0.100
	A. piscivorus	0.143	_	0.167	0.182
Captive	*A. contortrix*	0.200	0.167	_	0.231
	A. piscivorus	0.100	0.182	0.231	_

esis that individuals feeding only on one prey type such as laboratory mice (*Mus musculus*) would demonstrate a lower diversity of esophageal bacterial species. These results also agree with findings of Theakston et al. (1990) where captive snakes had fewer positive bacterial cultures. Although captive *A. contortrix* had the greatest number of bacterial species, captive *A. contortrix* and *A. piscivorus* demonstrated the greatest similarity (S_J = 0.231) in bacterial microflora (Table 2).

No study has investigated the bacterial microflora of the esophageal track in *Agkistrodon*. Some clinical work has been done on the antibacterial activity of venom against the bacteria of the oral cavity in crotalid snakes (e.g., Talan 1991). Unlike such clinical investigations, we provide the first inventory and assessment of species richness for common bacteria found in the oral cavity and esophageal tract of any species of *Agkistrodon*. Placing this information in the context of differences in prey use between *A. contortrix* and *A. piscivorus* might prove interesting. If differences in bacterial microflora are correlated with differences in prey ingestion by *A. contortrix* and *A. piscivorus*, then our findings might provide indirect but additional evidence for food partitioning between these sympatric snake species.

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Distribution of the Amphibians of Honduras by Departments

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McCranie and Castañeda (2007) recently published a review of the amphibian fauna of Honduras. That review included 124 species verified to occur in the country, an increase of seven species over that published in McCranie and Wilson (2002). Despite these two reviews, a summary of distribution by departments has never been published for the amphibian fauna of Honduras. The purpose of this paper is to present such a summary, an analysis of which should point out which areas of Honduras are understudied.

Materials and Methods.—The generic taxonomy used herein follows the recent changes proposed by Faivovich et al. (2005), Frost et al. (2006a, 2006b), and Nascimento et al. (2005). Also, the taxonomy for the *Ollotis coccifer* complex suggested by Mendelson et al. (2005) is not followed for the reasons discussed by McCranie and Castañeda (2007).

Of the 499 departmental records listed in Table 1, only seven are based on literature records of specimens not examined by me in the work leading up to McCranie and Wilson (2002) and McCranie and Castañeda (2007). These seven records are: *Bolitoglossa conanti* (Santa Bárbara), *Oedipina elongata* (Cortés), *Hyalinobatrachium cardiacalyptum* (Colón), *Plectrohyla dasypus* (Santa Bárbara), *Craugastor rostralis* (Santa Bárbara), *C. stadelmani* (Atlántida), and *Rhinophrynus dorsalis* (Francisco Morazán). A list of these literature records and of all specimens examined was provided by McCranie (2006).

Results.—Examination of Table 1 indicates that two departments (Lempira and Santa Bárbara) are clearly understudied. Lempira has only 13 species verified from within its limits, whereas Ocotepeque and Intibucá, which border Lempira on either side, have 20 and 25 species, respectively. However, a better indication of Lempira's poorly-studied status is demonstrated by the absence of records for *Scinax staufferi* and *Smilisca baudinii*, both of which are otherwise known from each of the 17 remaining Honduran departments. Also, no records of *Lithobates brownorum*, or *L. forreri*, or their putative "hybrids" have been recorded from Lempira, again the only department not represented by vouchers. Santa Bárbara has only 25 species verified from within its boundaries, but its neighbor to the west, Copán, has 37 species and Cortés, its neighbor to the north, has 49 species. Thus, Santa Bárbara should be expected to have a number somewhat intermediate between those for those two neighbors. Obvious missing species for Santa Bárbara are *Bolitoglossa rufescens*, *Agalychnis callidryas*, *Craugastor charadra*, *Hyalinobatrachium fleischmanni* (although males thought to be this species were heard calling on the night of 9 October 2006 at Cerro Negro, Santa Bárbara), *Leptodactylus melanonotus*, *Tlalocohyla loquax*, and *T. picta*. Also, McCranie and Castañeda (2007) predicted two species (*Nototriton brodiei* and *Craugastor nefrens*), both of which are known from the moun-

TABLE 1. Distribution by departments of the 125 species of amphibians known from Honduras. Department abbreviations are: ATL = Atlántida; CHO = Choluteca; COL = Colón; COM = Comayagua; COP = Copán; COR = Cortés; EP = El Paraíso; FM = Francisco Morazán; GAD = Gracias a Dios; INT = Intibucá; IBD = Islas de la Bahía; LAP = La Paz; LEM = Lempira; OCO = Ocotepeque; OLA = Olancho; SB = Santa Bárbara; VAL = Valle; and YOR = Yoro. Symbols in the species lists are: X = presence recorded; I = introduced; and H = "hybrid" populations between *Lithobates brownorum* and *L. forreri*.

SPECIES	ATL	CHO	COL	COM	COP	COR	EP	FM	GAD	INT	IDB	LAP	LEM	OCO	OLA	SB	VAL	YOR	Total
Caecilians (2)																			
Dermophis mexicanus	X	X	—	—	—	X	—	—	—	X	—	—	—	—	—	X	X	—	6
Gymnopis multiplicata	X	—	—	—	—	X	X	—	X	—	—	—	—	—	X	—	—	X	6
Subtotal	2	1	0	0	0	2	1	0	1	1	0	0	0	0	1	1	1	1	12
Salamanders (28)																			
Bolitoglossa carri	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	1
Bolitoglossa celaque	—	—	—	X	—	—	—	—	—	X	—	X	X	—	—	—	—	—	4
Bolitoglossa conanti	—	—	—	—	X	X	—	—	—	—	—	—	—	X	—	X[1]	—	—	4
Bolitoglossa decora	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	1
Bolitoglossa diaphora	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	1
Bolitoglossa dofleini	—	—	—	—	X	X	—	—	—	—	—	—	—	—	—	X[2]	—	X	4
Bolitoglossa dunni	—	—	—	—	X	X	—	—	—	—	—	—	—	—	—	—	—	—	2
Bolitoglossa heiroreias	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	1
Bolitoglossa longissima	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	1
Bolitoglossa mexicana	X	—	X	X	X	X	X	X	X	—	—	—	—	—	X	X[2]	—	X	11
Bolitoglossa occidentalis	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Bolitoglossa oresbia	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Bolitoglossa porrasorum	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	2
Bolitoglossa rufescens	X	—	—	—	X	X	—	—	—	—	—	—	—	—	—	—	—	X	4
Bolitoglossa striatula	—	—	—	—	—	—	—	—	X	—	—	—	—	—	X	—	—	—	2
Bolitoglossa synoria	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	1
Cryptotriton nasalis	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	1
Dendrotriton sanctibarbarus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	1
Nototriton barbouri	X	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	X	3
Nototriton lignicola	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	1
Nototriton limnospectator	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	1
Oedipina cyclocauda	X	—	X	—	—	—	—	—	X	—	—	—	—	—	X	—	—	X	5
Oedipina elongata	—	—	—	—	X	X	—	—	—	—	—	—	—	—	—	X[2]	—	—	3
Oedipina gephyra	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	2
Oedipina ignea	—	—	—	—	—	—	—	—	—	X	—	X	—	X	—	—	—	—	3
Oedipina stuarti	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	X	—	2
Oedipina taylori	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	1
Oedipina tomasi	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	1
Subtotals	6	0	2	4	6	10	1	4	3	2	0	2	1	4	6	6	1	7	65

TABLE 1. Continued.

SPECIES	ATL	CHO	COL	COM	COP	COR	EP	FM	GAD	INT	IDB	LAP	LEM	OCO	OLA	SB	VAL	YOR	Total
Anurans (95)																			
Agalychnis callidryas	X	—	X	—	X	X	X	—	X	—	—	—	—	—	X	—	—	—	7
Agalychnis moreletii	X	—	—	—	X	X	—	—	—	X	—	—	—	—	—	—	—	—	4
Agalychnis saltator	—	—	—	—	—	—	—	—	X	—	—	—	—	—	X	—	—	—	2
Anotheca spinosa	—	—	—	—	—	—	—	—	X	—	—	—	—	—	X	—	—	—	2
Atelophryniscus chrysophorus	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	2
Bromeliohyla bromeliacia	—	—	—	—	X	X	—	—	—	—	—	—	—	—	—	—	—	—	2
Centrolene prosoblepon	—	—	X	—	—	—	—	—	X	—	—	—	—	—	X	—	—	—	3
Chaunus marinus	X	X	X	X	X	X	X	X	X	X	I	X	X	X	X	X	X	X	18
Cochranella albomaculata	—	—	X	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	2
Cochranella granulosa	—	—	—	—	—	—	—	—	X	—	—	—	—	—	X	—	—	—	2
Cochranella spinosa	—	—	—	—	—	—	—	—	X	—	—	—	—	—	X	—	—	—	2
Craugastor anciano	—	—	—	—	—	—	—	—	—	—	—	—	X	X	—	—	—	—	2
Craugastor aurilegulus	X	—	X	—	—	—	—	—	—	—	—	—	—	—	X	—	—	X	4
Craugastor chac	X	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	2
Craugastor charadra	—	—	—	—	X	X	—	—	—	—	—	—	—	—	—	—	—	—	2
Craugastor coffeus	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Craugastor chrysozetetes	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Craugastor cruzi	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Craugastor cyanochthebius	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Craugastor emleni	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	2
Craugastor epochthidius	—	—	X	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	2
Craugastor fecundus	X	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
Craugastor fitzingeri	—	—	X	—	—	—	X	—	X	—	—	—	—	—	X	—	—	—	4
Craugastor laevissimus	—	—	—	X	—	X	X	X	—	X	—	X	—	—	X	X	—	—	8
Craugastor laticeps	X	—	—	—	X	X	—	—	—	—	—	—	—	—	—	X	—	—	4
Craugastor lauraster	—	—	—	—	—	—	X	—	X	—	—	—	—	—	X	—	—	—	3
Craugastor megacephalus	—	—	—	—	—	—	X	—	X	—	—	—	—	—	X	—	—	—	3
Craugastor merendonensis	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	1
Craugastor milesi	—	—	—	—	X	X	—	—	—	—	—	—	—	—	—	—	—	—	2
Craugastor mimus	—	—	—	—	—	—	—	—	X	—	—	—	—	—	X	—	—	—	2
Craugastor noblei	X	—	X	—	—	—	—	—	X	—	—	—	—	—	X	—	—	—	4
Craugastor olanchano	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	1
Craugastor omoaensis	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	1
Craugastor pechorum	—	—	X	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	2
Craugastor rhodopis	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	1
Craugastor rostralis	—	—	—	—	X	X	—	—	—	—	—	—	—	—	—	X[1]	—	X	4
Craugastor saltuarius	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	2
Craugastor stadelmani	X	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	X	3
Craugastor sp.[3]	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	1
Cruziohyla calcarifer	—	—	—	—	—	—	—	—	X	—	—	—	—	—	X	—	—	—	2
Dendropsophus ebraccatus	—	—	—	—	—	—	—	—	X	—	—	—	—	—	X	—	—	—	2
Dendropsophus microcephalus	X	—	X	X	X	X	X	X	X	X	X	—	—	—	X	X	—	X	13
Duellmanohyla salvavida	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	2
Duellmanohyla soralia	—	—	—	—	X	X	—	—	—	—	—	—	—	—	—	X[1]	—	—	3

TABLE 1. Continued.

SPECIES	ATL	CHO	COL	COM	COP	COR	EP	FM	GAD	INT	IDB	LAP	LEM	OCO	OLA	SB	VAL	YOR	Total
Ecnomiohyla miliaria	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	1
Ecnomiohyla salvaje	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Eleutherodactylus cerasinus	—	—	X	—	—	—	—	—	X	—	—	—	—	—	X	—	—	—	3
Eleutherodactylus ridens	X	—	X	—	—	—	—	—	X	—	—	—	—	—	X	—	—	—	4
Eleutherodactylus diastema	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	1
Engystomops pustulosus	—	X	—	X	X	X	X	X	—	X	—	X	X	X	X	X	X	—	13
Exerodonta catracha	—	—	—	X	—	—	—	—	—	X	—	X	—	—	—	—	—	—	3
Gastrophryne elegans	X	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	2
Hyalinobatrachium cardiacalyptum	—	—	X	—	—	—	—	—	X	—	—	—	—	—	X	—	—	—	3
Hyalinobatrachium crybetes	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	1
Hyalinobatrachium fleischmanni	X	—	—	X	X	X	X	—	X	—	—	X	—	—	X	—	—	X	9
Hyalinobatrachium pulveratum	—	—	X	—	—	—	—	—	X	—	—	—	—	—	X	—	—	—	3
Hypopachus barberi	—	—	—	—	—	—	—	—	—	X	—	X	—	X	—	—	—	—	3
Hypopachus variolosus	—	X	—	X	X	X	X	X	—	X	—	X	—	X	X	X	—	X	12
Isthmohyla insolita	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	1
Isthmohyla melacaena	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	1
Leptodactylus fragilis	—	X	—	X	X	X	X	X	X	X	—	X	X	—	X	X	X	X	14
Leptodactylus melanonotus	X	X	X	X	X	X	X	X	X	X	X	—	—	—	X	—	X	—	13
Leptodactylus savagei	—	—	X	—	—	—	X	—	X	—	—	—	—	—	X	—	—	—	4
Leptodactylus silvanimbus	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	1
Lithobates brownorum	X	—	X	X	X	X	X	X	X	X	X	—	—	—	X	X	—	X	13
Lithobates forreri	—	X	—	—	—	—	X	X	—	H	—	H	—	H	—	—	X	—	4
Lithobates maculatus	X	X	X	X	X	X	X	X	—	X	—	X	X	X	X	X[2]	—	X	15
Lithobates vaillanti	X	—	X	X	X	X	—	X	X	—	X	—	—	—	X	X	—	X	11
Lithobates warszewitschii	—	—	—	—	—	—	—	—	X	—	—	—	—	—	X	—	—	—	2
Ollotis campbelli	—	—	—	—	X	X	—	—	—	—	—	—	—	—	—	—	—	—	2
Ollotis coccifer	—	X	—	X	—	—	X	X	X	X	—	X	X	X	X	—	X	—	11
Ollotis leucomyos	X	—	X	—	—	—	—	—	—	—	—	—	—	—	X	—	—	X	4
Ollotis luetkenii	—	X	—	X	—	—	X	X	—	X	—	X	—	—	X	—	X	—	8
Ollotis valliceps	X	—	X	X	X	X	X	X	X	X	—	—	—	—	X	X	—	X	12
Plectrohyla chrysopleura	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Plectrohyla dasypus	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	X[1]	—	—	2
Plectrohyla exquisita	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	1
Plectrohyla guatemalensis	X	—	—	X	X	—	—	X	—	X	—	X	X	X	X	—	—	X	10
Plectrohyla hartwegi	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	1
Plectrohyla matudai	—	—	—	—	X	—	—	—	—	—	—	—	X	X	—	—	—	—	3
Plectrohyla psiloderma	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	1
Ptychohyla hypomykter	—	—	—	X	X	X	X	X	—	X	—	X	X	X	X	X	—	X	12
Ptychohyla salvadorensis	—	—	—	—	—	—	—	X	—	X	—	X	X	X	—	—	—	—	5
Ptychohyla spinipollex	X	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	3
Rhaebo haematiticus	—	—	X	—	—	—	—	—	X	—	—	—	—	—	X	—	—	—	3
Rhinophrynus dorsalis	—	—	—	—	—	X	—	X	—	—	—	—	—	—	—	—	—	—	2
Scinax boulengeri	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	1
Scinax staufferi	X	X	X	X	X	X	X	X	X	X	X	X	—	X	X	X	X	X	17
Smilisca baudinii	X	X	X	X	X	X	X	X	X	X	X	X	—	X	X	X	X	X	17

tains of Guatemala near the border with Santa Bárbara, should also occur in Santa Bárbara.

Colón, with its 31 species, also appears to be understudied. Atlántida, its neighbor to the west has 40 species and Gracias a Dios, its neighbor to the east, has 43 species. Several species otherwise only recorded from the Mosquitia in northeastern Honduras, should also occur in eastern Colón (e.g., *Cochranella granulosa*, *Craugastor mimus*).

The Pacific lowlands of Choluteca and Valle also appear to be understudied. Although badly denuded, there are several species that are recorded from these continuous lowlands both to the west and south, but have not yet been recorded from one or both of these departments (e.g., *Rhinophrynus dorsalis*, *Trachycephalus venulosus*).

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Table 1. Continued.

SPECIES	ATL	CHO	COL	COM	COP	COR	EP	FM	GAD	INT	IDB	LAP	LEM	OCO	OLA	SB	VAL	YOR	Total
Smilisca phaeota[4]	—	—	X	—	—	—	—	—	X	—	—	—	—	—	X	—	—	—	3
Smilisca sordida	—	—	X	—	—	—	—	—	X	—	—	—	—	—	X	—	—	—	3
Tlalocohyla loquax	X	—	—	X	X	X	—	X	X	X	—	—	—	—	X	—	—	X	9
Tlalocohyla picta	X	—	X	—	X	X	—	—	X	—	—	—	—	—	—	—	—	—	5
Trachycephalus venulosus	X	X	X	X	X	X	X	X	X	—	—	—	—	X	X	X	—	X	13
Triprion petasatus	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	1
Subtotal	32	12	30	21	31	37	23	23	39	22	7	16	12	16	49	18	9	24	422
Totals	40	13	31	25	37	49	25	27	43	25	7	18	13	20	56	25	11	32	499

[1]The La Fortuna, Santa Bárbara, record for this species based on Townsend (2006) was mapped by McCranie and Castañeda (2007), but not listed as from Santa Bárbara in McCranie (2006)

[2]This represents a new departmental record based on collections made at Cerro Negro, Santa Bárbara, on 9–10 October 2006

[3]This apparently represents an undescribed species of the *rugulosus* group recently collected on Montaña de Mixcure, Intibucá

[4]Erroneously mapped in El Paraíso by McCranie and Castañeda (2007)

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Comparison of Clutch Size from Natural Nests and Oxytocin Induced Clutches in the Red-Eared Slider, *Trachemys scripta elegans*

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The discovery (reviewed by Ewert and Legler 1978) that oxytocin could be used to induce oviposition in captive turtles represented a major innovation for studies of reproduction in turtles. The general presumption in studies using oxytocin to induce oviposition is that the number of eggs released in the laboratory by a particular turtle is the same as the number of eggs that turtle would have deposited in a natural nest. Because of the importance that oxytocin use has assumed in modern studies of turtle reproduction (e.g., Iverson and Smith 1993; Rowe 1994, Tucker et al. 1998a, b), it is appropriate to compare clutch sizes from natural nests to clutches from female Red-Eared Sliders (*Trachemys scripta elegans*) induced to oviposit with oxytocin.

The turtles were collected at nesting areas near Stump Lake (N = 131) in Jersey County, Illinois (USA), and from Swan Lake (N = 94) and Pohlman Slough (N = 21) in Calhoun County, Illinois. These localities are on or border the lower Illinois River. Additional turtles (N = 29) were collected from Gilead Slough, a backwater of the Mississippi River in Calhoun County, Illinois. Collecting methods and study sites are detailed in Tucker et al. (1998a, b).

A total of 25 turtles were found in the process of completing natural nests. In each case, the turtle was caught and palpated to determine if any oviductal eggs were retained following nesting. Nests were excavated, and the eggs were removed and counted.

Oxytocin (0.2 ml/kg) was used to induce oviposition in all turtles not found with completed nests. Because some females retain some or all of the complement of oviductal eggs after oxytocin is administered (Congdon and Gibbons 1985), each turtle was palpated to ensure that all eggs had been laid (Iverson and Smith 1993). Palpation is an effective method to detect eggs in this species (e.g., Thornhill 1982). However, when more than one egg per oviduct remains it becomes impossible to accurately count the eggs remaining in the turtle. Thus twelve of the induced turtles that retained more than two oviductal eggs upon palpation were excluded (Tucker et al. 1998a). No turtles making natural nests retained eggs and none were excluded.

The SAS system was used for statistical tests (SAS Institute 1998). Since most egg and clutch parameters are related to measures of female size, analysis of covariance (ANCOVA; female plastron length as the covariate) was used to compare clutch sizes. The resulting least squares means (LSM) are presented in the text along with unadjusted means.

Mean clutch size for 24 natural nests was 14.6 eggs (SD = 2.81, range 9–19 eggs) whereas mean clutch size for 251 turtles induced to oviposit in the laboratory was 14.3 eggs (SD = 3.72, range = 6–30). Once adjusted for plastron length, LSM (14.9 eggs) for natural nests did not differ (p = 0.3067) from LSM (14.2 eggs) for induced clutches. Because nesting behavior or response to oxytocin might vary between locations, we also compared clutches from natural nests and clutches induced by oxytocin from Swan and Stump Lakes where the bulk (21 of 25) of the natural nests were encountered. LSM (14.9 eggs, N = 14 clutches) for Swan Lake and LSM for Stump Lake (15.6 eggs, N = 7 clutches) for clutches from natural nests did not differ from induced clutches at Swan Lake (LSM = 14.1 eggs, N = 80 clutches, p = 0.2248) nor at Stump Lake (LSM = 14.9 eggs, N = 124 clutches, p = 0.6224).

The results confirm that clutch size from clutches induced with oxytocin are statistically equivalent to clutch size for clutches laid in natural nests by *Trachemys scripta elegans*. These results may be widely applicable to other North American temperate turtles but should be confirmed. The present study supports use of clutch size values determined with oxytocin induction along with counts from natural nests, because the values are comparable.

The accuracy of palpation as a method to count eggs in turtles is questionable. However, use of palpation to determine that only one or two eggs are remaining apparently is possible. Had it yielded systematic undercounts of eggs then the means for eggs induced by oxytocin and those for eggs laid in natural nests should have reflected this. Instead means differed by only 0.3 eggs per clutch. Use of palpation may not be applicable to other species. Some species (e.g., Common Snapping Turtle, *Chelydra serpentina*; Spiny Softshell, *Apalone spinifera*) may be too big for palpation to be useful. Others that lay small clutches (e.g., Painted Turtle, *Chrysemys picta*; Stinkpots, *Sternotherus odoratus*) may be more vulnerable to error than those that lay larger clutches. Use of x-rays to determine clutch size may be more accurate in these cases but that hypothesis remains untested.

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TECHNIQUES

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Clutch Bags for Aquatic-Breeding Amphibians

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Life history theory assumes that organisms endeavor to maximize fitness by making the greatest genetic contribution to their population (Begon et al. 2006; Stearns 1992). Fecundity, in turn, is often considered one of the most useful short-term measurements of lifetime fitness (Begon et al. 2006). By understanding how individual life history characteristics interact to regulate fecundity, and therefore fitness, we can draw conclusions about how those influences have shaped adaptation (Lauck 2005; Stearns 1992).

Amphibians are known for their complex and flexible life histories. Many species of amphibians lay eggs in a single mass (e.g. *Ambystoma jeffersonianum* and *A. maculatum*, Brodman 1995; *Eurycea cirrigera*, Guy et al. 2004; *Rana temporaria*, Loman 2001; *Rana sylvatica*, Starnes et al. 2000), allowing easy estimation of clutch size by inspection of natural nest-cover objects and introduced nest-cover objects (e.g., slate tiles, Guy et al. 2004). Other species, however, spread their eggs throughout the environment (e.g., *Tylototriton verrucosus*, Roy and Mushahidunnabi 2001; *Pseudacris triseriata feriarum* and *Hyla chrysoscelis*, Starnes et al. 2000), making estimation of clutch size more problematic. Furthermore, in order to determine how fecundity in amphibians is related to environmental conditions and other female life history traits such as body size, body condition, age, or size and age at metamorphosis, parentage of a clutch must be determined. In past studies, this has primarily been done by sacrificing individuals and determining clutch size via dissection (Chazal and Niewiarowski 1998; Lauck 2005; Redmer 2000, 2002). Other studies have followed individuals until they oviposit, although this typically results in a smaller sample size due to the time restrictions incurred (Giaretta and Menin 2004; Prado and Haddad 2005; Roy and Mushahidunnabi 2001).

An answer to the problem of determining parentage, as well as clutch size for amphibians that do not lay their eggs in a mass, is to capture gravid females during the breeding season and then confine them within their natural environment until they have oviposited. At this point adults can be measured, clutch characteristics determined, and both adults and eggs released without negative effects. In situ cages have been used in the past to rear tadpoles, for hatching eggs, or for containing adult amphibians, however these methodologies utilized bulky, non-collapsible frames or containers (e.g., De Solla et al. 2002; Harris et al. 2001; Hels 2002; Vorndran et al. 2002). Each of these methodologies, however, may prove too cumbersome or difficult to transport in other experimental situations. In response to our need to quantify clutch size of the Arizona Tiger Salamander *Ambystoma tigrinum nebulosum*, a subspecies that lays eggs singly (Collins 1980), we designed a lightweight and collapsible, submersible cage that allows a female to lay eggs within her native pond while permitting efficient collection of eggs. We evaluated our cage in six temporary and permanent ponds at the Mexican Cut Nature Preserve near Gothic, Colorado, USA.

Our "clutch bag" consisted of a cylindrical mesh bag and an internal PVC pipe frame (Fig. 1), which was modified from a design used by Pfennig et al. (1999). The mesh bag was 30.5 cm tall by 100 cm wide, and was made from flexible, galvanized fiberglass screening (New York Wire, Mt. Wolf, Pennsylvania). Each bag was sewn together at a local upholstery using an industrial sewing machine and had a 30.5 cm opening at the top. The supporting frame consisted of a central pipe (90 cm long) and four legs (30 cm long), all constructed from 1/2 in PVC pipe. Two legs were attached to each end of the central pipe using a three way elbow joint. The frames and bags were light to transport and easily assembled and disassembled due to the three way joints, which fit snugly with the PVC pipe without adhesive. These features are especially important when experimental set ups must be transported to remote locations.

Between June 28 and July 11, 2005, metamorphic and paedomorphic female tiger salamanders were collected using dip nets as a part of a long-term life history study of this population (Whiteman and Wissinger 2005). Swollen females were placed in individual cages along with sticks, small rocks and cut sedges from the immediate natural environment for oviposition. The opening to each bag was fastened shut using a plastic "chip clip", typically found in most grocery stores. Bags were placed so that only 2–3 cm of the cages were above water level. The cages were generally placed in the shade, however when shade was not available spruce boughs were placed on top of the cages to prevent overheating. Cages were checked for eggs every one to two days, and no female was left in their cage for more than five days. Any eggs found were counted and immediately released into the pond, except for ~15 eggs per female, which were kept for genetic analysis (Gerlanc unpublished data). In instances when females had not immediately laid eggs, the female was assumed to have not yet mated, and a sexually mature male was added to the bag for 24 h. If females still did not produce a clutch, it was assumed that females had laid prior to being captured and placed in a clutch bag.

Twenty-two of the 29 females placed in bags laid eggs, and none of the females appeared adversely affected by their containment. No salamanders escaped, and the easily manipulated bags allowed efficient counting of eggs. The frames also provided a safer enclosure than previous designs, which were propped open using sticks and often collapsed into themselves during heavy wind and wave action. When working with terrestrial amphibians an air pocket above water is necessary, and can be more consistently and safely provided with the PVC pipe frame than by propping bags open with the aforementioned sticks.

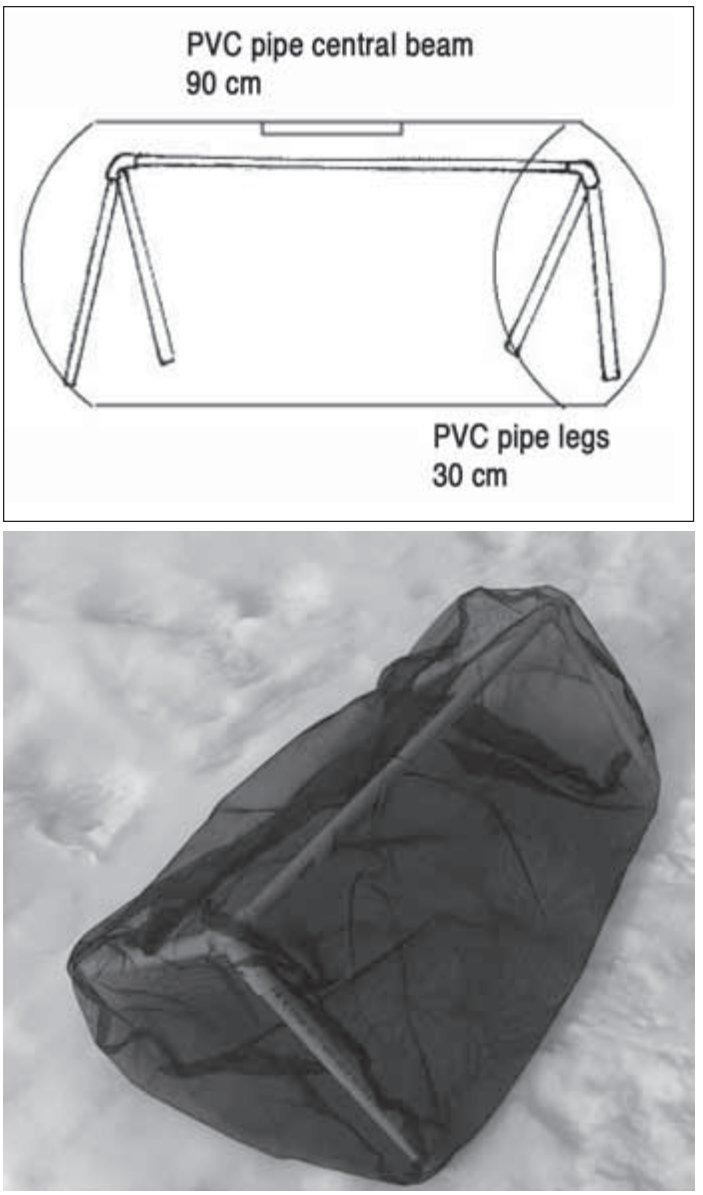


FIG. 1. PVC pipe frame and mesh bag for sampling clutch size. Images are courtesy of Barbara Doyle and Billy Barr.

These cages could be feasibly modified in size for collecting eggs of many different species of salamanders and small anurans, as well as rearing larvae of amphibian species, as has been done with smaller mesh bags and cages (De Solla et al. 2002; Vorndran et al. 2002). Clutch bags can also be used for mating experiments, e.g., to contain a breeding male and female, thereby creating known offspring pedigrees. Additionally, these bags could be used to safely contain predator species when studying the effects of predators on prey behavior in mesocosm experiments.

Materials used to create each bag cost approximately US $6.31. For each frame the budget was as follows: $1.09 for PVC pipe, $2.30 for 3-way elbows and adapters, and $2.92 for screening. Additional funds were spent for the labor to sew bags together; however this could be negligible if the bags were stapled together instead. The low cost, coupled with their versatility, make these bags a suitable and safe alternative to previous methodologies.

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Are Two Methods Better than One? Area Constrained Transects and Leaf Litterbags for Sampling Stream Salamanders

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Concern over large-scale amphibian and reptile declines and general acknowledgement of sparse baseline information for most herpetological species has prompted the initiation of several monitoring programs. These programs, as well as ecological studies focused on metapopulation dynamics and habitat associations, often use presence-absence (or probability of occupancy) as the parameter of interest. For example, the long-term monitoring design of the US Geological Survey's Amphibian Research and Monitoring Initiative (ARMI) uses multi-season models developed by MacKenzie et al. (2003) to estimate the changes in the proportion of sites occupied by a species. As a national program, ARMI has chosen occupancy as the state variable of interest (rather than abundance), because of the ease and relative cost efficiency of collecting survey data (i.e., detection or non-detection of each target species), and the ability to incorporate the probability of detecting a species to obtain unbiased estimates of occupancy (MacKenzie et al. 2002). Sampling methods may differ in their effectiveness in detecting a species at an occupied site (Bailey et al. 2004). Because a higher probability of detection means fewer surveys are needed to obtain good precision for the occupancy estimator (MacKenzie and Royle 2005), efficient survey designs should consider detection probabilities in the cost/benefit analysis of sampling methods. The goal of this study was to determine the most efficient method for estimating stream salamander habitat occupancy at a regional scale, as part of the Northeast region of the ARMI program (NE ARMI).

Several methods exist for sampling stream salamanders including area-constrained transects (Grant et al. 2005; Heyer et al. 1994), cover-controlled active searches (Heyer et al. 1994; Lowe and Bolger 2002), time-constrained searches (Barr and Babbitt 2002) and leaf litter refugia bags ('leaf litterbags'; Pauley and Little 1998). Area-constrained transect surveys may give a reliable index of the relative abundance of stream salamanders, and multiple passes can be used to estimate population sizes using removal models (Bruce 1995; Jung et al. 2000). Leaf litterbags are a uniform way to sample the leaf litter habitat and are an effective method for determining species presence, but not abundance (Chalmers and Droege 2002; Waldron et al. 2003). Leaf litterbags have been proposed as an appropriate method for determining site occupancy (Pauley and Little 1998; Waldron et al. 2003), and they may increase detection probabilities of some species or life stages.

During a survey, a species can be present but not detected (i.e., a false absence), causing the site to appear unoccupied. To estimate the true occupancy state of a species, multiple 'surveys' are required, which can be in the form of repeat site visits, multiple observers, replicate surveys, or multiple methods conducted simultaneously. Methods that increase detection probabilities of a species can reduce the optimal number of surveys of a site needed to obtain a precise estimate of occupancy (MacKenzie and Royle 2005). To determine the most efficient survey design, we compared the probabilities of detecting *Desmognathus fuscus*, *Eurycea bislineata*, and *Pseudotriton ruber* using area-constrained transects (hereafter 'transects') and leaf litterbags in twenty-five 30 m stream reaches within 12 first- and second-order streams in the Chesapeake & Ohio Canal National Historic Park, Maryland (38°59'N, 77°14'W) and Rock Creek National Park, District of Columbia (38°57'N, 77°02'W). We surveyed each site twice from 16 June to 29 July 2005. During the sample period, all age classes of *E. bislineata* and *P. ruber* were available for capture, while only adult and juvenile *D. fuscus* were available (as the previous year's larvae had metamorphosed by this time). By sampling with both methods within the same stream reach, we were able to estimate detection probabilities for each species-method combination, and determine the possible bias associated with each sampling method.

Methods.—The transects consisted of two 15 × 3 m areas (1 m in the water and 2 m on the bank), located on opposite banks and separated by 15 m. To survey each transect, one observer proceeded upstream, turning all cover objects greater than 6 cm in diameter. An aquarium net was used to facilitate the capture of salamanders. Three leaf litterbags were placed within each 15 m transect at 0, 7.5, and 15 m. The bags were placed one week prior to sampling to allow colonization by salamanders. Our leaf litterbags were constructed of two layers of 50 × 50 cm Deer Block brand plastic netting, with a mesh size of 15 × 15 mm, and filled with 50-60 grams (dry weight) of leaf litter (Chalmers and Droege 2002; Waldron et al. 2003). To maximize the likelihood of capturing larval salamanders, leaf litterbags were partially submerged (Waldron et al. 2003), using a rock to hold each bag in place. The leaf litterbags were checked after a week and again 3–4 weeks later by placing a net under the bag, and immediately placing the bag into a wash basin with water. We shook the bag in water for 15–20 seconds to loosen salamanders, then drained the contents of the basin into a net, and searched for salamanders.

We defined a site as a 30 m stream reach and used the program PRESENCE (MacKenzie et al. 2002) to estimate the proportion of sites that were occupied. For each of the following analyses we used the detection/non-detection data for each species separately, and estimated the species-specific detection probability (*p;* defined as the probability of detecting the species at an occupied site) and the proportion of sites occupied (ψ), while accounting for a species not always being detected when present (i.e., $p < 1$).

We conducted three separate analyses. First, we combined detection information from transect and leaf litterbag searches into a single survey event ('combined' dataset). In this dataset, the probability of detection represents the likelihood that the species was detected by either survey method during a survey event, and the resulting estimate of occupancy should provide an unbiased esti-

Table 1. Detection probability (*p)* and estimates of site occupancy (ψ) for the salamanders *Desmognathus fuscus*, *Eurycea bislineata*, and *Pseudotriton ruber*. The data was analyzed in three ways: using method as a covariate ('Method-covariate'), separately for each method ('Method-specific'), and combined detections from both methods for each survey event ('Combined'). Naïve occupancy estimates for *E. bislineata* (ψ = 0.68), *D. fuscus* (ψ = 0.44) and *P. ruber* (ψ = 0.28) do not account for missed detections. Occupancy could not be estimated for *D. fuscus* under the method-specific leaf litterbag model because there were too few detections for parameter estimation.

		Eurycea bislineata		*Desmognathus fuscus*		*Pseudotriton ruber*	
Survey Method	Dataset	*p* (SE)	ψ (SE)	*p* (SE)	ψ (SE)	*p* (SE)	ψ (SE)
Transect	Method-covariate	0.6206 (0.0879)	0.7153 (0.0992)	0.7869 (0.1052)	0.4602 (0.1052)	0.1127 (0.2979)	0.5412 (0.2979)
	Method-specific	0.6278 (0.1206)	0.7104 (0.1382)	0.8857 (0.0800)	0.4079 (0.1003)	0.6619 (0.3165)	0.0913 (0.0660)
Leaf litterbag	Method-covariate	0.5078 (0.0879)	0.7153 (0.0992)	0.1311 (0.0711)	0.4602 (0.1052)	0.2255 (0.2979)	0.5412 (0.2979)
	Method-specific	0.5476 (0.1410)	0.6669 (0.1678)	0.0612 (0.0342)	—	0.3282 (0.2465)	0.3713 (0.2699)
Both methods	Combined	0.8204 (0.0781)	0.7131 (0.1001)	0.8377 (0.0919)	0.4560 (0.1040)	0.4383 (0.2059)	0.4164 (0.1949)

mate of the true occupancy state of the site. Second, we analyzed a single dataset in which each detection/non-detection observation was separate for the two methods employed during a survey event ('method-covariate'). By modeling "method" as a covariate in the PRESENCE models, we were able to obtain detection estimates for each survey method, using knowledge of sites where the species was detected by the other method. Finally, we analyzed separate datasets ('method-specific') for each method, in which the probability of detection represents the likelihood that the species was detected by only one method. This dataset represents the data that would be collected if only one method was implemented, and thus may reveal a potentially biased estimate of the site occupancy, suggesting that the sampling method itself may be flawed.

These analyses allowed us to investigate possible heterogeneity in detection probabilities caused by sampling bias associated with each survey method. The two methods may differ in their detection probabilities, but if the methods are able to detect a species, then the detection-adjusted estimates of occupancy should be the same among all the analyses. Drastic differences in the occupancy estimates would suggest a bias in the actual sampling method (i.e., if one method was unable to detect, or had very low probability of detecting the target species at occupied sites). Comparing the method-specific estimates of occupancy with the 'method-covariate' and 'combined' datasets gives an assessment of sampling bias for each survey method (Bailey et al. 2004).

Results and Discussion.—For *D. fuscus* and *E. bislineata*, the detection probabilities were higher for transects than leaf litterbags (Table 1). For *D. fuscus* this was expected, because submerged leaf litterbags target the larval life stage (Waldron et al. 2003), which was not present during the survey period. We were therefore unable to estimate a method-specific estimate for leaf litterbags for *D. fuscus* (Table 1). For *E. bislineata* the probability of detection increased slightly when both methods were used. Both methods appear suitable for detecting this species, as the point estimates of site occupancy were similar across all datasets, though transects alone had a slightly higher probability of detection (Table 1). For both *D. fuscus* and *E. bislineata*, incorporating detection probability resulted in an estimate of occupancy that was higher than the naïve estimate (the fraction of sites where the species was detected without accounting for missed detections; naïve $\psi_{E.\ bislineata}$ = 0.68; naïve $\psi_{D.\ fuscus}$ = 0.44, Table 1).

For *P. ruber*, leaf litterbags were more effective at detecting salamanders than area constrained transects (Table 1). Using transects, *P. ruber* was detected at 2 of the 25 sites, and at one site it was found during both survey events. This resulted in a high estimate of *p*, (though with a large SE) for the method-specific transect dataset. However, when method is modeled as a covariate (Table 1; method-covariate dataset), additional information is provided from leaf litterbag detections, which were more efficient at detecting larval salamanders. Including detections from leaf litterbags reduced the estimate of *p* for the transect method (as *P. ruber* was never detected by both methods at a site). The estimate of occupancy for the method-specific dataset using transects was much lower than the known, naïve estimate of site occupancy (method-specific ψ = 0.09, naïve ψ = 0.28). These data indicate the bias in occupancy estimates which would have resulted from using only the transect sampling method, due to the very low probabilities of detecting *P. ruber* (i.e., *p* = 0.1127 for the transect survey method in the 'method-covariate' dataset). For this species, sampling with leaf litterbags in combination with transects increases the detection probability, eliminates or reduces bias in occupancy estimates that may result from using just one detection method, and also decreases the number of times a site should be visited to obtain an optimal occupancy estimate (i.e., low SE) from 19 to 4 visits (MacKenzie and Royle 2005; Table 2).

As expected, using two methods to detect the presence of a species provides a more precise estimate of occupancy than a single method alone (Table 1). For example, *P. ruber* was never detected by both methods at the same site, and the estimate of occupancy is more precise for the combined dataset (Table 1).

If one method is superior for detecting a species, then the addition of a second method provides redundant information that does not improve the occupancy estimate. The inferior sampling method can still be used, but the optimal number of visits to a site increases substantially (e.g., Table 1, 2; leaf litterbags are less suitable for detection of *D. fuscus*, and therefore inflate the optimal number of surveys from k = 2 to 17, MacKenzie and Royle 2005). Further, when the detection probability is high, the increase in detection provided by a second method does not change the esti-

TABLE 2. Optimal number of surveys (k) given occupancy (ψ) and detection (*p*) estimates from the method-covariate dataset and the combined dataset models (from Table 1).

Survey Method	*Eurycea bislineata*	*Desmognathus fuscus*	*Pseudotriton ruber*
Transect	3	2	19
Leaf litterbag	4	17	9
Combined	2	2	4

mate of occupancy or the optimal number of visits to a site (e.g., Table 1, 2; *E. bislineata*).

Sampling methodologies may vary in their effectiveness of sampling different life stages. Leaf litterbags are designed to preferentially capture larval salamanders (Waldron et al. 2003), and our transect surveys are designed to sample all life stages. In our study, leaf litterbags detected adult salamanders of all three species with low probabilities, and thus leaf litterbags are not likely to provide the data necessary to estimate patterns in stream occupancy by adult salamanders with sufficient power. If occupancy of a habitat by a particular life stage is of primary interest, then the sampling program should be designed primarily using methods that target that life stage. Regardless, interpretation of results should consider that a sampling method may detect all life stages, while having different detection probabilities for each life stage.

Conclusions.—In studies designed to assess the status and trends in occupancy of a suite of species across a large area, the allocation of survey effort is a chief concern. For species that are difficult to detect on a given sampling occasion, such as *P. ruber*, the use of an additional method may increase the precision and decrease bias in estimates of occupancy. However, since we found leaf litterbags were expensive to construct (materials cost per bag was US $2.50), difficult to maintain in the field, and had lethal effects on non-target organisms (i.e., two dead snakes were found tangled in the litterbags), we suggest sampling the leaf litter at a set distance interval (i.e., 1 m) using an aquarium net, rather than deploy leaf litterbags. Incorporating leaf litter sampling into the transect surveys may be more effective than using leaf litterbags because of increased detections of species that are more likely to be captured within the leaf litter (Bruce 2003; E. Grant, unpubl. data).

Regardless, when designing a research or monitoring program, assessment of the potential bias in survey methods should be incorporated into the study design (e.g., this study; Bailey et al. 2004; O'Connell et al. 2006). In addition, pilot data can guide optimization of data collection to meet a variety of study objectives (Bailey et al. *in press*; MacKenzie and Royle 2005), and will ultimately yield estimates that facilitate comparisons among studies, provided the state variable estimates account for missed detections.

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A New Method for Estimating Clutch Sizes of Ambystomatid Salamanders and Ranid Frogs: Introducing the Ovagram

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Clutch size is an important demographic trait of amphibians that is frequently used in descriptive ecological studies (Woodward 1982), biogeographic comparisons (Karraker et al. 2006), studies of population dynamics (Berven 1990) and population modeling (Vonesh and De la Cruz 2002). However, egg masses are large in many species, and clutch size cannot be easily determined visually in the field because embryos in the interior of the mass are obscured. In these instances, determination of clutch size often requires breaking clutches apart which can subject interior embryos to changes in temperature, predation, and microbial attack. Thus, it is important to develop techniques that permit collection of reliable clutch size data while minimizing impacts on study organisms.

Several methods have been used to estimate clutch sizes in Spotted Salamanders (*Ambystoma maculatum*) and Wood Frogs (*Rana sylvatica*), including direct counts of embryos (Berven 1982, Brodman 1995), visual estimation (Stenhouse 1987), photographic analysis (Harris 1980), regression estimation from dry weight (Howard and Kluge 1985), and dissection (Woodward 1982). Clutch sizes of *A. maculatum* were also determined by flattening egg masses beneath a glass plate and counting the embryos (Harris 1980). To my knowledge, none of these estimation techniques were assessed for accuracy.

Here I describe the construction and use of the "ovagram," a non-destructive device to quickly estimate clutch sizes of ambystomatid salamanders and ranid frogs. This improves on Harris's (1980) method of flattening egg masses of *A. maculatum* with a glass plate in being a lightweight, inexpensive device that is easily transported to remote locations, and the addition of grid lines increases ease of counting and probably accuracy. The ovagram is the first reported method, to my knowledge, of clutch size estimation for a ranid frog by flattening egg masses beneath a clear object. I provide results of an assessment of the ovagram's accuracy in estimating clutch sizes in *A. maculatum* and *Rana sylvatica*, and its impacts on hatching success in *A. maculatum*.

Materials and Methods.—The ovagram was constructed using two circular, 1400 ml plastic, reusable food storage containers. These containers were made of thin, clear plastic and are commonly available in supermarkets. The dimensions of the containers were as follows: top diameter 17 cm; bottom diameter 14.5 cm; circumference 53.4 cm; depth 8.5 cm. I drew a series of parallel lines, 1 cm apart, using a fine-point permanent marker, across the entire underside of one container (Fig. 1). Lines must be narrower than embryos so that embryos falling directly beneath the lines can be detected. To use the ovagram, an egg mass of *A. maculatum* was gently removed from the water and placed in the container without lines. The container with lines was placed on top of the egg mass inside the other container and pressure was gently applied to flatten the egg mass (Fig. 1). The amount of pressure applied was not great enough to physically damage the ova or the outer jelly matrix. Counts were made in a systematic pattern, for example left to right and top to bottom, counting the number of embryos intersecting the first line, then in the space between the first and second lines, and so on (Fig. 1). A similar method was used for clutches of *R. sylvatica*, except that clutches were cut into six, approximately equal-sized pieces with a sharp knife and counts were made for each piece separately. The ovagram can be used at any stage prior to hatching, but counts are more easily obtained from recently oviposited egg masses that are less turgid and smaller in size. For clutches of *R. sylvatica*, fewer embryos were damaged when cutting recently laid clutches. Estimates were made in approximately 10–20 s for *A. maculatum* and 2–3 minutes for *R. sylvatica*. Following estimation, clutches were returned to the water, and an attempt was made to return the egg mass to its original attachment point at the water depth from which it was taken.

The ovagram was used to estimate clutch sizes of 277 egg masses of *A. maculatum* from 30 ponds, and 116 clutches of *R. sylvatica* from 24 ponds in the Adirondack region of New York. It is important to note that female *A. maculatum* generally deposit 2–4 egg masses at breeding (Bishop 1941; Shoop 1974), so clutch size here refers to the number of eggs per egg mass and not the full egg complement. *Rana sylvatica* deposit one egg mass or clutch in a given breeding season (Wright and Wright 1949).



FIG. 1. Photograph (top view) of ovagram containing an egg mass of *Ambystoma maculatum* and showing parallel lines used to count embryos. Note that width of each line is narrower than that of each embryo.

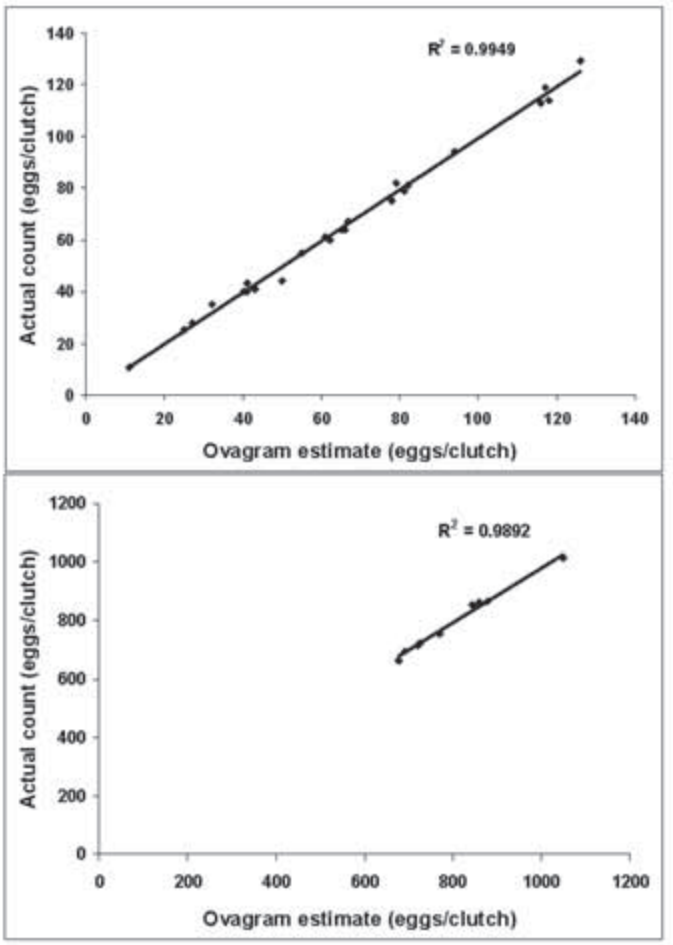


FIG 2. Relationship between estimates of clutch size using the ovagram and actual counts of 24 clutches from *A. maculatum* and 10 clutches from *R. sylvatica*.

To determine the accuracy of clutch size estimates using the ovagram, I collected 24 egg masses of *A. maculatum* from two vernal pools and 10 egg masses of *R. sylvatica* from two vernal pools in the same region. I estimated clutch size using the ovagram and then gently dissected each egg mass into easily counted sections containing 1–4 embryos each. I counted the number of embryos in the dissected portions twice for each egg mass, to ensure accurate counts. To determine the impacts of use of the ovagram on egg masses of *A. maculatum*, I compared the hatching success of embryos from egg masses manipulated by the ovagram and those not manipulated.

Results.—Average clutch size of *A. maculatum* in the central Adirondack region of New York estimated with the ovagram was 67.2 (SD = 30.5, N = 277) and clutch sizes ranged from 7–155. Mean clutch size of *R. sylvatica* was 682.4 (SD = 118.2, N = 116) and ranged from 429–1049 eggs per clutch.

In the accuracy assessment, the mean absolute difference between ovagram estimate and actual count for *A. maculatum* was 1.7 embryos (SD = 1.6, N = 24) and for *R. sylvatica* was 11.3 embryos (SD = 10.6, N = 10). In *A. maculatum*, seven of 24 ovagram estimates matched the actual counts (including four clutches that had more than 50 embryos each), 11 were overestimates (largest = 6 embryos), and 6 were underestimates (largest underestimate = 3 embryos). In *R. sylvatica*, 8 of 10 counts were overestimates (largest = 11) and 2 were underestimates (largest = 37). Clutch sizes of *A. maculatum* estimated using the ovagram averaged 65.7 embryos (SD = 31.8, range 11–126) and were comparable to actual counts which averaged 65.2 embryos (SD = 31.7, range 11–129) for the 24 egg masses evaluated in the accuracy assessment (Fig. 2). Similarly, in *R. sylvatica*, ovagram estimates averaging 798.9 embryos (SD = 107.7, range 662–1012) were comparable to actual counts which averaged 807.8 embryos (SD = 113.6, range 678–1049) (Fig. 2).

The ovagram was used to estimate clutch size in *A. maculatum* in a laboratory experiment, where survival to hatching averaged 83% (SD = 10; N = 5) in control (exposed only to filtered water) egg masses. Survival averaged 82% (SD = 17; N = 17) in egg masses not exposed to the ovagram and used as controls in another experiment (Karraker and Gibbs, in prep.), suggesting that survival of embryos to hatching was not compromised by the technique. I did not determine survival to hatching in clutches of *R. sylvatica* following use of the ovagram.

Discussion.—Variation in clutch size in this study was pronounced, ranging from at least 7–155 in *A. maculatum* and 429–1049 in *R. sylvatica*, emphasizing the need for accurate clutch size estimation for biological studies of these species. A number of other methods have been used previously to estimate clutch size in these amphibians. Egg masses have been marked in the field and frequent visits made to each clutch to monitor development. In one study (Brodman 1995), as the first larvae began hatching, all live and dead embryos were counted. Estimates using this method, as well as visual estimation at any time in the developmental period (Stenhouse 1987), may under- or overestimate clutch size because of the difficulties associated with counting interior embryos. Predation by caddisfly larvae (Stout et al. 1992) during development may also make accurate counts difficult. In addition, multiple visits must be made to egg masses, particularly as embryos near hatching, making it more difficult to obtain larger sample sizes. Female *A. maculatum* have been collected, euthanized, and dissected to determine clutch size (Woodward 1982), but this method, depending upon the numbers collected, may be detrimental to local populations. Egg masses have been photographed and embryos counted using gridded oculars on a dissecting scope (Harris 1980). This technique is minimally invasive, but if a photograph is taken from one perspective, an embryo directly in line with another may not be counted and the method can be cumbersome and protracted relative to the ovagram method described herein. Harris (1980) also flattened egg masses beneath a glass plate in a plastic tub and counted embryos, a method similar to the ovagram. However, the lines on the ovagram may improve accuracy, and the ovagram is small, lightweight, and inexpensive.

The ovagram can be used to accurately estimate clutch sizes of *A. maculatum* and *R. sylvatica*, and probably other ambystomatid salamanders and some ranid frogs, causing minimal physical damage to egg masses and without reducing survival of embryos in *A maculatum*. As all egg masses of *A. maculatum* examined in this study were clear, future research should test the efficacy of the ovagram on opaque eggs of *A. maculatum* and on the eggs of other species. To expedite counts, this method could be coupled with digital photography and an image processing and analysis pro-

gram that counts discrete objects in an image, such as has been used to measure compactness of substrates in nests of fish (Candolin and Salesto 2006). This would reduce time in the field and bias, if multiple observers are involved.

Acknowledgments.—Thanks to Jeff Alvarez, James Gibbs, Clara Wheeler, and Chris Phillips for helpful comments on previous drafts of this manuscript, and Geri Tierney for useful discussion. I am grateful for the financial support of the Declining Amphibian Populations Task Force, USGS Amphibian Research and Monitoring Initiative, and the U.S. Environmental Protection Agency (GRO Fellowship). This study was conducted in compliance with all applicable institutional animal care guidelines, and with all required state and federal permits.

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An Alternative Method for Restraining Frogs

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Herpetologists use several different methods for marking adult anurans to study their natural history and ecology. Some techniques include toe-clipping, passive integrated transponder (PIT) tags, visible implant elastomer (VIE), and radio transmitters (Donnelly et al. 1994). Employing these techniques requires maintaining control of study animals, which often requires additional personnel or the use of anesthetics (e.g., MS-222). These methods of restraint are often expensive and anesthetics require recovery time and may have lasting effects on an animal. Several devices have been designed for restraining herpetofauna (Hoefer et al. 2003; Jones and Hayes-Odum 1994; Poulin and Ivanyi 2003; Quinn and Jones 1974; Walston and Mullin 2005), however, only two methods have previously been described for restraining anurans (Christy 1998; Heyer et al. 1994). While effective, these methods are either useful with a specific marking method (e.g., PIT tags) or are overly complicated and have limited durability. Consequently, there is a need for an inexpensive and more efficient means of restraining anurans to be marked. Here I present a new device for restraining anurans being fitted with radio transmitters or marked using other techniques (e.g., PIT tags and VIE) that is inexpensive, durable, waterproof, easy to use and decontaminate, lightweight, and restrains frogs safely and quickly.

The device has five basic components: the base plate, the compression plate, two anchor bolts, two compression locks, and two compression pads (Fig. 1). The base plate is a 240 × 90 × 6 mm piece of clear Plexiglas® with a pair of countersunk and threaded 4 mm holes. Each hole is positioned 8 cm from one short edge and 1 cm in from each long edge. The compression plate, also constructed of clear Plexiglas® (90 × 25 × 6 mm), has two 6 mm holes centered along its width that align with the holes in the base plate. The two anchor bolts are 4 mm fine-thread stainless steel bolts screwed into the base plate. The compression pads are two pieces of weather stripping (PVC closed cell foam, 6 × 9 × 9.5 mm), which can be purchased at most hardware stores. This material is soft and forms to the contours of the frog's hind legs without damaging the skin. The two compression locks are plastic cord locks commonly used on backpacks and stuff sacks and are available for purchase at most camping stores. All components (~ US $7.00) are durable and easy to decontaminate when moving between study sites.

Restraining frogs is simple, quick, and effective. With hind legs extended, the frog is positioned ventral side down on the base plate with the knees centered on the base plate compression pad (Fig. 2). The positioning of the frog on the device is important because controlling the knees inhibits movement of the hind legs and prevents injury to the frog. The compression plate is then slid over the anchor bolts and appropriate pressure is applied to prevent the frog's legs from moving. The cord locks are then slid

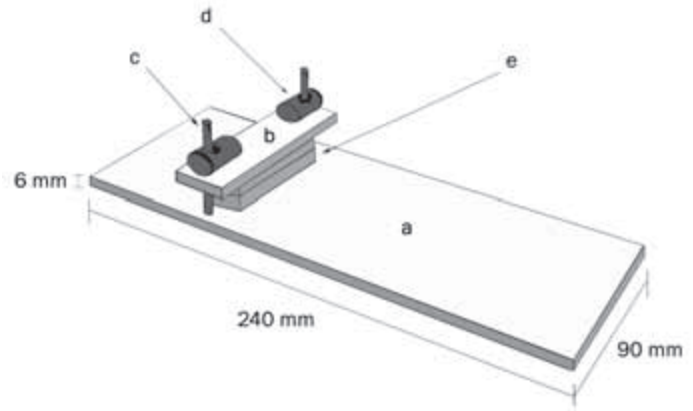


FIG. 1. The five basic components of the anuran restraining device: a) base plate; b) compression plate; c) two anchor bolts; d) two compression locks; and e) two compression pads.

over the anchor bolts and locked against the compression plate. Spinning the cord locks clockwise or counter clockwise allows fine-tuning of the pressure exerted on the frog. Care must be taken to avoid exerting excessive force, which could restrict blood flow. The amount of time required to restrain a frog using this device is approximately 15–30 seconds.

I have found this device to be invaluable when working alone and marking small to medium-sized ranid frogs (30–90 mm snout–urostyle length, SUL). To date it has been used to effectively restrain Foothill Yellow-legged Frogs (*Rana boylii*, N = 150 [R. Bourque, unpubl. data and C. Wheeler, pers. comm.]), Cascades Frogs (*Rana cascadae*, N = 711 [J. Garwood, pers. comm.]), and Mountain Yellow-legged Frogs (*Rana muscosa*, N = 15 [J. Bettaso, pers. comm.]) during PIT tag implantation, radio transmitter attachment, and/or toe clipping. I have also found this device to be effective for restraining Bullfrogs (*Rana catesbeiana*, N = 5), Pacific Treefrogs (*Hyla regilla*, N = 5), Northern Red-legged Frogs (*Rana aurora*, N = 5), and Coastal Tailed Frogs (*Ascaphus truei*, N = 5). Restraint of larger frogs (> 90 mm SUL) would require constructing a larger version of the device described here. Of approximately 148 individual frogs of three species (*R. boylii*, *R. cascadae*, *and R. muscosa*) that were restrained using this device and studied using radio telemetry for relatively long time periods (28–112 days), no visible ill effects were observed resulting from restraint. Lastly, this device has reduced handling time, and thus minimized the amount of stress experienced by the frog during marking procedures.

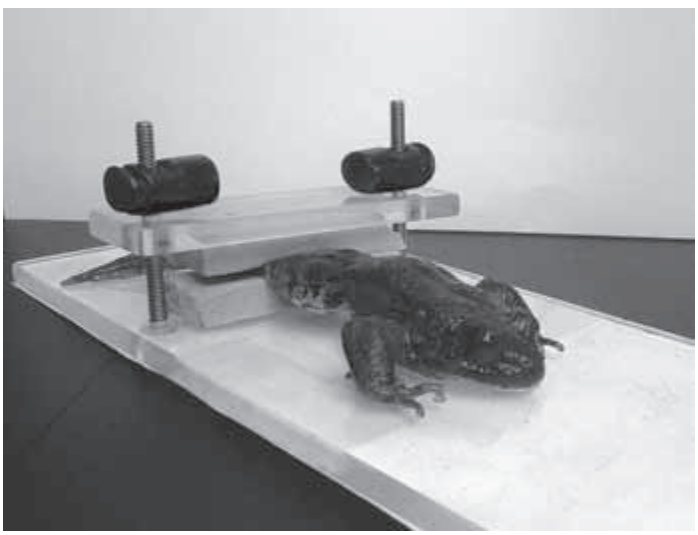


FIG. 2. Proper restraint of a frog (*Rana boylii*) with knees centered on the compression pads and immobilized using appropriate pressure, which is maintained by cord locks.

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Use of Ground Penetrating Radar to Image Burrows of the Gopher Tortoise (*Gopherus polyphemus*)

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The Gopher Tortoise (*Gopherus polyphemus*) is a large fossorial chelonian, averaging 23–28 cm in carapace length, that constructs extensive underground burrows in pyrogenic ecosystems of the southeastern US, especially favoring the sandhill and scrub vegetative communities (Auffenberg and Franz 1982; Diemer 1992). Because an entire community of at least 362 species of vertebrates and invertebrates use these burrows at some stage in their life or seasonal cycle (Jackson and Milstrey 1989), the Gopher Tortoise has been referred to as a keystone species (Eisenberg 1983). Gopher Tortoise burrows vary in diameter, depth, and complexity and play a critical role in the ecological processes of sandhill and scrub communities of Florida. They impact geomorphology (Butler 1995), soil dynamics (Gardner and Landers 1981), vegetation patterns (Kaczor and Hartnett 1990; Tuberville, 1998), animal community diversity (Milstrey 1987 for invertebrates, Franz 1986 for vertebrates), and possibly hydrology, at scales ranging from microsites to landscapes. Some species, such as Florida Mice (*Podomys floridanus;* Jones and Franz 1990), Eastern Cottontail Rabbits (*Sylvilagus floridanus;* Kinlaw 1999), and Armadillo (*Dasypus novemcinctus*; Guyer and Hermann 1997), will modify tortoise burrows for their own needs, adding complexity over time. Gopher Tortoise populations currently are in decline throughout the species' range (Auffenberg and Franz 1982; Diemer 1986; Estes and Mann 1996). The Florida Fish and Wildlife Commission (FWC) is currently reclassifying the tortoise from its present status as a 'Species of Special Concern' (FWC 2004) to a Threatened status (FWC 2006a), along with strengthening protection of its burrows (FWC 2006b).

Data on the internal geometry of a burrow can be obtained using simple measurement tools such as calipers, calibrated flexible rods, or by measuring dimensions of casts of burrows made from hardening agents. In the southeastern US, Gopher Tortoises are collected on sites slated for development by excavating their burrows using heavy equipment (Blankenship and Thomas 2005). Although general information about the depth and extent of burrows can be learned by this method, it destroys burrows, along with any opportunity for repeat measurements of burrow geometry. With excavation, any beneficial ecological effects of the destroyed burrow are lost. Invasive probing methods can cause burrow abandonment or behavioral disruption of the burrow inhabitants (A. Kinlaw, pers. obs.). Some success in understanding underground burrow structure for other animals has been achieved in the UK using geophysical methods. Butler et al. (1994) were successful in determining size for six badger (*Meles meles*) setts using soil resistivity but were unsuccessful using magnetmometry. Any approach to modeling changes of burrow structure over time, such as Meadow's (1991) model, which is based on tortuosity and complexity, requires a method to image burrows that is non-invasive, repeatable, and relatively quick.

Ground penetrating radar methodology.—Ground penetrating radar (GPR) is a non-invasive subsurface imaging technology which uses a surface antenna to transmit electromagnetic energy pulses in the form of radar waves, downward into the ground (Conyers 2004). Waves of varying amplitudes are then reflected back from buried interfaces to a receiving antenna, which is assembled together with the transmitting antennae on a movable sled or cart. The time elapsed between transmission and reception, the amplitude and phase of the received waves, and the frequency of those waves are recorded on the hard drive of a computer which interfaces with the antennas. Of the waves reflected back from buried interfaces, the largest amounts of energy are reflected back from highly contrasting media. In the case of air-filled burrows, a good deal of radar energy is reflected from the interface between the sandy sediment and the void of the burrow itself; other reflections can occur from tree roots, shallower burrows of other animals and sedimentary or soil beds. As the sled is slowly moved along pre-determined surface transects, a series of reflections can be collected at a programmed distance, determined by the revolutions of a survey wheel attached to the sled (Fig. 1A). All reflections are collected in radar travel times measured as two way-travel time in units of nanoseconds. These times can be converted to approximate depth in the ground when the velocity of the radar energy travel is calculated. When many hundreds of these reflections from varying depths are stacked and viewed in a two-dimensional vertical profile, a "cross-section" of the ground is produced.

Radar energy propagation occurs best in dry sandy soils, however good penetration also can occur in a number of other ground conditions (Conyers 2004). The applicability of GPR to locate cavities such as pipes or tunnels was recognized in the 1970s (Fullagar and Livleybrooks 1994). Since air-filled voids provide an excellent dielectric constant contrast (Daniels et al. 1992), GPR is used to identify animal burrows in earthen dams in the United States which might cause collapse of dams (ASDSO 1999).

Field Site Description and Burrow Selection.—Three study sites were located in the Ocala National Forest, Marion County, Florida, USA. The sandhill site (Kerr site) is located along the north shore of Lake Kerr, in the Lake George District of the Forest. The two oak scrub sites were located adjacent to the US Naval Reservation in the Seminole District of the Forest. In Florida, sandhill vegetative communities are rolling park-like woodlands of Longleaf Pines (*Pinus palustris*) rising above a continuous cover of Wiregrass (*Aristida stricta*) with other grasses and forbs, and occasional clumps of deciduous oaks, mostly Turkey Oak (*Quercus laevis*; Myers 1990). Visually, sandhills are open and one can often see for a hundred meters or so. Uncut Sand Pine scrub is a vegetative community of tall, twisted, leaning Sand Pine trees (*Pinus clausa*)

rising above a thick understory of evergreen scrub oaks (*Q. geminata*, *Q. myrtifolia*, *Q. inopina*, *Q. chapmanii*), Florida Rosemary (*Ceratiola ericoides*), interspersed with Rusty Lyonia (*Lyonia ferruginea*), Scrub Holly (*Ilex opaca* var. *arenicola*), Silk Bay (*Persea humilis*), and Scrub Hickory (*Carya floridana*; Myers 1990). However, scrub vegetation often has open areas. Our GPR scrub sites had been logged within 10 years previous to our study, thus the Sand Pine trees were between one and five meters high. The soil type in both sandhill and Sand Pine scrub vegetation is classified as entisols, dominated by gently sloping, well-drained thick sands (Brown et al. 1990). These excessively drained soils are derived from quartz sand (Brown, et al. 1990) and are mostly devoid of silt and clay.

Our plots and burrows were chosen as part of a related research project. Many sandhill plots were available, thus a map of this vegetative community was gridded into one hectare squares and each square assigned a number. The plots were then selected using a random numbers table (Steele and Torie 1980). Gopher tortoises seem to prefer sand pine scrub areas that have undergone succession three to five years after a clear-cut, so the scrub plots were chosen from the few appropriately aged plots available. We tried to select only burrows that appeared to have been recently dug or were actively being used by the tortoises, since the literature indicated that these provided the most biological insight.

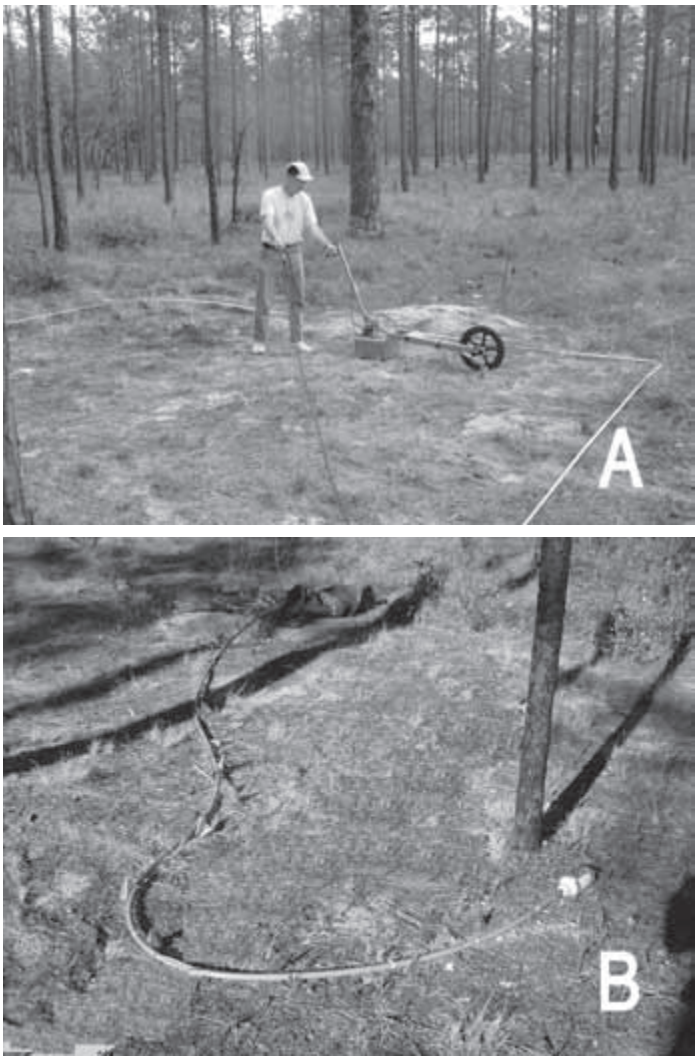


FIG. 1. A) Pulling GPR antenna in perpendicular direction across the long axis of gopher tortoise burrow in sandhills plant community, Ocala National Forest, Florida, USA. Note mound of sand behind antenna, indicating where tortoise piled up sand from digging activities. B) Two-dimensional profile of burrow Kerr6 on ground surface. The path of the burrow is outlined by the line marked by flags and spray paint, with the tube of the video camera also aligned along the path. View is opposite to the digging direction of the tortoise, with the burrow opening at the upper center of photo.

Prior to testing with GPR all burrows were examined with an infrared video probe camera attached to a 7.7 m section of polybutylene tubing (assembled by Edward E. Wester, Southern Ecosystems Research, 6485 Lee Road 54, Auburn, Alabama 36830, USA). This examination found that six of the burrows each contained a tortoise. The length of four others exceeded the length of the camera tether and occupancy could not be confirmed, but recent tracks, skid marks, and other surface signs indicated obvious use within a day or two prior to our testing. Finally, four burrows had sign that was somewhat deteriorated and did not have a resident tortoise (Table 1). Under the current scheme in use in the southeastern US to classify the status of Gopher Tortoise burrows (Auffenburg and Franz 1982), ten would be classified as "active" and four as "inactive."

GPR Collection Procedure.—The GPR antennae at our test sites were first calibrated for ground conditions that were often unique to each area. This included setting automatic range gain settings to enhance the reflection amplitudes with depth due to normal energy attenuation in the ground (Conyers 2004). A time window was selected, measured in nanoseconds, which preliminary velocity tests showed to be consistent with the maximum depth of the burrows. This time window varied between 50 and 70 nanoseconds, which corresponded to a maximum energy penetration depth of about 4–5 m. Optimal energy penetration occurs when the antennae are in direct contact with the ground surface at all times (Conyers 2004). To facilitate this, ca. 20–80 m^2 of vegetation immediately above each burrow was mowed. We then followed a two step procedure to map the burrows in the field. First, each burrow was probed with a piece of flexible electrical conduit to determine its beginning direction and maximum extent. Then, using a 900 MHz frequency antenna (Geophysical Survey Systems, Inc., 13 Klein Drive, PO Box 97, North Salem, New Hampshire 03073-0097, USA), we collected a series of "trial and error" transects at orientations estimated (from the initial probings) to be perpendicular to the burrow. In this way radar reflections when viewed in profile would produce a hyperbolic shaped reflection, with the apex of each hyperbola (Fig. 2A) denoting the top of the burrow tunnel. The location of each hyperbola apex was marked with a pin flag at the ground surface immediately over the section of tunnel that had just been crossed by the GPR antenna. This preliminary process of profile collection and immediate interpretation was continued until an approximate burrow path was delineated by flags, and then its total extent was marked with spray paint. During this preliminary step it was quickly determined that most burrows were not straight, but angled quickly from the surface as they continued down to greater depths. When many reflection profiles were collected in this way and viewed on the computer screen in "real time," the depth and orientation of the burrow void spaces could be determined. Often this process was con-

fusing, as shallower burrow reflections, tree roots and the complex nature of reflections from curving tortoise burrows that often reached three and a half meters in depth produced an array of reflections with many different orientations.

Following Stott (1996), we wanted to verify that the hyperbole reflected by the GPR antenna was in fact the subsurface tortoise burrow we believed we were imaging, not a different burrow, unknown air void, or a sampling artifact. During this pilot step, we confirmed that the GPR antenna was actually imaging the burrow path by examining the section of tunnel directly underneath with the video probe camera slid down the tunnel. By treating the vertical distance between the antenna and the burrow immediately below the antenna as side A of a right triangle, and the horizontal distance between the antenna and the burrow entrance on the ground surface as side B of the triangle, we used the Pythagorean Theorem to calculate the correct distance (hypotenuse) to slide the camera down the burrow to be immediately underneath the antenna. This confirmation step was only conducted near the entrance of the first few burrows we imaged before the burrow curved.

To accurately map the depth of the burrows, we conducted a velocity analysis to calibrate the relationship between radar travel time and depth. At several locations along the first three burrows we processed, a calibrated steel rod was inserted from the ground surface to the top of the burrow; the point of insertion into the burrow could be determined by a relaxation of insertion pressure as it entered the void space. Correct placement of the rod in the burrow chamber was confirmed by observation with the videoprobe camera. These depths were then measured and the elapsed radar time measured in the GPR reflection profile at that location was then obtained. In these tests an average radar travel velocity was calculated to be 8 cm/nanosecond. Using this average velocity a two-way radar travel time of 45 nanoseconds was equivalent to ca. 3.6 m in the ground. This velocity was used to convert all measured times of burrow reflections to depth at all test sites. For all the sites tested this average velocity appeared to be consistent, which is understandable as all the burrows tested were found in the same type of dry aeolian sand. Ground moisture conditions, which can sometimes dramatically change radar velocities, were similar during GPR data acquisition. By following this process, an accurate depth profile of each burrow was made.

In the second step, a rectangular grid was then arranged over the total extent of each burrow with tape measures and their surface extent was mapped as x and y coordinates, measured from the southwest datum of each grid. The GPR antennae were moved in four meter transects perpendicularly across the burrow to collect reflection profiles normal to the orientation of the burrow (Fig. 1a). The middle of the profile (at ca. 2 m) therefore denoted the approximate center of each burrow, no matter what its depth. Reflection transects were placed every 50 cm along each surface-outlined burrow in this second step, which was a more formal process than our preliminary trial and error step. Paint and surveyor flags were used to mark the orientation and extent of each burrow (Fig. 1b), and photographs were taken. In this fashion the x and y coordinates of the burrow were determined from the surface measurements with z values (depth) obtained for each profile by measuring from the surface down to the apex of each reflection hyperbola (Fig. 2a). On each burrow, we made a final longitudinal transect along the ground surface that followed the path of the burrow; the resulting profile illustrated the gradual vertical drop of the burrow as the antenna moved (Fig. 2B).

Image Analysis.—Data points were transferred to two programs which translate three-dimensional spatial data into visual displays. Slicer-Dicer (Pixotec, LLC, 15917 S.E. Fairwood Blvd, Renton, Washington 98058, USA) is a program that allows the user to visualize three-dimensional data as a projected volume. This program creates isosurfaces from the data, meaning that the inter-

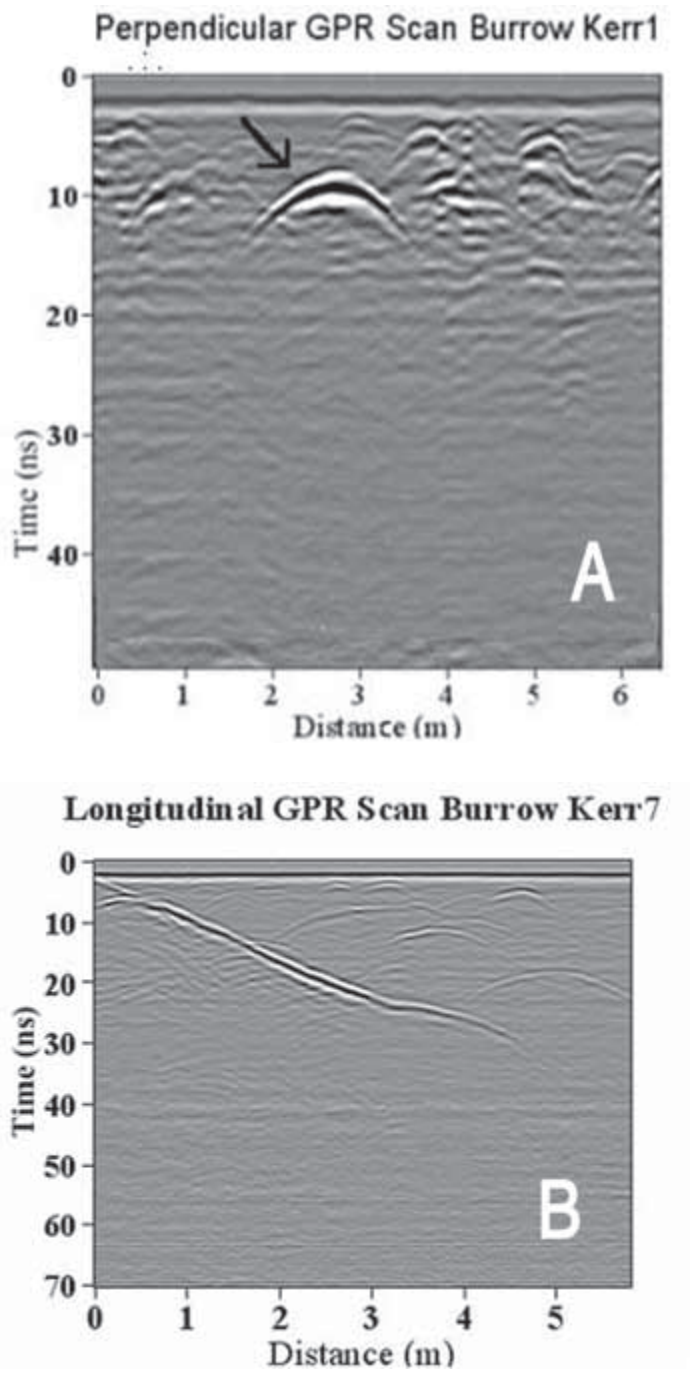


FIG. 2. A) Hyperbole (indicated by arrow) shown in GPR reflection profile, collected by moving the GPR antenna on the ground surface over the burrow at a 90° angle to the orientation of the burrow. B) GPR Longitudinal profile of burrow, collected by moving the GPR antenna on the ground surface following the path of the burrow.

faces producing the GPR reflections are placed in three dimensions, and a pattern or color is assigned to specific amplitudes in order for them to be visible (Heinz and Aigner 2003). The second program, FormZ **(**Auto·des·sys Inc., 2011 Riverside Drive, Columbus, Ohio 43221, USA), is a general-purpose solid and surface modeler with which the user can generate highly articulated renderings of most three-dimensional forms from x, y, and z data. To determine how accurately these renderings describe real burrow geometry, we compared them with physical casts of burrows prepared at a Clermont, Florida site where the burrows were being excavated for relocation purposes, with photos taken during these burrow excavations, and with one literature account.

Results.—The two dimensional outlines on the ground surface showed that nine burrows turned to the left within two to three meters of their opening, three turned right, and one was fairly straight (Table 1). Data were incomplete for one burrow which had collapsed about three m from the entrance. A 3-dimensional profile was developed for one burrow using the Slicer-Dicer visualization program, showing a downward corkscrew turn to the left (Fig. 3A). Three-dimensional profiles were developed for four burrows using the FormZ modeling program, which showed the burrow tunnels had smooth sides, some up and down loops or twists, and an overall "jagged" corkscrew shape (Fig. 3B). Examinations of hardened foam burrow casts and photos from the Clermont relocation site confirmed that those burrows had the same properties.

Discussion.—This research provided the first intact visual views of gopher tortoise burrows. The two-dimensional outlines on the ground surface show that most burrows investigated in this study turn in some fashion. The three-dimensional profile showing a corkscrew shape coincides with observations by Smith et al. (2005) for burrows that were excavated during a drought in east-central Florida. They reported burrows which angled down in a corkscrew fashion and attributed this to tortoises digging until they reached a cool hardpan layer under sand during the drought. Moreover, our comparison with the appearance and orientation of the FormZ three-dimensional renderings with actual hardened foam casts of burrows indicates that the models developed with this program accurately compares with the orientation and shape, including turns, of real burrows. Since the resolution of the GPR system we used was not detailed enough to image smaller side tunnels or rough surfaces along the side of the main tunnel, these features would not be represented in the visualization programs. Although the FormZ program smoothes the surface of a tunnel, this did not affect our results, as our burrow casts show fairly smooth surface features. These foam casts were taken in an area without shrubs or trees; we caution that the sides of burrows occurring in areas with more roots may not be as smooth. The longitudinal GPR profiles produced at each site clearly show burrows descending into the ground, sometimes leveling out, and again descending to their end. The FormZ models illustrate well both the up and down undulations of the burrows, as well as the turns, and the foam casts confirmed that these features occur in real burrows. All bio-mathematical models are approximations, and there is no reason why our three-dimensional renderings of burrows should be different. Thus, comparisons with features of real burrows show that these visualization programs using GPR data do provide reasonable models of burrows.

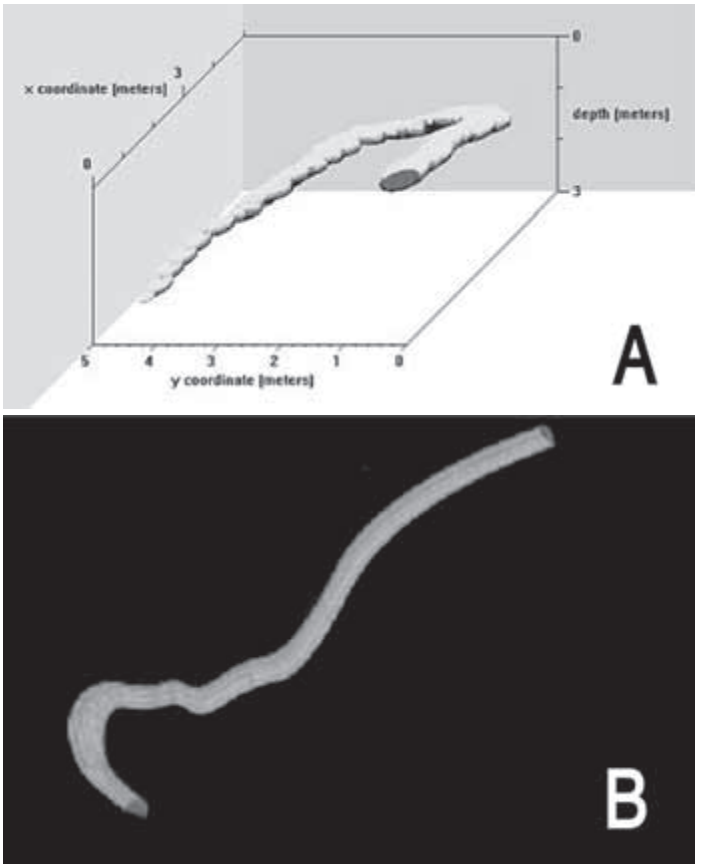


FIG. 3. A) Three-dimensional image of burrow Kerr3 developed using the Slicer-Dicer isosurface modeling program. B) Black on white three-dimensional rendering of burrow Kerr6 developed with the FormZ program.

Ground penetrating radar can assist with practical conservation efforts of the Gopher Tortoise. Gopher tortoises occur in a number of national forests and military reservations throughout the southeast. GPR could be used to assess or estimate the damage caused by heavy equipment, such as forestry skidders or military tanks, which can cause the collapse of burrow entrances. Gopher tortoises will also dig burrows in suitable soil occurring on cattle ranches. Trampling by cattle can collapse the opening or shallower sections of burrows, especially in overgrazed areas (A. Kinlaw, pers. obs.). The single collapsed burrow (NE2) found in this study was encountered very early in our study and we did not attempt to thoroughly map it. However, our subsequent mappings demonstrated that intact tortoise burrows could be imaged even if the entrance was completely sealed, because our GPR ground profiles showed other burrows underground (near our imaged burrows) that could be traced to old soil mounds.

By imaging the internal architecture of burrows, GPR technology could clarify issues relating to energy expenditure in building the burrows, flooding of burrows, respiratory environment, and amount of living space for invertebrates and commensal vertebrates. By collecting a time series of profiles at the same burrow, changes in the architecture of a burrow can be better understood, as well as changes in architecture brought about by other animals that modify a burrow.

There are many advantages of using GPR for mapping and vi-

TABLE 1. Data for Gopher Tortoise burrow study collected without and with ground penetrating radar.

	Data gathered before use of GPR			Additional data gathered with GPR			
Burrow Number	Habitat	Length Probed (m)	Tortoise Present?	Beginning Direction	Ending Direction	Configuration	Maximum Depth (m)
NE1	Scrub	4.9	N	160 °	?	turned left	2.48
NE2	Scrub	2.1 [a]	N?	260 °	?	straight (?)	1.28
Nor1	Scrub	4.1 [b]	Y	330 °	225 °	turned left	1.76
Nor2	Scrub	5.9 [b]	Y	170 °	55 °	turned left	1.52
Nor3	Scrub	3.4	Y	215 °	105 °	turned left	1.84
Nor4	Scrub	5.9	Y	315 °	30 °	turned right	2.88
KerrA	Sandhill	>7.6 [c]	?	60 °	75 °	straight	1.92
Kerr1	Sandhill	>7.9 [c]	?	310 °	210 °	turned left	1.04
Kerr2	Sandhill	>7.9 [c]	?	295 °	190 °	turned left	3.68
Kerr3	Sandhill	3.6 [b]	Y	200 °	?	turned left	2.0
Kerr4	Sandhill	6.7 [b]	Y	320 °	125 °	turned right	3.2
Kerr5	Sandhill	5.8	**N**	40 °	230 °	turned left	1.92
Kerr6	Sandhill	>6.4[c]	N	240 °	120 °	turned left	1.52
Kerr7	Sandhill	6.1	N	10 °	230 °	turned right	2.24

[a] Unable to manipulate camera past this point in burrow
[b] Gopher tortoise at length indicated, unable to manipulate camera past tortoise, burrow continues unknown length
[c] Burrow extends beyond length of camera; gopher tortoise probably residing in burrow based on recent tracks and sign

sualization of burrows. Like any good scientific method, GPR mapping is repeatable. A major advantage is its non-destructive abilities. Although the environmental impact of mowing a small amount of vegetation at the surface immediately above a burrow is not known, none of the burrows or entrances was physically impacted in any way using this technique. The method is non-invasive to the interior of the burrow; all the work is done at the surface. Finally, the digital format allows the data to be analyzed using a variety of approaches.

Presently the only other method available to obtain an image of a burrow is to fill a burrow with some type of material that hardens into a three-dimensional mold of the burrow shape, then excavate the mold. Although excavations are normally conducted to relocate gopher tortoises, it can be part of a process to map burrows, as in our Clermont foam study mentioned above. Although the time spent in the field with each activity was roughly comparable, mapping by excavation is an inefficient and crude technique compared to GPR. With GPR, we tested 14 sites in 8 field days, spending three to four hours at each site, including set-up time. Practically any burrow could be selected; with the excavation method only burrows listed on a State-issued permit could be imaged.

There are some limitations to the GPR method as well. Stott (1996) found that his GPR system exaggerated vertical tunnel height by a factor of 1.43. In our studies tunnel height could not be determined as the reflection derived from the top of the burrow in most cases was so high in amplitude that it effectively interfered with any reflections that might have occurred from the burrow base. In addition, the suitability of GPR to survey animal burrows in media other than dry sand can not be predicted. Although sand is well known as excellent for radar transmission, silty and clay-rich soils would likely attenuate energy prior to reaching the depth of burrows. For most intermediate-sized burrowing vertebrates that inhabit dry upland sandy regions of Florida, however, this would not be a problem. There have also been no tests of this technique with smaller (e.g., rodent) sized burrows. Burrows we surveyed were ca. 25–35 cm in width and 11–18 cm high. Our burrow camera showed the existence of smaller Florida Mice (*Podomys floridanus*) burrows intersecting the main tortoise tunnels, but our GPR profiles did not discern these smaller tunnels. It is possible that antennae with very high frequencies (greater than 900 MHz) could potentially be used to image smaller burrows, following techniques discussed in this paper. Higher frequency antennae have a greater resolution, but a shallower depth of total energy penetration. Finally, we were unable to confirm the presence of tortoises in two burrows where our camera showed that they were in fact there.

In our study, a catalog of the shape, depth, and orientation of burrows was produced for 14 Gopher Tortoise burrows in central Florida. Data were collected in dense grids of reflection profiles over 8 field days, which were then interpreted to show their orientation in three-dimensions. We demonstrated that the GPR method can be accurately and cost-effectively used in these types of studies for not only burrowing reptiles such as gopher tortoises, but potentially many other burrowing organisms. This imaging technique potentially has worldwide conservation implications for the study of these structures and the medium to large-sized vertebrates that dig and use them.

Ground-penetrating radar is one of the more complex near-surface geophysical methods and there is usually a learning curve involved for all who would like to use the technique. As with most tools, manuals are only partially helpful in standard set-up and data collection methods, which must usually be adjusted for each area studied. This is because ground conditions (soil type and

moisture) as well as the nature of the targets usually vary at different geographic sites. Some systems record directly to a laptop, but most record data internally within the radar control system for later downloading. Software to process received reflected data into profiles and three-dimensional images is available for each system, written by the manufacturer. A number of competing software packages are available, some for free on the internet, and some that necessitate yearly subscription expenses of about US $1500 or so. A complete GPR system costs about US $30,000 to purchase, but can be rented from a number of companies in the U.S. and around the world for about US $250 per day. If one wished to write a grant to use this technology in a study, perhaps US $2500 should be allocated for initial training, along with US $3000 for system rental for a few weeks. One should then plan on spending at least four weeks to learn the intricacies of this system in the field. The SlicerDicer program costs about US $600 (academic version US $450) and the FormZ program costs US $400. About one or two weeks is a reasonable time period required for one to effectively learn each program.

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Use of Satellite Imagery to Find the Salamander *Salamandrella keyserlingii* at Darhadyn Wetland, Mongolia

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Aquatic-breeding habitats are essential to many amphibian species that spend most of their life in terrestrial habitats. However, outside of the breeding season, it is difficult to find salamanders such as ambystomatids, hynobiids, and salamandrids. Post-breeding adults disperse upland, find refuge in subterranean burrows or under cover objects such as decaying logs, woody debris, leaves, and stones, and therefore cannot be readily found (Duellman and Trueb 1986). Because of their "unobservability" (sensu Verrell and Davis 2003) it is a common practice to survey for egg masses deposited in aquatic habitats as a means of detecting unknown sites of hynobiids (Hasumi and Kanda 1998). However, lack of roads or poor road conditions may hinder access to potential breeding sites, forestalling surveys. Darhadyn Wetland, Khovsgol Province, Mongolia (Fig. 1: 130 × 30 km area; 50°40'–51°40'N, 99°15'–99°45'E; 1540–1580 m elev.) seemed to correspond to such an inaccessible wetland.

The Siberian salamander *Salamandrella keyserlingii* (Hynobiidae) has the widest range of amphibians worldwide (Borkin 1999; Kuzmin 1999). This species is spread from eastern Europe to Kamchatka, and occurs sporadically in China, Japan, and Mongolia (Borkin and Kuzmin 1988). The Mongolian Red Data book has shown an anecdotal point of distribution for *S. keyserlingii* in Darhadyn Wetland (Shiirevdamba 1997). However, there was no mention of where this species existed within the large wetland. There also is a description of the occurrence of *S. keyserlingii* along the Shishkhid River, which flows through this wetland (Fig. 1, Site 5), but an accurate site location was not provided (Borkin and Kuzmin 1988). During and shortly after the breeding season (estimated to be early June), potential breeding sites of this species seemed to be inaccessible, except by horseback, due to poor road conditions caused by melting of the frozen soil.

If aquatic-breeding habitats cannot be accessed during spring at a target wetland, it may be helpful to conduct a summer survey of likely sites determined by inspection of a satellite picture (remote-sensing techniques: Carey et al. 2001). While larval surveys can be conducted during summer for many species and sites, at Darhadyn Wetland, larvae were rarely captured from crescent lakes and pools during summer because of their earlier metamorphosis (mostly during July: M. Hasumi, unpubl. data). Thus, trying to capture larvae during summer when roads become fully accessible (mid-July to August) is not a useful method to search for new sites of this species in Darhadyn Wetland. After metamor-

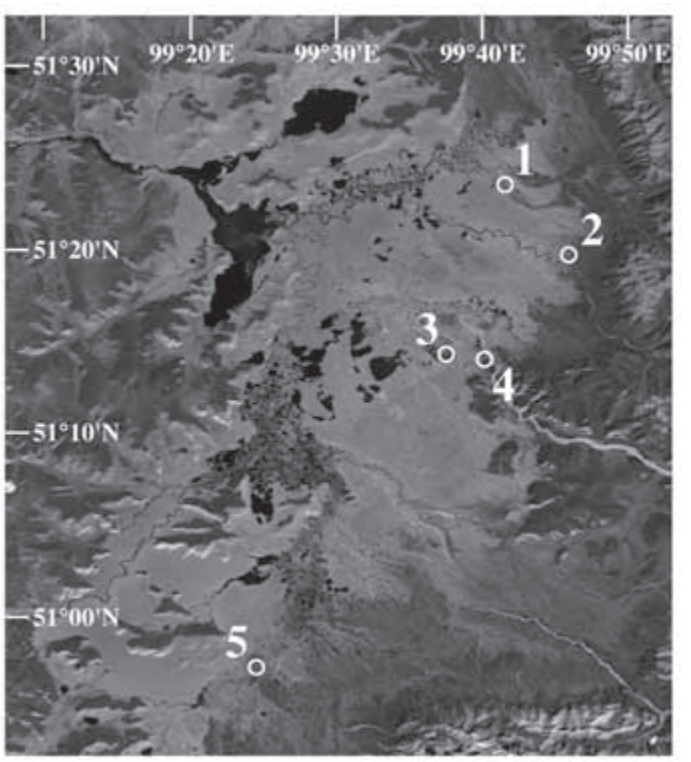


FIG. 1. A satellite picture of Darhadyn Wetland, Mongolia (excluding the northern and southern tips), photographed on 9 August 2001 from the Landsat (published by the ESDI), with five sites we examined for *Salamandrella keyserlingii* (open circles). A site was documented along the Khodon River (Site 2: 51°19'52"N, 99°45'52"E) and along the Shishkhid River (Site 5: 50°57'40"N, 99°24'30"E). No salamanders were found at three other sites proposed for salamander hunting (Site 1: 51°23'40"N, 99°41'30"E; Site 3: 51°14'20"N, 99°37'40"E; Site 4: 51°14'03"N, 99°40'10"E).

phosis, *S. keyserlingii* are nocturnal in summer (Grigoriev and Erdakov 1981); salamanders forage above ground at night and hide in cool, moist refugia during the daytime. Common refugia are decaying logs, and therefore searching forest zones adjacent to aquatic habitats may improve detectability of these salamanders. In this context, the aim of our study was to record occurrences of *S. keyserlingii* at potential sites with adjacent water bodies and forest zones, assessed by a satellite picture of the whole Darhadyn Wetland during the nonbreeding summer season, and to determine the efficiency of this method.

We utilized available Landsat pictures, which were published by the Earth Science Data Interface (ESDI) at the Global Land Cover Facility (University of Maryland, USA), and analyzed the most recent satellite picture of the whole Darhadyn Wetland, photographed on 9 August 2001. We chose Landsat pictures because of their availability and spatial scale including the entire wetland. Pictures from higher spatial resolution satellites such as IKONOS and SPOT were expensive, and while ASTER pictures were less expensive, they covered only one-third (western area) of this wetland by 2005. In band 4 of the Landsat data, having 760–900 nm wavelengths (infrared; 30 m resolution), water indicated a low value below 5% due to lack of its reflectance, but vegetation showed a high value around 40%. Thus, we could determine a site composed of both water bodies and forest zones with image processing. Where a river winds through the wetland, its track forms off-channel "oxbow" crescent lakes and pools (see Fig. 2A). In Darhadyn Wetland, the central region contained many areas like this, but these areas did not have much adjacent forest vegetation. Such areas with more forest vegetation were concentrated to the northeastern and eastern portions of the wetland. In this context, we proposed four potential habitats for salamander surveys (Fig. 1, sites 1–4).

We searched for *S. keyserlingii* at these four sites from 18–23 August 2005. At each site we conducted field reconnaissance and located bodies of water such as stream backwaters, crescent lakes, and pools by walking. We then went to the nearby forest zone and surveyed decaying logs for salamanders. We verified site locations and elevations using a Global Positioning System (GPS; eight satellites, to within 8 m), including the locations of logs. Distance between sites was calculated based on the satellite picture. We determined distance of a log that harbored any individual or the nearest water that was estimated to be suitable for oviposition, using a measuring tape and a GPS. We measured length and diameter of each log when it harbored individuals. We recorded "age class" (i.e., juvenile or adult), sex, and maturity of each individual, according to Hasumi (2001). We weighed each individual (body mass: BM, to within 0.05 g), and measured the broadest head width (HW), maximum tail height (TH), snout–anterior vent length (SAVL: distance from the tip of the snout to the anterior angle of the vent), snout–posterior vent length (SPVL: from the tip of the snout to the posterior angle of the vent), and tail length (TL: from the posterior angle of the vent to the tip of the tail) to within 0.01 mm by a modification of Wise and Buchanan's (1992) method without using anesthesia.

Additionally, at a suspected site along the Shishkhid River mentioned above (Fig. 1, Site 5; Fig. 2A), surveys were conducted from 18–23 July 2004 and from 6–17 August 2005. Previously, several individuals had been reported from this area (independent of analyzing a satellite picture) under decaying logs on land on 23 August 2002 (T. Hongorzul, unpubl. data) but related data were

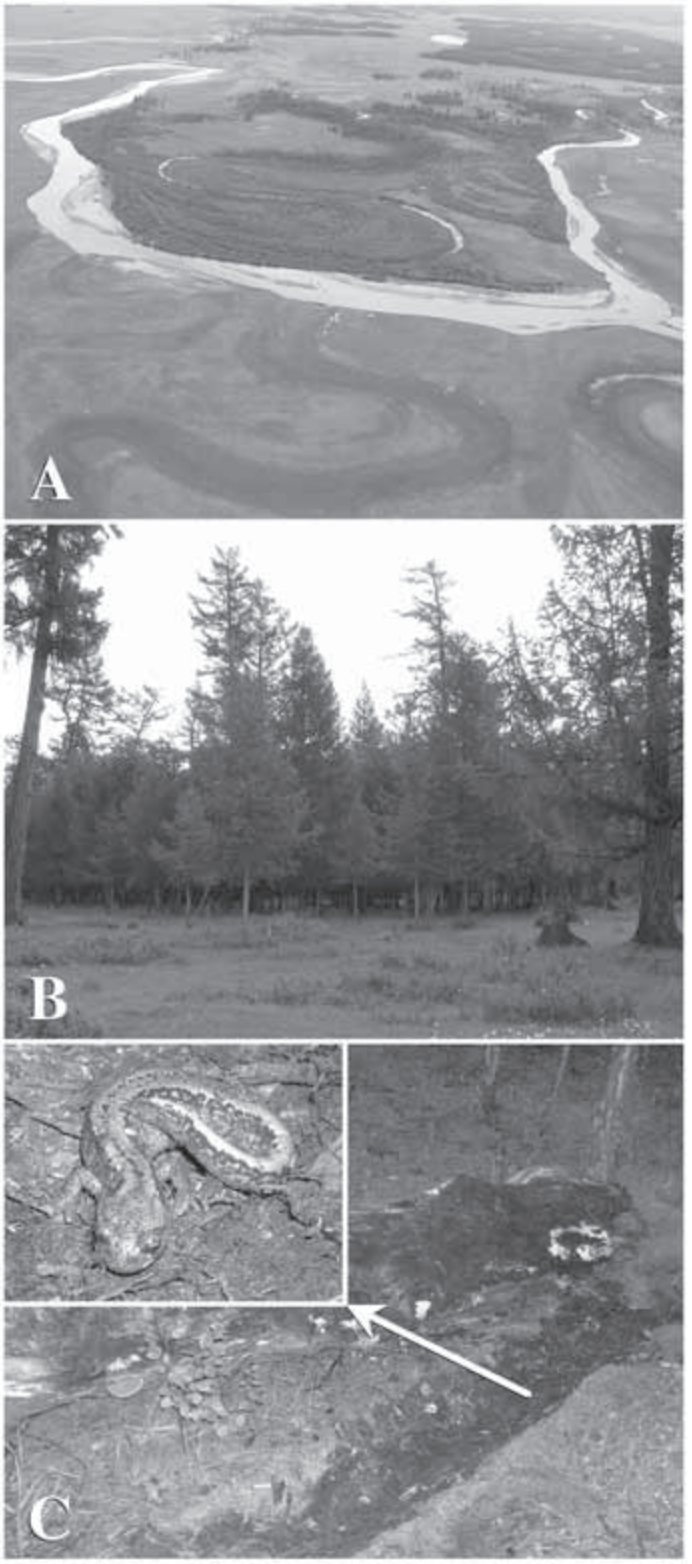


FIG. 2. Two sites of *S. keyserlingii* within Darhadyn Wetland, Mongolia: A) a bird's eye-view picture of site 5 (Fig. 1) with several off-channel crescent lakes and pools (photographed by T. Morita from a paraglider); B) a forest (*Larix* sp.) zone of site 2 (Fig. 1); and C) a decaying log under which a male was found.

not obtained at that time. This site is part of a separate mark–recapture study, and we report only occurrences here to better understand the distribution of the salamander at Darhadyn Wetland.

We detected salamanders at one of four sites selected from satellite imagery. This site occurred in a forest (*Larix* sp.) zone along the Khodon River at 1566 m elev. (Fig. 1, Site 2; Fig. 2B). In the forest, a male was discovered under a decaying log at 2010 h on 20 August 2005 (Fig. 2C). Due to near darkness at that time, this male was released after photographing, without measuring body size characteristics, and detailed site data were obtained from 1100–1320 h on the next day. The log was 3.0 × 0.4 m (length × diameter) and was 237 m from the nearest backwater (BW1). We found a stream approximately 400 m long with 20 or more backwater pools at the uppermost extent of BW1. Most of these backwaters appeared favorable for oviposition, but no larva was found. In this area, a second male (BM = 3.20 g, HW = 8.75 mm, TH = 4.85 mm, SAVL = 46.16 mm, SPVL = 49.53 mm, TL = 25.30 mm) was found under a decaying log (12.0 × 0.25 m) 5 m from the nearest backwater (BW2), located at a slope of the left bank (while looking downstream) near the water sources. There was 375 m distance between BW1 and BW2, and 439 m distance between the logs that harbored the first and second males.

We also found *S. keyserlingii* within a wetland complex in a floodplain along the Shishkhid River (40–60 m wide, 1560 m elev.; Fig. 1, Site 5; Fig. 2A). In summer surveys from 2004–2005, 299 individuals were collected by hand in and under decaying logs on land within the forest zone at this site. It is unknown whether or not this site corresponded to the site recorded previously (Borkin and Kuzmin 1988). In a follow-up survey in mid-May 2006, Site 5 (Fig. 1) could be accessed, but the water surface was frozen and no egg masses were found (M. Nakagawa, pers. comm.).

The distance between the first and second sites was 49.8 km. No salamander was found at three other sites proposed for salamander surveys (Fig. 1).

When aquatic-breeding habitats could not be accessed during spring, our summer surveys of water bodies and adjacent forest zones in the four sites proposed by a Landsat satellite picture were a relatively useful method, with a 25% detection rate of new *S. keyserlingii* sites. Although our approach was limited and we include only preliminary data, a satellite imagery method for predicting distribution of *S. keyserlingii* across huge and often inaccessible landscapes as found in Mongolia may have merits and broad applicability to other regions with similar landscapes. Our approach cannot definitely determine species absence. It is unknown whether or not a 50 km interval between the first and second sites (between the Khodon and Shishkhid Rivers) accurately reflects the distribution of *S. keyserlingii* in Darhadyn Wetland (Borkin and Kuzmin 1988). However, if this is the case, desertification or fragmentation of this wetland that now appears to be progressing due to climate changes melting the permafrost region (N. Fuji, unpubl. data), is a potential explanation for the species occurring at potentially isolated sites. Analyses of satellite images through time are needed to assess changes in wetland–forest habitat conditions, which also could be modeled into the future. While this is a broad-ranging species, its loss at specific sites across its range may be a concern for local population stability.

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Digital Recorders Increase Detection of *Eleutherodactylus* Frogs

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Improved methods for large-scale and long-term amphibian monitoring projects would aid species status assessments and identification of potentially declining species (e.g., Stuart et al. 2004). Acoustical surveys allow researchers to quickly determine species presence and calling activity level (Lips et al. 2001; Zimmerman 1994). The North American Amphibian Monitoring Program, a large-scale monitoring effort, uses acoustical surveys to monitor species in ponds and wetlands (United States Geological Survey 2004). A challenge of this approach is accurate species identification, which is particularly problematic in a tropical area with high anuran species diversity (e.g., anuran species richness in the Neotropics [2135] was greater than in the Neartic [90], Duellman 1999). Furthermore, abundant or loud species may lower the detection probability of other species.

An assumption that needs to be tested in acoustical surveys is that detection is highly correlated with the species presence or activity. Without an appropiate correction for detection probability, data will not accurately reflect the status of the species (MacKenzie et al. 2002). This may result in inappropriate management decisions that could waste time and money.

Digital recorders can be used as a standard method for species detection and determination of calling activity level in amphibian choruses in long-term monitoring projects. Digital recordings can be stored and transferred easily and can allow experts to analyze the recordings at their convenience. In addition, loud or abundant species can be filtered using computer software to increase the detection of other species. I tested the hypothesis that detection of species presence and calling activity level in anuran choruses will be higher when recordings are analyzed with the help of computer software compared to only hearing the recordings. The resulting increase in detection should result in improved population status data and reduced false negatives during species inventories (i.e., when a species is not detected due to interference).

Materials and Methods.—I recorded amphibian choruses at two sites in the Luquillo Experimental Forest (Tradewinds Trail site, 18.290°N, 65.798°W; Mount Britton Tower site, 18.303°N, 65.795° W), and at one site in the Carite State Forest (18.103° N, 66.035° W), Puerto Rico (Fig. 1). The Tradewinds and Mount Britton sites were located in the Lower Montane Wet Forest lifezone and the Carite State Forest site was located in the Subtropical Wet Forest lifezone (Ewell and Whitmore 1973). Recordings were made using an Automated Digital Recording System (ADRS; Acevedo and Villanueva-Rivera 2006). The recorder was a Nomad Jukebox 3 digital player and recorder (Model DAP-HD0003, Creative Labs, Inc, California), and was set to record in 16-bit wav files with a sampling rate of 48 kHz. Because the recorder had no microphone input, only a line level input, the microphone was connected to a portable preamplifier (Model SP-PREAMP, The Sound Professionals, Inc., New Jersey).

To test if digital recordings can be used to increase detection in tropical frog choruses, I compared one minute recordings, made at 2000, 2200, and 0000 h on five consecutive days, for a total of fifteen recordings per site. I analyzed these recordings using two methods: 1) listening to the recordings; and 2) listening and analyzing the recordings using computer software. For the first method I listened to the recordings with headphones, and each species heard was given an Amphibian Calling Index value (ACI; United States Geological Survey 2004). The ACI has four possible values: 0—no animals calling; 1—a few animals calling without overlap; 2—some overlap of animals calling; and 3—a full chorus of the species. For the second method, I listened to the recordings with headphones and analyzed them using computer software to detect the signal of each species' call by their sound and visual pattern in the auditory spectrum. There is little overlap in the call spectrum of the *Eleutherodactylus* frogs in Puerto Rico, and thus it was possible to distinguish each species (Drewry and Rand 1983). In addition, recordings of the calls of all the species have been published (Rivero 1998). Each recording was then filtered to remove the range of frequencies of the dominant species, *Eleutherodactylus coqui* (1–2.4 kHz), and re-analyzed. I gave each species a new ACI value for this second method. All recordings were coded and analyzed in random order to reduce bias. Each pair of results, for each recording, by species, were compared using Wilcoxon signed ranks tests.

To evaluate the differences in the level of the recorded sound of the species, which may explain why some species were not heard, I obtained the average signal level by frequency using the values of decibels full scale (dBFS), which corresponds, on a logarithmic scale, to the signal in the digital file. On this scale the maximum is 0 dB and the minimum is -96 dB, which corresponds to the maximum and minimum levels, respectively, of sound that the

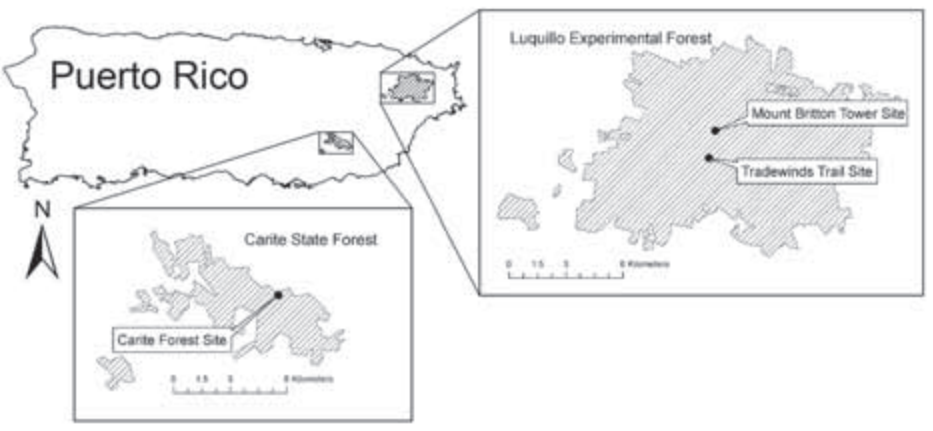


FIG. 1. Location of the three study sites in Puerto Rico.

digital file can store (Fries and Fries 2005). The recordings were analyzed using the program AUDITION (ver. 1.0, Adobe Systems, Inc., California, USA).

Results.—A total of eight species of *Eleutherodactylus* frogs were detected. Seven species were detected at the Tradewinds Trail site (Fig. 2a), where there was no difference between the methods

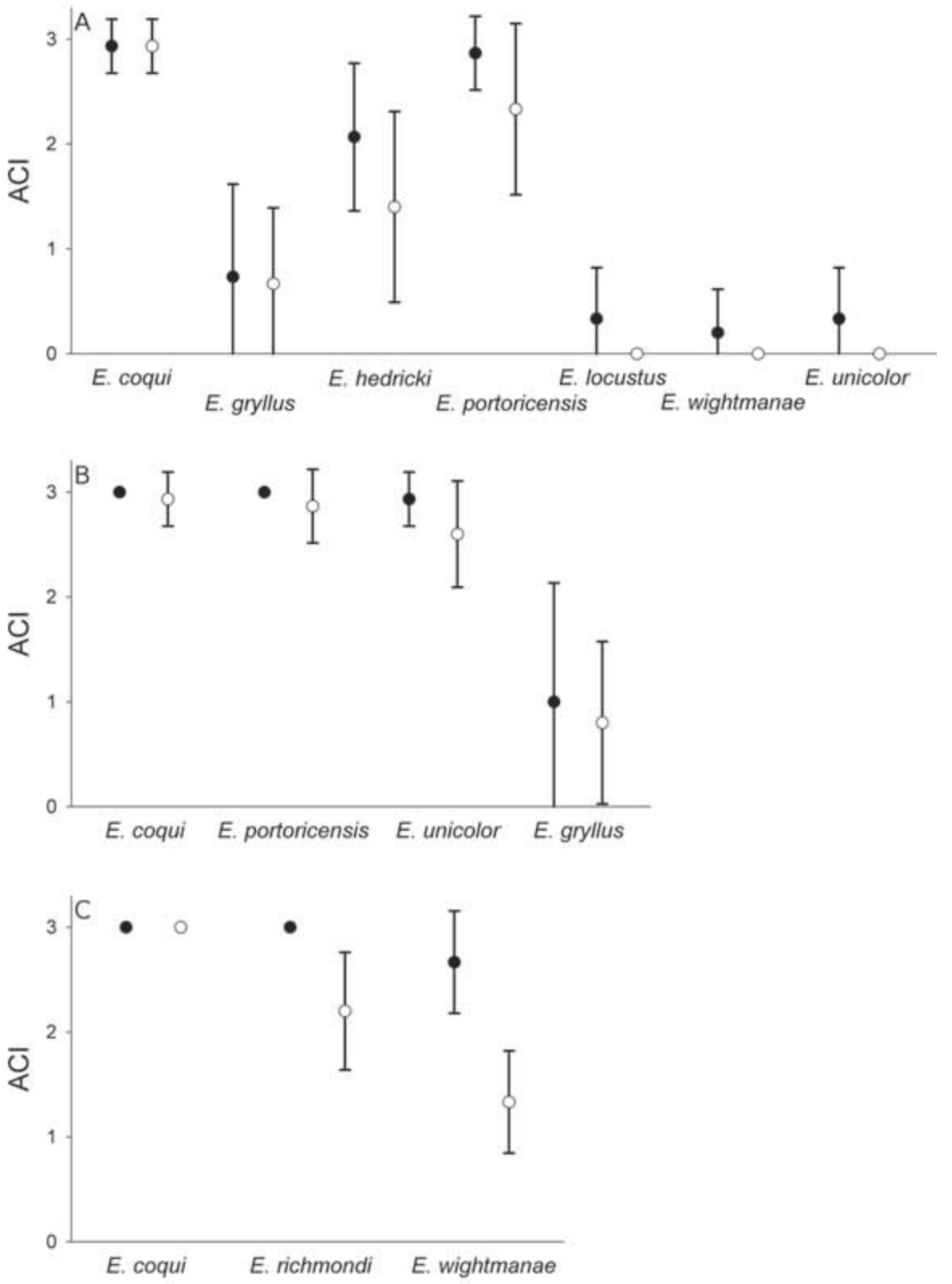


FIG. 2. ACI values (mean ± SD) per species using two methods at: A) Tradewinds Trail site; B) Mount Britton Tower site; and C) Carite Forest site. Filled circles = values for computer analysis method. Open circles = values for the listening method.

for *E. coqui* and *E. gryllus*. The ACI values of two species were higher on the computer-analyzed recordings: *E. hedricki* (P = 0.016) and *E. portoricensis* (P = 0.022). Three species were detected only when the signals of their calls were seen in the spectrogram and the recordings were filtered: *E. locustus*, *E. unicolor,* and *E. wightmanae*. I detected *E. locustus* and *E. unicolor* in five of the

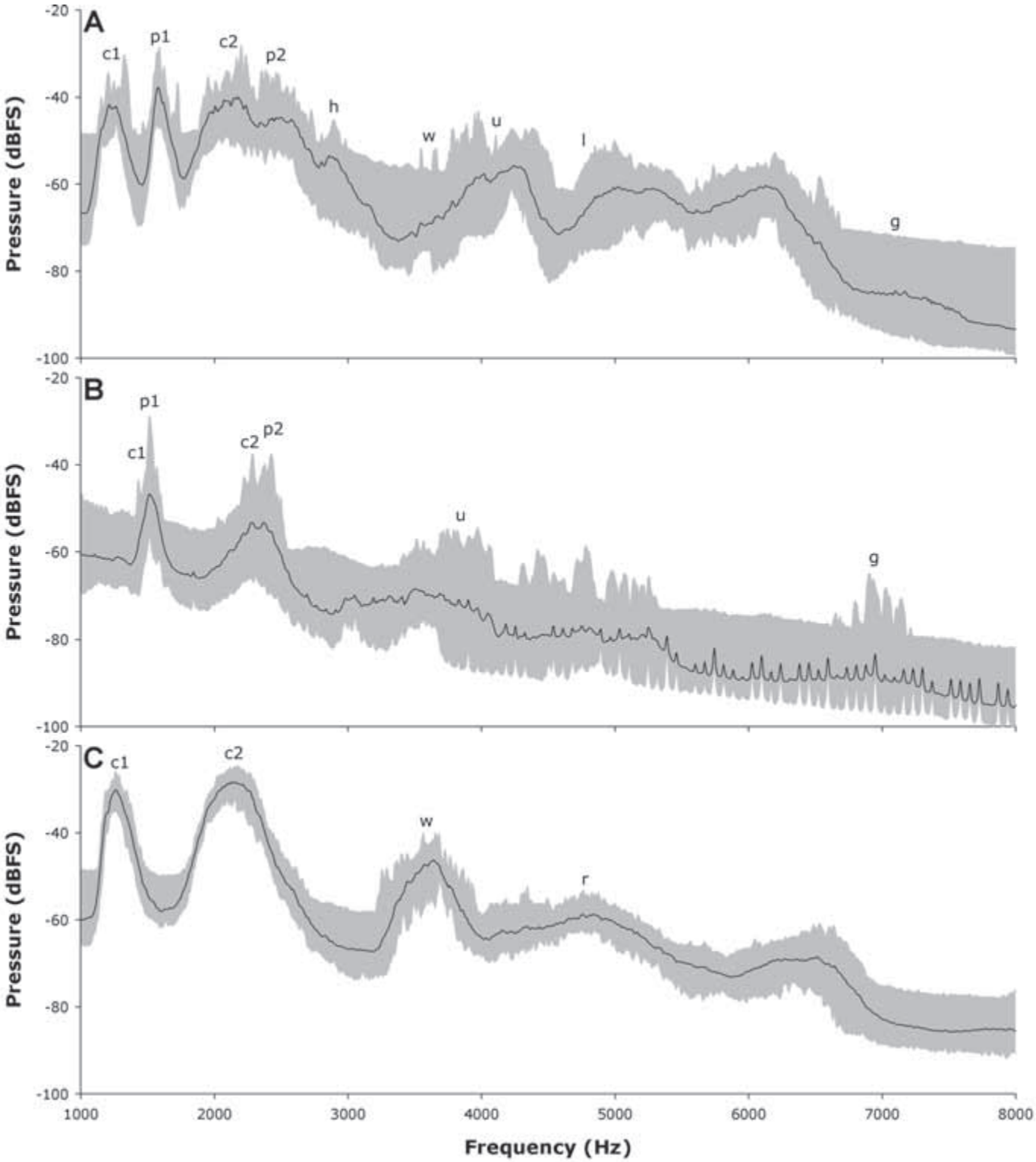


FIG. 3. Sound pressure by frequency of species of *Eleutherodactylus* frogs at the (A) Tradewinds Trail site, (B) Mount Britton Tower site, and (C) Carite Forest site. Sound pressure is measured in decibels full scale (dBFS). The black line represents the average for the fifteen recordings at each site and the shaded area encloses the range of values for each frequency. Letters above the graphs represent the dominant frequency for the species. c1 = first note of *E. coqui*; c2 = second note of *E. coqui*; p1 = first note of *E. portoricensis*; p2 = second note of *E. portoricensis*; h = *E. hedricki*; w = *E. wightmanae*; u = *E. unicolor*; l = *E. locustus*; r = *E. richmondi*; g = *E. gryllus*. Other peaks represent sounds made by insects.

fifteen recordings and *E. wightmanae* in only three of fifteen recordings. Two species had the highest sound pressures, *E. coqui* and *E. portoricensis* (Fig. 3a). The average level of the signal was -41.7 dB and -40.0 dB for the first and second notes of *E. coqui*, respectively, and -37.7 dB and -44.7 dB for the first and second notes, respectively, of *E. portoricensis*. The average maximum signal level for *E. locustus* was -50.7 dB, 13.0 dB less than the average of the loudest species, *E. portoricensis*. The average maximum signal level of *E. unicolor* was -44.5 dB and for *E. wightmanae* was -43.3 dB; these values were 6.8 dB and 5.6 dB lower than the loudest species, respectively.

There were four species at the Mount Britton Tower site: *E. coqui*, *E. gryllus*, *E. portoricensis*, and *E. unicolor*. There was no significant difference between methods for the four species (Fig. 2b).

I detected three species at the Carite State Forest site (Fig. 2c). There was no difference between methods for *E. coqui*, but the other two species had higher ACI values when analyzed by computer: *E. richmondi* (P = 0.004) and *E. wightmanae* (P = 0.002). The highest signal level was made by *E. coqui*, with -30.1 dB and -28.4 dB for the first and second notes, respectively (Fig. 3c). The average signal level for *E. richmondi* was -58.8 dB, 30.4 dB less than *E. coqui*, and for *E. wightmanae* it was -46.3 dB, 17.9 dB less than the loudest species.

Discussion.—The loudest species at the study sites, *E. coqui* and *E. portoricensis*, had a continuous chorus. In addition, the sound pressure of these species was higher than the species that were not as easily detected, up to 30 dB louder (Fig. 3). The continuous loud chorus of *E. coqui* and *E. portoricensis* caused interference in the detection of the other species.

The detection and level of activity measured using the ACI increased at two of three sites when recordings were filtered and the spectrogram was evaluated in the computer compared to only listening to the recordings. Of particular importance was the detection of three species, *E. locustus*, *E. unicolor*, and *E. wightmanae* at one of the sites only after filtering. These three species appear to be threatened or endangered since their range is restricted and few populations are known (Burrowes et al. 2004; pers. obs.).

Digital recordings, and their analysis using software, can be used as a tool to search for populations with apparently limited distributions, in areas where limited herpetological work has been conducted, and where loud species interfere with the detection of others. The ACI of four species was higher when the recordings were filtered to remove the common and loud *E. coqui*. Two of these four species, *E. hedricki* and *E. portoricensis*, have limited distribution in the highlands of Puerto Rico, and the two other species, *E. richmondi* and *E. wightmanae*, are thought to have only a few small populations (Burrowes et al. 2004; Villanueva-Rivera 2006).

Furthermore, recordings and computer analysis of choruses may advance our knowledge of anuran breeding phenology. For example, Bridges and Dorcas (2000) found that *Rana sphenocephala*, a species that was thought to be breeding only during the spring and fall, was also calling during the summer between 0200 and 0500 h. This finding, made with a cassette-based automated recording system, indicated a calling period that was missed by most herpetological work done in the area (Bridges and Dorcas 2000).

The use of digital recordings has important implications for the current discussion of amphibian declines and the need for long-term monitoring projects. In a study that tested the use of recorders to detect species of birds, several experts agreed on the identifications of the species present in the recordings, so the method was recommended as an effective avian monitoring method (Rempel et al. 2005). In another study, the number of species identified with recordings made with an ADRS was higher when compared to point counts for birds and transects for amphibians (Acevedo and Villanueva-Rivera 2006). For amphibian monitoring projects, technicians can deploy ADRS and record choruses to be analyzed by experts in the laboratory at another time. This can reduce personnel costs, especially for areas with a small temporal window of amphibian reproductive activity, areas that have high frog diversity, species that do not congregate, and species with low detection probabilities. Another important advantage is that a recording is a permanent record of the presence of a species. Lastly, as demonstrated here, digital recorders and use of computer software may help detect rare species or calls that are difficult to detect due to interference.

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A Comparison of the Effectiveness of Recommended Doses of MS-222 (tricaine methanesulfonate) and Orajel® (benzocaine) for Amphibian Anesthesia

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Traditionally, tricaine methanesulfonate (Ethyl 3-aminobenzoic methanesulfonate salt), commonly known as MS-222, has been used to anesthetize amphibians for a variety of procedures including surgery, marking, and photography (Anholt et al. 1998; Kaplan 1969; Kaiser and Green 2001). Recently, Orajel®, a widely used analgesic for oral pain in humans, has been suggested as an effective alternative (Brown et al. 2004; Chen and Combs 1999). Previous studies also have suggested that Orajel® may be a more convenient choice (Altig 1980; Chen and Combs 1999) because it may be purchased from pharmacies and convenience stores, is relatively inexpensive (Crook and Whiteman 2006) and may be easier to transport (Kaiser and Green 2001; Wright 2001).

Few studies have examined the responses of amphibians to either MS-222 (Anholt et al. 1998; Kaplan 1969; Lowe 2004) or Orajel® (Brown et al. 2004). Crook and Whitman (2006) found that benzocaine, the active ingredient in Orajel®, was more effective than MS-222 for anesthetizing *Ambystoma tigrinum*, and Cakir and Strauch (2005) found that benzocaine had more associated health risks than MS-222 in *Rana pipiens*. No other studies have compared the effectiveness of MS-222 and Orajel® among amphibian groups with dissimilar physiology that may affect their responses to anesthesia (Fellers et al. 1994). For example, factors such as rate of gas exchange across the skin vary among groups (e.g., plethodontid and ambystomatid salamanders), and may alter rates of anesthesia uptake.

We examined the effectiveness of recommended doses of MS-222 and Orajel® on four North American amphibian species (Northern Cricket Frogs [*Acris crepitans*], Mole Salamanders [*Ambystoma talpoideum*], Fowler's Toads [*Bufo fowleri*], and Northern Dusky Salamanders [*Desmognathus fuscus*]) by measuring the length of time required until induction, initial recovery, complete recovery, and the entire anesthesia process.

Methods.—We collected 54 adult *A. crepitans*, 41 adult *B. fowleri* and 46 adult *D. fuscus* from various localities within the western Piedmont of North Carolina, USA, and 16 adult *A. talpoideum* were collected on the Savannah River Site in the upper Coastal Plain of Aiken and Barnwell counties, South Carolina, USA. The snout-vent lengths ranged: 18–27 mm for *A. crepitans*; 29–64 mm for *B. fowleri*; 28–78 mm for *D. fuscus*; and 47–61 mm for *A. talpoideum*. After capture, we minimized stress by housing animals in dark containers with paper towels wetted with aged tap water. We housed *A. crepitans* and *D. fuscus* in same-species pairs in 18 × 18 × 7 cm plastic containers and housed *A. talpoideum* and *B. fowleri* in species-specific 75 × 32 × 30 cm aquariums with no more than 20 individuals per aquarium. *Acris crepitans*, *B. fowleri*, and *A. talpoideum* were kept at room temperature (ca. 21°C), and *D. fuscus* individuals were kept at 4°C but allowed to equilibrate to room temperature 3 h prior to testing. Individuals were kept no longer than a week prior to testing and monitored for at least 24 h before release. We prepared anesthesia solution by adding the recommended doses, 0.50 g/L for MS-222 (0.05%, Fellers et al. 1994) and 1.0 g/L of maximum strength Orajel® (Active ingredient: 20% benzocaine, Brown et al. 2004), to 1 L of 20–22°C, de-chlorinated tap water prepared by allowing chlorine evaporation overnight. We chose not to use a pH buffer with MS-222 as recommended by Lowe (2004) because we did not detect substantial pH change during use, as measured initially by a pH meter (YSI pH100; MS-222 pH = 6.53 ± 0.14, N = 6, Orajel® pH = 7.13 ± 0.08, N = 6) and by hydrion test strips (Micro Essential Laboratory, Inc.) following the last use of a solution (MS-222 pH = 7, N = 6, Orajel® pH = 7, N = 6). Baths were prepared in containers that allowed *D. fuscus* and *A. talpoideum* to completely submerge within the anesthesia solution. *Acris crepitans* and *B. fowleri* were placed in containers that allowed them to maintain their head above the solution until anesthetized.

After we prepared the solutions, individuals were arbitrarily assigned to two groups, either MS-222 or Orajel®, and no more than three individuals at a time were placed in their respective anesthesia solutions (Peterman and Semlitsch 2006). Animals were removed from the anesthetic solution when they failed to respond to our stimulus. We used a toe pinch as our stimulus and administered the pinch every minute in the anesthesia bath and every 2 minutes after induction until complete recovery. All amphibian species groups were tested separately, replacing anesthesia solutions after 15 animals were tested or after 1.5 h of testing. We defined "time until induction" as the period of time necessary for an individual to fail to respond to the toe pinch after being placed in the anesthesia bath. When the animal no longer responded to

our stimulus, we removed animals from the anesthesia bath and rinsed them for 30 seconds in a de-chlorinated water bath. We then placed test animals on moist paper towels, observed, and recorded time until the first response to a toe pinch, which defined our "time until initial recovery." At this point, we visually monitored individuals until they exhibited behavior with no signs of sluggishness or disorientation associated with anesthesia. We defined this time period to be the "time until complete recovery." We chose to use a toe pinch as our stimulus as opposed to a typical righting response (Crook and Whiteman 2006) because our use of anesthesia occurs mainly during injections of visual implant elastomer (Northwest Marine Technology; e.g., Nauwelaerts et al. 2000), and animals frequently responded to elastomer injections (i.e., were not completely anesthetized) even when they failed to right themselves.

We analyzed our data using a MANCOVA (Minitab ver. 12.1) for each species. We used anesthesia type as the independent variable, mass of individual as a covariate, and time until induction, time until initial recovery, time until complete recovery, and the total time for all three stages of anesthesia as dependent variables. We evaluated significance at an $\alpha = 0.05$ level in all statistical tests. Because of the unexpected mortality of *B. fowleri*, we used logistic regression (Hosmer and Lemeshow 1989) to examine the effects of mass, snout–vent length, and treatment on mortality. We used a stepwise procedure with an inclusion/removal cutoff of p = 0.10. This analysis was conducted using the SAS statistical package (SAS v. 9.1, SAS Institute, Cary, North Carolina, USA).

Results.—We found that Orajel® required less time until induction in all species tested (MANCOVA: *A. crepitans*, F = 46.38, df = 1, 51, p < 0.001; *A. talpoideum*, F = 24.21, df = 1, 13, p < 0.001; *B. fowleri*, F = 36.96, df = 1, 36, p < 0.001; *D. fuscus*, F = 20.99, df = 1, 42, p < 0.001; Fig.1), produced longer times until initial recovery in *A. crepitans, B. fowleri*, and *D. fuscus* (MANCOVA: *A. crepitans*, F = 148.73, df = 1, 51, p < 0.001; *B. fowleri*, F = 21.39, df = 1, 36, p < 0.001; *D. fuscus*, F = 70.77, df = 1, 42, p < 0.001; Fig. 1a–c), but a shorter initial recovery period in *A. talpoideum* (MANCOVA: F = 10.65, df = 1, 13, p = 0.006; Fig. 1d). Anesthesia type had no effect on complete recovery times in *A. crepitans, A. talpoideum,* or *D. fuscus* (MANCOVA: *A. crepitans*, F = 0.16, df = 1, 51, p = 0.69; *A. talpoideum*, F = 2.27, df = 1, 13, p = 0.156; *D. fuscus*, F = 0.24, df = 1, 42, p = 0.626; Fig. 1 a, b, d), but anesthetization using Orajel® resulted in a longer period until complete recovery in *B. fowleri* (MANCOVA: F = 14.55, df = 1, 36, p < 0.001; Fig. 1c). Anesthesia using Orajel® took less time for the entire anesthesia process in *A. crepitans* and *A. talpoideum* (MANCOVA: *A. crepitans*, F = 23.71, df = 1, 51, p < 0.001; *A. talpoideum*, F = 28.46, df = 1, 13, p < 0.001; Fig. 2), but more time in *B. fowleri* and *D. fuscus* (MANCOVA: *B. fowleri*, F = 24.74, df = 1, 36, p < 0.001; *D. fuscus*, F = 17.71, dF = 1, 42, p < 0.001; Fig. 2). Mass significantly affected time until induction in

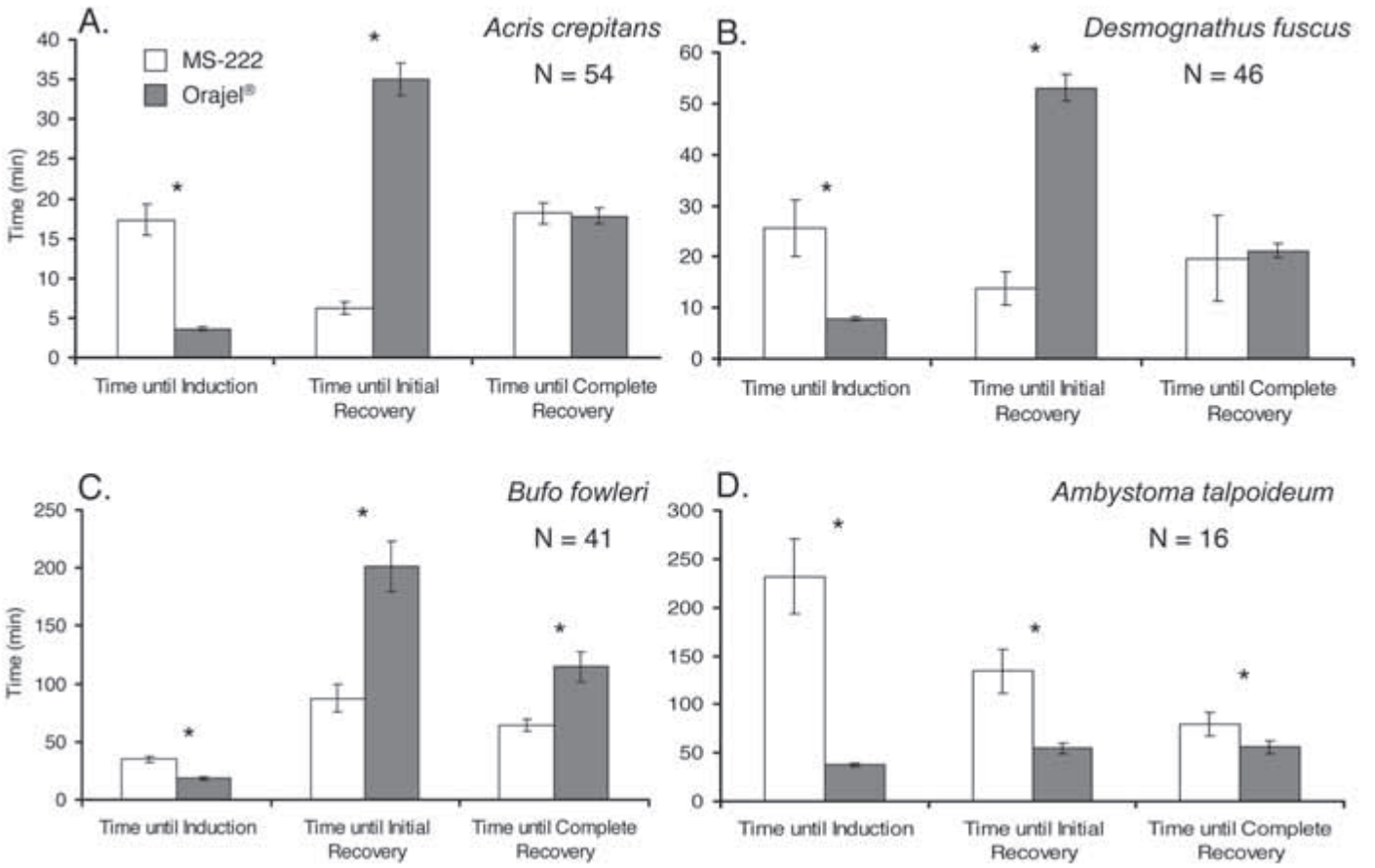


FIG. 1. Time (mean ± SE) required for the three stages of anesthesia using MS-222 and Orajel® in each test species. "*" indicates p < 0.001 (MANCOVA).

B. fowleri and *D. fuscus* (MANCOVA: *B. fowleri*, $F = 16.91$, $df = 1, 36$, $p < 0.001$; *D. fuscus*, $F = 8.53$, $df = 1, 42$, $p = 0.006$). We recorded relatively high mortality rates for *B. fowleri* in Orajel® (35%) and MS-222 (12%), but no mortality occurred in the other species tested. Results of our stepwise logistic regression identified mass as the best predictor of mortality, with heavier individuals having a higher probability of death (model likelihood ratio statistic = 4.9528, $p = 0.026$; parameter estimate for mass = -0.1193, $p = 0.032$).

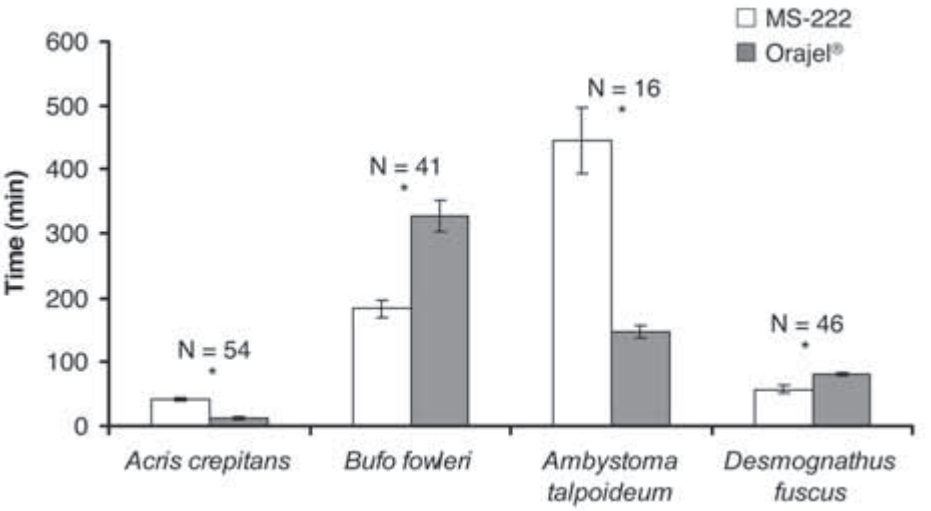


FIG. 2. Time (mean ± SE) required for the entire anesthesia process using MS-222 and Orajel® on our 4 test species. "*" indicates $p < 0.001$ (MANCOVA).

Discussion.—We observed that for most of the amphibian species we tested, anesthetization using Orajel® required less time for induction and produced a longer anesthetization period with variable recovery periods than recommended doses of MS-222 (Fig.1). The effect of anesthesia type on the time required for the entire anesthesia process varied among species (Fig. 2). We attribute inconsistent effects of anesthesia to variation in the physiologies of the species we tested. Factors such as methods of gas exchange, differing metabolic rates, or variation in water absorption rates likely impacted the reactions of species to each anesthesia (Feder and Burggren 1992).

Differences in time required for the three periods of the anesthetization process for each species also may have been a function of mass. We detected a positive effect of mass on induction time in *B. fowleri* and *D. fuscus*. Our sample contained individuals with masses ranging from 2.1 to 27.3 g in *B. fowleri* and 0.5 to 6.5 g in *D. fuscus*. Conversely, we were unable to detect any effect of mass in *A. crepitans* and *A. talpoideum*, which might be a result of testing similarly sized individuals (masses ranged from 0.4 to 1.6 g in *A. crepitans* and 3.9 to 7.6 g in *A. talpoideum*). Contrary to Lowe (2004) but similar to Peterman and Semlitsch (2006), we found that heavier individuals of some species required more time for induction than individuals that weighed less.

An unexpected result of our study was mortality experienced by *B. fowleri*. Orajel® and MS-222 have been used for euthanasia, but typically concentrations are higher or applied differently (Altig 1980). The mortality we observed might be attributed to behavioral and physiological responses of toads to physical handling. During handling, toads frequently released water from their cloacas. Toads might have rapidly absorbed water through their "pelvic patch" (Brekke et al. 1991) in response to water loss. Thus, they might have absorbed more anesthesia than necessary for anesthetization, effectively acquiring a lethal dose before showing signs of reduced motor coordination. Results from our logistic regression suggest that these effects may be most pronounced in heavier individuals. Despite the mortality we witnessed in toads, we suspect that Orajel® and MS-222 are safe for many non-bufonid species. For example, although not included in this study, we also have anesthetized several other species of larval and adult amphibians, including *Ambystoma maculatum*, *Eurycea cirrigera*, and *Pseudotriton ruber*, safely in Orajel® and have experienced no mortality. Yet, our study and others suggest the importance of experimenting with anesthesia type prior to anesthetizing many individuals because effects may vary between different species and life stages (Crook and Whiteman 2006).

Researchers should consider several factors when choosing an anesthesia. For example, researchers needing to work quickly in a field setting may want to consider the anesthesia that requires the least amount of time for the entire anesthesia process. Conversely, if total time or recovery time is less of a concern, researchers may choose to use the anesthesia that produces the shortest induction period, which was Orajel® in all tested species. Investigators choosing anesthesia may also consider the procedures they are conducting such as visual implant elastomer injections or implantation of radio transmitters, because a long anesthetization period may be required. For these longer procedures, Orajel® appears to be a better option for many species (Fig. 1).

Various other factors also may affect a researcher's choice of anesthesia. Although MS-222 must be purchased from a chemical supply company (Brown et al. 2004), Orajel® is a common oral analgesic, can be found at most convenience stores, and is slightly less expensive per dose than MS-222 (Orajel®: CVS Pharmacy in Davidson, NC, US $0.65/dose; MS-222: Sigma Aldrich US $0.87/dose). We also observed that, similar to Crook and Whiteman (2006), Orajel® anesthesia baths anesthetized more individuals than MS-222 baths. Furthermore, although there are no known negative side effects of low doses of Orajel® on amphibians, MS-222 may decrease natural cutaneous gram-negative bacterial growth (Fedewa and Lindell 2005).

Based on our study, researchers should prioritize their needs while choosing anesthesia for amphibians. Orajel® appears to be a relatively safe, quick, and convenient anesthesia, but MS-222 may be a better choice when the study organism requires less time for the entire anesthesia process, or the study organism's mortality risk due to anesthesia is high and/or the study species is of special conservation concern.

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for providing comments that improved the manuscript and H. Whiteman for advice that improved the study. Some animals for this study were collected at Mecklenburg County's Cowan's Ford Wildlife Refuge. All procedures were approved by the Davidson College Animal Care and Use Committee, (3-05-17; 2006). Manuscript preparation was aided by the Environmental Remediation Sciences Division of the Office of Biological and Environmental Research, U.S. Department of Energy through Financial Assistance Award number DE-FC09-96SR18546 to the University of Georgia Research Foundation. Funding was provided by: Davidson College Department of Biology; a Grant-in-Aid-of-Research from the National Academy of Sciences, administered by Sigma Xi, The Scientific Research Society; a Yarbrough Research Grant administered by the Collegiate Academy, North Carolina Academy of Science; Duke Power; and National Science Foundation grants (DEB-0347326 and DBI-1039153) to MED.

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NATURAL HISTORY NOTES

The Natural History Notes section is analogous to Geographic Distribution. Preferred notes should 1) focus on observations in the field, with little human intrusion; 2) represent more than the isolated documentation of developmental aberrations; and 3) possess a natural history perspective. Individual notes should, with few exceptions, concern only one species, and authors are requested to choose a keyword or short phrase which best describes the nature of their note (e.g., Reproduction, Morphology, Habitat, etc.). Use of figures to illustrate any data is encouraged, but should replace words rather than embellish them. The section's intent is to convey information rather than demonstrate prose. Articles submitted to this section will be reviewed and edited prior to acceptance.

Electronic submission of manuscripts is requested (as Microsoft Word or Rich Text format [rtf] files, as e-mail attachments). Authors without the ability to send manuscripts electronically may supply hard copy instead. Figures can be submitted electronically as JPG files, although higher resolution TIFF or PDF files will be requested for publication. Please DO NOT send graphic files as imbedded figures within a text file. Additional information concerning preparation and submission of graphics files is available on the SSAR web site at: http://www.ssarherps.org/HRinfo.html. Manuscripts should be sent to the appropriate section editor: **Marc P. Hayes** (amphisbaenids, crocodilians, lizards, and *Sphenodon*; mhayesrana@aol.com); **Charles W. Painter** (amphibians; charles.painter@state.nm.us); **Andrew T. Holycross** (snakes; holycross@asu.edu); and **James Harding** (turtles; hardingj@pilot.msu.edu).

Standard format for this section is as follows: SCIENTIFIC NAME, COMMON NAME (for the United States and Canada as it appears in Crother [2000. *Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, with Comments Regarding Confidence in Our Understanding*. Herpetol. Circ. 29:1–82; available online at <http://herplit.com/SSAR/circulars/HC29/Crother.html>]; for Mexico as it appears in Liner [1994, *Scientific and Common Names for the Amphibians and Reptiles of Mexico in English and Spanish*, Herpetol. Circ. 23:1–113]), KEYWORD. DATA on the animal. Place of deposition or intended deposition of specimen(s), and catalog number(s). Then skip a line and close with SUBMITTED BY (give name and address in full—spell out state names—no abbreviations). (NCN) should be used for common name where none is recognized. References may be briefly cited in text (refer to this issue for citation format).

Recommended citation for notes appearing in this section is: Lemos-Espinal, J., and R. E. Ballinger. 1994. *Rhyacosiredon leorae*. Size. Herpetol. Rev. 25:22.

CAUDATA

AMBYSTOMA TALPOIDEUM (Mole Salamander). **PREDATION**. On 15 May 2005, I observed a Nine-banded Armadillo (*Dasypus novemcinctus*) foraging along a drift fence at Ellenton Bay, a Carolina bay on the Savannah River Site in Aiken County, South Carolina, USA. It was a wet night with light rain falling, and many metamorphic Mole Salamanders were moving from the wetland toward surrounding terrestrial habitat. They were slowed and concentrated spatially by the drift fence of buried aluminum flashing, increasing their vulnerability to predators. The armadillo moved slowly along the fence, devouring salamanders repeatedly. On several occasions, it did not take the tail and I verified that the prey were Mole Salamanders by collecting these tails. Although I observed many salamanders captured in bucket traps along the fence during the night, they had all disappeared by morning; only parts of carcasses remained strewed around the traps. Because escape from these buckets was highly unlikely, armadillos probably ate most of these salamanders. Later in the migration season, I observed several individual armadillos foraging simultaneously at the same site. These observations indicate that nine-banded armadillos can be formidable predators of ambystomatid salamanders, perhaps severely affecting their populations when indirectly offered easy foraging opportunities by standard sampling

techniques for amphibians.

To my knowledge, this is the first report of Nine-banded Armadillos preying on Mole Salamanders. Several studies have reported that armadillos feed on various salamander species (Breece and Dusi 1985. *In* Montgomery [ed.], The Evolution and Ecology of Armadillos, Sloths, and Vermilinguas, pp. 419–427. Smithsonian Inst. Press, Washington, D.C.; Fitch et al. 1952. J. Mammal. 33:21–37; Kalmbach 1943. The Armadillo: Its Relation to Agriculture and Game. Texas Game, Fish and Oyster Comm. Bull.) but none reported Mole Salamanders specifically. Each of these reports concluded that amphibians are a very small portion of the total diet of armadillos (less than 2% by volume) and that a majority are taken during the cooler parts of the year when most salamander species migrate. However, the evidence reported here suggests that as nine-banded armadillos continue to expand their geographic range they may increasingly affect ambystomatid populations in new regions of the southeastern United States, especially when inadvertently aided by drift fences at research sites. Although researchers probably trap and remove most bothersome predators during sampling periods, potential for abnormally high predation remains if drift fences are left partially erect when inactive.

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PLETHODON ALBAGULA (Western Slimy Salamander). **BROODING DEFENSE BEHAVIOR AND OOPHAGY.** Salamanders of the genus *Plethodon* are known to brood egg clutches (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington D.C. 587 pp.; Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.). Aggressive defense behavior while brooding has been documented in *P. cinereus* (Redback Salamander) numerous times (Bachmann 1984. Herpetologica 40:436–443; Highton and Savage 1961. Copeia 1961:95–98). Although defensive brooding behavior has been documented in other plethodontids (see Bachmann 1984, *op. cit*., for citations), it has not been reported in *P. albagula*. Herein, we report four instances of brooding defense behavior by *P. albagula* and document oophagy in this species.

Spillway Mine (Garland Co. Arkansas, USA) is a sanctuary for brooding female *Plethodon albagula*. This 149-m linear abandoned mineshaft, located in the Ouachita National Forest in south-central Arkansas, is utilized by a number of *P. albagula* females each late summer and fall (August–December). Trauth et al. (*in press*, Herpetol. Nat. Hist.) reported on brooding postures and nest site fidelity of the females using this mineshaft. Several lone females, not attending an egg clutch, have been observed to freely roam the mine during the brooding season and could potentially be marauding egg clutches.

On 4 Oct 1984, a female *P. albagula* brooding a clutch of 19 eggs (76 m from mine entrance) was attacked by a lone adult female. Upon attack, the attacker approached the clutch from an unguarded side and violently pulled a single egg from the clutch. The attacking female retreated while the brooding female repeatedly bit the side and tail of the attacker after chasing it into a crevice. The bites were made as the intruder made one bite and released quickly. Afterwards, the brooding female returned and wrapped herself around her clutch. The second instance occurred on 13 Sept 2002, as a lone female attempted to inspect an egg clutch (99 m from mine entrance) attended by a brooding female. As the lone female traveled in front of the brooding female, she was inflicted with a series of bites to the tail until the lone female quickly retreated and settled 0.2 m from the attack site. The final instances occurred 23 Oct and 18 Nov 2004. On 23 Oct, a brooding female (55 m from mine entrance) attacked a pair of calipers and, subsequently, the researcher's finger as egg diameter measurements were being taken. The female proceeded to inflict three separate bites on the calipers until the researcher retreated. The second instance from the same female occurred on 18 Nov where the female inflicted one bite to the researcher's hand. These occurrences suggest brooding defense behavior is common in the wild for *P. albagula*.

On 5 Nov 1999, a female *P. albagula* was collected from Spillway Mine. Upon necropsy, the female contained three eggs in her digestive tract. During Fall 1999, 31 females were brooding clutches in the abandoned mine shaft and, through photo identification, this female was not determined to be a female with a clutch. Thus, to our knowledge this is the first documented instance of oophagy in *P. albagula*.

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PLETHODON GLUTINOSUS (Slimy Salamander). **BURROWING BEHAVIOR.** Slimy Salamanders get their name from the sticky substance excreted from their skin when grabbed or roughly handled (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, D.C. 587 pp.). It is also known that these salamanders frequently inhabit abandoned burrows made by other organisms and shelter underneath rocks and logs. On 17 Sept 2005 in West Davenport, New York (USA) I attempted to capture and measure an adult *P. glutinosus* as it went into a burrow. Upon excavation of the burrow, it was observed that the burrow was L-shaped, shallow (ca. 10 cm deep), non-continuous, and had just enough room to fit the salamander. A thick, cloudy, white, glue-like substance was found completely coating the walls of the burrow. This substance was strong enough to adhere clumps of dirt to my hand making further pursuit of the salamander difficult. Due to the thickness of the substance it was improbable that it was put there during the short period of attempted capture. During the excavation process, the adult *P. glutinosus* remained in the burrow.

This is the first report of *P. glutinosus* layering the walls of a burrow with slime. The slimed walls could be a means of prey capture or be used as an insulating mechanism during times of hibernation.

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ology, Hartwick College, Oneonta, New York 13820, USA; e-mail: diefenbachee@hartwick.edu.

TRITURUS MARMORATUS (Marbled Newt). **LIMB ABNORMALITIES.** Herein we report a high occurrence of limb abnormalities in a population of *Triturus marmoratus*. Data were gathered during 2000–2003 and 2005, while we were investigating the orientation behavior of this species (Diego-Rasilla and Luengo 2002. J. Ethol. 20:137–141; Diego-Rasilla and Luengo 2004. Behav. Ecol. Sociobiol. 55:556–560).

A temporal pond 270 m^2 situated in Valdeajos (Burgos, northern Spain; 42º44' 32 N, 3º54'41"W; 1040 m elev.) was monitored for Marbled Newts during the spring. This eutrophic pond, constructed for cattle use and surrounded by an agricultural landscape, is characterized by high levels of nutrient runoff from agricultural lands and heavy livestock use.

Of the 33 adult newts collected in 2000, one adult male and one adult female had visible abnormalities (6.1 % abnormal). The female newt had seven digits (polydactilia), which were poorly separated and short, indicating missing phalanges (brachydactyly) in its right hind limb. The male had the normal number of metatarsal bones in its right hind limb, but the number of phalanges was reduced (brachydactyly) (see Diego-Rasilla 2000. Bol. Asoc. Herpetol. Esp. 11[2]:88–89).

Fifteen newts were examined in 2001, and one adult male and one adult female appeared abnormal (13.3% abnormal). On the left hind limb of the male, digit IV had a duplicated phalanx (polyphalangy). In the adult female the left hind limb adopted a palette shape, only three digits were present (ectrodactyly), and they were all short (brachydactyly).

Of 27 adults collected 23 March 2002, one adult female had visible abnormalities (3.7% abnormal). Digit II of its right fore limb had a duplicated last phalanx (polyphalangy), and it was albino (Diego-Rasilla et al., submitted).

Twenty-three adult newts were captured on 11 April 2003. In this survey we collected the albino female again which was the only individual having visible abnormalities (4.3% abnormal).

We searched the pond again on 1 May 2005 and collected 18 adult newts. Three were identified as having abnormalities (16.7% abnormal), one of them being the albino female described above. The other two specimens, male and female, had abnormalities in three of their limbs. The adult female had four digits (i.e., four metatarsal bones) in its left fore limb, but the number of phalanges was reduced (brachydactyly); the right fore limb was very short, showing an absence of the proximal portion of the limb, with the foot attached very close to the body and proximal bones that could not be identified (phocomelia). This is phocomelia and not ectromelia because a foot is present, although the foot is abnormal with only three metatarsal bones (ectrodactyly) associated with a reduced number of phalanges (brachydactyly). The female also showed reduced right hind limb elements (brachydactyly), and digit III was rotated about 90º to the left. The male newt showed reduced right and left fore limb elements (brachydactyly); also digit III in its right fore limb was rotated about 90º to the left and showed reduced right hind limb elements (brachydactyly).

These rates of visual abnormalities exceeded the baseline abnormality percentage of 0–2% predicted in amphibian populations (Ouellet 2000. *In* Sparling et al. [eds.], Ecotoxicology of Amphibians and Reptiles, pp. 617–646. Soc. Environ. Toxicol. Chem.). It has been suggested that the composition of landscapes surrounding wetlands affects rates of limb malformation. Particularly, proximity to human associated land uses including agriculture, as is the case in our Marbled Newt population, is associated with an increased risk (Ouellet et al. 1997. J. Wildl. Dis. 33:95–104).

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TRITURUS MARMORATUS (Marbled Newt). **ALBINISM**. On 23 March 2002 we collected an albino adult female *Triturus marmoratus* (129 mm TL; 57 mm tail length; 12.2 g) from a temporary pond situated in Valdeajos (Burgos, northern Spain; 42º44'32"N, 3º54'41"W) at an elevation of 1040 m. The albino adult female also exhibited polyphalangy in its right forelimb. After being examined, the belly and dorsal patterns were photographed for identification and the individual was returned to its breeding pond.

The albino female was golden in appearance, whereas all other *T. marmoratus* captured at the pond showed the characteristic color pattern of this species (Barbadillo et al. 1999. Anfibios y Reptiles de la Península Ibérica, Baleares y Canarias. 419 pp.). This albino female had black eyes and a speckled body pattern, however due to the deficiency of melanophores, there were no greenish or black colors. The dorsal surface had a golden base color with dark spots showing poorly defined edges. Dorsally, the individual showed a golden, poorly defined, dorsal stripe. Golden shades were clearest on the limbs and on the ventral surface of the abdomen, thorax, and head because dark spots scarcely appeared on these surfaces. The ventral surface of the abdomen showed a thinner epidermis, and it was possible to see the intestines through the skin.

In a subsequent survey at the same pond on 11 April 2003, we collected the albino female for a second time (132 mm TL; 60 mm tail; 10.9 g). We searched the same pond again on 1 May 2005 and collected the albino female again (137 mm TL; 64 mm tail; 8.1 g). It seems that selective pressures against albinism in wild *T. marmoratus* may not be strong since this individual survived as an adult animal. Also, it successfully returned in successive years to the same pond, showing strong site fidelity for its breeding pond.

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ANURA

ASCAPHUS TRUEI (Tailed Frog). **NEST SITE**. Few nest sites of *A. truei* have been reported and the timing of oviposition is relatively unknown. Here I report the first *A. truei* nest site from Mendocino County, California (USA) and also the first site detected within a seep. Karraker and Beyersdorf (1997. Northwest. Nat. 78:110–111) reported the only previously documented site in California on 16 August 1994.

On 3 August 2005, I found an *A. truei* nest site ca. 9 km S of Elk, Mendocino Co., California in the Elk Creek drainage. Twenty-five eggs were attached to the underside of a large cobble (126 × 118 mm) in a seep (0.3 m wide), ca. 6 km inland from the Pacific Ocean. The eggs were in a continuous string and each egg was ca. 6 mm in diameter. The site occurred on private forest land in a west-facing seep with 75% gradient. Overstory vegetation was primarily 40-year old Coast Redwood (*Sequoia sempervirens*) and Douglas-fir (*Pseudotsuga menziesii*), with 89% canopy closure (measured with a densiometer). The nest site was located 1 m above the seep's confluence with a 3rd order fish-bearing stream.

On 18 August, five tadpoles were observed in the seep and there were no unhatched eggs remaining. The five tadpoles measured 15–17 mm TL and had moved as far as 15 cm downstream from the nest site towards the fish-bearing stream. The tadpoles had functioning oral discs and characteristic white tail flags. No predators were observed within the seep, and it appeared as if many tadpoles had moved into the fish-bearing stream prior to the second visit.

Although I do not know if predation of eggs occurred prior to my discovery, the clutch size (N = 25) is consistent with other clutches reported for coastal *A. truei* (Adams 1993. Northwest. Nat. 74:15–18; Karraker and Beyersdorf, *op. cit.*; Noble and Putnam 1931. Copeia 1931:97–101) and further supports the hypothesis that coastal populations have smaller clutch sizes than inland populations.

I thank David W. Ulrich and Christopher A. Morris for their assistance in concluding this work.

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GASTROPHRYNE ELEGANS (Elegant Narrow-mouthed Toad). **ABUNDANCE.** *Gastrophryne elegans* is found in Belize, Guatemala, Mexico, and Honduras and is characterized as a species of least concern by the IUCN Global Amphibian Assessment (http://www.globalamphibians.org; accessed 21 July 2005). Nonetheless, *G. elegans* is known from only a few localities in Belize (Meyer and Foster 1996. A Guide to the Frogs and Toads of Belize. Krieger Publ. Co., Malabar, Florida. 80 pp.). McCranie and Wilson (2002. The Amphibians of Honduras. SSAR Contrib. Herpetol. 19, 625 pp.) reported only two localities in Honduras, and Lee (1996. The Amphibians and Reptiles of the Yucatán Peninsula. Cornell Univ. Press, Ithaca, New York. 500 pp.) described it as uncommon. During a 20-month study in the Bladen Nature Reserve (16°33.124'N, 88°42.974'W), southern Belize, I observed *G. elegans* on several occasions. Here I present observations of unusually high abundance during April 2000, the driest month of the study.

From 24–28 April 2000, I observed many individuals of *G. elegans* during diurnal and nocturnal visual encounter surveys along an unpaved road in tropical evergreen forest. The road was recently graded and large clumps of soil were exposed on the surface. On 28 April 2000, during a 10-min. visual encounter survey that began at 1918 h, I observed 10 adults active on the road surface. The substrate was damp, but there was no standing water. On the same night at another location on the road, I observed 17 *G. elegans* over a period of 10 min. starting at 2005 h. The soil at this site was dry, and there was no standing water. Such abundance was not observed in forested sites distant from the road during April 2000 or during any other survey during the study period. These observations of aboveground activity are unusual because April 2000 was the driest month of my 20-month study, with only 9.6 mm of precipitation. This small quantity of rain fell during the first half of the month and therefore could not be a factor influencing these observations. Because *G. elegans* is fossorial, I suspect that the frogs were unearthed by the recent roadwork and were unable to obtain cover in the extremely dry and hard soil. These observations suggest that although infrequently encountered, *G. elegans* may exist at locally high densities.

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PHYLLOMEDUSA ROHDEI (Mertens' Leaf Frog). **DIET**. *Phyllomedusa rohdei* is endemic to the Atlantic Rainforest of southeastern Brazil. No information exists on food habits of this species. Herein we provide data on the stomach contents of 20 individuals (17 males and 3 females) of *P. rohdei* collected by one of us (RLT) on 20 January 2003, between 2000 and 2300 h, in the municipality of Nova Venécia (18°42'S, 40°30'W), Espírito Santo State, southeastern Brazil. Males ranged from 33.1 to 41.9 mm SVL (mean 37.2 ± 2.5 mm), and females from 42.1 to 45.0 mm SVL (mean 43.7 ± 1.5 mm). The diet was comprised of various arthropods, without a marked dominance of a single prey type, though stoneflies (Plecoptera) were the most important items overall. This is somewhat unexpected, as stoneflies have not been reported in the diets of other *Phyllomedusa* (Duellman 1978. Univ. Kansas Mus. Nat. Hist., Misc. Publ. 65:1–352; Duré 1999. Herpetol. Rev. 30:92; Santos et al. 2004. Iheringia, Sér. Zool. 94:433–438; Vaz-Silva et al. 2004. Herpetol. Rev. 35:160). Data

TABLE 1. Prey in the stomach contents of *Phyllomedusa rohdei* (N = 20) from Nova Venécia, Espírito Santo, southeastern Brazil. F = frequency of occurrence; N = number of individual prey items; M = prey wet mass (in mg).

Prey	F	N	%N	M	%M
INSECTA					
Coleoptera	2	2	6.9	12.3	5
Diptera	4	7	24.1	4.5	1.8
Homoptera	1	1	3.5	1.7	0.7
Lepidoptera (larvae)	4	4	13.8	36.8	15
Odonata	3	3	10.3	45.8	18.7
Orthoptera	1	1	3.5	7.3	3
Plecoptera	7	9	31	102.4	41.7
ARACHNIDA					
Araneae	2	2	6.9	13.4	5.5
MISCELLANEOUS					
Shed skin	2	—	—	21.3	8.7
TOTAL	-	29	100	245.5	100

from these studies, as well as that presented here, suggests an opportunistic diet consisting of a wide variety of arthropods, with frequent consumption of relatively large, soft-bodied prey such as orthopterans, spiders, cockroaches, and larvae. This report reinforces the notion that *Phyllomedusa* tend to be opportunistic predators. The presence of stoneflies and dragonflies (Odonata) in the diet suggests that *P. rohdei* in this population may frequently forage at the margins of water bodies.

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***PHRYNOHYAS* SPP**. (Golden-eyed Treefrogs). **PREDATION**. The genus *Phrynohyas* includes seven species distributed across the lowlands of Mexico, Central and South America east of the Andes, south to northern Argentina (Frost 2004. Amphibian Species of the World: an Online Reference. http://research.amnh.org/herpetology/amphibia/index.html; August 2005). These species are known to produce a secretion that can be irritating to skin and mucous membranes (Rodríguez and Duellman 1994. Univ. Kansas Nat. Hist. Mus. Special Publ. 22:1–80). Herein we report predation on two species of *Phrynohyas* (*P. mesophaea* and *P. venulosa*) by the snakes *Liophis* and *Leptophis*.

A *Liophis miliaris* (female; 65 cm TL) was collected during 1994 in Matinhos Municipality, Paraná State, Brazil (25°45'S, 48°30'W, Atlantic Forest, Restinga habitat). Stomach analysis revealed a partially digested *P. mesophaea*, swallowed headfirst. Stomach analysis of a *Liophis poecilogyrus* (female; 57.7 cm TL) collected during 1998 in Jussara Municipality (23°37'7"S, 52°28'10"W, Araucaria Forest) revealed a partially digested *P. venulosa*. On 17 March 2004 in Céu Azul Municipality (25°20'S, 53°46'W, Semi-deciduous Seasonal Forest) a VHS video recorded 1.5 m TL *Leptophis ahaetulla* resting on the roots of a tree at a river edge. As the collector approached, the snake exhibited the typical open-mouth threat display (Achaval and Olmos 2003. Graphis Press, Montevideo. 136 pp.) and then regurgitated a *P. venulosa* female covered in a thick mucous. *Liophis miliaris*, *L. poecilogyrus*, and *Leptophis ahaetulla* are known to include anurans in their diet (Michaud and Dixon 1989. Herpetol. Rev. 20:39–41; Pardo 2003. Herpetol. Rev. 34:231–232; Teixeira and Porto 1991. Herpetol. Rev. 22:132).

Voucher specimens, with prey items, were deposited in the Herpetological Collection of the Museu de História Natural Capão da Imbuia, Curitiba, Paraná, Brazil (MHNCI 8266, *Liophis poecilogyrus*; MHNCI 9732, *Liophis miliaris*). Video images of the *Leptophis ahaetulla* are also available in the herpetological laboratory at the same institution. We thank Reginaldo A. Machado for specimen identification, Paulo S. Bernarde for the revision of the text, and Beto Sporkens for the VHS image. We also thank Fernando C. Straube for the contribution of his field notes.

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RANA BOYLII (Foothill Yellow-legged Frog). **REPRODUCTION**. Recent work on explosive-breeding anurans has provided increasing evidence of male competition (e.g., *Agalychnis callidryas*, D'Orgeix and Turner 1995. Mol. Ecol. 4:505–508; *Rana dalmatina*, Lodé and Lesbarrères 2004. Naturwissenschaften 91:44–47; *Rana temporaria*, Vieites et al. 2004. Nature 431:305–308). However, evidence for male competition is sparse among North American ranid frogs, even for western species that exhibit explosive breeding, including *Rana boylii*. Hence, we provide observations from western Oregon (USA) indicating male competition in *R. boylii*.

These observations were made on 22 June 2004, during the oviposition period of the northernmost extant population of *R. boylii*. Elsewhere (Rombough and Hayes 2005. Herpetol. Rev. 36:163–164), we detail the location (on the South Santiam River) and provide a site description. Oviposition takes place exclusively in a few off-channel pools and troughs with reduced flow velocities that reduce the likelihood of egg scour (Rombough 2002. Status of the Foothill Yellow-legged Frog [*Rana boylii*] in the South Santiam River, Linn County, Oregon. Report to the Oregon Department of Fish and Wildlife. 42 pp.; but also see Kupferberg 1996. Ecol. Appl. 6:1332–1344; Lind et al. 1996. Herpetol. Rev. 27:62–67). Frogs discussed herein were captured for measurement after oviposition and after interactions between frogs were completed.

Between 1010 and 1045 h, CJR observed an amplectic pair (male: 51.5 mm SVL, 11.5 g; female: 59.0 mm SVL, 15.7 g) during their entire oviposition sequence, also described elsewhere (Rombough and Hayes 2005. Northwest. Nat. 87:157–160). During the oviposition process (including substrate preparation and egg deposition), at least seven other male frogs took up positions within 150 cm. Typically, males sat emergent in shallow water (< 2 cm) or on the bottom, near some sort of substrate irregularity (e.g., a cobble or bedrock ledge) in deeper water (> 10 cm). One of these males (No. 1; 56.5 mm SVL, 13.2 g) remained within 5–11 cm of the pair the entire time. This male never touched the pair nor got closer than 5 cm, even during egg deposition. He often hid under cobbles or sat underwater nearby, always facing the amplectic pair. As soon as the female had finished laying, No. 1 shot forward and rammed the left side of the pair, hitting mostly the male. Immediately after he contacted the pair, No. 1 gave a frog kick that caused the pair to swivel away from the mass. Then, holding the pair with his front limbs, he lowered his vent to the egg mass and held it there for ca. 60 sec. The pair then moved and started to swim, and No. 1 grappled at the male in the pair, but was shaken off, and the pair swam away. When the pair were just over 20 cm from the egg mass, they broke apart and each swam off in differ-

ent directions. After the pair separated, the formerly paired male grabbed No. 1 and began amplexing him, even though he struggled to escape. At this point, all three frogs were captured and measured. Over the period of observation, the paired frogs initially traveled ca. 2 m.

A second amplectic pair (male 53 mm SVL, 12.8 g; female 74.4 mm SVL, 35.5 g), observed entering the oviposition area at 1055 h, just after capture and release of the frogs described above, was also followed closely by two additional male frogs (No. 2: 54.0 mm SVL, 11.0 g; No. 3: 67.5 mm SVL, 20.0 g). These males behaved in a manner similar to No. 1, but approached much more closely and frequently made contact with the pair. On at least 10 occasions, they grappled at the paired male or the hind leg of the female. Usually, the female would forcefully kick the intruder(s) away, but occasionally both amplectic partners or rarely, only the male, would do the kicking. The unpaired males also continuously rushed, grabbed, and amplexed one another. Rushes would be made from a near touching position to distances > 45 cm away, with smaller males grabbing larger males and vice versa. Often, release following an amplectic grab would be immediate, without a sound. However, for at least one third of (> 30) such grabs, one male amplexed a second male for between 30 sec and 2 min, even while the other forcefully tried to escape, swimming a meter or more and flipping upside down (often with the frogs' bright yellow-and-white undersurfaces visible for at least 30 sec). These entire sequences occurred without any apparent vocalization. On at least three occasions, one male even grabbed another male facing backwards (i.e., the frogs were facing opposite directions). Although individual males would swim to the surface regularly (more frequently than the male/female pair) to gulp air (and then swim quickly back to the bottom to hide), pairs of males were also observed to surface together to gulp air on multiple occasions. This behavior continued for 3 hours, until the frogs were captured and measured.

Non-vocal competition for females is known for a number of anuran species, and is most common among explosive breeders (Wells 1977a. *In* Taylor and Guttman [eds.], The Reproductive Biology of Amphibians, pp. 233–262. New York, Plenum Press; Wells 1977b. Anim. Behav. 25:666–693). Over five years of study, the *R. boylii* at this location have completed most of their breeding activity within a week. At breeding sites, males outnumber females by an average of 7 to 1, and observations of breeding frogs indicate that females are amplexed by the first male they approach (CJR, unpubl. data). Because frogs in male-only aggregations often grab one another, tactile identification (rather than auditory or visual identification) of a suitable partner appears to be an important cue for stimulating amplexus (Noble and Aronson 1942. Bull. Am. Mus. Nat. Hist. 80:127–142; Wells 1977b, *op. cit.*).

While physical displacement of a competing male is obvious, male competition may not involve much, if any direct contact. In particular, the behavior performed by male No. 1 (holding his vent over freshly laid eggs) strongly resembles the "clutch piracy" behavior of *R. temporaria*, in which pirate males fertilize the eggs of another frog pair, either during or after laying (Vieites et al., *op. cit.*). Confirmation of this hypothesis requires genetic data, but our observations imply that such competitive behavior may be more widespread among ranid frogs than previously thought.

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RANA CATESBEIANA (American Bullfrog). **MORTALITY**. On 25 Aug 2005, I found a recently deceased adult male Bullfrog (snout–urostyle length ca. 16.5 cm) with the posterior half of an 11.5 cm TL Brown Bullhead (*Ameirus nebulosus*) protruding from its mouth. I made this observation along the edge of a drying pool in a blackwater creek swamp on Fort Stewart Military Installation, Long Co., Georgia, USA. The 4 × 6 m turbid and fetid pool was littered with the carcasses of dozens of Brown Bullheads and centrarchids that had recently died, likely due to anoxic conditions. A few live fish occasionally surfaced to gulp air. As seen in Fig. 1, the frog evidently choked on the fish while attempting to swallow it. Whether the dorsal or pectoral spines of the fish prevented the frog from swallowing the fish or whether the frog choked solely because of the large size of the prey is unknown. To my knowledge this is the first observation of a Bullfrog choking while attempting to prey on a bullhead.

I thank John G. Palis for reviewing this note.



FIG. 1. Adult American Bullfrog (*Rana catesbeiana*) that died while attempting to eat a Brown Bullhead (*Ameirus nebulosus*).

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TESTUDINES

PHRYNOPS HILARII (Hilaire's Side-necked Turtle). **FEEDING BEHAVIOR**. *Phrynops hilarii* posseses a prominent pair of barbels in the gular region that function as mechanoreceptors and are used during mating behavior (Bager 1997. M.S. Thesis. Universidade Federal do Rio Grande do Sul. Rio Grande do Sul.

Brazil. 110 pp.; Winokur 2005. J. Morphol. 172:59–74; Legler 1993. *In* Glasby et al. [eds.], Fauna of Australia, vol. 2, pp. 108–119. Canberra). The barbels are beige in color, matching the turtle's gular coloration, but have a conspicuous black ring at the base. Here we present a description of the species' use of the barbels in feeding, specifically in attracting and capturing fishes.

Captive-hatched *Phrynops hilarii* hatchlings (mean carapace length = 42.4 ± 3.25 mm; N = 111) were kept in a 500-L aquarium (30–40 turtles per tank) with a water depth of 50 cm, a small dry area, and a quantity of floating aquatic macrophytes. Hatchlings were fed live fish and pieces of beef. Thirty juvenile lambari (*Astyanax* sp.), a characid fish, with a mean length of 3.1 ± 0.5 cm, were placed in the tank weekly.

The *P. hilarii* hatchlings were observed using a unique feeding strategy whereby they aligned themselves with submerged *Pistia stratiotes* roots or stalks or on the terrarium substrate itself by extending their anterior limbs forward and hind limbs backward. Their necks remained fully extended, which is contrary to the strategy used by "fishing" *Chelus fimbriatus*, which keep the neck partially contracted (Pritchard 1984. Symp. Zool. Soc. London 52:87–110; Lemell et al. 2002. J. Exp. Biol. 205:1495–1506). The head is jerked in short and quick movements, which causes the barbels to move. It was observed that the black circle at the barbel's base gives an impression of discontinuity between the turtle's gular region and the barbel, hence it may resemble a small invertebrate to a passing fish. Juvenile fish that approach a *Phrynops hilarii* hatchling's head and try to bite at the barbels are often captured, though the efficiency of this strategy was not quantified.

The fish were not quickly swallowed, probably due to their comparatively large size. A hatchling *P. hilarii* that captured a fish was soon approached by other hatchlings, starting a competition for the resource involving agonistic behavior. Such behavior included bites to the anterior and posterior limbs.

The monitored hatchlings did not have any contact with juvenile or adult exemplars, making it unlikely that the observed feeding behaviors were learned. Systematic observations in a natural environment have not been made, but on several occasions we observed the same postures in juvenile and adult specimens submerged in rivers and wetlands, though a complete behavioral sequence with prey ingestion has not yet been noted.

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RHINOCLEMMYS FUNEREA (Black Wood Turtle). **REPRODUCTION**. The reproductive biology of *R. funerea* is inadequately known. Courtship and mating behavior, and egg-laying have been described by Iverson (1975. J. Herpetol. 9:249–250) and Merchán and Mora (2000. Reptilia 26:31–38). Nevertheless, the reproductive season, clutch size, and egg and hatchling size are poorly known. This note provides additional data on reproduction in Costa Rica.

Between November 1999 and December 2001 we found nine egg clutches of *R. funerea* in the Reserva Zoo Ave (Alajuela Province, Costa Rica). Mean clutch size was 4.3 eggs (range 1–7, SD = 1.94). Egg laying occurred between May and October, with a peak in May (44.4% of the sample). The incubation period ranged from 81 to 106 days (mean 92.3) at a temperature of 28ºC. Twenty-five of 40 eggs produced hatchlings. Data for 40 eggs are as follows. Mean mass = 49.6 g (range 37.3–60.0 g, SD = 6.0); mean length = 64.2 mm (range 55.3–76.1 mm, SD = 5.5); mean width = 34.9 mm (32.0–38.1 mm, SD = 1.3). Hatchling measurements are shown in Table 1.

TABLE 1. Data on 25 hatchlings of *Rhinoclemmys funerea*. Weight in grams, rest of measures in millimeters. St. Dev: Standard Deviation. SCL: Straight Carapace Length. SCW: Straight Carapace Width. SPL: Straight Plastron Length. SPW: Straight Plastron Width.

	N	Mean	Minimum	Maximum	St. Dev.
Weight	25	32.4	24.9	38.5	4.12
SCL	15	56.5	50.8	65.0	3.75
SCW	15	48.0	43.6	54.7	3.17
SPL	15	50.3	44.7	58.5	4.00
SPW	15	39.7	35.4	44.9	2.65

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CROCODYLIA

CROCODYLUS ACUTUS (American Crocodile). **MIGRATION**. American Crocodiles require an elevated, well-drained substrate for nesting (Mazzotti 1989. Bull. Mar. Sci. 44:220–228). In Florida, human-made nesting areas along canal banks (berms) at Crocodile Lake National Wildlife Refuge, East Cape Canal in Everglades National Park (ENP), and the cooling canal system at Turkey Point Power Plant provide near ideal nesting conditions, with year-round habitat adjacent or in close proximity to nesting sites. In contrast, nesting areas and nursery habitat in Florida Bay within ENP are often separated by kilometers, necessitating migrations by females to nest sites (Kushlan and Mazzotti 1989. J. Herpetol. 23:1–7). Mazzotti (1983. The Ecology of *Crocodylus acutus* in Florida. PhD dissertation, The Pennsylvania State University, University Park, Pennsylvania. 161 pp.) reported seasonal movements of 5–15 km from year-round habitat to nesting beaches. *Crocodylus acutus* at other locations across its range have been suspected to exhibit this behavior as well; however, to date no such reports have been published. Here we report the longest distance recorded yet for migration of one female *C. acutus* to a nest site.

During the 2003 nesting season, a crocodile nest was reported on Lower Matecumbe Key (24°52'30.4"N, 80°41'54.8"W, datum: WGS84; elev. 0.5 m) in the yard of a private estate. On 22 September 2003, the nesting female crocodile (272 cm total length, 70 kg) was captured along with nine hatchlings in a pond adjacent the nest. All individuals were measured, weighed and given a

unique scute mark as described by Mazzotti (1983, *op. cit.*). On 18 November 2004, during a spotlight survey in the Flamingo district of ENP, the female was recaptured (283 total length, 72 kg) in a creek between Henry Lake and Monroe Lake (25°11'23.2"N, 80°45'11.5"W, datum: WGS84; elev. 0.5 m), a straight-line distance from the nest site of over 35.5 km. The female likely traveled though several creeks and along a chain of islands in ENP, possibly passing areas with suitable nesting habitat before reaching her chosen nest site at Lower Matecumbe Key. We were able to identify this female at active nest sites on Lower Matecumbe Key in 2004 (nest failed) and 2005 (nest produced 20 hatchlings). Reuse of nest sites by individual females has been surmised (Thorbjarnarson 1988. Bull. Florida State Mus., Biol. Sci. 33:1–86) but is difficult to document. Mazzotti (1983, *op. cit.*) reports the only data concerning reuse of an individual nest over consecutive years for *C. acutus*.

We thank John Craig Eaton, Sally Horsfall Eaton, and Billy Bishop for bringing this nest to our attention, for providing us with access to their property, and for their willingness and appreciation of what it means to live with American Crocodiles in their backyard.

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LACERTILIA

AGAMA AGAMA AFRICANA (African Rainbow Lizard). **REPRODUCTION**. Wilson and Porras (1983. Univ. Kansas Mus. Nat. Hist. Spec. Publ. No. 9:1–89) first reported *Agama agama africana* in Florida. Subsequently, Enge et al. (2004. Florida Sci. 67:303–310) documented five allopatric populations in Broward, Charlotte, Martin, Miami-Dade, and Seminole counties (Florida), and reported gravid females in late May. Herein, we augment reproductive data in Florida for this non-native species.

On 7 April 2006, we collected eight *Agama a. africana* from two nearby sites under SR 17 in Punta Gorda, Charlotte County, Florida: at Lavilla Road (26°56'22.2"N, 82°01'38.2"W, datum: NAD83; elev. < 1 m) and at Florida Street (26°56'20.4"N, 82°01'28.9"W, datum: NAD83; elev. < 1 m). Specimens were collected using live crickets as bait after Krysko (2000. Carib. J. Sci. 36:162) and deposited in the Florida Museum of Natural History (FLMNH), University of Florida collection (UF). All females (N = 5, UF 147111–14, 147116) collected were gravid (i.e., contained shelled oviductal eggs) and ranged in size from 108.0–122.5 mm SVL. Mean clutch size of oviductal eggs was 7.6 ± 0.4 mm SE (range = 7–9), mean length of oviductal eggs was 19.6 ± 0.2 mm (range = 15.1–23.8, N = 38), and mean length of vitellogenic (i.e., yolk-producing) follicles was 5.7 ± 0.2 mm (range = 3.7–7.7, N = 49). Enge et al. (*op. cit.*) mistakenly reported clutch sizes to include both oviductal eggs and vitellogenic follicles. We recalculated their data to include mean clutch size of oviductal eggs as 8.7 ± 0.4 mm SE (range = 5–12, N = 17), mean length of oviductal eggs as 14.1 ± 0.3 mm (range = 8.6–21.2, N = 146), and mean length of vitellogenic follicles as 5.8 ± 0.2 mm (range = 3.8–8.8, N = 39). In Africa, *A. a. africana* oviposits multiple clutches consisting of 3–9 eggs each, with five or six eggs being most common (Daniel 1960. Copeia 1960:94–97; Harris 1964. The Life of the Rainbow Lizard. Hutchinson Tropical Monographs, London, 174 pp.). Our data for female *A. a. africana* from Florida are similar to those in their native range. Enge et al. (*op. cit.*) further suggested that their oviductal eggs found at the end of May were from a second clutch that year. Our larger oviductal eggs found in April support their findings and illustrate that reproduction in *Agama a. africana* occurs in as early as April in Florida, but breeding takes place even earlier. Besides oviductal eggs, we identified at least two size classes of vitellogenic follicles, suggesting the potential for females to oviposit three clutches annually. Although the ecological impacts of *Agama a. africana* on native Florida wildlife is unknown, the fecundity exhibited by this species secures its ecological status as an established non-native species.

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ANOLIS CUVIERI (Puerto Rican Giant Anole). **REPRODUCTIVE ECOLOGY**. Mating systems that include pair-bonding in lizards are rare and only well documented in few long-lived species, mostly scincids (*Eumeces laticeps*, *Niveoscincus microlepidotus*, *Tiliqua rugosa*; Pough et al. 2001. Herpetology, 2nd ed., Prentice Hall, Upper Saddle River, New Jersey. 612 pp.). For example, in the long-lived Australian skink *Tiliqua rugosa* (ca. 30 cm SVL), pair-bonding can reduce energetic costs associated with finding a mate during the breeding season and increase mating success (Bull 1994. *In* Vitt and Pianka [eds.], Lizard Ecology, pp. 159–174. Princeton Univ. Press, Princeton, New Jersey). In this species, energetic costs are reduced by mates by following each other into the same retreat and sleeping sites, thus reducing the time and effort to find mates during the breeding season (Bull, *op. cit.*).

In Puerto Rico, pair-bonding has been suggested for the Puerto Rican Dwarf Anole, *Anolis occultus* (ca. 3.4 cm SVL), based on observations of sleeping pairs in nature (Gorman 1980. Carib. J. Sci. 15:29–31). Unfortunately, the reproductive phenology of *A. occultus* is largely unknown, limiting interpretation of the adaptive significance of this behavior. Here, we document sleeping pair behavior in the Puerto Rican Giant Anole, *Anolis cuvieri*, a large-sized anole (ca. 12.5 cm SVL) that frequently occurs in the forest canopy and sub-canopy (Reagan 1996. *In* Reagan and Waide [eds.], The Food Web of a Tropical Rain Forest, pp. 321–345. The University of Chicago Press, Chicago, Illinois; Rivero 1998. The Amphibians and Reptiles of Puerto Rico, 2nd ed., revised. Editorial de la Universidad de Puerto Rico, San Juan, Puerto Rico. 510 pp.). *Anolis cuvieri* is widely distributed in forests throughout Puerto Rico, especially in the karst (limestone) habitats, but very little is known about its reproductive ecology. We interpret the possible adaptive significance of sleeping pair behavior to the species' reproductive phenology and population dynamics based on monthly samples obtained over a year.

Between 2130 and 2200 h on 20 October 2001, NRL found a sleeping pair of adult *A. cuvieri* (FIG. 1a) at a height of 2.2 m on a small (ca. 1-cm diam. twig) of *Quararibea turbinata*, an evergreen tree that can reach 6 m or more in height (Little and Wadsworth 1989. Common Trees of Puerto Rico and the Virgin Islands. U.S. Forest Service, Department of Agriculture, Washington. Agricultural Handbook No. 249. 556 pp.). This observation was made on a karst hillside in Sabana Seca (18°25'21"N, 66°11'37"W, datum: WGS84; elev. 25 m), Toa Baja, northern coastal Puerto Rico. This site is classified as Subtropical Moist Forest with an average annual rainfall and temperature of 1700 mm and 27°C, respectively (Ewel and Whitmore 1973. The Ecological Life Zones of Puerto Rico and the US Virgin Islands. Institute of Tropical Forestry, Río Piedras, Puerto Rico. Forest Service, US Department of Agriculture. Research Paper ITF 18:1–72). Microclimatic conditions at the height of the lizards were 0 km/h wind speed, 24.8°C air temperature, and 96% relative humidity. On a nearby karst valley (ca. 500 m away from the karst hill), NRL found another adult pair sleeping between 2200 and 2300 h on 27 June 2003 on an unidentified liana (ca. 2 cm diam.) at 3.3 m height (Fig. 1b). About a month later (25 July 2003), NRL observed a sleeping pair at 2100 h in the same orientation on this same liana, presumably the same pair. Between the years 2000 and 2003, ARPR also recorded 15 adult male-female pairs of *Anolis cuvieri* sleeping within centimeters of one another at heights between 2.2 m and 15 m in lianas (e.g., *Cissus trifoliata*) and trees (e.g., *Bursera simaruba*, *Quararibea turbinata*, and *Zanthoxylum martinicense*) while conducting nocturnal visual encounter surveys for the Puerto Rican boa, *Epicrates inornatus*, in several karst forests through the island. This suggests that sleeping pair behavior may be more common in *A. cuvieri* than previously recognized.



FIG. 1. Sleeping pairs of adult *Anolis cuvieri* on a tree branch (A) and on a liana (B). Note sexual dimorphism in the tail crest.

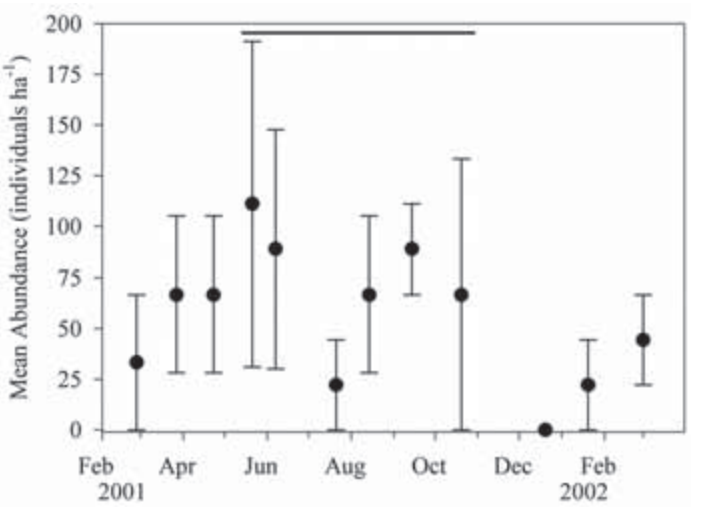


FIG. 2. Mean relative abundance (and standard deviation) of *Anolis cuvieri* from three karst microhabitats in Sabana Seca, Puerto Rico, between February 2001 and March 2002. Horizontal bar on top of graph spans dates when sleeping pairs were observed and the period when recently hatched juveniles were found among microhabitats.

Between February 2001 and March 2002, NRL performed detailed diurnal and nocturnal monthly visual surveys of adult and juvenile *A. cuvieri* along strip plots (50 m long × 3 m wide) in a karst hilltop, hillside, and closed-canopy valley in Sabana Seca, Puerto Rico. Here, both rainfall and temperature are mildly seasonal with most rain occurring May to November, which also represent the warmer months. The mean relative abundance of *Anolis cuvieri* increased to ca. 74 individuals ha^{-1} (range: 0–200 individuals ha^{-1}) during the warmer, wetter months and decreased to ca. 39 individuals ha^{-1} (range: 0–133 individuals ha^{-1}) during the cooler, drier months (December–April; Fig. 2). Recently hatched juveniles were only found during July and October (mean SVL = 4.1 cm, N = 7). Given that eggs of large species like *A. cuvieri* in the tropics may hatch after a ca. 55-day incubation period (R. Andrews, pers. comm.), the period between May and October may represent a distinct breeding season for *A. cuvieri* in Sabana Seca the way it occurs with other sympatric anoles, including native prey species (Reagan, *op. cit.*; Rivero, *op. cit.*).

In Sabana Seca, all *A. cuvieri* sleeping pairs were found only during months in which we found recently hatched juveniles (FIG. 2). Population dynamics and the natural history of the species implies that male and female *Anolis cuvieri* may sleep as pairs as part of a pair-bonding strategy, at least during the warmer, wetter months. The relative large home ranges (275–326 m^2 in males, and 68 m^2 in females: Losos 1990. Carib. J. Sci. 26:65–66; Dial and Roughgarden 1994. Carib. J. Sci. 30:278–279) and the low densities of *A. cuvieri* are consistent with pair-bonding as a strat-

egy to reduce the energetic costs associated with finding mates, and maximize mating success as known in other large-bodied, long-lived lizards with similar demographies (Bull, *op. cit.*).

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ANOLIS NEBULOSUS (Clouded Anole). **DIET.** *Anolis nebulosus* has been shown to vary its foraging sites and feeding rate with seasonal variations in prey abundance (Lister and García Aguayo 1992. J. Anim. Ecol. 61:717–733). However, no reports exist detailing its diet other than the assumption that it eats arthropods. Here we report observations on the stomach contents of 8 *A. nebulosus* collected during 2003 and 2004 from Chínipas, Chihuahua (N = 4; 27°23'39.9"N, 108°32'36.0"W, datum: WGS84; elev. 469 m), Rancho Jovinos, Chihuahua (N = 1; 27°21'3.5"N, 109°30'10.8"W, datum: WGS84; elev. 428 m); and Arroyo Las Borregas, Chihuahua (N = 3; 27°23'4.3"N, 108°32'21.1"W, datum: WGS84; elev. 470 m) (see Lemos-Espinal et al. 2004. Bull Chicago Herpetol. Soc. 39:164–168; Smith et al. 2005. Bull Chicago Herpetol. Soc. 40:45–51). Of the 8 individuals, 7 contained identifiable stomach contents; one individual had an empty stomach. Table 1 lists the diet items. Numerically, termites were the most important prey, but volumetrically grasshoppers were most important. Interestingly, we found plant material in one stomach. Whether the plant material was intentionally consumed is unclear as it was the only item found in that stomach.

TABLE 1. Stomach contents of 7 *Anolis nebulosus* from Chihuahua, México.

Prey Type	Prey Items N =	(%)	Volume cm^3	(%)	Number of Stomachs
Coleoptera					
Adults	2	(11.8)	0.05	(15.6)	2
Larvae	1	(5.9)	0.03	(9.4)	1
Hymenoptera (ants)	2	(11.8)	0.03	(9.4)	2
Isoptera	7	(41.2)	0.01	(3.1)	1
Lepidoptera	1	(5.9)	0.05	(15.6)	1
Orthoptera	3	(17.7)	0.12	(37.5)	2
Plant Material	1	(5.9)	0.03	(9.4)	1

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CALLISAURUS DRACONOIDES (Zebra-tailed Lizard). **DIET; CLUTCH SIZE.** *Callisaurus draconoides* is reported to eat a variety of insects and invertebrates (Hotton 1955. Am. Midl. Nat. 53:88–114; Asplund 1967. Am. Midl. Nat. 77:462–475; Pianka and Parker 1972. Copeia 1972:493–508; Smith et al. 1987. Great Basin Nat. 47:175–185) and rarely vegetation (Pianka and Parker, *op. cit.*). Two previous reports on its diet exist for México; Asplund (*op. cit.*) reported on lizards from Baja California, and Pianka and Parker (*op. cit.*) studied *C. draconoides* diet in Sonora. However, the latter authors pooled results with data from Arizona and California, disallowing distinguishing potential regional differences. Thus, we provide data on *C. draconoides* diet exclusively from Sonora, México.

Our observations are based on the stomach contents of 7 *C. draconoides* collected from 22–24 April and 25–27 July 2004 from three localities in Sonora: Valle de Guaymas (N = 3; 28°17'23.0"N, 119°43'0.8"W, datum: WGS84; elev. 103 m), Punta Chueca at Sierra Seri (N = 3; 28°53'20.6"N, 111°59'37.1"W; elev. 75 m), and near Bahía Kino (N = 1; 28°59'43.2"N, 112°7'43.3"W; elev. 48 m; see Smith et al. 2005. Bull Chicago Herpetol. Soc. 40:45–51). All 7 animals contained identifiable stomach contents comprising several invertebrate taxa and some plant material (Table 1). Beetles, found in 5 stomachs, were numerically most important, but volumetrically wasps were most important. One stomach had a small amount of plant material (leaves); as this individual also contained several (5) other prey, leaf ingestion was likely unintentional. Our observations are similar to previous reports on diet in that insects are dominant. However, both Asplund (*op. cit.*) and Hotton (*op. cit.*) found caterpillars important in *C. draconoides* diet, but we observed none. Otherwise, diet composition is very similar to the pooled Mojave and Sonoran Desert sample of Pianka and Parker

TABLE 1. Stomach contents of 7 *Callisaurus draconoides* from Sonora, México.

Prey Type	Prey Items N =	(%)	Volume mm^3	(%)	Number of Stomachs
Araneae	2	(5.6)	55.5	(3.4)	2
Coleoptera					
Adults	14	(38.9)	276.1	(16.8)	5
Larvae	2	(5.6)	42.4	(2.6)	1
Hymenoptera (wasps)	5	(13.9)	1151.2	(70.1)	3
Hymenoptera (ants)	3	(8.3)	1.6	(0.1)	1
Isoptera	4	(11.1)	13.0	(0.8)	1
Orthoptera	1	(2.8)	3.5	(0.2)	1
Unidentified insect	2	(5.6)	23.8	(1.5)	1
Unidentified larva	1	(2.8)	11.0	(0.7)	1
Plant Material	1	(2.8)	7.9	(0.5)	1
Unknown	1	(2.8)	56.1	(3.4)	1

(*op. cit*.), to the level of including some vegetation.

Two animals were females (67.1 mm and 65.7 mm SVL), each containing five enlarged ovarian follicles. These clutch sizes are similar to the mean clutch size reported for several populations of *C. draconoides* (Pianka and Parker, *op. cit*.; Smith et al., *op. cit*.).

Specimens were deposited in the Herpetological Collections of the Unidad de Biología, Tecnología y Prototípos (UBIPRO) (JLE11956–11957, 12153, 12334, 13130, 13201, 13377). Collection was conducted under a permit issued to JAL by the Dirección General de Vida Silvestre (DGVS) de la Secretaria del Medio Ambiente y Recursos Naturales.

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CNEMIDOPHORUS LONGICAUDUS (NCN). **BODY TEMPERATURE**. *Cnemidophorus longicaudus* is an oviparous lizard inhabiting the hot arid landscape of the Monte Phytogeographic Province in Argentina (Cei 1986. Museo Regionale di Scienze Naturali. Monografie IV. Torino, Italy. 527 pp.). Data on its biology are sparse. Limited study has addressed diet (Belver and Avila 2001. Bol. Soc. Biol. Concepción 72:37–42), time budgets and space use (Videla and Puig 1994. Multequina 3:99–112; Belver and Avila 2001. Bol. Soc. Biol. Concepción 72:31–36; Ontivero 2005. Uso especial y temporal de la estructura de parches de vegetación por *Liolaemus darwinii* [Squamata: Lilaemidae] y *Cnemidophorus longicaudus* [Squamata: Teiidae] en los Medanos grandes, San Juan, Argentina. Tesis de Licenciatura. Universidad Nacional de San Juan. 50 pp.), but information on its thermal ecology is lacking. Hence, we present preliminary data on *Cnemidophorus longicaudus* thermal ecology.

From February 2005 to February 2006, we conducted field work in Médanos Grandes, Departamento Caucete, Provincia de San Juan (38°41'S, 67°48'W, datum: WGS84; elev. 600 m). Located in the Monte Phytogeographic Province, *Bulnesia retama*, *Larrea* sp., and *Prosopis* sp. dominate the flora (Cabrera and Willink 1980. Biogeografía de América Latina. Washington, D.C. 109 pp.). We present data based on 30 individuals observed and 10 captures. To collect these data, we revisited a randomized selection of bushes across the study site. Captures were made by hand, and each individual was measured SVL (to nearest 0.1 mm). Sex was not determined in the field because obvious sexual dimorphism was lacking. For each capture, cloacal (T_c), substrate (T_s) and air (T_a) temperatures were measured (to nearest 0.1ºC) with a rapid-reading Miller-Weber thermometer. We took T_s at the exact point of observation, and T_a 1 cm above the substrate, both immediately following capture. We also recorded microhabitat type for each capture and activity time.

Mean SVL of the 10 captures was 43.6 mm (SD = 9.7, range: 32–58, N = 10). Mean body temperature of the 10 *C. longicaudus* was 36.7°C (SD = 2.2°C, range = 33–41°C). Mean air temperature was 37.7°C (SD = 6.5°C, range = 31.2–48°C). Mean substrate temperature was 39.3°C (SD = 7.3°C, range: 31.4–50°C). Body size appeared unrelated to T_c (Spearman Rank Correlation: r_s = 0.44, P = 0.19, N = 10). Cloacal temperature was not correlated with each of T_s and T_a (Spearman Rank correlation: r_s = 0.04, P = 0.13; r_s = 0.08, P = 0.81, respectively).

Most lizards were observed under vegetation (N = 27) and the remainder in open habitat (N = 3). The activity of *C. longicaudus* was unimodal, the first active lizards were sighted at 0900 h. Thereafter, number of active lizards increased until reaching a maximum of 11 individuals between 1300 and 1400 h; animals disappeared before 1500 h.

The mean body temperature of *C. longicaudus* is similar to *C. ocellifer* (36.5°C), *C. abaetensis* (36.7°C) in Restinga of Dunas do Abaeté (Dias and Rocha 2004. J. Herpetol. 38:586–588), *C. lemniscatus* (37.6°C) in Lavrado and Curuá-Una (Vitt et al. 1997. Copeia 1997:745–757) and *C. littoralis* (38.6°C) in Restinga de Jurubatiba, Macaé (Hatano et al. 2001. Rev. Brasil. Biol. 61:287–294). These similar body temperatures might reflect a conservative thermal physiology in the genus.

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CROTAPHYTUS COLLARIS (Eastern Collared Lizard). **COMMUNAL HIBERNATION; DISPERSAL.** Lizards living in temperate climates often hibernate in subterranean burrows where they sometimes aggregate (Ruby 1977**.** Herpetologica 33:322–333). As part of ongoing mark-recapture studies at Arcadia Lake (AL), Oklahoma, USA, on 27 March 2005 we discovered a hibernaculum on a south-facing rocky slope when a newly emergent mud-covered male retreated into a tunnel-like opening (6 cm wide) leading into a burrow beneath a rock. Removal of the rock caused this unidentified male to flee, revealing a bowl-shaped chamber (9.1 cm deep and 20 cm wide) unlike the J-shaped hibernaculum previously described for collared lizards at AL (Baird 1999. Herpetol. Rev. 30:227). Within this same burrow, we also found a two-year old male with his head and torso buried, but his hind limbs and tail exposed. The same burrow also contained two females (a two-year old and a one-year old) that were both tightly buried tail-first within the soil. The one-year old female was buried 13 cm below ground inside a 6 cm long horizontal cavity. Although all in the same burrow, these lizards were separated from one another by a mixture of sandy soil and pebbles. We also found one empty lizard eggshell within the burrow.

Mapped sightings revealed that these three identified lizards moved outside of their 2004 home ranges to hibernate even though burrowing sites similar to the occupied one are abundant throughout the homogeneous rock habitat at AL (Baird and Sloan 2003. Ethology 109:879–894). Only the first (25 April) and last (2 August) captures of the two-year old male in 2004 were within 10 m

of the hibernaculum, whereas the nearest border of his 2004 home range (based on 25 census sightings) was 62 m away. The proximity of the first and last sightings to the burrow suggests that this male may have used this location as a hibernaculum during the winter of 2003–2004, established a home range distant from it during the following spring, and then returned to hibernate in the same burrow over the 2004–2005 winter. Such interseasonal fidelity to hibernacula is documented for other lizards (Elfstrom and Zucker 1999. J. Herpetol. 33:240–248). The territory defended by this male as a two-year old in 2005 was six times larger than, and overlapped only 5% of his 2004 home range, but included the hibernaculum. Although the overlap of the home ranges occupied by the two-year old female during 2004 and 2005 was high (73%), neither included the hibernaculum, which was 26 m from her 2004 and 2005 home ranges, respectively. We first captured the one-year old female as a recent hatchling in August 2004, 126 m from the hibernaculum. Although we sighted this female only three times in May 2005, she dispersed as far as 68 m from the burrow.

Ours represents the second report in *C. collaris* of communal hibernation involving lizards of two generations as well as remnants of eggs (Legler and Fitch 1957. Copeia 1957:305–307). Because adults generally enter hibernacula before young hatch, the newly emerged juvenile must have located this burrow following hibernation of the three adults, which may suggest that conspecific cues are used to orient to communal burrows. Ours, along with one previous observation of collared lizard eggshells within hibernacula (Legler and Fitch 1957, *op. cit.*) suggests that this species uses the same burrows for over-wintering and nesting. Communal hibernation may have thermal advantages, or may be a consequence of limited suitable burrow sites (Gregory 1982. *In* C. Gans and H. Pough [eds.], Biology of the Reptilia Vol. 13, pp. 53–154. Academic Press, New York). Because we found each lizard surrounded by soil rather than in direct physical contact with conspecifics, thermal advantages seem unlikely in our observation. Even though similar burrowing sites are abundant in the human-constructed habitat at AL, they are much less abundant in the rocky substrate that is naturally inhabited by collared lizards (Baird and Sloan 2003, *op. cit.*). Therefore, limitation of suitable sites remains a viable hypothesis that may explain communal hibernation in this species.

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CTENOPHORUS NUCHALIS (Central Netted Ground-dragon). **ENDOPARASITES.** *Ctenophorus nuchalis* occurs in the central and northern coasts of Western Australia, the drier parts of central and northern Australia to central Queensland and western New South Wales; adults measure about 100 mm SVL (Cogger 1996. Reptiles & Amphibians of Australia, 6th ed., Ralph Curtis Publ., Sanibel Island, Florida. 808 pp.). One previous report of helminths exists for *C. nuchalis*; Jones (1995. Aust. J. Zool. 43:141–164) reported larvae assigned to *Abbreviata* (Physalopteridae).The purpose of this note is to report two additional species of Nematoda in *C. nuchalis.*

Coelomic cavities and small and large intestines of 18 *C. nuchalis* (mean SVL = 92 mm ± 12.0 SD, range: 70–110 mm from Western Australia, 28°27'S, 119°05'E [datum: AGD66] elev. ca. 530 m), collected 1966–1967 in the herpetology collection of the Natural History Museum of Los Angeles County (LACM 54225, 54227–28, 54231, 54234, 54236, 54243–44, 54246, 54251, 54254, 54256, 54259, 54268, 54270, 54272, 54274, 54278) were examined for helminths. Stomachs were unavailable for examination; they had been removed during an ecological study that included stomach content analysis (Pianka and Pianka 1976. Copeia 1976:125–142). Nematodes were cleared in a drop of glycerol on a glass slide, cover-slipped and identified as *Maxvachonia brygooi* (infection site: small intestine, large intestine; prevalence: infected lizards/lizards examined × 100 = 39%; mean intensity: mean number of helminths per infected lizard ± SD = 2.0 ± 1.5) and *Parapharyngodon kartana* (infection site: large intestine; prevalence: 6%, mean intensity: 1). Helminths were deposited in the United States National Parasite Collection, Beltsville, Maryland: *Maxvachonia brygooi* USNPC (98266); *Parapharyngodon kartana* USNPC (98267).

Maxvachonia brygooi is known from Australian scincids, agamids and a varanid (Goldberg and Bursey 2000. Trans. Roy. Soc. S. Aust. 124:127–133). *Parapharyngodon kartana* has been found in Australian scincids, agamids and gekkonids (Goldberg and Bursey, *op. cit.*). Infection by *Maxvachonia brygooi* (Cosmocercidae) and *P. kartana* (Oxyuridae) occurs from ingesting eggs (no intermediate host is utilized) (Anderson 2000. Nematode Parasites of Vertebrates: Their Development and Transmission. CABI Publishing, Wallingford, U.K. 650 pp.). *Ctenophorus nuchalis* represents a new host record for *Maxvachonia brygooi* and *Parapharyngodon kartana.*

We thank Christine Thacker (LACM) for permission to examine *C. nuchalis* and Dustin Goto (Whittier College) for assistance with dissections.

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CTENOSAURA MACROLOPHA (Mainland Spinytail Iguana). **DIET; CLUTCH SIZE.** Adults of members of the genus *Ctenosaura* are typically herbivorous (Durtsche 2000. Oecologia 124:185–195; Durtsche 2004. Physiol. Biochem. Zool. 77:459–470; Köhler 1996. Salamandra 32:153–162), but juveniles may be primarily insectivorous (Durtsche 2000, *op. cit.*; Durtsche 2004, *op. cit.*) and adults are known to take a variety of animal prey (e.g., Arndt 1999. Florida Sci. 62:111–114). Here we report observations on the stomach contents of *C. macrolopha* from Chihuahua, México.

Three *C. macrolopha* (78–89 mm SVL) were collected 5–12 July 2002 from Arroyo El Camuchil, Batopila and road to Satevo (27°1'34.1"N, 107°45'44.5"W, datum: WGS84; elev. 435 m; see Lemos-Espinal et al. 2004. Bull. Chicago Herpetol. Soc. 39:1–7).

TABLE 1. Stomach contents of 3 *Ctenosaura macrolopha* from Chihuahua, México.

Prey Type	Prey Items N =	(%)	Volume cm^3	(%)	Number of Stomachs
Hymenoptera (ants)	28	(58.3)	0.31	(27.2)	3
Isoptera	19	(39.6)	0.76	(66.7)	3
Seed	1	(2.1)	0.07	(6.1)	1

All three animals contained identifiable stomach contents (Table 1). Numerically, ants were the most important prey, but volumetrically termites were most important, although both groups were found in all three stomachs. Presence of a seed in the smallest of the three individuals suggests that *C. macrolopha* may consume fruit. Based on the maximum size of *C. macrolopha* observed near the collection locality (female = 106 mm SVL, male = 120 mm SVL), these individuals likely represent small adults; hence, insectivory might be expected if these animals, like smaller *Ctenosaura* that eat more insects (e.g., Durtsche 2000, *op. cit.*), are still in their interval of rapid growth.

Two of the *C. macrolopha* were females that contained enlarged ovarian follicles. An 87.4 mm SVL animal had 10 enlarged follicles; the other (88.9 mm SVL) had nine enlarged follicles. We are unaware of other reports of clutch size in *C. macrolopha*. However, the clutch sizes we observed for *C. macrolopha* are larger than those reported for *C. defensor* (2–3 eggs; Köhler, *op. cit.*) but similar to the maximum clutch sizes reported for *C. hemilopha* (Goldberg and Beaman 2005. Herpetol. Rev. 36: 317–318).

Specimens are deposited in the Herpetological Collections of the Unidad de Biología, Tecnología y Prototípos (UBIPRO) (JLE9386, 9389, 9392). Collection was conducted under a permit issued to JAL by the Dirección General de Vida Silvestre (DGVS) de la Secretaria del Medio Ambiente y Recursos Naturales.

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DIPLOLAEMUS BIBRONI (NCN). **MOUTH INJURY.** Lizard mouth injuries resulting from foraging activities in the wild are unreported in herpetological literature from South America. In fact, we were unable to find any citation in our survey of the literature related to any wild lizard population. Most external injuries reported for lizards are associated with predation attempts by other animals or result from encounters with conspecifics. Here, we provide the first report of injury resulting from foraging activities in a leiosaurine lizard from central Patagonia, Argentina.

On 25 February 2006, we encountered an adult male *Diplolaemus bibroni* (90.5 mm SVL) basking on an accumulation of small volcanic rocks along Provincial Road 26, 52.3 km W of its intersection with Provincial Road 25, southwest of Pampa de Los Guanacos, Departmento de Sarmiento, Chubut (45°16'43.9"S, 68°43'03.3"W, datum: WGS84; elev. 486 m). After observing its behavior for 10 min, we caught the lizard and held in captivity for 4 weeks. The lizard had an insect thorax jammed in his left lower jaw. Although the insect thorax was fairly large (5 mm long), occupying a significant area of the lizard's mouth (25.7 mm head length), the lizard did not seem to have any obvious limitations in prey capture, mobility or signs of distress, and we did not observe it trying to remove the thorax. The appearance of the wounded area suggested that it was an older injury. Insect part was identified as thorax of a tenebrionid beetle (Family Tenebrionidae, Subfamily Pimeliinae, Tribe Nycteliini, *Nyctella* sp.).

The lizard (LJAMM 3999) was deposited in collection Luciano Javier Avila Mariana Morando (LJAMM) now housed in Centro Nacional Patagónico (CENPAT-CONICET), Puerto Madryn, Argentina.

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KENTROPYX LAGARTIJA (NCN**). DIET.** Diet of few species of *Kentropyx* has been studied. *Kentropyx striatus* (Vitt and de Carvalho 1992. Can. J. Zool. 70:1995–2006), *K. pelviceps* and *K. altamazonica* (Vitt et al. 2000. Oecologia. 122:410–420) have all been reported to be insectivorous, but the diet of *K. lagartija* is unstudied. Hence, here we report an observation of predation by a young *K. lagartija* on a *Mabuya* (skink).

On 17 December 2002, we collected a young male *K. lagartija* (4.5 cm SVL) in the Parque Nacional Copo, 3.7 km SE of Puesto Maján (25°51'43.0"S, 62°11'10.1"W, datum: WGS84; elev. 160 m), Santiago del Estero, Argentina. It was found in an open grassy area inside the Chaco Forest. Dissection of this animal revealed a *Mabuya frenata* neonate (2.6 cm SVL) in the stomach.

The *K. lagartija* (MCN 1201) and the *M. frenata* neonate (MCN 1202) were deposited in the herpetological collection of the Museo de Ciencias Naturales of the Universidad Nacional de Salta (MCN).

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LEIOSAURUS BELLI (NCN). **PREDATION**. The natural history of *Leiosaurus belli*, a lizard inhabiting the austral Monte and northern Patagonian steppes, is poorly known. In particular, its predators are unreported (Cei 1986. Reptiles del Centro, Centro Oeste y Sur de la Argentina. Monographia IV, Torino, Italy. 527 pp.). Here, we provide the first observation of predation on *L. belli*. On 1 January 1986, A. Gosztonyi obtained a sample of fresh pellets and prey remains from a Burrowing Owl (*Athene cunicularia*)

burrow near Oasis Ranch, 120 km NW Puerto Madryn, Departamento Biedma, Chubut Province, Argentina (42°32'S, 65°40'W, datum: WGS 84; elev. 150 m). Lizards comprised the bulk of vertebrate remains, representing 62% of the individual prey items. Using diagnostic prefrontal bones, we identified 53 individuals of *Leiosaurus belli* from this sample. Variation in prefrontal bone sizes indicated that 28 lizards were juveniles (< 60 mm SVL), 21 were adults 90 mm SVL and 4 were adults > 90 mm SVL. Additionally, eight heads of *L. belli* were found around the burrow entrance, three of which were from adult lizards > 90 mm SVL.

Two aspects of our observation merit comment. First, a high percentage of lizard prey remains represents a pattern unusual for burrowing owl diet in Patagonia, where percentages of lizards taken have been <1.3% (Nabte 2003. Dieta de *Athene cunicularia* [Aves: Strigiformes] en el nordeste de la provincia del Chubut, Argentina. Tesis de licenciatura, Universidad Nacional de la Patagonia San Juan Bosco, Sede Puerto Madryn, Chubut, Argentina. 47 pp.). Second, *L. belli* is a species usually considered to occur at low densities, and that is more active near sunset (Cei, *op. cit.*), when *A. cunicularia* actively hunt (Nabte, *op. cit.*). The high frequency of *L. belli* as lizard prey indicates that either *Athene cunicularia* is a highly efficient hunter or that the density of this lizard, perhaps because of its behavior, has been underestimated.

The pellet sample remains were deposited in the Colección de Material de Egagrópilas y afines "Elio Massoia", Centro Nacional Patagónico CNP-E 86, Puerto Madryn, Chubut, Argentina.

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LIOLAEMUS PSEUDOANOMALUS (NCN). **REPRODUCTION.** *Liolaemus pseudoanomalus* is an oviparous lizard inhabiting the hot arid landscape of the Monte Phytogeographic Province in northern Argentina (Cabrera and Willink 1980. Biogeografía de América Latina. Washington, D.C. 109 pp.). *Liolaemus pseudoanomalus* has an ambiguous conservation status, defined as a species for which "insufficient knowledge" exists (Lavilla et al. 2000. Categorización de los Anfibios y Reptiles de la República Argentina. Asoc. Herpetol. Arg., Tucumán City. 97 pp.). Data on its biology are sparse. Limited study has been devoted to thermoregulation, sexual dimorphism, time budgets, and space use (Villavicencio et al., *in press*. Amphibia-Reptilia; Villavicencio et al. 2003. Rev. Esp. Herpetol. 17:87–92; Villavicencio et al. 2002. Multequina Latin Amer. J. Nat. Res. 11:51–60; Villavicencio et al. 2003. Nótulas Faunísticas, Segunda Serie 15:1–6; Villavicencio et al. 2003. Bull. Maryland Herpetol. Soc. 42:1–7). Hence, we add the first data addressing *L. pseudoanomalus* reproductive ecology.

We conducted fieldwork in a temporary creek bed near La Laja (31°19'S, 68°41'W, datum: WGS84; elev. 700 m), Departmento de Albardón, San Juan Province, Argentina. Data were collected every 10 days from August 2000 to August 2001 by a random pattern of revisits across the study site. Each animal was measured (SVL) and dissected for gonadal examination. In females, we recorded the number of developing follicles and oviductal eggs, the length and width of oviductal eggs, and the condition of the oviducts. In males, we recorded the width and length of testes to enable calculation of volume based on Dunham (1983. *In* Huey et al. [eds.], Lizard Ecology, pp. 261–280. Harvard Univ. Press, Cambridge, Massachusetts). Testicular volume was natural log-transformed to accommodate its curvilinear function (King 2000. J. Herpetol. 34:148–150). Clutch size was determined from the combined number of developing follicles and eggs in the oviducts. We used the simultaneous presence of developing follicles and enlarged oviducts to suggest that more than one clutch was produced seasonally. The smallest female with vitellogenic follicles or oviductal eggs was used to estimate SVL at maturity. We identified various reproductive states for females: a) non-vitellogenic follicles, b) vitellogenic follicles, c) oviductal eggs and d) post-reproductive (oviducts enlarged).

Males were considered sexually mature if they contained enlarged epididymides. All measurements were obtained to the nearest 0.02 mm with Vernier calipers. Testes of males and fat bodies of both sexes were removed and weighed (to nearest 0.001 g). We used residuals of each of two regressions (testicular volume vs. SVL and fat body mass vs. SVL) to describe male reproductive and fat bodies cycles. This technique retains variation due to extrinsic factors while minimizing the confounding effect of individual variation in SVL (Ramirez-Bautista et al. 1998. J. Herpetol. 32:18–24).

Of 101 captures, 43.6% were sexually mature (29 males and 15 females). Forty females ranged in size from 28 to 68 mm SVL; minimum reproductive size was 59 mm. Female body size was not correlated with clutch size (Spearman: $r_s = 0.50$; $P = 0.20$; N = 8). Clutch size averaged 6.8 (SD = 2.4, range: 2–10, N = 8). We did not observe females with developing follicles and enlarged oviducts simultaneously. Between October and February, we recorded 6 females with vitellogenic follicles. Between November and February, we recorded 4 females with oviductal eggs. Between December and April we recorded 11 females with enlarged

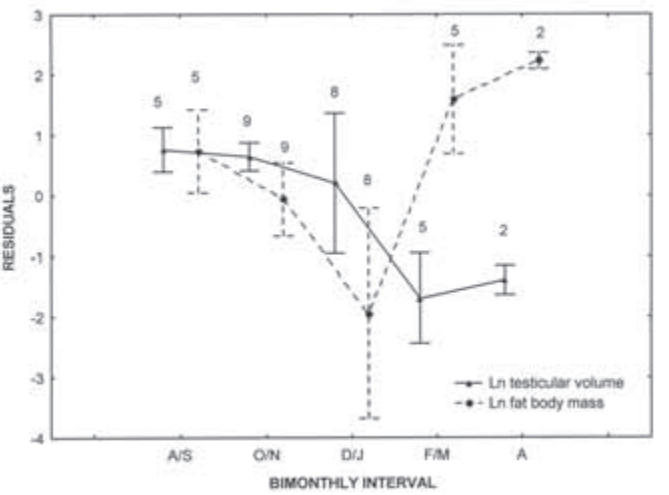


FIG. 1. Bimonthly change in relative testicular volume and fat body mass of the lizards *Liolaemus pseudoanomalus*. Dates are represented as means ± SD. Sample sizes appear above whisker. A/S = August / September; O/N= October / November; D/J = December / January; F/M = February / March and A = April.

oviducts.

Fifty-eight males ranged in size from 22 to 75 mm SVL; minimum reproductive size was 61 mm. Testicular volume was not correlated with body size (Spearman: $r_s = 0.33$; $P = 0.07$; N = 29). Testicular volume varied through the gonadal cycle (ANOVA: $F_{4,24} = 10.75$; $P = 0.0001$; N = 29; Fig. 1).

Seasonal variation in fat body mass (measured as bimonthly samples) was statistically significant (ANOVA: $F_{4.24} = 9.37$; $P = 0.0001$; N = 29; Fig. 1) for males.

Our data suggest that *Liolaemus pseudoanomalus* produces one clutch a year like *L. multimaculatus* (Vega 1999. Ecología de saurios arenícolas de las dunas costeras bonaerenses. Tesis doctoral, inédita, Universidad Nacional de Mar del Plata. 102 pp.) and *L. chacoensis* (Cruz and Ramirez-Pinilla 1996. Rev. Española Herpetol. 10:33–39). Mean clutch size of *L. pseudoanomalus* is larger than *L. darwinii* (mean: 4.9, range: 2–8, N = 40), *L. riojanus* (mean: 4.2, range: 3–6, N = 15) (Blanco et al. 2001, *op. cit.*; Blanco et al. 2003. Reunión de Com. Herpetol. Asoc. Herpetol. Argentina. XVII:31 pp.), *L. koslowskyi* (mean: 4.2, range: 3–9, N = 53) (Aun et al., *op. cit.*); and *L. wiegmanni* (mean: 4.6, range: 4–5, N = 19), *L. multimaculatus* (mean: 4.2, range: 3–7, N = 29), *L. gracilis* (mean: 4.7, range: 4–6, N = 19) (Vega, *op. cit.*) and *L. olongasta* (mean: 3.8, range: 1–8, N = 10) (Cánovas et al., *in press*. Herpetol. Rev.). Our data suggest spring–summer reproductive activity with a late maturing, single annual clutch reproductive strategy (Tinkle 1969. Amer. Nat. 103:501–516).

All specimens (IMCN-UNSJ 4100–4201) were deposited in the Herpetology Collections of Instituto y Museo de Ciencias Naturales of Universidad Nacional de San Juan. I thank M. Hayes for comments and suggestions, and CICITCA- 21E/E633 for financial support.

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PHRYNOSOMA CORNUTUM (Texas Horned Lizard). **WINTER ACTIVITY.** Reports of winter activity among horned lizards are sparse. One that appeared recently (Wone and Beauchamp 2003. J. Herpetol. 37:679–686) described winter activity of *Phrynosoma mcallii* from California. Although the Texas Horned Lizard, *P. cornutum*, is well studied across its geographic range, the only data close to addressing winter activity are those of Fair and Henke (1999. J. Herpetol. 33:525–517), who described activity prior to hibernation and after emergence in south Texas. Hence, here we report mid-winter activity of *P. cornutum* from west Texas.

Our observations were made in the Dog Canyon area of Big Bend National Park, Brewster County, Texas (29°37'N, 103°09'W, datum: NAD83; elev. 789 m). A small group (N = 3) of *P. cornutum* were individually fitted with PD-2T radio transmitters (Holohil Systems Ltd, Carp, Ontario, Canada) and iButton thermachron temperature dataloggers (Dallas Semiconductor, Sunnyvale, California, USA) to monitor overwinter activities and external temperatures. Additional thermachrons were placed on the ground at each of two reference sites (shade and sun). Dataloggers recorded temperatures every two hours from 1 September 2005 to 16 February 2006. We inferred lizard activity from the temperature datalogger record and verified this by regular observations of the lizards. Lizards were observed twice weekly from 7 August 2005 through 24 April 2006. Each lizard was assigned an alphanumeric identifier of a letter indicating its sex followed by a number. Measurements of each lizard (M1: 96 mm SVL, 73 g; F2000: 111 mm SVL, 99 g; F4000: 107 mm SVL, 93 g) were taken just prior to dormancy.

On 15 September 2005, the male (M1) buried himself 2 cm beneath the ground surface under the cover of a honey mesquite (*Prosopis glandulosa*) and did not emerge from this site until 7 March 2006. The two females buried themselves ca. 2 cm below the ground surface on 24 October 2005, both locations under the cover of *P. glandulosa*. Female F2000 remained underground until emerging on 16 April 2006. Interestingly, female F4000 emerged on 17 December 2005 (58 days after beginning dormancy) and moved to a second location 6 m away where she reburied herself for an additional 104 days until emerging on 2 April 2006. Exposed daytime ground temperatures nearby (~200 m) recorded a high of 29.0°C while the thermachron attached to the lizard's dorsum recorded a high of 29.5°C for 17 December 2005. Both pre- and post-movement refuges were located within one meter of the center of a *P. glandulosa* ca. 2 cm below ground level in sandy soils.

The low temperature recorded for F4000 on the morning of 17 December 2005 prior to its movement was 3.5°C while the thermachrons of two other lizards recorded lows of 7.0°C (M1) and 5.5°C (F2000) that morning. Low temperatures recorded on lizard F4000 10 days before and after movement averaged 5.4°C (range: -1.0–12.5°C) while the other two lizards (M1 and F2000) averaged 6.2ºC (range: 1.0–12.0°C) and 4.4°C (range: -1.5°–10.5ºC), for that time period respectively. An F-test indicated no significant difference in temperature variation recorded on lizard thermachrons before and after F4000 moved.

To our knowledge, this is the first report of mid-winter activity in *P. cornutum*. We believe the winter movement observed may have been a result of the low temperature recorded on the morning of 17 December 2005, but we cannot exclude the possibility of other factors. This type of winter activity may be more common than recognized, and only has come to light with the increasing use of temperature dataloggers and radio telemetry equipment during non-breeding seasons.

Permission for this research was granted to D. J. Leavitt from the National Park Service permit number BIBE-2005-SCI-0052.

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PHYLLODACTYLUS TUBERCULOSUS (Yellow-bellied Gecko). **DIET.** Knowledge of *Phyllodactylus tuberculosus* ecology and natural history is sparse. In particular, we have been unable to locate previous reports on its diet. However, reports on the diet of other *Phyllodactylus* from Peru and Iraq suggest that these geckos eat arthropods, especially insects (Weber 1960. Copeia 1960:153–154; Huey 1979. Oecologia 38:249–259). Hence, we provide preliminary data on *P. tuberculosus* diet from Chihuahua, México.

Our observations are based on the stomach contents of 9 *P. tuberculosus* collected from 12–16 July 2000 and from 21–23 July 2003 from two localities: the vicinity of Chínipas (N = 3; 27°22'48.0"N, 108°32'41.1"W, datum: WGS84; elev. 469 m) and the vicinity of Batopilas (N = 6; 27°1'34.1"N, 107°45'44.5"W; elev. 435 m; see Lemos-Espinal et al. 2001. Bull Chicago Herpetol. Soc. 36:201–208; Lemos-Espinal et al. 2004. Bull Chicago Herpetol. Soc. 39:164–168). Of nine individuals, seven contained identifiable stomach contents (Table 1); two had empty stomachs. Numerically, caterpillars were the most important prey, but volumetrically both orthopterans and caterpillars were important. These data agree with other reports of diet in *Phyllodactylus* (Weber, *op. cit.*; Huey, *op. cit.*).

Specimens are deposited in the Herpetological Collections of the Unidad de Biología, Tecnología y Prototípos (UBIPRO) (JLE5917, 5943–5947, 11845–11846, 11869). Collection was conducted under a permit issued to JAL by the Dirección General de Vida Silvestre (DGVS) de la Secretaria del Medio Ambiente y Recursos Naturales.

TABLE 1. Stomach contents of 7 *Phyllodactylus tuberculosus* from Chihuahua, México.

Prey Type	Prey Items N =	(%)	Volume mm^3	(%)	Number of Stomachs
Araneae	1	(10)	42.2	(2.4)	1
Coleoptera (larva)	2	(20)	194.6	(11.3)	2
Lepidoptera (larva)	4	(40)	743.5	(43.1)	2
Orthoptera	2	(20)	628.4	(36.4)	2
Unknown insect	1	(10)	117.3	(6.8)	1

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PLESTIODON BREVIROSTRIS (Short-nosed Skink). **REPRODUCTION**. *Plestiodon brevirostris*, variable and broadly distributed in Mexico, occurs in high montane pine and pine-oak-dominated terrains. Few data exist on its natural history. Axtell (1960. Copeia 1960:19–26) reported that four females collected in San Antonio de Las Alazanas on 6–7 July had three embryos each. Goldberg (2002. Herpetol. Rev. 33:134) reported that of four females recollected in June, one had two well-developed embryos and three appeared to have already given birth. Goldberg also collected two neonates in June: a 23 mm SVL animal on 19 June, and a 21 mm SVL individual on 27 June. However, he did not indicate the locality of origin of either the female or the neonates. Hence, we provide reproductive data on *P. brevirostis* from different points across its geographic range.

Each of the three females gave birth in captivity shortly after the date of collection. The first (MZFC 18774; 62 mm SVL, 50.4 mm tail [partly regenerated], 4.74 g) was collected in Pablillo, Nuevo León (24°34'53.0"N, 99°57'56.2"W, datum: WGS84; elev. 2330 m), in a forest dominated by *Pinus teocote* and *Quercus* spp. on 1 July 2005. On 13 July, this female gave birth to three live offspring, and the next day a fourth. After parturition, the female weighted 2.74 g. The SVL, tail length, and mass (mean ± SE) of the four neonates were 26.25 ± 0.12 mm, 25.25 ± 012 mm, 0.303 ± 001 g, respectively. The second female (MZFC 18779; 65 mm SVL, 37 mm tail [partly regenerated], post-parturition mass = 3.24 g) was collected ca. 14 miles E of San Antonio de las Alazanas, Coahuila, near of type locality of *P. b. pineus* (25°13'1.2"N, 100°23'17.9"W, elev. 2919 m) in forest dominated by *Pinus cembroides* on the same date as the previous female. On 14 July, this female gave birth to four neonates (mean ± SE: 26.87 ± 0.34 mm SVL, 24.75 ± 0.13 tail, 0.291 ± 005 g). The third female (MZFC 19135, 59 mm SVL, 132.2 mm tail, post-parturition mass = 3.5 g) was collected in Los Lirios, Coahuila (25°22'32.5"N, 100°30'38.9"W; elev. 2429 m) in a *Pinus cembroides-Cupressus* sp. forest on 2 July 2005. This female birthed two neonates (25.0 ± 0.12 mm SVL; 25.0 ± 0.15 mm tail) on 10 July 2005.

We also collected four neonate-sized lizards. Two (MZFC 18767–18768, both 25.0 mm SVL, 25.0 mm tail) near Marmolejo, Tamaulipas in the Sierra de San Carlos (24°37'19.8"N, 99°01'55.0"W; elev. 596 m) in a *Pinus pseudostrubus-Quercus canbyi* forest on 30 June 2005 at the type locality of *P. b. dicei*. The other two lizards were collected in Pablillo (MZFC 18770, 25.0 mm SVL, 25.0 mm tail), and in Los Lirios (MZFC 18783, 26.5 mm SVL, 27.5 mm tail) on 1 and 2 July of 2005, respectively. Locality data are as indicated previously. Our data suggest that both *P. b. dicei* and *P. b. pineus* give birth from late June to mid-July.

We also collected one presumptively neonate-sized lizard on 15 March 2006. This lizard (MZFC 19134, 27.0 mm SVL; 14 mm tail [broken]) was collected 4.8 km N of Mitla, Oaxaca, near the type locality of *P. b. brevirostris* (16°59'03.1"N, 96°20'05.3"W; elev. 2453 m). Assuming neonates at this latitude are birthed at a similar size, this suggests that the southern populations of *P. brevirostris* (i.e., *P. b. brevirostris*) are born about three months before offspring from populations in northeast Mexico (i.e., *P. b. dicei* and *P. b. pineus*).

The specimens were deposited in the herpetological collection of Museo de Zoología de la Facultad de Ciencias, in the Universidad Nacional Autónoma de México.

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PLESTIODON FASCIATUS (Five-lined Skink). **PREY**. At 1519 h on 11 June 2006, a mature male Five-lined Skink (67.2 mm SVL, 7.15 g) was observed stalking prey in the Clemson University Experimental Forest near the Issaqueena Dam (34°44'08.8"N, 82°51'46.1"W, datum: WGS 84; elev. 191 m) in South Carolina. The skink seized the potential prey item, pinned it to the ground and I captured it by hand within 5 sec of it seizing the item. The prey was identified as a Carolina Scorpion, *Vaejovis carolinianus* (0.37 g, 4.33 mm carapace length). The scorpion was held in the lizard's mouth by the cephalothorax with one pedipalp in the mouth and one extending from the right side. The scorpion was motionless and made no effort to sting or pinch. This method of seizing and holding scorpions, a potentially dangerous prey item, differs from that used by the Spotted Whiptail, *Cnemodophorus gularis* (O'Connell and Formanowicz 1998. J. Herpetol. 32:75–79), which repeatedly bit, shook, and released the bark scorpion, *Centruroides vittatus*, in laboratory studies. Arachnids have been reported to comprise a large percentage of the diet of some populations of *P. fasciatus* (Fitch 1954. Univ. Kansas Publ. Mus. Nat. Hist. 8:1–156). However, to our knowledge, this represents the first published record of predation on a scorpion by *P. fasciatus*.

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PODARCIS SICULA CAMPESTRIS (Italian Wall Lizard). **PREDATION**. Few accounts have mentioned predation on the wall lizards introduced to Long Island, New York. Long Island lacks native lizards and hence may lack predators that typically take them. Gossweiler (1975. Copeia 1975:584–585) suggested that cats, dogs, sea gulls, and "one snake" might prey on the introduced Long Island lizards; Burke and Ner (2005. Northeast Nat. 12:349–360) listed Northern Mockingbirds (*Mimus polyglottos*), Blue Jays (*Cyanocitta cristata*), and American Crows (*Corvus brachyrhynchos*) as potential predators. To date, the only predators documented to prey upon *P. sicula campestris* are non-native house cats (Burke and Ner, *op. cit.*), and spiders (species not identified) and mantids (probably *Tenodera aridifolia*) on hatchling lizards (Burke and Deichsel, *in press*. Herpetol. Conserv.).

I observed a single predation event while studying a population of *P. sicula campestris* at the Carle Place train station in Carle Place, New York (40°44'56"N, 73°36'19"W, datum: WGS84; elev. 30 m). The station, dominated by low growing exotic shrubs (e.g., *Artemisia vulgaris*) and herbaceous annuals and perennials (e.g., *Centaurea* sp.), lacks substantial shade. On 12 June 2006 at 1155 h, a *Corvus brachyrhynchos* was seen with an adult *P. sicula campestris* in its beak sitting on a pile of railroad ties ca. 2 m from the tracks. The capture was not witnessed. The crow was first observed holding the lizard by the torso in its beak, then dropped the lizard at its feet and picked at it several times before flying away with the lizard in its beak as a passenger train approached the station. Until the crow flew off, the lizard's tail had remained intact, implying capture by the head or torso given the lizard's ability to autotomize its tail when grabbed.

I also observed a predation attempt by an Eastern Garter Snake, *Thamnophis sirtalis sirtalis*. *Thamnophis s. sirtalis* are abundant at the Carle Place train station and can often be seen basking during morning hours in close proximity to *P. sicula campestris* in open clearings close to nearby vegetation (pers. obs.). On 17 June 2006 at 1112 h, a *T. s. sirtalis* (ca. 65 cm) was observed moving through low growing vegetation behind the westbound platform. An adult female *P. sicula campestris* was seen basking in a relaxed position (front limbs extended back against the body) in a nearby clearing ca. 1 m from the patch of vegetation partly concealing the snake. The snake slowly entered the clearing and came within 1 m of the lizard before the lizard became alarmed and quickly retreated to a nearby patch of vegetation ca. 2 m away. The snake chased the lizard into the vegetation, where the lizard rapidly ascended an *A. vulgaris* plant. After the failed capture attempt, the snake moved deeper into the vegetation, where it was not seen again. The *P. sicula campestris* descended after 4 mins and resumed basking on the vegetation edge.

No documented reports of Eastern Garter Snakes preying upon introduced wall lizards exist. Moreover, instances of *Thamnophis s. sirtalis* preying on any lizard are rare (Hamilton 1951. Am. Midl. Nat. 46:385–390; Carpenter 1952. Ecol. Monogr. 22:235–258). Hence, despite my observation of attempted predation, *Thamnophis s. sirtalis* might not be expected to be a frequent predator of the introduced lizards on Long Island.

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SCELOPORUS CYANOGENYS (Blue Spiny Lizard). **PREDATION.** There are few reports concerning the natural history of *Sceloporus cyanogenys*. Current knowledge addresses reproduction (Kennedy 1960. Southwest. Nat. 5:44–45), general behavior (Greenberg 1977. J. Herpetol. 11:177–195), taxonomy and distribution (Wiens and Reeder 1997. Herpetol. Monogr. 11:1–101), and mite infestations (García-de la Peña et al. 2005. Bull. Chicago Herpetol. Soc. 40:52–53). Recently, Castañeda et al. (2006. Herpetol. Rev. 37:227) added the Southwestern Rat Snake (*Pantherophis emoryi*) to its predator set. Here, we add *Trimorphodon tau tau* to that predator set.

At 2300 h on 6 May 2006 (air temperature 28°C) during a vertebrate inventory in the municipalities of Dr. Gonzalez, Higueras, and Cerralvo in the Sierra Picachos at a place called Rancho Fraile, Nuevo Leon, México (25°55'20"N, 99°46'12"W, datum: NAD27; elev. 435 m), we observed an adult male *S. cyanogenys* (109.mm SVL, 134 mm tail, 46.4 g) being consumed by a female *T. tau tau* (880 mm TL, 180.8 g including prey). Our observation occurred on a human-built brick structure (2 m × 1.5 m) covered with an unidentified vine. When first observed, the snake had seized the lizard. The feeding sequence took ca. 20 min. Local vegetation consists of a submontane matorral association of *Prosopis glandulosa* and *Hellieta parvifolia.* The snake was released following examination.

Information on the natural history of *Trimorphodon tau tau* is sparse (McDiarmid and Scott 1987. Los Angeles Co. Mus. Nat. Hist. 179:1–44; Scott and McDiarmid 1984. Cat. Amer. Amphib. Rept. 354.1). McDiarmid and Scott (*op. cit*.) provided the only dietary data for the species, indicating that it consumes frogs and lizards and may eat small mammals. They specify the genera *Cnemidophorus* and *Sceloporus* as lizard prey, but specific species are not mentioned. Because related species of *Trimorphodon* are reported to take these genera (Bogert 1939. Publ. Univ. California Los Angeles, Biol. Sci. 1:177–236), their appearance as prey items may be a generic-level pattern. This observation is the first record of *S. cyanogenys* as prey for *T. tau tau*.

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SCELOPORUS OCCIDENTALIS (Western Fence Lizard). **PREY**. The Argentine Ant (*Linepithema humile*) is a common invasive in California that competitively displaces native ants (Holway 1999. Ecology 80:238–251) and negatively affects some reptile species. Coast Horned Lizards (*Phrynosoma coronatum*) typcially do not eat Argentine Ants (Montanucci 1989. Herpetologica 45:208–216; Suarez et al. 2000. Ecol. Appl. 10:711–725) or experience negative growth rates in invaded communities when forced to consume them and other non-ant arthropods (Suarez and Case 2002. Ecol. Appl. 12:291–298). As a consequence, *P. coronatum* appears to avoid areas where Argentine Ants are abundant (Fisher et al. 2002. Conserv. Biol. 16:205–215). Argentine Ants also appear to negatively affect Orange-throated Whiptails (*Aspidoscelis hyperythra beldingi*) by displacing their natural prey items (Jennings and Hayes 1994. Amphibian and Reptile Species of Special Concern in California. California Dept. Fish Game, Inland Fisheries Division. Contract No. 8023. 260 pp.). Information on Argentine Ant consumption by other reptiles is lacking. Here, we report consumption of Argentine Ants by a *Sceloporus occidentalis* using unusual methods of prey capture.

At 1500 h on 12 June 2006, we observed a pair of *S. occidentalis* at the Santa Barbara Zoological Gardens, Santa Barbara Co., California (34°25'15"N, 119°39'58"W, datum: WGS84; elev. 9 m) moving out from underneath a metal tub and basking on gravel adjacent to a blacktop road. The male (ca. 8 cm SVL) moved into a path of Argentine Ants and stopped. Ants began to crawl on him intermittently. When an ant would crawl on his head, he would quickly consume it without displaying rejection behaviors (e.g., regurgitating, spitting out the prey). This unique method of prey capture was observed on five occasions over a period of ca. 15 min. The female (ca. 6 cm SVL) was not observed eating the ants. To our knowledge, this is the first report of Argentine Ant predation by *S. occidentalis* and potentially indicates flexibility in Western Fence Lizard diet. As Argentine Ants appear to be generally rejected by ant-consuming California reptiles, their consumption by *S. occidentalis* deserves further investigation, particularly for its potential effects on fence lizard body size and fitness.

We thank Michael Caterino (Santa Barbara Natural History Museum) for identifying five Argentine Ants, which were deposited in the SBNHM. We also thank Marc Hayes (Washington Department of Fish and Wildlife), Sam Sweet (University of California at Santa Barbara), Andrew Suarez (University of Illinois at Urbana-Champaign), and Estelle Sandhaus (Santa Barbara Zoological Gardens) for providing assistance in preparing this manuscript through valuable discussions of and information about Argentine Ants.

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SPHENOMORPHUS CHERRIEI (Striped Litter Skink, Chirbala Lisa). **ENDOPARASITES.** *Sphenomorphus cherriei*, a small diurnal litter-dwelling skink reaching 178 mm total length, occurs from central Veracruz, México on the Atlantic versant and Costa Rica on the Pacific slope to extreme western Panama (Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna Between Two Continents Between Two Seas. Univ. Chicago Press, Chicago, Illinois. 934 pp.). To our knowledge, no endoparasites are known from *S. cherriei.* The purpose of this note is to report one species of Digenea and three species of Nematoda from *S. cherriei.*

Coelomic cavities and stomachs and small and large intestines of 10 *S. cherriei* (mean SVL = 49 mm ± 3.8 SD, range: 43–55 mm) from Costa Rica collected between 10°04'N to 10°46'N and 83°22'W and 84°70'W (datum: WGS84) during 1959, 1960, and 1963 from the herpetology collection of the Natural History Museum of Los Angeles County (LACM 161180–161189) were examined for helminths. Digeneans were regressively stained in hematoxylin, mounted in Canada balsam, studied as whole mounts and identified as *Mesocoelium monas* (infection site: small intestine; prevalence: infected lizards/lizards examined × 100 = 10%; mean intensity: mean number of helminths per infected lizard ± SD [where appropriate] = 11). Nematodes were cleared in a drop of glycerol on a glass slide, cover-slipped, and identified as *Oswaldocruzia nicaraguensis* (infection site: stomach, small intestine; prevalence 30%; mean intensity 1.3 ± 0.60), *Physaloptera* sp. (infection site: stomach; prevalence 10%; mean intensity 7) and acuariid larvae (infection site: stomach wall; prevalence 10%; mean intensity 6). Helminths were deposited in the United States National Parasite Collection, Beltsville, Maryland: *Mesocoelium monas* USNPC (98269), *Oswaldocruzia nicaraguensis* USNPC (98270), *Physaloptera* sp. USNPC (98271), acuariid larvae USNPC (98272).

Mesocoelium monas has a wide distribution among amphibians and reptiles in the Neotropics, Oceania, and the Orient (Goldberg et al. 2005. Comp. Parasitol. 72:88–101). Cercariae emerge from the sporocyst to encyst in the viscera of a molluscan host or occasionally leave the host to encyst on vegetation; infection occurs upon ingestion of an infected snail or vegetation containing cysts (Prudhoe and Bray 1982. Platyhelminth Parasites of the Amphibia. British Museum, Oxford University Press, Oxford, United Kingdom. 217 pp.). *Oswaldocruzia nicaraguensis* was described from *Ameiva festiva* from Nicaragua (Bursey et al. 2006. J. Parasitol.

92:350–352). *Sphenomorphus cherriei* is the second species to harbor this nematode. Infection is direct (no intermediate host) (Anderson 2000. Nematode Parasites of Vertebrates: Their Development and Transmission, 2nd ed. CABI Publishing Oxon, United Kingdom. 650 pp.). Larvae of *Physaloptera* sp. (but not adults) are commonly found in amphibians and reptiles (Goldberg et al. 1993. Bull. South. California Acad. Sci. 92:43–51). *Physaloptera retusa* is the common species found in lizards of the Americas (Bursey et al. 2005. Comp. Parasitol. 72:50–68); but males are necessary to assign species. Physalopteridae utilize insect intermediate hosts (Anderson, *op. cit.*). Species of the Acuariidae are normally parasites of birds and utilize arthropod intermediate hosts (Anderson, *op. cit.*). Adults are not known from reptiles which likely serve as transport (paratenic) hosts. *Norops limifrons* from Costa Rica has also been reported to harbor acuariid larvae (Bursey and Goldberg 2003. J. Parasitol. 89:573–576).

Sphenomorphus cherriei represents a new host record for *Mesocoelium monas*, *Oswaldocruzia nicaraguensis*, *Physaloptera* sp., and acuariid larvae. Costa Rica is a new locality record for *O. nicaraguensis.*

We thank Christine Thacker (LACM) for permission to examine *S. cherriei*. Specimens are from the CRE collections donated to LACM by Jay M. Savage. Dustin Goto (Whittier College) assisted with dissections.

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TUPINAMBIS MERIANAE (Tiú, Teiú, Tegu, or Teju). **DIET**. *Tupinambis merianae*, a large, diurnal teiid, is broadly distributed from the Amazon River in Brazil southward to Argentina, Paraguay, and Uruguay (Colli et al. 1998. Herpetologica 54:477–492). Although the species is known to eat terrestrial arthropods, small vertebrates, and quantities of fruit (*op. cit.*), and therefore might also contribute to seed dispersal (Castro and Galetti 2004. Pap. Avul. Zool. 44:91–97), the range of its dietary habits, and hence its trophic ecology, are poorly known. Here, I present the stomach contents analysis of an adult *T. merianae* from southern Brazil that augments data on its diet.

The *T. merianae* examined, a large (27 cm SVL) adult male, was killed on Brazilian Highway PR 160 on 13 February 2000, adjacent to Klabin Ecological Park, in the municipality of Telêmaco Borba, in the state of Paraná (24°20'S, 50°35'W, datum: SAD69; elev. 715 m). Examination of the entire digestive tract contents of this individual revealed 14 different taxa, two plants and 12 animals: 6 gabiroba fruits (*Campomanesia xanthocarpa*); 8 false-coerana fruits (*Vassobia breviflora*); 2 beetles (Coleoptera: Cerambycidae: Prioninae); 2 crickets (Orthoptera: Gryllacrididae); 2 katydids (Orthoptera: Tettigoniidae), and 3 grasshoppers (Orthoptera: Acrididae); 1 (Orthoptera: Proscopiidae); 1 cicada (Hemiptera: Cicadidae); 5 caterpillars: 1 of which was a sphingid (Lepidoptera: Sphingidae: Sphinginae), and 4 saturniids (Lepidoptera: Saturniidae: Hemileucinae); 1 spider (Arachnida: Lycosidae); 1 millipede (Diplopoda); parts of an eggshell of the cowbird (*Molothrus bonariensis*); and the skull of a bat (Chiroptera: Vespertilionidae).

The cowbird egg might have come from a ground-nesting host, such as *Zonotrichia capensis*. Lack of other bones might indicate that the bat skull came from an already dead animal. This wide range of food items might indicate that the *T. merianae* is opportunistic, which might help explain its broad distribution.

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UMA EXSUL (Coahuila Fringe-toed Lizard). **SWIMMING.** The six recognized species in the genus *Uma* are sand habitat specialists well known for their ability to literally "swim" in sand (Cornett



FIG. 1. An adult *Uma exsul* swimming across a temporary pool (top) following heavy precipitation at the Bilbao Dunes, Coahuila, Mexico (bottom).

1983. Pacific Discovery 36:2–10; Pough et al. 1978. Copeia 1978:81–86; Jayne and Daggy 2000. J. Exp. Biol. 203:1241–1242). The fact that these highly xeric-adapted terrestrial lizards can also swim in the water remains unreported. Here, we report observations of the swimming ability of *Uma exsul*, a protected species endemic to the Chihuahua Desert (SEMARNAP 2000. Diario Oficial de la Federación [16 Octubre], México, D.F., México).

During October 2002 and July 2003, we observed two different *U. exsul* swim in the well-known dunes at Bilbao in the Municipality of Viesca, Coahuila, México (25°26'33.64"N, 102°53'33.19"W, datum: NAD27; elev. 1093 m) (Fig. 1). On each occasion, we observed an adult (70 and 72 mm SVL, respectively) swim across pools 8–20 cm deep. The pools were the result of heavy precipitation during those years (Comisión Nacional del Agua, Estación Meteorológica: Emiliano Zapata, Coahuila, 2004).

The lizards swam over a distance of about 10 m and 15 m, respectively. On the first occasion, the lizard was first observed at one end of the pool and swam across; no predator or conspecific was observed that might have precipitated the swim. During the July 2003 observation, the lizard was initially observed swimming in the center of the pool. The swimming movement made a serpentine pattern that was especially evident in the tail; this animal would stop periodically to float and to change direction.

Swimming behavior would allow *Uma exsul* to move between dunes or escape a predator during intervals when water fills interdune depressions.

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URACENTRON FLAVICEPS (Thornytail Iguana). **ENDOPARASITES.** *Uracentron flaviceps* is a medium-sized (100 mm SVL adults) tropidurid lizard found in western Amazonia, Brazil, Colombia, Ecuador, and Peru (Avila-Pires 1995. Lizards of Brazilian Amazonia [Reptilia: Squamata]. Zoologische Verhandelingen Nationaal Natuurhistorisch Museum, Leiden, Netherlands. 706 pp.). To our knowledge, no reports of parasites from *U. flaviceps* exist. The purpose of this note is to report two species of nematodes, *Physaloptera retusa* and *Physalopteroides venancioi* from *U. flaviceps*.

Five *U. flaviceps* females (mean SVL = 86 mm ± 1.5 SD, range: 84–88 mm) from Moropon, on Río Nanay (3°43'S, 73°14'W, datum: WGS84; elev. 100 m), Department Loreto, Peru, collected 13 September 1973 were borrowed from the Texas Cooperative Wildlife Collections (TCWC), Texas A&M University, College Station, Texas (TCWC 44562–63, 44566, 44568–69). The esophagus, stomach, small and large intestines were opened and separately examined for helminths under a dissecting microscope. The body cavity was also examined for helminths. Two species of nematodes, *Physaloptera retusa* (one adult female from the stomach of TCWC 44569) and *Physalopteroides venancioi* (one adult female from the stomach of TCWC 44563) were found. Nematodes were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland as: *Physaloptera retusa* (USNPC 99001) and *Physalopteroides venancioi* (USNPC 99002).

Physaloptera retusa is widely distributed in lizards and two bufonid species in the New World (Bursey et al. 2005. Comp. Parasitol. 72:50–68). Larvae occur in insects (Schell 1952. J. Parasitol. 38:462–472; Lincoln and Anderson 1975. Can J. Zool. 53:385–390). Lizards presumably become infected by eating insects containing larvae. *Physalopteroides venancioi* is known from South American anurans and lizards (Bursey et al., *op. cit.)*. Life cycles of species of *Physalopteroides* are unstudied, but like other members of the Physalopteridae, insects are probable intermediate hosts (Anderson 2000. Nematode Parasites of Vertebrates. Their Development and Transmission. CABI Publishing, Oxon, United Kingdom. 650 pp.). Both *P. retusa* and *P. venancioi* have previously been reported in other lizard species from Peru (Bursey et al., *op. cit.*). *Physaloptera retusa* and *P. venancioi* in *U. flaviceps* are new host records.

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SERPENTES

AGKISTRODON BILINEATUS (Cantil). **REPRODUCTION**. *Agkistrodon bilineatus* ranges along the Pacific Coast and foothills from southern Sonora, Mexico, southward through México into Guatemala, Belize, Honduras, and Nicaragua (Campbell and Lamar 2004. The Venomous Reptiles of the Western Hemisphere. Cornell University Press, Ithaca, New York. pp. 262–265). Currently, three subspecies are recognized within the *A. bilineatus* complex. The northern subspecies, *A. b. bilineatus*, occurs along the Pacific Coast of Mexico, Guatemala, and El Salvador, and in the Rio Grijalva Valley of Chiapas, Mexico (Campbell and Lamar, *op. cit*.). Little published information exists regarding the biology of the northern subspecies, *A. b. bilineatus.* Furthermore, the cantils as a group are under extreme pressure as vast amounts of habitat are being rapidly converted to agricultural lands (Parkinson et al. 2000. Mol. Ecol. 9:411–420). Species-specific surveys with the Tropical Deciduous Forest (TDF) of southern Sonora have yielded few additional specimens of *A. bilineatus*.

At approximately 0900 h on 10 July 2004, an adult female *A. b. bilineatus* (ca. 533 mm TL) was killed by a farmer on the Las Cabras Ranch, Alamos, Sonora. The ranch lies within the foothills of the Sierra Madre Occidental within the TDF zone. The snake was discovered in a pile of decomposing leaves in a mango-avocado orchard. It was collected of by one of us (SM) and immediately frozen. We opened the snake to check for stomach contents, and discovered three neonates in the early stages of development. To our knowledge this represents the first litter for the species in the state of Sonora.

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CONIOPHANES IMPERIALIS (Black-striped Snake). **DIET**. *Coniophanes imperialis* is a small, terrestrial snake that can be active day or night. *Coniophanes* spp. are known to have a broad diet that includes insects, salamanders, frogs, frog eggs, lizards, snakes, reptile eggs, bird eggs, insects, and earthworms (Köhler 2003. Reptiles of Central America. Herpeton Verlag, Offenbach, Germany. 367 pp.; Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna Between Two Continents, Between Two Seas. University of Chicago Press, Chicago, Illinois. 934 pp.), although *C. imperialis* has only been reported to consume lizards, frogs, and insects (Campbell 1998. Amphibians and Reptiles of Northern Guatemala, the Yucatan, and Belize, University of Oklahoma Press, Norman. 380 pp.). We report two prey items for *C. imperialis* on the island of Cayo Cochino Pequeño in the Cayos Cochinos Archipelago (Islas de la Bahia, Honduras).

On 27 May 2006 at 1700 h we captured a small female (177 mm SVL, 29 mm tail, 4.0 g) *C. imperialis* with an obvious prey bulge, crawling through the leaf litter. We forced the snake to regurgitate and identified the food item as a single lizard egg suspected to be *Norops lemurinus*, based on size and shape of the egg and that *N. lemurinus* is the most common polychrotid lizard on the island. Although *Coniophanes* spp. are known to feed on reptile eggs (Köhler, *op. cit.*) our observation represents the first report of *C. imperialis* preying on lizard eggs (Campbell, *op. cit.*).

On 21 June 2006 at 1600 h we observed a large male (245 mm SVL, 115 mm tail, 11.0 g) *C. imperialis* in the leaf litter that contained a very large food item. After capturing the snake and forcing it to regurgitate we identified the partially digested prey item as an adult male (65 mm SVL, 9 mm tail, 6.0 g) *N. lemurinus*. The lizard represented 54.5% of the snake's mass and a 43.1% of its length. *Coniophanes imperialis* is known to consume lizards, but our observation represents the first report of *N. lemurinus* in the diet of *C. imperialis*. Our observation is also the largest reported meal by mass or length for *C. imperialis* (Alvarez de Toro 1960. Los Reptiles de Chiapas. Inst. Zool. Estado, Tuxtla Gutierrez, Chiapas, 204 pp.), although *C. fissidens* was reported to consume an *Eleutherodactylus rugulosus* that weighed 76.4% of snake mass (Seib 1985. Biotropica 17:57–64).

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CONOPSIS NASUS (Large-nosed Earth Snake). **PREDATION.** On 3 October 2005, while conducting a road transect along Road No. 68 in the state of Aguascalientes in central Mexico, we found a DOR male Coachwhip (*Masticophis flagellum*) (SVL 920 mm, TL 200 mm). Close examination of the carcass (possibly killed the day before) revealed two partially digested *Conopsis nasus* (SVL 110 mm each, sexes undetermined) protruding from the gut. To our knowledge this is the first record of predation of *M. flagellum* on *C. nasus*.

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CROTALUS HORRIDUS (Timber Rattlesnake). **BEHAVIOR.** On 7 March 1998 we observed an adult *Crotalus horridus* at a communal hibernaculum in Scioto County, Ohio, USA. The snake alerted us to its presence by rattling, and dried mud was present on its tail. Skies were partly cloudy with occasional periods of sunlight and a light breeze. Ambient temperature was 14°C and substrate temperature was 18°C. Earliest emergence date is a key component of the seasonal cycle of this species (Brown 1993. Biology, Status, and Management of the Timber Rattlesnake [*Crotalus horridus*]: A Guide for Conservation. SSAR Herpetol. Circ. No. 22, 78 pp.). Published accounts of the seasonal cycle of *C. horridus* in Ohio note observations from May to September (Conant 1938. Amer. Midl. Nat. 20:1–200). To our knowledge, this is the earliest emergence date for *C. horridus* at this latitude (Martin 1992. *In* J. A. Campbell and E. D. Brodie Jr. [eds.], Biology of the Pitvipers, pp. 259–278. Selva Press, Tyler, Texas).

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CROTALUS LEPIDUS LEPIDUS (Mottled Rock Rattlesnake). **DIET**. The diet of *Crotalus lepidus* recently was reviewed by Holycross et al. (2002. J. Herpetol. 36:589–597), and relatively little information exists on mammals consumed by rock rattlesnakes under natural conditions. Mammals consumed by this species in the wild include shrew, mouse, *Dipodomys* spp., *Chaetodipus* spp., *Perognathus* spp., *Peromyscus* spp., and *Sigmodon* spp. (Holycross et al., *op. cit.*).

On 23 March 2005 I observed and photographed an adult *C. l. lepidus* consuming an adult White-ankled Mouse (*Peromyscus pectoralis*) at 1350 m elev. in Carlsbad Caverns National Park, Guadalupe Mountains, Eddy Co., New Mexico, USA (Arizona State University, ASU HP-00054). This event was observed below the stone amphitheater on the paved switchback trail leading into the large natural entrance of Carlsbad Cavern. At about 2230 h (Mountain Standard Time), I found the *C. l. lepidus* swallowing the *P. pectoralis* head-first with back legs and white ankles of the mouse still visible, which facilitated the specific identification (see

Fig. 63 in Geluso and Geluso 2004. Mammals of Carlsbad Caverns National Park, New Mexico. Bull. Univ. Nebraska State Mus. 17:1–180). My sighting represents the first documentation of a known species of mammal being consumed by *C. lepidus* under natural conditions. Information on the natural history of this subspecies is important because it is listed as endangered by the New Mexico Department of Game and Fish (Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. University of New Mexico Press, Albuquerque).

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CROTALUS VIRIDIS VIRIDIS (Prairie Rattlesnake). **BEHAVIOR**. Observations of the directional movements of experimentally displaced *Crotalus atrox* (Landreth 1973. Copeia 1973:26–31) and the straight-line paths of migratory *C. viridis viridis* between seasonal habitats (Duvall et al. 1985. Nat. Geogr. Res. 1:80–111) have led to the suggestion that rattlesnakes use celestial cues (e.g., the sun) for orientation. However, the use of other cues for orientation and navigation by rattlesnakes can not be ruled out based on limited experimental evidence. This observation of the homing ability of a naturally displaced prairie rattlesnake suggests that the species possesses not only a compass sense but also a map sense (Type III orientation; Griffin 1952. Biol. Rev. 27:359–400), providing knowledge of their location in relation to a destination. I employed radio telemetry to track the migrations of 18 non-gravid female Prairie Rattlesnakes, *Crotalus v. viridis*, from two dens near Medicine Hat, Alberta, Canada in 2005. One radio tagged rattlesnake was tracked across the South Saskatchewan River to its north side on 16 May (Fig. 1). The radio tagged rattlesnake remained on the north side of the river until 17 September and all recorded locations during this period were within approximately 560 m of the den of origin. On 18 September the rattlesnake crossed the river and was located on its south side ca. 2000 m east of its last known location. The river flows from west to east and it is assumed that the snake drifted downstream when crossing. Prior to this displacement the den was ca. 453 m from the snake's location on a true bearing of 103°. After displacement the den was ca. 1621 m away on a bearing of 246°. On the day following the crossing the snake moved 55 m from her previous location on a bearing of 333°. On the third and fourth day, four positions were recorded as the rattlesnake moved 1610 m back to the den. The route taken by the snake approximated a straight line with a mean bearing of 243.3° + 4.2°.

In this instance type II orientation can be discounted because the rattlesnake did not continue to orient as if it had not been displaced (Lawson 1994. Copeia 1994:263–274). Lohmann et al. (2004. Nature 428:909–910) stated, "Migratory animals capable of navigating to a specific destination, and of compensating for an artificial displacement into unfamiliar territory, are thought to have a compass for maintaining their direction of travel and a map sense that enables them to know their location relative to their destination." If we assume that Prairie Rattlesnakes are capable of using the sun as an effective compass it would allow the displaced rattlesnake to maintain a heading, but this would not account for the rattlesnake's apparent knowledge of its location relative to the den. Map sense in other taxa (e.g., turtles and birds) is thought to be based on the use of visual (Avens and Lohmann 2003. J. Exp. Biol. 206:4317–4325) or solar cues (Akesson et al. 2005. Current Biol. 15:1591–1597) combined with magnetic cues. Among snakes, chemosensory cues could also be used in combination with other cues for navigation during migration (Brown and Parker 1976. Copeia 1976:225–242; Fitch 1960. Univ. Kansas. Mus. Nat. Hist. Misc. Publ. 13:85–288; Lawson 1989. Musk-Ox 37:110–115). This observation of a naturally displaced Prairie Rattlesnake suggests



FIG. 1. Seasonal movements of a radio-tagged *Crotalus viridis viridis* displaced while crossing the South Saskatchewan River.

that this animal was capable of type III orientation. The advanced navigational abilities of Prairie Rattlesnakes might be based on the use of multiple sensory cues but further research is required to identify the role and importance of individual cues.

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DENDRELAPHIS PICTUS (Gmelin's Bronzeback). **DISPERSAL.** A juvenile *Dendrelaphis pictus* was found onboard a traditional fishing boat used for the transportation of tourists between Sape on the eastcoast of Sumbawa and Komodo Island, Indonesia. The boat embarked us as well as food (e.g., vegetables obtained in Sape), on 25 August 1998, and we were transported to the harbor off Kampong Komodo where we stayed overnight. The ship was never attached to a bridge at Komodo Island but remained anchored in a bay. The snake was discovered onboard the ship late afternoon the next day (26 August 1998). It seems impossible that it could have entered the ship from Komodo Island because no cargo was loaded there. More likely it was loaded with vegetables obtained in Sape on Sumbawa. The ship was used for this type of tourist transportation and had not visited other areas "for a long time," as the skipper informed me, so the snake probably originate from this area. All crew members, as well as the tourists onboard reacted negatively on the presence of the snake and killed it, suggesting the snake was not brought onboard intentionally. This observation is interesting because it illustrates the ease with which snakes can be accidentally transported by human activities.

The snake is deposited in the collection of the Natural History Museum, Göteborg, Sweden, under the number GNM Re.ex. 6587 and the identification was verified by Göran Nilson at this museum.

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DRYMARCHON CORAIS COUPERI (Eastern Indigo Snake). **FEEDING BEHAVIOR.** *Drymarchon corais couperi* is a dietary generalist that feeds on a wide range of vertebrate prey species including fish, frogs, toads, lizards, snakes (including venomous species), small turtles, birds, and small mammals (Moler 1992. Rare and Endangered Biota of Florida, Vol III: Amphibians and Reptiles. University of Florida Press, Gainesville. 291 pp.). *Drymarchon c. couperi* is a robust species that typically overpowers its prey using its strong jaws while pinning the prey item to the substrate with a body coil, usually swallowing its prey alive (Moler, *op. cit.*). Herein we report, not only a novel incident of carrion feeding in this species, but also a novel feeding behavior for Serpentes.

On 18 March 2001 at approximately 1330 h an adult *D. corais couperi* (ca. 2 m total length) was observed in the field at Pier 4, Playalinda Beach (Canaveral National Seashore, Brevard Co., Florida, USA) feeding on the head of a decapitated shark (species undetermined). Skies were overcast, ambient temperature was ca. 20°C, and a strong wind was blowing from the east. The feeding event occurred on top of a sand dune vegetated with sea oats (*Uniola paniculata*). Upon approaching the site, a Black Vulture (*Coragyps atratus*) flew off prior to observing the presence of the *D. corais couperi*. Feeding behavior consisted of the snake thrusting its head into the exposed neck musculature of the shark head and biting the exposed tissue. The snake would then twist its head and upper body laterally in attempt to tear the meat away. This behavior was observed for approximately three minutes, during which time it was photographed. The snake then ceased the biting behavior but continued to investigate the lateral surfaces of the shark head that had the skin intact, using its rostrum and lower jaw to push on it three more times. This behavior appeared to be associated with the snake's interest in locating additional feeding opportunities along the shark head. At this time the presence of small pieces of tissue derived from the neck musculature of the shark could be seen surrounding the upper and lower labial scales. The snake then abruptly left the carcass and crawled away into the dune grasses, appearing undisturbed. The amount of shark musculature actually ingested (if any) could not be determined as peristaltic contractions of the esophagus and neck region associated with swallowing could not be discerned.

A radio-telemetry study of over 80 *Drymarchon c. couperi* has been conducted from 1998 through 2005 in similar habitat at the Kennedy Space Center, Brevard Co., Florida, during which time carrion feeding was never observed (R. Bolt, pers. comm.). Observation of a snake attempting to tear pieces of flesh from a disarticulated carcass has not been previously reported.

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ELAPHE GUTTATA (Corn Snake). **PREY/PREDATOR WEIGHT RATIO.** To our knowledge, published accounts where prey mass has been equivalent to, or exceeded that of the predator have involved viperids (Greene 1983. Amer. Zool. 23:431–44; Lindey and Sorrell 2004. Herpetol. Rev. 35: 272–273; Mulcahy et al. 2003. Herpetol. Rev. 34:64) and boids (Weaver 2005. Herpetol. Rev. 36:189). Among the largest prey/predator weight ratios for colubrids are those reported by Lind and Welsh (1990. J. Herpetol. 24:104–106), who documented weight ratios for the genus *Thamnophis* as high as 0.88, and Tucker (2000. Herpetol. Rev. 31:106–107), who reported prey/predator weight ratios between 0.20 and 0.58 in four species of neonatal colubrid snakes. Hamilton et al. (1956. Ecology 37:519–526) described one instance of an *E. guttata* with a juvenile *Sigmodon hispidus* in its stomach that exceeded the weight of the snake, but did not provide the mass of predator or prey. Here we describe an observation of an *E. guttata* with an equivalent prey/predator weight ratio.

On 30 March 2006, one of us (TGJ) collected a neonate female *E. guttata* (369 mm SVL, 10 g) with a large bolus in its stomach. The snake was located in the southwestern corner of the Camp Shelby Training Site, Perry County, Mississippi, USA. I palpated a 10 g *Peromyscus* sp. from the snake's stomach, resulting in a prey/predator weight ratio of 1.00. An unsuccessful attempt was made to re-feed the prey item to the snake which was released at

the point of capture the following day.

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LEPTODEIRA ANNULATA (Banded Cat-eyed Snake). **DIET**. The anuran *Leptodactylus mystaceus* (Leptodactylidae) is distributed in the Amazon Basin from its southern limit in Brazil to Paraguay, Bolivia, Peru, Ecuador, Colombia, Venezuela, and the Guianas (Frost 2002. Amphibian Species of the World: An Online Reference V3.0). During a visual encounter survey on 07 November 2004, at 2125 h, an adult *L. mystaceus* (INPA-H 15713; 47 mm SVL; 8.7 g), was found being ingested by the snake *Leptodeira annulata* (Colubridae; INPA-H 12778; 601 mm SVL; 53 g), in a dry forest stream in the Brazilian Parque Nacional do Pico da Neblina (São Gabriel da Cachoeira municipality, Amazonas state). The snake was swallowing the frog head-first. From the time we first encountered it, the snake took an additional seven minutes to finish swallowing the frog. The new record reinforces assertions that *L. mystaceus* prey extensively on anurans (Vitt 1996. Herpetol. Nat. Hist. 4:69–76).

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LEPTODEIRA ANNULATA (Banded Cat-eyed Snake). **MATING**. *Leptodeira annulata* occurs from Mexico to Argentina (Peters and Donoso-Barros 1986. Catalogue of Neotropical Squamata. Part I, Snakes. Revised ed. Smithsonian Institution, Washington, D.C. 347 pp.). The ecology of *L. annulata* has been studied (Vitt 1996. Herpetol. Nat. Hist. 4:69–76), but little is known regarding its mating behavior.

On 08 Jun 2005, we found one female (577 mm SVL, 177 mm tail length, 36 g) and three male (514, 533, and 473 mm SVL; 188, 187, and 176 mm tail length; 24, 23, and 19 g, respectively) *L. annulata* in a pitfall trap at Floresta Nacional de Carajás, eastern Brazilian Amazônia (06°02'S, 50°15'W). The snakes were forming a breeding ball and were releasing a strong odor. When handled, males discharged fetid cloacal secretions and the female expelled a large amount of sperm from the vent. This observation suggests that, although this species is primarily arboreal, mate searching occurs in the ground, perhaps because tracking pheromone trails in the discontinuous arboreal substratum is difficult.

This observation was supported by Compahia Vale do Rio Doce.

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LEPTODEIRA ANNULATA (Banded Cat-eyed Snake)**. SIZE, REPRODUCTION, AND PREY.** The colubrid snake *Leptodeira annulata* has a wide distribution in the Neotropics, ranging from Mexico to Argentina (Peters and Orejas-Miranda 1986. Catalogue of the Neotropical Squamata, Part I – Snakes. Smithsonian Institution Press, Washington D.C. 347 pp.). Most of the published information on the ecology of *L. annulata* in South America originated from Amazonian populations (Fitch 1970. Misc. Publ. Mus. Nat. Hist. Univ. Kansas 52:1–247; Duellman 1978. Misc. Publ. Mus. Nat. Hist. Univ. Kansas 65:1–352; Henderson et al. 1979. Milwaukee Publ. Mus. Contr. Biol. Geol. 22:1–11; Vitt 1996. Herpetol. Nat. Hist. 4:69–76; Martins and Oliveira 1998. Herpetol. Nat. Hist. 6:78–150). Data are currently lacking for this species in the Atlantic Forest of eastern Brazil. In this note we report data on body size, reproductive traits, and stomach contents of an individual from an Atlantic Forest locality in southeastern Brazil.

On 28 September 2004 at 2105 h during a herpetofaunal survey at the Paraíso Ecological Station (22°29'S, 42°55'W; Guapimirim Municipality, Rio de Janeiro State, Brazil) two of us (DV and CCS) found a female *L. annulata* (718 mm SVL; 920 mm TL; 87 g) at the margin of a stream. The snake had a distinct mid-body bulge, indicating that it had eaten recently. Upon dissection, we found five eggs in the oviducts, with a mean length of 23.4 ± 1.7 mm (range 21.0–25.7 mm) and a mean width of 11.1 ± 1.7 mm (range 9.6–14.0 mm). The snake's stomach contained a partially digested *Bufo crucifer* (70 mm SVL) which had been swallowed head-first. The snake and its stomach contents were deposited at the Museu Nacional, Rio de Janeiro (MNRJ 12232).

Total length of MNRJ 12232 was larger than the maximum total lengths (between 760–870 mm) reported for *L. annulata* (Duellman 1958. Bull. Amer. Mus. Nat. Hist. 114:1–152; Duellman 1978, *op. cit.*; Fitch 1981. Misc. Publ. Mus. Nat. Hist. Univ. Kansas 70:1–72; Martins and Oliveira, *op. cit.*) and its SVL was greater than the maximum SVL (659 mm) of 59 Amazonian specimens examined by Vitt (*op. cit.*; total lengths not given). On the other hand, Savage (2002. The Amphibians and Reptiles of Costa Rica. University of Chicago Press, Chicago, Illinois. 934 pp.) reported a maximum total length of 1038 mm for this species in Costa Rica, which exceeds the size of MNRJ 12232. Nevertheless, the specimen reported here represents, to our knowledge, the largest size on record for *L. annulata* in South America.

Clutch size of this individual (five eggs) is within the ranges reported by Fitch (1970, *op. cit.*) for Amazonian Peru (2–7 eggs; mean = 4.0) and Vitt (*op. cit.*) for Amazonian Brazil and Ecuador (3–6 eggs; mean = 4.7). The eggs, on the other hand, were large compared to those reported for females of Amazonian populations: Vitt (*op. cit.*) reported an average length of 19.0 mm (range 13.5–22.4 mm) and an average width of 7.4 mm (range 5.3–10.2 mm) for 25 eggs taken from five females and Martins and Oliveira (*op. cit.*) recorded lengths of 17–18 mm and widths of 7–8 mm for six eggs taken from one female. It would be interesting to examine more *L. annulata* specimens from the Atlantic Rainforest domain to verify whether they usually lay larger eggs than their Amazo-

nian conspecifics, as suggested by the present data.

Prey reported for *L. annulata* at various localities consist almost exclusively of anuran amphibians, mainly hylids and leptodactylids (Duellman 1958, *op. cit.*; 1978, *op. cit.*; Vitt, *op. cit.*; Martins and Oliveira, *op. cit.*). Vitt (*op. cit.*) recorded one bufonid (*Bufo granulosus*) and Duellman (1958, *op. cit.*) reported three species of *Bufo* (*B. marinus*, *B. typhonius*, and *B. valliceps*) and a few indeterminate *Bufo* specimens from stomachs of *L. annulata*. The present note reports another species of *Bufo* as prey of *L. annulata*, which suggests that predation on such animals by this snake might not be infrequent. Thus, the toxic secretions from the parotoid glands of *Bufo* spp. do not seem to be an efficient deterrent from predation by *L. annulata*, which might not be affected by the toxin to any significant degree. The present data also indicate that *L. annulata* does not stop feeding during pregnancy.

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LEPTODEIRA ANNULATA (Banded Cat-eyed Snake). **PREY**. *Leptodeira annulata* is an arboreal and nocturnal colubrid that ranges from México through Central America and the Amazon basin into northern Argentina. Often it is found in trees and bushes near water and feeds primarily on anurans (Duellman 1958. Bull. Amer. Mus. Nat. Hist. 114:1–152; Savage 2002. The Amphibians and Reptiles of Costa Rica. The University of Chicago Press, Chicago, Illinois. 954 pp.).

On 12 March 2004 at 2140 h we observed an *Osteocephalus taurinus* (Anura) sitting on a rock ca. 50 cm above a small tributary to the Rio Chumilla (between Shapaja and Chazuta in the Tarapoto region of Peru, ca. 500 m elev.). Over a distance of ca. 5 m, a *L. annulata* (ca. 1 m TL) approached the frog from amidst overhanging branches. The frog leapt from its rock and was seized by the snake in mid-air. The snake ingested the seemingly alive, but paralyzed frog (hindlimbs first), while hanging head-down from its original perch over a period of ca. 30 minutes. To the best of our knowledge, this is the first documentation of *L. annulata* predation on *O. taurinus*.

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LIOPHIS REGINAE (Reticulated Snake). **DIET.** Throughout large parts of the Neotropics, peccaries (Tayassuidae, *Pecari tajacu* and *Tayassu pecari*) create and maintain wallows in the forest understory. These pools provide year-round breeding habitat for amphibians that opportunistically breed in pools. For several years, one of us (HB) has worked at the Cocha Cashu Biological Station within the Manu National Park (11°52'S, 71°21'W), Peru to test whether peccaries function as ecosystem engineers by creating new habitats (wallows) that may be colonized by other species. On 23 March 2005 while monitoring the breeding activities of the leptodactylid frog *Edalorhina perezi* at peccary wallows, we noticed a juvenile (186 mm SVL) *Liophis reginae* inside a terrestrial *E. perezi* foam nest. As the snake left the foam nest it was collected and preserved in 70% ethanol. Upon dissection, we found six *E. perezi* tadpoles in its stomach. This is the first record of *L. reginae* preying upon *E. perezi* tadpoles inside a foam nest. Depredation of frog eggs and larvae by snakes is well documented in the Neotropics, and several snake taxa may be considered anuran specialists. Few predators, however, have been documented feeding within the foam nests of leptodactylid frogs.

The snake (TUMZ 8051), the ingested tadpoles and voucher specimens (TUMZ 8052) from the foam nest are permanently stored at the Museum of Zoology at Towson University, Department of Biological Sciences.

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MASTICOPHIS FLAGELLUM FLAGELLUM (Eastern Coachwhip). **GROWTH AND MOVEMENT.** Little is known regarding growth rates of *Masticophis flagellum* and limited data have been generated regarding their movement (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Institution Press, Washington, D.C. 668 pp.). Herein we report on a PIT-tagged male *M. flagellum* that was captured three times over a 23-month time period in Baker Co., Georgia, USA. In May 2003, the individual measured 1605 mm SVL, 2078 mm TL, and 940 g. Reliable measurements were not taken during June 2004, when the snake was captured a second time. In April 2005, the same individual was recaptured and measured 1622 mm SVL, 2089 mm TL, and 951 g. The first and second capture locations were 1469 m apart (straight line distance) and separated by Ichawaynochaway Creek (a major tributary of the Flint River) while the second and third locations were 291 m apart (straight line distance) for a minimum cumulative movement of 1760 m. *Masticophis flagellum* are known to travel considerable distances (ca. 1 km; Secor 1995. Herpetol. Monogr. 9:169–186) but to our knowledge, movements on this scale have not been recorded. In addition, movement across aquatic habitats such as creeks or rivers does not appear to have been previously documented in this species.

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NERODIA ERYTHROGASTER FLAVIGASTER (Yellow-bellied Watersnake). **DIET**. *Nerodia erythrogaster* is a prey generalist with a diet consisting of crayfish, a variety of fish, salamander, anurans and their larvae. The majority of prey consumed by this semi-aquatic snake are amphibians including the potentially toxic toads of the genus *Bufo* (Gibbons and Dorcas 2004. North American Watersnakes: A Natural History. Univ. Oklahoma Press, Norman, Oklahoma. 438 pp.). Previously reported bufonid species have included *B. americanus*, *B. houstonensis*, *B. terrestris*, *B. valliceps*, and *B. woodhouseii*. There has been discrepancy in the literature about the validity of *Bufo velatus* as a species. Some researchers regard it as an intergrade between species in the *B. woodhouseii* complex (Conant and Collins 1998. Reptiles and Amphibians: Eastern and Central North America. Houghton Mifflin Co., New York. 616 pp.; Dixon 2000. Amphibians and Reptiles of Texas. Texas A & M University Press, College Station, Texas. 421 pp.). Herein, *B. velatus* is considered a species according to recent literature and systematic analysis (Dixon 2000, *op. cit.*; B. Fontenot, pers. comm.). No previous records are known of *N. erythrogaster* consuming *B. woodhouseii* within the currently understood range of *B. velatus*; thus this report is the first documentation of the East Texas Toad, *B. velatus*, as a prey item of *N. erythrogaster*.

On 2 May 2004 a *N. erythrogaster* (763 mm SVL, 310 g) was collected from under an artificial cover item at the Old Sabine Bottom Wildlife Management Area (OSBWMA) Smith County, Texas, USA (32°35.853'N, 95°20.369'W). A gravid female *B. velatus* (43.1 g) was palpated from the specimen.

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NERODIA ERYTHROGASTER FLAVIGASTER (Yellow-bellied Watersnake). **ANTI-PREDATORY BEHAVIOR**. Tail breakage is an anti-predatory strategy employed by several species of snake (Mendelson 1992. Herpetologica 48:448–445; Fitch 2003. Herpetol. Rev. 34:212–213). When a snake is captured by the tail it may roll or rapidly undulate to facilitate breakage. The remaining tail fraction creates little movement and the snake is provided an opportunity for escape. This behavior, however, potentially has detrimental effects on locomotion, courtship, and defensive behavior (Rossman et al. 1996. The Garter Snakes: Evolution and Ecology. University of Oklahoma Press, Norman. 332 pp.; Chapple et al. 2004. J. Herpetol. 38:137–140). This note is the first documentation of tail breakage by *Nerodia erythrogaster*.

On 9 April 2005, a female *N. erythrogaster* (720 mm SVL, 226.3 g) was found under a piece of tin at the Old Sabine Bottom Wildlife Management Area, Smith County, Texas, USA (32°35.945'N 095°20.638'W). The snake was seized by the tail as it attempted to flee. Very soon after restraint, the snake rotated its body and the tail broke off in my hand. The intact tail length was 179 mm and the disconnected tail fraction was 73 mm. Based upon length, approximately 29% of the tail was lost.

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NERODIA FASCIATA CONFLUENS (Broad-banded Watersnake). **DIET**. *Nerodia fasciata* is primarily a piscivorous snake (Mushinsky and Hebrard 1977. Herpetologica 33:162–166). A wide variety of amphibians, however, have also been documented as food items (Gibbons and Dorcas 2004. North American Watersnakes: A Natural History. University of Oklahoma Press, Norman, Oklahoma. 438 pp.). Five species of salamander, representing four families, have previously been reported as prey. Here I report the first published record of the family Ambystomatidae in the diet of *Nerodia fasciata*.

On 29 March 2005, a *N. fasciata* (163 mm SVL, 6 g) was found under a piece of corrugated tin at the Old Sabine Bottom Wildlife Management Area (OSBWMA) Smith County, Texas, USA (32°35.853'N, 95°20.369'W). The individual readily regurgitated a prey item identified as an *Ambystoma texanum* metamorph (0.7 g) approximately half-digested. The nearby pool was sampled for *A. texanum* larvae. Of three captured larvae, the mean SVL was 34.7 ± 5.8 mm and the mean mass was 1.93 ± 0.8 g. The OSBWMA is a bottomland floodplain that experiences occasional flooding. The floods create ephemeral pools that contain pulsed resources such as fish. However, droughts and dams up-river of the site have decreased the frequency and intensity of natural floods and fish are no longer common in the vernal pools. *Ambystoma texanum*, on the other hand, are quite numerous in this floodplain and are abundant prey items for many semi-aquatic snakes species.

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PHILODRYAS OLFERSII (NCN)**. NATURAL HISTORY.** *Philodryas olfersii* is found in western Brazil and eastern Peru through Bolivia and Paraguay to Uruguay and Argentina. Despite its wide distribution, information regarding the ecology of the species is scarce and focused in small portions of the species' distribution (e.g., northeastern Brazil). In Pantanal, the species was found in rocky areas, deciduous and semideciduous forest and urban environments. Here, we present data from oviposition in captivity and activity in rocky areas near Corumbá, Mato Grosso do Sul, Brazil. On 26 November 1998, five eggs with a mean length of 49.5 ± 4.9 mm (44.1–57.6 mm), mean width of 17.3 ± 1.2 mm (16.3–19.2 mm), and mean volume of 7800 ± 1297 mm^3 were found in Laboratório de Zoologia of Campus de Corumbá. After 73 days, four hatchlings with an average mass of 7.1 ± 1.1 g (5.8–8.5 g) emerged. Unfortunately, we did not measure the hatchlings. One month later (day 19) in the terrarium of the same female nine eggs were found with mean length 33.4 ± 2.7 mm (29.3–37.9 mm), mean width 17.3 ± 2.1 mm (14.8–21.5 mm), and mean volume 5263 ± 1336 mm^3. In this case only three eggs hatched (after 39 days), with a mean mass of 3.8 ± 0.4 g, mean SVL of 214.0 ± 10.8 mm, and mean tail length of 93.7 ± 4.0 mm. One hatchling died within 3 minutes of hatching. The specimens have been deposited in Coleção Zoológica de Referência do Campus de Corumbá (CEUCH 167, 191–195).

We captured five *P. olfersii* in rocky areas from June 2003 to March 2004. We found two individuals basking in bromeliads at 0700 h and 1324 h, one on the ground below bushes at 1525 h, and two were found foraging at 1340 h and 1450 h. Foraging behavior

consisted of constant movement in search for prey in bushes ca. 3 m high. One individual (CEUCH 044, SVL 946 mm) had a juvenile *Bufo schneideri* (TL 33.2 mm) in its stomach. Our observations suggest that *P. olfersii* is an active forager, uses foliage for foraging and basking, appears to produce more than one clutch/year, and oviposits in the early rainy season, unlike populations in the Caatinga of northeastern Brazil (Vitt 1980. Pap. Av. Zool. 34:87–98).

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PITUOPHIS CATENIFER SAYI (Bullsnake). **NESTING**. On 20 June 2005, while monitoring turtle activity at a drift fence north of Gimlet Lake on the Crescent Lake National Wildlife Refuge in Garden County, Nebraska, USA (see Iverson 1991. Herpetologica 47:371–393), we encountered an obviously gravid (palpable eggs, freshly ecdysed) female Bullsnake (1110 mm snout–vent length; 118 mm tail length; ca. 475 g body mass). Because of her condition and direction of movement (from low meadow to upland sandhills), we presumed that she was moving to oviposit, and force-fed her a transmitter (model LF1-STL-RS, LL Electronics, Urbana, Illinois) coated in wax (total weight 9 g) and released her. Over the next five days she spent the nights underground in an abandoned pocket gopher (*Geomys bursarius*) burrow complex (diameter of all nocturnal locations ca. 1 m). During the day she ventured up to 29 m (17 m minimum) from that complex, and when not actively moving, was found coiled in the partial shade of one of many yuccas (*Yucca glauca*) in the area. At 0545 h on 25 June she was underground in the gopher burrow, but at 0940 h she was obviously spent (298 g body mass, including transmitter) after having crossed the drift fence on her way toward the meadow. We assumed that she oviposited the previous night. She was captured at 1015 h after moving ca. 104 m directly toward Gimlet Lake (total distance from the burrow complex to the cattails fringing the lake's shoreline, ca. 200 m).

On 26 June at 0900 h we excavated the gopher burrow complex and located the snake's clutch of 9 eggs (mean length 44.4 mm; mean width 27.7 mm) in a single cemented cluster (total mass 176.8 g) at the end of a shallow branch off the main gopher burrow below where it had been located the day before. Depth from the soil surface to the top egg was 263 mm, and to the bottom of the lowest egg, 312 mm. We also found the shed skin of a much larger *P. catenifer* in another branch of the same burrow complex, but no other evidence of any other snakes or eggs. The nest site was on a southwest-facing (237 degrees), 14 degree slope in a sparsely vegetated area of mid-grass prairie dominated by Needle and Thread Grass (*Stipa comata*), bluestems (*Andropogon* sp.), Switchgrass (*Panicum virgatum*), yucca, and introduced cheat grass (*Bromus* sp.). Early on 27 June she defecated the transmitter and was released in the meadow.

Although nest sites of the Pinesnake (*Pituophis melanoleucus*) have been well described (Burger and Zappalorti 1991. J. Herpetol. 25:152–160), only anecdotal reports are available for *P. catenifer.* In western Oregon communal nests of Pacific Gophersnakes (*P. c. catenifer*) were found in "cavities" in a talus slope, with one specifically found at a depth of 30 cm in an inactive rodent burrow (Brodie et al. 1969. Herpetologica 25:223–227). Similarly, in British Columbia at least two female Great Basin Gophersnakes *(P. c. deserticola*) nested communally in a rodent burrow (Shewchuk 1996. M.S. thesis, Univ. of Victoria), and in northern Utah at least four females nested singly or communally (sometimes with *Masticophis taeniatus*) in abandoned rodent burrows at depths of 34–42 cm (Parker and Brown 1980. Milwaukee Publ. Mus. Publ. Biol. Geol. 7:1–104). These data suggest that *P. melanoleucus* excavates its nest burrows, whereas *P. catenifer* uses natural cavities or burrows for oviposition; however, further data are needed for both species to determine the universality of this pattern.

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PITUOPHIS MELANOLEUCUS LODINGI (Black Pinesnake) **CARRION FEEDING.** Members of the genus *Pituophis* are known to take a wide variety of prey items, including small mammals, birds and their eggs, lizards, snakes and their eggs, and insects (Ernst and Barbour 1989. Snakes of Eastern North America. George Mason University Press, Fairfax, Virginia. 282 pp.; Rodríguez-Robles 1998. Copeia 1998:463–466; Rodríguez-Robles 2002. Biol. J. Linn. Soc. 77:165–183). However, information pertaining to the diet and the prey items selected by the Black Pinesnake (*Pituophis melanoleucus lodingi*) are limited (e.g., Cliburn 1962. Herpetologica 18:34–37; Rudolph et al. 2002. Herpetol. Nat. Hist. 9:57–62). Herein I report an instance of carrion feeding by *P. melanoleucus lodingi*.

On 24 June 2005 at 1203 h, a female *P. melanoleucus lodingi* (121 cm SVL, 615 g), implanted with a radio transmitter (Holohil, SI-2T), was located as part of an ongoing radio-telemetry investigation into the movement patterns and general life history of *P. melanoleucus lodingi* on the Camp Shelby Training Site, Perry County, Mississippi, USA. The snake was observed basking 5 m from the entrance to an underground refugium (stump hole), and appeared to have recently fed as indicated by a large bolus in its stomach. Upon palpating the snake a young *Sciurus niger* was regurgitated. The squirrel was fairly decomposed and completely covered in maggots (still alive). When the snake was released it quickly retreated to the nearby stump hole, and the squirrel was placed in front of the refugia's entrance. The next day the snake was rediscovered in the exact location it had been observed the previous day and had presumably re-ingested the squirrel since it was nowhere to be found, and the snake was observed with a similarly sized bolus in its stomach. The presence of maggots on the prey item suggests the squirrel had died prior to being consumed, and the fact that the maggots were still alive implies the snake had recently eaten the animal. The frequency and propensity to scavenge and the relative contribution that carrion represents in the diet of the Black Pinesnake is unknown. However, carrion probably plays an important supplementary role, as is the case with a number of other snake species (See DeVault and Krochmal 2002. Herpetologica 58:429–436).

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PITUOPHIS MELANOLEUCUS LODINGI (Black Pinesnake). **SEXUAL BEHAVIOR.** *Pituophis melanoleucus lodingi* is a large, secretive colubrid whose range is limited to the Gulf Coastal Plain of Louisiana, Mississippi, and Alabama. Seasonal timing of sexual behavior (e.g., courtship, coitus) for this subspecies has not been reported, although detailed studies on the reproductive biology and reports of courtship exist for *P. m. melanoleucus* and *P. m. mugitus* (Ashton and Ashton 1981. Handbook of Reptiles and Amphibians of Florida. Part 1. The Snakes. Windward Publ. Inc., Miami, Florida. 176 pp.; Zappalorti et al. 1983. Bull. Chicago Herpetol. Soc. 18:57–72; Burger and Zappalorti 1986. Copeia 1986:116–121; Gerald and Holmes 2004. Herpetol. Rev. 35:180). The literature indicates that courtship takes place during late spring (the month of May, in both Tennessee [Gerald and Holmes, *op. cit.*] and New Jersey [Zappalorti et al., *op. cit.*] populations); although Goldberg and Parker (1975. Herpetologica 31:317–322) suggested that breeding throughout the year is possible. Here I report the first observation of copulatory behavior in a pair of *P. m. lodingi* from Mississippi, and possibly the latest known seasonal instance of such behavior for *P. melanoleucus*.

On 28 September 2005, at 1035 h, I observed a pair of *P. m. lodingi* copulating in the southwestern corner of the Camp Shelby Training Site, in Perry County, Mississippi, USA. Both individuals (male: 149.5 cm SVL, 1001 g; female: 121.2 cm SVL, 615 g) carried intraperitoneally implanted radio-transmitters weighing less than 5% of body mass. The pair was loosely coiled on the ground with the male's entire body positioned on top of the female's with the exception of the tail, which was extended along the side of her body in such a manner as to allow for copulation. Ambient air temperature was 33.2°C during the time of the observation and no precipitation occurred within the previous 24 h. The snakes remained together in the same area for 3 days following the initial observation, but were located below ground, in a rotted-out pine root system, during each visit. On the fourth day both snakes moved to different locations ca. 300 m apart.

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PYTHON MOLURUS BIVITTATUS (Burmese Python). **NESTING**. Although *Python molurus bivittatus* is native to Southeast Asia, both adult and juvenile specimens have been collected in Everglades National Park, Florida, USA, since the mid 1990s (Meshaka et al. 2000. Florida Sci. 63:84–102). Breeding of free-living *P. m. bivittatus* has not been confirmed anywhere in Florida. Here we document the first nest outside of captive breeding efforts in the United States.

On 25 January 2006 a female *P. m. bivittatus* was collected within Everglades National Park. On 8 February 2006 she was released with two VHF radio transmitters implanted subcutaneously as part of a study on movements and habitat use. On 17 May 2006 we located the female to remove her from the field and found her coiled around eggs (Everglades National Park Museum photograph, EVER 41050).

The nest (25.36°N, 80.68°W, elev. 0.5 m) was located in an overgrown debris pile (approximately a 20 m semicircle) comprised mainly of vines, small forbs and shrubs, other vegetation, cut logs, PVC pipe, barbed wire, poster-board, planks, cardboard, pieces of a filing cabinet, and other materials. The nest was located under a piece of metal that was under a nodule of the root system of the tallest tree (a Brazilian Pepper, *Schinus terebinthifolius*) in the debris pile. The eggs were clustered on a circle of decomposed organic matter ca. 80 cm in diameter. The nest had 46 eggs (42 fertile, 2 infertile, and 2 opened at the nest and not measured). Mean egg length (N = 44) was 91.8 mm (SD = 6.5), mean egg width was 62.7 mm (SD = 4.0), mean egg mass was 189.1 g (SD = 37.2). Mean embryo length (N = 24) was 90.0 mm (SD = 6.8).

To date, there are scant data of *P. m. bivittatus* nest structure or material, although pythons are known to nest in mammal burrows, hollow logs, cavities under rocks, and around plant roots (Minton and Minton 1973. Giant Reptiles. C. Scribner's Sons, New York. 345 pp.).

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SONORA SEMIANNULATA (Ground Snake). **PREDATION**. *Sonora semiannulata* (Colubridae) is a small burrowing species that occurs in desert, grassland, and semi-arid forest formations throughout the southwestern U.S. and northern Mexico (Frost 1983. Cat. Amer. Amphib. Rept. 333.1–4). The snake feeds primarily on small arthropods, including venomous centipedes, and was assumed to have some physiological resistance to venom or behavioral attributes allowing for successful prey capture without being envenomated (Kassing 1961. Texas J. Sci. 13:185–203; Werler and Dixon 2000. Snakes of Texas: Identification, Distribution, and Natural History. Univ. Texas Press, Austin, Texas, 437 pp.). Consuming venomous arthropods by *S. semiannulata* is thus well established, but the reverse situation, the predation on that species by venomous arthropods, has not been documented. Here we present the first reported observation of predation on a *S. semiannulata* by the centipede, *Scolopendra heros*, a large (maximum 210 mm TL) and voracious species, with relatively toxic venom, which reportedly consumes about any animal it can overpower, including snakes (Maldonado 1998. The Taxonomy and Biology of Southwestern U.S. Scolopendrid Centipedes [Chilopoda: Scolopendridae]. M.S. Thesis, Dept. of Biol. Sci., The Univ. of Texas at El Paso, 110 pp.). As an example, Easterla (1975. Southwest. Nat. 20:411) described a 118 mm (TL) *S. heros* eating a freshly killed 247 mm (TL) Long-nosed Snake, *Rhinocheilus*



FIG. 1. A *Scolopendra heros* examining a freshly killed *Sonora semiannulata* prior to devouring its soft body parts.

lecontei, near Study Butte, Brewster Co., Texas, and noted that soft portions of the head and neck of the snake were consumed first.

On 12 June 2003 at 0916 h, while lifting a pitfall trap cover board, a large *S. heros* (ca. 203 mm TL) was observed killing and then eating a *Sonora semiannulata* (ca. 218 mm TL; Fig. 1) near the headquarters of Indio Mountains Research Station (IMRS), Hudspeth Co., Texas (30°46'35"N, 105°00'55"W; 1215 m elev.). The local environment at the observation site was a sloping alluvial fan covered by Chihuahuan Desert scrub vegetation. Estimating length, which was determined by using a string to measure each animal, was necessary due to IMRS policy prohibiting unnecessary disruption of animals engaged in natural behavior. Fortunately, the centipede could be realistically measured since the animal ignored us while feeding. The snake was still alive when first discovered, but obviously incapacitated by either the centipede's venom or by other trauma associated with the attack. Even though the centipede was shorter than the snake, it nonetheless had a more massive body and in all probability had little difficulty initially overpowering its weaker prey. Surveillance of ensuing feeding behavior confirmed that the snake was being consumed from the head backward along the body (similar to that reported by Easterla, *op. cit.*). Soft parts were devoured flush to the vertebrae and ribs while the centipede made circular bites around the snake's torso. The feeding process was tracked for about 20 minutes, after which time the centipede carried away the half-eaten snake and disappeared into nearby vegetation. Fig. 1 and another digital photograph depicting the centipede consuming the snake are deposited in the photograph collection, Laboratory for Environmental Biology, Centennial Museum, The University of Texas at El Paso (UTEP G2005.1.1–1.2).

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THAMNOPHIS CYRTOPSIS (Black-necked Gartersnake). **BEHAVIOR**. On 12 August 2004, one of us (EWS) captured a small (179 mm SVL, 2.0 g), male *T. cyrtopsis* with a noticeable food bulge in a creek in the Rincon Mountains, Saguaro National Park, Arizona, USA. As the snake was readied for processing it was held loosely, during which time it coiled itself into a knot. The snake was looped into a circle with a coil around its body directly posterior of its head. The coil was tight and it seemed strength was gained by buttressing the anterior ventral surface against the top of the head. Proceeding posteriorly from the first loop, the tail was brought back under its head and another coil was looped around its body, anterior to the first loop. Here, it appeared strength was gained by buttressing against the side of the head. The end of the tail was placed against the top of the snake's head, giving the appearance that leverage was gained by the tail's placement. The combination of coils circling the body and bracing of body parts made for a very tight structure; the snake could literally be held by the long section of its body with the coiled head and tail remaining stiff and inflexible (Fig. 1). To our knowledge, this behavior has not been reported for any *Thamnophis*. Veer et al. (1997. Herpetol. Rev. 28:91) report similar behavior by *Sonora semiannulata* in response to attempted predation by *Micruroides euryxanthus*. Their report describes a behavior whereby a *Sonora* formed a loop that (temporarily) stymied predation by grasping itself behind its own head, forming a loop that the *Micruroides* "walked over" as it maneuvered to find the ground snake's head. Given that *T. cyrtopsis* is sympatric with *M. euryxanthus* and other ophidiophagous snakes (e.g., *Lampropeltis* spp., *Masticophis* spp., *Diadophis punctatus*), the unique behavior we observed may provide a similar defensive role.



FIG. 1. *Thamnophis cyrtopsis* showing presumed defensive behavior.

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THAMNOPHIS MARCIANUS MARCIANUS (Checkered Garter Snake). **DIET**. Although a wide variety of taxa, including invertebrates, fish, lizards, snakes, and mammals, are considered part of its diet, *Thamnophis marcianus* preys most frequently on amphibians (reviewed in Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Inst. Press, Washington,

D.C. 668 pp.). Only two species of lizard (*Cophosaurus texanum* and *Holbrookia maculata*) have been previously documented as prey items of *T. marcianus*. This is a report of the first documented occurrence of a teiid lizard, *Aspidoscelis inornatus*, as a prey item of *T. marcianus*.

On 3 August 2006 a *T. marcianus* (ca. 70 cm TL) was found crossing Highway 380, ca. 11 miles E of Roswell, Chaves Co., New Mexico, USA (33°23.843'N, 104°25.296'W). Upon capture, the snake readily regurgitated the remains of an *A. inornatus*.

Submitted by **PAUL M. HAMPTON**, Department of Biology, University of Louisiana at Lafayette, Lafayette, Louisiana 70504, USA; and **BRIAN E. FONTENOT**, Department of Biology, University of Texas at Arlington, Arlington, Texas 76019, USA.

THAMNOPHIS PROXIMUS PROXIMUS (Western Ribbon Snake). **NECROPHAGY**. Reports of necrophagy in snake species, although uncommon, have previously been documented, particularly with roadkill as the food item (Teixeira and Vrcibradic 2003. Herpetol. Rev. 34:248). The diet of *Thamnophis proximus* is broad, consisting of several salamanders, frogs, toads, and fish species (Rossman et al. 1996. The Garter Snakes: Evolution and Ecology. University of Oklahoma Press, Norman, Oklahoma. 332 pp.). This is the first published account necrophagy by *T. proximus*.

On 9 April 2005, a female *T. proximus* (679 mm SVL, 99 g) with an obvious prey bulge was captured at the Old Sabine Bottom Wildlife Management Area, Smith Co., Texas, USA (32°36.156'N, 95°20.329'W). An *Ambystoma texanum* (56 mm SVL, 2 g) was removed. The salamander was ingested mid-body first and appeared to have desiccated prior to ingestion as evidenced by sunken eyes and shrunken leathery skin. The salamander was also rigid, which is inconsistent with the generally soft body of palped amphibian prey. Little digestion was apparent, also inconsistent with other palped prey items. Given the condition of the food item, it is most likely that the item was eaten post-mortem.

Submitted by **PAUL M. HAMPTON**, Department of Biology, University of Texas at Tyler, 3900 University Blvd, Tyler, Texas 75799, USA.

GEOGRAPHIC DISTRIBUTION

Herpetological Review publishes brief notices of new geographic distribution records in order to make them available to the herpetological community in published form. Geographic distribution records are important to biologists in that they allow for a more precise determination of a species' range, and thereby permit a more significant interpretation of its biology.

These geographic distribution records will be accepted in a **standard format** only, and all authors *must* adhere to that format, as follows: SCIENTIFIC NAME, COMMON NAME (for the United States and Canada as it appears in Crother 2000. *Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, with Comments Regarding Confidence in Our Understanding*. SSAR Herpetol. Circ. 29:1–82, available online at <http://herplit.com/SSAR/circulars/HC29/Crother.html>; for Mexico as it appears in Liner 1994, *Scientific and Common Names for the Amphibians and Reptiles of Mexico in English and Spanish.* Herpetol. Circ. 23:1–113), LOCALITY (use metric for distances and give precise locality data), DATE (day-month-year), COLLECTOR, VERIFIED BY (*cannot* be verified by an author—curator at an institutional collection is preferred), PLACE OF DEPOSITION (where applicable, use standardized collection designations as they appear in Leviton et al. 1985, *Standard Symbolic Codes for Institutional Resource Collections in Herpetology and Ichthyology*, Copeia 1985[3]:802–832) and CATALOG NUMBER (required), COMMENTS (brief), CITATIONS (brief), SUBMITTED BY (give name and address in full—spell out state or province names—no abbreviations).

Some further comments. This geographic distribution section does not publish "observation" records. Records submitted should be based on preserved specimens which have been placed in a university or museum collection (private collection depository records are discouraged; institutional collection records will receive precedence in case of conflict). A good quality color slide or photograph may substitute for a preserved specimen *only* when the live specimen could not be collected for the following reasons: it was a protected species, it was found in a protected area, or the logistics of preservation were prohibitive (such as large turtles or crocodilians). Color slides and photographs *must* be deposited in a university or museum collection along with complete locality data, and the color slide catalog number(s) must be included in the same manner as a preserved record. Before you submit a manuscript to us, check Censky (1988, *Index to Geographic Distribution Records in Herpetological Review: 1967–1986*; available from the SSAR Publications Secretary) and other sources to make sure you are not duplicating a previously published record. The responsibility for checking literature for previously documented range extensions lies with authors. Do not submit range extensions unless a thorough literature review has been completed.

Please submit any geographic distribution records in the **standard format only** to one of the Section Co-editors: **Alan M. Richmond** (USA & Canadian records only); **Jerry D. Johnson** (Mexico and Central America, including the Caribbean Basin); **Indraneil Das** (all Old World records); or **Gustavo J. Scrocchi** (South American records). Short manuscripts are discouraged, and are only acceptable when data cannot be presented adequately in the standard format. **Electronic submission of manuscripts is required** (as Microsoft Word or Rich Text format [rtf] files, as e-mail attachments)**.** Refer to inside front cover for e-mail addresses of section editors.

Recommended citation for new distribution records appearing in this section is: Schmitz, A., and T. Ziegler. 2003. Geographic distribution. *Sphenomorphus rufocaudatus*. Herpetol. Rev. 34:385.

CAUDATA

AMBYSTOMA MACULATUM. (Spotted Salamander). USA: TENNESSEE: LAUDERDALE CO.: John Tully Wildlife Management Area managed by the Tennessee Wildlife Resources Agency located in the Golddust 7.5 minute Quad (35.66007°N, 89.803250°W, NAD 83). 17 October 2006. Daniel Stanfield of the Tennessee Wildlife Resources Agency. Austin Peay State University Museum of Zoology (APSU 18243). Verified by A. Floyd Scott. One Spotted Salamander found while conducting a visual encounter survey in bottomland hardwoods. Temperature at collection was 22°C. New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp.; hard copy and Internet versions, the latter of which includes links to information on Tennessee amphibians having appeared since 1996, http://www.apsu.edu/amatlas/, accessed 19 October 2006).

Voucher image collection made under the authority of the Tennessee Wildlife Resources Agency; field work supported by State Wildlife Grant (SWG) funding under the authority of the U.S. Fish and Wildlife Service.

Submitted by **CHRIS HUNTER**, Tennessee Wildlife Resources Agency, 200 Lowell Thomas Drive, Jackson, Tennessee 38301, USA; e-mail: christopher.hunter@state.tn.us.

AMBYSTOMA TALPOIDEUM (Mole Salamander). USA: TENNESSEE: LAUDERDALE CO.: John Tully Wildlife Management Area managed by the Tennessee Wildlife Resources Agency and located

in the Golddust 7.5-minute Quad (35.65639°N, 89.800450°W, NAD 83). 17 October 2006. Daniel Stanfield of the Tennessee Wildlife Resources Agency. Austin Peay State University Museum of Zoology (APSU 18244). Verified by A. Floyd Scott. One individual found while conducting a visual-encounter survey in bottomland hardwoods near Goose Pond. Temperature at collection was 23°C. New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp.; hard copy and Internet versions, the latter of which includes links to information on Tennessee amphibians having appeared since 1996, http://www.apsu.edu/amatlas/, accessed 19 October 2006).

Voucher image collection made under the authority of the Tennessee Wildlife Resources Agency; field work supported by State Wildlife Grant (SWG) funding under the authority of the U.S. Fish and Wildlife Service.

Submitted by **CHRIS HUNTER**, Tennessee Wildlife Resources Agency, 200 Lowell Thomas Drive, Jackson, Tennessee 38301, USA; e-mail: christopher.hunter@state.tn.us.

AMBYSTOMA TIGRINUM TIGRINUM (Eastern Tiger Salamander). USA: ILLINOIS: Hamilton Co.: Hamilton County State Fish and Wildlife Area, vernal pond ca. 500 m S of the Dolan Lake spillway parking lot (38°03'05"N, 88°24'08"W). 15 April 2006. Cy L. Mott and Michael A. Steffen. Verified by Ronald A. Brandon. SIUC H-08673. Larval specimen. New county record (Phillips et al. 1999. Field Guide to Amphibians and Reptiles of Illinois. Illinois Nat. Hist. Surv. Manual 8, Champaign, Illinois. xii + 282 pp.).

Submitted by **CY L. MOTT**, Cooperative Wildlife Research Laboratory, Department of Zoology, Southern Illinois University, Carbondale, Illinois 62901, USA; e -mail: cm8755@siu.edu.

HEMIDACTYLIUM SCUTATUM (Four-toed Salamander). USA: INDIANA: Henry Co: 2.4 km S of Springport (Minton 1998. *In* M. J. Lannoo [ed.], Status and Conservation of Midwestern Amphibians. Univ. Iowa Press, Iowa City). 01 April 2006. Kelly Jones. Verified by Michael J. Lannoo. INHS voucher photo INHS 2006d. Gravid female 39 mm SVL, 54 mm TL with partly regenerated tail seen climbing out of the water onto a moss-covered log at approximately 0030 h EST. Previously thought to be extirpated from site. First sighting of this species at this site and in this county in ~30 years (James List, pers. comm.).

Submitted by **KELLY JONES**, 6207 Welham Road, Indianapolis, Indiana 46220, USA; e-mail: kellyjones78@yahoo.com.

PLETHODON GLUTINOSUS (Northern Slimy Salamander). USA: OHIO: Preble Co.: Israel Township. Hueston Woods State Park (39°34.4627'N, 83°44.6420'W). 11 June 2006. Jeffrey G. Davis. Verified by John W. Ferner. Cincinnati Museum Center (CMNH 8970). New county record (Pfingsten and Matson 2003. Ohio Salamander Atlas. Ohio Biological Survey Misc. Contribution No. 9, Columbus).

Submitted by **JEFFREY G. DAVIS,** Cincinnati Museum Center – Fredrick and Amye Geier Research and Collections Center, 1301 Western Avenue, Cincinnati, Ohio 45203-1130, USA; e-mail: anura@fuse.net.

ANURA

AMOLOPS KAULBACKI (Kaulback's Torrent Frog). INDIA: MIZORAM: Lunglei District: Small stream at Theiriat, Lunglei (22º48'–52'N, 92º48'–53'E; 1050 m elev.). Male, SVL 67.5 mm. 14 August 2003 at ca. 2030 h. Department of Zoology Museum, North Eastern Hill University Collection HT 0004. H. T. Lalremsanga, Saipari Sailo, and R. N. K. Hooroo. Verified by Saibal Sengupta. Previously reported from Northern Myanmar (Smith 1940. Rec. Indian Mus. 42:465–486; Pl. VIII). New record for India.

Submitted by **SAIPARI SAILO** (e-mail: spsailo@yahoo.co.in), **H. T. LALREMSANGA** (e-mail: htlrsa@yahoo.co.in), and **RUPA NYLLA K. HOOROO** Department of Zoology, Developmental Biology Laboratory, North Eastern Hill University, Shillong 793 022, Meghalaya, India; e-mail: rnkhnehu@hotmail.com.

BUFO BOREAS (Western Toad). USA: IDAHO: Nez Perce Co.: Gravel access road S of Route 12 near Idaho Department of Transportation gravel pit (46°27.846'N, 116°46.820'W) 253 m elev. 29 October 2006. Alex Dornburg. Verified by Kenneth V. Kardong. Photo voucher deposited in the Washington State University Conner Museum Collection (CRCM-P-29) Juvenile was found under cover object near gravel pathway adjacent to train tracks. Ambient temperature at time of encounter was 12°C. First county record. This record fills a gap in distribution data, as this species has been documented in adjacent Latah, Clearwater, and Idaho counties (Nussbaum et al. 1983. Amphibians and Reptiles of the Pacific Northwest. University of Idaho Press, Moscow, Idaho, 332 pp.).

Submitted by **ROBERT E. WEAVER** (e-mail: weaverr@wsu.edu) and **ALEX DORNBURG**, School of Biological Sciences, Washington State University, Pullman, Washington 99164, USA (e-mail: dornburgalex@yahoo.com).

BUFO FOWLERI (Fowler's Toad). USA: OHIO: Miami Co.: Spring Creek Township, Statler Road (40°07'54.9"N, 84°08'20.5"W). 29 August 2004. Jeffrey G. Davis and Paul J. Krusling. Verified by John W. Ferner. Cincinnati Museum Center (CMNH 9778–9779). New county record (Davis and Menze 2000. Ohio Frog and Toad Atlas. Ohio Biological Survey Misc. Contributions No. 6, Columbus).

Submitted by **JEFFREY G. DAVIS (**e-mail: anura@fuse.net) and **PAUL J. KRUSLING**, Cincinnati Museum Center – Fredrick and Amye Geir Research and Collections Center, 1301 Western Avenue, Cincinnati, Ohio 45203-1130 USA (e-mail: pkrusling@fuse.net)**.**

BUFO MELANOSTICTUS (Asian Toad). WEST MALAYSIA: PERAK: CAMERON HIGHLANDS: Robinsons Falls Trail (04°28.318'N, 101°22.634'E) (La Sierra University Herpetological Collection 6596). 16 August 2004. Male; SVL 82 mm. Collected at night on a cement trail. Timothy M. Youmans, Perry L. Wood Jr. Verified by L. Lee Grismer. Known from Sri Lanka, Burma, Thailand, China, West Malaysia, Bali, Borneo, India (Manthey and Grossmann 1997. Amphibien und Reptilien Südostasiens. Natur und Tier-Verlag, Münster. 512 pp.). This specimen is a new record for Cameron highlands (Lim et al. 2002. J.

Wildl. Parks, Kuala Lumpur 20:49–57).

Submitted by **TIMOTHY M. YOUMANS** (e-mail: timoyoum@lasierra.edu) and **PERRY L. WOOD, JR.** (e-mail: perrwood@lasierra.edu), Department of Biology, La Sierra University, Riverside, California 92515-8247, USA.

BUFO WOODHOUSII (Woodhouse's Toad). USA: NEW MEXICO: LEA CO.: NM Hwy 508; 19.66 mi N, 10.62 mi E Tatum (jct. US Hwy 380 and NM Hwy 206); T9S, R37E, boundary of S11 (SW 1/4) and S14 (NW 1/4); 13S, 3712898N, 0673517E (WGS 84). MSB 72602. 09 July 2006 by Michael T. Hill, Taylor B. Cotten, and Clayton D. Crowder. Verified by Charles W. Painter. New county record (Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. University of New Mexico Press, Albuquerque. 431 pp.).

Submitted by **MICHAEL T. HILL, TAYLOR B. COTTEN**, Department of Wildlife and Fisheries Sciences, Texas A&M University, 2258 TAMU, College Station, Texas 77843, USA; and **CLAYTON D. CROWDER**, 14 Mountain Laurel, Los Lunas, New Mexico 87031, USA.

CHAUNUS PYGMAEUS. BRAZIL: ESPÍRITO SANTO: MIMOSO DO SUL MUNICIPALITY: 21°03'48"S, 41°23'23"W, 279 m elev. 01–05 November 2001. G. Ramos da Silva. Herpetological Collection, Departamento de Zoologia, Universidade Federal do Rio de Janeiro, Rio de Janeiro (ZUFRJ 8987–8989, males, calling in a temporary muddy pond). Verified by E. Izecksohn. Previously known only from Rio de Janeiro State, in coastal Brazil, where it occurs at very low elevations, from sea level up to only 50 m, in restingas (Carvalho-e-Silva et al. 2000. *In* F. A. Esteves and L. D. Lacerda [eds.], Ecologia de Restingas e Lagoas Costeiras, pp. 89–97. Nupem/Universidade Federal do Rio de Janeiro, Macaé, Rio de Janeiro). First state record and the first outside of restingas, where it was thought to be endemic. Extends range ca. 90 km NW from São Joao da Barra (Myers and Carvalho 1952. Zoologica 37:1–3.).

Submitted by **GUILHERME RAMOS DA SILVA** (e-mail: grscinax@gmail.com), **SERGIO POTSCH DE CARVALHO-E-SILVA** (e-mail: sergio@biologia.ufrj.br), and **ANA MARIA PAULINO TELLES DE CARVALHO-E-SILVA,** Departamento de Zoologia, Universidade Federal do Rio de Janeiro, caixa postal 68.044, CEP 21944-970, Cidade Universitária, Rio de Janeiro, Brazil (e-mail: atelles@unirio.br).

HYLA CINEREA (Green Treefrog). USA: TENNESSEE: HAMILTON CO.: 1278 Enclave Road, Chattanooga (35°05'39.7"N, 085°16'32.3"W). 24 September 2006. Ashley Miller and Thomas Wilson. Verified by John Jensen, Georgia DNR. The University of Tennessee at Chattanooga Natural History Museum (UTCA 187–188). Two deceased adult individuals collected from residential driveway. Fourteen individuals counted the previous day following heavy rain. Species previously reported from adjacent Marion County (Davenport et al. 2005. Herpetol. Rev. 36: 209–210). Represents first verified record for Hamilton County (Conant and Collins 1998. Reptiles and Amphibians: Eastern/ Central North America 3rd ed., expanded. Houghton Mifflin Co., Boston, Massachusetts, 616 pp.; Redmond and Scott 1996. Atlas of Amphibians in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. http//www.apsu.edu/amatlas/). Collection made under Tennessee Wildlife Resources Agency Permit 1534.

Submitted by **ASHLEY MILLER**, **THOMAS P. WILSON**, **MATTHEW B. SMITH**, **ROBERT MINTON**, and **CHRIS MANIS**, Department of Biological and Environmental Sciences, The University of Tennessee at Chattanooga, 615 McCallie Avenue, Chattanooga, Tennessee 37403, USA.

HYLA CINEREA (Green Treefrog) USA: TEXAS: BREWSTER CO.: Big Bend National Park: Rio Grande Village beaver pond. 29°10' 46"N, 102°57'12"W. 30 September 2006. Collected by D. J. Leavitt and T. C. Mullet. Verified by Steven G. Platt. Sul Ross State University J. F. Scudday Vertebrate Collection (SRSU 1502); one froglet found atop a submersed bunchgrass in thick vegetation. New county record and non-native (Dixon 2000. Reptiles and Amphibians of Texas. Texas A&M Univ. Press, College Station. 500 pp.) The location is near a frequently visited campground, suggesting inadvertent translocation. Dayton (2002. Amphibians and Reptiles Checklist: BBNP. BBNHA, BBNP) lists this species as hypothetical based on vocalizations heard at the Rio Grande Village beaver pond. This coupled with the age of the individual suggests an established breeding population.

Submitted by **DANIEL J. LEAVITT**, **TIMOTHY C. MULLET**, and **CHRISTOPHER M. RITZI**, Biology Department, Sul Ross State University, Alpine, Texas 79832, USA; and **J. RAYMOND SKILES**, National Park Service, Big Bend National Park, Texas 79834, USA.

HYLA VERSICOLOR (Gray Treefrog). USA: OHIO: TUSCARAWAS CO.: York Township. County Road 21 (40°28'39.2"N, 81°29'17.6"W). 27 July 2005. Danielle K. Thompson. Verified by John W. Ferner. Cincinnati Museum Center (CMNH Herp Photodocumentation Collection HP 250–251). New county record (Davis and Menze 2000. Ohio Frog and Toad Atlas, Ohio Biological Survey Misc. Contrib. No. 6, Columbus).

Submitted by **DANIELLE K. THOMPSON**, Institute of Environmental Sciences, Miami University, 102 Boyd Hall, Oxford, Ohio 40056, USA (e-mail: thompsondk@muohio.edu); and **JEFFREY G. DAVIS**, Cincinnati Museum Center – Fredrick and Amye Geier Research and Collections Center, 1301 Western Avenue, Cincinnati, Ohio 45203-1130, USA (e-mail: anura@fuse.net).

KALOPHRYNUS ORANGENSIS (Orang Sticky Frog): INDIA: WEST BENGAL: JALPAIGURI DISTRICT: Mendabari Range, Chilapata Reserve Forest (26º20'N, 89º25'E). 13 October 2006. Subhadip Paul. ZSIC A.10402. Verified by Sushil Kumar Dutta. Adult male, SVL 34.6 mm found calling from a bush, 60 cm above ground adjacent to Bong Basti Forest Village within primary semi-evergreen forest. Previously known from Orang National Park, 26º32'N, 92º15'E, Darrang District, eastern Assam, India (Dutta et al. 2000. Hamadryad 25:67–74). Westward range extension by ca. 320 km, and a new record for West Bengal State.

Submitted by **SUBHADIP PAUL**, Village Birpara, District Jalpaiguri, P.O. Alipurduar 736 121, West Bengal, India; **MANINDRA CHANDRA BISWAS**, Divisional Forest Officer, Cooch Behar Forest Division, Nilkuthi, Cooch Behar 736 101, West Bengal, India; and **KAUSHIK DEUTI**, Zoological Survey

of India, Nizam Palace, Kolkata 700 020, West Bengal, India (e-mail: kaushikdeuti@rediffmail.com).

LEPTOBRACHIUM SMITHI (Smith's Litter Frog). INDIA: MIZORAM: KOLASIB DISTRICT: Kawnpui (22º58'17.6"N, 92º41'34.8"E; 305 m elev.). Female, SVL 65.2 mm, found near small stream. 25 June 2006 at ca. 2000 h. Department of Zoology Museum, North Eastern Hill University Collection MZ 0100. Saipari Sailo, H. T. Lalremsanga, and R. N. K. Hooroo. Verified by Saibal Sengupta. Known from Assam State in northeast India, Myanmar, Thailand, and northern Malay Peninsula (Matsui et al. 1999. Japan. J. Herpetol. 18[1]:19–29; Sengupta et al. 2001. J. Bombay Nat. Hist. Soc. 98[2]:289–291; Das and Chanda 2004. Asiatic Herpetol. Res. 10:245–246). New state record for Mizoram State.

Submitted by **H. T. LALREMSANGA** (e-mail: htlrsa@yahoo.co.in), **SAIPARI SAILO** (e-mail: spsailo@yahoo.co.in), and **RUPA NYLLA K. HOOROO,** Department of Zoology, Developmental Biology Laboratory, North Eastern Hill University, Shillong 793 022, Meghalaya, India (e-mail: rnkhnehu@hotmail.com).

PHYLLOMEDUSA ROHDEI (Rohde's Leaf Frog). BRAZIL: BAHIA: Uruçuca (14º35'12"S; 39º17'23"W; ca. 100 m elev.). 16 August 2004. O. G. S. Araújo, L. F. Toledo, D. Loebmann, and J. Zina. Verified by C. F. B. Haddad. Coleção de anuros Célio F. B. Haddad, Departamento de Zoologia, Instituto de Biociências, Universidade Estadual Paulista, Rio Claro, São Paulo, Brazil (CFBH 13189–93). Previously known from the states of Rio de Janeiro (Rio de Janeiro, Teresópolis, and Saquarema Municipalities), São Paulo; Minas Gerais and Espírito Santo, Brazil (Frost 2006. Amphibian Species of the World: an Online Reference. Version 4. http://research.amnh.org/herpetology/amphibia/index.php; Wogel et al. 2005. J. Nat. Hist. 39:2035–2045; Sazima 1974. J. Herpetol. 8:376–377; Feio et al. 1998. Anfíbios do Parque Estadual do Rio Doce [Minas Gerais]. Universidade Federal de Viçosa, Viçosa, Brazil, 32 pp.; Vrcibradic et al. 2006. Herpetol. Rev. 37:101). First state record, extends the species distribution ca. 470 km N from the municipality of Nova Venécia, state of Espírito Santo (Vrcibradic et al., *op. cit.*) and ca. 780 km N from the municipality of Viçosa, state of Minas Gerais (Feio et al., *op. cit.*).

Submitted by **OLÍVIA GABRIELA DOS SANTOS ARAÚJO**, **DANIEL LOEBMANN**, **JULIANA ZINA**, and **LUÍS FELIPE TOLEDO**, Departamento de Zoologia, Instituto de Biociências, Universidade Estadual Paulista, Caixa Postal 199, CEP 13506-970, Rio Claro, São Paulo, Brazil (e-mail: oliviaaraujo@gmail.com).

PIPA ARRABALI **(**Arrabal's Surinam Toad**)**. BRAZIL: RONDÔNIA: PIMENTA BUENO MUNICIPALITY, Parque Municipal de Pimenta Bueno (11º40'21"S, 61º11'35"W). 20 February 2006. B. L. Sousa. Herpetological collection of Universidade Federal do Acre – UFAC, Campus Floresta, Cruzeiro do Sul, Acre (UFACF 079). Verified by R. A. Machado. Species was previously known from Guyana, Surinam, eastern Venezuela, and northern Brazil in the Amazonas and Pará states (Trueb and Cannatella 1986. Herpetologica 42[4]:412–449; Zimmerman and Rodrigues 1990. *In* Gentry [ed.], Four Neotropical Rainforests, pp. 426–454; Barrio-Amorós 1999 "1998." Acta Biol. Venezuel. 18:59). First state record, extends the range of this species 710 km SW from the Serra do Cachimbo, Novo Progresso municipality, Cristalino River, Pará State (Garda et al. 2006. S. Amer. J. Herpetol. 1[1]:20–24).

Submitted by **BRUNO LOPES DE SOUSA**, Faculdade de Ciências Biomédicas de Cacoal – FACIMED, Av. Cuiabá 3033, Jardim Clodoaldo, CEP: 78.976-005 Cacoal, RO, Brazil (e-mail: brunosousa_biologo@hotmail.com); and **PAULO SÉRGIO BERNARDE**, Centro de Ciências Biológicas e da Natureza, Campus Floresta, Universidade Federal do Acre – UFAC, CEP: 69980-000 Cruzeiro do Sul, AC, Brazil (e-mail: paulobernarde@uol.com.br).

PSEUDACRIS BRACHYPHONA (Mountain Chorus Frog). USA: GEORGIA: WALKER CO.: Roadside pool along Georgia Hwy 157, 7.2 km N of jct. with Moon Lake Road, on top of Lookout Mountain. 4 March 2004. John B. Jensen and Carlos D. Camp. GMNH 49903–04. Verified by Elizabeth McGhee. First county record and first Georgia record within the Cumberland Plateau physiographic province. Extends range ca. 45 km E of nearest record (Jackson Co., Alabama; Mount 1975. Reptiles and Amphibians of Alabama. Auburn University Agricultural Experiment Station, Auburn, Alabama). Many males were issuing breeding calls during daylight hours.

Submitted by **JOHN B. JENSEN**, Georgia Department of Natural Resources, Nongame-Endangered Wildlife Program, 116 Rum Creek Drive, Forsyth, Georgia 31029, USA (e-mail: john_jensen@dnr.state.ga.us.); and **CARLOS D. CAMP**, Department of Biology, Piedmont College, P.O. Box 10, Demorest, Georgia 30535, USA.

PSEUDACRIS CRUCIFER (Spring Peeper). USA: ILLINOIS: GALLATIN CO.: Shawnee National Forest, vernal pond ca. 1 km from Pounds Hollow Rd. on York Lane Rd. (37°36'14"N, 88°15'46"W). 04 March 2006. Cy L. Mott, Michael A. Steffen, John M. Uzzardo, and Brian K. Willey. Verified by Ronald A. Brandon. Color photo voucher. SIUC H-08676. New county record (Phillips et al. 1999. Field Guide to Amphibians and Reptiles of Illinois. Illinois Nat. Hist. Surv. Manual 8, Champaign, Illinois. xii + 282 pp.).

Submitted by **CY L. MOTT**, Cooperative Wildlife Research Laboratory, Department of Zoology, Southern Illinois University, Carbondale, Illinois 62901, USA; e - mail: cm8755@siu.edu.

PSEUDACRIS C. CRUCIFER (Northern Spring Peeper). USA: OHIO: MIAMI CO.: Newton Township. Brukner Nature Center (40° 00'53.9"N, 84°19'18.56"W). 13 April 2002. Jeffrey G. Davis and Paul J. Krusling. Verified by John W. Ferner. CMNH 9141–9142. New county record (Davis and Menze 2000. Ohio Frog and Toad Atlas, Ohio Biological Survey Misc. Contribution No. 6. Columbus).

Submitted by **JEFFREY G. DAVIS (**e-mail: anura@fuse.net**)** and **PAUL J. KRUSLING**, Cincinnati Museum Center – Fredrick and Amye Geier Research and Collections Center, 1301 Western Avenue, Cincinnati, Ohio 45203-1130, USA (e-mail: pkrusling@fuse.net).

PSEUDACRIS PACIFICA (Pacific Treefrog). USA: IDAHO: NEZ PERCE CO.: 30 m S of Route 12 near train tracks along the Clearwater River (46°28.234'N , 116°46.481'W) 258 m elev. 27 October 2006. Chad D. Brock. Verified by Kenneth V. Kardong. Photo voucher deposited in the Washington State University Conner Museum Collection (CRCM-P-28). Two adults were found sharing a cover object. Ambient temperature at time of collection was 16°C. First county record. Field guides depict the range of this species as continuous throughout most of northern and western Idaho (Jones et al. 2005. Amphibians of the Pacific Northwest. Seattle Audobon Society, Seattle, Washington), however, its presence in north-central Idaho is poorly documented. This record fills a distributional gap, as localities for this species have been reported for adjacent Latah and Idaho counties (Nussbaum et al. 1983. Amphibians and Reptiles of the Pacific Northwest. University of Idaho Press, Moscow, Idaho).

Submitted by **ALEX DORNBURG** (e-mail: dornburgalex@yahoo.com), **CHAD D. BROCK** (e-mail: cdbrock@wsu.edu), and **ROBERT E. WEAVER,** School of Biological Sciences, Washington State University, Pullman, Washington 99164, USA (e-mail: weaverr@wsu.edu).

PTERORANA KHARE (Winged Frog). INDIA: MEGHALAYA: EAST KHASI HILLS DISTRICT: vicinity of Lawsohtun (25°35'N, 91°55'E; 1588 m elev.). Two males collected; one from under boulder in stream. 24 August 2006 at ca. 1500 h. SVL 53.81 mm. Another from the same stream at 2300 h on 9 September 2006; SVL 41.1 mm. Department of Zoology Museum, North Eastern Hill University Collection DK 010–011. Duwaki Rangad, Ronald K. Lyngdoh Tron, and Rupa Nylla K. Hooroo. Verified by Indraneil Das. Previously reported from Nagaland (Kiyasetuo and Khare 1986. Asian J. Exp. Sci. 1:12–17), and from Aizawl District (Dey and Ramanujam 2003. Hamadryad 27:255–256). New record for Meghalaya State.

Submitted by **DUWAKI RANGAD** (e-mail: duwaki@yahoo.com), **RONALD K. LYNGDOH TRON**, and **RUPA NYLLA K. HOOROO** (e-mail: rnkh@hotmail.com), Department of Zoology, Developmental Biology Laboratory, North Eastern Hill University, Shillong 793022, Meghalaya, India.

SCAPHIOPUS COUCHI (Couch's Spadefoot). USA: NEW MEXICO: GUADALUPE CO.: Santa Rosa Lake (T10S R4E NW1/4 Sec 30) (1 male, 1 female). 30 May 1980. J. A. White and K. M. White. Museum of Southwestern Biology (MSB 37619). Guadalupe Co: 4.5 rd miles S of Santa Rosa Lake (T9N R22E, NE 1/4 Sec 36) (1 female). 31 May 2003. Bruce L. Christman and Michelle R. Cummer. MSB 72246. Verified by J. Tomasz Giermakowski. MSB 37619, first county record, and MSB 72246, second county record indicating continued persistence 23 years later (Degenhardt et al. 1996, Amphibians and Reptiles of New Mexico. Univ. of New Mexico Press, Albuquerque. xii + 431 pp.).

Submitted by **BRUCE L. CHRISTMAN** and **MICHELLE R. CUMMER,** 736 Cardenas SE, Albuquerque, New Mexico 87108, USA.

SCINAX GRANULATUS. ARGENTINA: BUENOS AIRES: PARTIDO DE GENERAL MADARIAGA: (37º01'09"S, 57º06'57"W). 20 September 2005. R. Cajade and D. A. Barrasso. Verified by J. Williams. Herpetological collection Museo de La Plata, Buenos Aires, Argentina (MLP.A. 4922–24). Species previously known from southern Brazil, southeastern Paraguay, northeastern Argentina, and Uruguay (Cei 1980. Monitore Zoologico Italiano N.S. 2:1–609; Aquino et al. [eds.] 1996. O.R.: 331– 400; Kwet 2001. Salamandra 37:211–238). Previously, the southernmost locality supported by voucher specimens was Pereyra Iraola, Partido de La Plata, Buenos Aires province, Argentina (Gallardo 1961. Com. Mus. Arg. Cien. Nat. "Bernardino Rivadavia" III [5]:145–158). Gallardo (*op. cit.*) mentioned two specimens from Sierra de la Ventana, located 450 km WSW from General Madariaga, but this record is not supported by voucher specimens. Therefore, the present account establishes a new southern vouchered record for *Scinax granulatus* and extends the range of the species ca. 250 km S from La Plata.

Submitted by **BARRASSO DIEGO A.** and **RODRIGO CAJADE**, Centro de Investigaciones del Medio Ambiente, Departamento de Química, Facultad de Ciencias Exactas, UNLP, 47 y 115 (CP 1900), La Plata, Bs. As., Argentina.

TESTUDINES

CHELYDRA SERPENTINA (Common Snapping Turtle). USA: ILLINOIS: FRANKLIN CO.: Snapping turtle was live caught from an ephemeral pool located on Wayne Fitzgerrell State Park just east of Fitzgerrell Park Road. GPS coordinates are as follows: N 0331325 and W 4219341, zone 16 using NAD27 CONUS map datum in UTM's. 08 March 2006, 2339 h. James T. Lamer and Chad R. Dolan, Illinois Natural History Survey. INHS 2006.59 Verified by Chris Phillips, Illinois Natural History Survey. Specimen is a photographic record and first county record. Photograph is located at the Illinois Natural History Survey in Champaign/Urbana, Illinois (Phillips 1999. Field Guide to Amphibians and Reptiles of Illinois). Turtle was kicked up while wading in pool and then hand caught during steady rainfall with an air temperature of 18.3°C. The following measurements were recorded: carapace length = 324 mm, carapace width = 287 mm, carapace height = 123 mm, plastron length = 222 mm, and mass = 9000 g.

Submitted by **JAMES T. LAMER, CHAD R. DOLAN,** and **JOHN K. TUCKER,** Illinois Natural History Survey, 8450 Montclair Ave, Brighton, Illinois 62012, USA.

CHRYSEMYS PICTA DORSALIS (Southern Painted Turtle). USA: ARKANSAS: MONROE CO.: On US Hwy 49, 0.5 mi N of Hwy 79; 34°42.364'N, 91°08.916'W (WGS 84): 22 Apr. 2005. Josh Engelbert and Melissa Patrick. Verified by Stanley E. Trauth. Voucher specimen in Arkansas State University Museum of Zoology (ASUMZ 29270). New county record (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. Univ. of Arkansas Press, Fayetteville, 421 pp.).

Submitted by **JOSH ENGELBERT** and **MELISSA PATRICK**, Department of Biological Sciences, Arkansas State University, P.O. Box 599, State University, Arkansas 72467-0599, USA (e-mail: josh.engelbert@smail.astate.edu).

EMYDOIDEA BLANDINGII (Blanding's Turtle). USA: WISCONSIN: OZAUKEE CO.: Mud Lake, Cedarburg Bog State Natural Area (43°22'39"N, 88°01'24"W, NAD27). 2–4 June 2006. Joshua

M. Kapfer and Timothy Muehlfeld. Verified by Christopher A. Phillips. INHS 2007a. New county record, fills gap where species occupies all neighboring counties (Casper 1996. Geographic Distributions of the Amphibians and Reptiles of Wisconsin. Milwaukee Public Museum, 87 pp.) and confirms several prior observational reports.

Submitted by **GARY S. CASPER**, University of Wisconsin-Milwaukee Field Station, 3095 Blue Goose Road, Saukville, Wisconsin 53080, USA; **JOSHUA M. KAPFER**, Department of Biological Sciences, University of Wisconsin-Milwaukee, Milwaukee, Wisconsin 53211, USA; and **TIMOTHY MUEHLFELD,** 123 North 87th Street, Wauwatosa, Wisconsin 53226, USA.

GRAPTEMYS PSEUDOGEOGRAPHICA KOHNII (Mississippi Map Turtle). USA: TEXAS: SMITH CO.: Texas Parks and Wildlife Department's Old Sabine Bottom Wildlife Management Area. Approximately 12.8 km N of Lindale, Texas on County Rd. 4106. UTM (NAD 83) 15S, 0281466 N, 3609440 W, 175 m elev. 15 May 2005. Jessica L. Coleman. Verified by Ronald L. Gutberlet, Jr. University of Texas at Arlington – Amphibian and Reptile Diversity Research Center (UTA digital images 1005–1007). Adult male photographed basking (1125 h) in a 1.5 km section of the Sabine River with approximately nine additional *G. p. kohnii* and five other species of turtles (Emydidae). In this section of river a total of 116 individual turtles of various species were observed basking that day. New county record (Dixon 2000. Amphibian and Reptiles of Texas. 2nd ed. Univ. of Texas A&M Press, viii+421 pp.).

Submitted by **JESSICA L. COLEMAN,** University Blvd., Tyler, Texas 75799, USA; e-mail: jachooo@hotmail.com.

LACERTILIA

EMOIA ATROCOSTATA (Littoral Skink). USA: GUAM: INARAJAN MUNICIPALITY: 400 m S of Inarajan town center, Inarajan Pool public park (13.271356°N; 144.74748°E, determined in WGS84 map projection), on raised limestone under *Pemphis acidula* shrub in high-energy coastal habitat. 07 September 2006. R. N. Reed. Verified by B. Lardner. USNM 563345. First record for the island of Guam. Three additional individuals observed in same area on this date. *E. atrocostata* is known from Cocos Island, Anae Islet, and Agrigan Islet, all just off the coast of Guam, as well as on several islands in the northern Marianas, but had not previously been documented on Guam proper.

Submitted by **ROBERT N. REED** (e-mail: robert_reed@usgs.gov), **GORDON H. RODDA**, and **THOMAS J. HINKLE**, U.S. Geological Survey, Fort Collins Science Center, 2150 Centre Ave, Bldg C, Fort Collins, Colorado 80526, USA.

HEMIDACTYLUS PLATYURUS (Flat-tailed Gecko). MALAYSIA: PAHANG: CAMERON HIGHLANDS: The Cool Point Hotel in Tanah Rata (04°28.318'N, 101°22.634'E). La Sierra University Herpetological Collection 6636. 17 August 2004. Male (SVL 54 mm, TL 61.5 mm) found ca. 1.5 m above ground on cement wall. Perry L. Wood, Jr. and Timothy Youmans. Verified by L. Lee Grismer. Previously known from India, Sri Lanka, Myanmar, Thailand, Vietnam, China, Taiwan, West Malaysia, Singapore, Borneo, Sumatra, Java, Sulawesi, Lombok, Sumbawa, Flores, New Guinea, and the Philippines (Manthey and Grossmann 1997. Amphibien und Reptilien Südostasiens. Natur und Tier Verlag, Münster. 512 pp.). New record for Cameron Highlands (Lim et al. 2002. J. Wildlife & Parks 20:49–57).

Submitted by **PERRY L. WOOD** (e-mail: pwoo213@my.lasierra.edu) and **TIMOTHY YOUMANS** (e-mail: tyou101@my.lasierra.edu), Department of Biology, La Sierra University, Riverside, California 92515-8247, USA.

LACERTA BILINEATA (Western Green Lizard) and ***PODARCIS MURALIS*** (Common Wall Lizard). UNITED KINGDOM: DORSET: Bournemouth Cliffs: Portman Ravine (01°43'W, 50°43'N). *Lacerta bilineata* were probably released at Portman Ravine circa 1995, but possibly earlier. An expanding colony of *L. bilineata* has now established itself along a 1.5 km stretch of cliff and cliff-top. Animals of all age classes can be seen basking around the margins of gorse (*Ulex major*) stands and in other scrub, herbs, and dune grasses. Observation over the last three years suggest that the animals are becoming more numerous, visible, and widespread. A population of *Podarcis muralis* became established at the same location around the same time, but does not appear to have extended as widely. The origins of both introductions are unknown. Gleed-Owen (2004. Herpetol. Bull. 2004:88,3–7) described the discovery of the population in 2002 and its subsequent monitoring. *L. bilineata* have been seen up to 550 m W and 1050 m E of the 'core area' at Portman Ravine, and a single animal has been seen 3.2 km W of the core area. This latter sighting raises suspicions that releases might be occurring. There are *Podarcis muralis* populations elsewhere on the cliffs of Poole Bay, and in other parts of southern England, but this is the only known *L. bilineata* population in Britain. The absence of *Lacerta agilis* from this part of Poole Bay has raised concerns that *L. bilineata* or *P. muralis* might be competitively displacing them, but historical reprofiling of the cliffs offers an alternative explanation. *Zootoca vivipara* is extant in the area and is being monitored by CGO for a possible decline as a consequence of the introduction of two lizard species alien to the United Kingdom. In continental Europe, there are numerous anecdotal reports and speculations on a negative effect of introduced *P. muralis* on native *Z. vivipara* and *L. agilis*. Only D. Münch (2001. Dortmunder Beiträge zur Landeskunde 35:187–190) provides data. He quantifies the duration of coexistence of introduced *P. muralis* and native *Z. vivipara* as 10 years, after which the latter were no longer observed in the area investigated near the city of Dortmund, Germany.

An autotomized tail of *Podarcis muralis* and two carcasses of *Lacerta* sp. (*viridis* or *bilineata*) was brought to one of us (CGO) between 03 and 11 May, 2005. CGO found another *Podarcis* tail at the frequently dog-walked site in this period. The tail tips were preserved in ethanol as tissue samples. No voucher specimens were retained. Total genomic DNA was extracted from each of the ethanol preserved tail tips, following a standard phenol-chloroform procedure. Amplifications of *cytochrome b* PCR fragments were performed in 25 µl reaction mixtures containing PCR buffer with 1.5 mM $MgCl_2$, 0.2 mM of each dNTP, 0.4 µM of each PCR primer, 0.5 units of *Taq* polymerase (Amersham). Reaction conditions comprised an initial denaturation step of 2 min at 94°C, 35 cycles of 10 s at 95°C, 15 s at 50°C, 50 s at 72°C, and a final extension step of 7 min at 72°C.

For *P. muralis* a 1019 bp long segment was amplified (primers: "sicnt-L" 5'-TTTGGATCCCTGTTAGGCCTCTGTT-3' and "H15906" 5'-GGTTTACAAGACCAGTGCTTT-3') and direct-sequenced (primers: "sicnt-L" and "murnum" 5'-AGGCACCTCCATAGTTCACC-3'). For the Green lizards the complete *cytochrome b* sequence was amplified using the primers NThe-H (5'-GGTTTACAAGACCAGTGCTTT-3') and LGluLK (5'-AACCGCTGTTGTCTTCAACTA-3'). PCR products were cloned using the TA vector (TOPO TA Cloning Kit, Invitrogen). Sequencing was performed by MWG sequencing service (Ebersberg, Germany).

The sequences of both *P. muralis* samples were identical and deposited at GenBank (accession number DQ646343). They were compared with homologous regions of sequences from samples scattered across the most of the range of *P. muralis* and which were analyzed in the course of a thorough genetic analysis of the species (Schweiger et al., unpubl.). The sequences of the Bournemouth samples were nearly identical to samples from the eastern Po plain and Friuli regions in Italy, and southern Slovenia. *P. muralis* from that region used to be assigned to subspecies *maculiventris*. However, since the systematics of *P. muralis* is currently under revision, we refrain from assigning a subspecies name to the Bournemouth population.

The sequence of one of the *Lacerta* sp. samples proved to be incomplete, possibly due to decay of the carcass. Amplified fractions of it were similar but not identical to the complete section of 807 bp gained from the other carcass. This complete section was compared with homologous sequences of *Lacerta viridis* from Austria, *Lacerta bilineata* from the Croatian island of Cres (Mayer, unpubl.) and GenBank sequences of *L. bilineata* samples from Italy. The sequences were most similar to samples from northern Italy and the island of Cres, proving that these specimens from the Bounemouth population belong to the latter species and are consistent with an origin similar to that of the *P. muralis*. The sequence was deposited at GenBank (accession number DQ646344).

Submitted by **GUNTRAM DEICHSEL**, Friedr.-Ebert-Str. 62, Biberach an der Riss, Germany D–88400 (e-mail: guntram.deichsel@gmx.de); **CHRIS GLEED-OWEN,** The Herpetological Conservation Trust, 655a Christchurch Road, Boscombe, Bournemouth, BH1 4AP, United Kingdom (e-mail: chris.go@herpconstrust.org.uk); and **WERNER MAYER**, Natural History Museum, Molecular Systematics, Burgring 7, Vienna, Austria A–1014 (e-mail: werner.mayer@nhm-wien.ac.at).

LIOLAEMUS BURGERI. ARGENTINA: MENDOZA PROVINCE: San Rafael Department: 47 km S from El Nihuil, Ruta Provincial 180, deviation 9 km S road to Cerro Negro, Sierra del Nevado (35º20'07.6"S, 68º36'48.8"W) 18 January 2006. C. S. Abdala, R. Juarez, and C. Robles. Museo Ciencias Naturales, Salta, Argentina (MCN 2188). Verified by F. Lobo. Previously known from Paso Pehuenche and Valle Hermoso, Malargüe Department, Mendoza Province (Cei 1986. Mus. Reg. Sci. nat. Torino Monografie IV: 527 pp.; Pincheira and Nuñez 2005. Mus. Nac. His. Nat. Chile, Publ. Ocac. Nº 59:7–486). The present record extends the eastern range 135 km from Paso Pehuenche and 153 km from Valle Hermoso (Cei, *op. cit*.).

Submitted by **CRISTIAN ABDALA** (e-mail: popper@tucbbs.com.ar) and **CECILIA ROBLES,** Instituto de Herpetología, Fundación Miguel Lillo, Miguel Lillo 251, 4000 Tucumán, Argentina (e-mail: zezi74@hotmail.com).

LIOLAEMUS UMBRIFER. ARGENTINA: CATAMARCA PROVINCE: Tinogasta Department: Between Fiambalá and Cazadero Grande, 57 km NW of Fiambalá, 2800 m elev. (27º43'11.6"S, 68º08'29.52"W). 15 October 2005. C. S. Abdala, S. Quinteros, and C. Robles. Museo Ciencias Naturales, Salta, Argentina (MCN 2185–2187). Verified by S. Quinteros. Previously known from Quebrada de Randolfo, Antofagasta Department, Catamarca Province and from 2 km SE of Peña Fría, Antofagasta Department, Catamarca Province (Espinoza and Lobo 2003. Herpetologica 59:89–105). The present record extends the southwestern range 164 km from Quebrada de Randolfo and 151 km from the Peña Fría record (Espinoza and Lobo, *op. cit.*).

Submitted by **CRISTIAN ABDALA,** Instituto de Herpetología, Fundación Miguel Lillo, Miguel Lillo 251, 4000 Tucumán, Argentina (e-mail: popper@tucbbs.com.ar); and **FERNANDO LOBO**, Cátedra de Anatomía Comparada, Facultad de Ciencias Naturales, Universidad Nacional de Salta, Bolivia 5150, 4400, Salta, Argentina (e-mail: flobo@unsa.edu.ar).

OPHISAURUS VENTRALIS (Eastern Glass Lizard): USA: VIRGINIA: City of Virginia Beach: near Munden (36°34'46"N, 76°02'47"W, NAD 83), 14 May 1981. D. Jones. Verified by William M. Palmer (North Carolina State Museum of Natural History, NCSM 67451). Listed by the Virginia Department of Game and Inland Fisheries as state threatened based on its rarity in the southeastern corner of the Commonwealth. (Mitchell and Pague 1981. *In* K. Terwilliger [coord.], Virginia's Endangered Species, pp. 464–466. McDonald & Woodward Publ. Co., Blacksburg, Virginia). Previously known only from Back Bay National Wildlife Refuge and False Cape State Park on the eastern side of Back Bay (Mitchell and Pague, *op. cit.*, Mitchell 1994. The Reptiles of Virginia. Smithsonian Inst. Press, Washington, DC, 352 pp.; Mitchell and Reay 1999. Atlas of Amphibians and Reptiles in Virginia. Spec. Publ. 1, Virginia Dept. Game and Inland Fish, Richmond, Virginia, 122 pp.). The immature specimen represents the only known record west of Back Bay and is about 14 km WSW of the closest known site at False Cape Landing in False Cape State Park on the Currituck Spit. The record suggests that this state-listed species might have a broader distribution in southeastern Virginia than previously understood.

Submitted by **JOSEPH C. MITCHELL**, Department of Biology, University of Richmond, Richmond, Virginia 23173, USA; e-mail: dr.joe.mitchell@gmail.com.

PHYMATURUS VERDUGO. ARGENTINA: MENDOZA PROVINCE: Malargüe Department: Surroundings of Arroyo El Gancho, 9 km NW of Las Loicas (35°50'48.15"S, 70°00'22.04"W). 25 January 2006. C. S. Abdala, R. Juárez, and C. Robles. Museo Ciencias Naturales, Salta, Argentina (MCN 1958, 1960–61). Verified by F. Lobo. Extends the range 104 km SE from the only previously known (and type) locality: Mendoza Province, Malargüe Department, Río Grande source, Peteroa Vulcan (Cei and Videla 2003. Boll. Mus. Reg. Sci. nat. Torino 20[2]:291–314).

Submitted by **CRISTIAN ABDALA**, Instituto de Herpetología, Fundación Miguel Lillo, Miguel Lillo 251, 4000 Tucumán, Ar-

gentina (e-mail: popper@tucbbs.com.ar); and **RICARDO JUAREZ**, Departamento de Zoología, Museo de Historia Natural de San Rafael, Parque Mariano Moreno, 5600, San Rafael, Mendoza, Argentina (e-mail: ricardoj73@hotmail.com).

PTYCHOZOON KUHLI (Kuhl's Parachute Gecko). WEST MALAYSIA: JOHOR: PULAU PEMANGGIL: Kampung Buau (02°35.02'N, 104°18.925'E), 20 m elev. An embryo was collected from an egg stuck to underside of a rock, ca. 1 m above ground. First record of eggs attached to a rock. La Sierra University Herpetological Collection 8024. 21 August 2006. Hatchling, SVL 26 mm. Perry Lee Wood, Jr. Verified by L. Lee Grismer. Previously reported from Nicobar Islands, southern Thailand, West Malaysia, Singapore, Borneo, Sumatra, Pulau Enggano, Java, and questionably from Myanmar (Manthey and Grossmann 1997. Amphibien und Reptilien Südostasiens. Natur und Tier Verlag, Münster. 512 pp.). New record for Pulau Pemanggil (Grismer et al. 2006. Raffles Bull. Zool. 54[1]:173–196).

Submitted by **PERRY L. WOOD**, Department of Biology, La Sierra University, Riverside, California 92515-8247, USA; e-mail: pwoo213@my.lasierra.edu.

SCELOPORUS CYANOGENYS (Blue Spiny Lizard). USA: TEXAS: Nueces Co.: South of Bishop, ca. 20 m S of County Road 4, 1 road km E of business Highway 77 (27°34.130'N, 97°48.358'W). 08 October 2006. Collected by Randy L. Powell. Verified by Travis J. LaDuc. Texas Natural History Collections (TNHC 65743). New county record, extends range east one county (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. Texas A&M Univ. Press, College Station. 421 pp.).

Submitted by **RANDY L. POWELL,** Department of Biological and Health Sciences, MSC 158, Texas A&M University, Kingsville, Texas 78363, USA; e-mail: randy.powell@tamuk.edu.

SERPENTES

BOIGA KRAEPELINI (Kraepelin's Cat Snake): VIETNAM: LANG SON PROVINCE: Cao Loc District: Mau Son Commune: Mau Son Mountain: THE R1006, nr. 21°52.012'N, 106°57.947'E, ~400 m elev., ca. 150 km NE Vinh Phuc Province (Orlov et al. 2003. Russian J. Herpetol. 10:217–240). 15 October 2006. T. Q. Nguyen, K. V. Doan, and C. T. Ho. On tree, ca. 2 m above stream. Verified by Nikolai L. Orlov. Known from Cao Bang, Vinh Phuc, Nghe An, Ha Tinh, and Thua Thien-Hue provinces of Vietnam; and extralimitally, China (including Hainan), Taiwan, and possibly Laos (Bain et al. 2007. Herpetol. Rev. 38:107–117; Ho et al. 2005. J. Biol., Hanoi 27[4A]:95–102; Orlov and Ryabov 2002. Russian J. Herpetol. 9:33–56; Orlov et al. 2000. Russian J. Herpetol. 7:69–80; Orlov et al. 2003, *op cit.*; Tillack et al. 2004. Sauria, Berlin 26[4]:3–12; Ziegler 2002. Die Amphibien und Reptilien eines Tieflandfeuchtwald-Schutzgebietes in Vietnam. Natur und Tier-Verlag GmbH, Münster. 342 pp.). First provincial record for the species.

Submitted by **NGUYEN QUANG TRUONG, DOAN VAN KIEN, HO THU CUC,** and **NGUYEN VAN SANG**, Institute of Ecology and Biological Resources, 18 Hoang Quoc Viet, Hanoi, Vietnam (e-mail: truong@iebr.vast.ac.vn).

CALLOSELASMA RHODOSTOMA (Malayan Pit Viper). LAOS: KAMPHAENG NAKHON VIENTIANE (Vientiane Prefecture): 6 km N of Vientiane, in American housing compound. 15 June 1963. Louis G. Bush. AMNH R-90639. Verified by Bryan L. Stuart. Deuve (1970. Mem. ORSTOM. 39:239) reported this distinct species from the Xieng Khuoang (= Xiang Khoang) Plateau (Xiang Khoang Province), as well as Thakhek (= Khammouan) and Savannakhet Provinces in Laos, but without reference to specific locality or voucher information. Outside of Laos, this species is known from Thailand, the Malay Peninsula, the Greater Sunda Islands, Cambodia (Mondolkiri, Koh Khong, Kompong Som, Kampot Provinces), and the southern Vietnam provinces of Ninh Thuan, Binh Phuoc, Binh Duong, Ba Ria-Vung Tau, Tay Ninh, Dong Nai, and An Giang (Campden-Main 1969. A Field Guide to the Snakes of South Vietnam, p. 96; Smith 1943. The Fauna of British India, Ceylon and Burma, Including the Whole of the Indo–Chinese Region. Vol. III. Serpentes:498; Saint Girons 1972. Mém. Mus. Nat. Hist. Natur. n. s., A, Zool.:155; Stuart and Emmett 2006. Fieldiana: Zool., n.s., 109:23; Stuart et al. 2006. Raffles Bull. Zool. 54:152; Taylor 1965. Univ. Kansas Sci. Bull. 45:1060). Orlov et al. 2002. Faun. Abh. 23:200) also report this species from Kon Tum, Gia Lai, and Dak Lak Provinces of Vietnam, but without reference to specific locality or voucher information.

Submitted by **RAOUL H. BAIN**, Center for Biodiversity and Conservation, American Museum of Natural History, Central Park West at 79th Street, New York, New York 10024, USA; and **NGUYEN QUANG TRUONG** and **DOAN VAN KIEN**, Department of Vertebrate Zoology, Institute of Ecology and Biological Resources, 18 Hoang Quoc Viet, Hanoi, Vietnam.

CHIRONIUS BICARINATUS (Two-keeled Whipsnake). URUGUAY: Dpto. Cerro Largo: Cañada Vichadero (32º07'43"S 53º43'48"W). 22 March 2002. F. Scarabino and E. Gonzalez. Colección de Reptiles, Museo Nacional de Historia Natural y Antropología, Montevideo (MNHN 6758, adult female). The range of this species includes Brazil from Salvador (Bahia) to Pelotas (Rio Grande do Sul) and some islands on the coast; southwest of Misiones and Rio Uruguay, Chaco, Corrientes, Salta, Formosa and Entre Ríos in Argentina; in Uruguay was reported from departments on the Rio Uruguay, Artigas, Salto and Rio Negro (Peters and Orejas Miranda 1970. Bull. U.S. Natl. Mus. 297: i-viii + 1–347; Dixon et al. 1993. Revision of the Neotropical snake genus *Chironius* Fitzinger [Serpentes, Colubridae]. Museo Regionale di Scienze Naturali, Torino, Monografía 13, 279 pp.; Carreira et al. 2005. Reptiles de Uruguay. DI.R.A.C. Facultad de Ciencias, Universidad de la República, Montevideo, 639 pp.). Carreira et al. (2005) cited the presence of this species on the east of Cerro Largo, but the locality was not confirmed because no voucher was collected. This specimen is the first for the east of Uruguay, and provides evidence for the continuous distribution of this species from Argentina to Brazil. The nearest locality is Pelotas, Rio Grande do Sul (31º45'25"N, 51º20'16"W), ca. 140 km distant. First departament record, and extends known distribution in Uruguay ca. 420 km from localities in Dpto. Rio Negro.

Submitted by **SANTIAGO CARREIRA** and **IGNACIO LOMBARDO**, Museo Nacional de Historia Natural y Antropología, 25 de Mayo 582, CP 11000, Montevideo, Uruguay (e-mail: carreira@fcien.edu.uy).

DENDRELAPHIS CAUDOLINEATUS (Stripe-tailed Bronzeback). MALAYSIA: JOHOR: Kampung Buau, W coast of Pulau Pemanggil (02°34.973'N, 104°18.868'E), 10 m elev. Collected at night, ca. 1 m above ground on a small tree. La Sierra University Herpetological Collection 8031. 21 August 2006. Female, SVL 853 mm, TL 339 mm. Perry Lee Wood, Jr. Verified by L. Lee Grismer. Previously known from Indonesia (Babi, Bangka, Batu Islands, Belitung, Kalimantan, Mentawai Archipelago, Nias, Riau Archipelago, Sumatra, and questionably from Java), Brunei Darussalam, Malaysia, Myanmar, and the Philippines (including Palawan and Sulu Tandjong) (David and Vogel 1996. The Snakes of Sumatra. An Annotated Checklist and Key with Natural History Notes. Edition Chimaira, Frankfurt am Main. 260 pp.). New record for Pulau Pemanggil (Grismer et al. 2006. Raffles Bull. Zool. 54[1]:173–196).

Submitted by **PERRY L. WOOD**, Department of Biology, La Sierra University, Riverside, California 92515-8247, USA; e-mail: pwoo213@my.lasierra.edu.

DIADOPHIS PUNCTATUS EDWARDSII (Northern Ringnecked Snake). USA: OHIO: BROWN CO.: Pleasant Township. Straight Creek Road on valley wall of Straight Creek (38°49.839'N 83°50.5003'W). 13 June 2006. Jeffrey G. Davis, John W. Ferner, and Paul J. Krusling. Verified by Greg Lipps Jr. Cincinnati Museum Center (CMNH 10460). New county record (Wynn and Moody 2006. Ohio Turtle, Lizard, and Snake Atlas. Ohio Biological Survey Misc. Contribution No. 10, Columbus).

Submitted by **JEFFREY G. DAVIS (**e-mail: anura@fuse.net) and **PAUL J. KRUSLING**, Cincinnati Museum Center – Fredrick and Amye Geier Research and Collections Center, 1301 Western Ave., Cincinnati, Ohio 45203-1130, USA (e-mail pkrusling@fuse.net); and **JOHN W. FERNER**, Department of Biology, Thomas More College, Crestview Hills, Kentucky 41017 USA (e-mail: JohnFerner@Thomasmore.edu).

DIADOPHIS PUNCTATUS EDWARDSII (Northern Ringnecked Snake). USA: OHIO: CLINTON CO.: Vernon Township. Shoreline of Cowan Creek along Cowan Creek Road (39°24.008'N 83°56.591'W). 30 July 2006. Jeffrey G. Davis and Scott A. Menze. Verified by John W. Ferner. Cincinnati Museum Center (CMNH 10597). New county record (Wynn and Moody 2006. Ohio Turtle, Lizard, and Snake Atlas, Ohio Biological Survey Misc. Contribution No. 10, Columbus).

Submitted by **JEFFREY G. DAVIS**, Cincinnati Museum Center – Fredrick and Amye Geier Research and Collections Center, 1301 Western Avenue, Cincinnati, Ohio 45203-1130, USA; and **SCOTT A. MENZE**, William Henry Harrison High School, 9860 West Road, Harrison, Ohio 45030, USA (e-mail: anura@fuse.net).

DRYMOLUBER BRAZILI (Brazilian Woodland Racer). PARAGUAY: CANINDEYU DEPARTMENT: Mbaracayu Forest Natural Reserve: Horqueta mí (24°08'09.2"S, 55°19'21.3"W). 2004. S. Fernández and F. Ramírez. Museo Nacional de Historia Natural del Paraguay, Asunción, Paraguay (MNHNP 11025, female, SVL 291.5 mm, TL 120.5 mm). Verified by N. J. Scott, Jr. Previously known only from Brazil (Amaral 1977. Serpentes do Brasil. Iconografía colorida. Ed. Melhoramentos & Inst. Nac. Livro, Edit. Univ. Sao Paulo, 248 pp.; Nogueira 2001. Herpetol. Rev. 32:286; Argôlo 2004. Herpetol. Rev. 35:191; Lehr et al. 2004. Copeia 2004 [1]:46–52). First country record, extends range ca. 167 km S of Ponta Porã, Mato Grosso do Sul, Brazil, the southernmost locality known for the species (Lehr et al., *op. cit.*).

Submitted by **PIER CACCIALI**, Museo Nacional de Historia Natural, Sucursal 1, Ciudad Universitaria, San Lorenzo, Paraguay (e-mail: pier_cacciali@yahoo.com); **SIXTO FERNÁNDEZ** and **FREDDY RAMÍREZ**, Fundación Moisés Bertoni, Prócer Carlos Argüello 208, CC 714, Asunción, Paraguay (e-mail: mbertoni@mbertoni.org.py).

DRYOCALAMUS DAVISONII (Bridled Snake): VIETNAM: KIEN GIANG PROVINCE: PHU QUOC ISLAND: Bai Thom Commune: Bai Dai: IEBR 3128, nr. 10°21.787'N, 104°04.863'E, ca. 30 m elev., ca. 300 km SW Dong Nai Province (Nguyen an Ho 2002. J. Biol. 24[2A]:2–10). 30 October 2006. K. V. Nguyen. Verified by Nikolai L. Orlov. Previously known from Quang Binh, Quang Tri, Khanh Hoa, Binh Thuan, Dong Nai, Tay Ninh Provinces, and Ho Chi Minh City, and extralimitally, Myanmar, Laos, Thailand, and Cambodia (Campden-Main 1970. A Field Guide to the Snakes of South Vietnam. Smithsonian Institution, Washington, D.C. 114 pp.; Chan-ard et al. 1999. Amphibians and Reptiles of Peninsular Malaysia and Thailand, an Illustrated Checklist. Bushmaster Publications, Würselen. 240 pp.; Cox et al. 1998. A Photographic Guide to Snakes and other Reptiles of Thailand and Southeast Asia. New Holland Publishers [UK] Ltd., London. 144 pp.; Ngo 1998. J. Biol., Hanoi 20[4]:12–19; Nguyen and Ho 2002. J. Biol. 24[2A]:2–10; Pham et al. 2000. J. Biol., Hanoi 22[1B]:24–29; Smith 1943. Fauna of British India. Vol. 3- Serpentes. Taylor & Francis, London. 525 pp.; Ziegler et al. 2006. *In* Vences et al. [eds.], Herpetologia Bonnensis II. Proc. 13th Congress Soc. Europ. Herpetol., pp. 247–262). First provincial record.

Submitted by **NGUYEN QUANG TRUONG**, Institute of Ecology and Biological Resources, 18 Hoang Quoc Viet, Hanoi, Vietnam; e-mail: truong@iebr.vast.ac.vn.

GEOPHIS DUGESII AQUILONARIS (Chihuahuan Earth Snake). MÉXICO: SONORA: MUNICIPIO DE YÉCORA, E slope of Sierra El Chuchupate, 10.7 km S of Mex Hwy 16 (28°18.272'N, 108°47.389'W), 1400 m elev. 09 July 2005. E. Enderson and R. Bezy. Verified by George Bradley. Photographic voucher, UAZ 56421-PSV. First state record, extending the range ca. 153 km (airline) NE of Creel, Chihuahua (Downs 1967. Misc. Publ. Mus. Zool. Univ. Michigan 131:1–193).

Submitted by **ERIK F. ENDERSON**, Drylands Institute, PMB 405, 2509 North Campbell Avenue, Tucson, Arizona 85719, USA (e-mail: eenderson@cox.net); and **ROBERT L. BEZY**, Herpetology, Natural History Museum of Los Angeles County, Los Angeles, California 90007, USA.

GEOPHIS DUGESII AQUILONARIS (Chihuahuan Earth Snake). MÉXICO: SONORA: 48.3 km E km marker 280 on Hwy 16 at eastern edge of Yécora (ca. 28°04'N, 108°31'W), 1450 m elev. 20 August 2005. Ian M. Recchio and Christopher M. Rodriguez. Verified by Jonathan A. Campbell. Photographic collection, Laboratorio de Herpetología, Universidad Autónoma de Nuevo León (UANL 6798). Second record for Sonora (see Enderson and Bezy 2007. Herpetol. Rev. 38:103), otherwise ex-

tending range ca. 60 km west from the closest known locality in the Sierra Tarahumari at Yoquivo, Chihuahua (BM 1911.12.12.30–31). The snake was found active on ground surface during a light, early evening rainstorm in pine-oak forest on the Sierra Madre Occidental.

Submitted by **IAN M. RECCHIO**, Los Angeles Zoo, 5333 Zoo Drive, Los Angeles, California 90027, USA (e-mail: irecchio@zoo.lacity.org); **CHRISTOPHER M. RODRIGUEZ**, Department of Biology, California State University, Northridge, Northridge, California 91330-8303, USA and Los Angeles Zoo, 5333 Zoo Drive, Los Angeles, California 90027, USA (e-mail: christopher.rodriguez.68@csun.edu); and **DAVID LAZCANO,** Universidad Autonoma de Nuevo Leon, Facultad de Ciencias Biológicas, Laboratorio de Herpetologia, Apartado Postal-513, San Nicolas de los Garza, Nuevo Leon, C.P.66450, México (e-mail: dvlazcano@hotmail.com).

GONIONOTOPHIS BRUSSAUXI (Mocquard's Lesser File Snake). CENTRAL AFRICAN REPUBLIC, Ngotto Forest, Baturi River area (03°54'N, 17°2'E; 445 m elev.), right bank of the Lobaye River. Within a mixed-species semi-deciduous primary rainforest at northern limit of the Guineo-Congolese rainforest. Between 25 November 1998 and 6 December 1999. P. Barrière. MNHN 2003.2959. Verified by Laurent Chirio. Subadult, SVL 222 mm, tail L 73 mm, found dead in a pitfall trap. First country record. Previously known from the forested areas of Cameroon, Equatorial Guinea, Gaboon, Republic of Congo, Democratic Republic of Congo, south through Angola, and east through Uganda. The unique Uganda specimen belongs to the eastern subspecies, *G. b. prigoginei* with higher ventral and subcaudal counts. Central African Republic reptiles have been subject of a recent publication (Chirio and Ineich 2006. Afr. J. Herpetol. 55[1]:23–59) dealing with a collection comprising about 5000 specimens deposited in MNHN; this species is unlisted in that collection.

Submitted by **IVAN INEICH**, Muséum national d'Histoire naturelle, Département de Systématique et Evolution, USM 602 Taxinomie et collections (Reptiles), 25 rue Cuvier, F–75005 Paris, France (e-mail: ineich@mnhn.fr); **THIERRY FRETEY**, Association Racine, 2 rue de la Cité, F–35360 Médréac, France (e-mail: fretey.thierry@wanadoo.fr); **MARC COLYN**, and **PATRICK BARRIÈRE**, Laboratoire Ecobio: Ecosystèmes, Biodiversité et Evolution, UMR 6553–CNRS, Université de Rennes 1, Station Biologique, F–35380 Paimpont, France (e-mail: Patrick.Barriere@laposte.net).

LAMPROPELTIS TRIANGULUM CELAENOPS (New Mexico Milksnake). USA: NEW MEXICO: Luna Co.: NM Hwy 27, 2.7 road miles N of Nutt (T20S, R6W, SE1/4 Sec 6), one male AOR. 07 September 2005. Bruce L. Christman, Michelle R. Cummer, and June M. Christman. Museum of Southwestern Biology (MSB 72462). Verified by J. Tomasz Giermakowski. First county record, first specimen documented from Nutt grasslands (Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. Univ. of New Mexico Press, Albuquerque. xii + 431 pp.).

Submitted by **BRUCE L. CHRISTMAN**, **MICHELLE R. CUMMER,** and **JUNE M. CHRISTMAN,** 736 Cardenas SE, Albuquerque, New Mexico 87108, USA.

LAMPROPELTIS T. TRIANGULUM (Eastern Milksnake). USA: OHIO: Brown Co.: Union Township. South-facing hillside overlooking Ohio River along State Route 52 (38°45.526'N, 83°51.658'W). 13 June 2006. Paul J. Krusling, Jeffrey G. Davis, and John W. Ferner. Verified by Greg Lipps Jr. Cincinnati Museum Center (CMNH 10461). New county record (Wynn and Moody 2006. Ohio Turtle, Lizard, and Snake Atlas. Ohio Biological Survey Misc. Contribution No. 10, Columbus).

Submitted by **PAUL J. KRUSLING (**e-mail: pkrusling@fuse.net) and **JEFFREY G. DAVIS,** Cincinnati Museum Center – Fredrick and Amye Geier Research and Collections Center, 1301 Western Avenue, Cincinnati, Ohio 45203-1130, USA (e-mail: anura@fuse.net); and **JOHN W. FERNER**, Department of Biology, Thomas More College, Crestview Hills, Kentucky 41017, USA (e-mail: JohnFerner@Thomasmore.edu).

LYCODON LAOENSIS (Indo-chinese Wolf Snake). LAOS: KAMPHAENG NAKHON VIENTIANE (Vientiane Prefecture): vicinity of Vientiane. January 1963. Louis G. Bush. Verified by Bryan L. Stuart. AMNH R-94153–94154. This is a new provincial record for Laos. Dueve (1970. Mem. ORSTOM. 39:124) states that this species is also known from all of the provinces in central and southern Laos, but without localities or voucher information. This species is also known from India, the Malay Peninsula, Thailand, China (Yunnan Province), Cambodia (Kompong Som, Siem Reap Provinces), and Vietnam (Quang Nam, Lam Dong, and Dong Nai Provinces, as well as Ho Chi Minh City) (Campden-Main 1969. A Field Guide to the Snakes of South Vietnam, p. 34; Saint Girons 1972. Mém. Mus. Nat. Hist. Natur. new ser. A, Zool.:56; Smith 1943. The Fauna of British India, Ceylon and Burma, including the Whole of the Indo–Chinese Region. Vol. III. Serpentes, p. 260; Taylor 1965. Univ. Kansas Sci. Bull. 45:740–748; Zhao and Adler 1993. Herpetology of China. Society for the Study of Amphibians and Reptiles, Contributions to Herpetology, No. 10, p. 246). In Vietnam, it has also been reported from Bac Giang, Song Be (= Binh Phuoc), and Tay Ninh Provinces, but without reference to specific locality or voucher information (Nguyen et al. 2005. Checklist of Reptiles and Amphibians of Vietnam, p. 88; Pham et al. 2000. J. Biol. 22:24–29).

Submitted by **RAOUL H. BAIN**, Center for Biodiversity and Conservation, American Museum of Natural History, Central Park West at 79th Street, New York, New York 10024, USA; **NGUYEN QUANG TRUONG** and **DOAN VAN KIEN**, Department of Vertebrate Zoology, Institute of Ecology and Biological Resources, 18 Hoang Quoc Viet, Hanoi, Vietnam.

NERODIA SIPEDON (Northern Watersnake). USA: ILLINOIS: Hamilton Co.: Hamilton County State Fish and Wildlife Area (38°03'56"N, 88°23'52"W). 15 April 2006. Cy L. Mott and Michael A. Steffen. Verified by Ronald A. Brandon. Color photo voucher. SIUC R-03446. Juvenile specimen. New county record (Phillips et al. 1999. Field Guide to Amphibians and Reptiles of Illinois. Illinois Nat. Hist. Surv. Manual 8, Champaign, Illinois. xii + 282 pp.).

Submitted by **CY L. MOTT**, Cooperative Wildlife Research Laboratory, Department of Zoology, Southern Illinois University, Carbondale, Illinois 62901, USA; e-mail: cm8755@siu.edu.

OPHEODRYS AESTIVUS (Rough Greensnake). USA: ARKANSAS: VAN BUREN CO.: near Brock Creek Lake: 35.49037°N, 92.80132°W. 15 Oct. 2005. Josh Engelbert, Melissa Patrick, Ashley Patrick, and Mauricio Solis. Verified by Stanley E. Trauth. Voucher specimen in Arkansas State University Museum of Zoology (ASUMZ 29441). County record (Trauth et al., 2004. The Amphibians and Reptiles of Arkansas. Univ. of Arkansas Press, Fayetteville, 421 pp.).

Submitted by **JOSH ENGELBERT, MELISSA PATRICK,** and **MAURICIO SOLIS,** Department of Biological Sciences, Arkansas State University, P.O. Box 599, State University, Arkansas 72467-0599, USA (e-mail: josh.engelbert@smail.astate.edu).

OPHEODRYS AESTIVUS (Rough Greensnake). USA: ILLINOIS: CLAY CO.: Snake was found DOR at 1.8 km S of Effingham County line on IL Rt. 37 (38.8997°N, –88.6892°W). 16 September 2006. Specimen collected by John K. Tucker and Maelin J. Abbott, Illinois Natural History Survey. INHS 20134. Verified by Chris Phillips. Specimen is a first county record (Phillips et al. 1999. Field Guide to Amphibians and Reptiles of Illinois. Illinois Nat. Hist. Surv. Manual 8, Champaign, Illinois. xii + 282 pp.).

Submitted by **JAMES T. LAMER, JOHN K. TUCKER, CHAD R. DOLAN,** and **MAELIN J. ABBOTT**, Illinois Natural History Survey, 8450 Montclair Ave, Brighton, Illinois 62012, USA.

OXYRHOPUS MELANOGENYS (Black-headed Calico Snake). GUYANA: Mazaruni-Potaro District, Wokomung Massif (04°55'34"N, 59°55'24"W), ~1077 m elev. 05 December 2006. Collected by D. Bruce Means and Michelle Kalamandeen. Verified from photographs by William W. Lamar. Specimen preserved in 95% ethanol and deposited in Centre for the Study of Biological Diversity, University of Guyana Museum (HR-700), plus four photographs deposited in the Florida Museum of Natural History (UF-150161). Found crawling through wet leaf litter on top of a log and a few moments later, partially under a rock loosely embedded in dry overflow sediments of a rocky mountain stream. First record of species in Guyana and extends range about 640 km ESE of the closest known locality in French Guiana (Hollowell and Reynolds [eds.] 2005. Checklist of the Terrestrial Vertebrates of the Guiana Shield. Bull. Biol. Soc. Washington 13:1–109; Starace 1998. Guide des Serpents et Amphisbenes de Guyane. Ibis Rouge Editions, Guadaloupe, Guyane). The record is notable because it fills a distributional gap between French Guiana (Guyane) on the east and Venezuela on the west.

Submitted by **D. BRUCE MEANS**, Coastal Plains Institute and Land Conservancy, 1313 Milton Street, Tallahassee, Florida 32303, USA; and **MICHELLE KALAMANDEEN**, Centre for the Study of Biological Diversity, Department of Biology, University of Guyana, Turkeyen Campus, East Coast Demerara, Guyana.

PROTOBOTHROPS MUCROSQUAMATUS (Brown-spotted Pitviper). VIETNAM: LANG SON PROVINCE: CAO LOC DISTRICT: Mau Son Commune: Mau Son Mountain: IEBR 2492, nr. 21°52.012'N, 106°57.947'E, 380 m elev., ca. 200 km SE Ha Giang Province (Ziegler et al. 2006. Sauria, Berlin 28[1]:29–40). 14 October 2006. T. Q. Nguyen, K. V. Doan, and C. T. Ho. Verified by Nikolai L. Orlov. Previously recorded from Lao Cai, Ha Giang, Cao Bang, Bac Kan, Thai Nguyen, Vinh Phuc, Quang Ninh, Hai Phong, Hai Duong, Ha Tay, Ninh Binh, Nghe An, Ha Tinh, Quang Tri, Kon Tum, Gia Lai, and Thua Thien-Hue provinces; extralimitally, India, Bangladesh, China (including Hainan), Taiwan, and Myanmar (Bain et al. 2007. Herpetol. Rev. 38:107–117; Darevsky 1999. *In* H. Ota [ed.], Tropical Island Herpetofauna: Origin, Current Diversity, and Conservation, pp. 27–42, Elsevier Science B.V., Amsterdam; Gumprecht et al. 2004. Asian Pitvipers. Geitje Books, Berlin. 368 pp.; Herrmann et al. 2004. Herpetologica 60[2]:211–221; Ho et al. 2001. J. Biol., Hanoi 23[3b]:137–145; Ho et al. 2005. J. Biol., Hanoi 27[4A]:95–102; Hoang et al. 2005. J. Biol., Hanoi 27[4A]:109–116; Le 1978. Sci. Newsl. Nat. Sci. Part 1[2]:96–101; Le and Hoang 2001. J. Biol., Hanoi 23[3b]:59–65; Leviton et al. 2003. Proc. California Acad. Sci. 54[24]:407–462; Nguyen 2000. J. Biol., Hanoi 22[15]:195–201; Nguyen et al. 2005. A Checklist of Amphibians and Reptiles of Vietnam. Agricultural Publishing House, Hanoi. 180 pp.; Orlov et al. 2000. Russian J. Herpetol. 7:69–80; Smith 1943. Fauna British India. Vol. 3: Serpentes. Taylor & Francis, London. 525 pp.; Szyndlar and Nguyen 1996. The Snake 27[2]:91–98; Tran and Nguyen 1995. Poisonous Snakes of Vietnam. Science and Technology Publishing House, Hanoi. 204 pp.; Tran et al. 1981. *In* Dao et al. Science and Technology Publishing House, Hanoi, pp. 365–427; Vogel 2006. Venomous Snakes of Asia. Edition Chimaira, Frankfurt am/Main. 148 pp.; Zhao and Adler 1993. Herpetology of China. Society for the Study of Amphibians and Reptiles, Oxford, Ohio. 522 pp.; Ziegler 2002. Die Amphibien und Reptilien eines Tieflandfeuchtwald-Schutzgebietes in Vietnam. Natur und Tier-Verlag GmbH, Münster. 342 pp.; Ziegler et al. 2006. Sauria, Berlin 28[1]:29–40). First provincial record.

Submitted by **NGUYEN QUANG TRUONG**, **DOAN VAN KIEN**, **HO THU CUC**, and **NGUYEN VAN SANG**, Institute of Ecology and Biological Resources, 18 Hoang Quoc Viet, Hanoi, Vietnam (e-mail: truong@iebr.vast.ac.vn).

PSEUDOFICIMIA FRONTALIS (False Ficimia). MÉXICO: SONORA: MUNICIPIO DE YÉCORA: W slope of the Sierra Madre Occidental, 0.3 km (by Mex Hwy 16) E Tepoca (28º26.230'N, 109º15.470'W), 593 m elev. 01 September 2005. E. Enderson and R. Bezy. Verified by George Bradley. Photographic voucher, UAZ 56368-PSV. Northernmost record for the species, extending the range ca. 161 km (airline) N of Alamos, Sonora (Hardy 1972. J. Herpetol. 6:53–69; Schwalbe and Lowe 2000. *In* Robichaux and Yetman [eds.], The Tropical Deciduous Forest of Alamos, pp. 172–199. Univ. Arizona Press, Tucson). The snake was AOR at 2308 h in tropical deciduous forest.

Submitted by **ERIK F. ENDERSON**, Drylands Institute, PMB 405, 2509 North Campbell Avenue, Tucson, Arizona 85719, USA (e-mail: eenderson@cox.net); and **ROBERT L. BEZY**, Herpetology, Natural History Museum of Los Angeles County, Los Angeles, California 90007, USA.

REGINA GRAHAMII (Graham's Crayfish Snake). USA: ILLINOIS: GRUNDY CO.: found dead in a minnow trap in a shallow cattail marsh pool at Goose Lake Prairie State Natural Area (UTM: Zone 16 390697E and 4580308N; 41.3669°N, 88.3069°W, NAD 83 CONUS map datum). 27 June 2006. M. J. Dreslik and D. Ludwig.Verified by Christopher A. Phillips, INHS 20119. This is

the second specimen observed; the first was captured live on 22 June 2006, photographed and released. Over the next few weeks several more individuals were found in other marsh wetlands within the natural area. Specimen is the first county record (Phillips et al. 1999. Field Guide to Amphibians and Reptiles of Illinois. Illinois Nat. Hist. Surv. Manual 8, 300 pp.).

Submitted by **SARAH J. BAKER,** Illinois Natural History Survey, Division of Biodiversity and Ecological Entomology, 1816 South Oak Street, Champaign, Illinois 61820, USA; **DANIEL KIRK,** Illinois Department of Natural Resources, Silver Springs State Park, 13608 Fox Road, Yorkville, Illinois 60560, USA; **CARL E. SCHMIDT** and **MICHAEL J. DRESLIK**, Illinois Natural History Survey, Division of Biodiversity and Ecological Entomology, 1816 South Oak Street, Champaign, Illinois 61820, USA.

SINONATRIX AEQUIFASCIATA (Spotted Water Snake): VIETNAM: LANG SON PROVINCE: CAO LOC DISTRICT: Mau Son Commune: Mau Son Mountain: IEBR 2446, 2480, and 2494, nr. 21°52.012'N, 106°57.947'E, 380 m elev., ca. 450 km N Nghe An Province (Ziegler and Hoang 2005. Herpetol. Rev. 36:84). 13–14 October 2006. T. Q. Nguyen, K. V. Doan, and C. T. Ho. Verified by Nikolai L. Orlov. On tree above stream in secondary forest. Previously recorded from Lao Cai, Ha Giang, Cao Bang, Vinh Phuc, Bac Giang, Nghe An, and Ha Tinh provinces of Vietnam; extralimitally, China (including Hong Kong) (Bain and Nguyen 2004. Amer. Mus. Novit. 3453:1–42; Bain et al. 2007. Herpetol. Rev. 38:107–117; Ho et al. 2005. J. Biol., Hanoi 27[4A]:95–102; Karsen et al. 1998. Hong Kong Amphibians and Reptiles. Provisional Urban Council, Hong Kong. 186 pp.; Nguyen et al. 2002. J. Biol., Hanoi 24[2A]:11–14; Nguyen et al. 2005. A Checklist of Amphibians and Reptilies of Vietnam. Agricultural Publishing House, Hanoi. 180 pp; Orlov et al. 2000. Russian J. Herpetol. 7:69–80; Vogel et al. 2004. Hamadryad 29:110–114; Zhao and Adler 1993. Herpetology of China. Society for the Study of Amphibians & Reptiles, Oxford, Ohio. 522 pp; Ziegler and Hoang 2005. Herpetol. Rev. 36:84). First provincial record.

Submitted by **NGUYEN QUANG TRUONG**, **DOAN VAN KIEN, HO THU CUC**, and **NGUYEN VAN SANG**, Institute of Ecology and Biological Resources, 18 Hoang Quoc Viet, Hanoi, Vietnam (e-mail: truong@iebr.vast.ac.vn).

SISTRURUS CATENATUS TERGEMINUS (Western Massasauga). USA: OKLAHOMA: WASHINGTON CO.: 1.3 km N of East Tuxedo Blvd on Bison Rd. (N 3990): 15S 241225, 4073104 (UTM WGS84). 14 September 2004. Josh Engelbert and Melissa Patrick. Verified by Stanley E. Trauth. Voucher specimen in Arkansas State University Museum of Zoology (ASUMZ 29859). New county record (Webb 1970. Reptiles of Oklahoma. University of Oklahoma Press, Norman, 370 pp.; and Distribution of Oklahoma Amphibians and Reptiles by Recorded Sighting, http://www.biosurvey.ou.edu/dokadesc.html.

Submitted by **JOSH ENGELBERT** and **MELISSA PATRICK**, Department of Biological Sciences, Arkansas State University, P.O. Box 599, State University, Arkansas 72467-0599, USA (e-mail: josh.engelbert@smail.astate.edu).

SONORA SEMIANNULATA (Groundsnake). USA: NEVADA: PERSHING CO.: Sonoma Range, above Sonoma Creek (40°48'49.0"N, 117°42'29.8"W, 1505 m elev.) under a small rock in sagebrush habitat. 07 May 2006. Bryan Hamilton. Verified by Jack Sites (BYU 8591). Three individuals of this species were observed at this locality in 1993 but no vouchers were collected (Scott, pers. comm.). This record fills a gap in the northeastern distribution of this species with the nearest documented records 64 km E (Battle Mountain, Humboldt Co., Nevada; CAS-SUR 10032), 160 km NW (Denio, Pershing Co., Nevada; Stebbins 2003. Western Reptiles and Amphibians. 3rd ed., Houghton Mifflin Company, Boston, Massachusetts), and 60 km SW (Humboldt House, Pershing Co., Nevada; UNR 493).

Submitted by **BRYAN HAMILTON,** 100 Great Basin National Park, Baker, Nevada 89311, USA; and **PAULETTE CONRAD,** Nevada Department of Wildlife, 4747 Vegas Drive, Las Vegas, Nevada 89108, USA (e-mail: pconrad@ndow.org).

STORERIA DEKAYI (Dekay's Brownsnake). USA: ARKANSAS: LONOKE CO.: 2.2 km E. Ward (T5N, R9W, S25). 10 April 2005. Donald F. McKenzie. Verified by Stanley E. Trauth. Arkansas State University Museum of Zoology Herpetological Collection (ASUMZ 29316). New county record (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. Univ. of Arkansas Press, Fayetteville. 421 pp.).

Submitted by **MICHAEL V. PLUMMER**, Department of Biology, Box 12251, Harding University, Searcy, Arkansas 72149, USA (e-mail: plummer@harding.edu); and **DONALD F. MCKENZIE,** Wildlife Management Institute, 2396 Cocklebur Road, Ward, Arkansas 72176, USA (e-mail: wmidm@ipa.net).

STORERIA OCCIPITOMACULATA (Northern Red-bellied Snake). USA: SOUTH DAKOTA: MARSHALL CO.: BIA Hwy 15, 4.8 km S Veblin. 26 September 2005. Lars Bryan Williams. Verified by Zannita Fast Horse. Campbell Museum, Clemson University (CUSC 2323–24). Two snakes found crossing road near wetland. County record (Ballinger et al. 2000. Trans. Nebraska Acad. Sci. 26:29–46). Extends distribution ca. 46 km NW from populations in adjacent Roberts Co.

Submitted by **LARS BRYAN WILLIAMS**, Department of Math and Science, Oglala Lakota College, P.O. Box 490, Kyle, South Dakota 57752, USA; **STEVEN G. PLATT**, Department of Biology, P.O. Box C-64, Sul Ross State University, Alpine, Texas 79832, USA (e-mail: splatt@sulross.edu); **THOMAS R. RAINWATER**, The Institute of Environmental and Human Health, Department of Environmental Toxicology, P.O. Box 764, Jefferson, Texas 75657, USA; and **STANLEE M. MILLER**, Department of Biological Sciences, 132 Long Hall, Clemson University, Clemson, South Carolina 29634-1903, USA.

THAMNOPHIS PROXIMUS PROXIMUS (Orange-striped Ribbonsnake). USA: ARKANSAS: LEE CO.: Jct. of US Hwy 79 and US Hwy 78: 34.46.545N, 90.57.874W (WGS 84): 22 April 2005. Josh Engelbert and Melissa Patrick. Verified by Stanley E. Trauth. Voucher specimen in Arkansas State University Museum of Zoology (ASUMZ 29276). New county record (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. Univ. of Arkansas Press, Fayetteville, 421 pp.).

Submitted by **JOSH ENGELBERT** and **MELISSA PATRICK**, Department of Biological Sciences, Arkansas State University, P.O. Box 599, State University, Arkansas 72467-0599, USA (e-mail: josh.engelbert@smail.astate.edu).

TROPIDODRYAS STRIATICEPS (Jiboinha). BRAZIL: BAHIA. MUNICIPALITY OF PALMEIRAS: Vale do Capão, 12º31'S, 41º33'W. 14 August 2003. Collector unknown. Verified by G. Puorto. Coleção de Répteis do Museu de Zoologia da Universidade Federal da Bahia, Salvador, Bahia, Brazil (UFBA-SER 1380). Species previously known from Rio Grande do Sul to Bahia states in Brazil (Argôlo 1999. Herpetol. Rev. 30:56; Hofstadler-Deiques and Di-Bernardo 2004. Herpetol. Rev. 25:193; Lema 2002. Os Répteis do Rio Grande do Sul: atuais e fósseis – biogeografia – ofidismo. Edipucrs, Porto Alegre, 264 pp.; Thomas and Dixon 1977. The Pearce-Sellards Series 27:1–20). Northernmost locality for the species, extends range ca. 280 km N from Barra do Choça, the previously known northern locality (Argôlo 1999, *op. cit.*)

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New Herpetofaunal Records from Vietnam

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Between 1997 and 2005, increased survey effort and closer examination of natural history collections have resulted in the description of 53 new species of amphibians and 27 new species of reptiles from Indochina (Laos, Cambodia, and Vietnam). Over that same time period, range extensions into Indochina of 36 amphibian species and 33 reptile species were recorded. Despite this increase in knowledge, the diversity of the region remains imperfectly known, as new discoveries continue to be published at a rapid pace; in 2006 (up until mid-November) six species of amphibians, one species of snake, and one species of lizard were described from the region, along with 37 new country or provincial records (Bain and Stuart 2006 [2005]; Bain et al. 2006; Ohler and Delorme 2006; Orlov, Ananjeva, and Ho 2006; Orlov, Dutta et al. 2006; Orlov, Nguyen, and Nguyen 2006; Stuart 2006; Stuart and Emmett 2006; Stuart et al. 2006; Ziegler and Le 2006; Ziegler, Ohler et al. 2006; Ziegler, Thanh et al. 2006). Herein, we provide one novel country record and 60 novel provincial records for Vietnam. We feel that specific locality and voucher data is crucial to understanding patterns of diversity, so we include species that have been reported in the literature, but without reference to specific locality or voucher material. We comment on those records that have been reported on in only a general way, and we provide novel natural history information for recently described species that are very poorly known. Our taxonomy follows Frost et al. (2006), Malhotra and Thorpe (2004), Schmitz et al. (2004), and Utiger et al. (2002). Referred specimens are housed either at the Institute of Ecology and Biological Resources, Hanoi (IEBR), or the American Museum of Natural History, New York (AMNH). Specimens on long term custodial loan from IEBR to AMNH are assigned dual catalogue numbers (e.g., AMNH XXXX/IEBR YYYY).

AMPHIBIA

ORDER ANURA

FAMILY BUFONIDAE

Ingerophrynus macrotis. THUA THIEN-HUE PROVINCE, A Luoi District, Huong Nguyen Commune: IEBR 2303, 16°14.529'N, 107°27.354'E, elev. ~ 150 m, 17 August 2005, R. H. Bain, T. Q. Nguyen, and A. X. Tran. A Roang Commune: AMNH A-169338, nr. 16°04.636'N, 107°29.290'E, elev. ~ 650 m, 26 August 2005, R. H. Bain, T. Q. Nguyen, and V. S. Ho; from undergrowth on a bank, of a rocky stream in primary forest . *Ingerophrynus macrotis* is a widespread species (Myanmar, Thailand, Laos, and Cambodia), but in Vietnam voucher specimens have only been reported from Dak Lak Province (Buon Geng District [= Buon Giang Lanh]) (Bourret 1942; Inger et al. 1999; Nguyen and Hoang 2000; Ohler et al. 2002; Smith 1930; Stuart 2005b; Taylor 1962).

FAMILY MICROHYLIDAE

Microhyla marmorata. THUA THIEN-HUE PROVINCE, A Luoi District, A Roang Commune: AMNH A-169291, nr. 16°04.636'N, 107°29.290'E, elevation ~ 650 m, 29 August 2005, R. H. Bain and T. Q. Nguyen; AMNH A-169292, elevation ~ 680 m, 30 August 2005, R. H. Bain, T. Q. Nguyen, and V. S. Ho. Both specimens were collected along leaf litter around forest ponds. Dozens of males were calling in and around the pond: floating on the surface, atop herbaceous undergrowth (< 5 cm from the ground), atop fallen logs, and from the leaf litter. In life the oblique shape on the dorsum and head is green-grey, outlined with white; spots along the dorsum, legs, and flanks are black, outlined in white; white lines run along the dorsum and legs; limbs pinkish with brown bands; the remainder of the dorsum mottled yellow; venter brown, mottled with yellow on chest and belly. This species is known from Ha Tinh (Huong Son, Ky Anh- Ke Go Districts), Quang Binh (Phong Nha District), and Quang Nam (Tra My District) Provinces in Vietnam, as well as Khammouan and Bolikhamxay Provinces in Laos (Bain and Nguyen 2004a).

FAMILY MEGOPHRYIDAE

Brachytarsophrys feae. LAO CAI PROVINCE, Van Ban District, Nam Tha Commune, forest above Nam Tha River: AMNH A-168658, nr. 21°55'13" N, 104°22'15" E, elevation 950 m, 7 Sep-

tember 2004, R. H. Bain. AMNH A-168659, 168660, 21°54'56"N, 104°21' 39" E, elevation 1300–1400 m, 11–12 September 2004, R. H. Bain, T. Q. Nguyen, K. V. Doan, A. C. Lu, and V. T. Trieu. AMNH A-168658 was collected from a pitfall trap set in mixed hardwood and bamboo forest between two tributaries of the Nam Tha. AMNH A-168659, 660 were collected under leaves on the forest floor, > 20 m from a small stream. Within Vietnam, this species has been reported from Lang Son (Mao Son [= Mau Son]), and Vinh Phuc (Tam Dao N.P.) (Bourret 1942; Inger et al. 1999). Orlov et al. (2002) include 'northern Vietnam' in the distribution, Nguyen, Ho, and Nguyen (2005) note this species from Lao Cai Province, and Ho et al. (2005) note this from Cao Bang (Nguyen Binh District), but without reference to precise locality or voucher specimens. It is otherwise known from Myanmar, Thailand, and China (Yunnan Province) (Bourret 1942; Fei et al. 2005; Taylor 1962).

Leptobrachium banae. THUA THIEN-HUE PROVINCE, A Luoi District, A Roang Commune: AMNH A-169283, 16°04.877'N, 107°28.424'E, elevation ~ 850–900 m, 28 August 2005, R. H. Bain, T. Q. Nguyen, and V. S. Ho; collected from the bank of a cascading, rocky stream, a few meters from the water. IEBR 2304 nr. 16°04.636'N, 107°29.290'E, elevation ~ 650 m, 29 August 2005, R. H. Bain and T. Q. Nguyen; on the stream bank. Color in life as in holotype with the following exceptions: limb bands and flank spots orange; venter grey, spotted with white on throat and thighs, marbled with white on chest and belly. Within Vietnam, this species is only known from its type locality in Gia Lai Province (An Khe District [= K Bang]) (Lathrop et al. 1998). Nguyen, Ho, and Nguyen (2005) note this from Quang Nam Province, but without reference to voucher specimens or specific locality. This species has also been reported from Xe Kong Province, Laos (Stuart 2005b).

Leptolalax pluvialis. HA GIANG PROVINCE, Vi Xuyen District, Cao Bo Commune, Mount Tay Con Linh II: AMNH A-163833–163834, 22°46'18"N, 104°49'12"E, elevation 1710 m, 10 September 2000, C. Johnston; from a small pan trap set in the forest floor. They were erroneously reported as juveniles of *L. bourreti* (Bain and Nguyen 2004b), but subsequent analysis showed that these were adults of *L. pluvialis*. This is the first record of this species east of the Red River. It is otherwise only known from the type locality on Mt. Fan Si Pan, Lao Cai Province (Ohler et al. 2000).

Leptolalax sungi. LAO CAI PROVINCE, Van Ban District, Nam Tha Commune, tributary to Khe Pan River: AMNH A-168676–168677, 21°56'39"N, 104°24'12"E, elevation 331 m, 17 September 2004, R. H. Bain, K. V. Doan, and V. T. Trieu. AMNH A-168676 was collected on an embankment ~ 5 m from the stream's edge atop an herbaceous leaf (~ 2 m off the ground), and AMNH A- 168677 was collected on the ground of a flat, rocky stream bank, ~ 1.5 m from the edge of the water. These specimens have distinct day and night coloration. At night, the dorsum is a solid red-brown with creamy yellow tubercles towards the sacrum; flank yellow, with some black speckling; limbs banded with light brown; canthus and supratympanic fold each creamy yellow above, with thick dark brown line below; loreal red-brown, with two dark spots, upper lip with three dark spots. In the day, the color is the same except that the dorsum is creamy with irregular brown splotches; a black loreal spot extends above canthus; dorsal tubercles red-brown; finger tips white. This species is otherwise known only from the type locality of Vinh Phuc Province (Tam Dao N.P.) (Lathrop et al. 1998). This is the first record of it west of the Red River. Nguyen, Ho, and Nguyen (2005) note this species from Van Yen District, Yen Bai Province, but without reference to precise locality or voucher specimens.

Leptolalax tuberosus. THUA THIEN-HUE PROVINCE, A Luoi District, A Roang Commune: AMNH A-169283, 16°04.877'N, 107°28.424'E, elevation ~ 850–900 m, 28 August 2005, R. H. Bain, T. Q. Nguyen, and V. S. Ho. Calling from atop a shrub on a steep bank, ~ 1 m above the ground, 5 m from the edge of a cascading, rocky stream in disturbed primary forest. In life, dorsum sandy with green hatching pattern; brown spots on upper lip and posterior portion of tympanum; limbs with olive green bands; iris sandy-gold, upper one-quarter peach, with thick network of deep indigo. This species is only known from two other provinces in Vietnam, Gia Lai (An Khe District [= K Bang]) and Quang Nam (Tra My District) (Bain and Nguyen 2002a; Inger et al. 1999).

Ophryophryne gerti. THUA THIEN-HUE PROVINCE, A Luoi District, A Roang Commune, A Pat Stream, above Ho Chi Minh Highway marker kilometer 398 + 700: AMNH A-169287, nr. 16°04.636'N, 107°29.290'E, elevation ~ 680 m, 30 August 2005, R. H. Bain, T. Q. Nguyen, and V. S. Ho. This was collected sitting on a leaf atop a small shrub (< 1 m), beside a rocky-bottomed stream. QUANG NAM PROVINCE, Tra My District, Tra Don Commune: AMNH A-163668, nr. 15°11.688'N, 108°02.413'E, elevation 980 m, 17 March 1999, T. Q. Nguyen. In life, dorsum brown, butterfly markings and irregular patterns darker brown, outlined in tan; dorsal ridges, including supratympanic fold, outlined in tan; loreal, upper lip, tympanic regions, and anterior portion of upper arm dark brown, continuing as a sash on forearm; front of knee, leg bands dark brown; flank tan, with anterior grey wash; flank tubercles black below, tan above; iris orange-brown. In Vietnam, this species is otherwise only known from Gia Lai (An Khe District [= K Bang]) and Lam Dong (Cam Li, Dran) Provinces (Ohler 2003). It has also been reported from Champasak Province, Laos (Stuart 2005b).

Ophryophryne hansi. THUA THIEN-HUE PROVINCE, Huong Thuy District, Khe Dau, Duong Hoa Commune, tributary to Dau River: AMNH A-169286, nr. 16°17.995'N, 107°33.307'E, elevation ~ 109 m, 8 September 2005, R. H. Bain, T. Q. Nguyen, C. K. Dang, and T. D. Nguyen; in leaf litter, a few meters from edge of a stream. A Luoi District: Huong Nguyen Commune, Vu Vu Stream: AMNH A-169284, 16°14'30"N, 107°29'23"E, elevation ~ 100 m, 20 August 2005, R. H. Bain, T. Q. Nguyen, and M. V. An. In Vietnam, this species is also known from Quang Binh Province (Phong Nha-Ke Bang), Quang Nam Province (Tra My District) and Gia Lai Province (An Khe District [= K Bang]) (Frost et al. 2006; Ohler 2003; Ziegler, Ohler et al. 2006). The specimen reported by Frost et al. (2006), AMNH A-163669 from Quang Nam, has dorsum dark brown, with irregular light brown markings; limbs with light brown markings forming bands; dorsal tubercles either red-brown or tan; iris grey-brown. This species has also been reported from Laos (Bolikhamxay, Khammouan, and Xe Kong Provinces), and Cambodia (Stung Treng Province) (Stuart 2005b; Stuart et al. 2006).

Ophryophryne microstoma. THUA THIEN-HUE PROVINCE, A Luoi District, A Roang Commune: AMNH A-169285, nr. 16°04.636'N, 107°29.290'E, elevation ~ 680 m, 23 August 2005, R. H. Bain, T. Q. Nguyen, and V. S. Ho. LAO CAI PROVINCE, Van Ban District, Nam Tha Commune, tributary to Khe Pan River: AMNH A-168682, 21°56'39"N, 104°24'12"E, elevation 331 m, 17 September 2004, R. H. Bain, K. V. Doan, and V. T. Trieu. In Vietnam, this species is also known from a wide latitudinal range of provinces: Ha Giang (Yen Minh District), Cao Bang (Nguyen Binh), Lang Son (Mao Son [= Mau Son]), Vinh Phuc (Tam Dao N.P.), and Gia Lai (An Khe District = [K Bang]) (Bain and Nguyen 2004b; Inger et al. 1999; Ohler 2003). This species has also been reported from Thua Thien-Hue (A Luoi), Lao Cai (Van Ban), Hai Duong (Chi Linh), Thanh Hoa (Ben En), Quang Tri (Dong Tam Ve), but without reference to specific locality data or voucher information (Ho et al. 2001; Ho et al. 2005; Nguyen, Ho, and Nguyen 2005; Nguyen, Nguyen, and Ho 2005). It is otherwise known from Thailand and Yunnan Province, China (Fei et al. 2005; Ohler 2003).

Ophryophryne pachyproctus. HA TINH PROVINCE, Huong Son District, Rao An region, tributaries of Rao An River: AMNH A-161358, 18°21'53"N, 105°13'13"E, elevation 200 m, 12 May 1998, D. A. Kizirian, and T. Q. Nguyen. In Vietnam, this species has been reported from two provinces, Vinh Phuc (Tam Dao N.P.) and Nghe An (Inger et al. 1999; Ohler 2003). Nguyen, Ho, and Nguyen (2005) report this from Huong Son District and other provinces, but without reference to specific locality data or voucher information. It is otherwise known from Yunnan Province, China (Fei et al. 2005; Ohler 2003).

Family Dicroglossidae

Limnonectes hascheanus. THUA THIEN-HUE PROVINCE, A Luoi District, A Roang Commune: AMNH A-169294, nr. 16°04.285'N, 107°29.499'E, elevation ~ 680–820 m, 27 August 2005, R. H. Bain, T. Q. Nguyen, and V. S. Ho; calling from a mud burrow, about 3 m from low-flowing water. This specimen was one of several males of this species calling alongside the stream. NGHE AN PROVINCE, Con Cuong District, Chau Khe Commune, Hieng Stream: AMNH A-161224, 19°2'17"N 104°42'6"E, elevation 300 m, 29 April 1998, T. Q. Nguyen. LAM DONG PROVINCE, Da Teh District, Quoc Oai Commune: IEBR 1263, nr. 11°41.010'N, 107°32.032'E, elevation 630 m, 6 May 2003, T. Q. Nguyen. This specimen was collected from a small puddle on a logging road. In Vietnam, this species has been reported from Lao Cai (Thai Nien) and Quang Binh (Phong Nha District) Provinces (Bourret1942; Ziegler 2002; Ziegler et al. 2004). This species has also been reported from Ha Tinh (Khe Tho-Ke Do), Quang Tri (Dak Rong, Huong Hoa), and Dong Nai (Cat Tien) Provinces, as well as from 'central and northern regions of Annam mountains,' but without specific locality or voucher information (Le 2005; Nguyen and Ho 2002; Orlov et al. 2002). This is a widespread species across continental southeast Asia and the Greater Sunda islands (Smith 1930).

Limnonectes poilani. THUA THIEN-HUE PROVINCE, A Luoi District, Huong Nguyen Commune, Da Stream: AMNH A-169295, 16°15.625'N 107°26.634'E, elevation ~ 160 m, 16 August 2005, R. H. Bain, Q. T. Nguyen, and X. A. Tran; collected in the mud of a slow-moving portion of the stream surrounded by secondary forest. A Lieng Stream: AMNH A-169296, 16°14.185'N 107°27.669'E, elevation ~ 160 m, 17 August 2005, R. H. Bain, T. Q. Nguyen, and A. X. Tran. A Bong stream: AMNH A-169297, 16°14.285'N, 107°27.177'E, elevation, ~ 150 m, 19 August 2005, R. H. Bain, T. Q. Nguyen, and A. X. Tran. LAM DONG PROVINCE, Da Teh District, Quoc Oai Commune: IEBR 1261, nr. 11°41.010'N, 107°32.032'E, elevation 630 m, 5 May 2003, T. Q. Nguyen. This was described from Quang Tri Province (Dong Tam–Ve), and has been reported from Quang Nam Province (Tra My District), Quang Binh Province (Minh Hoa), and (as *L.* cf. *blythii*) Gia Lai Province (An Khe District [= K Bang]) (Bourret 1942; Frost et al. 2006; Inger et al. 1999; Ngo et al., 2006; Ziegler, Ohler et al. 2006). This species has been reported from A Luoi District, and Cat Tien N.P., Dong Nai Province (both as *L. blythii*), but without exact locality or voucher information (Ho 2002b; Nguyen and Ho 2002; Nguyen, Ho, and Nguyen 2005). This species is also known from Mondolkiri Province, Cambodia (Stuart et al. 2006).

Occidozyga martensii. THUA THIEN-HUE PROVINCE, A Luoi District, Huong Nguyen Commune: AMNH A-16928, 16°14.529'N, 107°27.354'E, elevation, ~ 150 m, 17 August 2005, R. H. Bain, T. Q. Nguyen, and A. X. Tran; floating in amplexus, in a large buffalo wallow. This species is also reported from Ha Tinh (Huong Son District), Quang Binh (Phong Nha District), Dac Lak (Yok Don), Gia Lai (An Khe District), and Ba Ria-Vung Tau (Con Dao) Provinces (Frost et al. 2006; Inger et al. 1999; Ngo et al. 2006; Smith 1920; Ziegler 2002; Ziegler et al. 2004). It has also been reported from Lao Cai (Van Ban), Son La (Sop Cop, Xuan Nha), Thanh Hoa (Ben En), Nghe An (Pu Mat, Pu Huong) Quang Nam (Phuoc Son), Thua Thien-Hue (A Luoi), Dong Nai (Cat Tien), but without reference to locality or voucher specimens (Le and Hoang 2001; Le and Nguyen 1999; Ho 2002b; Hoang et al. 2005; Nguyen 2005; Nguyen, Nguyen, and Ho 2005; Nguyen and Ho 2002; Nguyen and Hoang 2000). It is also known from Thailand, Laos (Champasak, Vientiane, Bolikhamxay, and Attapeu Provinces), China (Yunnan, Hainan, and Guangxi Provinces), and the Cardamom Mountains of Cambodia (Fei et al 2005; Ohler et al. 2002; Stuart 2005b; Taylor 1962; Teynie et al. 2004).

Family Ranidae

Amolops cremnobatus. QUANG BINH PROVINCE, Minh Hoa District, Cha Lo: AMNH A-161141, 14 April 1998, D. A. Kizirian, and T. Q. Nguyen. This species has previously been reported from neighboring Ha Tinh Province (Huong Son District) and Nghe An Province (Con Cuong District) (Bain and Nguyen 2001; Chen et al. 2005). Outside of Vietnam, this species is known from Vientiane Municipality, and Khammouan and Bolikhamxay Provinces of Laos (Inger and Kottelat 1998; Stuart 2005b).

Huia absita. THUA THIEN-HUE PROVINCE, A Luoi District, A Roang Commune, A Pat Stream, above Ho Chi Minh Highway marker kilometer 398 + 700: AMNH A-169302, 16°4'28"N, 107°29'14"E, elevation ~ 653 m, 23 August 2005, R. H. Bain, T. Q. Nguyen, V. S. Ho, and V. T. Le; alongside a stream in a patch of grass. KON TUM PROVINCE, Kon Plong District, Mang But Commune, nr. Vi Xay Village, Nuoc Re Stream: IEBR 307, 315, 316, 14°45.665'N, 108°15.245'E, elevation 1120–1200 m, 3–4 January 2001, T. Q. Nguyen. Mang Canh Commune, Nuoc Ka

Stream: IEBR 337, 14°41.950'N, 108°12.095'E, elevation 1100–1200 m, 10 January 2001, T. Q. Nguyen. The Kon Tum specimens were all collected in small streams in mixed evergreen-bamboo forest in humid weather. This species is currently only known from Quang Nam Province (Tra My District), Vietnam (Bain and Nguyen 2005), and Xe Kong and Saravane Provinces, Laos (Stuart and Chan-ard 2005). Orlov, Ananjeva, and Ho (2006) described a new species of cascade ranid, *Rana gigatympana*, from Kon Tum Province (Kon Plong District), which looks remarkably like *Huia absita*, although it exhibits a much larger tympanum (male tympanum diameter: eye diameter 1.14–1.31 for *R. gigatympana*, 0.60–0.89 for *H. absita*). The tympanum diameter of our specimens from Kon Plong (all males), however, fell well within the range of *Huia absita* (tympanum diameter: eye diameter 0.69–0.92).

Huia bacboensis. LAO CAI PROVINCE, Van Ban District, Nam Tha Commune, tributary to Khe Pan River: AMNH A-168739, 21°56'24"N, 104°24'7"E, elevation 360–400 m, 15 September 2004, R. H. Bain, K. V. Doan, and V. T. Trieu. This species is otherwise known from the following provinces: Tuyen Quang (Na Hang Nature Reserve), Bac Kan (Ba Be National Park), and Nghe An (Con Cuong) (Bain et al. 2003).

Huia banaorum. HA TINH PROVINCE, Huong Son District, Huong Son Reserve, Rao An region: AMNH A-161249–161250, 18°22'N, 105°13'E, elevation 200 m, 20 April 1998, T. Q. Nguyen. This species has otherwise only been reported from An Khe District (= K Bang), Gia Lai Province in Vietnam (Bain et al. 2003), and from Mondolkiri, Stung Treng, and Ratanakiri Provinces of eastern Cambodia (Stuart et al. 2006). Nguyen, Ho, and Nguyen (2005) report this species from Danang (Ba Na N.P.), but without reference to specific locality or voucher information.

Huia khalam. KON TUM PROVINCE, Kon Plong District, Mang But Commune: IEBR 231, 250, 251, 268–270, 286, 288, 312. 14°45.657'N, 108°15.835'E, elevation 1400–1540 m, 28 December 2000–4 January 2001, T. Q. Nguyen. This species has only been reported from Thua Thien-Hue (Bach Ma N. P.) and Da Nang (Ba Na N. P.) Provinces in Vietnam, and Xe Kong (Kaleum District) and Saravane (Samoy District) Provinces in Laos (Stuart et al. 2005).

Huia morafkai. THUE THIEN-HUE PROVINCE, A Luoi District, Huong Nguyen Commune, A Lieng Stream: AMNH A-169309, 16°14'11"N, 107°27'40" E, elevation ~ 160 m, 17 August 2005, R. H. Bain, T. Q. Nguyen, and A. X. Tran; from a branch ~ 4 m off the ground, ~ 3 m from the side of the stream. AMNH A-169311–169312: A Roang Commune, forested stream at Ho Chi Minh Highway marker kilometer 398+700, 16°4'28"N 107°29'14" E, elevation ~ 653 m, 26 August 2005, R. H. Bain, N.Q. Nguyen, and V. S. Ho; from rocky cascades. AMNH A-169313: 16°4'53"N, 107°28'25"E, elevation ~ 850–900 m, 28 August 2005, R. H. Bain, N.Q. Nguyen, and V. S. Ho; from rocky cascades. In Vietnam, this species has previously been reported from the following provinces: Ha Tinh (Huong Son District), Quang Nam (Tra My District), and Gia Lai (An Khe District [= K Bang]), (Bain et al. 2003; Bain and Stuart 2006 [2005]). It is otherwise known from Champasak and Xe Kong Provinces in Laos, and Ratanakiri and Mondolkiri Provinces of Cambodia (Bain and Stuart 2006 [2005]; Stuart et al. 2006; Teynie et al. 2004).

Huia orba. THUA THIEN-HUE PROVINCE, A Luoi District, A Roang Commune, stream at Ho Chi Minh Highway marker kilometer 398 + 700: AMNH A-169314, 16°4'28"N, 107°29'14"E, elevation ~ 653 m, 23 August 2005, R. H. Bain, T. Q. Nguyen, V. S. Ho, and T. V. Le; atop a small fern (< 1 m off the ground), ~ 3 m from the bank of a swift, rocky bottomed stream. This species is otherwise only known from Ha Tinh Province (Huong Son District) in Vietnam, and eastern portions of Khammouan and Bolikhamxay Provinces of Laos (Stuart and Bain 2005).

Sylvirana attigua. THUE THIEN-HUE PROVINCE, A Luoi District, Huong Nguyen Commune: AMNH A-169303, nr. 16°14'26"N, 107°27'11"E, elevation ~152 m, 19 August 2005, R. H. Bain, T. Q. Nguyen, and V. M. Tran; from a small branch above a small, still, streamside pool. Vu Vu Stream: AMNH A-169304, 16°14'30"N, 107°29'23"E, 20 August 2005, R. H. Bain, T. Q. Nguyen, and M. V. Tran. A Roang Commune, stream at Ho Chi Minh Highway marker kilometer 398 + 700: AMNH A-169305, nr. 16°4'28"N, 107°29'14"E, elevation ~ 653 m, 26 August 2005, R. H. Bain, T. Q. Nguyen, and V. S. Ho; on a leaf about 0.5 m above the ground, 2 m from the stream. Nam Dong District, Thuong Lo Commune, tributary to Cha May River: AMNH A-169306, 16°7'40"N, 107°44'44"E, elevation 220–270 m, 2 September 2005, R. H. Bain, T. Q. Nguyen, and V.P. Nguyen; collected atop a small stick over a tiny pool of water in the forest. This species has been reported from Quang Nam (Tra My District), and Gia Lai (An Khe District [= K Bang]) Provinces (Bain and Nguyen 2002b; Inger et al. 1999). This species has been reported from Thua Thien-Hue Province and Kon Tum Province (Ngoc Linh Mountain, and Kon Plong District), but without precise locality data or voucher specimen information (Nguyen 2002; Nguyen, Ho, and Nguyen 2005). It is otherwise known from Champasak and Xe Kong Provinces in Laos and Mondolkiri Province in Cambodia (Stuart 2005b; Stuart et al. 2006).

Sylvirana maosonensis. BAC KAN PROVINCE, Ba Be Lake National Park, ca. 1 km W on trail into forest from shoreline on west end of Lake: AMNH A-161488, 8 August 1997, D. R. Frost, and C. J. Raxworthy. In Vietnam, this species is known from the following provinces Ha Giang (Vi Xuyen District), Lang Son (Mau Son), Vinh Phuc (Tam Dao N.P.), Ha Tinh (Khe Tho- Ke Do), and Quang Binh (Minh Hoa) (Bain and Nguyen 2004b; Bourret 1942; Inger et al. 1999; Ziegler 2002; Ziegler, Ohler et al. 2006). This species has been reported from other northeastern provinces of Vietnam, but without reference to specific localities or voucher specimens (Ho et al. 2001; Ho et al. 2005; Nguyen 2005; Nguyen et al. 2000; Nguyen, Ho, and Nguyen 2005; Orlov et al. 2002). This species has also been reported from Bolikhamxay and Khammouan Provinces of Laos (Stuart 2005b).

Family Rhacophoridae

Chiromantis vittatus. THUA THIEN HUE PROVINCE, A Luoi District, Huong Nguyen Commune: A169316, 169317, 169337, 16°14'32"N, 107°27'21"E, 17 August 2005, R. H. Bain, T. Q. Nguyen, and A. X. Tran; in amplexus on a branch above a buffalo wallow. The green eggs were also collected from the foam nest. Several other pairs were in amplexus in and around the wallow. In Vietnam, this species is known from the following provinces: Quang Binh (Phong Nha District), Ha Tinh (Chin Xai), Gia Lai

(An Khe District [= K Bang]), and Ba Ria-Vung Tau (as Cap St. Jacques) (Bourret 1942; Inger et al. 1999; Ziegler 2002; Ziegler et al. 2004). It has also been reported from Lang Son (Huu Lien), Phu Tho (Thanh Son, Ha Hoa), and Dong Nai (Cat Tien), but without reference to locality or voucher information (Ho 2002a; Nguyen and Ho 2002; Nguyen et al. 2000). This species is also known from India, Myanmar, Thailand, China (Xizang, Hainan, Guangxi, Fujian, and Yunnan Provinces), Laos (Vientiane Municipality, Champasak Province), and Cambodia (Cardamom Mountains) (Chanda 2002; Fei et al. 2005; Ohler et al. 2002; Stuart 2005b; Stuart et al. 2006; Teynie et al. 2004; Taylor 1962).

Philautus banaensis. THUA THIEN-HUE PROVINCE, Huong Thuy District, Binh Thanh Commune, IEBR 2307, 16°17'58"N, 107°33'18"E, elevation 109 m, 8 September 2005, R. H. Bain, T. Q. Nguyen, C. K. Dang, and T. D. Nguyen; collected calling from atop leaves, ~ 3 m high above a stream. This species is otherwise known from Quang Nam Province (Tra My District) and the type locality in Danang Province (Ba Na) in Vietnam (Bourret 1942; Stuart, *in press*). This species has previously been reported from Thua Thien-Hue and Thanh Hoa Provinces, but without reference to a distinct locality or voucher information (Ho 2002b; Nguyen, Ho, and Nguyen 2005; Nguyen and Hoang 2000; Orlov et al. 2002).

Rhacophorus annamensis. THUA THIEN-HUE PROVINCE, A Luoi District, Huong Nguyen Commune, Khe Coi Stream: AMNH A-169325, 16°15'32"N, 107°27'15"E, elevation ~ 101 m, 18 August 2005, R. H. Bain, T. Q. Nguyen, and M. V. Tran; from the side of a deep rocky pool. Other specimens were present on small branches overtop of the pool. Huong Thuy District, Binh Thanh Commune: AMNH A-169326, 16°17'49"N, 107°32'48"E, elevation 100–200 m, 9 September 2005, R. H. Bain, T. Q. Nguyen, C. K. Dang, and T. D. Nguyen; on a streamside rock. QUANG NAM PROVINCE, Tra My District, Tra Don Commune: AMNH A-163745, 15°11'41"N, 108°2'25"E, elevation 940 m, 19 March 1999, T. Q. Nguyen; AMNH A-163746, 15°11'41"N, 108°2'32"E, elevation 970 m, 22 March 1999 T. Q. Nguyen; AMNH A-163747, 15°11'30"N, 108°2'23"E, elevation 960–990 m, 13 March 1999, T. Q. Nguyen; AMNH A-163748, 15°11'41"N, 108°2'25"E, elevation 940 m, 26 March 1999, P. R. Sweet. Within Vietnam, this species has been reported from Quang Binh Province (Minh Hoa District, Phong Nha-Ke Bang), Gia Lai Province (An Khe District [= K Bang]), and Lam Dong Province (Daban) (Bourret 1942; Frost et al. 2006; Inger et al. 1999; Ziegler, Ohler et al. 2006). Nguyen, Ho, and Nguyen (2005) report this species from Tra My District and Thua Thien-Hue Province, and Orlov et al. (2002) report this species from Ninh Thuan, Lam Dong, Dak Lak, and Kon Tum Provinces, but neither refer to exact locality or voucher information. It is also known from Mondolkiri Province of Cambodia (Stuart et al. 2006).

Rhacophorus bipunctatus. THUA THIEN-HUE PROVINCE, A Luoi District, Huong Nguyen Commune: A169333, 16°14’32"N, 107°27’21"E, 17 August 2005, R. H. Bain, T. Q. Nguyen, and A. X. Tran; from foliage overhanging a large buffalo wallow. LAO CAI PROVINCE, Van Ban District, Liem Phu Commune, Cham Vai: IEBR 1197, 21°57.445'N, 104°20.963'E, elevation 1100 m, 28 June 2002, T.Q. Nguyen and H. V. Nguyen; collected from leaves ~ 1 m over a small, rocky stream in disturbed primary forest. In Vietnam, this species has also been reported from Quang Binh (Phong Nha Khe Bang N.P.), Ha Tinh (Huong Son District), and Gia Lai (Anh Khe), Provinces (Frost et al. 2006; Inger et al. 1999; Ziegler et al. 2004). Orlov et al. (2002) state that this species ranges from Gia Lai northwards to Ha Tinh Province, but without reference to any specific localities or voucher specimens. This species has been reported from Lao Cai (Van Ban), and Dong Nai (Cat Tien) Provinces, but without any reference to specific localities or voucher information (Nguyen and Ho 2002; Nguyen, Nguyen, and Ho 2005). This wide-ranging species is also known from India, Myanmar, Thailand, Xizang Province in China, Phongsalay and Sayaboury Provinces in Laos, and the Cardamom Mountains of Cambodia (Bourret 1942; Fei et al. 2005; Ohler et al. 2002; Stuart 2005b; Taylor 1962).

Rhacophorus calcaneus. HA TINH PROVINCE, Huong Son District, Huong Son Reserve, Rao An region: AMNH A-161404, 18°22'N, 105°13'E, elevation 200 m, 21 April 1998, D. A. Kizirian, and T. Q. Nguyen. THUA THIEN-HUE PROVINCE, A Luoi District, Huong Nguyen Commune, Da Stream: AMNH A-169328, 163929, 16°15'38"N, 107°26'38"E, 16 August 2005, R. H. Bain, T. Q. Nguyen, and A. X. Tran; calling from thin branches of streamside trees, ~ 2 m off the ground. Little A Ma Stream: AMNH A-169331,16°15'17"N, 107°26'59"E, elevation ~ 90 m, 21 August 2005, R. H. Bain, T. Q. Nguyen, and M. V. Tran. Nam Dong District, Thuong Lo Commune, tributary to the Cha May River: AMNH A-169332, 16°7'40"N, 107°44'44"E, elevation ~ 220 m, 1 September 2005, R. H. Bain, T. Q. Nguyen, V. P. Nguyen, V. T. Nguyen, and V. M. Ngo; from branch of a streamside tree, ~ 3 m high. In Vietnam, this species has been reported from Gia Lai (An Khe District [= K Bang]), and Quang Nam Provinces (Tra My District), as well as the Lam Vien Plateau (Bourret 1942; Frost 2006; Inger et al. 1999). It has been reported widely from the country (including Thua Thien-Hue and Quang Nam Provinces), but without specific localities or voucher information (Nguyen 2002; Nguyen, Ho, and Nguyen 2005). It is also known from Xe Kong Province, in Laos (Stuart 2005b).

Rhacophorus exechopygus. THUA THIEN-HUE PROVINCE, A Luoi District, A Roang Commune: IEBR 2011, nr. 16°04.636'N, 107°29.290'E, elevation ~ 680 m, 23 August 2005, R. H. Bain, T. Q. Nguyen, and V. S. Ho; atop a broadleaf on a shrub, ~ 3 m off the ground, ~ 3 m from the stream up a steep embankment. This species is known only from the Vietnamese provinces of Gia Lai (An Khe District [= K Bang]) and Quang Nam (Tra My District) (Bain and Nguyen 2002c; Inger et al. 1999). Orlov et al. (2002) report this species from Kon Tum Province, but without reference to specific locality or voucher information.

Rhacophorus kio. THUA THIEN-HUE PROVINCE, A Luoi District, Huong Nguyen Commune: AMNH A-169327, 16°14'32"N, 107°27'21"E, 17 August 2005, R. H. Bain, T. Q. Nguyen, and A. X. Tran; in amplexus on a branch overhanging a large buffalo wallow. This species has recently been shown to be separate from *Rhacophorus reinwardtii*, which is currently known from the Greater Sundas and the southern portion of the Malay peninsula. In Vietnam, this species has been reported from the following provinces (as *Rh. reinwardtii*): Lao Cai, Ha Tinh (Chin Xai, Khe Tho, Ke Do), and Gia Lai (An Khe District [= K Bang]) (Inger et al. 1999; Ohler and Delorme 2006; Orlov et al. 2001; Ziegler 2002; Ziegler et al. 2004). Several other accounts across Vietnam are

listed (Cao Bang [Nguyen Binh], Hai Duong [Chi Linh], Son La [Xuan Nha], Thanh Hoa [Thach Thanh, Ben En], Thua Thien-Hue [A Luoi], Da Nang [Ba Na], and Quang Nam [Nam Giang, Tay Giang] Provinces), but without specific locality or voucher information (Ho 2002b; Ho et al. 2001; Ho et al. 2005; Ho and Orlov 2000; Le 2000; Le and Nguyen 1999; Nguyen 2000; Nguyen 2005; Nguyen and Hoang 2000). This widespread species is also known from Thailand (although not on the Malay Peninsula), China (Guangdong, Yunnan Provinces), and Laos (Bokeo, Khammouan, Phongsaly, Huaphahn, Sayabourym Provinces) (Ohler and Delorme 2006; Stuart 2005b).

Rhacophorus orlovi. NGHE AN PROVINCE, Con Cuong District, Chau Khe Commune, Ngun Stream: AMNH A-161411, 19°2'17"N, 104°42'6"E, elevation 300 m, 27 April 1998, T. Q. Nguyen and D. A. Kizirian. LAO CAI PROVINCE, Van Ban District, Nam Tha Commune, tributary to Khe Pan River: AMNH A-168770, 21°56'24"N, 104°24'7"E, elevation 360–400 m, 15 September 2004, R. H. Bain, K. V. Doan, and V. T. Trieu; from the stem of a broadleaf plant, 1.5 m above the ground, ~ 4 m from the stream. THUA THIEN-HUE PROVINCE, A Luoi District, Huong Nguyen Commune, Little A Ma Stream: IEBR 2305, 16°15'17"N, 107°26'59"E, elevation ~ 90 m, 21 August 2005, R. H. Bain, T. Q. Nguyen, and M. V. Tran. Within Vietnam, this species is known from the following provinces: Ninh Binh (Cuc Phuong N.P.), Quang Binh (Phong Nha-Khe Bang N.P.), Ha Tinh (Ky Anh-Ke Go), Gia Lai (An Khe District [= K Bang]) (Stuart 2005a; Ziegler and Köhler 2001; Ziegler et al. 2002). It is also known from Thailand and Khammouan Province, Laos (Chan-ard 2003; Stuart 2005b).

Reptilia
Suborder Sauria
Family Agamidae

Calotes emma. BAC KAN PROVINCE, Ba Be Lake National Park, cave area, ca 1.5 km E of guest house: AMNH R-147066, 22°24'1"N, 105°37'54"E, 8 August 1997, D. R. Frost, and C. J. Raxworthy. THUA THIEN-HUE PROVINCE, Huong Thuy District, Binh Thanh Commune: AMNH R-154613, stream nr. 16°17'49"N, 107°32'48"E, elevation 100–200 m, 9 September, R. H. Bain, T. Q. Nguyen, C. K. Dang, and T. D. Nguyen. This widespread species has been reported from across continental southeast Asia (e.g., Boulenger 1885; Smith 1935; Stuart et al. 2006; Taylor 1963; Ziegler 2002; Ziegler et al. 2004), however these are new provincial records within Vietnam. Nguyen, Ho, and Nguyen (2005) report this species from Bac Kan, but without reference to specific locality or voucher information.

Pseudocalotes floweri. VIETNAM, KON TUM PROVINCE, Kon Plong District, Mang Canh Commune, forest nr. Nuoc Ka Stream: IEBR 330, 14°41.950'N, 108°12.095'E, elevation 1200 m, 10 January 2001, T. Q. Nguyen; in secondary forest. The specimen is female, snout-vent length 68.2 mm; head length nearly twice its breadth; upper labials 8 left side, 10 right side; lower labials 9 left side, 8 right side; eye diameter 4.8 mm (more than twice the tympanum of 2.1 mm); snout length 9.2 mm (nearly twice the obit diameter); six scales between nasal and supraorbital; nuchal crest with 8 erect spines; length of finger III = IV; 52–56 scales round the middle of the body; tail length 151.2 mm. Body compressed; upper head scales keeled; series of enlarged scales forming a λ-shaped figure on forehead; dorsal scales feebly keeled, all pointing backwards and downwards; median ventrals small and strongly keeled; 19 scales under finger IV; blade-like outer keels under toe III, not bicarinate; tail compressed, covered with keeled scales. In life, this specimen is brown, enlarged dorsal scales bluish, spines are light brown; radiate dark brown lines around eye to supraorbital ridge; limbs yellow with dark brown irregular bands; dark brown gular spot, and 10 dark brown spots on the tail (which fade in preservative). This species is otherwise known from Chanthaburi, Thailand and the Elephant Mountains (Bockor [= Bokor]), Cambodia (Smith 1935; Taylor 1963; Hallerman and Böhme 2000). This is the first country record for Vietnam. Our specimen is shorter than those previously described (snout–vent length for type specimen 98 mm; 95 mm for referred specimen) (Boulenger 1912; Smith 1935; Taylor 1963 described specimens from Thailand without reporting their snout–vent lengths).

Pseudocalotes microlepis. BAC KAN PROVINCE, Ba Be District, Ba Be National Park, cave area, ca 1.5 km E of guest house: AMNH R-147071, 22°24'1"N, 105°37'54"E, 8 August 1997, D. R. Frost, and C. J. Raxworthy. In Vietnam this species is also known from Quang Ninh, Danang (Ba Na), and Lam Dong (Lang Bian, Camley [= Cam Ly]) Provinces (Ziegler, Thanh et al. 2006). Otherwise, it is known from Myanmar, Thailand, China (Hainan Island, Guizhou Province), and Laos (Phong Saly [= Phong Sali Province]) (Bourret 1939b; Smith 1935; Hallerman and Böhme 2000; Zhao and Adler 1993).

Family Dibamidae

Dibamus greeri. THUA THIEN-HUE PROVINCE, A Luoi District, A Roang Commune: AMNH R-154630/IEBR 2311, nr. 16°04.636'N, 107°29.290'E, elevation ~ 650 m, 26 August, 2005, R. H. Bain, T. Q. Nguyen, and V. S. Ho; under a streamside rotting log. This specimen conforms precisely with the description of the holotype, including the diagnositic characters: incomplete medial-rostral nasal suture; one postocular; two supra labials; very large frontal; posteromedial edge of infralabials bordered by one long, narrow scale; 20 mid-body scale rows (the tail is partially regenerated). In life the body is purplish-brown with a blue-grey mid body transverse band. A second blue-grey transverse band just posterior to the head is evident in preservative. This species is otherwise only known from its type locality in An Khe District [= K Bang], Gia Lai Province (Darevsky 1992).

Family Scincidae

Plestiodon quadrilineatus. HA TINH PROVINCE, Huong Son District, Huong Son Reserve, Rao An Region, nr. top of Po-mu Mountain: AMNH R-147116, elevation 900–1200 m, 22 April 1998, T. Q. Nguyen. AMNH R-147117, nr. 18°22'N, 105°13'E, April 1998, Diana Silva. In Vietnam, this species is known from Lang Son Province (Man Son Mountains [= Mau Son Mountains]) and Quang Binh Province (Phong Nha), (Bourret 1939a; Darevsky and Orlov 2005; Taylor 1935; Ziegler et al. 2004). This species has been reported from Cao Bang (Nguyen Binh), Quang Ninh (Ba Mun), Son La (Moc Chau, Cao Pha), Thanh Hoa (Ben En), Ha Tinh, Nghe An (Pu Mat, Pu Huong), and Da Nang (Ba Na) Provinces, but without reference to a precise locality or voucher information (Ho et al. 2005; Hoang et al. 2005; Le 2000; Le and

Hoang 2001; Le and Nguyen 1999; Nguyen 2000; Nguyen 2005; Nguyen, Ho, and Nguyen 2005; Nguyen and Hoang 2000). In addition, this species is known from Thailand, China (Guangdong, Hong Kong, Guangxi, Sichuan, Hainan Provinces), and Cambodia (Smith 1935; Taylor 1935; Zhao and Adler 1993).

Sphenomorphus cryptotis. LAO CAI PROVINCE, Van Ban District, Nam Tha Commune, tributary to Khe Pan River: AMNH R-153698, 153699, 153700, 21°56'24"N, 104°24'7"E, elevation 360–400 m, 15 September 2004, R. H. Bain, K. V. Doan, and V. T. Trieu. AMNH R-153701, 21°56'39"N, 104°24'12"E, elevation 331 m, 17 September 2004, R. H. Bain, K. V. Doan, and T. V. Trieu. All specimens were collected sleeping on leaves or small branches overhanging a stream. This species is only known from Quang Ninh (Uong Bi Town, Yen Tu Mountain), and Nghe An (Quy Chau District) provinces in northern Vietnam (Darevsky et al. 2004).

Sphenomorphus tridigitus. QUANG NAM PROVINCE, Tra My District, Tra Don Commune, Mt. Ngoc Linh: IEBR 73, 15°11.688'N, 108°02.413'E, elevation 940 m, 21 March 1999, C.A. Johnson; IEBR 74. 15°10.762'N, 108°02.731'E, elevation 1470 m, P. R. Sweet. Both specimens were collected in pit fall traps, which were set near the ridges of the mountainous primary forest. Our specimen agrees with a recent redescription (Greer et al. 2006), including discrepancies with the type. As with the specimen of Greer et al. (2006), our specimens include a frontonasal with two widely separated prefrontals, and fusion of nasal and first infralabial scales. The loreal scale is not fused with the preocular, as Greer et al. (2006) believe it may be in the poorly preserved holotype. In Vietnam, this species is only known from Thua Thien-Hue Province (Bach Ma) from the original description (Bourret 1939c). It otherwise only known from Champasak Province, Laos (Teynie et al. 2004).

Tropidophorus cocincinus. THUA THIEN-HUE PROVINCE, Huong Thuy District: Binh Thanh Commune, tributary to Dau River: AMNH R-154623, nr. 16°17.995'N, 107°33.307'E, elevation 109 m, 8 September 2005, R. H. Bain, T. Q. Nguyen, C. K. Dang, and T. D. Nguyen; from a rocky shore of the stream. A Luoi District, Huong Nguyen Commune, A Lieng Stream: AMNH R-154624, 16°14'10"N 107°27'26"E, elevation ~ 160 m, 17 August 2005, R. H. Bain, T. Q. Nguyen, A. X. Tran; from a rocky portion of the stream edge in the water. A Luoi District, Huong Nguyen Commune: AMNH R-154625, 154626, nr. 16°14'26"N 107°27'11"E, elevation ~ 152 m, 19 August 2005, R. H. Bain, T. Q. Nguyen, and M. V, Tran; collected from a rocky portion of the stream edge in the water. In Vietnam this species is known from Kon Tum (Kon Tum) and Quang Binh (Phong Nha-Khe Bang) Provinces (Bourret 1939c; Darevsky and Orlov 2005; Smith 1935; Ziegler et al. 2004). This species has been reported from Thua-Thien-Hue (A Luoi) and Da Nang (Son Tra) Provinces, but without specific locality or voucher information (Dinh and Nguyen 2000; Ho 2002b; Nguyen, Ho, and Nguyen 2005). It is otherwise known from Laos (Xe Kong Province) and Thailand (Greer and Biswas 2004; Taylor 1963).

Tropidophorus hainanus. HA TINH PROVINCE, Huong Son District, Huong Son Reserve, Rao An region: AMNH R-147123, 18°20'47"N, 105°14'10"E, elevation 870 m, 9 May 1998, D.T. Pham. LAO CAI PROVINCE, Van Ban District, Nam Xay Commune: IEBR 1219, 21°58.731'N, 104°01.403'E), elevation 1550 m, 6 July 2002, Nguyen Quang Truong and Nguyen Van Hung; disturbed primary forest. This latter specimen was found on the ground near the steep bank of a small rocky stream within a hardwood forest. In Vietnam, this species has been reported from Tonkin (Tam Dao, Ngan Son) [= Tam Dao Mt., Vinh Phuc Province and Ngan Son District, Bac Kan Province], Nam Dinh (Giao Thuy District), and Cuc Phuong N.P. (Cuc Phuong borders Hoa Binh, Thanh Hoa, and Ninh Binh provinces, but the record from Bobrov [1993] does not stipulate from which part of the park the species was found) (Bourret, unpubl. 1937a, 1939b, 1939c; Bobrov 1993). Ziegler, Thanh et al. (2006) also list Bac Kan, Cao Bang, Dak Lak, Ha Tay, Hai Duong, Kon Tum, Lai Chau, Phu Tho, and Quang Ninh provinces of Vietnam as having records of this species, but they cite Nguyen (2005) and Orlov (2005), neither of which give precise locality or voucher information. Outside of Vietnam, this species is known from China (Hainan, Jiangxi, Guangxi provinces) (Smith 1935; Zhao and Adler 1993).

SUBORDER SERPENTES
FAMILY COLUBRIDAE

Dendrelaphis ngansonensis. QUANG NAM PROVINCE, Tra My District, Tra Don Commune, AMNH R-148550, nr. 15°11.459'N, 108°2.523'E, elevation 1100 m, 1 April 1999, P. R. Sweet. In Vietnam this species is known from the following provinces Cao Bang (Ngan Son), Vinh Phuc (Tam Dao), Quang Binh (Phong Nha Khe-Bang), Ha Tinh ("Chuc A", Ke Anh-Ke Go, Chin Xai), Thua Thien-Hue (Bach Ma), Col des Nuages nr. Tourane = (Quang Nam Danang Province nr. Danang City), and in Cuc Phuong N.P. (this park borders Hoa Binh, Thanh Hoa, and Ninh Binh provinces, but the record from Ziegler and Vogel [1999] does not stipulate from which part of the park the species was found) (Bourret 1936; Orlov et al. 2000; Ziegler 2002; Ziegler et al. 2004). Nguyen, Ho, and Nguyen 2005 state that it is found in Quang Nam Province (Chu Lai), but without specific locality or voucher information. This species is also known from Xieng-Khouang (= Xieng Khoang) Province, Laos (Deuve 1970).

Dinodon septentrionalis. THUA THIEN-HUE PROVINCE, Nam Dong District, Thuong Lo Commune, Cha May River: AMNH R-154176, 16°7'40"N, 107°44'44"E, elevation ~ 220 m, 1 September 2005, R. H. Bain, T. Q. Nguyen, V. P. Nguyen, V. T. Nguyen, and V. M. Ngo; collected from among tree roots next to a cascade. In Vietnam, this species has been reported from the following provinces: Lai Chau, Lao Cai, Bac Kan, Cao Bang, Vinh Phuc, Nghe An, Quang Binh, Ha Tinh (Orlov et al. 2003). This wide-ranging species is also known from India, Myanmar, Thailand, China (Yunnan Province), Laos (Kiang Kuoang [= Xieng Khoang] Province), and Cambodia (Mondolkiri Province) (Bourret 1936; Orlov and Ryabov 2004; Smith 1943; Stuart et al. 2006).

Euprepiophis mandarinus. HA TINH PROVINCE, Huong Son District, Huong Son Reserve, Rao An region, top of Po-mu Mountain: IEBR 2302, 18°20'53"N, 105°14'38"E, elevation 1010–1080 m, 8 May 1998, T.X. Le. In Vietnam this species is known from Lao Cai (Mt. Fan Si Pan, Chapa [= Sa Pa], Ngo Toi), Lang Son (Mau Son), Vinh Phuc (Tam Dao), and Tuyen Quang (Na Hang District) Provinces (Angel and Bourret 1933; Bourret 1936; Le and Ziegler 2004; Orlov et al. 2000; Parker 1925). This species has been reported from Son La (Ta Sua, Xuan Nha), as well as Ha Tinh (Huong Son), but without a specific locality or voucher in-

formation (Nguyen 2000; Nguyen 2005; Nguyen, Ho, and Nguyen 2005). Elsewhere it is known from India, Myanmar, and several provinces across China (Smith 1943; Zhao and Adler 1993).

Pareas carinatus. QUANG NAM PROVINCE, Quang Nam, Tra My District, Tra Don Commune, Ngoc Linh Mountain: AMNH R-148551, elevation 980 m, 17 March 1999, T. Q. Nguyen. Smith (1943) stated that in Vietnam, this species was found "below 19°", otherwise it has only been specifically reported from Vinh Phuc (Tam Dao), Gia Lai (Son Lang), Quang Tri (Quang Tri), Quang Bonh (Phong Nha), Tay Ninh (Tay Ninh), and Dong Nai (Trang Bom) Provinces (Campden-Main 1969; Orlov et al. 2000; Szyndlar and Nguyen 1996; Ziegler, Ohler et al. 2006). This species has also been reported from Lam Dong (Lac Duong), Dong Nai (Cat Tien), and Tay Ninh (Ba Den Mt.), but without reference to specific voucher or locality information (Ho and Nguyen 1982; Nguyen and Ho 2002; Pham et al. 2000). It is otherwise known from Myanmar, the Greater Sundas, Thailand, China, Laos, and Cambodia, (Manthey and Grossmann 1997; Pauwels et al. 2003; Saint Girons 1972; Smith 1943; Stuart and Emmett 2006; Zhao and Adler 1993).

Pseudoxenodon macrops. LAI CHAU PROVINCE, Mount Fan Si Pan: AMNH R-147147, elevation 2,020 m 19 August 1997, D. R. Frost and C. J. Raxworthy. HA TINH PROVINCE, Huong Son District, Huong Son Reserve, Rao An Region: AMNH R-147148, nr. 18°22'N, 105°13'E, 9 May 1998, via D. A. Kizirian. This species has previously been reported from Lao Cai (Ngoi Tio, Sa Pa), Vinh Phuc (Tam Dao), Da Nang (Ba Na), and Lam Dong (Fyan, Da Lat, Lang Bian) provinces (Campden-Main 1969; Orlov et al. 2000; Parker 1925). It is otherwise a widespread species throughout southeast Asia, from the eastern Himalayas to the Malay peninsula and east through Myanmar, Thailand, China and the Indochinese peninsula (Farkas and Fritz 1999; Smith 1943; Taylor 1965; Zhao and Adler 1993).

Sibynophis collaris. BAC KAN PROVINCE, Ba Be District, Ba Be National Park: AMNH R-147156, 7 August 1997, D. R. Frost and C. J. Raxworthy; beside a cascade. HA TINH PROVINCE, Ke Go Nature Reserve, Mon Stream: AMNH R-147157, 11 April 1998, T.Q. Nguyen and D. A. Kizirian. In Vietnam, this species is known from Lai Chau (Muong Nha), Nonh Bonh (Xom Bong [= Cuc Phuong]), Quang Binh (Phong Nha), Quang Tri (Xa Huc), Thua Thien-Hue (Hue), Gia Lai (Son Lang), Lam Dong (Bao Loc, Da Lat, Lang Bian), and Dong Nai (Bien Hoa) Provinces. (Campden-Main 1969; Szyndlar and Nguyen 1996; Ziegler et al. 2004). In Vietnam it has also been reported from Nghe An (Pu Mat, Pu Huong, Ky Son), Ha Tinh (Huong Son), Thua Thien-Hue (A Luoi), and Dong Nai (Cat Tien) Provinces, but without any voucher information (Ho 2002b; Le and Hoang 2001; Nguyen 2000; Nguyen and Ho 2002; Nguyen, Ho, and Nguyen 2005). This species is widespread across India, Nepal, Myanmar, Thailand, China, Laos, and Cambodia (Smith 1943).

Sinonatrix aequifasciata. LAO CAI PROVINCE, Van Ban District, Nam Tha Commune, tributary to Nam Tha River: AMNH R-153712, 153713, 21°55'23"N, 104°22'43"E, elevation ~ 640 m, 3 September 2004, R. H. Bain, T. Q. Nguyen, K. V. Doan, and A. C. Lu; from tree branches overhanging fast flowing water. Tributary to Khe Pan River: AMNH R-153714, 21°56'24"N, 104°24'7"E, elevation 360–400 m, 16 September 2004, R. H. Bain and K. V. Doan. In Vietnam, this species has been reported from Ha Giang (Vi Xuyen District), Vinh Phuc (Tam Dao) and Nghe An (Ky Son) Provinces (Bain and Nguyen 2004b; Orlov et al. 2000; Vogel et al. 2004; Ziegler and Hoang 2005). This species has also been reported from Lao Cai (Van Ban), Cao Bang (Nguyen Binh), and Bac Giang (Luc Nam) provinces, Vietnam, but without reference to specific locality or voucher information (Ho et al. 2005; Nguyen et al. 2002; Nguyen, Nguyen, and Ho 2005). This species is otherwise known from China (Guangxi, Guangdong, Hong Kong, Hainan, Fujian, Guizhou, Hunan, Jiangxi, Sichuan, Zhejiang) (Zhao and Adler 1993; Zhou and Yu 2002).

Sinonatrix percarinata. THUA THIEN-HUE PROVINCE, A Luoi District, A Roang Commune: IEBR 2312, nr. 16°04.636'N, 107°29.290'E, elevation ~ 680 m, 23 August 2005, R. H. Bain, T. Q. Nguyen, and V. S. Ho; on vegetation overhanging a stream, ~ 2 m above the surface. In Vietnam, this species is otherwise known from Lao Cai (Chapa [= Sa Pa], Thai Nien, Ngoi Toi), Ha Giang (Yen Minh District), Bac Kan (Ngan Son), Vinh Phuc (Tam Dao), Bac Giang (An Lac, Thanh Son), Quang Binh (Phong Nha Khe Bang N.P.), Ha Tinh (Chin Xia, Ke Go-See), and Kon Tum (Kon Tum, Kon Plong) provinces (Bain and Nguyen 2004b; Bourret 1937b, 1939; Campden-Main 1969; Orlov et al. 2000; Parker 1925; Szyndlar and Nguyen 1996; Ziegler 2002; Ziegler et al. 2004). This species has also been reported from Cao Bang (Nguyen Binh), Lang Son (Huu Lung), Son La (Muong Do, Xuan Nha), Hoa Binh (Da Bac), Bac Giang (Luc Nam), Thua Thien-Hue (A Luoi, Hung Thuy), and Dong Nai (Cat Tien) Provinces, but without reference to specific locality or voucher information (Dang et al. 1975; Ho 2002b; Ho et al. 2005; Nguyen 2005; Nguyen and Ho 2002; Nguyen et al. 2000; Nguyen et al. 2002; Nguyen, Ho, and Nguyen 2005). This species is otherwise known from India, Myanmar, Thailand, China (Hainan, Chekiang, Jiangxi, Fujian, Guangdong, Guangxi, Kweichow, Sichuan, and Hupeh Provinces), and Taiwan (Captain et al. 1998; Smith 1943; Zhao and Adler 1993; Zhou and Yu 2002).

Family Viperidae

Protobothrops mucrosquamata. LAO CAI PROVINCE, Van Ban District, Nam Tha Commune, forested stream above Nam Tha River: AMNH R-153720, 21°55'13"N, 104°22'15"E, elevation ~ 950 m, 5 September 2004, R. H. Bain, T. Q. Nguyen, K. V. Doan, V. T. Trieu, and A. L. Chu. In Vietnam, this species has been reported from Ha Giang (Du Gia Commune), Cao Bang, Bac Kan (Ngan Son), Thai Nguyen, Vinh Phuc (Tam Dao), Quang Ninh (Nam Son, Quan Lan), Ha Tay, Hai Duong, Ninh Binh, Nghe An, Ha Tinh (Ky Anh-Ke Go), Thua Thien-Hue (A Luoi), Gia Lai, and Kon Tum Provinces (Bourret 1936; Orlov et al. 2000; Szyndlar and Nguyen 1996; Ziegler 2002; Ziegler, Thanh et al. 2006). This widespread species is otherwise known from Bangladesh, India, Myanmar, and China (Leviton et al. 2003; Smith 1943; Zhao and Adler 1993).

Viridovipera vogeli. THUA THIEN-HUE PROVINCE, A Luoi District, A Roang Commune, stream at Ho Chi Minh Highway marker kilometer 398+700: AMNH R-154632, 16°4'28"N, 107°29'14"E, elevation ~ 653 m, 23 August 2005, R. H. Bain, T. Q. Nguyen, V. S. Ho, and V.T. Le; from flat rocky stream bank. HA TINH PROVINCE, Huong Son District, Rao An Region, nr. top of Po-mu Mountain: AMNH R-147162, elevation 900–1200

m, 22 April 1998, T. Q. Nguyen. In Vietnam, this species is known from Quang Binh, Gia Lai (An Khe =[K Bang], Krong Pa), Quang Nam, and Danang (Ba Na) Provinces (Malhotra and Thorpe 2004; Malhotra et al. 2004; Orlov et al. 2003). Nguyen, Ho, and Nguyen (2005) report this species from A Luoi, but without any specific locality or voucher specimen information. This species is otherwise known from Thailand, Laos (Champasak), and Cambodia (Mondolkiri Province, Cardamom Mountains) (David et al. 2001; Malhotra et al. 2004; Stuart et al. 2005).

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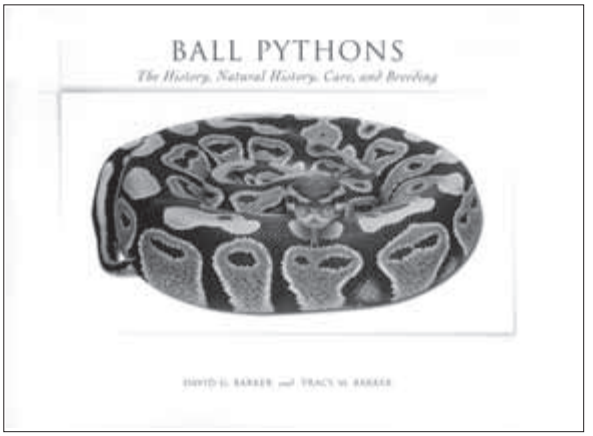
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BOOK REVIEWS

Herpetological Review, 2007, 38(1), 118–119.
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Pythons of the World, Volume II. Ball Pythons: The History, Natural History, Care, and Breeding, by David G. Barker and Tracy M. Barker. 2006. Vida Preciosa International, P.O. Box 300, Boerne, Texas 78006, USA (www.vpi.com). Clothbound. xv + 320 pp. US $75.00 (Leather bound US $250.00). ISBN 0-9785411-0-3.

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Like a locomotive slowly building up steam, the herpetoculture juggernaut commercially came of age sometime in the late 1980s to early 1990s. After years of simply just trying to keep amphibians and reptiles alive in captivity, this plateau marked the beginning of an era of not only successful maintenance of these fascinating animals, but also standardized propagation that could, at least in some cases, be called "cookbook." Since the early 1990s amphibian and reptile books and magazines have proliferated, products specifically targeting these animals have appeared on the store shelves, expos have become a weekly event, and through the use of a little thing known as the internet, the global community is suddenly within reach and ideas are quickly disseminated.

Several species come to mind as being the most successful in herpetoculture, these being leopard geckos (*Eublepharis macularius*), corn snakes (*Pantherophis guttata*), and ball pythons (*Python regius*). The reasons for the success of these three species are probably many, including among others, their relatively small size, easy adaptability to captivity, and attractiveness. A further common feature is the incredible variety of selectively bred color and pattern phenotypes available and, at least in the case of ball python designer morphs, the tremendous prices they command.

Who else would be better suited or more qualified to write about or simply more in love with the subject of this new book than Dave and Tracy Barker? *Pythons of the World, Volume II. Ball Pythons: The History, Natural History, Care, and Breeding* is a colossal effort from two skilled biologists/herpetoculturists who have spent practically their entire lives working with pythons. As is the case with the first volume in the series, *Pythons of the World, Volume I. Australia*, the current book is an incredible photographic and literary feast.

As a prelude, the book begins with Contents, Acknowledgments, Introduction, About This Book, About the Pictures, and The Golden Age of Herpetoculture. The Barkers describe how their obsession with ball pythons started—getting one, then another, then another, and how things "began to spiral out of control." This indeed is something many reptile enthusiasts (including some professional herpetologists) can identify with.

The first chapter, "Introducing the Ball Python," sets the groundwork for the reader and covers the early history of pythons in Europe, classification, habitat and distribution, life span, natural history, abundance, defensive behavior, and the reasons why they are so popular. Chapter Two, "The Relationships of Humans and Ball Pythons in Africa" includes both python worship and modern day human interaction with the ball python. Beginning with the humorous opening statement "We are not the first people to revere and even worship ball pythons," the authors describe how ophiolatry, or the worship of snakes, affected the lives of the Whydah,an African culture inhabiting the border region between present day Benin and Nigeria. Pythons were regarded as gods incarnate and the penalty for killing one was severe.

Chapter Three, "The Physical Ball Python," describes the ball python, with information on physical characteristics, size, intelligence, sensory abilities, the reproductive system, and determination of sex. This chapter is particularly useful to keepers in that it describes as well as illustrates sex determination techniques such as probing and manually everting the hemipenes of a male (also known as popping). The following chapter, "Skin and Shedding," covers the outer surface of the ball python and ends with practical information on shedding problems.

Chapter Five, "The Basis of Color and Pattern," is devoted to the mechanics of the various chromatophores and how they relate to color and pattern. The chapter includes "A Glossary of Color Terms" with definitions of the terminology used in the discussion. Chapter Six, "The Morphs," takes one to the very core of the success of ball pythons in herpetoculture. Eighteen pages cover everything from why morphs have become popular, naming a morph, to wild morphs (those found in nature), and designer morphs (those produced in captivity from crossing wild morphs). Fifty-three pages of color photographs featuring over 240 individual ball python morphs follow.

The next fourteen chapters focus on husbandry related issues and begin with what to look for when acquiring a ball python (Chapter 7, "Choosing a Ball Python"). The next chapter, "Transporting Ball Pythons," covers everything one should know about packing and shipping — including importing and exporting CITES regulated species such as ball pythons. "The Ultimate Snake Room," "Snake Room Equipment and Supplies," and "Snake Cages" (Chapters 9–11) together constitute a thorough checklist (with explanations) of everything that should be considered when housing these snakes.

The Barkers begin Chapter 12, "Temperatures," with a nice discussion on what exactly is an optimal temperature for a snake. Too often captive snakes are maintained at subpar temperatures

with complete disregard for the fact that they behaviorally thermoregulate to control their temperatures. Working at a zoo, I found the next chapter, "Maintenance," particularly poignant in that it discusses my regular working routine: cleaning, disinfecting, and quarantining. However, regular maintenance is an essential area that is neglected by many who maintain snakes. Chapter 14, "Feeding," explains why ball pythons acquired the reputation of being recalcitrant feeders in captivity. Sound, practical information follows, touching all the bases from when, what, and how much to feed, to the presentation of food, to the last ditch efforts of force feeding a reluctant snake. Accidents occasionally happen during feeding and the snake may mistake your hand for the food being presented which opens the door, hence Chapter 15, "Snake Bites."

The word "herpetoculture," defined as maintaining and propagating reptiles, strikes to the heart of Chapter 16, "Breeding Ball Pythons." One of the very reasons why reptiles have gained popularity in recent years is not only because of their innate physical and behavioral features, but also because they can and do reproduce in captivity. Having bred literally thousands of ball pythons (as well as other reptiles), the authors are more than capable of delivering the message behind the mechanics of reproducing this species. Chapter 17, "Eggs, Incubation, and Hatching," flows naturally from the previous chapter and thoroughly covers eggs and their management.

"Medical Matters" (Chapter 18) focuses on health issues including how to find a local veterinarian who specializes in reptiles. One may question why the subject of the next chapter, "Eradicating Snake Mites" was not included in the previous chapter. For those of us who have had to deal with large infestations of snake mites, the answer is very understandable: there are very few circumstances that are as life altering as having a collection affected by mites. Not only do they feed upon blood, but mites have also been implicated as possible vectors for diseases that may debilitate an entire collection. Practical information about recognizing and eliminating mites is treated by the authors as a military-style battle plan.

The closing sections of this book include the chapter "Basic Genetics for Python Breeders" — an introduction into the basic principles of genetics and inheritance. A glossary of anatomical terms (Appendix I) and a quick reference to many (233) of the ball python morphs (Appendix II) follows, with the book finishing off nicely with an extensive bibliography of all published references concerning ball pythons (including images), Literature Cited, and Index.

Very few errors or problems could be found in this book. The most noticeable, however, were the faint captions accompanying the photographs and figures which made reading the smaller captions difficult at best. According to one of the authors, this unfortunate mistake resulted from a misunderstanding between the layout studio and the printer (D. Barker, pers. comm.). A short perusal into the sensory abilities of ball pythons in Chapter Three "The Physical Ball Python," brought my attention to a citation for Young (2003) on page 25. Interested in locating the particular reference, I skipped back to the Literature Cited section on page 314 and found the author's name and the paper's title, yet a publication reference wasn't given. Another problem I found was a lack of Latin nomenclature accompanying the popular names of some of the pythons mentioned in the text. I had the feeling that I knew what a Lesser Sundas Python and a Halmahera Python were (page 44), but common names are not necessarily common to all readers.

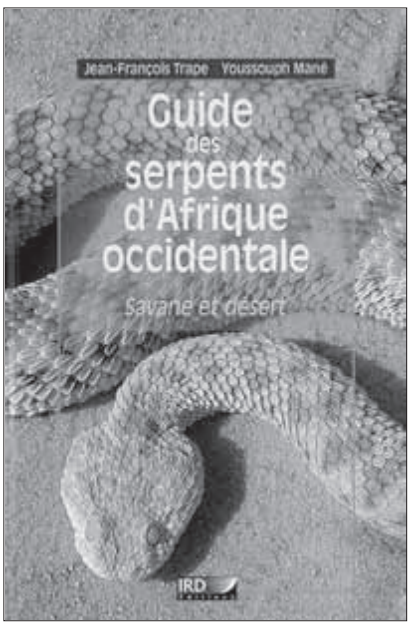
Written primarily for the Ball Python enthusiast, but highly useable by all snake keepers, *Pythons of the World, Volume II* is a comprehensive effort that easily distances itself from any other husbandry book on this or any other snake species. It is very easy to read and the depth of coverage in the husbandry chapters alone is simply astounding, leaving few stones unturned. Coupled with superb photography and excellent line drawings, the authors have produced a solid effort that should become a classic for years to come.

I had been patiently awaiting the arrival of this second volume in the *Pythons of the World* series for the last ten years. In that time, my eyesight and lower back have slowly deteriorated to the point of requiring attention. Was it worth the wait? You bet.

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Guide des Serpents d'Afrique Occidentale (Savane et Desert), by Jean-Francois Trape and Youssouph Mane. 2006. Editions IRD, Paris. Softcover. 226 pages. 29.00 € (approx. US $38.00). ISBN 2-7099-1600-2.

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The herpetological literature of West Africa has been of little use to the naturalist, particularly where snakes are concerned. Some good papers have been published, for example Dunger's series of papers in the *Nigerian Field* (1971a, 1971b, 1972, 1974) and Doucet's papers on the Ivory Coast snakes (1963), but these are hard to find. However, the books—for example Leeson (1950), Villiers (1950, with several new editions since, but little improved) and Roman (1980)—have been mostly characterized by a lack of maps, a poor selection of black and white photographs, often of specimens that are long-dead, mutilated or distant from the camera, fairly useless line drawings, no common names, and no attempt to make the data accessible to non-specialists. George Cansdale's handy little book (1961, reprinted in 1973) is a notable exception, with its reasonably accurate color paintings and sensible selection of species, although it is somewhat biased towards snakes known from Ghana. A decent attempt to improve the situation was made by

Chippaux (1999), although his book is marred by lack of common names and an arcane selection of color pictures, some of which are misidentified (see the review by Hughes 2000). So it is a pleasure to come across a book on West African snakes that is thorough, sound, illustrates all its subjects in color photographs and is accessible to the interested naturalist.

Trape and Mane's book covers the 81 species of snake that are deemed by the authors to inhabit the savanna, semi-desert, and desert of western Africa, north of latitude 9°N. Species solely inhabiting forest and woodland are excluded, although some genuine rainforest areas lie within the map boundaries. The baseline data for this book are derived from two large collections. One comprises 13,000 snakes, mostly from Senegal and Mali, but with some from Mauritania, Niger, and Guinea. These are preserved in the IRD research center in Dakar, Senegal, where Mane is the curator. The other is a collection of 4000+ preserved snakes from Burkina Faso, deposited in the National Scientific and Research Centre in Ouagadougou by the late eccentric Spanish priest Pere Benigno Roman.

The aim of this book, stated in the introduction, is to assist with the rapid identification of the snakes of six main countries of western Africa (Senegal, the Gambia, Mauritania, Mali, Niger, and Burkina Faso). The authors emphasize the significance of snakebite in western Africa, which at 10 cases per 100,000 inhabitants per year is, according to the authors, higher than the road accident deaths in Africa and Europe. Next, there are sections on snakebite (including details on treatment), the climate and vegetation of the region, identification, capture and preservation of snakes, and familiar and specific keys to all species, plus some useful tables comparing scale counts, sizes, etc. The environmental section includes 16 color photographs of habitats, ranging from the desert and oases to the well-wooded Guinea Savanna, and a rainfall map. The descriptions of the 81 species are in classic user-friendly, field guide style, with all the information in one place. Each species gets a double-page spread, with two photographs occupying an entire page; the map, description, and drawings of head scales (in plan and profile) are on the facing page. The book concludes with an eight-page bibliography and an index of scientific names. It is very nicely produced, slightly larger than octavo, tough and well bound, on glossy paper. There are some fascinating pictures in addition to the species illustrations, for example, the lady receiving local treatment for an *Echis* bite in the form of a cow dung poultice.

As anyone who has been involved in assisting the public to identify snakes will tell you, what they want are decent, large color illustrations. The big, mostly half-page pictures, nearly all taken by Trape, fit that bill exactly. Most show a whole animal and a close-up, but some show two color forms. There are species here that I don't think have ever been illustrated in color before, for example *Haemorrhois dorri* and the red-banded form of *Lycophidion albomaculatum*. The relatively large maps, showing western Africa from 18°W to 16°E, and 9° to 27°N, are divided into degree squares and national borders are shown. A locality is marked by red shading of the relevant square. In addition to the six countries mentioned above, the map also shows parts of Western Sahara, Algeria, Libya, Chad, western Cameroon, and the northern sectors of the countries of the West African seaboard, from Nigeria west to Guinea, and relevant records for the featured species within those countries are given. The description includes names (French, scientific, English) and a few lines on rapid identification plus notes under the headings Size, Distribution and Habitat, Description (scale data and color/pattern), and Natural History.

The distribution maps give nice insight into West African zoogeography. The high country of East and Southern Africa is full of fragmented habitats, each with their quota of endemic species, often confined to a single mountain range or high forest ("and all waiting to become extinct," as a colleague once cynically remarked to me). Western Africa is very different. With the exception of a few isolated massifs, most of the region is flat country, largely below 500 m altitude. The differing vegetation and climatic zones occupy huge east-west swaths, changing only as one travels north into increasing aridity. In West Africa one can drive hundreds of kilometers in an east-west direction and see very little variation in either altitude or habitat. This lack of habitat diversity is reflected in the distributions shown here; no fewer than 58 of the 81 species extend over 30 degrees of longitude. Consequently only one "single-country" endemic species is featured, *Mehelya gabouensis*, although there are a few snakes that are endemic to the southwestern corner of West Africa (e.g., *Rhinoleptus koniaguiu*, *Lycophidion albomaculatum*, *Elapsoidea trapei*). The featured snakes fit into clear faunal groups: Pan-African savanna species (*Bitis arietans*, *Naja nigricollis*), West African savanna forms (*Psammophis elegans*, *Dromophis praeornatus*), desert species (both species of *Cerastes*, *Malpolon moilensis*). There are also a few examples of what Hughes (1983) calls "East African invaders" (*Hemirhagerrhis nototaenia*, *Eryx colubrinus*) and a couple of large, genuine forest snakes (*Toxicodryas blandingi* and *Dendroaspis viridis*) whose size and consequent mobility have enabled them to colonize the woodland of the Casamance and River Gambia.

Their large collections and familiarity with the snakes of the area have enabled Trape and Mane to have a confident shot at getting rid of what is the curse of African herpetology, dubious records. Such records are usually old, often without supporting specimens, or with imprecise or possibly inaccurate labelling. Unfortunately, they often cannot be simply discarded because they might turn out to be valid, and have value simply because there are so little other data (for example, see Branch and Bauer 1992). In the introduction, as well as listing the new species they have added (seven of which have been described in the last 10 years, six by the authors), Trape and Mane briskly discard 15 species. Justifications for both additions and deletions are provided. The catalogue of deletions is fascinating and includes several species routinely listed for the Gambia, including *Lamprophis virgatus* and *Hapsidophrys smaragdina*, and, startlingly, *Rhamphiophis maradiensis*, described in 1991, which we learn was a misidentified *Malpolon moilensis*. With hindsight, in view of the lack of one-country endemics from this region, this is perhaps not unexpected. Consequently, whatever might be added in the future, the species featured in this book are what one might call the cast-iron, core snake fauna of the region. This book thus represents seminal literature.

I have a few complaints. Many of the illustrations are of dead snakes. This is unavoidable, you can't always find living examples of the species you want. If you want to illustrate every species

from your area, you will have to photograph a few dead museum specimens. In most cases here the photographs of obviously dead snakes are adequate for identification, pin-sharp, and of freshly killed or recently preserved specimens, retaining their original color. They are just aesthetically unpleasing, with misaligned or gaping mouths, sunken or dulled eyes, and curious postures. But it is disappointing to see magnificent animals like the cobras and mambas illustrated by lifeless corpses. The fine photographs of the rearing Egyptian cobra on page 195 and the alert *Cerastes* on page 208 show what can be done. Good pictures of living examples of a number of prominent species are in existence. I wish the authors had attempted to obtain these rather than relying so heavily on their own pictures of dead specimens. In addition, although burrowing asps, *Atractaspis*, do have very long fangs, the fang of *Atractaspis aterrima* illustrated on page 19 seems to me to be deceptively long; I suspect it has been dislocated.

The taxonomy here is largely conservative and very sound, but there are some decisions I find odd. Three new species of egg-eating snake are illustrated here, *Dasypeltis confusa*, *D. sahelensis*, and *D. gansi*. This last is what was regarded as a savanna form of *Dasypeltis fasciata*. However, I am not aware that the original paper (Trape and Mane 2006) has actually appeared. The egg-eaters are a complex and confusing genus, showing a huge amount of variation in both scale counts and color. Eminent herpetological taxonomists have struggled with the group, for example see Gans (1959 and 1964) and Hughes (1997). On present evidence I have my doubts as to the validity of *D. sahelensis* and *D. confusa*. The use of the generic name *Haemorrhois* for part of *Coluber* is indicative of the taxonomic morass that at present envelopes this widespread genus; it will be a long time before the debate is settled and it might have been worth sticking with the old name until the situation is resolved. There are also a few errors and typos (e.g., Bob Drewes has become Dewes on page 223, *Hemirhagerrhis nototaenia* is described as non-venomous on page 112, but it is rear-fanged). I am not sure I would agree with the authors' observations that the house snake, *Lamprophis fuliginosus*, is placid and easily captured and handled. It is harmless but in my experience these snakes are quick moving and bite savagely and rapidly when first captured.

I do not want to carp or nit-pick, however. The huge merits of this book far outweigh its minor shortcomings. It is well researched, well illustrated and, in these days of what I sometimes consider almost insanely high prices for herpetological books, relatively inexpensive. It makes the West African savanna and desert snake fauna accessible to the man in the street, and will be genuinely useful in the field. Most important of all, in the hands of medical professionals in West Africa, this book will save lives. In herpetological publishing, you don't get more useful than that.

Acknowledgments.—I thank Barry Hughes for helpful criticisms and information.

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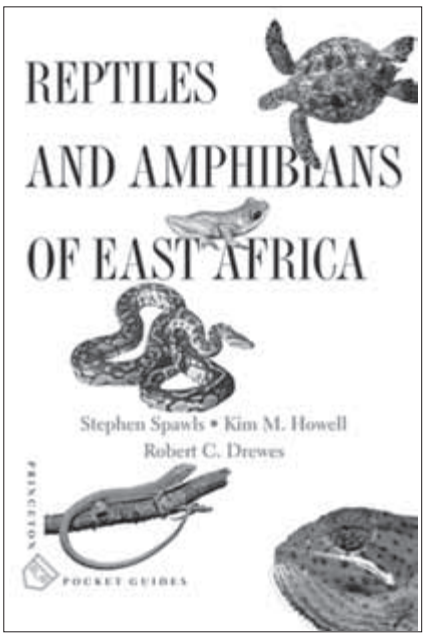
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Reptiles and Amphibians of East Africa, by Stephen Spawls, Kim M. Howell, and Robert C. Drewes. 2006. Princeton University Press (press.princeton.edu). Softcover. 240 pp. US $24.95. ISBN 0-691-12884-7.

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In the Introduction to *Reptiles and Amphibians of East Africa* (RAEA) the authors explain that their book is meant to be a portable field guide to identify the 190 reptiles and 85 amphibians (of their estimated 620 species total) that they feel the public are most likely to encounter in East Africa. The authors have certainly accomplished this modest goal with their photo-rich, lightweight, compact book (12.5 × 19 cm), which can



easily fit into a backpack or vehicle glove compartment.

Short (1–3 pages), illustrated subsections of the Introduction entitled "How to use this book," "East African reptiles and amphibians and their zoogeography," "Observing and collecting reptiles and amphibians," "Conservation," "Safety and reptiles," "Identifying reptiles," and "Identifying amphibians" orient the novice through basic information about East African amphibian and reptile morphology, biogeography, behavior and natural history. One-page introductions to the orders of reptiles and amphibians precede their respective species accounts. There are also one-paragraph descriptions of each family (and in some cases, suborders), including taxonomic notes, natural history, identification pointers and content in East Africa. The brief species accounts with photos are about half a page each, and convey basic information about identification (size, coloration, basic morphology), habitat and distribution in East Africa, and natural history comments. Other species are listed without photos and are limited to one or two sentences about identification and distribution. I counted 193 reptile species accounts with photos, nine species with photos mixed in with the 230 additional, abbreviated reptile accounts, 84 amphibian species accounts with photos, and two species with photos in the 85 additional, abbreviated amphibian accounts. Although the main focus of the book is on the East African countries of Kenya, Uganda, Tanzania, Rwanda and Burundi, some accounts include information about the surrounding countries of Somalia, Democratic Republic of Congo, Malawi, Mozambique, and Zambia. At the back of the book, the authors have included brief (1–3 pages) sections including a Glossary, Institutions involved with East African herpetology, Photo credits, Index of scientific names, and Index of English names.

For more extensive information, identification keys, and additional reptile species accounts, RAEA directs readers to *The Dangerous Snakes of Africa* (Spawls and Branch, 1995) and *A Field Guide to the Reptiles of East Africa* (Spawls et al., 2002). Herpetologists familiar with the latter book will recognize the exact same information and photographs in many of RAEA's reptile species accounts. The information has been condensed, and just over 75% of the photos are identical. The photographs range in quality from excellent to poor, consistent with a review of Spawls et al. (2002) by Branch (2002). However, many of the new photographs are of improved quality, and one snake (*Polemon christyi*) was not illustrated in Spawls et al. (2002) or *Snakes of Zambia* by Broadley et al. (2003). Nearly all of the amphibian photographs are original—only one of the amphibian photographs (*Hyperolius orkarkarri*) is present in *Treefrogs of Africa* (Schiøtz, 1999), and none seem to be identical to photographs in *Amphibians of Central and Southern Africa* (Channing, 2001) or *Amphibians of East Africa* (Channing and Howell, 2006). Moreover, RAEA illustrates six species (*Schoutedenella schubotzi*, *Hemisus guineensis*, *Phrynobatrachus irangi*, *Spelaeophryne methneri*, *Xenopus wittei*, and *X. victorianus*) that are not illustrated in the latter amphibian volumes, and 11 different color patterns of the highly variable *Hyperolius viridiflavus*/*glandicolor* complex.

In addition to the photographic benefits of the book, RAEA is sprinkled with interesting natural history information and creative descriptions of certain groups. Many readers will be delighted to learn about geckos that are known to steal bread and sugar from homes (*Lygodactylus picturatus*, pg. 39), a skink that can swim well in the ocean (*Cryptoblepharus boutonii*, pg. 48), a lacertid that can glide between trees when pursued by predators (*Holaspis guentheri*, pg. 52), chameleons that supercool (*Chamaeleo hoehnelii*, pg. 68; *C. rudis*, pg. 71), toads with internal fertilization (*Mertensophryne micranotis*, pg. 167; two species of *Nectophrynoides*, pg. 169), female frogs that can carry tadpoles on their backs (*Hemisus marmoratus*, pg. 173), and treefrogs with bile pigments in their circulatory system that stain its muscles, bone and blood green (*Leptopelis barbouri*, pg. 178). Some of the unique observations about certain groups include plated lizards that make "excellent, confiding pets" (*Gerrhosaurus major*, pg. 59), vipers that can form C-shaped coils and rub them together, "making a noise like water falling on a hot plate" (pg. 147), and my personal favorite—rain frogs (*Breviceps*) that "resemble badly made meatballs to which the chef has added a face and four legs" (pg. 218).

Because the writing of the book was completed in August, 2005, herpetologists should not look for recent, major taxonomic changes of amphibians (e.g., Frost et al., 2006). RAEA seems to have benefited from criticism of *A Field Guide to the Reptiles of East Africa* (Spawls et al. 2002) by Branch (2002) and Broadley (2002) in some cases. For example, the correction by Broadley (2002) of the genus of large tree agamas from *Acanthocerus* to *Acanthocercus* was incorporated, but the advice regarding the common name of *A. atricollis* was ignored. In a similar fashion, some but not all of the taxonomic changes suggested by Branch (2002) were incorporated, including the correction of a misidentified photo of *Mehelya poensis*. Taxonomic changes and species descriptions that were published recently have, in some cases, been missed or unincorporated (e.g., *Trachylepis* instead of *Mabuya*, Bauer, 2003; *Strongylopus kilimanjaro*, Clarke and Poynton, 2005).

I noticed that RAEA listed *Boulengerula taitanus* instead of *B. taitana*, which was spelled correctly by Channing and Howell (2006). The authors use the term paratoid gland (pg. 216) to refer to the lack of glandular tissue behind the eyes of *Tomopterna*, but this spelling should be used for similar glands in salamanders (Tyler et al. 2001). In frogs the correct spelling is parotoid gland, not parotid gland (salivary glands in mammals), which is used elsewhere in RAEA (amphibian features figure on pg. 16; pgs. 18, 162–71, 232). This book review would not be complete without the requisite listing of typographical errors, of which I noticed a few: "This is particularly useful identification pointers are the colours…" (pg. 6); "Most of their lives is spent buried…" (pg. 15); "A quick-moving gecko, with a round pupils…" (*Cnemaspis* accounts, pgs. 31–32); "recognized throughout sub-Saharan African…" (pg. 195); "with an isolated recorded from…" (pg. 206). Finally, I found it frustrating that none of the species in the abbreviated accounts are listed in the index.

These drawbacks aside, this book will be an informative, inexpensive, and practical field guide to herpetologists, other biologists, and tourists on safari in East Africa. Because this book is bound to be popular, and tourists surely uncover rare species from time to time, I was especially pleased to see the authors encouraging people to bring worm lizards (amphisbaenians) to museums (pg. 79) because they are harmless and poorly known. Professional herpetologists who are interested in East Africa and own a copy of *A Field Guide to the Reptiles of East Africa* (Spawls et al. 2002) will still want to pick up a copy of RAEA for the

unique amphibian photos and practical use in the field.

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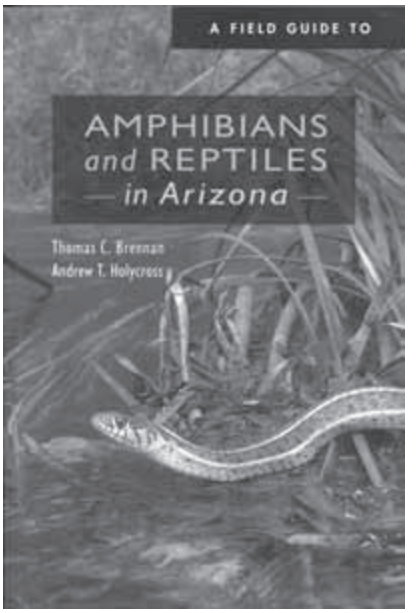
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Herpetological Review, 2007, 38(1), 123–124.

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A Field Guide to Amphibians and Reptiles in Arizona, by Thomas C. Brennan and Andrew T. Holycross. 2006. Arizona Game and Fish Department, Phoenix, Arizona (www.azgfd.gov). Softcover. vi + 150 pp. US $12.00. ISBN 0-917563-53-0.

TRIP LAMB
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Those of us old enough to remember the indispensable little green book—whether Conant or Stebbins—share a collective longing for its economy and ergonomic form. Into the glove box or backpack it would go, altogether unobtrusive and readily retrievable. True, back then we on the Eastern Seaboard dealt with just one species of slimy salamander while western colleagues enjoyed a monotypic *Rhyacotriton*. As our recognition of herpetological diversity grew, however, so did its documentation. And we watched our once slim, succinct guides become encyclopedic, lamentably unwieldy—more of a desk reference than anything suitable for the field. Enter the new *Field Guide to Amphibians and Reptiles in Arizona* by Thomas Brennan and Andrew Holycross, with one of its many appealing features—portability. At a modest 150 pages, the book is comprehensive without being cumbersome, the authors having struck a near perfect balance between content and utility.

Totaling 132 species, Arizona's rich herpetofaunal diversity is attributable to the region's interplay of geography, geology, and climate. Eight major biomes fall within the state, yielding 14 distinct biotic communities that range from tropical desert scrub to alpine tundra. Brennan and Holycross convey the significance of these communities to Arizona's natural history in a concise treatment of biotic community structure. Each community is profiled and illustrated by an accompanying photograph, and its overall distribution color-coded on a state map. In my view, this illustration may be the single most important figure in the book, as much of Arizona's herpetofauna is community-specific. To this end, the authors appropriately list those species common to each biotic community, and the community map provides a valuable cross-reference for the species distribution maps.

Species accounts are where this book really shines; much thought and effort apparently went into their layout with respect to function and aesthetics. The color plates are superb and beautiful to browse. Field guide plates can often be distractingly cluttered, but

not here. Turning page after page, I was struck by the clarity of the plates, each bearing images that seemingly draw you in, right to the key characters, clearly marked. Where necessary, particularly when diagnostic scalation is an issue, species photographs are supplemented with clean line drawings. For the few species with distinctly marked young (e.g., Barking Frog, Madrean Alligator Lizard, Eastern Racer), a photograph of the juvenile accompanies the adult. Ventral shots are included for the lizard genera *Callisaurus*, *Cophosaurus*, *Holbrookia*, and *Uma*, illustrating diagnostic patterns and/or coloration on the throat or belly. I was duly impressed by the photograph of the Zebra-tailed Lizard (*Callisaurus draconoides*) in characteristic field pose: tail upturned and arched over the back, revealing its black and white ventral barring.

Species accounts, set up on facing pages, opposite respective photographs, allow the reader to glance back and forth between the two with ease. Each species profile provides requisite information on size (mm and inches), description, occupied biotic communities, habitat specificity, and activity period. For the vast majority of species, details on diet, breeding season, and clutch or litter size are also given. A brief description of the call is included for the anurans. Where applicable, species are noted as being NON-NATIVE, PROTECTED, and/or VENOMOUS in colored-coded, bold font that prefaces the general text. Distribution maps, though small, are fairly detailed and color-coded to distinguish current (green) versus historic (tan) geographic ranges, as well as introductions (red).

Brennan and Holycross made every effort to incorporate the latest taxonomic updates, with attendant nomenclatural changes involving both common and scientific names. The section on common and scientific names outlines their justification for decisions regarding full specific status in some cases (Arizona Black Rattlesnake, *Crotalus cerberus*) and synonymy in others (*Rana subaquavocalis* is subsumed in *R. chirichauensis*). Many of the citations providing the phylogenetic justification behind these taxonomic decisions are conveniently listed in this section. The book's current taxonomy reminds us seasoned recalcitrants that we're just going to have to let go of *Cnemidophorus* and start thinking *Aspidoscelis* the next time we try to identify a whiptail in Arizona.

Current status is equally important from an ecological perspective, and Brennan and Holycross bring to light those species that are experiencing decline. One particularly disturbing case involves the Narrow-headed Gartersnake (*Thamnophis rufipunctatus*). This strongly aquatic snake, characterized by a distinctively tapered, gracile head, is a foraging specialist on many of the state's native fishes. Populations have undergone precipitous declines recently in both Arizona and adjacent New Mexico. Non-native fish and crayfish have been argued to account, in part, for this unusual species' unfortunate demise.

What better state field guide than Arizona's to include a section on envenomation. Here the authors offer a paragraph invoking common sense as the main operative for avoiding snake and Gila Monster bites, but provide "To Do" and "NOT To Do" first aid lists should such an incident occur. In their account on the Mohave Rattlesnake (*Crotalus scutulatus*), Brennan and Holycross underscore this snake's distinction in producing primarily neurotoxic venom and warn that populations inhabiting southeastern Arizona carry exceptionally potent neurotoxins. They also include a section on the Sonoran Desert Toad (formerly, the Colorado River Toad) as a potential threat to overly curious pets, given this toad's size and toxicity. Oddly, they do not mention Sonoran Desert Toads in the context of "toad licking" or the hallucinatory state its toxins can reputedly produce.

In keeping with the tenor of a field guide, the book includes a short though insightful section on viewing tips, a glossary, and checklist of scientific names, in which each name is followed by a short space for jotting down dates, locality data, etc. In summary, Brennan and Holycross have succeeded admirably in assembling a field guide that is delightfully accessible, one allowing readers —from the weekend naturalist to professional herpetologist—to identify Arizona's amphibians and reptiles quickly, easily, and reliably. No herpetologist should venture field-side in Arizona without one. In fact, take two—they're small!

PUBLICATIONS RECEIVED

Skin Diseases of Exotic Pets, edited by Sue Paterson. 2006. Blackwell Publishing, Ames, Iowa (www.blackwellpublishing.com). x + 333 pp. Softcover. US $74.990. ISBN 0-632-05969-9.

This book is intended for a veterinary audience and provides basic information on the diagnosis and treatment of skin diseases in a variety of vertebrates. Amphibians are not considered, but 65 pages are devoted to reptiles. An introductory chapter includes an overview of the basic structure and function of reptile skin, including normal histology and the process of ecdysis. General aspects of patient examination and diagnosis are presented, along with a basic reptile formulary. Separate chapters deal with skin diseases and treatments of snakes, lizards, and chelonians. Parasitic diseases, trauma, dysecdysis, neoplasias and both nutritionally- and endocrinologically-induced conditions are covered as are their clinical signs and recommended therapy. The book is illustrated by color photos throughout. Other sections of the text deal with fish, birds, and a variety of small mammalian pets, exclusive of dogs and cats.

Synopsis of Helminths Endoparasitic in Snakes of the United States and Canada, by Carl H. Ernst and Evelyn M. Ernst. 2006. Society for the Study of Amphibians and Reptiles (www.ssarherps.org). SSAR Herpetological Circular No. 34. 86 pp. Softbound. US $9.00. ISBN 0-916984-67-2.

Parasitic worms have been reported from 61% of the 131 North American snake species occurring north of Mexico. This small book provides both a synopsis of the helminths recorded from snakes and a list of worms organized by snake host species. The former list includes synonyms, habitats (the organs or regions of the host that harbor the worms), host species recorded, geographic distribution, and references. The later presents an alphabetical listing of worms by major taxonomic group (cestodes, trematodes, acanthocephalans, nematodes) and references. Many widespread snakes support a surprising diversity of parasites (e.g., approximately 50 species in *Nerodia sipedon*). A bibliography of nearly

450 entries comprehensively covers the scattered literature dealing with parasitic worms of North American snakes. Separate indices to the scientific names of worms and snakes conclude the work.

Ecology of the Acanthocephala, by C. R. Kennedy. 2006. Cambridge University Press, Cambridge, UK (www.cambridge.org). ix + 249 pp. Harcover. US $110.00. ISBN 0-521-85008-8.

This book is devoted to a relatively poorly-studied group of parasitic worms that are capable of damaging the intestines of their hosts. All 1000 or so acanthocephalans have intermediate arthropod hosts and definitive vertebrate hosts. They occur in terrestrial, freshwater and marine environments. Only 2% and 1.8% of known species have as their final hosts amphibians and reptiles, respectively. However, snakes, lizards, and frogs are commonly utilized as paratenic hosts (i.e., they eat the intermediate host and are in turn eaten by the definitive bird or mammal host, providing the parasite the opportunity to jump between trophic levels). This book is written from the perspective of the biology of the parasite, but the ecological relationships described are equally relevant to the host organisms, including amphibians and reptiles.

Emerging Threats to Tropical Forests, edited by William F. Laurence and Carlos A. Peres. 2006. University of Chicago Press, Chicago (www.press.uchicago.edu). xii + 563 pp. Softcover. US $40.00. ISBN 0-226-47022-9.

Emerging threats are dangers to biodiversity resulting from direct or indirect human action on the environment. Forty-nine contributors in 23 chapters discuss the impacts of several categories of these threats including climatic and atmospheric change, pathogens and invasive species, habitat loss and fragmentation, and fire. Solutions to these problems and means of mitigating threats are discussed in several chapters. Examples come from throughout the tropics, with an emphasis on the Neotropics and Central Africa. Although the focus of most contributions is on threats to forest biodiversity in a broad sense, some chapters focus on particular forest-dwelling taxa, such as primates. No chapters are devoted to the herpetofauna, but mention of tropical frogs and reptiles are scattered throughout the book and amphibian declines are a focus of the chapter on emerging infectious diseases. The broad regional or global nature of the environmental changes documented in this volume bear directly on the future of all tropical biota. The book is illustrated throughout with maps, graphs and black and white photos. A 79-page cumulative literature cited section provides an entry into the relevant environmental literature. This book will be particularly appreciated by ecologists and tropical biologists.

Amniote Paleobiology: Perspectives on the Evolution of Mammals, Birds, and Reptiles, edited by Matthew T. Carrano, Timothy J. Gaudin, Richard W. Blob, and John R. Wible. 2006. University of Chicago Press, Chicago, Illinois (www.press.uchicago.edu). vi + 547 pp. Softcover. US $40.00. ISBN 0-226-09478-2.

This volume honoring University of Chicago paleontologist James Allen Hopson comprises 15 contributed chapters by leading amniote paleontologists. These are arranged into four main subsections, as well as a biography and bibliography of Hopson. Three of these, "New Fossils and Phylogenies," "Large-scale Evolutionary Patterns," and "Ontogeny and Evolution" include chapters devoted to fossil reptiles. Among the taxa treated are dinosaurs (Theropod Dinosaurs from the Early Jurassic of Huizachal Canyon; The Origins of High Browsing and on Neck Length in Sauropodomorphs; Body-Size Evolution in the Dinosauria), plesiosaurs (Neoteny and the Plesiomorphic Condition of the Plesiosaur Basicranium), the early tetrapod *Whatcheeria deltae*, and a variety of mammals and mammal-like reptiles. Most of the contributions are data-rich and well illustrated by black and white photographs and line drawings. This volume will be of interest to those interested in functional and evolutionary morphology and in amniote phylogenetics, as well as to vertebrate paleontologists in general.

ERRATUM

In the article "The influence of body size and trophic morphology on the size of molluscan prey of female Texas map turtles (*Graptemys versa*)" by Collins and Lindeman (Herpetol. Rev. 37:416–418), the incorrect data were depicted in Fig. 3. The corrected Fig. 3 is shown here. A pdf reprint of the article, with the correct version of Fig. 3, is available from Lindeman (e-mail: plindeman@edinboro.edu).

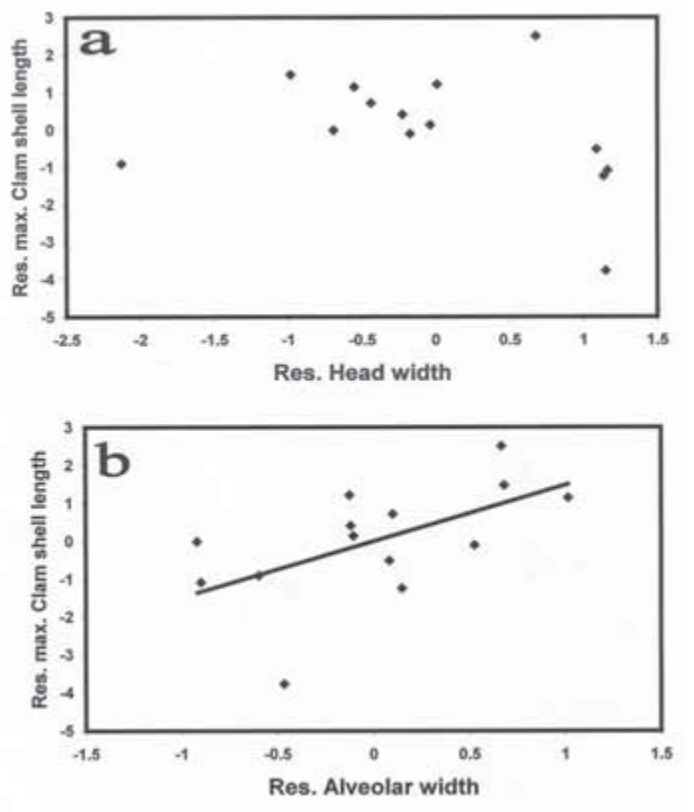


FIG. 3. Results of residual analyses testing (a) whether maximum shell length was related to head width (HW) after correction for both variables' log-log correlation with plastron length (r = 0.335, P = 0.24) and (b) whether maximum shell length was related to alveolar width (AW) after correction for both variables' log-log correlation with plastron length (r = 0.575, P = 0.032).

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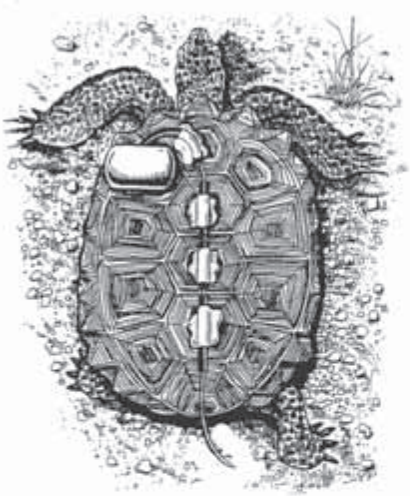
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